Application & Installation Guide

Cat® EMCP 4.3 and 4.4 Generator Set Control

LEBE0007-08

Table of Contents

Foreword 14
1.0 General Information 15
1.1 Introduction 15
1.2 Applications 15
1.3 References 15
2.0 Safety Information 16
2.1 Electrical Safety 16
2.2 Electrostatic Discharge Awareness 16
3.0 Installation 17
3.1 Mounting Location 17
3.2 Operating Temperature Range 17
3.3 Power Requirements 17
3.4 Battery Charger 18
3.5 Electrical Connections 19
3.6 EUI Engines 19
3.7 EMCP 4.3 and 4.4 Electrical Diagrams 20
3.8 Winding Connections 23
3.9 Transformer Connections 25
3.10 Wiring Requirements 27
3.11 Shielded and Communication Wiring 28
4.0 Initial Operation and User Orientation 29
4.1 Types of Events 29
4.2 Using the Cat® Service Tool 29
4.3 Viewing System Parameters 32
4.3.1 Supported Parameters 32
4.3.2 Engine Overview 32
4.3.3 AC Overview 38
4.3.4 Generator Set Overview 40
4.3.5 Bus Overview (EMCP 4.4 only) 40
4.4 Viewing and Adjusting Preferences 41
4.4.1 Setting the Preferences Using the EMCP 4 Display 41
4.4.2 Changing the EMCP 4 Contrast When the Display is Unreadable 43
4.4.3 Changing the EMCP 4 Display to Technician English 43
4.4.4 Changing the EMCP 4 Display to the Primary Language 44
4.4.5 Setting the Preferences Using the Service Tool 44
4.5 Configuring Time/Date 45
4.5.1 Changing the Time/Date 45
4.5.2 Changing Date Format 48

4.6 Adjusting Generator Set Parameters 49
4.6.1 Generator Output Voltage 49
4.6.2 Engine Speed 49
4.6.3 Idle/Rated 51
4.6.4 Engine Sensor Versus Data Link 52
4.6.5 Engine Oil Pressure 55
4.6.6 Engine Coolant Temperature 59
4.7 Starting and Stopping the Generator Set 62
4.7.1 Starting the Engine 62
4.7.2 EMCP 4 Remote Start 63
4.7.3 Stopping the Engine 64
4.7.4 Emergency Stop 66
4.8 Engine Setpoint Verification 68
4.8.1 Procedure for Overspeed Verification 68
4.8.2 Procedure for Low Oil Pressure Verification 69
4.8.3 Procedure for High Coolant Temperature Verification 69
4.9 Engine Operating Hours 70
4.9.1 Updating Engine Operating Hours 70
5.0 Handling Events 72
5.1 Configuring Event Responses 73
5.2 Changing an Event Response Configuration 74
5.3 Resetting Individual Active Events for the EMCP 4 77
5.4 Resetting All Active Events for a Single Module 78
5.5 Resetting All Active Events for All Modules 80
5.6 Resetting Events through Digital Input 80
5.7 Resetting Events for Engine ECMs Without Primary CAN Data Link Support 81
5.8 Troubleshooting Resetting Events 81
5.8.1 Not in Auto Warning 81
5.8.2 Service Maintenance Interval 82
5.9 Using Status Events 86
6.0 Security 91
6.1 Configurable Security Levels by Group 94
6.1.1 Customer Password Security Level for Analog Input #1 95
6.1.2 Customer Password Security Level for Analog Input #2 96
6.1.3 Customer Password Security Level for Analog Input #3 97
6.1.4 Customer Password Security Level for Analog Input #4 98
6.1.5 Customer Password Security Level for Automatic Start/Stop 99
6.1.6 Customer Password Security Level for Fuel Transfer Feature 100
6.1.7 Customer Password Security Level for Generator Rated Voltages 100
6.1.8 Customer Password Security Level for Integrated Voltage Regulator 101
6.1.9 Customer Password Security Level for Programmable Cycle Timer Feature 102

6.1.10 Customer Password Security Level for Digital Inputs 102
6.1.11 Customer Password Security Level for Digital Outputs 103
6.1.12 Customer Password Security Level for Generator Protection Monitoring 103
6.1.13 Customer Password Security Level for Engine Protection Monitoring 112
6.1.14 Customer Password Security Level for Load Shed Feature 117
6.1.15 Customer Password Security Level for Analog Outputs 118
7.0 kWh and kVArh Meters 120
7.1 Lifetime Totals 120
7.1.1 Updating Values 120
7.2 Trip Totals 122
7.2.1 Updating Values 122
7.2.2 Resetting Values 123
7.2.3 Updating and Resetting Trip Values from Cat Service Tool 123
8.0 kW Load Histogram 125
8.1 Viewing the Histogram 125
8.2 Clearing the Histogram 125
8.3 Cat ET Interface 126
8.4 Clearing the Load Histogram Data 127
9.0 Setpoints 129
9.1 Configuring Setpoints 129
9.2 Setpoint Sub-menus 131
9.3 Setpoints on the Cat Service Tool 131
9.3.1 Setpoint Categories 132
10.0 Digital Inputs 135
10.1 Programming Digital Inputs Using the Display 137
10.1.1 Viewing the Current Digital Input Status 137
10.1.2 Configuring Digital Inputs for Status Parameters 139
10.1.3 Digital Input Status Descriptions 142
10.1.4 Configuring Digital Inputs for System Events 145
10.1.5 Configuring Digital Inputs for SCADA Data link 149
10.1.6 Disabling Digital Inputs 151
10.1.7 Programming Digital Inputs Using the Cat Service Tool 153
10.1.8 Configuring Digital Inputs for Status Parameter 154
10.1.9 Configuring Digital Inputs for System Events 155
10.1.10 Configuring Digital Inputs for SCADA Data link 159
10.1.11 Disabling Digital Inputs 159
11.0 Analog Inputs 160
11.1 Programming Analog Inputs Using the Display 162
11.1.1 Viewing the Current Analog Input Status 162

11.1.2 Configuring Analog Inputs for Resistive Mode....163
11.1.3 Configuring Analog Inputs for PWM Mode....166
11.1.4 Configuring Analog Inputs for Current Mode....170
11.1.5 Configuring Analog Inputs for Voltage Mode....174
11.1.6 Disabling Analog Inputs....178
11.2 Programming Analog Inputs Using the Cat Service Tool....180
11.2.1 Configuring Analog Inputs for Resistive Mode....181
11.2.2 Configuring Analog Inputs for PWM Mode....184
11.2.3 Configuring Analog Inputs for Current Mode....187
11.2.4 Configuring Analog Inputs for Voltage Mode....190
11.2.5 Disabling Analog Inputs....193
11.3 Analog Input Maps....193
11.4 Custom Analog input Maps....199
11.4.1 Custom Map Configuration via Display....199
11.4.2 Configurable Maps through ET....202
11.5 Analog Input Current and Voltage Ranges....202
11.5.1 Warnings and Shutdowns....203
11.5.2 Unsupported Analog Input Sensor Ranges....203
11.5.3 Sensor Range is Smaller than Setpoint Options....203
11.5.4 Sensor Range is Larger than Setpoint Options, but Usable Range is Not....204
11.5.5 Sensor Range is Larger than Setpoint Options, and Usable Range is Larger than Setpoint Options....204
12.0 Digital Outputs....205
12.1 Programming Digital Outputs Using the Display....205
12.1.1 Viewing the Current Digital Output Status....206
12.1.2 Configuring Digital Outputs for Status Parameters....207
12.1.3 Digital/Relay Output Status Descriptions....210
12.1.4 Configuring Digital Outputs for System Events....214
12.1.5 Digital/Relay Output System Event Descriptions....218
12.1.6 Configuring Digital Outputs for SCADA Data Link....220
12.1.7 Disabling Digital Outputs....222
12.2 Programming Digital Outputs Using the Cat Service Tool....223
12.2.1 Configuring Digital Outputs for Status Parameters....224
12.2.2 Configuring Digital Outputs for System Events....225
12.2.3 Configuring Digital Outputs for SCADA Data Link....226
12.2.4 Disabling Digital Outputs....227
13.0 Analog Outputs....228
13.1 Programming Analog Outputs Using the Display....228
13.1.1 Viewing the Current Analog Output Status....228
13.1.2 Configuring Analog Outputs for Voltage Mode....230
13.1.3 Configuring Analog Outputs for Current Mode....233

13.2 Programming Analog Outputs Using the Cat Service Tool....236
13.2.1 Configuring Analog Outputs for Voltage Mode....237
13.2.2 Configuring Analog Outputs for Current Mode....239
14.0 PWM Outputs....241
14.1 Programming PWM Outputs Using the Display....241
14.1.1 Viewing the Current PWM Output Status....241
14.1.2 Configuring PWM Outputs....242
14.2 Programming PWM Outputs Using the Cat Service Tool....246
15.0 Hardwired Paralleling (EMCP 4.4 Only)....249
15.1 Hardwired Paralleling Functions....249
15.1.1 Dead Bus Arbitration....249
15.1.2 Synchronizing....249
15.1.3 Load Sharing....249
15.1.4 Load Shed....249
15.1.5 Load Sense/Load Demand....249
15.2 Paralleling (Synchronizing) Modes of Operation....249
15.2.1 Automatic Paralleling (Auto Synchronizing)....249
15.2.2 Manual Paralleling (Manual Synchronizing)....249
15.2.3 Sync Check Mode....250
15.3 Hardwired Dead Bus Arbitration....250
15.3.1 Purpose....250
15.3.2 Wiring....250
15.3.3 Basic Operation....251
15.3.4 Enabling Dead Bus Arbitration....252
15.3.5 Viewing Parameters....254
15.3.6 Controlling Parameters....254
15.3.7 Configuring Parameters....255
15.3.8 Dead Bus Arbitration Events....255
15.4 Hardwired Load Sense Load Demand Details....255
15.4.1 Purpose....255
15.4.2 Wiring....255
15.4.3 Basic Operation....256
15.4.4 Enabling Load Sense Load Demand....259
15.4.5 Viewing Parameters....260
15.4.6 Controlling Parameters....261
15.4.7 Configuring Parameters....261

15.5 Synchronizing Details....262
15.5.1 Sync Mode Switch....262
15.5.2 Automatic Synchronizing....263
15.5.3 Manual Synchronizing....263
15.5.4 Check Synchronizing....264

15.5.5 Generator Sensing Fault (SPN3545-2) 264
15.5.6 Viewing Parameters 264
15.5.7 Controlling Parameters 265
15.5.8 Configuring Parameters 268
15.5.9 Synchronization Gain Tuning Procedure 270
15.6 Real and Reactive Load Sharing in Island Mode Details 273
15.6.1 Purpose 273
15.6.2 Wiring 273
15.6.3 Basic Operation 273
15.6.4 Sharing Lines (kW and kVAr) 274
15.6.5 Enabling Load Sharing 274
15.6.6 Viewing Parameters 276
15.6.7 Controlling Parameters 277
15.6.8 Configuring Parameters 279
15.6.9 Load Sharing Gain Tuning 281
15.7 Load Shed 282
15.7.1 Purpose 282
15.7.2 Basic Operation 282
15.7.3 Configuring Parameters 283
15.8 Breaker Selection 283
16.0 Modifiable Text Strings 284
16.1 Language Support 284
16.2 Programming Modifiable Text Strings Using the Cat Service Tool 285
17.0 Saving and Restoring Setpoints 290
17.1 Saving EMCP 4 Configuration Data 290
17.1.1 Fleet Configuration Option 291
17.1.2 ECM Replacement Option 291
17.2 Loading EMCP 4 Configuration Data 292
18.0 Programmable Cycle Timer 295
18.1 Configuring the Programmable Cycle Timer Using the Display 297
18.2 Configuring the Programmable Cycle Timer Using the Cat Service Tool 300
19.0 Reduced Power Mode 302
19.1 Actions to Enable Rpm 302
20.0 Electric Cooling Fan Control 304
20.1 Configuration of the Electric Cooling Fan Control 304
20.2 Cooling Fan Functionality Example 305

21.0 Bund Level 307
22.0 Generator Set Control Software Type 308
23.0 Overview Screen 309
24.0 Transfer Switch 311
24.1 Transfer Switch in Auto Mode 311

24.2 Transfer Switch Manual Mode 312
24.2.1 Transfer Switch Digital Inputs 312
24.2.2 Transfer Switch Display Interface 312
24.2.3 Transfer Switch Modbus Interface 316
24.3 Transfer Switch Setpoints 317
24.4 Transfer Switch Events 319
24.5 Reduced Power Mode with Transfer Switch 320
24.5.1 Not in Reduced Power Mode Relay Wiring Option 320
24.5.2 Loss of Utility/Transfer to Generator Remote Initiate Wiring Option 321
24.6 Transfer Switch Wiring for EMCP 4.4 Paralleling 321
25.0 Programmable kW Relay Function 322
25.1 Configuring the Programmable kW Relay from the Display 323
25.2 Configuring the Programmable kW Relays Using the Cat Service Tool 326
26.0 Overcurrent 328
27.0 Engine Cylinder Temperature Differential Monitor 331
28.0 Dynamic Gas Blending™ (DGB™) 334
29.0 Integrated PLC Feature Set 335
29.1 Logical Operation Blocks 335
29.2 Function Blocks 340
29.2.1 Special Function Blocks 341
29.3 Debug Window Blocks 347
29.4 PLC Config Creation and Programming 348
29.4.1 Creating a PVC File 348
29.4.2 Using RS-485 348
29.4.3 Using TCP/IP 352
29.4.4 Creation and Editing of Configs 355
29.4.5 Downloading PLC Configuration to the EMCP 357
29.4.6 Troubleshooting the PLC Function 358
30.0 CAN Data Links 359
30.1 Primary CAN Data Link (CAN 1) 359
30.1.1 Primary CAN Wiring 359
30.1.2 Network Topology 359
30.2 Accessory CAN Data Link (CAN 2) 360
30.2.1 Accessory CAN Wiring 361
30.2.2 Network Topology 361

31.0 Optional Modules 363
31.1 CAN Annunciator 364
31.1.1 Annunciator Features 364
31.1.2 Annunciator Specifications 365
31.1.3 Annunciator Wiring 365
31.1.4 LED Colors 366
31.1.5 CAN Annunciator Software Configuration 367
31.1.6 Global Acknowledge 367
31.1.7 ECU Instance Number 367
31.1.8 Configuring Annunciator LED Behavior 368
31.1.9 Trigger Condition 371
31.1.10 Severity Level 371
31.1.11 Suspect Parameter Number 372
31.2 RS-485 Annunciator 372
31.2.1 Annunciator Features 373
31.2.2 Annunciator Specifications 373
31.2.3 RS-485 Annunciator Wiring 374
31.2.4 LED Colors 375
31.2.5 Lamp Test Function 376
31.2.6 Alarm Acknowledge 376
31.2.7 RS-485 Annunciator Alarm Groups 376
31.2.8 Alarm Group Selection Mode (AGSM) 377
31.2.9 Entering AGSM 377
31.2.10 Re-configuring/Selecting Alarm Group Address 378
31.2.11 Exiting AGSM 378
31.2.12 RS-485 Annunciator Custom Alarm Group Configuration 378
31.2.13 Severity Level 379
31.2.14 Suspect Parameter Number 380
31.2.15 Alarm Groups 381
31.2.16 Configuring Custom Alarm Groups Using Cat Service Tool 385
31.3 Thermocouple Module 392
31.3.1 Thermocouple Features 392
31.3.2 Thermocouple Specifications 392
31.3.3 Thermocouple Wiring 393
31.3.4 Thermocouple Physical Layout 394
31.3.5 Thermocouple Module – Configuration 394
31.3.6 Configuring Thermocouple Inputs 396
31.4 RTD Module 397
31.4.1 RTD Features 397
31.4.2 RTD Specifications 398
31.4.3 RTD Wiring 399

31.4.4 RTD Physical Layout 400
31.4.5 RTD Module – Configuration 400
31.4.6 Configuring RTD Inputs 401
31.5 Discrete I/O Module 402
31.5.1 Discrete I/O Features 402
31.5.2 Discrete I/O Specifications 403
31.5.3 Discrete I/O Wiring 404
31.5.4 Discrete I/O Physical Layout 405
31.5.5 Discrete I/O – Configuration 405
31.5.6 Configuring Digital Inputs 407
31.5.7 Configuring Relay Outputs 408
32.0 SCADA (Modbus) RS-485 Data Link 409
32.1 Wiring 409
32.2 Line Termination 410
32.3 Software Configuration 411
32.3.1 Configuring the SCADA Data Link Using the Display 411
32.3.2 Configuring the SCADA Data Link Using the Cat Service Tool 413
33.0 SCADA (Modbus) TCP/IP Data Link 416
34.0 Cat Data Link (CDL) 418
34.1 Cat Data Link Wiring 418
34.2 Cat Data Link Configuration 418
35.0 Integrated Voltage Regulator (IVR) 421
35.1 IVR Features 421
35.2 IVR Hardware Installation 422
35.2.1 EMCP IVR Connections 422
35.2.2 IVR Excitation Module 422
35.2.3 IVR Excitation Module Physical Layout 423
35.2.4 IVR Excitation Module Connections 424
35.2.5 IVR Excitation Module Over-excitation Protection 424
35.2.6 IVR Excitation Module Fusing 425
35.3 IVR Software Configuration 426
35.3.1 Voltage Regulator Control Source Configuration 427
35.3.2 Starting Profile 427
35.3.3 IVR PID Gain Setpoints 430
35.3.4 Under-frequency Roll-off (Loading) Profile 430
35.3.5 Voltage Regulator Load Compensation Type Configuration 431
35.3.6 Line Loss (IR) Compensation 431
35.3.7 Reactive Droop Compensation 432
35.3.8 Voltage Regulator Lockout Configuration 434
35.3.9 Loss of Sensing Shutdown Event 434
35.3.10 Over Excitation Shutdown Event 435

35.4 IVR Voltage Adjustment 435
35.4.1 Digital Inputs 436
35.4.2 Voltage/Hz Control (EMCP Display) 436
35.4.3 SCADA Modbus 436
35.4.4 Analog Inputs 437
35.5 IVR Display Screens 437
36.0 Transient Load Relief (TLR) 440
36.1 TLR Operation 440
36.2 TLR Setpoint Configuration 443
36.3 TLR Tuning Process 447
37.0 Multiple Genset Data Link (MGDL) 453
37.1 Introduction 453
37.2 MGDL Hardware Installation 454
37.2.1 EMCP 4.4 MGDL Connections 454
37.2.2 MGDL Network Topologies 455
37.2.3 Ethernet Switch/Hub/Repeater Considerations 456
37.2.4 MGDL and TCP/IP SCADA Monitoring 457
37.3 MGDL Software Configuration 458
37.3.1 MGDL System Configuration 458
37.3.2 Multiple Genset Control Data Link Unit Number 459
37.3.3 Minimum Power Required for Feeder Breaker 460
37.3.4 MGDL Dead Bus Arbitration Configuration 460
37.3.5 Breaker Close to Dead Bus Input Configuration 461
37.3.6 Breaker Close to Dead Bus Maximum Time 461
37.3.7 Dead Bus Voltage Percentage Threshold 461
37.3.8 MGDL Load Sharing Configuration 462
37.3.9 Generator Real Load Sharing Soft Loading/Unloading 464
37.3.10 MGDL Load Sense Load Demand Configuration 467
37.3.11 MGDL Event Response Configurations 472
37.4 MGDL Paralleling Features Operation 474
37.4.1 MGDL Dead Bus Arbitration Operation 475
37.4.2 Failsafe Dead Bus Arbitration Operation 478
37.4.3 MGDL Load Sharing Operation 479
37.4.4 MGDL Group Start Command Operation 481
37.4.5 MGDL Load Sense Load Demand Operation 482
37.4.6 MGDL Feeder Breaker Control 491
37.4.7 MGDL Loss of Communications Strategy 492
37.4.8 MGDL Network Configuration Reset (Expected Units) 495
37.4.9 MGDL Load Sharing Failsafe Operation 496

37.5 MGDL Paralleling Tuning Guide 500
37.5.1 Background 500
37.5.2 Strategy 502
37.5.3 Guidelines 502
37.6 MGDL Display Screens 504
37.6.1 MGDL System Overview Screens 504
37.6.2 MGDL Control Screen 508
37.6.3 MGDL Synchronizing Screens 510
37.6.4 MGDL Load Sharing Screens 512
37.6.5 MGDL Dead Bus Arbitration Screens 515
37.6.6 MGDL Load Sense Load Demand Screens 517
37.6.7 MGDL Network Status Screens 521
37.6.8 MGDL Status Event Log Screens 522
37.6.9 MGDL Genset Event Log Screen 523
37.7 MGDL Troubleshooting 524
37.7.1 MGDL Configuration Error Event (SPN-FMI: 625-14) 524
37.7.2 MGDL Control is Offline Event (SPN-FMI: 625-31) 526
37.7.3 MGDL Communications Failure Event (SPN-FMI: 625-19) 528
37.7.4 Software Version (Protocol) Mismatch Event (SPN-FMI: 234-31) 528
37.7.5 Ethernet Port Abnormal Update Rate (SPN-FMI: 625-9) 529
37.7.6 Dead Bus Arbitration Failure Events (SPN-FMI: 2530-17 & 2530-1) 529
37.7.7 Dead Bus Inconsistent Sensing Event (SPN-FMI: 2530-2) 530
38.0 Installing and Upgrading Software 531
39.0 Appendix A – Menu Structures 535
40.0 Appendix B – EMCP 4 Front View and Navigation Keys 537
41.0 Appendix C – IVR Excitation Module Connection Diagrams 540
42.0 Glossary of Terms 548

Foreword

This Application and Installation Guide describes the EMCP 4.3 and 4.4 Series electric power generator set controls.

Some data used in this guide is generalized and is provided only for the purpose of comparison or illustration. Also, PC application screenshots and EMCP 4 screen images may be actual screens or simulated and are shown for illustrative purposes only. These images may not be identical to those seen by the user. Screen images of the EMCP 4 may differ from the actual screens depending on flash file language, flash file version, setpoint configuration, engine interface, or series of the EMCP (4.3 versus 4.4).

In various places throughout this document, reference is made to the release date of the EMCP 4 software. This information can be found by connecting to the subject module using the Cat Service Tool, and viewing the ECM Summary (this is the default startup screen). The release date is found in the field entitled Software Group Release Date.

See Figure 1, showing the release date for an EMCP 4.3 flash file.

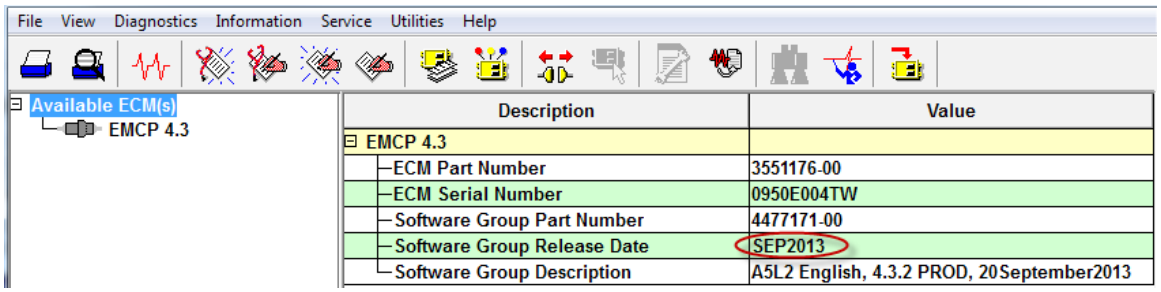


Figure 1 – EMCP Software Release Date

Other product specific information and data is available from a variety of sources. For more information, contact the Cat Dealer or dealer TC nearest you.

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Note: Proper application of EMCP 4.4 paralleling controllers is critical; along with the technical requirements outlined elsewhere in this guide, please consider the following commercial requirements for applications within the U.S. and Canada (or other markets that require equipment compliant with ANSI/NEMA standards):

1. Generally, the EMCP 4.4 is expected to be used in applications whose aggregate current for paralleled units is 5000A or less; for applicatons whose aggregate current falls between 6000A and 10,000A review/approval of the application by Caterpillar A&I Engineering is required prior to installation.

   While applications exceeding 10,000A aggregate current are not commonly recommended, dealers desiring consideration/support for such opportunities may contact the ASC to seek an assessment, and if acceptable a written approval from the Systems Product Team prior to offering such a system for sale.

2. EMCP 4.4 paralleling may be applied only on low voltage generator sets (less than 1000V).

3. EMCP 4.4 generator set paralleling controls may interface only with package-mounted generator source breakers.

Please Note: EMCP 4.4 paralleling can be sold/applied without any commercial limitation in markets which require IEC compliant equipment (except for use within the U.S. or Canada).

1.0 General Information

1.1 Introduction

Caterpillar has developed a product line of Generator Set Controls for use in the Electronic Modular Control Panel 4 (EMCP 4). They are available in four versions based on Generator Set Control feature sets.

The EMCP 4 Generator Set Control, or GSC, is the primary controller within the Generator Set Control system. The EMCP 4 line of Generator Set Controllers includes EMCP 4.1, 4.2, 4.3, and 4.4. Appendix B shows a front view of the EMCP 4.3 and 4.4.

This Application and Installation Guide is intended to cover the EMCP 4.3 and 4.4 Generator Set Control and its application in generator set systems. It also includes information on optional add-on modules. The intended audience for this guide includes Cat generator set system designers, Caterpillar service support personnel, Cat Dealers and Service Technicians, contractors, and customers.

1.2 Applications

The EMCP 4 product line of generator set controllers is designed for use in a wide range of applications. They can be used on standby and prime Cat brand power generator sets. The configurability of the controllers allows them to be used, in some cases, on other applications such as Marine auxiliary generators, switchgear applications, and industrial engines and generator sets.

Most of the information in this document applies to all applications. However, the document was written with Cat brand generator sets in mind. Please contact your Caterpillar support representative for questions regarding different applications.

Note: Proper application of EMCP 4.4 paralleling controllers is critical; along with the technical requirements outlined elsewhere in this guide, please consider the following commercial requirements applicable to ANSI certified areas of the world:

1. The EMCP 4.4 is primarily intended for applications whose aggregate current of paralleled units is 6000A or less.

2. Applications, whose aggregate current for paralleled units is between 6000A and 10,000A are acceptable; however, review/approval of the application by Caterpillar A&I Engineering, via the ASC, is required prior to installation. Application whose aggregate current for paralleled units exceeds 10,000A are not generally recommended; dealers wishing consideration/support for such opportunities must contact the ASC to secure written approval from the Systems Product Team prior to sale. Cat floor-standing paralleling switchgear better suits large-scale, complex applications such as these.

3. EMCP 4.4 paralleling is commercially intended for low voltage generator set applications only (less than 1000V); Cat floor-standing control or switchgear should be utilized for medium and high voltage applications in these ANSI certified areas.

1.3 References

The System Operation Testing, Troubleshooting, and Adjusting manual (UENR 1210) is also available for EMCP 4.3 and 4.4 Generator Sets. The generator set Operations and Maintenance manual contains details for specific products.

2.0 Safety Information

2.1 Electrical Safety



DO NOT operate or work on a generator set unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Cat dealer for replacement manuals. Proper care is your responsibility.

⚠ WARNING

2.2 Electrostatic Discharge Awareness

EMCP 4 control contains components that are sensitive to ELECTROSTATIC DISCHARGE (ESD). An electrostatic charge can damage the control resulting in EMCP 4 breakdown or improper operation.

Take the following precautions while installing/removing/handling the control:

- Handle equipment correctly. Use ESD protective packaging and material handling containers that are anti-static and provide discharge protection and electric field suppression.
- Use protective devices: ESD-protective workstations and/or work surfaces (grounding mat, anti-static wrist strap, etc.).
- Keep all plastic items away from the devices. Any plastic item is a potential static generator. This includes candy wrappers, foam cups, synthetic carpet, foam cushions, etc.
- The anti-static bag cannot function as a static dissipating mat.
- DO NOT use an anti-static bag for any other purpose than to enclose a product.

Caution: The 120-pin connector (and additional 70-pin connector for EMCP 4.4) on the back of the control is the most vulnerable area to ELECTROSTATIC DISCHARGE (ESD). While handling the EMCP 4, extra attention is required to the back of the control. The control may become damaged or inoperable if extra care is not taken.

Note: Locking out the generator set does not remove voltage on the EMCP 4.4 at the bus voltage sensing leads. Consult the Electrostatic Discharge Association for proper procedure during particular situations: http://www.esda.org.

3.0 Installation

3.1 Mounting Location

When selecting a mounting location for the EMCP 4, consider the following:

- Protection from high-voltage and high-current devices.
- Protection from devices which may produce electromagnetic interference.
- Protection from excessive vibration. The EMCP 4 controls are designed to withstand normal generator set vibrations. They should not be mounted directly to the engine block.
- Protection from direct exposure to water. Once installed with gasket, the EMCP 4 controllers are sealed to a level of IP Level 56 for resistance to moisture from the face.

Suitable for Flat Surface Mounting in a Type 1 Enclosure only.

3.2 Operating Temperature Range

EMCP 4 has a continuous operating temperature range of -20°C (-4°F) to +70°C (158°F) ambient. The EMCP 4 controller will continue to operate down to temperatures of -40°C (-40°F) but the display will become unusable.

3.3 Power Requirements

The EMCP 4.3 and 4.4 require a nominal voltage of 12VDC or 24VDC. A DC to DC converter may be needed for 12VDC applications. If batteries are used for operating power, a charging source such as an alternator or dual-mode battery charger is necessary to maintain a stable supply voltage. The maximum power consumption of the 4.3 and 4.4 with all I/O at maximum power drain will not exceed 10A at 24VDC.

Regional electrical codes must be followed. In the case of standby operation, follow the regional requirements for installing standby power systems. An example of this is the National Fire Protection Association (NFPA) guidelines for emergency power systems.

When connecting the EMCP 4 to the DC power source, make sure that there is only one common connection to the negative potential of the power source. Make extra effort to avoid any ground loops in the DC electrical system. A single point common ground for sensitive electronics is recommended at the negative battery terminal or Power Distribution Box.

Avoid daisy-chaining power supply connections from one device to another. This builds resistance from one Battery (-) point to the next, effectively building a potential difference between two different reference points. Each electronics subsystem and major engine subsystem should have its own DC network so that they do not interfere with each other (see Figure 3.1).

As shown in Figure 3.1, all sensitive electronics are electrically isolated from higher current loads, such as the starter motor. All electronics have a COMMON POWER BUS and SINGLE POINT REFERENCE. This point is the generator set customer ground connection. The CHASSIS GROUND should be bonded separately to the customer ground connection and not be used as the electronics reference.

The sensitive electronics, such as sensors and control modules, have isolated power source paths. High current loads such as starters and solenoids can cause interference and possibly damage to low current loads, such as controllers and sensors.

Caution: Extra effort must be made to keep the high current and low current loads electrically separated.

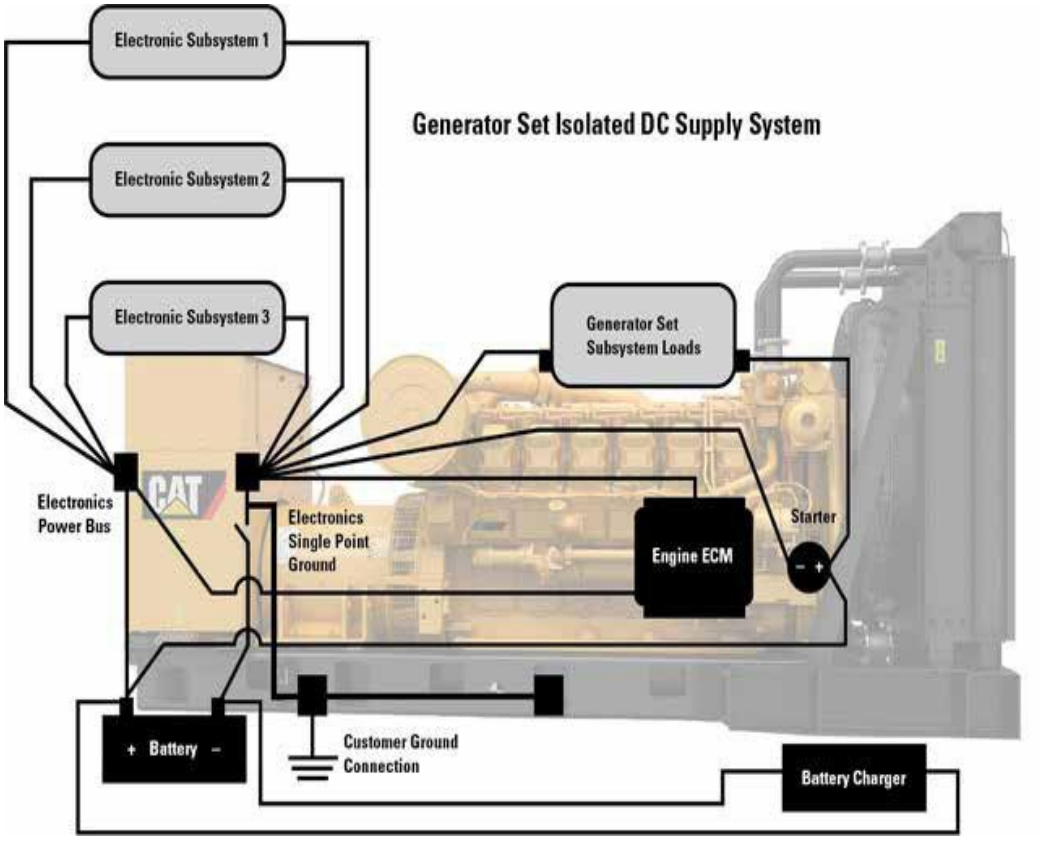


Figure 3.1 – Generator Set Network Isolation

The two types of loads may share common Battery (+) and Battery (–) connections but, they should not be electrically connected at any other point. This strategy ensures maximum isolation between high current and low current loads.

The battery DISCONNECT SWITCH is usually located on the negative side of the battery supply.

3.4 Battery Charger

If a battery charger is to be used, it should be connected on the battery side of the disconnect switch. Most battery chargers are not to be used as power supplies. Proper battery charger operation requires that the actual battery load be present.

If battery charger fault condition wiring is connected to the EMCP Digital Inputs and these Digital Inputs are set to DISABLED or are improperly configured, then any battery charger faults or events will not be broadcast or annunciated on the network. See Chapter 10.

3.5 Electrical Connections

The EMCP 4.3 has one 120-pin connector on the back of the control (not all of the 120 pins are used). The EMCP 4.4 has the same 120-pin connector on the back of the control as the EMCP 4.3 and an additional 70-pin connector (not all of the 70 pins are used). The 70-pin connector on the EMCP 4.4 is not keyed or configured the same as the 70-pin connector on the EMCP 4.1 and 4.2.

Figure 3.2 and Figure 3.3 show:

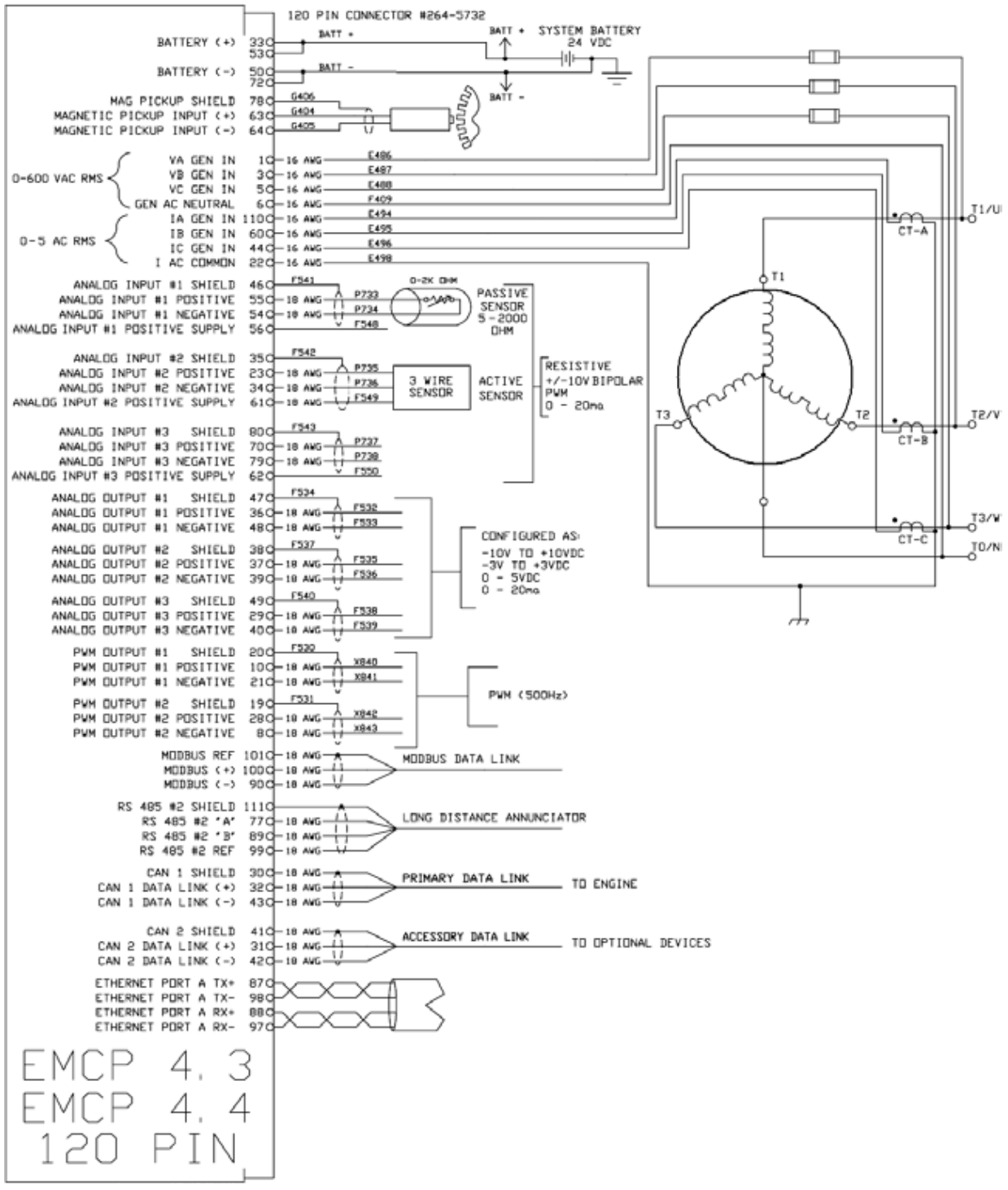
- All possible connections
- What pins are used for connections
- How each pin is connected for each control version

3.6 EUI Engines

For EUI engines, the Oil Pressure and Coolant Temperature sensors will typically be wired to the engine ECM and the EMCP 4 will get that information from the engine ECM via the Primary CAN Data Link. Ensure the EMCP 4 Oil Pressure and Coolant Temperature setpoints are configured for Data Link.

In order for the generator set to function properly in Cooldown mode, some setpoints in the EMCP 4 must be coordinated with some engine ECM setpoints. For generator sets where the engine ECM controls cooldown, the cooldown time should be set to 0 seconds in the EMCP. For generator sets where the engine ECM does not control cooldown, the cooldown time should be set to 0 seconds in the engine ECM if applicable.

3.7 EMCP 4.3 and 4.4 Electrical Diagrams



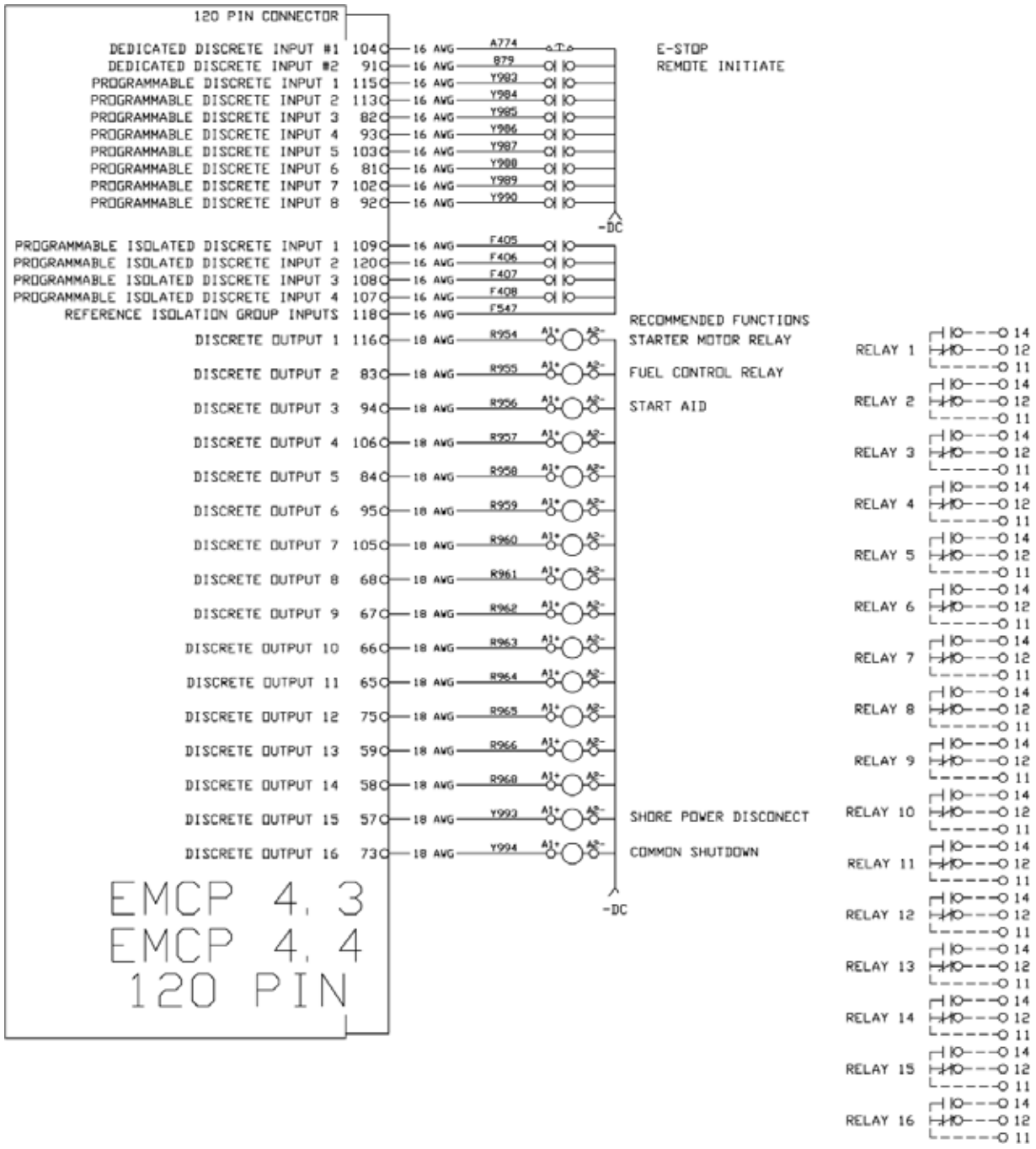


Figure 3.2 – EMCP 4.3 and EMCP 4.4 120-pin Connector Electrical Diagram

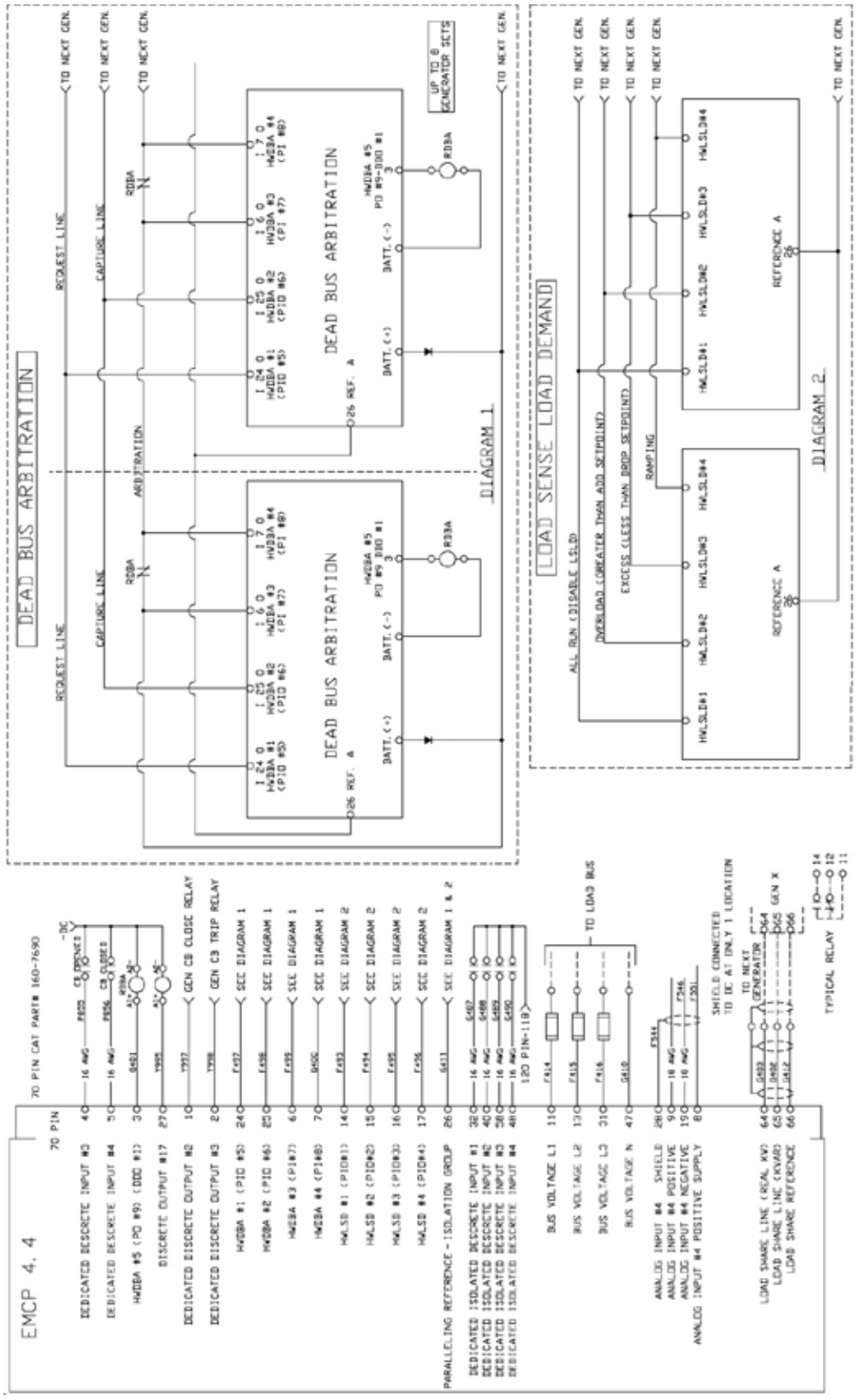


Figure 3.3 – EMCP 4.4 70-pin Connector and Paralleling I/O Electrical Diagram

3.8 Winding Connections

The connections between the generator and the EMCP 4 depend on the winding configuration as shown in the connection diagrams below .

Note: EMCP 4 .4 paralleling functional are only supported with 3 phase connections .

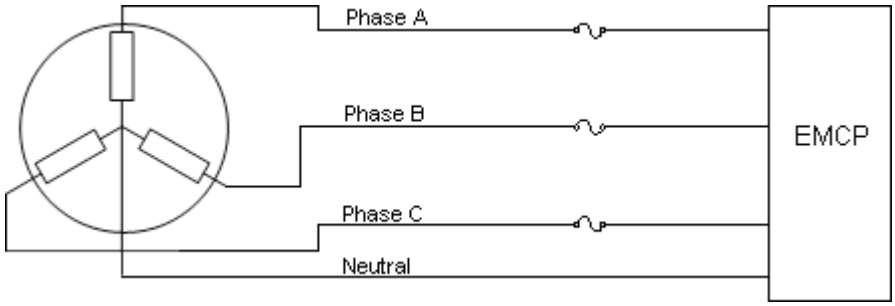


Figure 3.4 – Three Phase Four Wire (Series or Parallel) Wye (Star)

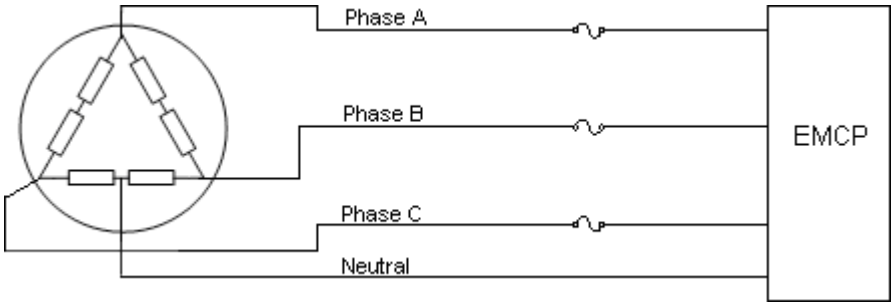


Figure 3.5 – Three Phase Four Wire Delta (L2-N-L3)

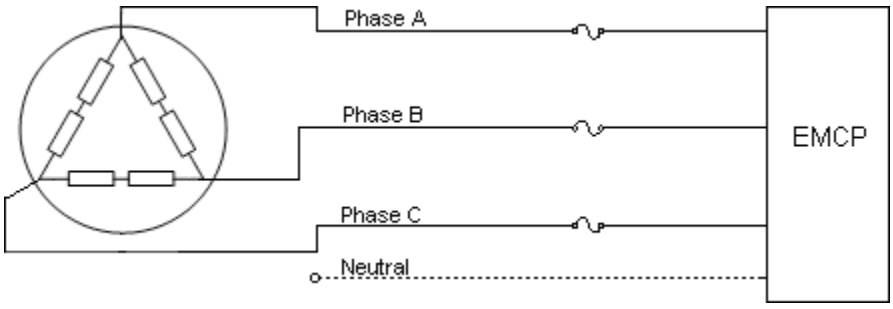


Figure 3.6 – Three Phase Three Wire Delta

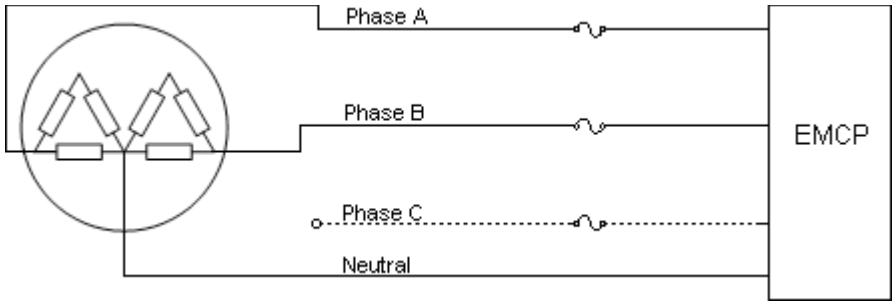


Figure 3.7 – Single Phase Three Wire, (L1-N-L2), Double Delta (Not supported with EMCP 4.4 paralleling)

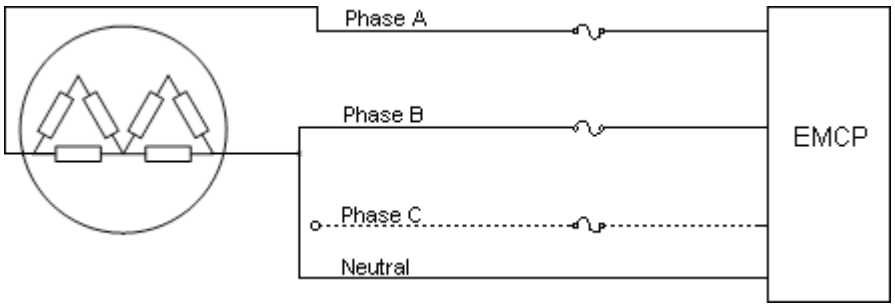


Figure 3.8 – Single Phase Two Wire, (L1-L2), Double Delta (Not supported with EMCP 4.4 paralleling)

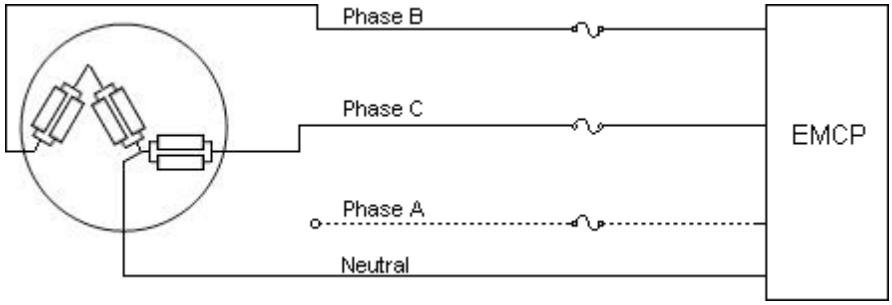


Figure 3.9 – Single Phase Three Wire (L2-N-L3), Zig-Zag (Not supported with EMCP 4.4 paralleling)

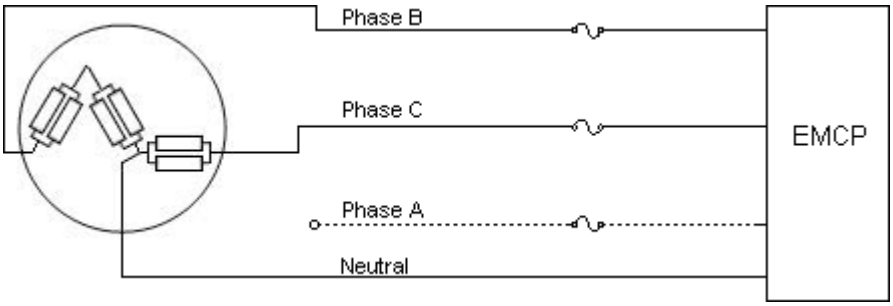


Figure 3.10 – Single Phase Two Wire (L2-L3), Zig-Zag (Not supported with EMCP 4.4 paralleling)

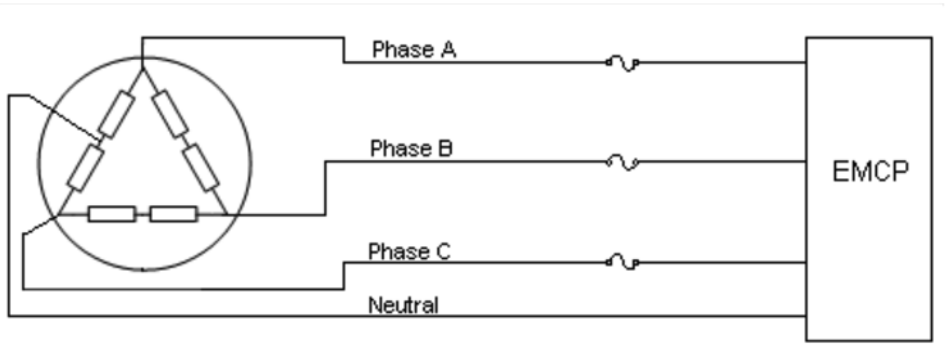


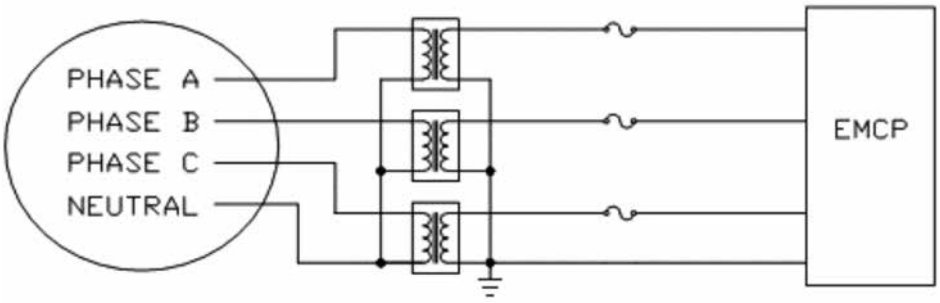
Figure 3.11 – Three Phase Four Wire Delta (L1-N-L3)

3.9 Transformer Connections

In order to monitor generator output voltages greater than 600 Volts nominal [grounded wye (star)], external potential transformers must be used.

Note: The EMCP 4 must be programmed for the correct winding ratios when connecting external potential transformers. See Chapter 7, Setpoints for more information on how to program the winding ratios. If delta potential transformers are used on a wye (star) generator, the EMCP must be programmed for a delta generator.

Caution: The WYE (STAR) configuration of external potential transformers is preferred for 4 wire WYE (STAR) generators because of the greater accuracy when loads are unbalanced. With the open delta configuration, some power parameters cannot be determined. These parameters are real power phase A, B, C and power factor phase A, B, C. For maximum accuracy, the open delta configuration of external potential transformers should be used only for 3-wire delta generators. See Table 3.1– Power Values Available by Generator Configuration.



(PT) on the 4-Wire Wye (Star) Connected Generator

Figure 3.12 – Wye (Star) Configuration of External Potential Transformers (PT) on the 4-Wire WYE Connected Generator

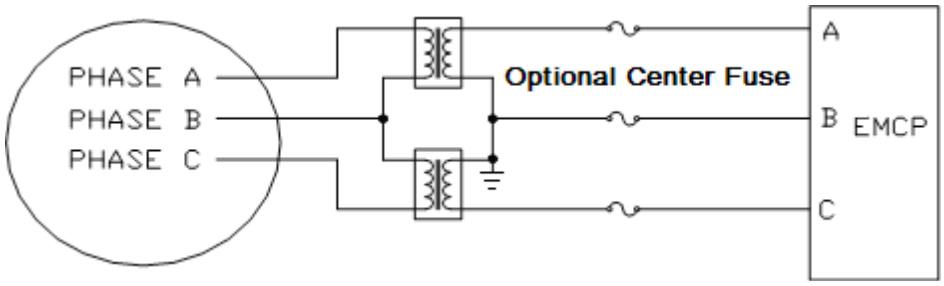


Figure 3.13 – Open Delta Configuration of External Potential Transformers (PT) on the 3-Wire Delta Connected Generator

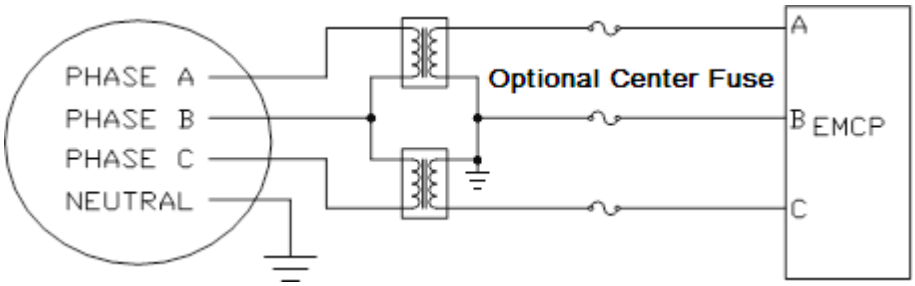


Figure 3.14 – Open Delta Configuration of External Potential Transformers (PT) on the 4-Wire WYE Connected Generator

Power Values Available by Generator Configuration							
Parameter	**WYE (STAR)**	**3-WIRE DELTA**	**4-WIRE DELTA**	**2-WIRE 1-PHASE (L1-L2)**	**2-WIRE 1-PHASE (L2-L3)**	**3-WIRE 1-PHASE (L1-N-L2)**	**3-WIRE 1-PHASE (L2-N-L3)**
Gen Freq	Available	Available	Available	Available	Available*	Available	Available*
$V_{L\text{-}L\ AVG}$	Available	Available	Available	Available	Available	Available	Available
$V_{A\text{-}B}$	Available	Available	Available	Available	Not Available	Available	Not Available
$V_{B\text{-}C}$	Available	Available	Available	Not Available	Available	Not Available	Available
$V_{C\text{-}A}$	Available	Available	Available	Not Available	Not Available	Not Available	Not Available
$V_{L\text{-}N\ AVG}$	Available	Not Available	Available	Not Available	Not Available	Available	Available
V_A	Available	Not Available	Available	Not Available	Not Available	Available	Not Available
V_B	Available	Not Available	Available	Not Available	Not Available	Available	Available
V_C	Available	Not Available	Available	Not Available	Not Available	Not Available	Available
I_{AVG}	Available	Available	Available	Available	Available	Available	Available
I_A	Available	Available	Available	Available	Not Available	Available	Not Available
I_B	Available	Available	Available	Available	Available	Available	Available
I_C	Available	Available	Available	Not Available	Available	Not Available	Available

Table 3.1 – Power Values Available by Generator Configuration

Note: Accuracy of the potential and current transformers will affect the accuracy of the voltage and current readings. *L1 must be connected to Neutral or L3 to measure Generator Frequency on L2-L3 connections.

3.10 Wiring Requirements

When selecting the type of wire to use, consideration must be given to the wire voltage drop (line loss), accuracy, communication error, and other requirements. See Table 3.2.

Component	Wire Size (AWG)	Type of Wire	Connections [1]
Three-Wire Sensors (When applicable. Not used on all systems)	16	Shielded twisted triad cable is recommended. For conduits inside facilities, use Belden 8618. For the engine harness, use the 4G-2556 Shielded Cable. The cable must be resistant to fuel and oil. The cable must have a temperature range from -40ºC (-40ºF) to plus 125ºC (257ºF).	Deutsch DT type of connectors are recommended. If Spring Spade or Ring Terminals are used, the connection between the terminals and the wire should be crimped and soldered.
Two-Wire Components (Magnetic Speed Sensors)	16 or 18	Shielded twisted pair cable is recommended. For conduits inside facilities, use the 123-2376 Electrical Cable or the 3E-4594 Electrical Cable. For the engine harness, use the 6V-2744 Wire. The cable must be resistant to fuel and oil. The cable must have a temperature range of -40ºC (-40ºF) to plus 125ºC (257ºF).	
Primary and Accessory Data Link Cable	16 or 18	Part number 153-2707 is available for lengths of up to 200 ft. The cable has a temperature range of -40ºC (-40ºF) to plus 125ºC (257ºF). For longer runs, select a cable that meets SAE J1939-11 requirements.	Deutsch DT type of connectors are recommended. If Spring Spade or Ring Terminals are used, the connection between the terminals and the wire should be crimped and soldered.
Engine Solenoids (Air Shutoff)	Multiple 14	Stranded wire normally used on engine harnesses. The cable must be resistant to fuel and oil. The cable must have a temperature range of -40ºC (-40ºF) to plus 125ºC (257ºF).	The leads of the cable should have Spring Spade Terminals or Ring Terminals. The Connection between the wire and the terminal should be crimped and soldered.
Power			
RS-485 Annunciator	14 or 16 or 18	Shielded twisted triad cable is recommended. Stranded wire normally used on engine harnesses. The cable must be resistant to fuel and oil. The cable must have a temperature range of -40ºC (-40ºF) to plus 125ºC (257ºF).	Deutsch DT type of connectors are recommended.
Ethernet Connector	18 or 20	Cat 5, Cat 5e, or Cat 6. Dual twisted pair wire maybe used to wire from the EMCP. Cat part numbers 143-2454 (20 AWG), 9X-8922 (18 AWG), or quantity of 2 of 143-5018 (18 AWG) may be suitable for this purpose. The cable must be resistant to fuel and oil. The cable must have a temperature range of -40ºC (-40ºF) to plus 125ºC (257ºF).	RJ-45 male connector

[1] The number of connections must be kept to a minimum.

Table 3.2 – Wiring Requirements

3.11 Shielded and Communication Wiring

Shielded twisted pair cable is required for the magnetic speed sensor . J1939 CAN cable is required for Primary and Accessory CAN data links. This cable is used for maximum protection against inductive noise, electromagnetic interference, and radio frequency interference . The shield greatly reduces the amplitude of any unwanted voltages on the signal wire . The shields should not be connected to the sheet metal . If the shields are connected to sheet metal, the connections are susceptible to loose bolts, corrosion, etc . The faulty connections increase the resistance of the shield . Faulty connections also reduce the effectiveness of the shield .

Sensor shields should be brought to the EMCP if pins are allocated on the controller for that purpose . When the cable terminates at junction boxes, the shields must be connected to each other in order to maintain a continuous path . A continuous path must be maintained in the shield wire for sensors, whenever possible . Wire exposed beyond the shield should be as short as possible . When no provisions exist to incorporate the draining of the shield wire internal to the controller, the shield must be connected to battery negative as close to the controller as possible . Shields should be drained at one point only . When possible, this should be done at, or close to, the EMCP 4 .

To avoid electromagnetic interference, do not run shielded signal wires near other wires carrying large currents . In installations with unavoidable risk of electromagnetic interference (EMI), shielded wire run in conduit, extra shielding, or other precautions may be necessary .

4.0 Initial Operation and User Orientation

4.1 Types of Events

The EMCP 4 has two lamps to annunciate events. The amber lamp indicates warning-type events, while the red lamp indicates shutdown-type events. The amber lamp also lights if a "Protect" lamp state is being sent by a different module. ET 2012B and later can be used to help identify what modules are sending different lamp statuses. The lamps flash when new events arrive, and remain flashing (often accompanied by an audible horn) until acknowledged by pressing the acknowledge button locally or remotely. Shutdown-type events do not clear until the user fixes the condition(s) that caused the shut down and "resets" the events. The EMCP 4 supports a very large number of events, and most events generated by the EMCP can be configured based on application needs. For information on viewing, resetting, and configuring events, see Chapter 5.

Note: The EMCP 4 will annunciate and display events from other modules, even if these events are not generated by the EMCP 4. These events are not logged in the EMCP itself, but are viewable from the individual module log located in the EMCP 4.

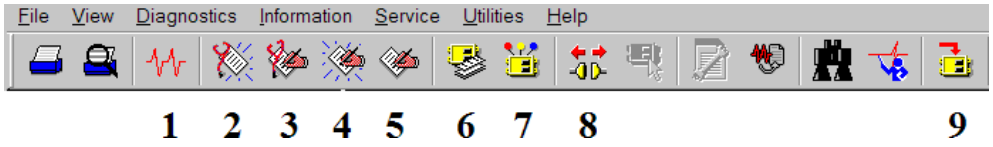
4.2 Using the Cat Service Tool

Many of the features of the EMCP 4 system can be accessed via the Cat Service Tool. These features include viewing status data, monitoring optional modules, viewing and resetting events, and configuring setpoints.

Note: A minimum of the Cat ET Service Tool version 2013B is required to communicate properly with the EMCP 4. If an earlier version is used, the EMCP 4 will be grayed out. In order to have access to the latest setpoints, the latest version of the Cat ET service tool should always be used.

Throughout this document, instructions for accessing a feature both via the EMCP 4 display and via the Cat Service Tool will be given. However, the Cat Service Tool also offers other unique features that are useful for site commissioning, ECM retrofitting, or troubleshooting, such as the ability to log data to a file or graph data in real-time. Such features are not in the scope of this document. For more information on the Cat Service Tool, refer to the Cat Service Tool documentation and training.

Figure 4.1 outlines the EMCP 4 features that are available within the Cat Electronic Technician software.



1. Status Tool
2. Active Diagnostic Codes
3. Logged Diagnostic Codes
4. Active Event Codes
5. Logged Event Codes
6. ECM Summary
7. Configuration Tool
8. Connect/Disconnect
9. Winflash

Figure 4.1 – Electronic Technician EMCP 4 Features

When in the Status tool, buttons to Active Codes and Events are provided at the bottom of the screen.

Connecting to the EMCP 4 to Configure Setpoints

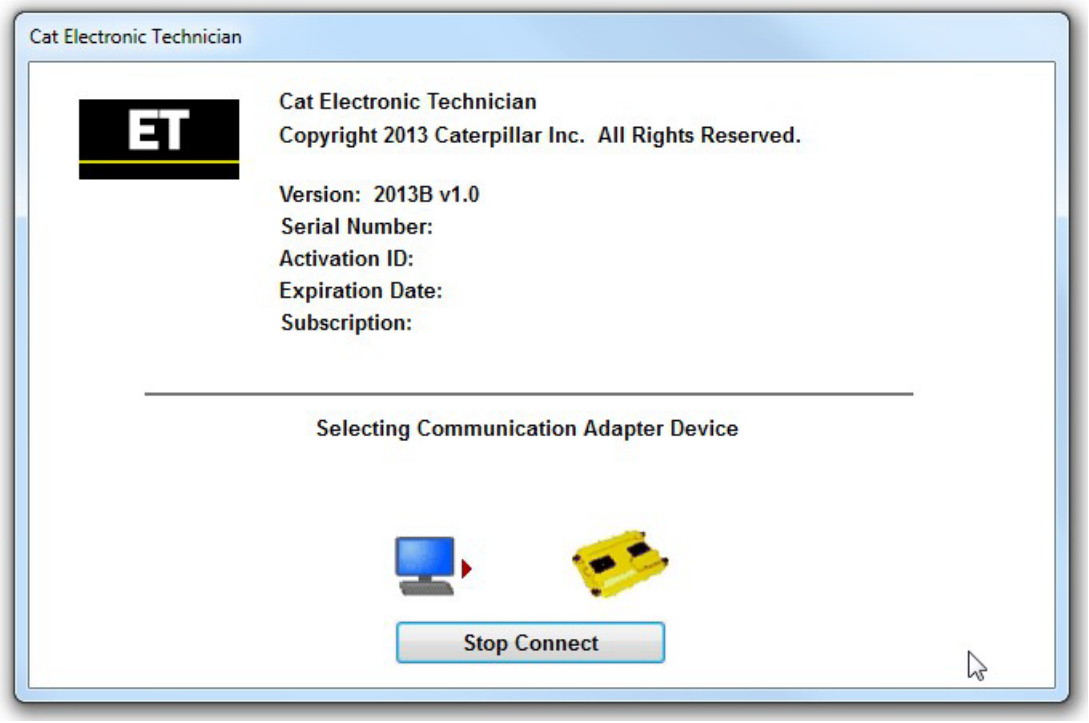
In order to use the Cat Service Tool with the EMCP and configure setpoints, do the following:

1. Connect the Service Tool to the PC and configure the port settings as appropriate.

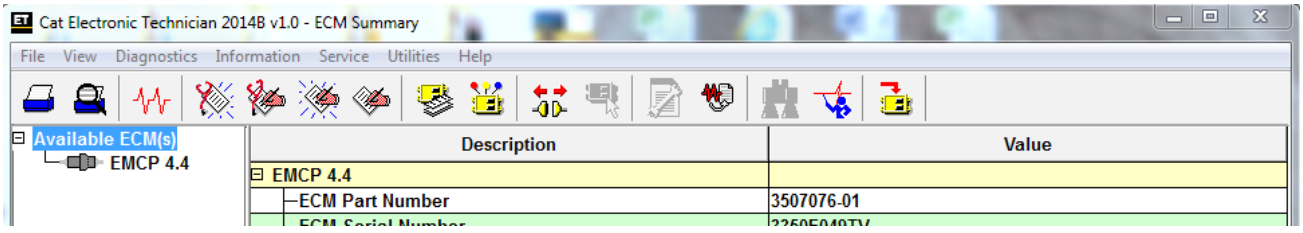
2. Ensure the Service Tool is connected to the Primary Data Link (CAN 1).

3. Start the Cat Electronic Technician software.

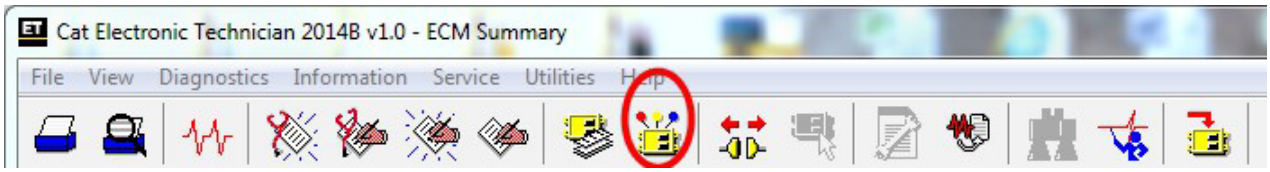
4. The software will search the data links.



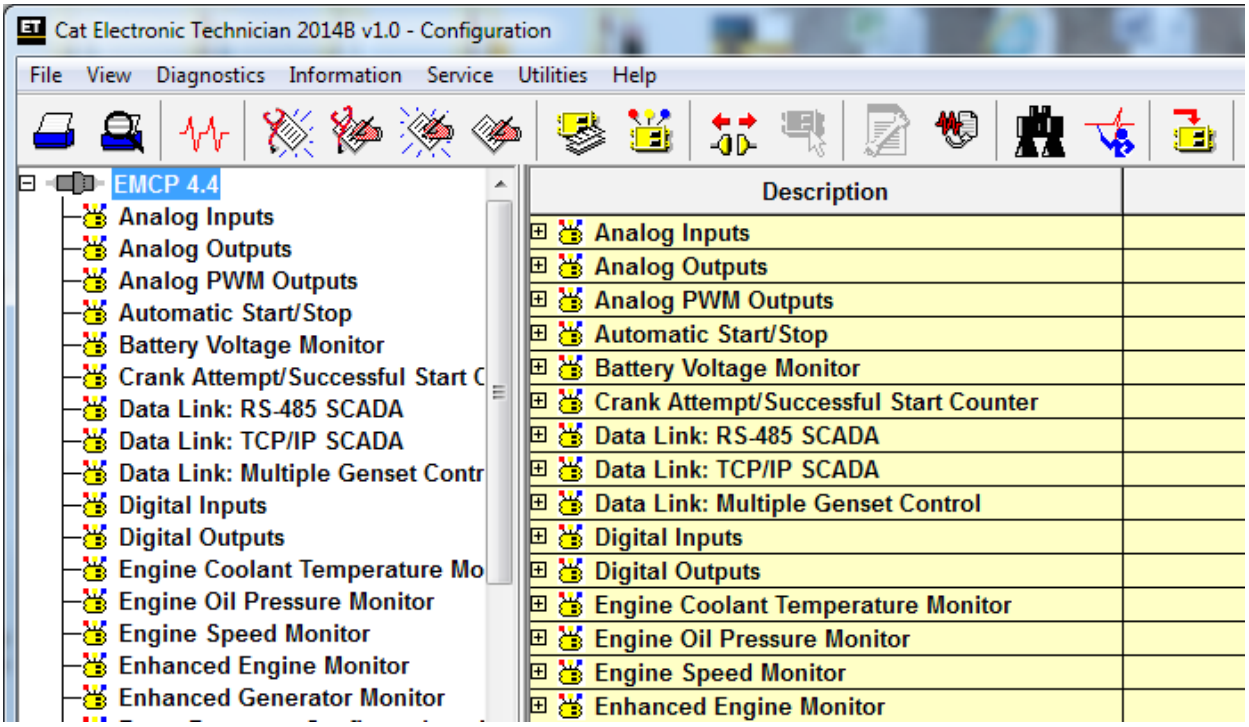
5. When the software finds the EMCP and connects to it, The ECM Summary screen will appear. If multiple devices are detected, always select the EMCP before continuing to be able to access special EMCP features with ET such as annunciator configuration and device lamp status.



6. To view configurable parameters within the EMCP 4, press the Configuration button.



7. The parameter groups will appear.



8. Selecting a group in the left pane will show all the parameters within that group in the right pane.

4.3 Viewing System Parameters

Many generator and engine parameters are viewable in real time from both the Cat Service Tool, and the EMCP 4 display.

From the Cat Service Tool

Parameters are accessed by selecting Information → Status from the menu, or by clicking on the STATUS TOOL icon in the toolbar. Only a subset of EMCP 4 parameters are available in the ET Status Tool. Refer to the Cat Service Tool help from the Help → Contents menu for more information on the Status Tool.

From the EMCP 4 Display

Parameters are accessed (irrespective of the current screen position) by pressing the AC OVERVIEW , ENGINE OVERVIEW , Main Menu , or Control  buttons located below the screen. Detailed screens provide even more information by pressing the SCROLL DOWN  button from each of the overview screens. Alternately, this additional information may be accessed by pressing "Page Down" from the soft keys. For a description of the front view and navigation keys, refer to Appendix B.

The EMCP 4 parameters are organized with different levels of users in mind. These levels are as follows: View, Control, and Configure. Some of the parameters are accessible from multiple paths. For a complete menu structure, refer to Appendix A.

4.3.1 Supported Parameters

Different revisions of the EMCP 4 software support different numbers of parameters. EMCP 4.4 supports several parameters not supported on the EMCP 4.3. Some parameters are only available in certain configurations, for example, electronic engine ECMs provide more engine data than what is available from mechanical engines. The sections below list most of the parameters available, and on which level of EMCP 4 they may be available. All parameters are not available on any single unit.

Parameters are displayed with units, some of which are configurable. For changing units or setting other user preferences see Section 4.4, Viewing and adjusting preferences.

Parameters that are not available to the EMCP 4 are shown as **** (four asterisks). This may indicate an incorrect software configuration, a wiring problem, or a problem with the sensor.

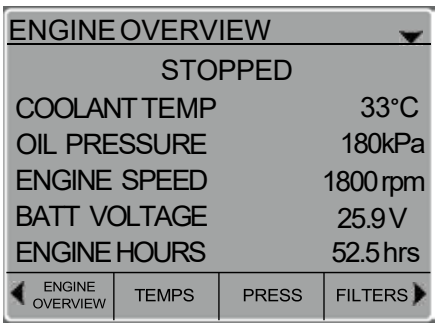
4.3.2 Engine Overview

The Engine Overview screens display various engine parameters, if available. Soft keys provide a quick link to the first page of individual groups of engine parameters and page down button presses access the remainder of the engine parameters not shown on the first screen. (Only the first screens are illustrated below.) Pressing the left and right button will scroll through the quick links to additional engine parameter groups. The following parameters are displayed on the Engine Overview screens if they are being received over the data link.

Note: Not all engine parameters listed below exist on all engine packages.

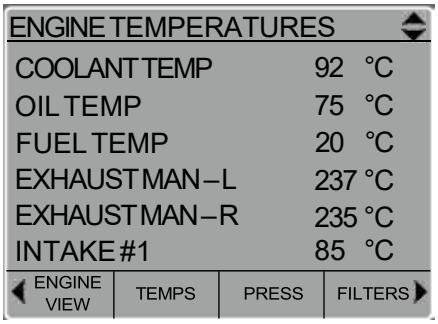
Engine Overview Screen

- Engine Operating State (Initialization, Pre-Crank, Starting, Running, Pre-Cooldown, Cooldown, Stopping, Stopped, Idling; many states are transient and only briefly active, and some states may not occur in some configurations)
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Battery Voltage, as measured at the connector entering the EMCP 4
- Engine Operating Hours (measured by the EMCP)



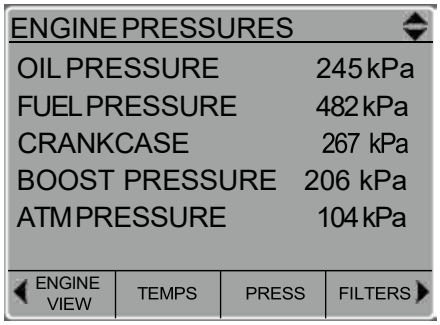
Engine Temperatures Screen

- Engine Coolant Temperature
- Engine Oil Temperature
- Engine Fuel Temperature
- Engine Exhaust Manifold – Left
- Engine Exhaust Manifold – Right
- Engine Intake Manifold #1 Temperature
- Oil to Coolant Differential Temperature
- Engine Coolant Temperature #2
- Engine Coolant Temperature #3
- Engine Intake Air Temp
- Engine Aftercooler Inlet Temperature
- Engine Aftercooler Outlet Temperature



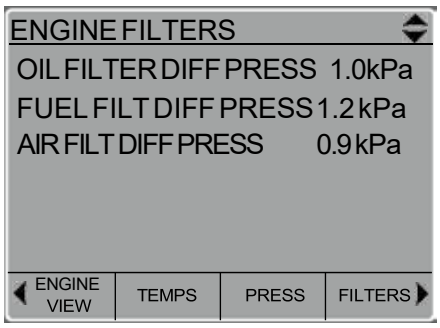
Engine Pressures Screen

- Engine Oil Pressure
- Engine Fuel Pressure
- Crankcase Pressure
- Boost Pressure
- ATM Pressure
- Coolant Outlet Pressure
- Intake Manifold Air Pressure
- Engine Air to Fuel Differential Pressure
- Engine Turbo Charger Boost Pressure
- Engine Air Filter #2 Differential Pressure
- Engine Turbocharger Compressor Control
- Intake Fuel Valve Differential Pressure
- Turbo Compressor Bypass Position
- Left Turbo Inlet Pressure from Data Link
- Right Turbo Inlet Pressure from Data Link
- Throttle Valve Differential Pressure
- Desired Throttle Valve Differential Pressure
- Hydraulic Pressure



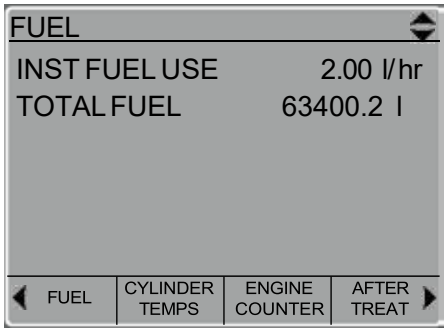
Engine Filters Screen

- Engine Oil Filter Pressure
- Engine Fuel Filter Differential Pressure
- Air Filter Differential Pressure
- Pre-filter Oil Pressure



Fuel Screen

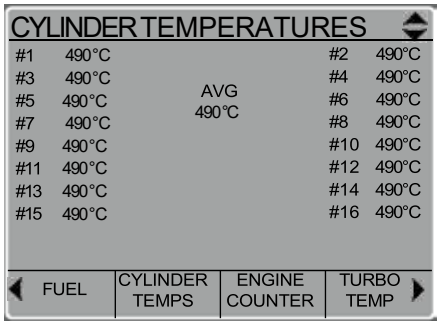
- Instantaneous Fuel Use
- Total Fuel
- Fuel Level
- Fuel Energy Content
- Bund Level
- Fuel Correction Factor
- Fuel Specific Gravity
- Specific Heat Ratio
- Engine Load
- Engine Inlet Air Mass Flow Rate
- Fuel Gas Pressure
- Throttle Actuator Position Command



Engine Cylinder Temperatures Screen*

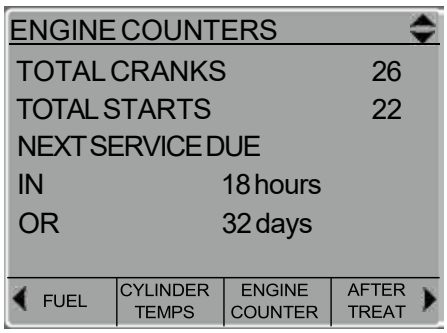
- Cylinder #N Temperature

*Enhanced Engine Monitor setpoint Engine Cylinder Temperature Sensor Installation Status must be INSTALLED .



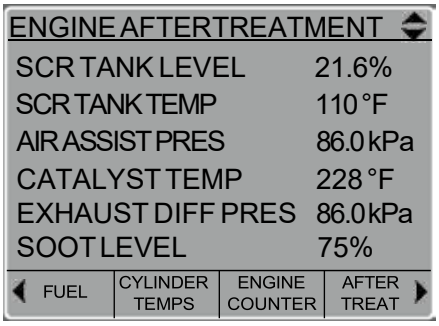
Engine Counters Screen

- Total engine Cranks since last reset (a crank is defined as the number of times the starter motor switches on)
- Total engine Starts since last reset (a start is defined as the number of times the engine transitions from below the Crank Terminate speed setpoint to above it)
- Engine Hours remaining until Service Maintenance Interval expires
- Calendar Days remaining until Service Maintenance Interval expires



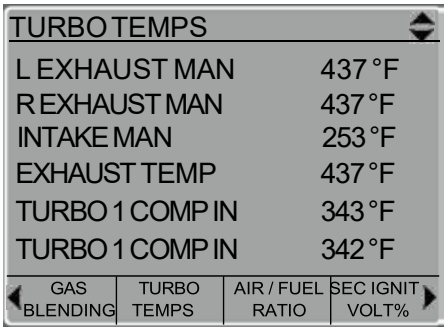
Engine Aftertreatment Screen

- SCR Tank Level
- SCR Tank Temperature
- SCR Air Assist Pressure
- SCR Catalyst Temperature
- SCR Exhaust Differential Pressure
- Soot Level
- SCR Status
- DEF Dosing Temperature
- Total DEF Used
- Time Since Last Inducement
- Time Until Inducement
- Inducement Override Mode
- Inducement Override Time Left



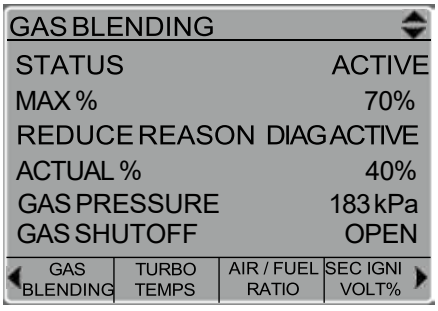
Engine Turbo Temps Screen

- Engine Exhaust Manifold – Left
- Engine Exhaust Manifold – Right
- Engine Intake #1 Temperature
- Engine Exhaust Temperature
- Turbo 1 Compressor Inlet Temperature
- Turbo 2 Compressor Inlet Temperature
- Turbo 3 Compressor Inlet Temperature
- Turbo 4 Compressor Inlet Temperature
- Turbo 1 Turbine Intake Temperature
- Turbo 1 Turbine Outlet Temperature
- Turbo 2 Turbine Intake Temperature
- Turbo 2 Turbine Outlet Temperature
- Turbo 3 Turbine Intake Temperature
- Turbo 3 Turbine Outlet Temperature
- Turbo 4 Turbine Intake Temperature
- Turbo 4 Turbine Outlet Temperature
- Engine Exhaust Temperature Average
- Engine Exhaust Temperature Average (Bank 1)
- Engine Exhaust Temperature Average (Bank 2)
- Engine Turbo 1 Compressor Outlet Temperature



Engine Gas Blending Screen

- Gas Substitution Status
- Maximum Gas Substitution Percentage
- Gas Substitution Reduction Reason
- Actual Gas Substitution Percentage
- Engine Fuel Valve Intake Pressure
- Engine Fuel Valve Shutoff Status
- Total Fuel without Gas Substitution
- Fuel Rate without Gas Substitution

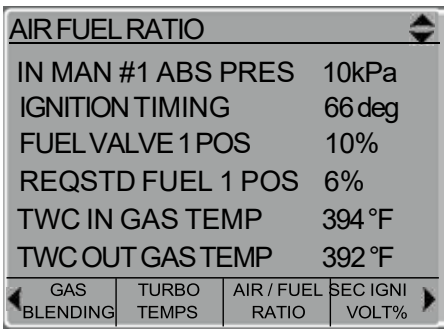


Engine Air/Fuel Ratio Screen

- Desired Ignition Timing
- Engine Actual Ignition Timing
- Engine Fuel Valve #1 Position
- Requested Engine Fuel Valve #1 Position
- Engine Throttle Valve Position
- Desired Engine Throttle Valve Position
- Emissions Feedback Mode
- Three Way Catalyst Intake Temperature
- Three Way Catalyst Outlet Temperature
- Three Way Catalyst Differential Temperature
- Aftertreatment Intake O_2 Percent
- Aftertreatment Outlet O_2 Percent
- Oxygen Sensor Status
- Oxygen Sensor Closed Loop Operation
- Intake Oxygen Sensor Voltage
- Desired Intake Oxygen Sensor Voltage
- Outlet Oxygen Sensor Voltage
- Desired Outlet Oxygen Sensor Voltage
- Intake Oxygen Sensor Fuel Trim Percentage
- Outlet Oxygen Sensor Fuel Trim Percentage
- Engine Running Status
- Engine Ventilation Status
- Gas Fuel Flow
- Desired Air to Fuel Ratio
- Actual Air to Fuel Ratio
- Intake Manifold Air Flow
- Desired Intake Manifold Air Pressure
- Choke Position Command
- Wastegate Position Command
- Exhaust NOx Level
- Desired Exhaust NOx Level
- Exhaust NOx Level Sensor Status
- Three Way Catalyst Differential Pressure

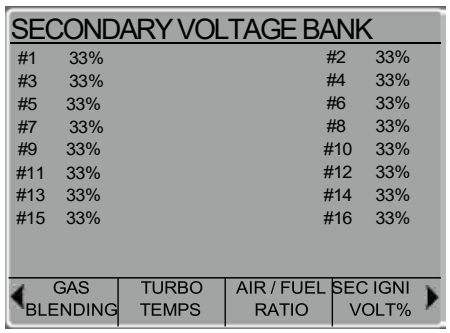
Relay Status Screen

- Engine Low Idle Switch Position
- Engine Emergency Shutdown Indication
- Engine Auxiliary Shutdown Switch
- Engine Oil Priming State
- Engine Oil Priming Switch
- Starter Relay Coil Status
- Engine Starter Mode
- Engine Fuel Shutoff Valve #1
- Engine Hydraulic Pressure Governor Switch
- Engine Running FLag
- Engine Ventilation Status
- Engine Pre-Lube Mode



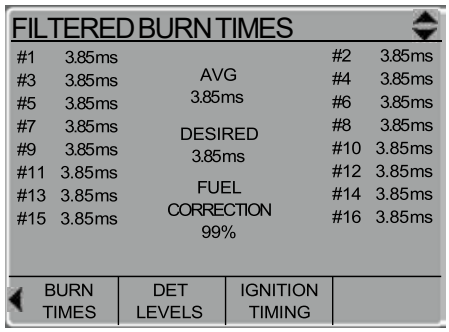
Engine Cylinder Ignition Transformer Secondary Output Screen

- Cylinder #N Secondary Output (%)



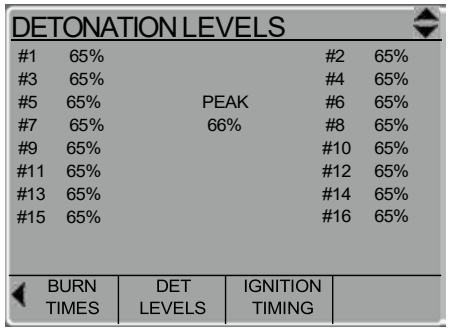
Engine Cylinder Filtered Burn Times Screen

- Cylinder #N Burn Time (ms)



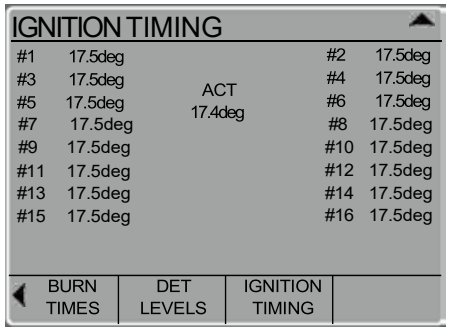
Engine Cylinder Detonation Levels Screen

- Cylinder #N Detonation Level (%)



Engine Cylinder Ignition Timing

- Cylinder #N Ignition Timing (deg)



Deration Information Screen

- Engine Derate Percentage
- Desired Engine Speed

Engine ECM Info Screen

- Engine Rating Map #

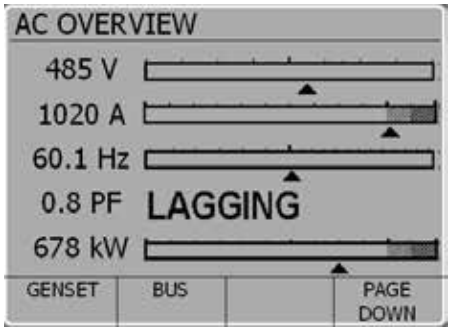
4.3.3 AC Overview

The AC Overview screens display various generator parameters. Soft keys provide a quick link to the Engine Overview screens, Bus Overview screens (EMCP 4.4), and a page down button to access the remainder of the engine parameters not shown on the first screen. The following parameters are displayed on the AC Overview screens:

AC Overview Screen

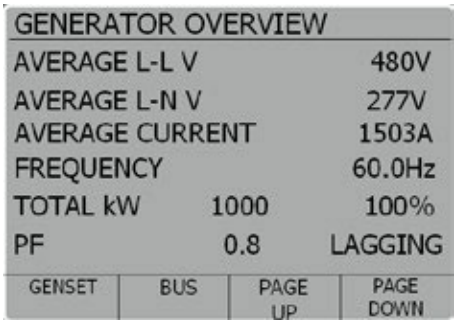
- Average Line-Line AC Voltage (numerical and graphical)
- Average Current (numerical and graphical)
- AC Frequency (numerical and graphical)
- Power Factor
- Power Factor Lead/Lag status
- Total Generator Real Power – kW (numerical and graphical)

Note: The lighter shaded area on the graph represents 100-110% of full rated, while the darker shaded area represents 110-120% of rated.



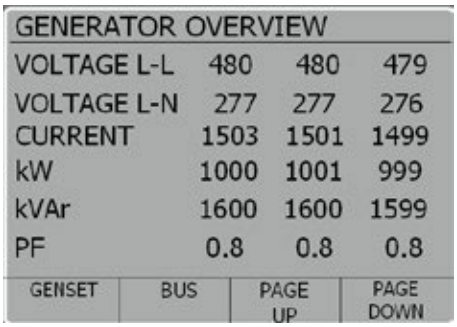
Generator Overview Screen 1

- Average Line-Line AC Voltage
- Average Line-Neutral AC Voltage
- Average Current
- AC Frequency
- Total Generator Real Power – kW
- Percent Real Power as a percentage of Generator Rated Power
- Power Factor
- Power Factor Lead/Lag status



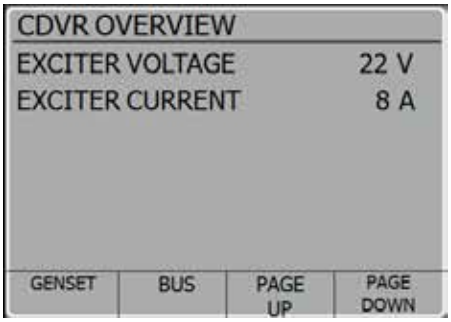
Generator Overview Screen 2

- Line-Line Voltages: A-B, B-C, C-A
- Line-Neutral Voltages: A-N, B-N, C-N
- Phase Currents: A, B, C
- Per Phase Generator Real Power: A, B, C
- Per Phase Generator Reactive Power: A, B, C
- Per Phase Power Factor: A, B, C



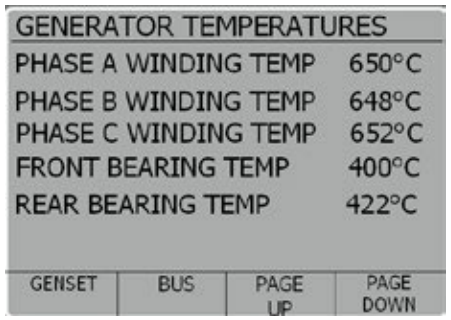
CDVR Overview Screen (with CDVR only)

- Exciter Voltage
- Exciter Current



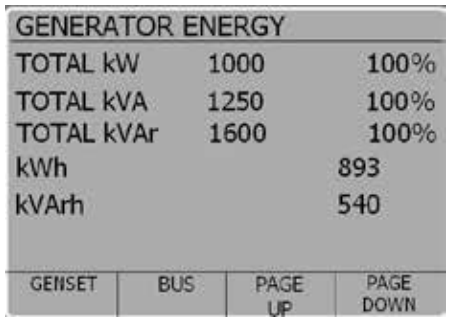
Generator Temperature Screen

- Generator Phase A Winding Temperature
- Generator Phase B Winding Temperature
- Generator Phase C Winding Temperature
- Generator Front Bearing Temperature
- Generator Rear Bearing Temperature



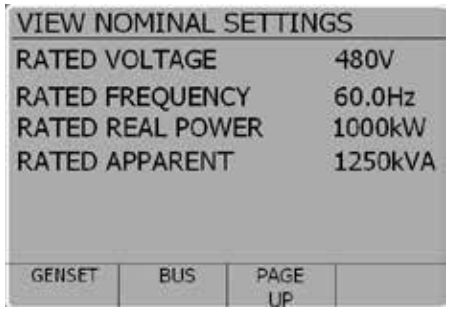
Generator Energy Screen

- Total kW
- % kW
- Total kVA
- % kVA
- Total kVAr
- % kVAr



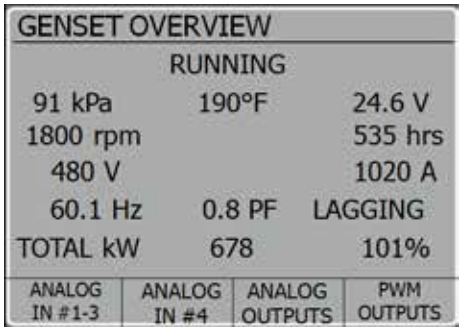
View Nominal Settings Screen

- Rated Voltage
- Rated Frequency
- Rated Real Power
- Rated Apparent Power



4.3.4 Generator Set Overview

The Generator Set Overview screen displays a combination of engine and generator parameters on one convenient screen. Soft keys provide quick links to any configured Analog Input and Analog Output parameters on the EMCP 4. The following parameters are displayed on the Generator Set Overview screen:

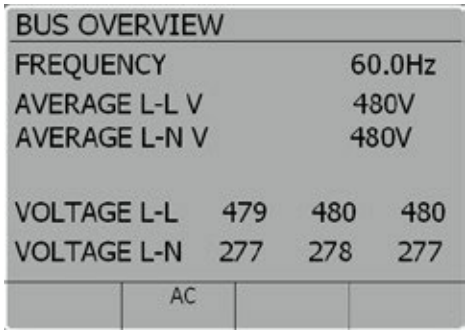


Generator Set Overview

- Engine Operating State (Initialization, Pre-Crank, Starting, Running, Pre-Cooldown, Cooldown, Stopping, Stopped, Idling; many states are transient and only briefly active, and some states may not occur in some configurations)
- Engine Oil Pressure
- Engine Coolant Temperature
- Battery Voltage, as measured at the connector entering the EMCP 4
- Engine Speed
- Engine Operating Hours
- Average Line-Line AC Voltage
- Average Current
- AC Frequency
- Power Factor
- Power Factor Lead/Lag status
- Total Generator Real Power – kW
- Percent Real Power – as a percent of Generator Rated Power setpoint

4.3.5 Bus Overview (EMCP 4.4 only)

The Bus Overview screens display various bus parameters. A soft key provides a quick link to the AC Overview screen. The following parameters are displayed on the Bus Overview screens:



Bus Overview Screen

- Bus AC Frequency
- Average Bus Line-Line AC Voltage
- Average Bus Line-Neutral AC Voltage
- Bus Line-Line Voltages: A-B, B-C, C-A
- Bus Line-Neutral Voltages: A-N, B-N, C-N

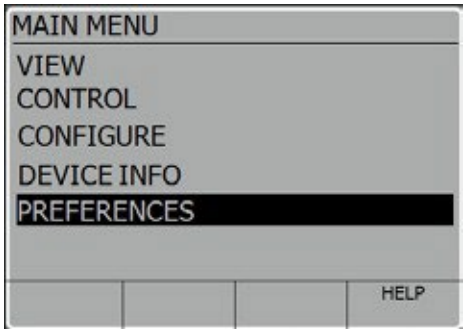
4.4 Viewing and Adjusting Preferences

The EMCP 4 display can be used for monitoring the generator status, viewing and resetting events, and configuring setpoints. There are several preferences to alter how you view the data on the display. These include: display contrast, units used to display pressure, units used to display temperature, units used to display volume, circuit breaker symbol (EMCP 4.4 only), and displayed language (to select between the customer language and Technician English).

Note: These preferences do not affect operation of the EMCP 4, the values in the SCADA Communications (Modbus) or the data as viewed in the Cat Service Tool. They only affect how the text and data is converted and displayed on the EMCP 4 display.

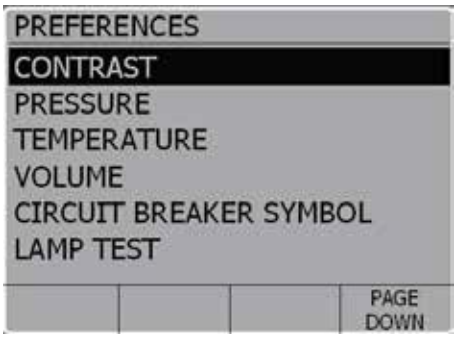
4.4.1 Setting the Preferences Using the EMCP 4 Display

On the EMCP 4 display, the Preferences menu is located at the bottom of the Main Menu.



For any preference, press OK KEY 

to accept the change (or ESCAPE KEY  to reject the change) and return to the Preferences menu.



Preferences Contrast

This determines the darkness of the pixels on the display. A minimum contrast setting (reached by pressing and holding the down or left arrow) effectively blanks the screen, and a maximum contrast setting (reached by pressing and holding the up or right arrow) effectively darkens the entire screen. To change the contrast if the screen is unreadable due to a misconfiguration or ambient conditions, see CHANGING THE EMCP 4 CONTRAST WHEN THE DISPLAY IS UNREADABLE .

Pressure

This allows pressure parameters (such as Engine Oil Pressure) and setpoints (such as Low Engine Oil Pressure Event Threshold) to be shown in either kPa, psi, or bar. Select the desired unit with the up or down arrows, or the Function keys.

Temperature

This allows temperature parameters (such as Engine Coolant Temperature) and setpoints (such High Engine Coolant Temperature Event Threshold) to be shown in either Celsius (Centigrade) or degrees Fahrenheit. Select the desired unit with the up or down arrows, or the Function keys.

Volume

This allows volume parameters (such as Fuel Volume) to be shown in Liters, Imperial Gallons, or U.S. Gallons. Select the desired unit with the up or down arrows, or the Function keys.

Circuit Breaker Symbol (EMCP 4.4 only)

This allows the graphic for the circuit breaker to be either the ISO symbol, or the U.S. symbol. Select the desired symbol with the left or right arrows.

Lamp Test

When this selection is highlighted, pressing and holding the OK KEY 

will darken all pixels on the screen and illuminate all LEDs on the face of the controller.

Language

This allows the display to be switched between Technician English (always listed first) and the customer language (always listed second, and written in the font of the customer language). The example below shows the language selection in the German language flash file. Select the desired language with the up or down arrows. To change the language to Technician English, regardless of the current screen, and without needing to read the text, see CHANGING THE EMCP 4 DISPLAY TO TECHNICIAN ENGLISH.

The LANGUAGE setting has been conveniently located at the bottom of the Preferences menu, which is at the bottom of the Main Menu.

4.4.2 Changing the EMCP 4 Contrast When the Display is Unreadable

1. Press the MAIN MENU  key.

2. Scroll DOWN  until scrolling stops. If the display is unreadable such that scrolling can't be seen, press down a minimum of 10 times.

3. Press the OK KEY  (this will take you into the Preferences Menu).

4. Press the OK KEY  again (this will take you into the Contrast selection).

5. Press and hold either LEFT ARROW  or RIGHT ARROW  until the text and graphics become visible.

6. Press the OK KEY  to accept the adjustment.

4.4.3 Changing the EMCP 4 Display to Technician English

1. Press the MAIN MENU  key.

2. SCROLL DOWN  until the scrolling stops.

3. Press the OK KEY  (this will take you into the Preferences Menu).

4. SCROLL DOWN  until the scrolling stops.

5. Press the OK KEY  (this will take you into the Language selection).

6. Press the UP ARROW  key until the scrolling stops.

7. Press the OK KEY  to select TECHNICIAN ENGLISH.

The EMCP 4 language setting is changed back to TECHNICIAN ENGLISH. Similar steps can be followed by a customer who is unfamiliar with English, to change the language setting back to their primary language:

4.4.4 Changing the EMCP 4 Display to the Primary Language

1. Press the MAIN MENU key.

2. SCROLL DOWN until the scrolling stops.

3. Press the OK KEY (this will take you into the Preferences Menu).

4. SCROLL DOWN until the scrolling stops.

5. Press the OK KEY (this will take you into the language selection).

6. Press the SCROLL DOWN arrow to select the customer language.

7. Press the OK KEY to change to the customer language.

The EMCP 4 language setting is changed back to the customer language.

4.4.5 Setting the Preferences Using the Service Tool

Only the preferences for units can be configured using the Cat Service Tool. They are located in the Configuration Tool. Select Display Preferences from the left panel.

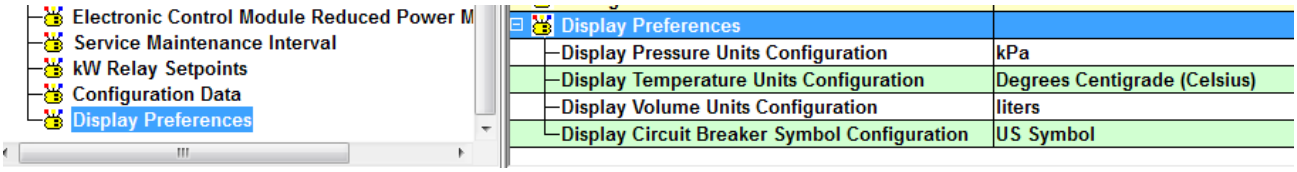


Figure 4.2 – EMCP 4 Display Preferences

The display units can be changed the same way other setpoints are changed with the Service Tool.

Pressure

This allows pressure parameters (such as Engine Oil Pressure) and some setpoints (such as Low Engine Oil Pressure Event Threshold via Data Link) to be shown in either kPa, psi, or bar.

Temperature

This allows temperature parameters (such as Engine Coolant Temperature) and setpoints (such High Engine Coolant Temperature Event Threshold) to be shown in either Celsius (Centigrade) or degrees Fahrenheit.

Volume

This allows volume parameters (such as Fuel Volume) to be shown in Liters, Imperial Gallons, or U.S. Gallons.

Circuit Breaker Symbol (EMCP 4.4 only)

This allows a choice of graphics for the circuit breaker symbol for various display screens.

4.5 Configuring Time/Date

The EMCP 4.3 and 4.4 have an internal Real Time clock that is used for time-stamping events, Programmable Cycle Timer (Chapter 16), and the Status Event Log (Chapter 5). The timestamps for the last date and time an event has occurred and the first date and time the event has occurred are viewed by selecting a module in the Event Log and pressing the OK key. See Figure 4.3.

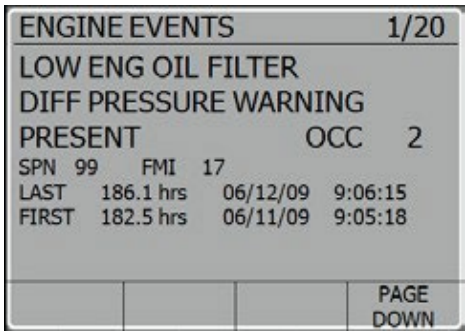


Figure 4.3 – Event Details Screens

4.5.1 Changing the Time/Date

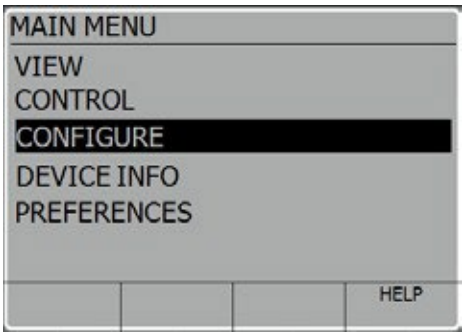
The EMCP 4 clock allows the time/date to be modified. Changing the time/date will change the timestamp on all future events, but not for existing events. (For example, an event that has occurred previously will still show the same FIRST time/date, but if it occurs again after the time/date has been adjusted, the LAST time/date will reflect the change.)

This procedure must be performed on the EMCP 4 display; it cannot be done using the Cat Service Tool. In order to update time/date, LEVEL 1 ACCESS is required. Refer to Chapter 6, Security for information on obtaining LEVEL 1 ACCESS.

To Change the Time/Date

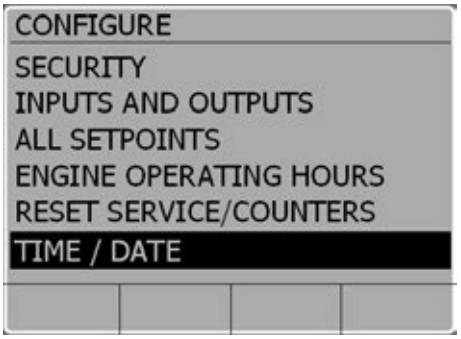
1. At MAIN MENU scroll DOWN  to CONFIGURE.

2. Press the OK KEY .



3. Scroll DOWN  to TIME/DATE.

4. Press the OK KEY .



5. To begin editing the time, press the OK KEY  while the current time is selected.



6. Select a digit using the LEFT ARROW  or RIGHT ARROW .

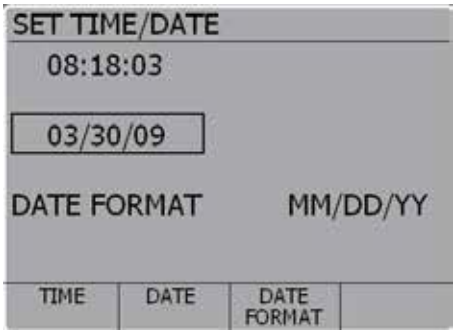
7. To change the selected digit use the UP ARROW  or DOWN ARROW .

8. To accept changes, press the OK KEY . To reject changes, press the ESCAPE KEY .

To Change the Date From This Point



1. Press the ESCAPE KEY again to return to the SET TIME/ DATE screen.



2. Press the DOWN ARROW key to put the box around the date.

   Alternately, pressing the DATE softkey from the Set Time screen will bring up this screen.

3. To begin editing the date, press the OK KEY while the current date is selected.

4. Select a digit using the LEFT ARROW or RIGHT ARROW.

5. To change the selected digit use the UP ARROW or DOWN ARROW.

6. To accept changes, press the OK KEY. To reject changes, press the ESCAPE KEY.

4.5.2 Changing Date Format

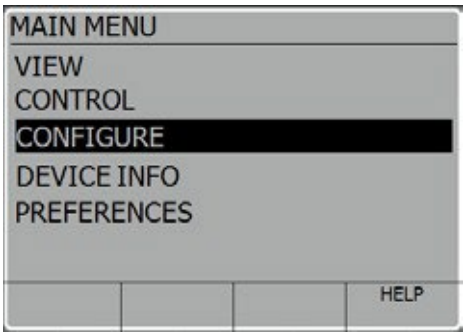
The data format can be set to either display in the form Month/Day/Year or the form Day/Month/Year. This procedure must be performed on the EMCP 4 display; it cannot be done using the Cat Service Tool.

Note: This preference does not affect operation of the EMCP 4 or the data as viewed in the Cat Service Tool. It only affects how the date is displayed on the EMCP 4 display and the format of the event time stamps.

To Change The Date Format

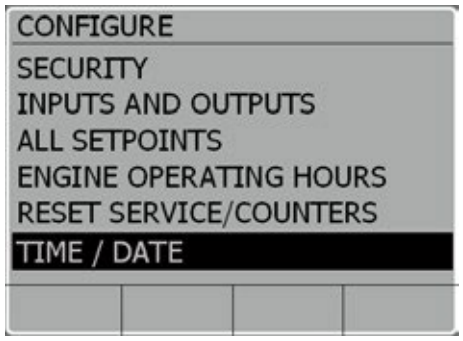
1. At MAIN MENU scroll DOWN  to CONFIGURE.

2. Press the OK KEY .



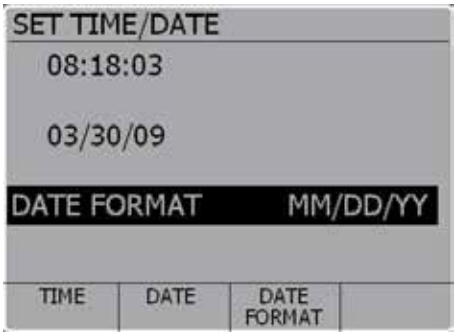
3. SCROLL DOWN  to TIME/DATE.

4. Press the OK KEY .



5. Press the DOWN ARROW  key to highlight the date format.

6. Press the OK KEY .



7. Select the format using the LEFT ARROW  or RIGHT ARROW  or soft keys, then press the OK KEY  to accept, or the ESCAPE KEY  to reject, the change.

4.6 Adjusting Generator Set Parameters

On many generator sets, the engine speed, generator output voltage, and idle/rated status can be adjusted from the display of the EMCP 4. This ability is dependent upon the engine interface strategy and input/output configuration.

Note: The EMCP 4.4 takes over control during loadsharing and automatic synchronizing including loadsharing with itself.

4.6.1 Generator Output Voltage

If the generator set is equipped with a Cat Digital Voltage Regulator (Cat DVR) or the Integrated Voltage Regulator (IVR), then the generator output voltage can be adjusted from the display of the EMCP 4. When using the CDVR, the CDVR must be programmed to allow this control. In order for the VOLTAGE ADJUST to work via CAN, the AVR VOLTAGE CONTROL DESIRED INPUT CONFIGURATION setpoint in the Cat DVR must be programmed for CAN INPUT. If that setpoint is set to SWITCH, the VOLTAGE CONTROL from the EMCP 4 will NOT WORK. These adjustments do NOT change the programmed voltage which is done under configuration. Generator Output Voltage can also be adjusted using an analog input.

4.6.2 Engine Speed

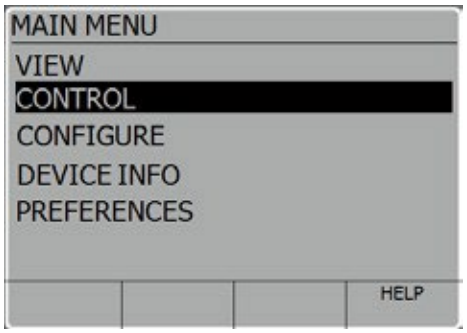
If the generator set is equipped with an ADEM A3 or A4 governor, then the engine speed can be adjusted from the display of the EMCP 4, provided the A3 or A4 is programmed to allow this control. In order for the SPEED ADJUST to work via CAN, the DESIRED THROTTLE INPUT CONFIGURATION setpoint in the A3 or A4 must be programmed for CAN INPUT. If that setpoint is set to PWM, the SPEED CONTROL from the EMCP 4 will NOT WORK.

Adjusting the Generator Output Voltage and Engine Speed

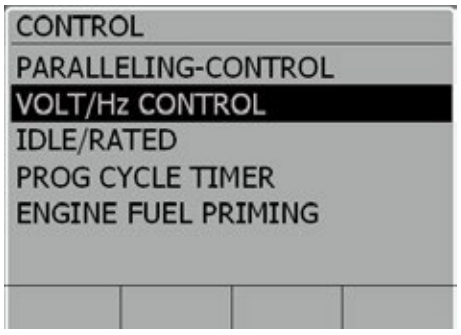
1. From the MAIN MENU select CONTROL.

2. Press the OK KEY 

.

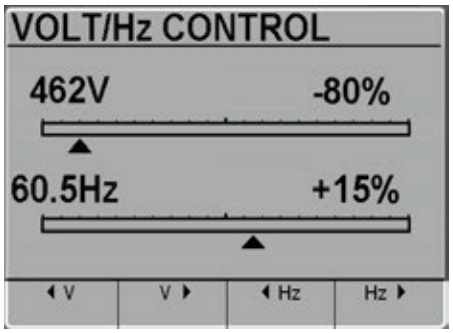


3. From the CONTROL MENU, select VOLT/HZ CONTROL.



4. Press the OK KEY 

.
The speed and voltage adjust screen will be displayed. The small arrow below the bar indicates the value of voltage or speed relative to the setpoint. Numerical values, along with percentages away from the setpoints, are also shown for reference.



To Adjust the Generator Voltage from This Screen

1. Press the F1 KEY 

to DECREASE the generator voltage.

2. Press the F2 KEY 

to INCREASE the generator voltage.

To Adjust the Engine Speed From This Screen

1. Press the F3 KEY 

to DECREASE the engine speed.

2. Press the F4 KEY 

to INCREASE the engine speed.

The EMCP 4 will broadcast an engine speed bias based on the adjustment that is made. When the engine speed is adjusted, then that value will remain until either it is adjusted again or until the control is power-cycled. For the EMCP 4.3, if an Analog or Digital Input is programmed for desired engine speed, this can affect the desired engine speed along with the Function keys. If the EMCP 4.3 is power cycled, then any bias made by a Digital Input, or change from the Function keys will not be saved. However, the bias from the analog input will be there when it powers back up. Alternative methods of retaining an Engine Speed Bias are detailed in an application paper available on PowerNet.

For the EMCP 4.4, if the controller is in Auto, the Sync Mode Switch is in Check, or the circuit breaker is closed (in Load Share or Load Control mode), then the Function keys, Digital and Analog Inputs programmed for desired engine speed will not affect engine speed. If the EMCP 4.4 is in Manual mode with the CB open, or if the Sync Mode Switch is in the Off position, then the desired engine speed works just like the EMCP 4.3.

Unlike the setpoints or preferences (i.e. contrast), any changes to this screen take effect immediately. The OK KEY 

and ESCAPE KEY  do not serve to accept or cancel changes.

4.6.3 Idle/Rated

The EMCP 4.3 and EMCP 4.4 both have the ability to be placed into Idle mode via the display, a Discrete Input, or through the SCADA Data Link. With some generator set systems, the engine ECM may also send the EMCP into Idle mode when the engine ECM is operating in Idle mode. Idle mode will disable Under Speed, Under Voltage, and Under Frequency protections in the EMCP 4. It will also use a different set of oil pressure thresholds.

Note: The Engine Forced Idle Feature Enable Status parameter must be set to "Enabled" within Cat ET. This setpoint is under the Automatic Start/Stop submenu in Cat ET or on the display where it is referenced as Engine Idle Operation Enable Status.

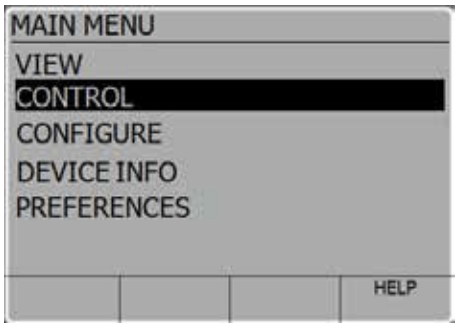
When the EMCP 4 is placed in Idle mode, a programmable output may be programmed and wired to signal that it is not operating in Rated Mode. In some wiring configurations, the EMCP will also send a signal via the Primary CAN Data Link to the ADEM. If an Analog Output on the EMCP is sending the desired speed signal to the engine governor, then when the programmable output gives an Idle command, the desired engine speed signal will not change on the Analog Output when the Idle command is removed.

The engine speed can be toggled between LOW IDLE and RATED SPEED from the display of the control as follows:

1. From the MAIN MENU select CONTROL.

2. Press the OK KEY 

.

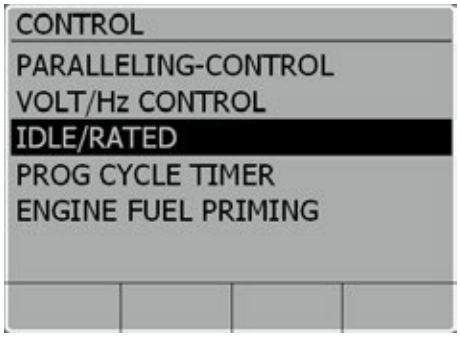


3. From the CONTROL MENU select IDLE/RATED.

4. Press the OK KEY 

.

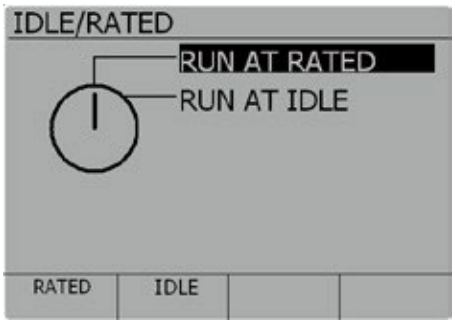
5. The IDLE/RATED screen will be displayed and the current state will be shown.



6. Press the UP ARROW  or DOWN ARROW  or the soft keys to change the state.

7. Press the OK KEY 

.



4.6.4 Engine Sensor Versus Data Link

The Engine Oil Pressure and Engine Coolant Temperature setpoints need special care when programming. These can be configured as either SENSOR or DATA LINK.

Note: The Engine Forced Idle Feature Enable Status parameter must be set to "Enabled" within Cat ET prior to seeing this menu option on the display. This setpoint is under the Automatic Start/Stop submenu in Cat ET.

When SENSOR is configured, the physical sensor is connected directly to the EMCP 4. In this configuration, Analog Inputs are configured with the desired setpoints for the rated speed warnings and shutdowns. The idle setpoints are still configured under the Engine Oil Pressure Monitor.

When DATA LINK is configured, the physical sensors are connected to the engine ECM. The engine ECM is configured with setpoints to protect the engine. Sensor values may also be communicated to the EMCP over the data link. The EMCP allows for redundant setpoints to be assigned based on this information seen from the engine.

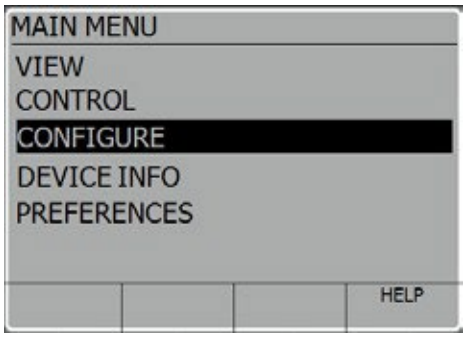
To Configure the Controller as Sensor or Data Link Using the Display:

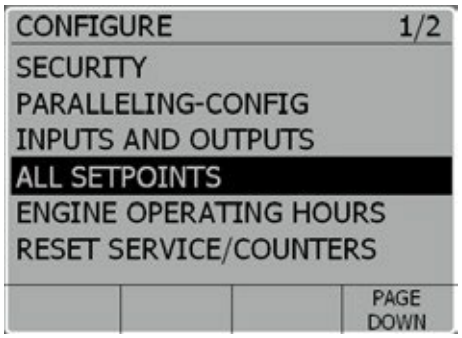
1. At MAIN MENU SCROLL DOWN  to CONFIGURE.

2. Press the OK KEY .

3. Scroll DOWN  to ALL SETPOINTS.

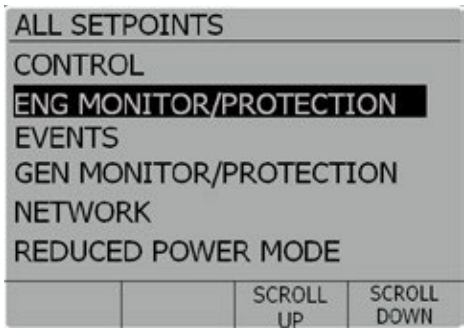
4. Press the OK KEY .





5. SCROLL DOWN  to ENG MONITOR/PROTECT.

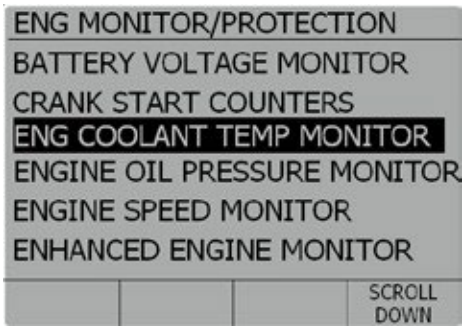
6. Press the OK KEY .



7. SCROLL DOWN  to ENG COOL TEMP MON OR ENG OIL PRES MON.

8. Press the OK KEY .

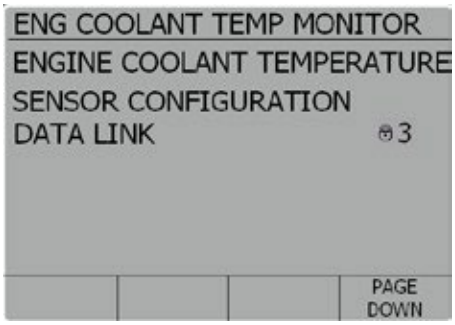
Note: Level 3 password is required.



9. Press the OK KEY .

10. To change the selection use the UP ARROW  or DOWN ARROW .

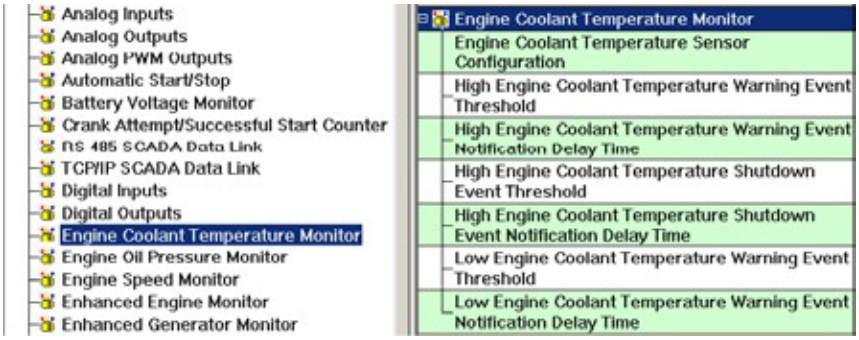
11. Press the OK KEY .



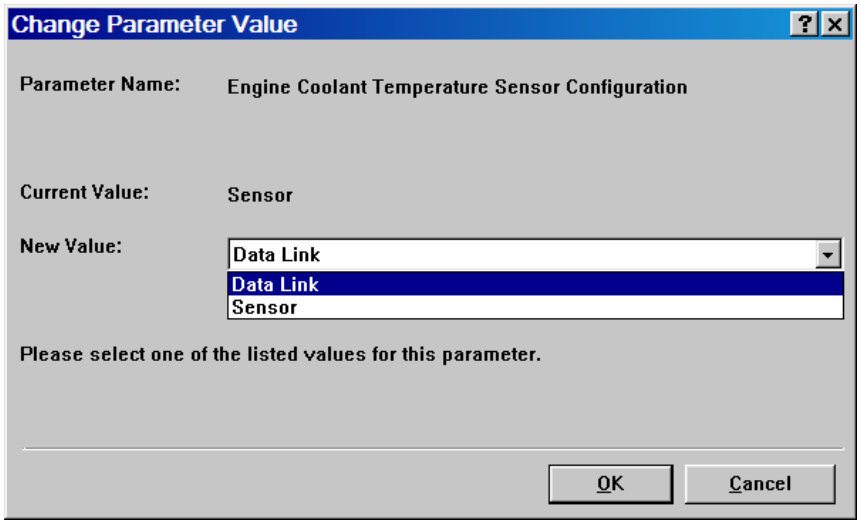
To Configure the Controller as Sensor or Data Link Using Cat ET:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

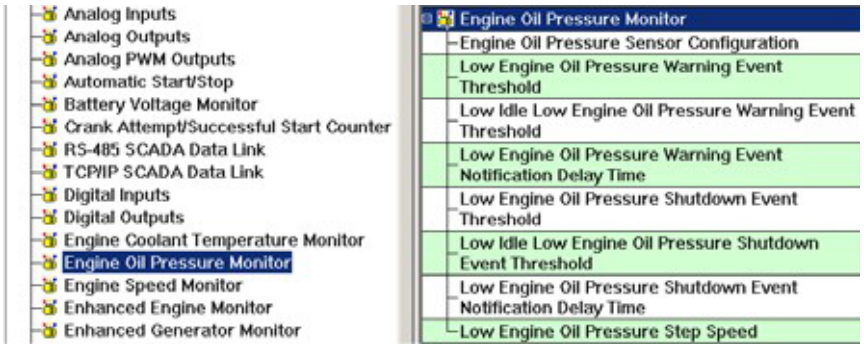
2. Select Engine Coolant Temperature Monitor.



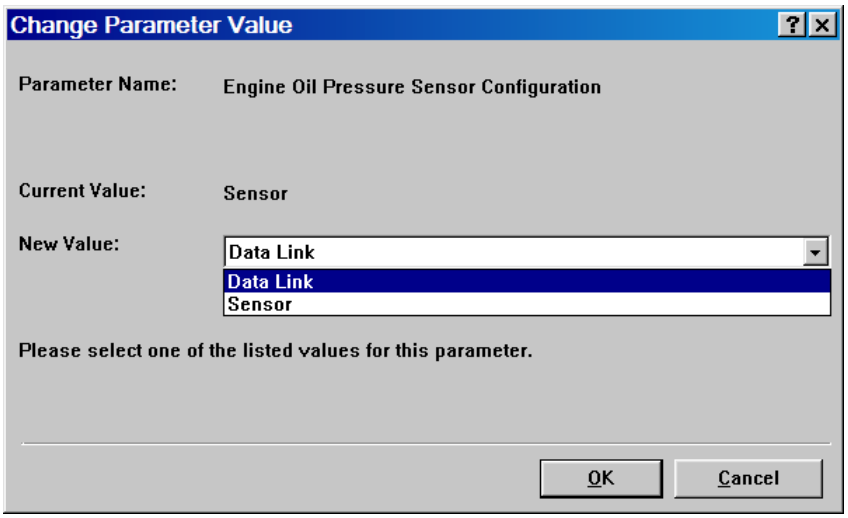
3. Double click the Engine Coolant Temperature Sensor Configuration setpoint to change this value from the drop down menu. Click the OK button to program.



4. Select Engine Oil Pressure Monitor on the left.



5. Double click the Engine Oil Pressure Sensor Configuration setpoint to change this value from the drop down menu. Click the OK button to program.



4.6.5 Engine Oil Pressure

The Engine Oil Pressure setpoints need special care when programming. The first step is to set the configuration as either SENSOR or DATA LINK.

When SENSOR is configured, the physical sensor is connected directly to the EMCP 4. In this configuration, Analog Input #1 (normally used for Oil Pressure Sensor) is configured with the desired setpoints for the rated speed Oil Pressure warnings and shutdowns. The idle speed step and idle oil pressure setpoints are still configured under the Engine Oil Pressure Monitor.

When DATA LINK is configured, the physical sensor is connected to the engine ECM. The engine ECM is configured with setpoints to protect the engine. Sensor values may also be communicated to the EMCP over the data link. The EMCP allows for redundant setpoints to be assigned based on this information seen from the engine.

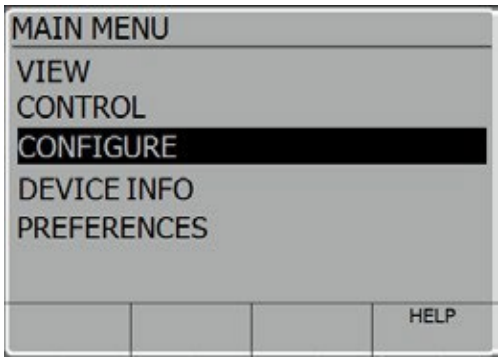
Sensor Configuration

In SENSOR configuration, Analog Input #1 contains the parameters for warnings and shutdowns for High and Low OIL PRESSURE. Security Level 3 is required to program Analog Input #1.

To Configure Analog Input #1 for Engine Oil Pressure:

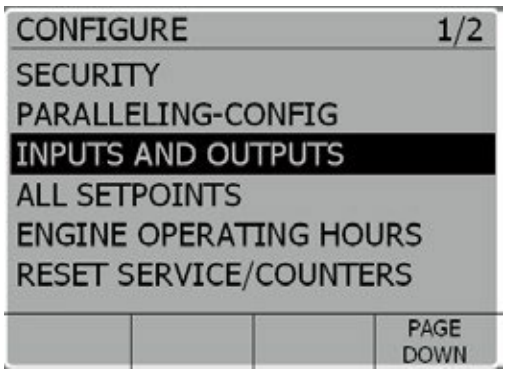
1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY .



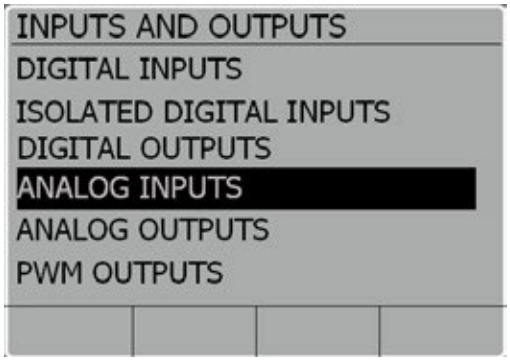
3. SCROLL DOWN  to INPUTS & OUTPUTS.

4. Press the OK KEY .



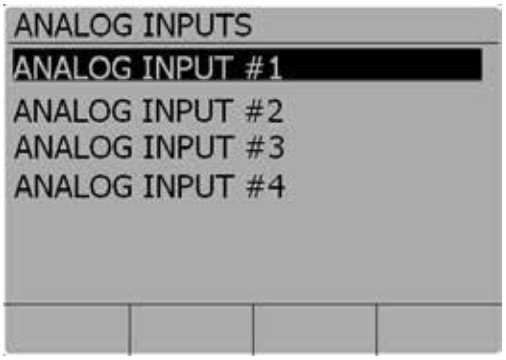
5. SCROLL DOWN  to ANALOG INPUTS.

6. Press the OK KEY . Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

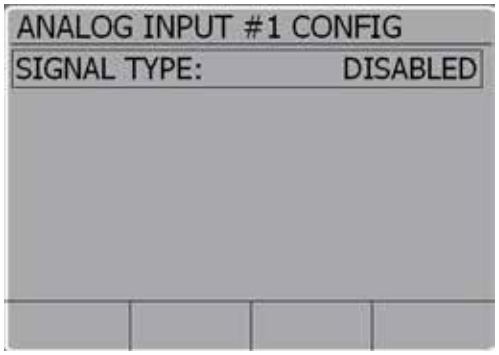


7. Select the ANALOG INPUT #1.

8. Press the OK KEY .

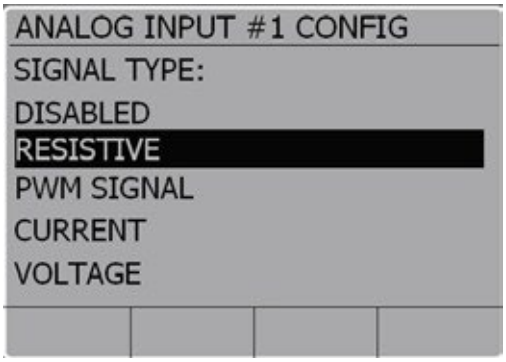


9. Press the OK KEY  to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



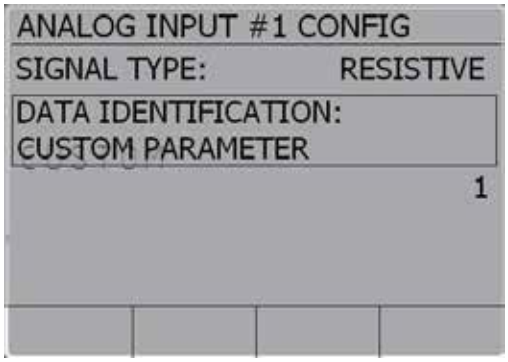
10. Scroll DOWN  to RESISTIVE.

11. Press the OK KEY .



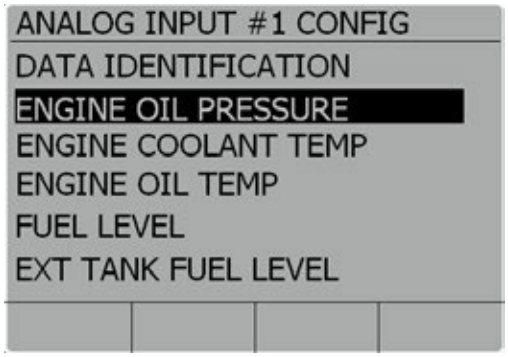
12. Scroll DOWN  to DATA IDENTIFICATION.

13. Press the OK KEY  to change the current DATA IDENTIFICATION.



14. Select the DATA IDENTIFICATION to ENG OIL PRES.

15. Press the OK KEY .



16. Scroll DOWN  to configure the remaining setpoints for Analog Input #1:

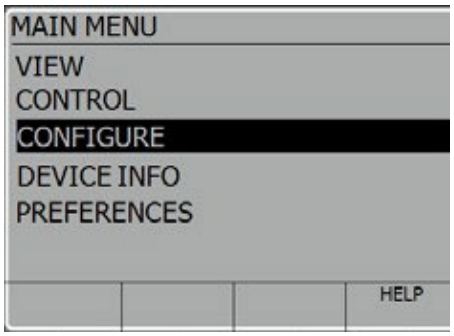
- Map Selection Number
- Low Warning Threshold
- Low Warning Delay
- Low Warning Event Response
- Low S/D Threshold
- Low S/D Delay
- Low S/D Event Response
- Shared Supply Voltage

In addition to the setpoints for high and low Oil Pressure available in Analog Input #1, setpoints for LOW IDLE LOW OIL PRESSURE and STEP SPEED are also available in the ENG MONITOR/PROTECT menu.

To Configure These Setpoints:

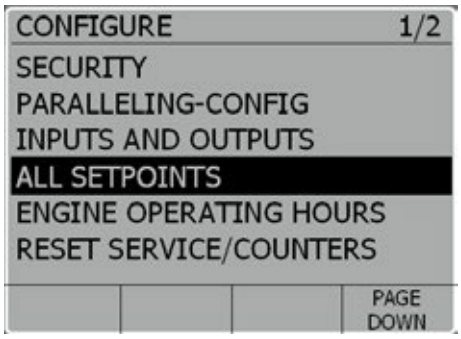
1. At MAIN MENU SCROLL DOWN to CONFIGURE.

2. Press the OK KEY.



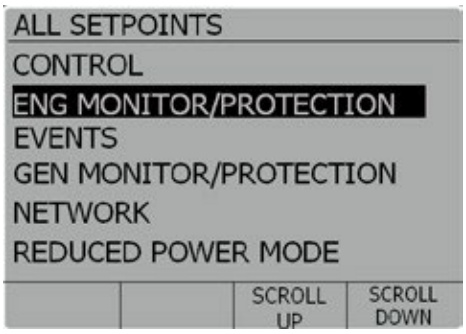
3. Scroll DOWN to ALL SETPOINTS.

4. Press the OK KEY.



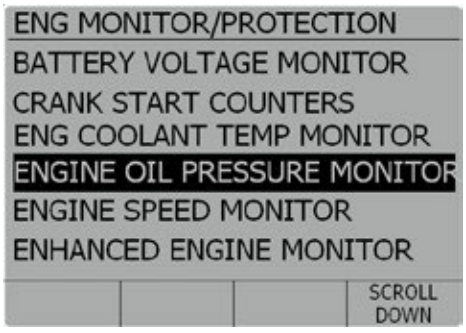
5. SCROLL DOWN to ENG MONITOR/PROTECT.

6. Press the OK KEY.



7. SCROLL DOWN to ENG OIL PRES MON.

8. Press the OK KEY.



Note: Level 3 password is required.

9. Scroll DOWN  to configure the remaining setpoints for Engine Oil Pressure Monitor:

- Low Eng Oil Pressure Warning Threshold*
- Low Idle Low Eng Oil Pres Warn Threshold*
- Low Eng Oil Pressure Warning Delay Time*
- Low Eng Oil Pressure Shutdown Threshold*
- Low Idle Low Eng Oil Pres S/D Threshold
- Low Idle Low Eng Oil Pressure Shutdown Delay Time
- Low Engine Oil Pressure Step Speed

Note: All DATA LINK OIL PRESSURE* setpoints in this menu are inactive and hidden when in SENSOR configuration. The Low Idle setpoints are still active regardless of SENSOR or DATA LINK. Setpoints are labeled as DATA LINK to refer to the fact that they are only active when the DATA LINK configuration is chosen.

Data Link

The OIL PRESSURE setpoints when in the DATA LINK configuration are redundant to the primary protection provided by the engine ECM. If these protections are not programmed to match those in the ADEM and an event occurs, check the Event Logs to determine which module generated the event.

4.6.6 Engine Coolant Temperature

The Engine Coolant Temperature setpoints need special care when programming. The first step is to set the configuration as either SENSOR or DATA LINK.

When SENSOR is configured, the physical sensor is connected directly to the EMCP. In this configuration, Analog Input #2 (normally used for Coolant Temperature) is configured with the desired setpoints for Coolant Temperature warnings and shutdowns.

When DATA LINK is configured, the physical sensor is connected to the engine ECM. The engine ECM is configured with setpoints to protect the engine. Sensor values may also be communicated to the EMCP over the data link. The EMCP allows for redundant setpoints to be assigned based on this information seen from the engine.

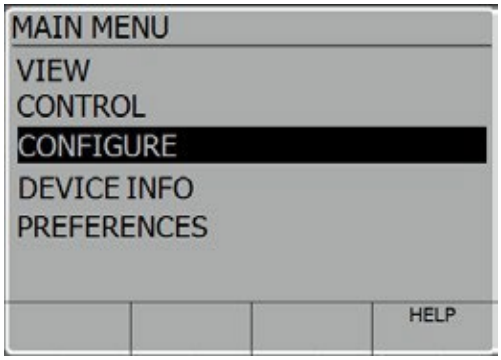
Sensor Configuration

In SENSOR configuration, Analog Input #2 contains the configurations for alarms and shutdowns for High and Low COOLANT TEMPERATURE. Security Level 3 is required to program Analog Input #2.

To Configure Analog Input #2 for Engine Coolant Temperature:

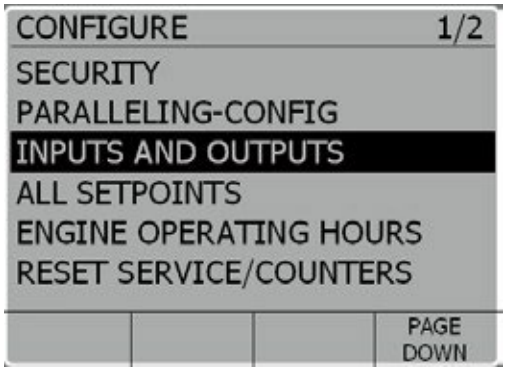
1. AT THE MAIN MENU, scroll down to CONFIGURE.

2. Press the OK KEY.



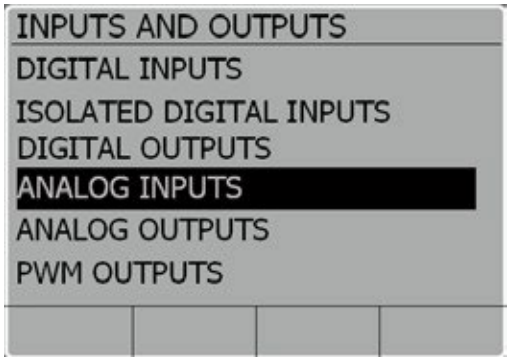
3. SCROLL DOWN to INPUTS & OUTPUTS.

4. Press the OK KEY.



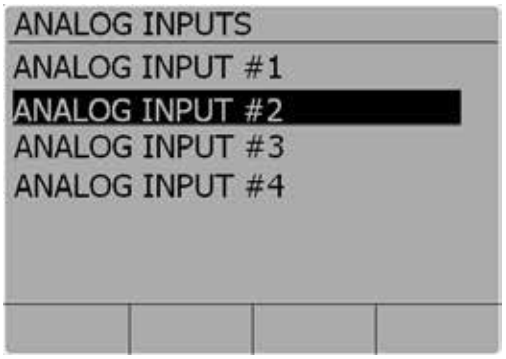
5. SCROLL DOWN to ANALOG INPUTS.

6. Press the OK KEY.
   Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



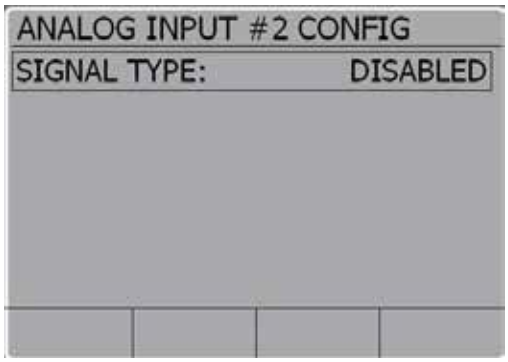
7. Select the ANALOG INPUT #2.

8. Press the OK KEY.



9. Press the OK KEY 

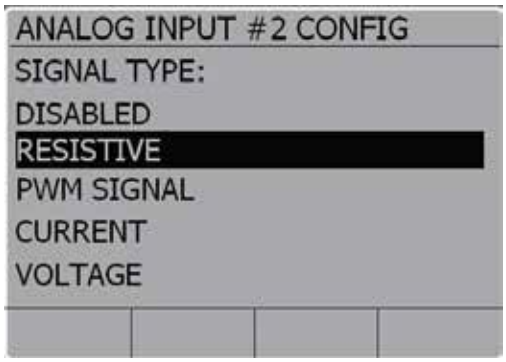
to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



10. Scroll DOWN  to RESISTIVE.

11. Press the OK KEY 

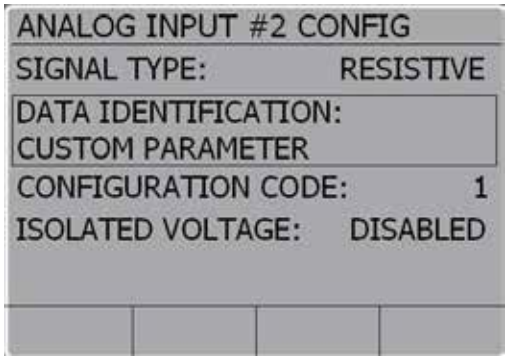
.



12. Scroll DOWN  to DATA IDENTIFICATION.

13. Press the OK KEY 

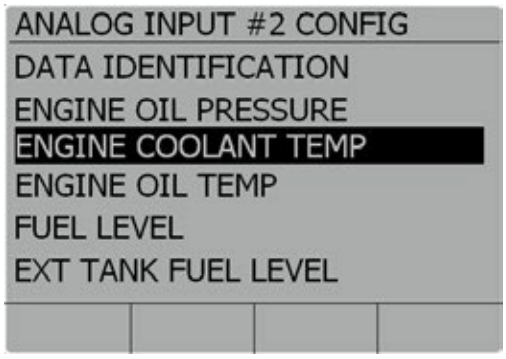
to change the current DATA IDENTIFICATION.



14. Select the DATA IDENTIFICATION to ENG COOLANT TEMP.

15. Press the OK KEY 

.



16. Scroll DOWN  to configure the remaining setpoints for Analog Input #2:

- Map Selection Number
- High Warning Threshold
- High Warning Delay
- High Warning Event Response
- High Warning Threshold
- Low Warning Delay
- Low Warning Event Response
- High S/D Threshold
- High S/D Delay
- High S/D Event Response
- Shared Supply Voltage

Note: All COOLANT TEMP setpoints in the ENG MONITOR/PROTECT menu are inactive when in SENSOR configuration. They are labeled as DATA LINK to refer to the fact they are only active when the DATA LINK configuration is chosen.

Data Link

The COOLANT TEMPERATURE setpoints when in the DATA LINK configuration are redundant to the primary protection provided by the engine ECM. If these protections are not programmed to match those in the ADEM and an event occurs, check the Event Logs to determine which module generated the event.

4.7 Starting and Stopping the Generator Set

4.7.1 Starting the Engine

Once the control is configured correctly, the control panel is powered up, and the generator set is ready to be operated, the generator set can be started. Figure 4.4 Stopping the Engine. There are several ways the generator set can be started from the control panel.

To START the Engine:

1. In MANUAL OPERATION, press the RUN KEY 

   or
   Activate a Digital Input programmed for ECS in Run
   or
   Place the control in AUTO mode, then

The engine can be started THREE DIFFERENT WAYS.

a. Activate DEDICATED DISCRETE INPUT #2, which is the REMOTE START INPUT OR DEDICATED ISOLATED DISCRETE INPUT #1 which is the GROUP START INPUT.

b. Activate a REMOTE INITIATE over the MODBUS data link.

c. Configure a PROGRAMMABLE CYCLE TIMER. See Chapter 18.

When the control panel initiates a start command on an engine, the control checks to make sure there are no SHUTDOWN EVENTS present (labeled PRESENT) or that there are no latched SHUTDOWN EVENTS (labeled ACTIVE).

If there are no shutdown events that are active or present, and after any pre-crank or start-aid activities have completed, the starter motor and fuel control will be activated. The EMCP 4 will activate the Digital Output programmed to activate the starter motor magnetic switch, and the Digital Output programmed to activate the fuel enable circuit.

On electronic engines with ADEM A3 or newer engine ECMs using Common Engine Interface, the start command and fuel enable signals may be sent from the EMCP 4 to the engine ECM via the PRIMARY CAN data link. After receiving the signals, the engine ECM will operate the fuel control relay and starter motor magnetic switch. Digital Outputs #1 and #2 are not needed on those engines and can be configured for other uses.

The Starter Motor Relay will remain active until the programmed ENGINE CRANK TIME has been reached, or until the engine speed has reached the programmed CRANK TERMINATE SPEED setpoint value.

Note: The EMCP 4 Crank setpoints number of cranks, crank duration, and crank terminate speed are not used on engines with the Common Engine Interface option or newer engine ECM. These values must be adjusted in the engine ECM.

Caution: To determine the exact starting sequence for your engine, consult your engine's Operation and Maintenance Manual.

Note: If a Digital Input is programmed for ECS in Auto, or Run, or Stop, and a maintaining switch latches that input to make it active, the front panel buttons will not have any effect.

4.7.2 EMCP 4 Remote Start

The EMCP 4 has the ability to accept a remote start signal. If this signal is activated, the EMCP will send an Engine Start request to the engine controller. If the Remote Start signal is removed, the EMCP will send a Stop request signal to the engine controller. A momentary signal will not keep the engine running.

This signal should be wired into pin 91 on the 120-pin connector. This input will be logically active when pulled down to battery.

4.7.3 Stopping the Engine

Once the engine is started, the engine can be stopped by pressing the STOP KEY 

on the control panel, or activating a Digital Input programmed for ECS in Stop. If the control is in AUTO, the engine can also be stopped by DEACTIVATING all of the remote initiate commands. There are three possible sources for this command:

1. The REMOTE START INPUT

2. The REMOTE START COMMAND over the Modbus data link.

3. The PROGRAMMABLE CYCLE TIMER. See Chapter 18.

Once the STOP command is issued, the control will go into COOLDOWN MODE. Cooldown mode will run for the duration of time that it is programmed in the COOLDOWN DURATION setpoint. If the cooldown time is set for zero minutes, the engine will stop immediately.

On engines with ADEM A4 or newer engine ECMs using Common Engine Interface (CEI), the cooldown timer in the EMCP 4 should be set to 0 (Zero) minutes because the cooldown time is controlled from the engine ECM (if this is not done, both cooldown timers will run in sequence). Also, the ENGINE OPERATING STATE INPUT CONFIGURATION parameter must be set to CAN INPUT.

The cooldown timer on the EMCP can be overridden by pressing and holding the STOP KEY 

for approximately 5 seconds. The display will show a splash screen that will ask if you want to BYPASS COOLDOWN? or continue with the cooldown cycle.

If the OK KEY 

is pressed from the splash screen, the cooldown timer will be bypassed.

If the ESCAPE KEY 
is pressed from the splash screen, the cooldown cycle will continue until the programmed cooldown time has elapsed.

When the cooldown timer has elapsed or has been bypassed, the Discrete or Relay Output programmed for fuel injection will be deactivated (by default, Relay Output #2 will deactivate, but this may be programmed differently). The STOP command will also be sent over the PRIMARY CAN data link for those engines that require it. The engine will come to a stop.

Any time, while the engine is RUNNING:

If the EMCP 4 detects a condition where an engine or generator parameter is ABOVE or BELOW programmed thresholds for a programmed amount of time, or another SHUTDOWN EVENT occurs, then the EMCP 4 will attempt to shut the engine down.

Note: Event behavior is determined by setpoints called EVENT RESPONSE CONFIGURATIONS. If a shutdown-type event's EVENT RESPONSE CONFIGURATION is disabled or not set to shutdown, it may not shut the engine down. Appropriate default values are pre-configured in the factory. Modify EVENT RESPONSE CONFIGURATIONS at your own risk! See Section 5.2.

Note: If a Digital Input is programmed for ECS in Auto, or Run, or Stop, and a maintaining switch latches that input to make it active, the front panel buttons will not have any effect.

Depending on how a specific EVENT RESPONSE configuration is programmed, the EMCP 4 will either put the engine in COOLDOWN, followed by a shutdown (SOFT SHUTDOWN) or shut the engine down immediately (HARD SHUTDOWN). See Figure 4.4.

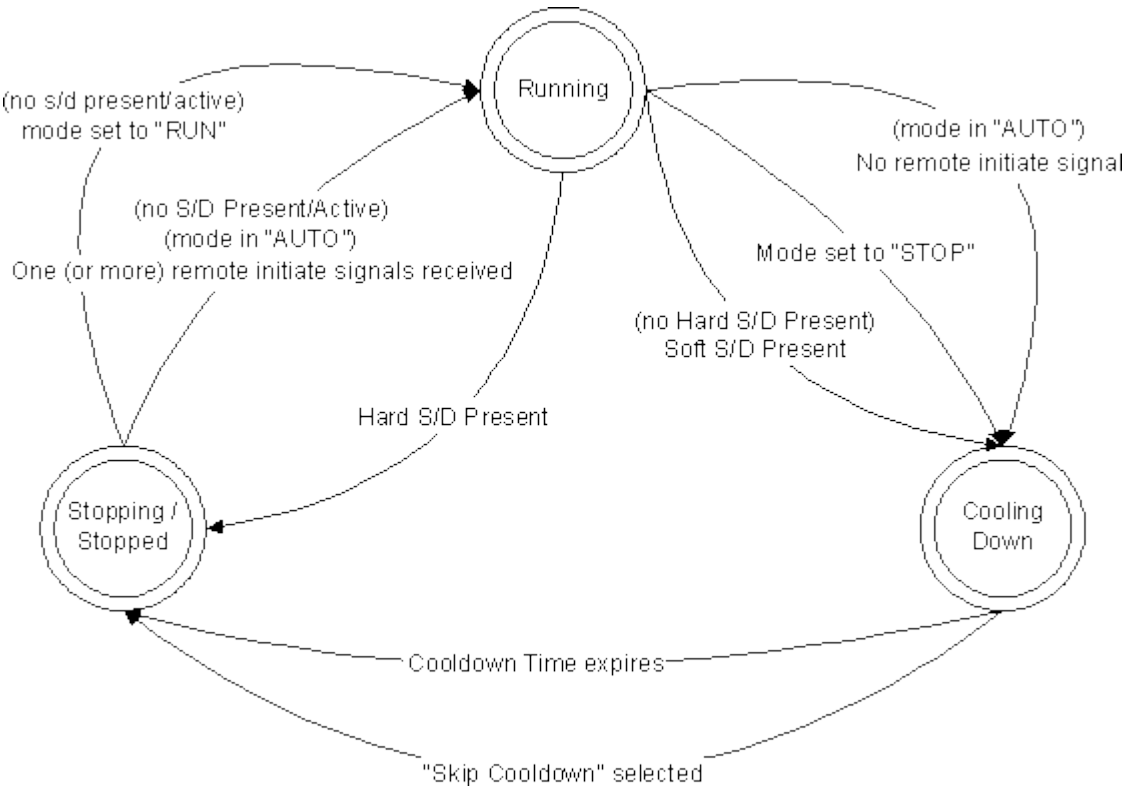


Figure 4.4 – Stopping the Engine

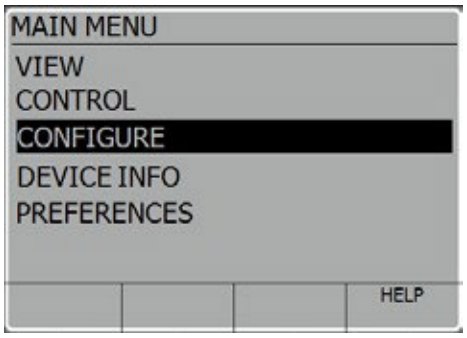
4.7.4 Emergency Stop

The EMCP 4 Emergency Stop input is configurable as Active High, or Active Low. The active state may be configured within the EMCP 4 display or within Cat ET.

To Configure the E-Stop Active State Configuration from the Display, Do the Following:

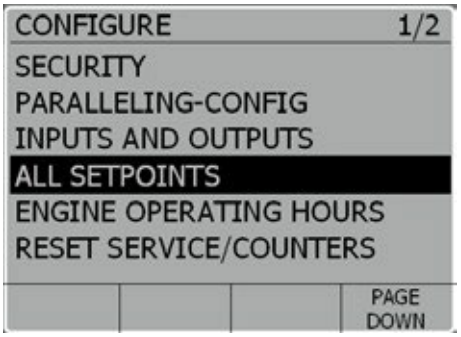
1. At MAIN MENU SCROLL DOWN to CONFIGURE.

2. Press the OK KEY.



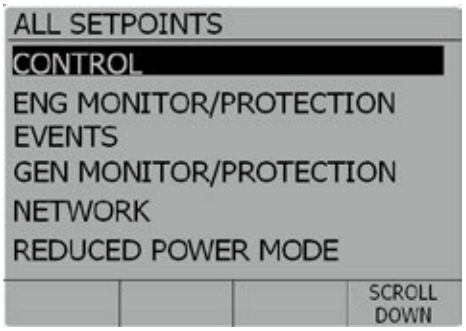
3. Scroll DOWN to ALL SETPOINTS.

4. Press the OK KEY.



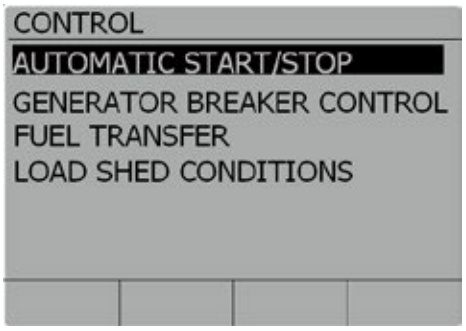
5. SCROLL DOWN to CONTROL.

6. Press the OK KEY.

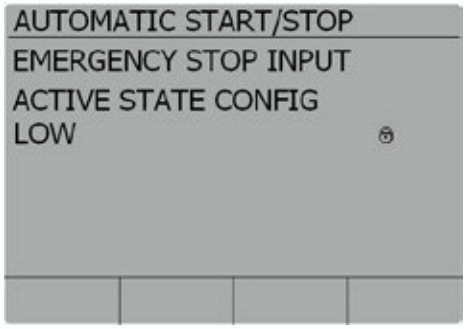


7. SCROLL DOWN to AUTO START/STOP.

8. Press the OK KEY.



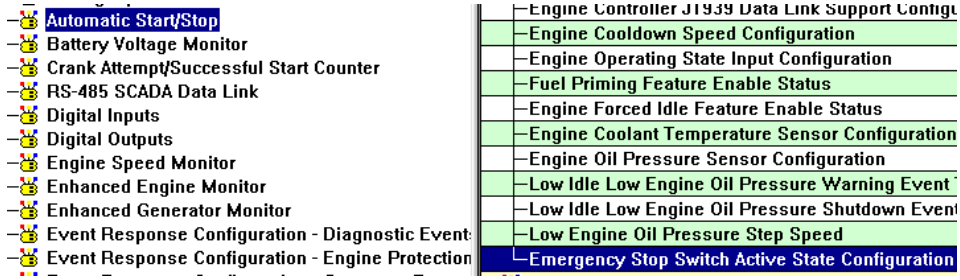
9. SCROLL DOWN  to EMERGENCY STOP INPUT ACTIVE STATE CONFIG.



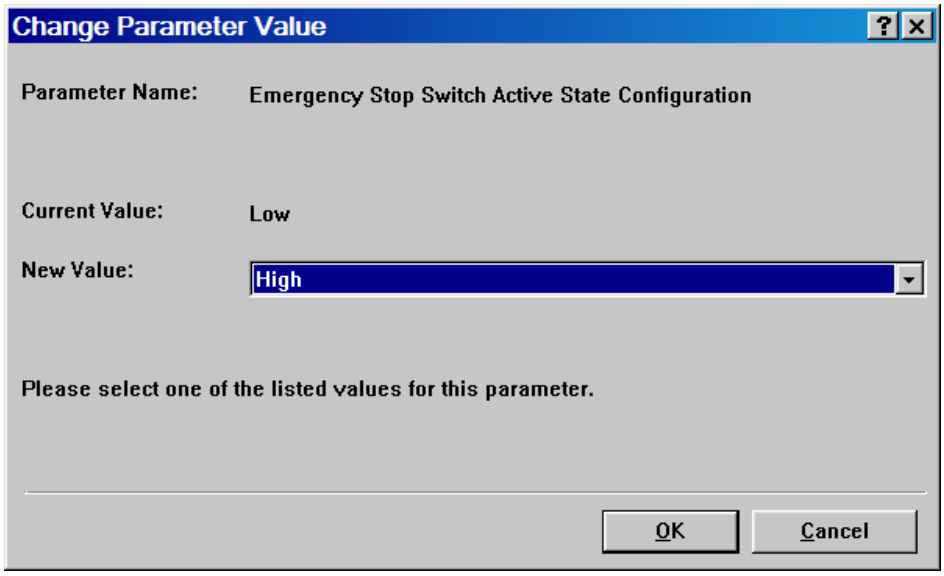
To Change the E-Stop Active State Configuration with ET, Do the Following:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

2. Select Automatic Start/Stop on the left.



3. Double click Emergency Stop Switch Input Configuration on the right to select a new value.



4.8 Engine Setpoint Verification

The engine setpoint verification procedure verifies that the EMCP 4 operates correctly when a LOW OIL PRESSURE or HIGH COOLANT TEMPERATURE event occurs. The engine setpoint verification procedure also verifies that the EMCP 4 operates correctly when an ENGINE OVERSPEED event occurs.

On an ENGINE OVERSPEED EVENT, the EMCP 4 will shut the engine down.

LOW OIL PRESSURE and HIGH COOLANT TEMPERATURE each have two events, WARNING and SHUTDOWN. The EMCP 4 will issue a WARNING whenever the warning threshold is reached and a SHUTDOWN whenever the shutdown threshold is reached. This verification procedure will modify configuration setpoints used in normal operation. The steps below outline how to perform the LOW OIL PRESSURE SHUTDOWN and HIGH COOLANT TEMPERATURE SHUTDOWN PROCEDURE. A similar process can be used for LOW OIL PRESSURE WARNING and HIGH COOLANT TEMPERATURE WARNING, along with LOW IDLE LOW OIL PRESSURE.

During this procedure:

- Each configuration setpoint should be recorded prior to adjustment.
- Returned back to the original setting after the setpoint has been verified.

The following conditions are required before the ENGINE SETPOINTS are verified:

Required Conditions

- The setpoints must be correct for the engine application.
- No shutdown events should be present. If necessary, troubleshoot, correct, and reset any and all shutdown events.

4.8.1 Procedure for Overspeed Verification

Note: Adjustment of ENGINE OVER SPEED SHUTDOWN THRESHOLD setpoint from the display requires a level 3 password. For details on changing security levels refer to Chapter 6, Security.

The Security Level only affects changing parameters from the EMCP 4. Changing parameters with the Cat Service Tool does not require passwords.

1. Start the engine and run the engine at rated speed.
2. Adjust the setpoint value for Engine Over Speed Shutdown Threshold to a value that is below the speed that the engine is running at. An Engine Overspeed Shutdown event will occur immediately after the setpoint is changed, and the engine will shut down.
3. View the event by going to the Generator Set Control event log. Reset the event. For more information about how to view and reset the event, refer to Chapter 5, Handling Events.
4. Return the setpoint value for Engine Over Speed Shutdown Threshold to the original value.

4.8.2 Procedure for Low Oil Pressure Verification

Note: Low Oil Pressure Shutdown is disabled during start-up and while the engine is not running by the Fault Protection Timer (FPT). The fault protection timer starts timing when crank terminate rpm is reached during the starting sequence. The fault protection timer will then run for a programmed time which is determined by the Engine Start Fault Protection Activation Delay Time setpoint. Make sure the fault protection timer has elapsed before starting the Low Oil Pressure Verification.

1. Start the engine and run the engine at rated speed.

2. Determine whether the controller is set for SENSOR or DATA LINK, refer to Section 4.6.

   If SENSOR is selected, perform steps 3-5 in the CONFIGURE-INPUTS & OUTPUTS-ANALOG INPUTS configuration for ANALOG INPUT#1 setpoints.

   If DATA LINK is selected, perform steps 3-5 in the CONFIGURE→ALL SETPOINTS-ENG MONITOR/ PROTECT-ENG OIL PRES MON setpoints.

3. Adjust the setpoint value for Low Engine Oil Pressure Shutdown Event Threshold to a value that is above the oil pressure that the engine is operating at. The shutdown event will occur after the programmable time delay (the Low Engine Oil Pressure Shutdown Delay Time setpoint).

4. View the event by going to the Generator Set Control event log. Reset the event. For more information about how to view and reset the event, refer to Chapter 5, Handling Events.

5. Return setpoint value for Low Engine Oil Pressure Shutdown Event Threshold to the original value.

4.8.3 Procedure for High Coolant Temperature Verification

Note: High Coolant Temperature shutdown is disabled during start-up and while the engine is not running by the Fault Protection Timer (FPT). The fault protection timer starts timing when the crank terminate rpm is reached during the starting sequence. The fault protection timer will then run for a programmed time (the Engine Start Fault Protection Activation Delay Time setpoint). Make sure the fault protection timer has elapsed before starting the High Coolant Temperature Verification.

1. Start the engine and run the engine at rated speed.

2. Determine whether the controller is set for SENSOR or DATA LINK, refer to Section 4.6.

   If SENSOR is selected, perform steps 3-5 in the CONFIGURE-INPUTS & OUTPUTS-ANALOG INPUTS configuration for ANALOG INPUT#2 setpoints.

   If DATA LINK is selected, perform steps 3-5 in the CONFIGURE-ALL SETPOINTS-ENG MONITOR/ PROTECT-ENG COOL TEMP MON setpoints.

3. Adjust setpoint value for High Engine Coolant Temperature Shutdown Event Threshold to a value that is below the engine coolant temperature that the engine is operating at. The minimum value for this setpoint is 49ºC (120ºF), so you may have to run the engine for a few minutes to get the temperature above the minimum value. The shutdown event will occur after the programmable time delay (the High Engine Coolant Temperature Shutdown Event Notification Delay Time setpoint).

4. View the event by going to the Generator Set Control event log.

5. Reset the event. Refer to Handling Events for more information about how to view and reset the event.

6. Return setpoint value for High Engine Coolant Temperature Shutdown Event Threshold to the original value.

4.9 Engine Operating Hours

One of the features of the EMCP 4 is the ability to maintain the ENGINE OPERATING HOURS, which is the cumulative amount of time that the engine has run above the Crank Terminate speed. This time is displayed on the Engine Overview screen, just below Battery Voltage.

4.9.1 Updating Engine Operating Hours

For applications where a new EMCP 4 is fitted to a generator set that was previously in operation, the EMCP 4 allows the user to increment the engine hours to match the engine.

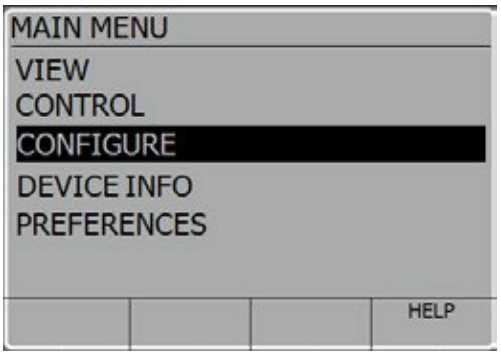
Note: Engine Hours can only be increased. They cannot be decreased.

This procedure can be performed with ET under the Information/Current Totals Menu or on the EMCP 4 display. In order to update engine hours using the display, LEVEL 3 ACCESS is required. Refer to Chapter 6, Security for information on obtaining LEVEL 3 ACCESS.

Updating Engine Hours

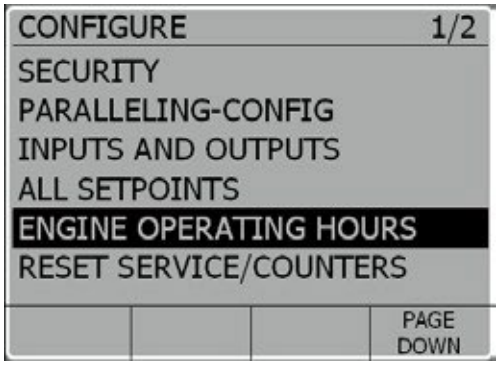
1. At MAIN MENU SCROLL DOWN  to CONFIGURE.

2. Press the OK KEY .



3. Scroll DOWN  to ENGINE OPERATING HOURS.

4. Press OK KEY . (If pressing OK has no effect, then Level 3 access has not been obtained .)



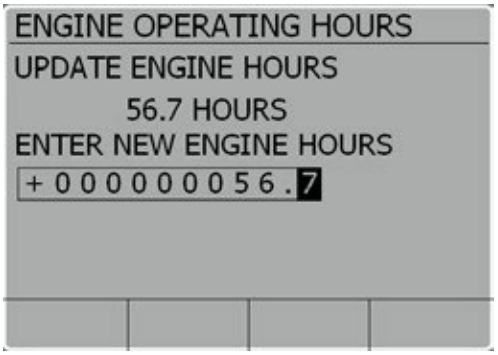
Current Engine Hours Are Displayed

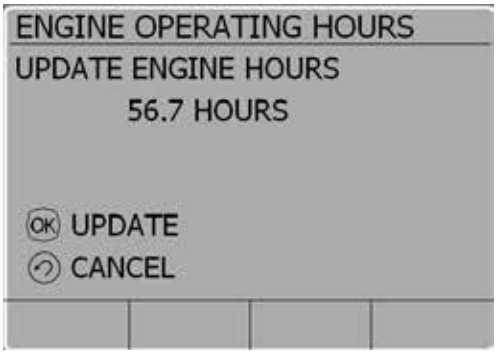
1. To edit the ENGINE HOURS, select a digit using the LEFT ARROW  or RIGHT ARROW .

2. To change the selected digit use the UP ARROW  or DOWN ARROW .

3. To accept the changes, press the OK KEY . To reject the changes, press the ESCAPE KEY .

4. Again, press the OK KEY  to confirm, or the ESCAPE KEY  to reject the changes.





5.0 Handling Events

The EMCP 4 shows previous and current events from both the EMCP and external modules. These events are organized into logs for each physical module the EMCP 4 is receiving EVENT messages from.

The logs include:

STATUS EVENTS	Recent operational event history (See Section 5.8)
GENSET CONTROL	Events for the EMCP 4 GSC
ENGINE CONTROL	Events for a Primary CAN Data Link-compatible engine ECM
DIGITAL AVR	Events for the Cat Digital Voltage Regulator (Cat DVR)
THERMOCOUPLE	Events for the Thermocouple Module
EXTERNAL I/O	Events for the Discrete Input/Output (DIO) module
RTD MODULE	Events for the Resistive Temperature Device (RTD) module
SCR MODULE	Events for Engine Aftertreatment systems

The Genset Control Log stores events generated by the EMCP 4. Any other event is stored within the module that generated the event. Even if the EMCP annunciates an event, it does not mean that the EMCP logs that event. It may be within another module's log.

Each log is visible only if the module is connected to the appropriate data link, either the Primary data link or the Accessory data link, and is communicating with the EMCP 4.

The list of Event Logs can be viewed by pressing the Event Log key 

or via the View Submenu. Select the log you wish to view and press OK to view the events.

The EMCP 4 supports more than one instance of some of the above modules. (See Chapter 31, for the number of modules supported by each of the EMCP models). Those modules are uniquely identified with a number at the end of the log name.

The module number is software-configured, and is called the module's ECU INSTANCE NUMBER. The ECU Instance Number can be viewed and modified by the Cat Service Tool. See the appropriate sub section of Chapter 31, for the expansion module in question, to see how to program the Instance Number.

An event in the EMCP 4 Genset Control Log can be in one of three states: PRESENT, ACTIVE, or INACTIVE.

Present

This state is only applicable to the Genset Control Log. PRESENT means that the condition that caused the event is still present. The condition needs to be addressed before the event can be reset.

Note: This state only applies to Genset Control Events. Other modules will not have Present in logs.

Active

The event was previously in a “Present” state, but it is no longer present. It has been latched by the event system and needs to be reset before the engine can be restarted.

Within the Generator Set Control Log, the condition that caused the event is still affecting the system, but may be reset. (See Sections 5.3 to 5.6 on how to Reset Events). Warning type events automatically reset when the condition that caused the event is resolved and will never be Active.

Within any log other than the Generator Set Control Log, the condition that caused the event is affecting the system. The event may, or may not, be resettable. If the Reset All command fails to reset the event, then this event is still occurring and must be resolved before the event can be reset.

Note: Many events go from Present to Active when the engine is shutdown and may reoccur once the engine starts running again. Further action may be required to resolve the issue.

Inactive

The event has happened at some time in the past but is no longer affecting the system. Inactive events are stored for historical purposes only.

5.1 Configuring Event Responses

The category of event, as well as other behavior when an event occurs, can be configured via a group of EMCP 4 setpoints called EVENT RESPONSE CONFIGURATIONS. An example of an event response configuration is LOW ENGINE LOW OIL PRESSURE WARNING EVENT RESPONSE CONFIGURATION. This setpoint determines what actions the EMCP 4 takes when it receives an event.

Note: Event Response Configuration is only valid for the EMCP 4, not any other modules.

Each EVENT RESPONSE CONFIGURATION type setpoint can either be viewed or edited. By default, VIEW is highlighted. These setpoints can only be edited when the ECS (Engine Control Switch) is in the Stop mode.

The following is a list of all the possible options for an event response configuration:

Warning

Creates a Warning event in the event log and lights the amber LED. The engine will not shut down. A Warning event will reset by itself (i.e. it will go from the “Present” state to the “Inactive” state) as soon as the condition that caused it goes away.

Audible Alert

Determines whether this event will also trigger an audible horn. If so, the event activates any relays that are programmed for Horn Control (see Chapter 12). If no relay is programmed for Horn Control, no action will be taken; the EMCP 4 does not have an internal horn. Audible Alert can only be programmed if either a Warning or Shutdown is also programmed.

Soft Shutdown

Creates a Shutdown event in the event log, lights the red LED, and shuts the engine down after the cooldown period has expired (see Section 4.7: Starting and Stopping the Engine).

Hard Shutdown

Creates a Shutdown event in the event log, shuts the engine down immediately and lights the red LED.

Breaker #1 Trip

Activates a Breaker #1 Trip, which can be programmed for a Relay Output or Digital Output for external use. Breaker #1 refers to the Generator circuit breaker on an EMCP 4.4 controller. It may refer to the generator circuit breaker with an EMCP 4.3 controller.

Breaker #2 Trip

Activates a Breaker #2 Trip, which can be programmed for a Digital Output or Relay Output for external use. Breaker #2 may refer to a second circuit breaker.

Fault Protection Timer Enabled

Suppresses the event unless the engine is running and the Fault Protection Timer has expired (this prevents nuisance events during startup, or ones that are not relevant when the engine is stopped).

Active Only

Creates an Active Only event in the event log. Active Only events are for informational purposes only. They typically do not light the Amber LED or behave like a Warning (although many events can be configured to do so). When the condition goes away, the event disappears from the event log.

Note: Not all options are available for all setpoints. For example, the Engine Low Oil Pressure Warning event cannot be configured as a shutdown, because there is a separate event (Engine Low Oil Pressure Shutdown) dedicated for that purpose. Likewise, events cannot be generated for any and all conditions. For example, a Low Engine Coolant Temperature Shutdown is meaningless and cannot be generated.

5.2 Changing an Event Response Configuration

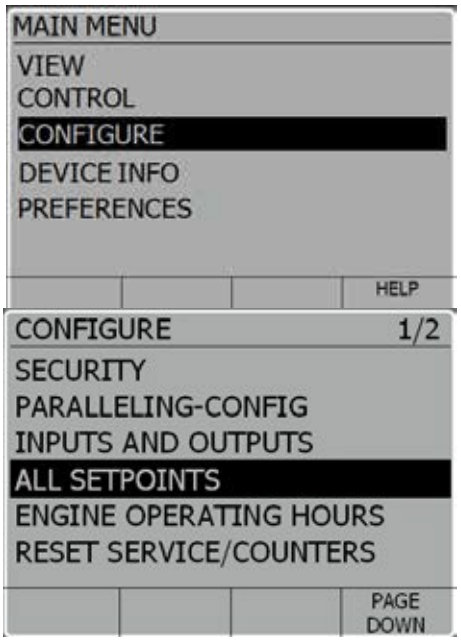
To change an event response configuration, the control must be in STOP mode.
Here are the steps to access event response configurations on the EMCP 4 display.

1. At the MAIN MENU, scroll DOWN  to CONFIGURE.

2. Press the OK KEY .

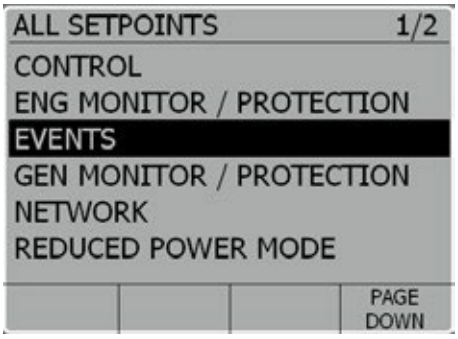
3. Scroll DOWN  to ALL SETPOINTS.

4. Press the OK KEY .



5. Scroll DOWN  to EVENTS.

6. Press the OK KEY .



The group name should help find the setpoint. However, a list of setpoints in each group, or submenu is given in Table 5.1.

Diagnostics Config
- Accessory Data Link
- Engine Speed
- Primary Data Link
- RS-485 SCADA Data Link
- TCP/IP SCADA Data Link
- Battery Charger Fail
- Eng Cont Not Responding
- RS485-Annunciator Data Link
- Analog Inputs
- MGDL Comms Failure
- MGDL Unit Not Detected

Engine Protection Config

Pressures
- Engine Oil
- Gas Pressure

Temperatures
- Engine Coolant
- Engine Oil
- Exhaust

Levels
- Engine Coolant
- Engine Oil
- Fuel Level
- Ext Fuel Tank Level
- Aftercooler Level
- Bund Level

Others
- Air Damper Closed
- Unexpected Engine Shutdown
- Overspeed
- Underspeed
- Emergency Stop
- Fail to Start
- Fuel Leak
- Service Maintenance Interval
- Engine Inlet Manifold Charge Combustion
- Remote E-Stop

Generator Protection Config
- Generator Rear Bearing Temperature
- Generator Overcurrent
- Generator Over Frequency
- Generator Under Frequency
- Reverse Power
- Generator Over Voltage
- Generator Under Voltage
- Earth Fault
- Generator Winding Temperature #1
- Generator High Power
- Generator Current Balance
- Reverse Reactive Power
- Gen to Bus Synch Failure
- Gen Not Ready to Auto Parallel
- Prog kW Relay Levels
- Dead Bus Inconsistent Sensing

Custom Event Config
- Digital Input Custom Events
- Analog Input Custom Events
- Aux #1 Event Inputs
- Aux #2 Event Inputs
- Aux #3 Event Inputs

Other System Config
- Battery Voltage
- Battery Charging System Voltage
- Engine in Cooldown
- Speed-Frequency Mismatch
- Not in Auto
- Earth Leakage
- EPS Supplying Load
- Battery Cranking Voltage
- Gen Breaker Fail to Open
- Gen Breaker Fail to Close

Event System
- Breaker #1 Trip Response Auto Reset Enable Status (only configurable within Cat ET)
- Engine Running Lamp Conditions

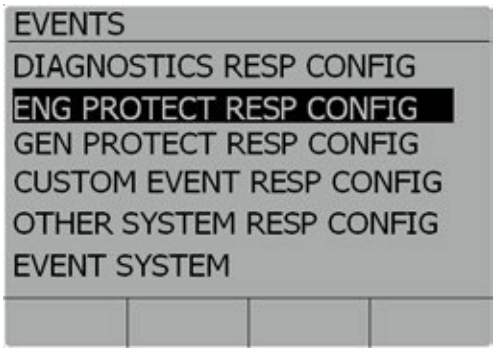
Table 5.1 – Event Response Configuration Setpoints

Example:

1. Select ENGINE PROTECTION CONFIG.

2. Press the OK KEY 

.

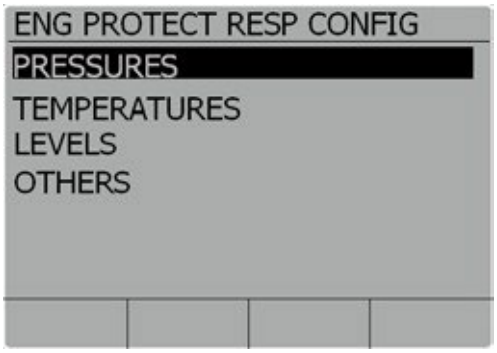


In this group of event response configurations, there are four types of events, grouped by the type of data: Pressures, Temperatures, Levels, and Others (such as status).

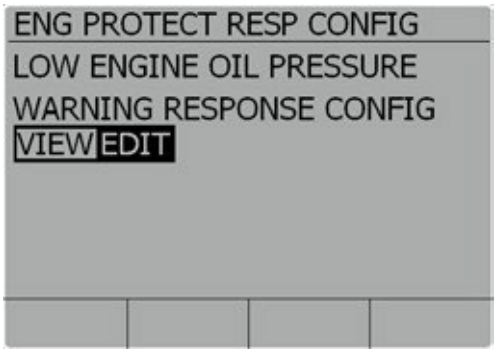
3. Select PRESSURES.

4. Press the OK KEY 

.



5. To edit a setpoint, press the RIGHT ARROW  key to highlight EDIT.



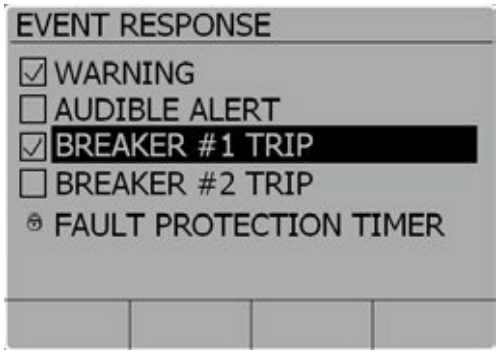
This brings up a list of event response configuration setpoints. Use the Up or Down arrows to scroll through the list.

Note: This will only work if the control is in STOP mode. Some setpoints cannot be configured, or require a minimum security level. Those setpoints will display a lock icon to the right of the EDIT text.

6. Then, press the OK KEY to edit the setpoint.

7. Use the LEFT ARROW  and RIGHT ARROW  to toggle between checked and unchecked, and use the UP ARROW  and DOWN ARROW  to move between the responses.

Here you can edit individual responses, as described above.



Some responses are fixed and cannot be disabled. For those responses, a lock will be displayed instead of a checkbox.

5.3 Resetting Individual Active Events for the EMCP 4

There are three ways to reset events. One way, described in this chapter, which applies to the EMCP 4 GSC only (the "Generator Set Control" log), is to reset individual Active events by navigating to the desired event in the event log, described below.

The second way, which applies to all modules other than the EMCP 4, is to reset all Active events in that module's event log by navigating to one of the Active events in the event log (see Section 5.4).

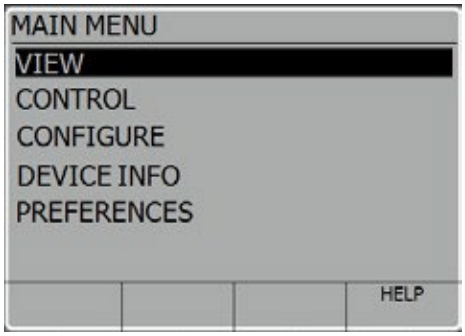
The third way is an approach that resets all Active events for all modules (see Section 5.5).

With any of these methods, you must be in STOP mode.

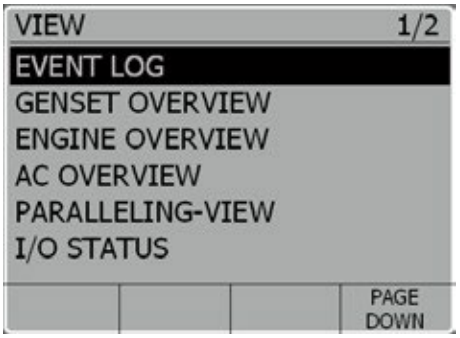
To reset individual events on the EMCP 4, start by navigating to the event log:

1. At MAIN MENU Select VIEW by pressing the OK KEY.

2. Alternately, press the EVENT LOG BUTTON to access the EVENT LOG.

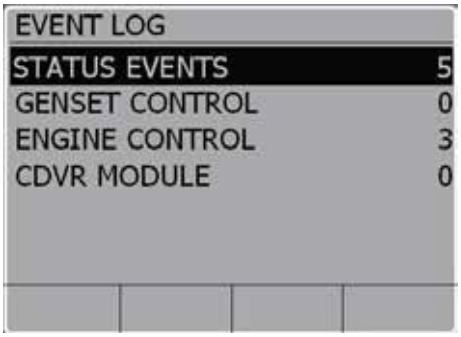


3. Select EVENT LOGS by pressing the OK KEY .



4. Scroll up or down to select the GENSET CONTROL Log.

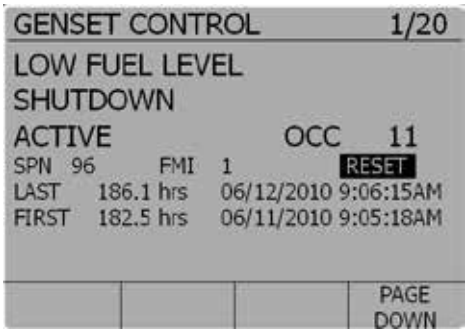
5. Press the OK KEY.



In this example image, there are five STATUS events and three PRESENT or ACTIVE events under Engine Control.

6. Scroll up or down through the list of events and find the ACTIVE event that requires resetting. If the control is in STOP mode, RESET will be shown and highlighted.

   Generally, events are ordered by the status of the event; PRESENT events are listed first, followed by ACTIVE events, and finally the INACTIVE events. Within each status, the events are listed with the most recent first.



7. Pressing the OK KEY will RESET the event.

Note: If the event status is present, the RESET text will not be visible and the event cannot be reset until the condition that caused the event has been addressed.

5.4 Resetting All Active Events for a Single Module

The second way to reset events, described in this chapter, which applies to all modules other than the EMCP 4, is to reset all of the module's Active events by navigating to one of the Active events in the event log. This method doesn't apply to the EMCP 4 Genset Control Log. For information on resetting events on the EMCP 4, see Sections 5.3 or 5.5. This method also doesn't apply to the Status Event log. For more information about the Status Event log, see Chapter 5.

With any method, you must be in STOP mode. A key difference between the EMCP 4 and all other modules is that the other modules don't display a PRESENT status for events.

Events are shown as ACTIVE if they are currently affecting the system, or as INACTIVE if they are not.

To reset all of a modules Active events on any individual module except the EMCP 4 (listed as GENSET CONTROL in the event log), start by navigating to the event log.

1 . At MAIN MENU scroll DOWN  to VIEW by pressing the OK KEY .

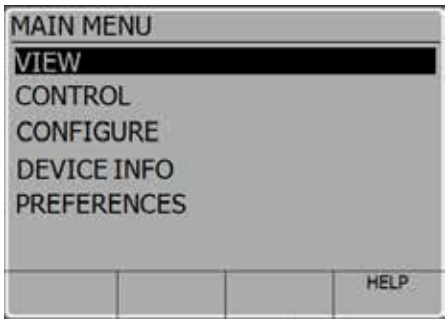
2 . Select EVENT LOGS by pressing the OK KEY .

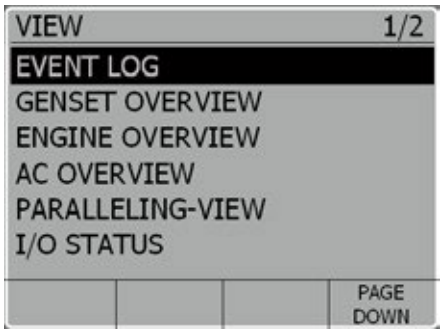
3 . Scroll up  or down  to select the desired log and Press the OK KEY .

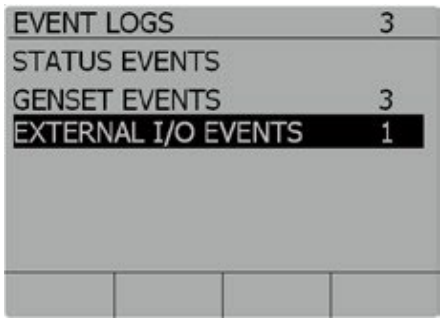
4 . Press OK KEY  to view an event .

Pressing the OK KEY  will RESET all of the ACTIVE events in that module's event log that can be reset .

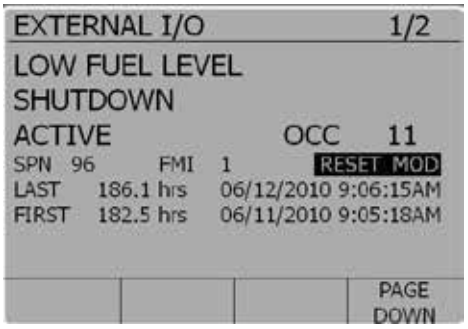
Note: Modules other than the EMCP 4 cannot display events as PRESENT . If pressing OK KEY  at RESET ALL doesn't reset all of the events, the condition causing the event being viewed may still be present . For example, if the engine shut down on high coolant temperature, then the events will not reset until the coolant temperature drops below the shutdown threshold .







In this example image, there are three PRESENT or ACTIVE events under Engine Control #1, and one ACTIVE event in the External I/O module .



If the control is in STOP mode, and engine speed is zero, RESET MOD will be shown and highlighted .

5.5 Resetting All Active Events for All Modules

The third way to reset events, described in this chapter, is a shortcut that resets all Active events for all modules. With any method, you must be in STOP mode.

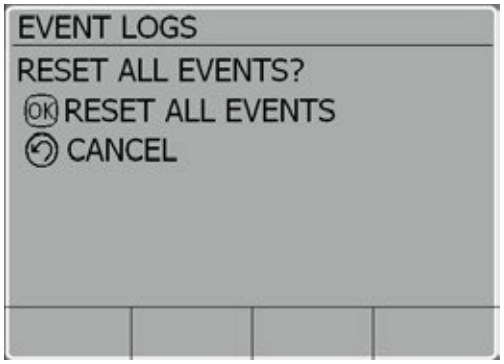
Once all of the condition(s) that are causing the events have been corrected, all Active events (those for which the condition is not present) on all modules can be reset using the RESET ALL EVENTS feature.

In order to do this, the control must be in STOP mode and engine speed should be zero. The Reset All command can be issued from the front EMCP display or via a SCADA Modbus connection. For information on performing the Reset All Events Command via Modbus, refer to the EMCP 4 SCADA Data Links, Application and Installation Guide (LEBE0010). To Reset All Events from the EMCP 4 display, perform the following:

From Any Screen:

1. Press the RESET KEY 

. A confirmation prompt will appear.



2. Pressing the OK KEY 

will continue and RESET all events on all modules.

3. Pressing the ESCAPE KEY  will CANCEL the reset operation.

4. The controller will display which events were reset, and which ones were not.

Note: Reset All Events will not reset Present events! For example, if the E-Stop switch is pressed and an EMERGENCY STOP SWITCH ACTIVATED SHUTDOWN is present, it cannot be reset until the E-Stop is pulled out and the event status changes from PRESENT to ACTIVE.

5.6 Resetting Events through Digital input

The user can reset all events on the EMCP and other modules through the activation of digital inputs. This functionality must be enabled by the Automatic Start/Stop setpoint Digital Input Electronic Control Unit Fault Reset Enable Status. This is configurable through the service tool or by obtaining level 3 password security on the EMCP (see Chapter 6 for how to obtain level 3 security).

- The control's engine control switch must be in STOP
- The engine cannot be running or stopping during the time of reset
- Any unacknowledged events must be acknowledged by either the alarm acknowledge digital input or by pressing the ACK button on the face of the control

Once these conditions are met, the active events can be reset by activating the digital input configured for ECU Fault Reset.

5.7 Resetting Events for Engine ECMs Without Primary CAN Data Link Support

The EMCP 4 has the ability to reset all events for electronic engines with no PRIMARY CAN support by means of a Digital Output. A number of conditions must be satisfied in order for this to work.

First

One of the Outputs must be configured as a Command/Status for ECU FAULT RESET. See Chapter 12.

Second

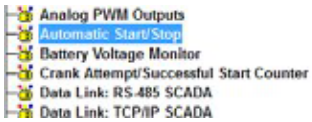
The corresponding output must be wired to a corresponding Fault Reset I/O pin on the engine ECM or it must be setup to power cycle the ECM.

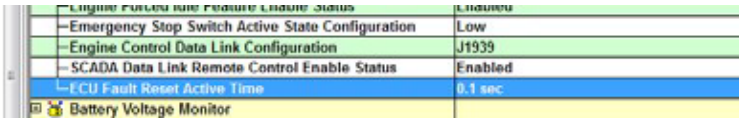
Third

Pressing the RESET ALL KEY 

or issuing a Reset All Command via SCADA Modbus with this option selected will activate the ECU FAULT RESET Digital Output and trigger the engine ECU to reset its faults or will power cycle the ECU. This will only activate the ECU FAULT RESET OUTPUT if the EMCP has a warning or fault. This warning or fault can be triggered by using a custom event on a digital input that is wired to the fault alarm of the ECU.

The amount of time the Digital Output configured for ECU Fault Reset is active is configurable in the EMCP 4 via the ECU Fault Reset Active Time setpoint. This setpoint is found in the Automatic Start/Stop setpoint group in ET or EMCP 4 display menu.





5.8 Troubleshooting Resetting Events

There are common reasons for the EMCP 4 not allowing events to be reset. First of all, in order to reset any event, the EMCP 4 must be in STOP mode. In order to reset engine ECM events, the engine speed must also be zero. SERVICE MAINTENANCE INTERVAL WARNING and NOT IN AUTO WARNING are explained more fully below.

5.8.1 Not In Auto Warning

This event is Present whenever the control is in either RUN or STOP. As a result, it cannot be reset in STOP

(since the event is present). The event will reset when the control is returned to AUTO 

. This event can be disabled by modifying the GENERATOR CONTROL NOT IN AUTOMATIC WARNING EVENT RESPONSE CONFIGURATION setpoint. See Section 5.2 for instructions on editing that setpoint.

5.8.2 Service Maintenance Interval

If a SERVICE MAINTENANCE INTERVAL WARNING is PRESENT, it cannot be reset. The warning is PRESENT because one of the countdown timers has reached zero. To clear the warning, the timer must be reset, rather than the event. When the timer is reset, it returns to the programmed interval (typical is 180 calendar days and 500 engine hours). This timer must be reset from the display; it cannot be reset by using the Service Tool alone. This warning can only be disabled with the Event Response Configuration. See Section 5.1.

Note: This warning does not appear on the face of the EMCP 4 as a flashing LED unless configured to do so within Cat ET under Event Response Configuration – Engine Protection Events.

To View and Reset the Timer Settings on the Display:

1. At MAIN MENU scroll DOWN  to CONFIGURE.

2. Press the OK KEY .

3. Scroll DOWN  to RESET COUNTER.

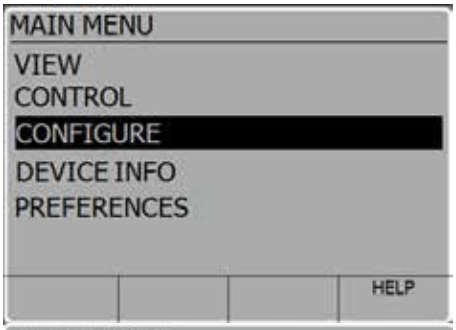
4. Press the OK KEY .

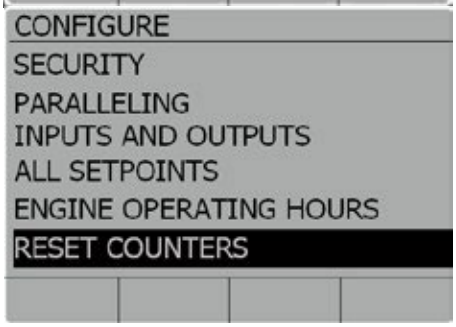
5. Scroll DOWN  until you reach SERVICE MAINTENANCE INTERVAL.

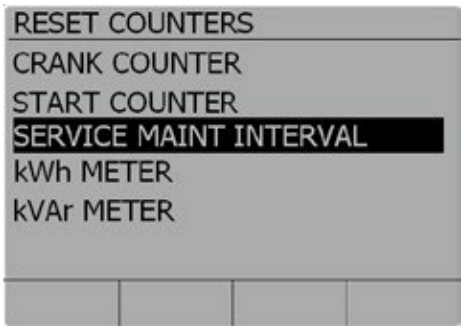
6. Press the OK KEY .

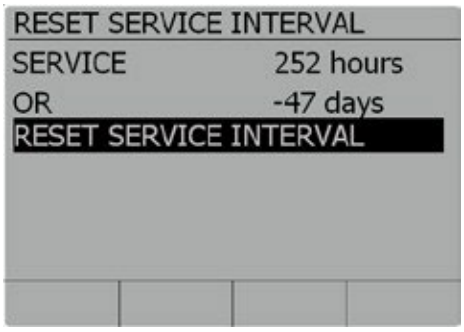
The SERVICE MAINTENANCE INTERVAL HOURS AND DAYS are displayed along with the PASSWORD REQUIRED TO RESET THE SERVICE MAINTENANCE INTERVAL.

The security level required to reset the service maintenance level is shown as a level 2, but the security level required to change the level is level 3. The required security level can be changed by using the Service Tool.









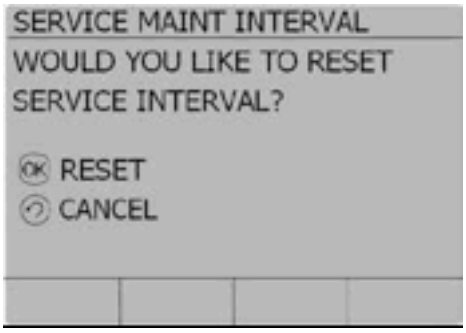
7. To RESET the service interval press the OK KEY 

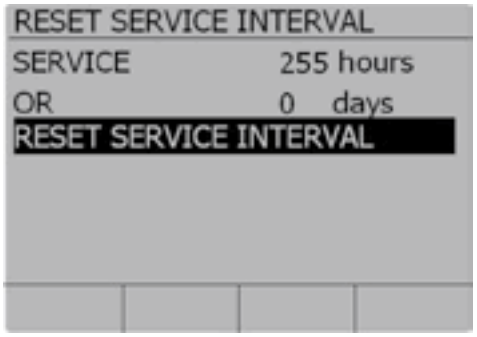
.

A confirmation prompt will appear. Pressing the OK KEY 

will continue and RESET the service maintenance interval. Pressing the ESCAPE KEY  will CANCEL the reset operation.

The new Service intervals will be displayed.



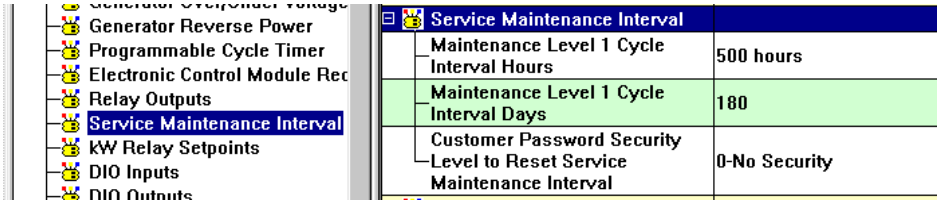


Caution: Be sure to change the password level (using the Service Tool) back to LEVEL 3 after the reset, to prevent inadvertently resetting the timer at other times unless the lower level of security is desired!

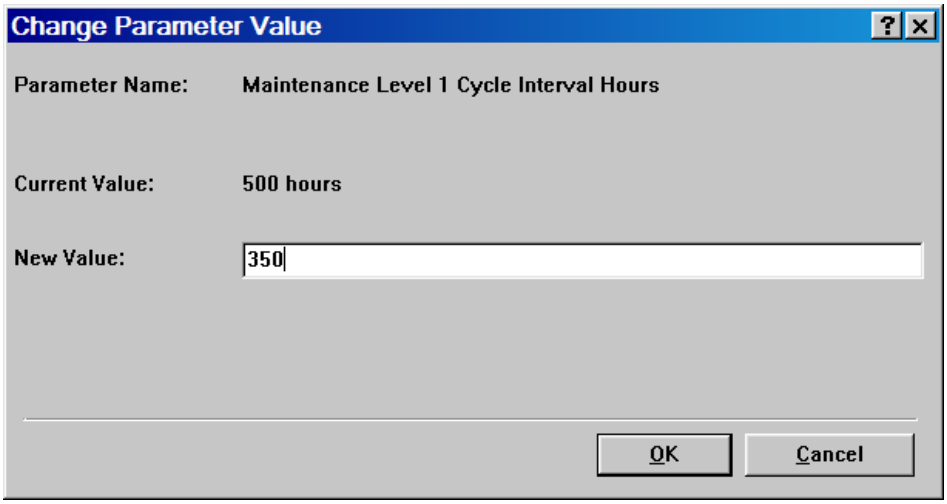
To Adjust the Timer Settings from Cat ET, Do the Following:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

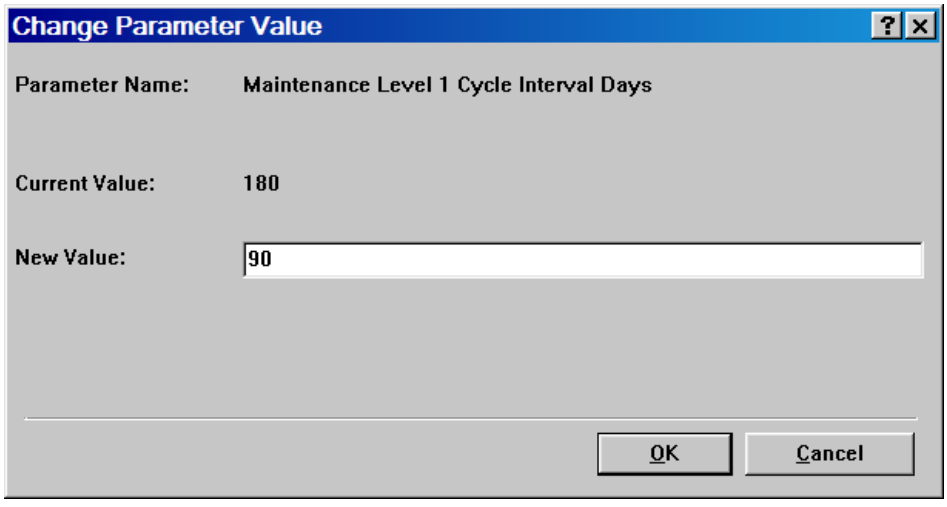
2. Select Service Maintenance Interval on the left.



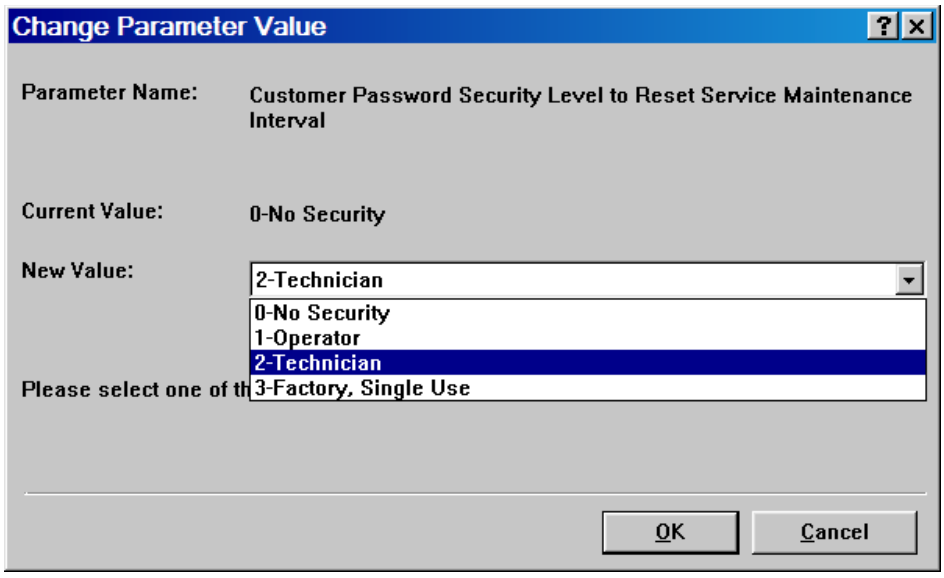
3. Double click Maintenance Level 1 Cycle Interval Hours on the right to enter a new interval.



4. Double click Maintenance Level 1 Cycle Interval Days on the right to enter a new interval.



5. Double click Customer Password Security Level to Reset Service Maintenance Interval on the right to enter a new security level.



Caution: Be sure to change the password level back to LEVEL 3 after the reset, to prevent inadvertently resetting the timer at other times!

5.9 Using Status Events

Status events are useful troubleshooting information that can help determine or understand the sequence of operation that led up to a failure or specific system condition. Status events differ from normal event log events in that they do not generate a red shutdown or amber warning lamp on the EMCP and are not necessarily indicative of a failure mode. Status events can be triggered as a result of user configuration changes or normal system operation.

Each status event in the status event log has a short description and an associated time/date stamp. The status event log holds the last 500 status events that occurred in the system. Once the status event log is filled, old status events are lost and are replaced by the most recent status events.

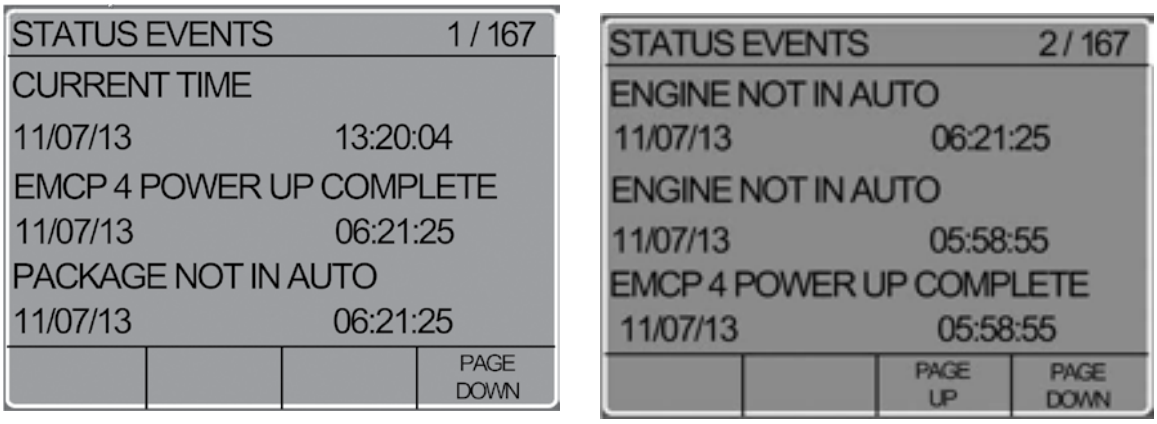


Figure 5.1 – Examples of Status Event Log Entries

The first page of the Status Event Log shows the current time/date as configured on the EMCP 4 controller for reference.

Note: If the time/date setting on the EMCP 4 is updated, already logged status event time/date stamps are NOT updated and will retain the previous time/date stamp. However, all future triggered status events will use the updated time/date setting.

A list of the possible EMCP 4.3 and EMCP 4.4 status events and the corresponding trigger conditions are provided in Table 5.1.

Status Event	Trigger Conditions
ACCEPTABLE V & HZ REACHED	Voltage and Frequency are within acceptable operating parameters.
AIR SHUTOFF ISSUED	Air Shutoff Activated. For example, engine overspeed event can trigger a digital output configured for Air Shutoff.
BUS VOLTAGE DETECTED*	Voltage has been detected on the electrical bus through the EMCP 4 .4 AC bus inputs.
CRANK TERMINATE REACHED	Engine RPM has reached a speed that no longer requires cranking.
DEAD BUS ARBITRATE DISABLED*	The Dead Bus Arbitration feature is configured to disabled.
DEAD BUS ARBITRATE ENABLED*	The Dead Bus Arbitration feature is configured to enabled.
EMCP 4 POWER UP COMPLETE	The EMCP 4 control has completed a power up transition from OFF to ON.
EMERGENCY STOP RECEIVED	An Emergency Stop input or command has been activated.
ENGINE NOT IN AUTO	The Engine Control Switch is NOT in Automatic mode and will not start upon receiving a remote initiate signal.
GEN BREAKER CLOSE COMMAND*	A command to Close the Generator Circuit Breaker has been received.
GEN BREAKER OPEN COMMAND*	A command to Open the Generator Circuit Breaker has been received.
GEN BREAKER STATUS CLOSED*	The Generator Circuit Breaker has closed.
GEN BREAKER STATUS OPENED*	The Generator Circuit Breaker has opened.
GEN BREAKER CLOSE INHIBITED*	The Generator Circuit Breaker is NOT allowed to close.
GEN BREAKER CLOSE ALLOWED*	The Generator Circuit Breaker is allowed to close (removal of an inhibit).
LSLD DISABLE RECEIVED*	The Load Sense Load Demand feature is disabled.
LSLD DISABLE REMOVED*	The Load Sense Load Demand feature is enabled.
LSLD EXCESS RECEIVED*	The hardwired Load Sense Load Demand feature has determined that a unit has excess capacity and a unit needs to be dropped from the system.
LSLD EXCESS REMOVED*	The hardwired Load Sense Load Demand feature has reconciled excess capacity.
LSLD OVERLOAD RECEIVED*	The hardwired Load Sense Load Demand feature has determined that a unit is nearing capacity and needs to add a unit to the system.
LSLD OVERLOAD REMOVED*	The hardwired Load Sense Load Demand feature has reconciled the load demand.
LSLD UNIT OFFLINE*	The unit is offline (not running), it is in standby and under control of the Load Sense Load Demand feature.
LSLD UNIT ONLINE*	The unit is online (running) and operating under control of the Load Sense Load Demand feature.
V/Hz GROUP 1 ACTIVATED	Voltage, Frequency, and AC Ratings Group 1 settings have been selected.
V/HZ GROUP 2 ACTIVATED	Voltage, Frequency, and AC Ratings Group 2 settings have been selected.
V/HZ GROUP 3 ACTIVATED	Voltage, Frequency, and AC Ratings Group 3 settings have been selected.
V/HZ GROUP 4 ACTIVATED	Voltage, Frequency, and AC Ratings Group 4 settings have been selected.
PACKAGE NOT IN AUTO*	The Generator Package is NOT in automatic mode (not ready for remote start) because: Engine Control Switch is NOT in auto OR Sync Mode Switch not in auto OR Dead Bus Arbitration is disabled OR programmable input configured for Inhibit generator breaker close is active OR engine not in rated OR generator breaker status is unknown (FID) OR red lamp (shutdown) status is active.

Status Event	Trigger Conditions
REMOTE INITIATE RECEIVED	Remote Initiate input is activated.
REMOTE INITIATE REMOVED	Remote Initiate input is deactivated.
RESET EVENTS COMMAND ISSUED	Command to Reset All Events has been received.
S/D OVERRIDE MODE ACTIVE	Shutdown Emergency Override Mode is Activated.
S/D OVERRIDE MODE DEACTIVE	Shutdown Emergency Override Mode is Deactivated.
SYNC MODE SWITCH IN AUTO*	Sync Mode Switch placed in Automatic.
SYNC MODE SWITCH IN MANUAL*	Sync Mode Switch placed in Manual.
SYNC MODE SWITCH IN CHECK*	Sync Mode Switch placed in Check.
PCT OUTPUT #1 REMOVED	Programmable Cycle Timer Output #1 was active but has been removed.
PCT OUTPUT #1 ACTIVATED	Programmable Cycle Timer Output #1 has become active.
PCT OUTPUT #2 REMOVED	Programmable Cycle Timer Output #2 was active but has been removed.
PCT OUTPUT #2 ACTIVATED	Programmable Cycle Timer Output #2 has become active.
PCT OUTPUT #3 REMOVED*	Programmable Cycle Timer Output #3 was active but has been removed.
PCT OUTPUT #3 ACTIVATED*	Programmable Cycle Timer Output #3 has become active.
UTILITY BREAKER CLOSED*	The programmable digital inputs configured for Utility Circuit Breaker are detected to have become closed.
UTILITY BREAKER OPENED*	The programmable digital inputs configured for Utility Circuit Breaker are detected to have become open.
MODBUS ECS IN RUN	Engine Control Switch placed in RUN mode by receiving the command via Modbus RS-485 or TCP/IP Data Link.
MODBUS ECS IN STOP	Engine Control Switch placed in STOP mode by receiving the command via Modbus RS-485 or TCP/IP Data Link.
MODBUS ECS IN AUTO	Engine Control Switch placed in AUTO mode by receiving the command via Modbus RS-485 or TCP/IP Data Link.
MODBUS REMOTE INITIATE RECVD	Remote Initiate activated from Modbus RS-485 or TCP/IP Data Link.
MODBUS REMOTE INITIATE REMVD	Remote Initiate deactivated from Modbus RS-485 or TCP/IP Data Link.
BUS V & Hz WITHIN LIMITS*	Bus Voltage and Bus Frequency are within acceptable operating parameters.
BUS V OR Hz OUT OF LIMITS*	Bus Voltage or Bus Frequency are out of acceptable operating parameters.
LOAD SHED ACTIVATED	Load Shed activated based on configuration conditions.
LOAD SHED DEACTIVATED	Load Shed deactivated based on configuration conditions.
PACKAGE IN AUTO*	The Generator Package is in automatic mode (ready for remote start) if: Engine Control Switch is in auto AND Sync Mode Switch in auto AND Dead Bus Arbitration is enabled AND any programmable input configured for Inhibit generator breaker close is inactive AND any programmable input configured for Inhibit generator breaker close is inactive AND engine in rated AND generator breaker status is known (not inconsistent) AND red lamp (shutdown) status is inactive.
SYNC MODE SWITCH IN OFF*	Sync Mode Switch placed in Off.

Status Event	Trigger Conditions
REMOTE COMMS CONTROL ENABLED	Indicates when SCADA control (Modbus Write parameters) is configured to enable.
REMOTE COMMS CONTROL DISABLED	Indicates when SCADA control (Modbus Write parameters) is configured to disabled.
NO MGDL UNITS DETECTED*	Expected number of controls is non-zero, actual number of controls is one. The unit detects only itself and no other MGDL units on the network.
MGDL UNIT(S) NOT DETECTED*	Expected number of controls is non-zero, actual number of controls is non-zero and not equal to expected number of controls. The unit no longer detects one or more MGDL units on the network.
ALL MGDL UNITS DETECTED*	Expected number of controls equals actual number of controls. The unit detects all expected MGDL units on the network.
DBA CAUTION MODE ACTIVATED*	Unit is attempting to dead bus close while operating under a failure mode caused by a loss of communications or MGDL protocol mismatch.
FAILSAFE DROOP ACTIVATED*	Loss of communications or MGDL protocol mismatch has occurred and the unit is attempting to load share while grouped in the Proceed with Caution failsafe group.
FAILSAFE DROOP DEACTIVATED*	Unit is no longer in the Proceed with Caution failsafe group because of either loss of communications recovery or exiting of load sharing.
FAILSAFE ISOCH ACTIVATED*	Loss of communications has occurred and the unit is attempting to load share while grouped in the Proceed as Normal failsafe group.
FAILSAFE ISOCH DEACTIVATED*	Unit is no longer in the Proceed as Normal failsafe group because of either loss of communications recovery or exiting of load sharing.
GROUP START INPUT ACTIVE*	Group Start input is activated.
GROUP START INPUT INACTIVE*	Group Start input is deactivated.
MGDL GROUP START RCVD*	Group Start command was received via the MGDL network.
MGDL GROUP START RMVD*	Group Start command was removed via the MGDL network.
MGDL GROUP START LATCHED*	Group Start command was latched due to the group start command being lost from the MGDL network.
MGDL GROUP START UNLATCHED*	Group Start command was unlatched by the return of the lost MGDL group start command, the assertion of a new group start command or the controller being taken out of auto mode.
DUPLICATE UNIT NUMBER DETECTED*	Multiple units on the MGDL network were detected with the same MGDL unit number.
MASTER CONTROL ENABLED	Switchgear Master Controller is detected and is controlling the EMCP.
MASTER CONTROL DISABLED	Switchgear Master Controller was detected and is no longer controlling the EMCP.
AUTO PARALLEL DISABLE RCVD*	Programmable digital input configured for Auto Parallel Disable is activated.
AUTO PARALLEL DISABLE RMVD*	Programmable digital input configured for Auto Parallel Disable is deactivated.
ECS IN RUN	Engine Control Switch is placed in RUN mode from the EMCP fascia.
ECS IN AUTO	Engine Control Switch is placed in AUTO mode from the EMCP fascia.
ECS IN STOP	Engine Control Switch is placed in STOP mode from the EMCP fascia.

Status Event	Trigger Conditions
ECS IN RUN INPUT	Engine Control Switch is placed in RUN mode by receiving the command via digital input.
ECS IN AUTO INPUT	Engine Control Switch is placed in AUTO mode by receiving the command via digital input.
ECS IN STOP INPUT	Engine Control Switch is placed in STOP mode by receiving the command via digital input.
ECM TIME/DATE MODIFIED	The controller time/date settings were modified.
LSLD DROP DENIED KVAR*	Unit is kept online because the kVAr load is too high for the remaining units even though the kW load is not
N+X STRATEGY MET*	There are enough units online to support LSLD N+X Strategy, where X is the number of redundant units
N+X STRATEGY NOT MET*	There are not enough units online to support LSLD N+X, where X is the number of redundant units
ELECTRIC FAN ACTIVATED	The Electric Cooling Fan Control output has been activated
ELECTRIC FAN DEACTIVATED	The electric cooling fan control output has been deactivated
ELECTRIC FAN LS ACTIVATED	The electric cooling fan low speed command outut has been ctivated
ELECTRIC FAN LS DEACTIVATED	The electric cooling fan low speed command output has been deactivated
PLC LOGIC UPDATED	A new PLC logic configuration has been downloaded to the control
LSLD EVENT N+1 ACTIVE*	A redundant unit has been brought online because of an active warning conditoin on one of the running units
LSLD EVENT N+1 INACTIVE*	A redundant unit that was brought online because of an active warning condition is no longer required to run since the warning conditoin is no longer active.
LSLD EVENT N+1 NOT MET*	A redundant unit is required to be brought online because of an active warning condition on one of the running units but there are no units available to run.
LSLD MULTI-GRP #1 ACTIVATED*	The Load Sense Load Demand setpoints for group 1 are being used
LSLD MULTI-GRP #1 INACTIVE*	The LSLD multi group feature was disabled while this group was active
LSLD MULTI-GRP #2 ACTIVATED*	The Load Sense Load Demand setpoints for group 2 are being used
LSLD MULTI-GRP #2 INACTIVE*	The LSLD multi group feature was disabled while this group was active
LSLD MULTI-GRP #3 ACTIVATED*	The Load Sense Load Demand setpoints for group 3 are being used
LSLD MULTI-GRP #3 INACTIVE*	The LSLD multi group feature was disabled while this group was active
LSLD MULTI-GRP #4 ACTIVATED*	The Load Sense Load Demand setpoints for group 4 are being used
LSLD MULTI-GRP #4 INACTIVE*	The LSLD multi group feature was disabled while this group was active
LSLD ENABLED*	Load Sense Load Demand has been enabled
LSLD DISABLED*	Load Sense Load Demand has been disabled
LSLD ADD UNIT*	System load has exceeded the Load Sense Load Demand add unit threshold and an additional unit has been brought online
LSLD FAST ADD UNIT*	System load has exceeded the Load Sense Load Demand fast add unit threshold and an additional unit has been brought online
LSLD DROP UNIT*	System load has decreased to below the Load Sense Load Demand drop unit threshold and a unit has been taken offline

*Status event available on EMCP 4 .4 only

Table 5.1 – EMCP 4 Status Events and Trigger Conditions

6.0 Security

There are five levels of security access on EMCP 4: LEVEL 0, LEVEL 1, LEVEL 2, LEVEL 3, and SERVICE TOOL. Any configurable parameter or function that is set to Level 0 can be accessed by anyone at any time, and there will never be any security information on the display screen.

LEVEL 1 ACCESS and LEVEL 2 ACCESS represent increasing levels of access to the setpoints and functions of the controller. Both levels 1 and 2 can be password protected with separate user-defined passwords.

Note: These are optional levels of security; by default these passwords are disabled, and the default access level is LEVEL 2 from Parts Service.

LEVEL 3 ACCESS is password protected at the factory, and requires contacting the Cat dealer TC to obtain a password.

- If the present security level of the controller is below the level needed to perform a desired function, a padlock and a number will be displayed at the bottom right hand corner of the display. The number represents the level of security that is required in order to perform the desired function: 1, 2, or 3.
- If there is a padlock but no number, then the Cat Service Tool is required in order to perform the desired function; or the setpoint may be read only and cannot be changed.

All of the adjustable parameters are associated with a specific level of security required to make an adjustment to the parameter. Certain functions, such as resetting the number of crank attempts, are also associated with a specific level of security. The passwords only affect actions taken at the EMCP 4. Access of the EMCP 4 remotely via the Cat Service Tool or via the SCADA data link is not affected by the security level on the EMCP 4 display.

Changing parameters with the Cat Service Tool does not require passwords, since the Service Tool already has the highest level of access.

When connecting via the SCADA DATA LINK, passwords can also be used. The levels of access granted via SCADA are identical to the levels of access granted at the EMCP 4. However, the passwords themselves may differ. Furthermore, the EMCP 4 and the SCADA data link may be at different levels of access at any given time. For more information about SCADA security see Chapter 6.

Level 1 and Level 2 passwords are usually DISABLED when shipped from the factory. Level 1 and Level 2 passwords can be user defined if desired. If the Level 1 and Level 2 passwords are not user defined, the Level 2 will be the MINIMUM LEVEL. All parameters that require Level 0, Level 1, or Level 2 security will be able to be changed by anyone at any time.

Note: The EMCP 4 will always move up in security level to the highest level of access that is not password protected when a certain level of access is requested. For example, if a Level 1 password has been defined, but a Level 2 password has not, the EMCP 4 will start at Level 0 on power up. When the Level 1 password is entered, the EMCP 4 will move up to Level 2 access.

If neither a level 1, nor a level 2 password has been defined, the EMCP 4 will always be at least at a Level 2 access.

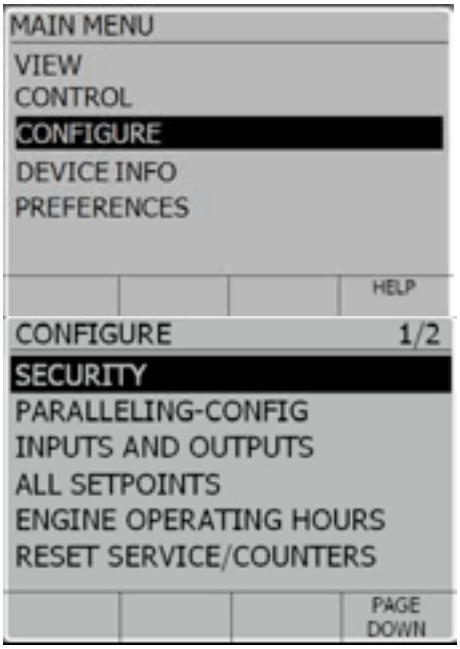
The Security Menu

To get to the security menu:

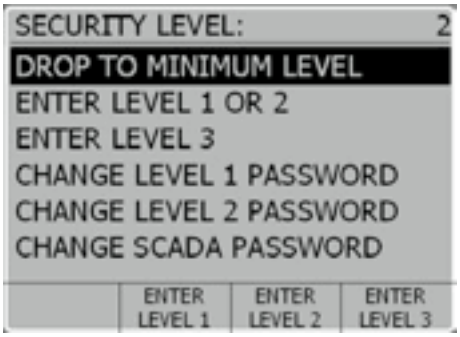
1. At MAIN MENU scroll DOWN  to Configure.

2. Press the OK KEY .

3. At SECURITY, press the OK KEY .



4. The SECURITY MENU will show the current level of security at the top of the screen.



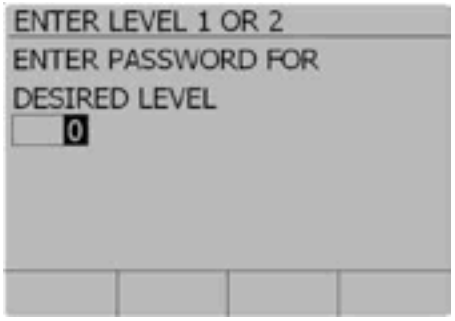
There are six options on the security menu:

- DROP TO MINIMUM LEVEL
- ENTER LEVEL 1 OR 2
- ENTER LEVEL 3
- CHANGE LEVEL 1 PASSWORD
- CHANGE LEVEL 2 PASSWORD
- CHANGE SCADA PASSWORD

Selecting DROP TO MIN LEVEL will make the control go to the minimum level of security. As previously discussed, if the level 1 and level 2 passwords are not defined by the user, the minimum level of security will be level 2. If a level 2 password is defined by the user, but not a level 1 password, then the minimum level of security will be level 1.

In contrast, if a level 1 password is defined by the user, but not a level 2 password, then the minimum level of security will be level 0.

1. Selecting ENTER LEVEL 1 OR 2 will open up a password entry screen.

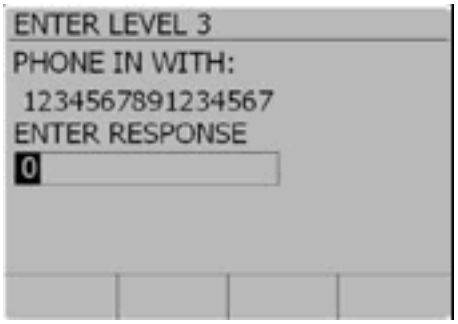


The password entry screen will have 4 spaces. In each space a numbers from 0 through 9 can be entered. The password can be from 1 to 4 digits and is entirely user defined. Enter the password for either level 1 or level 2 if either of those passwords have been defined.

2. Use the UP ARROW  or DOWN ARROW  to change the value of any highlighted digit.

3. Use the LEFT ARROW  or RIGHT ARROW  to navigate between digits.

Selecting ENTER LEVEL 3 will cause the display to say "PHONE IN WITH" and a 16 digit number will be displayed. Under that, ENTER RESPONSE will be highlighted with a password entry field. Record the 16 digit number and call the Cat dealer TC with this number.



Note: Level 3 seed key and response will change based on various pieces of information. It is valid only when generated, and will be different in the future for that specific controller. The TC will reply with another 16 digit number. Enter the password that was supplied by the TC in the same manner as the other types of passwords.

4. Press the OK KEY  to confirm, or ESCAPE KEY  to reject the change. Pressing the OK KEY  after entering the number will set the current level to 3. The control will remain in level 3 security level until no key presses have been made for 10 minutes. After 10 minutes of inactivity the control will revert back to the minimum level of security.

Note: To change a level 3 parameter requires either a level 3 password from the TC or a PC connection using a Service Tool. Therefore, if you have a Service Tool, try to change the parameter using the Service Tool rather than calling the TC.

Selecting CHANGE LVL 1 PSWD will allow for the level 1 password to be changed. The control must be at level 1 security in order to select CHANGE LVL 1 PSWD. The CHANGE LVL 1 PSWD screen looks just like the password entry screen. It has 4 blank spaces that can each be set to a number from 0 to 9. The password can use as few as one digit and can use as many as 4 digits. It is entirely up to the user. If a password has been set but, it is now desired to not have level 1 password protection, the level 1 password can be disabled by setting the password to be a single 0.

5. Once the desired password is entered, press the OK KEY 

and the control will go back to the security screen and the level 1 password will be set.

Selecting CHANGE LVL 2 PSWD will allow for the level 2 password to be changed. The control must be at level 2 security in order to select CHANGE LVL 2 PSWD. The CHANGE LVL 2 PSWD screen looks just like the password entry screen. It has 4 blank spaces that can each be set to a number from 0 to 9. Selecting a password is entirely up to the user and can use as few as one digit or as many as 4 digits.

The level 2 password can be disabled by setting the password to be a single 0.

6. Once the desired password is entered, press the OK KEY 

and the control will go back to the SECURITY SCREEN and the level 2 password will be set.

Selecting CHANGE SCADA PSWD will allow for the SCADA password to be changed.

This password, if ENABLED, will require a SCADA system to first enter the password into the WRITE ACCESS PASSWORD register prior to conducting any other reads and writes. The control must be at level 2 security in order to select CHANGE SCADA PSWD. The CHANGE SCADA PSWD screen looks just like the password entry screen. It has 8 blank spaces that can each be set to a number from 0 to 9. The password can use as few as one digit and can use as many as 8 digits. Keep in mind that most control and changes over SCADA also require the SCADA Remote Control to be Enabled.

Just as with level 1 and level 2 passwords, entering a single 0 will DISABLE the SCADA password.

6.1 Configurable Security Levels by Group

As of version 4.7H software, the EMCP 4 will allow the user to configure the security level of specified setpoint groups separately. The configured security level is the minimum required level of security that must be acquired to access the setpoints governed by that security setpoint. The configurable levels of security are:

Configurable Levels of Security	
0-No Security	Setpoint group can be modified at security Level 0
1-Operator	Security Level 1 is required to modify setpoint group
2-Technician	Security Level 2 is required to modify setpoint group
3-Customer Level (Factory, Single Use)	Security Level 3 is required to modify setpoint group
Factory Default	Setpoint group uses the default security requirement to modify setpoints

There are 15 security setpoints which govern access to setpoints based on their grouping in the software. The setpoint grouping is listed below. Any setpoint that is not listed below will not have a configurable security level.

Each one of these groups can be configured for No Security (level 0), Operator Security (level 1), Technician Security (level 2), Factory Security (level 3). Security level 3 or higher required to be able to configure setpoint group security levels.

To configure the security level for setpoint groups, navigate to MAIN MENU → CONFIGURATION → SECURITY → CUSTOM SECURITY. This menu lists the customer security password setpoints for each setpoint group.

6.1.1 Customer Password Security Level for Analog Input #1

Governs the security level for all setpoints associated with analog input #1 Group. The factory default security level of these setpoints is 3-Customer Level/Factory, Single Use.

Setpoints controlled by this Customer Password Security Level:

ANALOG INPUT #1 SIGNAL TYPE
ANALOG INPUT #1 SIGNAL RANGE
ANALOG INPUT #1 DATA IDENTIFICATION
ANALOG INPUT #1 MAP SELECTION NUM
ANALOG INPUT #1 DATA RANGE MIN
ANALOG INPUT #1 DATA RANGE MAX
ANALOG INPUT #1 HIGH WARNING THRESHOLD
ANALOG INPUT #1 HIGH WARNING DELAY
ANALOG INPUT #1 LOW WARNING THRESHOLD
ANALOG INPUT #1 LOW WARNING DELAY
ANALOG INPUT #1 HIGH SHUTDOWN THRESHOLD
ANALOG INPUT #1 HIGH SHUTDOWN DELAY
ANALOG INPUT #1 LOW SHUTDOWN THRESHOLD
ANALOG INPUT #1 LOW SHUTDOWN DELAY

6.1.2 Customer Password Security Level for Analog Input #2

Governs the security level for all setpoints associated with analog input #2 Group. The factory default security level of these setpoints is 3-Factory, Single Use.

Setpoints controlled by this Customer Password Security Level are:

ANALOG INPUT #2 SIGNAL TYPE
ANALOG INPUT #2 SIGNAL RANGE
ANALOG INPUT #2 DATA IDENTIFICATION
ANALOG INPUT #2 MAP SELECTION NUM
ANALOG INPUT #2 DATA RANGE MIN
ANALOG INPUT #2 DATA RANGE MAX
ANALOG INPUT #2 HIGH WARNING THRESHOLD
ANALOG INPUT #2 HIGH WARNING DELAY
ANALOG INPUT #2 LOW WARNING THRESHOLD
ANALOG INPUT #2 LOW WARNING DELAY
ANALOG INPUT #2 HIGH SHUTDOWN THRESHOLD
ANALOG INPUT #2 HIGH SHUTDOWN DELAY
ANALOG INPUT #2 LOW SHUTDOWN THRESHOLD
ANALOG INPUT #2 LOW SHUTDOWN DELAY

6.1.3 Customer Password Security Level for Analog Input #3

Governs the security level for all setpoints associated with analog input #3 Group. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

ANALOG INPUT #3 SIGNAL TYPE
ANALOG INPUT #3 SIGNAL RANGE
ANALOG INPUT #3 DATA IDENTIFICATION
ANALOG INPUT #3 MAP SELECTION NUM
ANALOG INPUT #3 DATA RANGE MIN
ANALOG INPUT #3 DATA RANGE MAX
ANALOG INPUT #3 HIGH WARNING THRESHOLD
ANALOG INPUT #3 HIGH WARNING DELAY
ANALOG INPUT #3 LOW WARNING THRESHOLD
ANALOG INPUT #3 LOW WARNING DELAY
ANALOG INPUT #3 HIGH SHUTDOWN THRESHOLD
ANALOG INPUT #3 HIGH SHUTDOWN DELAY
ANALOG INPUT #3 LOW SHUTDOWN THRESHOLD
ANALOG INPUT #3 LOW SHUTDOWN DELAY

6.1.4 Customer Password Security Level for Analog Input #4

Governs the security level for all setpoints associated with analog input #4 Group. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

ANALOG INPUT #4 SIGNAL TYPE
ANALOG INPUT #4 SIGNAL RANGE
ANALOG INPUT #4 DATA IDENTIFICATION
ANALOG INPUT #4 MAP SELECTION NUM
ANALOG INPUT #4 DATA RANGE MIN
ANALOG INPUT #4 DATA RANGE MAX
ANALOG INPUT #4 HIGH WARNING THRESHOLD
ANALOG INPUT #4 HIGH WARNING DELAY
ANALOG INPUT #4 LOW WARNING THRESHOLD
ANALOG INPUT #4 LOW WARNING DELAY
ANALOG INPUT #4 HIGH SHUTDOWN THRESHOLD
ANALOG INPUT #4 HIGH SHUTDOWN DELAY
ANALOG INPUT #4 LOW SHUTDOWN THRESHOLD
ANALOG INPUT #4 LOW SHUTDOWN DELAY

6.1.5 Customer Password Security Level for Automatic Start/Stop

Governs the security level for all setpoints associated with Automatic Start/Stop Group . The factory default security level of these setpoints is 2-Technician .

Setpoints controlled by this Customer Password Security Level are:

ENG START FAULT ACTIVATE DELAY
CRANK DURATION
CRANK CYCLE REST INTERVAL
ENGINE START SEQUENCE DELAY TIME
MAXIMUM NUMBER OF CRANK CYCLES
COOLDOWN DURATION
START AID ACTIVATION TIME
CRANK ALERT ACTIVATION TIME
ENGINE COOLDOWN SPEED CONFIGURATION
EMERGENCY STOP INPUT ACTIVE STATE
SCADA REMOTE CNTRL ENABLE STATUS
ECU FAULT RESET ACTIVE TIME

6.1.6 Customer Password Security Level for Fuel Transfer Feature

Governs the security level for all setpoints associated with Fuel Load and Unload (complex software enabled). The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

FUEL TRANSFER FEATURE STATUS
AUTO FUEL LOAD PUMP ON % THRESHOLD
AUTO FUEL LOAD PUMP OFF % THRESHOLD
FUEL UNLOAD PUMP OFF PERCENTAGE THRESHOLD (complex only)

6.1.7 Customer Password Security Level for Generator Rated Voltages

Governs the security level for all setpoints for rated generator set voltages and generator set rated voltage #1- #4 for complex software. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

GENERATOR RATED VOLTAGE
GENERATOR RATED VOLTAGE #1 (complex only)
GENERATOR RATED VOLTAGE #2 (complex only)
GENERATOR RATED VOLTAGE #3 (complex only)
GENERATOR RATED VOLTAGE #4 (complex only)

6.1.8 Customer Password Security Level for Integrated Voltage Regulator

Governs the security level for all setpoints associated with the IVR features. The factory default security level of these setpoints is 2-Technician .

Setpoints controlled by this Customer Password Security Level are:

VOLT REG STARTING TIME
VOLT REG STARTING VOLTAGE PERCENT
VOLT REG LOOP GAIN PERCENTAGE
VOLT REG CORNER <KNEE> FREQUENCY
VOLT REG DEV FROM CORNER <KNEE> FREQ
VOLT REG VOLTS/HZ SLOPE 1
VOLT REG VOLTS/HZ SLOPE 2
VOLT REG MIN VOLTAGE <SETPOINT> PERCENTAGE
VOLT REG MIN FREQ THRESHOLD
VOLT REG LOAD COMPENSATION TYPE
VOLT REG (IR) COMPENSATION PCT
VOLT REG MAXIMUM DROOP PERCENTAGE
VOLT REG LOCKOUT CONFIGURATION
VOLT REG LOSS OF SENSING S/D DELAY
VOLT REG OVER EXCITATION S/D THRESH

VOLT REG OVER EXCITATION S/D DELAY
VOLT REG EXCITATION DURING SHUTDOWN
TRANSIENT LOAD RELIEF ENABLE STATUS
TLR ACTIVATION LOAD PERCENTAGE THRESHOLD
TLR ENGINE LOAD CAPABILITY PERCENTAGE
TLR ACTIVATION LOAD PERCENTAGE THRESHOLD #1
TLR ENGINE LOAD CAPABILITY PERCENTAGE #1
TLR ACTIVATION LOAD PERCENTAGE THRESHOLD #2
TLR ENGINE LOAD CAPABILITY PERCENTAGE #2
TLR ACTIVATION LOAD PERCENTAGE THRESHOLD #3
TLR ENGINE LOAD CAPABILITY PERCENTAGE #3
TLR ACTIVATION LOAD PERCENTAGE THRESHOLD #4
TLR ENGINE LOAD CAPABILITY PERCENTAGE #4
TLR TRANSIENT PROPORTIONAL GAIN PERCENTAGE
TLR VOLTAGE RECOVERY RAMP RATE

6.1.9 Customer Password Security Level for Programmable Cycle Timer Feature

Governs the security level for all setpoints associated with the Programmable Cycle Timer. The factory default security level of these setpoints is 1-Operator.

Setpoints controlled by this Customer Password Security Level are:

PRGRM CYCLE TMR #1 – #7 ACTIVE DAY OF WEEK
PRGRM CYCLE TMR #1 – #7 ACTIVATE START TIME
PROGRAMMABLE CYCLE TIMER #1 – #7 ACTIVE TIME
PRGRM CYCLE TMR #1 – #7 OUTPUT #1 ACTIVE CFG
PRGRM CYCLE TMR #1 – #7 OUTPUT #2 ACTIVE CFG
PRGRM CYCLE TMR #1 – #7 OUTPUT #3 ACTIVE CFG

6.1.10 Customer Password Security Level for Digital Inputs

Governs the security level for all setpoints associated with Digital Input configuration. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

DIGITAL IN #1 – #6 COMMAND / STATUS PARAMETER
DIGITAL IN #1 – #6 EVENT DELAY
DIGITAL IN #1 – #6 EVENT SUSPECT PARAM NUM
DIGITAL IN #1 – #6 EVENT FAILURE MODE IDENTIFIER
DIGITAL IN #1 – #6 ACTIVE STATE CONFIGURATION
DIGITAL IN #1 – #6 USAGE TYPE

6.1.11 Customer Password Security Level for Digital Outputs

Governs the security level for all setpoints associated with Digital Output configuration. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

DIGITAL OUTPUT #1- #2 USAGE TYPE
DIGITAL OUTPUT #1- #2 COMMAND/STATUS
DIGITAL OUTPUT #1- #2 SUSPECT PARAM NUM
DIGITAL IN #1 – #6 EVENT TRIGGER CONDITION

6.1.12 Customer Password Security Level for Generator Protection Monitoring

Governs the security level for all setpoints associated with protection parameters for the generator. This also includes some setpoints for battery voltage, data link diagnostics, custom parameter events and transfer switch setpoints. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

HIGH BATTERY VOLTAGE WARNING THRESHOLD
HIGH BATTERY VOLTAGE WARNING DELAY TIME
HIGH BATTERY VOLTAGE SHUTDOWN THRESHOLD
HIGH BATTERY VOLTAGE SHUTDOWN DELAY TIME
LOW BATTERY VOLT WARNING THRESHOLD
LOW BATTERY VOLT WARNING DELAY TIME
LO BATT CHARGING SYS VOLT WARN THRESH
LO BATT CHARGING SYS VOLT WARN DELAY

LOW BATT CRANKING VOLT WARN THRESH
LOW BATT CRANKING VOLT WARN DELAY
BATT CHARGER FAILURE DIAGNOSTIC CONFIG
RS-485 SCADA DATA LINK DIAGNOSTIC CONFIG
MGDL COMMS FAILURE DIAGNOSTIC RESPONSE CONFIG
MGDL UNIT NOT DETECTED DIAGNOSTIC RESPONSE CONFIG
GEN CURRENT IMBALANCE WARN EVENT PERCENT THRESHOLD
GEN CURRENT IMBALANCE WARNING EVENT DELAY TIME
GEN CURRENT IMBALANCE S/D EVENT PERCENT THRESHOLD
GEN CURRENT IMBALANCE SHUTDOWN EVENT DELAY TIME
RS-485 ANNUNCIATOR DATA LINK DIAG CONFIG
GEN DEF TIME OVER CURR WARN % THRESH
GEN INV TIME OVER CURR S/D TIME MULTIPLR
GEN DEF TIME OVER CURRENT S/D % THRESH
GEN DEF TIME OVER CURRENT DELAY TIME
GEN INVERSE TIME OVER CURRENT S/D % THRESH

GEN INVERSE DEFINITE MIN TIME CURVE TYPE
GENERATOR RATED CURRENT MULTIPLIER
GEN OVER FREQUENCY WARNING % THRESHOLD
GEN OVER FREQUENCY WARNING DELAY TIME
GEN OVER FREQUENCY S/D % THRESHOLD
GEN OVER FREQUENCY SHUTDOWN DELAY TIME
GEN UNDER FREQUENCY WARNING % THRESHOLD
GEN UNDER FREQUENCY WARNING DELAY TIME
GEN UNDER FREQUENCY S/D % THRESHOLD
GEN UNDER FREQUENCY SHUTDOWN DELAY TIME
GEN OVER VOLTAGE WARNING % THRESHOLD
GEN OVER VOLTAGE WARNING DELAY TIME
GEN OVER VOLT S/D % THRESHOLD
GEN OVER VOLTAGE SHUTDOWN DELAY TIME
GEN UNDER VOLTAGE WARNING % THRESHOLD
GEN UNDER VOLTAGE WARNING DELAY TIME
GEN UNDER VOLT S/D % THRESHOLD

GEN UNDER VOLTAGE SHUTDOWN DELAY TIME
HIGH GEN REAR BEARING TEMP WARNING CONFIG
HIGH GEN REAR BEARING TEMP SHUTDOWN CFG
LOW GEN REAR BEARING TEMP WRN CFG
LOW GEN REAR BEARING TEMP S/D CFG
GEN OVERCURRENT WARNING CONFIG
GEN OVERCURRENT SHUTDOWN CONFIG
GEN OVER FREQUENCY WARNING CONFIG
GEN OVER FREQUENCY SHUTDOWN CONFIG
GEN UNDER FREQUENCY WARNING CONFIG
GEN UNDER FREQUENCY SHUTDOWN CONFIG
GEN REVERSE POWER WARNING CONFIG
GEN REVERSE POWER SHUTDOWN CONFIG
GEN OVER VOLTAGE WARNING CONFIG
GEN OVER VOLTAGE SHUTDOWN CONFIG
GEN UNDER VOLTAGE WARNING CONFIG

GEN UNDER VOLTAGE SHUTDOWN CONFIG
EARTH FAULT EVENT CONFIGURATION
HIGH GEN WINDING #1 TEMP WARNING CONFIG
HIGH GEN WINDING #1 TEMP SHUTDOWN CFG
GEN HIGH POWER WARNING CONFIG
GEN REVERSE REACTIVE POWER WARN CONFIG
GEN TO BUS SYNC FAILURE WARNING RESPONSE CONFIG
GEN TO BUS SYNC FAILURE SHUTDOWN RESPONSE CONFIG
GEN NOT READY TO AUTO PARALLEL WARN RESP CONFIG
DEAD BUS INCONSISTENT SENSING RESPONSE CONFIG
PROGRAMMABLE kW RELAY TRIP #1 EVENT RESPONSE CONFIG
GEN REVERSE REACTIVE POWER S/D CONFIG
PROG kW RELAY TRIP #1 EVENT RESPONSE
PROG kW RELAY TRIP #2 EVENT RESPONSE
GEN REVERSE POWER WARNING % THRESHOLD
GEN REVERSE POWER WARNING DELAY TIME
GEN REVERSE POWER S/D % THRESHOLD

GEN REVERSE POWER SHUTDOWN DELAY TIME
GEN REVERSE REACTIVE POWER WARN % LIMIT
GEN REVERSE REACTIVE POWER WARN DELAY
GEN REVERSE REACTIVE POWER S/D % LIMIT
GEN REVERSE REACTIVE POWER S/D DELAY
HIGH BATTERY VOLTAGE WARNING CONFIG
HIGH BATTERY VOLTAGE SHUTDOWN CONFIG
LOW BATT VOLTAGE WARNING CONFIG
LOW BATT CHARGING SYS VOLT WARN CFG
GEN BREAKER OPEN EVENT CONFIGURATION
GEN BREAKER CLOSED EVENT CONFIGURATION
GEN CONTROL NOT IN AUTO WARNING CONFIG
EARTH LEAKAGE EVENT CONFIGURATION
EPS SUPPLYING LOAD EVENT RESPONSE CFG
LOW BATT CRANKING VOLTAGE WARN CFG
CUSTOM EVENT #1 EVENT RESPONSE

CUSTOM EVENT #2 EVENT RESPONSE
CUSTOM EVENT #3 EVENT RESPONSE
CUSTOM EVENT #4 EVENT RESPONSE
ISOLATED DIGITAL INPUT #1 CUSTOM EVENT RESPONSE
ISOLATED DIGITAL INPUT #2 CUSTOM EVENT RESPONSE
ISOLATED DIGITAL INPUT #3 CUSTOM EVENT RESPONSE
ISOLATED DIGITAL INPUT #4 CUSTOM EVENT RESPONSE
CUSTOM EVENT #5 EVENT RESPONSE
CUSTOM EVENT #6 EVENT RESPONSE
CUSTOM EVENT #7 EVENT RESPONSE
CUSTOM EVENT #8 EVENT RESPONSE
ANALOG INPUT #1 CUSTOM HIGH WARN
ANALOG INPUT #1 CUSTOM HIGH S/D
ANALOG INPUT #1 CUSTOM LOW WARN
ANALOG INPUT #1 CUSTOM LOW S/D
ANALOG INPUT #2 CUSTOM HIGH WARN
ANALOG INPUT #2 CUSTOM HIGH S/D

ANALOG INPUT #2 CUSTOM LOW WARN
ANALOG INPUT #2 CUSTOM LOW S/D
ANALOG INPUT #3 CUSTOM HIGH WARN
ANALOG INPUT #3 CUSTOM HIGH S/D
ANALOG INPUT #3 CUSTOM LOW WARN
ANALOG INPUT #3 CUSTOM LOW S/D
ANALOG INPUT #4 HIGH WARNING EVENT RESPONSE
ANALOG INPUT #4 HIGH SHUTDOWN EVENT RESPONSE
ANALOG INPUT #4 LOW WARNING EVENT RESPONSE
ANALOG INPUT #4 LOW SHUTDOWN EVENT RESPONSE
UTILITY BKR FAIL TO OPEN EVENT RESPONSE CONFIG
UTILITY BKR FAIL TO CLOSE EVENT RESPONSE CONFIG
LOSS OF UTILITY EVENT RESPONSE CONFIGURATION
UTIL TO GEN TRANSFER FAILURE WARNING CONFIG
UTIL TO GEN TRANSFER FAILURE SHUTDOWN CONFIG
GEN TO UTIL TRANSFER FAILURE WARNING CONFIG
UTILITY BKR SYSTEM FAULT EVENT RESPONSE CFG

GEN/UTILITY AUTOMATIC TRANSFER ENABLE STATUS
LOSS OF UTILITY EVENT NOTIFICATION DELAY TIME
GENERATOR TO UTILITY TRANSFER DELAY TIME
GEN TO UTILITY FAST TRANSFER DELAY TIME
UTIL TO GEN TRANSFER FAILURE WARN THRESHOLD
UTILITY TO GEN TRANSFER FAILURE S/D THRESHOLD
GEN TO UTIL TRANSFER FAILURE WARN THRESHOLD
MINIMUM UNPOWERED LOAD TIME
GEN READY TO ACCEPT LOAD THRESHOLD %
GENERATOR READY TO ACCEPT LOAD DELAY TIME
GENERATOR TO UTILITY TRANSFER MODE
UTILITY BREAKER MAX CLOSE TIME
UTILITY BREAKER MAX OPEN TIME

6.1.13 Customer Password Security Level for Engine Protection Monitoring

Governs the security level for all setpoints associated with engine protection and monitoring. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

ENGINE SPEED SENSOR DIAGNOSTIC CONFIG
DATA LINK HIGH COOL TEMP WARN THRESHOLD
DATA LINK HIGH COOL TEMP WARNING DELAY
DATA LINK HIGH COOL TEMP S/D THRESHOLD
DATA LINK HIGH COOL TEMP S/D DELAY
DATA LINK LOW COOL TEMP WARN THRESHOLD
DATA LINK LOW COOL TEMP WARNING DELAY
DATA LINK LOW OIL PRES WARNING THRESH
LOW IDLE LOW ENG OIL PRES WARN THRESHOLD
DATA LINK LOW OIL PRES WARNING DELAY
DATA LINK LOW OIL PRES S/D THRESH
LOW IDLE LOW ENG OIL PRES S/D THRESHOLD
DATA LINK LOW OIL PRES S/D DELAY
LOW ENGINE OIL PRESSURE STEP SPEED

AIR DAMPER CLOSED EVENT CONFIGURATION
UNEXPECTED ENGINE SHUTDOWN CONFIG
ENGINE OVER SPEED SHUTDOWN CONFIG
ENGINE UNDER SPEED WARNING CONFIG
ENGINE UNDER SPEED SHUTDOWN CONFIG
EMERGENCY STOP ACTIVE EVENT CONFIG
HIGH ENGINE COOLANT LEVEL WARNING CONFIG
HIGH ENGINE COOLANT LEVEL SHUTDOWN CFG
LOW ENGINE COOLANT LEVEL WARNING CONFIG
LOW ENGINE COOLANT LEVEL SHUTDOWN CFG
HIGH ENG COOLANT TEMP WARNING CONFIG
HIGH ENGINE COOLANT TEMP SHUTDOWN CFG
LOW ENG COOLANT TEMP WARNING CONFIG
ENG FAILURE TO START SHUTDOWN CONFIG
HIGH ENGINE OIL LEVEL WARNING CONFIG
HIGH ENGINE OIL LEVEL SHUTDOWN CONFIG
LOW ENGINE OIL LEVEL WARNING CONFIG

LOW ENGINE OIL LEVEL SHUTDOWN CONFIG
LOW ENGINE OIL PRES WARNING CONFIG
LOW ENGINE OIL PRES SHUTDOWN CONFIG
HIGH ENGINE OIL TEMP WARNING CONFIG
HIGH ENGINE OIL TEMP SHUTDOWN CONFIG
LOW ENGINE OIL TEMP WARNING CONFIG
LOW ENGINE OIL TEMP SHUTDOWN CONFIG
HIGH EXHAUST TEMP WARNING CONFIG
HIGH EXHAUST TEMP SHUTDOWN CONFIG
LOW EXHAUST TEMP WARNING CONFIG
LOW EXHAUST TEMP SHUTDOWN CONFIG
HIGH FUEL LEVEL WARNING CONFIG
HIGH FUEL LEVEL SHUTDOWN CONFIG
LOW FUEL LEVEL WARNING CONFIG
LOW FUEL LEVEL SHUTDOWN CONFIG
EXT TANK HIGH FUEL LEVEL WARNING CONFIG

EXT TANK HIGH FUEL LEVEL SHUTDOWN CFG
EXT TANK LOW FUEL LEVEL WARNING CONFIG
EXT TANK LOW FUEL LEVEL SHUTDOWN CFG
FUEL LEAK EVENT CONFIGURATION
HIGH GAS PRESSURE WARNING CONFIG
HIGH GAS PRESSURE SHUTDOWN CONFIG
LOW GAS PRESSURE WARNING CONFIG
LOW GAS PRESSURE SHUTDOWN CONFIG
REMOTE EMERGENCY STOP ACTIVE RESPONSE
HIGH AFTERCOOLER LEVEL WARNING RESPONSE CONFIG
HIGH AFTERCOOLER LEVEL SHUTDOWN RESPONSE CONFIG
LOW AFTERCOOLER LEVEL WARNING RESPONSE CONFIG
LOW AFTERCOOLER LEVEL SHUTDOWN RESPONSE CONFIG
HIGH BUND FLUID LEVEL WARNING CONFIG
HIGH BUND FLUID LEVEL SHUTDOWN CONFIG

HIGH ENGINE COOLANT TEMP #2 WARNING RESPONSE CONFIG
HIGH ENGINE COOLANT TEMP #2 SHUTDOWN RESPONSE CONFIG
LOW ENGINE COOLANT TEMP #2 WARNING RESPONSE CONFIG
LOW ENGINE COOLANT TEMP #2 SHUTDOWN RESPONSE CONFIG
HIGH ENGINE COOLANT TEMP #3 WARNING RESPONSE CONFIG
HIGH ENGINE COOLANT TEMP #3 SHUTDOWN RESPONSE CONFIG
LOW ENGINE COOLANT TEMP #3 WARNING RESPONSE CONFIG
LOW ENGINE COOLANT TEMP #3 SHUTDOWN RESPONSE CONFIG
CYLINDER TEMP DIFF MONITOR ENABLE STATUS
HIGH LOAD CYLINDER TEMP DIFF MONITOR WARNING % THRESH
CYLINDER TEMP DIFF HIGH LOAD % THRESHOLD
CYLINDER TEMP DIFF MINIMUM LOAD % THRESHOLD
ENGINE UNDER SPEED WARNING DELAY TIME
ENGINE UNDER SPEED SHUTDOWN DELAY TIME
FAN MIN AIRFLOW COOLANT TEMP
FAN MAX AIRFLOW COOLANT TEMP

FAN COOLANT TEMP HYSTERESIS
FAN MIN AFTRCLR OUT AIR TEMP THRESH
FAN AFTRCLR OUT AIR TEMP HYSTERESIS
FAN MAX AFTRCLR OUT AIR TEMP THRESH
ENGINE IN COOLDOWN EVENT CONFIGURATION
SPEED-FREQ MISMATCH WARNING CONFIG

6.1.14 Customer Password Security Level for Load Shed Feature

Governs the security level for all setpoints associated with load shedding. The factory default security level of these setpoints is 2-Technician .

Setpoint controlled by this Customer Password Security Level is:

- Load Shed Conditions

6.1.15 Customer Password Security Level for Analog Outputs

Governs the security level for all setpoints associated with analog output configuration. The factory default security level of these setpoints is 2-Technician.

Setpoints controlled by this Customer Password Security Level are:

ANALOG OUTPUT #1 OUTPUT TYPE
ANALOG OUTPUT #2 OUTPUT TYPE
ANALOG OUTPUT #3 OUTPUT TYPE
ANALOG OUTPUT #1 OUTPUT RANGE
ANALOG OUTPUT #2 OUTPUT RANGE
ANALOG OUTPUT #3 OUTPUT RANGE
ANALOG OUTPUT #1 DATA IDENTIFICATION
ANALOG OUTPUT #2 DATA IDENTIFICATION
ANALOG OUTPUT #3 DATA IDENTIFICATION
ANALOG OUTPUT #1 DATA RANGE MIN
ANALOG OUTPUT #2 DATA RANGE MIN
ANALOG OUTPUT #3 DATA RANGE MIN
ANALOG OUTPUT #1 DATA RANGE MAX
ANALOG OUTPUT #2 DATA RANGE MAX

ANALOG OUTPUT #3 DATA RANGE MAX
PWM OUTPUT #1 ENABLE STATUS
PWM OUTPUT #2 NABLE STATUS
PWM OUTPUT #1 OUTPUT RANGE
PWM OUTPUT #2 OUTPUT RANGE
PWM OUTPUT #1 DATA IDENTIFICATION
PWM OUTPUT #2 DATA IDENTIFICATION
PWM OUTPUT #1 DATA RANGE MIN
PWM OUTPUT #2 DATA RANGE MIN
PWM OUTPUT #1 DATA RANGE MAX
PWM OUTPUT #2 DATA RANGE MAX

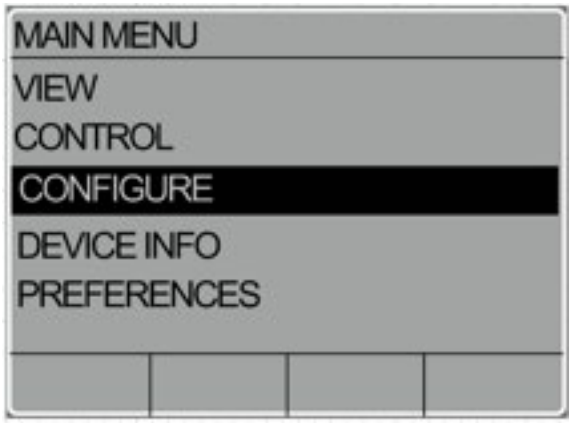
7.0 kWh and kVArh Meters

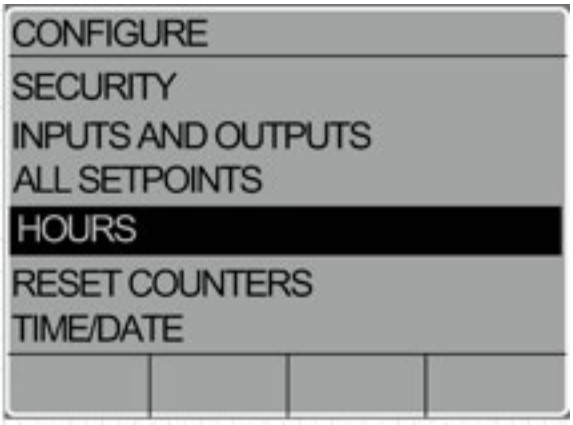
7.1 Lifetime Totals

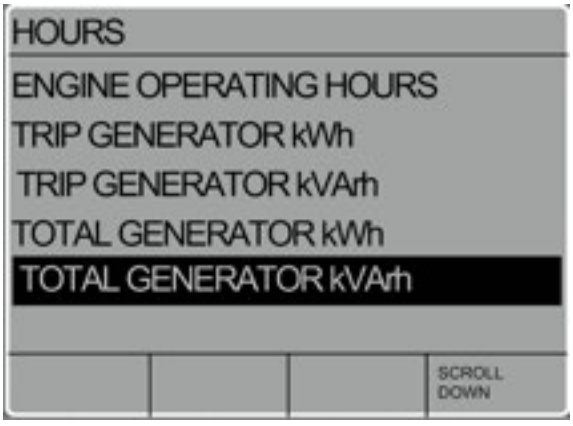
The EMCP has two lifetime total energy meters; one for kilo-Watt hours and another for kilo-Volt-Ampere reactive hours. These meters contain the lifetime total energy output of the generator set as measured by the EMCP 4 controller. These values can be incremented (for control swap, etc.) via display or ET, however the lifetime totals cannot be reset.

7.1.1 Updating Values

To increment the meter values through the display, obtain level 3 security level. Then Navigate to MAIN MENU → CONFIGURE → HOURS → TOTAL GENERATOR kWH (or kVArh).

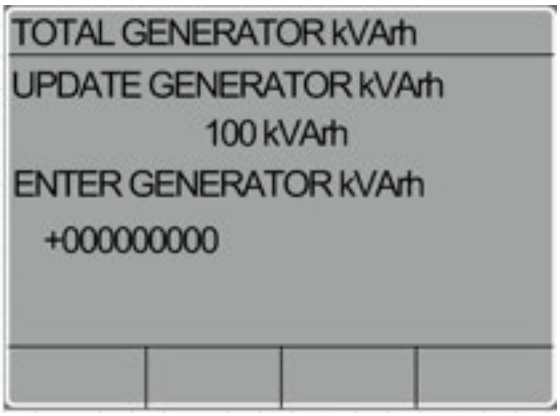






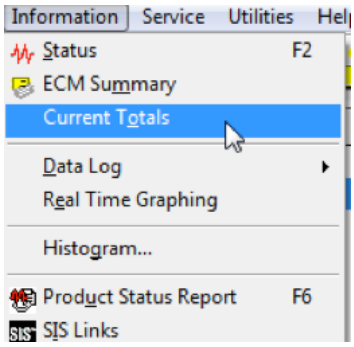
Pressing the “OK” button on this screen will bring up a dialog box where the user can enter the desired value.

Note: The value entered here cannot be less than the current value.

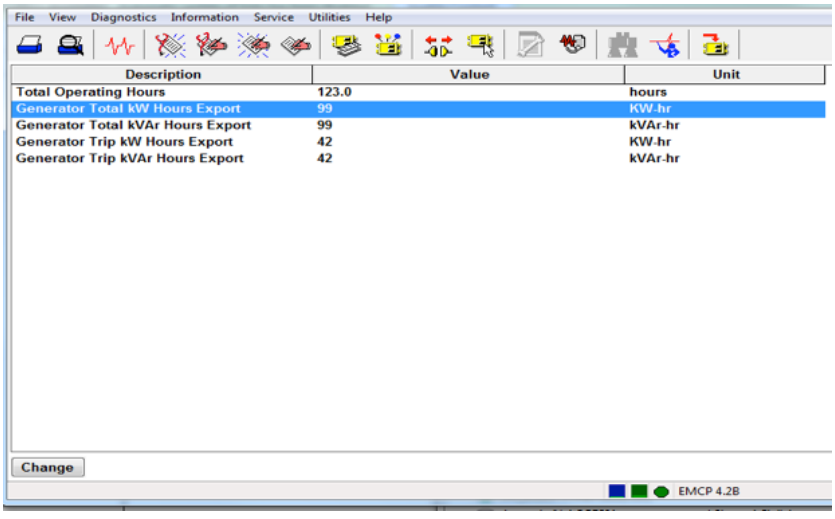


Updating Lifetime Values from Cat Service Tool

Lifetime energy meter values can be updated by navigating to the Current Totals screen:



To update the Lifetime values you can select the desired energy meter and select the “Change” button in the lower left hand corner of the screen.



User can then enter the new Lifetime value. Note that the new value cannot be lower than the current Lifetime value; the new value must larger than the current lifetime value.

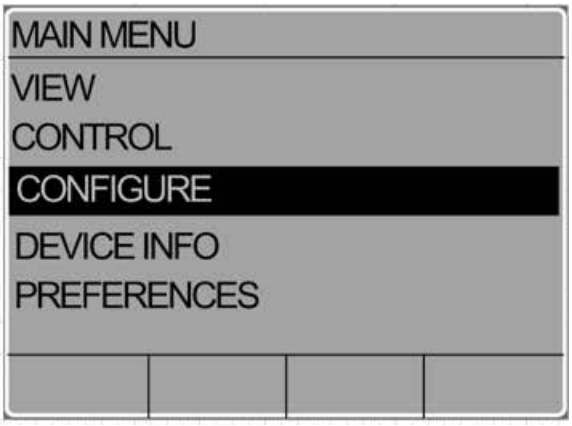


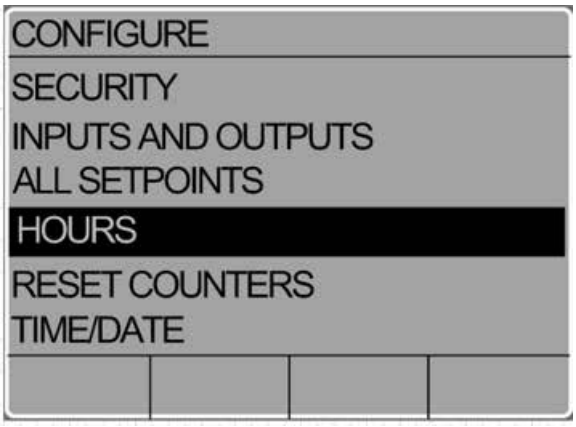
7.2 Trip Totals

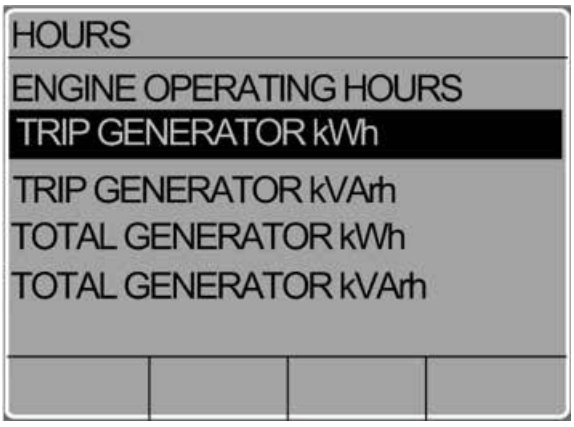
The EMCP 4 offers two additional energy meters; one for kilo-Watt hours and another for kilo-Volt-Ampere reactive hours. These will be displayed on the EMCP as “Trip Generator kWh” and “Trip Generator kVArh.” These meters are intended to be used primarily in a rental application where the user wants to track energy usage over a short interval. The trip energy meters can be reset through a display command or through Cat ET.

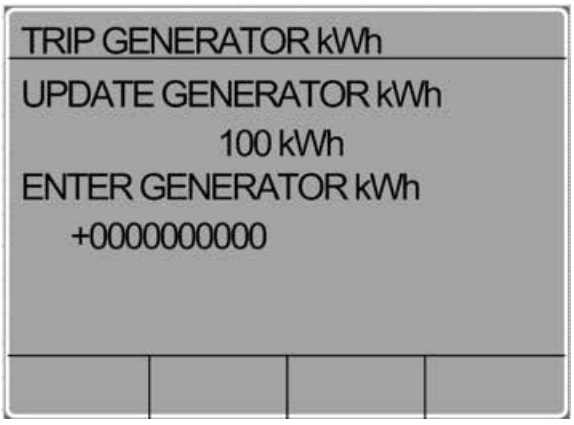
7.2.1 Updating Values

To update the trip energy meters through the display, obtain level 3 security. Then navigate to MAIN MENU → CONFIGURE → HOURS → TRIP GENERATOR kWh (or kVArh).





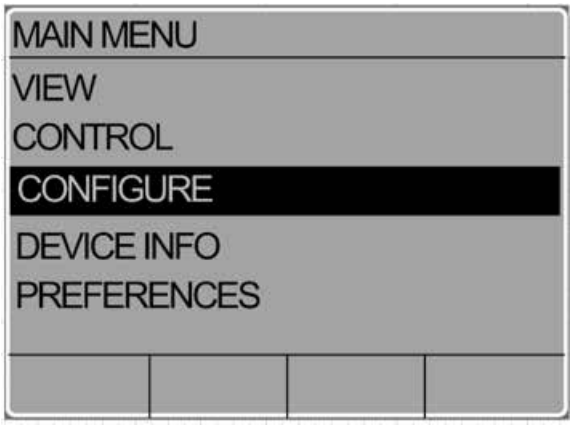


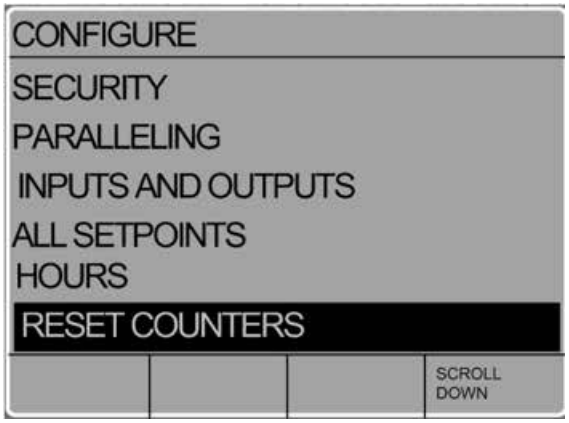


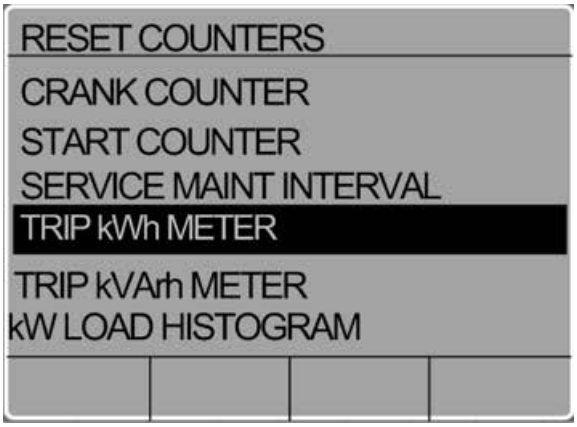
Note: These counters will only accept being updated to a value greater than the current value and less than or equal to the total energy meter values.

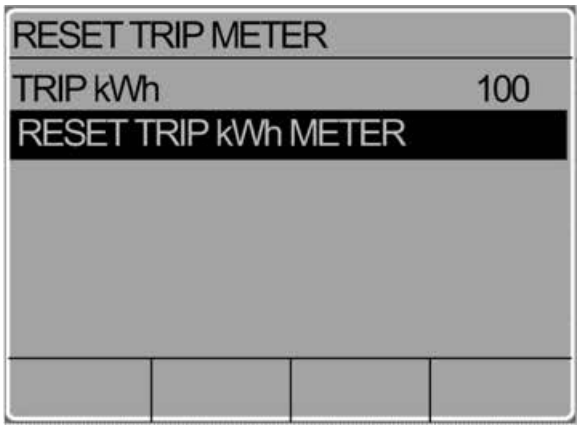
7.2.2 Resetting Values

To update the trip energy meters through the display, obtain level 3 security. Then navigate to MAIN MENU → CONFIGURE → RESET COUNTERS → TRIP kWh METER (or TRIP kVArh METER).





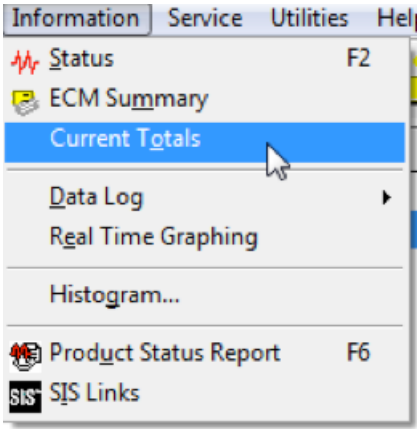




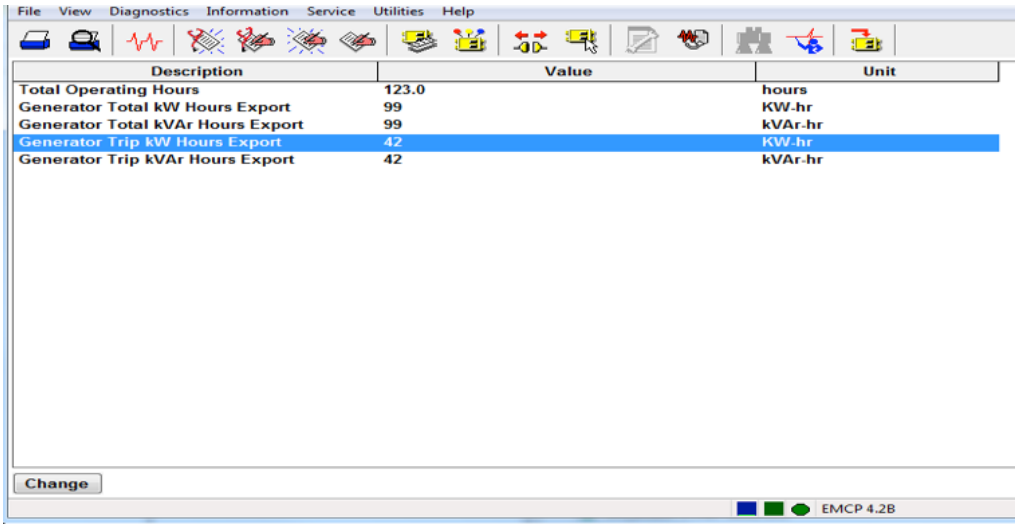
Pressing the "OK" button on this screen will reset the selected energy meter.

7.2.3 Updating and Resetting Trip Values from Cat Service Tool

Trip values can be updated or reset by navigating to the Current Totals screen:

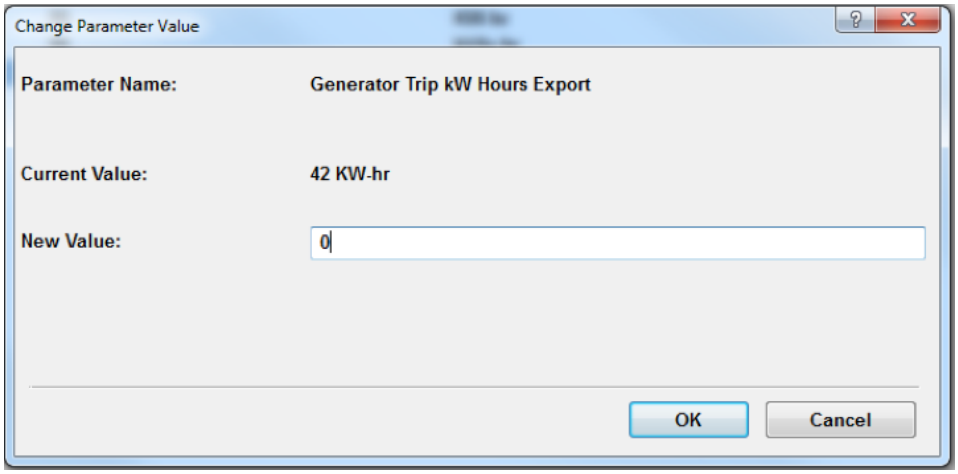


To update the Trip values you can select the desired energy meter and select the "Change" button in the lower left hand corner of the screen.



User can then enter the new trip value . Note that the Trip values cannot be set higher than its corresponding Lifetime Totals meter values .

In order to reset a trip meter, the user will need to enter “0” for the new value .



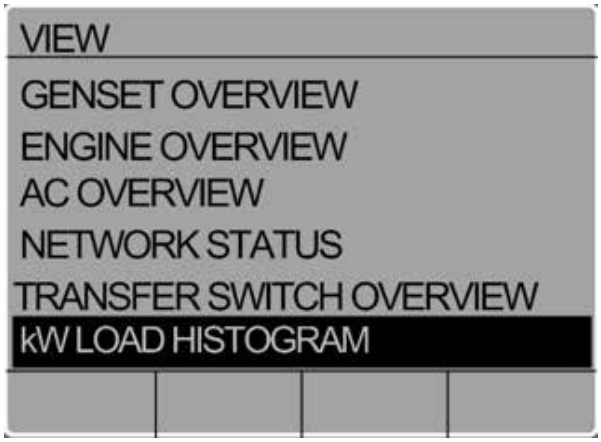
8.0 kW Load Histogram

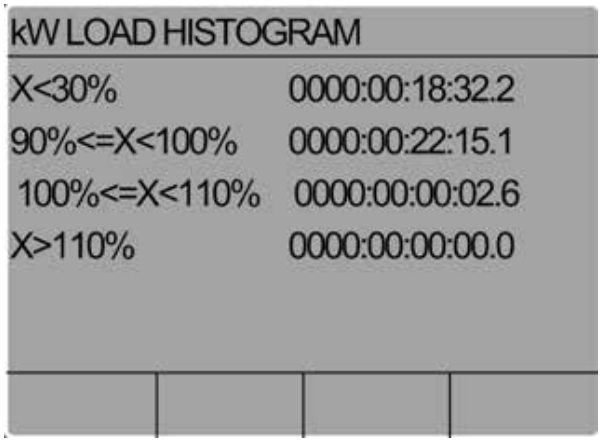
The EMCP 4 is equipped with a (real) load histogram. This feature will keep track of the amount of time the generator percent kW is within certain predefined ranges. The ranges are not configurable. There are four ranges that the EMCP will keep track of.

1. Time spent below 30% load
2. Time spent greater than or equal to 90% load and less than 100% load
3. Time spent greater than or equal to 100% load and less than 110% load
4. Time spent greater than or equal to 110% load

8.1 Viewing the Histogram

The histogram display screen is accessible under VIEW → kW LOAD HISTOGRAM.

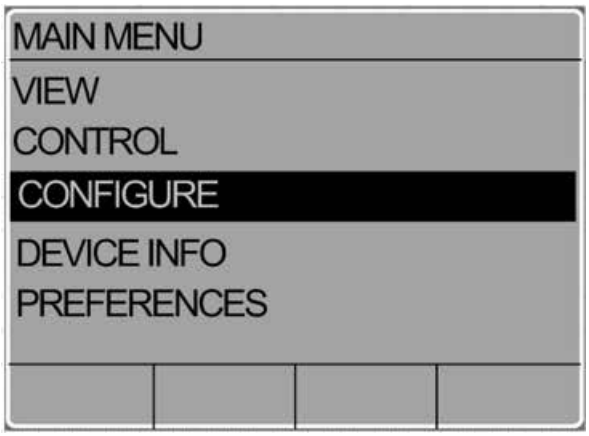


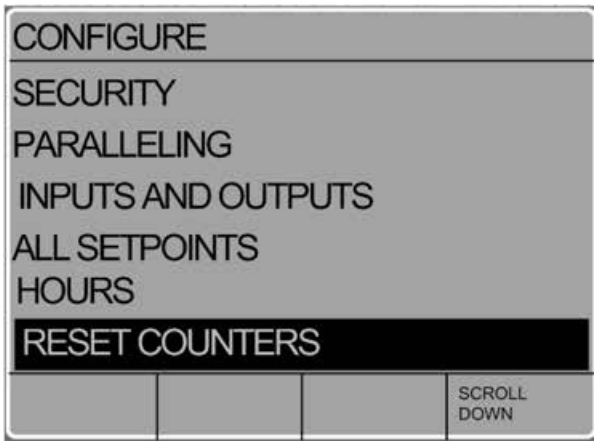


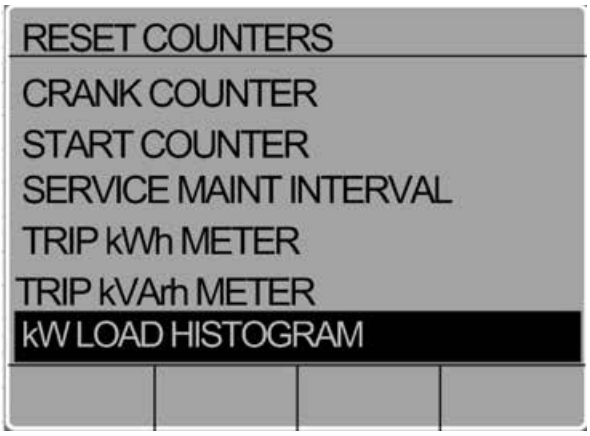
The time format is in days:hours:minutes:seconds with a .1 resolution for seconds.

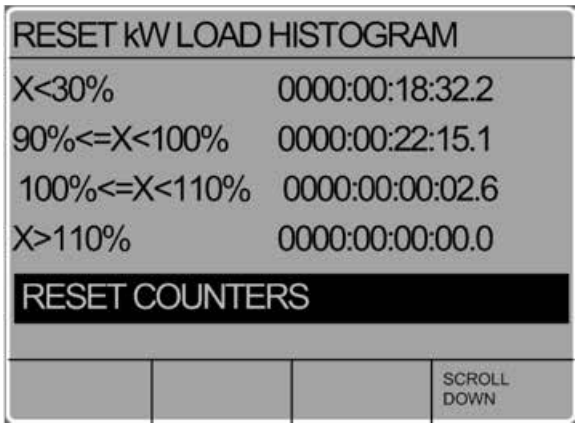
8.2 Clearing the Histogram

The histogram can be reset through display or through Cat Electronic Technician. To reset the histogram through the display navigate to MAIN MENU → CONFIGURE → RESET COUNTERS → kW LOAD HISTOGRAM. This command will reset all four of the counters at once. Level 3 password security is required for a reset.



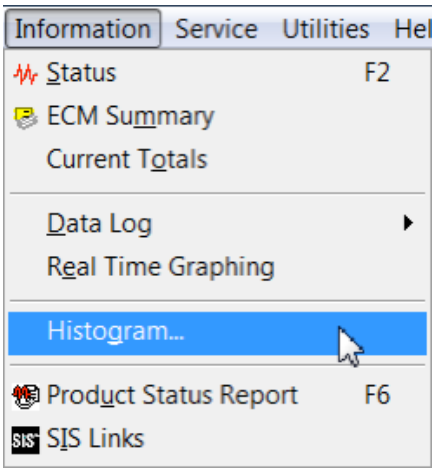




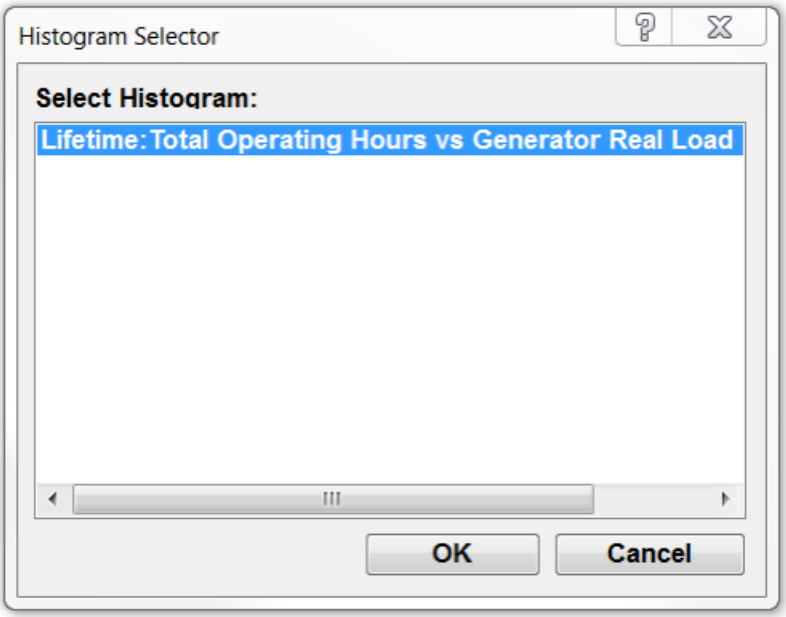


8.3 Cat ET Interface

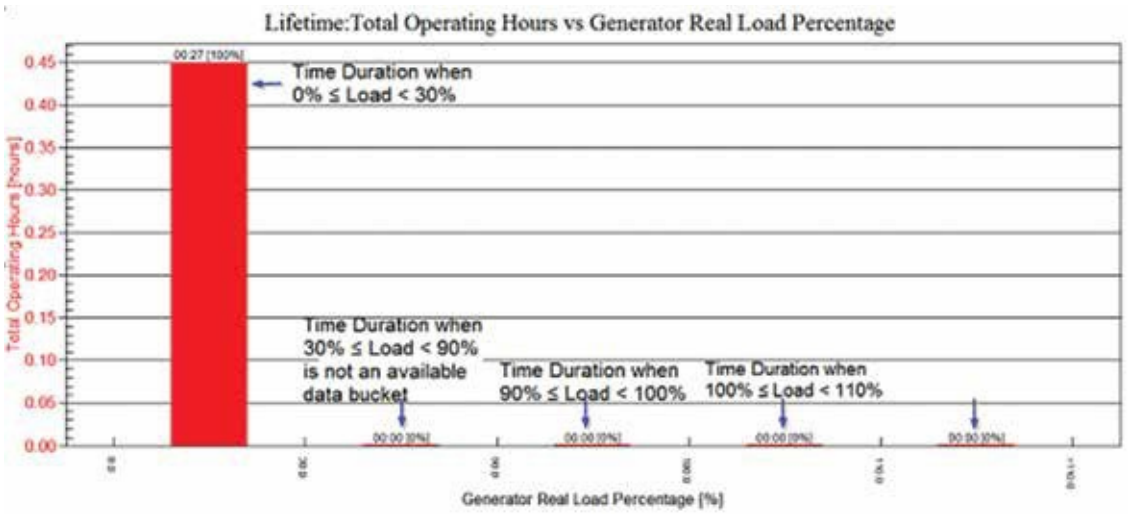
The load histogram can be viewed in Cat ET under the “Information” menu.



Selecting “Histogram…” will bring up a dialog box allowing the user to select which histogram to view. The EMCP 4 only supports the Lifetime: Total Operating Hours vs Generator Real Load selection.



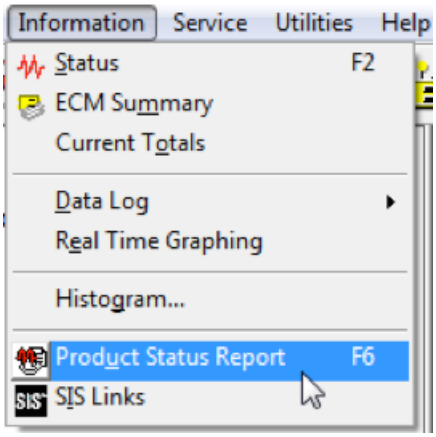
Selecting this option will bring up the histogram viewer in Cat ET.



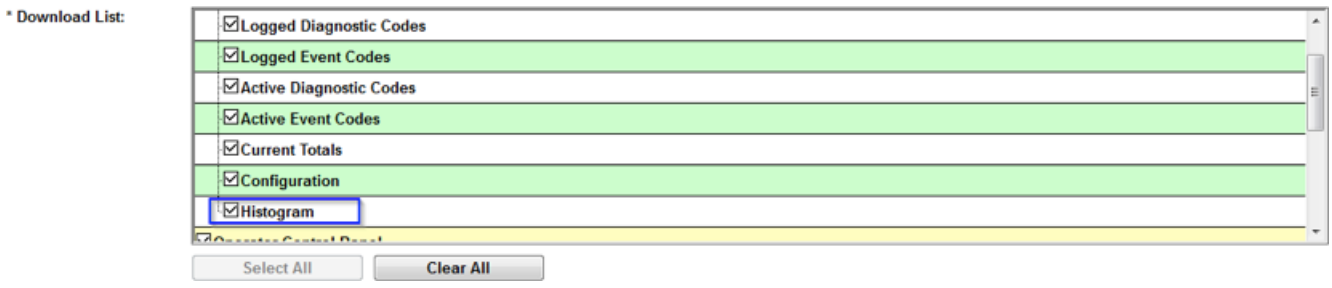
The Histogram time is displayed in units of Hours:Minutes and as a percent of the total histogram time.

$$x = \frac{this\ load\ range's\ time}{sum\ of\ all\ load\ range\ times} * 100$$

The histogram data can also be retained in a Cat Electronic Techinician PSR (Product Status Report) by selecting:



Then make sure that "Histogram" is selected in the "Download List.



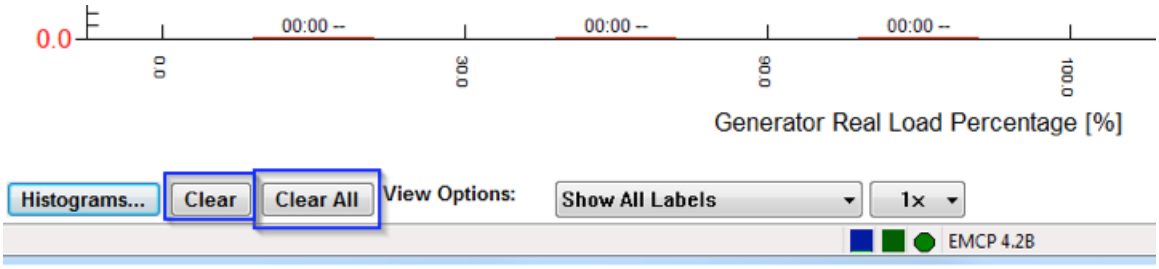
8.4 Clearing the Load Histogram Data

Clearing the Histogram Buckets from the Display:

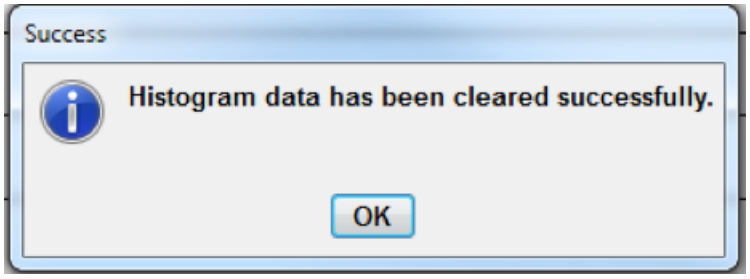
To reset the histogram through the display navigate to MAIN MENU → CONFIGURE → RESET COUNTERS → LOAD HISTOGRAM. This command will reset all four of the counters at once. Level 3 password security is required for a reset.

Clearing the Histogram Buckets from the Cat Service Tool:

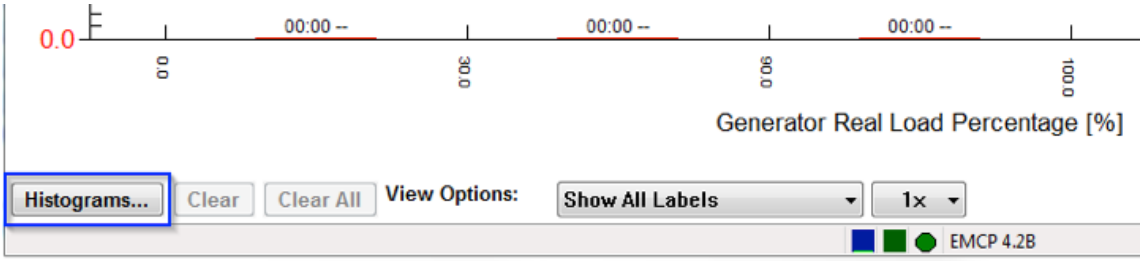
The histogram buckets can be cleared from this screen as well by selection the Clear or Clear All button.



The following message will appear when the histogram buckets are successfully cleared:



After selecting OK, the (cleared) histogram will not automatically reload. User must select the Histogram... button in order to view a cleared histogram.



9.0 Setpoints

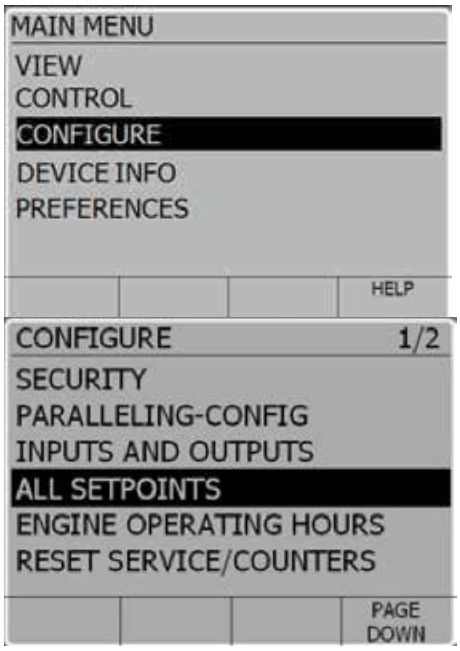
The EMCP 4.3 and 4.4 have a variety of setpoints that can be programmed or adjusted. These setpoints can be adjusted via the display, or via the Cat Service Tool. In order to program the setpoints via the display, go through the following menu options:

1. At MAIN MENU scroll DOWN  to CONFIGURE.

2. Press the OK KEY .

3. Scroll DOWN  to ALL SETPOINTS.

4. Press the OK KEY .



All of the setpoints on EMCP 4 can be accessed through this menu. However, setpoints related to input and output configuration can also be accessed through the INPUTS AND OUTPUTS menu under CONFIGURE. It is recommended to use the latter to configure inputs and outputs. For more information on configuring inputs and outputs, see Chapters 10 to 14.

9.1 Configuring Setpoints

Setpoints can be one of four different types: NUMERICAL ENTRY, SELECTION, SUSPECT PARAMETER NUMBER, or EVENT RESPONSE. Each type is configured differently. For configuring any setpoint via the display, the user must first have the proper security access. See Chapter 6 for more information on security.

NUMERICAL ENTRY setpoints are parameters like time delays, thresholds, etc. For these setpoints the display will show the current value.

To change the value of a NUMERICAL ENTRY type setpoint:

1. Press the OK KEY  when the setpoint is highlighted. The current value of the setpoint will be shown with the rightmost digit highlighted.

2. Use the UP  and DOWN  arrow keys to adjust that digit to the desired value. Digits will wrap around. Therefore, pressing up when 9 is shown will change it to 0, or pressing down when 0 is shown will change it to 9.

3. Once that digit is set to the desired value, use the LEFT  arrow key to move the cursor to the next digit.

4. Then use the UP  and DOWN  arrow keys to adjust that digit to the desired value.

5. Continue this process until the desired value for the setpoint is set.

6. Then press the OK KEY  to save the value.

Tip: You can quickly select the largest possible value for the setpoint by pressing the LEFT  arrow key until the leftmost digit is shown, and then pressing the UP  arrow key until the value stops changing.

Similarly you can select the smallest possible value by pressing the LEFT  arrow key until the leftmost digit is shown, and then pressing and holding DOWN  arrow key until the value stops changing.

SELECTION type setpoints, such as Generator Configuration, or Active State, have options that are not numerical. For these setpoints, the display will show the current setting.

To change the value of a SELECTION type setpoint:

1. Press the OK KEY  when the setpoint is highlighted. The current setting of the setpoint will be shown.

2. Use the UP  or DOWN  arrow keys to scroll through the options that are available for that setpoint. Scroll quickly by holding the key.

3. When the desired option is displayed, press the OK KEY  to save the setting.

SUSPECT PARAMETER NUMBER type setpoints are similar to SELECTION type setpoints, but the selections are grouped into four groups:

1. Pressures
2. Temperatures
3. Levels
4. Others

Any selection with units that are not pressure, temperature, or percent will be in the “Others” group. This group also contains Custom Parameters and Custom Events. Suspect parameter numbers indicating status (like Gen Breaker Open) will also be here.

To change the value of a SUSPECT PARAMETER NUMBER type setpoint:

1. Press the OK KEY 

when the setpoint is highlighted. Notice here that the setpoint value is not shown. Instead, the first group name, PRESSURE, is shown.

2. Use the UP  or DOWN  arrow keys to scroll through the four groups: PRESSURE, TEMPERATURE, LEVEL, OTHERS.

3. When the desired option is displayed, press the OK KEY 

to see the suspect parameter numbers (by name) in that group.

4. Use the UP  or DOWN  arrow keys to scroll through the suspect parameter numbers (by name) until the desired one is selected.

5. Press the OK KEY 

to save the setting. Alternately, press the BACK  key to return to the group selection: PRESSURE, TEMPERATURE, LEVEL, OTHERS.

EVENT RESPONSE CONFIGURATION type setpoints are a little different from the previously discussed setpoints. Each setpoint configures one or more actions that occur when the event occurs. See Section 5.1 for more information.

9.2 Setpoint Sub-menus

The setpoints in the EMCP 4 are organized into multiple submenus. See Appendix A and the appropriate sections of this document for more information.

9.3 Setpoints on the Cat Service Tool

EMCP 4 setpoints can also be configured using the Cat Service Tool (ET). To access setpoints, see Section 4.2.

If a value is changed from the EMCP display, Cat ET will not refresh the setpoint automatically. Press the “Config Tool” icon to refresh the list.

Categories of setpoints are listed along the left pane, and clicking on one of them will bring up that list in the right pane.

The EMCP 4.3 and 4.4 have different numbers of setpoints. The categories shown here match those in ET version 2013C. Older versions may have less, and newer versions may have more.

Note: Any setpoint with a value given as Unavailable is not applicable to that level of EMCP 4.

9.3.1 Setpoint Categories

Here are the categories of setpoints as found in the left pane of the ET Configuration Tool:

Analog Inputs
Setpoints related to Analog Inputs. See Chapter 11.

Analog Outputs
Setpoints related to Analog Outputs. See Chapter 13.

Analog PWM Outputs
Setpoints related to Analog PWM Outputs. See Chapter 14.

Automatic Start/Stop
Setpoints related to starting and stopping the generator set, as well as engine configuration.

Battery Voltage Monitor
Setpoints related to monitoring battery voltage from the battery power input to the EMCP 4.

Crank Attempt/Successful Start Counter
Setpoints related to crank/start counters.

Data Link: RS-485 SCADA
Setpoints related to SCADA (Modbus) data link communications. See Chapter 32.

Data Link: TCP/IP SCADA
Setpoints related to Ethernet communications. See Chapter 33.

Data Link: Multiple Genset Control
Setpoints related to MGDL. See Chapter 37.

Digital Inputs
Setpoints related to Digital Inputs. See Chapter 10.

Digital Outputs
Setpoints related to Digital Outputs. See Chapter 12.

Engine Coolant Temperature Monitor
Setpoints related to monitoring engine coolant temperature.

Engine Oil Pressure Monitor
Setpoints related to monitoring engine oil pressure.

Engine Speed Monitor
Setpoints related to monitoring engine speed using the Magnetic Pick-Up (MPU) input.

Enhanced Engine Monitor
Setpoints related to engine cylinder temperature and temperature differential monitoring via an optional Thermocouple module.

Enhanced Generator Monitor
Setpoints related to generator bearing and winding temperature monitoring via the optional RTD module.

Event Response Configuration – Diagnostic Events
Setpoints used to configure the EMCP 4 response to diagnostic events. See Chapter 5.

Event Response Configuration – Engine Protection Events
Setpoints used to configure the EMCP 4 response to engine protection events. See Chapter 5.

Event Response Configuration – Generator Protection Events
Setpoints used to configure the EMCP 4 response to generator protection events. See Chapter 5.

Event Response Configuration – Other System Events
Setpoints used to configure the EMCP 4 response to events that do not fit into the category of diagnostics, engine protection, or generator protection. See Chapter 5.

Event Response Configuration – Custom Events
Setpoints used to configure the EMCP 4 response to custom events. See Chapter 5.

Event System
Setpoint related to auto resetting a breaker.
Setpoints used to configure the Engine Running Conditions for the Engine Run Lamp on the RS-485 Annunciator. See Section 24.2.

Fuel Transfer
Setpoints related to fuel transfer feature.

Generator AC Monitor
Setpoints related to generator configuration (for EMCP 4 calculation and reporting).

Generator AC Power Monitor
Setpoints related to generator power monitoring.

Generator Breaker Control
Setpoints related to the generator breaker.

Generator Current Monitoring
Setpoints related to generator AC overcurrent monitoring.

Generator Dead Bus Arbitration
Setpoints related to Hard Wired Dead Bus Arbitration. See Section 15.3.
Setpoints related to MGDL Dead Bus Arbitration. See Section 37.3.

Generator Over/Under Frequency
Setpoints related to generator overfrequency and underfrequency monitoring.

Generator Over/Under Voltage
Setpoints related to generator AC overvoltage and undervoltage monitoring.

Generator Load Sharing and Control
Setpoints related to Load Sharing tuning.

Generator Reverse Power
Setpoints related to generator AC reverse power monitoring.

Generator to Bus Synchronizer
Setpoints related to Synchronizing. See Chapter 15.

Integrated Voltage Regulator
Setpoints related to configuring the Integrated Voltage Regulator (if installed). See Chapter 35.

Load Sense/Load Demand
Setpoints related to Hard Wired Load Sense Load Demand. See Section 15.4.
Setpoints related to MGDL Load Sense Load Demand. See Section 37.3.

Load Shed Conditions
Setpoints related to breaker control and load shed conditions.

Programmable Cycle Timer
Setpoints related to configuring Programmable Cycle Timers. See Chapter 18.

Electronic Control Module Reduced Power Mode
Setpoints related to a power-saving mode of the EMCP 4 called Reduced Power Mode. See Chapter 19.

Service Maintenance Interval
Setpoints related to configuring and resetting the timers used to indicate a service needed warning.
See Chapter 5.

kW Relay Setpoints
Setpoints related to configuring the behavior of the Trip Point function, which is used to indicate that the generator is approaching overload.

Configuration Data
Contains the Engine Serial Number setpoint, which is read-only.

Display Preferences
Setpoints determining the units used on the EMCP 4 display. Note that this does not affect the data as viewed on the Cat Service Tool. See Section 4.4.

10.0 Digital Inputs

The EMCP 4.3 and 4.4 have eight programmable Digital Inputs and four isolated programmable Digital Inputs. The user programmable Digital Inputs are referenced to Battery (-) and will see a change in state at ~3VDC with a 1VDC hysteresis. The isolated user programmable Digital Inputs are all referenced to a common signal that is user supplied and will see a change in state at ~4VDC. This user supplied reference should be wired to pin 118 on the 120-pin connector of the EMCP 4.3 and 4.4.

In addition to the user programmable Digital Inputs, the EMCP 4.3 and 4.4 have dedicated Digital Inputs, both isolated and non-isolated. The dedicated isolated Digital Inputs are all referenced to a common signal that is user supplied and is the same as the user supplied reference wired to pin 118 on the 120-pin connector of the EMCP 4.3 and 4.4.

Table 10.1 outlines which functions are assigned to each of the dedicated inputs. A "Y" under a controller name indicates that the input is supported, while an "N/A" indicates it is not.

Input	EMCP 4.3	EMCP 4.4	Onscreen Label	Dedicated Function
Dedicated Non-Isolated Digital	Y	Y	A	Emergency Stop
Dedicated Non-Isolated Digital #2	Y	Y	B	Remote Initiate
Dedicated Non-Isolated Digital #3	N/A	Y	C	Gen CB Aux "a"
Dedicated Non-Isolated Digital #4	N/A	Y	D	Gen CB Aux "b"
Dedicated Isolated Digital #1	N/A	Y	A	Group Start*
Dedicated Isolated Digital #2	N/A	Y	B	Gen CB Bell Alarm
Dedicated Isolated Digital #3	N/A	Y	C	Gen CB Trip Manual Command
Dedicated Isolated Digital #4	N/A	Y	D	Gen CB Close Manual Command

Table 10.1 – Dedicated Input Assignments

*If using Group Start, Reduced Power Mode should NOT be used since Group Start will not wake up a controller out of "Sleep."

The other inputs are linked to functions that are called STATUS OR SYSTEM EVENTS and can be configured to trigger warnings or shutdowns in the EMCP 4. System Event configurations determine the EMCP 4 response to any supported event. For more information on Event Response Configurations, see Section 5.1.

The programming of the Digital Inputs starts by selecting a “Usage Type“. The rest of the programming is dependent upon what Usage Type is selected. Programming Digital Inputs from the EMCP display requires Level 2 security access. Figure 10.1 summarizes the paths possible for Programming a Digital Input.

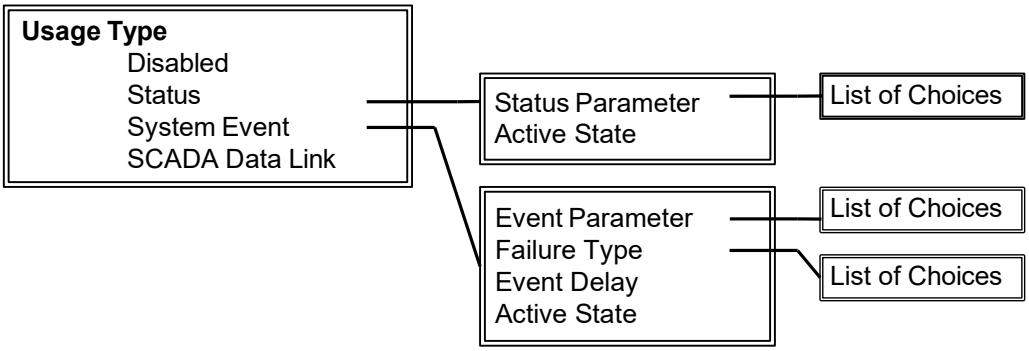


Figure 10.1 – Digital Input Programming Paths

The Usage Type of DISABLED is used to completely disable the input. No status will be shown, and no action will be taken by the EMCP 4.

The Usage Type of STATUS is used to make certain system conditions be known by the EMCP 4; an example of a system condition is the Generator Breaker status for an EMCP 4.3 or a command to perform a certain operation.

The Usage Type of SYSTEM EVENT is used to inform the EMCP 4 of system conditions that require the EMCP 4 to trigger an event.

The Usage Type of SCADA DATA LINK is used to bring in data to the EMCP 4 specifically for use by the SCADA data link. EMCP 4 will not take any action or trigger any events on such an input.

The Digital Inputs of the EMCP 4 are tied to an internal pull-up resistor inside the controller. Therefore, if a Digital Input is UNCONNECTED, the Digital Input will sit at a PHYSICAL HIGH state. See Figure 10.2. Note that a Digital Input wired to battery positive will always remain Active if programmed for Active High, and will always remain Inactive if programmed for Active Low.

A battery negative input should be switched to each EMCP 4 Digital Input for proper operation. Isolated Digital inputs must be switched to Isolated Reference.

- If an ACTIVE HIGH configuration is desired, the reference or battery negative input should be wired through a normally-closed switch.
- If an ACTIVE LOW configuration is desired, the reference or battery negative input should be wired through a normally-open switch.

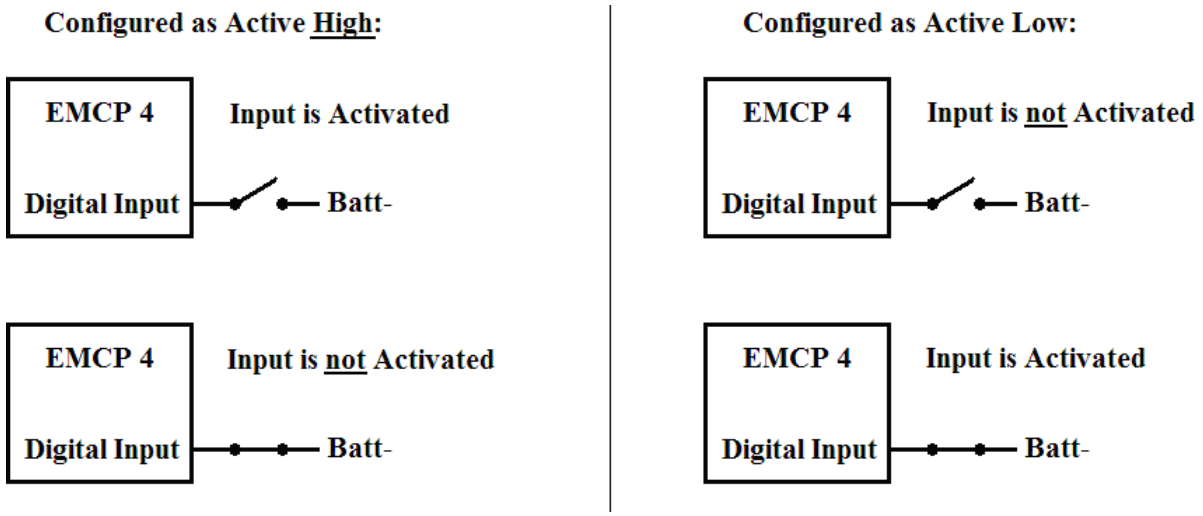


Figure 10.2 – Valid States of Digital Input Wiring and Configuration

Note: Improper configuration of these inputs can cause a false event to be triggered, or cause an event to not be triggered when desired.

Note: If more than one Digital Input is configured for the same physical quantity (i.e. the setpoint Digital Input Data Identification matches between two Digital Inputs), then the higher numbered Digital Input value will have priority. For example, if both Digital Input #4 and Digital Input #5 are configured for ECS in Run but Digital Input #4 is activated with Digital Input #5 left inactive, then Digital Input #4 will be ignored and ECS in Run will be inactive.

10.1 Programming Digital Inputs Using the Display

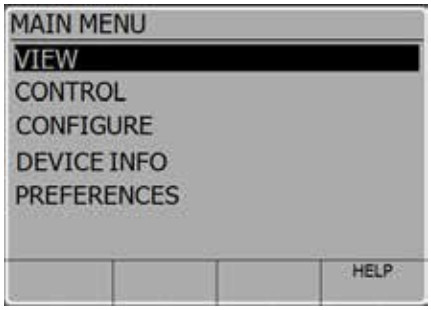
The steps to configure the Digital Inputs for each of the Usage Types are described below.

10.1.1 Viewing the Current Digital Input Status

To view the current status of a Digital Input, go through the following menu options:

1. AT THE MAIN MENU, scroll DOWN  TO VIEW.

2. Press the OK KEY .



3. Scroll DOWN to I/O STATUS.

4. Press the OK KEY.

5. Scroll DOWN to DIGITAL INPUTS.

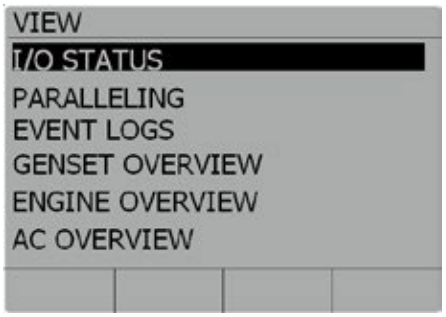
6. Press the OK KEY.

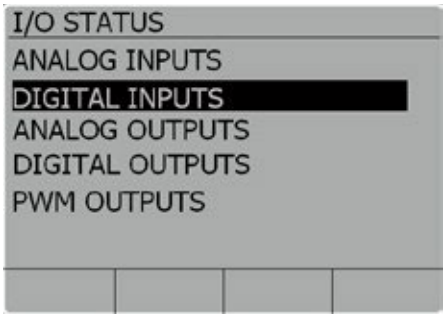
The status of all Digital Inputs is shown.

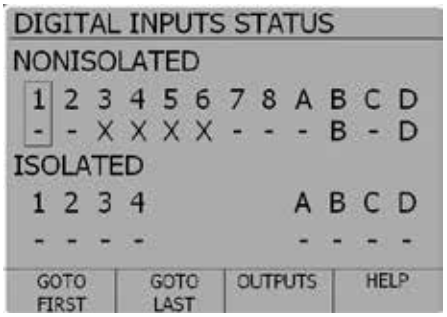
A dash under an input number (or letter) indicates an input that is programmed, but inactive. A large “X” under an input number (or letter) indicates an input that is disabled. A number (or letter) under an input number (or letter) indicates an input that is programmed and active.

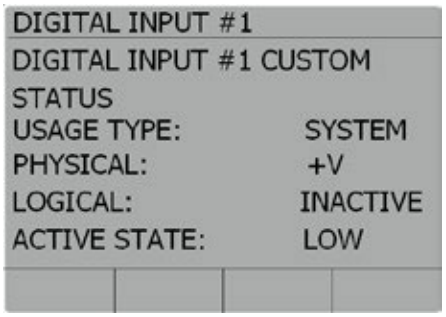
7. With the LEFT ARROW or RIGHT ARROW, select the DIGITAL INPUT that you want to view, then press the OK KEY.

The programmed parameters of the selected Digital Input are shown.





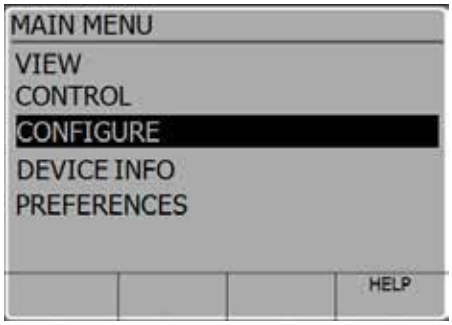




10.1.2 Configuring Digital Inputs for Status Parameters

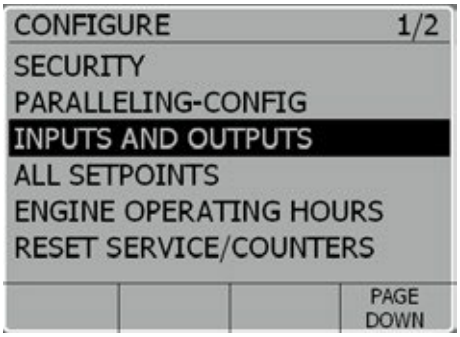
Command or Status parameters are used to control specific functions within the control system or to make certain conditions within the system be known. To configure a Digital Input as a Command or Status Parameter, go through the following menu options:

1. AT THE MAIN MENU, scroll DOWN TO CONFIGURE.



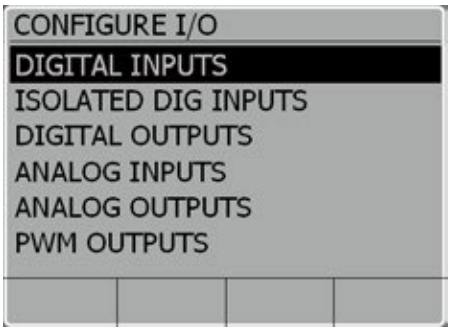
2. Press the OK KEY.

3. Scroll DOWN to INPUTS & OUTPUTS.



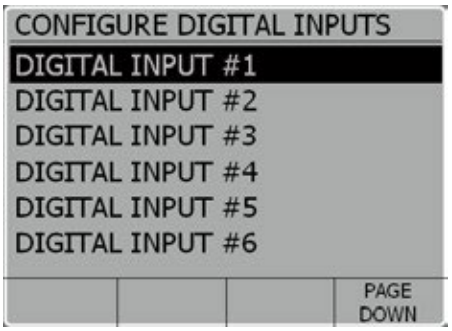
4. Press the OK KEY.
   Alternately, access to the INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

5. Press the OK KEY to access DIGITAL INPUTS.



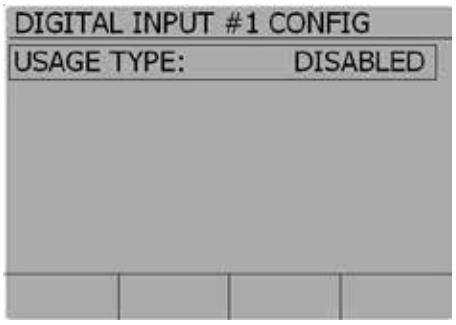
6. Select the DIGITAL INPUT that you want to program.

7. Press the OK KEY.



8. Press the OK KEY 

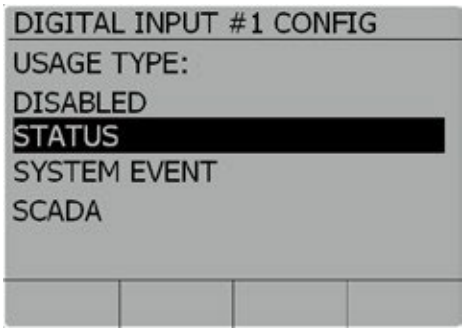
to highlight the current configuration (DISABLED, STATUS, SYSTEM EVENT, OR SCADA).



9. Scroll DOWN  to STATUS.

10. Press the OK KEY 

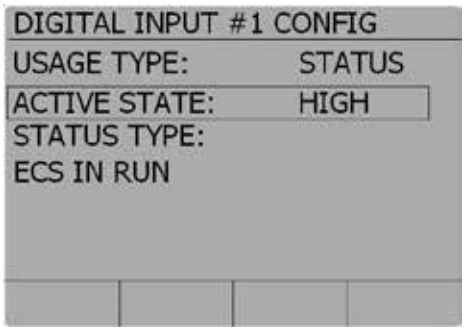
.



11. Scroll DOWN  to ACTIVE STATE.

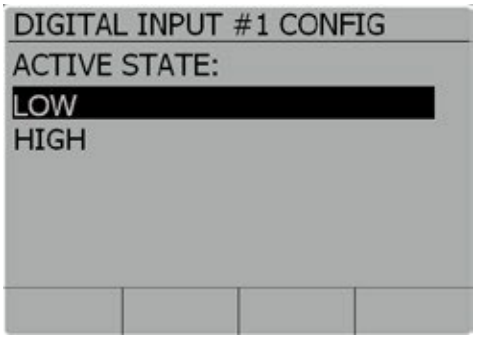
12. Press the OK KEY 

to highlight the current ACTIVE STATE.



13. Select the ACTIVE STATE that you want to program and Press the OK KEY 

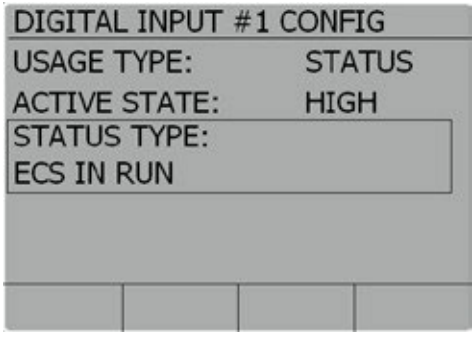
.



14. Scroll DOWN  to STATUS TYPE.

15. Press the OK KEY 

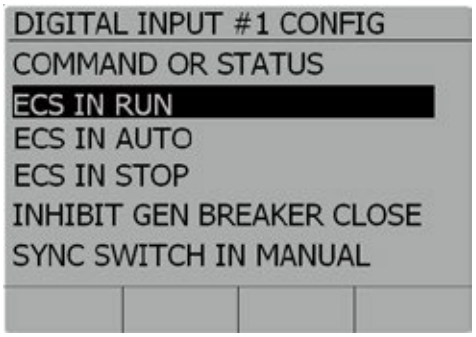
to highlight the current STATUS TYPE.



16. Select the STATUS TYPE that you want to program.

Press the OK KEY 

.



Any Digital Input can be configured for any one of the Status parameters in Table 10.2:

Status Parameter	Status Parameter
ECS in Run*	Lower Speed
ECS in Auto*	Nominal Voltage Selection is Low***
ECS in Stop*	Auto Load Fuel
Inhibit Generator Breaker Closure (4.4)	Auto Unload Fuel***
Utility Breaker Aux A (4.4)***	Start Aid Timer Bypass
Utility Breaker Aux B (4.4)***	kVAr Power Sharing Inhibit (4.4)
Sync Mode Switch in Manual (4.4)	Load Shed Reset Command
Sync Mode Switch in Auto (4.4)	Fuel Priming Command
Sync Mode Switch in Check (4.4)	Disable Auto Paralleling Command (4.4)
Idle Mode Command	Inhibit Reactive Droop Compensation**
Inhibit Cooldown	Inhibit Line Drop Compensation**
Raise Voltage	Enable Power Factor Control Command**
Lower Voltage	Disable Gas Substitution
Raise Speed	Disable Generator Excitation**
Alarm Acknowledge	ECU Fault Reset
Generator Breaker Aux A (4.3)	Generator Breaker Aux B (4.3
Loss of Utility	Transfer to Generator Power
Generator to utility Transfer Delay Bypass	

Table 10.2 – Digital Input Command/Status Options

*If a Digital Input is programmed for ECS in Auto, or Run, or Stop, and a maintained switch latches that input to make it active, the front panel buttons will not have any effect.

**Only available with Integrated Voltage Regulator

***Not available with Control Software Type configured to Standard software

10.1.3 Digital Input Status Descriptions

Below is a brief description of the purpose of each command/status digital input option:

ECS in Run

- When activated, has the same effect as pressing the “Run” button (puts the EMCP in RUN mode and runs the generator at rated voltage and speed). While this input is Logically Active, the ECS can’t be changed from RUN.

ECS in Auto

- When activated, has the same effect as pressing the “Auto” button (puts the EMCP in AUTO mode). While this input is Logically Active, the ECS can’t be changed from AUTO.

ECS in Stop

- When activated, has the same effect as pressing the “Stop” button (puts the EMCP in STOP mode). While this input is Logically Active, the ECS can’t be changed from STOP.

Inhibit Generator Breaker Closure

- When activated, the generator breaker is inhibited (locked out) from closing. EMCP 4.4 only.

Utility Breaker AUX A

- When activated, indicates the status of the auxiliary A input of an externally controlled utility breaker. EMCP 4.4 Complex Software Only.

Utility Breaker AUX B

- When activated, indicates the status of the auxiliary B input of an externally controlled utility breaker. EMCP 4.4 Complex software only

Sync Mode Switch in Manual

- When activated, the sync mode switch is placed in MANUAL mode. While this input is Logically Active, the sync mode switch cannot be changed from MANUAL. EMCP 4.4 only.

Sync Mode Switch in Auto

- When activated, the sync mode switch is placed in AUTO mode. While this input is Logically Active, the sync mode switch cannot be changed from AUTO. EMCP 4.4 only.

Sync Mode Switch in Check

- When activated, the sync mode switch is placed in CHECK mode. While this input is Logically Active, the sync mode switch cannot be changed from CHECK. EMCP 4.4 only.

Idle Mode Command

- When activated, attempts to force the engine to run at idle speed when the engine is running. This action will also disable various protective functions including functions such as underspeed, undervoltage and underfrequency. Actual changing of engine speed depends on system configuration.

Inhibit Cooldown

- While activated, prevents the engine from entering cooldown and keeps the EMCP in pre-cooldown state. Must be de-activated before the engine will completely stop. A hard shutdown will still stop the engine even if Inhibit Cooldown is in place.

Raise Voltage

- When activated, raises generator voltage level by 0.5% of rated. If the input is maintained, after 0.5 seconds generator voltage level increases by 0.5% every 400 ms (approximate). Typically used for external voltage biasing and/or external paralleling control.

Lower Voltage

- When activated, lowers generator voltage level by 0.5% of rated. If the input is maintained, after 0.5 seconds generator voltage level decreases by 0.5% every 400 ms (approximate). Typically used for external voltage biasing and/or external paralleling control.

Raise Speed

- When activated, raises engine speed by 0.5% of rated. If the input is maintained, after 0.5 seconds engine speed increases by 0.5% every 400 ms (approximate). Typically used for external speed biasing and/or external paralleling control.

Lower Speed

- When activated, lowers engine speed by 0.5% of rated. If the input is maintained, after 0.5 seconds engine speed decreases by 0.5% every 400 ms (approximate). Typically used for external speed biasing and/or external paralleling control.

Nominal Frequency Selection Is Low***

- When activated, selects low frequency ratings group #3 or #4. If an input is not mapped to a digital input, it is assumed to be a logical "0." When used in conjunction with Nominal Voltage Selection is Low the following ratings groups can be selected:

Programmable Digital Input "Nominal Frequency is Low" Logical Status	Programmable Digital Input "Nominal Frequency is Low" Logical Status	Ratings Group Selected
0 (high frequency)	0 (high voltage)	Group #1
0 (high frequency)	1 (low voltage)	Group #2
1 (low frequency)	0 (high voltage)	Group #3
1 (low frequency)	1 (low voltage)	Group #4

(Not available on standard software)

Nominal Voltage Selection Is Low***

- When activated, selects low voltage ratings group #2 or #4. If an input is not mapped to a digital input, it is assumed to be a logical "0." When used in conjunction with Nominal Frequency Selection is Low the following ratings groups can be selected:

Programmable Digital Input "Nominal Frequency is Low" Logical Status	Programmable Digital Input "Nominal Frequency is Low" Logical Status	Ratings Group Selected
0 (high frequency)	0 (high voltage)	Group #1
0 (high frequency)	1 (low voltage)	Group #2
1 (low frequency)	0 (high voltage)	Group #3
1 (low frequency)	1 (low voltage)	Group #4

(Not available on standard software)

Auto Load Fuel

- When activated, initiates the automatic fuel transfer in feature (if enabled). Typically used in conjunction with programmable digital outputs and analog input to control loading fuel.

Auto Unload Fuel***

- When activated, initiates the automatic fuel transfer out feature (if enabled). Typically used in conjunction with programmable digital outputs and analog input to control unloading fuel. (Not available on standard software.)

Baseload Via Analog Input (Baseload Via Analog In)***

- When activated, baseload setting is based on analog input value instead of programmed value. If an analog input is programmed for Desired Generator Power Factor, it will also be used in lieu of the programmed value.

Start Aid Timer Bypass

- When activated, bypasses any remaining Start Aid Activation time and allows the set to proceed directly to cranking.

Kvar Power Sharing Inhibit (Kvar Power Share Inhibit)

- When activated, reactive power (kVAr) sharing is inhibited. Typically used in installations where an external method of controlling reactive power is desired.

Load Shed Reset Command (Load Shed Reset)

- When activated, an EMCP 4.4 generator set control latched load shed output is reset (made inactive), if all load shed conditions are no longer present.

Fuel Priming Command

- When activated, initiates fuel priming pump (if enabled). If Engine Operating State is configured for Hardwired, EMCP controls the fuel priming pump using fuel control relay output. If Engine Operating State is configured for CAN Input, EMCP communicates fuel priming command to engine ECM.

Disable Auto Parallel Command (Disable Auto Parallel CMD)

- When activated, load sharing and load control is disabled. The SYNC MODE switch will be forced to MANUAL when the generator circuit breaker is open. When the generator circuit breaker is closed, the SYNC MODE switch is forced to OFF. Typically used when a single generator set is operating via an Automatic Transfer Switch (ATS) by jumpering the manual close request to always Active to automatically close the breaker when the generator starts and come up to speed and automatically open the breaker when the generator stops. All loadsharing is disabled when this input is active.

Inhibit Reactive Droop Compensation (Volt Droop Inhibit)

- When activated, reactive droop compensation bias (if configured) is removed from generator voltage output. (Only Available With Integrated Voltage Regulator).

Inhibit Line Drop Compensation (Line Loss Comp Inhibit)

- When activated, line drop compensation bias (if configured) is removed from generator voltage output. (Only available with Integrated Voltage Regulator).

Enable Power Factor Control Command

- When activated, voltage regulator control is performed in order to control power factor to a desired level. (Only available with Integrated Voltage Regulator and standard software).

Disable Gas Substitution (Disable Gas Blending)

- When activated, gas blending is disabled with the Caterpillar Dynamic Gas Blending System and gas substitution percentage is forced to zero.

Disable Generator Excitation Command (Disable Excitation)

- When activated, generator excitation command is forced to zero and generator voltage output will only consist of residual voltage. (Only active with Integrated Voltage Regulator).

Loss of Utility

- When activated this will generate a loss of utility condition. If the transfer switch is enabled, this will command the generator to run and disconnect the utility from the bus.

Transfer to Generator Power

- When activated this input will command the system to run on generator power. The utility will be disconnected from the bus and the generator will run and close to the bus.

Generator to Utility Transfer Delay Bypass

- When activated this input will bypass the utility "stability timers." The stability timers delay the system from transferring back to utility once a utility failure is detected and a return of the utility is seen to ensure the utility is stable. This gives the user to ability to transfer back to utility immediately after the utility returns without waiting for it to stabilize.

Generator Breaker Aux A or B (4.3)

- When this input is activated, this will determine the position of the generator breaker on the EMCP 4.3. The 4.4 has dedicated breaker input contacts that don't need to be configured.

Alarm Acknowledge

- Activating this input will acknowledge any unacknowledged alarms on the EMCP. This is the equivalent to pressing the ACK button on the face of the control.

ECU Fault Reset

- Activating this input will cause any active events or diagnostics to be reset. **Note:** Before a reset can occur, all alarms must be acknowledged, the engine cannot be running or stopping, and the control must be in STOP.

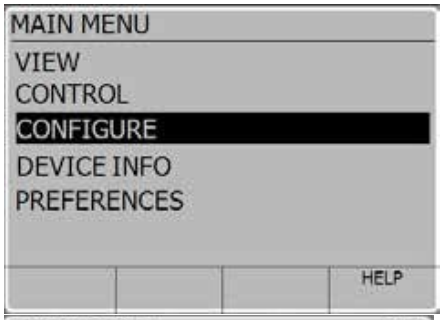
10.1.4 Configuring Digital Inputs for System Events

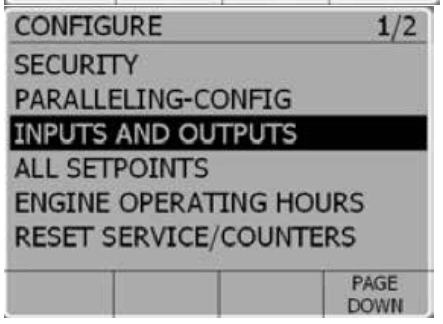
System Events are used to know when specific conditions are reached and to alert the control system of warning or shutdown conditions. To configure a Digital Input as a System Event, go through the following menu options:

1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY .

3. SCROLL DOWN  to INPUTS & OUTPUTS.





4. Press the OK KEY 

.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

5. Press the OK KEY 

to access DIGITAL INPUTS.

6. Select the DIGITAL INPUT that you want to program and

Press the OK KEY 

.

7. Press the OK KEY 

to highlight the current configuration (DISABLED, STATUS, SYSTEM EVENT, OR SCADA).

8. Scroll DOWN  to SYSTEM EVENT.

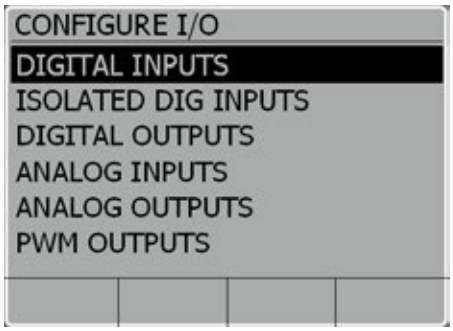
9. Press the OK KEY 

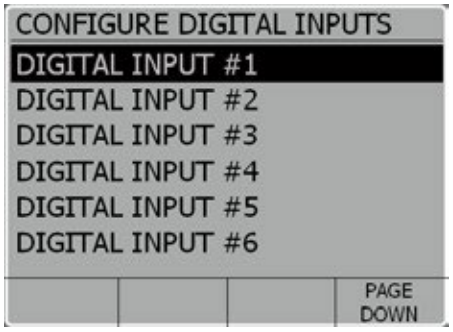
.

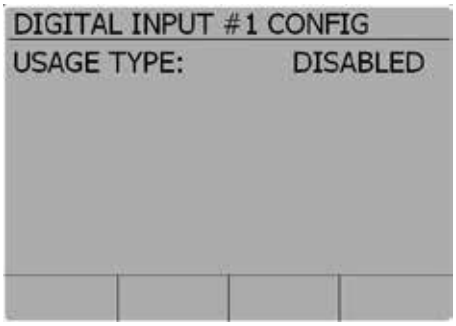
10. Scroll DOWN  to ACTIVE STATE.

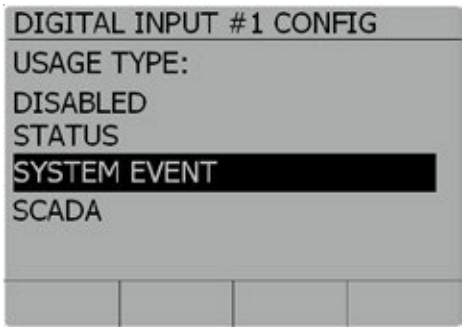
11. Press the OK KEY 

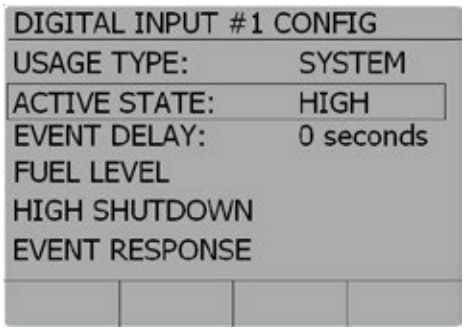
to highlight the current ACTIVE STATE.





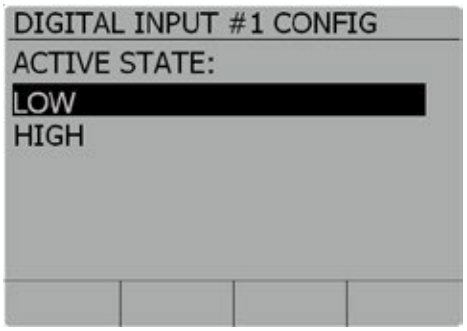






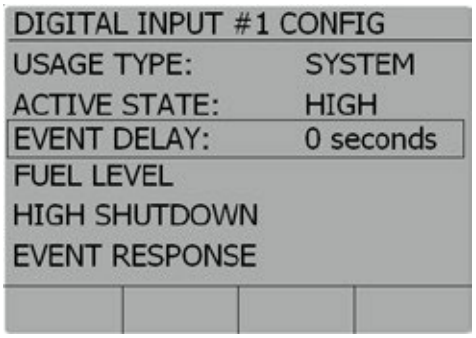
12 Select the ACTIVE STATE that you want to program and Press the

OK KEY OK.



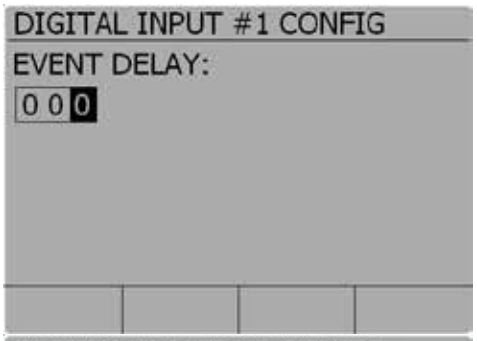
13. Scroll DOWN to EVENT DELAY.

14. Press the OK KEY to highlight the current EVENT DELAY.



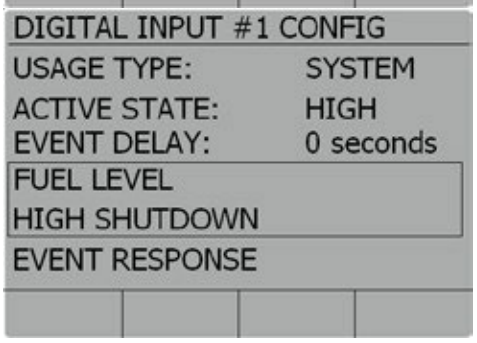
15. Select the EVENT DELAY that you want.

16. Press the OK KEY.



17. Scroll DOWN to EVENT PARAMETER.

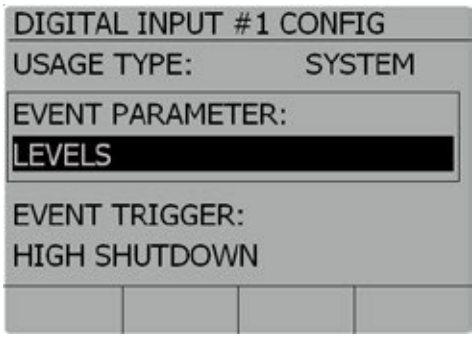
18. Press the OK KEY to edit the current EVENT PARAMETER.



19. Select the type of EVENT PARAMETER that you want to program (Pressures, Temperatures, Levels, or Others).

20. Press the OK KEY.

21. Select the EVENT PARAMETER that you want to program.



22. Press the OK KEY 

.

23. Scroll DOWN  to EVENT TRIGGER.

24. Press the OK KEY 

to highlight the current EVENT TRIGGER.

25. Select the EVENT TRIGGER that you want.

26. Press the OK KEY 

.

27. Press the ESCAPE KEY .

28. Scroll DOWN  to EVENT RESPONSE.

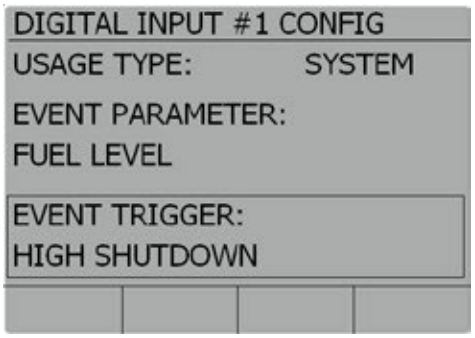
29. Press the OK KEY 

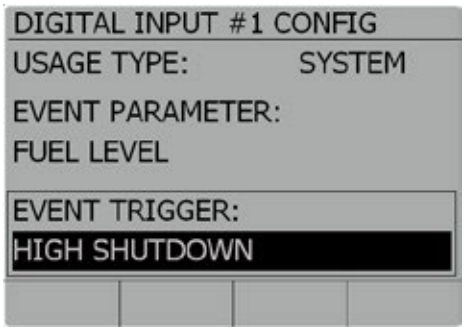
.

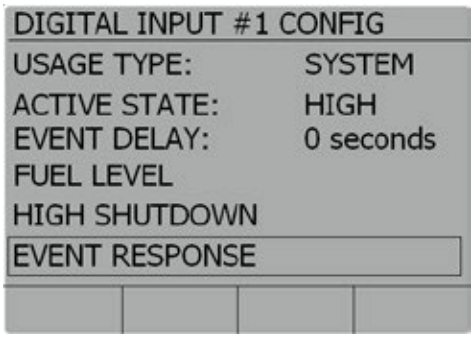
30. Select the EVENT RESPONSE that you want.

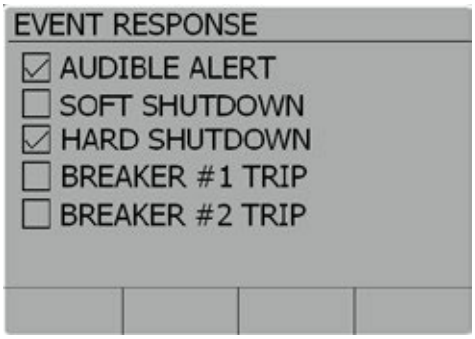
31. Press the OK KEY 

.









Any Digital Input can be configured for any one of the System Event parameters in Table 10.3:

Pressures	**Others**
Engine Oil Pressure	Custom Event*
Gas Pressure	Air Damper Closed
Temperatures	Battery Charger Failure
Engine Coolant Temperature	Fuel Leak
Engine Oil Temperature	Earth Fault
Exhaust Temp	Earth Leakage
Generator Rear Bearing Temperature	Battery Charging System Voltage
Generator Winding #1 Temperature	Generator Breaker Closed
Levels	Generator Breaker Open
Engine Coolant Level	Generator Current
Engine Oil Level	Generator Real Power
Fuel Level	Inlet Manifold Charge Combustion
External Tank Fuel Level	EPS Supply Load (EMCP 4.2 only)
Aftercooler Coolant Level	Emergency Stop Switch (Remote)
Engine Fluid Bund Level	

Table 10.3 – Digital Input System Events

***Note:** Digital Inputs configured for Custom Event SPNs (701-718) are shared between the EMCP and DIO Modules. Therefore ONLY one Custom Event SPN-FMI can be used between the two modules. SPN701 (Digital Input #1 Custom Event) may also be used in the Configuration of "Engine Running."

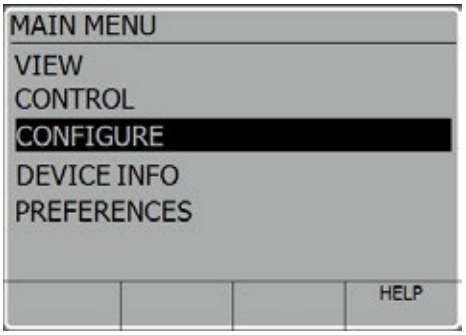
10.1.5 Configuring Digital Inputs for SCADA Data Link

When a Digital Input is configured for SCADA Data Link, the state of the input will be placed into the appropriate MODBUS register only. No alarms or warnings will be generated by the EMCP. To configure a Digital Input for SCADA Data Link, go through the following menu options:

1. AT THE MAIN MENU, scroll down  TO CONFIGURE.

2. Press OK KEY 

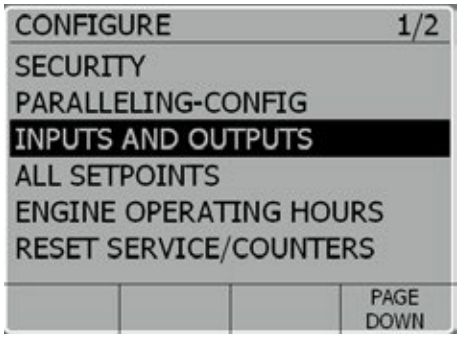
.



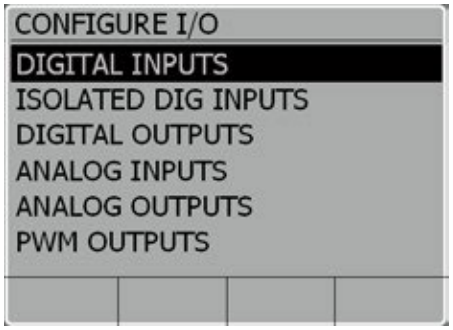
3. SCROLL DOWN to INPUTS & OUTPUTS.

4. Press OK KEY.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

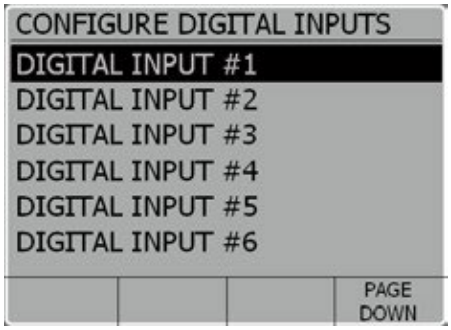


5. Press OK KEY to access DIGITAL INPUTS.

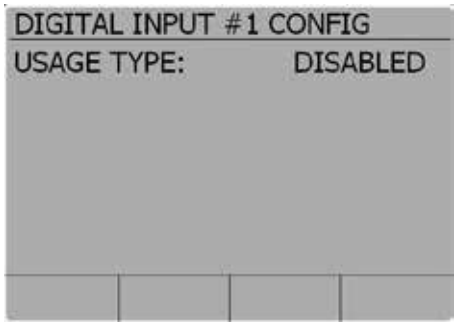


6. Select the DIGITAL INPUT that you want to program and

Press the OK KEY.

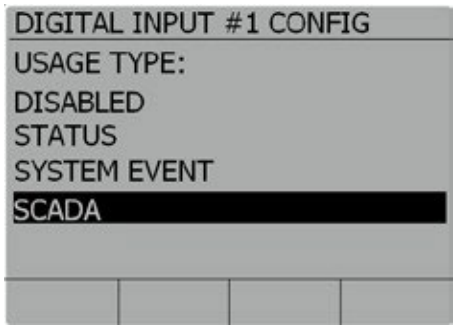


7. Press the OK KEY to highlight the current configuration (DISABLED, STATUS, SYSTEM EVENT, OR SCADA).



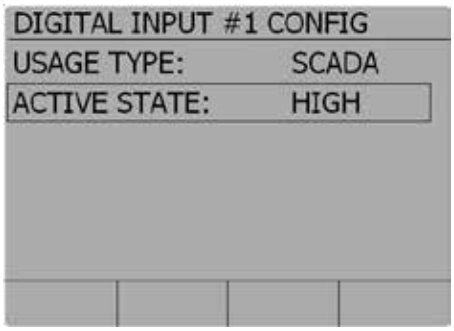
8. Scroll DOWN to: SCADA.

9. Press the OK KEY.



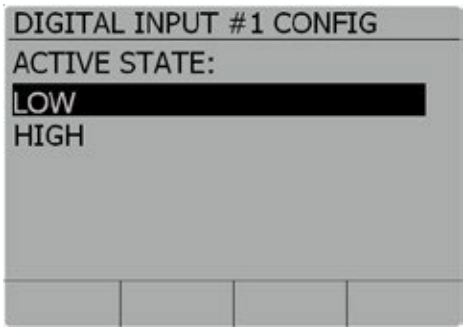
10. Scroll DOWN  to ACTIVE STATE.

11. Press the OK KEY  to highlight the current ACTIVE STATE.



12. Select the ACTIVE STATE that you want to program.

13. Press the OK KEY .



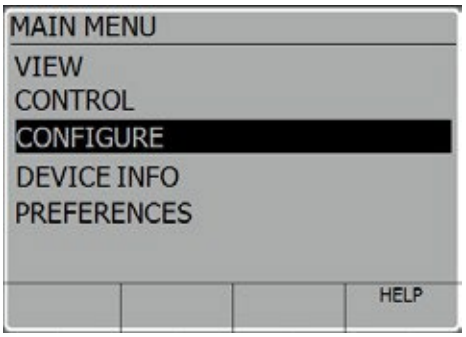
For information on reading the status of Digital Inputs via MODBUS, please refer to the SCADA documentation.

10.1.6 Disabling Digital Inputs

To disable a Digital Input, go through the following menu options:

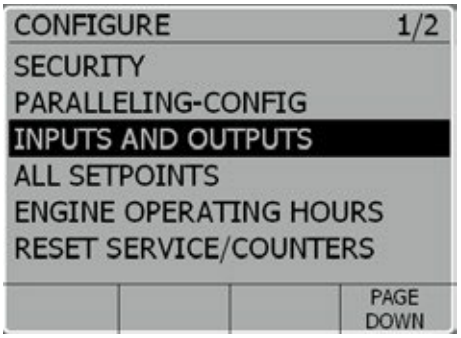
1. AT THE MAIN MENU, scroll down  TO CONFIGURE.

2. Press the OK KEY .



3. SCROLL DOWN  to INPUTS & OUTPUTS.

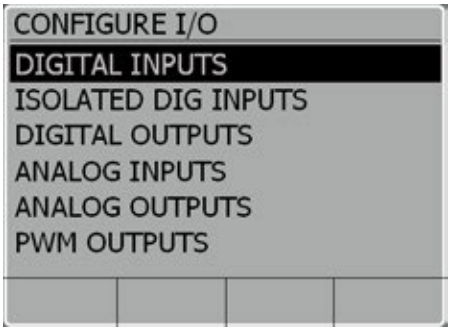
4. Press the OK KEY .



Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

5. Press the OK KEY 

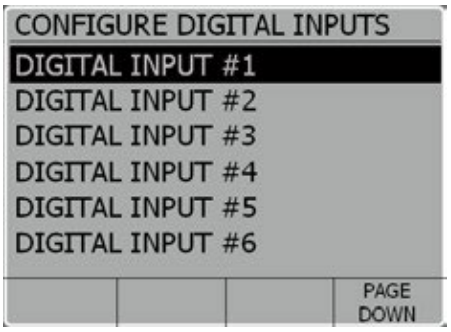
to access DIGITAL INPUTS.



6. Select the DIGITAL INPUT that you want to program and

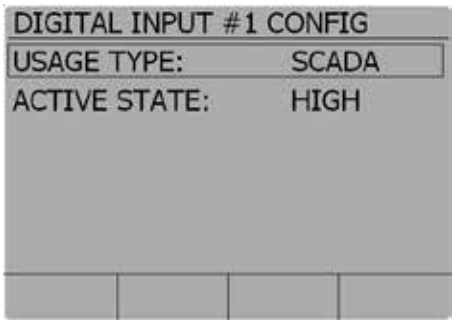
Press the OK KEY 

.

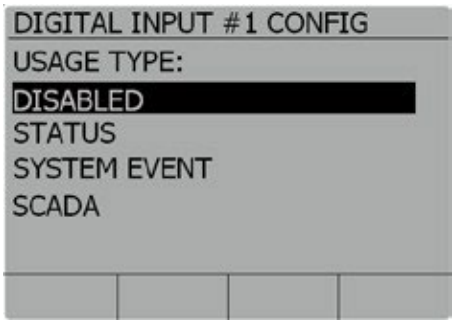


7. Press the OK KEY 

to highlight the current configuration (DISABLED, STATUS, SYSTEM EVENT, OR SCADA).



8. Scroll DOWN  to DISABLED.



9. Press the OK KEY 

.

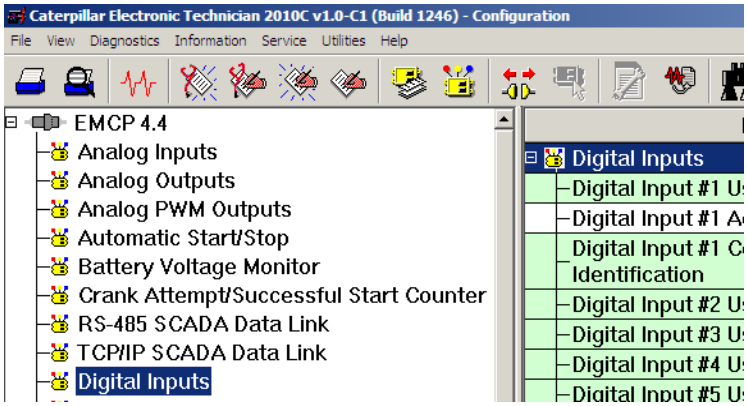
Note: If a Digital Input is set to Disabled, then any faults or events on that input will not be broadcast or annunciated on the network.

10.1.7 Programming Digital Inputs Using the Cat Service Tool

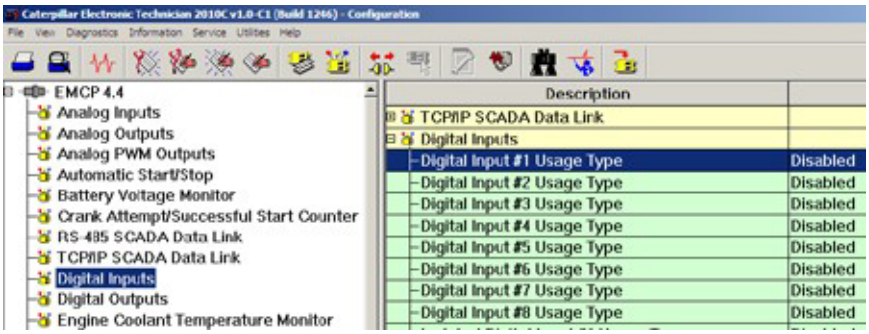
The EMCP 4 Digital Inputs can be configured using the Cat Service Tool. The key to programming them is to program the setpoints related to each input in order from top to bottom. To program an input, do the following steps:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

2. Select Digital Inputs on the left.



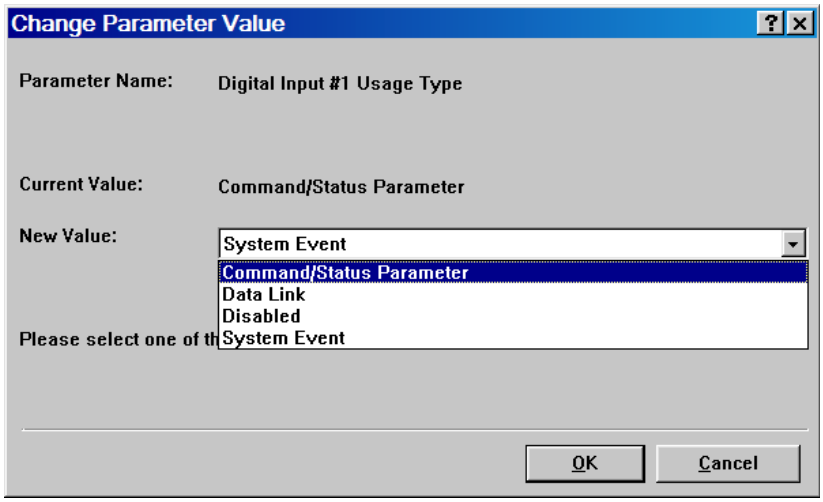
3. Determine which input is to be configured. For example, all of the setpoints for Digital Input #1 have the text "#1" in their name.



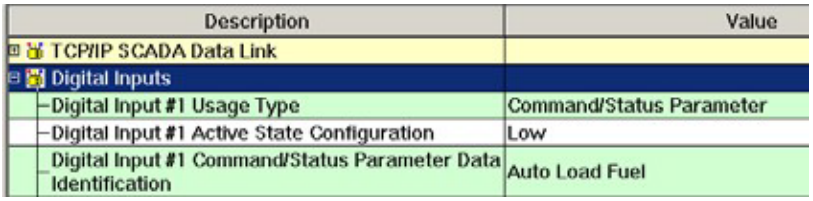
4. Next follow the steps below according to which Usage Type is desired.

10.1.8 Configuring Digital Inputs for Status Parameter

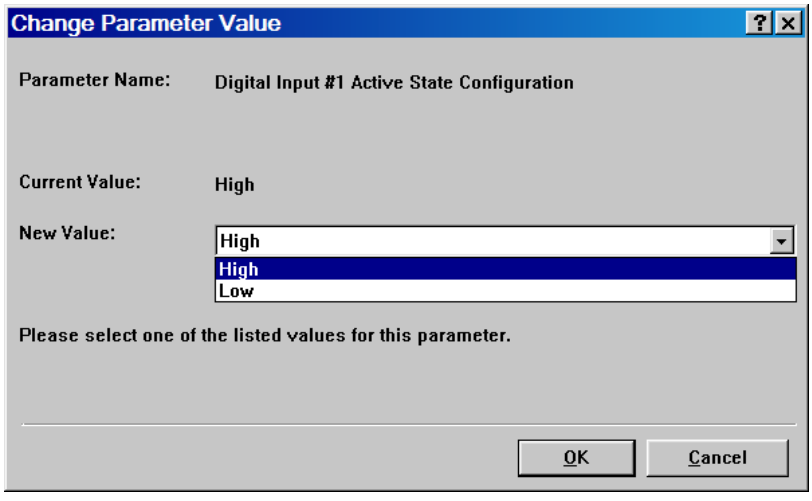
1. Double click the Digital Input #N Usage type to change this value to Command/Status Parameter from the drop down menu. Click the OK button to program.



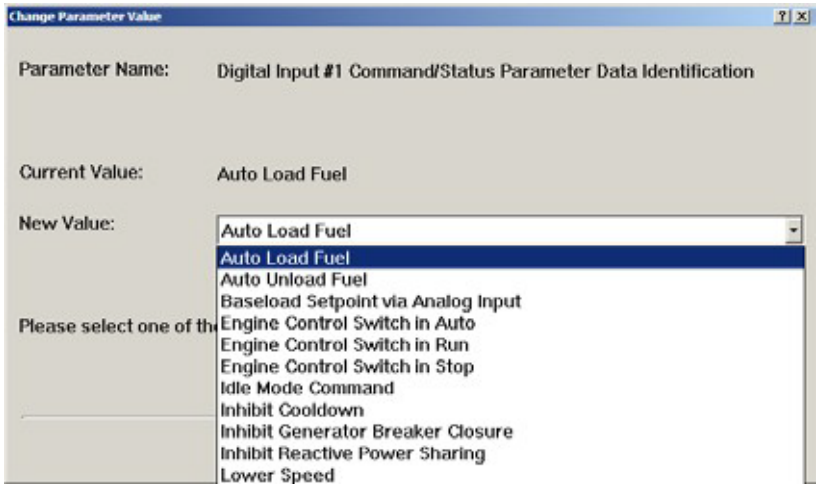
2. The Digital Input #N Command/Status Parameter Data Identification and Active State Configuration parameters will now be visible in the right pane.



3. Configure the Active State Configuration setpoint according to your wiring – either active High or active Low. Click the OK button to program.



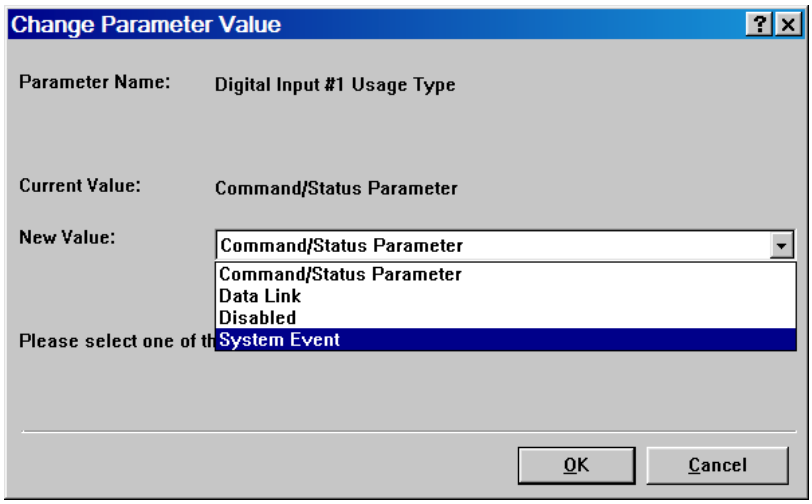
4. Double click the Configure the Command/Status Parameter Data Identification setpoint to change this value from the drop down menu. Click the OK button to program.



See Table 10.2 for a complete list of possible Command/Status Parameter Data Identifications.

10.1.9 Configuring Digital Inputs for System Events

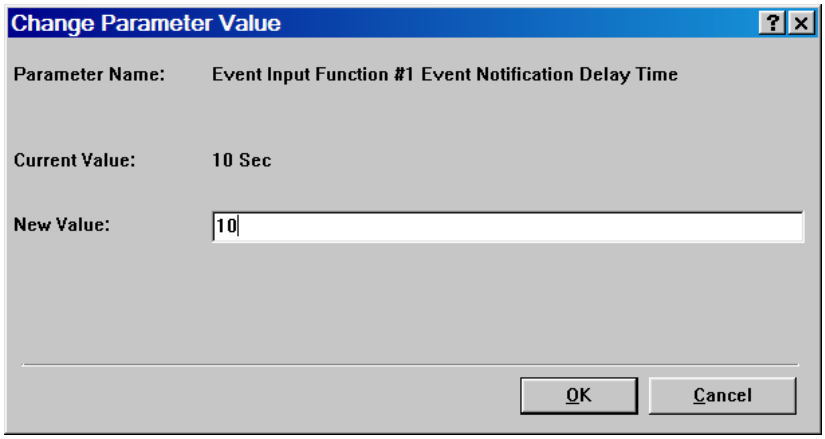
1. Double click the Digital Input #N Usage type to change this value to System Event from the drop down menu. Click the OK button to program.



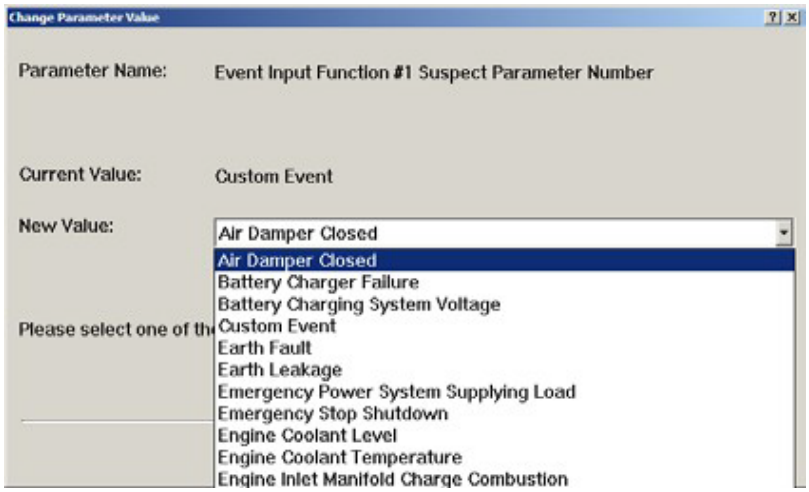
2. The Event Input Function #N Event Notification Delay Time, Suspect Parameter Number (SPN), Failure Mode Identifier (FMI) and Active State Configuration parameters will now be visible in the right pane.

Description	Value
Digital Inputs	
Digital Input #1 Usage Type	System Event
Digital Input #1 Active State Configuration	Low
Event Input Function #1 Event Notification Delay Time	0 sec
Event Input Function #1 Suspect Parameter Number	Custom Event
Event Input Function #1 Failure Mode Identifier	Condition Exists

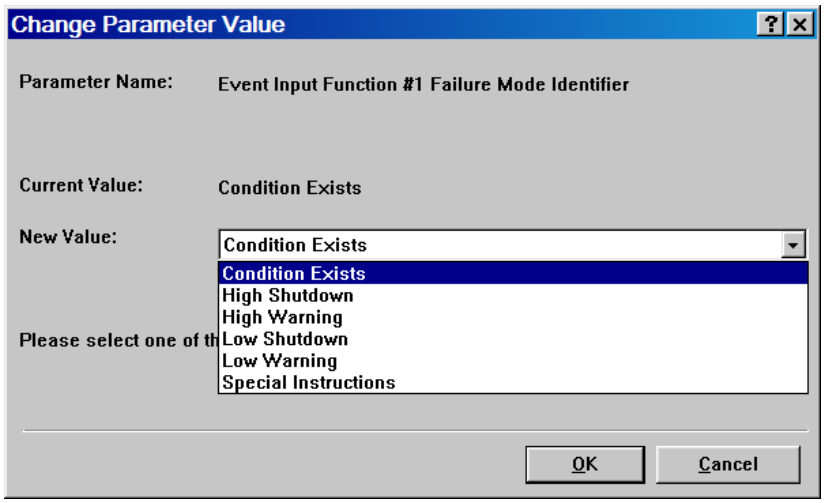
3. Double click the Event Input Function #N Event Notification Delay Time setpoint to change this value. Click the OK button to program.



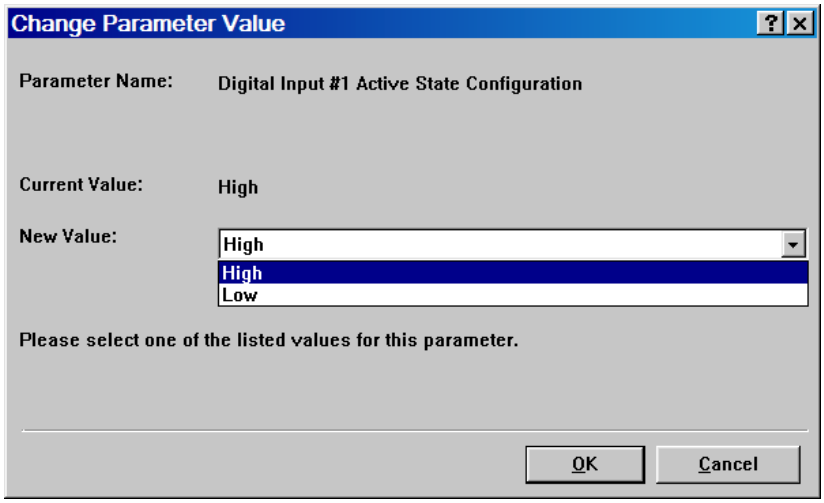
4. Double click the Event Input Function #N Suspect Parameter Number (SPN) setpoint to change this value from the drop down menu. Click the OK button to program.



5. Double click the Event Input Function #N Failure Mode Identifier (FMI) setpoint to change this value from the drop down menu. Click the OK button to program.



6. Configure the Active State Configuration setpoint according to your wiring – either active High or active Low. Click the OK button to program.



7. Once the input is set with an SPN and FMI, the Event Response Configuration may have to be checked. For information on Event Response Configurations and how to program them, see Chapter 5.

Not all SPN and FMI combinations are valid. Table 10.4 indicates which FMIs are valid for which SPNs. If a combination other than one indicated with a "Y" in the table below is configured, the event will not trigger any response by the EMCP 4. The EMCP 4 may not give the option of an invalid FMI for a given SPN. In Cat ET, there is no restriction on the SPN/FMI combination. An invalid combination in Cat ET will result in an "Out of Range" error.

		Failure Mode Identifier Valid Options				
Category	**Suspect Parameter Number**	**High Shutdown**	**Low Shutdown**	**High Warning**	**Low Warning**	**Status**
Pressures	Engine Oil Pressure	Y (4.4 only)	Y	Y (4.4 only))	Y	Y*
	Gas Pressure	Y	Y	Y	Y	
Temperatures	Engine Coolant Temperature	Y	Y (4.4 only)	Y	Y	
	Engine Oil Temperature	Y	Y	Y	Y	
	Exhaust Temperature	Y		Y	Y	
	Generator Rear Bearing Temperature	Y	Y	Y	Y	
	Generator Winding #1 Temperature	Y		Y		
Levels	Engine Coolant Level	Y	Y	Y	Y	
	Engine Oil Level	Y	Y	Y	Y	
	Fuel Level	Y	Y	Y	Y	
	External Tank Fuel Level	Y	Y	Y	Y	
	Aftercooler Coolant Level	Y	Y	Y	Y	
	Engine Fluid Bund level	Y		Y		
Others	Air Damper Closed	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Battery Charging System Voltage	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y	
	Battery Charger Failure	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Custom Event (see note below)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Earth Fault	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Earth Leakage	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Emergency Stop Switch	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y**
	EPS Supply Load	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Fuel Leak	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y
	Gen Breaker Closed					Y
	Gen Breaker Open					Y
	Generator Current	Y	Y	Y	Y	
	Generator Real Power	Y (4.4 only)	Y	Y	Y	
	Inlet Manifold Charge Combustion	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y (4.4 only)	Y

Table 10.4 – Event Input Function SPN and FMI Options

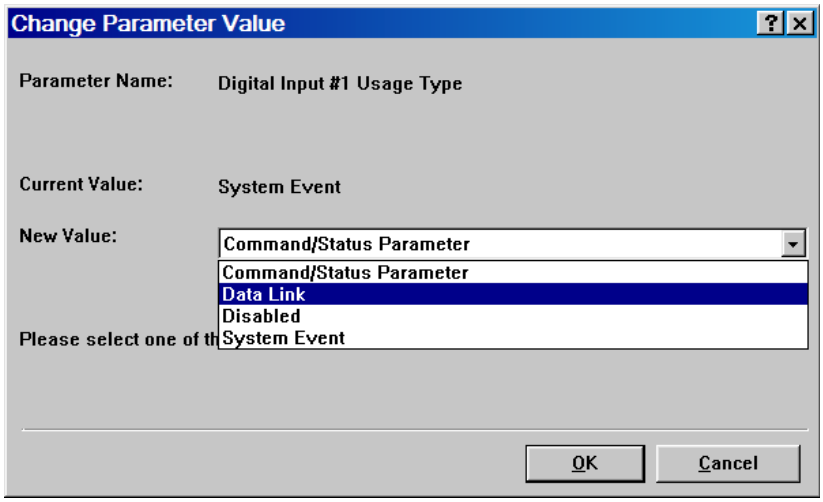
*This status is FMI 14 (Special Instruction), not FMI 31 (Condition Exists).

**This status is FMI 14 (Special Instruction), not FMI 31 (Condition Exists). This gives a means to differentiate between a Remote Emergency Stop and Emergency Stop.

Note: For Custom Events, each input can only trigger the custom event number that matches the Digital Input number (Digital Input #1 can only activate Custom Event #1, etc.).

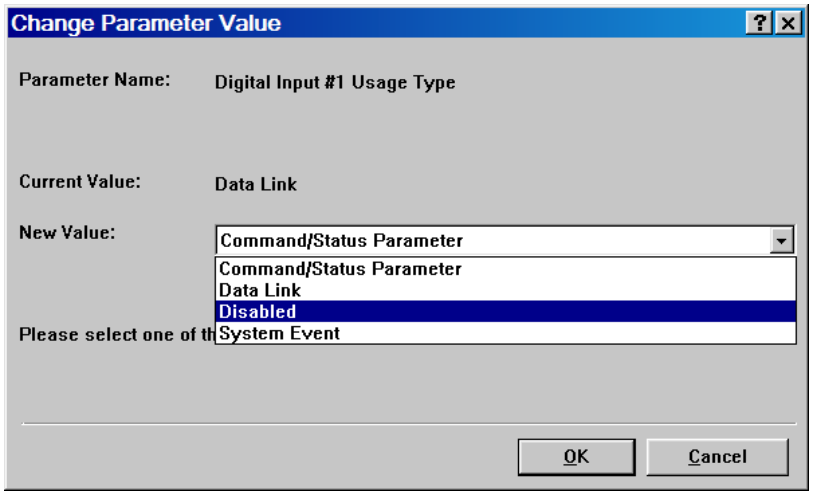
10.1.10 Configuring Digital Inputs for SCADA Data Link

1. Double click the Digital Input #N Usage type to change this value to Data Link from the drop down menu. Click the OK button to program.



10.1.11 Disabling Digital Inputs

1. Double click the Digital Input #N Usage type to change this value to Disabled from the drop down menu. Click the OK button to program.



11.0 Analog Inputs

The EMCP 4.3 supports three (EMCP 4.4 supports four) 2-wire (plus shield) individually isolated Analog Inputs. None of these inputs are dedicated to specific functions. These are individually selectable +/- 10V bipolar, PWM, Resistive Sender or current (0-20mA) inputs for interface to senders, customer signals, etc. For resistive senders, the negative signal is tied to the negative pin on the controller for that sender. The modes of operation are described below:

- Voltage mode: The input impedance is a minimum of 1M Ohms (see Table 11 for ranges).
- PWM Mode: approximately 500 Hz, non-synchronized, 5VDC peak, 0.5% accuracy or better with software selectable sub-ranges.
- Current Mode: The input impedance is a minimum of 50 Ohms and maximum of 250 Ohms with software selectable sub-ranges.
- Resistive Sender (VDO type) Mode: 5-2000 Ohms, with 1% accuracy or 0.5 Ohms, whichever is worse.

For the EMCP 4.3 and 4.4, each of these Analog Inputs have an individual isolated power supply capable of supplying up to 50mA, are software configurable as 5V or 8V, and have overload protection. These supplies are to be used to provide power to sensors if required by the source power pin and Analog Input negative. These supplies are isolated from battery negative.

See Electrical Connections Section 3.5 for illustrations on how to connect the sensors to the control.

Analog Inputs programmed to monitor pressures should be wired to sensors that read gauge, not absolute pressure, unless absolute pressure is desired.

For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration if data is acceptable to be negative (see Chapter 5).

The first and second Analog Inputs are configured by default for non-electronic engines to monitor engine oil pressure and engine coolant temperature, respectively, and are protected by Level 3 security. The third and fourth Analog Inputs are protected at Level 2 security. For help on programming the Level 3 password prior to running this procedure, see Chapter 6, Security. Alternately, the Cat Service Tool can be used to program these setpoints.

Note: If the Analog Inputs are set to DISABLED, then any sensor faults or events will not be broadcast or annunciated on the network.

Note: If more than one Analog Input is configured for the same physical quantity (i.e. the setpoint Analog Input Data Identification matches between two Analog Inputs), then the lowest numbered Analog Input value will be displayed on the Engine Overview screen. For example, if both Analog Input #2 and Analog Input #3 are configured for oil temperature, but the sensor is connected only to Analog Input #2 (and Analog Input #3 is left open), an open circuit diagnostic will result. The Engine Overview screen will display the value from Analog Input #3. Warnings and Shutdowns will be monitored for both Analog Inputs. **When troubleshooting inputs, always make sure to check for configuration conflicts!**

The Analog Inputs are often not used for electronic engines that use ADEM A3, A4 or newer, engine ECM. On these engines, the engine oil pressure sensor and the engine coolant temperature sensors may be wired to the engine ECM and not to the generator set control. In order to receive the sensor information from the data link instead of from sensors wired into the EMCP 4, the setpoints Engine Oil Pressure Sensor Configuration and Engine Coolant Temperature Sensor Configuration must be set to Data Link. If they are not set this way, the sensor values on the Engine Overview screen on the EMCP 4 display will show **** (asterisks).

Note: Improper configuration of these inputs can cause a false event to be triggered, or cause an event to not be triggered when desired. If a user disables an input without including other external protection, or disables the annunciation of an enabled input, detection will not be available. If a spare input is enabled, but not wired to a sensor, a false event may occur.

The programming of the Analog Inputs starts by selecting a "Usage Type." The rest of the programming is dependent upon what Usage Type is selected. Figure 11.1 summarizes the paths possible for Programming an Analog Input.

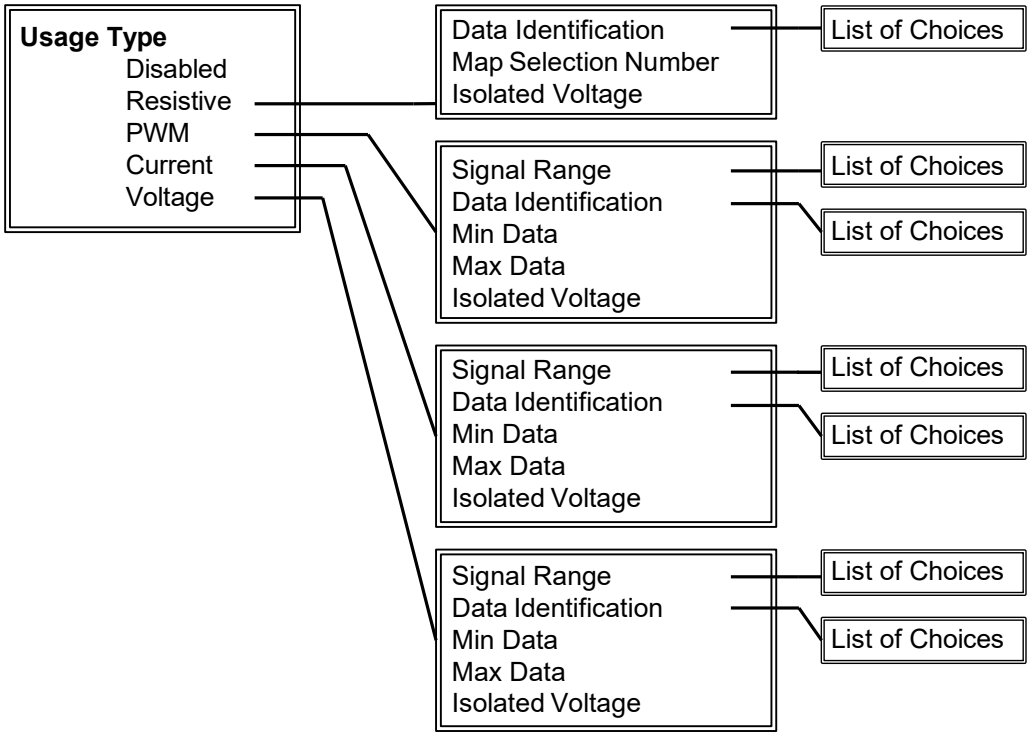


Figure 11.1 – Analog Input Programming Paths

11.1 Programming Analog Inputs Using the Display

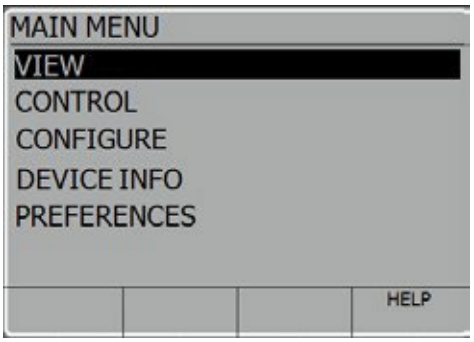
The steps to configure the Analog Inputs for each of the Usage Types are described below. Level 3 security is required for Analog Inputs #1 and #2. Level 2 security is required for Analog Input #3 and #4.

11.1.1 Viewing the Current Analog Input Status

To view the current status of an Analog Input, go through the following menu options:

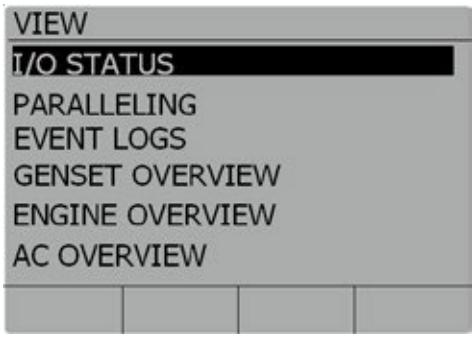
1. AT THE MAIN MENU, scroll DOWN  TO VIEW.

2. Press the OK KEY .



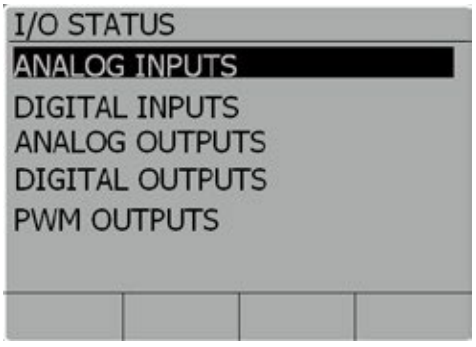
3. Scroll DOWN  to I/O STATUS.

4. Press the OK KEY .



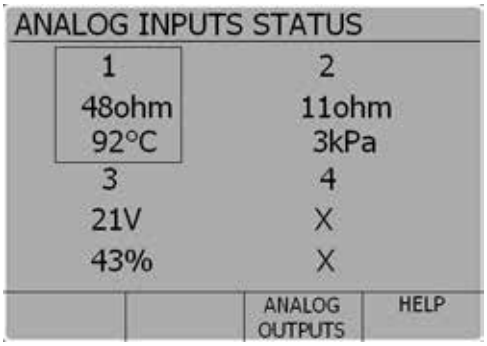
5. Scroll DOWN  to ANALOG INPUTS.

6. Press the OK KEY .



The status of all Analog Inputs is shown.

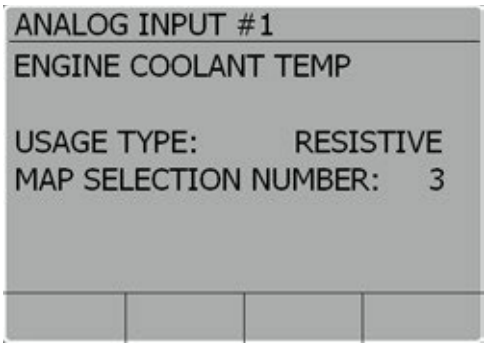
A dash under an input number indicates an input that is programmed, but inactive. A large “X” under an input number indicates an input that is disabled. A number under an input number indicates an input that is programmed and active.



7. With the arrow keys, select the ANALOG INPUT that you want to view, then press the OK KEY 

.

The programmed parameters of the selected Analog Input are shown.



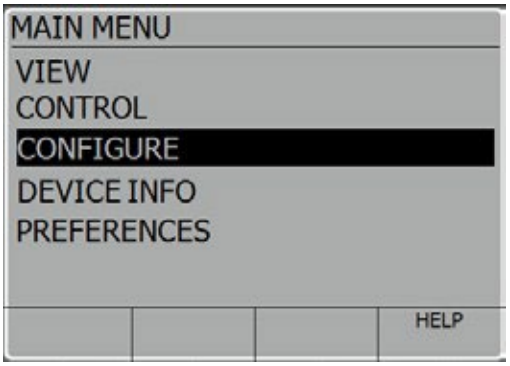
11.1.2 Configuring Analog Inputs for Resistive Mode

To configure an Analog Input for Resistive Mode, go through the following menu options:

1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY 

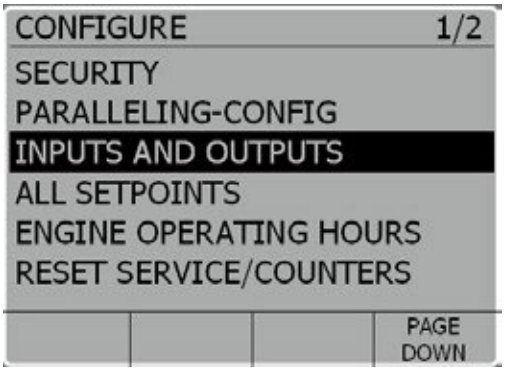
.



3. SCROLL DOWN  to INPUTS & OUTPUTS.

4. Press the OK KEY 

.

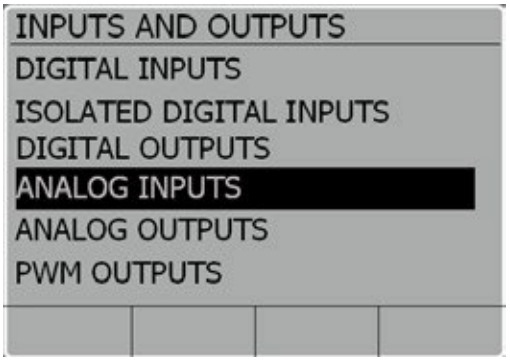


5. SCROLL DOWN  to ANALOG INPUTS.

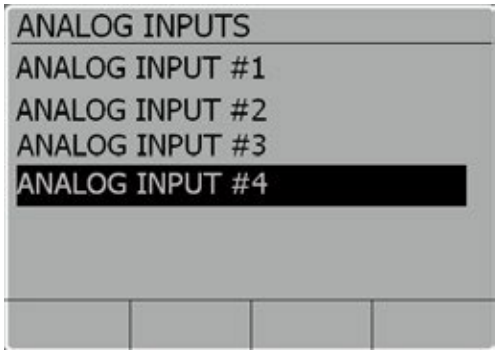
6. Press the OK KEY 

.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



7. Select the ANALOG INPUT that you want to program.

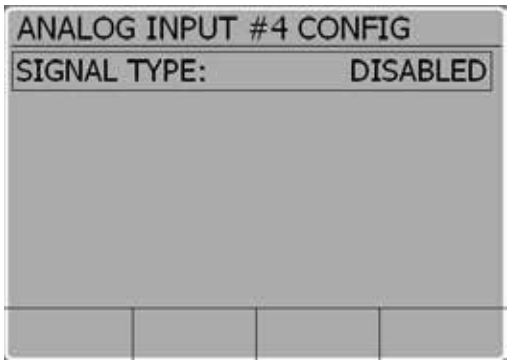


8. Press the OK KEY 

.

9. Press the OK KEY 

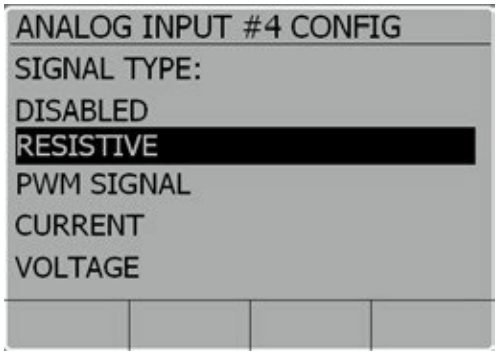
to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



10. Scroll DOWN  to RESISTIVE.

11. Press the OK KEY 

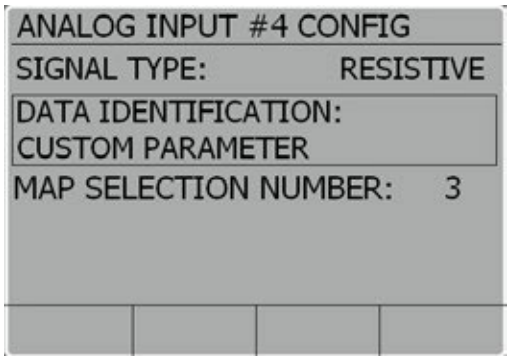
.



12. Scroll DOWN  to DATA IDENTIFICATION.

13. Press the OK KEY 

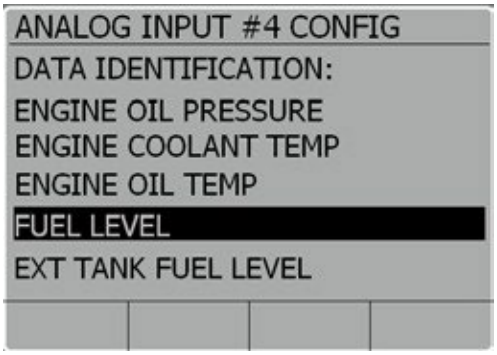
to change the current DATA IDENTIFICATION.



14 Select the DATA IDENTIFICATION that you want to program.

15. Press the OK KEY 

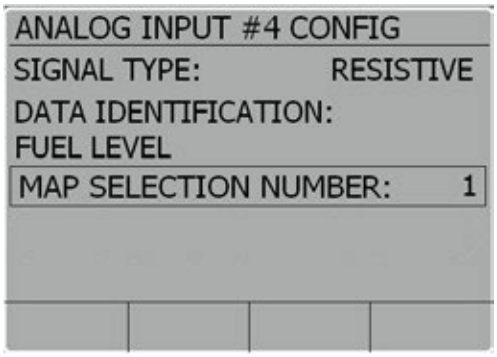
.



16. Scroll DOWN  to MAP SELECTION.

17. Press the OK KEY 

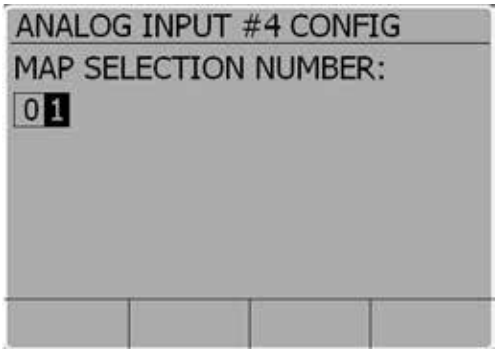
to change the current MAP SELECTION.



18. Select the MAP SELECTION that you want to program.

19. Press the OK KEY 

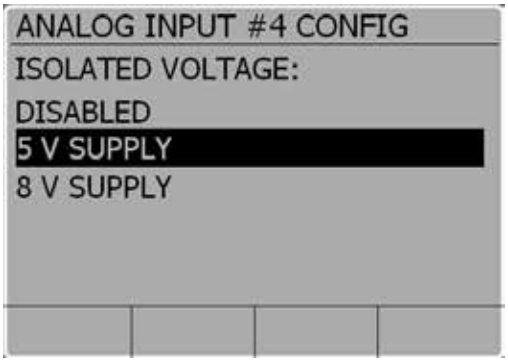
.



20. Scroll DOWN  to ISOLATED VOLTAGE.

21. Press the OK KEY 

to change the current ISOLATED VOLTAGE.



22. Select the ISOLATED VOLTAGE that you want to program.

Note: Isolated Voltage Supply is not required for Resistive Senders.

23. Press the OK KEY 

.

The Data Identification will remain the same when switching between Resistive and Voltage.

Any Analog Input can be configured for any one of the Data Identification parameters in Table 11.1:

Data Identification Parameters	
Engine Oil Pressure	Base Load Setpoint 4.4 Only)
Engine Coolant Temperature	Custom Parameters #N
Engine Oil Temperature	Data Link – SCADA
Engine Fuel Level	Desired Engine Speed Control
External Tank Fuel Level	Desired Generator Voltage Control
Urea Level	Gearbox Oil Pressure
Utility kW Reading (4.4 Only)	Gearbox Oil Temperature
Utility kVAr Reading (4.4 Only)	Ambient Temperature
Utility PF Reading (4.4 Only)	Engine Coolant Temperature #2
Desired Gen PF (4.4 Only)	Engine Coolant Temperature #3
Engine Fluid Bund Level	

Table 11.1 – Analog Input Data Identifications

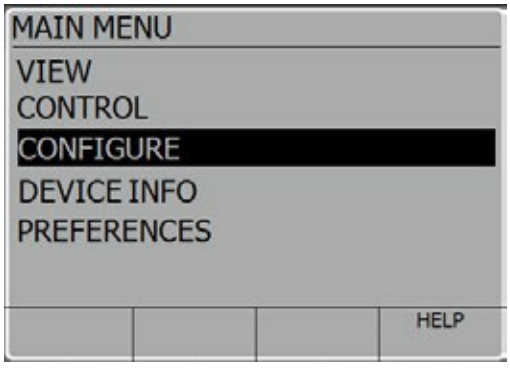
The Sensor Codes correspond to sensor maps as defined in Section 11.3.

11.1.3 Configuring Analog Inputs for PWM Mode

To configure an Analog Input for PWM Mode, go through the following menu options.

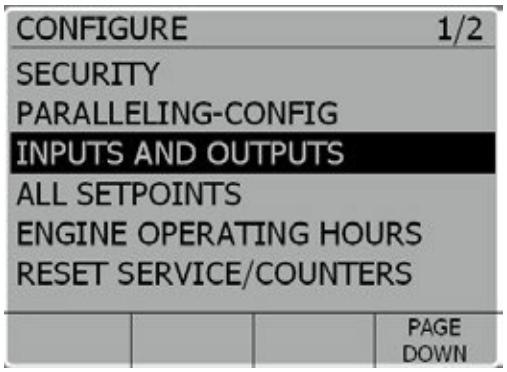
1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY .



3. SCROLL DOWN  to INPUTS & OUTPUTS.

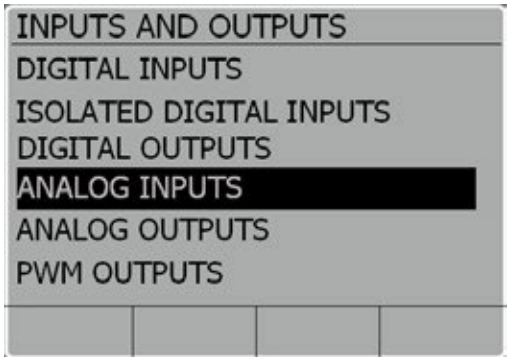
4. Press the OK KEY .



5. SCROLL DOWN  to ANALOG INPUTS.

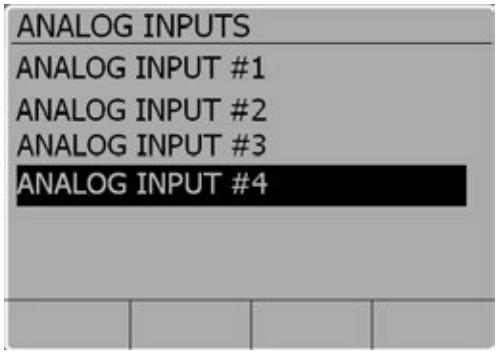
6. Press the OK KEY .

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

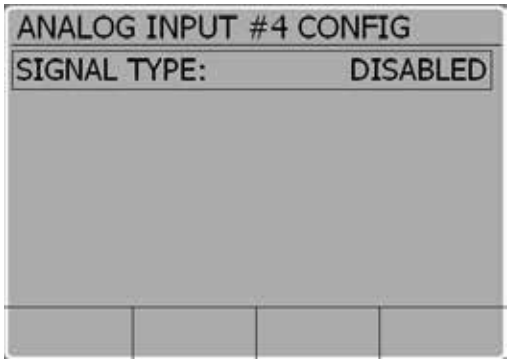


7. Select the ANALOG INPUT that you want to program.

8. Press the OK KEY .

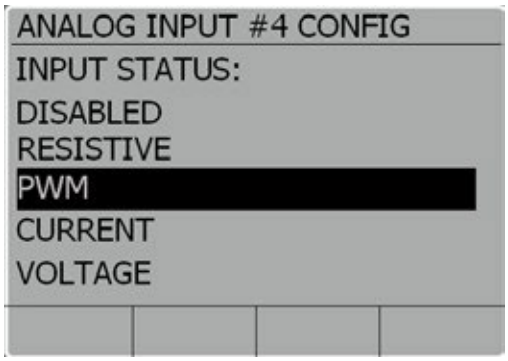


9. Press the OK KEY  to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



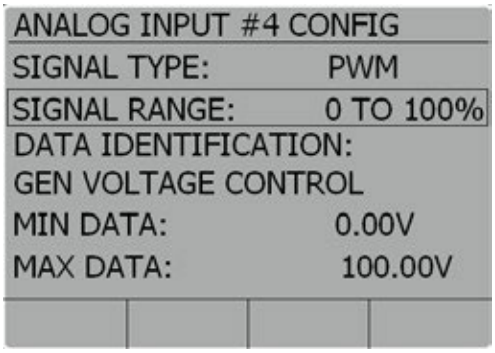
10. Scroll DOWN  to PWM.

11. Press the OK KEY .



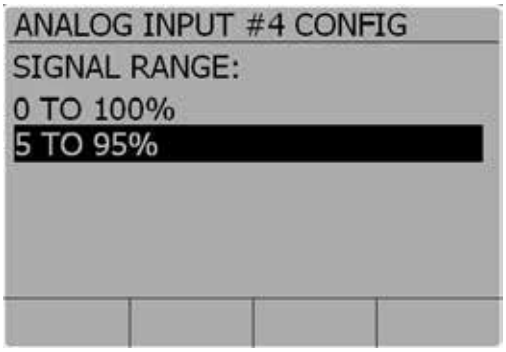
12. Scroll DOWN to SIGNAL RANGE.

13. Press the OK KEY to change the current SIGNAL RANGE.



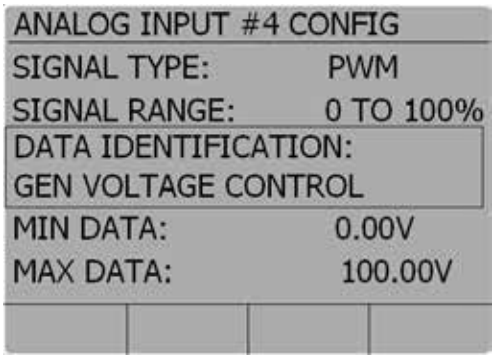
14. Select the SIGNAL RANGE that you want to program.

15. Press the OK KEY.



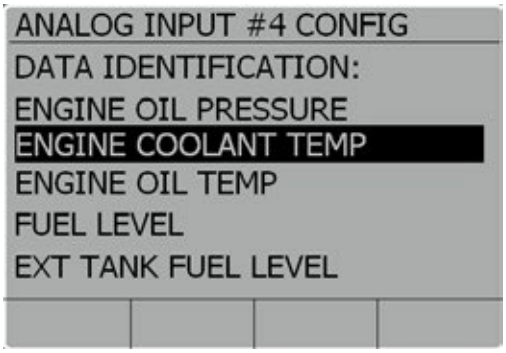
16. Scroll DOWN to DATA IDENTIFICATION.

17. Press the OK KEY to change the current DATA IDENTIFICATION.



18. Select the DATA IDENTIFICATION that you want to program.

19. Press the OK KEY.



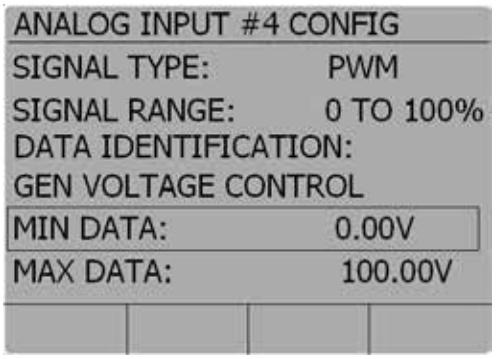
20. Scroll DOWN to MIN DATA.

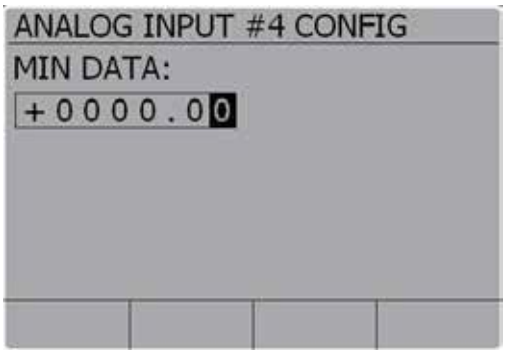
21. Press the OK KEY to change the current MIN DATA.

For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration if data is acceptable to be negative (see Section 5 .2) .

22. Select the MIN DATA that you want to program.

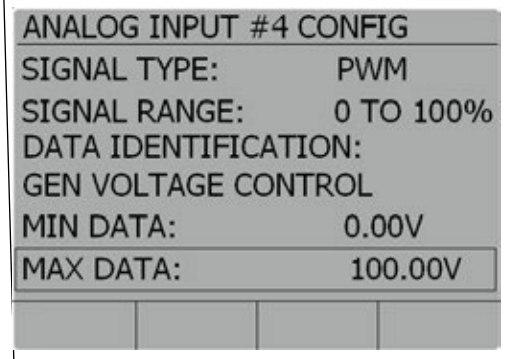
23. Press the OK KEY .





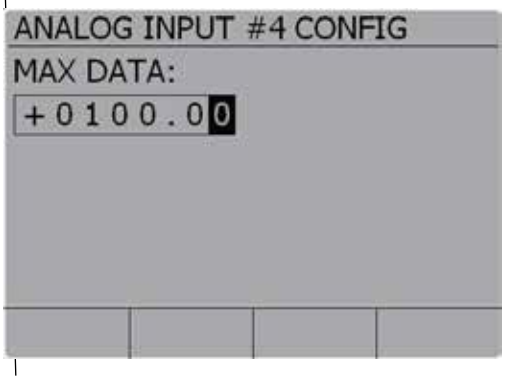
24. Scroll DOWN to MAX DATA.

25. Press the OK KEY to change the current MAX DATA.



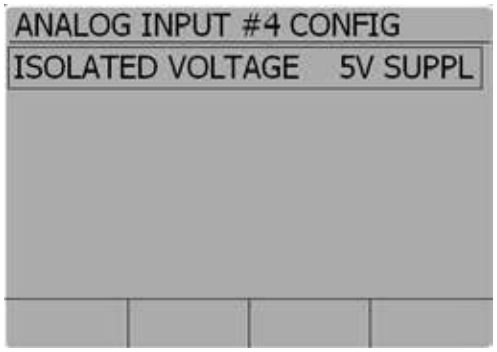
26. Select the MAX DATA that you want to program.

27. Press the OK KEY .



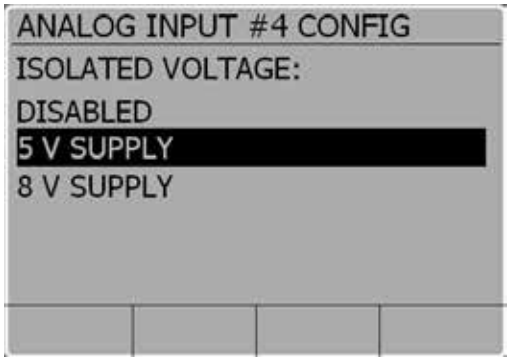
28. Scroll DOWN  to ISOLATED VOLTAGE.

29. Press the OK KEY  to change the current ISOLATED VOLTAGE.



30. Select the ISOLATED VOLTAGE that you want to program.

31. Press the OK KEY .

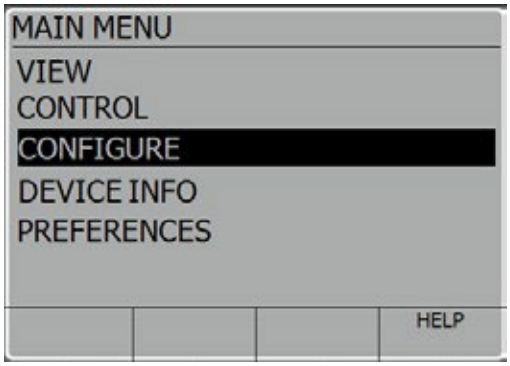


11.1.4 Configuring Analog Inputs for Current Mode

To configure an Analog Input for Current Mode, go through the following menu options:

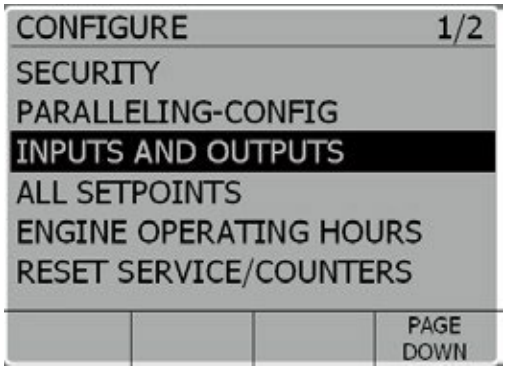
1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY .



3. SCROLL DOWN  to INPUTS & OUTPUTS.

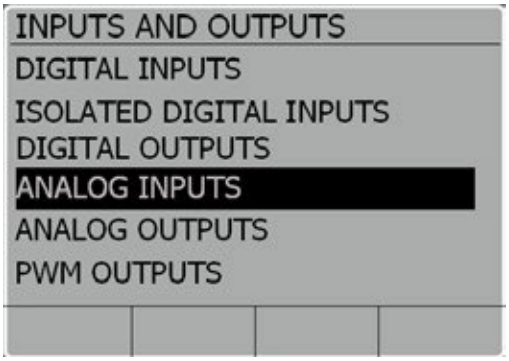
4. Press the OK KEY .



5. SCROLL DOWN  to ANALOG INPUTS.

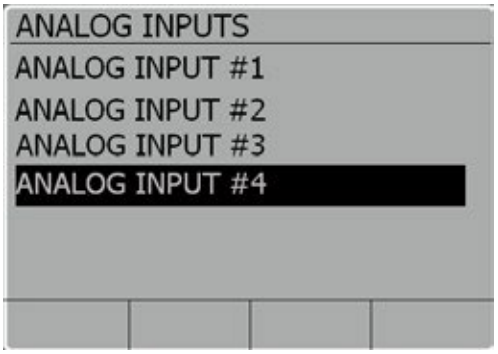
6. Press the OK KEY .

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

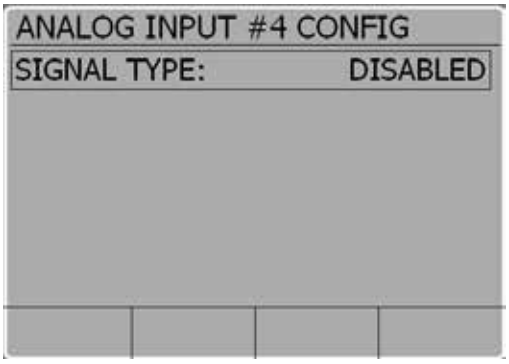


7. Select the ANALOG INPUT that you want to program.

8. Press the OK KEY .

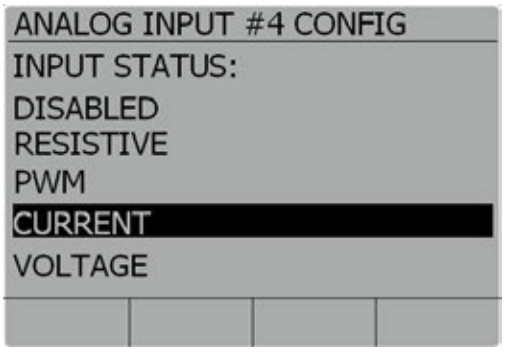


9. Press the OK KEY  to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



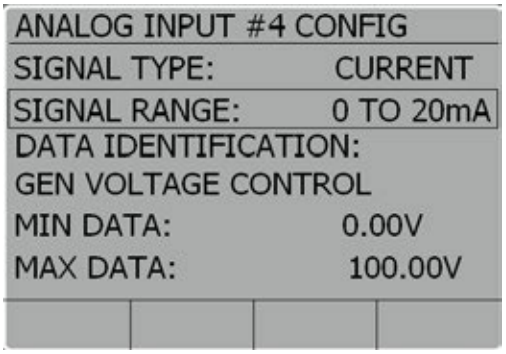
10. Scroll DOWN  to CURRENT.

11. Press the OK KEY .



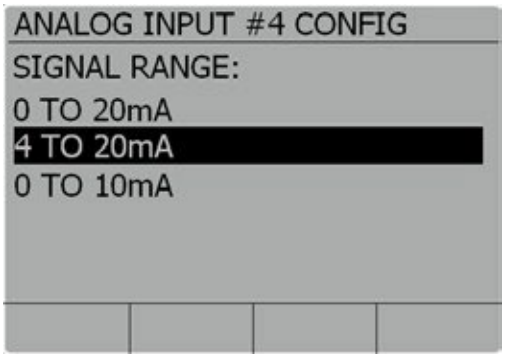
12. Scroll DOWN to SIGNAL RANGE.

13. Press the OK KEY to change the current SIGNAL RANGE.



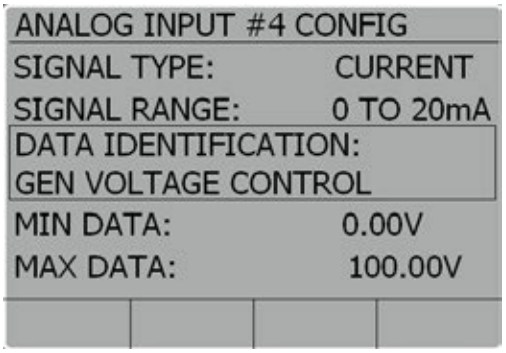
14. Select the SIGNAL RANGE that you want to program.

15. Press the OK KEY.



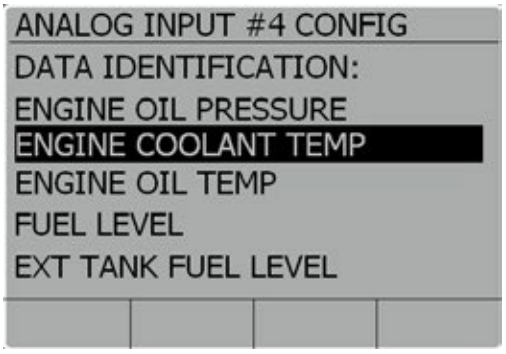
16. Scroll DOWN to DATA IDENTIFICATION.

17. Press the OK KEY to change the current DATA IDENTIFICATION.



18. Select the DATA IDENTIFICATION that you want to program.

19. Press the OK KEY.



20. Scroll DOWN  to MIN DATA.

21. Press the OK KEY  to change the current MIN DATA.

For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration
if data is acceptable to be negative (see Section 5.2).

22. Select the MIN DATA that you want to program.

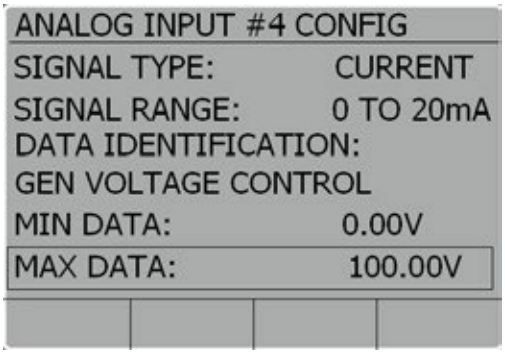
23. Press the OK KEY .

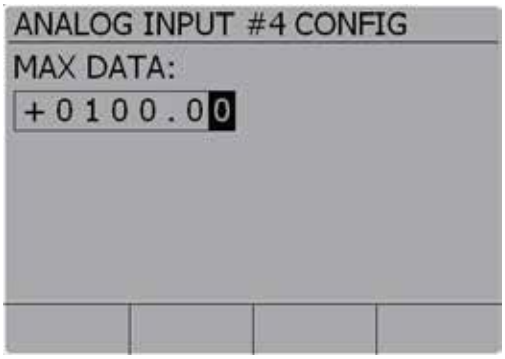
24. Scroll DOWN  to MAX DATA.

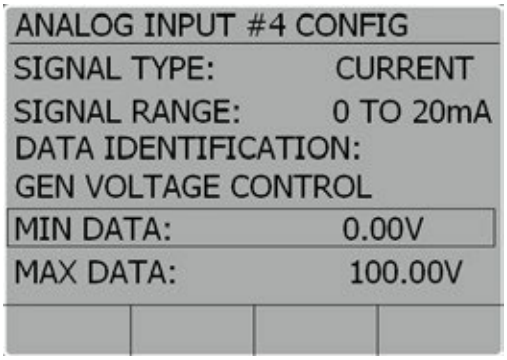
25. Press the OK KEY  to change the current MAX DATA.

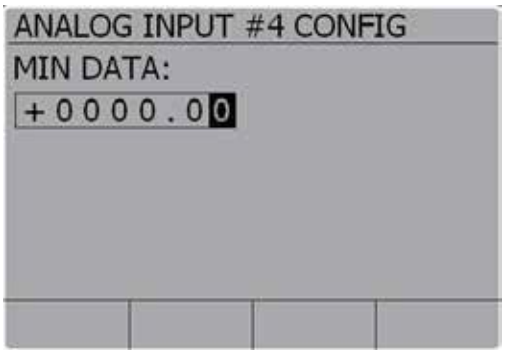
26. Select the MAX DATA that you want to program.

27. Press the OK KEY .



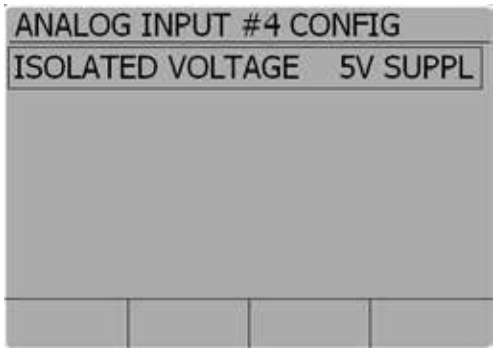






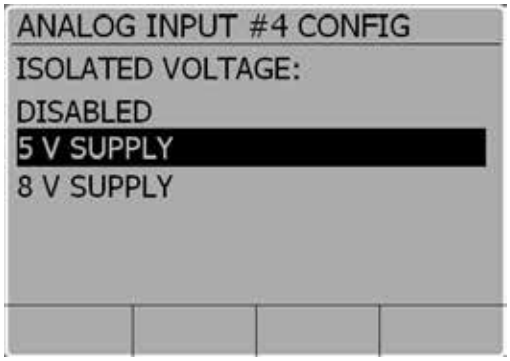
28. Scroll DOWN  to ISOLATED VOLTAGE.

29. Press the OK KEY  to change the current ISOLATED VOLTAGE.



30. Select the ISOLATED VOLTAGE that you want to program.

31. Press the OK KEY .

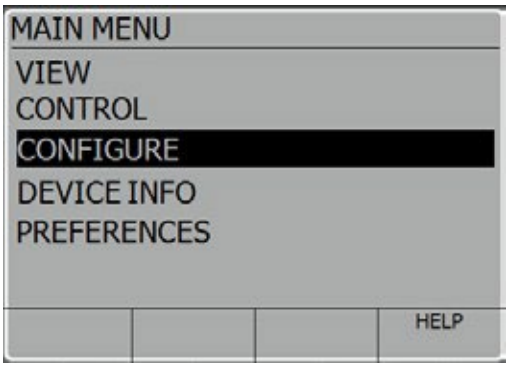


11.1.5 Configuring Analog Inputs for Voltage Mode

To configure an Analog Input for Voltage Mode, go through the following menu options:

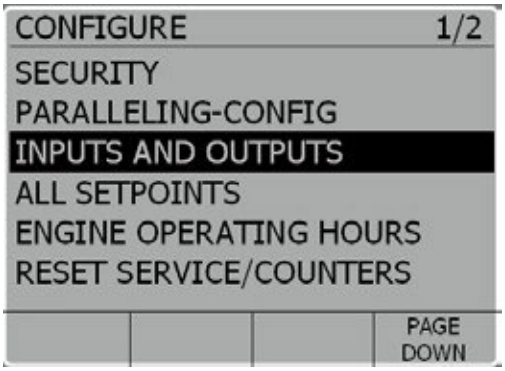
1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY .



3. SCROLL DOWN  to INPUTS & OUTPUTS.

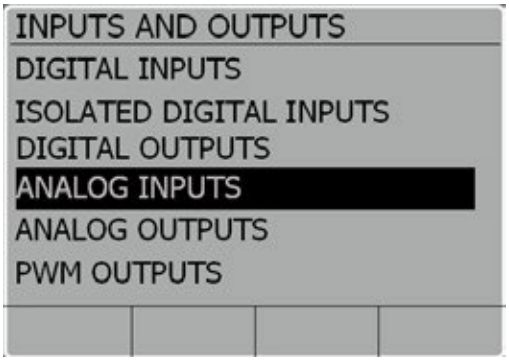
4. Press the OK KEY .



5. SCROLL DOWN  to ANALOG INPUTS.

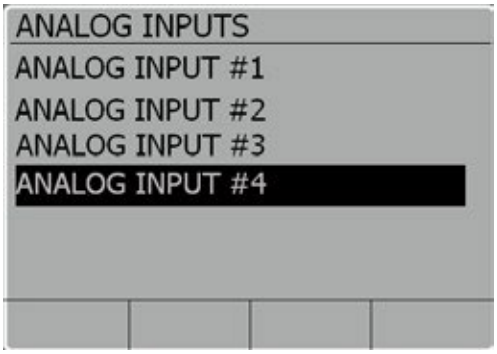
6. Press the OK KEY .

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

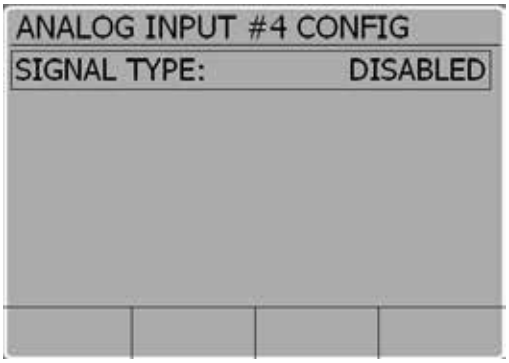


7. Select the ANALOG INPUT that you want to program.

8. Press the OK KEY .

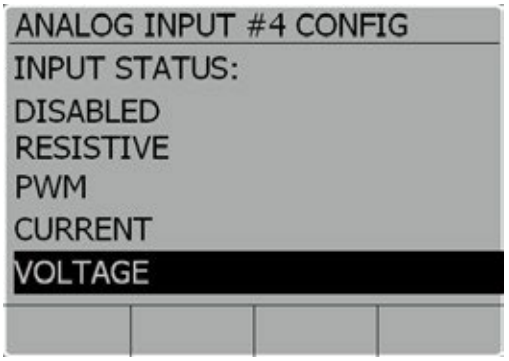


9. Press the OK KEY  to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



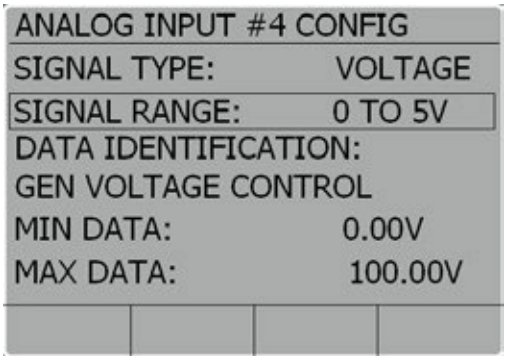
10. Scroll DOWN  to VOLTAGE.

11. Press the OK KEY .



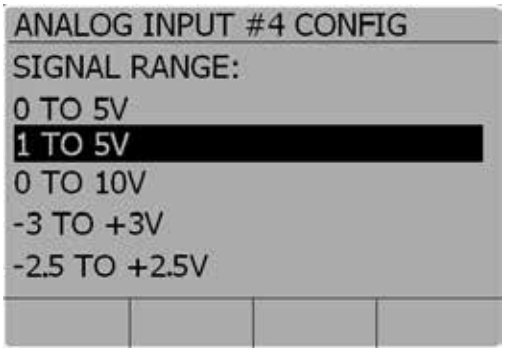
12. Scroll DOWN  to SIGNAL RANGE.

13. Press the OK KEY  to change the current SIGNAL RANGE.



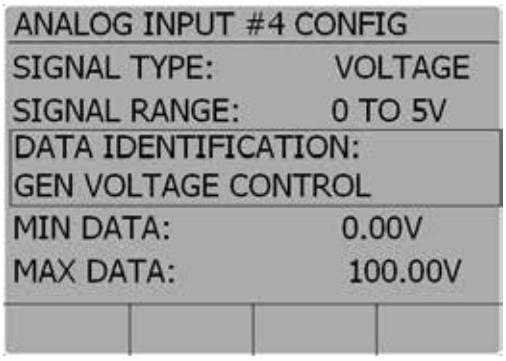
14. Select the SIGNAL RANGE that you want to program.

15. Press the OK KEY .



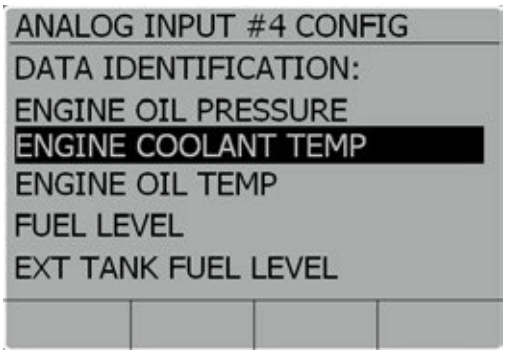
16. Scroll DOWN  to DATA IDENTIFICATION.

17. Press the OK KEY  to change the current DATA IDENTIFICATION.



18. Select the DATA IDENTIFICATION that you want to program.

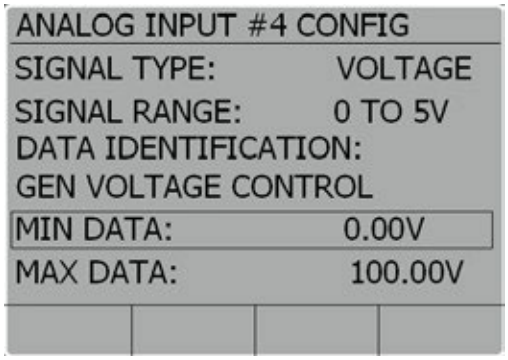
19. Press the OK KEY .



20. Scroll DOWN  to MIN DATA.

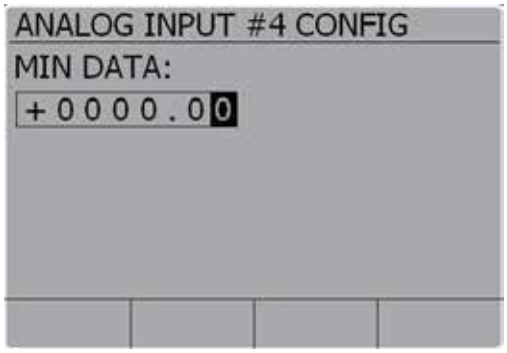
21. Press the OK KEY  to change the current MIN DATA.

For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration if data is acceptable to be negative (see Section 5.2).



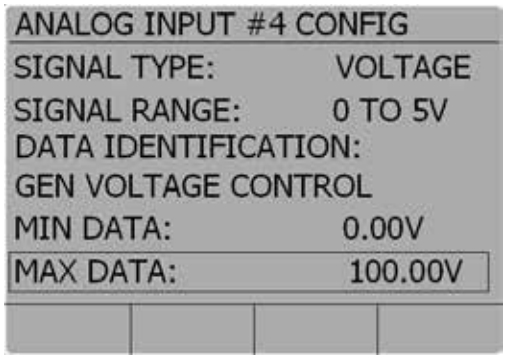
22. Select the MIN DATA that you want to program.

23. Press the OK KEY .



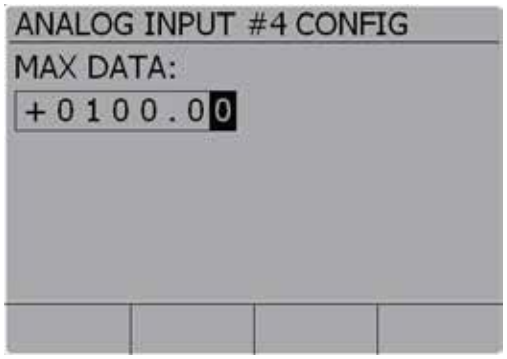
24. Scroll DOWN  to MAX DATA.

25. Press the OK KEY  to change the current MAX DATA.



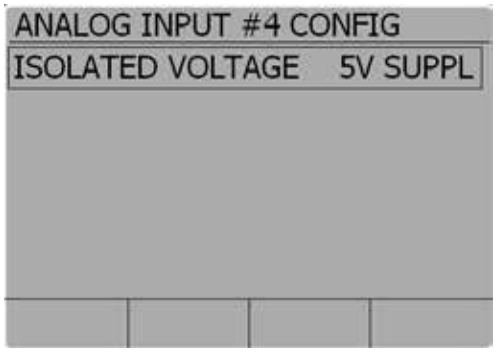
26. Select the MAX DATA that you want to program.

27. Press the OK KEY .



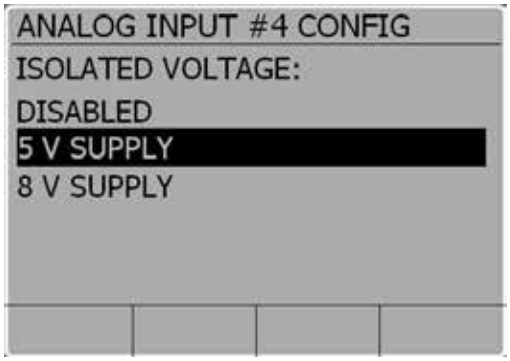
28. Scroll DOWN  to ISOLATED VOLTAGE.

29. Press the OK KEY  to change the current ISOLATED VOLTAGE.



30. Select the ISOLATED VOLTAGE that you want to program.

31. Press the OK KEY .



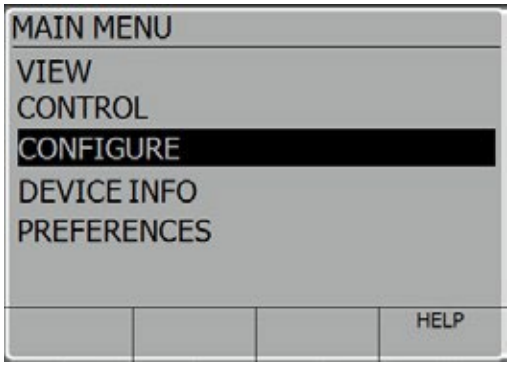
The Data Identification list is the same whether Signal Type is Resistive, PWM, or Voltage. Any Analog Input can be configured for any one of the Data Identification parameters in Table 11.1.

11.1.6 Disabling Analog Inputs

To configure an Analog Input for Voltage Mode, go through the following menu options:

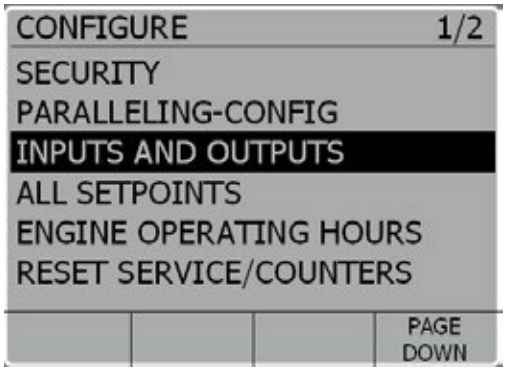
1. AT THE MAIN MENU, scroll down  to CONFIGURE.

2. Press the OK KEY .



3. SCROLL DOWN  to INPUTS & OUTPUTS.

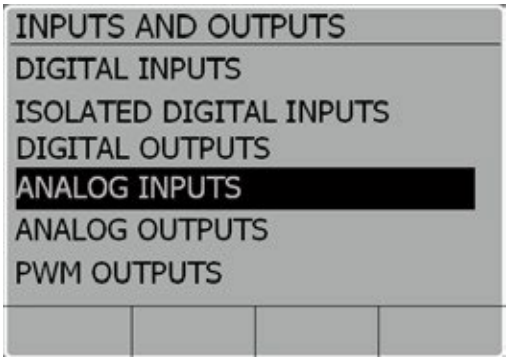
4. Press the OK KEY .



5. SCROLL DOWN  to ANALOG INPUTS.

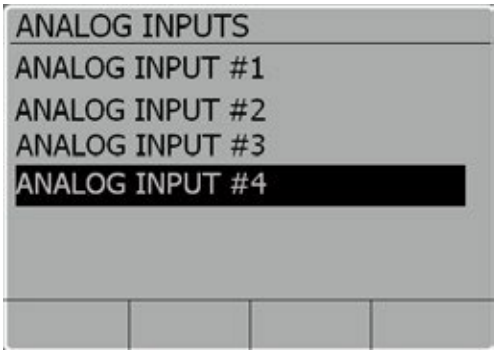
6. Press the OK KEY .

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

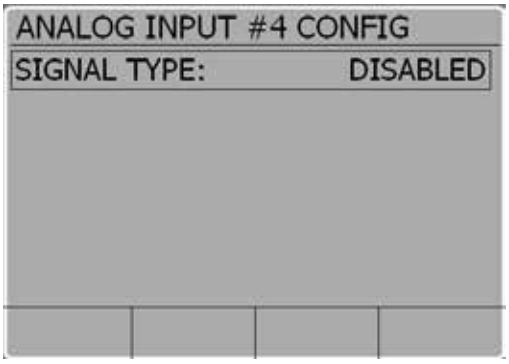


7. Select the ANALOG INPUT that you want to program.

8. Press the OK KEY .

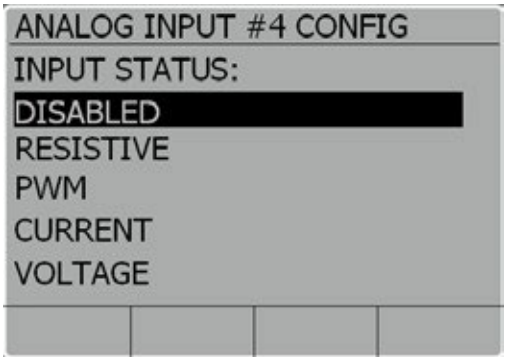


9. Press the OK KEY  to highlight the current configuration (DISABLED, RESISTIVE, PWM SIGNAL, CURRENT, OR VOLTAGE).



10. Scroll DOWN  to DISABLED.

11. Press the OK KEY .

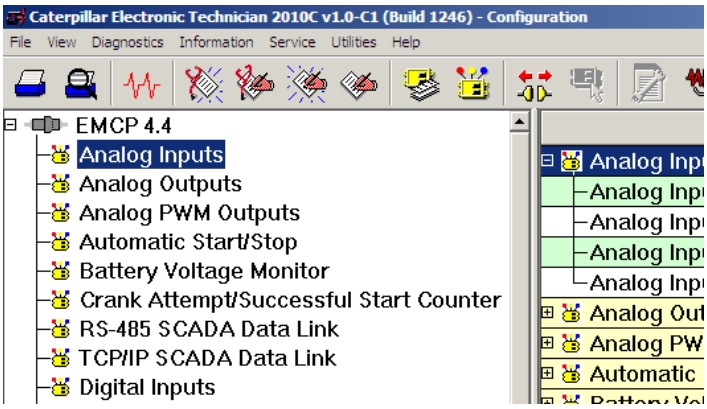


11.2 Programming Analog Inputs Using the Cat Service Tool

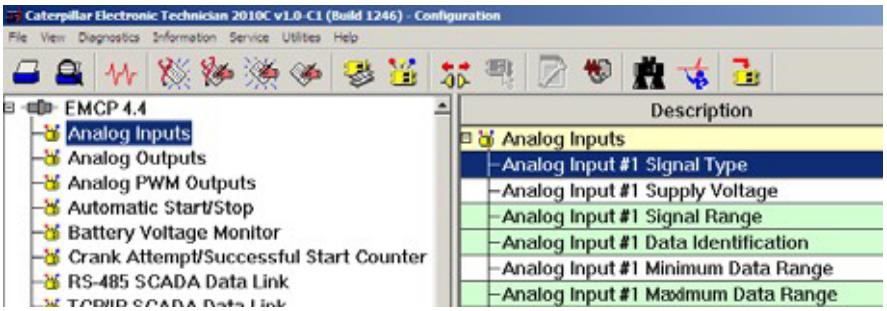
The EMCP 4 Analog Inputs can be configured using the Cat Service Tool . The key to programming them is to program the setpoints related to each input in order from top to bottom . To program an Analog Input, do the following steps:

1 . Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4 .2 .

2 . Select Analog Inputs on the left .



3 . Determine which input is to be configured . For example, all of the setpoints for Analog Input #1 have the text “#1” in their name .

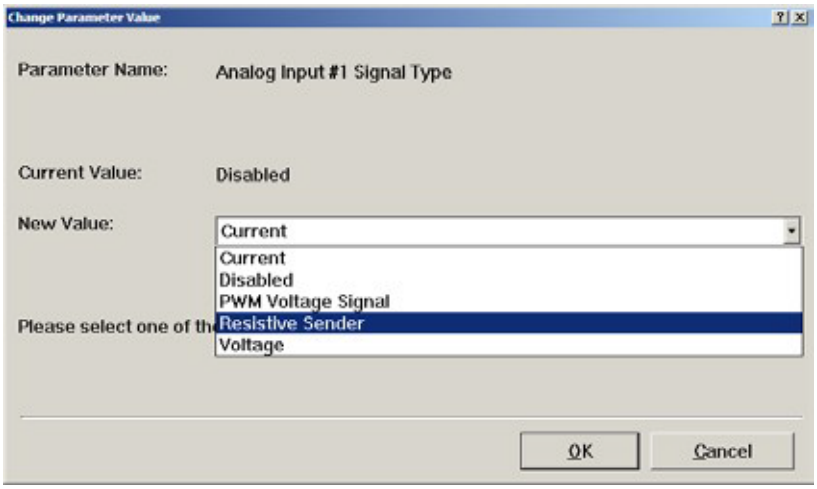


4 . Follow the next steps according to which Usage Type is desired .

11.2.1 Configuring Analog Inputs for Resistive Mode

The EMCP 4 supports resistive sender maps, which are nonlinear maps representing the transfer function of the resistive sender. Once an Analog Input is configured as a Resistive input type, a map must be selected.

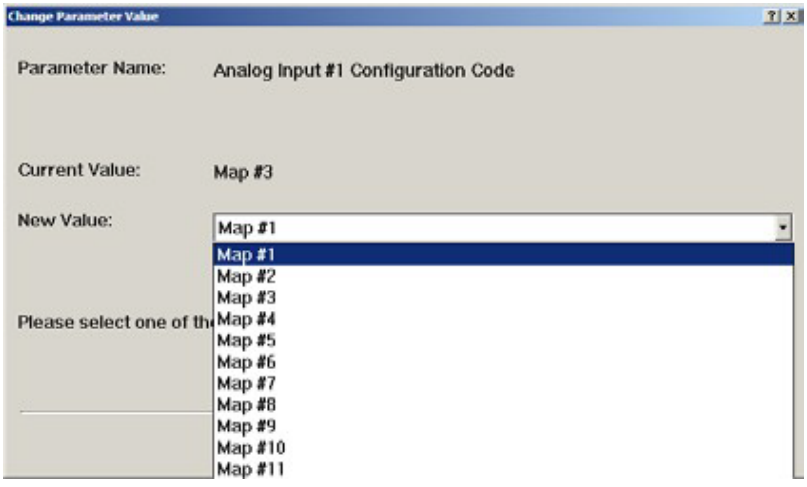
1. Double click the Analog Input #N Usage type to change this value to Resistive Sender from the drop down menu. Click the OK button to program.



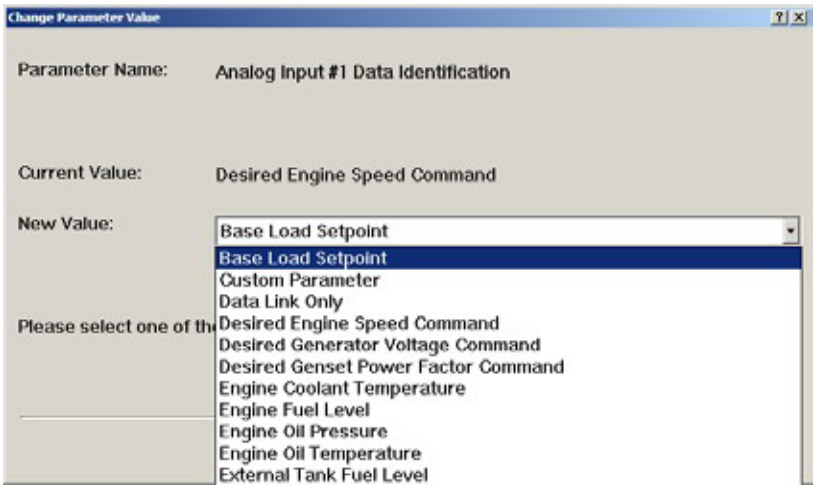
2. The Analog Input #N Configuration Code and Data Identification parameters will now be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	Resistive Sender
Analog Input #1 Configuration Code	Map #3
Analog Input #1 Data Identification	Data Link Only

3. Double click the Configuration Code setpoint to change this value from the drop down menu. Click the OK button to program.



4. Double click the Data Identification setpoint to change this value from the drop down menu. Click the OK button to program.



Based on whether or not the selected option supports events, the list of setpoints shown will adjust accordingly. If the selected option does not support events, then the configuration is complete.

5. If the selected option does support events, then continue and configure the event thresholds and delays. The Analog Input #N Threshold and Delay Time parameters will now be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	Resistive Sender
Analog Input #1 Configuration Code	Map #1
Analog Input #1 Data Identification	Custom Parameter
Analog Input #1 High Warning Event Threshold	80
Analog Input #1 High Warning Event Delay Time	0 Sec
Analog Input #1 High Shutdown Event Threshold	84
Analog Input #1 High Shutdown Event Delay Time	0 Sec
Analog Input #1 Low Warning Event Threshold	20
Analog Input #1 Low Warning Event Delay Time	0 Sec
Analog Input #1 Low Shutdown Event Threshold	16
Analog Input #1 Low Shutdown Event Delay Time	0 Sec

Table 11.2 lists the options and which, if any, events they support. Not all SPN and FMI combinations are valid. Table 11.2 indicates which FMIs are valid for which SPNs. If a combination other than one indicated with a “y” in the table above is configured, the event will not trigger any response by the EMCP 4. The EMCP 4 may not give the option of an invalid FMI for a given SPN. In Cat ET, there is no restriction on the SPN/FMI combination. An invalid combination in Cat ET may result in an “Out of Range” error or just a non-operative event.

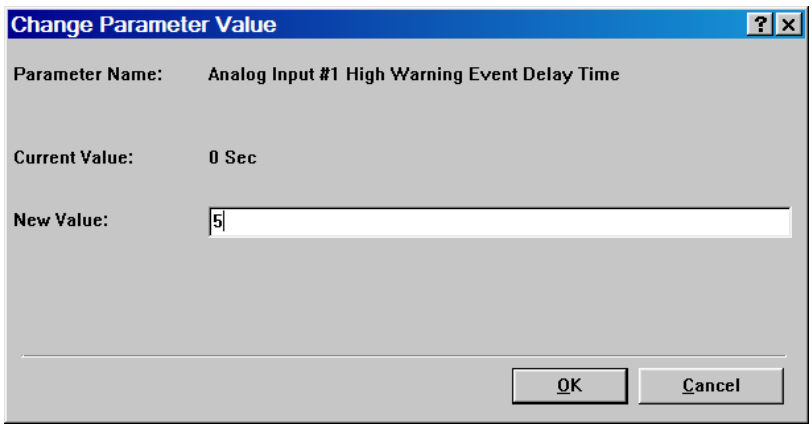
Suspect Parameter Number	Failure Mode Identifier Valid Options			
	High Shutdown	Low Shutdown	High Warning	Low Warning
Engine Oil Pressure		Y		Y
Engine Coolant Temperature	Y		Y	Y
Engine Oil Temperature	Y	Y	Y	Y
Fuel Level	Y	Y	Y	Y
External Tank Fuel Level	Y	Y	Y	Y
Urea Level*				
Utility kW Reading (4.4 only)*				
Utility kVAr Reading (4.4 only)*				
Utility PF Reading (4.4 only)*				
Desired Gen PF (4.4 only)*				
Base Load Setpoint (4.4 only)*				
AI #N Custom Parameter (see note below)	Y	Y	Y	Y
Data Link – SCADA*				
Engine Speed Control*				
Gen Voltage Control*				
Gearbox Oil Pressure	Y	Y		
Gearbox Oil Temperature			Y	Y
Ambient Temperature*				
Engine Coolant Temperature #2	Y	Y	Y	Y
Engine Coolant Temperature #3	Y	Y	Y	Y
Engine Fluid Bund Level	Y		Y	

*Information only.

Table 11.2 – Event Input Function SPN and FMI Options

Note: For Custom Events, each input can only trigger the custom event number that matches the Analog Input number (Analog Input #1 can only activate Custom Event #1, etc.).

6. Configure each of these setpoints by double clicking each one and typing a new value. Click the OK button to program.

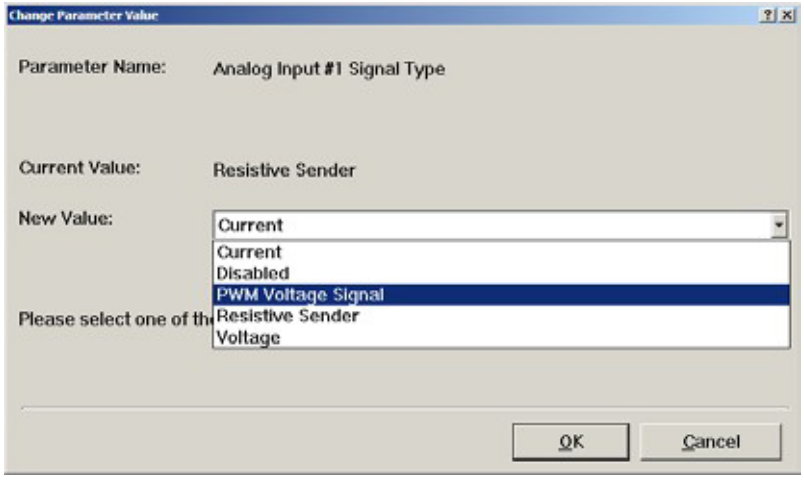


Note: The units for the event thresholds are not shown. For pressures, the units are always kPa. For temperatures, they are always degrees Celsius. For levels, they are always percent. For the custom parameter type, they are unitless. The range for custom parameters is defined by the selected sensor map if programmed for resistive.

11.2.2 Configuring Analog Inputs for PWM Mode

The EMCP 4 supports PWM voltage senders, which are senders whose output duty cycle varies linearly with the change in a physical measurement. Once the Analog Input is configured as a PWM Input type, the linear mapping must be defined by entering the sensor voltage range and the corresponding minimum and maximum physical measurement range.

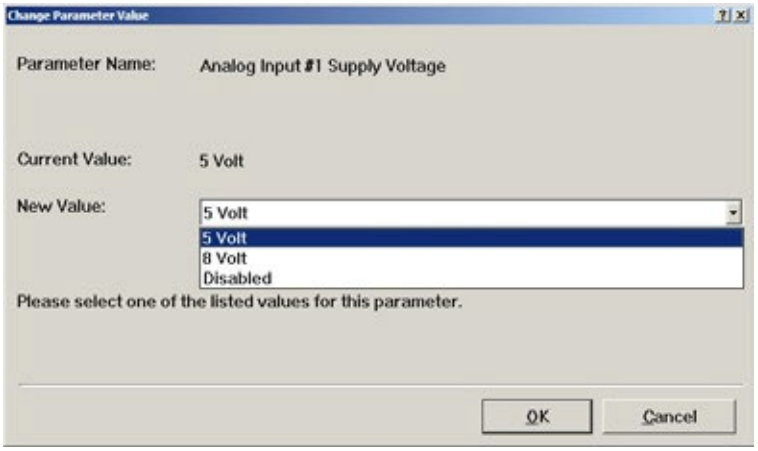
1. Double click the Analog Input #N Usage type to change this value to PWM Voltage Sender from the drop down menu. Click the OK button to program.



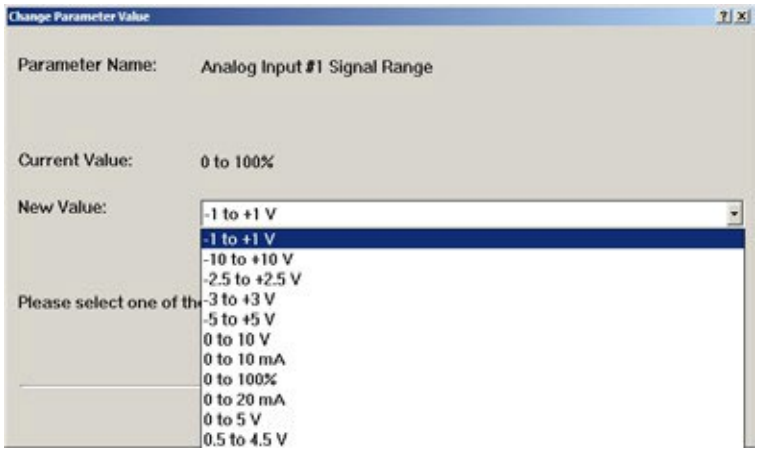
2. The Analog Input #N Supply Voltage, Signal Range, Data Identification, and Minimum and Maximum Data Range parameters will now be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	PWM Voltage Signal
Analog Input #1 Supply Voltage	5 Volt
Analog Input #1 Signal Range	0 to 100%
Analog Input #1 Data Identification	Data Link Only
Analog Input #1 Minimum Data Range	0.000
Analog Input #1 Maximum Data Range	100.000

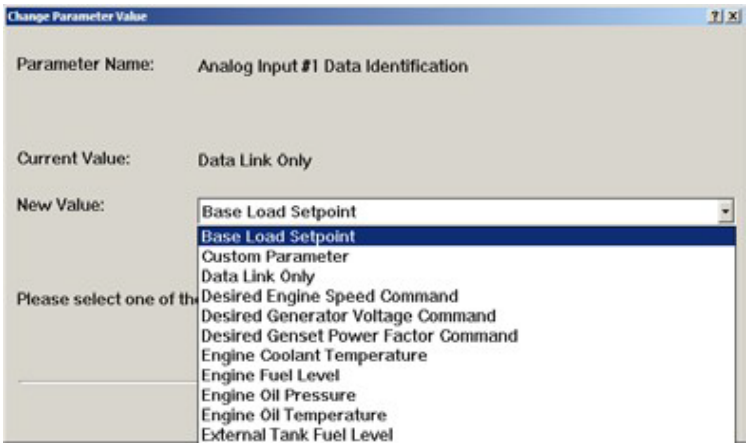
3. Double click the Supply Voltage setpoint to change this value from the drop down menu. Choose the desired voltage and then click the OK button to program.



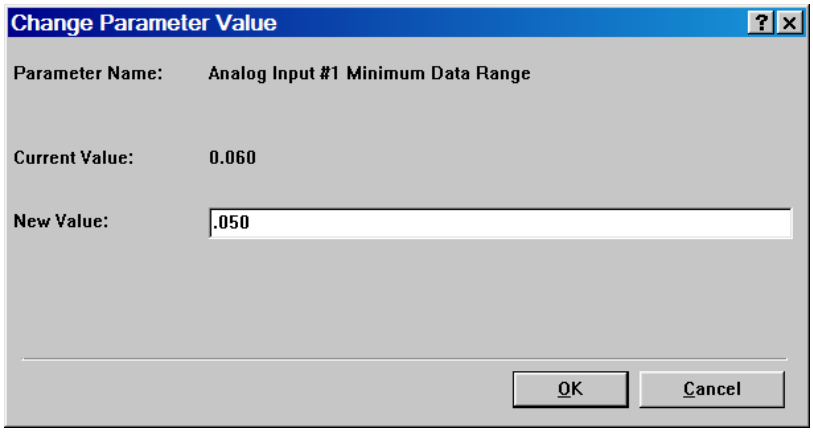
4. Double click the Signal Range setpoint to change this value from the drop down menu to match the range supported by your sensor (or the next larger range). See Section 11.3 for what to do if the desired sensor's range is not supported. Click the OK button to program.



5. Double click the Data Identification setpoint to change this value from the drop down menu. Click the OK button to program. For a full list of options available, see Section 11.3.



6. Configure each of the Minimum and Maximum Data Range setpoints by double clicking each setpoint and typing a new value. Click the OK button to program.



For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration if data is acceptable to be negative (see Section 5 .2).

7. If the selected Data Identification does support events, then continue and configure the event thresholds and delays. The Analog Input #N Threshold and Delay Time parameters will be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	PWM Voltage Signal
Analog Input #1 Supply Voltage	5 Volt
Analog Input #1 Signal Range	0 to 100%
Analog Input #1 Data Identification	Custom Parameter
Analog Input #1 Minimum Data Range	0.000
Analog Input #1 Maximum Data Range	100.000
Analog Input #1 High Warning Event Threshold	255
Analog Input #1 High Warning Event Delay Time	2.5 sec
Analog Input #1 High Shutdown Event Threshold	200
Analog Input #1 High Shutdown Event Delay Time	5.5 sec
Analog Input #1 Low Warning Event Threshold	10
Analog Input #1 Low Warning Event Delay Time	8.3 sec
Analog Input #1 Low Shutdown Event Threshold	0
Analog Input #1 Low Shutdown Event Delay Time	1.7 sec

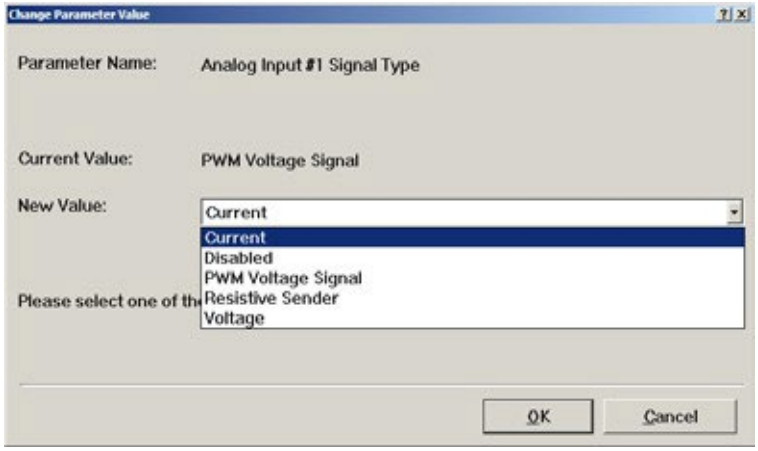
8. Configure each of these setpoints by double clicking each one and typing a new value. Click the OK button to program.

Note: The units for the event thresholds are not shown. For pressures, the units are always kPa. For temperatures, they are always degrees Celsius. For levels, they are always percent. For the custom parameter type, they are unitless. The range for custom parameters is defined by the selected sensor map.

11.2.3 Configuring Analog Inputs for Current Mode

The EMCP 4 supports current senders, which are senders whose output voltage varies linearly with the change in a physical measurement. Once the Analog Input is configured as a Voltage Input type, the linear mapping must be defined by entering the sensor voltage range and the corresponding minimum and maximum physical measurement range.

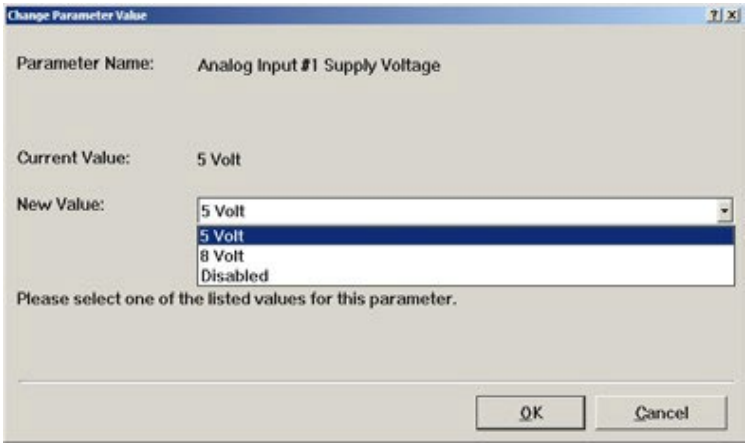
1. Double click the Analog Input #N Usage type to change this value to PWM Voltage Sender from the drop down menu. Click the OK button to program.



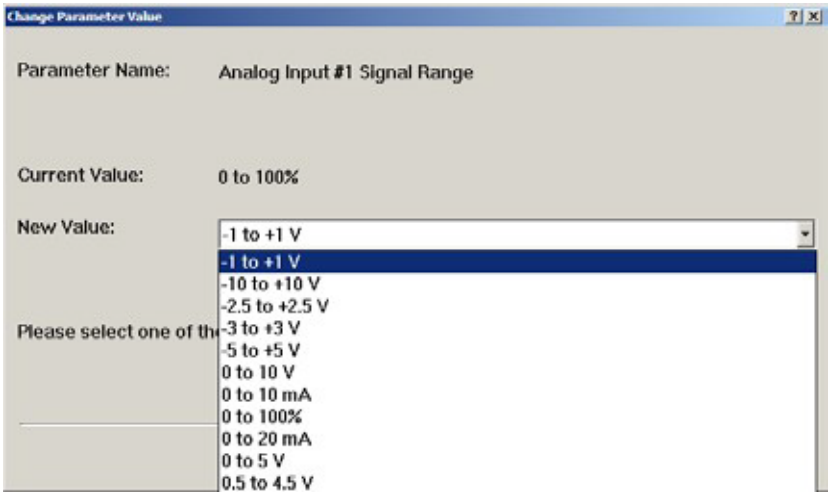
2. The Analog Input #N Supply Voltage, Signal Range, Data Identification, and Minimum and Maximum Data Range parameters will now be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	Current
Analog Input #1 Supply Voltage	5 Volt
Analog Input #1 Signal Range	0 to 20 mA
Analog Input #1 Data Identification	Data Link Only
Analog Input #1 Minimum Data Range	0.000
Analog Input #1 Maximum Data Range	100.000

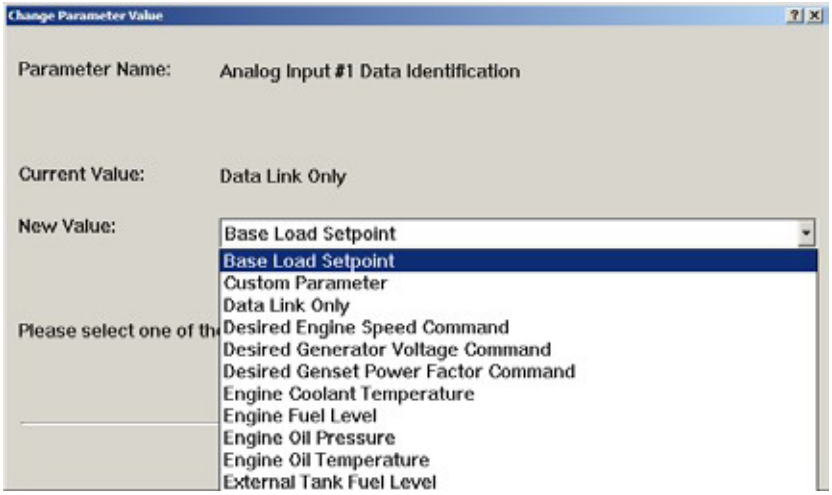
3. Double click the Supply Voltage setpoint to change this value from the drop down menu. Choose the desired voltage and then click the OK button to program.



4 . Double click the Signal Range setpoint to change this value from the drop down menu to match the range supported by your sensor (or the next larger range) . See Section 11 .3 for what to do if the desired sensor's range is not supported . Click the OK button to program .

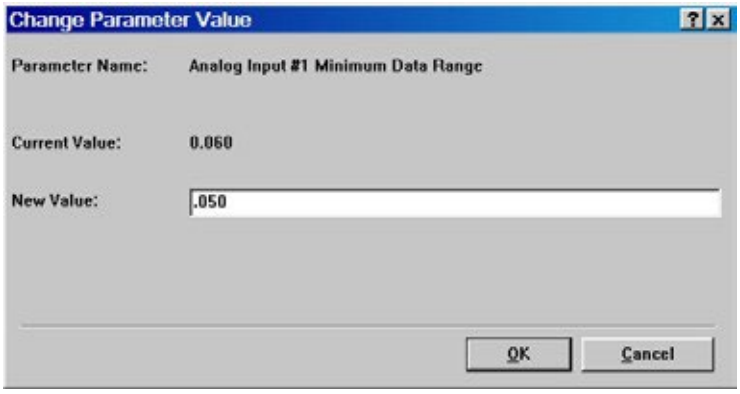


5 . Double click the Data Identification setpoint to change this value from the drop down menu . Click the OK button to program . For a full list of options available, see Section 11 .3 .



6 . Based on whether or not the selected option supports events, the list of setpoints shown will adjust accordingly . Table 11 .2 lists the options and which, if any, events they support .

7. Configure each of the Minimum and Maximum Data Range setpoints by double clicking each setpoint and typing a new value. Click the OK button to program.

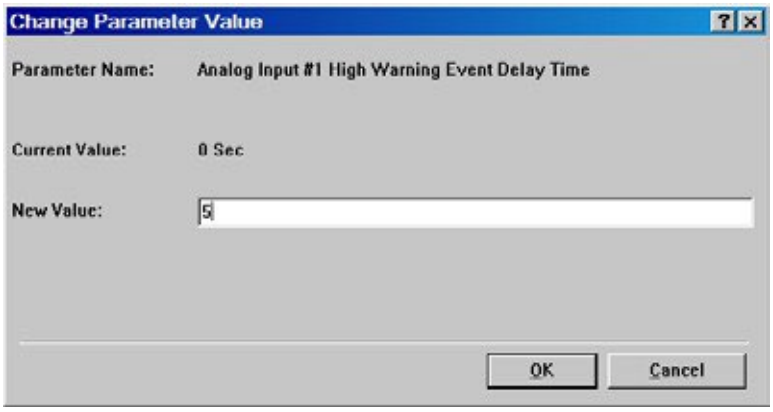


For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration if data is acceptable to be negative (see Section 5 .2).

8. If the selected Data Identification does support events, then continue and configure the event thresholds and delays. The Analog Input #N Threshold and Delay Time parameters will be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	Current
Analog Input #1 Supply Voltage	5 Volt
Analog Input #1 Signal Range	0 to 20 mA
Analog Input #1 Data Identification	Custom Parameter
Analog Input #1 Minimum Data Range	0.000
Analog Input #1 Maximum Data Range	100.000
Analog Input #1 High Warning Event Threshold	255
Analog Input #1 High Warning Event Delay Time	2.5 sec
Analog Input #1 High Shutdown Event Threshold	200
Analog Input #1 High Shutdown Event Delay Time	5.5 sec
Analog Input #1 Low Warning Event Threshold	10
Analog Input #1 Low Warning Event Delay Time	8.3 sec
Analog Input #1 Low Shutdown Event Threshold	0
Analog Input #1 Low Shutdown Event Delay Time	1.7 sec

9. Configure each of these setpoints by double clicking each one and typing a new value. Click the OK button to program.

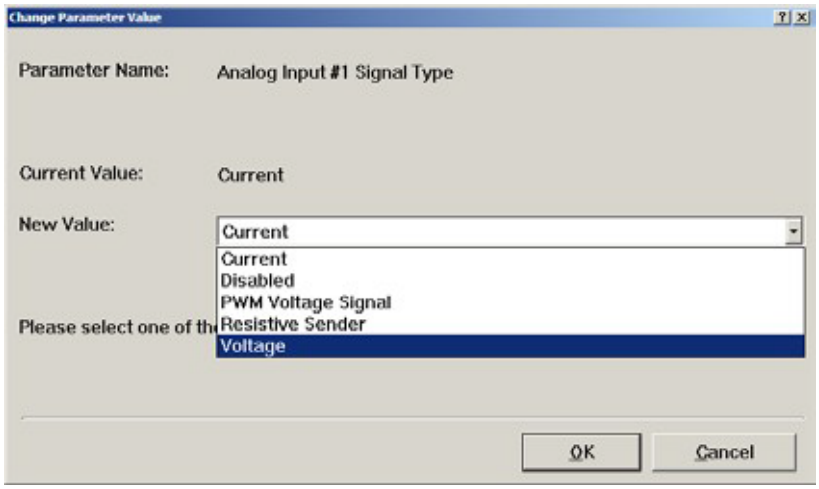


Note: The units for the event thresholds are not shown. For pressures, the units are always kPa. For temperatures, they are always degrees Celsius. For levels, they are always percent. For the custom parameter type, they are unitless. The range for custom parameters is defined by the selected sensor map.

11.2.4 Configuring Analog Inputs for Voltage Mode

The EMCP 4 supports linear voltage senders, which are senders whose output voltage varies linearly with the change in a physical measurement. Once the Analog Input is configured as a Voltage Input type, the linear mapping must be defined by entering the sensor voltage range and the corresponding minimum and maximum physical measurement range.

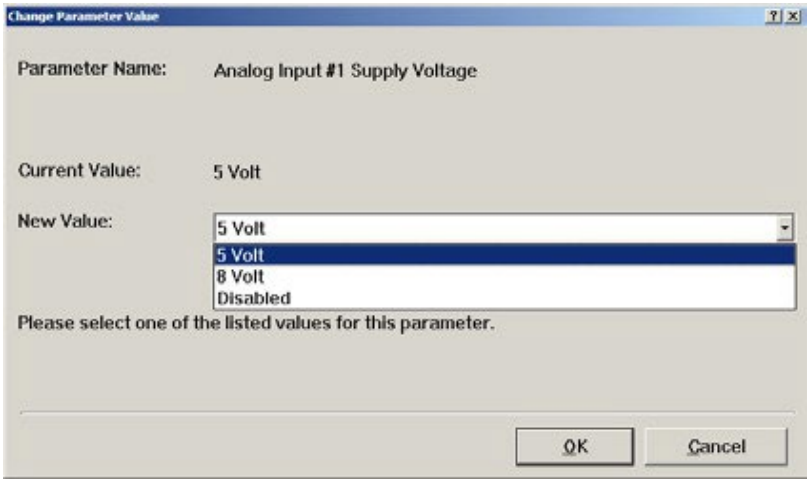
1. Double click the Analog Input #N Usage type to change this value to Voltage from the drop down menu. Click the OK button to program.



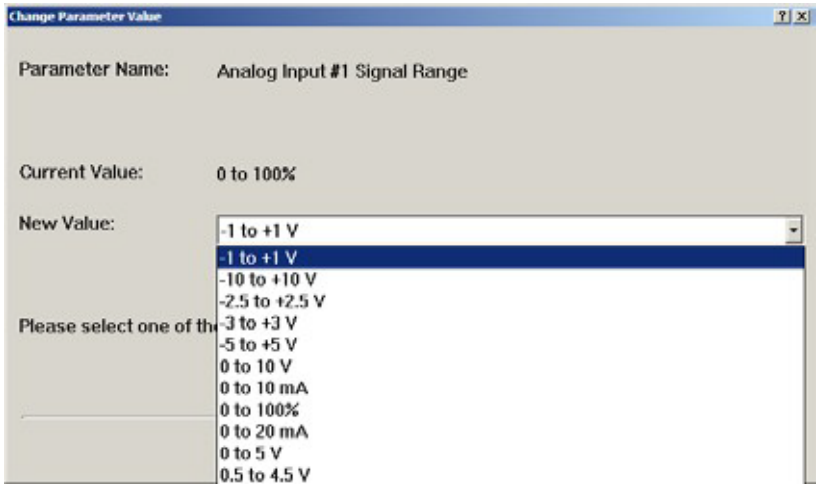
2. The Analog Input #N Signal Range, Data Identification, and Minimum and Maximum Data Range parameters will now be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	Voltage
Analog Input #1 Supply Voltage	5 Volt
Analog Input #1 Signal Range	0 to 5 V
Analog Input #1 Data Identification	Data Link Only
Analog Input #1 Minimum Data Range	0.000
Analog Input #1 Maximum Data Range	100.000

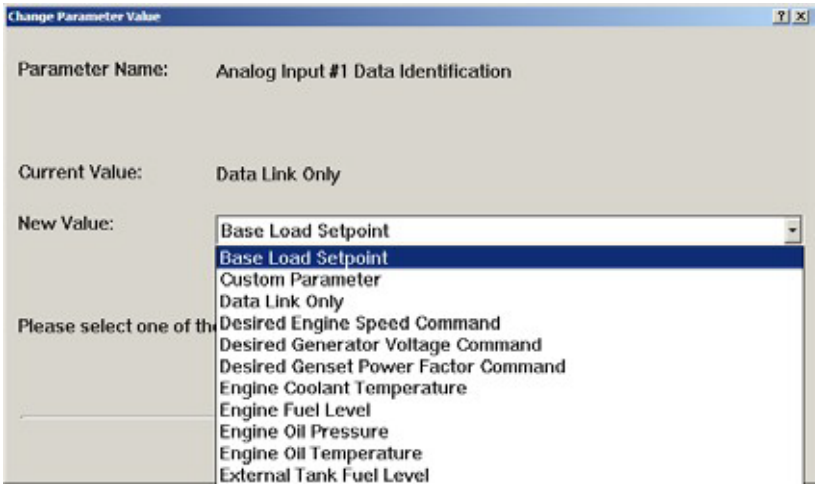
3. Double click the Supply Voltage setpoint to change this value from the drop down menu. Choose the desired voltage and then click the OK button to program.



4. Double click the Signal Range setpoint to change this value from the drop down menu to match the range supported by your sensor (or the next larger range). See Section 11.3 for what to do if the desired sensor's range is not supported. Click the OK button to program.

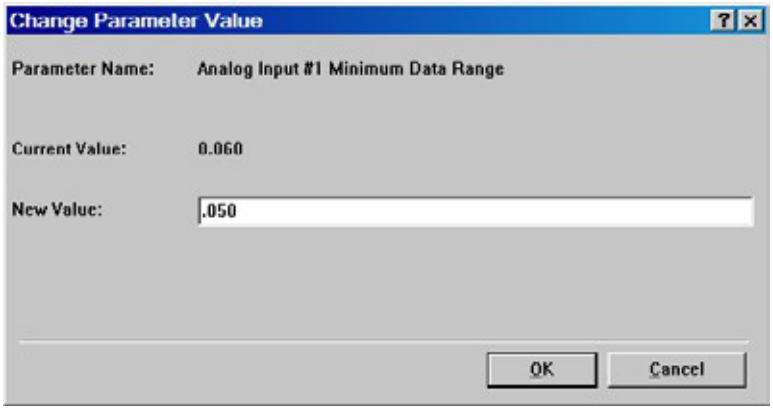


5. Double click the Data Identification setpoint to change this value from the drop down menu. Click the OK button to program.



6. Based on whether or not the selected option supports events, the list of setpoints shown will adjust accordingly. Table 11.2 lists the options and which, if any, events they support.

7. Configure each of the Minimum and Maximum Data Range setpoints by double clicking each setpoint and typing a new value. Click the OK button to program.

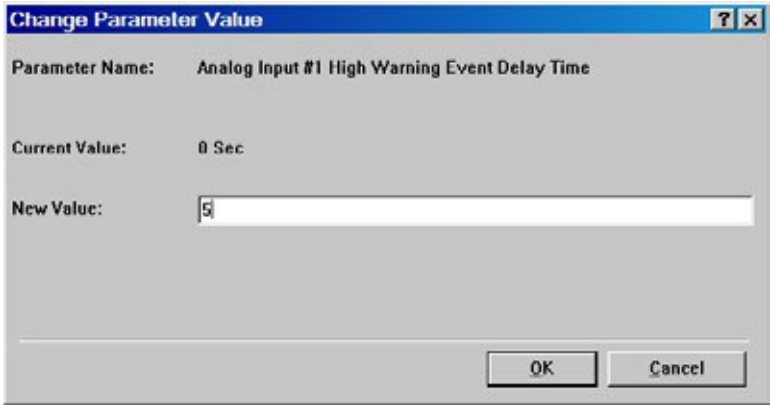


For Analog Inputs, the data range can be positive or negative, but Event thresholds are only positive. Therefore, to prevent nuisance alarms for low warnings, disable the Event Response Configuration if data is acceptable to be negative (see Section 5 .2).

8. If the selected Data Identification does support events, then continue and configure the event thresholds and delays. The Analog Input #N Threshold and Delay Time parameters will be visible in the right pane.

Description	Value
Analog Inputs	
Analog Input #1 Signal Type	Current
Analog Input #1 Supply Voltage	5 Volt
Analog Input #1 Signal Range	0 to 20 mA
Analog Input #1 Data Identification	Custom Parameter
Analog Input #1 Minimum Data Range	0.000
Analog Input #1 Maximum Data Range	100.000
Analog Input #1 High Warning Event Threshold	255
Analog Input #1 High Warning Event Delay Time	2.5 sec
Analog Input #1 High Shutdown Event Threshold	200
Analog Input #1 High Shutdown Event Delay Time	5.5 sec
Analog Input #1 Low Warning Event Threshold	10
Analog Input #1 Low Warning Event Delay Time	8.3 sec
Analog Input #1 Low Shutdown Event Threshold	0
Analog Input #1 Low Shutdown Event Delay Time	1.7 sec

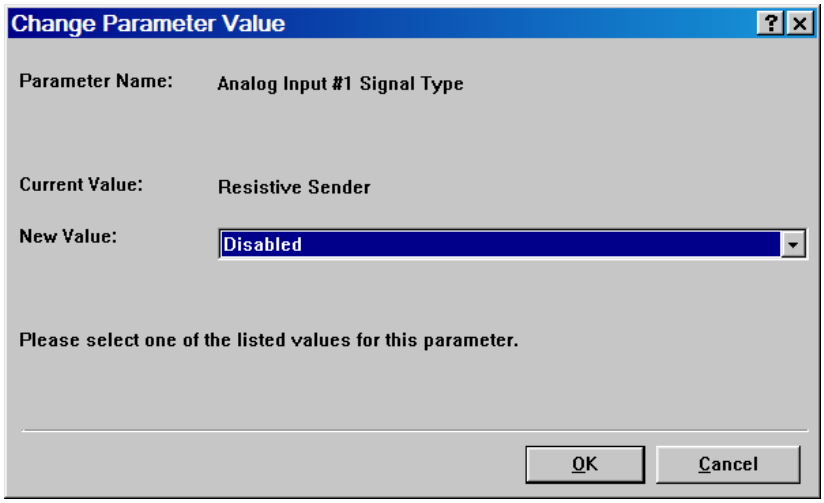
9. Configure each of these setpoints by double clicking each one and typing a new value. Click the OK button to program.



Note: The units for the event thresholds are not shown. For pressures, the units are always kPa. For temperatures, they are always degrees Celsius. For levels, they are always percent. For the custom parameter type, they are unitless. The range for custom parameters is defined by the selected sensor map.

11.2.5 Disabling Analog Inputs

1. Double click the Analog Input #N Usage type to change this value to Disabled from the drop down menu. Click the OK button to program.



Note: If the Analog Inputs are set to Disabled, then any sensor faults or events will not be broadcast or annunciated on the network.

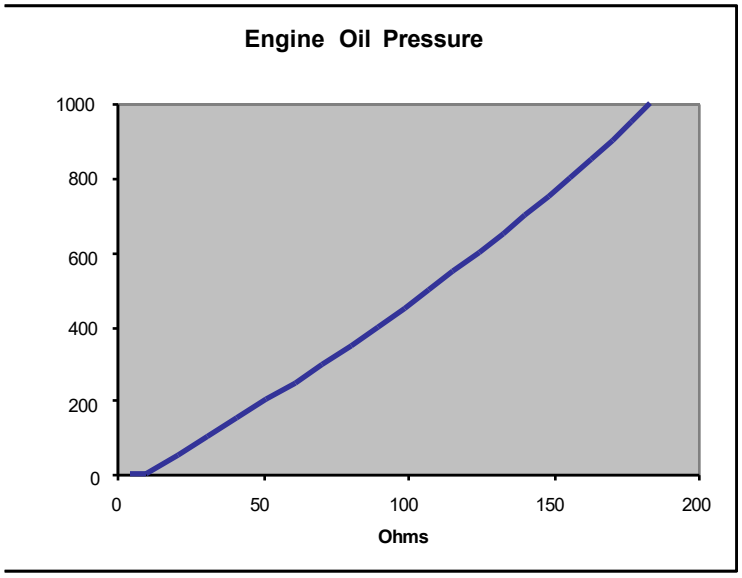
11.3 Analog Input Maps

Resistive senders can use nonlinear sensor maps. These maps are not available for Voltage or Current modes. Maps are predefined in the software flash file, and can be selected by the customer. The Analog Inputs are capable of reading resistance from ~5 Ohms up to 2000 Ohms.

The following maps are predefined:

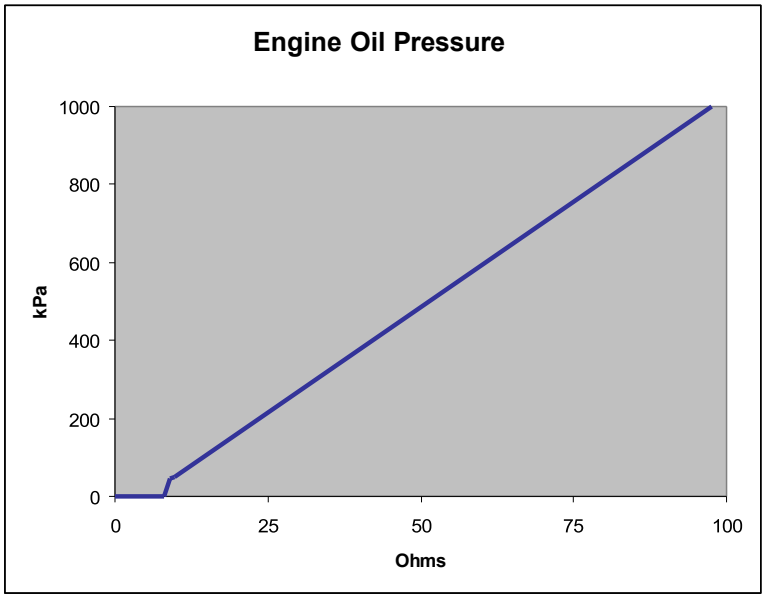
Analog Input Map #1

Engine Oil Pressure Map #1			
Ohms	**kPa**	**Ohms**	**kPa**
5.1	0	107.3	500
10.2	0	115.9	550
20.9	50	124.3	600
31.3	100	132.5	650
41.6	150	140.5	700
51.6	200	148.2	750
61.3	250	155.8	800
70.9	300	163.1	850
80.4	350	170.2	900
89.5	400	177.2	950
98.6	450	183.9	1000



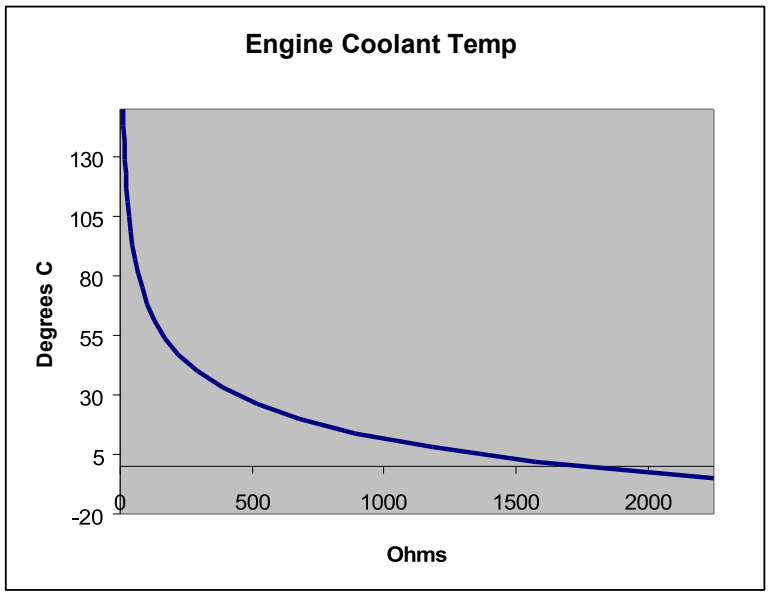
Analog Input Map #2

Engine Oil Pressure Map #2	
Ohms	kPa
0	0
8	0
9	45
9.8	50
97.5	1000



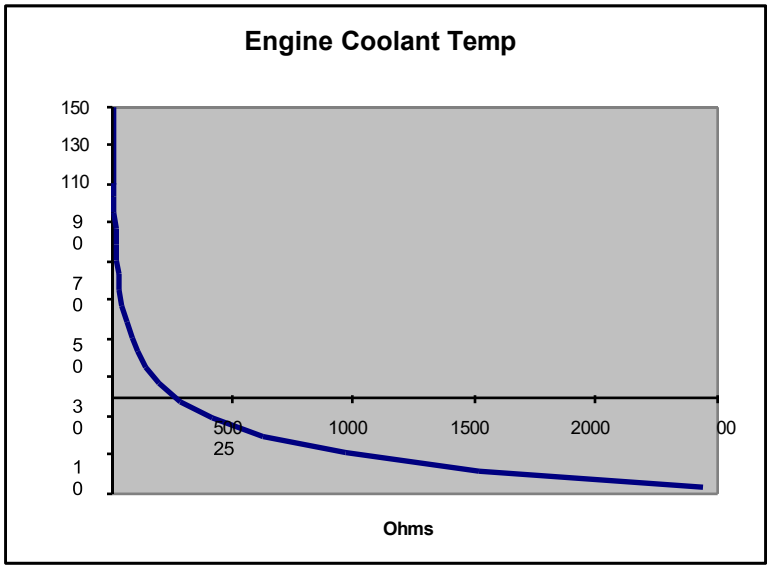
Analog Input Map #3

Engine Coolant Temperature Map #1			
Ohms	°C	Ohms	°C
11.0	150	103.6	68
12.8	143	129.6	61
15.0	136	168.0	54
17.9	129	221.9	47
20.8	123	291.5	40
24.2	117	387.5	33
28.4	111	520.6	26
33.4	105	677.0	20
39.6	99	890.6	14
46.9	93	1182.9	8
56.1	87	1575.6	2
67.9	81	2249.4	-5
82.4	75		



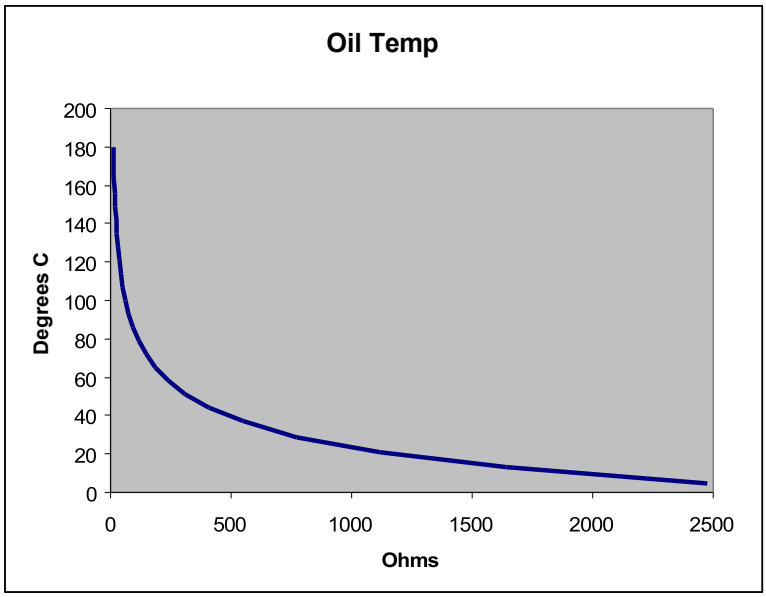
Analog Input Map #4

Engine Coolant Temperature Map #2			
Ohms	°C	Ohms	°C
2442	-48	31	62
1518	-39	24.8	70
968.9	-30	20	78
633.6	-21	16.3	86
423.9	-12	13.3	94
289.7	-3	11.0	102
201.9	6	9.18	110
148.8	14	7.7	118
111.2	22	6.5	126
84.2	30	5.5	134
64.5	38	4.7	142
50	46	4.1	150
39.2	54		



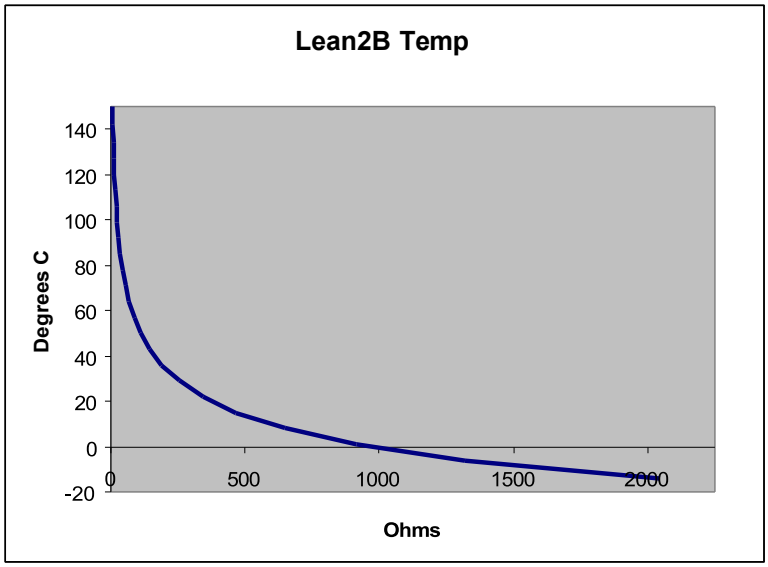
Analog Input Map #5

Oil Temperature			
Ohms	°C	Ohms	°C
10.2	180	93.6	86
11.9	172	115.6	79
13.9	164	145.2	72
16.4	156	184.7	65
19.0	149	238.0	58
22.0	142	309.9	51
25.7	135	408.7	44
30.2	128	546.6	37
35.6	121	773.7	29
42.5	114	1114.9	21
51.2	107	1640.3	13
61.9	100	2473.6	5
75.8	93		



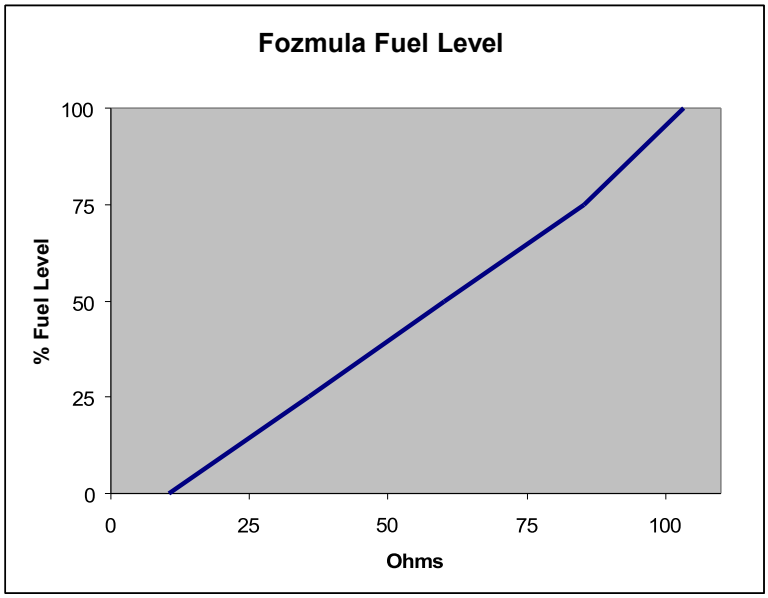
Analog Input Map #6

Engine Coolant Temperature Map #3			
Ohms	°C	Ohms	°C
6.9	150	68.5	64
8.2	142	87.1	57
9.8	134	111.8	50
11.6	127	145.1	43
13.8	120	190.5	36
16.3	113	253.4	29
19.6	106	341.5	22
23.8	99	467.0	15
28.8	92	648.8	8
35.4	85	916.6	1
43.7	78	1318.5	-6
54.5	71	2046.6	-14



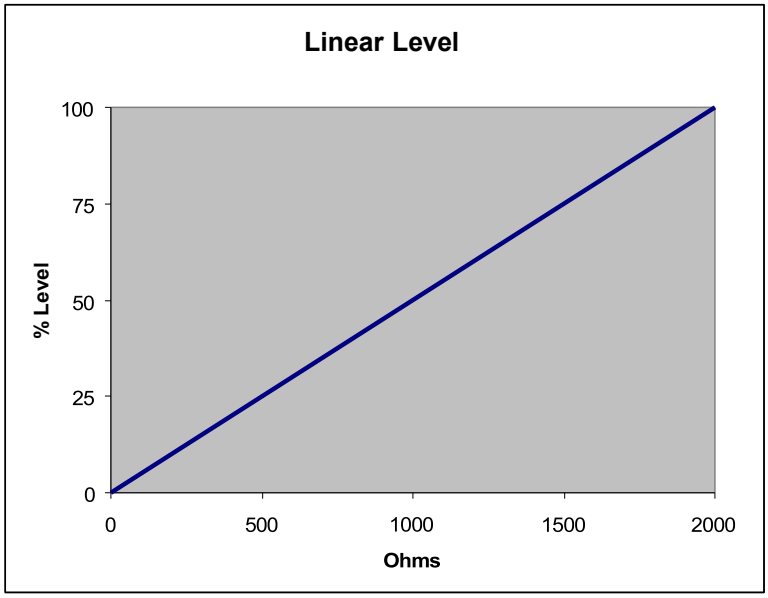
Analog Input Map #7

Fozmula Fuel Level	
Ohms	%
9.0	0
10.5	0
35.6	25
60.2	50
85.2	75
103.2	100
110.0	100



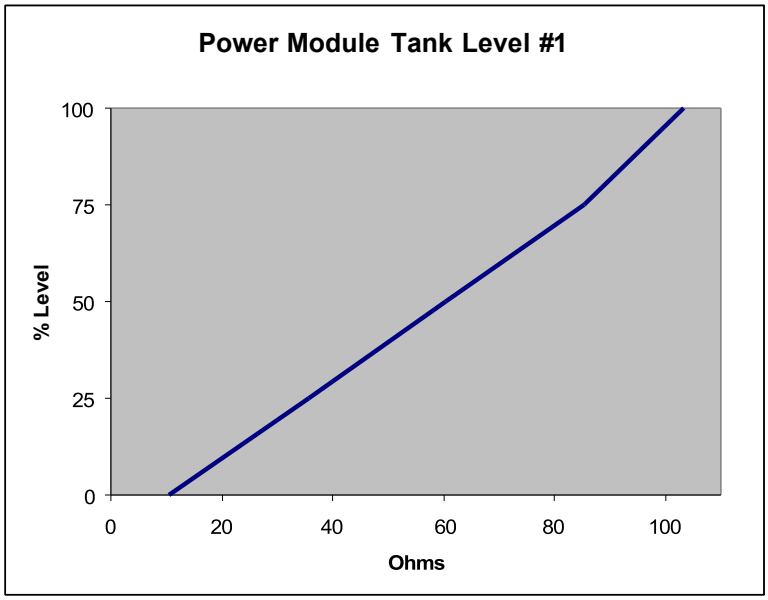
Analog Input Map #8

Linear Level	
Ohms	**%**
0	0
2000	1000



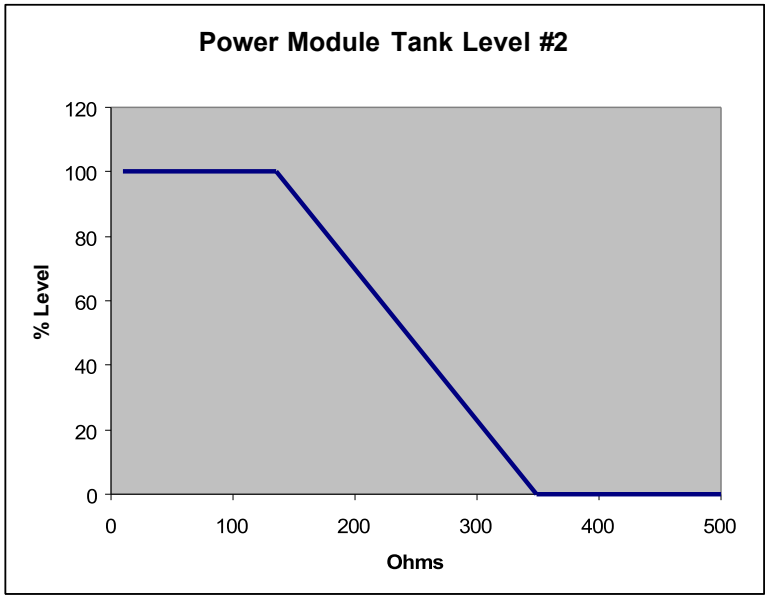
Analog Input Map #9

Power Module Tank Level #1	
Ohms	**%**
10.5	0
35.6	25
60.2	50
85.2	75
103.2	100



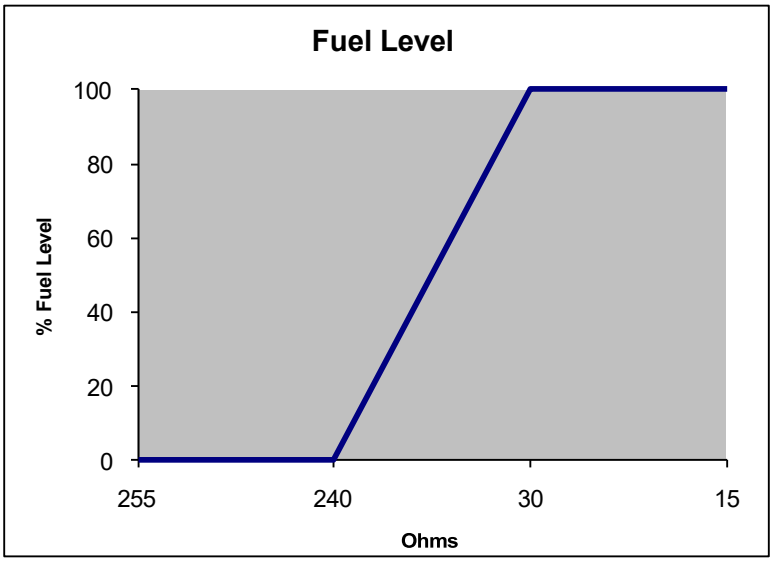
Analog Input Map #10

Power Module Tank Level #2	
Ohms	%
10	100
135	100
348 .2	0
500	0



Analog Input Map #11

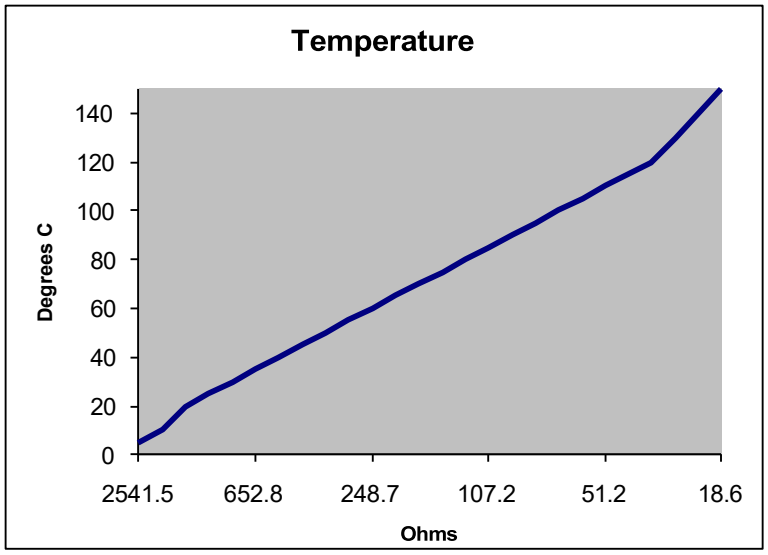
Fuel Level	
Ohms	%
255	0
240	0
30	100
15	100



Analog Input Map #12

Useful for temperatures based on Cat sensor part number 256-6453. (EMCP only supports down to 10°C).

Temperature			
Ohms	°C	Ohms	°C
2541.5	5	148.1	75
1991.4	10	125.7	80
1249.5	20	107.2	85
1000	25	91.7	90
805.5	30	78.8	95
652.8	35	68	100
532.3	40	58.9	105
436.6	45	51.2	110
360	50	44.6	115
298.4	55	39	120
248.7	60	30.1	130
208.2	65	23.6	140
175.2	70	18.6	150

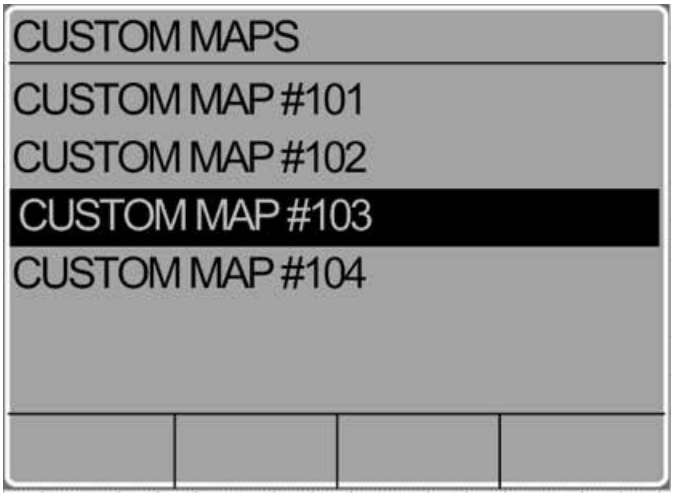


11.4 Custom Analog Input Maps

The EMCP 4 allows the user to configure 4 custom resistive sender maps. These user configurable maps can be applied to any of the analog inputs on the EMCP 4 control.

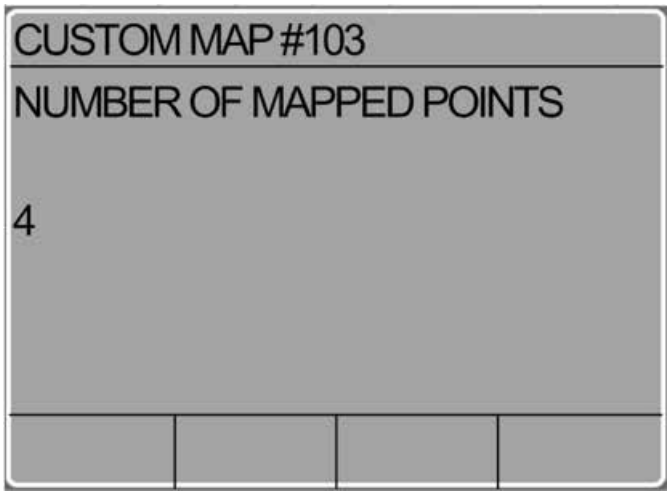
11.4.1 Custom Map Configuration via Display

To access the configuration screen, navigate from the MAIN MENU to CONFIGURE → INPUTS AND OUTPUTS → ANALOG INPUTS → CUSTOM MAPS. From this screen the user can select which custom map to edit.

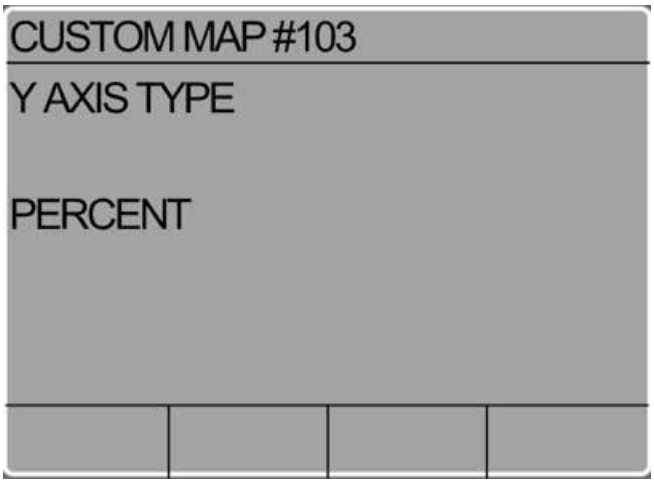


Once a custom map is selected the user can edit the setpoints for that map. The configurable setpoints are explained below.

The number of mapped points lets the user configure how many data points will be defined in the configurable map. The minimum is 4 points and maximum is 10 points.



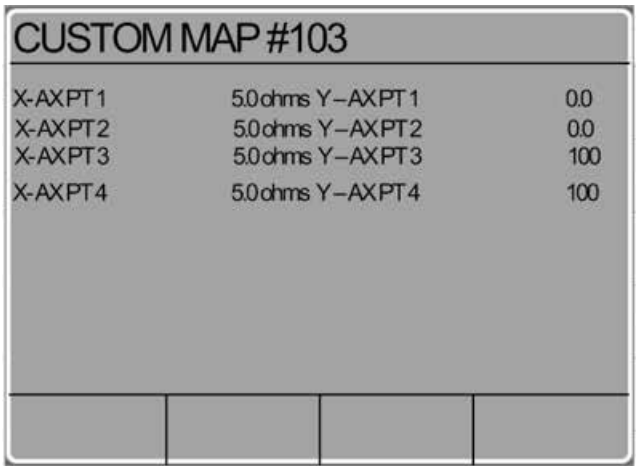
The user can configure the y-axis type which is the data type of the parameter being measured. The choices are temperature, pressure, percentage, and custom (unit less).



Next, the user can configure the individual map x and y points. The number of points that can be configured depend on the configured number of mapped points. If there are only 3 mapped points then the user can only edit pints 1-3.

For the x-axis being a resistive data type, the minimum configurable value is 5 ohm and the Maximum configurable value is 2000 ohm. The resistance values must be entered in order of increasing resistance.

For all y-axis data types the minimum configurable value is -50,000 and maximum configurable value is 50,000.



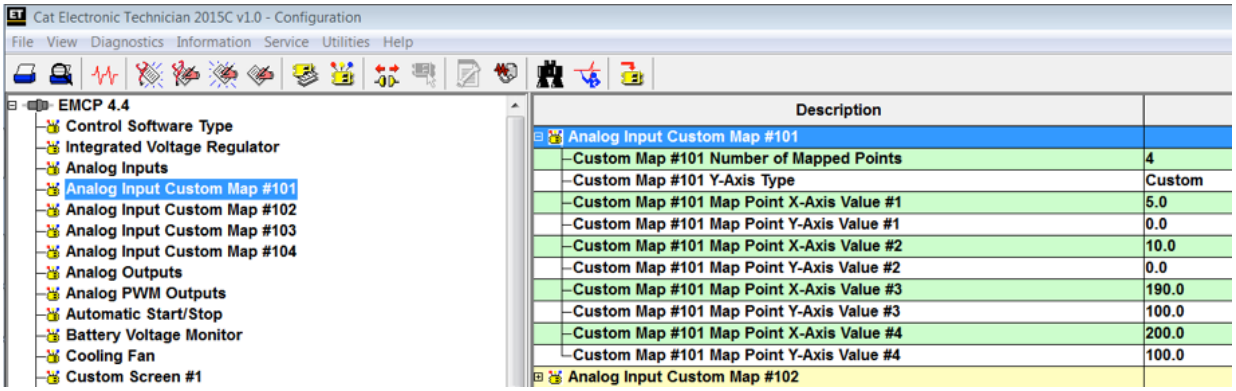
The default values for the map points is as follows:

1. X-axis in ohms
   a. Default: Point 1 = 5 .0
   b. Default: Point 2 = 10 .0
   c. Default: Point 3 = 190 .0
   d. Default: Point 4 = 200 .0
   e. Default: Point 5-10 = 2000 .0
2. Y-axis in %, temp, pressure, or custom
   a. Default: point 1 = 0
   b. Default: point 2 = 0
   c. Default: point 3 = 100
   d. Default: point 4 = 100
   e. Default: point 5-10 = 50000

Any map points that are above the configurable number of map points will automatically be set to the default values listed above .

11.4.2 Configurable Maps through ET

Cat ET offers an interface to configure all custom map setpoints. These setpoints are listed under Analog Input Custom Map #10x.



11.5 Analog Input Current and Voltage Ranges

For EMCP 4.3 and 4.4, PWM, voltage, and current senders can be configured within the ranges in Table 11.3:

PWM Sender Ranges	Current Sender Ranges	Voltage Sender Ranges
0 to 100% 5 to 95%	0 to 20mA 4 to 20mA 0 to 10mA	0 to 5V 1 to 5V 0 to 10V -3 to +3V -2.5 to +2.5V -5 to +5V -10 to +10V 0.5 to 4.5V -1 to +1V

Table 11.3 – Analog Input Ranges

Analog Input data ranges can be defined with positive and negative values, but Event thresholds are only programmable as positive values. Therefore, to prevent nuisance alarms for low warnings when using negative numbers for data ranges, the Event Response Config can be disabled, if input data is acceptable to be negative.

11.5.1 Warnings and Shutdowns

Each of these inputs can be configured to have HIGH WARNINGS, LOW WARNINGS, HIGH SHUTDOWNS and LOW SHUTDOWNS with configurable thresholds. Any value below the bottom point on the map or above the highest point on the map will raise a corresponding diagnostic event. Also, all of the events associated with the Analog Inputs have programmable time delays. Low Idle Oil Pressure setpoints are also available under the Engine Oil Monitor area. Information on how to program these thresholds and time delays can be found in Chapter 1, Setpoints.

11.5.2 Unsupported Analog Input Sensor Ranges

There may be Voltage sensors available that use ranges not explicitly supported by the EMCP 4. Depending on the situation, there may be different ways to handle this. The following sections give options on how to handle these situations.

11.5.3 Sensor Range is Smaller than Setpoint Options

If the desired sensor range is smaller than one of the available setpoint options, then extrapolation may be used to support the desired sensor. For example, for a 0-3V temperature sensor reads -30°C to 120°C, the only range that includes all of 0-3V is 0-5V. The 0-5V range should be used. The range between 3V and 5V will simply never be used. To make the data accurate, set the Minimum Data Range to -30°C, and determine the Maximum Data Range mathematically. See Figure 11.2.

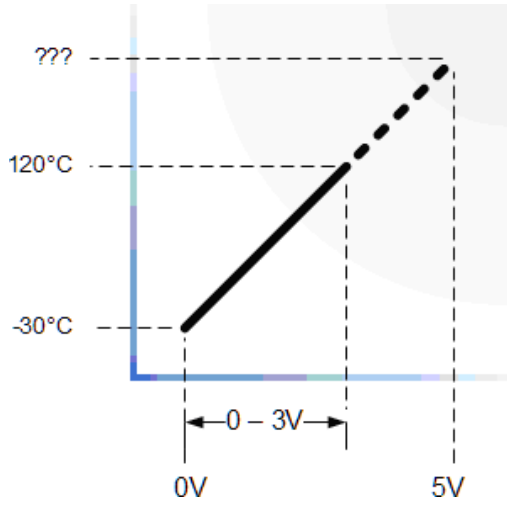


Figure 11.2 – Mathematical Extrapolation of Maximum Data Range

The Maximum Data Range can be found graphically or algebraically. In this example, the Maximum Data Range would be defined by the equation of the line after the slope is determined. Since the data rises by 50 degrees for every volt, increasing two volts above the three volt limit requires the maximum range to be 100 degrees above the sensor limit of 120 degrees, or 220 degrees total. See Figure 11.3.

$$\left[\frac{[120C - (-30C)]}{(3V - 0V)}\right] * (5V) + (-30C) = 220C$$

Figure 11.3 – Example Calculation for Extrapolation of Maximum Data Range

11.5.4 Sensor Range is Larger than Setpoint Options, but Usable Range is Not

If the desired sensor range is larger than one of the available setpoint options, but the useful range for the sensor is within the supported ranges, then interpolation may be used to support the desired sensor. For example, for a 0-6V temperature sensor that reads -40°C to 500°C, the EMCP 4 will not support the analog voltages higher than 5V. However, as long as the sensor will not exceed 5V, the 0-5V range may be used. To make the data accurate, set the Minimum Data Range to -40°C, and determine the Maximum Data Range mathematically. See Figure 11.4.

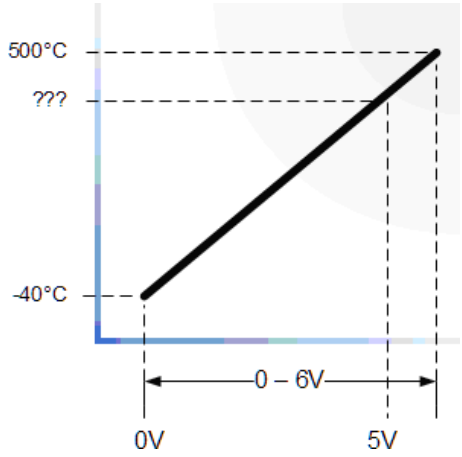


Figure 11.4 – Mathematical Interpolation of Maximum Data Range

The Maximum Data Range can be found graphically or algebraically. In this example, the Maximum Data Range would be defined by the equation of the line after the slope is determined. Since the data rises by 90 degrees for every volt, decreasing one volt below the six volt limit requires the maximum range to be 90 degrees below the sensor limit of 500 degrees, or 410 degrees total. See Figure 11.5.

$$\left[\frac{[500C - (-40C)]}{(6V - 0V)}\right] * (5V) + (-40C) = 410C$$

Figure 11.5 – Example Calculation for Interpolation of Maximum Data Range

11.5.5 Sensor Range is Larger than Setpoint Options, and Usable Range is Larger than Setpoint Options

If the desired sensor range is larger than one of the available setpoint options, and the useful range for the sensor is outside of the supported ranges, a third party device is required to convert the signal range into a supported range. See Figure 11.6.

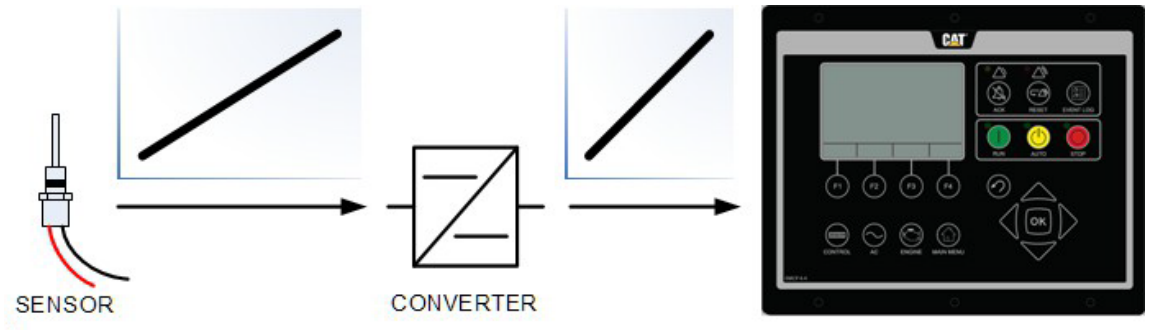


Figure 11.6 – Signal Conversion of Sensor Range

12.0 Digital Outputs

The EMCP 4.3 and 4.4 support 16 programmable discrete sourcing outputs capable of driving 200mA per channel. The voltage of these outputs will be the source voltage to the EMCP 4 plus a voltage drop of ~1 VDC. The common signal is Battery (-). The EMCP 4.4 has an additional 17th programmable discrete sourcing output (DDO#17) capable of driving 200mA.

The EMCP 4.4 additionally supports two dedicated discrete sourcing outputs capable of driving 300mA per channel and one capable of driving 100mA. The 300mA outputs are reserved for CB Close Command (DDO #2) and CB Trip Command (DDO #3). The 100mA output is reserved as a paralleling output (HWDBA #5/DDO #1).

Outputs can be configured by using the EMCP 4 display. For some of the setpoints, LEVEL 2 OR LEVEL 3 ACCESS is required. For information on obtaining Level 2 Access refer to Chapter 6, Security. This section will assume that Level 2 or Level 3 Access has already been obtained. Alternately, the Cat Service Tool can be used to configure these outputs.

The programming of the Digital Outputs starts by selecting a "Usage Type". The rest of the programming is dependent upon what Usage Type is selected. Figure 12.1 summarizes the paths possible for Programming a Digital Output.

Note: If the Engine Operating State is configured as Hardwired, then Digital Output #1 must be programmed to Starter Motor Relay.

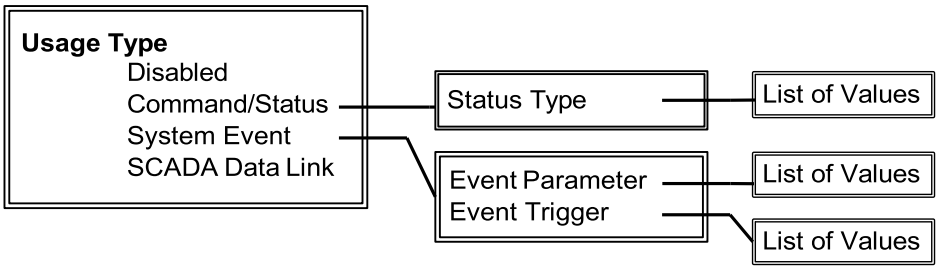


Figure 12.1 – Digital Output Programming Paths

12.1 Programming Digital Outputs Using the Display

For some of the setpoints, LEVEL 2 OR LEVEL 3 ACCESS is required. For information on obtaining Level 2 Access refer to Chapter 6, Security. This section will assume that Level 2 or Level 3 Access has already been obtained.

12.1.1 Viewing the Current Digital Output Status

To view the current status of an Output, go through the following menu options:

1. AT THE MAIN MENU, scroll DOWN TO VIEW.

2. Press the OK KEY.

3. Scroll DOWN to I/O STATUS.

4. Press the OK KEY.

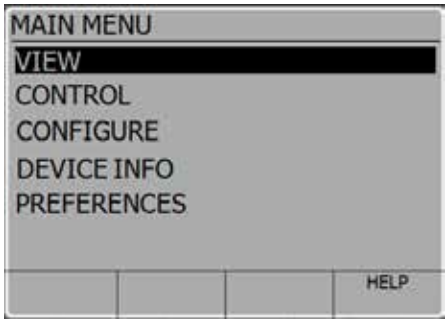
5. Scroll DOWN to access DIGITAL OUTPUTS.

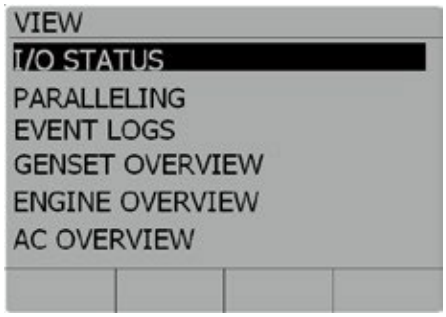
6. Press the OK KEY.

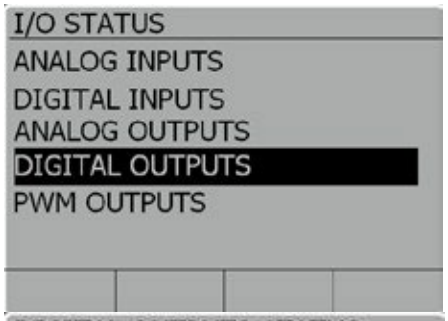
The status of all Digital Outputs is shown.
A dash under an output number indicates an output that is programmed, but inactive. A large "X" under an output number indicates an output that is disabled. A number under an output number indicates an output that is programmed and active.

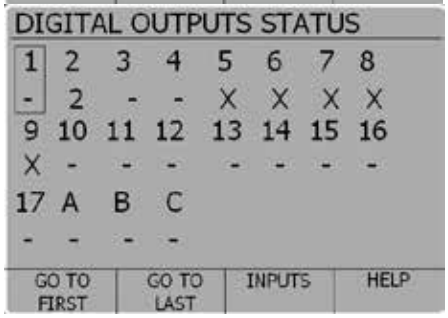
7. With the LEFT ARROW or RIGHT ARROW, select the DIGITAL OUTPUT that you want to view, then press the OK KEY.

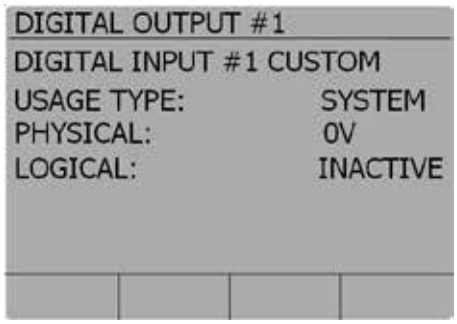
The programmed parameters of the selected Digital Output are shown.











12.1.2 Configuring Digital Outputs for Status Parameters

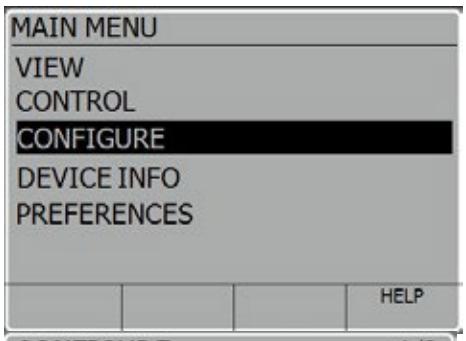
Command or Status parameters are used to control specific functions within the control system or to make certain conditions within the system be known.

Note: The Fuel Control Relay does not pickup when the Engine Operating State is set to CAN. Engine Start Initiated can be used in Lieu of the Fuel Control Relay for most purposes.

To configure a Digital Output as a Status Parameter, go through the following menu options:

1. AT THE MAIN MENU, scroll down TO CONFIGURE.

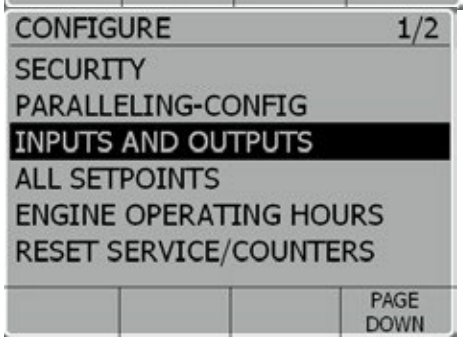
2. Press the OK KEY.



3. SCROLL DOWN to INPUTS & OUTPUTS.

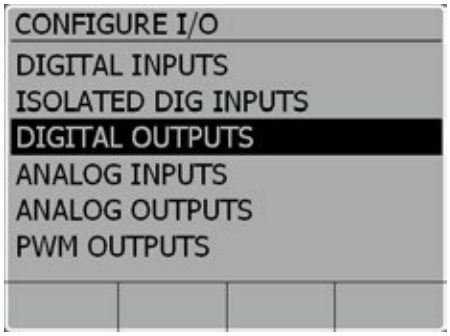
4. Press the OK KEY.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



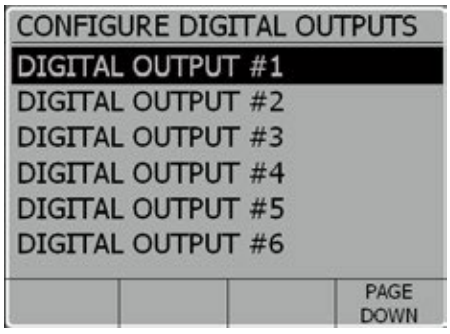
5. SCROLL DOWN to DIGITAL OUTPUTS.

6. Press the OK KEY.



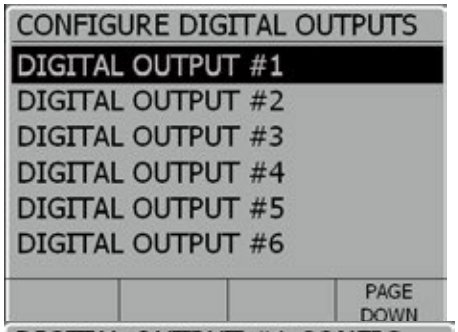
7. Select the DIGITAL OUTPUT that you want to program.

8. Press the OK KEY.

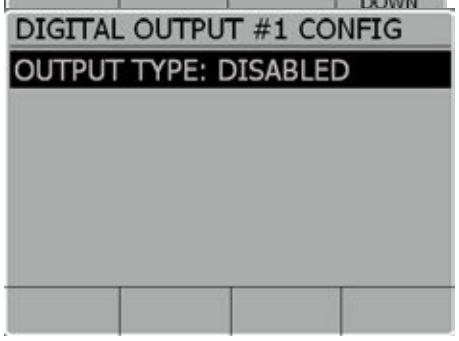


7. Select the DIGITAL OUTPUT that you want to program.

8. Press the OK KEY .



9. Press the OK KEY to highlight the current configuration (DISABLED, COMMAND/STATUS, SYSTEM EVENT, OR SCADA DATA LINK).



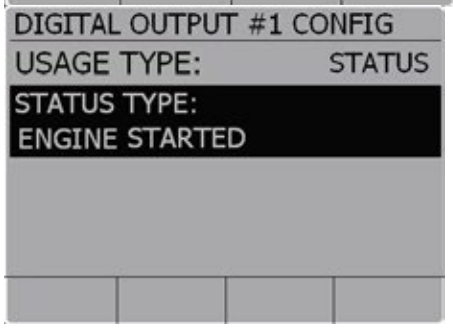
10. Scroll DOWN to COMMAND/STATUS.

11. Press the OK KEY .



12. Scroll DOWN to STATUS TYPE.

13. Press the OK KEY to highlight the current STATUS TYPE.



14. Select the STATUS PARAMETER that you want to program and press the OK KEY .

Any Output can be configured for any one of the COMMAND/Status parameters in Table 12.1:

COMMAND/Status Parameters	
Run Mode	Common Alarm
Auto Mode	Breaker #1 Trip (4.3 only)***
Stop Mode	Breaker #2 Trip***
Package Not in Auto	Not in Reduced Power Mode
Fuel Control Relay*	Transfer Fuel In
Starter Motor Relay	Transfer Fuel Out
Start Aid	Load Shed Command
Disable Aux AC Supply	Voltage Raise Command
Crank Alert	Voltage Lower Command
Engine Start Initiated	Speed Raise Command
Engine Started	Speed Lower Command
Rated Speed	Live Bus Indication (4.4 only)
V/Hz Within Limits	Nominal Frequency Selection Low/High
Engine in Cooldown	Nominal Voltage Selection Low/High
Package Waiting on Delay on Stop	Feeder Breaker Close (4.4 only)
Horn Control	Feeder Breaker Trip (4.4 only)
Common Warning	Ignition Shutoff Relay
Common Shutdown	Governor ECM Power Relay
ECU Fault Reset	Generator Circuit Breaker Open (4.4 only)
Air Shutoff	Generator Circuit Breaker Closed (4.4 only)
Programmable Cycle Timer Output #2	Gas Substitution (Blending) Mode On
Programmable kW relay Trip #1	Gas Substitution (Blending) Active
Programmable kW relay Trip #2	Gas Shutoff Valve Closed
Generator Contact Close Command (4.3)	Generator Breaker Close (4.3)
Generator Breaker Trip (4.3)	Utility Contact Close Command
Utility Breaker Close	Utility Breaker Trip
Transfer Switch in Normal Position	Transfer Switch in Emergency Position
Programmable Logic Function	

Table 12.1 – Output Command/Status List

*The Fuel Control Relay does not pickup when the Engine Operating State is set to CAN. Engine Start Initiated can be used in lieu of the Fuel Control Relay for most purposes.

**Not available with Standard software

***This output does not control a circuit breaker unless the user makes the connections to do so. This output type should be viewed as having a generic name because the name does not necessarily imply the action that is performed.

Note: If the Engine State Configuration is configured for Hard Wired, then Relay Output #1 must be programmed for the Status Parameter of Starter Motor Relay. As of version 4.2.2 PROD software, Relay Output #2 is no longer required to be programmed for Fuel Control Relay.

12.1.3 Digital/Relay Output Status Descriptions

Below is a brief description of the purpose of each command/status digital/relay output option:

Run Mode

- Activates when the EMCP is placed in RUN mode (such as when the 'Run' button is pressed). Matches the state of ECS LED on the EMCP.

Auto Mode

- Activates when the EMCP is placed in AUTO mode (such as when the 'Auto' button is pressed). Matches the state of ECS LED on the EMCP.

Stop Mode

- Activates when the EMCP is placed in STOP mode (such as when the 'Stop' button is pressed). Matches the state of ECS LED on the EMCP.

Package Not In Auto

- Activates when conditions are present that prevent the EMCP from operating in AUTO mode (such as engine control switch not in auto, engine not in Rated mode, shutdown red lamp is active).

Fuel Control Relay

- Activates when the engine pre-crank timing delay expires during the engine start sequence and the while the engine is running, along with during fuel priming when engine operating state is configured for Hardwired Input.

Starter Motor Relay

- Activates during the Crank Duration time during the starting state of the engine starting sequence when the engine operating state setpoint is configured for Hardwired Input.

Start Aid

- Activates during the Start Aid Activation Time during the pre-crank state of the engine starting sequence.

Disable AUX AC

- Activates when the generator set enters the Pre-Crank State. This output will be activated during Crank Alert, Start Aid, Cranking, Running, Cooldown, etc., but will stay deactivated if the generator set is unable to start due to a shutdown fault. Typically used to turn off equipment such as static battery chargers, generator space heater and jacket water heaters when the engine is running.

Crank Alert

- Activates during the Crank Alert Activation Time during the pre-crank state of the engine starting sequence.

Engine Start Initiated

- Activates when the engine has been commanded to start and remains active until the end of cooldown.

Engine Started

- Activates when the engine has been commanded to start and the engine speed is greater than Crank Terminate rpm and remains active until engine speed drops below Crank Terminate rpm.

Rated Speed

- Activates when the engine is configured to run at rated speed (regardless of actual engine speed). Useful to determine when the engine is commanded to run at idle speed. **Note:** This is NOT an indication that the set is at rated speed. It is an indication that the set has not been requested to run at Idle.

V/HZ Within Limits

- Activates if voltage and frequency are within the Over/Under Voltage and Over/Under Frequency protection limits (typically 90% to 110% of rated).

Engine In Cooldown

- Activates when the engine is running in cooldown mode.

Wait Delay Stop

- Activates when the engine is running in the pre-cooldown state. Typically a stop signal has been received, but an inhibit cooldown command is preventing the unit from entering cooldown.

Horn Control

- Activates when a horn alert is sounding. Typically occurs when any event configured with an audible alert event response is PRESENT or ACTIVE and unacknowledged.

Common Warning

- Activates when any warning is PRESENT in the event log (regardless of source).

Common Shutdown

- Activates when any shutdown is PRESENT or ACTIVE in the event log (regardless of source).

ECU Fault Reset

- Activates for a configurable period of time when a Reset All Events command is issued. Typically only used to interface to legacy engines.

Air Shutoff

- Activates based on engine shutdown conditions such as engine overspeed, engine speed sensor diagnostic, emergency stop, and engine speed failure to decrease. When activated this output will remain active for 15 seconds.

Programmable Cycle Timer Output #2

- Activates for the duration of the Programmable Cycle Timer #N Active Time as configured in the Programmable Cycle Timer feature (refer to Chapter 18).

kW Relay Trip #1

- Activates based on the programmable trip point trigger conditions of the Programmable kW Relay Function (refer to Chapter 20).

kW Relay Trip #2

- Activates based on the programmable trip point trigger conditions of the Programmable kW Relay Function (refer to Chapter 20.

Common Alarm

- Activates when any shutdown is PRESENT or ACTIVE in the event log or any warning is PRESENT in the event log (regardless of source).

Breaker #1 Trip (EMCP 4.3 Only)

- Activates when any event configured with a Breaker #1 Trip event response is PRESENT or ACTIVE.
  Note: EMCP 4.4 use Breaker #1 for the Generator Set Breaker.

Breaker #2 Trip

- Activates when any event configured with a Breaker #2 Trip event response is PRESENT or ACTIVE.

Reduced Power Off

- Activates when the EMCP is NOT in reduced power mode (Useful for placing other controls in a reduced power mode when the EMCP is in Reduced Power Mode).

Transfer Fuel In

- Activates when manual or automatic fuel loading is initiated.

Transfer Fuel Out

- Activates when manual or automatic fuel unloading is initiated. (Not available on standard software.)

Voltage Raise Command

- Activates when a command to raise voltage is received.

Voltage Lower Command

- Activates when a command to lower voltage is received.

Speed Raise Command

- Activates when a command to raise speed is received.

Speed Lower Command

- Activates when a command to lower speed is received.

Nominal Frequency Selection Is Low

- Activates when a digital input configured for "Nominal Frequency Selection is Low" is active.

Programmable Digital Input "Nominal Frequency is Low" Logical Status	Programmable Digital Input "Nominal Voltage is Low" Logical Status	Ratings Group Selected
0 (high frequency)	0 (high voltage)	Group #1
0 (high frequency)	1 (low voltage)	Group #2
1 (low frequency)	0 (high voltage)	Group #3
1 (low frequency)	1 (low voltage)	Group #4

(Not available in standard software Programmable Digital Input)

Nominal Voltage Selection Is Low

- Activates when a digital input configured for "Nominal Voltage Selection is Low" is active.

Programmable Digital Input "Nominal Frequency is Low" Logical Status	Programmable Digital Input "Nominal Voltage is Low" Logical Status	Ratings Group Selected
0 (high frequency)	0 (high voltage)	Group #1
0 (high frequency)	1 (low voltage)	Group #2
1 (low frequency)	0 (high voltage)	Group #3
1 (low frequency)	1 (low voltage)	Group #4

(Not available in standard software Programmable Digital Input)

Ignition Shutoff Relay

- **Note:** This is a shutoff relay so the output is active when ignition is NOT desired. Deactivates during the Engine Purge Cycle with Ignition time and while engine is starting and running. Typically used for gas engine starting/stopping sequence.

Governor ECM Power Relay

- Activates at the start of the "Engine Start Sequence Delay Time" prior to engine cranking and deactivates 15 seconds after engine speed has reached zero rpm.

Gas Substitution Mode Status

- Activates when the gas blending/substitution feature is enabled.

Gas Substitution Status
- Activates when the gas blending/substitution is actively blending fuels.

Gas Shutoff Valve Closed
- Activates when the gas shutoff valve is being commanded to a closed position.

Generator Circuit Breaker Open (4.4 only)
- Reflects the status of the Generator Circuit Breaker.

Generator Circuit Breaker Closed (4.4 only)
- Reflects the status of the Generator Circuit Breaker.

Generator Contactor Close Command (4.3 only)
- This output will be activated when the transfer switch closes the contactor and will be held active when the contactor is desired closed . When the transfer switch wants to open the contactor this output will be deactivated and remain deactivated

Generator Breaker Close (4.3 only)
- This output will be activated when the transfer switch wants to close the generator breaker and will be deactivated when the breaker position is determined to be closed

Generator Breaker Trip (4.3 only)
- This output will be activated when the transfer switch wants to open the generator breaker and will be deactivated when the breaker position is determined to be open.

Utility Contactor Close Command
- This output will be activated when the transfer switch closes the utility contactor and will be held active when the contactor is desired closed . When the transfer switch wants to open the utility contactor this output will be deactivated and remain deactivated

Utility Breaker Close
- This output will be activated when the transfer switch wants to close the utility breaker and will be deactivated when the breaker position is determined to be closed

Utility Breaker Trip
- This output will be activated when the transfer switch wants to open the utility breaker and will be deactivated when the breaker position is determined to be open.

Transfer switch in Normal Position
- This output is activated when the utility breaker or contactor is closed and the system is running on utility power

Transfer Switch in Emergency Position
- This output is activated when the generator breaker or contactor is closed and the system is running on generator provided power.

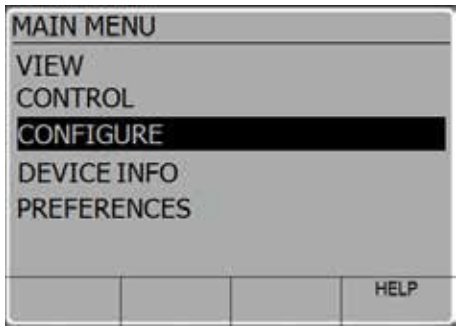
Programmable Logic Function
- When configured to this command status, this output will be controlled by the EMCP's embedded PLC.

12.1.4 Configuring Digital Outputs for System Events

System Events are used to know when specific conditions are reached and to alert the control system of warning or shutdown conditions. To configure a Digital Output as a System Event, go through the following menu options:

1. AT THE MAIN MENU, scroll down TO CONFIGURE.

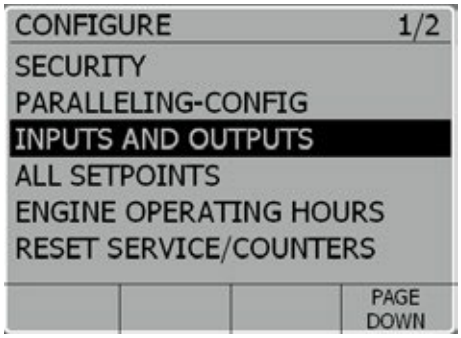
2. Press the OK KEY.



3. SCROLL DOWN to INPUTS & OUTPUTS.

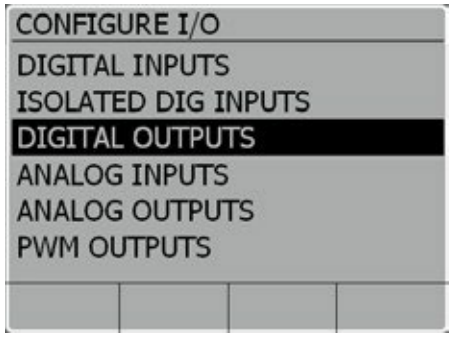
4. Press the OK KEY.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



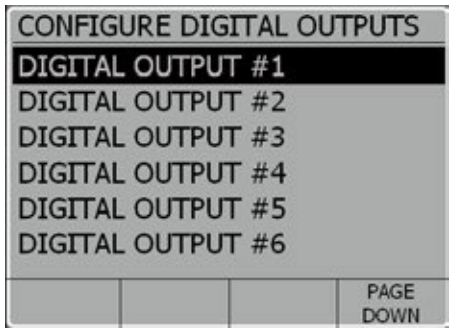
5. SCROLL DOWN to DIGITAL OUTPUTS.

6. Press the OK KEY.



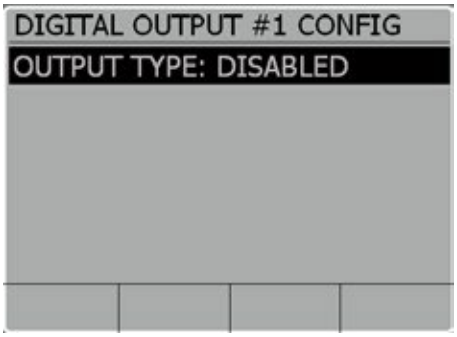
7. Select the DIGITAL OUTPUT that you want to program.

8. Press the OK KEY.



9. Press the OK KEY 

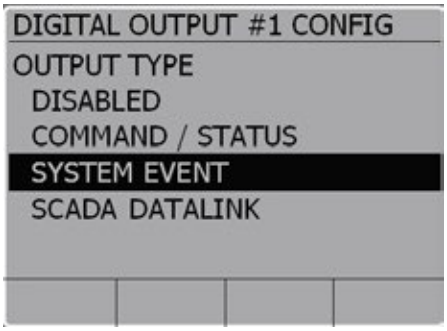
to highlight the current configuration (DISABLED, STATUS, SYSTEM EVENT, OR SCADA DATA LINK).



10. Scroll DOWN  to SYSTEM EVENT.

11. Press the OK KEY 

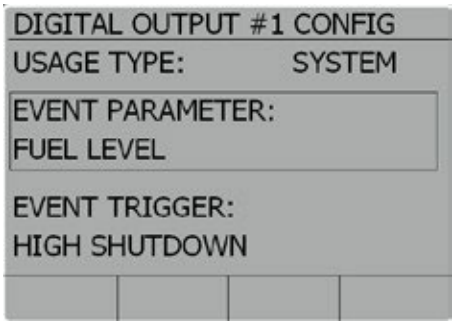
.



12. Scroll DOWN  to EVENT PARAMETER.

13. Press the OK KEY 

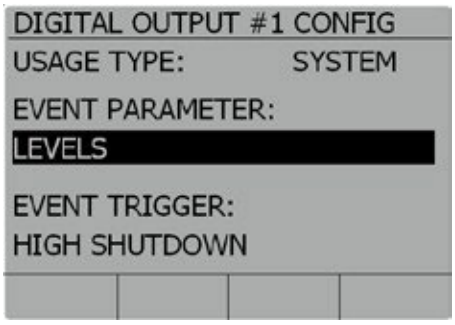
to edit the current EVENT PARAMETER.



14. Select the type of EVENT PARAMETER that you want to program (Pressures, Temperatures, Levels, or Others).

15. Press the OK KEY 

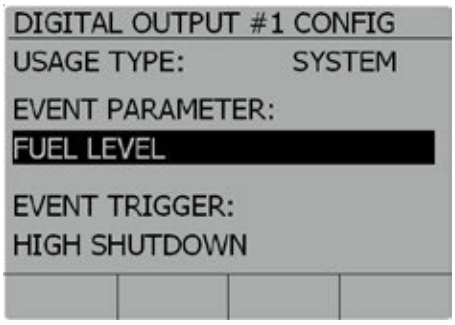
.



16. Select the EVENT PARAMETER that you want to program.

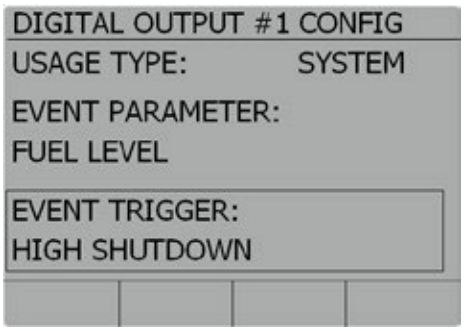
17. Press the OK KEY 

.



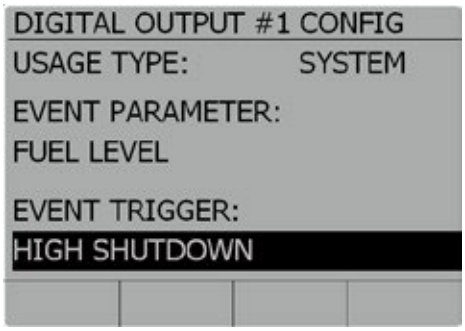
18. Scroll DOWN  to EVENT TRIGGER.

19. Press the OK KEY  to edit the current EVENT TRIGGER.



20. Select the EVENT TRIGGER that you want to program.

21. Press the OK KEY .



Any Output can be configured for any one of the System Events in Table 12.2:

System Events		
Pressure Engine Oil Pressure Gas Pressure	**Others** Any Suspect Parameter Number Accessory Data Link Battery Charging System Voltage Battery Voltage Emergency Stop Switch Engine in Cooldown Engine Failure to Start Engine Speed Generator Control Not in Automatic Generator Current (Amp) Generator Output Frequency Generator Output Power Generator Output Voltage Primary Data Link SCADA Data Link Serv Maint Interval Expired Unexpected Engine Shutdown Earth Fault Earth Leakage Engine Controller Fuel Leak Air Damper Closed Battery Charger Failure Generator Circuit Breaker Open Generator Circuit Breaker Closed Loss of Utility	**Custom Events** Digital Input #1 Custom Event Digital Input #2 Custom Event Digital Input #3 Custom Event Digital Input #4 Custom Event Digital Input #5 Custom Event Digital Input #6 Custom Event Digital Input #7 Custom Event Digital Input #8 Custom Event Isolated Dig Input #1 Custom Isolated Dig Input #2 Custom Isolated Dig Input #3 Custom Isolated Dig Input #4 Custom Analog Input #1 Custom Event Analog Input #2 Custom Event Analog Input #3 Custom Event Analog Input #4 Custom Event (EMCP 4.4 Only)
Temperature Engine Coolant Temperature Engine Oil Temperature Exhaust Temperature Generator Rear Bearing Temperature Generator Winding #1 Temperature		
Levels Engine Coolant Level Engine Oil Level Fuel Level External Tank Fuel Level Engine Fluid Bund Level		

Table 12.2 – Output System Events

Care must be taken in configuring the correct triggers. Only some of these parameters can be configured for a specific System Event and even if it can be configured, it may not be representative of the system requirements. Output system event trigger conditions are listed in Table 12.3.

Category	SPN	Suspect Parameter	Supported FMI Trigger Conditions
Pressures	100	Engine Oil Pressure	1, 3, 4, 14, 17
	1390	Gas Pressure	0, 1, 15, 17
Temperatures	110	Engine Coolant Temperature	0, 3, 4, 14, 15, 17
	175	Engine Oil Temperature	0, 1, 15, 17
	173	Exhaust Temperature	0, 1,15, 17
	1122	Generator Rear Bearing Temperature	0, 1, 15, 17
	1124	Generator Winding #1 Temperature	0, 15
Levels	111	Engine Coolant Level	0, 1, 15, 17
	98	Engine Oil Level	0, 1, 15, 17
	96	Fuel Level	0, 1, 15, 17
	38	External Tank Fuel Level	0, 1, 15, 17
	7785	Engine Fluid Bund Level	0, 15
Others	n/a	Any Suspect Parameter Number	n/a
	1231	Accessory Data Link	11
	167	Battery Charging System Voltage	17
	168	Battery Voltage	0, 15, 17
	970	Auxiliary Engine Shutdown Switch	14, 31
	4006	Engine in Cooldown	31
	1664	Engine Failure to Start	31
	190	Engine Speed	0, 1, 2, 5, 17
	4007	Generator Control Not in Automatic	31
	2448	Generator Current (Amps)	0,1,15, 17
	2436	Generator Output Frequency	0, 1, 2, 12, 15, 17
	2452	Generator Output Power	1, 15, 17
	2440	Generator Output Voltage	0, 1, 15, 17
	639	Primary Data Link	11
	3581	SCADA Data Link	11
	2648	Service Maintenance Interval Expired	31
	1383	Unexpected Engine Shutdown	11
	4028	Earth Fault	31
	4029	Earth Leakage	31
	3543	Engine Controller	9
	1239	Fuel Leak	31
	4000	Air Damper Closed	31
	4003	Battery Charger Failure	31
	4013	Generator Circuit Breaker Open	6, 31
	4004	Generator Circuit Breaker Closed	6, 31
	3577	Loss of Utility	31

Category	SPN	Suspect Parameter	Supported FMI Trigger Conditions
Custom Events	701	Digital Input #1 Custom Event	31
	702	Digital Input #2 Custom Event	31
	703	Digital Input #3 Custom Event	31
	704	Digital Input #4 Custom Event	31
	705	Digital Input #5 Custom Event	31
	706	Digital Input #6 Custom Event	31
	707	Digital Input #7 Custom Event	31
	708	Digital Input #8 Custom Event	31
	1083	Analog Input #1 Custom Parameter	0, 1, 6, 15, 17
	1084	Analog Input #2 Custom Parameter	0, 1, 6, 15, 17
	4158	Analog Input #3 Custom Parameter	0, 1, 6, 15, 17
	4157	Analog Input #4 Custom Parameter (EMCP 4.4 only)	0, 1, 6, 15, 17

Table 12.3 – Supported Output System Event SPN and FMI Trigger Conditions

12.1.5 Digital/Relay Output System Event Descriptions

Below is a brief description of the purpose of each system event digital/relay output option:

Engine Oil Pressure

- Activates when an engine oil pressure event (SPN 100) is triggered in the EMCP event log.

Gas Pressure

- Activates when a gas pressure event (SPN 1390) is triggered in the EMCP event log.

Engine Coolant Temperature

- Activates when an engine coolant temperature event (SPN 110) is triggered in the EMCP event log.

Engine Oil Temperature

- Activates when an engine oil temperature event (SPN 175) is triggered in the EMCP event log.

Exhaust Temperature

- Activates when an exhaust temperature event (SPN 173) is triggered in the EMCP event log.

Generator Rear Bearing Temperature

- Activates when a generator rear bearing temperature event (SPN 1122) is triggered in the EMCP event log.

Generator Winding #1 Temperature

- Activates when a generator winding #1 temperature event (SPN 1124) is triggered in the EMCP event log.

Engine Coolant Level

- Activates when an engine coolant level event (SPN 111) is triggered in the EMCP event log.

Engine Oil Level

- Activates when an engine oil level event (SPN 98) is triggered in the EMCP event log.

Fuel Level

- Activates when a fuel level event (SPN 96) is triggered in the EMCP event log.

External Fuel Level
- Activates when an external fuel level event (SPN 38) is triggered in the EMCP event log.

Any Suspect Parameter Number
- Activates when any suspect parameter number is triggered in the EMCP event log.

Accessory Data Link
- Activates when an accessory data link diagnostic (SPN-FMI: 1231-11) is triggered in the EMCP event log.

Battery Charging System Voltage
- Activates when a battery charging system voltage event (SPN-FMI: 167-17) is triggered in the EMCP event log.

Battery Voltage
- Activates when a battery voltage event (SPN 168) is triggered in the EMCP event log.

Auxillary Engine Shutdown Switch
- Activates when an auxiliary engine shutdown switch event (SPN 970) is triggered in the EMCP event log.

Engine In Cooldown
- Activates when an engine in cooldown event (SPN 4006) is triggered in the EMCP event log.

Engine Failure To Start
- Activates when an engine fail to start event (SPN 1664) is triggered in the EMCP event log.

Engine Speed
- Activates when an engine speed event (SPN 190) is triggered in the EMCP event log.

Generator Control Not In Automatic
- Activates when a generator control not in auto event (SPN 4007) is triggered in the EMCP event log.

Generator Current (Amp)
- Activates when a generator current event (SPN 2448) is triggered in the EMCP event log.

Generator Output Frequency
- Activates when a generator output frequency event (SPN 2436) is triggered in the EMCP event log.

Generator Output Power (kW)
- Activates when a generator output power (kW) event (SPN 2452) is triggered in the EMCP event log.

Generator Output Voltage
- Activates when a generator output voltage event (SPN 2440) is triggered in the EMCP event log.

Primary Data Link
- Activates when a primary data link diagnostic (SPN 639) is triggered in the EMCP event log.

SCADA Data Link
- Activates when a SCADA data link diagnostic (SPN 3581) is triggered in the EMCP event log.

Service Maintenance Interval Expired
- Activates when a service maintenance interval expired event (SPN 2648) is triggered in the EMCP event log.

Unexpected Engine Shutdown
- Activates when an unexpected engine shutdown event (SPN 1383) is triggered in the EMCP event log.

Earth Fault
- Activates when an earth fault event (SPN 4028) is triggered in the EMCP event log.

Earth Leakage
- Activates when an earth leakage event (SPN 4029) is triggered in the EMCP event log.

Engine Controller
- Activates when an engine controller diagnostic (SPN 3543) is triggered in the EMCP event log.

Fuel Leak
- Activates when a fuel leak event (SPN 1239) is triggered in the EMCP event log.

Air Damper Closed
- Activates when an air damper closed event (SPN 4000) is triggered in the EMCP event log.

Battery Charger Failure
- Activates when a battery charger failure event (SPN 4003) is triggered in the EMCP event log.

Generator Circuit Breaker Open
- Activates when a generator circuit breaker open event (SPN 4013) is triggered in the EMCP event log.

Generator Circuit Breaker Closed
- Activates when a generator circuit breaker closed event (SPN 4004) is triggered in the EMCP event log.

Digital Input #N Custom Event
- Activates when a digital input #N custom event (SPN 701 to 708) is triggered in the EMCP event log.

Analog Input #N Custom Event
- Activates when an analog input #N custom event (SPN 1083, 1084, 4158, 4157) is triggered in the EMCP event log

Engine Fluid Bund Level
- Activates when there is a high bund level warning or shutdown present or active

Loss of Utility
- Activates when there is a loss of utility present

12.1.6 Configuring Digital Outputs for SCADA Data Link

When a Digital Output is configured for SCADA Data Link, an active state will be sent to the output over MODBUS communications . No alarms or warnings will be generated by the EMCP . To configure a Digital Output for SCADA Data Link, go through the following menu options:

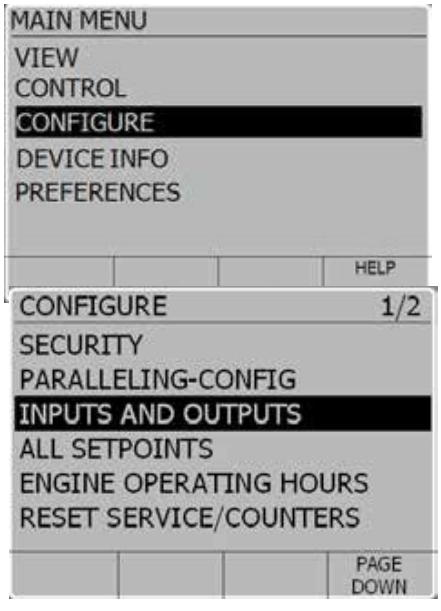
1. AT THE MAIN MENU, scroll down  TO CONFIGURE.

2. Press the OK KEY .

3. SCROLL DOWN  to INPUTS & OUTPUTS.

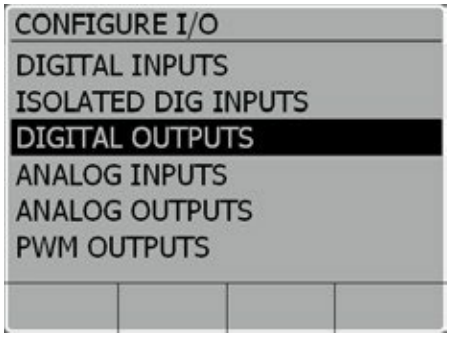
4. Press the OK KEY .

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS .



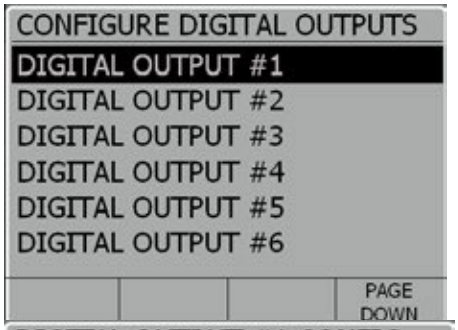
5. SCROLL DOWN  to DIGITAL OUTPUTS.

6. Press the OK KEY .

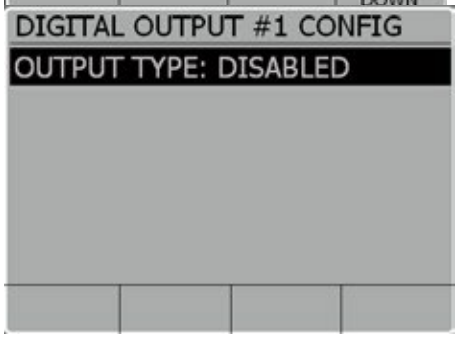


7. Select the DIGITAL OUTPUT that you want to program.

8. Press the OK KEY .

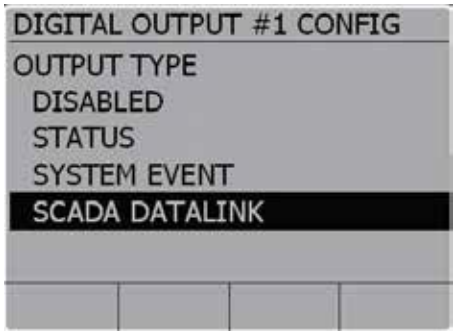


9. Press the OK KEY  to highlight the current configuration (DISABLED, COMMAND/STATUS, SYSTEM EVENT, OR SCADA DATA LINK).



10. Scroll DOWN  to SCADA DATA LINK.

11. Press the OK KEY .



12.1.7 Disabling Digital Outputs

To disable a Digital Output, go through the following menu options:

1. AT THE MAIN MENU, scroll down TO CONFIGURE.

2. Press the OK KEY.

3. SCROLL DOWN to INPUTS & OUTPUTS.

4. Press the OK KEY.

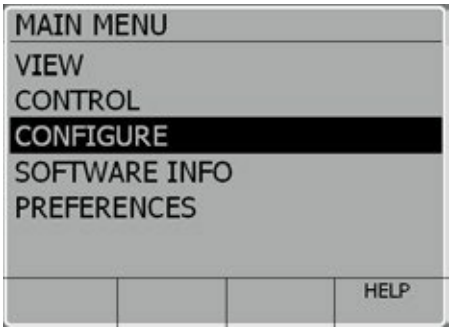
Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.

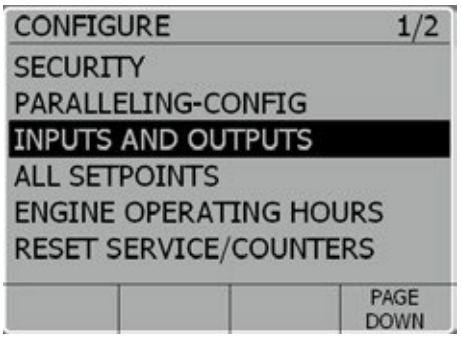
5. SCROLL DOWN to DIGITAL OUTPUTS.

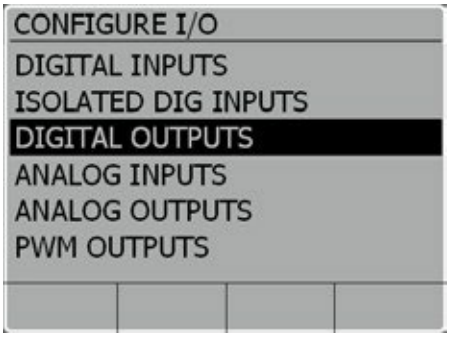
6. Press the OK KEY.

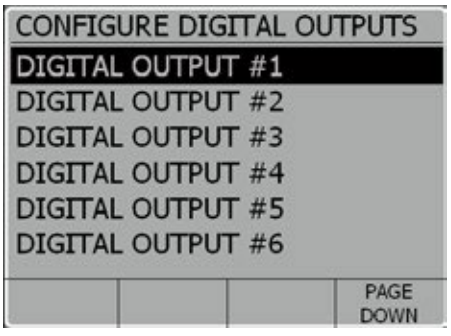
7. Select the DIGITAL OUTPUT that you want to program.

8. Press the OK KEY.

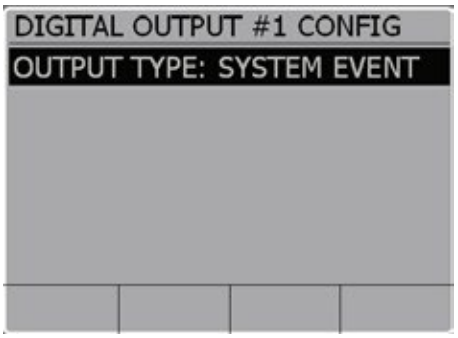






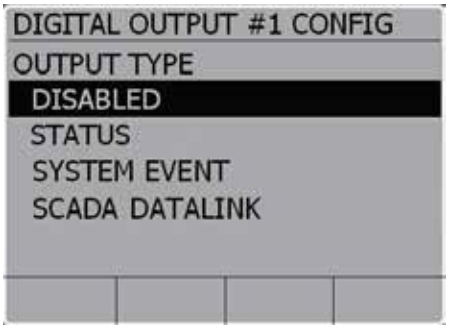


9. Press the OK KEY  to highlight the current configuration (DISABLED, COMMAND/STATUS, SYSTEM EVENT, OR SCADA DATA LINK).



10. Scroll DOWN  to DISABLED.

11. Press the OK KEY .

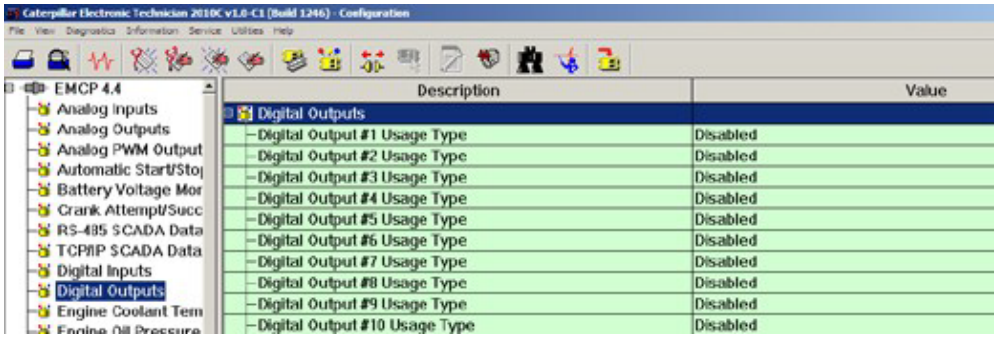


12.2 Programming Digital Outputs Using the Cat Service Tool

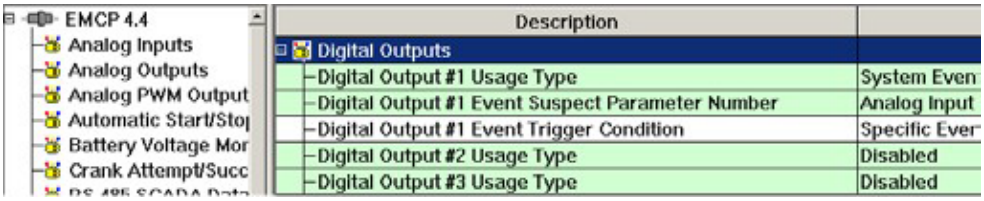
The EMCP 4 Digital Outputs can be configured by using the Cat Service Tool. The key to programming them is to program the setpoints related to each output in order from top to bottom. To program a Digital Output, do the following steps:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

2. Select Digital Outputs on the left.



3. Determine which Digital Output is to be configured. For example, all of the setpoints for Digital Output #1 have the text “#1” in their name.



4. Next follow the steps below according to which Usage Type is desired.

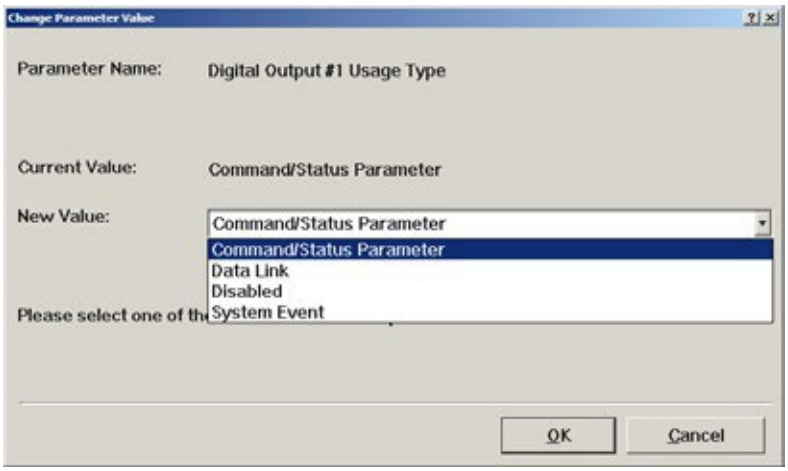
12.2.1 Configuring Digital Outputs for Status Parameters

Command or Status parameters are used to control specific functions within the control system or to make certain conditions within the system be known.

Note: The Fuel Control Relay does not pickup when the Engine Operating State is set to CAN. Engine Start Initiated can be used in Lieu of the Fuel Control Relay for most purposes.

To configure a Digital Output as a Command or Status Parameter, go through the following menu options:

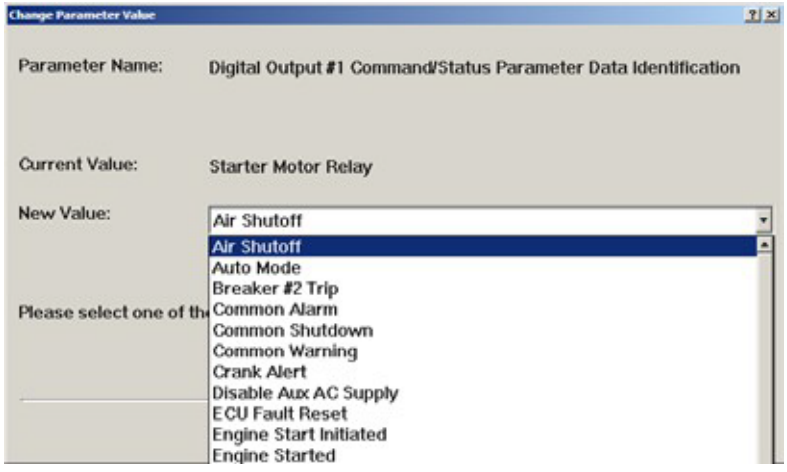
1. Double click the Digital Output #N Usage type to change this value to Command/Status Parameter from the drop down menu. Click the OK button to program.



2. The Digital Output #N Command/Status Parameter Data Identification parameter will now be visible in the right pane.

Description	Value
Digital Outputs	
Digital Output #1 Usage Type	Command/Status Parameter
Digital Output #1 Command/Status Parameter Data Identification	Starter Motor Relay

3. Double click the Configure the Command/Status Parameter Data Identification setpoint to change this value from the drop down menu. Click the OK button to program.

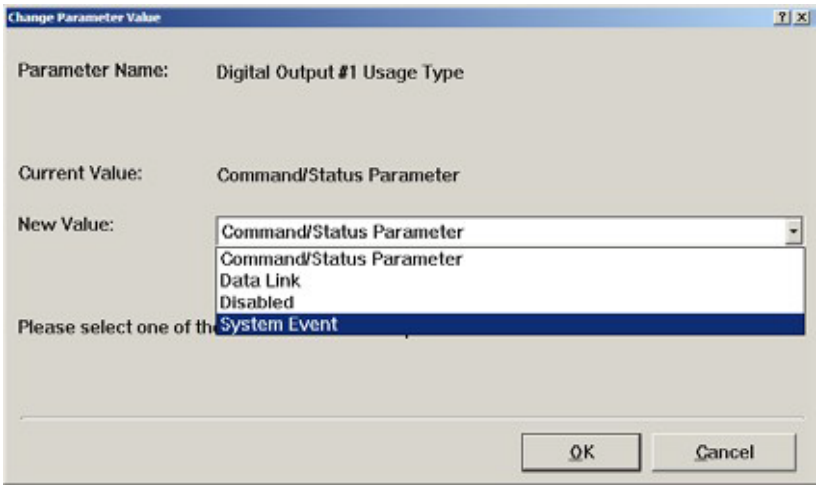


See Table 12.1 for a complete list of possible Command/Status Parameter Data Identifications.

12.2.2 Configuring Digital Outputs for System Events

System Events are used to know when specific conditions are reached and to alert the control system of warning or shutdown conditions. To configure a Digital Output as a System Event, go through the following menu options:

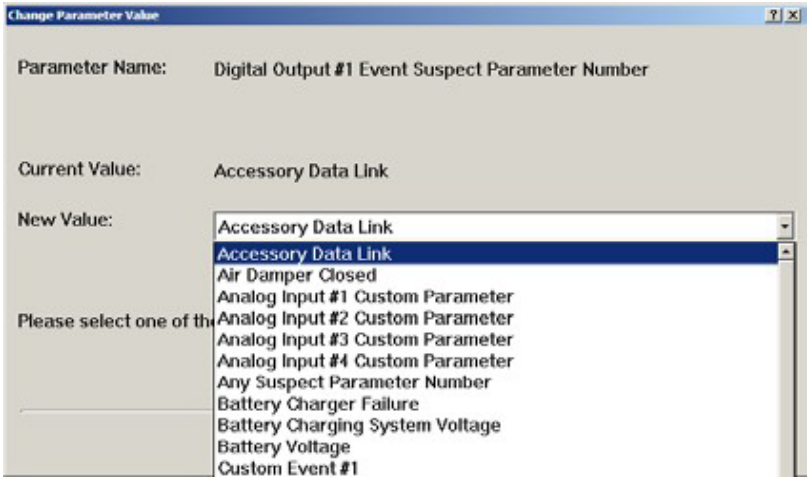
1. Double click the Digital Output #N Usage Type to change this value to System Event from the drop down menu. Click the OK button to program.



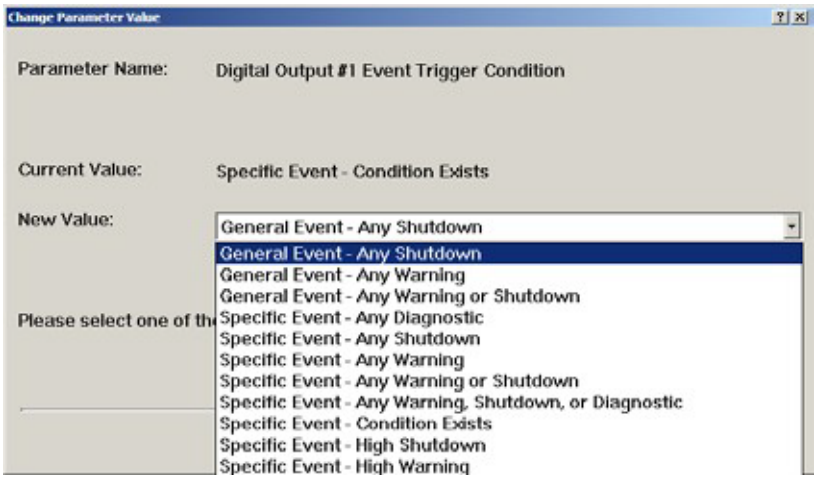
2. The Digital Output #N Suspect Parameter Number (SPN) and Event Trigger Condition parameters will now be visible in the right pane.

Description	Value
Digital Outputs	
Digital Output #1 Usage Type	System Event
Digital Output #1 Event Suspect Parameter Number	Analog Input #4 Custom Parameter
Digital Output #1 Event Trigger Condition	Specific Event - Condition Exists

3. Double click the Digital Output #N Suspect Parameter Number (SPN) setpoint to change this value from the drop down menu. Click the OK button to program.



4. Double click the Digital Output #N Event Trigger Condition setpoint to change this value from the drop down menu. Click the OK button to program.

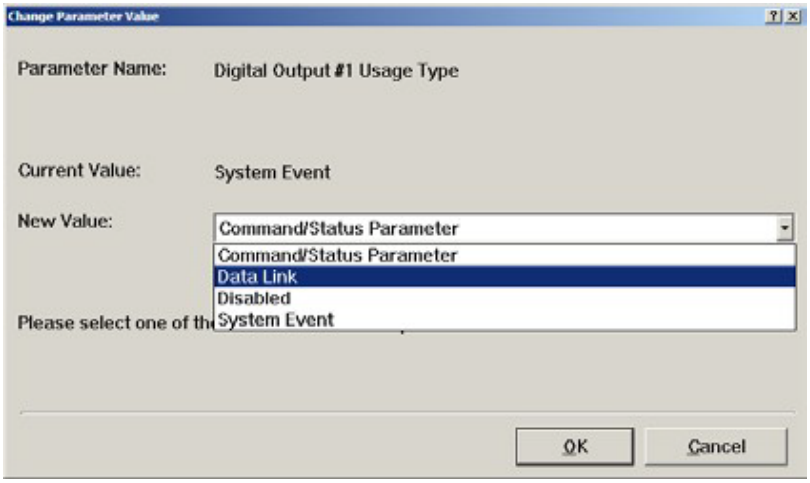


See Table 12.2 for a complete list of possible System Events.

12.2.3 Configuring Digital Outputs for SCADA Data Link

When a Digital Output is configured for SCADA Data Link, an active state will be sent over MODBUS. No alarms or warnings will be generated by the EMCP. To configure a Digital Output for SCADA Data Link, go through the following menu options:

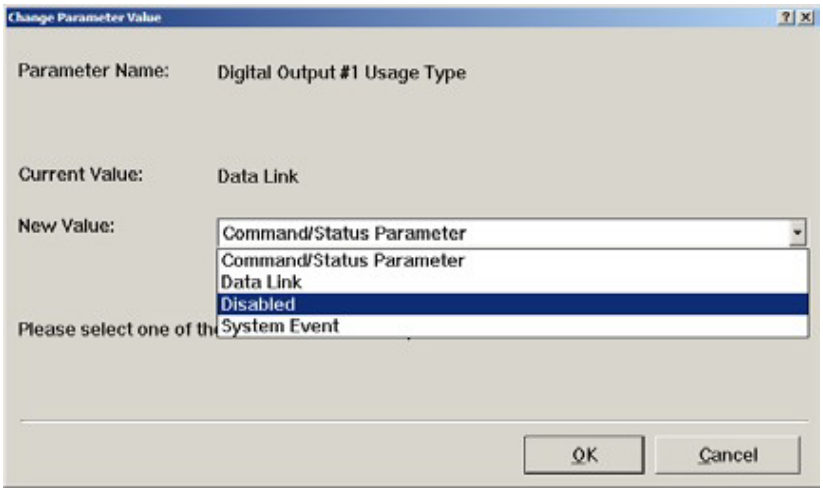
1. Double click the Digital Output #N Usage type to change this value to Data Link from the drop down menu. Click the OK button to program.



12.2.4 Disabling Digital Outputs

To disable a Digital Output, go through the following menu options:

1. Double click the Digital Output #N Usage type to change this value to Disabled from the drop down menu. Click the OK button to program.



13.0 Analog Outputs

The EMCP 4.3 and 4.4 support three 2-wire (plus shield) fully individually isolated Analog Output channels (individually switchable for 0 to 20mA current) or analog voltage -10 to 0 to +10VDC.

Full resolution, with a minimum of 8 bits (256 points) of data, is supported -10 to +10VDC, -3 to +3VDC, 0-5VDC, along with equivalent current ranges (0 to 20 mA).

Configurable Analog Outputs can be configured to two different types: voltage or current. The hardware limitations are: -10V to +10V for voltage, 0 to 20 mA for current. Refer to Table 13.1 for the valid configuration ranges.

Current Sender Ranges	Voltage Sender Ranges
0 to 20mA 4 to 20mA 0 to 10mA	0 to 5V 1 to 5V 0 to 10V -3 to +3V -2.5 to +2.5V -5 to +5V -10 to +10V 0.5 to 4.5V -1 to +1V

Table 13.1 – Analog Output Configuration Ranges

If a load share module is installed, and an Analog Output is used as a requested speed signal, set a Digital Output to RATED SPEED and wire the correct relay contact to the load share module Idle/Rated Ramp input. Check the load share module input to determine which style contact is required.

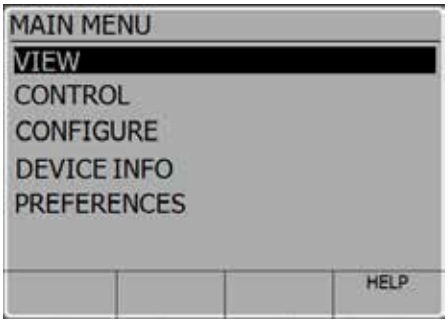
13.1 Programming Analog Outputs Using the Display

13.1.1 Viewing the Current Analog Output Status

To view the current status of an Analog Output, go through the following menu options:

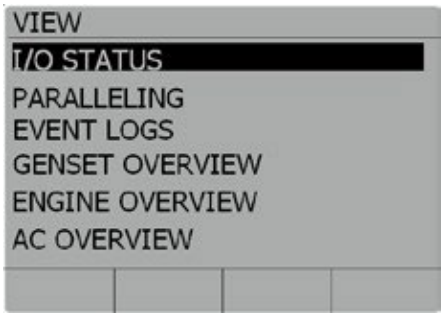
1. AT THE MAIN MENU, scroll DOWN  TO VIEW.

2. Press the OK KEY .



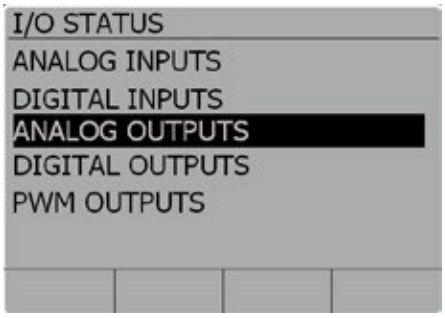
3. Scroll DOWN  to I/O STATUS.

4. Press the OK KEY .



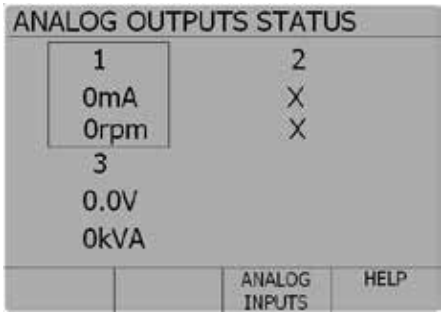
5. Scroll DOWN  to access ANALOG OUTPUTS.

6. Press the OK KEY .



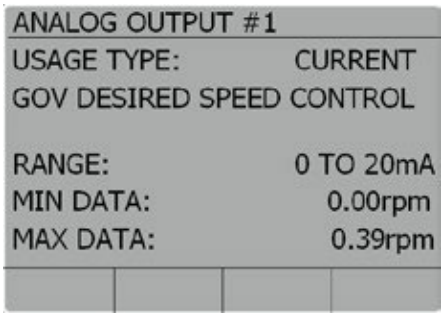
7. The status of all Analog Outputs is shown.

A dash under an output number indicates an output that is programmed, but inactive. A large "X" under an output number indicates an output that is disabled. A number under an output number indicates an output that is programmed and active.



8. With the LEFT ARROW  or RIGHT ARROW , select the ANALOG OUTPUT that you want to view, then press the OK KEY .

The programmed Usage Type, Range, Min Data, and Max Data of the selected Analog output are shown.

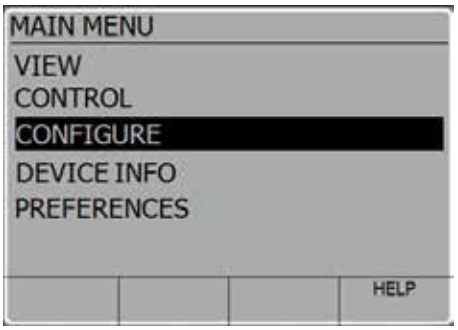


13.1.2 Configuring Analog Outputs for Voltage Mode

To configure an Analog Output for Voltage mode using the EMCP 4 display, go through the following menu options:

1. AT THE MAIN MENU, scroll down TO CONFIGURE.

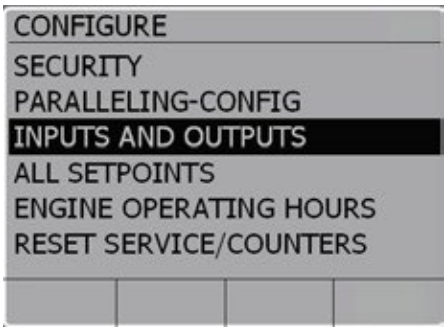
2. Press the OK KEY.



3. SCROLL DOWN to INPUTS & OUTPUTS.

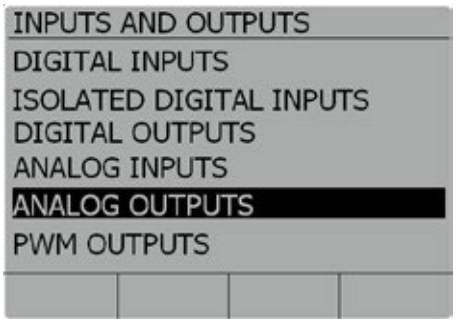
4. Press the OK KEY.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



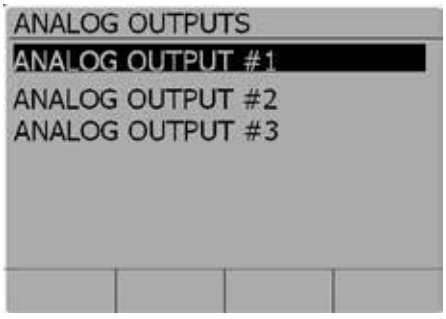
5. Scroll DOWN to ANALOG OUTPUTS.

6. Press the OK KEY.

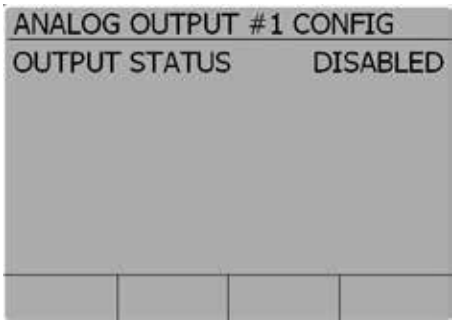


7. Select the ANALOG OUTPUT that you want to program.

8. Press the OK KEY.

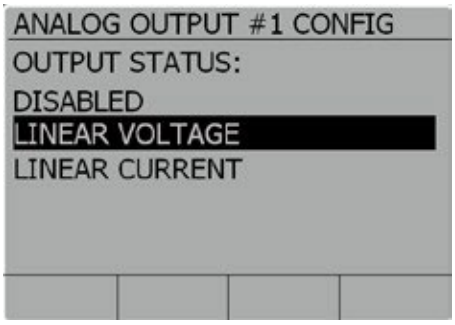


9. Press the OK KEY to highlight the current OUTPUT TYPE (DISABLED, LINEAR VOLTAGE, AND OR LINEAR CURRENT).



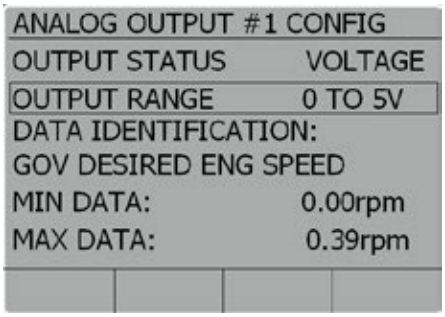
10. Scroll DOWN to select VOLTAGE.

11. Press the OK KEY.



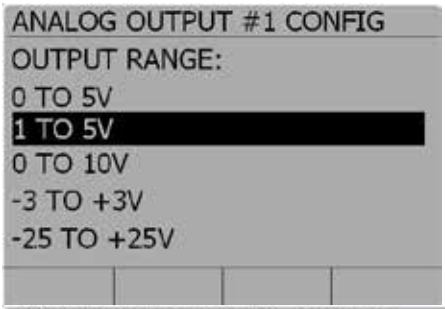
12. Scroll DOWN to OUTPUT RANGE.

13. Press the OK KEY.



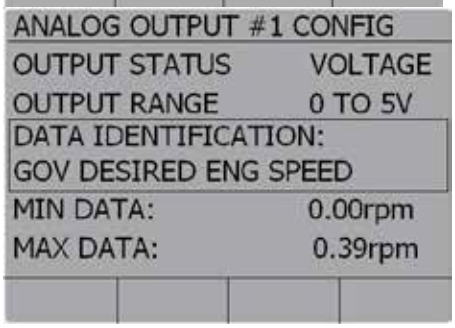
14. Select the OUTPUT RANGE that you want (see Table 13.1).

15. Press the OK KEY.



16. Scroll DOWN to DATA IDENTIFICATION.

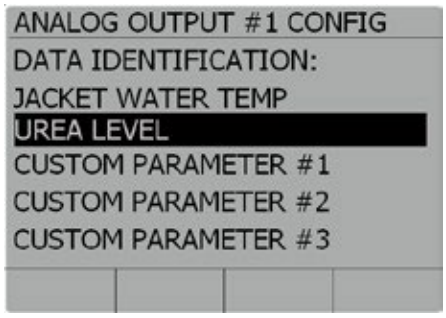
17. Press the OK KEY to edit the current DATA IDENTIFICATION.



18. Select the type of DATA IDENTIFICATION that you want to program.

19. Press the OK KEY 

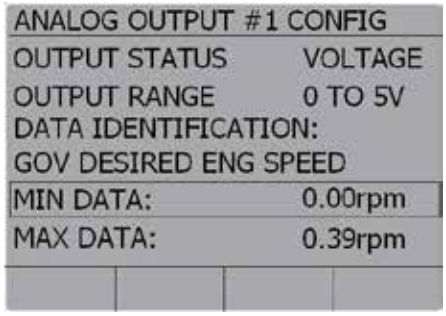
.



20. Scroll DOWN  to MIN DATA.

21. Press the OK KEY 

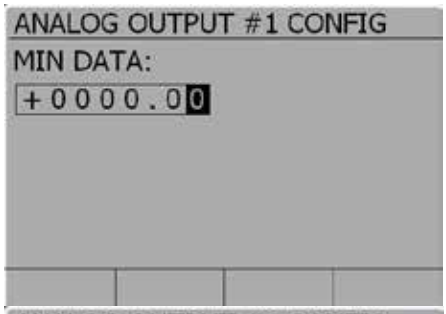
to edit the current MIN DATA.



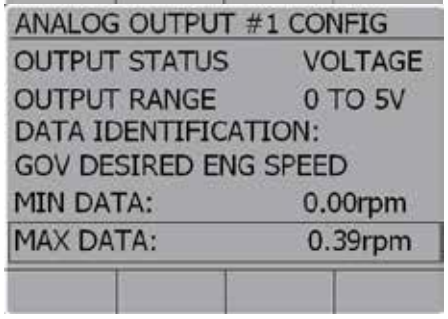
22. Select the MIN DATA that you want to program.

23. Press the OK KEY 

.



24. Scroll DOWN  to MAX DATA.



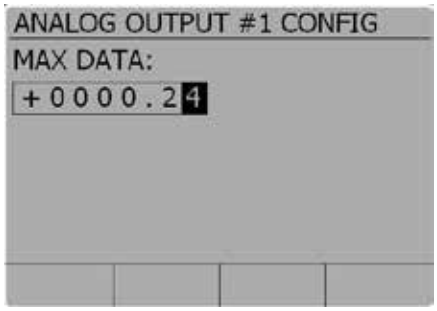
25. Press the OK KEY 

to edit the current MAX DATA.

26. Select the MAX DATA that you want to program.

27. Press the OK KEY 

.

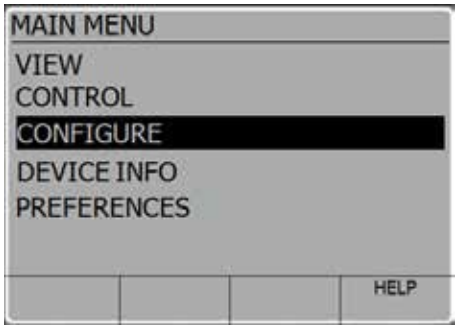


13.1.3 Configuring Analog Outputs for Current Mode

To configure an Analog Output for Current mode using the EMCP 4 display, go through the following menu options:

1. AT THE MAIN MENU, scroll down TO CONFIGURE.

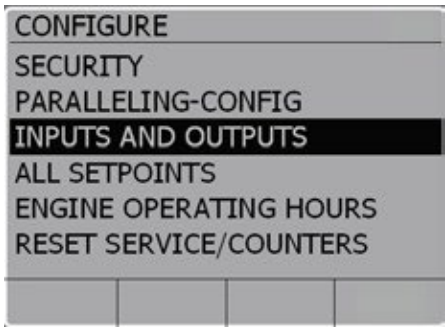
2. Press the OK KEY.



3. SCROLL DOWN to INPUTS & OUTPUTS.

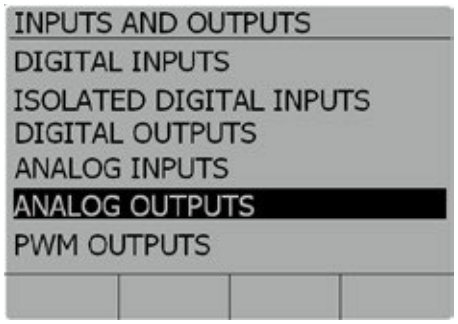
4. Press the OK KEY.

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



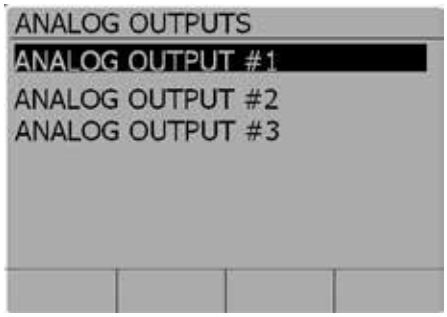
5. Scroll DOWN to ANALOG OUTPUTS.

6. Press the OK KEY.

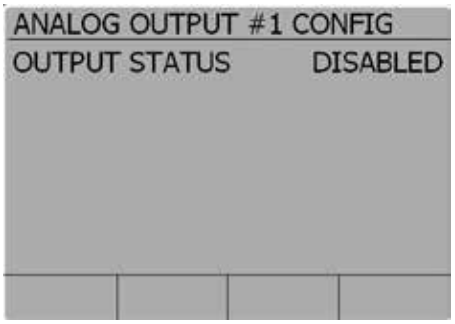


7. Select the ANALOG OUTPUT that you want to program.

8. Press the OK KEY.

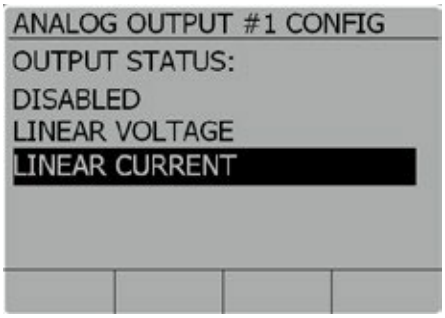


9. Press the OK KEY to highlight the current OUTPUT TYPE (DISABLED, LINEAR VOLTAGE, OR LINEAR CURRENT).



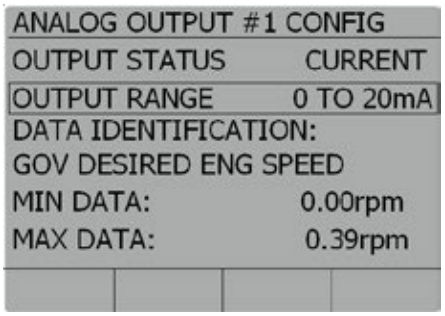
10. Scroll DOWN to select CURRENT.

11. Press the OK KEY.



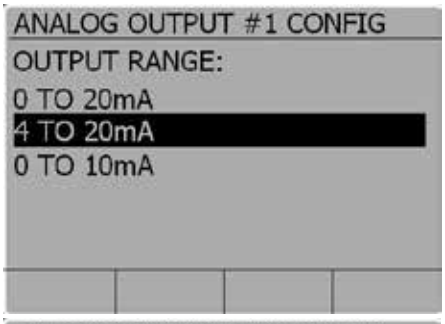
12. Scroll DOWN to OUTPUT RANGE.

13. Press the OK KEY.



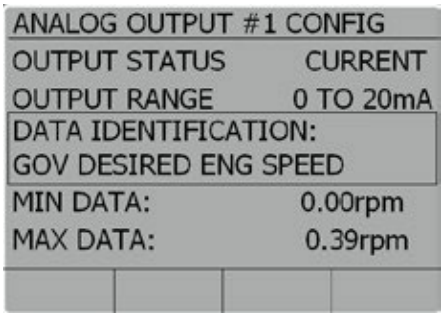
14. Select the OUTPUT RANGE that you want (see Table 13.1).

15. Press the OK KEY.



16. Scroll DOWN to DATA IDENTIFICATION.

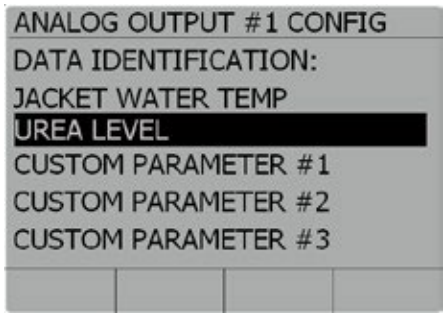
17. Press the OK KEY to edit the current DATA IDENTIFICATION.



18. Select the type of DATA IDENTIFICATION that you want to program.

19. Press the OK KEY 

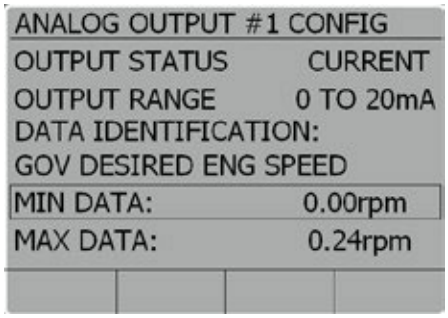
.



20. Scroll DOWN  to MIN DATA.

21. Press the OK Key 

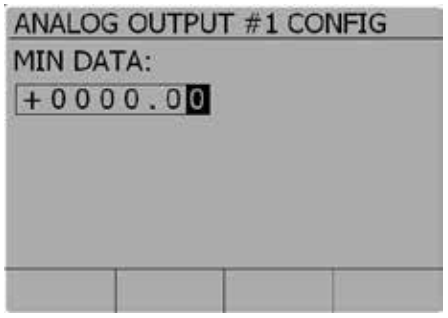
to edit the current MIN DATA.



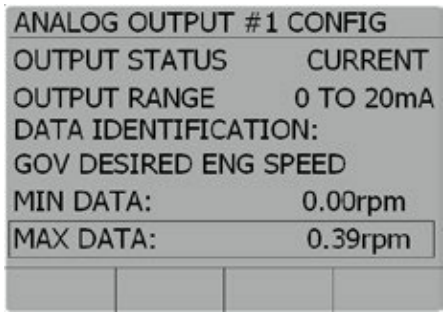
22. Select the MIN DATA that you want to program.

23. Press the OK KEY 

.



24. Scroll DOWN  to MAX DATA.



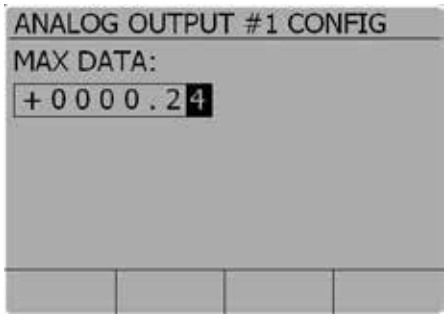
25. Press the OK KEY 

to edit the current MAX DATA.

26. Select the MAX DATA that you want to program.

27. Press the OK KEY 

.



Any Analog Output can be configured for any one of the Data Identifications in Table 13.2:

Data Identifications	
GOV DESIRED ENG SPEED	AVG PHASE CURRENT
AVR DESIRED VOLTAGE	ENGINE SPEED
GEN REAL POWER	ENGINE COOLANT TEMP
GEN REACTIVE POWER	UREA LEVEL
GEN APPARENT POWER	CUSTOM PARAMETER #1
GEN PF	CUSTOM PARAMETER #2
ENG OIL TEMP	CUSTOM PARAMETER #3
GEN FREQUENCY	CUSTOM PARAMETER #4 (4.4 Only)
GEN CURRENT PHASE A	GEN WINDING TEMP PHASE A
GEN CURRENT PHASE B	GEN WINDING TEMP PHASE B
GEN CURRENT PHASE C	GEN WINDING TEMP PHASE C
GEN L-N VOLT PHASE A	GEN FRT BEARING TEMP
GEN L-N VOLT PHASE B	GEN REAR BEARING TEMP
GEN L-N VOLT PHASE C	OUTPUT FROM SCADA
GEN L-L VOLT PHASE A-B	ENGINE FUEL LEVEL
GEN L-L VOLT PHASE B-C	ENGINE OIL PRESSURE
GEN L-L VOLT PHASE C-A	EXT TANK FUEL LEVEL
GEN AVG L-N VOLTAGE	FUEL PRESSURE
GEN AVG L-L VOLTAGE	GAS BLENDING PERCENTAGE

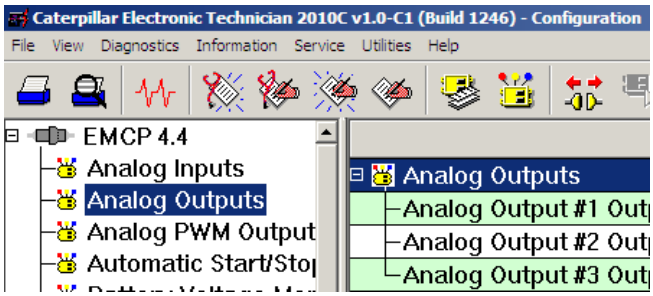
Table 13.2 – Analog Output Data Identifications List

13.2 Programming Analog Outputs Using the Cat Service Tool

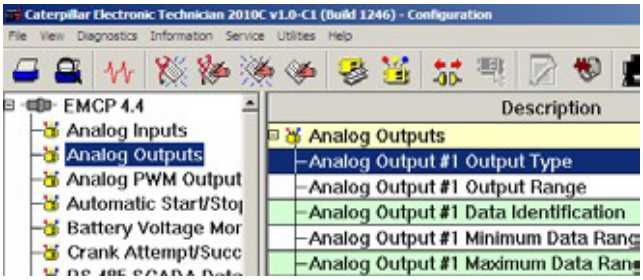
The EMCP 4 Analog Outputs can be configured by using the Cat Service Tool. The key to programming them is to program the setpoints related to each output in order from top to bottom. To program an Analog Output, do the following steps:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

2. Select Analog Outputs on the left.



3. Determine which Analog Output is to be configured. For example, all of the setpoints for Analog Output #1 have the text “#1” in their name.

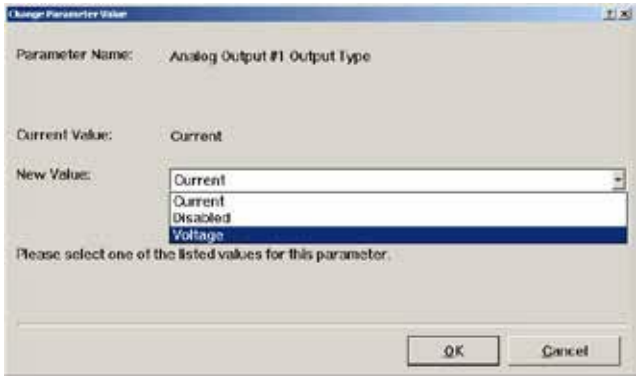


4. Next follow the steps below according to which Usage Type is desired.

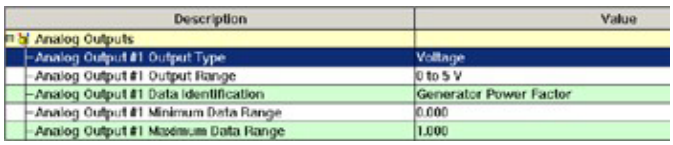
13.2.1 Configuring Analog Outputs for Voltage Mode

To configure an Analog Output for Voltage mode, go through the following menu options:

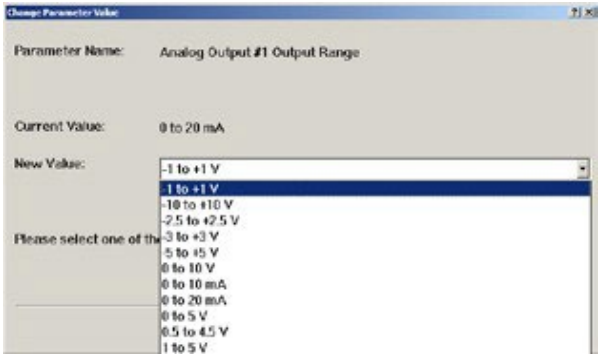
1. Double click the Analog Output #N Output Type to change this value to Voltage from the drop down menu. Click the OK button to program.



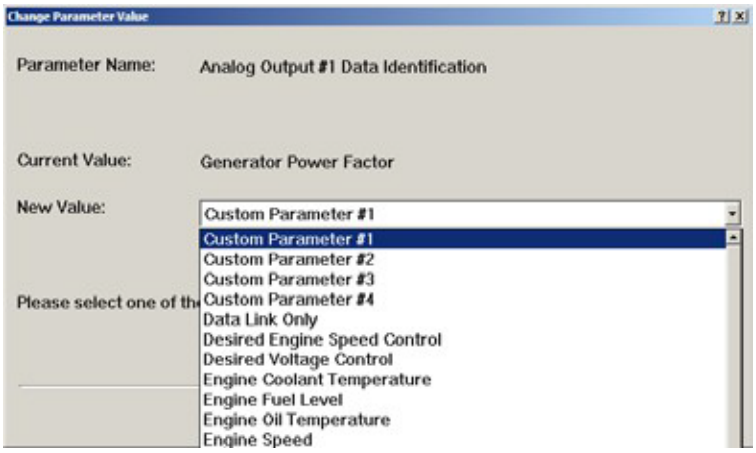
2. The remaining Analog Output #N Voltage parameters will now be visible in the right pane.



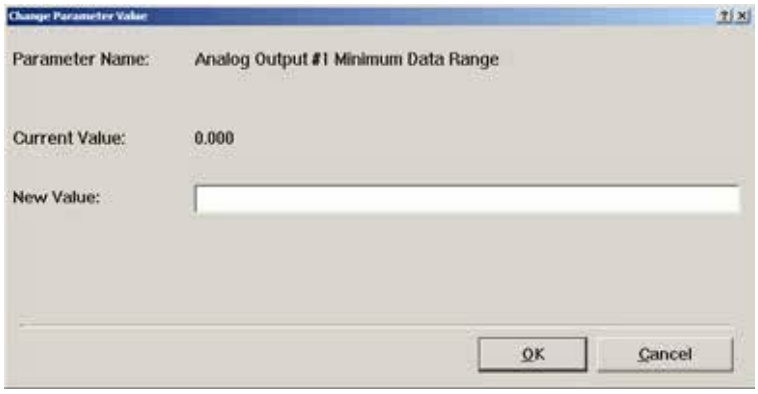
3. Double click the Analog Output #N Output Range to change this value from the drop down menu. Click the OK button to program.



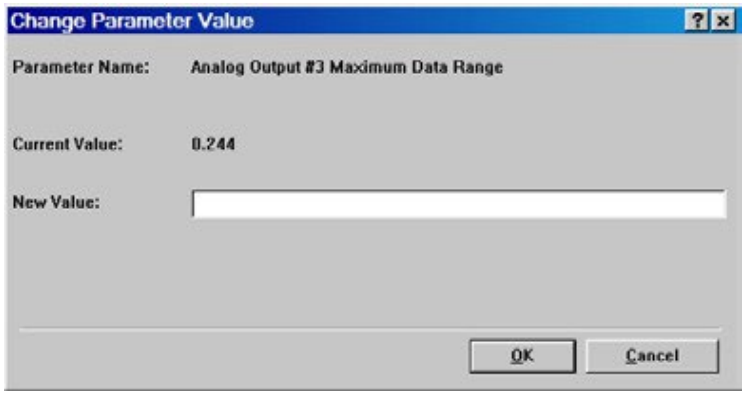
4. Double click the Analog Output #N Data Identification to change this value from the drop down menu. Click the OK button to program.



5. Double click the Analog Output #N Minimum Data Range to change this value. Click the OK button to program.



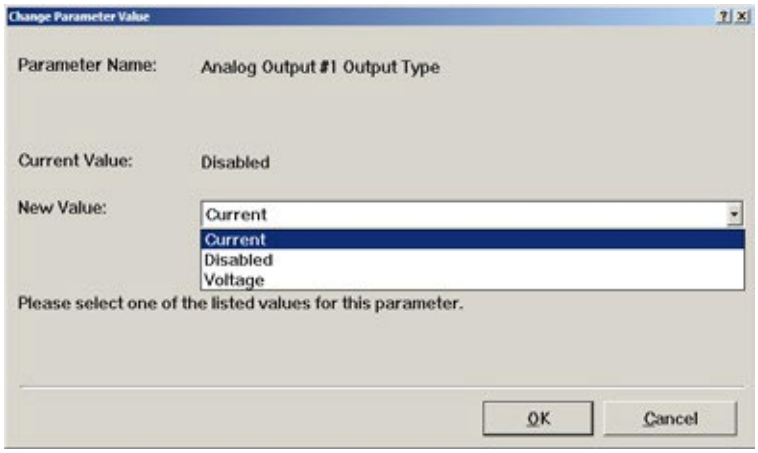
6. Double click the Analog Output #N Maximum Data Range to change this value. Click the OK button to program.



13.2.2 Configuring Analog Outputs for Current Mode

To configure an Analog Output for Current mode, go through the following menu options:

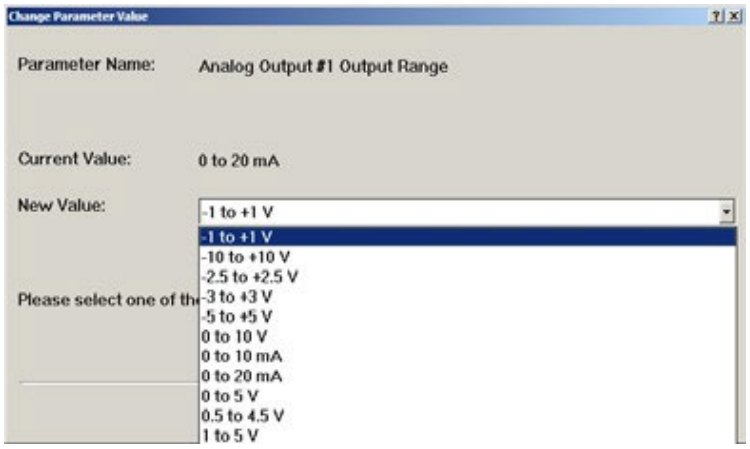
1. Double click the Analog Output #N Output Type to change this value to Current from the drop down menu. Click the OK button to program.



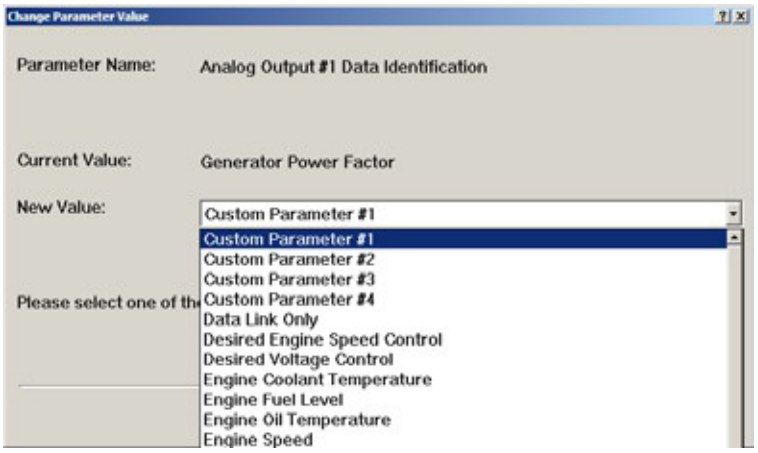
2. The remaining Analog Output #N Current parameters will now be visible in the right pane.

Description	Value
Analog Outputs	
Analog Output #1 Output Type	Current
Analog Output #1 Output Range	0 to 20 mA
Analog Output #1 Data Identification	Generator Power Factor
Analog Output #1 Minimum Data Range	0.000
Analog Output #1 Maximum Data Range	1.000

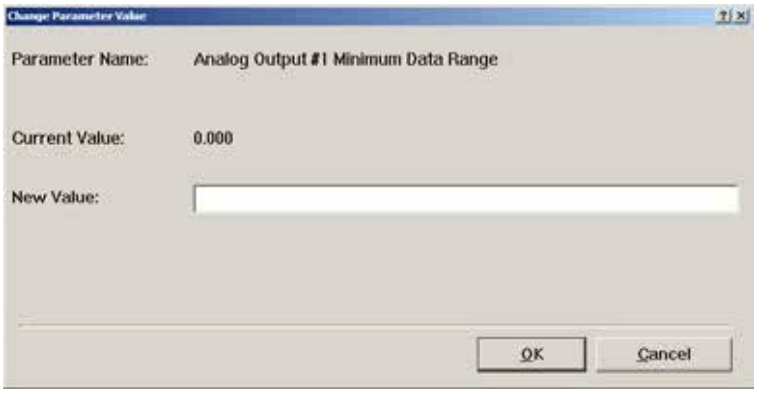
3. Double click the Analog Output #N Output Range to change this value from the drop down menu. Click the OK button to program.



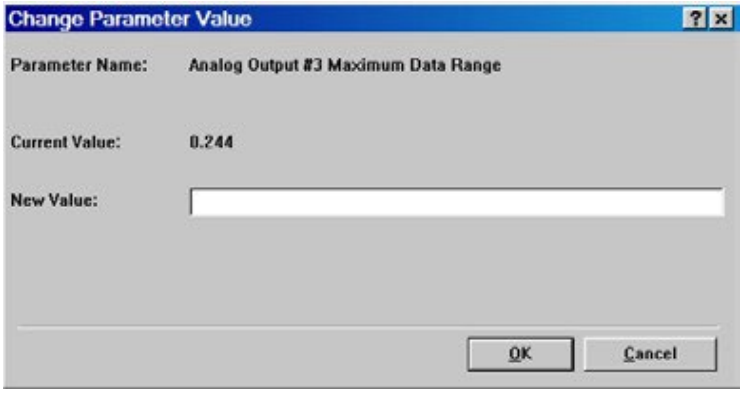
4. Double click the Analog Output #N Data Identification to change this value from the drop down menu. Click the OK button to program.



5. Double click the Analog Output #N Minimum Data Range to change this value. Click the OK button to program.



6. Double click the Analog Output #N Maximum Data Range to change this value. Click the OK button to program.



14.0 PWM Outputs

The EMCP 4.3 and 4.4 support two 2-wire (plus shield) fully individually isolated analog PWM output channels.

The PWM outputs can be configured for one of two different ranges: 0 to 100%, or 5 to 95%. The data range is configurable and should be set to the generator voltage. The output signal is ~6V peak.

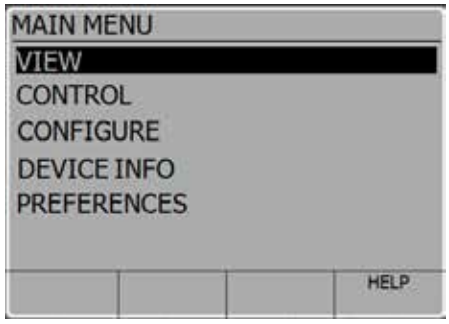
14.1 Programming PWM Outputs Using the Display

14.1.1 Viewing the Current PWM Output Status

To view the current status of a PWM Output, go through the following menu options:

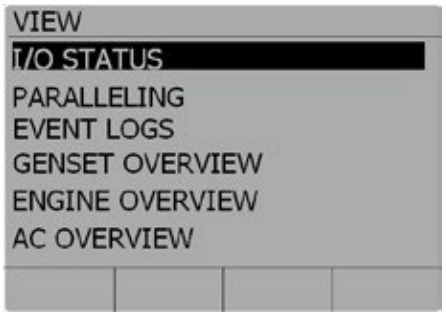
1. AT THE MAIN MENU, scroll DOWN TO VIEW.

2. Press the OK KEY.



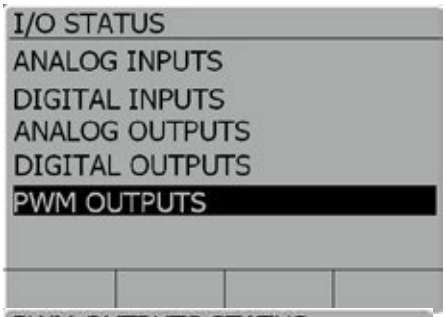
3. Scroll DOWN to I/O STATUS.

4. Press the OK KEY.

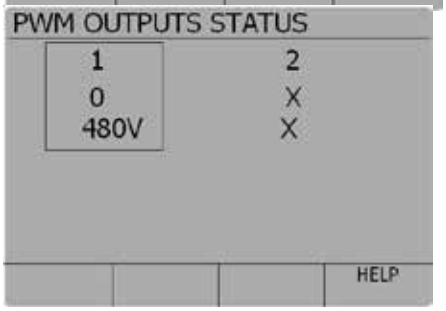


5. Scroll DOWN to access PWM OUTPUTS.

6. Press the OK KEY.



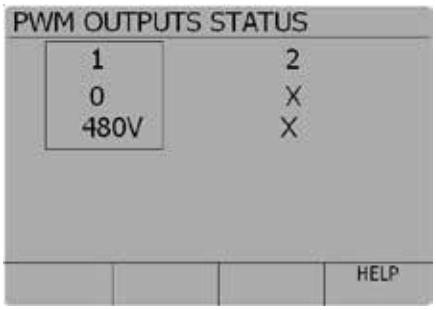
7. The status of all PWM Outputs is shown.



A dash under an output number indicates an output that is programmed, but inactive. A large “X” under an output number indicates an output that is disabled. A number under an output number indicates an output that is programmed and active.

8. With the LEFT ARROW  or RIGHT ARROW , select the PWM OUTPUT that you want to view, then press the OK KEY .

9. The programmed Status, Usage Type, Range, Min Data, and Max Data of the selected Analog output are shown.

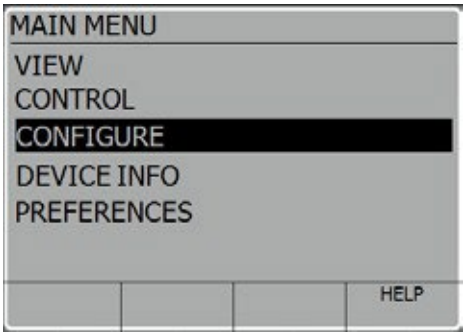


14.1.2 Configuring PWM Outputs

To configure a PWM Output using the EMCP 4 display, go through the following menu options:

1. AT THE MAIN MENU, scroll down  TO CONFIGURE.

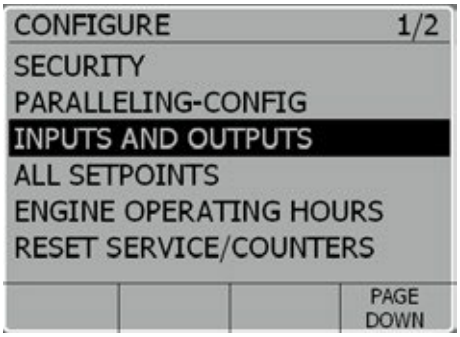
2. Press the OK KEY .



3. SCROLL DOWN  to INPUTS & OUTPUTS.

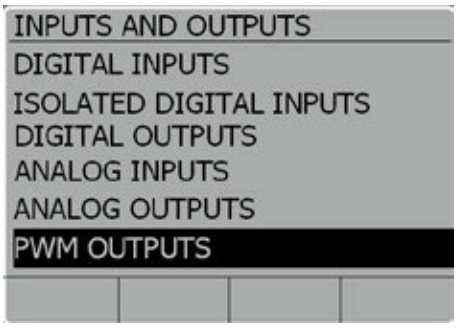
4. Press the OK KEY .

Alternately, access to THE INPUTS & OUTPUTS submenu is accessible from ALL SETPOINTS.



5. Scroll DOWN  to PWM OUTPUTS.

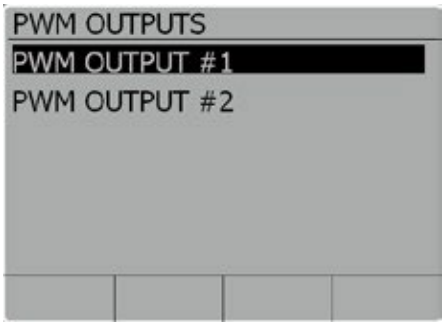
6. Press the OK KEY .



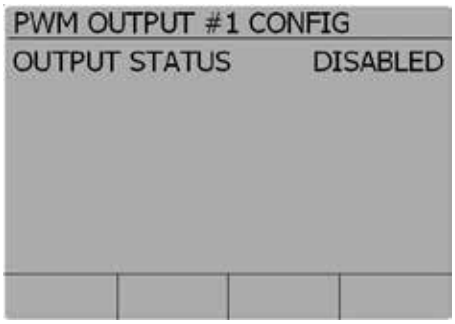
7. Select the PWM OUTPUT that you want to program.

8. Press the OK KEY 

.



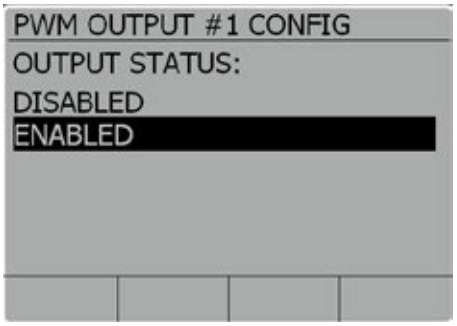
9. Press the OK KEY to highlight the current Output Type (DISABLED, OR ENABLED).



10. Scroll DOWN  to select the desired OUTPUT TYPE.

11. Press the OK KEY 

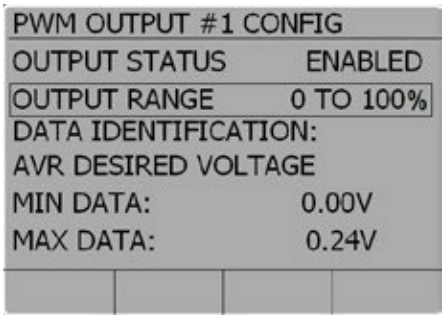
.



12. Scroll DOWN  to OUTPUT RANGE.

13. Press the OK KEY 

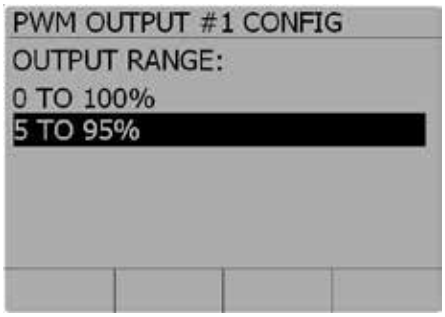
.



14. Select the OUTPUT RANGE that you want (0-100%, or 5-95%).

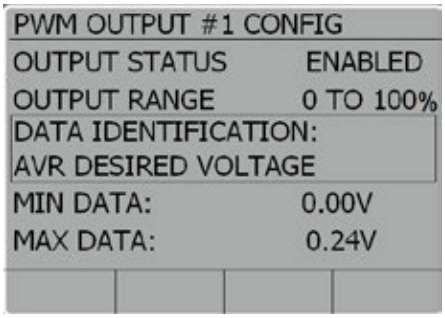
15. Press the OK KEY 

.



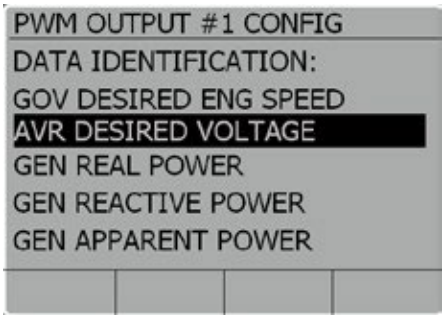
16. Scroll DOWN to DATA IDENTIFICATION.

17. Press the OK KEY to edit the current DATA IDENTIFICATION.



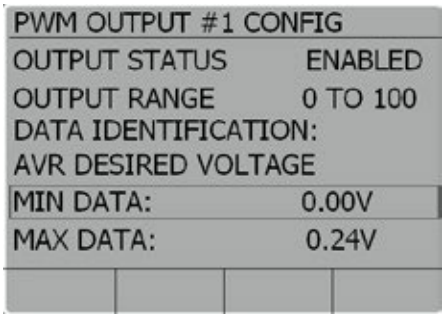
18. Select the type of DATA IDENTIFICATION that you want to program.

19. Press the OK KEY.



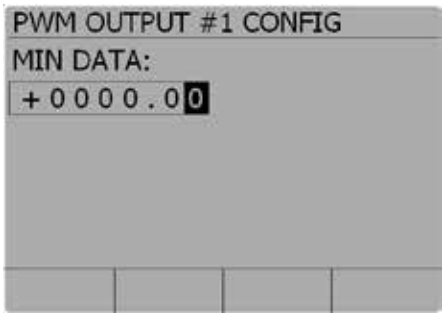
20. Scroll DOWN to MIN DATA.

21. Press the OK KEY to edit the current MIN DATA.



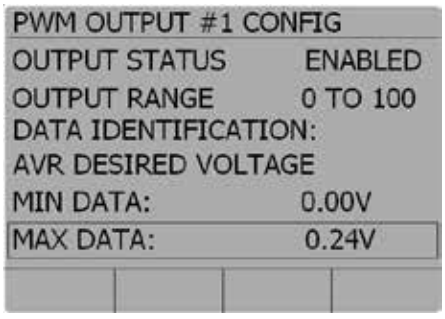
22. Select the type of MIN DATA that you want to program.

23. Press the OK KEY.



24. Scroll DOWN to MAX DATA.

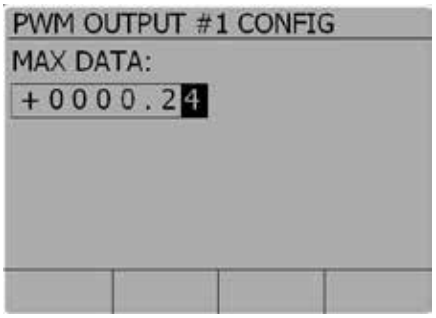
25. Press the OK KEY to edit the current MAX DATA.



26. Select the type of MAX DATA that you want to program.

27. Press the OK KEY 

.



Any PWM Output can be configured for any one of the Data Identifications in Table 14.3:

Data Identifications	
GOV DESIRED ENG SPEED	AVG PHASE CURRENT
AVR DESIRED VOLTAGE	ENGINE SPEED
GEN REAL POWER	ENGINE COOLANT TEMP
GEN REACTIVE POWER	UREA LEVEL
GEN APPARENT POWER	CUSTOM PARAMETER #1
GEN PF	CUSTOM PARAMETER #2
ENG OIL TEMP	CUSTOM PARAMETER #3
GEN FREQUENCY	CUSTOM PARAMETER #4 (4.4 Only)
GEN CURRENT PHASE A	GEN WINDING TEMP PHASE A
GEN CURRENT PHASE B	GEN WINDING TEMP PHASE B
GEN CURRENT PHASE C	GEN WINDING TEMP PHASE C
GEN L-N VOLT PHASE A	GEN FRT BEARING TEMP
GEN L-N VOLT PHASE B	GEN REAR BEARING TEMP
GEN L-N VOLT PHASE C	OUTPUT FROM SCADA
GEN L-L VOLT PHASE A-B	ENGINE FUEL LEVEL
GEN L-L VOLT PHASE B-C	ENGINE OIL PRESSURE
GEN L-L VOLT PHASE C-A	EXT TANK FUEL LEVEL
GEN AVG L-N VOLTAGE	FUEL PRESSURE
GEN AVG L-L VOLTAGE	GAS BLENDING PERCENTAGE

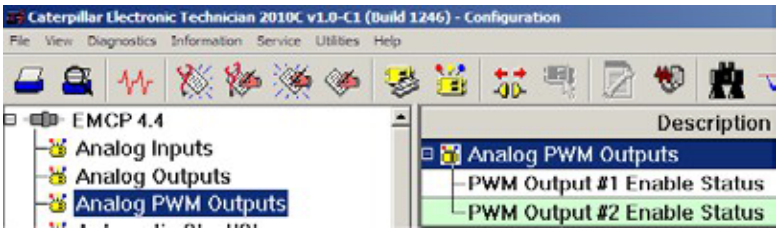
Table 14.3 – PWM Output Data Identifications List

14.2 Programming PWM Outputs Using the Cat Service Tool

The EMCP 4 PWM Outputs can be configured by using the Cat Service Tool. The key to programming them is to program the setpoints related to each output in order from top to bottom. To program a PWM Output, do the following steps:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

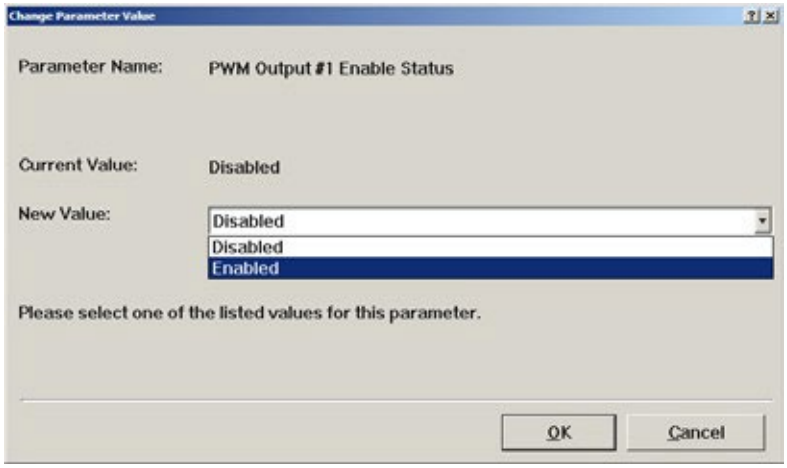
2. Select Analog PWM Outputs on the left.



3. Determine which PWM Output is to be configured. For example, all of the setpoints for PWM Output #1 have the text "#1" in their name.

Description	Value
Analog PWM Outputs	
PWM Output #1 Enable Status	Disabled
PWM Output #2 Enable Status	Disabled

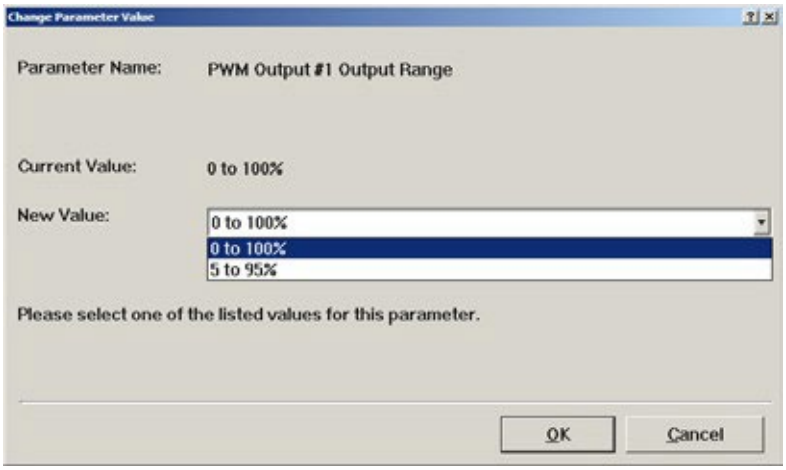
4. Double click the PWM Output #N Enable Status to change this value to Enabled from the drop down menu. Click the OK button to program.



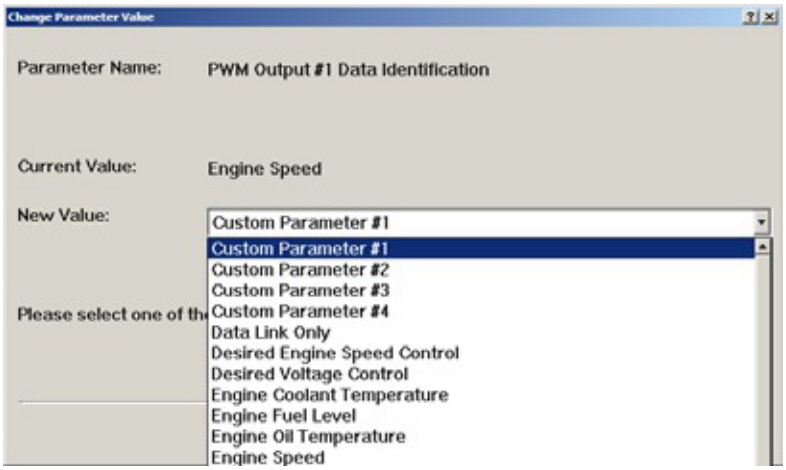
5. The remaining parameters will now be shown.

Description	Value
Analog PWM Outputs	
PWM Output #1 Enable Status	Enabled
PWM Output #1 Output Range	0 to 100%
PWM Output #1 Data Identification	Engine Speed
PWM Output #1 Minimum Data Range	0.000
PWM Output #1 Maximum Data Range	2000.000

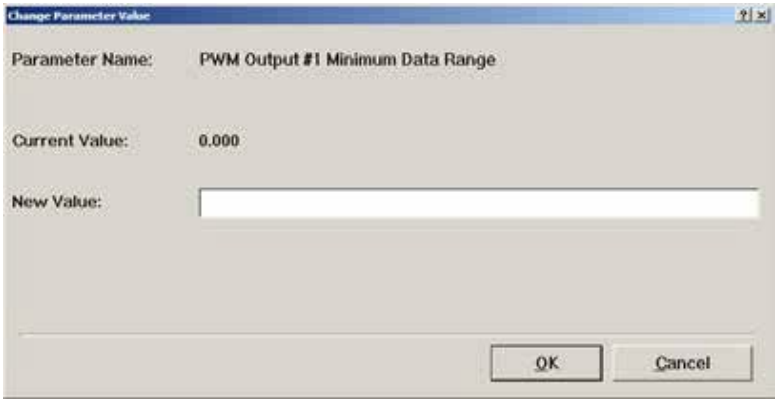
6. Double click the PWM Output #N Output Range to change this value from the drop down menu. Click the OK button to program.



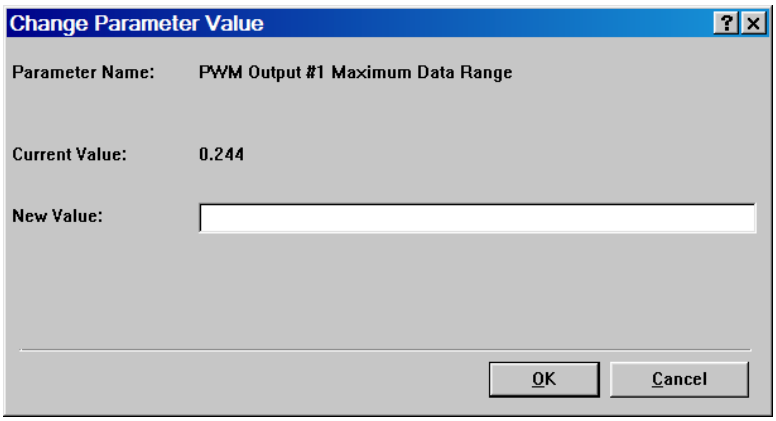
7. Double click the PWM Output #N Data Identification to change this value from the drop down menu. Click the OK button to program. For a full list of options, see Table 17.



8. Double click the PWM Output #N Minimum Data Range to change this value. Click the OK button to program.



9. Double click the PWM Output #N Maximum Data Range to change this value. Click the OK button to program.



15.0 Hardwired Paralleling (EMCP 4.4 Only)

The EMCP 4.4 has a variety of paralleling functions including dead bus arbitration, synchronizing, load sharing, load shed, and load sense/load demand. The EMCP 4.4 also provides for multiple modes of operation, including automatic synchronizing, manual synchronizing, and sync check mode. For paralleling features available using the Multiple Genset Data Link (MGDL) over Ethernet which has greater flexibility, see Chapter 37.

15.1 Hardwired Paralleling Functions

15.1.1 Dead Bus Arbitration

The EMCP 4.4 incorporates true dead bus arbitration to determine and select the primary generator set to close to a dead bus, allowing only one unit to close to the dead bus. The dead bus arbitration control minimizes the time for the first generator set to close to the dead bus. See Section 15.3.

15.1.2 Synchronizing

The EMCP 4.4 monitors all three phases of the generator and main bus. The proprietary synchronizing algorithms drive the generator output frequency, voltage, and phase to match another source, and close the generator circuit breaker when conditions have been met. See Section 15.5.

15.1.3 Load Sharing

The EMCP 4.4 actively monitors the real (kW) and reactive (kVAr) load requirement of all paralleled generator sets as shown on the load sharing lines, and adjusts output of the generator set to maintain a balanced loading of all generator sets. See Section 15.6.

15.1.4 Load Shed

The EMCP 4 provides a configurable signal to aid in the removal of load. See Section 15.7.

15.1.5 Load Sense/Load Demand

The EMCP 4.4 includes logic to sequence generator sets based on the total load requirement of the system. If the site load exceeds a minimum reserve kW threshold, additional generator sets will automatically start, synchronize, and close the generator breaker. If the site load falls below a reserve kW threshold, a generator set will automatically unload, open the generator circuit breaker, and shut down. See Section 15.4.

15.2 Paralleling (Synchronizing) Modes of Operation

15.2.1 Automatic Paralleling (Auto Synchronizing)

In the automatic paralleling mode, the EMCP 4.4 controller automatically adjusts the voltage and frequency of the generator set. When the generator output is synchronized with the second source, the EMCP 4.4 controller closes the generator circuit breaker. See Section 15.2.

15.2.2 Manual Paralleling (Manual Synchronizing)

In the manual paralleling mode, the operator manually adjusts the voltage and frequency of the generator set. When the generator set is synchronized with the second source, the operator initiates a generator circuit breaker close command. A sync check function is also included to prevent out of phase paralleling. See Section 15.2.

15.2.3 Sync Check Mode

In the sync check mode, the EMCP 4 .4 controller automatically adjusts the voltage and frequency of the generator set without closing the generator circuit breaker . When the generator set is synchronized with the second source, the operator initiates a generator circuit breaker close command . See Section 15 .2 .

15.3 Hardwired Dead Bus Arbitration

15.3.1 Purpose

The purpose of Hardwired Dead Bus Arbitration (HWDBA) is to determine whether or not a dead bus condition exists and provide dead bus close arbitration in the absence of a multiple generator set data link . Dead Bus Arbitration selects the unit that is first ready to close to the dead bus and allows one and only one unit to close to that dead bus . If the selected unit is unable to close to the dead bus, Dead Bus Arbitration removes the permission from that unit and allows a different ready unit to close to the dead bus . In this way, Dead Bus Arbitration minimizes the amount of time for a unit to be able to close to a dead bus .

Hardwired Dead Bus Arbitration operates using hardwired inputs and outputs connected between up to eight generator sets that are to be operated in parallel .

In HWDBA, arbitration between generators is accomplished using a virtual token-based procedure . All generators are allowed to request the token, but only one generator is allowed to capture the token, and subsequently close to the bus . To capture the token and then close to the bus, a generator must successfully obtain priority by passing arbitration conditions . A Request line is provided to allow a unit to detect whether to keep trying to close or to allow a different unit to attempt to close .

Once a unit has successfully connected to the dead bus, HWDBA is no longer needed . The generators may function under the Load Sharing mode or the Load Sense Load Demand mode from this point .

15.3.2 Wiring

Hardwired Dead Arbitration between generators requires five hardwired lines:

- Requesting Line
- Capturing Line
- Arbitration Line
- Best Battery Positive
- Reference “A”

Additionally, HWDBA requires that only one generator set have a hardwired line between the Best Battery Positive and its own HWDBA relay contact . All wires should be a minimum of 16AWG, 600V, or equivalent . The connections between generator sets are described in Figure 15 .1 .

1 . **Requesting Line –** Internally referenced to Reference “A .” Connected between all generator sets directly .

2 . **Capturing Line** – Internally referenced to Reference “A .” Connected between all generator sets directly .

3 . **Arbitration Line** – Should connect between generators via series connected normally closed arbitration relay contacts . One arbitration relay is associated with each generator . The arbitration relay coil is controlled by a single Digital Output (HWDBA #5, rated 100 mA sinking) . This line is pulled high by the Best Battery Positive line . HWDBA requires two input connections monitoring the status of both sides of the normally closed arbitration relay . This signal is referenced to local Battery negative .

4. **Best Battery Positive Line** – Should connect between generators at the installed diode cathode (which is installed between the generator set Battery positive and the Best Battery Positive line).

5. **Reference "A"** – Common reference between generator sets. This is the same line as Reference "A" for HWLSLD (see Section 15.4). Connected between all generator sets directly.

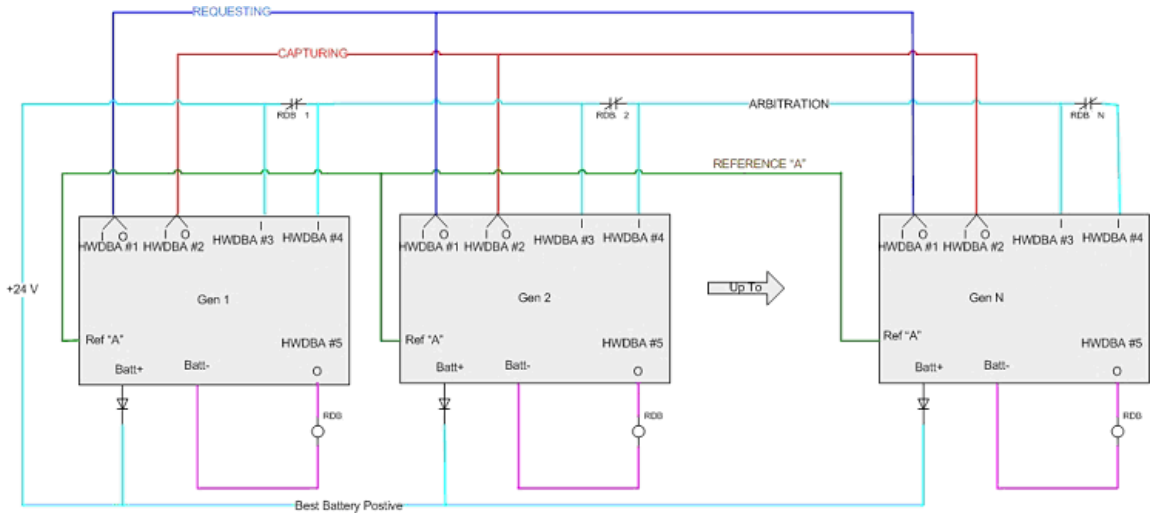


Figure 15.1 – Hardwired Dead Bus Arbitration Wiring

The reference "A" that Hardwired Dead Bus Arbitration uses is the same reference "A" that the HWLSLD uses. Each of these outputs incorporates a pull up resistor internal to the controller to float the voltage and is pulled low to the isolated reference when active. The two arbitration relay inputs and one arbitration relay output do not use the reference A, but are referenced to local battery negative.

One, and only one, unit must be designated as the lead unit. This is accomplished by connecting the Best Battery Positive line of a unit to the HWDBA #3 input of that same unit.

Note: If breaker controls on a generator set are wired to the EMCP 4.4 inputs, the breaker will not close if the Close request control is activated unless HWDBA is enabled and the lead unit connection is installed.

15.3.3 Basic Operation

The following cases describe typical behavior and order of operations for HWDBA:

Case 1 (Normal Operation): Multiple units come up to speed, but only unit X captures the token.

1. Multiple units come up to speed and voltage
2. Multiple units pull the Requesting line low
3. Unit X pulls the Capturing line low first, releases the Requesting line, and activates the Dead Bus Relay, thus capturing the token
4. No other units can pull the Capturing line low, but keep the Requesting line low
5. Unit X connects to the bus successfully

Case 2 (Unit Fails to Connect): Multiple units come up to speed, unit X captures the token, fails to connect to the bus, and unit Y captures the token.

1. Multiple units come up to speed and voltage
2. Multiple units pull the Requesting line low
3. Unit X pulls the Capturing line low first, releases the Requesting line, and activates RDB, thus capturing the token
4. No other units will pull the Capturing line low, but will keep the Requesting line low
5. Unit X fails to connect to the bus
6. Since Unit X knows that other units are ready to close, Unit X releases the Capturing line and de-energizes RDB, thus losing the token
7. Upon seeing the Capturing line released, unit Y pulls the Capturing line low next, releases the Requesting line, and activates RDB, thus capturing the token
8. No other units will pull the Capturing line low, but will keep the Requesting line low
9. Unit Y connects to the bus successfully

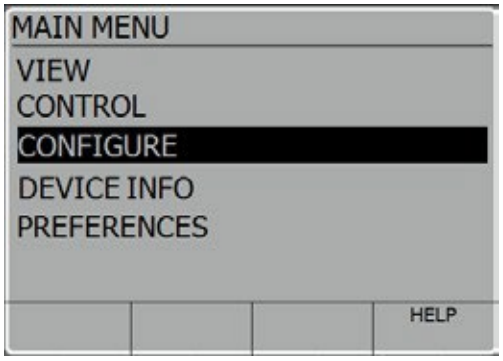
Case 3 (Simultaneous Token Capture): Multiple units come up to speed, and units X and Y try to capture the token at the same time (unit X has HWDBA #3 directly connected to Best Battery Positive).

1. Multiple units come up to speed and voltage
2. Multiple units pull the Requesting line low
3. Units X and Y pull the Capturing line low together, release the Requesting line, and activate RDB, thus trying simultaneously to capture the token
4. No other units can pull the Capturing line low, but keep the Requesting line low
5. Unit Y releases the Capturing line since it does not see Best Battery Positive anymore on the Arbitration line due to unit X opening its RDB contacts
6. Unit X now has the token exclusively and connects to the bus successfully

15.3.4 Enabling Dead Bus Arbitration

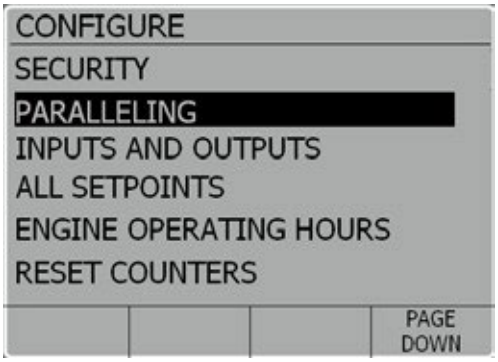
In order to enable Dead Bus Arbitration, go through the following menu options:

1. At the MAIN MENU, scroll DOWN  to CONFIGURE.
2. Press the OK KEY .



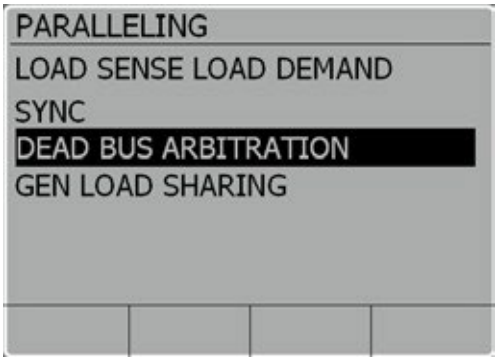
3. Scroll DOWN  to PARALLELING.

4. Press the OK KEY .

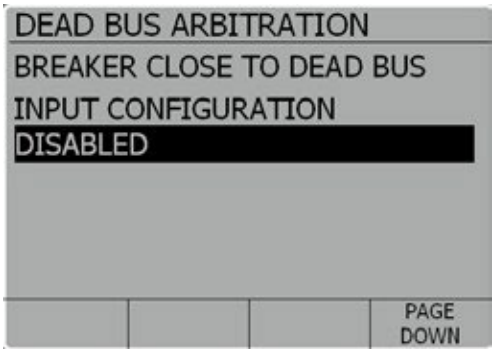


5. Scroll DOWN  to DEAD BUS ARBITRATION.

6. Press the OK KEY .

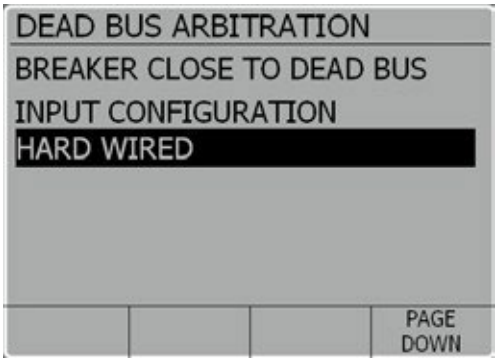


7. Press the OK KEY  to highlight the BREAKER CLOSE TO DEAD BUS INPUT CONFIGURATION setting.



8. Select HARD WIRED.

9. Press the OK KEY .



15.3.5 Viewing Parameters

Within the “View” submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for viewing only. No control or configuration is available from this submenu. Soft keys allow for quick navigation between submenus.

The Dead Bus Arbitration screen shows the current status of the Dead Bus Arbitration circuit. The status of the HWDBA lines as well as the bus voltage, output breaker position, HWDBA relay position, and status of the generator Dead Bus Arbitration are shown. Soft keys allow quick toggling between the Sync Overview, Load Share, Dead Bus Arbitration, and Load Sense Load Demand. See Figure 15.2.

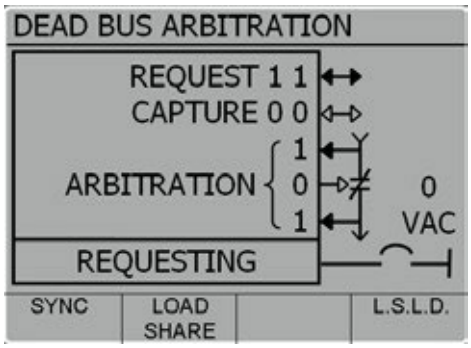


Figure 15.2 – Dead Bus Arbitration – View Screen

A double ended arrow indicates a combined Input/Output line, while a single ended arrow indicates either an Input or an Output. If an arrow is shaded, it represents an active signal. If an arrow is not shaded, then it represents an inactive signal. The number to the left of the arrow also indicates the status of the lines. A “1” represents an active signal, while a “0” represents an inactive signal. For double digit lines, the left most digit represents the state of the incoming signal, while the right most digit represents the state of the outgoing signal. Whenever the outgoing signal is active, the incoming signal will also be active.

13.3.6 Controlling Parameters

Within the “Control” submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for control. No configuration is available from this submenu.

The Dead Bus Arbitration screen shows the current status of the Dead Bus Arbitration circuit as well as control of parameters within the HWDBA Setup screen. The status of the HWDBA lines as well as the bus voltage, breaker position, and status of the generator Dead Bus Arbitration are shown. Soft keys allow quick toggling to the Sync Overview and HWDBA Setup screens. See Figure 15.3.

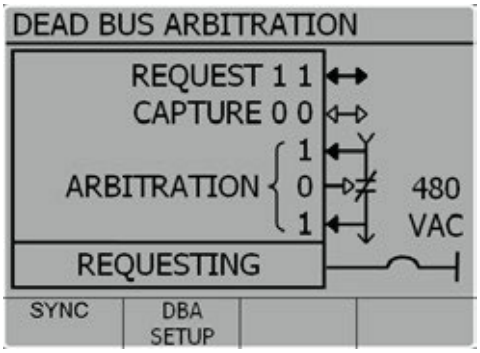


Figure 15.3 – Dead Bus Arbitration – Control Screen

A double ended arrow indicates a combined Input/Output line, while a single ended arrow indicates either an Input or an Output. If an arrow is shaded, it represents an active signal. If an arrow is not shaded, then it represents an inactive symbol. The number to the left of the arrow also indicates the status of the lines. A "1" represents an active signal, while a "0" represents an inactive signal. For double digit lines, the left most digit represents the state of the incoming signal, while the right most digit represents the state of the outgoing signal.

15.3.7 Configuring Parameters

Within the "Configuration" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for configuration. These parameters may also be accessed through the "All Setpoints" submenu.

The Dead Bus Arbitration (HWDBA) configuration screen contains the parameters necessary to set up the functions associated with connecting a running generator set to a dead bus and managing which generator set will connect to the bus when multiple units simultaneously try to connect.

The "Dead Bus Arbitration" submenu allows for configuration of the following parameters by using the Page Down soft key:

Parameter	Range/Choices
Breaker Close to Dead Bus Input Configuration	Not Installed/Hard Wired input/Ethernet
Breaker Close to Dead Bus Maximum Time	0 .1-10 seconds

15.3.8 Dead Bus Arbitration Events

If the EMCP 4 .4 Generator Set controller detects a wiring fault in the dead bus arbitration circuit, an event (SPN2530-7) will be generated. This can be corrected by reviewing Figure 15 .1. The display screen of the EMCP 4 .4 will also help in troubleshooting this wiring.

15.4 Hardwired Load Sense Load Demand Details

15.4.1 Purpose

The purpose of Hardwired Load Sense Load Demand (HWLSLD) is to have an automatic priority sequencing function to modulate the number of generator sets online to control load percentages per machine . Greater flexibility including up to 16 generator sets and Engine Operating hour based selection is available via MGDL.

Hardwired Load Sense Load Demand operates using hardwired combined Input/Output pins connected between up to 8 equal or similar-sized generator sets that are to be operated in parallel. HWLSLD does not work well with generator sets of significantly different kW ratings. This feature will work the best with equal sized generator sets. If generator sets are significantly different in power outputs, less flexibility of configuration and operation will occur.

Each generator set will monitor its own kilowatt (kW) output.

15.4.2 Wiring

Hardwired Load Sense Load Demand between generators requires five hardwired lines connected directly between generator sets:

- All Run Line
- Overload Line
- Excess Line
- Ramping Line
- Reference "A" (same line as Reference "A" for HWDBA, see Section 15 .3)

These wires should be a minimum of 16AWG, 600V, or equivalent. The connections between generator sets are described in Figure 15.4.

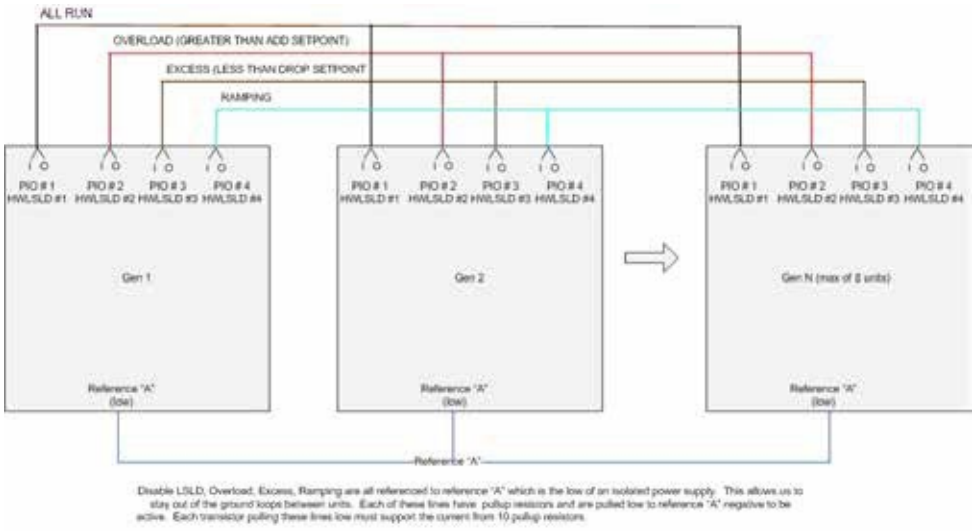


Figure 15.4 – Hardwired Load Sense Load Demand Wiring

15.4.3 Basic Operation

Hardwired Load Sense Load Demand operates using hardwired inputs and outputs connected between up to 8 equal or similar-sized generator sets that are to be operated in parallel. All units at a site must be in HWLSLD for HWLSLD mode to take any units offline. If any unit is connected, but offline, the ALL RUN signal will stay active. In HWLSLD, each generator set is assigned a Paralleling Priority Unit Number (1 through N, with N being the highest number unit in the system). A default time delay is associated with the Paralleling Priority Unit Number, which is used as priority to ensure only one generator set starts, to act upon a request from any of the generator sets.

There are two setpoints that are key to understanding the HWLSLD scheme. The Drop Threshold setpoint determines the kW level in which a generator set will drop off line. The Add Threshold setpoint determines the kW level in which an additional generator set will need to come online to pick up the additional load requirement.

Each generator set monitors its own kilowatt (kW) output. If the kW output of any one of the generator sets is below (above) the programmable Drop (Add) Threshold setpoint, the controller(s) on the generator sets activate the Excess (Overload) Line output. The other controllers register the signal as an input and, after an adjustable time delay, begin the arbitration process of determining which generator set goes offline (or goes online).

The arbitration process works as follows. Once the adjustable time delay has expired, a second time delay is initiated based on the generator set Paralleling Priority Unit Number. Once the Paralleling Priority Unit Number based time delay expires on a single controller, that controller shall energize its Ramping output, which will block the other controllers in the system from ramping. Then, the generator set will continue to ramp up to share load (Overload condition) or ramp down to shed load (Excess condition).

HWLSLD is designed to operate with equal or similar sized generator sets. For operation with significantly unequal sized generators, rapidly changing load could cause non-optimum mix of generator set loading. In the unequal sized generator set case, the smallest sized units should be designated with the lowest Paralleling Priority Unit Number (highest priority). Automatic cycling of priorities are not supported by HWLSLD.

If the ALL RUN is activated for any reason including underfrequency and undervoltage warnings, then all units will come online without any additional delay.

The following describes the Hardwired Load Sense Load Demand logic:

1. Before a unit is allowed to enter HWLSLD control, the following conditions must be true for each unit in the system:
   - 15.4.1.1 – Engine Control Switch in Auto
   - 15.4.1.2 – Synch Mode Switch in Auto
   - 15.4.1.3 – Idle/Rated in Rated
   - 15.4.1.4 – No Shutdown faults
   - 15.4.1.5 – HWLSLD Enable Mode setpoint set to "HW"
   - 15.4.1.6 – Valid Initiate command via Remote Initiate, Group Start*, or Programmable Cycle timer

Note: If using Group Start, Reduced Power Mode should NOT be used.

2. The unit will either NOT enter HWLSLD control or, if under HWLSLD control, will exit immediately under either of the following conditions:
   - 15.4.1.7 – If any unit has the HWLSLD Enable Mode setpoint set to "disable," or
   - 15.4.1.8 – If any unit is running in manual and the generator circuit breaker is closed, regardless of the HWLSLD Enable Mode setpoint.

3. Once the unit meets the conditions above, it will start as required, synchronize to get online, and accept its share of load based upon the analog load share line.
   - 15.4.1.9 – The unit will start the HWLSLD Enable Delay as soon as the Initiate command is received.
   - 15.4.1.10 – The All Run Line output will stay active when the unit first starts until the HWLSLD Enable Delay expires. If units differ in this time delay, the unit with the longest time delay will keep the All Run Line output active until the delay times out.
   - 15.4.1.11 – If any unit gets a disabling HWLSLD event (i.e. an under frequency or load shed output), the All Run Line output will go active, requiring all units in the system to exit HWLSLD control.
   - 15.4.1.12 – If the HWLSLD Enable Mode setpoint is set to "Disabled," the All Run Line will be active. If any unit in the system has this line active, then all other units in the system will not be prohibited from running due to the HWLSLD logic. It is advised to set all units the same.

4. Once under HWLSLD control, a unit analyzes its own load with respect to its HWLSLD Drop Unit Percentage Threshold and HWLSLD Add Unit Percentage Threshold setpoints. If the load is within the HWLSLD Drop Unit Percentage Threshold and HWLSLD Add Unit Percentage Threshold the Overload and Excess Line outputs will be inactive.

5. An online unit that detects that its own load is greater than its HWLSLD Add Unit Percentage Threshold setpoint for the duration of the HWLSLD Add Unit Delay will activate the Overload Line output. The "overload" condition means the current online generator set is overloaded and any available offline generators should come online to share load.
   - 15.4.1.13 – When the Overload Line input of a unit is activated and the Ramping Line input is not active, the arbitration process begins. In arbitration, the unit starts the Paralleling Priority Unit Number Delay Timer. After the Paralleling Priority Unit Number Delay Time expires, the unit may activate the Ramping Line output only if its Ramping Line input is NOT already active.

- 15.4.1.14 – The offline unit with the shortest Paralleling Priority Unit Number Delay Time (highest priority) will be first to activate the Ramping Line output and win arbitration.
- 15.4.1.15 – A unit that activates its Ramping Line following an activated Overload Line input does the following:
  - 15.4.1.15.1 – Ramps up to speed according to the HWLSLD Add Unit Ramp Rate, closes the breaker, and begins sharing load. If a disabling HWLSLD event (i.e. Close Circuit Breaker Failure, Fail to Sync, or Fail to Start) or any event that takes the Sync Mode Switch or Engine out of Auto occurs, the unit activates the All Run Line and disables HWLSLD for all units.
  - 15.4.1.15.2 – Releases the Ramping Line as soon as it reaches its share of the load.
  - 15.4.1.15.3 – Analyzes its own load with respect to the HWLSLD Drop Unit Percentage Threshold and HWLSLD Add Unit Percentage Threshold setpoints.

6. An online unit that senses that its own load is less than its own HWLSLD Drop Unit Percentage Threshold setpoint for the duration of the HWLSLD Drop Unit Delay will activate the Excess Line output. The “excess” condition means the current online generator set has an excess capacity and the highest priority online unit should go offline.
   - 15.4.1.16 – When the Excess Line input of a unit is activated and the Ramping Line input is not active, the arbitration process begins. In arbitration, the unit starts the Paralleling Priority Unit Number Delay Timer. After the Paralleling Priority Unit Number Delay Time expires, the unit may activate the Ramping Line output only if its Ramping Line input is NOT already active.
   - 15.4.1.17 – The online unit with the shortest Paralleling Priority Unit Number Delay Time (highest priority) will be first to activate the Ramping Line output and win arbitration.
   - 15.4.1.18 – A unit that activates its Ramping Line following an activated Excess Line input checks to see if it is the last unit online before ramping down. It checks by releasing its Excess Line Output and monitors its Excess Line Input after a short delay. The following steps are then taken:
     - 15.4.1.18.1 – If the Excess Line Input is not active, the unit is the last to go offline and the unit cancels the ramp down and remains online until an “overload” condition is detected and then follow the steps described above.
     - 15.4.1.18.2 – If the Excess Line Input is still active, the unit is NOT the last online unit and the unit does the following:
       a. Ramps down according to the HWLSLD Drop Unit Ramp Rate. Once the load drops to the disconnect level (setpoint), then a signal is sent to the circuit breaker logic to open. The unit then cools down and stops (Handled in Gen Real Load Control Block).
       b. Releases the Ramping Line as soon as its circuit breaker opens.
       c. Waits until an “overload” condition is detected and follows the steps described above.
   - 15.4.1.19 – If an “overload” condition is detected while the unit is ramping down from an “excess” condition, the unit immediately begins ramping up according to the HWLSLD Add Unit Ramp Rate.

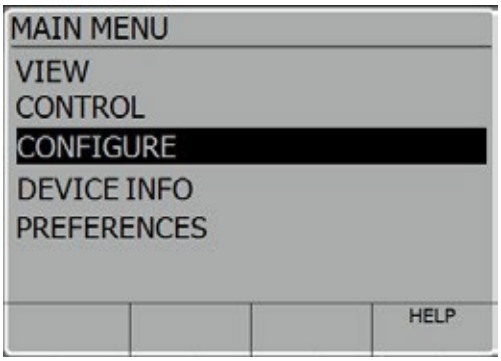
7. Any unit that detects a simultaneous overload and excess condition via the Excess Line and Overload Line inputs generates a warning and disables HWLSLD.

15.4.4 Enabling Load Sense Load Demand

In order to enable Load Sense Load Demand, go through the following menu options:

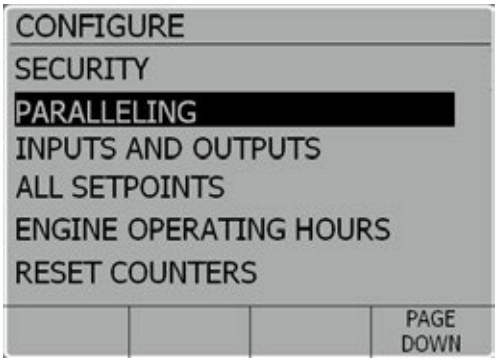
1. At the MAIN MENU, scroll DOWN to CONFIGURE.

2. Press the OK KEY.



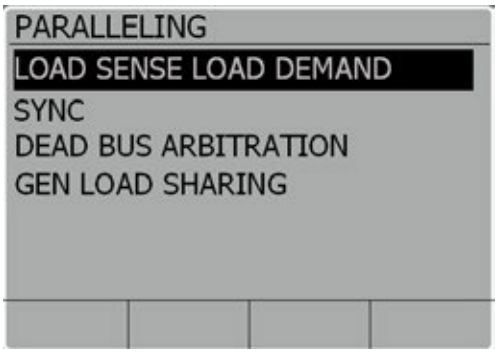
3. Scroll DOWN to PARALLELING.

4. Press the OK KEY.

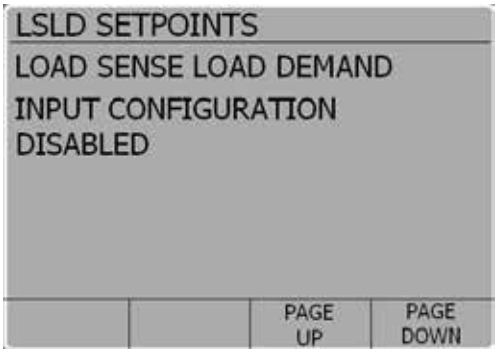


5. Press the OK KEY to enter LOAD SENSE LOAD DEMAND.

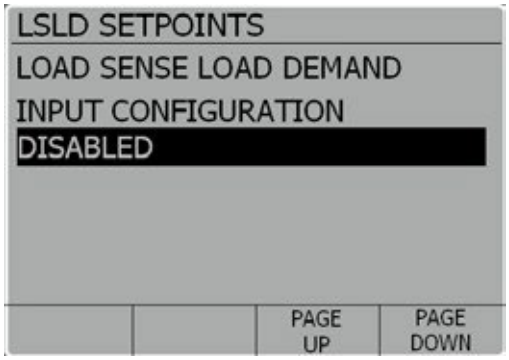
6. Press the OK KEY.



7. Press the PAGE DOWN soft key to access LOAD SENSE LOAD DEMAND INPUT CONFIGURATION setting.

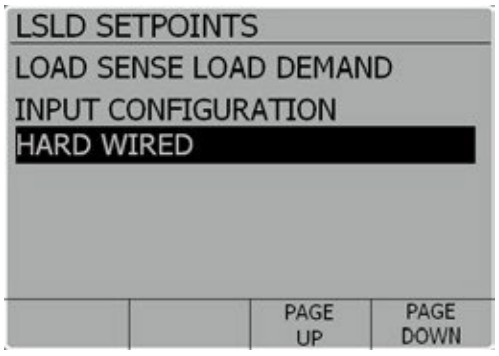


8. Press the OK KEY to highlight the LOAD SENSE LOAD DEMAND INPUT CONFIGURATION setting.



9. Select HARD WIRED.

10. Press the OK KEY.



15.4.5 Viewing Parameters

Within the "View" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for viewing only. No control or configuration is available from this submenu. Soft keys allow for quick navigation between submenus.

The Load Sense Load Demand screen shows the current status of the Load Sense Load Demand circuit. The status of the HWLSLD lines as well as the bus voltage, breaker position, percent of load, and status of the generator load sharing are shown. The generator set priority number is also shown in the upper right corner. Soft keys allow quick toggling between the Sync Overview, Load Share, Dead Bus Arbitration, and Load Sense Load Demand. See Figure 15.5.

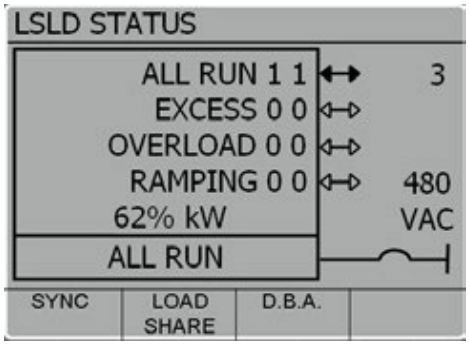


Figure 15.5 – Load Sense Load Demand – View Screen

A double ended arrow indicates a combined Input/Output line. If an arrow is shaded, it represents an active signal. If an arrow is not shaded, then it represents an inactive symbol. The number to the left of the arrow also indicates the status of the lines. A "1" represents an active signal, while a "0" represents an inactive signal. For double digit lines, the left most digit represents the state of the incoming signal, while the right most digit represents the state of the outgoing signal.

15.4.6 Controlling Parameters

Within the "Control" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for control. No configuration is available from this submenu.

The Load Sense Load Demand screen shows the current status of the Load Sense Load Demand circuit as well as access to control of parameters within the HWLSLD Setup screen. The status of the HWLSLD lines as well as the bus voltage, breaker position, percent of load, and status of the generator load sharing are shown. The generator set priority number is also shown in the upper right corner. Soft keys allow quick access to the AC Overview and HWLSLD Setup screens. See Figure 15.6.

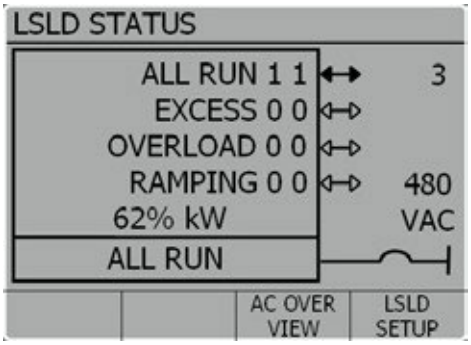


Figure 15.6 – Load Sense Load Demand – Control Screen

A double ended arrow indicates a combined Input/Output line. If an arrow is shaded, it represents an active signal. If an arrow is not shaded, then it represents an inactive symbol. The number to the left of the arrow also indicates the status of the lines. A "1" represents an active signal, while a "0" represents an inactive signal. For double digit lines, the left most digit represents the state of the incoming signal, while the right most digit represents the state of the outgoing signal.

15.4.7 Configuring Parameters

Within the "Configuration" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for configuration. These parameters may also be accessed through the "All Setpoints" submenu.

The Load Sense Load Demand (HWLSLD) configuration screen contains the parameters necessary for automatically bringing other generator sets online and offline to share load under the HWLSLD scheme.

The "Load Sense Load Demand" submenu allows for configuration of the following parameters by pressing the Page Down soft key.

Load Sense Load Demand Enable Delay

This setpoint determines the amount of time to run before entering HWLSLD mode. The range for this setpoint is 1-30 minutes. It is the amount of time the generator must wait after the breaker closes before releasing the All Run HWLSLD line and allowing HWLSLD control to begin (see Section 15.4).

Load Sense Load Demand Input Configuration

This setpoint determines if the EMCP 4.4 enables HWLSLD. Possible choices for this setpoint are Disabled, Hardwired, and Ethernet.

Load Sense Load Demand Add Unit Percentage Threshold

This setpoint determines the percentage of the generator rated kW that the unit is providing before another unit is brought online to share load. The range for this setpoint is 50-90%. If the unit load extends above this setpoint an "overload" condition is triggered within the HWLSLD internal circuitry.

Load Sense Load Demand Add Unit Delay Time

This setpoint determines the amount of time it will take to bring another unit online to share load. The range for this setpoint is 0-10 seconds. This setpoint is the amount of time the unit load must exceed the Add Unit Percentage Threshold setting before an "overload" condition is triggered within the HWLSLD internal circuitry.

Load Sense Load Demand Drop Unit Percentage Threshold

This setpoint determines the percentage of the generator rated kW that the unit is providing before it is taken offline. The range for this setpoint is 10-50%. If the unit load is below this setpoint an "excess" condition is triggered within the HWLSLD internal circuitry.

Load Sense Load Demand Drop Unit Delay Time

This setpoint determines the amount of time it will take to take the current unit offline. The range for this setpoint is 0-10 seconds. This setpoint is the amount of time the unit load must be below the Drop Unit Percentage Threshold setting before an "excess" condition is triggered within the HWLSLD internal circuitry.

Generator Paralleling Priority Number

This setpoint 0 determines what the current generator priority is for coming online and going offline for load sharing. If a generator has a lower number assigned, it will have a higher priority. For example, if two generators are programmed for priority 2 and 3 respectively, then generator 2 will go online first to share load on the system and generator 3 will be taken offline first.

15.5 Synchronizing Details

15.5.1 Sync Mode Switch

The Sync Mode Switch (SMS) is a four position soft switch within the EMCP 4.4 controller. It has "Auto," "Check," "Off," and "Manual" positions. The switch is automatically placed in the "Auto" position upon boot up of the controller or placing the engine control switch of the controller into "Auto." In any position of the engine control switch, the SMS may be placed into any other position using the display, or a programmable digital input. When the SMS is placed into "Check," the system shall operate as if in "Auto," but "Fail to Parallel" will be disabled and a breaker close signal will not be issued. In addition, the SMS may be changed in position using a momentary discrete switch wired to a programmable Digital Input such as may be done with the Rental XQ implementation. More detailed descriptions of each mode are described below.

Note: Any of these actions, or state selection via the display, can be overridden by activation of a Digital Input command for Sync Mode Switch in Auto, Sync Mode Switch in Manual, or Sync Mode Switch in Check. If more than one Digital Input command is active and maintained at one time, the Sync Mode Switch will be placed in the mode driven by the lowest numbered digital input. All other SMS commands are momentary (display, Modbus input, ECS changed to Auto) and therefore can all have the same priority. If one of these momentary commands is activated while a Digital Input command for SMS is activated, it will take effect immediately and then be overwritten by the Digital Input if the digital input is maintained.

A quick reference of which functions are enabled for the different SMS modes is shown in Table 15.1 with more detail described.

Function	SMS Mode		
	Auto	Manual	Check
Auto Match Phase and Voltage	√	X	√
Auto Breaker Control	√	X	X
Sync Check for V, Hz, Phase	√	√	√

Table 15.1 – SMS Modes and Functions

There are differences between how the breaker control buttons external to the EMCP 4.4 work. The Close button sends a request to the EMCP 4.4 to close the breaker. The Open button is typically wired both to the EMCP and directly to the breaker to trip it.

15.5.2 Automatic Synchronizing

The EMCP 4.4 provides a feature for 3 phase automatic matching phase angle and 3 phase average voltage. This feature also provides for automatic breaker control and includes a sync check function for frequency, phase and voltage internal to the EMCP 4.4 control. This check functionality cannot be disabled. When operating in Automatic Synchronizing mode, frequency, phase and voltage synchronizing cannot be disabled. Automatic Synchronizing only occurs when the Sync Mode Switch (SMS) is in Auto.

In “Auto” mode the EMCP 4.4 will take control of the speed and voltage control to bring the engine into sync and within the voltage level as quickly as possible. When these conditions are met, the control will issue a breaker close command.

15.5.3 Manual Synchronizing

The EMCP 4.4 provides a feature for manually matching phase angle and voltage. This feature also provides for manual breaker closure signaling while maintaining a sync check function for frequency, phase, and voltage internal to the EMCP 4.4 control. This check functionality cannot be disabled. Manual Synchronizing only occurs when the Sync Mode Switch (SMS) is in Manual. In manual synchronizing, speed and voltage commands can be sent from the display or a programmable input. In addition, the breaker close signal can be sent from the display or the dedicated manual close push button. The signal to close the circuit breaker can only be sent when sync check is valid. The Phase Angle Window and Dwell Time still apply for the sync check functionality.

In “Manual Mode” there is no automatic voltage or speed control, but if the phase difference and voltage are within the window a manual breaker closure request can be issued (by push-button or other external signal). In this mode the operator will have total control over voltage and speed to match the bus to the generator. Internal Sync Check device is always being monitored and the EMCP 4.4 will only issue a close signal to the breaker when the unit is in frequency, voltage, and phase.

15.5.4 Check Synchronizing

The EMCP 4.4 provides a feature for 3-phase automatic matching phase angle and 3 phase average voltage. This feature does not provide for automatic breaker control, but includes a sync check function internal to the EMCP 4.4. Automatic Synchronizing including frequency, phase and voltage occurs when the Sync Mode Switch (SMS) is in Check. A breaker close signal is not issued. The fail to parallel timer does not operate when SMS is in Check.
In "Check Mode," the EMCP 4.4 will take control of the speed and voltage control to bring in the engine into sync as quickly as possible. The sync will maintain the voltage and speed for to be in phase sync and voltage match. There is no command for breaker closure. This mode is used mainly for adjustment of the gain parameters. A breaker close signal may be sent externally to the EMCP.

15.5.5 Generator Sensing Fault (SPN3545-2)

A non-adjustable and non-programmable shutdown immediately occurs when the generator breaker is closed, and a phase difference (non zero) between a phase on the generator and the corresponding phase on the bus is detected. This fault will be triggered if the EMCP is told the breaker is closed, but the phases aren't locked together due to another breaker or fuse in line with the paralleling breaker. This fault will also be triggered if a draw-out breaker is being operated in the test position. This fault can also be triggered in the aux "a" and aux "b" contacts are not in opposite states.

Maximum reliability is achieved when the circuit breaker is capable of supporting both a DC powered shunt trip and a DC powered undervoltage trip.

15.5.6 Viewing Parameters

Within the "View" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for viewing only. No control or configuration is available from this submenu.

The Sync Overview screen shows the current status of the generator and bus with the generator on the left hand side of the screen. Voltage and frequency are shown numerically, as well as graphically. Phase and breaker position are represented graphically only. Soft keys allow quick toggling between the Sync Overview, Load Share, Dead Bus Arbitration, and Load Sense Load Demand. See Figure 15.7.

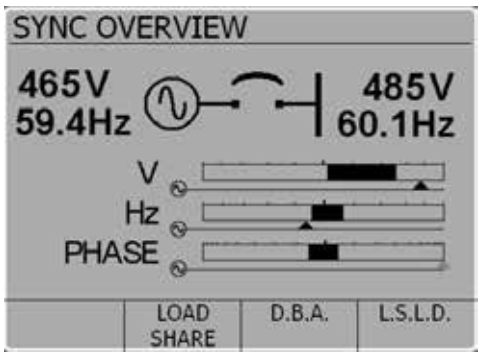


Figure 15.7 – Sync Overview – View Screen

The arrows on the graphs of voltage, frequency, or phase show the value of that generator parameter relative to the corresponding bus value. The black bar on the graph represents the sync window for that parameter. When the arrow lines up to the black portion of the graph, then this parameter is close to the value of the same bus parameter. The width of the black bar is representative of the size of the programmed window for that parameter.

Note: The Phase Bar is non-linear, so each degree gets smaller as you move away from the center.

15.5.7 Controlling Parameters

Within the "Control" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for control. No configuration is available from this submenu.

The Sync Overview screen shows the current status of the generator and bus with the generator on the left hand side of the screen. Voltage and frequency are shown numerically, as well as graphically. Phase and breaker position are represented graphically only. This screen also shows the Sync Mode Switch position at the top. Soft keys will vary depending on the SMS position. See Figure 15.8.

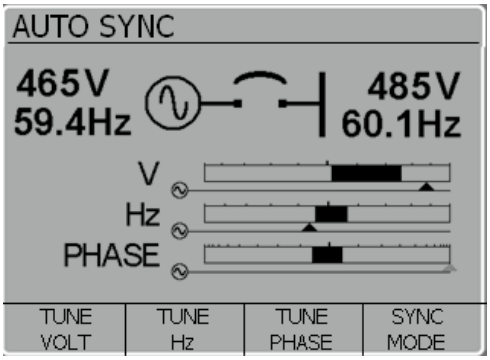


Figure 15.8 – Sync Overview – Control Screen

The arrows on the graphs of voltage, frequency, or phase show the value of that generator parameter relative to the corresponding bus value. The black bar on the graph represents the sync window for that parameter. When the arrow lines up to the black portion of the graph, then this parameter is close to the value of the same bus parameter. The width of the black bar is representative of the size of the programmed window for that parameter.

Table 15.2 describes the soft keys in each SMS position for the Sync Overview screen within the Control submenu.

SMS Position	F1	F2	F3	F4
Auto	Tune Volt	Tune Hz	Tune Phase	Sync Mode
Check	Tune Volt	Tune Hz	Tune Phase	Sync Mode
Off		Load Share	HWDBA	HWLSLD
Manual	<V	V>	<Hz	Hz>

Table 15.2 – Sync Overview Screen Soft Keys

Note: When the SMS is in the off position, the Sync Overview screen within the Control submenu is the same screen as in the View submenu.

When the SMS is in Auto, or Check positions, the gain adjustment screens for Voltage, Frequency, and Phase become accessible.

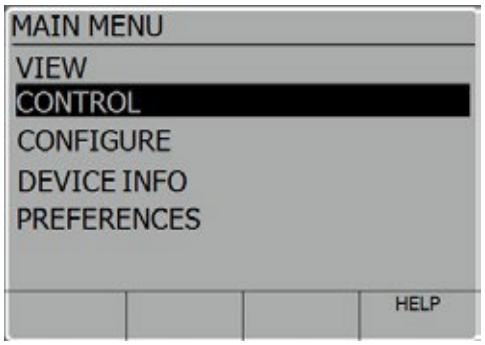
To Change The Sync Gain Settings:

Ensure the SMS is in the Auto, or Check position.

At the MAIN MENU

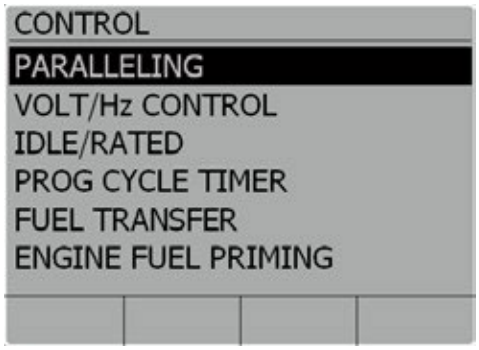
1. SCROLL DOWN to: CONTROL.

2. Press OK KEY.



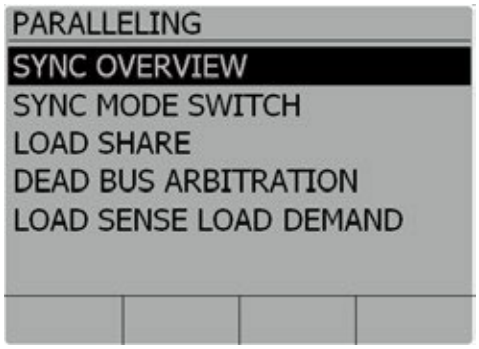
3. SCROLL DOWN to: PARALLELING.

4. Press OK KEY.

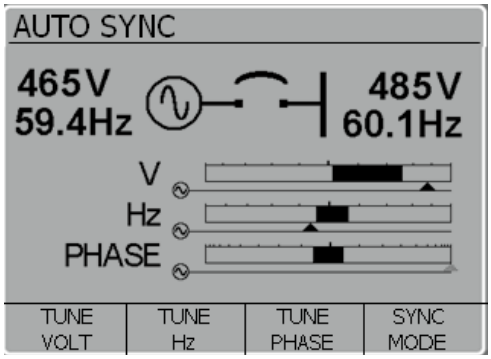


5. SCROLL DOWN to: SYNC OVERVIEW.

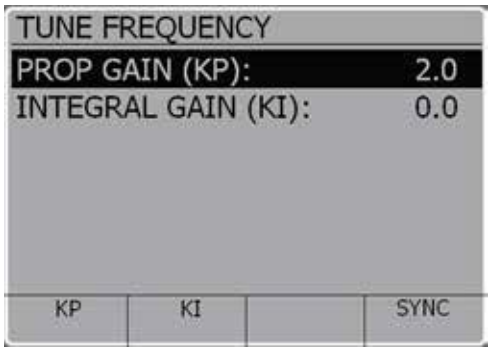
6. Press OK KEY.



The Sync Overview screen shows. Press the desired soft key. (In this example, “Tune Hz” is selected).

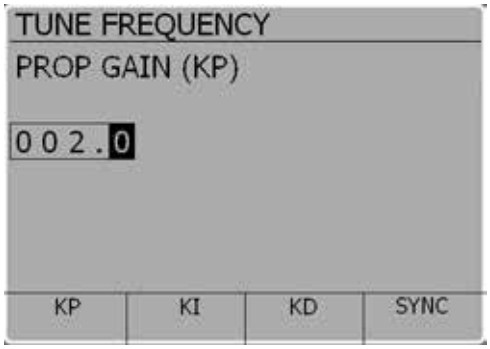


7. Select the desired gain to adjust by pressing the corresponding soft key, or using the DOWN ARROW and pressing the OK KEY. (In this example, “Prop Gain” is selected).



To edit the GAIN:

8. Select a digit using the LEFT ARROW or RIGHT ARROW.
9. To change the selected digit use the UP ARROW or DOWN ARROW.
10. To accept the change: Press the OK KEY.
11. To reject the change: Press the ESCAPE KEY.



Note: Using the soft keys to switch between gains will not save any changes made to the gains at this point.

Sync Mode Switch

The Sync Mode Switch is a four-position software switch. It can be placed in the “Auto,” “Check,” “Off,” and “Manual” positions. These modes are described below. The Sync Mode Switch screen allows for placement of this switch into any of these positions, as well as allowing quick access to the Sync Overview screen. See Figure 15.9.

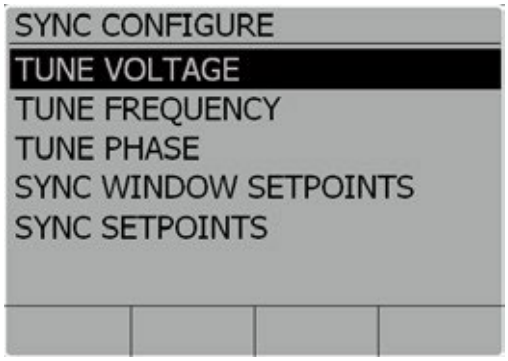


Figure 15.9 – Sync Mode Switch Screen

Selection of the Sync mode is made with the corresponding soft keys or pressing the up or down arrow keys, then pressing the OK key. To select Sync Overview, press the down arrow until the Sync Overview text is highlighted, and then press the OK key. See Section 13.2.1 for more details.

Note: If the EMCP 4.4 is set to “AUTO” then the Sync Mode is automatically set to “AUTO.” If the EMCP 4.4 is set to “RUN” then the Sync Mode is automatically set to “MANUAL.”

Auto Sync

The Auto Sync feature of the EMCP 4.4 allows the EMCP to monitor both generator and bus voltage, current, and phase. The EMCP then adjusts these parameters and automatically closes the generator breaker when they fall within the programmed windows.

Check Sync

The Check Sync feature of the EMCP 4.4 allows the EMCP to monitor both generator and bus phase voltage, current, and phase. The EMCP then adjusts these parameters until they fall within the programmed windows, but does not automatically close the generator breaker. An external signal can close the breaker.

Off

When the Sync Mode Switch is set to the Off position, the EMCP does not monitor generator and bus voltage, current, or phase. The EMCP 4 will not issue a breaker close signal even if a breaker close request is issued to the EMCP 4, provided the breaker close signal is wired only to the EMCP 4.

Manual Sync

The Manual Sync feature of the EMCP 4.4 allows the user to monitor both generator and bus phase voltage, current. The user may then adjust these parameters until they fall within the programmed windows, and manually close the generator breaker. The EMCP only offers indication of the parameters adjusted by the user.

15.5.8 Configuring Parameters

Within the “Configuration” submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for configuration. These parameters may also be accessed through the “All Setpoints” submenu.

The Sync configuration screen contains the parameters necessary to set up the functions related to synchronization with a live bus. The following paralleling functions are configurable within the “Sync” submenu of the EMCP 4.4 “Configure” submenu (see Figure 15.10).

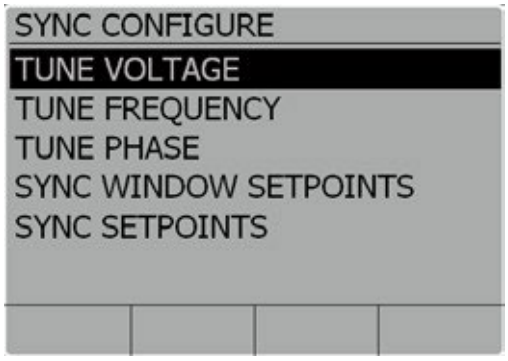


Figure 15.10 – Sync Configure Submenu

The “Sync” submenu allows for configuration of the following parameters:

Tune Voltage

This submenu determines how the generator voltage should behave in order to be in sync with the bus.

The following parameters are available within this submenu:

Parameter	Range/Choices
Gen to Bus Sync Automatic Voltage Match Enable Status	Disabled/Enabled
Gen to Bus Max Voltage Difference % Thresh	1-15%
Gen to Bus Sync Voltage Match Rate Configuration	1-100%/sec

Tune Frequency

This submenu determines how the generator frequency should behave in order to be in sync with the bus. Keep in mind that the engine governor will also be driving to a certain speed. In order to tune the frequency gains, there needs to be an offset between the programmed governor speed and the desired frequency.

The following parameters are available within this submenu:

Parameter	Range/Choices
Prop Gain (Kp)	0-100%
Integral Gain (Ki)	0-100%

Tune Phase

This submenu determines how the generator phase should behave in order to be in sync with the bus.

The following parameters are available within this submenu:

Parameter	Range/Choices
Prop Gain (Kp)	0-100%
Integral Gain (Ki)	0-100%

Sync Window Setpoints

This submenu determines how close the generator voltage, frequency, and phase need to be to the bus in order to be considered in sync with the bus in preparation for a breaker closure.

The following parameters are available within this submenu:

Parameter	Range/Choices
Phase Deg Window (+)	0-30 degrees
Phase Deg Window (-)	0-30 degrees
Min Dwell Time (Sec)	0.1-1 Sec

Sync Setpoints

This submenu determines how the generator handles a failure to synchronize to the bus.

The following parameters are available within this submenu:

Parameter	Range/Choices
Gen to Bus Sync Negative Slip Freq Enable Status	Disabled/Enabled
Gen to Bus Sync Failure Warning Event Threshold	0-99 seconds
Gen to Bus Sync Failure Shutdown Event Threshold	0-99 seconds

15.5.9 Synchronization Gain Tuning Procedure

Each system and configuration has different synchronization needs. This section is intended to aid in properly tuning the system.

Background

While the AVR matches voltage, the synchronizing control algorithm looks at frequency and phase angle across the generator breaker. If the frequency difference is greater than 0.1 Hz, then only frequency is considered. This is the Frequency Match control. Once the frequency difference is less than 0.1 Hz, then the phase angle is added to the control loop set point. This is the Phase Match control.

Proportional gain has the largest overall effect on tuning. If Proportional gain is set too high, the unit will overshoot the desired point and have trouble maintaining stability. If it is set too low, the unit will have difficulty reaching the desired window in a reasonable amount of time. In this case, Integral gain may be used. Integral gain will provide the extra push needed when the Proportional gain is just short of what is needed to bring the unit to within the desired window after a large change was needed.

General Considerations

1. Ensure the generator set to be tuned has proper engine governor and voltage regulator tuning and runs with stable voltage and frequency prior to adjusting the synchronization setpoints.
2. The engine governor and voltage regulator tuning may affect this tuning procedure. Setting those module gains lower may aid this procedure.
3. For engines with electronic governors, adjusting fewer gain settings in the EMCP 4.4 (only adjusting Ki, for example) will cause a less complicated interaction with the engine gains.
4. The temperature of the equipment to be tuned, ambient temperature, and altitude will affect the gain tuning and response of the system. A more cautious tuning of slow and stable vs. fast and unstable is recommended.
5. For the generator set to be tuned, ensure there are no inputs that can put the generator set, or the SMS into Auto. Do not press the Auto button. A Digital Input could be programmed to force the SMS to be in Check. If the unit is in Auto during the gain tuning procedure, then a Fail to Parallel event will occur after a predefined time.
6. If applicable, ensure the generator set and 3-phase source “Load Share” setpoints are properly tuned. See Section 15.6.
7. Disable HWLSLD on the generator set and the 3-phase source (if applicable), or ensure HWLSLD setpoints are not set in a manner that will cause nuisance breaker tripping.
8. If the 3-phase source is another EMCP 4.4 generator set, you may put that unit in Auto with its SMS in Auto and enable HWDBA to ensure its breaker will close.
9. If a Group start signal is used, ensure that both generator set packages are in Auto and HWDBA is enabled on the first generator set (the one not being tuned).

Strategy

When synchronizing, the EMCP 4.4 matches Voltage, Frequency, and Phase. The Voltage matching does not require a tuning procedure but does have setpoints associated with it to be considered. See Section 15.5.

This tuning procedure will first explain how to tune the Frequency matching, then the Phase matching. In order to properly tune, the procedure should be done multiple times. If tuning against a 3-phase source with load share capability, the tuning procedure variations should be done in order of the most stable to least stable. The iterations from most stable to least stable are as follows:

1. 3-phase source or Load Share disabled with load on bus
2. 3-phase source or Load Share disabled with no load on bus
3. 3-phase source or Load Share enabled with no load on bus
4. 3-phase source or Load Share enabled with load on bus

In order to see a proper response from the generator set, there needs to be a way to create a frequency difference between the generator set being tuned and the 3-phase source. In general the best method is to tune to a source that has a lower frequency first, then tune to a source with a higher frequency. Tuning to a source with a higher frequency usually will provide a better response that may provide false confidence if not tuned to a source with a slower frequency first.

Procedure

1. Ensure a 3-phase source is on the bus.
2. Start the generator set to be tuned, but NOT from Auto.
3. Tune Frequency Match – Phase arrow will be gray, not solid.
   a. Put SMS into the Check position.
   b. Go to the Sync Overview Screen and verify there is the proper voltage on the bus.
   c. Press the Tune Hz soft key.
   d. Set Kp, Ki to 0.
   e. Press the Sync Screen softkey.
   f. Watch the arrow for generator Frequency.
   g. Look for a rapid approach to the frequency band with a long dwell time within the band. The long dwell time is the more important characteristic.
   h. Create a frequency on the bus that is lower than the generator set by either changing the frequency of the 3-phase source (load step, frequency setting), or adjusting the generator set frequency to a value above the bus frequency. Adjusting the generator set frequency is the preferred method. Ensure an electronic engine governor is not driving frequency match or else a kW/kVAr shutdown may occur.
   i. On the Sync Screen, look for a rapid approach to the frequency band with a long dwell time within the band. The long dwell time is the more important characteristic.
   j. If the arrow does not show the behavior above, adjust the PI settings until the above behavior is seen (repeat steps e through i). Start by adjusting Ki first, and change gains settings one at a time.
   k. Repeat steps e through i again, but with a frequency on the bus that is higher than the generator set in step h.
   l. When the frequency seems stable within the band, watch for the numeric value of the frequency to be stable.
   m. Watch that the phase arrow also stays black at this point.
   n. The better the frequency is tuned, the easier phase matching will be.
   o. Instability in frequency may be an indicator that engine tuning is not suitable.

4. Tune Phase Match
   a. Verify the phase arrow is solid black. Gray indicates the controller is still in the Tune Frequency Match mode.
   b. Adjusting the phase settings will affect the frequency response of the generator set.
   c. Notice that the measurement marks on the phase bar are not linear.
   d. With the SMS still in the Check position, press the Tune Phase soft key.
   e. Set Kp, Ki, Kd to 0.
   f. Press the Sync Screen softkey.
   g. Watch the arrow for generator Phase.
   h. On the Sync Screen, look for a rapid approach to the phase band with a long dwell time within the band. The long dwell time is the more important characteristic. If the phase arrow goes gray, then Hz gain is not optimal.
   i. Create a frequency on the bus that is lower than the generator set by either changing the frequency of the 3-phase source (load step, frequency setting), or adjusting the generator set frequency to a value above the bus frequency. Adjusting the generator set frequency is the preferred method. Ensure an electronic engine governor is not driving frequency match or else a kW/kVAr shutdown may occur.
   j. On the Sync Screen, look for a rapid approach to the phase band with a long dwell time within the band. The long dwell time is the more important characteristic. Sync Window setpoints may affect this tuning. See Section 15 .5 .
   k. If the arrow does not show the behavior above, adjust the PI until above behavior is seen (repeat steps e through i). Start by adjusting Ki first, and change settings one at a time.
   l. Repeat steps e through i again, but by creating a frequency on the bus that is higher than the generator set in step h.
   m. The better the frequency is tuned, the easier phase matching will be.
   n. Phase tuning can be more aggressive than frequency match since once the breaker closes, the phase will stay matched.

5. Ensure any Digital Inputs placing the SMS into any state other than Auto are not active.

6. Put the SMS in Auto to see if the unit synchronizes.

7. If a successful synchronization occurs, open the breaker and resynchronize a few more times to ensure an acceptable, repeatable synchronization time.

8. If a Reverse kW shutdown occurs, this is an indication that gains are not programmed for appropriate stability.

9. If the unit takes too long to synchronize, check that the start time is acceptable. The time to sync from Auto with the generator set running is the start time plus the sync time.

10. Repeat steps 1 through 7 for the next iteration of Load Share enabled vs load on the bus as described in the Strategy section.

15.6 Real and Reactive Load Sharing in Island Mode Details

15.6.1 Purpose

The purpose of Real and Reactive Load Sharing is to share the real and reactive load proportionally among all of the online units in an island mode type configuration. This island mode configuration can be prime power, standby, or peak shaving (disconnected from the mains/utility).

15.6.2 Wiring

These wires should consist of a shielded twisted triad, or equivalent. Wire size should be 18 AWG or larger. The connections between generator sets are described in Figure 15.11.

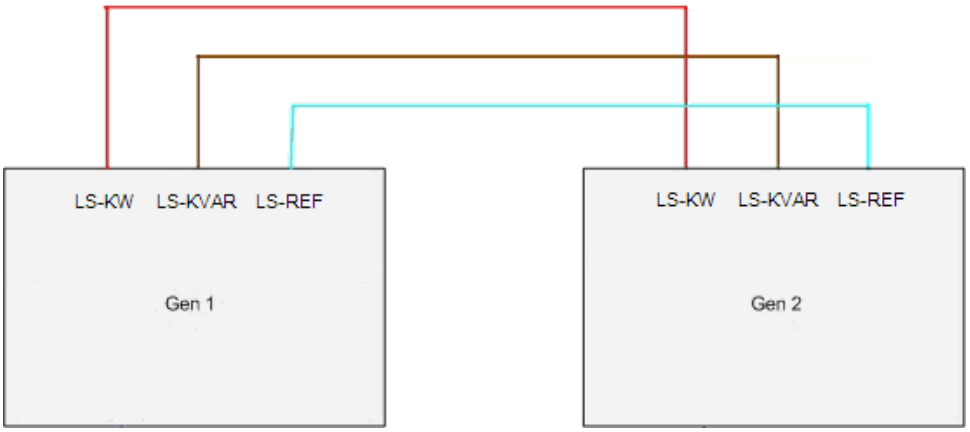


Figure 15.11 – Load Sharing Wiring

15.6.3 Basic Operation

EMCP 4 .4 controllers can operate in an island mode sharing load via load sharing lines . Separate lines are used for both real power (kW) and reactive power (kVAr) . When the generator breaker is closed and the load sharing is set to HW, the unit controls load until the internally generated load signal matches the externally measure load signal.

As the externally measured signal changes, the EMCP 4 .4 changes the generator set speed or voltage control to match the signal. If Generator Reactive Load Sharing is turned off, no signals are sent to the AVR to control the voltage. This allows customers to implement voltage droop or cross current separate from the EMCP 4 controller. As different units enter or leave the system, or the load changes, the units need to adjust their contribution to contribute equal amounts.

The kW (real load) sharing line can operate at either a 0-10VDC or 0-3VDC level. The 0-10VDC level is preferred, unless other devices on the loadsharing network require the lower voltage level.

The kVAr (reactive load) sharing line will only operate at a 0-10VDC level. It is not designed to interface to other devices.

The loadsharing lines are isolated signals reference to the 3rd line (reference). This reference must be connected between all of the units. This reference is not connected to battery negative by the EMCP 4 .4.

Always keep in mind that an EMCP 4 .4 controller is unable to know if other controllers are on the loadsharing network. An EMCP 4 .4 controller will load share with itself even if no other controllers are on the hardwired loadsharing network.

15.6.4 Sharing Lines (kW and kVAr)

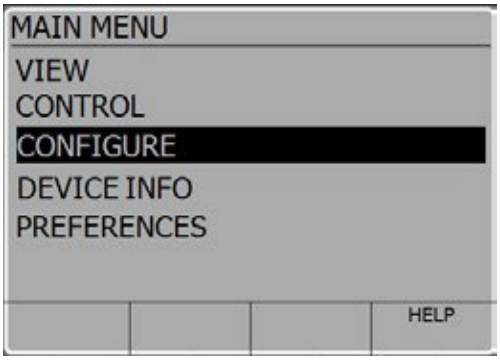
The EMCP 4.4 supports one 3-wire (plus shield) load sharing line (Analog Input and Output on a single pin for each signal). The real power (kW) is compatible with Woodward Load (LSM) sharing line (0-3VDC) systems. The reactive power (kVAr) operates in a similar manner to the real power lines, but is based upon reactive power and is not compatible with SPMD systems (0-2-4VDC). This hardware operates at a higher voltage (0-10VDC) for improved resolution when not being used with legacy Woodward components. A reference pin is provided on the EMCP for this sharing line.

15.6.5 Enabling Load Sharing

In order to enable Load Sharing, go through the following menu options:

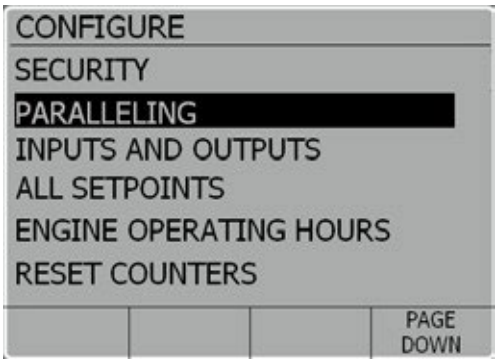
1. At the MAIN MENU, scroll DOWN  to CONFIGURE.

2. Press the OK KEY .



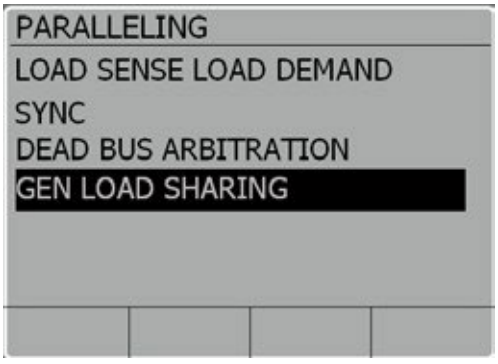
3. Scroll DOWN  to PARALLELING.

4. Press the OK KEY .



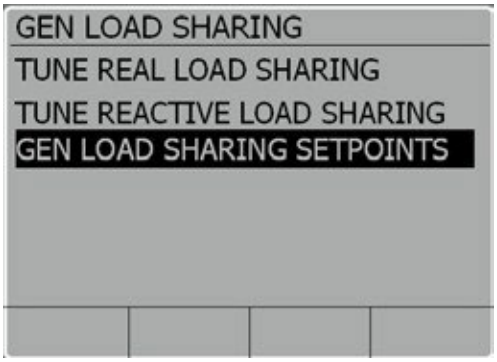
5. Scroll DOWN  to GEN LOAD SHARING.

6. Press the OK KEY .

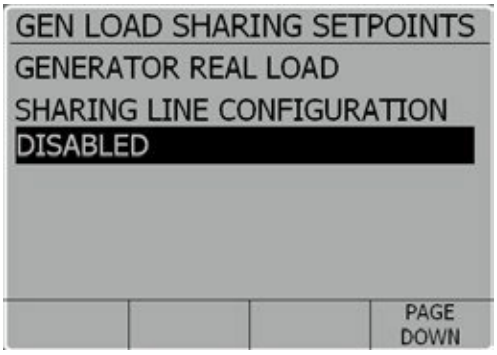


7. Scroll DOWN  to GEN LOAD SHARING SETPOINTS.

8. Press the OK KEY .

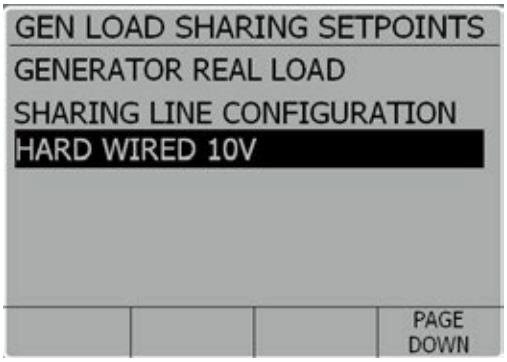


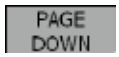
9. Press the OK KEY  to highlight the GENERATOR REAL LOAD SHARING LINE CONFIGURATION setting.

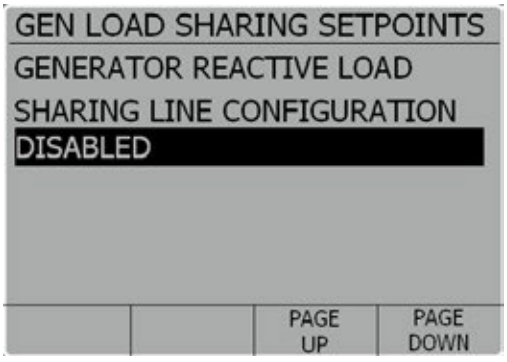


10. Select either HARDWIRED 10V, or WIRED 3V LEGACY MODE.

11. Press the OK KEY .



12. Press the PAGE DOWN  soft key to access GENERATOR REACTIVE LOAD SHARING LINE CONFIGURATION.

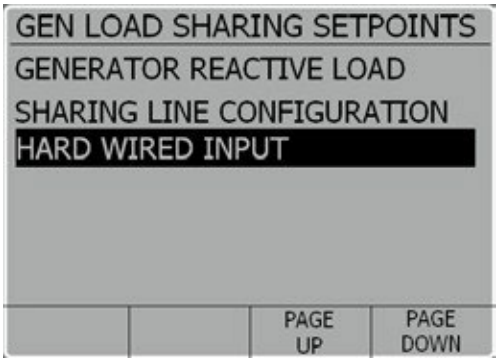


13. Press the OK KEY  to highlight the GENERATOR REACTIVE LOAD SHARING LINE CONFIGURATION setting.

14. Select HARDWIRED INPUT.

15. Press the OK KEY 

.



15.6.6 Viewing Parameters

Within the "View" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for viewing only. No control or configuration is available from this submenu.

The Load Share screen shows the current status of the generator power and load target with the generator on the left hand side of the screen. Real and Reactive load are shown as a percentage, as well as graphically. Breaker position is represented graphically only. Soft keys allow quick toggling between the Sync Overview, Load Share, Dead Bus Arbitration, and Load Sense Load Demand. See Figure 15.12.

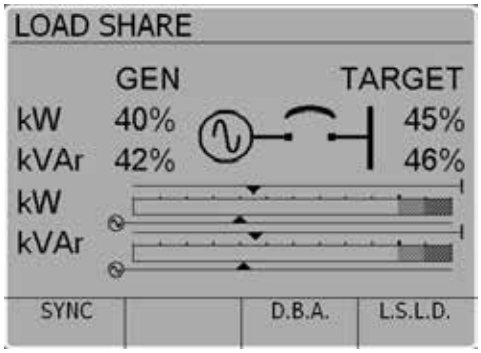


Figure 15.12 – Load Share – View Screen

The arrows on the graphs of kW and kVAr connected to the generator symbol indicate the percentage of full generator capacity. The arrows connected to Target kW and kVAr indicate the desired percentage of generator capacity via the load sharing lines. When the generator and target values line up, the generator is sharing load. The light gray shaded area of the graph represents the 100-110% rating of the generator. The dark gray shaded area of the graph represents the 110-120% rating of the generator.

15.6.7 Controlling Parameters

Within the "Control" submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for control. No configuration is available from this submenu.

The Load Share screen allows for control of the kW and kVAr settings and shows the current status of the generator power and load target with the generator on the left hand side of the screen. Real and Reactive load are shown as a percentage, as well as graphically. Breaker position is represented graphically only. Soft keys allow quick toggling to the Tune kW and Tune kVAr screens. See Figure 15.13.

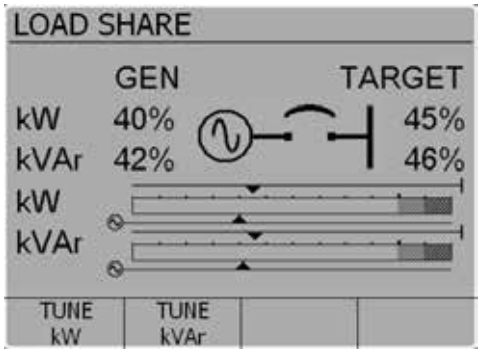


Figure 15.13 – Load Share – Control Screen

The arrows on the graphs of kW and kVAr connected to the generator symbol indicate the percentage of full generator capacity. The arrows connected to Target kW and kVAr indicate the desired percentage of generator capacity via the load sharing lines. When the generator and target values line up, the generator is sharing load. The light gray shaded area of the graph represents the 100-110% rating of the generator. The dark gray shaded area of the graph represents the 110-120% rating of the generator.

To adjust the kW or kVAr gains, press the corresponding soft key.

Within the gain adjustment screens for kW and kVAr, the Proportional and Integral, gains can be individually selected and changed. A soft key allows quick access back to the Load Share screen. See Figure 15.14.

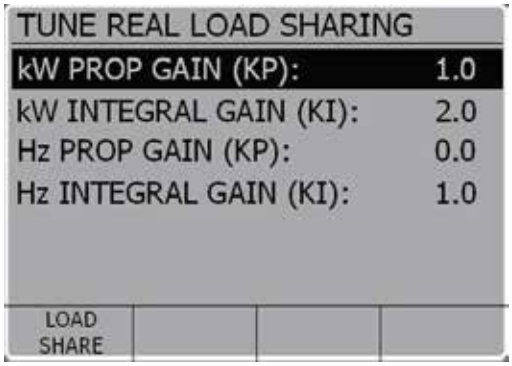


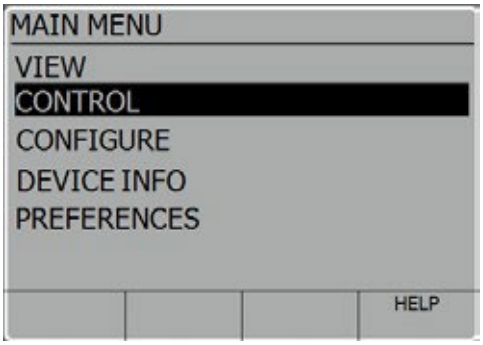
Figure 15.14 – Tune Real Load Share Gains Screen

To Change the Load Sharing Gain Settings:

At the MAIN MENU

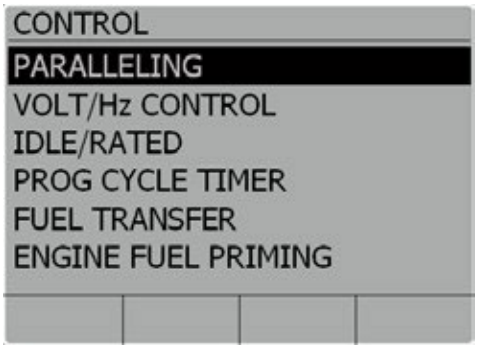
1. SCROLL DOWN  to: CONTROL.

2. Press OK KEY .



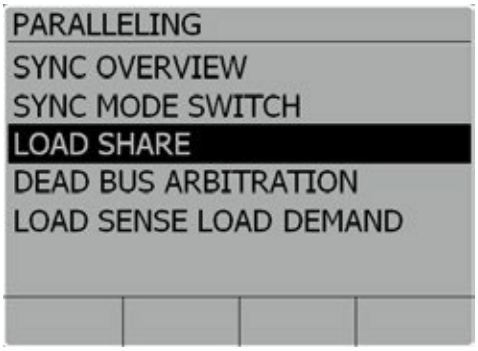
3. Scroll DOWN  to: PARALLELING.

4. Press OK KEY .

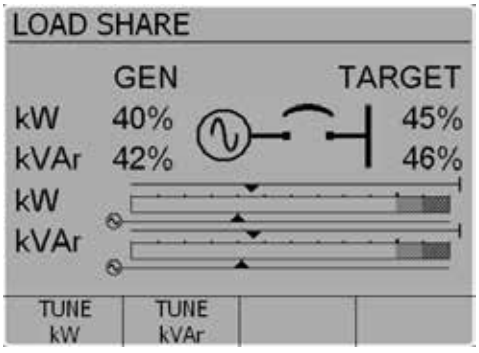


5. SCROLL DOWN  to LOAD SHARE.

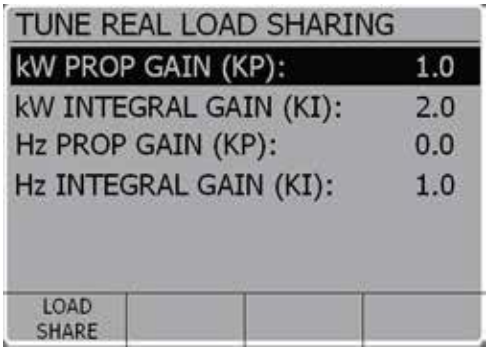
6. Press the OK KEY .



7. The Load Share screen shows. Press the desired soft key. (In this example, “Tune kW” is selected).



8. Select the desired gain to adjust by pressing the corresponding soft key, or using the DOWN ARROW and pressing the OK KEY. (In this example, “Prop Gain” is selected).



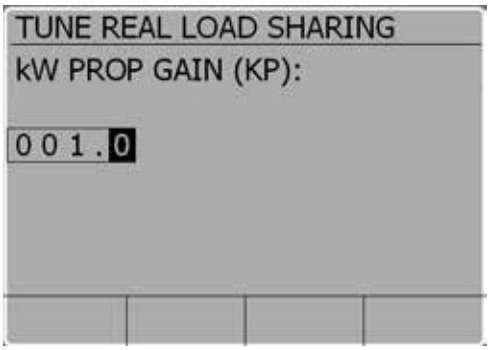
To Edit the GAIN:

9. Select a digit using the LEFT ARROW or RIGHT ARROW.

10. To change the selected digit use the UP ARROW or DOWN ARROW.

11. To accept the change, press the OK KEY.

12. To reject the change, press the ESCAPE KEY.



15.6.8 Configuring Parameters

Within the “Configuration” submenu, the Paralleling selection allows navigation to the parameters specific to paralleling that are for configuration. These parameters may also be accessed through the “All Setpoints” submenu.

The Gen Load Sharing configuration screen contains the parameters necessary to set up the Gen Load Sharing functions. The following paralleling functions are configurable within the “Gen Load Sharing” submenu of the EMCP 4.4 “Configure” submenu (see Figure 15.5).

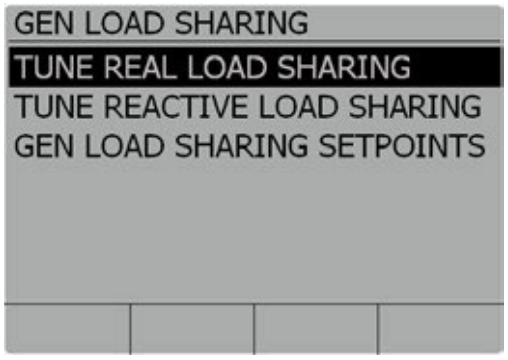


Figure 15.5 – Gen Load Sharing – Configure Submenu

The “Gen Load Sharing” submenu allows for configuration of the following parameters:

Tune Real Load Sharing

These setpoints determine the generator response while in Real Load Sharing mode.

The following parameters are available within this submenu:

Parameter	Range/Choices
kW Prop Gain (Kp)	0-100%
kW Integral Gain (Ki)	0-100%
Hz Prop Gain (Kp)	0-100%
Hz Integral Gain (Ki)	0-100%

TUNE REACTIVE LOAD SHARING

These setpoints determine the generator response while in Reactive Load Sharing mode.

The following parameters are available within this submenu:

Parameter	Range/Choices
kVAr Prop Gain (Kp)	0-100%
kVAr Integral Gain (Ki)	0-100%
Volt Prop Gain (Kp)	0-100%
Volt Integral Gain (Ki)	0-100%

Gen Load Sharing Setpoints

These setpoints enable Load Sharing and determine the generator Real Load Sharing time delays and thresholds.

The following parameters are available within this submenu:

Parameter	Range/Choices
Gen Real Load Sharing Line Config	Disabled/Hard Wired 10V/Hard Wired 3V legacy Mode/Ethernet
Gen Reactive Load Sharing Line Config	Disabled/Hard Wired Input/ Ethernet
Gen Real Load Control Max Gen Soft Load Time Config – The amount of time used to calculate a ramp rate (kW/second) to go from no load (0% of kW) to full load (100% of kW).	0-600 seconds
Gen Real Load Control Max Gen Soft Unload Time Config – The amount of time used to calculate a ramp rate (kW/second) to go from full load (100% of kW) to no load (0% of kW).	0-600 seconds
Gen Real Load Control Soft Unload Complete % Threshold – The percentage of real load (kW) at which the EMCP 4 will disconnect the load by sending a command to open the generator circuit breaker.	1-50%

15.6.9 Load Sharing Gain Tuning

Each system and configuration has different load share gain tuning needs. This section is intended to aid in properly tuning the system.

Background

Load sharing is the process of sharing the real power (kW) and reactive power (kVAr) between generator sets while still maintaining proper frequency and voltage.

General Considerations

The controlling factors for kW and frequency is the same. Both are based upon the torque or power being provided by the engine. Increasing the power from the engine will either increase the kW being provided, which must be consumed, or the frequency will increase. The kVAr and voltage is based on the excitation of the generator. Increasing the excitation will provide additional kVArs which must be consumed, or the voltage will increase. For these reasons, the tuning of Load Sharing is more difficult since multiple factors are driving a single control point.

Strategy

Since each of these factors have multiple controlling factors, a means of approaching the tuning of load sharing is required. One item to keep in mind is that full concentration on any portion of the load sharing is not possible since these different factors interact with each other. For example, any instability in the voltage/kVAr sharing affects the frequency/kW since the power consumed by the load is usually affected by the voltage. For this reason, multiple items must be considered simultaneously.

Guidelines

Be sure to be familiar with navigation of the screens and setpoints before attempting to develop a set of gains. Read through and become familiar with how to view the information about the load status along with information on the electrical output of the generator set. Since load sharing affects multiple units in the system, it is easy for the system to become unstable.

All protective relay settings such as reverse power and reverse kVAr should be reviewed and possibly tightened for commissioning in order to protect the generator set. It is recommended to use a resistive and reactive load bank to tune generator load sharing. While it is possible to tune the real power sharing with just a resistive load bank, tuning of both parameters require kW and kVAr control. If customer load is going to be used for tuning, care must be taken to ensure that the voltage and frequency variations will not cause damage to the load.

The process of load sharing tuning is an iterative procedure. It is NOT possible to arrive at optimum settings for one setting before tuning the other settings. In addition, it is NOT possible to tune one generator set without tuning the other generator sets with which it is load sharing. If the generator sets are equivalent power ratings, tuning is easier since the setpoints can be copied from one unit to the next. The use of multiple people or use of ET on one unit with the laptop near the second unit will help in modifying the setpoints of multiple units.

In order to keep the frequency (voltage) gains from overpowering kW (kVAr) gains, the frequency and voltage gains are turned off when the generators are close to nominal frequency and voltage. This may cause a slight ripple in frequency and voltage while it oscillates around the nominal frequency or voltage.

Regardless of the amount of units at a site, it is recommend to first develop initial gains only using two units. These gains may need to be adjusted as part of an iterative process when additional units are added, but it easier to tweak gains once a stable set has been arrived at.

The units may ship with starting point gains. If they do, start with these gains and adjust them as needed. If there are no usable gains to start with, perform the following steps to develop initial gains:

1. Zero out the Hz and Voltage gains (Kp and Ki). This will allow the units to concentrate on sharing kVAr and kW, regardless of the voltage or frequency of the system. If different generator sets are being used, these may not be able to be zeroed out since the governor or regulator may influence frequency (speed) or voltage.

2. Start with a very small integral gain or even zero, but have a medium size proportional gain for kW and kVAr. Pay close attention to what is going on with the system. While working with the proportional gain, do NOT expect the units to share equally, but some sharing should be occurring.

3. Increase the integral gain to improve the process. Keep in mind a slightly slower response keeps you further from instability as parts of the system change due to ambient conditions, loading conditions, fuel quality, etc.

4. Once you have some gains that allow reasonable (+/-10%) sharing to occur, start bringing in the Voltage and Hertz gains in order to correct the voltage and frequency to the nominal values. These gains will be processed simultaneously with kW and kVAr loop, and may drive changes. While adjusting these gains, the system should be looked at for response to load changes, adding and removing generator sets, etc. Make sure to watch for response as a single unit load sharing with itself, along with the second unit on the bus.

There is no single right set of gains, but an iterative process to develop gains. Any changes in governor software or settings or voltage regulator software or settings will have an effect on optimum gains. If you are running into instability problems, lowering the gains of the governor or voltage regulator may allow for an improved system performance. The optimum settings of a single unit against a load are NOT the optimum settings for a unit as part of a system.

15.7 Load Shed

15.7.1 Purpose

The Load Shed feature provides a method to disconnect loads from the system based upon user configuration. This can be used for multiple or single generator sets.

15.7.2 Basic Operation

Load Shed is a configurable function that can be used to activate one or more Digital Outputs. These outputs can be configured to activate based upon user defined criteria. When one, or more, of the criteria are met, the associated Digital Output will activate.

15.7.3 Configuring Parameters

Within the "All Setpoints" submenu within the "Configuration" menu, the "Control" submenu provides access to the parameters specific to Load Shed that can be configured.

The Load Shed Conditions configuration screen contains the parameters necessary to set up the Load Shed functions. The following functions are configurable within the "Gen Load Sharing" submenu of the EMCP 4.4 "Configure" submenu (see Figure 15.6).

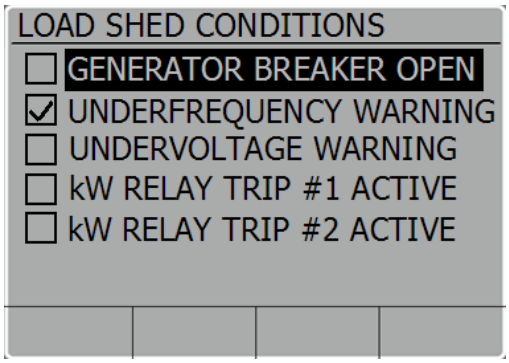


Figure 15.6 – Load Shed Conditions – Configure Submenu

Load Shed will activate when all of the following conditions are met:

1. A Digital Output is programmed for Load Shed,

2. Any, or all of the Load Shed conditions are selected in the Load Shed Conditions screen, and

3. Any of the selected Load Shed conditions occurs

The Load Shed signal shall be latched until the generator loses the start signal (STOP command or loss of Remote Initiate) or the operator activates a momentary Load Shed Reset Command via digital input or from the EMCP 4 display. The load shed output is reset only if all activation conditions are cleared.

15.8 Breaker Selection

Care must be taken in the selection of Circuit Breakers for EMCP 4.4 paralleling controller. The breaker must be sized appropriately for the generator current capability, along with interrupting capability for fault currents from paralleled sources.

The capability of meeting industry 5 to 6 cycle close capability is required, along with the ability to electrically open and close the circuit breaker. Aux contacts (A and B) from the circuit breaker are also required. An electrically operated breaker is required for the paralleling system.

For maximum reliability, both a DC powered shunt trip and a DC powered undervoltage trip shall be used when the circuit breaker is capable of supporting both. If the circuit breaker can support only one of these, the DC undervoltage release shall be used. An undervoltage release will open the circuit breaker upon the loss of DC power to the circuit breaker.

If a circuit breaker stays closed upon loss of control to the generator set, the generator will act as a motor and damage to the generator set will result. Care should be taken in the design of the package wiring when multiple disconnect means exist on the DC voltage system.

All electrically controlled breakers used with the paralleling EMCP 4.4 controller must have a cover that disables the close button on the circuit breaker. The circuit breaker must only be able to be closed after verification by the EMCP 4.4 that the bus is dead or that the generator set is in phase with the bus.

16.0 Modifiable Text Strings

The EMCP 4.3 and EMCP 4.4 support the renaming of digital input Custom Events for the event log and analog input Custom Parameters for monitoring and the event log. This feature is called MODIFIABLE TEXT STRINGS. This is useful when an existing SPN and text string do not exist for the required event or parameter. These events/parameters can be configured and triggered similar to other events/parameters. However, these events/parameters are unique in that their displayed text strings can be customized via the Cat Service Tool using any character in the supported character set of the EMCP 4 software flash file. Furthermore, the Cat Service Tool has the capability to upload a Modifiable Text Strings configuration file (containing previously saved custom event text strings) from the computer, or download a configuration from the EMCP 4 to the computer.

In order to display a custom text string for an event, the following steps must be taken:

1. One of the Digital Inputs must be configured as a Custom Event with a Failure Mode Identifier of Status (or Condition Exists). For more information on configuring Digital Inputs, see Section 10.1.7.
2. A custom string must be entered, using the Modifiable Text Strings tool in the Cat Service Tool, as described in Chapter 16.
3. The language must be set to the customer language, not to Technician English.

An example of entering a modifiable text string for Digital Input Custom Event #1 is given in Figure 16.1.

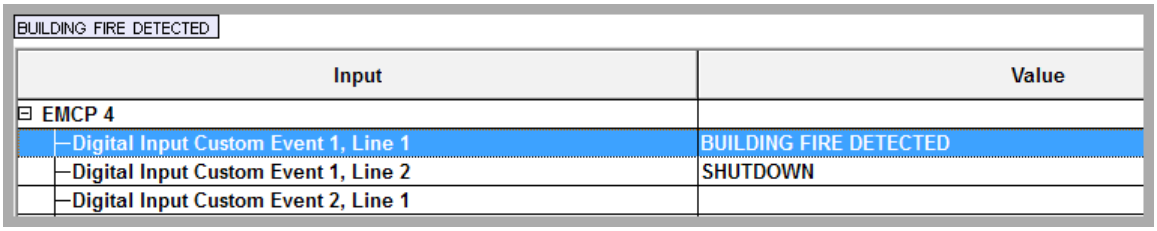


Figure 16.1 – Customizing A Text String With the Cat Service Tool

The EMCP 4.3 and EMCP 4.4 support one Modifiable text string per Custom Event on each programmable Digital Input and a Modifiable text string per Custom Parameter and one per Custom Units on each programmable analog input.

16.1 Language Support

The primary language for the EMCP 4 control will always be Technician English. The user will always be able to revert back to Technician English from the selected language that is supported by the flash file. However, when the EMCP 4 display is viewed in Technician English, the user will not be able to view the custom text strings and will only be able to view the default strings (Custom Event #N) for a given input.

The EMCP 4 has the capability of supporting one flash file containing one secondary language at any particular time. If the user is interested in having a new secondary language, a new flash file to configure the new language must be installed. Therefore, the user is not able to install multiple flash files supporting different languages simultaneously.

The EMCP 4 supports Unicode characters from the English character set, as well as the character set from the local language supported by the file. It is the user's responsibility to install the preferred flash file with the correct language support that will allow the modification of text strings.

The user is also responsible for choosing the appropriate operating system or Unicode text entry system for the chosen language. The Cat Service Tool software accepts input from the PC keyboard settings. If, for example, the PC keyboard setting is for U.S. English, it may be difficult to enter Russian (or other non-English) characters.

Different language software supports different sets of characters. Therefore, Modifiable Text String configuration files created in one language will not become translated if new language software is flashed into the EMCP 4. The original text string will still show as originally entered, or it may not show correctly if the new software language does not support all the characters in the original language.

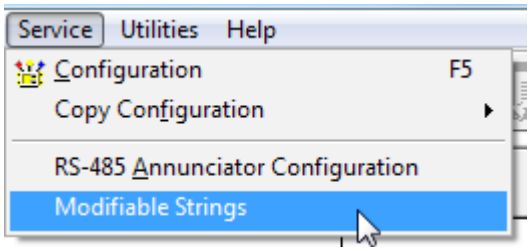
16.2 Programming Modifiable Text Strings Using the Cat Service Tool

To configure a Modifiable Text String using the Cat Service Tool, go through the following menu options:

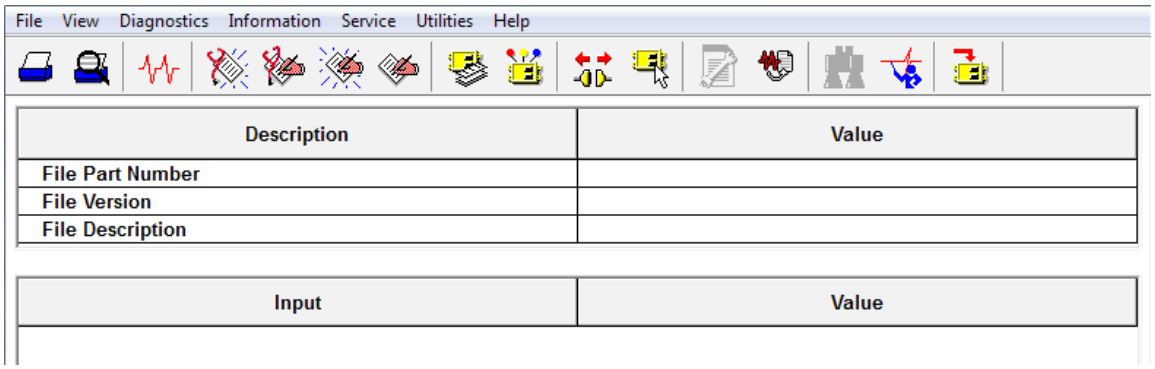
1. Connect the EMCP to the Cat Electronic Technician as described in Section 4.2.

Note: The Service Tool must be connected to CAN 1 and the EMCP must be selected during the connection if multiple ECMs are present.

2. Select “Modifiable Strings” under “Service” from the choices at the top of the software screen.



3. The “Modifiable Strings” screen will appear.



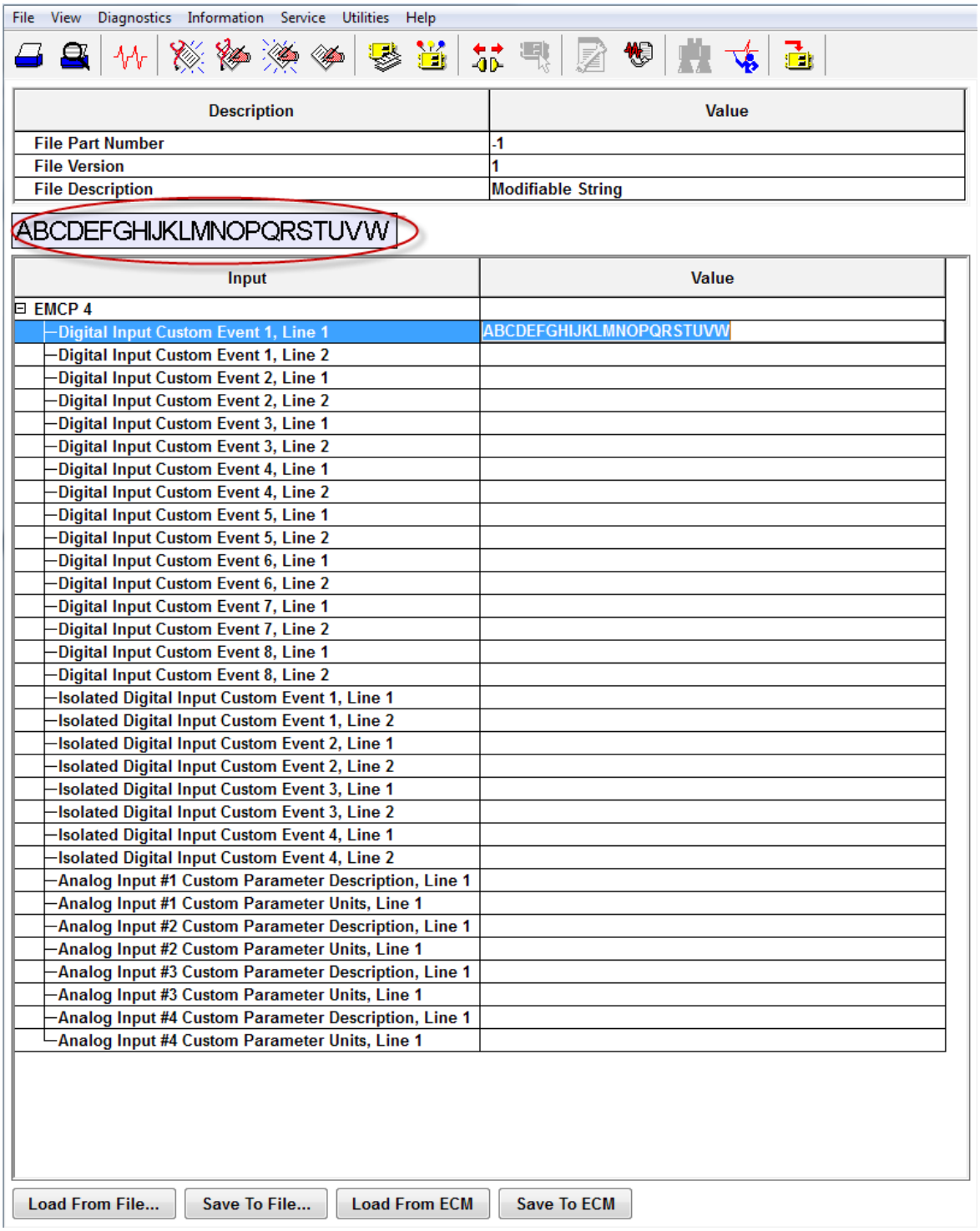
4. In order to load the existing text string file from the ECM, click the “Load From ECM” button on the bottom of the screen.



5. The stored strings, if any, will appear. For first time configuration, the strings will be blank.

Input	Value
EMCP 4	
Digital Input Custom Event 1, Line 1	
Digital Input Custom Event 1, Line 2	
Digital Input Custom Event 2, Line 1	
Digital Input Custom Event 2, Line 2	
Digital Input Custom Event 3, Line 1	
Digital Input Custom Event 3, Line 2	
Digital Input Custom Event 4, Line 1	
Digital Input Custom Event 4, Line 2	
Digital Input Custom Event 5, Line 1	
Digital Input Custom Event 5, Line 2	
Digital Input Custom Event 6, Line 1	
Digital Input Custom Event 6, Line 2	
Digital Input Custom Event 7, Line 1	
Digital Input Custom Event 7, Line 2	
Digital Input Custom Event 8, Line 1	
Digital Input Custom Event 8, Line 2	
Isolated Digital Input Custom Event 1, Line 1	
Isolated Digital Input Custom Event 1, Line 2	
Isolated Digital Input Custom Event 2, Line 1	
Isolated Digital Input Custom Event 2, Line 2	
Isolated Digital Input Custom Event 3, Line 1	
Isolated Digital Input Custom Event 3, Line 2	
Isolated Digital Input Custom Event 4, Line 1	
Isolated Digital Input Custom Event 4, Line 2	
Analog Input #1 Custom Parameter Description, Line 1	
Analog Input #1 Custom Parameter Units, Line 1	
Analog Input #2 Custom Parameter Description, Line 1	
Analog Input #2 Custom Parameter Units, Line 1	
Analog Input #3 Custom Parameter Description, Line 1	
Analog Input #3 Custom Parameter Units, Line 1	
Analog Input #4 Custom Parameter Description, Line 1	
Analog Input #4 Custom Parameter Units, Line 1	

6. Click in the Value column next to the event/parameters to be modified. Type the desired text string. The Modifiable Text String is considered a pair of text strings, and the user has the option of customizing the pair of text strings. The second event line has less available space, because the event log index is also displayed on that line. The analog input custom parameter units line has less available space as well.



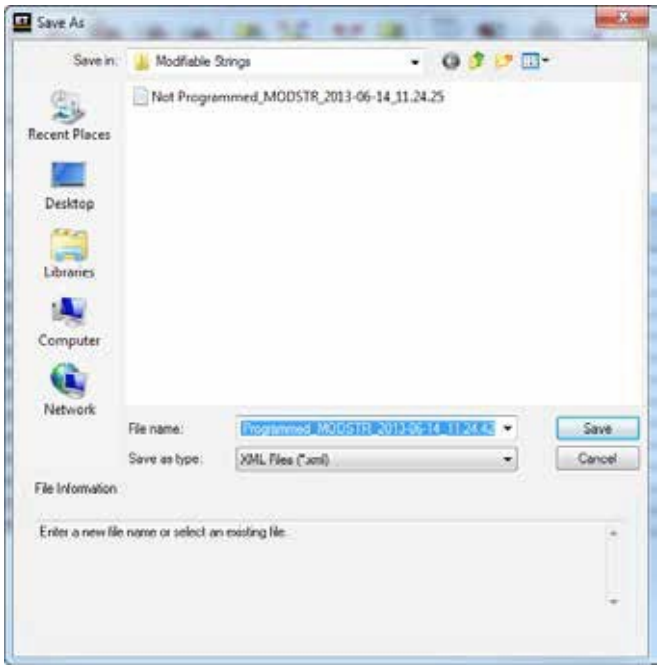
7. Once all text strings are entered for all events/parameters desired, click on the “Save to ECM” button on the bottom of the screen.



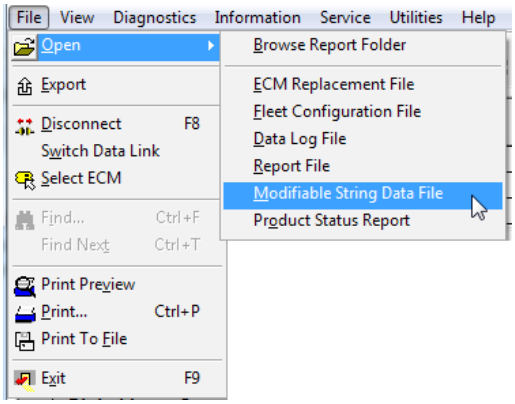
8. To then save the same file to the hard disk, click on the “Save to File .. ” and browse to the appropriate folder.



9. Once the file destination is found, click ”Save ”



10. To edit a saved text string in ET while not connected to the ECM, navigate to File → Open → Modifiable String Data File. This is equivalent to clicking on the “Load From File ...” button on the bottom left side of the “Modifiable Strings” screen.



11. Select the desired string data and click “Open.” This opens the “Modifiable Strings” screen again.

12. Edit as desired, then save to ECM, or save to a file.

Note: The Modifiable Text String parameter value’s field is initially blank until it is replaced with a custom text string parameter value. The custom text string parameter value entered will replace the default strings.

The user’s Custom Text Strings are displayed in the user’s preferred language. If the service tool doesn’t support the user’s preferred language, US English will be used.

It is advisable to split the text across both lines even if it can fit on a single line since the default terms will show if text has not been entered.

Note: The user must save any offline changes before attempting to connect the Service Tool to the EMCP 4, or the changes will not be saved.

17.0 Saving and Restoring Setpoints

The EMCP 4 supports the saving and uploading of the EMCP 4 setpoints through a setpoint configuration file. This file, called the ECM Replacement File, or Fleet Replacement File, is accessible via the ECM Replacement tool of the Cat Service Tool software. The file contains information specific to the EMCP 4, and includes the setpoint values that are specific to a given EMCP 4 module. The user has the option of saving the data to an ECM Replacement File from an EMCP 4 module or uploading the data from the ECM Replacement File to another EMCP 4 module. The user also has the option of uploading general configuration data to several EMCP 4 modules by means of a similar tool called Fleet Configuration. Both of these options are accomplished through the Cat Service Tool software.

Note: This chapter only addresses setpoints residing in the EMCP 4. To save and restore setpoints for other (optional) modules on the EMCP 4 CAN data links, a similar procedure must be followed for each individual module.

17.1 Saving EMCP 4 Configuration Data

The Cat Service Tool is used to save an EMCP 4 configuration.

The EMCP 4 configuration should be saved upon initial access or after any configuration change. This will be required for future accessibility when exchanging or replacing the EMCP 4 module.

After connecting to the EMCP 4, navigate to Service → Copy Configuration. (See Figure 17.1). There are two options:

- Fleet Configuration
- ECM Replacement

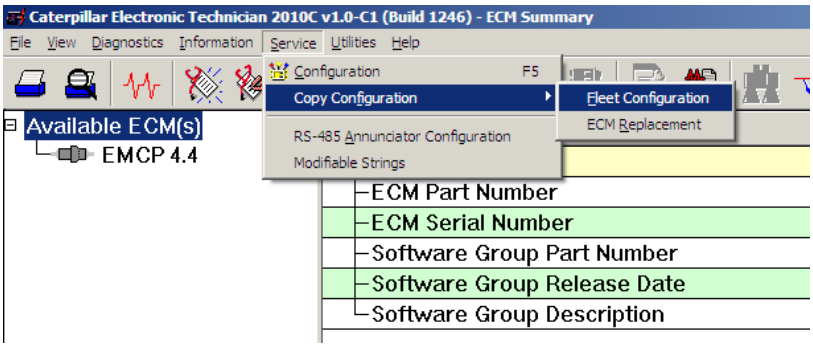


Figure 17.1 – Cat Service Tool EMCP 4 GSC Summary Screen

The loading of EMCP 4 configuration data is very similar between ECM REPLACEMENT and FLEET CONFIGURATION. For illustration purposes, the ECM REPLACEMENT option will be described here.

17.1.1 Fleet Configuration Option

Select the FLEET CONFIGURATION option when there is a need to save and copy GENERAL DATA to several ECMs (non-module-specific).

The FLEET CONFIGURATION tool works very similar to the ECM Replacement tool, with the exception of ignoring module-specific data such as ENGINE SERIAL NUMBER and ENGINE OPERATING HOURS.

17.1.2 ECM Replacement Option

To save EMCP 4 configuration data to an ECM Replacement file:

1. From the Service Tool menu, select the following: Service → Copy Configuration → ECM Replacement. See Figure 17.1.

2. The software will prompt the user to open a previously saved ECM Replacement file. Click "Cancel."

3. The following message is displayed: "No Data Is Available. Load From ECM Now?" Press "No."

4. Click "Load from ECM" from the bottom left of the ECM Replacement screen to upload the setpoints. See Figure 17.2.

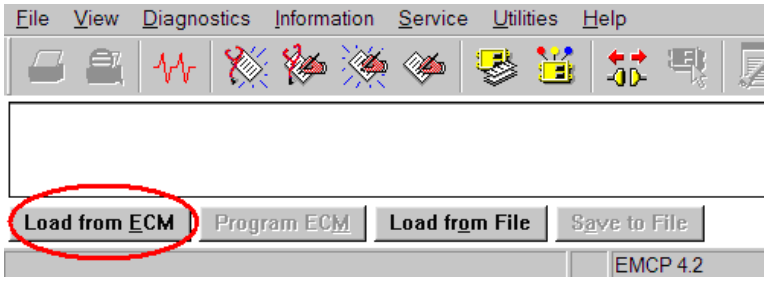


Figure 17.2 – Load from ECM

5. After the software loads the data, the replacement file parameters will be shown. See Figure 15.3.

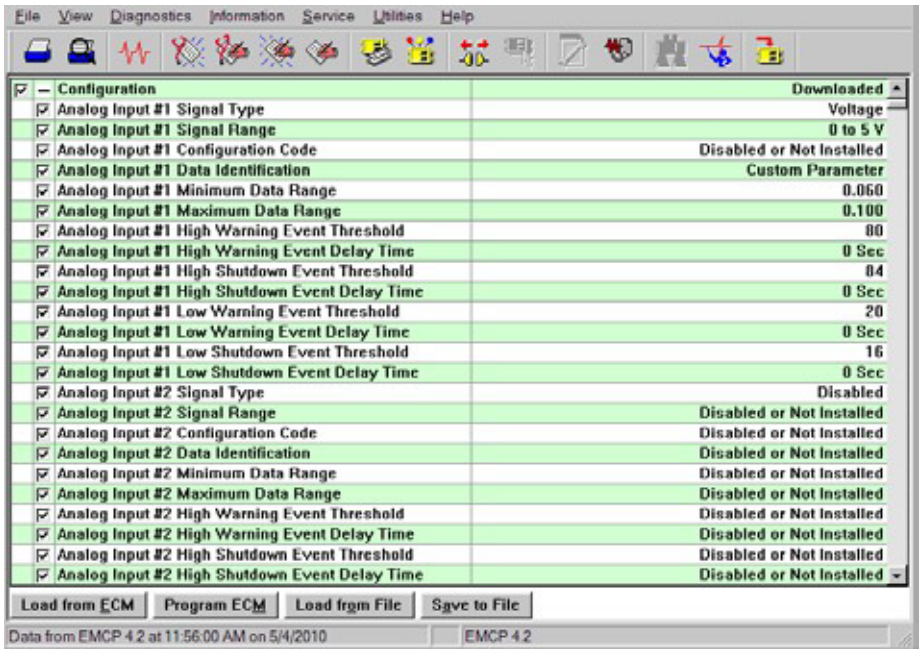


Figure 17.3 – ECM Replacement File Parameters

6. Select which ECM's configuration data is to be viewed and/or saved for future use by adding, or removing check boxes from the side of the parameters.

7. After any selection changes are completed, click "Save to File" from the bottom of the ECM Replacement screen to save the file. See Figure 17.4. Make sure to note where the file is stored.

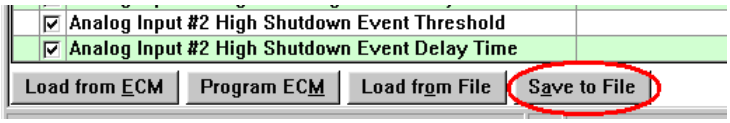


Figure 17.4 – Save to File

Note: The configuration data **must be saved to a file** before disconnecting from the service tool or the data WILL BE LOST and must be re-loaded from the source module again.

17.2 Loading EMCP 4 Configuration Data

The loading of EMCP 4 configuration data is very similar between ECM REPLACEMENT and FLEET CONFIGURATION. For illustration purposes, the ECM REPLACEMENT option will be described here.

Warning: When loading an ECM Replacement File, the engine operating hours will increase to the newly loaded value (if larger than the old value). To avoid this, deselect the Engine Operating Hours setting.

To load an ECM Replacement file to an EMCP 4:

1. From the Service Tool menu, select the following: Service → Copy Configuration → ECM Replacement. See Figure 17.1.

2. The software will prompt the user to open a previously saved ECM Replacement file.

3. Navigate to the location where the file is stored and click "Open."

4. The software will confirm opening the file. See Figure17.5. Click "OK."

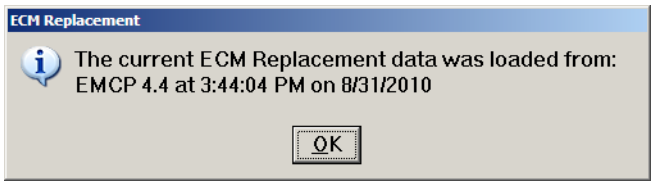


Figure 17.5 – Load from File

5. The replacement file parameters will be shown. See Figure 17.6.

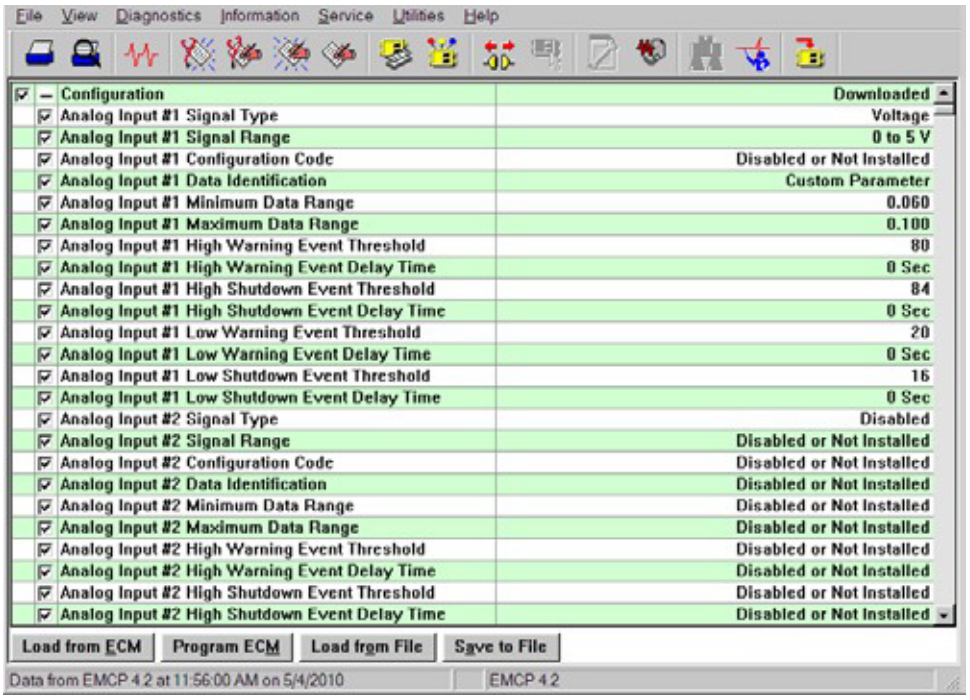


Figure 17.6 – ECM Replacement File Parameters

6. Select which ECM's configuration data is to be programmed into the EMCP 4 by adding, or removing check boxes from the side of the parameters.

7. After any selection changes are completed, click "Program ECM" from the bottom of the ECM Replacement screen to load the file into the EMCP 4. See Figure 17.7.

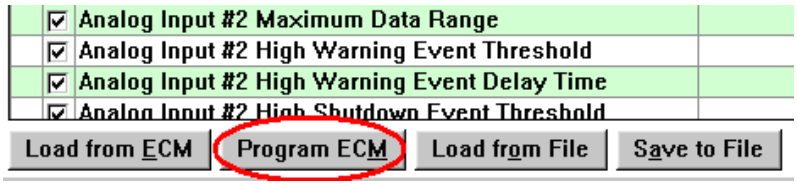


Figure 17.7 – Program ECM

8. If another replacement file is to be programmed or if the user is already at the ECM Replacement screen prior to opening a replacement file, press the "Load from File" button at the bottom of the screen and follow steps 3 through 7 above. See Figure 17.8.

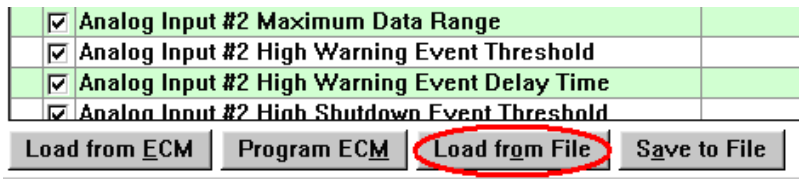


Figure 17.8 – Load ECM Replacement File

Note: By default, ECM Replacement files are stored in the ECM Replacement folder, while Fleet Configuration files are stored in the Fleet Configuration folder.

The previous steps, for uploading saved configuration data, will need to be repeated for each EMCP 4 module needing same or similar setpoint configurations. For programming multiple units with the same setpoints, it is recommended to use Fleet Configuration files.

Note: When programming EVENT RESPONSE CONFIGURATION setpoints, the control must be in STOP mode. If the control is not in STOP, there will be a message after the programming is complete. The message will show that none of the Event Response Configuration setpoints were changed.

18.0 Programmable Cycle Timer

The Programmable Cycle Timer (PCT) feature allows the operator to program seven independent times, when tasks (called PCT Outputs), will be activated or deactivated automatically during the week. This is useful for exercising generator sets, or cases where two or more generators are required to automatically share the duty of supplying a load throughout the week.

Using the PCT, each generator set can be programmed to start and stop at pre-set times. The PCT is capable of handling a seven day sequence with seven independent starts happening one or more times each week. The timing of these start/stop cycles may be programmed in advance, either locally or via the service tool.

For example, if a standby set does not have access to a utility supply to power a trickle charger, the PCT can be set for an hour a week to run the generator set to have the charging alternator help keep the battery charged.

Caution: External equipment such as a transfer switch is required to ensure that the generator sets are not stopped on load.

The PCT FEATURE consists of seven independent timers; each timer has the following setpoints (setpoints shown are for PCT #1):

PROGRAMMABLE CYCLE TIMER #1: Activation Day of the Week:

This permits independent selection of each day (Sun → Sat) that the timer will activate. All seven days can be selected, if desired.

PROGRAMMABLE CYCLE TIMER #1: Activation Start Time

The time of day (in hours and minutes) that the timer will activate. The time must be programmed using a 24-hour clock.

PROGRAMMABLE CYCLE TIMER #1: Active Time

The duration (in hours and minutes) for which the timer will be active (up to 24 hours).

PROGRAMMABLE CYCLE TIMER #1: Output #1 Activation Configuration

The Programmable Cycle Timer's first output will be activated when this timer is active and will allow the generator set to start if in Auto. This will not close the generator breaker.

PROGRAMMABLE CYCLE TIMER #1: Output #2 Activation Configuration

The Programmable Cycle Timer's second output will be activated when this timer is active. Output #2 can be assigned to a programmable output for connection to an external device. This external device can be used to control a load bank, transfer switch or other device.

PROGRAMMABLE CYCLE TIMER #1: Output #3 Activation Configuration (EMCP 4.4 only)

The Programmable Cycle Timer's third output will be activated when this timer is active. The EMCP 4 will not close the generator circuit breaker unless Output #3 is configured and all other required conditions are met. Output #3 will signal the EMCP 4 controller to synchronize and close the generator circuit breaker if the Sync Mode Switch (SMS) is in Auto, ECS is in Auto, and Hardwired Dead Bus Arbitration (HWDBA) is enabled (if a live bus does not exist).

The PCT has two internal outputs (three for EMCP 4.4); these should not be confused with the physical outputs of the control. The outputs are connected internally to the control module. In the standard configuration, PCT OUTPUT #1 is connected to an internal Remote Initiate command. OUTPUT #2 is customer configurable via a discrete output. OUTPUT #3 is connected to breaker control. This allows the operator to configure a timed relay, for external connectivity.

Note: The outputs of all seven timers are tied together in an "OR" fashion. This means that if any one, or more, timer is activated, then any output will activate (depending on programming).

The status of each output is indicated by a 1, 0, or - in the PROG CYCLE column under #1 through #7.
See Figure 18.1.

A – Programmed to be TRUE at another time.

A DASH (–) means that this PCT is NOT programmed to activate this output.

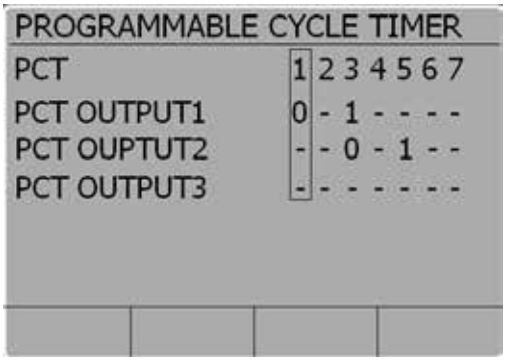


Figure 18.1 – PCT Main Screen

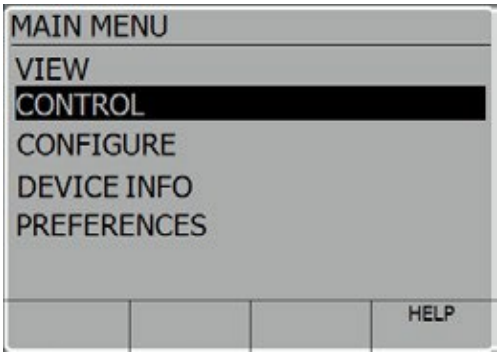
- In Figure 18.1, PCT #1 is INACTIVE on Output #1. Outputs #2 and #3 are NOT enabled and will never activate, as programmed.
- PCT #3 is ACTIVE on Output #1, and NOT enabled on Output #2. Output #3 is NOT enabled and will never activate, as programmed.
- PCT #5 is NOT enabled and will never activate, as programmed, on Outputs #1 and #3. Output #2 is ACTIVE.
- PCT #2, PCT #4, PCT #6, and PCT #7 are DISABLED. They NEVER activate Output #1, Output #2, or Output #3, as programmed.
- To select a specific Programmable Cycle Timer, use the LEFT and RIGHT buttons until the desired PCT is within the selection box and then press the OK KEY.

18.1 Configuring the Programmable Cycle Timer Using the Display

To configure a Programmable Cycle Timer with the display, go through the following menu options:

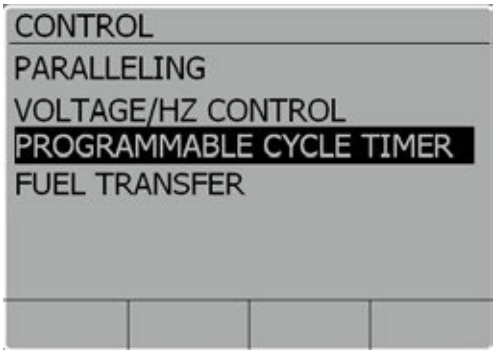
1. At MAIN MENU, scroll down  to CONTROL.

2. Press the OK KEY .



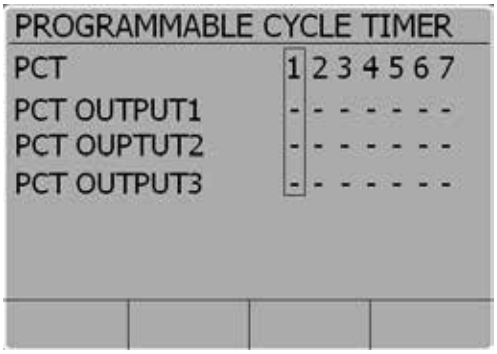
3. Scroll DOWN  to PROG CYCLE TIMER.

4. Press the OK KEY .



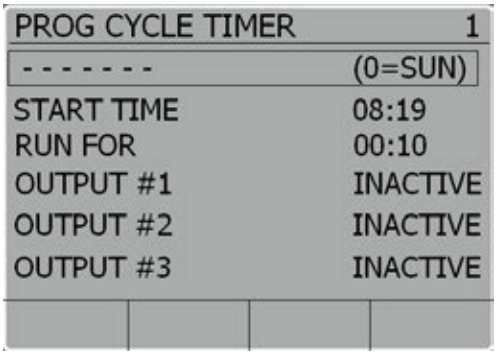
5. The box surrounding the first column outlines the first of seven timers.

6. Press the OK KEY  to program this timer.



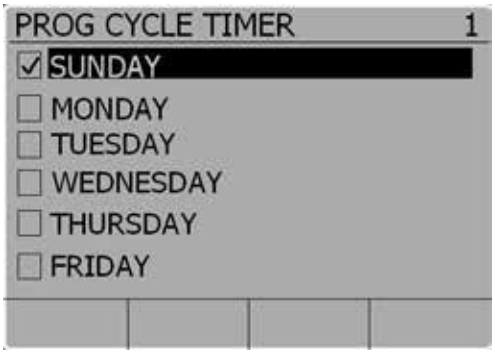
7. The box surrounding the first row outlines the day selection.

8. Press the OK KEY  to select the day(s) for this timer.



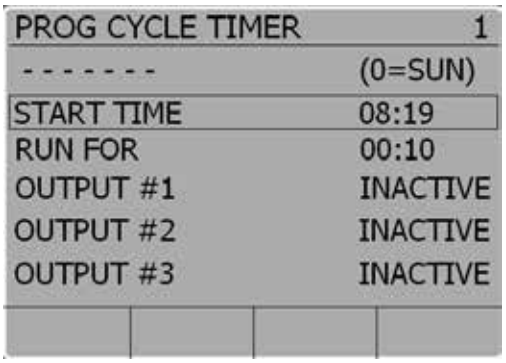
9. Use the UP and DOWN arrow keys along with the LEFT and RIGHT arrow keys to select the days that this timer will activate.

10. Press the OK KEY when done. To program Saturday, continue scrolling down past Friday.



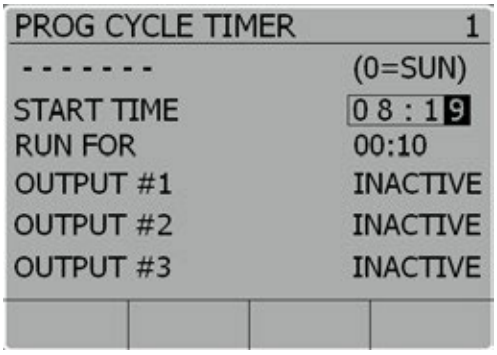
11. Scroll DOWN to select the START TIME.

12. Press the OK KEY.



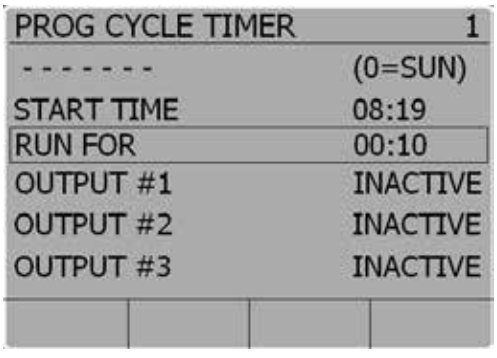
13. Use the arrow keys to enter the START TIME.

14. Press the OK KEY when done.



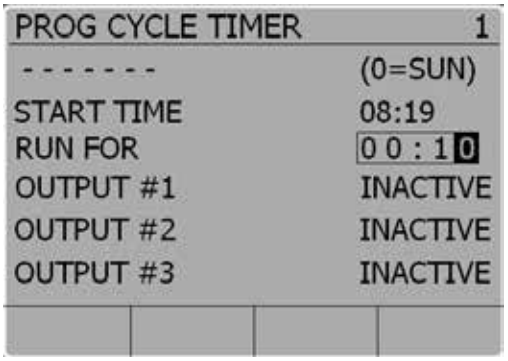
15. Scroll DOWN to select the RUN FOR time.

16. Press the OK KEY.



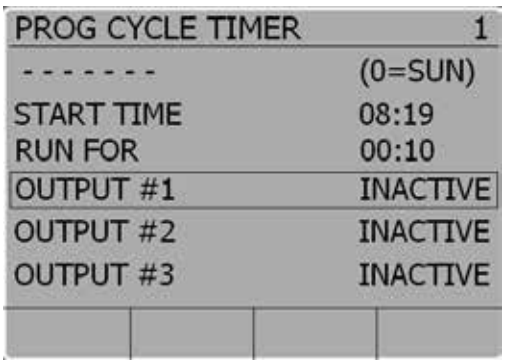
17. Use the arrow keys to enter the RUN FOR time.

18. Press the OK KEY  when done.



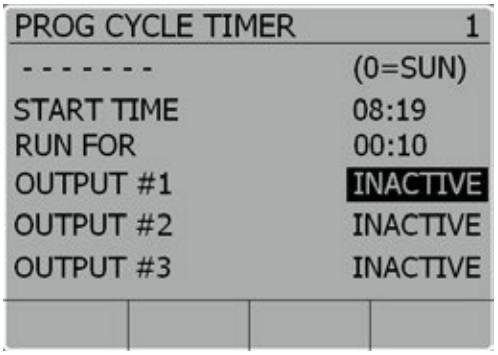
19. Scroll DOWN  to select the OUTPUT STATE for Output #1.

20. Press the OK KEY .



21. Select the OUTPUT STATE that you want to program.

22. Press the OK KEY  when done.



23. Scroll DOWN  to select the OUTPUT STATE for Output #2 and #3 to program with the same steps as Output #1.

24. Press the ESCAPE KEY  to return to the Programmable.

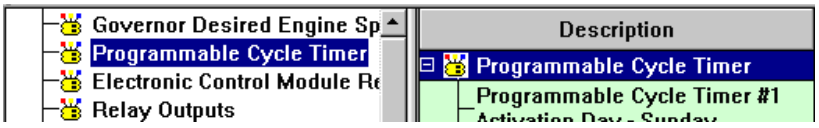
Cycle Timer main screen. Use the LEFT  and RIGHT  buttons to select the other timers and repeat the above steps.

18.2 Configuring the Programmable Cycle Timer Using the Cat Service Tool

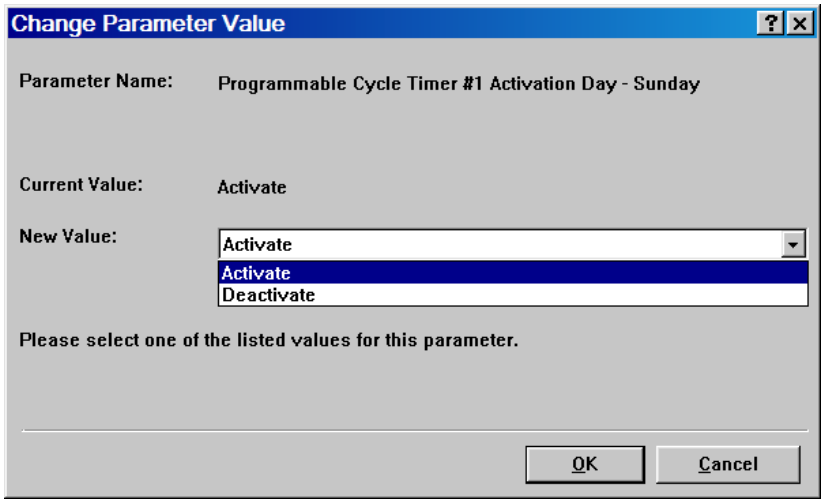
To configure a Programmable Cycle Timer with the Cat Service Tool, go through the following menu options:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

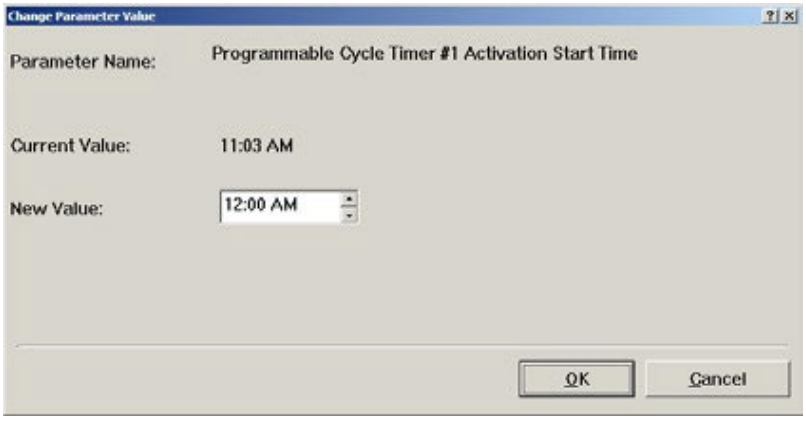
2. Select Programmable Cycle Timer on the left.



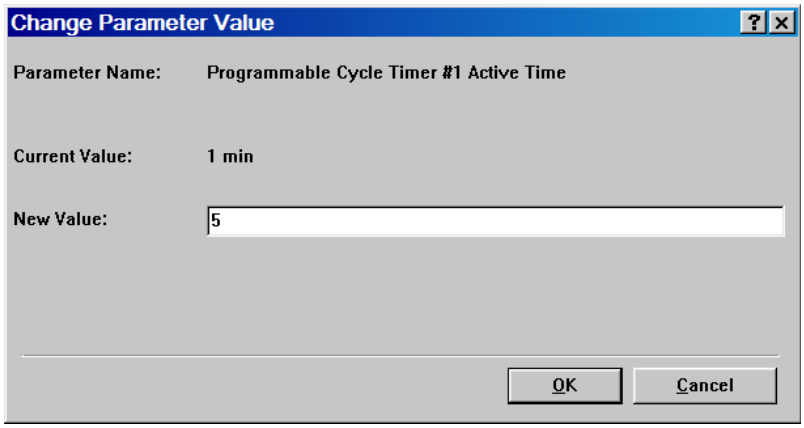
3. Double click the Programmable Cycle Timer #N Activation Day setpoint for a given day to change this value from the drop down menu. Click the OK button to program.



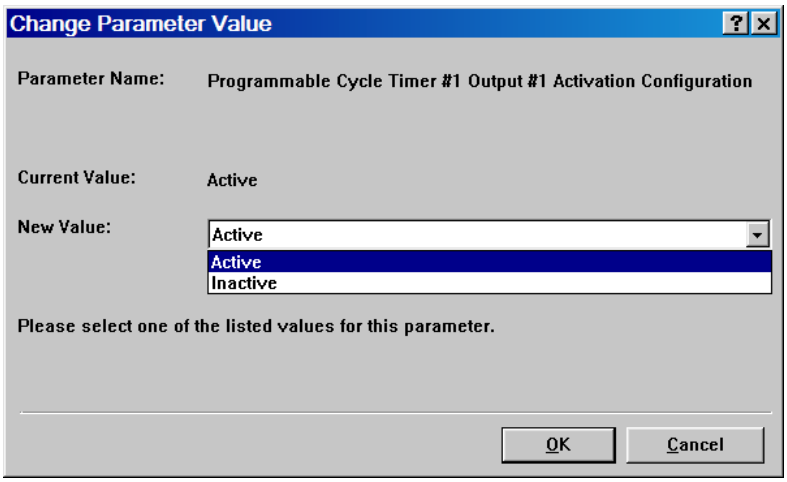
4. Double click the Programmable Cycle Timer #N Activation Start Time setpoint to change this value. Click the OK button to program.



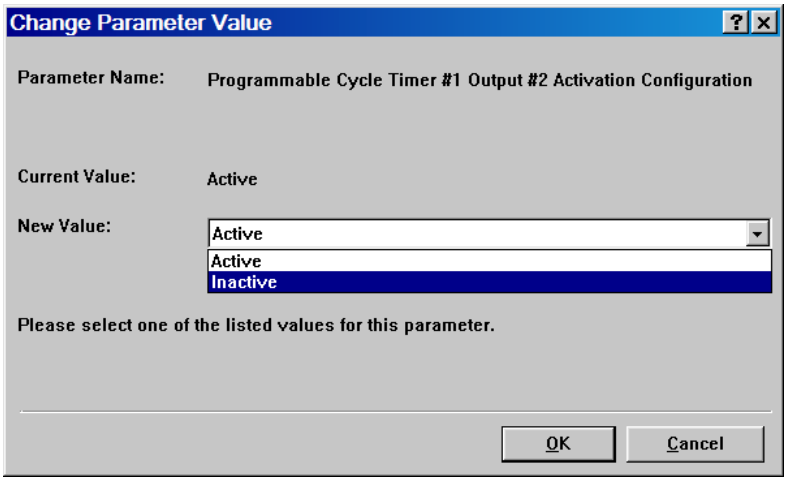
5. Double click the Programmable Cycle Timer #N Active Time setpoint to change this value. Click the OK button to program.



6. Double click the Programmable Cycle Timer #N Output #1 Active Configuration setpoint to change this value from the drop down menu. Click the OK button to program.



7. Double click the Programmable Cycle Timer #N Output #2 Active Configuration setpoint to change this value from the drop down menu. Click the OK button to program.



8. Repeat the above steps to program additional timers.

19.0 Reduced Power Mode

REDUCED POWER MODE (RPM) is a feature that puts the control into a state where the power consumption is reduced. RPM is intended to extend the amount of time the generator can sit between runs before the control drains the batteries too low to crank the generator in cases where a battery trickle charger is not fitted.

In order to reduce the power consumed when in RPM, many functions within the control are turned OFF.

Turned Off During Rpm

- The display
- The communication lines, including Annunciator communication
- All inputs except Remote Initiate
- All outputs
- LEDs (lamps) on the front of the control blink briefly every second (rather than being on continuously).

When RPM is enabled, the control will only enter RPM after a programmable time delay provided the generator is stopped and no keys have been pressed during the delay time.

Note: If using Group Start, Reduced Power Mode should NOT be used.

The control will wake from RPM on any one of the following conditions:

Wake From Rpm

- Sending a hardwired remote start signal to the controller (Group Start signal will not wake the EMCP)
- Cycling power to the controller
- A key on the keypad is pressed
- The Programmable Cycle Timer is about to enter a period when it will activate an output.

19.1 Actions to Enable Rpm

1. Change the setpoint Reduced Power Mode Enable Status to ENABLED. This can be done with either ET or using a level 3 password to navigate Configure → Setpoints → Other → Reduced Power Mode.
2. The setpoint Reduced Power Mode Delay Time should be checked. It should be at a desirable value. This value is the amount of time (once the generator is at rest and after the last key-press) before the control will go into Reduced Power Mode.

The following conditions must be met in order for the EMCP 4 to enter Reduced Power Mode:

1. Engine speed must be 0
2. Remote Initiate signal cannot be active
3. Must not be within 15 min of a Programmed Cycle Timer
4. Group start signal must be inactive

Semi-awake

The EMCP 4 becomes SEMI-AWAKE when in Reduced Power Mode. Approximately every 30 minutes it will do status checks of the control for about 40 seconds. During SEMI-AWAKE the display remains off and the LEDs (lamps) continue to blink. The EMCP will start up to check for Analog Input faults, engine speed sensor diagnostics, and AC faults. If any of these faults become active at this time, the system will respond accordingly (warning or shutdown LED indicators may turn on). During the semi-awake time any active relays (such as common alarm) will energize.

Once the SEMI-AWAKE time is completed the control will return to full RPM (deactivating any relays that are active). An active event will not prevent the control from entering reduced power mode. If a programmable cycle timer is set to become active in the near future, the timer before waking will be adjusted to ensure the controller wakes in time to process the programmable cycler timer.

20.0 Electric Cooling Fan Control

The EMCP 4 has the ability to operate an electronically controlled engine cooling fan via 2 digital outputs. Based off of coolant temp, and air to air after cooler temp (ATAAC), the EMCP will determine whether to run the cooling fan at high speed, low speed or not at all.

20.1 Configuration of the Electric Cooling Fan Control

The EMCP 4 controls the cooling fan via two digital (or relay) outputs which must be configured for such. Steps for configuring outputs is outlined in Chapter 12.

Cooling Fan Control Digital Outputs

One output must be configured for "Cooling Fan Control." This output is the command that will turn the fan on or off. If dual fan speed operation is desired, a Second output can be configured for "Cooling Fan Low Speed Command." When the conditions for low fan speed are present, the output will be activated.

Cooling Fan Control Setpoints

The electric cooling fan setpoints can be found under MAIN MENU → CONFIGURE → ALL SETPOINTS → CONTROL → COOLING FAN

Engine Cooling Fan Minimum Air Flow Coolant Temperature

(Shown on the display as FAN MIN AIRFLOW COOLANT TEMP)
This is the temperature threshold for the engine coolant that will turn on the cooling fan. When the engine coolant temperature rises to above this this threshold, the fan is engaged. If coolant temp at any time falls below this threshold minus the Engine Cooling Fan Coolant Temperature Hysteresis, AND the ATAAC out Temp is below its temperature threshold minus its hysteresis amount, then the cooling fan will be disengaged.

Engine Cooling Fan Coolant Temperature Hysteresis

(Shown on the display as FAN COOLANT TEMP HYSTERESIS)
This is the hysteresis that is applied to the coolant temperature reading to determine when to turn the fan off or put the fan in high speed mode.

Engine Cooling Fan Minimum Air flow After Cooler Output Air Temperature Threshold

(Shown on the display as FAN MIN AFTRCLR OUT AIR TEMP THRESH)
This is the temperature threshold for the ATAAC output temperature that will turn on the cooling fan. When the temperature is above this threshold the cooling fan is activated. If at any time the ATAAC temperature falls below this threshold minus the Engine Cooling Fan Aftercooler Output Air Temperature Hysteresis, AND the coolant temp is below its temperature threshold minus its hysteresis amount, then the cooling fan will be disengaged.

Engine Cooling Fan Aftercooler Output Air Temperature Hysteresis

(Shown on the display as FAN AFTRCLR OUT AIR TEMP HYSTERESIS)
This is the hysteresis that is applied to the ATAAC output temperature reading to determine when to turn the fan off or put the fan in high speed mode.

Engine Cooling Fan Maximum Air Flow Coolant Temperature

(Shown on the display as FAN MAX AIRFLOW COOLANT TEMP)
This is the engine coolant temperature threshold that determines whether the cooling fan will run in low or high speed mode. When the coolant temperature rises above this threshold then the fan is put in high speed mode. If the coolant temp falls below this threshold minus the Engine Cooling Fan Coolant Temperature Hysteresis AND the ATAAC temp falls below its threshold minus its hysteresis amount, then the fan will be put into low speed mode again.

Engine Cooling Fan Maximum Air Flow Aftercooler Output Air Temperature Threshold

(Shown on the display as FAN MAX AFTRCLR OUT AIR TEMP THRESH)
This is the ATAAC output temperature threshold that determines whether the cooling fan will run in low or high speed mode. When the ATAAC output temperature rises above this threshold then the fan is put in high speed mode. If the ATAAC output temperature falls below this threshold minus the Engine Cooling Fan Aftercooler Output Air Temperature Hysteresis, AND the coolant temp falls below its temperature threshold minus its hysteresis amount, then the fan will be put into low speed mode again.

Cooling Fan Operation

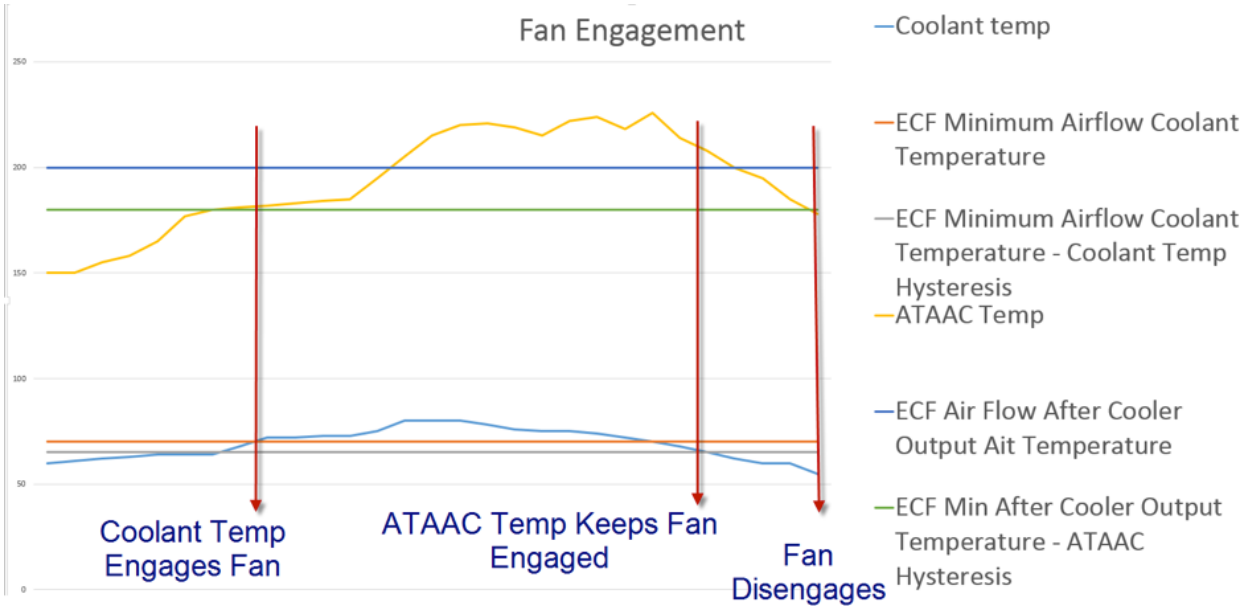
Once engine speed is detected to be above crank terminate, then the EMCP 4 will determine whether or not to run the cooling fan based off of coolant temperature and ATAAC output temperature. If EITHER coolant temperature OR ATAAC output temperature rise to above their respective thresholds (listed above) then the cooling fan will be engaged. Once engaged, BOTH coolant temperature AND ATAAC output temperature must fall below their respective thresholds (listed above) by at least their respective hysteresis amounts (also listed above) in order to disengage the cooling fan.

The EMCP 4 will also determine whether to run the cooling fan at high speed or low speed based off of coolant temperature and ATAAC output temperature. If EITHER the coolant temperature OR ATAAC out temperature rises above their respective max airflow thresholds (listed above), then the fan will be commanded to run at full speed. Once running at full speed, BOTH the coolant temp AND ATAAC out temperatures must fall below their respective max airflow thresholds by at least their respective hysteresis amounts (also listed above) in order for the fan to be commanded to low speed again.

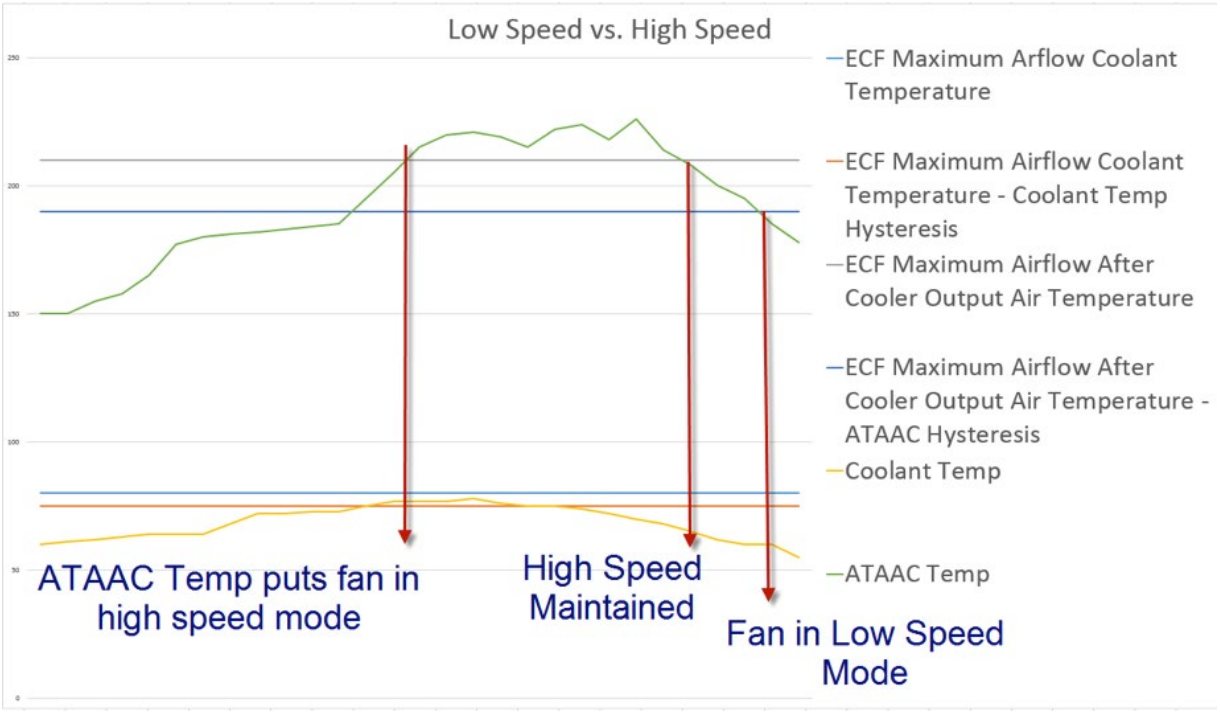
If at any time the engine speed drops below crank terminate, then the fan will be commanded to stop.

20.2 Cooling Fan Functionality Example

In the example below, the coolant temp and ATAAC temps rise above and fall below the threshold for engaging the fan. Since the coolant temperature rises above its threshold first, it engages the fan. When the coolant temperature falls below it threshold – hysteresis amount, the fan stays on since the ATAAC temp is not below its threshold-hysteresis amount.



In the example below, the coolant temp and ATAAC temps rise above and fall below the threshold for putting the fan in high speed mode .



21.0 Bund Level

The EMCP 4 has the ability to monitor a “bund” or often called a spill basin. An analog input must be used to monitor the level percent of the bund. For instructions on how to configure analog inputs refer to Chapter 9. The Bund Level feature has the option to configure a high warning and a high shutdown threshold for bund level. The event response configuration for this follows the same format outlines in Chapter 5. Bund level will be displayed on engine screen 11 right after Total Fuel Consumption.

22.0 Generator Set Control Software Type

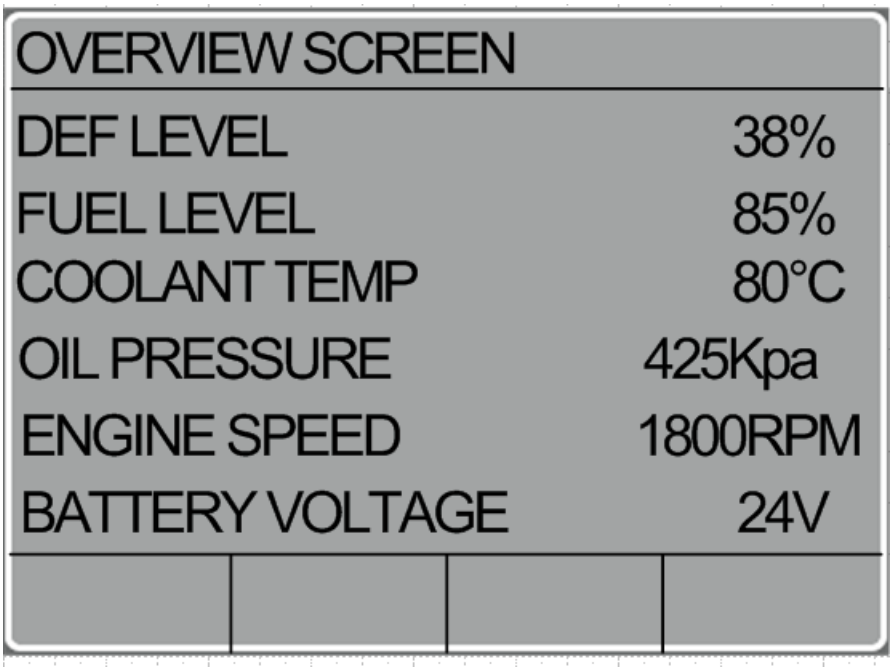
Prior to v4.7H software, there were two separate flashfiles for standard and complex software. With version 4.7H and after both standard and complex features are integrated into one flashfile and the complex features are enabled with the setpoint "Generator Set Control Software Type." Configuring the software type to complex enables certain features:

- **Multiple Rating Groups**
  - Up to 4 different rated voltage, rated power, rated frequency, and generator winding configurations can be programmed in the control. These rating groups are selected through digital inputs. For more information on selecting rating groups reference Chapter 8 Section 1. **Note:** For IVR controls there are four ratings for
- **Fuel Unload Feature**
  - Complex software allows the user to configure a digital (or relay) output for transfer fuel out. When the function is activated, the output will be active to engage a fuel unload pump and will deactivate once the fuel level drops to a configurable level.
- **Power Factor Control**
  - The EMCP 4 allows the user to configure a digital input to enable power factor control.
- **IVR Minimum and Corner Frequency**
  - The EMCP 4 allows the configuration of minimum and corner frequency for the under frequency roll-off feature. With four possible rated frequencies there is the need for four different minimum and corner frequencies each for a specific rating group. For more information on under frequency roll-off, see Section 24.3.

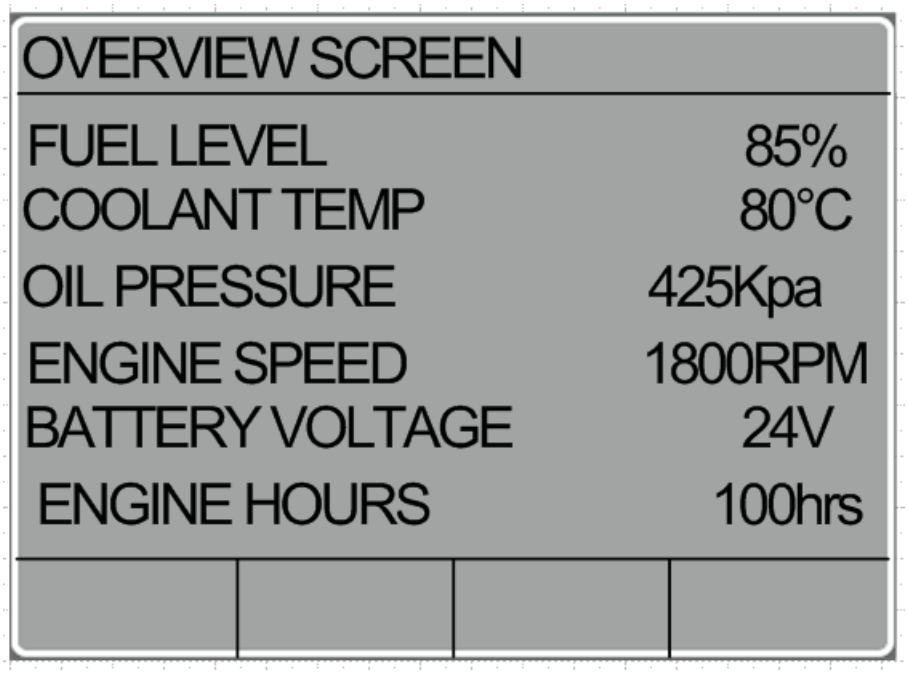
23.0 Overview Screen

The EMCP 4 has the option to enable an overview screen that will scroll through engine overview and AC overview information after an inactivity timeout. If no button presses are seen by the control after the timeout period, then the EMCP will start scrolling through the engine and AC overview screens automatically. Any button press will bring the EMCP back to the last screen viewed before the overview screen was activated. The overview screen feature on the EMCP 4 is enabled through ET or display. To access the overview screen setpoints via the display, navigate to Main Menu → Preferences → Overview Screen. On this screen the user can enable or disable the feature and configure the keypad inactivity timeout period.

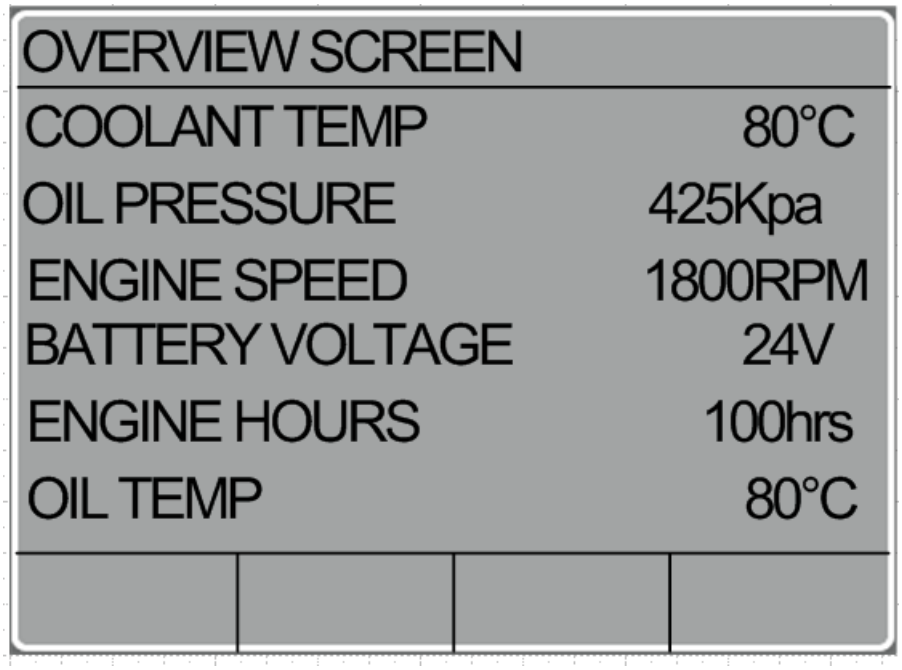
If the default screen is enabled and no buttons are pressed on the EMCP 4 for the configured timeout period, the EMCP display will show the default screen. The default screen will show Fuel Level and DEF Level on the first two lines if the EMCP is receiving data for these parameters (J1939 or analog input for Fuel Level and J1939 only for DEF level). The remaining lines will scroll through the first six lines of the Engine Overview screens and AC Overview screens.



If there is no data for DEF Level or Fuel Level then that line will be used to scroll as well.



If neither DEF or Fuel Level is available then all three lines will be used to scroll.



24.0 Transfer Switch

The EMCP 4 is equipped with an automatic transfer switch feature which will autonomously change the power source between utility and generator provided power via an open transfer method. An open transfer is described by the bus being unpowered for a finite amount of time before either power source can connect. The EMCP 4 monitors the condition of the utility via a digital input (Loss of Utility) and will automatically start the generator and transfer the system to generator power upon utility failure. A third part module must be used to generate the Boolean signal for loss of utility since the EMCP will not monitor the utility voltage and frequency directly. The transfer can also be manually initiated by the user via digital input, via display, or via SCADA command.

The EMCP 4 now has the ability to control a utility breaker (EMCP 4.4 only) or contactor (all versions of controls) via a utility contactor close command signal (energized to close, de-energized to trip) or utility breaker close and trip commands. The EMCP 4.3 now has the ability to control a generator contactor and utility contactor. These are operational ONLY when the transfer switch feature is enabled AND the transfer switch logic is what is requesting contactors or breakers to open or close. If the engine control switch is put in RUN or the remote initiate input is energized, the generator set will run but the contactor control output or breaker close command will not be energized unless the transfer switch logic decides to close the contactor or breaker. Also when the transfer switch feature is enabled, the generator breaker will not close even with auto paralleling enabled unless the transfer switch logic determines to close the generator breaker. The utility contactor output is maintained and does NOT work the same way as the momentary breaker close and trip outputs on the EMCP 4.4.

Inputs and Outputs Configuration

Digital outputs must be configured for Utility Contactor Close Command or utility breaker close/trip and Digital inputs must be configured for Utility Breaker Aux A for this feature to be functional.

Note: For the EMCP 4.3 control, there is only the option to control contactors for the generator and utility. Outputs must be configured for both generator and utility contactor control for the feature to be functional.

24.1 Transfer Switch in Auto Mode

While configured in auto mode, the EMCP 4 will monitor the loss of utility (configurable) input to determine the state of the utility. When the input is activated the EMCP will attempt to go into "Emergency Mode." In this mode the EMCP will start the generator set and open the utility contactor (the output for utility contactor will be de-energized to trip) or breaker (by energizing the utility breaker trip command). The control is required to wait a setpoint configurable amount of time (minimum unpowered load time) before attempting to close the generator breaker. Once this time is expired and the generator set is considered available then the generator breaker is commanded to close. The generator is available when the AC voltage and frequency are greater than the Generator Available to Accept Load Threshold for Generator Available to Accept Load Delay Time (configurable setpoints).

When the loss of utility signal becomes inactive again, the EMCP will wait for the utility to stabilize. This stability times are configurable through the setpoints "Generator to Utility Transfer Delay Time" and "Generator to Utility Fast Transfer Delay Time." If the generator is available to run and provide power or is currently providing power and the loss of utility condition goes away, then the Generator to Utility Transfer Delay Time is used to time when the utility is considered "stable." If the generator is not available to provide power, then the Generator to Utility Fast Transfer Delay Time is used to determine when the utility is considered "stable." Once the applicable transfer timer expires, the EMCP will open the generator breaker, wait the minimum unpowered load time and then command the utility contactor (the output for utility breaker contactor will be energized to close) or utility breaker (energize utility breaker close command) to close.

The Gen to Utility (Fast) Transfer Delay timers can be skipped if a digital input programmed for “Generator to Utility Transfer Delay Bypass,” command via display, or SCADA command to Modbus register 320 is activated. This will cause the system to immediately transfer to utility power if the utility is available.

EMCP 4.4 Paralleling in Auto Mode

For the EMCP 4.4 only, at least one unit on the MGDL network must have a digital input configured for “loss of utility” in order for the system to transfer into emergency mode upon a utility failure. Multiple units can have an input configured for “loss of utility.” If ANY unit on the MGDL network has a digital input for “loss of utility” that is activated, the entire system will assume that the utility is failed and the system will transfer to emergency mode. While in emergency mode, all units with an input configured for loss of utility must have that input inactive in order for the system to transfer back to normal mode (utility supplied power).

Any number of units on the MGDL network can have a digital input configured for “Generator to Utility Transfer Delay Bypass.” If any of the units with this input configured has their input activated while the utility stability timers are delaying a generator to utility transfer, then the stability timers will be bypassed and a transfer to utility will immediately be attempted.

24.2 Transfer Switch Manual Mode

24.2.1 Transfer Switch Digital Inputs

While configured to manual mode, a digital input configured for “Transfer to Generator Power” or a command enter through the display, or a SCADA command can be used to change the transfer switch position. If any one of the three commands is activated, the EMCP will start the generator set and transfer power over to the generator (same process as auto mode only there is no delay to transfer). When the input is deactivated, the EMCP will immediately transfer power back to the utility (same as auto only the stability timers are not used).

Transferring to generator power can be done via configured digital input, via display, or via Modbus SCADA register 331.

A loss of utility can still be detected via a digital input configured for “Loss of Utility” while in manual mode. The Generator to Utility Transfer Delay Bypass function is also functional while in manual mode. If a loss of utility is what caused the system to transfer to generator power, then the system will automatically transfer back to utility power once the utility returns. If the retransfer is desired to be manually initiated, the user can activate the transfer to gen input to keep the system on generator power until a retransfer is desired.

EMCP 4.4 Paralleling with Manual Mode Digital inputs

For the EMCP 4.4 only, multiple units can have a digital input configured for “transfer to gen.” If any of the units on the MGDL network have an input for “transfer to gen” active, then the system will transfer to generator provided power. While running on generator provided power, all units on the MGDL network that have inputs configured for “transfer to gen” must have their inputs inactive before the system can transfer back to utility provided power.

24.2.2 Transfer Switch Display Interface

Transfer Switch Status on EMCP 4.3

To view the transfer switch status screen navigate from the main menu to VIEW → TRANSFER SWITCH OVERVIEW. This screen will show the status of the utility, whether the generator is available to accept load, the utility contactor position, and the generator contactor position.

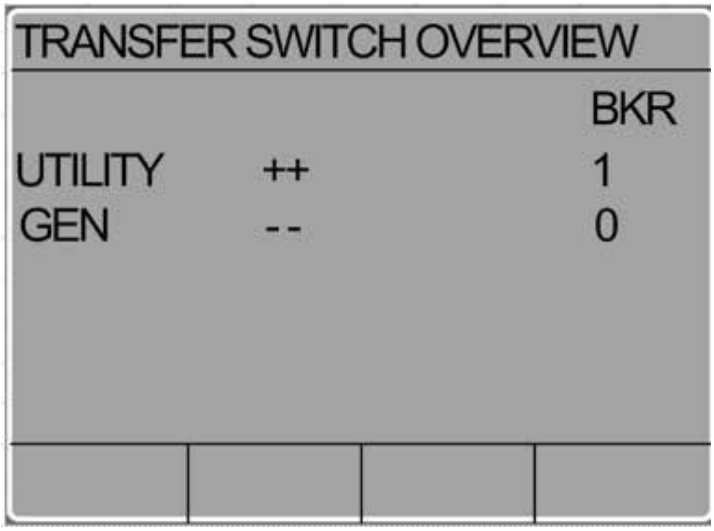
A “++” next to utility indicates that the loss of utility input is false and the utility is available to carry load.

A “--“ next to utility indicates the loss of utility input is true and the utility is not available to carry load.

A “++” next to gen indicates the AC frequency and voltage of the generator output has been greater than the “Generator Ready to Accept Load Threshold” for “Generator Available to Accept Load Delay Time.”

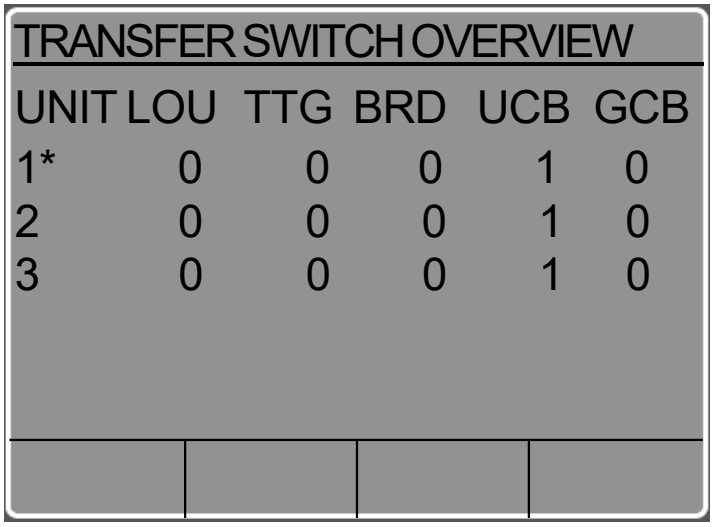
A “--“ next to gen indicates the AC frequency and voltage of the generator output is less than the “Generator Available to Accept Load Threshold.”

A ‘1’ in the BKR column indicates the contactor is closed and ‘0’ indicates the contactor is open.
In the below example, the utility is available to carry load, the gen output is below the defined threshold, the utility contactor is closed, and the generator contactor is opened.



Transfer Switch Status on EMCP 4.4 (MGDL)

To view the transfer switch status screen navigate from the main menu to VIEW → TRANSFER SWITCH OVERVIEW. This screen will show the status of the utility, the utility contactor or breaker position, the generator breaker position, the loss of utility input status, the transfer to generator power input status, and the bypass retransfer delay input status for EACH unit on the MGDL network.



The abbreviations for the previous illustration are defined below:

Abbreviation	Meaning	Possible Values	Definition
UNIT	MGDL unit number configured for that control	1-64	
LOU	Loss of Utility digital input state	0, 1, ?	0=Loss of utility input inactive 1=Loss of utility input active ? = no loss of utility input configured, or unit does not support transfer switch
TTG	Transfer to Generator Power Command	0, 1, x	0= Utility power desired 1= Generator power desired X= don't care, or unit does not support transfer switch
BRD	Generator to Utility Transfer Delay Bypass command	0, 1	0= Continue waiting for stability timers 1=bypass utility stability timers
UCB	Utility Circuit Breaker (or contactor) status	0, 1, ?	0= Open 1= Closed ?= Unknown, or unit does not support transfer switch
GCB	Generator Circuit Breaker status	0, 1, ?	0= Open 1= Closed ?= Unknown

Table 24.1

UNIT: The MGDL unit number for a generator set must be configured to 1-64 in order for the unit to participate in MGDL and show up on the Transfer Switch Overview Screen. A unit number of 0 will hide the unit.

Loss of Utility: If a digital input is not configured for loss of utility, then this will show up as a '?' for that unit.

Note: Software prior to 4.7 PROD does not support this feature, so any units on the MGDL network that have older software will always show a '?' for this parameter.

Transfer to Generator Power: This shows the command that the unit is sending to other units on the MGDL network. A '1' means that that this unit is commanding the system to transfer over to generator provided power and a '0' means that this unit is commanding the system to transfer over to utility provided power. An 'X' means that this control is not sending a command to transfer. If all units are 'X' then the system will stay on whatever power source it is currently on until a unit gives a command to transfer. If there is a conflict between a unit commanding '1' for generator power and a unit commanding '0' for utility power, then the system will transfer to generator provided power. In other words if any unit is requesting the system to transfer to generator provided power, then the system will transfer to generator provided power.

Generator to Utility Transfer Delay Bypass Command: if a digital input for Generator to Utility Transfer Delay Bypass is configured and active, or a display command for Generator to Utility Transfer Delay Bypass is activated, then this parameter will show a '1'. Otherwise this parameter will show a '0.' Software prior to 4.7 PROD does not support this feature so any units with old software will always show a '0' for this parameter. Whenever this parameter is a '1,' that unit is commanding all units on the MGDL network to bypass the utility stability timers (described below in Section 23.3).

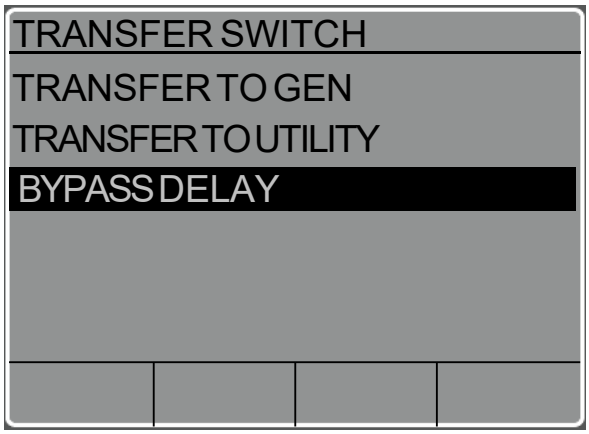
Utility Circuit Breaker Status: This shows the utility circuit breaker (or contactor) position that is determined from digital inputs configured for utility Breaker AUX A and/or Utility Breaker Aux B . The breaker is considered open if Aux A is inactive and Aux B is active and vice versa .

Generator Circuit Breaker Status: This shows the Generator circuit breaker position that is determined from the dedicated digital inputs for Generator Breaker AUX A and Generator Breaker Aux B . The breaker is considered open if Aux A is inactive and Aux B is active and vice versa .

Transfer Switch Control via Display

The EMCP 4 allows the user to initiate a transfer and bypass the Generator to Utility delay timers with a display command . To access this screen from the main menu, navigate to MAIN MENU → CONTROL → TRANSFER SWITCH .

At this screen the user will have three options available:



Selecting transfer to gen is the equivalent of activating a digital input configured for transfer to generator power . The system will follow the same process in Section 20 .2 . The user will be prompted to confirm the command before it can be activated .

Selecting transfer to utility is equivalent to deactivating a digital input that is configured for transfer to generator power . The system will follow the same process in Section 20 .2 . The user will be prompted to confirm the command before it can be activated .

Note: If a digital input for loss of utility or transfer to gen is active, then these display commands will be overridden . The digital input has the highest priority when there is a conflict .

Selecting Bypass Delay is equivalent to activating a digital input configured for Generator to Utility Transfer Delay Bypass . Activating this will immediately expire the Generator to Utility Transfer Delay Timer and the Generator to Utility Fast Transfer Delay Timer and cause an immediate transfer back to utility if the control was waiting for the timers to expire . If the control was not waiting for these timers to expire to transfer back to utility, then the control will display a warning message indicating that the timers are inactive . This is so the user knows that the system is still being required to run on generator power and the delay timers are not the reason the system is not transitioning to utility power .

The bypass delay is a momentary command, meaning that one single activation will bypass any currently active Generator to Utility delay timers but if the Generator to Utility delay timers become active afterwards they will not be bypassed unless another command is issued .

EMCP 4.4 Paralleling Transfer Switch Control via Display

With the EMCP 4.4 only, activating a transfer to gen or a transfer to utility will trigger all units to either transfer to gen or utility. The user does not have to activate the command on multiple units since it is relayed to all units over the MGDL communication network.

When a transfer to gen is activated on a unit's display, the user does not need to activate a transfer to utility from the same unit. A display command can be activated from any unit on the MGDL network and it will command the system to transfer in either direction over the MGDL data link.

24.2.3 Transfer Switch Modbus Interface

The following registers can be used to control and monitor the transfer switch feature.

Parameter Name	Read/Write	Register Count	Register Number	Datatype
Retransfer Delay In Progress	R	1	184	Boolean
Generator Ready to Accept Load	R	1	189	Boolean
Bypass Retransfer Delay Command	R/W	1	320	Boolean
Transfer to Generator Power Command	R/W	1	331	Boolean
Loss of Utility	R	1	345	Boolean
Generator Breaker Status	R	1	1065	Breaker Status (Explained Below)
Utility Contactor Status	R	1	1066	Breaker Status (Explained Below)

Table 24.2

Breaker Status Data Type

A value of numerical 0 (00)b declares that the contactor is open. A numerical 1 (01)b declares that the contactor is closed. A numerical 2 or 3 (10)b (11)b declares that the contactor position is unknown.

Retransfer Delay in Progress

This register is used to determine if the utility stability timers (Gent to Utility Transfer Delay and Gen to Utility Fast Transfer Delay) are active. Reading a '1' means the timers are active and '0' means they are not. If these timers are active, then a bypass retransfer delay command will immediately put the system back to utility power. If the timers are not active then a bypass retransfer delay command will not be accepted.

Generator Ready to Accept Load

This register is used to determine if the generator set is allowed to close to the bus and provide load. This will be "true" if the AC voltage and frequency of the generator output are both above the configured percent threshold of their nominal ratings for the configured delay time. Reading a '1' means the generator is ready to close to the bus and provide power, reading a '0' means it is not.

Bypass Retransfer Delay Command

This register is used to issue the bypass retransfer delay command. This command will cause the control to skip the utility stability timers (Gen to Utility Transfer Delay Timer and Gen to Utility Fast Transfer Delay Timer) and immediately transfer to utility if a retransfer delay was in progress. Writing a '1' to this register issues the command. The command is a momentary command so a single activation will only bypass the current transfer delay and will not cause the control to bypass the stability timers on the next retransfer.

Transfer to Generator Power Command

This register is used to initiate a utility to generator transfer. The control will follow the same behavior as the digital input transfer to generator power explained above. To initiate this command, write a '1' to this register. Commands to this register will be latched so in order to initiate a transfer back to utility a '0' must be written to this register. This register can also be read to determine if a command was initiated or not.

Loss of Utility

This register is used to communicate the status of the utility. When the loss of utility input is "true" for Loss of Utility Event Notification Delay Time this register will read '1,' and when the input is false this register will read '0.'

Generator Breaker Status

This register is used to read the generator contactor status. When the contactor is detected as 'open' the register will read '0.' When the contactor is detected as 'closed' the register will read '1.'

Utility Breaker/Contactor Status

This register is used to read the utility contactor status. When the contactor is detected as 'open' the register will read '0'. When the contactor is detected as 'closed' the register will read '1.'

Note: If a digital input for transfer to gen or Bypass Retransfer Delay Command is active, then these SCADA commands will be overridden. The digital input has the highest priority when there is a conflict.

24.3 Transfer Switch Setpoints

Generator/Utility Automatic Transfer Enable Status

This is used to turn on or turn off the feature. This is defaulted to DISABLED.

Warning: If using the transfer switch is desired, all other setpoints should be configured before enabling the feature. Enabling this feature without properly configuring the contactor control and aux feedback I/O could result in unexpected or even dangerous behavior.

Loss of Utility Event Notification Delay Time

This setpoint is used to configure the debounce time that the Loss of Utility Input must be "true" before the utility is considered faulted. This also determines the debounce time the Loss of Utility Input must be "false" before the utility is considered "good" again.

Generator to Utility Transfer Delay Time (Stability Timer)

This setpoint is used to configure the amount of time the EMCP 4 will wait before it transfers back to utility once the utility is considered "good" after a utility fault. This timer will also be used if the generator is supplying load when the utility recovers from a fault.

Generator to Utility Fast Transfer Delay Time (Stability Timer)

This setpoint is used to configure the amount of time the EMCP 4 will wait before it transfers back to utility once the utility is considered "good" AND the generator is not providing power. If the load is not powered, the control should wait a shorter amount of time to transfer back to utility.

Utility to Generator Transfer Failure Warning Event Threshold

This setpoint is used to configure the amount of time the system is allowed to attempt transferring to generator power before it gives up and returns to utility power. If a condition arises where a transfer to generator power is malfunctioning, this setpoint will ultimately determine the amount of time the bus will be unpowered before the system decides to return to utility provided power. The timer is started from the moment the utility contactor opens and stops when the generator contactor is read back as 'closed.' If this event is active, the control will not attempt to transfer to gen power. This event must be reset once it becomes active.

Utility to Generator Transfer Failure Shutdown Event Threshold

This event is identical to the warning expect it will issue a red lamp shutdown on the generator set when it becomes active.

Generator to Utility Transfer Failure Warning Event Threshold

This setpoint is used to configure the amount of time the system is allowed to attempt a transfer from generator to utility before it gives up and transfers back to generator power. The timer starts the moment the generator contactor is opened and stops when the utility contactor is read back as closed. This setpoint will ultimately determine the amount of time the bus will be unpowered in the event of a transfer failure from generator to utility power. This event must be reset once it becomes active. When this event is active the system will not attempt to transfer to utility until the event is reset.

Generator Ready to Accept Load Threshold Percentage

This setpoint is used to configure the minimum percentage of AC frequency and voltage that the generator output must achieve before the generator set is considered "available."

Generator Ready to Accept Load Delay Time

This setpoint is used to configure the amount of time the AC frequency and voltage of the generator output must be above the Generator Ready to Accept Load Threshold Percentage to be considered "available."

Generator to Utility Transfer Mode

This setpoint configured the transfer switch to either auto or manual. The functionality of both modes is explained in detail in Sections 21.1 and 21.2. In short, auto mode only supports transfer on a loss of utility while manual support both loss of utility and manually initiated transfer.

Utility Breaker Maximum Closing Time

This setpoint is used to configure the amount of time the system will attempt to close the utility contactor before giving up and transferring back to generator power.

Utility Breaker Maximum Opening Time

This setpoint is used to configure the amount of time the system will attempt to open the utility contactor before giving up and going back to utility power.

Generator/Utility Automatic Transfer Minimum Unpowered Load Time

This setpoint is used to configure the amount of time the bus must be unpowered (both utility and generator contactors opened) before the utility or generator contactor can be closed.

Utility Breaker Failure to Open Event Response Configuration

This can be configured to warning shutdown or disabled for when the utility breaker fails to open.

Loss of Utility Event Response Configuration

This setpoint can be configured for a warning, active only, or disabled.

Utility to Generator Transfer Failure Warning Event Response Configuration

This setpoint can be a warning or disabled, for when the utility to gen transfer failure happens.

Utility to Generator Transfer Failure Shutdown Event Response Configuration

This setpoint can be a shutdown or disabled for when a transfer to gen failure shutdown happens.

Utility Breaker System Fault Event Response Configuration

This setpoint can be a warning shutdown or disabled.

Warning: When using the 4.4, all Event Response Configuration setpoints for controls on the same MGDL network should be identical. Having a discrepancy will cause controls to react differently to the same conditions and may cause the system to behave unexpectedly.

24.4 Transfer Switch Events

Loss of Electric Utility Grid (3577-31)

This event becomes present when the loss of utility input is activated for the loss of utility event notification delay time. The event will self-clear when the loss of utility input is deactivated.

Utility to Gen Transfer Failure (3575-15) and Utility to Gen Transfer Shutdown (3575-0)

This warning or shutdown becomes present when a transfer to generator is initiated but is not completed within the warning or shutdown event threshold time. Once this event becomes present or active, this will force the system to run on utility power. This event must be cleared manually in order to be able to run generator power again.

Warning: When using the 4.4, if this event becomes present on any of the controls, the user must confirm that all digital inputs for Transfer to Generator Power on all controls are inactive before resetting this event. If this event is reset when the transfer to generator power digital input is active on any controls in the MGDL network, that unit will immediately start and try to transfer to generator power even when other units are trying to run utility power. This may cause the system to behave unexpectedly. The digital input status from all units can be found on the Transfer Switch Overview Screen.

Generator to Utility Transfer Failure (3576-15)

This event becomes present when a transfer from generator to utility power is initiated and is not completed within the event threshold time. When this is event is active, the system will be forced to generator supplied power. This event must be cleared manually.

Note: When using the 4.4, resetting this event on a control will cause the event to be cleared on all controls on the MGDL network.

Utility Breaker Failure to Open (4012-7)

This event becomes present when the utility breaker or contactor is commanded to open and the position remains closed.

Utility Breaker Failure to Close (4012-31)

This event becomes present when the utility breaker or contactor is commanded to close but does not close.

Utility Breaker System Fault (3546-11)

This event becomes present if the utility breaker or contactor opens without being commanded to open by the EMCP 3 times within a minute. When this event becomes present or active, the system will be forced to generator provided power. This event must be cleared manually.

24.5 Reduced Power Mode with Transfer Switch

The EMCP 4 comes equipped with reduced power mode (see Chapter 18). In reduced power mode, all digital and relay outputs will be made inactive meaning the contactor command signals will be in the "trip" position. Also while in reduced power mode, the control can only be "woken up" by a button press or a remote initiate signal. Therefore, reduced power mode cannot be enabled if using transfer switch is desired without additional relay wiring of the contactor signals.

24.5.1 Not in Reduced Power Mode Relay Wiring Option

There is an optional wiring configuration that can be used if use of reduced power mode is desired while using transfer switch.

1. Configure a digital output to "Not in Reduced Power Mode." This output will remain active as long as the control is not in reduced power mode.
2. Install a relay on the "Not in Reduced Power Mode" output. Connect the NC terminal of the "Not in Reduced Power Mode" relay to the NO terminal of the utility contactor close command relay.
3. Connect the common of the "Not in Reduced Power Mode" relay to the common of the utility contactor close command relay.

Whenever the EMCP goes into reduced power mode, the utility contactor close command will be maintained and the utility contactor will remain closed.

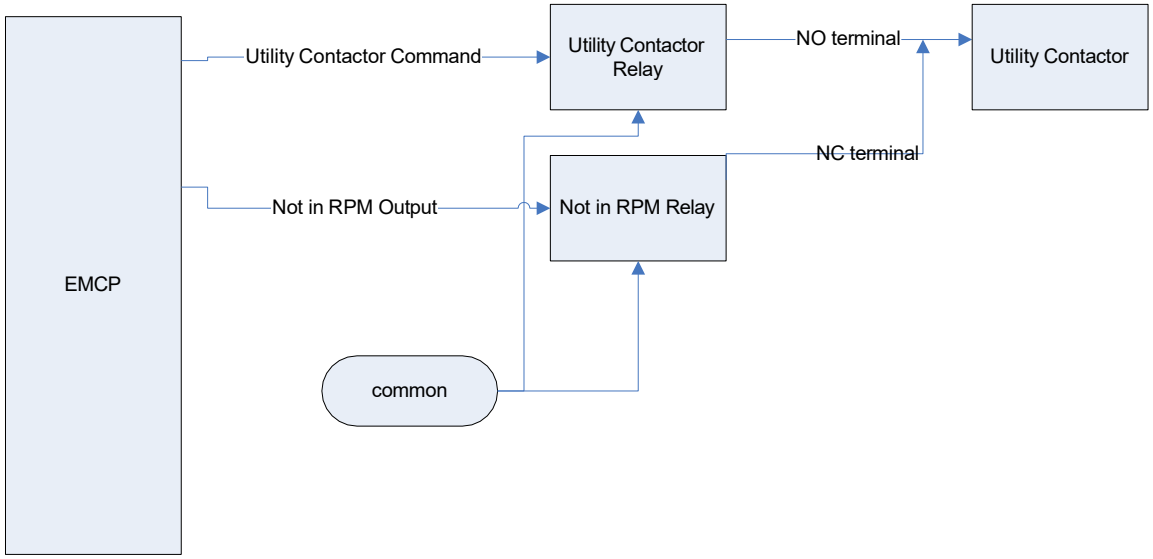


Figure 24.1

Warning: With this wiring configuration, if power to the EMCP is removed apart from disengaging the battery disconnect switch, the utility contactor close command will be active and will close the utility contactor.

24.5.2 Loss of Utility/Transfer to Generator Remote Initiate Wiring Option

There is an optional wiring configuration that will “wake up” the EMCP from reduced power mode in the event of a loss of utility or a transfer to generator signal becoming active.

1. To wake up the control on an event of a utility loss, wire the loss of utility input in parallel with the remote initiate input (DDI #2 pin J1-55).

2. To wake up the control for a manual transfer to generator power command, wire the transfer to generator power input in parallel with the remote initiate input.

Warning: With this wiring configuration, if a switch is wired to the remote initiate input while the loss of utility is wired in parallel, activating a remote initiate will generate a loss of utility condition. However, it is not advised to use the remote initiate function while transfer switch is enabled

24.6 Transfer Switch Wiring for EMCP 4.4 Paralleling

The EMCP 4.4’s MGDL network will communicate transfer switch information from unit to unit so it is only necessary to connect the digital input signals to one unit. However for redundancy there is the option to wire the transfer switch digital inputs to multiple or all unit on the MGDL network. This can be done through any of the configurable digital inputs on the EMCP, however it is advised to use the isolated discrete inputs for signals that will go to multiple units.

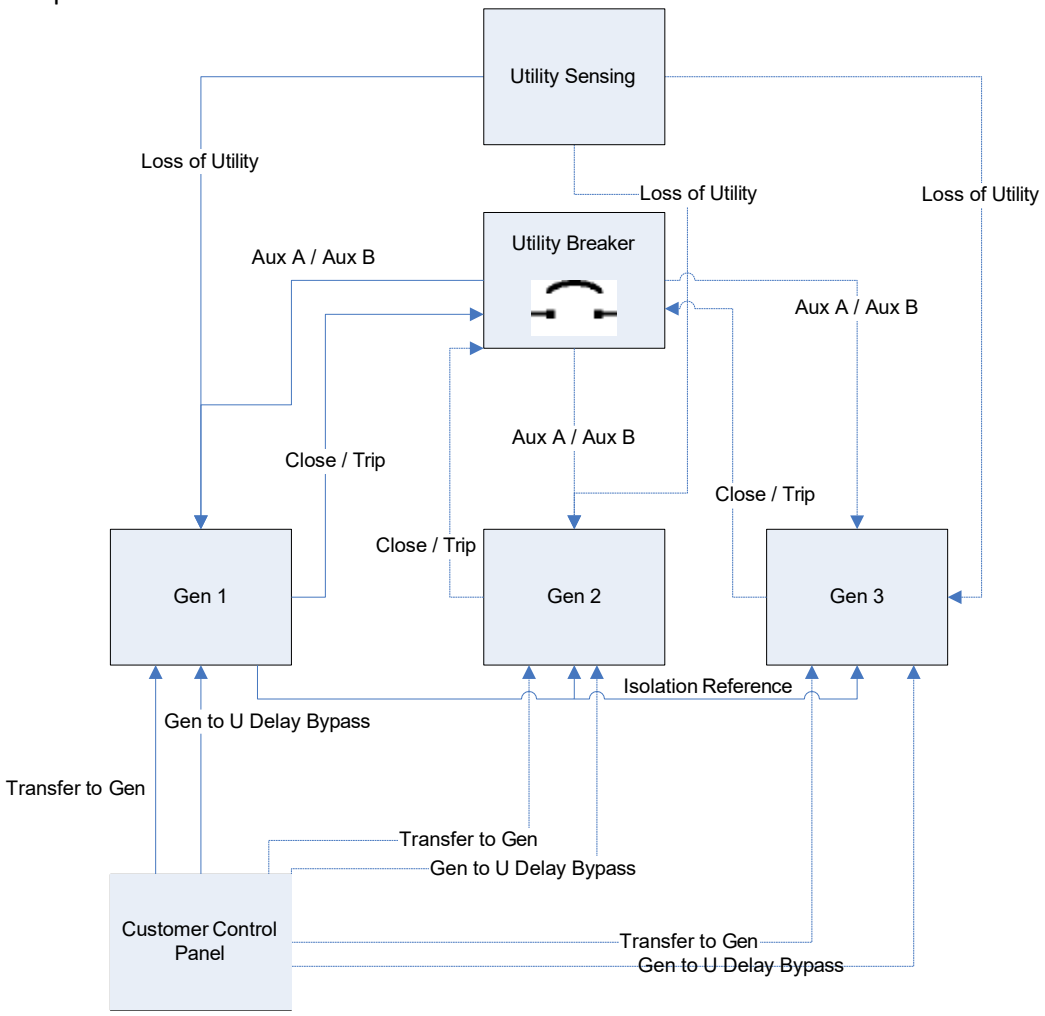


Figure 24.2

25.0 Programmable kW Relay Function

The EMCP 4.3 and EMCP 4.4 have two Programmable kW Relay functions configured to respond to the % kW of the generator set. These functions can be mapped to the EMCP Outputs. In addition, these functions can be used to trigger events using an event response configuration located under Events/Generator Protection Configuration. These events will then be recorded within the Event Log, and may be sent back if remote monitoring of events is being performed.

The setpoints within the Programmable kW Relay functions can be changed from the display, and are as follows:

Programmable kW Relay #N Trigger Condition

- Choices: Disabled, Trip Above Threshold, Trip Below Threshold
- This selects whether the output will be active if the value is above or below the threshold.

Programmable kW Relay #N Percentage Threshold

- Range: -100-120%
- This is the threshold of rated kW that the function must pass in order to change the state of the output.

Programmable kW Relay #N Hysteresis Percentage

- Range: 0-100%
- Once the output is on, the value must return by this much past the Threshold before the output turns off again. For example, if this value is 5% and the Percentage Threshold is 90%, then the relay will activate at 90% but not turn off again until 85% of rated kW (90-5). This hysteresis is used to ensure that a value close to the threshold does not cause the output to oscillate.

Programmable kW Relay #N Trip Activation Delay Time

- Range: 0-999 seconds
- This is the time that the value must exceed the threshold before the relay becomes active. It is used to ensure that the momentary transients are ignored.

Programmable kW Relay #N Trip Deactivation Delay Time

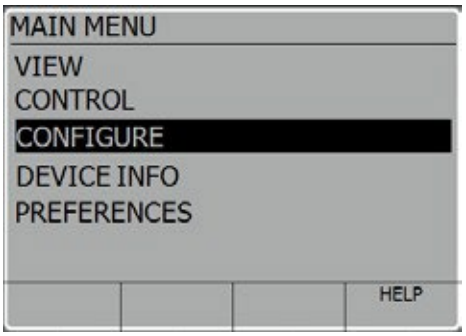
- Range: 0-999 seconds
- This is the time that the value must return past the threshold before the relay becomes inactive again. It is used to ensure that the momentary transients are ignored.

25.1 Configuring the Programmable kW Relay from the Display

To configure a Programmable kW Relay with the display, go through the following menu options:

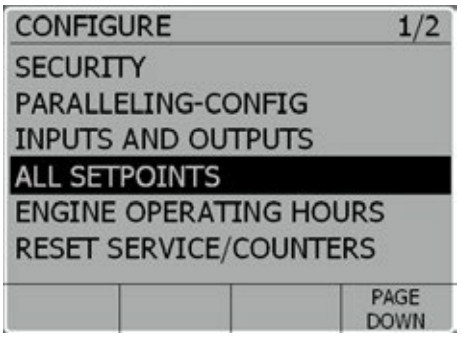
1. At MAIN MENU, scroll DOWN to CONFIGURE.

2. Press the OK KEY.



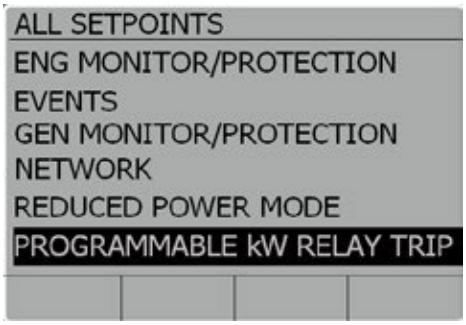
3. Scroll DOWN to ALL SETPOINTS.

4. Press the OK KEY.



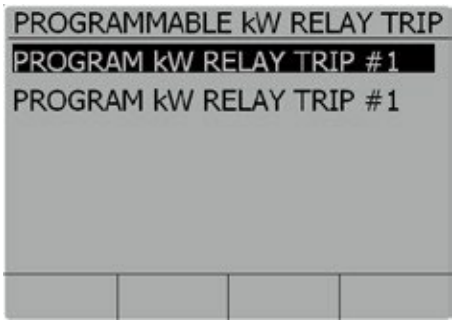
5. SCROLL DOWN to PROGRAMMABLE kW RELAY.

6. Press the OK KEY.



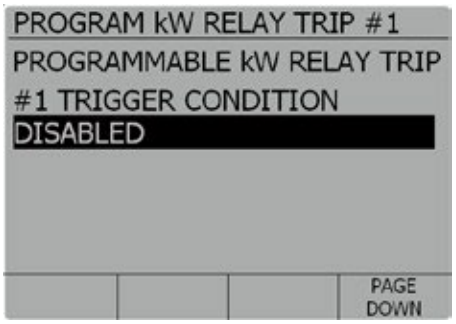
7, Select the PROG kW RELAY that you want to program.

8. Press the OK KEY.



.

9. Press the OK KEY to highlight the current configuration (DISABLED, TRIP BELOW THRESH, TRIP ABOVE THRESH).



Select the type of PROGRAMMABLE kW RELAY #N TRIGGER CONDITION that you want to program.

1. Press the OK KEY.

2. Scroll DOWN to PROGRAMMABLE kW RELAY #N PERCENTAGE THRESHOLD.

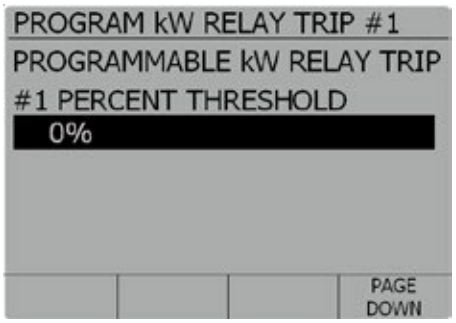
3. Press the OK KEY to edit the current PROGRAMMABLE kW RELAY #N PERCENTAGE THRESHOLD.

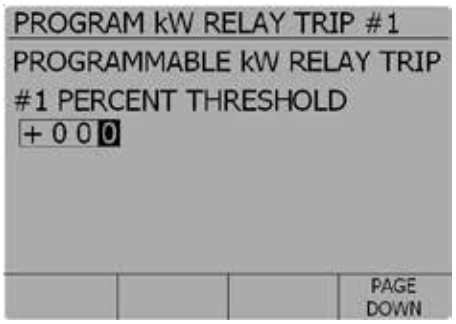
4. Select the PROGRAMMABLE kW RELAY #N PERCENTAGE THRESHOLD that you want to program.

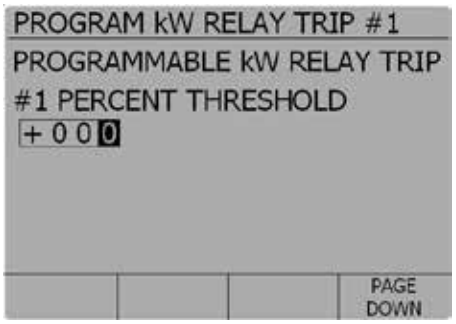
5. Press the OK KEY.

6. Scroll DOWN to PROGRAMMABLE kW RELAY #N HYSTERESIS PERCENTAGE.

7. Press the OK KEY to edit the current PROGRAMMABLE kW RELAY #N HYSTERESIS PERCENTAGE.







8. Select the PROGRAMMABLE kW RELAY #N HYSTERESIS PERCENTAGE that you want to program.

9. Press the OK KEY .

10. Scroll DOWN to PROGRAMMABLE kW RELAY #N TRIP ACTIVATION DELAY TIME .

11. Press the OK KEY to edit the current PROGRAMMABLE kW RELAY #N TRIP ACTIVATION DELAY TIME .

12. Select the PROGRAMMABLE kW RELAY #N TRIP ACTIVATION DELAY TIME that you want to program.

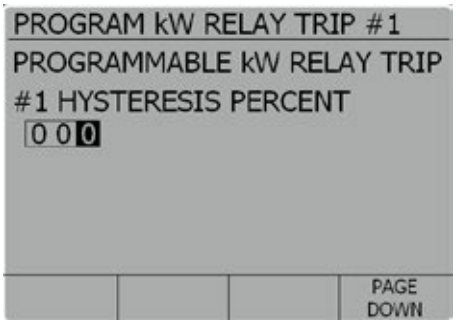
13. Press the OK KEY .

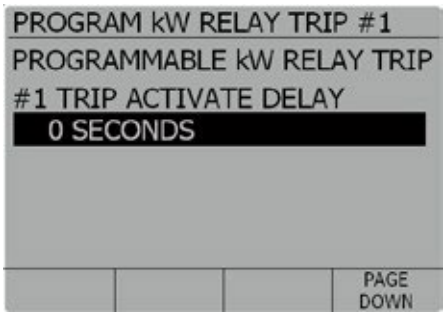
14. Scroll DOWN to PROGRAMMABLE kW RELAY #N TRIP DEACTIVATION DELAY TIME .

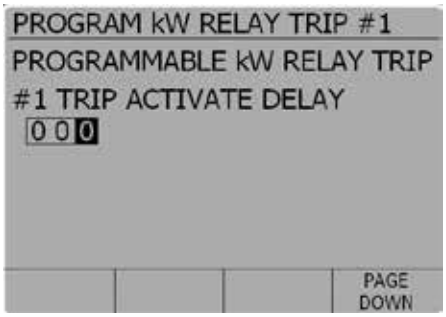
15. Press the OK KEY to edit the current PROGRAMMABLE kW RELAY #N TRIP DEACTIVATION DELAY TIME .

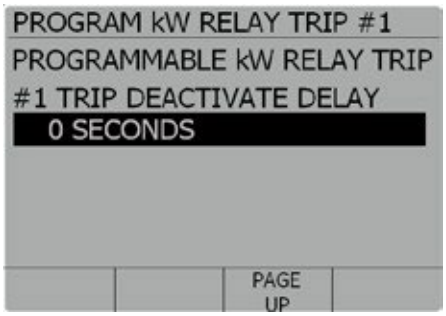
16. Select the PROGRAMMABLE kW RELAY #N TRIP DEACTIVATION DELAY TIME that you want to program.

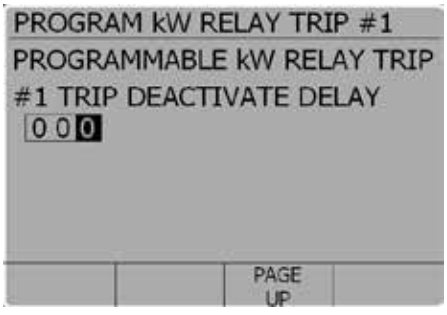
17. Press the OK KEY .









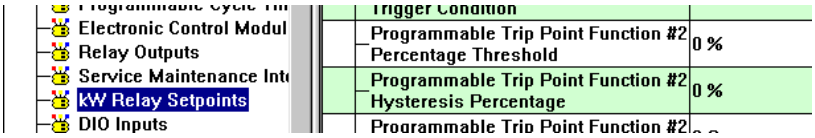


25.2 Configuring the Programmable kW Relays Using the Cat Service Tool

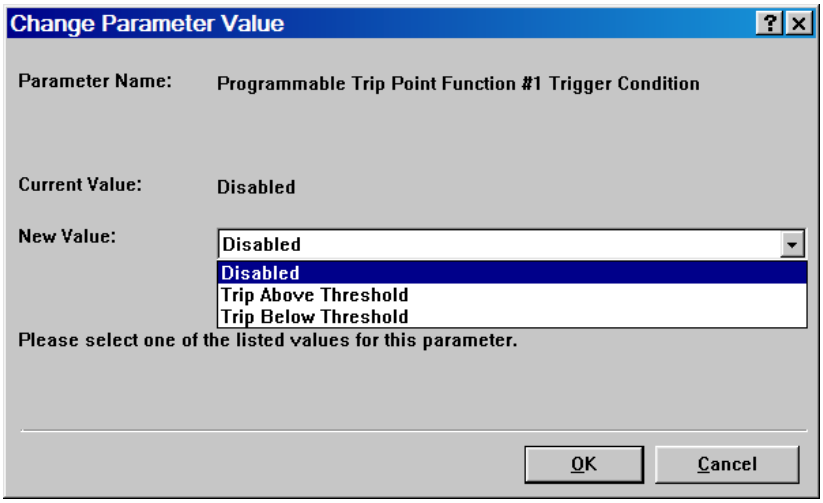
To configure a Programmable kW Relay with the Cat Service Tool, go through the following menu options:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

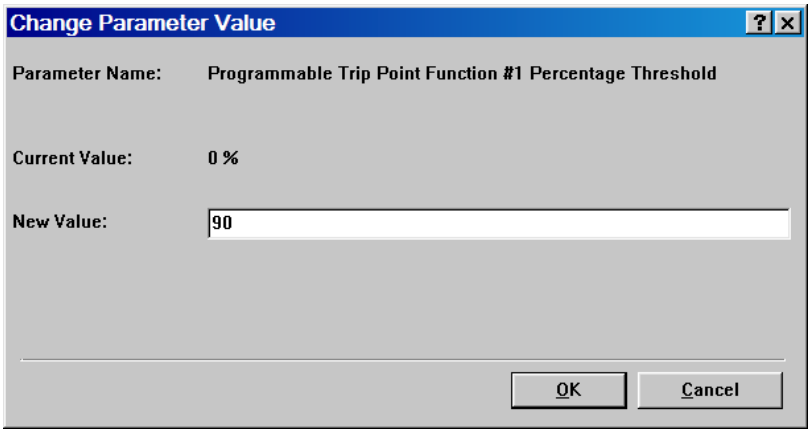
2. Select kW Relay Setpoints on the left.



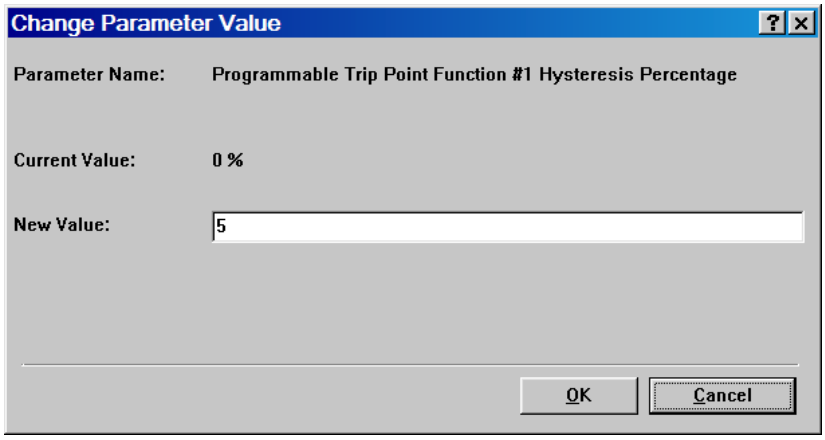
3. Double click the Programmable Trip Point #N Trigger Condition setpoint to change this value from the drop down menu. Click the OK button to program.



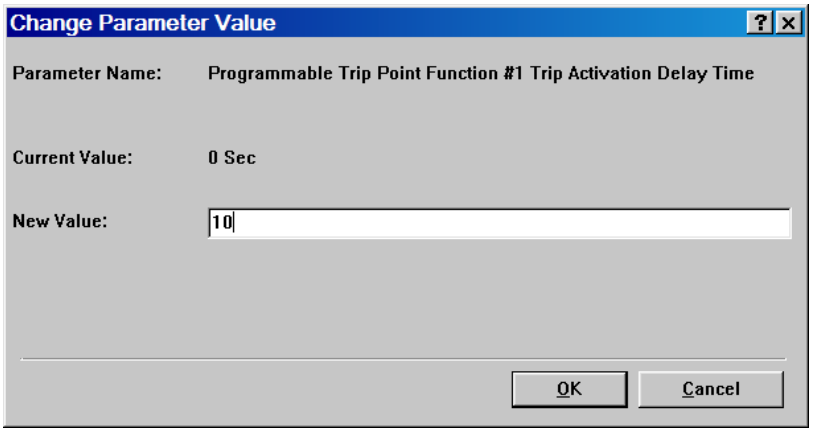
4. Double click the Programmable Trip Point #N Percentage Threshold setpoint to change this value. Click the OK button to program.



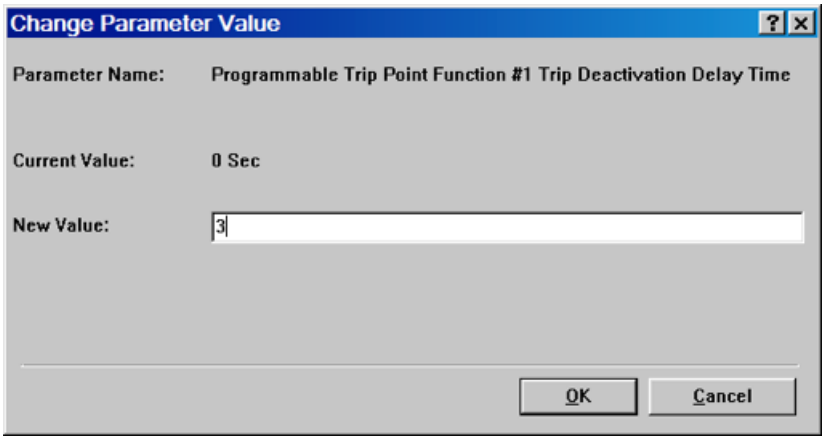
5. Double click the Programmable Trip Point #N Hysteresis Percentage setpoint to change this value. Click the OK button to program.



6. Double click the Programmable Trip Point #N Output #1 Trip Activation Delay Time setpoint to change this value from the drop down menu. Click the OK button to program.



7. Double click the Programmable Trip Point #N Output #2 Trip Activation Delay Time setpoint to change this value from the drop down menu . Click the OK button to program.



8. Repeat the above steps to program an additional timer.

26.0 Overcurrent

The EMCP 4 as of 4.7 PROD software has the addition of an enhanced overcurrent detection algorithm that allows the user to configure how much overcurrent is allowed on a time based approach before triggering an overcurrent event. This additional algorithm functions in conjunction with the existing overcurrent algorithm and an event can be generated from either algorithm at any time.

The enhanced overcurrent algorithm is controlled by 4 new setpoints located under the Generator Current Monitoring group of setpoints. The 4 new setpoints are:

Generator Inverse Time Overcurrent Shutdown Event Threshold	This configures the percentage of rated current that the enhanced overcurrent algorithm will start activating. Below this threshold the enhanced overcurrent algorithm will not generate an event for overcurrent.
Generator Inverse Time Overcurrent Shutdown Event Time Multiplier	This is a time value that is multiplied to the algorithm calculation that will extend the time before the enhanced overcurrent algorithm will generate an overcurrent event. This is explained further in the equations listed below.
Generator Inverse Definite Minimum Time Curve Type Configuration	This configures which logarithmic curve is used by the algorithm to calculate the trip time. The selections are: Normally Inverse Very Inverse Extremely Inverse Thermal Damage Curve The detailed explanations for these is listed below.
Generator Rated Current Multiplier	Used only when the thermal damage curves are selected as the curve type. This setpoint multiplies the rated current to alculate the effective rated current that the algorithm will use to execute the trip time calculations.
Generator Definite Time Overcurrent Warning Event Percentage Threshold	Configures the percent of rated current that will raise and overcurrent warning event with no delay.
Generator Definite Time Overcurrent Shutdown Event Percentage Threshold	Configures the percent of rated current that will cause a shutdown event after the configured shutdown event notification delay time.
Generator Definite Time Overcurrent Shutdown Event Notification Delay Time	Configures the amount of time delay between the generator current rising above the Generator Definite Time Overcurrent Shutdown Event Percentage Threshold and the raising of an overcurrent shutdown.

Table 26.1

The first three curve types are normally, very, and extremely inverse curves. Respectively, these curves have progressively slower trip times for the same conditions and configurations. Equations used to calculate the trip times are shown here.

IEC curves

Normal Inverse

$$T(s) = \frac{0.14 * TM}{\left(\frac{I}{Is}\right)^{0.02} - 1}$$

Very inverse

$$T(s) = \frac{13.5 * TM}{\left(\frac{I}{Is}\right)^{1.0} - 1}$$

Extremely Inverse

$$T(s) = \frac{80 * TM}{\left(\frac{I}{Is}\right)^{2.0} - 1}$$

In these equations:

TM = the Generator Inverse Time Overcurrent Shutdown Event Time Multiplier setpoint

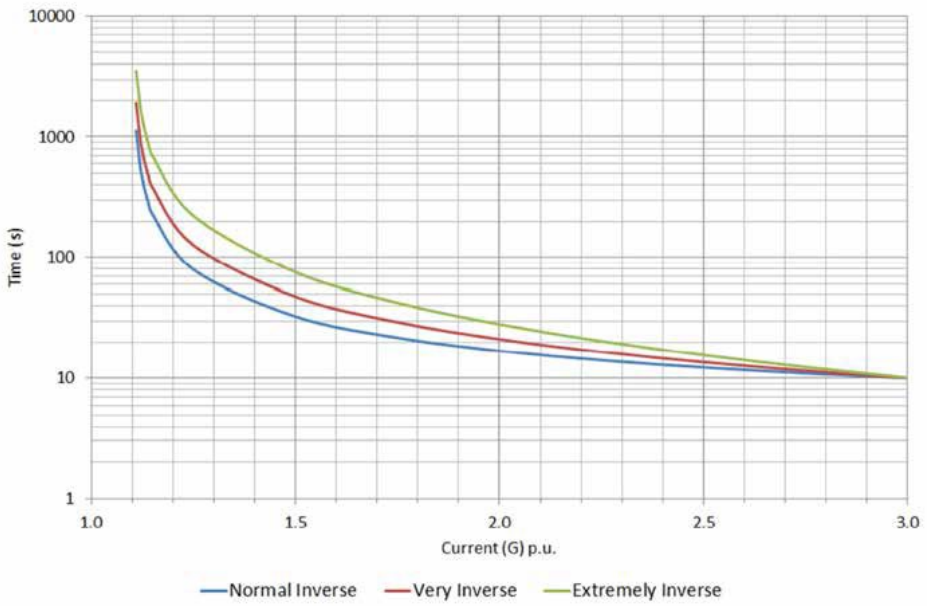
IS = the starting current which is configured by the Generator Inverse Time Overcurrent Shutdown Event Threshold setpoint

I = the measured generator current

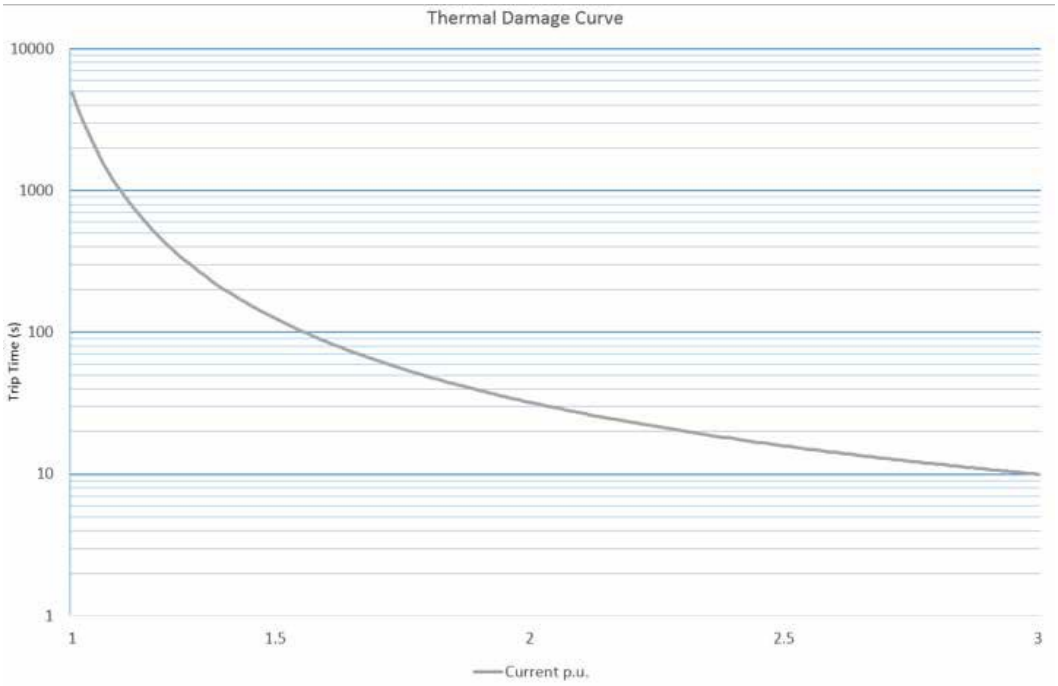
T(s) = the time before the overcurrent event is generated while the measured generator current is above the starting current.

In the below example the three curve types are plotted graphically.

	Normal Inverse	Very Inverse	Extremely Inverse
Time Multiplier (TM)	1.45	1.28	0.81
Starting Current (I_s) per-unit	1.1	1.1	1.1



For the selection of the Thermal Damage Curves, a different equation is used that is specific to a generator design. A graphical representation of the thermal damage cure follows.



In this equation I is the rated genset current [(rated VA/rated voltage)/sqrt(3)] multiplied by the rated current multiplier setpoint. After the trip time expires, an overcurrent shutdown will be generated.

27.0 Engine Cylinder Temperature Differential Monitor

The EMCP 4.3 and EMCP 4.4 used in conjunction with the optional Thermocouple module provide the ability to monitor individual engine exhaust cylinder temperatures as well as all cylinder temperature differentials. Cylinder temperature differentials are calculated based on an individual cylinder temperatures compared with the average temperature of all cylinders. Because excessive engine cylinder temperature differentials can be an indication of engine problems, when an individual cylinder temperature is determined to be much higher or much lower than the average cylinder temperature the EMCP triggers an event.

The allowable cylinder temperature differential can vary based on engine loading and operating conditions and is user configurable. For example, cylinder temperature differentials are ignored while the engine is starting using the Fault Protection Timer. Also, under light loading the cylinder temperature differential may be larger than during heavier loading. Therefore, the Engine Exhaust Temperature Differential Monitor feature can be configured by the following setpoints located under Enhance Engine Monitor configuration group.

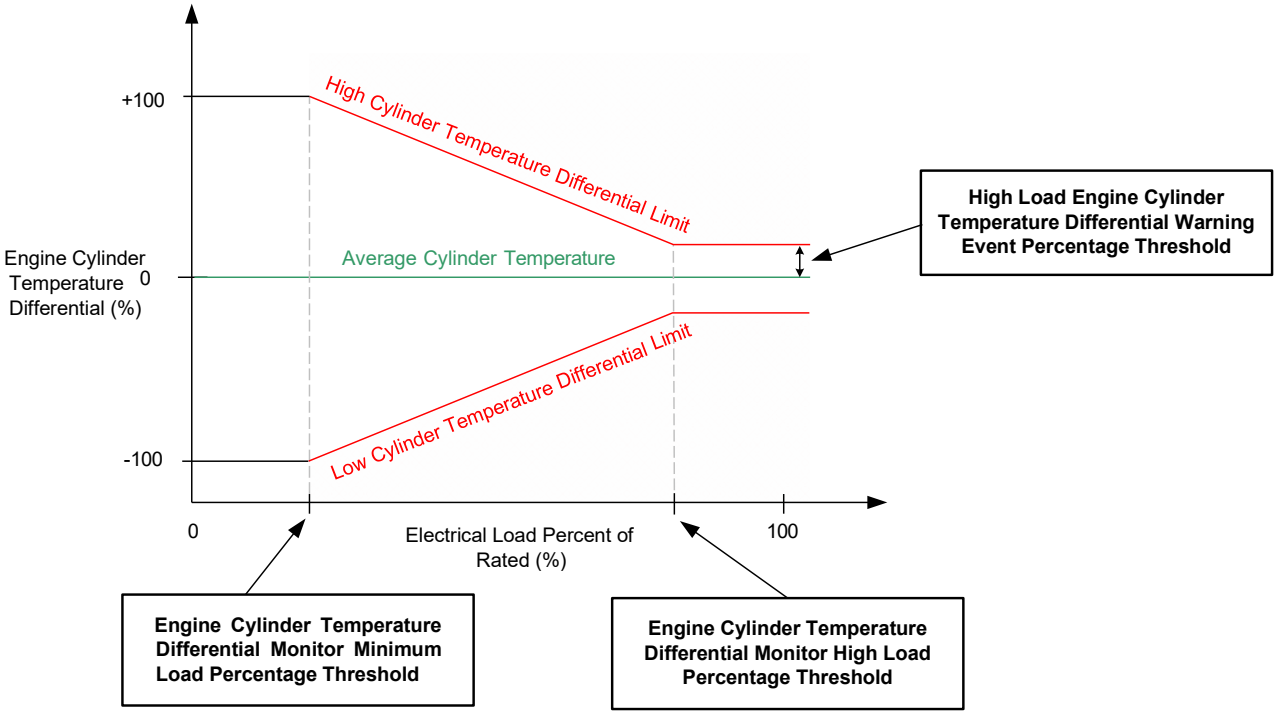


Figure 27.1 – Engine Cylinder Temperature Differential Monitor Setpoints and Profile

Engine Cylinder Temperature Differential Monitor Enable Status

- Choices: Enabled, Disabled
- This selects whether the EMCP calculates cylinder temperature differentials and triggers events based on those cylinder temperature differentials and engine operating conditions.

High Load Engine Cylinder Temperature Differential Warning Event Percentage Threshold

- Range: 10-40%
- This is the absolute cylinder temperature differential threshold at which the EMCP triggers a cylinder temperature differential warning event. This cylinder temperature differential threshold applies only at engine loads that are greater than the ENGINE CYLINDER TEMPERATURE DIFFERENTIAL HIGH LOAD PERCENTAGE THRESHOLD setpoint.

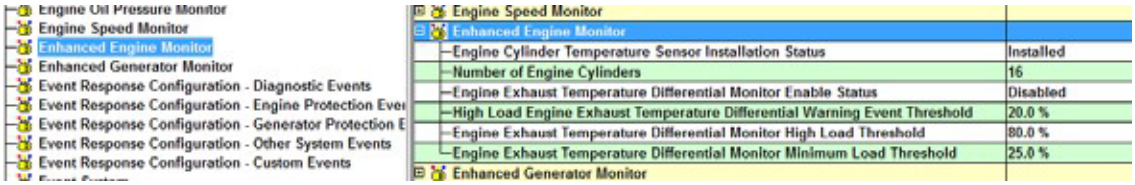
Engine Cylinder Temperature Differential Minimum Load Percentage Threshold

- Range:10-50%
- This is the engine load percentage level at which the cylinder temperature differential warning threshold begins to take effect. At engine loads greater than this value, the cylinder temperature differential warning threshold is decreased proportionally to increasing engine load until the ENGINE CYLINDER TEMPERATURE DIFFERENTIAL HIGH LOAD PERCENTAGE THRESHOLD engine load point is reached. For example, if this value is 25% then the engine load must be greater than 25% before the EMCP will begin monitoring engine cylinder temperature differentials.

Engine Cylinder Temperature Differential High Load Percentage Threshold

- Range: 50-100%

  This is the engine load percentage level at which the cylinder temperature differential warning threshold remains constant. For example, if this value is 80% and the HIGH LOAD ENGINE CYLINDER TEMPERATURE DIFFERENTIAL WARNING EVENT PERCENTAGE THRESHOLD is 20%, then the EMCP will trigger an engine cylinder temperature differential warning event if an individual cylinder temperature is 20% greater than or less than the average temperature of all cylinders AND only if the engine load is greater than 80%.



When the Engine Cylinder Temperature Differential Monitor feature is enabled, two cylinder temperature limits are displayed on the Engine Cylinder Temperatures screen on the EMCP Engine Overview (see Figure 27.2). These two cylinder temperature limits (high limit and low limit) are calculated based on the cylinder temperature differential profile as configured and shown in Figure 27.1.

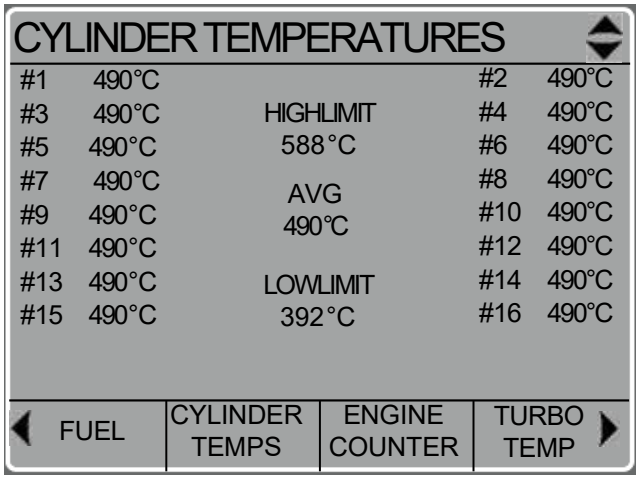


Figure 27.2 – Engine Cylinder Temperatures View with High and Low Limits

When an individual cylinder temperature is greater than the high cylinder temperature limit for 10 seconds the EMCP will trigger a High Engine Cylinder #N Warning event that will remain active until the individual engine cylinder temperature decreases to 20°C below the high cylinder temperature limit.

When an individual cylinder temperature is less than the low cylinder temperature limit for 10 seconds the EMCP will trigger a Low Engine Cylinder #N Warning event that will remain active until the individual engine cylinder temperature increases to 20°C above the low cylinder temperature limit.

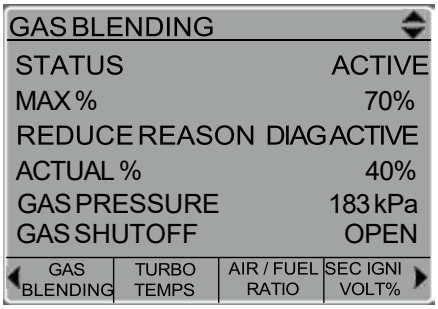
When the Engine Cylinder Temperature Differential Monitor feature is enabled if an individual cylinder temperature is lost the EMCP will trigger an Engine Cylinder #N Abnormal Update Rate diagnostic to indicate a problem with the individual cylinder temperature sensor hardware or configuration. If all cylinder temperatures are lost, the EMCP will trigger an Exhaust Temperature Module Abnormal Update Rate diagnostic indicating a problem with the temperature sensing module communications or hardware.

28.0 Dynamic Gas Blending

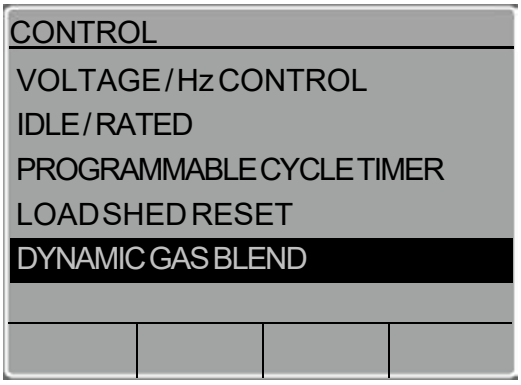
The EMCP 4.3 and EMCP 4.4 have the ability to monitor and control generator sets fitted with the Cat Dynamic Gas Blending system. If installed, the EMCP 4.3 and EMCP 4.4 automatically detects the dynamic gas blending system and dynamic gas blending parameters are available for monitoring under the ENGINE OVERVIEW screen (details provided in Section 4.3.2).

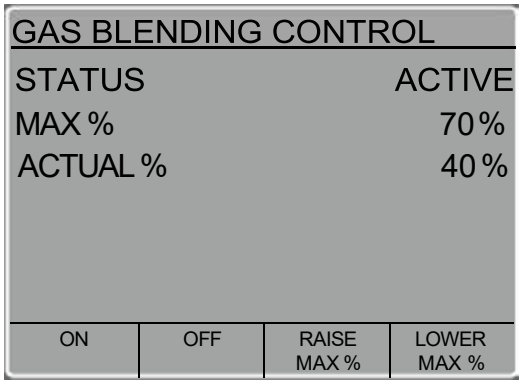
Engine Gas Blending Screen

- Gas Substitution Status
- Maximum Gas Substitution Percentage
- Gas Substitution Reduction Reason
- Actual Gas Substitution Percentage
- Engine Fuel Valve Intake Pressure
- Engine Fuel Valve Shutoff Status



If installed, dynamic gas blending control is available via the EMCP 4.3 and EMCP 4.4 display under the CONTROL screen. From this screen, the active/inactive status of the gas blending is displayed as well as the maximum possible gas substitution percentage along with the actual gas substitution percentage. Using the function keys on the EMCP 4 gas blending can be enabled/disabled and the maximum gas substitution percentage can be raised or lowered.





A selection of programmable analog and digital input and output options for interfacing external controls with the dynamic gas blending feature are also available on the EMCP 4.3 and EMCP 4.4 and provided in Table 28.1. For information on programming digital inputs, digital outputs and analog outputs on the EMCP 4 refer to Section 10, Section 12, and Section 13, respectively.

Digital Output Option	Analog Output Option	Digital Input Option
Gas Substitution (Blending) Mode On Gas Substitution (Bending) Active Gas Shutoff Valve Closed	Gas Substitution (Blending) Percentage	Disable Gas Substitution (Blending) Command

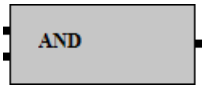
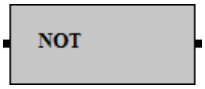
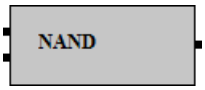
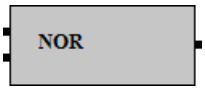
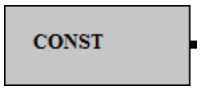
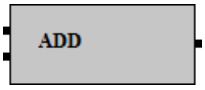
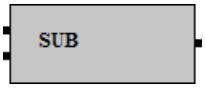
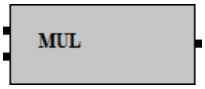
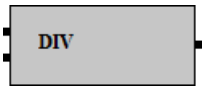
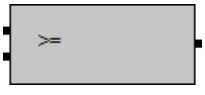
Table 28.1 – Gas Blending Input/Output Options

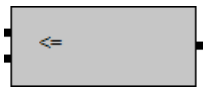
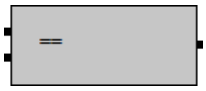
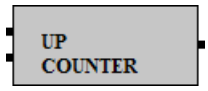
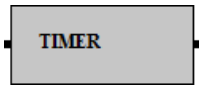
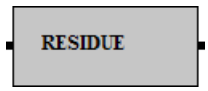
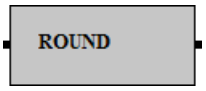
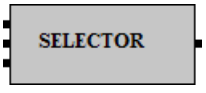
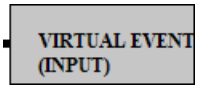
29.0 Integrated PLC Feature Set

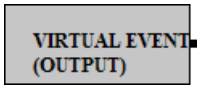
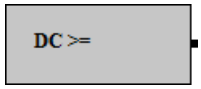
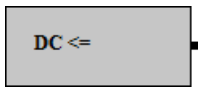
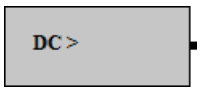
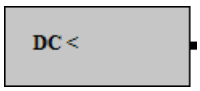
The EMCP 4 .2 is equipped with many of the features of a PLC controller . This feature set allows the user to create custom logic functions which interact with internal signals within the control software as well as input and output channels to the control . The logic functions can read the physical inputs to the control or internal signals to drive logical operations which can manipulate other internal signals or drive the physical outputs of the control .

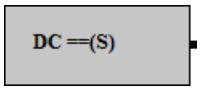
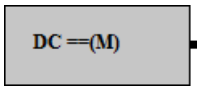
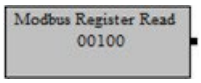
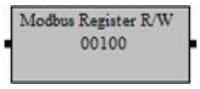
29.1 Logical Operation Blocks

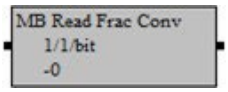
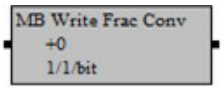
There are 33 logical operations that can be done by the EMCP's PLC feature set . Listed below is a table showing the graphical representation in the PLC config tool software, name, and brief description of each logic operation

	Takes two Boolean inputs and performs an "AND" function which drives a Boolean output . If both inputs are true then the output is true, otherwise the output is false .
	Takes two Boolean inputs and performs an "OR" function which drives a Boolean output . If either input is true then the output is true, otherwise the output is false .
	Takes one Boolean input and drives the opposite logic value at the output . If the input is true then the output is false and vice versa .
	Takes two Boolean inputs and performs an "AND" function then outputs the opposite of the result . If both inputs are true then the output is false, otherwise the output is true .
	Takes two Boolean inputs and performs a "NOR ." If either of the two inputs is true then the output is false, if both inputs are false then the output is true .
	Constant Block . This block will output a customer configured value with up to 3 decimal places of precision .
	Takes two inputs and outputs the sum .
	Takes two inputs and outputs the difference of input 1 (top) – input 2 (bottom) .
	Takes two inputs and outputs the product .
	Takes two inputs and outputs the ratio of input 1 (top)/input 2 (bottom) .
	Greater than or equal to comparator . This block outputs a "true" when input 1 (top) is greater than or equal to input 2 (bottom) . This block has configurable hysteresis of up to 100% . With a 10% hysteresis for example, once the greater than or equal to condition is true, input 1 must be 10% less than input 2 (input 1 < 90%* input 2) before the output will be false again .

	Less than or equal to comparator . This block outputs a “true” when input 1 (top) is less than or equal to input 2 (bottom) . This block has configurable hysteresis of up to 100% . With a 10% hysteresis for example, once the less than or equal to condition is true, input 1 must be 10% greater than input 2 (input 1 > 110%*input 2) before the output will be false again .
	Greater than comparator . This block outputs a “true” when input 1 (top) is greater than input 2 (bottom) . This block has configurable hysteresis of up to 100% . With a 10% hysteresis for example, once the greater than condition is true, input 1 must be 10% less than input 2 (input 1 < 90%* input 2) before the output will be false again .
	Less than comparator . This block outputs a “true” when input 1 (top) is less than input 2 (bottom) . This block has configurable hysteresis of up to 100% . With a 10% hysteresis for example, once the less than condition is true, input 1 must be 10% greater than input 2 (input 1 > 110%* input 2) before the output will be false again .
	Equal to comparator . This block will output a “true” when the two inputs are equal . This block has configurable hysteresis of up to 100% . With a 10% hysteresis for example, once the output becomes true, input 1 must be 10% greater than or less than input 2 (input 1 > 110%* input 2 or input 1 < 90%* input 2) before the output will be “false “ again .
	Up Counter . This block takes two Boolean inputs and will count the rising edges on input 1 and output the number at the output port . The number of rising edges can be reset by activating input 2 .
	Timer Block . This block will start a timer when the Boolean input is activated . Once the “on delay” expires, the output will be set to true . Once the input is deactivated, the output will be deactivated after the “off delay .” The “on delay” and “off delay” are both configurable through the PLC config tool .
	Residue Block . This block takes a number at the input and returns the decimal portion of that number at the output . Ex 1 .428 is input; output will be .428 .
	Round Block . This block takes a number at the input and rounds it to the nearest whole number at the output . EX 1 .428 is input; output will be 1 .
	Selector Block . This block takes two universal inputs (#1 and #2) and 1 Boolean input (#3) . When input 3 is false, input 1 is carried through to the output . If input 3 is true, input 2 is carried through to the output .
	Virtual Event Input Block . This block takes one Boolean input . When the input is activated, the PLC will generate a J1939 DIAGNOSTIC TROUBLE CODE . The user can specify the SPN and FMI of the J1939 DIAGNOSTIC TROUBLE CODE in the PLC config tool when adding a virtual event block . **Note:** Only EMCP supported DIAGNOSTIC TROUBLE CODES can be configured .

	Virtual Event Output Block. This block has no inputs and one Boolean output. The user configures a specific SPN and FMI combination for this block. When that J1939 DIAGNOSTIC TROUBLE CODE becomes present or active, this block will activate its Boolean output. **Note:** Only EMCP supported DIAGNOSTIC TROUBLE CODEs can be configured.
	Greater Than or Equal to Date Comparator. This block has a Year, Month, Date, Hour, Minute, and Second that can be configured by the user. When the current real time clock value of the EMCP is greater than or equal to that user configured value, this block will activate its Boolean output. If any of the date fields are left blank, they will not be evaluated in the comparison. Ex User configured 2015, October, 10th, 12 o'clock, but no minute or second. The block will activate its output when the real time clock value of the EMCP is greater than or equal to October 10th 2015 at 12 PM regardless of what minute or second it is.
	Less Than or Equal to Date Comparator. This block has a Year, Month, Date, Hour, Minute, and Second that can be configured by the user. When the current real time clock value of the EMCP is less than or equal to that user configured value, this block will activate its Boolean output. If any of the date fields are left blank, they will not be evaluated in the comparison. Ex User configured 2015, October, 10th,12 o'clock, but no minute or second. The block will activate its output when the real time clock value of the EMCP is less than or equal to October 10th 2015 at 12 PM regardless of what minute or second it is.
	Greater Than to Date Comparator. This block has a Year, Month, Date, Hour, Minute, and Second that can be configured by the user. When the current real time clock value of the EMCP is greater than that user configured value, this block will activate its Boolean output. If any of the date fields are left blank, they will not be evaluated in the comparison. Ex User configured 2015, October, 10th, 12 o'clock, but no minute or second. The block will activate its output when the real time clock value of the EMCP is greater than October 10th 2015 at 12 PM regardless of what minute or second it is.
	Less Than Date Comparator. This block has a Year, Month, Date, Hour, Minute, and Second that can be configured by the user. When the current real time clock value of the EMCP is less than that user configured value, this block will activate its Boolean output. If any of the date fields are left blank, they will not be evaluated in the comparison. Ex User configured 2015, October, 10th, 12 o'clock, but no minute or second. The block will activate its output when the real time clock value of the EMCP is less than October 10th 2015 at 12 PM regardless of what minute or second it is.

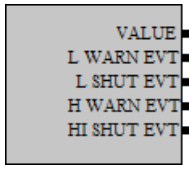
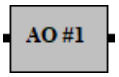
	Equal to Single Date Comparator. This block has a Year, Month, Date, Hour, Minute, and Second that can be configured by the user. When the current real time clock value of the EMCP is equal to that user configured value, this block will activate its Boolean output. If any of the date fields are left blank, they will not be evaluated in the comparison. Ex User configured 2015, October, 10th, 12 o'clock, but no minute or second. The block will activate its output when the real time clock value of the EMCP is equal to October 10th 2015 at 12 PM regardless of what minute or second it is.
	Equal to Multiple Dates Comparator. This block allows the user to enter either multiple months and dates, or multiple months and days of the week where the comparator output will be true when the real time clock of the EMCP equals those dates. The user is only allowed to select months and dates or days, years, hours, minutes, and seconds are excluded from this block.
	Read Register. This block takes one Boolean input and no output. This block allow the user to read data associated with a programmed Modbus register (Example: Modbus register number 100 will indicate the value for "Generator Average Line-Line AC RMS Voltage). When users select this logical block, a Pop-up window will be generated asking the user to enter the Modbus Holding Register along with the number of registers to be read.
	Write Register. This block has no input and one Boolean output. This block allow the user to write data to a register associated with a programmed Modbus register (Example: Modbus register number 300 is "Bypass Cool down". A command to bypass remaining cool down duration and immediately stop engines upon next soft shutdown request). When users select this logical block, a Pop-up window will be generated asking the user to enter the Modbus Holding Register along with number of registers to be written.
	Read Write Register. This block has one Boolean input and one Boolean output respectively. This block allow the user to Read/Write the data associated with a programmed Modbus Register (Example: Modbus registernumber 320 is "Bypass Transfer Delay Command". A command used for the basic transfer switch feature to issue a bypass transfer delay). When users select this logical block, a Pop-up window will be generated asking the user to enter the Modbus Holding Register along with number of registers to be Read/written.

	Read Conversion. This block has one boolean input and one boolean output respectively. When users select this logical block, a Pop-up window will be generated asking the user to choose the type of conversion (Fractional/ Decimal). Once users selects the type of conversion, another Pop-up window will be generated to fill the value for the scale factor and offset.
	Write Conversion. This block has one boolean input and one boolean output respectively. When users select this logical block, a Pop-up window will be generated asking the user to choose the type of conversion (Fractional/ Decimal). Once users selects the type of conversion, another Pop-up window will be generated to fill the value for the scale factor and offset.

29.2 Function Blocks

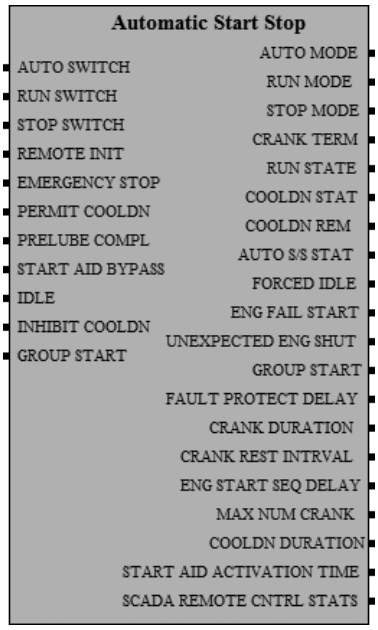
General Input/Output Blocks

The EMCP 4 PLC feature set allows the user to interact with digital and analog inputs/outputs in their custom PLC configuration.

	Analog Input Block. This block can be associated with any of the analog inputs to the EMCP 4. As long as the input is not disabled, the data from that analog input will be valid. The "Value" output returns the data value for the analog input. For example if the input is configured to oil pressure, then value will return the pressure value NOT the raw resistance or voltage read by the input. The low warning event, low shutdown event, high warning event, and high shutdown event outputs are Boolean outputs that will be true whenever that particular event becomes present. These event thresholds are configurable under the analog input configuration setpoints.
	Digital input Block. This block can be associated with any of the digital inputs to the EMCP 4 (programmable digital inputs 1-8, Programmable Isolated Digital inputs 1-4, Dedicated isolated and non isolated digital inputs, and paralleling digital inputs 1 and 2). Whenever that input is activated, this block will return a Boolean true at its output. The configurable digital inputs cannot be disabled if they are to be used with this.
	Digital Output Block. This block can be associated to either of the two digital outputs on the EMCP 4 control and can read and or control the digital outputs. To read the state of outputs whenever the selected output is active, this block will return a Boolean true at its output. In order to control digital outputs, the command/status data identification for the digital output must be programmed to "programmable logic function." This can be done through Cat ET or through the display interface. This block will then take a Boolean input which will activate or deactivate the selected digital output.
	Analog Output Block. This block can be associated with any of the Analog outputs on the EMCP 4.3/ EMCP 4.4 control (Analog output 1-3, and Analog PWM output 1-2). It can be ale to read and/or control the Analog outputs whenever the selected output is active. In order to control Analog outputs, the command/status data identification for the analog output must be programmed to "Programmable Logic Function". This can be done through Cat ET or through the display interface. This block will then take an input which will activate or deactivate the selected Analog output.

29.2.1 Special Function Blocks

The PLC feature set allows the user to read and manipulate internal control signals in specific functional blocks of the control. The functions that can be manipulated are listed below.



Automatic Start Stop Block. This is the interface to the control's logic for starting and stopping the generator set.

Inputs

Auto Run and Stop Switches – activating these Boolean inputs will put the engine control switch in to auto run or stop.

Remote Initiate – activating this Boolean input will activate the remote initiate input into the control. The physical remote initiate is still functional and is "OR'ed" with this signal.

Emergency Stop – activating this Boolean input will activate the emergency stop input. The physical input is still functional and is "OR'ed" with this input.

Permit Cooldown – activating this input will allow the control to transition out of the pre-cool down state. If the input is not connected, the EMCP will always skip the pre-cooldown state.

Prelube Complete – If engine prelube is being used, this Boolean input can override the prelube and allow the control to proceed to starting.

Start Aid Bypass – activating this Boolean input will cause the control to skip the start aid timer if configured.

Idle – activating this Boolean input will command the engine to go to Idle. (Not all engines are configured to support idle.)

Inhibit Cooldown – activating this input will prevent the control from entering cooldown mode. The control will stay in the pre-cooldown state until this input is deactivated.

Group Start (EMCP 4.4 Only) – activating this Boolean input will generate an MGDL group start.

Outputs

Auto, Run and Stop Modes – returns a Boolean signal when the engine control switch is in one of these modes.

Crank Term – returns a Boolean signal of true when the engine speed is above the crank terminate setpoint.

Run State – returns a Boolean true whenever the engine is being commanded to start or run.

Cooldown State – returns a Boolean true if the generator set is in cooldown mode.

Cooldown Remaining – returns a numerical value of seconds for the amount of cooldown time remaining before the engine stops.

Auto Start Stop State – returns a numerical value for the state of the generator set.
The enumeration is as follows; 0=init; 1=pre crank; 2=starting; 3=running; 4=pre cooldown; 5=cooldown; 6=stopping; 7=stopped; 8= idling.

Forced Idle – returns a Boolean true if the EMCP is in idle mode.

Engine Failure to Start – returns a Boolean true if the event for engine failure to start becomes present.

Unexpected Engine Shutdown – returns a Boolean true if the event for unexpected engine shutdown becomes present.

Fault Protection Delay – returns a numerical value for the setpoint "Fault Protection Timer" in seconds.

Crank Duration – returns a numerical value for the crank duration setpoint in seconds.

Crank Rest interval – returns a numerical value for the crank rest interval setpoint in seconds.

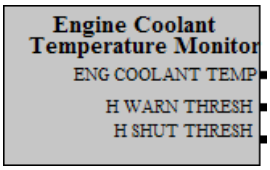
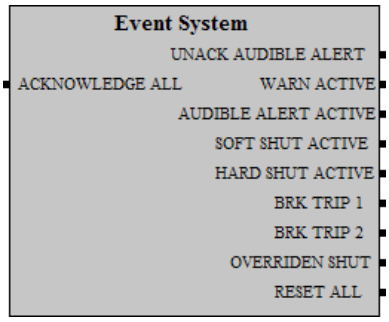
Engine Start Sequence Delay – returns a numerical value for the start sequence delay setpoint in seconds.

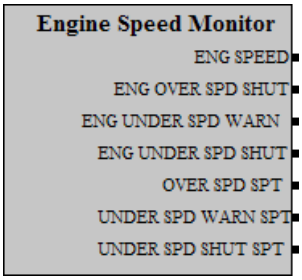
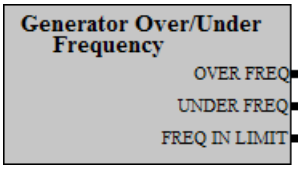
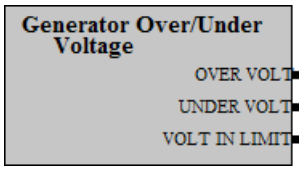
Maximum Number of Crank Cycles – returns a numerical value for the maximum number of crank cycles setpoint.

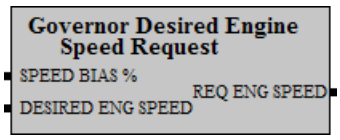
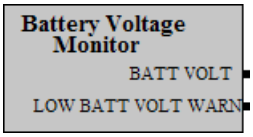
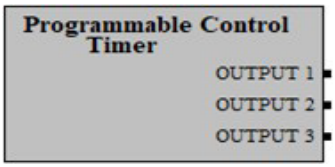
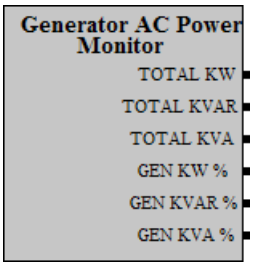
Cooldown Duration – returns a numerical value for the cooldown duration setpoint in seconds.

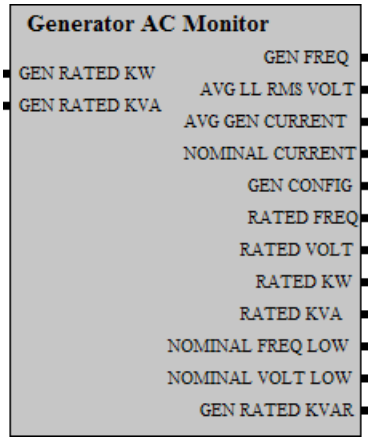
Start Aid Activation Time – returns a numerical value for the start aid activation time setpoint in seconds.

SCADA Remote Control Enable Status – returns a Boolean true when the SCADA remote control enabled status is set to "enabled."

 The engine coolant temp monitor block allows the customer to access the engine coolant temperature data link value. If an analog sensor is used for coolant temperature, then the analog input block will provide the coolant temperature value. The high warning and shutdown thresholds are also provided for reading.	**No Inputs**	**Outputs** **Engine Coolant Temp** – returns the engine coolant temperature received from the engine ECM over the generator set's data link. The units are in degrees Celsius. **High Warning Threshold** – returns the high warning threshold setpoint value in degrees Celsius. **High Shutdown Threshold** – returns the high shutdown threshold setpoint value in degrees Celsius.
	**Inputs** **Acknowledge All** – Boolean input that when activated will acknowledge all unacknowledged events and diagnostics.	**Outputs** **Unacknowledged Audible Alert** – returns a Boolean true if there is an unacknowledged alert on the EMCP. **Warning Active** – returns a Boolean true if there is an active warning on the EMCP. **Audible Alert Active** – returns a Boolean true if an event with audible alert enabled is active or present. This will deactivate once the event becomes inactive. **Soft Shutdown Active** – returns a Boolean true if an event with an event response configuration set to soft shutdown becomes present or active. **Hard Shutdown Active** – returns a Boolean true if an event with an event response configuration set or hardcoded to hard shutdown becomes present or active. **Breaker Trip 1** – returns a Boolean true if an event with breaker trip enabled becomes present or active. **Breaker Trip 2** – returns a Boolean value if an event with breaker trip 2 enabled becomes present or active. **Overridden Shutdown** – returns a Boolean true if a shutdown is overridden by the shutdown override feature. **Note:** This is only available in special shutdown override flashfiles. **Reset All** – returns a Boolean true if the reset all events command is activated.

 This block allows the user to monitor information about the engine speed. Control of engine speed is implemented in a separate block.	**No Inputs**	**Outputs** **Engine Speed** – returns a numerical value for engine speed in RPM. **Engine Over Speed Setpoint** – returns a numerical value for the engine overspeed setpoint in RPM. **Engine Underspeed Warning Setpoint** – returns a numerical value for the engine underspeed setpoint in RPM. **Engine Underspeed Shutdown Setpoint** – returns the numerical value for the engine underspeed shutdown setpoint in RPM. **Engine Overspeed Shutdown** – returns a Boolean true whenever an engine overspeed shutdown is present or active. **Engine Underspeed Warning** – returns a Boolean true whenever an engine underspeed warning is present. **Engine Underspeed Shutdown** – returns a Boolean true whenever an engine underspeed Shutdown is present or active.
	**No Inputs**	**Outputs** **Over Frequency** – returns a Boolean true if an over frequency shutdown becomes present or active. **Under Frequency** – returns a Boolean true if an under frequency shutdown becomes present or active. **Frequency in Limits** – returns a Boolean true when the generator AC frequency is within 10% of the rated frequency.
	**No Inputs**	**Outputs** **Over Voltage** – returns a Boolean true when an overvoltage shutdown is present or active. **Under Voltage** – returns a Boolean true if an under voltage shutdown is present or active. **Volt in Limit** – returns a Boolean true if the generator AC voltage is within 10% of the rated voltage.

	**Inputs** **Speed Bias %** – accepts a numerical value for a percentage of the maximum speed bias (-100% to 100%). The speed bias is a percentage of the maximum allowed bias of ±200 rpm. **Desired Engine Speed** – accepts a numerical value in RPM for an override of desired engine speed. This input has highest priority for determining desired engine speed. If anything is connected to this input, then the input value will override desired engine speed bias %.	**Output** **Requested Engine Speed** – returns a numerical value for the EMCP's engine speed request to the engine in RPM. **Note:** When using an electronic engine, often times the engine will have its own minimum and maximum speed. The EMCP can request any speed but the engine speed will clip at the engine's minimum or maximum speed.
	**No Inputs**	**Outputs** **Battery Voltage** – returns a numerical value for the battery voltage measured at the control. **Low Battery Voltage Warning** – returns a Boolean true if there is a low battery voltage warning event present.
	**No Inputs**	**Outputs** **Output 1** – returns a Boolean true if any of the 7 programmable cycle timers are active and have their output 1 enabled. **Output 2** – returns a Boolean true if any of the 7 programmable cycle timers are active and have their output 2 enabled. **Output 3 (EMCP 4.4 Only)** – returns a Boolean true if any of the 7 programmable cycle timers are active and have their output 3 enabled.
	**No Inputs**	**Outputs** **Total kW** – returns a numerical value for the total generator real power being supplied in kilo-watts. **Total kVA** – returns a numerical value for the total generator apparent power being supplied in kilo-volt-amperes. **Total kVAr** – returns a numerical value for the total generator reactive power being supplied in kilo-volt-amperes-reactive. **Gen kW%** – returns a numerical value for the total generator real power being supplied as a percent of rated real power. **Gen kVA%** – returns a numerical value for the total generator apparent power being supplied as a percent of rated apparent power. **Gen kVAr%** – returns a numerical value for the total generator reactive power being supplied as a percent of rated reactive power (reactive power is calculated by: $\sqrt{kVA^2 - kW^2}$



Inputs

Generator Rated kW – accepts a numerical value that will override the generator rated real power setpoint.

Generator Rated kVA – accepts a numerical value that will override the generator rated apparent power setpoint.

Outputs

Generator Frequency – returns a numerical value for the measured generator outputs AC frequency.

Average L-L RMS Voltage – returns a numerical value for the measured average root-mean-squared generator Line to Line AC voltage.

Average Generator Current – returns a numerical value for the average generator phase current.

Nominal Current – returns a numerical value for the generator nominal current. The nominal current is calculated as:

$$A = \frac{(Rated\ kVA)/(Rated\ Voltage)}{\sqrt{3}}$$

Generator Configuration – returns a numerical value representing the generator connection configuration type that has been programmed in the EMCP. Enumeration is as follows:

0 = Wye (Star) connection
1 = Delta 3-wire (open delta)
2 = Delta 4-wire
3 = Single-phase (2-wire)
4 = Single-phase (3-wire)
10 = Singe-phase 2 wire (L2-L3)
11 = Single-phase 3-wire (L2-N-L3)
12 = Delta 4-wire center Tapped (L1-N-L3)

Rated Frequency – returns a numerical value for the generator rated frequency setpoint in Hertz.

Rated Voltage – returns a numerical value for the generator rated voltage setpoint in Volts.

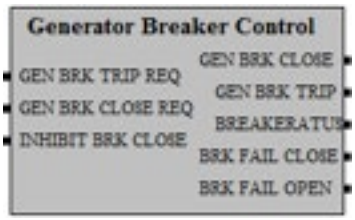
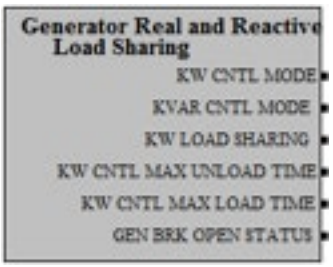
Rated kW – returns a numerical value for the generator rated real power setpoint in kilo-watts.

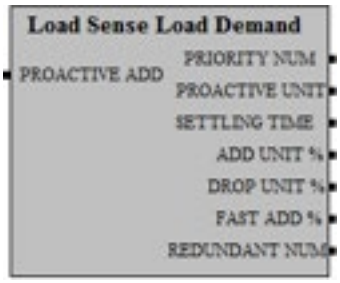
Rated kVA – returns a numerical value for the generator rated apparent power setpoint in kilo-volt-amperes.

Nominal Frequency is Low – returns a Boolean true if a digital input is configured for "nominal frequency is low" and is active.

Nominal Voltage is Low – returns a Boolean true if a digital input is configured for "nominal voltage is low" and is active.

Generator Rated kVAr – Returns a numerical value for the generator's rated reactive power in kilo-volt-amperes-reactive.

EMCP 4.4 Only  	**Inputs** **Generator Breaker Trip Request** – activating this Boolean input will request the EMCP to open the Generator Breaker. **Generator Breaker Close Request** – activating this Boolean input will request the EMCP to close the generator breaker. This input is only functional when the sync mode switch is in "manual" and the generator voltage frequency and phase are in sync with the bus voltage frequency and phase. **Inhibit Breaker Closure** – activating this boolean input will inhibit the generator breaker from closing and trip the breaker if it is already closed.	**Outputs** **Generator Breaker Closed** – this Boolean output is true when the breaker close dedicated digital output is being activated and false otherwise. **Generator Breaker Trip** – this Boolean output is true when the breaker trip dedicated digital output is being activated and false otherwise. **Breaker Status** – returns a Boolean '1' if the generator breaker closure is inhibited by the operator (not the software itself). The output is '0' otherwise. **Breaker Failure to Close** – this Boolean output is true when the event for breaker failure to close becomes present. **Breaker failure to open** – this Boolean output is true whenever the event for breaker failure to open becomes present.
EMCP 4.4 Only  	**No Inputs**	**Outputs** **kW Control Mode** – this numerical output returns a number for the real load sharing state. Enumeration is as follows: 1 = Inactive or Disabled 2 = Droop 3 = Isochronous 4 = Base Load 5 = Load Sharing **kVAr Control Mode** – returns a numerical number for the reactive load sharing state. Enumeration is as follows: 1 = Inactive or Disabled 2 = Droop 3 = VAr Sharing 4 = Power Factor Control 5 = VAr Control **Kw Load Sharing – returns Boolean true when the generator set is load sharing** **kW Control Max Unload Time** – returns a numerical value for the setpoint. **kW Control Max Load Time** – returns a numerical value for the setpoint. **Generator Breaker Open Status** – returns a boolena "1" when the generator breaker is open and "0" when it is closed. If the breaker position is unknown the output will return a "1."

EMCP 4.4 Only 	**Inputs** **Baseload Setpoint** – accepts a numerical value in kW for the desired base load power output. This input is only functional when the generator set is in base load mode.	**Outputs** **Utility Breaker Status** – this Boolean output returns a "1" if the utility breaker is closed and a "0" if it is open.
EMCP 4.4 Only 	**Inputs** **Proactive Add** – adds additional units to the bus. This input accepts a Boolean input to add a single unit per input activation, or a numerical input to add multiple units per activation. (See section on LSLD Proactive Add for explanation of functionality.)	**Outputs** **Priority Number** – returns a numerical value for the Load Sense Load Demand Priority number that is configured (if the generator sets are in priority number mode) or the system calculated priority number based off of engine operating hours (if the generator sets are in total operating hours mode). **Proactive Unit** – returns a numerical value for the number of remaining proactive units that will be added to the bus. **Settling Time** – returns a numerical value for the settling time setpint that has been configured in the Load Sense Load Demand setpoints. **Add Unit %** – returns a numerical value for the add unit percent threshold setpoint. **Drop unit %** – returns a numerical value for the drop unit percent threshold setpoint. **Fast Add %** – returns a numerical value for the fast add unit percent threshold setpoint. **Redundant Number** – returns a numerical value for the number of redundant units setpoint.

29.3 Debug Window Blocks

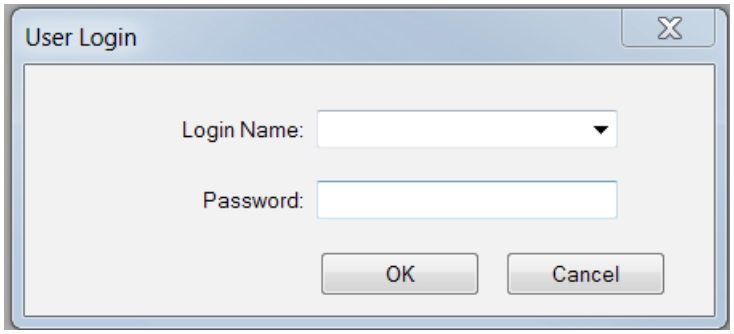
The Cat PLC Config Tool allows the user to create and attach debug windows to any signal in the custom built logic. The debug windows will display whatever signal they are attached to in the PLC config tool view window. This allows the user to debug their configuration in real time through the PLC Config Tool.

	**Inputs** Any signal or parameter in the PLC configuration.	**Outputs** The debug block itself will display the value of the received signal or parameter once it is connected in the PLC config tool's view window.

29.4 PLC Config Creation and Programming

29.4.1 Creating a PVC File

Once the Cat PLC Config Tool is opened, the user must select File → New to create a new config file. The user will then be prompted to enter their credentials for security.



The EMCP Monitoring Software has a built in security feature. Three access levels allow the restriction of certain capabilities. There are three preconfigured users. The user login names, access levels, and default passwords are given in Table 29.1 below.

Default User Logins	Access Levels	Default Passwords
administrator	Administrator	admin
poweruser	Power User	power
normaluser	Normal User	normal

Table 29.1

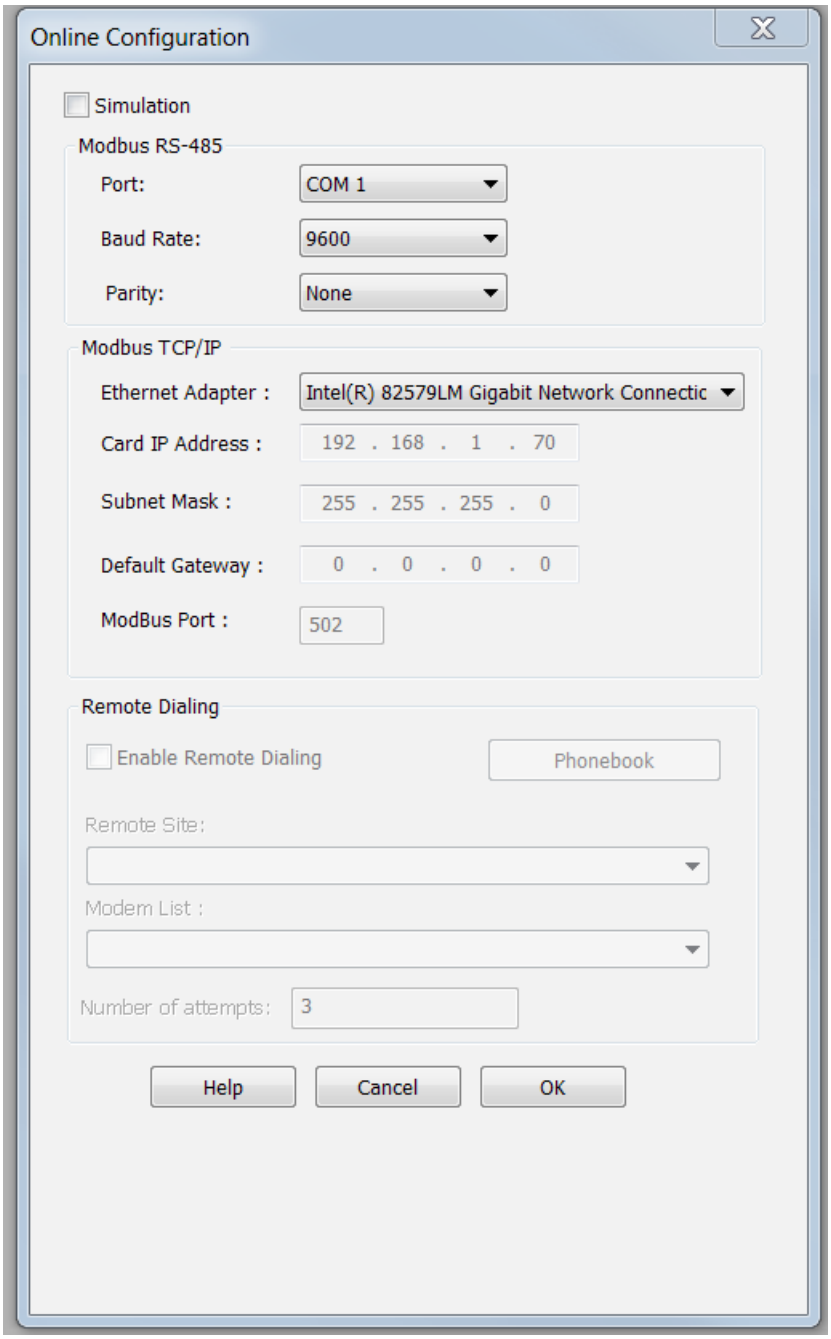
The Administrator access level has all privileges and is able to configure screens/settings, change all passwords and read/write data. Additionally, the Administrator level can add or remove users, and change access levels.

The Power User access level has the same privileges as Administrator, except is not allowed to configure user accounts or change user passwords.

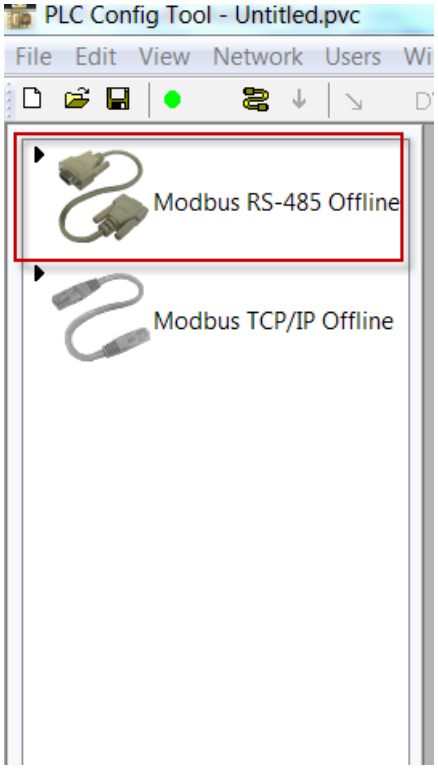
The Normal User access level is allowed only to use preconfigured screens to read and write all data. The Normal User level cannot make configurations changes and cannot change passwords.

29.4.2 Using RS-485

Once the user has logged in they must configure the Modbus RS-485 port settings in the config tool and on the EMCP to match each other. First record the baud rate and parity configurations in the EMCP's RS-485 SCADA Data Link setpoints and also the comm port being used on the computer. Next select Network → online configuration in the config tool menu bar. On this screen the user will be prompted to enter the RS-485 configuration information for the config tool. This information should match the EMCP.


Online Configuration
Simulation
Modbus RS-485
Port:
COM 1
Baud Rate:
9600
Parity:
None
Modbus TCP/IP
Ethernet Adapter :
Intel(R) 82579LM Gigabit Network Connectic
Card IP Address :
192 . 168 . 1 . 70
Subnet Mask :
255 . 255 . 255 . 0
Default Gateway :
0 . 0 . 0 . 0
ModBus Port :
502
Remote Dialing
Enable Remote Dialing
Phonebook
Remote Site:
Modem List :
Number of attempts:
3
Help
Cancel
OK

Once the physical Modbus port settings are applied the user must now add a device to the config. To do this, right-click on the “Modbus RS-485 Offline” icon in the left pane of the config tool window and select “add Device.”

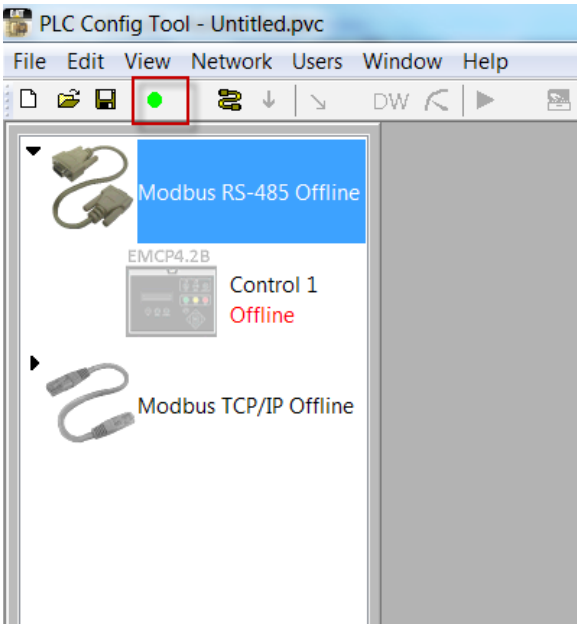


Once a decive is added the user will be prompted to name the device and select the device type and slave address.

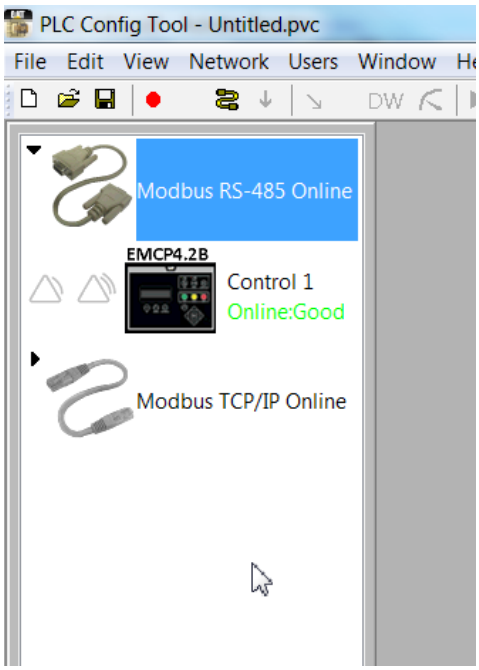


The name can be any unique descriptor chosen by the user. For the creating a config for the EMCP 4.4, select EMCP 4.4 as the device type. The network interface should be set to Modbus RS-485. The slave address should match the slave address programmed in the EMCP 4 under the RS-485 SCADA Data Link Setpoints.

Once the user selects add, a device icon should appear in the left pane of the config tool indicating a new device has been added with the user defined device name. The user should also have the option to connect to the device by clicking the green dot in the menu pane.

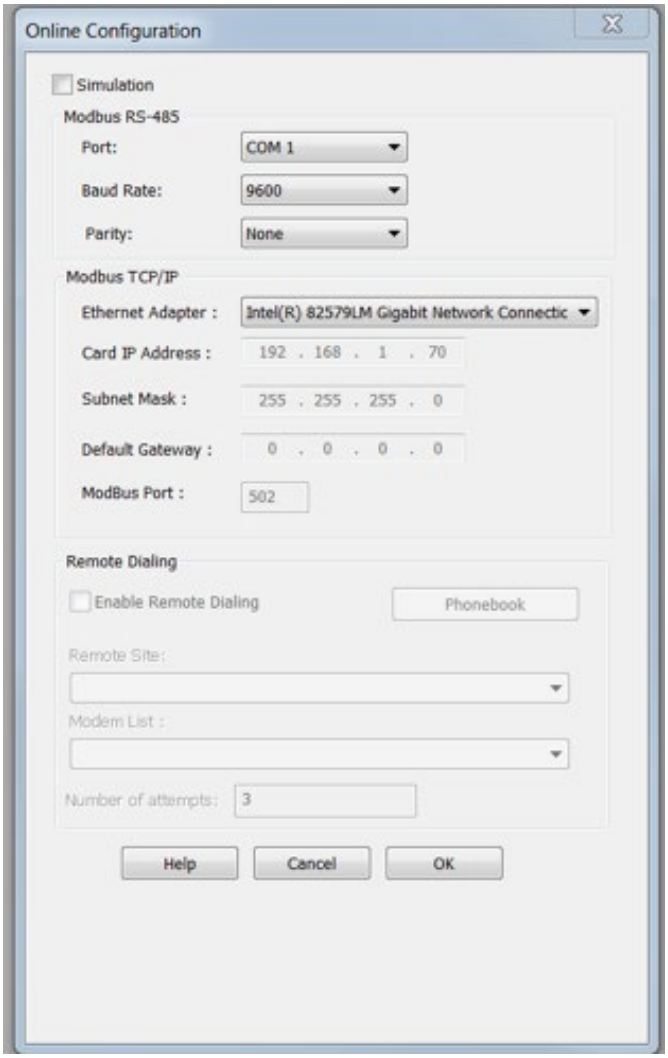


If the connection to the control is successful, the text “online: good” will appear under the icon and the icon will darken as such:

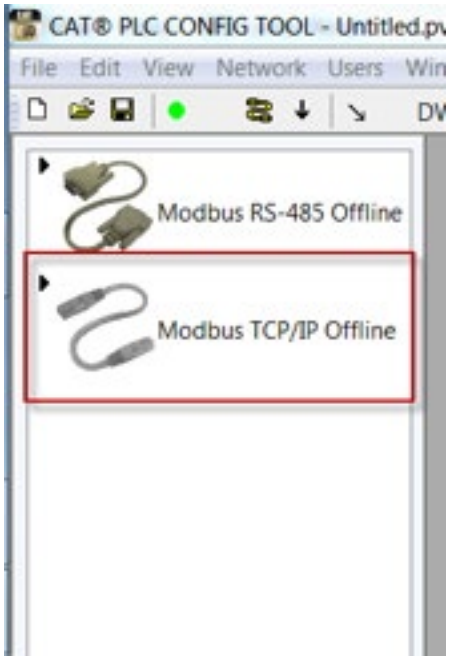


29.4.3 Using TCP/IP

Once the user has logged in they must configure the Modbus Ethernet port IP network in their computer, config tool, and on the EMCP to match each other. First configure the IP address and subnet mask configurations in the EMCP's TCP/IP SCADA Data Link. Next configure the computer to have the same first three digits of the EMCP's IP address and a unique 4th digit and an identical subnet mask. Next select Network → online configuration in the config tool menu bar. On this screen the user will be prompted select the Ethernet port that the confg tool will use. The port selected should match the port that the EMCP is connected to. The IP settings are automatically imported from the computer's IP settings.



Once the physical Modbus port settings are applied the user must now add a device to the config. To do this, right-click on the “Modbus TCP/IP Offline” icon in the left pane of the config tool window and select “add Device.”

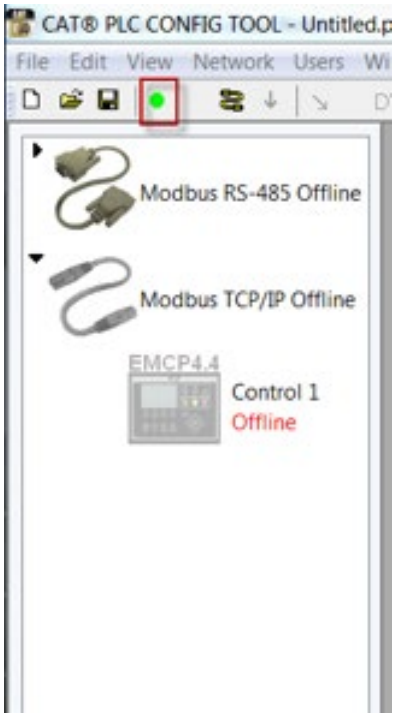


Once a decive is added the user will be prompted to name the device and enter the device type, slave address, and IP address.

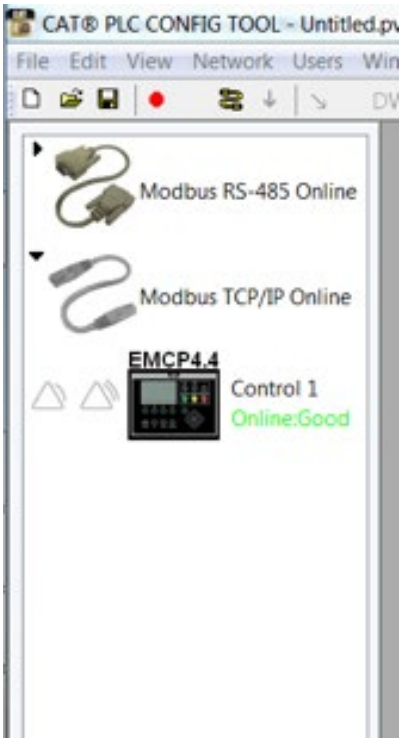


The name can be any unique descriptor chosen by the user. For the creating a config for the EMCP 4.4, select EMCP 4.4 as the device type. The network interface should be set to Modbus TCP/IP. The IP address should match the IP address programmed in the EMCP 4 under the TCP/IP SCADA Data Link Setpoints. The slave address should also match.

Once the user selects add, a device icon should appear in the left pane of the config tool indicating a new device has been added with the user defined device name. The user should also have the option to connect to the device by clicking the green dot in the menu pane.

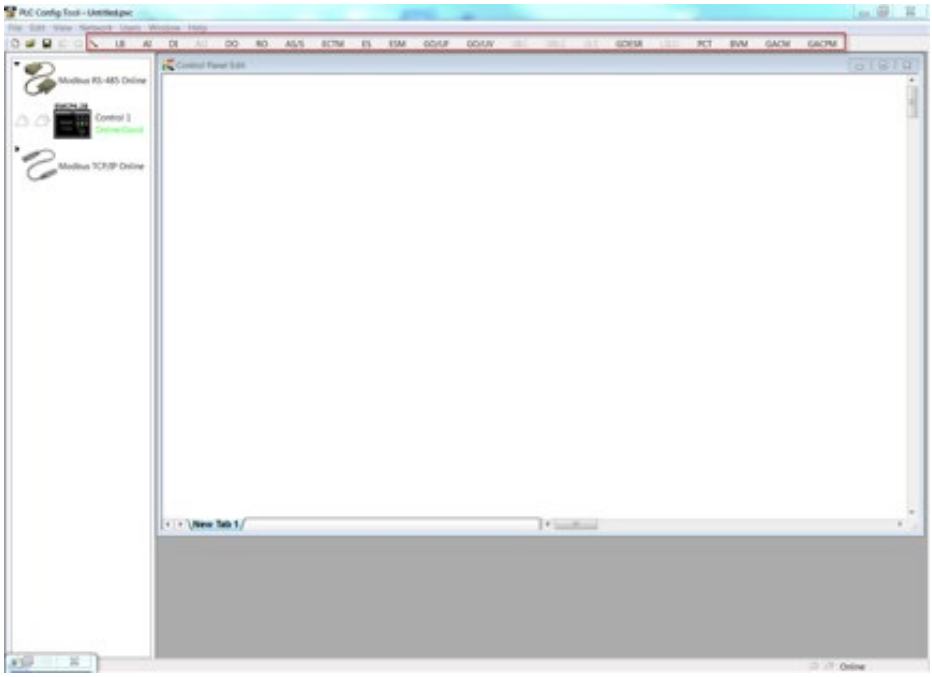


If the connection to the control is successful, the text “online: good” will appear under the icon and the icon will darken as such:

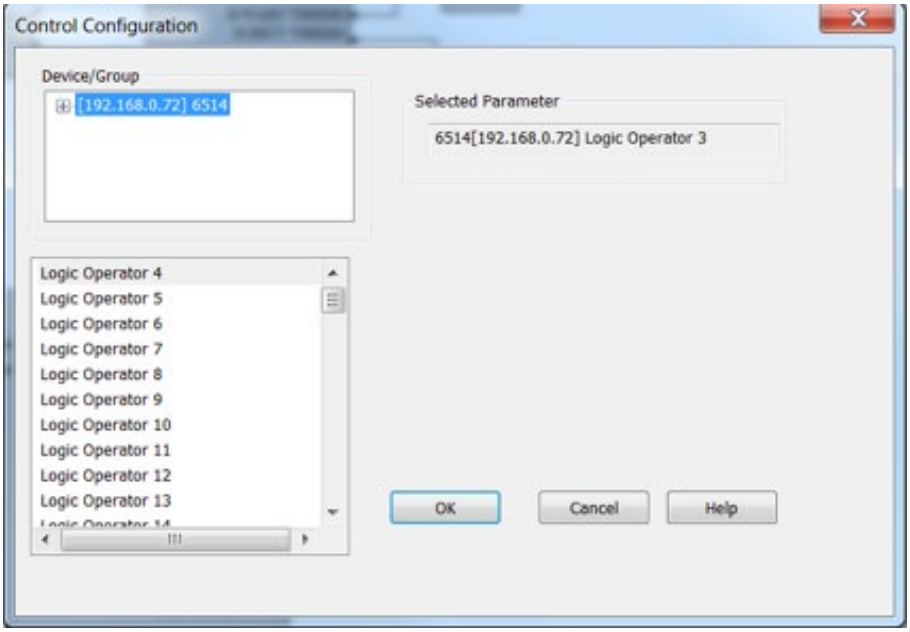


29.4.4 Creation and Editing of Configs

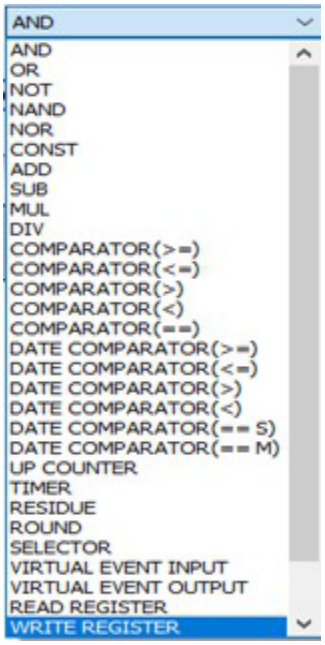
Now the user can begin creating a PLC config. By selecting Edit → Control Panel Configuration in the config tool's menu bar, the edit window is brought up. In the edit window all of the logic and function blocks described in Sections 24.1, 2, and 3 above can be added to the edit window.



To add a block, select the desired block type in the top menu pane and then click anywhere in the edit window. Logic Blocks (LB) must be associated to a logic operator before using. To associate a logic block to a logic operator, the user must first add a logic block by clicking the LB in the menu pane and clicking anywhere in the edit window and then right-clicking on the logic block and select Parameter Association. This will bring up a prompt where the user can select Logic Operator 1-80 and click the "OK" button to complete the parameter association.

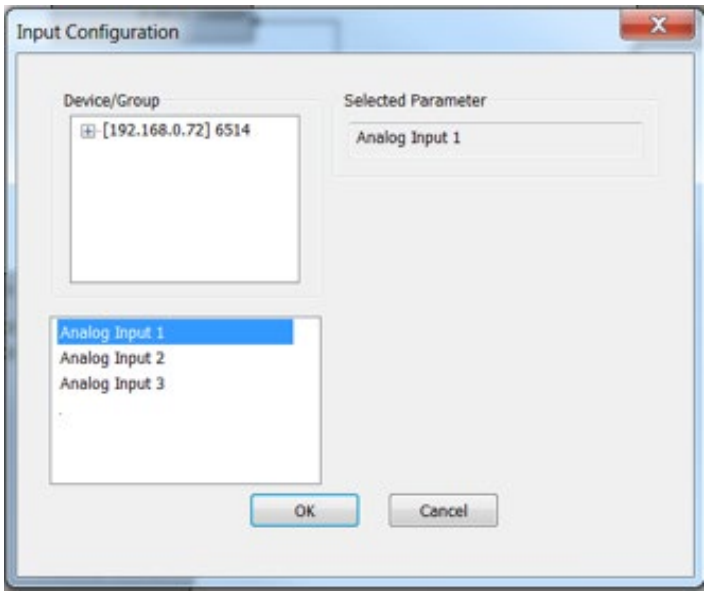


Once a logic block has been associated to a Logic Operator, it can then be programmed to any of the logical operations explained in Section 24.1. To program a logic block, the user must double left-click on the logic block and select the operator type from the drop down menu that appears.

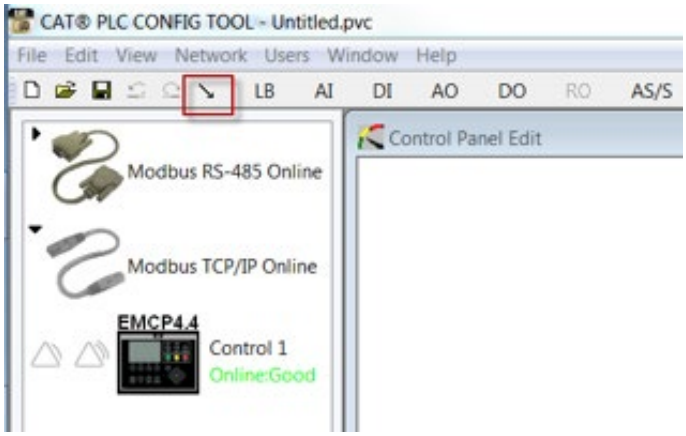


Some logic operators will prompt the user to enter in additional information for configuring the logic operator (ex. hysteresis on the comparators).

Analog Inputs (AI), Digital Inputs (DI), Digital outputs (DO), and Analog Outputs (AO) must be associated to a corresponding I/O port. To associate input and output ports the user must first add an I/O block by clicking one of the selections in the menu pane and then clicking anywhere in the edit window. Then the user must right-click on the I/O block and select set input association or parameter association depending on whether the block is an input or an output. This will bring up a prompt where the user can assign a particular I/O channel to the I/O block being programmed.

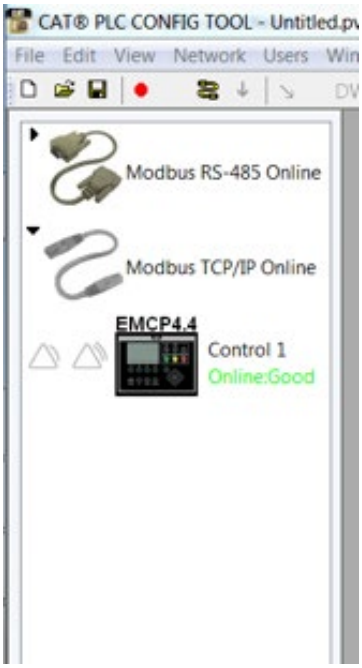


Once PLC blocks are added to the edit window, they must be connected to form logical operations . To connect blocks the user must select the arrow button in the menu pane and then click the source and destination points for the connections .



29.4.5 Downloading PLC Configuration to the EMCP

Once a PLC configuration is built and ready to be downloaded, the user must open the view window . To open the view window, select VIEW → Control Panel Data from the menu pane . Next, make sure that the config tool has a good connection to the control . This can be verified by the green text “Online:Good” appearing under the controller’s icon .



The next step is to save the configuration . After saving, the user must prepare the control for downloading . To prepare the control for downloading the following conditions must be met:

- The Engine Control Switch must be in STOP
- The engine speed must be 0 RPM (not FID or stars)
- The setpoint for Remote Control SCADA Data Link Enable Status must be set to enabled

Warning: Before downloading the PLC configuration to the control, make sure the connections and logic are consistent with what is desired. This feature gives the config creator an “administrator-like” ability to affect how the EMCP software normally operates and can cause the generaotr set to behave unsafely if programmed to do so.

Once these conditions are met, the user will be permitted to downloading the configuration to the EMCP by pressing the downward arrow in the menu pane.



In order for the customer downloaded configuration to be active, the setpoint in the EMCP for Programmable Logic Feature Enable Status must be set to enabled. This setpoint is located under the Programmable Logic Feature group.

29.4.6 Troubleshooting the PLC Function

If the genset is behaving poorly after downloading a PLC config, trouble shoot in this order:

1. Set the EMCP setpoint for Programmable Logic Feature Enable Status to disabled and
2. Run the genset again. If the problems are not present after disabling the PLC then the problem lies in the customer configuration.
3. Review the customer configuration and verify that all connections and logic flow are implemented as desired.
4. If any corrections need to be made, reconfigure the PLC program and download to the EMCP and retest.

30.0 CAN Data Links

30.1 Primary CAN Data Link (CAN 1)

The Primary CAN Data Link is supported by all levels of the EMCP 4.

The Primary CAN Data Link is used for local communication among modules associated with a single generator set. These include one or two engine Electronic Control Modules (ECM), the Cat Digital Voltage Regulator (Cat DVR), a Thermocouple Module, and the Cat Clean Emissions Module System.

For the other modules, logs are not kept in the EMCP if power is cycled to the EMCP. Other modules may log the events and repopulate the EMCP with the logged events.

30.1.1 Primary CAN Wiring

The Primary CAN communication wires are brought out of the EMCP 4 as part of the 120-pin connector. The pins, as designated on the EMCP 4 connector, are shown in Table 30.1.

Primary CAN Communication Wires		
Pin #	**Name**	**Description**
43	CAN 1 -	Differential (-) for CAN
30	CAN 1 SH	Shield for CAN
32	CAN 1 +	Differential (+) for CAN

Table 30.1

30.1.2 Network Topology

The physical topology of the CAN network used in the Primary CAN Data Link is a bus topology, consisting of a main trunk and small drops.

- The maximum allowable trunk length is 130 ft (40 m), and the maximum drop length is 3 ft (1 m).
- The CAN network requires a 120 ohm termination resistor on the extreme ends of the main trunk.

An example of the topology for the EMCP 4.3 and 4.4 is illustrated in Figure 30.1.

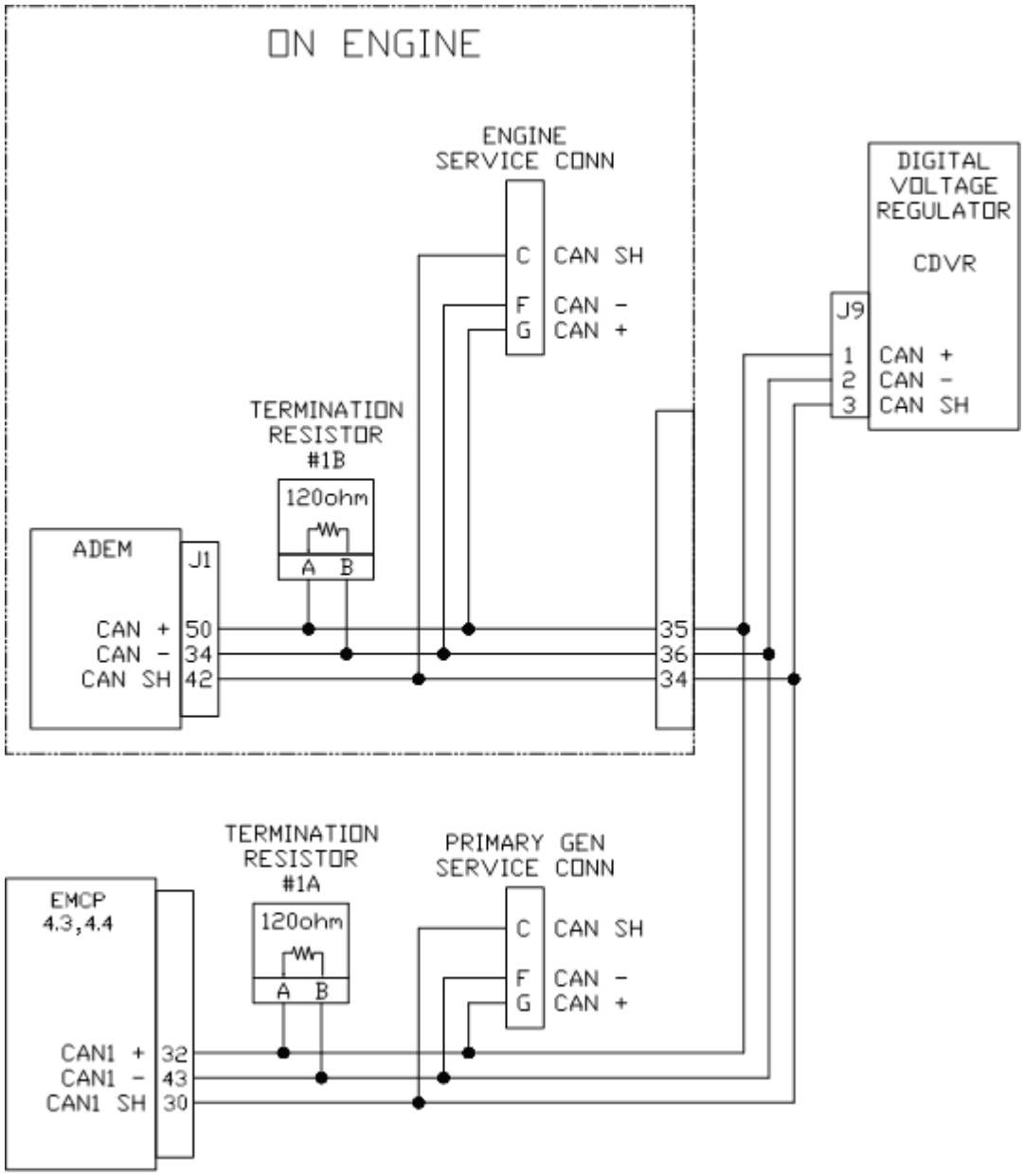


Figure 30.1 – EMCP 4.3 and 4.4 CAN 1 Wiring Diagram

30.2 Accessory CAN Data Link (Can 2)

The Accessory CAN Data Link is supported by the EMCP 4.3 and 4.4.

The Accessory Data Link (CAN 2) is used for local or remote communication among modules associated with a single generator set. These include a Resistance Temperature Device (RTD) Module, a Thermocouple Module, up to four Digital Input/Output Modules, and up to four Annunciators.

30.2.1 Accessory CAN Wiring

The Accessory CAN communication wires are brought out of the EMCP 4.3 and 4.4 as part of the 120-pin connector. The pins, as designated on the EMCP 4 connector, are shown in Table 30.2.

Accessory CAN Communication Wires		
Pin #	**Name**	**Description**
62	CAN 2 +	Differential (+) for CAN
63	CAN 2 SH	Shield for CAN
64	CAN 2 -	Differential (-) for CAN

Table 30.2 – Accessory CAN Data Link on the 120-pin EMCP 4 Connector

30.2.2 Network Topology

The physical topology of the CAN network used in the Accessory CAN Data Link is a bus topology, consisting of a main trunk and small drops.

- The maximum allowable trunk length is 800 ft (250 m), and the maximum drop length is 9 ft (3 m).
- The CAN network requires a 120 ohm termination resistor on the extreme ends of the main trunk.

The topology for the EMCP 4.3 and 4.4 in the default configuration, with no remote devices connected, is illustrated in Figure 21.1.

The topology for the EMCP 4.3 and 4.4 with some remote devices connected is illustrated in Figure 30.2.

Note: The devices shown in Figure 30.2 are only representative; more remote devices can be connected, as long as the proper lengths are maintained, and the termination resistor is placed at the end of the trunk. Refer to Table 30.1 in Chapter 31 for the maximum number of devices supported on each level.

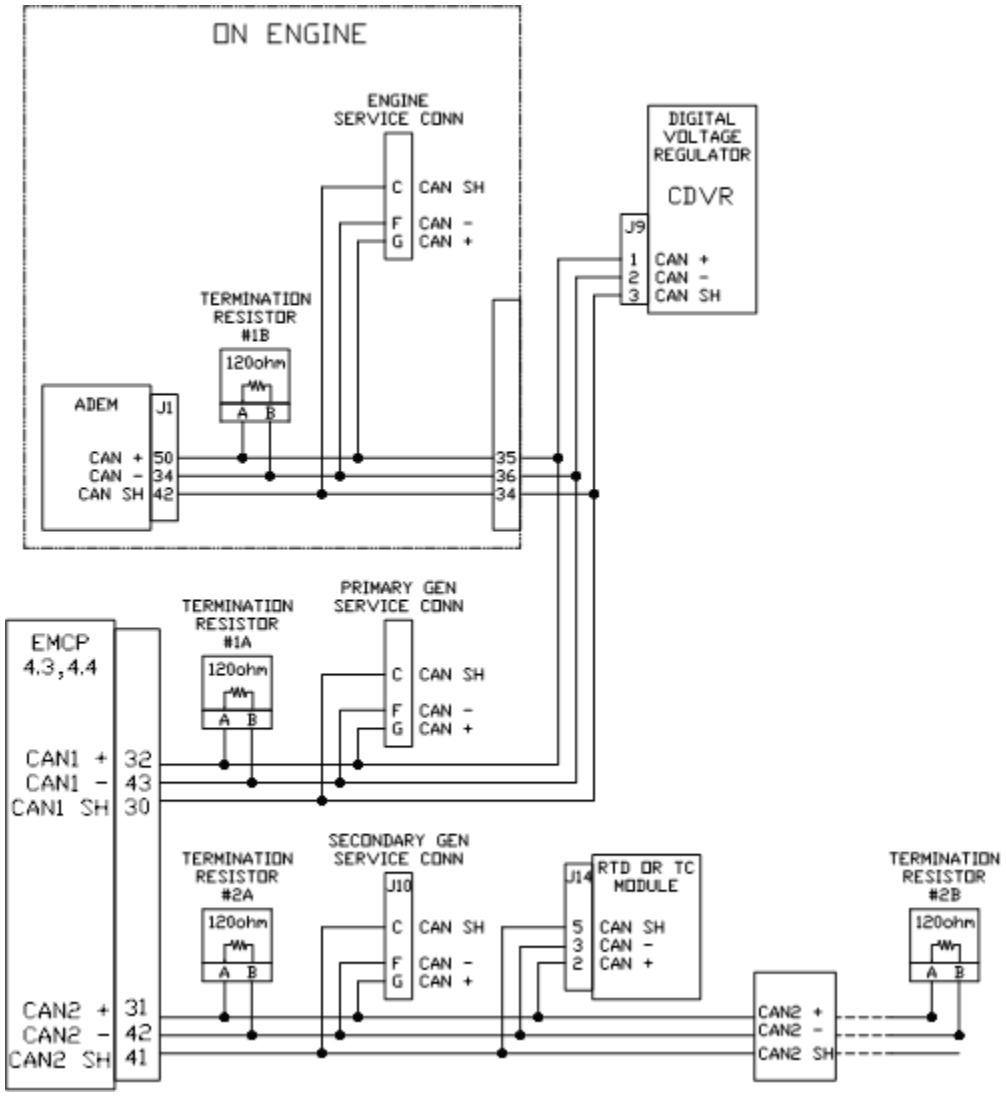


Figure 30.2 – EMCP 4.3 and 4.4 CAN 1 and CAN 2 Wiring Diagram (with Optional Modules)

31.0 Optional Modules

The EMCP 4 consists of the EMCP 4 Generator Set Controller, as well as some optional auxiliary modules. These modules connect to the EMCP 4 via either the Primary or Accessory CAN data link, or an RS-485 SCADA Data Link (Modbus RTU, Half Duplex). The EMCP 4 can also communicate with a Cat Engine ECM on the CAN network (though this is not considered an optional module for those engines).

Different numbers of modules are supported for different levels of EMCP 4. The maximum numbers of modules supported on the CAN networks are given in Table 31.1.

Module	EMCP 4.3		EMCP 4.4	
	Primary CAN	Accessory CAN	Primary CAN	Accessory CAN
Engine ECM	1 or 2	0	1 or 2	0
Cat DVR	1	0	1	0
CAN Annunciator	0	4	0	4
Thermocouple	1	1	1	1
RTD	0	1	0	1
DIO	0	4	0	4

Table 31.1 – Number of Optional Modules Supported on CAN Networks

Note: The number of RS-485 Annunciators is only limited by the RS-485 standard impedance for wiring and devices. (EMCP 4.1 does not support the RS-485 annunciator.)

The CAN Annunciator module is an auxiliary alarm indication device, consisting of 16 pairs of indicator LEDs, and an audible horn. Each pair can be individually configured based for an application, and a custom film kit is available to customize the graphic/text indication. For further information see Section 31.1.

The RS-485 Annunciator module is an auxiliary alarm indication device, consisting of 16 pairs of indicator LEDs, and an audible horn. Each annunciator can be mapped to one of four predefined group of alarms (including custom groups) based on application needs. A custom film kit is available to customize the graphic/text indication. For further information see Section 31.2.

The Thermocouple, RTD, and DIO

EMCP 4 uses a common form factor for the three modules known as the Thermocouple, RTD (Resistance Temperature Detector) and DIO (Discrete I/O) modules. The same case design is used for all three.

The Thermocouple module, RTD module, and DIO module feature identical rugged packaging and Deutsch IPD connectors. The only physical difference in packages between these three optional modules is that the DIO module has an LED to indicate communication network status.

Applications can include networked power generator set control systems.

For further information on the Thermocouple module Section 31.3, for the RTD module see Section 31.4, and for the DIO module see Section 31.5.

The Cat Digital Voltage Regulator

The Cat Digital Voltage Regulator (Cat DVR) module is an auxiliary voltage regulator device, regulating the generator voltage to provide optimal response to various load types and changes in load. It is connected to the generator exciter and field, and communicates with the EMCP 4 for monitoring purposes. For further information see RENR7941 Cat Digital Voltage Regulator.

31.1 CAN Annunciator



The EMCP CAN Annunciator serves to display system alarm conditions and status indications. The CAN Annunciator has been designed for use on the EMCP 4 Accessory CAN data link and may be used in either Local or Remote applications, providing customers with enhanced site flexibility.

In Local application, the CAN Annunciator may be mounted on the Package generator set with the EMCP 4 to provide a complete package-mounted monitoring solution.

The CAN Annunciator may also be mounted separately from the generator set to provide Remote indication of system operating and alarm conditions.

A maximum of four CAN Annunciators can be mounted locally or remotely and connected to the Accessory CAN 2 data link.

31.1.1 Annunciator Features

The Annunciator includes:

- Sixteen (16) LED pairs for annunciation of up to 32 system events
- An additional pair of LEDs provides status indication of the CAN data link connection
- Annunciation of alarm conditions received from any module on the CAN data link
- Alarm Horn with Lamp Test and Alarm Acknowledge pushbuttons
- Configurable to NFPA 99/110 requirements for local and remote annunciation on Emergency Standby Generator Systems
- Provides a simple means to change the labels for the annunciation LEDs for site specific requirements (Custom Label Kit purchased separately)
- Superior visibility of the LEDs in direct sunlight
- Graphic symbols along with text labels are provided next to each LED pair to indicate various alarms and events
- Can be mounted either locally on the package generator set or remotely (up to 800 feet using J1939 cable) on the Accessory CAN Data Link
- Designed and tested to meet stringent Impulse Shock and Operating Vibration requirements
- 288 mm (11.34 in) High x 158 mm (6.22 in) Wide x 66 mm (2.37 in) Deep

31.1.2 Annunciator Specifications

Electrical Specifications

- Control Power 12VDC and 24VDC nominal (9-32VDCacceptable)
- Over voltage capability is 80VDC for 2 minutes @ 70°C
- Reverse voltage capability is –32VDC for 1 hour @ 70°C
- Single, 6-pin connector provides both power and communication
- Designed to meet relevant European standards for EMI/RFI/Immunity without the use of external filtering (third party testing is being pursued). UL testing to take place with production units.

Environmental Specifications

- Operating Temperature -40°C to 70°C
- Storage Temperature -50°C to +85°C
- Relative Humidity 90%, non-condensing, 30°C to 60°C
- Can be mounted directly on the generator set panel or remotely

Network Communications Interface

- Incorporates a communications port, able to operate on the EMCP 4 Accessory CAN data link
- Node address is auto configurable
- Optical isolation is provided for the CAN line
- Module retains configured setpoints in non-volatile memory with loss of communications and power
- Configuration is accomplished with the Cat Service Tool over the CAN 2 network

31.1.3 Annunciator Wiring

The back of the CAN Annunciator module contains an 8-terminal screw terminal block. Attached to the block is a 6-pin Deutsch adapter. The pin outs for both are shown in Figure 31.3 and Table 31.2.

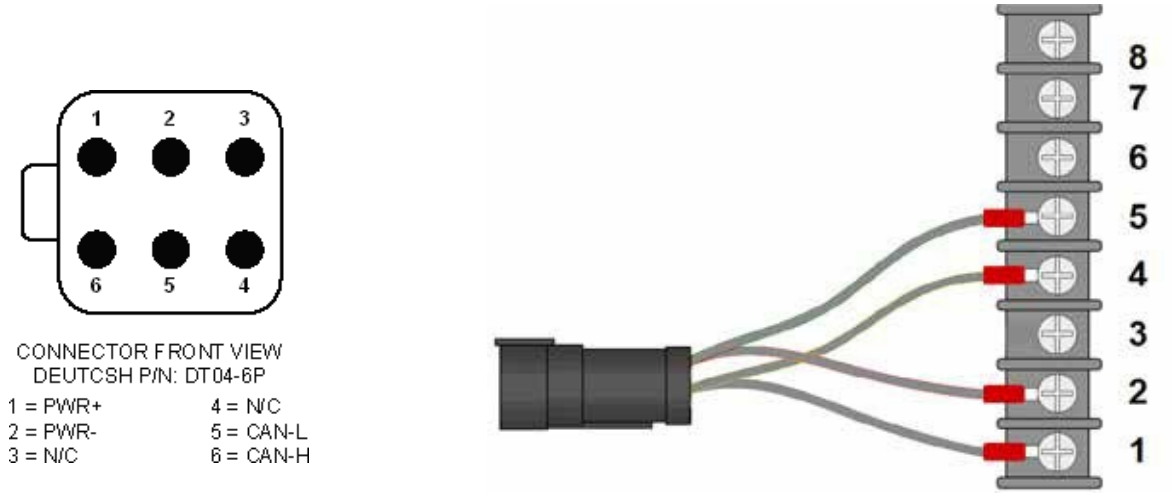


Figure 31.3 – Annunciator Deutsch Connector Pin Configuration and Terminal Block

Annunciator Terminal Block Pin Configuration		
Terminal #	**Function**	**Description**
1	PWR-	- Battery Input
2	PWR+	+ Battery Input, connects to Horn(+)
3	N/C	Not Connected
4	CAN2-L	CAN Data Link LOW
5	CAN2-H	CAN Data Link HIGH
6	Lamp Test	Lamp Test
7	Alarm Ack	Alarm Acknowledge
8	Horn Driver	Connects to negative terminal of Horn

Table 31.2 – Annunciator Terminal Block Pin Configuration

31.1.4 LED Colors

Each pair of LEDs on the Annunciator consists of two of the following three colors: Green, Amber, and Red, which allows for custom configuration of STATUS, WARNING and SHUTDOWN conditions. The available colors and combinations are listed in Table 31.3 LED Colors:

LED Colors					
Row	**Led 1**	**Led 2**	**Row**	**Led 1**	**Led 2**
1	Red	Amber	9	Red	Amber
2	Red	Amber	10	Red	Amber
3	Red	Amber	11	Red	Amber
4	Red	Amber	12	Red	Amber
5	Red	Amber	13	Green	Amber
6	Red	Amber	14	Green	Amber
7	Red	Amber	15	Red	Green
8	Red	Amber	16	Red	Green

Table 31.3 – LED Colors

Module Status LED

A red/green pair located at the bottom of the CAN Annunciator, is used to report Module/Network Status. The various states indicated are explained in Table 31.4.

Behavior	Explanation
Red solid	CAN 2 data link diagnostic. For example: the module is wired wrong (data link), wrong cable, or no terminating resistor.
Green solid	CAN 2 data link OK.
Green flashing	No CAN 2 data link diagnostic, but no communication detected. Hooking the Annunciator up with the power on.
Red/green alternating	No application software loaded.



Table 31.4 – CAN Annunciator Module/Network Status LED Behavior

31.1.5 CAN Annunciator Software Configuration

The CAN Annunciator is field-programmable using the Cat Service Tool. It is also flash programmable to update software using the Cat Service Tool.

The service tool software must be installed on a Windows PC. The Cat communication adapter must be connected between the PC and the CAN 2 Accessory data link on which the target CAN 2 Annunciator is connected.

31.1.6 Global Acknowledge

The CAN Annunciator can be configured to both initiate and respond to an Event Acknowledge message over the CAN Accessory data link. If this setpoint is enabled, the CAN Annunciator events may be acknowledged locally on the CAN Annunciator by pressing the Alarm Acknowledge button or remotely by pressing the Alarm Acknowledge button on the EMCP 4 or by pressing the Acknowledge button on another CAN Annunciator configured for Global Acknowledge that is on the same data link. Acknowledging events also silences the horn.

The default setting for this setpoint is DISABLED, but it can be enabled from the Configuration tool within Cat Electronic Technician.

31.1.7 ECU Instance Number

The Module Description will also indicate a number that identifies the CAN Annunciator uniquely from any other CAN Annunciator modules on the Accessory CAN data link.

This number is called the ECU INSTANCE and it is programmable.

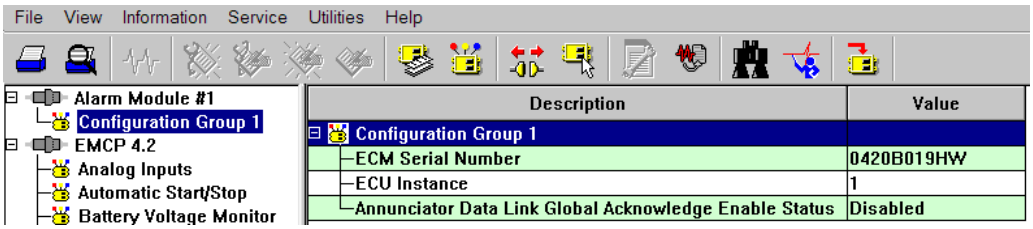
The service tool configuration screen identifies the serial number of the CAN Annunciator that is connected. This is important in matching the desired ECU Instance to the actual hardware.

Note: If two CAN Annunciators on the same communications network are programmed for the same ECU Instance number, neither will communicate.

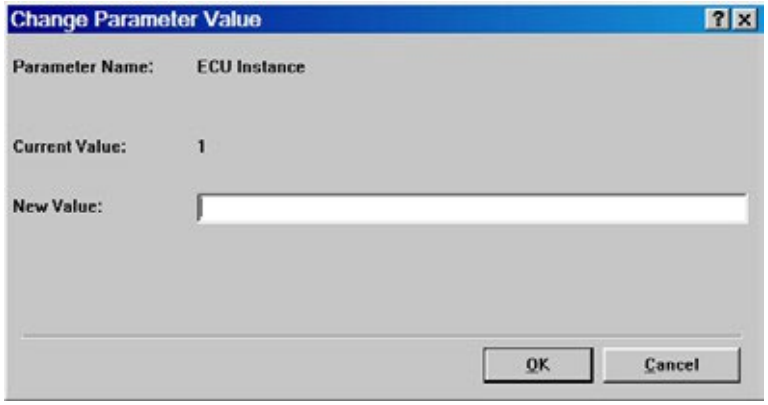
31.1.8 Configuring Annunciator LED Behavior

1. Connect to the Annunciator using the Cat Service Tool as stated in Section 4.2.

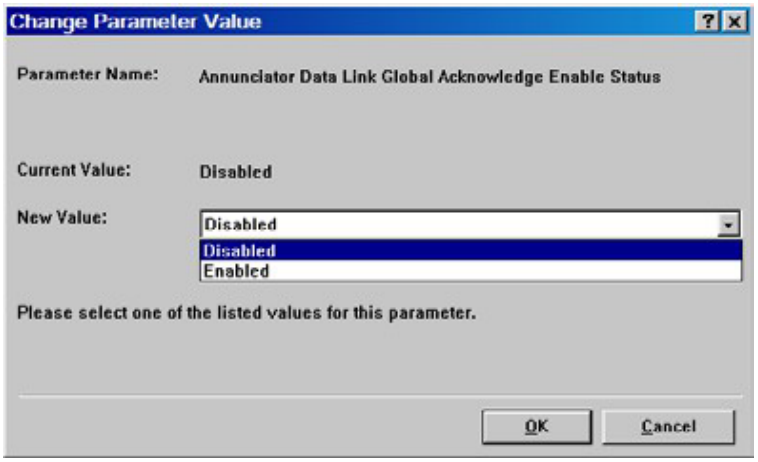
2. Select Configuration Group #N from the left pane.



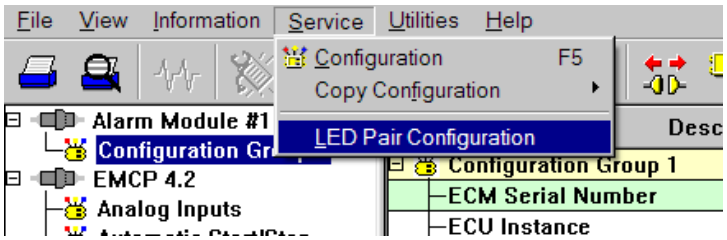
3. Double click ECU Instance Number to enter a new ECU Instance Number.



4. Double click Annunciator Data Link Global Acknowledge Enable Status to change this value from the drop down menu.



5. Select Service → LED Pair Configuration.

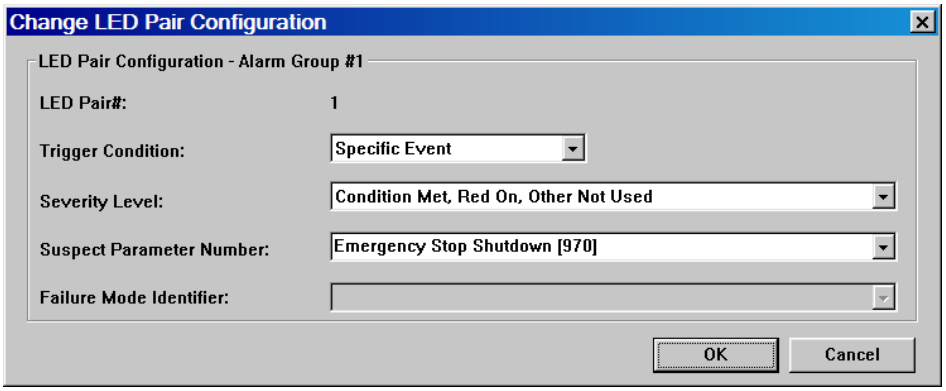


6. The LED pairs will become visible in a new window.

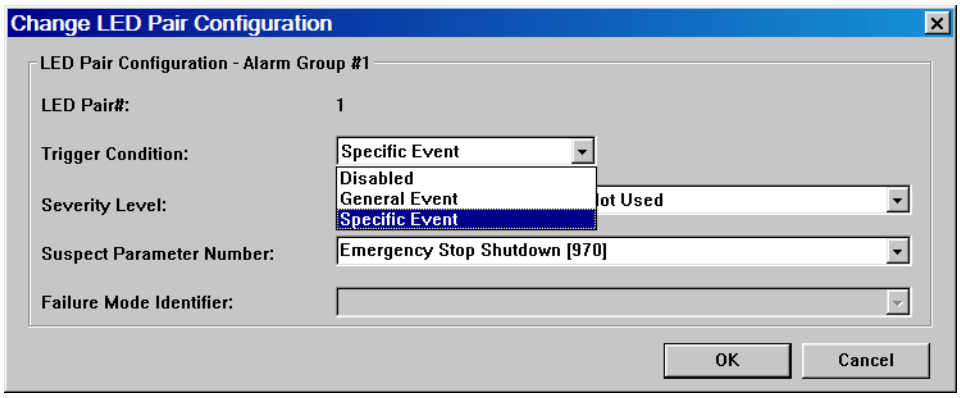


LED Pair#	Trigger Condition	Severity Level	Suspect Parameter Number	Failure Mode Identifier
1	Specific Event	Condition Met, Red On, Other Not Used, Horn On	Emergency Stop Shutdown [970]	
2	Specific Event	Condition Met, Red On, Other Not Used, Horn On	Engine Failure to Start Shutdown [1654]	
3	Specific Event	Low Warning	Engine Coolant Temperature [110]	
4	Specific Event	High Warning or High Shutdown	Engine Coolant Temperature [110]	
5	Specific Event	Low Warning or Low Shutdown	Engine Oil Pressure [100]	
6	Specific Event	High Shutdown	Engine Speed [190]	
7	Specific Event	Low Warning or Low Shutdown	Engine Coolant Level [111]	
8	Specific Event	Low Warning or Low Shutdown	Fuel Level (Local Tank) [96]	
9	Specific Event	Condition Met, Amber On, Other Not Used	Unknown SPN [4002]	
10	Specific Event	Condition Met, Amber On, Other Not Used, Horn On	Generator Control Not in Automatic Warning [4067]	
11	Specific Event	High Warning or High Shutdown	Battery Voltage [168]	
12	Specific Event	Low Warning	Battery Voltage [168]	
13	Specific Event	Specific Diagnostic	Battery Charging System Voltage [167]	Root Cause Not Known
14	Specific Event	Low Warning	Starting Air Pressure [82]	
15	Specific Event	Condition Met, Red On, Other Not Used, Horn On	Unknown SPN [4000]	
16	Disabled			

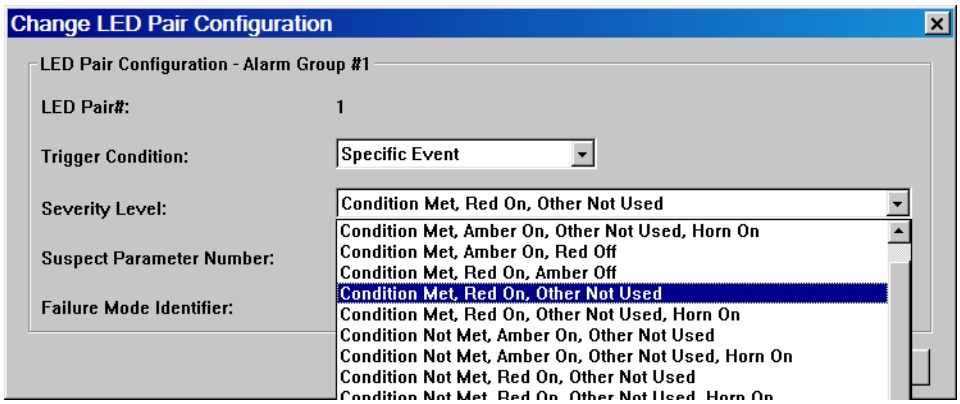
7. Double click on an LED pair to configure the pair.



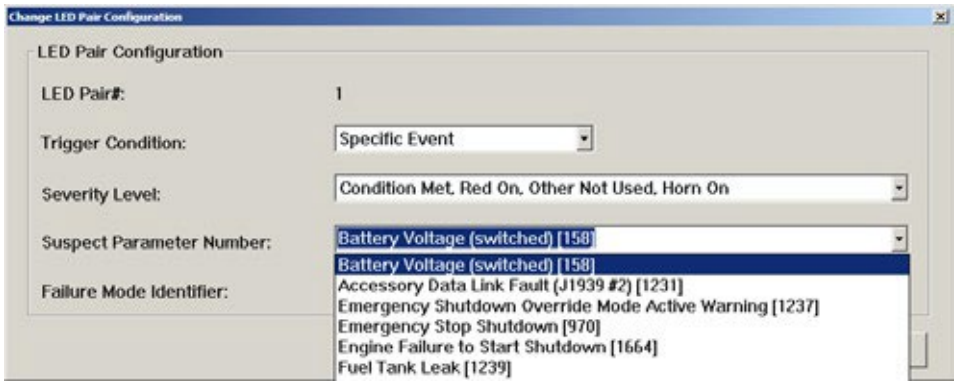
8. Select the Trigger condition for the pair in the drop down menu.



9. Select the Severity Level for the pair in the drop down menu.



10. Select the Suspect Parameter Number for the pair in the drop down menu.



11. The Failure Mode Identifier does not normally need to be programmed since the Severity Level typically has this information embedded.

To configure the behavior of the LED pairs, enter the LED Pair Configuration screen by selecting Service → LED Pair Configuration.

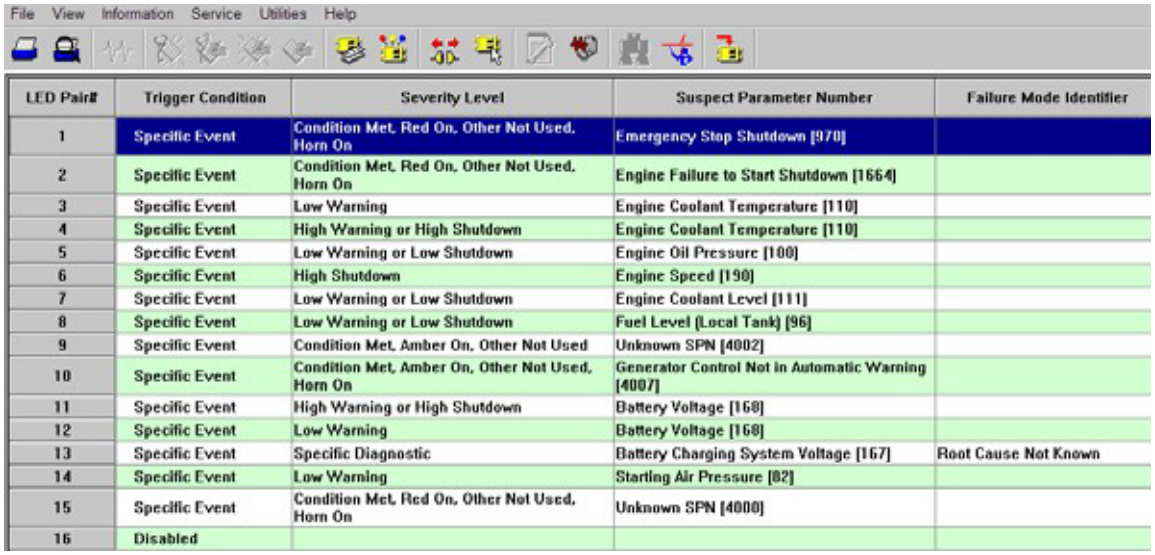
Each LED pair has four parameters associated with it. Each parameter is dependent on the parameter(s) preceding it (to the left); first Trigger Condition, next Severity Level, then Suspect Parameter Number, and finally Failure Mode Identifier (if required).

31.1.9 Trigger Condition

There are three possible selections for Trigger Condition: SPECIFIC EVENT, GENERAL EVENT, and DISABLED.

- **Specific Event** is used to assign an LED pair to a specific data link parameter, such as Oil Pressure, Engine Speed, Coolant Temperature, etc. The desired parameter must be chosen in the Suspect Parameter Number column.
- **General Event** is used to assign an LED pair as a general alarm or shutdown indicator. When configured as General Event, the LED will not be assigned to a particular parameter. It will respond to any event with a severity level chosen in the Severity Level column, regardless of the Suspect Parameter Number.

  For this reason, when General Event is selected, the Suspect Parameter Number cannot be changed.



LED Pair#	Trigger Condition	Severity Level	Suspect Parameter Number	Failure Mode Identifier
1	Specific Event	Condition Met, Red On, Other Not Used, Horn On	Emergency Stop Shutdown [970]	
2	Specific Event	Condition Met, Red On, Other Not Used, Horn On	Engine Failure to Start Shutdown [1664]	
3	Specific Event	Low Warning	Engine Coolant Temperature [110]	
4	Specific Event	High Warning or High Shutdown	Engine Coolant Temperature [110]	
5	Specific Event	Low Warning or Low Shutdown	Engine Oil Pressure [100]	
6	Specific Event	High Shutdown	Engine Speed [190]	
7	Specific Event	Low Warning or Low Shutdown	Engine Coolant Level [111]	
8	Specific Event	Low Warning or Low Shutdown	Fuel Level (Local Tank) [96]	
9	Specific Event	Condition Met, Amber On, Other Not Used	Unknown SPN [4002]	
10	Specific Event	Condition Met, Amber On, Other Not Used, Horn On	Generator Control Not in Automatic Warning [4007]	
11	Specific Event	High Warning or High Shutdown	Battery Voltage [168]	
12	Specific Event	Low Warning	Battery Voltage [168]	
13	Specific Event	Specific Diagnostic	Battery Charging System Voltage [167]	Root Cause Not Known
14	Specific Event	Low Warning	Starting Air Pressure [82]	
15	Specific Event	Condition Met, Red On, Other Not Used, Horn On	Unknown SPN [4000]	
16	Disabled			

Figure 31.4 – Cat Service Tool CAN 2 Annunciator LED Configuration Screen

- **Disabled** is used to disable the LED pair. When Disabled is selected, the other three parameters cannot be changed.

31.1.10 Severity Level

Severity Level defines which types of events the LED pair will react to. Selections that begin with Condition Exists will respond to CAN Event messages for Failure Mode Identifier (FMI) 31 Condition Exists.

For example, LED pair #2 is configured for Condition Exists, Red On, Other Not Used, Horn On with SPN 190 (Emergency Stop Active). This means that when the Annunciator received a CAN message indicating Emergency Stop with FMI 31, the Red LED will turn on and the Horn will also turn on.

Other Not Used indicates that the other LED color in the pair is never used.

Green Off (for example) indicates that the green LED lights when the condition chosen for this LED pair is NOT active.

Most Severity Level selections imply (a) CAN Failure Mode Identifier (FMI) code(s):

- CONDITION EXISTS is equivalent to FMI 31
- HIGH WARNING can be FMI 15 or FMI 16
- LOW WARNING can be FMI 17 or FMI 18
- HIGH SHUTDOWN is equivalent to FMI 0
- LOW SHUTDOWN is equivalent to FMI 1
- HIGH OR LOW SHUTDOWN is equivalent to FMI 0 or FMI 1

Since the FMI codes are implied by this column, the FMI column is grayed out for any of these selections.

The only option that will allow an FMI to be configured is SPECIFIC DIAGNOSTIC.

31.1.11 Suspect Parameter Number

The Suspect Parameter Number column is used to select or type in the SPN for the parameter assigned to the LED pair. Most supported SPNs can be selected from the list. Refer to the UENR1210 Systems Operation Testing and Adjusting Manual for a complete list of supported SPNs.

31.2 RS-485 Annunciator



The EMCP RS-485 Annunciator serves to display system alarm conditions and status indications. The RS-485 Annunciator has been designed for use on a dedicated EMCP 4 fully isolated two wire RS-485 SCADA Data Link (Half Duplex), and may be used in either Local or Remote applications, providing customers with enhanced site flexibility. The RS-485 Annunciator uses a custom master-slave communication protocol. The EMCP 4 controller will be the Master, and the RS-485 Annunciator(s) will be the slave(s). Configuration takes place within the EMCP 4.

In Local application, the RS-485 Annunciator may be mounted on the Package generator set with the EMCP 4 to provide a complete package-mounted monitoring solution.

The RS-485 Annunciator may also be mounted separately from the generator set to provide Remote indication of system operating and alarm conditions.

The number of RS-485 Annunciators is limited by the RS-485 standard.

31.2.1 Annunciator Features

The Annunciator includes:

- Sixteen (16) LED pairs for annunciation of up to 32 system events
- An additional pair of LEDs provides status indication of the dedicated RS-485 Annunciator Network communication connection
- Ability to annunciate alarm conditions sent from the EMCP 4 within preconfigured alarm groups
- Alarm Horn with Lamp Test and Alarm Acknowledge pushbuttons
- Configurable to NFPA 99/110 requirements for local and remote annunciation on Emergency Standby Generator Systems
- Provides a simple means to change the labels for the annunciation LEDs for site specific requirements (Custom Label provided with Custom Alarm Group #1 and #2 RS-485 Annunciator)
- Superior visibility of the LEDs in direct sunlight
- Graphic symbols along with text labels are provided next to each LED pair to indicate various alarms and events.
- Configurable with Cat ET via settings within the EMCP 4
- Can be mounted either locally on the package generator set or remotely (up to 4000 feet)
- Designed and tested to meet stringent Impulse Shock and Operating Vibration requirements
- 286 mm (11.26 in) High x 157 mm (6.18 in) Wide x 68 mm (2.67 in) Deep

31.2.2 Annunciator Specifications

Electrical Specifications

- Control Power 12VDC and 24VDC nominal (9-32VDC acceptable)
- Reverse voltage capability is -32VDC for 1 hour @ 70°C
- Over voltage capability is 80VDC for 2 minutes @ 70°C
- Single, 8-pin connector provides both power and communication
- Designed to meet relevant European standards for EMI/RFI/Immunity without the use of external filtering

Environmental Specifications

- Operating Temperature -40°C to 70°C
- Storage Temperature -50°C to +85°C
- Relative Humidity 90%, non-condensing, 30°C to 60°C
- Failure Point 85°C – if the ambient temperature were to exceed 85°C, the device would NOT be expected to return to proper operation
- Can be mounted directly on the generator set panel or remotely

Network Communications Interface

- EMCP 4 provides a dedicated, fully isolated RS-485 SCADA Data Link (Half Duplex) separate from the MODBUS port used on the EMCP 4
- Operates at 19200 bits per second
- Configuration is accomplished with the Cat Service Tool by connecting to the EMCP 4
- RS-485 Annunciator communication is not compatible with third party devices.

31.2.3 RS-485 Annunciator Wiring

The back of the RS-485 Annunciator module contains an 8-terminal screw terminal block. Attached to the block is an 8-pin Deutsch receptacle, Cat part number 3E-3388 (Deutsch DT04-08PA-E005). The mating plug is Cat part number 155-2264 (Deutsch DT06-08SA-EP08, or equivalent). The pinouts for both the receptacle and terminal block are shown in Figure 31.5 and Table 31.5 and Table 31.6.

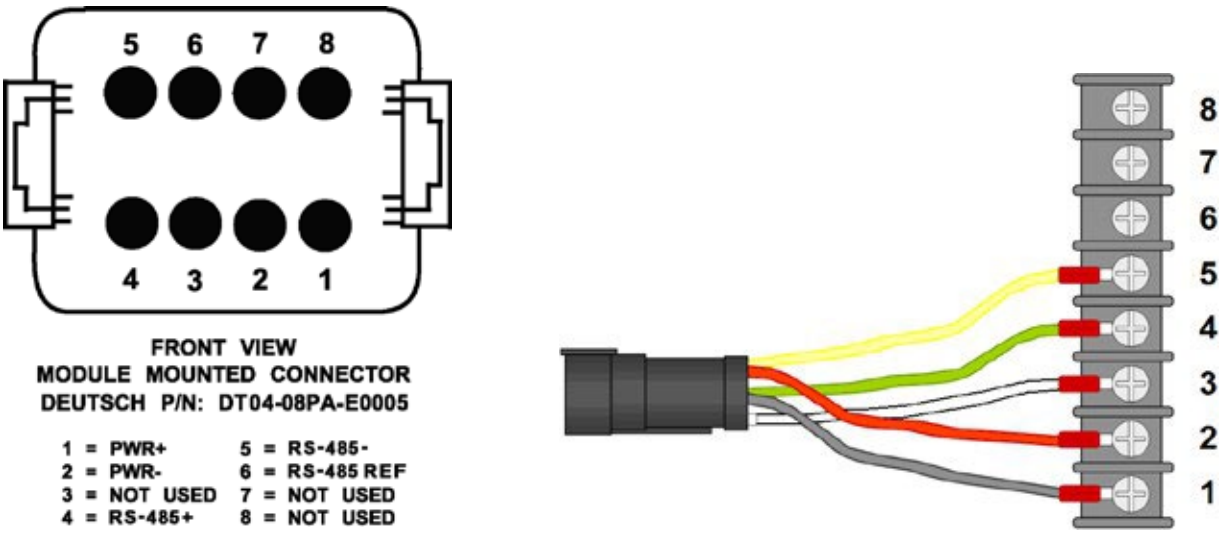


Figure 31.5 – RS-485 Annunciator Deutsch Connector Pin Configuration and Terminal Block

RS-485 Annunciator Deutsch Connector Pin Configuration		
Pin #	**Function**	**Comments**
1	BATT +	+ Battery input
2	BATT -	- Battery input
3	NOT USED	NOT USED
4	RS-485 B (+)	+ Non-Inverting Positive RS-485 input signal
5	RS-485 A (-)	- Inverting Negative RS-485 input signal
6	RS-485 R	RS-485 Reference
7	NOT USED	NOT USED
8	NOT USED	NOT USED

Table 31.5 – RS-485 Annunciator Deutsch Connector Pin Configuration

RS-485 Annunciator Terminal Block Pin Configuration		
Terminal #	**Function**	**Comments**
1	BATT -	- Battery input
2	BATT +	+ Battery input
3	RS-485 R	RS-485 Reference
4	RS-485 A (-)	- Inverting Negative RS-485 input signal
5	RS-485 B (+)	+ Non- Inverting Positive RS-485 input signal
6	Lamp Test SW	Lamp Test
7	Alarm ACK	Alarm Acknowledge
8	Horn Drive	Connects to negative terminal on Horn

Table 31.6 – RS-485 Annunciator Terminal Block Pin Configuration

31.2.4 LED Colors

Each pair of LEDs on the RS-485 Annunciator consists of two of the following three colors: Green, Amber, and Red, which allows for custom configuration of STATUS, WARNING and SHUTDOWN conditions. The available colors and combinations are listed in Table 31.7, LED Colors:

LED Colors					
Row	**Led 1**	**Led 2**	**Row**	**Led 1**	**Led 2**
1	Red	Amber	9	Red	Amber
2	Red	Amber	10	Red	Amber
3	Red	Amber	11	Red	Amber
4	Red	Amber	12	Red	Amber
5	Red	Amber	13	Green	Amber
6	Red	Green	14	Green	Amber
7	Red	Amber	15	Red	Green
8	Red	Amber	16	Red	Amber

Table 31.7 – Led Colors

Module Status LED

A red/green pair located at the bottom of the RS-485 Annunciator, is used to report Module/Network Status. The various states indicated are explained in Table 31.8.

Behavior	Explanation
Red solid	Data Link diagnostic. For example: the module is wired wrong (Data Link), or no terminating resistor.
Green solid	Data is being received from the EMCP 4
Green flashing	Loss of communication
Red/green alternating	No application software loaded, or Alarm Group Selection Mode is active



Table 31.8 – Annunciator Module/Network Status LED Behavior

31.2.5 Lamp Test Function

The Annunciator supports a lamp test function from a button press on the EMCP 4.

The lamp test function cycles continuously through two test modes while pressing and holding in the Lamp Test button. The first mode is a column test mode. The left column of LEDs will be lit for one second while the right column is off. Then the right column of LEDs will be lit for one second, while the left column is off. This will occur twice. During the second run of this test mode (during the first cycle only), the horn will be on.

The second test mode is an individual LED test mode. In this mode, the LEDs will light one at a time, starting from the top left LED, down to the left hand module status LED, then over to the right hand module status LED, then up to the top right LED. Each LED will be lit for 1/2 second, after which it will turn off and the next LED will be lit. At the completion of this test mode, the cycle will restart with the first test mode. However, on subsequent runs of the first test mode, the horn will not turn on.

The RS-485 Annunciator returns to normal operation once the lamp test button is released.

31.2.6 Alarm Acknowledge

The RS-485 Annunciator supports an acknowledge event/silence horn function from a button press on the RS-485 Annunciator or from the EMCP 4. Both cases have different behavior and are outlined below.

When an active event is received from the EMCP 4 and is acknowledged locally with a button press on the RS-485 Annunciator module, any flashing LED tied to that event will stop flashing and maintain a steady illumination and the horn will be silenced.

Note: Only the local RS-485 Annunciator module that acknowledges the active event will change the state of its flashing LED(s) and silence the horn. The acknowledge signal of the annunciation is not broadcast to any other units on the RS-485 Annunciator Data Link.

When an active event is received from the EMCP 4 and is acknowledged globally with a button press on the EMCP 4 controller, it is transmitted to the RS-485 Annunciator(s) module(s). Any flashing LED tied to that event will stop flashing and maintain a steady illumination and the horn will be silenced.

Note: In this case, the EMCP 4 may acknowledge active events on multiple RS-485 Annunciators simultaneously.

The horn silence/acknowledge function will cause the local horn to be silenced until another event causes an LED to be activated.

31.2.7 RS-485 Annunciator Alarm Groups

The RS-485 Annunciator supports four different Alarm Groups. Alarm Group 01, 02, 03, and Alarm Group 04. Two of these Alarm Groups, 03 and 04, are fixed and are not configurable and two Alarm Groups, 01 and 02, are reserved for custom event settings and are fully configurable.

Selecting which of the four Alarm Groups to configure the RS-485 Annunciator is determined by the film that is placed on the front left panel. The Alarm Groups and the events that make up the films for each of the Alarm Groups are detailed below in Tables 24, 25 and 26. Configuring the RS-485 Annunciator to one of the four Alarm Groups is accomplished through the front panel of the RS-485 Annunciator and is described further in Alarm Group Selection Mode.

31.2.8 Alarm Group Selection Mode (AGSM)

The RS-485 Annunciator supports an Alarm Group Selection Mode (AGSM) that provides the ability to configure the RS-485 Annunciator to monitor a predetermined set of 32 events communicated by the EMCP 4 through the dedicated RS-485 Annunciator Data Link.

Alarm Group selection and assignment are determined by the desired functions of the RS-485 Annunciator (Custom or non-configurable) and the film that is placed on the front left panel that reflects the predefined events monitored by the RS-485 Annunciator. When in AGSM, the top first four rows of LEDs will indicate which Alarm Group the RS-485 Annunciator has been assigned to by powering 'on' both LEDs in each row, i.e. row 1 for Alarm Group 01, row 2 for Alarm Group 02, row 3 for Alarm Group 03, and row 4 for Alarm Group 04. (**Note:** The RS-485 Annunciator will be preprogrammed to Alarm Group 04.)

The RS-485 Annunciator will continue to communicate to the EMCP 4 while in AGSM. Events received from the EMCP 4 while in AGSM will not be annunciated until AGSM has been exited only if the event that is received is an event in the selected Alarm Group.

Once the RS-485 Annunciator has successfully been assigned to an Alarm Group, it shall receive and process any Event transmitted from the EMCP 4 to the assigned Alarm Group without power cycling the module. The Network Status LEDs will alternate flashing at a 2 Hz rate at all times while in AGSM.

31.2.9 Entering AGSM

The RS-485 Annunciator shall enter AGSM by depressing the two buttons on the front panel of the RS-485 Annunciator (Lamp Test and Alarm ACK) for 3 seconds. The RS-485 Annunciator shall acknowledge entrance of AGSM by flashing the top 4 rows of LEDs 4 times at a 1 second rate.

After the 3 second period has timed out, the row representing the currently assigned alarm group address will be powered on, the remaining 11 rows of LEDs will not be powered on. See Table 31.9 AGSM LED Behavior.

Row	Column 1	Column 2
1	Solid if Assigned to Alarm Group 01, else off	Solid if Selected to Alarm Group 01, else off
2	Solid if Assigned to Alarm Group 02, else off	Solid if Selected to Alarm Group 02, else off
3	Solid if Assigned to Alarm Group 03, else off	Solid if Selected to Alarm Group 03, else off
4	Solid if Assigned to Alarm Group 04, else off	Solid if Selected to Alarm Group 04, else off
5	Off	Off
6	Off	Off
7	Off	Off
8	Off	Off
9	Off	Off
10	Off	Off
11	Off	Off
12	Off	Off
13	Off	Off
14	Off	Off
15	Off	Off
16	Off	Off

Table 31.9 – AGSM LED Behavior

31.2.10 Re-configuring/Selecting Alarm Group Address

While the RS-485 Annunciator is still in AGSM it will cycle through the four Alarm Groups by pressing one of the two buttons on the front panel. Pressing the Lamp Test button will cycle up through the 4 Alarm Groups and pressing the Alarm ACK button will cycle down through the 4 Alarm Groups.

Upon reaching Alarm Group 04 (row 4) while cycling down through the Alarm Groups with the Alarm ACK button, an additional Alarm ACK button press will bring the selection to Alarm Group 01 (row 1). Upon reaching the Alarm Group 01 (row 1) while cycling up through the Alarm Groups with the Lamp Test button, an additional Lamp Test button press will bring the selection to Alarm Group 04 (row 4).

When selecting a new Alarm Group address, the left column (red LED) will represent the previously configured Alarm Group selection . The right column (amber LED) will represent the currently selected Alarm Group . When AGSM is exited, the currently selected register address will be configured as the new Alarm Group.

31.2.11 Exiting AGSM

The Annunciator will exit AGSM under two possible conditions:

- A time out period without any button presses
- Pressing and holding the two buttons (ACK and Horn buttons) for 3 seconds

After a period of 15 seconds without any button presses, the RS-485 Annunciator will automatically exit AGSM and disregard any changes made to the Alarm Group selection and remain configured to the Alarm Group prior to entering AGSM.

When an Alarm Group selection has been made and the two buttons are pressed (Lamp Test and Alarm ACK) and held in continuously for 3 seconds, the RS-485 Annunciator will update the current configured Alarm Group to the current selected Alarm Group and then exit AGSM . Be sure to pay attention to confirm that the group being saved is the correct Alarm Group.

After exiting AGSM under either one of the two exit conditions listed, the RS-485 Annunciator will flash all 16 rows of LEDs for 3 seconds at which time the RS-485 Annunciator will enter regular annunciation mode.

31.2.12 RS-485 Annunciator Custom Alarm Group Configuration

The RS-485 Annunciator is field-programmable by the EMCP 4 via the Cat Service Tool when configured for Alarm Groups 01 and 02. Alarm Groups 01 and 02 support customization of the 32 events for the 16 LEDs.

The service tool software must be installed on a Windows PC. The Cat communication adapter must be connected between the PC and the CAN Primary data link on which the target EMCP 4 is connected.

Custom Alarm Group Selection

When the Cat Service Tool is communicating, the EMCP 4 shall be selected as the target module. Located at the top of the Cat Service Tool screen is the tool bar, select Service → RS-485 Annunciator. The RS-485 Annunciator configuration screen will be displayed with the Alarm Group Select at the top left of the screen. There are two possible selections for Alarm Groups: #1 and #2.

To configure the RS-485 Annunciator LEDs, select each of the LEDs individually. With the selected LED window displayed the initial selection is for Trigger Condition. There are three possible selections for Trigger Condition: SPECIFIC EVENT, GENERAL EVENT, and Disabled.

- **Specific Event** is used to assign an LED pair to a specific data link parameter, such as Oil Pressure, Engine Speed, Coolant Temperature, etc. The desired parameter must be chosen in the Suspect Parameter Number column.
- **General Event** is used to assign an LED pair as a general alarm or shutdown indicator. When configured as General Event, the LED will not be assigned to a particular parameter. It will respond to any event with a severity level chosen in the Severity Level column, regardless of the Suspect Parameter Number.

  For this reason, when General Event is selected, the Suspect Parameter Number cannot be changed.
- **Disabled** is used to disable the LED pair. When Disabled option is selected, the other three parameters cannot be changed.

31.2.13 Severity Level

Severity Level defines which types of events the LED pair will react to. Selections that begin with Condition Exists will respond to CAN Event messages for Failure Mode Identifier (FMI) 31 Condition Exists.

For example, LED pair #1 is configured for Condition Exists, Red On, Other Not Used, Horn On with SPN 970 (Emergency Stop Active). This means that when the RS-485 Annunciator receives data from the EMCP 4 over the RS-485 Annunciator Data Link indicating Emergency Stop with FMI 31, the Red LED will turn on and the Horn will also turn on.

- Other Not Used indicates that the other LED color in the pair is never used.
- Green Off (for example) indicates that the green LED lights when the condition chosen for this LED pair is NOT active.

Most Severity Level selections imply (a) Failure Mode Identifier (FMI) code(s):

- CONDITION EXISTS is equivalent to FMI 31
- HIGH WARNING can be FMI 15 or FMI 16
- LOW WARNING can be FMI 17 or FMI 18
- HIGH SHUTDOWN is equivalent to FMI 0
- LOW SHUTDOWN is equivalent to FMI 1
- HIGH OR LOW SHUTDOWN is equivalent to FMI 0 or FMI 1

Since the FMI codes are implied by the choice made in the Severity Level column, the FMI column is grayed out for any of these selections.

The only option that will allow a specific FMI to be configured is SPECIFIC DIAGNOSTIC.

31.2.14 Suspect Parameter Number

The Suspect Parameter Number column is used to select one of the listed SPNs in the drop down menu or type in a specific SPN number for an SPN that may not be listed in the drop down menu for the parameter assigned to the LED pair. Most supported SPNs can be selected from the list.

Engine Running

When configuring the RS-485 Annunciator for ENGINE RUNNING, special consideration must be taken to trigger the event. The event can be triggered in a variety of ways. A selection of Engine Running trigger conditions is provided in ET and on the EMCP display.

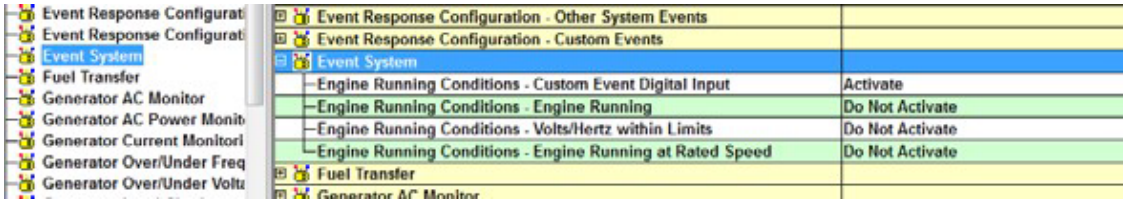


Figure 31.6 – Cat Service Tool Engine Running Conditions Configuration Screen

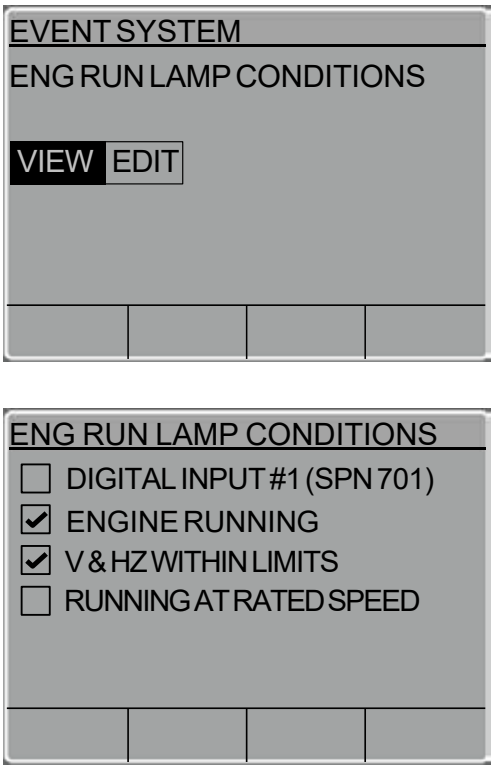


Figure 31.7 – EMCP 4.3 and EMCP 4.4 Display Engine Running Conditions Configuration Screen

The Engine Running Conditions can be logically combined together such that any selection will activate the condition and consists of the following options:

- Custom Event Digital Input #1 (SPN 701)
- Engine Running (based on Engine Overview state with non-zero engine speed)
- V/Hz Within Limits (unit is close to rated voltage and rated frequency)
- Engine Running at Rated Speed (Engine Running, not in Idle, not in Cooldown)

For using the Custom Event Digital Input trigger condition, the SPN shall be configured for Auxiliary I/O #1 (SPN 701) and it shall have a Severity Level configured for any one of the Condition Met setpoints. Digital Input #1 shall be physically wired to the active status signal that is to be used to trigger this programmed LED. If it is only to be based upon the status of the generator set controlled by the EMCP, then an output such as Relay Output #2, Fuel Control Relay, or Engine Start Initiated for Common Engine Interface generator sets on the EMCP 4 can be used. The Fuel Control Relay or Engine Start Initiated active status signal is continually active only while the engine is running.

Alarm Group #3 has LED #15 pre-configured for Engine Running and requires selecting one or multiple Engine Running Conditions to trigger an Engine Running event on the RS-485 Annunciator. If using a custom Alarm Group, use SPN 4244 and Severity Level of Condition Met.

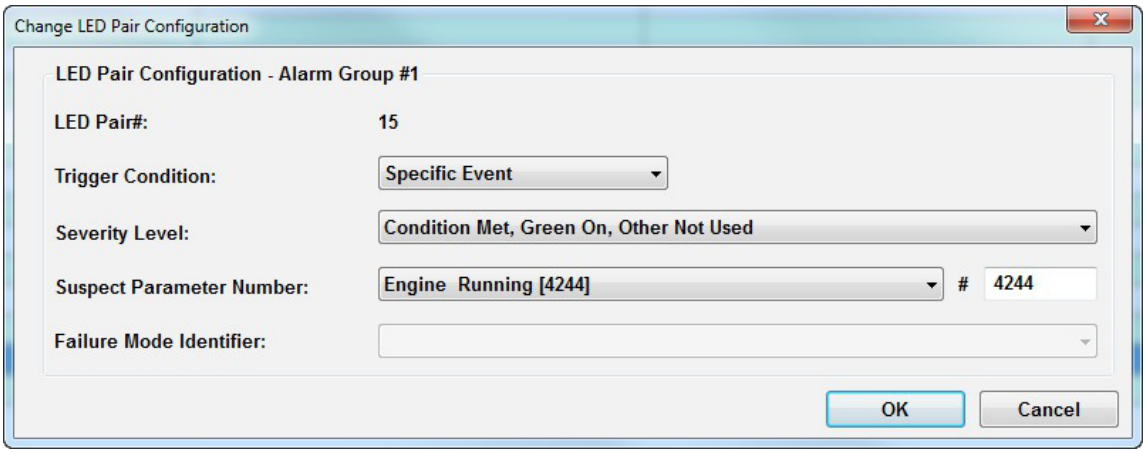


Figure 31.8 – RS-485 Annunciator Custom Alarm

31.2.15 Alarm Groups

The RS-485 Annunciator is capable of being configured for one of four Alarm Groups. Two of these Alarm Groups are fixed, two are configurable. Selection of the Alarm Group to be used is accomplished by using the front panel of the RS-485 Annunciator module as explained above in Alarm Group Selection Mode (AGSM).

The assignment of films for each of the Alarm Groups is outlined below:

- Alarm Group #1 (Custom Configurable 1) – Film #1 (see Table 31.10) and custom film
- Alarm Group #2 (Custom Configurable 2) – Film #1 (see Table 31.10) and custom film
- Alarm Group #3 (Fixed) – Film #1 (see Table 31.10)
- Alarm Group #4 (Fixed) – Film #2, or Film #3 (see Table 31.11 and Table 31.12)

Row	LED Colors	Default LED and Setpoint Assignments	Horn
1	Red	E-Stop Shutdown	Y
	Amber	Not Used	NA
2	Red	Overcrank	Y
	Amber	Not Used	NA
3	Red	High Coolant Temp Shutdown	Y
	Amber	High Coolant Temp Warning	Y
4	Red	Not Used	NA
	Amber	Low Coolant Temp Warning	Y
5	Red	Low Oil Pressure Shutdown	Y
	Amber	Low Oil Pressure Warning	Y
6	Red	Overspeed Shutdown	Y
	Green	Not Used	NA
7	Red	Low Coolant Level Shutdown	Y
	Amber	Low Coolant Level Warning	Y
8	Red	Low Fuel Level Shutdown	Y
	Amber	Low Fuel Level Warning	Y
9	Red	Not Used	NA
	Amber	Generator Not in Auto Warning	Y
10	Red	High Battery Voltage Shutdown	Y
	Amber	High Battery Shutdown Warning	Y
11	Red	Not Used	NA
	Amber	Low Battery Voltage Warning	Y
12	Red	Not Used	NA
	Amber	Low Cranking Voltage Warning	Y
13	Green	Not Used	NA
	Amber	Battery Charger AC Failure	Y
14	Green	Not Used	NA
	Amber	EPS Supplying Load	N
15	Red	Not Used	NA
	Green	Engine Running	N
16	Red	SCR SPN 4792	Y
	Amber	SCR SPN 4792	Y

Table 31.10 – Film #1. Alarm Group 01 & 02 Default Film and Alarm Group 03 Film Assignments. NFPA 99/110 Events. Includes Fuel Level, Engine Running, and SCR SPN 4792 Events.

Row	LED Colors	Default LED and Setpoint Assignments	Horn
1	Red	E-Stop Shutdown	Y
	Amber	Not Used	NA
2	Red	Overcrank	Y
	Amber	Not Used	NA
3	Red	High Coolant Temp Shutdown	Y
	Amber	High Coolant Temp Warning	Y
4	Red	Not Used	NA
	Amber	Low Coolant Temp Warning	Y
5	Red	Low Oil Pressure Shutdown	Y
	Amber	Low Oil Pressure Warning	Y
6	Red	Overspeed Shutdown	Y
	Green	Not Used	NA
7	Red	Low Coolant Level Shutdown	Y
	Amber	Low Coolant Level Warning	Y
8	Red	Low Fuel Level Shutdown	Y
	Amber	Low Fuel Level Warning	Y
9	Red	Not Used	NA
	Amber	Generator Not in Auto Warning	Y
10	Red	High Battery Voltage Shutdown	Y
	Amber	High Battery Shutdown Warning	Y
11	Red	Not Used	NA
	Amber	Low Battery Voltage Warning	Y
12	Red	Not Used	NA
	Amber	Low Cranking Voltage Warning	Y
13	Green	Not Used	NA
	Amber	Battery Charger AC Failure	Y
14	Green	Not Used	NA
	Amber	EPS Supplying Load	N
15	Red	Air Damper Shutdown	Y
	Green	Not Used	NA
16	Red	SCR SPN 4792	Y
	Amber	SCR SPN 4792	Y

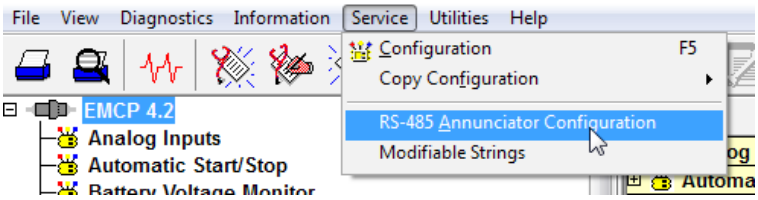
Table 31.11 – Film #2. Alarm Group 04. NFPA 99/110 Events.
Includes Fuel Level, Air Damper Shutdown, and SCR SPN 4792 Events.

Row	LED Colors	Default LED and Setpoint Assignments	Horn
1	Red	E-Stop Shutdown	Y
	Amber	Not Used	NA
2	Red	Overcrank	Y
	Amber	Not Used	NA
3	Red	High Coolant Temp Shutdown	Y
	Amber	High Coolant Temp Warning	Y
4	Red	Not Used	NA
	Amber	Low Coolant Temp Warning	Y
5	Red	Low Oil Pressure Shutdown	Y
	Amber	Low Oil Pressure Warning	Y
6	Red	Overspeed Shutdown	Y
	Green	Not Used	NA
7	Red	Low Coolant Level Shutdown	Y
	Amber	Low Coolant Level Warning	Y
8	Red	Low Fuel Level Shutdown	Y
	Amber	Low Fuel Level Warning	Y
9	Red	Not Used	NA
	Amber	Generator Not in Auto Warning	Y
10	Red	High Battery Voltage Shutdown	Y
	Amber	High Battery Shutdown Warning	Y
11	Red	Not Used	NA
	Amber	Low Battery Voltage Warning	Y
12	Red	Not Used	NA
	Amber	Low Cranking Voltage Warning	Y
13	Green	Not Used	NA
	Amber	Battery Charger AC Failure	Y
14	Green	Not Used	NA
	Amber	EPS Supplying Load	N
15	Red	Air Damper Shutdown	Y
	Green	Not Used	NA
16	Red	Not Used	NA
	Amber	Not Used	NA

Table 31.12 – Film #3. Alarm Group 04 Film Assignments. NFPA 99/110 Events. Includes Fuel Level and Air Damper Shutdown. Does Not Include SCR SPN 4792.

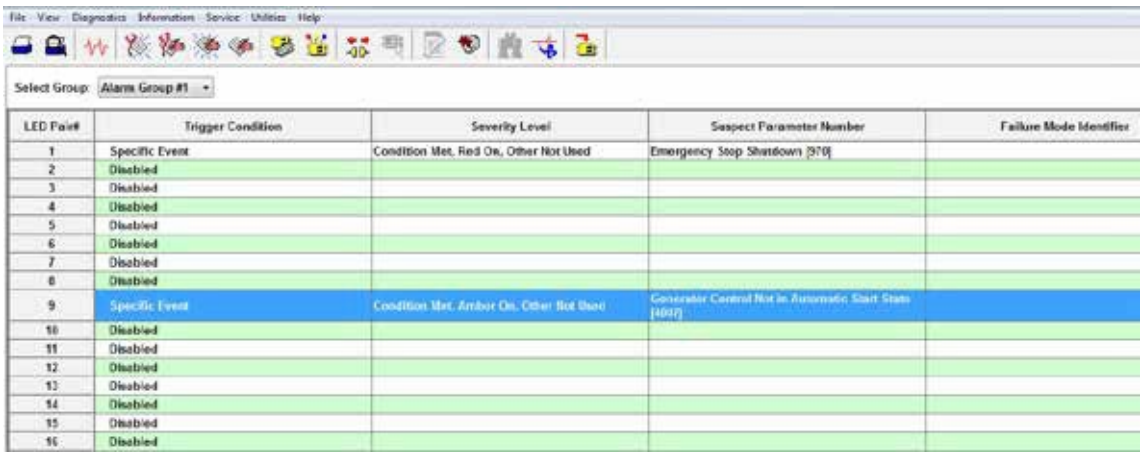
31.2.16 Configuring Custom Alarm Groups Using Cat Service Tool

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.
2. Select Service → RS-485 Annunciator Configuration.

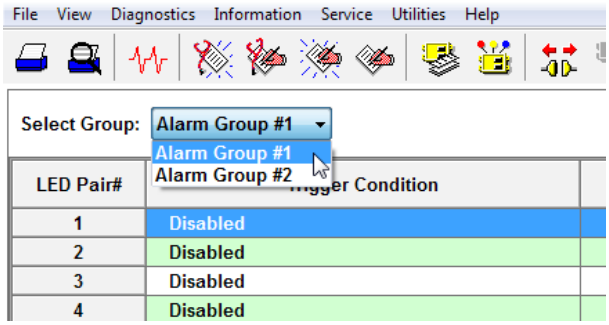


Note: This option will not appear if the EMCP 4 was not selected in the ECM Summary Screen when connecting to Cat ET.

3. The LED pairs will become visible in a new window.



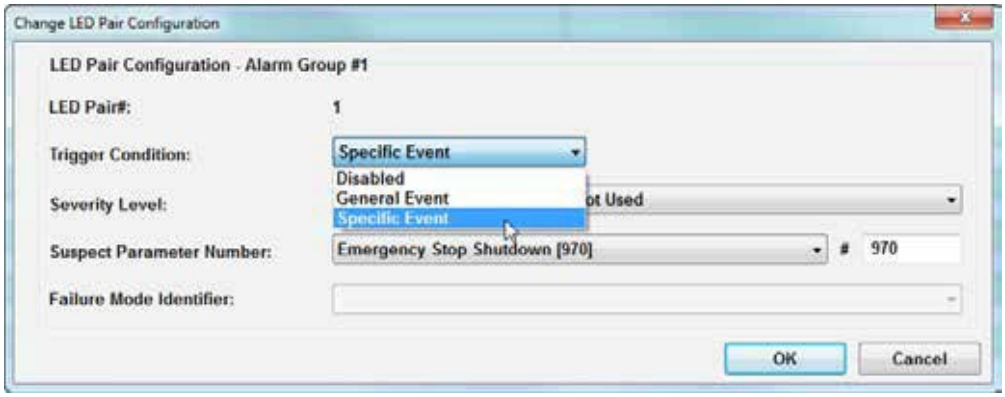
4. Select the Alarm Group for the Annunciator by choosing from the drop down menu.



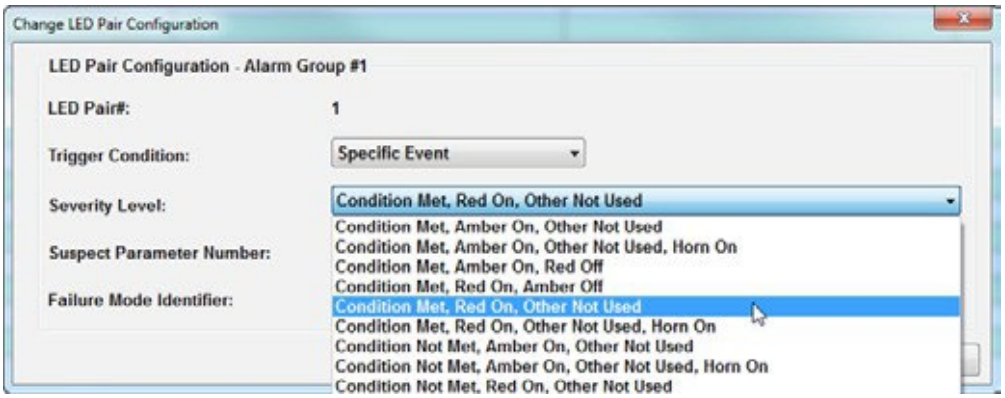
5. Double click on an LED pair to configure the pair.



6. Select the Trigger condition for the pair in the drop down menu.

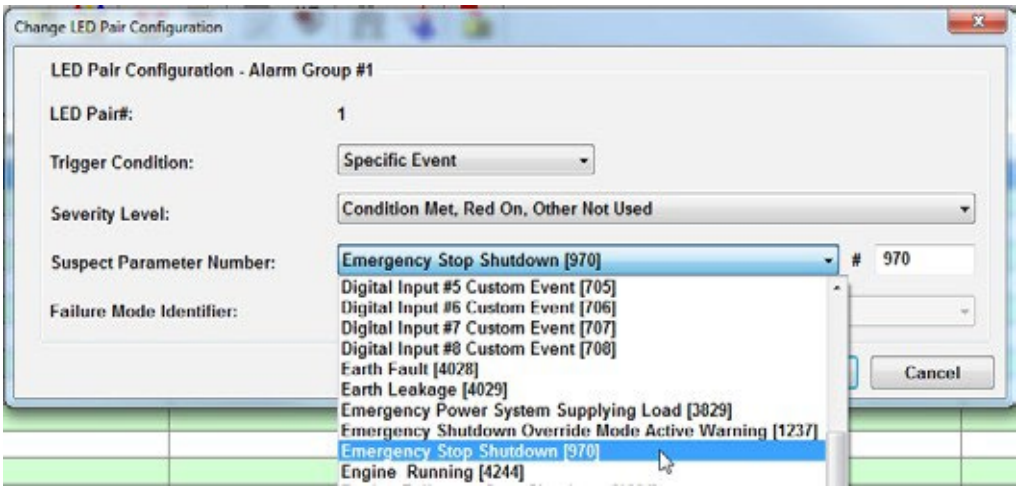


7. Select the Severity Level for the pair in the drop down menu.



For a complete list of choices for Severity Level, see Tables 31.15 and 31.16.

8. Select the Suspect Parameter Number for the pair in the drop down menu.



For a complete list of choices refer to Suspect Parameter Number Text on pages 387 to 389.

9. The Failure Mode Identifier does not normally need to be programmed since the Severity Level typically has this information embedded.

If the LED Trigger Condition is configured as Specific Event, the Severity Level can be configured according to Table 31.13.

Trigger Condition Severity Level	Allowed for LED Pairs…		
	1-5, 7-12, 16	13-14	6, 15
Low Warning	√	√	
Low Shutdown	√		√
High Warning	√	√	
High Shutdown	√		√
High or Low Warning	√	√	
High or Low Shutdown	√		√
Low Warning or Low Shutdown	√		
High Warning or High Shutdown	√		
High or Low Warning, High or Low Shutdown	√		
High or Low Warning, High or Low Shutdown or Diagnostic	√	√	√
Diagnostic Other Than Warning/Shutdown/ Condition Exists	√	√	

Table 31.13 – General Event Severity Levels

If the LED Trigger Condition is configured as Specific Event, the Severity Level can be configured according to Table 31 .14 .

Trigger Condition Severity Level	Allowed for LED Pairs…		
	1-5, 7-12, 16	13-14	6, 15
Low Warning	√	√	
Low Shutdown	√		√
High Warning	√	√	
High Shutdown	√		√
High or Low Warning	√	√	
High or Low Shutdown	√		√
Low Warning or Low Shutdown	√		
High Warning or High Shutdown	√		
High or Low Warning, High or Low Shutdown	√		
High or Low Warning, High or Low Shutdown or Diagnostic	√	√	√
Diagnostic Other Than Warning/Shutdown/Condition Exists	√	√	
Specific Diagnostic	√	√	√
Condition Exists, Red On, Other Not Used	√		√
Condition Exists, Amber On, Other Not Used	√	√	
Condition Exists, Green On, Other Not Used		√	√
Condition Exists, Red On, Amber Off	√		
Condition Exists, Red On, Green Off			√
Condition Exists, Amber On, Red Off	√		
Condition Exists, Amber On, Green Off		√	
Condition Exists, Green On, Red Off			√
Condition Exists, Green On, Amber Off		√	
Condition Does Not Exist, Red On, Other Not Used	√		√
Condition Does Not Exist, Amber On, Other Not Used	√	√	
Condition Does Not Exist, Green On, Other Not Used		√	√
Condition Exists, Red On, Other Not Used, Horn On	√		√
Condition Exists, Amber On, Other Not Used, Horn On	√	√	
Condition Exists, Green On, Other Not Used, Horn On		√	√
Condition Does Not Exist, Red On, Other Not Used, Horn On	√		√
Condition Does Not Exist, Amber On, Other Not Used, Horn On	√	√	
Condition Does Not Exist, Green On, Other Not Used, Horn On		√	√

Table 31.14 – Specific Event Severity Levels

For Trigger Condition Severity Level listed in the table above from 'Low Warning' to 'Specific Diagnostic the following Suspect Parameter Number options can be used:

Suspect Parameter Number Text	Value
Fuel Level (External Tank)	38
Aftercooler Temperature	52
Starting Air Pressure	82
Fuel Filter Differential Pressure	95
Fuel Level (Local Tank)	96
Engine Oil Level	98
Oil Filter Differential Pressure	99
Engine Oil Pressure	100
Crankcase Pressure	101
Air Filter Differential Pressure	107
Barometric Pressure	108
Engine Coolant Temperature	110
Engine Coolant Level	111
Battery Voltage (switched)	158
Battery Charging System Voltage	167
Battery Voltage	168
Ambient Air Temperature	171
Inlet Air Temperature	172
Exhaust Temperature	173
Engine Oil Temperature	175
Engine Speed	190
Long Distance Annunciator Data Link Fault	625
Primary Data Link Fault	639
Emergency Stop Shutdown	970
Analog Input #1 Custom Parameter	1083
Analog Input #2 Custom Parameter	1084
Generator Rear Bearing Temperature	1122
Generator Front Bearing Temperature	1123
Generator Winding Temperature #1	1124
Generator Winding Temperature #2	1125
Generator Winding Temperature #3	1126
Accessory Data Link Fault	1231
Unexpected Engine Shutdown	1383
Right Exhaust Temperature	2433
Left Exhaust Temperature	2434

Suspect Parameter Number Text (continued)	Value
Generator Frequency	2436
Generator AC Voltage	2440
Generator AC Current	2448
Generator Real Power (kW)	2452
Generator Reactive Power (kVAr)	2456
Generator to Bus Synchronization Failure (Low)	2529
Dead Bus Arbitration Failure (Low)	2530
Engine Controller (Abnormal Update Rate)	3543
Modbus Data Link	3581
Generator Breaker Closed	4004
Generator Breaker Open	4013
Utility to Generator Transfer Failure (High)	4015
Analog Input #4 Custom Parameter	4157
Analog Input #3 Custom Parameter	4158
Cranking Voltage	4256

Table 31.15

For the Trigger Condition Severity Levels listed in Table 31.15 above from 'Condition Exists, Red On, other Not Used' to 'Condition Does Not Exists, Green On, other Not used, Horn On' the following Suspect Parameter Number options can be used:

Suspect Parameter Number Text	Value
Digital Input #1 Custom Event	701
Digital Input #2 Custom Event	702
Digital Input #3 Custom Event	703
Digital Input #4 Custom Event	704
Digital Input #5 Custom Event	705
Digital Input #6 Custom Event	706
Digital Input #7 Custom Event	707
Digital Input #8 Custom Event	708
Isolated Digital Input #1 Custom Event	3920
Isolated Digital Input #2 Custom Event	3921
Isolated Digital Input #3 Custom Event	3922
Isolated Digital Input #4 Custom Event	3923
Emergency Stop Shutdown	970
Emergency Shutdown Override Mode Active	1237
Fuel Tank Leak	1239
Engine Failure to Start	1664
Service Interval Warning	2648

Suspect Parameter Number Text	Value
Generator Unavailable to Start/Run	3677
EPS Supplying Load	3829
Air Damper Closed	4000
ATS in Normal Position	4001
ATS in Emergency Position	4002
Battery Charger Failure	4003
Generator Breaker Closed	4004
Utility Breaker Closed	4005
Engine in Cooldown	4006
Generator Control Not in Automatic Warning	4007
Generator Breaker Failure to Open	4009
Generator Breaker Failure to Close	4011
Generator Breaker Open	4013
Loss of Utility	4017
Generator Breaker Locked Out	4018
Utility Breaker Locked Out	4019
Bus Phase Sequence Incorrect	4024
Generator Phase Sequence Incorrect	4025
Earth Fault	4028
Earth Leakage	4029
Engine Running	4244

Table 31.16

If the Trigger Condition Severity Level is programmed for Diagnostic, then the Failure Mode Identifier for any pair of LEDs can be configured as any of the following:

Failure Mode Identifier	
Data Erratic, Intermittent, or Incorrect	Abnormal Rate of Change
Voltage Above Normal, or Shorted to High Source	Root Cause Not Known
Voltage Below Normal, or Shorted to Low Source	Bad Intelligent Device or Component
Current Below Normal or Open Circuit	Out of Calibration
Current Above Normal or Grounded Circuit	Special Instructions
Mechanical System Not Responding or Out of Adjustment	Received Network Data In Error
Abnormal Frequency or Pulse Width or Period	Data Drifted High
Abnormal Update Rate	Data Drifted Low

Table 31.17

31.3 Thermocouple Module

31.3.1 Thermocouple Features

Reads up to 20 Type J or K thermocouple inputs.



Temperatures are configured to indicate the SAE CAN J1939 SPN to be transmitted by that temperature input. Suspect Parameter Numbers (SPNs) for configuration of temperature inputs are customer specific. Resolution: One byte parameters have a of 1°C/bit and a range of -40°C to 210°C. Two byte parameters have resolution of 0.03125°C/bit and a range of -273°C to 1735°C. **Note:** EMCP 4 controls are also compatible with other thermocouple modules broadcasting the correct SPN values.

- Cold junction compensation is provided
- System throughput has all 20 channels scanned in 2 seconds (100 ms/channel)
- Overall drift with temperature is 0.015%/°C of span (maximum)
- Module is fully functional during configuration and communications
- Parameter values and diagnostic error codes are retained when the modules are de-energized
- Open-circuit and short-circuit diagnostics are supported Can be mounted directly on the generator set panel or remotely
- Suitable for moist, high shock and vibration environments
- Compact size (see mechanical drawing, Figure 31.9)

31.3.2 Thermocouple Specifications

Electrical Specifications

- Accept 5-32VDC power (12 or 24VDC nominal)
- Over voltage capability is 32VDC for 1 hour @ 85°C
- Power supply inputs are protected against transient surges and short circuits and are isolated from I/O
- Three way isolation is provided for the CAN line, inputs and power supply; isolation voltage is 1500 V AC (rms) or 2550 V for 1 sec
- Burden is limited to less than 200 mA; inrush not to exceed 800 mA
- Common mode rejection is -80 db@ 5V p-p (50-60 Hz)
- Common mode input range is +/- 4 V minimum
- Designed to meet relevant European standards for EMI/RFI/Immunity without the use of external filtering

Environmental Specifications

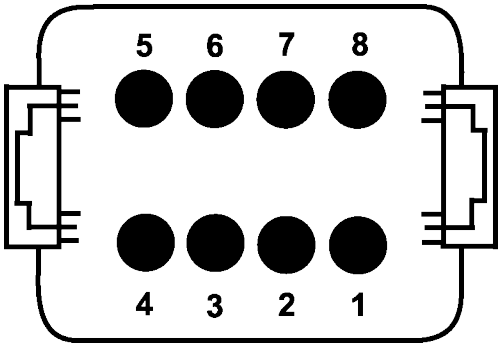
- Encapsulated in a rugged aluminum housing with watertight Deutsch connectors (IP65 rating)
- Operating temperature range -40°C to 85°C (-40°F to 185°F)
- The ambient storage temperature range is -50°C to +120°C
- It is protected against 95% humidity non-condensing, 30°C to 60°C

Network Communications Interface

- Capable of operating on the EMCP 4 Accessory CAN (2) data link.
- Optical isolation is provided for the CAN line.
- Retains current date and time relative to synchronization every 24 hours (or upon boot up) with equipment system time via an explicit command from the EMCP 4 or Service Tool when the EMCP 4 is not available; synchronization time is accurate to within 1 sec.
- Includes a watchdog timer to automatically reboot should the microprocessor lock.
- Module operates normally with loss of communication link, retaining configured values and error codes in non-volatile memory.
- Configuration and firmware updates are accomplished with the Cat Service Tool over the CAN network.

31.3.3 Thermocouple Wiring

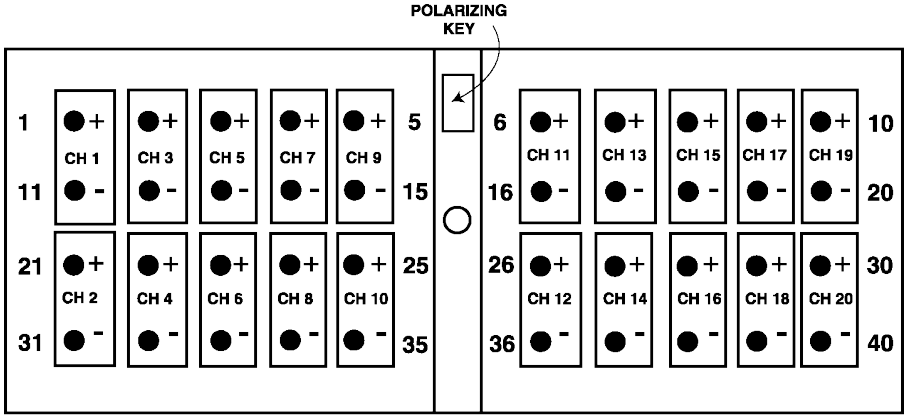
Power and Can Bus Wiring



FRONT VIEW
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DT13-08PA

1 = PWR+ 5 = SHIELD
2 = CAN-H 6,7,8 = NOT USED
3 = CAN-L
4 = PWR-

Thermocouple Sensor Wiring



FRONT VIEW OF
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DRC13-40PA

31.3.4 Thermocouple Physical Layout

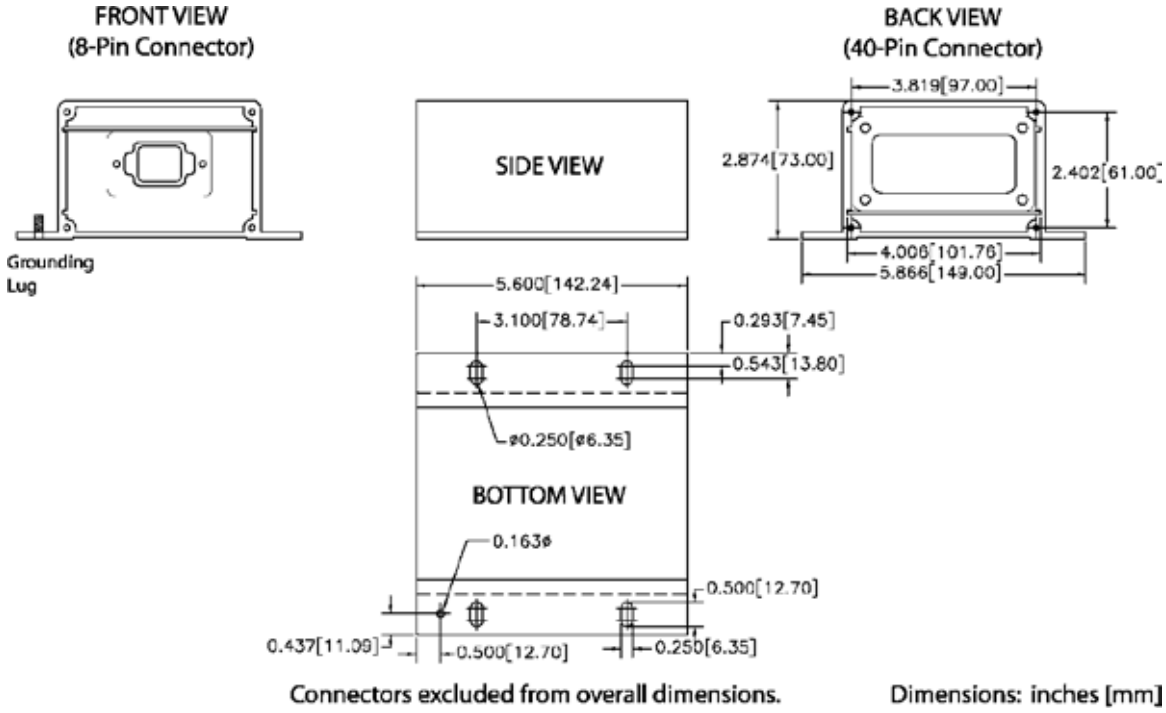


Figure 31.9 – Thermocouple, RTD, and Discrete I/O Module Physical Layout

31.3.5 Thermocouple Module – Configuration

The Thermocouple module is field programmable using the Cat Service Tool. It is also flash programmable to update software using the Cat Service Tool.

The service tool software must be installed on a Windows PC. The Cat communication adapter must be connected between the PC and the CAN data link on which the target Thermocouple module is connected. When connecting the Thermocouple module, the user will first see the Module Summary screen shown in Figure 31.10.

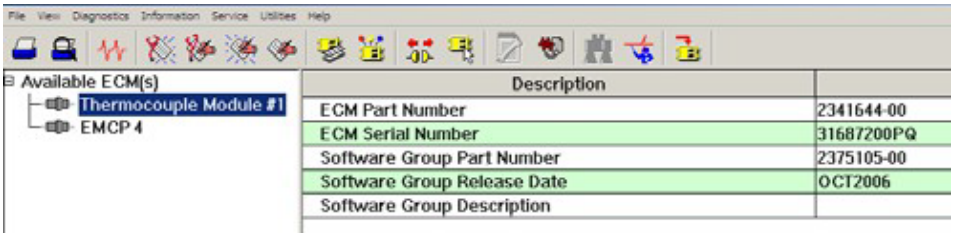


Figure 31.10 – Cat Service Tool Thermocouple Module Summary Screen

The service tool configuration tool contains setpoints for configuring the Thermocouple module identification, as well as the thermocouple inputs.

Figure 31.11 shows the ECM Identification Parameters list. This list shows the ECM serial number (read-only) of the module that is connected, and allows for configuration of the ECU instance. Each thermocouple module on the data link must have a unique ECU instance. If ECU instances are duplicated, one of the modules must be disconnected and the other reconfigured to a different ECU instance.

Note: ECU Instance #1 is reserved for the Accessory Data Link (CAN 2), while ECU Instance #2 is reserved for the Primary Data Link (CAN 1) .

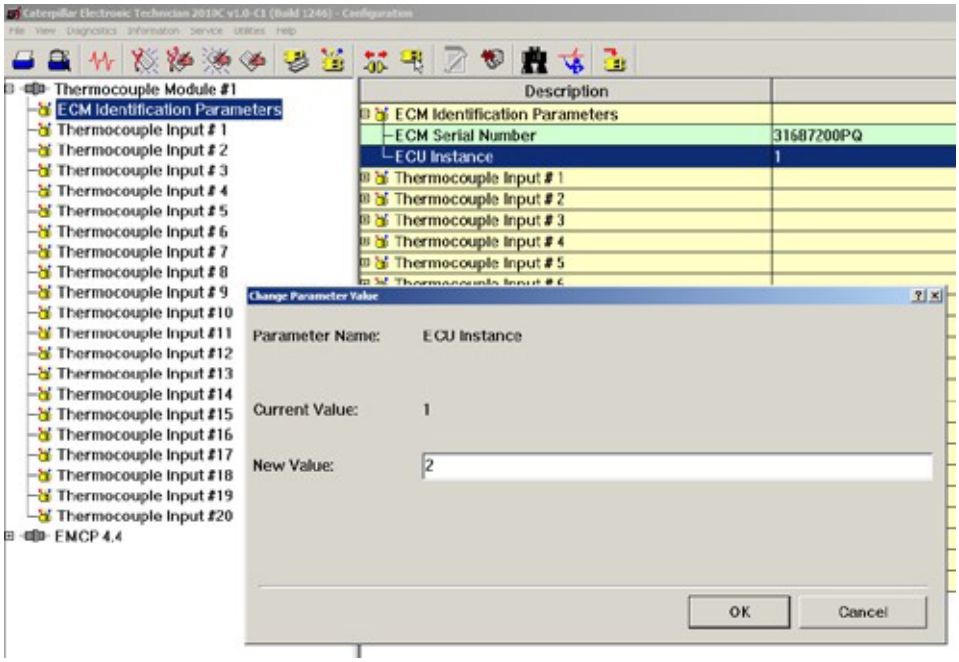


Figure 31.11 – Cat Service Tool Thermocouple Module Identification Parameters

Upon changing the ECU instance, the Cat Service Tool will automatically reconnect to the data link, and the Thermocouple module name should reflect the new ECU instance. In this example, as shown in Figure 31.12, the module was previously named Thermocouple Module #1, and after the ECU instance is changed to 2 and the service tool reconnects, the name reads Thermocouple Module #2.

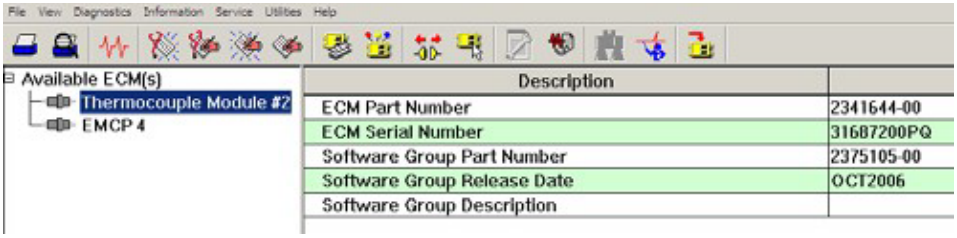
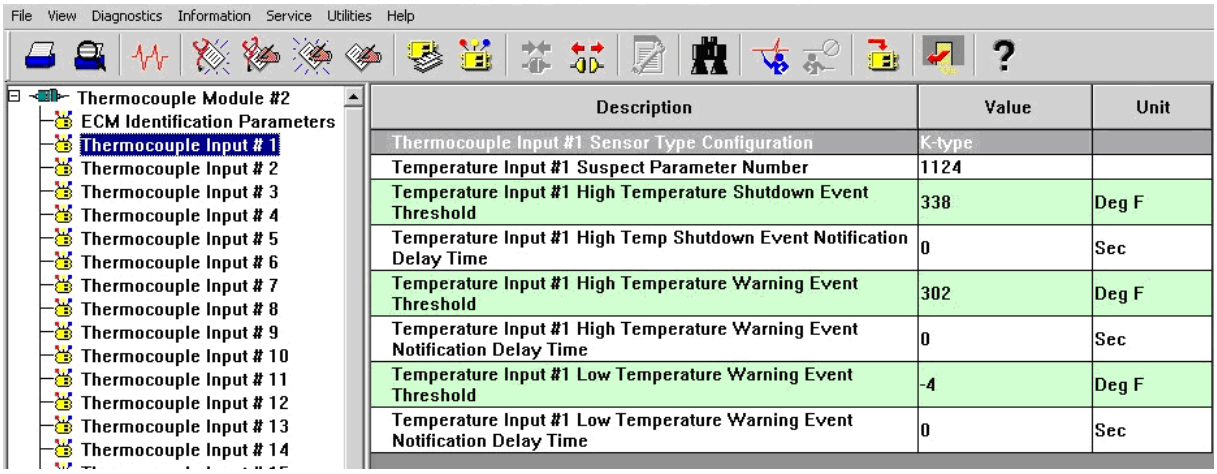


Figure 31.12 – Cat Service Tool Thermocouple Module After ECU Instance Change

31.3.6 Configuring Thermocouple Inputs

Figure 31.13 shows the THERMOCOUPLE INPUT #1 Configuration list, when using the Cat Service Tool. All twenty thermocouple inputs have identical parameters and options.



Description	Value	Unit
Thermocouple Input #1 Sensor Type Configuration	K-type	
Temperature Input #1 Suspect Parameter Number	1124	
Temperature Input #1 High Temperature Shutdown Event Threshold	338	Deg F
Temperature Input #1 High Temp Shutdown Event Notification Delay Time	0	Sec
Temperature Input #1 High Temperature Warning Event Threshold	302	Deg F
Temperature Input #1 High Temperature Warning Event Notification Delay Time	0	Sec
Temperature Input #1 Low Temperature Warning Event Threshold	-4	Deg F
Temperature Input #1 Low Temperature Warning Event Notification Delay Time	0	Sec

Figure 31.13 – Cat Service Tool Thermocouple Input Configuration

The SENSOR TYPE CONFIGURATION selects either a J or K type configuration. Select the appropriate configuration based on the type of thermocouple installed. Reference the TC Module specification sheet (LEHE0126) for available Temperature Inputs.

The SUSPECT PARAMETER NUMBER (SPN) is a numerical entry between a predetermined list of SPNs that are supported by the Thermocouple module. All of the thermocouple inputs support the same list of SPNs. To change the SPN, type in the number that corresponds with the desired parameter as shown in Figure 31.14. See RENR7902 for specific information on what possible SPN values can be used.

The HIGH TEMPERATURE SHUTDOWN EVENT THRESHOLD sets the temperature at which a high shutdown event will occur.

The HIGH TEMPERATURE WARNING EVENT THRESHOLD sets the temperature at which a high warning event will occur.

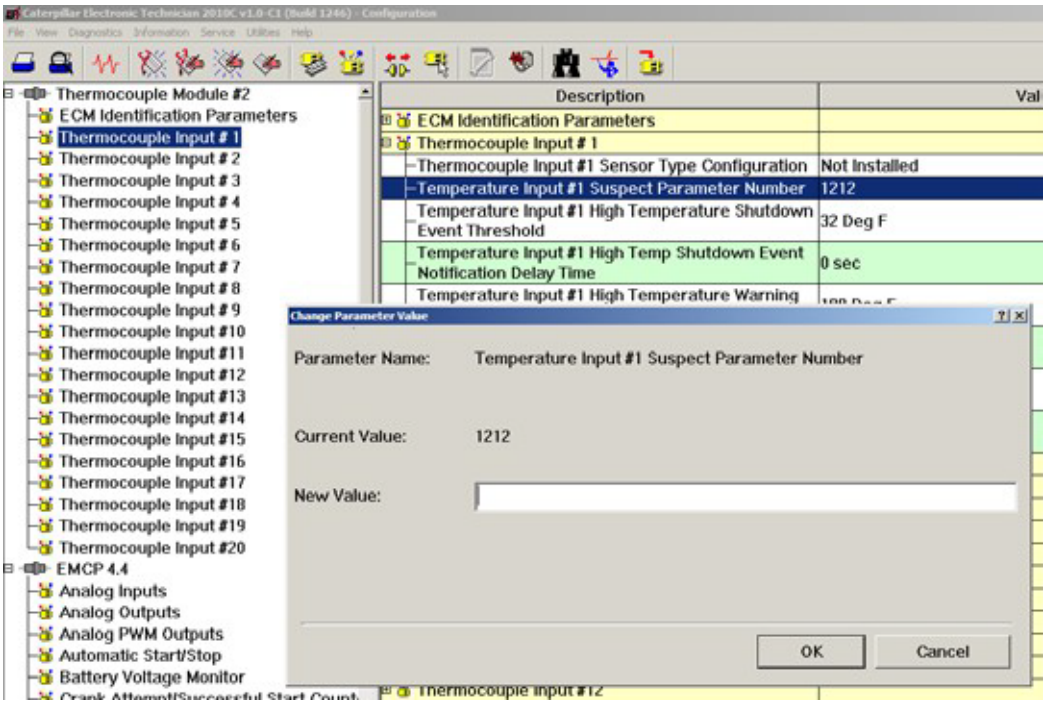


Figure 31.14 – Cat Service Tool Thermocouple Module Suspect Parameter Number

The LOW TEMPERATURE WARNING EVENT THRESHOLD sets the temperature at which a low warning event will occur.

The EVENT NOTIFICATION DELAY TIME sets the amount of time the threshold must be exceeded until the Thermocouple module triggers that particular event on the data link. Each of the delay time options corresponds with a particular event type.

31.4 RTD Module

31.4.1 RTD Features

- Reads up to eight (8) Platinum RTD inputs with 2, 3, and 4 wire configurations.
- System throughput has all 8 channels scanned in 2 seconds 250 ms/channel).
- Overall drift with temperature is 15 mOhm/°C (maximum).
- Module is fully functional during configuration and communications.
- Parameter values and diagnostic error codes are retained when the modules are de-energized.
- Suitable for moist, high shock and vibration environments.
- Compact size (see mechanical drawing, Figure 31.15).



31.4.2 RTD Specifications

Electrical Specifications

- Accept 5-32VDC power (12 or 24VDC nominal).
- Over voltage capability is 32VDC for 1 hour @ 85°C.
- Power supply inputs are protected against transient surges and short circuits and are isolated from I/O.
- Optical isolation is 500VDC from input to ground. Three way isolation is provided for the CAN line, inputs and power supply.
- Burden is limited to less than 200 mA; inrush not to exceed 800 mA.
- Designed to meet relevant European standards for EMI/RFI/Immunity without the use of external filtering.

Environmental Specifications

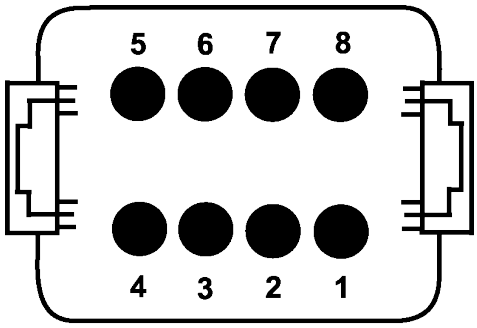
- Encapsulated in a rugged aluminum housing with watertight Deutsch connectors (IP65 rating).
- Operating temperature range -40°C to 85°C (-40°F to 185°F).
- The ambient storage temperature range is -50°C to +120°C.
- Protected against 95% humidity non-condensing, 30°C to 60°C.

Network Communications Interface

- Operates on the EMCP 4 Accessory CAN data links.
- Optical isolation is provided for the CAN line.
- Retains current date and time relative to synchronization every 24 hours (or upon boot up) with equipment system time via an explicit command from the EMCP 4 or Service Tool when the GSC is not available; synchronization time is accurate to within 1 sec.
- Includes a watchdog timer to reset the module if required. Module operates normally with loss of communication link, retaining configured values and error codes in non-volatile memory.
- Configuration and firmware updates are accomplished with the Cat Service Tool over the CAN network.

31.4.3 RTD Wiring

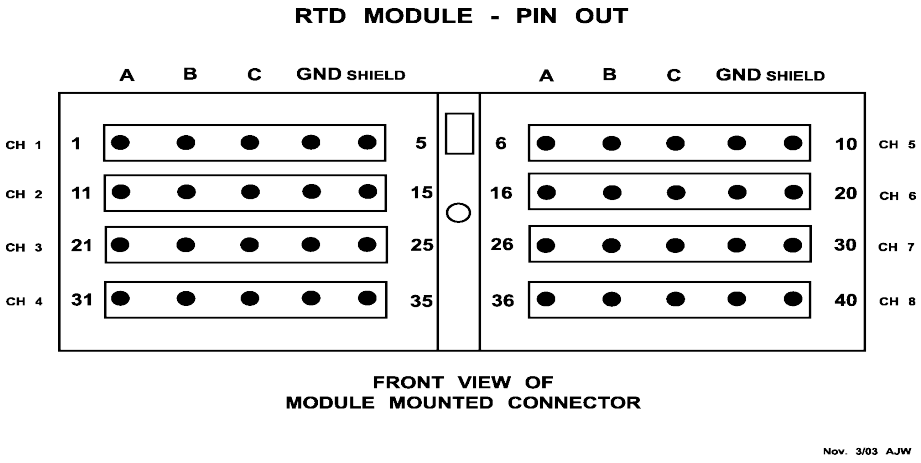
Power and Can Bus Wiring



FRONT VIEW
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DT13-08PA

1 = PWR+ 5 = SHIELD
2 = CAN-H 6,7,8 = NOT USED
3 = CAN-L
4 = PWR-

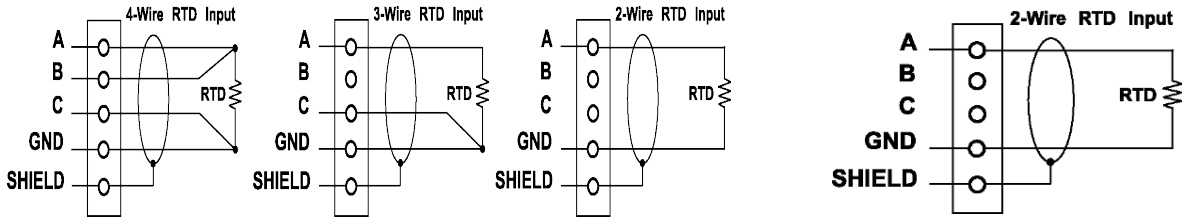
RTD Sensor Wiring



FRONT VIEW OF
MODULE MOUNTED CONNECTOR

Nov. 3/03 AJW

RTD Wiring Typical Connections



31.4.4 RTD Physical Layout

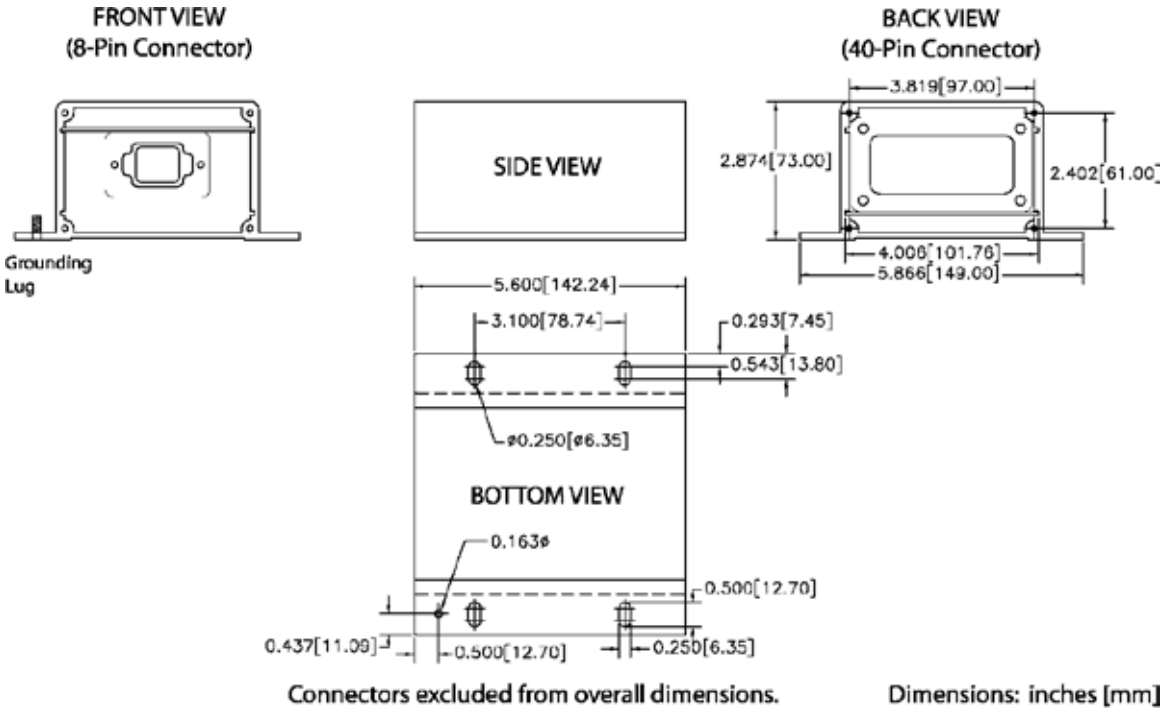


Figure 31.15 – Thermocouple, RTD, and Discrete I/O Module Physical Layout

31.4.5 RTD Module – Configuration

The RTD (Resistance Temperature Detector) module is field programmable using the Cat Service Tool. It is also flash programmable to update software using the Cat Service Tool.

The service tool software must be installed on a Windows PC.

The Cat communication adapter must be connected between the PC and the CAN data link on which the target RTD module is connected.

When connecting to the RTD module, the user will first see the Module Summary screen shown in Figure 31.16.

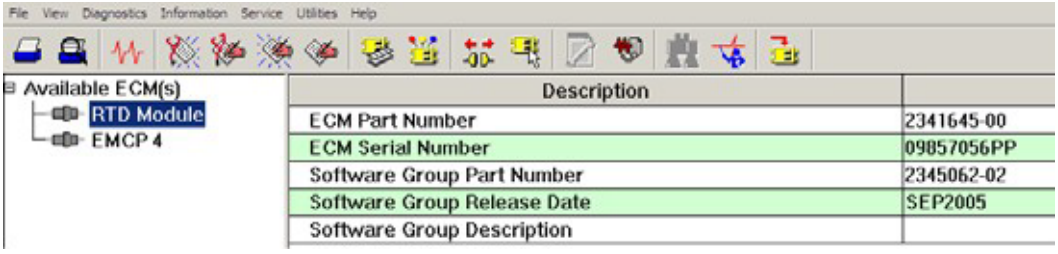


Figure 31.16 – Cat Service Tool RTD Module Summary Screen

The service tool configuration tool, accessed by pressing F5 or clicking the configuration tool icon on the toolbar, contains setpoints for configuring the RTD module identification, as well as the RTD inputs.

31.4.6 Configuring RTD Inputs

The RTD Input #1 Configuration list of the service tool configuration tool is shown in Figure 31.17. All eight RTD inputs have identical parameters and options.

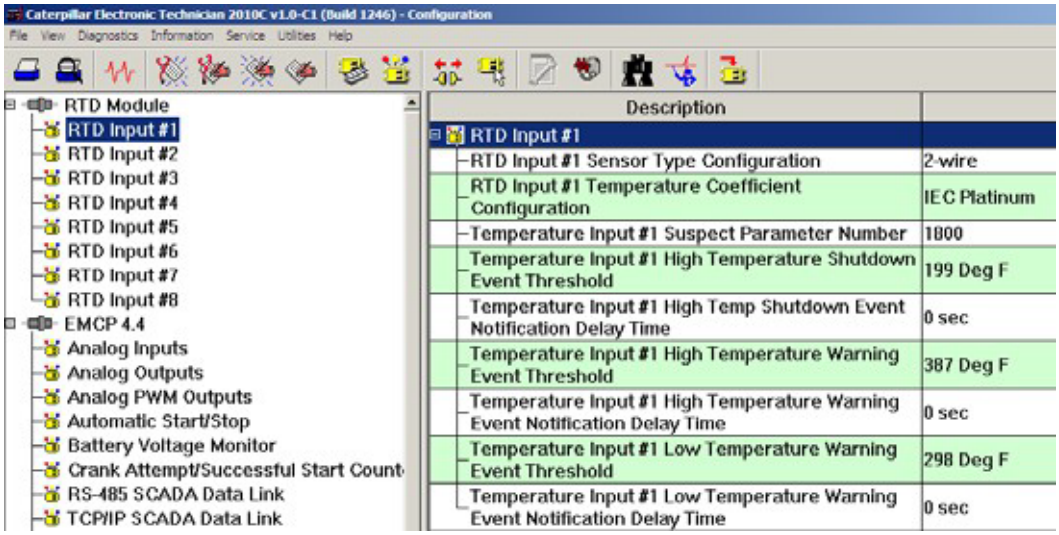


Figure 31.17 – Cat Service Tool RTD Module Digital Input Configuration

The SENSOR TYPE CONFIGURATION selects between a 2, 3, or 4 wire configuration. Select the appropriate configuration based on the type of RTD sensor installed. Reference the RTD Module specification sheet (LEHE0124) for available Temperature Inputs.

The TEMPERATURE COEFFICIENT CONFIGURATION selects between an IEC Platinum, JIS Platinum, Legacy US Platinum, SA MA Platinum or US Platinum type of RTD sensor. Select the appropriate configuration based on the type of RTD sensor installed.

The SUSPECT PARAMETER NUMBER (SPN) is a choice between a predetermined list of SPNs that are supported by the RTD module. All of the RTD inputs support the same list of SPNs. To change the SPN, type in the number that corresponds to the desired parameter as shown in Figure 31.18. See UENR1210 for specific information on what possible SPN values can be used.

The HIGH TEMPERATURE SHUTDOWN EVENT THRESHOLD sets the high temperature at which a shutdown event will occur.

The HIGH TEMPERATURE WARNING EVENT THRESHOLD sets the high temperature at which a high warning event will occur.

The LOW TEMPERATURE WARNING EVENT THRESHOLD sets the low temperature at which a low warning event will occur.

The EVENT NOTIFICATION DELAY TIME sets the amount of time the threshold must be reached until the RTD module triggers that particular event on the data link. Each of the delay time options corresponds with a particular event type.

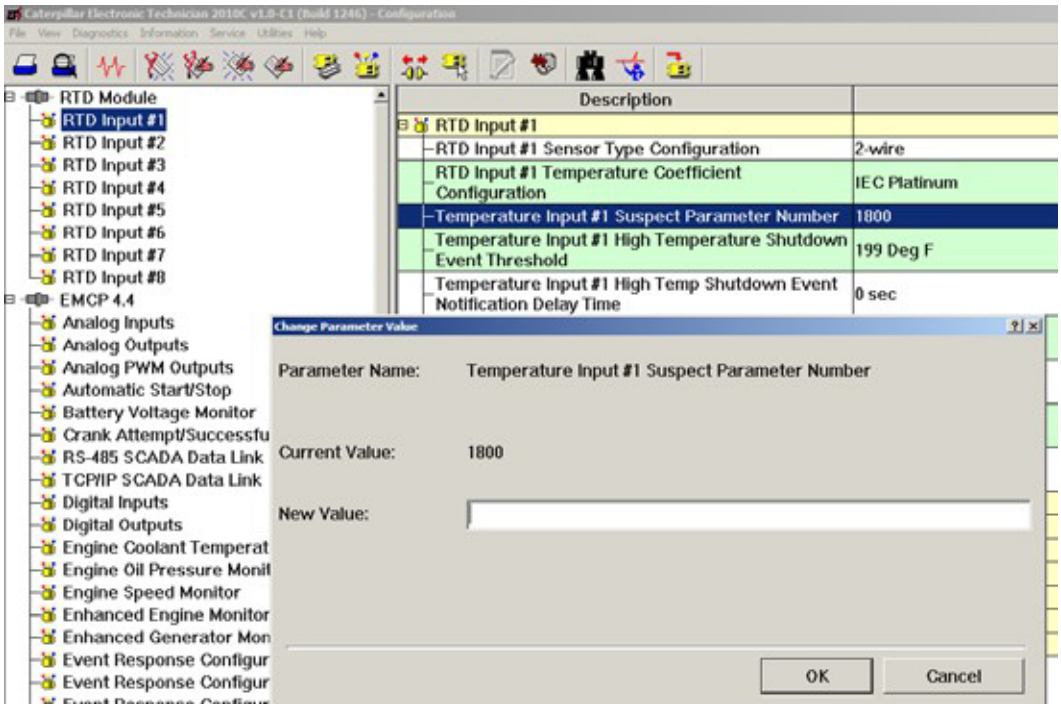


Figure 31.18 – Cat Service Tool RTD Module Suspect Parameter Number

31.5 Discrete I/O Module

The EMCP Discrete I/O (DIO) module is designed for mounting on generator sets or remotely, to provide auxiliary switch inputs or relay contact outputs. Up to 4 DIO modules can be used on the EMCP 4 Accessory CAN data link, given that they are programmed to unique ECU Instance numbers.

31.5.1 Discrete I/O Features

- Reads twelve (12) discrete inputs and sets eight (8) Form C Relay Outputs.
- Converts between physical I/O and CAN data link commands.
- System throughput: All channels are scanned in 100 ms.
- Low-Level input voltage range: 0 to 0.8V.
- High-Level input voltage range: 3.75 to 24V.
- Inputs have internal pull-up resistors.
- LED to indicate communication network status.
- Compact size (see mechanical drawing, Figure 31.19).



31.5.2 Discrete I/O Specifications

Electrical Specifications

- Accept 5-32VDC power (12 or 24VDC nominal)
- Over voltage capability is 32VDC for 1 hour @ 85°C
- Resistive Loads rated for 3A @ 30 VDC
- Normally Closed (NC) relay contacts rated for 2A @ 125 VAC/2A @ 30 VDC
- Normally Open (NO) relay contacts rated for 2A @1 25 VAC/2A @ 30 VDC
- Inductive Loads rated for 0 .5A @ 250 VAC cosφ=0 .4
- Maximum current draw of 400mA + 50mA per energized relay @ 12 VDC/24 VDC
- Power supply inputs are protected against transient surges and short circuits and are isolated from I/O

Environmental Specifications

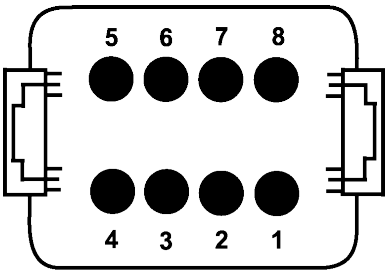
- Encapsulated in a rugged aluminum housing with watertight Deutsch connectors (IP65 rating)
- Operating temperature range -40°C to 85°C (-40°F to 185°F)
- The ambient storage temperature range is -50°C to +120°C .
- It is protected against 95% humidity non-condensing, 30°C to 60°C .
- Designed to meet relevant European standards for EMI/RFI/Immunity without the use of external filtering

Network Communications Interface

- Operates on the EMCP 4 .2 Accessory CAN data link
- Node address is auto configurable
- Optical isolation is provided for the CAN line
- Retains current date and time relative to synchronization every 24 hours (or upon boot up) with equipment system time via an explicit command from the EMCP 4 or Service Tool when the GSC is not available; synchronization time is accurate to within 1 sec
- Includes a watchdog timer to automatically reboot should the microprocessor lock
- Module operates normally with loss of communication link, retaining configured values and error codes in non-volatile memory
- Configuration and firmware updates are accomplished with the Cat Service Tool over the CAN network
- Monitored parameters and alarms are read-only over the network

31.5.3 Discrete I/O Wiring

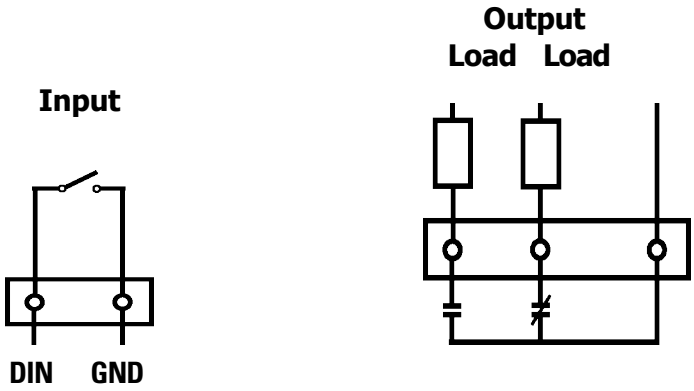
Power and Can Bus Wiring



FRONT VIEW
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DT13-08PA

1 = PWR+ 5 = SHIELD
2 = CAN-H 6,7,8 = NOT USED
3 = CAN-L
4 = PWR-

I/O Wiring Typical Connections



Inputs	Pin	Outputs	Pin	Outputs	Pin
DIN1	1	NC_1	5	C_6	19
DIN2	11	C_1	6	NO_6	20
DIN3	21	NO_1	7	NC_7	28
DIN4	31	NC_2	15	C_8	29
DIN5	2	C_2	16	NO_7	30
DIN6	12	NO_2	17	NC_8	38
DIN7	22	NC_3	25	C_8	39
DIN8	32	C_3	26	NO_8	40
DIN9	3	NO_3	27	NO = Normally Open NC = Normally Closed C = Common	
DIN10	13	NC_4	35		
DIN11	23	C_4	36		
DIN12	33	NO_4	37		
GND	4	NC_5	8		
GND	14	C_5	9		
GND	24	NO_5	10		
GND	34	NC_6	18		

Note: The GND pin is not the package ground, but the Isolated Reference for the module.

31.5.4 Discrete I/O Physical Layout

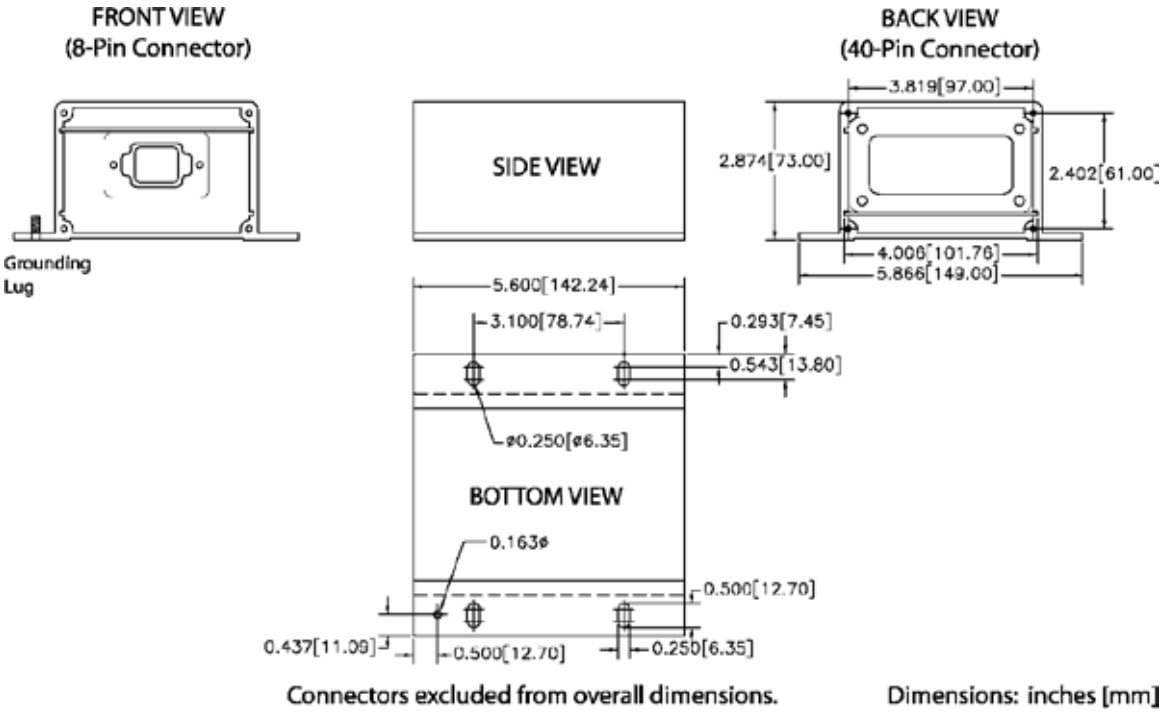


Figure 31.19 – Thermocouple, RTD, and Discrete I/O Module Physical Layout

31.5.5 Discrete I/O – Configuration

The DIO module is field-programmable using the Cat Service Tool. It is also flash programmable to update software using the Cat Service Tool.

The service tool software must be installed on a Windows PC. The Cat communication adapter must be connected between the PC and the CAN data link on which the target DIO module is connected. (The service tool may be connected to the EMCP 4 Accessory Data Link service connector).

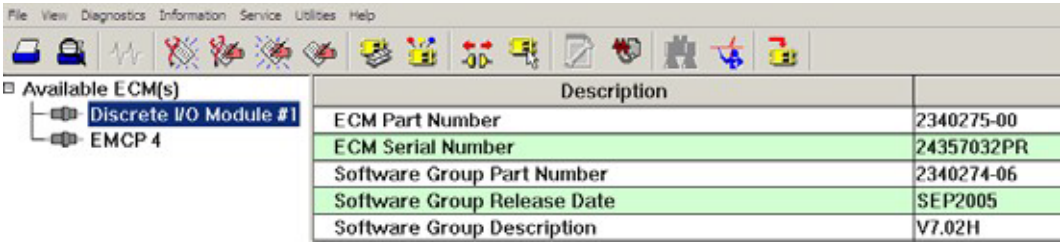


Figure 31.20 – Cat Service Tool DIO Summary Screen

When connecting to the DIO, the user will first see the Module Summary screen shown in Figure 31.20. The service tool configuration tool, accessed by pressing F5 or clicking the configuration tool icon on the toolbar, contains setpoints for configuring the DIO identification, as well as the inputs and outputs.

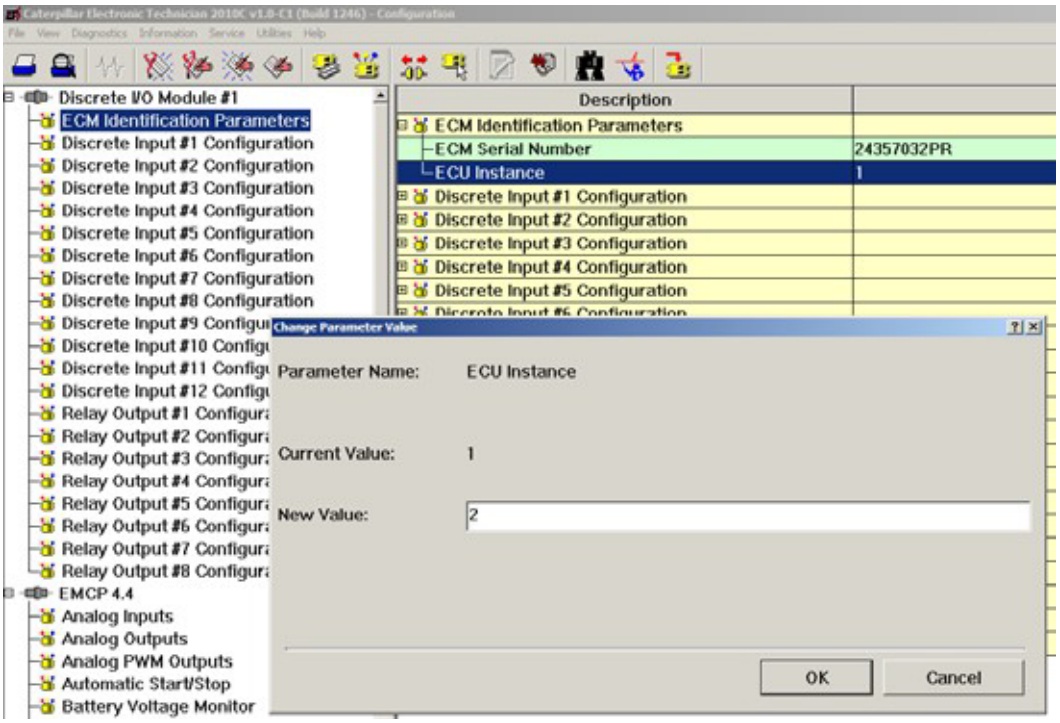


Figure 31.21 – Cat Service Tool DIO Identification Parameters

Figure 31.21 shows the ECM Identification Parameters list. This list shows the ECM serial number (read-only) of the module that is connected, and allows for configuration of the ECU instance.

Note: It is important to match a specific module to a certain ECU instance. The system will not function properly if ECU instances are duplicated.

Upon changing the ECU instance, the Cat Service Tool will automatically disconnect and reconnect to the data link, and the DIO module name should reflect the new ECU instance.

In the example shown in Figure 31.22, the module was previously named Discrete I/O Module #1, and after the ECU instance is changed to 2 and the service tool reconnects, the name reads Discrete I/O Module #2.

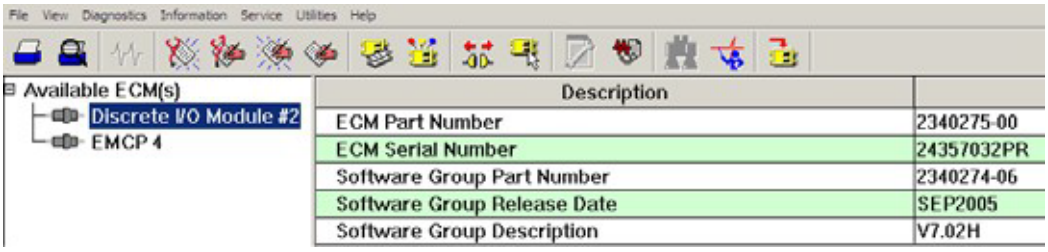


Figure 31.22 – Cat Service Tool DIO After ECU Instance Change

31.5.6 Configuring Digital Inputs

Figure 31.23 shows the Discrete Input #1 Configuration list using the service tool configuration tool. All twelve discrete inputs have identical parameters and options.

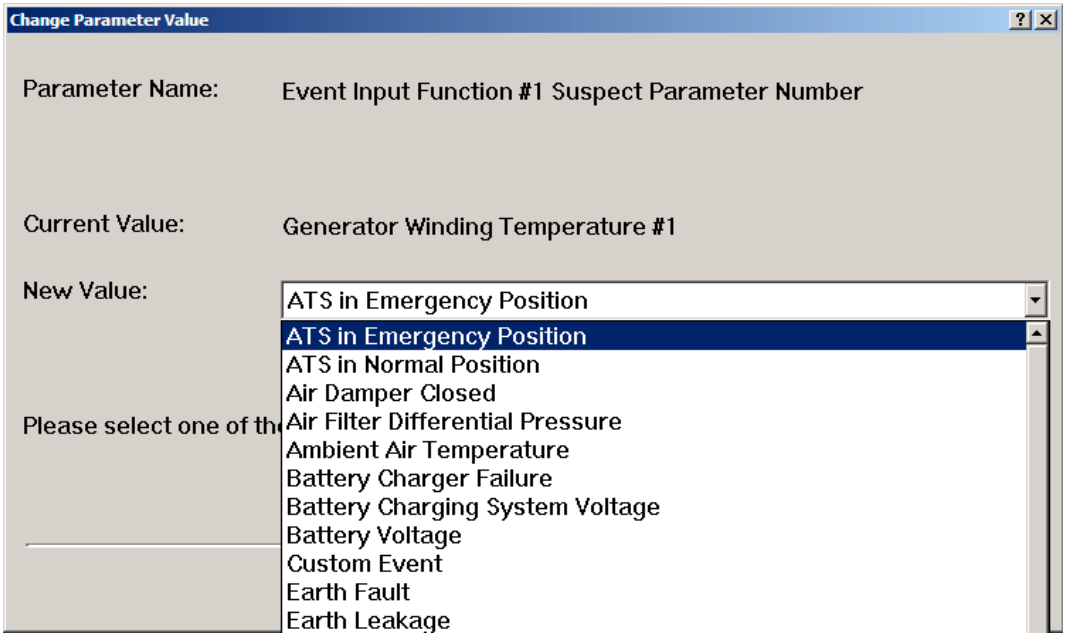


Figure 31.23 – Cat Service Tool DIO Digital Input Configuration

The active state configuration determines which state (high or low) triggers the event, and depends on the sensor/switch wiring configuration.

The event notification delay time sets the amount of time the input must remain active until the DIO module triggers an event on the data link.

Suspect Parameter Number (SPN)

The suspect parameter number (SPN) is a choice from a predetermined list of SPNs that are supported by the DIO module. All of the discrete inputs support the same list of SPNs, except Custom Event.

Discrete Input #1, when set to Custom Event, will trigger an event for Custom Event #1. Discrete Input #2, when set to Custom Event, will trigger an event for Custom Event #2; likewise for all twelve discrete inputs.

Note: Discrete Inputs configured for Custom Event SPNs (701-718) are shared between the EMCP and DIO Modules. Therefore ONLY one Custom Event SPN-FMI can be used between the two modules for each Input #.

Failure Mode Identifier (FMI)

The FAILURE MODE IDENTIFIER (FMI) configures what type of failure this event will represent. The technician is free to configure any FMI for any SPN, but discretion must be used. Certain combinations may not be meaningful (i.e. the EMCP 4 may not be configurable to display or trigger a response for certain combinations of SPN and FMI).

For example, a Fuel Level SPN with a Condition Exists FMI is not meaningful; the EMCP 4 can be configured to display or react to only fuel level low or high warnings or shutdowns.

31.5.7 Configuring Relay Outputs

The Relay Output #1 Configuration list of the service tool configuration tool is shown in Figure 31.24. All eight Relay Outputs have identical parameters and options.

The suspect parameter number (SPN) is a choice from a predetermined list of SPNs that are supported by the DIO module. If you wish to configure the DIO to trigger an output based on an event on the data link related to a specific SPN, the SPN must be selected here.



Figure 31.24 – Cat Service Tool DIO Relay Output Configuration

The trigger condition is a list of conditions that will trigger this output. For the conditions labeled specific event, the relay will be activated upon receiving a category of events (either a single FMI or a set of FMIs) for the SPN selected in the suspect parameter number parameter. For the conditions labeled general event, the relay will be activated upon receiving a category of events (either a single FMI or a set of FMIs) for any SPN. In this case, the DIO module will ignore the entry in the suspect parameter number parameter. If the disabled condition is chosen, the Relay Output will not activate on any condition.

32.0 SCADA (Modbus) RS-485 Data Link

The SCADA DATA LINK or MODBUS is supported on the EMCP 4.3 and 4.4.

The EMCP 4.3 and 4.4 have a SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) communications link between the controller and a host device using the MODBUS protocol. The host device is able to remotely monitor or control the generator set package equipped with the EMCP 4 in much the same way an operator does from the panel.

- The host device connects to the EMCP GSC through an RS-485 SCADA Data Link (Modbus RTU, Half Duplex).
- The data is transmitted in a binary format over the serial connection.
- The host device acts as Modbus Master, and the EMCP 4 acts as the Modbus Slave, also called a REMOTE TRANSMITTER UNIT (RTU).
- The host device initiates all communication, sending commands or requests for information to the EMCP 4.
- The EMCP 4 then takes action based on the query and/or sends a response to the query over Modbus.
- In order to enable the Control functionality, SCADA Remote Control must be enabled via the display under MAIN MENU/CONFIGURE/ALL SETPOINTS/AUTO START/STOP.

Baud rates can be configured on the EMCP 4. Various data rates between 9600 bits/second (baud) and 57,600 bits/second are available. See Section 23.2 for instructions.

Note: This port may be required to be used to communicate to switchgear or other monitoring device. Only a single device can be used with this port.

32.1 Wiring

SCADA COMMUNICATION wires are brought out of the EMCP 4 as part of the 120-pin connector. The pins, as designated on the EMCP connector, are shown in Table 32.1.

SCADA Pins on EMCP 120-pin Connector		
Pin #	**Name**	**Description**
90	MODBUS –	Optically isolated half-duplex differential (-) for Modbus
101	MODBUS Reference	Half-duplex RS-485 Reference for Modbus
100	MODBUS +	Optically isolated half-duplex differential (+) for Modbus

Table 32.1 – SCADA Pins on EMCP 120-pin Connector

MODBUS DATA TRANSMISSION over RS-485 is accomplished over a single shielded twisted pair for differential signaling with transmit and receive alternating over the same wire pair (MODBUS+ and MODBUS-). The Reference (MODBUS REF) should be connected to the shield, to prevent ground loop currents.

- Figure 32.1 shows a possible wiring configuration to a RS-485 device.
- Figure 32.2 shows a possible wiring configuration to a RS-485 to RS-232 converter.

Note: See documentation of connected device to verify wiring configuration.

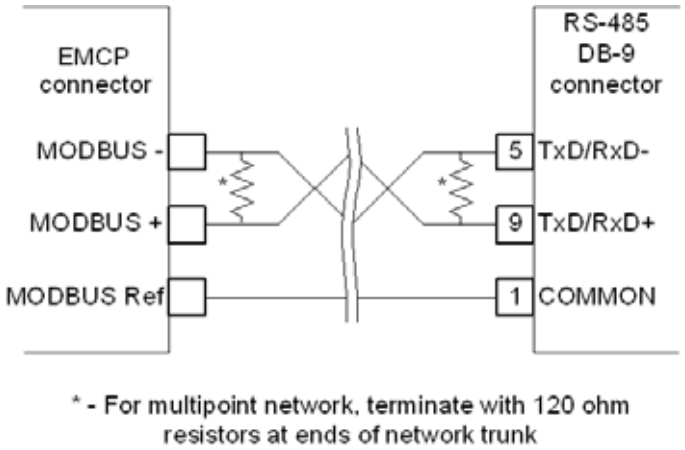


Figure 32.1 – Possible Wiring Configuration to an RS-485 Device

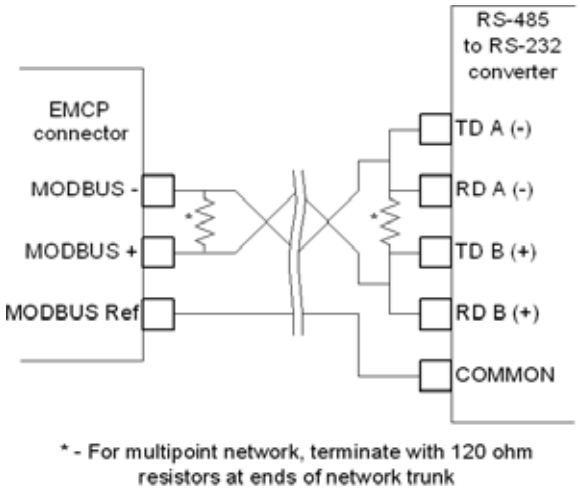


Figure 32.2 – Possible Wiring Configuration to an RS-485 to RS-232 Converter

32.2 Line Termination

Both ends of the Modbus lines (or the extreme ends of the trunk, for a multipoint network) should have termination between MODBUS+ (B) and MODBUS- (A).

A 0.5W 150Ω resistor may be adequate.

If line polarization is implemented (see Software Configuration section), a better choice is a 10 µF capacitor (10V minimum) in series with a 0.25W 120Ω resistor.

A bias resistor may be used for Line Polarization. Line Polarization is used to keep the network voltages at well-defined levels during silent times to prevent potential false diagnostics and communication failures. This bias resistor is different than a termination resistor. There should only be one device on the network with bias resistors enabled to polarize the network.

Note: For more details on setting up a Modbus network over a serial line, please refer to RS-485 specifications or Modbus specifications. See the Software Configuration section for instructions on enabling line polarization.

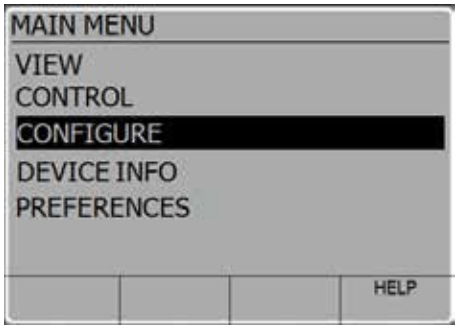
32.3 Software Configuration

32.3.1 Configuring the SCADA Data Link Using the Display

The SCADA DATA LINK may require software configuration. The configuration parameters are accessible on the EMCP 4 via the following menu options:

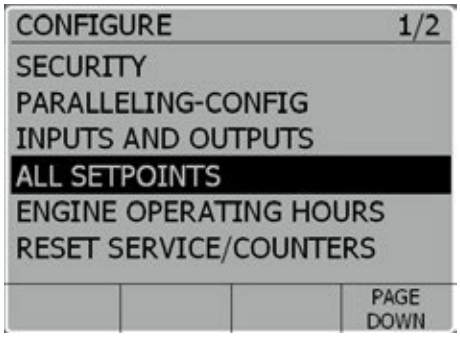
1. At MAIN MENU, scroll DOWN to CONFIGURE.

2. Press the OK KEY.



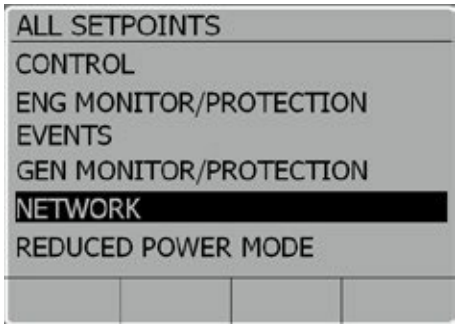
3. Scroll DOWN to ALL SETPOINTS.

4. Press the OK KEY.



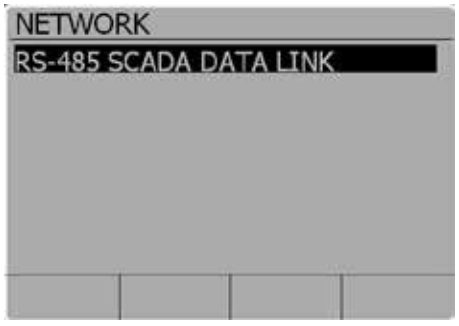
5. Scroll DOWN to NETWORK.

6. Press the OK KEY.

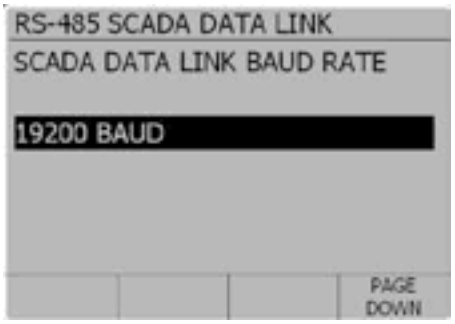


7. Scroll DOWN to RS-485 SCADA DATA LINK.

8. Press the OK KEY.

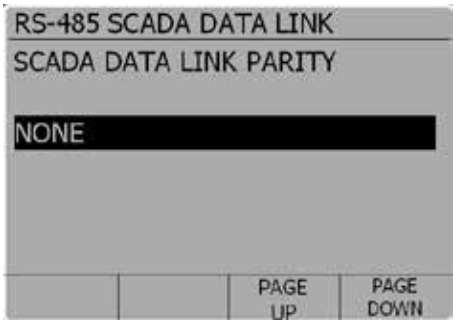


9. Press the OK KEY to edit the current SCADA DATA LINK BAUD RATE.

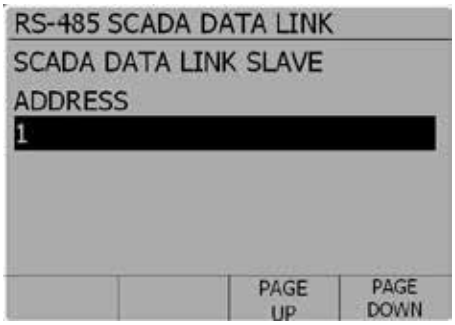


Select the SCADA DATA LINK BAUD RATE that you want to program.

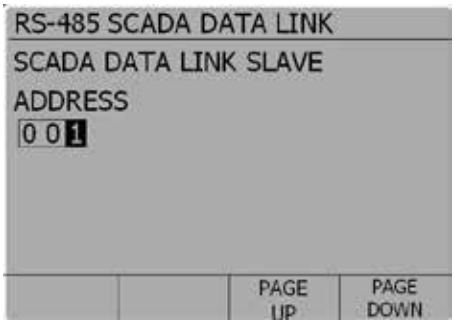
1. Press the OK KEY.
2. Scroll DOWN to SCADA DATA LINK PARITY.
3. Press the OK KEY to edit the current SCADA DATA LINK PARITY.
4. Select the SCADA DATA LINK PARITY that you want to program.
5. Press the OK KEY.



6. Scroll DOWN to SCADA DATA LINK SLAVE ADDRESS.
7. Press the OK KEY to highlight the current SCADA DATA LINK SLAVE ADDRESS.



8. Select the SCADA DATA LINK SLAVE ADDRESS that you want.
9. Press the OK KEY.

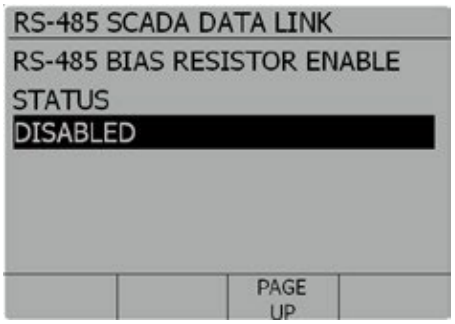


10. Scroll DOWN to RS-485 BIAS RESISTOR ENABLE STATUS.

11. Press the OK KEY to edit the current RS-485 BIAS RESISTOR ENABLE STATUS.

12. Select the RS-485 BIAS RESISTOR ENABLE STATUS that you want to program.

13. Press the OK KEY.

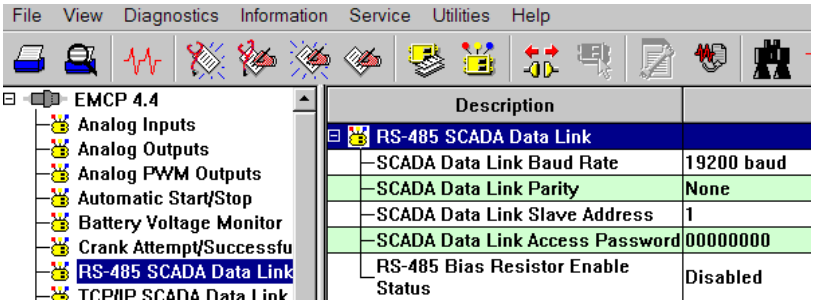


32.3.2 Configuring the SCADA Data Link Using the Cat Service Tool

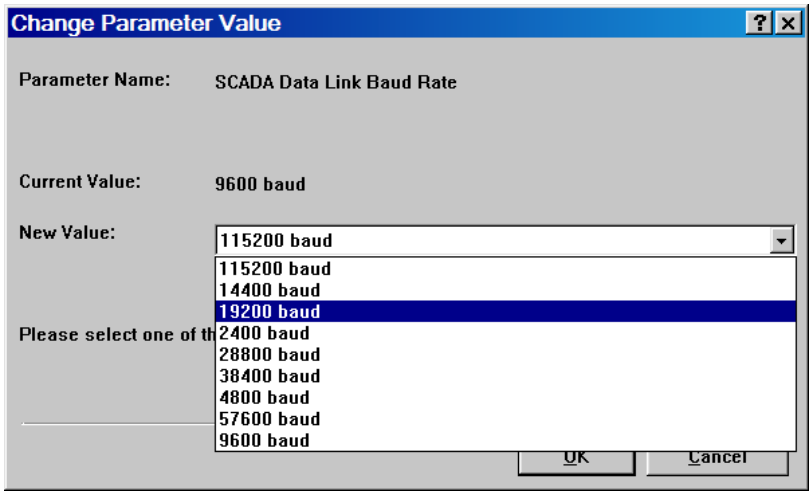
The EMCP 4 SCADA Data Link can be configured using the Cat Service Tool. To program this Data Link, do the following steps:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

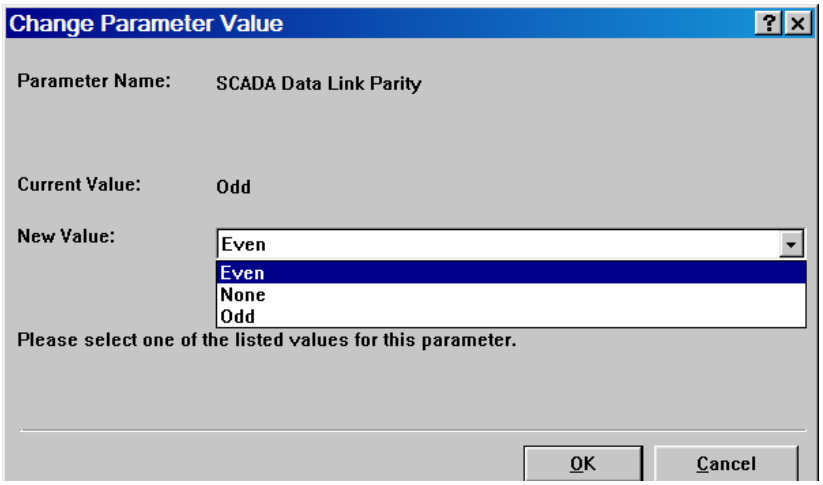
2. Select RS-485 SCADA Data Link on the left.



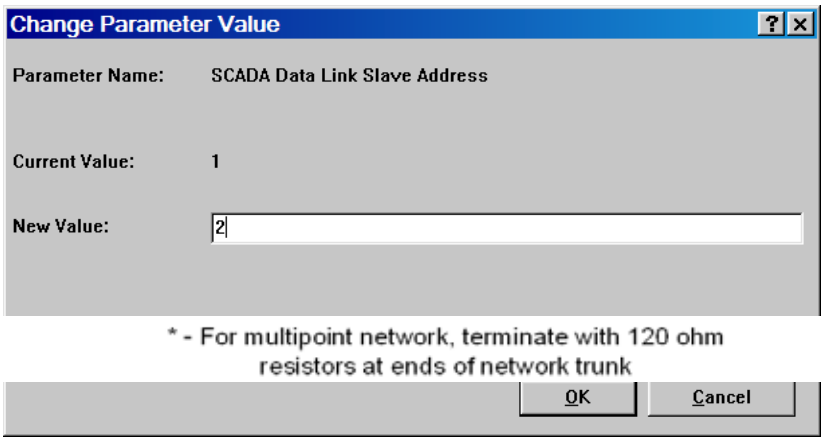
3. Double click SCADA Data Link Baud Rate to change this to the desired value from the drop down menu. Click the OK button to program.



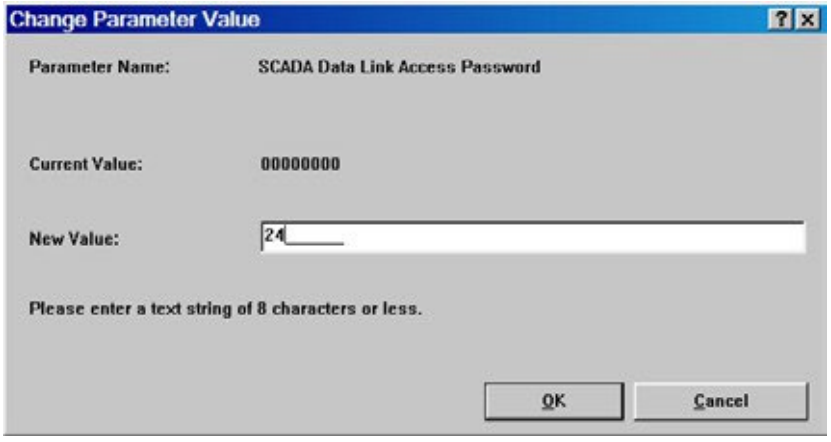
4. Double click SCADA Data Link Parity to change this value from the drop down menu. Click the OK button to program.



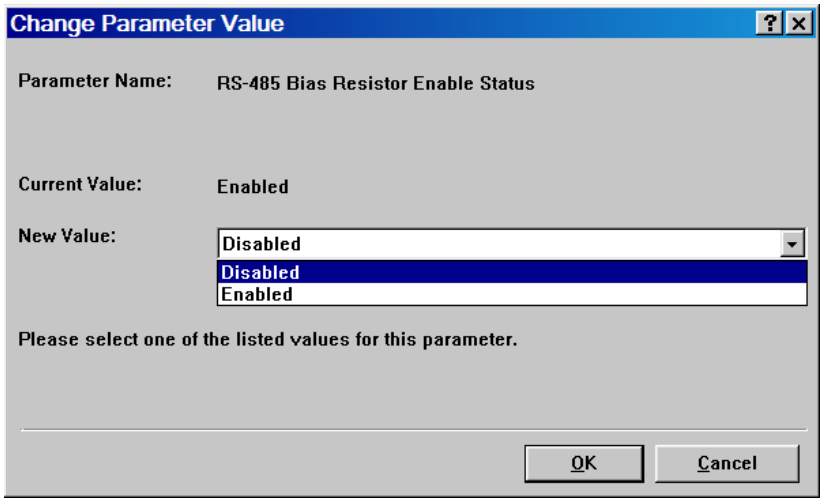
5. Double click SCADA Data Link Slave Address. Change this value by typing a new value. Click the OK button to program.



6. Double click SCADA Data Link Access Password. Change this value by typing a new value. Click the OK button to program.



7. Double click RS-485 Bias Resistor Enable Status to change this value from the drop down menu. Click the OK button to program.



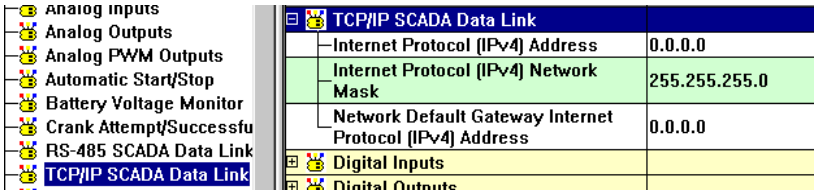
33.0 SCADA (Modbus) TCP/IP Data Link

The EMCP 4 .3 and 4 .4 have a Modbus TCP/IP data link for customer monitoring and control . This data link allows for remote monitoring of all parameter data visible on the display and the service tool . It also allows for data link based control of outputs . The Modbus TCP/IP functionality is similar to the Modbus RTU data link, but with much higher speed capability . All Ethernet UDP messages used for the Multiple Genset Data Link are automatically filtered out . In order to Enable the Control functionality, SCADA Remote Control must be enabled via the display under MAIN MENU/CONFIGURE/ALL SETPOINTS/AUTO START/STOP .

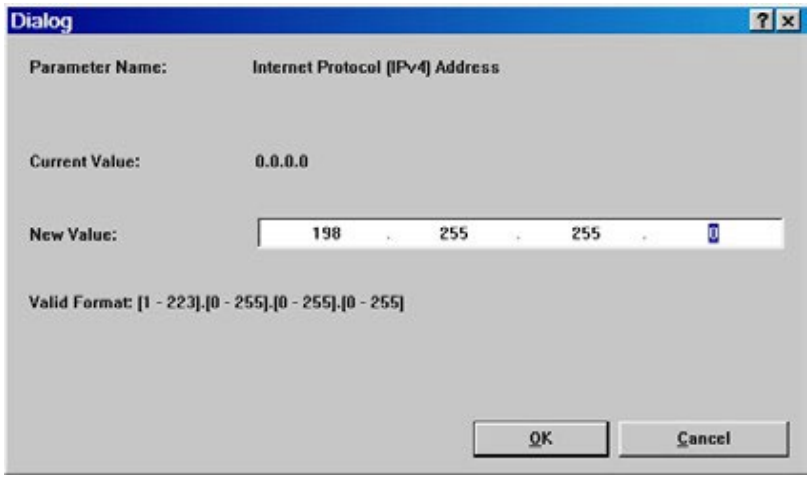
In addition, this data link can be used for interfacing with Cat Switchgear . The Modbus TCP/IP data link can be configured with the service tool or from the EMCP 4 GSC . To program this data link with the service tool, do the following steps:

1 . Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4 .2 .

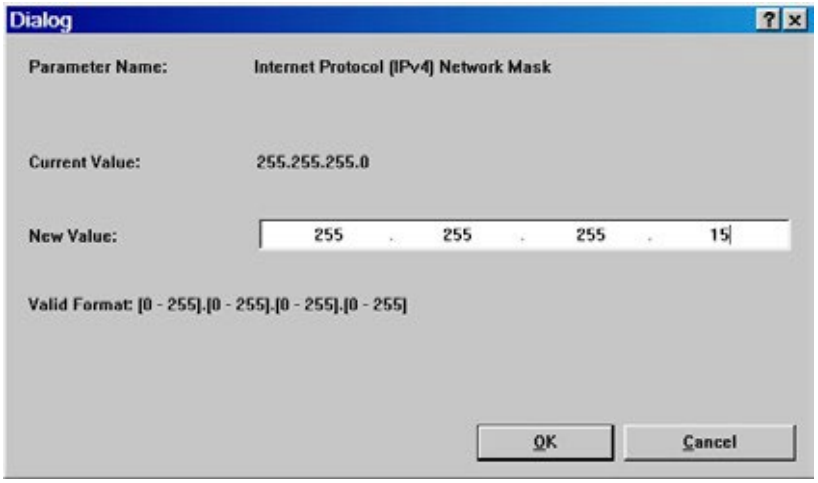
2 . Select TCP/IP Data Link on the left .



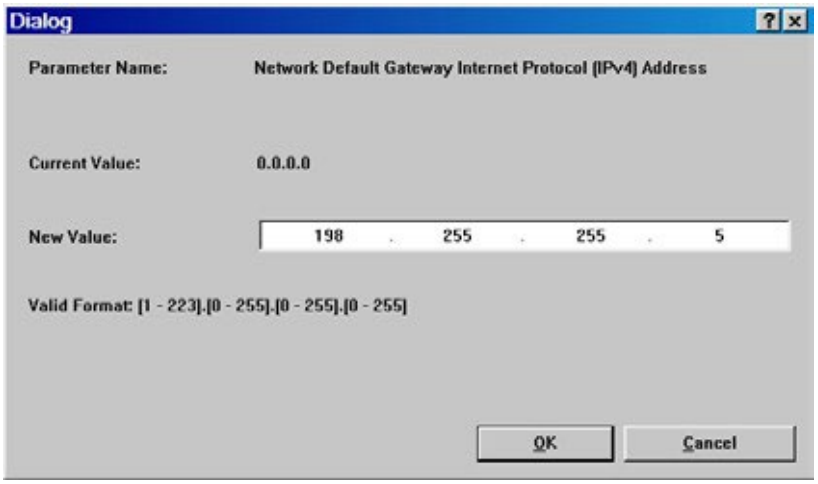
3 . Double click Internet Protocol Address to change this to the desired value . Click the OK button to program .



4. Double click Internet Protocol Network Mask to change this to the desired value. Click the OK button to program.



5. Double click Network Default Gateway Internet Protocol Address to change this to the desired value. Click the OK button to program.



These setpoints will need to be changed from 255.255.255.255 prior to first use.

34.0 Cat Data Link (CDL)

The Cat Data Link or CDL is supported on the EMCP 4.3 and EMCP 4.4 controllers with FPGA firmware version 4.1 and above. The FPGA firmware version installed on the EMCP 4 is listed in the Device Info screen (see Figure 34.1). This data link allows for the monitoring of engine data and events/diagnostics on engine ECMs that support Cat Data Link. EMCP 4 does not support engine control or ET configuration over the Cat Data Link connection.

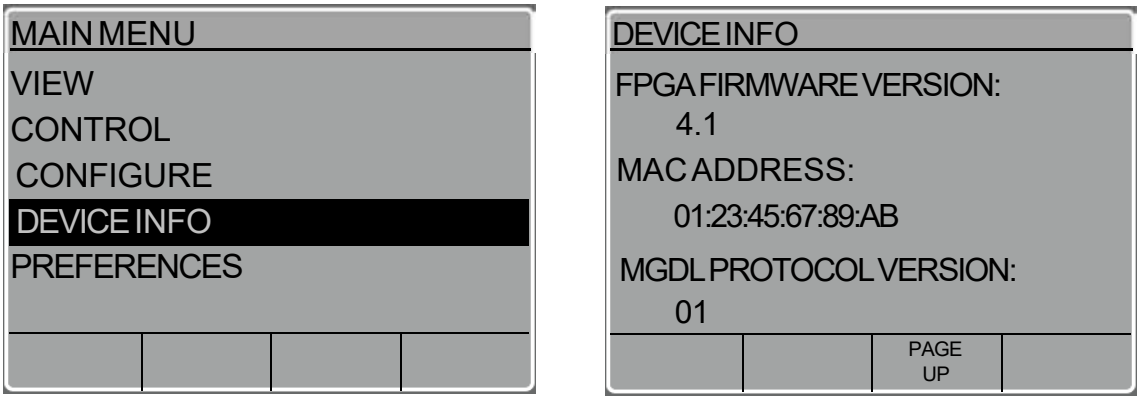


Figure 34.1 – EMCP 4 Device Info Screen

Note: In order to use Cat Data Link on the EMCP 4.3 or EMCP 4.4, the RS-485 SCADA port is repurposed for CDL use. Therefore, when Cat Data Link is enabled, the RS-485 SCADA (Modbus) data link functionality is lost and all RS-485 SCADA setpoints are hidden. The Modbus TCP/IP port is still available for SCADA monitoring.

34.1 Cat Data Link Wiring

The Cat Data Link communication wires are brought out of the EMCP 4 as part of the 120-pin connector. As noted previously, because the RS-485 port is repurposed for CDL, the CDL pins are the same pins used for an RS-485 SCADA (Modbus) connection. The pins, as designated on the EMCP 4 connector, are shown in Table 34.1.

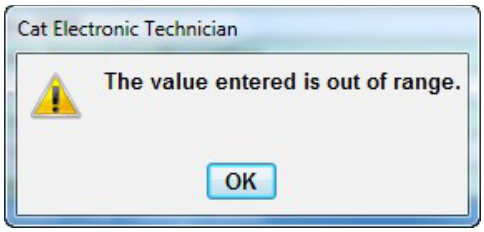
Cat Data Link Communication Wires		
Pin #	**Name**	**Description**
90	CDL -	Differential (-) for CDL
100	CDL +	Differential (+) for CDL

Table 34.1 – Cat Data Link Pins on the 120-Pin EMCP 4 Connector

34.2 Cat Data Link Configuration

In order to enable receiving engine data over CDL, the EMCP 4 Engine Control Data Link setpoint, found under the Automatic Start/Stop menu in ET, must be configured to “Cat Data Link.” After applying this configuration, a power cycle of the EMCP 4 is REQUIRED.

If Cat ET returns a “The value entered is out of range.” error when trying to configure the Engine Control Data Link setpoint to “Cat Data Link,” the EMCP 4 controller FPGA firmware may need to be updated in order to support Cat Data Link. Contact your local DSN to make such a request.



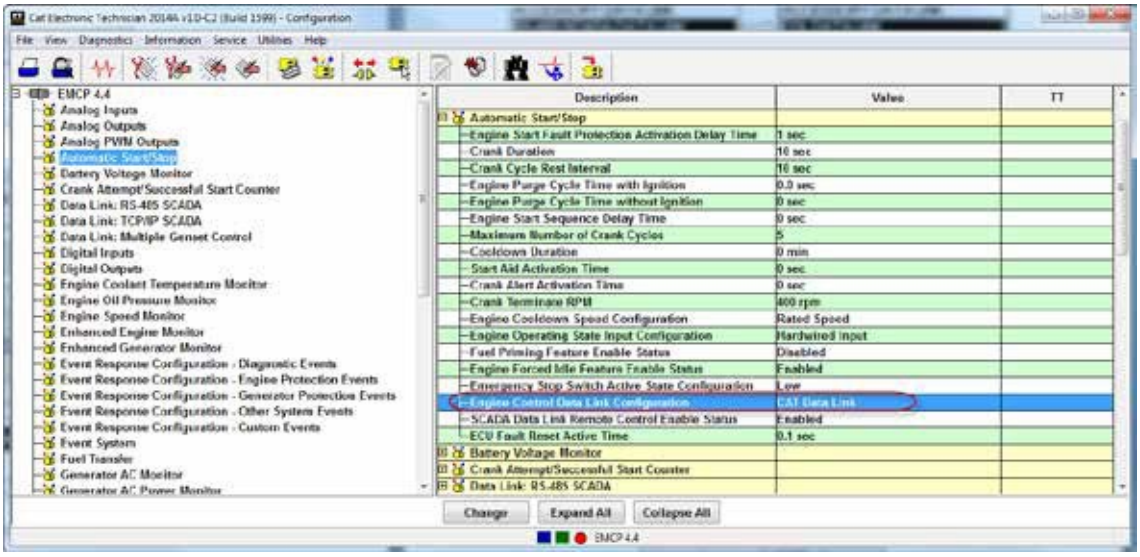


Figure 34.2 – Engine Control Data Link Configuration Setpoint in ET

On the EMCP 4 display, when CDL is enabled the RS-485 SCADA Data Link network status is replaced by the Cat Data Link network status under the network status screen.

MAIN MENU → VIEW → NETWORK STATUS

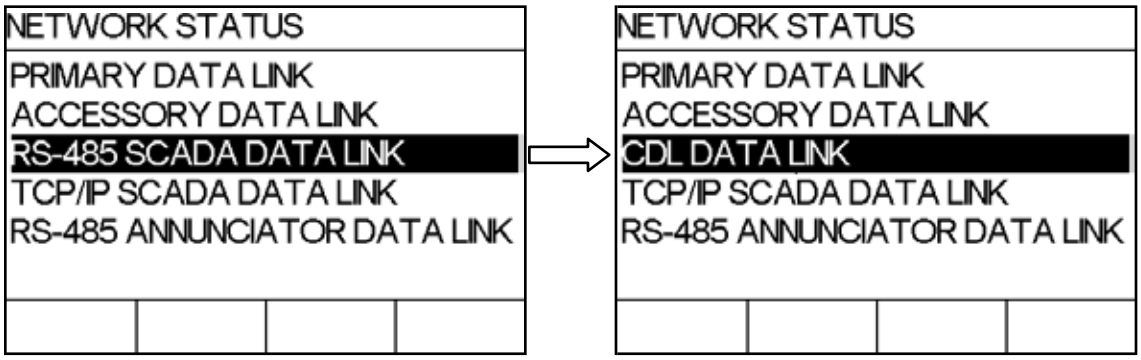


Figure 34.3 – RS-485 Network Status Changes to CDL Network Status

When CDL is enabled, the supported CDL engine events (EID) and diagnostics codes (CID) are displayed under the existing EMCP 4 engine event log as shown in Figures 34.4 and 34.5:

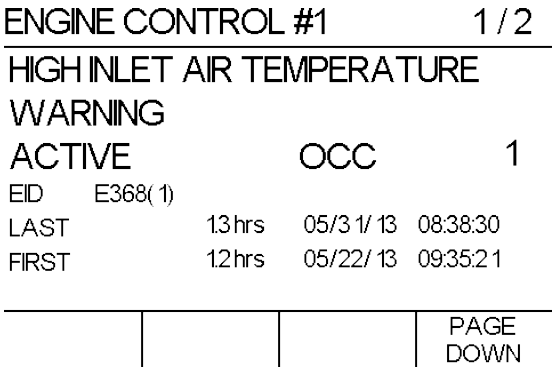


Figure 34.4 – CDL Event Code Event Log Entry

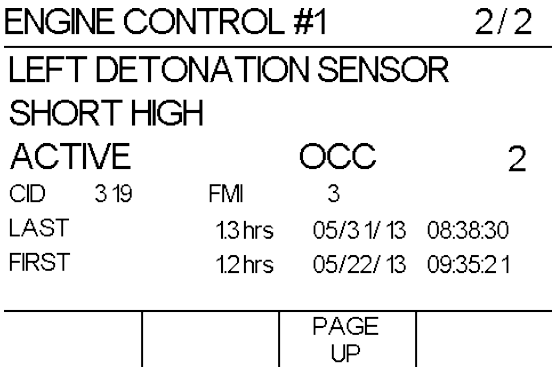


Figure 34.5 – CDL Diagnostic Code Event Log Entry

Only a limited number of EID-CID codes are supported with text. Other EID-CID codes will only display the EID-CID code.

35.0 Integrated Voltage Regulator (IVR)

The EMCP Integrated Voltage Regulator (IVR) feature is a substitute for a traditional voltage regulator topology consisting of a dedicated controller (CDVR, VR6…etc.) for regulating voltage. The EMCP 4 internal controller regulates generator output voltage by sending a command to the Excitation Module (EM10/EM15) that controls generator excitation and therefore generator output voltage.

This feature is available with existing EMCP 4.3 and EMCP 4.4 hardware controllers with software version 4.2 PROD and newer.

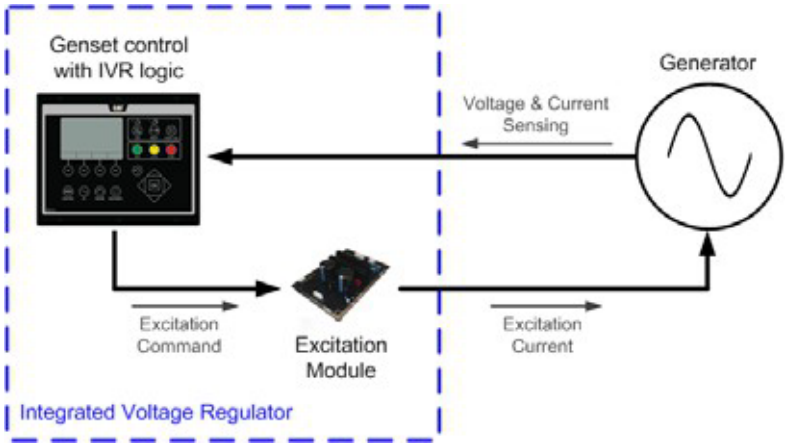


Figure 35.1 – EMCP IVR System

35.1 IVR Features

When used with an Excitation Module the EMCP 4.3 and EMCP 4.4 controllers with IVR logic provide:

- Automatic Voltage Regulation (AVR)
- Programmable stability settings
- Soft start control with an adjustable time setting in AVR control mode
- Dual Slope, Configurable Under Frequency (Volts/Hz) regulation
- Three-phase or single-phase generator voltage (RMS) sensing/regulation in AVR mode
- Setpoint configuration adjustment from the EMCP display or Cat ET Service Tool
- Voltage Output Adjustment via Display, Analog Input, Digital Input, or SCADA (Modbus)
- IVR Operating Status and Voltage Bias Overview screens to provide an enhanced level of user interface
- IVR event monitoring
- Power Factor Regulation (PF)
- Reactive Droop compensation
- Line drop compensation

35.2 IVR Hardware Installation

35.2.1 EMCP IVR Connections

To regulate the generator terminal voltage the EMCP communicates the desired excitation command to the Excitation Module via a PWM signal. It is recommended that twisted pair shielded cable is used for this communication link. Table 35.1 details the connections to be made between the EMCP and Excitation Module.

EMCP 4.3, EMCP 4.4 – 120-Pin Connector		Excitation Module – 3-Pin Connector	
PWM Output #2 Positive	28	CS+	P3-2
PWM Output #2 Negative	8	CS-	P3-3
PWM Output #2 Shield	19	Shield	P3-1

Table 35.1 – EMCP 4.3 and EMCP 4.4 Connections to Excitation Module

35.2.2 IVR Excitation Module

The Integrated Voltage Regulator consists of an EMCP 4 interfacing with an Excitation Module. There is a range of Excitation Modules available to cover the full range of Cat generator sets.



Figure 35.2 – EM10 Excitation Module and EM15 Excitation Module

Table 35.2 provides information on the technical specification of the EM10 and EM15 modules. Selection of the appropriate module should be determined by the nominal and maximum generator excitation current at full load (standby, 0.8PF), and the maximum AC voltage input.

Details on nominal field current are available in TMI (Technical Marketing Information) or from the generator datasheet. Care must be taken on Self-Excited (shunt) generators to understand how the connections are being made from the winding to the excitation module in order to understand the maximum AC voltage input. It is recommended that an intermediate, half-phase to Neutral connection is used for Self-Excited generators.

	EM10	EM15
Cat Part Number	**398-7247**	**398-7248**
Compatible Generator Excitation Types	Permanent Magnet (PM) Self-Excitation (SE) Internal Excitation (AREP)	
Nominal Field Current Output	6 Amps	7 Amps
Maximum (forcing) Field Current Output	10 Amps	15 Amps
Maximum AC Voltage Input	180 Vrms	240 Vrms
Exciter Field Resistance (recommended)	6 to 16 ohms	

Table 35.2 – EM10 and EM15 Technical Specifications

35.2.3 IVR Excitation Module Physical Layout

It is recommended that the Excitation Module should be mounted within the generator set control panel or the generator terminal box in landscape orientation in order to achieve optimum cooling from the module heat sink. The module should be fixed in place using 4 M6 x 30 mm mounting bolts. The torque applied to the mounting bolts should be 5 N•m ± 1 N•m. It is recommended that an M6 washer (external diameter 12 mm) is used with the mounting bolts to protect the module. A dimensioned diagram of the EM10 module is presented in Figure 35.3.

Note: The same dimensions also apply for the EM15 module.

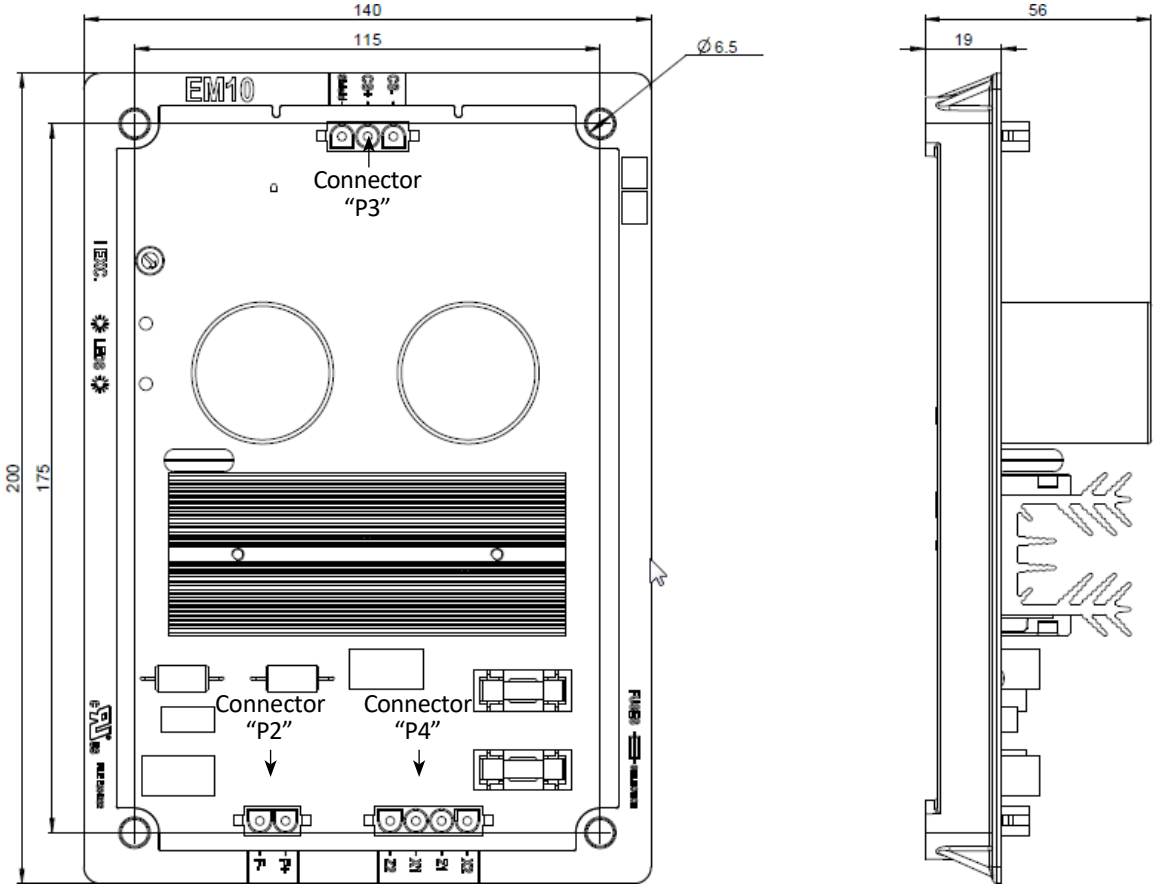


Figure 35.3 – EM10 Excitation Module Dimensions (in millimeters)

35.2.4 IVR Excitation Module Connections

The EM10 and EM15 Excitation Modules have three multiple-pin, Mate-n-Lok plug type connectors. These connectors are labeled “P2,” “P3,” and “P4” as shown in Figure 35.3. Table 35.3 describes the signal and function of each connector pin.

Terminal	Label	Signal/Function
P2-1	F+	Exciter Field Positive
P2-2	F-	Exciter Field Negative
P3-1	Shield	Excitation Command Control Signal Shield
P3-2	CS+	Excitation Command Control Signal Positive
P3-3	CS-	Excitation Command Control Signal Negative
P4-1	X2	Excitation Power Supply Input X2
P4-2	Z1	Excitation Power Supply Input Z1
P4-3	X1	Excitation Power Supply Input X1
P4-4	Z2	Excitation Power Supply Input Z2

Table 35.3 – Excitation Module Connector Pins

Note: Connections X2 and Z1 are internally linked within the Excitation Module, providing a point of common connection for the auxiliary windings where an AREP/IE excitation supply is available. Alternatively, connections X2 and Z1 may be linked external to the Excitation Module, and only three connections made to the device (X1, X2 and Z2). Fully detailed Excitation Module connection diagrams for self-excitation (shunt), auxiliary windings (AREP/IE) and permanent magnet (PM) are provided in Appendix C.

35.2.5 IVR Excitation Module Over-excitation Protection

The Excitation Module has a built-in over-excitation protection strategy that is designed to protect the generator from thermal damage. The protection strategy employed is illustrated in Figure 35.4.

Under normal conditions the excitation current will remain well below the upper limit and the GREEN LED on the Excitation Module will be lit continuously while power is being received on the power supply input.

In the event of a fault condition, for example during a short-circuit on the generator terminals, the excitation current will increase rapidly, known as ‘field forcing.’ The Excitation Module will limit the forcing current to the defined upper limit for a fixed period of 10 seconds.

When the Excitation Module is actively limiting the field current a RED LED will flash indicating a fault condition. After the fixed delay time has expired, the Excitation Module will ‘limit’ the excitation current to a safer level that is 10% of the upper limit.

When the Excitation Module has shut down the excitation current, the RED LED is lit continuously and the GREEN LED is not lit. The RED LED will be lit only while voltage is being supplied to the Excitation Module. In order to reset the excitation current limiting the excitation current, the power supply must be removed from the Excitation Module by shutting down the generator set.

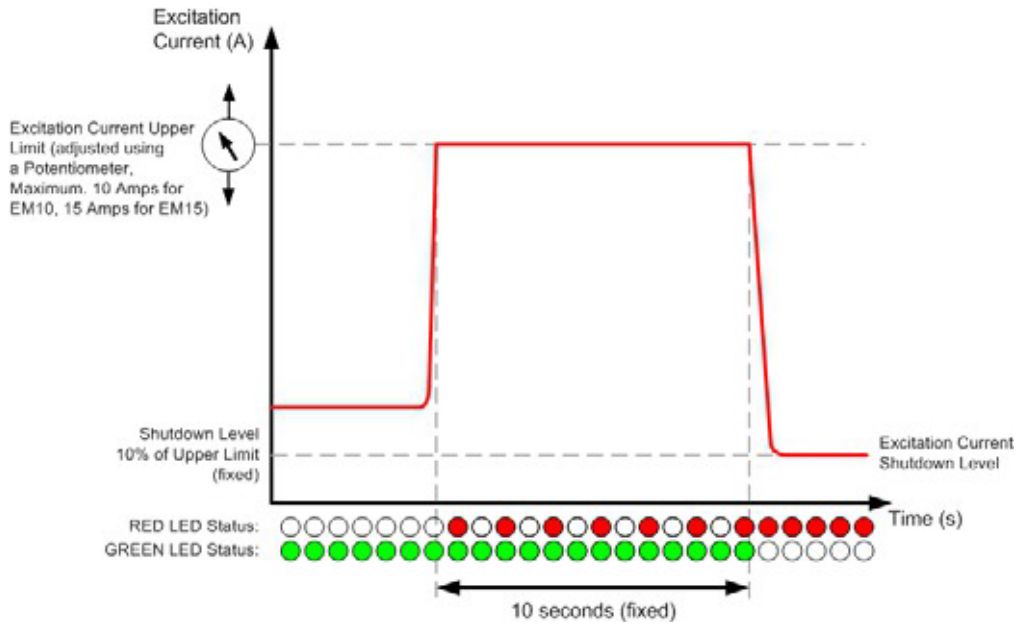
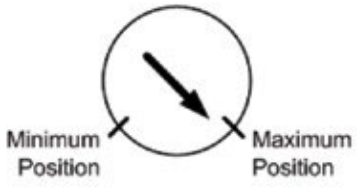


Figure 35.4 – Excitation Module Over-Excitation Protection Strategy

The Excitation Limit Potentiometer on the Excitation Module has 270 degrees of rotation and is used to configure the Excitation Current Upper Limit as shown in Figure 35.5. Keep in mind that this must be set for maximum forcing current, and not nominal excitation current.



	EM10	EM15
Minimum Position	4 Amps	6 Amps
Maximum Position	10 Amps	15 Amps

Figure 35.5 – Maximum and Minimum Limits of Excitation Current Limit Potentiometer

35.2.6 IVR Excitation Module Fusing

The EM10 has internal fusing, therefore it is not necessary to fit external fuses on the excitation power supply inputs.

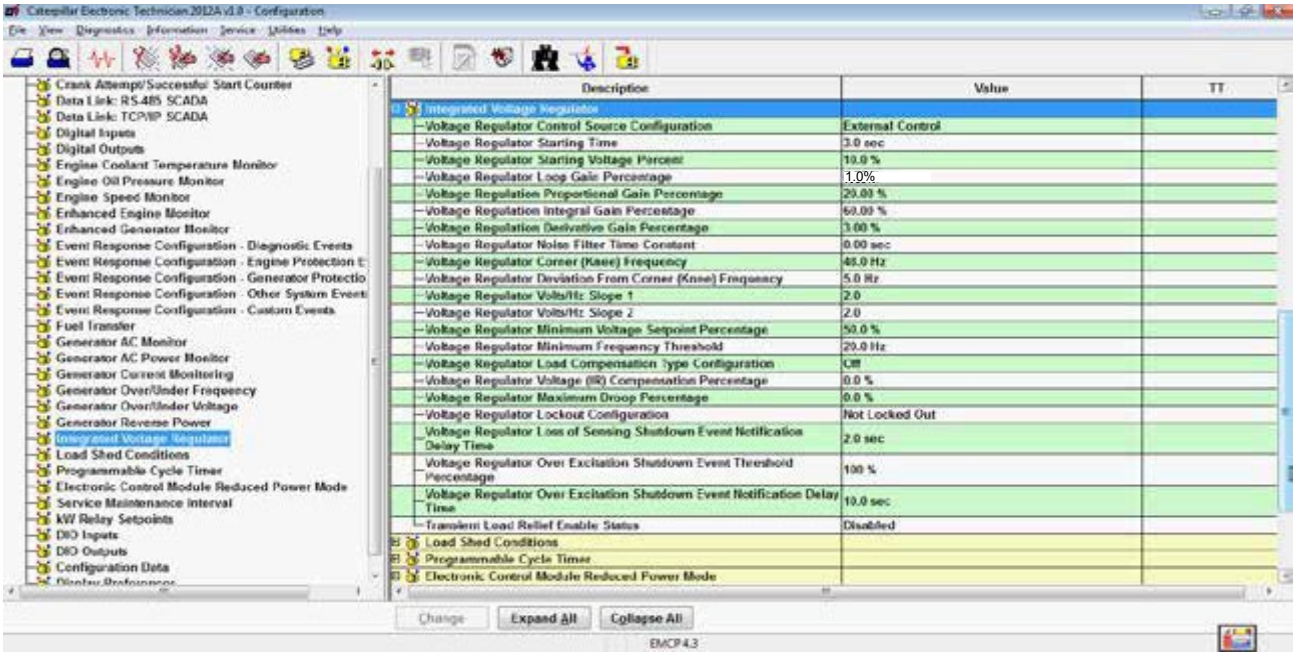
The EM15 requires external fusing to be fitted on inputs X1 and Z2. The recommended fuse for UL listed generator sets is a Bussman KTK-10 (Cat part number 6V7802). For non-UL listed generator sets an alternative fuse of Bussman AGC-10RX (Cat part number 3K8782) may also be used.

Connection diagrams showing the location of external fusing on the EM15 are provided in Appendix C.

35.3 IVR Software Configuration

The Integrated Voltage Regulator parameters can be accessed using either the Cat ET Service Tool, or directly through the EMCP display. Some setpoints are locked at ET only or at Security Level 3 and cannot be changed from the EMCP display or will require a level 3 password. Please note that ET Service Tool version 2012C or later is recommended for accessing and adjusting IVR parameters.

To access the Integrated Voltage Regulator setpoints using the ET Service Tool, connect to the EMCP Generator Set Control and click on the 'Configuration Tool' button  (alternatively press F5) to enter the configuration menu. Select 'Integrated Voltage Regulator' from the menu on the left and set Voltage Regulator Control Source Configuration equal to 'Generator Set Control' to display the following default settings:



To access the Integrated Voltage Regulator setpoints through the EMCP display, navigate to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ ALL SETPOINTS

→ VOLTAGE REGULATOR

If replacing a CDVR with IVR, the parameters can be programmed the same as the CDVR (using ET scaling) in order to achieve similar performance. If the IVR is a new installation, or a R450 or VR6 voltage regulator is being replaced, the parameters can be programmed to the default values with a low loop gain starting at 1.0%. Note that the default parameters should provide stable voltage control for most generator sets, however some optimization and tuning may be required to achieve the desired performance. The following subsections provide further detail on each individual setpoint, including range, resolution and default values.

35.3.1 Voltage Regulator Control Source Configuration

Name	Options	Default Value	Access
Voltage Regulator Control Source Configuration	0 = External Control 1 = Genset Control	0 (External Control)	ET Service Tool Only

Table 35.4

The Voltage Regulator Control Source Configuration parameter is used to enable or disable the Integrated Voltage Regulator feature.

- If set to 'EXTERNAL' the Integrated Voltage Regulator feature of the EMCP is disabled and the generator set can run with an external voltage regulator, for example, CDVR, R450, VR6, etc.
- If set to 'GENSET CONTROL' the Integrated Voltage Regulator feature of the EMCP is enabled and the generator set will run using an Excitation Module.

Note: This parameter will only change state if the generator set is stopped (stop button pressed and engine speed 0 rpm), and can only be changed via ET, and not directly through the EMCP display.

⚠ WARNING

It is important that the Voltage Regulator Control Source Configuration is correctly programmed BEFORE starting the genset.

In the case where an external voltage regulator is used, if Voltage Regulator Control Source Configuration is set to 'Genset Control', there is a risk of nuisance triggering of IVR-related warning and shutdown events.

In the case where IVR is to be used but the Voltage Regulator Control Source Configuration is set to 'External', there is a risk that the PWM (DO#2) output may float high causing the Excitation Module to force the excitation current to the upper limit and risking damage to the generator set and/or load.

35.3.2 Starting Profile

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Starting Voltage Percent	0.0	90.0	0.1	%	10.0	ET Service Tool or EMCP Display
Voltage Regulator Starting Time	0.0	60.0	0.1	Seconds	3.0	

Table 35.5

The starting profile setpoints defined above are used to determine the slope of the voltage ramp when starting the generator set.

If the Voltage Regulator Starting Voltage Percent is zero, the Voltage Regulator Starting Time defines the time to reach the rated voltage setpoint from the point that the frequency exceeds the Voltage Regulator Minimum Frequency Threshold. An example Starting Profile with Voltage Regulator Starting Voltage Percentage set to 0% and Voltage Regulator Starting Time set to 5 seconds is illustrated in Figure 35.6.

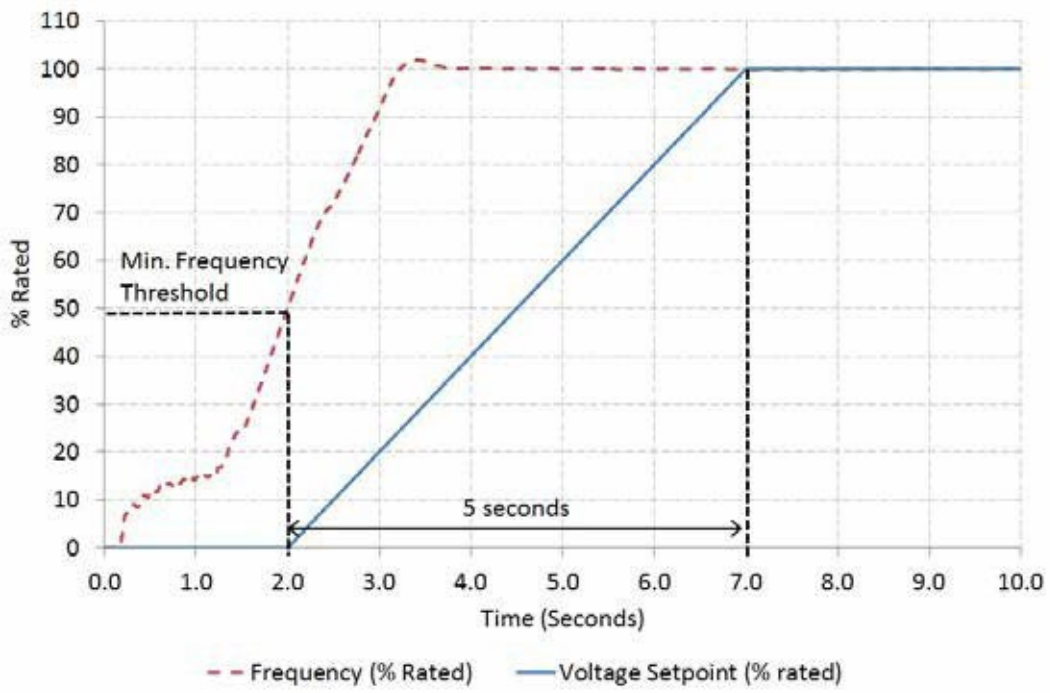


Figure 35.6 – Starting Profile with Voltage Regulator Starting Voltage Set to 0% and Voltage Regulator Starting Time Set to 5 Seconds

If the Voltage Regulator Starting Voltage Percent is non-zero, the Voltage Regulator Starting Time defines the time to get to the rated voltage setpoint from the point that the Voltage Regulator Starting Voltage Percent is reached by following the programmed Volts/Hz slope. An example Starting Profile with Voltage Regulator Starting Voltage Percentage set to 10% and Voltage Regulator Starting Time set to 3 seconds is illustrated in Figure 35.7.

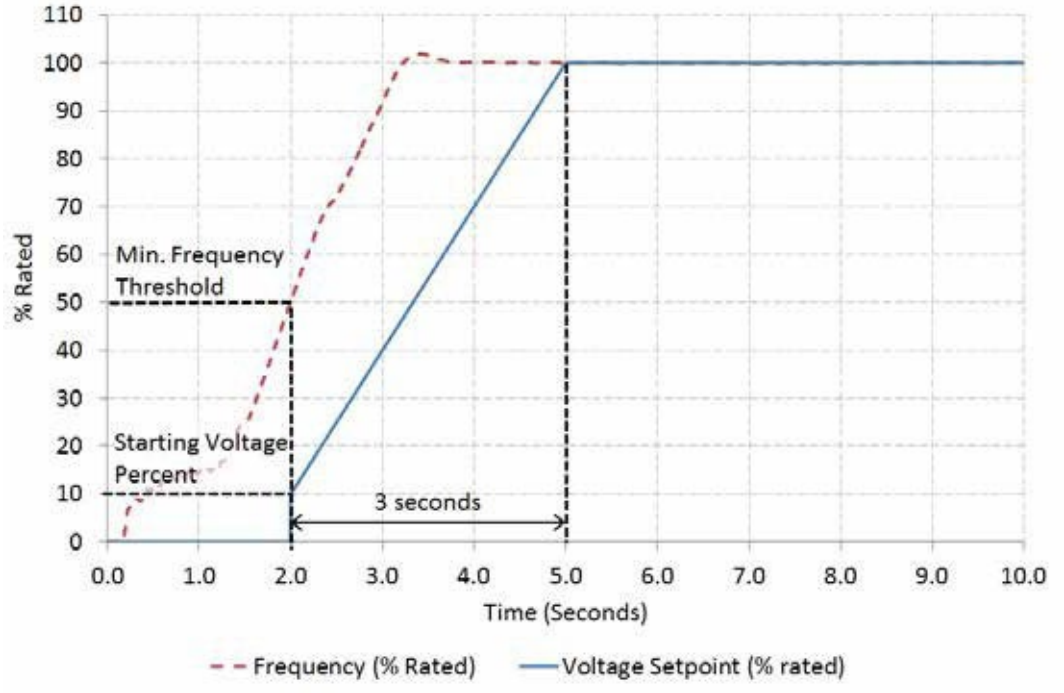


Figure 35.7 – Starting Profile with Voltage Regulator Starting Voltage Set to 10% and Voltage Regulator Starting Time Set to 3 Seconds

A further example with Voltage Regulator Starting Voltage Percentage set to 90% and Voltage Regulator Starting Time set to 3 seconds is illustrated in Figure 35.8.

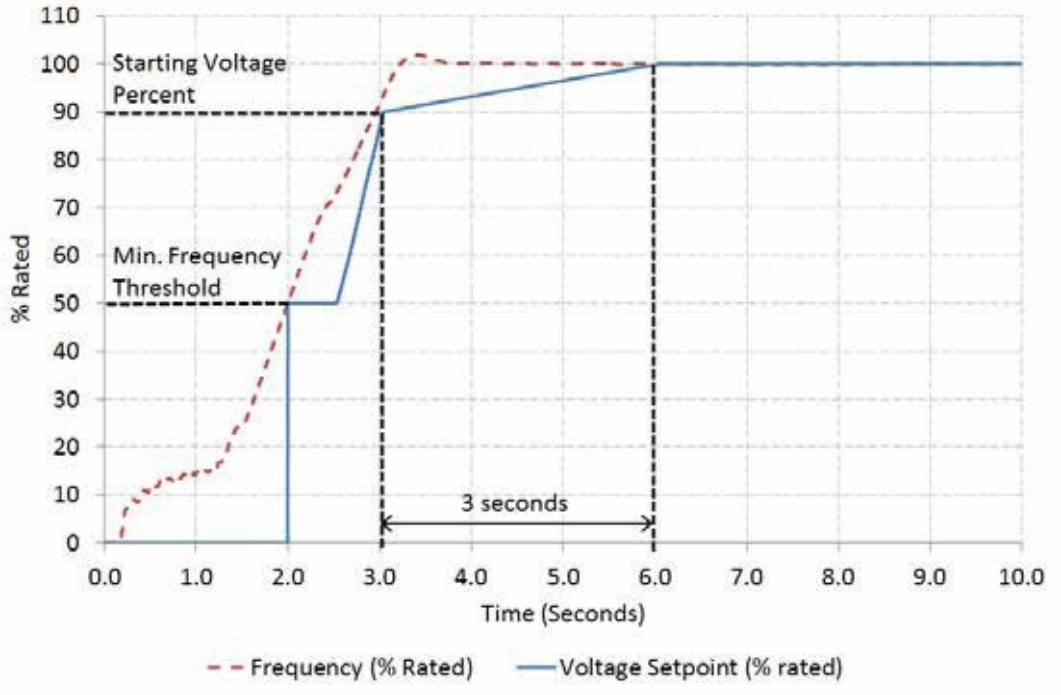


Figure 35.8 – Starting Profile with Voltage Regulator Starting Voltage Set to 90% and Voltage Regulator Starting Time Set to 5 Seconds

If the Voltage Regulator Starting Time is set to zero, or the engine has a slow starting ramp, the Integrated Voltage Regulator will follow the programmed Volts/Hz slopes. The voltage setpoint during starting is therefore the minimum of the Starting Profile setpoint and the Under-Frequency Roll-Off (Loading) Profile setpoint.

In order to avoid a large voltage overshoot during starting, particularly on generators with Shunt or AREP excitation systems, the Excitation Command output from the EMCP is limited to a maximum value of 20% during starting. This prevents integral windup within the PID controller in the case where, during starting, there is insufficient residual voltage at the generator output to build excitation.

Once the frequency exceeds the Voltage Regulator Corner <Knee> Frequency threshold and the nominal voltage setpoint has been reached, the Integrated Voltage Regulator will follow the Under-Frequency Roll-Off (Loading) Profile. The Starting Profile will not be initiated again until the frequency drops below the Voltage Regulator Minimum Frequency Threshold.

35.3.3 IVR PID Gain Setpoints

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Loop Gain Percentage	0.00	100.00	0.01	%	1.00	ET Service Tool or EMCP Display
Voltage Regulator Proportional Gain Percentage	0.00	100.00	0.01	%	20.00	ET Service Tool Only (Level 3 Password
Voltage Regulator Integral Gain Percentage	0.00	100.00	0.01	%	60.00	
Voltage Regulator Derivative Gain Percentage	0.00	100.00	0.01	%	3.00	
Voltage Regulator Noise Filter Time Constant	0.00	1.00	0.01	Seconds	0.00	

Table 35.6

The PID gain setpoints can be tuned to achieve the desired voltage response depending on the application and generator set configuration. The default parameters have been selected to provide stable voltage control on most generators, however some optimization may be required.

If the voltage regulation appears unstable, it may be necessary to reduce the Voltage Regulator Loop Gain Percentage to achieve stability. As a guideline, decreasing in steps of 0.5-1.0% is generally sufficient to observe a noticeable improvement.

35.3.4 Under-frequency Roll-off (Loading) Profile

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Corner <Knee> Frequency	45.0	65.0	0.1	Hz	48.0	ET Service Tool or EMCP Display
Voltage Regulator Deviation From Corner <Knee> Frequency	0.0	10.0	0.1	Hz	5.0	
Voltage Regulator Volts/Hz Slope 1	0.0	10.0	0.1	Volts/Hz	2.0	
Voltage Regulator Volts/Hz Slope 2	0.0	10.0	0.1	Volts/Hz	2.0	
Voltage Regulator Minimum Voltage <Setpoint> Percentage	30	100	1	%	50	
Voltage Regulator Minimum Frequency Threshold	20	40	1	Hz	20	

Table 35.7

The 'Voltage Regulator Knee Frequency" needs to be configured for your specific package requirements. The Knee Frequency for 50 Hz operation will usually be between 48.0 and 49.8 Hz, whereas for 60 Hz operation this parameter should be set between 58.0 and 59.8 Hz.

An example Under-Frequency Roll-Off (Loading) Profile is illustrated in Figure 35.9.

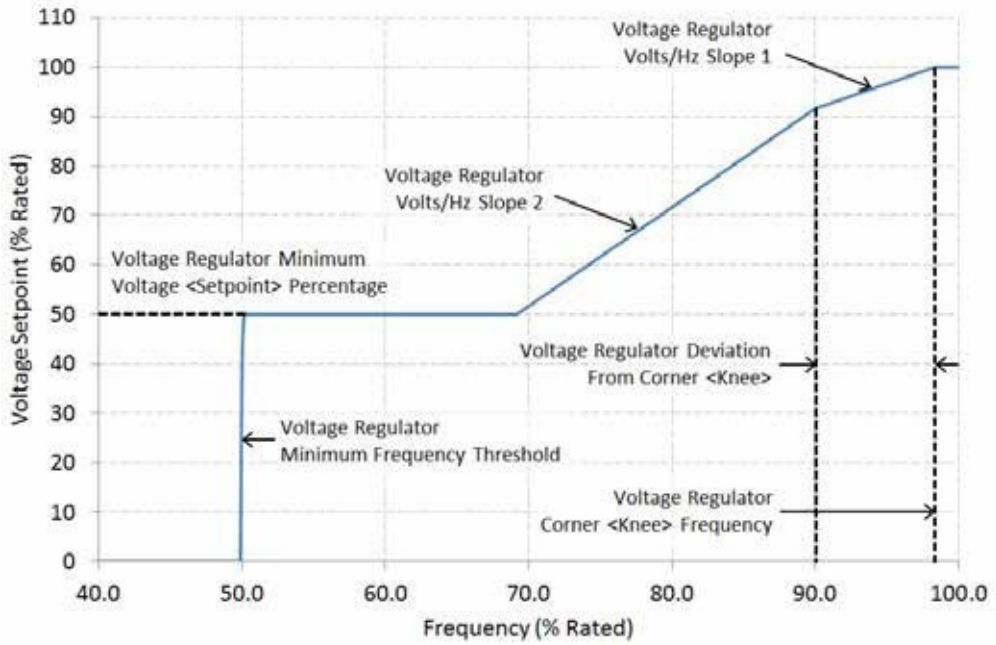


Figure 35.9 – Example Under-Frequency (Loading) Profile, Slope 1 = 1.0 V/Hz, Slope 2 = 2.0 V/Hz

35.3.5 Voltage Regulator Load Compensation Type Configuration

Name	Options	Default Value	Access
Voltage Regulator Load Compensation Type Configuration	0 = OFF 1 = IR Compensation 2 = Voltage Droop	0	ET Service Tool or EMCP Display

Table 35.8

The load compensation features of IR Compensation and Voltage Droop are explained in sections below.

Note: IR Compensation and Voltage Droop are mutually exclusive features designed for different applications; therefore it is not possible to enable both compensation types at the same time.

35.3.6 Line Loss (IR) Compensation

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Voltage (IR) Compensation Percentage	0.0	10.0	0.1	%	0.0	ET Service Tool or EMCP Display

Table 35.9

In some installations where a single generator is used with long feeder lines to the load, it may be advantageous to provide line loss compensation. Line loss compensation is commonly referred to as IR compensation.

Current flowing through a long conductor causes a voltage drop due to the resistance of the wire. Therefore, the voltage at the load end of the conductor will be lower than the voltage at the generator end due to the voltage drop along the conductor. This condition is commonly referred to as line loss. In order to improve the power quality the IVR can compensate for this phenomenon. As generator load increases, the IVR will increase the output voltage at the generator terminals in order to compensate for line losses. The Voltage Regulator Voltage (IR) Compensation Percentage setpoint controls the quantity of voltage compensation at the rated kVA load. It should be adjusted to yield a constant voltage at the location of the load.

For example, if it is observed that the voltage at the load side of the feeder line has decreased by 5% from rated voltage when the generator is supplying rated kVA load, the Voltage Regulator (IR) Compensation Percentage should be set to 5.0%. In this case, the output voltage measured at the generator terminals will increase from 100% to 105% of rated voltage as the generator load increases from 0% to 100% of rated kVA, as illustrated in Figure 35.10.

If a bias is applied to the voltage setpoint from an external source, the IR compensation percentage is applied to the nominal setpoint plus the bias percentage. For example, if a +10% or -10% bias were applied to the nominal voltage, the voltage setpoint would increase linearly as shown by the Upper and Lower Bias Limit dashed lines indicated on the diagram presented in Figure 35.10.

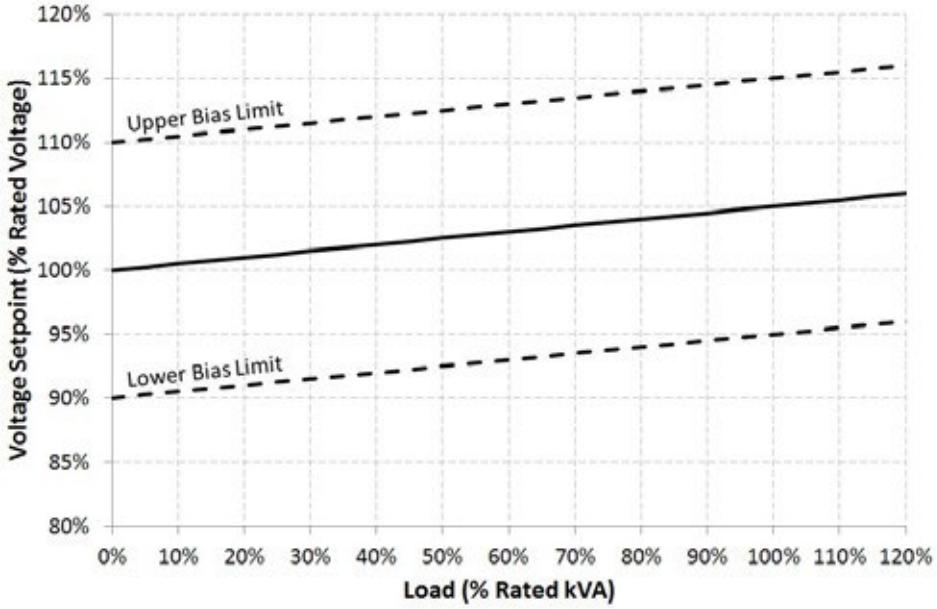


Figure 35.10 – Line Loss Voltage Setpoint Change Based on Total (kVA) Load

Note: It is important that the capability of the machine is not exceeded during operation.

35.3.7 Reactive Droop Compensation

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Maxumum Droop Percentage	0.0	10.0	0.1	%	0.0	ET Service Tool or EMCP Display

Table 35.10

When generators operate in parallel, two primary objectives are for the generators to share both the real power requirements and the reactive power requirements of the system electrical load. The engine governors will control sharing of the real power requirements (kW) and the voltage regulators will control sharing of the reactive power requirements (kVAr) of the total system load. When one or more generators are connected in parallel, the voltage measured at the output terminals of each generator will be the same. However, if the voltage setpoint of one generator is slightly higher than the other generators, it will increase excitation in an attempt to raise the system voltage and in doing so will supply lagging reactive current to the other generators connected in the group. This current will circulate between generators, causing excessive heating of the generator windings and an increased risk of thermal damage.

One method of minimizing this effect is to cause an individual generator's voltage setpoint to sag, or "droop," in proportion to its reactive power output. For proper reactive load sharing, the regulator must know the rated generator reactive power (kVAr), which is calculated from the generator set rated kVA and kW, and the desired percentage of output voltage droop when the generator is supplying rated reactive power.

As the reactive power output increases, the IVR will cause the output voltage to droop (reduce the voltage) proportionally. If the measured reactive power output is leading, the output voltage will rise in the same linear fashion. In either case, this action will tend to support better kVAr sharing with other generators. Note that it is important that the generator operation remains within its capability.

The Voltage Regulator Maximum Droop Percentage setpoint controls how much the generator output voltage will vary for a given amount of reactive power output. For example, if the Maximum Droop Percentage is set to 5.0%, the voltage setpoint will drop from 100% to 95% of rated voltage as the reactive power output increases from 0% to 100% of rated kVAr (lagging). This is illustrated in the diagram presented in Figure 35.11.

If a bias is applied to the voltage setpoint from an external source, the reactive droop percentage is applied to the nominal setpoint plus the bias percentage. For example, if a +10% or -10% bias were applied to the nominal voltage, the voltage setpoint would droop as shown by the Upper and Lower Bias Limit dashed lines indicated on the diagram presented in Figure 35.11.

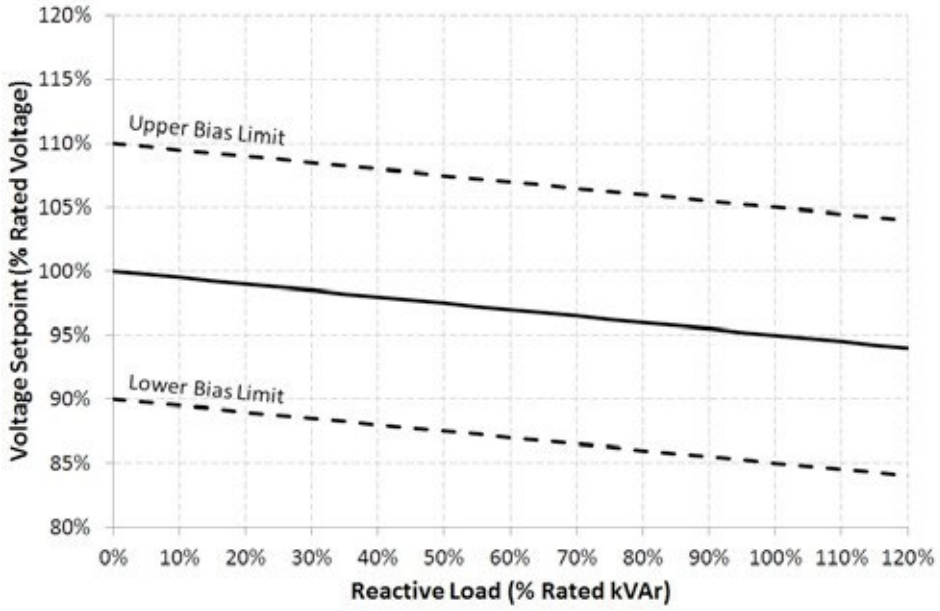


Figure 35.11 – Reactive Droop Voltage Setpoint Change Based on reactive (kVAr) Load

Note: It is important that the capability of the machine is not exceeded during operation.

35.3.8 Voltage Regulator Lockout Configuration

Name	Options	Default Value	Access
Voltage Regulator Lockout Configuration	0 = Not Locked Out 1 = Locked Out	0.0	ET Service Tool Only

Table 35.11

When Voltage Regulator Lockout Configuration is set to 'Not Locked Out,' the Integrated Voltage Regulator will operate normally and control the generator voltage output to the reference setpoint.

When Voltage Regulator Lockout Configuration is set to 'Locked Out,' the Integrated Voltage Regulator will be prevented from controlling the generator voltage output and the Excitation Command output will remain at zero. Excitation is therefore disabled in this scenario, and the generator will only produce residual voltage.

The Voltage Regulator Lockout Configuration setpoint can only be changed when the generator set is STOPPED (EMCP stop button pressed) and engine speed equals zero.

35.3.9 Loss of Sensing Shutdown Event

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Loss of Sensing Shutdown Event Notification Delay Time	0.0	25.0	0.1	Seconds	2.0	ET Service Tool or EMCP Display

Table 35.12

The Voltage Regulator Loss of Sensing Shutdown Event Notification Delay Time determines the time delay between when a loss of sensing voltage is recognized and when a Loss of Sensing Shutdown event (SPN-FMI: 611-0) is generated. Based on average line-to-line voltage monitoring, loss of sensing is triggered under the following conditions:

For Single-Phase configuration: Average line-to-line voltage < 8% of rated

For Three-Phase configuration:

- Balanced three-phase average < 8% of rated OR
- Imbalance between a line quantity and three-phase average > 20% of rated OR
- Loss of a phase (line-to-neutral voltage < 8% of rated).

The Loss of Sensing Shutdown event is inhibited when:

- A generator short circuit condition is detected (any phase current exceeds 300% of rated)
- During voltage starting profile (IVR operating mode equals SOFT START)
- For 5 seconds after frequency increases above the Voltage Regulator Minimum Frequency Threshold setpoint
- When excitation is disabled (Voltage Regulator Lockout Configuration is set to 'Locked Out')

35.3.10 Over Excitation Shutdown Event

Name	Min	Max	Resolution	Units	Default Value	Access
Voltage Regulator Over Excitation Shutdown Event Threshold	10	100	1	%	100.0	ET Service Tool or EMCP Display
Voltage Regulator Over Excitation Shutdown Event Notification Delay Time	0.1	20.0	0.1	Seconds	10.0	

Table 35.13

The Over Excitation Shutdown Event Threshold configuration determines the percentage of excitation command that will cause an Over Excitation Shutdown event. If the excitation command percentage exceeds the Over Excitation Shutdown Event Threshold for longer than the Over Excitation Shutdown Event Notification Delay Time, an Over Excitation Shutdown event (SPN-FMI: 3381-0) will be generated.

Note: The Over Excitation Shutdown event monitors and triggers an event based on Excitation Command Percentage and does NOT trigger based on measured excitation current. See the section on Excitation Module Over-Excitation Protection for a description of the Excitation Module over-excitation protection feature that is based on measured excitation current.

35.4 IVR Voltage Adjustment

Voltage adjustments are categorized into two types: Manual biasing and Analog biasing. Manual voltage adjustment includes fine tuning the generator output voltage via digital input, EMCP display or SCADA (Modbus). Analog voltage adjustment is performed via programmable analog inputs to the EMCP and provide a voltage control interface for external potentiometers or external control systems (such as switchgear).

It is important to note that the setpoint Gen Maximum Voltage Bias Percentage must be correctly configured to be greater than the expected bias range, otherwise it may not be possible to achieve the required voltage bias. The parameter Gen Maximum Voltage Bias Percentage is accessed within the Cat ET Service Tool configuration menu under Generator AC Monitor, or can be accessed from the EMCP display by navigating to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ ALL SETPOINTS

→ GEN AC MONITOR

Note: All manual voltage biasing is removed and reset to zero when the engine is stopped. Manual voltage bias levels are not carried over to the next start up after an engine shutdown.

35.4.1 Digital Inputs

Remote voltage adjustment toggle switches may be used to fine tune the generator output voltage by programming an EMCP digital input for Raise Voltage and Lower Voltage. Each activation of the digital input raises or lowers the voltage by 0.2% of rated. When the digital input is activated continuously, the voltage bias is raised or lowered by 0.2% of rated approximately every 400 ms.

Refer to Chapter 10 for further details on programming digital inputs on EMCP 4 controllers.

35.4.2 Voltage/Hz Control (EMCP Display)

The EMCP display may be used to fine tune the generator output voltage. Each press of the voltage raise or voltage lower key raises or lowers the voltage by 0.2% of rated voltage. When the voltage raise or voltage lower key is pressed and held continuously, the voltage bias is raised or lowered by 0.2% of rated approximately every 400 ms.

The Voltage/Hz Control screen can be found on the EMCP display by navigating to the following sub-menu:

MAIN MENU

→ CONTROL

→ VOLTAGE/Hz CONTROL

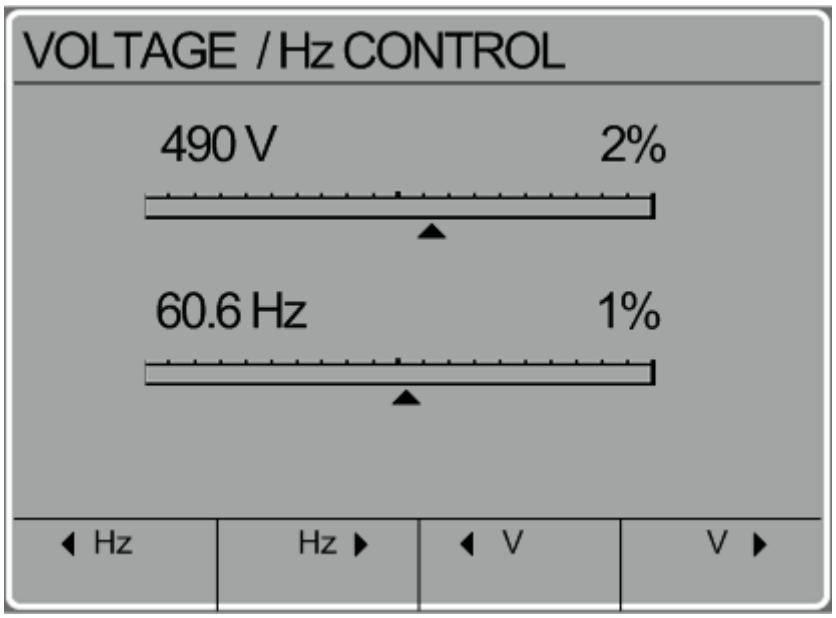


Figure 35.12 – EMCP 4.3 and EMCP 4.4 Volts/Hz Control Screen

35.4.3 SCADA Modbus

EMCP 4 SCADA data link also provides a means for adjusting voltage remotely. EMCP 4 Modbus registers are defined for reading and controlling the target output voltage of the generator. Refer to EMCP 4 SCADA Data Links Application and Installation Guide (LEBE0010) for more details on EMCP 4 dedicated SCADA data links.

35.4.4 Analog Inputs

Analog voltage adjustment is done via a programmable analog input to the EMCP configured for Generator Voltage Control. Analog inputs provide a voltage control interface for external potentiometers or external control systems (such as switchgear). The following analog input types can be configured on an EMCP 4.3 and EMCP 4.4 to adjust the generator voltage setpoint:

- Resistive (a range of input maps are available depending on the potentiometer size)
- PWM
  - 0 to 100%
  - 5 to 95%
- Current
  - 0 to 20 mA
  - 4 to 20 mA
  - 0 to 10 mA
- Voltage
  - 0 to 5 V
  - 1 to 5 V
  - 0 to 10 V
  - -3 to +3 V
  - -2.5 to +2.5 V
  - -5 to + 5 V
  - -10 to +10 V
  - 0.5 to 4.5 V
  - -1 to +1 V

The Generator Voltage Control analog input signal is interpreted and converted by the EMCP into a voltage bias percentage of (nominal) rated voltage. For example, consider an analog input configured for a signal range of -10 to +10 V and a data range of -10% to 10%. When this analog input signal value equals +2 V, a voltage bias percentage of +2.0% of rated will be applied to the generator output voltage.

Refer to Chapter 9 for further details on programming analog inputs on EMCP 4 controllers.

35.5 IVR Display Screens

The Integrated Voltage Regulator Overview and Voltage Bias Overview can be accessed directly through the EMCP display. To access the IVR Overview and Voltage Bias Overview through the EMCP display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ IVR OVERVIEW

→ VOLTAGE BIAS OVERVIEW

The IVR Overview screen provides IVR operating mode, target voltage, excitation command and voltage compensation information. The Voltage Bias Overview screen provides information on all active voltage biasing on the generator system.

Note: Excitation command percentage is NOT a measurement of excitation current, but rather a commanded excitation operating point. A non-zero excitation command percentage MAY be displayed on screen during a fault scenario even though zero excitation current output is present.

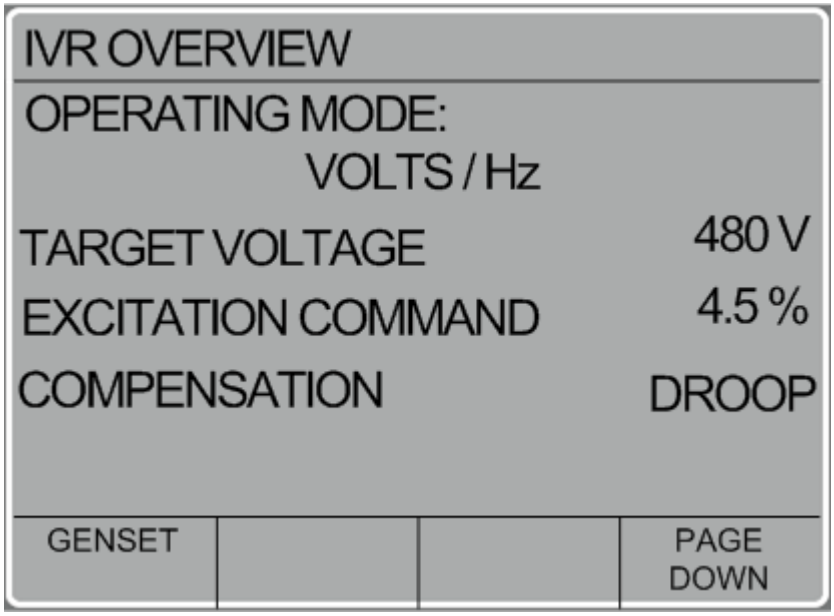


Figure 35.13 – EMCP 4.3 and EMCP 4.4 IVR Overview Screens

The IVR operating modes for EMCP 4.3 and EMCP 4.4 are described below:

- VOLTS/Hz – voltage is regulated according to the under frequency roll off (Volts/Hz) profile.
- V/Hz + DROOP – voltage is regulated according to the under frequency roll off (Volts/Hz) profile.
- V/Hz + LINE LOSS – voltage is regulated according to the under frequency roll off (Volts/Hz) profile in addition to any line loss (IR) compensation bias.
- SOFT START – voltage is ramped during start up from 0 voltage to rated voltage according to the starting profile.
- IVR LOCKED OUT – voltage regulation is locked out and the excitation command is disabled (forced to 0%). Generator output voltage will not build beyond residual voltage.
- SYNCHRONIZING – voltage regulation is performed in order to synchronize generator voltage with bus voltage in paralleling operation (EMCP 4.4 only).
- PF CONTROL – voltage regulation is performed in order to control power factor to a desired level.
- kVAr SHARING – voltage regulation is performed in order to maintain reactive load sharing levels in paralleling operation (EMCP 4.4 only).
- STOPPING – voltage is ramped down in proportion to engine speed during shutdown.

The Voltage Bias Overview screen on the EMCP 4.3 and EMCP 4.4 displays manual, analog, load compensation and total voltage bias percentages applied to the generator output.

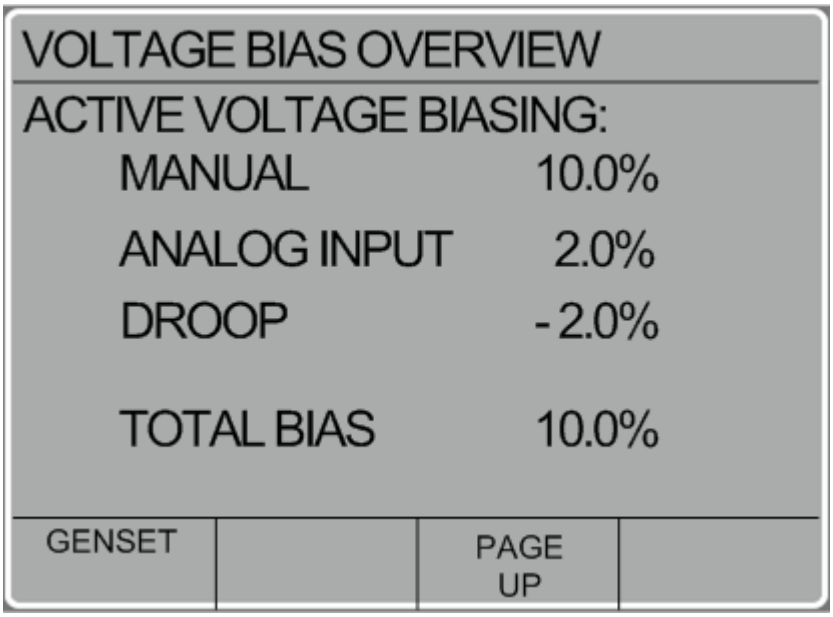


Figure 35.14 – EMCP 4.3 and EMCP 4.4 Voltage Bias Overview Screens

The voltage biasing information for EMCP 4.3 and EMCP 4.4 is described below:

- MANUAL – summation of any voltage bias applied via programmable digital input, Voltage/Hz Control screen on the EMCP display or SCADA (Modbus) voltage bias.
- ANALOG – any voltage bias applied via a programmable analog input described in Section 11.
- DROOP or LINE LOSS – any voltage bias applied as a result of reactive droop or line loss load compensation.
- TOTAL – total voltage bias applied to the generator system. This total percentage bias is the summation of any manual, analog, or compensation (droop or line loss) biasing in the system.

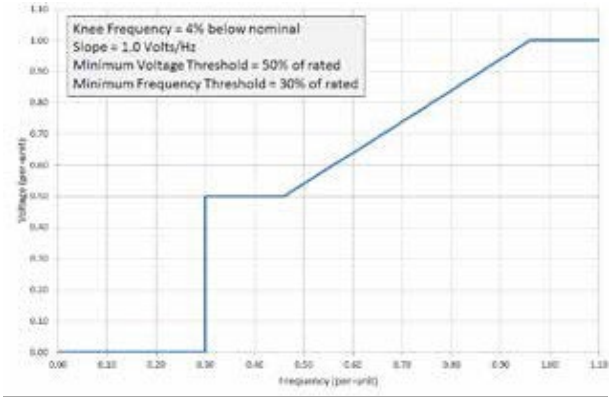
Note: The total percentage bias that can be applied to the generator system is limited by the Maximum Generator Voltage Output Bias Percentage setpoint configured in the EMCP.

36.0 Transient Load Relief (TLR)

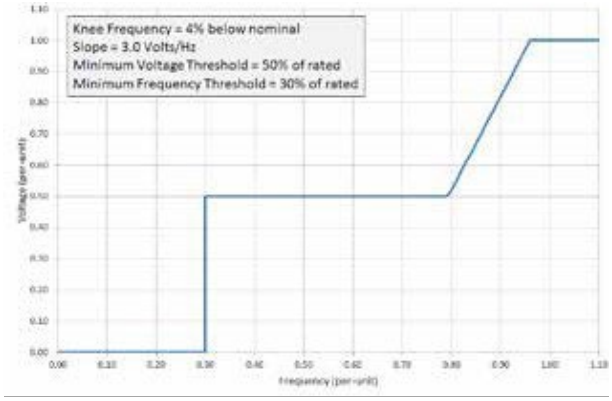
36.1 TLR Operation

Transient Load Relief (TLR) is a patented software feature of the EMCP 4.3 and EMCP 4.4 IVR designed to optimize generator set load acceptance performance within customer-defined voltage and frequency dip limits, for example, ISO G2 Classification limits.

Traditional voltage regulators employ a linear 'Volts per Hertz (Volts/Hz)' strategy to 'roll-off' (reduce) the voltage in proportion to frequency when a load is applied to the generator set and the frequency has decreased below a defined threshold known as the 'corner' or 'knee' frequency. A typical 1.0 Volts/Hz characteristic is presented in Figure 36.1 (a) – with the knee frequency set 4% below the nominal value, the voltage setpoint will be reduced by 1% for every 1% decrease in frequency below 96%. Similarly, if the slope is increased to 3.0 Volts/Hz, the voltage setpoint will be reduced by 3% for every 1% decrease in frequency below 96% as shown in Figure 36.1 (b). In both cases, the voltage setpoint is maintained at a minimum threshold, typically 50%, until the frequency decreases below a defined 'cut-off' threshold. If the frequency drops below the cut-off threshold the voltage setpoint will be switched off to avoid over-excitation of the generator during low-frequency operation, starting and shutdown.



(a) 1.0 Volts/Hz Characteristic



(b) 3.0 Volts/Hz Characteristic

Figure 36.1 Comparison of 1.0 Volts/Hz and 3.0 Volts/Hz Characteristics

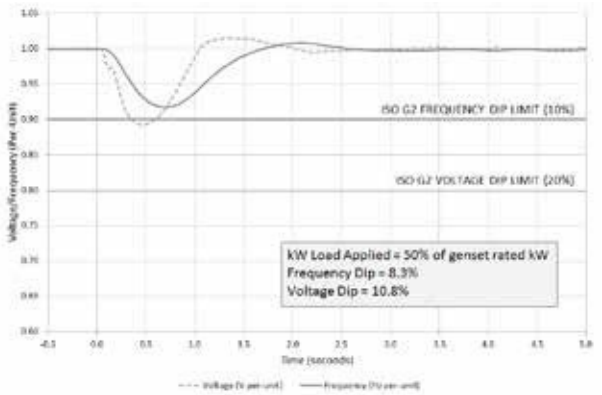
In addition to protecting the generator from over-excitation during low frequency operation, the Volts/Hz slope also assists with transient performance. Since the square of the voltage magnitude is proportional to the resistive electrical load, the effect of reducing the voltage in proportion to frequency is to reduce the load and in doing so reduce the kW (torque) demand on the engine, allowing it to recover more easily back to rated speed. The Volts/Hz slope is typically selected to achieve a compromise in generator set voltage/frequency response to small, medium and large load steps.

For example, consider a 50% of rated kW resistive load step applied on a generator set with the voltage regulator knee frequency set 4% below nominal and the slope programmed to 1.0 Volts/Hz – the voltage and frequency response is presented in Figure 36.2 (a). Increasing the slope to 3.0 Volts/Hz offers little improvement to the frequency dip (around 1.0%) as shown by comparing Figure 36.2 (a) with Figure 36.2 (b), however the voltage dip is significantly larger. The optimum setting for a 50% load step on this generator set would therefore be 1.0 Volts/Hz.

Considering a 100% of rated kW load step applied on a generator set with the voltage regulator knee frequency set 4% below nominal and the slope programmed to 1.0 Volts/Hz – the voltage and frequency response are presented in Figure 36.2 (c). In this case, increasing the slope to 3.0 Volts/Hz offers a significant improvement in the frequency dip (approximately 10%) which is observed by comparing Figure 36.2 (c) and Figure 36.2 (d), therefore a 3.0 Volts/Hz setting may be a more optimum selection for a 100% resistive load step on this generator set.

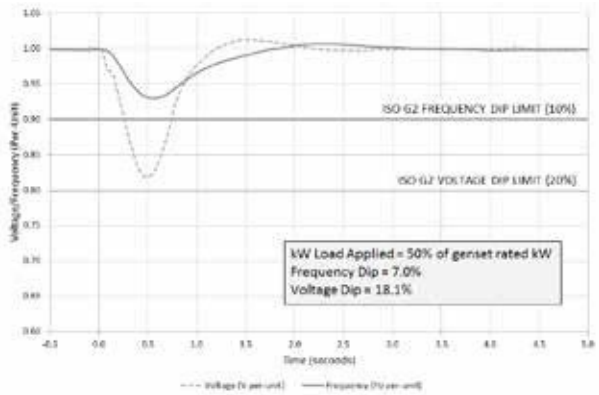
From analysis of the test results presented in Figure 36.2 it is concluded that by using a linear Volts/Hz strategy with a fixed slope setting the performance is not always optimal for the load applied. In most cases therefore a compromise in performance across the generator set load range is reached by setting the Volts/Hz slope at a mid-way point, for example 2.0 Volts/Hz.

1.0 Volts/Hz Slope

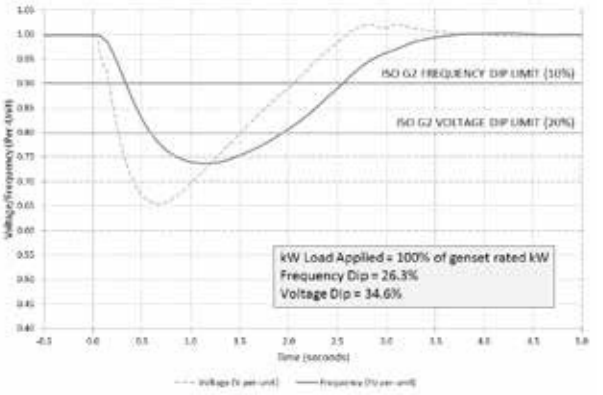


(a) 50% Load Step, Knee Frequency 4% below nominal, Slope 1.0 Volts/Hz

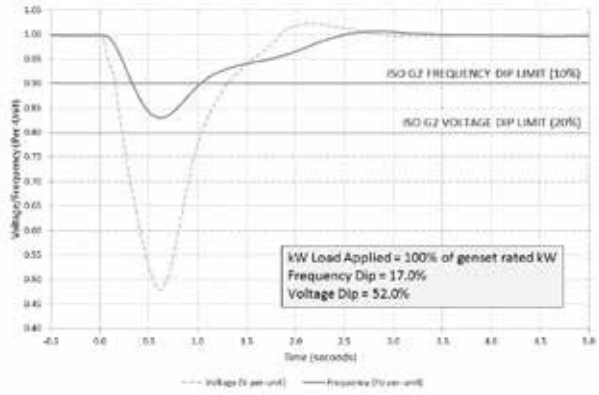
3.0 Volts/Hz Slope



(b) 50% Load Step, Knee Frequency 4% below nominal, Slope 3.0 Volts/Hz



(c) 100% Load Step, Knee Frequency 4% below nominal, Slope 1.0 Volts/Hz



(d) 100% Load Step, Knee Frequency 4% below nominal, Slope 3.0 Volts/Hz

Figure 36.2 – Comparison of Generator Set Load Step Response with Different Volts/Hz Slope Settings

The TLR feature of the Integrated Voltage Regulator provides a method of voltage setpoint reduction to achieve the best possible generator set response. The kW load on the generator set is monitored continuously, which allows for rapid detection of a load change.

For small load increases less than a pre-defined threshold, TLR is not activated and the Integrated Voltage Regulator will follow a Volts/Hz characteristic which can be optimized for small load changes. For load increases greater than the threshold, TLR will be activated and trigger a voltage setpoint reduction that is calculated in order to reduce the transient kW load to match the engine torque capability. TLR therefore offers a sophisticated, dynamic load relief strategy that provides a more optimized transient response across the entire load range of the generator set when compared with the traditional Volts/Hz strategy.

The advantage of TLR can be more clearly demonstrated by observing Figure 36.3 and Figure 36.4. In Figure 36.3, the maximum voltage dip following a load increase is plotted across the load range of a generator set. The dashed line is the maximum voltage dip (%) with TLR disabled and a 2.0 Volts/Hz slope, and the solid line is the maximum voltage dip (%) with TLR enabled. In Figure 36.4, the maximum frequency dip following a load increase is plotted across the load range of the generator set. The dashed line is the maximum frequency dip (%) with TLR disabled and a 2.0 Volts/Hz slope, and the solid line is the maximum frequency dip (%) with TLR enabled.

With TLR disabled, the voltage dip is linearly proportional to the frequency dip. With TLR enabled, the Integrated Voltage Regulator follows a 1.0 Volts/Hz slope (knee frequency set 4% below nominal) for small steps <45% of rated load. TLR is then activated for medium/large steps > 45% of rated load, and the voltage reduction is calculated to optimize the frequency response. The result is that the maximum load step within ISO G2 limits on this generator set has been increased from 53% with TLR disabled to 59% with TLR enabled, an improvement of 6% in this case. It is also observed that the voltage and frequency dip for a 100% load step are significantly reduced by enabling TLR.

As the operation of TLR is dependent on the engine/generator combination and the resulting dynamics, it should be noted that the load step improvement benefits will vary from package to package. TLR is more beneficial for resistive (kW) type loads and does NOT improve load step performance for kVAr load steps since the kVAr load response is mainly due to the generator itself, and not the engine.

Note: TLR is automatically disabled during EMCP 4.4 paralleling operations.

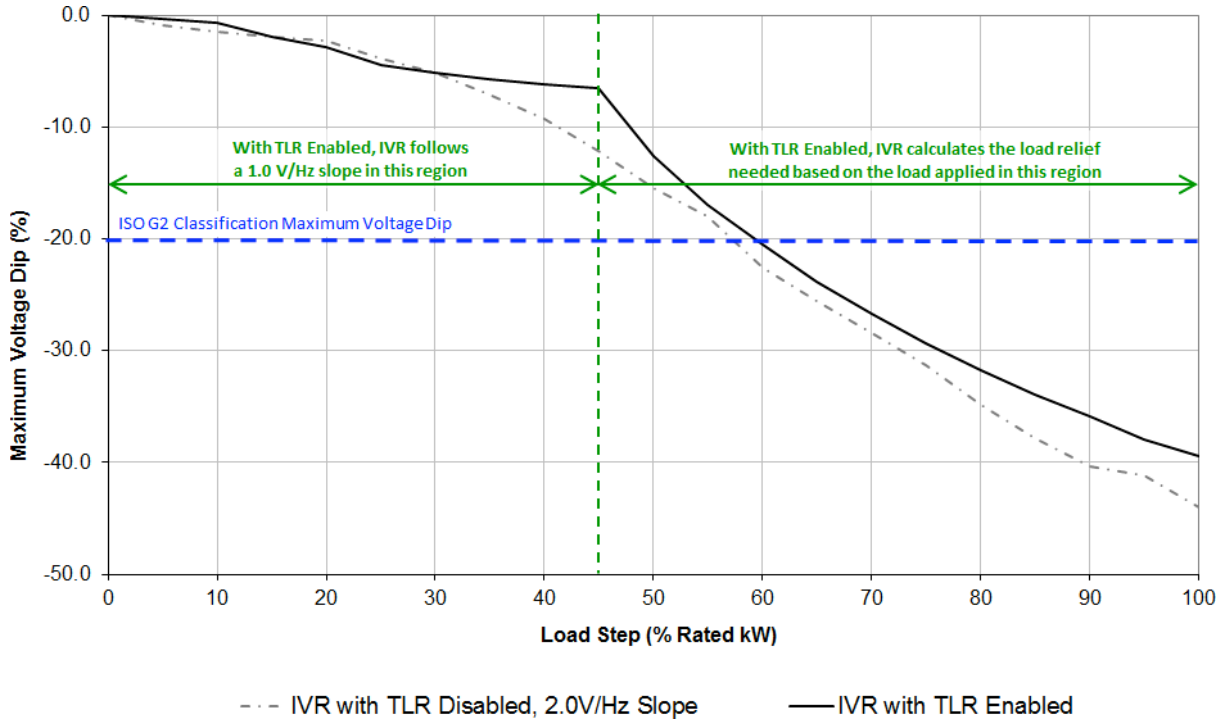


Figure 36.3 – Maximum Voltage Dip Comparison with TLR Enabled/Disabled

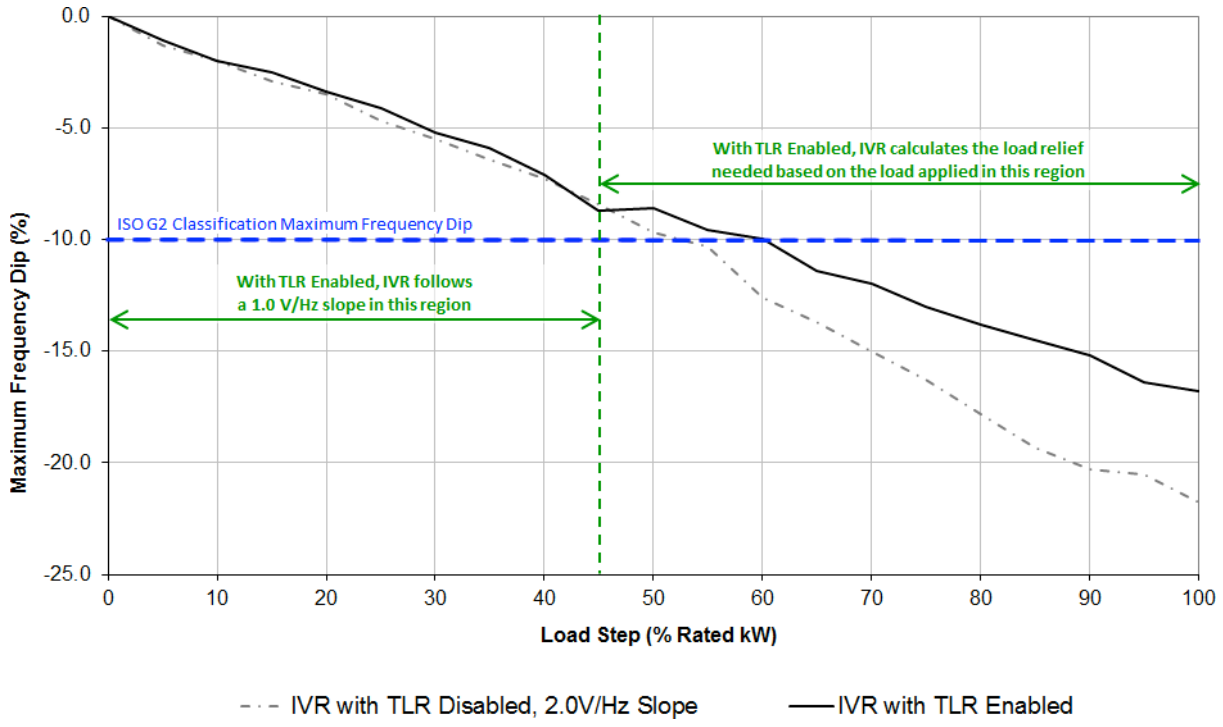


Figure 36.4 – Maximum Frequency Dip Comparison with TLR Enabled/Disabled

36.2 TLR Setpoint Configuration

This section explains the setpoints applicable to Transient Load Relief, which can be accessed and adjusted via the EMCP display or Cat ET service tool.

Transient Load Relief Enable Status

Name	Options	Default Value	Access
Transient Load Relief Enable Status	0 = Disabled 1 = Enabled	0 (Disabled)	ET Service Tool or EMCP Display

Table 36.1

Transient Load Relief Enable Status is used to enable or disable the TLR feature. If set to 'Disabled,' the Integrated Voltage Regulator will follow the programmed Volts/Hz slope. If set to 'Enabled,' the Integrated Voltage Regulator will follow the programmed Volts/Hz slope for load steps less than the threshold defined by *Transient Load Relief Engine Transient Load Capability Percentage.* For load steps greater than this threshold Transient Load Relief will be activated.

Transient Load Relief Activation Transient Load Percentage Threshold

Name	Min	Max	Resolution	Units	Default Value	Access
Transient Load Relief Activation Transient Load Percentage Threshold	10.0	120.0	0.1	%	120.0	ET Service Tool or EMCP Display

Table 36.2

Transient Load Relief Activation Transient Load Percentage Threshold is the magnitude of the kW load change which activates TLR, defined as a percentage of the generator set rated kW load. In most cases it is sufficient to set this parameter equal to the value programmed for *Transient Load Relief Engine Transient Load Capability Percentage.*

Note: The default value for this parameter is 120.0% (maximum value), which means that TLR will provide NO benefit until the parameter is properly tuned.

Transient Load Relief Engine Transient Load Capability Percentage

Name	Min	Max	Resolution	Units	Default Value	Access
Transient Load Relief Engine Transient Load Capability Percentage	10.0	120.0	0.1	%	120.0	ET Service Tool or EMCP Display

Table 36.3

Transient Load Relief Engine Transient Load Capability Percentage is the kW load that TLR will 'match' transiently by reducing the voltage, defined as a percentage of the generator set rated kW load.

Note: The default value for this parameter is 120.0% (maximum value), which means that TLR will provide NO benefit until the parameter is properly tuned. More information on how to configure the Transient Load *Relief Engine Transient Load Capability Percentage* is provided in the 'Tuning Process' section of this document (see STEP 1).

Transient Load Relief Transient Proportional Gain Percentage

Name	Min	Max	Resolution	Units	Default Value	Access
Transient Load Relief Transient Proportional Gain Percentage	10.0	100.0	0.1	%	10.0	ET Service Tool or EMCP Display

Table 36.4

Following a large load step, when TLR is active the voltage and frequency are typically below the nominal values. This effectively reduces the IVR controller gain since the excitation power supply voltage is also suppressed. A transient boost in controller proportional gain is therefore required to assist the IVR in regulating to the reduced TLR voltage setpoint.

Transient Load Relief Transient Proportional Gain Percentage is a proportional gain term that is only introduced when TLR is active. It is generally sufficient to set this value in the range 10-50% (10% yields a multiplier of 1.0 on the overall controller gain during the transient period, 20% yields a multiplier of 2.0 on the overall controller gain during the transient period, etc.).

The effect of the Transient Proportional Gain Percentage on the voltage response is more clearly illustrated in Figure 36.5. By increasing the value within the recommended range 10% to 50%, it is observed that the overshoot of the voltage setpoint is reduced. This proportional gain term is useful for optimizing the response and preventing the voltage dip from going outside limits. For example, in the case presented if the preferred voltage dip limit were 40%, the TLR Transient Proportional Gain Percentage could be set to 50% in order to achieve this target.

When the engine begins to recover (rate-of-change of speed is positive and increasing), TLR is deactivated and the voltage setpoint is then ramped back to the nominal value. During this process the transient gain boost is also ramped off, which has the consequence of increasing the voltage recovery time as observed in Figure 36.5. A higher value of Transient Proportional Gain Percentage will yield a longer voltage recovery time. The optimum setting of Transient Proportional Gain Percentage is therefore a compromise between voltage dip and voltage recovery time.

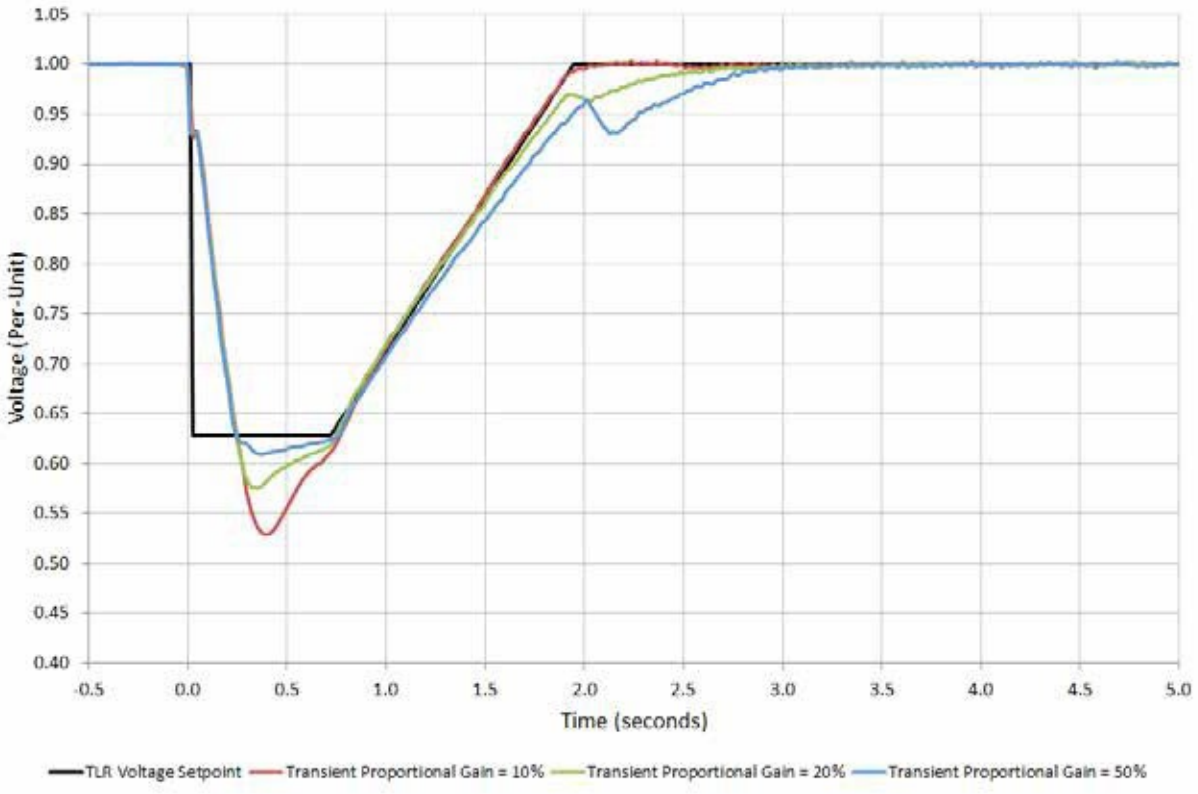


Figure 36.5 – Effect of Transient Proportional Gain Percentage on Voltage Response

Transient Load Relief Voltage Recovery Ramp Rate

Name	Min	Max	Resolution	Units	Default Value	Access
Transient Load Relief Voltage Recovery Ramp Rate	0.1	10.0	0.1	sec/Hz	0.5	ET Service Tool or EMCP Display

Table 36.5

The Transient Load Relief Voltage Recovery Ramp Rate defines the rate at which the voltage setpoint is returned to the nominal value following TLR activation. During TLR activation, the AC frequency is monitored, and the maximum frequency dip is calculated. Once the frequency reaches a minimum turning point and the engine begins to recover speed, TLR is deactivated and the voltage setpoint is then ramped back to the nominal value over a period of 't' seconds, where 't' is calculated as:

Voltage Recovery Time 't' (sec) = Max. Frequency Dip (Hz) x Transient Load Relief Voltage Recovery Ramp Rate (sec/Hz)

The result is a smooth ramp of load on to the engine when TLR switches off, avoiding the risk of a second frequency dip.

An example illustrating the voltage setpoint change with different values of Voltage Recovery Ramp Rate is presented in Figure 36.6. In the case shown, for a frequency dip of 17.4% (equivalent to 10.44 Hz on a 60 Hz generator set) the voltage recovery time is demonstrated to increase as a function of the programmed Voltage Recovery Ramp Rate. For example, if Voltage Recovery Ramp Rate is set to 0.125 sec/Hz, once the frequency begins to recover and TLR switches off, the voltage setpoint is ramped back to the nominal value over a period of 10.44 Hz x 0.125 sec/Hz = 1.305 seconds. If a slower ramp rate is required to facilitate a smoother transition of load to the engine then a value of 0.25 sec/Hz or 0.5 sec/Hz may be programmed which has the consequence of increasing the voltage recovery time.

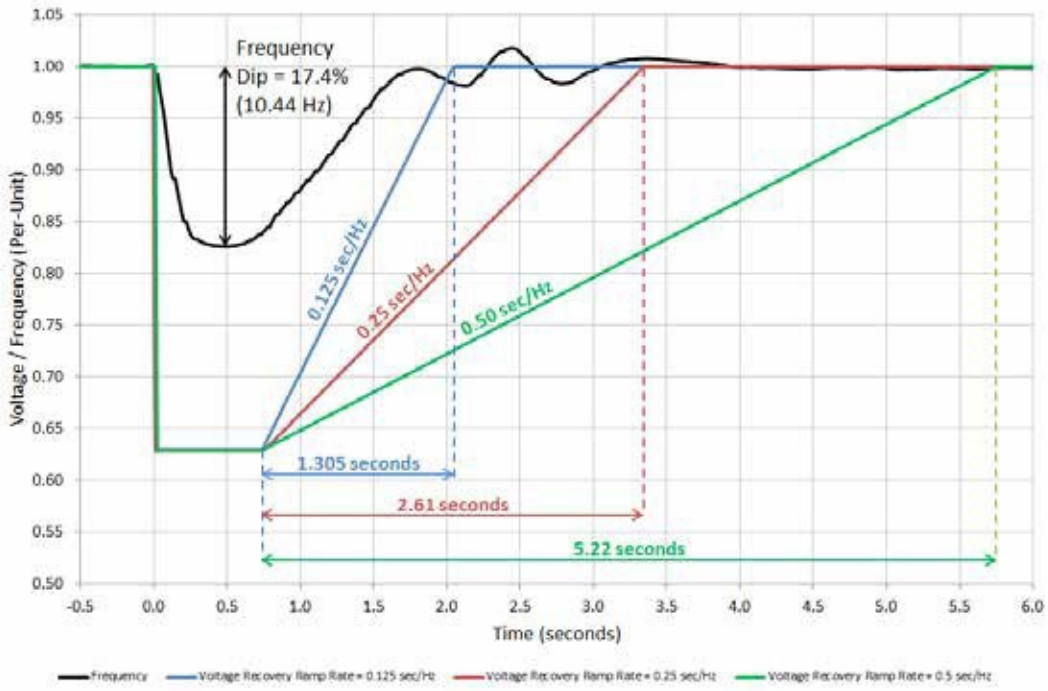


Figure 36.6 – Effect of Voltage Recovery Ramp Rate on Voltage Recovery Time (60 Hz Generator Set)

It is recommended that the Voltage Recovery Ramp Rate setpoint is tuned to achieve the desired voltage recovery time based on the largest load step that the generator set is expected to accept at site.

36.3 TLR Tuning Process

The process that should be followed to tune the Transient Load Relief setpoints is described in detail in this section. The preferred method of determining the value of *Transient Load Relief Engine Transient Load Capability Percentage* is through testing on an actual generator set where a load bank is available. However, it is possible to get an estimated value using the data provided through the SpecSizer sizing tool, which is also explained in detail.

STEP 1: Determine the *Transient Load Relief Engine Transient Load Capability Percentage*

Method 1 (preferred) – confirm via generator set test with a load bank

Configure IVR setpoints as follows:

- Voltage Regulator Corner <Knee> Frequency = 57.6 Hz for 60 Hz generator sets (or 48 Hz for 50 Hz generator sets)
- Voltage Regulator Volts/Hz Slope #1 = 0.0 V/Hz
- Voltage Regulator Volts/Hz Slope #2 = 0.0 V/Hz
- Transient Load Relief Enable Status = Disabled

All other IVR setpoints should be left as per the original package configuration.

Start generator set, and observe voltage control during startup. Ensure voltage and frequency are stable. Apply load and allow engine to reach rated operating temperature. Continue to run on load for a minimum of 10 minutes before rejecting the load.

Apply load steps to the generator (0% to x%) and use an iterative approach to determine the maximum kW load step within ISO G2 limits (maximum 10% frequency dip, 20% voltage dip). In the example presented in Figure 36.7, the maximum load step within ISO G2 limits is 43.8% of the generator set rated kW with a corresponding frequency dip of 10.0% and a voltage dip of 4.9%.

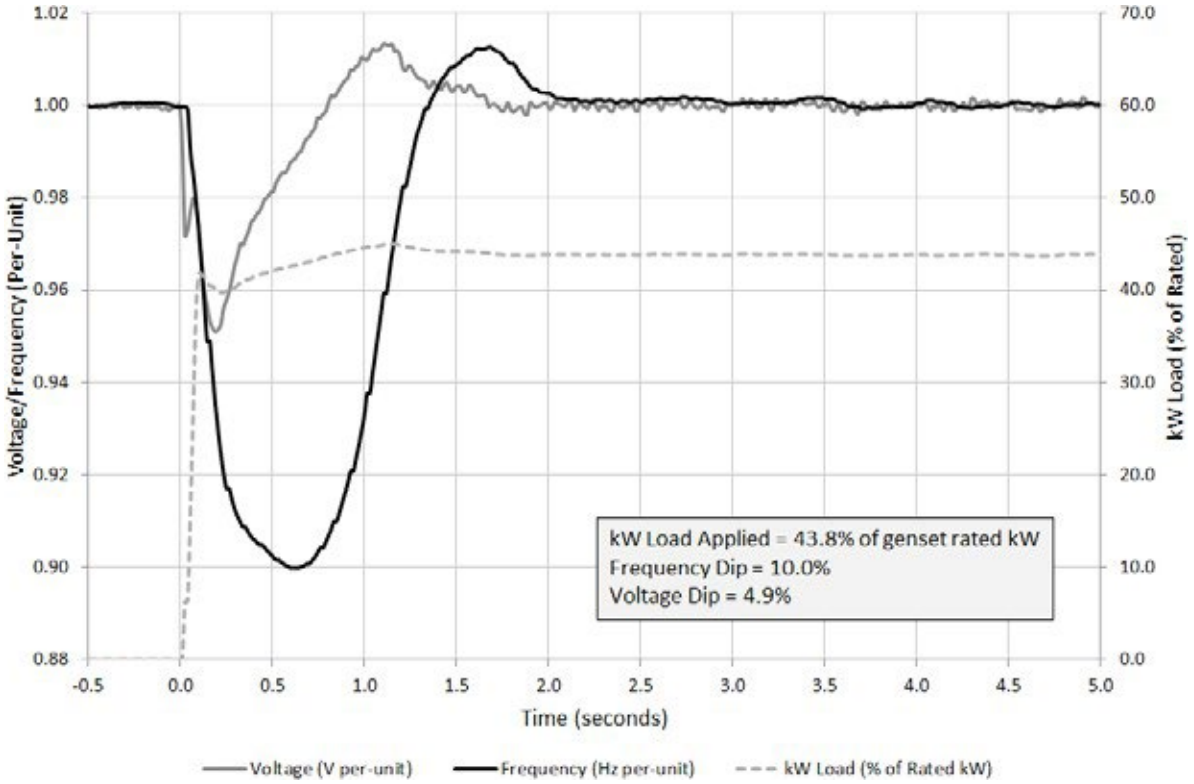


Figure 36.7 – Example Load Step Trace Showing Maximum Load Step Within ISO G2 Limits

For the maximum load step within a 10% frequency dip, record the maximum voltage dip (in percent) and substitute this value into the following formula:

$$TLR\ Engine\ Transient\ Load\ Capability\ Percentage = \left(\left[\left(1 - \frac{Max.\ Voltage\ Dip\ \%}{100} \right)^2 \right] \times \frac{Max\ \%\ Load\ Step\ Within\ Limits}{100} \right) \times 100$$

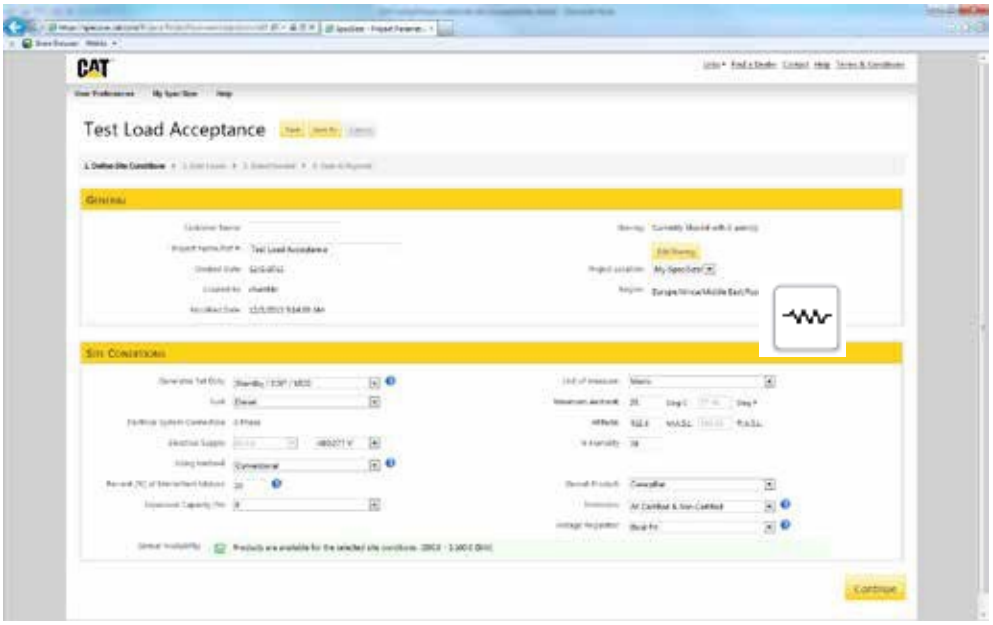
Using the example shown in Figure 27.7, the TLR Engine Transient Load Capability Percentage is calculated as:

$$TLR\ Engine\ Transient\ Load\ Capability\ Percentage = \left(\left[\left(1 - \frac{4.9}{100} \right)^2 \right] \times \frac{438}{100} \right) \times 100 = 39\%$$

Method 2 (alternative) – confirm by using the SpecSizer sizing tool:

It should be possible to get an estimate of TLR Engine Transient Load Capability Percentage using the SpecSizer sizing tool. The steps outlined below explain how to determine the load capability percentage using the information provided by the SpecSizer sizing tool.

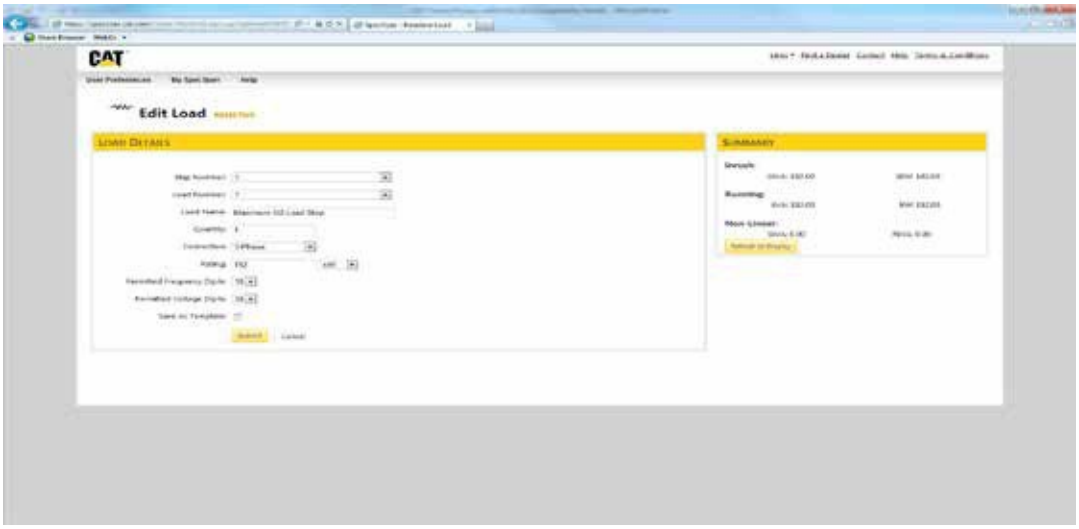
Firstly, create a new project and define the site conditions to select the “Best Fit” Voltage Regulator.



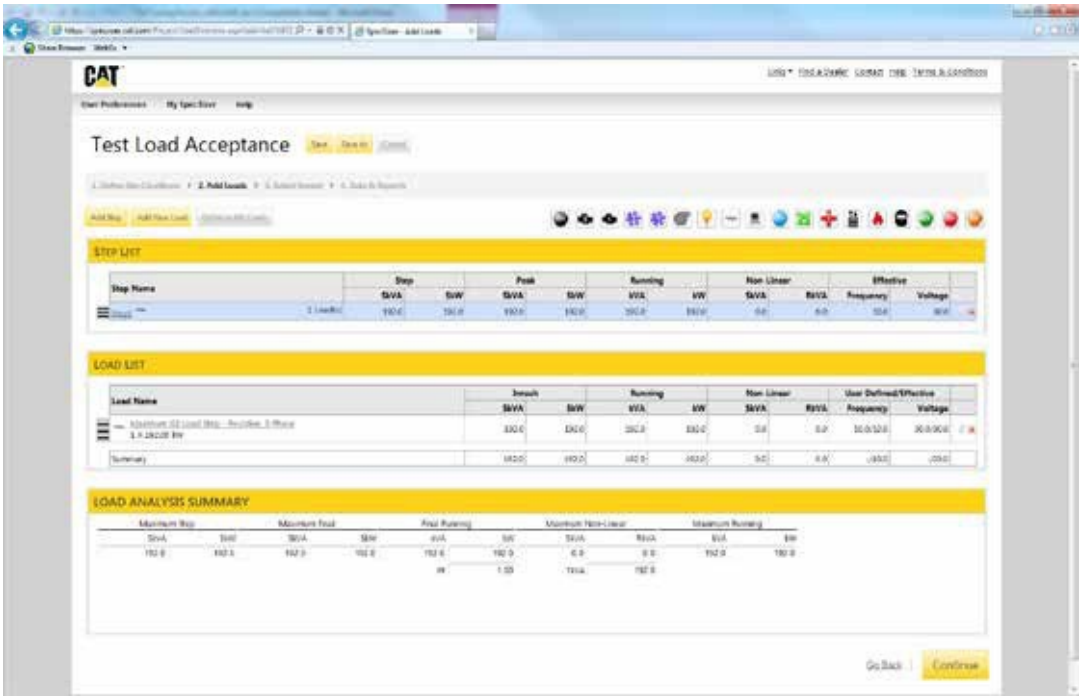
Click “Continue,” then on the ‘Add Loads’ tab, click on the Resistive Load icon:



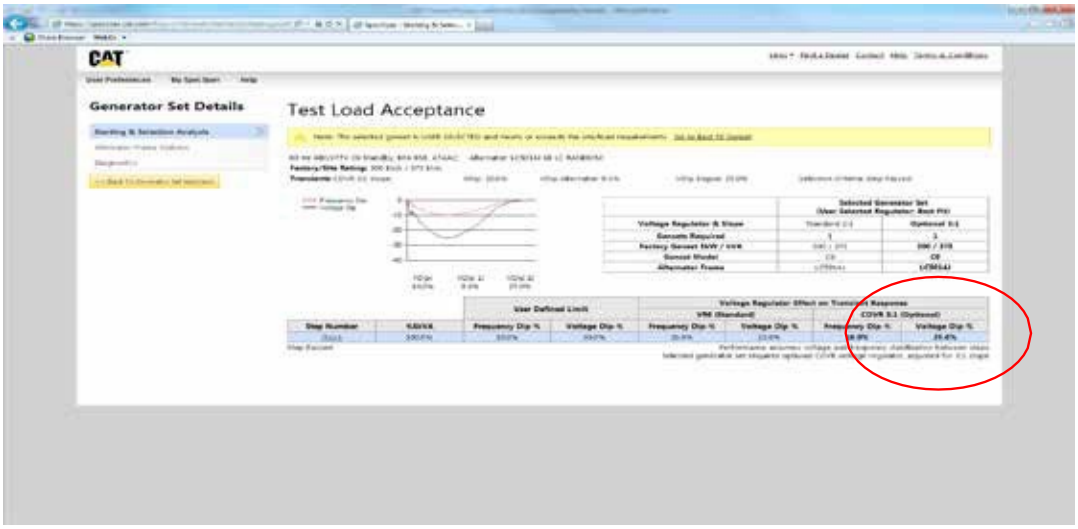
Add a new resistive load to Step 1. The objective is to find the load step on the selected generator set that will yield a 10% frequency dip. For the generator set selected in this example, a 192 kW load step is estimated to yield a 10% frequency dip. Some iteration of the load kW value may be required to achieve the required frequency dip.



Once the load details have been entered, click 'Submit' and review the load step list as shown.



The next step is to select the generator set and check the estimated frequency dip is approximately 10%. In the example shown we have selected a Cat C9 generator set rated at 300 kW Standby (480 V, 60 Hz). On this generatpr set, a 192 kW (64.0%) load step results in an estimated frequency dip of 10.0%, with a corresponding voltage dip of 25.0% (CDVR with 3:1 (optional) slope). If the frequency dip is not equal to 10.0%, then adjust the load value until the target frequency dip is achieved.



For the maximum load step within a 10% frequency dip, substitute the voltage dip (in percent) into the following formula:

$$TLR\ Engine\ Transient\ Load\ Capability\ Percentage = \left(\left[\left(1 - \frac{Max.\ Voltage\ Dip\ \%}{100} \right)^2 \right] \times \frac{Max\ \%\ Load\ Step\ Within\ Limits}{100} \right) \times 100$$

Using the example shown, the *TLR Engine Transient Load Capability Percentage* is calculated as:

$$TLR\ Engine\ Transient\ Load\ Capability\ Percentage = \left(\left[\left(1 - \frac{25.0}{100} \right)^2 \right] \times \frac{64.0}{100} \right) \times 100 = \underline{36.0\%}$$

Using SpecSizer, the *TLR Engine Transient Load Capability Percentage* is calculated as 36 .0%, which is close to and more conservative than the value of 39 .6% estimated using Method 1 . Using SpecSizer to estimate the value is therefore considered a suitable alternative to testing with a load bank where site testing is not feasible .

STEP 2: Set Transient Load Relief Activation Transient Load Percentage Threshold equal to Transient Load Relief Engine Transient Load Capability Percentage .

STEP 3: Set Transient Load Relief Transient Proportional Gain Percentage to be 30 .0% as a good starting value . Note that it may be necessary to increase this setting in steps of 5 .0% until the desired transient voltage control is achieved; however, it is not recommended to increase the value above 50 .0% as setting the gain too high can result in unstable voltage .

STEP 4: Set Transient Load Relief Voltage Recovery Ramp Rate to a starting (default) value of 0 .5 sec/Hz . This is equivalent to a 5 .0 second voltage recovery ramp time for a frequency dip of 10% . Note that it may be necessary to further optimize this setting to achieve the desired voltage recovery time for a given load step .

STEP 5: Enable TLR by setting Transient Load Relief Enable Status to 'Enabled .'

STEP 6: Set the Volts/Hz parameters to an optimum value for small load steps (typically 1.0 Volts/Hz).

- Voltage Regulator Corner <Knee> Frequency = 57.6 Hz for 60 Hz generator sets (or 48 Hz for 50 Hz generator sets)
- Voltage Regulator Volts/Hz Slope #1 = 1.0 V/Hz
- Voltage Regulator Volts/Hz Slope #2 = 1.0 V/Hz

STEP 7: Run a load test on the generator set and confirm that the performance meets expectations.

Some further optimization of the Transient Load Relief Engine Transient Load Capability Percentage value may be necessary to fully achieve the desired optimum performance, however the tuning process described in STEP 1 should provide a good starting point.

An example of the transient voltage and frequency response with TLR enabled is shown in Figure 36.8. It is observed from the kW Load trace (dashed line) that TLR has been effective in reducing the transient load to approximately 39.6% (with some overshoot of the target voltage), and the generator set response remains within ISO G2 limits.

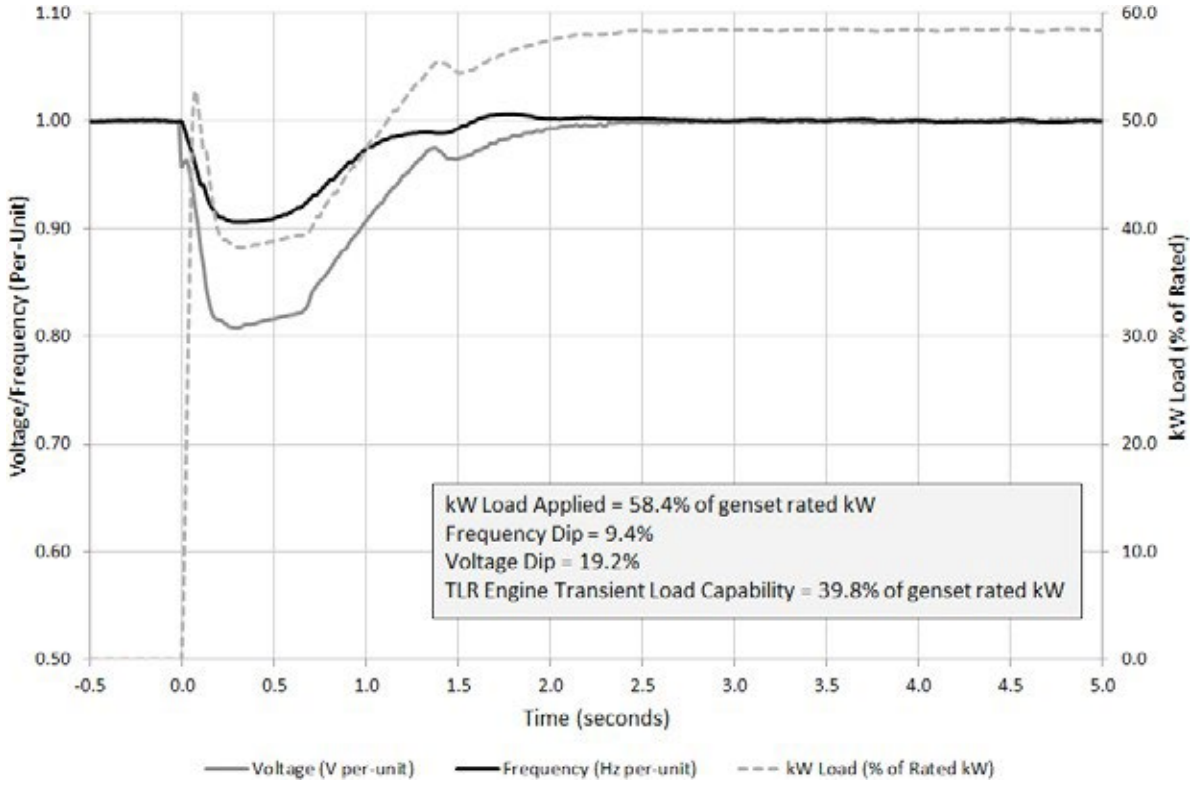


Figure 36.8 – Voltage and Frequency Response Following a Load Step with TLR Enabled

37.0 Multiple Genset Data Link (MGDL)

37.1 Introduction

The EMCP 4.4 Multiple Genset Data Link (MGDL) feature is an Ethernet data link used between engine-generator sets for on-package paralleling and control. The EMCP 4.4 MGDL feature does NOT employ a master controller strategy for paralleling operation. The EMCP 4.4 controller uses a proprietary protocol to communicate information between generator sets to control paralleling features like dead bus arbitration, synchronizing, load sharing and load sequencing. The EMCP 4.4 is not designed or intended to connect to third-party products over this data link.

The MGDL feature requires EMCP 4.4 controllers with at least v4.3 PROD software installed. MGDL capability does NOT exist in EMCP 4.4 controller software versions prior to v4.3 PROD. Up to sixteen (16) EMCP 4.4 controllers can be networked together in a single system via MGDL. MGDL provides a view of the entire system as well as visibility to all other units in the system from a single EMCP 4.4 display (Figure 37.1).

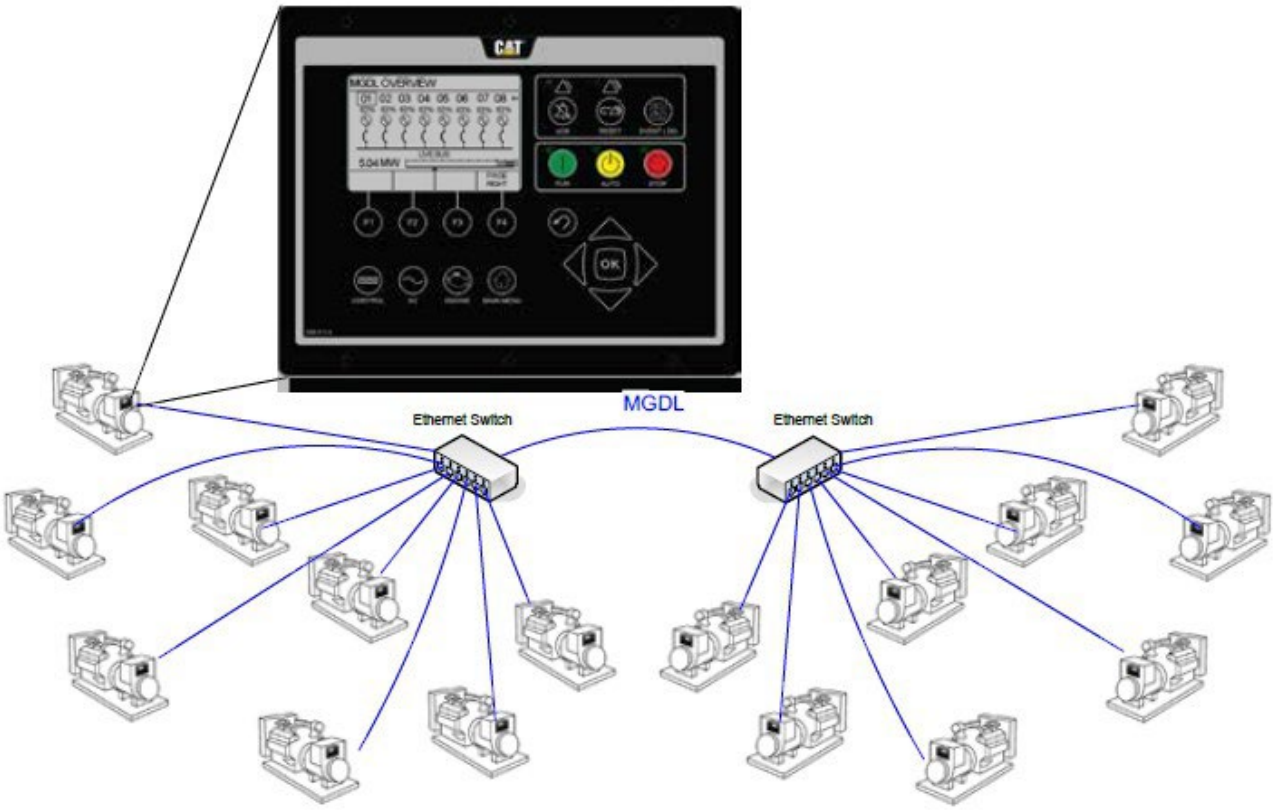


Figure 37.1 – MGDL

The “Multiple Generator Set” load topology example shown in Figure 37.2 is a representation of a system application in which the EMCP 4.4 MGDL feature can be used. A degree of flexibility is built into the MGDL control system to allow for additional topology support (such as feeder breaker control). The EMCP 4.4 MGDL feature does not support utility paralleling or intelligent automatic transfer switch capabilities with the initial version of PROD v4.3 software.

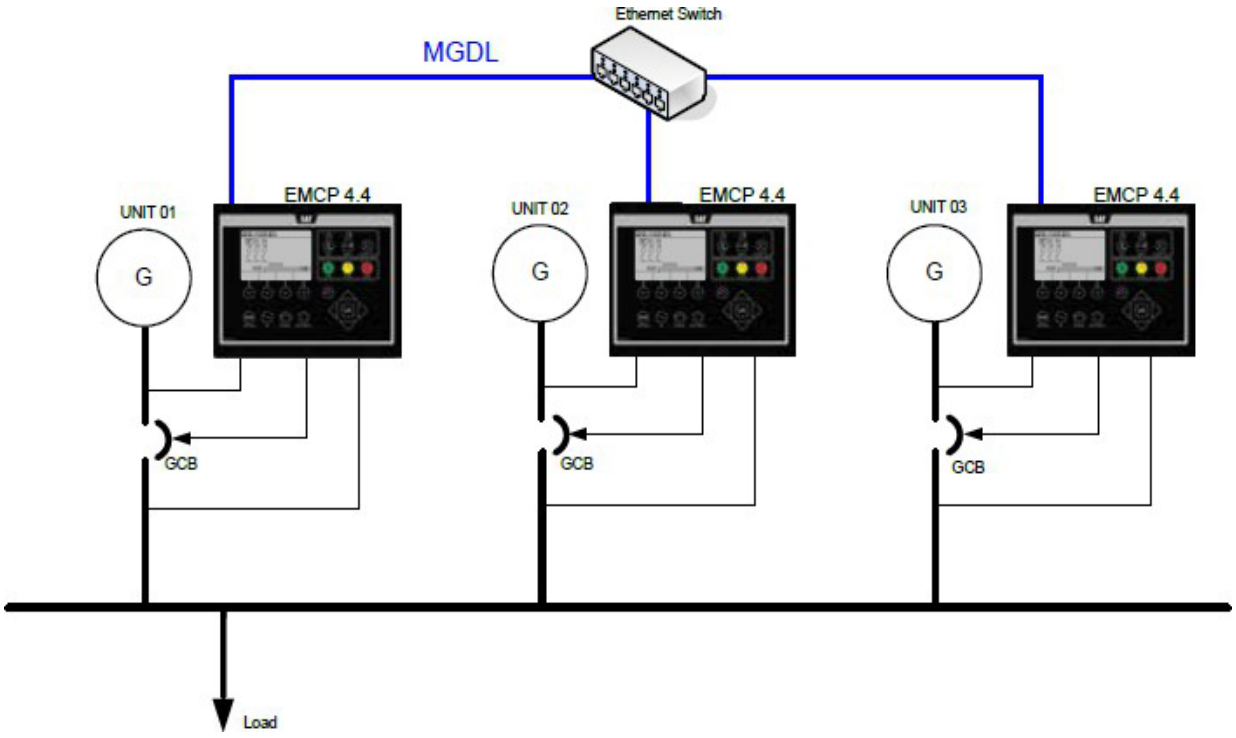


Figure 37.2 – Multiple Generator Set, Topology Example

The following guide describes the installation, configuration, and operation of the EMCP 4.4 MGDL feature.

37.2 MGDL Hardware Installation

37.2.1 EMCP 4.4 MGDL Connections

The MGDL uses a 10BaseT connection to an Ethernet network. It requires a minimum of Category-5 (Cat5) cable, but Category-5e or Category-6 are also permitted and preferred. It uses four-wire communications. It requires two twisted pairs of conductors (Rx+ and Rx-, Tx+ and Tx-) and may be terminated in a connection such as RJ-45 jack. See Table 37.1 for the Ethernet pins on the EMCP 4.4.

Pin #	Name	Description
87	ETH1-3	Ethernet differential non-inverting transmit line (Tx+)
88	ETH1-1	Ethernet differential non-inverting receive line (Rx+)
97	ETH1-2	Ethernet differential inverting receive line (Rx-)
98	ETH1-4	Ethernet differential inverting transmit line (Tx-)

Table 37.1 – EMCP 4.4 MGDL (Ethernet) Connections

The MGDL connection is the same connection as the Modbus TCP/IP connection. While the same connection is used, the protocols are different and do not interfere with each other under normal conditions. Because the receiving lines on one device need to be connected to the sending lines on another, it is possible that a crossover cable will be required. Fortunately, many Ethernet adapters automatically detect and internally crossover; the EMCP 4 also automatically detects and does an internal crossover. See Figure 37.3 below for an illustration of connecting the EMCP 4.4 to a typical RJ-45 connector or device.

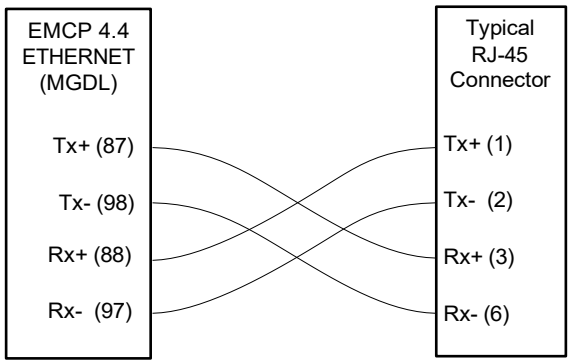


Figure 37.3 – EMCP 4.4 Wiring to RJ-45 Connector/Device

37.2.2 MGDL Network Topologies

The MGDL is Ethernet-based and supports the 10BT topologies. The recommended topologies for MGDL are the star or tree topology using a hub, switch, or repeater Ethernet device. See Figure 37.4 for an illustration of a star network topology and a tree network topology.

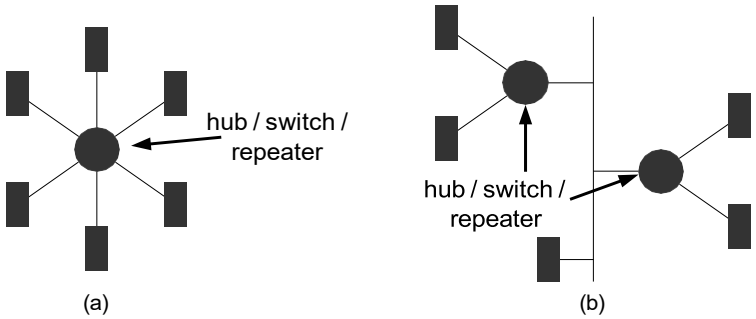
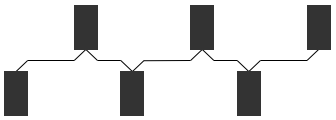


Figure 37.4 – Recommended MGDL Ethernet Network Topologies
(a) Star Network and (b) Tree Network

For maximum redundancy, using the dual connections available on some EMCP 4.4 hardware to daisy chain connections is NOT recommended for an MGDL network since a single wire break can cause loss of communications between large portions of the network. See Figure 37.5 for an illustration of a daisy-chained network topology.



(a)

Figure 37.5 – Non-recommended MGDL Ethernet Network Topologies
(a) Daisy-chain Network Between Internal EMCP 4.4 Hubs

The limits on the length are 330 ft (100 m) between each device (controller, computer, hub, or switch). Fiber optic converters are recommended for any network section length greater than 330 ft (100 m), but may be worthwhile in order to give greater electrical immunity for all connections.

37.2.3 Ethernet Switch/Hub/Repeater Considerations

Because of the wide range of installation scenarios and large number of Ethernet hubs, switches, or repeaters available, specific devices are not called out in this document. However, certain characteristics should be considered when choosing an Ethernet hub, switch or repeater to install with an MGDL network. Switches are always preferable over hubs in order to minimize communication conflicts. In addition, if the MGDL network is being connected to any other network, a switch is strongly recommended. The hub/switch/repeater characteristics to consider for a specific application include:

- Power Supply Requirements
- Availability of Power Supply with and without Utility Power
- Environmental Specifications (Temperature, Humidity, Pressure, EMC…etc.)
- Transmission Speed/Length Requirements
- Maximum Number of Ports Required
- Troubleshooting Signal LEDs

Two examples of Ethernet switches that were tested with an MGDL network system are provided in Table 37.2. These devices are NOT Caterpillar serviceable parts, but are provided here for reference only.

Ethernet Switch Device	Image
B&B Electronics – ESW205-T	
Phoenix Contact – 2832849 FL Switch SF16TX	

Table 37.2 – Example Ethernet Switch Devices

37.2.4 MGDL and TCP/IP SCADA Monitoring

It should be noted that the EMCP 4.4 Ethernet MGDL connection points are the same as the Ethernet TCP connection points used for SCADA monitoring. The EMCP 4.4 dual purpose Ethernet port lends itself to convenient wiring and reduced connection points. However, MGDL and TCP/IP SCADA data links are separate in their operation and function.

Note: The same Ethernet network used for MGDL can also be used for TCP/IP SCADA monitoring.

In order to perform TCP/IP SCADA monitoring of all EMCP 4.4 controllers that are connected to an MGDL network, connect to the existing Ethernet network and follow standard TCP/IP SCADA monitoring setup procedures. Figure 37.6 below illustrates an example of a TCP/IP SCADA network connected to an EMCP 4.4 MGDL network.

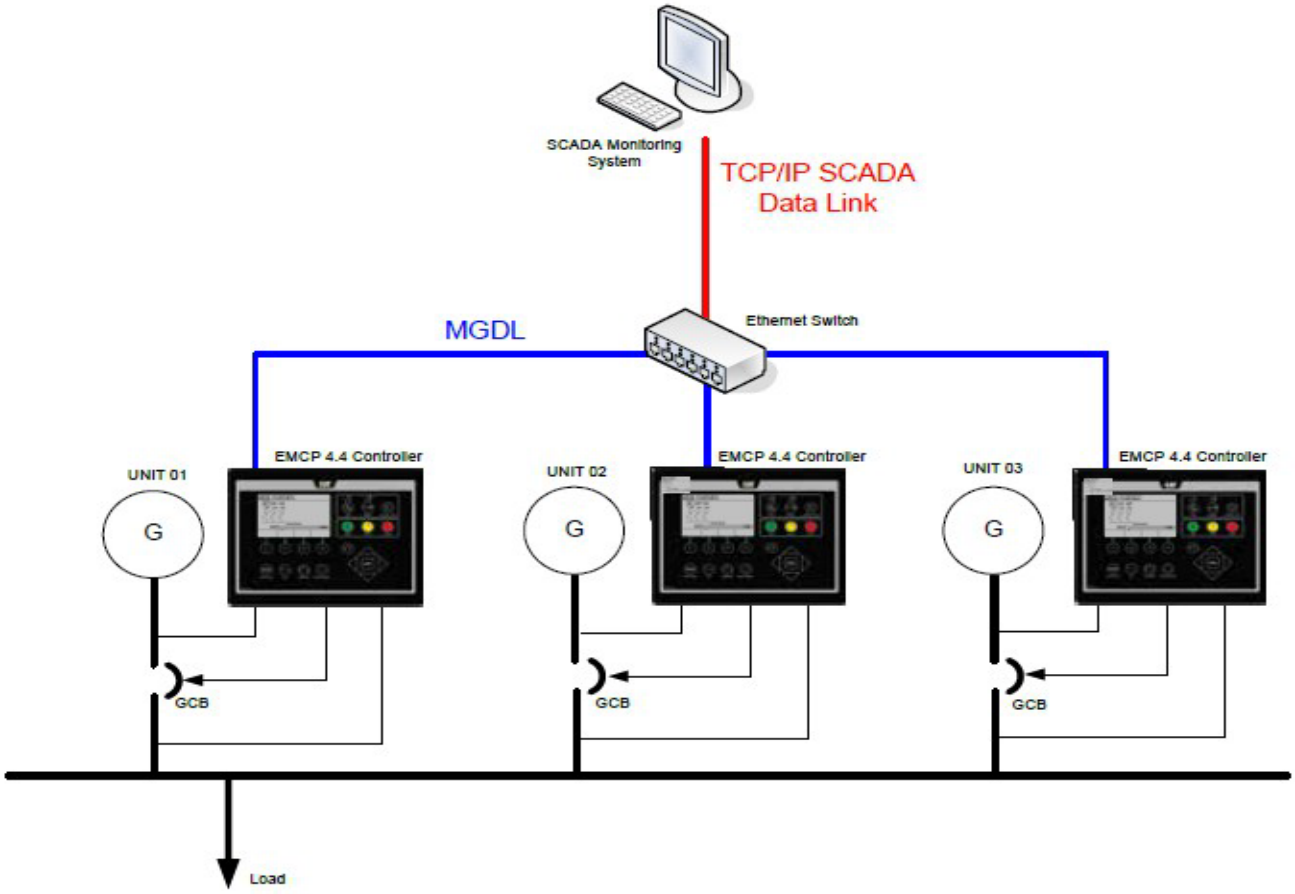


Figure 37.6 – Concurrent MGDL and TCP/IP Network Overview

Separate IP addresses exist for EMCP 4.4 controllers on the MGDL network and on a TCP/IP SCADA network. The EMCP 4.4 TCP IP address, subnet and gateway used for SCADA monitoring are configurable by the user whereas the EMCP 4.4 MGDL IP address is NOT configurable. The EMCP 4.4 MGDL IP address is dynamically assigned at the time the unit connects to an MGDL network. Therefore, the EMCP 4.4 MGDL IP address MAY change based on existing MGDL network nodes. The EMCP 4.4 MGDL IP address is provided on the EMCP 4.4 display screen for reference only and is described in the MGDL Network Status Screens section of this manual (Section 37.6.7). Due to the criticality of the MGDL communications, care should be taken in the routing of the signals to be sure other network traffic does not interfere in the transmission of these critical control parameters. For more information on EMCP 4 SCADA data links including TCP/IP SCADA monitoring refer to the EMCP 4 SCADA Data Links, Application and Installation Guide (LEBE0010).

37.3 MGDL Software Configuration

The MGDL feature setpoints can be accessed using either the Cat ET Service Tool, or directly through the EMCP display. Some setpoints are locked at ET only or at Security Level 3 and cannot be changed from the EMCP display or will require a level 3 password. Please note that ET Service Tool version 2013A or later is recommended for accessing and adjusting MGDL setpoints.

37.3.1 MGDL System Configuration

To access the MGDL system configuration setpoints using the ET Service Tool, connect to the EMCP 4.4 Generator Set Control and click on the 'Configuration Tool' button (alternatively press F5) to enter the configuration menu. Select 'Data Link: Multiple Genset Control' from the menu on the left to display the following default settings shown in Figure 37.7:

Note: If any combination of Hardwired and MGDL setpoint configuration exists, a shutdown will be triggered on the EMCP 4.4 controller until the configuration is corrected.

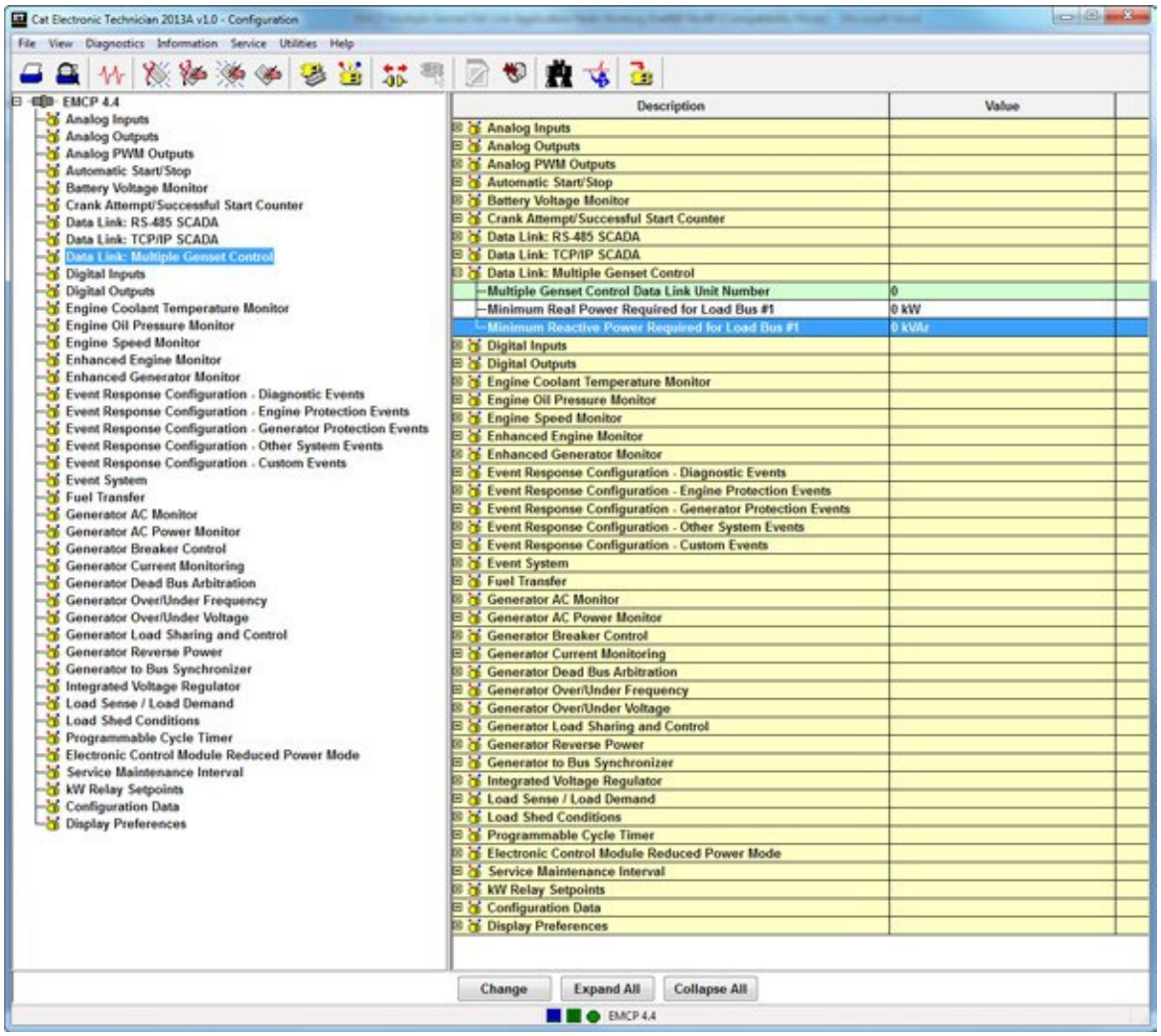


Figure 37.7 – MGDL System Configuration View in ET

To access the MGDL setpoints through the EMCP display, navigate to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ PARALLELING

→ MULTIPLE GENSET DATA LINK

The minimum, maximum, resolution, units and default for each setpoint along with a brief description of the purpose of each setpoint are provided below.

37.3.2 Multiple Genset Control Data Link Unit Number

Name	Min	Max	Resolution	Units	Default Value	Access
Multiple Genset Control Data Link Unit Number	0	64	1	N/A	0	ET Service Tool or EMCP Display

Table 37.3

The *Multiple Genset Control Data Link Unit Number* (setpoint) is used to assign a unit number to the controller on the MGDL network as well as enable or disable communication of the EMCP 4.4 controller on the MGDL network. All EMCP 4.4 controllers configured to operate using MGDL should be assigned a unique MGDL Unit Number.

- If set to 'zero' the MGDL feature is disabled and the EMCP 4.4 will not communicate over the MGDL network to other controllers.
- If set to a non-zero value (1-64) the MGDL feature is enabled and the EMCP 4.4 will communicate over the MGDL network to other controllers.
- While the software supports 64 different MGDL Unit Numbers, only a maximum of 16 units on the MGDL network are currently supported simultaneously.
- It is recommended to use lower numbers since under failure scenarios, higher number will slow down the operation of the unit.

Note: Configuring this setpoint to zero automatically hides all MGDL-related screens on the EMCP 4.4 display.

⚠ WARNING

Each unit MUST be assigned a unique MGDL unit number before operation. Updating or changing the MGDL unit number during generator set operation is NOT recommended and may cause a unit and/or system shutdown.

Failure to heed this warning can lead to loss of load, system failures, product damage, personal injury or death.

The EMCP 4.4 contains logic that does not allow two units to be configured to the same MGDL unit number. If the EMCP 4.4 detects duplicate MGDL unit numbers on the MGDL network a MULTIPLE GENSET DATA LINK CONFIGURATION ERROR (SPN-FMI: 625-14) event is triggered and the two units will be shutdown. For more details on troubleshooting the MULTIPLE GENSET DATA LINK CONFIGURATION ERROR (SPN-FMI: 625-14) event refer to Section 37.7.1.

37.3.3 Minimum Power Required for Feeder Breaker

Name	Min	Max	Resolution	Units	Default Value	Access
Minimum Real Power Required for Load Bus #1	0	62,500,000	1	kW	0	ET Service Tool or EMCP Display
Minimum Reactive Power Required for Load Bus #1	0	62,500,000	1	kVAr	0	

Table 37.4

The MGDL feature provides limited feeder breaker control. For control of a feeder breaker a programmable digital output must be configured for Feeder Breaker Close Command and/or Feeder Breaker Trip Command. See Section 37.4.6 for more information on EMCP 4.4 MGDL Feeder Breaker Control. In addition, this feature can also be used to implement load add functionality.

The *Minimum Real Power Required for Load Bus #1* (setpoint) and *Minimum Reactive Power Required for Load Bus #1* (setpoint) determine the minimum available power required before issuing a feeder breaker close command. The available power is determined by the rated power (real and reactive) of all units communicating on the MGDL network that are closed to the bus.

The following subsections provide setpoint configuration details on each of the MGDL paralleling features.

37.3.4 MGDL Dead Bus Arbitration Configuration

To access the MGDL Dead Bus Arbitration configuration setpoints in ET, select 'Generator Dead Bus Arbitration' from the menu on the left to display the following settings:

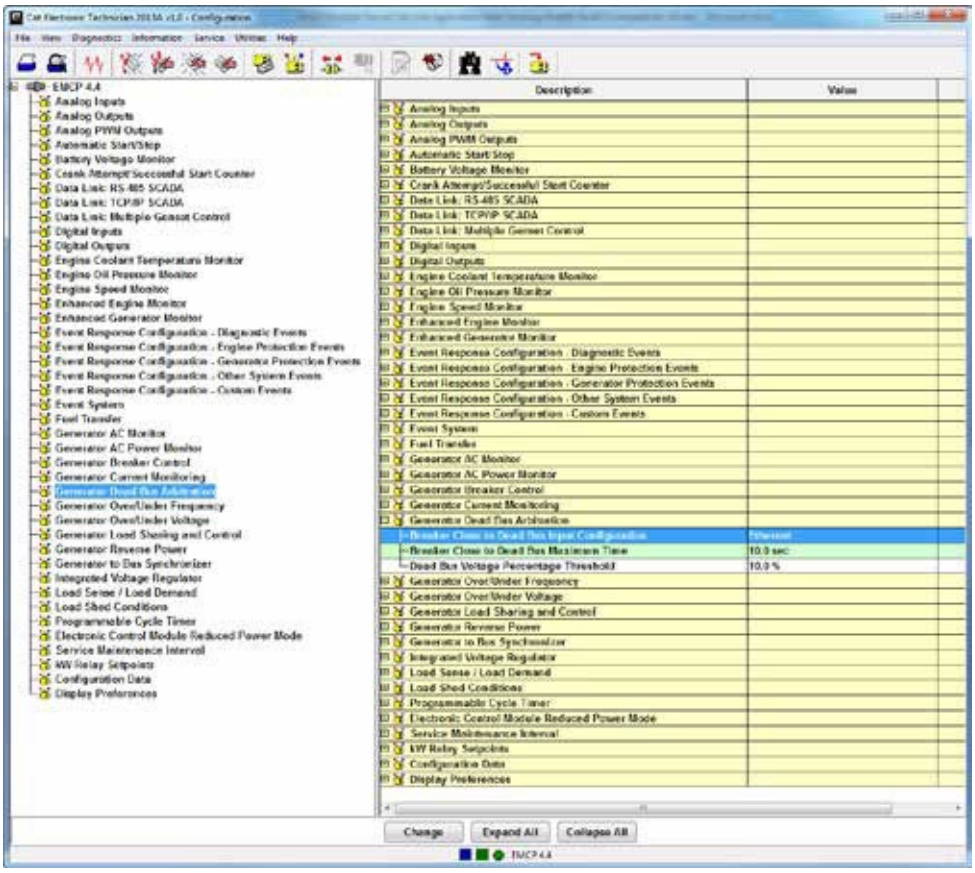


Figure 37.8: MGDL Dead Bus Arbitration Setpoint Configuration View in ET

To access the MGDL Dead Bus Arbitration setpoints through the EMCP display, navigate to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ PARALLELING

→ DEAD BUS ARBITRATION

Each setpoint used for configuring MGDL Dead Bus Arbitration is described below.

37.3.5 Breaker Close to Dead Bus Input Configuration

Name	Options	Default Value	Access
Breaker Close to Dead Bus Input Configuration	0 = Not Installed 1 = Hardwired Input 2 = Ethernet (MGDL)	1 = Hardwired Input	ET Service Tool or EMCP Display

Table 37.5

The *Breaker Close to Dead Bus Input Configuration* (setpoint) is used to select the method used for dead bus arbitration. Select 'Ethernet (MGDL)' for dead bus closing via multiple generator set data link.

37.3.6 Breaker Close to Dead Bus Maximum Time

Name	Min	Max	Resolution	Units	Default Value	Access
Breaker Close to Dead Bus Maximum Time	0.1	10.0	0.1	Seconds	1.0	ET Service Tool or EMCP Display

Table 37.6

The *Breaker Close to Dead Bus Maximum Time* (setpoint) determines the maximum amount of time a unit will attempt to close to a dead bus when other units are available to dead bus close.

When no other units are available to dead bus close, *Breaker Close to Dead Bus Maximum Time* is not enforced. Instead the *Generator Breaker Maximum Closing Time* (setpoint) found in the Generator Breaker Control setpoints group is enforced.

37.3.7 Dead Bus Voltage Percentage Threshold

Name	Min	Max	Resolution	Units	Default Value	Access
Dead Bus Voltage Percentage Threshold	5	50	1	%	10	ET Service Tool or EMCP Display

Table 37.7

The *Dead Bus Voltage Percentage Threshold* (setpoint) is a percentage of rated voltage used to determine a live bus or dead bus status. If average bus voltage is measured below this threshold, the bus is considered dead and a unit may close to the bus without synchronizing.

37.3.8 MGDL Load Sharing Configuration

To access the MGDL Load Sharing configuration setpoints in ET, select 'Generator Load Sharing and Control' from the menu on the left to display the following settings:

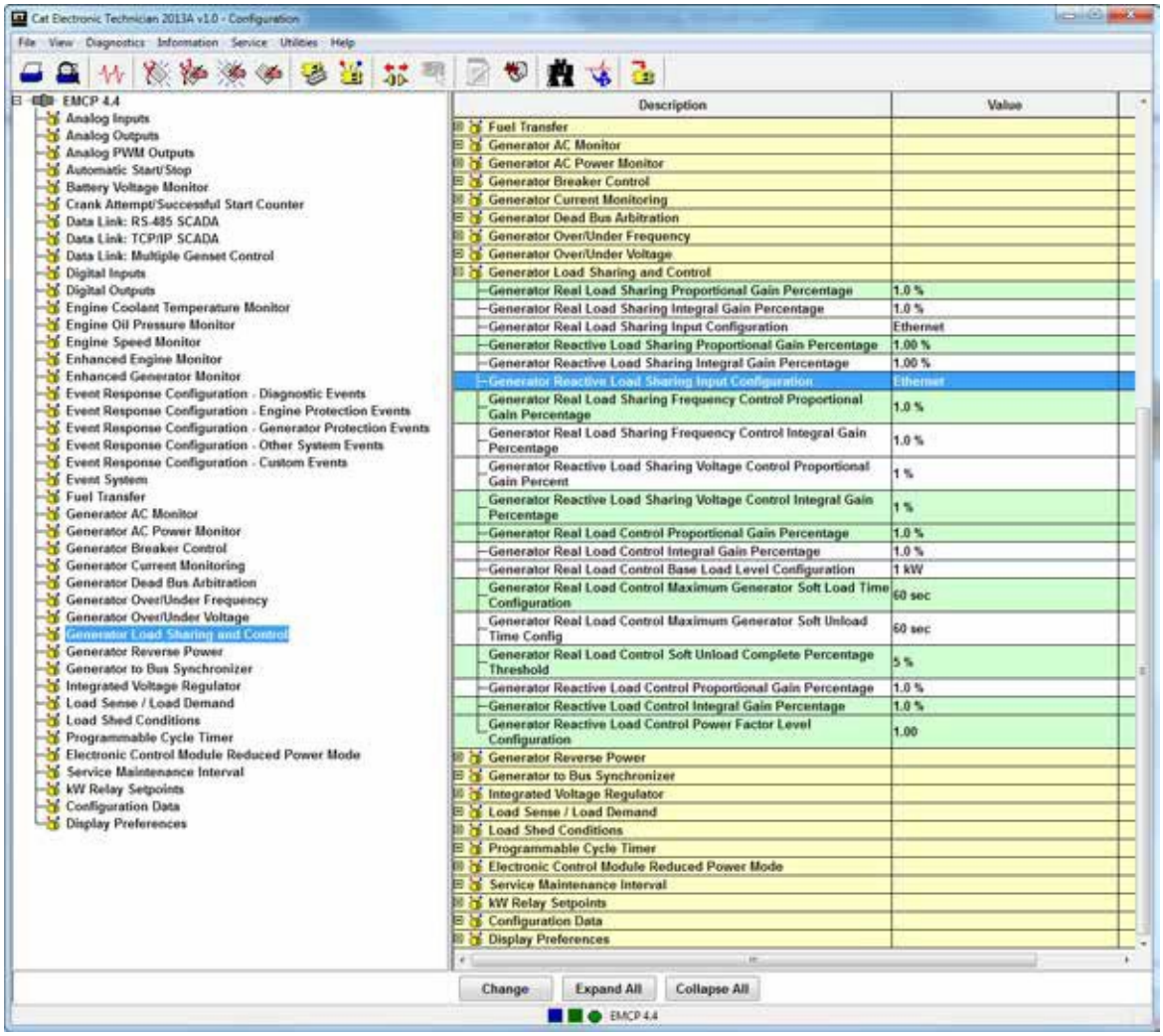


Figure 37.9 – MGDL Load Sharing Setpoint Configuration View in ET

To access the MGDL Generator Load Sharing setpoints through the EMCP display, navigate to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ PARALLELING

→ GEN LOAD SHARING

Each setpoint used for configuring MGDL Load Sharing is described below.

Generator Real Load Sharing Input Configuration

Name	Options	Default Value	Access
Generator Real Load Sharing Input Configuration	0 = Disabled 1 = 0 to 10 V 2 = 0 to 3 V 3 = Ethernet (MGDL)	0 (Disabled)	ET Service Tool or EMCP Display

Table 37.9

The *Generator Real Load Sharing Input Configuration* (setpoint) is used to select the method used for real load sharing between generator sets. Select 'Ethernet (MGDL)' for real load sharing via multiple generator set data links.

Generator Real Load Sharing PI Gains

Name	Min	Max	Resolution	Units	Access
Generator Real Load Sharing Proportional Gain Percentage	0.0	100.0	0.1	%	ET Service Tool or EMCP Display
Generator Real Load Sharing Integral Gain Percentage	0.0	100.0	0.1	%	

Table 37.10

Real Load Sharing PI gains control how equally real power is shared between generator sets operating in parallel. The *Generator Real Load Sharing Proportional Gain Percentage* (setpoint) and *Generator Real Load Sharing Integral Gain Percentage* (setpoint) can be tuned to achieve the desired load sharing response depending on the application and generator set configuration. Some optimization and tuning may be required from default values.

Please refer to the MGDL Paralleling Tuning Guide section of this manual (Section 28.5) for further information on tuning the controller gains.

Generator Real Load Sharing Frequency Control PI Gains

Name	Min	Max	Resolution	Units	Access
Generator Real Load Sharing Frequency Control Proportional Gain Percentage	0.0	100.0	0.1	%	ET Service Tool or EMCP Display
Generator Real Load Sharing Frequency Control Integral Gain Percentage	0.0	100.0	0.1	%	

Table 37.11

Real Load Sharing Frequency Control PI gains control how closely bus frequency is regulated to the desired value when generator sets are load sharing in parallel.

The *Generator Real Load Sharing Frequency Control Proportional Gain Percentage* (setpoint) and *Real Load Sharing Frequency Control Integral Gain Percentage* (setpoint) can be tuned to control to the desired bus frequency based on the application type and generator set configuration. Some optimization may be required from default values.

Please refer to the MGDL Paralleling Tuning Guide section of this manual (Section 37.5) for further information on tuning the controller gains.

37.3.9 Generator Real Load Sharing Soft Loading/Unloading

Name	Min	Max	Resolution	Units	Default Value	Access
Generator Real Load Control Maximum Generator Soft Load Time Configuration	0	600	1	Seconds	60	ET Service Tool or EMCP Display
Generator Real Load Control Maximum Generator Soft Unload Time Configuration	0	600	1	Seconds	60	
Generator Real Load Control Soft Unload Complete Percentage Threshold	1	50	1	%	5	

Table 37.12

When load sharing, soft loading and soft unloading reduces instability and risk to equipment by increasing or decreasing load in a controlled manner before closing or opening the generator breaker.

The *Generator Real Load Control Maximum Generator Soft Load Time Configuration* (setpoint) is the amount of time a unit will take to increase real power from 0% to 100% real power when coming on the bus. The *Generator Real Load Control Maximum Generator Soft Unload Time Configuration* (setpoint) is the amount of time a unit will take to decrease real power from 100% to 0% real power when going off the bus. The *Generator Real Load Control Soft Unload Complete Percentage Threshold* (setpoint) is the percentage of rated real power at which a unit completes soft unloading and opens the generator breaker.

For example, if *Generator Real Load Control Maximum Generator Soft Unload Time Configuration* is set to 60 seconds and *Generator Real Load Control Soft Unload Complete Percentage Threshold* is set to 5%, a unit decreasing load from 50% of rated real power should be expected to soft unload for approximately 27 seconds (or 1.67%/sec) before opening the generator breaker.

Similarly, if *Generator Real Load Control Maximum Generator Soft Load Time Configuration* is set to 30 seconds, a unit that is increasing load to 50% of rated real power should be expected to soft load for approximately 15 seconds (or 3.33%/second) before closing the generator breaker. Refer to Figure 37.10 for an illustration of this example of soft unloading and soft loading.

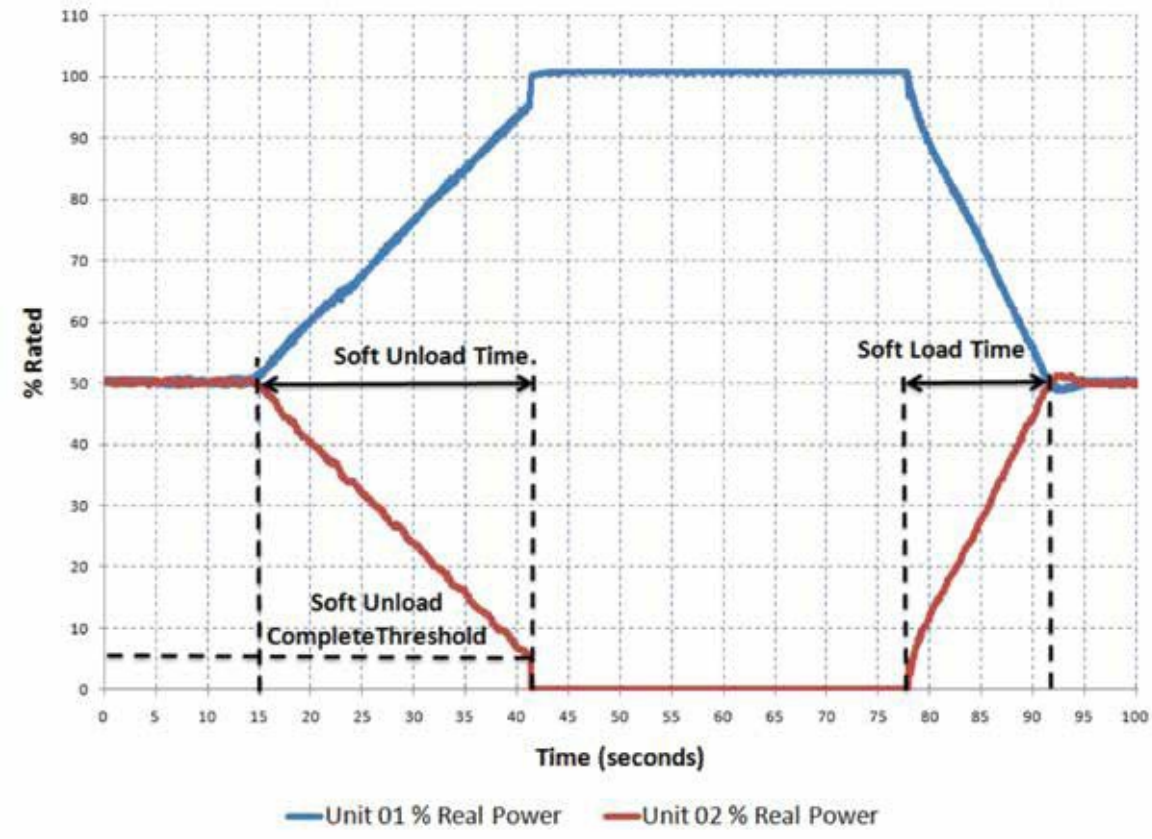


Figure 37.10 – Soft Loading/Unloading Profile with Soft Unload Time Setpoint = 60 Sec, Soft Load Time Setpoint = 30 Sec, and Soft Unload Complete % Threshold Setpoint = 5%

Generator Reactive Load Sharing Input Configuration

Name	Options	Default Value	Access
Generator Reactive Load Sharing Input Configuration	0 = Disabled 1 = 0 to 10 V 2 = Ethernet (MGDL)	0 (Disabled)	ET Service Tool or EMCP Display

Table 37.13

The *Generator Reactive Load Sharing Input Configuration* (setpoint) is used to select the method used for reactive load sharing between generator sets . Select 'Ethernet (MGDL)' for reactive load sharing via multiple generator set data links .

Generator Reactive Load Sharing PI Gains

Name	Min	Max	Resolution	Units	Access
Generator Reactive Load Sharing Proportional Gain Percentage	0.0	100.0	0.1	%	ET Service Tool or EMCP Display
Generator Reactive Load Sharing Integral Gain Percentage	0.0	100.0	0.1	%	

Table 37.14

Reactive Load Sharing PI gains control how equally reactive power is shared between generator sets operating in parallel. The *Generator Reactive Load Sharing Proportional Gain Percentage* (setpoint) and *Generator Reactive Load Sharing Integral Gain Percentage* (setpoint) can be tuned to achieve the desired load sharing response depending on the application and generator set configuration. Some optimization and tuning may be required from default values.

Please refer to the MGDL tuning section of this manual (Section 37.5) for further information on tuning the controller gains.

Generator Reactive Load Sharing Voltage Control PI Gains

Name	Min	Max	Resolution	Units	Access
Generator Reactive Load Sharing Voltage Control Proportional Gain Percentage	0.0	100.0	0.1	%	ET Service Tool or EMCP Display
Generator Reactive Load Sharing Voltage Control Integral Gain Percentage	0.0	100.0	0.1	%	

Table 37.15

Reactive Load Sharing Voltage Control PI gains control how closely bus voltage is regulated to the desired value when generator sets are load sharing in parallel.

The *Generator Reactive Load Sharing Voltage Control Proportional Gain Percentage* (setpoint) and *Generator Reactive Load Sharing Voltage Control Integral Gain Percentage* (setpoint) can be tuned to control to the desired bus voltage based on the application type and generator set configuration. Some optimization may be required from default values.

Please refer to the MGDL tuning section of this manual (Section 37.5) for further information on tuning the controller gains.

37.3.10 MGDL Load Sense Load Demand Configuration

To access the MGDL Load Sense Load Demand configuration setpoints in ET, select 'Load Sense/Load Demand' from the menu on the left to display the following settings:

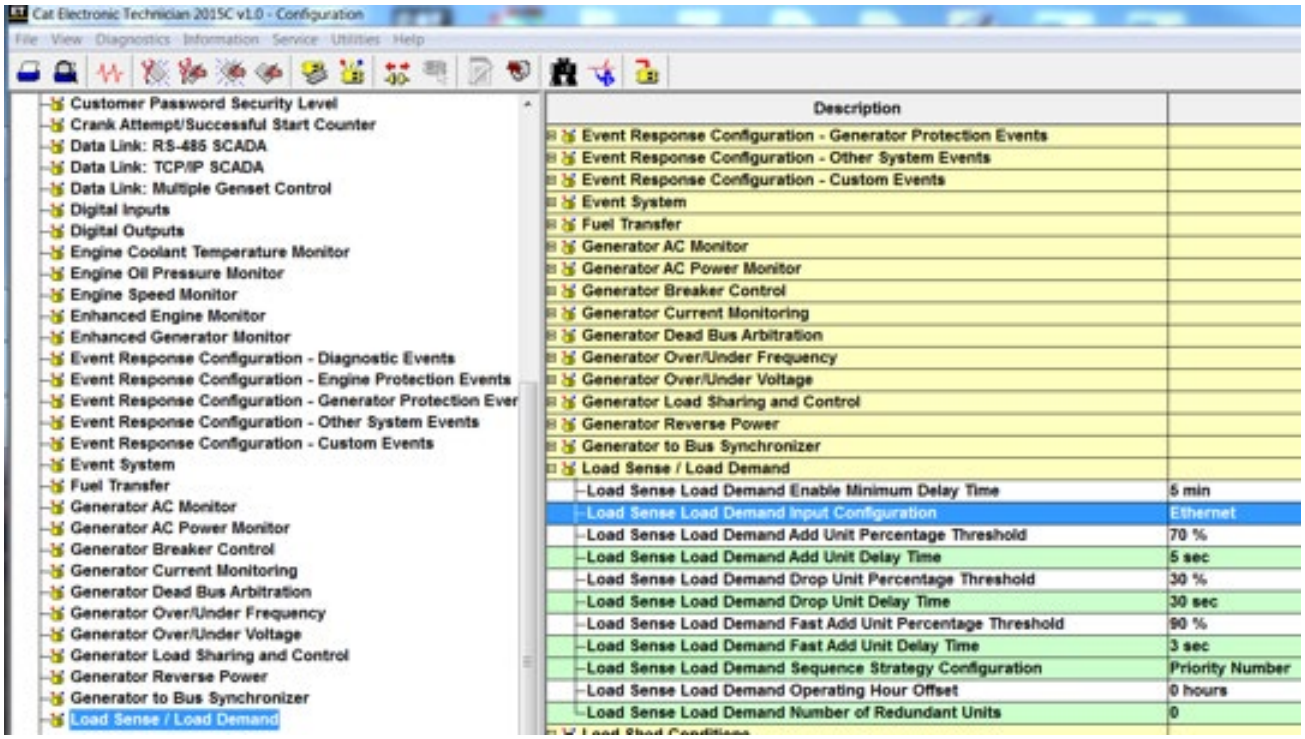


Figure 37.11 – MGDL Load Sense Load Demand Setpoint Configuration View in ET

To access the MGDL Load Sense Load Demand setpoints through the EMCP display, navigate to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ PARALLELING

→ LOAD SENSE LOAD DEMAND

Each setpoint used for configuring MGDL Load Sense Load Demand is described below.

Load Sense Load Demand Input Configuration

Name	Options	Default Value	Access
Load Sense Load Demand Input Configuration	0 = Disabled 1 = Hardwired Input 2 = Ethernet (MGDL)	0 (Disabled)	ET Service Tool or EMCP Display

Table 37.16

The *Load Sense Load Demand Input Configuration* (setpoint) is used to select the method used for sequencing generator sets on or off the bus based on load demand. Select 'Ethernet (MGDL)' for load sequencing via multiple generator set data links.

Note: All LSLD system-wide setpoints are configurable via ET or EMCP Display even when Load Sense Load Demand Input Configuration is set to DISABLED. When MGDL unit number is set to zero, LSLD system-wide setpoints are configurable, but not communicated over the MGDL network.

Load Sense Load Demand Enable Minimum Delay Time

Name	Min	Max	Resolution	Units	Default Value	Access
Load Sense Load Demand Enable Minimum Delay Time	1	30	1	Minutes	5	ET Service Tool or EMCP Display

Table 37.17

The *Load Sense Load Demand Enable Minimum Delay Time* (setpoint) is the minimum amount of time after a live bus is detected a unit must delay before entering LSLD mode. After this time, units may sequence on or off the bus based on load demand.

Note: This setpoint is considered a "system-wide" setpoint and is configurable from any node in the MGDL network. The setpoint is automatically applied to all EMCP 4.4 controllers on the MGDL network (regardless of whether the LSLD is set to 'Disabled' or 'Ethernet (MGDL)') and any controller powered up will adopt the strategy of other controllers already powered up.

Load Sense Load Demand Add/Drop Units Configuration

Name	Min	Max	Resolution	Units	Default Value	Access
Load Sense Load Demand Add Unit Percentage Threshold	0	115	1	%	70	ET Service Tool or EMCP Display
Load Sense Load Demand Add Unit Delay Time	0	300	1	Seconds	5	
Load Sense Load Demand Drop Unit Percentage Threshold	0	90	1	%	30	
Load Sense Load Demand Drop Unit Delay Time	0	900	1	Seconds	30	
Load Sense Load Demand Fast Add Unit Percentage Threshold	0	150	1	%	90	
Load Sense Load Demand Fast Add Unit Delay Time	0	300	1	Seconds	3	

Table 37.18

The Load Sense Load Demand Add/Drop Unit Percentage Threshold setpoints set the percentage of system rated real power at which units will be sequenced on the bus (Add) or sequenced off the bus (Drop). The percentage of system rated real power must be above or below these thresholds for the respective Add/Drop Unit Delay Time before sequencing will occur.

Note: These setpoints are considered "system-wide" setpoints and are configurable from any node in the MGDL network. The setpoints are automatically applied to all EMCP 4.4 controllers on the MGDL network (regardless of whether the LSLD is set to 'Disabled' or 'Ethernet (MGDL)') and any controller powered up will adopt the strategy of other controllers already powered up.

While under LSLD control, the percentage of system real power is calculated ONLY from units on the bus (breaker closed) that are operating in LSLD mode. For example, Figure 37.12 depicts the loading of Unit 01, 02, and 03 in four different scenarios. Each scenario demonstrates the loading with respect to the default LSLD Add/Drop Units setpoints. The system % kW is the average % kW of Unit 01, 02, and 03 and is the value compared to the LSLD Add/Drop Unit Percentage Threshold system-wide setpoints.

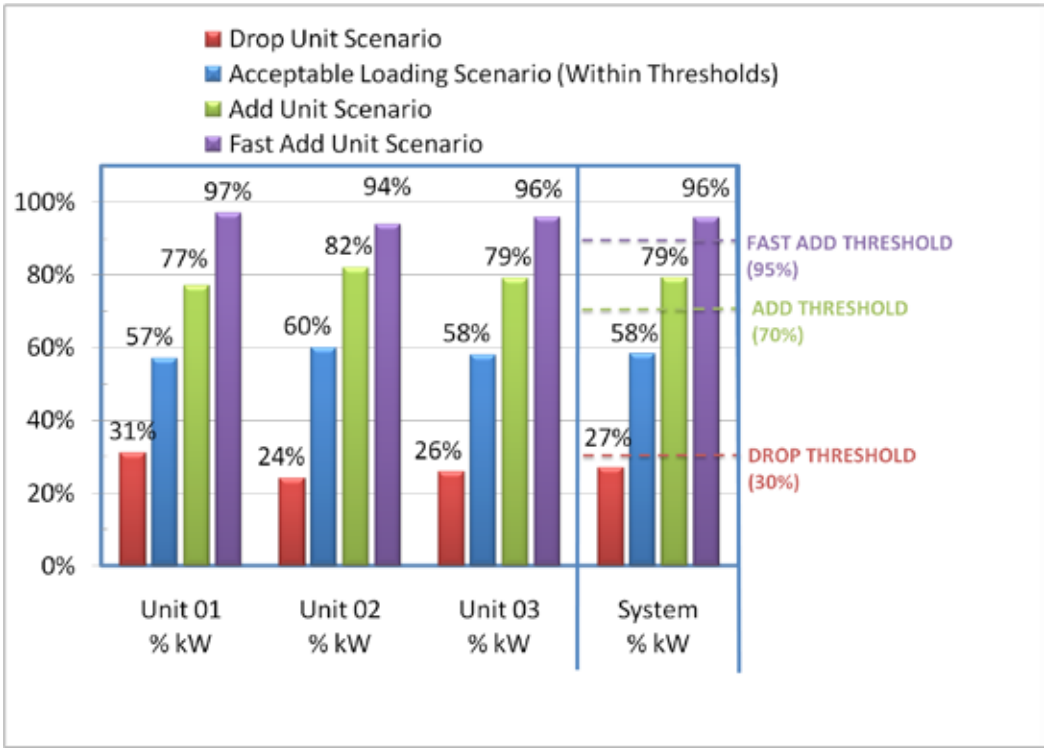


Figure 37.12 – LSLD Add/Drop Unit Example Scenarios

Load Sense Load Demand Sequence Strategy Configuration

Name	Options	Default Value	Access
Load Sense Load Demand Sequence Strategy Configuration	0 = Total Operating Hours 1 = Priority Number	1 = Priority Number	ET Service Tool or EMCP Display

Table 37.19

The *Load Sense Load Demand Sequence Strategy Configuration* (setpoint) sets the strategy used for determining the order in which units sequence on or off the bus under LSLD control.

- The 'Total Operating Hours' strategy is intended to balance the engine hours between individual generator sets.
- The 'Priority Number' strategy sequences units on or off based only on the assigned priority number.

Note: This setpoint is considered a "system-wide" setpoint and is configurable from any node in the MGDL network. The setpoint is automatically applied to all EMCP 4.4 controllers on the MGDL network [regardless of whether the LSLD is set to 'Disabled' or 'Ethernet (MGDL)'] and any controller powered up will adopt the strategy of other controllers already powered up.

Load Sense Load Demand Sequence Priority Number

Name	Min	Max	Resolution	Units	Default Value	Access
Load Sense Load Demand Sequence Priority Number	1	64	1	N/A	16	EMCP Display Only

Table 37.20

The *Load Sense Load Demand Sequence Priority Number* (setpoint) determines the priority (order) in which units sequence on or off the bus under LSLD control.

- The lowest priority number is the last unit to go off the bus and is the unit most likely to run.
- The highest priority number is the unit most likely to go off the bus first.

This setpoint is accessible ONLY through the EMCP LSLD Priority Assignment screen (Section 37.6.6) and is NOT configurable through Cat ET. This setpoint is also not transferred with an ECM/Fleet configuration file and must be re-programmed with any new configuration.

Note: LSLD sequencing priority (order) is NOT related to MGDL Unit number.

Each unit MUST be assigned a unique LSLD sequence priority number. EMCP Load Sense Load Demand software provides protection from this scenario by detecting and resolving sequence priority number conflicts automatically. As a result, user programmed sequence priority numbers MAY be re-assigned automatically to avoid conflicts. Do NOT confuse LSLD sequencing priority number with MGDL unit number. Duplicate MGDL unit numbers will shutdown the generator set.

Load Sense Load Demand Operating Hour Offset

Name	Min	Max	Resolution	Units	Default Value	Access
Load Sense Load Demand Operating Hour Offset	0	65,503	1	Hours	0	EMCP Display or ET Service Tool

Table 37.21

Load Sense Load Demand Operating Hour Offset determines the amount of engine hours that the user wants to artificially add to the engine hour meter to manipulate the load sense load demand priority when using total operating hours as the load sense load demand sequence strategy.

For example:

	Unit 1	Unit 2
Operating Hours	1000	250
Operating Hour Offset (setpoint)	0	0
Effective Hour meter for LSLD	1000	250
LSLD Priority	2	1

Table 37.22

If unit 1 is desired to be higher priority than unit 2 then an hours offset for unit 2 must be programmed

	Unit 1	Unit 2
Operating Hours	1000	250
Operating Hour Offset (setpoint)	0	800
Effective Hour meter for LSLD	1000	1050
LSLD Priority	1	2

Table 37.23

Load Sense Load Demand Number of Redundant Units (N+X Strategy)

Name	Min	Max	Resolution	Units	Default Value	Access
Load Sense Load Demand Number of Redundant Units (N+X Strategy)	0	4	1	N/A	0	EMCP Display or ET Service Tool

Table 37.24

Load Sense Load Demand Number of Redundant Units (N+X Strategy) controls the number of redunmdant units that will run when a group start is active.

37.3.11 MGDL Event Response Configurations

The EMCP 4.4 response to an event being triggered can be configured in the EMCP 4.4 via setpoints called Event Response Configurations. These setpoints determine the actions the EMCP 4.4 takes when the event occurs. To access the MGDL related event response configuration setpoints in ET, select one of the 'Event Response Configuration' groups from the menu on the left to display the setpoints.

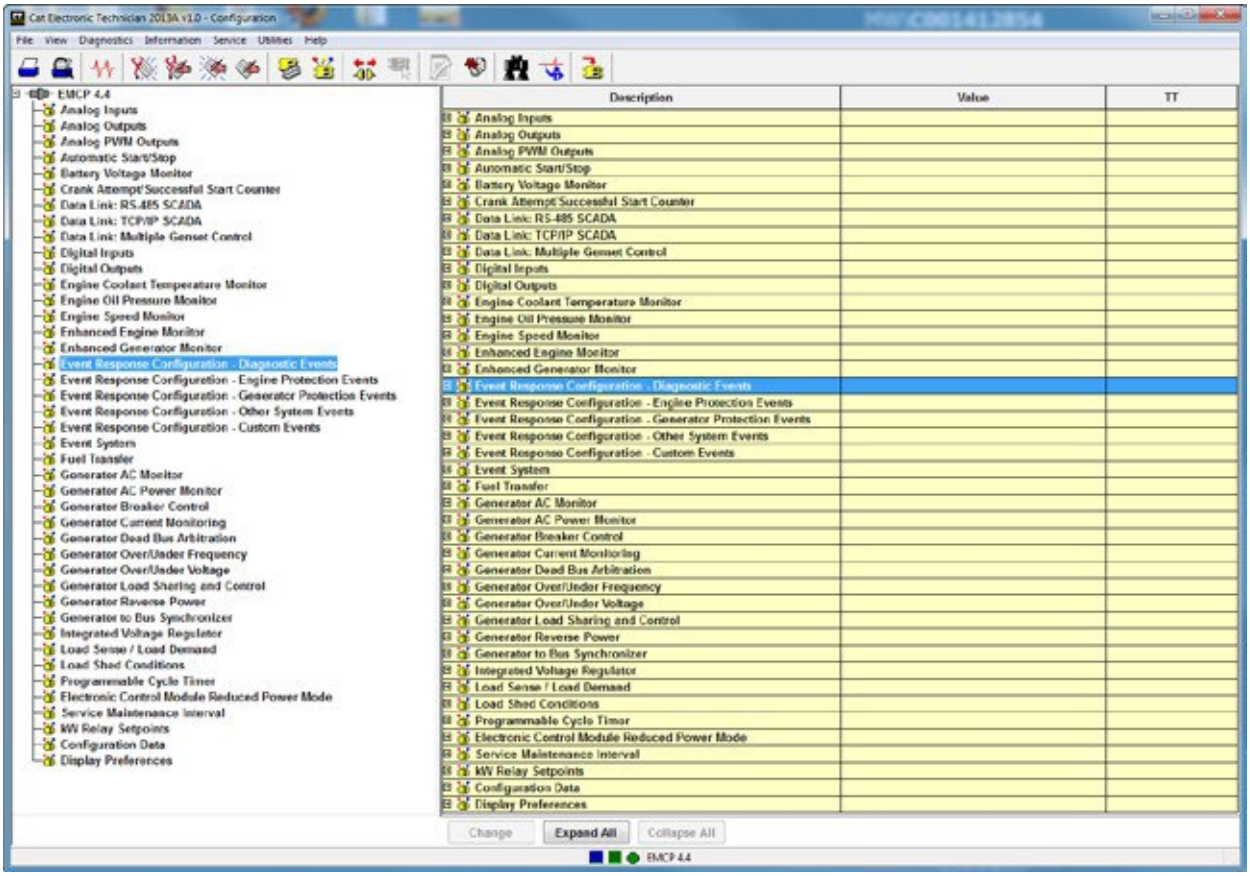


Figure 37.13 – Event Response Configuration View in ET

To access the Event Response Configuration setpoints through the EMCP display, navigate to the following sub-menu:

MAIN MENU

→ CONFIGURE

→ ALL SETPOINTS

→ EVENTS

→ DIAGNOSTIC RESP CONFIG

→ GEN PROTECT RESP CONFIG

Each setpoint used for configuring MGDL related event response configurations is described on the following page.

MGDL Network Diagnostic Response Configurations

Name	Min	Max	Default Value	Access
Multiple Genset Control Data Link Communication Failure Diagnostic Response Configuration	Disabled	Warning, Audible Alert, Soft Shutdown, Hard Shutdown, Breaker #1 Trip, Breaker #2 Trip, Fault Protection Timer Enabled, Active Only	Audible Alert, Hard Shutdown	ET Service Tool or EMCP Display
Control is Offline Multiple Genset Control Data Link Diagnostic Response Configuration	Disabled	Warning, Audible Alert, Soft Shutdown, Hard Shutdown, Breaker #1 Trip, Breaker #2 Trip, Fault Protection Timer Enabled, Active Only	Audible Alert, Warning, Active Only	

Table 37.25

The *Multiple Genset Control Data Link Communication Failure Diagnostic Response Configuration* (setpoint) determines how the EMCP 4.4 responds to an MGDL COMMUNICATION FAILURE (SPN-FMI: 625-19) event. See Section 37.7.3 for further details on this event.

The *Control is Offline Multiple Genset Control Data Link Diagnostic Response Configuration* (setpoint) determines how the EMCP 4.4 responds to the loss of communications with an expected unit on the MGDL network that triggers an MGDL CONTROL IS OFFLINE (SPN-FMI: 625-31) event. See Section 37.7.2 for further details on this event.

Dead Bus Inconsistent Sensing Event Response Configuration

Name	Min	Max	Default Value	Access
Dead Bus Inconsistent Sensing Warning Event Response Configuration	Disabled	Warning, Audible Alert, Breaker #1 Trip, Breaker #2 Trip, Active Only	Audible Alert, Warning	ET Service Tool or EMCP Display

Table 37.26

The *Dead Bus Inconsistent Sensing Warning Event Response Configuration* (setpoint) determines how the EMCP 4.4 responds to inconsistent dead bus sensing between units on the MGDL network that triggers a DEAD BUS INCONSISTENT SENSING (SPN-FMI: 2530-2) event. See Section 37.7.7 for further details on this event.

37.4 MGDL Paralleling Features Operation

The EMCP 4.4 with MGDL has several paralleling functions including dead bus arbitration, synchronizing, load sharing, load shed, and load sense/load demand. The EMCP 4.4 with MGDL also provides for multiple modes of operation, including automatic synchronizing, manual synchronizing, and sync check mode. In the case of loss of communications, failsafe paralleling modes are also discussed here.

Dead Bus Arbitration

The EMCP 4.4 with MGDL incorporates true dead bus arbitration to determine and select the primary generator set to close to a dead bus, allowing only one unit to close to the dead bus. The dead bus arbitration control minimizes the time for the first generator set to close to the dead bus. See Section 37.4.1.

Synchronizing

The EMCP 4.4 monitors all three phases of the generator and main bus. The proprietary synchronizing algorithms drive the generator output frequency, voltage, and phase to match another source, and close the generator circuit breaker when conditions have been met. With the addition of MGDL network feature, the synchronizing functionality on the EMCP 4.4 has not changed from the Hardwired version. Please refer to Section 15.5 for detailed information on EMCP 4.4 synchronizing.

Load Sharing

The EMCP 4.4 actively monitors the real (kW) and reactive (kVAr) load requirement of all paralleled generator sets on the MGDL network, and adjusts output of the generator set to maintain a balanced loading of all generator sets. See Section 37.4.3.

Load Shed

The EMCP 4 provides a configurable signal to aid in the removal of load. With the addition of MGDL network feature, the load shed functionality on the EMCP 4.4 has not changed. Please refer to Section 15.7 for detailed information on the EMCP 4.4 load shed feature.

MGDL Group Start Command

The EMCP 4.4 provides the ability to command all units to start and run via MGDL from a single unit's dedicated isolated group start digital input. See Section 37.4.4 for more information.

Load Sense/Load Demand

The EMCP 4.4 includes logic to sequence generator sets based on the total load requirement of the system. If the site load exceeds a minimum reserve kW threshold, additional generator sets will automatically start, synchronize, and close the generator breaker. If the site load falls below a reserve kW threshold, a generator set will automatically unload, open the generator circuit breaker, and shut down. Generator sets can be configured to sequence on and off in order to balance engine hours (with an optional offset) or priority assignment. See Section 37.4.5.

Feeder Breaker Control (Load Add)

The EMCP 4.4 includes limited feeder (tie) breaker close and trip control for connecting a generator bus and a load bus in an automatic mains failure (AMF) or utility dead bus condition. See Section 37.4.6.

MGDL Loss of Communications Strategy

The EMCP 4.4 includes logic that provides redundancy to the MGDL paralleled system in the case of a unit being lost from the MGDL network. The loss of communications strategy groups units and alters modes in failure scenarios in order to maximize the load capability of the MGDL paralleled system but also to minimize the risk of loss of load or damage to equipment. See Section 37.4.7.

MGDL Network Configuration (Expected Units) Reset

The EMCP 4.4 provides the ability for updating or re-configuring the MGDL network configuration (topology) by resetting the number of expected units on the MGDL network. This capability is typically only necessary for re-defining the MGDL network node count and should be done with caution. See Section 37.4.8.

MGDL Failsafe Load Sharing/Droop

The EMCP 4.4 provides a patented failsafe strategy for load sharing in loss of MGDL communication scenarios. In these failure mode scenarios, this strategy adaptively adjusts generator set operating conditions in order to maximize the amount of load the MGDL paralleled system can provide while introducing minimal disruption or instability into the system. See Section 37.4.9.

37.4.1 MGDL Dead Bus Arbitration Operation

When multiple generator sets are simultaneously started, their outputs are not synchronized when they reach rated speed and voltage. If more than one generator set is allowed to simultaneously close to the de-energized (dead) bus an out of phase paralleling situation (crash-parallel) can occur that may cause equipment damage or failure. To avoid a crash-parallel situation, one generator must be selected to close to the dead bus and create a synchronization reference for other generator sets.

Failure of an operator or a control system to allow ONLY one generator to exclusively close to a dead bus could result in extensive damage to the generator sets. Therefore automatic circuit breaker closure is inhibited to all units except one in dead bus arbitration. The one generator set that is selected is typically the first generator to reach rated speed and voltage.

Basic Operation

Dead bus arbitration between generators is accomplished using the MGDL network to communicate between generator sets. There is NO master or group controller in MGDL DBA. A virtual token-based methodology is used to arbitrate between generator sets and consists of the following rules:

- All units must agree that the bus is dead.
- All units are allowed to request the token if they are up to speed and voltage.
- Only one unit may capture (possess) the token.
- A unit that captures the token must receive permission from all other requesting units (dead bus close grant) before it attempts to dead bus close.

This methodology minimizes the amount of time for a unit to close to a dead bus and allows a unit to detect whether to keep trying or allow a different unit to attempt to close to a dead bus. If there are no prohibiting events, arbitration between the generators is performed using the rules described above. A typical arbitration sequence consists of the following:

1. Once a unit is within thresholds for speed and voltage, the unit requests the token.

2. If no other unit has the token, the unit captures the token.

3. The unit that captures the token waits for all other requesting units to grant it permission to dead bus close.

4. The unit is granted permission from all other requesting units and issues a generator breaker close command.

5. The unit detects a generator breaker close and a live bus.

Dead bus arbitration is complete for all units when the live bus is detected. At this time, units that are off the bus may proceed to synchronize and close to the live bus. The individual unit DBA states and system DBA states are visible from the EMCP 4.4 display. Refer to Section 37.6.5 MGDL Dead Bus Arbitration Screens for more details.

Note: Automatic Dead Bus Arbitration operation requires the Sync Mode Switch (SMS) to be placed in AUTO. Dead bus arbitration is still performed with the sync mode switch in other states. The operation of dead bus arbitration with respect to all sync mode switch states is:

- If the SMS is in Auto, only automatic operation of DBA is allowed.
- If the SMS is in Manual, DBA will only attempt to dead bus arbitrate when there is a request (via digital input) to manually close the generator breaker.
- If the SMS is in Check, DBA allows a manual request to close (via digital input) if the generator set meets the voltage and frequency requirements, similar to SMS in Manual.
- If the SMS is in Off, DBA will not function.

Dead Bus Detection

All units (that are sensing any particular bus) need to agree that a bus is dead before a unit may dead bus close to that bus, even if that unit directly detects the bus as dead. This helps protect against a unit with blown/open bus sensing from dead bus closing to a live bus.

Each EMCP 4.4 on the MGDL unit uses bus voltage sensing inputs to measure average bus voltage. If average bus voltage is measured below the Dead Bus Voltage Percentage Threshold setpoint, the bus is considered dead and the unit communicates this status to all other units on the MGDL network.

Each EMCP 4.4 considers the bus status of ALL units on the MGDL network when determining the system bus status. The system bus status is considered live when any MGDL unit detects a live bus and is considered dead when all MGDL units detect a dead bus. If the system bus status is dead a unit may initiate dead bus arbitration and close to the bus without synchronizing.

A unit activates the Dead Bus Inconsistent Sensing Warning event (SPN-FMI: 2530-2) if two or more MGDL units do not agree on the dead bus status. The warning will be cleared only when all units on the MGDL network agree on the status of the bus. If an MGDL unit has lost communication with the rest of the group, then its dead bus detection will not be used in determining system dead bus status.

Generator Breaker Fail to Close to Dead Bus

One key requirement for dead bus arbitration is to minimize the time required to get a generator set on the bus. This requirement must be balanced with providing a single generator set sufficient time/attempts to close to a dead bus. Therefore, a unit will attempt to close to the dead bus immediately if all requesting units grant it permission to dead bus close. However, if the unit is granted permission but fails to close, dead bus arbitration operates such that other units are allowed to close (and re-attempt to close) to the dead bus as soon as possible. Dead bus fail to close operation for a single unit and multiple units is described below:

- If multiple units are requesting, a unit that fails to close must delay 2 seconds before re-requesting to allow other units equal chance to close. If multiple other units are requesting (up to speed and voltage) permission is passed to the unit with the next highest MGDL unit number. (When there are no more higher MGDL unit numbers, permission is cycled back to the lowest MGDL unit number.)

Note: If an operator issues a manual generator breaker close command, the unit will immediately take permission and attempt to dead bus close. In automatic mode, system is designed to minimize the possibility of a simultaneous dead bus close; however, ultimately the responsibility lies with the operator issuing the manual generator breaker close command.

- If a unit fails to dead bus close after a maximum of 5 attempts, a Dead Bus Arbitration Failure Shutdown (SPN-FMI: 2530-1) is generated. The maximum failure count is reset to zero anytime a live bus is detected or the unit experiences a shutdown event.

- If multiple units are requesting, the Breaker Close to Dead Bus Maximum Time (setpoint) determines how long after issuing a breaker close a unit will try to close. If the Breaker Close to Dead Bus Maximum Time (setpoint) expires with no detection of generator breaker closed a Dead Bus Arbitration Failure Warning (SPN-FMI: 2530-17) event is triggered (Figure 37.14).

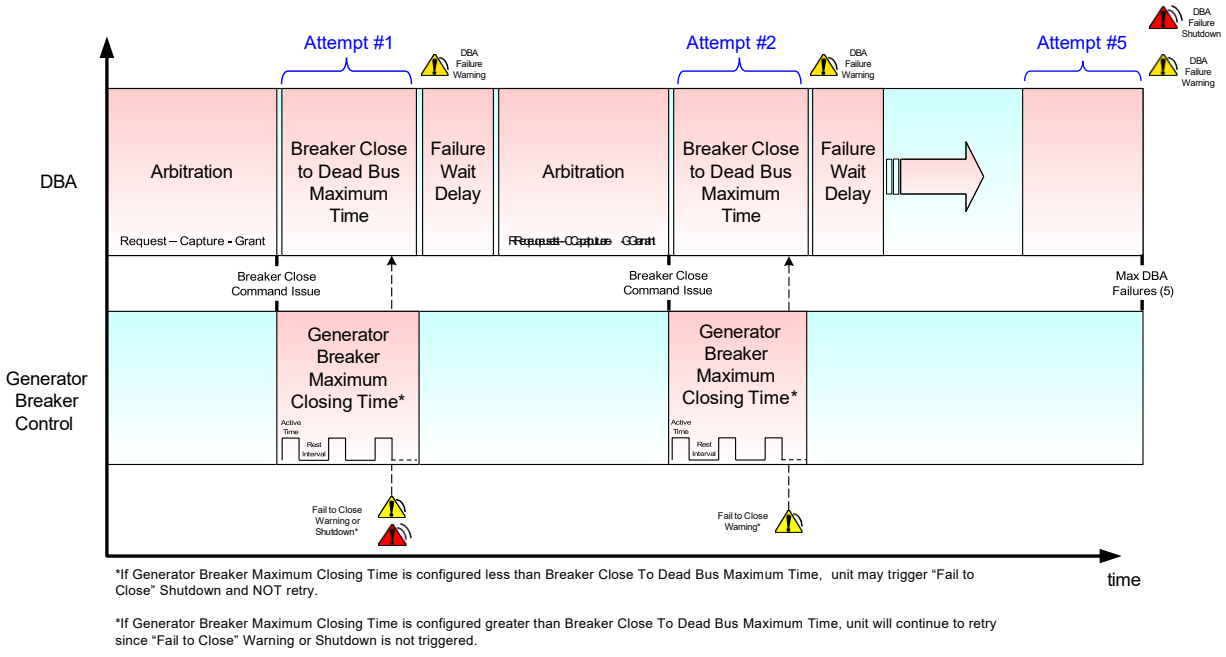


Figure 37.14 – Dead Bus Fail to Close Scenario with Multiple Units Requesting

- If no other units are requesting, a failed unit may re-request immediately. In this scenario, the unit will re-request indefinitely if the Generator Breaker Fail to Close is configured only for a Warning.
- If no other units are requesting, the Generator Breaker Maximum Closing Time (setpoint) within the Generator Breaker Control logic determines how long after issuing a breaker close a unit can try to close. If the Generator Breaker Maximum Closing Time (setpoint) expires with no detection of breaker closed a Generator Breaker Fail to Close (SPN-FMI: 4011-31) event is triggered (Figure 37.15).

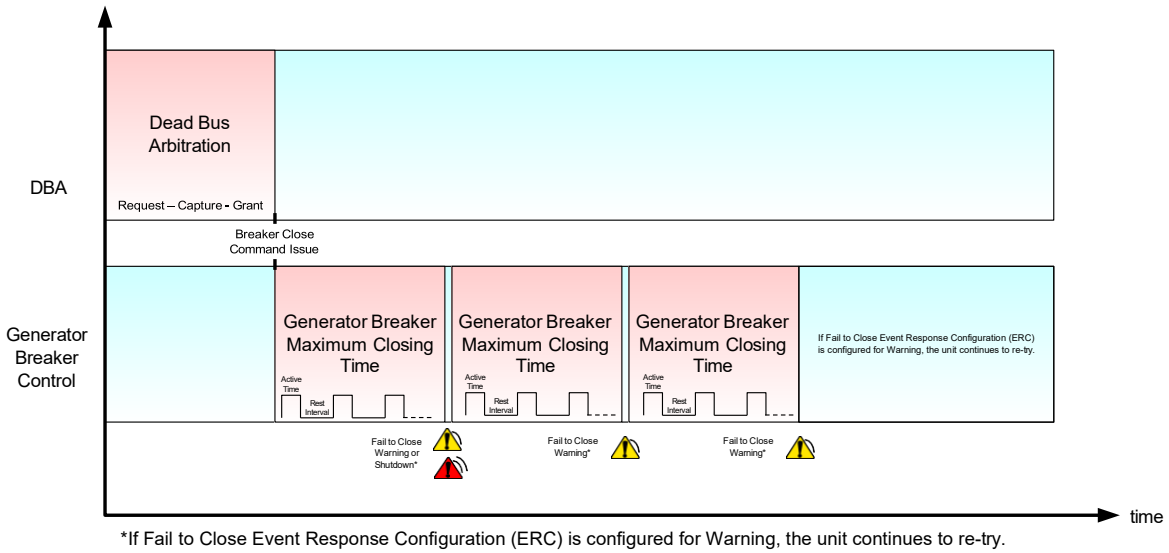


Figure 37.15 – Dead Bus Fail to Close Scenario with a Single Unit Requesting

Note: *Generator Breaker Maximum Closing Time* (Generator Breaker Control setpoint) MUST be configured to a value greater than *Breaker Close to Dead Bus Maximum Time* (Dead Bus Arbitration setpoint) in order for a unit to keep trying after a failure to dead bus close. The *Breaker Close to Dead Bus Maximum Time* is meant specifically for dead bus close situations when getting a unit to close to the bus is crucial. *Generator Breaker Maximum Closing Time*, however, is NOT limited to dead bus arbitrations situations and is applied in any breaker closure attempts, such as synchronizing. Therefore the *Breaker Close to Dead Bus Maximum Time* is meant to be configured to a shorter duration than *Generator Breaker Maximum Closing Time* in order to minimize the time required for ANY single unit to dead bus close.

37.4.2 Failsafe Dead Bus Arbitration Operation

The following describes dead bus close control operation during a loss of communication on the MGDL network. The MGDL system uses knowledge of the network topology (expected number of controls online) to be 'cautious' in regards to missing or non-communicating units.

As described in Section 37.4.7 – MGDL Loss of Communications Strategy, units in a fragmented MGDL network are separated into a Proceed as Normal (majority) and a Proceed with Caution (minority) group. The Proceed with Caution group is forced to be cautious when dead bus closing since this group's communication is isolated from other units and other units' dead bus close status is unknown. Without knowing the dead bus close status of other units, two units that are out of synchronization could potentially close to the bus at the same time resulting in a crash parallel. While it is necessary to avoid this scenario, the downside, is forcing units to be overly cautious (not allowing units to dead bus close at all) and no unit ever closes to the dead bus.

Note: A unit can also be placed into a Proceed with Caution group due to a Software Version Mismatch event (SPN-FMI: 234-31) – see troubleshooting Section 37.7.4 for more details.

With this in mind, MGDL dead bus arbitration operates such that when a unit is placed in the Proceed with Caution mode, a failsafe dead bus arbitration rule is applied. The failsafe arbitration rule applies a unique time delay to each individual unit that attempts to dead bus close. This is done in order to attempt to differentiate each unit's dead bus close timing from other missing units and avoid simultaneous dead bus closes. No algorithm can completely remove the risk of a simultaneous dead bus close when communications are lost. However, this failsafe arbitration logic attempts to reduce this risk to an acceptable level. The Proceed with Caution failsafe arbitration rule is defined as:

- A unit in a Proceed with Caution group that has been granted permission to dead bus close, delays (5 + 1.25* MGDL Unit Number) seconds before issuing a dead bus close command to the generator breaker.

37.4.3 MGDL Load Sharing Operation

In order to sufficiently supply load to a system, it is beneficial for all paralleled generator sets to equally balance the load between one another. This optimizes loading capabilities of the system, increases stability and improves the system's response to transients. With balanced isochronous load sharing, even if the generator sets are of unequal ratings, the output of each generator set will be proportional to its rated output.

Purpose

The purpose of Real and Reactive Load Sharing is to share the real and reactive load proportionally (and equally if units are equal-sized) among all of the units on the MGDL network in an island mode (isolated from mains/utility) type configuration. This island mode configuration can be prime power, standby, or peak shaving (disconnected from the mains/utility).

Basic Operation

The EMCP 4.4 actively monitors the real (kW) and reactive (kVAr) load requirement of all paralleled generator sets on the MGDL Network and adjusts their output to maintain balanced loading of all generator sets at isochronous speed and voltage. As units enter or leave the system, or the load changes, the units adjust their contribution in order to contribute proportionally equal amounts. In failsafe modes, standard load sharing is exited and failsafe load sharing modes are applied (Section 37.4.9).

When the generator breaker is closed and the load sharing is set to Ethernet (MGDL), the unit calculates a system load sharing target based on information provided on the MGDL network. The unit controls load until the individual generator load matches the system load sharing target. As the system load sharing target changes, the EMCP 4.4 adjusts the generator set speed or voltage control to match the target.

Simultaneously, the EMCP 4.4 regulates speed and voltage setpoints to rated values in order to maintain proper bus frequency and voltage. An example of regulating real power load sharing and generator frequency through a real load transient is shown in Figure 37.16. The degree to which the EMCP 4.4 regulates to the system load sharing target as well as the frequency/voltage target values is based on the tune settings of the closed loop Proportional-Integral (PI) control system.

Please refer to the MGDL Paralleling Tuning Guide section of this manual (Section 37.5) for further information on tuning the load sharing controller gains.

Note: During normal MGDL operation actual kW % or kVAr % is output as voltage signals on analog load sharing lines for troubleshooting or monitoring purposes only. Hardwired Load Sharing is NOT permitted when configured for Ethernet (MGDL) load sharing.

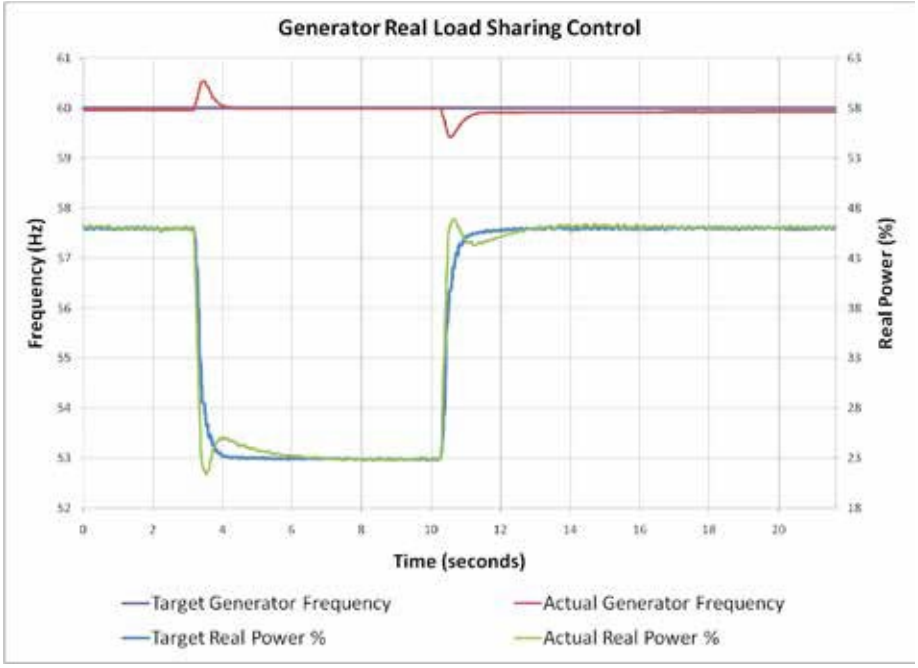


Figure 37.16 – Generator Real Load Sharing and Frequency Regulation

Monitoring and tuning of MGDL load sharing can be done via the EMCP 4 .4 display . The load sharing screens that include load sharing mode, actual/target real and reactive load sharing values as well as PI control system tuning are described further in MGDL Load Sharing Screens Section 37 .6 .4 .

Note: If Generator Reactive Load Sharing is turned off or inhibited via programmable digital input, no reactive load sharing control signal is sent to the voltage regulator to control the voltage . This allows customers to implement voltage droop or other voltage or reactive power control methods separate from the EMCP 4 .4 controller .

Soft Loading and Unloading

When load sharing isochronously, soft loading and soft unloading reduces instability and risk to equipment by increasing or decreasing generator output in a controlled manner before closing or opening the generator breaker .

Soft loading a generator set into an isochronous load sharing system is accomplished by controlling the rate of change of the bias signal of frequency or voltage . At the instant the generator breaker closes the generator set is electrically tied to the load sharing system . A frequency/voltage bias is applied to the oncoming generator set so that it produces little or no power, but remains in parallel with the system . The bias signals are then slowly increased, causing the generator output to increase . The rate the output increases is determined by the rate that the bias is increased and is a configurable setpoint (see Section 37 .3 .9 Generator Real Load Sharing Soft Loading/ Unloading and Figure 37 .10) .

The oncoming generator set will pick up load until the system load sharing target is reached . At the same time, the generator sets already in isochronous load sharing, will collectively reduce their load by the amount of load picked up by the oncoming generator set . Once the oncoming generator set reaches the system target its contribution is included in the calculation of the system load sharing target and all units now will be producing their proportional share of load while maintaining isochronous frequency/voltage .

Soft unloading is accomplished in a similar, but reverse manner. An off going generator set's load is ramped down by controlling the voltage/frequency bias signals. Once the generator output is decreased to a configurable threshold, the generator set is disconnected from the load sharing system by opening the generator breaker.

While it is useful to soft load and unload units into a load sharing system, certain conditions make it necessary to abandon soft loading/unloading and proceed directly into load sharing in order to adequately supply load. The following conditions will cause soft loading or unloading to be exited:

- Oncoming unit fails to soft load (% kW/kVAr is not increasing)
- Oncoming or off going unit's frequency has changed by 0.1 Hz in 5 seconds or less (frequency disturbance)
- Off going unit's voltage has changed by 8 V in 5 seconds (voltage disturbance)
- Off going unit fails to soft unload (% kW/kVAr is not decreasing)

37.4.4 MGDL Group Start Command Operation

Group Start Command Assertion

The EMCP 4.4 has the ability to accept a group start signal via a dedicated isolated digital input. If this signal is activated and MGDL is enabled, the EMCP 4.4 will send a group start request over the MGDL network to all MGDL units and each unit will issue an engine start request to the engine. If the group start signal is removed, the EMCP 4.4 will remove the group start request from all MGDL units on the network and each unit will issue a stop request to the engine. This signal should be wired into pin 32 on the EMCP 4.4 controller 70-pin connector. This input will become logically active when pulled down to the isolation reference pin 118 on the EMCP 4.4 controller 120-pin connector. The physical and logical status of the group start input is visible from the I/O Status screen on EMCP 4.4 display. The group start input is Dedicated Isolated Digital Input A.

Note: If using group start, Reduced Power Mode is NOT recommended. An active group start input or MGDL group start command will prevent an EMCP 4.4 from entering reduced power mode, but will not wake up a unit that is already in Reduced Power Mode. If a group start input or MGDL group start command is active during the "semi-awake" period of reduced power mode, the unit will exit reduced power mode, begin broadcasting on the MGDL network, start, and run. For more information on the operation of EMCP 4.4 Reduced Power Mode, refer to the EMCP 4.3, 4.4 Generator Set Control, Application and Installation Guide (LEBE0007).

Load Sense Load Demand control is initiated only when a group start command is received by a control and at least one generator set is ready to automatically parallel. If a unit receives a group start command with the engine control switch in auto, but does not meet all conditions for participating in LSLD, the unit will still start and run.

An MGDL group start command is issued to all other MGDL units regardless of the state of the control issuing the command. For example, a unit could be in STOP and still issue a group start command to all other units over MGDL. All group start commands received by a unit on the MGDL network are logically OR-ed together. Therefore wiring out group start inputs from multiple units is recommended and provides redundancy to the MGDL system.

Group Start Command Removal

If all MGDL group start commands are removed and the unit that was sending the group start command is still on the network, then the generator sets are no longer required to run. The units soft unload, cooldown, and stop in a controlled manner. If configured, feeder breaker trip logic is followed when the last unit opens its generator breaker. (See Section 37.4.6 – MGDL Feeder Breaker Control.)

In practice, the operator should remove load from the generator sets before removing the group start command and the above group start command removal operation will suffice. If the operator removes the group start command while generator sets are still loaded, the following logic is used in order to protect the generator set equipment as much as possible:

- If the total system load % is less than the rating of the smallest unit on the bus, units independently soft unload, open generator breakers and cooldown.
- If the total system load % is greater than the rating of the smallest unit on the bus, follow feeder breaker logic if configured (See Section 37.4.6 – MGDL Feeder Breaker Control) and check new total system load %.
- If the total system load % with feeder breaker trip command active (if configured) is greater than the rating of the smallest unit on the bus, all units on the MGDL network attempt to open their generator breakers as close to simultaneously as possible.

Group Start Command With Loss of MGDL Communications

If all MGDL group start commands are removed and the unit(s) sending the group start command are NOT on the network, all MGDL group start commands are latched. This means that a unit that loses an MGDL group start command due to loss of communications will continue to run and provide load if on the bus.

If an MGDL group start command is latched it can be unlatched by the following:

- Return of the lost MGDL unit that was sending the group start with the group start command removed
- Assertion of another group start command
- Package being removed from AUTO mode (engine control switch in manual mode, red lamp status…etc.)
- Generator Breaker transitions from closed to open (but NOT as a result of normal LSLD operation)

37.4.5 MGDL Load Sense Load Demand Operation

Purpose

MGDL Load Sense Load Demand (LSLD) is the control system used in EMCP 4.4 controllers to automatically bring generator sets on the bus or take generator sets off the bus in order to serve facility loads while maintaining fuel efficiency and adequate reserve. The LSLD control algorithm analyzes system load levels, sequence priority assignments and generator status communicated via MGDL. This information is used to compare load levels with programmable thresholds and time delays before deciding to drop under loaded generator sets or add additional available generator sets in order to efficiently match load demand. See Figure 37.17 for an example loading of LSLD system.

The setpoint configuration for MGDL LSLD is described in Section 37.3.10 and the MGDL LSLD display screens are described in Section 37.6.6. The operation and methodology of MGDL LSLD is described below.

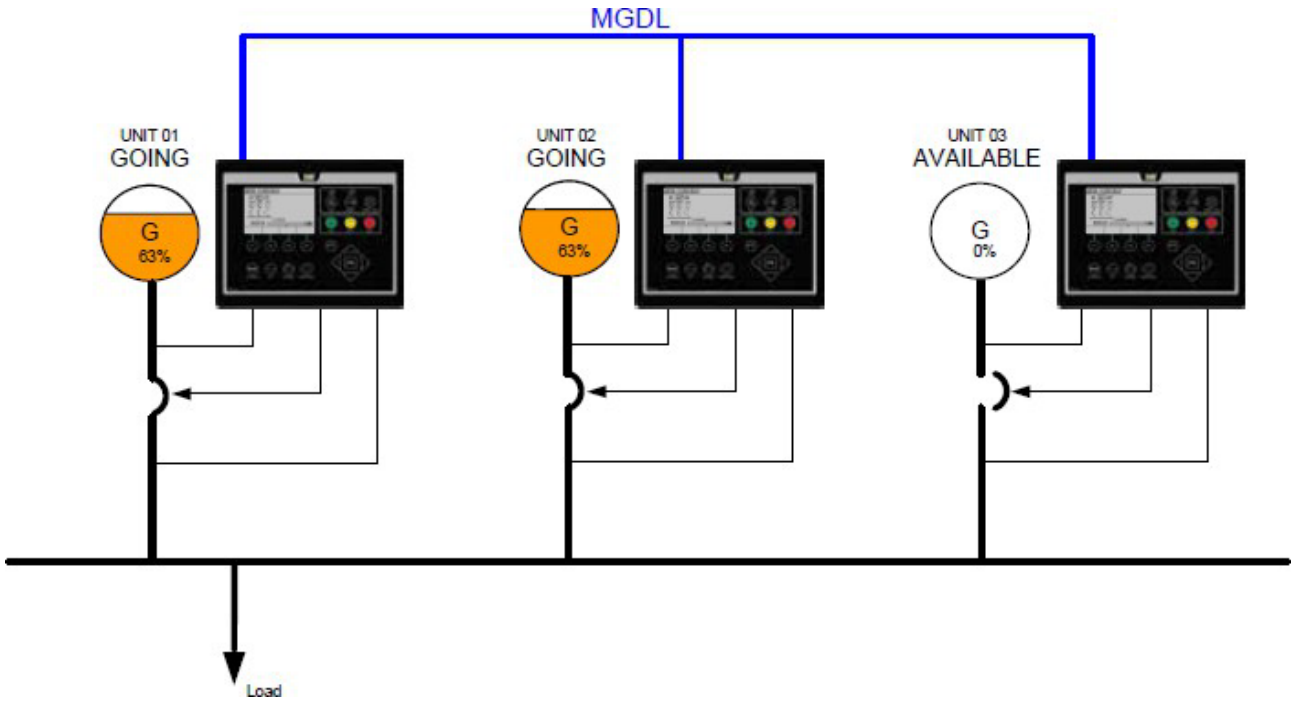


Figure 37.17 – MGDL LSLD Loading Example

Basic Operation

Load sense load demand is accomplished using the MGDL network to communicate between generator sets. There is NO master or group controller in MGDL LSLD. This feature supports up to 16 generator sets operating in parallel on a common bus and performs optimally with equal sized generator sets. If generator sets are significantly different in power outputs, less flexibility of configuration and operation will occur. Sequencing of generator sets will be accomplished based on Load Sense *Load Demand Sequence Strategy Configuration* (setpoint) described in Section 37.3.10.

There are several LSLD participation conditions that a control must satisfy in order to participate in LSLD with other controllers on the network. ALL of the following conditions must be satisfied and if ANY one condition is NOT, the control is considered unable to participate in LSLD.

- *Load Sense Load Demand Enable Input Configuration* (setpoint) is set to 'Ethernet (MGDL)'
- Engine Control Switch (ECS) is in AUTO
- Sync Mode Switch (SMS) is in AUTO
- Idle/Rated is set to RATED
- Valid Group Start Signal (Dedicated Isolated Group Start Digital Input is ACTIVE or MGDL Group Start Command is received over the MGDL network)
- Inhibit Breaker Close is INACTIVE

- Following Warnings Events are not PRESENT:
  - Not Ready to Automatically Parallel Warning
  - Generator to Bus Synchronization Failure Warning
  - Generator Under Frequency Warning AND Generator Breaker is CLOSED
  - Generator Breaker Failure to Open
  - Generator Breaker Failure to Close
  - Generator Breaker FID Diagnostic
  - MGDL Communication Failure
- No Shutdown Events exist
- Load Control Mode with Utility is INACTIVE
- No Emergency All Run signals exist
- Master Control is NOT present
- Load Sharing State is NOT in LOAD SHARE – FAILSAFE DROOP

LSLD is initiated when a group start command is received by a control and at least one generator set is ready to automatically parallel. An operator can request all the sets in a group to start from any generator set via a dedicated isolated digital input only. When a Group Start (input) is ACTIVE a Group Start Command is sent over MGDL to all units. If a unit receives a Group Start Command, but does not meet all conditions for participating in LSLD, the unit will still start and run if the Engine Control Switch (ECS) is in AUTO. For more information on Group Start refer to Section 37.4.4 – MGDL Group Start Command Operation.

Note: A Group Start Signal (input or command) overrides a Remote Initiate command (digital input or modbus) and initiates LSLD control if ALL other conditions (above) are satisfied. If there is no Group Start Signal, the unit follows the Remote Initiate Command (LSLD control will not be active).

Before enabling LSLD control, the LSLD settling timer *Load Sense Load Demand Enable Minimum Delay Time* (setpoint) must expire. The settling timer is a configurable setpoint and is explained further in 0. The purpose of the settling timer is to allow sites to step system load on gradually and settle before LSLD control begins analyzing load levels and considers walking generator sets off the bus.

The settling timer is reset anytime a unit no longer detects bus voltage OR the unit receives an emergency all run message via MGDL. After the settling timer expires, normal LSLD operation commences. An emergency all run message is triggered when a loaded unit experiences a Generator Under Frequency Warning.

It is possible to have an Under Frequency Warning during an overload situation depending on how tight the conditions for triggering the warning are configured. Generator sets are walked-off/walked-on the bus based on the LSLD system % kW logic and LSLD sequencing strategy which is discussed in the following section.

LSLD Add/Drop Conditions

During normal load sharing, each unit communicates its % kW and rated kW to the other units on the MGDL network. Each unit is therefore capable of calculating the target % kW and load share appropriately. The LSLD system % kW calculation is done using the rated kW of all units participating in LSLD (Unit LSLD Status = GOING). Units not under LSLD control are considered zero load, therefore are not included in LSLD calculations. The Unit LSLD Status is described further below in Section 37.4.5. Each controller calculates the LSLD system % kW from MGDL network information.

Below is an example of calculating LSLD system % kW:

A 500 kW set is GOING on load at 350 kW (70%) and an 800 kW set is GOING on load at 420 kW (52.5%).
Each set can calculate that the LSLD system % kW is ((350+420)/(500+800) = 59.2% (not (70%+52.5%)/2 = 61.3%).

The *Load Sense Load Demand Sequence Strategy Configuration* (setpoint) is configurable from any node on the network, but is a system-wide parameter that determines the sequence strategy used by all controllers in the system under LSLD control. Any controller being powered up in a group will adopt the strategy of controllers already powered up. Any change in a system-wide setpoint is broadcast to all units. The possible LSLD sequence strategies are:

- Total Operating Hours
- Priority Number (default)

When sequencing under the Total Operating Hours strategy, the unit with the least accumulated total operating hours has the highest priority. The "highest priority" unit is the one most likely to run and remain on the bus. The "lowest priority" unit is the one most likely to go off the bus.

Two controllers with identical Total Operating Hours next in sequence priority will resolve this conflict based on the MGDL unit number (highest MGDL unit number is dropped from the bus first, lowest MGDL unit number is added to the bus first).

Priority Number sequencing mode is ignored and has no impact when in Total Operating Hours sequencing mode.

To maintain hours balance, if a unit is off the bus (Unit LSLD Status = AVAILABLE) and has 10 fewer total operating hours than a unit that is GOING, the AVAILABLE unit shall come on the bus. At this point, normal LSLD sequencing shall continue to operate as configured.

When configured to Priority Number sequencing mode, the lowest Priority Number has the highest priority.

Note: Priority Number sequencing mode is the opposite operation of the *Generator Paralleling Priority Number* (setpoint) used in Hardwired LSLD. The *Generator Paralleling Priority Number* setpoint does NOT apply to MGDL LSLD.

Priority Number sequencing mode is the default sequence strategy for all units. Priority Number is only programmable from display on LSLD Priority Assignment screen, described below in Section 37.6.6. An offset can be added to the Total Operating Hours in order to compensate for different starting points or a desire to have a separation for maintenance purposes.

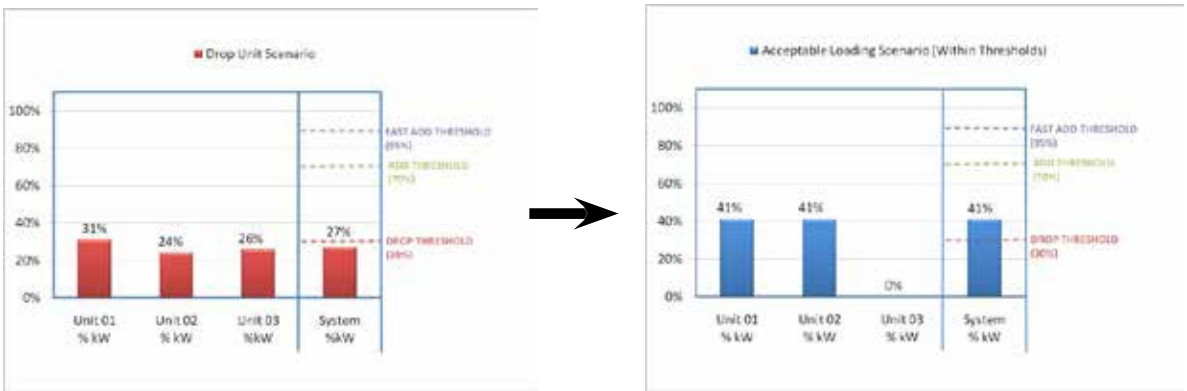


Figure 37.18 – LSLD Drop Unit Scenario Example

A generator set will be dropped from the bus according to the following conditions:

- The LSLD system % kW falls below the *LSLD Drop Unit Percentage Threshold* (setpoint) for the *LSLD Drop Unit Delay Time* (setpoint) AND the removal of the next generator set in the sequence will not cause the LSLD system % kW of the remaining generator sets to rise to within 5% of the *LSLD Add Unit Percentage Threshold* (setpoint). (Figure 37.18 – LSLD Drop Unit Scenario)

Note: This drop unit check functionally is NOT included in Hardwired LSLD.

- Controllers are only allowed to be walked-off when no units are in LSLD Status = LOADING or UNLOADING states.
- At least two units must have LSLD Status = GOING and no units can be LSLD Status = SETTLING.

Generator sets will be dropped off in order of:

- Lowest priority (highest sequence priority number) with LSLD Status = GOING.

Note: The highest sequence priority unit with LSLD Status = GOING will not be dropped, regardless of the load level. One unit under LSLD control shall always remain on the bus.

If conditions have been met for a unit to be dropped off, the lowest priority unit online will soft unload and open its generator breaker. In a normal drop scenario, the unit's LSLD Status will progress through the following unit LSLD states:

GOING → UNLOADING → AVAILABLE

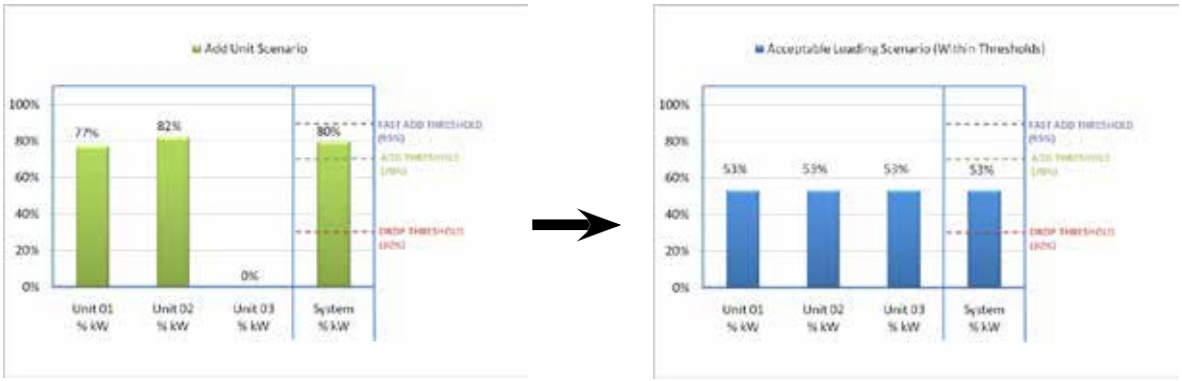


Figure 37.19– LSLD Add Unit Scenario Example

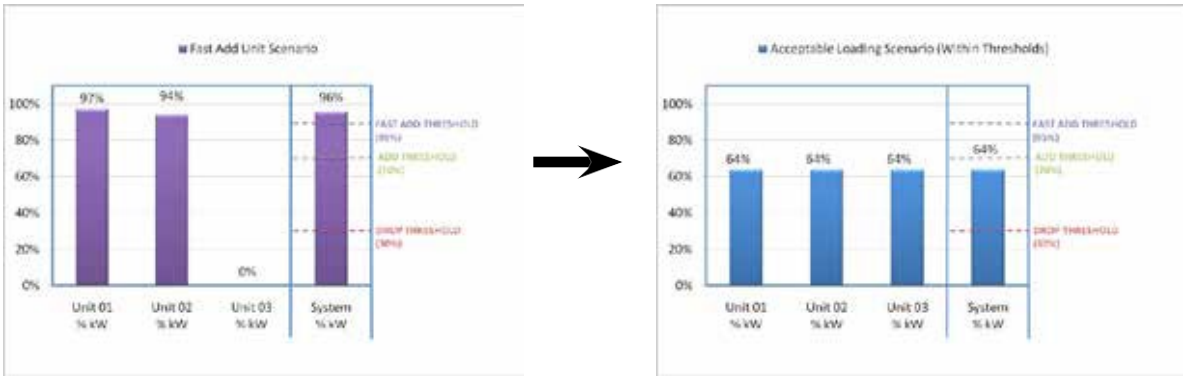


Figure 37.20 – LSLD Fast Add Unit Scenario Example

A new generator set will be added to the bus if any one of the following conditions are met:

- The LSLD system % kW rises above the *LSLD Add Unit Percentage Threshold* (setpoint) for the corresponding time delay [(*LSLD Add Unit Delay Time* (setpoint) (Figure 37.19)]
- The LSLD system % kW rises above the *LSLD Fast Add Unit Percentage Threshold* (setpoint) for the corresponding time delay [(*LSLD Fast Add Unit Delay Time* (setpoint) (Figure 37.20)]
- Maintain Sequence Priority – A unit that is GOING (on the bus) has a lower priority (higher sequence priority number) than a unit that is AVAILABLE. This could result from a new sequence priority number assignment while the units are participating in LSLD. (Only when LSLD Sequence Strategy is configured to "Priority Number.")
- Maintain Hours Balance – A unit that is GOING (on the bus) has 10 more engine hours than a unit that is AVAILABLE (off the bus). This could result from engine hours accumulating on units that are on the bus. (Only when LSLD Sequence Strategy is configured to "Total Operating Hours.")

Note: No drop check protection exists, i.e checking that adding a unit results in LSLD system % kW dropping below the *LSLD Drop Unit Percentage Threshold* (setpoint).

Controllers are only allowed to be added to the bus when no units are in LSLD Status = LOADING or UNLOADING states.

Generator sets will be added to the bus in order of:

- Highest priority (lowest sequence priority number) with unit LSLD Status = AVAILABLE.

If LSLD is attempting to add a generator set, and the unit's LSLD Status changes to GOING LSLD OFF or UNAVAILABLE, then the next highest priority generator set in sequence will immediately be brought on the bus. In a normal add unit scenario, the unit's LSLD Status will progress through the following states:

AVAILABLE → LOADING → GOING

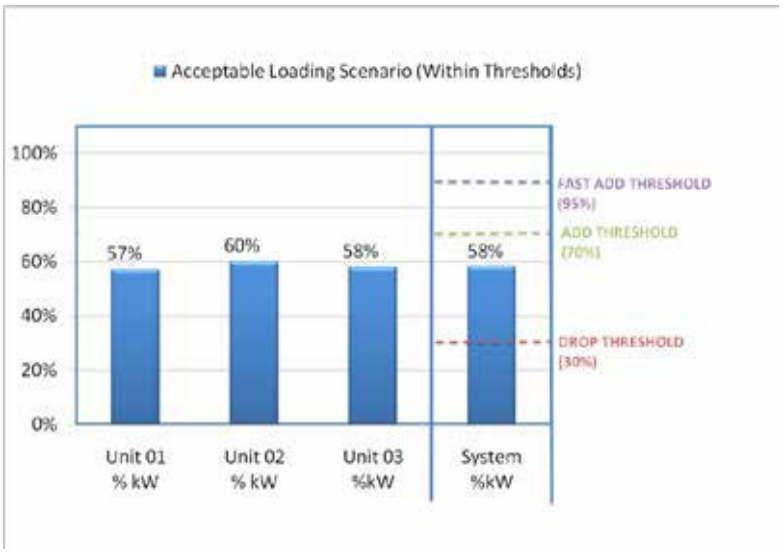


Figure 37.21 – LSLD Acceptable Loading (Within Thresholds) Scenario Example

As long as The LSLD system % kW is maintained above the *LSLD Drop Unit Percentage Threshold* (setpoint) AND below the *LSLD Add Unit Percentage Threshold* (setpoint) and *LSLD Fast Add Unit Percentage Threshold* (setpoint) no units will be added or dropped from the bus as a result of LSLD operation (Figure 37.21).

LSLD Redundancy

When it is desired to run an additional unit for redundancy sake, the EMCP can be configured to do so. The purpose of this function is to have a redundant unit already paralleled and closed to the bus so it can provide uninterrupted power in the event that a unit experiences an unexpected failure. The setpoint *Load Sense Load Demand Num Redundant Units* configures how many extra units the system will run. The possible configuration vales are 0-4 units. A redundant unit is brought online when the system load is greater than the generator sets' capacity excluding the largest unit. This ensures that if a unit shuts down, the remaining generator sets can carry the load without interrupting power.

LSLD Event Based Redundancy (v4.8 PROD or later)

In some cases it is desired to only run redundant units when a failure is anticipated. For this feature, when enabled, if a running unit has a present high coolant temperature warning or low oil pressure warning, then a redundant unit will be brought online to anticipate a unit failure. The maximum number of redundant units that can be brought online by this feature is 1, meaning if a high coolant temperature warning or low oil pressure warning becomes present on multiple units, still only one unit will be brought online for redundancy. To enable this feature, the user must configure the setpoint *LSLD Event Trigger Redundant Unit Enable Status* to enabled. If the user enables this feature and also has the LSLD number of redundant units configured to 1-4, this feature will still add a unit upon a present warning even if redundant units are brought online from the non-event based redundancy.

LSLD Multi Group System Setpoints (v4.8 PROD and later)

This feature, when enabled, turns on 4 independent groups of LSLD setpoints. Using digital inputs, the EMCP display and keypad, or Modbus commands, the user can switch between which of the 4 groups are used. The setpoints that are included in this feature are:

LSLD SEQUENCE STRATEGY CONFIG FOR GROUP #1
LSLD ENABLE DELAY FOR GROUP #1
LSLD ADD UNIT PERCENTAGE THRESHOLD FOR GROUP #1
LSLD ADD UNIT DELAY TIME FOR GROUP #1
LSLD DROP UNIT PERCENT THRESHOLD FOR GROUP #1
LOAD SENSE LOAD DEMAND DROP UNIT DELAY TIME FOR GROUP #1
LSLD FAST ADD UNIT PERCENT THRESHOLD FOR GROUP #1
LSLD FAST ADD UNIT DELAY TIME FOR GROUP #1
LSLD OPERATING HOUR OFFSET FOR GROUP #1
LSLD NUM REDUNDANT UNITS FOR GROUP #1
LSLD REACTIVE PWR ADD UNIT % THRESHOLD FOR GROUP #1
LSLD REACTIVE PWR ADD UNIT DELAY TIME FOR GROUP #1
LSLD REACTIVE PWR FAST ADD UNIT % THRESHOLD FOR GROUP #1
LSLD REACTIVE PWR FAST ADD UNIT DELAY TIME FOR GROUP #1

Each of these has a corresponding group 2-4 setpoint. To enable this feature, the user must configure the setpoint LSLD Multi-Group System Enable Status to enabled. If any unit on the MGDL network does not support this feature, then the feature is automatically disabled and a LSLD Feature Software Mis-Match Warning (234-15) will become present. Once enabled the user can select which group of setpoints is active through digital input, display or Modbus. The default group that is used at first enable is group #1. If the feature is disabled and enabled again, it will retain the last active group number when it is re-enabled.

Selecting Groups via Digital Input

First the user must configure a digital input usage type to command status – Load Sense Load Demand User Operation Setting #X. When that digital input is activated, then the control will use that setpoint group as well as command all other controls on the MGDL network to use that setpoint group as well.

Selecting Groups via Display

The user has the option to select which LSLD setpoint group the system will run through the display interface. The LSLD control screen is where the user can select this.

Selecting Groups via Modbus

To command the system to use a group of setpoints, the user must write a command to register 6100.

Command	Result
0	The system will use the non-group LSLD setpoints
1-4	The system will use group 1-4 LSLD setpoints
5-FFFF	Invalid, take no action

Conflicts Between Setpoint Groups

Within a single control if there is a conflict between the different possible input methods, the following hierarch is used.

Input Method	Priority
Digital input	Highest priority
Display and Modbus commands	Lower priority (equal to each other)

If multiple digital inputs are configured for setpoint groups, then the lowest numbered setpoint group takes the highest priority. For example, if an input configured for group 4 and an input configured for group 2 are both active, then the control would consider group 2 to be the user selected setpoint group.

When there is a conflict between selected setpoint groups between separate controls, the control that is requesting the lowest numbered setpoint group will win the arbitration. For example, if gen 1 considers group 1 to be the user selected setpoint group and gen 5 considers group 3 to be the user selected setpoint group, then the system will use group 1 as the user selected setpoint group.

Unit/System LSLD Status

Each controller communicates its Unit LSLD Status over the MGDL network. The Unit LSLD Status is based on the LSLD participation conditions, generator breaker status, settling timer, etc. The System LSLD Status is also communicated over the MGDL network. The System LSLD states are based off each individual unit's Unit LSLD state. The individual Unit LSLD Status and the System LSLD Status is displayed on the LSLD Screens described in Section 37.6.6.

System-Wide LSLD Setpoints

When *Load Sense Load Demand Input Configuration* (setpoint) is set to "ETHERNET (MGDL)," the following setpoints are considered "system-wide" setpoints:

- *Load Sense Load Demand Add Unit Percentage Threshold*
- *Load Sense Load Demand Add Unit Delay Time*
- *Load Sense Load Demand Drop Unit Percentage Threshold*
- *Load Sense Load Demand Drop Unit Delay Time*
- *Load Sense Load Demand Fast Add Unit Percentage Threshold***
- *Load Sense Load Demand Fast Add Unit Delay Time***
- *Load Sense Load Demand Sequence Strategy Configuration***
- *Load Sense Load Demand Operating Hour Offset***
- *Load Sense Load Demand Num Redundant Units***
- *LSLD Reactive Power Add Unit Percentage Threshold***
- *LSLD Reactive Power Add Unit Delay Time***
- *LSLD Reactive Power Fast Add Unit % Threshold***
- *LSLD Reactive Power Fast Add Unit Delay Time***
- *LSLD Multi-Group System Enable Status***
- *LSLD Sequence Strategy Config For Group #1-4***
- *LSLD Enable Delay For Group #1-4***
- *LSLD Add Unit Percentage Threshold For Group #1-4***
- *LSLD Add Unit Delay Time For Group #1-4***
- *LSLD Drop Unit Percent Threshold For Group #1-4***
- *LSLD Sense Load Demand Drop Unit Delay Time For Group #1-4***
- *LSLD Fast Add Unit Percent Threshold For Group #1-4***
- *LSLD Fast Add Unit Delay Time For Group #1-4***
- *LSLD Operating Hour Offset For Group #1-4***
- *LSLD Num Redundant Units For Group #1-4***
- *LSLD Reactive Pwr Add Unit % Threshold For Group #1-4***
- *LSLD Reactive Pwr Add Unit Delay Time For Group #1-4***
- *LSLD Reactive Pwr Fast Add Unit % Threshold For Group #1-4***
- *LSLD Reactive Pwr Fast Add Unit Delay Time For Group #1-4***
- *LSLD Event Trigger Redundant Unit Enable Status***

**This is a setpoint specific to MGDL Load Sense Load Demand and is NOT used for Hardwired LSLD.

System-wide setpoints are configurable from any node in the MGDL network. The setpoint is automatically applied to all EMCP 4.4 controllers on the MGDL network, and any controller powered up will adopt the configuration of other controllers already powered up.

Note: All LSLD system-wide setpoints are configurable via ET or EMCP Display when *Load Sense Load Demand Input Configuration* is set to "DISABLED." When MGDL Unit Number = 0, LSLD system-wide setpoints are configurable, but not communicated over the network.

Configuration of the system-wide LSLD setpoints is described in Section 37.3.10.

FAILSAFE LSLD OPERATION

The following describes LSLD control operation during a loss of communication on the MGDL network. The MGDL system uses knowledge of the network topology (expected number of controls online) to be 'cautious' in regards to missing or non-communicating units.

Note: A unit can also be placed into a Proceed with Caution group due to a Software Version Mismatch event (SPN-FMI: 234-31) – see troubleshooting Section 37.7.4 for more details.

As described in Section 37.4.7 – MGDL Loss of Communications Strategy, units in a fragmented MGDL network are separated into a Proceed as Normal (majority) and a Proceed with Caution (minority) group. The units grouped in the Proceed with Caution group exit LSLD, start, and go on the bus since their MGDL communication is isolated from other units that are potentially on the same electrical bus.

Units that are GOING and are grouped in the majority (Proceed as Normal) group continue to follow LSLD logic and may sequence on or off the bus. MGDL communications are still intact with these units so LSLD is allowed to continue in this failure mode.

37.4.6 MGDL Feeder Breaker Control

Limited feeder breaker support for connecting a generator bus and a load bus is included with the EMCP 4.4 MGDL feature. In order for a unit to provide feeder breaker control, a programmable digital output MUST be configured for "Feeder Breaker Close Command" with "Feeder Breaker Trip Command" programmed for an additional digital output as optional. Setpoints *Minimum Real Power Required for Load Bus #1* and *Minimum Reactive Power Required for Load Bus #1* also must be configured (see Section 37.3.3).

Minimum Real Power Required for Load Bus #1 and *Minimum Reactive Power Required for Load Bus #1* setpoints determine the minimum available power required before issuing a feeder breaker close command. The available power is determined by the rated power (real and reactive) of all units communicating on the MGDL network that are closed to the bus. Each setpoint acts as a local setpoint for each controller. These setpoints are present in all modules and for redundancy, it may make sense to have multiple controllers programmed the same and wired to the feeder breaker in case a controller is powered down for routine maintenance on the engine generator set. If multiple feeder breakers exist, or the feeder breaker signal is being used to add load, each controller or group of controllers can be used to add a load step.

Available power levels are monitored and compared with *Minimum Real Power Required for Load Bus #1* and *Minimum Reactive Power Required for Load Bus #1* regardless of engine state remote initiate, or group go state. Feeder Breaker Close Command digital output and Feeder Breaker Trip Command digital output are set according to the following logic:

- If there are sufficient (real and reactive) power levels available, the unit sets Feeder Breaker Close Command digital output to active.
- If there are insufficient (real or reactive) power levels available, the unit waits for additional generators to synchronize and close to the bus during which time Feeder Breaker Close Command digital output remains inactive.
- Feeder Breaker Close Command digital output is set to inactive when the last unit on the MGDL network opens its generator breaker.
- Feeder Breaker Trip Command digital output is set to active for 1 second when the last unit on the MGDL network opens its generator breaker.

Figure 37.22 depicts an example of 3 MGDL units configured for Feeder Breaker Control. In this example each unit is assumed to be 1000 kW, 750 kVAr rated generator sets. Also assumed is that each unit is configured such that *Minimum Real Power Required for Load Bus #1* = 2,000 kW and *Minimum Reactive Power Required for Load Bus #1* = 1,500 kVAr. With this configuration and with Unit 01 and Unit 02 closed to the bus, the feeder breaker close command output will be active for all three (3) units.

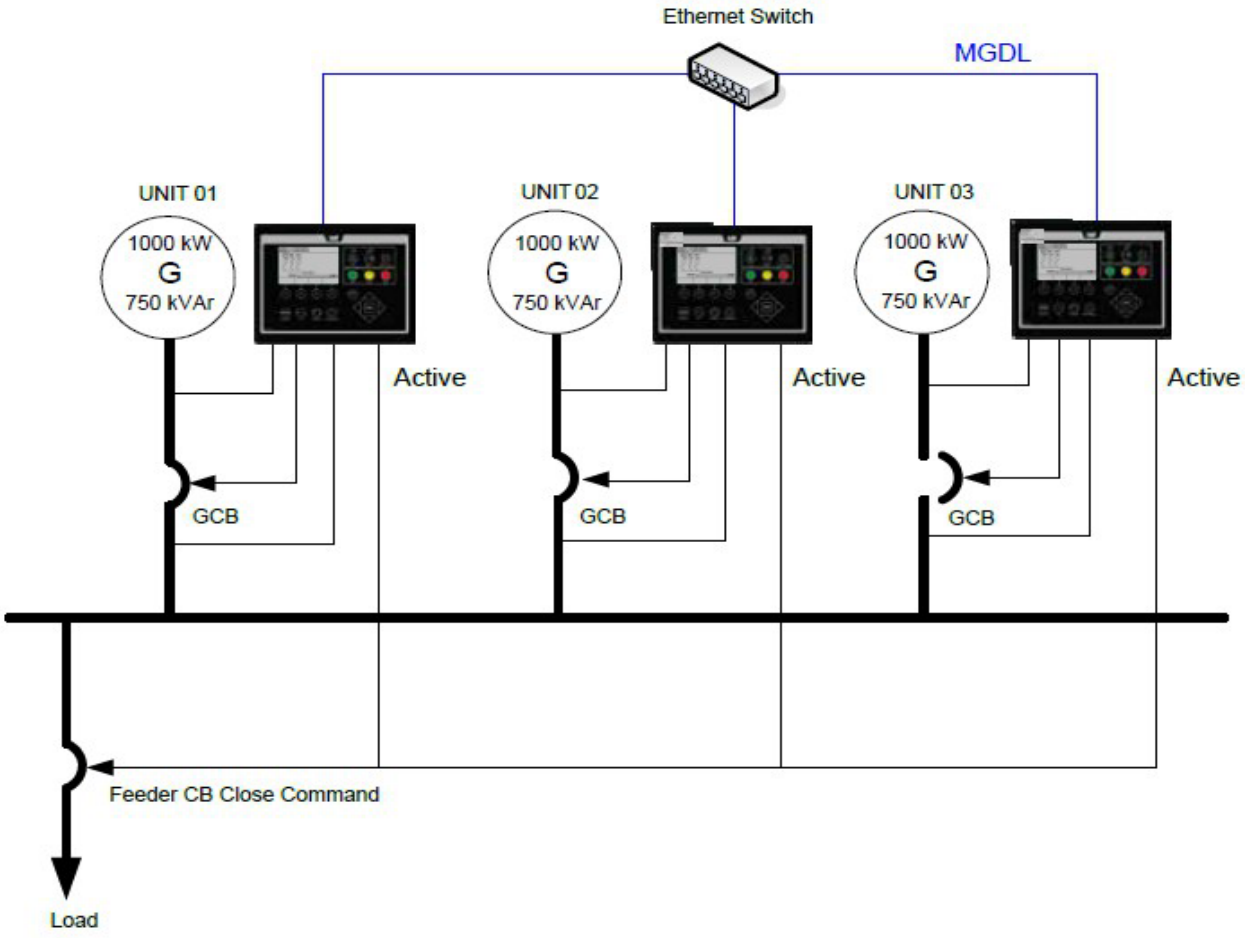


Figure 37.22 – MGDL Feeder Breaker Control Example

37.4.7 MGDL Loss of Communications Strategy

MGDL Loss of Communication is defined as MGDL messages from one or more of expected controls online NOT being received after a specified period of time. This can occur as a result of conditions such as broken wires, mis-configuration, or Ethernet router/switch/hub device power loss, or power loss to the EMCP 4.4, for example. If a communication loss is detected by an EMCP 4.4 on the MGDL network the following actions are taken:

- Unit Number of lost unit on the MGDL Overview screen is replaced with a question mark symbol (see Section 37.6.1 – MGDL System Overview Screens for full details).
- CONTROL IS OFFLINE MULTIPLE GENSET CONTROL DATA LINK diagnostic (SPN-FMI: 625-31) event is triggered (see Section 37.7.2 – MGDL Control Is Offline event).
- "MGDL Unit(s) Not Detected" status event is triggered if some, but not all units are lost.
- "No MGDL Units Detected" status event is triggered if ALL units are lost.
- Based on the communication status of expected number of MGDL units, Proceed with Caution or Proceed as Normal grouping is performed (as described on the next page).
- Based on Proceed with Caution or Proceed as Normal grouping, the operational mode for MGDL features such as DBA, LSLD, and Load Sharing are updated as necessary.

The operating modes of units during a loss of communications are updated in order to best serve the generator system. For example, if the lost units are still running and on the bus it is necessary for them to behave in a safe way. The MGDL system uses knowledge of the network topology to be cautious in regards to missing units. A loss of communication on the MGDL network results in a fragmented or split network. Units in a fragmented MGDL network are separated into a Proceed as Normal (majority of the units) and a Proceed with Caution (minority of the units) group based on the following:

- Number of units still communicating out of the total expected number of controls (pre-loss of communication) AND
- The lowest MGDL Unit Number

Examples of fragmented network scenarios with Proceed as Normal and Proceed with Caution grouping are described below.

Split Network Scenario #1

If my control (Unit 05 in Figure 37.27) detects less than half of expected number of controls online (minority) then proceed with caution and operate in the following failsafe modes:

Paralleling Feature	Proceed with Caution Failsafe Operating Mode
Dead Bus Arbitration	Proceed with Caution DBA
Real and Reactive Load Sharing	Failsafe Adaptive Droop
Load Sense Load Demand	Exist LSLD

Table 37.27 – Proceed with Caution (Minority) Group Failsafe Operating Modes

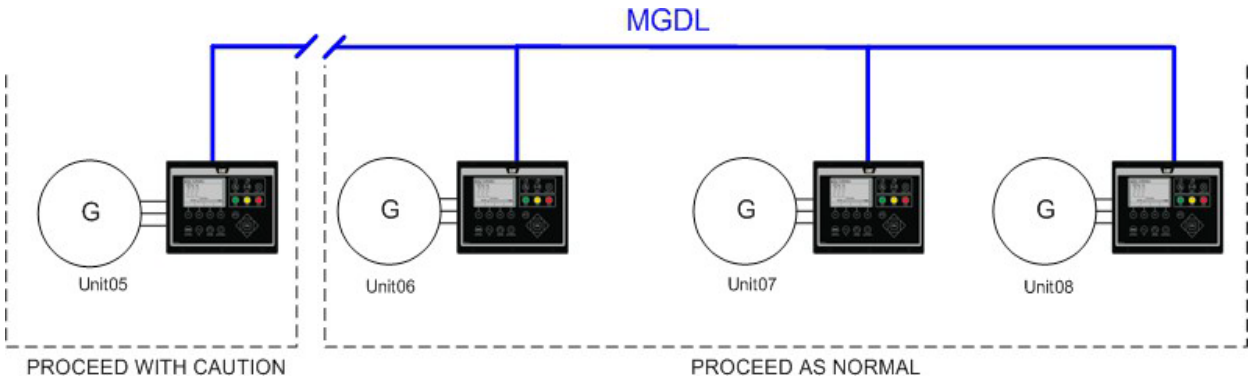


Figure 37.23 – MGDL Loss of Communications with My Unit in Proceed with Caution (Minority) Group

Split Network Scenario #2

If my control (Unit 05 in Figure 37.23) detects more than half of expected number of controls online (majority) then proceed as normal:

Paralleling Feature	Proceed as Normal Failsafe Operating Mode
Dead Bus Arbitration	Normal DBA
Real and Reactive Load Sharing	Failsafe Isochronous Load Sharing
Load Sense Load Demand	Normal LSLD

Table 37.28 – Proceed as Normal (Majority) Group Failsafe Operating Modes

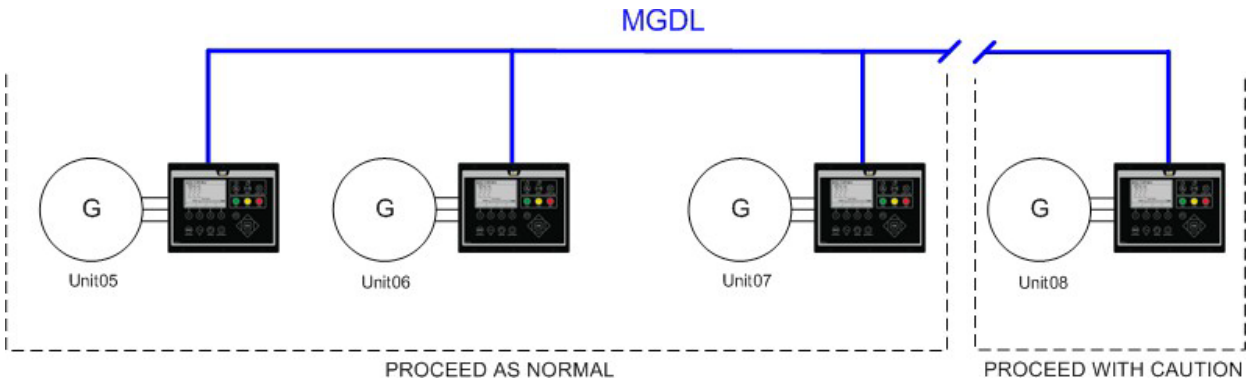


Figure 37.23 – MGDL Loss of Communications with My Unit in Proceed as Normal (Majority) Group

Split Network Scenario #3

If my control (Unit 05 in Figure 37.24) detects exactly half of expected number of controls online then:

- If my control sees the lowest unit number: Proceed as Normal.
- If my control does NOT see the lowest unit number: Proceed with Caution.

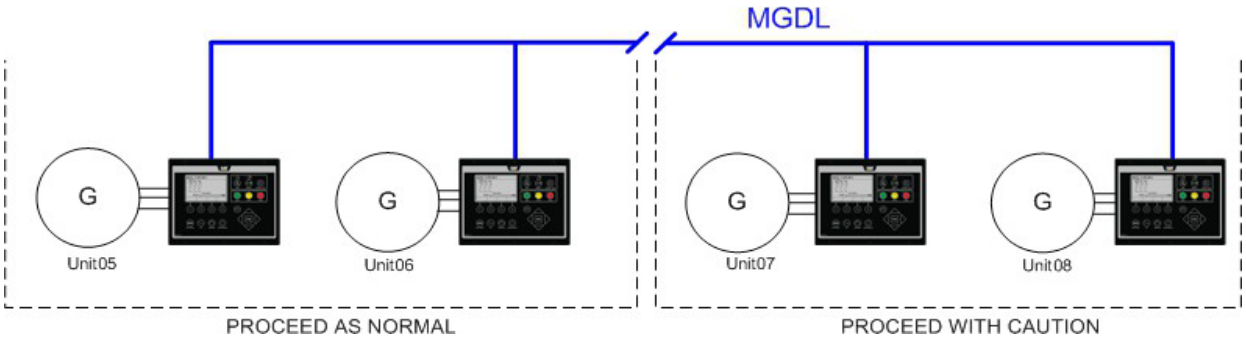


Figure 37.24 – MGDL Loss of Communications with Evenly Split Network

Note: With multiple splits in the MGDL network at different times, it is possible to end up with ONLY proceed with caution groups and zero proceed as normal groups as shown in Figure 37.25.

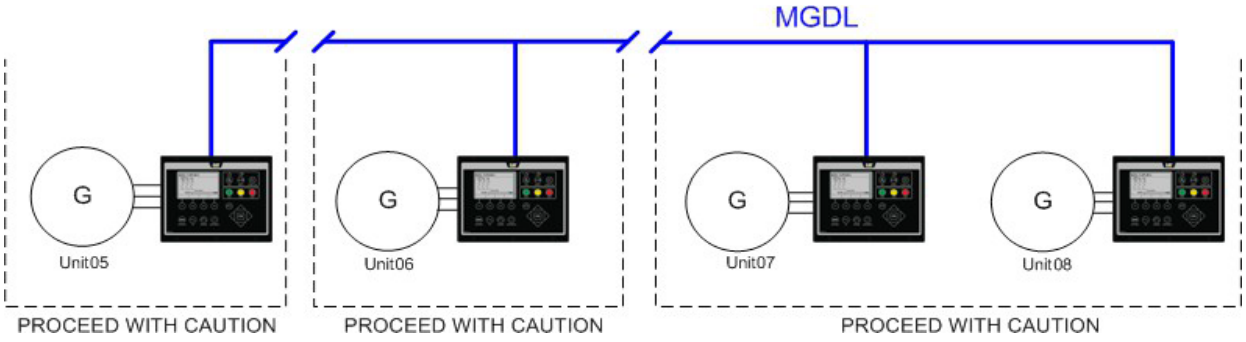


Figure 37.25 – MGDL Loss of Communications with Only Proceed with Caution Groups

In all of the scenarios above, a group start signal being received over the MGDL network is latched on an individual unit during the loss of communications. If a unit was receiving a group start command before loss of communications and the unit that was sending the group start command is no longer on the network, the group start is latched. The latched group start command can be unlatched by the assertion of another group start command, the package being removed from automatic mode (engine control switch in manual mode, red lamp status . etc.), or a generator circuit breaker transitioning from closed to open (but not as a result of normal LSLD operation). See Section 37.4 4 – MGDL Group Start Command Operation for more details on the operation of the group start command.

37.4.8 MGDL Network Configuration Reset (Expected Units)

As described above, the MGDL network configuration is determined by the number of actual controls detected (communicating) and the number of expected controls on the MGDL network These values allow each unit to determine network topology information such as the total number of nodes in the MGDL network as well as assign the appropriate failsafe modes during loss of communications The MGDL network configuration and each unit's understanding of the network is reliant on the accuracy of these values.

The actual number of controls detected is dynamically sensed and therefore is not user adjustable However, the number of expected controls on the MGDL network is the critical parameter used by each unit and is user resettable Expected number of controls is defined as the maximum number of unique MGDL unit numbers broadcasting on the MGDL network over a given period of time The expected number of controls on the MGDL network ONLY increments and can only be reset or decremented in the following ways:

1. Forced to reset from display (MGDL Control Screen – Section 37.6.1 of this manual) A Reset Expected command from display is communicated to ALL units on the MGDL network In order for all controls to agree on the network configuration, if one unit is commanded to reset expected number of controls all other units will reset expected number of controls.

2. After certain period of time being powered down the EMCP 4 4 controller will "clear" internal memory of the number of expected controls This is done in order to benefit generator sets that are commonly relocated and are frequently powered up into new MGDL network topologies (such as rental units) The logic for this resetting of expected number of controls is after my control is powered down for >12 hours:

   a If all other controllers on the network with mature communications agree on the expected number of controls online,
   – Reset expected number of controls to the agreed upon expected number of controls online.

   b If all controllers on the network with mature communications do NOT agree on the expected number of controls online,
   – Reset expected number of controls online to zero and re-calculate the units.

   c If all controllers on the network have immature communications,
   – Reset expected number of controls online to zero and re-calculate the units.

Note: The actual detected number of controls online and the expected number of controls online is indicated on display on the MGDL Control screen described in Section 37.6.1 of this manual.

⚠ WARNING

Resetting expected number of controls on the MGDL network should be done with extreme caution. Resetting expected number of MGDL controls during operation may create isolated communication networks between generator sets connected to the same electrical bus.

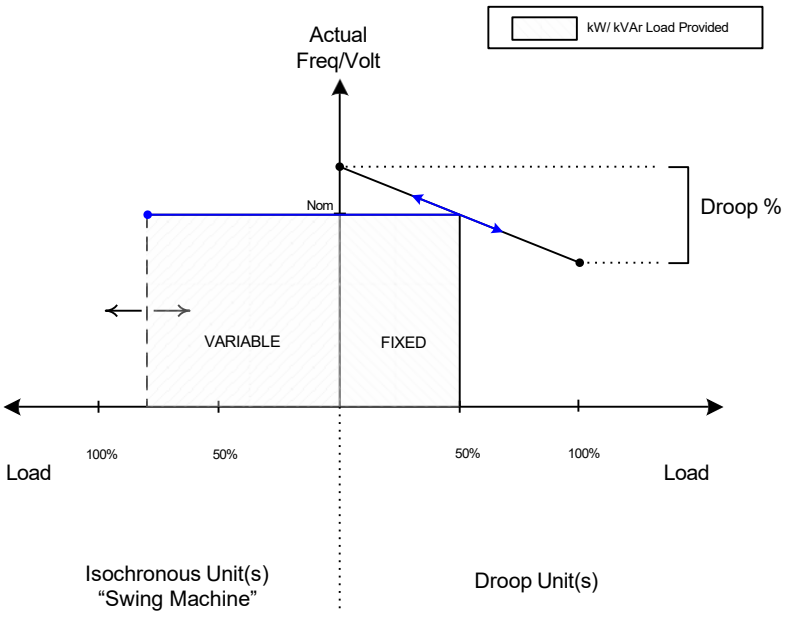
Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Resetting expected number of controls via display should only be done as a result of proper troubleshooting or only when intentional MGDL network node adjustments are desired. It is NOT recommended to reset expected number of controls while generator sets are running and providing load. Resetting expected number of controls results in the definition of new MGDL network nodes connected to the same electrical bus that may or may not communicate with each other. Therefore resetting expected number of controls inappropriately creates a risk of system instability and/or a crash-parallel.

37.4.9 MGDL Load Sharing Failsafe Operation

A unit is considered lost from the MGDL network based on the conditions outlined in the MGDL Loss of Communications Strategy section of this manual (Section 37.4.7). Units that are lost from the network are expected to operate in a failsafe mode. If units are still running and on the bus when a communications failure occurs, they attempt to behave in a safe way by moving to a failsafe mode such as Failsafe Isochronous Load Sharing and/or Failsafe Adaptive Droop as outlined below.

Background



In a standard (non-EMCP 4) failure implementation (Figure 37.26), units are divided into two modes; droop and isochronous. Failsafe droop units are automatically placed at a fixed, pre-determined target load, such as 50% load at nominal frequency. Failsafe isochronous or swing machines take on the majority of load changes. Only after isochronous units become overloaded (>100%) will the failsafe droop units tend to pick up more load. This standard control scheme implementation can introduce several issues when generator sets switch in and out of failsafe conditions.

For instance, if the droop units were operating at a different load percentage immediately prior to entering the failsafe mode, each droop generator set would abruptly shift its frequency and load point to the pre-determined target load. The abrupt change in generator set operation may cause instability in the overall system and a loss of power synchronization. In addition, the standard droop control scheme implementation does not allow for an even distribution of loads among the generator sets. For instance, the isochronous generator set may be allowed to become overloaded while the droop generator sets are under loaded. The MGDL Failsafe Adaptive Droop control scheme (patent pending) attempts to address the issue described above.

Failsafe Adaptive Load Sharing/Droop Strategy

For a system that loses MGDL communications between units, the failure mode is to intelligently switch lost units to Failsafe Adaptive Droop while other units switch to Failsafe Isochronous Load Sharing. The first function of Failsafe Adaptive Droop is to seamlessly switch units into a failsafe operating mode while continuing to provide load with minimal disruption to the system. The second function of Failsafe Adaptive Droop is to provide more even distribution of loading between units as system load changes by preventing premature overloading of the isochronous units.

The Failsafe Adaptive Droop and Failsafe Isochronous Load Sharing control profiles are depicted together in Figure 37.27. Failsafe droop units are controlled based on adaptive droop curves that converge to a standard droop curve with each successive system load swing. This allows for a controlled migration from the droop unit's initial (last known load sharing) load level to a fixed 50% loading.

Failsafe isochronous units that experience loading beyond specified thresholds (q1% and q2%) droop benefit from the ability of failsafe droop units to provide additional load. This means at extreme (but within ratings) load levels, the failsafe isochronous units avoid premature overloading/underloading and force failsafe droop units to compensate.

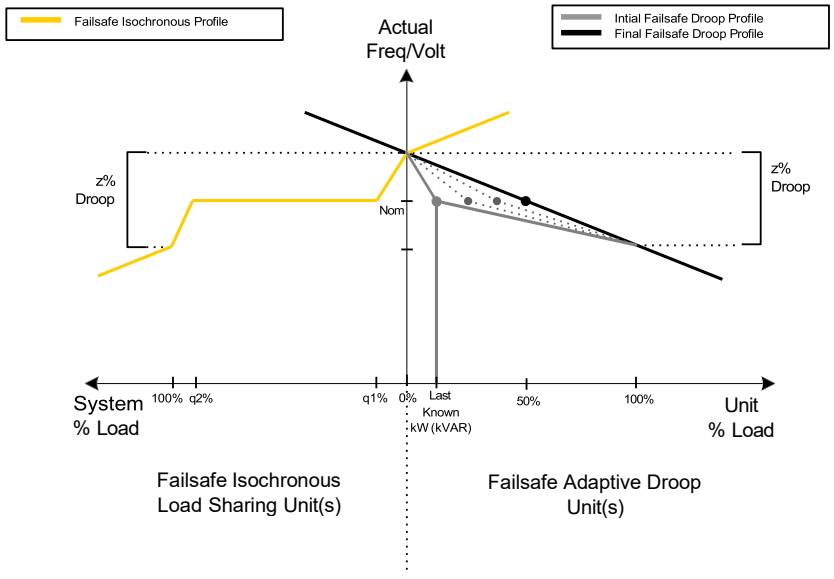


Figure 37.27 – Failsafe Adaptive Droop Control Scheme

Failsafe Isochronous Load Sharing

In general, a generator set operating in isochronous mode maintains constant speed/frequency (voltage) regardless of the load it is supplying. However, Failsafe Isochronous units operate such that speed/frequency (voltage) remain the same for the majority of its load range, but droop speed/frequency (voltage) slightly at extreme load ranges. This is done to prevent premature overloading or underloading and provide more even distribution of loading during failsafe conditions. The operating ranges for units in Failsafe Isochronous Load Sharing are shown in Figure 37.28 and are described below.

- For system % kW (kVAr) in the middle range from q2 to q1%
  – Run isochronous load sharing at nominal frequency (voltage).
- For system % kW (kVAr) in the lower range from 0 to q1%
  – Target frequency (voltage) droop with slope (z*0.5%)/q1% applied.
- For system % kW (kVAr) in the upper range from q2 to100%
  – Target frequency (voltage) droop with slope (z*0.5%)/(100-q2%) applied.

Where reactive (kVAr) loading z% droop is fixed to 6% and for real (kW) loading z% droop is fixed to 3%. The load ranges q1 and q2 are fixed percentages of load such that:

- q1 = 20%
- q2 = 80%

Note: If failsafe isochronous load sharing units' % kW (kVAr) drops below 0% kW (kVAr) or rises above 100% kW (kVAr), the standard z% droop is implemented.

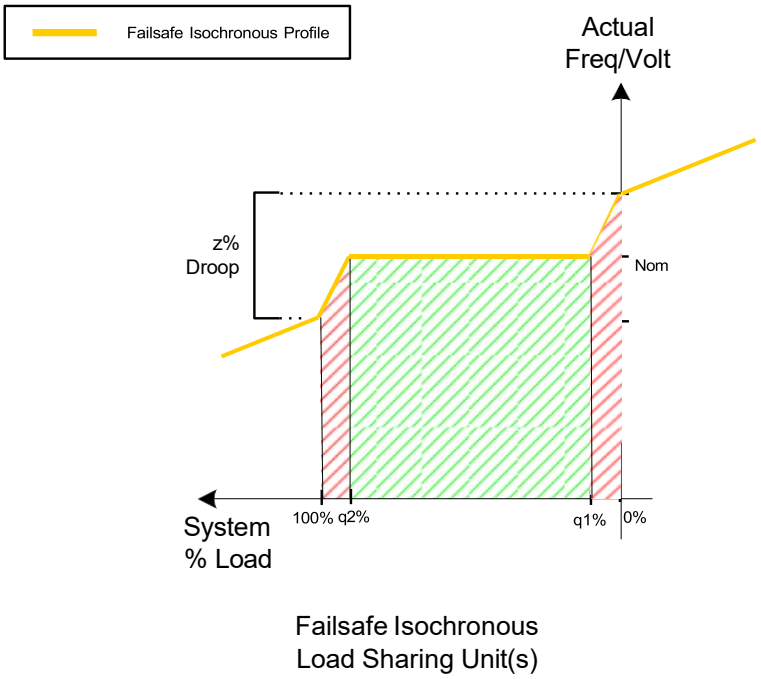


Figure 37.28 – Failsafe Isochronous Load Sharing Operating Ranges

It should be noted that unless load sharing capabilities exist, no more than one generator set connected to the same bus may run in isochronous mode. If two generator sets, operating in isochronous mode without load sharing capabilities are supplying the same load, one of the units will try to carry the entire load and the other will shed its entire load. As explained in the MGDL Loss of Communications Strategy (Section 37.4.7) only units that are in the Majority MGDL group are placed in Failsafe Isochronous Load Sharing mode. Therefore, two or more generator sets in the same Majority MGDL group operating may operate in Failsafe Isochronous Load Sharing mode and will share load equally with each other.

Failsafe Adaptive Droop

In general, generator sets operating in droop mode decrease speed/frequency (voltage) proportionally to load. That is, as the load increases the speed/frequency (voltage) decreases. With the standard droop implementation control scheme a generator set will always produce the same power output at a particular speed/frequency (voltage). However, Failsafe Adaptive Droop units operate such that the last known power output at the time of loss of communications remains constant to avoid instability and any sudden load transfer. Over time, however, the power output level is migrated to a more desired level with each successive load swing. This controlled migration results in a more even distribution of loading between droop units and isochronous units. The process by which this migration is accomplished in Failsafe Adaptive Droop is shown in Figure 37.29 and described below.

At the time of communications loss, a failsafe adaptive droop unit will run at an operating point defined as nominal frequency at the last known % kW (kVAr) of that individual generator set. From this operating point, a droop characteristic made up of two (2) droop slopes is defined:

- Load Decrease Slope – From nominal actual frequency (voltage) at the last known kW (kVAr) to nominal actual frequency + (z/2)*frequency at 0% kW (kVAr).
- Load Increase Slope – From nominal actual frequency (voltage) at last known kW (kVAr) to nominal actual frequency – (z/2)* frequency at 100 % kW (kVAr).

The droop unit's frequency (voltage) tracks up the Load Decrease Slope and down the Load Increase Slope as droop unit % kW (kVAr) varies. The Load Decrease Slope and Load Increase Slope are re-calculated at each movement up and down. Therefore as the droop unit's load varies the Load Decrease Slope and Load Increase Slope converge to a standard droop slope with 50% load at nominal frequency (voltage). A droop unit's kVAr and voltage droop operation is analogous to the kW and frequency operation described above. For reactive (kVAr) loading z% droop is fixed to 6% and for real (kW) loading z% droop is fixed to 3%.

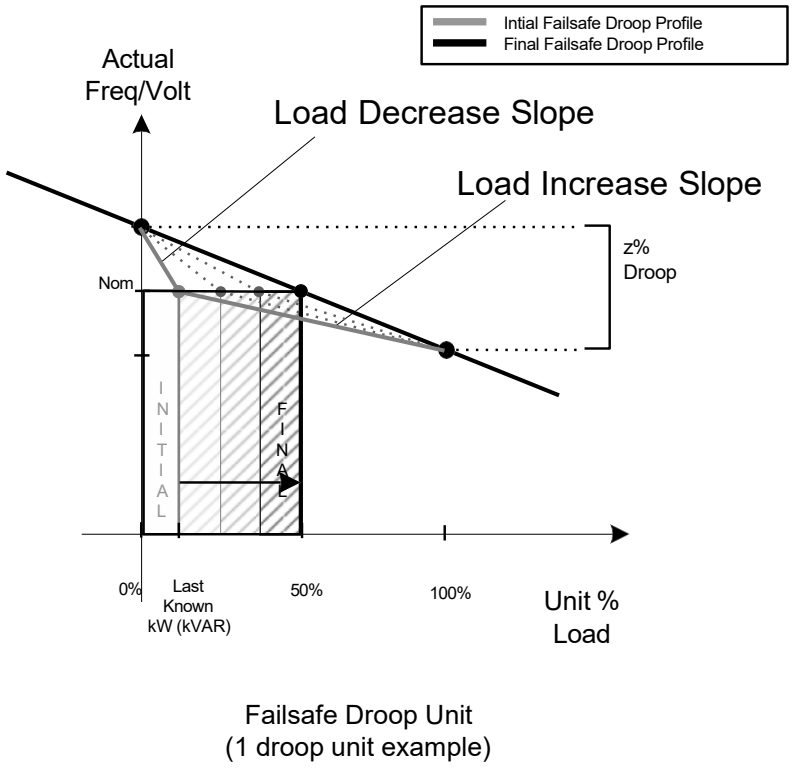


Figure 37.29 – Failsafe Adaptive Droop Slopes

Note: If failsafe adaptive droop units' % kW drops below 0% kW or rises above 100% kW, the standard z% droop is implemented.

37.5 MGDL Paralleling Tuning Guide

Each generator system has different load share gain tuning needs. This section is intended to aid in properly tuning the system as well as:

- Provide an overview of the Real and Reactive Load Sharing control loops in the EMCP 4.4
- Identify setpoints used for adjusting/tuning Real and Reactive Load Sharing
- Provide basic guidelines for setting up and tuning Real and Reactive Load Sharing

37.5.1 Background

Load sharing is the process of sharing the real power (kW) and reactive power (kVAr) between generator sets while maintaining proper bus frequency and voltage. The controlling factor for kW and frequency is the same. Both are based upon the torque (or power) being provided by the engine. Increasing the power from the engine through the desired speed setting will either increase the kW being provided, which must be consumed, or the bus frequency will increase. The kVAr and voltage are based on the excitation of the generator. Increasing the generator excitation through the desired voltage setting will provide additional kVArs which must be consumed, or the bus voltage will increase. For these reasons, the tuning of Load Sharing is more difficult since single control points (desired speed, desired voltage) drive multiple output parameters (bus frequency and kW, bus voltage and kVAr). An overview of the real and reactive load sharing control loops is presented in Figure 37.30.

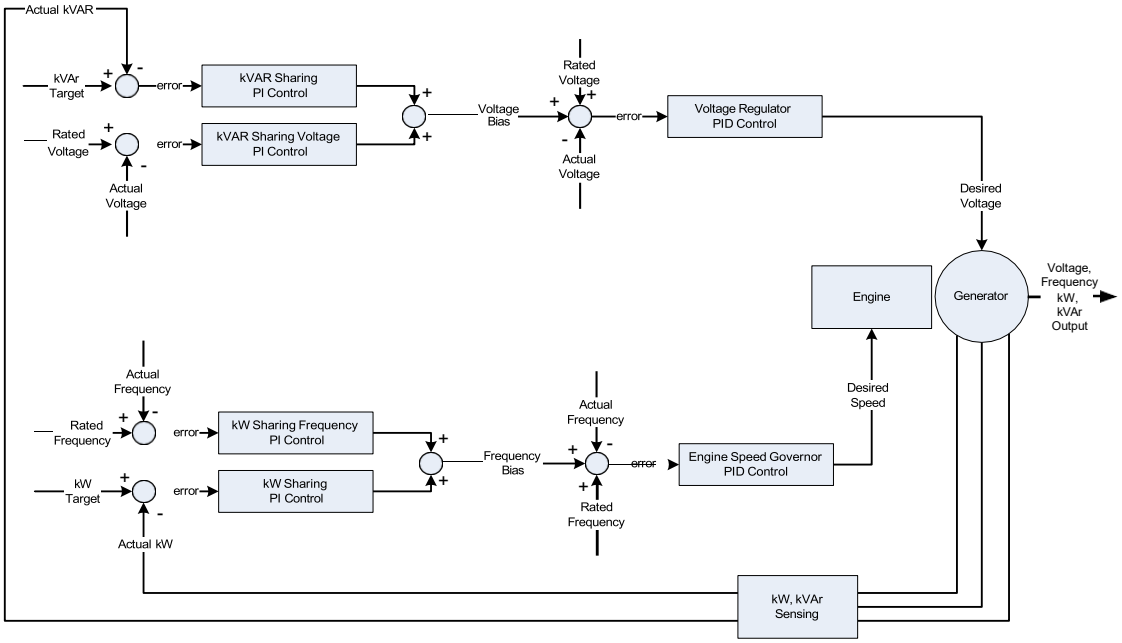


Figure 37.30 – Real and Reactive Load Sharing Control Loop Overview

As shown in Figure 37.31, a number of PID controls are involved in regulating the real and reactive load sharing output of a generator set. Each control is tuned individually using respective set of PID (or PI) gain parameters. The overview of the real and reactive load sharing control loop with these PID (or PI) gain parameters included is shown in Figure 37.31 for reference.

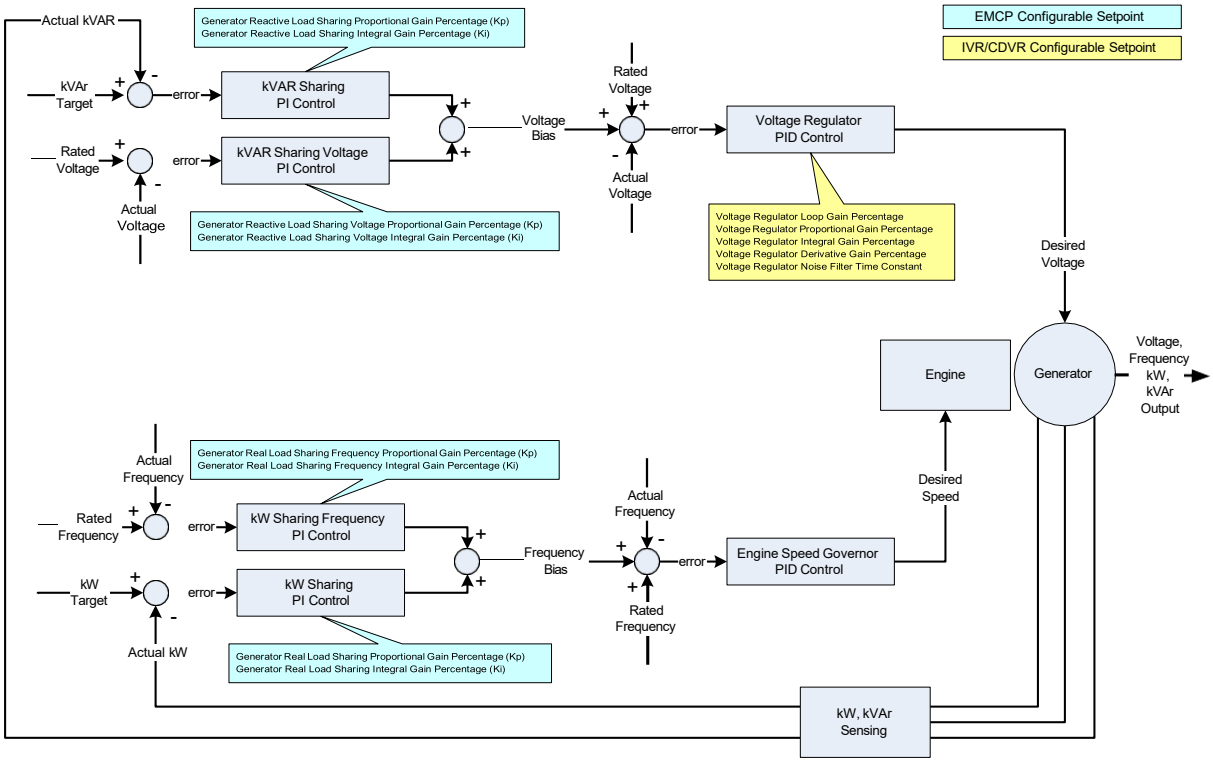


Figure 37.31 – Real and Reactive Load Sharing Control Loop Overview with PID Gain Setpoints

37.5.2 Strategy

Since each of these controls has multiple controlling factors, a means of approaching the tuning of load sharing is required. One item to be considered is that full concentration on any one portion of load sharing is not possible since these different control loops interact with each other. For example, any instability in the voltage/kVAr sharing affects the frequency/kW since the power consumed by the load is usually affected by the voltage. For this reason, multiple items must be considered simultaneously.

37.5.3 Guidelines

Be sure to be familiar with navigation of the EMCP screens and setpoints before attempting to develop a set of gains. Read through and become familiar with how to view the load status information along with information on the electrical output of the generator set. Since load sharing affects multiple units in the system, it is easy for the system to become unstable. All protective relay settings such as reverse kW and reverse kVAr should be reviewed and possibly tightened for commissioning in order to protect the generator set. It is recommended to use a resistive and reactive load bank to tune generator load sharing.

While it is possible to tune the real power sharing with just a resistive load bank, tuning of both parameters require kW and kVAr control. If customer load is going to be used for tuning, care must be taken to ensure that the voltage and frequency variations will not cause damage to the load.

The process of load sharing tuning is an iterative procedure. It is NOT possible to arrive at optimum settings for one PID gains before tuning the other gains. In addition, it is NOT possible to tune one generator set without tuning the other generator sets with which it is load sharing. If the generator sets are equivalent power ratings, tuning is easier since the setpoints can be copied from one unit to the next. The use of multiple people or use of ET on 1 unit with the laptop near the second unit will help in modifying the setpoints of multiple units.

In order to keep the frequency (voltage) gains from overpowering kW (kVAr) gains, the frequency and voltage gains are automatically turned off in the software control when the generators are close to nominal frequency and voltage. This may cause a slight ripple in frequency and voltage while it oscillates around the nominal frequency or voltage.

Regardless of the number of units at a site, it is recommended to first develop initial gains only using 2 units. These gains may need to be adjusted as part of an iterative process when additional units are added, but it is easier to slightly adjust gains once a stable set has been arrived at. The units may ship with starting point gains. If they do, start with these gains and adjust them as needed. If there are no usable gains to start with, perform the following steps to develop initial gains:

1. Tune Voltage Regulator PID and Engine Governor (if available) controls for stability in single generator set operation. If stability cannot be achieved while operating as a single generator set, do not move on to load sharing tuning. Consult engine or voltage regulator tuning procedures for troubleshooting single generator set tuning. These gains will need to be decreased as additional control loops are added. If using an electronic voltage regulator, the loop gains can simply be reduced by 30% or more.
2. Zero out the Frequency and Voltage Sharing gains (Kp and Ki). This will allow the units to concentrate on sharing kVAr and kW, regardless of the voltage or frequency of the system. If different generator sets are being used, these may not be able to be zeroed out since the governor or voltage regulator may influence frequency (speed) or voltage.
3. Start with a very small integral gain or even zero, but have a medium size proportional gain for kW and kVAr sharing gains. Pay close attention to load sharing levels of the system. While working with the proportional gain, do NOT expect the units to share equally, but some sharing should occur.

4. Increase the integral gain to improve the equality of load sharing. Keep in mind a slightly slower response to transients reduces the chance of instability as parts of the system change due to ambient conditions, loading conditions, fuel quality, etc.

5. Once kW and kVAr sharing gains exist that allow reasonable (+/-10%) sharing to occur, start adjusting the Voltage and Frequency gains from zero in order to correct the bus voltage and bus frequency to the nominal values. These gains will be processed simultaneously with the kW and kVAr loop, and may drive changes in the system. While adjusting these Voltage and Frequency gains, the system should be monitored for response to load changes, adding and removing generator sets, etc. Make sure to watch the response as a single unit load sharing with itself, along with the second unit on the bus.

Figure 37.32 identifies the PID control setpoints involved in each of the 5 steps for developing initial gains described above.

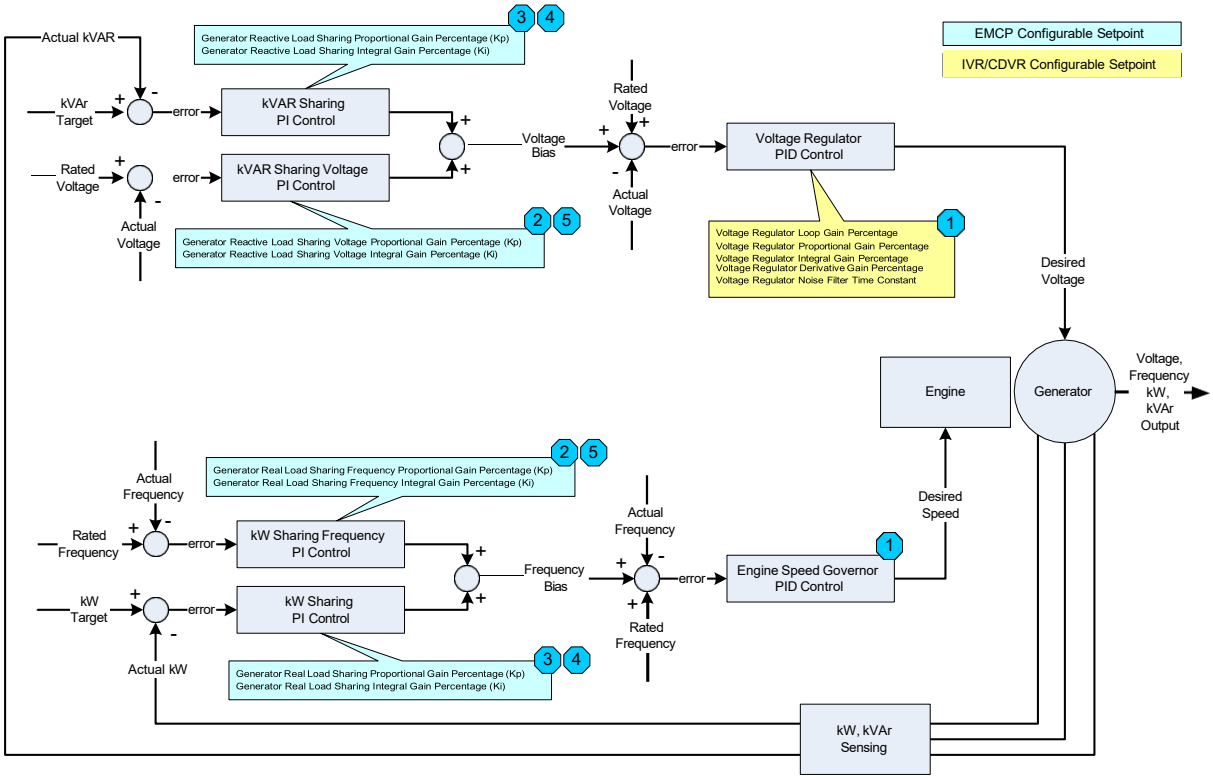


Figure 37.32 – Real and Reactive Load Sharing Control Loop Tuning Steps

There is not a single set of optimal gains that apply to all generator systems, but only an iterative process to develop acceptable gains. Any changes in engine governor software settings or voltage regulator software settings will have an effect on acceptable gains. If instability problems exist, consider lowering the gains of the governor or voltage regulator for improved system performance. The optimum settings of a single unit against a load are NOT the optimum settings for a unit as part of a paralleled system.

37.6 MGDL Display Screens

The EMCP 4.4 MGDL display screens provide information on the individual unit's paralleling operations. The display screens also provide the ability to monitor key information from ANY EMCP 4.4 controllers communicating on the MGDL network. The EMCP 4.4 MGDL display screens also provide additional control and configurability that is NOT available through ET. Each MGDL display screen is described in more detail below.

37.6.1 MGDL System Overview Screens

The MGDL System Overview and MGDL Unit Details screens can be accessed directly through the EMCP 4.4 display. To access the MGDL Overview and MGDL Unit Details through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ PARALLELING

→ MGDL OVERVIEW

The MGDL System Overview screen displays key information for all MGDL units from a single EMCP 4.4 controller's display. The MGDL System Overview screen information is described in Figures 37.33 through Figure 37.36.

Note: These screens are hidden from display until *Multiple Genset Control Data Link Unit Number* (setpoint) is configured to a non-zero value.

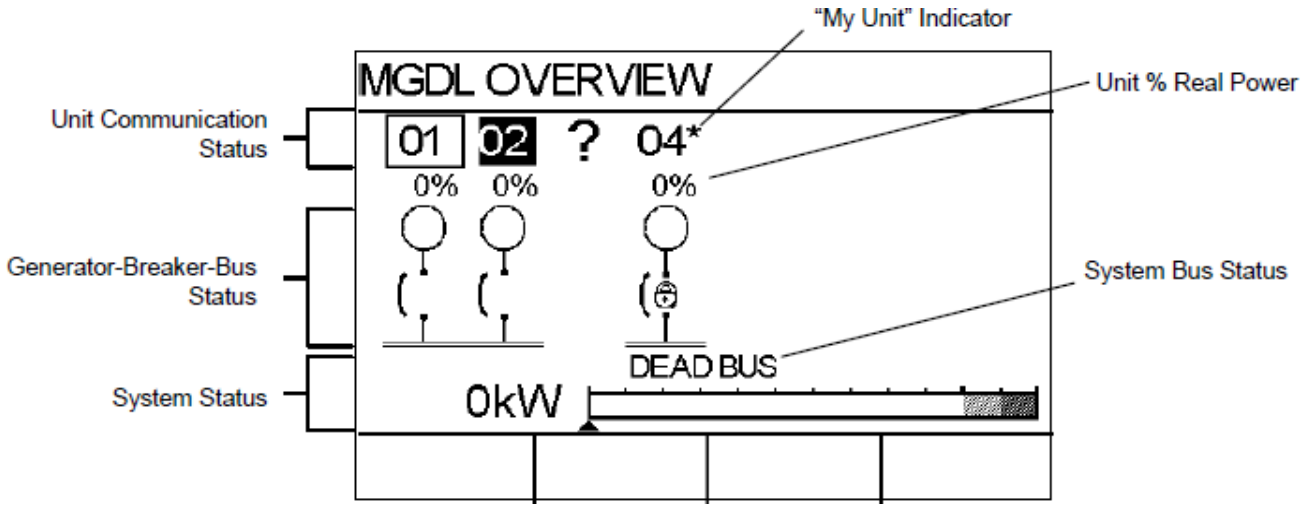


Figure 37.33 – MGDL Overview Screen with Less Than 8 MGDL Units

The unit communication status information of all MGDL units is provided in the top section of the MGDL Overview screen.

- The unit number of any MGDL unit that is broadcasting information on the network will automatically appear in a solid block text.
- A unit number that is reverse videoed 02 indicates immature communications. The immature communications indicator is active for the first 60 seconds after a unit begins broadcasting on the MGDL network.
- A unit number is replaced with a question mark if communications have been lost with that unit. Scrolling to and selecting the question mark on the MGDL Overview screen displays a message indicating the unit number of the lost unit (Figure 37.38).
- To avoid confusion and improve troubleshooting, an asterisk next to a unit number indicates “my unit” and refers to the unit number assigned to the controller whose display is being viewed.

The percent of rated real power of each individual MGDL unit is displayed just below the unit number identification. This provides an indication of the real power loading of each MGDL unit at a given point in time.

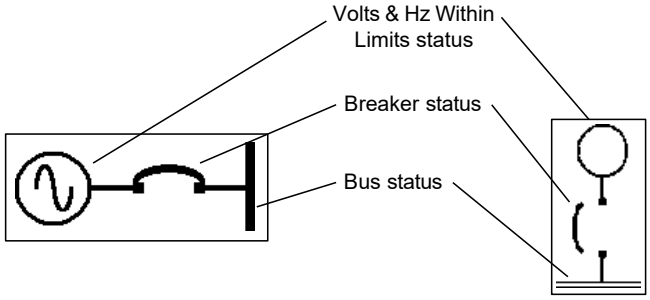


Figure 37.34 – Generator-Breaker-Bus Status Symbol

The generator-breaker-bus status symbol (Figure 37.34) provides an indication of the generator operating state and consists of three separate indicators:

1. Generator Volts/Hz Within Limits Status

2. Generator Breaker Status

3. Bus Voltage Status

If communications are lost, the generator-breaker-bus symbol disappears since the information is unknown.

The Generator Volts/Hz Within Limits Status provides an indication to the generator sets readiness. The generator circle is populated with a sinusoidal wave symbol when the generator voltage and generator frequency are greater than 90% of their rated values. The generator circle is left blank when either generator voltage or generator frequency are less than or equal to 90% of their rated values.

The Generator Breaker Status provides an indication of the generator breaker state. Table 37.28 shows the possible generator breaker states and corresponding symbols on display.

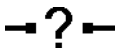
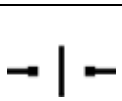
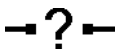
	Open	Closed	Locked Out	Unknown
U.S.				
International				

Table 37.28 – Generator Breaker Status Symbols

The generator breaker status symbol can be switched between U.S. and International symbols under the EMCP display preferences.

The Bus Voltage Status detected by each MGDL unit is indicated by the bottom row of the generator-breaker-bus symbol. The unit bus bar symbol is filled in to indicate a live bus is detected and is left empty to indicate a dead bus is detected by the individual unit.

The System Bus Status indication considers the dead bus detection of all MGDL units on the network. The system bus status reads LIVE BUS when any MGDL unit detects a live bus and reads DEAD BUS when all MGDL units detect a dead bus.

The System kW value is the total real power provided by all MGDL units on the network. The System % kW is the real power provided by all the MGDL units on the network as a percentage of all the rated power of all the MGDL units on the network regardless of their operating state.

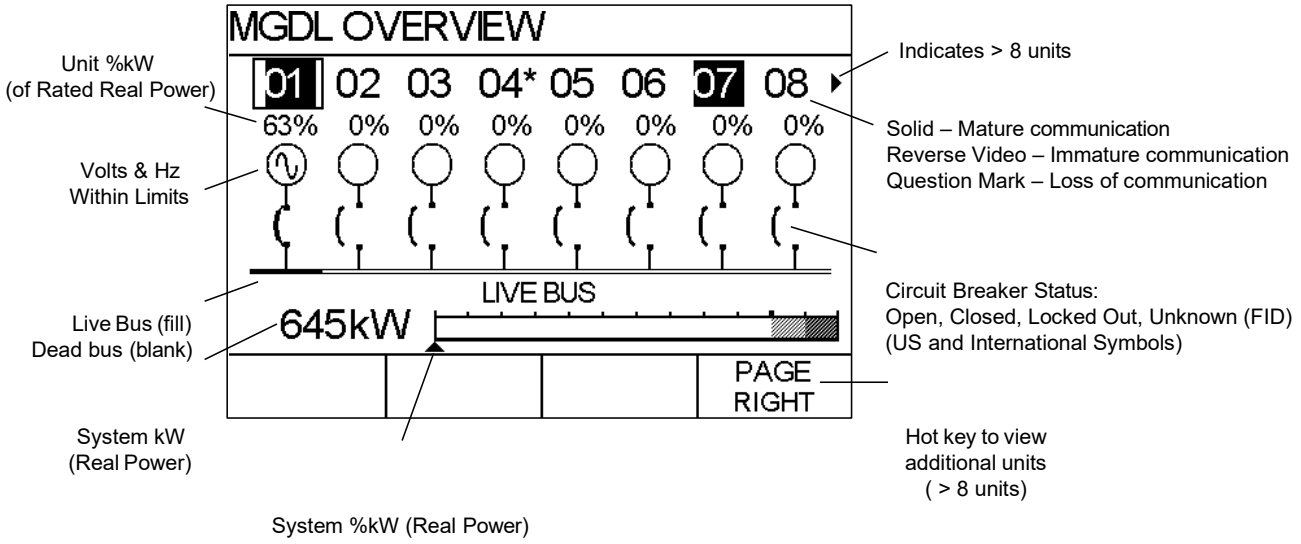


Figure 37.35 – MGDL Overview Screen with Greater Than 8 MGDL Units (Screen 1 of 2)

When more than 8 units are connected to the MGDL network an arrow appears indicating an additional MGDL Overview screen is available. Pressing the PAGE RIGHT (F4 hot key) navigates to the second MGDL Overview screen (Figure 37.36).

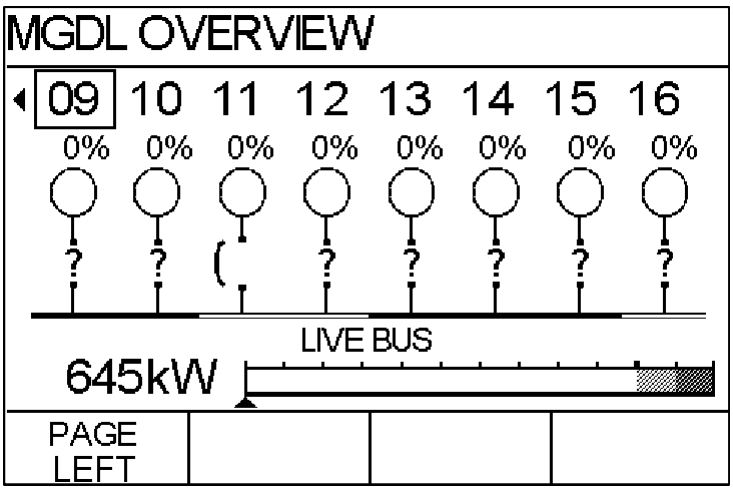


Figure 37.36 – MGDL Overview Screen with Greater Than 8 MGDL Units (Screen 2 of 2)

Scrolling left and right on the MGDL Overview screen with the left and right arrow keys allows the user to select a particular MGDL unit . Pressing the OK key provides more detailed information (Figure 37 .37) on the operation of the selected MGDL unit .

MGDL Unit Details

The MGDL Unit Details screen displays detailed information of the selected MGDL unit from a single EMCP 4 .4 controller's display. The MGDL Unit Details screen information is described in Figure 37 .37 and Figure 37 .38 .

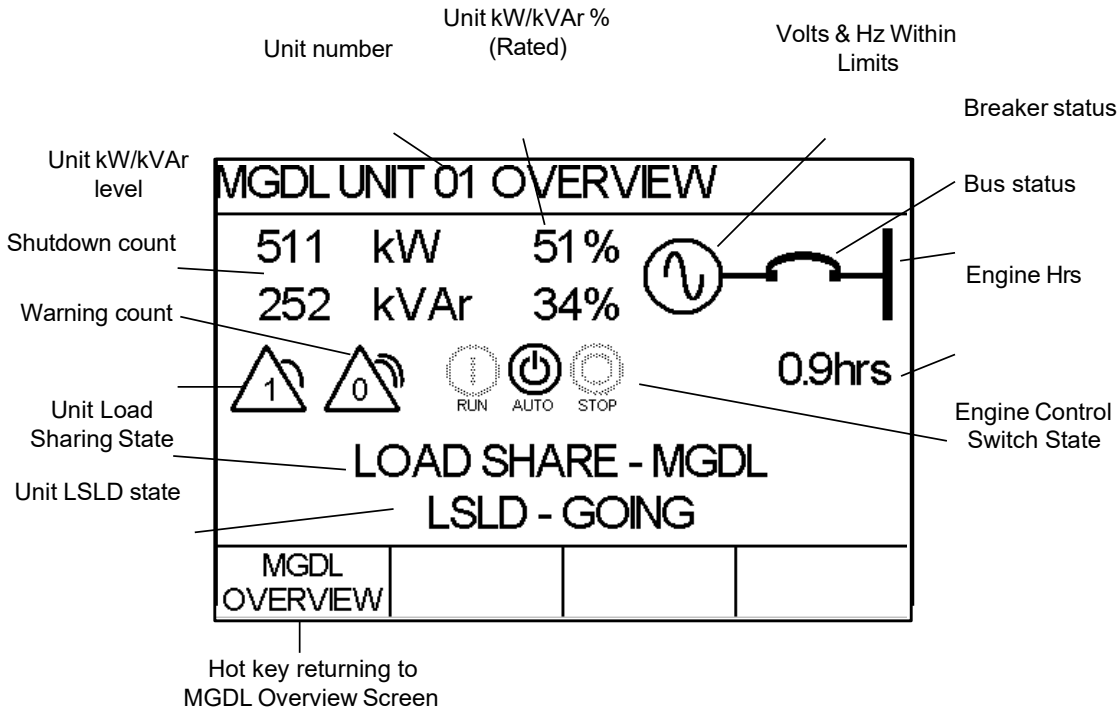


Figure 37.37 – MGDL Unit Details Screen

- The unit number of the MGDL unit details being viewed is listed in the title bar of the MGDL Unit Details Screen.
- The actual kW and kVAr totals as well as % kW and % kVAr of the unit is listed in the top left of this screen.
- The generator-breaker-bus status (described in Figure 37.34) is also replicated on this screen from the MGDL Overview screen.
- In the middle of the screen, the number of active warnings and active shutdowns on the MGDL unit are displayed. If the number of warnings or shutdowns is greater than 9, the number is replaced by a "+" symbol.
- The engine control switch symbols (RUN, AUTO, and STOP) visible on the EMCP fascia are replicated on this screen representing the current operating state of the MGDL unit's engine control switch. As the engine control switch is changed from the unit's RUN, AUTO, and STOP keys, the symbol is updated on display.
- The total operating hours of the unit is listed to the right of the engine control switch status.
- The unit's load sharing and LSLD state is listed on the final two rows of this screen. See Table 37.29 and Table 37.29 for a complete list of the possible load sharing and LSLD states.
- If communications are lost with a unit, the unit details are not available and the unit details screen is replaced with a message indicating a loss of communications as shown in Figure 37.38.

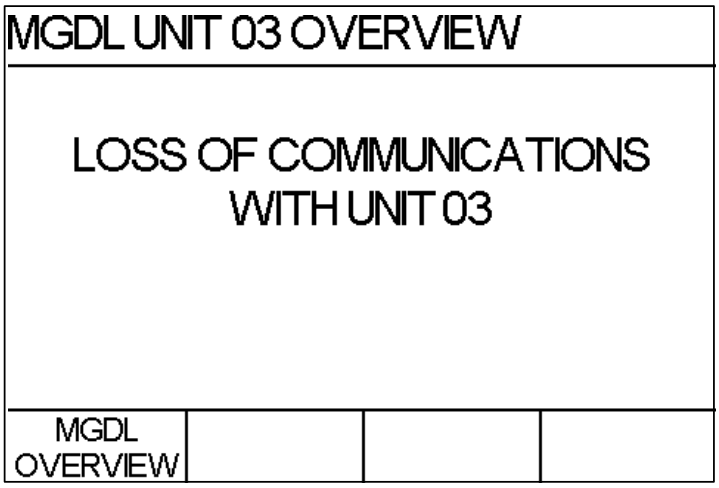


Figure 37.38 – MGDL Unit Details Screen of Unit with Loss of Communications

37.6.2 MGDL Control Screen

The EMCP 4.4 maintains a list of expected controls on the MGDL network and actual controls on the MGDL network. Under normal operation the expected controls equal actual controls. However, in the case of network topology updates or loss of communications, expected controls may NOT equal actual controls. The ability to view and reset the number of expected controls to the number of actual controls for ALL units on the MGDL network is provided through the MGDL Control screen.

Note: RESET EXPECTED is a system-wide reset where resetting the expected number of MGDL units from "my unit" sends a system-wide command to ALL units on the MGDL network to reset expected number of MGDL units.

Further details and implications of resetting expected controls on the MGDL network are provided in MGDL Network Configuration (Expected Units) Reset Section 37.4.8 and Troubleshooting section of this manual Section 37.7.

To access the MGDL Control screens through the EMCP display, navigate to the following sub-menus:

MAIN MENU

→ CONTROL

→ PARALLELING

→ MGDL CONTROL

Note: Pressing the CONTROL key  on the face of the EMCP 4.4 provides a shortcut to the control menu.

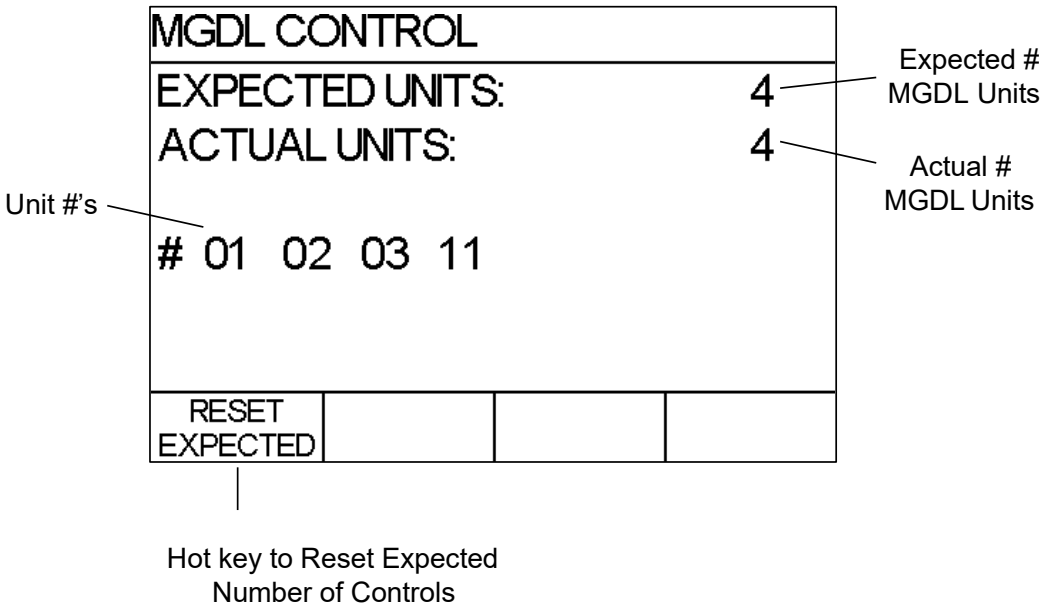


Figure 37.39 – MGDL Control Screen for Viewing/Resetting Expected Number of Units on the MGDL Network

Pressing the RESET EXPECTED (F1 hot key) populates an additional verification screen that requires an OK button press to reset the expected number of MGDL units.

37.6.3 MGDL Synchronizing Screens

The MGDL Synchronizing screens can be accessed directly through the EMCP display. To access the MGDL Synchronizing view screens through the EMCP display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ PARALLELING

→ SYNC OVERVIEW

The MGDL Sync Overview screen displays important synchronizing information of the individual EMCP 4.4 controller. The MGDL Sync Overview screen information is described in Figure 37.40.

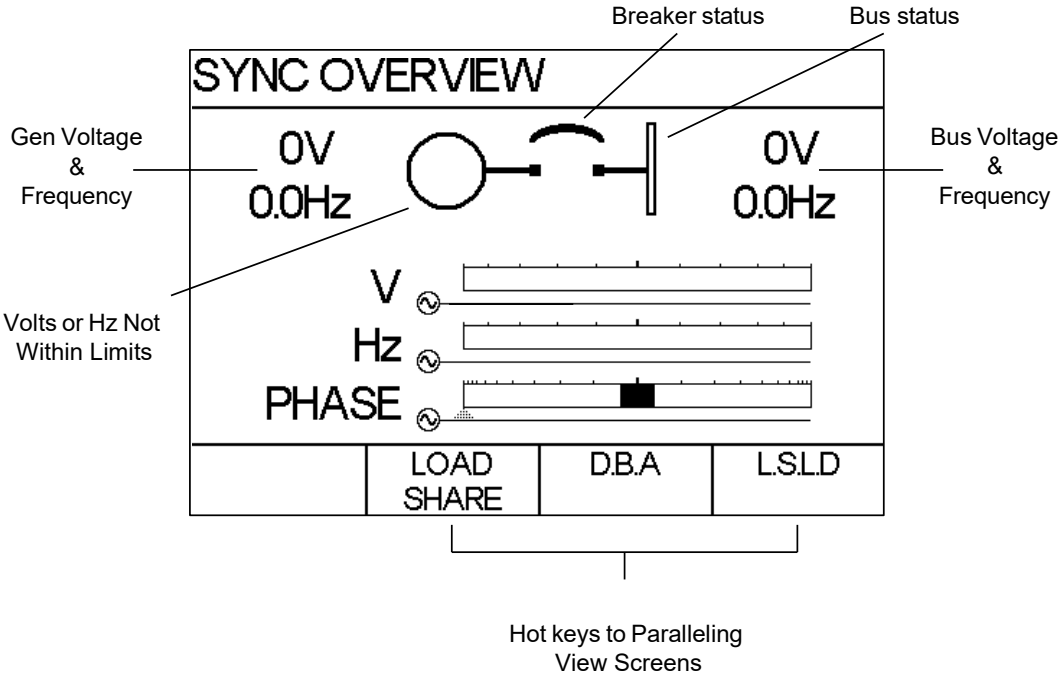


Figure 37.40 – MGDL Sync Overview Screen

Both generator voltage and frequency and bus voltage and frequency are displayed at the top of the screen. The generator-breaker-bus status (described in Figure 37.34) is also replicated on this screen from the MGDL Overview screen.

Hot keys are provided for quick access to the other MGDL paralleling view screens [(LOAD SHARE (F2 hot key), D.B.A (F3 hot key), and L.S.L.D (F4 hot key)].

To access the MGDL Synchronizing control screens through the EMCP display, navigate to the following sub-menus:

MAIN MENU

→ CONTROL

→ PARALLELING

→ SYNC OVERVIEW

→ SYNC MODE SWITCH

Note: Pressing the CONTROL key on the face of the EMCP 4 .4 provides a shortcut to the control menu .

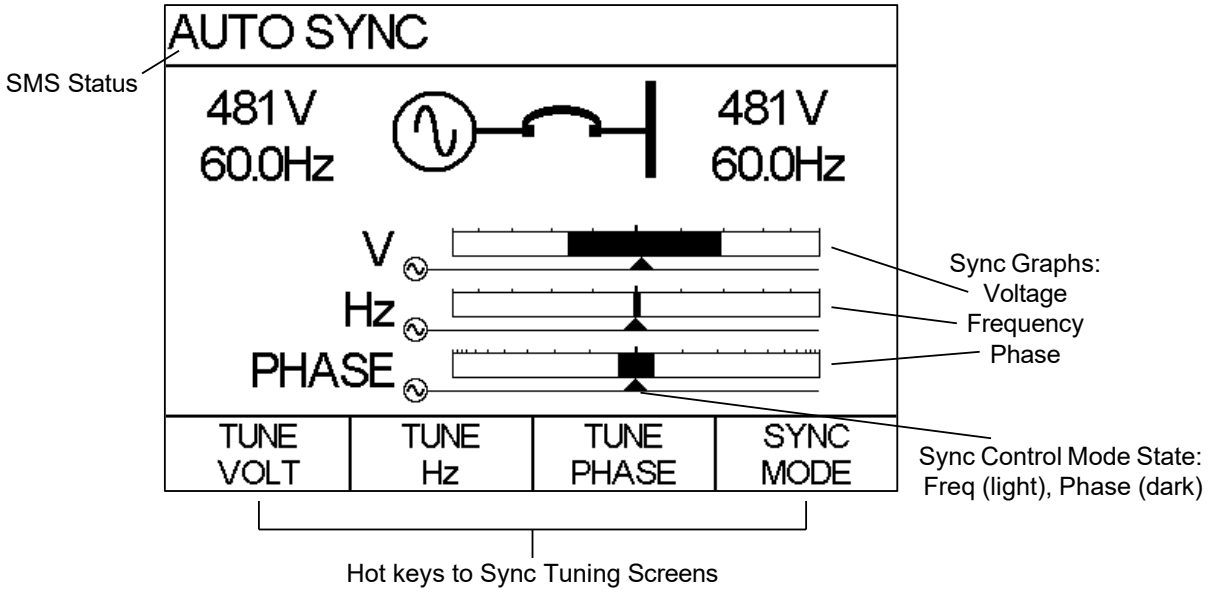


Figure 37.41 – MGDL Sync Control Screen

The Sync Graphs: voltage, frequency, and phase are displayed on this screen . These graphs update while synchronization is occurring . The sync control mode state changes for frequency correction and phase correction . Hot keys are provided for quick access to Sync Control screens to tune voltage, frequency and phase as well as select the Sync mode [(TUNE VOLT (F1 hot key), TUNE HZ (F2 hot key), TUNE PHASE (F3 hot key), and SYNC MODE (F4 hot key)] . The sync mode switch (SMS) state is shown in the title bar and can be configured from the MGDL Sync Control Screen or from the path below:

MAIN MENU

→ CONTROL

→ PARALLELING

→ SYNC MODE SWITCH

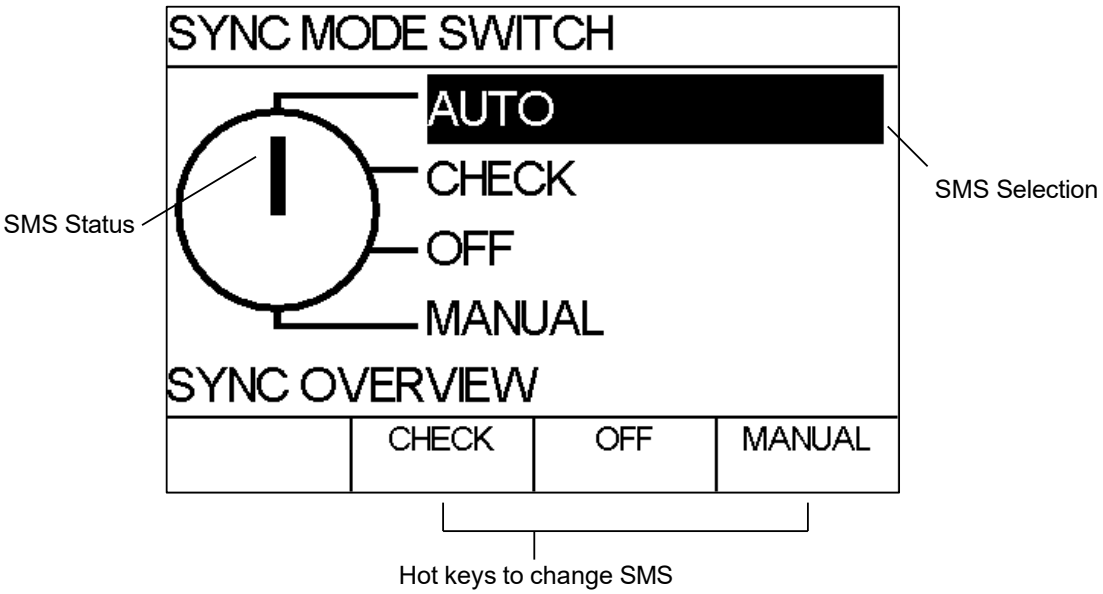


Figure 37.42 – MGDL Sync Mode Switch

The SMS can be changed via the hot keys or by using the arrows on the EMCP fascia.

37.6.4 MGDL Load Sharing Screens

The MGDL Load Sharing screens can be accessed directly through the EMCP 4.4 display. To access the MGDL Load Sharing view screens through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ PARALLELING

→ Load Share

The MGDL Load Sharing screen displays important load sharing information of the individual EMCP 4.4 controller. The MGDL Load Sharing screen information is described in Figure 37.43.

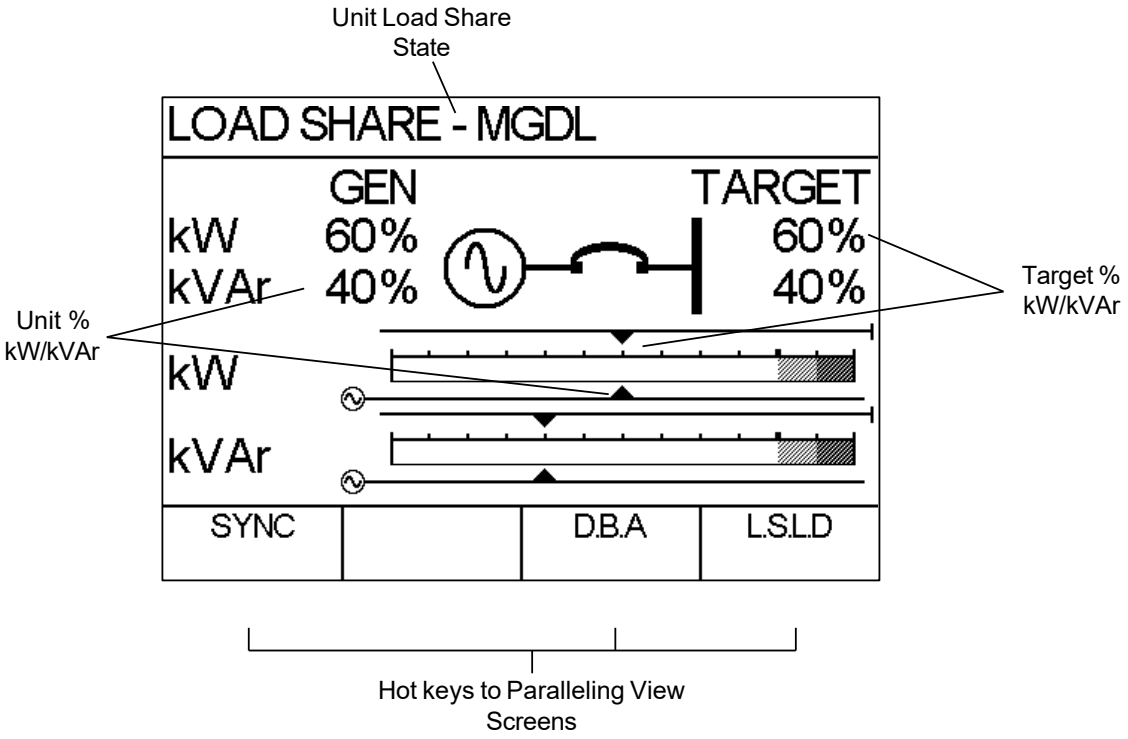


Figure 37.43 – MGDL Load Share View Screen

The Unit Load Share State in the title bar of this screen reflects the generator load control operating mode as seen by the rest of the system. This state takes into account the configured load sharing mode, engine and breaker status, and soft load/unload status. The possible load sharing states are listed in Table 37.29.

Unit Load Share State	Description
DISABLED	Unit is configured to have load sharing disabled.
INACTIVE	Unit is not actively load sharing.
SOFT LOAD	Unit is increasing load in a controlled manner before attempting to close its generator breaker.
SOFT UNLOAD	Unit is decreasing load in a controlled manner before attempting to open its generator breaker.
FAILSAFE DROOP	Unit has exited normal load sharing due to a failure in the MGDL network and is controlling load according to a failsafe droop curve.
FAILSAFE ISOCH	Unit has exited normal load sharing due to a failure in the MGDL network and is controlling load according to a failsafe isochronous load sharing curve.
BASE LOAD	Unit is controlling load to a desired base load level (typically in parallel to utility/mains). (This feature is only available with complex software.)
ANALOG	Unit is actively load sharing via analog (hardwired) load sharing lines.
MGDL	Unit is actively load sharing via multiple generator set data link.

Table 37.29 – MGDL Load Share Operating State

- The generator-breaker-bus status (described in Figure 37.34) is also replicated on this screen from the MGDL Overview screen.
- This screen also provides the actual kW/kVAr provided with respect to the target kW/kVAr. These values are provided numerically as the percentage of rated as well as visually on the Load Share Graph. During normal load sharing the actual kW/kVAr should regulate to the target kW/kVAr.
- MGDL Load Sharing Control screen is similar to the view screen except it provides easy access to load sharing tuning parameters via the F1 and F2 hot keys (shown in Figure 37 .44) . To access the MGDL Load Sharing control screens through the EMCP display, navigate to the following sub-menus:

MAIN MENU

→ CONTROL

→ PARALLELING

→ LOAD SHARE

Note: Pressing the CONTROL key  on the face of the EMCP 4 .4 provides a shortcut to the control menu.

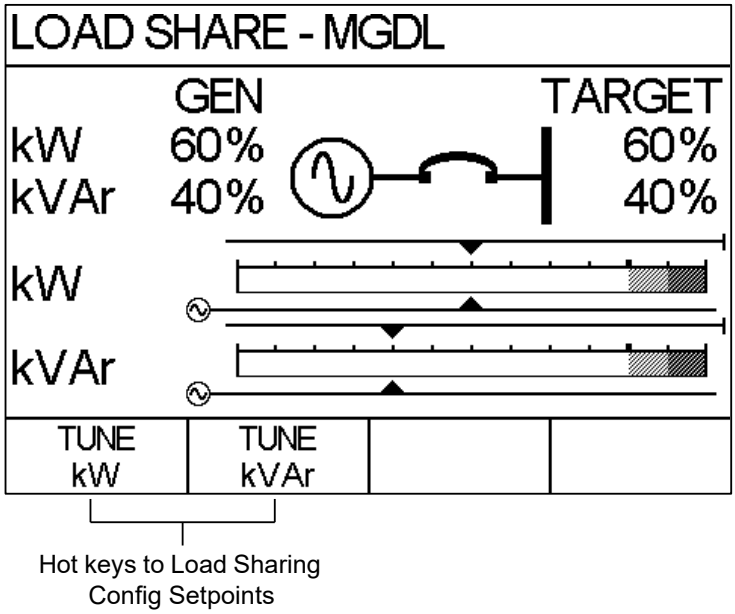


Figure 37.44 – MGDL Load Share Control Screen

37.6.5 MGDL Dead Bus Arbitration Screens

The MGDL Dead Bus Arbitration screens can be accessed directly through the EMCP 4.4 display. To access the MGDL Dead Bus Arbitration view screens through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ PARALLELING

→ DEAD BUS ARBITRATION

The MGDL Dead Bus Arbitration screen displays important dead bus arbitration information of the individual EMCP 4.4 controller as well as the overall MGDL system. The MGDL Dead Bus Arbitration screen information is described in Figure 37.45.

Note: These screens are hidden from display until the *Dead Bus Close Input Configuration* (setpoint) is configured to "Ethernet (MGDL)."

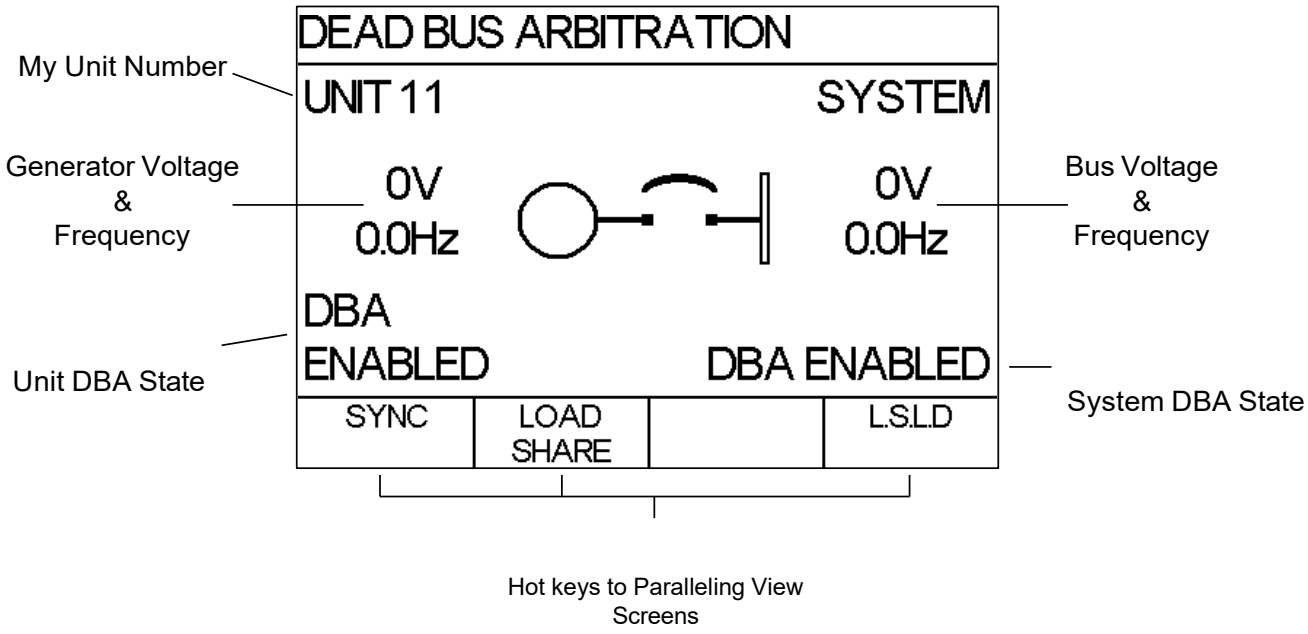


Figure 37.45 – MGDL Dead Bus Arbitration View Screen

The Unit DBA State reflects the state of the unit's DBA operating mode as seen by the rest of the system. These states take into account the configured DBA mode, progress towards dead bus closing, and generator breaker status. The possible Unit DBA states are listed in Table 37.30.

Unit DBA State	Description
DBA DISABLED	Unit is configured to have DBA disabled.
DBA ENABLED	Unit is configured to have DBA enabled (either Hardwired or Ethernet (MGDL)).
REQUESTING	Unit is ready to dead bus close and is requesting permission from other MGDL units to dead bus close.
CAPTURING	Unit is ready to dead bus close and has captured authority to dead bus close but is waiting for all other MGDL units to grant permission to dead bus close.
CLOSE GRANTED	Unit has been granted permission from other MGDL units to dead bus close and has issued a close breaker command, but has not yet detected a breaker closure.
BREAKER CLOSED	Breaker closure has been detected and the unit is on the bus.
FAILURE WAIT	Unit failed to dead bus close and is waiting before re-requesting permission to dead bus close. The unit releases authority to dead bus close to other units.
MAX FAILURES	A maximum number of dead bus close failures (5) has occurred. A Dead Bus Arbitration Failure Shutdown (SPN-FMI: 2530-1) accompanies this state.
LIVE BUS	A live bus is detected and dead bus arbitration is no longer required.

Table 37.30 – MGDL Unit Dead Bus Arbitration Operating State

The System DBA State reflects the state of DBA at an overall system level. This state takes into account the individual DBA state of all units on the MGDL network. The possible System DBA states are listed in Table 37.31.

System DBA State	Description
DBA DISABLED	All DBA units are in the DBA DISABLED state then the system is DBA DISABLED.
DBA ENABLED	Any DBA unit is in the DBA ENABLED state then the system is DBA ENABLED.
REQUESTING	Any single DBA unit is in the REQUESTING state then the system is REQUESTING.
UNIT XX CAPTURING	Any DBA unit is in the CAPTURING or CLOSE GRANTED state then the system is CAPTURING and the capturing unit number is identified.
LIVE BUS	Any DBA unit detects a live bus and dead bus arbitration is no longer required.

Table 37.31 – MGDL System Dead Bus Arbitration Operating State

The generator-breaker-bus status (described in Figure 37.34) is also replicated on this screen from the MGDL Overview screen.

This screen also provides the generator voltage and frequency measurements as well as bus voltage and frequency measurements.

MGDL Dead Bus Arbitration control screen is similar to the view screen (Figure 37.46) except it provides easy access to the synchronizing control screen (F1 hot key). To access the MGDL Dead Bus Arbitration control screens through the EMCP display, navigate to the following sub-menus:

MAIN MENU

→ CONTROL

→ PARALLELING

→ DEAD BUS ARBITRATION

Note: Pressing the CONTROL key  on the face of the EMCP 4.4 provides a shortcut to the control menu.

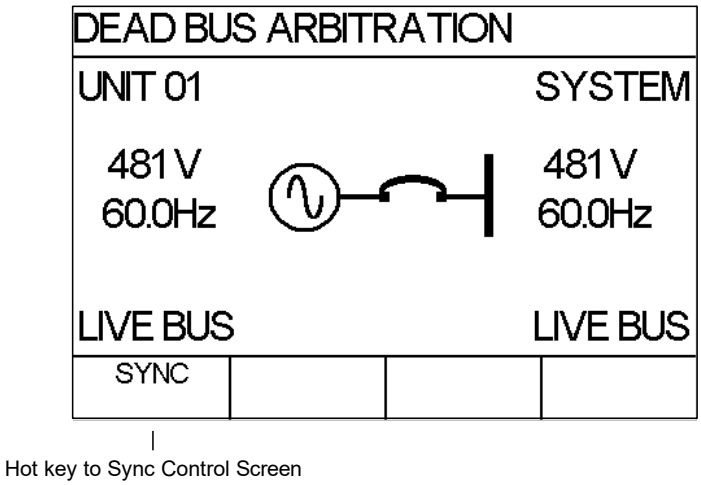


Figure 37.46 – MGDL Dead Bus Arbitration Control Screen

37.6.6 MGDL Load Sense Load Demand Screens

The MGDL Load Sense Load Demand screens can be accessed directly through the EMCP 4.4 display. To access the MGDL Load Sense Load Demand view screens through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ PARALLELING

→ LOAD SENSE LOAD DEMAND

The MGDL Load Sense Load Demand view screen displays load sense load demand information of the individual EMCP 4.4 controller as well as the overall MGDL system. The MGDL Load Sense Load Demand view screen information is described in Figure 37.47.

Note: These screens are hidden from display until the LSLD Input Configuration setpoint is configured to "Ethernet (MGDL)."

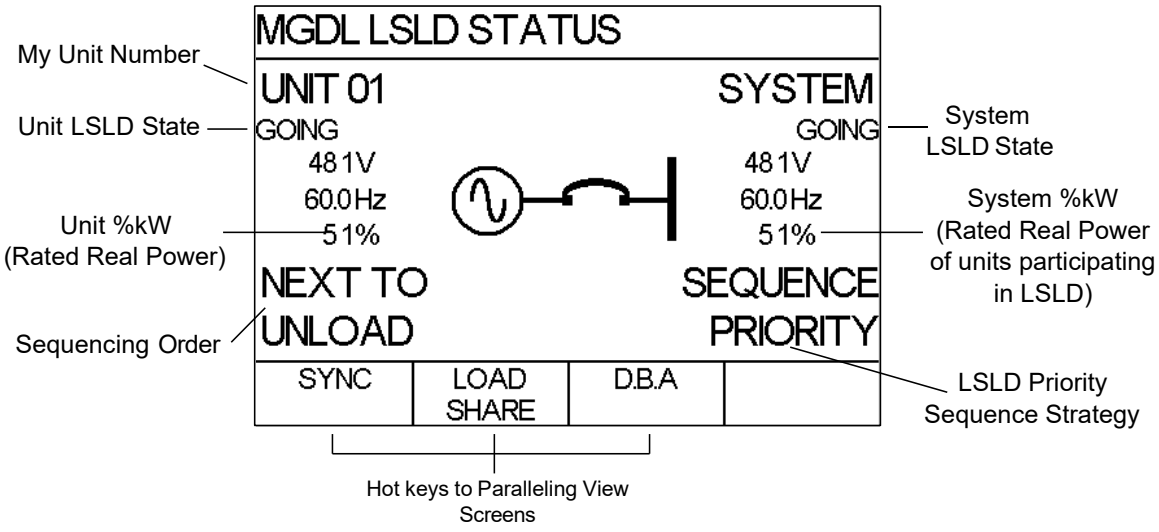


Figure 37.47 – MGDL Load Sense Load Demand View Screen

The Unit LSLD State reflects the state of the unit's LSLD operating mode as seen by the rest of the system. These states take into account the configured LSLD mode, generator breaker status, and soft load/unload status. The possible Unit LSLD states are listed in Table 37.32.

Unit LSLD State	Description
Unit Operating Under LSLD Control	
GOING	Unit is running with the generator breaker closed and soft loading complete under LSLD control. This unit could sequence off as required based on load demand.
SETTLING	Unit is running with the generator breaker closed and soft loading complete with the LSLD Enable Delay Timer active. No units will sequence off until the LSLD Enable Delay (Settling) Timer has expired.
UNLOADING	Unit is stopping and soft unloading under LSLD control.
LOADING	Unit is starting, synchronizing, and soft loading under LSLD control.
AVAILABLE	Unit is stopped with the generator breaker open under LSLD control and is available to come on the bus.
Unit Unable to Participate Under LSLD Control	
GOING LSLD OFF	Unit is running and the generator breaker is closed, but the unit is unable to participate in LSLD control due to failure to meet certain conditions (such as by the result of manually starting and synchronizing or a failure to open breaker condition).
UNAVAILABLE	Unit is stopping or stopped and the generator breaker is open, but the unit is unable to participate in LSLD control due to certain conditions (such as by the result of pressing the STOP key or an active shutdown).

Table 37.32 – LSLD Unit Operating State

The System LSLD State reflects the state of LSLD at an overall system level. This state takes into account the individual LSLD state of all units on the MGDL network. The possible System LSLD states are listed in Table 37.33.

System LSLD State	Description
GOING	All LSLD units are in the GOING state then the system is GOING.
SETTLING	Any LSLD unit is in the SETTLING state then the system is SETTLING.
UNLOADING	Any LSLD unit is in the UNLOADING state then the system is UNLOADING.
LOADING	Any LSLD unit is in the LOADING state then the system is LOADING.
AVAILABLE	Any LSLD unit is in the AVAILABLE state then the system is AVAILABLE implying that the system is not operating at full capacity.
GOING LSLD OFF	At least one LSLD unit is in the GOING LSLD OFF state and all units are either GOING LSLD OFF or UNAVAILABLE.
UNAVAILABLE	All LSLD units are in the UNAVAILABLE state then the system is UNVAILALBLE.

Table 37.33 – LSLD System Operating State

The generator-breaker-bus status (described in Figure 37.34) is also replicated on this screen from the MGDL Overview screen.

This screen also provides the generator voltage, frequency and percent real power measurements as well as bus voltage, frequency and system percent real power measurements.

The individual unit's order for sequencing on or off the bus under LSLD is indicated by the "NEXT TO LOAD" or "NEXT TO UNLOAD" status in the bottom left corner of this screen. If the unit is going under LSLD and it is prioritized such that it is 1st unit to unload, this status reads "NEXT TO UNLOAD." If the unit is prioritized such that it is 2nd unit to unload, this status reads "NEXT TO UNLOAD + 1."

Similarly, if the unit is available for loading under LSLD and it is prioritized such that it is the 1st unit to load this status reads "NEXT TO LOAD." If the unit is prioritized such that it is the 2nd unit to load this status reads "NEXT TO LOAD + 1."

The currently active LSLD sequence strategy as configured in the LSLD setpoints is listed in the bottom right corner of this screen.

MGDL Load Sense Load Demand control screen (Figure 37.48) is similar to the view screen except it provides easy access to the LSLD configuration setpoints as well as access to the LSLD Priority Assignment screen. To access the MGDL Load Sense Load Demand control screens through the EMCP 4.4 display, navigate to the following sub-menus:

MAIN MENU

→ CONTROL

→ PARALLELING

→ LOAD SENSE LOAD DEMAND

Note: Pressing the CONTROL key  on the face of the EMCP 4.4 provides a shortcut to the control menu.

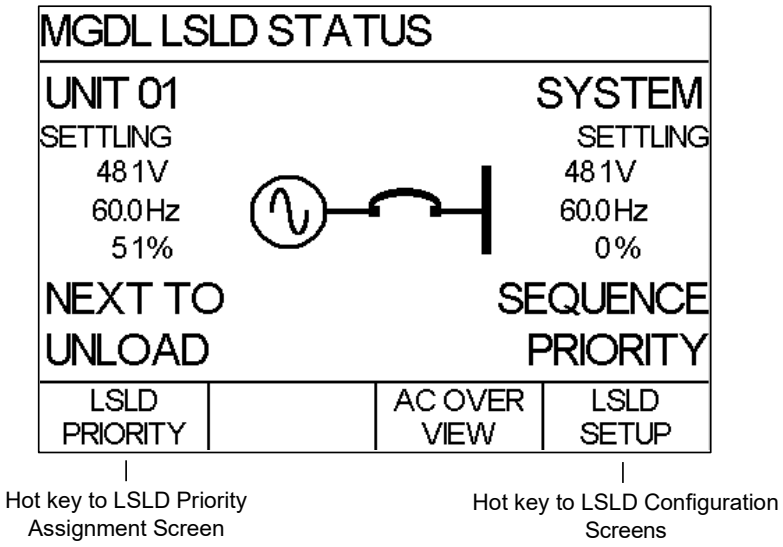


Figure 37.48 – MGDL Load Sense Load Demand Control Screen

The MGDL LSLD Priority Assignment screen displays the LSLD priority assigned to each controller in the MGDL network. This priority is only utilized when operating in the "PRIORITY NUMBER" Sequence Strategy. The LSLD Priority can also be edited from this screen by selecting the "EDIT" F1 hot key. When editing is complete, save the changes by pressing the "ASSIGN ALL PRIORITY" F1 hot key. The LSLD Priority Assignment screens are shown in Figure 37.49 and Figure 37.50.

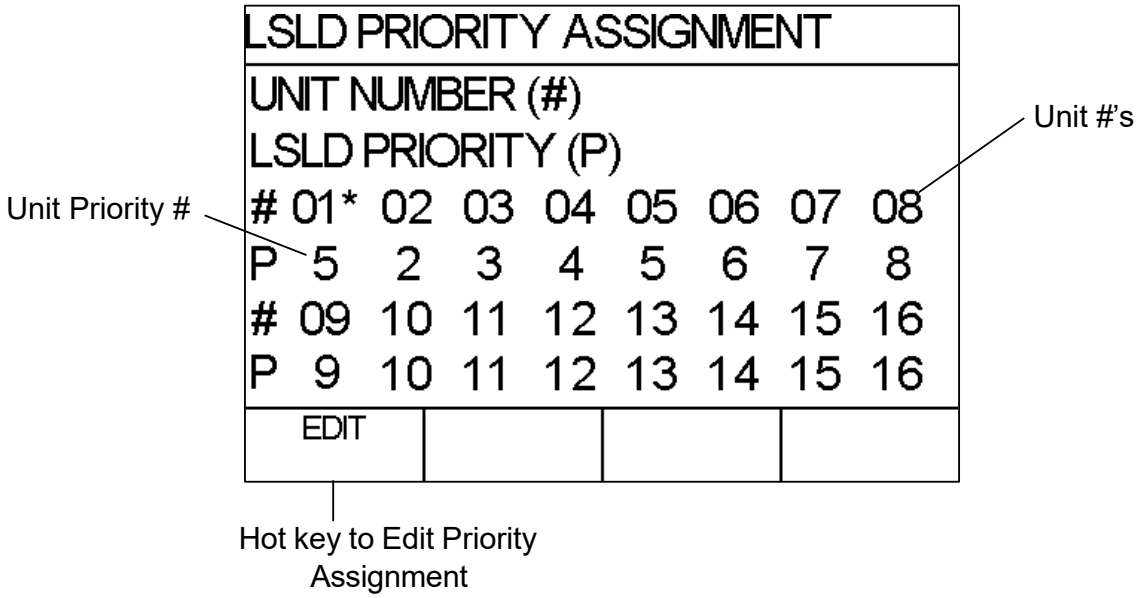


Figure 37.49 – MGDL LSLD Priority Assignment View Screen

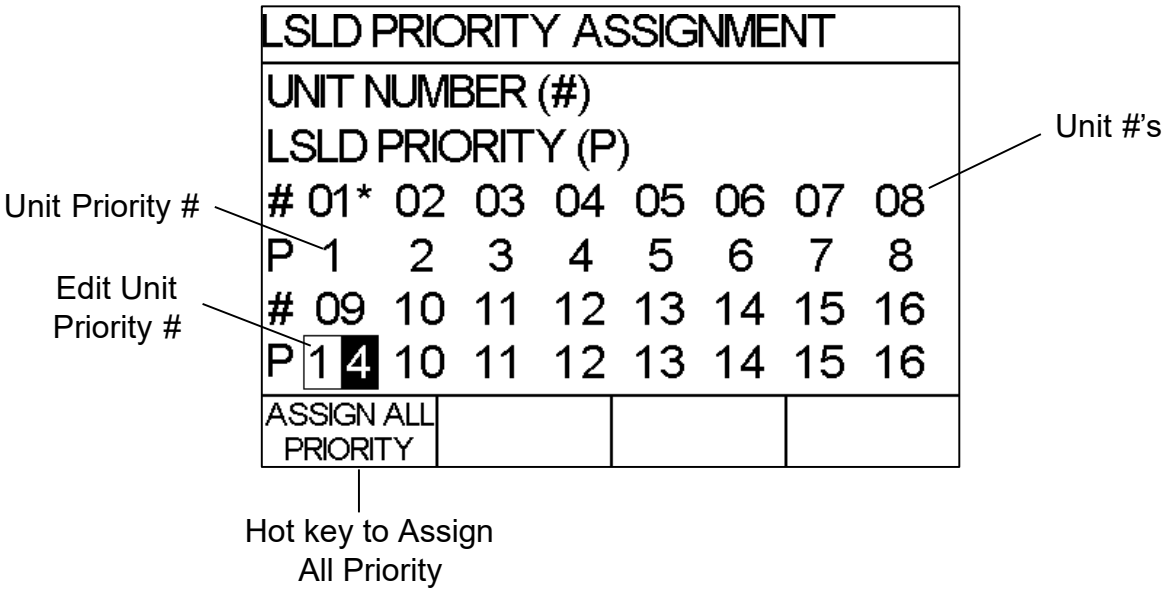


Figure 37.50 – MGDL LSLD Priority Assignment Edit Screen

37.6.7 MGDL Network Status Screens

The MGDL Network Status screens can be accessed directly through the EMCP 4.4 display. To access the MGDL Network Status screens through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ NETWORK STATUS

→ MULTIPLE GENSET DATA LINK

Note: This screen is hidden from display until *Multiple Genset Control Data Link Unit Number* (setpoint) is configured to a non-zero value.

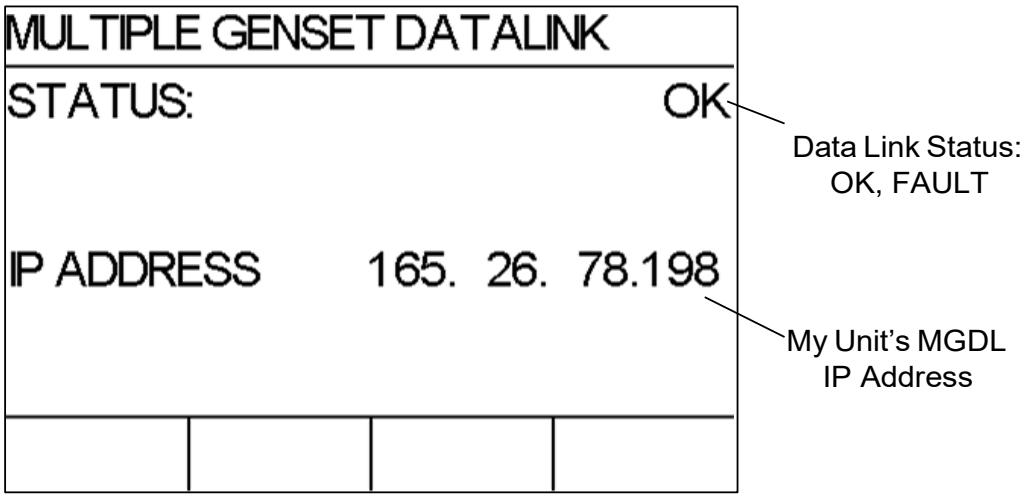


Figure 37.51 – MGDL Network Status Screen

The MGDL Network Status screen provides an indication of the status of the MGDL network. If the MGDL network status displays "FAULT," there is a problem with the MGDL network and the event log should be consulted for troubleshooting. Otherwise, the MGDL network status displays "OK."

The MGDL network IP address listed on the MGDL Network Status screen is specific to the MGDL network node and is NOT related to the TCP/IP network IP address. The MGDL network IP address is dynamically assigned at power-up and is NOT configurable by the user. The MGDL network IP address may change based on network topology and is provided on this screen for reference purposes only.

37.6.8 MGDL Status Event Log Screens

The Status Event Log screens can be accessed directly through the EMCP 4.4 display. To access the Status Event Log screens through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ EVENT LOGS

→ STATUS EVENTS

Note: Pressing the EVENT LOG key  on the face of the EMCP 4.4 provides a shortcut to the event logs menu.

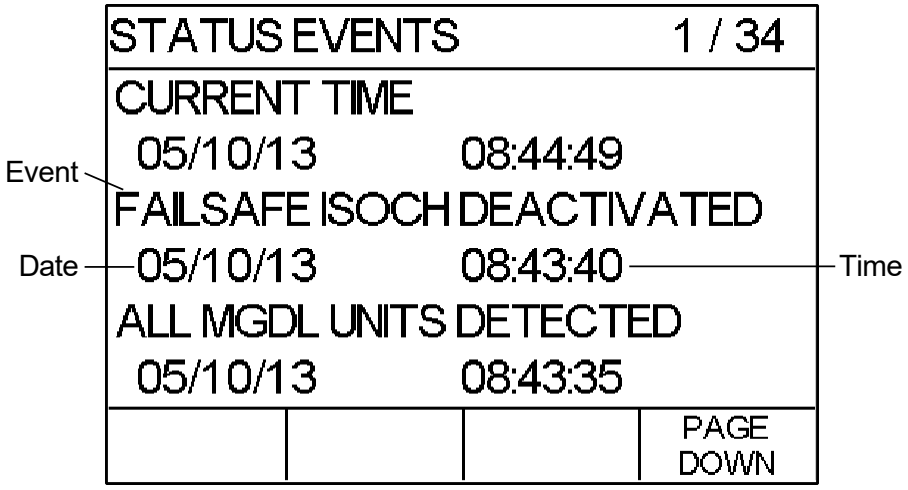


Figure 37.52 – Status Events Screen

The status event log is meant to provide a record of recent generator set events or conditions with time stamps to assist in troubleshooting. Many status events exist and are triggered for the EMCP 4.4. Only the MGDL network related status events and their trigger conditions are listed in Table 37.34.

Status Event	Trigger Conditions
NO MGDL UNITS DETECTED	Expected number of controls is non-zero, actual number of controls is one. The unit detects only itself and no other MGDL units on the network.
MGDL UNIT(S) NOT DETECTED	Expected number of controls is non-zero, actual number of controls is non-zero and not equal to expected number of controls. The unit no longer detects one or more MGDL units on the network.
ALL MGDL UNITS DETECTED	Expected number of controls equals actual number of controls. The unit detects all expected MGDL units on the network.
DBA CAUTION MODE ACTIVATED	Unit is attempting to dead bus close while operating under a failure mode caused by a loss of communications or MGDL protocol mismatch.
FAILSAFE DROOP ACTIVATED	Loss of communications or MGDL protocol mismatch has occurred and the unit is attempting to load share while grouped in the Proceed with Caution failsafe group.
FAILSAFE DROOP DEACTIVATED	Unit is no longer in the Proceed with Caution failsafe group because of either loss of communications recovery or exiting of load sharing.
FAILSAFE ISOCH ACTIVATED	Loss of communications has occurred and the unit is attempting to load share while grouped in the Proceed as Normal failsafe group.
FAILSAFE ISOCH DEACTIVATED	Unit is no longer in the Proceed as Normal failsafe group because of either loss of communications recovery or exiting of load sharing.

Table 37.34 – MGDL-related Status Events

37.6.9 MGDL Genset Event Log Screen

The Genset Event Log screens can be accessed directly through the EMCP 4.4 display. To access the Genset Event Log screens through the display, navigate to the following sub-menus:

MAIN MENU

→ VIEW

→ EVENT LOGS

→ GENSET EVENTS

Note: Pressing the EVENT LOG key  on the face of the EMCP 4.4 provides a shortcut to the event logs menu.

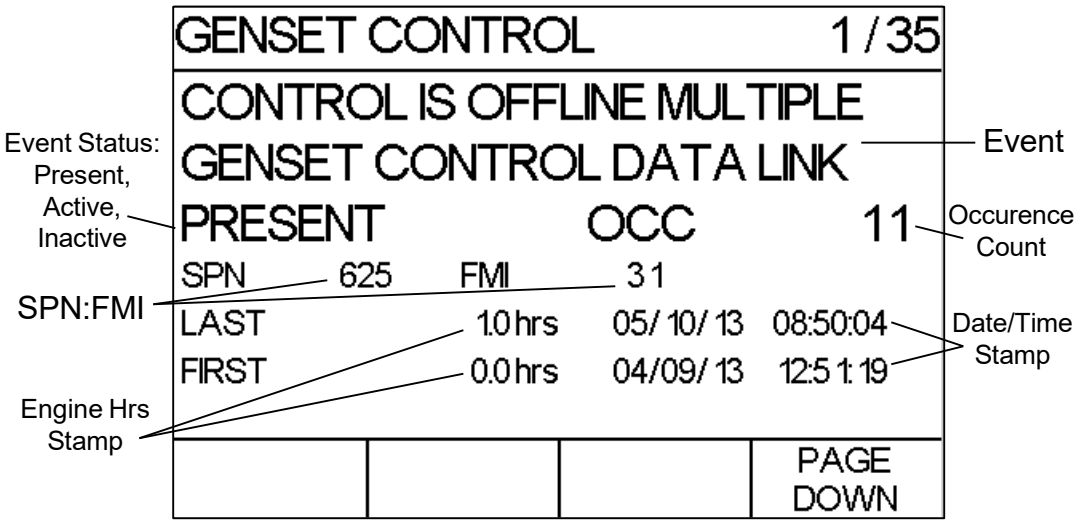


Figure 37.53 – Genset Event Log Entry

The Genset Event Log is meant to provide a detailed log of current and past generator set events including information such as event status, SPN: FMI, occurrence count, and date/time stamps of the last and first time that particular event occurred to assist in troubleshooting. The MGDL-related generator set events are explained further as well as troubleshooting assistance in Section 37.7.

37.7 MGDL Troubleshooting

The EMCP 4.4 is designed to provide diagnostics or events to alert the operator to problems with the MGDL network configuration or operation of paralleled generator sets over the MGDL network. Some of the most common MGDL-related events are listed and described here along with general troubleshooting steps. All of these MGDL-related events appear in the EMCP (Genset Control) Event Log when triggered. For further details on troubleshooting EMCP events refer to the EMCP 4.3/4.4 Systems Operation and Troubleshooting and Adjusting (SOTA) Guide – UENR1210 and LEBE0031-EMCP 4.4 Multiple Genset Data Link.

37.7.1 MGDL Configuration Error Event (SPN-FMI: 625-14)

The MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC (SPN-FMI: 625-14) is used to identify when a mis-configuration of the MGDL network is present. This event response is a fixed shutdown and is not configurable. This shutdown event must be cleared before an MGDL unit will operate and is used to confirm that the EMCP 4.4 is configured appropriately.

For operating in full HARDWIRED paralleling mode, configure the EMCP 4.4 based on Table 37.35.

EMCP 4.4 Setpoint	Setpoint Value
Multiple Genset Control Data Link Unit Number	ZERO
Breaker Close to Dead Bus Input Configuration	HARDWIRED INPUT
Generator Real Load Sharing Input Configuration	0 TO 10 V or 0 TO 3 V
Generator Reactive Load Sharing Input Configuration	0 TO 10 V
Load Sense Load Demand Input Configuration	HARDWIRED INPUT

Table 37.35 – EMCP 4.4 Hardwired Paralleling Configuration

For operating in full MGDL paralleling mode, configure the EMCP 4.4 based on Table 37.36.

EMCP 4.4 Setpoint	Setpoint Value
Multiple Genset Control Data Link Unit Number	NON-ZERO
Breaker Close to Dead Bus Input Configuration	ETHERNET (MGDL)
Generator Real Load Sharing Input Configuration	ETHERNET (MGDL)
Generator Reactive Load Sharing Input Configuration	ETHERNET (MGDL)
Load Sense Load Demand Input Configuration	ETHERNET (MGDL)

Table 37.36 – EMCP 4.4 MGDL Paralleling Configuration

If Load Sense Load Demand or Dead Bus Arbitration features are not desired, they may be configured to "DISABLED." The EMCP 4.4 must be configured either for HARDWIRED paralleling operation or MGDL paralleling operation. No mixture of HARDWIRED and MGDL modes is permitted. If a configuration mixture of these two modes is detected the MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC (SPN-FMI: 625-14) is triggered. With that in mind, the MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC trigger conditions are summarized in Table 37.37.

EMCP 4.4 Setpoint	Setpoint Value				
Multiple Genset Control Data Link Unit Number	Zero (0)	Non-zero (1 to 64)	— (don't care)	Non-zero (1 to 64)	Zero (0)
Breaker Close to Dead Bus Input Configuration	ANY configured to Ethernet (MGDL)	ANY configured to Hardwired Input	ANY mixture of Ethernet (MGDL) AND Hardwired Input	ALL configured to Ethernet (MGDL) or Disabled	ALL configured to Hardwired Input or Disabled
Generator Real Load Sharing Input Configuration					
Generator Reactive Load Sharing Input Configuration					
Load Sense Load Demand Input Configuration					
MGDL Configuration Error Event (SPN-FMI: 625-14)				√	√

Table 37.37 – MGDL Configuration Error Conditions

Note: The MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC can also be triggered as a result of two other conditions:

- If the EMCP 4.4 detects duplicate MGDL unit numbers on the MGDL network the two units with the same unit number will shutdown with this event.
- The MGDL feature is NOT intended to operate with single phase genset applications. Therefore, the MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC will be triggered if the EMCP 4.4 is configured for MGDL and any one of the following single phase Generator AC Connection Configurations:
  – Single Phase (2-Wire L1-L2) Connection
  – Single Phase (3-Wire L1-N-L2) Connection
  – Single Phase (2-Wire L2-L3) Connection
  – Single Phase (3-Wire L2-N-L3) Connection

Troubleshooting Steps:

If the MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC is PRESENT in the Genset Events Log on EMCP 4.4 display:

1. Review all setpoints listed in Table 37.37 to verify there is no mixture of HARDWIRED and MGDL setpoint configurations.
2. Review the Generator Connection Configuration setpoint to verify the genset is not configured for single phase operation.
3. If all setpoints are configured appropriately for one of the modes, then verify there are not multiple units on the MGDL network configured to the same unit number.
4. If multiple units are configured for the same MGDL Unit Number, re-assign unique unit numbers to those units.
5. Event will transition to ACTIVE once the MGDL configuration is correct, event can now be reset.

It is common for the MULTIPLE GENSET CONTROL DATA LINK CONFIGURATION ERROR DIAGNOSTIC to be triggered during commissioning while individual paralleling features (DBA, LSLD, Load Sharing) are being configured for the first time. Once MGDL and paralleling configuration is complete the event should be capable of being reset.

37.7.2 MGDL Control is Offline Event (SPN-FMI: 625-31)

The CONTROL IS OFFLINE MULTIPLE GENSET CONTROL DATA LINK DIAGNOSTIC (SPN-FMI: 625-31) is used to identify when a unit that is expected to be on the MGDL network is no longer communicating. The event response for this event is a warning by default, but is configurable via the *Control is Offline Multiple Genset Control Data Link Diagnostic Response Configuration* (setpoint) and is described in Section 37.3.11.

This event is triggered as a result of no MGDL messages being received from one or more of expected controls online over a specified period of time. This can occur as a result of conditions such as broken or unplugged Ethernet cables, mis-configuration, power loss to Ethernet router/switch/hub devices, or power loss to EMCP 4.4. The EMCP 4.4 strategy for handling loss of communications is detailed in Section 37.4.7.

Troubleshooting Steps:

If the CONTROL IS OFFLINE MULTIPLE GENSET CONTROL DATA LINK DIAGNOSTIC is PRESENT in the Genset Events Log on EMCP 4.4 display:

1. Navigate to the MGDL System Overview Screen described in Section 37.6.1. Identify any question mark symbols (?) that are displayed. A unit number is replaced with a question mark symbol (?) if the MGDL unit has lost communications. Scrolling to and selecting the question mark (?) on the MGDL Overview screen displays a message indicating the unit number of the lost node (Figure 37.39).
   a. A single lost node may indicate a broken wire or mis-configuration. Refer to step 2.
   b. Multiple lost nodes may indicate several broken wires or a possible power loss to Ethernet router/switch/hub devices. Refer to step 3.
2. On the MGDL System Overview Screen, use the “my unit” indicator (*) to determine this controller’s perspective of the MGDL network. If the MGDL System Overview Screen displays only one question mark (?) then there is only one other EMCP 4.4 that has lost communications.
   a. Check the STATUS EVENTS log for “MGDL Unit(s) Not Detected” status event. This triggers if some, but not all units are lost.

b. Check if the unit with a loss of communications has lost power to the EMCP 4.4.
c. Check if the unit with a loss of communications has the Ethernet cable unplugged from the Ethernet router/switch/hub device that it was connected to.
d. Check if the unit with a loss of communications has lost power to the Ethernet router/switch/hub device that it was connected to.
e. Check if the unit with a loss of communications has a broken Ethernet wire. On the EMCP 4.4 120-pin J1 connector, verify wiring to pin 87, 88, 97, and 98. These are the Ethernet connections and could cause loss of communications, if broken or poorly connected. These connections are explained further above in Section 37.2.1.
f. Check if the unit with a loss of communications is properly configured for MGDL operation. Refer to Section 37.7.1.

3. On the MGDL System Overview Screen, use the "my unit" indicator (*) to determine this controller's perspective of the MGDL network. If the MGDL System Overview Screen displays multiple question marks (?) then there are multiple other EMCP 4.4 controllers that have lost communications.
   a. Check the STATUS EVENTS log for "No MGDL Units Detected" status event, this triggers if ALL units are lost.
      – Check if this unit's Ethernet cable is unplugged from the Ethernet router/switch/hub device that it was connected to.
      – Check if this unit has lost power to the Ethernet router/switch/hub device it was connected to.
   b. Check if this unit has a broken Ethernet wire. On the EMCP 4.4 120-pin J1 connector, verify wiring to pin 87, 88, 97, and 98. These are the Ethernet connections and could cause loss of communications, if broken or poorly connected. These connections are explained further in Section 37.2.1.
   c. Check the STATUS EVENTS log for "MGDL Unit(s) Not Detected" status event, this triggers if some, but not all units are lost.
      – Check if the units with a loss of communications have the Ethernet cable unplugged from the Ethernet router/switch/hub device that it was connected to.
      – Check if the units with a loss of communications have lost power to the EMCP 4.4.
      – Check if the units with a loss of communications have lost power to the Ethernet router/switch/hub device they were connected to.
   d. Check if the units with a loss of communications have a broken Ethernet wire. On the EMCP 4.4 120-pin J1 connector, verify wiring to pin 87, 88, 97, and 98. These are the Ethernet connections and could cause loss of communications if broken or poorly connected. These connections are explained further in Section 37.2.1.

4. Once proper troubleshooting steps have been completed and MGDL communications are re-established:
   a. CONTROL IS OFFLINE MULTIPLE GENSET CONTROL DATA LINK DIAGNOSTIC should transition from PRESENT to INACTIVE in the Genset Events Log on EMCP 4.4 display.
   b. "All MGDL Units Detected" status event should appear in the Status Events Log.

If it is desired to intentionally disconnect unit(s) from the network for maintenance or permanently removing from the site then "RESET EXPECTED" should be considered. This will keep the system from operating in a failsafe mode during these situations, but must be done with understanding of the effect on the generator system. Refer to Section 37.4.8 above for an explanation of the "RESET EXPECTED" operation as well as implications that could result from this action.

37.7.3 MGDL Communications Failure Event (SPN-FMI: 625-19)

The MULTIPLE GENSET CONTROL DATA LINK COMMUNICATION FAILURE DIAGNOSTIC (SPN-FMI: 625-19) is used to identify when EMCP 4.4 receives unexpected data over the data link. The event response for this event is a hard shutdown by default, but is configurable via the *Multiple Genset Control Data Link Communication Failure Diagnostic Response Configuration* (setpoint) and is described in Section 37.3.11.

If the EMCP 4.4 receives an unexpected data packet over the data link the MULTIPLE GENSET CONTROL DATA LINK COMMUNICATION FAILURE DIAGNOSTIC will be displayed in the Genset Events Log and the unit will shutdown. This event may be triggered due to mismatched software versions installed on the EMCP 4.4s in your network topology. While this event is present, the unit can no longer participate in Load Sense Load Demand.

Troubleshooting Steps:

If the MULTIPLE GENSET CONTROL DATA LINK COMMUNICATION FAILURE DIAGNOSTIC is PRESENT in the Genset Events Log on EMCP 4.4 display:

1. Check the software version installed on the EMCP 4.4. To access this information through the EMCP 4.4 display, navigate to the following sub-menus:

   MAIN MENU

   → SOFTWARE INFO

   a. If mismatched software versions are installed on the network a SOFTWARE VERSION (PROTOCOL) MISMATCH (SPN-FMI: 243-31) event may also be present in the Genset Events Log. This event as well as further troubleshooting is explained below in Section 37.7.4.

37.7.4 Software Version (Protocol) Mismatch Event (SPN-FMI: 234-31)

The SOFTWARE VERSION MISMATCH (SPN-FMI: 234-31) event is used to identify when mismatched EMCP 4.4 MGDL communication software is detected between units on the MGDL network. Units attempting to operate with mismatched software may have mismatched MGDL communication protocols and have the potential for unsafe operating conditions. Therefore this scenario should be identified and avoided. Each EMCP 4.4 contains logic to ensure that all units on the MGDL network have matched MGDL communication protocols.

If any mismatch in the MGDL communication protocol is detected the SOFTWARE VERSION MISMATCH warning event (SPN-FMI: 234-31) is triggered and the unit enters the Proceed with Caution failsafe modes. The event response to this event is a fixed warning and is not configurable. The unit will remain in failsafe mode and the warning event will remain active until the software mismatch is no longer detected.

Troubleshooting Steps:

If the SOFTWARE VERSION MISMATCH event is PRESENT in the Genset Events Log on EMCP 4.4 display:

1. Check the software version installed on the EMCP 4.4 controllers and identify any mismatches. To access this information through the EMCP 4.4 display, navigate to the following sub-menus:

   MAIN MENU

   → SOFTWARE INFO

2. Resolve any mismatch in software version by updating the software in MGDL units as necessary. As soon as ALL units connected to the MGDL network have the same software version without any protocol violations, the SOFTWARE VERSION MISMATCH (SPN-FMI: 234-31) event should be set to INACTIVE.

37.7.5 Ethernet Port Abnormal Update Rate (SPN-FMI: 625-9)

The ETHERNET PORT ABNORMAL UPDATE RATE (SPN-FMI: 625-9) warning event is used to detect a scenario when the Ethernet port is overloaded due to improper network traffic or mis-wiring (such as a ring topology). This event uses the EMCP 4 Ethernet statistics to detect an abnormal increase in the rate of incoming packets.

If the rate of incoming packages is too high the Ethernet port is disabled to self protect the EMCP 4 and the event is triggered. The Ethernet port is re-activated any time the warning event is acknowledged (if the abnormal rate of incoming packets still exists the warning will trigger again). If the warning event is not acknowledged the Ethernet port is re-activated once per hour in an attempt to return to normal operations (if the abnormal rate of incoming packets still exists the warning event remains present).

Troubleshooting Steps:

If the ETHERNET PORT ABNORMAL UPDATE RATE warning event is ACTIVE in the Generator Set Events Log on EMCP 4 display:

1. Check Ethernet wiring of the network to verify a ring topology is NOT present. Two examples of ring topology networks are shown below:

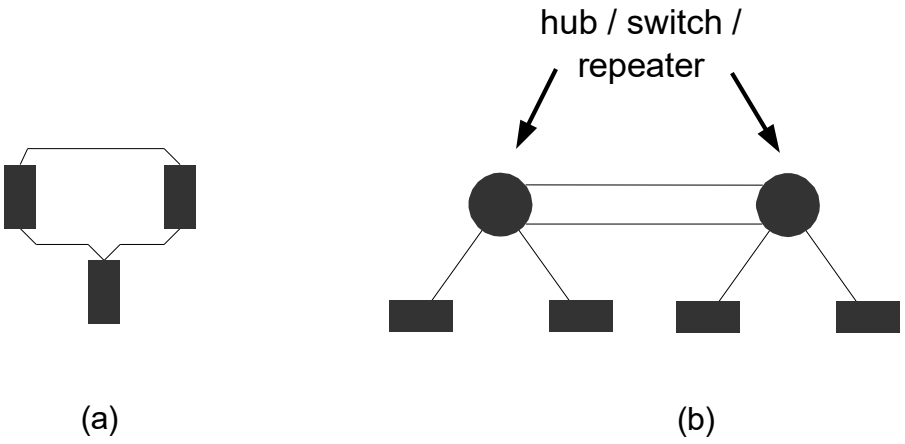


Figure 37.54 – Ring Topology Network Examples

2. Investigate all nodes connected to the Ethernet network and audit the network traffic using a network analyzer (such as Wireshark). Determine if any or which device or service is abusing the network with excess traffic.

37.7.6 Dead Bus Arbitration Failure Events (SPN-FMI: 2530-17 & 2530-1)

The Dead Bus Arbitration Failure events are triggered during dead bus arbitration when a failure occurs. Once a unit has obtained the dead bus close grant, it attempts to close to the dead bus immediately. If another unit is requesting, the *Breaker Close to Dead Bus Maximum Time* (setpoint) determines how long after issuing a breaker close a unit can try to close before it is determined to have failed. If the *Breaker Close to Dead Bus Maximum Time* expires with no detection of breaker closed, the DEAD BUS ARBITRATION FAILURE WARNING (SPN 2530-17) event is triggered. The event response is a fixed warning and is not configurable.

If a unit fails to close it must remove the breaker close command and then relinquish the dead bus close grant. If other units are requesting, a failed unit may re-request after delaying and deactivating the DEAD BUS ARBITRATION FAILURE WARNING event. If a unit fails to dead bus close a maximum of five dead bus close attempts, a DEAD BUS ARBITRATION FAILURE SHUTDOWN (SPN-FMI: 2530-1) event is generated. The event response is a fixed hard shutdown and is not configurable.

Troubleshooting Steps:

If the DEAD BUS ARBITRATION FAILURE WARNING (SPN 2530-17) event or the DEAD BUS ARBITRATION FAILURE SHUTDOWN (SPN-FMI: 2530-1) event is PRESENT in the Generator Set Events Log on EMCP 4.4 display:

1. Verify a GEN BREAKER CLOSE COMMAND status event was logged in the Status Event Log with the expected timestamp. Each time the EMCP 4.4 issues a breaker close command the Isolated Dedicated Digital Output B is activated and a GEN BREAKER CLOSE COMMAND status event is logged.
   a. If a GEN BREAKER CLOSE COMMAND was issued from the EMCP 4.4, but a dead bus close did not follow, troubleshoot the generator circuit breaker hardware components such as:
      – Generator Circuit Breaker relay/fuse failure
      – Generator Circuit Breaker closing coil failure
      – Generator Circuit Breaker charging system failure
   b. If a GEN BREAKER CLOSE COMMAND was not issued from the EMCP 4.4, investigate conditions that could inhibit a generator breaker closure such as:
      – An ACTIVE programmable digital input configured for INHIBIT GEN BREAKER CLOSE (refer to the I/O STATUS screen)
      – An ACTIVE programmable digital input configured for any system event with an event response configured for BREAKER #1 TRIP (refer to the I/O STATUS screen and GENERATOR SET EVENT LOG)
      – Any ACTIVE system event with an event response configured for BREAKER #1 TRIP (refer to the GENERATOR SET EVENT LOG)
      – An ACTIVE generator circuit breaker trip command – Isolated Dedicated Digital Input C (refer to the I/O STATUS screen)

37.7.7 Dead Bus Inconsistent Sensing Event (SPN-FMI: 2530-2)

The DEAD BUS INCONSISTENT SENSING (SPN-FMI: 2530-2) event will be made PRESENT if two or more EMCP 4.4 controllers do not agree on the bus live/dead status. This event will trigger if any EMCP 4.4 detects a DEAD BUS while any other unit communicating detects a LIVE BUS and vice versa. The event response for this event is a warning by default, but is configurable via the *Dead Bus Inconsistent Sensing Warning Event Response Configuration* (setpoint) described above in Section 37.3.11. This event will be triggered if the EMCP 4.4 is not connected to the bus due to broken bus wire(s) or a failed bus sensing fuse(s). Disabling of this event is NOT recommended.

Troubleshooting Steps:

If the DEAD BUS INCONSISTENT SENSING event is PRESENT in the Generator Set Events Log on EMCP 4.4 display:

1. Check if there is a poor connection on the back of the EMCP 4.4 or broken bus wire(s). On the back of the EMCP 4.4, pay attention to wires going into pin 11 (Bus V-A), pin 13 (Bus V-B), pin 31 (Bus V-C), and pin 47 (Bus V-N) on the J2 70-pin connector. These are the bus sensing connections and could cause inconsistent sensing if broken or poorly connected.

2. Check bus sensing fuses. There will be one on each phase. Replace if fuse has opened.

38.0 Installing and Upgrading Software

The EMCP 4 supports field-programming (called flashing) of software for all of the modules. This is done by using the Cat Service Tool software and a Cat Communication Adapter. The Primary Data Link (CAN 1) service connector must be used for modules connected to the Primary Data Link. The Accessory Data Link (CAN 2) service connector must be used for modules connected to the Accessory Data Link. Refer to your generator set package documentation for the location of the service connectors.

Note: Mismatched MGDL software versions will cause units to shutdown.

To flash the EMCP 4 requires the following hardware and software:

Software and Hardware Required

- The Cat Service Tool software installed and licensed on a PC
- A Cat Communication Adapter
- A 9-pin Deutsch service connection to the Primary Data Link (CAN 1)
- The new application software flash file for the EMCP 4

In order to install software into the EMCP 4, the generator set must be stopped. If upgrading software, it may be important to back up the current configuration (see Chapter 17). Flashing application software does not affect the setpoints. However, if a problem occurs during flashing, this backup can be used to quickly configure a replacement module.

Record the current software version information. This is seen in the ECM Summary screen of ET (see Figure 38 .1) or the Device Info Screen on the EMCP (see Figure 38 .2). This information is useful to obtain the correct flash file if it is desired to return to the previous version of software after flashing.

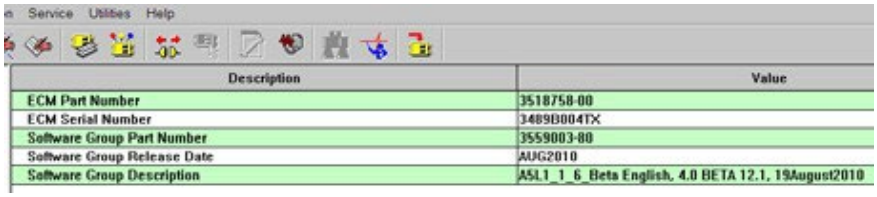


Figure 38.1 – ECM Summary Information in ET

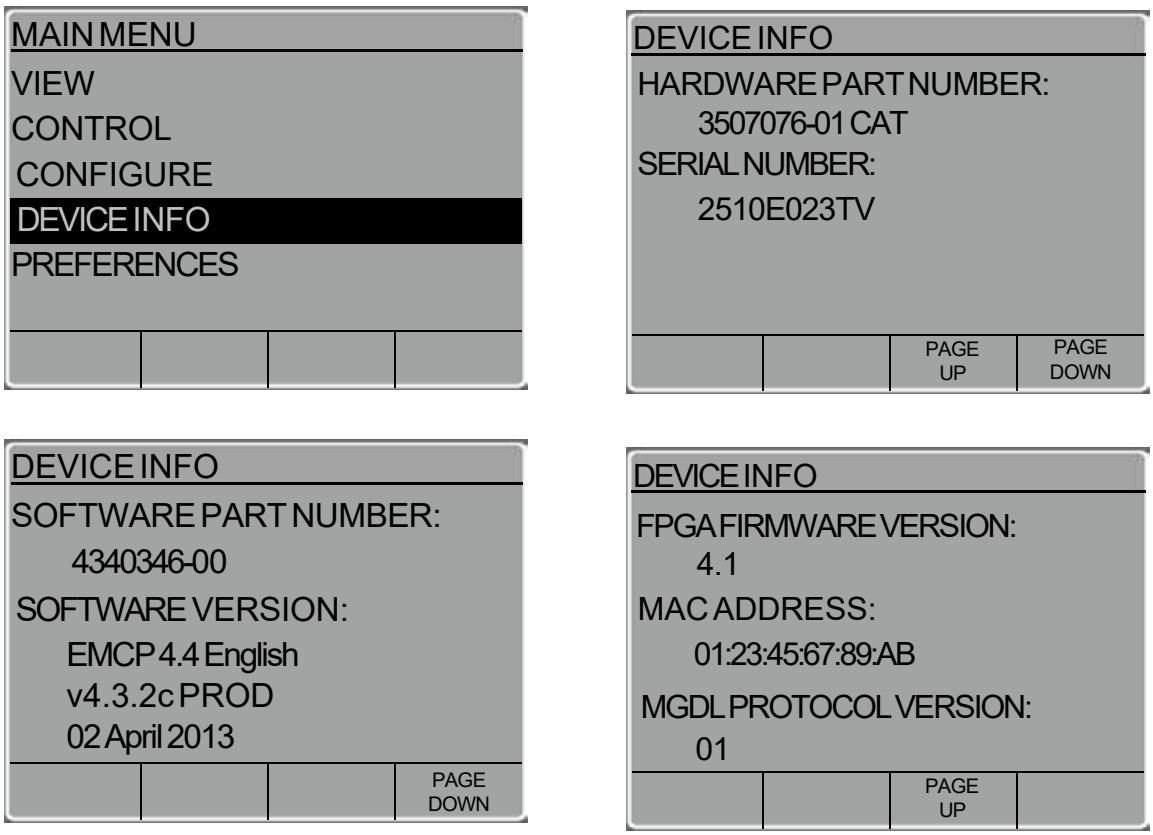


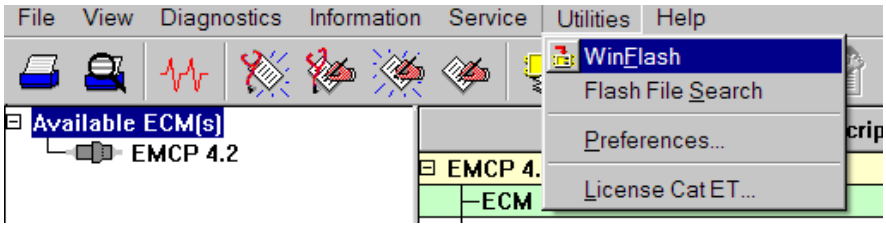
Figure 38.2 – Device Info Summary in EMCP

Flashing of modules other than the EMCP 4 follow similar steps as the ones outlined below.

In order to flash an EMCP 4 module, do the following steps:

1. Connect to the EMCP 4 using the Cat Service Tool as stated in Section 4.2.

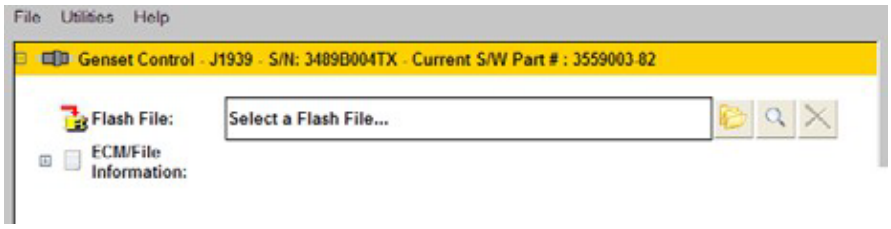
2. Enter the WinFlash Utility by selecting Utilities → WinFlash,



or by clicking the WinFlash Icon.



3. The WinFlash screen will appear.

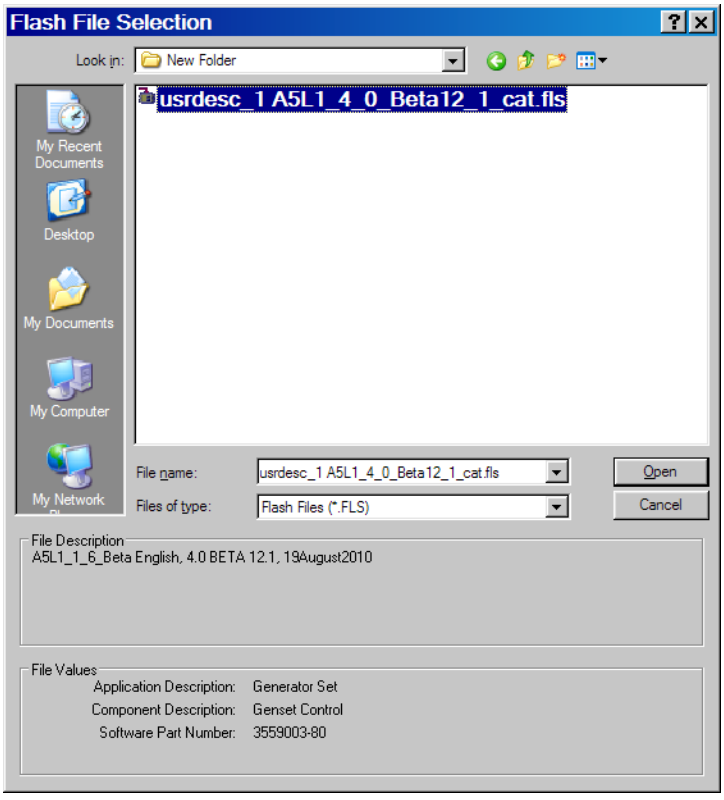


Note: If WinFlash does not find all of the modules on the J1939 data link to which it is connected, re-scan the data link by pressing F8 (or selecting File → Update ECM List).

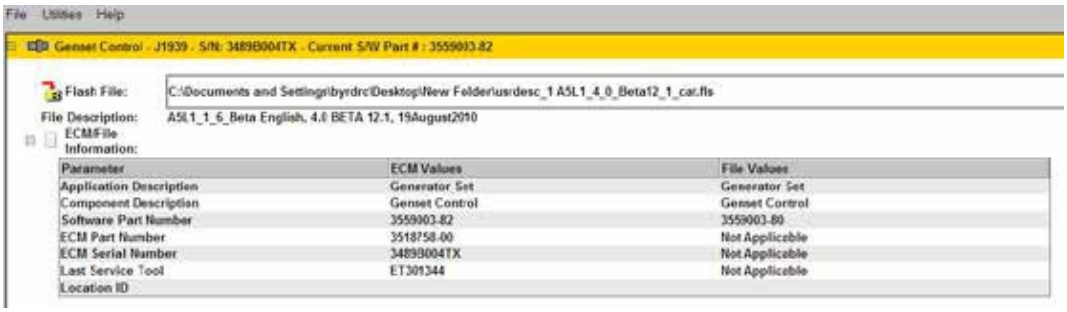
4. Select the Genset Control if multiple modules are listed, then click the "Browse for a File" button on the right hand side.



5. Browse to the appropriate file and click "Open."



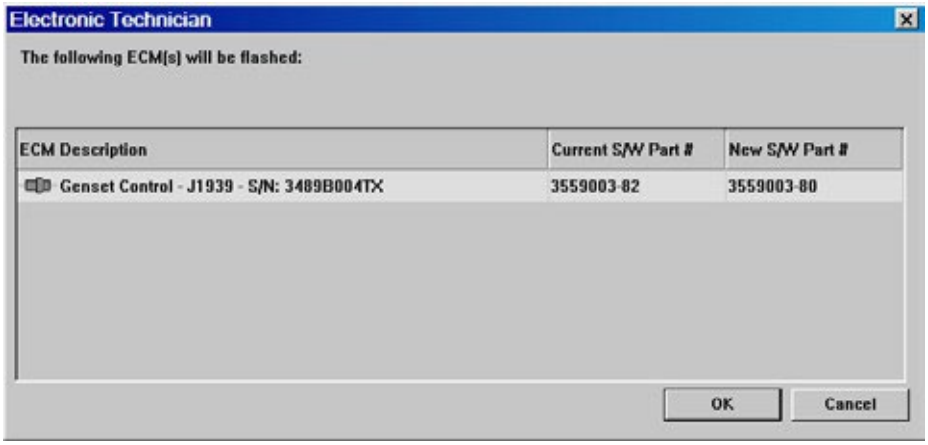
6. The new file information will be displayed.



7. Click “Begin Flash” in the lower left corner.

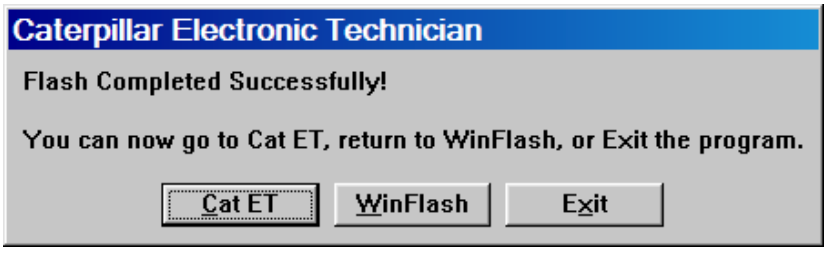


8. A confirmation screen will appear. Click “OK.”



9. A progress meter will show the status of the flash and the EMCP display will show that software installation is occurring.

10. When the flashing process is complete, the ECM that was flashed will reboot. Also, WinFlash will bring up a window giving options for what to do next. This indicates that the software has finished flashing, and is ready to use.



11. On startup, the EMCP 4 shows the software part number. Verify the software part number matches the new application software that was flashed.

39.0 Appendix A – Menu Structures

For details on the setpoints available within each submenu, refer to the appropriate section.

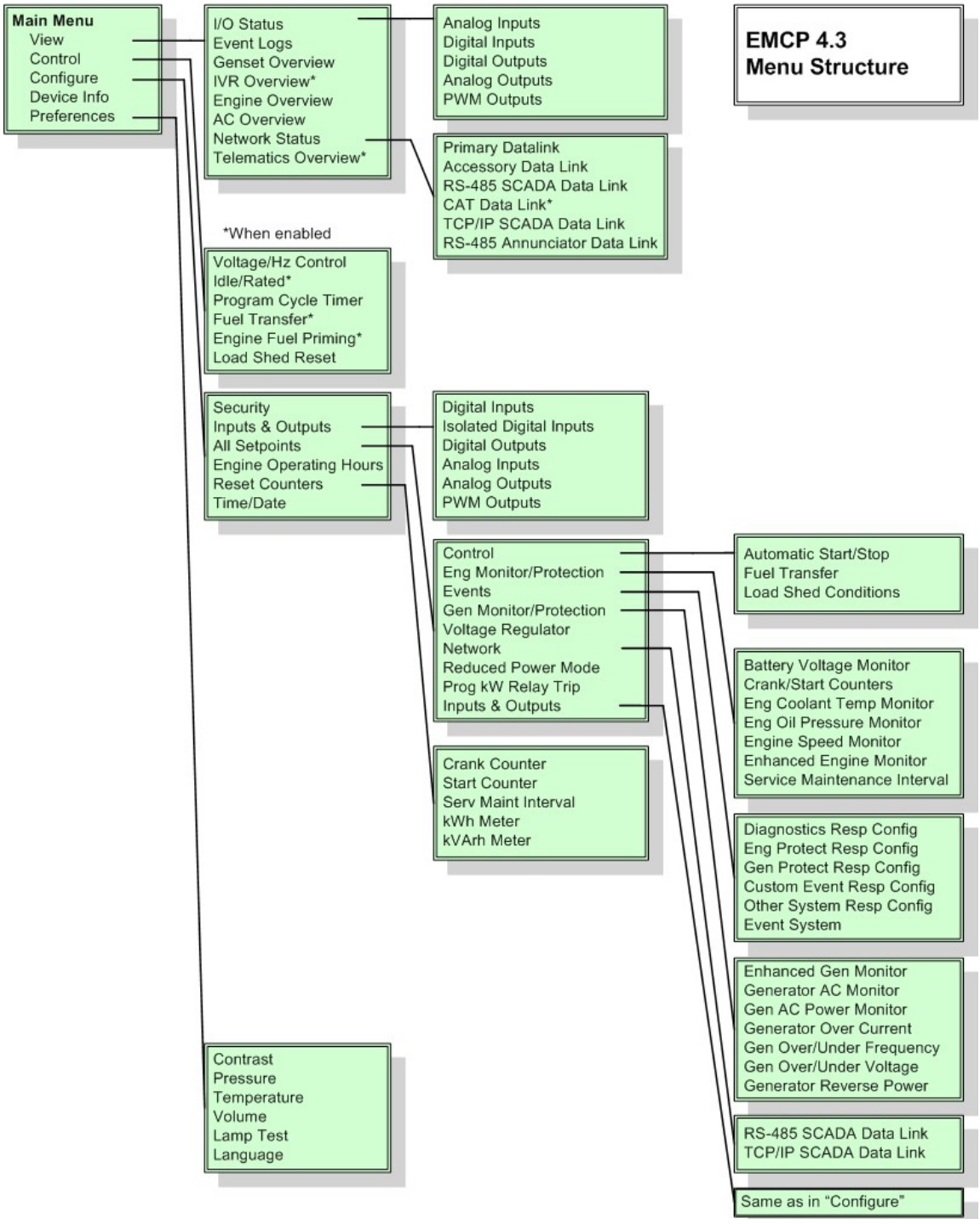


Figure – A1

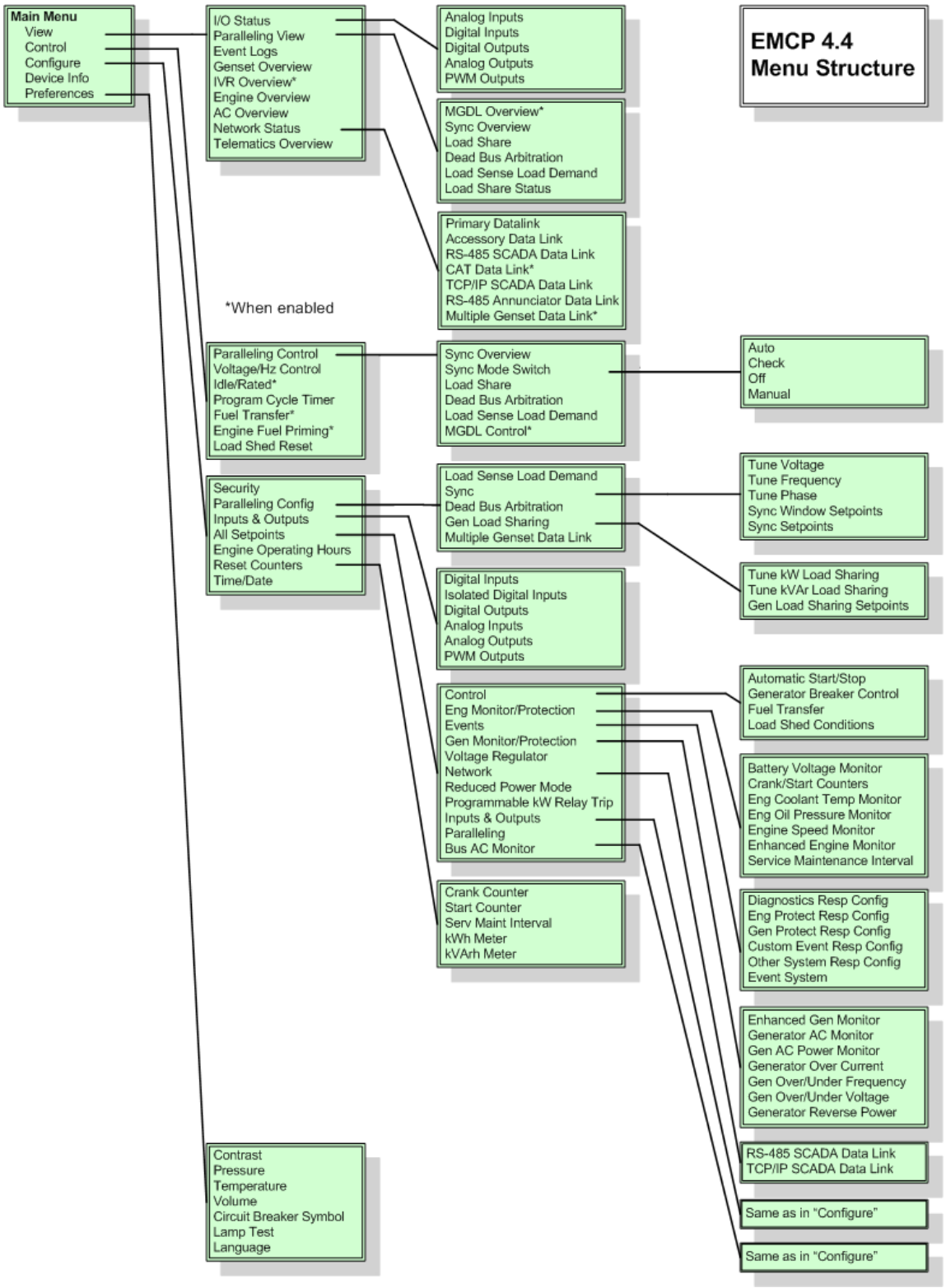
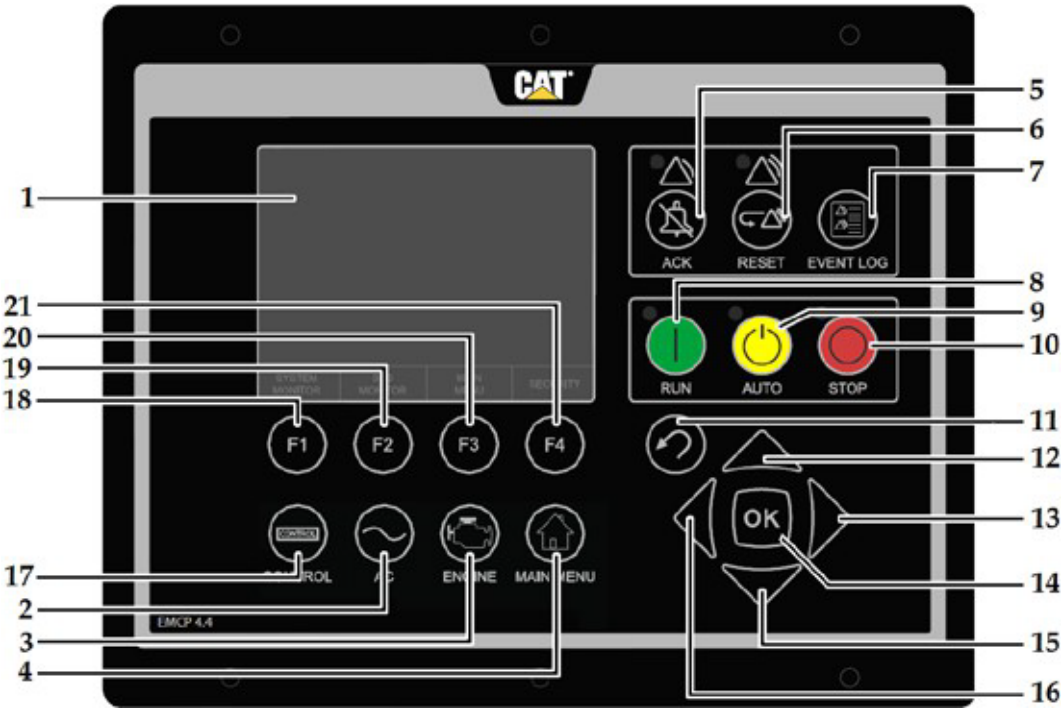

Main Menu
View
Control
Configure
Device Info
Preferences
I/O Status
Paralleling View
Event Logs
Genset Overview
IVR Overview*
Engine Overview
AC Overview
Network Status
Telematics Overview
Analog Inputs
Digital Inputs
Digital Outputs
Analog Outputs
PWM Outputs
MGDL Overview*
Sync Overview
Load Share
Dead Bus Arbitration
Load Sense Load Demand
Load Share Status
Primary Datalink
Accessory Data Link
RS-485 SCADA Data Link
CAT Data Link*
TCP/IP SCADA Data Link
RS-485 Annunciator Data Link
Multiple Genset Data Link*
*When enabled
EMCP 4.4
Menu Structure
Paralleling Control
Voltage/Hz Control
Idle/Rated*
Program Cycle Timer
Fuel Transfer*
Engine Fuel Priming*
Load Shed Reset
Sync Overview
Sync Mode Switch
Load Share
Dead Bus Arbitration
Load Sense Load Demand
MGDL Control*
Auto
Check
Off
Manual
Security
Paralleling Config
Inputs & Outputs
All Setpoints
Engine Operating Hours
Reset Counters
Time/Date
Load Sense Load Demand
Sync
Dead Bus Arbitration
Gen Load Sharing
Multiple Genset Data Link
Tune Voltage
Tune Frequency
Tune Phase
Sync Window Setpoints
Sync Setpoints
Tune kW Load Sharing
Tune kVAr Load Sharing
Gen Load Sharing Setpoints
Digital Inputs
Isolated Digital Inputs
Digital Outputs
Analog Inputs
Analog Outputs
PWM Outputs
Control
Eng Monitor/Protection
Events
Gen Monitor/Protection
Voltage Regulator
Network
Reduced Power Mode
Programmable kW Relay Trip
Inputs & Outputs
Paralleling
Bus AC Monitor
Automatic Start/Stop
Generator Breaker Control
Fuel Transfer
Load Shed Conditions
Battery Voltage Monitor
Crank/Start Counters
Eng Coolant Temp Monitor
Eng Oil Pressure Monitor
Engine Speed Monitor
Enhanced Engine Monitor
Service Maintenance Interval
Crank Counter
Start Counter
Serv Maint Interval
kWh Meter
kVArh Meter
Diagnostics Resp Config
Eng Protect Resp Config
Gen Protect Resp Config
Custom Event Resp Config
Other System Resp Config
Event System
Enhanced Gen Monitor
Generator AC Monitor
Gen AC Power Monitor
Generator Over Current
Gen Over/Under Frequency
Gen Over/Under Voltage
Generator Reverse Power
RS-485 SCADA Data Link
TCP/IP SCADA Data Link
Same as in "Configure"
Same as in "Configure"
Contrast
Pressure
Temperature
Volume
Circuit Breaker Symbol
Lamp Test
Language

Figure – A2

40.0 Appendix B – EMCP 4 Front View and Navigation Keys



EMCP 4.3 and 4.4

1. Display Screen
2. AC Overview Key
3. Engine Overview Key
4. Main Menu Key
5. Alarm Acknowledge/Silence Key with Yellow Warning Lamp
6. Event Reset Key with Red Shutdown Lamp
7. Event Log Key
8. Run Key
9. Auto Key
10. Stop Key
11. Escape Key
12. Scroll Up Key
13. Scroll Right Key
14. OK Key
15. Scroll Down Key
16. Scroll Left Key
17. Control Key
18. F1 Soft Key
19. F2 Soft Key
20. F3 Soft Key
21. F4 Soft Key

1. SCREEN

Displays various generator set information and parameters.

2. AC OVERVIEW

The AC Overview Key will navigate the display to the first screen of AC information. The AC Overview Key information contains various AC parameters that summarize the electrical operation of the generator set.

3. ENGINE OVERVIEW

The Engine Overview Key will navigate the display to the first screen of engine information. The Engine Overview information contains various engine parameters that summarize the operation of the generator set.

4. MAIN MENU

The Main Menu key will navigate the display to the main menu directly without having to navigate out of menus.

5. ALARM ACKNOWLEDGE/SILENCE

Pressing the Alarm Acknowledge/Silence Key will cause the horn Relay Output to turn off and silence the horn. Pressing the key will also cause any amber or red flashing lights to turn off or to become solid depending on the active status of the alarms. The Alarm Acknowledge/Silence Key may also be configured to send out a global alarm silence on the CAN Data Link which will silence horns on Annunciators, if the CAN Annunciator is configured to respond.

6. EVENT RESET

The Event Reset button will clear all inactive fault conditions.

7. EVENT LOG

The Event Log button will navigate the display to the list of event logs.

8. RUN

Pressing the RUN Key will cause the EMCP to enter the RUN mode.

Note: If a Digital Input is programmed for ECS in Auto, or Stop, and a maintained switch latches that input to make it active, the front panel RUN key will not have any effect.

9. AUTO

Pressing the AUTO Key will cause the EMCP to enter the AUTO mode.

Note: If a Digital Input is programmed for ECS in RUN, or Stop, and a maintained switch latches that input to make it active, the front panel AUTO key will not have any effect.

10. STOP

Pressing the STOP Key will cause the EMCP to enter the STOP mode.

Note: If a Digital Input is programmed for ECS in Auto, or RUN, and a maintained switch latches that input to make it active, the front panel STOP key will not have any effect.

11. ESCAPE

The Escape Key is used during menu navigation in order to navigate up through the menu/sub-menu structure. Each key press causes the user to move backwards/upwards through the navigation menus. The Escape Key is also used to cancel out of data entry screens during setpoint programming. If the Escape Key is pressed during setpoint programming, none of the changes made on screen will be saved to memory. Pressing this key will bring the user back one menu/submenu.

12. SCROLL UP

The Scroll Up Key is used to navigate up through the various menus or monitoring screens. The Scroll Up Key is also used during setpoint entry. During numeric data entry the Scroll Up Key is used in order to increment the digits (0-9). If the setpoint requires selection from a list, the Scroll Up Key is used to navigate through the list.

13. SCROLL RIGHT

The Scroll Right Key is used during setpoint adjustment. During numeric data entry, the Scroll Right Key is used to choose which digit is being edited. The Scroll Right Key is also used during certain setpoint adjustments to select or deselect a check box. If a box has a check mark inside the box, pressing the Scroll Right Key will cause the check mark to disappear, disabling the function. If the box does not have a check mark inside the box, pressing the Scroll Right Key will cause a check mark to appear, enabling the function.

14. OK

The OK Key is used during menu navigation to select menu items in order to navigate forward/downward in the menu/sub-menu structure. The OK Key is also used during setpoint programming in order to save setpoints changes. Pressing the OK Key during setpoint programming causes setpoint changes to be saved to memory.

15. SCROLL DOWN

The Down Key is used to navigate down through the various menus or monitoring screens. The Down Key is also used during setpoint entry. During numeric data entry the Down Key is used in order to decrement the digits (0-9). If the setpoint requires selection from a list, the Down Key is used to navigate down through the list.

16. SCROLL LEFT

The Scroll Left Key is used during setpoint adjustment. During numeric data entry, the Scroll Left Key is used to choose which digit is being edited. The Scroll Left Key is also used during certain setpoint adjustments to select or deselect a check box. If a box has a check mark inside the box, pressing the Scroll Left Key will cause the check mark to disappear, disabling the function. If the box does not have a check mark inside the box, pressing the Scroll Left Key will cause a check mark to appear, enabling the function.

17. CONTROL

The Control key will navigate the display to the screen that allows the user to monitor and/or adjust various special control features.

18. F1

Pressing the F1 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll the screen up or down, the Scroll Up and Scroll Down keys will also function in that same capacity.

19. F2

Pressing the F2 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll the screen up or down, the Scroll Up and Scroll Down keys will also function in that same capacity.

20. F3

Pressing the F3 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll the screen up or down, the Scroll Up and Scroll Down keys will also function in that same capacity.

21. F4

Pressing the F4 key will enable the function that is described on the screen directly above this key. When this key is defined on screen to scroll the screen up or down, the Scroll Up and Scroll Down keys will also function in that same capacity.

Alarm Indicators

AMBER WARNING LIGHT

The Amber Warning Light is located directly above the Alarm Acknowledge/Silence Key (5). A flashing amber light indicates that there are unacknowledged active warnings. A solid amber light indicates that there are acknowledged warnings active. If there are any active warnings, the amber light will change from flashing amber to solid amber after the Alarm Acknowledge/Silence Key (5) is pressed. If there are no longer any active warnings, the amber light will turn off after the Alarm Acknowledge/Silence Key (5) is pressed.

RED SHUTDOWN LIGHT

The Red Shutdown Light is located directly above the Event Reset Key (6). A flashing red light indicates that there are unacknowledged active shutdown events. A solid red light indicates that there are acknowledged shutdown events active. If there are any active shutdown events the red light will change from flashing red to solid red after the Alarm Acknowledge/Silence Key (5) is pressed. Any condition that has caused an EMCP shutdown event must be manually reset. If there are no longer any active shutdown events, the red light will turn off.

41.0 Appendix C – IVR Excitation Module Connection Diagrams

EM10 – Self-Excitation (SHUNT)

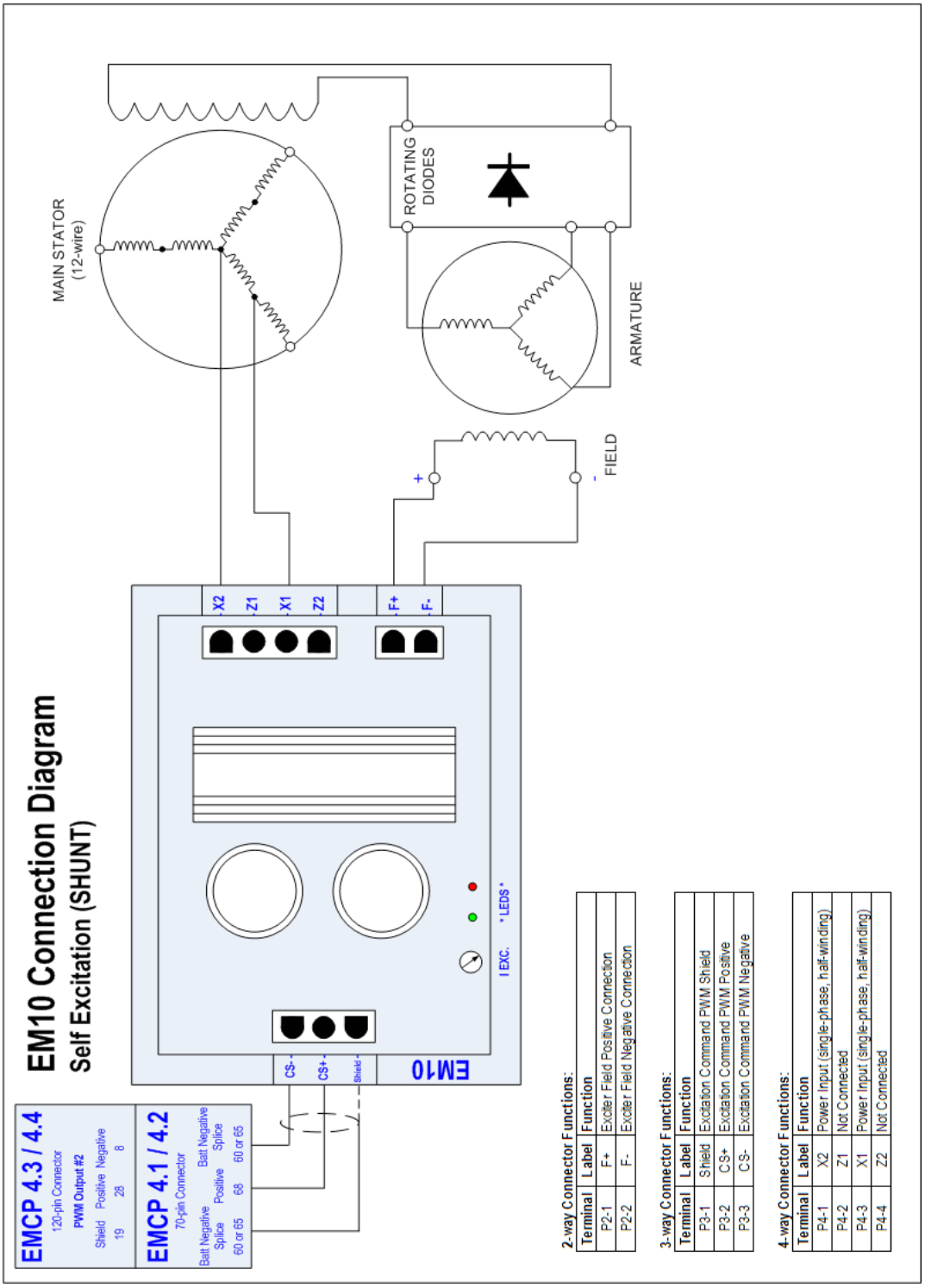
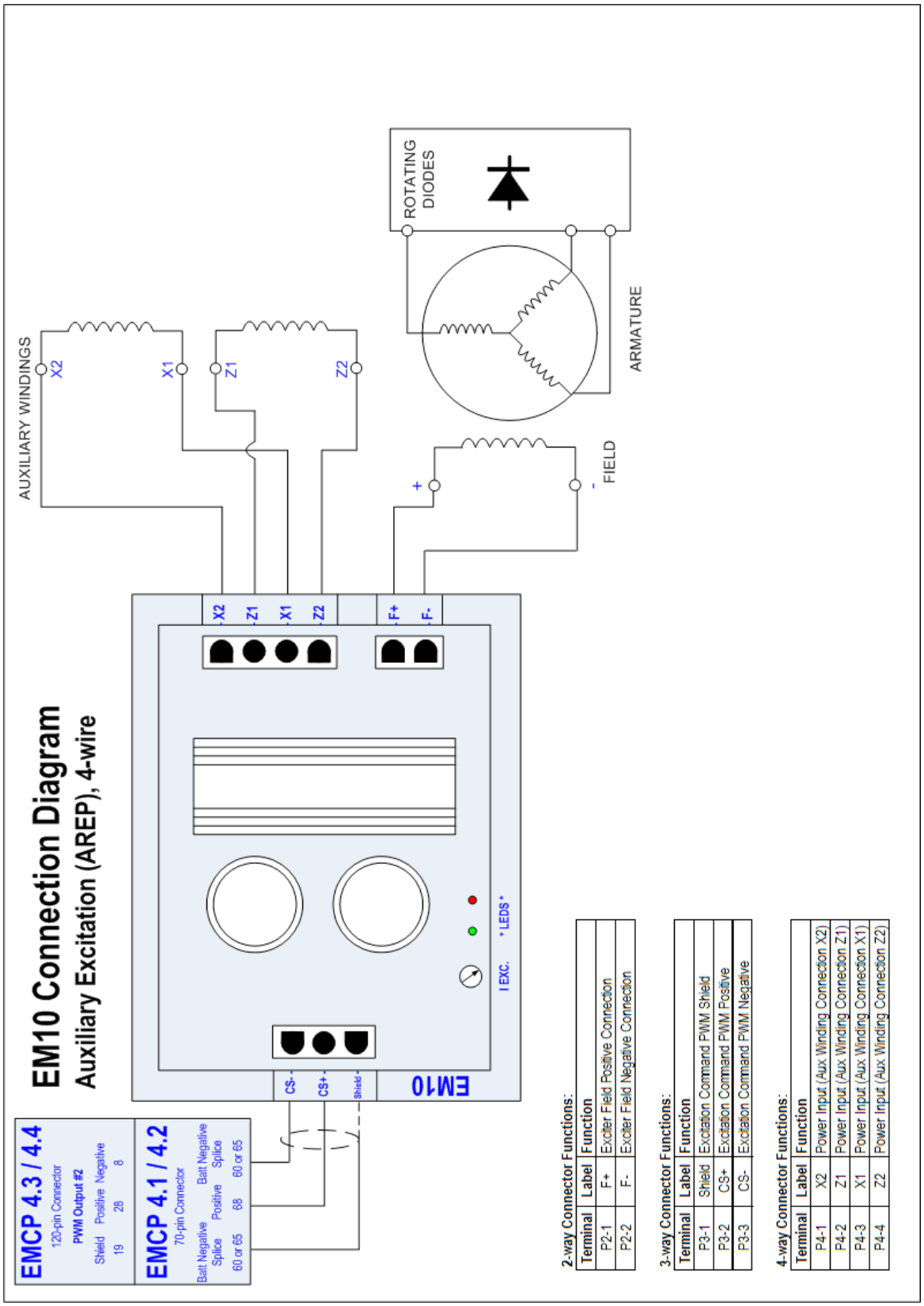


Figure – C1

EM10 – Auxiliary Winding (Internal) Excitation (AREP/IE), 4-wire



2-way Connector Functions:

Terminal	Label	Function
P2-1	F+	Exciter Field Positive Connection
P2-2	F-	Exciter Field Negative Connection

3-way Connector Functions:

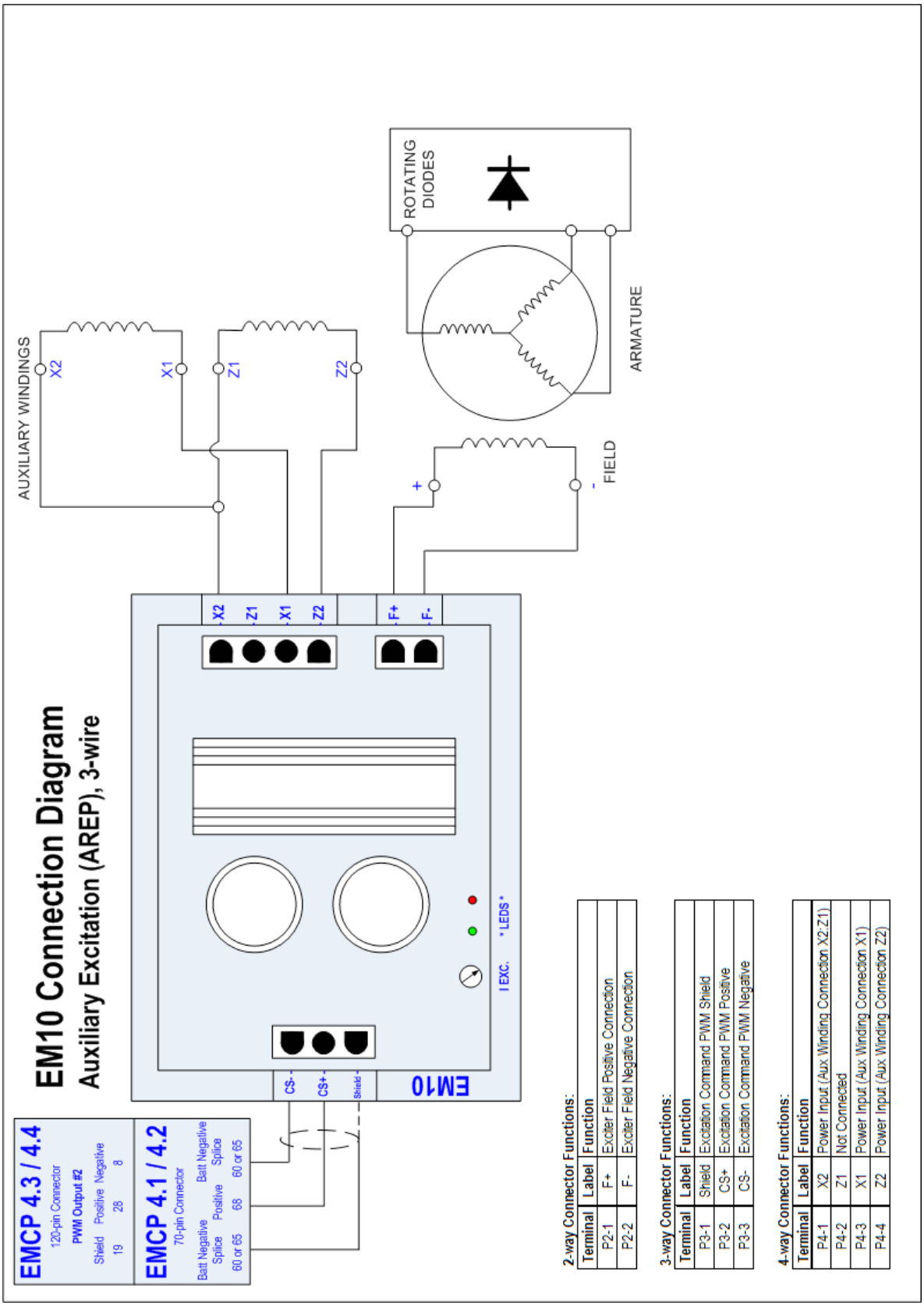
Terminal	Label	Function
P3-1	Shield	Excitation Command PWM Shield
P3-2	CS+	Excitation Command PWM Positive
P3-3	CS-	Excitation Command PWM Negative

4-way Connector Functions:

Terminal	Label	Function
P4-1	X2	Power Input (Aux Winding Connection X2)
P4-2	Z1	Power Input (Aux Winding Connection Z1)
P4-3	X1	Power Input (Aux Winding Connection X1)
P4-4	Z2	Power Input (Aux Winding Connection Z2)

Figure – C2

EM10 – Auxiliary Winding (Internal) Excitation (AREP/IE), 3-wire



2-way Connector Functions:

Terminal	Label	Function
P2-1	F+	Exciter Field Positive Connection
P2-2	F-	Exciter Field Negative Connection

3-way Connector Functions:

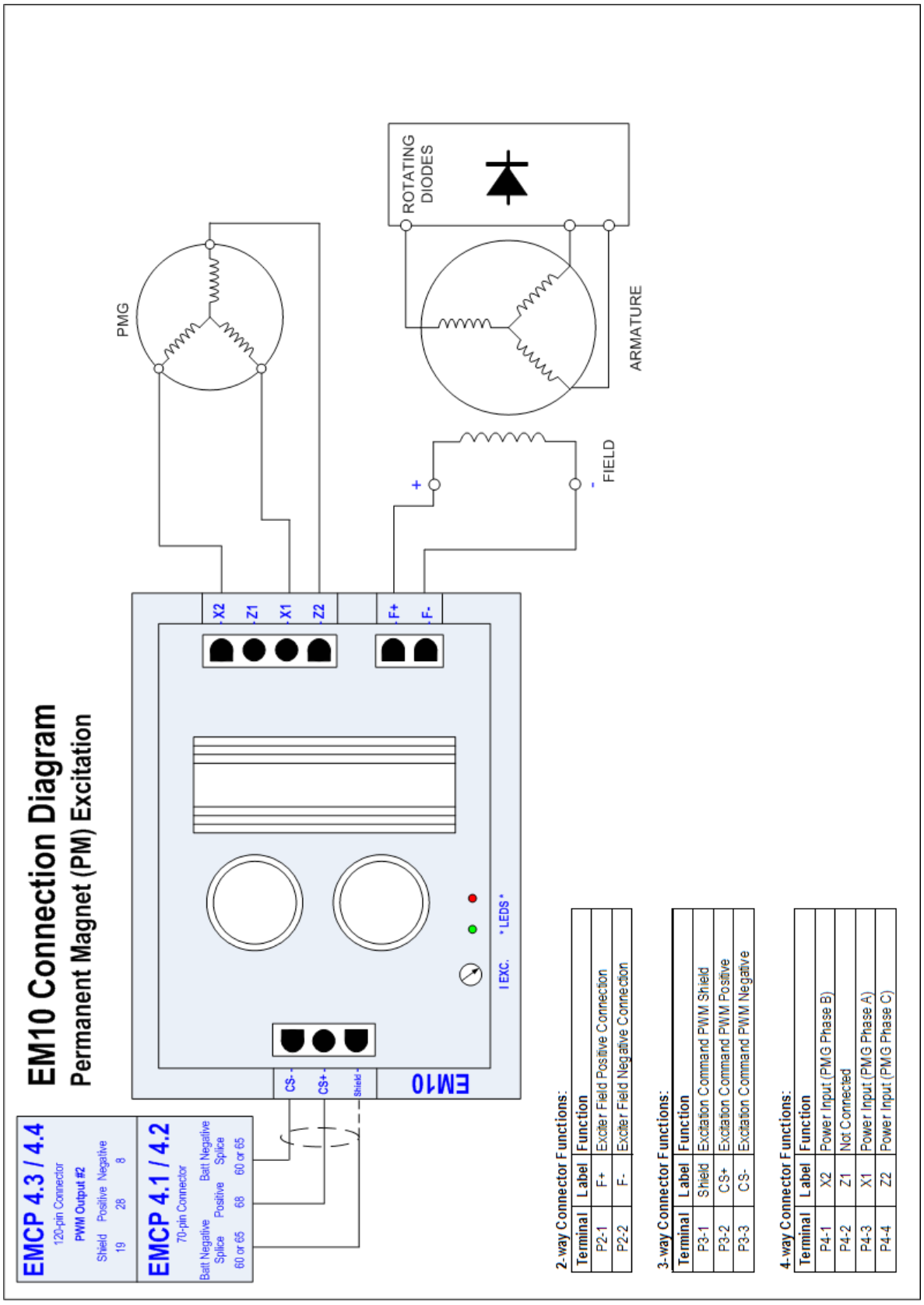
Terminal	Label	Function
P3-1	Shield	Excitation Command PWM Shield
P3-2	CS+	Excitation Command PWM Positive
P3-3	CS-	Excitation Command PWM Negative

4-way Connector Functions:

Terminal	Label	Function
P4-1	X2	Power Input (Aux Winding Connection X2:Z1)
P4-2	Z1	Not Connected
P4-3	X1	Power Input (Aux Winding Connection X1)
P4-4	Z2	Power Input (Aux Winding Connection Z2)

Figure – C3

EM10 – Permanent Magnet Excitation (PM)



2-way Connector Functions:

Terminal	Label	Function
P2-1	F+	Exciter Field Positive Connection
P2-2	F-	Exciter Field Negative Connection

3-way Connector Functions:

Terminal	Label	Function
P3-1	Shield	Excitation Command PWM Shield
P3-2	CS+	Excitation Command PWM Positive
P3-3	CS-	Excitation Command PWM Negative

4-way Connector Functions:

Terminal	Label	Function
P4-1	X2	Power Input (PMG Phase B)
P4-2	Z1	Not Connected
P4-3	X1	Power Input (PMG Phase A)
P4-4	Z2	Power Input (PMG Phase C)

Figure – C4

EM15 – Self Excitation (SHUNT)

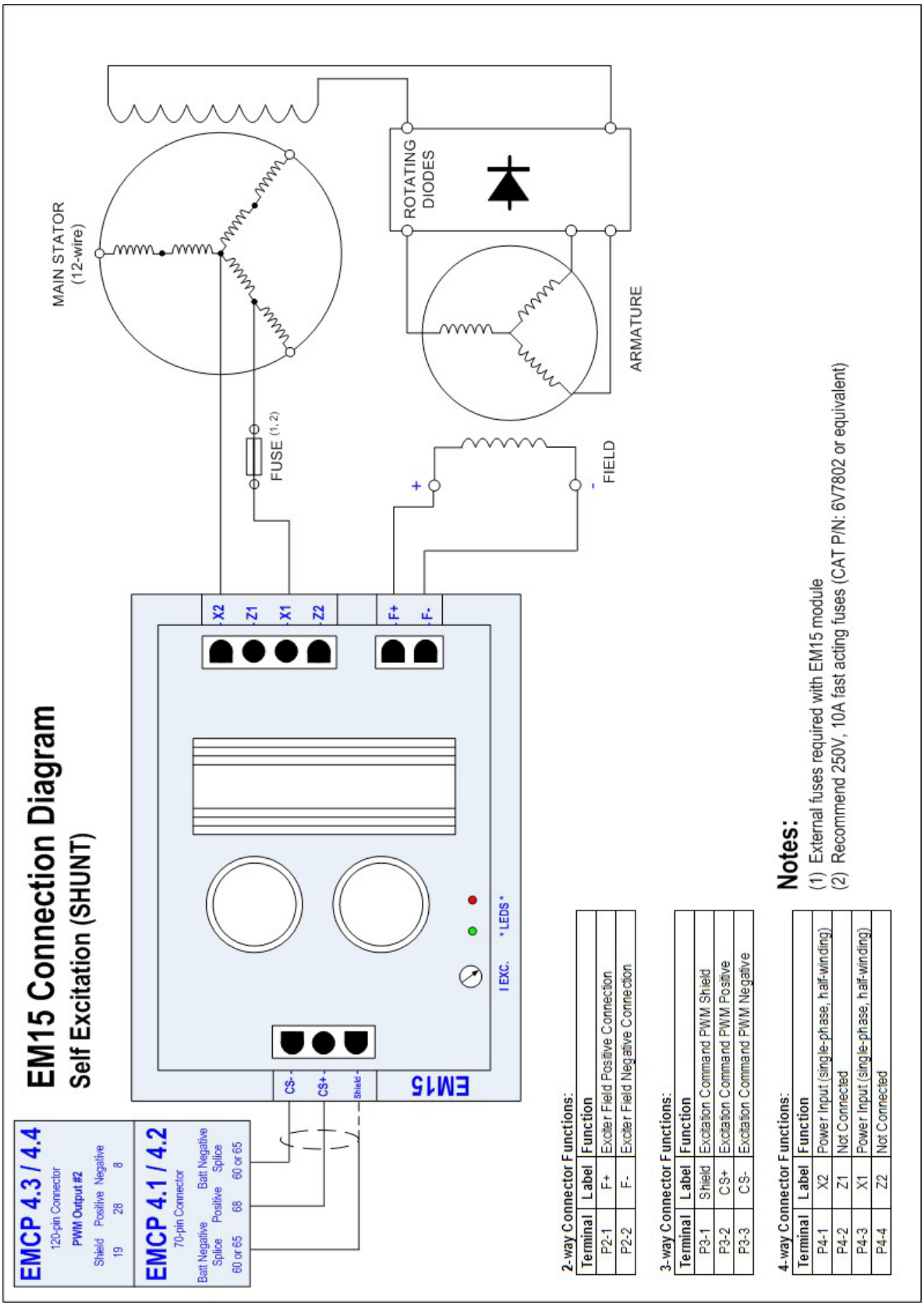


Figure – C5

EM15 – Auxiliary Winding (Internal) Excitation (AREP/IE), 4-wire

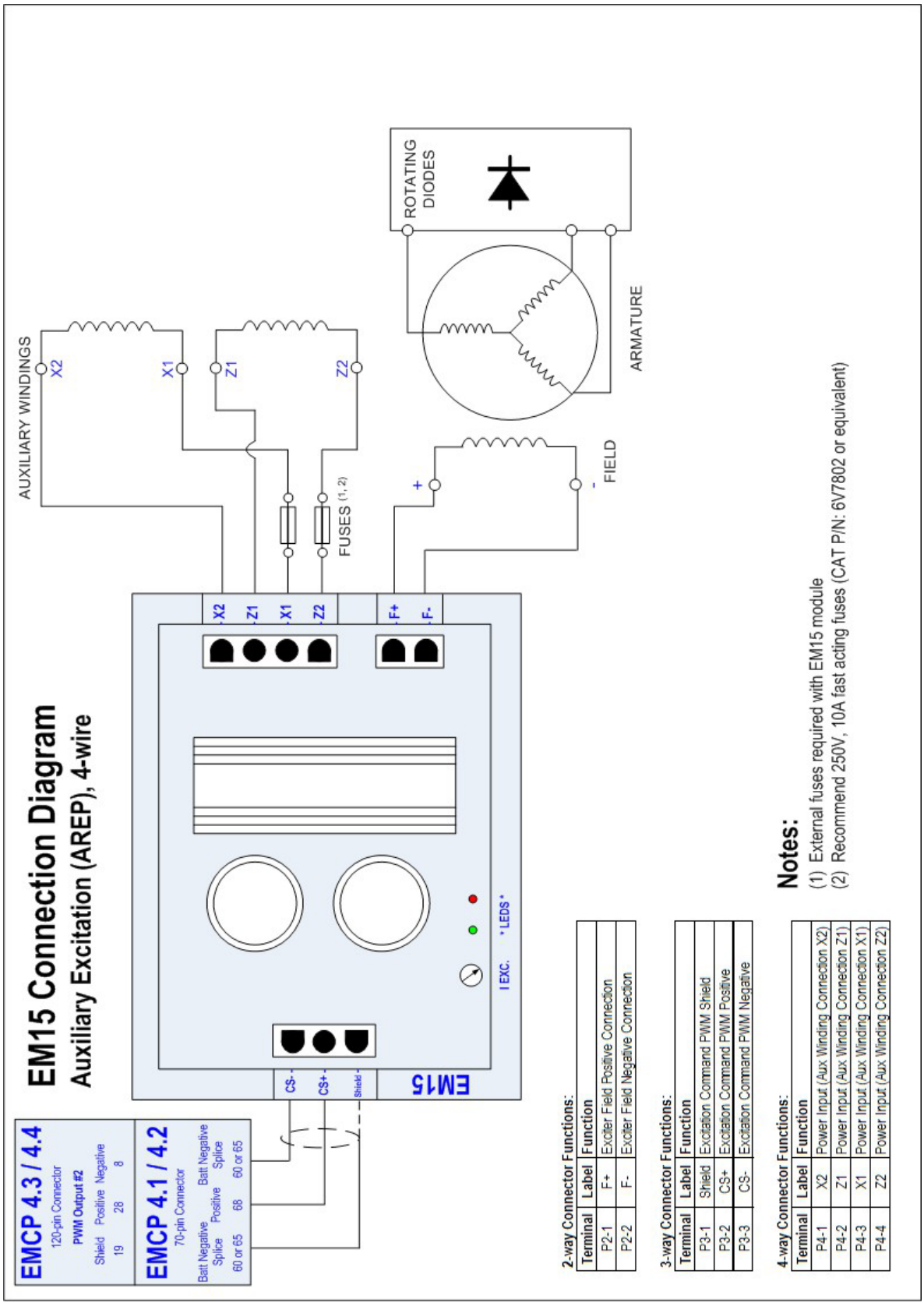
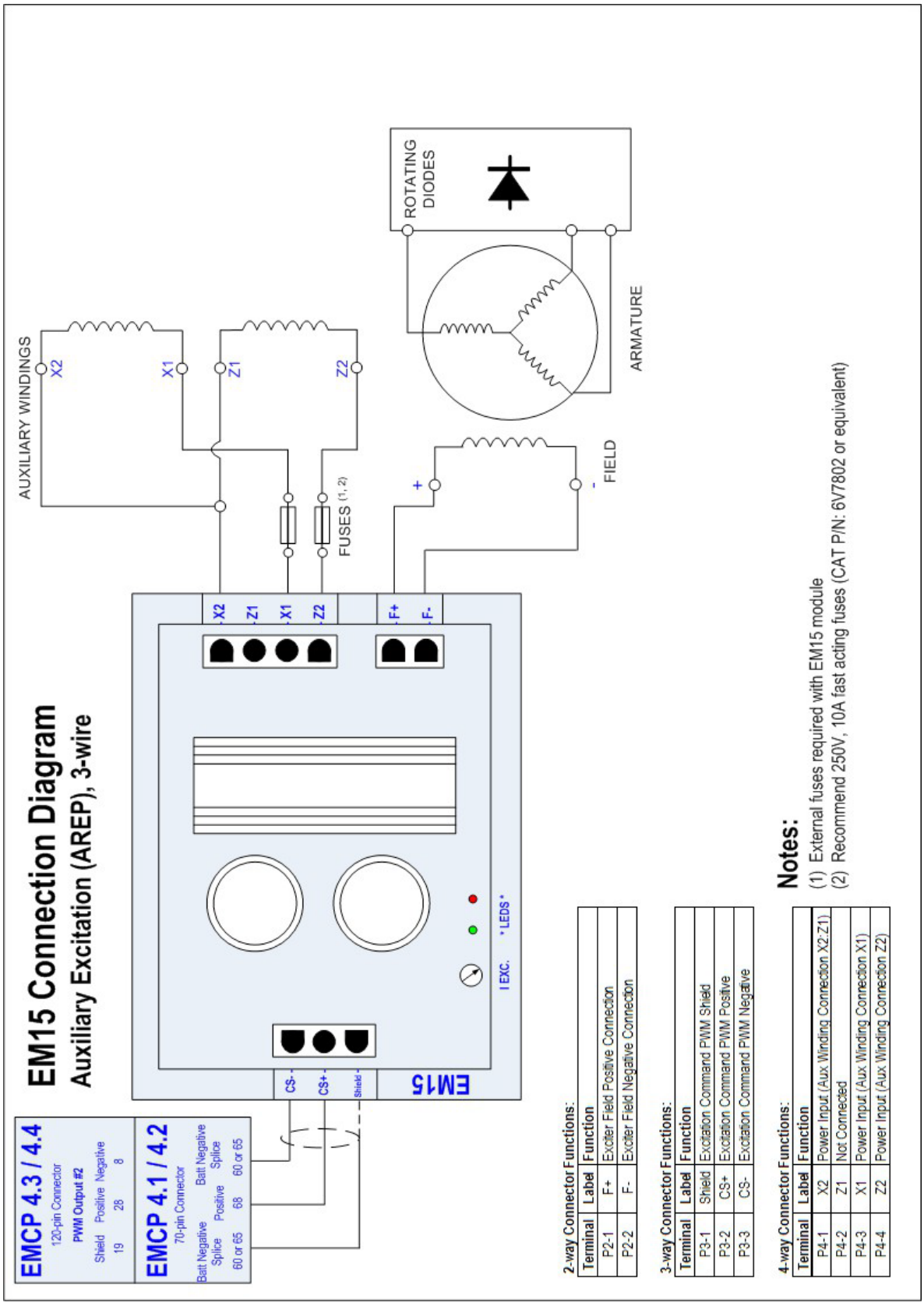


Figure – C6

EM15 – Auxiliary Winding (Internal) Excitation (AREP/IE), 3-wire



2-way Connector Functions:

Terminal	Label	Function
P2-1	F+	Exciter Field Positive Connection
P2-2	F-	Exciter Field Negative Connection

3-way Connector Functions:

Terminal	Label	Function
P3-1	Shield	Excitation Command PWM Shield
P3-2	CS+	Excitation Command PWM Positive
P3-3	CS-	Excitation Command PWM Negative

4-way Connector Functions:

Terminal	Label	Function
P4-1	X2	Power Input (Aux Winding Connection X2:Z1)
P4-2	Z1	Not Connected
P4-3	X1	Power Input (Aux Winding Connection X1)
P4-4	Z2	Power Input (Aux Winding Connection Z2)

Notes:

(1) External fuses required with EM15 module

(2) Recommend 250V, 10A fast acting fuses (CAT P/N: 6V7802 or equivalent)

Figure – C7

EM15 – Permanent Magnet Excitation (PM)

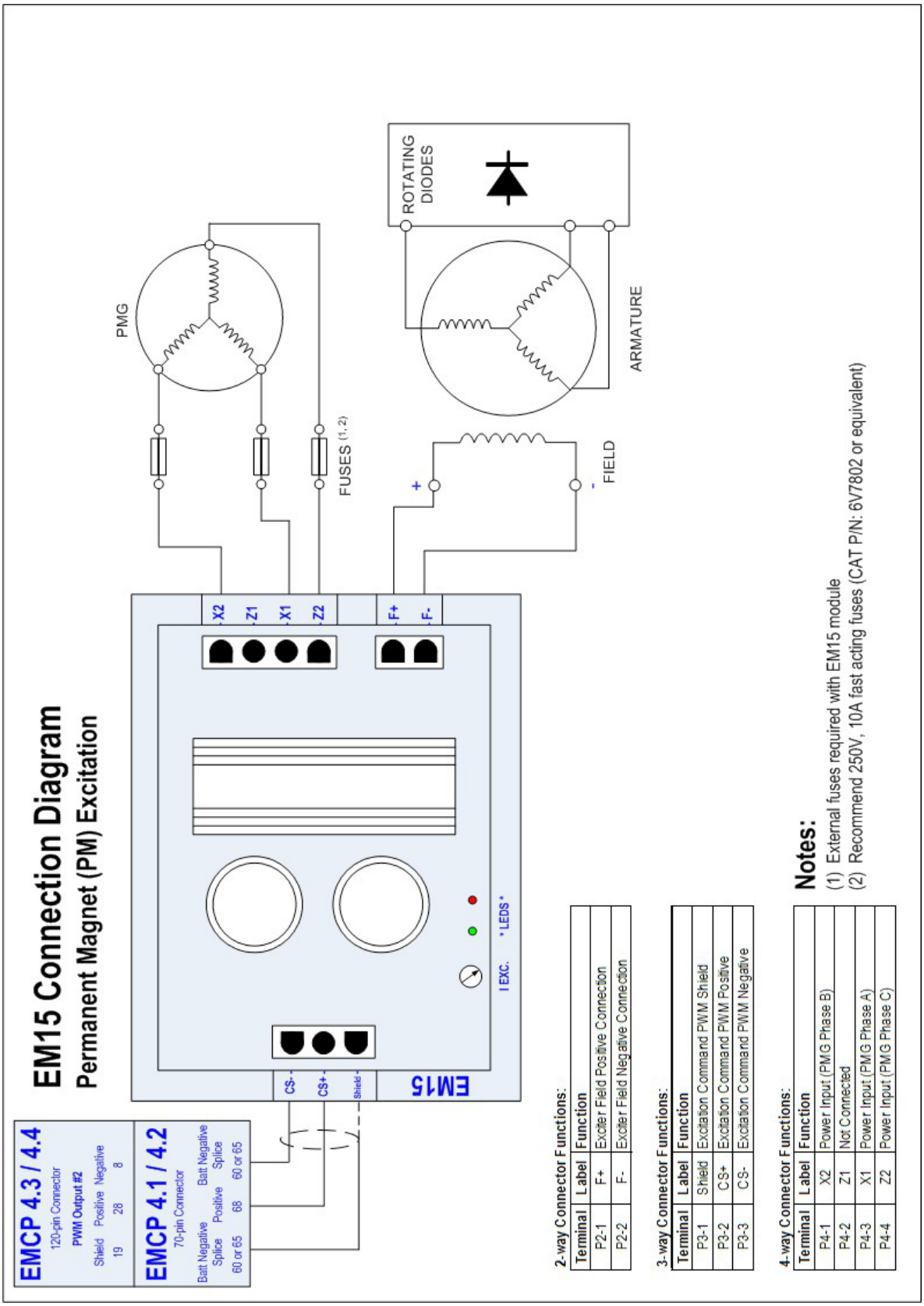


Figure – C8

42.0 Glossary of Terms

ACK – Acknowledge

AGSM – Alarm Group Selection Mode. The mode in which group of alarms the RS-485 annunciator will respond is selected in.

CAN – Controller Area Network. This will often refer to our CAN J1939 Communications between ECMs.

CDVR – Caterpillar Digital Voltage Regulator. A microprocessor based digital voltage regulator which communicates with the EMCP and controls excitation current to control generator voltage.

DIO – Discrete Input/Output Module

EMCP 4 – Electronic Modular Control Panel 4. This is the Cat generator set control panel, consisting of a generator set control (GSC).

ECM – Engine Control Module. This is a general term and can refer to any microprocessor-based module that is part of a control system. The engine ECM is an ECM dedicated to the task of engine timing and air/fuel control.

ECS – Engine Control Switch

ECU – Engine Control Unit. Another name for an ECM (Electronic Control Module).

EM – Excitation Module. This is the excitation power converter component required for use with the EMCP 4 Integrated Voltage Regulator (IVR).

EUI – Electronic Unit Injector. A type of Fuel Injector.

FMI – Failure Mode Indicator. The CAN term for a failure code associated with a particular Suspect Parameter Number. For a complete list of FMI codes, refer to the Systems Operation Troubleshooting Testing and Adjusting guide.

FPT – Fault Protection Timer. A time delay that suppresses some events for a configurable amount of time after the generator set starts to allow values to settle before taking action on the event.

GSC – Generator Set Controller. This is the module responsible for the overall generator protection and control functions. It is the master module on the generator set, interfacing with the user as well as the engine ECM and any other accessory modules.

IVR – Integrated Voltage Regulator. This is a voltage regulating system integrated into EMCP controls. Requires an Excitation Module component.

MGDL – Multiple Genset Data Link. A proprietary Ethernet based data link network between EMCP 4.4 controllers used for paralleling operations.

MUI – Mechanical Unit Injector. A type of fuel injector.

NFPA – National Fire Protection Association. An American standards body responsible for creation of various codes.

PCT – Programmable Cycle Timer. A timer which supports starting a generator set for exercise on a 7 day basis.

RMS – A mathematical approach of representing a useful average for varying quantities; this is useful to indicate AC quantities.

rpm – Revolutions per minute

RPM – Reduced Power Mode. A mode to reduce the power consumption of an EMCP controller when a battery charger is not fitted to the generator set.

RS-232 – Recommended Standard 232, maintained by the Electronics Industries Alliance (EIA). Also known as EIA-232.

RS-485 – Recommended Standard 485, maintained by the Electronics Industries Alliance (EIA). Also known as EIA-485.

RTD – Resistive Temperature Device. A temperature sensor that changes resistance based on temperature.

RTU – Remote Transmitter Unit. This term refers to a Slave device in a MODBUS network that merely responds to requests from the Master. The EMCP 4.2 can function as an RTU on a SCADA system via the RS-485 SCADA port.

SCR – Selective Catalyst Reduction. This is a form of emission treatment.

SCADA – Supervisory Control And Data Acquisition. This term represents any computing system designed to perform high-level control and monitoring over various subsystems. On the EMCP 4, we provide a MODBUS interface to allow any SCADA systems to connect and collect data about the operations of the control and the generator set(s).

SPN – Suspect Parameter Number. The CAN term for any parameter whose data is transmitted over a CAN network, such as the EMCP 4 primary or accessory data link. For a complete list of SPNs supported by the EMCP 4, refer to the Diagnostic Trouble Code List in the Systems Operation Troubleshooting Testing and Adjusting guide.

TLR – Transient Load Relief. A patented software feature of the EMCP 4 Integrated Voltage Regulator (IVR) designed to optimize generator set load acceptance performance.

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