Product Manual 26473
(Revision NEW, 4/2011)
Original Instructions

E3 Stoichiometric Control System

Application Manual

General Precautions	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

Proper Use	**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

Translated Publications	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.**

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Contents

Contents

Illustrations and Tables

Illustrations and Tables

Illustrations and Tables

Illustrations and Tables

Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE **Battery Charging Device**	**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
General Information

About this Manual

This manual describes how to install, monitor, and commission the E3 Stoichiometric Control system. This system can have different configurations. The core functionality is air/fuel ratio trim control using exhaust oxygen feedback. Additional functions are available by adding optional hardware. The following list shows the available functions and the corresponding hardware requirements:

Base System	**Base Hardware**
Air/fuel ratio	E3 controller, trim valve(s), magnetic pickup & StableSense™ HEGO sensors
Optional Functions	**Additional Hardware**
Speed/load control	Mixture throttle actuator(s)
Integrated ignition	IC-920/-922 ignition system
Generator integration	easYgen™-3000 family generator controller
Thermocouple Monitoring	3rd Party J1939 CAN I/O Node

System Description

Digital Engine Control

The E3 Stoichiometric Control system is a gas-engine control system that controls speed/load, air/fuel ratio and spark timing, on a wide variety of rich-burn engines in many different applications. It can be applied to carbureted four-stroke inline or multibank engines in a wide range of power outputs, both naturally aspirated and turbo-charged.

Highly developed Air/Fuel Ratio

The control maintains the Three-Way Catalyst inlet conditions using the StableSense HEGO Sensor. The sensor and StableSense algorithm cover a wide range of gas compositions, including LPG, pipeline natural gas, and coal-seam gas. Changes in gas quality and environment during normal operation of the engine are compensated by the control by means of HEGO closed loop.

Key Air/Fuel Ratio Functions

- Pre-catalyst, closed loop, exhaust oxygen feedback control.
- Post-catalyst, exhaust oxygen feedback, cascade control allowing adaptation to changing catalyst performance.
- Post-catalyst exhaust oxygen control set point variable with engine load.
- User-friendly fuel valve dithering algorithm for better catalyst control.
- Catalyst temperature monitoring to protect the catalyst from engine fueling malfunctions .
- Catalyst differential pressure monitoring to indicate ash build-up and help meet regulatory requirements.
- Open loop valve positioning in event of critical oxygen sensor malfunction or large transient load changes.

Catalyst Protection Options

The control can be configured to use high temp RTD for catalyst temperatures measurement and protection. An external third-party thermocouple node can be used instead to monitor catalyst temperature thermocouples. Inputs for Catalyst differential pressure are provided to allow full catalyst health measurement.

Proven Control Architecture

The fuel metering subsystem consists of a carburetor combined with a fuel trim valve in-line. The control can accommodate a venturi style mixer or air-plug type carburetor with the trim valve in-between the regulator and the mixer.

Plant Control Link

The E3 Stoich control provides a number of inputs/outputs to interface to plant controls and systems. A Modbus® * Slave Port is provided to allow system data gathering, diagnosis, and remote control.

*—Modbus is a trademark of Schneider Automation Inc.

Performance and Troubleshooting

The control is programmable via Woodward Toolkit that provides user-friendly commissioning and troubleshooting support.

High Energy Ignition with Control Integration

Integrated ignition control is available using an IC-920/922 ignition system. The IC-92x ignition controller is integrated with the E3 controller over a J1939 CAN communication network. The E3 sends timing and energy commands and receives diagnostic ignition information.

Advanced Power Management with Control Integration

Integrated power management is available using the easYgen-3100/3200 power management controller, which communicates with the E3 controller over the J1939 CAN communication network. The E3 receives power measurement and reference along with Speed Bias over the J1939 CAN.

Control Options

Two versions of software are offered for the E3 Stoichiometric:

- 8280-1104 – AFR Only
- 8280-1105 – AFR with Speed Control

Each version has a separate Toolkit Service Tool file. The AFR Only Version is a subset of the Speed Control version functionality.

Nomenclature

A/D	analog-to-digital
A/R	as required
AFR	air to fuel ratio
ATDC	after top dead center
AWG	American Wire Gauge
BARO	barometric pressure
BMEP	brake mean effective pressure
BTDC	before top dead center
c	celerity (the speed of light)
CAN	controller area network, the digital communications link between control modules
ECT	engine coolant temperature
ESD	emergency shutdown
EMI	electromagnetic interference
FMI	failure mode identifier
HEGO	heated exhaust gas oxygen (sensor)
HMI	human machine interface
I/O	input/output
ITB	integrated throttle body
kbits/s	kilobits/second
kHz	kilohertz
kPa	kilopascals
kW	kilowatt
kWe	kilowatt electric
LPG	liquefied petroleum gas (also referred to as propane)
LSO	low-side output
mA	milliamp
MAP	manifold absolute pressure
MAT	manifold air temperature
Mbit/s	megabits/second
µF	microfarad
MHz	megahertz
mJ	millijoules
MPRD	master power relay driver
MPU	magnetic pickup
ms	milliseconds
N/A	not applicable
N.C.	normally closed
N.O.	normally open
NPT	National Pipe Thread
NTC	negative temperature coefficient
pF	picofarad
PID	proportional-integral-derivative (feedback control parameters)
PN	part number
PWM	pulse width modulated
SAE	Society of Automotive Engineers
SDR	speed derivative ratio
SPN	suspect parameter number
Tau (τ)	time constant (e.g. for a filter)
TDC	top dead center
TMAP	combined manifold temperature and pressure sensor
TPS	throttle position sensor
UEGO	universal exhaust gas oxygen (sensor)
Vdc	voltage of direct current type

Chapter 2.
System Description and Application

E^3 Stoichiometric Air/Fuel Ratio Control

The E3 Stoichiometric gas engine control is a microprocessor-based control for carbureted, four-stroke, gaseous-fueled engines operating with a near-Stoichiometric air/fuel ratio. It is designed to work in conjunction with a three-way catalytic converter to efficiently reduce exhaust emissions. By automatically maintaining an optimum air/fuel mixture, emissions compliance is achieved and catalyst life is maximized without operator supervision.

There are two types of AFR Trim used in systems like these, Full-Flow Trim and Supplementary Trim. In Full-Flow Trim mode, the carburetor remains in place on the engine. The base AFR is adjusted slightly rich, and the trim valve restricts the fuel flow to the carburetor to bring the air/fuel mixture to the precise value that will make the catalytic converter most efficient. In supplementary mode, the carburetor remains in place on the engine, adjusted slightly lean, the AFR control then adds fuel through a supplementary fuelling system. The range of operation for Supplementary Trim is very narrow and is not recommended for the vast majority of applications. The E3 Stoichiometric is optimized for Full Flow Trim architecture.

A catalyst that simultaneously eliminates hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) is referred to as a "three-way" catalyst. The use of a three-way catalyst will reduce the emissions of a Stoichiometric engine. However, for these reductions to be reliable and maximized and to protect the catalyst element from premature aging or damage, a very precisely controlled air/fuel ratio is required.

If a three-way catalyst receives exhaust gas containing emissions in the proportions shown in the "Stoich" window of Figure 2-1, the resulting emissions exiting the catalyst will be reduced to the levels shown in Figure 2-2.

The heated exhaust gas oxygen sensor (HEGO) will generate a voltage signal that is characteristic of this ideal Stoichiometric window. The E3 control will use this voltage value to keep the engine at this correct air/fuel ratio. For natural gas this voltage is usually around 0.720 V.

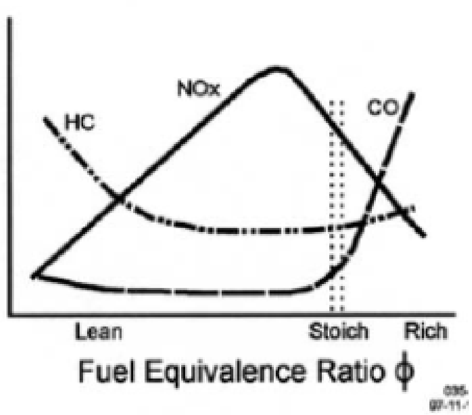


Figure 2-1. Pre-Catalyst Emissions

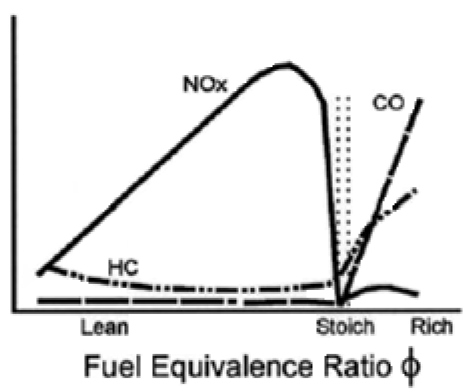


Figure 2-2. Post-Catalyst Emissions

Pre-Catalyst Exhaust Oxygen Control

The E3 control increases or decreases the fuel flowing through the fuel system to hold the HEGO 1 (and HEGO 2 if present) average sensor voltage at this target value.

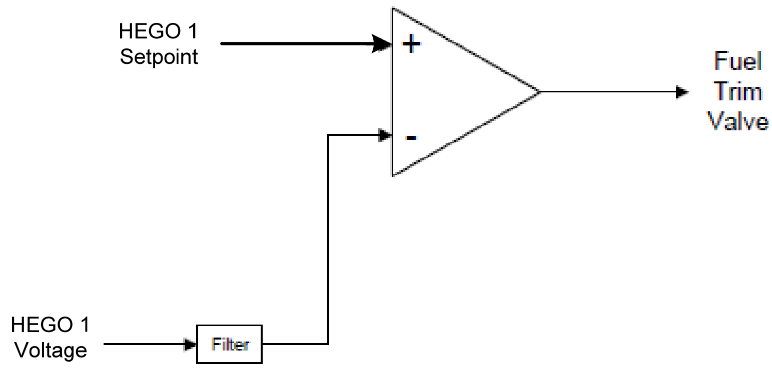


Figure 2-3. Basic Control Logic for Pre-catalyst EGO Control

Post-Catalyst Exhaust Oxygen Control

In order to assure optimal catalyst performance over time as conditions vary and the catalyst element ages, the E3 Stoichiometric control has a "Cascade" control loop that uses feedback from a second oxygen sensor in the exhaust downstream of the catalyst element. This post-catalyst control loop "adapts" the primary pre-catalyst control to changes in fuel, catalyst, and environmental conditions that are reflected in the post-catalyst oxygen concentration. A post-catalyst oxygen sensor voltage of 0.720 V is a typical post-catalyst control loop set point.

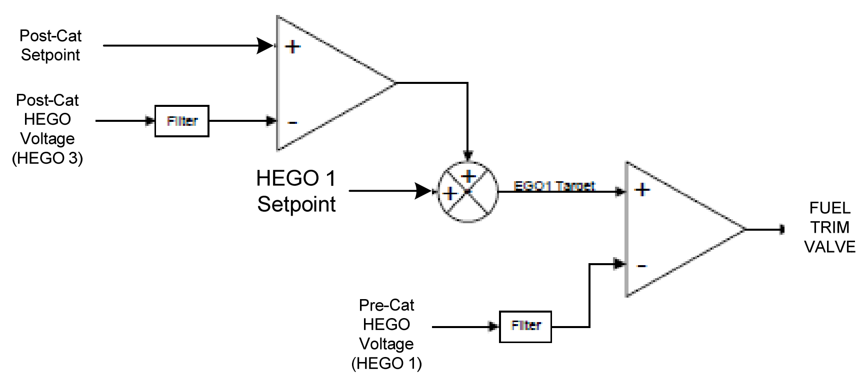


Figure 2-4. Basic Control Logic for Post-Catalyst HEGO Control

EGO3 Setpoint Table

This EGO3 Base value may vary several millivolts from engine to engine, catalyst to catalyst, and load to load. Some engines operate with varying loads. In order to keep such an engine and catalyst at optimum performance, the Post-Cat Setpoint may need to be adjusted. The required setpoints are entered into the Post-Cat Setpoint table in the E3 control so that it can vary the target at different loads to ensure compliance throughout the engine load range. The E3 control keeps track of engine load by monitoring the intake manifold pressure and temperature (MAP & MAT) and engine speed (MPU). The intake manifold pressure/temperature and engine speed are used to calculate an approximate engine fuel flow is then used as a load indicator. The load range of the engine is divided into eight segments. A Post-Cat setpoint value can be manually entered for each of these load levels with this feature.

Open Loop Control Mode

The open loop control mode will control the coarse air/fuel ratio of the engine without the closed loop HEGO measurement. This mode is less accurate than the closed loop mode but it is more accurate than the carburetor alone. This mode positions the fuel control valve to predetermined values based on the load of the engine (Qmix). This engine flow is used in a table Fuel Trim Valve position versus Qmix. This table is called the Open Loop table. This table stores valve operating positions in eight (8) load points over the engine load range. Values in between load points are interpolated.

The open loop feed-forward mainly serves as a framework to the pre-catalyst closed loop control mode as the closed loop bias adds to the open loop table. If HEGO 1 or HEGO 2 sensor fails, the control automatically defaults to the open loop mode recalling the values in this table that were manually entered during initial control calibration.

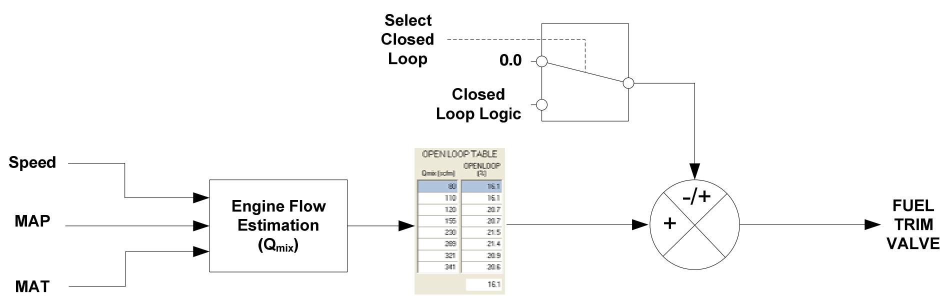


Figure 2-5. Basic Control Logic Open Loop Feed-Forward

Fuel Valve Dithering

It has been shown that “dithering” the Air/fuel ratio into the catalyst increases the window of air/fuel ratio variation to enhance the performance of the catalyst. The E3 includes parameters to adjust the amplitude and frequency of the dithering to optimize the oxygen storage capability of the catalyst. This strategy widens the window of operation and will allow the system to drift more without reducing the efficiency of the catalyst.

Stereo Control

The Control can be used in two general architectures: Mono and Stereo. Mono AFR Control is for engines with one Pre-Cat HEGO and one Pre-Cat control loop. Mono can be used with dual carburetor setups that have only one Pre-Cat HEGO; in this case the two Fuel Trim Valves are given the same demand signal from the E3 Control. See Figure 2-6 for Mono architecture. Stereo systems are used on dual bank engines and need two Pre-Cat HEGO sensors (one on each bank) and two Fuel Trim Valves (one on each bank) See Figure 2-7 for Stereo architecture. Stereo control—while more difficult due to the doubling of components—does offer the chance to improve the catalyst efficiency by dithering the banks out of phase with one another.

Diagnostics and Monitoring

For system reliability the E3 control monitors sensor inputs and control outputs for high and low failure conditions as well as extensive self-diagnostics for system functionality. Alarm or shutdown control relay outputs are available to allow integration into an engine or system control panel for component failure or emissions compliance requirements. These alarms are configured in the software. In addition, the E3 control has oxygen sensor and catalyst health diagnostics.

Communications

Communication with the system is via a computer (PC) interface. Control setup and tuning is accomplished through the Toolkit Service Tool screens.

Modbus Slave Communication
The E3 Stoichiometric control is also capable of interacting with a supervisory control or SCADA system. The communication protocol is Modbus Slave. There is remote control capability over the Modbus link, however is not capable of remote configuration or tuning.

System Diagram Examples

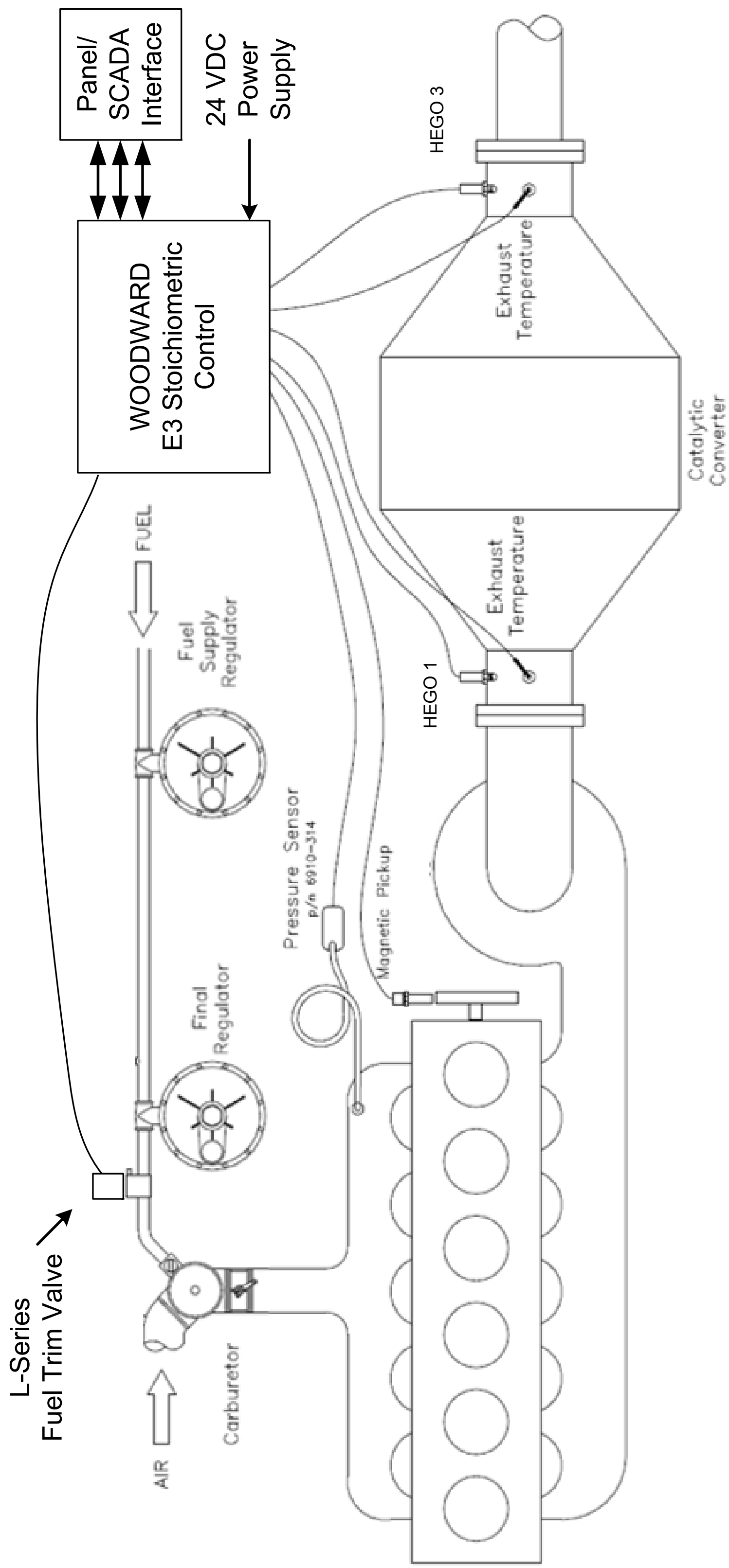


Figure 2-6. E3 Stoichiometric Mono AFR System

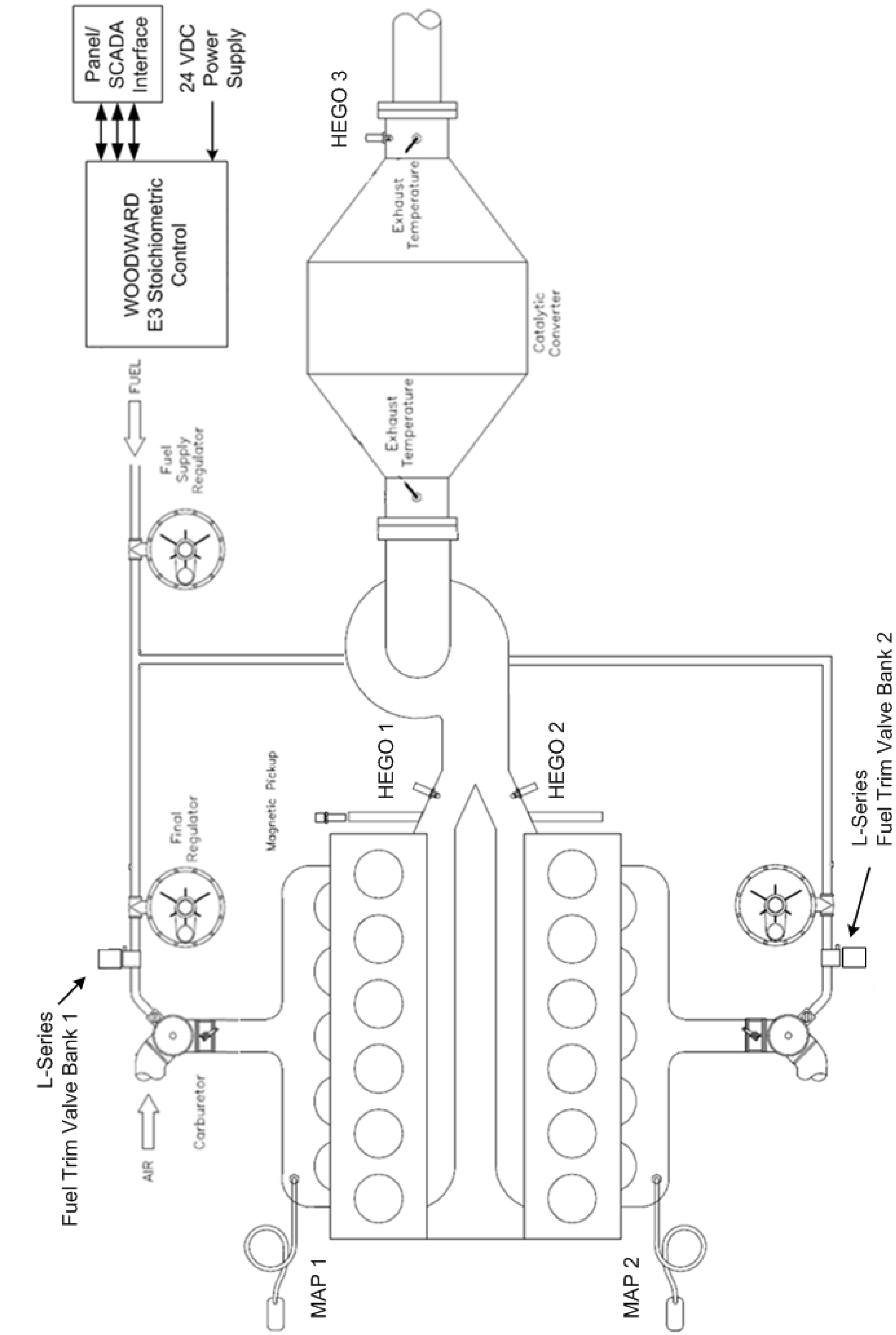


Figure 2-7. E3 Stoichiometric Stereo AFR System

Chapter 3.
System Software and HMI Functionality

Introduction

⚠WARNING	**An unsafe condition could occur with improper use of the HMI tools. Only trained personnel should access the control with these tools.**

This chapter provides detailed information on the system software functions and instructions for their configuration and calibration via the HMI application (Woodward *Toolkit*).

Navigation

Layout

The Service Tool is organized in a page structure. The Navigation Page provides shortcut buttons to each page. Also, the Navigation page provides fault status to indicate what page the currently activated faults can be found.

Info Bar

All online pages display the Info Bar readout (see Figure 3-1).
It is located at the top of the screen and provides key operational information pertaining to the control.

Figure 3-1. Info Bar

Dashboard

The Dashboard (see Figure 3-2) is located on the left side of the screen and provides key operational information pertaining to the control and engine. All online pages except Configuration pages display the Dashboard readout. The Dashboard also contains a graphical indication of the HEGO sensor modes.

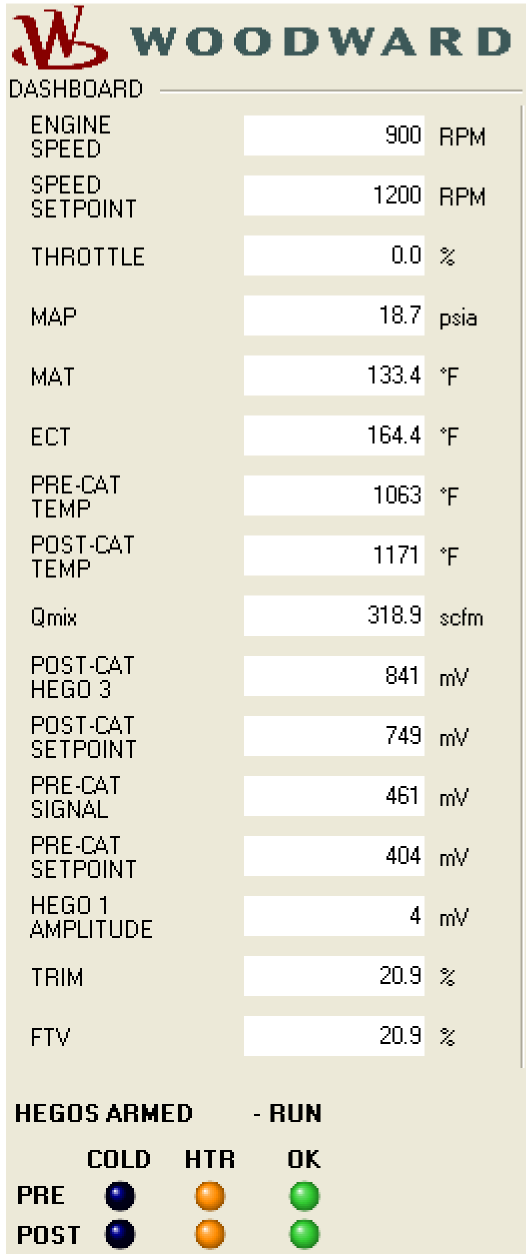


Figure 3-2. Dashboard

I/O Calibration

Remote Reference Input

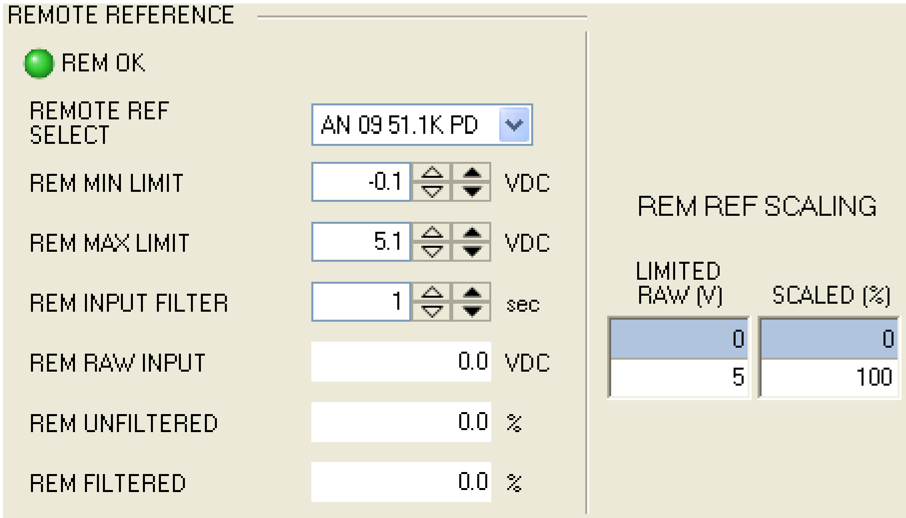


Figure 3-3. Remote Reference Signal Configuration (HMI Screen 6.11)

In Figure 3-3 the HMI settings for user configuration of the remote speed or load reference are shown. This input can be used for either a remote speed reference input or a remote load reference input. The remote speed reference input could be used in a variable speed application when you want to set the engine speed from a remote location with an analog signal (which could also be done with the raise and lower speed contact inputs). The remote load reference input could be used when the E3 is controlling generator load when parallel with the grid. To enable the remote reference input select one of the options in the drop down box at the top of the figure, other than “NOT USED”. The input voltage range should be set in accordance with the plant signal. The allowable input voltage is 0 to 5 V. In the table on the right the input voltage versus the Speed/Load percentage scaling is configured. This specifies the conversion of the input signal voltage to percent (see Figure 3-4).

The default calibration is:
0.5 V – (0 % of the speed limit range) + Lower Speed limit
4.5 V – (100 % of the speed limit range) + Lower Speed limit

The speed limit range is calculated as follows:
Raise Speed limit – Lower Speed limit = Speed range
These limits also apply to the discrete input raise and lower speed limits.

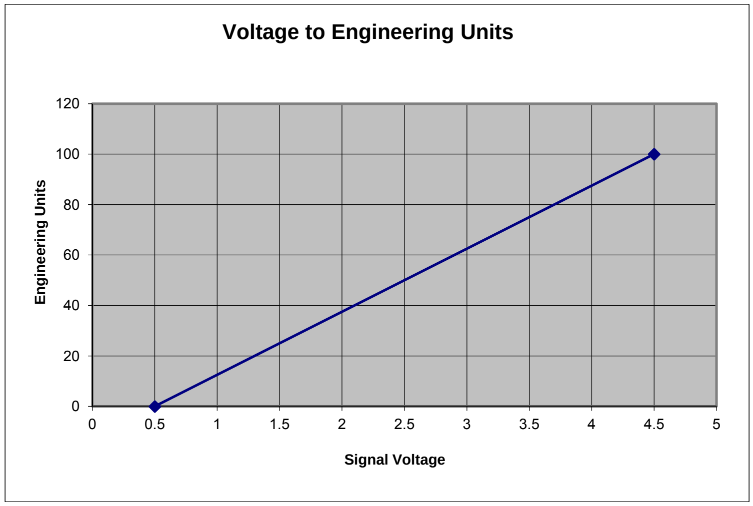


Figure 3-4. Input voltage to Engineering Units

NOTICE **The input should be galvanically isolated from external voltage signals to avoid ground loops and incorrect readings.**

The alarm threshold levels can be adjusted with parameters "REM MIN LIMIT" and "REM MAX LIMIT" (See Figure 3-3). The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 4.75 V.

Also a filter time constant ("REM INPUT FILTER") can be tuned to filter noise from the input signal.

Upon signal failure the Remote reference input will hold the last value. This value is used until a valid signal is re-established and the fault cleared.

Load Input

In Figure 3-5 the HMI settings for user configuration of the Load sensor are shown. To enable the load sensor input select one of the options in the drop down box at the upper center of the figure, other than "NOT USED". In the table on the right the input voltage versus load (kW) scaling is configured. Also a filter time constant ("LOAD INPUT FILTER") can be entered to filter noise from the input signal.

The default calibration is:
1.2 V – 0 kW
5 V – 300 kW

The alarm thresholds are adjusted in the fields on the left. The default value for low voltage alarm threshold is 0.25 V and for the high voltage alarm threshold is 4.75 V.

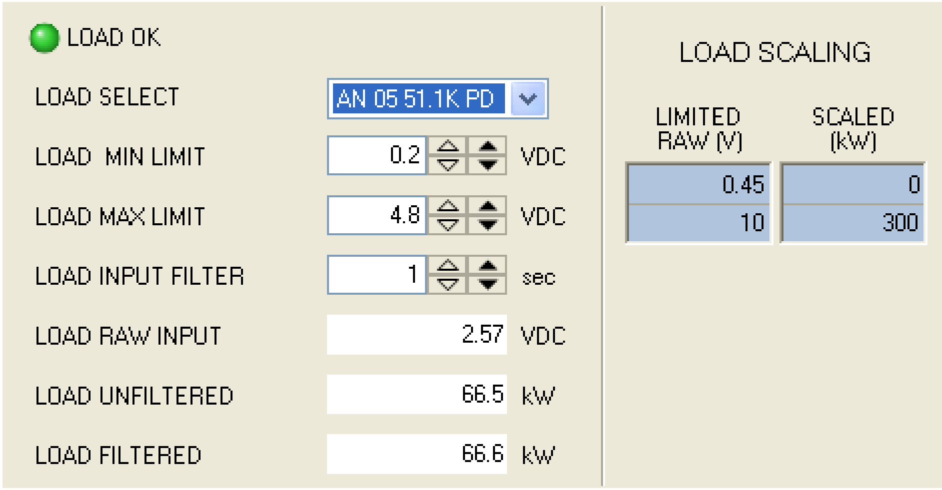


Figure 3-5. Load Sensor Signal Configuration (HMI Screen 6.10)

If the E3 Stoichiometric Control system is used in combination with the easYgen™ 3000, the generator load information can be received over the external J1939 link. In this case, no separate load sensor is needed. To use this option, select the option depicted in Figure 3-6 and set the easYgen J1939 ADDRESS in accordance with the easYgen documentation and settings.

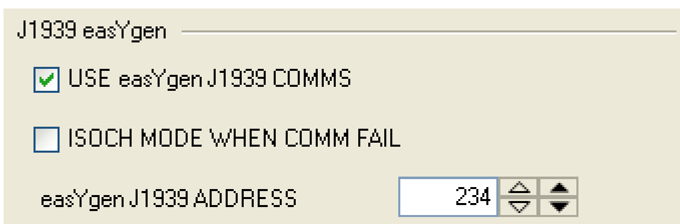


Figure 3-6. Enabling easYgen with J1939 (HMI Screen 7.0)

Manifold Absolute Pressure (MAP) Signal Input

In Figure 3-7 the HMI settings for user configuration of the manifold air pressure sensor are shown. To enable MAP 1 and/or MAP 2 and configure their function and input selection, make the appropriate selections in the drop-down boxes beside “MAP IO CONFIG”, “MAP 1 SELECT”, and “MAP 2 SELECT”. In the tables to the right for MAP 1 and MAP 2 the input voltage versus the MAP scaling is configured. Also a filter time constant can be entered to filter noise from the input signal.

The default calibration is (for Woodward part number 6910-314 MAP sensor):
0.0 V – 0.6 psia
5.0 V – 45.7 psia

The alarm thresholds are adjusted in corresponding fields “MAP 1 MIN LIMIT”, “MAP 1 MAX LIMIT”, “MAP 2 MIN LIMIT”, and “MAP 2 MAX LIMIT”. The default value for low voltage alarm threshold is 0.25 V and for the high voltage alarm threshold is 4.75 V. If the sensor voltage is out of range, this will result in an alarm or engine shutdown, depending on configuration (see Alarm/Shutdown Configuration in Chapter 4).

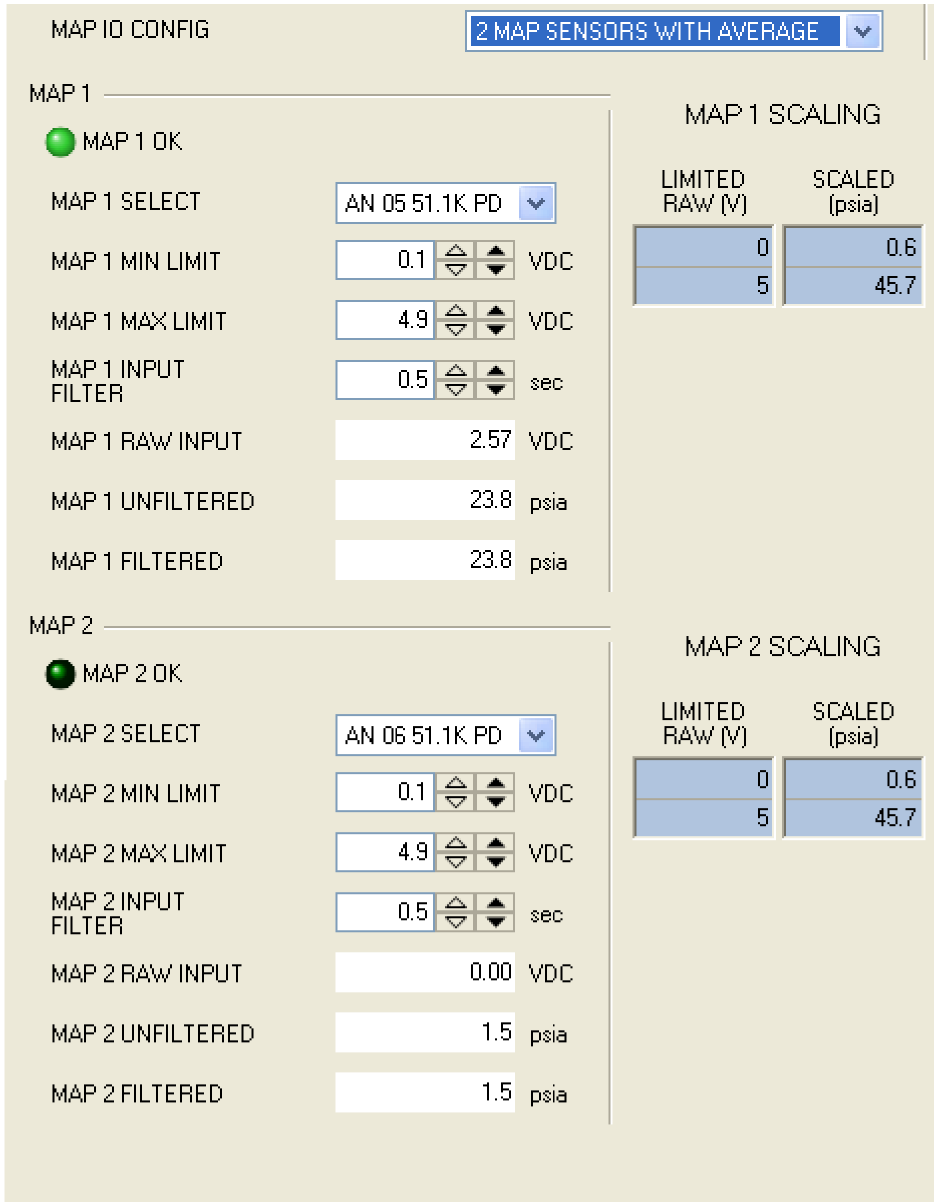


Figure 3-7. MAP Signal Configuration (HMI Screen 6.9)

Manifold Air Temperature (MAT) Signal Inputs

In Figure 3-8 the HMI settings for user configuration of the MAT signal are shown. To enable MAT 1 and/or MAT 2 and configure their function and input selection, make the appropriate selections in the drop-down boxes beside “MAT IO CONFIG”, “MAT 1 SELECT”, and “MAT 2 SELECT”. In the tables to the right for MAT 1 and MAT 2 the voltage-to-temperature scaling tables are adjusted by the user.

The alarm thresholds are adjusted in the corresponding fields “MAT 1 MIN LIMIT”, “MAT 1 MAX LIMIT”, “MAT 2 MIN LIMIT”, and “MAT 2 MAX LIMIT”. The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 4.75 V.

A filter time constant can be entered to filter noise from the input signal.

Note that the sensor works as a resistor in a voltage dividing circuit inside the PCM128-HD (see Figure 3-9).

The correct voltage as a function of temperature can be calculated with the following formula:

$$\left(Voltage\_at\_input = \frac{Rthermistor}{Rthermistor+2210} * 5V\right)$$

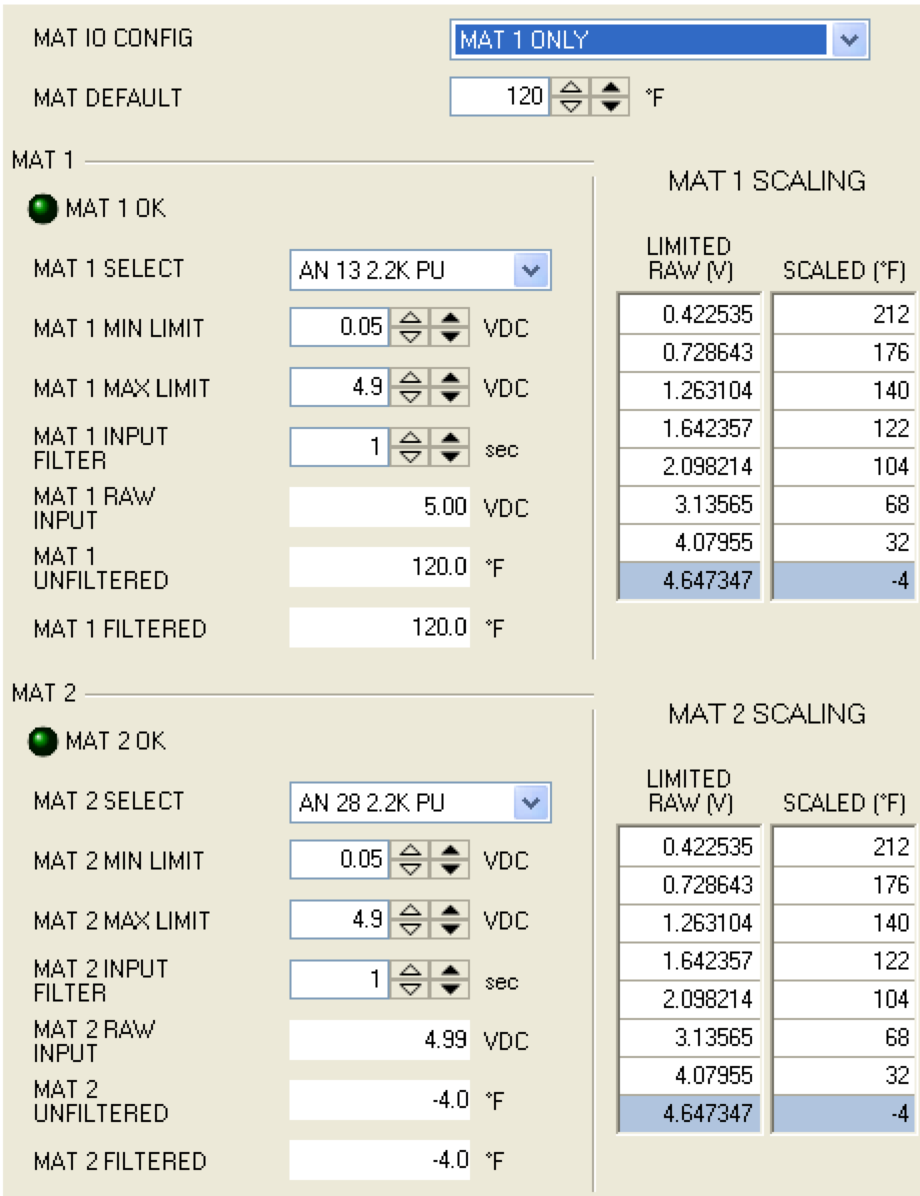


Figure 3-8. MAT Signal Configuration (HMI Screen 6.9)

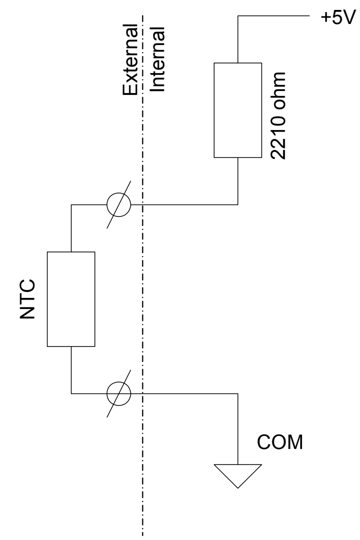


Figure 3-9. Analog Input Circuit – Resistance Temperature Sensors

The calibration for the Woodward MAT sensor DL08041301 is given in the table below and shown graphically in Figure 3-10.

Ohms	**Temp °C**	**Voltage at E3 Input**
204	100	0.42
275	90	0.55
376	80	0.73
526	70	0.96
746	60	1.26
1081	50	1.64
1598	40	2.10
2417	30	2.61
3717	20	3.14
5969	10	3.65
9795	0	4.08
29124	-20	4.65

Table 3-1. MAT Sensor Calibration

If a sensor with a different scaling is used, the scaling table (see Figure 3-8) should be adjusted accordingly.

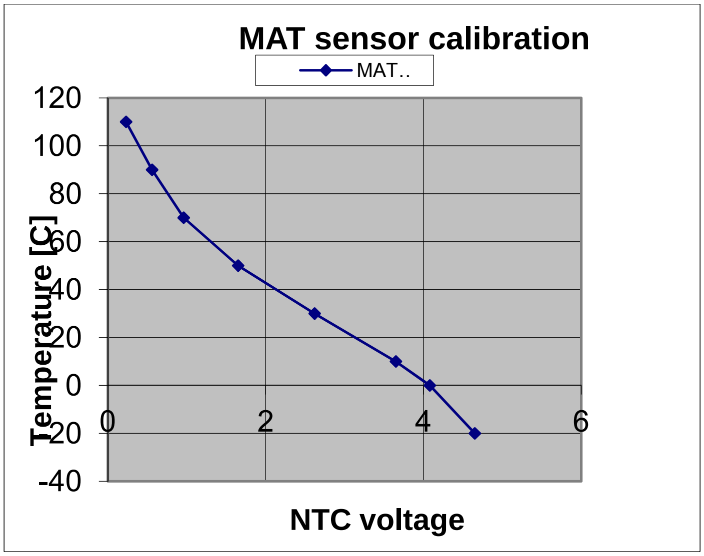


Figure 3-10. MAT Sensor Calibration

Engine Coolant Temperature (ECT) Signal Input

In Figure 3-11 the HMI settings for user configuration of the ECT signal are shown. To enable the ECT sensor input select one of the options in the drop down box at the upper center of the figure, other than “NOT USED”. In the table on the right the voltage to temperature scaling table is adjusted by the user. The input is designed to work with 0 to 5 Volt signals and requires a resistor type sensor connected to ground. Note that the sensor works as a resistor in a voltage dividing circuit inside the PCM128-HD. The correct voltage as a function of temperature can be calculated with the following formula:

$$\left(Voltage\_at\_input = \frac{Rthermistor}{Rthermistor + 2210} * 5V\right)$$

The calibration for the Woodward MAT sensor DL08041301 is given in the table below and shown graphically in Figure 3-12).

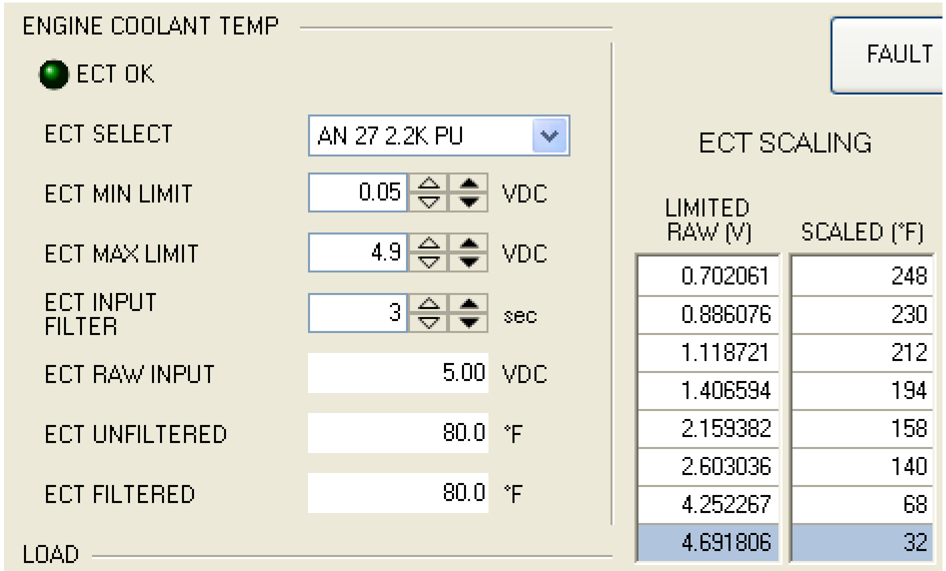


Figure 3-11. ECT Signal Configuration (HMI Screen 6.10)

Ohms	**Temp °C**	**Voltage at E3 Input**
204	100	0.42
275	90	0.55
376	80	0.73
526	70	0.96
746	60	1.26
1081	50	1.64
1598	40	2.10
2417	30	2.61
3717	20	3.14
5969	10	3.65
9795	0	4.08
29124	-20	4.65

Table 3-2. ECT Signal Configuration (HMI Screen 6.10)

If a sensor with a different scaling is used, the scaling table (see Figure 3-12) should be adjusted accordingly.

The alarm thresholds are adjusted in the fields on the left. The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 4.75 V.

A filter time constant (“ECT INPUT FILTER”) can be entered to filter noise from the input signal.

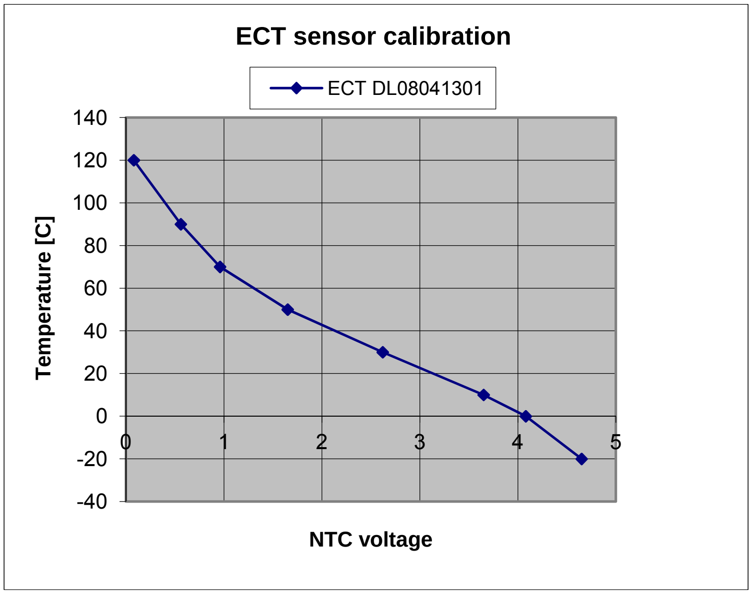


Figure 3-12. ECT Sensor Voltage vs Temperature (°C)

Lube Oil Pressure (LOP) Signal Input

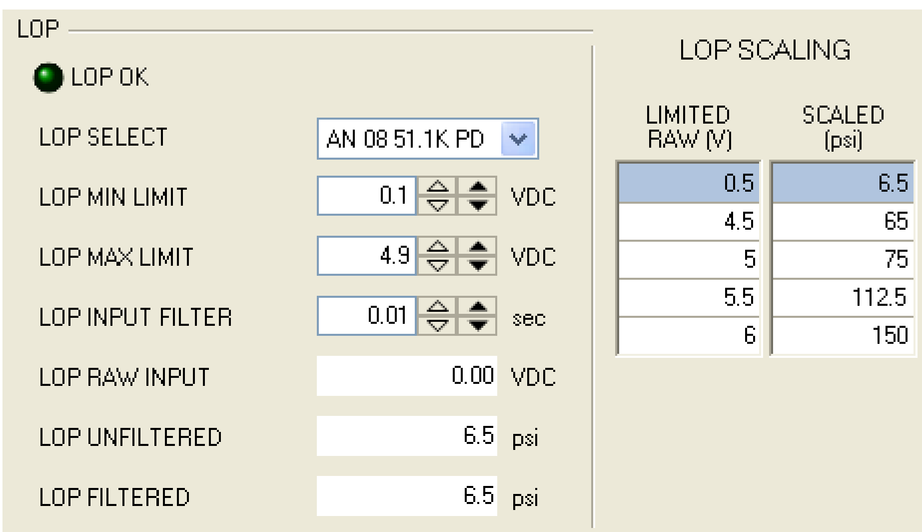


Figure 3-13. LOP Signal Configuration (HMI Screen 6.10)

In Figure 3-13 the HMI settings for user configuration of the lube oil pressure sensor are shown. To enable the LOP sensor input select one of the options in the drop down box at the upper center of the figure, other than “NOT USED”. In the table on the right the input voltage versus the LOP scaling is configured. Also a filter time constant can be entered to filter noise from the input signal.

The alarm thresholds are adjusted in the fields on the left. The default value for low voltage alarm threshold is 0.25 V and for the high voltage alarm threshold is 4.75 V. If the sensor voltage is out of range, this will result in an alarm or engine shutdown, depending on configuration (see Alarm/Shutdown Configuration in Chapter 4).

Speed Bias Input

In Figure 3-14 the HMI settings for user configuration of the Speed bias signal are shown. To enable the speed bias sensor input select one of the options in the drop down box at the upper center of the figure, other than “NOT USED”. In the table on the upper right the voltage to speed bias scaling table is adjusted by the user. This input is designed to work with 0 to 5 V signals.

The default calibration for the bias is:
0.5 V – -90 rpm
4.5 V – +90 rpm

The alarm thresholds are adjusted in the fields on the left. The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 4.75 V.

A filter time constant (“SPEED BIAS INPUT FILTER”) can be entered to filter noise from the sensor input signal.

NOTICE	**The input should be galvanically isolated from external voltage signals to avoid ground loops and wrong indications.**

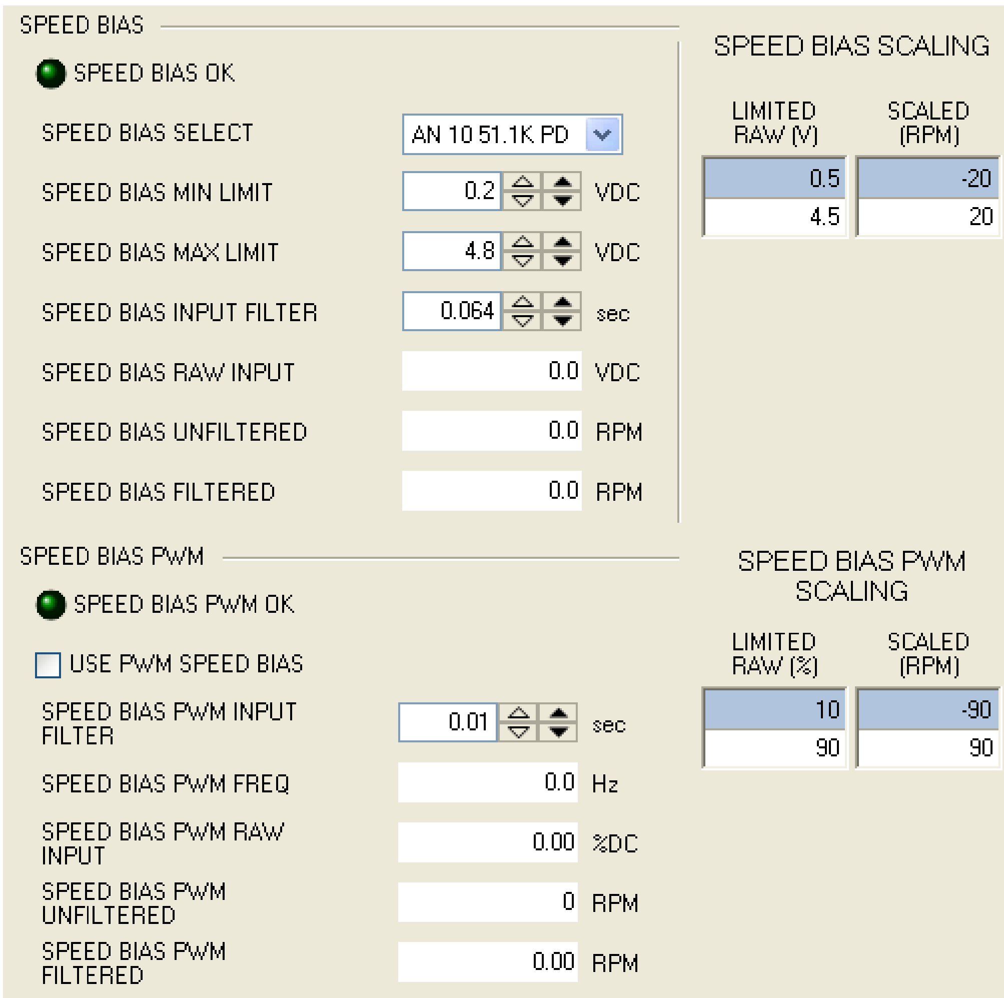


Figure 3-14. Speed Bias Signal Configuration (HMI Screen 6.11)

Optionally, a PWM input can be used for speed bias. To enable the PWM Speed Bias place a check mark in the USE PWM SPEED BIAS value. In the table on the lower right the % duty cycle to speed bias scaling table is adjusted by the user. This input is designed to work with PWM signals.

A filter time constant ("SPEED BIAS PWM INPUT FILTER") can be entered to filter noise from the PWM input signal.

Fuel Trim Position Feedback (FTPS) and Actuator Throttle Position Feedback (TPS) Signal Input

In Figures 2-15(a) and 2-15(b) the HMI settings for user configuration of the TPS signals are shown. Calibration is performed on a different screen (described below).

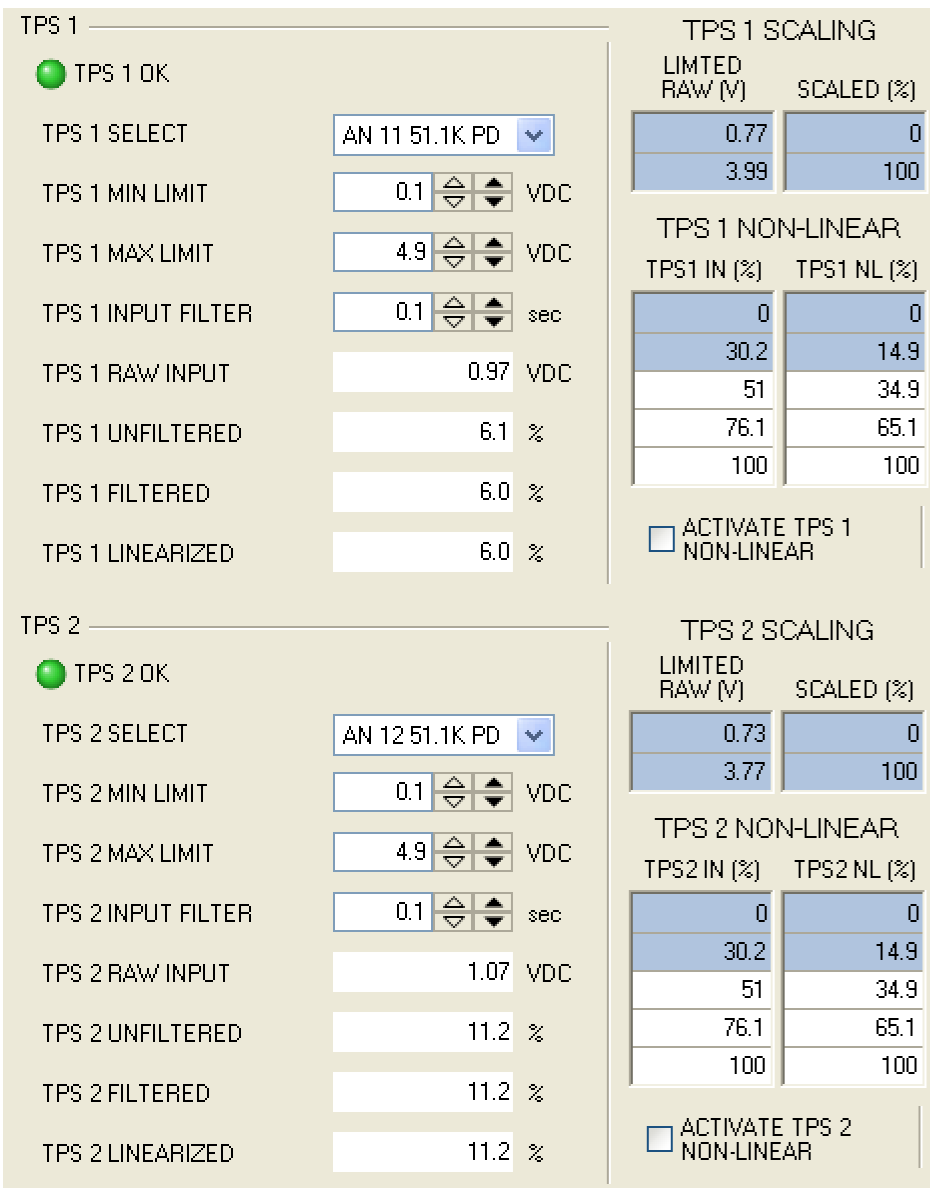


Figure 3-15a. TPS 1 & TPS 2 Signal Configuration (HMI Screen 6.8)

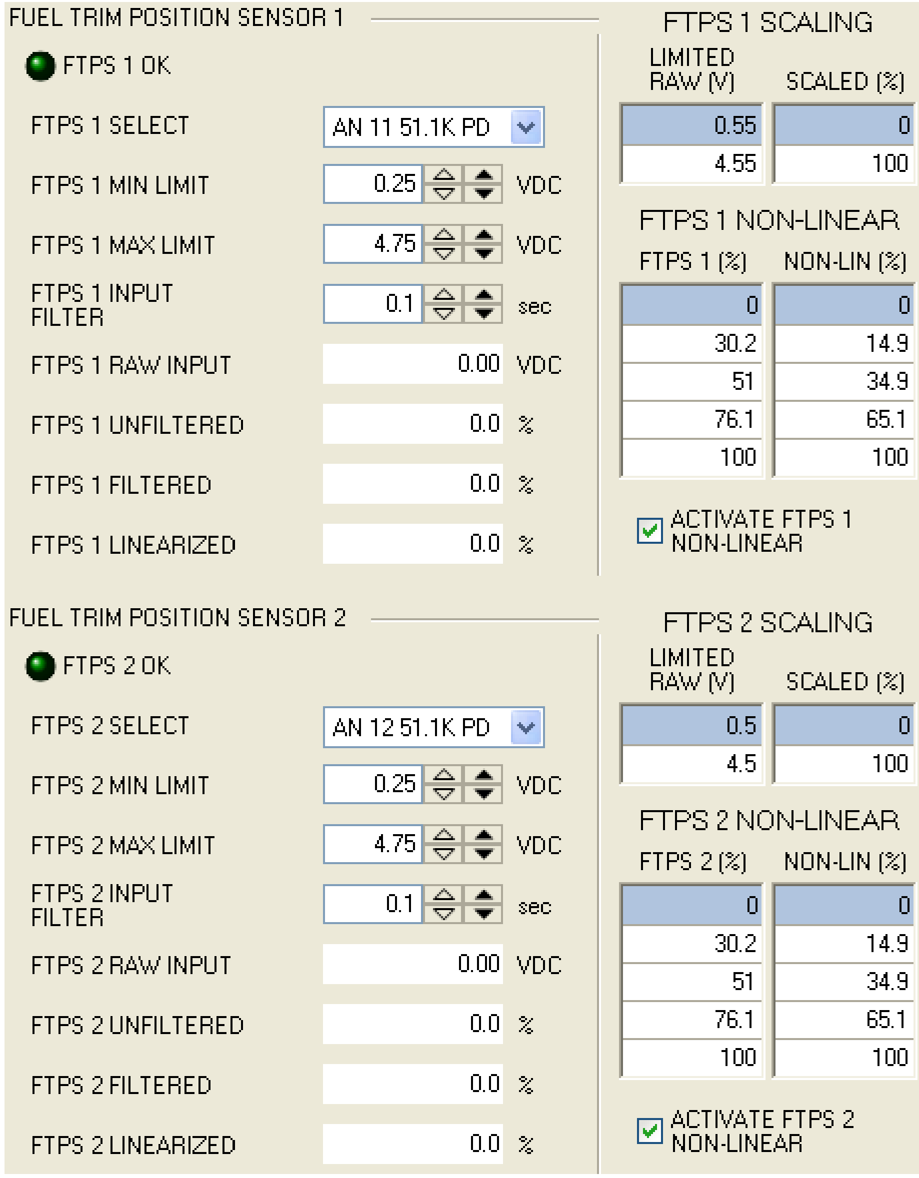


Figure 3-15b. FTPS 1 & FTPS 2 Signal Configuration (HMI Screen 6.8)

The TPS feedback signal is optional for throttle actuators. To enable TPS 1, TPS 2, FTPS 1, and/or FTPS 2, and configure their function and input selection, make the appropriate selections in the drop-down boxes beside “TPS 1 SELECT”, “TPS 2 SELECT”, “FTPS 1 SELECT” and “FTPS 2 SELECT”. In the tables to the right of the respective figures the TPS 1 – FTPS 2 voltage-to-position scaling tables are adjusted by the user.

The TPS feedback signal can be used in conjunction with a J1939-controlled actuator if desired.

The alarm thresholds are adjusted in the corresponding “MIN LIMIT” and “MAX LIMIT” fields. The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 4.75 V.

A filter time constant (“TPS x INPUT FILTER”) can be entered to filter noise from the input signal.

Throttle & Trim Valve Actuator Calibration

Figure 3-16 depicts the HMI settings for throttle and trim valve calibration and testing (Throttle 1 shown for example).

The following instructions for calibration of the actuator are also included on the HMI screen for reference.
This procedure is applicable to PWM duty cycle controlled actuators only, not J1939 serial communications controlled actuators.

The J1939 CAN throttles have internal calibration, however minimum and maximum stroke should be verified though the control using the steps on the PWM Throttle Actuator Calibration Procedure (NOT using TPS) to stroke the valve.

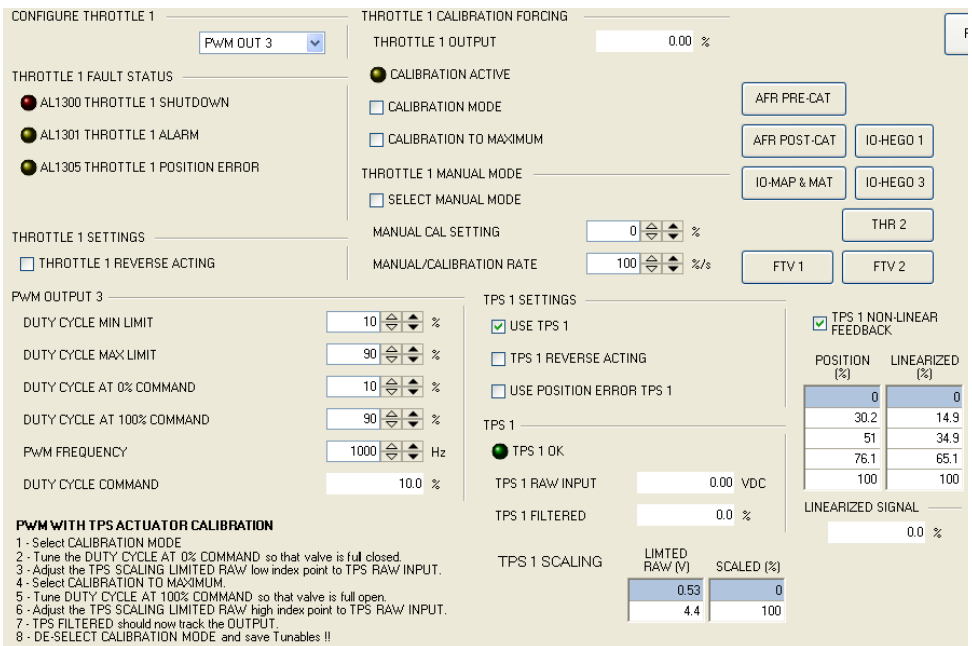


Figure 3-16. Throttle Actuator Calibration (HMI Screen 6.2)

PWM Throttle Actuator Calibration Procedure (using TPS)

1. Select “CALIBRATION MODE” (upper right of figure)
2. Tune the “DUTY CYCLE AT 0% COMMAND” so that the valve is mechanically fully closed. This should be checked visually on the valve if possible. Record the TPS voltage on the HMI and tune the “TPS at minimum.” value to this voltage.
3. Adjust the TPS SCALING LIMITED RAW low index point to TPS RAW INPUT.
4. Select “CALIBRATION TO MAXIMUM”
5. Tune the “DUTY CYCLE AT 100% COMMAND” value so that the valve is just mechanically fully open. This should be visually checked on the valve if possible.
6. Adjust the TPS SCALING LIMITED RAW high index point to TPS RAW INPUT.
7. TPS Filtered should now track the OUTPUT.
8. De-select “CALIBRATION MODE” and save settings.

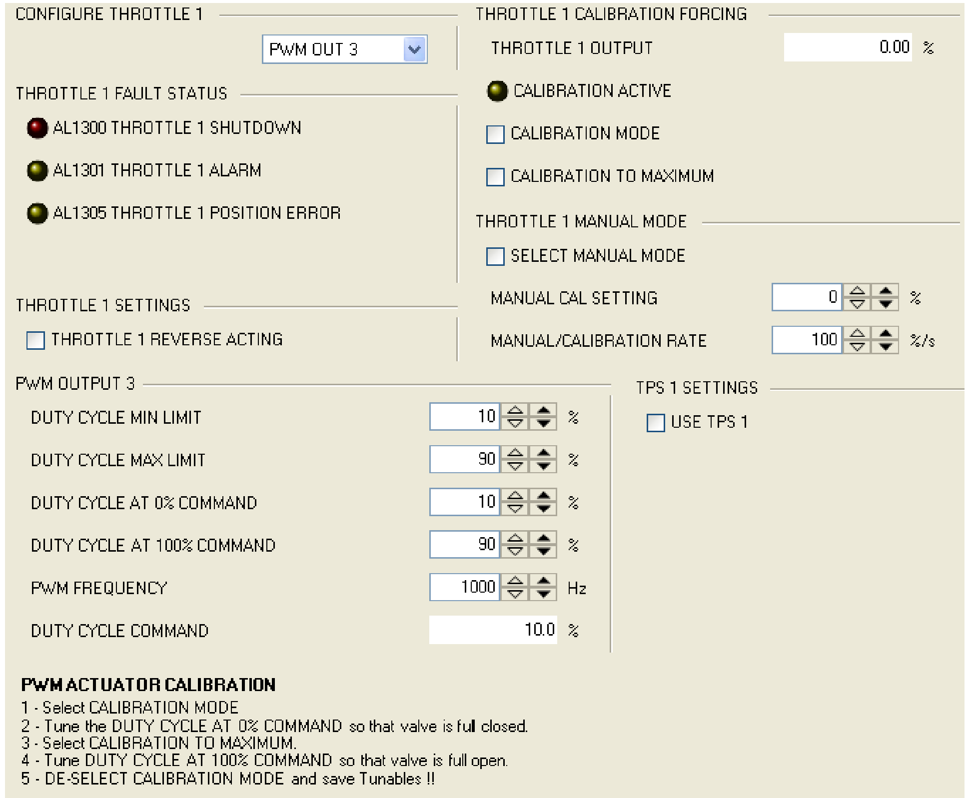


Figure 3-17. Throttle Actuator Calibration (HMI Screen 6.2)

PWM Throttle Actuator Calibration Procedure (NOT using TPS)

1. Select “CALIBRATION MODE” (upper right of figure)
2. Tune the “DUTY CYCLE AT 0% COMMAND” so that the valve is mechanically fully closed. This should be checked visually on the valve if possible.
3. Select “CALIBRATION TO MAXIMUM”
4. Tune the “DUTY CYCLE AT 100% COMMAND” value so that the valve is just mechanically fully open. This should be visually checked on the valve if possible.
5. De-select “CALIBRATION MODE” and save settings.

Lube Oil Temperature (LOT) Signal Input

In Figure 3-18 the HMI settings for user configuration of the LOT signal are shown. To enable the LOT sensor input select one of the options in the drop down box at the upper center of the figure, other than “NOT USED”. In the table on the right the voltage to temperature scaling table is adjusted by the user. The input is designed to work with 0 to 5 Volt signals and requires a resistor type sensor connected to ground. Note that the sensor works as a resistor in a voltage dividing circuit inside the PCM128-HD. The correct voltage as a function of temperature can be calculated with the following formula:

$$\left(Voltage\_at\_input = \frac{Rthermistor}{Rthermistor + 2210} * 5V\right)$$

The calibration for the Woodward LOT sensor DL08041301 is given in the table below and shown graphically in Figure 3-19).

Ohms	Temp °C	Voltage at E3 Input
204	100	0.42
275	90	0.55
376	80	0.73
526	70	0.96
746	60	1.26
1081	50	1.64
1598	40	2.10
2417	30	2.61
3717	20	3.14
5969	10	3.65
9795	0	4.08
29124	-20	4.65

Table 3-3. LOT Signal Configuration (HMI Screen 6.10)

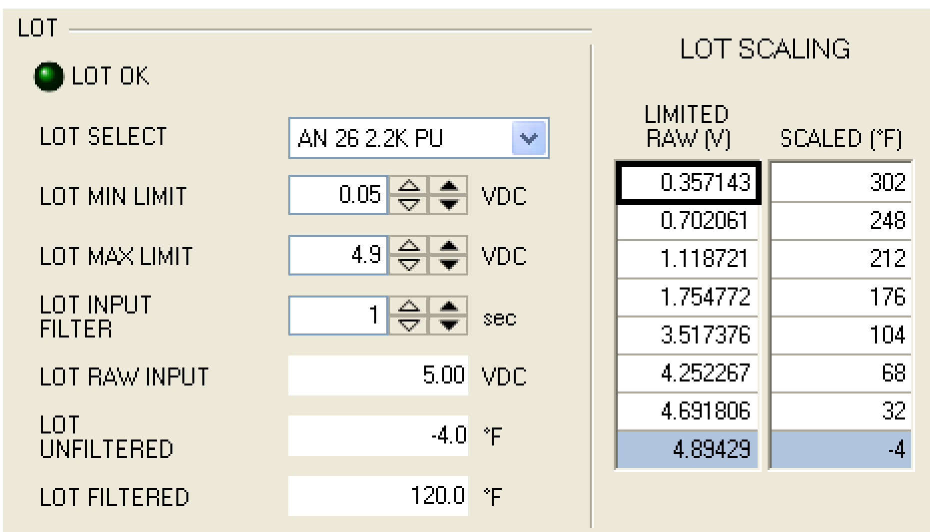


Figure 3-18. LOT Signal Configuration (HMI Screen 6.10)

If a sensor with a different scaling is used, the scaling table (see Figure 3-19) should be adjusted accordingly.

The alarm thresholds are adjusted in the fields on the left. The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 4.75 V.

A filter time constant (“LOT INPUT FILTER”) can be entered to filter noise from the input signal.

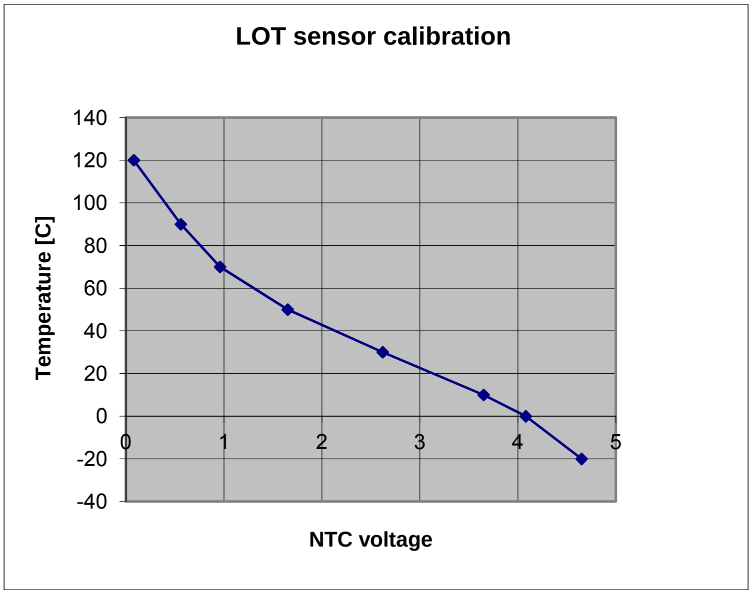


Figure 3-19. LOT Sensor Voltage vs Temperature (°C)

HEGO Sensors

The E3 Stoichiometric Control system uses Woodward StableSense™ HEGO Sensors (Woodward part number 1689-1697). The HEGO sensor measures the amount of oxygen in the exhaust gas. This measurement is then used to control the air/fuel ratio.

The system uses one or more pre-Catalyst HEGO Sensors and one Post-Catalyst HEGO Sensor.

Figure 3-20 depicts the HMI settings for user calibration of HEGO 1 sensor input filter time constant and heater settings.

Fault thresholds are adjusted for the sense cell and Heater Current and are depicted in Figure 3-21. The default value for sense cell voltage low alarm threshold is 1 mV and for the voltage high alarm threshold is 1050 mV. The default value for window alarm threshold is 440 m V and for the window high alarm threshold is 480 mV.

The GRACE PERIOD value delays the HEGO faults until the time entered has elapsed. This gives the sensor time to heat up and read properly. If a sensor fault is detected after the GRACE PERIOD expires, a fault is latched and the control is placed in the appropriate mode.

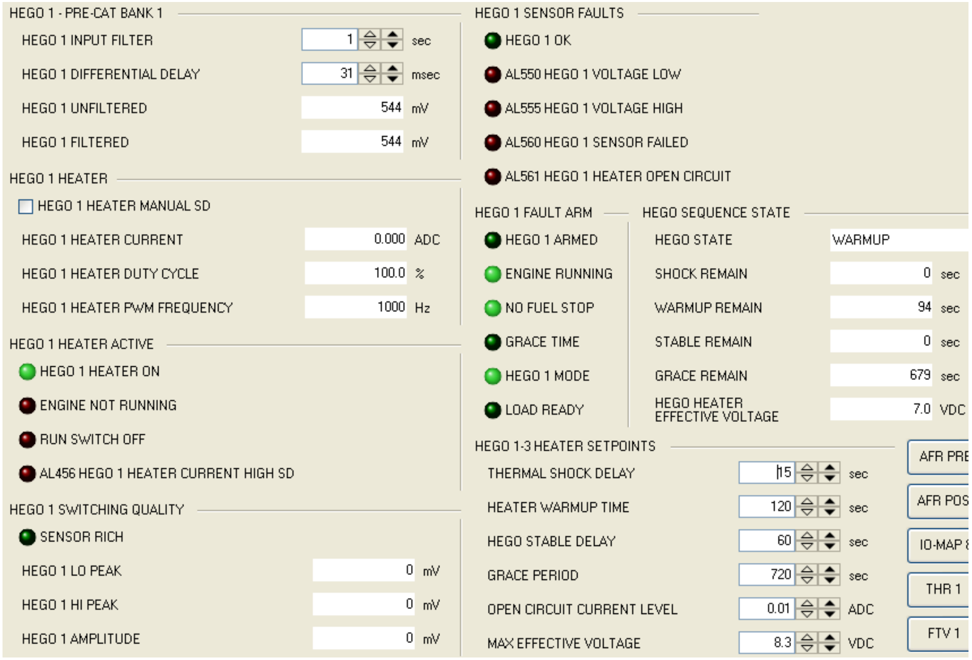


Figure 3-20. StableSense HEGO Sensor Settings (HMI Screen 6.14)

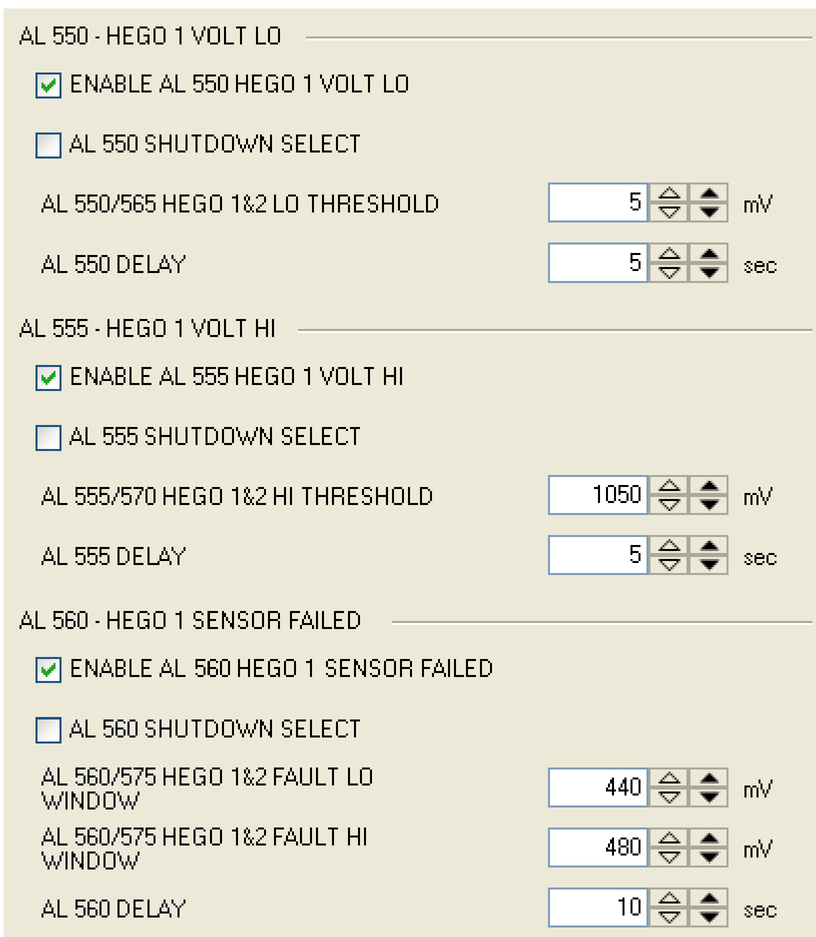


Figure 3-21. HEGO 1 Fault Thresholds (HMI Screen 7.11)

Air Fuel Ratio Bias Input

In Figure 3-22 the HMI settings for user configuration of the air-fuel ratio (AFR) bias signal are shown. To enable the AFR Bias Input select one of the options in the drop down box at the upper center of the figure, other than “NOT USED”. In the table on the right the AFR INDEX to mV scaling table is adjusted by the user. This input is designed to work with 0 to 5 V signals. The default calibration for the bias is NO BIAS.

The alarm thresholds are adjusted in the fields on the left. The default value for low alarm threshold is -0.10 V and for the high alarm threshold is 5.1 V.

A filter time constant (“POT INPUT FILTER”) can be entered to filter noise from the sensor input signal.

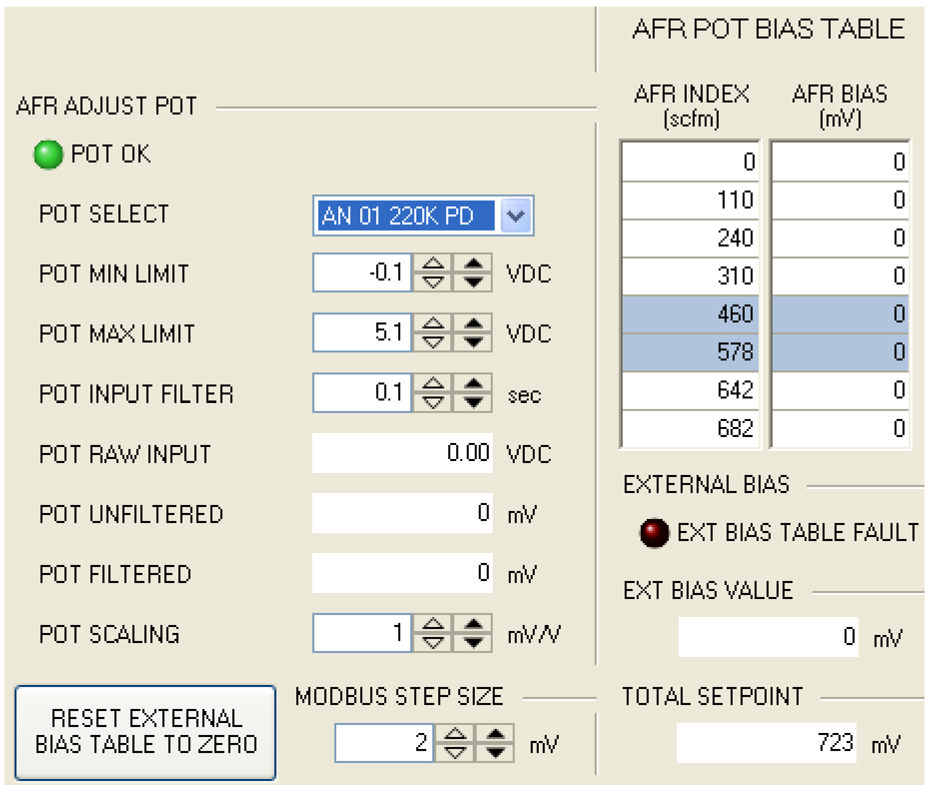


Figure 3-22. AFR Bias Signal Configuration (HMI Screen 6.11)

Air/Fuel Ratio (AFR) Control

Open Loop Trim Valve Control

Trim valve open loop control uses a trim valve lookup table to control the fuel to the engine. There is no feedback such as a HEGO sensor. The HMI settings for open loop trim valve control are shown in Figure 3-23.

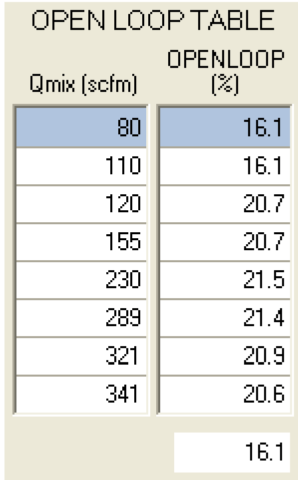


Figure 3-23. Trim Valve Open Loop Table (HMI Screen 1.1)

Air-Fuel Ratio Closed Loop Control

The HMI settings for open loop trim valve control are shown in Figure 3-24. The air-fuel ratio (AFR) closed loop control uses a heated exhaust gas oxygen (HEGO) sensor to determine the actual AFR and it compares this to the AFR setpoint.

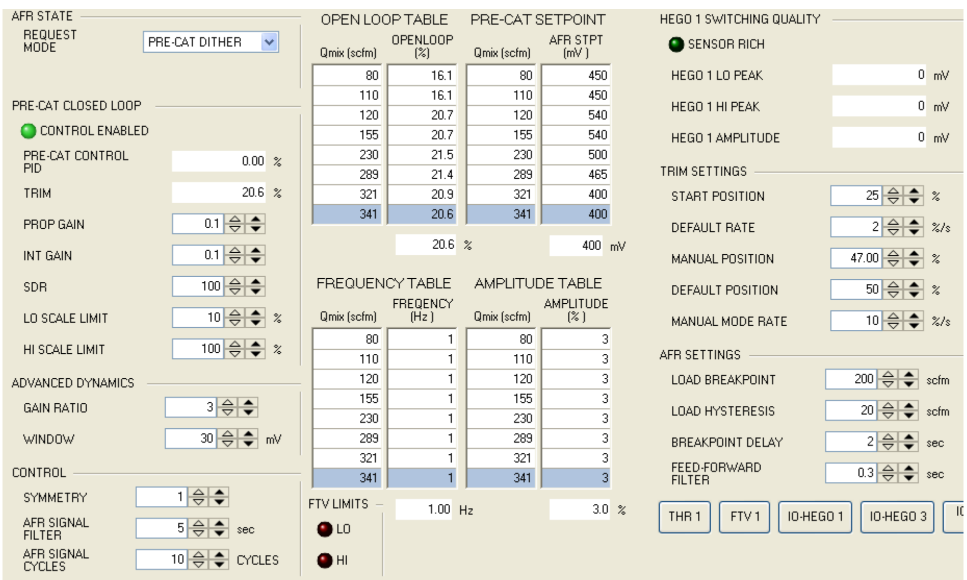


Figure 3-24a. AFR Pre-Cat Mono Settings (HMI Screen 1.1)

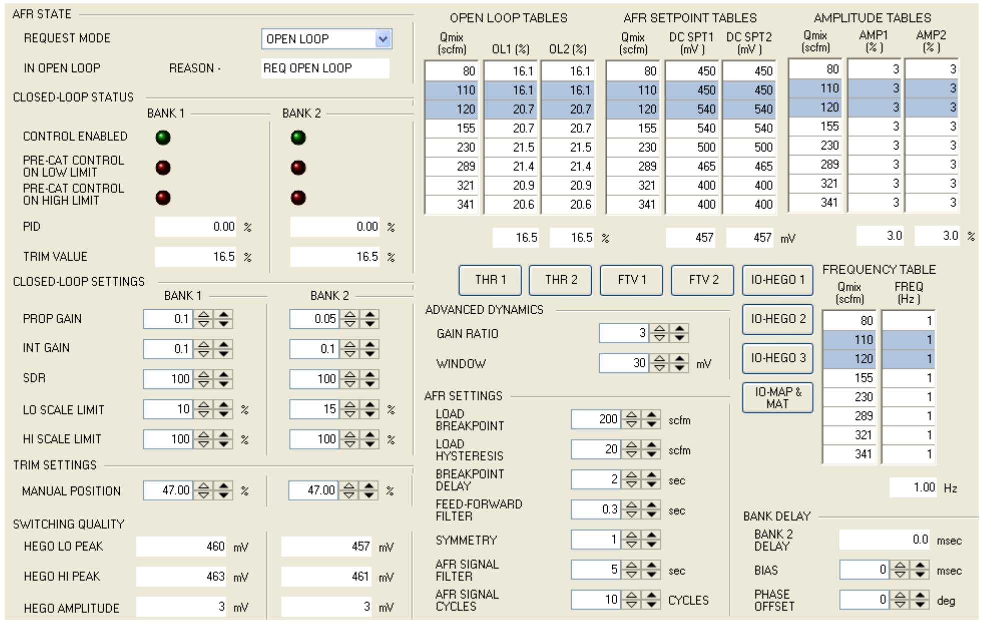


Figure 3-24b. AFR Pre-Cat Stereo Settings (HMI Screen 1.1)

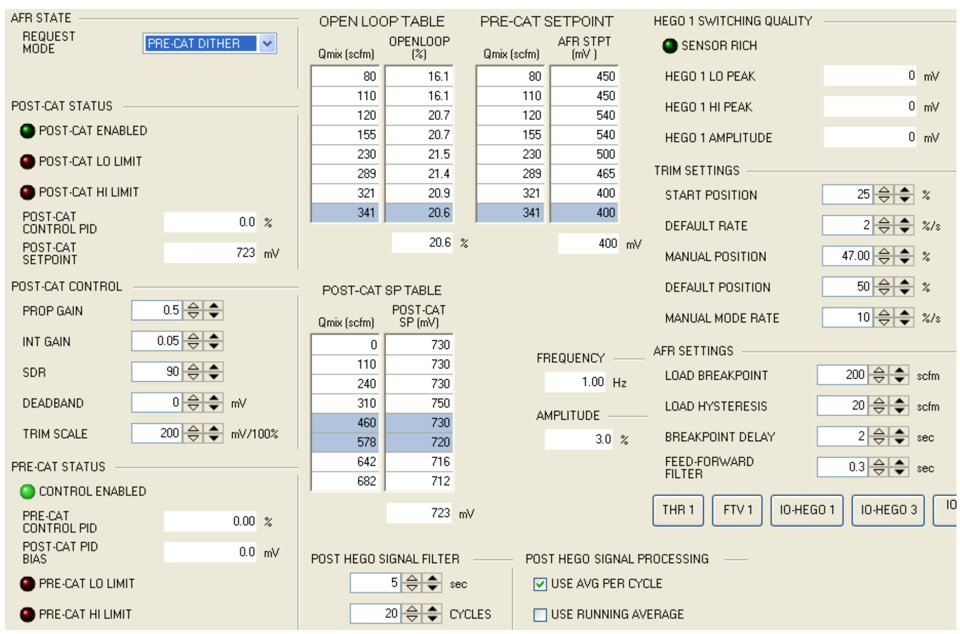


Figure 3-25a. AFR Post-Cat Mono Settings (HMI Screen 1.2)

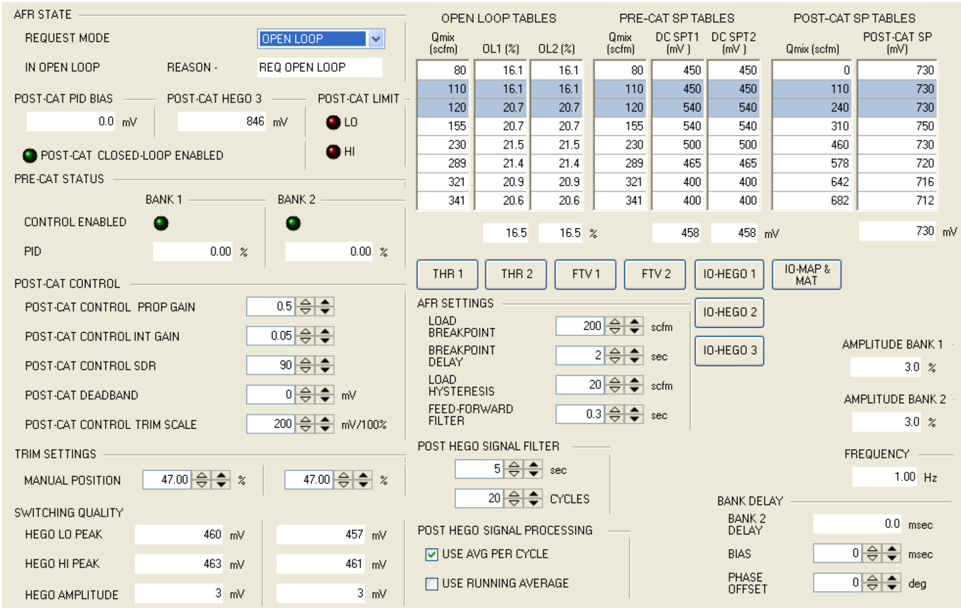


Figure 3-25b. AFR Post-Cat Stereo Settings (HMI Screen 1.2)

Speed/Load Control

The Speed and Load Control functions use PID logic. In all speed applications or in generator applications without load (generator breaker open) or with load but in island mode (generator breaker closed, but grid breaker open) the control uses a speed reference and the actual engine speed as inputs for the PID. When in grid mode (both the generator breaker and the grid breaker are closed and “USE E3 INTERNAL BASE LOAD CONTROL” is selected on HMI screen 7.0), a load set point and the actual measured mechanical load are the inputs for the PID.

Speed Sensing

In speed control mode, the actual speed of the engine needs to be accurately measured. The raw speed signal enters the software as a frequency and is converted into engine speed (rpm).

Figure 3-26 shows the HMI settings for user configuration of the engine speed signals.

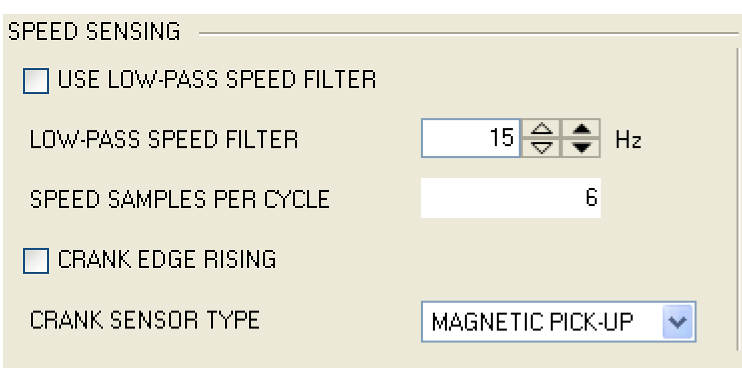


Figure 3-26. Speed Sensing Configuration (HMI Screen 7.3)

This speed signal is filtered with a second order low-pass filter, with a tunable cutoff frequency. This tunable value has a range of 0.01 to 16 Hz (unfiltered) and a default of 15 Hz.

Filtering should be kept to a minimum to minimize lag, i.e. the cutoff frequency constant should be as large as possible.

Speed Reference

The HMI basic configuration settings for speed control are shown in Figure 3-27.

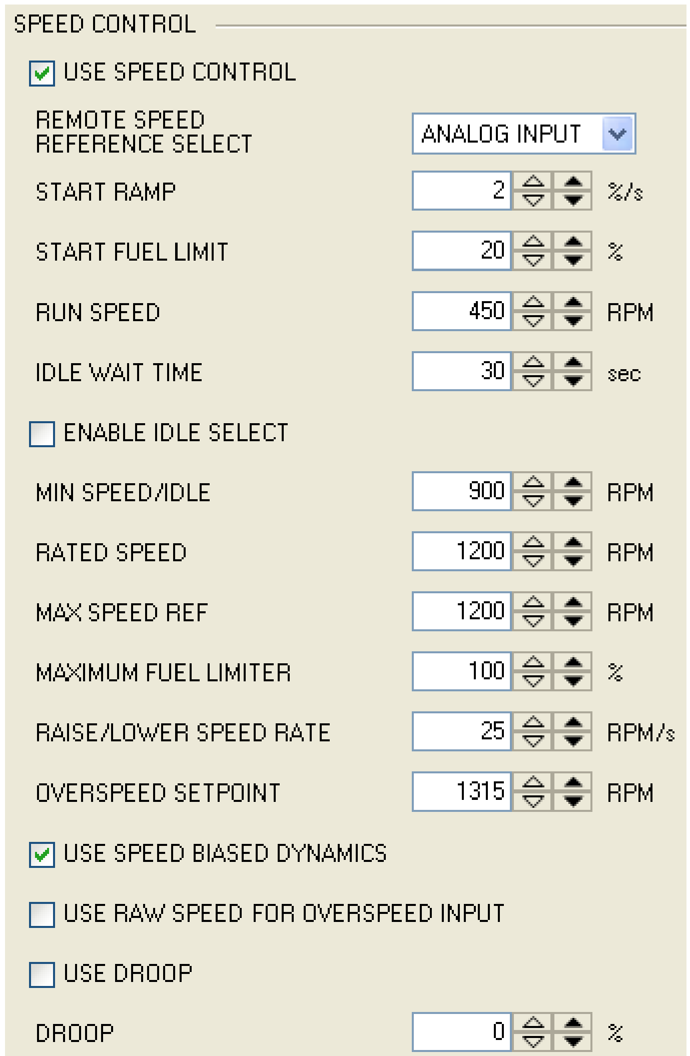


Figure 3-27. Speed Control Settings (HMI Screen 7.2)

The control provides two Speed Reference modes: Generator Mode and Mechanical Drive Mode.

Generator Mode

The speed reference can be changed by the speed Lower/Raise contacts, the 0-5 Vdc Speed/Load reference input, the 0–5 Vdc Speed Bias Input, the PWM Speed Bias Input, Modbus command, or biased via CAN from an easYgen.

On start, the speed reference will run at “Minimum Speed ref/Idle” and remain for a tunable warm-up delay time. Once this timer expires the reference will ramp up to the tunable rated speed at the Accel/Decel Rate.

When the reference is ramping from Idle to Rated and the raise or lower discrete input is activated, the reference will stop the automatic ramp to rated and hold at that set point. The reference then can be adjusted using the raise or lower inputs at the Raise/Lower rates.

Idle Speed
Idle speed is selected under any of the following conditions: During the Idle warm-up; discrete input Idle/Rated is active; when the engine is stopped; engine speed is below the user input value for “Run Speed” AND the generator breaker is open.

Rated Speed
Rated speed is selected under any of the following conditions: Idle speed is reached and Idle delay/warm-up timer is expired; Generator breaker is closed and the “Droop Mode” tunable is FALSE (isochronous mode); Generator breaker Opens.

Raise and Lower Inputs
The manual speed adjustments are active when the generator breaker input is open and the idle delay timer has expired. When the Lower input is active, the speed reference ramps to “Minimum Speed ref/Idle” at the “Raise/Lower Speed Rate”. When the Raise input is active, the speed reference ramps to “Maximum Speed ref” at the “Raise/Lower Speed Rate”.

Remote speed setting
Remote speed setting, the reference will ramp at the Raise/Lower ramp rate while the remote speed setting is active. If either of the remote input fault alarms activate, the reference will hold at the last value just before the fault was detected. The speed reference can then only be adjusted with the raise and lower inputs until the signal is restored and faults cleared.

Droop Mode - Generator Application Only
It is possible to run the control in droop mode. To do this, the engine needs to be synchronized to the grid by using raise or lower speed inputs or the speed bias and closing the utility breaker.

The control needs to remain in Speed control mode (utility breaker open).

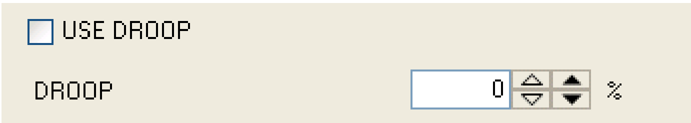


Figure 3-28. Droop Settings (HMI Screen 7.2)

Droop Mode with Dual Dynamics (using Dynamics 1 and Dynamics 2)
Figure 3-28 shows the HMI settings for droop mode with dual dynamics. In this mode the generator breaker position is monitored. To make possible switching between Dynamics 1 and Dynamics 2 in droop mode, the generator breaker input must be connected and the checkbox "Droop Mode (Dual Dynamics)" must be checked. The following methods can be used to change the speed reference in this mode: Raise/Lower discrete contacts, the speed bias input when configured correctly and the Remote speed reference input. A suggested starting load droop percentage is 5%.

In this mode the speed reference is not set to rated when the breaker closes, there is only a reset to rated when the breaker opens (allowing different grid frequencies and improved load rejection performance).

Mechanical Drive Mode

In mechanical drive mode the speed reference can be changed between user specified limits for minimum and maximum speed via the Lower/Raise contacts, the 0–5 Vdc Speed/Load reference input, or Modbus command.

On start, the speed reference will run at "Minimum Speed ref/Idle" and remain at that speed until the Raise or Remote input is activated.

Speed Raise and Lower Inputs
The manual speed adjustments are active after the idle delay timer has expired. When the Lower input is active, the speed reference ramps to "Minimum Speed ref/Idle" at the "Raise/Lower Speed Rate". When the Raise input is active, the speed reference ramps to "Maximum Speed ref" at the "Raise/Lower Speed Rate".

Remote speed setting
The remote Speed/Load reference is selected by closing both the Lower and Raise contacts.

The reference will ramp at the Raise/Lower ramp rate while the remote speed setting is active.

If either of the remote input fault alarms activate, the reference will hold at the last value just before the fault was detected. The speed reference can then only be adjusted with the raise and lower inputs until the signal is restored and faults cleared.

Remote speed setting is selected when all of the following conditions are simultaneously met: Raise and lower inputs are both active for more than 2 seconds; Idle delay timer has expired; the remote input limit alarms are both inactive.

Load Sensing

Load sensing requires an external signal. *See Load Input* on Page 6 for information about configuring this signal. In the software the signal is converted to a kW signal. Optionally, if the easYgen J1939 is activated the measured load will be received over the J1939 network from easYgen 3100/3200.

Load Control

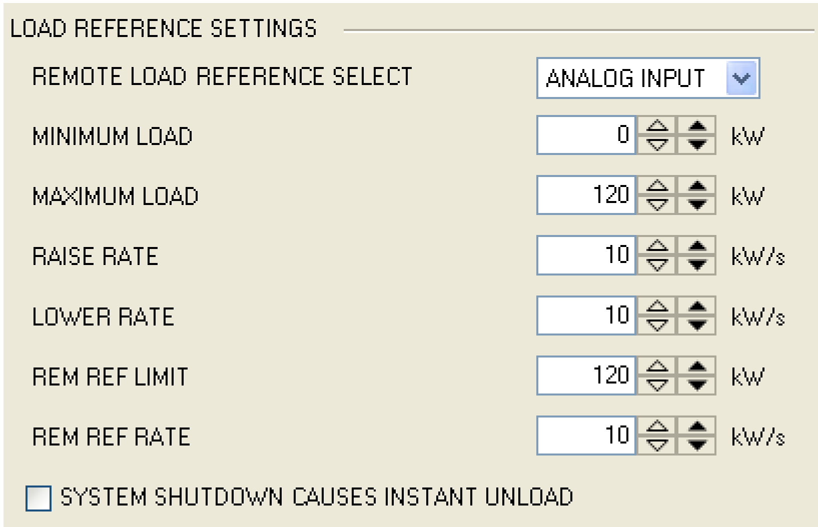


Figure 3-29. Load Control (Grid Mode) Settings (HMI Screen 7.2)

Figure 3-29 shows the HMI user settings for Load Control (Grid Mode). The load reference is active only when in load control (grid) mode, i.e. when the generator breaker and utility breaker discrete inputs are both closed. The load reference can then be changed with the raise and lower inputs, or with the remote load reference input if enabled and active. See *Remote Speed/Load Reference Input* on Page 5 for information about configuring this signal.

When running in Load Control (Grid mode) mode, the plant/island electrical bus is connected to the grid via the utility breaker (both breaker feedback inputs are TRUE). When the engine is configured as a droop system in island mode (utility breaker open), this means that the Speed set point + Droop to PID will change depending on the droop percentage that is configured and the base load (island load) that is required. This speed set point will be lower than the rated speed set point. When the utility breaker is opened and the system goes into island mode, it depends on the island load what the resulting speed set point will be. It will be lower than the rated speed frequency but this also depends on the droop percentage and the actual island load.

For example: Droop % = 3%
Rated load = 1000 kW
Plant load = 300 kW
Rated Speed = 1500 rpm

When the engine runs in Load Control (Grid mode) mode with both the utility and generator breaker closed the total load is 1000 kW (300 kW island load + 700 kW exported to the grid). With 3% droop, this gives a resulting speed set point of 1500 – 30 = 1470 rpm. The control measures the new actual plant load of 300 kW. This gives a new speed set point of 1500 – 9 = 1491 rpm. To get to the rated speed set point, the operator needs to raise the speed setting manually. When more engines are connected to the plant and configured as droop system, an equal droop percentage for all engines is required to divide the load in the above-mentioned situation. When only one engine is on the plant bus, it is better to configure 0% droop (isochronous operation), so no speed change is seen when switching from Load Control (Grid mode) to speed control.

Load Raise and Lower Inputs
The manual Raise & Lower Discrete Input load adjustments are active when in Load Control mode and the Remote Input is not active AND easYgen CAN J1939 is NOT enabled. When the Lower input is active, the load reference ramps to “Minimum Load” at the “Load Lower Rate”. When the Raise input is active, the load reference ramps to “Maximum Load” at the “Load Raise Rate”.

Remote load setting
The Load reference will ramp at the Remote ramp rate while the remote load setting is active. The max remote reference is limited based on a tunable REM REF LIMIT in Toolkit. If either of the remote input fault alarms activate, the reference will hold at the last value just before the fault was detected. The load reference can then only be adjusted with the raise and lower inputs until the signal is restored and faults cleared.

Remote load setting is selected when all of the following conditions are simultaneously met:
Load Control is active
Raise and Lower inputs are both active for more than 2 seconds
easYgen CAN J1939 is NOT enabled
The remote input limit alarms are both inactive.
The discrete input Idle/Rated is not active (rated)+

EasYgen remote load setting overrides the remote input when all of the following conditions are simultaneously met:
EasYgen CAN J1939 is enabled
Watch dog fault for easYgen is FALSE

PID Control

The PID controller compares the actual value with the set point. When the actual value is higher than the set point the PID output will decrease, when the actual value is lower than the set point the PID output will increase. There are 3 different control settings that determine the dynamic behavior of the PID:

- Proportional Gain
- I-gain
- Derivative

The above-mentioned PID settings can be attributed to different time domains. The proportional action reacts on the present situation, the Integral action reacts on the past and the derivative action predicts what will happen and reacts on that.

The output of a PID controller will change in response to a change in measurement or set-point. Tuned PID combinations of proportional, integral, and derivative will provide the best type of process control required. Figure 3-30 shows the process response to a perturbation with different combinations of P, I, and D control. For a full explanation of PID control, refer to publication 83402.

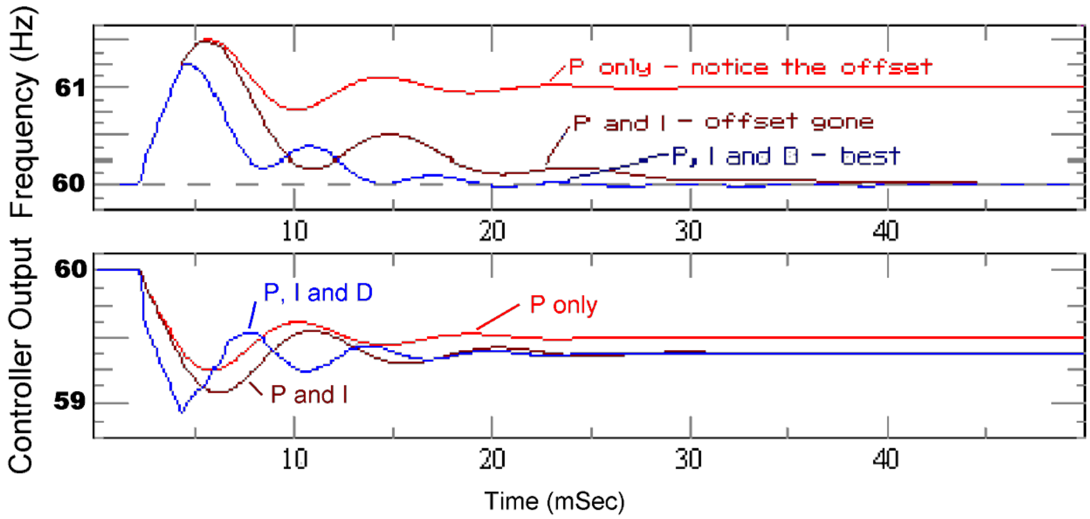


Figure 3-30. PID Response

Dynamic Settings Selection
The Speed and Load dynamics depend on operator selections and engine running modes. The following selections are made by the user:

Fixed dynamics or variable dynamics.
Variable dynamics have two options:
- Dynamics not depending on speed or load
- Dynamics depending on speed
- Dynamics depending on load
- Dynamics depending on speed and load

Fixed Dynamics
When fixed P, I, and D gains are selected in the SPEED CONTROL FIXED DYNAMICS HMI user settings (Figure 3-31), the selected fixed gains are independent of the run mode of the engine (generator breaker and utility breaker positions). Also the load and PID% have no influence on the selected fixed gains.

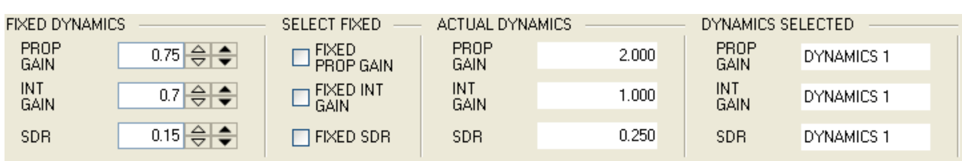


Figure 3-31. Fixed Dynamics Settings (HMI Screen 1.3)

Variable Dynamics
When the P, I, or D fixed gain is not selected, the corresponding variable gain curve will be active. These variable dynamics depend on the engine mode (generator breaker status and grid breaker status).

There are 3 different variable dynamics selections possible. Figure 3-32 shows the logic used for selecting dynamics in different operating modes. The 3 modes are:

- Dynamics 1 – Speed control mode (both the generator breaker and the grid breaker are open)
- Dynamics 2 – Island mode (the generator breaker is closed but the grid breaker is open) – Generator application only
- Dynamics 3 – Load Control (Grid mode) mode (both the generator breaker and the grid breaker are closed; the engine is parallel to the grid) – Generator application only

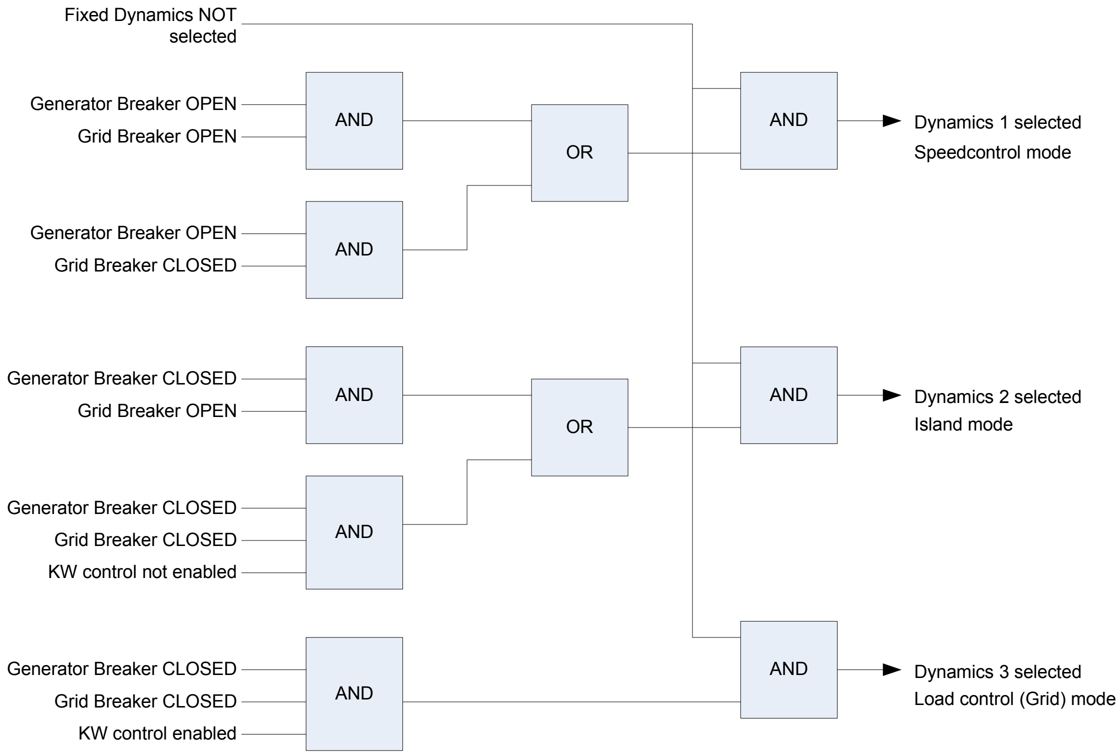


Figure 3-32. Dynamics Selection Logic

The Proportional Gain is a result of this formula:
P GAIN = Base Gain X Cold Gain Fraction X Speed Fraction X Gain Ratio

The Base Gain is developed in the table; the table indices are selectable from Q_{mix}, Throttle Command, or the Load Input. Dynamics 1 & 2 share the same index. Dynamics 3 Index uses kW input

The Cold Gain Fraction is developed based on the ECT measurement. When the ECT is at or below the COLD DYNAMICS TEMP, the Cold Gain Fraction is equal to the PROP GAIN FRACTION @COLD tunable. As the ECT increases the Cold Gain Fraction rises and is linearly interpolated. The Cold Gain Fraction levels out to 1.0 as the ECT rises to and above the WARM DYNAMICS TEMP.

The GAIN RATIO is activated when the absolute value of the speed error is greater than the Window Width. The Gain Ratio is then passed into the formula above.

When SPEED BIASED DYNAMICS is activated, the Prop gain and Int Gain are reduced by multiplying by a factor equal to: $\frac{\text{ACTUAL\_SPEED}}{\text{RATED\_SPEED}}$, the actual engine speed is bounded by IDLE SPEED and RATED SPEED.

In dynamics 3 mode (on grid) the Proportional Gain is determined through 1 curve block that receives its input from the generator load only.

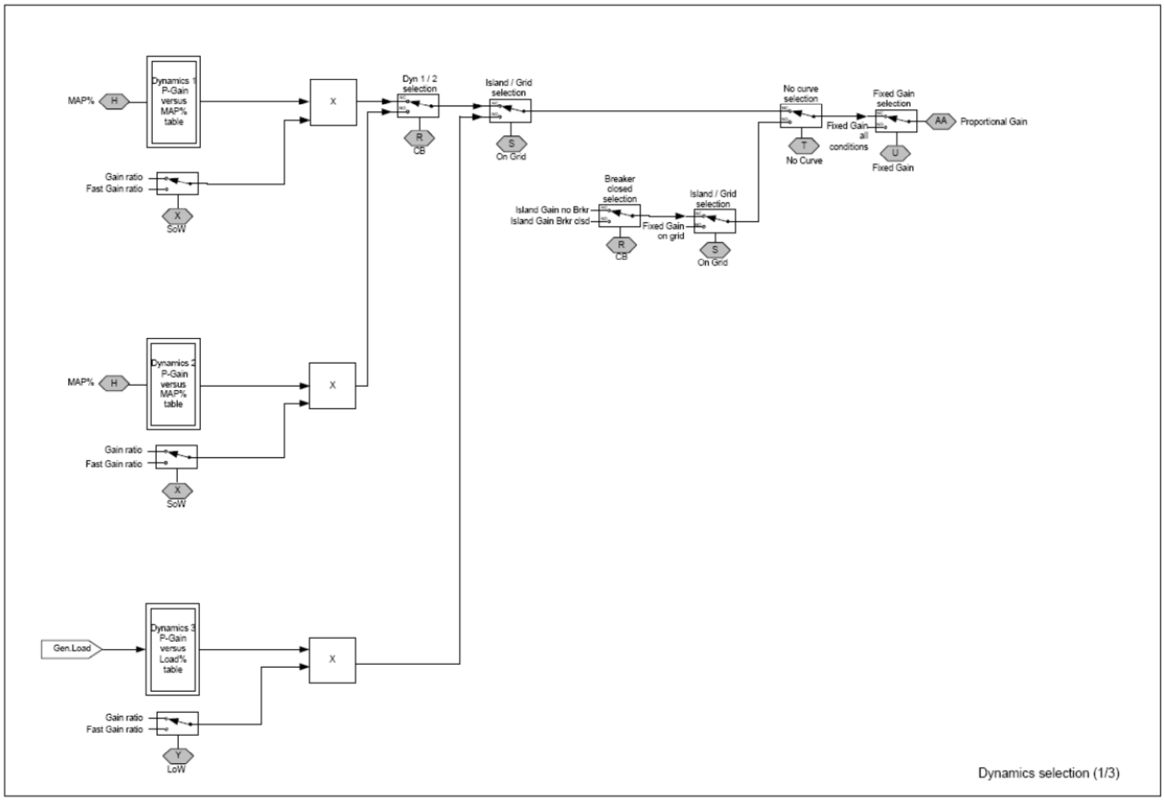


Figure 3-33. Proportional Gain Logic

As shown in Figure 3-34, the I-gain and SDR (Speed Derivative Ratio) do not use the ratio factor.

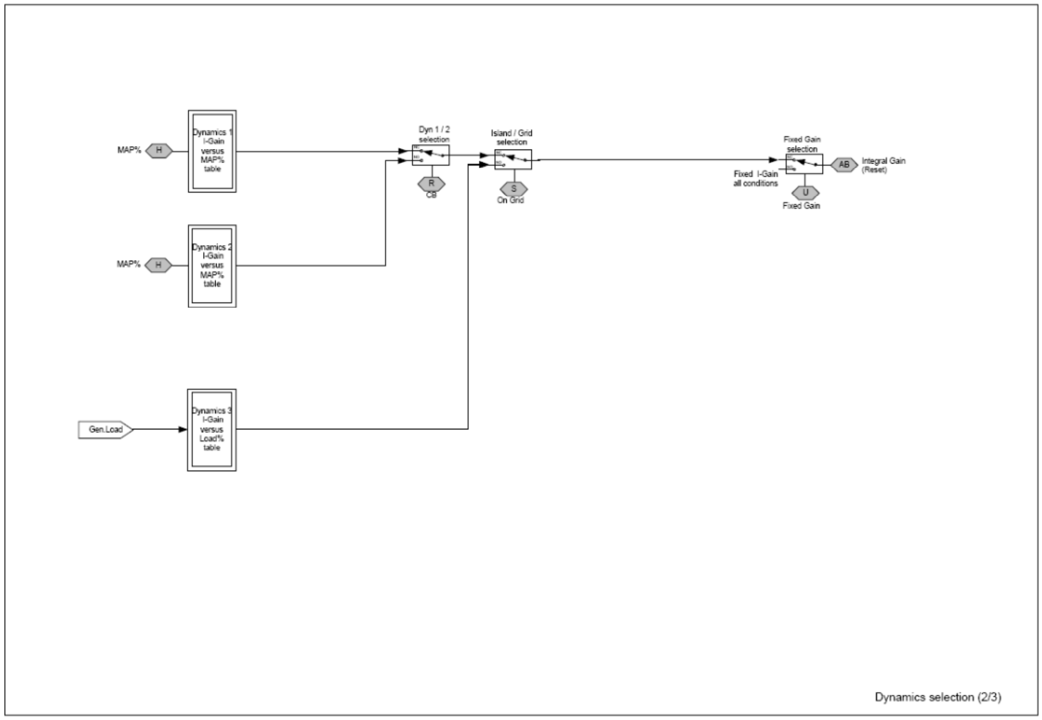


Figure 3-34. I-gain and SDR (Speed Derivative Ratio) Logic

Figure 3-35 shows the HMI user settings for Dynamics 1. The curves are tuned in the tables in the center. The resulting gains and SDR factor are shown in the fields on the right.

Similar settings are available for Dynamics 2, when the generator breaker is closed but the engine is still in speed control mode (Figure 3-36).

Figure 3-37 shows the HMI user settings for Load Control Dynamics. The ratio factor in V is based on a load error that is compared to an absolute load window.

The box beside “Enable KW Dynamics” needs to be checked to activate V. When this box is not checked the control will use Dynamics 2 regardless of the grid breaker status.

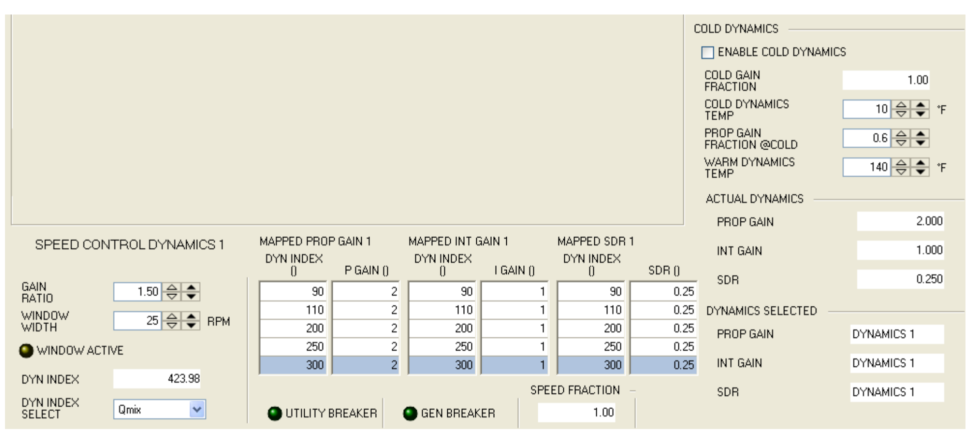


Figure 3-35. HMI settings for Dynamics 1 (HMI Screen 2.3)

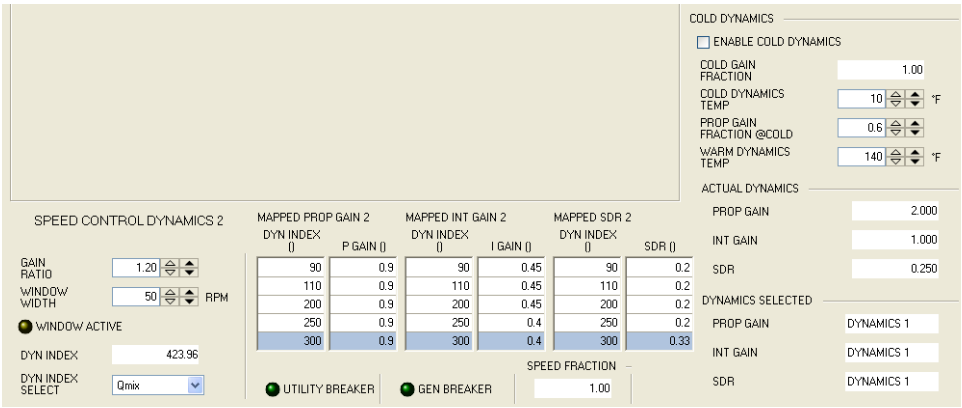


Figure 3-36. HMI settings for Dynamics 2 (HMI Screen 2.4)

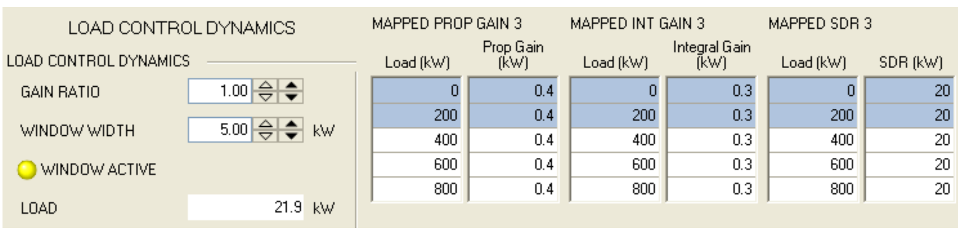


Figure 3-37. HMI Settings for Load Control Dynamics (HMI Screen 1.8)

Load Rejection Assist

Figure 2.40 shows the HMI settings for the Load Rejection Assist Function. The function is enabled by placing a check in the box “USE CIRCUIT BREAKER FEED-FORWARD” and/or “USE LOGICAL OVERSPEED”. This function applies a limit to the mixture throttle position for the duration specified in “REJECTION TIME DURATION”. The limit applied is the value specified in “”REJECTION THROTTLE POSITION”. Triggering of this function occurs when a generator breaker transition from closed to open is detected (if circuit breaker feed-forward is selected) and/or when measured engine speed reaches the “LOGICAL OVERSPEED LEVEL” (if logical overspeed level is selected). This function is disabled when measured manifold pressure is below the value specified in “REJECTION MAP THRESHOLD”.

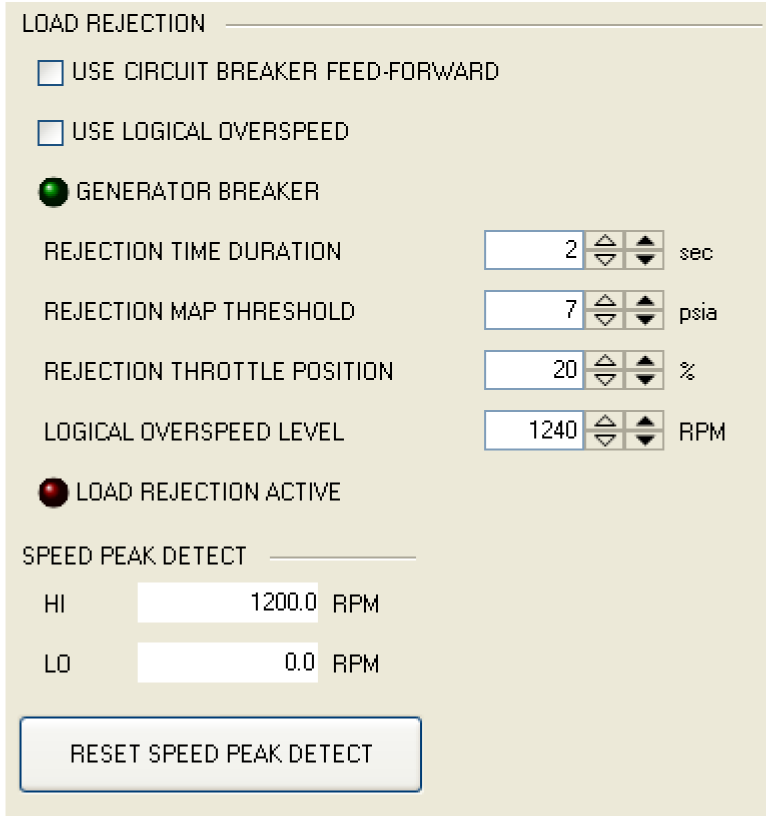


Figure 3-38. HMI Settings for Load Rejection Assist (HMI Screen 1.6)

Start Settings

Figure 3-39 shows the HMI settings for engine starting. The individual parameters are adjusted by the user to achieve desired results, as follows.

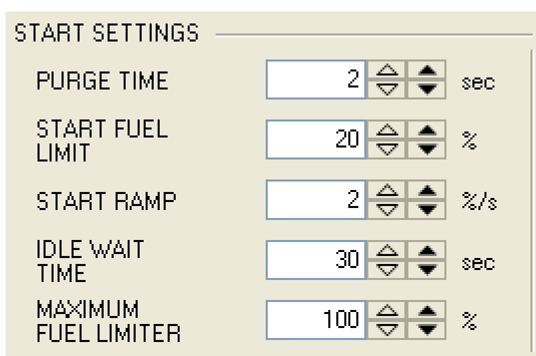


Figure 3-39a. Engine Start Settings (HMI Screen 2.0)

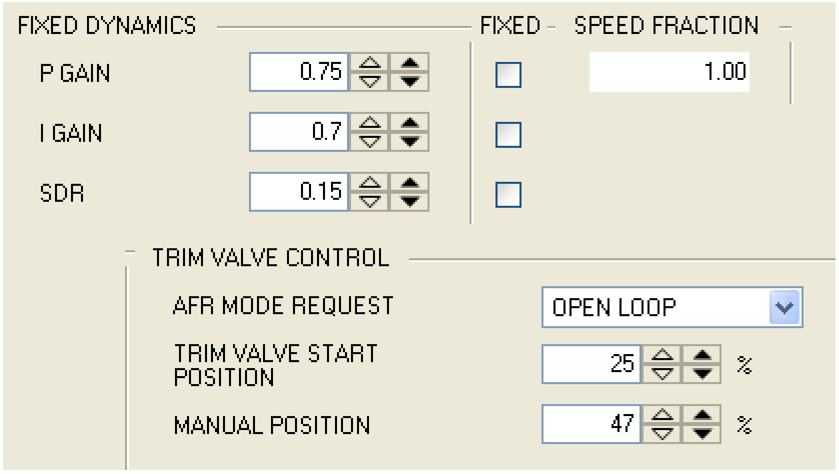


Figure 3-39b. Engine Start Settings (HMI Screen 2.0)

PURGE TIME – the desired length of time during engine cranking between detection of engine rotation and enabling fuel delivery. This allows the engine to be purged with air to provide for a safe startup condition. If an external ignition system is used, the main gas shutoff valve signal should also be wired into the external ignition enable input to prevent the ignition from firing before the purge time has expired.

START FUEL LIMIT – the maximum permitted mixture throttle opening until “run speed” is reached (and control of mixture throttle position is released to the speed control PID)

START RAMP - limits the rate that the Speed Control PID can open the mixture throttle after “run speed” is reached. The Start Ramp function ends when the measured speed reaches 95% of the reference speed and the Speed Control PID is in control for greater than 1 second.

MAXIMUM FUEL LIMITER – limits the maximum mixture throttle opening, irrespective of other control inputs

Bank Balancing

The HMI settings for user configuration of bank balancing are shown in Figure 3-42.

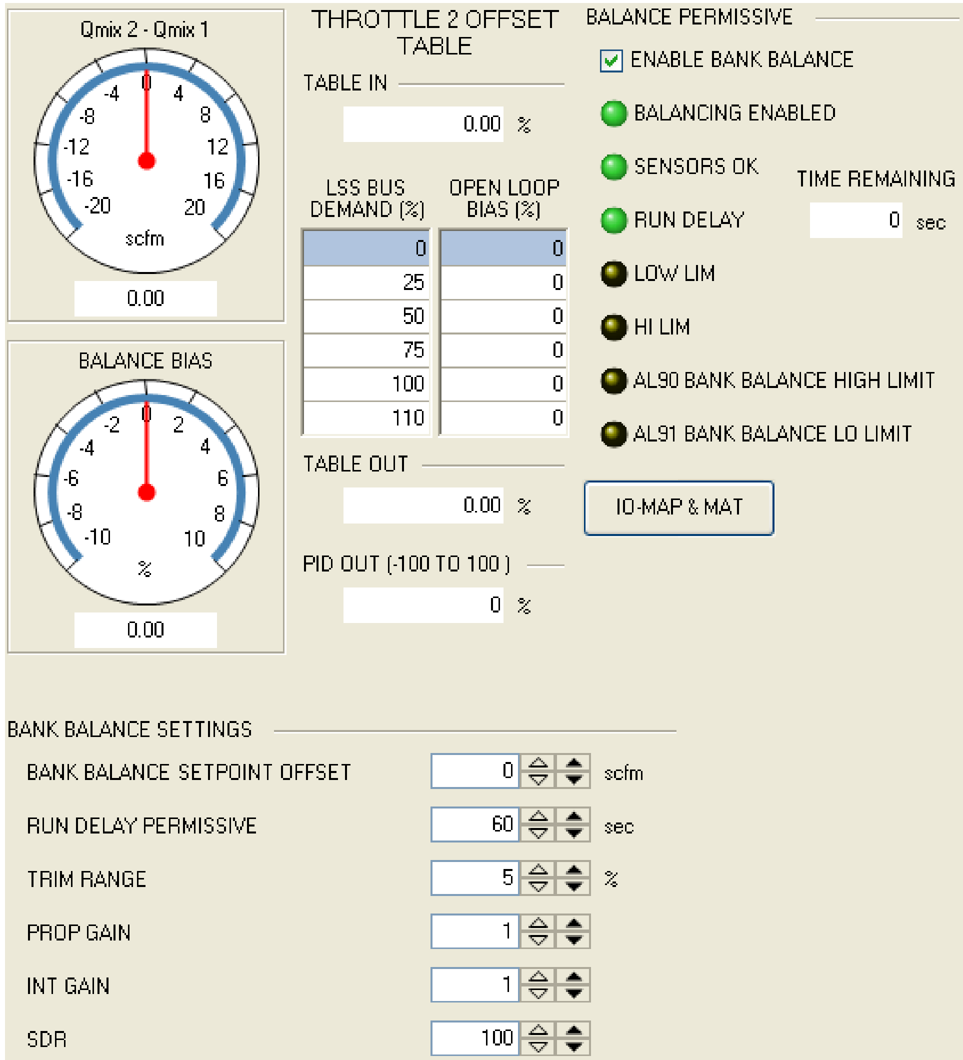


Figure 3-40. Bank Balancing Settings (HMI Screen 2.0)

To enable bank balancing, place a check in the box beside ENABLE BANK BALANCE.

BANK BALANCE SETPOINT OFFSET - The setpoint for the Bank Balance PID (%). Changing this will allow the user to intentionally unbalance the banks to test balancing dynamics.

RUN DELAY PERMISSIVE- The delay after engine run that the balancing will activate.

TRIM RANGE - This value establishes the maximum adjustment that can be made to correct for imbalance conditions (%). This is the max trim adjustment that the balancing PID will make at 100%.

PROP GAIN - The Proportional Gain of the Pre-Cat Control Loop, decreasing the Prop Gain will reduce the response of the control loop. See PID control section.

INT GAIN - The Integral Gain of the Pre-Cat Control Loop, decreasing the Int Gain will slow the response of the control loop. See PID control section.

SDR - The SDR of the Pre-Cat Control Loop. See PID control section.

AFR Post-Cat

The HMI settings for user configuration of AFR Post-Cat are shown in Figure 3-43.

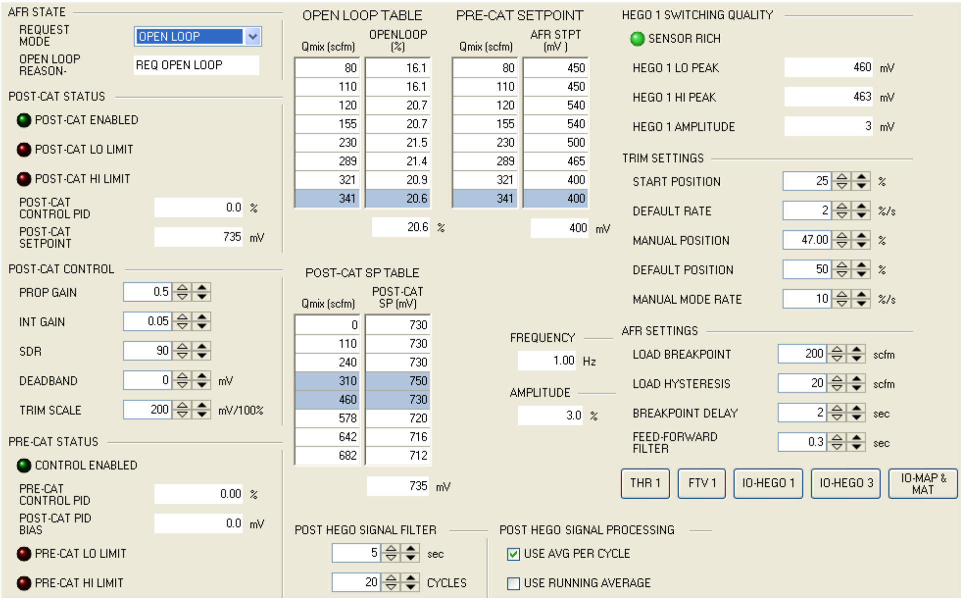


Figure 3-41. Post Cat AFR Settings (HMI Screen 3.3)

AFR Health

This page shows catalyst health conditions and system flow information.

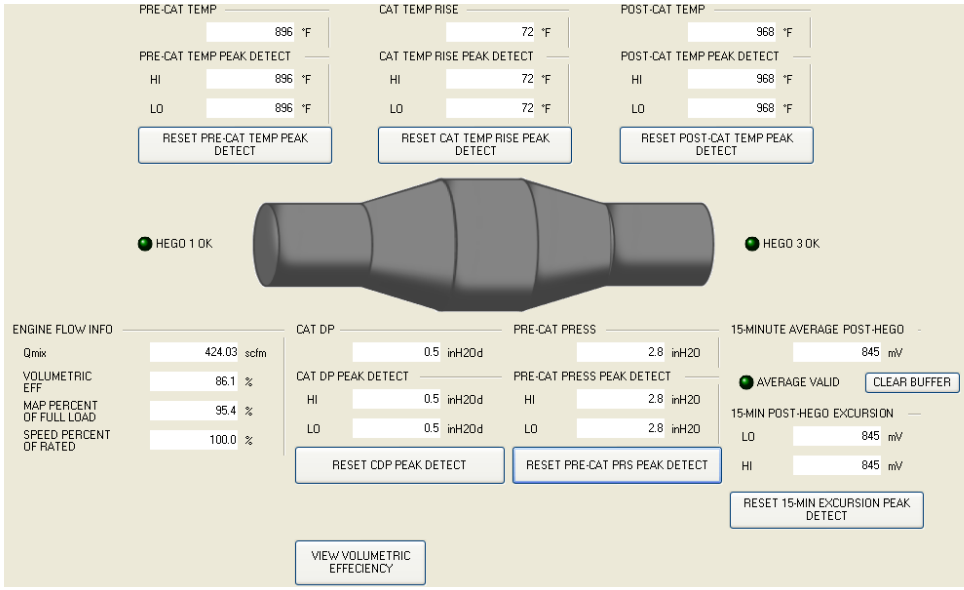


Figure 3-42. AFR Health Page (HMI Screen 1.4)

Misfire Detection

Figure 3-42 shows the HMI screen for Misfire Detection. Global misfire detection based on instantaneous crank angle velocity (ICAV) measurement has the capability of detecting persistent misfire of any cylinder. The individual misfiring cylinder is not identified. The Misfire Detection system monitors the irregularity of the engine speed, which has a regular pattern corresponding to cylinder combustion events.

When the engine speed irregularity exceeds the user-calibrated level during the user calibrated period a fault will be activated.

Deviation from the regular pattern, which generally causes an increase in the irregularity, can be due to failures in the ignition system like spark plugs, coils, cables, extenders etc. Also a problem with the A/F ratio control, e.g. when the mixture is too lean, can cause a Misfire Detection alarm. Furthermore, engine problems like damaged valves or pistons will increase the level of irregularity.

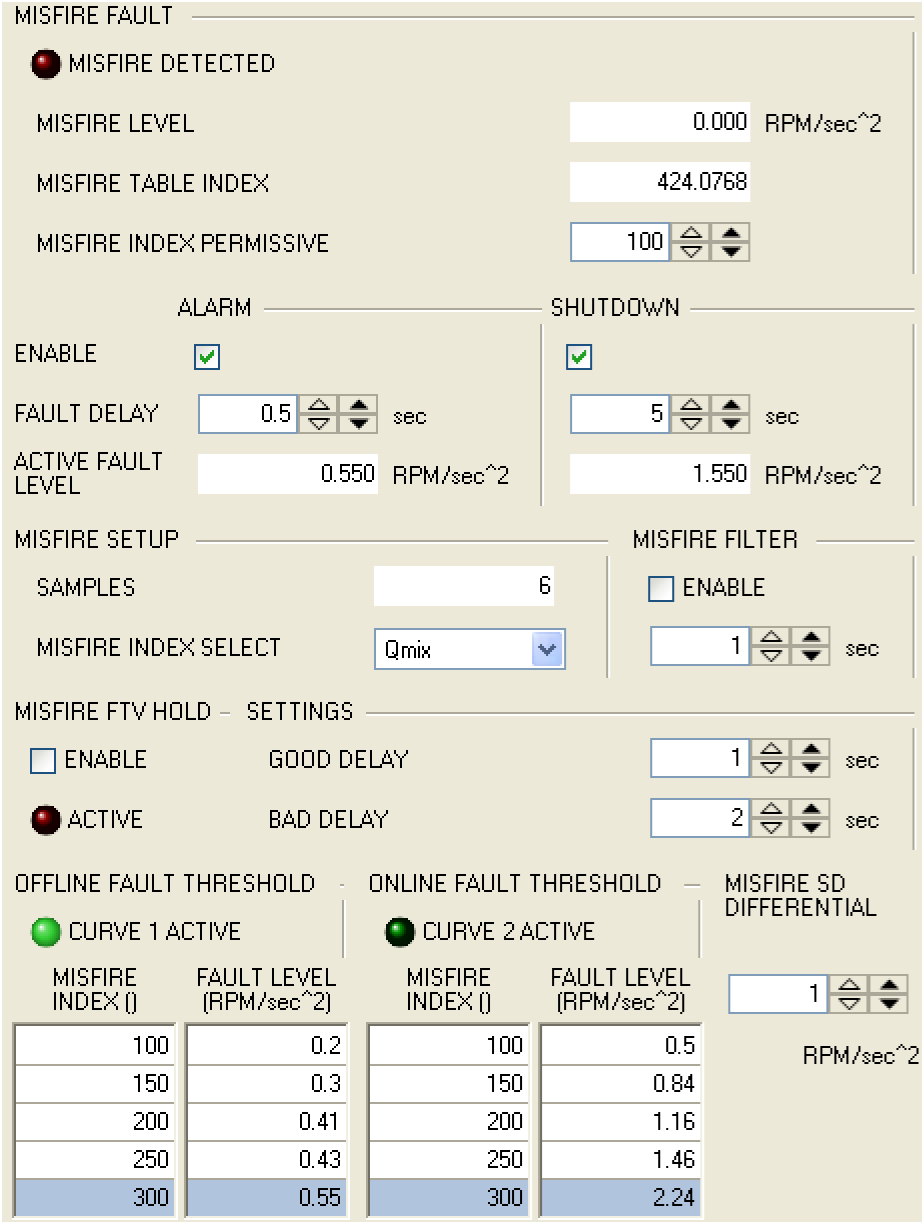


Figure 3-43. Misfire Detection HMI Screen (HMI Screen 5.1)

MISFIRE INDEX PERMISSIVE - The threshold that the MISFIRE INDEX must be above to enable the Misfire Faults.

ENABLE ALARM - Set this TRUE to enable the Misfire Alarm.

ENABLE SHUTDOWN - Set this TRUE to enable the Misfire Shutdown.

FAULT DELAY ALARM - The delay the misfire condition must stay TRUE before an alarm is activated (sec).

FAULT DELAY SHUTDOWN - The delay the misfire condition must stay TRUE before a shutdown is activated (sec).

MISFIRE INDEX SELECT - A drop down selection box that allows the Misfire Fault mapping to be driven by different indices. Allowable values are: THROTTLE, Qmix, or LOAD INPUT.

MISFIRE ALARM THRESHOLD TABLE - 2 x 5 lookup table Misfire Index () vs. Alarm Level (RPM/sec^2) allows a non-linear mapping of the fault threshold over the operating range of the engine.

MISFIRE SD THRESHOLD TABLE - 2 x 5 lookup table Misfire Index () vs. Shutdown Level (RPM/sec^2) allows a non-linear mapping of the fault threshold over the operating range of the engine.

MISFIRE FILTER ENABLE - Check this box to enable the Misfire Filter, uncheck and the filter is bypassed.

MISFIRE FILTER - The Misfire Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

MISFIRE FTV HOLD

When a misfire occurs for longer than a tunable delay AND the control is in one of the closed-loop modes the Fuel Trim Valve is held in place. The FTV resumes normal control when the MISFIRE condition is false for a tunable amount of time.

MISFIRE FTV HOLD ENABLE - Set this TRUE to enable the FTV HOLD function.

Knocking combustion or detonation does not produce a significant change in the irregularity of the engine, and will not be detected by the Misfire Detection system.

Irregularity and Misfire

Normal Irregularity
Reciprocating engines do not have a continuous combustion, in contrast to turbines. The speed of the flywheel changes continuously in accordance with each individual cylinder combustion event. Superimposed on this constant irregularity is the irregularity between successive combustion events, due to the stochastic nature of spark ignited engine combustion events.

If the engine has no hardware defects and runs with correct A/F ratio and correct spark advance, there will be a certain basic speed irregularity as measured at the flywheel. This basic irregularity is influenced by:

- Number of cylinders, firing order, firing intervals, and cylinder angle (V-engine)
- Inertia of engine and generator
- Stiffness of crankshaft and driveline
- Mode of operation (i.e. parallel to the grid, or island).
- Combustion stability.

Judicious calibration of the misfire detection system during the commissioning of the engine is required for reliable detection of real misfire and to avoid false alarms when there is no misfire.

Misfire Detection Signals

The Misfire Detection system uses a normal inductive speed pick-up that senses the flywheel ring gear teeth. The same signal is used for engine speed control.

The speed signal is processed in such way that only irregularity caused by combustion failures will lead to misfire detection based on the derivative signal. After filtering and peak detection, the processed signal is used to trigger the alarm. During engine commissioning, the goal is to calibrate the fault levels and the fault delays of the Misfire Detection system in such a way that no false alarms will be generated.

Misfire Detection System Operation

If the Misfire Detection system triggers an alarm in service, it is an indication that there is more irregularity in the speed of the flywheel than there was when the misfire detection was calibrated during the commissioning of the system. When this occurs, it could be due to a problem with the ignition, the A/F ratio or the engine itself (e.g. valves, pistons, etc).

The user is advised against adjusting the calibration to eliminate the alarm. The recommended correction is to diagnose the problem and bring the engine back in its original condition.

HEGO Configuration & Monitoring

The HMI settings for HEGO configuration & monitoring are shown in Figure 3-43 (HEGO 1 shown for example).

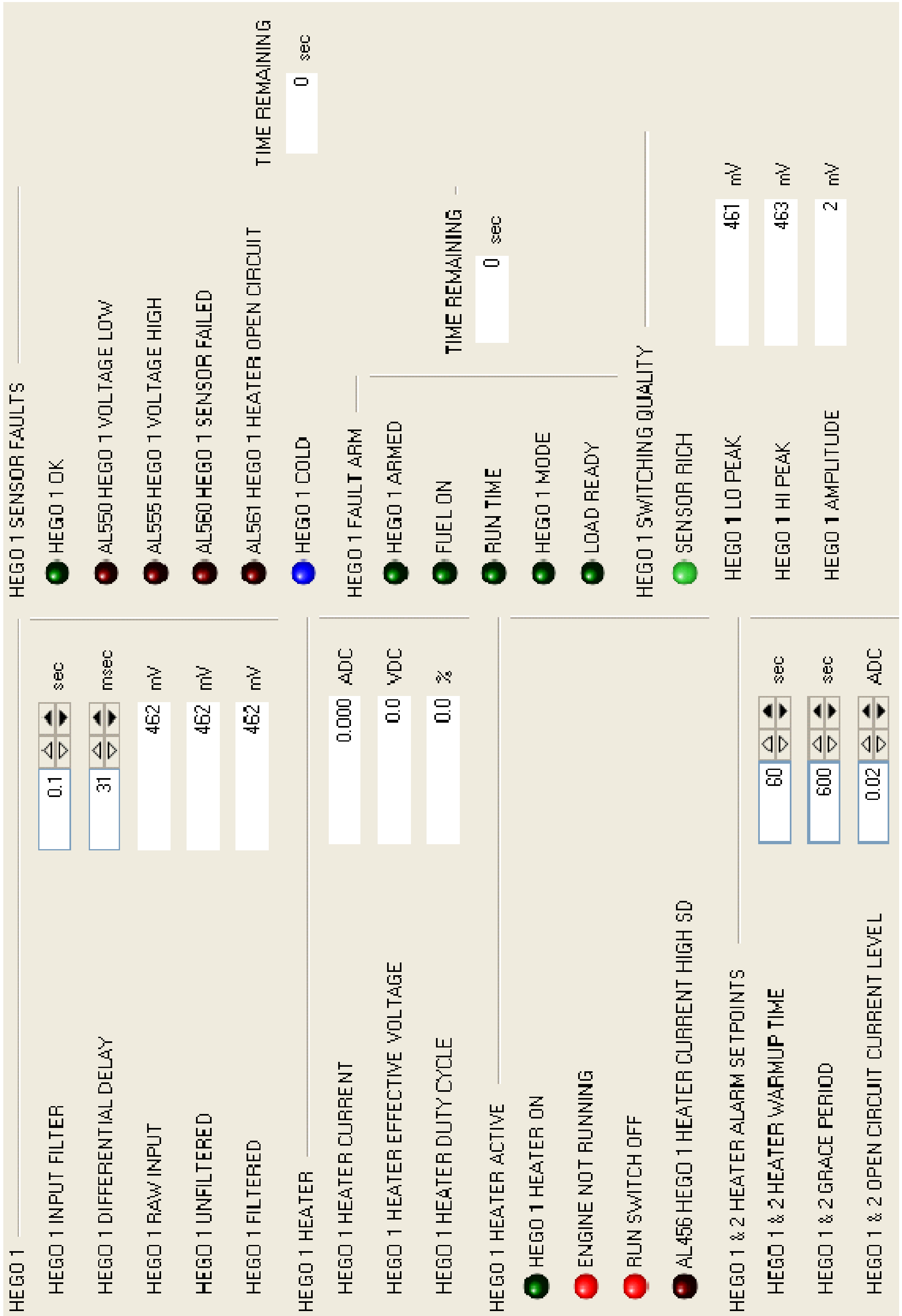


Figure 3-44. HMI Settings for HEGO Configuration & Monitoring (HMI Screen 6.14)

HEGO 1 INPUT FILTER - The HEGO Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

HEGO 1 DIFFERENTIAL DELAY - Calibration value to shift switch times, typically left at default.

HEGO 1 HEATER MANUAL SD - Check this box to shutdown the heater voltage, used for troubleshooting and setup.

THERMAL SHOCK DELAY - Time period the heater is shutoff after run (sec).

HEATER WARMUP TIME - Time period the heater is in warm-up mode (sec).

HEGO STABLE DELAY - The time period the heater must be at maximum before considered stable (sec).

GRACE PERIOD - The time period after which the HEGO sensor should be considered warmed up and ready to go (sec). Once the GRACE PERIOD is expired, any HEGO sensor fault will trigger a latched fault.

OPEN CIRCUIT CURRENT LEVEL - The HEGO Heater current read back threshold level (ADC).

MAX EFFECTIVE VOLTAGE - The HEGO Heater current read back threshold level (ADC).

Engine & Catalyst Protection

Optional engine protection features can be selected and configured using the HMI. Selection and configuration of each feature is done on the individual HMI screens as described in detail below.

A Derate function is provided to allow the engine to keep running at a lower load even though certain engine parameters exceed normal operating condition. The control derates based on analog and discrete parameters.

Derate Action

The current Derate level is expressed as percent, 100% representing no Derate and 0% representing full Derate.

If the control is in mechanical drive mode, the Derate function applies to the speed reference.

If the control is in Generator mode AND the Load control is active, the Derate function applies to the Load Reference.

If the control is in Generator mode AND the Load Control is NOT active then the Derate function has no effect.

Analog Derate Function

There are nine parameters for each analog derate function:
Select Derate function – This tunable selects the analog protection mode and has four possibilities:

- OFF – Analog Protection disabled
- DERATE – Analog Derate, Alarm, and Shutdown
- ALARM – Analog Alarm only
- ALARM + SD – Analog Alarm and Shutdown only

Alarm Threshold – The level at which the Alarm function initiates.
Alarm Delay – The delay at which a fault will initiate the Alarm function.
Derate Threshold – The level at which the derate function initiates.
Derate Stepsize – The amount that the derate decreases when a derate condition exists.
Derate Clear Stepsize – The amount that the derate increases when a derate condition no longer exists.
Derate Looptime – The time that the control waits while in derate Alarm condition before it decreases the Derate value by the “Derate Stepsize”.
Derate Shutdown Threshold – The Derate level at which the Shutdown function initiates.
Derate Shutdown Delay – The time that the control waits while exceeding the Shutdown Threshold before it issues a System Shutdown.

If the Alarm threshold is exceeded for the Alarm Delay time, a fault is latched to alert the user that a problem occurred.

If the Derate Threshold is exceeded for the Derate Looptime, the individual derate indicator latches and the function lowers the individual derate value by the Derate Stepsize and repeats every Derate Looptime until it gets to the Derate Shutdown Threshold for the Derate Shutdown Delay at which point a system shutdown is issued.

If the fault is self-corrected and exceeds the alarm threshold, the derate level rises by the Clear Stepsize back toward 100% and awaits another Derate Looptime if appropriate.

Derate for an individual derate protection is disabled if the respective sensor is in a hardware fault state.

Analogs available for derate function:

- MAT1
- MAT2
- ECT
- LOP

If Alarm + SD mode is selected then the Shutdown is initiated by exceeding the Shutdown Threshold for the Shutdown Delay period.

Discrete Derate function

There are seven parameters for each discrete derate function:
Select Derate function – This tunable selects the analog protection mode and has four possibilities:

- OFF – Discrete Protection disabled
- DERATE – Discrete Derate, Alarm, and Shutdown
- ALARM – Discrete Alarm only
- ALARM + SD – Discrete Alarm and Shutdown only

Alarm Delay – The delay at which a fault will initiate the derate function.
Derate Stepsize – The amount that the derate decreases when a derate Alarm condition exists.
Derate Clear Stepsize – The amount that the derate increases when a derate Alarm condition no longer exists.
Derate Looptime – The time that the control waits while in derate Alarm condition before it decreases the Derate value by the "Derate Stepsize".
Derate Shutdown Threshold – The Derate level at which the Shutdown function initiates.
Derate Shutdown Delay – The time that the control waits while in a Shutdown condition before it issues a System Shutdown.

If the Alarm condition is exceeded for the delay time a fault is latched to alert the user that a problem occurred.

If the Fault trips for the Derate Looptime, the individual derate indicator latches and the function lowers the individual derate value by the Derate Stepsize and repeats every Derate Looptime until it gets to the Derate Shutdown Threshold for the Derate Shutdown Delay at which point a system shutdown is issued.

If the fault is self-corrected the derate function rises by the Derate Clear Stepsize back to 100% and awaits another Derate Looptime if appropriate.

Discretes available for derate function:
- EOL
- ECL

If Alarm + SD mode is selected then the Shutdown is initiated by fault tripping for the Shutdown Delay period.

All protection derates go into a Low-Signal Select bus (LSS) and the lowest is used as the global derate (0-100%).

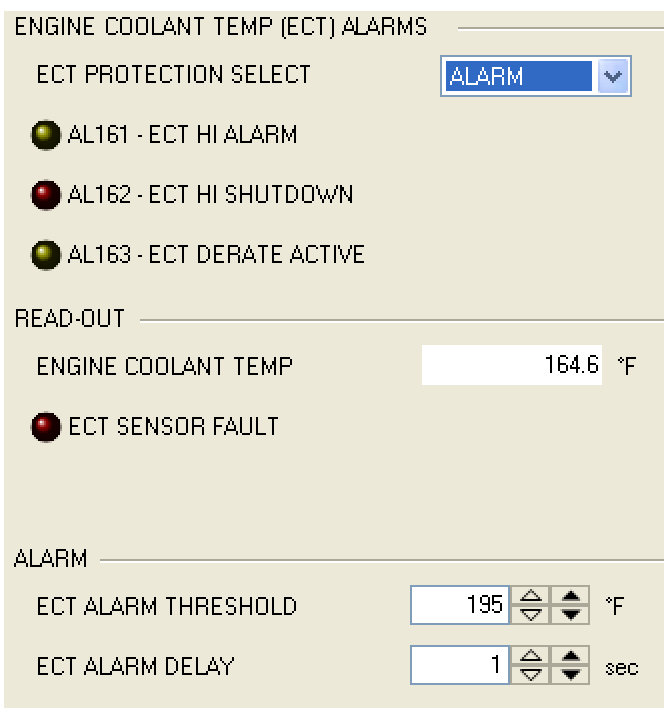


Figure 3-45a. Example HMI Settings for ALARM Protection (HMI Screen 4.6)

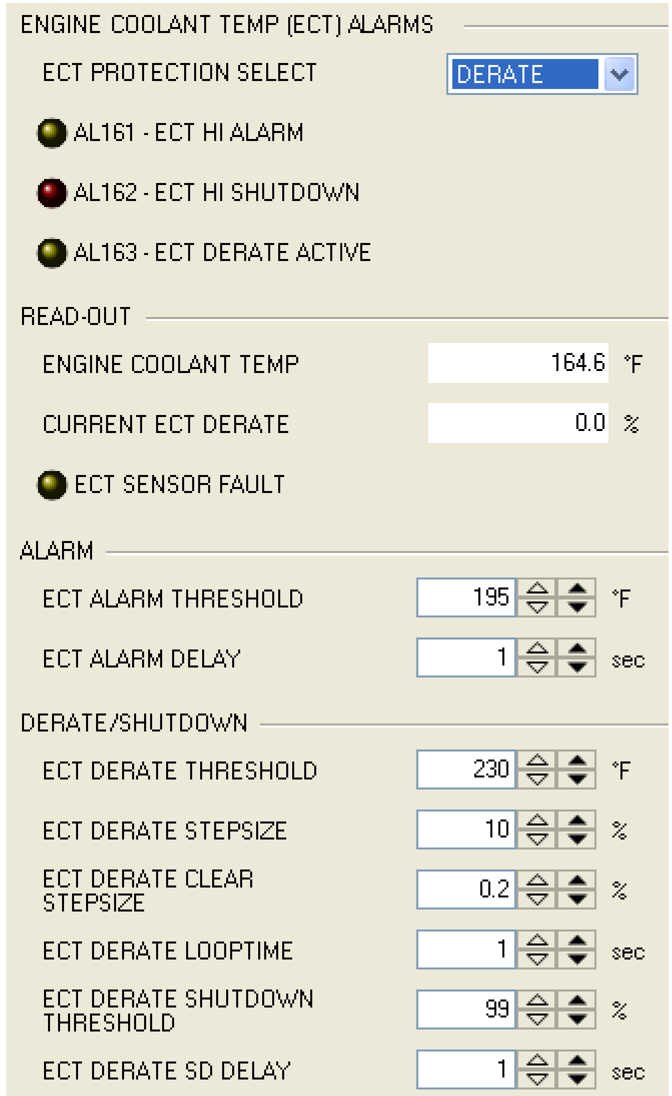


Figure 3-45b. Example HMI Settings for DERATE Protection (HMI Screen 4.6)

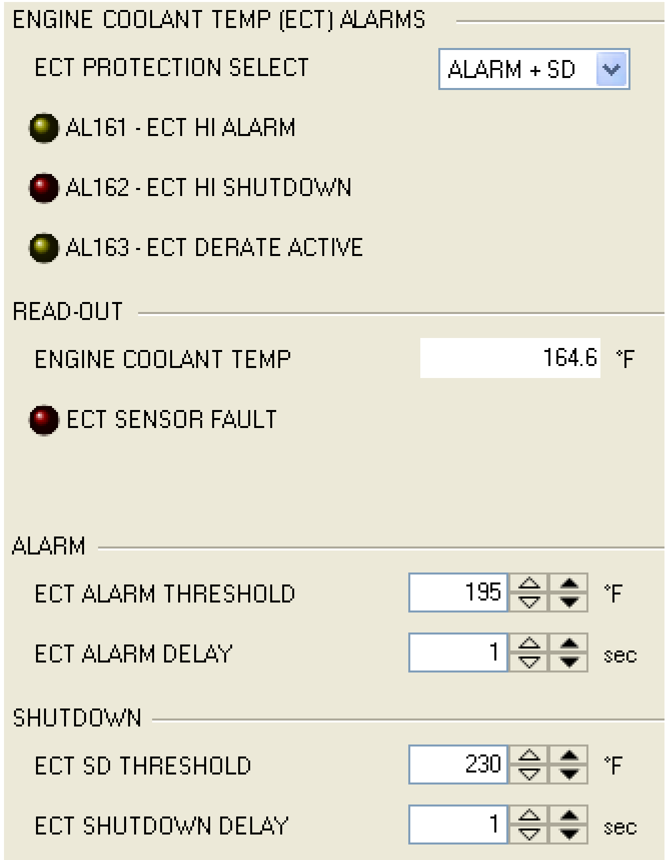


Figure 3-45c. Example of ANALOG with ALARM + SD (HMI Screen 4.6)

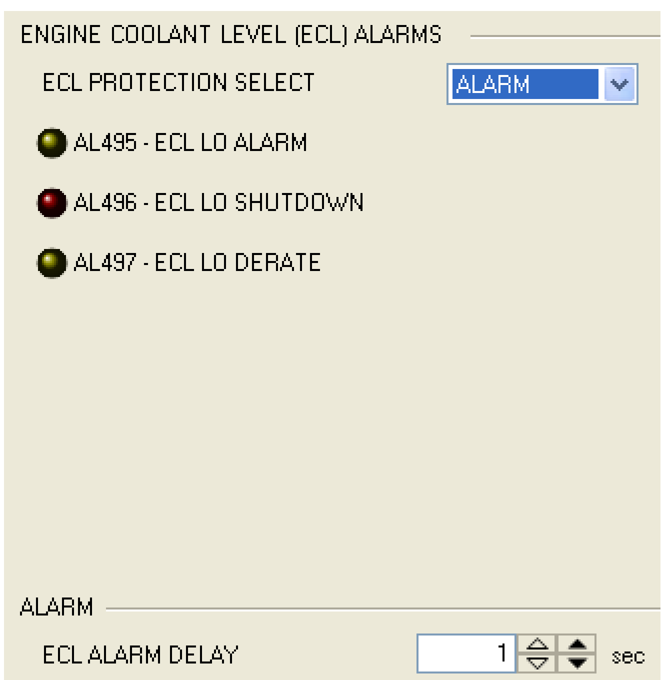


Figure 3-45d. Example of DISCRETE with ALARM (HMI Screen 4.6)

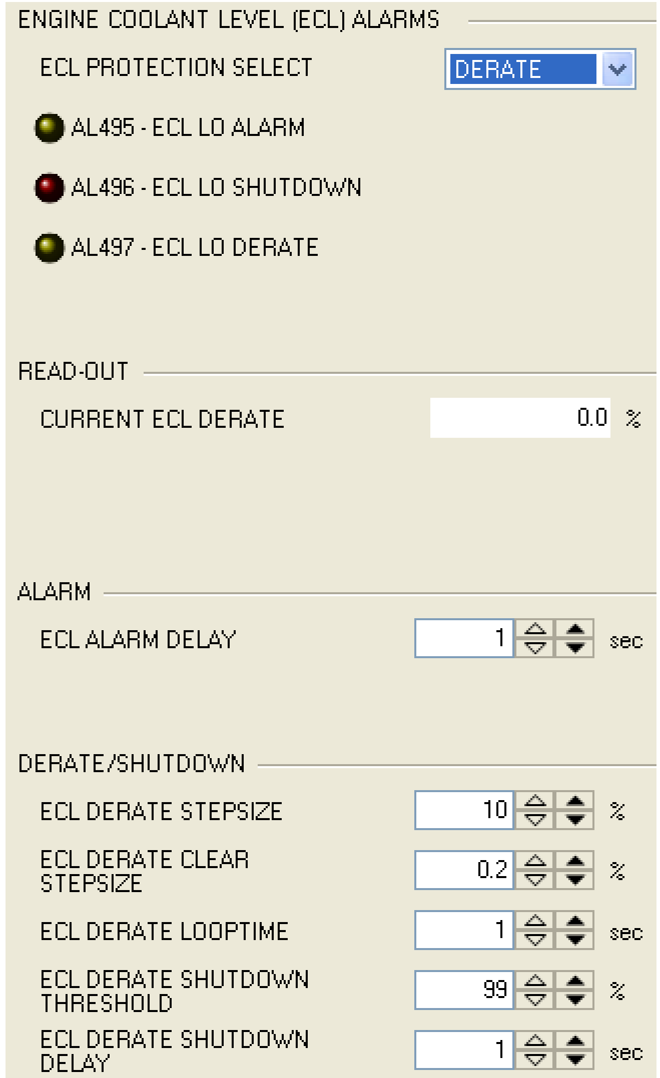


Figure 3-45e. Example of DISCRETE with DERATE (HMI Screen 4.6)

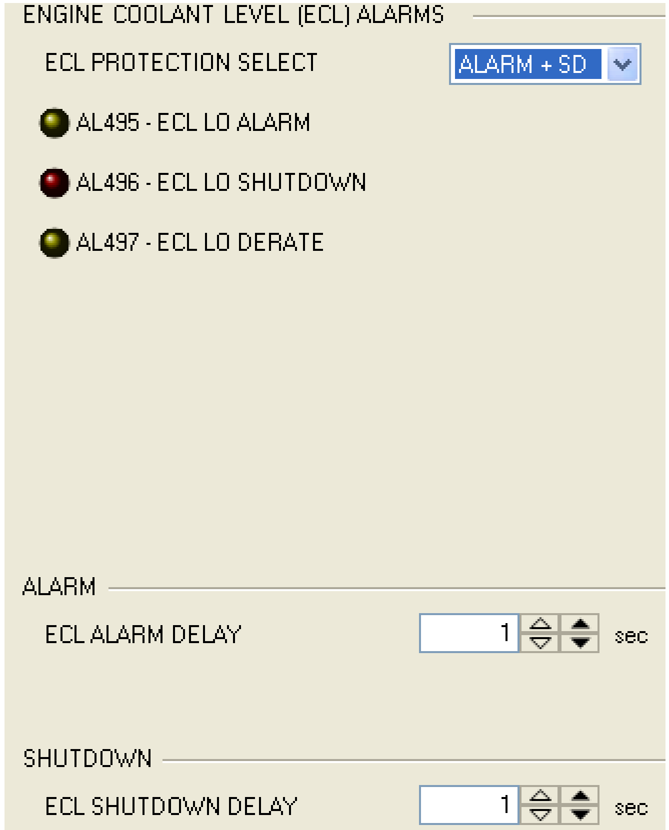


Figure 3-45f. Example of DISCRETE with ALARM + SD (HMI Screen 4.6)

ECT Protection
ECT Protection follows the Analog Derate scheme above.

Lube Oil Pressure Engine Protection
Engine Lube Oil Protection follows the Analog Derate scheme above.

MAT1 Engine Protection
MAT 1 Protection follows the Analog Derate scheme above.

MAT2 Engine Protection
MAT 2 Protection follows the Analog Derate scheme above.

Engine Coolant Level Engine Protection
Engine Coolant Level Protection follows the Discrete Derate scheme above.

Engine Oil Level Protection
Engine Oil Level Protection follows the Discrete Derate scheme above.

Lube Oil Temperature (LOT) Protection

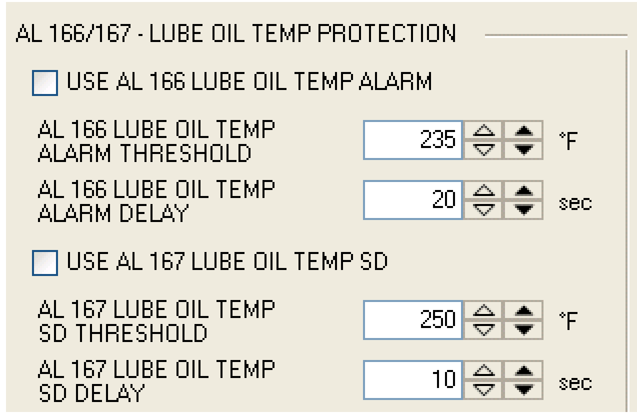


Figure 3-46. HMI Settings for LOT Engine Protection (HMI Screen 7.6)

The HMI settings for Lube Oil Temperature (LOT) protection are shown in Figure 3-46. This alarm and/or shutdown is only active if a LOT sensor is used and enabled in the system, and the corresponding checkbox beside "USE AL166 LUBE OIL TEMP ALARM" and/or "USE AL167 LUBE OIL TEMP SD "is checked. The individual alarms /shutdowns will trigger if the sensed lube oil temperature reaches the applicable calibrated threshold, and the delay time has expired.

Engine Overpower Protection

The aim of this function is to provide a safe engine shutdown in the event overpower occurs that cannot be arrested via throttle command signal. The primary inputs for this function are the mixture throttle TPS and status signals. If these signals are not present or is invalid this function will use secondary data.

This function is enabled by placing a check in the box beside "ENABLE AL442 UNCONTROLLED OVERPOWER PROTECTION" (see Figure 3-47).

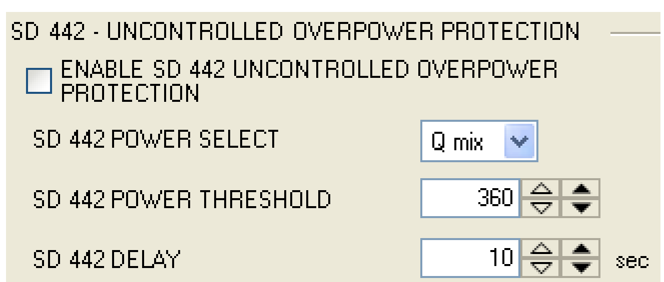


Figure 3-47. Enable Setting for Engine Overpower Protection (HMI Screen 7.7)

The overpower logic provides for engine shutdown when the power exceeds the reference value plus an offset due to a malfunctioning throttle that is indicated by a TPS error, when a valid TPS signal is present (note that if the throttle is functioning correctly – i.e. the TPS signal is valid and is following the commanded position – the system should be able to bring the power (MAP) under control by closing the throttle, so no action is taken by this function until/unless throttle is already being commanded to 0). But if TPS alarm/shutdown logic is disabled (e.g. because TPS signal not implemented) or if there is any TPS malfunction (Voltage Hi/Lo or TPS error) then shutdown will occur as soon as throttle position command goes to zero.

Note that this function will be pre-empted by a TPS triggered shutdown if any of the configurable TPS alarm/shutdowns are configured for shutdown and are active. There are no user adjustable settings for this function.

For more information see AL442 (Uncontrolled overpower) – Shutdown only in Chapter 5.

Catalyst Temperature Monitoring & Protection

Signal Configuration

The HMI settings for catalyst temperature signal configuration are shown in Figure 3-48.

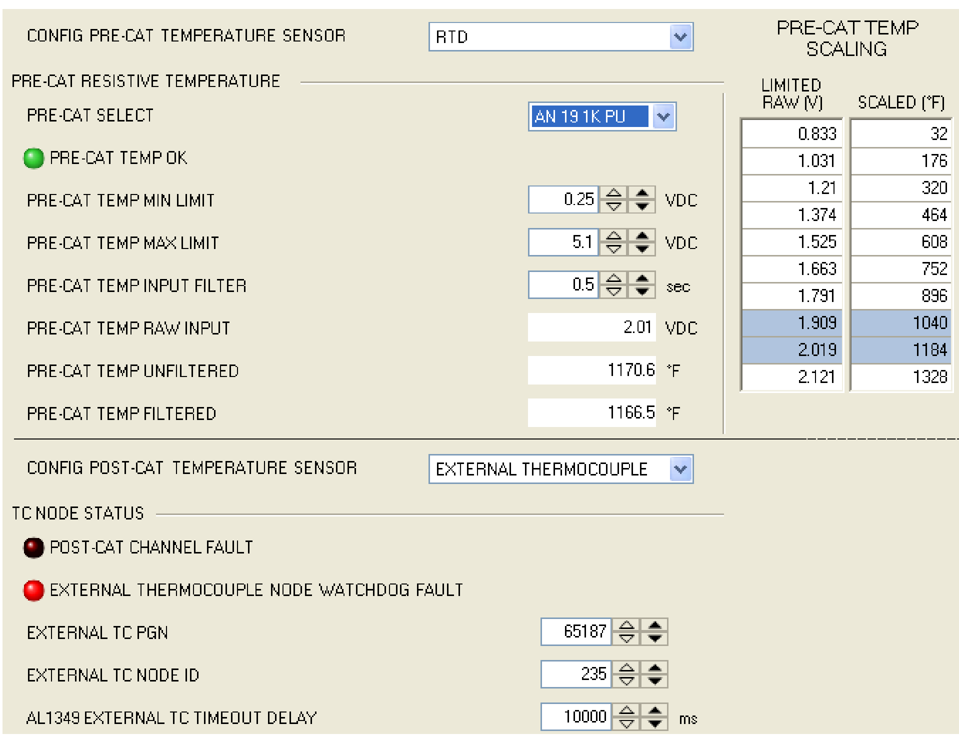


Figure 3-48. Catalyst Temperature Signal Configuration Settings (HMI Screen 6.12)

To enable the pre-cat or post-cat sensor inputs select one of the options in the corresponding drop down box, other than “NONE”. If a resistive type sensor (thermistor) is chosen (as shown for pre-cat in Figure 3-48 for example), the table shown on the right will appear on the screen. In this table the voltage to temperature scaling table is adjusted by the user. The input is designed to work with 0 to 5 Volt signals and requires a resistor type sensor connected to ground. Note that the sensor works as a resistor in a voltage dividing circuit inside the PCM128-HD. The correct voltage as a function of temperature can be calculated with the following formula:

$$\left(Voltage\_at\_EGS\_input = \frac{Rthermistor}{Rthermistor + 2210} * 5V\right)$$

The calibration for a standard 200 Ω Pt RTD is given in the table below and shown graphically in Figure 3-49).

Ohms	**Temp °C**	**Voltage at E3 Input**
200.00	32	0.833
259.66	176	1.031
319.33	320	1.21
378.99	464	1.374
438.66	608	1.525
498.32	752	1.663
557.98	896	1.791
617.65	1040	1.909
677.31	1184	2.019
736.98	1328	2.121

Table 3-4. Catalyst Temperature Signal Configuration Settings (HMI Screen 6.12)

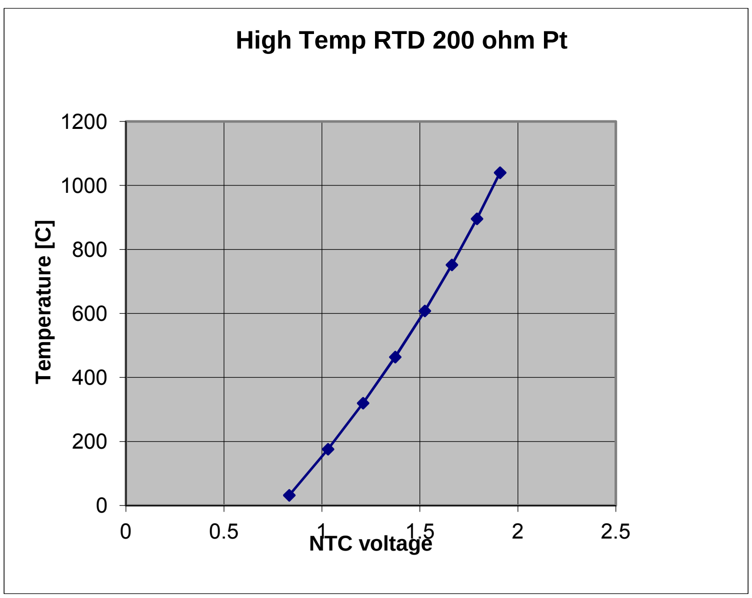


Figure 3-49. Catalyst RTD Voltage vs Temperature (°F)

If a sensor with a different scaling is used, the scaling table (see Figure 3-49) should be adjusted accordingly.

The alarm thresholds are adjusted in the fields on the left. The default value for low alarm threshold is 0.25 V and for the high alarm threshold is 5.1 V.

A filter time constant (“PRE-CAT TEMP INPUT FILTER”) can be entered to filter noise from the input signal.

The above functionality also applies to the post-cat sensor if a resistive type is used.

If the external SAE J1939 thermocouple option is chosen , the communication parameters will appear (as shown for post-cat in Figure 3-48 for example). These parameters should be configured in accordance with those of the external thermocouple module. This functionality also applies to the pre-cat temperature if an external thermocouple module is used for pre-cat temperature. The PGN is tunable though Toolkit but the SPN structure is Fixed. The control only supports a 16-bit SPN located in bytes 1-2 for TC channel 1 for Pre-Catalyst Thermocouple as defined in EPT1 - SPN 1137. The control only supports a 16-bit SPN located in bytes 3-4 for TC channel 2 for Post-Catalyst Thermocouple as defined in EPT1 - SPN 1138.

Alarm & Shutdown Setup

The HMI settings for pre-catalyst and post-catalyst temperature alarm and shutdown logic are shown in Figure 3-50. The individual alarms/shutdowns are only active if the corresponding sensor is used and enabled in the system, and the applicable box next to the individual sensor is checked. The individual alarms /shutdowns will trigger if the corresponding sensed value reaches the applicable calibrated threshold, and the delay time has expired.

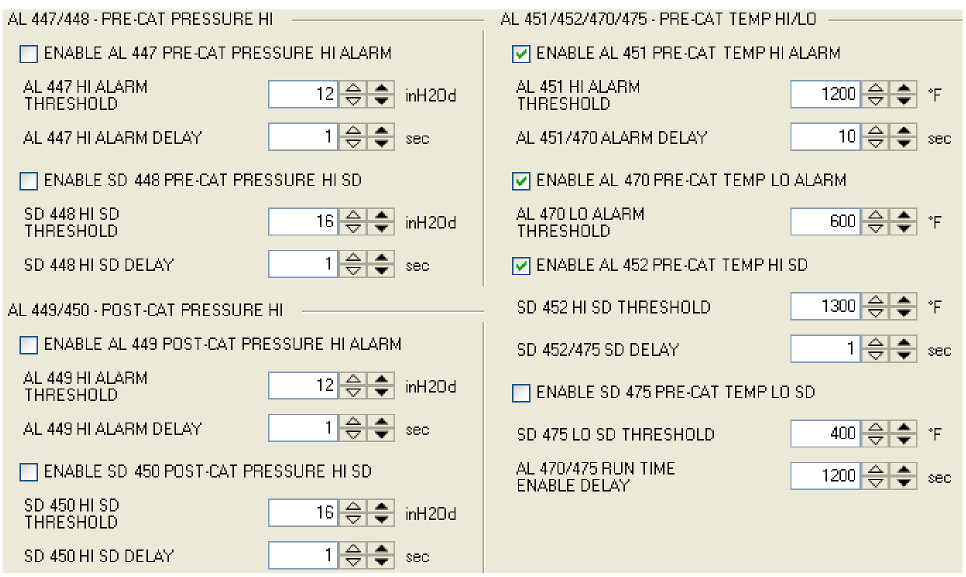


Figure 3-50a. Catalyst Temperature Alarm & Shutdown Settings (HMI Screen 7.8)

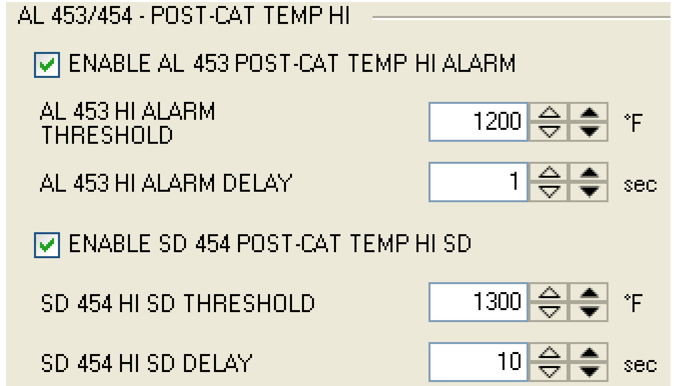


Figure 3-50b. Catalyst Temperature Alarm & Shutdown Settings (HMI Screen 7.8)

Catalyst Pressure Monitoring & Protection

Signal Configuration
The HMI settings for catalyst pressure signal configuration are shown in Figures 2-59(a), (b) & (c).

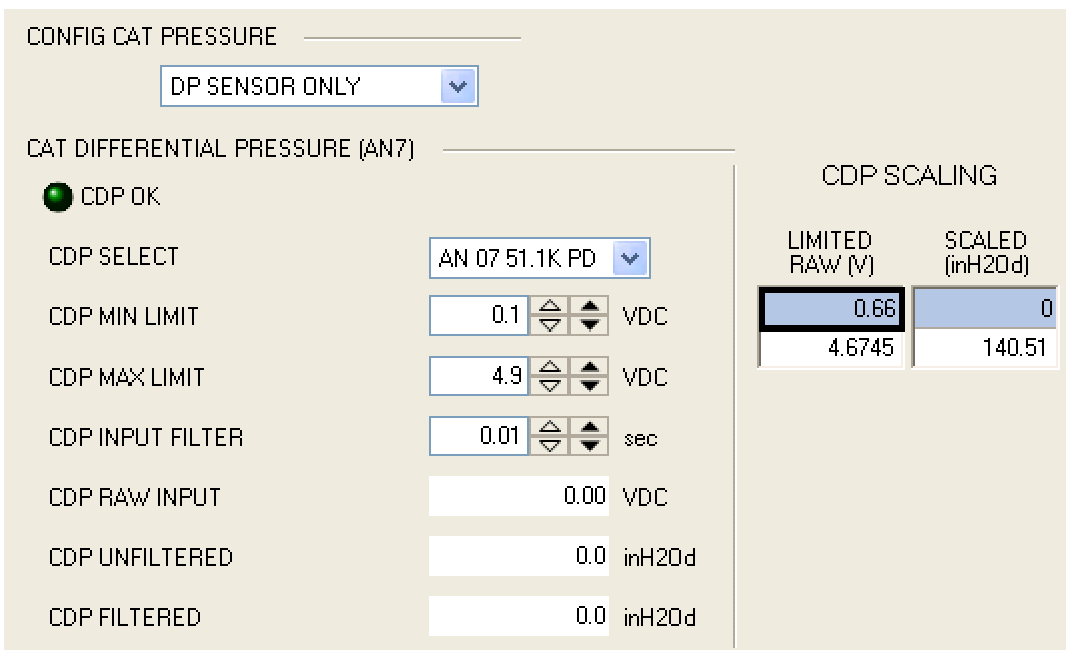


Figure 3-51a. Catalyst Pressure Monitoring & Protection Settings (DP Option, HMI Screen 6.13)

To enable catalyst pressure monitoring select one of the options in the drop down box under “CONFIG CAT PRESSURE”, other than “NONE”. Then select the desired input channel(s) in the applicable drop down box(es) for CDP, PRE-, POST- and/or CDP w/AMB. In the table(s) on the right the input voltage versus the sensor scaling is configured. Also a filter time constant can be entered to filter noise from the input signal.

The alarm thresholds are adjusted in the fields on the left. The default value for low voltage alarm threshold is 0.25 V and for the high voltage alarm threshold is 4.75 V. If the sensor voltage is out of range, this will result in an alarm or engine shutdown, depending on configuration (see Alarm/Shutdown Configuration in Chapter 4).

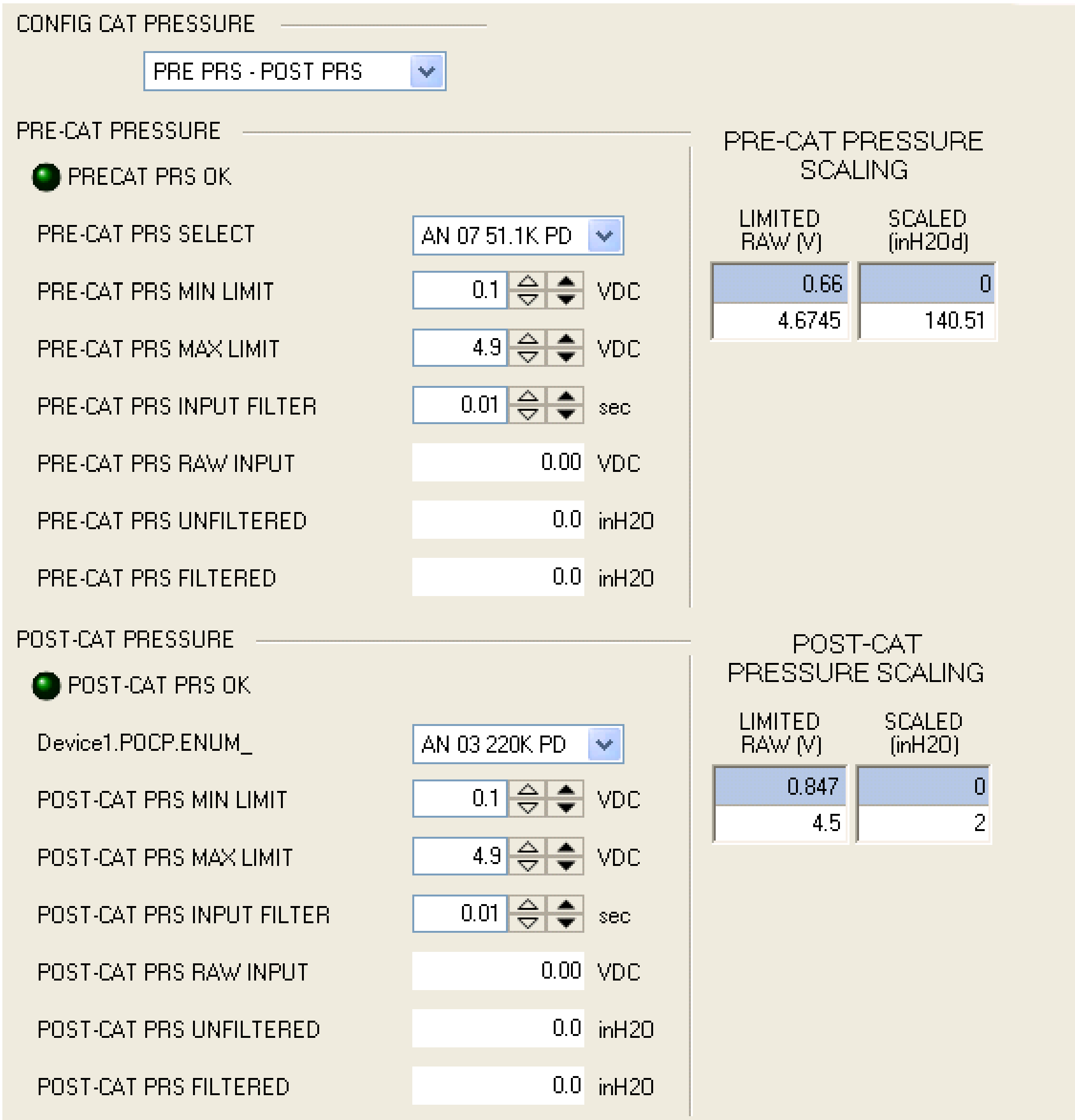


Figure 3-51b. Catalyst Pressure Monitoring & Protection Settings (PRE PRS – POST PRS Option, HMI Screen 6.13)

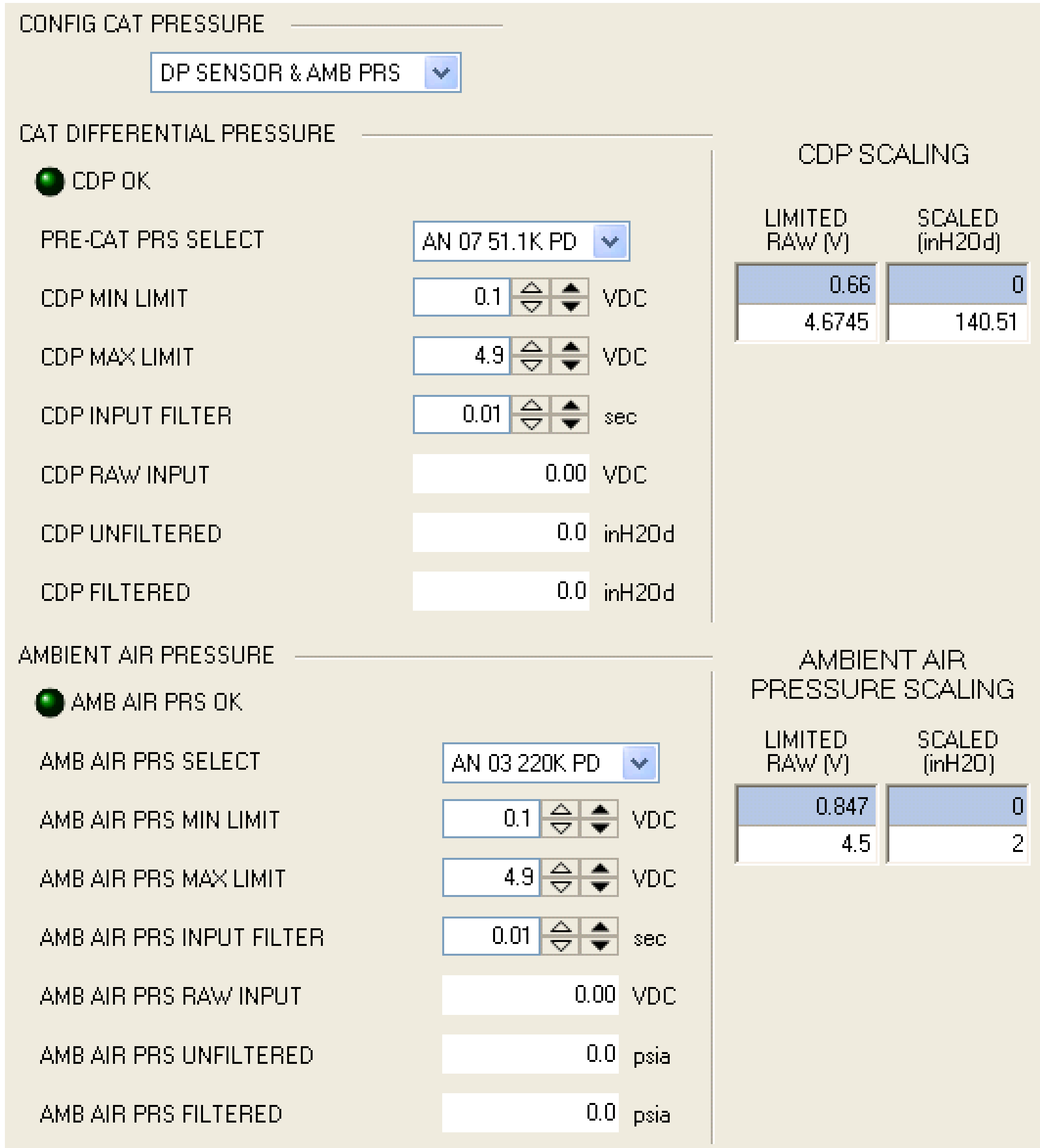


Figure 3-51c. Catalyst Pressure Monitoring & Protection Settings (DP SENSOR & AMB PRS Option, HMI Screen 6.13)

The HMI settings for pre-catalyst and post-catalyst temperature alarm and shutdown logic are shown in Figure 3-51. The individual alarms/shutdowns are only active if the corresponding sensor is used and enabled in the system, and the applicable box next to the individual sensor is checked. The individual alarms will trigger if the corresponding sensed value reaches the applicable calibrated threshold, and the delay time has expired.

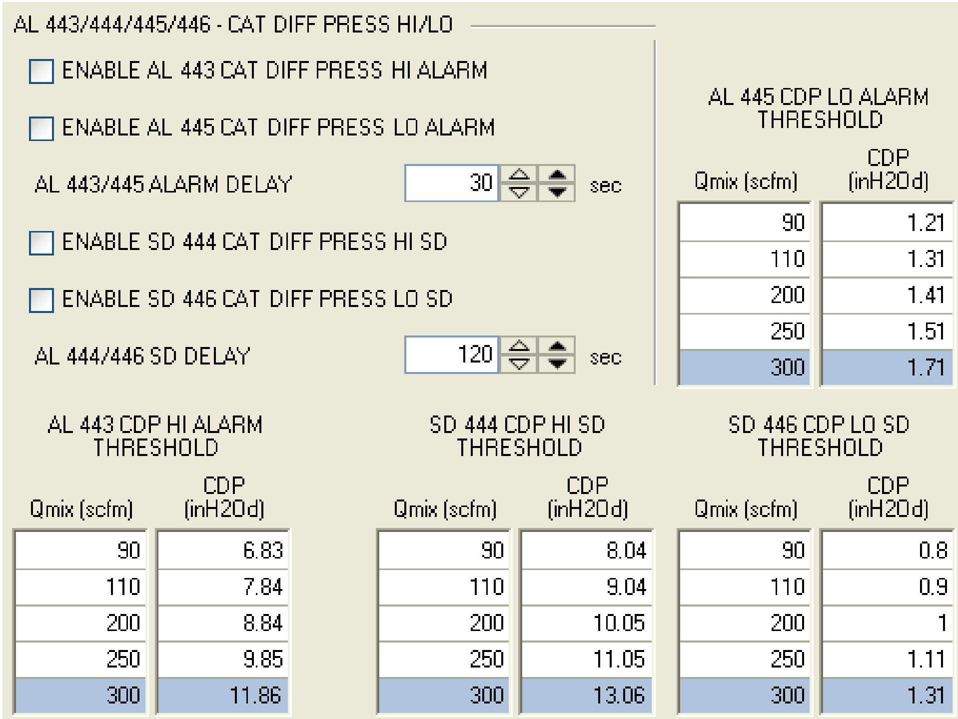


Figure 3-52. Catalyst Pressure Alarm & Shutdown Settings (HMI Screen 7.8)

Air/Fuel Ratio & HEGO Diagnostics

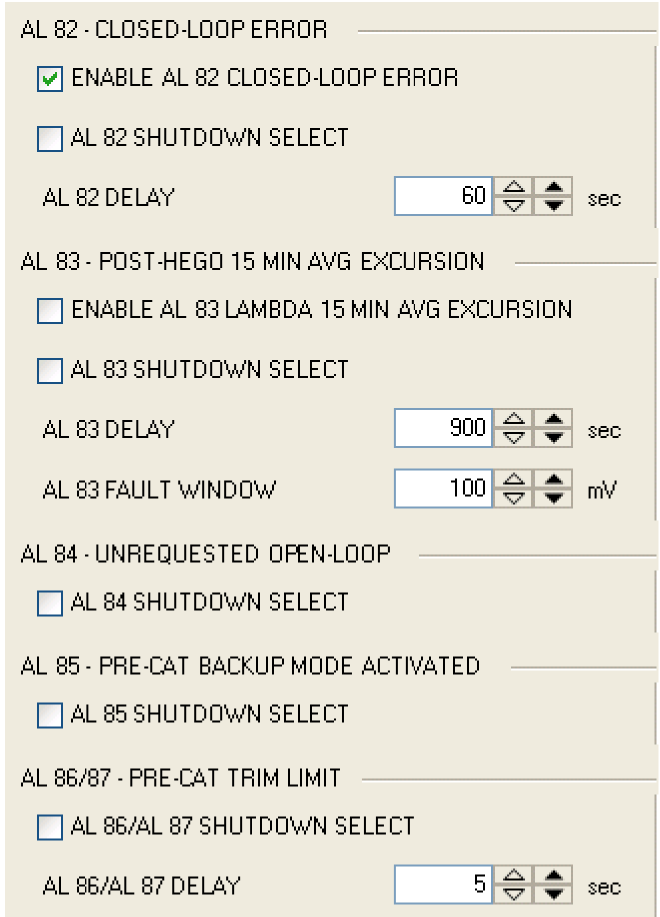


Figure 3-53. Air/Fuel Ratio Alarm & Shutdown Settings AL 81 – AL 84 (HMI Screen 7.5)

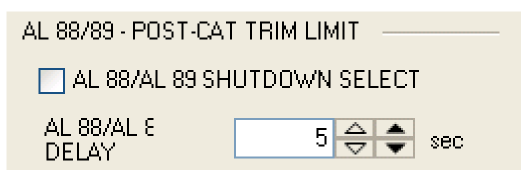


Figure 3-54. Air/Fuel Ratio Alarm & Shutdown Settings AL 88 & AL 89 (HMI Screen 7.5)

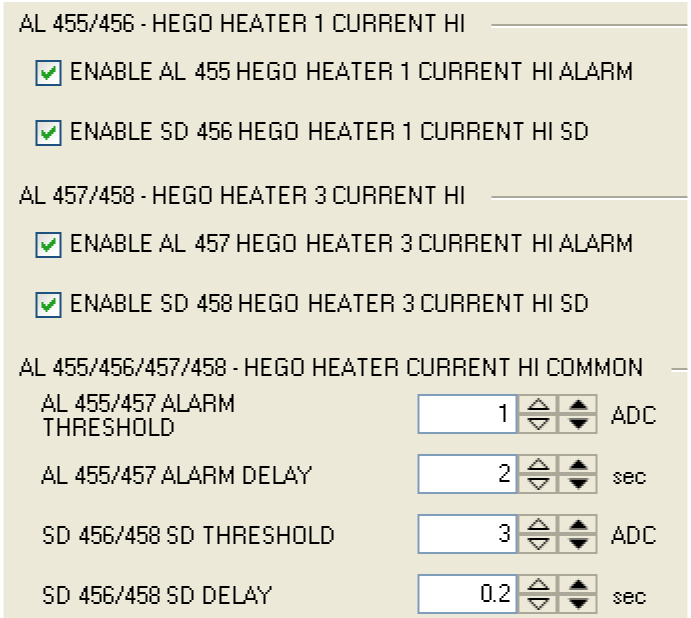


Figure 3-55. HEGO Heater Alarm & Shutdown Settings AL 455 – AL 458 (HMI Screen 7.8)

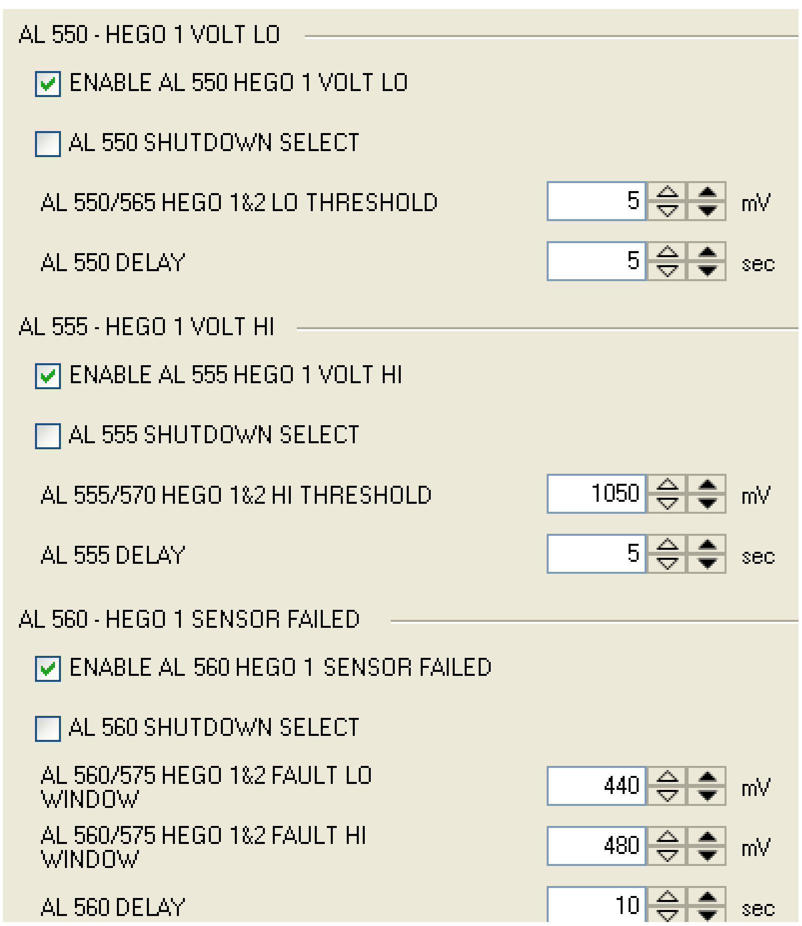


Figure 3-56a. HEGO Alarm & Shutdown Settings AL 550 – AL 560 (HMI Screen 7.10)

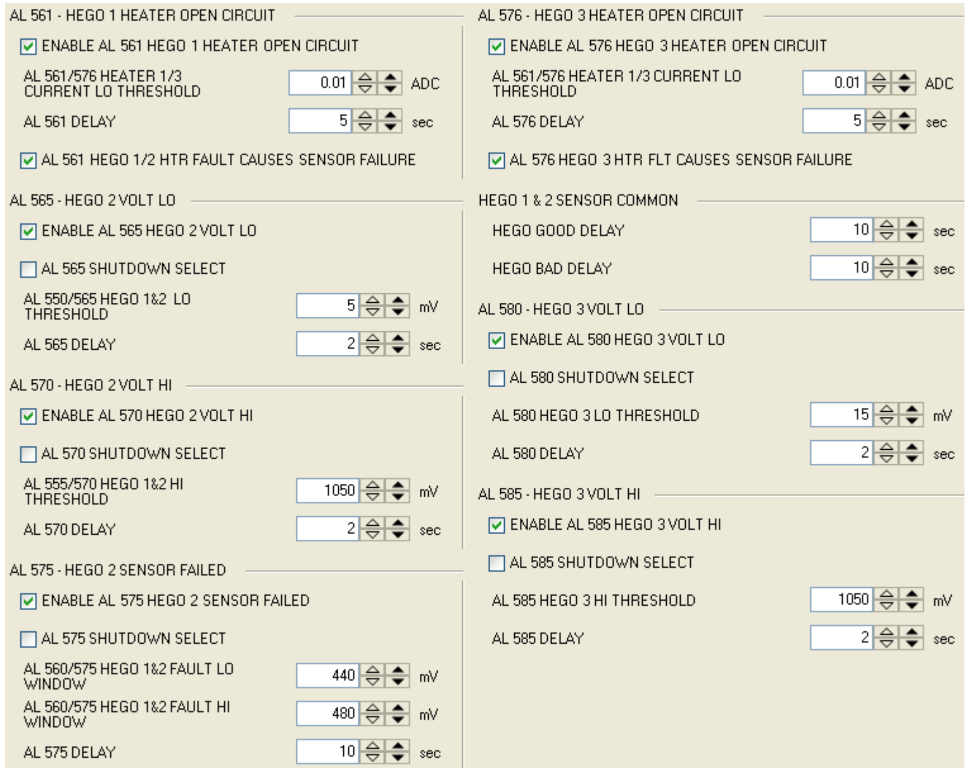


Figure 3-56b. HEGO Alarm & Shutdown Settings AL 561 – AL 585 (HMI Screen 7.11)

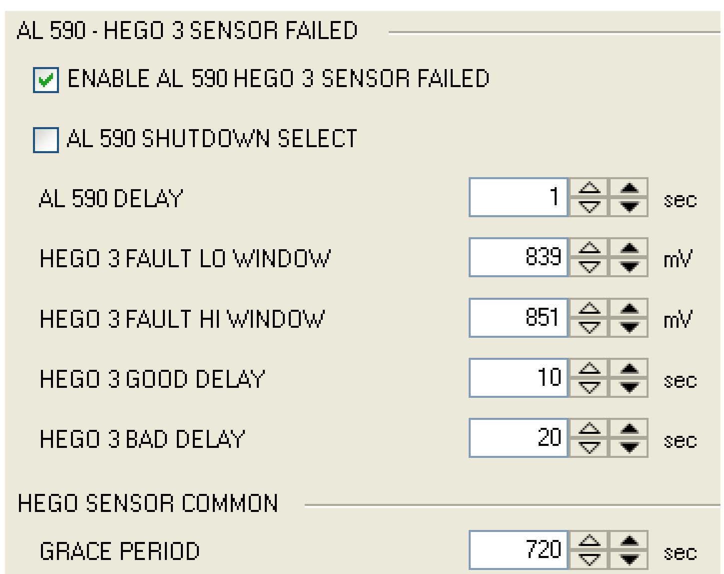


Figure 3-56c. HEGO Alarm & Shutdown Settings AL 590 (HMI Screen 7.11)

Ignition Control (IC-920/922)

Figure 3-57 shows the HMI user selections for ignition options.

The options are “IC-92X WITH J1939” (IC-920 or IC-922) or “3rd PARTY IGNITION”. Installation/application information for IC-920/922, installation and operation information is in the IC-920/-922 Installation and Operation Manual, publication 26263.

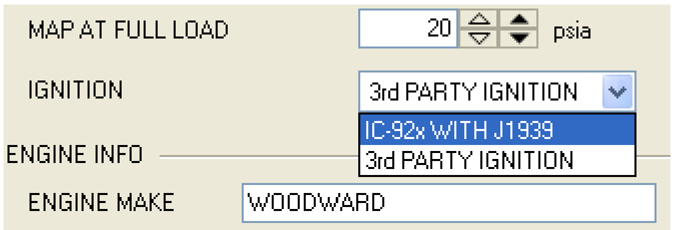


Figure 3-57. HMI Settings for Ignition Options (HMI Screen 7.0)

Figure 3-58 shows the HMI user settings for IC-92X J1939 address and coil energy.

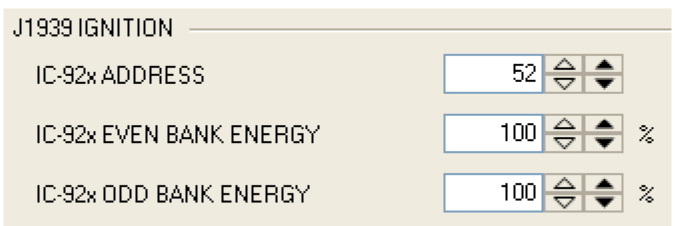


Figure 3-58. HMI Settings for IC-92X J1939 Address and Coil Energy (HMI Screen 7.0)

The IC-92X J1939 address should be set to match the setting in the IC-920/922 ignition. Even bank and odd bank coil energy settings can be adjusted individually. For further information on these settings, please consult the IC-920/-922 Installation and Operation Manual, publication 26263.

Figure 3-59 shows the HMI user settings for ignition timing.
For all timing values: a positive value indicates spark timing in degrees advanced or BTDC; a negative value indicates degrees retarded or ATDC.

The spark timing determination is as follows:

Spark Timing (“Ignition Advance Total” in the control) =
Global Advance + Base Advance from Table + Coolant Temp Advance

Following is a description of these and other parameters used in the ignition subsystem.

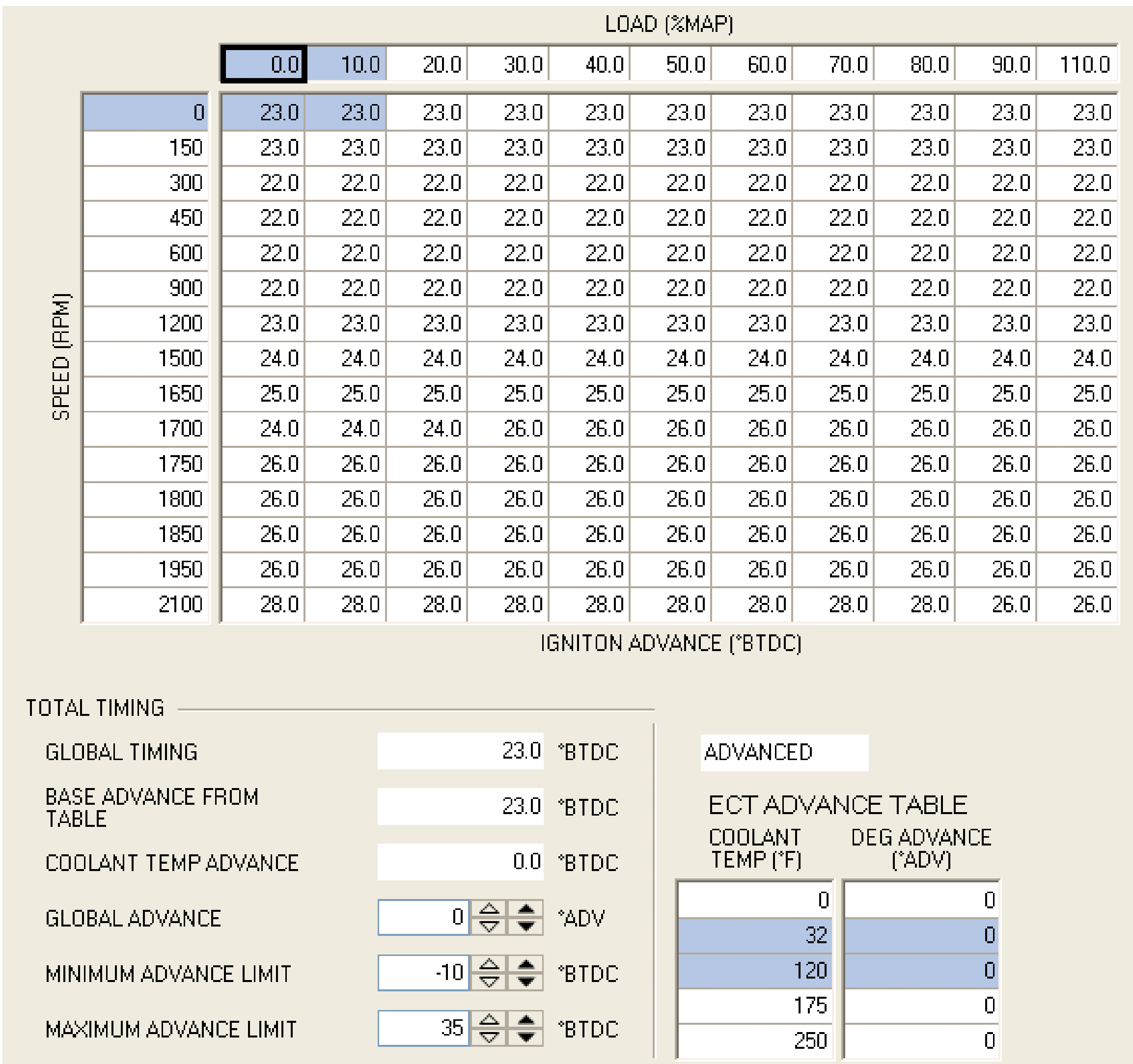
Global Advance
This is the user adjustable offset for global timing, shown in Figure 3-59. Typically this value is kept at zero except for special purposes during engine development or commissioning (for example when adjusting TDC OFFSET, see below).

Base Advance from Table
This is from the table for adjustment of the timing as a function of speed and load, shown in Figure 3-59.

Coolant Temp Advance
This is from the table for adjustment the timing as a function of engine coolant temperature, shown in Figure 3-59.

Global Timing (Total Timing to IC-920/922)
As defined above, Global Timing = Global Advance + Advance Base Curve + Advance ECT Curve Bias.

Minimum Advance Limit
This is the user adjusted minimum advance limit of the Global Timing (can be negative as shown in Figure 3-59).



LOAD (%MAP) / SPEED (RPM) — IGNITON ADVANCE (°BTDC)

SPEED (RPM)	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	110.0
0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
150	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
300	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
450	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
600	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
900	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
1200	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
1500	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
1650	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
1700	24.0	24.0	24.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
1750	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
1800	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
1850	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
1950	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
2100	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	26.0	26.0

TOTAL TIMING

GLOBAL TIMING	23.0	°BTDC
BASE ADVANCE FROM TABLE	23.0	°BTDC
COOLANT TEMP ADVANCE	0.0	°BTDC
GLOBAL ADVANCE	0	°ADV
MINIMUM ADVANCE LIMIT	-10	°BTDC
MAXIMUM ADVANCE LIMIT	35	°BTDC

ADVANCED

ECT ADVANCE TABLE

COOLANT TEMP (°F)	DEG ADVANCE (°ADV)
0	0
32	0
120	0
175	0
250	0

Figure 3-59. HMI Settings for Ignition Timing (HMI Screen 2.2)

Maximum Advance Limit
This is the user adjusted maximum advance limit of the Global Timing.

In Figure 3-60 the user settings for individual cylinder ignition timing offsets are shown. The individual cylinder offsets are adjusted by the user, but do not become active unless the box beside “ACTIVATE INDIVIDUAL CYLINDER OFFSETS” is checked. The resultant total timing for each cylinder is displayed in the corresponding fields.

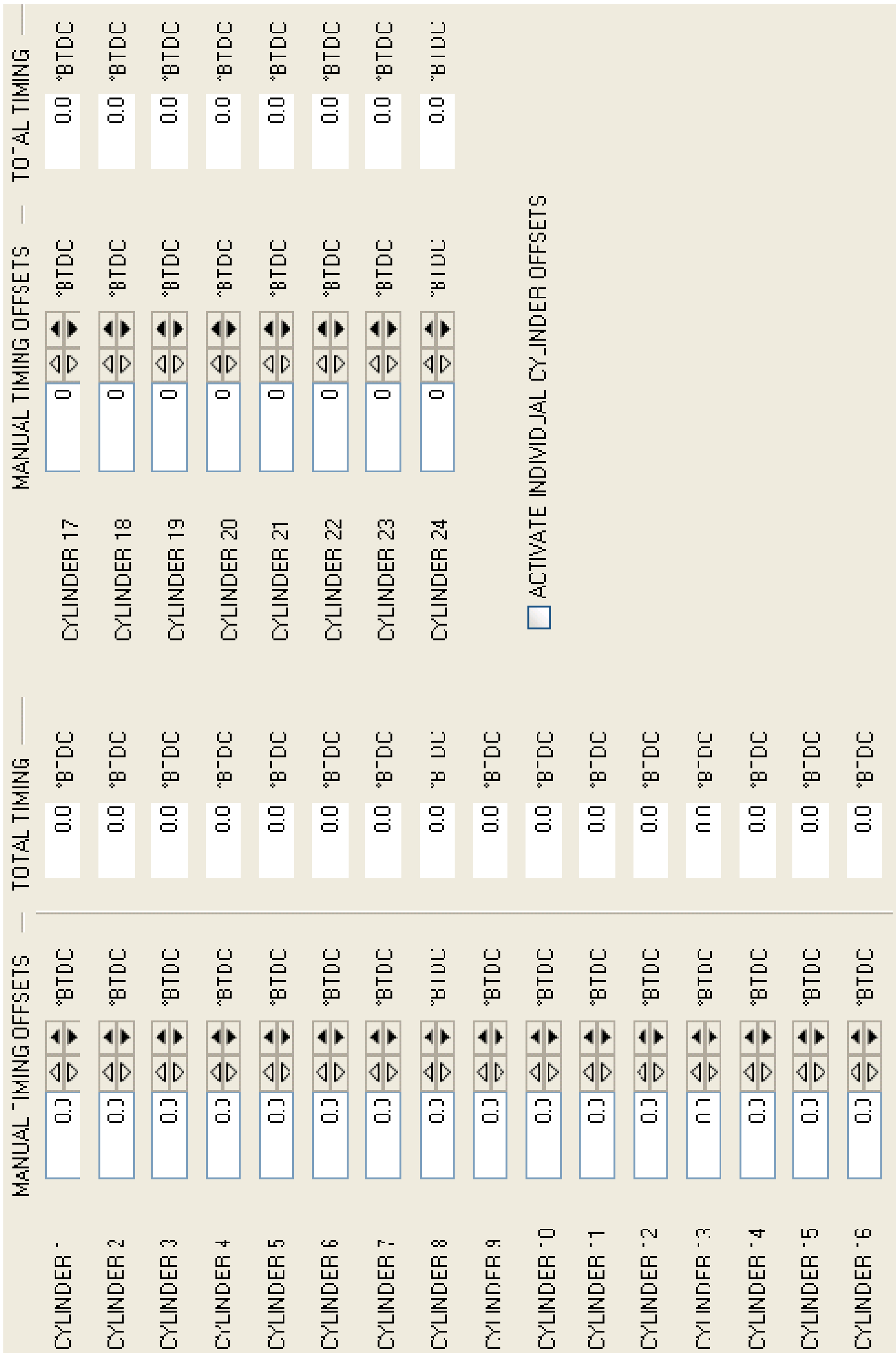


Figure 3-60. HMI Settings for Individual Cylinder Offset (HMI Screen 2.3)

easYgen 3100/3200 Power Management Interface

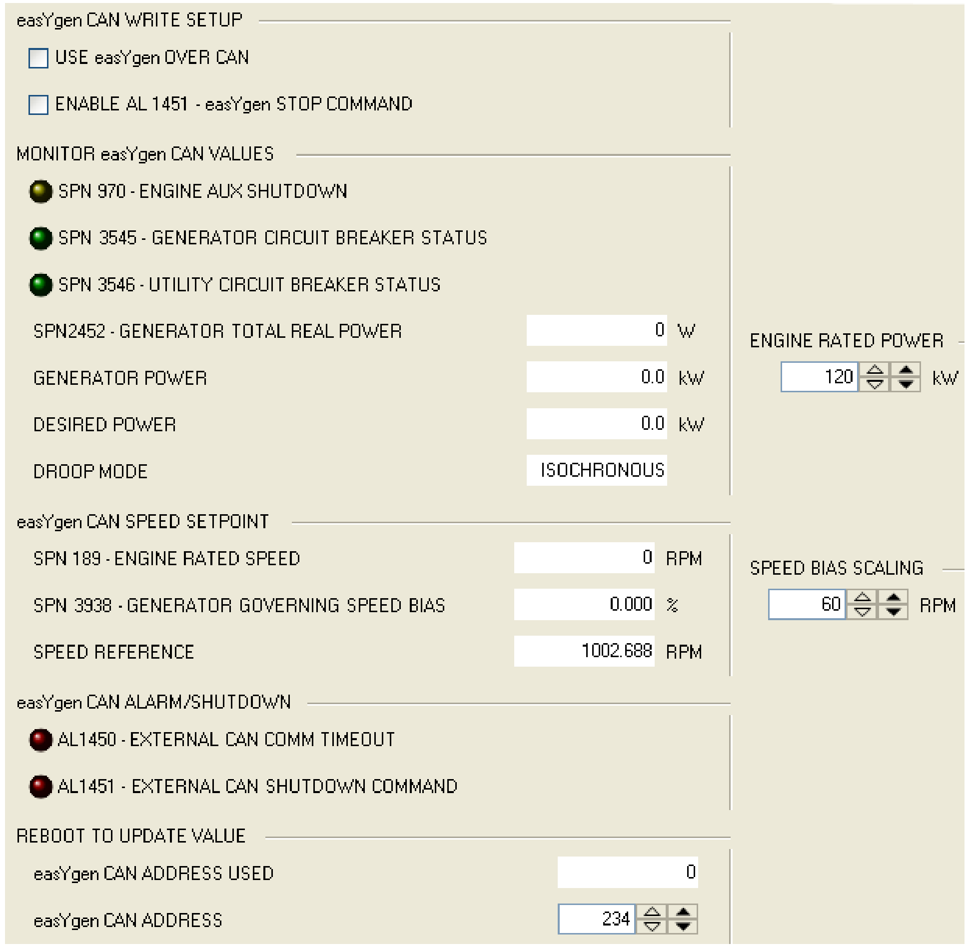


Figure 3-61. easYgen 3100/3200 HMI settings (HMI Screen 6.1)

Figure 3-61 shows the HMI user settings for enabling and configuring the easYgen 3100/3200 interface.

The E3 Stoichiometric Control system can be configured to receive speed or load control signals from the easYgen 3100/3200 Power Management module. The easYgen 3100/3200 is connected to the external (plant) J1939 communication bus to integrate it with the E3 System. Complete information on installation, configuration, and operation of the easYgen 3100/3200 can be found in documents 37223, 37224 and 37225.

System Setup

SYS INFO

Figure 3-62 shows the HMI display screen for system information.

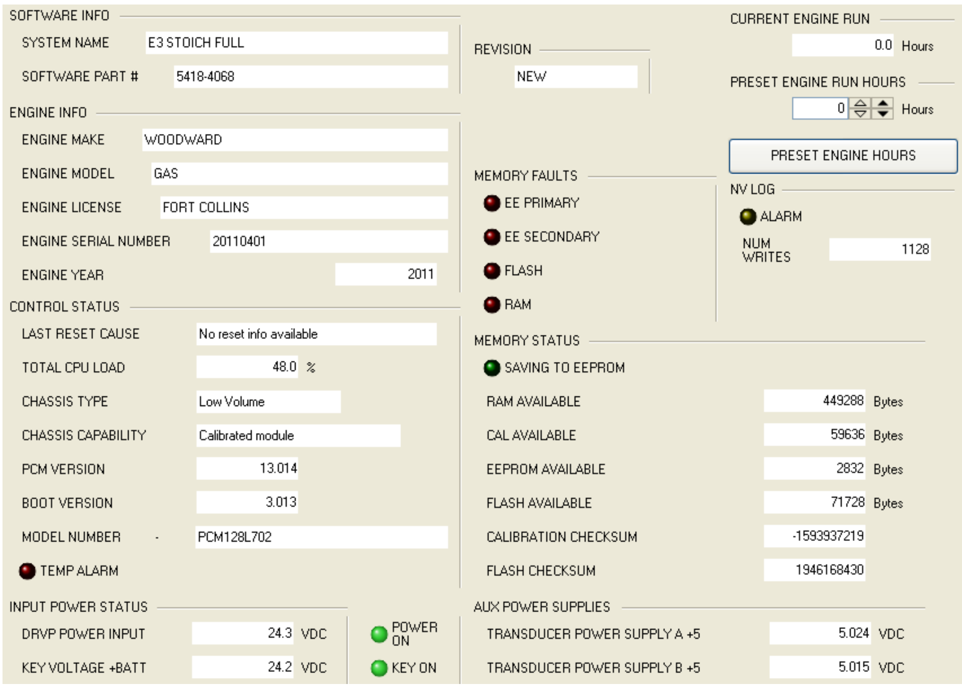


Figure 3-62. SYS INFO (HMI Screen 5.0)

The SYS INFO screen displays status information about the system. The only user configurable item is "PRESET ENGINE HOURS" in the upper right. To preset the engine hours, type the desired value in the box "PRESET VALUE" and click the button "PRESET ENGINE HOURS".

System Configuration

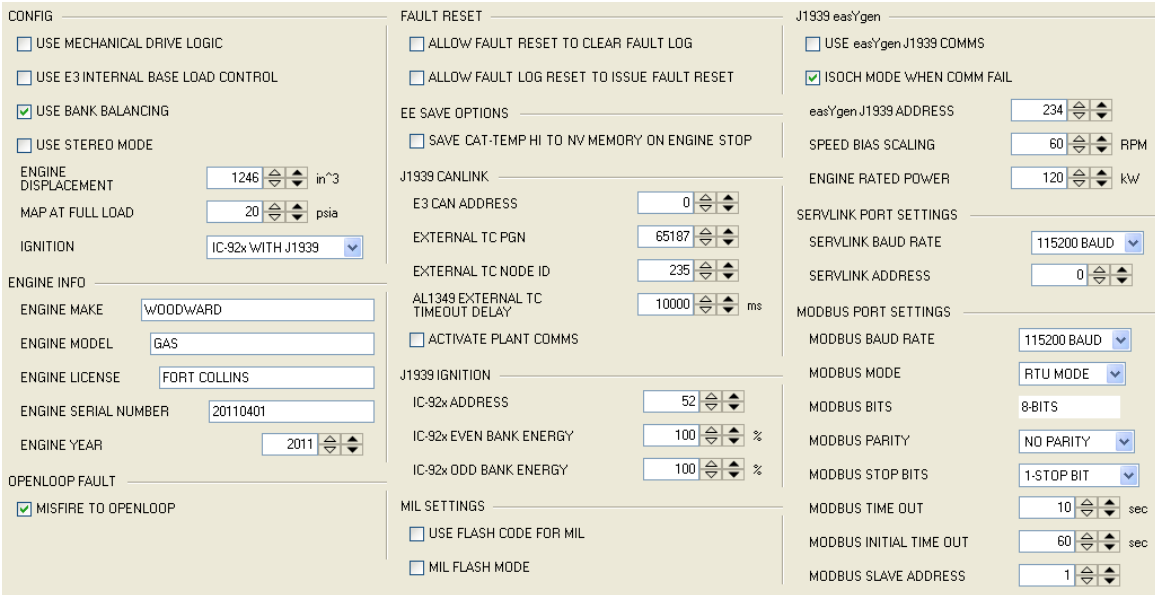


Figure 3-63. Basic System Configuration (HMI Screen 7.0)

Figure 3-63 shows the HMI user settings for basic system configuration on the CONFIG SYS screen.

The basic system configuration options are:

USE MECHANICAL DRIVE LOGIC – When the system will be used in generator applications this box must be unchecked. When running the system in pump/compressor (variable speed mechanical drive) applications this box must be checked.

USE E3 INTERNAL BASE LOAD CONTROL – When the system will be used for generator application parallel to the grid with no external load control this box must be checked.

USE BANK BALANCING – On dual bank applications with two mixture throttles this box can be checked to enable MAP balancing between the two banks.

USE STEREO MODE – On dual bank applications with two trim valves and two pre-cat HEGO sensors this box should be checked to enable stereo closed loop air/fuel ratio control.

ENGINE DISPLACEMENT – The correct engine displacement should be entered as this is used for calculation air and fuel flow.

MAP AT FULL LOAD – The expected MAP at full load should be entered as this is used for scaling of ignition and fuel lookup tables.

IGNITION – This selects which ignition option will be used. “IC-92x WITH J1939” or “3rd PARTY IGNITION (i.e. standalone ignition not connected to or controlled by E3 system).

ENGINE INFO – If desired by the user, information can be entered in the ENGINE INFO fields. The information in these fields is for reference only and does not affect system operation.

FAULT RESET – These options allow selection of the method for clearing faults that are no longer active. Checking both, either or neither of the boxes are all valid selections.

EE SAVE OPTIONS – These options allow auto-saving configuration data and the peak catalyst temperature during the current start-stop cycle to EEPROM on engine stop.

J1939 CANLINK – When the system will use SAE J1939 for IC-92x ignition or Plant Communications these fields must be correctly configured. Check the box "ACTIVATE PLANT COMMUNICATIONS" to allow transmission of operating data and diagnostic messages on the J1939 CAN bus.

J1939 IGNITION – When the system will use SAE J1939 for IC-92x ignition these fields must be correctly configured.

J1939 easYgen – When the system will use an easYgen 3000 with J1939 to receive generator information (measured load, generator and utility breaker, load reference, etc.) the box "USE easYgen J1939 COMMS" must be checked (and the other fields must be correctly configured). When the E3 controller receives this information via hard wired inputs, this box must be unchecked.

SERVLINK PORT SETTINGS – These fields allow configuration of Servlink port settings that are used for Woodward Toolkit and other Woodward applications that can communicate with the E3 control.

MODBUS PORT SETTINGS – These fields allow configuration of Modbus port settings for transmission of operating data and diagnostic messages on the Modbus network.

Discrete I/O Setup

Figure 3-64 shows the HMI user settings for Discrete Input setup.

In the drop-down boxes underneath "DISCRETE INPUT CONFIGURATION" the functionality of the individual inputs can be configured. Depending on the input being configured, choices may include "ALWAYS OFF", "ALWAYS ON", any of the physical inputs listed under "DISCRETE IN", specific MODBUS messages, and specific J1839 CAN messages (e.g. "IC-92X CAN"). The behavior of the physical inputs can be changed from active closed to active open by checking the corresponding box underneath "DI ACTIVE OPEN".

Discrete Inputs Function Description

EXTERNAL SD 1 & 2
These Discrete functions allow for an external device or condition to issue an internal Shutdown condition.

COOLING WATER LEVEL LOW
This Discrete function allows for an external device or condition to issue an internal Alarm condition. This input does not have to be water level, but can be any discrete condition in the system. This function is also tied into the Derate functionality.

LUBE OIL LEVEL LOW
This Discrete function allows for an external device or condition to issue an internal Alarm condition. This input does not have to be oil level, but can be any discrete condition in the system. This function is also tied into the Derate functionality. The default action of this fault is to check the level at all times, to check oil level only when the engine is stopped select EOL CHECK ONLY WHEN STOPPED.

MODBUS SELECT
This Discrete function is intended to be used when Modbus communication is desired. Connect a toggle switch inside the panel to switch the Serial Port to Modbus Slave protocol. Once this switch is activated the port flushes for 5 (five) seconds and switches to Modbus.

BACKDOOR MODE
If immediately after switching the port to Modbus or control power up, there is a Modbus Link error for greater than 60 seconds then the serial port will switch back to Servlink for only 60 seconds to give the user an opportunity to connect to the control and correct the issue.

RUN/STOP
This Discrete function must be asserted for the control to open the throttle, Gas SOV, or Trim Valve. Connect this input to the system control or panel switch. The engine will not run if this input is FALSE.

FAULT RESET
This Discrete function allows the user to reset control faults; it has the same function as the RESET FAULTS button in Toolkit. Connect a momentary spring-return push button on the control panel. The Reset Faults input will only reset Shutdown conditions if the engine is stopped.

IDLE/RATED
This Discrete function is only used for Speed Control Generator Mode and forces the speed to Idle speed reference if the breaker is open. See the Speed Reference section for more information.

LOWER
This Discrete function is only used for Speed Control Mode and lowers the speed reference. Typical application is to use a 3-position switch spring return to center, with the center position unconnected and the CCW position connected to the LOWER input and the CW position connected to the RAISE input. Another toggle switch labeled LOCAL/REMOTE can also be added. When this switch is closed, both the Raise and Lower inputs are closed to place the unit in Remote reference mode. See the Speed Reference section for more information.

RAISE
This Discrete function is only used for Speed Control Mode and raises the speed reference. Typical application is to use a 3-position switch spring return to center, with the center position unconnected and the CCW position connected to the LOWER input and the CW position connected to the RAISE input. Another toggle switch labeled LOCAL/REMOTE can also be added. When this switch is closed, both the Raise and Lower inputs are closed to place the unit in Remote reference mode. See the Speed Reference section for more information.

GENERATOR BREAKER
This Discrete function is only used for Speed Control Mode and switches the control to 2nd Dynamics. Connect this input to the Generator CB AUX contact. This input is also used in conjunction with the UTILITY BREAKER input to place the control into Internal Load Control.

UTILITY BREAKER
This Discrete function is only used for Speed Control Mode and switches the control to Internal Load Control if the GENERATOR BREAKER is also closed. Connect this input to the Utility tie breaker AUX contact.

IGNITION ON
This Discrete function provides a firing indication to the E3 Controller. This input must be closed to open the Gas Shutoff Valve (GSOV), if this input opens while the engine is running, then the GSOV, throttle, and Fuel Trim Valve will close. Connect this input to the third-party Ignition controller "IS FIRING" output. If this functionality is not desired then no connection is to be made to this input and go into the Service Tool and configure this input as 'ALWAYS ON'.

AFR POT LEARN
The AFR POT LEARN input is used in conjunction with the AFR Adjust Potentiometer to allow external AFR setpoint bias. Connect the AFR learn switch to a normally open pushbutton. To use: press the AFR learn button, adjust pot (CW to increase setpoint), release button and the bias increment has been saved for the current load level, all other load levels are not affected.

THROTTLE 1 OK
The THROTTLE 1 OK can provide diagnostic feedback from the throttle. Connect to the Throttle 1 Status Output to this input.

THROTTLE 2 OK
The THROTTLE 2 OK can provide diagnostic feedback from the throttle. Connect to the Throttle 2 Status Output to this input.

FUEL TRIM VALVE 1 OK
The FUEL TRIM VALVE 1 OK can provide diagnostic feedback from the FTV. Connect to the FTV 1 Status Output to this input.

FUEL TRIM VALVE 2 OK
The FUEL TRIM VALVE 2 OK can provide diagnostic feedback from the FTV. Connect to the FTV 2 Status Output to this input.

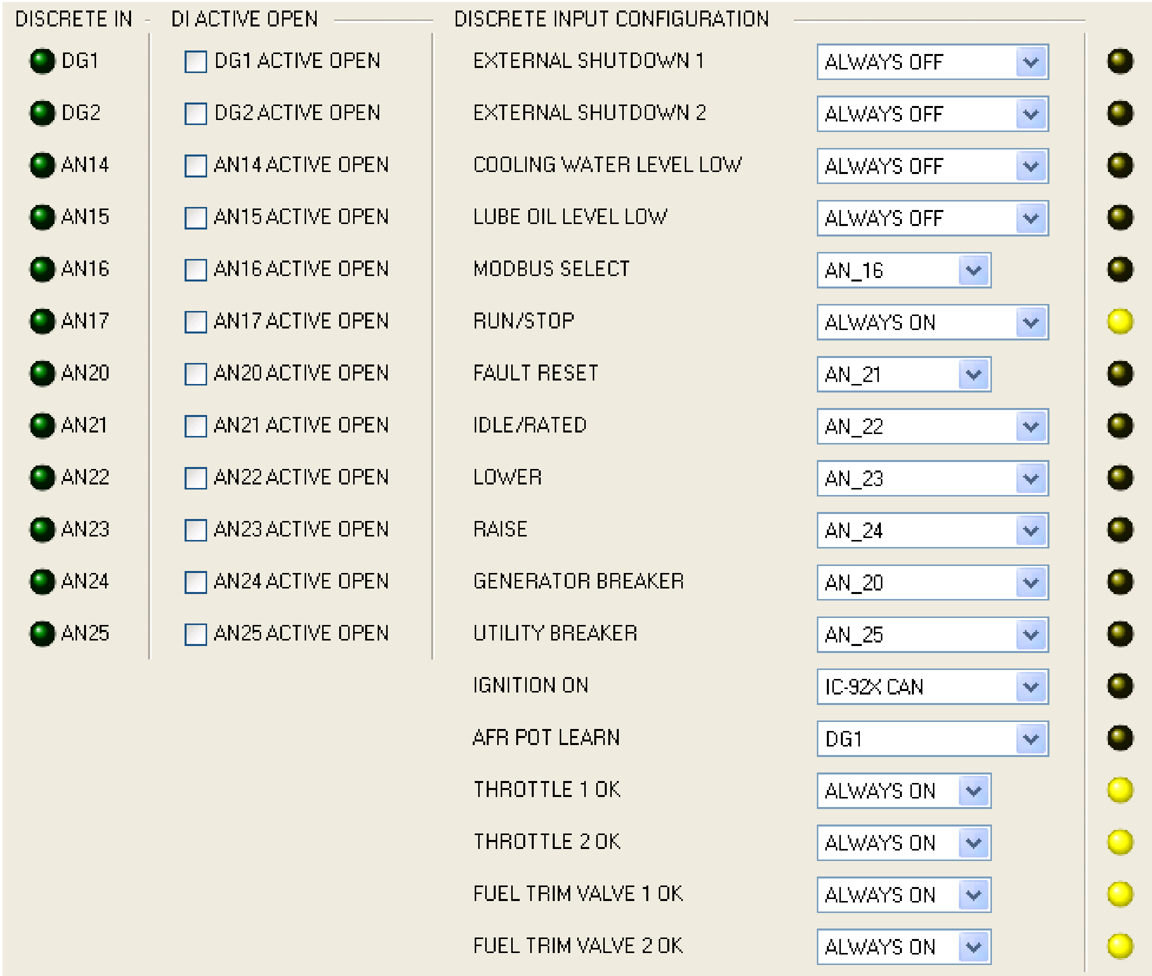


Figure 3-64. Discrete Input Setup (HMI Screen 6.7)

Figure 3-65 shows the HMI user settings for Discrete Output setup. Each output can be manually forced with the engine stopped. If engine speed is detected, all outputs will inhibit the Force mode and operate normally. To enable Force Mode for any Discrete Output check the box next to ENABLE LS XX RELAY FORCE MODE. At that point the LS XX RELAY FORCE VALUE checkbox will match the current condition to avoid any unwanted transitions. At that point the LS XX RELAY FORCE VALUE checkbox will control the output to perform wiring checks, device forcing, or troubleshooting.

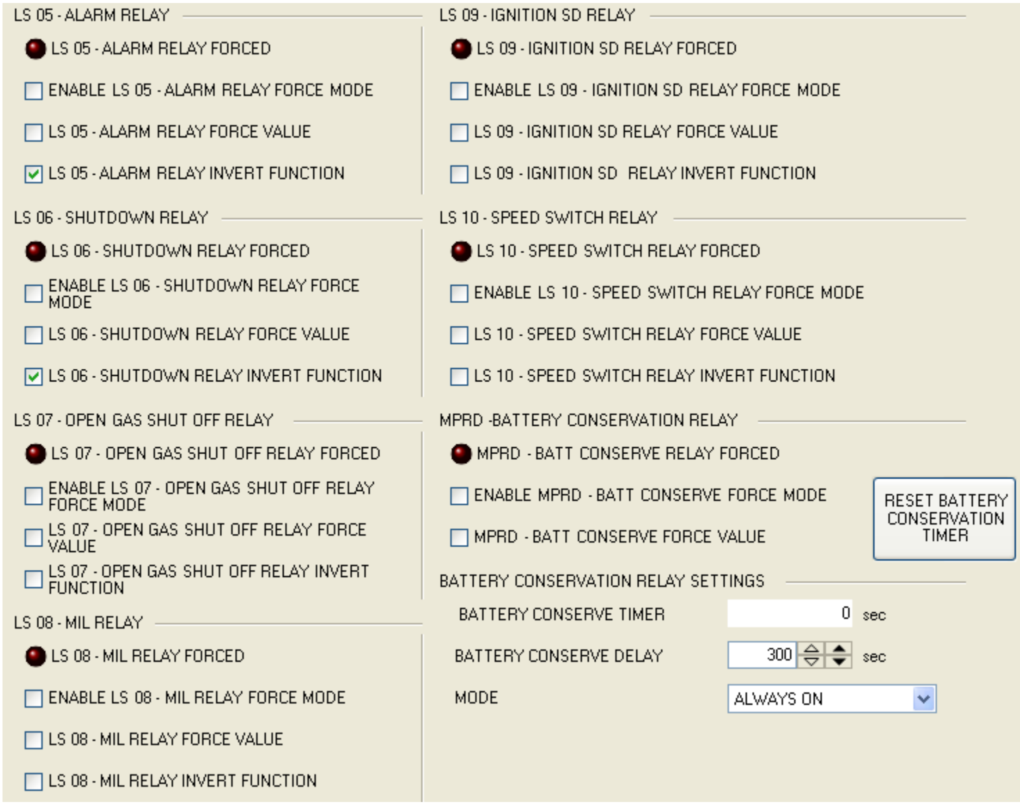


Figure 3-65. Discrete Output Setup (HMI Screen 6.6)

Discrete Outputs Function Description

LS05 - ALARM RELAY

This output indicates an ALARM fault condition is active in the E3 Control. This output will latch until reset. Connect a relay that lights a lamp or signals to the SCADA or engine control that there is a latched fault condition.

LS06 - SHUTDOWN RELAY

This output indicates a SHUTDOWN fault condition is active in the E3 Control. This output will latch until reset. Connect a relay that lights a lamp or signals to the SCADA or engine control that there is a latched SHUTDOWN condition.

LS07 – OPEN GSOV RELAY

This output opens the engine Gas Shutoff Valve. This output will operate based on the run sequence. Connect a relay that opens the GSOV.

LS08 – MIL RELAY

This output has two selectable modes: Emissions Fault or MIL Flash code. When USE FLASH CODE FOR MIL is checked the MIL will flash when there is a fault. FLASH CODE: Flash the number 12 to signal the start of the flash sequence followed by the first applicable event from the FAULT LOG. When the first applicable event is finished, the MIL block will flash the next fault until all faults have been displayed then start over with the number 12. Uncheck this box to configure the MIL output to activate only when an emissions related fault occurs.

LS09 – IGNITION SD RELAY

This output provides the Ignition Shutdown signal to an external Ignition controller (including the IC-92X). This output works with the Purge timer and Shutdown Logic to provide a means to shutdown the Ignition Controller. Connect to the permissive input for the Ignition Controller (Contact A for the IC-92X).

LS10 – SPEED SWITCH RELAY

This output provides a simple speed switch function for external use. Connect to the external device through a relay. If the Pickup setting is higher than the dropout, the switch becomes active above the pick up speed and becomes inactive when the speed drops below the dropout setting. If the dropout setting is higher than the pickup setting, then the switch becomes active below the dropout speed and inactivates when the speed rises above the pickup setting.

MPRD – BATTERY CONSERVATION RELAY

This output provides a means to turn off or disable electric actuators used by the system. Connect through a relay to control the Actuator power directly. Alternately the relay contacts can be used to switch the RUN ENABLE inputs for the actuators. The relay is energized immediately on control power-up or engine start and resets after the engine has been stopped for a tunable delay time.

Fault Configuration

In Figures 2-74(a) through 2-74(h) the user settings for fault configuration are shown. For detailed descriptions of each fault see Chapter 5. These settings allow an individual fault to be enabled, its delay time to be configured (when applicable), and other parameters pertaining to specific faults to be adjusted.

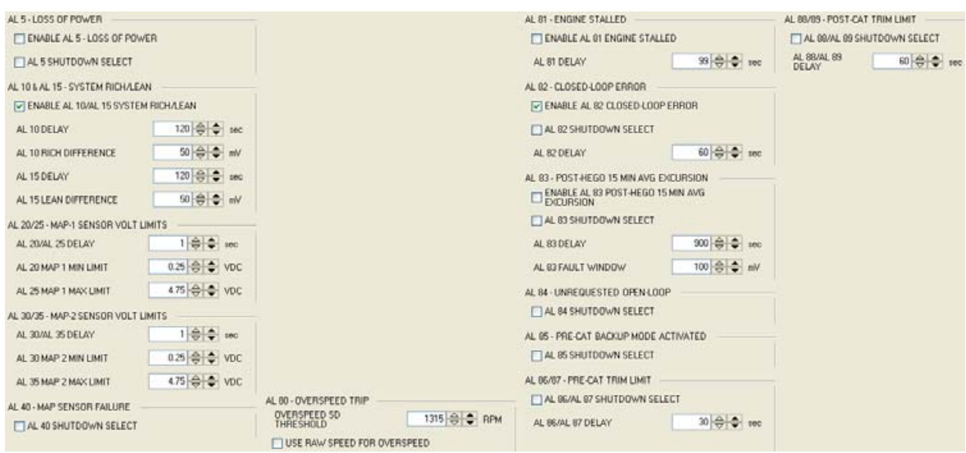


Figure 3-66a. Fault Configuration Faults 5-89 (HMI Screen 7.4)

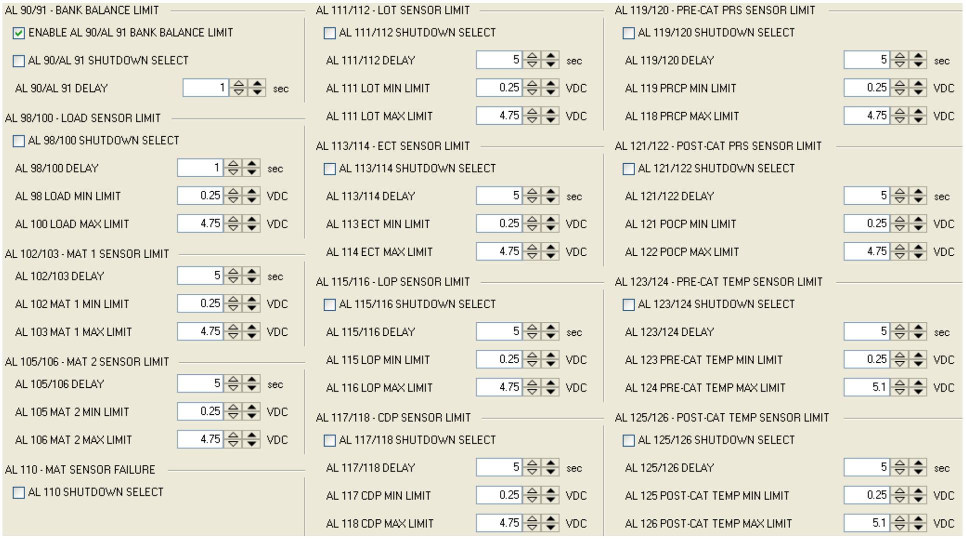


Figure 3-66b. Fault Configuration Faults 90-126 (HMI Screen 7.5)

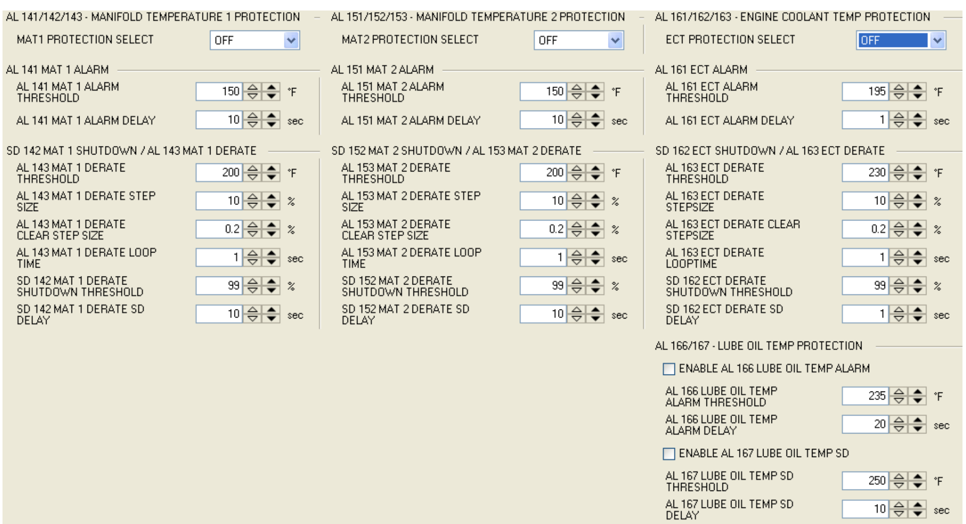


Figure 3-66c. Fault Configuration Faults 141-167 (HMI Screen 7.6)

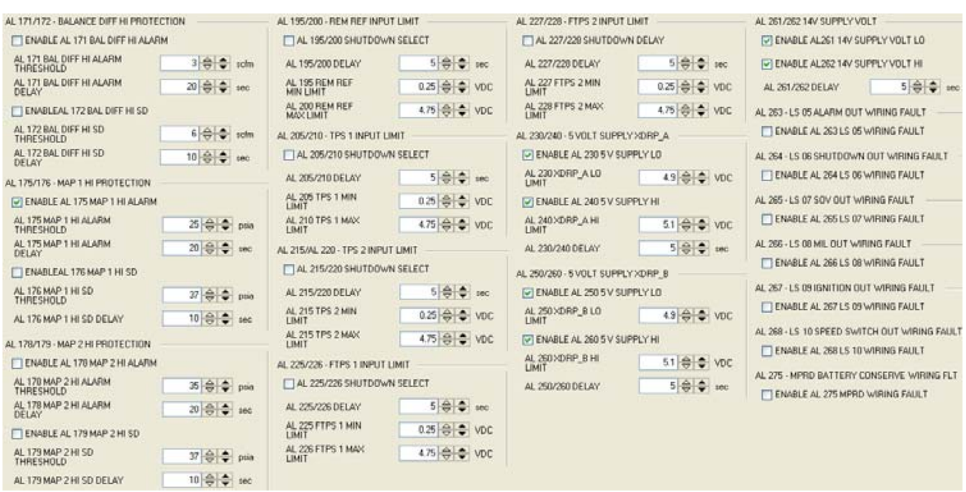


Figure 3-66d. Fault Configuration Faults 171-275 (HMI Screen 7.7)

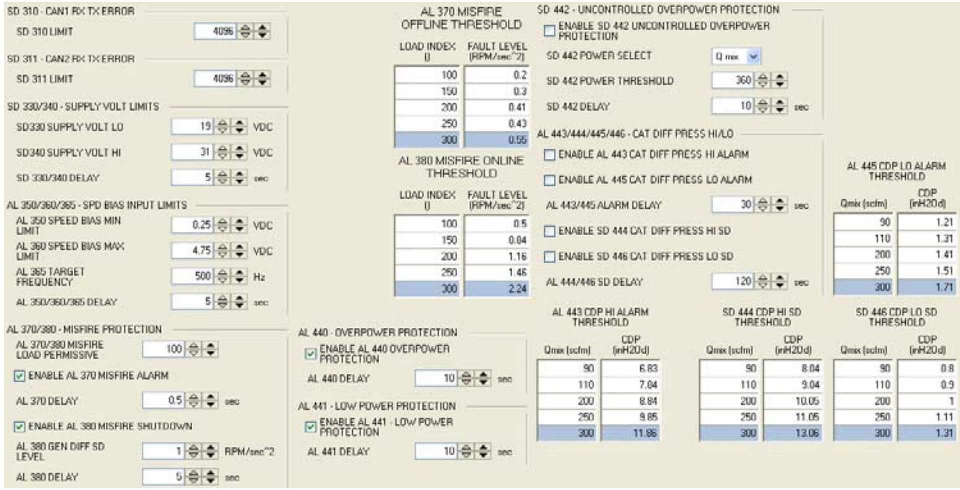


Figure 3-66e. Fault Configuration Faults 310-446 (HMI Screen 7.8)

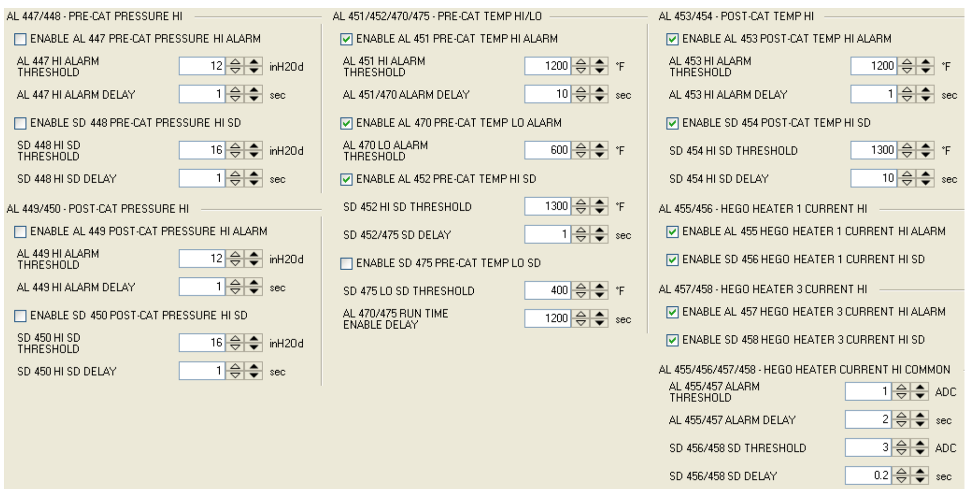


Figure 3-66f. Fault Configuration Faults 447-475 (HMI Screen 7.9)

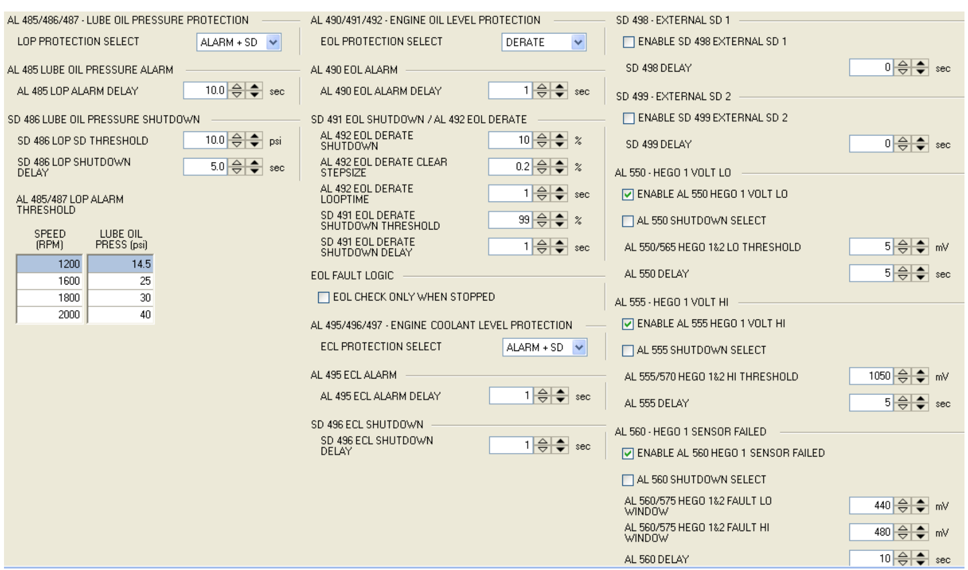


Figure 3-66g. Fault Configuration Faults 485-560 (HMI Screen 7.10)

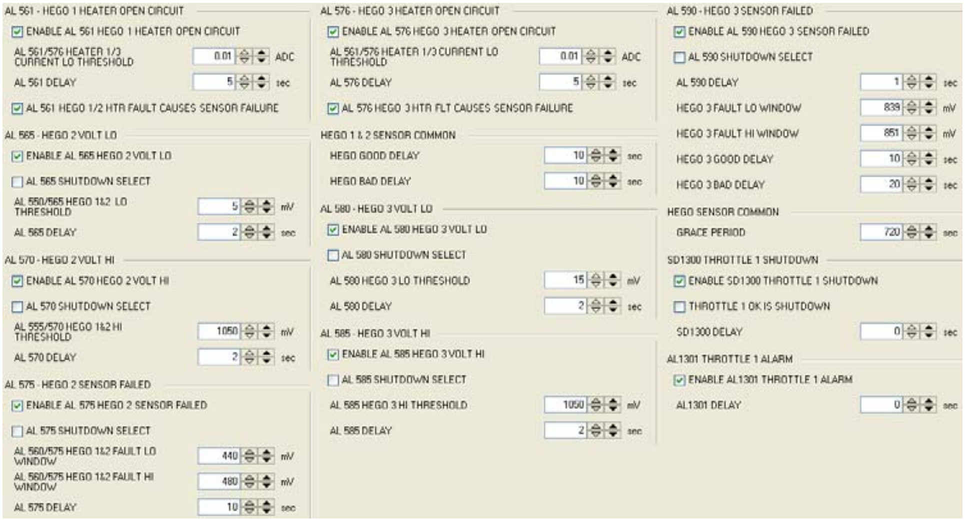


Figure 3-66h. Fault Configuration Faults 561-1301 (HMI Screen 7.11)

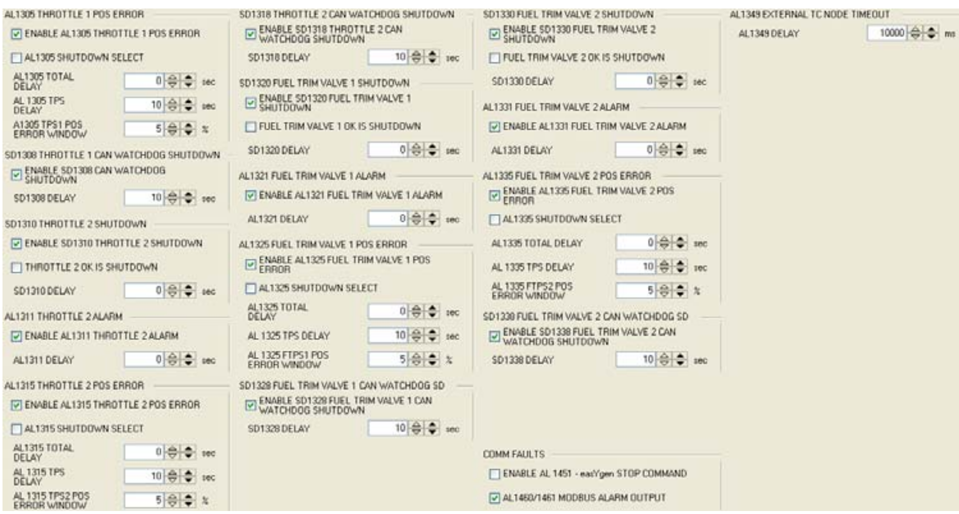


Figure 3-66i. Fault Configuration Faults 1305 & up (HMI Screen 7.12)

LISTING OF SETTINGS AND DEFINITIONS

Dashboard

The Dashboard (see Figure 3-2) is located on the left side of the screen and provides key operational information pertaining to the control and engine.

All online pages except Configuration pages display the Dashboard readout.

The Dashboard also contains a graphical indication of the HEGO sensor modes.

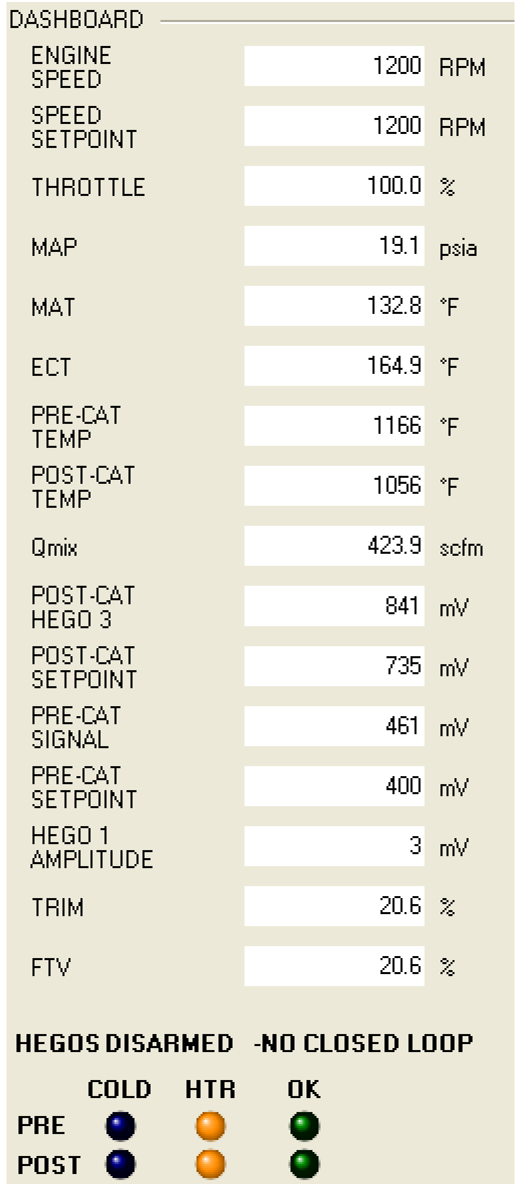


Figure 3-67. E3 Stoich Mono Dashboard

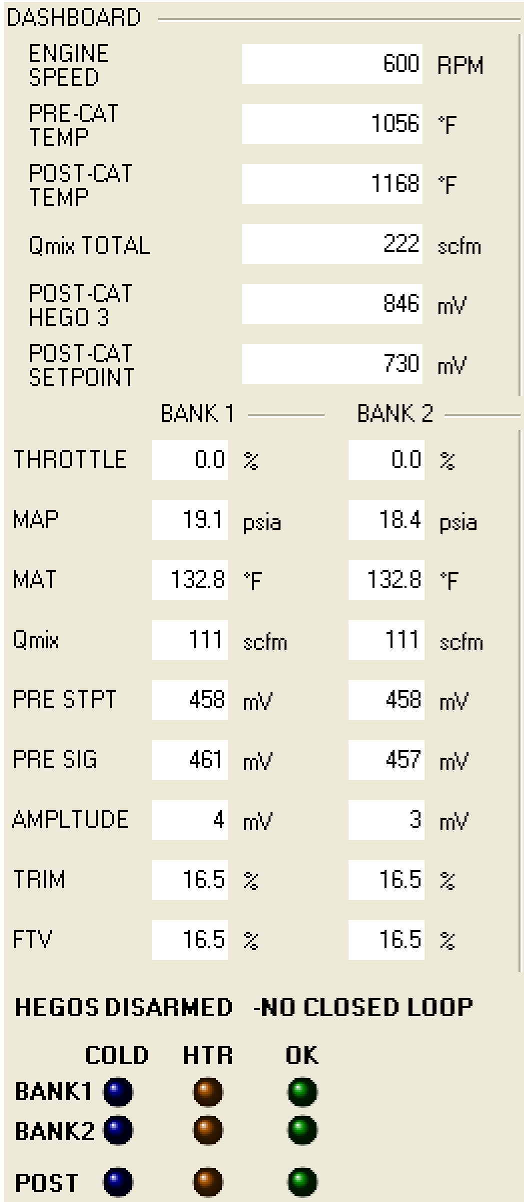


Figure 3-68. E3 Stoich Stereo Dashboard

ENGINE SPEED
Filtered engine speed (RPM).

SPEED SETPOINT
Speed setpoint for the speed control (RPM).

THROTTLE
Throttle demand for the speed control (%).

MAP
Resultant Manifold Absolute Pressure (psia).

MAT
Resultant Manifold Air Temperature (°F).

ECT
Engine Coolant Temperature (°F).

PRE-CAT TEMP
Catalyst Inlet Temperature (°F).

POST-CAT TEMP
Catalyst Outlet Temperature (°F).

Qmix
Estimated engine charge flow (scfm).

POST-CAT HEGO 3
Catalyst Outlet HEGO sensor measurement (mV).

POST-CAT SETPOINT
Voltage setpoint for the Post-Cat AFR control (mV).

PRE-CAT SIGNAL
Processed signal for the Pre-Cat AFR control (mV).

PRE-CAT SETPOINT
Voltage setpoint for the Pre-Cat AFR control (mV).

HEGO 1 AMPLITUDE
Pre-Cat peak dither amplitude feedback measurement (mV).

TRIM
The base (non-dithered) trim command (%).

FTV
Actual FTV position demand (with dither) (%).

Info Bar

All online pages display the Info Bar readout.
It is located at the top of the screen and provides key operational information pertaining to the control.

Figure 3-69. Info Bar (All Screens)

ALARM
Current control Alarm status.

MIL
Current control Malfunction Indicator Lamp (Emissions fault) status.

SHUTDOWN
Current control Shutdown status.

AFR MODE
The current Air/Fuel Ratio Operational Mode display.

FAULT LOG (BUTTON)
Shortcut button to the FAULT LOG page.

NAVIGATION PAGE (BUTTON)
Shortcut button to the NAVIGATION page.

RUN TIME
Shows the cumulative run hours of the engine (Hours).

AFR Control

AFR PRE-CAT

The main page for Air/Fuel Ratio control setup and troubleshooting.
Provides key settings pertaining to the pre-catalyst AFR control.

AFR STATE
REQUEST MODE *
Dropdown box that that selects the Air/Fuel Ratio Mode.

IN OPEN LOOP - REASON
Indication of the reason for the Open Loop Mode - Possible States: “IGN OPEN/SHORT”, “MISFIRE”, “LOAD NOT READY”, “SENSORS COLD”, “FAILED SENSOR”, or “REQ OPEN LOOP”.

PRE-CAT CLOSED LOOP
CONTROL ENABLED
LED indicating that the Pre-Cat Control loop is enabled.

PRE-CAT CONTROL PID
Readout of bias to Post-Cat Control Loop (%).

TRIM
Readout of the pre-dither base signal (%).

PROP GAIN *
The Proportional Gain of the Pre-Cat Control Loop, decreasing the Prop Gain will reduce the response of the control loop. See PID control section.

INT GAIN *
The Integral Gain of the Pre-Cat Control Loop, decreasing the Int Gain will slow the response of the control loop. See PID control section.

SDR *
The SDR of the Pre-Cat Control Loop. See PID control section.

LO SCALE LIMIT *
The minimum trim command out, this parameter establishes the minimum trim limit for the Pre-Cat Control PID (%). If the PID is driven to this value for the delay timer, an alarm will be triggered.

HI SCALE LIMIT *
The maximum trim command out, this parameter establishes the maximum trim limit for the Pre-Cat Control PID (%). If the PID is driven to this value for the delay timer, an alarm will be triggered.

ADVANCED DYNAMICS

GAIN RATIO *
The ratio applied to the Prop Gain when the Pre-Cat AFR control error has exceeded the WINDOW. See PID control section.

WINDOW *
The Pre-Cat AFR control error threshold that activates the GAIN RATIO (mV). See PID control section.

CONTROL

SYMMETRY *
Values below 1.0 allow an asymmetric signal to reduce the lean AFR excursions into the catalyst.
AFR SIGNAL FILTER *
The AFR Signal filter value after the Running average calculations (sec). Increasing this parameter smoothes the signal but slows response.
AFR SIGNAL CYCLES *
The number of samples used for the Running average calculations. Increasing this parameter smoothes the signal but slows response.

FTV LIMITS

LO
LED indicating the Pre-cat control loop is on its Low Limit.

HI
LED indicating the Pre-cat control loop is on its High Limit.

AFR TABLES
These tables provide the settings for the Air Fuel Ratio control and all share a common index. The output of each table is also shown.

OPEN LOOP TABLE *
2 x 8 lookup table Qmix (scfm) vs. Fuel Trim Valve Position (%) which provides the feed-forward Fuel Trim Valve signal.

PRE-CAT SETPOINT TABLE *
2 x 8 lookup table Qmix (scfm) vs. Pre-Cat Setpoint (mV) allows a non-linear setpoint over engine load.

FREQUENCY TABLE *
2 x 8 lookup table Qmix (scfm) vs. Frequency (Hz) allows a non-linear Dither Frequency setting over engine load.

AMPLITUDE TABLE *
2 x 8 lookup table Qmix (scfm) vs. Amplitude (%) allows a non-linear Dither Amplitude setting over engine load.

HEGO SWITCHING QUALITY
This group provides a snapshot of the switching quality of the Pre-Cat HEGO sensor.

SENSOR RICH
An LED indication that the Pre-Cat HEGO sensor reading is above 450 mV.

HEGO 1 LO PEAK
The lowest HEGO 1 reading in the last dither cycle (mV).

HEGO 1 HI PEAK
The highest HEGO 1 reading in the last dither cycle (mV).

HEGO 1 AMPLITUDE
The difference in the peak measurements for the last dither cycle (mV).

TRIM SETTINGS
START POSITION *
The Fuel Trim Valve position held during engine start (%).

DEFAULT RATE *
The rate at which the trim valve ramps to the default position when the MAP sensor(s) have failed (%/sec).

MANUAL POSITION *
The setting that allows the commissioning engineer to manipulate the trim valve during setup and troubleshooting (%). NOTE: The Manual Position setting tracks the previous trim valve position for bumpless transition into manual mode.

DEFAULT POSITION *
The position the Fuel trim valve goes to when the MAP sensor(s) have failed (%).

MANUAL MODE RATE *
The rate at which the fuel trim valve moves when a new manual position is commanded from the Toolkit (%/sec).

AFR SETTINGS
LOAD BREAKPOINT *
The Qmix threshold that activates the closed-loop AFR control (scfm).

LOAD HYSTERESIS *
The Qmix difference below the LOAD BREAKPOINT that the closed-loop AFR control will disable (scfm).

BREAKPOINT DELAY *
The delay time that the Qmix has to be above the LOAD BREAKPOINT to activate closed-loop AFR control (sec).

FEED-FORWARD FILTER *
The filter applied to the OPEN LOOP TABLE feed-forward value. A higher value will result in a sluggish fuel valve response (sec).

AFR POST-CAT

AFR STATE
REQUEST MODE *
Dropdown box that that selects the Air/Fuel Ratio Mode.

IN OPEN LOOP - REASON
Indication of the reason for the Open Loop Mode - Possible States: “IGN OPEN/SHORT”, “MISFIRE”, “LOAD NOT READY”, “SENSORS COLD”, “FAILED SENSOR”, or “REQ OPEN LOOP”.

POST-CAT STATUS
POST-CAT ENABLED
LED indicating the Post-Cat Control loop is enabled.

POST-CAT LO LIMIT
LED indicating the Post-cat control loop is on its Low Limit.

POST-CAT HI LIMIT
LED indicating the Post-cat control loop is on its High Limit.

POST-CAT CONTROL PID
Readout of the Post-Cat Control PID (+/-%).

POST-CAT SETPOINT
Readout of the Post-Cat Setpoint including the bias and the AFR SETPOINT TABLE (mV).

POST-CAT CONTROL
PROP GAIN
The Proportional Gain of the Post-Cat Control Loop, decreasing the Prop Gain will reduce the response of the control loop. See PID control section.

INT GAIN *
The Integral Gain of the Post-Cat Control Loop, decreasing the Int Gain will slow the response of the control loop. See PID control section.

SDR *
The SDR of the Post-Cat Control Loop. See PID control section.

DEADBAND *
Once the post-cat control has reached setpoint, the PID will freeze until the absolute value of the control error is greater than this value (mV).

TRIM SCALE *
The range of the post-cat PID, this value represents 100% bias (mV).

PRE-CAT STATUS
CONTROL ENABLED
LED indicating that the Pre-Cat Control loop is enabled.

PRE-CAT CONTROL PID
Readout of bias to Post-Cat Control Loop (%).

POST-CAT PID BIAS
Readout of the post-cat control loop bias to the pre-cat setpoint (mV).

PRE-CAT LO LIMIT
LED indicating the Pre-cat control loop is on its Low Limit.

PRE-CAT HI LIMIT
LED indicating the Pre-cat control loop is on its High Limit.

AFR TABLES
These tables provide the settings for the Air Fuel Ratio control, the pre-cat tables all share a common index. The Post-Cat Setpoint and External Bias tables share an index. The output of each table is also shown.

OPEN LOOP TABLE *
2 x 8 lookup table Qmix (scfm) vs. Fuel Trim Valve Position (%) which provides the feed-forward Fuel Trim Valve signal.

AFR SETPOINT TABLE *
2 x 8 lookup table Qmix (scfm) vs. Pre-Cat Setpoint (mV) allows a non-linear setpoint over engine load.

POST-CAT SP TABLE *
2 x 8 lookup table Qmix (scfm) vs. Post-Cat Setpoint (mV) allows a non-linear Post-Cat setpoint setting over engine load.

FREQUENCY *
Readout of the Pre-Cat Dither Frequency (Hz).

AMPLITUDE *
Readout of the Pre-Cat Dither Amplitude (Hz).

POST HEGO SIGNAL FILTER

POST-HEGO SIGNAL FILTER *
The Post-Cat HEGO Signal filter value after the Running average calculations (sec). Increasing this parameter smoothes the signal but slows response.

POST-HEGO SIGNAL CYCLES *
The number of samples used for the Running average calculations. Increasing this parameter smoothes the signal but slows response.

POST HEGO SIGNAL PROCESSING

USE AVG PER CYCLE *
Use the per cycle average as the process signal, if this value is unchecked the control uses the HEGO 3 INPUT FILTERED for the PID process signal.

USE RUNNING AVERAGE *
Use the running average for the Post-Cat HEGO signal.

HEGO 1 SWITCHING QUALITY
This group provides a snapshot of the switching quality of the Pre-Cat HEGO sensor.

SENSOR RICH
An LED indication that the Pre-Cat HEGO sensor reading is above 450 mV.

HEGO 1 LO PEAK
The lowest HEGO 1 reading in the last dither cycle (mV).

HEGO 1 HI PEAK
The highest HEGO 1 reading in the last dither cycle (mV).

HEGO 1 AMPLITUDE
The difference in the peak measurements for the last dither cycle (mV).

TRIM SETTINGS
START POSITION *
The Fuel Trim Valve position held during engine start (%).

DEFAULT RATE *
The rate at which the trim valve ramps to the default position when the MAP sensor(s) have failed (%/sec).

MANUAL POSITION *
The setting that allows the commissioning engineer to manipulate the trim valve during setup and troubleshooting (%). NOTE: The Manual Position setting tracks the previous trim valve position for bumpless transition into manual mode.

DEFAULT POSITION *
The position the Fuel trim valve goes to when the MAP sensor(s) have failed (%).

MANUAL MODE RATE *
The rate at which the fuel trim valve moves when a new manual position is commanded from the Toolkit (%/sec).

AFR SETTINGS
LOAD BREAKPOINT *
The Qmix threshold that activates the closed-loop AFR control (scfm).

LOAD HYSTERESIS *
The Qmix difference below the LOAD BREAKPOINT that the closed-loop AFR control will disable (scfm).

BREAKPOINT DELAY *
The delay time that the Qmix has to be above the LOAD BREAKPOINT to activate closed-loop AFR control (sec).

FEED-FORWARD FILTER *
The filter applied to the OPEN LOOP TABLE feed-forward value (sec). A higher value will result in a sluggish fuel valve response.

AFR TREND

The AFR TREND page shows important AFR related variables.

CATALYST HEALTH

This page shows catalyst health conditions and system flow information.

PRE-CAT TEMP
PRE-CAT TEMP
Displays the current pre-cat temperature (°F). Reads -100 °F if not configured.

PRE-CAT TEMP PEAK HI
The highest value captured @5 ms since reset.

PRE-CAT TEMP PEAK LO
The lowest value captured @5 ms since reset.

RESET PRE-CAT TEMP PEAK DETECT
Momentary button that resets the peak detectors.

CAT TEMP RISE
CAT TEMP RISE
Displays the current cat temp rise temperature (°F).

CAT TEMP RISE PEAK HI
The highest value captured @5 ms since reset (°F).

CAT TEMP RISE PEAK LO
The lowest value captured @ 5 ms since reset (°F).

RESET CAT TEMP RISE PEAK DETECT
Momentary button that resets the peak detectors.

POST-CAT TEMP
POST-CAT TEMP
Displays the current pre-cat temperature (°F). Reads -100 °F if not configured.

POST-CAT TEMP PEAK HI
The highest value captured @5 ms since reset (°F).

POST-CAT TEMP PEAK LO
The lowest value captured @5 ms since reset (°F).

RESET POST-CAT TEMP PEAK DETECT
Momentary button that resets the peak detectors.

15-MINUTE AVERAGE POST-HEGO
15-MINUTE AVERAGE POST-HEGO
Displays the current average post-HEGO measurement (mV).
Reads current buffer average when buffer is not full.

15-MINUTE AVERAGE VALID
LED that indicates the buffer is full and the average is valid.

15-MINUTE AVERAGE CLEAR BUFFER
Momentary button that resets the buffer count to one.

15-MINUTE EXCURSION PEAK HI
The highest value captured @5 ms since reset (mV).

15-MINUTE EXCURSION PEAK LO
The lowest value captured @5 ms since reset (mV).

RESET 15-MINUTE EXCURSION PEAK DETECT
Momentary button that resets the peak detectors.

ENGINE FLOW INFO
Qmix
Displays the current engine flow estimate (scfm).

VOLUMETRIC EFF
VE table output (%).

MAP PERCENT OF FULL LOAD
MAP AT FULL LOAD / current MAP X 100 (%).

SPEED PERCENT OF FULL LOAD
RATED SPEED / current Speed X 100 (%).

VIEW VOLUMETRIC EFFICIENCY *
A toggle button that switches the display between VE table and 15-MIN AVG/CAT PRESSURE.

VOLUMETRIC EFFICIENCY TABLE *
5 x 5 lookup table SPEED%(%) vs. LOAD% (%) vs. VE (%) which provides the VE estimate for the Qmix calculation.

VE AT CURRENT SPEED AND LOAD
The current VE table output (%).

CAT DP
Catalyst Differential pressure based on one dP sensor or pre/post-cat pressure difference.

CAT DP
Displays the current catalyst differential pressure (“H2Od).

CAT DP PEAK HI
The highest value captured @5 ms since reset (“H2Od).

CAT DP PEAK LO
The lowest value captured @5 ms since reset (“H2Od).

RESET CAT DP PEAK DETECT
Momentary button that resets the peak detectors.

PRE-CAT PRESS
PRE-CAT PRESS
Displays the current pre-cat pressure (“H2O).

PRE-CAT PRESS PEAK HI
The highest value captured @5 ms since reset (“H2O).

PRE-CAT PRESS PEAK LO
The lowest value captured @5 ms since reset (“H2O).

RESET PRE-CAT PRESS PEAK DETECT
Momentary button that resets the peak detectors.

Speed Control

Start

This page shows important engine start and control information.

SPEED CONTROL
SPEED REFERENCE
Displays the current Speed setpoint (RPM).

ACTUAL SPEED
The speed that the control PID uses to control the throttle(s) (RPM). This speed is filtered using a dynamic rotational filter using sampling and averaging.

RAW SPEED
The Raw Speed is used for speed switches that control the E3 sequencing (RPM).

THROTTLE DEMAND
Readout that indicates the command sent to the throttle (%).

IDLE TIME WAITING
Indication of the time remaining for the Idle Delay (sec).

START SETTINGS
PURGE TIME *
Sets the time delay for the engine to expel explosive mixtures through the intake and exhaust before the ignition is activated (sec).

START FUEL LIMIT *
The value the throttle is set upon start (%). The throttle stays at this value until the engine reaches RUN SPEED at which the throttle will ramp up at the START RAMP rate.

START RAMP *
The rate that the throttle will increase after the RUN SPEED is exceeded (%/sec).

IDLE WAIT TIME *
The time delay after which the engine speed reaches idle that the control will ramp to RATED speed id in Generator Mode (sec).

MAXIMUM FUEL LIMITER *
The maximum value the throttle demand will go to (%). This acts as an electronic limiter or troubleshooting tool.

INPUTS
RUN
LED indicating the RUN input status, throttle or Fuel Trim Valve will not open if RUN is not active.

IDLE
LED indicating the IDLE input status; active only in generator mode, the IDLE input will ramp the speed reference to the MIN SPEED setpoint.

LOWER
LED indicating the LOWER input status; the LOWER input allows discrete remote control of the speed reference.

RAISE
LED indicating the RAISE input status; the RAISE input allows discrete remote control of the speed reference.

IGNITION FIRING
LED indicating the IGNITION FIRING input status; the IGNITION input allows the FUEL VALVE to open.

STATUS
ENGINE STOPPED
LED indicating the ENGINE STOPPED internal speed switch status.

ENGINE CRANKING
LED indicating the ENGINE CRANKING internal speed switch status.

ENGINE RUNNING
LED indicating the ENGINE RUNNING internal speed switch status.

IGNITION SHUTDOWN
LED indicating the IGNITION SHUTDOWN output status; the IGNITION input and RUN input must be active and the engine must be rolling for the PURGE TIME to allow the IGNITION SHUTDOWN to be deactivated.

FUEL SHUTOFF VALVE OPEN
LED indicating the FUEL SHUTOFF VALVE output status; if the FUEL SHUTOFF VALVE is open then the Throttle and Fuel Trim Valve will be allowed to open.

SPEED PEAK DETECT

SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

DYNAMICS SELECTED

PROP GAIN SELECTED
A text box indicating the status of the Prop Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

INT GAIN SELECTED
A text box indicating the status of the Int Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SDR SELECTED
A text box indicating the status of the SDR Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SPEED FRACTION
Displays the fraction of the base gain that is developed by the SPEED BIASED DYNAMICS.

FIXED DYNAMICS

P GAIN *
This setting allows the user to select a constant P GAIN setting by checking the box.

I GAIN *
This setting allows the user to select a constant I GAIN setting by checking the box.

SDR *
This setting allows the user to select a constant SDR setting by checking the box.

LSS BUS STATUS
A bar graph that illustrates the throttle control LSS bus; LEDs indicate which input is in control of the throttle command.

OUT
The output of the speed control Low Signal Select (LSS) Bus (%); this signal is used to drive the throttle.

PID
The output of the PID going into the LSS bus.

LOAD REJ
The LOAD REJECTION logic output (%).

MAX
The MAX FUEL LIMITER value into the LSS (%).

SFL
The START FUEL LIMIT value into the LSS (%).

TRIM VALVE CONTROL
Select AFR trim settings to allow for start adjustments.

AFR MODE REQUEST *
Dropdown box that that selects the Air/Fuel Ratio Mode.

TRIM VALVE START POSITION *
The position the Fuel Trim Valve goes during start (%).

MANUAL POSITION *
The setting that allows the commissioning engineer to manipulate the trim valve during setup and troubleshooting (%). NOTE: The Manual Position setting tracks the previous trim valve position for bumpless transition into manual mode.

FIXED DYNAMICS

FIXED DYNAMICS
This page allows the user to use the fixed dynamics to tune the speed control loop and map the dynamics to the engine operating range without concern about the automatic mapping exhibited on the other dynamics settings.

PROP GAIN *
The Proportional Gain of the Post-Cat Control Loop, decreasing the Prop Gain will reduce the response of the control loop. See PID control section.

INT GAIN *
The Integral Gain of the Post-Cat Control Loop, decreasing the Int Gain will slow the response of the control loop. See PID control section.

SDR *
The SDR of the Post-Cat Control Loop. See PID control section.

SELECT FIXED
FIXED PROP GAIN *
This setting allows the user to select a constant P GAIN setting by checking the box.

FIXED INT GAIN *
This setting allows the user to select a constant I GAIN setting by checking the box.

FIXED SDR *
This setting allows the user to select a constant SDR setting by checking the box.

ACTUAL DYNAMICS
Displays the readout of the actual dynamics values used by the PID.

PROP GAIN *
Readout of the actual P GAIN used by the Speed Control PID.

INT GAIN *
Readout of the actual I GAIN used by the Speed Control PID.

SDR *
Readout of the actual SDR used by the Speed Control PID.

DYNAMICS SELECTED

PROP GAIN *
A text box indicating the status of the Prop Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

INT GAIN *
A text box indicating the status of the Int Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SDR *
A text box indicating the status of the SDR Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SPEED FRACTION *
Displays the fraction of the base gain that is developed by the SPEED BIASED DYNAMICS.

SPEED PEAK DETECT

SPEED PEAK HI
The highest value captured @5 ms since reset (RPM).

SPEED PEAK LO
The lowest value captured @5 ms since reset (RPM).

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

DYNAMICS 1

SPEED CONTROL DYNAMICS 1
Dynamics 1 is used for Generator Breaker Open or most mechanical Drive applications.

GAIN RATIO *
The value of the Prop Gain multiplier when the absolute value of the speed error is greater than the WINDOW WIDTH.

WINDOW WIDTH *
The Speed Error window that switches on the GAIN RATIO (RPM). This helps give a low P GAIN at steady state and a high P GAIN during speed excursions (transients).

WINDOW ACTIVE *
LED indicator that displays when the Speed Error is outside the WINDOW WIDTH and the P GAIN is multiplied by the GAIN RATIO.

DYN INDEX *
Readout of the Dynamics Index Value

DYN INDEX SELECT *
A drop down selection box that allows the dynamics mapping to be driven by different indices. Allowable values are: THROTTLE, Qmix, or LOAD INPUT.

MAPPED PROP GAIN 1
2 x 5 lookup table DYN INDEX vs. PROP GAIN allows a non-linear gain mapped over the operating range of the engine.

MAPPED INT GAIN 1
2 x 5 lookup table DYN INDEX vs. INT GAIN allows a non-linear gain mapped over the operating range of the engine.

MAPPED SDR 1
2 x 5 lookup table DYN INDEX vs. SDR allows a non-linear mapping over the operating range of the engine.

UTILITY BREAKER
LED indicating the Utility breaker input status, the Utility breaker allows the controller to go into internal Base Load Control.

GEN BREAKER
LED indicating the Generator breaker input status, the Generator breaker switches the controller into DYNAMICS 2 when closed.

SPEED FRACTION
Displays the fraction of the base gain that is developed by the SPEED BIASED DYNAMICS logic.

SPEED PEAK DETECT
SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

COLD DYNAMICS
A cold engine Proportional Gain, a cold engine temperature (based on ECT), and a warm engine temperature are tunable. The Proportional Gain runs at the cold gain at the cold temp and is linearly interpolated as temperature increases and levels out to be equal to the normal Prop gain above the warm temp.

ENABLE COLD DYNAMICS *
Select this checkbox to enable the COLD DYNAMICS function.

COLD GAIN FRACTION *
Readout of the Cold Gain Fraction developed by the COLD DYNAMICS function.

COLD DYNAMICS TEMP *
The temperature that exhibits the PROP GAIN FRACTION @COLD (°F). The PROP GAIN fraction will stay at that level even though the temperature goes lower.

PROP GAIN FRACTION @COLD *
The fraction that the PROP GAIN will be multiplied by when the ECT is at or lower than the COLD DYNAMICS TEMP.

WARM DYNAMICS TEMP *
The Temperature that the PROP GAIN fraction will equal 1.0 (°F). If the ECT goes above this temperature the PROP GAIN fraction will remain at 1.0.

ACTUAL DYNAMICS
PROP GAIN
Readout of the actual P GAIN the Control PID is using.

INT GAIN
Readout of the actual I GAIN the Control PID is using.

SDR
Readout of the actual SDR the Control PID is using.

DYNAMICS SELECTED
Select AFR trim settings to allow for start adjustments.

PROP GAIN *
A text box indicating the status of the Prop Gain Dynamics selection; possible states are "FIXED", "DYNAMICS 1", "DYNAMICS 2", or "DYNAMICS 3".

INT GAIN *
A text box indicating the status of the Int Gain Dynamics selection; possible states are "FIXED", "DYNAMICS 1", "DYNAMICS 2", or "DYNAMICS 3".

SDR *
A text box indicating the status of the SDR Dynamics selection; possible states are "FIXED", "DYNAMICS 1", "DYNAMICS 2", or "DYNAMICS 3".

DYNAMICS 2

SPEED CONTROL DYNAMICS 2
Dynamics 2 is used for Generator Breaker Closed or mechanical Drive applications with a need for a second set of dynamics.

GAIN RATIO *
The value of the Prop Gain multiplier when the absolute value of the speed error is greater than the WINDOW WIDTH.

WINDOW WIDTH *
The Speed Error window that switches on the GAIN RATIO (RPM). This helps give a low P GAIN at steady state and a high P GAIN during speed excursions (transients).

WINDOW ACTIVE *
LED indicator that displays when the Speed Error is outside the WINDOW WIDTH and the P GAIN is multiplied by the GAIN RATIO.

DYN INDEX *
Readout of the Dynamics Index Value

DYN INDEX SELECT *
A drop down selection box that allows the dynamics mapping to be driven by different indices. Allowable values are: THROTTLE, Qmix, or LOAD INPUT.

MAPPED PROP GAIN 2
2 x 5 lookup table DYN INDEX vs. PROP GAIN allows a non-linear gain mapped over the operating range of the engine.

MAPPED INT GAIN 2
2 x 5 lookup table DYN INDEX vs. INT GAIN allows a non-linear gain mapped over the operating range of the engine.

MAPPED SDR 2
2 x 5 lookup table DYN INDEX vs. SDR allows a non-linear mapping over the operating range of the engine.

UTILITY BREAKER
LED indicating the Utility breaker input status, the Utility breaker allows the controller to go into internal Base Load Control.

GEN BREAKER
LED indicating the Generator breaker input status, the Generator breaker switches the controller into DYNAMICS 2 when closed.

SPEED FRACTION
Displays the fraction of the base gain that is developed by the SPEED BIASED DYNAMICS logic.

SPEED PEAK DETECT
SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

COLD DYNAMICS
The COLD DYNAMICS option maps the PROP GAIN to Engine Coolant Temperature (ECT) to permit a lower PROP GAIN setting during cold engine operation.

ENABLE COLD DYNAMICS *
Select this checkbox to enable the COLD DYNAMICS function.

COLD GAIN FRACTION *
Readout of the Cold Gain Fraction developed by the COLD DYNAMICS function.

COLD DYNAMICS TEMP *
The temperature that exhibits the PROP GAIN FRACTION @COLD (°F). The PROP GAIN fraction will stay at that level even though the temperature goes lower.

PROP GAIN FRACTION @COLD *
The fraction that the PROP GAIN will be multiplied by when the ECT is at or lower than the COLD DYNAMICS TEMP.

WARM DYNAMICS TEMP *
The Temperature that the PROP GAIN fraction will equal 1.0 (°F). If the ECT goes above this temperature the PROP GAIN fraction will remain at 1.0.

ACTUAL DYNAMICS
PROP GAIN
Readout of the actual P GAIN the Control PID is using.

INT GAIN
Readout of the actual I GAIN the Control PID is using.

SDR
Readout of the actual SDR the Control PID is using.

DYNAMICS SELECTED
Select AFR trim settings to allow for start adjustments.

PROP GAIN *
A text box indicating the status of the Prop Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

INT GAIN *
A text box indicating the status of the Int Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SDR *
A text box indicating the status of the SDR Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

TRANSIENT COMPENSATION

LOAD REJECTION
This page is used to adjust the LOAD REJECTION feature, which can help the engine successfully endure large load dumps while keeping the engine running without exceeding its overspeed level.

USE CIRCUIT BREAKER FEED-FORWARD *
This selects the Circuit-breaker feed-forward aspect of the logical Load rejection. This function causes the throttle to go to a pre-programmed setpoint when the Generator Circuit Breaker is opened while the MAP pressure is above a pre-programmed level.

USE LOGICAL OVERSPEED *
This selects the Logical Overspeed aspect of the logical Load rejection. This function causes the throttle to go to a pre-programmed setpoint when the Engine Speed reaches a high threshold while the MAP pressure is above a pre-programmed level.

GENERATOR BREAKER
LED indicating the Generator Breaker status.

REJECTION TIME DURATION *
The duration that the Throttle is held after a Load Rejection Event is detected (sec).

REJECTION MAP THRESHOLD *
The MAP level that the engine must be above to trigger the Load Rejection Event (psia).

REJECTION THROTTLE POSITION *
The Throttle position that the Load Rejection function forces for the REJECTION TIME DURATION when the Load Rejection Event is triggered (%).

LOGICAL OVERSPEED LEVEL *
The speed above Rated and below overspeed that will trigger the Load Rejection Event when enabled (RPM).

LOAD REJECTION ACTIVE
LED indication of the Load Rejection status.

SPEED PEAK DETECT
SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

LOAD CONTROL

This page allows monitoring of the LOAD CONTROL PID and Load Reference functions.

LOAD PID
LOAD REFERENCE
Readout of the current LOAD REFERENCE (RPM).

GEN LOAD
Readout of the current LOAD measurement from the LOAD Input (kW).

THROTTLE DEMAND
The current Throttle demand (%).

LOAD PID STATUS
PID IN CONTROL
LED indicator that the LOAD CONTROL PID is in control of the LSS bus.

MAX LIMITER IN CONTROL
LED indicator that the MAX LIMITER is in control of the LSS bus.

BREAKER POSITIONS
GENERATOR BREAKER CLOSED
LED feedback of the Generator Breaker position.

UTILITY BREAKER CLOSED
LED feedback of the Utility Breaker position.

LOAD SETPOINT SELECTED
This section allows monitoring of the LOAD REFERENCE ramp.

ZERO LOAD SELECTED
LED indicator that Zero Load is selected.

TRACKED LOAD SELECTED
LED indicator that the Load Reference, has activated and locked in the load reference at the previous position.

MAXIMUM LOAD SELECTED
LED indicator that MAX LOAD is selected.

REMOTE REF SELECTED
LED indicator that LOAD CONTROL REMOTE REFERENCE is selected.

LOWER LOAD REF
LED indicator that the LOWER LOAD INPUT is selected.

RAISE LOAD REF
LED indicator that the RAISE LOAD INPUT is selected.

DYNAMICS SELECTED
PROP GAIN *
A text box indicating the status of the Prop Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

INT GAIN *
A text box indicating the status of the Int Gain Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SDR *
A text box indicating the status of the SDR Dynamics selection; possible states are “FIXED”, “DYNAMICS 1”, “DYNAMICS 2”, or “DYNAMICS 3”.

SPEED PEAK DETECT
SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

LOAD DYNAMICS

Use this page to tune and setup the E3 internal Load Control.

LOAD CONTROL DYNAMICS
GAIN RATIO *
The value of the Prop Gain multiplier when the absolute value of the load error is greater than the WINDOW WIDTH.

WINDOW WIDTH *
The Speed Error window that switches on the GAIN RATIO (kW). This helps give a low P GAIN at steady state and a high P GAIN during load excursions (transients).

WINDOW ACTIVE *
LED indicator that displays when the Load Error is outside the WINDOW WIDTH and the P GAIN is multiplied by the GAIN RATIO.

LOAD
Readout of the Load Input (kW).

MAPPED PROP GAIN 3
2 x 5 lookup table Load (kW) vs. PROP GAIN allows a non-linear gain mapped over the operating range of the engine.

MAPPED INT GAIN 3
2 x 5 lookup table Load (kW) vs. INT GAIN allows a non-linear gain mapped over the operating range of the engine.

MAPPED SDR 3
2 x 5 lookup table Load (kW) vs. SDR allows a non-linear mapping over the operating range of the engine.

SPEED PEAK DETECT
SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

LOAD CONTROL PERMISSIVES
GENERATOR BREAKER CLOSED
LED readout of the Generator Breaker Status

UTILITY BREAKER CLOSED
LED readout of the Utility Breaker Status

KW DYNAMICS ACTIVE
LED readout indicating that internal Load Control is active.

ACTUAL DYNAMICS
PROP GAIN
The highest value captured @5 ms since reset.

INT GAIN
The lowest value captured @5 ms since reset.

SDR
The highest value captured @5 ms since reset.

DYNAMICS SELECTED
Select AFR trim settings to allow for start adjustments.

PROP GAIN
Readout of the actual P GAIN the Control PID is using.

INT GAIN
Readout of the actual I GAIN the Control PID is using.

SDR
Readout of the actual SDR the Control PID is using.

Engine Performance

BANK BALANCING

BANK BALANCE MONITOR GRAPHICS
A series of bar graphs to indicate the balance of key parameters.

Qmix BALANCE
This is a bar graph showing the Qmix of each bank (scfm)

MANIFOLD PRESSURE BALANCE
This is a bar graph showing the MAP of each bank (psia).

MANIFOLD TEMP BALANCE
This is a bar graph showing the MAT for each bank (°F).

THROTTLE BALANCE
This is a bar graph showing the Throttle command for each bank (%).

Qmix DIFFERENCE GAUGE
A circular gauge indicating the difference in Qmix between the banks (scfm).

BALANCE BIAS GAUGE
A circular gauge indicating the Bank Balance PID command to Bank 2 (%).

BANK BALANCE SETTINGS
BANK BALANCE SETPOINT OFFSET *
The setpoint for the Bank Balance PID (%). Changing this will allow the user to intentionally unbalance the banks to test balancing dynamics.

RUN DELAY PERMISSIVE *
The delay after engine run that the balancing will activate.

TRIM RANGE *
This value establishes the maximum adjustment that can be made to correct for imbalance conditions (%). This is the max trim adjustment that the balancing PID will make at 100%.

PROP GAIN *
The Proportional Gain of the Pre-Cat Control Loop, decreasing the Prop Gain will reduce the response of the control loop. See PID control section.

INT GAIN *
The Integral Gain of the Pre-Cat Control Loop, decreasing the Int Gain will slow the response of the control loop. See PID control section.

SDR *
The SDR of the Pre-Cat Control Loop. See PID control section.

THROTTLE 2 OFFSET
This table is an open loop correction table; it accepts Throttle 1 command and outputs a correction. This correction is added to Throttle 1 command and sent to Throttle 2. This table is active when the Bank Balancing is inactive and is the manual throttle balance calibration.

TABLE IN
Readout of Throttle 1 Demand (%).

THROTTLE 2 OFFSET TABLE *
2 x 6 lookup table Throttle 1 Demand (%) vs. Correction factor (%) allows a non-linear mapping of the throttle differences over the operating range of the engine.

TABLE OUT
Readout of the THROTTLE 2 OFFSET TABLE (%).

PID OUT
Readout of the Bank Balance PID (-100% to 100%).

BALANCE PERMISSIVE
All the permissives must be TRUE for the Bank Balance PID to activate.

ENABLE BANK BALANCE *
Manual Enable/Disable for Bank Balance.

BALANCING ENABLED
LED that indicates Bank Balancing is enabled.

SENSORS OK
LED indicating both MAP sensors are not faulted.

RUN DELAY
LED indicating the engine has been running for at least the time indicated by the tunable RUN DELAY PERMISSIVE.

RUN TIME REMAINING
Countdown timer indicating the remaining time for the BANK BALANCE RUN DELAY (sec).

LOW LIM
LED indicating the Bank Balance PID is on the Low Limit (-100%).

HI LIM
LED indicating the Bank Balance PID is on the High Limit (+100%).

AL90 BANK BALANCE HIGH LIMIT
LED alarm indication, this alarm activates when the PID has been on the limit for the tunable delay time.

AL91 BANK BALANCE LO LIMIT
LED alarm indication, this alarm activates when the PID has been on the limit for the tunable delay time.

MISFIRE

Global misfire detection based on instantaneous crank angle velocity (ICAV) measurement has the capability of detecting persistent misfire of any cylinder. The individual misfiring cylinder is not identified.

MISFIRE FAULT
MISFIRE DETECTED
LED indicating that the misfire level is above the fault threshold.

MISFIRE LEVEL
Readout of the Misfire level (RPM/sec^2), a measure of the irregularity of the engine crank speed signal based on the number of cylinders entered in SAMPLES.

MISFIRE TABLE INDEX *
An indicator of the Misfire Table index value, available indices are: THROTTLE, Qmix, or LOAD INPUT.

MISFIRE INDEX PERMISSIVE *
The threshold that the MISFIRE INDEX must be above to enable the Misfire Faults.

ENABLE ALARM *
Set this TRUE to enable the Misfire Alarm.

ENABLE SHUTDOWN *
Set this TRUE to enable the Misfire Shutdown.

FAULT DELAY ALARM *
The delay the misfire condition must stay TRUE before an alarm is activated (sec).

FAULT DELAY SHUTDOWN *
The delay the misfire condition must stay TRUE before a shutdown is activated (sec).

ACTIVE FAULT LEVEL ALARM
The current Misfire Alarm threshold.

ACTIVE FAULT LEVEL SHUTDOWN
The current Misfire Shutdown threshold.

MISFIRE SETUP
SAMPLES
Readout of the SAMPLE tunable, use the offline editor to enter the number of engine cylinders or integral divisor.

MISFIRE INDEX SELECT *
A drop down selection box that allows the Misfire Fault mapping to be driven by different indices. Allowable values are: THROTTLE, Qmix, or LOAD INPUT.

MISFIRE FILTER
MISFIRE FILTER ENABLE *
Check this box to enable the Misfire Filter, uncheck and the filter is bypassed.

MISFIRE FILTER *
The Misfire Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

MISFIRE FTV HOLD
When a misfire occurs for longer than a tunable delay AND the control is in one of the closed-loop modes the Fuel Trim Valve is held in place. The FTV resumes normal control when the MISFIRE condition is false for a tunable amount of time.

MISFIRE FTV HOLD ENABLE *
Set this TRUE to enable the FTV HOLD function.

MISFIRE FTV HOLD ACTIVE
LED indicating the FTV HOLD function is currently active.

MISFIRE THRESHOLDS
MISFIRE ALARM THRESHOLD TABLE *
2 x 5 lookup table Misfire Index () vs. Alarm Level (RPM/sec^2) allows a non-linear mapping of the fault threshold over the operating range of the engine.

MISFIRE SD THRESHOLD TABLE *
2 x 5 lookup table Misfire Index () vs. Shutdown Level (RPM/sec^2) allows a non-linear mapping of the fault threshold over the operating range of the engine.

MISFIRE PEAK DETECT
MISFIRE PEAK HI
The highest value captured @5 ms since reset.

MISFIRE PEAK LO
The lowest value captured @5 ms since reset.

RESET MISFIRE PRESS PEAK DETECT
Momentary button that resets the peak detectors.

SPEED PEAK DETECT
SPEED PEAK HI
The highest value captured @5 ms since reset.

SPEED PEAK LO
The lowest value captured @5 ms since reset.

RESET SPEED PRESS PEAK DETECT
Momentary button that resets the peak detectors.

Ignition

IGNITION ADVANCE

IGNITION ADVANCE TABLES
IGNITION ADVANCE TABLE *
15 x 11 lookup table Engine Speed (RPM) vs. MAP% (% FULL LOAD) vs. Timing advance (°BTDC) allows a non-linear mapping of the timing setpoint over the operating range of the engine.

BASE TIMING
Readout of the IGNITION ADVANCE TABLE (°BTDC)

TOTAL TIMING
The Total Timing is the IGNITION ADVANCE TABLE + COOLANT TEMP ADVANCE + GLOBAL ADVANCE.

GLOBAL TIMING
This is the total timing sent to the ignition system (°BTDC)

BASE ADVANCE FROM TABLE
The timing from the IGNITION ADVANCE TABLE (°BTDC).

COOLANT TEMP ADVANCE
The timing from the ECT ADVANCE TABLE (°ADV).

GLOBAL ADVANCE *
Manual Advance/Retard (°ADV).

MINIMUM ADVANCE LIMIT
The minimum advance/retard limit for the GLOBAL TIMING (°BTDC).

MAXIMUM ADVANCE LIMIT
The maximum advance limit for the GLOBAL TIMING (°BTDC).

IC-92X CAN STATUS
IC-92X NODE ONLINE
LED indication that the IC-92X is communicating online.

IC-92X NODE WATCHDOG
LED indication that the IC-92X is activated but not communicating online.

IC-92X EVENTS
ERROR NUMBER OF TEETH
LED indication of the IC-92X fault not latched.

WAIT FOR 0 RPM
LED indication of the IC-92X fault not latched.

WARNING MISSING RING GEAR SIGNAL
LED indication of the IC-92X fault not latched.

WARNING MISSING RESET SIGNAL
LED indication of the IC-92X fault not latched.

WARNING MISSING CAMSHAFT SIGNAL
LED indication of the IC-92X fault not latched.

IC-92X WITH J1939
IC-92X ADDRESS *
The J1939 Address for the IC-92X in the system, the unit address can be found using the IC-92X service tool.

ODD BANK ENERGY *
The energy command for the IC-92X Odd Bank (%).

EVEN BANK ENERGY *
The energy command for the IC-92X Even Bank (%).

IGNITION OFFSETS

MANUAL TIMING OFFSETS CYLINDER X *
This adds to the individual cylinder timing to allow independent timing offsets for all available cylinders (°ADV). A positive offset advances that cylinder.

TOTAL TIMING CYLINDER X
Readout of the Total timing for each cylinder, this is what is read if a timing light were placed on this cylinder (°BTDC).

ACTIVATE INDIVIDUAL OFFSETS *
Check this box to enable individual cylinder offsets. NOTE: this take effect immediately so prepare for a shift in timing when this box is changed while the engine is running.

FAULT LOG

GRID DISPLAY
The FAULT LOG displays the faults in a grid format with columns: FLASH ID, FAULT, COUNT, FAULT STATE, EMISSIONS FAULT, EMISSIONS ACTIVE, and RUN HOURS.

FLASH ID COLUMN
The FLASH ID column displays a unique identifier that corresponds to the MIL FLASH CODE if enabled.

FAULT COLUMN
The FAULT column displays the Fault description.

COUNT COLUMN
The COUNT column displays the number of times the fault has reoccurred without being removed from the FAULT LOG.

FAULT STATE COLUMN
The FAULT STATE column displays the current state of the latched fault INACTIVE/ACTIVE.

EMISSIONS FAULT COLUMN
The EMISSIONS FAULT column displays whether or not the fault is an emissions related fault.

EMISSIONS ACTIVE COLUMN
The EMISSIONS ACTIVE column indicates TRUE if the fault is emissions related and ACTIVE.

RUN HOURS COLUMN
The RUN HOURS column displays the engine RUN HOURS at the time of the fault.

RESET INDIVIDUAL
Click this momentary button to clear selected INACTIVE faults from the FAULT LOG.

RESET ALL
Click this momentary button to clear all INACTIVE faults from the FAULT LOG.

EXPORT
Click this momentary button to save the FAULT LOG to a text file.

FAULT RESET
Click this momentary button to send a fault reset pulse, all cleared ALARMS will clear. The engine must be stopped to reset SHUTDOWNs.

FIRST OUT SHUTDOWN
Text readout indicating the description of the first shutdown to trigger.

Inputs/Outputs

SYS INFO

SOFTWARE INFO
SYSTEM NAME
Text readout indicating the system name.

SOFTWARE PART #
Text readout indicating the software part number.

SOFTWARE REVISION
Text readout indicating the software revision.

ENGINE INFO
Text variables have been provided to enter user information regarding the application. This page the variables are read only, to modify go to the CONFIG SYS page. The information in these fields is for reference only and does not affect system operation.

ENGINE MAKE
Text readout indicating the ENGINE MAKE.

ENGINE MODEL
Text readout indicating the ENGINE MODEL.

ENGINE LICENSE
Text readout indicating the ENGINE LICENSE.

ENGINE SERIAL NUMBER
Text readout indicating the ENGINE SERIAL NUMBER.

ENGINE YEAR
Text readout indicating the ENGINE YEAR.

CONTROL STATUS
LAST RESET CAUSE
Text readout, this may be helpful for Woodward Support personnel.

TOTAL CPU LOAD
Text readout, this may be helpful for Woodward Support personnel.

CHASSIS TYPE
Text readout, this may be helpful for Woodward Support personnel.

CHASSIS CAPABILITY
Text readout, this may be helpful for Woodward Support personnel.

PCM VERSION
Text readout, this may be helpful for Woodward Support personnel.

BOOT VERSION
Text readout, this may be helpful for Woodward Support personnel.

MODEL NUMBER
Text readout, this may be helpful for Woodward Support personnel.

TEMP ALARM
LED indicating CPU temperature has exceeded the high threshold.

INPUT POWER STATUS
DRVP POWER INPUT
Readout indicating the Battery Input supply voltage.

KEY VOLTAGE +BATT
Readout indicating the KEYSWITCH INPUT supply voltage.

POWER ON
LED indicating Battery Voltage is OK.

KEY ON
LED indicating KEYSWITCH Voltage is OK.

AUX POWER SUPPLIES
TRANSDUCER POWER SUPPLY A +5
Readout indicating the TRANSDUCER POWER SUPPLY A +5 supply voltage (V).

TRANSDUCER POWER SUPPLY B +5
Readout indicating the TRANSDUCER POWER SUPPLY B +5 supply voltage (V).

MEMORY STATUS
SAVING TO EEPROM
LED indicating the control is currently saving to EEPROM. NOTE: DO NOT POWER OFF DURING EEPROM SAVE.

RAM AVAILABLE
Readout, this may be helpful for Woodward Support personnel.

CAL AVAILABLE
Readout, this may be helpful for Woodward Support personnel.

EEPROM AVAILABLE
Readout, this may be helpful for Woodward Support personnel.

FLASH AVAILABLE
Readout, this may be helpful for Woodward Support personnel.

CALIBRATION CHECKSUM
Readout of the CALIBRATION CHECKSUM, this will indicate the EEPROM calibration memory integrity and will change if the contents of the EEPROM memory changes.

FLASH CHECKSUM
Readout of the FLASH CHECKSUM, this will indicate the FLASH memory integrity and will change if the contents of the FLASH memory changes.

MEMORY FAULTS
EE PRIMARY
LED indicating EE PRIMARY memory fault, this usually means the power was lost during a EEPROM write. If EE SECONDARY is FALSE, then the backup was loaded OK.

EE SECONDARY
LED indicating EE SECONDARY memory fault, this usually indicates a more serious issue. If both EE FAULTS are TRUE then backup was NOT loaded OK.

FLASH
LED indicating FLASH memory fault, this usually indicates a serious issue. Contact your Woodward agent for support.

RAM
LED indicating RAM memory fault, this usually indicates a serious issue. Contact your Woodward agent for support.

ENGINE RUN HOURS
CURRENT ENGINE RUN
Readout of the current engine runtime.

PRESET ENGINE RUN HOURS *
Enables the user to preset engine hours to any value.

PRESET ENGINE RUN HOURS BUTTON
This momentary button commits the hours entered into PRESET ENGINE RUN HOURS.

NV LOG ALARM
LED indicating NV LOG fault, this may mean engine run time was lost. Contact your Woodward agent for support.

NUM WRITES
Readout indicating the number of NV LOG writes, which gives EE memory usage.

INPUTS OVERVIEW

DISCRETE INPUTS
To activate any Discrete Input, connect the signal input to ground. 18 internal DISCRETE FUNCTIONs are configured in Toolkit through an Enumerated Dropdown box – Each Discrete input function will allow mapping to Modbus, constants and 12 physical Discrete Inputs.

FUNCTION ACTIVE COLUMN
LED indication of the DISCRETE FUNCTION status.

DESCRIPTION COLUMN
Text description of the DISCRETE FUNCTION.

IO POINT COLUMN
Text indication of the IO point associated with the function.

DI STATUS
LED indication of each DISCRETE INPUT.

ANALOG INPUTS
ANALOG INPUT OK COLUMN
LED indicating the ANALOG FUNCTION is used and within voltage limits.

DESCRIPTION COLUMN
Text description of the ANALOG FUNCTION.

RAW INPUT COLUMN
The raw voltage going into the ANALOG FUNCTION.

IO POINT COLUMN
Text indication of the IO point associated with the ANALOG FUNCTION.

OUTPUTS OVERVIEW

LOW SIDE DRIVER STATUS
FUNCTION ACTIVE COLUMN
LED indicating the Low-Side Output is energized.

DESCRIPTION COLUMN
Text description of the Low-Side Output function.

LOW SIDE DRIVER MONITOR
HEGO X HEATER DUTY CYCLE OUT
Readout of the HEGO Heater coil Driver Duty Cycle (%).

HEGO X HEATER PWM FREQUENCY
Readout of the HEGO Heater coil Driver Frequency (Hz).

HEGO X HEATER CURRENT
Readout of the HEGO Heater coil current (ADC).

PWM ACTUATOR MONITOR
PWM ACT X DUTY CYCLE OUT
Readout of the PWM Out Driver Duty Cycle (%).

PWM ACT X FREQUENCY OUT
Readout of the PWM Driver Frequency (Hz).

IO - CAN

CAN PORT 1 - ENGINE CAN BUS
ENGINE CAN BUS OFF
LED indicating the CAN controller is in the BUS OFF state. A buss off condition is often the result of a baud rate mismatch, reverse polarity wiring, shorted or open wiring but can be caused by other conditions as well.

ENGINE CAN TRANSMIT WARNING
LED indicating CAN controller transmit error counter is greater than 96.

ENGINE CAN TRANSMIT ERROR
LED indicating CAN controller transmit error counter is greater than 127.

ENGINE CAN RECEIVE WARNING
LED indicating CAN controller receive error counter is greater than 96.

ENGINE CAN RECEIVE ERROR
LED indicating CAN controller receive error counter is greater than 127.

ENGINE CAN RED LED
LED indicating CAN status LED, OFF = CAN link operating within acceptable parameters, Flash = A TX or RX Warning condition is active, or ON = A buss off condition is active.

ENGINE CAN GREEN LED
LED indicating CAN status LED, OFF = CAN is disabled, Flash = The J1939 address claimed message was failed, or ON = The network (application level) is working normally.

ENGINE CAN ONLINE
LED indicating the J1939 Address Claim process is successful. If another node with a higher priority claims the same Node ID later, this field will transition to FALSE and the DUP_ADDR will transition to TRUE.

ENGINE CAN DUPLICATE ADDRESS
LED indicating J1939 Address Claim process fails due to a duplicate address (Node ID) detected on the network.

ENGINE CAN BUS LOAD
Readout of the current loading of the CAN_PORT in %. It will not be perfectly accurate but gives a reasonable "real time" monitor of the network load. It has some averaging to stabilize it. It should be used as a troubleshooting tool. No network should be loaded more than 80% for reliable data transmission. Networks used for control purposes should be loaded as little as possible to ensure repeatable, timely delivery of messages.

ENGINE CAN RX/TX ERRORS
Readout of the cumulative number of network errors. It will be reset to 0 upon initialization, CAN RESET, or counter rollover.

ENGINE CAN TRANSMIT OVERFLOW
Readout displaying the total transmit messages dropped due to buffer overflow. If this field is increasing, then the data you are trying to transmit is not going out on the wire.

ENGINE CAN RECEIVE OVERFLOW
Readout displaying the total receive messages dropped due to buffer overflow. If this field is increasing, then the receive buffer may not be large enough.

RESET CAN 1 BUS
Momentary button that when pressed, shuts down the J1939 protocol and reinitializes it with the current protocol settings. This reset input will also reset the FAULT and STATUS outputs. Arbitration for network access and node ID usage will be repeated.

CAN PORT 1 - J1939 STATUS
J1939 NODE WATCHDOG
LED indication that the J1939 Node is activated but not communicating online.

J1939 NODE ONLINE
LED indication that the J1939 Node is communicating online.

CAN PORT 2 - ENGINE CAN BUS
ENGINE CAN BUS OFF
LED indicating the CAN controller is in the BUS OFF state. A buss off condition is often the result of a baud rate mismatch, reverse polarity wiring, shorted or open wiring but can be caused by other conditions as well.

ENGINE CAN TRANSMIT WARNING
LED indicating CAN controller transmit error counter is greater than 96.

ENGINE CAN TRANSMIT ERROR
LED indicating CAN controller transmit error counter is greater than 127.

ENGINE CAN RECEIVE WARNING
LED indicating CAN controller receive error counter is greater than 96.

ENGINE CAN RECEIVE ERROR
LED indicating CAN controller receive error counter is greater than 127.

ENGINE CAN RED LED
LED indicating CAN status LED, OFF = CAN link operating within acceptable parameters, Flash = A TX or RX Warning condition is active, or ON = A buss off condition is active.

ENGINE CAN GREEN LED
LED indicating CAN status LED, OFF = CAN is disabled, Flash = The J1939 address claimed message was failed, or ON = The network (application level) is working normally.

ENGINE CAN ONLINE
LED indicating the J1939 Address Claim process is successful. If another node with a higher priority claims the same Node ID later, this field will transition to FALSE and the DUP_ADDR will transition to TRUE.

ENGINE CAN DUPLICATE ADDRESS
LED indicating J1939 Address Claim process fails due to a duplicate address (Node ID) detected on the network.

ENGINE CAN BUS LOAD
Readout of the current loading of the CAN_PORT in %. It will not be perfectly accurate but gives a reasonable "real time" monitor of the network load. It has some averaging to stabilize it. It should be used as a troubleshooting tool. No network should be loaded more than 80% for reliable data transmission. Networks used for control purposes should be loaded as little as possible to ensure repeatable, timely delivery of messages.

ENGINE CAN RX/TX ERRORS
Readout of the cumulative number of network errors. It will be reset to 0 upon initialization, CAN RESET, or counter rollover.

ENGINE CAN TRANSMIT OVERFLOW
Readout displaying the total transmit messages dropped due to buffer overflow. If this field is increasing, then the data you are trying to transmit is not going out on the wire.

ENGINE CAN RECEIVE OVERFLOW
Readout displaying the total receive messages dropped due to buffer overflow. If this field is increasing, then the receive buffer may not be large enough.

RESET CAN 2 BUS
Momentary button that when pressed, shuts down the J1939 protocol and reinitializes it with the current protocol settings. This reset input will also reset the FAULT and STATUS outputs. Arbitration for network access and node ID usage will be repeated.

IO – EASY GEN J1939

easYgen CAN WRITE SETUP
USE easYgen OVER CAN *
Check this box to use easYgen over J1939 CAN.

ENABLE AL 1451 - easYgen STOP COMMAND *
Check this box to allow the easYgen to issue a Normal Stop command to the E3, USE easYgen OVER CAN must be TRUE.

MONITOR easYgen CAN VALUES
SPN 970 - ENGINE AUX SHUTDOWN
LED indicating the J1939 message is TRUE.

SPN 3545 - GENERATOR CIRCUIT BREAKER STATUS
LED indicating the J1939 message is TRUE.

SPN 3546 - UTILITY CIRCUIT BREAKER STATUS
LED indicating the J1939 message is TRUE.

SPN2452 - GENERATOR TOTAL REAL POWER
Readout of the J1939 Real Power Message (W).

GENERATOR POWER
Readout of the Generator Load for internal use (kW).

ENGINE RATED POWER *
Tunable value setting the MAX LOAD scaling (kW).

DESIRED POWER
Readout of the J1939 Woodward Proprietary Desired Power Message PGN 65403 with bits and scaling the same as the Generator power message PGN 65029 (kW).

DROOP MODE
Text readout of the J1939 Droop Request SPN 2881, possible states: “DROOP” or “ISOCHRONOUS”.

easYgen CAN SPEED SETPOINT
SPN 189 - ENGINE RATED SPEED
Readout of the J1939 Rated Speed from easYgen (RPM).

SPN 3938 - GENERATOR GOVERNING SPEED BIAS
Readout of the J1939 Speed Bias (%).

SPEED REFERENCE
Readout of the total Speed reference due to easYgen and is equal to SPN 189 Rated + (SPN 3938 Spd Bias * SPEED BIAS SCALING/100)

SPEED BIAS SCALING *
Tunable value to scale the Speed Bias signal to RPM (RPM/100%).

easYgen CAN ALARM/SHUTDOWN
AL1450 - EXTERNAL CAN COMM TIMEOUT
LED indicates the watchdog has expired and the easYgen is not communicating with the E3 control.

AL1451 - EXTERNAL CAN SHUTDOWN COMMAND
LED indicates the EXTERNAL CAN SHUTDOWN COMMAND is latched to shutdown the engine. The condition automatically resets when the engine stops.

REBOOT TO UPDATE VALUE
easYgen CAN ADDRESS USED
Readout of current easYgen CAN Address.

easYgen CAN ADDRESS *
Tunable value to select the easYgen CAN Address, control must be reboot for setting to take effect.

IO – DISCRETE OUTPUTS

LOW SIDE DRIVER STATUS
FUNCTION ACTIVE COLUMN
LED indicating the Low-Side Output is energized.

DESCRIPTION COLUMN
Text description of the Low-Side Output function.

LS 05 - ALARM RELAY
LS 05 - ALARM RELAY FORCED
LED indicates the Output is in FORCE MODE

ENABLE LS 05 - ALARM RELAY FORCE MODE *
Check this box to enable FORCE MODE for this output.

LS 05 - ALARM RELAY FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

LS 05 - ALARM RELAY INVERT FUNCTION *
Check this box to invert the function and energize when function is FALSE.

LS 06 - SHUTDOWN RELAY
LS 06 - SHUTDOWN RELAY FORCED
LED indicates the Output is in FORCE MODE

ENABLE LS 06 - SHUTDOWN RELAY FORCE MODE *
Check this box to enable FORCE MODE for this output.

LS 06 - SHUTDOWN RELAY FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

LS 06 - SHUTDOWN RELAY INVERT FUNCTION *
Check this box to invert the function and energize when function is FALSE.

LS 07 - OPEN GAS SHUT OFF RELAY
LS 07 - OPEN GAS SHUT OFF RELAY FORCED
LED indicates the Output is in FORCE MODE

ENABLE LS 07 - OPEN GAS SHUT OFF RELAY FORCE MODE *
Check this box to enable FORCE MODE for this output.

LS 07 - OPEN GAS SHUT OFF RELAY FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

LS 07 - OPEN GAS SHUT OFF RELAY INVERT FUNCTION *
Check this box to invert the function and energize when function is FALSE.

LS 08 - MIL RELAY
LS 08 - MIL RELAY FORCED
LED indicates the Output is in FORCE MODE.

ENABLE LS 08 - MIL RELAY FORCE MODE *
Check this box to enable FORCE MODE for this output.

LS 08 - MIL RELAY FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

LS 08 - MIL RELAY INVERT FUNCTION *
Check this box to invert the function and energize when function is FALSE.

LS 09 - IGNITION SD RELAY
LS 09 - IGNITION SD RELAY FORCED
LED indicates the Output is in FORCE MODE.

ENABLE LS 09 - IGNITION SD RELAY FORCE MODE *
Check this box to enable FORCE MODE for this output.

LS 09 - IGNITION SD RELAY FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

LS 09 - IGNITION SD RELAY INVERT FUNCTION *
Check this box to invert the function and energize when function is FALSE.

LS 10 - SPEED SWITCH RELAY
LS 10 - SPEED SWITCH RELAY FORCED
LED indicates the Output is in FORCE MODE.

ENABLE LS 10 - SPEED SWITCH RELAY FORCE MODE *
Check this box to enable FORCE MODE for this output.

LS 10 - SPEED SWITCH RELAY FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

LS 10 - SPEED SWITCH RELAY INVERT FUNCTION *
Check this box to invert the function and energize when function is FALSE.

MPRD -BATTERY CONSERVATION RELAY
MPRD - BATT CONSERVE RELAY FORCED
LED indicates the Output is in FORCE MODE.

ENABLE MPRD - BATT CONSERVE FORCE MODE *
Check this box to enable FORCE MODE for this output.

MPRD - BATT CONSERVE FORCE VALUE *
Check this box to toggle the forced output, this value assumes the status of the output when FORCE MODE is activated for a bumpless transfer into FORCE MODE.

BATTERY CONSERVATION RELAY SETTINGS
RESET BATTERY CONSERVATION TIMER
Momentary button when clicked resets the Battery Conservation Timer equal to BATTERY CONSERVE DELAY.

BATTERY CONSERVE TIMER
Readout of the BATTERY CONSERVE OUTPUT remaining time.

BATTERY CONSERVE DELAY *
Time period the BATTERY CONSERVE OUTPUT is on after last engine roll (sec)

MODE *
Dropdown select box with possible states: BATTERY CONSERVATION, ALWAYS ON, or ALWAYS OFF. BATTERY CONSERVATION mode sets the relay immediately on engine start and resets after the engine has been stopped for BATTERY CONSERVE DELAY. ALWAYS ON OR ALWAYS OFF modes allow troubleshooting and setup.

IO – DISCRETE INPUTS

DISCRETE INPUTS SETTINGS
DISCRETE IN ACTIVE COLUMN
LED indicates DISCRETE INPUT hardware status CLOSED.

DI ACTIVE OPEN COLUMN *
Check this box to invert the function to activate when the input is OPEN.

DISCRETE INPUT FUNCTION CONFIGURATION COLUMN *
Dropdown select box to allow Mapping of the Discrete Function to a hardware input.

DISCRETE INPUT FUNCTION ACTIVE COLUMN
LED indicating the Discrete Function is active.

EXTERNAL SHUTDOWN 1
This input allows a discrete external condition to cause a SHUTDOWN.

EXTERNAL SHUTDOWN 2
This input allows a second discrete external condition to cause a SHUTDOWN.

COOLING WATER LEVEL LOW
This input allows a discrete external condition to cause an ALARM or SHUTDOWN. This function also ties into the optional Derate function.

LUBE OIL LEVEL LOW
This input allows a discrete external condition to cause an ALARM or SHUTDOWN. This function also ties into the optional Derate function.

MODBUS SELECT
Close this contact to activate Modbus. WARNING: Modbus uses the same port as the Service Tool and activation of this function will cease communication to the Toolkit until the switch is returned to the inactive position.

RUN/STOP
Close this contact to activate the Speed control and AFR control.

FAULT RESET
Close this contact to activate the FAULT RESET function, this functions identical to the Toolkit FAULT RESET.

IDLE/RATED
In Generator Speed Control mode, this causes the speed reference to ramp to IDLE SPEED. See Speed Reference section.

LOWER
Close this input to Lower the Speed Reference. This input can also be used in conjunction with the Raise input to use the analog Remote Reference.

RAISE
Close this input to Raise the Speed Reference. This input can also be used in conjunction with the Lower input to use the analog Remote Reference.

GENERATOR BREAKER
For Generator applications, connect this to the Circuit Breaker Aux contact. This input will allow a second set of dynamics, allow Feed-Forward Load Rejection, and allow for an online and offline MISFIRE FAULT TABLE.

UTILITY BREAKER
For Generator applications, connect this to the Utility Tie Bus AUX. This should be TRUE whenever the generator is parallel to the utility.

IGNITION ON
Connect this input to the third-party ignition 'Is Firing' Relay Output. If using IC-92X, set the selection to "IC-92X CAN". If no ignition integration is desired set the selection to "ALWAYS ON".

AFR POT LEARN
Connect this input to a momentary push button typically located inside the panel to allow EXTERNAL AFR BIAS.

THROTTLE 1 OK
Connect this input to the Status output of the Actuator, the E3 control can be set to alarm or shutdown when this occurs.

THROTTLE 2 OK
Connect this input to the Status output of the Actuator, the E3 control can be set to alarm or shutdown when this occurs.

FUEL TRIM VALVE 1 OK
Connect this input to the Status output of the Actuator, the E3 control can be set to alarm or shutdown when this occurs.

FUEL TRIM VALVE 2 OK
Connect this input to the Status output of the Actuator, the E3 control can be set to alarm or shutdown when this occurs.

Analog Inputs

IO – POSITION SENSOR INPUTS

THROTTLE POSITION SENSOR 1
TPS 1 OK
TPS 1 is active and between the MIN/MAX LIMITS.

TPS 1 SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

TPS 1 OK
Select the hardware input to use for TPS 1.

TPS 1 MIN LIMIT *
The low voltage threshold that will trigger the TPS 1 MIN SENSOR FAULT.

TPS 1 MAX LIMIT *
The high voltage threshold that will trigger the TPS 1 MAX SENSOR FAULT.

TPS 1 INPUT FILTER *
The TPS 1 low-pass filter time constant, reduce to improve input response.

TPS 1 RAW INPUT
The unfiltered hardware voltage signal.

TPS 1 UNFILTERED
The unfiltered engineering units value for TPS 1.

TPS 1 FILTERED
The filtered engineering units value for TPS 1.

TPS 1 NON-LINEAR TABLE *
A 2 x 5 lookup table, scale the return position feedback signal from an L-Series voltage with the engineering units throughout the operational range. This allows a more accurate position error when using an L-Series with non-linear position mapping.

TPS 1 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

THROTTLE POSITION SENSOR 2
TPS 2 OK
TPS 2 is active and between the MIN/MAX LIMITS.

TPS 2 SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

TPS 2 SELECT *
Select the hardware input to use for TPS 2.

TPS 2 MIN LIMIT *
The low voltage threshold that will trigger the TPS 2 MIN SENSOR FAULT.

TPS 2 MAX LIMIT *
The high voltage threshold that will trigger the TPS 2 MAX SENSOR FAULT.

TPS 2 INPUT FILTER *
The TPS 2 low-pass filter time constant, reduce to improve input response.

TPS 2 RAW INPUT
The unfiltered hardware voltage signal.

TPS 2 UNFILTERED
The unfiltered engineering units value for TPS 2.

TPS 2 FILTERED
The filtered engineering units value for TPS 2.

TPS 2 NON-LINEAR TABLE *
A 2 x 5 lookup table, scale the return position feedback signal from an L-Series voltage with the engineering units throughout the operational range. This allows a more accurate position error when using an L-Series with non-linear position mapping.

TPS 2 TUNABLE
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

FUEL TRIM POSITION SENSOR 1
FTPS 1 OK
FTPS 1 is active and between the MIN/MAX LIMITS.

FTPS 1 SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

FTPS 1 SELECT *
Select the hardware input to use for FTPS 1.

FTPS 1 MIN LIMIT *
The low voltage threshold that will trigger the FTPS 1 MIN SENSOR FAULT.

FTPS 1 MAX LIMIT *
The high voltage threshold that will trigger the FTPS 1 MAX SENSOR FAULT.

FTPS 1 INPUT FILTER *
The FTPS 1 low-pass filter time constant, reduce to improve input response.

FTPS 1 RAW INPUT
The unfiltered hardware voltage signal.

FTPS 1 UNFILTERED
The unfiltered engineering units value for FTPS 1.

FTPS 1 FILTERED
The filtered engineering units value for FTPS 1.

FTPS 1 NON-LINEAR TABLE *
A 2 x 5 lookup table, scale the return position feedback signal from an L-Series voltage with the engineering units throughout the operational range. This allows a more accurate position error when using an L-Series with non-linear position mapping.

FTPS 1 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

FUEL TRIM POSITION SENSOR 2
FTPS 2 OK
FTPS 2 is active and between the MIN/MAX LIMITS.

FTPS 2 SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

FTPS 2 SELECT *
Select the hardware input to use for FTPS 2.

FTPS 2 MIN LIMIT *
The low voltage threshold that will trigger the FTPS 2 MIN SENSOR FAULT.

FTPS 2 MAX LIMIT *
The high voltage threshold that will trigger the FTPS 2 MAX SENSOR FAULT.

FTPS 2 INPUT FILTER *
The FTPS 2 low-pass filter time constant, reduce to improve input response.

FTPS 2 RAW INPUT
The unfiltered hardware voltage signal.

FTPS 2 UNFILTERED
The unfiltered engineering units value for FTPS 2.

FTPS 2 FILTERED
The filtered engineering units value for FTPS 2.

FTPS 2 NON-LINEAR TABLE *
A 2 x 5 lookup table, scale the return position feedback signal from an L-Series voltage with the engineering units throughout the operational range. This allows a more accurate position error when using an L-Series with non-linear position mapping.

FTPS 2 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

IO – MAP & MAT

ANALOG INPUTS CONFIGURATION
MAP IO CONFIG *
Select the MAP configuration, MAP 1 ONLY, MAP 2 ONLY, MAP WITH BACKUP, or MAP WITH AVERAGE. MAP 1 ONLY uses just MAP 1; MAP 2 ONLY uses just MAP 2; MAP WITH BACKUP uses MAP unless it is failed and then it uses MAP 2; MAP WITH AVERAGE uses the average of the two MAP sensors unless one is failed and then it uses the good one.

RESULTANT MAP FILTER *
The filter used for the calculated resultant MAP signal.

MAT IO CONFIG *
Select the MAT configuration, MAT 1 ONLY, MAT 2 ONLY, MAT WITH BACKUP, or MAT WITH AVERAGE. MAT 1 ONLY uses just MAT 1; MAT 2 ONLY uses just MAT 2; MAT WITH BACKUP uses MAT unless it is failed and then it uses MAT 2; MAT WITH AVERAGE uses the average of the two MAT sensors unless one is failed and then it uses the good one.

MAT DEFAULT *
The value that is substituted in for the MAT if no good sensors remain.

MAP SENSOR 1
MAP 1 OK
MAP 1 is active and between the MIN/MAX LIMITS.

MAP 1 SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

MAP 1 SELECT *
Select the hardware input to use for MAP 1.

MAP 1 MIN LIMIT *
The low voltage threshold that will trigger the MAP 1 MIN SENSOR FAULT.

MAP 1 MAX LIMIT *
The high voltage threshold that will trigger the MAP 1 MAX SENSOR FAULT.

MAP 1 INPUT FILTER *
The MAP 1 low-pass filter time constant, reduce to improve input response.

MAP 1 RAW INPUT
The unfiltered hardware voltage signal.

MAP 1 UNFILTERED
The unfiltered engineering units value for MAP 1.

MAP 1 FILTERED
The filtered engineering units value for MAP 1.

MAP 1 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

MAP SENSOR 2
MAP 2 OK
MAP 2 is active and between the MIN/MAX LIMITS.

MAP 2 SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

MAP 2 SELECT *
Select the hardware input to use for MAP 2.

MAP 2 MIN LIMIT *
The low voltage threshold that will trigger the MAP 2 MIN SENSOR FAULT.

MAP 2 MAX LIMIT *
The high voltage threshold that will trigger the MAP 2 MAX SENSOR FAULT.

MAP 2 INPUT FILTER *
The MAP 2 low-pass filter time constant, reduce to improve input response.

MAP 2 RAW INPUT
The unfiltered hardware voltage signal.

MAP 2 UNFILTERED
The unfiltered engineering units value for MAP 2.

MAP 2 FILTERED
The filtered engineering units value for MAP 2.

MAP 2 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

MAT SENSOR 1
MAT 1 OK
MAT 1 is active and between the MIN/MAX LIMITS.

MAT 1 SCALING TABLE *
A 2 x 8 lookup table, scale the voltage with the engineering units throughout the operational range.

MAT 1 SELECT *
Select the hardware input to use for MAT 1.

MAT 1 MIN LIMIT *
The low voltage threshold that will trigger the MAT 1 MIN SENSOR FAULT.

MAT 1 MAX LIMIT *
The high voltage threshold that will trigger the MAT 1 MAX SENSOR FAULT.

MAT 1 INPUT FILTER *
The MAT 1 low-pass filter time constant, reduce to improve input response.

MAT 1 RAW INPUT
The unfiltered hardware voltage signal.

MAT 1 UNFILTERED
The unfiltered engineering units value for MAT 1.

MAT 1 FILTERED
The filtered engineering units value for MAT 1.

MAT 1 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

MAT SENSOR 2
MAT 2 OK
MAT 2 is active and between the MIN/MAX LIMITS.

MAT 2 SCALING TABLE *
A 2 x 8 lookup table, scale the voltage with the engineering units throughout the operational range.

MAT 2 SELECT *
Select the hardware input to use for MAT 2.

MAT 2 MIN LIMIT *
The low voltage threshold that will trigger the MAT 2 MIN SENSOR FAULT.

MAT 2 MAX LIMIT *
The high voltage threshold that will trigger the MAT 2 MAX SENSOR FAULT.

MAT 2 INPUT FILTER *
The MAT 2 low-pass filter time constant, reduce to improve input response.

MAT 2 RAW INPUT
The unfiltered hardware voltage signal.

MAT 2 UNFILTERED
The unfiltered engineering units value for MAT 2.

MAT 2 FILTERED
The filtered engineering units value for MAT 2.

MAT 2 TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

IO – LOP, LOT, ECT, & LOAD

LUBE OIL PRESSURE SENSOR
LOP OK
LOP is active and between the MIN/MAX LIMITS.

LOP SCALING TABLE *
A 2 x 5 lookup table, scale the voltage with the engineering units throughout the operational range.

LOP SELECT *
Select the hardware input to use for LOP.

LOP MIN LIMIT *
The low voltage threshold that will trigger the LOP MIN SENSOR FAULT.

LOP MAX LIMIT *
The high voltage threshold that will trigger the LOP MAX SENSOR FAULT.

LOP INPUT FILTER *
The LOP low-pass filter time constant, reduce to improve input response.

LOP RAW INPUT
The unfiltered hardware voltage signal.

LOP UNFILTERED
The unfiltered engineering units value for LOP.

LOP FILTERED
The filtered engineering units value for LOP.

LOP TUNABLE *
The analog voltage value that gets passed through when the input is selected for ‘TUNABLE’.

LUBE OIL TEMPERATURE SENSOR
LOT OK
LOT is active and between the MIN/MAX LIMITS.

LOT SCALING TABLE *
A 2 x 8 lookup table, scale the voltage with the engineering units throughout the operational range.

LOT SELECT *
Select the hardware input to use for LOT.

LOT MIN LIMIT *
The low voltage threshold that will trigger the LOT MIN SENSOR FAULT.

LOT MAX LIMIT *
The high voltage threshold that will trigger the LOT MAX SENSOR FAULT.

LOT INPUT FILTER *
The LOT low-pass filter time constant, reduce to improve input response.

LOT RAW INPUT
The unfiltered hardware voltage signal.

LOT UNFILTERED
The unfiltered engineering units value for LOT.

LOT FILTERED
The filtered engineering units value for LOT.

LOT TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

IO – ENGINE COOLANT SENSOR
ECT OK
ECT is active and between the MIN/MAX LIMITS.

ECT SCALING TABLE *
A 2 x 8 lookup table, scale the voltage with the engineering units throughout the operational range.

ECT SELECT *
Select the hardware input to use for ECT.

ECT MIN LIMIT *
The low voltage threshold that will trigger the ECT MIN SENSOR FAULT.

ECT MAX LIMIT *
The high voltage threshold that will trigger the ECT MAX SENSOR FAULT.

ECT INPUT FILTER *
The ECT low-pass filter time constant, reduce to improve input response.

ECT RAW INPUT
The unfiltered hardware voltage signal.

ECT UNFILTERED
The unfiltered engineering units value for ECT.

ECT FILTERED
The filtered engineering units value for ECT.

ECT TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

IO – LOAD SENSOR
LOAD OK
LOAD is active and between the MIN/MAX LIMITS.

LOAD SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

LOAD SELECT *
Select the hardware input to use for LOAD.

LOAD MIN LIMIT *
The low voltage threshold that will trigger the LOAD MIN SENSOR FAULT.

LOAD MAX LIMIT *
The high voltage threshold that will trigger the LOAD MAX SENSOR FAULT.

LOAD INPUT FILTER *
The LOAD low-pass filter time constant, reduce to improve input response.

LOAD RAW INPUT
The unfiltered hardware voltage signal.

LOAD UNFILTERED
The unfiltered engineering units value for LOAD.

LOAD FILTERED
The filtered engineering units value for LOAD.

LOAD TUNABLE *
The analog voltage value that gets passed through when the input is selected for ‘TUNABLE’.

EXTERNAL BIAS

IO – SPEED BIAS
SPEED BIAS OK
SPEED BIAS is active and between the MIN/MAX LIMITS.

SPEED BIAS SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

SPEED BIAS SELECT *
Select the hardware input to use for SPEED BIAS.

SPEED BIAS MIN LIMIT *
The low voltage threshold that will trigger the SPEED BIAS MIN SENSOR FAULT.

SPEED BIAS MAX LIMIT *
The high voltage threshold that will trigger the SPEED BIAS MAX SENSOR FAULT.

SPEED BIAS INPUT FILTER *
The SPEED BIAS low-pass filter time constant, reduce to improve input response.

SPEED BIAS RAW INPUT
The unfiltered hardware voltage signal.

SPEED BIAS UNFILTERED
The unfiltered engineering units value for SPEED BIAS.

SPEED BIAS FILTERED
The filtered engineering units value for SPEED BIAS.

SPEED BIAS TUNABLE *
The analog voltage value that gets passed through when the input is selected for ‘TUNABLE’.

IO – REMOTE REFERENCE
REM OK
REM is active and between the MIN/MAX LIMITS.

REM SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

REM SELECT *
Select the hardware input to use for REM.

REM MIN LIMIT *
The low voltage threshold that will trigger the REM MIN SENSOR FAULT.

REM MAX LIMIT *
The high voltage threshold that will trigger the REM MAX SENSOR FAULT.

REM INPUT FILTER *
The REM low-pass filter time constant, reduce to improve input response.

REM RAW INPUT
The unfiltered hardware voltage signal.

REM UNFILTERED
The unfiltered engineering units value for REM.

REM FILTERED
The filtered engineering units value for REM.

REM TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

IO – SPEED BIAS PWM
SPEED BIAS PWM OK
SPEED BIAS PWM is active and between the MIN/MAX LIMITS.

SPEED BIAS PWM SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

SPEED BIAS PWM SELECT *
Select the hardware input to use for SPEED BIAS PWM.

SPEED BIAS PWM MIN LIMIT *
The low voltage threshold that will trigger the SPEED BIAS PWM MIN SENSOR FAULT.

SPEED BIAS PWM MAX LIMIT *
The high voltage threshold that will trigger the SPEED BIAS PWM MAX SENSOR FAULT.

SPEED BIAS PWM INPUT FILTER
The SPEED BIAS PWM low-pass filter time constant, reduce to improve input response.

SPEED BIAS PWM RAW INPUT *
The unfiltered hardware voltage signal.

SPEED BIAS PWM UNFILTERED
The unfiltered engineering units value for SPEED BIAS PWM.

SPEED BIAS PWM FILTERED
The filtered engineering units value for SPEED BIAS PWM.

SPEED BIAS PWM TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

IO – AFR ADJUST POT
The AFR Adjust Potentiometer allows external AFR setpoint bias. To use: connect AFR learn switch and pot, press AFR learn button, adjust pot (CW to increase setpoint), release button and bias increment has been save for the current load level, all other load levels are not affected.

AFR ADJUST POT OK
AFR ADJUST POT is active and between the MIN/MAX LIMITS.

AFR ADJUST POT BIAS TABLE *
A 2 x 8 lookup table, that stores the bias for each load step as programmed, shares an index with the POST-CAT SETPOINT TABLE..

AFR ADJUST POT SELECT *
Select the hardware input to use for AFR ADJUST POT.

AFR ADJUST POT MIN LIMIT *
The low voltage threshold that will trigger the AFR ADJUST POT MIN SENSOR FAULT.

AFR ADJUST POT MAX LIMIT *
The high voltage threshold that will trigger the AFR ADJUST POT MAX SENSOR FAULT.

AFR ADJUST POT INPUT FILTER *
The AFR ADJUST POT low-pass filter time constant, reduce to improve input response.

AFR ADJUST POT RAW INPUT
The unfiltered hardware voltage signal.

AFR ADJUST POT UNFILTERED
The unfiltered engineering units value for AFR ADJUST POT.

AFR ADJUST POT FILTERED
The filtered engineering units value for AFR ADJUST POT.

AFR ADJUST POT TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

POT SCALING *
Adjusts the sensitivity of the potentiometer, increase value to make the pot adjust more setpoint per turn.

MODBUS STEP SIZE *
The amount in mV that the Modbus will adjust the external bias table for each increment or decrement.

EXT BIAS TABLE FAULT
Indicates that a bias adjustment was not saved in the table. An example is if the AFR INDEX was outside the table defined limits and an adjustment was attempted.

This value will clear when a successful adjustment is made.

EXT BIAS VALUE
The readout of the bias table.

TOTAL SETPOINT
The result of the POST-CAT SETPOINT TABLE summed with the EXTERNAL BIAS TABLE.

RESET EXTERNAL BIAS TABLE TO ZERO
A momentary button that resets the entire EXTERNAL BIAS TABLE to zeroes.

Catalyst I/O

IO – HEGO 1

HEGO 1 – PRE-CAT BANK 1
HEGO 1 INPUT FILTER *
The HEGO Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

HEGO 1 DIFFERENTIAL DELAY *
Calibration value to shift switch times, typically left at default.

HEGO 1 UNFILTERED
The raw HEGO signal readout (mV).

HEGO 1 FILTERED
The filtered HEGO signal readout (mV).

HEGO 1 HEATER
HEGO 1 HEATER MANUAL SD *
Check this box to shutdown the heater voltage, used for troubleshooting and setup.

HEGO 1 HEATER CURRENT
Readout of the HEGO Heater Current (ADC)

HEGO 1 HEATER DUTY CYCLE
Readout of the HEGO Heater Duty Cycle (%).

HEGO 1 HEATER PWM FREQUENCY
Readout of the HEGO Heater PWM Frequency (Hz).

HEGO 1 HEATER ACTIVE
HEGO 1 HEATER ON
LED indication of the HEGO Heater status.

ENGINE NOT RUNNING
LED indication of the HEGO Heater status permissive.

RUN SWITCH OFF
LED indication of the HEGO Heater status permissive.

AL456 HEGO 1 HEATER CURRENT HIGH SD
LED indication of the HEGO Heater status permissive.

HEGO 1 SWITCHING QUALITY
This group provides a snapshot of the switching quality of the Pre-Cat HEGO sensor.

SENSOR RICH
An LED indication that the Pre-Cat HEGO sensor reading is above 450 mV.

HEGO 1 LO PEAK
The lowest HEGO 1 reading in the last dither cycle (mV).

HEGO 1 HI PEAK
The highest HEGO 1 reading in the last dither cycle (mV).

HEGO 1 AMPLITUDE
The difference in the peak measurements for the last dither cycle (mV).

HEGO 1 SENSOR FAULTS
HEGO 1 OK
LED indication that the HEGO health is ready for closed loop operation. AL550, 555, 560, 561 must all be FALSE after grace period. All the unlatched faults must be FALSE during the grace period.

AL550 HEGO 1 VOLTAGE LOW
LED indication of the fault the HEGO voltage is below the threshold.

AL555 HEGO 1 VOLTAGE HIGH
LED indication of the fault the HEGO voltage is above the threshold.

AL560 HEGO 1 SENSOR FAILED
LED indication of the fault the HEGO voltage is within the fault window.

AL561 HEGO 1 HEATER OPEN CIRCUIT
LED indication of the fault the HEGO read back current is below the fault threshold.

HEGO 1 FAULT ARM
HEGO 1 ARMED
LED indication of the HEGO ARMED status, HEGO SEQUENCE STATE must be RUN.

ENGINE RUNNING
LED indication of the ENGINE RUNNING status.

NO FUEL STOP
LED indication of the NO FUEL STOP status. NO FUEL STOP includes RUN/STOP INPUT, SHUTDOWN, and easYgen STOP.

GRACE TIME
LED indication of the GRACE PERIOD status, this lights when the grace period has expired.

HEGO 1 MODE
LED indicates the AFR MODE is a closed loop request.

LOAD READY
LED indication that the Qmix is above the LOAD BREAKPOINT.

HEGO SEQUENCE STATE
The HEGO HEATER sequence provides for sensor and heater element protection.

HEGO STATE
Text readout indicating the HEGO sequence, possible states: OFF, SHOCK PROTECT, WARMUP, STABILIZING, GRACE PERIOD, GRACE RUN, RUN, or NO CLOSED LOOP. OFF – Engine stopped heaters off; SHOCK PROTECT – voltage remains off to allow water droplets to pass by sensor; WARMUP – Heater operates at a reduced voltage; STABILIZING – Heater ramps to full power and stabilizes; GRACE PERIOD – No sensor faults announced; GRACE RUN – Sensor OK closed loop allowed still no latched faults; RUN – HEGO Faults fully armed any HEGO faults will result in fault action and latch; or NO CLOSED LOOP – Closed loop control is not required from the system due to warm-up, low load, or user intervention.

SHOCK REMAIN
The time remaining in shock protect mode (sec).

WARMUP REMAIN
The time remaining in warm-up protect mode (sec).

STABLE REMAIN
The time remaining in stabilizing mode (sec).

GRACE REMAIN
The time remaining in Grace Period (sec).

HEGO HEATER EFFECTIVE VOLTAGE
The Effective Voltage to the heater (Vrms).

HEGO 1-3 HEATER SETPOINTS
THERMAL SHOCK DELAY *
Time period the heater is shutoff after run (sec).

HEATER WARMUP TIME *
Time period the heater is in warm-up mode (sec).

HEGO STABLE DELAY *
The time period the heater must be at maximum before considered stable (sec).

GRACE PERIOD *
The time period after which the HEGO sensor should be considered warmed up and ready to go (sec). Once the GRACE PERIOD is expired, any HEGO sensor fault will trigger a latched fault.

OPEN CIRCUIT CURRENT LEVEL *
The HEGO Heater current read back threshold level (ADC).

MAX EFFECTIVE VOLTAGE *
The HEGO Heater current read back threshold level (ADC).

IO – HEGO 2

HEGO 2 – PRE-CAT BANK 2
HEGO 2 INPUT FILTER *
The HEGO Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

HEGO 2 DIFFERENTIAL DELAY *
Calibration value to shift switch times, typically left at default.

HEGO 2 UNFILTERED
The raw HEGO signal readout (mV).

HEGO 2 FILTERED
The filtered HEGO signal readout (mV).

HEGO 2 HEATER
HEGO 2 HEATER MANUAL SD *
Check this box to shutdown the heater voltage, used for troubleshooting and setup.

HEGO 2 HEATER CURRENT
Readout of the HEGO Heater Current (ADC)

HEGO 2 HEATER DUTY CYCLE
Readout of the HEGO Heater Duty Cycle (%).

HEGO 2 HEATER PWM FREQUENCY
Readout of the HEGO Heater PWM Frequency (Hz).

HEGO 2 HEATER ACTIVE
HEGO 2 HEATER ON
LED indication of the HEGO Heater status.

ENGINE NOT RUNNING
LED indication of the HEGO Heater status permissive.

RUN SWITCH OFF
LED indication of the HEGO Heater status permissive.

HEGO 2 SWITCHING QUALITY
This group provides a snapshot of the switching quality of the Pre-Cat HEGO sensor.

SENSOR RICH
An LED indication that the Pre-Cat HEGO sensor reading is above 450 mV.

HEGO 2 LO PEAK
The lowest HEGO 2 reading in the last dither cycle (mV).

HEGO 2 HI PEAK
The highest HEGO 2 reading in the last dither cycle (mV).

HEGO 2 AMPLITUDE
The difference in the peak measurements for the last dither cycle (mV).

HEGO 2 SENSOR FAULTS
HEGO 2 OK
LED indication that the HEGO health is ready for closed loop operation. AL565, 570, 575 must all be FALSE after grace period. All the unlatched faults must be FALSE during the grace period.

AL565 HEGO 2 VOLTAGE LOW
LED indication of the fault the HEGO voltage is below the threshold.

AL570 HEGO 2 VOLTAGE HIGH
LED indication of the fault the HEGO voltage is above the threshold.

AL575 HEGO 2 SENSOR FAILED
LED indication of the fault the HEGO voltage is within the fault window.

HEGO 2 FAULT ARM
HEGO 2 ARMED
LED indication of the HEGO ARMED status, HEGO SEQUENCE STATE must be RUN.

ENGINE RUNNING
LED indication of the ENGINE RUNNING status

NO FUEL STOP
LED indication of the NO FUEL STOP status. NO FUEL STOP includes RUN/STOP INPUT, SHUTDOWN, and easYgen STOP.

GRACE TIME
LED indication of the GRACE PERIOD status, this lights when the grace period has expired.

HEGO 2 MODE
LED indicates the AFR MODE is a closed loop request.

LOAD READY
LED indication that the Qmix is above the LOAD BREAKPOINT.

HEGO SEQUENCE STATE
The HEGO HEATER sequence provides for sensor and heater element protection.

HEGO STATE
Text readout indicating the HEGO sequence, possible states: OFF, SHOCK PROTECT, WARMUP, STABILIZING, GRACE PERIOD, GRACE RUN, RUN, or NO CLOSED LOOP. OFF – Engine stopped heaters off; SHOCK PROTECT – voltage remains off to allow water droplets to pass by sensor; WARMUP – Heater operates at a reduced voltage; STABILIZING – Heater ramps to full power and stabilizes; GRACE PERIOD – No sensor faults announced; GRACE RUN – Sensor OK closed loop allowed still no latched faults; RUN – HEGO Faults fully armed any HEGO faults will result in fault action and latch; or NO CLOSED LOOP – Closed loop control is not required from the system due to warm-up, low load, or user intervention.

SHOCK REMAIN
The time remaining in shock protect mode (sec).

WARMUP REMAIN
The time remaining in warm-up protect mode (sec).

STABLE REMAIN
The time remaining in stabilizing mode (sec).

GRACE REMAIN
The time remaining in Grace Period (sec).

HEGO HEATER EFFECTIVE VOLTAGE
The Effective Voltage to the heater (Vrms).

HEGO 1-3 HEATER SETPOINTS
THERMAL SHOCK DELAY *
Time period the heater is shutoff after run (sec).

HEATER WARMUP TIME *
Time period the heater is in warm-up mode (sec).

HEGO STABLE DELAY *
The time period the heater must be at maximum before considered stable (sec).

GRACE PERIOD *
The time period after which the HEGO sensor should be considered warmed up and ready to go (sec). Once the GRACE PERIOD is expired, any HEGO sensor fault will trigger a latched fault.

OPEN CIRCUIT CURRENT LEVEL *
The HEGO Heater current read back threshold level (ADC).

MAX EFFECTIVE VOLTAGE *
The HEGO Heater current read back threshold level (ADC).

IO – HEGO 3

HEGO 3 – POST-CAT
HEGO 3 INPUT FILTER *
The HEGO Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

HEGO 3 UNFILTERED
The raw HEGO signal readout (mV).

HEGO 3 FILTERED
The filtered HEGO signal readout (mV).

HEGO 1 HEATER
HEGO 3 HEATER MANUAL SD *
Check this box to shutdown the heater voltage, used for troubleshooting and setup.

HEGO 3 HEATER CURRENT
Readout of the HEGO Heater Current (ADC)

HEGO 3 HEATER DUTY CYCLE
Readout of the HEGO Heater Duty Cycle (%).

HEGO 3 HEATER PWM FREQUENCY
Readout of the HEGO Heater PWM Frequency (Hz).

HEGO 3 HEATER ACTIVE
HEGO 3 HEATER ON
LED indication of the HEGO Heater status.

ENGINE NOT RUNNING
LED indication of the HEGO Heater status permissive.

RUN SWITCH OFF
LED indication of the HEGO Heater status permissive.

AL458 HEGO 3 HEATER CURRENT HIGH SD
LED indication of the HEGO Heater status permissive.

HEGO 3 SIGNAL QUALITY
This group provides a snapshot of the signal quality of the Post-Cat HEGO sensor.

HEGO 3 LO PEAK
The lowest HEGO 3 reading in the last dither cycle (mV).

HEGO 3 HI PEAK
The highest HEGO 3 reading in the last dither cycle (mV).

HEGO 3 AMPLITUDE
The difference in the peak measurements for the last dither cycle (mV).

HEGO 3 SENSOR FAULTS
HEGO 3 OK
LED indication that the HEGO health is ready for closed loop operation. AL580, 585, 590, 591 must all be FALSE after grace period. All the unlatched faults must be FALSE during the grace period.

AL580 HEGO 3 VOLTAGE LOW
LED indication of the fault the HEGO voltage is below the threshold.

AL585 HEGO 3 VOLTAGE HIGH
LED indication of the fault the HEGO voltage is above the threshold.

AL590 HEGO 3 SENSOR FAILED
LED indication of the fault the HEGO voltage is within the fault window.

AL591 HEGO 3 HEATER OPEN CIRCUIT
LED indication of the fault the HEGO read back current is below the fault threshold.

HEGO 3 FAULT ARM
HEGO 3 ARMED
LED indication of the HEGO ARMED status, HEGO SEQUENCE STATE must be RUN.

ENGINE RUNNING
LED indication of the ENGINE RUNNING status

NO FUEL STOP
LED indication of the NO FUEL STOP status. NO FUEL STOP includes RUN/STOP INPUT, SHUTDOWN, and easYgen STOP.

GRACE TIME
LED indication of the GRACE PERIOD status, this lights when the grace period has expired.

HEGO 3 MODE
LED indicates the AFR MODE is a closed loop request.

LOAD READY
LED indication that the Qmix is above the LOAD BREAKPOINT.

HEGO SEQUENCE STATE
The HEGO HEATER sequence provides for sensor and heater element protection.

HEGO STATE
Text readout indicating the HEGO sequence, possible states: OFF, SHOCK PROTECT, WARMUP, STABILIZING, GRACE PERIOD, GRACE RUN, RUN, or NO CLOSED LOOP. OFF – Engine stopped heaters off; SHOCK PROTECT – voltage remains off to allow water droplets to pass by sensor; WARMUP – Heater operates at a reduced voltage; STABILIZING – Heater ramps to full power and stabilizes; GRACE PERIOD – No sensor faults announced; GRACE RUN – Sensor OK closed loop allowed still no latched faults; RUN – HEGO Faults fully armed any HEGO faults will result in fault action and latch; or NO CLOSED LOOP – Closed loop control is not required from the system due to warm-up, low load, or user intervention.

SHOCK REMAIN
The time remaining in shock protect mode (sec).

WARMUP REMAIN
The time remaining in warm-up protect mode (sec).

STABLE REMAIN
The time remaining in stabilizing mode (sec).

GRACE REMAIN
The time remaining in Grace Period (sec).

HEGO HEATER EFFECTIVE VOLTAGE
The Effective Voltage to the heater (Vrms).

HEGO 1-3 HEATER SETPOINTS
THERMAL SHOCK DELAY *
Time period the heater is shutoff after run (sec).

HEATER WARMUP TIME *
Time period the heater is in warm-up mode (sec).

HEGO STABLE DELAY *
The time period the heater must be at maximum before considered stable (sec).

GRACE PERIOD *
The time period after which the HEGO sensor should be considered warmed up and ready to go (sec). Once the GRACE PERIOD is expired, any HEGO sensor fault will trigger a latched fault.

OPEN CIRCUIT CURRENT LEVEL *
The HEGO Heater current read back threshold level (ADC).

MAX EFFECTIVE VOLTAGE *
The HEGO Heater current read back threshold level (ADC).

IO – CAT TEMPERATURE

CONFIG PRE-CAT EXTERNAL THERMOCOUPLE

CONFIG PRE-CAT TEMPERATURE SENSOR
Drop down selection box allows for an External Thermocouple J1939 Node, High temp RTD, or High temp thermistor.

PRE-CAT CHANNEL FAULT
LED indication of the pre-cat thermocouple channel fault.

EXTERNAL THERMOCOUPLE NODE WATCHDOG FAULT
LED indication of a node loss of communication fault.

EXTERNAL TC PGN *
Tunable PGN allows different SPNs to be used.

EXTERNAL TC NODE ID *
Tunable Node ID allows custom Node ID. Please note that the default PGN is compliant for the default setup of some third-party nodes. The J1939 standard PGN for Pre/Post Catalyst temperatures is 64838.

AL1349 EXTERNAL TC TIMEOUT DELAY *
Tunable delay for receiving robust communication, set to at least 3 times the normal repetition rate (ms).

CONFIG PRE-CAT RESISTIVE

CONFIG PRE-CAT TEMPERATURE SENSOR
Drop down selection box allows for an External Thermocouple J1939 Node, High temp RTD, or High temp thermistor.

PRE-CAT TEMP OK
PRE-CAT TEMP is active and between the MIN/MAX LIMITS.

PRE-CAT SCALING TABLE *
A 2 x 10 lookup table, scale the voltage with the engineering units throughout the operational range.

PRE-CAT SELECT *
Select the hardware input to use for PRE-CAT.

PRE-CAT MIN LIMIT *
The low voltage threshold that will trigger the PRE-CAT MIN SENSOR FAULT.

PRE-CAT MAX LIMIT *
The high voltage threshold that will trigger the PRE-CAT MAX SENSOR FAULT.

PRE-CAT INPUT FILTER *
The PRE-CAT low-pass filter time constant, reduce to improve input response.

PRE-CAT RAW INPUT
The unfiltered hardware voltage signal.

PRE-CAT UNFILTERED
The unfiltered engineering units value for PRE-CAT.

PRE-CAT FILTERED
The filtered engineering units value for PRE-CAT.

PRE-CAT TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

LED indication of the pre-cat resistive sensor health.

CONFIG POST-CAT EXTERNAL THERMOCOUPLE
CONFIG POST-CAT TEMPERATURE SENSOR
Drop down selection box allows for an External Thermocouple J1939 Node, High temp RTD, or High temp thermistor.

POST-CAT CHANNEL FAULT
LED indication of the POST-CAT thermocouple channel fault.

EXTERNAL THERMOCOUPLE NODE WATCHDOG FAULT
LED indication of a node loss of communication fault.

EXTERNAL TC PGN *
Tunable PGN allows different SPNs to be used.

EXTERNAL TC NODE ID *
Tunable Node ID allows custom Node ID.

AL1349 EXTERNAL TC TIMEOUT DELAY *
Tunable delay for receiving robust communication, set to at least 3 times the normal repetition rate (ms).

CONFIG POST-CAT RESISTIVE
CONFIG POST-CAT TEMPERATURE SENSOR
Drop down selection box allows for an External Thermocouple J1939 Node, High temp RTD, or High temp thermistor.

POST-CAT TEMP OK
POST-CAT TEMP is active and between the MIN/MAX LIMITS.

POST-CAT SCALING TABLE *
A 2 x 10 lookup table, scale the voltage with the engineering units throughout the operational range.

POST-CAT SELECT *
Select the hardware input to use for POST-CAT.

POST-CAT MIN LIMIT *
The low voltage threshold that will trigger the POST-CAT MIN SENSOR FAULT.

POST-CAT MAX LIMIT *
The high voltage threshold that will trigger the POST-CAT MAX SENSOR FAULT.

POST-CAT INPUT FILTER *
The POST-CAT low-pass filter time constant, reduce to improve input response.

POST-CAT RAW INPUT
The unfiltered hardware voltage signal.

POST-CAT UNFILTERED
The unfiltered engineering units value for POST-CAT.

POST-CAT FILTERED
The filtered engineering units value for POST-CAT.

POST-CAT TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

LED indication of the POST-CAT resistive sensor health.

IO – CAT PRESSURE

CONFIG CAT DIFFERENTIAL PRESSURE SENSOR
CONFIG CAT PRESSURE
Dropdown selection box allowing multiple CAT PRESSURE input options. The available states are: 'NONE', 'DP SENSOR ONLY', 'PRE PRS – POST PRS', and 'DP SENSOR & AMB PRS'. 'NONE' – All inputs are disabled; 'DP SENSOR ONLY' – Use one DP sensor; 'PRE PRS – POST PRS' – use two sensors and the control calculates the difference; and 'DP SENSOR & AMB PRS' – Use one DP sensor and one Ambient Air pressure sensor for monitoring only.

CDP OK
CDP is active and between the MIN/MAX LIMITS.

CDP SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

CDP SELECT *
Select the hardware input to use for CDP.

CDP MIN LIMIT *
The low voltage threshold that will trigger the CDP MIN SENSOR FAULT.

CDP MAX LIMIT *
The high voltage threshold that will trigger the CDP MAX SENSOR FAULT.

CDP INPUT FILTER *
The CDP low-pass filter time constant, reduce to improve input response.

CDP RAW INPUT
The unfiltered hardware voltage signal.

CDP UNFILTERED
The unfiltered engineering units value for CDP.

CDP FILTERED
The filtered engineering units value for CDP.

CDP TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

CONFIG POST-CAT PRESSURE SENSOR

CONFIG CAT PRESSURE
Dropdown selection box allowing multiple CAT PRESSURE input options. The available states are: 'NONE', 'DP SENSOR ONLY', 'PRE PRS – POST PRS', and 'DP SENSOR & AMB PRS'. 'NONE' – All inputs are disabled; 'DP SENSOR ONLY' – Use one DP sensor; 'PRE PRS – POST PRS' – use two sensors and the control calculates the difference; and 'DP SENSOR & AMB PRS' – Use one DP sensor and one Ambient Air pressure sensor for monitoring only.

POST-CAT PRESSURE OK
POST-CAT PRESSURE is active and between the MIN/MAX LIMITS.

POST-CAT PRESSURE SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

POST-CAT PRESSURE SELECT *
Select the hardware input to use for POST-CAT PRESSURE.

POST-CAT PRESSURE MIN LIMIT *
The low voltage threshold that will trigger the POST-CAT PRESSURE MIN SENSOR FAULT.

POST-CAT PRESSURE MAX LIMIT *
The high voltage threshold that will trigger the POST-CAT PRESSURE MAX SENSOR FAULT.

POST-CAT PRESSURE INPUT FILTER *
The POST-CAT PRESSURE low-pass filter time constant, reduce to improve input response.

POST-CAT PRESSURE RAW INPUT
The unfiltered hardware voltage signal.

POST-CAT PRESSURE UNFILTERED
The unfiltered engineering units value for POST-CAT PRESSURE.

POST-CAT PRESSURE FILTERED
The filtered engineering units value for POST-CAT PRESSURE.

POST-CAT PRESSURE TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

CONFIG PRE-CAT PRESSURE SENSOR

CONFIG CAT PRESSURE
Dropdown selection box allowing multiple CAT PRESSURE input options. The available states are: 'NONE', 'DP SENSOR ONLY', 'PRE PRS – POST PRS', and 'DP SENSOR & AMB PRS'. 'NONE' – All inputs are disabled; 'DP SENSOR ONLY' – Use one DP sensor; 'PRE PRS – POST PRS' – use two sensors and the control calculates the difference; and 'DP SENSOR & AMB PRS' – Use one DP sensor and one Ambient Air pressure sensor for monitoring only.

PRE-CAT PRESSURE OK
PRE-CAT PRESSURE is active and between the MIN/MAX LIMITS.

PRE-CAT PRESSURE SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

PRE-CAT PRESSURE SELECT *
Select the hardware input to use for PRE-CAT PRESSURE.

PRE-CAT PRESSURE MIN LIMIT *
The low voltage threshold that will trigger the PRE-CAT PRESSURE MIN SENSOR FAULT.

PRE-CAT PRESSURE MAX LIMIT *
The high voltage threshold that will trigger the PRE-CAT PRESSURE MAX SENSOR FAULT.

PRE-CAT PRESSURE INPUT FILTER *
The PRE-CAT PRESSURE low-pass filter time constant, reduce to improve input response.

PRE-CAT PRESSURE RAW INPUT
The unfiltered hardware voltage signal.

PRE-CAT PRESSURE UNFILTERED
The unfiltered engineering units value for PRE-CAT PRESSURE.

PRE-CAT PRESSURE FILTERED
The filtered engineering units value for PRE-CAT PRESSURE.

PRE-CAT PRESSURE TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

CONFIG AMBIENT AIR PRESSURE SENSOR
CONFIG CAT PRESSURE
Dropdown selection box allowing multiple CAT PRESSURE input options. The available states are: 'NONE', 'DP SENSOR ONLY', 'PRE PRS – POST PRS', and 'DP SENSOR & AMB PRS'. 'NONE' – All inputs are disabled; 'DP SENSOR ONLY' – Use one DP sensor; 'PRE PRS – POST PRS' – use two sensors and the control calculates the difference; and 'DP SENSOR & AMB PRS' – Use one DP sensor and one Ambient Air pressure sensor for monitoring only.

AMB PRESSURE OK
AMB PRESSURE is active and between the MIN/MAX LIMITS.

AMB PRESSURE SCALING TABLE *
A 2 x 2 lookup table, scale the voltage with the engineering units throughout the operational range.

AMB PRESSURE SELECT *
Select the hardware input to use for AMB PRESSURE.

AMB PRESSURE MIN LIMIT *
The low voltage threshold that will trigger the AMB PRESSURE MIN SENSOR FAULT.

AMB PRESSURE MAX LIMIT *
The high voltage threshold that will trigger the AMB PRESSURE MAX SENSOR FAULT.

AMB PRESSURE INPUT FILTER *
The AMB PRESSURE low-pass filter time constant, reduce to improve input response.

AMB PRESSURE RAW INPUT
The unfiltered hardware voltage signal.

AMB PRESSURE UNFILTERED
The unfiltered engineering units value for AMB PRESSURE.

AMB PRESSURE FILTERED
The filtered engineering units value for AMB PRESSURE.

AMB PRESSURE TUNABLE *
The analog voltage value that gets passed through when the input is selected for 'TUNABLE'.

Actuator Outputs

IO – ACTUATORS

ACTUATOR SELECT
THROTTLE 1
Drop down selection box allows to select PWM OUTPUTS for the THROTTLE 1 driver. Allowed states: PWM OUT 1, PWM OUT 2, PWM OUT 3, PWM OUT 4, CAN F-SERIES 1, CAN F-SERIES 2, CAN F-SERIES 3, CAN F-SERIES 4, CAN PROACT 1, or CAN PROACT 2.

THROTTLE 2
Drop down selection box allows to select PWM OUTPUTS for the THROTTLE 2 driver. Allowed states: PWM OUT 1, PWM OUT 2, PWM OUT 3, PWM OUT 4, CAN F-SERIES 1, CAN F-SERIES 2, CAN F-SERIES 3, CAN F-SERIES 4, CAN PROACT 1, or CAN PROACT 2.

TRIM VALVE 1
Drop down selection box allows to select PWM OUTPUTS for the TRIM VALVE 1 driver. Allowed states: PWM OUT 1, PWM OUT 2, PWM OUT 3, PWM OUT 4, CAN F-SERIES 1, CAN F-SERIES 2, CAN F-SERIES 3, CAN F-SERIES 4, CAN PROACT 1, or CAN PROACT 2.

TRIM VALVE 2
Drop down selection box allows to select PWM OUTPUTS for the TRIM VALVE 2 driver. Allowed states: PWM OUT 1, PWM OUT 2, PWM OUT 3, PWM OUT 4, CAN F-SERIES 1, CAN F-SERIES 2, CAN F-SERIES 3, CAN F-SERIES 4, CAN PROACT 1, or CAN PROACT 2.

PROACT SETTINGS
PROACT 1 ADDRESS
Drop down selection box allows Addresses: 1, 2, 3, or 4. 1 = 19, 2 = 20, 3 = 21, 3 = 22.

PROACT 2 ADDRESS
Drop down selection box allows Addresses: 1, 2, 3, or 4. 1 = 19, 2 = 20, 3 = 21, 3 = 22.

SELECT PROACT1 ISC
Check this box if ProAct 1 is a PISC.

SELECT PROACT2 ISC
Check this box if ProAct 2 is a PISC.

IO – THROTTLE 1

THROTTLE 1 CALIBRATION SETTINGS
Follow the steps on the Toolkit page to calibrate the Actuators and the Position feedback.

CALIBRATION MODE
Check this box if the engine is stopped to enter actuator calibration mode. The selected output is then forced to 0.0 % throttle; if CALIBRATION TO MAXIMUM is checked then the output is forced to 100% throttle.

CALIBRATION TO MAXIMUM
Check this box when CALIBRATION MODE is TRUE to force the selected output to go to 100% throttle demand.

SELECT MANUAL MODE
Check this box to ramp to the MANUAL CAL SETTING at the MANUAL/CALIBRATION RATE.

MANUAL/CALIBRATION RATE
The ramp rate the output moves while in MANUAL or CALIBRATION MODE (%/sec).

MANUAL CAL SETTING
The value of the manual actuator output.

THROTTLE 1 REVERSE ACTING
Check this box if a reverse acting response is desired; the output = 100 – ACT COMMAND.

IO – THROTTLE 2

THROTTLE 2 CALIBRATION SETTINGS
Follow the steps on the Toolkit page to calibrate the Actuators and the Position feedback.

CALIBRATION MODE
Check this box if the engine is stopped to enter actuator calibration mode. The selected output is then forced to 0.0 % throttle; if CALIBRATION TO MAXIMUM is checked then the output is forced to 100% throttle.

CALIBRATION TO MAXIMUM
Check this box when CALIBRATION MODE is TRUE to force the selected output to go to 100% throttle demand.

SELECT MANUAL MODE
Check this box to ramp to the MANUAL CAL SETTING at the MANUAL/CALIBRATION RATE.

MANUAL/CALIBRATION RATE
The ramp rate the output moves while in MANUAL or CALIBRATION MODE (%/sec)

MANUAL CAL SETTING
The value of the manual actuator output.

THROTTLE 2 REVERSE ACTING
Check this box if a reverse acting response is desired; the output = 100 – ACT COMMAND.

IO – TRIM VALVE 1

TRIM VALVE 1 CALIBRATION SETTINGS
Follow the steps on the Toolkit page to calibrate the Actuators and the Position feedback.

CALIBRATION MODE
Check this box if the engine is stopped to enter actuator calibration mode. The selected output is then forced to 0.0 % trim valve; if CALIBRATION TO MAXIMUM is checked then the output is forced to 100% trim valve.

CALIBRATION TO MAXIMUM
Check this box when CALIBRATION MODE is TRUE to force the selected output to go to 100% trim valve demand.

SELECT MANUAL MODE
Check this box to ramp to the MANUAL CAL SETTING at the MANUAL/CALIBRATION RATE.

MANUAL/CALIBRATION RATE
The ramp rate the output moves while in MANUAL or CALIBRATION MODE (%/sec).

MANUAL CAL SETTING
The value of the manual actuator output.

TRIM VALVE 1 REVERSE ACTING
Check this box if a reverse acting response is desired; the output = 100 – ACT COMMAND.

IO – TRIM VALVE 2

TRIM VALVE 2 CALIBRATION SETTINGS
Follow the steps on the Toolkit page to calibrate the Actuators and the Position feedback.

CALIBRATION MODE
Check this box if the engine is stopped to enter actuator calibration mode. The selected output is then forced to 0.0 % trim valve; if CALIBRATION TO MAXIMUM is checked then the output is forced to 100% trim valve.

CALIBRATION TO MAXIMUM
Check this box when CALIBRATION MODE is TRUE to force the selected output to go to 100% trim valve demand.

SELECT MANUAL MODE
Check this box to ramp to the MANUAL CAL SETTING at the MANUAL/CALIBRATION RATE.

MANUAL/CALIBRATION RATE
The ramp rate the output moves while in MANUAL or CALIBRATION MODE (%/sec).

MANUAL CAL SETTING
The value of the manual actuator output.

TRIM VALVE 2 REVERSE ACTING
Check this box if a reverse acting response is desired; the output = 100 – ACT COMMAND.

Configuration Settings

CONFIG SYS

CONFIG
USE MECHANICAL DRIVE LOGIC *
Check this box to configure the controller to accommodate a variable speed engine. Uncheck this box if the engine is driving a synchronous generator.

USE E3 INTERNAL BASE LOAD CONTROL *
Check this box to allow INTERNAL BASE LOAD CONTROL using an external kW sensor or easYgen.

USE BANK BALANCING *
Check this box to use Bank Balancing and show the settings on the Bank Balancing Page. Bank Balancing can also be performed on a MONO AFR configuration. Speed Control also needs to be enabled to use Bank Balancing.

USE STEREO MODE *
Check this box to use Stereo AFR control with two separate fuel systems and two Pre-Cat HEGOs. This tunable also switches the view for the AFR setup pages and the dashboard. Uncheck this box if there are one fuel system and one PRE-CAT HEGO or two fuel systems with one PRE-CAT HEGO.

ENGINE DISPLACEMENT *
Enter the displacement of the engine for Qmix calculations (in^3).

MAP AT FULL LOAD *
Enter MAP AT FULL LOAD to scale the index on the Volumetric Efficiency table.

IGNITION *
Drop down select box allows configuration of the ignition integration options. Options are: 3rd PARTY IGNITION or IC-92X WITH J1939. This tunable also switches the view for the respective Ignition setup pages.

ENGINE INFO
Text variables have been provided to enter user information regarding the application. The information in these fields is for reference only and does not affect system operation.

ENGINE MAKE *
Text readout indicating the ENGINE MAKE.

ENGINE MODEL *
Text readout indicating the ENGINE MODEL.

ENGINE LICENSE *
Text readout indicating the ENGINE LICENSE.

ENGINE SERIAL NUMBER *
Text readout indicating the ENGINE SERIAL NUMBER.

ENGINE YEAR *
Text readout indicating the ENGINE YEAR.

OPENLOOP FAULT
MISFIRE TO OPENLOOP *
Check this box to cause the control to go into OPEN LOOP during an active MISFIRE.

FAULT RESET
ALLOW FAULT RESET TO CLEAR FAULT LOG *
Check this box to allow a global RESET to clear the FAULT LOG. This is not recommended for operation since the non-volatile fault log would be cleared by pressing the RESET button.

ALLOW FAULT LOG RESET TO ISSUE FAULT RESET *
Check this box to allow a FAULT LOG RESET to clear the control faults. NOTE: This sometimes results in needing to press FAULT LOG RESET more than once to clear all the faults.

EE SAVE OPTIONS
AUTOSAVE EE ON ENGINE STOP *
Check this box to automatically save to non-volatile memory upon each engine stop. This will save more often the FAULT LOG values.

SAVE CAT-TEMP HI TO NV MEMORY ON ENGINE STOP *
Check this box to automatically save the Catalyst Temperatures High Peak to non-volatile memory.

J1939 CANLINK
E3 CAN ADDRESS *
This tunable allows the user to change the J1939 address of the E3 unit.

EXTERNAL TC PGN *
Tunable PGN allows different SPNs to be used for the External TC Node.

EXTERNAL TC NODE ID *
Tunable Node ID allows custom Node ID for the External TC Node.

AL1349 EXTERNAL TC TIMEOUT DELAY *
Tunable delay for receiving robust communication; set to at least 3 times the normal repetition rate (ms).

ACTIVATE PLANT COMMS *
Check this box to use the 733 CAN to Modbus Converter.

J1939 IGNITION
IC-92x ADDRESS *
Tunable IC-92X Address available if needed.

IC-92x EVEN BANK ENERGY *
Tunable EVEN BANK ENERGY command allows for operation with less than 100% voltage and energy.

IC-92x ODD BANK ENERGY *
Tunable ODD BANK ENERGY command allows for operation with less than 100% voltage and energy.

MIL SETTINGS
USE FLASH CODE FOR MIL *
Check this box to enable MIL FLASH CODE. The FLASH CODE: Flash the number 12 to signal the start of the flash sequence followed by the first applicable event from the FAULT LOG. When the first applicable event is finished, the MIL block will flash the next fault until all faults have been displayed then start over with the number 12. Uncheck this box to configure the MIL output to activate when an emissions related fault occurs.

MIL FLASH MODE *
Check this box and any event that is LOGGED will cause the MIL output to blink. Uncheck this box and only the fault codes from events that are currently ACTIVE will cause the MIL output to blink.

J1939 easYgen
USE easYgen J1939 COMMS *
Check this box to use easYgen over J1939 CAN.

ISOCH MODE WHEN COMM FAIL *
Check this box to switch over to Isochronous Mode if the easYgen communications fail. Uncheck this box to stay in DROOP if the link to the easYgen fails.

easYgen J1939 ADDRESS *
Tunable value to select the easYgen CAN Address, control must be reboot for setting to take effect.

SPEED BIAS SCALING *
Tunable value to scale the Speed Bias signal to RPM (RPM/100%).

ENGINE RATED POWER *
Tunable value setting the MAX LOAD scaling (kW).

SERVLINK PORT SETTINGS
SERVLINK BAUD RATE *
Drop down selection box that select the Servlink communications rate. Possible selections: 115200 BAUD, 57600 BAUD, 38400 BAUD, 19200 BAUD, 9600 BAUD, 4800 BAUD, 2400 BAUD, 1800 BAUD, 1200 BAUD, 600 BAUD, 300 BAUD, 110 BAUD. The default is 115200 BAUD but you may want to lower this for difficult network runs. Although proper termination, shielding, and grounding of the RS-485 network should allow operation @ high baud rates up to 10000 ft.

SERVLINK ADDRESS *
Tunable value reserved for future multi-drop service tool operation.

MODBUS PORT SETTINGS
MODBUS BAUD RATE *
Drop down selection box that select the Modbus communications rate. Possible selections: 115200 BAUD, 57600 BAUD, 38400 BAUD, 19200 BAUD, 9600 BAUD, 4800 BAUD, 2400 BAUD, 1800 BAUD, 1200 BAUD, 600 BAUD, 300 BAUD, 110 BAUD. The default is 115200 BAUD but you may want to lower this for difficult network runs. Although proper termination, shielding, and grounding of the RS-485 network should allow operation @ high baud rates up to 10000 ft.

MODBUS MODE *
Drop down selection box that select the Modbus communications mode. Possible selections: ASCII MODE or RTU MODE.

MODBUS BITS
The E3 Stoich can only communicate 8 bits on Modbus.

MODBUS PARITY *
Drop down selection box that select the Modbus communications PARITY Checking. Possible selections: NO PARITY, ODD PARITY, or EVEN PARITY.

MODBUS STOP BITS *
Drop down selection box that select the Modbus communications STOP BITS. Possible selections: 1-STOP BIT, 2-STOP BITS, or 1.5-STOP BITS.

MODBUS TIME OUT *
The Modbus time out is the time delay before issuing a LINK ERROR and should be set at least 3 times the nominal message rate.

MODBUS INITIAL TIME OUT *
After control power up the HMI panel is given additional time to boot and communicate without the E3 latching a link error alarm.

MODBUS SLAVE ADDRESS *
Enter the Modbus Slave Address as needed.

CONFIG FUNCTION

BANK BALANCE SETTINGS
ENABLE BANK BALANCE *
Manual Enable/Disable for Bank Balance.

MAP SENSOR FAILOVER TABLE *
2 x 6 lookup table Throttle 1 Demand (%) vs. Correction factor (%) allows a non-linear mapping of the throttle differences over the operating range of the engine.

BANK BALANCE SETPOINT OFFSET *
The setpoint for the Bank Balance PID (%). Changing this will allow the user to intentionally unbalance the banks to test balancing dynamics.

RUN DELAY PERMISSIVE *
The delay after engine run that the balancing will activate.

TRIM RANGE *
This value establishes the maximum adjustment that can be made to correct for imbalance conditions (%). This is the max trim adjustment that the balancing PID will make at 100%.

PROP GAIN *
The Proportional Gain of the Pre-Cat Control Loop, decreasing the Prop Gain will reduce the response of the control loop. See PID control section.

INT GAIN *
The Integral Gain of the Pre-Cat Control Loop, decreasing the Int Gain will slow the response of the control loop. See PID control section.

SDR *
The SDR of the Pre-Cat Control Loop. See PID control section.

BATTERY CONSERVATION

MODE *
Dropdown select box with possible states: BATTERY CONSERVATION, ALWAYS ON, or ALWAYS OFF. BATTERY CONSERVATION mode sets the relay immediately on engine start and resets after the engine has been stopped for BATTERY CONSERVE DELAY. ALWAYS ON OR ALWAYS OFF modes allow troubleshooting and setup.

BATTERY CONSERVE DELAY *
Time period the BATTERY CONSERVE OUTPUT is on after last engine roll (sec)

FAULT ARM DELAY FOR MPRD *
The time delay after the Battery Conservation Relay has energized that the device faults arm (sec)

SHUTDOWN INTERNAL +5V SUPPLIES WITH MPRD *
Turn off Internally provided +5 Volt sensor power supplies when Battery Conserve is active.

VOLUMETRIC EFFICIENCY TABLE

VOLUMETRIC EFFICIENCY TABLE *
5 x 5 lookup table SPEED% vs. LOAD% vs. VE which provides the VE estimate for the Qmix calculation.

MISFIRE FAULT

MISFIRE TABLE INDEX *
An indicator of the Misfire Table index value, available indices are: THROTTLE, Qmix, or LOAD INPUT.

MISFIRE INDEX PERMISSIVE *
The threshold that the MISFIRE INDEX must be above to enable the Misfire Faults.

ENABLE ALARM *
Set this TRUE to enable the Misfire Alarm.

ENABLE SHUTDOWN *
Set this TRUE to enable the Misfire Shutdown.

FAULT DELAY ALARM *
The delay the misfire condition must stay TRUE before an alarm is activated (sec).

FAULT DELAY SHUTDOWN *
The delay the misfire condition must stay TRUE before a shutdown is activated (sec).

MISFIRE SETUP

SAMPLES *
Tunable to enter the number of engine cylinders or integral divisor.

MISFIRE INDEX SELECT *
A drop down selection box that allows the Misfire Fault mapping to be driven by different indices. Allowable values are: THROTTLE, Qmix, or LOAD INPUT.

MISFIRE FILTER
Select AFR trim settings to allow for start adjustments.

MISFIRE FILTER ENABLE *
Check this box to enable the Misfire Filter, uncheck and the filter is bypassed.

MISFIRE FILTER *
The Misfire Signal filter value (sec). Increasing this parameter smoothes the signal but slows response.

MISFIRE FTV HOLD
When a misfire occurs for longer than a tunable delay AND the control is in one of the closed-loop modes the Fuel Trim Valve is held in place. The FTV resumes normal control when the MISFIRE condition is false for a tunable amount of time.

MISFIRE FTV HOLD ENABLE *
Set this TRUE to enable the FTV HOLD function.

MISFIRE THRESHOLDS
MISFIRE ALARM THRESHOLD TABLE *
2 x 5 lookup table Misfire Index () vs. Alarm Level (RPM/sec^2) allows a non-linear mapping of the fault threshold over the operating range of the engine.

MISFIRE SD THRESHOLD TABLE *
2 x 5 lookup table Misfire Index () vs. Shutdown Level (RPM/sec^2) allows a non-linear mapping of the fault threshold over the operating range of the engine.

CONFIG CONTROL

SPEED CONTROL
USE SPEED CONTROL *
Check this box to enable speed control mode.

REMOTE SPEED REFERENCE SELECT *
Drop down select box that selects the input used by the REMOTE REFERENCE. Possible selections: ANALOG INPUT, easYgen J1939, or MODBUS.

START RAMP *
The rate that the throttle will increase after the RUN SPEED is exceeded (%/sec).

START FUEL LIMIT *
The value the throttle is set upon start (%). The throttle stays at this value until the engine reaches RUN SPEED at which the throttle will ramp up at the START RAMP rate (%).

RUN SPEED *
Tunable speed switch that determines the activation of most AFR and Speed Control functions (RPM).

IDLE WAIT TIME *
The time delay after which the engine speed reaches idle that the control will ramp to RATED speed is in Generator Mode (sec).

ENABLE IDLE SELECT *
Check this box to allow the IDLE SWITCH to hold the speed reference at Idle speed.

MIN SPEED/IDLE *
Enter Idle Speed Reference (RPM)

RATED SPEED *
Enter Rated Engine Speed Reference (RPM).

MAX SPEED REF *
Enter the Maximum Speed Reference Limit in Mechanical Drive Mode (RPM).

MAXIMUM FUEL LIMITER *
The maximum value the throttle demand will go to (%). This acts as an electronic limiter or troubleshooting tool.

RAISE/LOWER SPEED RATE *
The rate at which the Speed Reference ramps.

OVERSPEED SETPOINT *
The Engine Speed threshold at which the Overspeed Shutdown occurs.

USE SPEED BIASED DYNAMICS *
Check this box to automatically activate speed based dynamics. When this function is activated, the Prop gain and Int Gain are reduced by multiplying by a factor equal to: $\frac{\text{ACTUAL\_SPEED}}{\text{RATED\_SPEED}}$, the actual engine speed is bounded by IDLE SPEED and RATED SPEED.

USE RAW SPEED FOR OVERSPEED INPUT *
Check this box to use the RAW Speed for the Overspeed Input. This will improve the sensitivity of the switch but may make it more susceptible to noise.

USE DROOP *
Check this box to allow the use of Droop, droop is calculated from the Real Power Input or the easYgen kW.

DROOP *
The amount of Droop, typical values are 3-7%.

COLD DYNAMICS
A cold engine Proportional Gain, a cold engine temperature (based on ECT), and a warm engine temperature are tunable. The Proportional Gain runs at the cold gain at the cold temp and is linearly interpolated as temperature increases and levels out to be equal to the normal Prop gain above the warm temp.

ENABLE COLD DYNAMICS *
Select this checkbox to enable the COLD DYNAMICS function.

COLD DYNAMICS TEMP *
The temperature that exhibits the PROP GAIN FRACTION @COLD (°F). The PROP GAIN fraction will stay at that level even though the temperature goes lower.

PROP GAIN FRACTION @COLD TEMP *
The fraction that the PROP GAIN will be multiplied by when the ECT is at or lower than the COLD DYNAMICS TEMP.

WARM DYNAMICS TEMP *
The Temperature that the PROP GAIN fraction will equal 1.0 (°F). If the ECT goes above this temperature the PROP GAIN fraction will remain at 1.0.

LOAD REJECTION
This page is used to adjust the LOAD REJECTION feature, which can help the engine successfully endure large load dumps while keeping the engine running without exceeding its overspeed level.

USE CIRCUIT BREAKER FEED-FORWARD *
This selects the Circuit-breaker feed-forward aspect of the logical Load rejection. This function causes the throttle to go to a pre-programmed setpoint when the Generator Circuit Breaker is opened while the MAP pressure is above a pre-programmed level.

USE LOGICAL OVERSPEED *
This selects the Logical Overspeed aspect of the logical Load rejection. This function causes the throttle to go to a pre-programmed setpoint when the Engine Speed reaches a high threshold while the MAP pressure is above a pre-programmed level.

REJECTION TIME DURATION *
The duration that the Throttle is held after a Load Rejection Event is detected (sec).

REJECTION MAP THRESHOLD *
The MAP level that the engine must be above to trigger the Load Rejection Event (psia).

REJECTION THROTTLE POSITION *
The Throttle position that the Load Rejection function forces for the REJECTION TIME DURATION when the Load Rejection Event is triggered (%).

LOGICAL OVERSPEED LEVEL *
The speed above Rated and below overspeed that will trigger the Load Rejection Event when enabled (RPM).

SEQUENCE SETTINGS
PURGE TIME *
Sets the time delay for the engine to expel explosive mixtures through the intake and exhaust before the ignition is activated (sec).

IS CRANKING SPEED *
Sets the engine speed that is considered cranking speed, this will activate the Start Fuel Limit (RPM).

IS RUNNING SPEED *
Sets the engine speed that the engine is considered running on its own. This is a key value, most sequencing in the E3 Control uses the Run Speed switch (RPM).

IS STOPPED SPEED *
Sets the engine speed that the engine is to be stopped (RPM).

LOAD REFERENCE SETTINGS
REMOTE SPEED REFERENCE SELECT *
Drop down select box that selects the input used by the REMOTE REFERENCE. Possible selections: ANALOG INPUT, easYgen J1939, or MODBUS.

MINIMUM LOAD *
The lowest Load Reference Limit (kW).

MAXIMUM LOAD *
The Highest Load Reference Limit (kW).

RAISE RATE *
The Load Reference Raise Rate (kW/sec).

LOWER RATE *
The Load Reference Lower Rate (kW/sec).

REM REF LIMIT *
The Remote Load Reference Maximum Limit (kW).

REM REF RATE *
The rate at which the control tracks the Remote Load Reference input (kW/sec).

SYSTEM SHUTDOWN CAUSES INSTANT UNLOAD *
Check this box to cause the Load Reference to instantly ramp to zero load if a Control Shutdown occurs.

DISCRETE OUT SETTINGS
IGNITION OFF DELAY *
The control waits this amount of time after closing the Gas Shut-Off Valve before the Ignition is turned off.

SPEED SWITCH RELAY DROPOUT *
The threshold at which the Speed Switch drops -out (sec). If the Dropout is higher than the pickup then the switch becomes active below the dropout speed.

SPEED SWITCH RELAY PICKUP *
The threshold at which the Speed Switch picks-up (sec). If the Pickup is higher than the dropout then the switch becomes active above the pickup speed.

BATTERY CONSERVE DELAY *
Time period the BATTERY CONSERVE OUTPUT is on after last engine roll (sec).

MODE *
Dropdown select box with possible states: BATTERY CONSERVATION, ALWAYS ON, or ALWAYS OFF. BATTERY CONSERVATION mode sets the relay immediately on engine start and resets after the engine has been stopped for BATTERY CONSERVE DELAY. ALWAYS ON OR ALWAYS OFF modes allow troubleshooting and setup.

AFR CONTROL SETTINGS *
USE AVERAGE SIGNAL FOR CONTROL *
Use the per cycle average as the process signal, if this value is unchecked the control uses the AFR SIGNAL calculation for the PID process signal.

USE PRE-CAT PID SAMPLING *
Check this box to use the Pre-cat PID synchronized to the HEGO sample gathering. Uncheck this box to use normal PID.

USE POST-CAT PID SAMPLING *
Check this box to use the Post-Cat PID synchronized to the HEGO sample gathering. Uncheck this box to use normal PID.

CONFIG SPEED SENSING

SPEED SENSING
USE LOW-PASS SPEED FILTER *
Check this box to activate the Low-Pass Speed Filter.

LOW-PASS SPEED FILTER *
Speed Filter Cut-off frequency (Hz).

SPEED SAMPLES PER CYCLE *
Enter the number of engine cylinders or integral divisor.

CRANK EDGE RISING *
Check this box to configure the Crank signal to trigger on the rising edge. Uncheck for falling edge.

CRANK SENSOR TYPE *
Drop down select box possible selections: PROXIMITY SWITCH or MAGNETIC PICK-UP.

GEAR PATTERN CONFIGURATION
CRANK TEETH *
Enter two times the number of teeth or holes on flywheel (teeth). NOTE: As the Crank Teeth goes up, the maximum rpm measurement is reduced. Speed signal measurement limitations are as follows: 2530 RPM at 301 Teeth, 761 RPM at 1000 teeth.

CAM TEETH *
Enter two times the number of teeth or holes on flywheel (teeth).

Changing Table Values in ToolKit HMI

The values in the 2D and 3D tables in toolkit can be changed by clicking on the value with the mouse and entering a new value. The value entered is used in the control after the left mouse button is clicked or the enter key is pressed. To make it easier to manipulate several values, or even a whole table at once, the cells to be edited are highlighted using the mouse and then the right mouse button is clicked. This opens a popup window as shown in Figure 3-70. In the popup window there are different options to modify the table values as shown in Figure 3-71.

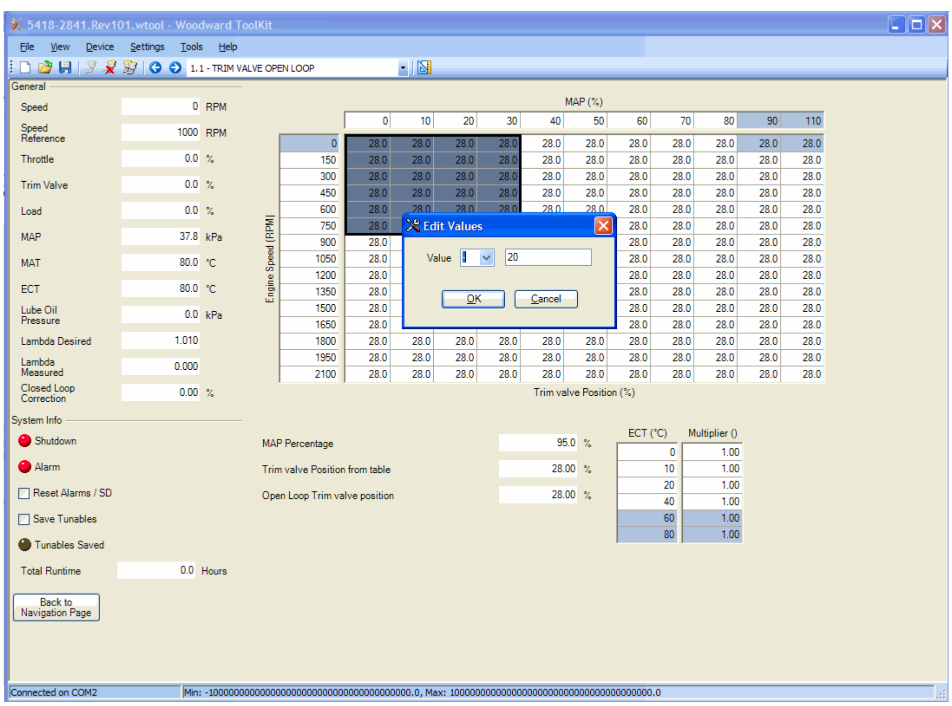


Figure 3-70. Editing Several Values in 2D and 3D Tables

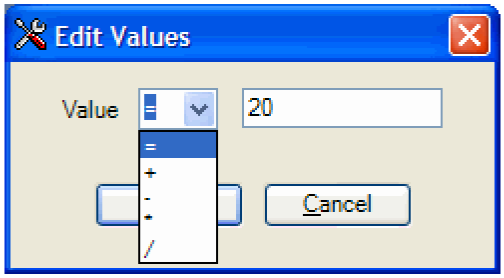


Figure 3-71. Selecting an Operator to Modify Table Values

Toolkit Trend Chart Component

The Toolkit Trend Chart Component allows you to monitor values in a trend window. See Common Component States in Toolkit Help for Trend Chart states.

Monitoring Values
The Trend Chart component displays multiple values in a trend with the parameter name.
To start monitoring values using the Trend Chart component, left mouse click on the **Start** button.
To stop monitoring values using the Trend Chart component, left mouse click on the **Stop** button.

Changing Trend Chart Properties
You can modify the properties of the plots and the Trend Chart component by clicking the **Properties** button on the Trend Chart component. Some of the properties you can change include the Time Span and Sample Rate of the chart as well as the Scale and Color of each individual plot.

Removing a Plot from the Trend Chart
There are several methods to remove a plot from the Trend Chart. Choose a method below to remove a plot. Once a plot has been removed, you will not be able to recover the plot. You can only re-add the parameter to the Trend Chart by dragging it from the list of parameters in the Design Tools window and dropping it on the Trend Chart component.
Method 1:
In Run Mode, **right-click** on the plot to remove.
Select **Remove Plot** from the pop-up menu.
Method 2:
In Run Mode, click on the **Properties** button.
In the Trending Properties dialog, select the plot to remove and click on the **Remove Plot** button.
Close the Trending Properties dialog.
Method 3:
In Design Mode, select the **Trend Chart** component.
Select the **Properties...** tab of the **Design Tools** window.
Click the **...** button adjacent to the **Plots** property.
In the Plot Properties dialog, select the plot to remove and click on the **Remove Plot** button.
Close the Plot Properties dialog.

Exporting Trend Values
The Trend Chart component allows you to export the trend values that are currently in the visible trend chart to a .csv file for inspection by other programs.
To export trend values:
Capture the trend in the trend chart window.
Right mouse click on the **Export...** button.
Select the file name to be saved in the **Save Dialog**.
Select the **Save** button on the **Save Dialog**.

Trend on the Fly
ToolKit allows you to trend any value even if a trend chart is not part of your tool.
To trend on the fly:
Connect to the device.
Right mouse click on the component containing the parameter value you wish to trend.
Left mouse click the **Add To Trend** pop-up menu item.
The **Trending** window will open with the parameter value you selected.
To add additional parameters to the trend repeat steps 3 and 4 for each parameter.

Chapter 4.
Hardware Installation

Introduction

This chapter contains instructions for E3 Stoichiometric Trim hardware installation. The system includes the following required or optional components and inputs/outputs:

- E3 control module (PCM128-HD)
- Engine speed sensor
- Manifold pressure sensor
- Manifold temperature sensor
- Engine coolant temperature sensor
- Engine protection sensors: oil pressure, oil level, coolant level
- Catalyst diagnostic sensors: delta-pressure, temperature
- Analog Inputs (0–5 V)
  - Generator Power input
  - Remote Speed/Load reference
  - Speed reference bias
  - Actuator Position Feedback (TPS)
- PWM Speed Bias Input
- HEGO sensors (pre-catalyst & post-catalyst)
- Discrete Inputs and Outputs
- Throttle actuator
- Trim valve
- IC-920/922 Ignition system
- easYgen™ 3100/3200 power management controller
- Third-Party SAE J1939 CAN Thermocouple Node

Figure 4-1 shows an overview of the major system components.

Figure 4-1. System Overview

Control Module

⚠WARNING	**EXPLOSION HAZARD—Refer to product manual 26309 for the PCM128-HD Digital Control for detailed regulatory compliance information and installation warnings associated with this product.**

⚠WARNING	**EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division or Zone applications.**

⚠WARNING	**The control will only meet ingress protection specifications with all mating connectors properly installed. In addition, all unused connections in the mating connectors must be plugged to ensure proper sealing of the connectors. Refer to Table 3-1 for the proper Connector Plug part numbers. Failure to adhere to these guidelines may result in product failure or decreased product life.**

⚠WARNING	**Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.**

NOTICE	**Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Chapter 6).**

Control Module Power Requirements

The PCM128-HD requires a voltage source of 18 to 32 Vdc (24 Vdc nominal). The power dissipation within the control is typically less than 15 W.

IMPORTANT	**Total power consumption for both the control and the driven load is dependent upon the application. A typical application may require 0.5 to 0.8 kW to drive the loads under all operating conditions. The power source must be sized appropriately for the application.**

NOTICE	**To prevent damage to the control, do not exceed the input voltage range.**

IMPORTANT	**If a battery is used for operating power, an alternator or other battery-charging device is necessary to maintain a stable supply voltage.**

NOTICE	**To prevent damage to the control, make sure that the alternator or other battery-charging device is turned off or disconnected before disconnecting the battery from the control.**

Location of Control Module

Consider these requirements when selecting the mounting location:

- Adequate ventilation for cooling. Select a location on the engine that will provide an operating temperature range of –40 to +85 °C (–40 to +185 °F). A position low on the engine is more likely to be in this temperature range.
- Space for servicing and repair.
- Protection from direct exposure to water or to a condensation-prone environment.
- Protection from high-voltage or high-current devices, or devices which produce electromagnetic interference in excess of levels defined in EN61000-6-2 (Immunity).
- Avoidance of high vibration. Vibration or shock dampeners should be used when mounting the control.
- The control should be electrically grounded to the engine. If the control is mounted inside an enclosure, it should be a metallic enclosure and attached to the engine such that the engine and enclosure have the same ground potential.
- Wiring to and from the control should be routed within two inches of engine-ground-potential structural components to minimize subjecting the control to electromagnetic interference.
- Mounting dimensions and instructions are shown in Figure 4-2.

Mounting of Control Module

Mount the control module using the included vibration dampeners.

Bolt dimensions and torque to 8 N·m. Engine ground – 1” (25 mm) wide copper braid 18” (46 cm) in length max. Ensure that the mounting location does not subject the control module to environmental factors in excess of the limits specified in the PCM128-HD hardware manual (document 26309).

Electrical Connections

Figure 4-3 shows the E3 connector location and terminology. Table 4-1 provides information on the mating connectors. Table 4-2 is the list of tools to be used for the pinning of the ECU (PCM128-HD).

Table 4-1. Mating Connectors

Connector	Woodward Part Number	Manufacturer’s Part Number
J1-C and J2-A, 24-pin Connector	1635-1175	Tyco 4-1437287-5
J1-B and J2-B, 24-pin Connector	1635-1176	Tyco 4-1437287-6
J1-A, 32-pin Connector	1635-1177	Tyco 4-1437287-7
Terminal 18-20 AWG (0.91-1.16 mm)	1602-1028	Tyco 0-1437284-9
Terminal 14-16 AWG (1.46-1.84 mm)	1602-1029	Tyco 1-1437284-0
Plug (Seals unused pin locations)	1602-1030	Tyco 4-1437292-3
24 pin connector cover	1635-7001	Tyco 4-1437287-8
32 pin connector cover	1635-7002	Tyco 4-1437287-9

Table 4-2. Connector Tools

Tool	Woodward Part Number	Manufacturer’s Part Number
Crimper	8996-2041	Tyco 1456088-1
Extractor (steel)	8996-2052	Tyco 1437303-9

A connector kit is available with all mating connectors and pins: PN 8928-1096.

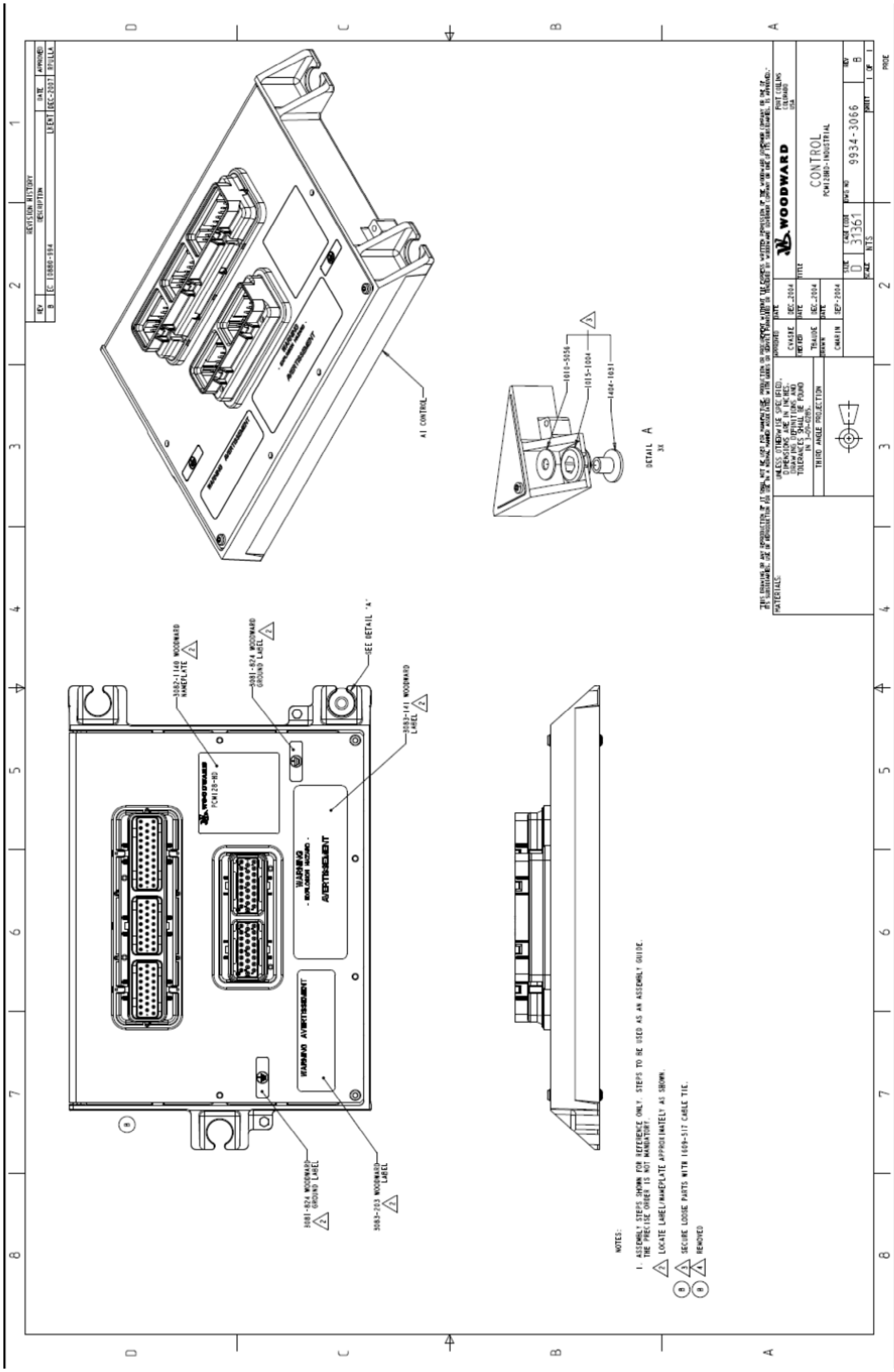


Figure 4-2. E3 (PCM128-HD) Hardware (PN 8237-1238)

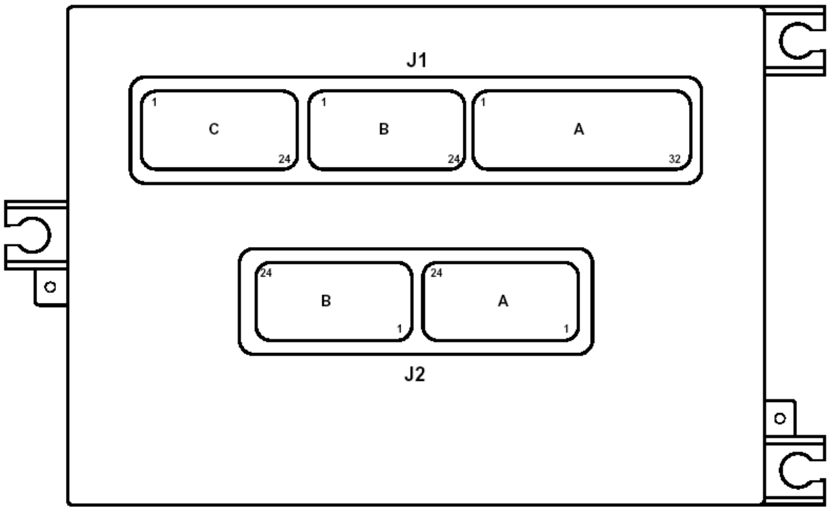


Figure 4-3. E3 Connector Terminology

Wiring Guidelines

IMPORTANT

DO NOT run signal wires next to wires carrying large currents (such as power source wiring).
- **All field wiring should be limited to < 30 meters in length.**
- **The power lines to the control should be limited to < 10 meters in length from the power supply.**

See Woodward application note 50532, *Interference Control in Electronic Governing Systems*, for more information.

Where shielded cable is used (such as cam or crank speed signals, HEGO sensor inputs, or communications signals), cut the cable to the desired length and prepare the cable as instructed below.
- Strip outer insulation from BOTH ENDS, exposing the braided or spiral wrapped shield. DO NOT CUT THE SHIELD.
- Using a sharp, pointed tool carefully spread the strands of the shield.
- Pull inner conductor(s) out of the shield. If the shield is the braided type, twist it to prevent fraying.
- Remove 6 mm (1/4 inch) of insulation from the inner conductors.
- Ground the shield at the source end and cut off the exposed shield at the receiving end.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Transducer Ground
Most sensor inputs are single-ended. The low side of these sensors should be connected to transducer ground, which is PCM128-HD terminal J1-A24 (TRANSDUCER GROUND).

Shielded Wiring
Connect all shielded wires to ground on J1-B24 (SHIELDING GROUND) (not to J1-A24 (TRANSDUCER GROUND))

Power Inputs

Power supply output must be low impedance (for example, directly from a battery). DO NOT power the control from high-voltage sources with resistors and zener diodes in series with the control power input.

NOTICE

To prevent damage to the control, do not power a low-voltage control from high-voltage sources, do not exceed 32 V on the power inputs for more than 1 minute, and do not power any control from high-voltage sources with resistors and zener diodes in series with the power input.

Power Ground

Connect the power leads directly from the power source to the control. DO NOT POWER OTHER DEVICES WITH LEADS COMMON TO THE CONTROL. Avoid long wire lengths. Connect the battery positive (power source positive) to the J1-B2, J1-B8, J2-A18, and J2-A19 inputs and battery negative (power source common) to J2-A15, J2-A16, J2-A24, and J2-B9. If the power source is a battery, be sure the system includes an alternator or other battery-charging device. Power supply wiring is shown schematically in Figure 4-4.

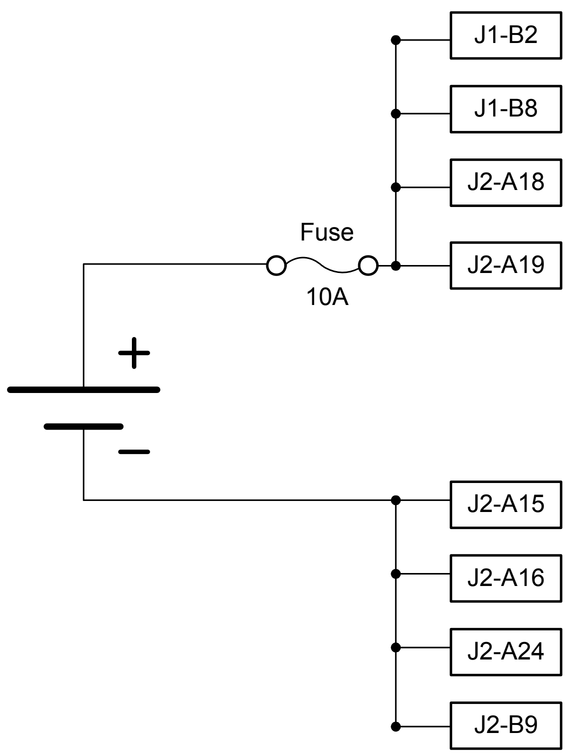


Figure 4-4. Power Supply Wiring

NOTICE

Proper fusing of the control is highly recommended to prevent damage to the control in case of shorts that may occur in the field wiring. Fuses should be wired in series with all the power inputs to the control.

Key Switch Input

The key switch (KEY_SW) discrete input provides a power-on wake-up command signal to the PCM128-HD control's internal power supply. Once activated the control's internal power supply will remain active until commanded to shutdown by the application program. The voltage at this terminal is reported to the application.

This input should be powered whenever the system is powered.

Serial Communications Port (RS-485)

RS-485 is also an ANSI standard definition of electrical connections for communications between devices. Because it uses balanced drivers, it can communicate over long distances (1200 m/4000 ft) at high baud rates (115 K).

Interface Cables
When choosing a cable for RS-485, it is necessary to examine the required distance of the cable run and the data rate of the system. Beyond the obvious traits such as number of conductors and wire gauge, cable specifications include a handful of less intuitive terms.

Characteristic Impedance (ohms)—A value based on the inherent conductance, resistance, capacitance, and inductance of a cable that represents the impedance of an infinitely long cable. When the cable is cut to any length and terminated with this Characteristic Impedance, measurements of the cable will be identical to values obtained from the infinite length cable. Therefore, termination of the cable with this impedance gives the cable the appearance of being infinite length, allowing no reflections of the transmitted signal. When termination is required in a system, the termination impedance value should match the Characteristic Impedance of the cable.

Shunt Capacitance (pF/ft)—The amount of equivalent capacitive load of the cable, typically listed in a per foot or per meter basis (1 pF/ft = 3.28 pF/m). One of the factors limiting total cable length is the capacitive load. Systems with long lengths benefit from using low capacitance cable.

Propagation velocity (% of c)—The speed at which an electrical signal travels in the cable. The value given typically must be multiplied by the speed of light (c, 3x108 m/s) to obtain units of meters per second. For example, a cable that lists a propagation velocity of 67% gives a velocity of 0.67 x 3x108 = 2.01x108 m/s. The higher the percentage, the smaller the signal delay.

General recommendations for serial cable are listed in Table 4-3.

Table 4-3. Serial Cable Requirements

Impedance	100 Ω ±20%
Cable capacitance	52.5 pF/m (15.0 pF/ft) at 1 kHz
Propagation Velocity	67.0%
Data Pairs	0.2 mm² (24 AWG) solid bare copper
Signal attenuation	6.0 dB maximum

Recommended Bulk Cable

Woodward recommended cables are compatible with long run lengths and high baud rates. Longer cable lengths than the maximum specified may be possible at lower baud rates with the best cables, but are not supported by the ANSI standards for RS-485.

Shielded Ethernet Category 5 cable is a very good cable selection for RS-485 networks. It will support cable lengths to 900 m (3000 ft) at baud rates up to 115200. Since Ethernet cable is easy to find and is inexpensive, it will often be the cable of choice. Shielded cable must always be used.

Belden 89207 is a 20 AWG low capacitance cable that is also a good choice for RS-485 networks. It is a larger wire size than Ethernet cables and other typical serial cables, so it is better suited for engine wiring and high-speed communications. At maximum baud rate this cable should be limited to 150 m (500 ft) or less. Shielded cable must always be used.

Since Ethernet cables and other typical serial cables have wire sizes smaller than the 18 AWG minimum for the ECU (PCM128-HD) connector, special wiring practices will be necessary for a good crimp.

The RS-485 serial port is used to provide communications between the control and a PC service tool. Figure 4-5 shows an RS-485 communication schematic.

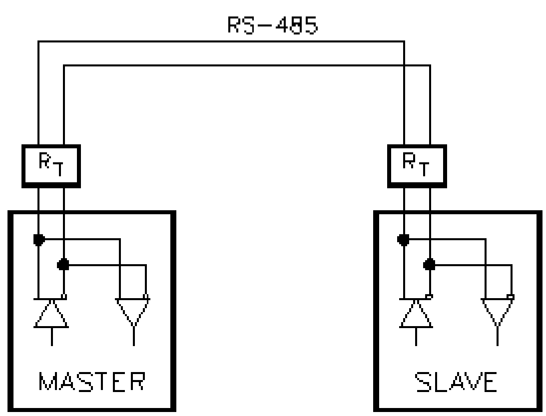


Figure 4-5. RS-485 Standard Link

Termination

For RS-485, termination should be at each end of the cable. The value of each termination resistor should be equal to the cable impedance (typically, 120 Ω for twisted pairs). If termination cannot be located at the end of a cable, it should be placed as close as possible to the end of the cables.

EasySync USB Serial Adapter, Woodward PN 1784-1037

Woodward recommends using the EasySync USB Serial Adapter when connecting the RS-485 communication port to a PC. The adapter receives its power from the USB port of the PC. It does not need an external power source. This adapter is automatically detected and installed when plugged into the USB port of a PC. If the device is not initially detected and installed, the unit comes accompanied with a Drivers/Installation guide that can be easily installed following the directions below:

Installation for Windows 2000/XP/2003 Drivers

1. Plug the USB connector into the USB port on the adapter, and connect the USB connector on the other end of the cable to the host USB port on the PC.
2. A window will open: “Found New Hardware Wizard.”
3. Click “Next.”
4. Select “Search for the best driver for my device”, and click “Next.”
5. Select “Specify a location” and click “Next”. In the “Copy Manufacturer’s file from”, type “D:\USB-COM” where “D” is the location of the PC’s CD-ROM.
6. Windows driver file searches for the device “USB-COM Serial Adapter”
7. Click “Next” to continue.
8. Windows has finished installing the software. Click “Finish” to complete the first part of the installation.
9. The “Found New Hardware Wizard” appears again, and will complete the installation for the device “USB Serial Port”.
10. Repeat steps (4) to (8) to complete installation.

Inside the unit, there is a 10x2 (20 pin) header block that must be jumpered properly to select the mode of operation. The adapter is capable of converting USB to RS 422 or RS 485, the port used by the PCM-HD. To configure the device, the plastic cover must be removed. To configure the adapter for the RS 485 port it must be configured as shown in the following table:

Jumper	Populated (Y/N?)
1-2	Y
3-4	N
5-6	Y
7-8	Y
9-10	N
11-12	Y
13-14	N
15-16	Y
17-18	N
19-20	Y

The EasySync adapter and its jumper locations are depicted in Figure 4-6.

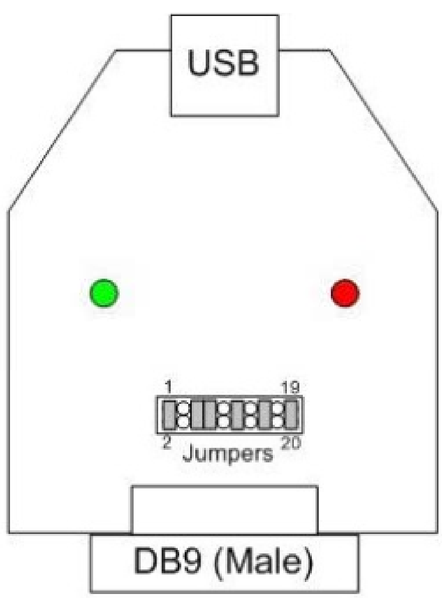


Figure 4-6. EasySync RS-485 to USB Adapter

CAN Communications Ports

The ECU (PCM128-HD) has two CAN ports. The CAN ports are not isolated from each other, or from any of the other circuitry on the PCM128-HD control, i.e., they share a common ground. The internal CAN port is used only for communication with Woodward on-engine hardware. Optional on-engine hardware with CAN communication includes the F-Series ITB/actuator with CAN, ProAct Digital PLUS, ProAct ISC, Third-Party J1939 TC Node, and the IC-920/922 ignition control. The external port is used for plant communications, and can be connected to other equipment when applying a CAN isolator or isolated gateway.

Table 4-4. PCM128-HD CAN Specification

Transceiver type	CAN 2.0B
Isolation voltage	None
Baud rates supported	125, 250, 500, and 1000 kbps
Protocols supported	CANopen, SAE J1939

Figure 4-7 depicts typical CAN bus topology.

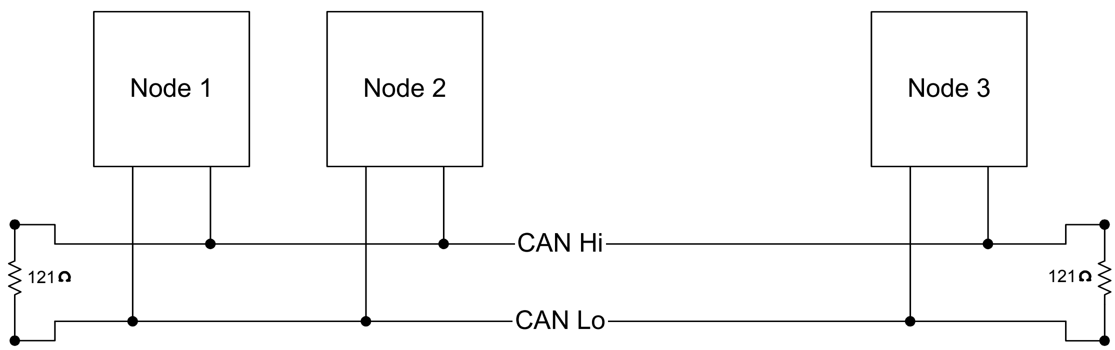


Figure 4-7. CAN Bus Topology

Per ISO 11898-2 the two-wire CAN bus must meet the following criteria:

- A maximum length of 25 m for 1 Mbit/s data rate, 40 m for 250 kbits/s.
- A recommended maximum drop line length of 0 m for 1 Mbit/s data rate, 1 m at 250 kbits/s.
- Characteristic line impedance of 120 Ω
- Nominal line resistance of 70 m./m.
- Nominal specific propagation delay of 5 ns/m.

On both CAN links the SAE J1939 protocol is used and restricted to 250 kbps and the SAE J1939 standard limits wiring distances to 40 meters, when un-isolated controls are connected to the J1939 link.

Recommended Cable
Use only recommended shielded cabling for a CAN network. Correct cable is available from Raychem and many other suppliers providing equivalent cable. "J1939/11" cable is a good example of CAN cable for on engine use.

Part Number	Description
Raychem 2019D0301	Cheminax, J1939-11, 0.75 mm², 120 Ω characteristic impedance, 10.5 pF/ft mutual capacitance, 74% velocity of propagation

The basic cable requirements are listed in Table 4-5. When selecting other cables, be sure they meet these requirements.

Table 4-5. Cable Specification

Data pair impedance	120 Ω ±10% at 1 MHz
Cable capacitance	12 pF/ft at 1 kHz (nominal)
Capacitive unbalance	1200 pF/1000 ft at 1 kHz (nominal)
Propagation delay	1.36 ns/ft (maximum)
DC Resistance	6.9 Ω / 1000 ft @ 20 °C (maximum)
Data Pair	0.75 mm² – 1.0 mm² corresponds to 20 – 18 AWG, individually tinned, 3 twists/foot
Drain / Shield Wire	0.75 mm² – 1.0 mm² Tinned Copper drain wire inside a braid or foil shield
Signal attenuation	0.13 dB/100 ft @ 125 kHz (maximum)
	0.25 dB/100 ft @ 500 kHz (maximum)
	0.40 dB/100 ft @ 1000 kHz (maximum)

Network Construction
There are a number of different ways to physically connect devices on a CAN network. Woodward recommends that multi-drop networks be constructed using either a "daisy chain" configuration (also called zero length drop line) or a "backbone" with very short drop lines for best performance.

In a daisy chain configuration, wires are run from one device to the next device without drop lines.

In a backbone with stubs configuration, a main trunk line is run between the two devices that are physically farthest apart and have the physically longest cable. Stub lines are run from the intermediate devices to the trunk line. Stubs should be kept as short as possible and may never exceed 6 m (20 ft). As shown in Figure 4-8, it is acceptable to mix both methods on the same network.

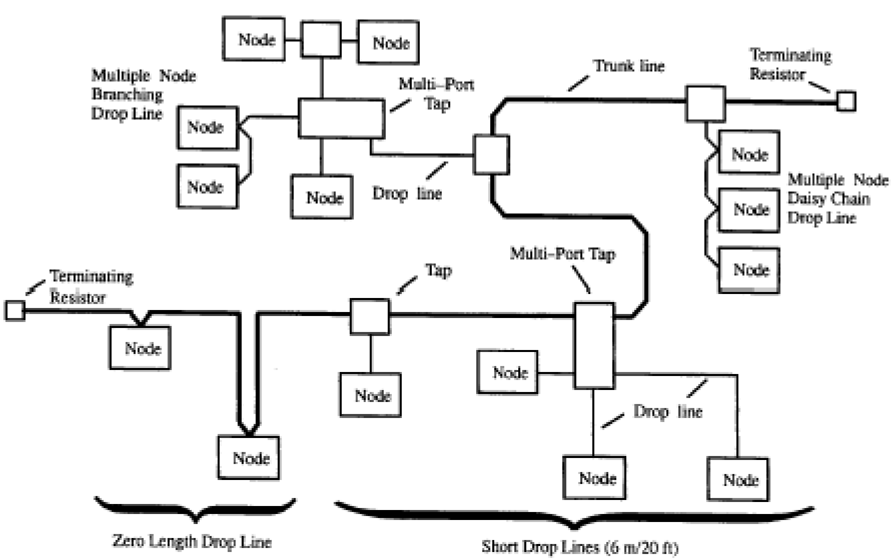


Figure 4-8. CAN System Wiring Example

A daisy chain (zero drop length) connection is not feasible at the PCM128-HD connection due to the sealed connector design. The next best alternative is to use a very short drop line from the trunk into the PCM128-HD. Special 'T' connectors (Tap in the diagram above) are available from multiple manufacturers to ease the wiring harness manufacture. Also available from the same manufacturers, are termination resistors that plug directly into the 'T' connectors for the network ends.

The PCM128-HD may be used on networks where isolated CAN devices are present. In this case the isolated nodes may have a signal common connection that should be connected to B- for proper referencing with the PCM128-HD. Non-isolated nodes (such as the PCM128-HD) do not have a signal common available for connection. Where the signal common is not available, use the alternate wiring scheme of connecting the CAN ground wire from the isolated nodes to the B- terminal at a non-isolated node. B- is typically the signal reference for CAN if isolation is not provided. Do not connect to B- at more than one location.

Termination

It is necessary to terminate the network to prevent interference caused by signal reflections. Depending on network length, many CAN networks will not operate without proper termination.

In order to allow the possibility of removing and inserting a unit onto a running network, the CAN termination network is not included inside the PCM128-HD control. An external CAN termination network must be provided.

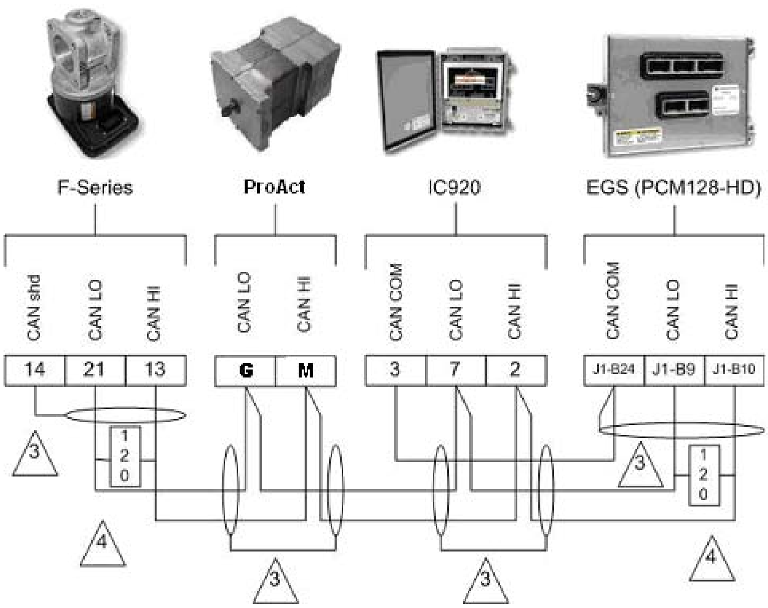
As a rule, no matter how many units are on a network, there should never be more than two network terminations installed. Termination resistors must be installed only for the two units that are at the physical ends of the network. Terminating more than two units can overload the network and stop all communications.

Termination is a simple 121 Ω, ¼ watt, 1% metal-film resistor placed between CAN high and CAN low terminals at the two end units, a differential termination. Do not connect the termination resistor to anything besides the CAN high and CAN low wires.

Shielding

Shielded CAN cable is not required between the ECU (PCM128-HD) and any other device(s), but it is highly recommended. Unshielded or improperly shielded cables are likely to cause communication problems and unreliable control operation. Improper shield termination to ground can also cause communication problems and unreliable control operation.

If shielding is used with the E3 CAN wiring, the shield should only be tied at the ECU (PCM128-HD) control ground J1-B24 (Shielding Ground). If the shield is grounded at the other end, it should be through a high-frequency AC ground, i.e., via a 0.01 µF capacitor to chassis-body ground. Figure 4-9 shows an example of a CAN network for the E3 Stoichiometric Control system.



Note 1: Cable per ISO 11898-2:
Maximum length of 40 m. For the J1939 on 250 Kbps.
Ends of the network need to be terminated with 120 Ω resistors
Nominal resistance of line is 70 mΩ/m
Nominal specific propagation delay of 5 ns/m.

Note 2: Maximum length of drop line length of 1 m at 250 kbps
Note 3: Shielding only to be connected to F-Series and E3 sides. The shielding needs to be continued through.
Note 4: Ends of the network need to be terminated with 120 Ω resistors
Note 5: Termination resistor on ProAct™ side is mounted inside ProAct. Only a jumper needs to be installed to make the termination active.

Figure 4-9. CAN Network Example

Fuel Trim Valve

⚠WARNING

EXPLOSION HAZARD—Leak check all gaseous fuel connections. Leaking gaseous fuel can cause explosion hazards, property damage, or loss of life.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2 or Zone 2.

⚠WARNING

Refer to product manuals 26249 and 26237 or 26289 for the L-Series; 26355 for F-Series; 26112 for the ProAct for detailed regulatory compliance information and installation warnings associated with these products.

⚠WARNING	**External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.**

⚠WARNING	**Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.**

NOTICE	**Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Chapter 6).**

⚠CAUTION	**Due to typical noise levels in engine environments, hearing protection should be worn when working on or around the Fuel Trim Valve.**

⚠CAUTION	**The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.**

Trim valve installation instructions are available in the individual component manuals. See the Approved Electronic Parts List (Chapter 7) for available trim valves and corresponding technical manuals.

For assistance with determining the correct valve size and actuator type, please contact Woodward.

Throttle Actuator (F-Series, Flo-Tech, & ProAct)

⚠WARNING	**Refer to product manuals 26355, 04141, and 26147 for the F-Series, Flo-Tech, and ProAct Analog for detailed regulatory compliance information and installation warnings associated with these products.**

⚠WARNING	**EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division 2 or Zone 2.**

AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2 ou Zone 2.

WARNING

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

NOTICE

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Chapter 6).

Throttle Body and Actuator Sizing

Please contact Woodward for correct throttle body and actuator sizing for your application.

Installation Instructions

Complete installation instructions for the F-Series, Flo-Tech & ProAct Analog throttle actuators are available in the individual manuals:

Manual 26355, F-Series Actuator and Integrated Throttle Body
Manual 04141, Flo-Tech™ Integrated Actuator and Throttle Body
Manual 26147, ProAct™ Analog Electric Actuator with Integral Driver

Electrical Connections

The mating connector kit for the 14 pin F-Series is part number 8923-1311. The mating connector kit for the 23 pin F-Series is part number 8923-1312. The connectors and terminals can also be purchased from the manufacturer directly:
Tyco Electronics

14 pin connector part number	770680-1
23 pin connector part number	776273-1
Contact part number	770854-3

The mating connector kit for the 75 mm Flo-Tech is part number 8923-371. The connectors and terminals can also be purchased from the manufacturer directly:
Delphi Packard Electric

Connector part number	12020926
Contact part number	12089188
Wire seal part number	12015323
Sealing plug part number	12010300

Supply Voltage

The supply voltage during normal operation must be 18 to 32 V, measured at the throttle actuator connector. Follow the supply power wiring requirements that are specified in the respective F-Series, Flo-Tech & ProAct installation and operation manuals.

Actuator PWM Option

The E3 Stoichiometric Control system is enabled to drive up to four (4) PWM Actuators including F-Series, L-Series, ProAct Digital Plus, and P-Series throttle bodies and actuators. With this option a TPS position monitoring signal and Status Output signal can be used by the E3 to provide robust diagnostics.

Actuator SAE J1939 Option

The E3 Stoichiometric Control system is enabled for F-series, ProAct Digital Plus, ProAct ISC, and P-Series throttle bodies and actuators with SAE J1939 communications capability for control and diagnostic messages.

CAN Termination
Follow the CAN termination instructions in the section above in this chapter, titled *CAN Communications Ports*.

Shielded Wiring
See the section above in this chapter, titled *CAN Communications Ports*, for recommended shielding practices.

The CAN Shield can be used to terminate the shield of the CAN wiring. Internally, this pin is connected to the actuator case through a capacitor.

Service Tool Communications

Please consult the respective Actuator Installation and Operation manual publication for instructions on connection and use of the Actuator service tool.

Engine Speed Sensor

If a variable reluctance magnetic pick-up sensor (MPU) input is used to detect engine speed, it should be mounted as shown in Figure 4-10 and connected to the PCM128-HD as shown in Figure 4-11. Shielded wire for the speed sensor inputs is recommended, but is not required unless problems are encountered due to noise on the signal. Connect the shield to J1-B24 (SHIELDING GROUND). Make sure the shield has continuity the entire distance to the speed sensor, and make sure the shield is insulated from all other conducting surfaces. If shielded wire is not used, then a twisted wire pair is the next best alternative.

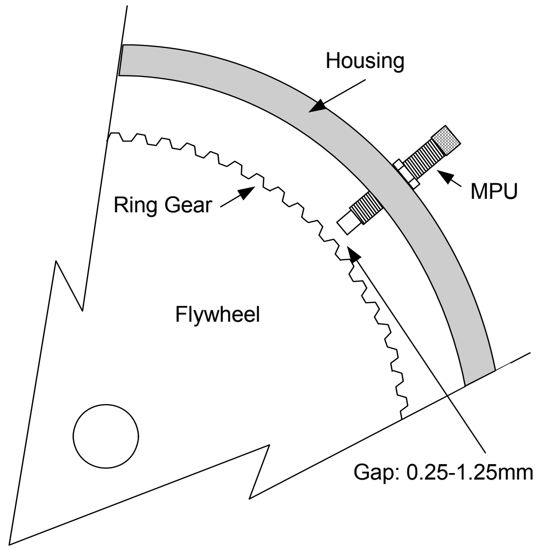


Figure 4-10. Magnetic Pickup Mounting in Flywheel Housing

The following installation guidelines should be observed:

- Install the magnetic pickup (MPU) on the outside diameter of the flywheel gear, either through a housing or a bracket. Usually the MPU will be located in the flywheel housing of the engine.
- Set the gap between the MPU and the flywheel gear between 0.25 and 1.25 mm.
- Connect the MPU wires to the E3 Stoichiometric Trim control, terminals J1-A2 and J1-A13.
- Minimum voltage of 1.5 to 2 Volt top-top is needed for proper signal detection.

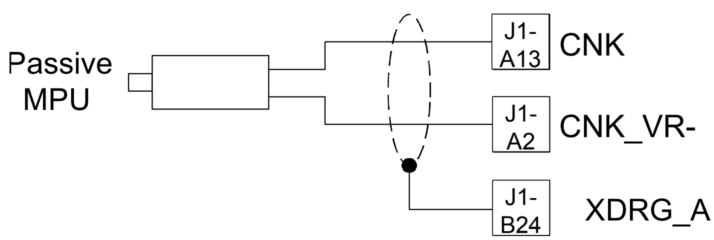


Figure 4-11. Magnetic Pickup Wiring – Speed sensor

Optionally, an active proximity probe can be used. Proximity sensor wiring is shown in Figure 4-12. For more information refer to the PCM128-HD hardware manual (document 26309).

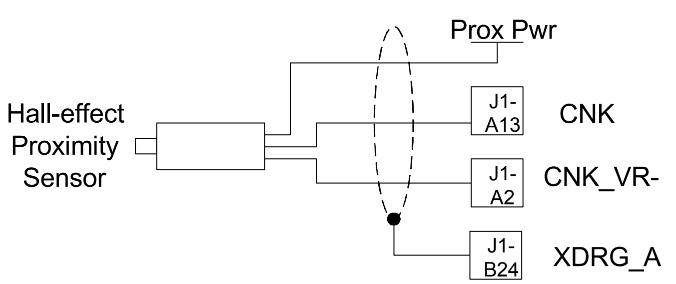


Figure 4-12. Proximity Sensor Wiring – Speed Sensor

Manifold Absolute Pressure Sensors (MAP1 & MAP2)

The standard Manifold Absolute Pressure (MAP) Sensor for the E3 system is PN 6910-314. The MAP sensor is required and is used to indicate engine load, calculated using the Engine Speed and Manifold Air Temperature. Two MAP sensors are required for Stereo AFR control. Two MAP sensors can be used for Mono AFR control and the control calculates the average for internal use or the second sensor is used as a hot standby and takes over if the first sensor faults.

Mount the MAP sensor at a position where only minor ambient temperature changes occur during normal operation. The pressure connection of the MAP sensor should be after the throttle valve, on the topside of the manifold to avoid oil, water or dirt entering the sensor or hose. Do not mount the pressure connection close to an intake port, directly after the throttle, or at the dead end of the manifold to avoid erratic readings due to pulsations or strong turbulence. Place the MAP sensor higher than the sample point. Mount the tube or hose continuously rising to avoid trapping oil, water or dirt in the hose or tube.

Connect the wires of the MAP sensors to terminals J1-A30 (MAP 1) & J1A6 (MAP 2), and transducer ground as shown in Figure 4-13. The physical inputs for these functions are configurable in the software; default input settings are shown.

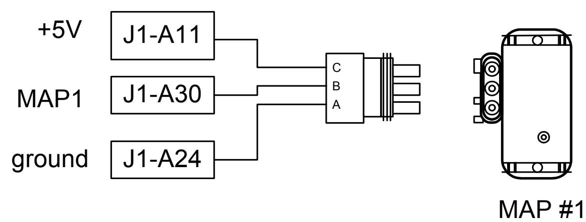


Figure 4-13. Manifold Pressure Sensor Wiring

For the use of customer-provided or optional Woodward-provided MAP sensors, please contact Woodward.

Manifold Air Temperature Sensors (MAT 1 & MAT 2)

The standard Air Temperature Sensor (MAT) Sensor for the E3 system is PN DL08041301. The MAT sensor is not required but improves accuracy of the engine load (Q_{mix}) based on air density in the manifold. Two MAT sensors can be used for Stereo AFR control. Two MAT sensors can be used for Mono AFR Control and the control calculates the average for internal use or the second sensor is used as a hot standby and takes over if the first sensor faults.

Install the Manifold Air Temperature (MAT) sensor in the inlet manifold of the engine. Connect the two wires of the sensor element to terminals J1-A10 (MAT 1) & J1-C6 (MAT 2) and transducer ground; see "E3 Wiring Diagram".

It is important that the sensing element in the tip of the sensor measures the temperature that represents a good average of the flow. When the tip of the sensor is too close to the wall, the influence of the temperature of engine components affects the measurement.

The PT-100 MAT sensor used with the legacy product EGS-01 is not compatible with the E3. The MAT sensor should be a NTC thermistor type. For the use of customer-provided or optional Woodward-provided MAT sensors, please contact Woodward.

TMAP Sensor

For small engines a combined TMAP sensor is available. For large engines (with relatively thick intake manifold castings) the tip of this sensor will not protrude far enough into the intake manifold, so the influence of the temperature of engine components will affect the measurement of manifold air temperature. Figure 4-14 shows TMAP sensor wiring. For more information refer to the TMAP sensor manual, document 82689 (this document has limited distribution – to receive a copy, please contact Woodward).

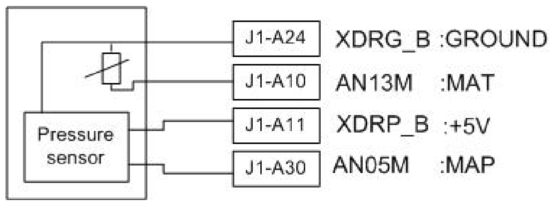


Figure 4-14. Bosch TMAP Sensor Wiring

Engine Coolant Temperature Sensor (ECT)

The Engine Coolant Temperature (ECT) sensor should be installed in the engine water jacket. The two wires of the sensor element should be connected to the signal terminal (defaulted to J1-C15) and transducer ground. For more information, refer to the control wiring diagram in Chapter 6.

Catalyst Pressure Transducers

The Catalyst Pressure taps should be installed in the exhaust stream. Ensure that water accumulation is accommodated by using drains or locating the transducer above the pressure tap. The signal output from the transducer connects to the signal input terminal; the signal return of the transducer is connected to transducer ground XDRG_B (J1-A24). If the sensor needs a 5 Volt power supply, connect to XDRP_B (J1-A11). For more information, refer to the control wiring diagram in Chapter 6.

Catalyst Temperature Sensors

The Catalyst Temperature sensors should be installed in the exhaust stream. The E3 supports two types of resistive temperature devices, RTD & Thermistor.

The two wires of the sensor element should be connected to the E3 signal input terminal and transducer ground. For more information, refer to the control wiring diagram in Chapter 6.

Analog Inputs (0–5 Vdc)

Analog inputs should be 0.5 to 4.5 Vdc signals. If their grounds are not common to engine ground, they should be isolated with a galvanic isolator. All the Analog Input functions except the HEGOs are selectable for that type of sensor i.e. Voltage type sensors and potentiometers can select from AN1 to AN12 (pull-down inputs). Resistive type inputs can select from AN13, AN 18, AN19, AN26, AN 27 & AN28 (pull-up inputs).

Generator Power Input

This input is configured for a load transducer (kW). It is only used if E3 Internal Load Control is desired.

Woodward recommends real power sensors that are powered separately from the generator so that a failed load signal is not detected during shutdown. The signal should be 0.5 to 4.5 Vdc so that a failed signal can be detected. Measurement of all three phases is recommended for accurate power control. A kW transducer needs a maximum response time of approximately 250 ms for a 0–90% change in load. An accurate signal and update time will improve Load Control. A signal from a PLC is not preferred. If a PLC signal is used, then a galvanic isolator must be mounted between E3 input and PLC output.

Remote Reference

The remote reference input (speed or load) is connected to J1-A25 and transducer ground. The signal should be a 0.5 to 4.5 Vdc signal, so that loss of signal can be detected.

Galvanic isolators are required in cases where the signal is shared with other applications and to eliminate ground loop problems.

Speed Bias

The speed reference bias signal is wired to J1-A16 (default) and transducer ground. This bias signal is added directly to the speed setpoint. The input signal must be configured with a null point, such as 2.5 Vdc. The null point voltage corresponds to a bias of 0 rpm.

PWM Speed Bias

The PWM Speed Bias signal is wired to DG3 (J1-A19) and transducer ground. DG3 has a 1 kΩ pull up resistor to internal +5 Vdc. The PWM driver must be able to pull this signal down to 4 Vdc to trigger the input comparator. The default setting is a 10-90% Duty Cycle with 50% as a null point (zero RPM bias), with the drive frequency from 16 to 4000 Hz. This bias signal is added directly to the speed setpoint.

StableSense™ HEGO Sensor

The StableSense HEGO (Heated Exhaust Gas Oxygen) sensor measures the oxygen content of the exhaust mixture. It is specifically designed for Natural Gas Engines and provides immunity for Methane and Hydrogen interference. The StableSense HEGO sensor wiring is shown in Figure 4-15.

The sensor has an M18x1.5-6e thread which should be coated with anti-seize for future removal. Mount the sensor such that the tip extends as much as possible into the exhaust stream. To extend sensor life it is recommended to locate the HEGO sensor close to the Catalyst to get a better read of what the Air/Fuel Ratio measures as it enters the catalyst element. The sensor should NOT be mounted on the catalyst housing if possible as this typically moves the sensor out of the exhaust stream. A thread boss should be used to provide a flush gasket contact surface. An example of an approved thread boss is a 1 inch diameter and ¼ - ½ inch deep Stainless Steel donut with M18 thread inside. Weld the boss flush with the exterior of the exhaust manifold, this will allow for the greatest protrusion of the sensor element into the exhaust stream.

IMPORTANT

NOTE—Woodward sensors are designed for use on industrial stationary applications only.

NOTICE

HANDLING

- **DO NOT drop or use an oxygen sensor that has been dropped as this may have caused shock damage to the ceramic cell**
- **DO NOT use any compounds on or around the sensor unless labeled as oxygen sensor friendly products**
- **DO NOT use impact wrench or conventional socket type wrench to install sensor**
- **DO NOT allow sensor or lead wires to touch exhaust manifold or any other hot component**
- **DO NOT expose this product to water, oil, anti-corrosion oil, grease, terminal cleaner, etc…**
- **DO NOT store under high humidity conditions**

Installation Instructions

1. Remove protector cap just prior to installation
2. If not already coated, apply anti-seize to oxygen sensor threads
3. Install sensor body ensuring lead wires are not twisted or bent
4. Install all sensors with new gasket supplied
5. Install finger tight then ½ - ¾ turn with wrench or O_2 sensor socket (26-33 ft-lb)
6. Connect and route lead wires

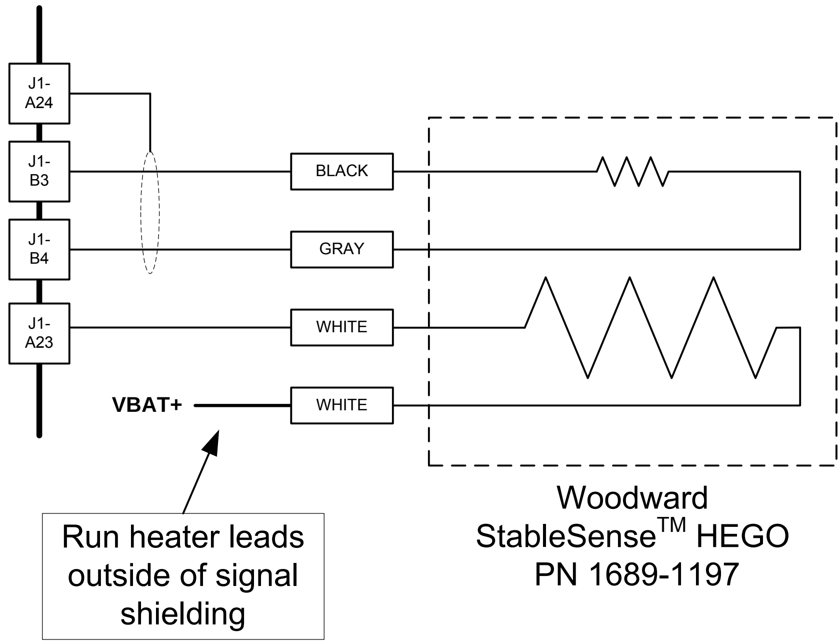


Figure 4-15. StableSense HEGO Sensor Wiring Diagram

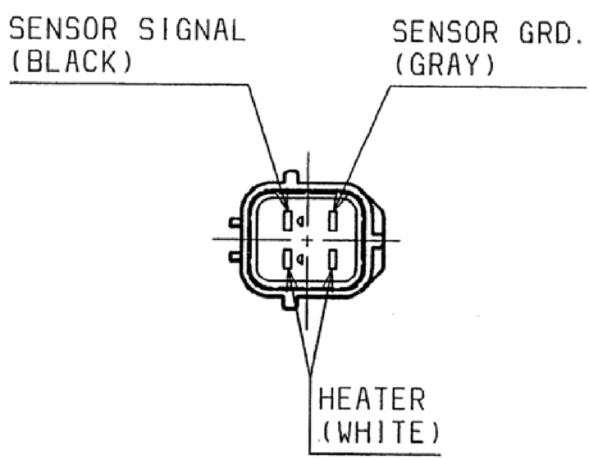


Figure 4-16. StableSense HEGO Sensor Connector Wiring Diagram looking into the connector.

IMPORTANT **It is recommended that the wires from the HEGO sensor(s) to the E3 control be shielded to reduce the levels of EMI. For best performance shield the heater wires separately to reduce noise emissions.**

Galvanic Isolation

To avoid problems with analog connections to the ECU, isolators should be used. These separate the analog input from the ECU galvanically. These devices require a power supply, which is also isolated from the input and the output of the isolator.

Phoenix supplies configurable isolating amplifiers like MINI MCR-SL-UI-UI(-SP) (–NC). On the input and output side, the standard signals 0–20 mA, 4–20 mA, 0–10 V, 2–10 V, 0–5 V, or 1–5 V are available, electrically isolated. The DIP switch accessible on the side of the housing allows the configuration of the input and output signal ranges. The voltage supply (19.2–30 Vdc) can either be provided via connecting terminal blocks "3"/"4" or "7"/"8" of the modules, or together, via the DIN rail connector.

Discrete Inputs and Outputs

Discrete Inputs

The discrete input HMI screen is shown in Figure 3-64. The E3 control uses up to 12 discrete inputs. The inputs need to be connected to transducer ground on the control to be activated. There is no detection of input or wiring failure of these inputs.

The Run command input is failsafe. A failed to open input or broken wiring will result in an engine stop.

Although certain inputs are user configurable for normally open or normally closed operation, it is highly recommended that inputs used for engine or equipment protection (e.g. coolant level, oil level, and external shutdowns) be configured as normally closed, so that a wiring or switch fault will result in a failsafe system shutdown, and will required user override or correction of the fault for engine restart.

NOTICE	**Input and wiring fault detection is not performed on discrete inputs.**

Discrete Outputs

The discrete input and output HMI screen is shown in Figure 3-65. The E3 control has 2 low-side relay driver outputs (LSO) to act as alarm (J2-B12) or shutdown (J2-B15) indicators.

A third LSO, J2-B17, can optionally be connected to a gas shutoff valve. If this option is used, a redundant automatic gas shutoff valve that is completely independent of the E3 system is strongly recommended.

Typical application of these outputs to drive a relay is shown in Figure 4-17.

In addition, there are optional outputs for driving a MIL (malfunction indicator lamp), a speed switch, Ignition SD, and Battery Conservation Relay..

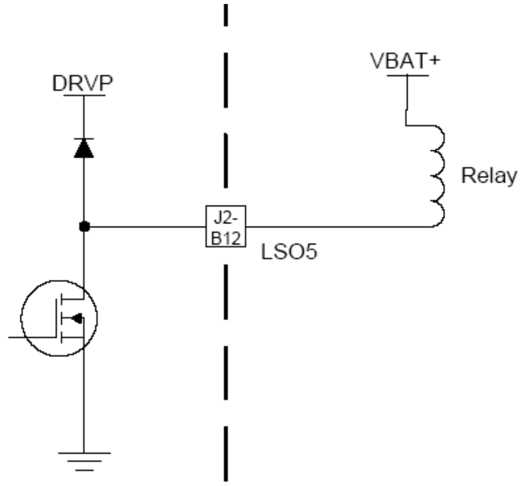


Figure 4-17. LSO Wiring Output Diagram (Alarm Relay shown)

IC-920/-922 Ignition Module

⚠WARNING **EXPLOSION HAZARD—Refer to product manual 26263 for the IC-920/-922 Ignition Module for detailed regulatory compliance information and installation warnings associated with this product.**

⚠WARNING **EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.**

Substitution of components may impair suitability for Class I, Division 2 or Zone 2.

⚠WARNING **Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.**

NOTICE **Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Chapter 6).**

Optional high energy capacitive discharge ignition functionality for this system is provided by the IC-920/-922 ignition module. The IC-920/-922 is shown in Figure 4-18. This module communicates with the E3 controller over the internal J1939 network.

The IC-920/-922 is a modern high-energy capacitance discharge ignition system. The system consists of a 16-bit CPU and other CPU related peripherals, sensor signal conditioning circuitry, a high voltage power supply, and 20 outputs (24 outputs are optional, for 12 cylinder engines with two coils per cylinder). The system can be configured for two cylinders up to 20 cylinders. The E3 system CD includes all the required software needed to configure the Ignition control for any type of industrial engine. All user programming/configuration is accomplished using IC-900 Series Service Tool software residing on a PC (personal computer). This software is included on a CD-ROM supplied with each IC-920/-922 system.

Figure 4-18. IC-920/922 Ignition Control

The IC-920/-922 uses information provided by 3 required sensors to precisely determine the correct crank angle for firing each output (speed sensor, TDC sensor and phase sensor).

During operation, the IC-920/-922 continuously monitors the status of the system by verifying proper information from all timing sensors and proper operation of the primary ignition circuit. Depending on the severity of a detected fault, the unit will either shut down or warn the operator via integral warning lamps as well as via fault signals communicated over the J1939 network to the E3 controller, which will in turn activate the corresponding alarm output.

The IC-920 is a CD system that stores a maximum of 180 mJ (at 100% energy setting) while the IC-922 stores a maximum of 360 mJ (at 100% energy setting). The IC-920 is the standard E3 system option; the IC-922 can be selected when higher ignition energy is required.

The IC-920/-922 module (part number 8408-0702 or 8408-0724) is integrated with the E3 System by connecting it to the Engine CAN bus (see Figure 4-8 or the control wiring diagram in Chapter 6). Control and diagnostic information is communicated between the units is through this bus connection.

For further description of IC-920/-922 functionality in the E3 system, see *Ignition Control (IC-920/922 or Smart Coils)* in Chapter 2 and *Commissioning of the IC-920/922 Ignition* in Chapter 4.

For complete information on the IC-920/-922, see the IC-920/922 Installation and Operation Manual (document 26263).

easYgen 3100/3200

As part of the E3 System in a generator application, the easYgen 3100/3200 power management module can be connected to CAN Bus 1 (see the control wiring diagram in Chapter 6). Control and diagnostic information between the units is exchanged via this bus connection.

For a full description of easYgen functionality, setup and configuration in the E3 system, see Chapters 2 and 4. For complete installation information, see the easYgen-3000 installation manual (document 37223).

Installation Checkout Procedure

When hardware installation is complete, observation of the following checkout procedures is recommended before commissioning is started.

1. Visual inspection
   A. Check for correct wiring in accordance with the control wiring diagram, (see Chapter 6 and individual component manuals as required).
   B. Check for broken terminals and loose terminal screws.
   C. Check for proper connections to the control connectors.
   D. Check the speed sensor(s) for visible damage. If the sensor is a magnetic pickup, check the clearance between the gear and the sensor, and adjust if necessary. Clearance should be between 0.25 and 1.25 mm (0.010 and 0.050 inch) at the closest point. Make sure the gear runout does not exceed the pickup gap.
2. Check for proper ground connection between the control and the engine chassis.
3. Check the shielding on CAN links has been correctly installed, following control wiring diagrams.
4. Check that installed fuses are in accordance with wiring diagram and with wiring used.

Chapter 5. Commissioning

Introduction

Commissioning can begin once all system hardware has been installed and connected (see Chapter 3). Commissioning is performed using the ToolKit HMI. See *Serial Communications Port (RS-485)* in Chapter 3 for instructions on establishing an RS-485 link between the E3 controller and the HMI PC.

When available, a settings file for an existing engine of the same type can be used and uploaded to the E3 controller. This makes the commissioning easier, however it is important to remember that when uploading a settings file, all previous settings will be overwritten. All settings and sensor calibrations should be checked to ensure they are valid for the new engine.

I/O Commissioning

I/O commissioning is performed by entering the correct settings for each sensor and actuator used. The HMI screens for these devices are organized under the heading I/O on the navigation screen. The alarm levels are configured by the user, at the top of each screen (Minimum and Maximum voltage levels). These voltage levels are used to detect a sensor/wiring failure. The scaling table is populated by the user to configure the relationship between the sensor input voltage and the engineering units used in the control.

TPS & FTPS

Figure 5-1 shows the HMI user settings for TPS & FTPS. The TPS when used with position error detection ensures proper operation of actuators.

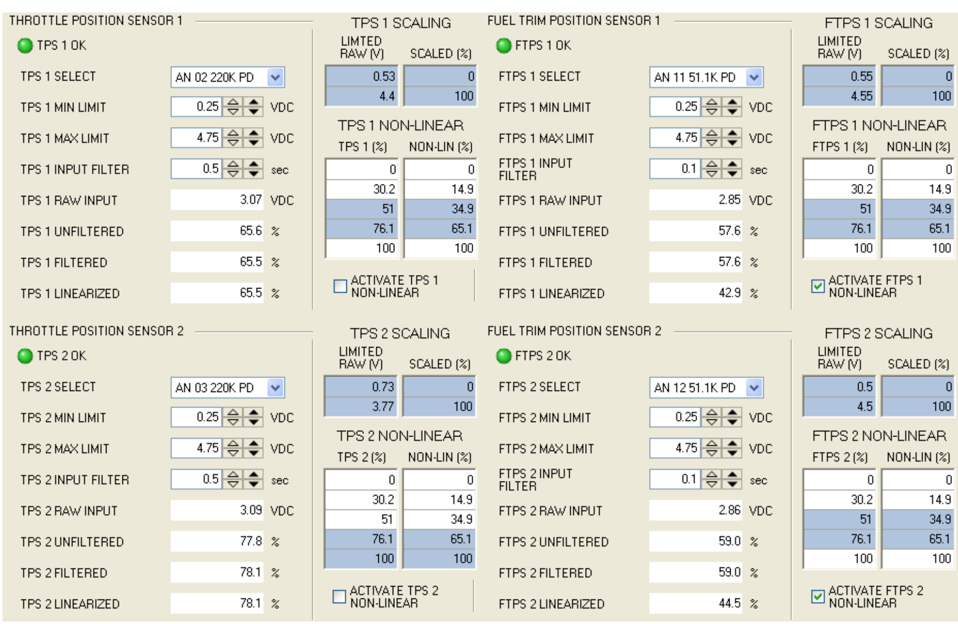


Figure 5-1. HMI Settings for TPS and FTPS (HMI Screen 6.9)

MAP and MAT

Figure 5-2 shows the HMI user settings for MAP and MAT. The MAP sensor is required and the MAT sensor is optional.

MAP & MAT configuration options: MAP 1 ONLY, MAP 2 ONLY, MAP WITH BACKUP, or MAP WITH AVERAGE. MAP 1 ONLY uses just MAP 1; MAP 2 ONLY uses just MAP 2; MAP WITH BACKUP uses MAP 1 unless it is failed and then it uses MAP 2; MAP WITH AVERAGE uses the average of the two MAP sensors unless one is failed and then it uses the good one.

“MAT DEFAULT” is a user specified value which is used by the logic if the sensed MAT sensor voltage is out of range. It is suggested to enter the value normally observed at full load operation. The default settings apply to the standard Woodward supplied sensors. When other transmitters are used, the applicable calibration data should be entered.

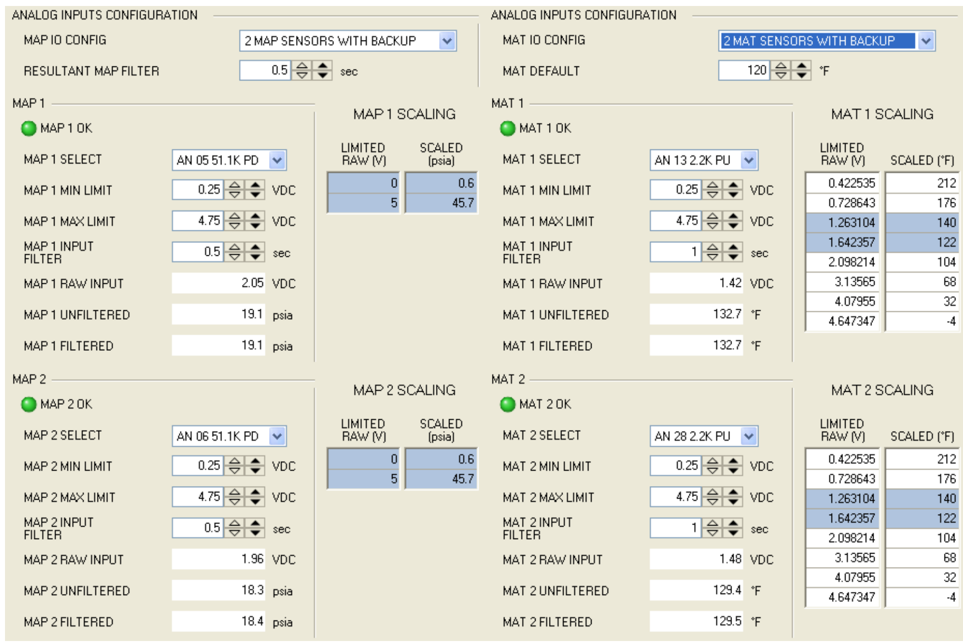


Figure 5-2. HMI Settings for MAP and MAT (HMI Screen 6.9)

LOP, LOT, ECT, & LOAD

Figure 5-3 shows the HMI user settings for LOP, LOT, ECT, & LOAD. The LOP, LOT, and ECT are optional . If internal Load Control is desired, the LOAD signal is required.

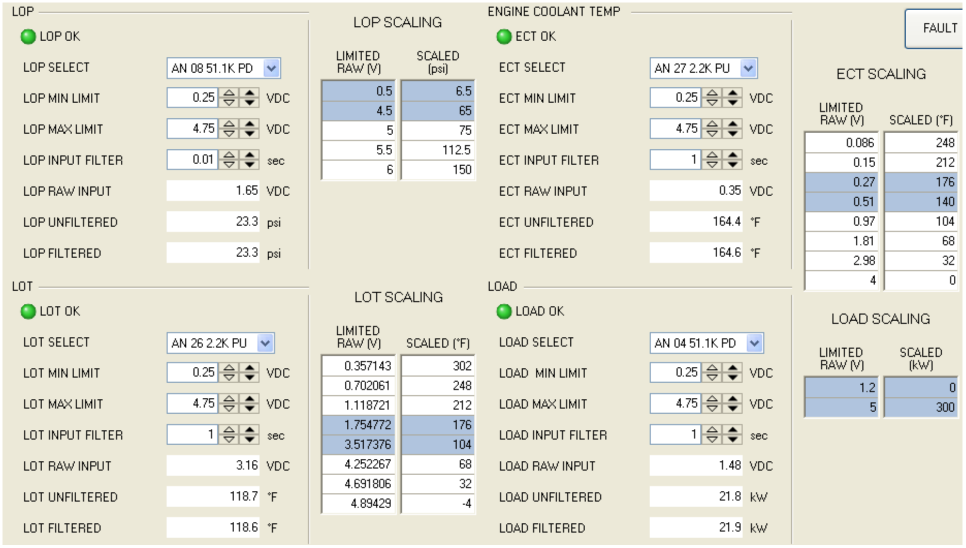


Figure 5-3. HMI Settings for LOP, LOT, ECT, & LOAD (HMI Screen 6.10)

EXTERNAL BIAS

Figure 5-4 shows the HMI user settings for SPEED BIAS, PWM SPEED BIAS, REMOTE INPUT, and AFR ADJUST POT.

Remote Speed/Load Reference - The remote reference is an optional input. It can be used as speed reference, or in the case of a generator application, either a load or speed reference, depending on the status of the generator breaker and the utility breaker inputs.

Speed Bias and PWM Speed Bias – Generator application only
This is the value that is directly added to the speed reference. It can be used as synchronizer input and as load sharing input.

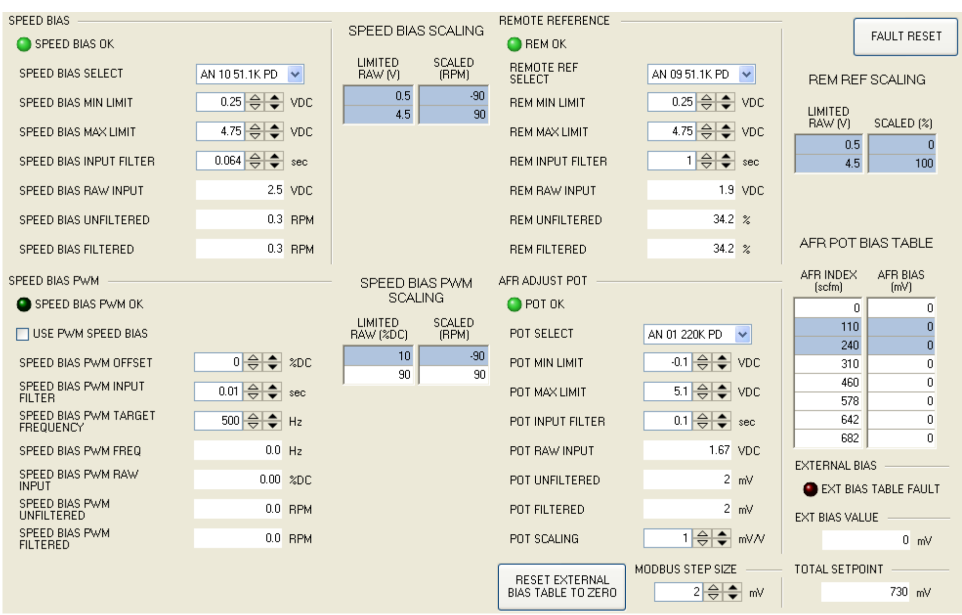


Figure 5-4. HMI Settings for EXTERNAL BIAS (HMI Screen 6.9)

Digital Inputs

Figure 5-5 shows the HMI user settings for digital inputs.

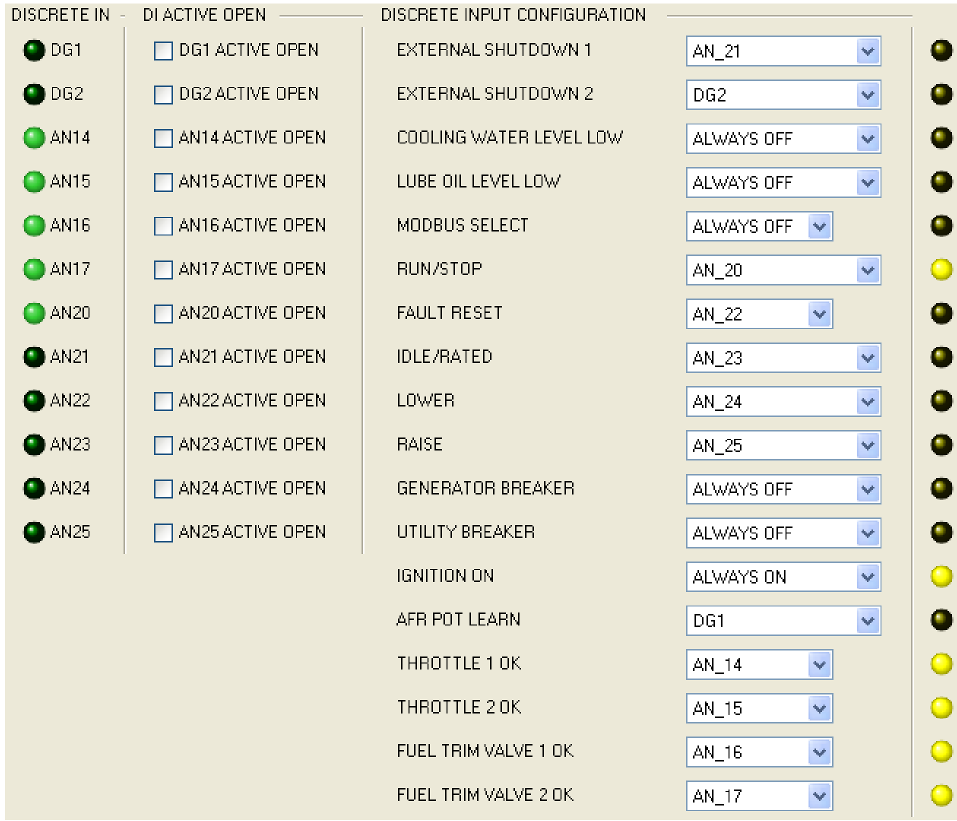


Figure 5-5. HMI Settings for DISCRETE INPUTS (HMI Screen 6.7)

Speed Sensor Input

Figure 5-6 shows the HMI user settings for SPEED SENSING.

Figure 5-6. HMI Settings for Speed Sensor Input (HMI Screen 7.3)

Figure 5-7 shows the HMI user settings for speed sensor inputs. The number of teeth on the geared wheel should always be entered in the box next to CRANK TEETH. This value is also used by the misfire detection algorithm; enter 2x number of teeth on the flywheel.

HEGO Heater & Condensation Protection

Figure 5-9 shows the HMI user settings for a typical HEGO sensor. Leave THERMAL SHOCK DELAY, HEATER WARMUP TIME, HEGO STABLE DELAY, OPEN CIRCUIT LEVEL, and MAX EFFECTIVE VOLTAGE at their defaults unless you are having issues damaging sensors due to improper heater control. To set the GRACE PERIOD determine the amount of time the sensor takes to normally become active, double that number and enter it in as the GRACE PERIOD.

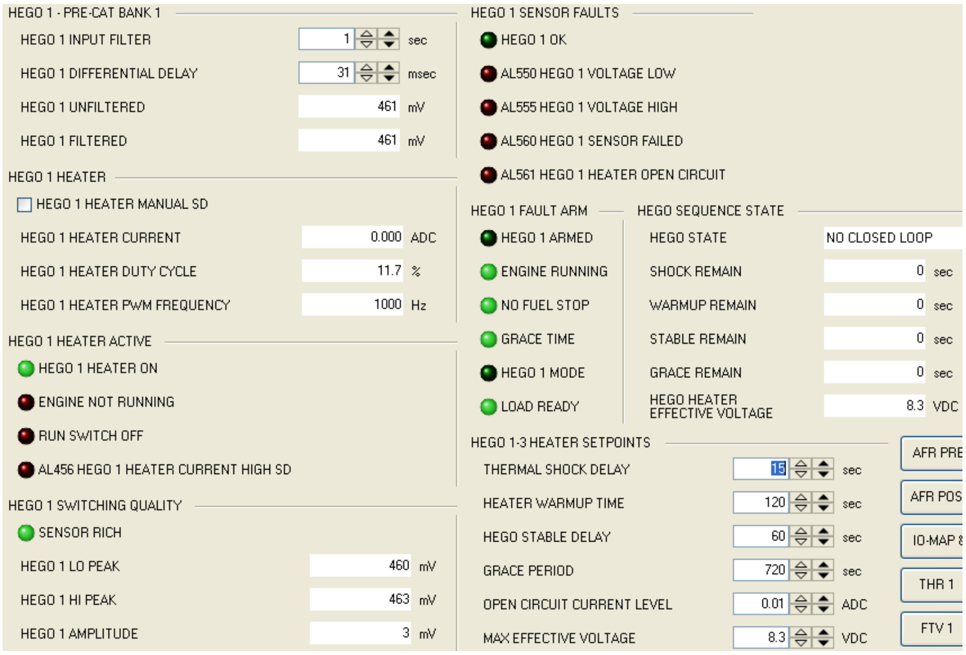


Figure 5-7. HMI Settings for HEGO sensor and Heater Control (HMI Screen 6.14)

easYgen™ 3100/3200

The E3 can communicate with the Woodward easYgen 3100/3200 for load sensing, breaker information, shutdown logic and speed reference. The communication between easYgen and E3 is over the J1939 CAN network.

Figure 5-8 shows the HMI screen for easYgen 3100/3200. When USE easYgen OVER CAN is checked the E3 will ignore the hard wired input for load, breakers, and speed/load bias.

When the box beside “ENABLE AL 1451 – easYgen STOP COMMAND” is checked, the E3 controller will obey commands from the easYgen to shutdown the engine.

The speed bias signal (±100%) received from the easYgen is converted to ± rpm by the user specified “SPEED BIAS SCALING”.

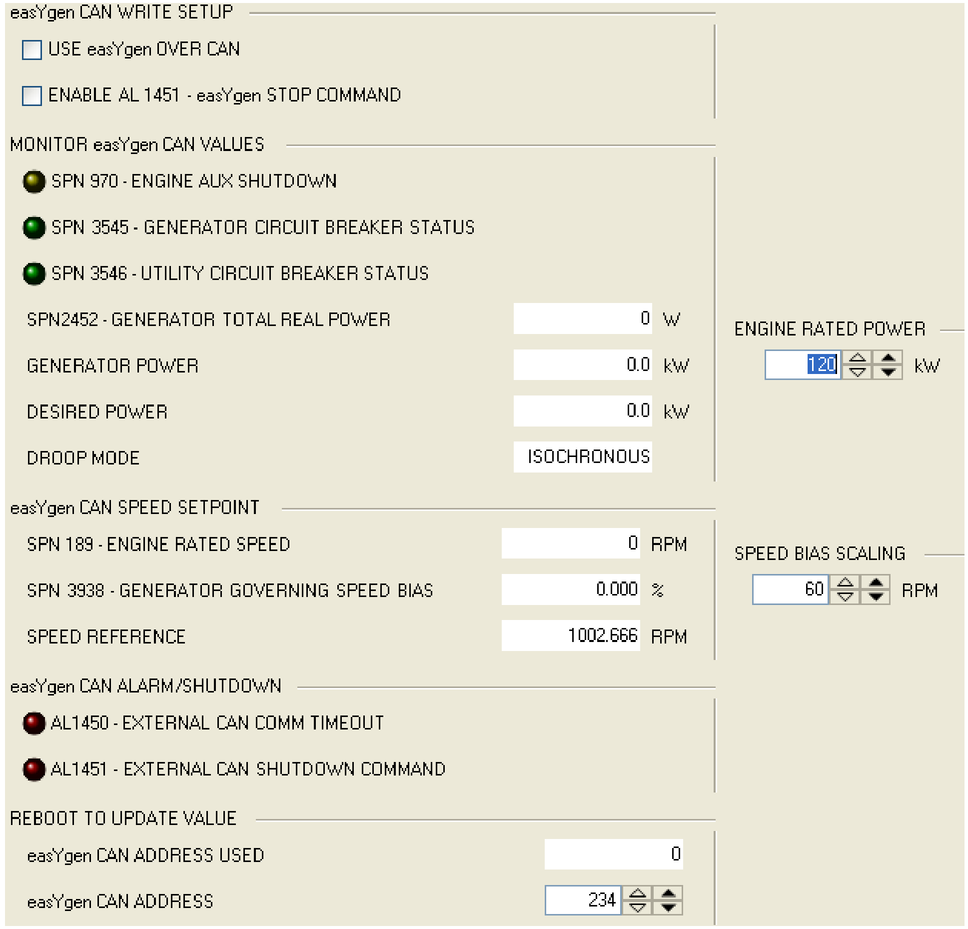


Figure 5-8. HMI Screen for easYgen 3100/3200 (HMI Screen 6.1)

Actuator Calibration

Depending on the hardware selected, there is an optional procedure to test and configure the mixture actuator for best performance.

Throttle & Fuel Trim Valve Actuator calibration
This procedure is described in Chapter 3 under *Throttle & Fuel Trim Valve Actuator Calibration*.

Set-up Before Starting the Engine

Before starting the engine for the first time with E3 Stoichiometric Trim the settings below must be correctly entered by the user.

System Configuration

Figure 5-9 shows the HMI user settings for system configuration.

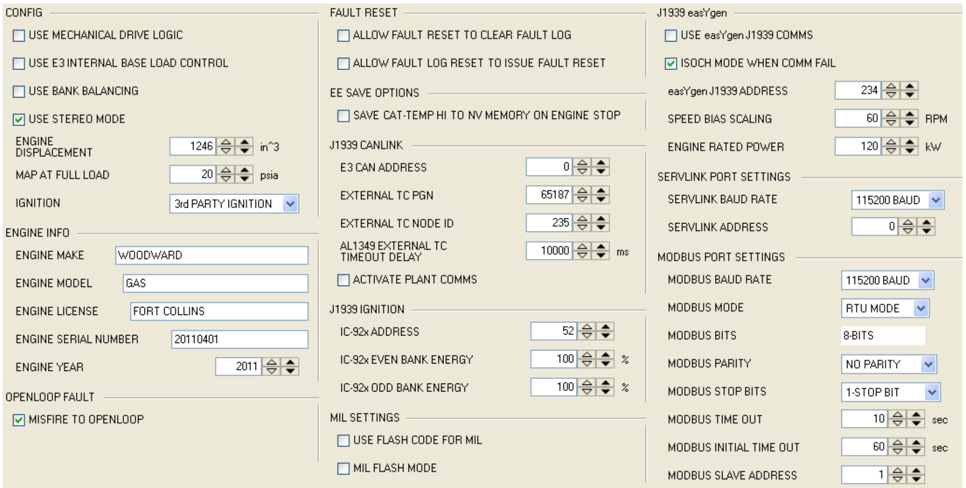


Figure 5-9. HMI Settings for System Configuration (HMI Screen 7.0)

The system configuration including devices connected to the J1939 busses and incorporated in the system is defined by checking the appropriate boxes on this screen.

I/O Selection

For complete information on all system configuration options, see *I/O Calibration* in Chapter 3.

Use of an Exhaust Gas Analyzer

To ensure that the engine is calibrated in accordance with the manufacturer's and local requirements, use of a suitable exhaust gas analyzer is recommended to measure the NO_X, O_2 and CO levels in the exhaust gas.

The exhaust gas analyzer should be installed and operated in accordance with the manufacturer's instructions.

Ignition Timing Settings

If the engine being commissioned includes ignition control by the E3 controller, check that the correct preliminary spark timing settings have been entered in the timing map. See *Ignition Control (IC-920/922 or Smart Coils)* in Chapter 3 for more information.

Speed Control Settings

For complete information on these settings see *Speed Reference* in Chapter 3. Prior to engine start the user should configure the following parameters:

- Idle speed set point
- Rated speed set point (activated after "Wait at min. speed" time has elapsed)
- Lower and higher limits around the rated speed, to allow synchronization in case of a generator set.
- Raise/Lower Speed Rate.
- Overspeed set point also needs to be configured; this triggers a shutdown of the engine.
- Wait (Warm-up) time at idle – this is the interval between the engine reaching run speed and beginning to ramp to rated speed. For first startup this time can be raised as desired to increase time to check the system while the engine runs at a lower speed.
- When a Droop system is used, the Load Droop percentage and the Droop Mode (Dual Dynamics) selection must be enabled by checking the box beside "Droop Mode (Dual Dynamics)".

Load Control (Grid mode) Settings

The Load Control (Grid mode) is used when the grid breaker is closed and the kW feedback signal is present, and when load control is activated by the user with the HMI. Figure 5-10 shows the HMI user settings for load control. The user should configure the following parameters.
Minimum and Maximum load
Raise and Lower rates
Remote Reference limit and rate

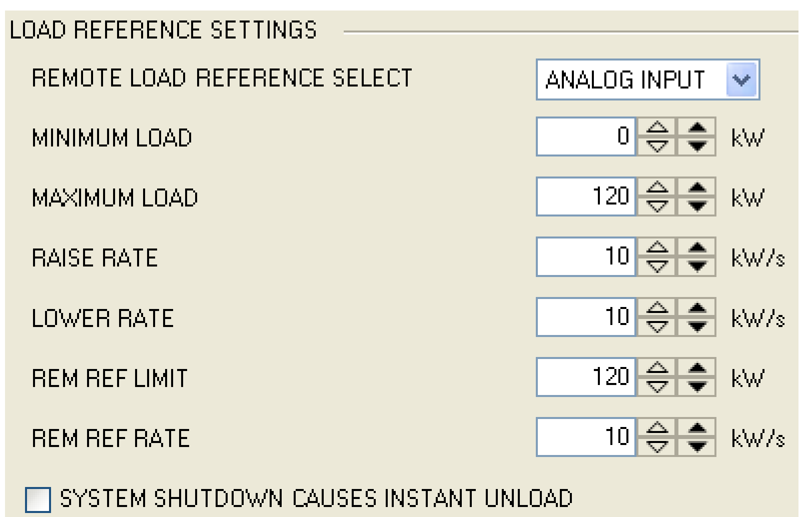


Figure 5-10. HMI Settings for Load Control (HMI Screen 2.5)

Dynamics Settings (Speed Control at First Start-up)

When the system is configured as a speed control appropriate settings need to be entered via the HMI. To start the commissioning it is simpler to select fixed dynamics. Then the gains do not change due to load or speed changes. Figure 5-11 shows the HMI user settings for fixed dynamics.

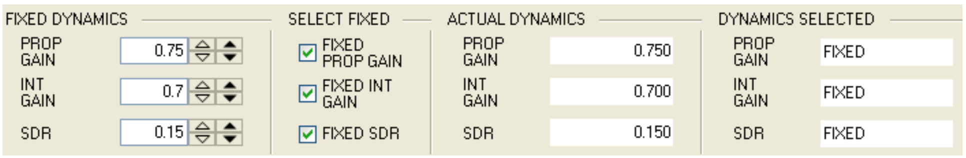


Figure 5-11. HMI Settings for Fixed Dynamics (HMI Screen 2.2)

In a later stage the Dynamics 1 and Dynamics 2 settings can be enabled and adjusted to optimize the speed and load control performance.

Load Rejection

Load rejection should be disabled by unchecking the box beside “USE CIRCUIT BREAKER FEED-FORWARD” as shown in Figure 5-12.

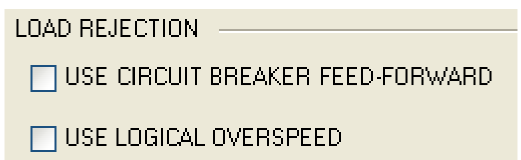


Figure 5-12. HMI Enable/Disable Setting for Load Rejection (HMI Screen 2.5)

Commissioning IC-920/922 Ignition

When the IC-920/922 ignition is integrated with the E3 system, the ignition controller must be configured before the engine is started the first time.
For the installation and commissioning of the IC-920/922 ignition controller, refer to the user manual, document 26263 and follow the procedures therein.
For J1939 control and communications between the E3 controller and IC-920/922, specific configuration parameters in the ignition controller must be checked and/or adjusted. To do this the IC-900-Series service tool is required. This software can be downloaded from the Woodward website (www.woodward.com) and can also be found on the CD-ROM that is included with the system purchase.

Figure 5-13 shows the IC-900-Series service tool start screen.

A communication cable for the service tool is required. As shown in Figure 5-14, it is a standard null modem cable where only pins 2, 3 and 5 need to be connected. The connection to both the PC and the IC-920/922 is via a DE-9 connector.

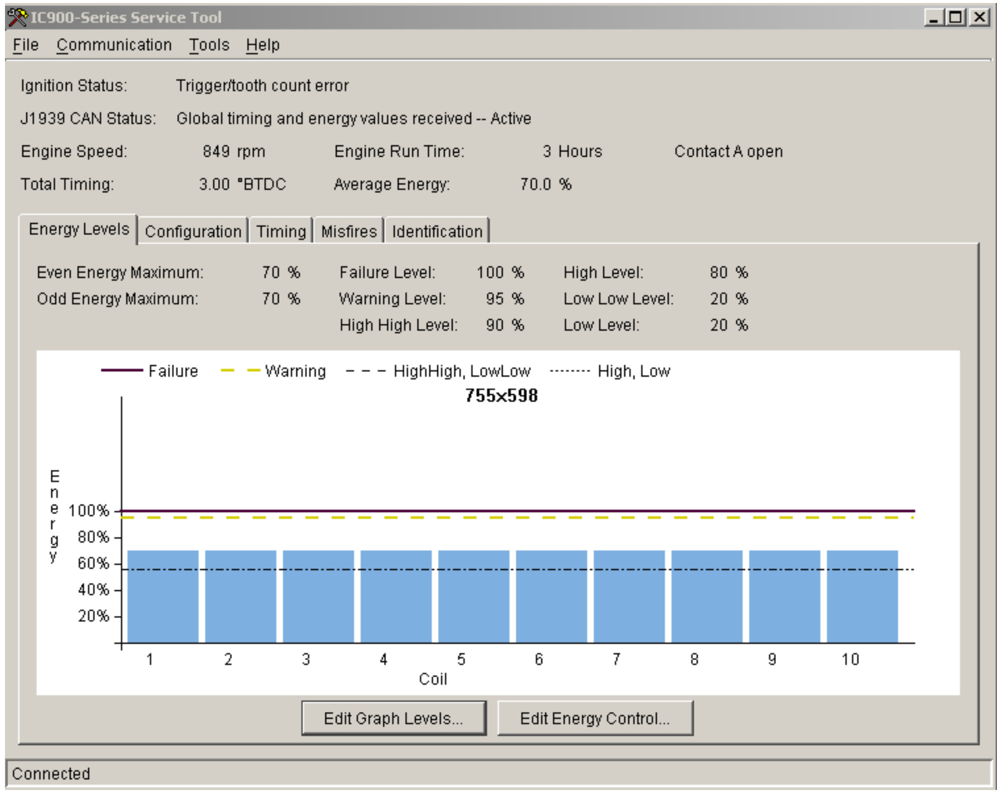


Figure 5-13. IC-900 Series Service Tool Start Screen

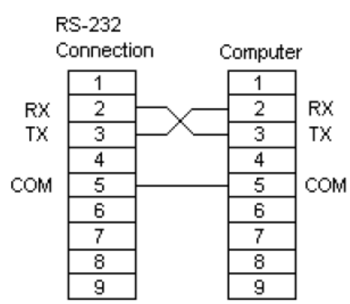


Figure 5-14. IC-900 Series Service Tool Connection Schematic

Figure 5-15 shows the configuration screen. To change the configuration click the “Change Configuration” button on the bottom of the screen. A new window will open (see Figure 5-16) where all the ignition system parameters can be configured (no password required). Click on the tab labeled “CAN”.

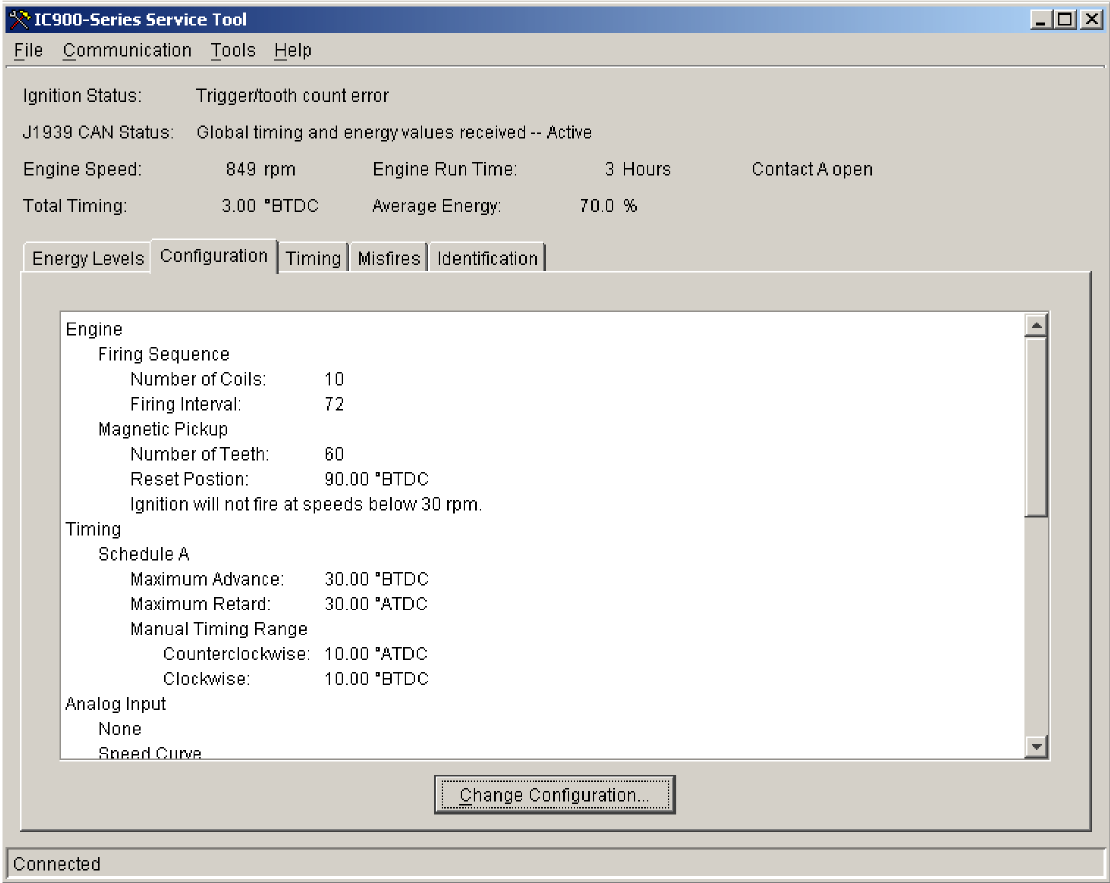


Figure 5-15. IC-900 Series Service Tool Configuration Screen

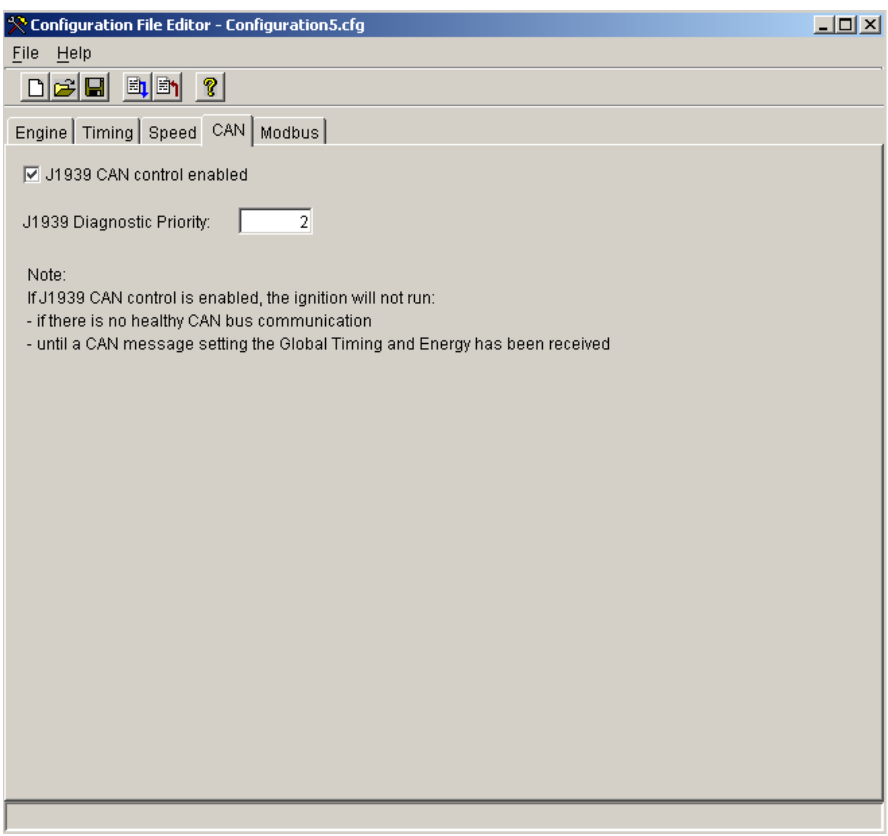


Figure 5-16. CAN J1939 Activation on IC-900 Series

On this screen the J1939 CAN bus communication can be activated by checking the box beside “J1939 CAN control enabled”.

This setting needs to be loaded and saved into the Ignition control. This is done by clicking the download icon as shown in Figure 5-17.

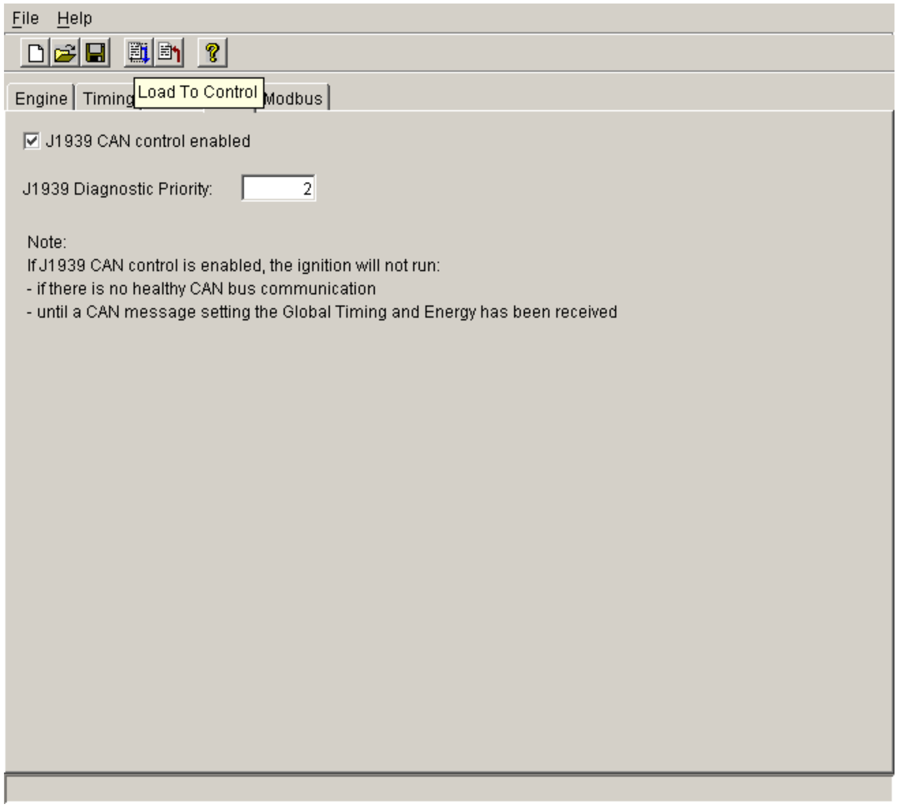


Figure 5-17. Loading the Settings to the IC-920/922

A password is required (Figure 5-18). This is the standard IC-900 series password (number of running hours + 10). Enter this value, then click “OK”. The settings will be loaded and saved in the ignition controller.

After loading new settings to the IC-920/922, the E3 controller should be power cycled to reset the system. The J1939 communication is monitored by a software watchdog. When the expected messages are not received, an alarm is activated (AL470 – IC-920/-922 J1939 watchdog timeout).

Further information about the IC-900 Series service tool can be found in the IC-920/922 series manual, document 26263.

User configuration of ignition timing is described in Chapter 4 under *Ignition Control (IC-920/922 or Smart Coils)*

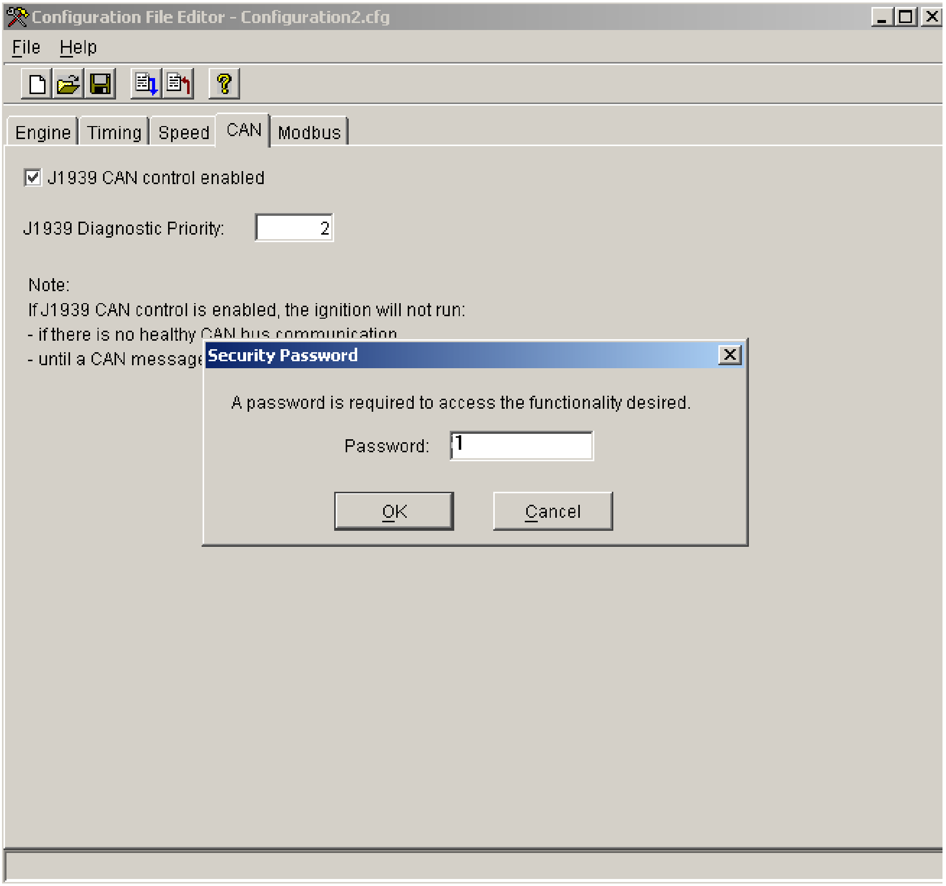


Figure 5-18. Password for Configuration Changes

Air Fuel Ratio Control Commissioning

This procedure assumes that all of the necessary end devices have been enabled and are functioning properly.

The 3 main tasks to accomplish when commissioning the AFR control are:
1. Get the engine to start
2. Get the engine to Full Load
    - Enabling Pre-Cat Closed Loop Control
    - Enabling Post-Cat Closed Loop
3. Tuning Emissions with analyzer

First Firing and Set-up after Starting the Engine

Engine Start

Crank the engine with the fuel supply turned off. During cranking, make sure that the E3 receives the speed signal from the magnetic pick-up by monitoring the speed in the HMI. If the speed reading remains at zero during cranking, check the wiring and adjustment (gap) of the MPU(s) (installation instructions can be found under *Engine Speed Sensor (MPU)* in Chapter 3).

When the speed signal is recognized the controller will count down the purge time (see *Purge Time* in Chapter 3), and then energize the gas shut-off valve relay. Before turning on the fuel supply, ensure that the base spark timing is correct, using a timing light while cranking. When this has been done, the fuel supply can be turned on. The engine should start at this time. If the engine does not start, find out if the gas shut-off valve has actually opened by measuring pressure downstream of the valve.

When the engine starts, record the time. This will be used for calibrating the warm-up time.

Failure to Start

If the engine fails to start, check and, if necessary, troubleshoot the following:
While engine is stopped

- Alarm and/or shutdown messages that reappear after clicking "Reset Faults"

During cranking

- Alarm and/or shutdown messages that reappear after clicking "Reset Faults"
- Speed reading on HMI screen correctly indicates cranking rpm
- Gas shut-off valve opens after purge time has elapsed
- Gas is supplied to trim valve
- Spark events are occurring at correct timing (using timing light)

If no faults exist after performing the steps above and the engine still fails to start, the cause could be that the trim valve open loop position is making the mixture too lean or too rich. Decrease or increase the trim valve position settings (See *Trim valve Settings* in this chapter) and attempt to start the engine. Another option to consider, instead of changing the trim valve position, is adjusting the gas supply pressure to the trim valve.

Getting the Engine to Start

The software has a start position for the fuel trim valve which is used to ensure reliable starting.

1. Force "Run/Stop" command to true
   a. Page 6.7 IO-Discrete Inputs will show the status of the input and allows the user to force the input logic by:
      i. Selecting "Always On" from configuration dropdown or
      ii. Inverting the default logic of the discrete by setting the input as "ACTIVE OPEN"
2. Force engine speed set point to idle
   a. If using the E3 Stoich speed control:
      i. Page 7.2 Config Control: Set "Rated Speed" to be equal to "Min Speed/Idle"
3. Page 2.0 Start: Set "AFR request mode" to "Manual Valve". Set "Manual Position" to 25%
4. Attempt to start Engine adjusting "Manual Position" as necessary to get the engine to start reliably.
5. Upon determining a reliable trim valve starting position enter this value into "Trim Valve Start Pos"

Tuning Speed Control Dynamics after First Start

After starting the engine, run the engine without load at idle speed (force to idle speed with the discrete input or in the HMI by increasing "Wait at min speed".

Next, tune the carburetor for the correct air/fuel ratio at idle using either the Idle Adjustment Screw or the fuel pressure regulator depending on the type of carburetor used.

Now tune the speed control in fixed dynamics mode. This is discussed in under *Dynamics Settings (Speed Control at First Start-up)* in this Chapter. Record the values for the proportional gain, the integral gain, the SDR and the Q_{mix}. Let the speed control ramp to rated speed and retune the P, I, and SDR terms. Record the new values and Q_{mix}. The two sets of values and the change in QMIX can then be used to configure the proportional gain versus the Q_{mix}.

Getting the Engine to Full Load

Next, attempt to get the engine to rated power so that the fuel regulator and main adjustment screw are in positions that allow the trim valve to have good control.

In order to do this, the engine needs to run rich enough to carry load (HEGO 1 reading >800 mV) while not being so rich as to cause an over temp on the catalyst element. This is done by setting the Open Loop table to trim valve positions 3% higher than the value at which the "Pre-cat signal" transitions from lean (<100 mV) to rich (>800 mV).

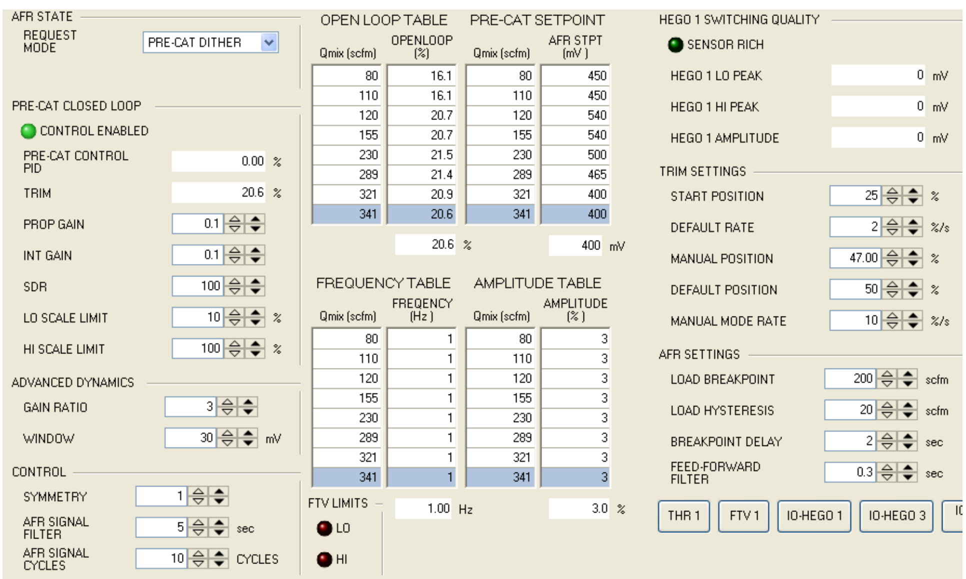


Figure 5-19. AFR Pre-Cat Mono Settings (HMI Screen 1.1)

1. Open Loop Table configuration
   a. With the engine idling copy the current "Qmix" in the dashboard to the first row of the Open Loop Table
   b. Transfer current "Manual Position" to first row of "Open Loop" (%)
   c. Change "AFR State" to "Open Loop".
      i. The trim valve position will now follow the "Open Loop Table"

d. Adjust the “Openloop (%)” until “Pre-cat signal” changes from lean (less than 100 mV) to rich (greater than 800 mV).
   i. Add 3% to the “Openloop (%)”

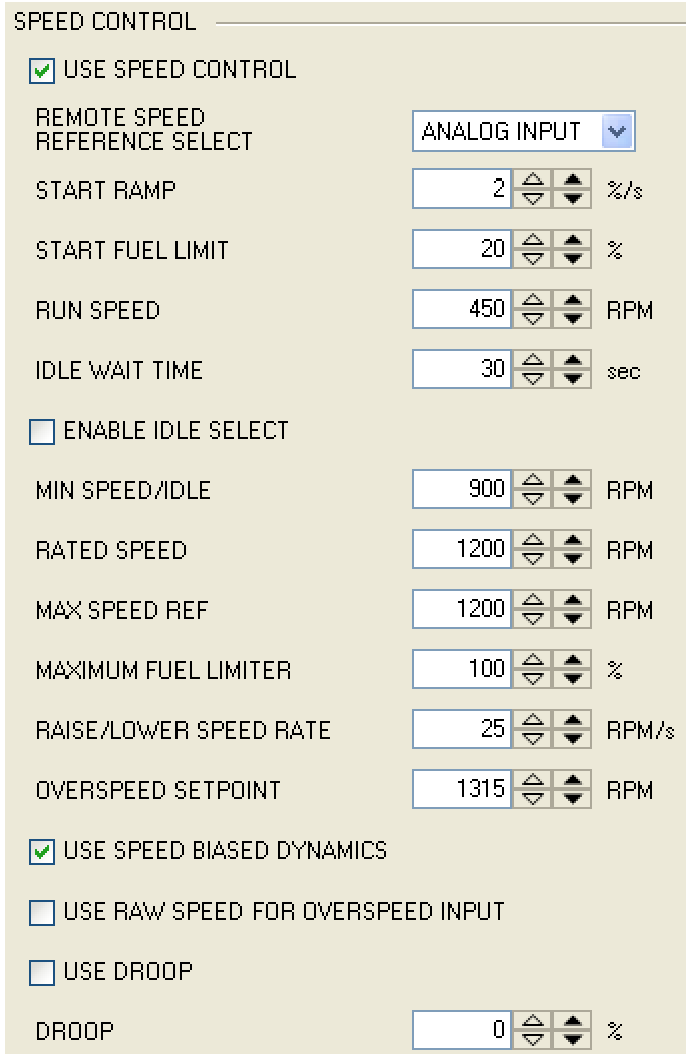


Figure 5-20. Speed Control Settings (HMI Screen 7.2)

2. Change “Rated Speed” to the actual engine rated speed
3. Enter the current “Qmix” into second row of the Open Loop Table
   a. Adjust the “Openloop (%)” until “Pre-cat signal” changes from lean (less than 100 mV) to rich (greater than 800 mV).
   b. Add 3%
4. Repeat Process as you carefully load the unit to full load. Filling in the second to last value in the “Qmix” column with your full load value. The last value is for your overload condition.
   a. If you open the valve to 100% and the pre-cat signal has still not switched rich you will need to either open your main adjustment screw and/or increase the pressure out of your final cut regulator.

Enabling Closed Loop

Enabling Pre-Catalyst Closed Loop

The trim valve should be ~60% open (between 55 and 70% open) at full load. Having the valve this far open gives good control while leaving enough margin for it to open further when conditions change. To get it to 60%, open the Main adjustment screw and adjust the final cut regulator. The pressure going into the carburetor or mixer should be between 0 and 5 inches H2O.

1. While at full load/full speed, adjust primarily the final cut fuel regulator(s), and secondarily the mixing screw(s) to maintain the appropriate amount of positive pressure on carburetors (downstream of the trim valve) while keeping the open loop position 3% richer than the lean-rich transition value.
2. With the full load value at ~60%, decrease load finding new Open Loop positions as was performed in step 4 of the previous section.
3. Return load to full load.
    a. With an "**AFR STPT**" of 450 mV, a "**Frequency**" of 2 Hz, and an "**Amplitude**" of 1%.
4. Set "AFR State" to "Pre-Cat dither".
5. Increase amplitude in increments of 1% until "HEGO1 Amplitude" is greater than 600 mV.
    a. Ideally the amplitude will be between one (1) and five (5). If the setup dictates a value higher than eight (8), try lowering the fuel pressure in 1 inch H2O increments.
6. Repeat process as the engine is carefully unloaded to the minimum load requiring AFR control.

Tuning Emissions with Analyzer

When the AFR is tuned with the analyzer, there is a number of different software knobs based on the emissions. There are three main knobs to turn. The AFR Setpoint (mV) is the biggest knob, followed by the Frequency. These values allow an increase or decrease of the amount of CO or NOx in the exhaust.

The amplitude knob is used to ensure that the emissions are switching from rich to lean consistently. If this value is too high, the emissions will bleed through the catalyst, causing high values for both CO and NOx that aren't affected by the AFR set point and frequency. If the amplitude value is a little too high or too low the emissions post catalyst will cycle between high NOx and high CO.

1. Load engine to full load.
2. Install emissions analyzer post-catalyst using dilution or Stoichiometric cells if available.
3. Adjust "AFR STPT" until your emissions are where they need to be.
    a. As a rule of thumb, try to keep the CO numbers somewhere around 3 to 5 times the NOx numbers while still having margin on the emissions permit. Stoichiometric engines tend to be very sensitive on the lean side.
4. Record a 15-minute trend of the "DASHBOARD" values.
5. Go to page 1.2 AFR POST-CAT and insert the average value of the Post-Cat HEGO3 into the POST-CAT SP TABLE.
6. Repeat the procedure as the engine is unloaded to the minimum load requiring AFR control.
7. Set the "Load Breakpoint" to be equal to the Qmix at the minimum load requiring AFR control.

Tuning the Speed and Load PID

For an explanation of the Woodward PID implementation, see *PID Control* in Chapter 3.

The following procedure describes a method of tuning the PID controls for optimum performance.

To start tuning the speed/load control, the process must be in a stable steady state condition. If operation is not stable, the Proportional gain should be reduced until the process stabilizes. During the tuning operation, no load or speed changes should be imposed from the process side. Toolkit trends can be used to monitor the behavior of different parameters.

I-gain should be reduced to a value that is lower than originally tuned, but that does not result in instability. The Derivative should be switched of by tuning it to 100.

Proportional Gain (P-gain)
Make a small change in the speed/load reference. Observe the response of the process. If little or no cycling takes place, increase the P-gain to 150% of its previous value, restore the speed/load reference to its original value and observe the process response.

After each set point change, if the process does not cycle in response to the change in speed/load reference, increase the P-gain to 150% of its previous value until cycling occurs as shown in Figure 5-21a. When this point is reached, reduce the P-gain to the previous setting (or slightly lower for extra margin in stability).

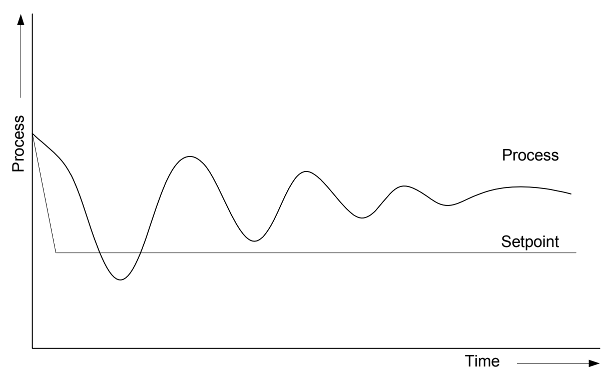


Figure 5-21a. Proportional Gain Too High Curve

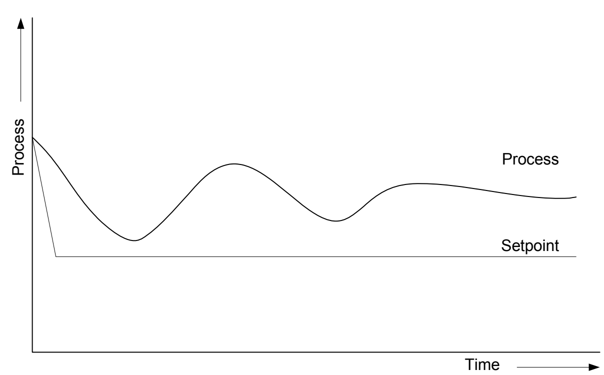


Figure 5-21b. Proportional Gain Optimum Curve

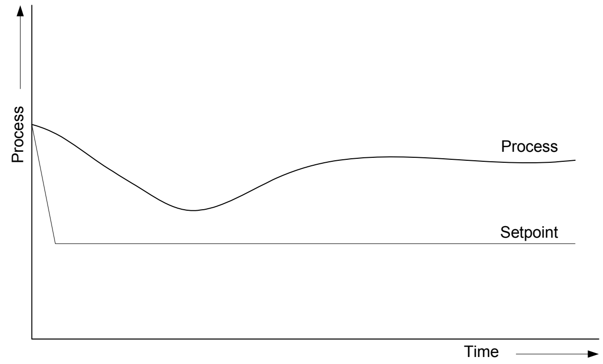


Figure 5-21c. Proportional Gain Too Low Curve

Integral Action (I-gain)

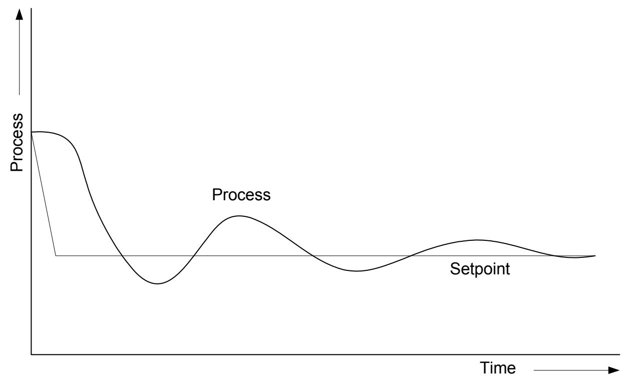


Figure 5-22a. Integral Action Too High Curve

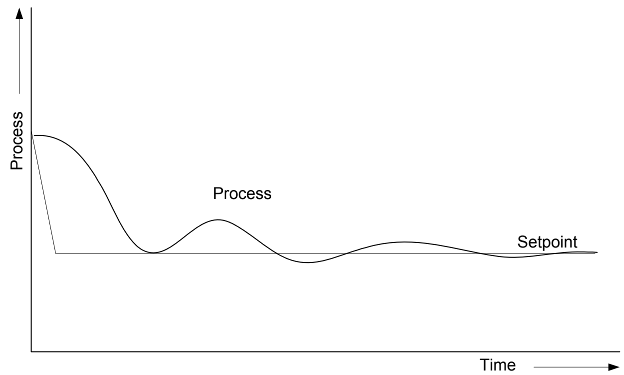


Figure 5-22b. Integral Action Optimum Curve

With the P-gain at the previously obtained in previous steps, make a change in speed/load reference and observe the recovery cycle. If there is no excessive cycling or oscillation, increase the I-gain to 150% of the original value. If there is an oscillation, reduce the value. Continue to tune until the response looks like the optimum Integral action response curve (Figure 5-22b).

Derivative Action (SDR—Speed Derivative Ratio)
With the P-gain and the I-gain previously obtained in previous steps, reduce the SDR to 50. Make a change in speed/load reference and observe the response curve. If there is no excessive cycling or oscillation, decrease the SDR to 25. Make another small change in set point and again observe the response curve. Continue this tuning by approximately halving the SDR and making small step changes to the set point, until a *Derivative action optimum response* curve is obtained (Figure 5-23b). If a setting gives a response that looks like the *Derivative action too high* curve (Figure 5-23a), increase the SDR to the previous value.

With the P-gain, I-gain and SDR adjustments at the values previously obtained, repeat previous steps starting with *Proportional Gain (P-gain)*, until controller adjustments show no further improvements. Normally it will be found that with the SDR tuned, the P-gain can be increased. After the P-gain and SDR have been optimized, the I-gain can be retuned as a final step.

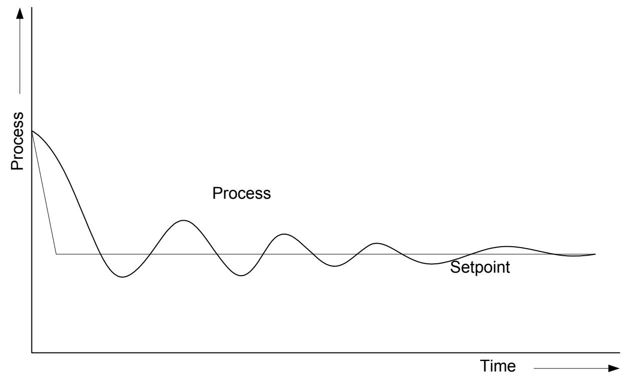


Figure 5-23a. Derivative Action Too High Curve

With the dynamics adjustments at the values previously obtained, verify adequate settings and response of the process by making a larger change in the speed/load reference and observing the process response. The desired typical response is shown in Figure 5-24.

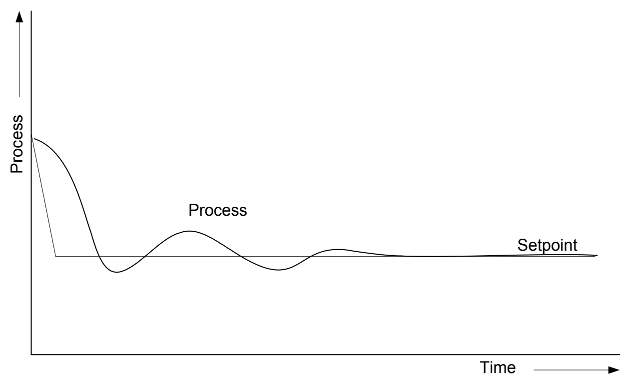


Figure 5-23b. Derivative Action Optimum Curve

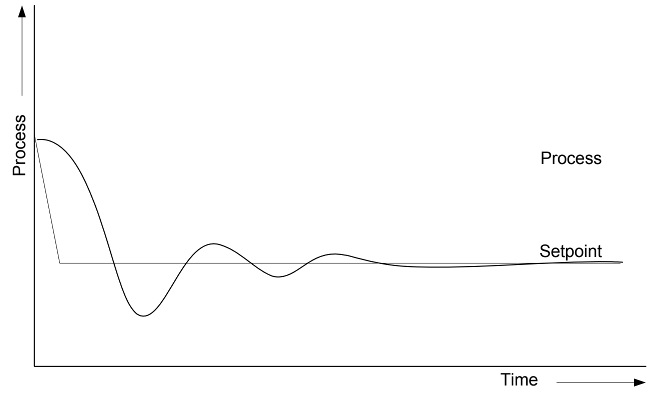


Figure 5-24. Typical Response to Speed or Load Change

Misfire Detection Calibration

Disabling ignition on individual cylinders for the purpose of calibrating misfire detection should be done on the primary side of the coils. Disconnecting the sparkplug cables when the engine is running is NOT recommended. The coil(s) can be damaged because of the high voltage that arises if the spark cannot jump! This also poses a risk of shock to personnel near the engine.

⚠WARNING	**HIGH VOLTAGE—Modern ignition systems can produce very high voltages which can be very dangerous.**

Alarm Override at Starting and Synchronization
To avoid misfire alarms during starting and synchronization misfire detection is only active above the user specified "MISFIRE INDEX PERMISSIVE".

Calibration of the Misfire Detection
Figure 5-25 shows the HMI settings for misfire detection. Misfire Detection should be calibrated to always recognize a misfire condition, but should not produce false alarms. In order to achieve this balance, the following procedure should be followed.

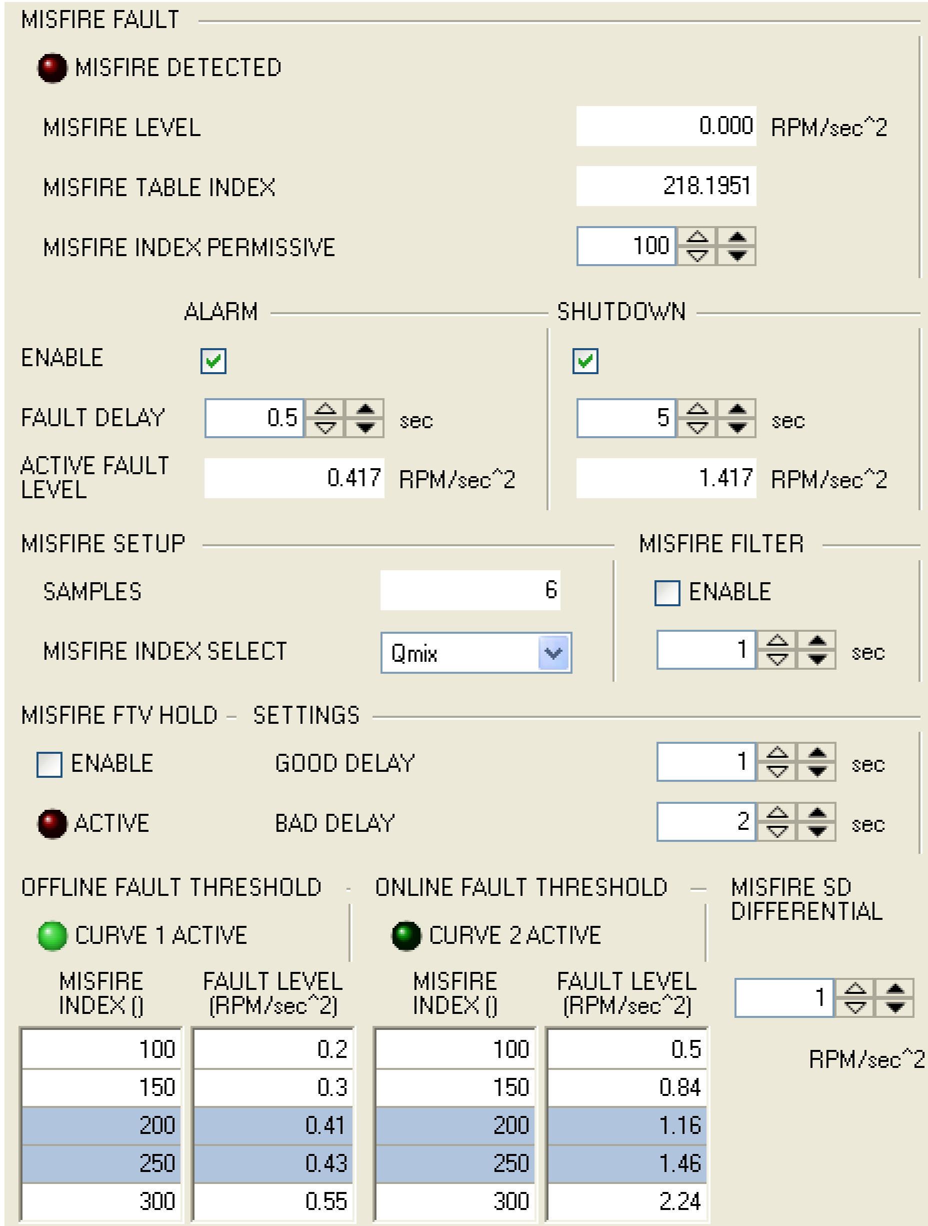


Figure 5-25. Misfire Detection HMI Settings (HMI Screen 3.1)

Misfire Alarm Table
The filtered speed derivative signal changes in response to engine load. When the engine is operating normally (no misfire, normal A/F ratio etc.) a baseline curve of filtered speed irregularity versus engine load is defined. When the speed irregularity signal is at or below this curve, this is interpreted as no misfire. During misfire calibration it must be determined how far the speed irregularity signal may go above this baseline before triggering an alarm. The speed irregularity vs. Load table for triggering a misfire alarm on the ToolKit misfire screen allows the user to adjust different alarm levels for different levels of Load.

The alarm is disabled below an adjustable load level. This to avoid spurious alarms, as the speed irregularity signal to noise ratio is poorer at low load.

In Figure 5-26 the linear relationship between the misfire signal and a changing load can be seen. The speed irregularity signal is the baseline for normal operation and is determined at the different load points. The Alarm Line is the allowed speed irregularity above the baseline.

Before starting the calibration it is recommended to override the misfire alarms. The ability to adjust load on the engine between 0 and 100% is required for this procedure.

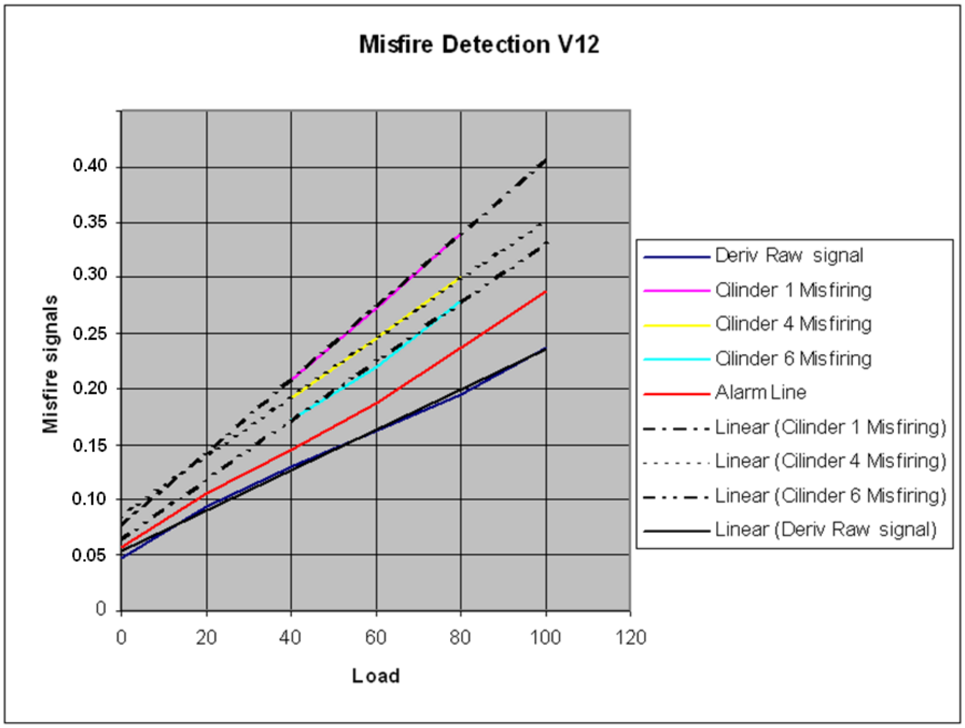


Figure 5-26. Misfire Detection Curves

Misfire Filter Value
The speed derivative signal is filtered to tune misfire detection sensitivity to “noise”. The default value of 0.2 s should be a good starting point. When the filter time constant is too high, the responsiveness of the misfire detection it will be reduced. The filter time (Tau) applies to a second order filter.

Minimum Load for Misfire Detection
The engine should be cycled through several starts and stops to check if false misfires are detected during starting and stopping. The idle, running, and synchronization modes should also be checked. The minimum Load for misfire detection should be adjusted during these checks if misfire is indicated at lower loads but is not really occurring.

Misfire Samples
The recommended setting for the number of samples parameter (“Samples = Number of Cyls”) is the number of cylinders of the engine. If desired, the setting can be fine tuned by trial and error. The maximum value is 16.

Alarm Delay
Figure 5-25 shows the HMI user setting for misfire alarm delay. The alarm delay should be tuned to avoid false misfire detection during transients.

Control Response to Misfire Detection

The response of the E3 controller to misfire detection is user configurable. There will always be an alarm. At the user's option, a shutdown on misfire detection can be selected by checking the box under "Shutdown". If shutdown is not selected, closed loop will be disabled and the E3 controller will run in open loop mode.

Chapter 6.
Diagnostics

Introduction

To facilitate troubleshooting problems in the system and to protect the engine, all the critical parameters are monitored via diagnostics logic.

There are three possible reactions of the E3 to a diagnostic event:
- Alarm with no derate
- Alarm with derate
- Shutdown

Below is a listing of all the alarms and shutdowns in numerical order. The faults can be overridden by the user if desired via the HMI, if communication with the control is established at or above the required password level. It is also possible to configure the control response to the different diagnostic events.

All the alarms and shutdowns are latching. This means that on the occurrence of a diagnostic event, the controller will record this information and keep the alarm/shutdown active, until it receives a reset command and the cause for the event has been removed.

Resets for the alarms can be commanded with the engine running; shutdowns can only be reset after the engine is stopped.

Table 6-1 is a full listing of alarms and shutdowns. The HMI alarm and shutdown screens are shown in Figures 6-1 through 6-5.

Table 6-1. E3 System Alarms

FAULT	FLASH ID	FMI	SPN	EMISSIONS?
AL5 LOSS OF POWER	111	18	168	FALSE
SD5 LOSS OF POWER	112	31	168	FALSE
AL10 SYSTEM RICH	113	16	1119	TRUE
AL15 SYSTEM LEAN	114	18	1119	TRUE
AL20 MAP 1 SENSOR VOLT LO	115	4	106	FALSE
AL25 MAP 1 SENSOR VOLT HI	116	3	106	FALSE
AL30 MAP 2 SENSOR VOLT LO	117	4	3562	FALSE
AL35 MAP 2 SENSOR VOLT HI	118	3	3562	FALSE
AL40 MAP SENSOR FAILURE	119	2	3563	TRUE
SD40 MAP SENSOR FAILURE	121	12	3563	TRUE
SD70 SPEED SENSOR CONFIG ERR	122	13	190	FALSE
AL71 CAM SENSOR FAIL	123	2	723	FALSE
SD71 CAM SENSOR FAIL	124	11	723	FALSE
SD72 CRANK SENSOR FAIL	125	2	190	FALSE
AL73 CRANK SPEED TOO LOW	126	17	1675	FALSE
AL74 CRANK SPEED TOO HIGH	127	15	1675	FALSE
AL75 MAX TIMING ERROR EXCEEDED	128	15	723	FALSE
SD75 MAX TIMING ERROR EXCEEDED	129	16	723	FALSE
AL76 CAM/CRK SYNC ERROR	131	7	723	FALSE

FAULT	FLASH ID	FMI	SPN	EMISSIONS?
SD76 CAM/CRK SYNC ERROR	132	0	723	FALSE
SD80 ENGINE OVERSPEED DETECTED	133	0	190	FALSE
SD81 ENGINE STALLED	134	1	190	FALSE
AL82 CLOSED-LOOP ERROR	135	16	4240	TRUE
SD82 CLOSED-LOOP ERROR	136	0	4240	TRUE
AL83 POST HEGO 15 MIN AVG EXCURSION	137	14	3235	TRUE
SD83 POST HEGO 15 MIN AVG EXCURSION	138	13	3235	TRUE
AL84 UNREQUESTED OPEN-LOOP	139	18	4240	TRUE
SD84 UNREQUESTED OPEN-LOOP	141	1	4240	TRUE
AL85 PRE-CAT BACKUP MODE ACTIVATED	142	17	4240	TRUE
SD85 PRE-CAT BACKUP MODE ACTIVATED	143	15	4240	TRUE
AL86 PRE-CAT TRIM HIGH LIMIT	144	3	4236	TRUE
SD86 PRE-CAT TRIM HIGH LIMIT	145	5	4236	TRUE
AL87 PRE-CAT TRIM LOW LIMIT	146	4	4236	TRUE
SD87 PRE-CAT TRIM LOW LIMIT	147	6	4236	TRUE
AL88 POST-CAT TRIM HIGH LIMIT	148	3	3235	TRUE
SD88 POST-CAT TRIM HIGH LIMIT	149	5	3235	TRUE
AL89 POST-CAT TRIM LOW LIMIT	151	4	3235	TRUE
SD89 POST-CAT TRIM LOW LIMIT	152	6	3235	TRUE
AL90 BANK BALANCE HIGH LIMIT	153	0	0	TRUE
SD90 BANK BALANCE HIGH LIMIT	154	0	0	TRUE
AL91 BANK BALANCE LOW LIMIT	155	0	0	TRUE
SD91 BANK BALANCE LOW LIMIT	156	0	0	TRUE
AL98 LOAD INPUT VOLT LO	157	4	2452	FALSE
SD98 LOAD INPUT VOLT LO	158	6	2452	FALSE
AL100 LOAD INPUT VOLT HI	159	3	2452	FALSE
SD100 LOAD INPUT VOLT HI	161	5	2452	FALSE
AL102 MAT 1 SENSOR VOLT LO	162	4	105	FALSE
AL103 MAT 1 SENSOR VOLT HI	163	3	105	FALSE
AL105 MAT 2 SENSOR VOLT LO	164	4	1131	FALSE
AL106 MAT 2 SENSOR VOLT HI	165	3	1131	FALSE
AL110 MAT SENSOR FAILURE	166	2	105	TRUE
SD110 MAT SENSOR FAILURE	167	12	105	TRUE
AL111 LOT SENSOR VOLT LO	168	4	175	FALSE
SD111 LOT SENSOR VOLT LO	169	6	175	FALSE
AL112 LOT SENSOR VOLT HI	171	3	175	FALSE
SD112 LOT SENSOR VOLT HI	172	5	175	FALSE
AL113 ECT SENSOR VOLT LO	173	4	110	FALSE
SD113 ECT SENSOR VOLT LO	174	6	110	FALSE
AL114 ECT SENSOR VOLT HI	175	3	110	FALSE
SD114 ECT SENSOR VOLT HI	176	5	110	FALSE
AL115 LUBE OIL SENSOR VOLT LO	177	4	100	FALSE
SD115 LUBE OIL SENSOR VOLT LO	178	6	100	FALSE
AL116 LUBE OIL SENSOR VOLT HI	179	3	100	FALSE

FAULT	FLASH ID	FMI	SPN	EMISSIONS?
SD116 LUBE OIL SENSOR VOLT HI	181	5	100	FALSE
AL117 CAT DIFF SENSOR VOLT LO	182	4	4291	FALSE
SD117 CAT DIFF SENSOR VOLT LO	183	6	4291	FALSE
AL118 CAT DIFF SENSOR VOLT HI	184	3	4291	TRUE
SD118 CAT DIFF SENSOR VOLT HI	185	5	4291	TRUE
AL119 PRE-CAT PRESS SENSOR VOLT LO	186	4	1209	TRUE
SD119 PRE-CAT PRESS SENSOR VOLT LO	187	6	1209	TRUE
AL120 PRE-CAT PRESS SENSOR VOLT HI	188	3	1209	TRUE
SD120 PRE-CAT PRESS SENSOR VOLT HI	189	5	1209	TRUE
AL121 POST-CAT PRESS SENSOR VOLT LO	191	0	0	TRUE
SD121 POST-CAT PRESS SENSOR VOLT LO	192	0	0	TRUE
AL122 POST-CAT PRESS SENSOR VOLT HI	193	0	0	TRUE
SD122 POST-CAT PRESS SENSOR VOLT HI	194	0	0	TRUE
AL123 PRE-CAT TEMP SENSOR VOLT LO	195	4	4289	TRUE
SD123 PRE-CAT TEMP SENSOR VOLT LO	196	6	4289	TRUE
AL124 PRE-CAT TEMP SENSOR VOLT HI	197	3	4289	TRUE
SD124 PRE-CAT TEMP SENSOR VOLT HI	198	5	4289	TRUE
AL125 POST-CAT TEMP SENSOR VOLT LO	199	4	4290	TRUE
SD125 POST-CAT TEMP SENSOR VOLT LO	211	6	4290	TRUE
AL126 POST-CAT TEMP SENSOR VOLT HI	212	3	4290	TRUE
SD126 POST-CAT TEMP SENSOR VOLT HI	213	5	4290	TRUE
AL141 MAT1 H	214	15	105	FALSE
SD142 MAT1 HH	215	0	105	FALSE
AL143 MAT1 H DERATE	216	16	105	FALSE
AL151 MAT2 H	217	15	1131	FALSE
SD152 MAT2 HH	218	0	1131	FALSE
AL153 MAT2 H DERATE	219	16	1131	FALSE
AL161 ECT H	221	15	110	FALSE
SD162 ECT HH	222	0	110	FALSE
AL163 ECT H DERATE	223	16	110	FALSE
AL166 LOT H	224	15	175	FALSE
SD167 LOT HH	225	0	175	FALSE

FAULT	FLASH ID	FMI	SPN	EMISSIONS?
AL171 BALANCE DIFFERENTIAL H	226	0	0	TRUE
SD172 BALANCE DIFFERENTIAL HH	227	0	0	TRUE
AL175 MAP 1 H	228	15	106	FALSE
SD176 MAP 1 HH	229	0	106	FALSE
AL178 MAP 2 H	231	15	3562	FALSE
SD179 MAP 2 HH	232	0	3562	FALSE
AL195 REM REF INPUT VOLT LO	233	4	898	FALSE
SD195 REM REF INPUT VOLT LO	234	6	898	FALSE
AL200 REM REF INPUT VOLT HI	235	3	898	FALSE
SD200 REM REF INPUT VOLT HI	236	5	898	FALSE
AL205 TPS 1 INPUT VOLT LO	237	4	51	TRUE
SD205 TPS 1 INPUT VOLT LO	238	6	51	TRUE
AL210 TPS 1 INPUT VOLT HI	239	3	51	TRUE
SD210 TPS 1 INPUT VOLT HI	241	5	51	TRUE
AL215 TPS 2 INPUT VOLT LO	242	4	4233	TRUE
SD215 TPS 2 INPUT VOLT LO	243	6	4233	TRUE
AL220 TPS 2 INPUT VOLT HI	244	3	4233	TRUE
SD220 TPS 2 INPUT VOLT HI	245	5	4233	TRUE
AL225 FTPS 1 INPUT VOLT LO	246	4	3673	TRUE
SD225 FTPS 1 INPUT VOLT LO	247	6	3673	TRUE
AL226 FTPS 1 INPUT VOLT HI	248	3	3673	TRUE
SD226 FTPS 1 INPUT VOLT HI	249	5	3673	TRUE
AL227 FTPS 2 INPUT VOLT LO	251	4	4238	TRUE
SD227 FTPS 2 INPUT VOLT LO	252	6	4238	TRUE
AL228 FTPS 2 INPUT VOLT HI	253	3	4238	TRUE
SD228 FTPS 2 INPUT VOLT HI	254	5	4238	TRUE
AL230 5 VOLT SUPPLY XDRP A LO	255	4	3509	FALSE
AL240 5 VOLT SUPPLY XDRP A HI	256	3	3509	FALSE
AL250 5 VOLT SUPPLY XDRP B LO	257	4	3510	FALSE
AL260 5 VOLT SUPPLY XDRP B HI	258	3	3510	FALSE
AL261 14V SUPPLY VOLT LO	259	4	3597	FALSE
AL262 14V SUPPLY VOLT HI	261	3	3597	FALSE
AL263 LS 05 WIRING FAULT	262	0	0	FALSE
AL264 LS 06 WIRING FAULT	263	0	0	FALSE
AL265 LS 07 WIRING FAULT	264	0	0	FALSE
AL266 LS 08 WIRING FAULT	265	0	0	FALSE
AL267 LS 09 WIRING FAULT	266	0	0	FALSE
AL268 LS 10 WIRING FAULT	267	0	0	FALSE
AL275 MPRD WIRING FAULT	268	0	0	FALSE
SD310 CAN1 RX TX ERROR	269	2	639	FALSE
AL311 CAN2 RX TX ERROR	271	2	1231	FALSE
SD320 CAN1 HARDWARE FAULT	272	31	639	FALSE
AL321 CAN2 HARDWARE FAULT	273	31	1231	FALSE
SD330 SUPPLY VOLT LO	274	1	168	FALSE
SD340 SUPPLY VOLT HI	275	0	168	FALSE
AL350 SPD BIAS INPUT VOLT LO	276	4	3938	FALSE
AL360 SPD BIAS INPUT VOLT HI	277	3	3938	FALSE
AL365 SPEED BIAS PWM FAULT	278	8	3938	FALSE

FAULT	FLASH ID	FMI	SPN	EMISSIONS?
AL370 MISFIRE DETECTED AL	279	16	3387	TRUE
SD380 MISFIRE DETECTED SD	281	0	3387	TRUE
AL440 MAX FUEL / ENGINE OVERLOAD	282	0	3464	FALSE
AL441 LO POWER	283	1	3464	FALSE
SD442 UNCONTROLLED OVERPOWER	284	20	3464	FALSE
AL443 CAT DIFF PRESSURE H	285	15	4291	TRUE
SD444 CAT DIFF PRESSURE HH	286	0	4291	TRUE
AL445 CAT DIFF PRESSURE L	287	17	4291	TRUE
SD446 CAT DIFF PRESSURE LL	288	1	4291	TRUE
AL447 PRE-CAT PRESSURE H	289	15	1209	TRUE
SD448 PRE-CAT PRESSURE HH	291	0	1209	TRUE
AL449 POST-CAT PRESSURE H	292	0	0	TRUE
SD450 POST-CAT PRESSURE HH	293	0	0	TRUE
AL451 PRE-CAT TEMP H	294	15	4289	TRUE
SD452 PRE-CAT TEMP HH	295	0	4289	TRUE
AL453 POST-CAT TEMP H	296	15	4290	TRUE
SD454 POST-CAT TEMP HH	297	0	4290	TRUE
AL455 HEGO 1 CURRENT H	298	16	3223	TRUE
SD456 HEGO 1 CURRENT HH	299	0	3223	TRUE
AL457 HEGO 3 CURRENT H	311	16	3262	TRUE
SD458 HEGO 3 CURRENT HH	312	0	3262	TRUE
AL470 PRE-CAT TEMP L	313	17	4289	TRUE
SD475 PRE-CAT TEMP LL	314	1	4289	TRUE
AL485 LUBE OIL PRESS L	315	17	100	FALSE
SD486 LUBE OIL PRESS LL	316	1	100	FALSE
AL487 LUBE OIL PRESS L DERATE	317	18	100	FALSE
AL490 LUBE OIL LVL L	318	17	98	FALSE
SD491 LUBE OIL LVL LL	319	1	98	FALSE
AL492 LUBE OIL LVL L DERATE	321	18	98	FALSE
AL495 COOLING WATER LVL L	322	17	111	FALSE
SD496 COOLING WATER LVL LL	323	1	111	FALSE
AL497 COOLING WATER LVL L DERATE	324	18	111	FALSE
SD498 EXTERNAL SD 1 ACTIVE	325	31	701	FALSE
SD499 EXTERNAL SD 2 ACTIVE	326	31	702	FALSE
AL550 HEGO 1 VOLT LO	327	4	3217	TRUE
SD550 HEGO 1 VOLT LO	328	6	3217	TRUE
AL555 HEGO 1 VOLT HI	329	3	3217	TRUE
SD555 HEGO 1 VOLT HI	331	5	3217	TRUE
AL560 HEGO 1 SENSOR FAILED	332	13	3217	TRUE
SD560 HEGO 1 SENSOR FAILED	333	12	3217	TRUE
AL561 HEGO 1 HEATER OPEN CIRCUIT	334	5	3223	TRUE
AL565 HEGO 2 VOLT LO	335	4	3256	TRUE
SD565 HEGO 2 VOLT LO	336	6	3256	TRUE
AL570 HEGO 2 VOLT HI	337	3	3256	TRUE
SD570 HEGO 2 VOLT HI	338	5	3256	TRUE

SENSOR SD
- SD40 MAP SENSOR FAILURE
- SD70 SPEED SENSOR CONFIG ERR
- SD98 LOAD INPUT VOLTAGE LO
- SD100 LOAD INPUT VOLTAGE HI
- SD110 MAT SENSOR FAILURE
- SD111 LOT SENSOR VOLT LO
- SD112 LOT SENSOR VOLT HI
- SD113 ECT SENSOR VOLT LO
- SD114 ECT SENSOR VOLT HI
- SD115 LUBE OIL SENSOR VOLT LO
- SD116 LUBE OIL SENSOR VOLT HI
- SD117 CAT DIFF PRS SENSOR VOLT LO
- SD118 CAT DIFF PRS SENSOR VOLT HI
- SD119 PRE-CAT PRS SENSOR VOLT LO
- SD120 PRE-CAT PRS SENSOR VOLT HI

SENSOR SD
- SD121 POST-CAT PRS SENSOR VOLT LO
- SD122 POST-CAT PRS SENSOR VOLT HI
- SD123 PRE-CAT TEMP SENSOR VOLT LO
- SD124 PRE-CAT TEMP SENSOR VOLT HI
- SD125 POST-CAT TEMP SENSOR VOLT LO
- SD126 POST-CAT TEMP SENSOR VOLT HI
- SD195 REM REF INPUT VOLT LO
- SD200 REM REF INPUT VOLT HI
- SD205 TPS 1 INPUT VOLT LO
- SD210 TPS 1 INPUT VOLT HI
- SD215 TPS 2 INPUT VOLT LO
- SD220 TPS 2 INPUT VOLT HI
- SD225 FTPS 1 INPUT VOLT LO
- SD226 FTPS 1 INPUT VOLT HI
- SD227 FTPS 2 INPUT VOLT LO
- SD228 FTPS 2 INPUT VOLT HI

SENSOR SD
- SD550 HEGO 1 VOLT LO
- SD555 HEGO 1 VOLT HI
- SD560 HEGO 1 SENSOR FAILED
- SD565 HEGO 2 VOLT LO
- SD570 HEGO 2 VOLT HI
- SD575 HEGO 2 SENSOR FAILED
- SD580 HEGO 3 VOLT LO
- SD585 HEGO 3 VOLT HI
- SD590 HEGO 3 SENSOR FAILED

Figure 6-1. SD - SENSOR (HMI Screen 4.0)

E3 SD
- SD5 LOSS OF POWER
- SD80 ENGINE OVERSPEED DETECTED
- SD81 ENGINE STALLED
- SD82 CLOSED-LOOP ERROR
- SD83 POST-CAT 15 MIN AVG EXCURSION
- SD84 UNREQUESTED OPEN-LOOP
- SD85 PRE-CAT BACKUP MODE ACTIVATED
- SD86 PRE-CAT TRIM HIGH LIMIT
- SD87 PRE-CAT TRIM LOW LIMIT
- SD88 POST-CAT TRIM HIGH LIMIT
- SD89 POST-CAT TRIM LOW LIMIT
- SD90 BANK BALANCE HIGH LIMIT
- SD91 BANK BALANCE LOW LIMIT
- SD167 LOT HH
- SD172 MANIFOLD DIFFERENTIAL HH
- SD176 MAP 1 HH

E3 SD
- SD179 MAP 2 HH
- SD310 CAN1 CONTROLLER ERROR STATUS
- SD320 CAN1 CONTROLLER BUS OFF STATUS
- SD330 SUPPLY VOLTAGE LOW
- SD340 SUPPLY VOLTAGE HIGH
- SD380 MISFIRE DETECTED SD
- SD442 UNCONTROLLED OVERPOWER
- SD444 CAT DIFF PRESSURE HH
- SD446 CAT DIFF PRESSURE LL
- SD448 PRE-CAT PRESSURE HH
- SD450 POST-CAT PRESSURE HH
- SD452 PRE-CAT TEMP HH
- SD454 POST-CAT TEMP HH
- SD456 HEGO 1 CURRENT HH
- SD458 HEGO 3 CURRENT HH
- SD475 PRE-CAT TEMP LL

E3 SD
- SD498 EXTERNAL SD 1 ACTIVE
- SD499 EXTERNAL SD 2 ACTIVE

PCMHD SD
- SD700 RATEGROUP SLIP
- SD701 PCMHD HI TEMP
- SD702 PCMHD ROM FAULT
- SD703 PCMHD RAM FAULT

IC-92X SD
- SD1000 ERROR MISSING RING GEAR SIGNAL
- SD1001 ERROR MISSING RESET SIGNAL
- SD1002 ERROR MISSING CAMSHAFT SIGNAL
- SD1004 UNKNOWN ENGINE APPLICATION CO
- SD1005 OVERSPEED SD
- SD1006 EEPROM CHECKSUM ERROR
- SD1008 UNK GLOBAL TIMING OR ENERGY LO
- SD1010 OPEN PRIMARY RATE EXCEEDED
- SD1011 SELF-TEST SHUTDOWN

Figure 6-2. SD - GENERAL (HMI Screen 4.1)

Figure 6-3. SD/ALARM – SMART DEVICES (HMI Screen 4.2)

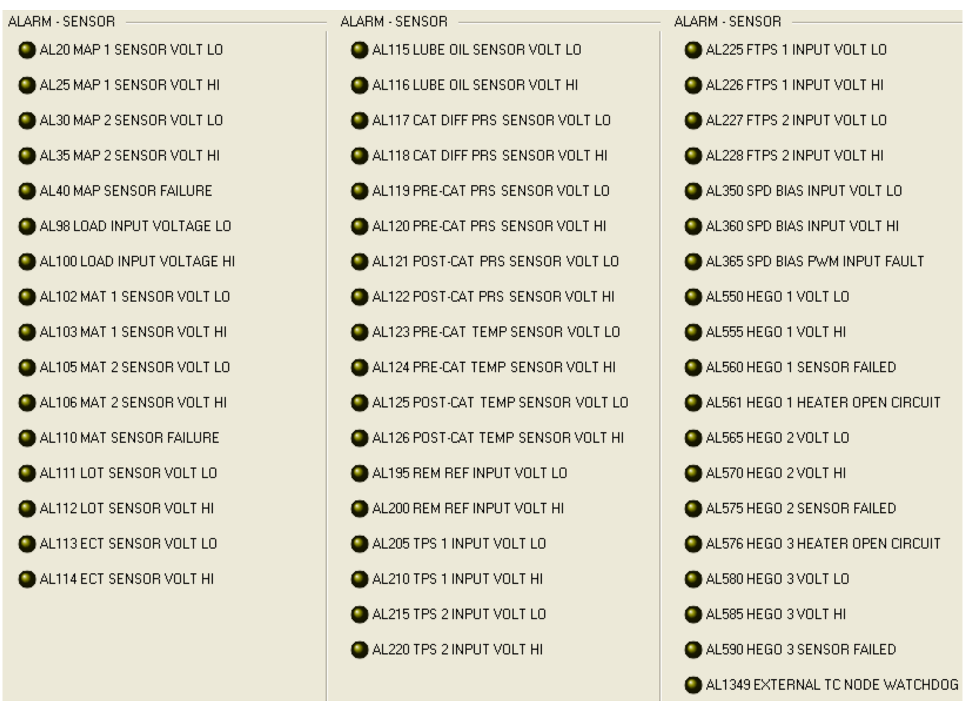


Figure 6-4. ALARM - SENSOR (HMI Screen 4.3)

Figure 6-5. ALARM – E3 (HMI Screen 4.4)

E3 System Alarms – Detailed Description

AL/SD5 LOSS OF POWER

This fault is set upon power-up; it informs the user that power has been lost.

AL10 SYSTEM RICH

The measured HEGO 3 value is compared to the setpoint. A fault occurs if the setpoint + difference is greater than the measured value for the delay time.

AL15 SYSTEM LEAN

The measured HEGO 3 value is compared to the setpoint. A fault occurs if the setpoint - difference is greater than the measured value for the delay time.

AL20 MAP 1 SENSOR VOLT LO and AL25 MAP 1 SENSOR VOLT HI

This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL30 MAP 2 SENSOR VOLT LO and AL35 MAP 2 SENSOR VOLT HI

This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD40 MAP SENSOR FAILURE

This indicates the sensor and the backup both had a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

SD70 SPEED SENSOR CONFIG ERR
This usually means the CRANK TEETH are out of range.

SD80 ENGINE OVERSPEED DETECTED
The fault is active when the speed rises above the threshold. A tunable allows the use of the Raw Speed for overspeed sensing.

AL/SD82 CLOSED-LOOP ERROR
This alarm is activated when the pre-cat HEGO sensor does not cross 450 mV for 60 seconds.

AL/SD83 POST HEGO 15 MIN AVG EXCURSION
This alarm is activated when the post-cat HEGO – setpoint is greater than the window for the delay time.

AL/SD84 UNREQUESTED OPEN-LOOP
This alarm is activated when a pre-cat HEGO sensor fault occurs after the Grace Period expires.

AL/SD85 PRE-CAT BACKUP MODE ACTIVATED
This alarm is activated when the post-cat HEGO sensor fault occurs after the Grace Period expires.

AL/SD86 PRE-CAT TRIM HIGH LIMIT
This alarm is activated when the pre-cat PID has been on the high limit for a delay time.

AL/SD87 PRE-CAT TRIM LOW LIMIT
This alarm is activated when the pre-cat PID has been on the low limit for a delay time.

AL/SD88 POST-CAT TRIM HIGH LIMIT
This alarm is activated when the post-cat PID has been on the high limit for a delay time.

AL/SD89 POST-CAT TRIM LOW LIMIT
This alarm is activated when the post-cat PID has been on the low limit for a delay time.

AL/SD90 BANK BALANCE HIGH LIMIT
This alarm is activated when the Bank Balance PID has been on the high limit for a delay time.

AL/SD91 BANK BALANCE LOW LIMIT
This alarm is activated when the Bank Balance PID has been on the low limit for a delay time.

AL/SD98 LOAD INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD100 LOAD INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL102 MAT 1 SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL103 MAT 1 SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL105 MAT 2 SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL106 MAT 2 SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD110 MAT SENSOR FAILURE
This indicates the sensor and the backup both had a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD111 LOT SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD112 LOT SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD113 ECT SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD114 ECT SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD115 LUBE OIL SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD116 LUBE OIL SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD117 CAT DIFF SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD118 CAT DIFF SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD119 PRE-CAT PRESS SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD120 PRE-CAT PRESS SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD121 POST-CAT PRESS SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD122 POST-CAT PRESS SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD123 PRE-CAT TEMP SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD124 PRE-CAT TEMP SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD125 POST-CAT TEMP SENSOR VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD126 POST-CAT TEMP SENSOR VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL141 MAT1 H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD142 MAT1 HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL143 MAT1 H DERATE
This protection derate activates when the measured value exceeded the threshold for a delay time.

AL151 MAT2 H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD152 MAT2 HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL153 MAT2 H DERATE
This protection derate activates when the measured value exceeded the threshold for a delay time.

AL161 ECT H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD162 ECT HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL163 ECT H DERATE
This protection derate activates when the measured value exceeded the threshold for a delay time.

AL166 LOT H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD167 LOT HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL171 BALANCE DIFFERENTIAL H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD172 BALANCE DIFFERENTIAL HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL175 MAP 1 H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD176 MAP 1 HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL178 MAP 2 H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD179 MAP 2 HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL/SD195 REM REF INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD200 REM REF INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD205 TPS 1 INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD210 TPS 1 INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD215 TPS 2 INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD220 TPS 2 INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD225 FTPS 1 INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD226 FTPS 1 INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD227 FTPS 2 INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL/SD228 FTPS 2 INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL230 5 VOLT SUPPLY XDRP A LO
This alarm is activated when the 5V sensor power supply exceeds the threshold for a delay time.

AL240 5 VOLT SUPPLY XDRP A HI
This alarm is activated when the 5V sensor power supply exceeds the threshold for a delay time.

AL250 5 VOLT SUPPLY XDRP B LO
This alarm is activated when the 5V sensor power supply exceeds the threshold for a delay time.

AL260 5 VOLT SUPPLY XDRP B HI
This alarm is activated when the 5V sensor power supply exceeds the threshold for a delay time.

AL261 14V SUPPLY VOLT LO
This alarm is activated when the internal 14V sensor power supply exceeds the threshold for a delay time.

AL262 14V SUPPLY VOLT HI
This alarm is activated when the internal 14V sensor power supply exceeds the threshold for a delay time.

AL263 LS 05 WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

AL264 LS 06 WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

AL265 LS 07 WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

AL266 LS 08 WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

AL267 LS 09 WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

AL268 LS 10 WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

AL275 MPRD WIRING FAULT
This alarm is activated when the Low-side driver senses an open or shorted output. If the fault occurs when the driver is energized then it is a Short Circuit. If the fault occurs when the driver is de-energized then it is an Open Circuit.

SD310 CAN1 RX TX ERROR
This fault activates when the number of RX TX Errors accumulate greater than the tunable threshold.

AL311 CAN2 RX TX ERROR
This fault activates when the number of RX TX Errors accumulate greater than the tunable threshold.

SD320 CAN1 HARDWARE FAULT
This alarm is activated when the CAN RED LED is ON; this usually indicates a network wiring issue.

AL321 CAN2 HARDWARE FAULT
This alarm is activated when the CAN RED LED is ON; this usually indicates a network wiring issue.

SD330 SUPPLY VOLT LO
This alarm is activated when the input supply voltage exceeds the tunable threshold.

SD340 SUPPLY VOLT HI
This alarm is activated when the input supply voltage exceeds the tunable threshold.

AL350 SPD BIAS INPUT VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL360 SPD BIAS INPUT VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is outside the prescribed limits for the delay time.

AL365 SPEED BIAS PWM FAULT

This indicates a sensor fault. A fault occurs when the measured Duty Cycle is outside the prescribed limits for the delay time
OR when the input frequency falls below 0.6 * tunable frequency target
OR rises above 4000 Hz.

AL370 MISFIRE DETECTED AL

This alarm is activated when MISFIRE LEVEL is greater than the tunable threshold level for a tunable delay time.

SD380 MISFIRE DETECTED SD

This shutdown is activated when MISFIRE LEVEL is greater than the tunable threshold level for a tunable delay time.

AL440 MAX FUEL / ENGINE OVERLOAD

This alarm is activated when the throttle stays at MAX FUEL LIMIT for a tunable delay time.

AL441 LO POWER

This alarm is activated when the Speed PID is greater than 95% for a tunable delay time AND the Speed Error is greater than 2% of Rated Speed.

SD442 UNCONTROLLED OVERPOWER

This alarm is activated when the load is greater than a tunable threshold AND (the PID is less than 1% OR a Throttle Position error is active.

AL443 CAT DIFF PRESSURE H

This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD444 CAT DIFF PRESSURE HH

This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL445 CAT DIFF PRESSURE L

This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD446 CAT DIFF PRESSURE LL

This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL447 PRE-CAT PRESSURE H

This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD448 PRE-CAT PRESSURE HH

This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL449 POST-CAT PRESSURE H

This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD450 POST-CAT PRESSURE HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL451 PRE-CAT TEMP H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD452 PRE-CAT TEMP HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL453 POST-CAT TEMP H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD454 POST-CAT TEMP HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL455 HEGO 1 CURRENT H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD456 HEGO 1 CURRENT HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL457 HEGO 3 CURRENT H
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD458 HEGO 3 CURRENT HH
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL470 PRE-CAT TEMP L
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD475 PRE-CAT TEMP LL
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL485 LUBE OIL PRESS L
This protection alarm activates when the measured value exceeded the threshold for a delay time.

SD486 LUBE OIL PRESS LL
This protection shutdown activates when the measured value exceeded the threshold for a delay time.

AL487 LUBE OIL PRESS L DERATE
This protection derate alarm activates when the measured value exceeded the threshold for a delay time.

AL490 LUBE OIL LVL L
This protection alarm activates when the input is active for a delay time.

SD491 LUBE OIL LVL LL
This protection shutdown activates when the input is active for a delay time.

AL492 LUBE OIL LVL L DERATE
This protection derate activates when the input is active for a delay time.

AL495 COOLING WATER LVL L
This protection alarm activates when the input is active for a delay time.

SD496 COOLING WATER LVL LL
This protection shutdown activates when the input is active for a delay time.

AL497 COOLING WATER LVL L DERATE
This protection derate activates when the input is active for a delay time.

SD498 EXTERNAL SD 1 ACTIVE
This protection shutdown activates when the input is active for a delay time.

SD499 EXTERNAL SD 2 ACTIVE
This protection shutdown activates when the input is active for a delay time.

AL/SD550 HEGO 1 VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is lower than the prescribed limits for the delay time.

AL/SD555 HEGO 1 VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is higher than the prescribed limits for the delay time.

AL/SD560 HEGO 1 SENSOR FAILED
This indicates a sensor fault. A fault occurs when the measured voltage resides in the tunable window for the tunable delay time.

AL561 HEGO 1 HEATER OPEN CIRCUIT
This alarm is activated when the current measured in HEGO 1 Heater is below the tunable threshold while the heater is active.

AL/SD565 HEGO 2 VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is lower than the prescribed limits for the delay time.

AL/SD570 HEGO 2 VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is higher than the prescribed limits for the delay time.

AL/SD575 HEGO 2 SENSOR FAILED
This indicates a sensor fault. A fault occurs when the measured voltage resides in the tunable window for the tunable delay time.

AL576 HEGO 3 HEATER OPEN CIRCUIT
This alarm is activated when the current measured in HEGO 3 Heater is below the tunable threshold while the heater is active.

AL/SD580 HEGO 3 VOLT LO
This indicates a sensor fault. A fault occurs when the measured voltage is lower than the prescribed limits for the delay time.

AL/SD585 HEGO 3 VOLT HI
This indicates a sensor fault. A fault occurs when the measured voltage is higher than the prescribed limits for the delay time.

AL/SD590 HEGO 3 SENSOR FAILED
This indicates a sensor fault. A fault occurs when the measured voltage resides in the tunable window for the tunable delay time.

SD700 RATEGROUP SLIP
This alarm is activated when a serious E3 Controller problem exists; please call Woodward if this occurs.

SD701 PCMHD HI TEMP
This alarm is activated when the internal electronics temperature has exceeded its limit.

SD702 PCMHD ROM FAULT
This alarm is activated when a serious E3 Controller problem exists; please call Woodward if this occurs.

SD703 PCMHD RAM FAULT
This alarm is activated when a serious E3 Controller problem exists; please call Woodward if this occurs.

AL704 EE BACKUP FAULT
This alarm is activated when the backup EEPROM calibration memory is corrupted; please call Woodward if this occurs.

SD1000 ERROR MISSING RING GEAR SIG
This alarm is activated from the IC-92X and indicates activity on the Reset pin and Cam pin but no ring gear signals.

SD1001 ERROR MISSING RESET SIGNAL
This alarm is activated from the IC-92X and indicates activity on the ring gear and Cam pin but no Reset pin signals.

SD1002 ERROR MISSING CAMSHAFT SIGNAL
This alarm is activated from the IC-92X and indicates activity on the Reset pin and ring gear but no Cam pin signals.

SD1004 UNKNOWN ENGINE APP CODE
This alarm is activated from the IC-92X and indicates a problem when control booted-up.

SD1005 IC-92X OVERSPEED SD
This alarm is activated from the IC-92X, please note that all IC shutdowns can only be reset by cycling power on the IC-92X itself and then activating a Fault Reset from the E3.

SD1006 EEPROM CHECKSUM ERROR
This alarm is activated from the IC-92X and indicates an internal problem, please contact Woodward if this occurs.

AL1007 GLOBAL TIMING OUT OF RANGE

This alarm is activated from the IC-92X and indicates that it is receiving CAN signals but they are out of its limit range. Please check the IC timing limit (which are still active in CAN mode) or the E3 command to ensure they are the correct range.

SD1008 UNKNOWN TIMING OR ENERGY LVL

This alarm is activated from the IC-92X and indicates that it is set to receive CAN signals but no messages are coming from the E3.

AL1009 INDV TIMING OUT OF RANGE

This alarm is activated from the IC-92X and indicates that it is receiving CAN signals but at least one individual offset is out of its limit range. Please check the IC timing limit (which are still active in CAN mode) or the E3 command to ensure all cylinders are in the correct range.

SD1010 OPEN PRIMARY RATE EXCEEDED

This alarm is activated from the IC-92X and indicates that the primary open signal rate has exceeded its fault threshold.

SD1011 IC-92X SELF-TEST SHUTDOWN

This alarm is activated from the IC-92X and indicates that it is in Self-Test mode.

AL1012 OPEN PRIMARY CHANNEL 1

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 1.

AL1013 OPEN PRIMARY CHANNEL 2

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 2.

AL1014 OPEN PRIMARY CHANNEL 3

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 3.

AL1015 OPEN PRIMARY CHANNEL 4

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 4.

AL1016 OPEN PRIMARY CHANNEL 5

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 5.

AL1017 OPEN PRIMARY CHANNEL 6

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 6.

AL1018 OPEN PRIMARY CHANNEL 7

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 7.

AL1019 OPEN PRIMARY CHANNEL 8

This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 8.

AL1020 OPEN PRIMARY CHANNEL 9
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 9.

AL1021 OPEN PRIMARY CHANNEL 10
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 10.

AL1022 OPEN PRIMARY CHANNEL 11
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 11.

AL1023 OPEN PRIMARY CHANNEL 12
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 12.

AL1024 OPEN PRIMARY CHANNEL 13
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 13.

AL1025 OPEN PRIMARY CHANNEL 14
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 14.

AL1026 OPEN PRIMARY CHANNEL 15
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 15.

AL1027 OPEN PRIMARY CHANNEL 16
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 16.

AL1028 OPEN PRIMARY CHANNEL 17
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 17.

AL1029 OPEN PRIMARY CHANNEL 18
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 18.

AL1030 OPEN PRIMARY CHANNEL 19
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 19.

AL1031 OPEN PRIMARY CHANNEL 20
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 20.

AL1032 OPEN PRIMARY CHANNEL 21
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 21.

AL1033 OPEN PRIMARY CHANNEL 22
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 22.

AL1034 OPEN PRIMARY CHANNEL 23
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 23.

AL1035 OPEN PRIMARY CHANNEL 24
This alarm is activated from the IC-92X and indicates that it is sensing a open primary on channel 24.

AL1037 SCR FAULT ODD
This alarm is activated from the IC-92X and indicates an internal component problem, please contact Woodward if this occurs.

AL1038 SCR FAULT EVEN
This alarm is activated from the IC-92X and indicates an internal component problem, please contact Woodward if this occurs.

AL1045 ODD ENERGY LVL OUT OF RANGE
This alarm is activated from the IC-92X and indicates that it is receiving CAN signals but the ODD ENERGY signal is out of range.

AL1046 EVEN ENERGY LVL OUT OF RANGE
This alarm is activated from the IC-92X and indicates that it is receiving CAN signals but the EVEN ENERGY signal is out of range.

SD1300 THROTTLE 1 SHUTDOWN
This fault is activated when the selected Throttle 1 has reported a Shutdown. If the throttle is configured as a PWM out, the THROTTLE 1 OK Discrete input can be configured as the Shutdown indicator. If the throttle is configured for CAN then the Shutdown was reported over the CAN link.

AL1301 THROTTLE 1 ALARM
This fault is activated when the selected Throttle 1 has reported an alarm. If the throttle is configured as a PWM out, the THROTTLE 1 OK Discrete input can be configured as the Alarm indicator. If the throttle is configured for CAN then the Alarm was reported over the CAN link.

AL/SD1305 THROTTLE 1 POSITION ERROR
This fault is activated when the selected Throttle 1 has developed a position error. If the throttle is configured as a PWM out, the TPS 1 Input can be used to determine the position error. If the throttle is configured for CAN then the Alarm was reported over the CAN link, in addition a hardwire TPS 1 can be used.

SD1308 THROTTLE 1 WATCHDOG CAN TIMEOUT
This fault is activated when only when throttle is configured for CAN and no messages for the timeout period have been received.

SD1310 THROTTLE 2 SHUTDOWN
This fault is activated when the selected Throttle 2 has reported a Shutdown. If the throttle is configured as a PWM out, the THROTTLE 2 OK Discrete input can be configured as the Shutdown indicator. If the throttle is configured for CAN then the Shutdown was reported over the CAN link.

AL1311 THROTTLE 2 ALARM
This fault is activated when the selected Throttle 2 has reported an alarm. If the throttle is configured as a PWM out, the THROTTLE 2 OK Discrete input can be configured as the Alarm indicator. If the throttle is configured for CAN then the Alarm was reported over the CAN link.

AL/SD1315 THROTTLE 2 POSITION ERROR

This fault is activated when the selected Throttle 2 has developed a position error. If the throttle is configured as a PWM out, the TPS 2 Input can be used to determine the position error. If the throttle is configured for CAN then the Alarm was reported over the CAN link, in addition a hardwire TPS 2 can be used instead.

SD1318 THROTTLE 2 WATCHDOG CAN TIMEOUT

This fault is activated when only when throttle is configured for CAN and no messages for the timeout period have been received.

SD1320 FTV 1 SHUTDOWN

This alarm is activated when the selected FTV 1 has reported a Shutdown. If the throttle is configured as a PWM out, the FTV 1 OK Discrete input can be configured as the Shutdown indicator. If the throttle is configured for CAN then the Shutdown was reported over the CAN link.

AL1321 FTV 1 ALARM

This fault is activated when the selected FTV 1 has reported an alarm. If the throttle is configured as a PWM out, the FTV 1 OK Discrete input can be configured as the Alarm indicator. If the throttle is configured for CAN then the Alarm was reported over the CAN link.

AL/SD1325 FTV 1 POSITION ERROR

This fault is activated when the selected FTV 1 has developed a position error. If the FTV is configured as a PWM out, the FTPS 1 Input can be used to determine the position error. If the throttle is configured for CAN then the Alarm was reported over the CAN link, in addition a hardwire FTPS 1 can be used instead.

SD1328 FTV 1 WATCHDOG CAN TIMEOUT

This fault is activated when only when FTV is configured for CAN and no messages for the timeout period have been received.

SD1330 FTV 2 SHUTDOWN

This alarm is activated when the selected FTV 1 has reported a Shutdown. If the throttle is configured as a PWM out, the FTV 1 OK Discrete input can be configured as the Shutdown indicator. If the throttle is configured for CAN then the Shutdown was reported over the CAN link.

AL1331 FTV 2 ALARM

This fault is activated when the selected FTV 2 has reported an alarm. If the throttle is configured as a PWM out, the FTV 2 OK Discrete input can be configured as the Alarm indicator. If the throttle is configured for CAN then the Alarm was reported over the CAN link.

AL/SD1335 FTV 2 POSITION ERROR

This fault is activated when the selected FTV 2 has developed a position error. If the FTV is configured as a PWM out, the FTPS 2 Input can be used to determine the position error. If the throttle is configured for CAN then the Alarm was reported over the CAN link, in addition a hardwire FTPS 2 can be used instead.

SD1338 FTV 2 WATCHDOG CAN TIMEOUT

This fault is activated when only when FTV is configured for CAN and no messages for the timeout period have been received.

AL1348 IGNITION CAN WATCHDOG TIMEOUT
This fault is activated when the IC-92X is selected for J1939 CAN and no messages have been received for the timeout period (10 seconds)

AL1349 TC NODE WATCHDOG CAN TIMEOUT
This fault is activated when the IC-92X is selected for J1939 CAN and no messages have been received for the timeout period (10 seconds)

AL1450 EASYGEN J1939 TIMEOUT
This fault is activated when the IC-92X is selected for J1939 CAN and no messages have been received for the timeout period (10 seconds)

AL1451 EASYGEN STOP COMMAND
This is not an alarm, if an easYgen Stop Signal is sensed then the command is latched until the engine stops. The event shows up in the FAULT LOG.

AL1460 MODBUS LINK ERROR
If a Modbus Link Error (tunable timeout) occurs during Modbus operation, this fault is latched.

AL1461 MODBUS EXCEPTION ERROR
If a Modbus Exception Error occurs during Modbus operation, this fault is latched.

Fault Log

Figure 6-6 shows the Service Tool Fault Log. This list gives an overview of the alarms that are active or have been active in the past. The following columns give relevant information:

GRID DISPLAY
The FAULT LOG displays the faults in a grid format with columns: FLASH ID, FAULT, COUNT, FAULT STATE, EMISSIONS FAULT, EMISSIONS ACTIVE, and RUN HOURS.

FLASH ID COLUMN
The FLASH ID column displays a unique identifier that corresponds to the MIL FLASH CODE if enabled.

FAULT COLUMN
The FAULT column displays the Fault description.

COUNT COLUMN
The COUNT column displays the number of times the fault has reoccurred without being removed from the FAULT LOG.

FAULT STATE COLUMN
The FAULT STATE column displays the current state of the latched fault INACTIVE/ACTIVE.

EMISSIONS FAULT COLUMN
The EMISSIONS FAULT column displays whether or not the fault is an emissions related fault.

EMISSIONS ACTIVE COLUMN
The EMISSIONS ACTIVE column indicates TRUE if the fault is emissions related and ACTIVE.

RUN HOURS COLUMN
The RUN HOURS column displays the engine RUN HOURS at the time of the fault.

RESET INDIVIDUAL
Click this momentary button to clear selected INACTIVE faults from the FAULT LOG.

RESET ALL
Click this momentary button to clear all INACTIVE faults from the FAULT LOG.

EXPORT
Click this momentary button to save the FAULT LOG to a text file.

FAULT RESET
Click this momentary button to send a fault reset pulse, all cleared ALARMS will clear. The engine must be stopped to reset SHUTDOWNs.

FIRST OUT SHUTDOWN
Text readout indicating the description of the first shutdown to trigger.

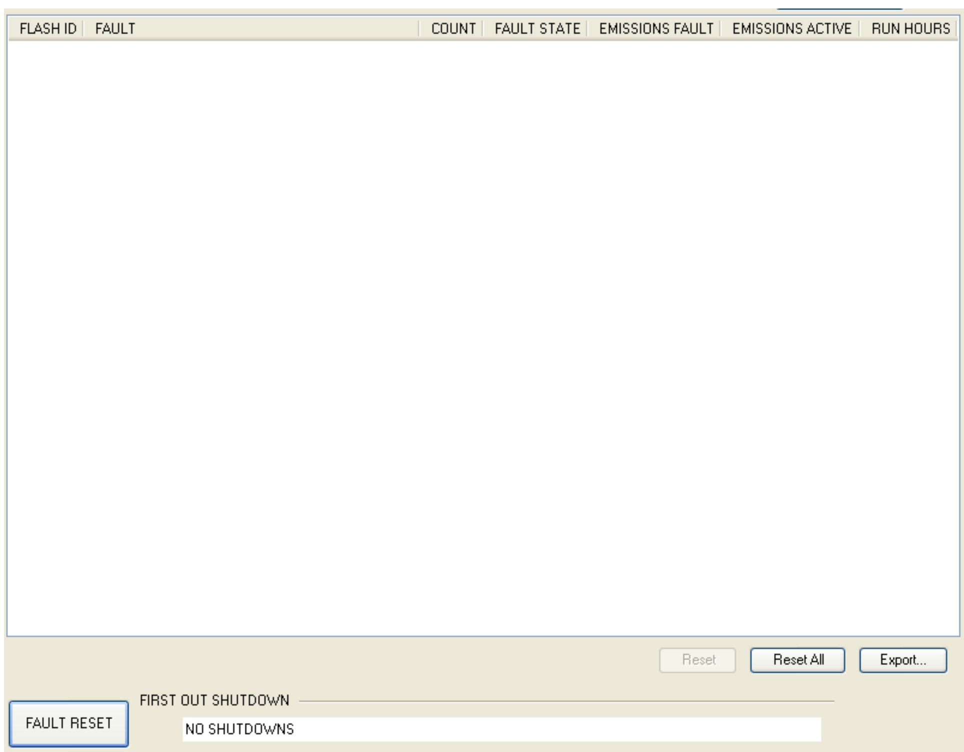


Figure 6-6. Fault Log (HMI Screen 7.1)

Chapter 7.
Control Wiring Diagram

The E3 Stoichiometric Trim control wiring diagram, documents 9971-1330 for AFR ONLY version and 9971-1331 for SPEED CONTROL version, is reproduced below. This document is available in electronic form on the CD-ROM that is supplied with the system controller and from Woodward on request. Note that all system and wiring options are shown. Wiring of individual applications will be reduced from that shown.

REVISION HISTORY			
REV	DESCRIPTION	DATE	APPROVED
NEW	RELEASE TO NEW	4-13-2011	JFELTS

WOODWARD

E3 STOICHIOMETRIC CONTROL SYSTEM WITH CATALYST AND ENGINE PROTECTION SYSTEM

E3 Stoichiometric AFR Only 8280-1104

CONTROL WIRING DIAGRAM

DRAWN: John Felts	WOODWARD, INC. LARGE ENGINE SYSTEMS LOVELAND, COLORADO, USA	DIAGRAM- CONTROL WIRING E3 STOICHIOMETRIC AFR ONLY	SIZE B	CAGE CODE	DWG NO 9971-1330			REV NEW
DATE: 4/13/2011			SCALE NONE		TITLE	SHEET 1	OF 5	

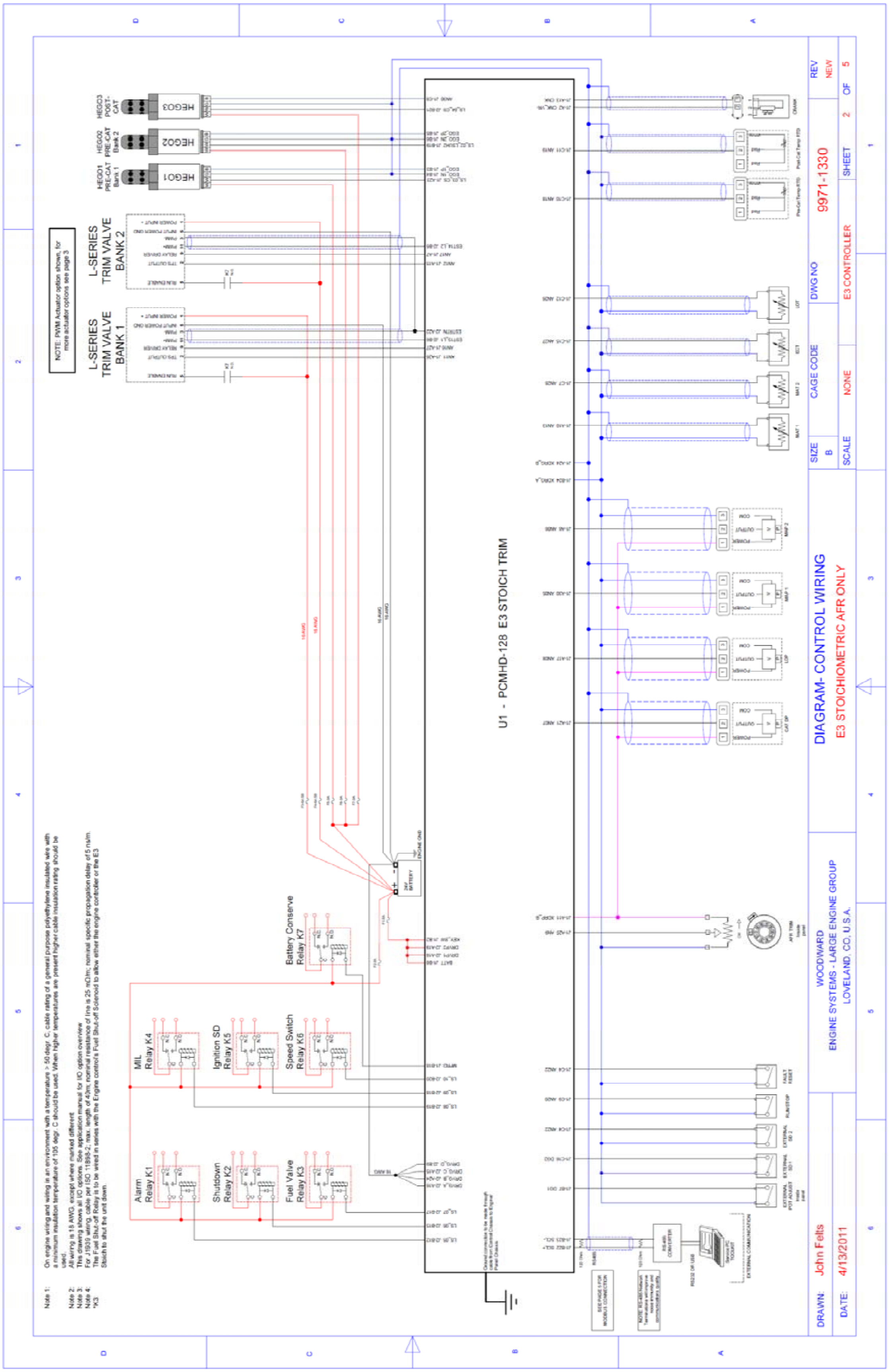
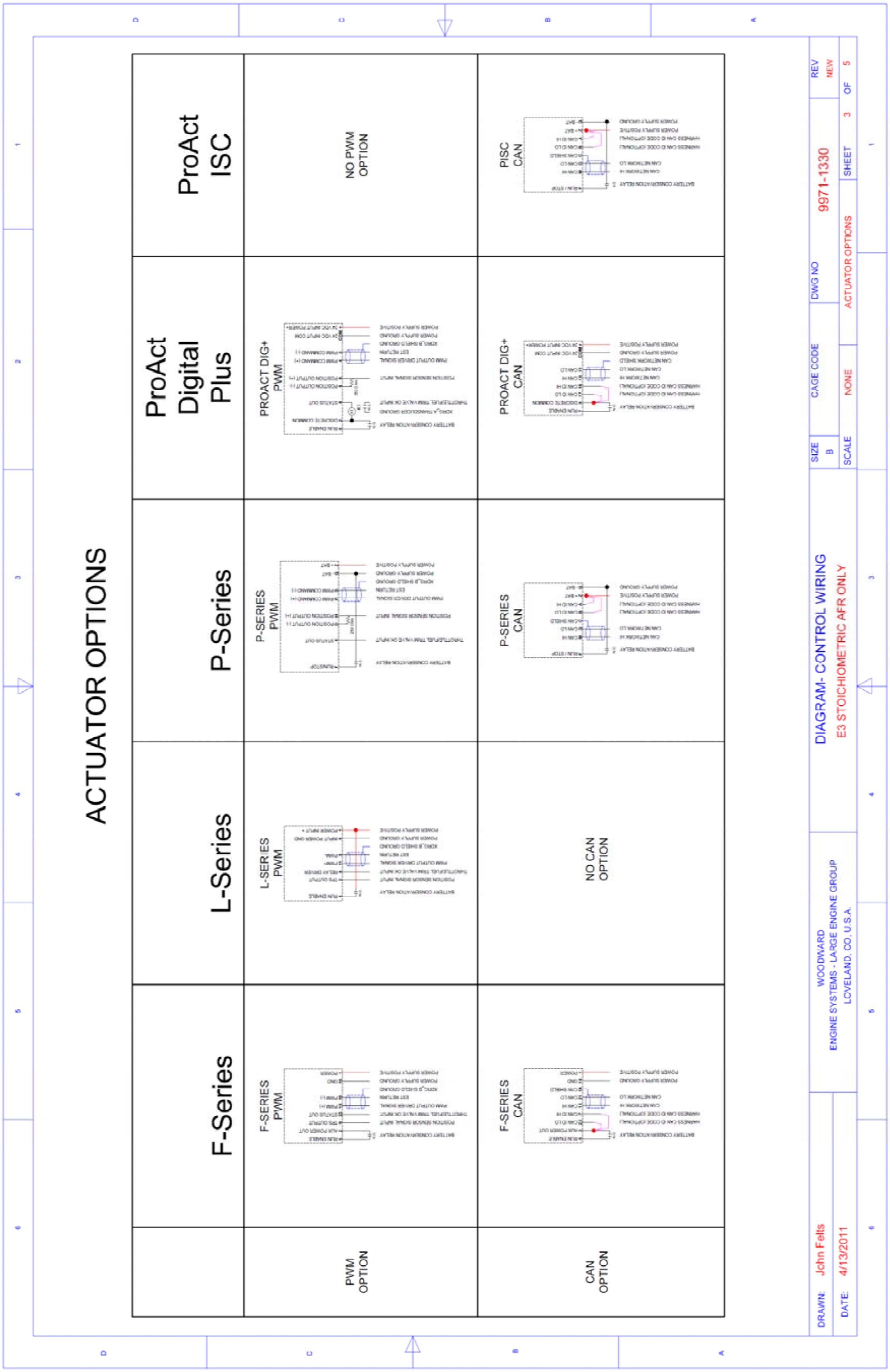
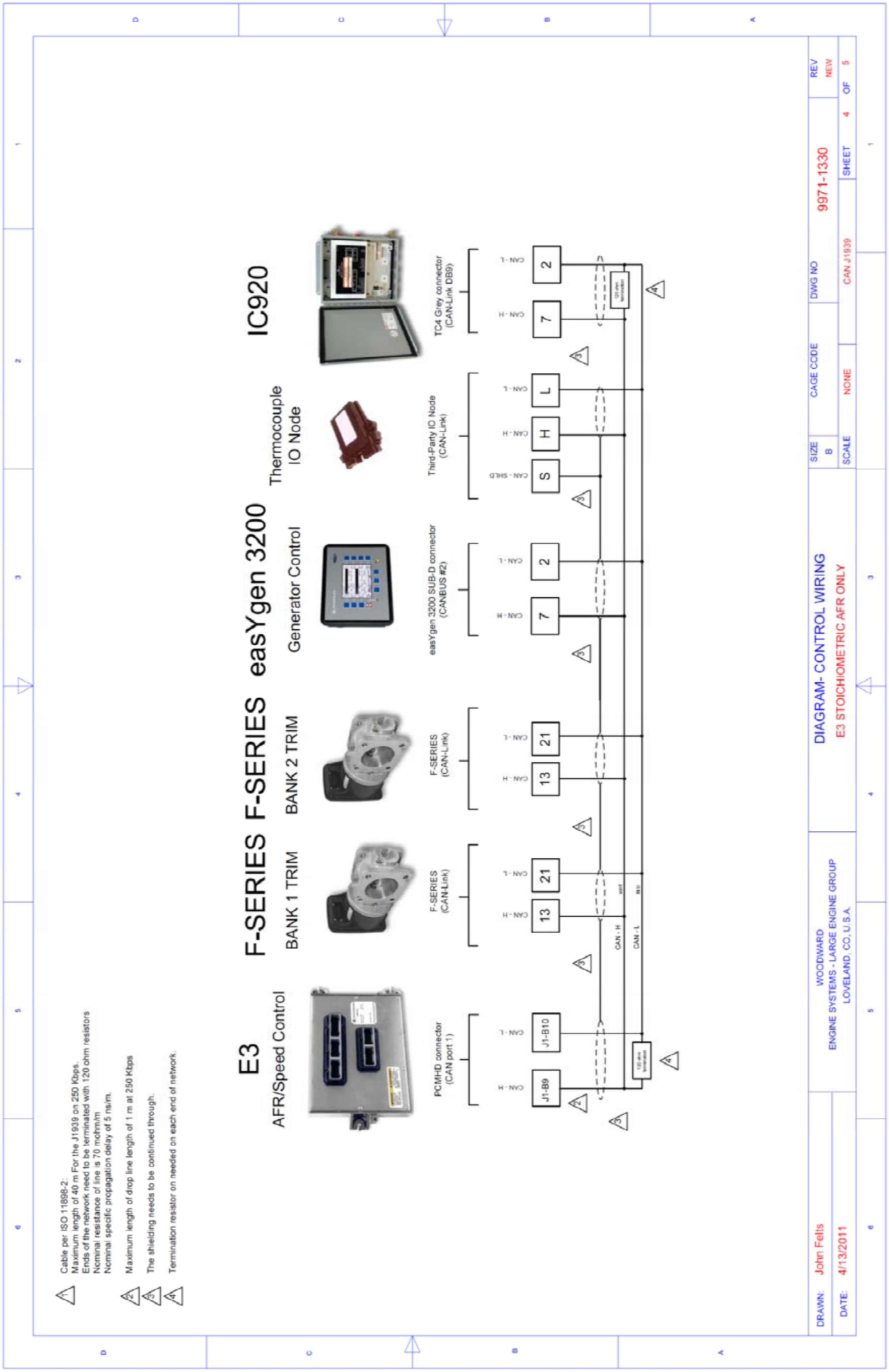
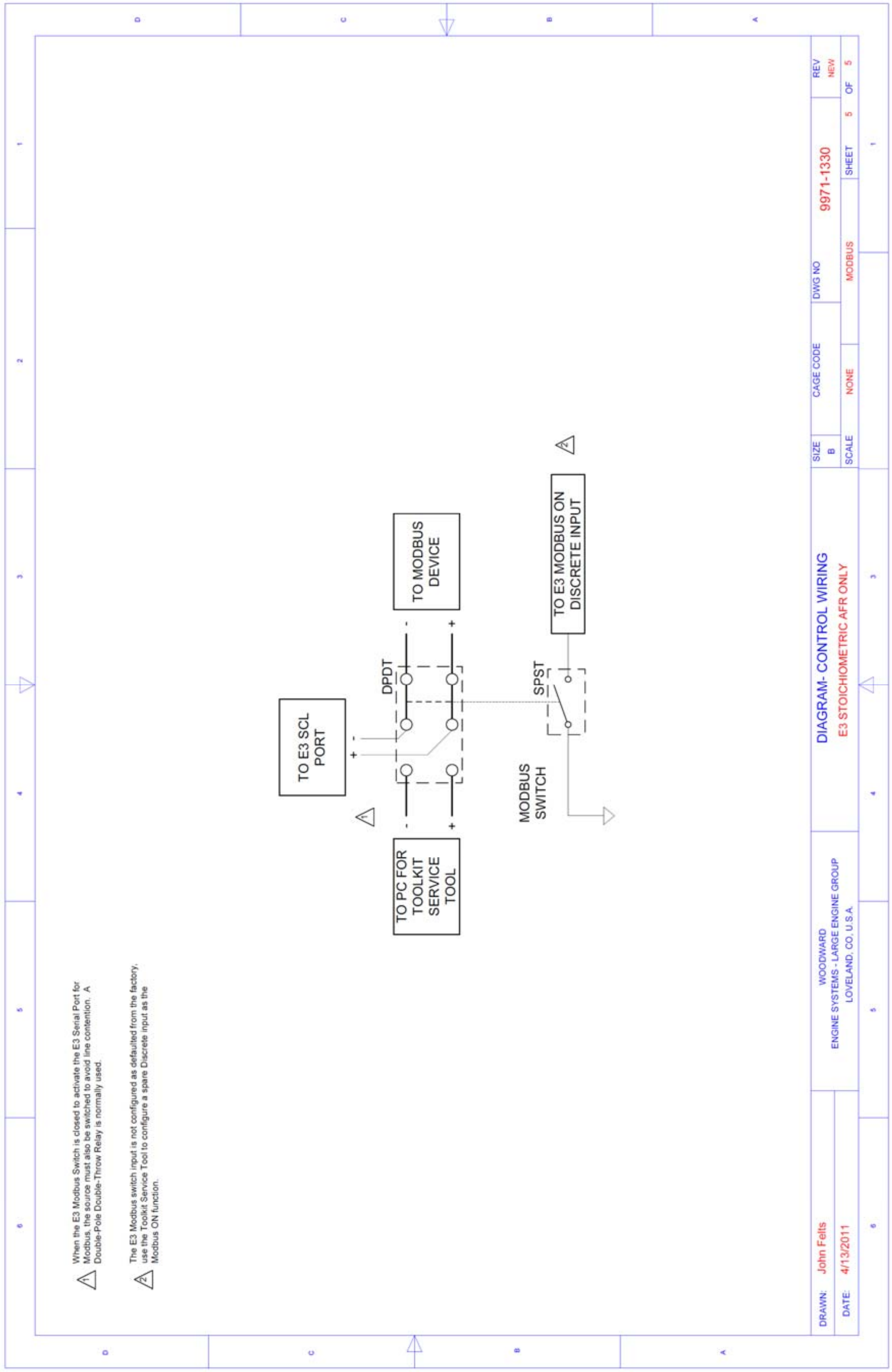


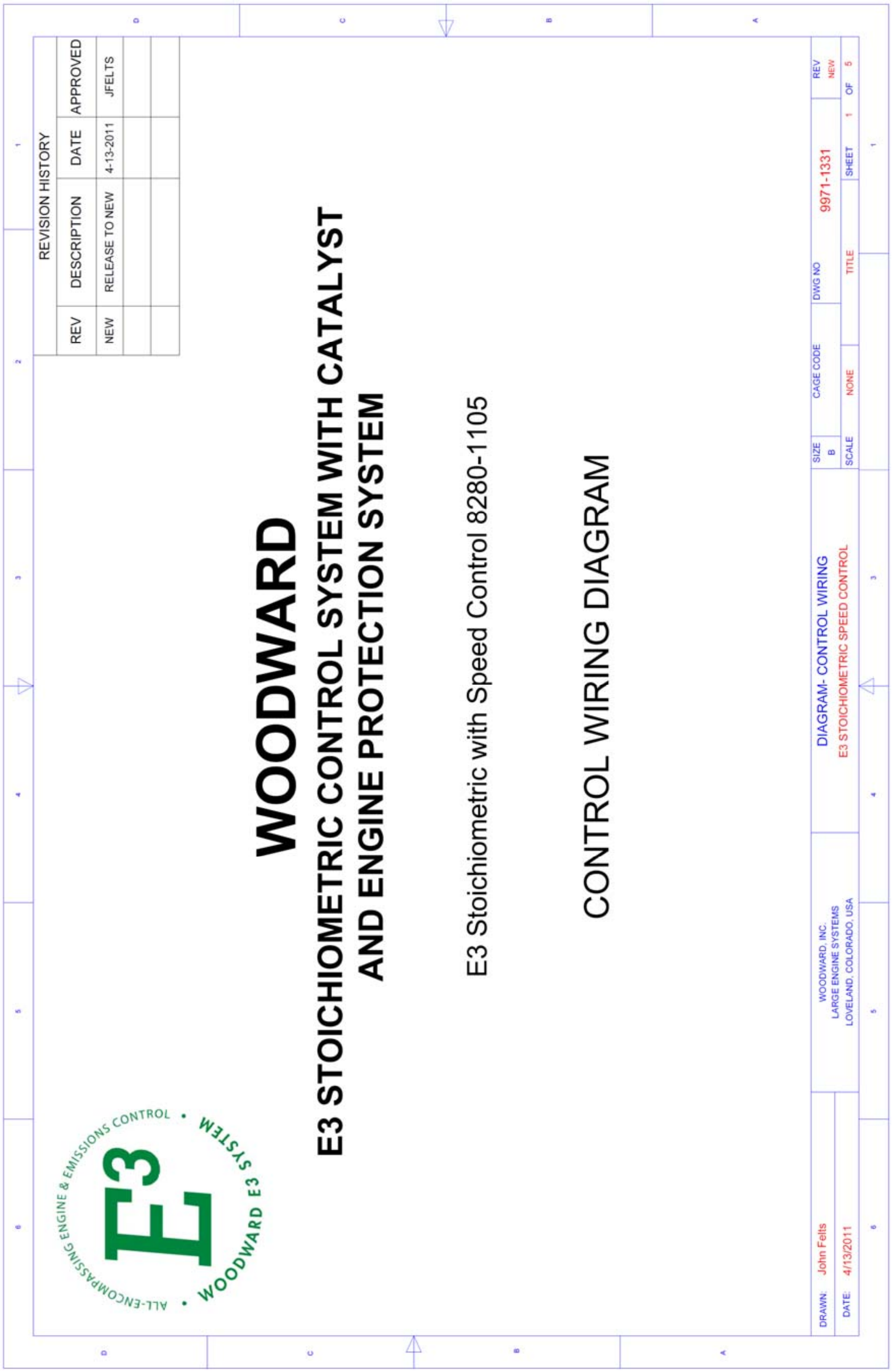
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC AFR ONLY
U1 - PCMHD-128 E3 STOICH TRIM
HEGO1
HEGO2
HEGO3
L-SERIES TRIM VALVE BANK 1
L-SERIES TRIM VALVE BANK 2
NOTE: PWM Actuator option shown, for more actuator options see page 3
Alarm Relay K1
Shutdown Relay K2
Fuel Valve Relay K3
MIL Relay K4
Ignition SD Relay K5
Speed Switch Relay K6
Battery Conserve Relay K7
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO, U.S.A.
DWG NO
9971-1330
E3 CONTROLLER
SHEET 2 OF 5
REV NEW
SIZE B
CAGE CODE NONE
SCALE
DRAWN: John Felts
DATE: 4/13/2011


ACTUATOR OPTIONS
ProAct ISC
ProAct Digital Plus
P-Series
L-Series
F-Series
PWM OPTION
CAN OPTION
NO PWM OPTION
PISC CAN
PROACT DIG+ PWM
PROACT DIG+ CAN
P-SERIES PWM
P-SERIES CAN
L-SERIES PWM
NO CAN OPTION
F-SERIES PWM
F-SERIES CAN
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC AFR ONLY
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO. U.S.A.
DWG NO
9971-1330
ACTUATOR OPTIONS
CAGE CODE
NONE
SIZE
B
SCALE
REV
NEW
SHEET
3
OF
5
DRAWN:
John Felts
DATE:
4/13/2011


Cable per ISO 11898-2:
Maximum length of 40 m For the J1939 on 250 Kbps.
Ends of the network need to be terminated with 120 ohm resistors
Nominal resistance of line is 70 mohm/m
Nominal specific propagation delay of 5 ns/m.
Maximum length of drop line length of 1 m at 250 Kbps
The shielding needs to be continued through.
Termination resistor on needed on each end of network.
E3
AFR/Speed Control
F-SERIES
BANK 1 TRIM
F-SERIES
BANK 2 TRIM
easYgen 3200
Generator Control
Thermocouple
IO Node
IC920
PCMHD connector
(CAN port 1)
F-SERIES
(CAN-Link)
F-SERIES
(CAN-Link)
easYgen 3200 SUB-D connector
(CANBUS #2)
Third-Party IO Node
(CAN-Link)
TC4 Grey connector
(CAN-Link DB9)
CAN - H
CAN - L
CAN - SHLD
J1-B9
J1-B10
13
21
7
2
S
H
L
CAN - H
CAN - L
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO, U.S.A.
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC AFR ONLY
DRAWN: John Fells
DATE: 4/13/2011
SIZE B
CAGE CODE NONE
DWG NO 9971-1330
REV NEW
SCALE
CAN J1939
SHEET 4 OF 5



TO E3 SCL PORT
DPDT
TO MODBUS DEVICE
TO PC FOR TOOLKIT SERVICE TOOL
SPST
MODBUS SWITCH
TO E3 MODBUS ON DISCRETE INPUT
1 When the E3 Modbus Switch is closed to activate the E3 Serial Port for Modbus, the source must also be switched to avoid line contention. A Double-Pole Double-Throw Relay is normally used.
2 The E3 Modbus switch input is not configured as defaulted from the factory, use the Toolkit Service Tool to configure a spare Discrete input as the Modbus ON function.
DRAWN: John Felts
DATE: 4/13/2011
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO, U.S.A.
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC AFR ONLY
SIZE B
SCALE
CAGE CODE
NONE
DWG NO
9971-1330
MODBUS
SHEET 5 OF 5
REV NEW


REVISION HISTORY
REV
DESCRIPTION
DATE
APPROVED
NEW
RELEASE TO NEW
4-13-2011
JFELTS
WOODWARD
E3 STOICHIOMETRIC CONTROL SYSTEM WITH CATALYST
AND ENGINE PROTECTION SYSTEM
E3 Stoichiometric with Speed Control 8280-1105
CONTROL WIRING DIAGRAM
ALL-ENCOMPASSING ENGINE & EMISSIONS CONTROL • WOODWARD E3 SYSTEM •
DRAWN: John Felts
DATE: 4/13/2011
WOODWARD, INC.
LARGE ENGINE SYSTEMS
LOVELAND, COLORADO, USA
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC SPEED CONTROL
SIZE B
SCALE
CAGE CODE
NONE
DWG NO
9971-1331
TITLE
SHEET 1 OF 5
REV NEW

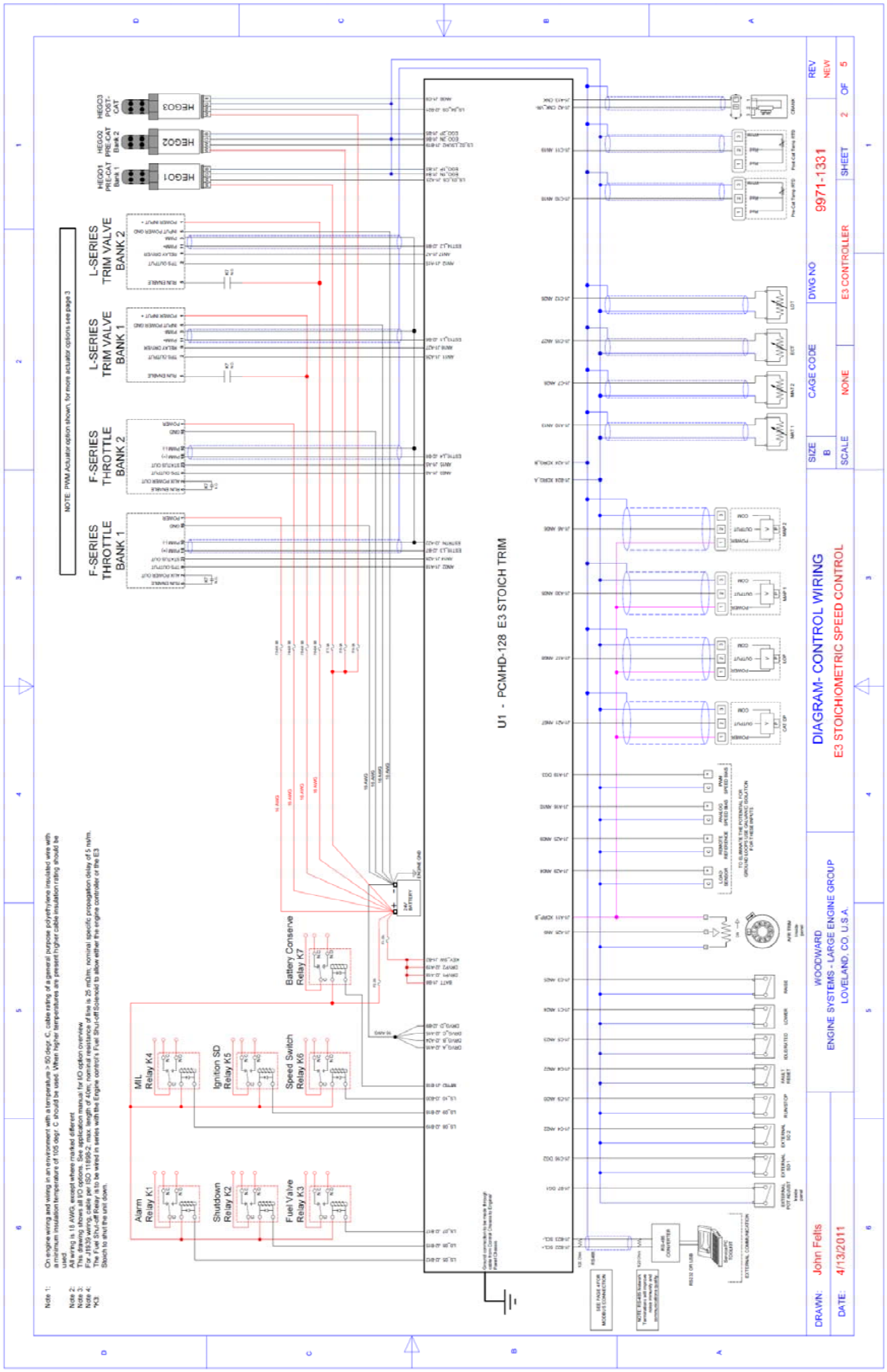
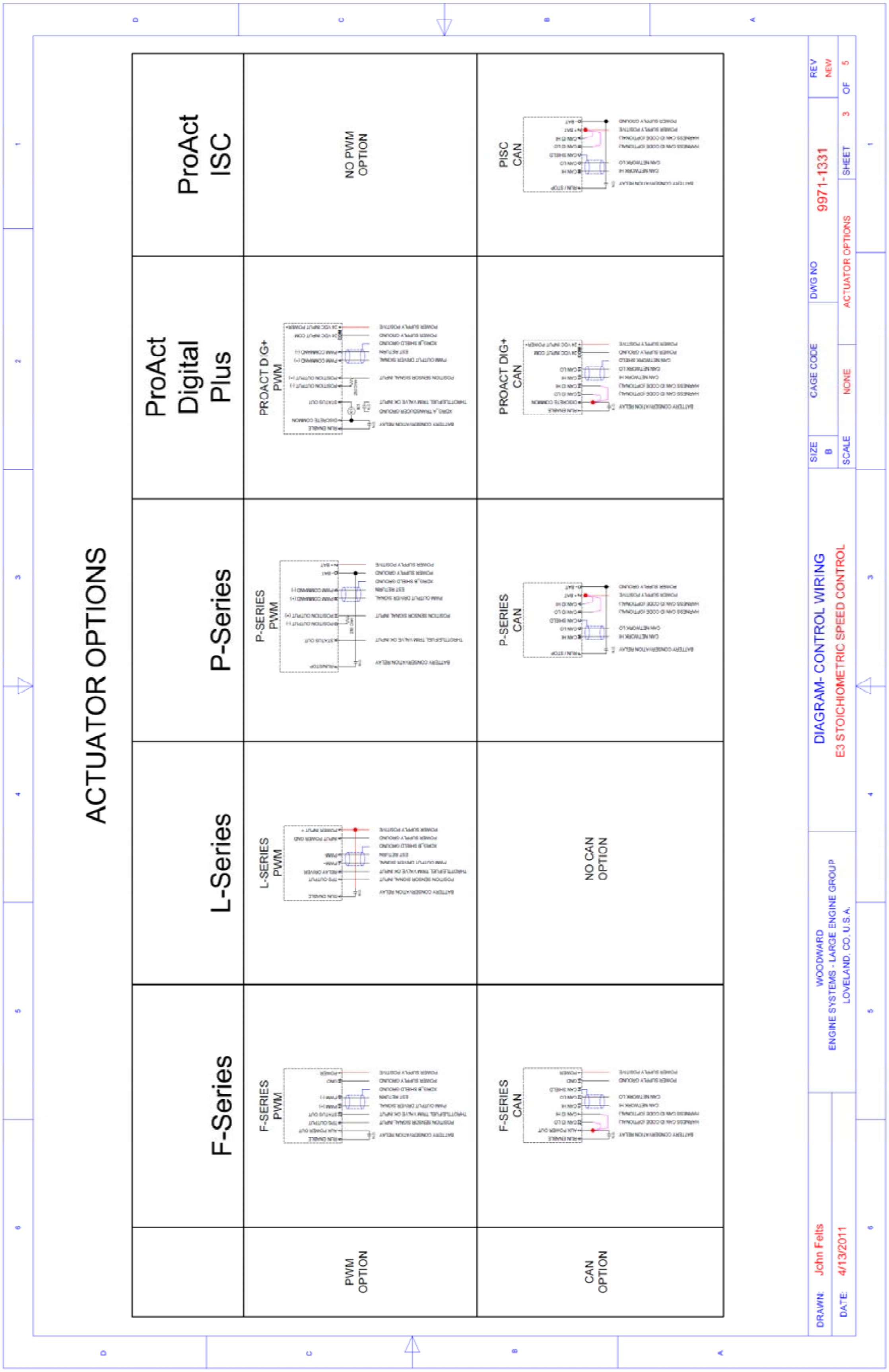
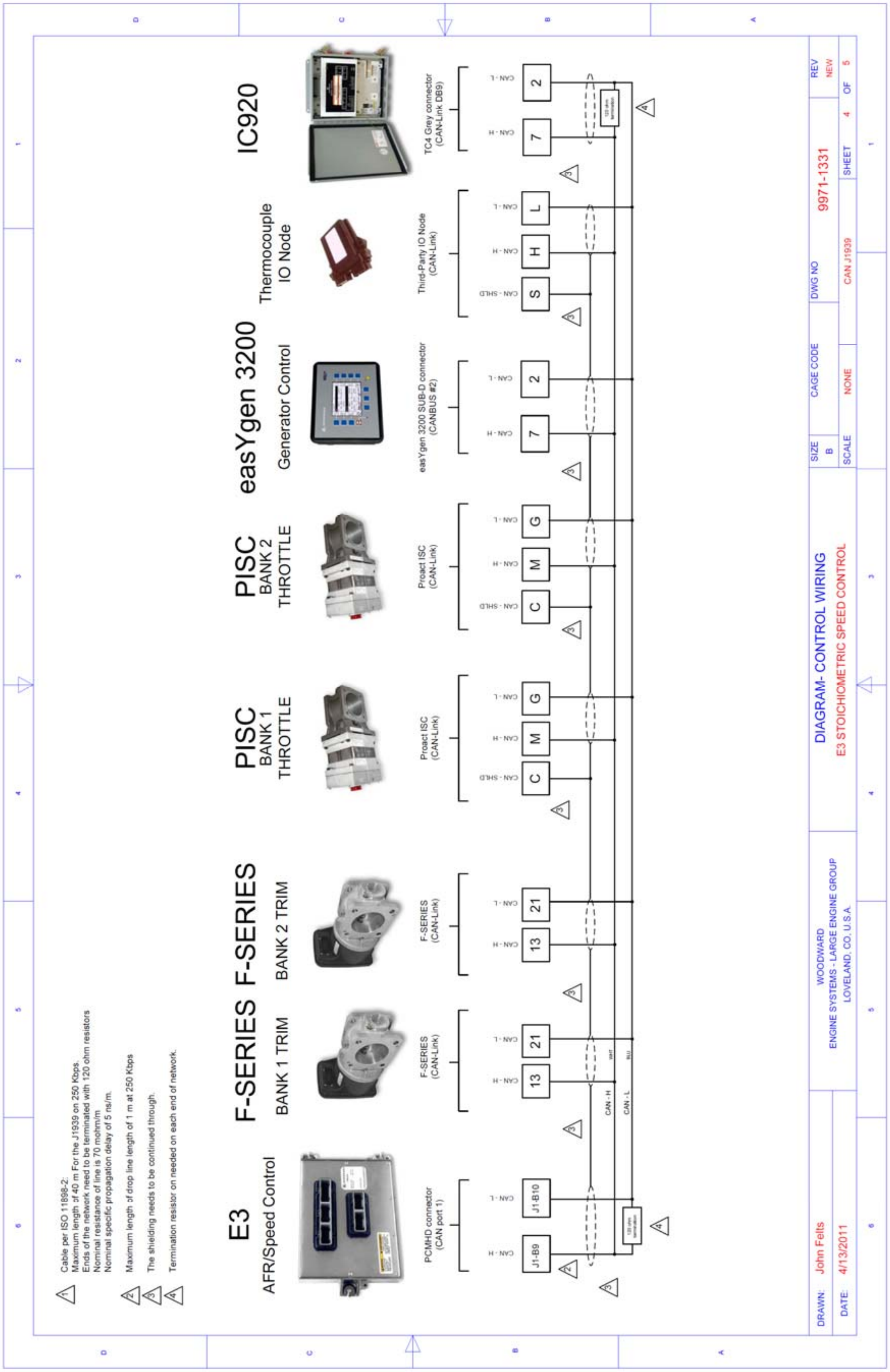
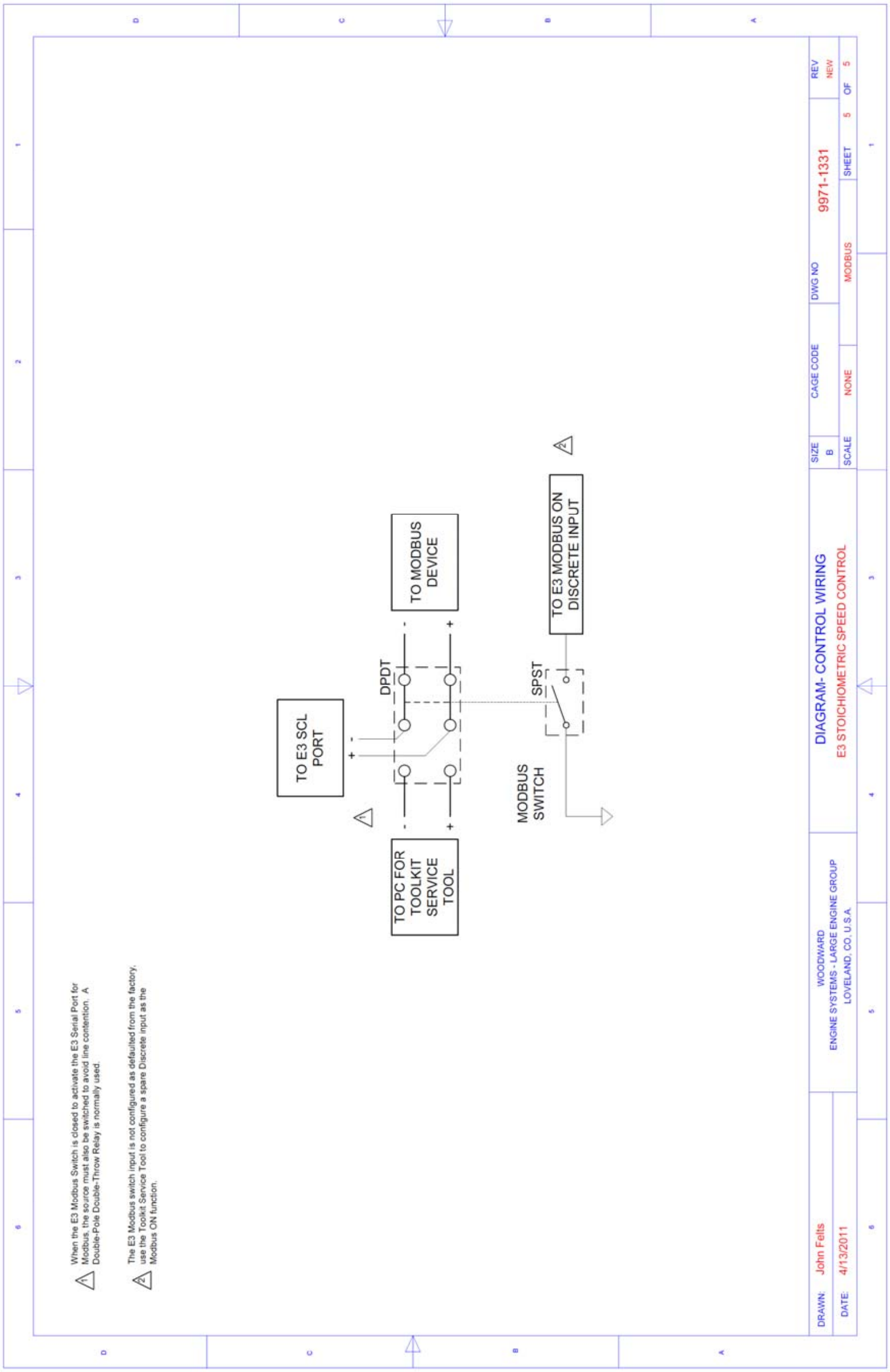


DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC SPEED CONTROL
U1 - PCMHD-128 E3 STOICH TRIM
F-SERIES THROTTLE BANK 1
F-SERIES THROTTLE BANK 2
L-SERIES TRIM VALVE BANK 1
L-SERIES TRIM VALVE BANK 2
HEGO1
HEGO2
HEGO3
Alarm Relay K1
Shutdown Relay K2
Fuel Valve Relay K3
MIL Relay K4
Ignition SD Relay K5
Speed Switch Relay K6
Battery Conserve Relay K7
9971-1331
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO, U.S.A.
John Fells
4/13/2011


ACTUATOR OPTIONS
ProAct ISC
ProAct Digital Plus
P-Series
L-Series
F-Series
PWM OPTION
CAN OPTION
NO PWM OPTION
PROACT DIG+ PWM
P-SERIES PWM
L-SERIES PWM
F-SERIES PWM
PISC CAN
PROACT DIG+ CAN
P-SERIES CAN
NO CAN OPTION
F-SERIES CAN
DRAWN: John Felts
DATE: 4/13/2011
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO. U.S.A.
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC SPEED CONTROL
SIZE B
SCALE
CAGE CODE NONE
DWG NO 9971-1331
ACTUATOR OPTIONS
SHEET 3 OF 5
REV NEW



Cable per ISO 11898-2:
Maximum length of 40 m For the J1939 on 250 Kbps.
Ends of the network need to be terminated with 120 ohm resistors
Nominal resistance of line is 70 mohm/m
Nominal specific propagation delay of 5 ns/m.
Maximum length of drop line length of 1 m at 250 Kbps
The shielding needs to be continued through.
Termination resistor on needed on each end of network.
E3
AFR/Speed Control
F-SERIES
BANK 1 TRIM
F-SERIES
BANK 2 TRIM
PISC
BANK 1
THROTTLE
PISC
BANK 2
THROTTLE
easYgen 3200
Generator Control
Thermocouple
IO Node
IC920
PCMHD connector
(CAN port 1)
F-SERIES
(CAN-Link)
Proact ISC
(CAN-Link)
easYgen 3200 SUB-D connector
(CANBUS #2)
Third-Party IO Node
(CAN-Link)
TC4 Grey connector
(CAN-Link DB9)
CAN - H
CAN - L
CAN - SHLD
J1-B9
J1-B10
13
21
C
M
G
7
2
S
H
L
CAN - H
CAN - L
WHT
BLU
DRAWN: John Felts
DATE: 4/13/2011
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE GROUP
LOVELAND, CO, U.S.A.
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC SPEED CONTROL
SIZE B
CAGE CODE
DWG NO 9971-1331
REV NEW
SCALE NONE
CAN J1939
SHEET 4 OF 5



TO PC FOR TOOLKIT SERVICE TOOL
TO E3 SCL PORT
DPDT
TO MODBUS DEVICE
MODBUS SWITCH
SPST
TO E3 MODBUS ON DISCRETE INPUT
1 When the E3 Modbus Switch is closed to activate the E3 Serial Port for Modbus, the source must also be switched to avoid line contention. A Double-Pole Double-Throw Relay is normally used.
2 The E3 Modbus switch input is not configured as defaulted from the factory, use the Toolkit Service Tool to configure a spare Discrete input as the Modbus ON function.
DRAWN: John Felts
DATE: 4/13/2011
WOODWARD
ENGINE SYSTEMS - LARGE ENGINE ENGINE GROUP
LOVELAND, CO, U.S.A.
DIAGRAM- CONTROL WIRING
E3 STOICHIOMETRIC SPEED CONTROL
SIZE B
CAGE CODE NONE
DWG NO 9971-1331
MODBUS
REV NEW
SCALE
SHEET 5 OF 5

Chapter 8.
Approved Electronic Parts List & Mating Connector Reference Table

Approved Electronic Parts List

Item	Part Number	Detail	Required	Qty.	Manuals
Controller & Accessories	8280-1104	E3 - Stoichiometric Control (AFR Only)	Yes	1	26473
	8280-1105	E3-Stoichiometric Trim (AFR or GQCL, S.C., and Misfire)			
	8928-1096	Hardware E3 System - Mating Connectors	No	1	
Crank Pickup	5430-929	Magnetic(.625-18,1680-622 P.U.)	Yes	1	82510
Cam Pickup	5430-929	Magnetic(.625-18,1680-622 P.U.)	No	1	
	1689-1114	Sensor-Active Speed, M16X1.5, 5.12 OAL			
	1689-1115	Sensor-Active Speed, 5/8-18 UNF-2A, 5.12 OAL			
MAP/TMAP Sensor	1689-1091	TMAP	Yes	1	82689
	VM5734.0230	MAP 3 Bar with 6m Cable			
	6910-314	MAP 3 Bar, sensor only			
	8928-7261	Kit - Sensor, MAP, 4 Bar, 0.5-4.5v, W/ Connector			
	1689-1110	MAP, E3 Lean Trim			
MAT Sensor	DL08041301	N.T.C., with Coupling 1/4" NPT, Wire Length 3mtr.	Yes	1	
	1689-1120	Temperature, Engine, 2-Pin Passive, M12x1.5 Thread			
ECT Sensor	DL08041301	N.T.C., with Coupling 1/4" NPT, Wire Length 3mtr.	No	1	
	1689-1120	Temperature, Engine, 2-Pin Passive, M12x1.5 Thread			
HEGO Sensor & Accessories	1689-1197	Sensor – Industrial HEGO	Yes	1	
	VM5581.0004	HEGO Fitting	No	1	
	DL10170006	Plug for HEGO Sensor Fitting	No	1	
	DL10081824	Washer, Copper 18 x 24	No	1	
	8928-7363	Kit-AMP 4-Pin Connector Mating	Yes	1	
kW Transducer	8444-1022	UMT111B/A3SU	No	1	37139 36356
	1680-6015	Watt; 0-300kW; In:3X380V/2X5A, 220V; Out:4-20mA			
IC-920/922 Ignition & Accessories	8408-0725	IC-920 CSA Listed 20 Cylinder Industrial Ignition J-1939 CANbus	No	1	26263
	8408-0727	IC-922 CSA Listed 20 Cylinder Industrial Ignition J-1939 CANbus	No	1	
	5404-1072	Harness, IC 920 Odd Bank	No	1	
	5404-1073	Harness, IC 920 Even Bank	No	1	
	8408-501	Negative Gnd, Molded, Unshielded Blue	No	1 per	

Item	Part Number	Detail	Required	Qty.	Manuals
	8409-501	Coil, shielded blue negative ground	No	cyl.	
	5430-929	Pickup, Magnetic(.625-18,1680-622 P.U.)	No	3	82510
Trim Valve/ Actuator & Accessories	8404-2013	L-Series ITB, 25mm, PWM Positioner	Yes	1	23237 26249
	8404-2014	L-Series ITB, 30mm, PWM Positioner			
	8404-2015	L-Series ITB, 36mm, PWM Positioner			
	8404-2016	L-Series ITB, 43mm, PWM Positioner			
	8404-2017	L-Series ITB, 50mm, PWM Positioner			
	8235-601	F-Series ITB, 14-Pin-A, 48mm-Std, Default Sch, N/C			26355
	8235-605	F-Series ITB, 14-Pin-A, 60mm-Std, Default Sch, N/C			
	8235-609	F-Series ITB, 14-Pin-A, 68mm-Std, Default Sch, N/C			
	8235-650	F-Series Act, 23-Pin, Std-Mnt, Std-Shft, Dflt Pmtrs, No Spring (EGS)			
	8235-140	Flo-Tech ITB 75mm			04141
	8404-077	ProAct P-Series, Model II			26578
	8928-396	Kit, ITB & LCS/LC-50, Connector, Socket, Key (for L-series)	No	1	
	8923-1311	Kit, F-Series 14-Pin Mating Connector	No	1	
	8923-371	Kit, Connector Packard Elec. Weather Pack 6 Pin (for Flo-Tech)	No	1	
	6995-1021	Kit, Straight Plug Connector (for ProAct w/integrated connector)	No	1	
Mixture Throttle/ Actuator & Accessories	8404-2013	L-Series ITB, 25mm, PWM Positioner	No	1	23237 26249
	8404-2014	L-Series ITB, 30mm, PWM Positioner			
	8404-2015	L-Series ITB, 36mm, PWM Positioner			
	8404-2016	L-Series ITB, 43mm, PWM Positioner			
	8404-2017	L-Series ITB, 50mm, PWM Positioner			
	8235-601	F-Series ITB, 14-Pin-A, 48mm-Std, Default Sch, N/C			26355
	8235-602	F-Series ITB, 23-Pin-A, 48mm-Std, Default Sch, N/C			
	8235-605	F-Series ITB, 14-Pin-A, 60mm-Std, Default Sch, N/C			
	8235-606	F-Series ITB, 23-Pin-A, 60mm-Std, Default Sch, N/C			
	8235-609	F-Series ITB, 14-Pin-A, 68mm-Std, Default Sch, N/C			
	8235-610	F-Series ITB, 23-Pin-A, 68mm-Std, Default Sch, N/C			

Item	Part Number	Detail	Required	Qty.	Manuals
	8235-650	F-Series Act, 23-Pin, Std-Mnt, Std-Shft, Dflt Pmtrs, No Spring (EGS)			
	8235-140	Flo-Tech ITB 75mm			04141
	8404-077	P-Series, Model II			26578
	8404-073	P-Series, Model III			
	8404-076	P-Series, Model IV			
	8404-077	P-Series, Model II			
	8235-373	180 mm ITB, ProAct P-Series Model IV			
	8235-372	160 mm ITB, ProAct P-Series Model III			
	8235-371	135 mm ITB, ProAct P-Series Model III			
	8235-366	120 mm ITB, ProAct P-Series Model II			
	8235-365	105 mm ITB, ProAct P-Series Model II			
	8235-370	95 mm ITB, ProAct P-Series Hi Temp Bearings			
	8235-369	85 mm ITB, ProAct P-Series Hi Temp Bearings			
	8928-396	Kit, ITB & LCS/LC-50, Connector, Socket, Key (for L-series)			
	8923-1311	Kit, F-Series 14-Pin Mating Connector	No	1	
	8923-1312	Kit, F-Series 23-Pin Mating Connector	No	1	
	8923-371	Kit, Connector Packard Elec. Weather Pack 6 Pin (for Flo-Tech)	No	1	
	1631-045	Connector-3106F18-9S, Crimp, Zinc-Cobalt Plating (for ProAct Analog)	No	1	
easYgen	8440-1818	easYgen-3100-1	No	1	37223 37224 37225
	8440-1817	easYgen-3100-5			
	8440-1816	easYgen-3200-1			
	8440-1831	easYgen-3200-5			
USB to RS-485 Converter	1784-1037	USB to RS-485/422 Optically Isolated	No	1	
Galvanic Isolator	1784-453	Amplifier-3-Way Isolating, with Configurable In/Output - (MCR-C-UI-UI-DCI/..., Phoenix, 2810913)	No	A/R	

Mating Connector Reference Table

Connector for	System Component Part No.	Harness Connector		Qty	Terminals		Qty	Lock/cover		Qty
		Mfr & p/n	Woodward p/n		Mfr p/n	Woodward p/n		Mfr p/n	Woodward p/n	
ECU J1-A		TYCO 4-1437287-7	1635-1177	1	1-1437284-0 (14-16 ga.)	1602-1029 14-16 ga.)		4-1437287-9	1635-7002	1
ECU J1-B		TYCO 4-1437287-6	1635-1176	1						1
ECU J1-C		TYCO 4-1437287-5	1635-1175	1						1
ECU J2-A		TYCO 4-1437287-5	1635-1175	1		1602-1028				1
ECU J2-B	8237-1181	TYCO 4-1437287-6	1635-1176	1	0-1437284-9 9 (18-20 ga)	(18-20 ga)	A/R	4-1437287-8	1635-7001	1
CAN/RS485 Termination Resistor plug	N/A	Deutsch DT06-3S-E008	N/A	A/R	0462-201-1631	N/A	2 per plug	W3S-1939	N/A	4
CAN/RS485 Termination Resistor	N/A	Deutsch DT04-3P-P006	N/A	A/R	0460-202-1631	N/A	2 per plug	N/A		
L Series	various	Deutsch DT06-12SA	1630-625	1	0462-201-16141	1634-005	6	W12S	1790-277	1
F Series	various	TYCO 770680-1	1751-805	1	770854-3	1608-1044	5	N/A	N/A	N/A
Flo-Tech	8235-140	Delphi 12020926	1635-991	1	12089188	1635-183	5	12015323	1635-173	1
ProAct ISC/ P-Series	various	Amphenol ACC 06E 24-28S (025)	1635-1113	1	10-597109-171 (CRIMP)	NONE	A/R	N/A	N/A	N/A
		Cannon CA 06R 24-28S A206		1	031-0560-161 (CRIMP)		A/R	N/A	N/A	N/A
StableSense HEGO	1689-1197	AMP 174257-2	PE24-030-04	1	173707-1	1607-813	4	174258-7	PE24-031-04	1
TMAP sensor	1689-1091	Bosch 928 000 453								
MAP sensor	6910-314	Packard 12041332	1790-279	1	12089040	1635-171	3	N/A	N/A	N/A
MAT sensor Coolant Temp	6913-011	Packard 12162197	1790-281	1	1	1752-295	2	N/A	N/A	N/A
MPU	1680-622	Bendix ACC06AF10SL-4S(025)	203771	1	N/A	N/A	N/A	AMP MS3420-4	1633-647	1
Proximity Switch	1689-1115	Amphenol MS3106A-10SL-3S	1631-002		N/A	N/A	N/A	MILITARY/QPL M85049/41-4A	1633-601	1
Smart Coil	1698-1009	Packard 12162825	1635-1266	1 per coil	12161184	1635-1267	4 per coil	N/A	N/A	N/A

Appendix.
Modbus Address List

	Address	Description	Multiplier
Boolean Writes			
	0:0001	FAULT RESET	
	0:0002	FIRST OUT RESET	
	0:0003	SPEED MONITOR RESET	
	0:0004	MISFIRE MONITOR RESET	
	0:0005	CAT DELTA PRESSURE MONITOR RESET	
	0:0006	PRE-CAT PRESSURE MONITOR RESET	
	0:0007	PRE-CAT TEMP MONITOR RESET	
	0:0008	POST-CAT TEMP MONITOR RESET	
	0:0009	CAT TEMP RISE MONITOR RESET	
	0:0010	15 MIN AVERAGE MONITOR RESET	
	0:0011	DI - EXTERNAL SHUTDOWN 1	
	0:0012	DI - EXTERNAL SHUTDOWN 2	
	0:0013	DI - COOLING WATER LEVEL LOW	
	0:0014	DI - LUBE OIL LEVEL LOW	
	0:0015	DI - RUN/STOP	
	0:0016	DI - IDLE/RATED	
	0:0017	DI - LOWER	
	0:0018	DI - RAISE	
	0:0019	DI - GENERATOR BREAKER	
	0:0020	DI - UTILITY BREAKER	
	0:0021	DI - AFR POT LEARN	
	0:0022	DI - IGNITION ON	
	0:0023	CLEAR EXTERNAL BIAS TABLE	
	0:0024	INCREMENT AFR SETPOINT	
	0:0025	DECREMENT AFR SETPOINT	
Boolean Reads			
	1:0001	SYSTEM SHUTDOWN	
	1:0002	SYSTEM ALARM	
	1:0003	ENGINE CRANKING	
	1:0004	ENGINE RUNNING	
	1:0005	PID IN CONTROL	
	1:0006	START RAMP IN CONTROL	
	1:0007	MAX LIMITER IN CONTROL	
	1:0008	LOAD REJECTION IN CONTROL	
	1:0009	15 MINUTE AVERAGE SAMPLE VALID	

	Address	Description	Multiplier
	1:0010	DI - DG1	
	1:0011	DI - DG2	
	1:0012	DI - AN14	
	1:0013	DI - AN15	
	1:0014	DI - AN16	
	1:0015	DI - AN20	
	1:0016	DI - AN21	
	1:0017	DI - AN22	
	1:0018	DI - AN23	
	1:0019	DI - AN24	
	1:0020	DI - AN25	
	1:0021	DI - AN17	
	1:0022	IGNITION FIRE CONFIRM	
	1:0023	COOLING WATER LEVEL LOW	
	1:0024	LUBE OIL LEVEL LOW	
	1:0025	MODBUS SELECT	
	1:0026	RUN	
	1:0027	GEN BREAKER	
	1:0028	RESET	
	1:0029	IDLE	
	1:0030	LOWER	
	1:0031	RAISE	
	1:0032	UTILITY BREAKER	
	1:0033	EXTERNAL SHUTDOWN 1	
	1:0034	EXTERNAL SHUTDOWN 2	
	1:0035	THROTTLE OK 1	
	1:0036	THROTTLE OK 2	
	1:0037	THROTTLE OK 3	
	1:0038	THROTTLE OK 4	
	1:0039	IGNITION ON	
	1:0040	MPRD BATTERY CONSERVE ON	
	1:0041	LSO 5 ALARM RELAY	
	1:0042	LSO 6 SHUTDOWN RELAY	
	1:0043	LSO 7 OPEN FUEL SHUTOFF VALVE	
	1:0044	LSO 8 MIL RELAY	
	1:0045	LSO 9 EXTERNAL IGNITION SD	
	1:0046	LSO 10 RUN RELAY	
	1:0047	AL5 LOSS OF POWER	
	1:0048	SD5 LOSS OF POWER	
	1:0049	AL10 SYSTEM RICH	

	Address	Description	Multiplier
	1:0050	AL15 SYSTEM LEAN	
	1:0051	AL20 MAP 1 SENSOR VOLT LO	
	1:0052	AL25 MAP 1 SENSOR VOLT HI	
	1:0053	AL30 MAP 2 SENSOR VOLT LO	
	1:0054	AL35 MAP 2 SENSOR VOLT HI	
	1:0055	AL40 MAP SENSOR FAILURE	
	1:0056	SD40 MAP SENSOR FAILURE	
	1:0057	SD70 SPEED SENSOR CONFIG ERR	
	1:0058	AL71 CAM SENSOR FAIL	
	1:0059	SD71 CAM SENSOR FAIL	
	1:0060	SD72 CRANK SENSOR FAIL	
	1:0061	AL73 CRANK SPEED TOO LOW	
	1:0062	AL74 CRANK SPEED TOO HIGH	
	1:0063	AL75 MAX TIMING ERROR EXCEEDED	
	1:0064	SD75 MAX TIMING ERROR EXCEEDED	
	1:0065	AL76 CAM/CRK SYNC ERROR	
	1:0066	SD76 CAM/CRK SYNC ERROR	
	1:0067	SD80 ENGINE OVERSPEED DETECTED	
	1:0068	SD81 ENGINE STALLED	
	1:0069	AL82 CLOSED-LOOP ERROR	
	1:0070	SD82 CLOSED-LOOP ERROR	
	1:0071	AL83 POST HEGO 15 MIN AVG EXCURSION	
	1:0072	SD83 POST HEGO 15 MIN AVG EXCURSION	
	1:0073	AL84 UNREQUESTED OPEN-LOOP	
	1:0074	SD84 UNREQUESTED OPEN-LOOP	
	1:0075	AL85 PRE-CAT BACKUP MODE ACTIVATED	
	1:0076	SD85 PRE-CAT BACKUP MODE ACTIVATED	
	1:0077	AL86 PRE-CAT TRIM HIGH LIMIT	
	1:0078	SD86 PRE-CAT TRIM HIGH LIMIT	
	1:0079	AL87 PRE-CAT TRIM LOW LIMIT	
	1:0080	SD87 PRE-CAT TRIM LOW LIMIT	
	1:0081	AL88 POST-CAT TRIM HIGH LIMIT	
	1:0082	SD88 POST-CAT TRIM HIGH LIMIT	
	1:0083	AL89 POST-CAT TRIM LOW LIMIT	
	1:0084	SD89 POST-CAT TRIM LOW LIMIT	
	1:0085	AL90 BANK BALANCE HIGH LIMIT	
	1:0086	SD90 BANK BALANCE HIGH LIMIT	
	1:0087	AL91 BANK BALANCE LOW LIMIT	
	1:0088	SD91 BANK BALANCE LOW LIMIT	
	1:0089	AL98 LOAD INPUT VOLT LO	

	Address	Description	Multiplier
	1:0090	SD98 LOAD INPUT VOLT LO	
	1:0091	AL100 LOAD INPUT VOLT HI	
	1:0092	SD100 LOAD INPUT VOLT HI	
	1:0093	AL102 MAT 1 SENSOR VOLT LO	
	1:0094	AL103 MAT 1 SENSOR VOLT HI	
	1:0095	AL105 MAT 2 SENSOR VOLT LO	
	1:0096	AL106 MAT 2 SENSOR VOLT HI	
	1:0097	AL110 MAT SENSOR FAILURE	
	1:0098	SD110 MAT SENSOR FAILURE	
	1:0099	AL111 LOT SENSOR VOLT LO	
	1:0100	SD111 LOT SENSOR VOLT LO	
	1:0101	AL112 LOT SENSOR VOLT HI	
	1:0102	SD112 LOT SENSOR VOLT HI	
	1:0103	AL113 ECT SENSOR VOLT LO	
	1:0104	SD113 ECT SENSOR VOLT LO	
	1:0105	AL114 ECT SENSOR VOLT HI	
	1:0106	SD114 ECT SENSOR VOLT HI	
	1:0107	AL115 LUBE OIL SENSOR VOLT LO	
	1:0108	SD115 LUBE OIL SENSOR VOLT LO	
	1:0109	AL116 LUBE OIL SENSOR VOLT HI	
	1:0110	SD116 LUBE OIL SENSOR VOLT HI	
	1:0111	AL117 CAT DIFF SENSOR VOLT LO	
	1:0112	SD117 CAT DIFF SENSOR VOLT LO	
	1:0113	AL118 CAT DIFF SENSOR VOLT HI	
	1:0114	SD118 CAT DIFF SENSOR VOLT HI	
	1:0115	AL119 PRE-CAT PRESS SENSOR VOLT LO	
	1:0116	SD119 PRE-CAT PRESS SENSOR VOLT LO	
	1:0117	AL120 PRE-CAT PRESS SENSOR VOLT HI	
	1:0118	SD120 PRE-CAT PRESS SENSOR VOLT HI	
	1:0119	AL121 POST-CAT PRESS SENSOR VOLT LO	
	1:0120	SD121 POST-CAT PRESS SENSOR VOLT LO	
	1:0121	AL122 POST-CAT PRESS SENSOR VOLT HI	
	1:0122	SD122 POST-CAT PRESS SENSOR VOLT HI	
	1:0123	AL123 PRE-CAT TEMP SENSOR VOLT LO	
	1:0124	SD123 PRE-CAT TEMP SENSOR VOLT LO	
	1:0125	AL124 PRE-CAT TEMP SENSOR VOLT HI	
	1:0126	SD124 PRE-CAT TEMP SENSOR VOLT HI	
	1:0127	AL125 POST-CAT TEMP SENSOR VOLT LO	
	1:0128	SD125 POST-CAT TEMP SENSOR VOLT LO	
	1:0129	AL126 POST-CAT TEMP SENSOR VOLT HI	

	Address	Description	Multiplier
	1:0130	SD126 POST-CAT TEMP SENSOR VOLT HI	
	1:0131	AL141 MAT1 H	
	1:0132	SD142 MAT1 HH	
	1:0133	AL143 MAT1 H DERATE	
	1:0134	AL151 MAT2 H	
	1:0135	SD152 MAT2 HH	
	1:0136	AL153 MAT2 H DERATE	
	1:0137	AL161 ECT H	
	1:0138	SD162 ECT HH	
	1:0139	AL163 ECT H DERATE	
	1:0140	AL166 LOT H	
	1:0141	SD167 LOT HH	
	1:0142	AL171 BALANCE DIFFERENTIAL H	
	1:0143	SD172 BALANCE DIFFERENTIAL HH	
	1:0144	AL175 MAP 1 H	
	1:0145	SD176 MAP 1 HH	
	1:0146	AL178 MAP 2 H	
	1:0147	SD179 MAP 2 HH	
	1:0148	AL195 REM REF INPUT VOLT LO	
	1:0149	SD195 REM REF INPUT VOLT LO	
	1:0150	AL200 REM REF INPUT VOLT HI	
	1:0151	SD200 REM REF INPUT VOLT HI	
	1:0152	AL205 TPS 1 INPUT VOLT LO	
	1:0153	SD205 TPS 1 INPUT VOLT LO	
	1:0154	AL210 TPS 1 INPUT VOLT HI	
	1:0155	SD210 TPS 1 INPUT VOLT HI	
	1:0156	AL215 TPS 2 INPUT VOLT LO	
	1:0157	SD215 TPS 2 INPUT VOLT LO	
	1:0158	AL220 TPS 2 INPUT VOLT HI	
	1:0159	SD220 TPS 2 INPUT VOLT HI	
	1:0160	AL225 FTPS 1 INPUT VOLT LO	
	1:0161	SD225 FTPS 1 INPUT VOLT LO	
	1:0162	AL226 FTPS 1 INPUT VOLT HI	
	1:0163	SD226 FTPS 1 INPUT VOLT HI	
	1:0164	AL227 FTPS 2 INPUT VOLT LO	
	1:0165	SD227 FTPS 2 INPUT VOLT LO	
	1:0166	AL228 FTPS 2 INPUT VOLT HI	
	1:0167	SD228 FTPS 2 INPUT VOLT HI	
	1:0168	AL230 5 VOLT SUPPLY XDRP A LO	
	1:0169	AL240 5 VOLT SUPPLY XDRP A HI	

	Address	Description	Multiplier
	1:0170	AL250 5 VOLT SUPPLY XDRP B LO	
	1:0171	AL260 5 VOLT SUPPLY XDRP B HI	
	1:0172	AL261 14V SUPPLY VOLT LO	
	1:0173	AL262 14V SUPPLY VOLT HI	
	1:0174	AL263 LS 05 WIRING FAULT	
	1:0175	AL264 LS 06 WIRING FAULT	
	1:0176	AL265 LS 07 WIRING FAULT	
	1:0177	AL266 LS 08 WIRING FAULT	
	1:0178	AL267 LS 09 WIRING FAULT	
	1:0179	AL268 LS 10 WIRING FAULT	
	1:0180	AL275 MPRD WIRING FAULT	
	1:0181	SD310 CAN1 RX TX ERROR	
	1:0182	AL311 CAN2 RX TX ERROR	
	1:0183	SD320 CAN1 HARDWARE FAULT	
	1:0184	AL321 CAN2 HARDWARE FAULT	
	1:0185	SD330 SUPPLY VOLT LO	
	1:0186	SD340 SUPPLY VOLT HI	
	1:0187	AL350 SPD BIAS INPUT VOLT LO	
	1:0188	AL360 SPD BIAS INPUT VOLT HI	
	1:0189	AL365 SPEED BIAS PWM FAULT	
	1:0190	AL370 MISFIRE DETECTED AL	
	1:0191	SD380 MISFIRE DETECTED SD	
	1:0192	AL440 MAX FUEL / ENGINE OVERLOAD	
	1:0193	AL441 LO POWER	
	1:0194	SD442 UNCONTROLLED OVERPOWER	
	1:0195	AL443 CAT DIFF PRESSURE H	
	1:0196	SD444 CAT DIFF PRESSURE HH	
	1:0197	AL445 CAT DIFF PRESSURE L	
	1:0198	SD446 CAT DIFF PRESSURE LL	
	1:0199	AL447 PRE-CAT PRESSURE H	
	1:0200	SD448 PRE-CAT PRESSURE HH	
	1:0201	AL449 POST-CAT PRESSURE H	
	1:0202	SD450 POST-CAT PRESSURE HH	
	1:0203	AL451 PRE-CAT TEMP H	
	1:0204	SD452 PRE-CAT TEMP HH	
	1:0205	AL453 POST-CAT TEMP H	
	1:0206	SD454 POST-CAT TEMP HH	
	1:0207	AL455 HEGO 1 CURRENT H	
	1:0208	SD456 HEGO 1 CURRENT HH	
	1:0209	AL457 HEGO 3 CURRENT H	

	Address	Description	Multiplier
	1:0210	SD458 HEGO 3 CURRENT HH	
	1:0211	AL470 PRE-CAT TEMP L	
	1:0212	SD475 PRE-CAT TEMP LL	
	1:0213	AL485 LUBE OIL PRESS L	
	1:0214	SD486 LUBE OIL PRESS LL	
	1:0215	AL487 LUBE OIL PRESS L DERATE	
	1:0216	AL490 LUBE OIL LVL L	
	1:0217	SD491 LUBE OIL LVL LL	
	1:0218	AL492 LUBE OIL LVL L DERATE	
	1:0219	AL495 COOLING WATER LVL L	
	1:0220	SD496 COOLING WATER LVL LL	
	1:0221	AL497 COOLING WATER LVL L DERATE	
	1:0222	SD498 EXTERNAL SD 1 ACTIVE	
	1:0223	SD499 EXTERNAL SD 2 ACTIVE	
	1:0224	AL550 HEGO 1 VOLT LO	
	1:0225	SD550 HEGO 1 VOLT LO	
	1:0226	AL555 HEGO 1 VOLT HI	
	1:0227	SD555 HEGO 1 VOLT HI	
	1:0228	AL560 HEGO 1 SENSOR FAILED	
	1:0229	SD560 HEGO 1 SENSOR FAILED	
	1:0230	AL561 HEGO 1 HEATER OPEN CIRCUIT	
	1:0231	AL565 HEGO 2 VOLT LO	
	1:0232	SD565 HEGO 2 VOLT LO	
	1:0233	AL570 HEGO 2 VOLT HI	
	1:0234	SD570 HEGO 2 VOLT HI	
	1:0235	AL575 HEGO 2 SENSOR FAILED	
	1:0236	SD575 HEGO 2 SENSOR FAILED	
	1:0237	AL576 HEGO 3 HEATER OPEN CIRCUIT	
	1:0238	AL580 HEGO 3 VOLT LO	
	1:0239	SD580 HEGO 3 VOLT LO	
	1:0240	AL585 HEGO 3 VOLT HI	
	1:0241	SD585 HEGO 3 VOLT HI	
	1:0242	AL590 HEGO 3 SENSOR FAILED	
	1:0243	SD590 HEGO 3 SENSOR FAILED	
	1:0244	SD700 RATEGROUP SLIP	
	1:0245	SD701 PCMHD HI TEMP	
	1:0246	SD702 PCMHD ROM FAULT	
	1:0247	SD703 PCMHD RAM FAULT	
	1:0248	AL704 EE BACKUP FAULT	
	1:0249	SD1000 ERROR MISSING RING GEAR SIG	

	Address	Description	Multiplier
	1:0250	SD1001 ERROR MISSING RESET SIGNAL	
	1:0251	SD1002 ERROR MISSING CAMSHAFT SIGNAL	
	1:0252	SD1004 UNKNOWN ENGINE APP CODE	
	1:0253	SD1005 IC-92X OVERSPEED SD	
	1:0254	SD1006 EEPROM CHECKSUM ERROR	
	1:0255	AL1007 GLOBAL TIMING OUT OF RANGE	
	1:0256	SD1008 UNKNOWN TIMING OR ENERGY LVL	
	1:0257	AL1009 INDV TIMING OUT OF RANGE	
	1:0258	SD1010 OPEN PRIMARY RATE EXCEEDED	
	1:0259	SD1011 IC-92X SELF-TEST SHUTDOWN	
	1:0260	AL1012 OPEN PRIMARY CHANNEL 1	
	1:0261	AL1013 OPEN PRIMARY CHANNEL 2	
	1:0262	AL1014 OPEN PRIMARY CHANNEL 3	
	1:0263	AL1015 OPEN PRIMARY CHANNEL 4	
	1:0264	AL1016 OPEN PRIMARY CHANNEL 5	
	1:0265	AL1017 OPEN PRIMARY CHANNEL 6	
	1:0266	AL1018 OPEN PRIMARY CHANNEL 7	
	1:0267	AL1019 OPEN PRIMARY CHANNEL 8	
	1:0268	AL1020 OPEN PRIMARY CHANNEL 9	
	1:0269	AL1021 OPEN PRIMARY CHANNEL 10	
	1:0270	AL1022 OPEN PRIMARY CHANNEL 11	
	1:0271	AL1023 OPEN PRIMARY CHANNEL 12	
	1:0272	AL1024 OPEN PRIMARY CHANNEL 13	
	1:0273	AL1025 OPEN PRIMARY CHANNEL 14	
	1:0274	AL1026 OPEN PRIMARY CHANNEL 15	
	1:0275	AL1027 OPEN PRIMARY CHANNEL 16	
	1:0276	AL1028 OPEN PRIMARY CHANNEL 17	
	1:0277	AL1029 OPEN PRIMARY CHANNEL 18	
	1:0278	AL1030 OPEN PRIMARY CHANNEL 19	
	1:0279	AL1031 OPEN PRIMARY CHANNEL 20	
	1:0280	AL1032 OPEN PRIMARY CHANNEL 21	
	1:0281	AL1033 OPEN PRIMARY CHANNEL 22	
	1:0282	AL1034 OPEN PRIMARY CHANNEL 23	
	1:0283	AL1035 OPEN PRIMARY CHANNEL 24	
	1:0284	AL1037 SCR FAULT ODD	
	1:0285	AL1038 SCR FAULT EVEN	
	1:0286	AL1045 ODD ENERGY LVL OUT OF RANGE	
	1:0287	AL1046 EVEN ENERGY LVL OUT OF RANGE	
	1:0288	SD1300 THROTTLE 1 SHUTDOWN	
	1:0289	AL1301 THROTTLE 1 ALARM	

	Address	Description	Multiplier
	1:0290	AL1305 THROTTLE 1 POSITION ERROR	
	1:0291	SD1305 THROTTLE 1 POSITION ERROR	
	1:0292	SD1308 THROTTLE 1 WATCHDOG CAN TIMEOUT	
	1:0293	SD1310 THROTTLE 2 SHUTDOWN	
	1:0294	AL1311 THROTTLE 2 ALARM	
	1:0295	AL1315 THROTTLE 2 POSITION ERROR	
	1:0296	SD1315 THROTTLE 2 POSITION ERROR	
	1:0297	SD1318 THROTTLE 2 WATCHDOG CAN TIMEOUT	
	1:0298	SD1320 FTV 1 SHUTDOWN	
	1:0299	AL1321 FTV 1 ALARM	
	1:0300	AL1325 FTV 1 POSITION ERROR	
	1:0301	SD1325 FTV 1 POSITION ERROR	
	1:0302	SD1328 FTV 1 WATCHDOG CAN TIMEOUT	
	1:0303	SD1330 FTV 2 SHUTDOWN	
	1:0304	AL1331 FTV 2 ALARM	
	1:0305	AL1335 FTV 2 POSITION ERROR	
	1:0306	SD1335 FTV 2 POSITION ERROR	
	1:0307	SD1338 FTV 2 WATCHDOG CAN TIMEOUT	
	1:0308	AL1348 IGNITION CAN WATCHDOG TIMEOUT	
	1:0309	AL1349 TC NODE WATCHDOG CAN TIMEOUT	
	1:0310	AL1401 CYLINDER 1 OPEN CIRCUIT	
	1:0311	SD1401 CYLINDER 1 OPEN CIRCUIT	
	1:0312	AL1402 CYLINDER 2 OPEN CIRCUIT	
	1:0313	SD1402 CYLINDER 2 OPEN CIRCUIT	
	1:0314	AL1403 CYLINDER 3 OPEN CIRCUIT	
	1:0315	SD1403 CYLINDER 3 OPEN CIRCUIT	
	1:0316	AL1404 CYLINDER 4 OPEN CIRCUIT	
	1:0317	SD1404 CYLINDER 4 OPEN CIRCUIT	
	1:0318	AL1405 CYLINDER 5 OPEN CIRCUIT	
	1:0319	SD1405 CYLINDER 5 OPEN CIRCUIT	
	1:0320	AL1406 CYLINDER 6 OPEN CIRCUIT	
	1:0321	SD1406 CYLINDER 6 OPEN CIRCUIT	
	1:0322	AL1411 CYLINDER 1 SHORT CIRCUIT	
	1:0323	SD1411 CYLINDER 1 SHORT CIRCUIT	
	1:0324	AL1412 CYLINDER 2 SHORT CIRCUIT	
	1:0325	SD1412 CYLINDER 2 SHORT CIRCUIT	
	1:0326	AL1413 CYLINDER 3 SHORT CIRCUIT	
	1:0327	SD1413 CYLINDER 3 SHORT CIRCUIT	
	1:0328	AL1414 CYLINDER 4 SHORT CIRCUIT	
	1:0329	SD1414 CYLINDER 4 SHORT CIRCUIT	

	Address	Description	Multiplier
	1:0330	AL1415 CYLINDER 5 SHORT CIRCUIT	
	1:0331	SD1415 CYLINDER 5 SHORT CIRCUIT	
	1:0332	AL1416 CYLINDER 6 SHORT CIRCUIT	
	1:0333	SD1416 CYLINDER 6 SHORT CIRCUIT	
	1:0334	SD1430 ALL COILS OPEN CIRCUIT FLT	
	1:0335	SD1440 ALL COILS SHORT CIRCUIT FLT	
	1:0336	AL1450 EASYGEN J1939 TIMEOUT	
	1:0337	AL1451 EASYGEN STOP COMMAND	
	1:0338	AL1460 MODBUS LINK ERROR	
	1:0339	AL1461 MODBUS EXCEPTION ERROR	
Analog Reads			**Multiplier**
	3:0001	AFR MODE STATE	1
	3:0002	SOV SEQUENCE STATE	1
	3:0003	AFR SEQUENCE STATE	1
	3:0004	CURRENT RUN DURATION(HRS)	10
	3:0005	TOTAL RUN HOURS(HRS)	1
	3:0006	TOTAL RUN HOURS 2ND WORD(HRS)	1
	3:0007	ENGINE SPEED(RPM)	10
	3:0008	SPEED REFERENCE(RPM)	10
	3:0009	MISFIRE LEVEL(RPM/SEC^2)	1000
	3:0010	MISFIRE ALARM LEVEL(RPM/SEC^2)	1000
	3:0011	MISFIRE SD LEVEL(RPM/SEC^2)	1000
	3:0012	THROTTLE 1(%)	10
	3:0013	THROTTLE 2(%)	10
	3:0014	TRIM VALVE 1(%)	10
	3:0015	TRIM VALVE 2(%)	10
	3:0016	IGNITION ADVANCE(DEG BTDC)	10
	3:0017	ECT TIMING BIAS(DEG ADV)	10
	3:0018	IGNITION BASE(DEG BTDC)	10
	3:0019	MANUAL ADVANCE(DEG ADV)	10
	3:0020	MAP USED(PSIA)	10
	3:0021	MANIFOLD PRS BANK 1(PSIA)	100
	3:0022	MANIFOLD PRS BANK 2(PSIA)	100
	3:0023	MAT USED(DEG F)	10
	3:0024	MANIFOLD TEMP BANK 1(DEG F)	10
	3:0025	MANIFOLD TEMP BANK 2(DEG F)	10
	3:0026	Q MIX TOTAL(SCFM)	1
	3:0027	Q MIX BANK 1(SCFM)	1
	3:0028	Q MIX BANK 2(SCFM)	1
	3:0029	BASE TRIM VALUE BANK 1(%)	10

	Address	Description	Multiplier
	3:0030	BASE TRIM VALUE BANK 2(%)	10
	3:0031	OPENLOOP VALUE BANK 1(%)	10
	3:0032	OPENLOOP VALUE BANK 2(%)	10
	3:0033	AFR SETPOINT BANK 1(MV)	1
	3:0034	AFR SETPOINT BANK 2(MV)	1
	3:0035	AFR SIGNAL RUN AVG BANK 1(MV)	1
	3:0036	AFR SIGNAL RUN AVG BANK 2(MV)	1
	3:0037	AFR SIGNAL BANK 1(MV)	1
	3:0038	AFR SIGNAL BANK 2(MV)	1
	3:0039	EXTERNAL CORRECTION BIAS(MV)	10
	3:0040	POST-CAT SETPOINT(MV)	10
	3:0041	POST-CAT HEGO RAW(MV)	1
	3:0042	POST-CAT HEGO AVG(MV)	1
	3:0043	POST-CAT HEGO3(MV)	1
	3:0044	POST-CAT PID BIAS(%)	10
	3:0045	POST-CAT 15-MIN AVERAGE(MV)	1
	3:0046	PRE-CAT HEGO1(MV)	1
	3:0047	PRE-CAT HEGO2(MV)	1
	3:0048	PRE-CAT HEGO VOLTAGE BANK 1(MV)	1
	3:0049	PRE-CAT HEGO VOLTAGE BANK 2(MV)	1
	3:0050	HEGO 1 HEATER CURRENT(A)	1000
	3:0051	HEGO 3 HEATER CURRENT(A)	1000
	3:0052	AMPLITUDE BANK 1(%)	100
	3:0053	AMPLITUDE BANK 2(%)	100
	3:0054	FREQUENCY(HZ)	100
	3:0055	LOAD REFERENCE PERCENT(%)	100
	3:0056	MAP FULL LOAD PERCENT(%)	10
	3:0057	LOAD FULL LOAD PERCENT(%)	10
	3:0058	PRE-CAT PID BANK 1(%)	10
	3:0059	PRE-CAT PID BANK 2(%)	10
	3:0060	CAT DIFF PRESS CALC(IN H2O)	100
	3:0061	CAT DIFF PRESS INPUT(IN H2O)	100
	3:0062	PRE-CAT PRESS(IN H2O)	100
	3:0063	POST-CAT/AMBIENT PRS(IN H2O)	100
	3:0064	PRE-CAT TEMP(DEG F)	1
	3:0065	POST-CAT TEMP(DEG F)	1
	3:0066	CAT TEMP RISE(DEG F)	1
	3:0067	TPS 1(%)	10
	3:0068	TPS 2(%)	10
	3:0069	FTPS 1(%)	10

	Address	Description	Multiplier
	3:0070	FTPS 2(%)	10
	3:0071	LOAD(KW)	1
	3:0072	MAP 1(PSIA)	10
	3:0073	MAP 2(PSIA)	10
	3:0074	MAT 1(DEG F)	10
	3:0075	MAT 2(DEG F)	10
	3:0076	LUBE OIL PRS(PSI)	100
	3:0077	LUBE OIL TEMPERATURE(DEG F)	10
	3:0078	ENGINE COOLANT TEMP(DEG F)	10
	3:0079	REMOTE REF(%)	10
	3:0080	SPEED BIAS(RPM)	10
	3:0081	SPEED MON HI(RPM)	10
	3:0082	SPEED MON LO(RPM)	10
	3:0083	MISFIRE MON HI(RPM/SEC^2)	1000
	3:0084	MISFIRE MON LO(RPM/SEC^2)	1000
	3:0085	CAT DELTA PRS MON HI(IN H2O)	100
	3:0086	CAT DELTA PRS MON LO(IN H2O)	100
	3:0087	PRE-CAT PRS MON HI(IN H2O)	100
	3:0088	PRE-CAT PRS MON LO(IN H2O)	100
	3:0089	PRE-CAT TEMP MON HI(DEG F)	1
	3:0090	PRE-CAT TEMP MON LO(DEG F)	1
	3:0091	POST-CAT TEMP MON HI(DEG F)	1
	3:0092	POST-CAT TEMP MON LO(DEG F)	1
	3:0093	CAT TEMP RISE MON HI(DEG F)	1
	3:0094	CAT TEMP RISE MON LO(DEG F)	1
	3:0095	15 MIN AVERAGE MON HI(MV)	1
	3:0096	15 MIN AVERAGE MON LO(MV)	1
Analog Writes			**Multiplier**
	4:0001	REMOTE LOAD REFERENCE(kW)	1
	4:0002	REMOTE SPEED REFERENCE(RPM)	1

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26473.

WOODWARD

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

Complete address / phone / fax / email information for all locations is available on our website.