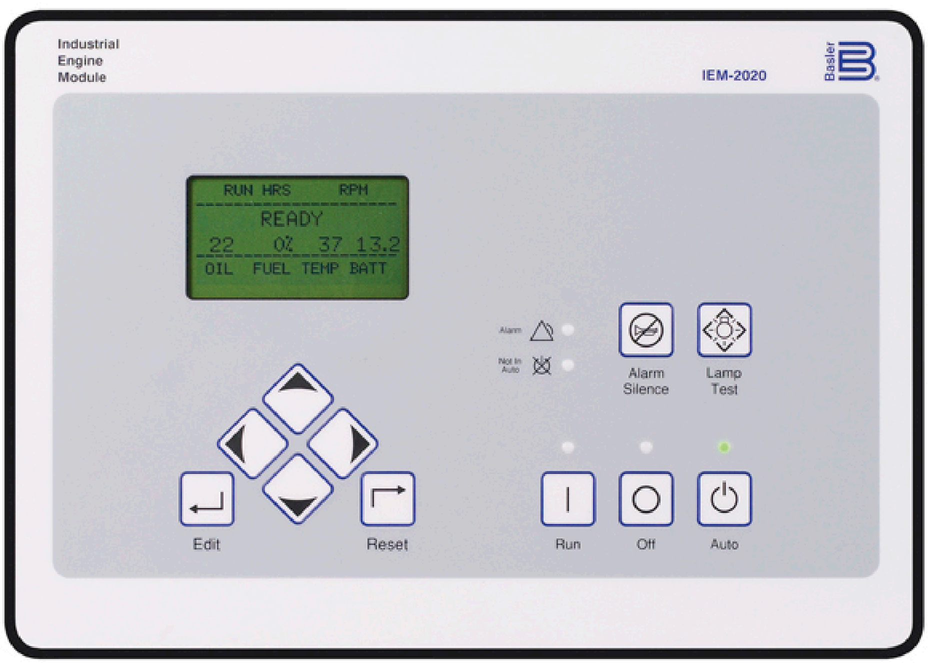
INSTRUCTION MANUAL

FOR

INDUSTRIAL ENGINE MODULE
IEM-2020



Basler Electric®

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Revision: C 06/17

INTRODUCTION

This instruction manual provides information about the operation and installation of the IEM-2020 Industrial Engine Module. To accomplish this, the following information is provided:

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Graphical User Interface Operation
- Installation
- Setup
- Maintenance and Troubleshooting
- LSM-2020 (Load Share Module)
- CEM-2020 (Contact Expansion Module)
- AEM-2020 (Analog Expansion Module)
- Modbus® Communication
- Logic Library Files
- MTU Fault Codes
- Exhaust Treatment

Warning!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures in this manual.

Note

Check for the latest version of this instruction manual at www.basler.com.

IEM-2020 controllers are mounted using the four permanently-attached 10-24 studs and the provided self-locking nuts. Failure to use the proper 10-24 locking nuts may damage the stud threads and/or improperly secure the IEM-2020.

Be sure that the controller is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the rear of the unit. When the controller is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

The IEM-2020 utilizes password protection that guards against unauthorized changing of IEM-2020 settings. Instructions for changing passwords are provided in Section 4, *BESTCOMSPlus® Software, General Settings, Device Security Setup.* The default passwords are listed below.

- OEM access level: **OEM**
- Settings access level: **SET**
- Operator access level: **OP**

BOX DEFINITIONS

Warning!

A warning box indicates a potentially hazardous situation which could result in death or injury.

Caution

A caution box indicates a potentially hazardous situation which could result in equipment or property damage.

Note

A note box provides helpful information.

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REVISION HISTORY

The following information provides a historical summary of the changes made to this instruction manual (9441000990), BESTCOMS*Plus*® software, firmware package, and hardware of the IEM-2020.

Manual Revision and Date	Change
C, 06/17	• Updated UL and CSA Certifications for IEM-2020, LSM-2020, AEM-2020, and CEM-2020. • Removed CE Compliance from IEM-2020 and LSM-2020. • Added EU Compliance for IEM-2020 and LSM-2020. • Added EAC Mark for IEM-2020, LSM-2020, CEM-2020, and AEM-2020. • Added caution statement about nonvolatile memory. • Added Status LED description to LSM-2020, CEM-2020, and AEM-2020 sections. • Added descriptions for Modbus registers 45004, 45106-45168.
B, 02/14	• External modules (AEM-2020, CEM-2020, and LSM-2020) now have gold-plated communication terminals for increased signal integrity. • Removed product registration information. • Minor text edits.
A, 07/12	• Revised to support firmware package version 1.01.02. (See firmware package version history). • Revised to support BESTCOMS*Plus* versions 2.12.01, 2.11.02, 2.11.01, 2.11.01, 2.10.02, 2.08.01, and 2.07.01. (See BESTCOMS*Plus* revision history.)
—, 01/10	• Initial release

BESTCOMS*Plus*® Version and Date	Change
3.17.00, 05/17	• Maintenance release (DGC-2020HD, BE1-11, and DECS-250 changes)
3.15.00, 09/16	• Maintenance release (DGC-2020HD changes)
3.14.00, 07/16	• Maintenance release (DECS-250E launch, DECS-150 and BE1-11 changes)
3.12.00, 03/16	• Changed to keep Offline Simulator button enabled after sending settings to the device. • Added Windows® 10 compatibility
3.11.00, 11/15	• Maintenance release (BE1-11 changes)
3.10.00, 06/15	• Maintenance release (DECS-150 release)
3.09.00, 04/15	• Maintenance release (DGC-2020HD changes)
3.08.02, 02/15	• Maintenance release (DGC-2020HD changes)
3.08.00, 02/15	• Maintenance release (DECS-250 changes)
3.07.03, 01/15	• Maintenance release (DECS-250 changes)

BESTCOMS*Plus*® Version and Date	Change
3.07.00, 10/14	• Added Load Share and Control Diagnostics screens. • Changed to allow the Metering Status screen to open before a connection is made. • Removed duplicate results in the device discovery list. • Improvements to device directory on Connection screen. • Changed how the LSM-2020 model number is reported on the Device Info screen. • Changed to allow a comma in the Device ID. • Changed to annunciate a connection failure message when a device is not present on a selected port. • Improved prompts to save settings when choosing to close all open views. • Changed to hide security settings for the LSM-2020 when opening a settings file. • Changed to allow the middle mouse button to close the security view. • Improved display of raw analog input currents. • Changed to make BESTlogic*Plus* status LEDs report all logic errors.
3.06.00, 04/14	• Maintenance release (BE1-11 changes)
3.05.03, 03/14	• Maintenance release (DECS-250N changes)
3.05.02, 12/13	• Maintenance release
3.04.00, 08/13	• Maintenance release
3.03.03, 08/13	• Updated to support firmware package version 1.01.04 (see firmware package version history).
3.03.00, 07/13	• Maintenance release
3.02.00, 02/13	• Maintenance release
3.01.01, 11/12	• Maintenance release
3.00.02, 09/12	• Maintenance release
2.14.00, 07/12	• Maintenance release
2.13.00, 04/12	• Updated to support firmware package version 1.01.02 (see firmware package version history).
2.11.02, 12/11	• Added the ability to disable settings download after reconnect or initial connect on the *Advanced Properties* dialog in the *IEM-2020 Connection* screen. • Improved workspace files.
2.11.01, 11/11	• Enhanced settings file printout.
2.10.02, 06/11	• Added the ability to select what data to view/export from the Preview Metering and Export Metering buttons. • Added the ability to save workspace. • Added the ability to auto reconnect when connection is lost. • Added ability to close multiple views. • Enhanced BESTlogic*Plus*.
2.08.01, 10/10	• Improved off-page logic.
2.08.00, 08/10	• Changes invisible to the user.
2.07.03, 06/10	• Changes invisible to the user.
2.07.01, 03/10	• Added Windows® 7 64-bit compatibility and removed Windows 2000 compatibility.

BESTCOMS*Plus*® Version and Date	Change
2.06.02, 01/10	• Initial release

Firmware Package Version and Date	Change
1.01.04, 08/13	• Fixed a bug which caused settings to revert to default when power was removed while saving system state. • Fixed a bug which did not allow the IEM-2020 to shut down in AUTO when ATS was removed, or in OFF mode (CAN Bus units only).
1.01.02, 04/12	• Added support for local analog inputs. • Added RPM Profile. • Added PID loop capability to control measured parameters. • Added RPM request over CANBus. • Added seven-day timer. • Added raise/lower through the front panel HMI. • Added modem setup through the front panel HMI. • Enhanced configurable protection. • Enhanced HMI and Metering views. • Enhanced ECU support. • Enhanced J1939.
1.00.00, 11/09	• Initial release

IEM-2020 Hardware Revision and Date	Change
G, 02/17	• New enclosure.
F, 07/15	• Improved membrane.
E, 08/13	• Updated to support firmware package version 1.01.04 (see firmware package version history).
D, 07/13	• New front-panel encasement now properly accommodates LCD heater wires.
C, 06/13	• New front-panel encasement.
B, 07/12	• Added local analog inputs.
A, 01/10	• Documentation update.
—, 01/10	• Initial release

DETAILED FIRMWARE RELEASE HISTORY

Pkg. File Ver.	Industrial Engine Module (IEM-2020)			Load Share Module (LSM-2020)		Contact Expansion Module (CEM-2020/H)	Analog Expansion Module (AEM-2020)
	Application Code	Flash Language Module		CAN Bus App.	Ethernet App.		
	Version & P/N	Version & P/N	Lang.*	Version & P/N	Version & P/N	Version & P/N	Version & P/N
1.01.04	2.01.04 08/13/13 9441003005/-006 1.01.04 08/13/13 9441001007/-008	1.01.02 04/18/12 9441001006	E,C,S	1.02.04 03/29/12 9417501018	1.02.04 03/29/12 9417501019	1.01.03 03/29/12 9421001013	1.00.04 03/29/12 9421103001
1.01.02	2.01.02 04/18/12 9441003001/-002 1.01.02 04/18/12 9441001004/-005	1.01.02 04/17/12 9441001006	E,C,S	1.02.04 03/29/12 9417501018	1.02.04 03/29/12 9417501019	1.01.03 03/29/12 9421001013	1.00.04 03/29/12 9421103001
1.00.00	1.00.00 11/09/09 9441001001	1.00.00 11/05/09 9441001003	E,C,S	1.00.05 12/09/08 9417501012	1.00.05 12/09/08 9417501013	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009

* E = English, C = Chinese, S = Spanish

Note: For a firmware upgrade procedure, refer to Section 4, *BESTCOMSPlus® Software.*

CONTENTS

SECTION 1 • GENERAL INFORMATION

TABLE OF CONTENTS

Figures

SECTION 1 • GENERAL INFORMATION

Description

The IEM-2020 Industrial Engine Module provides integrated engine control, protection, and metering in a single package. Microprocessor based technology allows for exact measurement, setpoint adjustment, and timing functions. Front panel controls and indicators enable quick and simple IEM-2020 operation. Basler Electric communication software (BESTCOMS*Plus*®) allows units to be easily customized for each application. A wide temperature-range liquid crystal display (LCD) with backlighting can be viewed under a wide range of ambient light and temperature conditions.

Features

IEM-2020 Industrial Engine Modules have the following features:

- Local and Remote Engine Control
- Local Analog Inputs
- Engine Protection
- Programmable Analog Engine Senders
- ECU Communications via SAE J1939
- 16 Programmable Contact Inputs
- Programmable Logic
- Integrated RS485 (optional)
- Exercise Timer
- Additional modules available to expand the capabilities of the IEM-2020

Functions

IEM-2020 Modules perform the following functions:

Engine Protection and Metering

Engine protection features include oil pressure and coolant temperature monitoring, overcrank protection, ECU specific protection elements, and diagnostic reporting.

Metered engine parameters include oil pressure, coolant temperature, battery voltage, speed, fuel level, coolant level (from ECU), ECU specific parameters, and run-time statistics.

Event Recording

An event log retains a history of system events in nonvolatile memory. Up to 30 event types are retained and each record contains a time stamp of the first and last occurrence, and the number of occurrences for each event. Details of the most recent 30 occurrences of each event type are recorded. Thus, details of up to 900 event occurrences are recorded. For more information, see Section 3, *Functional Description, Event Recording.*

Contact Inputs and Output Contacts

IEM-2020 modules have one dedicated emergency stop contact input and 16 programmable contact inputs. All contact inputs recognize dry contacts. The programmable inputs can be configured to initiate a pre-alarm or alarm. A programmable input can be programmed to receive an input from an automatic transfer switch or override IEM-2020 alarms and protection functions. Each programmable input can be assigned a user-defined name for easy identification at the front panel display and in fault records.

Output contacts include three dedicated relays for energizing an engine’s glow plugs, fuel solenoid, and starter solenoid. An additional four user-programmable output contacts are provided if the style number is xxAxxxxxx. If the style number is xxBxxxxxx, an additional twelve output contacts are provided.

Additional contact inputs and output contacts can be accommodated with an optional CEM-2020 (Contact Expansion Module). Contact Basler Electric for ordering information.

Analog Inputs

The IEM-2020 provides a 0 to 10 Vdc voltage input and a 4 to 20 mAdc current input. Each analog input has under/over thresholds that can be configured as status only, alarm, or pre-alarm. When enabled, an out of range alarm alerts the user of an open or damages analog input wire. The label text of each analog input is customizable. Analog inputs can be incorporated into a BESTlogic*Plus* programmable logic scheme.

Additional analog inputs can be accommodated with an optional AEM-2020 (Analog Expansion Module). Contact Basler Electric for ordering information.

Communication

Standard IEM-2020 communication features include a standard USB port and SAE J1939 interface. Optional communication features include a dial-out modem and RS-485 communication port. BESTCOMS*Plus* can communicate with the IEM-2020 through Ethernet via an optional LSM-2020 (Load Share Module). Contact Basler Electric for ordering information.

USB Port

A USB communication port can be used with BESTCOMS*Plus* software to quickly configure an IEM-2020 with the desired settings or retrieve metering values and event log records.

CAN Bus Interface

A CAN Bus interface provides high-speed communication between the IEM-2020 and the engine control unit (ECU) on an electronically controlled engine. This interface provides access to oil pressure, coolant temperature, and engine speed data by reading these parameters directly from the ECU. When available, engine diagnostic data can also be accessed. The CAN Bus interface supports the following protocols:

- SAE J1939 Protocol - Oil pressure, coolant temperature, and engine speed data are received from the ECU. In addition, DTCs (Diagnostic Trouble Codes) help diagnose any engine or related failures. The engine DTCs are displayed on the front panel of the IEM-2020 and may be obtained using BESTCOMS*Plus* software.
- MTU Protocol - An IEM-2020 connected to an engine equipped with an MTU engine ECU receives Oil pressure, coolant temperature, and engine speed data from the engine controller, along with various alarms and pre-alarms that are MTU specific. In addition, the IEM-2020 tracks and displays the active fault codes issued by the MTU engine ECU.

Dial-Out Modem

The optional dial-out modem enables remote control, monitoring, and setting of the IEM-2020. When an alarm or pre-alarm condition occurs, the IEM-2020 can dial up to four telephone numbers, in sequence, until an answer is received and the condition is annunciated.

RS-485 Port

An optional RS-485 communication port uses the Modbus® communication protocol and enables remote control and monitoring of the IEM-2020 over a polled network.

AEM-2020 (Analog Expansion Module)

The optional AEM-2020 provides eight remote analog inputs, eight remote RTD inputs, two remote thermocouple inputs, and four remote analog outputs to the IEM-2020. The AEM-2020 communicates with the IEM-2020 through a CAN Bus interface. Refer to Section 11, *AEM-2020 (Analog Expansion Module),* for more information.

CEM-2020 (Contact Expansion Module)

The optional CEM-2020 provides 10 additional contact inputs and 18 or 24 additional output contacts (depending on module type) to the IEM-2020. The CEM-2020 communicates with the IEM-2020 through a CAN Bus interface. Refer to Section 10, *CEM-2020 (Contact Expansion Module),* for more information.

LSM-2020 (Load Share Module)

The optional LSM-2020 in conjunction with the IEM-2020 provides The LSM-2020 communicates through an Ethernet port and provides access to the IEM-2020 via Ethernet. Refer to Section 9, *LSM-2020 (Load Share Module),* for more information.

Style and Part Numbers

Style Number

Standard-order IEM-2020 modules are identified by a style number which consists of a combination of letters and numbers that define the module's electrical characteristics and operational features. The model number, together with the style number, describes the options included in a specific module. Figure 1-1 illustrates the IEM-2020 style number identification chart.

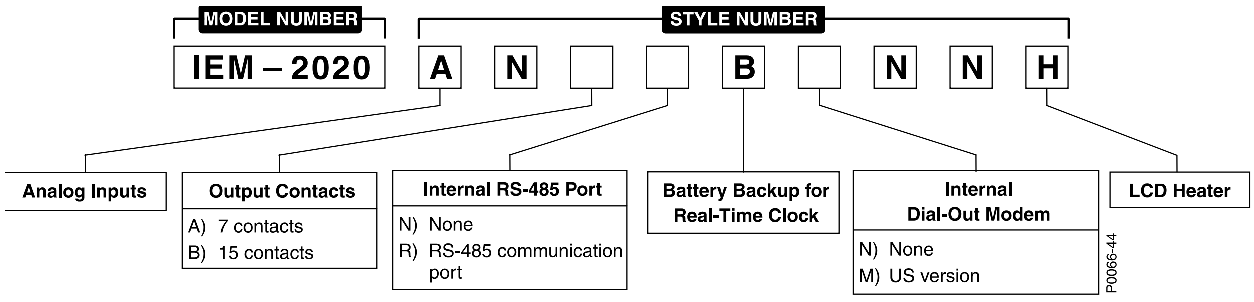


Figure 1-1. IEM-2020 Style Chart

For example, if an IEM-2020 style number were **ANBNBMNNH**, the module would have the following characteristics and operating features.

A .... One Voltage Analog Input and One Current Analog Input
B .... Three fixed-function output contacts and 12 programmable output contacts
N .... No RS-485 communication port
B .... Battery backup for real-time clock during losses of control power
M .... Internal dial-out modem—US version
H .... LCD heater

Previous Versions

Prior to July 2012, IEM-2020s were not equipped with local analog inputs. The style chart in Figure 1-2 identifies the previous features and capabilities of the IEM-2020. All subsequent references to local analog inputs do not apply.

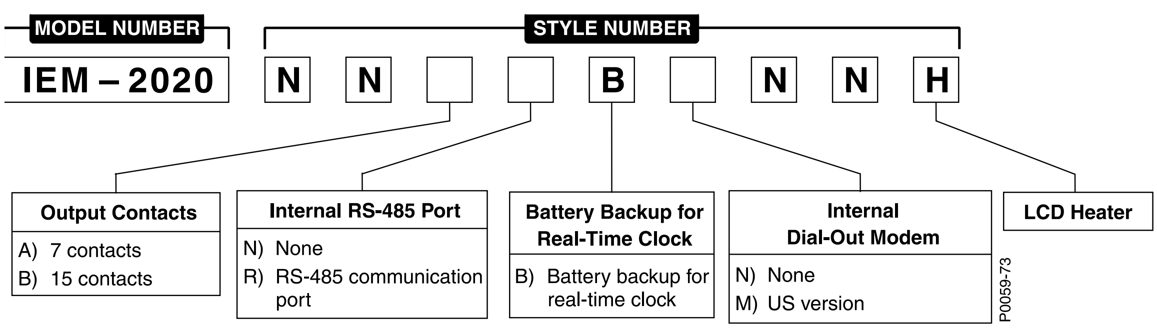


Figure 1-2. IEM-2020 Style Chart for Previous Versions

All subsequent references to local analog inputs do not apply to these previous versions of the IEM-2020.

Specifications

Operating Power

Nominal..12 or 24 Vdc
Range ....6 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms)
Terminals...3 (+), 2 (–), 1 (chassis ground)

Power Consumption

Sleep Mode......................................5W with all relays non-energized
Normal Operational Mode ....7.9W - Run mode, LCD heater off, 3 relays energized
Maximum Operational Mode ....14.2W - Run mode, LCD heater on, 6 relays energized

Battery Ride Through

Withstands cranking ride-through down to 0 V for 50 ms

Contact Sensing

Contact sensing inputs include 1 emergency stop input and 16 programmable inputs. All inputs accept dry contacts.

Time from an IEM-2020 input application to:

Shutdown the engine via an alarm = 490 ms max
Close a relay on board the IEM-2020 = 215 ms max
Close a relay on board the CEM-2020 = 400 ms max

Terminals

Emergency Stop 46, 47

Programmable

Input 1...30, 2
Input 2...29, 2
Input 3...28, 2
Input 4...27, 2
Input 5...26, 2
Input 6...25, 2
Input 7...24, 2
Input 8...23, 2
Input 9...22, 2
Input 10...21, 2
Input 11...20, 2
Input 12...19, 2
Input 13...18, 2
Input 14...17, 2
Input 15...16, 2
Input 16...15, 2

Engine System Inputs

∗ Stated accuracies are subject to the accuracy of the senders used. Values within these ranges are deemed “acceptable” and the IEM-2020 will use them for the appropriate calculation and protection. Values outside these ranges are deemed “unacceptable” and the IEM-2020 will begin timing towards a sender failure condition.

Fuel Level Sensing

Resistance Range ....5 to 280 Ω nominal
Terminals...9, 11 (sender common)

Coolant Temperature Sensing

Resistance Range ....5 to 3,100 Ω nominal
Terminals...10, 11 (sender common)

Oil Pressure Sensing

Resistance Range ....5 to 250 Ω nominal
Terminals...8, 11 (sender common)

Engine Speed Sensing

Magnetic Pickup

Voltage Range ....3 to 35 V peak (6 to 70 V peak-peak)
Frequency Range ....32 to 10,000 Hz
Terminals...31 (+), 32 (–)

Output Contacts

PRESTART, START, and *RUN Relays*

Rating ....30 Adc at 28 Vdc—make, break, and carry

Programmable Relays (12)

Rating ....2 Adc at 30 Vdc—make, break, and carry

Terminals*

Output 1 ....52, 51 (common)
Output 2 ....53, 51 (common)
Output 3 ....54, 51 (common)
Output 4 ....56, 55 (common)
Output 5 ....57, 55 (common)
Output 6 ....58, 55 (common)
Output 7 ....60, 59 (common)
Output 8 ....61, 59 (common)
Output 9 ....62, 59 (common)
Output 10 ....64, 63 (common)
Output 11 ....65, 63 (common)
Output 12 ....66, 63 (common)

* The number of programmable output contacts provided is determined by the output contacts character of the IEM-2020 style number. Modules with output contacts option A have 4 programmable outputs (Outputs 1, 2, 3, and 4). Modules with output contacts option B have 12 programmable outputs.

The programmable relays share common terminals: terminal 51 is used for outputs 1, 2, and 3, terminal 55 is used for outputs 4, 5, and 6, terminal 59 is used for outputs 7, 8, and 9, 63 is used for outputs 10, 11, and 12.

Analog Inputs

Voltage

Rating ....0 to 10 Vdc
Burden ....300k Ω minimum
Terminals ....43 (AIN V+) and 45 (AIN V–)

Current

Rating ....4 to 20 mAdc
Burden ....89 Ω maximum
Terminals ....35 (AIN I+) and 37 (AIN I–)

Metering

Oil Pressure

Metering Range ....0 to 150 psi, 0 to 10.3 bar, or 0 to 1,034 kPa
Accuracy ....±3% of actual indication or ±2 psi, ±0.12 bar, or ±12 kPa (subject to accuracy of sender)
Display Resolution ....1 psi, 0.1 bar, or 1 kPa

Coolant Temperature

Metering Range ....32 to 410°F or 0 to 204°C
Accuracy ....±3% of actual indication or ±2° (subject to accuracy of sender)

Battery Voltage

Metering Range ....6 to 32 Vdc
Accuracy ....±3% of actual indication or ±0.2 Vdc
Display Resolution ....0.1 Vdc

Engine RPM

Metering Range ....0 to 4,500 rpm
Accuracy* ....±2% of actual indication or ±2 rpm
Display Resolution ....2 rpm

∗ When engine speed is below 2% of full-scale, reported rpm is 0.

Engine Run Time

Engine run time is retained in nonvolatile memory.

Metering Range ....0 to 99,999 hours
Update Interval ....6 min
Accuracy ....±1% of actual indication or ±12 min
Display Resolution ....1 minute

Maintenance Timer

Maintenance timer indicates the time remaining until engine service is due. Value is retained in nonvolatile memory.

Metering Range ....0 to 5,000 hours
Update Interval ....6 min
Accuracy ....±1% or actual indication or ±12 min
Display Resolution ....1 minute

Fuel Level

Metering Range ....0 to 100%
Accuracy ....±2% (subject to accuracy of sender)
Display Resolution 1.0%

Logic Timers

Range
  Hours..0 to 250
    Increment.............................1
  Minutes......................................0 to 250
    Increment.............................1
  Seconds ....0 to 1,800
    Increment.............................0.1
Accuracy ....±15 ms

Communication Interface

USB

Specification Compatibility................USB 2.0
Data Transfer Speed ....9600 baud
Connector Type ....Mini-B jack

RS-485 (Optional)

Baud 9600
Data Bits 8
Parity...None
Stop Bits 1
Terminals ....14 (A), 13 (B), and 12 (shield)

RDP-110

Minimum Wire Size...........................20 AWG
Maximum Wire Length......................4,000 feet (1,219 meters)
Terminals ....6 (RDP TXD–), 7 (RDP TXD+)

CAN Bus

Differential Bus Voltage ....1.5 to 3 Vdc
Maximum Voltage ....–32 to +32 Vdc with respect to negative battery terminal
Communication Rate ....250 kb/s
Terminals ....48 (low), 49 (high), and 50 (shield)

Note

1. If the IEM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals 48 (CANL) and 49 (CANH).
2. If the IEM-2020 is not part of the J1939 bus, the stub connecting the IEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the IEM-2020.

Modem (Optional)

Connector Type ....RJ-11 jack

Real-Time Clock

Clock has leap year and selectable daylight saving time correction. Backup capacitor and backup battery sustain timekeeping during losses of IEM-2020 operating power.

Resolution..1 s
Accuracy..±1.73 s/d at 25°C

Clock Holdup

Battery Holdup Time.........................Approximately 10 yrs
Battery Type ....Rayovac BR2032, lithium, coin-type, 3 Vdc, 195 mAh
Basler Electric P/N 38526

Caution

Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings on the battery socket while inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.

It is recommended that the battery be removed if the IEM-2020 is to be operated in a salt-fog environment. Salt-fog is known to be conductive and may short-circuit the battery.

Note

Failure to replace the battery with Basler Electric P/N 38526 may void the warranty..

LCD Heater

The ambient temperature is monitored by a temperature sensor located near the LCD inside the IEM-2020. The LCD heater turns on when the ambient temperature falls below 0°C (32°F). The heater turns off when the ambient temperature rises above 5°C (41°F). This range of operation implements 5°C (9°F) of hysteresis between heater turn on and turn off.

Type Tests

Shock and Vibration EN60068-2-6
Dielectric Strength ....IEC 255-5
Impulse EN60664-1

Transients EN61000-4-4
Static Discharge................................ EN61000-4-2

Shock

Withstands 15 G in 3 perpendicular planes.

Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz .... 1.5 G peak for 5 minutes
29 to 52 to 29 Hz .... 0.036 inches (0.914 mm) double amplitude for 2.5 minutes
52 to 500 to 52 Hz .... 5 G peak for 7.5 minutes

Radio Interference

Type tested using a 5 W, hand-held transceiver operating at random frequencies centered around 144 and 440 MHz with the antenna located within 150 mm (6") of the device in both vertical and horizontal planes.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the IEM-2020 was subjected to temperature tests (tested over a temperature range of –100°C to +115°C), vibration tests (of 5 to 50 G at +20°C), and temperature/vibration tests (tested at 40 G over a temperature range of –80°C to +90°C). Combined temperature and vibration testing at these extremes proves that the IEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in Section 1 of this manual.

Ignition System

Tested in close proximity to an unshielded, unsuppressed Altronic DISN 800 Ignition System.

Environment

Operating Temperature .... –40 to +70°C (–40 to +158°F)
Storage Temperature........................ –40 to +85°C (–40 to +185°F)
Humidity .... IEC 68-2-38
Salt Fog .... ASTM B 17-73, IEC 68-2-11
Ingress Protection............................. IEC IP54 for front panel

Agency Information

UL Recognition

The IEM-2020 is a Recognized Component covered under File 97035 CCN# FTPM2/FTPM8 and applicable to Canadian and US safety standards and requirements by UL.
Standards used for evaluation:

- UL 6200
- CSA C22.2 No. 14

Caution
To follow UL guidelines, replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

CSA Certification

The IEM-2020 was tested and has met the certification requirements for electrical, plumbing, and/or mechanical products. CSA File 1042505 (LR 23131-138S).

Standards used for evaluation:

- CSA C22.2 No. 14

EU Compliance

This product has been evaluated and complies with the requirements set forth by the EU legislation.

EC Directives:

- Low Voltage Devices (LVD) – 2014/35/EU
- Electromagnetic Compatibility (EMC) – 2014/30/EU

Harmonized Standards used for evaluation:

- EN 50178: *Electronic Equipment for use in Power Installations*
- EN 61000-6-4: *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2: *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

EAC Mark (Eurasian Conformity)

TC RU C-US.HO03.B.00210

- TP TC 004/2011
- TP TC 020/2011

Physical

Weight..4.40 lb (1.99 kg)
Dimensions......................................See Section 6, *Installation*.

SECTION 2 • HUMAN-MACHINE INTERFACE

TABLE OF CONTENTS

Figures

Tables

SECTION 2 • HUMAN-MACHINE INTERFACE

Introduction

This section describes the components of the IEM-2020 human-machine interface (HMI). IEM-2020 HMI components are located on the front panel (controls and indicators) and the rear panel (terminals and connectors).

Front Panel

Figure 2-1 illustrates the front panel HMI of the IEM-2020. Table 2-1 lists the call-outs of Figure 2-1 along with a description of each HMI component.

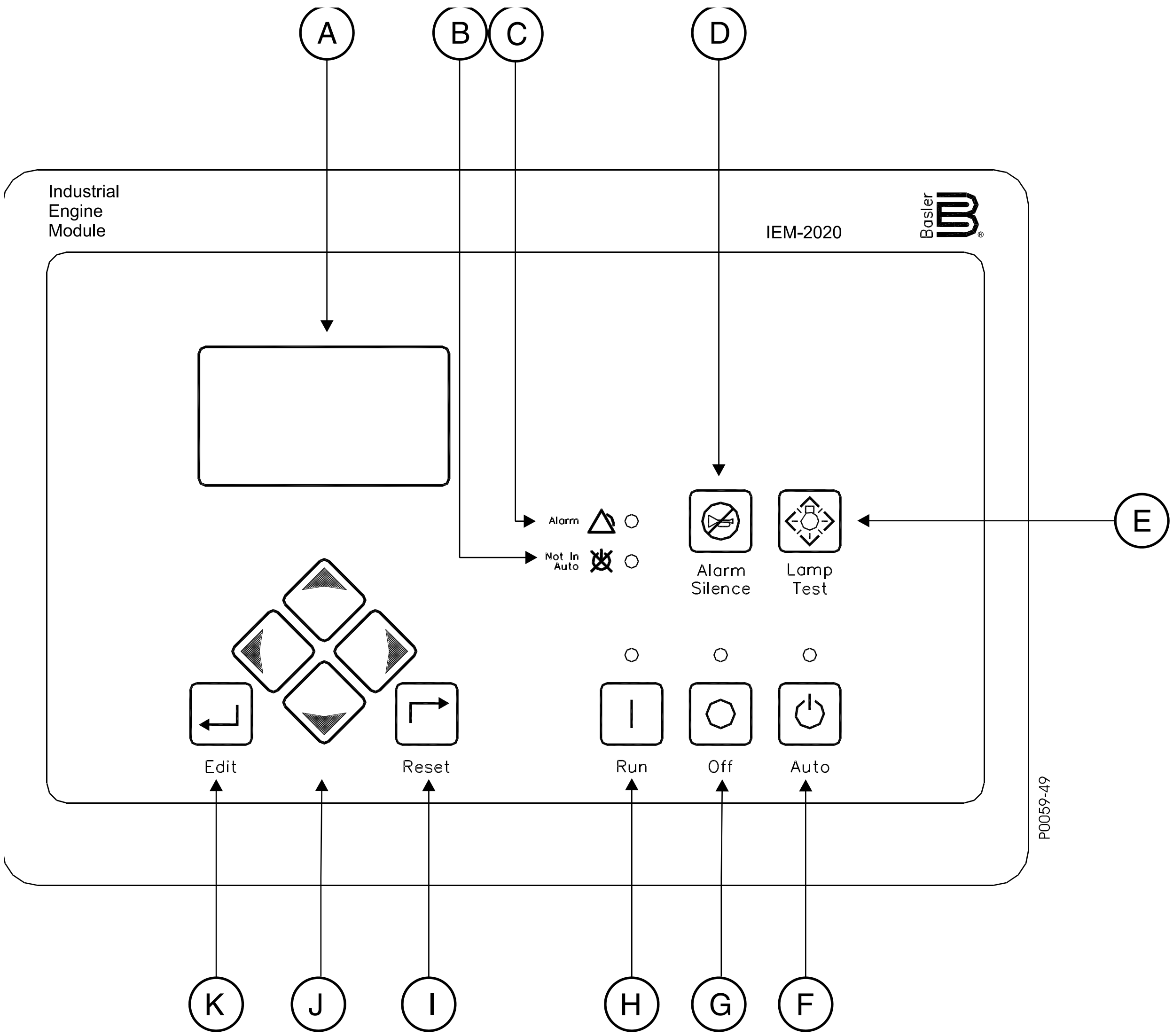


Figure 2-1. Front Panel HMI

Table 2-1. Front Panel HMI Descriptions

Locator	Description
A	*Liquid Crystal Display.* The backlit, 64 by 128 pixel LCD serves as the local information source for metering, alarms, pre-alarms, and protective functions. Display operation is maintained at –40°C.
B	*Not in Auto Indicator.* This red LED lights when the IEM-2020 is not operating in Auto mode.
C	*Alarm Indicator.* This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.
D	*Alarm Silence Pushbutton.* Pressing this button opens the relay output programmed as the horn output.
E	*Lamp Test Pushbutton.* Pressing this button tests the IEM-2020 indicators by exercising all LCD pixels and lighting all LEDs.
F	*Auto Pushbutton and Mode Indicator.* Pressing the Auto button places the IEM-2020 in Auto mode. The green Auto mode LED lights when Auto mode is active.
G	*Off Pushbutton and Mode Indicator.* Pressing this button places the IEM-2020 in Off mode. The red Off mode LED lights when the IEM-2020 is in Off mode.
H	*Run Pushbutton and Mode Indicator.* Pressing this button places the IEM-2020 in Run mode. The green Run mode LED lights when Run mode is active.
I	*Reset Pushbutton.* This button is pressed to cancel a settings editing session and discard any settings changes. When pressed momentarily, this button also resets the ECU7 Alarms. This button is also used to reset the Maintenance Interval when pressed for 10 seconds while viewing Hours Until Maintenance or Maintenance Due Pre-Alarm.
J	*Arrow Pushbuttons.* These four buttons are used to navigate through the front panel display menus and modify settings. The left- and right-arrow buttons are used to navigate through the menu levels. The right-arrow button is pressed to move downward through the menu levels and the left-arrow button is pressed to move upward. Within a level, the up-arrow and down-arrow buttons are used to move among items within the menu level. Pressing the down-arrow button moves to items lower in the list. Pressing the up-arrow button moves to items higher in the list. During a settings editing session, the up- and down-arrow buttons are used to raise and lower the value of the selected setting.
K	*Edit Pushbutton.* Pressing this button starts an editing session and enables changes to IEM-2020 settings. At the conclusion of an editing session, the Edit pushbutton is pressed again to save the setting changes.

Display Operation

The front panel display is used to make settings changes and display metering values. Refer to call-outs I, J, and K in Table 2-1 for information on changing settings through the front panel and navigating through the Metering screens.

Login and Permissions

Login

To login, navigate to the SETTINGS, ENTER PASSWORD screen and press the *Edit* key. Use the *Up/Down* arrow keys to scroll through the characters. Use the *Left/Right* arrow keys to enter more characters. Once the password has been entered, press the *Edit* key to login. A LOGOUT selection now appears in the list of SETTINGS. To logout, navigate to SETTINGS, LOGOUT and press the *Edit* key. The LOGOUT selection is removed from the SETTINGS list.

Permissions

If communications access is active through the modem or USB, the front panel will display REMOTE COMMS, FRONT PANEL IS READ ONLY and the summary screen. This informs the user that the front panel can only be used for viewing metering data and settings information. Remote access must be ended before modifying settings through the front panel.

Summary Screen and Configurable Metering

The summary screen can be set to standard or scrolling. To select a standard or scrolling summary, navigate to the SETTINGS, GENERAL SETTINGS, FRONT PANEL HMI screen and edit the SUMMARY VIEW.

When the summary screen is set to standard, OIL, FUEL, TEMP, BATT, and RPM are displayed. The summary screen also displays the enabled overview items at a delay time (PRM TOG DELAY) specified by the user. See Figure 2-2. To enable the overview items, navigate to the SETTINGS, GENERAL SETTINGS, FRONT PANEL HMI, OVERVIEW PRM SELECT. The following overview items may be enabled by the user:

- ENGINE STATUS
- RUN HRS
- ALG VOLT
- ALG CUR
- RPM SETPT
- PARAM SETPT
- RPM SRC
- COOLANT LEVL
- ALG IN X (X = 1 to 8) (with AEM-2020)
- RTD IN X (X = 1 to 8) (with AEM-2020)
- THRM CPL X (X = 1 to 2) (with AEM-2020)
- FUEL DELV P
- INJ RAIL RPS
- TOTAL FUEL USED
- FUEL TEMP
- ENG OIL TEMP
- ENG INTCLR TEMP
- COOLANT PRESS
- FUEL RATE
- BOOST PRESS
- INTAK MNFLD TEMP
- CHRG AIR TMP

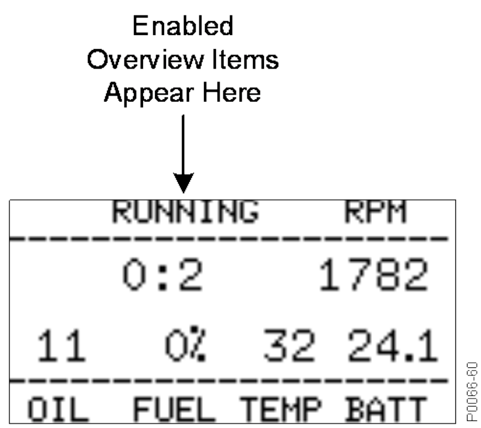


Figure 2-2. Standard Summary View (Shown with Engine Status Enabled)

When the summary screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values will scroll at a delay time (SCROLL DELAY) specified by the user. See Figure 2-3.

To select the scrolling values, navigate to the SETTINGS, GENERAL SETTINGS, FRONT PANEL HMI screen and edit the CONFIGURABLE METERING. The following items may be selected by the user to be placed in the scrolling summary:

- NONE (Removes a line from the scrolling list)
- BLANK (Shows nothing on this line)
- OIL P
- TEMP
- BATT V
- RPM
- FUEL
- RUN HRS
- ALG IN X (X = 1 to 8) (with AEM-2020)
- FUEL TEMP
- ENGINE OIL TEMP
- ENGINE INTCLR TEMP
- COOLANT PRESS
- FUEL RATE
- BOOST PRESS
- INTAK MNFLD TMP
- CHRG AIR TMP
- ENGINE % LOAD

- RTD IN X (X = 1 to 8) (with AEM-2020)
- THRM CPL X (X = 1 to 2) (with AEM-2020)
- FUEL DELV P
- INJ RAIL PRS
- TOTAL FUEL USED
- RPM SRC
- ALG VOLT
- ALG CUR
- PARAM SETPT
- RPM SETPT

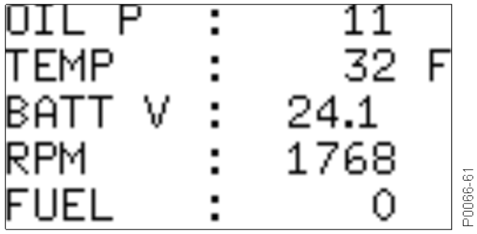


Figure 2-3. Scrolling Summary View

Sleep Mode

Sleep mode serves as a power saving feature. If the IEM-2020 is in Off mode or Auto mode not running and a key is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The IEM-2020 resumes normal display operation when any front panel button is pressed or the engine is started remotely via the Auto Start input. The IEM-2020 will not go to sleep while in an Alarm state. If needed, Sleep mode can be permanently disabled via BESTCOMS*Plus*® or the front panel.

Changing a Setting

To change a setting, navigate to the setting you want to change and press the *Edit* key. If you are not already logged in, you will be asked to enter your password at this time. Use the *Up/Down* arrows to raise or lower the value. Press the *Edit* key again when finished.

Front Panel Display Structure

The front panel display begins with the SUMMARY SCREEN. Pressing the *Right* arrow key will open the MAIN MENU screen. The MAIN MENU screen consists of METERING and SETTINGS. The METERING screen branches are shown in Figure 2-4. Details of the METERING screen branches follow Figure 2-4. The SETTINGS screen branches are shown in Figure 2-5. Details of the SETTINGS screen branches follow Figure 2-5.

METERING

ENGINE
RUN STATISTICS
ALARMS-STATUS
DIAGNOSTICS

P0066-50

Figure 2-4. Metering Screen Branches

ENGINE

- **OIL PRESSURE**
- **COOLANT TMP**
- **BATTERY VOLT**
- **RPM SETPT**
- **RPM**
- **SPEED SRC**
- **FUEL LEVEL**
- **COOLANT LEVL (Visible when CANBUS is enabled.)**
- **TOTAL RUN TM**
- **HRS TO MAINT**
- **DEF TANK1 LEVEL %** (Visible when CAN Bus is enabled.)
- **DEF TANK2 LEVEL %** (Visible when CAN Bus is enabled.)

RUN STATISTICS

- **CUMULATIVE**
  - CUMULATIVE
    - START
    - # STARTS
    - HRS TO MAINT
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
- **SESSION**
  - SESSION
    - START
  - TOTAL RUN TIME
    - HOURS
    - MINUTES

ALARMS-STATUS

- **ACTIVE ALARMS**
- **ACTIVE PRE-ALARMS**
- **MTU FAULT CODES** (Visible when ECU is configured for MTU MDEC, MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
- **MTU STATUS** (Visible when ECU is configured for MTU MDEC, MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
  - NMT-ALIVE STATUS (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - SPS NODE
    - SW TYP
    - SW VAR
    - SW ED1
    - SW ED2
    - REV
    - SW MOD
  - TRIP FUEL (Visible when ECU is configured for MTU ECU7/ECU8.)
    - TRIP HRS
    - TRIP IDLE HRS
    - FUEL RATE
    - TRIP FL RATE
    - TOTAL RUN TM
    - DAILY FUEL
    - TOTAL FUEL
  - FUEL (Visible when ECU is configured for MTU ADEC.)
    - DAY TANK LVL
    - STORE TANK LVL
  - ENGINE STATUS (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - MTU FAULT CODES
    - ENG RUNNING
    - CYL CUTOUT
    - ENG OPTIMIZED (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - PREHT NT RCHD (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - SPEC TORQUE (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - SPD DMD FL MD (Visible when ECU is configured for MTU ADEC.)
    - CURR P DEGREE (Visible when ECU is configured for MTU ADEC.)
    - LOAD GEN ON (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - PRIME PUMP ON (Visible when ECU is configured for MTU ADEC.)
    - RUNUP SPD LO (Visible when ECU is configured for MTU ADEC.)
    - IDLE SPD LO (Visible when ECU is configured for MTU ADEC.)
    - CYL CUTOUT CD (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - DROOP % (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
    - ENG COOL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CHRG AIR TMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INTRCOOLR TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ENG OIL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FUEL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)

    - OIL PRESSURE (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CHG AIR P (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FUEL DELV P (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FL RAIL P (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - IDLE RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU SHUTDOWN (Visible when ECU is configured for MTU ECU7/ECU8.)
    - TOTAL RUN TM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU SUPP VOLTS (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INJCT DBR % (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RATED RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INJCT QTY (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RATED KW (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RESRV PWR % (Visible when ECU is configured for MTU ECU7/ECU8.)
    - START SEQ (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
    - ECU OVRD FDBK (Visible when ECU is configured for MTU Smart Connect.)
    - COOLNT PRHT DONE (Visible when ECU is configured for MTU Smart Connect.)
    - REQ TORQUE (Visible when ECU is configured for MTU Smart Connect.)
    - EXT STOP (Visible when ECU is configured for MTU Smart Connect.)
    - OPERATING MODE (Visible when ECU is configured for MTU Smart Connect.)
- SPEED (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - SEL SPD DMD
    - EFF SET SPEED
    - CAN SPD DMD
    - ANLG SPD DMD
    - SPD DMD FL MD
    - RATED RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - IDLE RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - SPD DMD SRC (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FREQ RPM DMD (Visible when ECU is configured for MTU ECU7/ECU8.)
- SIGNL FEEDBK (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - ECU OVRD FDBK
    - EXT STOP
    - SPD UP IN
    - SPD DN IN
    - CAN MODE FDBK
    - CYL CUTOUT (Visible when ECU is configured for MTU ECU7/ECU8.)
- DIAGNOSTICS (Visible when ECU is configured for MTU ECU7/ECU8.)
    - AL PWR AMP 1
    - AL PWR AMP 2
    - XSTR OUT AL
    - XSTR OUT STS
    - ECU SHUTDOWN
- CANBUS (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CAN MODE FDBK
    - CAN NODES
    - LOST NODES
- LIMITS (Visible when ECU is configured for MTU ECU7/ECU8.)
    - OIL PRESSURE
    - LO LIM OILP
    - LOLOLIM OILP
    - ENG COOL TEMP
    - CLNT LMT HI
    - CLNT LMT HIHI
    - CHRG AIR TMP
    - CHG AIR LMT HI
    - ECU SUPP VOLTS
    - L1L ECU VOLTS
    - L2L ECU VOLTS
    - U1L ECU VOLTS
    - U2l ECU VOLTS
    - INTRCOOLR TMP
    - INTCLR LMT HI

- **STATUS**
  - AUTOSTART INPUT (Visible when the Auto Start programmable function is configured to be driven by an input.)
  - BATTLE OVERRIDE (Visible when the Battle Override programmable function is configured to be driven by an input.)
  - LOW COOL LEVEL (Visible when the Low Coolant Level programmable function is configured to be driven by an input.)
  - BATT CHRG FAIL (Visible when the Battery Charger Fail programmable function is configured to be driven by an input.)
  - FUEL LEAK DETECT (Visible when the Fuel Leak Detect programmable function is configured to be driven by an input.)
  - ENG RUNNING
  - CLDN TMR ACTVE
  - OFF MODE COOLDN
  - COOLDN REQ
  - COOL & STOP REQ
  - EXT START DEL
  - START DEL BYPASS
  - RESET
  - ALARM SILENCE
  - LAMP TEST
  - IDLE REQUEST
  - LSM CONNECTED
  - CEM CONNECTED
  - AEM CONNECTED
- **INPUTS**
  - INPUT X (X = 1 to 16 (17 to 26 optional))
- **OUTPUTS**
  - START
  - RUN
  - PRESTART
  - OUTPUT X (X = 1 to 12 (13 to 36 optional))
- **LOGIC CTL RELAYS**
  - LCR X (X = 1 to 16)
- **LOCAL ALG IN (Optional)**
  - SCALED
    - ALG VOLT
    - ALG CUR
  - RAW
    - ALG VOLT
    - ALG CUR
- **LSM INPUTS** (Visible when LSM-2020 is enabled.)
  - SCALED
    - LSM IN
  - RAW
    - LSM IN
- **ANALOG INPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - ALG IN X (X = 1 to 8)
  - RAW
    - ALG IN X (X = 1 to 8)
- **THERMAL INPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - RTD IN X (X = 1 to 8)
    - THRM CPL X (X = 1 to 2)
  - RAW
    - RTD IN X (X = 1 to 8)
    - THRM CPL X (X = 1 to 2)
- **ANALOG OUTPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - ALG OUT X (X = 1 to 4)
  - RAW
    - ALG OUT X (X = 1 to 4)
- **LOCAL ALG STATUS** (Optional)
- **ANALOG STATUS** (Visible when AEM-2020 is enabled.)
- **CONF ELEMENTS**
  - CONFIG ELEMENT X (X = 1 to 8)
- **CONF PROT STATUS**

- **EVENT LOG**
    - [EVENT NAME]
        - ACTIVE
        - OCCURRENCE COUNT
        - FIRST DATE
        - FIRST TIME
        - LAST DATE
        - LAST TIME
        - FIRST ENG HRS
        - LAST ENG HRS
        - DETAILS
            - OCCURRENCE (Use the *Edit/Up/Down* keys to change the occurrence.)
            - DATE
            - TIME
            - ENG HRS
        - CLEAR EVENT (Visible when logged in through the front panel.)
- **J1939 DATA** (Visible when CANbus is enabled and ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, or Cummins.)
    - THROTTLE POSITN
    - LOAD @ CRNT RPM
    - ACTUAL ENG TORQ
    - ENGINE SPEED
    - INJ CNTRL PRESS
    - INJ RAIL PRS
    - ENGINE HOURS
    - TRIP FUEL
    - TOTAL FUEL USED
    - ENG COOLANT TEMP
    - FUEL TEMP
    - ENG OIL TEMP
    - ENG INTCLR TEMP
    - FUEL DELV P
    - ENG OIL LEVEL
    - ENG OIL PRESS
    - COOLANT PRESS
    - COOLANT LEVEL
    - FUEL RATE
    - BAROMETRIC PRESS
    - AMB AIR TEMP
    - AIR INLET TEMP
    - BOOST PRESS
    - INTAK MNFLD TEMP
    - AIR FLTR DIF PRS
    - EXHAUST GAS TEMP
    - BATTERY VOLTAGE
    - ECU INPUT VOLTS
    - TRANS OIL PRESS
    - TRANS OIL TEMP
    - WINDG 1 TEMP
    - WINDG 2 TEMP
    - WINDG 3 TEMP
    - ECU TEMP
    - AUX PRESSURE1
    - AUX PRESSURE2
    - RATED KW
    - RATED RPM
    - EXHAUST TMP A
    - EXHAUST TMP B
    - CHRG AIR TMP
    - FUEL 1 LEAK
    - FUEL 2 LEAK
    - ALARM RST FDBK
    - ECU SHUTDOWN
    - DEF TANK1 LEVEL %
    - DEF TANK2 LEVEL %
- **J1939 ENGINE CONFIG** (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, or Cummins.)
    - SPD @ IDLE PNT 1

    - TRQ @ IDLE PNT 1
    - SPD @ PNT 2
    - TRQ @ PNT 2
    - SPD @ PNT 3
    - TRQ @ PNT 3
    - SPD @ PNT 4
    - TRQ @ PNT 4
    - SPD @ PNT 5
    - TRQ @ PNT 5
    - SPD @ PNT 6
    - ENDSPEED GOV KP
    - REF ENG TORQUE
    - O-RIDE SPD PNT 7
    - O-RIDE TIME LMT
    - SPEED LOWER LMT
    - SPEED UPPER LMT
    - TORQUE LOWER LMT
    - TORQUE UPPER LMT
- **J1939 ACTIVE DTC** (Visible when DTC support is enabled and any ECU type is selected.)
    - CLEAR DTCs
- **J1939 PREV DTC** (Visible when DTC support is enabled and any ECU type is selected.)
    - CLEAR DTCs

DIAGNOSTICS

- **MODBUS RD**
- **MODBUS WR**
- **FLASH WR**

SETTINGS

RPM PROFILE
SEVEN DAY TIMER
GENERAL SETTINGS
COMMUNICATIONS
SYSTEM PARAMS
PROGRAMMABLE INPUTS
PROGRAMMABLE OUTPUTS
CONFIG PROTECTION
ALARM CONFIGURATION
LOGIC TIMERS
GOV CONTROL
ENTER PASSWORD

P0066-51

Figure 2-5. Settings Screen Branches

RPM PROFILE

- **AUTO MODE**
    - RPM
        - RUNNING
        - COOLING
        - IDLE
        - INTERMEDIATE
    - TIME
        - IDLE
        - INTERMEDIATE
        - COOLING
        - RAMP UP1
        - RAMP UP2
        - RAMP DOWN
    - CTRL MODE

- **RUN MODE**
  - RPM
    - RUNNING
    - COOLING
    - IDLE
    - INTERMEDIATE
  - TIME
    - IDLE
    - INTERMEDIATE
    - COOLING
    - RAMP UP1
    - RAMP UP2
    - RAMP DOWN
  - CTRL MODE

SEVEN DAY TIMER

- **SUNDAY to SATURDAY**
  - TIMER X (X = 1 to 8)
    - START HOUR
    - START MINUTE
    - RUN HOURS
    - RUN MINUTES

GENERAL SETTINGS

- **FRONT PANEL HMI**
  - SUMMARY VIEW
  - LCD CONTRAST
  - SLEEP MODE
  - LANGUAGE
  - PRM TOG DELAY
  - OVERVIEW PRM SELECT
  - SCROLL DELAY
  - CONFIGURABLE METERING
    - ITEM X (X = 1 to 20)
- **CONFIGURE DATE/TIME**
  - YEAR
  - MONTH
  - DAY
  - HOURS
  - MINUTES
  - SECONDS
  - UTC OFFSET
  - DST ENABLED
  - CLK NOT SET WRN
- **VIEW DATE/TIME**
- **VERSION INFO**
  - IEM-2020
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - LANGUAGE VERSION
    - LANGUAGE PART NUM
    - STYLE CODE
  - LSM-2020 (Visible when LSM-2020 is enabled.)
    - VERSION INFO
      - FIRMWARE VERSION
      - BOOT CODE VERSION

    - TCP/IP SETTINGS
      - IP ADDRESS
      - SUBNET MASK
      - GATEWAY ADDRESS
      - DHCP ENABLE
  - CEM-2020 (Visible when CEM-2020 is enabled.)

        - FIRMWARE VERSION
        - BOOT CODE VERSION
        - SERIAL NUMBER
        - PART NUMBER
        - MODEL NUMBER
        - BUILD DATE
    - AEM-2020 (Visible when AEM-2020 is enabled.)
        - FIRMWARE VERSION
        - BOOT CODE VERSION
        - SERIAL NUMBER
        - PART NUMBER
        - MODEL NUMBER
        - BUILD DATE

COMMUNICATIONS

- **CANBUS SETUP**
    - CANBUS SETUP
        - CANBUS ENABLE
        - DTC ENABLE (Visible when CAN Bus is enabled.)
        - SPN CONV METHOD (Visible when CAN Bus is enabled.)
        - CANBUS ADDR (Visible when CAN Bus is enabled.)
        - ECU OPT SLCT (Visible when CAN Bus is enabled.)
        - ECU PULSING (Visible when CAN Bus is enabled.)
        - ENG SHTDN TM (Visible when CAN Bus is enabled.)
        - PLS CYCL TM (Visible when CAN Bus is enabled.)
        - ECU SET TM (Visible when CAN Bus is enabled.)
        - RESP TIMEOUT (Visible when CAN Bus is enabled.)
    - ECU SETUP
        - ECU CONF (Visible when CAN Bus is enabled.)
        - ENGINE PARAM XMT
        - TRIP RESET (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
        - DPF REGENRATE SETUP (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
            - DPF MANUAL REGEN
            - DPF REGEN DISABLE
        - SPEED SELECT (Visible when ECU is configured for Volvo Penta.)
        - MODULE TYPE (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
        - ALIVE MSG (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
        - SPEED SETUP (Visible when ECU is configured for (MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
            - J1939 RPM ENABLE (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
            - ENGINE RPM
            - RPM BAND WIDTH
            - IDLE RPM
            - SPEED UP (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
            - SPEED DN (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
            - TEST OVRSPEED (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
            - SPD DMAND SRC (Visible when ECU is configured for MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
            - IDLE REQUEST (Visible when ECU is configured for MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
            - INCREASE IDLE (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
        - ECU SETUP (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
            - TRIP RESET (Visible when ECU is configured for MTU ECU7/ECU8.)
            - INT OIL PRIME
            - GOV PRM SW (Visible when ECU is configured for MTU ADEC or MTU Smart Connect.)
            - ENG STRT PRIME (Visible when ECU is configured for MTU ECU7/ECU8.)
            - FAN OVERRIDE (Visible when ECU is configured for MTU ECU7/ECU8.)
            - MODE SWITCH (Visible when ECU is configured for MTU ECU7/ECU8.)

            - GOV PARAM SET (Visible when ECU is configured for MTU ECU7/ECU8.)
            - CAN RATING SW 1 (Visible when ECU is configured for MTU ECU7/ECU8.)
            - CAN RATING SW 2 (Visible when ECU is configured for MTU ECU7/ECU8.)
            - DIS CYL CUT 1 (Visible when ECU is configured for MTU ECU7/ECU8.)
            - DIS CYL CUT 2 (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
            - OPERATING MODE (Visible when ECU is configured for MTU Smart Connect.)
- **MODEM SETUP**
    - DIALOUT X (X = 1 TO 4)
    - PAGER ID X (X = 1 TO 4)
    - RINGS FOR ANSWER
    - OFFLN DELAY
    - DIALOUT DLY
    - PGR BUFF LMT
    - PGR COM
- **RS485 SETUP**
    - COMM BAUD
    - COMM PARITY
    - MODBUS ADDR

SYSTEM PARAMS

- **SYSTEM SETTINGS**
    - RATED RPM
    - MAX RPM
    - MIN RPM
    - SPEED CTRL
    - FUEL LVL TYP
    - SYSTEM UNITS
    - PRESSURE UNITS (Visible when Metric is selected for System Units.)
    - BATTERY VOLT
    - FLYWHL TEETH
    - MAINT RESET
    - HORN
    - NOT IN AUTO HORN
    - POWER UP DELAY
    - RELAY CONTROL
        - START
        - RUN
        - PRESTART
- **REMOTE MODULE SETUP**
    - LSM SETUP
        - ENABLE
        - CANBUS ADDR (Visible when LSM-2020 is enabled.)
        - VERSION INFO (Visible when LSM-2020 is enabled.)
            - FIRMWARE VERSION
            - BOOT CODE VERSION
        - TCP/IP SETTINGS (Visible when LSM-2020 is enabled.)
            - IP ADDRESS
            - SUBNET MASK
            - GATEWAY ADDRESS
            - DHCP ENABLE
    - CEM SETUP
        - ENABLE
        - OUTPUTS (Visible when CEM-2020 is enabled.)
        - CANBUS ADDR (Visible when CEM-2020 is enabled.)
        - VERSION INFO (Visible when CEM-2020 is enabled.)
            - FIRMWARE VERSION
            - BOOT CODE VERSION
            - SERIAL NUMBER
            - PART NUMBER
            - MODEL NUMBER
            - BUILD DATE
        - CEM DEBUG MENU (Visible when CEM-2020 is enabled.)
            - IEM TO CEM BP
            - CEM TO IEM BP

- AEM SETUP
  - ENABLE
  - CANBUS ADDR (Visible when AEM-2020 is enabled.)
  - VERSION INFO (Visible when AEM-2020 is enabled.)
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - BUILD DATE
  - AEM DEBUG MENU (Visible when AEM-2020 is enabled.)
    - IEM TO AEM BP
    - AEM TO IEM BP
    - ANALOG INPUTS
      - SCALED
        - ALG IN X (X = 1 TO 8)
      - RAW
        - ALG IN X (X = 1 TO 8)
    - THERMAL INPUTS
      - SCALED
        - RTD IN X (X = 1 TO 8
        - THRM CPL X (X = 1 TO 2)
        - AMBIENT
      - RAW
        - RTD IN X (X = 1 TO 8
        - THRM CPL X (X = 1 TO 2)
    - ANALOG OUTPUTS
      - SCALED
        - ALG OUT X (X = 1 TO 4)
      - RAW
        - ALG OUT X (X = 1 TO 4)

- **CRANK SETTINGS**
  - DISCNCT LMIT
  - PRECRNK DELY
  - PRESTRT CNTCT
  - STYLE
  - # CYCLES (Visible when Cycle is selected for Cranking Style.)
  - CONT TIME (Visible when Continuous is selected for Cranking Style.)
  - CYCLE TIME
  - PRESTART REST CONFIG
    - CONF
  - OIL PRS CRANK DISC
    - ENABLE
    - CRANK DISC PRS
- **AUTOMATIC RESTART**
  - ENABLE
  - ATTEMPTS
  - INTERVAL
- **EXERCISE TIMER**
  - MODE
  - START HOUR
  - START MINUTE
  - RUN HOURS
  - RUN MINUTES
- **ENGINE STATISTICS**
  - START YEAR
  - START MONTH
  - START DAY
  - # STARTS
  - HRS TO MAINT
  - TOTAL HRS

PROGRAMMABLE INPUTS

- **CONFIGURABLE INPUTS**
  - INPUT X (X = 1 to 26)
    - ALARM CONFIG
    - ACTIVATN DLY

        - RECOGNITION
        - NAME
- **PROG FUNCTIONS**
    - AUTO START INPUT
        - INPUT
        - RECOGNITION (Visible when an INPUT is selected.)
    - BATTLE OVERRIDE
        - INPUT
        - RECOGNITION (Visible when an INPUT is selected.)
    - BATT CHRG FAIL
        - INPUT
        - ALARM CONFIG (Visible when an INPUT is selected.)
        - ACTIVATN DLY (Visible when an INPUT is selected.)
        - RECOGNITION (Visible when an INPUT is selected.)
    - LOW COOL LEVEL
        - INPUT
        - ALARM CONFIG (Visible when an INPUT is selected.)
        - ACTIVATN DLY (Visible when an INPUT is selected.)
        - RECOGNITION (Visible when an INPUT is selected.)
    - FUEL LEAK DETECT
        - INPUT
        - ALARM CONFIG (Visible when an INPUT is selected.)
        - ACTIVATN DLY (Visible when an INPUT is selected.)
        - RECOGNITION (Visible when an INPUT is selected.)
- **LOCAL ALG IN**
    - ALG VOLT
        - MIN VOLTAGE
        - MAX VOLTAGE
        - PARAM MIN
        - PARAM MAX
        - OVER 1
            - THRESHOLD
            - ALARM CONFIG
        - OVER 2
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 1
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 2
            - THRESHOLD
            - ALARM CONFIG
        - ARMING DELAY
        - THR1 ACT DLY
        - THR2 ACT DLY
        - HYSTERESIS
        - OOR ALM CFG
        - NAME
    - ALG CUR
        - MIN CURRENT
        - MAX CURRENT
        - PARAM MIN
        - PARAM MAX
        - OVER 1
            - THRESHOLD
            - ALARM CONFIG
        - OVER 2
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 2
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 2
            - THRESHOLD
            - ALARM CONFIG
        - ARMING DELAY
        - THR1 ACT DLY
        - THR2 ACT DLY

        - HYSTERESIS
        - OOR ALM CFG
        - NAME
- **LSM INPUTS** (Visible when LSM-2020 is enabled.)
    - ALG IN 1
        - INPUT TYPE
        - MIN VOLTAGE
        - MAX VOLTAGE
        - MIN CURRENT
        - MAX CURRENT
        - PARAM MIN
        - PARAM MAX
- **ANALOG INPUTS** (Visible when AEM-2020 is enabled.)
    - ALG IN X (X = 1 to 8)
        - INPUT TYPE
        - MIN VOLTAGE
        - MAX VOLTAGE
        - MIN CURRENT
        - MAX CURRENT
        - PARAM MIN
        - PARAM MAX
        - OVER 1
            - THRESHOLD
            - ALARM CONFIG
        - OVER 2
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 1
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 2
            - THRESHOLD
            - ALARM CONFIG
        - ARMING DELAY
        - THR1 ACT DLY
        - THR2 ACT DLY
        - HYSTERESIS
        - OOR ALM CFG
        - NAME
- **THERMAL INPUTS** (Visible when AEM-2020 is enabled.)
    - RTD IN X (X = 1 to 8)
        - TYPE
        - OVER 1
            - THRESHOLD
            - ALARM CONFIG
        - OVER 2
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 1
            - THRESHOLD
            - ALARM CONFIG
        - UNDER 2
            - THRESHOLD
            - ALARM CONFIG
        - ARMING DELAY
        - THR1 ACT DLY
        - THR2 ACT DLY
        - HYSTERESIS
        - OOR ALM CFG
        - NAME
    - THRM CPL X (X = 1 to 2)
        - OVER 1
            - THRESHOLD
            - ALARM CONFIG
        - OVER 2
            - THRESHOLD
            - ALARM CONFIG

            - UNDER 1
                - THRESHOLD
                - ALARM CONFIG
            - UNDER 2
                - THRESHOLD
                - ALARM CONFIG
            - ARMING DELAY
            - THR1 ACT DLY
            - THR2 ACT DLY
            - HYSTERESIS
            - OOR ALM CFG
            - NAME

PROGRAMMABLE OUTPUTS

- **OUTPUTS**
    - OUTPUT X (X = 1 to 12) (X = 1 to 36 when CEM-2020 is enabled.)
        - NAME
- **CONFIG ELEMENTS**
    - CONFIG ELEMENT X (X = 1 to 8)
        - ALARM CONFIG
        - ACTIVATN DLY
        - RECOGNITION
        - NAME
- **ANALOG OUTPUTS** (Visible when AEM-2020 is enabled.)
    - ANALOG OUTPUT X (X = 1 to 4)
        - OUTPUT TYPE
        - MIN VOLTAGE
        - MAX VOLTAGE
        - MIN CURRENT
        - MAX CURRENT
        - PARAM MIN
        - PARAM MAX
        - OOR ALM CFG
        - OOR ACT DLY
        - PARAM

CONFIG PROTECTION

- **CONFIG PROT X (X = 1 to 9)**
    - PARAM
    - OVER 1
        - THRESHOLD
        - ALARM CONFIG
    - OVER 2
        - THRESHOLD
        - ALARM CONFIG
    - UNDER 1
        - THRESHOLD
        - ALARM CONFIG
    - UNDER 2
        - THRESHOLD
        - ALARM CONFIG
    - ARMING DELAY
    - THR1 ACT DLY
    - THR2 ACT DLY
    - HYSTERESIS
    - NAME

ALARM CONFIGURATION

- **HORN CONFIGURATION**
    - HORN
    - NOT IN AUTO HORN
- **PRE-ALARMS**
    - RPM LIMIT
        - ENABLE

- HIGH COOLANT TEMP
  - ENABLE
  - THRESHOLD
- LOW COOLANT TEMP
  - ENABLE
  - THRESHOLD
- LOW OIL PRESSURE
  - ENABLE
  - THRESHOLD
- LOW FUEL LEVEL
  - ENABLE
  - THRESHOLD
- MAINTENANCE INTERVAL
  - ENABLE
  - THRESHOLD
- BATTERY OVERVOLTAGE
  - ENABLE
  - THRESHOLD
- LOW BATTERY VOLTAGE
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- WEAK BATTERY VOLTAGE
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- HIGH FUEL LEVEL
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- ACTIVE DTC (Visible when DTC is enabled.)
  - ENABLE
- ECU COMMS FAIL (Visible when CAN Bus is enabled.)
  - ENABLE
- COOLANT LEVEL (Visible when CAN Bus is enabled.)
  - ENABLE
  - THRESHOLD
- LSM COMM FAIL (Visible when LSM-2020 is enabled.)
  - ENABLE
- CEM COMM FAIL (Visible when CEM-2020 is enabled.)
  - ENABLE
- AEM COMM FAIL (Visible when AEM-2020 is enabled.)
  - ENABLE
- CHECKSUM FAIL
  - ENABLE

- **ALARMS**
  - HIGH COOLANT TEMP
    - ENABLE
    - THRESHOLD
    - ARMING DELAY
  - LOW OIL PRESSURE
    - ENABLE
    - THRESHOLD
    - ARMING DELAY
  - LOW FUEL LEVEL
    - ENABLE
    - THRESHOLD
    - ACTIVATN DLY
  - OVERSPEED
    - ENABLE
    - THRESHOLD
    - ACTIVATN DLY
  - COOLANT LEVEL (Visible when CAN Bus is enabled.)
    - ENABLE
    - THRESHOLD

> **NOTE**
>
> The HIGH COOLANT TEMP and LOW OIL PRESSURE alarms have an ARMING DLY setting that disables the alarm for the specified time after engine startup.

- **SENDER FAIL**
  - COOL TEMP SENDR FAIL
    - CONFIG TYPE
    - ACTIVATN DLY
  - OIL PRESS SENDR FAIL
    - CONFIG TYPE
    - ACTIVATN DLY
  - FUEL LEVL SENDR FAIL
    - CONFIG TYPE
    - ACTIVATN DLY
  - SPEED SENDR FAIL
    - TIME DELAY

LOGIC TIMERS

- **TIMER X (X = 1 to 10)**
  - HOURS
  - MINUTES
  - SECONDS

GOV CONTROL

- **OUTPUT**
  - TYPE
- **CONTACT** (Visible when Contact is selected for Output Type.)
  - TYPE
  - CORRECTION PULSE (Visible when Proportional is selected for Contact Type.)
    - WIDTH
    - INTERVAL
    - MAX ON RPM
  - DEADBAND
- **KP**
- **KI** (Visible when ECU is selected for Output Type.)
- **KD** (Visible when ECU is selected for Output Type.)
- **TD** (Visible when ECU is selected for Output Type.)
- **LOOP GAIN** (Visible when ECU is selected for Output Type.)
- **INPUT SRC**
- **SETPOINT SRC**
- **SETPT ALG MAX**
- **SETPT ALG MIN**
- **SETPOINT**
- **DEADBAND**
- **RPM BAND WIDTH**
- **PARAM UP/DN RATE**
- **RPM UP/DN RATE**
- **FP UP/DN ADJ**
- **CONTROL DEBUG**
  - SPEED PID
  - SPEED ERR

ENTER PASSWORD

LOGOUT (Visible when logged in through the front panel.)

Rear Panel

All IEM-2020 terminals and connectors are located on the rear panel. Rear panel terminals and connectors are illustrated in Figure 2-6. (To show the terminals and connectors, Figure 2-6 shows the IEM-2020 with the rear cover removed.) Table 2-2 lists the call-outs of Figure 2-6 along with a description of each connector type.

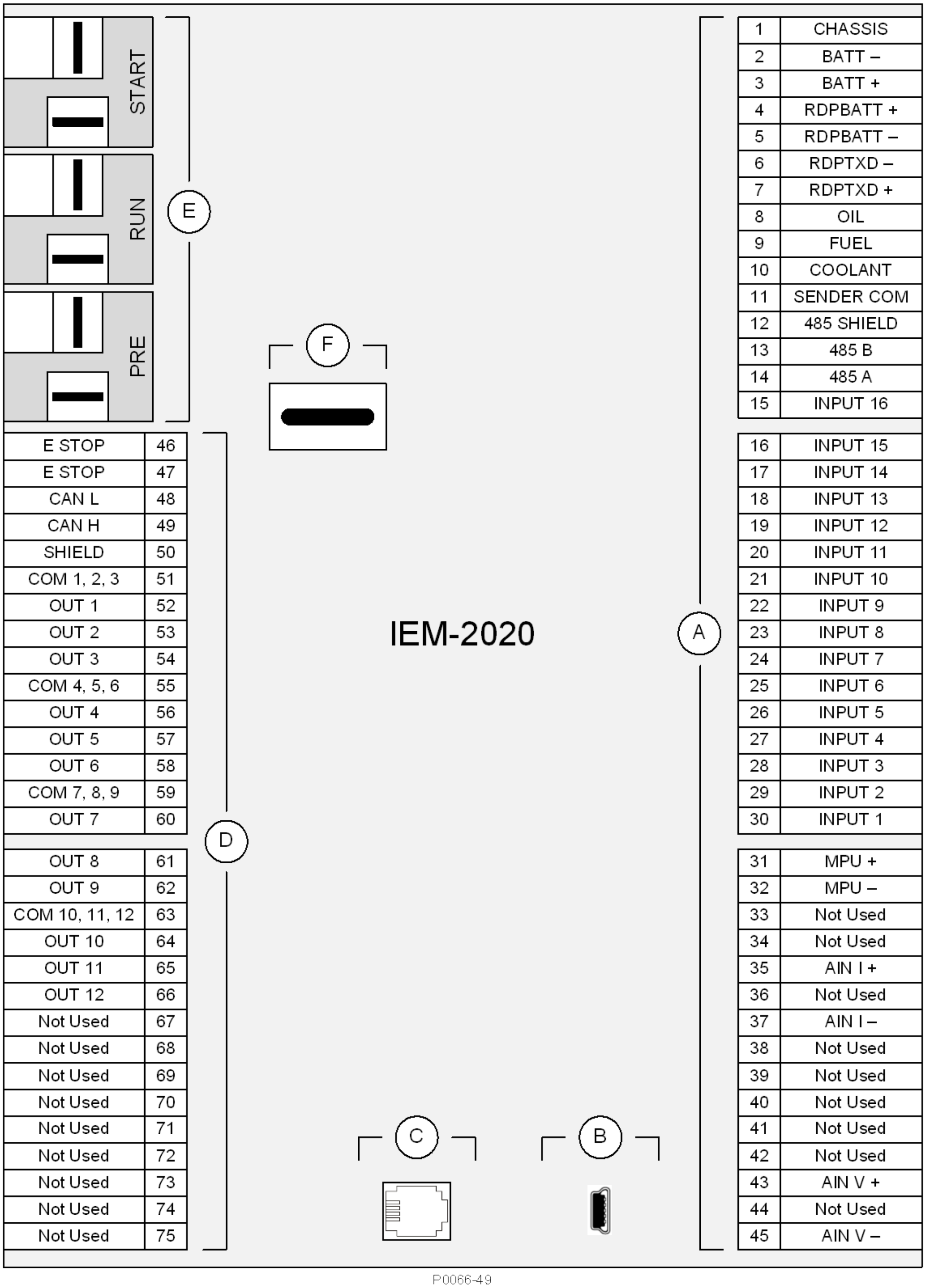


Figure 2-6. Rear Panel

Table 2-2. Rear Panel HMI Descriptions

Locator	Description
A, D	The majority of external, IEM-2020 wiring is terminated at 15-position connectors with compression terminals. These connectors plug into headers on the IEM-2020. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG.
B	The mini-B USB socket mates with a standard USB cable and is used with a PC running BESTCOMS*Plus* software for local communication with the IEM-2020.
C	IEM-2020 modules with an optional, internal, dial-out modem connect to a telephone line through a USOC RJ-11 jack.
E	Connections to the IEM-2020 Start (starter), Run (fuel solenoid), and Pre (glow plug) output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals.
F	The IEM-2020 provides a backup battery for the real-time clock. See Section 8, *Maintenance and Troubleshooting,* for instructions on replacing the battery. Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

SECTION 3 • FUNCTIONAL DESCRIPTION

TABLE OF CONTENTS

Figures

Tables

SECTION 3 • FUNCTIONAL DESCRIPTION

Introduction

This section describes how the IEM-2020 functions. A detailed description of each function block is provided in the paragraphs under the heading of IEM-2020 Function Blocks.

IEM-2020 operating and metering features are described in Section 4, *BESTCOMSPlus® Software.*

IEM-2020 Function Blocks

To ease understanding, IEM-2020 functions are illustrated in the block diagram of Figure 3-1. The following paragraphs describe each function in detail.

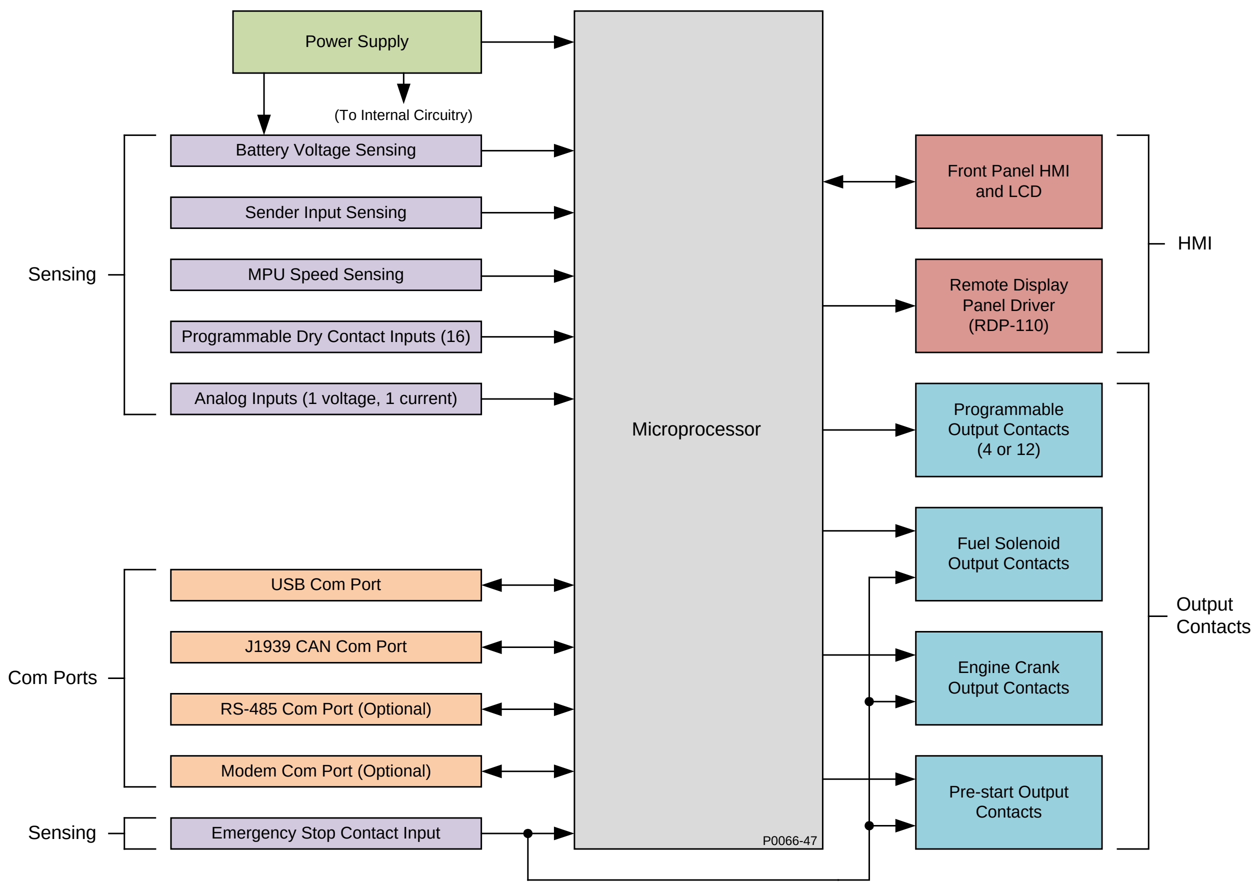


Figure 3-1. Function Block Diagram

Power Supply

The internal, switch-mode power supply uses the applied battery voltage to generate operating power for the internal circuitry of the IEM-2020. The power supply accepts a nominal battery voltage of 12 or 24 Vdc and has an operating range of 6 to 32 Vdc. Battery voltage is applied to terminals 2 (–) and 3 (+). Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the IEM-2020 will not operate.

<u>Battery Voltage Sensing</u>

Voltage applied to the power supply is filtered and reduced to a suitable level for sensing by the microprocessor.

Microprocessor

The microprocessor controls the overall functionality of the IEM-2020 and makes decisions based on programming and system inputs.

Circuits relating to the microprocessor inputs are described in the following paragraphs.

Analog-to-Digital Converter

Scaled and conditioned signals representing the coolant temperature, fuel level, oil pressure, and battery voltage are digitized by the microprocessor's analog-to-digital converter. The digitized information is stored in random access memory (RAM) and used by the microprocessor for all metering and protection functions.

Watchdog Timer

The watchdog timer monitors the firmware executed by the microprocessor. If the firmware ceases normal operation, the watchdog timer will reset the microprocessor. After reset, the microprocessor will resume normal operation if the condition that caused the watchdog reset is no longer present. If the condition is still present, the unit will reset repeatedly until it can resume normal operation.

Analog Engine Sender Inputs

Programmable analog engine sender inputs give the IEM-2020 user the flexibility to select the engine sender to be used in an application. Information about programming the sender inputs is provided in Section 4, *BESTCOMSPlus Software*.

Oil Pressure

A current is provided to the oil pressure sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the oil pressure sender terminals will cause the IEM-2020 to indicate a failed sender. Oil pressure senders that are compatible with the IEM-2020 include Datcon model 02505-00, Isspro model R8919, and Stewart-Warner models 411K and 411M. Other senders may also be used. BESTCOMS*Plus* software allows for the programming of sender characteristics. See Section 4, *BESTCOMSPlus Software*, for more information.

Oil pressure sender connections are made at terminals 8 and 11 (sender common).

Coolant Temperature

A current is provided to the coolant temperature sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the coolant temperature sender terminals will cause the IEM-2020 to indicate a failed sender. Coolant temperature senders that are compatible with the IEM-2020 include Datcon model 02019-00, Faria model TS4042, Isspro model R8959, and Stewart-Warner model 334P. Other senders may be used. BESTCOMS*Plus* software allows for the programming of sender characteristics. See Section 4, *BESTCOMSPlus Software*, for more information.

Coolant temperature sender connections are made at terminals 10 and 11 (sender common).

Fuel Level

A current is provided to the fuel level sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the fuel level sender terminals will cause the IEM-2020 to indicate a failed sender. Fuel level senders that are compatible with the IEM-2020 include Isspro model R8925. Other senders may be used. BESTCOMS*Plus* software allows for the programming of sender characteristics. See Section 4, *BESTCOMSPlus Software*, for more information.

Fuel level sender connections are made at terminals 9 and 11 (sender common).

Speed Signal Input

The IEM-2020 uses the signal from the magnetic pickup input to detect machine speed.

Magnetic Pickup Input (MPU)

Voltage supplied by a magnetic pickup is scaled and conditioned for use by the internal circuitry as a speed signal source. The MPU input accepts a signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz.

Magnetic pickup connections are provided at terminals 31 (+) and 32 (–).

Contact Inputs

The IEM-2020 has seventeen contact sensing inputs: an emergency stop input and 16 programmable inputs. Additional contact inputs can be accommodated with a CEM-2020 (Contact Expansion Module). Contact Basler Electric for availability and ordering information.

Emergency Stop Input

This input accepts Form B, dry contacts. An open circuit at this continuously monitored input initiates an emergency stop. An emergency stop removes operating power from the IEM-2020 Pre-Start, Run, and Fuel output relays.

Emergency stop contact connections are made at terminals 46 and 47.

Programmable Inputs

Each programmable input (Input 1 through Input 16) can be independently configured to perform the following functions. By default, each programmable input is disabled.

- Auto Start
- Battery Charger Fail
- Battle Override
- Fuel Leak Detect
- Low Coolant Level

The programmable inputs accept normally open, Form A contacts. A contact is connected between a programmable input and the negative side of the battery. Through BESTCOMS*Plus*, each programmable contact input can be assigned a name (16 alphanumeric characters, maximum) and configured as an alarm input, a pre-alarm input, or neither. The default names for the inputs are INPUT_x (where x = 1 to 16). When a programmable contact input is closed, the front panel display shows the name of the closed input if it was programmed as an alarm or pre-alarm input. Alarm inputs are annunciated through the Normal display mode screens of the front panel. Pre-alarm inputs are annunciated through the pre-alarm metering screen of the front panel. If neither is programmed, no indication is given. Programming an input as neither is useful when a programmable input is used as an input to programmable logic.

Connections for the programmable inputs are provided at terminals 15 (Input 16) through 30 (Input 1). The negative side of the battery voltage (terminal 2) serves as the return connection for the programmable inputs.

Analog Inputs

The IEM-2020 has two analog inputs as described below. Additional analog inputs can be accommodated with an AEM-2020 (Analog Expansion Module).

Voltage

Connections for this input are made at terminals 45 and 47. This input accepts a 0 to 10 Vdc signal.

Current

Connections for this input are made at terminals 35 and 37. This input accepts a 4 to 20 mAdc signal.

Front Panel HMI

The front panel HMI provides a convenient interface for viewing system parameters and for controlling the IEM-2020/engine set. Front panel HMI components include an LCD (liquid crystal display), LED (light emitting diodes) indicators, and pushbuttons.

LCD

The backlit LCD provides metering, pre-alarm, and alarm information. Detailed information about the LCD is provided in the *Software Operation* sub-section.

LED Indicators

The LEDs indicate pre-alarm and alarm conditions along with IEM-2020 status and engine status.

Pushbuttons

The pushbuttons are used to scroll through and select parameters displayed on the LCD, change setpoints, start and stop the engine, and reset alarms.

Remote Display Panel (Optional)

Applications that require remote annunciation can use Basler Electric's Remote Display Panel, RDP-110. Using the RDP-110 with the IEM-2020 meets the requirements of NFPA Standard 110. The RDP-110 uses a dedicated, four-terminal interface with the IEM-2020. The RDP-110 communicates with the IEM-2020 via terminals 6 (RDP TXD–) and 7 (RDP TXD+) and receives power from terminals 4 (RDP BATT+) and 5 (RDP BATT-). Remote indication of many pre-alarm and alarm conditions is provided by the RDP-110.

The following pre-alarm conditions are indicated by LEDs on the RDP-110 front panel:

- Battery charger failure ∗
- Battery overvoltage
- High coolant temperature
- Low coolant temperature
- Low fuel level
- Low oil pressure
- Weak battery

The following alarm conditions are indicated by LEDs and an audible alarm on the RDP-110 front panel:

- Low coolant level ∗
- High coolant temperature
- Low oil pressure
- Overcrank
- Overspeed
- Emergency stop
- Fuel leak/fuel sender failure ∗
- Engine sender unit failure

∗ Can be configured in the IEM-2020 as *None, Alarm,* or *Pre-Alarm.* See Section 4, *BESTCOMSPlus, Programmable Inputs, Programmable Functions,* for more information. The light on the RDP-110 will turn on when the input that is assigned to the programmable function is closed, whether the function is configured as *None, Alarm,* or *Pre-Alarm*.

Additionally, the RDP-110 indicates when the IEM-2020 is not operating in Auto mode. For more information about the RDP-110, request product bulletin SNE.

RDP-110 communication connections are made at IEM-2020 terminals 6 (RDP TXD–) and 7 (RDP TXD+). RDP-110 operating power is supplied at IEM-2020 terminals 4 (RDP BATT+) and 5 (RDP BATT–).

Communication Ports

IEM-2020 communication ports include a USB jack, CAN terminals, optional RS-485 terminals, and an optional modem jack.

USB

The rear-panel, mini-B USB socket enables local communication with a PC running BESTCOMS*Plus* software. The IEM-2020 is connected to a PC using a standard USB cable. BESTCOMS*Plus* is a Windows® based communication software package that is supplied with the IEM-2020. A detailed description of BESTCOMS*Plus* is provided in Section 4, *BESTCOMSPlus Software*.

CAN Bus

A Controller Area Network (CAN) is a standard interface that enables communication between multiple modules on a common network using a standard message protocol. IEM-2020 modules have a CAN Bus interface that supports the SAE J1939 protocol and the MTU protocol.

Applications using an engine-driven engine set controlled by an IEM-2020 may also have an Engine Control Unit (ECU). The CAN Bus interface allows the ECU and IEM-2020 to communicate. The ECU reports operating information to the IEM-2020 through the CAN Bus interface. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed for monitoring.

The primary use of the CAN Bus interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level, and engine hours without the need for direct connection to individual senders. Table 3-1 lists the ECU parameters and Table 3-2 lists the engine configuration parameters supported by the IEM-2020 CAN Bus interface. These parameters are transmitted via the CAN Bus interface at preset intervals. See the column labeled Update Rate in Table 3-1 for transmission rates. This information can also be transmitted upon user request.

CAN Bus interface connections are made at 48 (CAN L), 49 (CAN H), and 50 (SHIELD).

Table 3-1. ECU Parameters Obtained from CAN Bus Interface

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Actual Engine Percent Torque	%	%	Engine Speed Dependent	513
Air Filter Differential Pressure	kPa	psi	500 ms	107
Air Inlet Temperature	kPa	°F	1 s	172
Alarm Reset Feedback	Binary (0 or 1)		1 s	2815
Ambient Air Temperature	°C	°F	1 s	171
Auxiliary Pressure 1	kPa	psi	On Request	1387
Auxiliary Pressure 2	kPa	psi	On Request	1388
Barometric Pressure	kPa	psi	1 s	108
Battery Voltage	Vdc	Vdc	1 s	168
Boost Pressure	kPa	psi	500 ms	102
Charge Air Temperature	°C	°F	1 s	2629
Coolant Level	%	%	500 ms	111
Coolant Pressure	kPa	psi	500 ms	109
ECU Temperature	°C	°F	1 s	1136
Engine Coolant Temperature	°C	°F	1 s	110
Engine Intercooler Temperature	°C	°F	1 s	52
Engine Oil Level	%	%	500 ms	98
Engine Oil Pressure	kPa	psi	500 ms	100
Engine Oil Temperature	°C	°F	1 s	175
Engine Speed	RPM	RPM	Engine Speed Dependent	190
Exhaust Gas Temperature	°C	°F	500 ms	173
Exhaust Temperature A	°C	°F	500 ms	2433
Exhaust Temperature B	°C	°F	500 ms	2434
Fuel Delivery Pressure	kPa	psi	500 ms	94
Fuel Leak Filter 1	Binary (0 or 1)		1 s	1239
Fuel Leak Filter 2	Binary (0 or 1)		1 s	1240
Fuel Rate	liter/hr	gal/hr	100 ms	183
Fuel Temperature	°C	°F	1 s	174
Injection Control Pressure	MPa	psi	500 ms	164
Injector Metering Rail Pressure	MPa	psi	500 ms	157
Intake Manifold Temperature	°C	°F	500 ms	105
Percent Load at Current RPM	%	%	50 ms	92
Rated Power	watts	watts	On Request	166
Rated RPM	RPM	RPM	On Request	189
Shutdown from ECU	Binary (0 or 1)		1 s	1110
Switched Battery Voltage (at ECU)	Vdc	Vdc	1 s	158
Throttle (Accelerator Pedal) Position	%	%	50 ms	91
Total Engine Hours	hours	hours	Requested 1.5 s	247
Total Fuel Used	liters	gallons	Requested 1.5 s	250
Transmission Oil Pressure	kPa	psi	1 s	127
Transmission Oil Temperature	°C	°F	1 s	177
Trip Fuel	liters	gallons	Requested 1.5 s	182
Winding 1 Temperature	°C	°F	1 s	1124
Winding 2 Temperature	°C	°F	1 s	1125
Winding 3 Temperature	°C	°F	1 s	1126

* SPN is suspect parameter number.

Table 3-2. Engine Configuration Parameters Obtained from CAN Bus Interface

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Engine Speed at High Idle Point 6	RPM	RPM	5 s	532
Engine Speed at Idle Point 1	RPM	RPM	5 s	188
Engine Speed at Point 2	RPM	RPM	5 s	528
Engine Speed at Point 3	RPM	RPM	5 s	529
Engine Speed at Point 4	RPM	RPM	5 s	530
Engine Speed at Point 5	RPM	RPM	5 s	531
Gain (Kp) of End Speed Governor	%/RPM	%/RPM	5 s	545
Maximum Momentary Engine Override Speed Point 7	RPM	RPM	5 s	533
Maximum Momentary Engine Override Time Limit	seconds	seconds	5 s	534
Percent Torque at Idle Point 1	%	%	5 s	539
Percent Torque at Point 2	%	%	5 s	540
Percent Torque at Point 3	%	%	5 s	541
Percent Torque at Point 4	%	%	5 s	542
Percent Torque at Point 5	%	%	5 s	543
Reference Engine Torque	N•m	ft-lb	5 s	544
Requested Speed Control Range Lower Limit	RPM	RPM	5 s	535
Requested Speed Control Range Upper Limit	RPM	RPM	5 s	536
Requested Torque Control Range Lower Limit	%	%	5 s	537
Requested Torque Control Range Upper Limit	%	%	5 s	538

* SPN is suspect parameter number.

CAUTION
When the CAN Bus is enabled, the IEM-2020 will ignore the following sender inputs: oil pressure, coolant temperature, and magnetic pickup.

Under certain circumstances, the following strings may be displayed on the front panel HMI and in the Metering Explorer of BESTCOMS*Plus*:

- *NC (Not Connected)* - String displayed for a J1939 parameter when the engine ECU is not connected to the IEM-2020.
- *SF (Sender Fail)* - String displayed for a J1939 parameter when the engine ECU sends a special code indicating a measurement failure for the parameter. For example, if oil sender is determined to be bad by the ECU, it sends a special code in place of the J1939 oil pressure data indicating a sender fail condition.
- *NS (Not Sent)* - String displayed for a J1939 parameter when the J1939 parameter has not been sent to the IEM-2020 by the engine ECU.
- *NA (Not Applicable)* - String displayed for a J1939 parameter when the engine ECU sends a special code for the parameter indicating that the parameter is not implemented or not applicable in the ECU.
- *UF (Unknown Failure)* - String displayed when the J1939 parameter data received by the ECU is not within the valid J1939 data range for the parameter but is not one of the special codes above.

Table 3-3 lists the J1939 data transmitted from the IEM-2020.

Table 3-3. J1939 Data Transmitted from the IEM-2020

ECU Parameter	Update Rate	* SPN
Battle Override Switch	100 ms	1237
Speed Request	10 ms	898
Note: Requests from the IEM-2020 to the Engine ECU for various parameters are made by issuing the request.		
Address Claim Request	Once on power up, and any time a Global Request for Address Claim (GRAC) PGN is received.	NA
Currently Active Diagnostic Trouble Codes Request	Whenever a refresh of Currently Active Diagnostic Trouble Code Requests is received.	NA
Previously Active Diagnostic Trouble Codes Request	2 s	NA
Clear Currently Active Diagnostic Trouble Codes Request	Whenever a request to reset Currently Active Diagnostic Trouble Code Request is made.	NA
Clear Previously Active Diagnostic Trouble Codes Request	Whenever a request to reset Previously Active Diagnostic Trouble Code Request is made.	NA
Engine Hours/Revolutions Request	2 s	NA
Fuel Consumption Request	2 s	NA
Electronic Engine Controller #4 (Rated Speed and Power) Request	2 s	NA
Auxiliary Analog Information	2 s	N/A

* SPN is suspect parameter number.

Diagnostic Trouble Codes (DTCs)

The IEM-2020 obtains diagnostic engine information from a compatible engine control unit (ECU). The IEM-2020 will receive an unsolicited message of a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. Table *3-4* lists the diagnostic information that the IEM-2020 obtains over the CAN Bus interface.

Table 3-4. Diagnostic Information Obtained Over the CAN Bus Interface

Parameter	Transmission Repetition Rate
Active diagnostic trouble code	1 s
Lamp status	1 s
Previously active diagnostic trouble code	On request
Request to clear active DTCs	On request
Request to clear previously active DTCs	On request

DTCs are reported in coded diagnostic information that includes the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI), and Occurrence Count (OC). All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The reported problem may not be an electrical failure but a subsystem condition needing to be reported to an operator or technician. The OC contains the number of times that a fault has gone from active to previously active.

For certain DTCs, if the IEM-2020 recognizes a pair of SPN and FMI numbers, it displays a single string as listed in Table 3-6. If the IEM-2020 recognizes an SPN in Table 3-6, but the FMI does not match the FMI in Table 3-6, then it displays the string from Table 3-6 corresponding to the table entry where the FMI is # and a second string corresponding to the FMI number listed in Table 3-5. For example, if the IEM-2020 receives SPN 29 and FMI 13, it displays ACCEL PEDAL 2 POSITN and OUT OF CALIBRATION. If the IEM-2020 does not have descriptive information about an SPN and FMI that was received, the description will display as “NO TEXT AVAILABLE”.

Table 3-5. DTCs Displayed by the IEM-2020 (FMI Strings)

FMI	String Displayed	Description
0	DATA HI MOST SEVERE	Data is higher than expected at the most severe level
1	DATA LO MOST SEVERE	Data is lower than expected at the most severe level
2	DATA ERRATIC OR BAD	Data is erratic, intermittent, or incorrect
3	VOLTS HI OR SHORTED	Measured voltage is higher than expected or shorted to a high source
4	VOLTS LO OR SHORTED	Measured voltage is lower than expected or shorted to a low source
5	CURRENT LO OR OPEN	Measured current is lower than expected or the circuit is open
6	CURRENT HI OR SHORTED	Measured current is higher than expected or shorted
7	MECHANICAL SYSTM ERR	Mechanical system error
8	FREQ OR PWM ERROR	Error in frequency, pulse width or period of any frequency or PWM signal is outside its predetermined limits
9	ABNORMAL UPDATE RATE	Update rate of parameter is abnormal
10	DATA RT OF CHG ERR	Rate of change of data is abnormal
11	FAILURE CAUSE UNKNOWN	String indicating failure cause is unknown
12	BAD INTELLIGNT DEVICE	Engine ECU is reporting that an intelligent device or component failure has been detected
13	OUT OF CALIBRATION	Device or parameter is out of calibration
14	CONSULT ENG MFG DATA	User should consult engine manufacturer's data
15	DATA HI LST SEVERE	Data is higher than expected at the least severe level
16	DATA HI MODERATE SVR	Data is higher than expected at a moderately severe level
17	DATA LO LST SEVERE	Data is lower than expected at the least severe level
18	DATA LO MODERATE SVR	Data is lower than expected at a moderately severe level
19	NETWORK DATA ERR	String Indicating Network Data contained an error indication

Table 3-6. DTCs Displayed by the IEM-2020

SPN	FMI	String Displayed	Description
28	3	Throttle Volt HI	Throttle Voltage High
28	4	Throttle Volt LO	Throttle Voltage Low
28	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	3	Throttle Volt HI	Throttle Voltage High
29	4	Throttle Volt LO	Throttle Voltage Low
29	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	#	ACCEL PEDAL 2 POSITN	Caption string for accelerator pedal 2 position
52	15	INTERCOOLER TEMP HI	Engine Intercooler Temperature is above the HIGH threshold
91	3	Thr Pos Sns Volt HI	Throttle Position Sensor Input Voltage (High)
91	4	Thr Pos Sns Volt LO	Throttle Position Sensor Input Voltage (Low)
91	14	Thr Pos Sns Volt OOR	Throttle Voltage (Out of Range)
94	1	FUEL DELIV PRS LO LO	Engine Fuel Delivery Pressure is below the LOW LOW threshold
94	3	Fuel Pmp Prs Volt HI	Fuel Pump Pressure Input Voltage (High)
94	4	Fuel Pmp Prs Volt LO	Fuel Pump Pressure Input Voltage (Low)
94	17	Fuel Pressure LO	Fuel Supply Pressure (Low Least Severe)
97	3	Water In Fl Volt HI	Water In Fuel Signal Voltage High
97	4	Water In Fl Volt LO	Water In Fuel Signal Voltage Low
97	16	Water in Fuel	Water In Fuel Detected
98	#	ENG OIL LEVEL	Caption used on front panel for Display of J1939 Parameter
99	#	OIL FILTER DIFF PRESS	Caption string for oil filter differential pressure parameter

SPN	FMI	String Displayed	Description
100	1	ENG OIL PRESS LO LO	Engine Oil Pressure is below the LOW LOW threshold
100	3	Oil Prs Snsr Volt HI	Oil Pressure Sensor Input Voltage (High)
100	4	Oil Prs Snsr Volt LO	Oil Pressure Sensor Input Voltage (Low)
100	17	ENG OIL PRESS LO	Engine Oil Pressure is below the LOW threshold
100	18	Oil Prs Snsr Volt MLO	Oil Pressure Sensor Input Voltage (Moderately Low)
100	31	Oil Pressure INVLD	Oil Pressure (Invalid)
101	#	CRANKCASE PRESSURE	Caption string for crankcase pressure
102	2	Manifld Air Prs INVD	Manifold Air Pressure Invalid
102	3	Mnfld AirP SnsVlt HI	Manifold Air Pressure Sensor Input Voltage High
102	4	Mnfld AirP SnsVlt LO	Manifold Air Pressure Sensor Input Voltage Low
103	0	Trbo Overspd Severe	Turbo Overspeed (Most Severe)
103	2	Trbo Speed MisMatch	Turbo Speed (Mismatch)
103	5	Trbo Spd Sns Curr LO	Turbo Speed Sensor Current (Low)
103	6	Trbo Spd Sns Curr HI	Turbo Speed Sensor Current (High)
103	8	Trbo Speed INVLD	Turbo Speed (Invalid)
103	31	Trbo Speed MISSING	Turbo Speed (Missing)
105	0	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	3	EGR Air Temp Vlt HI	Exhaust Gas Recirculation Mixed Air Temp Voltage (High)
105	4	EGR Air Temp Vlt LO	Exhaust Gas Recirculation Mixed Air Temp Voltage (Low)
105	15	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	16	EGR MxdAir Tmp MHI	Exhaust Gas Recirculation Mixed Air Temp (Moderately High)
107	0	Air Filt Restricted	Air Filter Restriction (High)
108	2	Barometrc Prs INVLD	Barometric Pressure (Invalid)
108	31	Barometrc Prs ERR	Barometric Pressure (Error)
109	1	ENG COOLNT PRS LO LO	Engine Coolant Pressure is below the LOW LOW threshold
109	17	ENG COOLANT PRS LO	Engine Coolant Pressure is below the LOW threshold
110	0	ENG COOLNT TMP HI HI	Engine Coolant Temperature is above the HIGH HIGH threshold
110	3	Cool Tmp Sns Volt HI	Coolant Temp Sensor Input Voltage (High)
110	4	Cool Tmp Sns Volt LO	Coolant Temp Sensor Input Voltage (Low)
110	15	ENG COOLANT TEMP HI	Engine Coolant Temperature is above the HIGH threshold
110	16	Cool Temp MHI	Coolant Temp Sensor Input (Moderately High)
110	17	Cool Temp LO	Coolant Temp Sensor Input (Low Least Severe)
111	1	Coolnt Lvl LO	Coolant Level (Low)
111	17	ENG COOLANT LVL LO	Engine Coolant Level is below the LOW threshold
111	#	LOW COOL LEVEL	Low Coolant Level string used in event log and/or Alarm and Pre-alarm annunciation
157	3	Fuel Rail Prs Vlt HI	Fuel Rail Pressure Input Voltage (High)
157	4	Fuel Rail Prs Vlt LO	Fuel Rail Pressure Input Voltage (Low)
157	10	Fuel Rail Prs LOSS	Fuel Rail Pressure Loss Detected
157	17	Fuel Rl Prs NOT DEV	Fuel Rail Pressure Not Developed
158	0	KSW BATT VOLTS HI HI	Key Switch Battery Potential is above the HIGH HIGH threshold
158	1	KSW BATT VOLTS LO LO	Key Switch Battery Potential is below the LOW LOW threshold
158	15	KSW BATT VOLTS HI	Key Switch Battery Potential is above the HIGH threshold
158	17	KSW BATT VOLTS LO	Key Switch Battery Potential is below the LOW threshold
168	#	LOW BATT VOLT	Low Battery Voltage string used in event log and/or Alarm and Pre-alarm annunciation

SPN	FMI	String Displayed	Description
174	0	Fuel Temp EXT HI	Fuel Temp (Extremely High)
174	3	Fuel Tmp Sns Volt HI	Fuel Temp Sensor Input Voltage (High)
174	4	Fuel Tmp Sns Volt LO	Fuel Temp Sensor Input Voltage (Low)
174	16	Fuel Temp MHI	Fuel Temp (Moderately High)
175	#	ENG OIL TEMP	Caption used on front panel for Display of J1939 Parameter
188	17	SPEED AT IDLE LO	Metering string for ECU trouble code metering indicates Engine Idle speed is below the LOW threshold
189	0	Engine Spd DERATE	Engine Speed Derate
190	0	Engine OvrSpd EXTRM	Engine Overspeed (Extreme)
190	1	ENGINE SPEED LOW	Engine speed is below the LOW threshold
190	16	Engine OvrSpd MODRT	Engine Overspeed (Moderate)
190	17	SPEED AT IDLE LO	Engine Idle speed is below the LOW threshold
190	#	ENGINE SPEED	Caption used on front panel for Display of J1939 Parameter
237	2	VIN Data MisMatch	VIN Data Mismatch with other controllers
412	0	EGR Temp EXT HI	Exhaust Gas Recirculation Temp (Extremely High)
412	3	EGR Temp In Vlt HI	Exhaust Gas Recirculation Temp Input Voltage (High)
412	4	EGR Temp In Vlt LO	Exhaust Gas Recirculation Temp Input Voltage (Low)
412	16	EGR Temp MHI	Exhaust Gas Recirculation Temp (Moderately High)
520	#	RETARDER % TORQUE	Caption string for retarder % torque
563	#	ABS ACTIVE	Caption String for Antilock Brake System (ABS) active
611	3	Inj Short to PWR	Injector Wiring Shorted to Power
611	4	Inj Short to GND	Injector Wiring Shorted to Ground
624	#	DIAGNOSTIC LAMP	Caption String for Diagnostic Lamp
627	1	Inj Spply Vlt Problm	Injector Supply Voltage Problem
627	16	ECU Power Volt HI	ECU Power High Voltage
627	18	ECU Power Volt LO	ECU Power Low Voltage
627	13	ECU ERROR	ECU Error
630	#	ECU INTERNAL ERROR	Caption string for ECU Internal Error
636	2	Pump Pos Sns Noisy	Pump Position Sensor Input Noise
636	5	Pump Pos Sns Curr LO	Pump Position Sensor Current (Low)
636	6	Pump Pos Sns Curr HI	Pump Position Sensor Current (High)
636	8	Pump Pos Sns In MSNG	Pump Position Sensor Input Missing
636	10	Pump Pos Sns In ERR	Pump Position Sensor Input Pattern Error
637	2	Crank Pos Sns Noisy	Crank Position Input Noise
637	5	Crank Pos Sns Curr LO	Crank Position Sensor Current (Low)
637	6	Crank Pos Sns Curr HI	Crank Position Sensor Current (High)
637	7	Crnk/Pmp Pos Tmg OOS	Crank/Pump Position Timing Moderately Out of Sync
637	8	Crank Pos Sns MSNG	Crank Position Missing
637	10	Crank Pos Sns In ERR	Crank Position Input Pattern Error
639	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
641	4	Trbo Actuator ERR	Turbo Actuator Error
641	12	ECU/Trbo Comm ERR	ECU/Turbo Communication Error
641	13	TrboAct Lrnd Val ERR	Turbo Actuator Learned Value Error
641	16	Trbo Act Temp MHI	Turbo Actuator Temp (Moderately High)
651	2	Cyl 1 EUI PN INVLD	Cylinder #1 EUI Part Number (Invalid)
651	5	Cyl 1 EUI Ckt OPEN	Cylinder #1 EUI Circuit (Open)

SPN	FMI	String Displayed	Description
651	6	Cyl 1 EUI Ckt SHORT	Cylinder #1 EUI Circuit (Shorted)
651	7	Cyl 1 EUI Ckt MECH FL	Cylinder #1 EUI Circuit (Mechanical Failure)
651	13	Cyl 1 EUI QR INVLD	Cylinder #1 EUI Circuit QR Code (Invalid)
651	#	CYLINDER 1 INJECTOR	Caption String for Cylinder 1 Injector
652	2	Cyl 2 EUI PN INVLD	Cylinder #2 EUI Part Number (Invalid)
652	5	Cyl 2 EUI Ckt OPEN	Cylinder #2 EUI Circuit (Open)
652	6	Cyl 2 EUI Ckt SHORT	Cylinder #2 EUI Circuit (Shorted)
652	7	Cyl 2 EUI Ckt MECH FL	Cylinder #2 EUI Circuit (Mechanical Failure)
652	13	Cyl 2 EUI QR INVLD	Cylinder #2 EUI Circuit QR Code (Invalid)
652	#	CYLINDER 2 INJECTOR	Caption String for Cylinder 2 Injector
653	2	Cyl 3 EUI PN INVLD	Cylinder #3 EUI Part Number (Invalid)
653	5	Cyl 3 EUI Ckt OPEN	Cylinder #3 EUI Circuit (Open)
653	6	Cyl 3 EUI Ckt SHORT	Cylinder #3 EUI Circuit (Shorted)
653	7	Cyl 3 EUI Ckt MECH FL	Cylinder #3 EUI Circuit (Mechanical Failure)
653	13	Cyl 3 EUI QR INVLD	Cylinder #3 EUI Circuit QR Code (Invalid)
653	#	CYLINDER 3 INJECTOR	Caption String for Cylinder 3 Injector
654	2	Cyl 4 EUI PN INVLD	Cylinder #4 EUI Part Number (Invalid)
654	5	Cyl 4 EUI Ckt OPEN	Cylinder #4 EUI Circuit (Open)
654	6	Cyl 4 EUI Ckt SHORT	Cylinder #4 EUI Circuit (Shorted)
654	7	Cyl 4 EUI Ckt MECH FL	Cylinder #4 EUI Circuit (Mechanical Failure)
654	13	Cyl 4 EUI QR INVLD	Cylinder #4 EUI Circuit QR Code (Invalid)
654	#	CYLINDER 4 INJECTOR	Caption String for Cylinder 4 Injector
655	2	Cyl 5 EUI PN INVLD	Cylinder #5 EUI Part Number (Invalid)
655	5	Cyl 5 EUI Ckt OPEN	Cylinder #5 EUI Circuit (Open)
655	6	Cyl 5 EUI Ckt SHORT	Cylinder #5 EUI Circuit (Shorted)
655	7	Cyl 5 EUI Ckt MECH FL	Cylinder #5 EUI Circuit (Mechanical Failure)
655	13	Cyl 5 EUI QR INVLD	Cylinder #5 EUI Circuit QR Code (Invalid)
655	#	CYLINDER 5 INJECTOR	Caption String for Cylinder 5 Injector
656	2	Cyl 6 EUI PN INVLD	Cylinder #6 EUI Part Number (Invalid)
656	5	Cyl 6 EUI Ckt OPEN	Cylinder #6 EUI Circuit (Open)
656	6	Cyl 6 EUI Ckt SHORT	Cylinder #6 EUI Circuit (Shorted)
656	7	Cyl 6 EUI Ckt MECH FL	Cylinder #6 EUI Circuit (Mechanical Failure)
656	13	Cyl 6 EUI QR INVLD	Cylinder #6 EUI Circuit QR Code (Invalid)
656	#	CYLINDER 6 INJECTOR	Caption String for Cylinder 6 Injector
657	#	CYLINDER 7 INJECTOR	Caption String for Cylinder 7 Injector
658	#	CYLINDER 8 INJECTOR	Caption String for Cylinder 8 Injector
659	#	CYLINDER 9 INJECTOR	Caption String for Cylinder 9 Injector
660	#	CYLINDER 10 INJECTOR	Caption String for Cylinder 10 Injector
661	#	CYLINDER 11 INJECTOR	Caption String for Cylinder 11 Injector
662	#	CYLINDER 12 INJECTOR	Caption String for Cylinder 12 Injector
663	#	CYLINDER 13 INJECTOR	Caption String for Cylinder 13 Injector
664	#	CYLINDER 14 INJECTOR	Caption String for Cylinder 14 Injector
665	#	CYLINDER 15 INJECTOR	Caption String for Cylinder 15 Injector
666	#	CYLINDER 16 INJECTOR	Caption String for Cylinder 16 Injector
667	#	CYLINDER 17 INJECTOR	Caption String for Cylinder 17Injector
668	#	CYLINDER 18 INJECTOR	Caption String for Cylinder 18 Injector

SPN	FMI	String Displayed	Description
669	#	CYLINDER 19 INJECTOR	Caption String for Cylinder 19 Injector
670	#	CYLINDER 20 INJECTOR	Caption String for Cylinder 20 Injector
671	#	CYLINDER 21 INJECTOR	Caption String for Cylinder 21 Injector
672	#	CYLINDER 22 INJECTOR	Caption String for Cylinder 22 Injector
673	#	CYLINDER 23 INJECTOR	Caption String for Cylinder 23 Injector
674	#	CYLINDER 24 INJECTOR	Caption String for Cylinder 24 Injector
676	#	ENG GLOW PLUG RELAY	Caption String for Engine Glow Plug Relay
677	#	ENGINE START RELAY	Caption String for Engine Start Relay
701	#	AUX I/O 1	Caption String for Auxiliary I/O 1
702	#	AUX I/O 2	Caption String for Auxiliary I/O 2
703	#	AUX I/O 3	Caption String for Auxiliary I/O 3
704	#	AUX I/O 4	Caption String for Auxiliary I/O 4
705	#	AUX I/O 5	Caption String for Auxiliary I/O 5
706	#	AUX I/O 6	Caption String for Auxiliary I/O 6
707	#	AUX I/O 7	Caption String for Auxiliary I/O 7
708	#	AUX I/O 8	Caption String for Auxiliary I/O 8
709	#	AUX I/O 9	Caption String for Auxiliary I/O 9
710	#	AUX I/O 10	Caption String for Auxiliary I/O 10
711	#	AUX I/O 11	Caption String for Auxiliary I/O 11
712	#	AUX I/O 12	Caption String for Auxiliary I/O 12
713	#	AUX I/O 13	Caption String for Auxiliary I/O 13
714	#	AUX I/O 14	Caption String for Auxiliary I/O 14
715	#	AUX I/O 15	Caption String for Auxiliary I/O 15
716	#	AUX I/O 16	Caption String for Auxiliary I/O 16
898	2	REQ SPD DATA ERRATIC	Speed Demand Data is erratic
898	9	Spd/Trq Msg INVLD	Vehicle Speed/Torque Message Invalid
898	#	ENGINE REQSTED SPEED	Caption String for Engine Requested Speed
923	#	PWM OUTPUT	Caption String for Engine PWM Output
970	2	Aux Eng SD SW INVLD	Auxiliary Engine Shutdown Switch (Invalid)
970	31	Aux Eng SD SW ACTV	Auxiliary Engine Shutdown Switch Active
971	31	Eng Derate SW ACTV	External Engine Derate Switch Active
975	#	FAN SPEED	Caption String for Engine Fan Speed
1072	#	ENG BRAKE OUTPUT 1	Caption String for Engine Brake Output 1
1074	#	ENG EXHAUST BRAKE OUT	Caption String for Engine Exhaust Brake Output
1075	5	Fuel TR Pump Curr LO	Fuel Transfer Pump Current (Low)
1075	6	Fuel TR Pump Curr HI	Fuel Transfer Pump Current (High)
1075	12	Fuel TR Pump ERR	Fuel Transfer Pump (Error)
1079	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
1080	3	Snsr Supp 1 Volt LO	Sensor Supply 1 Voltage (Low)
1080	4	Snsr Supp 1 Volt HI	Sensor Supply 1 Voltage (High)
1080	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
1081	#	ENG WAIT TO START LMP	Caption String for Engine Wait to Start Lamp
1109	31	Eng Shutdown WARNING	Engine Shutdown Warning
1109	#	EPS SHUTDN APPROACHG	Caption String for indication that Engine Protective System Shutdown Is Approaching
1110	31	Eng Prot Shutdown	Engine Protection Shutdown

SPN	FMI	String Displayed	Description
1136	0	ECU Temp EXT HI	ECU Temperature (Extremely High)
1136	15	ENG ECU TEMP HI	ECU Temperature has exceeded the HIGH level
1136	16	ECU Temp MHI	ECU Temperature (Moderately High)
1172	3	Trbo Cmp Tmp Volt HI	Turbo Compressor Inlet Temp Input Voltage (High)
1172	4	Trbo Cmp Tmp Volt LO	Turbo Compressor Inlet Temp Input Voltage (Low)
1172	16	Trbo Cmp In Tmp MHI	Turbo Compressor Inlet Temp (Moderately High)
1180	0	Trbo Trbn Tmp EXT HI	Turbo Turbine Inlet Temp (Extremely High)
1180	16	Trbo Trbn In Tmp MHI	Turbo Turbine Inlet Temp (Moderately High)
1231	#	J1939 NETWORK 2	Caption String for J1939 Network number 2
1235	#	J1939 NETWORK 3	Caption String for J1939 Network number 3
1237	#	ENG SHUTDN ORIDE SW	Caption String for Engine Shutdown Override Switch
1322	#	MULTI CYL MISFIRE	Caption String for Misfire detected on multiple engine cylinders
1323	#	MISFIRE CYLINDER 1	Caption String for Misfire detected on a single engine cylinder
1324	#	MISFIRE CYLINDER 2	Caption String for Misfire detected on a single engine cylinder
1325	#	MISFIRE CYLINDER 3	Caption String for Misfire detected on a single engine cylinder
1326	#	MISFIRE CYLINDER 4	Caption String for Misfire detected on a single engine cylinder
1327	#	MISFIRE CYLINDER 5	Caption String for Misfire detected on a single engine cylinder
1328	#	MISFIRE CYLINDER 6	Caption String for Misfire detected on a single engine cylinder
1329	#	MISFIRE CYLINDER 7	Caption String for Misfire detected on a single engine cylinder
1330	#	MISFIRE CYLINDER 8	Caption String for Misfire detected on a single engine cylinder
1331	#	MISFIRE CYLINDER 9	Caption String for Misfire detected on a single engine cylinder
1332	#	MISFIRE CYLINDER 10	Caption String for Misfire detected on a single engine cylinder
1333	#	MISFIRE CYLINDER 11	Caption String for Misfire detected on a single engine cylinder
1334	#	MISFIRE CYLINDER 12	Caption String for Misfire detected on a single engine cylinder
1335	#	MISFIRE CYLINDER 13	Caption String for Misfire detected on a single engine cylinder
1336	#	MISFIRE CYLINDER 14	Caption String for Misfire detected on a single engine cylinder
1337	#	MISFIRE CYLINDER 15	Caption String for Misfire detected on a single engine cylinder
1338	#	MISFIRE CYLINDER 16	Caption String for Misfire detected on a single engine cylinder
1339	#	MISFIRE CYLINDER 17	Caption String for Misfire detected on a single engine cylinder
1340	#	MISFIRE CYLINDER 18	Caption String for Misfire detected on a single engine cylinder
1341	#	MISFIRE CYLINDER 19	Caption String for Misfire detected on a single engine cylinder
1342	#	MISFIRE CYLINDER 20	Caption String for Misfire detected on a single engine cylinder
1343	#	MISFIRE CYLINDER 21	Caption String for Misfire detected on a single engine cylinder
1344	#	MISFIRE CYLINDER 22	Caption String for Misfire detected on a single engine cylinder
1345	#	MISFIRE CYLINDER 23	Caption String for Misfire detected on a single engine cylinder
1346	#	MISFIRE CYLINDER 24	Caption String for Misfire detected on a single engine cylinder
1347	3	Pump Ctrl Vlv Curr HI	Pump Control Valve Current (High)
1347	5	Pmp Ctrl Vlv C MSMCH	Pump Control Valve Current (Mismatch)
1347	7	Fuel Rl Prs Ctrl ERR	Fuel Rail Pressure Control (Error)
1569	31	Fuel Derate	Fuel Derate
1638	#	HYDRAULIC TEMP	Caption String for Hydraulic Temperature
1639	1	Fan Speed Zero	Fan Speed Detected (Zero)
1639	16	Fan Speed HI	Fan Speed Detected (High)
1639	18	Fan Speed LO	Fan Speed Detected (Low)
2000	13	Security Violation	Security Violation
2005	9	TSC CAN Msg NT RCV	TSC CAN Message Not Received

SPN	FMI	String Displayed	Description
2030	9	AC Clutch Msg NT RCV	A/C Clutch Status CAN Message Not Received
2071	9	Tr Oil Can Msg NT RCV	Trans. Oil, Tier Size, Vehicle Speed CAN Message Not Received
2629	0	TRBO 1 OUT TMP HI HI	Turbocharger 1 outlet pressure is above the HIGH HIGH threshold
2629	15	TURBO 1 OUT TMP HI	Turbocharger 1 outlet pressure is above the HIGH threshold
2630	0	EGR FrAir Tmp EXT HI	Exhaust Gas Recirculation Fresh Air Temp (Extremely High)
2630	3	EGR FrAir Tmp Vlt HI	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (High)
2630	4	EGR FrAir Tmp Vlt LO	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (Low)
2630	15	EGR FrAir Tmp HI	Exhaust Gas Recirculation Fresh Air Temp (High Least Severe)
2630	16	EGR FrAir Tmp MHI	Exhaust Gas Recirculation Fresh Air Temp (Moderately High)
2634	#	POWER RELAY	Caption String for main Power Relay
2659	2	EGR Flo/Tmp MISMATCH	Exhaust Gas Recirculation Flow/Temp Mismatch
2659	15	EGR Flo Rt High	Exhaust Gas Recirculation Flow Rate (High Least Severe)
2659	17	EGR Flo Rt LO	Exhaust Gas Recirculation Flow Rate (Low Least Severe)
2790	16	Trbo Cmp Out Tmp HI	Turbo Compressor Outlet Temp (Moderately High)
2791	2	EGR Vlv Pos Invld	Exhaust Gas Recirculation Valve Position Invalid
2791	3	EGRVlv Pos In Vlt HI	Exhaust Gas Recirculation Valve Position Input Voltage (High)
2791	4	EGRVlv Pos In Vlt LO	Exhaust Gas Recirculation Valve Position Input Voltage (Low)
2791	13	EGR Vlv Control ERR	Exhaust Gas Recirculation Valve Control Error
2791	31	EGR Valve Cal ERR	Exhaust Gas Recirculation Valve Calibration Error
2791	#	EGR VALVE CONTROL	Caption String for EGR Valve Control
2795	7	Trbo Act Pos MSMATCH	Turbo Actuator Position Mismatch
3719	0	DPF SOOT LVL EXT HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Most Severe Level
3719	15	DPF SOOT LVL HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Least Severe Level
3719	16	DPF SOOT LVL MOD HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Moderately Severe Level
520837	1	STARTER SPEED LOW LOW	Starter Speed is below the LOW LOW threshold
520838	12	ENGINE RUN UP SPEED LOW LOW	Run Up Speed is below the LOW LOW threshold
522192	1	MTU ENGINE CONTROLLER - BAD DEVICE OR COMPONENT	Component failure of the MTU engine control ECU
523212	#	ENGPRT CAN MSG	Caption String for CAN Bus Message
523216	#	PREHTENCMD CAN MSG	Caption String for CAN Bus Message
523218	#	RxCCVS CAN MSG	Caption String for CAN Bus Message
523222	#	TC01 CAN MSG	Caption String for CAN Bus Message
523238	#	SWTOUT CAN MSG	Caption String for CAN Bus Message
523239	#	DECV1 CAN MSG	Caption String for CAN Bus Message
523240	#	FUNMODCTL CAN MSG	Caption String for CAN Bus Message
523350	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523351	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523352	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523353	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523354	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523355	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523370	#	RAIL PRESSURE	Caption String for Rail Pressure

SPN	FMI	String Displayed	Description
523420	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523450	#	MULTI STATE SWITCH 1	Caption String for Multi State Switch 1
523451	#	MULTI STATE SWITCH 2	Caption String for Multi State Switch 2
523452	#	MULTI STATE SWITCH 3	Caption String for Multi State Switch 3
523470	#	RAIL PRESSURE LMT VLV	Caption String for Rail Pressure Limit Valve
523490	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523500	#	CAN MSG TIMEOUT	Caption String indicating Can Message Timeout has occurred
523550	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523561	#	INJECTN PERIOD CYL 1	Caption String for Single Cylinder Injection Period
523562	#	INJECTN PERIOD CYL 2	Caption String for Single Cylinder Injection Period
523563	#	INJECTN PERIOD CYL 3	Caption String for Single Cylinder Injection Period
523564	#	INJECTN PERIOD CYL 4	Caption String for Single Cylinder Injection Period
523565	#	INJECTN PERIOD CYL 5	Caption String for Single Cylinder Injection Period
523566	#	INJECTN PERIOD CYL 6	Caption String for Single Cylinder Injection Period
523567	#	INJECTN PERIOD CYL 7	Caption String for Single Cylinder Injection Period
523568	#	INJECTN PERIOD CYL 8	Caption String for Single Cylinder Injection Period
523600	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523601	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523602	#	FAN SPEED	Caption String for Engine Fan Speed
523604	#	RXENGTMP CAN MSG	Caption String for CAN Bus Message
523605	#	TSC1-AE MSG MISSING	Caption String for CAN Bus Message
523606	#	TSC1-AR MSG MISSING	Caption String for CAN Bus Message
523607	#	TSC1-DE MSG MISSING	Caption String for CAN Bus Message
523608	#	TSC1-DR MSG MISSING	Caption String for CAN Bus Message
523609	#	TSC1-PE MSG MISSING	Caption String for CAN Bus Message
523610	#	TSC1-VE MSG MISSING	Caption String for CAN Bus Message
523611	#	TSC1-VR MSG MISSING	Caption String for CAN Bus Message
523612	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523613	#	RAIL PRESSURE	Caption String for Rail Pressure
523615	#	METERING UNIT VALVE	Caption String for Metering Unit Valve
523617	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error

MTU Fault Codes

An IEM-2020 connected to a engine equipped with an MTU engine ECU tracks and displays the active fault codes issued by the MTU engine ECU. Active MTU fault codes can be viewed through BESTCOMS*Plus* by using the Metering Explorer to expand the MTU tree or through the front panel display by navigating to METERING, ALARMS-STATUS, MTU FAULT CODES.

Each fault code is displayed with a fault description and the fault number. If the IEM-2020 does not have descriptive information about a fault number that was received, the fault description will display as “NO TEXT AVAILABLE”. Fault codes displayed by the IEM-2020 are described in Appendix C, *MTU Fault Codes*.

RS-485 (Optional)

IEM-2020 modules with the optional RS-485 communication port (style number NNxRxxNNH) can be monitored and controlled via a polled network using the Modbus™ protocol. The RS-485 port supports a user-selectable baud rate of 1200, 2400, 4800, or 9600. Odd, even, or no parity is supported. Fixed communication settings include the number of data bits (8) and stop bits (1). Modbus register values for the IEM-2020 are listed and defined in Appendix A, *Modbus™ Communication.* RS-485 port connections are made at IEM-2020 terminals 14 (485A), 13 (485B), and 12 (485 SHIELD).

Modem (Optional)

When equipped with the optional, internal, dial-out modem, the IEM-2020 can be connected to a standard telephone line through its RJ-11 jack. The modem enables the IEM-2020 to dial up to four pager telephone numbers and annunciate conditions selected by the user. These conditions include any IEM-2020 alarm or pre-alarm, closure of any programmable contact input, and an active cooldown timer. The modem accommodates pagers that use seven data bits with even parity or modems using eight data bits with no parity.

Output Contacts

Output contact operation is controlled by the operating mode of the IEM-2020. The state of the Emergency Stop contact input also affects output contact operation. When the Emergency Stop contact input is open (emergency stop condition), the PRESTART, START, and RUN outputs open. When the Emergency Stop input is closed, all output contacts operate normally.

IEM-2020 output contacts include PRESTART, START, and RUN, and up to 12 standard programmable outputs. Additional output contacts can be accommodated with a CEM-2020 (Contact Expansion Module).

PRESTART

This output closes to energize the engine glow plugs. The PRESTART output can be programmed to close up to 30 seconds prior to engine cranking. The PRESTART output can also be programmed to open upon engine startup or remain closed as long as the engine is operating.

During the resting state, the PRESTART can be set to Off, On, or Preheat Before Crank. If Preheat Before Crank is selected, the PRESTART output will be closed for a time equal to the Pre-crank delay time prior to re-entering the cranking state. If the Pre-crank delay setting is longer than the rest interval, the PRESTART output will be closed for the entire rest time.

PRESTART output connections are made through terminals located on the PRESTART relay.

START

This output closes when engine cranking is initiated by the IEM-2020 and opens when the magnetic pickup (MPU) or engine frequency indicates that the engine has started. Prior to engine starting, the duration of cranking is determined by the cranking style (cycle or continuous) selected. Cycle cranking permits up to 7 crank cycles with crank cycle duration of 5 to 15 seconds. The continuous crank time is adjustable from 5 to 60 seconds.

START output connections are made through terminals located on the START relay.

RUN

This output closes when engine cranking is initiated by the IEM-2020. The RUN output remains closed until an off command or emergency stop command is received.

RUN output connections are made through terminals located on the RUN relay.

Programmable

IEM-2020 modules with a style number of NNAxxxNNH have four programmable output contacts (OUT 1 through 4). Twelve programmable outputs (OUT 1 through 12) are provided on modules with a style number of NNBxxxNNH.

Modes of Operation

OFF

When in the OFF mode, the IEM-2020 will not start under any circumstance. It cannot be started automatically. Programmable logic functions normally in this mode.

RUN

When in the RUN (manual) mode, the IEM-2020 runs and cannot be shut off automatically.

AUTO

When in the AUTO mode, the IEM-2020 may be started automatically or “self-start” from an automatic starting feature listed in the following paragraphs. If the IEM-2020 is not in AUTO mode, the self-starting modes will have no effect.

Auto Start

The Auto Start programmable function has an input mapped to it from BESTCOMS*Plus*. The unit will start and run when this contact is closed, and will stop when the contact is open. This mode is independent of the other self-starting modes.

Engine Exerciser

The unit will start at the designated time and will run for the specified duration. This mode is independent of the other self-starting modes.

Engine Run Logic Element

When the engine run logic element start input is energized, the unit will start. When the engine run logic element stop input is energized, the unit will cool down and then stop.

Event Recording

An event log retains history of system events in nonvolatile memory. Thirty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 30 records in memory, the record that has the oldest "last" event occurrence is removed from the log, and the new category takes its place. Since 30 event records with up to 99 occurrences each are retained in memory, a history of nearly 3,000 specific events are retained in the IEM-2020. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 30 event records; thus the time, date, and engine hours details for up to 900 specific event occurrences are retained in the event log.

BESTCOMS*Plus* can be used to view and download the event log. The event log may also be viewed through the front panel HMI by navigating to *Metering, Alarms-Status, Event Log.* Use the Up/Down keys to highlight an event and press the *Right* key to view the summary of that event record. The summary contains the description of the event, date, time, and engine hours of the first occurrence of the event, along with date, time, and engine hours of the most recent occurrence of the event. To view details of specific event occurrences, press the *Down* key until DETAILS is highlighted and then press the *Right* key. The occurrence number can be changed by pressing the *Edit* key, *Up/Down* keys to select #, and pressing the *Edit* key again to exit. Table 3-7 lists all possible event strings (as shown in the event log).

Table 3-7. Event List

Event String	Event Description	Event Type
AEM COMM FAIL P	AEM-2020 Communications Failure	Pre-Alarm
AEM OUTX OUT RNG (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4)	Status
AEM OUTX OUT RNG A (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4)	Alarm
AEM OUTX OUT RNG P (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4)	Pre-Alarm
AL ECU FAULTY P	ECU Faulty	Pre-Alarm
ALG CUR O1 A	User Configurable Analog Current Over 1	Alarm
ALG CUR O1 P	User Configurable Analog Current Over 1	Pre-Alarm
ALG CUR O2 A	User Configurable Analog Current Over 2	Alarm
ALG CUR O2 P	User Configurable Analog Current Over 2	Pre-Alarm
ALG CUR OOR A	User Configurable Analog Current Out of Range	Alarm
ALG CUR OOR P	User Configurable Analog Current Out of Range	Pre-Alarm
ALG CUR U1 A	User Configurable Analog Current Under 1	Alarm
ALG CUR U1 P	User Configurable Analog Current Under 1	Pre-Alarm
ALG CUR U2 A	User Configurable Analog Current Under 2	Alarm
ALG CUR U2 P	User Configurable Analog Current Under 2	Pre-Alarm
ALG IN X_O1 (X = 1 to 8)	User Configurable Remote Analog Input X Over 1 (X = 1 to 8)	Status
ALG IN X_O1 A (X = 1 to 8)	User Configurable Remote Analog Input X Over 1 (X = 1 to 8)	Alarm
ALG IN X_O1 P (X = 1 to 8)	User Configurable Remote Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
ALG IN X_O2 (X = 1 to 8)	User Configurable Remote Analog Input X Over 1 (X = 1 to 8)	Status
ALG IN X_O2 A (X = 1 to 8)	User Configurable Remote Analog Input X Over 1 (X = 1 to 8)	Alarm
ALG IN X_O2 P (X = 1 to 8)	User Configurable Remote Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
ALG IN X_OOR (X = 1 to 8)	User Configurable Remote Analog Input X Out of Range (X = 1 to 8)	Status
ALG IN X_OOR A (X = 1 to 8)	User Configurable Remote Analog Input X Out of Range (X = 1 to 8)	Alarm

Event String	Event Description	Event Type
ALG IN X_OOR P (X = 1 to 8)	User Configurable Remote Analog Input X Out of Range (X = 1 to 8)	Pre-Alarm
ALG IN X_U1 (X = 1 to 8)	User Configurable Remote Analog Input X Under 1 (X = 1 to 8)	Status
ALG IN X_U1 A (X = 1 to 8)	User Configurable Remote Analog Input X Under 1 (X = 1 to 8)	Alarm
ALG IN X_U1 P (X = 1 to 8)	User Configurable Remote Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
ALG IN X_U2 (X = 1 to 8)	User Configurable Remote Analog Input X Under 1 (X = 1 to 8)	Status
ALG IN X_U2 A (X = 1 to 8)	User Configurable Remote Analog Input X Under 1 (X = 1 to 8)	Alarm
ALG IN X_U2 P (X = 1 to 8)	User Configurable Remote Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
ALG VOLT O1 A	User Configurable Analog Voltage Over 1	Alarm
ALG VOLT O1 P	User Configurable Analog Voltage Over 1	Pre-Alarm
ALG VOLT O2 A	User Configurable Analog Voltage Over 2	Alarm
ALG VOLT O2 P	User Configurable Analog Voltage Over 2	Pre-Alarm
ALG VOLT OOR A	User Configurable Analog Voltage Out of Range	Alarm
ALG VOLT OOR P	User Configurable Analog Voltage Out of Range	Pre-Alarm
ALG VOLT U1 A	User Configurable Analog Voltage Under 1	Alarm
ALG VOLT U1 P	User Configurable Analog Voltage Under 1	Pre-Alarm
ALG VOLT U2 A	User Configurable Analog Voltage Under 2	Alarm
ALG VOLT U2 P	User Configurable Analog Voltage Under 2	Pre-Alarm
AUTO RESTART	Automatic Restart in Progress	Status
AUTO RESTART FAIL A	Automatic Restart Fail	Alarm
AUTOSTART	Auto Start	Status
BATT CHRG FAIL A	Battery Charger Fail	Alarm
BATT CHRG FAIL P	Battery Charger Fail	Pre-Alarm
BATT OVERVOLT P	Battery Overvoltage	Pre-Alarm
BATTLE OVERRIDE	Battle Override	Status
CAN BUS OFF	CAN Bus entered Bus Off state	Status
CAN ERROR PASSIVE	CAN Bus entered Error Passive state	Status
CEM COMM FAIL P	CEM-2020 Communications Failure	Pre-Alarm
CEM HW MISMATCH P	Connected CEM-2020 is wrong type	Pre-Alarm
CHECKSUM FAIL P	Corrupt user settings or firmware code	Pre-Alarm
COMBINED RED A	Combined Red	Alarm
COMBINED YELLOW P	Combined Yellow	Pre-Alarm
CONF PROT X_O1 (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Status
CONF PROT X_O1 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Alarm
CONF PROT X_O1 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Pre-Alarm
CONF PROT X_O2 (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Status
CONF PROT X_O2 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Alarm
CONF PROT X_O2 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Pre-Alarm
CONF PROT X_U1 (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Status
CONF PROT X_U1 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Alarm
CONF PROT X_U1 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Pre-Alarm
CONF PROT X_U2 (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Status
CONF PROT X_U2 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Alarm
CONF PROT X_U2 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Pre-Alarm
CONFIG ELEMENT X A (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Alarm
CONFIG ELEMENT X P (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Pre-Alarm
COOL LVL SNDR FL A	Coolant Level Sender Fail	Alarm
COOL SNDR FAIL	Coolant Temperature Sender Fail	Status
COOL SNDR FAIL A	Coolant Temperature Sender Fail	Alarm
COOL SNDR FAIL P	Coolant Temperature Sender Fail	Pre-Alarm
DEF ENGINE DERATE P	Diesel Exhaust Fluid Engine Derate	Pre-Alarm
DEF FLUID EMPTY P	Diesel Exhaust Fluid Empty	Pre-Alarm
DEF FLUID LOW P	Diesel Exhaust Fluid Low	Pre-Alarm
DEF INDUCMT O-RIDE P	Diesel Exhaust Fluid Inducement Override	Pre-Alarm
DEF PRESVR INDUCMT P	Diesel Exhaust Fluid Pre-Severe Inducement	Pre-Alarm
DEF SEVERE INDUCMT P	Diesel Exhaust Fluid Severe Inducement	Pre-Alarm
DIAG TRBL CODE P	Diagnostic Trouble Code	Pre-Alarm
DIAL OUT FAILED	Modem Dialout Failed	Status
DIAL OUT SUCCESS	Modem Dialout Success	Status
DPF REGEN REQD P	Diesel Particulate Filter Regeneration Required	Pre-Alarm

Event String	Event Description	Event Type
DPF REGNRATE DISABLD P	Diesel Particulate Filter Regeneration Disabled	Pre-Alarm
DPF SOOT LVL EXT HI P	Diesel Particulate Filter Soot Level Extremely High	Pre-Alarm
DPF SOOT LVL HI P	Diesel Particulate Filter Soot Level High	Pre-Alarm
DPF SOOT LVL MOD HI P	Diesel Particulate Filter Soot Level Moderately High	Pre-Alarm
ECU SHUTDOWN A	ECU Shutdown	Alarm
EMERGENCY STOP A	Emergency Stop	Alarm
ENGINE RUNNING	Engine Running	Status
FUEL FLT PRS HI P	Fuel Filter Differential Pressure High	Pre-Alarm
FUEL LEAK 1 P	Fuel Filter 1 Leak	Pre-Alarm
FUEL LEAK 2 P	Fuel Filter 2 Leak	Pre-Alarm
FUEL LEAK DETECT A	Fuel Leak Detect	Alarm
FUEL LEAK DETECT P	Fuel Leak Detect	Pre-Alarm
FUEL LEVL SENDR A	Fuel Level Sender Fail	Alarm
FUEL LEVL SENDR FAIL	Fuel Level Sender Fail	Status
FUEL LEVL SENDR P	Fuel Level Sender Fail	Pre-Alarm
GLBL SNDR FAIL A	Global Sender Fail	Alarm
HI COOLANT TMP A	High Coolant Temp	Alarm
HI COOLANT TMP P	High Coolant Temp	Pre-Alarm
HI DAY TANK LEVEL P	High Day Tank Level	Pre-Alarm
HI ECU VOLTS A	High ECU Supply Voltage	Alarm
HI EXHAUST A T P	High Exhaust Temp A	Pre-Alarm
HI EXHAUST B T P	High Exhaust Temp B	Pre-Alarm
HI PRESSURE IN 1 P	High Pressure Input 1	Pre-Alarm
HI PRESSURE IN 2 P	High Pressure Input 2	Pre-Alarm
HI SUPPLY VOLTS P	High Voltage Supply	Pre-Alarm
HI T FUEL P	High Fuel Temp	Pre-Alarm
HIGH AMB TEMP P	High Ambient Temp	Pre-Alarm
HIGH CHARGE AIR TEMP A	High Charge Air Temp	Alarm
HIGH CHARGE AIR TEMP P	High Charge Air Temp	Pre-Alarm
HIGH COIL TEMP 1 P	High Temp Coil 1	Pre-Alarm
HIGH COIL TEMP 2 P	High Temp Coil 2	Pre-Alarm
HIGH COIL TEMP 3 P	High Temp Coil 3	Pre-Alarm
HIGH COOLANT TEMP A	High Coolant Temp	Alarm
HIGH COOLANT TEMP P	High Coolant Temp	Pre-Alarm
HIGH ECU TEMPERATURE P	High ECU Temp	Pre-Alarm
HIGH EXHAUST TEMP P	High Exhaust Temp	Pre-Alarm
HIGH FUEL LEVEL P	High Fuel Level	Pre-Alarm
HIGH FUEL RAIL PRESS P	High Fuel Rail Pressure	Pre-Alarm
HIGH INTRCOOLER TEMP P	High Intercooler Temp	Pre-Alarm
HIGH OIL TEMPERATURE P	High Oil Temp	Pre-Alarm
HIGH OIL TERMPERATURE A	High Oil Temp	Alarm
HIGH STRG TANK LEVEL P	High Storage Tank Level	Pre-Alarm
IDLE SPD LO P	Idle Speed Low	Pre-Alarm
IEM HEARTBEAT FAIL P	IEM Heartbeat Fail	Pre-Alarm
INPUT X A (X = 1 to 40)	User Configurable Input X (X = 1 to 40)	Alarm
INPUT X P (X = 1 to 40)	User Configurable Input X (X = 1 to 40)	Pre-Alarm
LO AFTERCLR COOL LVL A	Low After Cooler Cool Level	Alarm
LO CHG AIR CLNT LVL P	Low Charge Air Coolant Level	Pre-Alarm
LO DAY TANK LEVEL P	Low Day Tank Level	Pre-Alarm
LO ECU VOLTS P	Low ECU Supply Voltage	Pre-Alarm
LO FUEL DLV PRESSURE A	Low Fuel Delivery Pressure	Alarm
LO SUPPLY VOLTS P	Low Voltage Supply	Pre-Alarm
LOGIC OUPUT A	Logic Output	Alarm
LOGIC OUPUT P	Logic Output	Pre-Alarm
LOSS REM COMS P	Loss of Remote Module Communication	Pre-Alarm
LOST ECU COMM A	Loss of ECU Communication	Alarm
LOST ECU COMM P	Loss of ECU Communication	Pre-Alarm
LOW BATT VOLT P	Low Battery Voltage	Pre-Alarm
LOW CHARGE AIR PRESS P	Low Charge Air Pressure	Pre-Alarm

Event String	Event Description	Event Type
LOW COOL LEVEL A	Low Coolant Level	Alarm
LOW COOL LEVEL P	Low Coolant Level	Pre-Alarm
LOW COOL TMP A	Low Coolant Temperature	Alarm
LOW COOL TMP P	Low Coolant Temperature	Pre-Alarm
LOW COOLANT LEVEL P	Low Coolant Level	Pre-Alarm
LOW FUEL DELIV PRESS P	Low Fuel Delivery Pressure	Pre-Alarm
LOW FUEL LEVEL A	Low Fuel Level	Alarm
LOW FUEL LEVEL P	Low Fuel Level	Pre-Alarm
LOW FUEL RAIL PRESS P	Low Fuel Rail Pressure	Pre-Alarm
LOW OIL PRES A	Low Oil Pressure	Alarm
LOW OIL PRES P	Low Oil Pressure	Pre-Alarm
LOW OIL PRESSURE A	Low Oil Pressure	Alarm
LOW OIL PRESSURE P	Low Oil Pressure	Pre-Alarm
LOW STRG TANK LEVEL P	Low Storage Tank Level	Pre-Alarm
LSM AVR OUT LMT P	LSM-2020 AVR Output Limit	Pre-Alarm
LSM COMMS FAIL P	LSM-2020 Communications Failure	Pre-Alarm
LSM GOV OUT LMT P	LSM-2020 GOV Output Limit	Pre-Alarm
LSM HEARTBEAT FAIL P	LSM-2020 Heartbeat Failed	Pre-Alarm
LSM INTERGEN COM FAIL P	LSM-2020 Intergen Communications Failure	Pre-Alarm
MAINT INTERVAL P	Maintenance Interval	Pre-Alarm
MAX RPM P	Maximum RPM	Pre-Alarm
MIN RPM P	Minimum RPM	Pre-Alarm
MPU FAIL P	Magnetic Pickup Fail	Pre-Alarm
MULTIPLE AEM P	Multiple AEM-2020's	Pre-Alarm
MULTIPLE CEM P	Multiple CEM-2020's	Pre-Alarm
MULTIPLE LSM P	Multiple LSM-2020's	Pre-Alarm
NORM SHUTDOWN	Normal Shutdown	Status
OIL SNDR FAIL	Oil Pressure Sender Fail	Status
OIL SNDR FAIL A	Oil Pressure Sender Fail	Alarm
OIL SNDR FAIL P	Oil Pressure Sender Fail	Pre-Alarm
OVERCRANK A	Overcrank	Alarm
OVERSPEED A	Overspeed	Alarm
OVRSPD TEST ON P	Overspeed Test On	Pre-Alarm
PRIMING FAULT P	Priming Fault	Pre-Alarm
PROT SHUTDOWN	Protective Shutdown	Status
RTD_IN_X_O1 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
RTD_IN_X_O1 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
RTD_IN_X_O1 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_O2 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
RTD_IN_X_O2 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
RTD_IN_X_O2 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_OOR (X = 1 to 8)	User Configurable RTD Input X Out of Range (X = 1 to 8)	Status
RTD_IN_X_OOR A (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Alarm
RTD_IN_X_OOR P (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Pre-Alarm
RTD_IN_X_U1 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
RTD_IN_X_U1 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
RTD_IN_X_U1 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_U2 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
RTD_IN_X_U2 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
RTD_IN_X_U2 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
RUNUP SPD LO P	Run Up Speed Low	Pre-Alarm
SCREEN ERROR	Screen Error	Status
SERFLASH RD FAIL P	Serial Flash Read Fail	Pre-Alarm
SPD SNDR FAIL	Speed Sender Fail	Status
SPD SNDR FAIL A	Speed Sender Fail	Alarm
SPEED DMD FL P	Speed Demand Fail	Pre-Alarm
SPEED TOO LOW P	Engine Speed Too Low	Pre-Alarm
SS OVERRIDE ON P	Shutdown Override	Pre-Alarm
START SPEED LOW P	Start Speed Low	Pre-Alarm

Event String	Event Description	Event Type
THRM_CPL_X_O1 (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Status
THRM_CPL_X_O1 A (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Alarm
THRM_CPL_X_O1 P (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_O2 (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Status
THRM_CPL_X_O2 A (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Alarm
THRM_CPL_X_O2 P (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_OOR (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Status
THRM_CPL_X_OOR A (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Alarm
THRM_CPL_X_OOR P (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_U1 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Status
THRM_CPL_X_U1 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Alarm
THRM_CPL_X_U1 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_U2 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Status
THRM_CPL_X_U2 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Alarm
THRM_CPL_X_U2 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Pre-Alarm
WEAK BATTERY P	Weak Battery	Pre-Alarm

RPM Control

The following paragraphs describe RPM Profile, Parameter Control, External Raise/Lower Handling, and RPM Control Outputs.

RPM Profile

The IEM-2020 implements an internal automatic RPM Profile which has an internal speed setpoint that can be used to send speed requests through CAN Bus to ECUs. RPM profile functions and statuses are available in BESTlogic*Plus.* The RPMCONTROL logic element provides raise/lower ability to set the desired engine RPM on engines that do not accept speed requests over CAN Bus. The RPM Profile function becomes active when the IEM-2020 in AUTO or RUN modes. Each mode has independent settings. The RPM Profile diagram is illustrated in Figure 3-2.

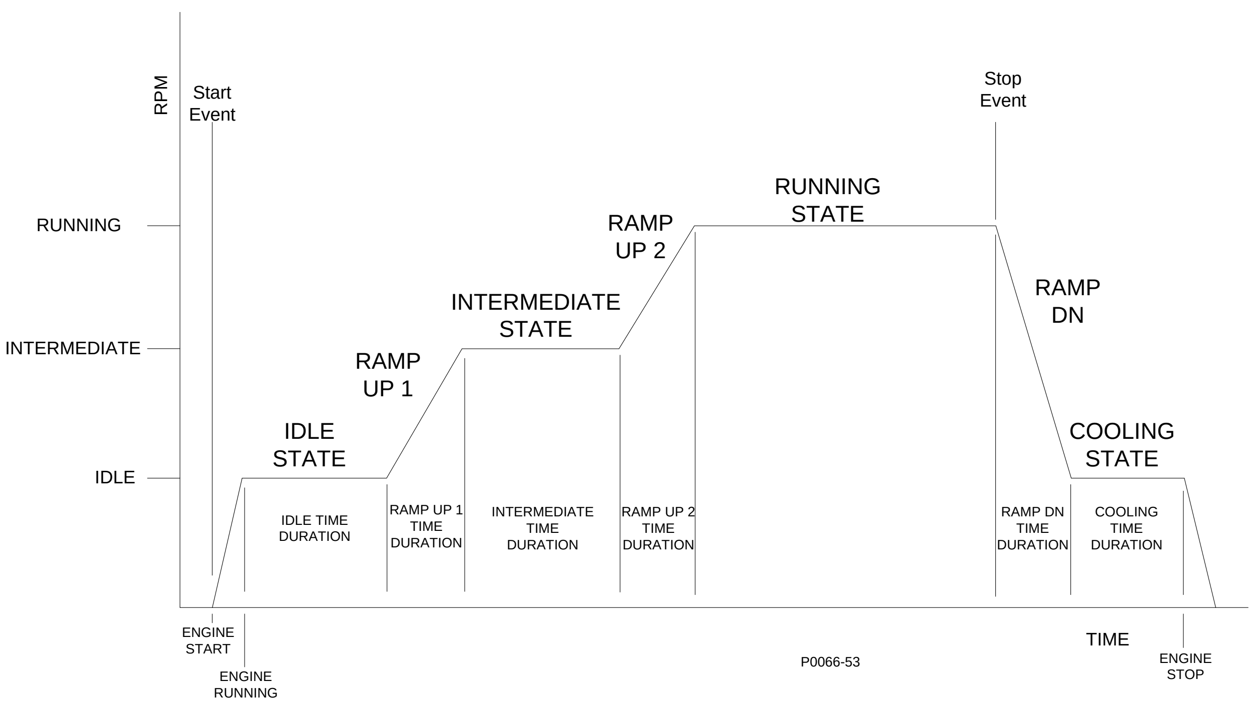


Figure 3-2. RPM Profile Diagram

The operating RPM for the IEM-2020 at any given time is determined from the current state of the RPM Profile. If the Auto Start contact input or AUTOSTART logic element is removed during IDLE or INTERMEDIATE state or the OFF button is pressed, the engine shuts down. If the OFF button is pressed, the Auto Start contact input is removed, or AUTOSTART logic element is removed any time after completion of the INTERMEDIATE state, the profile will ramp to the COOLING state, cool for the user-specified duration, and shut down.

The IEM-2020 does not allow abrupt speed changes in any case. This prevents damage in systems where these conditions (excessive water hammer in pump systems, etc) may be harmful. Once the IEM-2020 reaches IDLE state RPM, all speed adjustments occur at a user-defined ramp rate, according to the RAMP UP 1, RAMP UP 2, or RAMP DOWN time duration settings.

Settings are provided for IDLE, INTERMEDIATE, RUNNING, and COOLING state RPM. If any of these settings are changed while the IEM-2020 is in the corresponding state, the change will not take effect until the next time the RPM Profile is run. For example, if the RUNNING state RPM setting is changed and the unit is in the RUNNING state, the RPM remains the same. If the RUNNING state RPM setting is changed in another state, such as the INTERMEDIATE or RAMP UP 2 state, the RPM Profile will ramp to the new setting according to the RPM profile. If desired, external raise/lowers must be used to change the RPM in any state.

State Override Logic Elements

BESTlogic*Plus* logic elements can be used to force the profile to a state within the profile. For example, if the water in a tank is above a certain level, the engine is started and the IEM-2020 goes through the profile to begin pumping. If the water rises above a higher float level, the warm up and INTERMEDIATE states are skipped and the profile changes directly to the RAMP UP 2 state to begin ramping towards the RUNNING state to begin pumping as much as possible. If more than one OVERRIDE logic element is true at the same time, the one with the highest priority takes action first. The OVERRIDE logic elements (sorted by priority) are listed below:

- RUNNING STATE OVERRIDE (Highest Priority)
- RAMP DN 1 STATE OVERRIDE
- COOLING STATE OVERRIDE
- RAMP UP 2 STATE OVERRIDE
- INTERMEDIATE STATE OVERRIDE
- RAMP UP 1 STATE OVERRIDE
- IDLE STATE OVERRIDE (Lowest Priority)

If the OVERRIDE logic element is removed after forcing the profile into a state, the profile will proceed as normal from that point. If a state if forced and has a time duration associated with it, the timing occurs while the forcing is in effect, but the profile will not change states until both the time duration has expired and the OVERRIDE logic element causing the forcing is removed. This allows the logic to hold the profile in a specific state longer than the timing would normally hold it, if desired.

These logic override elements cannot directly change the speed. Forcing a ramp state will cause a ramp to the speed of the next state. If the current speed is already above the next state RPM, the ramp state will end immediately. The IDLE, INTERMEDIATE, and RUNNING states have constant RPMs, in absence of external raise/lower inputs. Switching from one of these states to another changes the state, but will not change the RPM.

The RAMPUP1OVR and RAMPUP2OVR logic elements are used to shorten the time in a state. For example, if you want to immediately leave the IDLE state, pulse the RAMPUP1OVR. Take note that pulsing the INTERMEDIATEOVR will change the state, but will not change the operating RPM.

The IDLEOVR and INTERMEDIATEOVR logic elements are used to remain in a state longer than specified by the RPM Profile settings. For example, a longer IDLE may be necessary due to a temperature transducer input. Holding the IDLEOVR true until the temperature rises above a certain value prevents the RPM Profile from continuing to higher RPM states until the engine is warmed up.

Engine Cool-down

The IEM-2020 can ensure proper engine and turbocharger cooldown by maintaining engine operation for a user-specified duration. The cooling time delay is initiated for any one of the following conditions:

- Auto Start opens while operating in AUTO mode
- Normal shutdown is initiated
- Remote shutdown is initiated while in AUTO mode
- Off Mode Cooldown is initiated
- The Cooldown Request logic element is initiated
- The Cool and Stop Request logic element is initiated

Off Mode Cool-down

Pressing the IEM-2020 front panel OFF button one time will cause the unit to go through a cool-down cycle for the duration of the cooling time delay. At the end of the cool down cycle, the unit will go to OFF mode. If it is desired to stop the machine immediately, pressing the OFF button twice will cause the unit to go to OFF mode immediately. Furthermore, if an Off Mode Cooldown is in progress and the OFF button is pressed, the unit will immediately shut down. If the unit was in RUN mode when the OFF button was pressed, it remains in RUN for the remainder of the cooldown cycle. If the machine was in the AUTO mode when the OFF button was pressed, it remains in AUTO mode until the cooldown and shutdown cycle are completed, or until the OFF button is pressed a second time forcing the unit to OFF mode. The OFF LED will flash to indicate an off mode cool-down is in progress. In addition, the unit will display “OFF MODE COOLDN” while the cooldown timer is displayed.

If the RUN button is pressed while an Off Mode Cooldown is in progress, the cooldown will be aborted and the unit will go to RUN mode.

If the AUTO button is pressed while an Off Mode Cool-down is in progress, the Off Mode Cooldown is cleared and the unit returns to normal AUTO operation. Thus, if conditions exist where the unit would normally run in AUTO, it will resume running in AUTO. If conditions exist where the unit would normally shut down in AUTO, the unit will finish the remaining cooldown cycle then stop and remain in AUTO.

If Off Mode Cooldown is not enabled, pressing the OFF button once at any time will immediately force the unit to OFF mode.

The Off Mode Cooldown feature works from the front panel HMI buttons only. Any OFF command received through BESTlogic*Plus* or BESTCOMS*Plus* control result in an immediate transition of the machine to OFF.

External Raise/Lower Handling

The operating RPM can be increased or decreased via external Raise/Lower inputs. If the IEM-2020 is determining RPM based on the RPM Profile, and a Raise or Lower is received, the IEM-2020 continues to control the RPM to the modified speed until the RPM profile enters a new state. Depending on the state the RPM Profile is entering the RPM may remain at the modified value or be changed to the RPM specified by the new state of the RPM Profile.

External Raise Handling

When the RPM Profile is in the IDLE state or INTERMEDIATE state, if the RPM is increased due to receipt of external raise commands, the RPM will remain running at the modified RPM for the duration of the time that the IEM-2020 remains in that state. In the RAMP UP 1 and RAMP UP 2 states, the RPM is compared to the RPM of the state after the ramp state (i.e. when IDLE state ends, the RPM is compared to that of the INTERMEDIATE state, when INTERMEDIATE state ends, the RPM is compared to that of the RUNNING state). If the RPM is already greater than or equal to the RPM of the next state, the ramp will be skipped and the IEM-2020 will advance to the next state, and the RPM will remain at the modified level throughout the duration of the new state.

When the RPM Profile is in the RUNNING state and the Control Mode on the Governor Control Settings screen in BESTCOMS*Plus* is set for RPM, if the RPM is increased due to receipt of external raise commands, the RPM will remain running at the modified RPM until an event occurs which terminates the RUNNING state (i.e. in AUTO mode the Auto Start switch or logic element is removed, or the OFF button is pressed). In AUTO mode or OFF mode, if Off Mode Cooldown is enabled, the IEM-2020 will ramp from the modified RPM down to the COOLING state RPM in the time specified by the RAMP DN time duration. In OFF mode, if Off Mode Cooldown is disabled, the unit will shut down immediately, skipping the ramp down and cooling cycle.

When the RPM Profile is in the RUNNING state and the Control Mode is set for Parameter, external raise commands will raise the parameter setpoint by an amount determined by the RPM Up/Down Rate on the Governor Control Settings screen in BESTCOMS*Plus*. The operating RPM will not be affected directly by the external raise command, but may be modified by the PID controller due to the setpoint change.

If an external raise command is received during the RAMP UP 1, RAMP UP 2, or RAMP DN states, the IEM-2020 will continue ramping from the modified value at the same RPM/sec rate at which it was ramping before the external raise command was received until it moves on to the next state. This effectively would shorten UP ramps and lengthen DN ramps.

When the RPM Profile is in the COOLING state, if the RPM is increased due to external raise commands, the RPM will remain running at the modified RPM until the COOLING state time duration expires which causes the machine to shut down.

External Lower Handling

When the RPM Profile is in the IDLE state or INTERMEDIATE state, if the RPM is decreased due to external lower commands, the RPM will remain running at the modified RPM for the duration of the time that the IEM-2020 remains in that state. When it comes to the next state, which is a ramp state, it will ramp up from the modified RPM to the RPM required for the state after the ramp (i.e. INTERMEDIATE state is after RAMP UP 1 state and RUNNING state is at the end of the RAMP UP 2 state).

When the RPM Profile is in the RUNNING state and the Control mode on the Governor Control Settings screen in BESTCOMS*Plus* is set for RPM, if the RPM is decreased due to external lower commands, the RPM will remain running at the modified RPM until an event occurs that terminates the RUNNING state (i.e. in AUTO mode the Auto Start switch contact or logic element is removed, or the OFF button is pressed). In AUTO mode or OFF mode, if Off Mode Cooldown is enabled, the IEM-2020 will ramp from the modified RPM down to the COOLING state RPM in the time specified by the RAMP DN time duration. In OFF mode, if Off Mode Cooldown is disabled, the unit will skip the ramp down and cooling cycle and immediately shut down.

When the RPM Profile is in the RUNNING state and the Control Mode is set for Parameter, external lower commands will lower the parameter setpoint by an amount determined by the RPM Up/Down Rate on the Governor Control Settings screen in BESTCOMS*Plus*. The operating RPM will not be affected directly by the external lower command, but may be modified by the PID controller due to the setpoint change.

If an external lower command is received during the RAMP UP 1, RAMP UP 2, or RAMP DN states, the IEM-2020 will continue ramping from the modified value at the same RPM/sec rate at which it was ramping before the external lower command was received until it moves on to the next state. This effectively would lengthen UP ramps and shorten DN ramps.

When the RPM Profile is in the COOLING state, if the RPM is decreased due to external lower commands, the RPM will remain running at the modified RPM until the COOLING state time duration expires which causes the machine to shut down.

Parameter Control

The IEM-2020 implements a PID controller which works in conjunction with the RPM Profile to allow closed loop control of a parameter metered through an analog input, such as liquid depth, pressure in a pipe, flow rate, etc. This will allow the IEM-2020 to control any type of parameter that can be affected by varying engine speed and for which a 4-20 mA or 0-10 Vdc based transducer can be obtained. The PID controller is enabled to maintain the parameter measured by the specified IEM-2020 analog input whenever the IEM-2020 is in the RUNNING state portion of the RPM Profile and the Control Mode setting of the RUNNING state is set for Parameter on the Governor Control Settings screen in BESTCOMS*Plus*. At all other times, the PID controller is disabled. The speed control for the IEM-2020 can be implemented either through contact outputs or via CAN Bus RPM request. The controller implementation is described in the following paragraphs.

PID Operation Summary

A block diagram of the controller is illustrated in Figure 3-3.

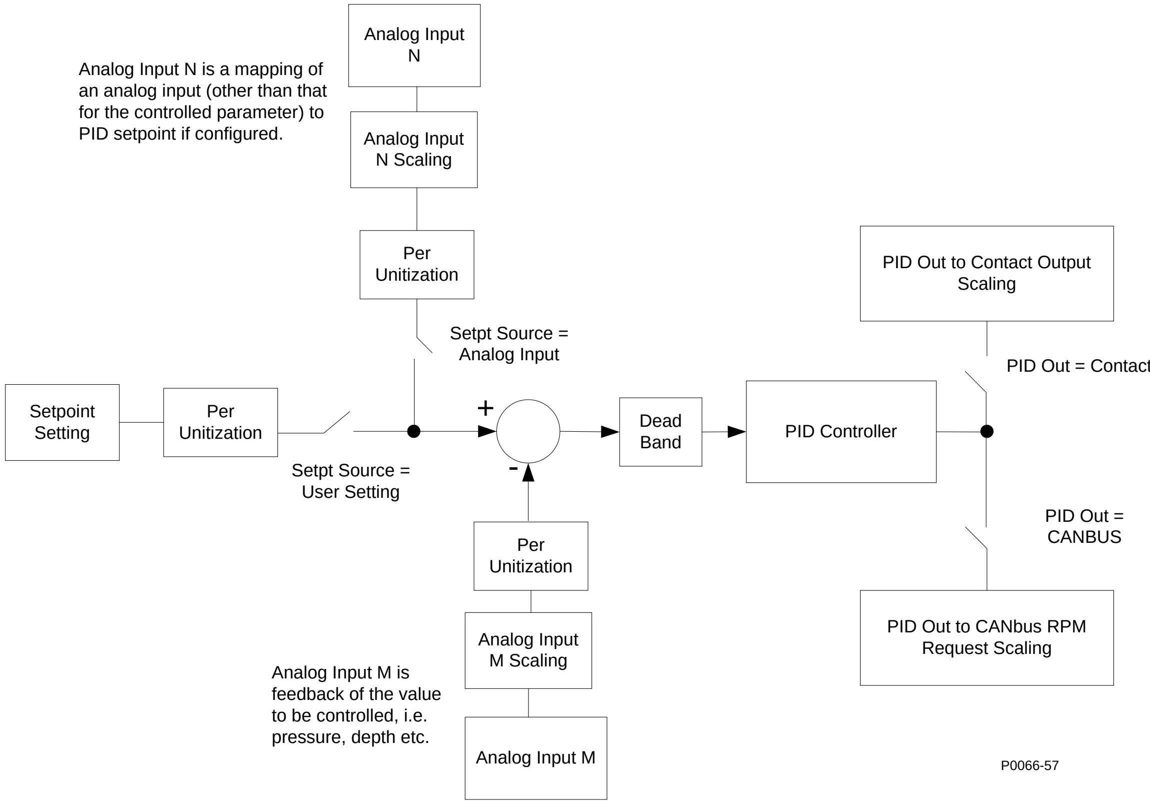


Figure 3-3. Controller Block Diagram

The metered parameter is metered by Analog Input M in Figure 3-3. The Setpoint is provided as a user setting on the Governor Control Settings screen in BESTCOMS*Plus* or can be set via another analog input (Analog Input N) using the *Setpoint Source* setting.

The Setpoint user settings are in terms of scaled analog input units. In other words, if Analog Input M is measuring pipe pressure where 4 mA represents 0 psi and 20 mA represents 150 psi, the PID controller could control the pressure at a level between 0 and 150 psi, therefore the reasonable range for the PID setpoint would be 0 to 150 (Setpoint Analog Min = 0 and Setpoint Analog Max = 150). The units of the PID setpoint are in scaled units, i.e. pressure, rather than raw analog input units, i.e. 4-20 mA.

The Parameter Deadband on the Governor Control Settings screen is also expressed in terms of scaled units, such as pressure, rather than raw analog input units, such as 4-20 mAdc. The Parameter Deadband setting is provided to prevent excessive speed “hunting” in situations where it is not necessary to correct the measured parameter unless it falls outside of a range around the setpoint. For example, controlling the level in a tank on a windy day when there are waves in the liquid level. The Parameter Deadband could be used to prevent a control action from occurring every time a wave passes the transducer.

The PID algorithm is performed on per-unitized representations of the control variable. Per unitization is performed based on the midpoint of the parameter range being defined as 1 per unit. Thus, in the previous example, where the parameter range goes from 0 to 150 psi, the control setpoints and the measured variables are per unitized based on 75 psi being defined as 1.0 per unit. Then, 0 psi is defined as –1.0 per unit and 150 psi is defined as +1.0 per unit.

Gain settings (Kp, Ki, Kd, Td, and Kg) are also provided for the PID. When Contact is selected for the output type, only Kp and Kg apply.

The output of the PID can be set for CAN Bus RPM request or contact outputs. The mapping of PID output to CAN Bus RPM request or contact outputs is explained in the following paragraphs.

CAN Bus RPM Request

When ECU is selected as the output type, the speed biasing is accomplished by raising or lowering the RPM speed bias above or below the RPM setting by an amount corresponding to the RPM Bandwidth setting, which specifies the RPM range over which the speed requests can be varied. The RPM setting is the RPM setting from the RUNNING state portion of the RPM Profile. The PID output is mapped to the CAN Bus RPM request as shown below.

- PID output of –1.0 results in a CAN Bus RPM request of:

  Requested RPM = RPM Setting – (RPM Bandwidth)/2

- PID output of +1.0 results in a CAN Bus RPM request of:

  Requested RPM = RPM Setting + (RPM Bandwidth)/2

When the PID output is between –1.0 and +1.0, the CAN Bus RPM request varies linearly between the two requested RPM values. See Figure 3-4.

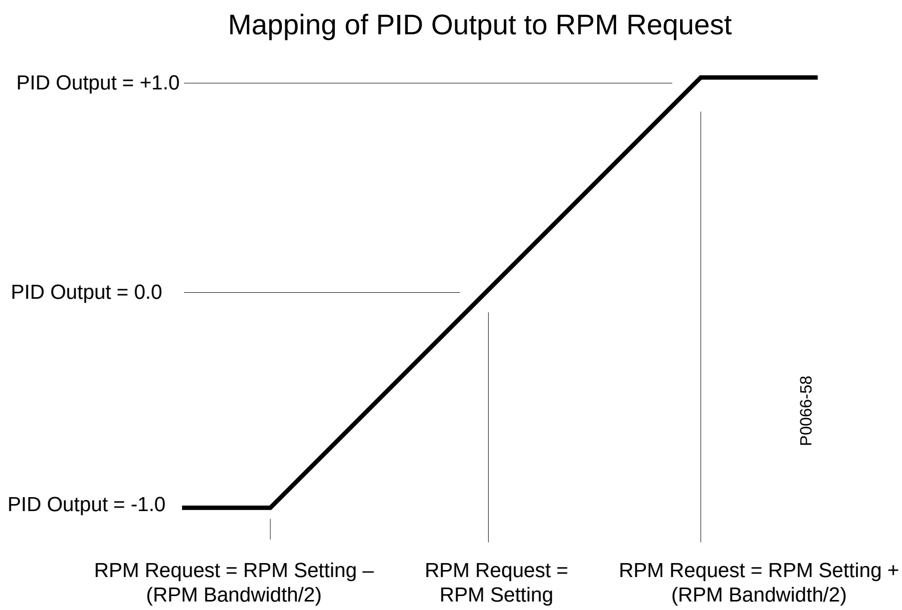


Figure 3-4. Mapping of PID Output to RPM Request

Contact Outputs

When Contact is selected as the output type, the contact type can be set for proportional or continuous. DEAD BAND is equal to the Per Unitized Dead Band setting, or 0.01, whichever is greater. When continuous outputs are selected, when the PID output is lower than –DEAD BAND, the lower output is on. When the PID output is greater than +DEAD BAND, the raise output is on. When –DEAD BAND < PID Output < +DEAD BAND, neither raise nor lower outputs are on.

When proportional contact outputs are selected, the correction pulse width and correction pulse interval must be specified. The pulse interval along with the pulse width specifies how often a new pulse occurs. The total time between pulses is the pulse width plus the pulse interval.

The mapping of PID outputs to correction pulse width is proportional in the sense that the greater the PID output magnitude, the greater the ON time of the output pulses. When the PID output is greater than or equal to 1.0, the raise pulse is on at its maximum pulse width. When the PID output is equal to DEAD BAND, the raise output is on at its minimum pulse width. The pulse width goes from minimum to maximum pulse width linearly as the PID output increases from DEAD BAND to 1.0.

Similarly, when the PID output is less than or equal to –1.0, the lower pulse is on at its maximum pulse width. When the PID output is equal to –DEAD BAND, the lower output is on at its minimum pulse width. The pulse width goes from minimum to maximum pulse width linearly as the PID output goes from –DEAD BAND to –1.0.

When the PID output is between –DEAD BAND and +DEAD BAND, neither the raise nor the lower output are closed.

The mappings of PID outputs to contact outputs for both continuous and proportional outputs are shown in Figure 3-5.

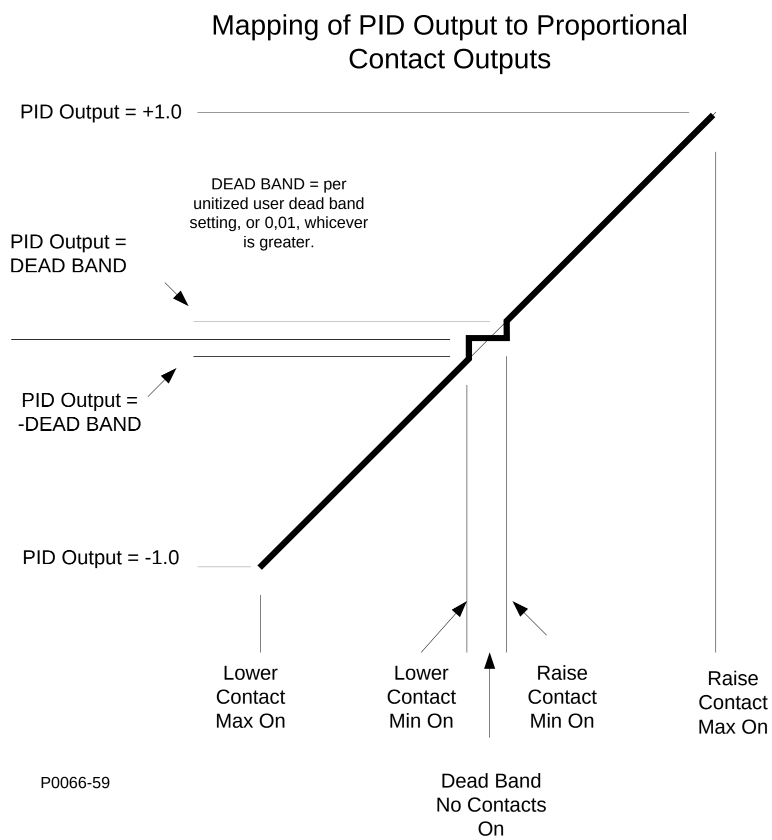


Figure 3-5. Mapping of PID Output to RPM Request

RPM Control Outputs

Either ECU or Contact can be set as the RPM Control Output Type on the Governor Control Settings screen in BESTCOMS*Plus*.

CAN Bus

The IEM-2020 can request desired RPM from the engine ECU over CAN Bus. For engines employing J1939 standard communications, the J1939 Torque Speed Control 1 (TSC1) PGN is utilized to communicate the speed requests. All engine types selectable in the ECU Configuration use the J1939 protocol, with the exception of MTU MDEC and MTU ECU7/ECU8, which utilize a protocol proprietary to MTU.

Some engine ECUs must be configured to accept the TSC1 PGN. In addition, some engines must be configured with a J1939 address from which the TSC1 PGN will be accepted. For instance, some ECUs have a default setting for the J1939 address from which TSC1 will be accepted. As an example, the address is defaulted to 3 in some John Deere engines. Other addresses may be specified, but the ECU configuration software must be used to change the address.

When Volvo Penta is selected as the ECU type, the IEM-2020 will send the TSC1 PGN and the Volvo proprietary parameter for Accelerator Pedal Position.

When MTU MDEC or MTU ECU7/ECU8 is selected as the ECU type, and the Speed Demand Source is set for CAN Bus Speed Demand, the IEM-2020 will send the proprietary Speed Demand parameter to request desired RPM.

It is recommended that the engine manufacturer’s documentation be consulted when implementing CAN Bus speed requests.

Raise/Lower

When Contact Output is selected as the RPM Contact Output Type on the Governor Control Settings screen in BESTCOMS*Plus*, the user must specify continuous or proportional outputs.

Continuous Outputs

When the difference between the requested RPM and the actual RPM is greater than the RPM Deadband setting, the RAISE output will be closed. When the difference between the requested RPM and the actual RPM is less than the negative of the RPM Deadband setting, the LOWER output will be closed.

Proportional Outputs

When the difference between the requested RPM and the actual RPM is greater than the RPM Deadband setting, the RAISE output will be closed with the on time of the pulse being proportional to the size of the difference. When the difference between the requested RPM and the actual RPM is less than the negative of the RPM Deadband setting, the LOWER output will be closed with the on time of the pulse being proportional to the size of the difference. This is shown in Figure 3-6.

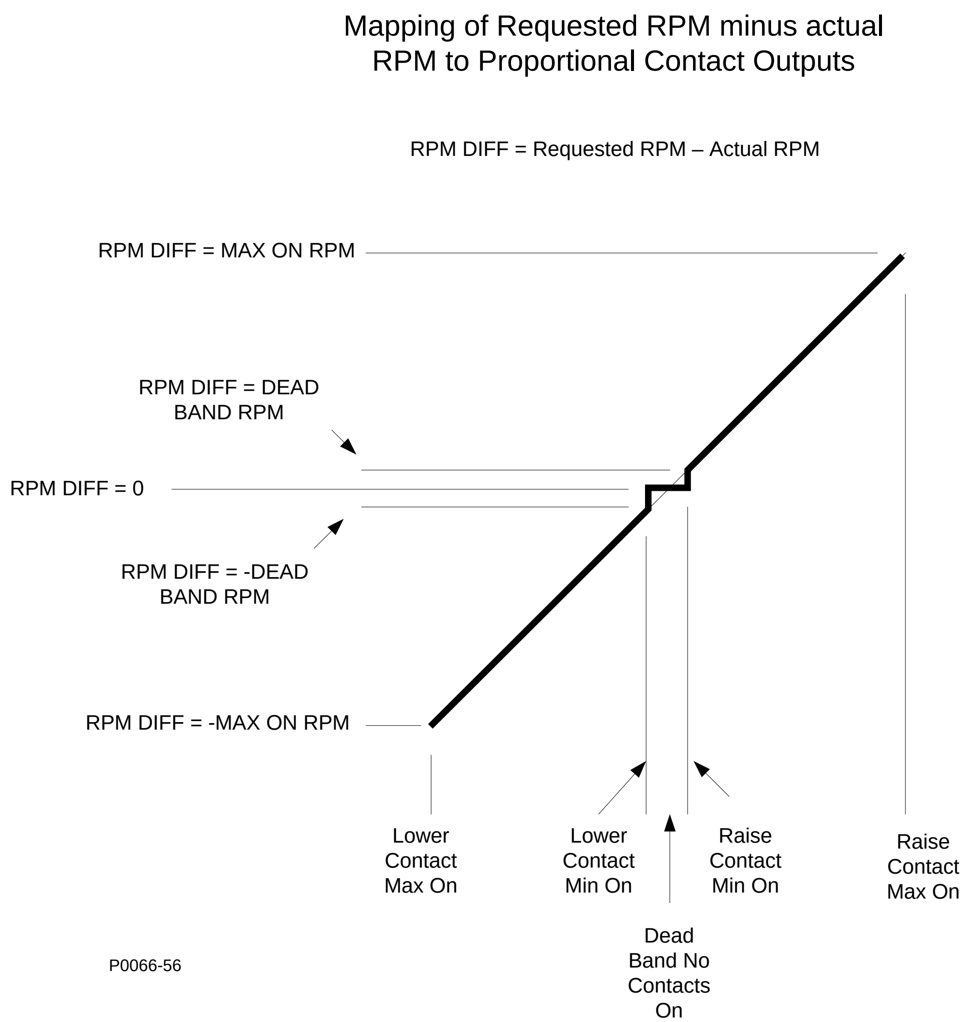


Figure 3-6. RPM Mapping

SECTION 4 • BESTCOMS*Plus*® SOFTWARE

TABLE OF CONTENTS

Figures

Tables

SECTION 4 • BESTCOMS*Plus*® SOFTWARE

Introduction

BESTCOMS*Plus*® is a Windows®-based, PC application that provides a user-friendly, graphical user interface (GUI) for use with Basler Electric communicating products. The name BESTCOMS*Plus* is an acronym that stands for Basler Electric Software Tool for Communications, Operations, Maintenance, and Settings.

BESTCOMS*Plus* provides the user with a point-and-click means to set and monitor the IEM-2020. The capabilities of BESTCOMS*Plus* make the configuration of one or several IEM-2020 modules fast and efficient. A primary advantage of BESTCOMS*Plus* is that a settings scheme can be created, saved as a file, and then uploaded to the IEM-2020 at the user's convenience.

BESTCOMS*Plus* uses plug-ins allowing the user to manage several different Basler Electric products. The IEM-2020 is a plug-in for BESTCOMS*Plus* and must be activated before use.

The IEM-2020 plug-in opens inside the BESTCOMS*Plus* main shell with the same default logic scheme that is shipped with the IEM-2020. This gives the user the option of developing a custom setting file by modifying the default logic scheme or by building a unique scheme from scratch.

BESTlogic*Plus* Programmable Logic is used to program IEM-2020 inputs and outputs, and alarms. This is accomplished by the drag-and-drop method. The user can drag elements, components, inputs, and outputs onto the program grid and make connections between them to create the desired logic scheme.

Figure 4-1 illustrates the typical user interface components of the IEM-2020 plug-in with BESTCOMS*Plus*.

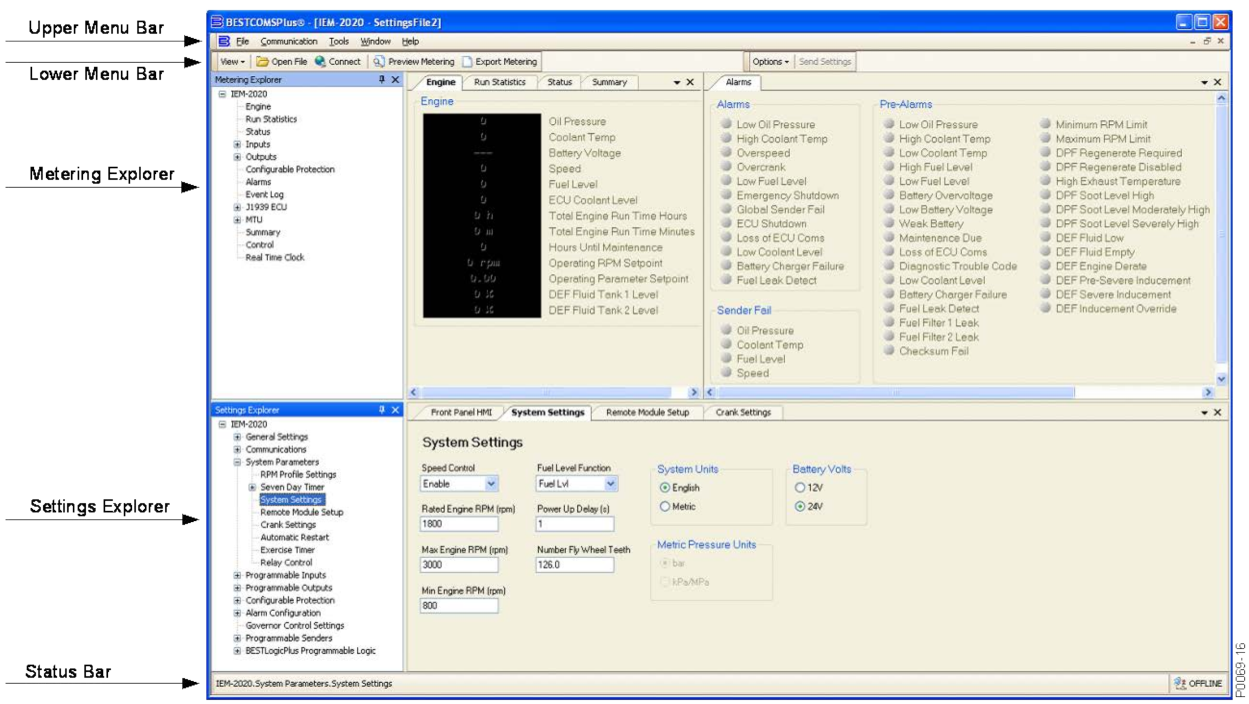


Figure 4-1. Typical User Interface Components

Installation

BESTCOMS*Plus* software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Plus* on your PC also installs the IEM-2020 plugin and the required version of .NET Framework (if not already installed). BESTCOMS*Plus* operates with systems using Windows® XP 32-bit SP2/SP3, Windows Vista 32-bit (all editions), Windows 7 32-bit (all editions), Windows 7 64-bit (all editions), Windows 8, and Windows 10. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMS*Plus*. System recommendations for the .NET Framework and BESTCOMS*Plus* are listed in Table 4-1.

Table 4-1. System Recommendations for BESTCOMSPlus and the .NET Framework

System Type	Component	Recommendation
32/64 bit	Processor	2.0 GHz
32/64 bit	RAM	1 GB (minimum), 2 GB (recommended)
32 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC.)
		950 MB (if .NET Framework is not already installed on PC.)
64 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC.)
		2.1 GB (if .NET Framework is not already installed on PC.)

To install and run BESTCOMS*Plus*, a Windows user must have Administrator rights. A Windows user with limited rights might not be permitted to save files in certain folders.

Installing BESTCOMS*Plus*®

NOTE

Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete might result in unwanted or unexpected errors.

1. Insert the BESTCOMS*Plus* CD-ROM into the PC CD-ROM drive.
2. When the BESTCOMS*Plus* Setup and Documentation CD menu appears, click the *Install* button for the BESTCOMS*Plus* application. The setup utility installs BESTCOMS*Plus*, the .NET Framework (if not already installed), the USB driver, and the IEM-2020 plugin for BESTCOMS*Plus* on your PC.

When BESTCOMS*Plus* installation is complete, a Basler Electric folder is added to the Windows programs menu. This folder is accessed by clicking the Windows *Start* button and then accessing the Basler Electric folder in the *Programs* menu. The Basler Electric folder contains an icon that starts BESTCOMS*Plus* when clicked.

Activate the IEM-2020 Plugin for BESTCOMSPlus®

The IEM-2020 plugin is a module that runs inside the BESTCOMS*Plus* shell. The IEM-2020 plugin contains specific operational and logic settings for only the IEM-2020. Uploading settings to the IEM-2020 is only possible after activating the IEM-2020 plugin.

The IEM-2020 plugin can be activated automatically or manually. Automatic activation is achieved by using a USB cable to establish communication between the IEM-2020 and BESTCOMS*Plus*. Manual activation is initiated by contacting Basler Electric for an activation key and entering the key into BESTCOMS*Plus*. Manual activation is useful if you want to create a settings file prior to receiving your IEM-2020. Refer to *Manual Activation of IEM-2020 Plugin.*

Connect a USB Cable

The USB driver was copied to your PC during BESTCOMS*Plus* installation and is installed automatically after powering the IEM-2020. USB driver installation progress is shown in the Windows taskbar area. Windows will notify you when installation is complete.

Connect a USB cable between the PC and your IEM-2020. Apply operating power to the IEM-2020. Wait until the boot sequence is complete.

Start BESTCOMS*Plus*® and Activate IEM-2020 Plugin Automatically

To start BESTCOMS*Plus*, click the *Start* button, point to *Programs*, *Basler Electric*, and then click the *BESTCOMSPlus* icon. During initial startup, the *BESTCOMSPlus Select Language* screen is displayed (Figure 4-2). You can choose to have this screen displayed each time BESTCOMS*Plus* is started, or you can select a preferred language and this screen will be bypassed in the future. Click *OK* to continue. This screen can be accessed later by selecting *Tools* and *Select Language* from the menu bar.

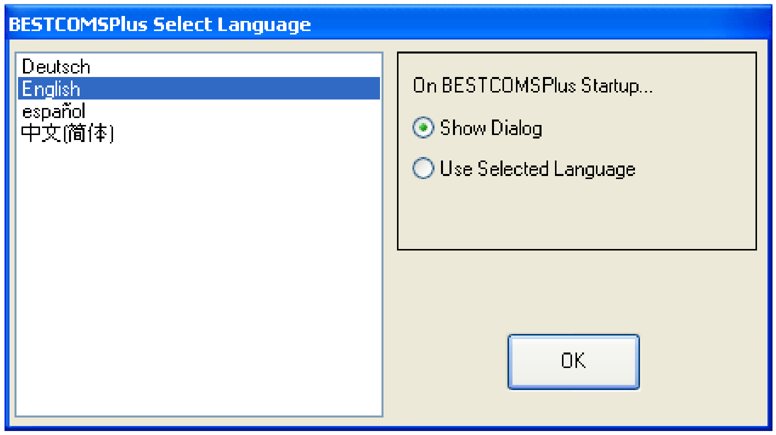


Figure 4-2. BESTCOMSPlus Select Language

The BESTCOMS*Plus* splash screen is shown for a brief time. See Figure 4-3.

Figure 4-3. Splash Screen

The BESTCOMS*Plus* platform window opens. Select *New Connection* from the *Communication* pull-down menu and select *IEM-2020*. See Figure 4-4. The IEM-2020 plugin is activated automatically after connecting to an IEM-2020.

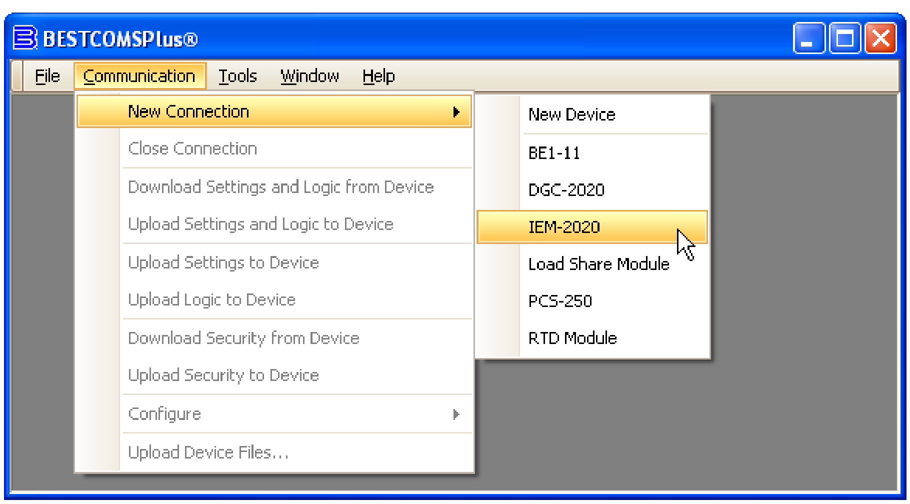


Figure 4-4. Communication Pull-Down Menu

The *IEM-2020 Connection* screen shown in Figure 4-5 will appear.

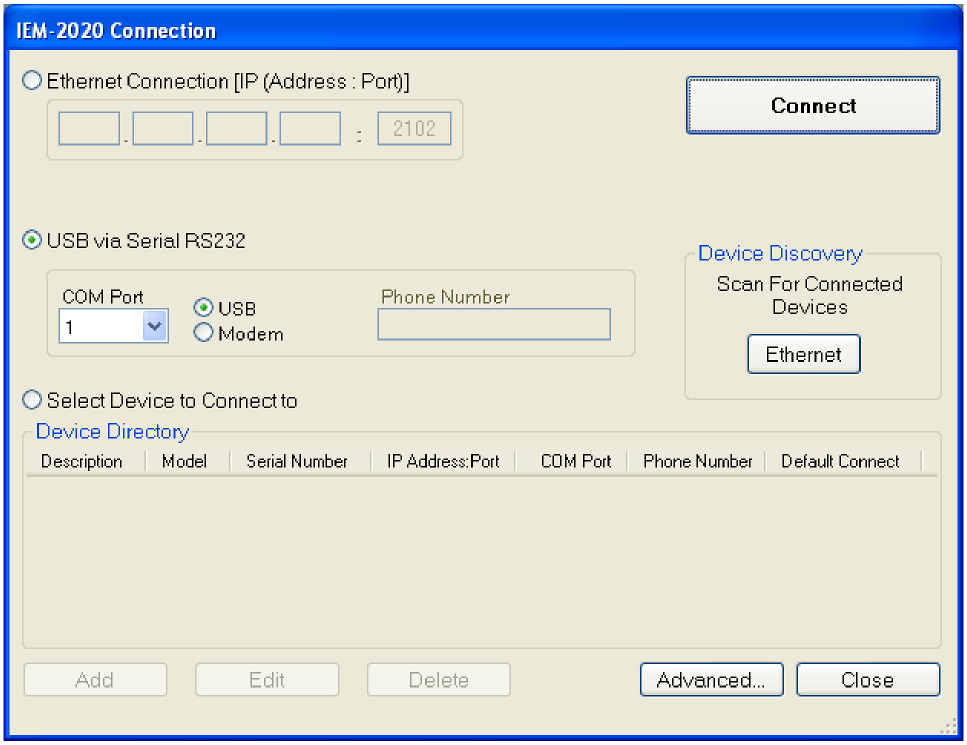


Figure 4-5. IEM-2020 Connection

Select *USB via Serial RS232, USB,* and enter *COM Port.* The USB drivers are installed automatically during the BESTCOMS*Plus* installation process. To select the correct *COM Port,* open Windows Device Manager and expand the *Ports (COM & LPT)* branch. Locate the device named *CP2101 USB to UART Bridge Controller (COMx).* The *COM Port* number will be displayed in parenthesis *(COMx).* Be sure operating power is applied to the IEM-2020 and the USB cable is connected before opening the Device Manager. See Figure 4-6.

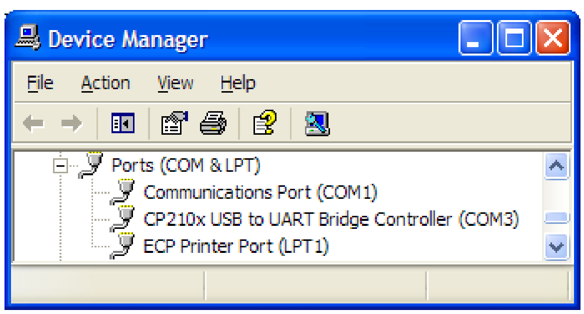


Figure 4-6. Device Manager

The IEM-2020 plugin opens indicating that activation was successful. You can now configure the IEM-2020 communication ports and other IEM-2020 settings.

Installing the USB Driver if Automatic Installation Fails

To install the USB driver for the IEM-2020:

1. Apply operating power to the IEM-2020 and wait for the boot sequence to complete.
2. Connect a USB cable between the PC and IEM-2020.
3. The *Found New Hardware Wizard* dialog box appears.
4. Select “**No, not this time**” and select *Next* to continue.
5. Choose to “**Install from a list or specific location (Advanced)**” and select *Next* to continue.
6. Insert the CD-ROM labeled BESTCOMS*Plus* into the PC CD-ROM drive.

7. Navigate to C:\Program Files\Basler Electric\BESTCOMSPlus\USBDeviceDrivers\ and select *Next* to continue.

When installation of the driver is complete, you might be asked to restart your computer.

Manual Activation of the IEM-2020 Plugin

Manual activation of the IEM-2020 plugin is required only if your initial use of BESTCOMSPlus will be on a PC that is not connected to an IEM-2020. Manual activation is described in the following paragraphs.

Requesting an Activation Key

When initially running the IEM-2020 plugin, the *Activate Device Plugin* pop-up appears. You must contact Basler Electric for an activation key before you can activate the IEM-2020 plugin. You can request an activation key through email or the Basler Electric website. Click either the *Website* or *Email* button. Click the *Activate* button when you are ready to enter the activation key you received from Basler Electric. The *Activate Device Plugin* pop-up appears. Refer to Figure 4-7.

Entering an Activation Key

Select IEM-2020 from the *Device* pull-down menu. Enter your *Email Address* and *Activation Key* provided by Basler Electric. If you received an email containing the *Activation Key*, you can select all of the text in the email and copy it to the Windows clipboard using normal Windows techniques. The *Get Data* button will extract the *Device, Email Address,* and *Activation Key* from the Windows clipboard and paste it into the appropriate fields. Click the *Activate* button to continue. The *Activate Device Plugin* screen is also found by selecting *Activate Device* from the *Tools* pull-down menu of the BESTCOMS*Plus* main screen.

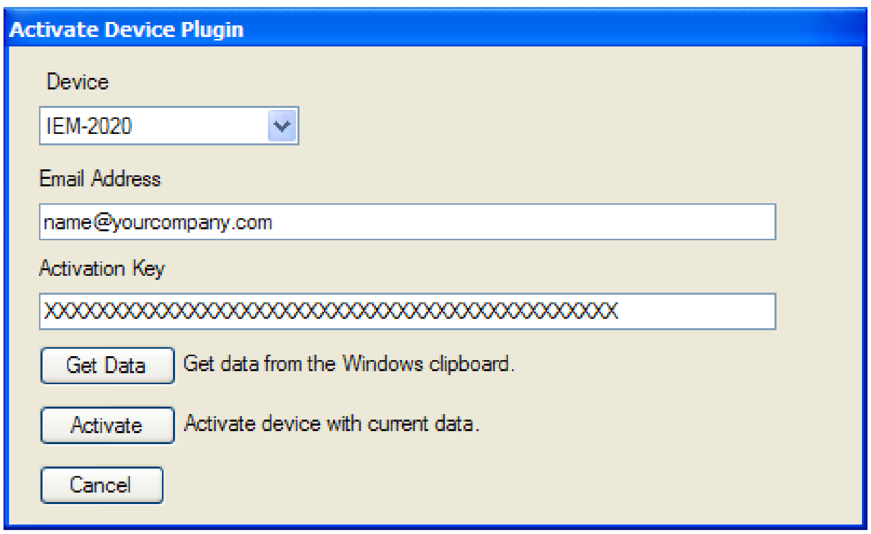


Figure 4-7. Activate Device Plugin

Communication

Modem Communication (Optional)

If connecting to the IEM-2020 through a telephone line, select *USB via Serial RS232, Modem,* and enter *Phone Number.* To select the correct *COM Port,* open Windows Device Manager and expand the *Modems* branch. Right-click on the modem name and choose *Properties*. Open the *Advanced* tab to view the COM port.

Ethernet Communication

Communication with the IEM-2020 can be made through an optional LSM-2020 (Load Share Module). In order to use the Ethernet capabilities of the LSM-2020, the network settings in the LSM-2020 must first be configured. LSM-2020 network settings can be configured through Device Discovery in BESTCOMS*Plus,* through the front panel of the IEM-2020, or through the IEM-2020 and sent to the LSM-2020 over the CAN Bus interface. The following procedures can be used to configure LSM-2020 network settings and connect to the IEM-2020 through Ethernet via an LSM-2020.

Configure LSM-2020 Network Settings through Device Discovery in BESTCOMSPlus

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN Bus address so that the IEM-2020 and LSM-2020 are properly linked together. If a USB connection to the IEM-2020 is active, the LSM-2020 enable setting and CAN Bus address can be found by using the Settings Explorer in BESTCOMS*Plus* to open the *System Parameters, Remote Module Setup* tree branch. The IEM-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the front panel of the IEM-2020.
2. In BESTCOMS*Plus*, click the *Communication* drop-down menu and select *New Connection, Load Share Module.* The *Load Share Module Connection* screen appears. See Figure 4-8.

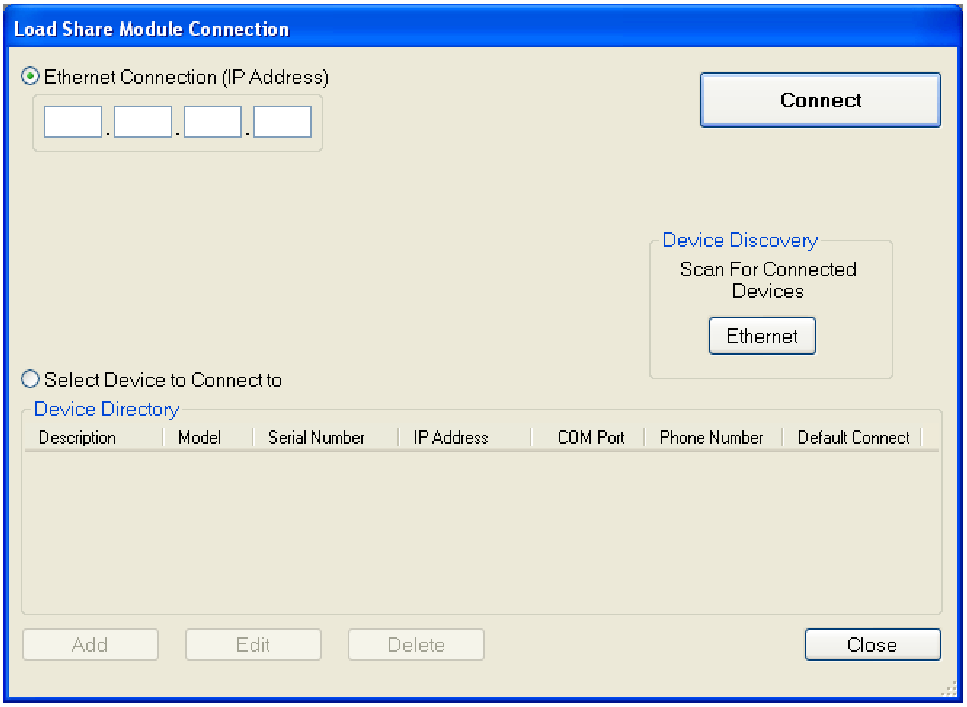


Figure 4-8. Load Share Module Connection

3. Click the *Ethernet* button under *Device Discovery (Scan For Connected Devices).*
4. After scanning for connected devices, the *Device Discovery* screen appears. See Figure 4-9.

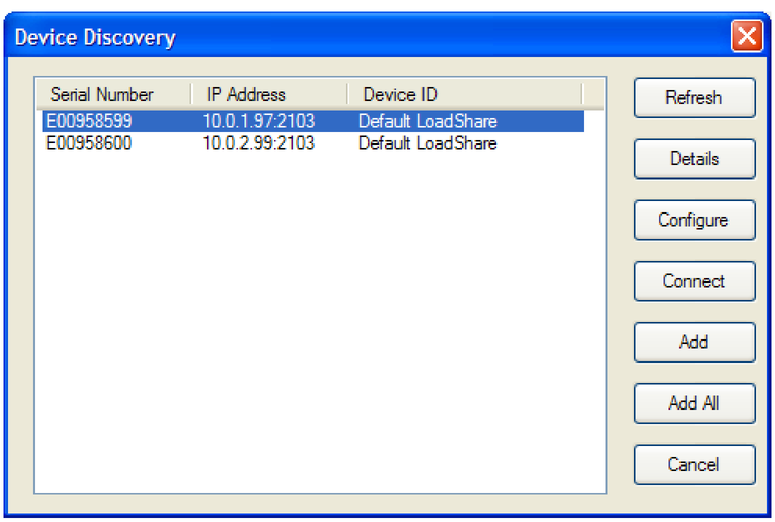


Figure 4-9. Device Discovery

5. Use the mouse to highlight the desired Load Share Module and click the *Configure* button.

6. The *Configure Ethernet Port* screen appears. See Figure 4-10.

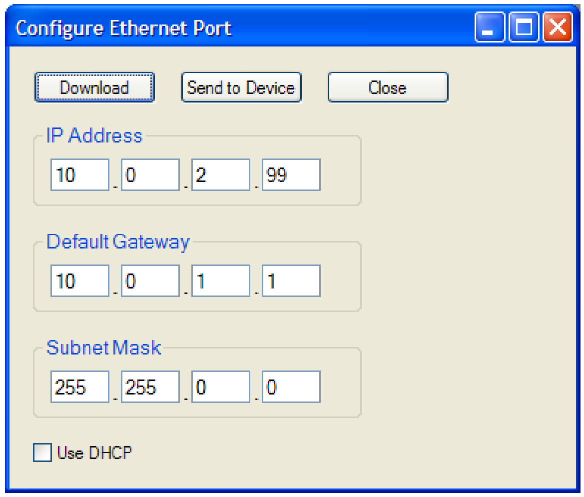


Figure 4-10. Configure Ethernet Port

7. Assign an IP Address, Default Gateway, and Subnet Mask to the Load Share Module by entering values in the same range as your network or PC. If DHCP will be used, check the *Use DHCP* box.
8. Click *Send to Device*. A password is required. The default password is "**OEM**". The LSM-2020 will reboot and use the new settings.

Configure LSM-2020 Network Settings through the Front Panel of the IEM-2020

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN Bus address so that the IEM-2020 and LSM-2020 are properly linked together. If a USB connection to the IEM-2020 is active, the LSM-2020 enable setting and CAN Bus address can be found by using the Settings Explorer in BESTCOMS*Plus* to open the *System Parameters, Remote Module Setup* tree branch. The IEM-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the front panel of the IEM-2020.
2. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup, TCP/IP* Settings screen on the front panel HMI.

   Configurable options include:

IP Address:	Internet Protocol Address to be used by the LSM-2020.
Subnet Mask:	Mask used to determine the range of the current network subnet.
Gateway Address:	Default host to send data destined for a host not on the network subnet.
Use DHCP:	Automatically configures IP Address, Default Gateway, and Subnet Mask via DHCP. This can be used only if the Ethernet network has a properly configured DHCP server running. The LSM-2020 does not act as a DHCP server.

The values for these options should be obtained from the site administrator if the LSM-2020 is intended to share the network with other devices. If the LSM-2020 is operating on an isolated network, the IP address might be chosen from one of the following ranges as listed in IETF publication RFC 1918, *Address Allocation for Private Networks.*

10.0.0.0 - 10.255.255.255
172.16.0.0 - 172.31.255.255
192.168.0.0 - 192.168.255.255

If the LSM-2020 is operating on an isolated network, the *Subnet Mask* can be left at 0.0.0.0 and the *Default Gateway* can be chosen as any valid IP address from the same range as the LSM-2020 IP address.

3. Click the *Edit* button to change settings. After settings are configured, click the *Edit* button again to exit.
4. Use the *Left* arrow key to navigate back to the *LSM Setup* screen on the front panel HMI. After leaving the leaving the *TCP/IP Settings* screen, the LSM-2020 will reboot and use the new settings.

Alternate Method to Configure LSM-2020 Network Settings through the IEM-2020

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN Bus address so that the IEM-2020 and LSM-2020 are properly linked together. If a USB connection to the IEM-2020 is active, the LSM-2020 enable setting and CAN Bus address can be found by using the Settings Explorer in BESTCOMS*Plus* to open the *System Parameters, Remote Module Setup* tree branch. The IEM-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the USB interface of the IEM-2020.
2. Connect to the IEM-2020 through the USB port as described under *USB Communication.* Select *Configure, Ethernet* from the *File* pull-down menu. If the LSM-2020 is connected properly, the *Configure Ethernet Port* screen shown in Figure 4-11 will appear.

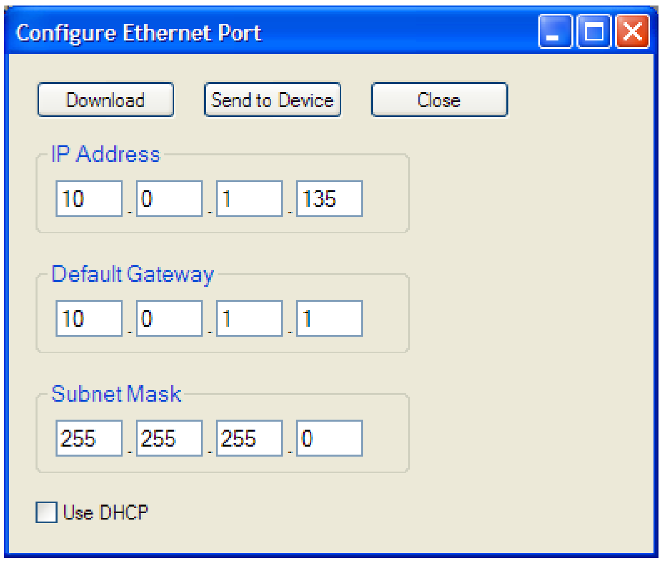


Figure 4-11. Configure Ethernet Port

Configurable options include:

IP Address:	Internet Protocol Address to be used by the LSM-2020.
Default Gateway:	Default host to send data destined for a host not on the network subnet.
Subnet Mask:	Mask used to determine the range of the current network subnet.
Use DHCP:	Automatically configures IP Address, Default Gateway, and Subnet Mask via DHCP. This can be used only if the Ethernet network has a properly configured DHCP server running. The LSM-2020 does not act as a DHCP server.

The values for these options should be obtained from the site administrator if the LSM-2020 is intended to share the network with other devices. If the LSM-2020 is operating on an isolated network, the IP address might be chosen from one of the following ranges as listed in IETF publication RFC 1918, *Address Allocation for Private Networks.*

10.0.0.0 - 10.255.255.255
172.16.0.0 - 172.31.255.255
192.168.0.0 - 192.168.255.255

If the LSM-2020 is operating on an isolated network, the *Subnet Mask* can be left at 0.0.0.0 and the *Default Gateway* can be chosen as any valid IP address from the same range as the LSM-2020 IP address.

3. Click the *Send to Device* button located on the *Configure Ethernet Port* screen. A confirmation popup will be displayed notifying the user that the LSM-2020 will reboot after settings are sent. Click the *Yes* button to allow settings to be sent. After the unit has rebooted and the power-up sequence is complete, the LSM-2020 is ready to be used on a network.

4. If desired, LSM-2020 settings can be verified by selecting *Download Settings and Logic* from the *Communication* pull-down menu. Active settings will be downloaded from the LSM-2020 and IEM-2020. Verify that the downloaded settings match the previously sent settings.
5. Connection to the IEM-2020 can be made through Ethernet via an LSM-2020 with properly configured network settings. When making a new connection to the IEM-2020, the *Ethernet Connection* option shown in Figure 4-5 will allow the user to enter the IP address of the LSM-2020 with which to connect. The *Ethernet* button under *Device Discovery, Scan for Connected Devices,* allows automatic detection of any LSM-2020 devices connected to the local network.

NOTES

The PC running BESTCOMS*Plus* software must be configured correctly to communicate with the LSM-2020. The PC must have an IP address in the same subnet range as the LSM-2020 if the LSM-2020 is operating on a private local network. Otherwise, the PC must have a valid IP address with access to the internet and the LSM-2020 must be connected to a properly configured router. The network settings of the PC depend on the operating system installed. Refer to the operating system manual for instructions. On most Microsoft Windows based PCs, the network settings can be accessed through the *Network Connections* icon located inside the Control Panel.

Microsoft Windows 2000 and XP SP1 contain a potential bug that might prevent device discovery from functioning properly. This issue might present itself if the PC running BESTCOMS*Plus* has more than one network interface card. See Microsoft KB article 827536 for more information.

Firmware updates to the LSM-2020 are made through the Ethernet port. Firmware updates to the IEM-2020 are only available through the USB port of the IEM-2020.

Establishing Communication

Communication between BESTCOMS*Plus* and the IEM-2020 is established by clicking on the *Connect* button on the *IEM-2020 Connection* screen (see Figure 4-5) or by clicking on the *Connect* button on the lower menu bar of the main BESTCOMS*Plus* screen (Figure 4-1). If you receive an "Unable to Connect to Device" error message, verify that communications are configured properly. If communication is established, BESTCOMS*Plus* will automatically read all settings and logic from the IEM-2020 and load them into BESTCOMS*Plus* memory. See Figure 4-12.

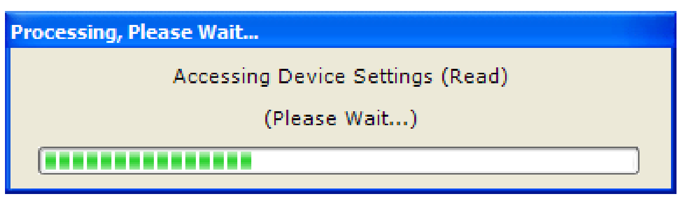


Figure 4-12. Processing, Please Wait…

Advanced Properties

Click the *Advanced* button on the *Connection* screen to display the *Advanced Properties* dialog. Default settings are shown in Figure 4-13.

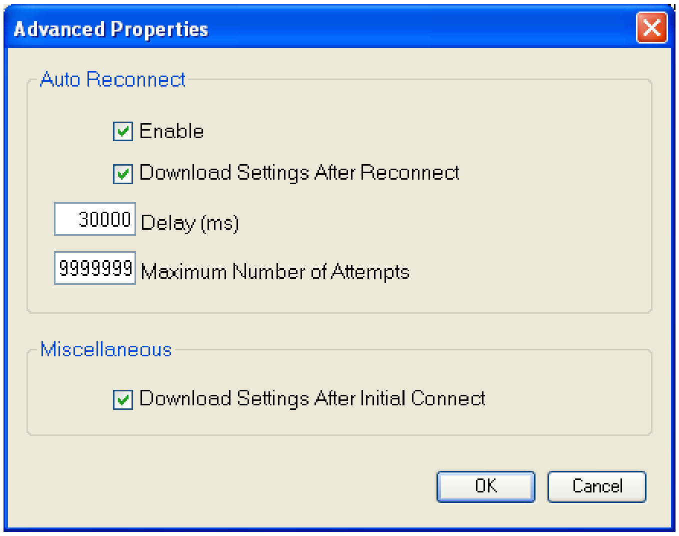


Figure 4-13. Advanced Properties

Menu Bars

The menu bars are located near the top of the BESTCOMS*Plus* screen (see Figure 4-1). The upper menu bar has five pull-down menus. With the upper menu bar, it is possible to manage settings files, configure communication settings, upload and download settings/security files, and compare settings files. The lower menu bar consists of clickable icons. The lower menu bar is used to change BESTCOMS*Plus* views, open a settings file, connect/disconnect, preview metering printout, export metering, switch to live mode, and send a settings file to the IEM-2020.

Upper Menu Bar (BESTCOMS*Plus*® Shell)

Upper menu bar functions are listed and described in Table 4-2.

Table 4-2. Upper Menu Bar (BESTCOMSPlus Shell)

Menu Item	Description
File	
New	Create a new settings file
Open	Open an existing settings file
Open File As Text	Generic file viewer for *.csv, *,txt, etc. files
Close	Close settings file
Save	Save settings file
Save As	Save settings file with a different name
Export To File	Save settings as a *.csv file
Print	Print, export, or send a settings file
Properties	View properties of a settings file
History	View history of a settings file
Recent Files	Open a previously opened file
Exit	Close BESTCOMS*Plus* program
Communication	
New Connection	Choose new device or IEM-2020
Close Connection	Close communication between BESTCOMS*Plus* and IEM-2020
Download Settings and Logic from Device	Download operational and logic settings from the device
Upload Settings and Logic to Device	Upload operational and logic settings to the device
Upload Settings to Device	Upload operational settings to the device

Menu Item	Description
Upload Logic to Device	Upload logic settings to the device
Download Security from Device	Download security settings from the device
Upload Security to Device	Upload security settings to the device
Configure	Ethernet settings
Upload Device Files	Upload firmware to the device
Tools	
Select Language	Select BESTCOMS*Plus* language
Activate Device	Activate the IEM-2020 plugin
Set File Password	Password protect a settings file
Compare Settings Files	Compare two settings files
Auto Export Metering	Exports metering data on a user-defined interval
Event Log - View	View the BESTCOMS*Plus* event log
Event Log - Clear	Clear the BESTCOMS*Plus* event log
Event Log - Set New File Name	Set a new file name for event log
Window	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
Help	
Check for Updates	Check for BESTCOMS*Plus* updates via the internet
Check for Update Settings	Enable or changed automatic checking for updates
About	View general, detailed build, and system information

Lower Menu Bar (IEM-2020 Plug-In)

The lower menu bar functions are listed and described in Table 4-3.

Table 4-3*. Lower Menu Bar (IEM-2020 Plugin)*

Menu Button	Description
View	Enables you to show/hide the Metering Panel, Settings Panel, or Settings Info Panel. Opens and saves workspaces. Customized workspaces make switching between tasks easier and more efficient.
Open File	Opens a saved settings file.
Connect	Connect: Opens the *IEM-2020 Connection* screen which enables you to connect to the IEM-2020 via USB or a modem. This button only appears when an IEM-2020 is not connected.
Disconnect	Disconnect: Used to disconnect a connected IEM-2020. This button only appears when an IEM-2020 is connected.
Preview Metering	Displays the *Print Preview* screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.
Export Metering	Enables all metering values to be exported into a *.csv file.
Options	Displays a drop-down list entitled *Live Mode Settings* which enables *Live* mode where settings are automatically sent to the device in real time as they are changed.

Menu Button	Description
Send Settings	Sends settings to the IEM-2020 when BESTCOMS*Plus* is not operating in Live Mode. Click this button after making a setting change to send the modified setting to the IEM-2020.

Settings Explorer

The Settings Explorer is a convenient tool within BESTCOMS*Plus* used to navigate through the various settings screens of the IEM-2020 plug-in as listed in the following paragraphs.

Logic setup will be necessary after making certain setting changes. For more information, refer to Section 5, *BESTlogicPlus Programmable Logic*.

IEM-2020 and System Parameters

Prior to use, the IEM-2020 must be configured for operation in the intended application. Descriptions of these configuration settings are organized as follows:

- General Settings
- Communications
- System Parameters
- Programmable Inputs
- Programmable Outputs
- Configurable Protection
- Alarm Configuration
- Governor Control Settings
- Programmable Senders
- BESTlogic*Plus* Programmable Logic

NOTE

In the following descriptions, superscript letters (e.g., setting[X]) mark words and phrases relating to IEM-2020 settings. Each letter references settings illustrated in BESTCOMS*Plus*. Lettered notes at the end of each group of descriptions provide the range and increment for each setting.

General Settings

General IEM-2020 settings consist of settings controlling the HMI display and indicators. Additional general settings include style number configuration, IEM-2020 identification, IEM-2020 version information, device security setup, and clock setup.

Front Panel HMI

The contrast[A] of the front panel LCD (liquid crystal display) can be adjusted to suit the viewing angle used or compensate for environmental conditions.

A power saving feature, referred to as Sleep mode[B], will turn the front panel LCD backlight and LCD heater off when the IEM-2020 is in Off mode or Auto mode (not in Run mode) and a key is not pressed for more than 15 minutes. Normal display operation is resumed when any front panel button is pressed or the engine is started remotely via the Auto Start. Sleep mode is enabled and disabled in BESTCOMS*Plus*.

Specific language modules can be uploaded into the IEM-2020. When the language module upload is complete, use the Language[C] selector to select the correct language.

When Scrolling Screen is enabled[D], the front panel summary screen will scroll through the list of Scrolling Screen Items selected on the Configurable HMI Summary Settings screen. The Scrolling Screen Delay[E] determines the scrolling speed. When this feature is disabled OIL, FUEL, TEMP, BATT, RPM and the enabled overview settings are shown on the front panel summary screen.

Two custom initializing messages[FG] are displayed on the initial boot screen of the IEM-2020.

The BESTCOMS*Plus* Front Panel HMI screen is illustrated in Figure 4-14.

Figure 4-14. Front Panel HMI

[A] *LCD Contrast Value:* Adjustable from 0 to 100 (maximum contrast) in increments of 1.
[B] *Front Panel Sleep Mode:* Enable or Disable.
[C] *Language:* English, Chinese, or Spanish.
[D] *Scrolling Screen Enable:* Enable or Disable.
[E] *Scrolling Screen Delay:* Adjustable from 1 to 120 s in 1 s increments.
[F] *Initializing Message 1:* Accepts an alphanumeric string of up to 16 characters. Displayed on the second line of the initial boot screen.
[G] *Initializing Message 2:* Accepts an alphanumeric string of up to 16 characters. Displayed on the third line of the initial boot screen.

Overview Settings

The front panel summary screen will display the enabled items per the scrolling interval[A]. The overview items do not appear when Scrolling Screen is enabled on the Front Panel HMI settings screen.

The BESTCOMS*Plus* Overview Settings screen is illustrated in Figure 4-15.

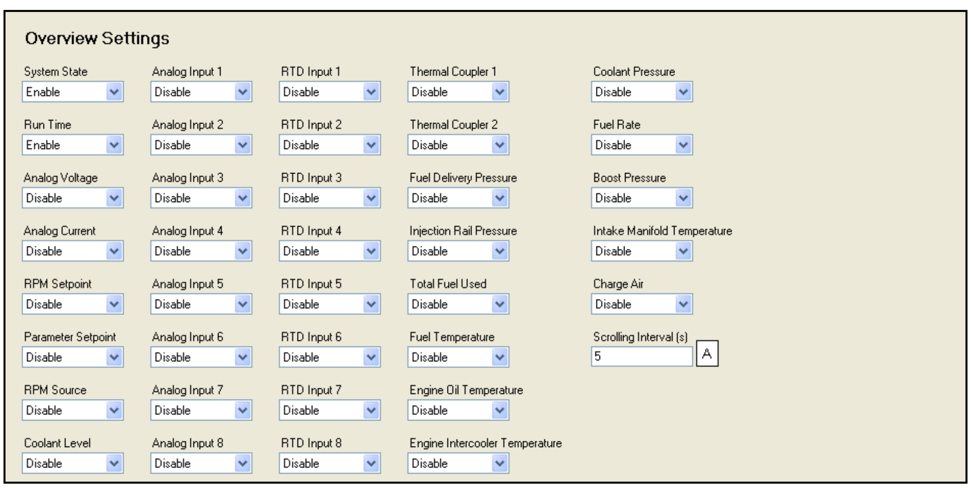


Figure 4-15. Overview Settings

[A] *Scrolling Interval:* Adjustable from 1 to 60 s in 1 s increments.

Configurable HMI Summary Settings

When Scrolling Screen is enabled on the Front Panel HMI screen, the front panel HMI on the IEM-2020 will scroll through the list of Scrolling Screen Items.

The BESTCOMS*Plus* Configurable HMI Summary Settings screen is illustrated in Figure 4-16.

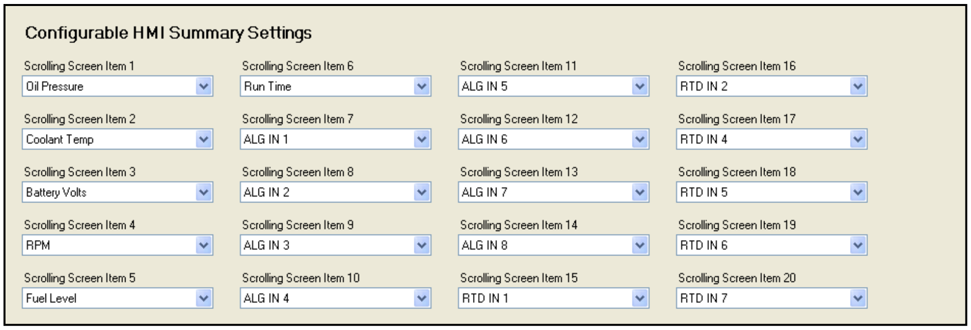


Figure 4-16. Configurable HMI Summary Settings

Style Number

When a PC operating BESTCOMS*Plus* is communicating with an IEM-2020, the style number of the IEM-2020 is automatically displayed on the BESTCOMS*Plus* Style Number screen.

When configuring IEM-2020 settings off-line, the style number for the unit to be configured can be entered into BESTCOMS*Plus* to enable configuration of the required settings.

The BESTCOMS*Plus* Style Number screen is illustrated in Figure 4-17.

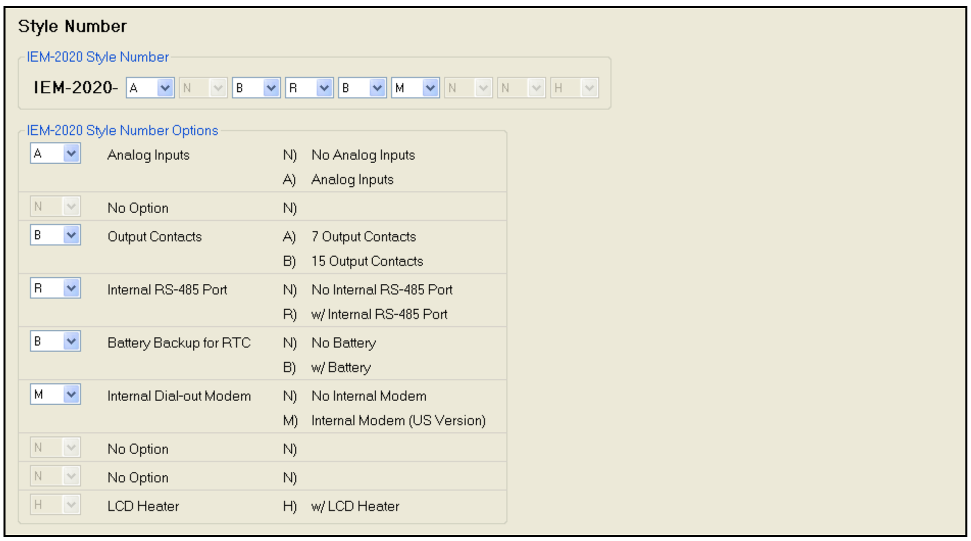


Figure 4-17. Style Number

Device Info

Information about an IEM-2020, LSM-2020 (Load Share Module), CEM-2020 (Contact Expansion Module), and AEM-2020 (Analog Expansion Module) can be obtained when communicating with BESTCOMS*Plus*.

IEM-2020

Information about an IEM-2020 communicating with BESTCOMS*Plus* can be obtained on the Device Info tab of BESTCOMS*Plus*.

Select application version[A] when configuring IEM-2020 settings off-line. When on-line, read-only information includes the application version[B], boot code version[C], application build date[D], serial number[E], application part number[F], model number[G], Language Module Version[H], and Language Module Part Number[I].

The user can assign site-specific information for the IEM-2020. This label includes a unit name string[J].

Load Share Module

Information about an LSM-2020 communicating with BESTCOMS*Plus* can also be obtained on the Device Info tab of BESTCOMS*Plus*.

When on-line, read-only information includes the application version[K], boot code version[L], application build date[M], serial number[N], application part number[O], and model number[P]. The *Refresh* button[Q] is used to refresh the screen after connecting an optional LSM-2020.

Contact Expansion Module

Information about a CEM-2020 communicating with BESTCOMS*Plus* can also be obtained on the Device Info tab of BESTCOMS*Plus*.

When on-line, read-only information includes the application version[R], boot code version[S], application build date[T], serial number[U], application part number[V], and model number[W]. The *Refresh* button[X] is used to update the screen after connecting an optional CEM-2020.

BESTCOMS*Plus* device information values and settings are illustrated in Figure 4-18.

Analog Expansion Module

Information about an AEM-2020 communicating with BESTCOMS*Plus* can also be obtained on the Device Info tab of BESTCOMS*Plus*.

When on-line, read-only information includes the application version[Y], boot code version[Z], application build date[AA], serial number[BB], application part number[CC], and model number[DD]. The *Refresh* button[EE] is used to update the screen after connecting an optional AEM-2020.

The BESTCOMS*Plus* Device Info screen is illustrated in Figure 4-18.

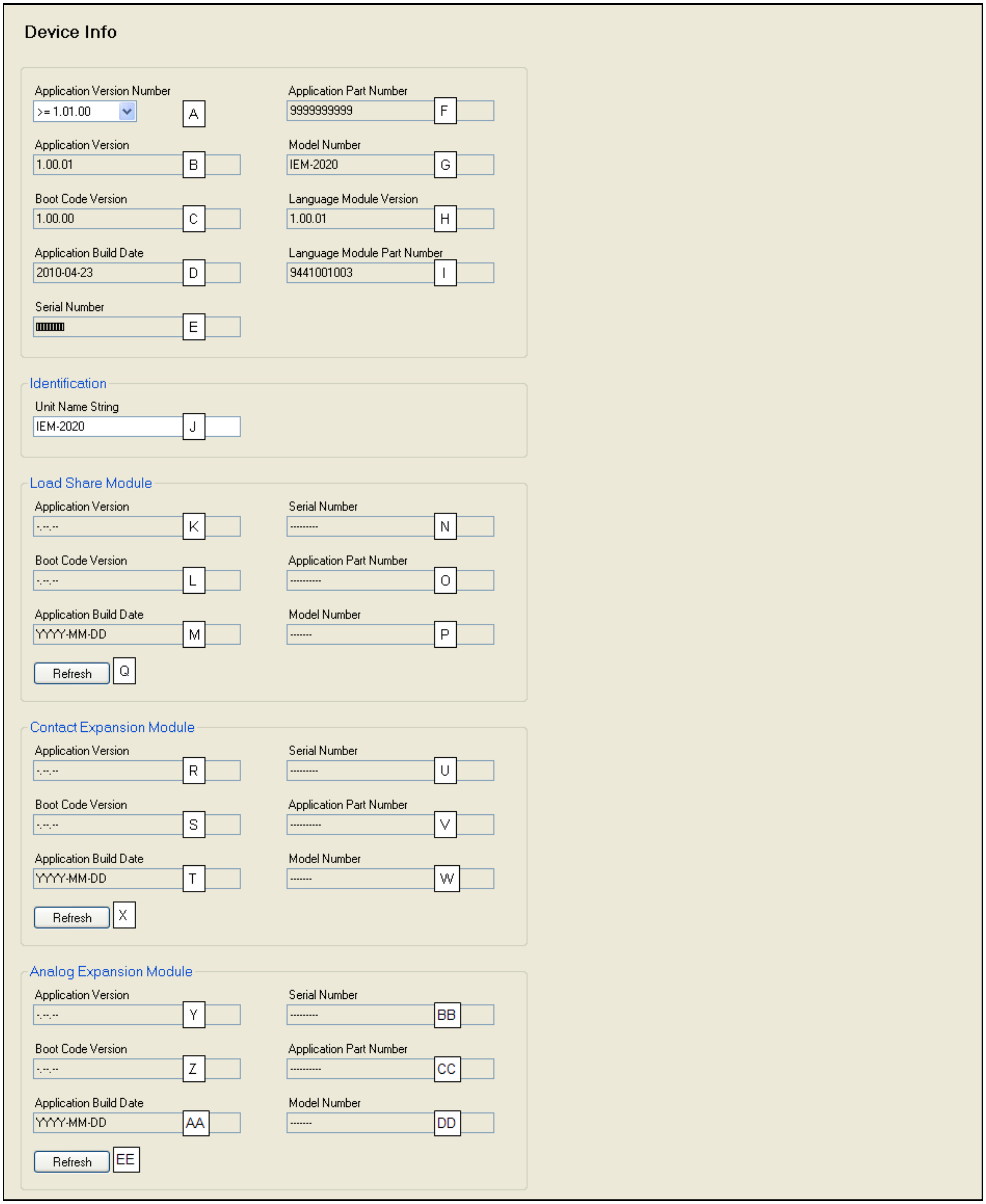


Figure 4-18. Device Info

[A] *Application Version:* When configuring IEM-2020 settings off-line, the application version for the unit to be configured must be selected.

[B] *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.

[C] *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.

[D] *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.

[E] *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.
[F] *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.
[G] *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.
[H] *Language Module Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.
[I] *Language Module Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.
[J] *Unit Name String:* Accepts an alphanumeric character string of up to 16 characters.
[K] *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.
[L] *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.
[M] *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.
[N] *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.
[O] *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.
[P] *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.
[Q] *Refresh:* Clicking this button will refresh the screen after connecting an optional LSM-2020.
[R] *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.
[S] *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.
[T] *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.
[U] *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.
[V] *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.
[W] *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.
[X] *Refresh:* Clicking this button will refresh the screen after connecting an optional CEM-2020.
[Y] *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.
[Z] *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.
[AA] *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.
[BB] *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.
[CC] *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.
[DD] *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.
[EE] *Refresh:* Clicking this button will refresh the screen after connecting an optional AEM-2020.

Device Security Setup

Password protection guards against unauthorized changing of IEM-2020 settings. IEM-2020 passwords are case sensitive. Three levels of password protection are available. Each level is described in the following paragraphs.

- *OEM Access.* This password level allows access to all settings. The default, OEM-access password is **OEM**.
- *Settings Access.* This password level allows all except uploading of firmware and clearing of device event log. The default, settings-access password is **SET**.
- *Operator Access.* The default, operator-access password is **OP**. This password level allows all settings to be read and allows changes to be made to the following:

- o LCD Contrast
- o Sleep Mode
- o Date/Time
- o All Sender Fail Time Delays
- o Metric Conversion
- o Low Fuel Pre-Alarm Level
- o Low Fuel Alarm Level
- o Pre-Start Contact after Cranking
- o Cooldown Time
- o Pre-Crank Time Delay
- o Reset of Maintenance Interval
- o All controls on the Control screen available via the Metering Explorer in BESTCOMS*Plus*

Changing Passwords

Passwords can be changed only after communication between the PC and IEM-2020 is established. Changes to passwords are made through the *Device Security Setup* screen. Use the Settings Explorer in BESTCOMS*Plus* to open the *General Settings, Device Security Setup* screen.

The content of the *Device Security Setup* screen depends on the password level used when accessing the screen. For example, someone logged in with a settings-access password will be able to change only the settings-access and operator-access passwords - not the OEM-access password.

The BESTCOMS*Plus* Device Security Setup screen is illustrated in Figure 4-19. All three access levels are shown.

A password is changed by clicking on the access level[A], entering the new password[B], and then clicking on the *Save Password* button[C].

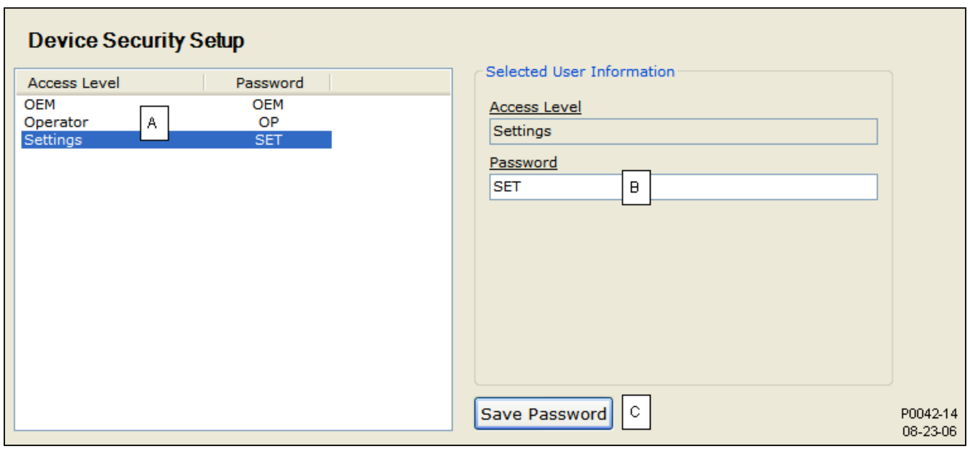


Figure 4-19. Device Security Setup

[A] *Access Level/Password:* Read-only value obtained when BESTCOMS*Plus* is communicating with the IEM-2020.
[B] *Password:* Accepts an alphanumeric character string of up to 16 characters.
[C] *Save Password:* Clicking this button will save the password changes in BESTCOMS*Plus* memory.

Saving Passwords in a IEM-2020 Settings File

The passwords can be modified while BESTCOMS*Plus* is connected to an IEM-2020, then the settings from the BESTCOMS*Plus* session can be saved into a settings file. The settings file will contain the new passwords. Also, the passwords in a settings file can be modified off line, saved with the file, and then later loaded into an IEM-2020.

Saving passwords to a settings file when BESTCOMS*Plus* is connected to an IEM-2020 (on line):

1. When connected to an IEM-2020 with BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY SETUP.
2. You will be prompted to enter a password.

3. Enter a password that is of a level as high as or higher than the password you wish to modify. BESTCOMS*Plus* will display all passwords of a level equal to and below the level of the password that was entered.
4. Click on the password you wish to modify. Type in the new password under the “Password” setting that became active when the password to modify was clicked.
5. Click the “Save” button to save the new password into BESTCOMS*Plus* memory (it’s not in the IEM-2020 yet).
6. Repeat steps 4 and 5 for all password levels you with to modify.
7. Once all password modifications are complete, in the main menu of BESTCOMS*Plus*, select *Upload Security* from the *Communications* pull-down menu. This is the step where passwords are sent to the IEM-2020. Failure to perform this step may cause all password modifications to be lost.
8. Close the *Device Security Setup* tab in BESTCOMS*Plus*.
9. Re-open the *Device Security Setup* tab in BESTCOMS*Plus*. This will read the passwords back out of the IEM-2020.
10. Verify the passwords obtained from the IEM-2020 are correct.
11. Once all desired settings have been loaded into the IEM-2020, save the settings file. The resulting settings file has the passwords saved as part of the saved settings.
12. At this point, the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

Saving passwords to a settings file when working off line:

1. When the settings file is open in BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY SETUP.
2. You will be prompted to enter a password.
3. Enter a password that is of a level as high as or higher than the password you wish to modify. BESTCOMS*Plus* will display all passwords of a level equal to and below the level of the password that was entered.
4. Click on the password you wish to modify. Type in the new password under the “Password” setting that became active when the password to modify was clicked.
5. Click the “Save” button to save the new password into BESTCOMS*Plus* memory.
6. Repeat steps 4 and 5 for all password levels you wish to modify.
7. Close the *Device Security Setup* tab in BESTCOMS*Plus*.
8. Save the settings file.
9. Close the settings file by clicking on the X in the upper right-hand corner of the settings file, or close BESTCOMS*Plus*.
10. Restart BESTCOMS*Plus* if you have shut it down.
11. Re-open the settings file that you have saved with the password information.
12. When the settings file is open in BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY SETUP.
13. You will be prompted to enter a password.
14. Enter the password for the highest level of password modified; it should be the new modified password.
15. When passwords are shown, verify they are correct.
16. At this point the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

Loading Passwords from a Settings File into the IEM-2020

1. Connect to the IEM-2020 with BESTCOMS*Plus*.
2. Once connected, click the “Open File” button that is used to load a settings file into the IEM-2020.
3. You will be prompted asking if you wish to load settings and logic into the IEM-2020. Select *Yes* if you need to upload settings logic. Select *No* if all you need to do is update security. If you select *No*, the settings file opens into BESTCOMS*Plus* memory.

4. Whether you have loaded settings and logic to the IEM-2020 or not, the next step is to select *Upload Security* from the *Communications* pull-down menu.
5. DO NOT try to view the passwords before performing step 4. This would download the existing passwords from the IEM-2020 and they will overwrite the new passwords that were loaded into BESTCOMS*Plus* memory from opening the settings file.
6. If you are prompted for a password, enter a password of a level equal to that of the highest level password you wish to modify.
7. The passwords are uploaded to the IEM-2020.
8. After you have uploaded the new passwords, select GENERAL SETTINGS > DEVICE SECURITY SETUP in the settings explorer of BESTCOMS*Plus.* Verify the passwords are correct.
9. This concludes loading passwords from a settings file into the IEM-2020.

Clock Setup

Configuration of daylight saving time and coordination of the local time with universal time (if desired) is performed on this screen. If required, enter the *UTC (Universal Time Coordinates) Offset*[A]. Choose the type of *DST Configuration*[B] and then set the *Start Day*[C]*, End Day*[D]*,* and *Bias*[E]*.*

The BESTCOMS*Plus* Clock Setup screen is illustrated in Figure 4-20.

Clock Not Set Warning

When the clock not set warning[F] is enabled, the IEM-2020 will notify the user when the clock is not set.

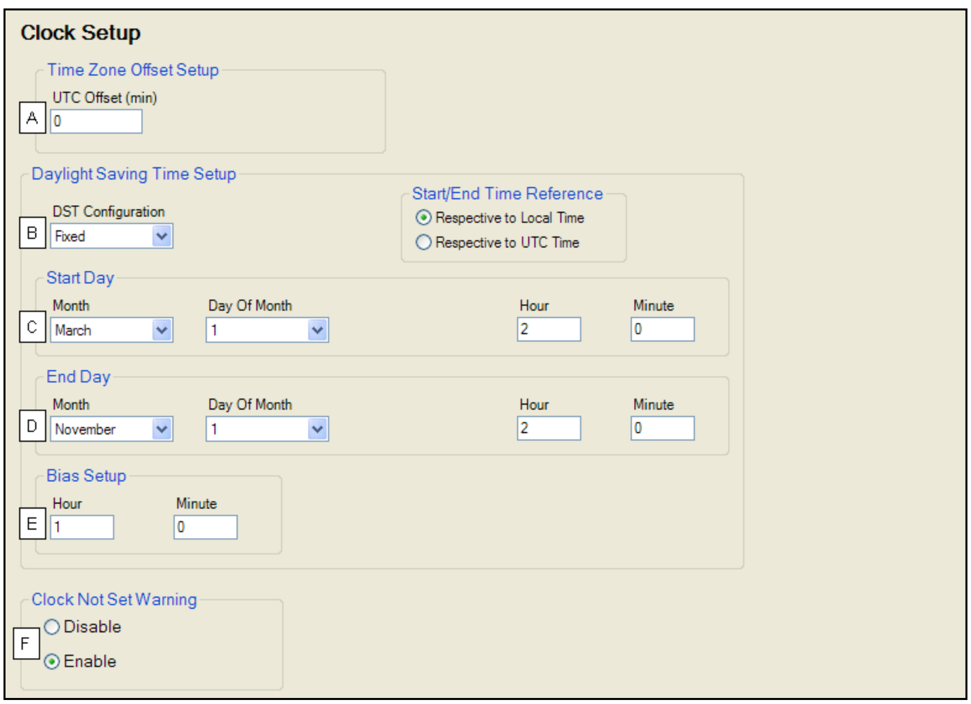


Figure 4-20. Clock Setup

[A] *UTC Offset (min):* Adjustable from -1,440 to 1,440 minutes in increments of 1.
[B] *DST Configuration:* Disabled, Fixed, or Floating.
[C] *Start Day:*

Fixed DST Configuration
Month (January to December), Day of Month (1 to 31 in increments of 1), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).
Floating DST Configuration
Month (January to December), Occurrence of Day (First to Fourth, or Last), Weekday (Sunday to Saturday), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

[D] *End Day:*

Fixed DST Configuration

Month (January to December), Day of Month (1 to 31 in increments of 1), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

Floating DST Configuration

Month (January to December), Occurrence of Day (First to Fourth, or Last), Weekday (Sunday to Saturday), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

[E] *Bias:* Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

[F] *Clock Not Set Warning:* Enable or Disable.

Communications

IEM-2020 communication settings include setup parameters for CAN Bus, ECU, modem, and RS-485 communication.

CAN Bus Setup

The IEM-2020 CAN Bus interface provides high-speed communication between the IEM-2020 and the engine control unit (ECU) on an electronically controlled engine. When ECU support is enabled[A], the IEM-2020 will ignore the analog coolant temperature, oil pressure, and engine speed inputs and rely upon the ECU for these parameters. The IEM-2020 will also stop calculating engine run time and begin using the run time recorded by the ECU.

When enabled[B], the IEM-2020 will receive and retain unsolicited diagnostic trouble codes (DTCs) from an ECU with DTC capabilities.

Early versions of the J1939 specifications were unclear about how the 19 bits of the SPN were arranged within their allocated places in the data. While it was clear which bytes and bits contained the 19 bits of SPN data, it was not clear whether the data within the bytes was arranged with the most significant bit first or least significant bit first. It was also unclear which byte was most significant and which was least significant. The ambiguity led to various engine manufacturers adopting three different methods of converting the data into SPN numbers.

This was remedied in the J1939 specs, and the SPN Conversion Method[C] bit was added. When this bit is a zero, the conversion method is indicated as version 4. The IEM-2020 will automatically set the conversion method to 4 when the CM bit is zero; this occurs for most engine types. However, if the CM bit is 1, indicating the SPN conversion method is NOT 4, the user will have to consult the engine manufacturer to learn the correct method of SPN conversion, and set the SPN Conversion Method setting in the IEM-2020 accordingly.

An IEM-2020 operating on a CAN Bus network is identified by a unique address number[D]. The CAN Bus Address is set internally by the IEM-2020 when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply. See Table 4-4.

Table 4-4. CAN Bus Address per ECU Type

ECU Type	CAN Bus Address
Standard	User-selectable
Volvo Penta	17
MTU MDEC	6
MTU ADEC	1
MTU ECU7/ECU8	6
GM/Doosan	User-selectable
Cummins	220
MTU Smart Connect	234

In applications where the ECU is not continuously powered, the IEM-2020 has provisions for applying power to the ECU and pulsing the ECU to update its engine monitoring data. Either the IEM-2020 RUN or PRESTART relay output can be used to apply power to the ECU[E]. If the PRESTART contact is selected, the RUN output will still close during cranking and engine operation to provide a separate indication that the engine is running. For applications where pulsing of the ECU is not desired, this pulsing feature[F] may be disabled.

The BESTCOMS*Plus* CAN Bus Setup screen is illustrated in Figure 4-21.

ECU Limitations

For some ECUs, an external source cannot stop the engine without removing power from the ECU. Turning off power to the ECU is the only way to remove fuel from the engine and shut it down. Different ECU manufacturers have their own rpm setpoints for reapplying fuel to an engine. If the ECU is powered up and the engine is still spinning above 60 rpm, then the ECU will automatically turn the fuel on. Detroit Diesel J1939 ECUs, for example, have a setpoint of 60 rpm.

Not being able to stop the engine without removing ECU power causes two problems. The first problem is that the only way to stop the engine is to turn the ECU off and wait for the engine speed to decrease below 60 rpm before powering the ECU back on. Otherwise, the engine will take off running. The second problem is that while the ECU is off, you can no longer meter and update coolant level, coolant temperature alarm/pre-alarm, and crank control.

The IEM-2020 Solution

The IEM-2020 resolves ECU limitations by using four timers:

- *Engine Shutdown.*[G] The time in seconds to stay disconnected from the ECU when going from running to shutdown before starting the first pulse. This timer should allow enough time for the engine to slow down so that when the IEM-2020 pulses, the ECU will not start the engine.
- *Pulse Cycle Time.*[H] The time in minutes that the module waits before pulsing.
- *Settling Time.*[I] The time in tenths of seconds to gather data after connecting to the ECU during the pulsing state. This allows all the metered values to be sent and ramp as designated by the J1939 protocol. ECU values initially sent are low and the ECU takes time to average out its own data values.
- *Response Timeout.*[J] The time in seconds to attempt communication with the ECU when the IEM-2020 is in the pulsing state or connecting state.

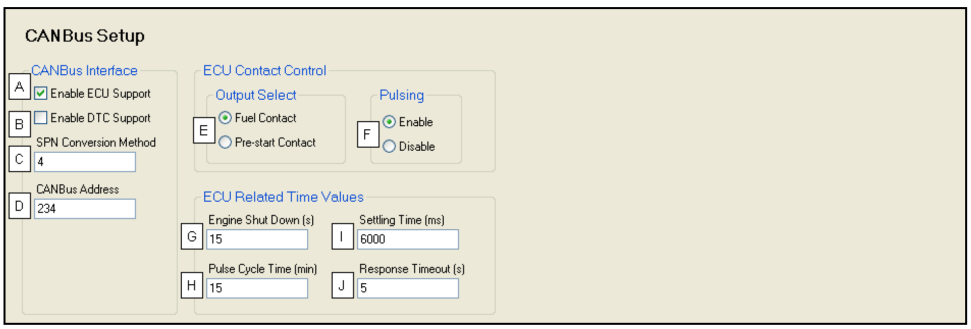


Figure 4-21. CAN Bus Setup

[A] *Enable ECU Support:* Check box to enable ECU support.
[B] *Enable DTC Support:* Check box to enable DTC support.
[C] *SPN Conversion Method:* 1, 2, 3, or 4.
[D] *CAN Bus Address:* Accepts an address number from 1 to 253 in increments of 1.
[E] *Output Select:* Fuel Contact (RUN) or Pre-start Contact.
[F] *Pulsing:* Enable or Disable.
[G] *Engine Shutdown:* Adjustable from 1 to 60 s in 1 s increments.
[H] *Pulse Cycle Time:* Adjustable from 1 to 60 min in 1 min increments.
[I] *Settling Time:* Adjustable from 5,500 to 30,000 ms in 1 ms increments.
[J] *Response Timeout:* Adjustable from 1 to 60 s in 1 s increments.

ECU Setup

The IEM-2020 can be configured for Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7/ECU8, GM/Doosan, Cummins, or MTU Smart Connect[A].

When the Engine Parameter Transmit[B] setting is enabled, the IEM-2020 broadcasts engine metered parameters over CAN Bus. When the Engine Parameter Transmit setting is disabled, transmission of J1939 commands from the IEM-2020 to the engine is disabled, but commands from the engine to the IEM-2020 are allowed.

Volvo Penta

Configuring the IEM-2020 for Volvo Penta* necessitates the configuration of the Speed Select setting. The Speed Select setting[C] configures the Volvo Penta ECU to operate the engine at the primary or secondary base speed. In generator drive engines, if the engine is configured by Volvo for 60 Hz applications, the primary base speed is 1,800 rpm and the secondary base speed is 1,500 rpm. If the engine is configured by Volvo for 50 Hz applications, the primary base speed is 1,500 rpm and the secondary base speed is 1,800 rpm. In non-generator drive engines, this setting has no effect.

The IEM-2020 automatically sends the Accelerator Position to the engine ECU expressed as a percentage of pedal position. In non-generator drive engines, the Accelerator Position range of 0 to 100% selects the RPM range of 0 RPM to the maximum RPM available in the engine. The IEM-2020 sets the Accelerator Position to obtain the RPM specified by the RPM Profile based on the following equation:

Accelerator Position = (Desired RPM / Max Engine RPM) * 100

where Max Engine RPM is set by the user on the System Parameters screen in BESTCOMS*Plus*.

The IEM-2020 sends the following parameters to a Volvo Penta ECU through Volvo Proprietary J1939 communications:

- Start Request - sent when starting the engine.
- Stop Request - sent when shutting down the engine.
- Idle Request - sent when the Idle Request logic element is true in BESTlogic*Plus.*
- Preheat Request - sent anytime the IEM-2020 would normally have its PRE relay closed for engines requiring a preheat contact.
- Accelerator Pedal Position - sent based on a percentage of pedal position.
- Primary/Secondary Engine Speed - sent based on the Speed Select setting. Primary speed is sent when the Speed Select setting is set for Primary and Secondary speed is sent when the Speed Select setting is set for Secondary.

∗ The Volvo Penta ECU configuration is applicable only to the EDC3 and EMS2 models of Volvo Penta engine controllers.

Note: The Accelerator Position setting[D] is not available in version 2 firmware.

Cummins

When Cummins is selected as the ECU type, the following parameters are sent to the engine via Cummins Proprietary J1939 communications:

- Start Request - sent when starting or running the engine.
- Stop Request - sent when stopping the engine.
- Idle Request - sent when the Idle Request logic element is true in BESTlogic*Plus.*
- Rated Speed (50 or 60 Hz) - sent based on the Rated Speed setting of the IEM-2020.

Diesel Particulate Filter (DPF)

The diesel particulate filter settings are used when the ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect. The IEM-2020 supports the CAN Bus parameters that are related to the diesel particulate filter implemented on certain engines to meet Tier 4 emission requirements. For more information, refer to Appendix D, *Exhaust Treatment.* Three pre-alarms provide DPF status:

- DPF Regenerate Required pre-alarm – announced when the DPF lamp status broadcast over CAN Bus indicates that regeneration is required.
- DPF Regenerate Disabled pre-alarm – announced when the engine ECU reports via CAN Bus that DPF regeneration is disabled.
- High Exhaust Temperature pre-alarm – announced when the ECU reports via CAN Bus that a high exhaust temperature condition exists.

Two parameters are provided to initiate or disable DPF regeneration. The first, Manual Regeneration[E], is transmitted to the engine over CAN Bus to initiate DPF regeneration. The second, Disable Regeneration[F], is transmitted to the engine over CAN Bus to disable DPF regeneration. Extended operation with regeneration disabled is not recommended.

MTU

If the engine is configured as MTU MDEC, the configuration of the following settings is necessary:

- MDEC Module Type[G] - Specifies the type of MDEC module.
- Speed Demand Switch[H] - Specifies speed demand source for the MTU engine ECU.
- NMT Alive Transmit Rate[I] - Specifies the rate at which messages are transmitted to the MTU engine.

If the engine is configured as MTU ADEC, the configuration of the following settings is necessary:

- Speed Demand Switch[G] - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test[J] - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Governor Param Switch Over[K] - Specifies which governor parameters an MTU ECU should use.
- Trip Reset[L] - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime[M] - Causes an MTU ECU engine to perform an internal lubrication cycle.

If the engine is configured as MTU ECU7/ECU8, the configuration of the following settings is necessary:

- Speed Demand Switch[G] - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test[I] - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Speed Up[N] - Increases speed of the MTU ECU.
- Speed Down[O] - Decreases speed of the MTU ECU.
- Idle Request[P] - Turns the idle request on or off.
- Increased Idle[Q] - Sets the MTU ECU idle.
- Trip Reset[K] - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime[L] - Causes an MTU ECU engine to perform an internal lubrication cycle.
- Engine Start Prime[R] - Turns the engine start prime on or off.
- Fan Override[S] - Turns the fan override on or off.
- Mode Switch[T] - Turns the mode switch on or off.
- Governor Param Switch Over[J] - Specifies which governor parameters an MTU ECU should use.
- Governor Param Set Select[U] - Sets the governor parameter set select.
- CAN Rating Switch 1 & 2[V] - Turns the CAN rating switch 1 & 2 on or off.
- Cylinder Cutout Disable 1 & 2[W] - Turns the cylinder cutout disable 1 & 2 on or off.
- MTU ECU7/ECU8 Module Type[X] - Specifies ECU7/ECU8 Module type.
- NMT Alive Transmit Rate[H] - Specifies the rate at which messages are transmitted to the MTU engine.

If the engine is configured as MTU Smart Connect, the configuration of the following settings is necessary:

- Speed Demand Switch[G] - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test[I] - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Speed Up[M] - Increases speed of the MTU ECU.
- Speed Down[N] - Decreases speed of the MTU ECU.
- Idle Request[O] - Turns the idle request on or off.
- Trip Reset[K] - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime[L] - Causes an MTU ECU engine to perform an internal lubrication cycle.
- Governor Param Switch Over[J] - Specifies which governor parameters an MTU ECU should use.
- Cylinder Cutout Disable 2[V] - Turns the cylinder cutout disable 2 on or off.
- Engine Operating Mode[Y] - Selects engine operating mode 1 or 2.

The Engine RPM[Z] setting is set automatically by the IEM-2020 based on the RPM Profile. The MTU 50 Hz 60 Hz Switch Setting[AA] does not apply because engine speed is set automatically by the IEM-2020 based on the RPM Profile.

The BESTCOMS*Plus* ECU Setup screen is illustrated in Figure 4-22.

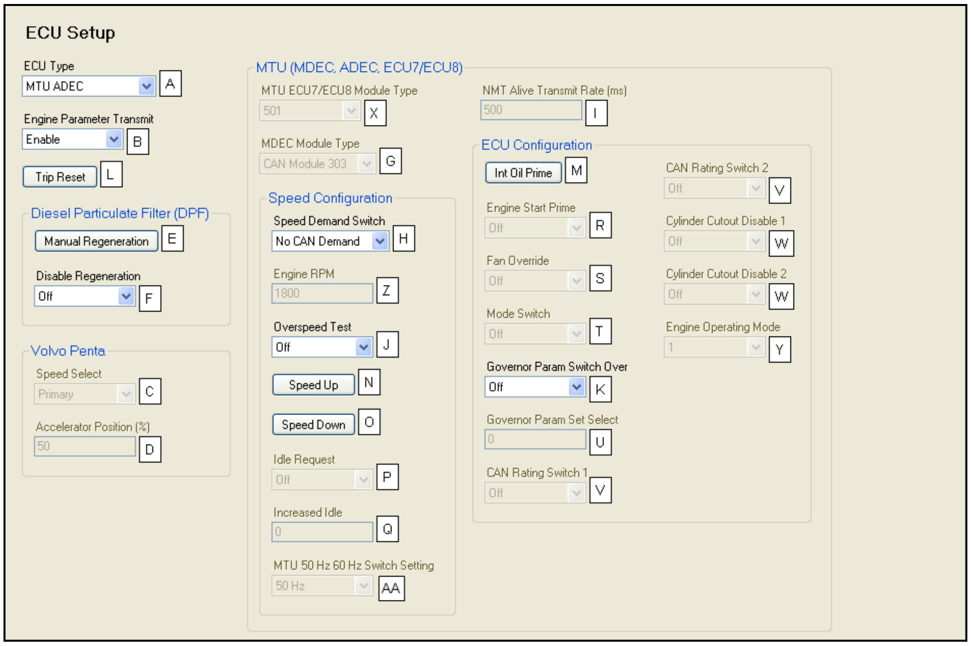


Figure 4-22. ECU Setup

[A] *ECU Type:* Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7/ECU8, GM/Doosan, Cummins, or MTU Smart Connect.
[B] *Engine Parameter Transmit:* Enable or Disable.
[C] *Speed Select:* Primary or Secondary.
[D] *Accelerator Position:* Not available in version 2 firmware.
[E] *Manual Regeneration:* Press to set.
[F] *Disable Regeneration:* Off or On.
[G] *MDEC Module Type:* CAN Module 201, 302, 303, or 304.
[H] *Speed Demand Switch:* Analog CAN, Up Down ECU, Up Down CAN, Analog ECU, Frequency, No CAN Demand.
[I] *NMT Alive Transmit Rate:* Adjustable from 100 to 500 ms in 100 ms increments.
[J] *Overspeed Test:* Off or On.
[K] *Governor Param Switch Over:* Off or On.
[L] *Trip Reset:* Press to set.
[M] *Int Oil Prime:* Press to set.
[N] *Speed Up:* Press to set.
[O] *Speed Down:* Press to set.
[P] *Idle Request:* Off or On.
[Q] *Increased Idle:* Adjustable from 0 to 1,000 in increments of 1.
[R] *Engine Start Prime:* Off or On.
[S] *Fan Override:* Off or On.
[T] *Mode Switch:* Off or On.
[U] *Governor Param Set Select:* Adjustable from 0 to 1,000 in increments of 1.
[V] *CAN Rating Switch 1 & 2:* Off or On.
[W] *Cylinder Cutout Disable 1 & 2:* Off or On.
[X] *MTU ECU7/ECU8 Module Type:* 501 or 502.
[Y] *Engine Operating Mode:* 1 or 2.
[Z] *Engine RPM:* Set automatically by the IEM-2020 based on the RPM Profile.
[AA] *MTU 50 Hz 60 Hz Switch Setting:* Does not apply because engine speed is set automatically by the IEM-2020 based on the RPM Profile.

Modem Setup (Optional)

IEM-2020 modules with style number xxxxxMxxx are equipped with an internal telephone modem that has dial-in and dial-out capability. The modem gives the IEM-2020 the ability to dial up to four telephone numbers[A] and annunciate user-selected conditions to specified pagers[B]. These user-selected conditions include[C]:

- AEM Comm Failure
- Auto Restart Failure Alarm
- Auxiliary Input X Closed (X = 1 to 16)
- Battery Charger Fail Status
- Battery Overvoltage Pre-Alarm
- CEM Comm Failure
- Config Element X Status (X = 1 to 8)
- Coolant Temp Sender Fail Alarm
- Coolant Temp Sender Fail Pre-Alarm
- Cooldown Timer Active
- DPF Regeneration Inhibited
- DPF Regeneration Required
- Duplicate AEM Pre-Alarm
- Duplicate CEM Pre-Alarm
- Duplicate LSM Pre-Alarm
- Emergency Stop Alarm
- Engine Running
- Fuel Leak Detect Status
- Fuel Level Sender Fail Alarm
- Fuel Level Sender Fail Pre-Alarm
- High Coolant Temperature Alarm
- High Coolant Temp Pre-Alarm
- High Exhaust Temperature
- High Fuel Pre-Alarm
- Loss of ECU Coms Alarm
- Loss of ECU Coms Pre-Alarm
- Low Battery Voltage Pre-Alarm
- Low Coolant Level Status
- Low Coolant Temp Pre-Alarm
- Low Fuel Alarm
- Low Fuel Pre-Alarm
- Low Oil Pressure Alarm
- Low Oil Pressure Pre-Alarm
- LSM Comm Failure
- MPU Speed Sender Fail Alarm
- Oil Pressure Sender Fail Alarm
- Oil Pressure Sender Fail Pre-Alarm
- Overcrank Alarm
- Overspeed Alarm
- Scheduled Maintenance Pre-Alarm
- Switch Not in Auto
- Weak Battery Voltage Pre-Alarm

Dial-Out

The IEM-2020 uses telelocator alphanumeric protocol (TAP) version 1.7 when communicating with paging companies. This data format[D] specifies seven data bits with even parity. If required, eight data bits with no parity may be specified.

The message string sent by the IEM-2020 can be limited to a length supported by the receiving pagers[E]. If a message to be transmitted by the IEM-2020 exceeds the pager message limit, the IEM-2020 will make multiple calls to transmit the complete message.

Dial-out messages are sent by the IEM-2020 at a user-defined interval[F]. This interval gives an operator the opportunity to dial into the IEM-2020. A second user-defined interval[G] determines how frequently dial-out attempts are made following a dial-out failure.

Dial-In

When the IEM-2020 modem shares a line used for voice communication, the number of rings[H] required for the modem to answer can be increased to allow time for an operator to answer an incoming telephone call.

The BESTCOMS*Plus* Modem Setup screen is illustrated in Figure 4-23.

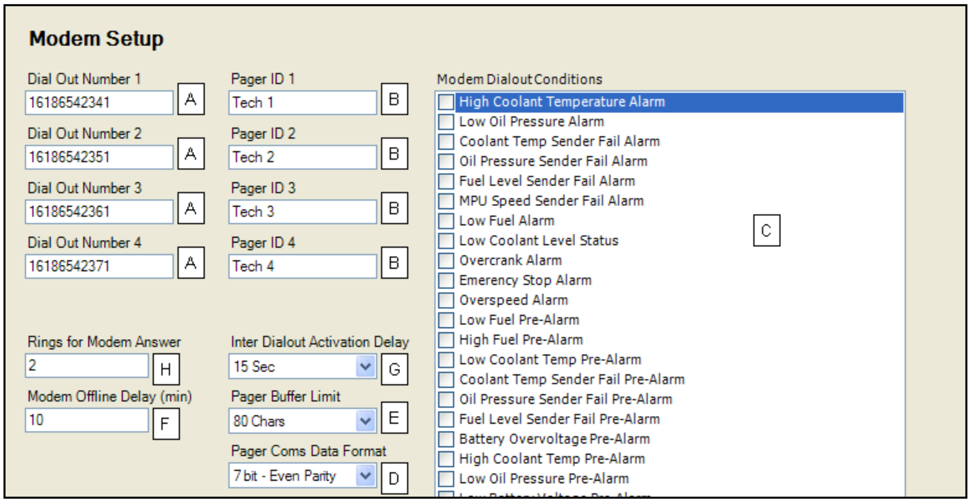


Figure 4-23. Modem Setup

[A] *Dial Out Number:* Accepts a telephone number of up to 16 characters.
[B] *Pager ID:* Accepts a pager identification number of up to 16 characters.
[C] *Modem Dialout Conditions:* Check boxes to select conditions that will initiate a dial-out message.
[D] *Pager Coms Data Format:* 7 bit – Even Parity or 8 bit – No Parity.
[E] *Pager Buffer Limit:* Adjustable from 80 to 200 characters in increments of 40.
[F] *Modem Offline Delay:* Adjustable from 1 to 240 min in 1 min increments.
[G] *Inter Dialout Activation Delay:* A delay of 15, 30, 60, or 120 s may be selected.
[H] *Rings for Modem Answer:* Adjustable from 1 to 9 in increments of 1.

Modem Setup through the Front Panel HMI

If a USB or Ethernet connection is not available, the modem can be completely set up through the front panel HMI. Navigate to MAIN MENU > SETTINGS > COMMUNICATIONS > MODEM SETUP and enter parameters for Dialout Numbers, Pager IDs, Rings for Answer, Offline Delay, Dialout Delay, Pager Buffer Limit, and Pager Communication Data Format.

After the modem is set up properly, a modem connection between a computer running BESTCOMS*Plus* and the IEM-2020 can be established.

RS485 Setup (Optional)

IEM-2020 modules with the optional RS-485 communication port (style number xxxRxxxxx) can be monitored and controlled via a polled network using the Modbus protocol. Adjustable RS-485 port settings include the baud rate[A], parity[B], and port address[C]. Fixed RS-485 port settings include the number of data bits (8) and stop bits (1).

Modbus register values for the IEM-2020 are listed and defined in Appendix A, *Modbus Communication*.

The BESTCOMS*Plus* RS485 Setup screen is illustrated in Figure 4-24.

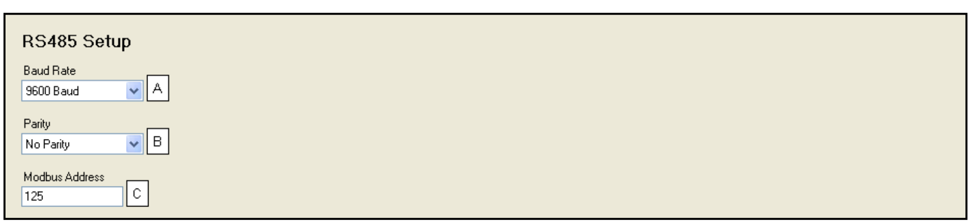


Figure 4-24. RS485 Setup

[A] *Baud Rate:* A value of 1200, 2400, 4800, or 9600 may be selected.
[B] *Parity:* No Parity, Odd Parity, or Even Parity.
[C] *Modbus Address:* A value of 1 to 247 may be entered in increments of 1.

System Parameters

System parameters configure the IEM-2020 for operation with a specific application and are divided into eight categories: RPM Profile Settings, Seven Day Timer, System Settings, Remote Module Setup, Crank Settings, Automatic Restart, Exercise Timer, and Relay Control.

RPM Profile Settings

The IEM-2020 implements an internal automatic RPM Profile which has an internal speed setpoint that can be used to send speed requests through CAN Bus to ECUs. RPM profile functions and statuses are available in BESTlogic*Plus.* Refer to Section 3, *Functional Description, RPM Control, RPM Profile*.

The RPMCONTROL logic element provides raise/lower ability to set the desired engine rpm on engines that do not accept speed requests over CAN Bus.

The RPM Profile function becomes active when the IEM-2020 is in AUTO or RUN mode. Each mode has independent settings. An RPM Profile diagram[A] is available by clicking *Show RPM Profile Diagram*.

The Control Mode setting[B] specifies how the RPM Profile should be controlled. The RPM Profile consists of the following states, each with independent settings. Each state is available as a status input in BESTlogic*Plus* Programmable Logic.

- IDLE - The engine runs at a user-specified rpm[C] for the Idle time duration[D].
- RAMP UP 1 - The engine ramps up from the IDLE rpm to the INTERMEDIATE rpm according to the Ramp Up 1 time duration[E].
- INTERMEDIATE - The engine runs at a user-specified rpm[F] for the Intermediate time duration[G].
- RAMP UP 2 - The engine ramps up from the INTERMEDIATE rpm to the RUNNING rpm according to the Ramp Up 2 timer duration[H].
- RUNNING - The engine runs at a user-specified rpm[I] until the Auto Start contact or logic element is removed.
- RAMP DN - The engine ramps down from the RUNNING rpm to the COOLING rpm according to the Ramp Down timer duration[J].
- COOLING - The engine runs at a user-specified rpm[K] for the Cooling time duration[L] and then stops.

The operating rpm for the IEM-2020 at any given time is determined from the current state of the RPM Profile. If the Auto Start contact input or AUTOSTART logic element is removed during IDLE or INTERMEDIATE state or the OFF button is pressed, the engine shuts down. If the OFF button is pressed, the Auto Start contact input is removed, or AUTOSTART logic element is removed any time after completion of the INTERMEDIATE state, the profile will ramp to the COOLING state, cool for the user-specified duration, and shut down.

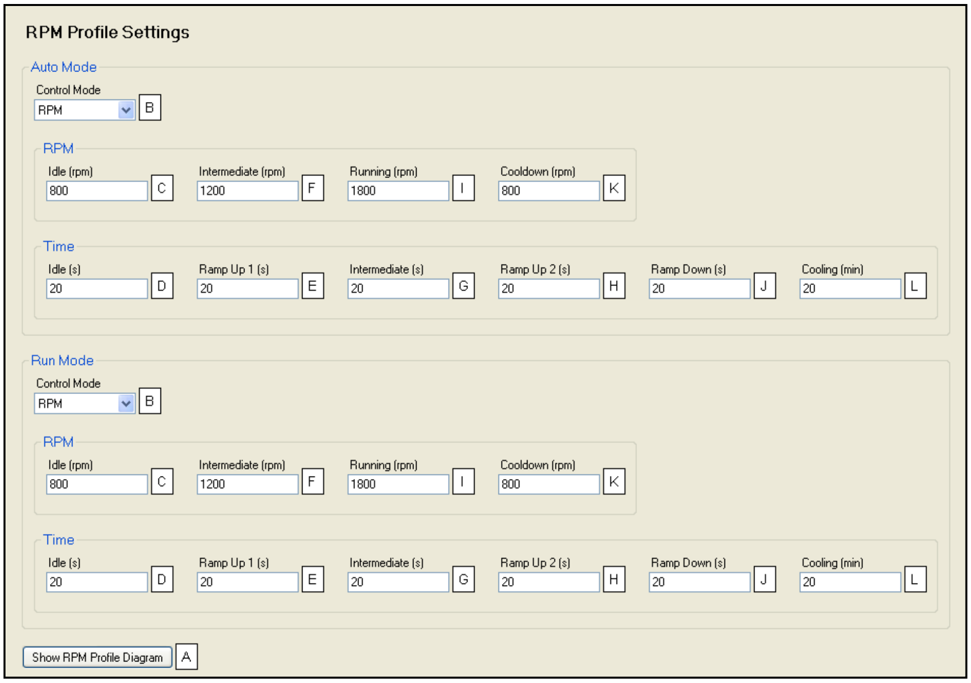


Figure 4-25. RPM Profile Settings

[A] *Show RPM Profile Diagram:* Displays the RPM Profile Diagram.
[B] *Control Mode:* RPM or Parameter.
[C] *Idle RPM:* Adjustable from 100 to 4,000 rpm in increments of 1.
[D] *Idle Time:* Adjustable from 0 to 7,200 s in 1 s increments.
[E] *Ramp Up 1 Time:* Adjustable from 0 to 600 s in 1 s increments.
[F] *Intermediate RPM:* Adjustable from 100 to 4,000 rpm in increments of 1.
[G] *Intermediate Time:* Adjustable from 0 to 7,200 s in 1 s increments.
[H] *Ramp Up 2 Time:* 0 to 600 s in 1 s increments.
[I] *Running RPM:* Adjustable from 100 to 4,000 rpm in 1 rpm increments.
[J] *Ramp Down Time:* Adjustable from 0 to 600 s in 1 s increments.
[K] Cooldown RPM: Adjustable from 100 to 4,000 in increments of 1.
[L] *Cooling Time:* Adjustable from 0 to 60 min in 1 min increments.

Seven Day Timer

The seven day timer provides multiple unique timers per day of the week (Sunday, Monday, etc) to automatically exercise the engine. Each timer can be programmed with a start time and a run period. If the unit is in AUTO mode, at the specified time the engine will start and ramp up according to the RPM Profile. After the run period has elapsed, the unit will cool down and stop. Each day of the week: Sunday, Monday, etc, has eight unique timers which can be set independently, totaling 56 timers overall. This function is similar to the existing Exercise Timer, but allows 8 independent timers per day of the week.

The starting time is expressed as start hour[A] and minutes[B], which specifies the local clock time to start the engine. The run period is expressed as hours[C] and minutes[D]. The total running time is Run Period Hours plus Run Period Minutes. There is no disable setting for any timer. In order to disable a timer, the Run Period Hours and Run Period Minutes settings must both be set to 0.

Timers may overlap into the following day. For example, a timer set on Sunday may run until the following Monday if the run period setting allows for it. Timers may overlap in time. The engine will run as soon as any timer run period is entered, and will continue to run until all timer run periods have elapsed. For example, with a timer set to run for 1 hour from 12:30 am to 1:30 am and a timer to set for 1 hour from 1:00 am to 2:00 am, the engine will run continuously for an hour and a half from 12:30 am to 2:00 am.

A single logic element, TESTINHIBIT, can be driven to inhibit all timers from starting the engine. This is the same logic element that will also prevent the Exercise Timer from starting the engine. If TESTINHIBIT is not driven, the unit must be in AUTO mode for a timer to start the engine.

Several status points are available as inputs to logic that are driven high whenever a timer is active. To prevent requiring 56 unique status inputs, there are only status inputs for when a timer of each day of the week is active and for when a timer number is active. Thus, there are “Sunday Timer Active”, “Monday

Timer Active", etc, input points and "Timer 1 Active", "Timer 2 Active", etc, input points. If logic for a specific timer on a specific day is required it can be created using these points along with discrete logic gates. If multiple timers are active simultaneously their statuses will all be true in logic simultaneously.

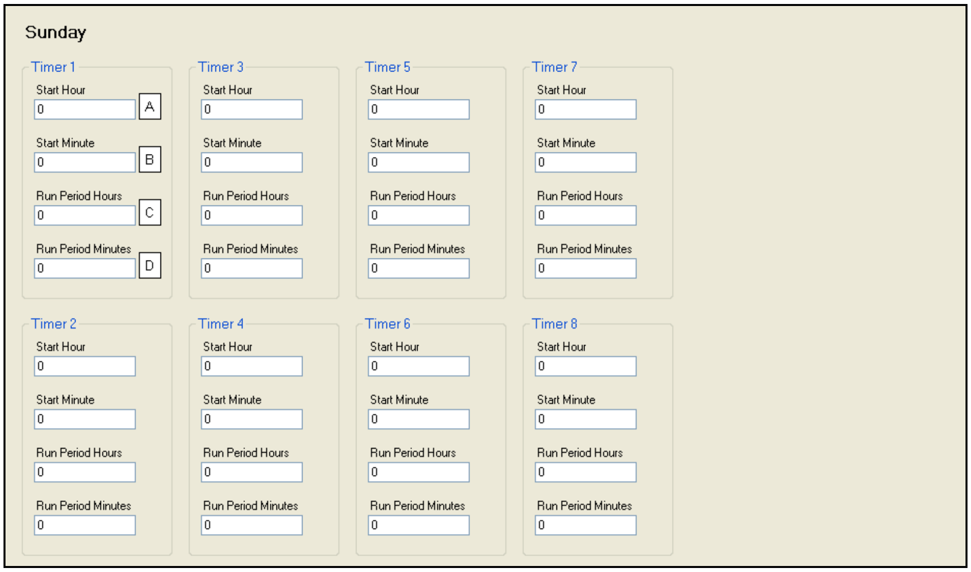


Figure 4-26. Seven Day Timer (Sunday Shown)

[A] *Start Hour:* Adjustable from 0 to 23 in increments of 1.
[B] *Start Minute:* Adjustable from 0 to 59 in increments of 1.
[C] *Run Period Hours:* Adjustable from 0 to 23 in increments of 1.
[D] *Run Period Minutes:* Adjustable from 0 to 59 in increments of 1.

System Settings

The following settings are used to configure the IEM-2020 for operation with a specific engine application.

When enabled, Speed Control[A] allows RPM and raise/lower requests to be sent from the IEM-2020 to the engine.

Engine Speed Measurement

The IEM-2020 detects engine speed from a magnetic pickup (MPU).

The IEM-2020 uses the nominal rpm rating[B] and the number of flywheel teeth[C] when calculating engine rpm. The Max Engine RPM setting[D] specifies the maximum rpm at which the engine can operate. The Min Engine RPM setting[E] specifies the minimum rpm at which the engine can operate.

Measurement/Metering Units

The user can configure the IEM-2020 to display and report engine oil pressure and coolant temperature in English or metric units of measure[F]. Engine oil pressure has an additional parameter[G] for Metric Pressure Units.

Battery Voltage

The nominal voltage[H] of the starter battery is used by the IEM-2020 to detect and annunciate battery overvoltage and low or weak battery voltage.

Fuel Level Function

This setting[I] allows the selection of four fuel types: Fuel Lvl, Natural Gas, Liquid Propane, or Disabled. Selecting a fuel type other than Fuel Lvl will disable any fuel level indication, alarm, and pre-alarm and disable the Fuel Level value on the Engine screen of the Metering Explorer in BESTCOMS*Plus*.

Power Up Delay

In some cases, the ECU takes longer than the IEM-2020 to power up. The power up delay setting[J] is used to delay the initial pulsing of the ECU for data on IEM-2020 power up.

The BESTCOMS*Plus* System Settings screen is illustrated in Figure 4-27.

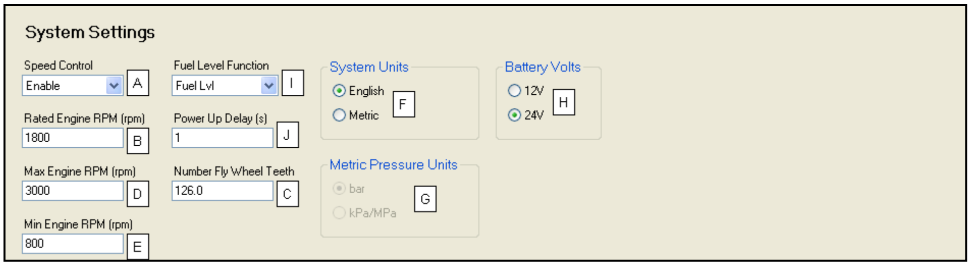


Figure 4-27. System Settings

[A] *Speed Control:* Enable or Disable.
[B] *Rated Engine RPM:* Adjustable from 750 to 4,000 rpm in 1 rpm increments.
[C] *Number Fly Wheel Teeth:* Adjustable from 1 to 500 in increments of 0.1.
[D] *Max Engine RPM:* Adjustable from 0 to 4,000 rpm in 1 rpm increments.
[E] *Min Engine RPM:* Adjustable from 0 to 4,000 rpm in 1 rpm increments.
[F] *System Units:* English or Metric.
[G] *Metric Pressure Units:* bar or kPa/MPa.
[H] *Battery Volts:* 12 or 24 Vdc.
[I] *Fuel Level Function:* Disable, Fuel Lvl, Natural Gas, or Liquid Propane.
[J] *Power Up Delay:* Adjustable from 0 to 60 s in 1 s increments.

Remote Module Setup

The following settings are used to configure the LSM-2020, CEM-2020, and AEM-2020.

Load Sharing Module

A J1939 Address[A] must be entered when an optional LSM-2020 is enabled[B].

Contact Expansion Module

A J1939 Address[C] must be entered when the optional CEM-2020 is enabled[D]. Select number of CEM-2020 outputs[E].

Analog Expansion Module

A J1939 Address[F] must be entered when the optional AEM-2020 is enabled[G].

The BESTCOMS*Plus* Remote Module Setup screen is illustrated in Figure 4-28.

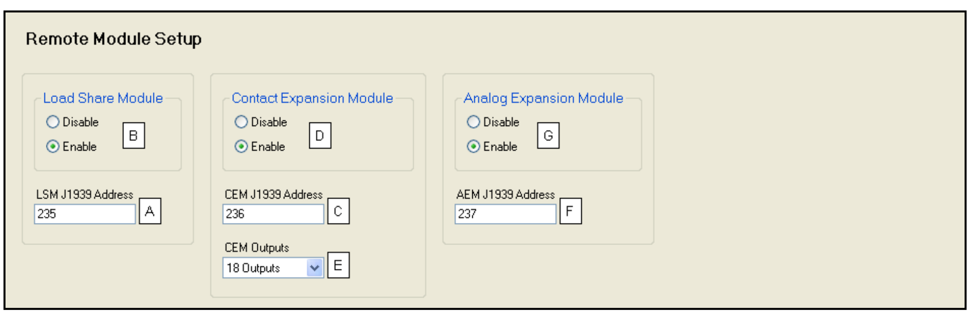


Figure 4-28. Remote Module Setup

[A] *LSM J1939 Address:* Adjustable from 1 to 253 in increments of 1.
[B] *Load Share Module:* Enable or Disable.
[C] *CEM J1939 Address:* Adjustable from 1 to 253 in increments of 1.
[D] *Contact Expansion Module:* Enable or Disable.
[E] *CEM Outputs:* 18 Outputs or 24 Outputs.
[F] *AEM J1939 Address:* Adjustable from 1 to 253 in increments of 1.
[G] *Analog Expansion Module:* Enable or Disable.

Crank Settings

The IEM-2020 can be programmed for either cycle or continuous engine cranking[A]. Cycle cranking provides multiple engine starting attempts[B]. Each starting attempt consists of a fixed interval of engine cranking[C] followed by a rest interval of the same duration. Continuous cranking[D] provides a single, extended engine-starting attempt.

The IEM-2020 uses the engine speed signal (supplied by a magnetic pickup (MPU)) and the Crank Disconnect Limit setting[E] to detect engine startup (and determine when engine cranking can be stopped). The Crank Disconnect Limit setting is expressed as a percentage of the nominal engine speed.

If desired, cycle or continuous cranking can be delayed after initiating engine startup. During this delay[F], the Pre-Start output closes to energize the engine glow plugs or pre-start lubrication pump. The Pre-Start output can be configured to open upon the conclusion of engine cranking or remain closed as long as the engine is running[G].

The Pre-Start can be configured[H] during the resting state. If Preheat Before Crank is selected, the Pre-Start output will be closed for a time equal to the Pre-crank delay time prior to re-entering the cranking state. If the Pre-crank delay setting is longer than the rest interval, the Pre-Start output will be closed for the entire rest time.

Under normal operation, engine rpm is used to determine crank disconnect. The Oil Pressure Crank Disconnect[I] provides a secondary indication that the engine is running so that the starter will be disconnected even if no engine rpm sources are functioning. When enabled, oil pressure is used as a check of whether the engine is running. If the engine oil pressure is above the threshold[J], the starter will be disconnected from the engine.

The BESTCOMS*Plus* Crank Settings screen is illustrated in Figure 4-29.

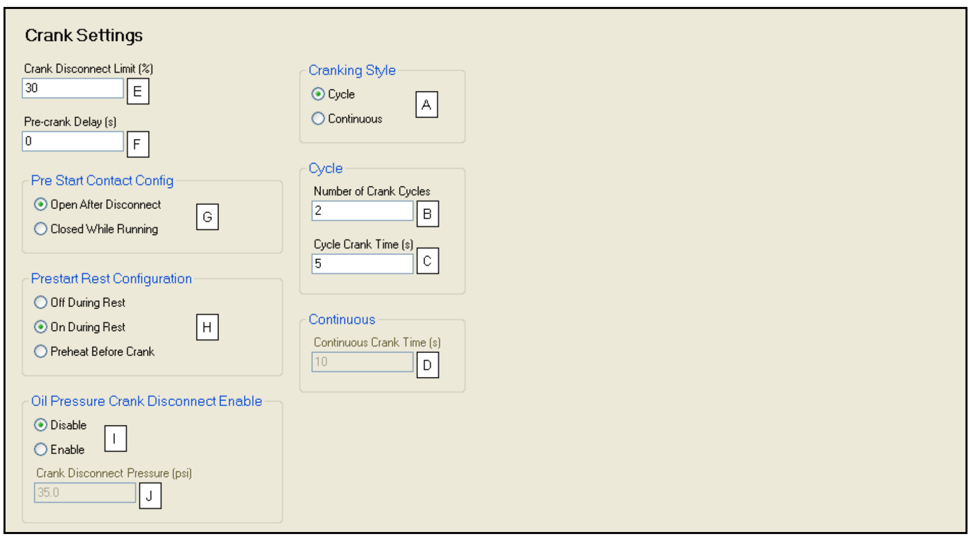


Figure 4-29. Crank Settings

[A] *Cranking Style*: Cycle or Continuous.
[B] *Number of Crank Cycles*: Adjustable from 1 to 7 cycles in 1 cycle increments.
[C] *Cycle Crank Time*: Adjustable over the range of 5 to 15 s in 1 s increments.
[D] *Continuous Crank Time*: Adjustable from 5 to 60 s in 1 s increments.
[E] *Crank Disconnect Limit*: Adjustable from 10 to 100% of nominal engine speed.
[F] *Pre-Crank Delay*: Adjustable from 0 to 30 s in 1 s increments.
[G] *Pre-Start Contact Configuration*: Open After Disconnect or Closed While Running.
[H] *Prestart Rest Configuration:* Off During Rest, On During Rest, or Preheat Before Crank.
[I] *Oil Pressure Crank Disconnect Enable:* Disable or Enable.
[J] *Crank Disconnect Pressure:* Adjustable from 3 to 150 psi in increments of 1 psi.

Automatic Restart

If the IEM-2020 has shut down due to an alarm condition, the automatic restart, when enabled[A], will automatically clear alarms. An attempt to restart the engine is made after a predetermined time delay[B] if the Auto Start contact input is closed. If an Auto Start contact is not present, the unit will remain in READY state with its alarms cleared. A restart will not be attempted if a low fuel alarm or emergency stop is present. The number of restart attempts[C] is programmable. Automatic restart attempts are recorded in the event log.

The BESTCOMS*Plus* Automatic Restart screen is illustrated in Figure 4-30.

Figure 4-30. Automatic Restart

A *Auto Restart Enable:* Enable or Disable.
B *Auto Restart Interval:* Adjustable from 0.5 to 30 min in 0.5 min increments.
C *Auto Restart Attempts:* Adjustable from 1 to 10 in increments of 1.

Exercise Timer

The exercise timer is used to start the engine at a predetermined time and run for the user-defined period. The mode[A] defines how often the engine will run. If monthly is selected, you must select the day of the month[B] to start. If weekly is selected, you must select the day of the week[C] to start. Settings for Start Hour[D] and Start Minutes[E] may also be defined. The Run Period Hours[F] and Minutes[G] define how long the engine will run each time.

Contact inputs and outputs can be assigned to the function. Refer to Section 5, *BESTlogicPlus Programmable Logic,* for more information.

The BESTCOMS*Plus* Exercise Timer screen is illustrated in Figure 4-31.

Figure 4-31. Exercise Timer

A *Mode:* Monthly, Weekly, or Daily.
B *Start Day Of Month:* Adjustable from 1 to 31 in increments of 1.
C *Start Day Of Week:* Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday.
D *Start Hour:* Adjustable from 0 to 23 in increments of 1.
E *Start Minute:* Adjustable from 0 to 59 in increments of 1.
F *Run Period Hours:* Adjustable from 0 to 23 in increments of 1.
G *Run Period Minutes:* Adjustable from 0 to 59 in increments of 1.

Relay Control

The default operational setting for the Start[A], Run[B], and Prestart[C] relays is “Predefined” or standard. Any of these relays can be logic driven by selecting the “Programmable” setting. Logic driven (programmable) relays must be set up using BESTlogic*Plus*.

The BESTCOMS*Plus* Relay Control screen is illustrated in Figure 4-32.

Figure 4-32. Relay Control

A *Start:* Predefined or Programmable.
B *Run:* Predefined or Programmable.
C *Prestart:* Predefined or Programmable.

Programmable Inputs

IEM-2020 programmable inputs can be assigned to trigger various functions and, when triggered, annunciate an alarm or pre-alarm. A user-assigned label can be assigned to each input to make identification easier. The description of these settings is organized as follows:

- Contact Inputs
- Local Analog Inputs
- Programmable Functions
- Remote LSM Inputs (Available with an optional LSM-2020 (Load Share Module).
- Remote Contact Inputs (Available with an optional CEM-2020 (Contact Expansion Module).
- Remote Analog Inputs (Available with an optional AEM-2020 (Analog Expansion Module).
- Remote RTD Inputs (Available with an optional AEM-2020 (Analog Expansion Module).
- Remote Thermocouple Inputs (Available with an optional AEM-2020 (Analog Expansion Module).

Contact Inputs

Each of the 16 contact inputs can be independently configured to annunciate an alarm or pre-alarm[A] when the input senses a contact closure. A user-adjustable time delay[B] can be set to delay generation of an alarm or pre-alarm when the input is configured as an alarm or pre-alarm. The status of the input is available immediately for BESTlogic*Plus* and on the Contact Inputs status screen on the front panel or in BESTCOMS*Plus*. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

To make identifying the contact inputs easier, a user-assigned name[C] can be given to each input.

Contacts can be recognized[D] always or while the engine is running only.

The contact inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Contact input status is available in BESTlogic*Plus* Programmable Logic when “None” is selected for Alarm Configuration.

The BESTCOMS*Plus* Contact Inputs screen is illustrated in Figure 4-33.

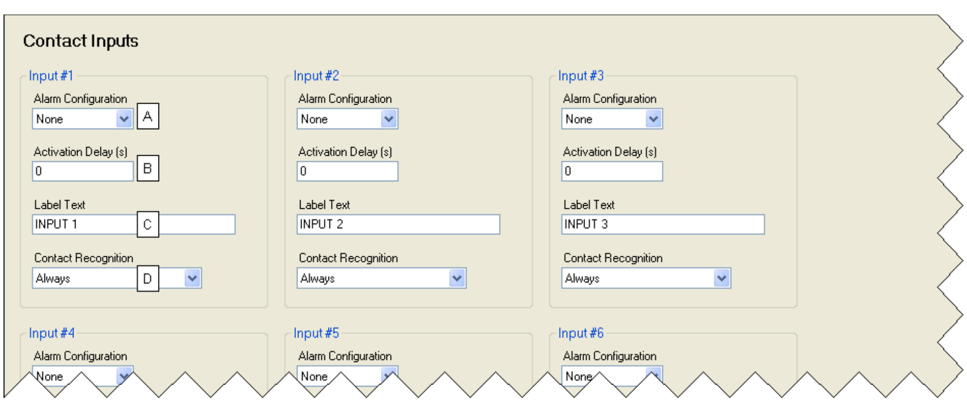


Figure 4-33. Contact Inputs

[A] *Alarm Configuration:* None, Alarm, or Pre-Alarm.
[B] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
[C] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[D] *Contact Recognition:* Always or While Engine Running Only.

Local Analog Inputs

The IEM-2020 has two analog inputs as described below. Additional analog inputs can be accommodated with an AEM-2020 (Analog Expansion Module).

Local Voltage Input

A user-assigned name[A] can be given to make identifying the voltage analog input easier. Enter the amount of hysteresis[B].

The voltage analog input is always monitored and its status is displayed on the appropriate metering screen. A user-adjustable arming delay[C] allows configuration of the voltage analog input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm[D] alerts the user of an open or damaged analog input wire.

Param Min[E] correlates to Min Input Voltage[F] and Param Max[G] correlates to Max Input Voltage[H].

The voltage analog input can be configured to annunciate an alarm, pre-alarm, or status only[I] when the voltage analog input signal falls beyond the threshold[J]. A user-adjustable activation delay[K] setting delays alarm annunciation after the threshold has been exceeded.

The voltage analog input is incorporated into a BESTlogic*Plus* programmable logic scheme by selecting it from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The voltage analog input is disabled when Alarm Configuration is set to "None". The voltage analog input status is available in BESTlogic*Plus* Programmable Logic when "Status Only" is selected.

The BESTCOMS*Plus* Local Voltage Input screen is illustrated in Figure 4-34.

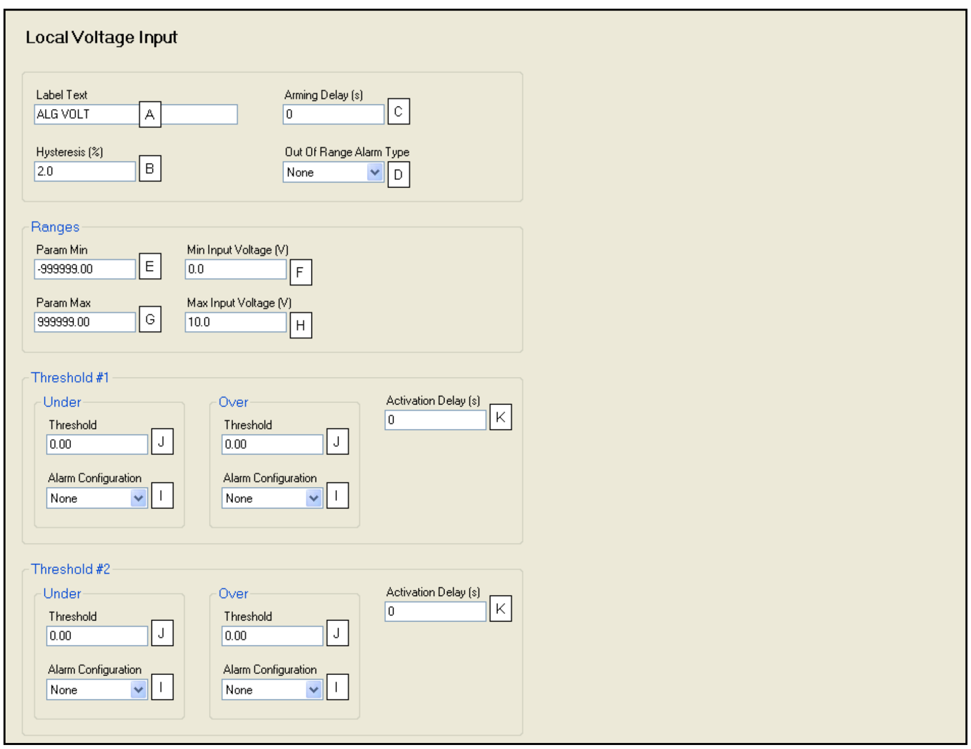


Figure 4-34. Local Voltage Input

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.

[B] *Hysteresis:* Adjustable from 0 to 100% in increments of 0.1%.
[C] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[D] *Out of Range Alarm Type:* None, Alarm, Pre-Alarm, or Status Only.
[E] *Param Min:* –9999.0 to +9999.0 in increments of 0.1.
[F] *Min Input Voltage:* Adjustable from 0 to 10 V in 1 V increments.
[G] *Parm Max:* –9999.0 to +9999.0 in increments of 0.1.
[H] *Max Input Voltage:* Adjustable from 0 to 10 V in 1 V increments.
[I] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[J] *Threshold:* –9999.0 to +9999.0 in increments of 0.1.
[K] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Local Current Input

A user-assigned name[A] can be given to make identifying the current analog input easier. Enter the amount of hysteresis[B].

The current analog input is always monitored and its status is displayed on the appropriate metering screen. A user-adjustable arming delay[C] allows configuration of the current analog input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm[D] alerts the user of an open or damaged analog input wire.

Param Min[E] correlates to Min Input Current[F] and Param Max[G] correlates to Max Input Current[H].

The current analog input can be configured to annunciate an alarm, pre-alarm, or status only[I] when the current analog input signal falls beyond the threshold[J]. A user-adjustable activation delay[K] setting delays alarm annunciation after the threshold has been exceeded.

The current analog input is incorporated into a BESTlogic*Plus* programmable logic scheme by selecting it from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The current analog input is disabled when Alarm Configuration is set to “None”. The current analog input status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Local Current Input screen is illustrated in Figure 4-35.

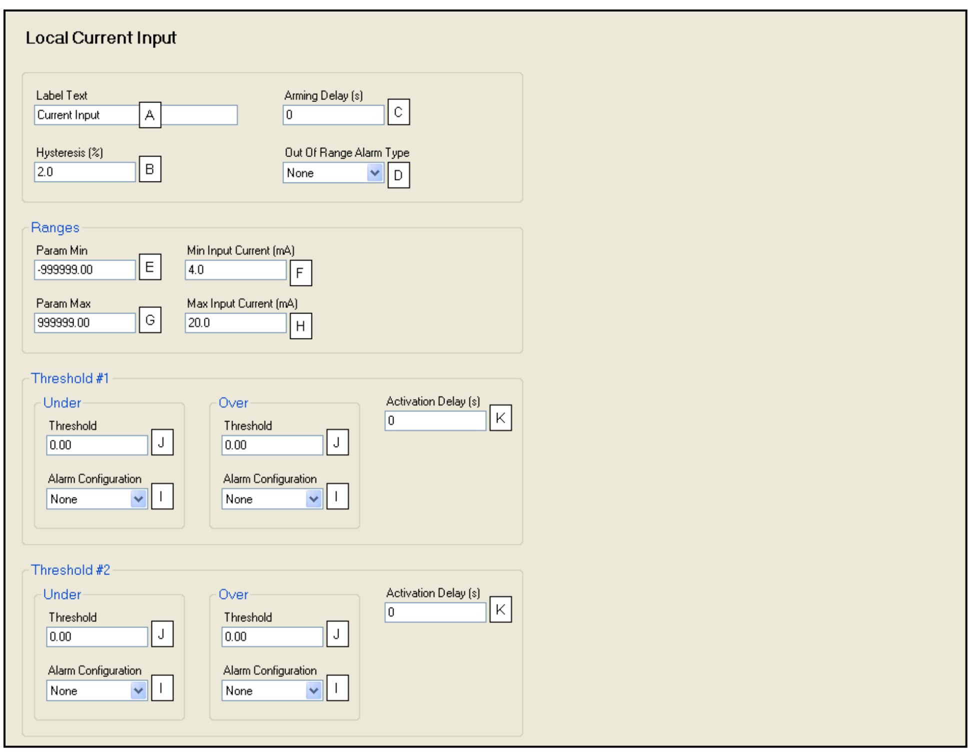


Figure 4-35. Local Current Input

A *Label Text:* An alphanumeric character string with a maximum of 16 characters.
B *Hysteresis:* Adjustable from 0 to 100% in increments of 0.1%.
C *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
D *Out of Range Alarm Type:* None, Alarm, Pre-Alarm, or Status Only.
E *Param Min:* –9999.0 to +9999.0 in increments of 0.1.
F *Min Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
G *Parm Max:* –9999.0 to +9999.0 in increments of 0.1.
H *Max Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
I *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
J *Threshold:* –9999.0 to +9999.0 in increments of 0.1.
K *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Programmable Functions

Any of the 16 contact inputs can be programmed to recognize any one of five function types:

- Auto Start[A] - Automatically starts the engine.
- Battle Override[B] - The alarms programmed to shut down the unit will be overridden and ignored.
- Battery Charger Fail[C] - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Low Coolant Level[D] - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Fuel Leak Detect[E] - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.

An Alarm Configuration setting of “None” prevents a function from being triggered by a contact input. Programmable function status is available in BESTlogic*Plus* Programmable Logic when “None” is selected.

The BESTCOMS*Plus* Programmable Functions screen is illustrated in Figure 4-36.

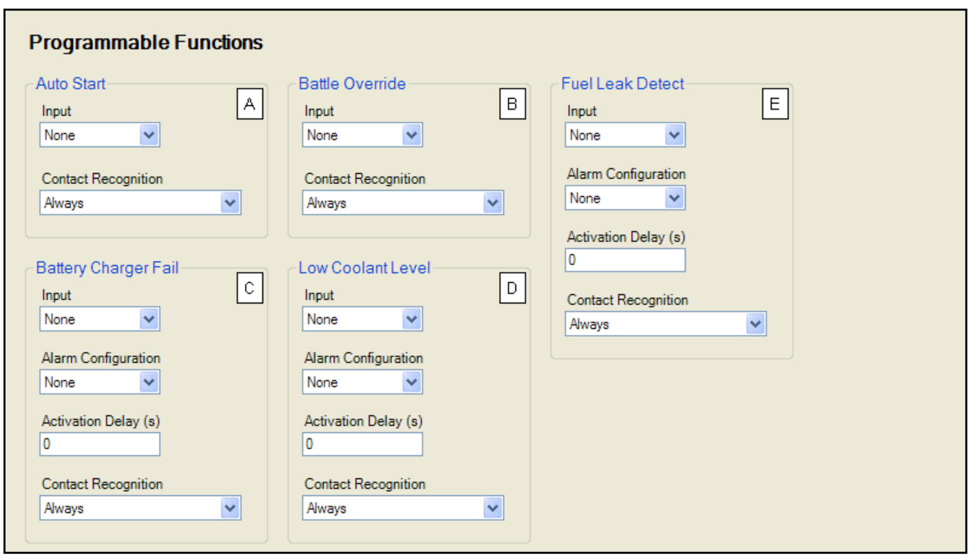


Figure 4-36. Programmable Functions

A *Auto Start:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
B *Battle Override:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
C *Battery Charger Fail:* Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 in increments of 1), and Contact Recognition (Always or While Engine Running Only).
D *Low Coolant Level:* Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 in increments of 1), and Contact Recognition (Always or While Engine Running Only).
E *Fuel Leak Detect:* Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 in increments of 1), and Contact Recognition (Always or While Engine Running Only).

Remote LSM Inputs

An optional LSM-2020 (Load Share Module) provides one configurable[A] analog input.

Ranges must be set for the selected input type. Param Min[B] correlates to Min Input Voltage[C] or Min Input Current[D] and Param Max[E] correlates to Max Input Voltage[F] or Max Input Current[G].

The remote LSM inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMS*Plus* Remote LSM Inputs screen is illustrated in Figure 4-38.

Figure 4-37. Remote LSM Inputs

[A] *Input Type:* Voltage or Current.
[B] *Param Min:* –999,999.00 to +999,999.00 in increments of 0.01.
[C] *Min Input Voltage:* Adjustable from 0 to 10 V in 0.1 V increments.
[D] *Min Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[E] *Parm Max:* –999,999.00 to +999,999.00 in increments of 0.01.
[F] *Max Input Voltage:* Adjustable from 0 to 10 V in 0.1 V increments.
[G] *Max Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.

Remote Contact Inputs

An optional CEM-2020 (Contact Expansion Module) provides 10 contact inputs. Each of the 10 contact inputs can be independently configured to annunciate an alarm or pre-alarm[A] when the input senses a contact closure. A user-adjustable time delay[B] can be set to delay recognition of a contact input. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

To make identifying the contact inputs easier, a user-assigned name[C] can be given to each input.

Contacts can be recognized[D] always or only while the engine is running.

The remote contact inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Remote contact input status is available in BESTlogic*Plus* Programmable Logic when "None" is selected for Alarm Configuration.

The BESTCOMS*Plus* Remote Contact Inputs screen is illustrated in Figure 4-38.

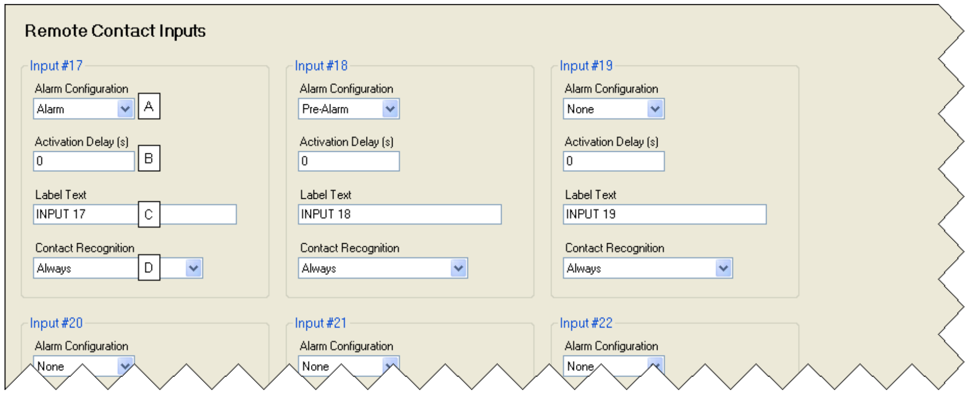


Figure 4-38. Remote Contact Inputs

[A] *Alarm Configuration:* None, Alarm, or Pre-Alarm.
[B] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
[C] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[D] *Contact Recognition:* Always or While Engine Running Only.

Remote Analog Inputs

An optional AEM-2020 (Analog Expansion Module) provides eight analog inputs. To make identifying the analog inputs easier, a user-assigned name[A] can be given to each input.

Select the input type[B] and amount of hysteresis[C]. The analog inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay[D] allows configuration of the analog input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm[E] alerts the user of an open or damaged analog input wire.

Ranges must be set for the selected input type. Param Min[F] correlates to Min Input Current[G] or Min Input Voltage[H] and Param Max[I] correlates to Max Input Current[J] or Max Input Voltage[K].

Each analog input can be independently configured to annunciate an alarm, pre-alarm, or status only[L] when the analog input signal falls beyond the threshold[M]. A user-adjustable activation delay[N] setting delays alarm annunciation after the threshold has been exceeded.

The remote analog inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

A remote analog input is disabled when Alarm Configuration is set to “None”. Remote analog input status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Remote Analog Input #1 screen is illustrated in Figure 4-39.

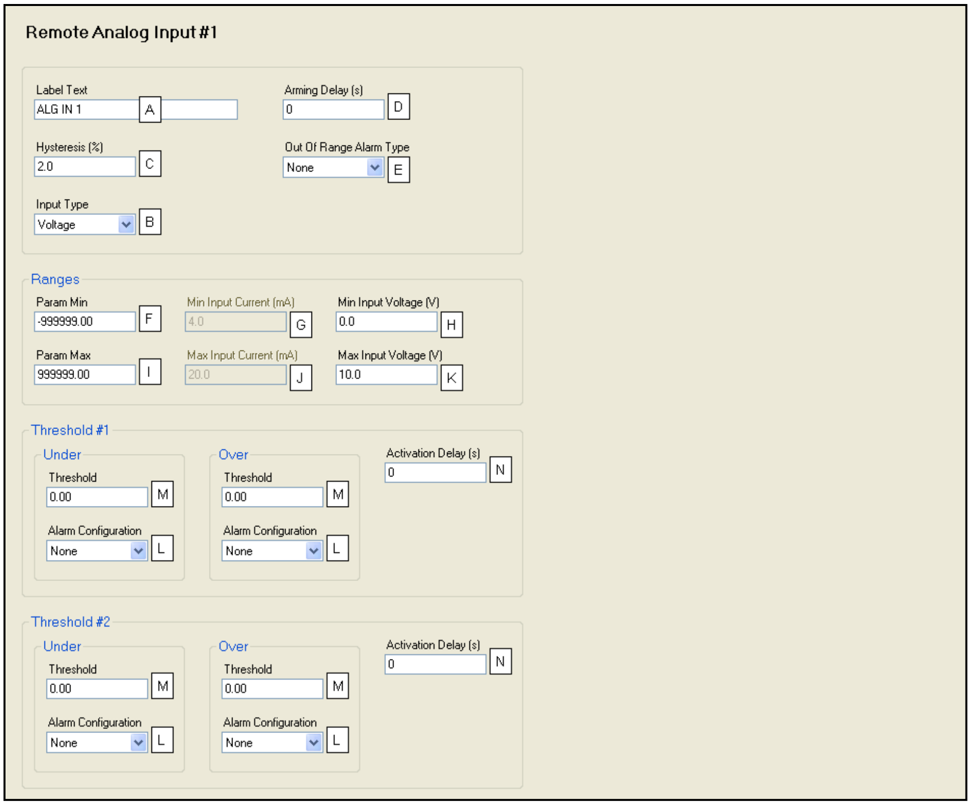


Figure 4-39. Remote Analog Input #1

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Input Type:* Voltage or Current.
[C] *Hysteresis:* Adjustable from 0 to 100% in increments of 0.1%.
[D] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[E] *Out of Range Alarm Type:* None, Alarm, Pre-Alarm, or Status Only.
[F] *Param Min:* –9999.0 to +9999.0 in increments of 0.1.
[G] *Min Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[H] *Min Input Voltage:* Adjustable from 0 to 10 V in 1 V increments.
[I] *Parm Max:* –9999.0 to +9999.0 in increments of 0.1.
[J] *Max Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[K] *Max Input Voltage:* Adjustable from 0 to 10 V in 1 V increments.
[L] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[M] *Threshold:* –9999.0 to +9999.0 in increments of 0.1.
[N] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Remote RTD Inputs

An optional AEM-2020 (Analog Expansion Module) provides eight RTD inputs. To make identifying the RTD inputs easier, a user-assigned name[A] can be given to each input.

Select the amount of hysteresis[B] and RTD type[C]. The RTD inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay[D] allows configuration of the RTD input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm[E] alerts the user of an open or damaged RTD input wire.

Each RTD input can be independently configured to annunciate an alarm, pre-alarm, or status only[F] when the RTD input signal falls beyond the threshold[G]. A user-adjustable activation delay[H] setting delays alarm annunciation after the threshold has been exceeded.

The remote RTD inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

A remote RTD input is disabled when Alarm Configuration is set to “None”. Remote RTD input status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Remote RTD Input #1 screen is illustrated in Figure 4-40.

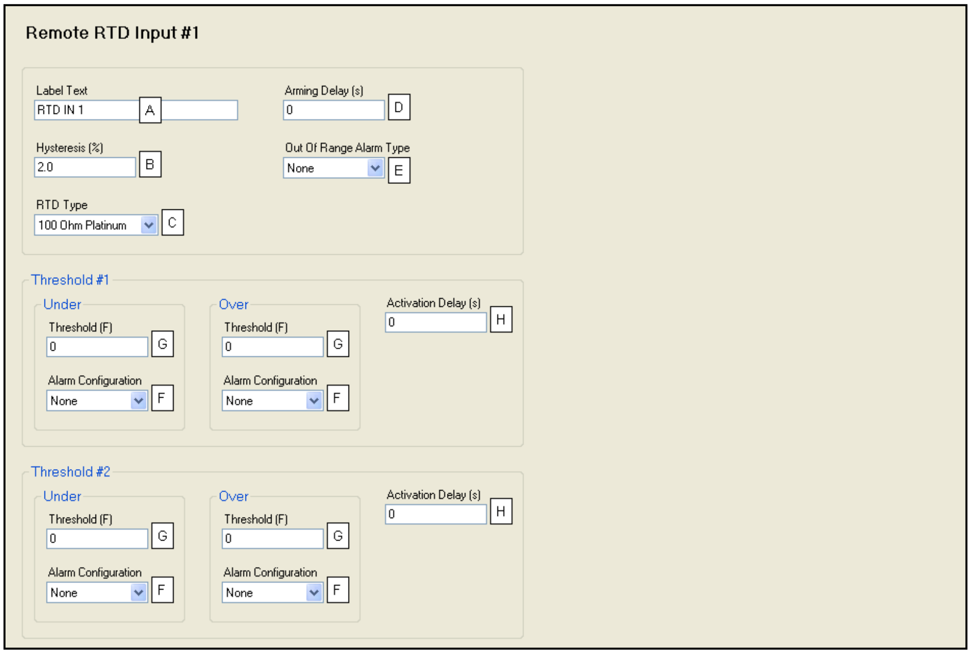


Figure 4-40. Remote RTD Input #1

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Hysteresis:* Adjustable from 0 to 100% in increments of 0.1%.
[C] *RTD Type:* 100 Ohm Platinum or 10 Ohm Copper.
[D] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[E] *Out of Range Alarm Type:* None, Alarm, Pre-Alarm, or Status Only.
[F] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[G] *Threshold:* –58 to +482°F in 1°F increments or –50 to +250°C in 1°C increments.
[H] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Remote Thermocouple Inputs

An optional AEM-2020 (Analog Expansion Module) provides two thermocouple inputs. To make identifying the thermocouple inputs easier, a user-assigned name[A] can be given to each input.

Select the amount of hysteresis[B]. The thermocouple inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay[C] allows configuration of the thermocouple input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete.

Each thermocouple input can be independently configured to annunciate an alarm, pre-alarm, or status only[D] when the thermocouple input signal falls beyond the threshold[E]. A user-adjustable activation delay[F] setting delays alarm annunciation after the threshold has been exceeded.

A remote thermocouple input is disabled when Alarm Configuration is set to “None”.

The remote thermocouple inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Remote thermocouple input status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Remote Thermocouple Input #1 screen is illustrated in Figure 4-41.

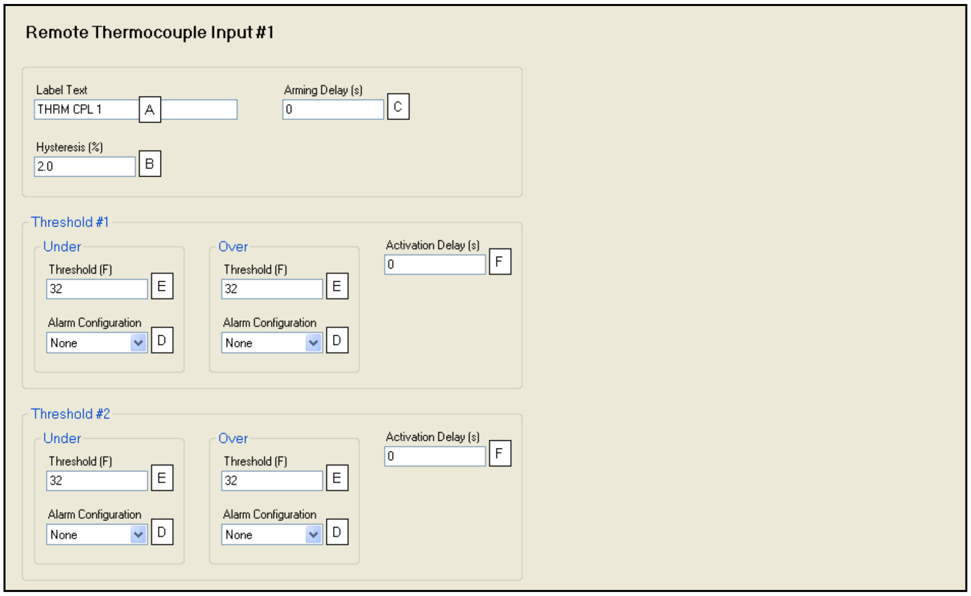


Figure 4-41. Remote Thermocouple Input #1

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Hysteresis:* Adjustable from 0 to 100% in increments of 0.1%.
[C] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[D] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[E] *Threshold:* 32 to 2,507°F in 1°F increments or 0 to 1,375°C in 1°C increments.
[F] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Programmable Outputs

IEM-2020 programmable outputs include four user-programmable contact outputs if the style number is xxAxxxxxx. If the style number is xxBxxxxxx, twelve contact outputs are provided. An additional 24 contact outputs are provided with an optional CEM-2020 (Contact Expansion Module). An optional CEM-2020H (Contact Expansion Module - High Current) provides 18 contact outputs.

Contact Outputs

To make identifying the contact outputs easier, each of the contact outputs can be given a user-assigned name[A].

The contact outputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMS*Plus* Contact Outputs screen is illustrated in Figure 4-42.

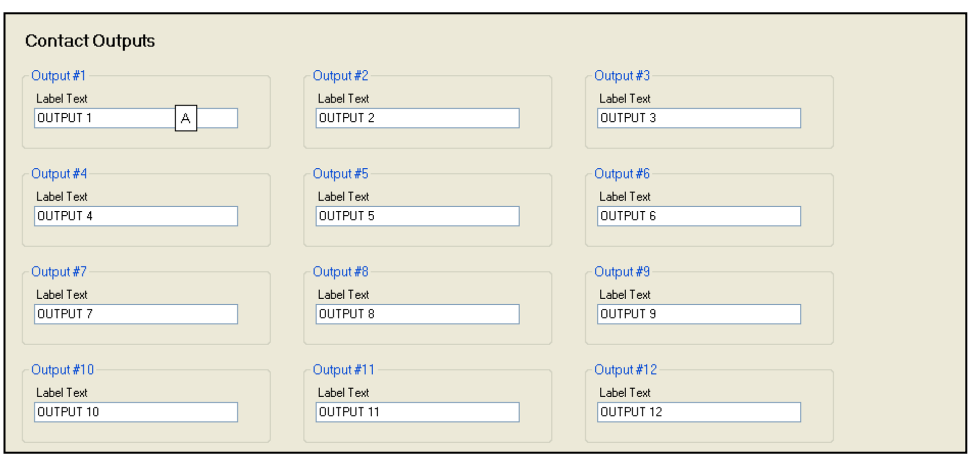


Figure 4-42. Contact Outputs

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.

Configurable Elements

Configurable elements are connected to the logic scheme as outputs. The configurable elements are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *Elements* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*. Each of the eight elements can be independently configured to annunciate an alarm or pre-alarm[A]. A user-adjustable time delay[B] can be set to delay recognition of an element. By default, all elements are configured so that they do not trigger an alarm or pre-alarm. To make identifying the element easier, each of the elements can be given a user-assigned name[C]. If used for an alarm or pre-alarm, the user-assigned name is what will appear in the alarm or pre-alarm annunciation and in the IEM-2020 event log. Elements can be recognized[D] always or only while the engine is running. Configurable element status is available in BESTlogic*Plus* Programmable Logic when "None" is selected for Alarm Configuration. Configurable element status can be used as logic inputs to drive other logic in the program, similar to logic control relays. In addition, the configurable element status can be used to generate modem dial outs which display the user-assigned name on modem equipped IEM-2020s.

The BESTCOMS*Plus* Configurable Elements screen is illustrated in Figure 4-43.

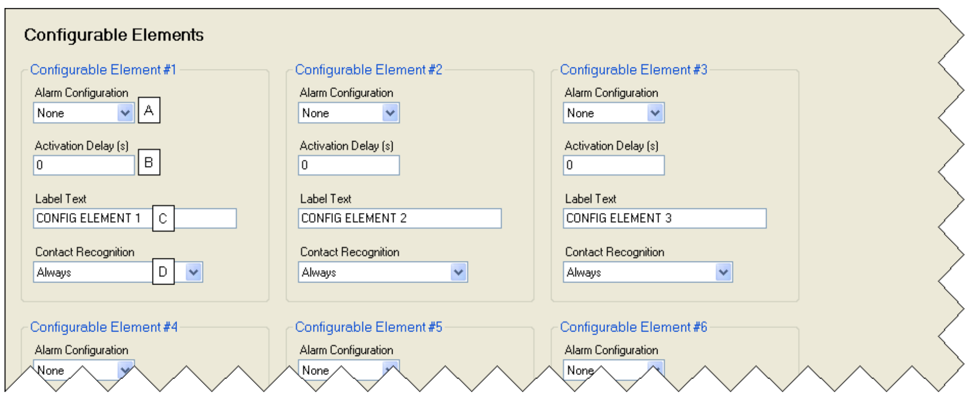


Figure 4-43. Configurable Elements

[A] *Alarm Configuration:* None, Alarm, or Pre-Alarm.
[B] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
[C] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[D] *Contact Recognition:* Always or While Engine Running Only.

Remote Contact Outputs

To make identifying the contact outputs easier, each of the contact outputs can be given a user-assigned name[A].

The remote contact outputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMS*Plus* Remote Contact Outputs screen is illustrated in Figure 4-44.

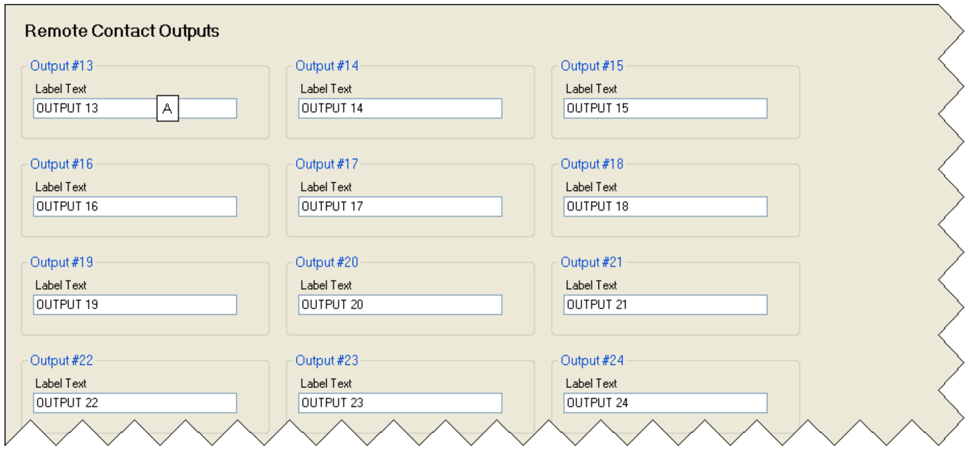


Figure 4-44. Remote Contact Outputs

A *Label Text:* An alphanumeric character string with a maximum of 16 characters.

Remote Analog Outputs

An optional AEM-2020 (Analog Expansion Module) provides four analog outputs.

Make a parameter selection[A] and select the output type[B]. When enabled, an out of range alarm[C] alerts the user of an open or damaged analog output wire. An out of range activation delay[D] setting delays alarm annunciation.

Ranges must be set for the selected output type. Param Min[E] correlates to Min Output Current[F] or Min Output Voltage[G] and Param Max[H] correlates to Max Output Current[I] or Max Output Voltage[J].

A remote analog output is disabled when Alarm Configuration is set to "None". Remote analog output status is available in BESTlogic*Plus* Programmable Logic when "Status Only" is selected.

The remote analog outputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMS*Plus* Remote Analog Output #1 screen is illustrated in Figure 4-45.

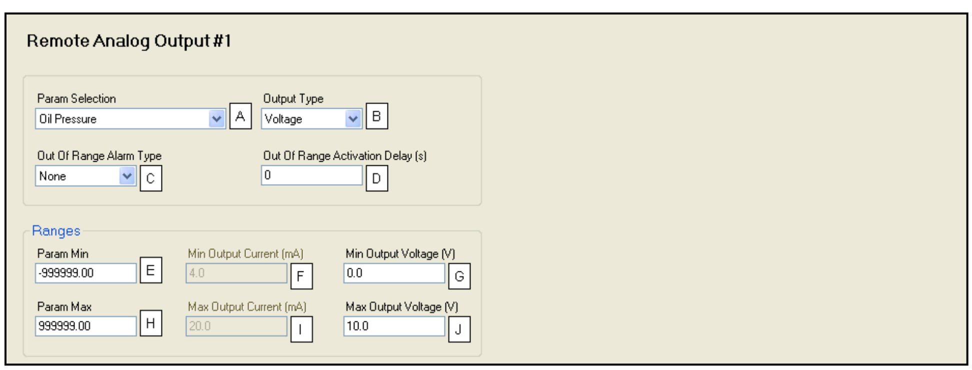


Figure 4-45. Remote Analog Output #1

A *Param Selection:* Oil Pressure, Coolant Temp, Battery Volts, RPM, Fuel Level, Analog Input 1-8, RTD Input 1-8, Thermocouple Input 1-2, Fuel Delivery Pressure, Injector Metering Rail Pressure, Total Fuel Used, Fuel Temperature, Engine Oil Temperature, Engine Intercooler Temperature, Coolant Pressure, Fuel Rate, Boost Pressure, Intake Manifold Temperature, Charge Air Temperature, Engine Percent Load, Voltage Input, or Current Input.
B *Output Type:* Voltage or Current.
C *Out of Range Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
D *Out of Range Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
E *Param Min:* –9999.0 to +9999.0 in increments of 0.1.
F *Min Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
G *Min Output Voltage:* Adjustable from 0 to 10 V in 1 V increments.
H *Parm Max:* –9999.0 to +9999.0 in increments of 0.1.

[I] *Max Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[J] *Max Output Voltage:* Adjustable from 0 to 10 V in 1 V increments.

Configurable Protection

Configurable protection can be used when the standard protection available with the IEM-2020 does not meet the application needs. Eight configurable protection items are provided. To make identifying the items easier, each of the items can be given a user-assigned name[A].

Select a parameter[B] to monitor. A user-adjustable arming delay[C] disables configurable protection during engine startup. If the arming delay is set to zero, the configurable protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the configurable protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed. A setting is provided to adjust the hysteresis[D].

Each configurable protection item can be independently configured to annunciate an alarm, pre-alarm, or status only[E] when the parameter selection falls beyond the threshold[F]. A user-adjustable activation delay[G] setting delays alarm annunciation after the threshold has been exceeded.

Configurable protection is disabled when Alarm Configuration is set to "None".

NOTE

The Arming Delay should <u>not</u> be set to zero if *Oil Pressure* or *Battery Volts* is selected for configurable protection and the threshold alarm configuration is set to *Alarm*. Setting the arming delay to zero will cause an immediate alarm and the engine will not start.

The configurable protection items are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Configurable Protection status is available in BESTlogic*Plus* Programmable Logic when "Status Only" is selected.

The BESTCOMS*Plus* Configurable Protection #1 screen is illustrated in Figure 4-46.

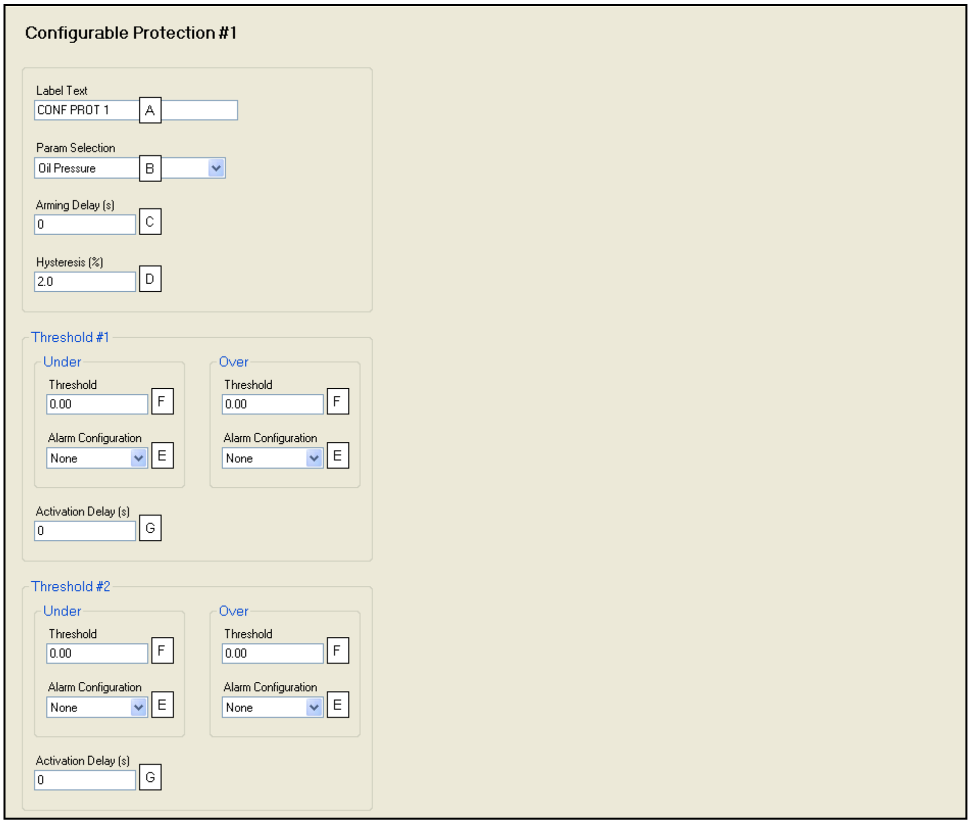


Figure 4-46. Configurable Protection #1

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Param Selection:* Oil Pressure, Coolant Temp, Battery Volts, RPM, Fuel Level, Analog Input 1-8, RTD Input 1-8, Thermocouple Input 1-2, Fuel Delivery Pressure, Injector Metering Rail Pressure, Total Fuel Used, Fuel Temperature, Engine Oil Temperature, Engine Intercooler Temperature, Coolant Pressure, Fuel Rate, Boost Pressure, Intake Manifold Temperature, Charge Air Temperature, Engine Percent Load, Voltage Input, or Current Input.
[C] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[D] *Hysteresis:* Adjustable from 0 to 100% in increments of 0.1%.
[E] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[F] *Threshold:* -999,999 to 999,999 in increments of 0.01.
[G] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Alarm Configuration

IEM-2020 alarms and pre-alarms can be used to annunciate system and engine sender conditions. The description of the alarm configuration settings is organized as follows:

- Horn Configuration
- Pre-Alarms
- Alarms
- Sender Fail

Horn Configuration

Horn

An output contact configured (through programmable logic) to energize a horn[A] can be enabled and disabled through BESTCOMS*Plus* or at the IEM-2020 front panel.

Not In Auto Horn Enable

This setting[B] allows the horn to annunciate when the IEM-2020 is not in auto mode.

Figure 4-47. Horn Configuration

[A] *Horn:* Enable or Disable.
[B] *Not In Auto Horn Enable:* Enable or Disable.

Pre-Alarms

A pre-alarm is annunciated when a condition programmed to trigger a pre-alarm is met. When a pre-alarm condition exists, it is annunciated (flashed) on the LCD, the front panel Alarm indicator flashes on and off and the Horn output (if programmed and enabled) alternates between an energized and de-energized state. The audible alarm is reset by pressing the front panel Alarm Silence pushbutton. When a pre-alarm condition ceases to exist for pre-alarms other than weak battery, all displayed annunciations are reset automatically. A weak battery pre-alarm must be cleared by either pressing the *Reset* button on the front panel or providing an input to the Reset logic element in BESTlogic*Plus*.

Active pre-alarms are displayed on the main display of the LCD. The LCD annunciates an active pre-alarm by alternating the pre-alarm message with the normally displayed data. All pre-alarms are individually displayed, in sequence, by scrolling through the LCD pre-alarms list.

Each IEM-2020 pre-alarm is described in the following paragraphs. Pre-alarms may be enabled and adjusted in BESTCOMS*Plus* or through the front panel HMI.

The BESTCOMS*Plus* Pre-Alarms screen is illustrated in Figure 4-48.

High Fuel Level

High fuel level pre-alarm settings[A] consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a high fuel level pre-alarm occurs when the metered fuel level increases above the threshold setting.

Low Battery Voltage

Low battery voltage pre-alarm settings[B] consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a low battery voltage pre-alarm occurs when the battery voltage decreases below the threshold setting for the duration of the activation time delay. The threshold setting range is based on the nominal battery voltage setting on the BESTCOMS*Plus* System Settings tab (IEM-2020, System Parameters, System Settings).

Weak Battery Voltage

Weak battery voltage pre-alarm settings[C] consist of an enable/disable setting, a threshold setting, and an activation time delay. If enabled, a weak battery voltage pre-alarm latches during engine cranking when the battery voltage decreases below the threshold setting for the duration of the activation delay. The threshold setting range is based on the nominal battery voltage setting on the BESTCOMS*Plus* System Settings tab (IEM-2020, System Parameters, System Settings).

A weak battery pre-alarm condition is reset through the front panel by navigating to the *Alarms-Status, Pre-Alarms* screen, scrolling through the list of pre-alarms until “Weak Battery” is displayed, and pressing the *Reset* key.

Battery Overvoltage

Battery overvoltage pre-alarm settings[D] consist of an enable/disable setting and a fixed threshold setting. If enabled, a battery overvoltage pre-alarm occurs when the battery voltage increases above the threshold setting for a fixed duration of two seconds.

Maintenance Interval

Maintenance interval pre-alarm settings[E] consist of an enable/disable setting and a threshold setting. If enabled, a maintenance interval pre-alarm is annunciated when the IEM-2020 maintenance timer counts down to zero from the threshold time setting. The maintenance interval pre-alarm can be reset through the IEM-2020 front panel or by using BESTCOMS*Plus*.

To reset the maintenance interval pre-alarm through the IEM-2020 front panel, navigate to the SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS > MAINT RESET screen. Operator, Settings, or OEM access level is required to reset the maintenance interval pre-alarm. If the maintenance interval pre-alarm is not enabled, the MAINT RESET parameter is not visible on the front panel.

To reset the maintenance interval pre-alarm by using BESTCOMS*Plus*, use the Metering Explorer to open the Run Statistics screen and click on the Reset Maintenance Interval button.

Low Fuel Level

Low fuel level pre-alarm settings[F] consist of an enable/disable setting and a threshold setting. If enabled, a low fuel level pre-alarm occurs when the metered fuel level decreases below the threshold setting for a fixed duration of two seconds.

High Coolant Temp

High coolant temperature pre-alarm settings[G] consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature pre-alarm is annunciated when the engine coolant temperature exceeds the threshold setting for a fixed duration of four seconds. The arming delay disables the high coolant temp pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the High Coolant Temp Arming Delay setting.

Low Coolant Temp

Low coolant temperature pre-alarm settings[H] consist of an enable/disable setting and a threshold setting. If enabled, a low coolant temperature pre-alarm occurs when the engine coolant temperature decreases below the threshold setting for a fixed duration of four seconds.

Low Coolant Level

Low coolant level pre-alarm settings[I] consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level pre-alarm occurs when the metered coolant level decreases below the threshold setting for a fixed duration of two seconds.

Low Oil Pressure

Low oil pressure pre-alarm settings[J] consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is triggered when the engine oil pressure decreases below the threshold setting for a fixed duration of two seconds. The arming delay disables the low oil pressure pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the Low Oil Pressure Alarm Arming Delay setting. System units and metric pressure units are configured on the System Settings screen.

ECU Coms Fail

ECU communication failure pre-alarm settings[K] consist of a single enable/disable setting. If enabled, an ECU communication failure pre-alarm is annunciated when the IEM-2020 detects a communication problem in the J1939 interface linking the IEM-2020 with the ECU (engine control unit).

Active DTC

Active DTC (diagnostic trouble code) pre-alarm settings[L] consist of a single enable/disable setting. If CAN and DTC support are both enabled, an “active DTC” pre-alarm may be enabled to announce the presence of a condition that is causing a DTC to be sent from the ECU to the IEM-2020.

LSM Comm Failure

LSM-2020 communication failure pre-alarm settings[M] consist of a single enable/disable setting. If enabled, an LSM-2020 communication failure pre-alarm is annunciated when communication between an optional LSM-2020 and IEM-2020 is lost.

CEM Comm Failure

CEM-2020 communication failure pre-alarm settings[N] consist of a single enable/disable setting. If enabled, a CEM-2020 communication failure pre-alarm is annunciated when communication between an optional CEM-2020 and IEM-2020 is lost.

AEM Comm Failure

AEM-2020 communication failure pre-alarm settings[O] consist of a single enable/disable setting. If enabled, an AEM-2020 communication failure pre-alarm is annunciated when communication between an optional AEM-2020 and IEM-2020 is lost.

Checksum Failure

The checksum failure pre-alarm will occur whenever one of the internal checksum calculations used for data integrity purposes has failed. This indicates that some of the user settings or firmware code has been corrupted.

The checksum failure pre-alarm can be cleared by pressing the reset button on the front panel. However, the pre-alarm will reoccur the next time the checksum is verified if the data is still corrupted. Some checksum calculations are done only on power up, so this may not occur until the next time the unit's operating power is cycled.

If there are consistent checksum failure pre-alarms, attempt the following actions to correct the problem:

1. Load default settings by holding UP+DOWN on the front panel while cycling power. After loading defaults, upload settings file through BESTCOMS*Plus* if needed.

Caution
Loading default settings will erase all custom settings. All reports and events will be cleared. BESTCOMS*Plus* can be used to download settings and save to a file so that settings can be restored later.

2. If the problem still exists, reload the firmware file with BESTCOMS*Plus*.
3. If the problem still exists, contact Basler Electric Technical Support.

The checksum failure pre-alarm can be disabled with the Checksum Failure pre-alarm enable[P] setting. Disabling this setting disables only the annunciation of the pre-alarm and does not correct any error conditions.

The checksum failure pre-alarm may occur after changing firmware versions through BESTCOMS*Plus*. The checksum failure pre-alarm is not indicative of an error in this case. The pre-alarm can be cleared with the reset button or by cycling power to the unit. If the pre-alarm reoccurs, then the pre-alarm is indicative of an error and corrective action should be attempted as described above.

RPM Limit

RPM Limit pre-alarm settings[Q] consist of a single enable/disable setting. If enabled, an RPM Limit pre-alarm is annunciated when the measured RPM rises above the Max Engine RPM setting or falls below the Min Engine RPM setting on the System Settings screen.

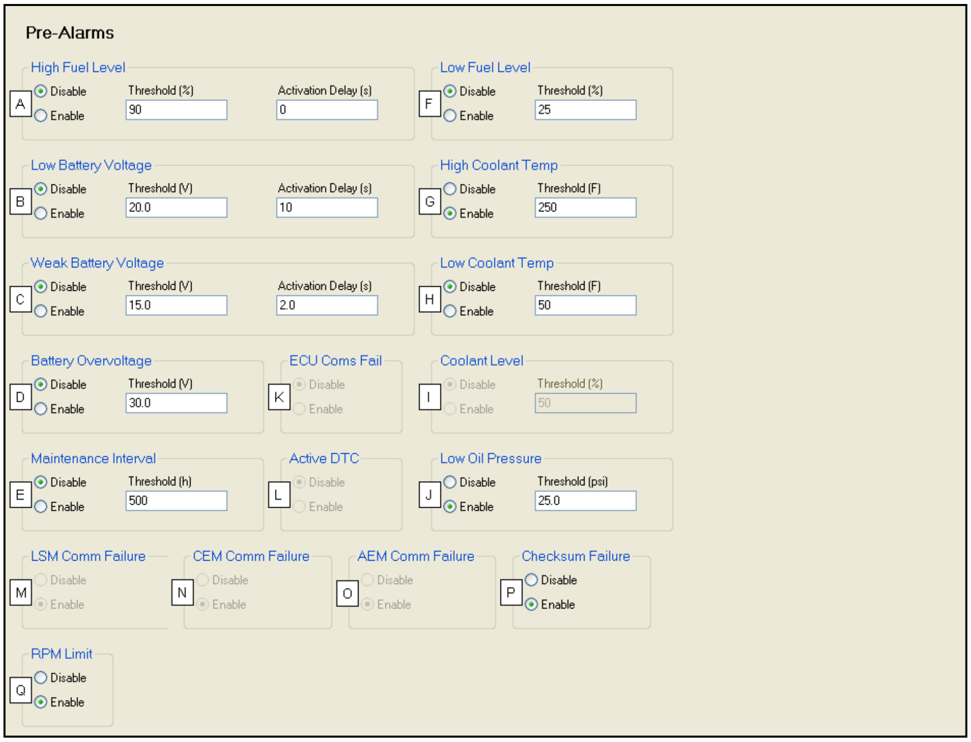


Figure 4-48. Pre-Alarms

[A] *High Fuel Level:* Enable or Disable, threshold is adjustable from 0 to 150% in 1% increments.
[B] *Low Battery Voltage:* Enable or Disable, threshold is adjustable from 6 to 12 Vdc (12 Vdc battery) or 12 to 24 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation delay is adjustable from 1 to 10 s in 1 s increments.
[C] *Weak Battery Voltage:* Enable or Disable, threshold is adjustable from 4 to 8 Vdc (12 Vdc battery) or 8 to 16 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation time delay is adjustable from 1 to 10 s in 1 s increments.
[D] *Battery Overvoltage:* Enable or Disable, threshold is adjustable from 12 to 32 Vdc in 0.1 increments.
[E] *Maintenance Interval:* Enable or Disable, threshold is adjustable from 0 to 5,000 hrs in 1 hr increments.
[F] *Low Fuel Level:* Enable or Disable, threshold is adjustable from 10 to 100% in 1% increments.
[G] *High Coolant Temp:* Enable or Disable, threshold is adjustable from 100 to 280°F or 38 to 138°C in 1° increments. Activation time delay is fixed at 60 s.
[H] *Low Coolant Temp:* Enable or Disable, threshold is adjustable from 35 to 151°F or 2 to 66°C in 1° increments.
[I] *Low Coolant Level:* Enable or Disable, threshold is adjustable from 1 to 99% in 1% increments.
[J] *Low Oil Pressure:* Enable or Disable, threshold is adjustable from 3 to 150 psi or 21 to 1,034 kPa in 7 psi or kPa increments. Activation time delay is fixed at 10 s.
[K] *ECU Coms Fail:* Enable or Disable.
[L] *Active DTC:* Enable or Disable.
[M] *LSM Comm Failure:* Enable or Disable.
[N] *CEM Comm Failure:* Enable or Disable.
[O] *AEM Comm Failure:* Enable or Disable.
[P] *Checksum Failure:* Enable or Disable.
[Q] *RPM Limit:* Enable or Disable.

Alarms

An alarm is annunciated when a condition programmed to trigger an alarm is detected. When an alarm condition exists, the front panel Alarm indicator lights, the Horn output (if programmed and enabled) energizes, and the cause of the alarm is displayed on the front panel LCD. An alarm condition stops the engine by opening the RUN output contact. Alarms are reset when the IEM-2020 is set to Off mode.

Each IEM-2020 alarm is described in the following paragraphs. Alarms may be enabled and adjusted in BESTCOMS*Plus* or through the front panel HMI.

The BESTCOMS*Plus* Alarms screen is illustrated in Figure 4-49.

High Coolant Temperature

High coolant temperature alarm settings[A] consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature alarm is triggered after a fixed four-second delay when the engine coolant temperature exceeds the threshold setting. The arming delay disables the high coolant temperature alarm function for a user-adjustable time during engine startup.

Low Oil Pressure

Low oil pressure alarm settings[B] include an enable/disable setting, an arming time delay, and a threshold setting. If enabled, a low oil pressure alarm is triggered after a fixed two-second delay when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure alarm function for a user-adjustable time during engine startup.

Overspeed

Overspeed alarm settings[C] include an enable/disable setting, an activation delay, and a threshold setting. If enabled, an overspeed alarm occurs when the engine speed (in rpm) exceeds the threshold setting for the duration of the activation time delay.

Low Fuel Level

Low fuel level alarm settings[D] consist of an enable/disable setting, an activation delay setting, and a threshold setting. If enabled, a low fuel level alarm is triggered when the metered fuel level drops below the threshold setting for the duration of the activation time delay.

Low Coolant Level

Low coolant level alarm settings[E] consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level alarm is triggered when the metered coolant drops below the threshold setting for a fixed duration of two seconds.

Note: ECU Support must be enabled on the *Communications, CAN Bus Setup* screen before this alarm can be configured.

Figure 4-49. Alarms

[A] *High Coolant Temp:* Enable or Disable, threshold is adjustable from 100 to 280°F or 38 to 138°C in 1° increments. Arming time delay is adjustable from 0 to 150 in 1 s increments.
[B] *Low Oil Pressure:* Enable or Disable, threshold is adjustable from 3 to 150 psi or 21 to 1,034 kPa in 7 psi or 1 kPa increments. Arming time delay is adjustable from 5 to 60 s in 1 s increments.
[C] *Overspeed:* Enable or Disable, threshold is adjustable from 105 to 140% of the rated engine rpm. Activation time delay is adjustable from 0 to 500 s in 1 s increments.
[D] *Low Fuel Level:* Enable or Disable, threshold is adjustable from 0 to 100% in 1% increments. Activation time delay is adjustable from 0 to 30 in 1 s increments.
[E] *Low Coolant Level:* Enable or Disable, threshold is adjustable from 1 to 99% in 1% increments.

Sender Fail

The IEM-2020 can be configured to annunciate a pre-alarm or alarm when a loss of signal is detected at the coolant temperature[A], oil pressure[B], or fuel level sender[C] input. The speed sender fail[D] alarm is always enabled. A user-adjustable time delay is provided for each sender alarm/pre-alarm.

Alarm and pre-alarm annunciations for loss of engine speed signals is not user-programmable and operates as follows. The MPU (magnetic pickup) is the sole engine speed source. If the MPU fails, an alarm (and shutdown) is triggered.

The BESTCOMS*Plus* Sender Fail screen is illustrated in Figure 4-50.

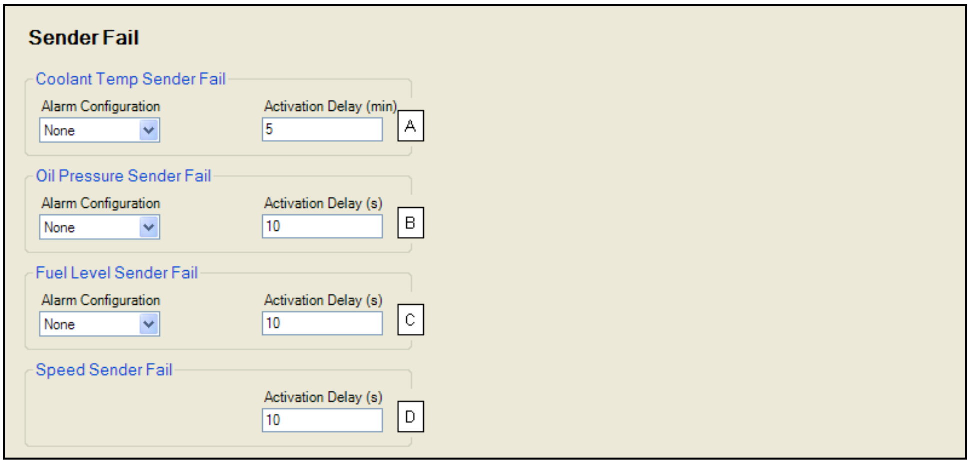


Figure 4-50. Sender Fail

[A] *Coolant Temp Sender Fail:* None, Alarm, or Pre-Alarm, time delay adjustable from 5 to 30 min in 1 min increments.
[B] *Oil Pressure Sender Fail:* None, Alarm or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.
[C] *Fuel Level Sender Fail:* None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.
[D] *Speed Sender Fail:* Time delay adjustable from 0 to 300 s in 1 s increments.

Governor Control Settings

Governor control consists of the following settings:

- Output Type[A] - Specifies how speed control is implemented.
- Contact Type[B] - Type of contact used when *Contact* is selected as the output type.
- Pulse Width[C] - Maximum width of the output pulse.
- Pulse Interval[D] - The pulse interval along with the pulse width specifies how often a new pulse occurs. The total time between pulses is the pulse width plus the pulse interval.
- Max On RPM[E] - RPM difference between requested RPM and actual RPM that results in proportional contact outputs being on with their maximum pulse width.
- RPM Deadband[F] - Maximum difference between the requested RPM and actual RPM.
- Front Panel Up / Down[G] - When enabled and the front panel display on the IEM-2020 is displaying the overview screen, these arrows can be pressed to perform a raise or lower of the operating RPM.
- Parameter Deadband[H] - This setting is provided to prevent excessive speed “hunting” in situations where it is not necessary to correct the measured parameter unless it falls outside of a range around the setpoint.
- Parameter Up / Down Rate[I] - Rate at which the parameter is raised or lowered.
- RPM Up / Down Rate[J] - Rate at which the RPM is raised or lowered.
- RPM Bandwidth[K] - RPM range over which the speed requests can be varied.
- PID Input Source[L] - Specifies the source of the PID input.
- Setpoint Source[M] - Specifies the setpoint source.

- Setpoint[N] - Specifies the setpoint when Setpoint Source is set for *User Setting.*
- Setpoint Analog Max[O] - Specifies the maximum analog setpoint when PID Setpoint Source is set for an analog input.
- Setpoint Analog Min[P] - Specifies the minimum analog setpoint when PID Setpoint Source is set for an analog input.
- Kp Proportional Gain[Q] - Sets the proportional gain of the PID controller.
- Ki Integral Gain[R]- Sets the integral gain of the PID controller.
- Kd Derivative Gain[S] - Sets the derivative gain of the PID controller.
- Td Derivative Filter Constant[T] - Sets the derivative filter constant of the PID controller.
- Kg Loop Gain[U] - Sets the loop gain of the PID controller.

The above settings are explained further in Section 3, *Functional Description, RPM Control.*

The BESTCOMS*Plus* Governor Control Settings screen is illustrated in Figure 4-51.

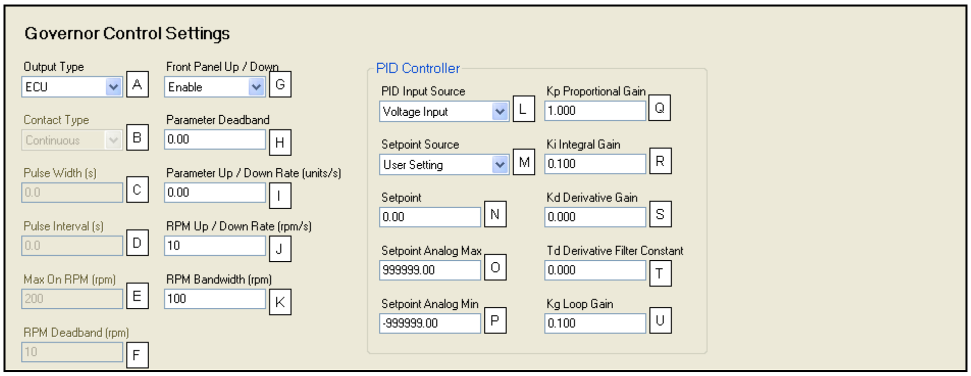


Figure 4-51. Governor Control Settings

[A] *Output Type:* Contact or ECU.
[B] *Contact Type:* Continuous or Proportional.
[C] *Pulse Width:* Adjustable from 0 to 99.9 s in 0.1 s increments.
[D] *Pulse Interval:* Adjustable from 0 to 99.9 s in 0.1 s increments.
[E] *Max On RPM:* Adjustable from 0 to 4,000 rpm in increments of 1.
[F] *RPM Deadband:* Adjustable from 0 to 100 rpm in increments of 1.
[G] *Front Panel Up / Down:* Disable or Enable.
[H] *Parameter Deadband:* Adjustable from 0 to 999,999 in increments of 0.01.
[I] *Parameter Up / Down Rate:* Adjustable from 0 to 999,999 in increments of 0.01.
[J] *RPM Up / Down Rate:* Adjustable from 0 to 4,000 in increments of 1.
[K] *RPM Bandwidth:* Adjustable from 0 to 1,000 in increments of 1.
[L] *PID Input Source:* Voltage Input, Current Input, LSM Analog Input 1, or ALG IN 1-8.
[M] *Setpoint Source:* User Setting, Voltage Input, Current Input, LSM Analog Input 1, or ALG IN 1-8.
[N] *Setpoint:* Adjustable from –999,999 to 999,999 in increments of 1.
[O] *Setpoint Analog Max:* Adjustable from –999,999 to 999,999 in increments of 1.
[P] *Setpoint Analog Min:* Adjustable from –999,999 to 999,999 in increments of 1.
[Q] *Proportional Gain (Kp):* Adjustable from 0 to 1,000 in increments of 0.001.
[R] *Integral Gain (Ki):* Adjustable from 0 to 1,000 in increments of 0.001.
[S] *Derivative Gain (Kd):* Adjustable from 0 to 1,000 in increments of 0.001.
[T] *Derivative Filter Constant (Td):* Adjustable from 0 to 1 in increments of 0.001.
[U] *Loop Gain (Kg):* Adjustable from 0 to 1,000 in increments of 0.001.

Programmable Senders

The sender inputs of the IEM-2020 can be customized to obtain maximum accuracy from the coolant temperature, oil pressure, and fuel level senders.

The characteristic curve of each sender input can be configured with up to 11 points[A]. Each point can be assigned a resistance input value and a corresponding temperature (coolant temperature sender), pressure (oil pressure sender), or percentage (fuel level sender) value. A sender slope setting[B] automatically orders the values in the resistance column according to whether the sender requires a negative or positive slope. Sender curve points are automatically plotted on a curve[C] in BESTCOMS*Plus*, which can be printed[D].

Sender curve points configured in BESTCOMS*Plus* can be saved in the configuration file[E]. The data for all three senders is automatically saved with the IEM-2020 configuration file.

Any changes made in BESTCOMS*Plus* to the sender points, can be reverted to the factory-default values[F]. A new settings file can also be created[G].

The BESTCOMS*Plus* Coolant Temperature programmable sender screen is illustrated in Figure 4-52. (The contents and layout of each BESTCOMS*Plus* programmable sender screen is identical.)

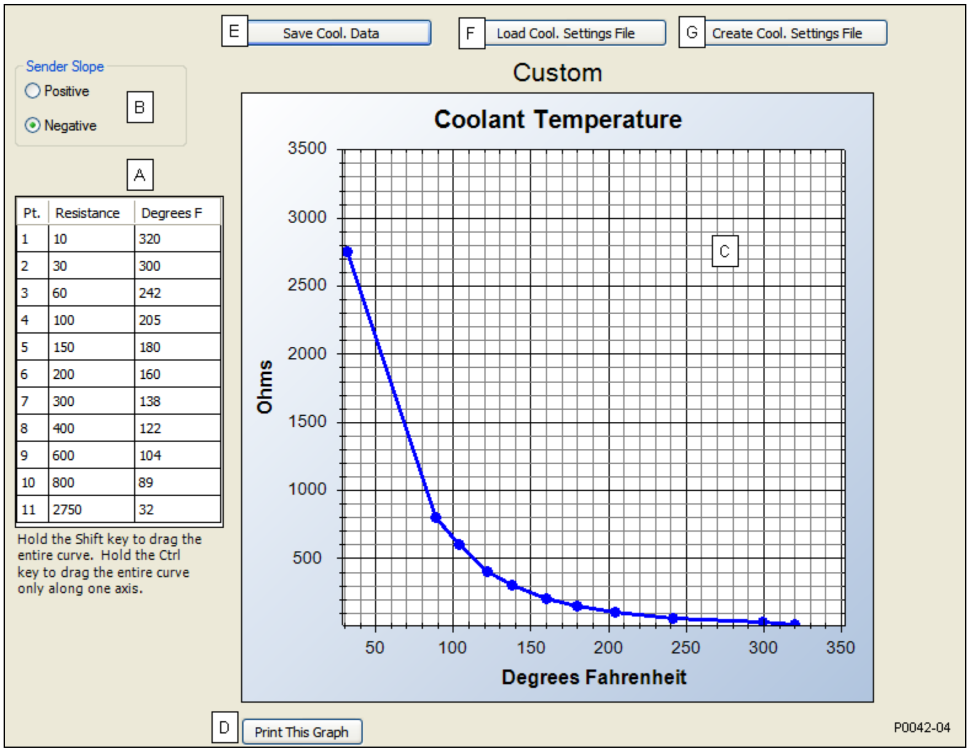


Figure 4-52. Coolant Temperature Sender

[A] *Sender Points:* Accepts up to 11 user-defined sender resistance points.
[B] *Sender Slope:* Positive or Negative causes sender points to be sorted and displayed accordingly.
[C] *Sender Point Curve:* Automatic plot of sender points data.
[D] *Print This Graph:* Click to print sender point curve.
[E] *Save Cool. Data:* Click to save file containing sender point data.
[F] *Load Cool. Settings File:* Click to clear all user-defined sender data and revert to the factory-default values.
[G] *Create Cool. Settings File:* Click to create a new settings file by entering sender point data.

BESTlogicPlus Programmable Logic

BESTlogic*Plus* Programmable Logic is used to set all logic functions in the IEM-2020. For detailed information on using BESTlogic*Plus*, refer to Section 5, *BESTlogicPlus Programmable Logic.*

Logic Timers

Refer to Section 5, *BESTlogicPlus Programmable Logic,* for information on using logic timers.

Settings File Management

A settings file contains all IEM-2020 settings including logic. A settings file assumes a file extension of "∗.bstx". It is possible to save the logic only as a separate logic library file on the *BESTlogicPlus Programmable Logic* screen. This is helpful when similar logic is required for several devices. A logic library file assumes a file extension of "∗.bslx". It is important to note that settings and logic can be uploaded to the device separately or together, but are always downloaded together. For more information on settings file management, refer to Section 3, BESTCOMS*Plus*. For more information on logic files, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Opening a Settings File

To open an IEM-2020 settings file with BESTCOMS*Plus*, pull down the *File* menu and choose *Open*. The *Open* dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and choose *Open*. You can also open a file by clicking on the *Open File* button on the lower menu bar. If connected to a device, you will be asked to upload the settings and logic from the file to the current device. If you choose *Yes*, the settings displayed in BESTCOMS*Plus* will be overwritten with the settings of the opened file.

Saving a Settings File

Select *Save* or *Save As* from the *File* pull-down menu. A dialog box pops up allowing you to enter a filename and location to save the file. Select the *Save* button to complete the save.

Upload Settings and/or Logic to Device

To upload a settings file to the IEM-2020, open the file through BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. Then pull down the *Communication* menu and select *Upload Settings and Logic to Device.* If you want to upload operational settings without logic, select *Upload Settings to Device*. If you want to upload logic without operational settings, select *Upload Logic to Device*. You are prompted to enter the password. The default password is "OEM". If the password is correct, the upload begins and the progress bar is shown.

Download Settings and Logic from Device

To download settings and logic from the IEM-2020, pull down the *Communication* menu and select *Download Settings and Logic from Device*. If the settings in BESTCOMS*Plus* have changed, a dialog box will open asking if you want to save the current settings changes. You may choose *Yes* or *No*. After you have taken the required action to save or discard the current settings, downloading begins. BESTCOMS*Plus* will read all settings and logic from the IEM-2020 and load them into BESTCOMS*Plus* memory.

Printing a Settings File

To view a preview of the settings printout, select *Print Preview* from the *File* pull-down menu. To print the settings, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by pulling down the *File* menu and selecting *Print*. A dialog box, *Print* opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

Comparing Settings Files

BESTCOMS*Plus* has the ability to compare two settings files. To compare files, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPlus Settings Compare Setup* dialog box appears (Figure 4-53). Select the location of the first file under *Left Settings Source* and select the location of the second file under *Right Settings Source*. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the *Select Unit* button to set up the communication port. Click the *Compare* button to compare the selected settings files.

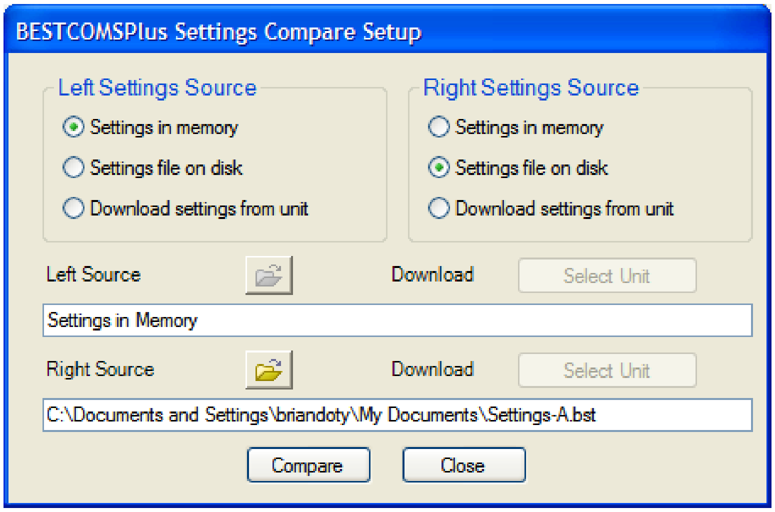


Figure 4-53. BESTCOMSPlus Settings Compare Setup

A dialog box will appear and notify you if any differences were found. The *BESTCOMSPlus Settings Compare* dialog box (Figure 4-54) is displayed where you can view all settings (*Show All Settings*), view only the differences (*Show Settings Differences*), view all logic *(Show All Logic Paths),* or view only logic differences *(Show Logic Path Differences).* Select *Close* when finished.

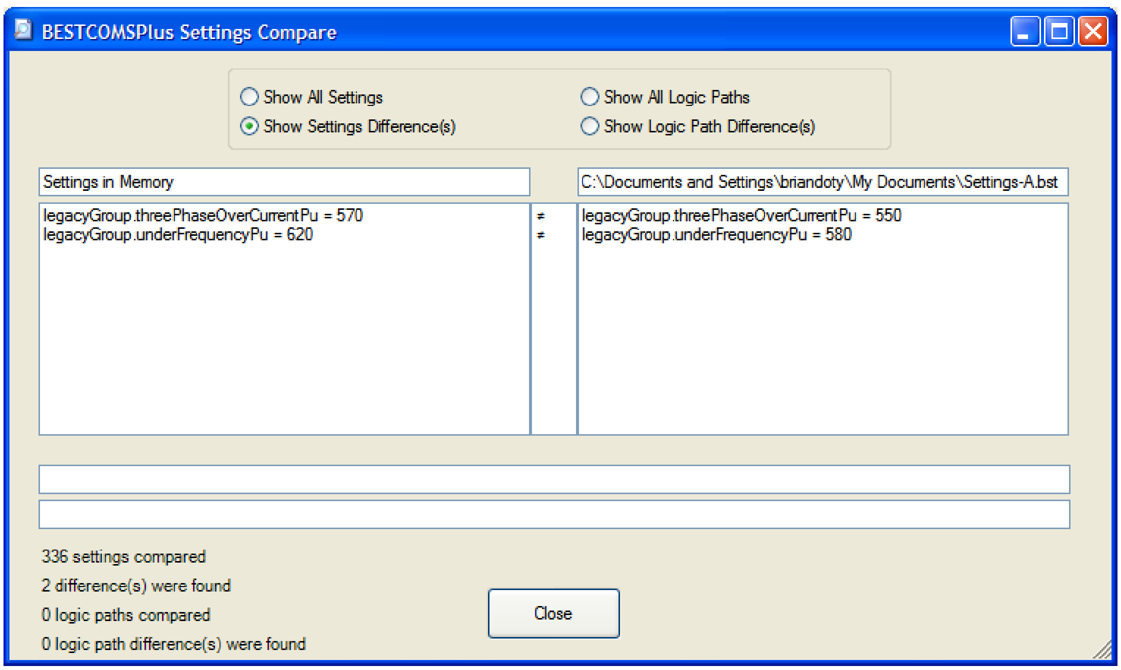


Figure 4-54. BESTCOMSPlus Settings Compare

Upgrading Firmware in The IEM-2020 and Expansion Modules

NOTE

The latest version of BESTCOMS*Plus* software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware and a language module. Embedded firmware is the operating program that controls the actions of the IEM-2020. The IEM-2020 stores firmware in nonvolatile flash memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Future enhancements to the IEM-2020 functionality may make a firmware update desirable. Because default settings are loaded when IEM-2020 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

The language of the front panel LCD can be changed by uploading a different language module into the IEM-2020. The IEM-2020 stores the language module in nonvolatile flash memory; the language module contains all language translations for the IEM-2020. The language module can be reprogrammed through the communications port. In general, any time a firmware upgrade is made to the IEM-2020, the language module should be uploaded as well.

The IEM-2020 may be used in conjunction with several expansion modules that expand the IEM-2020 capabilities. IEM-2020 expansion modules include LSM-2020, CEM-2020, and AEM-2020. When upgrading the firmware in any component of this system, the firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the various components.

CAUTION

The order in which the components are upgraded is critical. Assuming a system of an IEM-2020 and expansion modules is in a state where the IEM-2020 is communicating with all of the system expansion modules, **the expansion modules must be upgraded before the IEM-2020.** This is required because the IEM-2020 must be able to communicate to the expansion module before the IEM-2020 can send firmware to it. If the IEM-2020 were upgraded first, and the new firmware included a change in the IEM-2020 to expansion module communication protocol, it is possible that the expansion modules could no longer communicate with the upgraded IEM-2020. Without communications between the IEM-2020 and the expansion modules, upgrading the expansion modules is not possible.

NOTE

If power is lost or communication is interrupted during file transfer to the IEM-2020, the IEM-2020 will cease operating and will not recover automatically. If this occurs or if the front panel HMI becomes blank and all LEDs are flashing at a 2-second rate, the IEM-2020 will not have valid firmware installed and the firmware must be uploaded again. To accomplish this, cycle power to the IEM-2020 and activate the IEM-2020 plug-in in BESTCOMS*Plus*. Select *Upload Device Files* from the *Communication* pull-down menu and proceed normally.

Upgrading Firmware in Expansion Modules

The following procedure is used to upgrade firmware in IEM-2020 expansion modules. This must be completed before upgrading firmware in the IEM-2020. If no expansion modules are present, proceed to *Upgrading Firmware in the IEM-2020.*

1. Place the IEM-2020 in OFF mode. This can be accomplished by clicking the *Off* button on the *Control* screen inside the Metering Explorer or by pressing the *Off* button on the IEM-2020 front panel.
2. Enable the expansion modules that are present in the system. If they have not already been enabled, enable the expansion modules on the SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP screen.
3. Verify that the IEM-2020 and all associated expansion modules are communicating. This can be verified by examining the pre-alarm status using the Metering Explorer in BESTCOMS*Plus* or from the front panel by navigating to METERING > ALARMS > STATUS > PRE-ALARMS. There should be no *Loss of Comms* pre-alarms in the pre-alarm status when communications are functioning properly.
4. Connect to the IEM-2020 through the USB port if not already connected. Firmware upgrades cannot be accomplished through the Ethernet port, with the exception of the LSM-2020.
5. Select *Upload Device Files* from the Communication pull-down menu.
6. You will be asked to save the current settings file. Select *Yes* or *No*.
7. When the *Basler Electric Device Package Uploader* screen (Figure 4-55) appears, click on the *Open* button to browse for the device package you have received from Basler Electric. The *Package Files*

along with *File Details* are listed. Place a check in the boxes next to the individual files you want to upload.

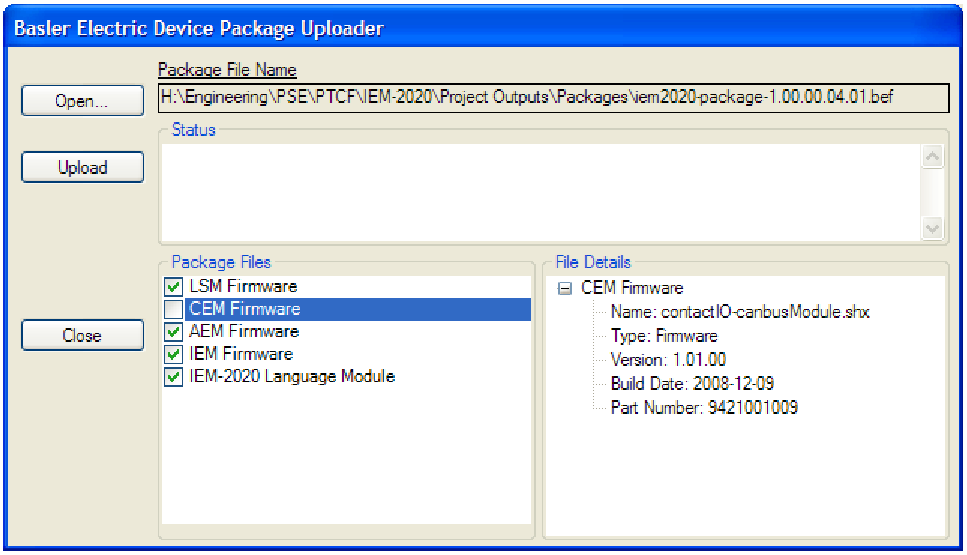


Figure 4-55. Basler Electric Device Package Uploader

8. Click on the *Upload* button and the *Proceed with Device Upload* screen will appear. Select *Yes* or *No*.
9. After selecting *Yes*, the *IEM-2020 Selection* screen will appear. Select the communication port to begin upload. Firmware updating is only possible locally through the USB port. Refer to Figure 4-56.

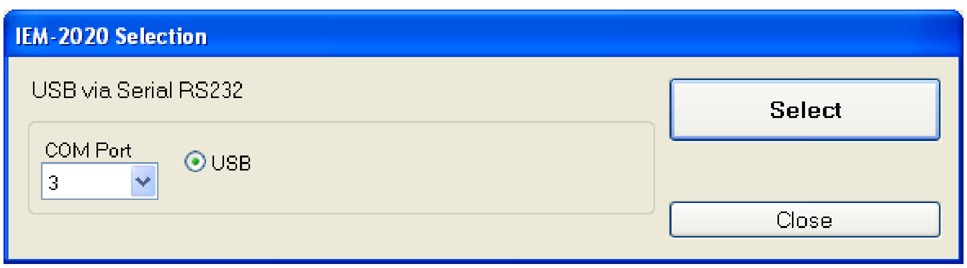


Figure 4-56. IEM-2020 Selection

10. The *Processing, Please Wait…* screen is displayed as file(s) are uploaded. See Figure 4-57.

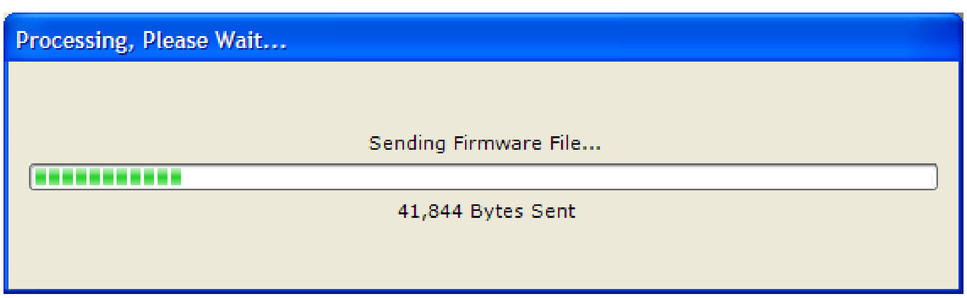


Figure 4-57. Processing, Please Wait…

11. After file(s) have been uploaded, click the *Close* button on the *Basler Electric Device Package Uploader* screen and disconnect communication to the IEM-2020.

Upgrading Firmware in the IEM-2020

Two scenarios are presented: (A) Upgrade IEM-2020 firmware and then load a settings file created with an earlier firmware version, and (B) Save settings file from IEM-2020, upgrade IEM-2020 firmware, and then load settings file back into the IEM-2020.

A. Upgrade IEM-2020 firmware and then load a settings file created with an earlier firmware version.

1. Upgrade the IEM-2020 firmware and language module.

    a. Connect to the IEM-2020 with BESTCOMS*Plus*. Check the firmware Application Version on the General Settings > Version Info > IEM-2020 screen.

    b. Select *Upload Device Files* from the *Communication* pull-down menu. You do not have to be connected to the IEM-2020 at this time. Save settings when prompted, if desired.

    c. Open the desired device package file (∗∗∗∗IEM-2020-∗∗∗∗∗_xxyyzz.bef, where ∗∗∗∗ may be additional descriptive text of varying length, and xx.yy.zz is the version number of the device package file.)

    d. Check the boxes for *IEM-2020 Firmware* and *IEM-2020 Language Module.* Note the version number of the IEM-2020 firmware; this is the version that will be used to set the Application Version in the settings file in a later step. This is NOT the same as the version of the package file that is contained in the fields xx.yy.zz in the package file name.

    e. Click the *Upload* button and follow the instructions that appear to begin the upgrade process.

    f. After the upload is complete, disconnect communication to the IEM-2020.

2. Load the saved settings file into the IEM-2020.

    a. Close all settings files.

    b. From the *File* pull-down menu, select *New*, *IEM-2020.*

    c. Connect to the IEM-2020.

    d. Once all settings have been read from the IEM-2020, open the saved settings file by selecting the file with *File, Open File* in the BESTCOMS*Plus* menu.

    e. When BESTCOMS*Plus* asks if you wish to upload settings and logic to the device, click *Yes*.

    f. If you are receiving upload failures and indications that the logic is incompatible with the firmware version, check that the IEM-2020 style number in the saved file matches that of the IEM-2020 into which the file is being uploaded. The style number in the settings file is found under General Settings > Style Number in BESTCOMS*Plus*.

    g. If the style number of the settings file does not match that of the IEM-2020 into which it is to be loaded, disconnect from the IEM-2020, then modify the style number in the settings file. Then repeat the steps titled *Load the Settings File into the IEM-2020.*

NOTE

If the settings file was saved with a previous version of firmware, BESTCOMS*Plus* will automatically perform a settings file conversion to make the settings file compatible with the new firmware.

Metering Explorer

The Metering Explorer is a convenient tool within BESTCOMS*Plus* used to navigate through the following metering screens of the IEM-2020 plug-in.

- Engine
- Run Statistics
- Status
- Inputs
  - Contact Inputs
  - Local Analog Inputs
  - Remote LSM Inputs
  - Remote Contact Inputs
  - Remote Analog Inputs
  - Remote RTD Inputs
  - Remote Thermocouple Inputs
  - Remote Analog Input Values
  - Logic Control Relays
- Outputs
  - Contact Outputs
  - Configurable Elements
  - Remote Contact Outputs
  - Remote Analog Outputs
- Configurable Protection
- Alarms
- Event Log
- J1939 ECU
  - ECU Data
  - Engine Configuration
  - Active DTC
  - Previously Active DTC
- MTU
  - MTU Alarms
  - MTU Fault Codes
  - MTU Status
  - MTU Engine Status
- Summary
- Control
- Real Time Clock

The Metering Explorer has a "Docking" feature allowing the user to arrange and dock metering screens. A blue transparent square representing the screen being moved, seven arrow buttons, and a tabs button appear when holding down the left mouse button on a metering tab and dragging it out. See Figure 4-58. Table 4-5 explains the call-outs on Figure 4-58.

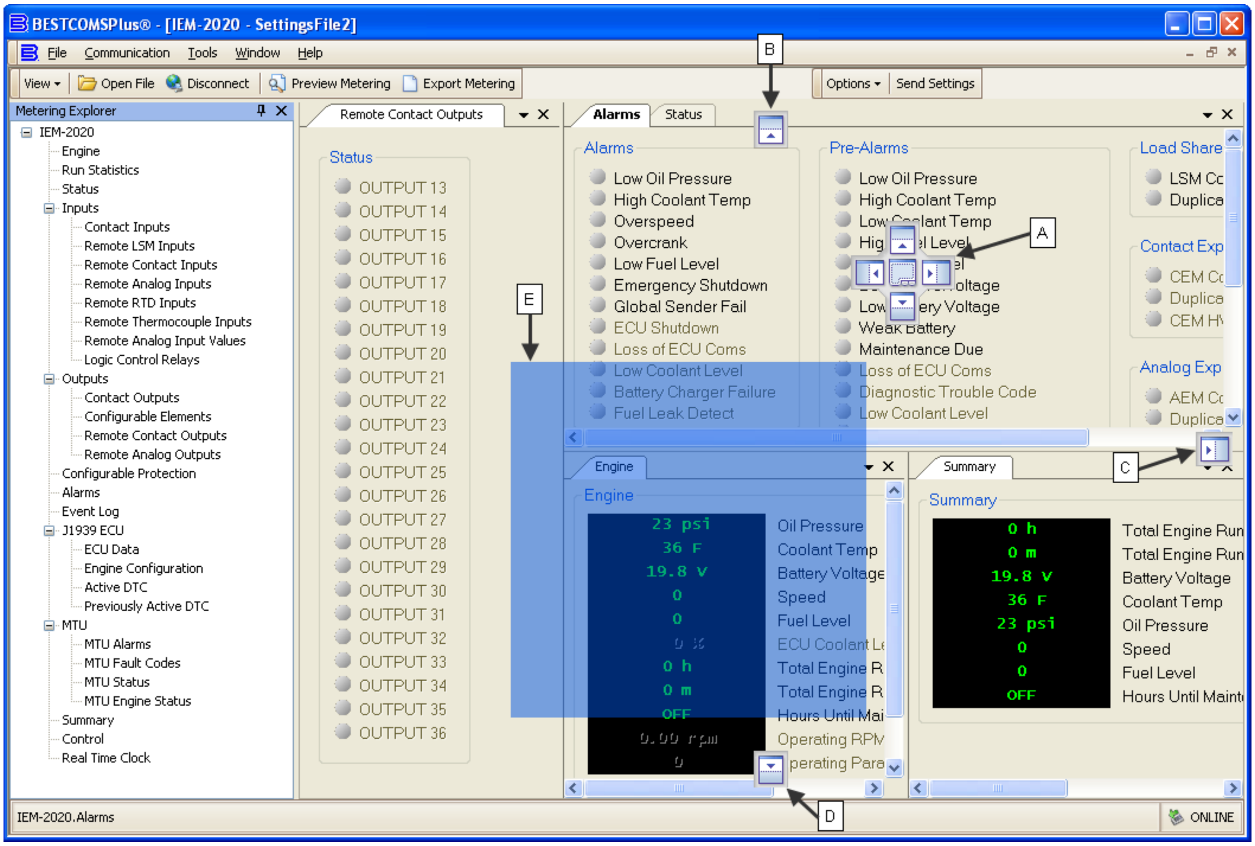
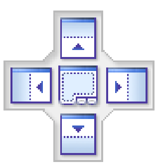
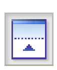
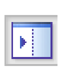


Figure 4-58. Metering, Docking Options

Table 4-5. Explanation of Call-Outs on Figure 4-58

Call-Out	Symbol	Explanation
A		Holding the left mouse button down on a metering tab and dragging it to one of the four arrow boxes will place it inside the selected window on the location selected. To place the metering tab as a tab inside the selected window, drop it on the tabs button in the center of the arrow buttons.
B		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the top of the screen. Click on the (thumbtack) to dock it on the top bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the top bar.
C		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the side of the screen. Click on the (thumbtack) to dock it on the side bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the side bar.
D		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the bottom of the screen. Click on the (thumbtack) to dock it on the bottom bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the bottom bar.
E		Holding the left mouse button down on a metering tab and dragging it to anywhere other than an arrow box will place it as a floating metering screen. This floating screen can later be closed by clicking on the in the upper right corner. It may also be dragged to one of the arrow boxes used for docking.

Engine

This screen provides information and metering of engine components. Refer to Figure 4-59.

Figure 4-59. Metering, Engine

Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. Refer to Figure 4-60.

The Hours Until Maintenance pre-alarm is configured on the Pre-Alarms screen in the Settings Explorer. The Hours Until Maintenance field will display "OFF" when the Maintenance Interval pre-alarm is disabled. Clicking Reset Maintenance Interval resets the Hours Until Maintenance to the value set for the Maintenance Interval pre-alarm on the Pre-Alarms screen in the Settings Explorer.

To change the commission date, click *Edit IEM Commission Date.* The IEM Commission Date dialog box appears. Enter the new commission date and click *Upload Data to Device*. Click *Close*. Note that the Commission Date field on the BESTCOMS*Plus* screen updates after the *Close* button is clicked.

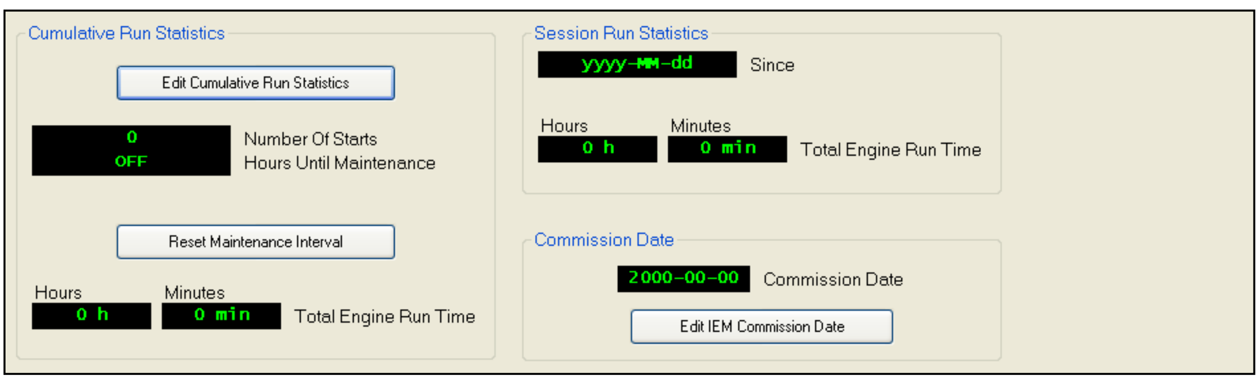


Figure 4-60. Metering, Run Statistics

Status

This screen indicates status of modes and switches. The status is true when the corresponding LED is red. Refer to Figure 4-61.

Figure 4-61. Metering, Status

Inputs

Contact Inputs

This screen indicates the status of contact inputs, contact input alarms, and contact input pre-alarms. The status is true when the corresponding LED is red. Refer to Figure 4-62.

Figure 4-62. Metering, Inputs, Contact Inputs

Local Analog Inputs

This screen indicates the value, status, pre-alarms, and alarms of the local analog inputs. Refer to Figure 4-63.

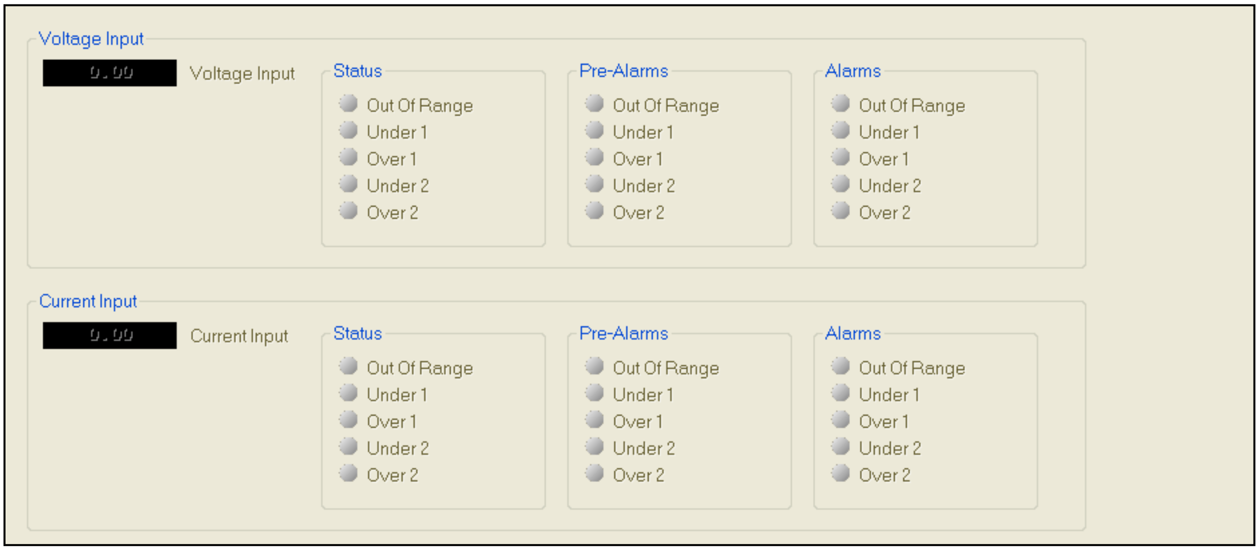


Figure 4-63. Metering, Inputs, Local Analog Inputs

Remote LSM Inputs

When an optional LSM-2020 (Load Share Module) is connected, the value of the analog inputs is displayed on this screen. Voltage is displayed when the input is configured for voltage and current is displayed when the input is configured for current. Refer to Figure 4-64.

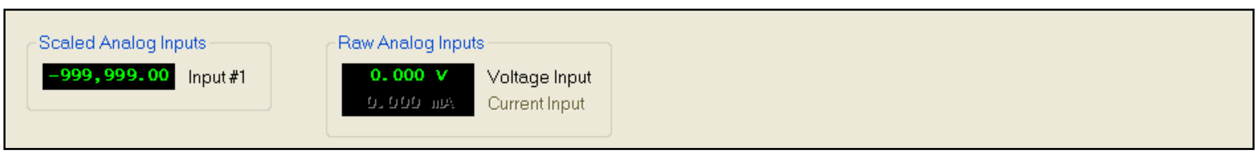


Figure 4-64. Metering, Inputs, Remote LSM Inputs

Remote Contact Inputs

When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact inputs, configurable remote contact input alarms, and remote contact input pre-alarms are shown on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-65.

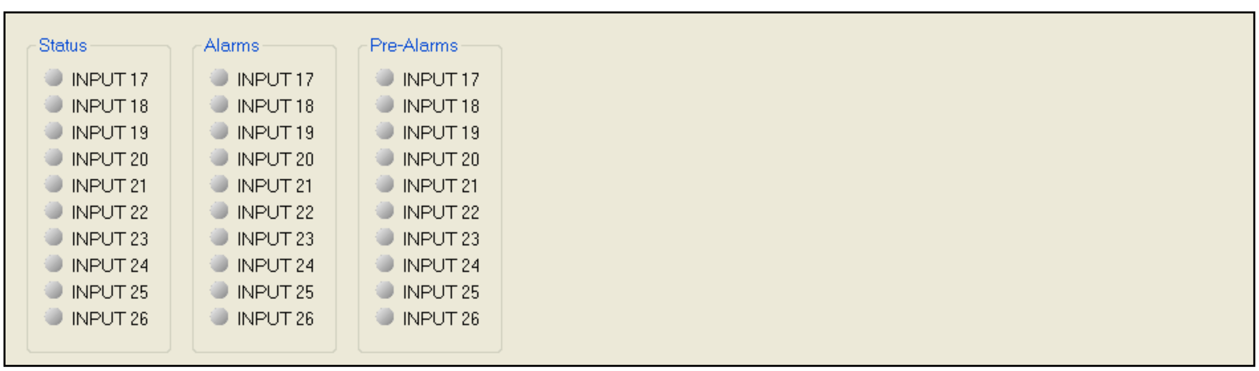


Figure 4-65. Metering, Inputs, Remote Contact Inputs

Remote Analog Inputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote analog inputs, remote analog input alarms, and remote analog input pre-alarms are shown on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-66. Remote Analog Input #1 is shown.

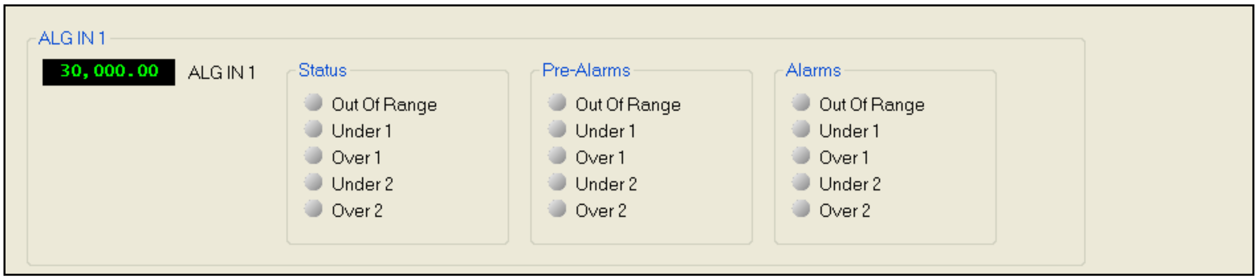


Figure 4-66. Metering, Inputs, Remote Analog Inputs

Remote RTD Inputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote RTD inputs, remote RTD input alarms, and remote RTD input pre-alarms are shown on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-67. Remote RTD Input #1 is shown.

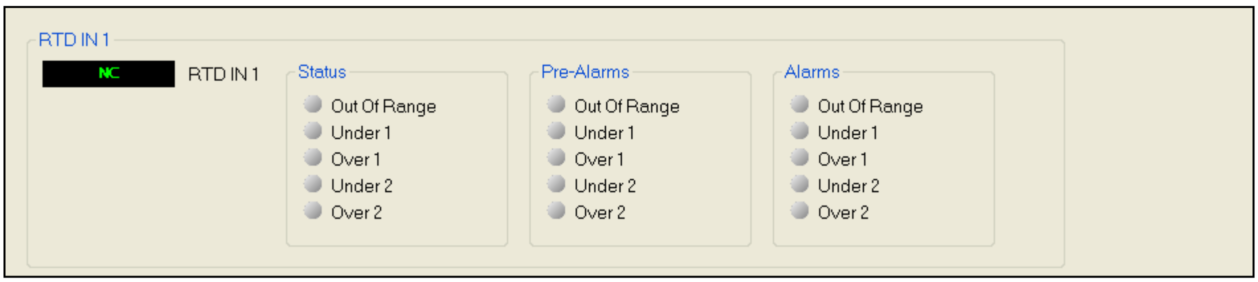


Figure 4-67. Metering, Inputs, Remote RTD Inputs

Remote Thermocouple Inputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote thermocouple inputs, remote thermocouple input alarms, and remote thermocouple input pre-alarms are shown on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-68. Remote Thermocouple Input #1 is shown.

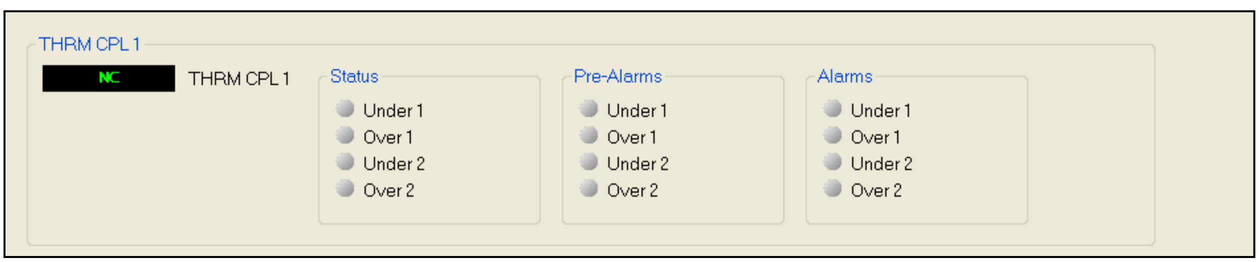


Figure 4-68. Metering, Inputs, Remote Thermocouple Inputs

Remote Analog Input Values

When an optional AEM-2020 (Analog Expansion Module) is connected, the values of the scaled analog inputs, raw analog inputs, RTD input temperatures, raw RTD inputs, thermocouple input temperatures, and raw thermocouple inputs are shown on this screen.

For each analog input, the raw metered input value is displayed along with the scaled metered input value. This is useful for checking if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 V voltage input or 4 to 20 mA current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input Settings. Refer to Figure 4-69.

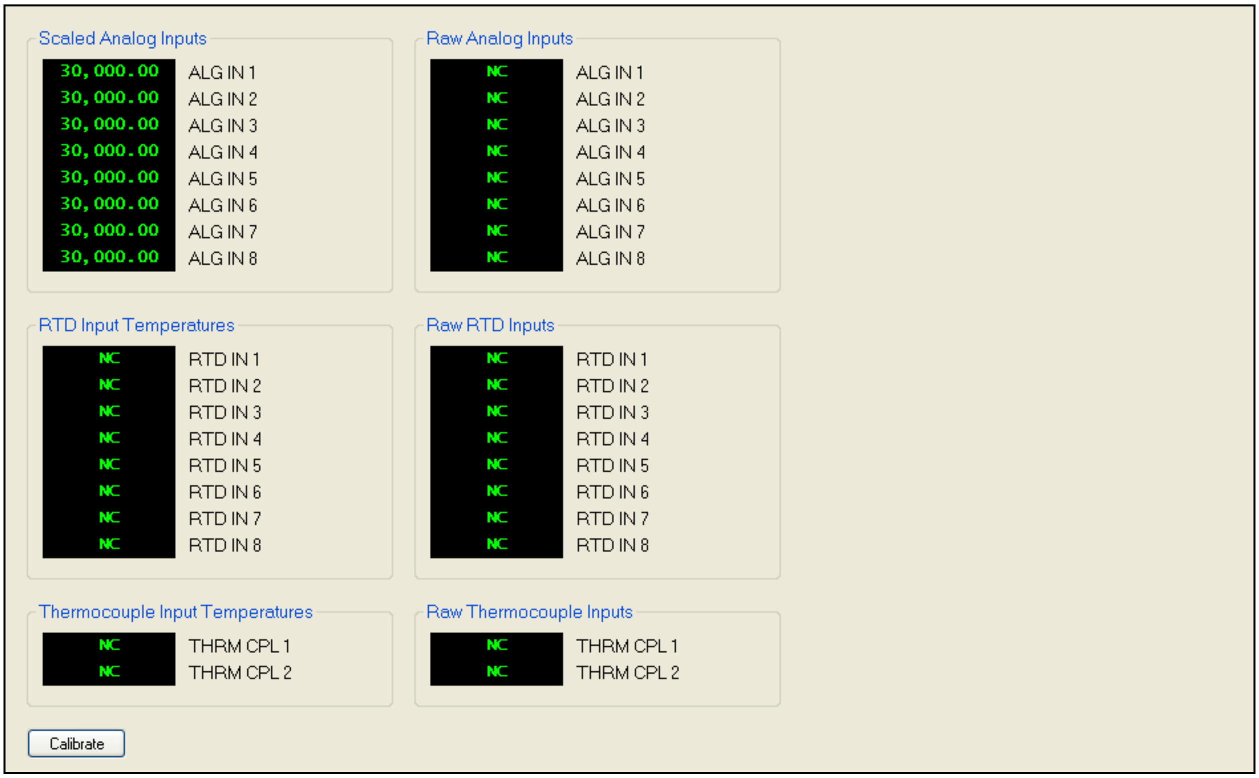


Figure 4-69. Metering, Inputs, Remote Analog Input Values

The *Calibrate* button on the Remote Analog Input Values screen opens the Analog Input Temperature Calibration screen shown in Figure 4-70. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

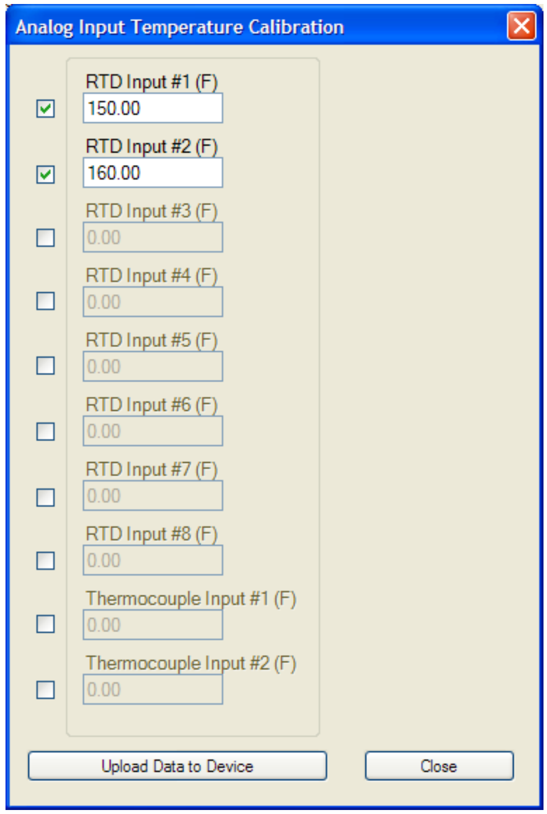


Figure 4-70. Analog Input Temperature Calibration

Logic Control Relays

This screen indicates the status of logic control relays. The status is true when the corresponding LED is green. Refer to Figure 4-71.

Figure 4-71. Metering, Inputs, Logic Control Relays

Outputs

Contact Outputs

This screen indicates the status of contact outputs. The status is true when the corresponding LED is green. Refer to Figure 4-72.

Figure 4-72. Metering, Outputs, Contact Outputs

Configurable Elements

This screen indicates the status of configurable elements. It also indicates alarms and pre-alarms of configurable elements. The status is true when the corresponding LED is green. Refer to Figure 4-73.

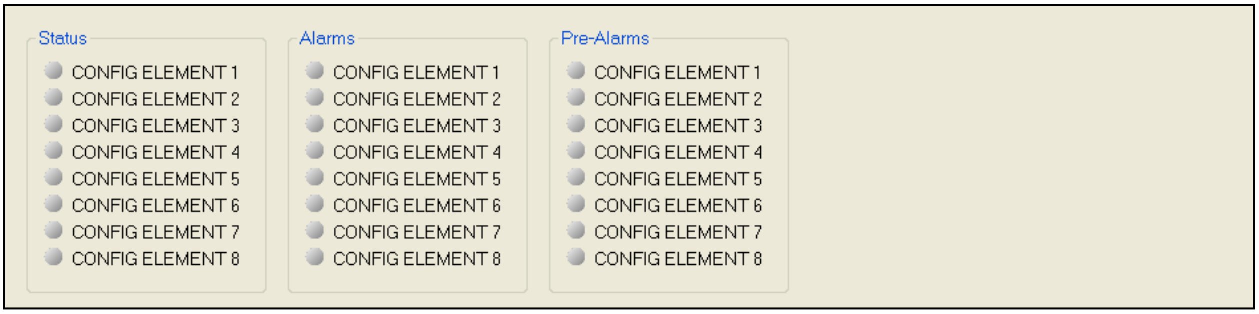


Figure 4-73. Metering, Outputs, Configurable Elements

Remote Contact Outputs

When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact outputs is shown on this screen. The status is true when the corresponding LED is green. Refer to Figure 4-74.

Figure 4-74. Metering, Outputs, Remote Contact Outputs

Remote Analog Outputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote analog outputs, scaled analog output values, and raw analog output values are shown on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-75.

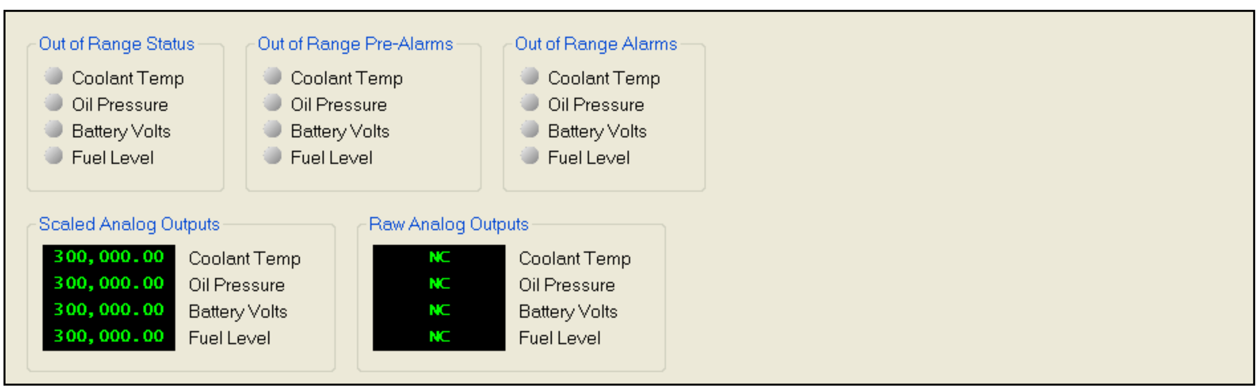


Figure 4-75. Metering, Outputs, Remote Analog Outputs

Configurable Protection

This screen indicates the status of configurable protection. It also indicates Pre-Alarms and Alarms of configurable protection. The status is true when the corresponding LED is red. Refer to Figure 4-76.

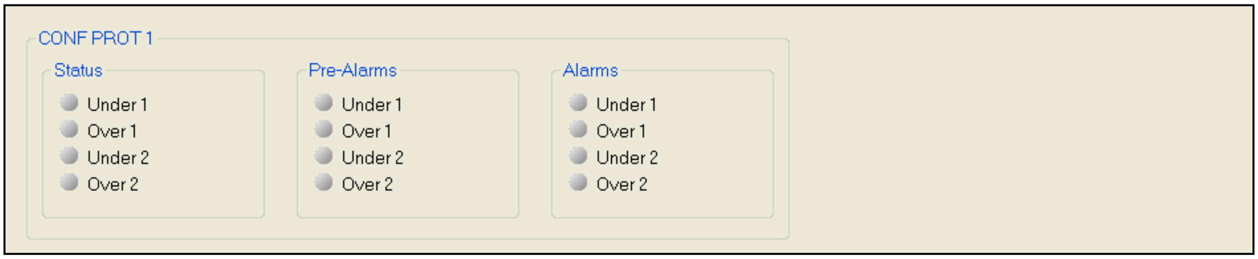


Figure 4-76. Metering, Configurable Protection

Alarms

This screen indicates the status of Alarms, Pre-Alarms, and Sender Fail. The status is true when the corresponding LED is red. Alarms and pre-alarms are reset when the IEM-2020 is set to the Off mode. Refer to Figure 4-77.

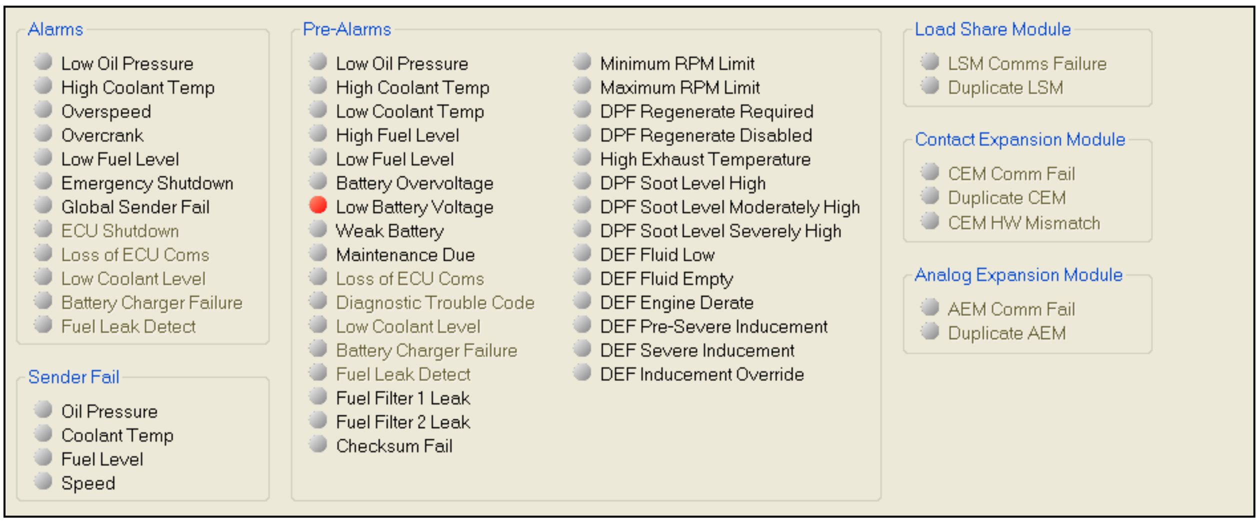
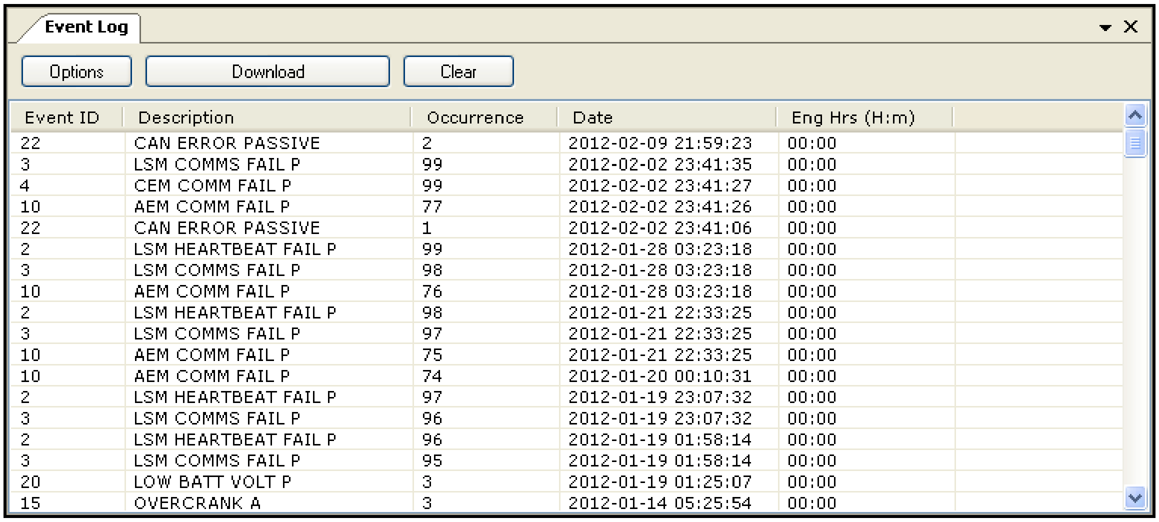


Figure 4-77. Metering, Alarms

Event Log

The event log provides a historical record of event occurrences detected by the IEM-2020. It is saved in nonvolatile memory so that is will not be affected if power is removed. Thirty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 30 records in memory, the record that has the oldest “last” event occurrence is removed from the log, and the new category takes its place. Since 30 event records with up to 99 occurrences each are retained in memory, a history of nearly 3,000 specific events are retained in the IEM-2020. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 30 event records; thus the time, date and engine hours details for up to 900 specific event occurrences is retained in the event log.

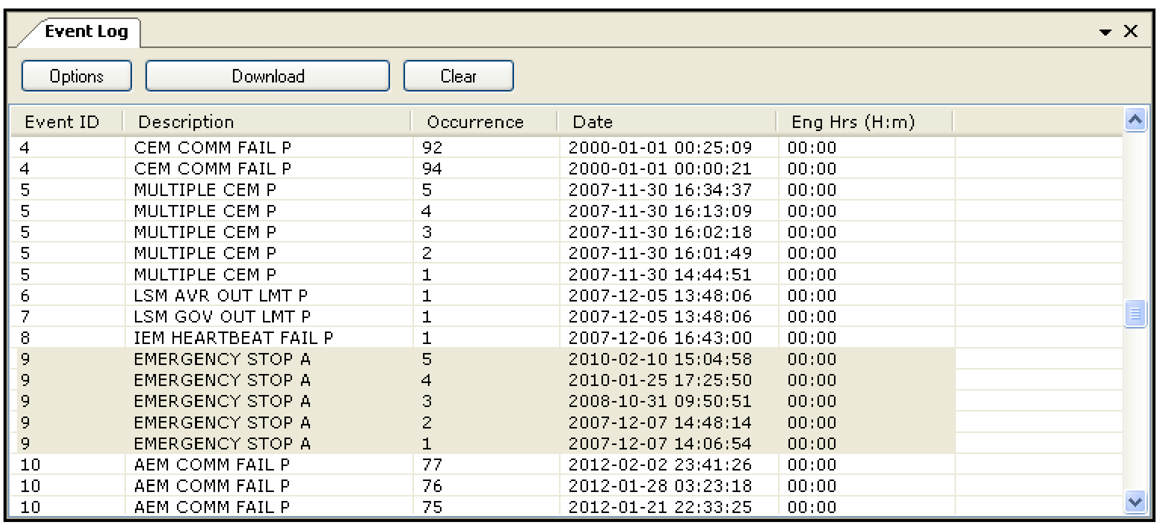
The user can download the event log data into BESTCOMS*Plus* for viewing, and then save the event logs as files. The *Options* button is used to save the entire event log to a file, or to save the list to the computer clipboard making it available for insertion into other software applications. It is possible to copy a portion of the log to the computer clipboard by selecting the desired portion with the mouse then using the Options->Copy Selection feature. The *Download* button refreshes the event log list by performing a fresh download of the list from the IEM-2020. The *Clear* button gives the user the option of clearing selected or all event logs. Refer to Figure 4-78.



Event ID	Description	Occurrence	Date	Eng Hrs (H:m)
22	CAN ERROR PASSIVE	2	2012-02-09 21:59:23	00:00
3	LSM COMMS FAIL P	99	2012-02-02 23:41:35	00:00
4	CEM COMM FAIL P	99	2012-02-02 23:41:27	00:00
10	AEM COMM FAIL P	77	2012-02-02 23:41:26	00:00
22	CAN ERROR PASSIVE	1	2012-02-02 23:41:06	00:00
2	LSM HEARTBEAT FAIL P	99	2012-01-28 03:23:18	00:00
3	LSM COMMS FAIL P	98	2012-01-28 03:23:18	00:00
10	AEM COMM FAIL P	76	2012-01-28 03:23:18	00:00
2	LSM HEARTBEAT FAIL P	98	2012-01-21 22:33:25	00:00
3	LSM COMMS FAIL P	97	2012-01-21 22:33:25	00:00
10	AEM COMM FAIL P	75	2012-01-21 22:33:25	00:00
10	AEM COMM FAIL P	74	2012-01-20 00:10:31	00:00
2	LSM HEARTBEAT FAIL P	97	2012-01-19 23:07:32	00:00
3	LSM COMMS FAIL P	96	2012-01-19 23:07:32	00:00
2	LSM HEARTBEAT FAIL P	96	2012-01-19 01:58:14	00:00
3	LSM COMMS FAIL P	95	2012-01-19 01:58:14	00:00
20	LOW BATT VOLT P	3	2012-01-19 01:25:07	00:00
15	OVERCRANK A	3	2012-01-14 05:25:54	00:00

Figure 4-78. Metering, Event Log, Sorted by Date

When viewed with BESTCOMS*Plus*, the event log can be sorted by Event ID, Description, Occurrence, Date, or Engine Hours. Selecting event log sorted by Date yields a list of all event occurrences in sequential order. This is a view that one would see in a typical "sequence of events" type of event log. Figure 4-78 shows the sequential list resulting from sorting by Date. Sorting by engine hours also results in a sequential list, where the sequence is in terms of engine hours rather than calendar date and time.
Selecting sorting by Event ID or Description allows one to view all the occurrences of a particular event type in their order of occurrence. In this view, one can see at a glance the times and dates of the occurrences of one type of event. For example, from Figure 4-79, if one wanted to know when all occurrences of Emergency Stop A took place, the information is readily available without having to sift through all the occurrences of unrelated events as would have to be done in a rolling log implementation. This is apparent in Figure 4-78.



Event ID	Description	Occurrence	Date	Eng Hrs (H:m)
4	CEM COMM FAIL P	92	2000-01-01 00:25:09	00:00
4	CEM COMM FAIL P	94	2000-01-01 00:00:21	00:00
5	MULTIPLE CEM P	5	2007-11-30 16:34:37	00:00
5	MULTIPLE CEM P	4	2007-11-30 16:13:09	00:00
5	MULTIPLE CEM P	3	2007-11-30 16:02:18	00:00
5	MULTIPLE CEM P	2	2007-11-30 16:01:49	00:00
5	MULTIPLE CEM P	1	2007-11-30 14:44:51	00:00
6	LSM AVR OUT LMT P	1	2007-12-05 13:48:06	00:00
7	LSM GOV OUT LMT P	1	2007-12-05 13:48:06	00:00
8	IEM HEARTBEAT FAIL P	1	2007-12-06 16:43:00	00:00
9	EMERGENCY STOP A	5	2010-02-10 15:04:58	00:00
9	EMERGENCY STOP A	4	2010-01-25 17:25:50	00:00
9	EMERGENCY STOP A	3	2008-10-31 09:50:51	00:00
9	EMERGENCY STOP A	2	2007-12-07 14:48:14	00:00
9	EMERGENCY STOP A	1	2007-12-07 14:06:54	00:00
10	AEM COMM FAIL P	77	2012-02-02 23:41:26	00:00
10	AEM COMM FAIL P	76	2012-01-28 03:23:18	00:00
10	AEM COMM FAIL P	75	2012-01-21 22:33:25	00:00

Figure 4-79. Metering, Event Log, Sorted by Event ID

J1939 ECU

The ECU reports operating information to the IEM-2020 through the CAN Bus interface when the ECU is configured for Volvo Penta. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed on these screens.

ECU Data

This screen displays ECU Lamp Status and ECU Data. The status is true when the corresponding LED is red. Refer to Figure 4-80.

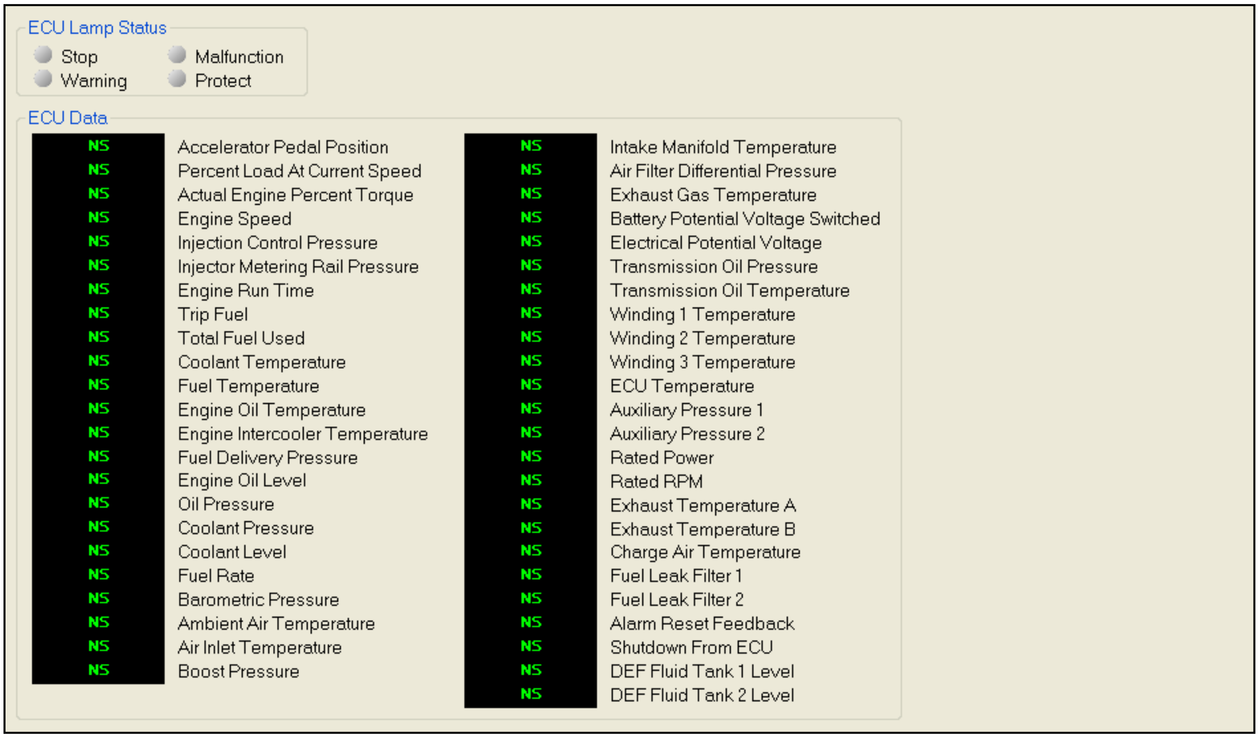


Figure 4-80. Metering, ECU Data

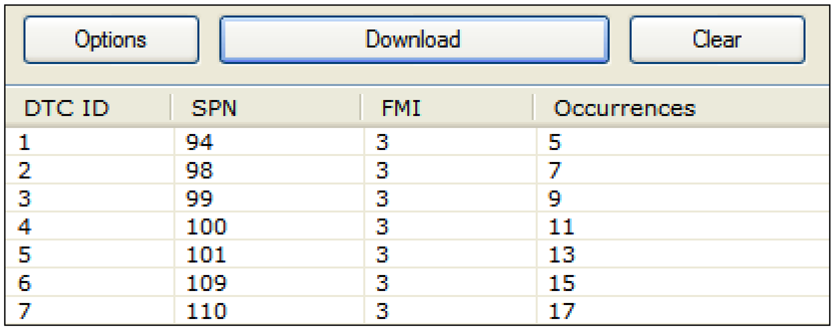
Engine Configuration

This screen displays Engine Configuration. Refer to Figure 4-81.

Figure 4-81. Metering, Engine Configuration

Active DTC and Previously Active DTC

This screen is used for viewing, downloading, and clearing DTC (Diagnostic Trouble Codes). Refer to Figure 4-82.



DTC ID	SPN	FMI	Occurrences
1	94	3	5
2	98	3	7
3	99	3	9
4	100	3	11
5	101	3	13
6	109	3	15
7	110	3	17

Figure 4-82. Metering, Download DTC

MTU

The MTU reports operating information to the IEM-2020 through the CAN Bus interface when the ECU is configured for MTU. Operating parameters and diagnostic information, if supported by the MTU, are decoded and displayed on these screens.

MTU Alarms

MTU Alarms and MTU Pre-Alarms are reported on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-83.

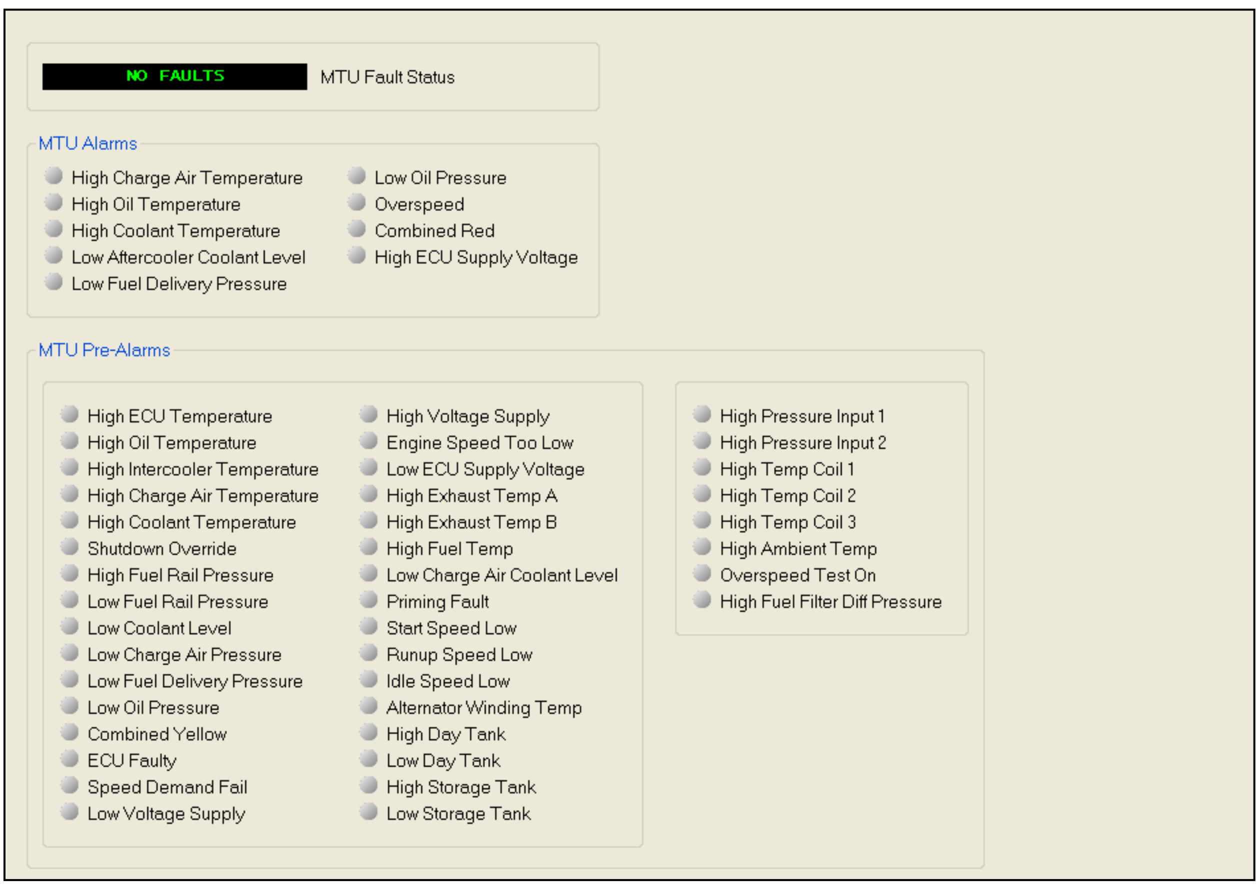


Figure 4-83. Metering, MTU Alarms

MTU Fault Codes

MTU Fault Codes can be viewed and downloaded on this screen. Refer to Figure 4-84.

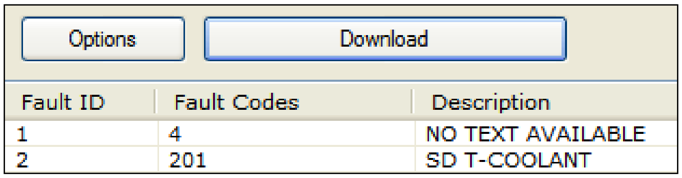


Figure 4-84. Metering, MTU Fault Codes

MTU Status

MTU Status is reported on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-85.

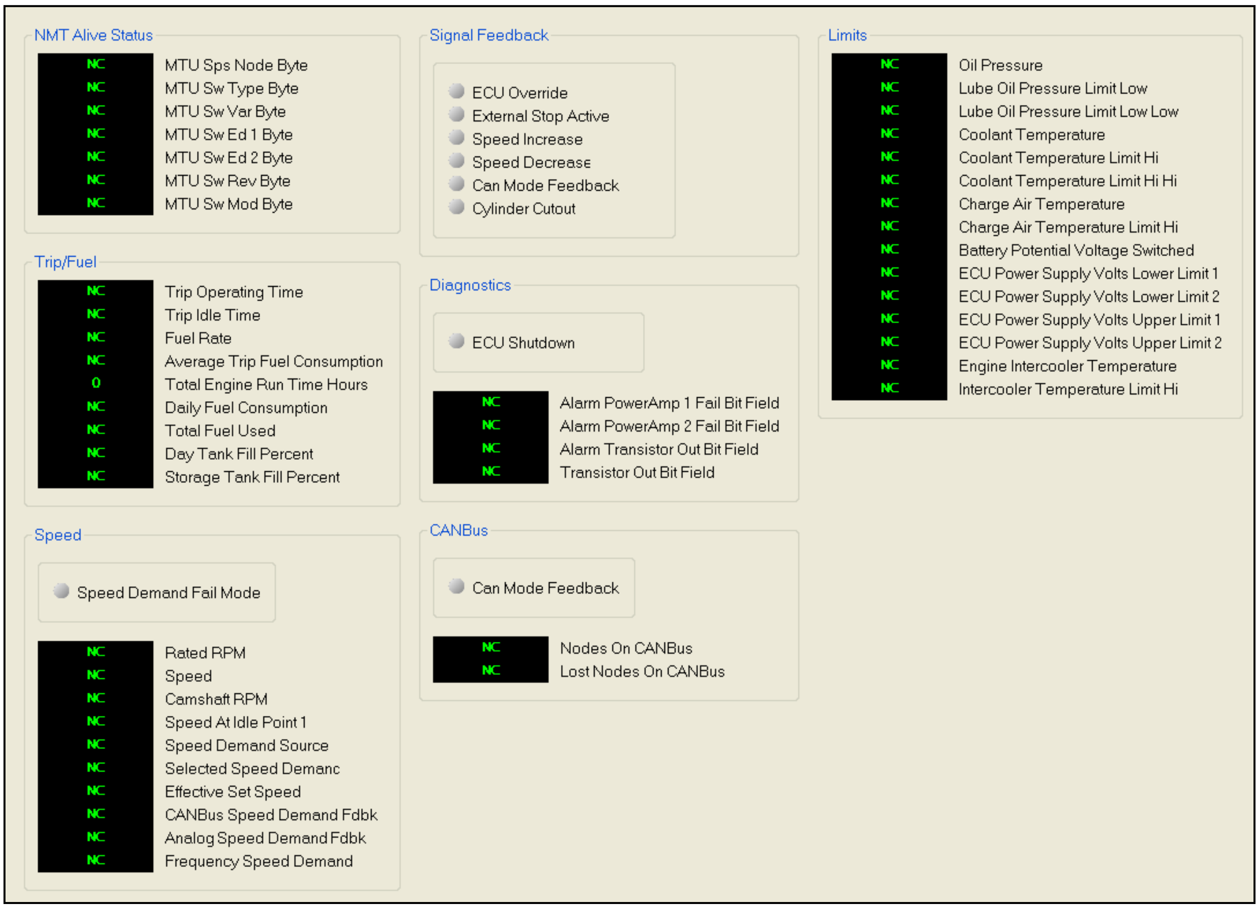


Figure 4-85. Metering, MTU Status

MTU Engine Status

MTU Engine Status is reported on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-86.

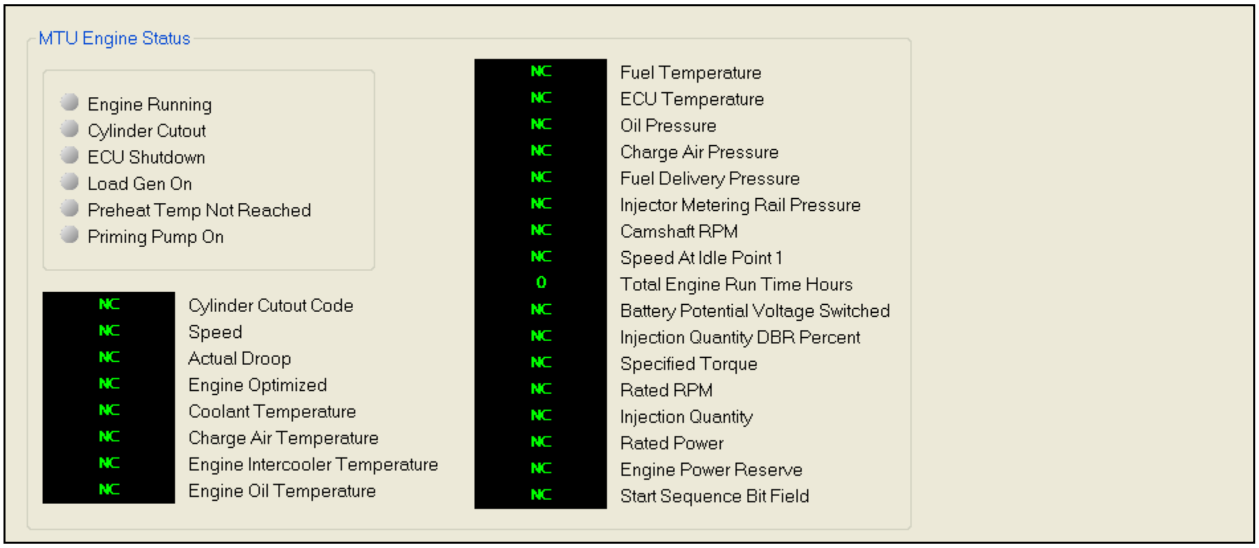


Figure 4-86. Metering, MTU Engine Status

Summary

This screen displays a metering summary. Refer to Figure 4-87.

Figure 4-87. Metering, Summary

Control

Controls for stopping/starting the engine, controls for opening/closing breakers, and controls for opening/closing switches are accessed through the *Control* branch.

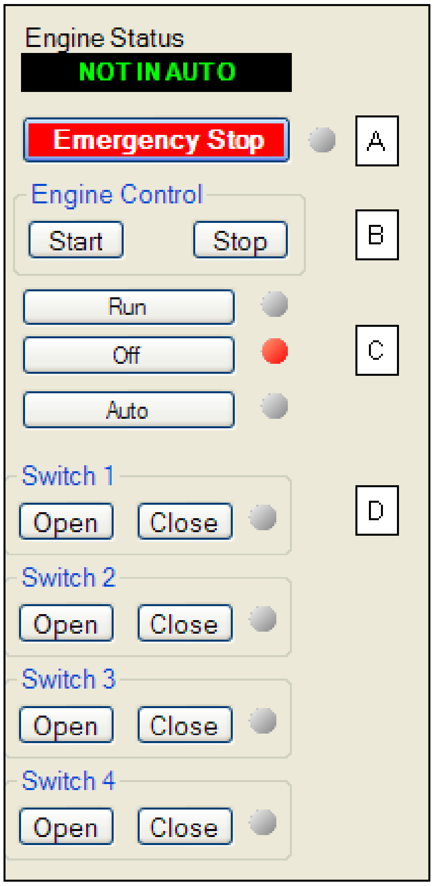


Figure 4-88. Metering, Control

The following controls are available by using the Metering Explorer in BESTCOMS*Plus* to open the *Control* branch. Refer to Figure 4-88.

A. The user has control to stop the engine in case of emergency by clicking on the *Emergency Stop* button.

B. The engine can be started and stopped by clicking on the *Start* and *Stop* buttons.

C. The engine can be set to Run, Auto, or Off.

D. Switches 1 through 4 can be opened or closed by clicking on the *Open* or *Close* buttons. The switch is closed when the corresponding LED is red.

When running BESTCOMS*Plus* in *Live* mode, these buttons will interact with the IEM-2020 in real time.

Real Time Clock

Settings for Date and Time are made here. Refer to Figure 4-89.

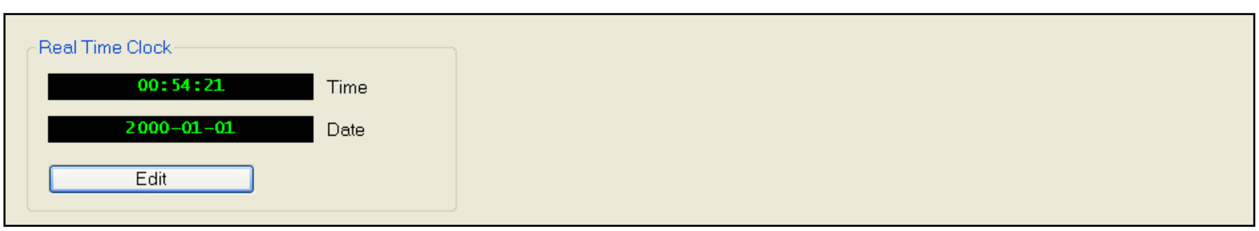


Figure 4-89. Metering, Real Time Clock

BESTCOMSPlus® Updates

Ongoing IEM-2020 functionality enhancements may make future IEM-2020 firmware updates desirable. Enhancements to IEM-2020 firmware typically coincide with enhancements to the IEM-2020 plugin for BESTCOMS*Plus*. When a IEM-2020 is updated with the latest version of firmware, the latest version of BESTCOMS*Plus* should also be obtained.

- If you obtained a CD-ROM containing a firmware update from Basler Electric, then that CD-ROM will also contain the corresponding version of BESTCOMS*Plus* software.
- You can check for BESTCOMS*Plus* updates by visiting www.basler.com.
- You can use the manual "check for updates" function in BESTCOMS*Plus* to ensure that the latest version is installed by selecting *Check for Updates* in the *Help* drop-down menu. (An internet connection is required.)

Auto Export Metering

The auto export metering function automatically exports metering data over a user-defined period when an IEM-2020 connection is active. The user specifies the *Number of Exports* and the *Interval* between each export. Enter a filename for the metering data and a folder in which to save. The first export is performed immediately after clicking the *Start* button. Click the *Filter* button to select specific metering screens. Figure 4-90 illustrates the *Auto Export Metering* screen.

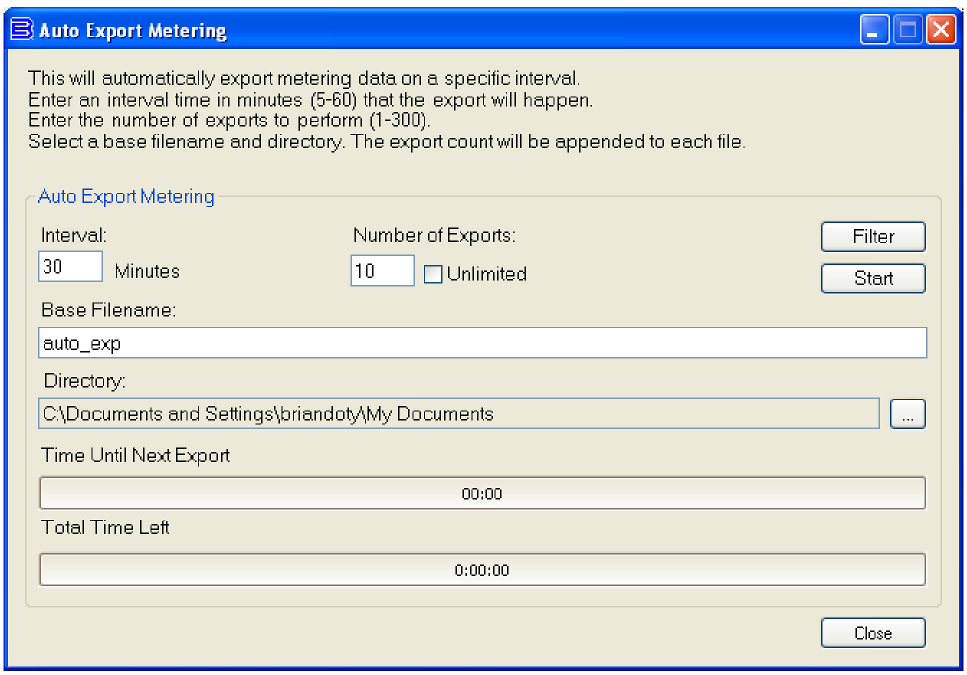


Figure 4-90. Auto Export Metering

SECTION 5 • BESTlogic™*Plus* PROGRAMMABLE LOGIC

TABLE OF CONTENTS

Figures

Tables

SECTION 5 • BESTLOGIC™*PLUS* PROGRAMMABLE LOGIC

Introduction

BESTlogic™*Plus* Programmable Logic is a programming method used for managing the input, output, control, monitoring, and reporting capabilities of Basler Electric's IEM-2020 Industrial Engine Module. Each IEM-2020 has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in equation form with BESTlogic*Plus*. BESTlogic*Plus* equations entered and saved in the IEM-2020 system's nonvolatile memory integrate (electronically wire) the selected or enabled protection and control blocks with control inputs and hardware outputs. A group of logic equations defining the logic of the IEM-2020 is called a logic scheme.

One default active logic scheme is pre-loaded into the IEM-2020. 12 pre-programmed logic schemes are available in the BESTCOMS*Plus*® installation directory on your PC. Detailed information on all pre-programmed logic schemes is available in Appendix B, *Logic Library Files.* These schemes are configured for typical applications and virtually eliminate the need for "start-from-scratch" programming. BESTCOMS*Plus* can be used to open a logic scheme that was previously saved as a file and upload it to the IEM-2020. Any of the logic schemes can also be customized to suit your application.

BESTlogic*Plus* is not used to define the operating settings (modes, thresholds, and time delays) of the individual functions. Changing logic settings is similar to rewiring a panel and is separate and distinct from making the operating settings that control the thresholds and time delays of an IEM-2020. Detailed information about operating settings is provided in Section 4, *BESTCOMSPlus® Software*.

CAUTION
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 10,000 erase/write cycles for Rev. 1 hardware and 100,000 erase/write cycles for Rev. 2 hardware. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Overview of BESTlogicPlus

Use BESTCOMS*Plus* to make BESTlogic*Plus* settings. Use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 5-1.

The *BESTlogicPlus Programmable Logic* screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

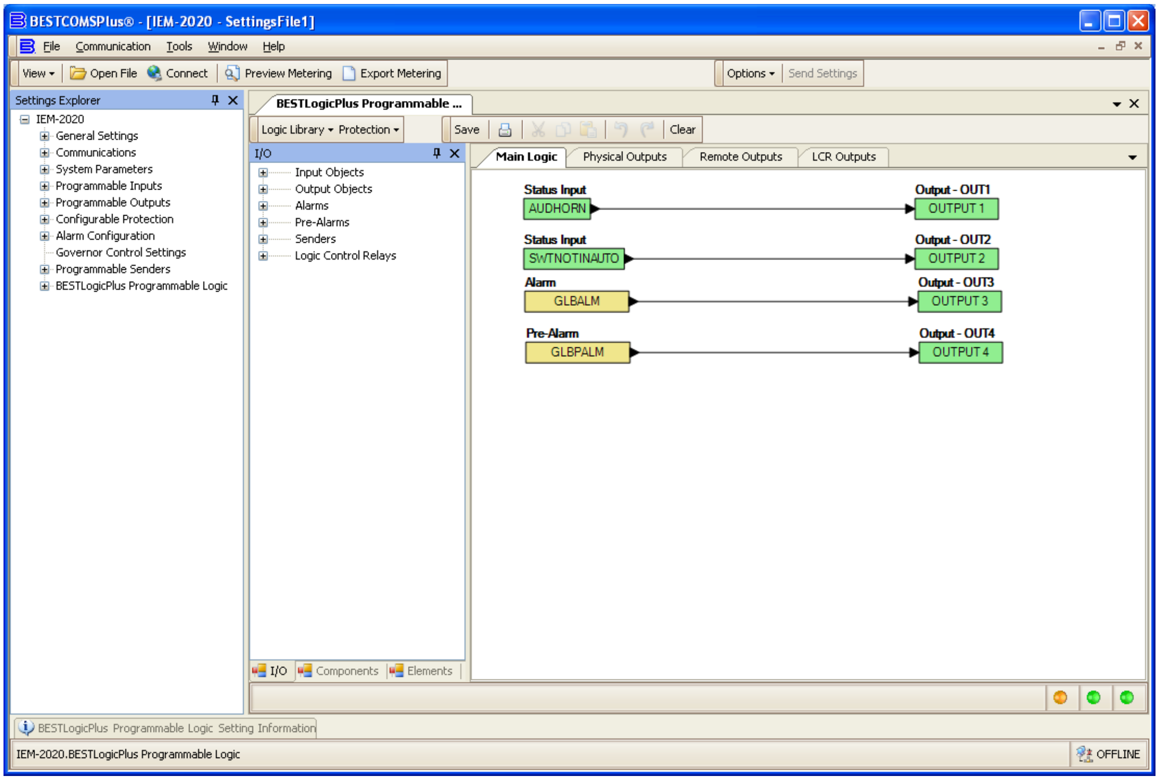


Figure 5-1. BESTlogicPlus Programmable Logic Tree Branch

BESTlogic*Plus* Composition

There are three main groups of objects used for programming BESTlogic*Plus*. These groups are *I/O, Components,* and *Elements.* For details on how these objects are used to program BESTlogic*Plus*, see the paragraphs on *Programming BESTlogicPlus.*

I/O

This group contains Input Objects, Output Objects, Alarms, Pre-Alarms, Senders, and Logic Control Relays. Table 5-1 lists the names and descriptions of the objects in the *I/O* group.

Table 5-1. I/O Group, Names and Descriptions

Name	Description	Symbol
Input Objects		
Logic 0	Always false (Low).	Fixed 0
Logic 1	Always true (High).	Fixed 1
Physical Inputs IN1 - IN16	True when Physical Input x is active.	**Input - IN1** INPUT 1
Remote Inputs IN17 - IN26	True when Remote Input x is active. (Available when an optional CEM-2020 is connected.)	**Input - IN17** INPUT 17
Virtual Inputs VIN1 - VIN4	True when Virtual Input x is active.	**Input - VIN1** VIN1
Status Input Alarm Silence	True when the Alarm Silence logic element is true or the Alarm Silence button is pressed on the front panel.	**Status Input** ALARMSILENCEIN

Name	Description	Symbol
Status Input Analog Expansion Module	Analog Expansion Module Connected. True when an optional AEM-2020 is connected to the IEM-2020.	Status Input AEMCONNECTED
Analog Expansion Module Remote Analog Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)	Status Input - RALGIN1O1 ALG IN 1
Analog Expansion Module Remote Analog Outputs 1-4	True when the analog output connection is open and the Out of Range Alarm Configuration is set to Status Only.	Status Input - RALGOUT1OOR Oil Pressure
Analog Expansion Module Remote RTD Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)	Status Input - RRTDIN1O1 RTD IN 1
Analog Expansion Module Remote Thermocouple Inputs 1-2	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)	Status Input - RTCIN1O1 THRM CPL 1
Status Input Auto Start Input	True when the Auto Start input is true or the Auto Start logic element is true.	Status Input AUTSTRTINSTATUS
Status Input Audible Horn	True when the Audible Horn is active.	Status Input AUDHORN
Status Input Auto Mode	True when the IEM-2020 is in Auto Mode or the Auto Mode logic element is true.	Status Input AUTOMODE
Status Input Auto Restart	True when the Automatic Restart function is active.	Status Input AUTORESTART
Status Input Battery Charger Fail	True when the Battery Charger Fail input is true.	Status Input BATTCHRGFAIL
Status Input Battle Override	True when the Battle Override input is true.	Status Input BATTLORIDE
Status Input Configurable Elements 1-8	True when the Configurable Element x logic element is true.	Status Input CONFIGELEMENT1
Status Input Configurable Protection 1-8	True when Over 1, Over 2, Under 1, or Under 2 is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)	Status Input - CONFPROT1O1 CONF PROT 1
Status Input Contact Expansion Module	Contact Expansion Module Connected. True when an optional CEM-2020 is connected to the IEM-2020.	Status Input CEMCONNECTED
Status Input Cool Down Timer Active	True when the Cool Down Timer is timing out.	Status Input CDOWNTMRACT

Name	Description	Symbol
Status Input Emergency Stop	True when the Emergency Stop button has been pressed.	Status Input EMERGSTOP
Status Input Engine Running	True while the Engine is Running.	Status Input ENGRUNNING
Status Input Exercise Test	True while the Engine is running in exercise mode.	Status Input EXERCTEST
Status Input Front Panel Buttons	True while the *AUTO* front panel button is pressed.	Status Input AUTOBUTTON
Status Input Front Panel Buttons	True while the *DOWN* front panel button is pressed.	Status Input DOWNBUTTON
Status Input Front Panel Buttons	True while the *EDIT* front panel button is pressed.	Status Input EDITBUTTON
Status Input Front Panel Buttons	True while the *LAMP TEST* front panel button is pressed.	Status Input LAMPBUTTON
Status Input Front Panel Buttons	True while the *LEFT* front panel button is pressed.	Status Input LEFTBUTTON
Status Input Front Panel Buttons	True while the *OFF* front panel button is pressed.	Status Input OFFBUTTON
Status Input Front Panel Buttons	True while the *RESET* front panel button is pressed.	Status Input RESETBUTTON
Status Input Front Panel Buttons	True while the *RIGHT* front panel button is pressed.	Status Input RIGHTBUTTON
Status Input Front Panel Buttons	True while the *RUN* front panel button is pressed.	Status Input RUNBUTTON
Status Input Front Panel Buttons	True while the *ALARM SILENCE* front panel button is pressed.	Status Input SILENCEBUTTON
Status Input Front Panel Buttons	True while the *UP* front panel button is pressed.	Status Input UPBUTTON
Status Input Fuel Leak	True when the Fuel Leak Detect input is true.	Status Input FUELLEAK
Status Input Global Low Coolant Level	True when the Low Coolant Level input is true.	Status Input GLBLOWCOOLLVL
Status Input In Alarm	True when the IEM-2020 is in an Alarm state.	Status Input INALARMSTATE
Status Input In Connecting	True when the IEM-2020 is in the Connecting state.	Status Input INCONNECTINGSTATE

Name	Description	Symbol
Status Input In Cooling	True when the IEM-2020 is in the Cooling State.	Status Input INCOOLINGSTATE
Status Input In Cranking	True when the IEM-2020 is in the Cranking state.	Status Input INCRANKINGSTATE
Status Input In Disconnect	True when the IEM-2020 is in the Disconnect state.	Status Input INDISCONNECTSTATE
Status Input In Idle	True when the IEM-2020 is in the Idle state.	Status Input INIDLESTATE
Status Input In Intermediate	True when the IEM-2020 is in the Intermediate state.	Status Input ININTERMEDIATESTATE
Status Input In Prestart	True when the IEM-2020 is in the Prestart state.	Status Input INPRESTARTSTATE
Status Input In Pulsing	True when the IEM-2020 is in the Pulsing state.	Status Input INPULSINGSTATE
Status Input In Ramp Down	True when the IEM-2020 is in the Ramp Down state.	Status Input INRAMPDOWNSTATE
Status Input In Ramp Up 1	True when the IEM-2020 is in the Ramp Up 1 state.	Status Input INRAMPUP1STATE
Status Input In Ramp Up 2	True when the IEM-2020 is in the Ramp Up 2 state.	Status Input INRAMPUP2STATE
Status Input In Ready	True when the IEM-2020 is in the Ready state.	Status Input INREADYSTATE
Status Input In Resting	True when the IEM-2020 is in the Resting state.	Status Input INRESTINGSTATE
Status Input In Running	True when the IEM-2020 is in the Running state.	Status Input INRUNNINGSTATE
Status Input Lamp Test	True when the Lamp Test logic element is true or the Lamp Test button is pressed on the front panel.	Status Input LAMPTESTIN
Status Input Load Share Module	Load Share Module Connected. True when an optional LSM-2020 is connected to the IEM-2020.	Status Input LSMCONNECTED
Status Input Local Analog Inputs	True when the Current Input connection is out of range and the Out of Range Alarm is configured as Status Only.	Status Input - LALGCUROOR Current Input
Status Input Local Analog Inputs	True when the Current Input Over 1 Alarm is configured as Status Only and the Over 1 threshold has been exceeded.	Status Input - LALGCURO1 Current Input
Status Input Local Analog Inputs	True when the Current Input Over 2 Alarm is configured as Status Only and the Over 2 threshold has been exceeded.	Status Input - LALGCURO2 Current Input

Name	Description	Symbol
Status Input Local Analog Inputs	True when the Current Input Under 1 Alarm is configured as Status Only and the Under 1 threshold has been exceeded.	Status Input - LALGCURU1 Current Input
Status Input Local Analog Inputs	True when the Current Input Under 2 Alarm is configured as Status Only and the Under 2 threshold has been exceeded.	Status Input - LALGCURU2 Current Input
Status Input Local Analog Inputs	True when the Voltage Input connection is out of range and the Out of Range Alarm is configured as Status Only.	Status Input - LALGVOLTOOR Voltage Input
Status Input Local Analog Inputs	True when the Voltage Input Over 1 Alarm is configured as Status Only and the Over 1 threshold has been exceeded.	Status Input - LALGVOLTO1 Voltage Input
Status Input Local Analog Inputs	True when the Voltage Input Over 2 Alarm is configured as Status Only and the Over 2 threshold has been exceeded.	Status Input - LALGVOLTO2 Voltage Input
Status Input Local Analog Inputs	True when the Voltage Input Under 1 Alarm is configured as Status Only and the Under 1 threshold has been exceeded.	Status Input - LALGVOLTU1 Voltage Input
Status Input Local Analog Inputs	True when the Voltage Input Under 2 Alarm is configured as Status Only and the Under 2 threshold has been exceeded.	Status Input - LALGVOLTU2 Voltage Input
Status Input Off Mode	True when the IEM-2020 is in Off Mode or the Off Mode logic element is true.	Status Input OFFMODE
Status Input Off Mode Cooldown	True when the IEM-2020 is in Off Mode and cooling down.	Status Input OFFMODECOOL
Status Input Pre Start Condition in Effect	True while in the Pre Start state.	Status Input PRESTCONDINEFFECT
Status Input Pre Start Input	True when the IEM-2020 is indicating that the Pre Start relay should be closed.	Status Input PRESTARTINPUT
Status Input Reset Active	True when the Reset logic element is true or when the Reset key on the front panel is pressed.	Status Input RESETACTIVE
Status Input Run Input	True when the IEM-2020 is indicating that the Run relay should be closed.	Status Input RUNINPUT
Status Input Run Mode	True when the IEM-2020 is in Run Mode or the Run Mode logic element is true.	Status Input RUNMODE
Status Input Seven Day Timer	True when a Sunday timer is running the engine.	Status Input SUNDAYEVENTACTIVE
Status Input Seven Day Timer	True when a Monday timer is running the engine.	Status Input MONDAYEVENTACTIVE
Status Input Seven Day Timer	True when a Tuesday timer is running the engine.	Status Input TUESDAYEVENTACTIVE
Status Input Seven Day Timer	True when a Wednesday timer is running the engine.	Status Input WEDNESDAYEVENTACTIVE

Name	Description	Symbol
Status Input Seven Day Timer	True when a Thursday timer is running the engine.	Status Input THURSDAYEVENTACTIVE
Status Input Seven Day Timer	True when a Friday timer is running the engine.	Status Input FRIDAYEVENTACTIVE
Status Input Seven Day Timer	True when a Saturday timer is running the engine.	Status Input SATURDAYEVENTACTIVE
Status Input Start Input	True when the IEM-2020 is indicating that the Start relay should be closed to start the engine.	Status Input STARTINPUT
Status Input Switch not in Auto	True when the IEM-2020 is not in Auto Mode.	Status Input SWTNOTINAUTO
Output Objects		
Physical Outputs OUT1 - OUTx	Physical Outputs 1 through 7 (style xxAxxxxxx) or 1 through 15 (style xxBxxxxxx).	Output - OUT1 OUTPUT 1
Remote Outputs OUT13 - OUT36	Remote Outputs 13 through 36. (Available when an optional CEM-2020 is connected.)	Output - OUT13 OUTPUT 13
Alarms		
Analog Expansion Module Remote Analog Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)	Alarm - RALGIN1O1ALM ALG IN 1
Analog Expansion Module Remote Analog Outputs 1-4	True when the analog output connection is open and the Out of Range Alarm Configuration is set to Alarm.	Alarm - RALGOUT1OORALM Oil Pressure
Analog Expansion Module Remote RTD Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)	Alarm - RRTDIN1O1ALM RTD IN 1
Analog Expansion Module Remote Thermocouple Inputs 1-2	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)	Alarm - RTCIN1O1ALM THRM CPL 1
Auto Restart Fail	True after the Automatic Restart function fails to restart the engine.	Alarm AUTORSTRTFAILALM
Battery Charger Fail	True when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.	Alarm BATTCHRGFAILALM
Configurable Protection Protection 1-8	True when Over 1, Over 2, Under 1, or Under 2 is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)	Alarm - CONFPROT1O1ALM CONF PROT 1
Coolant Level Sender Fail	True when a low coolant level error status code is received from the ECU. CAN Bus must be enabled.	Alarm COOLLVLSENDFAILALM

Name	Description	Symbol
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.	Alarm COOLTEMPSENDFAILALM
ECU Comm Loss	True when communication to ECU has been lost.	Alarm LOSSECUCOMMALM
ECU Shutdown	True when ECU has Shutdown the engine.	Alarm ECUSHUTDOWNALM
Emergency Stop	True when the Emergency Stop button has been pressed.	Alarm EMERGSTOPALM
Fuel Leak	True when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.	Alarm FUELLEAKALM
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.	Alarm FUELLSENDFAILALM
Global Alarm	True when one or more alarms are set.	Alarm GLBALM
Global Sender Fail	True when one or more of the Sender Fails are configured as alarms and are true.	Sender Fail GLBSENDFALM
Hi Coolant Temp	True when the High Coolant Temp Alarm settings have been exceeded.	Alarm HITEMPALM
Local Analog Inputs Current Input Out of Range	True when the Current Input connection is out of range the Out of Range Alarm is configured as Alarm.	Alarm - LALGCUROORALM Current Input
Local Analog Inputs Current Input Over 1	True when the Current Input Over 1 is configured as an alarm and the Over 1 threshold has been exceeded.	Alarm - LALGCURO1ALM Current Input
Local Analog Inputs Current Input Over 2	True when the Current Input Over 2 configured as an alarm and the Over 2 threshold has been exceeded.	Alarm - LALGCURO2ALM Current Input
Local Analog Inputs Current Input Under 1	True when the Current Input Under 1 configured as an alarm and the Under 1 threshold has been exceeded.	Alarm - LALGCURU1ALM Current Input
Local Analog Inputs Current Input Under 2	True when the Current Input Under 2 configured as an alarm and the Under 2 threshold has been exceeded.	Alarm - LALGCURU2ALM Current Input
Local Analog Inputs Voltage Input Out of Range	True when the Voltage Input connection is out of range and the Out of Range Alarm is configured as Alarm.	Alarm - LALGVOLTOORALM Voltage Input
Local Analog Inputs Voltage Input Over 1	True when the Voltage Input Over 1 configured as an alarm and the Over 1 threshold has been exceeded.	Alarm - LALGVOLTO1ALM Voltage Input

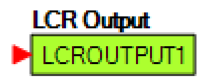
Name	Description	Symbol
Local Analog Inputs Voltage Input Over 2	True when the Voltage Input Over 2 configured as an alarm and the Over 2 threshold has been exceeded.	Alarm - LALGVOLTO2ALM Voltage Input
Local Analog Inputs Voltage Input Under 1	True when the Voltage Input Under 1 configured as an alarm and the Under 1 threshold has been exceeded.	Alarm - LALGVOLTU1ALM Voltage Input
Local Analog Inputs Voltage Input Under 2	True when the Voltage Input Under 2 configured as an alarm and the Under 2 threshold has been exceeded.	Alarm - LALGVOLTU2ALM Voltage Input
Low Coolant Level	True when the Low Coolant Level function is configured as an alarm and the activation delay has expired. In addition, true when CAN Bus is enabled and the Low Coolant Level Alarm threshold has been exceeded.	Alarm LOWCOOLLVLALM
Low Fuel Level	True when the Low Fuel Level Alarm settings have been exceeded.	Alarm LOWFUELLALM
Low Oil Pressure	True when the Low Oil Pressure Alarm settings have been exceeded.	Alarm LOWOILPRALM
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.	Alarm OILPRESSENDFAILALM
Overcrank	True when an Overcrank condition exists.	Alarm OCRANKALM
Overspeed	True when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPDALM
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Alarm SPDSENDFAILALM
Pre-Alarms		
Analog Expansion Module Analog Expansion Module Comm Fail	True when communication from the AEM-2020 to the IEM-2020 has been lost.	Pre-Alarm AEMCOMMFPALM
Analog Expansion Module Multiple Analog Expansion Modules Detected	True when more than one AEM-2020 is connected.	Pre-Alarm DUPAEMPALM
Analog Expansion Module Remote Analog Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm - RALGIN1O1PALM ALG IN 1

Name	Description	Symbol
Analog Expansion Module Remote Analog Outputs 1-4	True when the analog output connection is open and the Out of Range Alarm Configuration is set to pre-alarm.	Pre-Alarm - RALGOUT1OORPALM Oil Pressure
Analog Expansion Module Remote RTD Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm - RRTDIN1O1PALM RTD IN 1
Analog Expansion Module Remote Thermocouple Inputs 1-2	True when Over 1, Over 2, Under 1, or Under 2 is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm - RTCIN1O1PALM THRM CPL 1
Battery Charger Fail	True when the Battery Charger Fail function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm BATTCHRGFAILPALM
Battery Overvoltage	True when the Battery Overvoltage pre-alarm threshold has been exceeded.	Pre-Alarm BATOVOLTPALM
Checksum Failure	True when some of the user settings or firmware code has been corrupted. Refer to Section 4, *BESTCOMSPlus® Software, Alarm Configuration, Pre-Alarms,* for more details.	Pre-Alarm CHECKSUMFAILPALM
Configurable Protection Protection 1-8	True when Over 1, Over 2, Under 1, or Under 2 is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm - CONFPROT1O1PALM CONF PROT 1
Contact Expansion Module Multiple Contact Expansion Modules Connected	True when more than one CEM-2020 is connected.	Pre-Alarm DUPCEMPALM
Contact Expansion Module Contact Expansion Module Comm Fail	True when communication from the CEM-2020 to the IEM-2020 has been lost.	Pre-Alarm CEMCOMMFPALM
Contact Expansion Module Contact Expansion Modules Hardware Mismatch	True when the connected CEM-2020 does not have the same number of outputs as defined on the *System Parameters, Remote Module Setup* screen in BESTCOMS*Plus*.	Pre-Alarm CEMHWMISMATCHPALM
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm COOLTEMPSENDFAILPALM
Diag Trouble Code	True when a Diagnostic Trouble Code exists.	Pre-Alarm DIAGTRBCODEPALM

Name	Description	Symbol
DEF Engine Derate	This is the lowest level of inducement not to operate the engine when Diesel Exhaust Fluid (DEF) is low or of poor quality or there is a problem with the Exhaust After Treatment System (EATS). The engine is operating in a reduced power mode. Eventually the level of inducement will be increased unless the problem with the DEF or malfunction in the EATS is corrected.	Pre-Alarm DEFENGINEDERATEPALM
DEF Fluid Empty	True when the engine ECU reports via CAN Bus that Diesel Exhaust Fluid (DEF) is at a level below 8%.	Pre-Alarm DEFEMPTYPALM
DEF Fluid Low	True when the engine ECU reports via CAN Bus that the Diesel Exhaust Fluid (DEF) is at a level between 8 and 23%.	Pre-Alarm DEFLOWPALM
DEF Inducement Override	This pre-alarm indicates a temporary override of inducement not to operation the engine. This is set by the ECU and is not a user setting.	Pre-Alarm DEFINDUCEOVERRIDEPALM
DEF Pre-Severe Inducement	This pre-alarm indicates a high level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, after which it will enter a state of severe inducement unless the problem with the DEF or malfunction in the EATS is corrected.	Pre-Alarm DEFPRESEVEREINDUCEPALM
DEF Severe Inducement	This pre-alarm indicates the highest level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, or may be prevented from starting by the ECU until the problem is corrected. A service tool may be required to restart the engine.	Pre-Alarm DEFSEVEREINDUCEPALM
DPF Regenerate Disabled	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates that DPF regeneration is inhibited.	Pre-Alarm DPFREGENDISABLDPALM
DPF Regenerate Required	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates that DPF regeneration is required.	Pre-Alarm DPFREGENREQPALM
DPF Soot Level High	True when the engine ECU reports via CAN Bus that Diesel Particulate Filter (DPF) soot level is high.	Pre-Alarm DPFSOOTHIPALM
DPF Soot Level Moderately High	True when Diesel Particulate Filter (DPF) lamp status (yellow warning) broadcast over CAN Bus indicates that the soot level is moderately high.	Pre-Alarm DPFSOOTMODHIPALM
DPF Soot Level Severely High	True when Diesel Particulate Filter (DPF) lamp status (red warning) broadcast over CAN Bus indicates that the soot level is severely high.	Pre-Alarm DPFSOOTEXTHIPALM
ECU Com Loss	True when communication to ECU has been lost.	Pre-Alarm LOSSECUCOMMPALM
Fuel Leak	True when the Fuel Leak Detect function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLEAKPALM
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLSENDFAILPALM

Name	Description	Symbol
Global Pre-Alarm	True when one or more pre-alarms are set.	Pre-Alarm GLBPALM
Hi Coolant Temp	True when the High Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm HITEMPPALM
High Exhaust Temperature	True when Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates high exhaust temperature.	Pre-Alarm HIGHEXHTEMPPALM
High Fuel Level	True when the High Fuel Level Pre-Alarm settings have been exceeded.	Pre-Alarm HIFUELLPALM
Load Share Module Load Share Module Comm Fail	True when communication from the LSM-2020 to the IEM-2020 has been lost.	Pre-Alarm LSMCOMMFPALM
Load Share Module Multiple Load Share Modules Detected	True when more than one LSM-2020 is connected.	Pre-Alarm DUPLSMPALM
Local Analog Inputs Current Input Out of Range	True when the Current Input connection is out of range and the Out of Range Alarm is configured as Pre-Alarm.	Pre-Alarm - LALGCUROORPALM Current Input
Local Analog Inputs Current Input Over 1	True when the Current Input Over 1 is configured as a pre-alarm and the Over 1 threshold has been exceeded.	Pre-Alarm - LALGCURO1PALM Current Input
Local Analog Inputs Current Input Over 2	True when the Current Input Over 2 configured as a pre-alarm and the Over 2 threshold has been exceeded.	Pre-Alarm - LALGCURO2PALM Current Input
Local Analog Inputs Current Input Under 1	True when the Current Input Under 1 configured as a pre-alarm and the Under 1 threshold has been exceeded.	Pre-Alarm - LALGCURU1PALM Current Input
Local Analog Inputs Current Input Under 2	True when the Current Input Under 2 configured as a pre-alarm and the Under 2 threshold has been exceeded.	Pre-Alarm - LALGCURU2PALM Current Input
Local Analog Inputs Voltage Input Out of Range	True when the Voltage Input connection is out of range and the Out of Range Alarm is configured as Pre-Alarm.	Pre-Alarm - LALGVOLTOORPALM Voltage Input
Local Analog Inputs Voltage Input Over 1	True when the Voltage Input Over 1 configured as a pre-alarm and the Over 1 threshold has been exceeded.	Pre-Alarm - LALGVOLTO1PALM Voltage Input
Local Analog Inputs Voltage Input Over 2	True when the Voltage Input Over 2 configured as a pre-alarm and the Over 2 threshold has been exceeded.	Pre-Alarm - LALGVOLTO2PALM Voltage Input

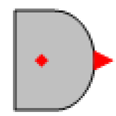
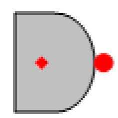
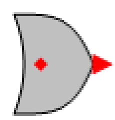
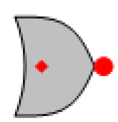
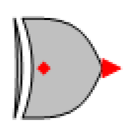
Name	Description	Symbol
Local Analog Inputs Voltage Input Under 1	True when the Voltage Input Under 1 configured as a pre-alarm and the Under 1 threshold has been exceeded.	Pre-Alarm - LALGVOLTU1PALM Voltage Input
Local Analog Inputs Voltage Input Under 2	True when the Voltage Input Under 2 configured as a pre-alarm and the Under 2 threshold has been exceeded.	Pre-Alarm - LALGVOLTU2PALM Voltage Input
Low Battery Voltage	True when the Low Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm LOWBATVPALM
Low Coolant Level	True when the Low Coolant Level function is configured as a pre-alarm and the activation delay has expired. In addition, true when CAN Bus is enabled and the Low Coolant Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWCOOLLVLPALM
Low Coolant Temp	True when the Low Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWTEMPPALM
Low Fuel Level	True when the Low Fuel Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWFUELLPALM
Low Oil Pressure	True when the Low Oil Pressure Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWOILPRPALM
Maintenance Interval	True when the Maintenance Interval Pre-Alarm threshold has been exceeded.	Pre-Alarm MAINTINTPALM
Max RPM Limit	True when the measured RPM rises above the Max Engine RPM setting.	Pre-Alarm MAXRPMLIMITPALM
Min RPM Limit	True when the measured RPM falls below the Min Engine RPM setting.	Pre-Alarm MINRPMLIMITPALM
MPU Fail	True when the MPU has failed.	Pre-Alarm MPUFAILPALM
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm OILPRESSENDFAILPALM
Weak Battery	True when the Weak Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm WEAKBATPALM
Senders		
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail COOLTEMPSENDFAIL
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail FUELLSENDFAIL
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail OILPRESSENDFAIL
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Sender Fail SPDSENDFAIL

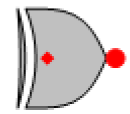
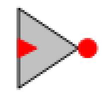
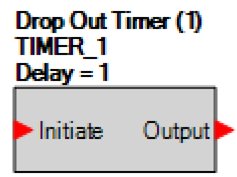
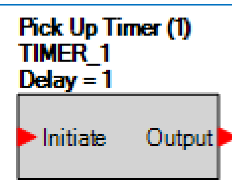
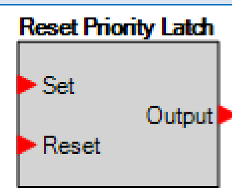
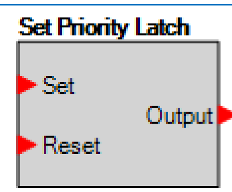
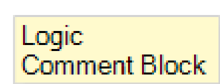
Name	Description	Symbol
Logic Control Relays		
The logic control relays (LCR) consist of LCR outputs and LCR inputs. You can use the output to terminate the "output" end of a logic network, and then use the corresponding input as an input to logic elsewhere in the logic scheme. When a given LCR output is true the corresponding LCR input is true. In other words, when LCR Output N (N being a number from 1 to 16) becomes true, then LCR Input N is true also. If you get a "too many logic levels" error while building a logic network, LCR outputs and inputs can be used as a solution to this problem. Place an LCR output on the end of the partial logic network and then use the corresponding LCR input to build more logic than was previously possible.		
Inputs Input 1-16	See description above.	
Outputs Output 1-16	See description above.	

Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, and Comment Blocks. Table 5-2 lists the names and descriptions of the objects in the *Components* group.

Table 5-2. Components Group, Names and Descriptions

Name	Description	Symbol
Logic Gates		
AND	Input | Output 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1	
NAND	Input | Output 0 0 | 1 0 1 | 1 1 0 | 1 1 1 | 0	
OR	Input | Output 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 1	
NOR	Input | Output 0 0 | 1 0 1 | 0 1 0 | 0 1 1 | 0	
XOR	Input | Output 0 0 | 0 0 1 | 1 1 0 | 1 1 1 | 0 When an XOR gate has more than 2 inputs, the output is true whenever an odd number of inputs are true.	

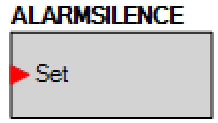
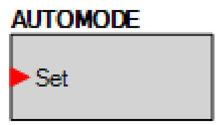
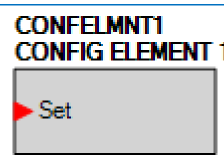
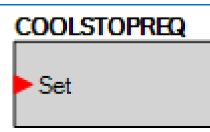
<table>
<tr><th>Name</th><th>Description</th><th>Symbol</th></tr>
<tr><td>XNOR</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>When an XNOR gate has more than 2 inputs, the output is true whenever an even number of inputs are true. The output is also true if no inputs are true.</td><td></td></tr>
<tr><td>NOT (INVERTER)</td><td><table><tr><th>Input</th><th>Output</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table></td><td></td></tr>
<tr><td colspan="3">Pickup and Dropout Timers</td></tr>
<tr><td>Drop Out Timer</td><td>Used to set a delay in the logic.
For more information, refer to Programming BESTlogicPlus, Pickup and Dropout Timers, later in this section.</td><td></td></tr>
<tr><td>Pickup Up Timer</td><td>Used to set a delay in the logic.
For more information, refer to Programming BESTlogicPlus, Pickup and Dropout Timers, later in this section.</td><td></td></tr>
<tr><td colspan="3">Latches</td></tr>
<tr><td>Reset Priority Latch</td><td>When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a reset priority latch will go to the RESET (OFF) state.</td><td></td></tr>
<tr><td>Set Priority Latch</td><td>When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a set priority latch will go to the SET (ON) state.</td><td></td></tr>
<tr><td colspan="3">Other</td></tr>
<tr><td>Comment Block</td><td>Enter user comments.</td><td></td></tr>
</table>

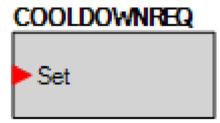
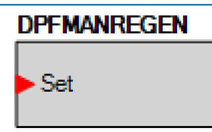
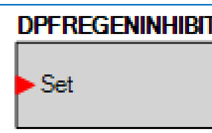
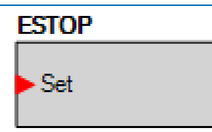
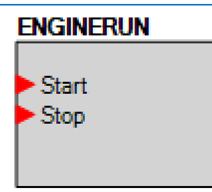
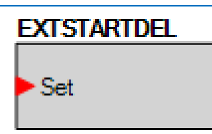
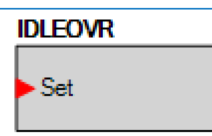
Elements

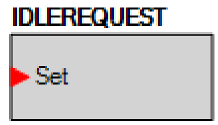
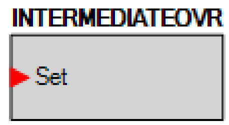
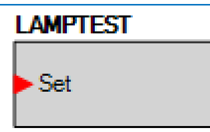
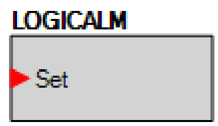
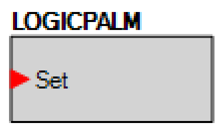
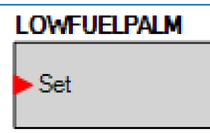
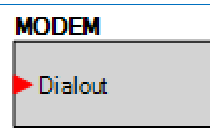
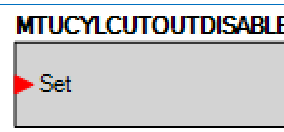
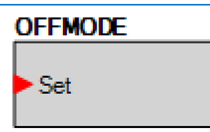
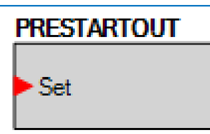
This group contains elements for Logic Alarm, Logic Pre-Alarm, Modem Control, Off Mode, Auto Mode, Run Mode, Configurable Elements 1-8, Engine Run, Auto Start, Run Inhibit, Test Inhibit, Prestart Output, Start Output, Run Output, Cool Down and Stop Request, Cool Down Request, External Start Delay, Start Delay Bypass, Reset, Alarm Silence, Lamp Test, Idle Request, DPF Manual Regeneration, DPF Regeneration Inhibit, Low Fuel Pre-Alarm, Emergency Stop, Speed Raise, Speed Lower, Idle State Override, Ramp Up 1 Override, Intermediate Override, Ramp Up 2 Override, Running Override, RPM Control, and MTU Cylinder Cutout Disable.

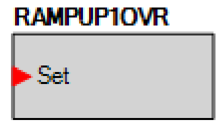
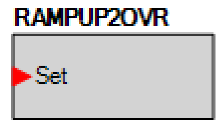
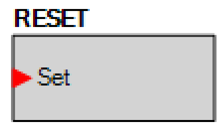
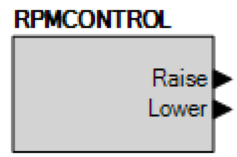
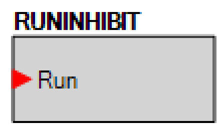
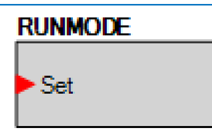
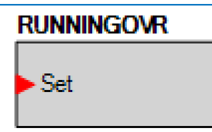
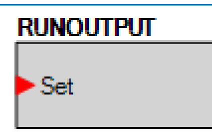
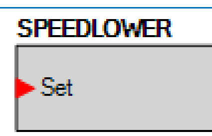
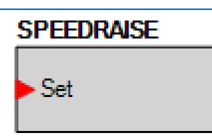
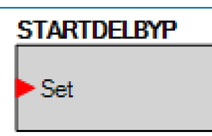
Table 5-3 lists the names and descriptions of the elements in the *Elements* group.

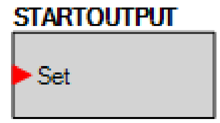
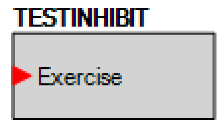
Table 5-3. Elements Group, Names and Descriptions

Name	Description	Symbol
ALARMSILENCE	The alarm will be silenced when this element is true. The alarm can also be silenced by pressing the Alarm Silence button on the front panel of the IEM-2020.	
AUTOSTART	When this logic element is true, and the IEM-2020 is in AUTO mode, the engine will run. This can be used in place of the Auto Start programmable function if it is desired to generate the Auto Start signal as a combination of programmable logic rather than a simple contact input. If either the Auto Start logic element is true or the contact mapped to the Auto Start programmable function is true, and the IEM-2020 is in AUTO mode, the engine will run. If both the Auto Start logic element and the Auto Start programmable function are false, and the IEM-2020 is in AUTO mode, the engine will cool down and stop.	
AUTOMODE	When this input is true, and the IEM-2020 is in OFF mode, the IEM-2020 will switch to AUTO mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	
CONFELMNTX (X = 1 to 8)	Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMS*Plus* under *Programmable Outputs, Configurable Elements.* The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or pre-alarm. If used for alarm or pre-alarm, the user's text is what will appear in the alarm or pre-alarm annunciation and in the IEM-2020 event log. In addition, the configurable element status can be used to generate modem dial outs which display the user's text on modem equipped IEM-2020's.	
COOLSTOPREQ	RUN Mode If the unit is in RUN mode when the Cool Stop Request is received, the unit will go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to OFF mode. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process, the unit will remain running. AUTO Mode If the unit is in AUTO mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in AUTO mode are cleared. Since all conditions that cause the unit to run have been removed, the unit goes into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in AUTO. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running.	

Name	Description	Symbol
COOLDOWNREQ	<u>RUN Mode</u> If the unit is in RUN mode when the Cool Down Request is received, the unit is forced to go into a cooldown cycle. While in the cool down cycle, the unit will display "COOLDOWN REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will remain running in RUN mode. If the Cool Down Request is removed during the cool down process, the unit will remain running in RUN mode. <u>AUTO Mode</u> If the unit is in AUTO mode and the Cool Down Request is received, the unit is forced to go into a cooldown cycle. While in the cooldown cycle, the unit will display "COOLDOWN REQ" in addition to displaying the cooldown timer. After the cool down timer expires, the unit will remain running in AUTO mode, unless there are no conditions that cause the unit to run in AUTO mode, in which case it will shut down and remain in AUTO mode. If the Cool Down Request is removed during the cool down process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running in AUTO mode.	
DPFMANREGEN	Diesel Particulate Filter Regeneration is forced manually when the Set input is true.	
DPFREGENINHIBIT	Diesel Particulate Filter Regeneration is inhibited when the Set input is true.	
ESTOP	When this element is true, an Emergency Shutdown alarm is annunciated and the Emergency Stop LED on the RDP-110 is illuminated.	
ENGINERUN	The Start input starts the engine. The Stop input stops the engine. The IEM-2020 only responds to this logic element when in AUTO mode.	
EXTSTARTDEL	If the Set input is true while the IEM-2020 is in the Pre Start state, the IEM-2020 will remain in the Pre Start state until the Set input is false.	
IDLEOVR	The RPM Profile is forced to the IDLE state when the Set input is true. For more information, refer to Section 3, *Functional Description, RPM Control, RPM Profile, State Override Logic Elements*.	

Name	Description	Symbol
IDLEREQUEST	When this element is true, the IEM-2020 will send an idle request to the engine ECU on J1939 engines that are equipped to receive such a request. At this time, only Volvo and Cummins are implemented. If the engine is not equipped to respond to idle requests, or the engine is not one of the listed J1939 engine types, this will have no effect.	
INTERMEDIATEOVR	The RPM Profile is forced to the INTERMEDIATE state when the Set input is true. For more information, refer to Section 3, *Functional Description, RPM Control, RPM Profile, State Override Logic Elements*.	
LAMPTEST	The lamp test will be performed when this element is true. The lamp test can also be accomplished by pressing the Lamp Test button on the front panel of the IEM-2020.	
LOGICALM	When this input is true, the IEM-2020 goes into an alarm condition.	
LOGICPALM	When this input is true, the IEM-2020 goes into a Pre-alarm condition.	
LOWFUELPALM	When this element is true, a Low Fuel Pre-Alarm is annunciated and the Low Fuel Level LED on the RDP-110 is illuminated.	
MODEM (Optional)	Connect the input to the output of another logic block. When true, the Modem will dial out.	
MTUCYLCUTOUTDISABLE	When this logic element is true, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are both sent to the engine ECU with true status. When this logic element is false, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are sent to the engine ECU with states set by the values programmed for the Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 IEM-2020 settings which are configured on the ECU Setup screen in BESTCOMS*Plus*.	
OFFMODE	When this input is true, the IEM-2020 will switch to OFF mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	
PRESTARTOUT	This element is used to drive the prestart output relay from logic when the Prestart Output Relay configuration is set to “Programmable”. When the Prestart Output Relay configuration is set to “Programmable”, the prestart relay will not close unless logic is used to drive this element. When the Prestart Output Relay configuration is set to “Predefined”, the prestart relay is closed according to the predefined prestart functionality of the IEM-2020. When the “Predefined” functionality is selected, the relay will not respond to this element.	

Name	Description	Symbol
RAMPUP1OVR	The RPM Profile is forced to the RAMP UP 1 state when the Set input is true. For more information, refer to Section 3, *Functional Description, RPM Control, RPM Profile, State Override Logic Elements*.	
RAMPUP2OVR	The RPM Profile is forced to the RAMP UP 2 state when the Set input is true. For more information, refer to Section 3, *Functional Description, RPM Control, RPM Profile, State Override Logic Elements*.	
RESET	Reset will be active when this element is true. Reset can also be accomplished by pressing the Reset button on the front panel of the IEM-2020.	
RPMCONTROL	This logic element provides raise/lower ability to set the desired engine rpm on engines that do not accept speed requests over CANBus. For more information, refer to Section 3, Functional Description, RPM Control.	
RUNINHIBIT	When this logic element is true, the IEM-2020 is prevented from starting and running the engine, regardless of any condition that would normally cause the generator to run. If this element is false and there is <u>any</u> condition in effect which will cause the engine to run, the IEM-2020 will start and run the engine.	
RUNMODE	When this input is true, and the IEM-2020 is in OFF mode, the IEM-2020 will switch to RUN mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	
RUNNINGOVR	The RPM Profile is forced to the RUNNING state when the Set input is true. For more information, refer to Section 3, *Functional Description, RPM Control, RPM Profile, State Override Logic Elements*.	
RUNOUTPUT	This element is used to drive the run output relay from logic when the Run Output Relay configuration is set to "Programmable". When the Run Output Relay configuration is set to "Programmable", the run relay will not close unless logic is used to drive this element. When the Run Output Relay configuration is set to "Predefined", the run relay is closed according to the predefined run functionality of the IEM-2020. When the "Predefined" functionality is selected, the relay will not respond to this element.	
SPEEDLOWER	This element lowers the speed setting of the IEM-2020 based on the RPM Up/Down Rate setting.	
SPEEDRAISE	This element raises the speed setting of the IEM-2020 based on the RPM Up/Down Rate setting.	
STARTDELBYP	This element allows the Pre Start state to be skipped based on logic. For example, a start delay may not be necessary when the engine is warm. This also allows an external device, such as an ECU, to control the pre start interval.	

Name	Description	Symbol
STARTOUTPUT	This element is used to drive the start output relay from logic when the Start Output Relay configuration is set to “Programmable”. When the Start Output Relay configuration is set to “Programmable”, the start relay will not close unless logic is used to drive this element. When the Start Output Relay configuration is set to “Predefined”, the start relay is closed according to the predefined start functionality of the IEM-2020. When the “Predefined” functionality is selected, the relay will not respond to this element.	
TESTINHIBIT	When this logic element is true, the generator exercise timer cannot start the generator. If the TESTINHIBIT logic function is false during an exercise period, or transitions from true to false at any time during an exercise period, the IEM-2020 will start and run the engine for the duration of the exercise period.	

Logic Schemes

A logic scheme is a group of logic variables written in equation form that defines the operation of an IEM-2020 Industrial Engine Module. Each logic scheme is given a unique name. This gives you the ability to select a specific scheme and be confident that the selected scheme is in operation. One logic scheme is configured for typical control applications and is the default active logic scheme. Only one logic scheme can be active at a given time. In most applications, preprogrammed logic schemes eliminate the need for custom programming. Preprogrammed logic schemes may provide more inputs, outputs, or features than are needed for a particular application. This is because a preprogrammed scheme is designed for a large number of applications with no special programming required. Unneeded logic block outputs may be left open to disable a function or a function block can be disabled through operating settings.

12 pre-programmed logic schemes are available in the BESTCOMS*Plus* installation directory on your PC. Detailed information on all pre-programmed logic schemes is available in Appendix B, *Logic Library Files.* These logic schemes were developed for the initial release of the IEM-2020 and implement a variety of typical pump applications. However, with the addition of the RPM profile features, many of the features in these schemes are now standard functionality. It is anticipated that much simpler logic can now accomplish most of the features that are implemented in the pre-programmed logic schemes.

When a custom logic scheme is required, programming time is reduced by modifying the default logic scheme.

WARNING!
The logic library files in this manual are intended to be used as basic logic configuration on which to build a complete logic scheme suitable for the application. The default logic scheme and logic library files may not be configured with adequate protection, time delays, and/or limits for every application. Carefully review these files and other settings within the IEM-2020 to be certain that they are appropriate for your application.

The Active Logic Scheme

Industrial Engine Modules must have an active logic scheme in order to function. All Basler Electric IEM-2020’s are delivered with a default, active logic scheme pre-loaded in memory. If the function block configuration and output logic of the default logic scheme meets the requirements of your application, then only the operating settings (system parameters and threshold settings) need to be adjusted before placing the IEM-2020 in service.

Copying and Renaming Preprogrammed Logic Schemes

Copying a saved logic scheme to the active logic (*Logic Name*) and assigning a unique name is accomplished by loading the saved logic scheme into BESTCOMS*Plus* and then typing over the logic scheme's name. Changes are not activated until the new settings have been saved and uploaded to the device.

Sending and Retrieving Logic Schemes

Retrieving a Logic Scheme from the IEM-2020

To retrieve settings from the IEM-2020, the IEM-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the IEM-2020 by selecting *Download Settings and Logic* on the *Communication* pull-down menu.

Sending a Logic Scheme to the IEM-2020

To send settings to the IEM-2020, the IEM-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the IEM-2020 by selecting *Upload Settings and Logic* on the *Communication* pull-down menu.

CAUTION
Always remove the IEM-2020 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the IEM-2020 is in service could generate unexpected or unwanted outputs. Modifying a logic scheme in BESTCOMS*Plus* does not automatically make that scheme active in the IEM-2020. The modified scheme must be uploaded into the IEM-2020.

Programming BESTlogicPlus

Use BESTCOMS*Plus* to program BESTlogic*Plus*. Using BESTCOMS*Plus* is analogous to physically attaching wire between discrete IEM-2020 terminals. To program BESTlogic*Plus*, use the Settings Explorer within BESTCOMS*Plus* to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 5-1.

The drag and drop method is used to connect a variable or series of variables to the logic inputs, outputs, components, and elements. To draw a wire/link from port to port (triangles), click the left mouse button on a port, pull the wire onto another port, and release the left mouse button. A red port indicates that a connection to the port is required or missing. A black port indicates that a connection to the port is not required. Drawing wires/links from input to input or output to output is not allowed. Only one wire/link can be connected to any one output. If the proximity of the endpoint of the wire/link is not exact, it may attach to an unintended port.

If an object or element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element. A red X indicates that an object or element is not available per the style number of the IEM-2020.

The view of the Main Logic, Physical Outputs, Remote Outputs, and LCR Outputs can be automatically arranged by clicking the right mouse button on the window and selecting *Auto-Layout.*

The following must be met before BESTCOMS*Plus* will allow logic to be uploaded to the IEM-2020:

- A minimum of two inputs and a maximum of four inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of five logic levels for any particular path. A path being an input block or an output side of an element block through gates to an output block or an input side of an element block. This is to include any OR gates on the Physical Output or Remote Output tab/pages, but not the matched pairs of Physical Output blocks or Remote Output blocks.
- Only 25 gates per logic level. All output blocks and input sides of element blocks are at the maximum logic level of the diagram. All gates are pushed forward/upwards in logic levels and buffered to reach the final output block or element block if needed. A maximum of 60 gates allowed per diagram.
- At all levels there can only be 96 used link/wired or endpoints. Endpoints being inputs, outputs, both sides of element blocks.

Three status LEDs are located in the lower right corner of the BESTlogic*Plus* window. These LEDs show the *Logic Save Status*, *Logic Diagram Status*, and *Logic Layer Status*. Table 5-4 defines the colors for each LED.

Table 5-4. Status LEDs

LED	Color	Definition
Logic Save Status (Left LED)	Orange	Logic has changed since last save.
	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.
Logic Layer Status (Right LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.

Pickup and Dropout Timers

A pickup timer produces a true output when the elapsed time is greater than or equal to the Pickup Time setting after a false to true transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to false, the output transitions to false immediately.

A drop out timer produces a true output when the elapsed time is greater than or equal to the Dropout Time setting after a true to false transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to true, the output transitions to false immediately.

Refer to Figure 5-2, *Pickup and Dropout Logic Timer Blocks.*

To program logic timer settings, use the Settings Explorer within BESTCOMS*Plus* to open the *BESTlogicPlus Programmable Logic/Logic Timers* tree branch. Enter a *Name* label that you want to appear on the timer logic block. The *Time Delay* value range is 0 to 250 hours in 1 hour increments, 0 to 250 minutes in 1 minute increments, or 0 to 1,800 seconds in 0.1 second increments.

Next, open the *Components* tab inside the BESTlogic*Plus* window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the *Logic Timers* tree branch. The *Logic Timer Properties Dialog Box* will appear. Select the timer you want to use.

Timing accuracy is ±15 milliseconds.

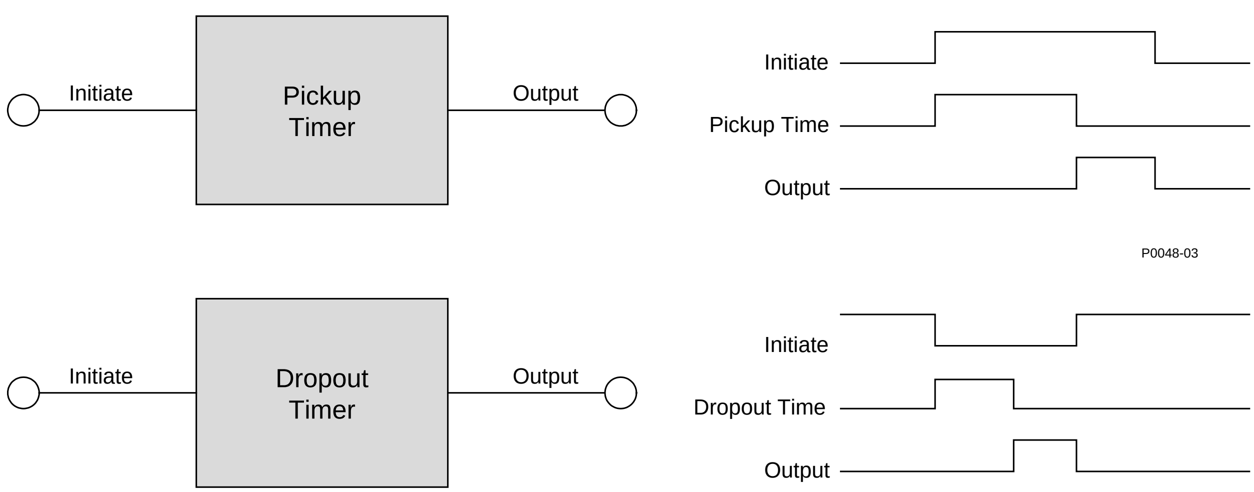


Figure 5-2. Pickup and Dropout Timer Logic Blocks

BESTlogicPlus File Management

To manage BESTlogic*Plus* files, use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch. Use the BESTlogic*Plus* Programmable Logic toolbar to manage BESTlogic*Plus* files. Refer to Figure 5-3. For information on Settings Files management, refer to Section 4, *BESTCOMSPlus® Software.*

Figure 5-3. BESTlogicPlus Programmable Logic Toolbar

Saving a BESTlogicPlus File

After programming BESTlogic*Plus* settings, click on the *Save* button to save the settings to memory.

Before the new BESTlogic*Plus* settings can be uploaded to the IEM-2020, you must select *Save* from the *File* pull-down menu located at the top of the BESTCOMS*Plus* main shell. This step will save both the BESTlogic*Plus* settings and the operating settings to a file.

The user also has the option to save the BESTlogic*Plus* settings to a unique file that contains only BESTlogic*Plus* settings. Click on the *Logic Library* drop-down button and select *Save Logic Library File.* Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename to save as.

Opening a BESTlogicPlus File

To open a saved BESTlogic*Plus* file, click on the *Logic Library* drop-down button on the BESTlogic*Plus* Programmable Logic toolbar and select *Open Logic Library File.* Use normal Windows techniques to browse to the folder where the file is located.

To open one of the 12 pre-programmed logic schemes, click on the *Logic Library* drop-down button on the BESTlogic*Plus* Programmable Logic toolbar and select *View Device's Logic Library File.*

Protecting a BESTlogicPlus File

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The locked object(s) cannot be changed. To view the lock status of the object(s), select *Show Lock Status* from the *Protection* drop-down menu. To lock object(s), use the mouse to select object(s) to be locked. Right click on the selected object(s) and select *Lock Object(s).* The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select *Protect Logic Document* from the *Protection* drop-down button. A password is optional.

Uploading a BESTlogicPlus File

To upload a BESTlogic*Plus* file to the IEM-2020, you must first open the file through BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. Then pull down the *Communication* menu and select *Upload Logic.*

Downloading a BESTlogicPlus File

To download a BESTlogic*Plus* file from the IEM-2020, you must pull down the *Communication* menu and select *Download Logic*. If the logic in your BESTCOMS*Plus* has changed, a dialog box will open asking you if want to save the current logic changes. You may choose *Yes* or *No*. After you have taken the required action to save or not save the current logic, the downloading is executed.

Printing a BESTlogicPlus File

To view a preview of the printout, click on the *Print Preview* icon located on the BESTlogic*Plus* Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by clicking on the *Printer* icon on the BESTlogic*Plus* Programmable Logic toolbar. A dialog box, *Select Views to Print* opens allowing you to check which views you would like to print. Next, the *Print* dialog box opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

A *Page Setup* icon is also provided on the BESTlogic*Plus* Programmable Logic toolbar allowing you to select *Paper Size, Paper Source, Orientation,* and *Margins.*

Clearing the On-Screen Logic Diagram

Click on the *Clear* button to clear the on-screen logic diagram and start over.

Example 1 - RPMCONTROL Logic Block Connections

Figure 5-4 illustrates the RPM Control logic block and two output logic blocks. Output 6 is active while the RPM is being raised and Output 9 is active while the RPM is being lowered.

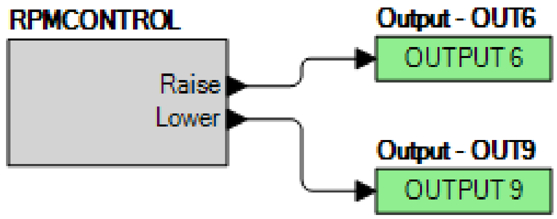


Figure 5-4. Example 1 - RPM Control Logic Block Connections

Example 2 - AND Gate Connections

Figure 5-5 illustrates a typical AND gate connection. In this example, Output 11 will become active when the Low Fuel alarm AND the Low Oil Pressure alarm are true.

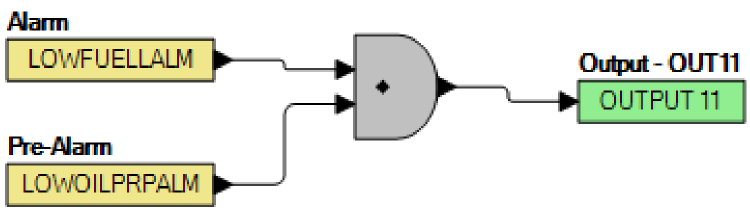


Figure 5-5. Example 2 - AND Gate Connections

SECTION 6 • INSTALLATION

TABLE OF CONTENTS

Figures

Tables

SECTION 6 • INSTALLATION

General

IEM-2020 modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a unit, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Hardware

IEM-2020 modules are packaged for mounting in any top-mount enclosure. The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. IEM-2020 modules are mounted using the four permanently attached 10-24 studs. The torque applied to the mounting hardware should not exceed 25 inch-pounds (2.8 Newton meters).

Mounting

Panel cutting and drilling dimensions are shown in Figure 6-1. The horizontal drilling measurement of 10.75 inches has a tolerance of +0.01/-0.01 inches. The horizontal cutout measurement of 10.38 inches has a tolerance of +0.04/-0 inches. The vertical drilling measurement of 7.25 inches has a tolerance of +0.01/-0.01 inches. The vertical cutout measurement of 6.88 inches has a tolerance of +0.04/-0. Figure 6-2 shows overall dimensions. Dimensions are in inches with millimeters in parenthesis.

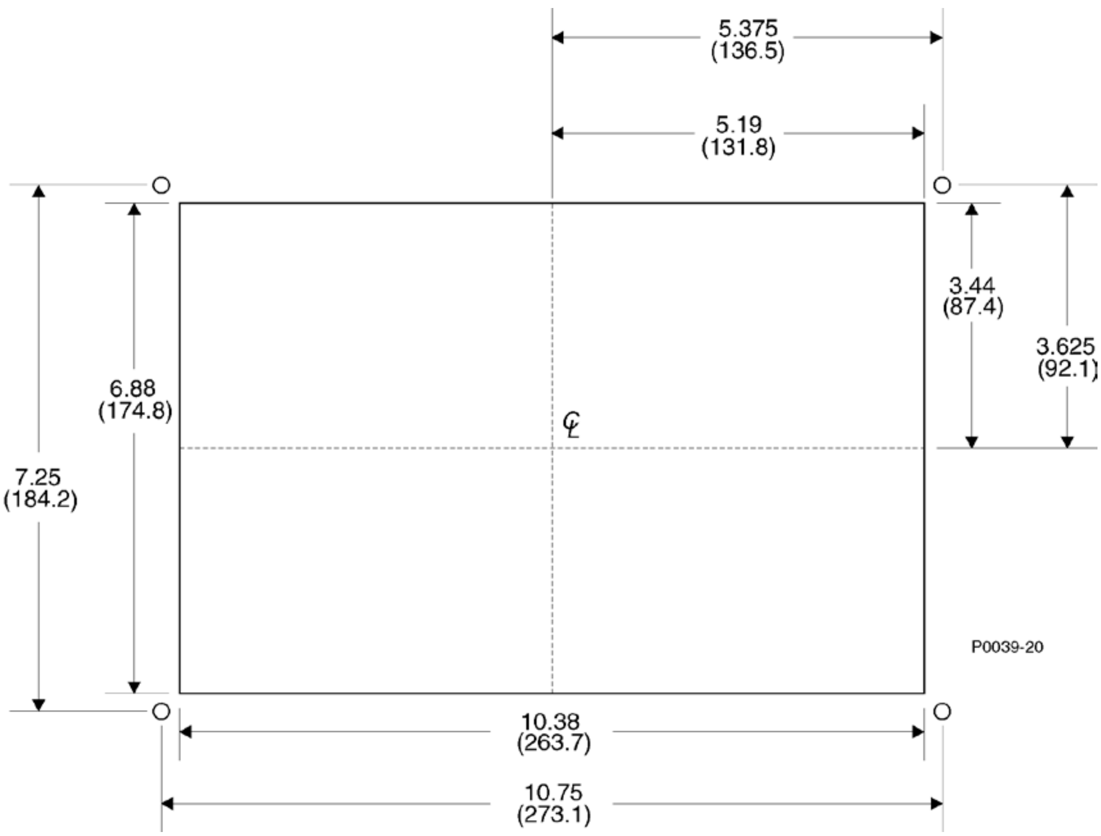


Figure 6-1. Panel Cutting and Drilling Dimensions

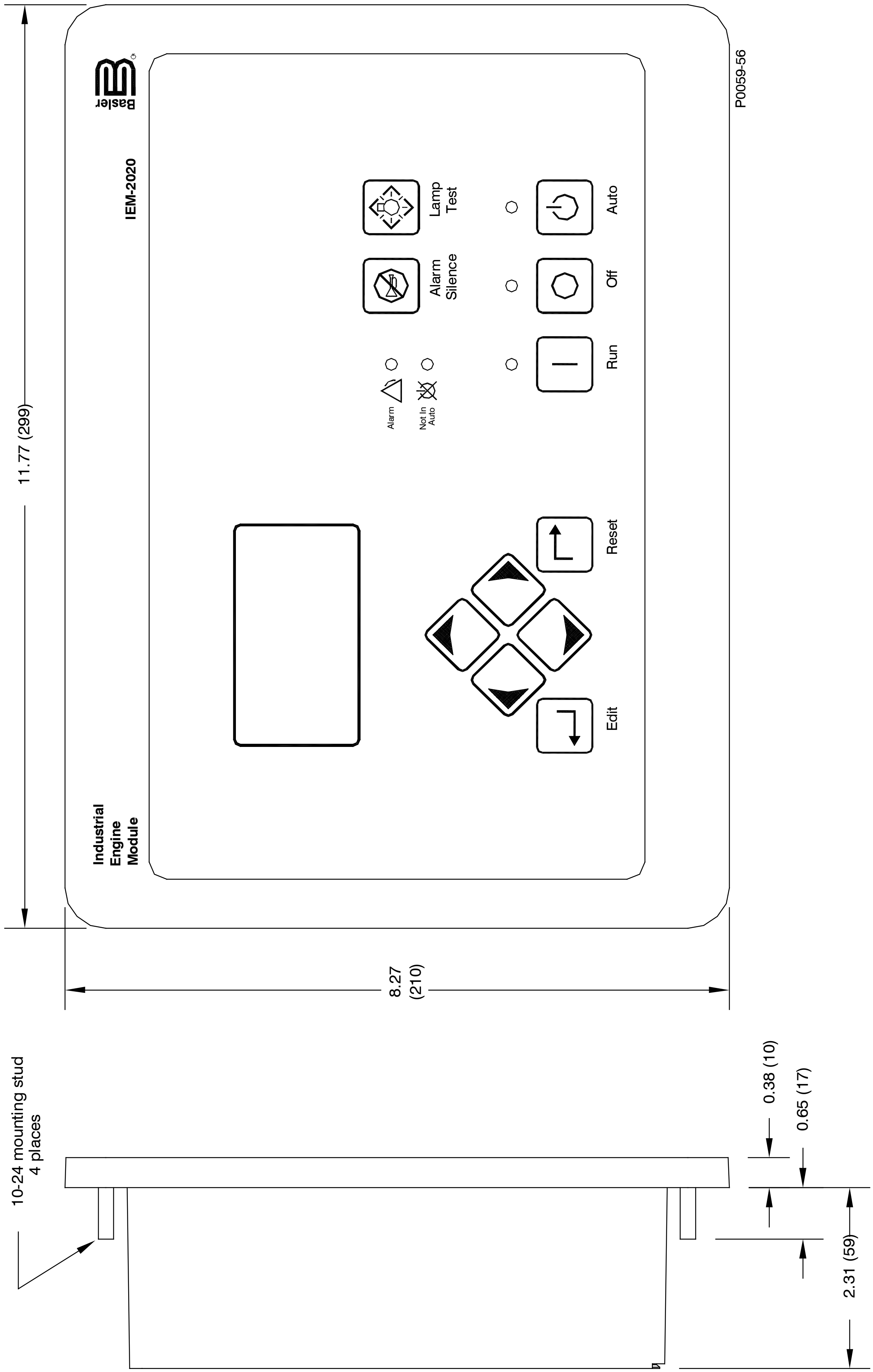


Figure 6-2. Overall Dimensions

Connections

IEM-2020 connections are dependent on the application. Incorrect wiring may result in damage to the controller.

> **NOTES**
>
> Be sure that the IEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal (terminal 1) on the rear of the controller.
>
> Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the IEM-2020 will not operate.

Terminations

All IEM-2020 terminals are located on the rear panel of the controller. There are three types of interface terminals: a mini-B USB socket, plug-in connectors with screw-down compression terminals, and quarter-inch, male, quick-connect terminals. Controllers equipped with the optional, internal dial-out modem have an additional RJ-11 jack.

The mini-B USB socket mates with a standard USB cable and provides local communication between the IEM-2020 and a PC running BESTCOMS*Plus*® software.

The majority of IEM-2020 connections are made with 15-position connectors with screw-down compression terminals. These connectors plug into headers on the IEM-2020. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 4 inch-pounds (0.45 N•m).

Connections to the IEM-2020 starter, fuel solenoid, and glow plug output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at these terminals.

The following paragraphs describe IEM-2020 terminal groups.

Operating Power

The IEM-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the IEM-2020 will not operate. Table 6-1 lists operating power terminals.

Basler Electric recommends adding a fuse for additional protection for the wiring to the battery input of the IEM-2020. A Bussmann ABC-7 fuse or equivalent will help prevent wire damage and nuisance trips due to initial power supply inrush current.

Table 6-1. Operating Power Terminals

Terminal	Description
1 (CHASSIS)	Chassis ground connection
2 (BATT–)	Negative side of operating power input
3 (BATT+)	Positive side of operating power input

Analog Engine Sender Inputs

Inputs are provided for oil pressure, fuel level, and coolant temperature senders.

Oil pressure senders that are compatible with the IEM-2020 include Datcon 02505-00, Isspro model R8919, Stewart-Warner models 279BF, 279C, 411K, and 411M, and VDO models 360025 and 360811. Other senders may be used.

Compatible fuel level senders include Isspro model R8925. Other senders may be used.

Coolant temperature senders that are compatible with the IEM-2020 include Datcon 02019-00, Faria TS4042, Isspro model R8959 and Stewart-Warner model 334-P. Other senders may be used.

Sender input terminals are listed in Table 6-2.

Table 6-2. Sender Input Terminals

Terminal	Description
8 (OIL)	Oil pressure sender input
9 (FUEL)	Fuel level sender input
10 (COOLANT)	Coolant temperature sender input
11 (SENDER COM)	Sender return terminal

Emergency Stop Input

The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the connection from terminal 46 (ESTOP) to ground is removed. See Figure 6-3. The ESTOP can be up to 75 ft (22 m) away from the IEM-2020 using a maximum wire length of 150 ft (45 m). Emergency stop input terminals are listed in Table 6-3. Terminal 47 is only used in the *Optional Wiring Method* below.

Table 6-3. Emergency Stop Input Terminals

Terminal	Description
46 (ESTOP)	Emergency stop contact input
47 (ESTOP)	

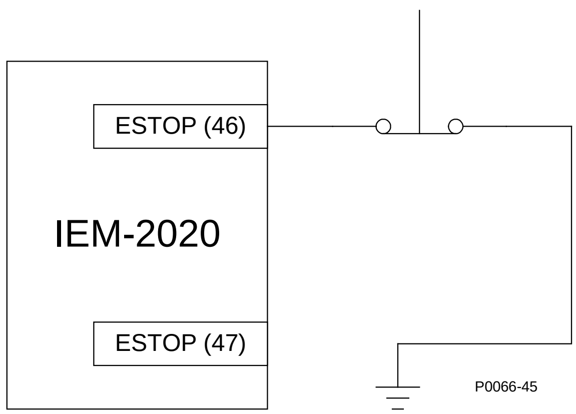


Figure 6-3. Emergency Stop Input Connections

Optional ESTOP Wiring Method

The following describes an optional wiring method for the emergency stop input. This method is no longer preferred. The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the short-circuit across the input is removed. See Figure 6-4. The ESTOP can be up to 75 ft (22 m) away from the IEM-2020 using a maximum wire length of 150 ft (45 m). Emergency stop input terminals are listed in Table 6-3.

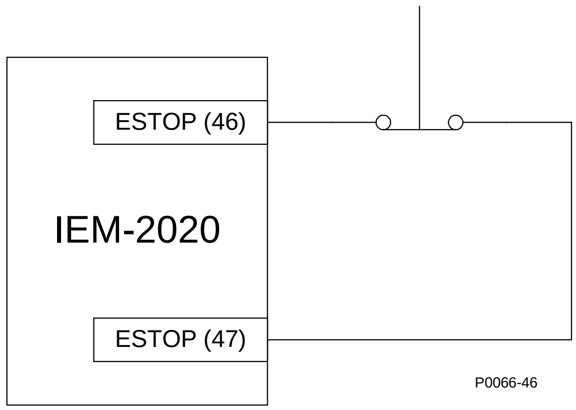


Figure 6-4. Emergency Stop Input Connections (Optional Wiring Method)

Magnetic Pickup Input

The magnetic pickup input accepts a speed signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz. Table 6-4 lists magnetic pickup input terminals.

Table 6-4. Magnetic Pickup Input Terminals

Terminal	Description
31 (MPU+)	Magnetic pickup positive input
32 (MPU–)	Magnetic pickup return input

Contact Sensing Inputs

Contact sensing inputs consist of 1 emergency stop input and 16 programmable inputs.

The programmable inputs accept normally open, dry contacts. Terminal 2 (BATT–) serves as the common return line for the programmable inputs. Section 4, *BESTCOMSPlus Software* provides information about configuring the programmable inputs.

Table 6-5 lists contact sensing input terminals.

Table 6-5. Contact Sensing Inputs

Terminal	Description
2 (BATT–)	Common return line for programmable contact inputs
15 (INPUT 16)	Programmable contact input 16
16 (INPUT 15)	Programmable contact input 15
17 (INPUT 14)	Programmable contact input 14
18 (INPUT 13)	Programmable contact input 13
19 (INPUT 12)	Programmable contact input 12
20 (INPUT 11)	Programmable contact input 11
21 (INPUT 10)	Programmable contact input 10
22 (INPUT 9)	Programmable contact input 9
23 (INPUT 8)	Programmable contact input 8
24 (INPUT 7)	Programmable contact input 7
25 (INPUT 6)	Programmable contact input 6
26 (INPUT 5)	Programmable contact input 5
27 (INPUT 4)	Programmable contact input 4
28 (INPUT 3)	Programmable contact input 3

Terminal	Description
29 (INPUT 2)	Programmable contact input 2
30 (INPUT 1)	Programmable contact input 1

Output Contacts

The IEM-2020 has three sets of fixed-function output contacts: Pre, Start, and Run. The Pre contacts supply battery power to the engine glow plugs, the Start contacts supply power to the start solenoid, and the Run contacts supply power to the fuel solenoid. Connections to the three sets of contacts are made directly at each relay using female, quarter-inch, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at each relay. For the location of the Pre, Start, and Run relays refer to Figure 2-2.

Depending on the style number, the IEM-2020 provides either 4 or 12 sets of programmable output contacts. IEM-2020 modules with a style number of xxAxxxxxx provide four programmable outputs. Modules with a style number of xxAxxxxxx provide 12 programmable outputs. Programmable output contact terminals are listed in Table 6-6.

Table 6-6. Programmable Output Contact Terminals

Terminal	Description
51 (COM 1, 2, 3)	Common connection for outputs 1, 2, and 3
52 (OUT 1)	Programmable output 1
53 (OUT 2)	Programmable output 2
54 (OUT 3)	Programmable output 3
55 (COM 4, 5, 6)	Common connection for outputs 4, 5, and 6
56 (OUT 4)	Programmable output 4
57 (OUT 5)	Programmable output 5
58 (OUT 6)	Programmable output 6
59 (COM 7, 8, 9)	Common connection for outputs 7, 8, and 9
60 (OUT 7)	Programmable output 7
61 (OUT 8)	Programmable output 8
62 (OUT 9)	Programmable output 9
63 (COM 10, 11, 12)	Common connection for outputs 10, 11, and 12
64 (OUT 10)	Programmable output 10
65 (OUT 11)	Programmable output 11
66 (OUT 12)	Programmable output 12

Analog Inputs

Analog inputs consist of a 0 to 10 Vdc voltage input and a 4 to 20 mAdc current input. Table 6-7 lists analog input terminals.

Table 6-7. Analog Input Terminals

Terminal	Description
35 (AIN I+)	Analog input positive current
37 (AIN I–)	Analog input negative current
43 (AIN V+)	Analog input positive voltage
45 (AIN V–)	Analog input negative voltage

USB Interface

A mini-B USB socket enables local communication with a PC running BESTCOMS*Plus* software. The IEM-2020 is connected to a PC using a standard USB cable equipped with a type A plug on one end (PC termination) and a mini-B plug on the other end (IEM-2020 termination).

RS-485 Communication Port

IEM-2020 modules with the optional RS-485 communication port (style number xxxRxxxxx) are equipped for polled communication over a Modbus™ network. Basler Electric recommends using twisted-pair, shielded cable for RS-485 port connections. Table 6-8 lists RS-485 communication port terminals.

Table 6-8. RS-485 Communication Port Terminals

Terminal	Description
12 (485 SHIELD)	Shield connection for RS-485 cable
13 (485B)	RS-485 send/receive B connection
14 (485A)	RS-485 send/receive A connection

CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol or the MTU protocol and provide high-speed communication between the IEM-2020 and an MTU engine ECU on an electronically controlled engine. Connections between the MTU engine ECU and IEM-2020 should be made with twisted-pair, shielded cable. Table 6-9 lists CAN Bus interface terminals. Refer to Figure 6-5 and Figure 6-6.

Table 6-9. CAN Bus Interface Terminals

Terminal	Description
48 (CAN L)	CAN low connection
49 (CAN H)	CAN high connection
50 (SHIELD)	CAN drain connection

NOTES

1. If the IEM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals 48 (CANL) and 49 (CANH).
2. If the IEM-2020 is not part of the J1939 bus, the stub connecting the IEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the IEM-2020.

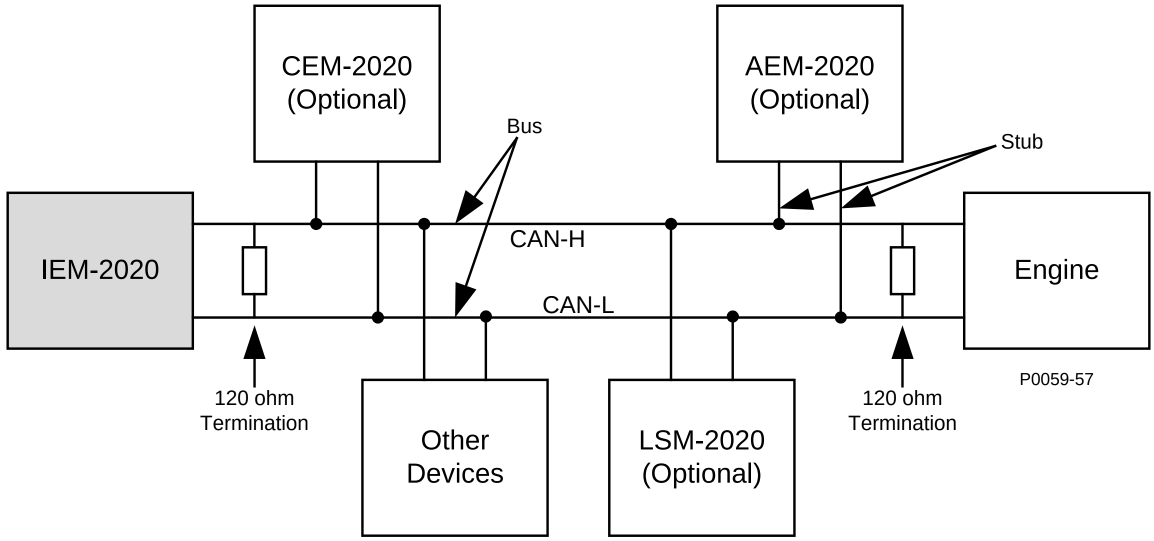


Figure 6-5. CAN Bus Interface with IEM-2020 providing One End of the Bus

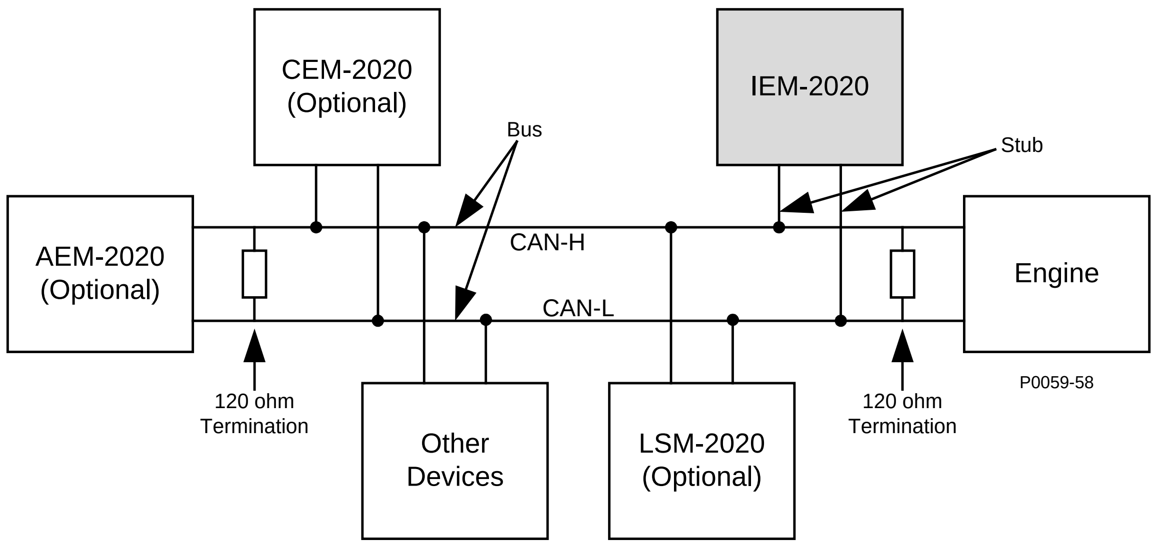


Figure 6-6. CAN Bus Interface with Optional AEM-2020 providing One End of the Bus

Dial-Out Modem

IEM-2020 controllers with style number xxxxxMxxx have an internal modem with dial-in, dial-out capability. The IEM-2020 connects to a standard-device telephone line through a USOC RJ-11C jack.

RDP-110 Connections

The IEM-2020 provides terminals for connection with the optional RDP-110 remote display panel. These terminals provide dc operating power to the RDP-110 and enable communication between the IEM-2020 and RDP-110. Basler Electric recommends using twisted-pair conductors for connecting the communication terminals of the IEM-2020 and RDP-110.

Table 6-10 lists the IEM-2020 terminals that connect to the RDP-110.

Table 6-10. RDP-110 Interface Terminals

Terminal	Connects To:
4 (RDP BATT+)	RDP-110 terminal 12/24
5 (RDP BATT–)	RDP-110 terminal DC COM
6 (RDP TXD–)	RDP-110 terminal 485–
7 (RDP TXD+)	RDP-110 485+

Connections for Typical Applications

Figure 6-7 shows connections for typical applications.

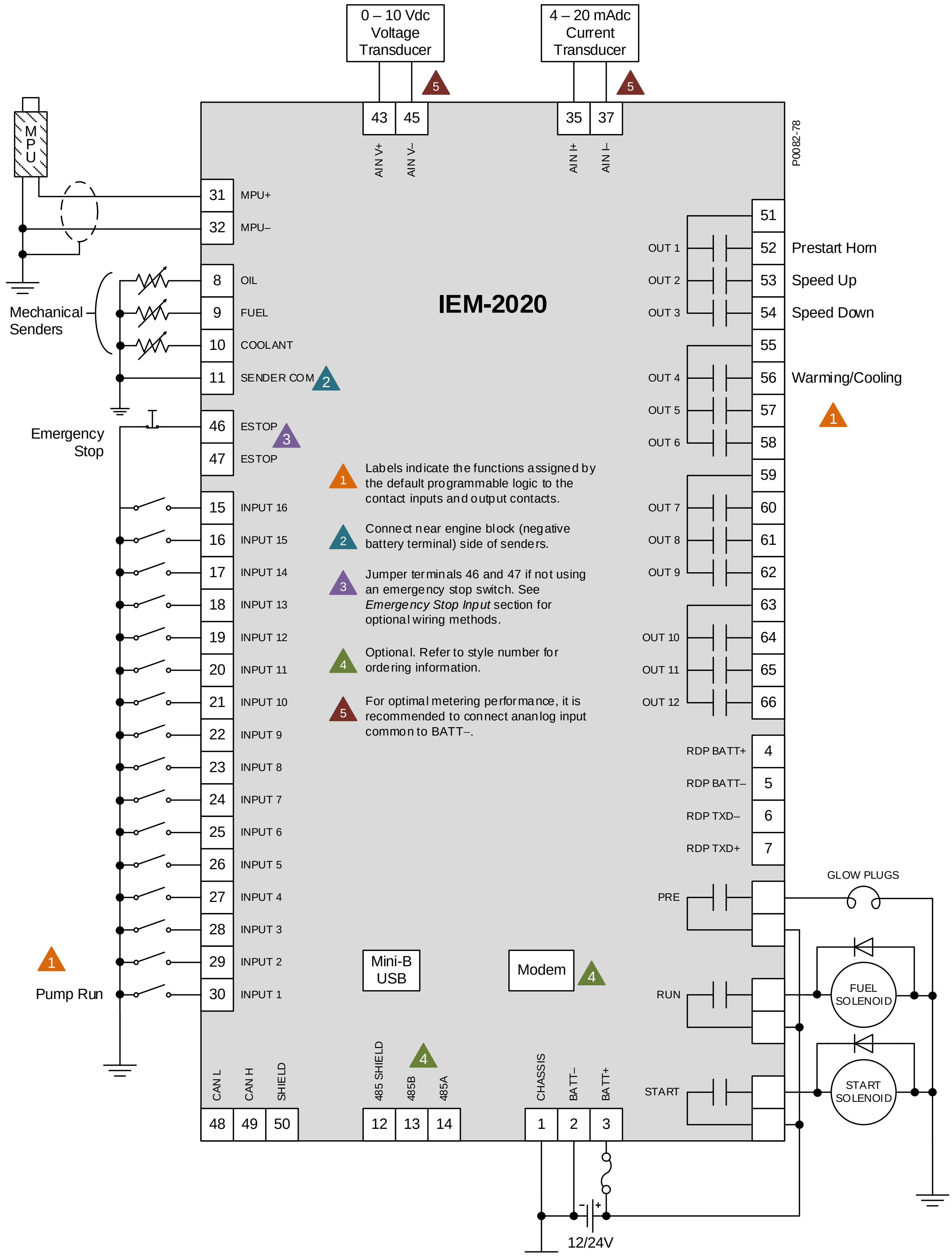


Figure 6-7. Connections for Typical Applications

Connections for Volvo Penta EDC III Applications

Engines equipped with Volvo Penta EDC III controllers will receive engine control commands (such as start and stop) from the IEM-2020 through the SAE J1939 communication interface. To invoke this feature, the EDC III must receive a J1939 message containing engine control information within one second of waking (exiting sleep mode). If the EDC III does not receive an engine control message within the prescribed time, it will enter the stand-alone mode and ignore any J1939 control messages. If this occurs, the EDC III must be forced back into sleep mode by pressing the auxiliary stop pushbutton on the engine or by shortly disconnecting EDC power.

The interconnection diagram of Figure 6-8 illustrates the IEM-2020 and EDC III connections that allow the IEM-2020 to awaken the EDC III and start the engine, or simply acquire engine status information. Wake-up of the EDC III is initiated by using the IEM-2020 RUN output contacts to apply battery power to the EDC. To stop the engine, the IEM-2020 sends a sleep command through the J1939 interface to the EDC III and opens the RUN output contacts. This causes the EDC to stop the engine and enter the sleep mode.

In order for the IEM-2020 to communicate with the EDC III, two IEM-2020 settings must be changed from their default values.

- The J1939 address of the IEM-2020 must be set at 17.
- The engine start/stop configuration setting must be set for Volvo Penta.

Both settings are configured on the *CAN Bus Setup* screen of BESTCOMS*Plus*. Section 4, *BESTCOMSPlus Software* has information about adjusting IEM-2020 settings through BESTCOMS*Plus*.

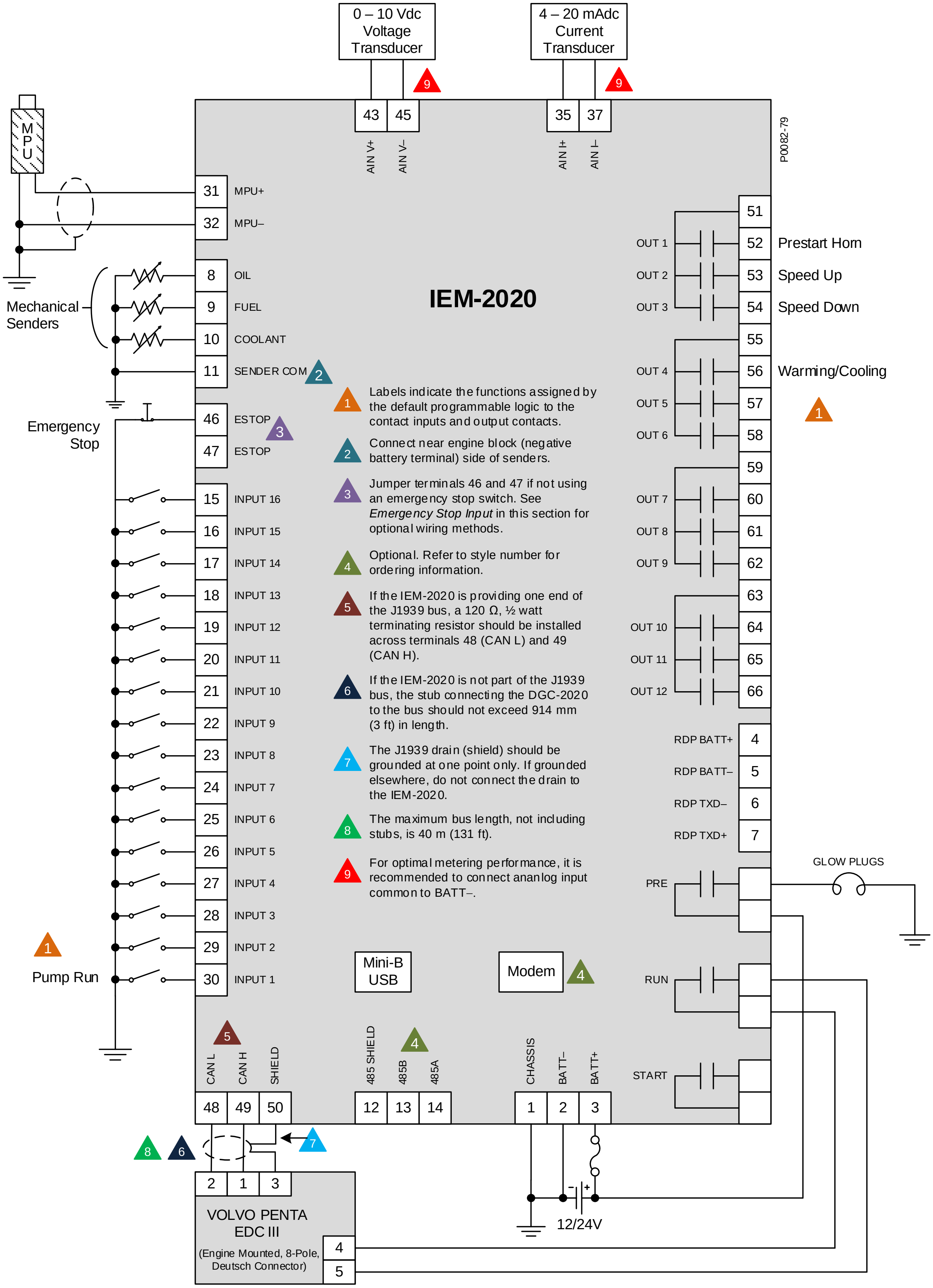


Figure 6-8. Connections for Volvo Penta EDC III Applications

Connections for MTU MDEC ECU Applications

MTU MDEC ECUs, supplied on some MTU engines, will receive engine control commands from the IEM-2020 and transmit engine operating status information to the IEM-2020 through the SAE J1939 communication interface.

In order for the IEM-2020 to communicate with the MTU MDEC ECU, ECU support must be enabled on the CAN Bus Setup screen of BESTCOMS*Plus* and "MTU MDEC" must be selected as the engine configuration. The appropriate ECU module type, speed demand source, and engine rpm must also be selected.

The MTU MDEC ECU must be configured properly in order for CAN Bus communication to function correctly. The parameters listed in Table 6-11 must be configured in the ECU with the MTU service tool. Contact MTU if ECU reconfiguration is required and your facility is not equipped to perform this task.

Table 6-11. MTU MDEC ECU Configuration Parameters

MTU Parameter Number	Parameter Name	Description and Value
200	CAN Bus Interface Config Param	Set to 898 – Indicates one CAN Bus with PIMS
201.01	CAN Bus Monitor Nodes 1–16	Binary value indicating which communication devices are on the CAN Bus network. If a binary representation of this parameter's value does not have the bit set corresponding to a value of 00100000, take the value in this register, add 32 to it, and rewrite it to the register to set the bit. This informs the MTU MDEC ECU that a third part controller resides on the CAN Bus.
156.19	CAN Bus Speed Demand Switch Active	Set to 1 – This is necessary only if it is desired to set the engine speed demand source and speed demand from the IEM-2020. Setting the parameter to zero blocks this capability.

The interconnection diagram of Figure 6-9 illustrates IEM-2020 and MTU MDEC ECU connections.

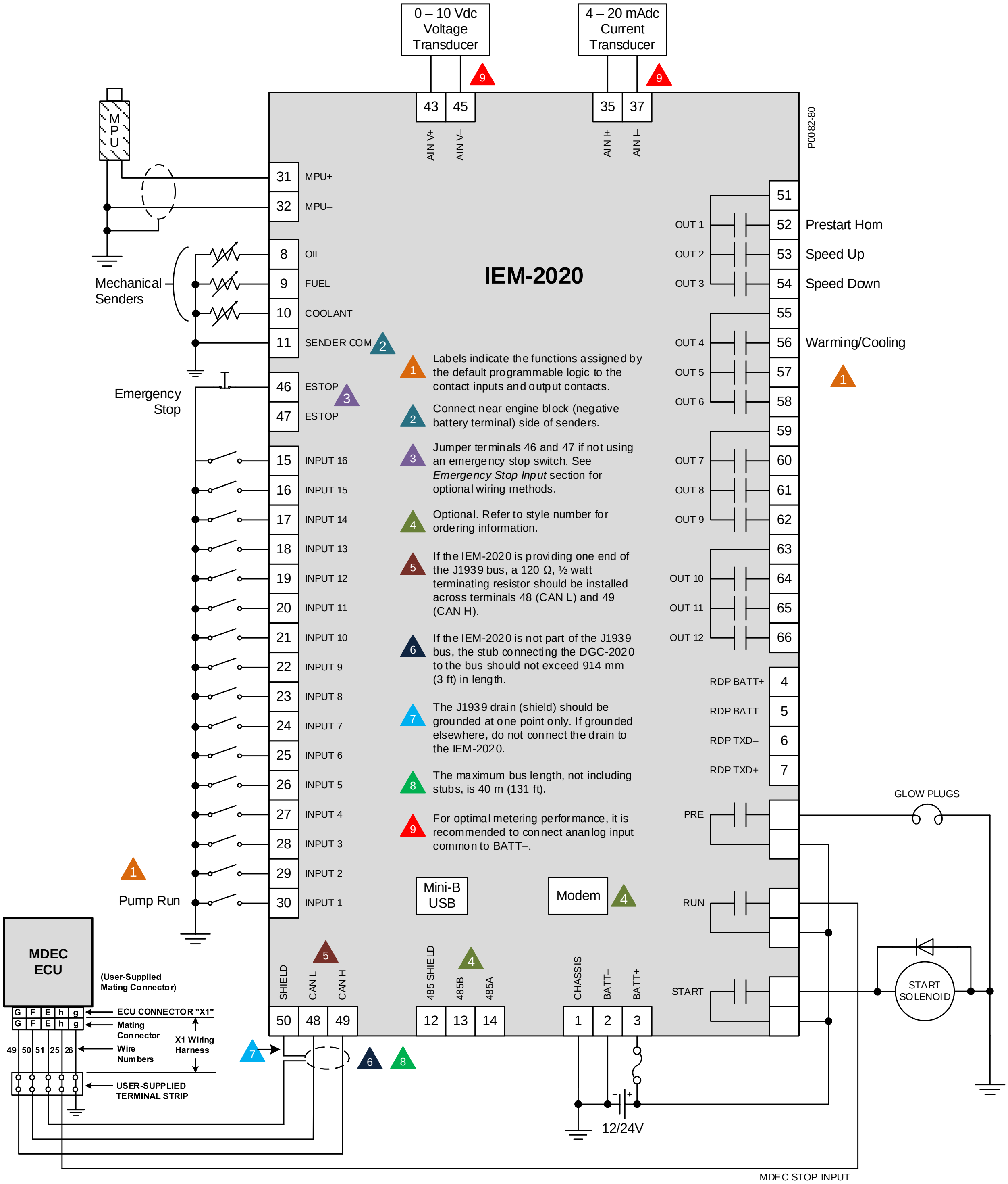


Figure 6-9. Connections for MTU MDEC ECU Applications

Connections with AEM-2020, CEM-2020/H, and LSM-2020

The AEM-2020 (Analog Expansion Module), CEM-2020/H (Contact Expansion Module), and LSM-2020 (Load Share Module) are optional modules that may be installed with the IEM-2020. These modules interface to the IEM-2020 via CAN Bus, thus the CAN BUS terminals are the only common connections (Figure 6-10) between the IEM-2020, AEM-2020, CEM-2020/H, and LSM-2020. Refer to Section 9, *LSM-2020 (Load Share Module),* for independent LSM-2020 connections. Refer to Section 10, *CEM-2020 (Contact Expansion Module),* for independent CEM-2020/H connections. Refer to Section 11, *AEM-2020 (Analog Expansion Module),* for independent AEM-2020 connections. Refer to *Connections, CAN Bus Interface,* in this section for details on IEM-2020 CAN Bus connections.

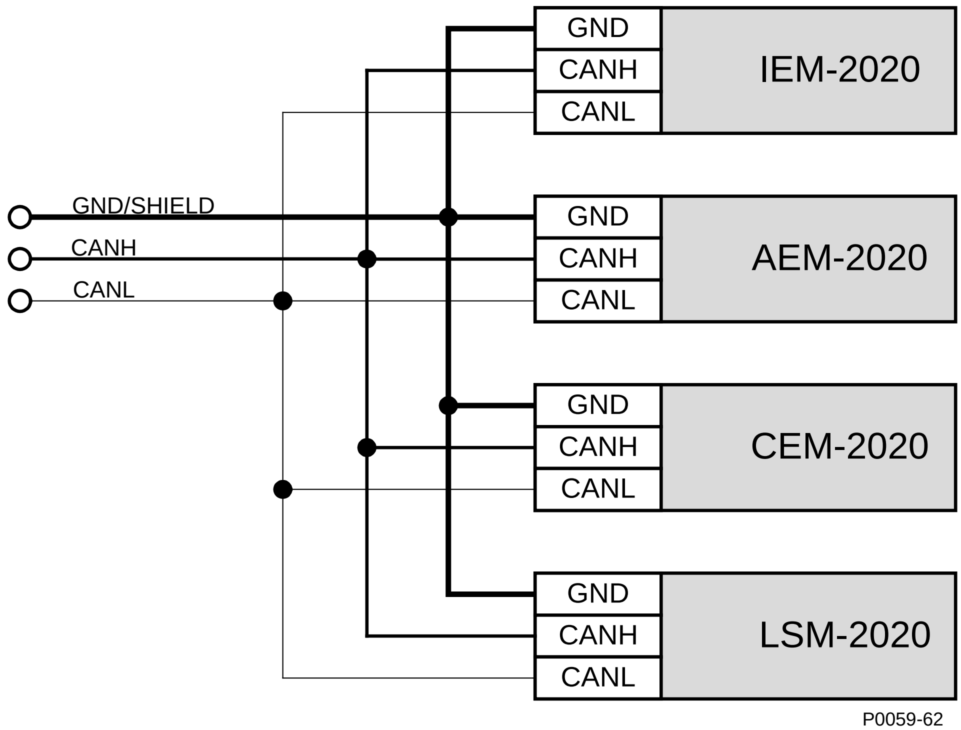


Figure 6-10. IEM-2020, AEM-2020, CEM-2020/H, LSM-2020 CAN Bus Connections

Installation in a Salt Fog Environment

Basler Electric recommends removing the backup battery for the real-time clock before installing the IEM-2020 in a salt-fog environment. Salt fog can be conductive and may short-circuit the battery.

Information on removing the backup battery for the real-time clock is found in Section 8, *Maintenance and Troubleshooting.*

SECTION 7 • SETUP

TABLE OF CONTENTS

Figures

SECTION 7 • SETUP

Introduction

The following paragraphs provide information for IEM-2020 initial setup and setting up IEM-2020 programmable inputs and outputs.

IEM-2020 Initial Setup

The IEM-2020 provides the desired machine control and protection when the parameters specific to the controlled machine are set up. Configure the following parameters prior to starting the engine. This instruction manual lists the parameters according to how the Settings Explorer in BESTCOMS*Plus*® presents them. These parameters can also be set through the front panel of the IEM-2020, but BESTCOMS*Plus* is generally more convenient.

Use BESTCOMS*Plus* to connect to the IEM-2020. After changing settings, click the *Send Settings* button to send the settings to the IEM-2020. Settings information may be lost if the *Send Settings* button is not pressed or if modified settings are not saved to a settings file.

Initial Setup Required to Operate Unit

Prior to running the machine, configure the following parameters in the IEM-2020. Only required parameters are presented in this discussion.

General Settings

Style Number (Figure 7-1)

Use BESTCOMS*Plus* to connect to the IEM-2020. Check the style number of the IEM-2020 to verify that the required features exist for the machine being configured.

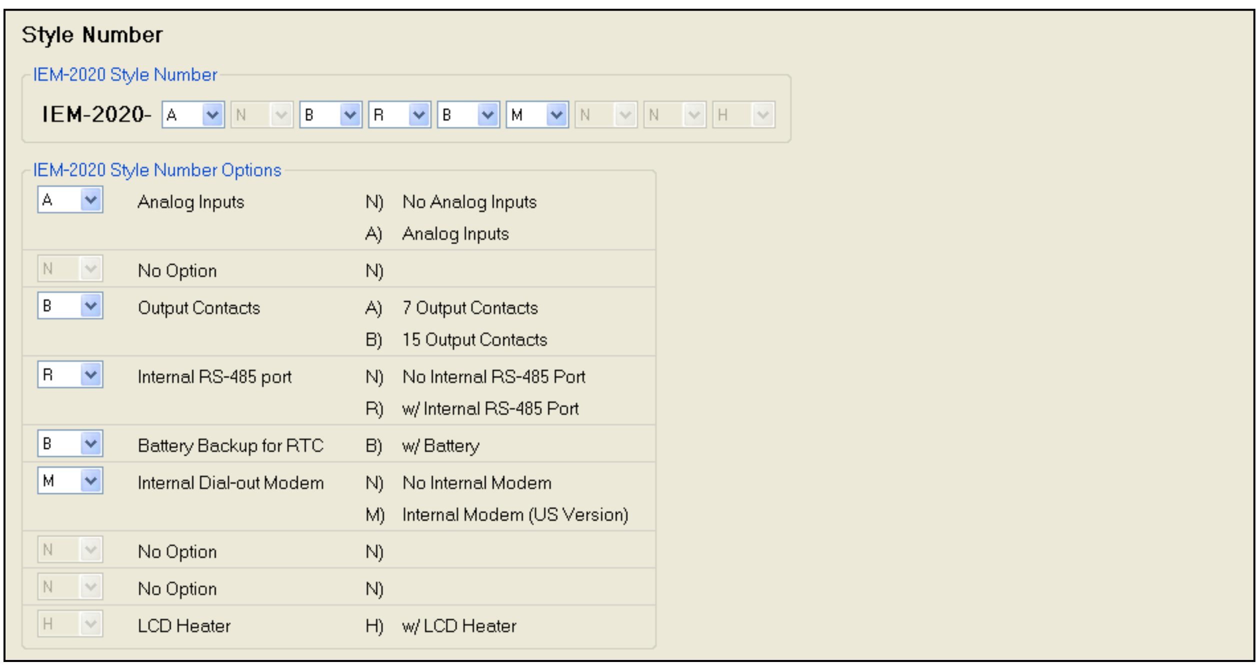


Figure 7-1. General Settings, Style Number Screen

Communications

Communications must be set up if the IEM-2020 will communicate with an ECU (engine control unit) that is connected to the engine.

CANBus Setup (Figure 7-2)

1. Enable ECU Support - Set to Enabled for the IEM-2020 to communicate with the ECU.

2. Enable DTC (Diagnostic Trouble Code) Support - If the ECU is a J1939 ECU, enable DTC support. The IEM-2020 will not log diagnostic trouble codes if the ECU does not support them.
3. SPN Conversion Method - When this bit is a zero, the conversion method is indicated as version 4. The IEM-2020 will automatically set the conversion method to 4 when the CM bit is zero; this occurs for most engine types. However, if the CM bit is 1, indicating the SPN conversion method is NOT 4, the user will have to consult the engine manufacturer to learn the correct method of SPN conversion, and set the SPN Conversion Method setting in the IEM-2020 accordingly.
4. CANBus Address - This parameter sets a unique address number for the IEM-2020 operating on a CANbus network. The CANbus Address is set internally by the IEM-2020 when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply.
5. ECU Contact Control - Output Select - Select whether the RUN output relay or the PRE (Prestart) output relay will close to give the ECU its “energize to run” signal. In some implementations, this relay may actually be providing ECU power.
6. ECU Contact Control - Pulsing Enable - Select if the ECU is not to be on line at all times. Often ECUs are allowed to go “off line” to conserve battery drain when the engine is not running. The IEM-2020 will “pulse” it periodically to force it to be active to allow the IEM-2020 to read data such as coolant temperature and coolant level. This is required if the IEM-2020 is to report low coolant temperature conditions (which may indicate failure of a block heater), or low coolant level conditions (if a leak occurs while the machine is not running). Pulsing is also used to check the integrity of CANBus communications when the machine is not running.
7. ECU Related Time Values - Engine Shut Down - Set this parameter for a time longer than the amount of time required to stop the engine after shutting down. The ECU is pulsed after this time expires. If the time is too short, the pulse may occur while the engine is still turning which could cause a brief re-start and possibly damage the flywheel and starter system.
8. ECU Related Time Values - Pulse Cycle Time - This parameter sets the desired time between ECU pulse cycles.
9. ECU Related Time Values - Settling Time - This parameter sets the duration of the “on line” time of the pulse cycle during which the IEM-2020 reads data from the ECU. The settling time should be set long enough so that any ECU parameters that require time to “settle down” after the ECU goes on line can do so. Since the IEM-2020 may use some of the ECU data for alarm or pre-alarm annunciation, it is important that the data have time to settle.
10. ECU Related Time Values - Response Timeout - This parameter defines the amount of time that the IEM-2020 will wait to receive data from the ECU during a pulse cycle or start attempt. A LOSS OF ECU COMMS pre-alarm is annunciated if data is not received during this time in a pulse cycle. If no data is received in this time during an engine starting attempt, a LOSS OF ECU COMMS alarm is annunciated.

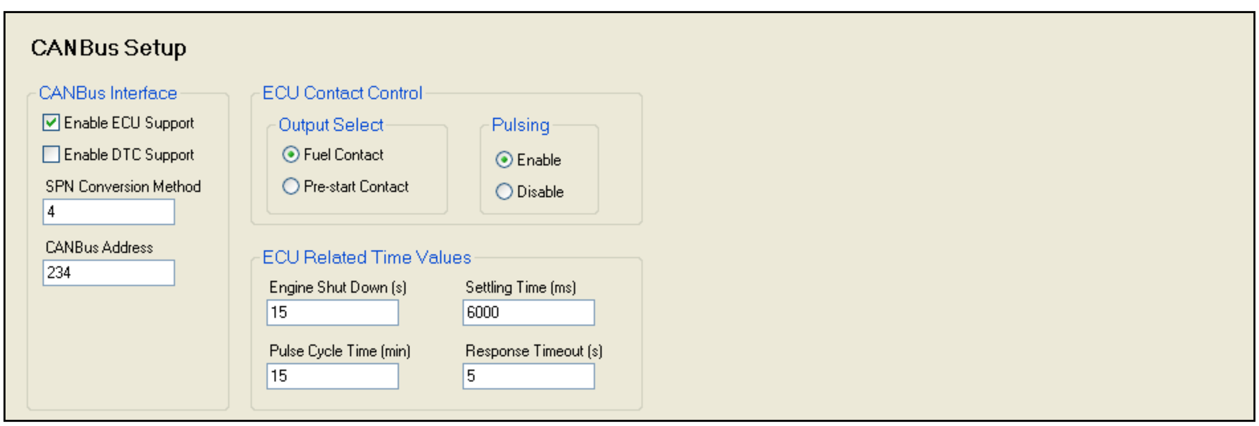


Figure 7-2. Communications, CANBus Setup Screen

ECU Setup (Figure 7-3)

1. ECU Type - For most engines, select *Standard*. However, there are exceptions. If your engine is a Volvo, select *Volvo-Penta*. If you have an MTU MDEC, ADEC, ECU-7/ECU8, GM/Doosan, Cummins, or MTU Smart Connect, make the appropriate selection. Depending on the ECU type selected, some parameters are enabled, allowing you to configure them for the specific engine. Modification of these parameters is not required for the initial setup. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information.

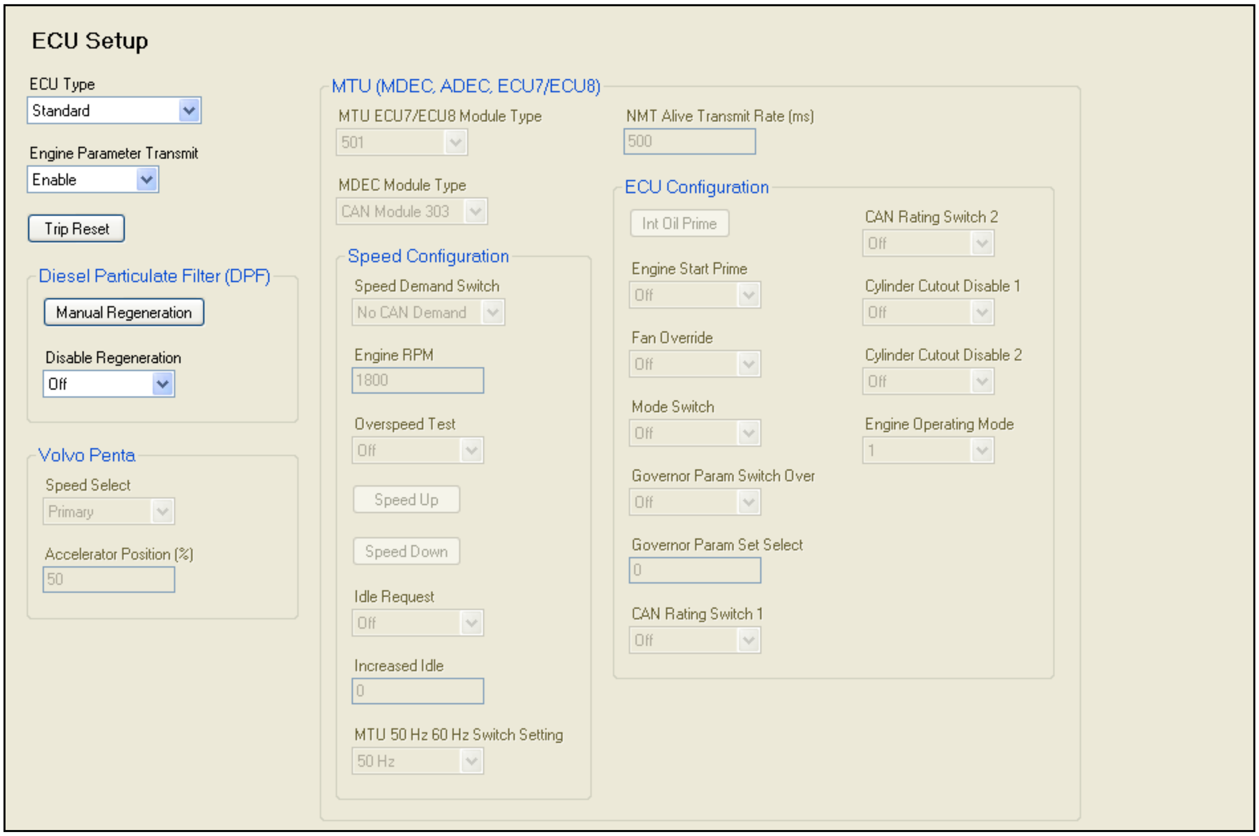


Figure 7-3. Communications, ECU Setup Screen

System Parameters

System Settings (Figure 7-4)

1. Speed Control - When enabled, this setting allows RPM and raise/lower requests to be sent from the IEM-2020 to the engine.
2. Rated Engine RPM - This parameter defines the rpm rating of the machine.
3. Max/Min Engine RPM - The Max Engine RPM setting specifies the maximum rpm at which the engine can operate. The Min Engine RPM setting specifies the minimum rpm at which the engine can operate.
4. Fuel Level Function - This setting defines the fuel type of the machine. If a fuel level sender is available in a tank, set this to *FUEL LVL*. If liquid propane or natural gas is used, set accordingly. When disabled, the IEM-2020 displays N/A for fuel level on the overview screen.
5. Power Up Delay - This setting defines the time duration to wait before pulsing the ECU for data on IEM-2020 power up.
6. Number of Flywheel Teeth - This setting defines the number of teeth on the flywheel for engines equipped with a magnetic pickup sensor (MPU) which detects engine speed.
7. System Units - This setting defines *English* or *Metric* units.
8. Battery Voltage - Select *12* or *24*.
9. Metric Pressure Units - Select Bar or kPa when System Units is Metric.

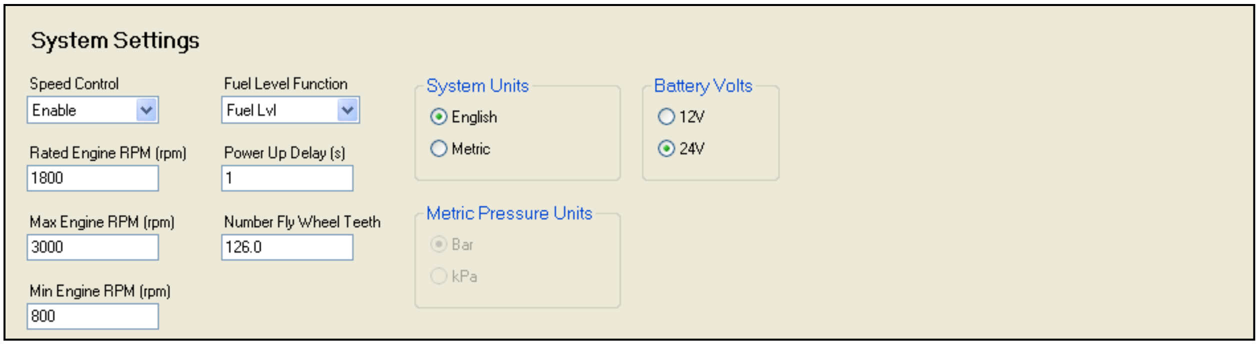


Figure 7-4. System Parameters, System Settings Screen

Remote Module Setup (Figure 7-5)

Enable the I/O modules that are used with the IEM-2020. Refer to the appropriate sections in the IEM-2020 manual for details regarding the individual I/O modules. Disable all if no modules are present.

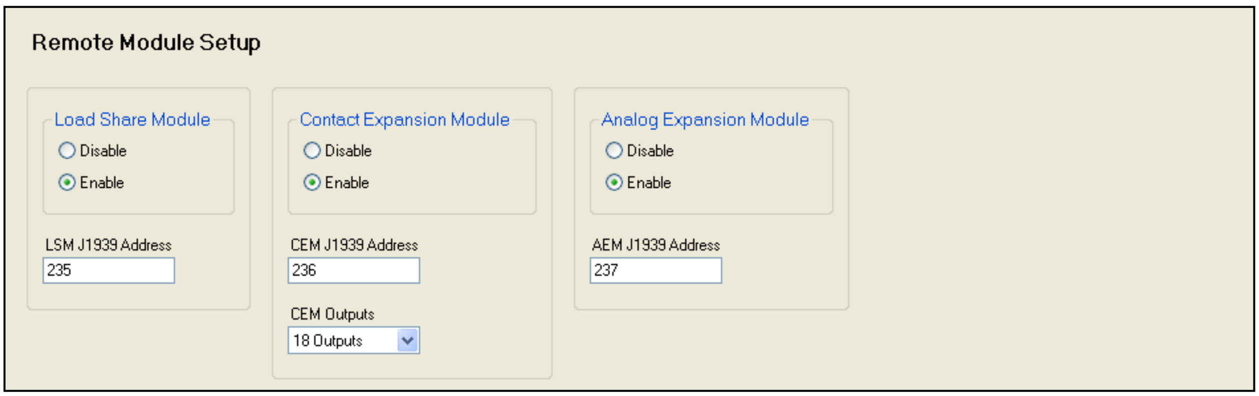


Figure 7-5. System Parameters, Remote Module Setup Screen

Crank Settings (Figure 7-6)

1. Crank Disconnect Limit - This setting defines the engine rpm threshold in percentage of rated rpm at which engine cranking should cease.
2. Pre-Crank Delay - This value specifies the amount of time pre-cranking occurs. The PRE contact output relay is closed during this time. This setting is typically used for engine preheating and/or pre-lubrication.
3. Prestart Contact Config - This parameter defines whether the PRE relay remains closed after the engine starts, or if it should open.
4. Prestart Rest Configuration - There may be situations where it is desired that the PRE relay be closed during engine cranking but open for all or part of a crank resting cycle. Configure this parameter accordingly. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus Software,* for additional information.
5. Oil Pressure Crank Disconnect - This setting provides an alternate method of determining conditions under which crank disconnect should occur. If the machine has no magnetic pick up (MPU) for rpm detection or a failed MPU, it will use oil pressure as criterion for crank disconnect. This will prevent long starter engagement if the engine starts and the IEM-2020 cannot determine engine speed for crank disconnect purposes.
6. Cranking Style - Cycle cranking or continuous cranking is selected with this setting.
    a. Cycle
        i. Number of Crank Cycles - This setting defines the number of crank cycles if *Cycle* is selected as the cranking style.
        ii. Crank Cycle Time - This setting defines the time duration of the crank cycle if *Cycle* is selected as the cranking style.

b. Continuous

i. Continuous Crank Time - This setting defines the time duration of the crank cycle if *Continuous* is selected as the cranking style.

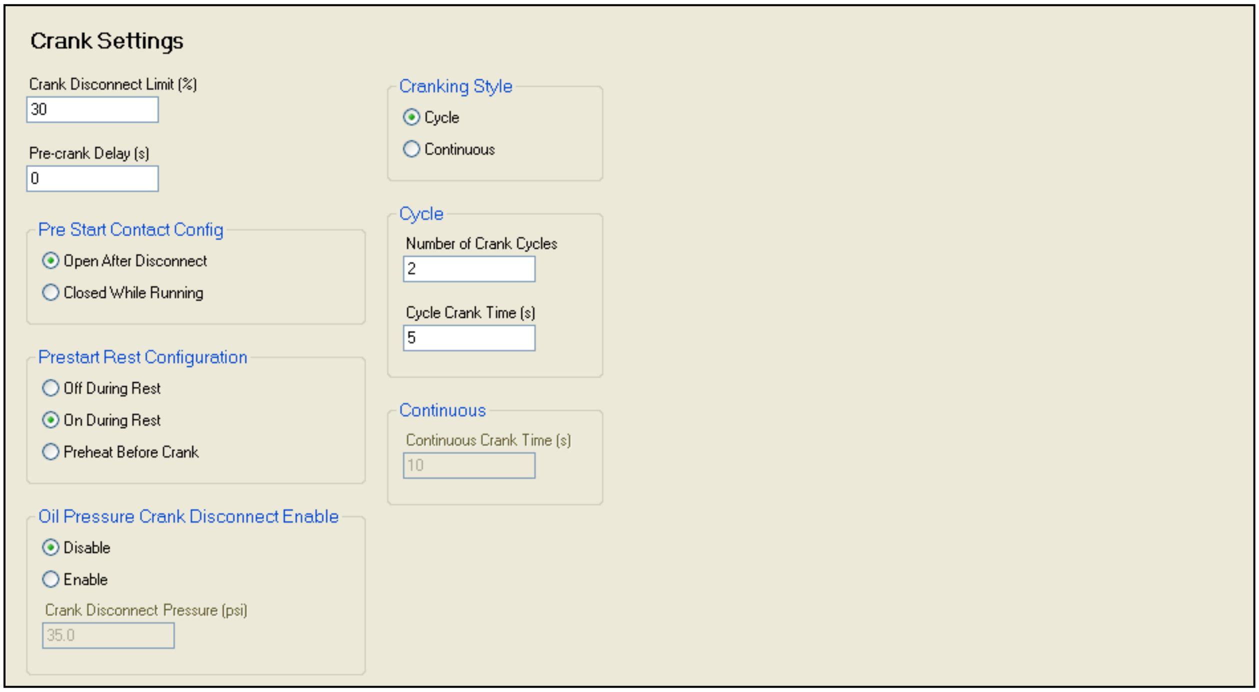


Figure 7-6. System Parameters, Crank Settings Screen

Relay Control (Figure 7-7)

These drop-down menus select the operating mode for the PRE, START, and RUN relays on the back of the IEM-2020. In general, most machines will use preconfigured functionality; more advanced users may select programmable. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus Software,* for additional information.

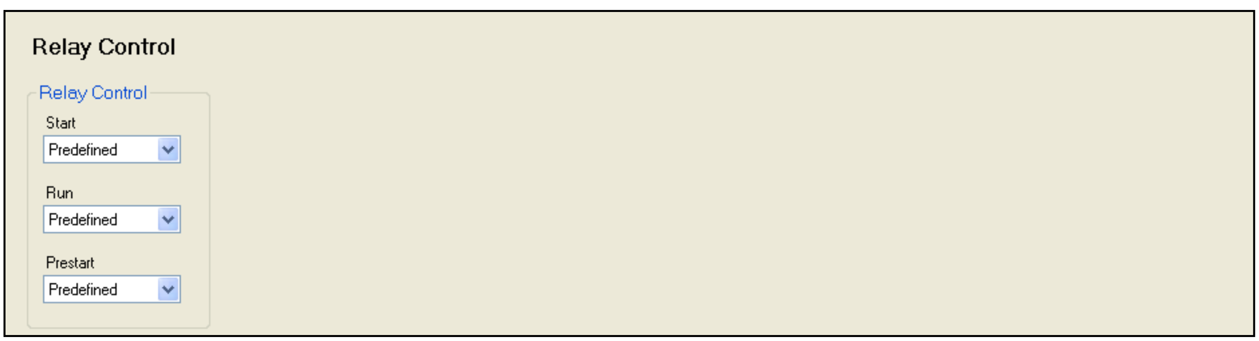


Figure 7-7. System Parameters, Relay Control Screen

Alarm Configuration

Horn Configuration (Figure 7-8)

1. Horn Enable - This setting enables or disables the output for the external alarm horn.
2. Not In Auto Horn Enable - This setting enables or disables the horn when not in auto mode.

Figure 7-8. Alarm Configuration, Horn Configuration Screen

Pre-Alarms (Figure 7-9)

Examine each of the pre-alarms. Pre-alarm setup is not required to operate the machine, but is likely to be desired to provide warnings for machine protection. Enable any desired pre-alarms and enter an appropriate threshold. Set the activation delay where possible. The activation delay is the duration that a condition remains in effect before annunciating a pre-alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus Software,* for additional information regarding pre-alarm configuration.

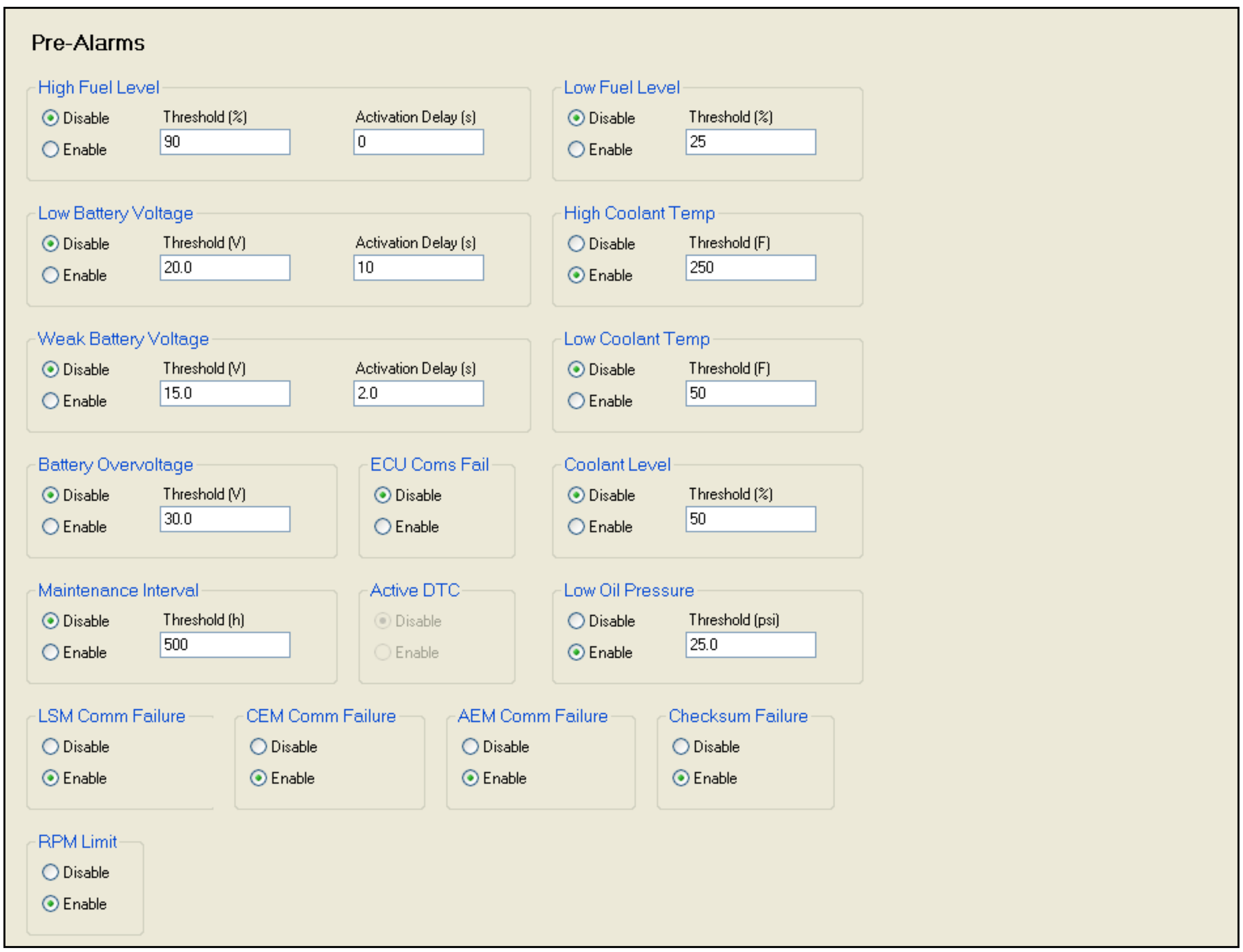


Figure 7-9. Alarm Configuration, Pre-Alarms Screen

Alarms (Figure 7-10)

Examine each of the alarms. Alarm setup is not required to operate the machine, but is likely to be desired to provide shutdowns for machine protection. Enable any desired alarms and enter an appropriate threshold. Set the *Activation Delay* where possible. The activation delay is the duration that a condition remains in effect before annunciating an alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus Software,* for additional information regarding alarm configuration.

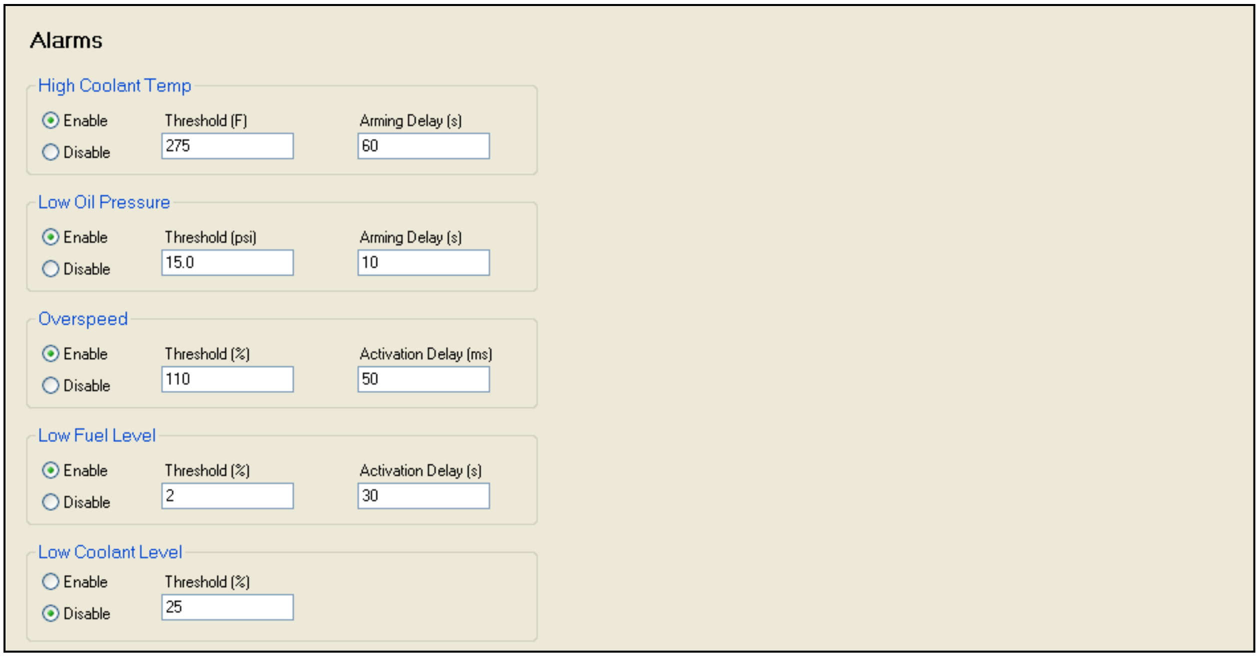


Figure 7-10. Alarm Configuration, Alarms Screen

Sender Fail (Figure 7-11)

Enable each sender type as desired by configuring it as an alarm or pre-alarm. Set an activation delay. The activation delay is the duration that the condition remains in effect before annunciating an alarm or pre-alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus Software,* for additional information regarding sender fail configuration. If an IEM-2020 is receiving engine information from an engine ECU, the sender fail for coolant temperature and oil pressure do not need configured because they have no effect. They are appropriate for resistive senders only.

Figure 7-11. Alarm Configuration, Sender Fail Screen

<u>*Programmable Senders*</u>

If an IEM-2020 is receiving engine information from an engine ECU, the programmable sender parameters for coolant temperature and oil pressure are not necessary because they have no effect. These parameters are appropriate for resistive senders only.

Coolant Temperature (Figure 7-12)

1. The coolant temperature sender is configured by selecting one of the sender types that come as part of the BESTCOMS*Plus* sender library by clicking *Load Cool Settings File* and selecting the appropriate sender.

2. If no sender file matches the sender being used, the individual points that map resistance points to coolant temperature may be modified by entering numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Cool Data* to save the data in the current settings file.
5. Manually entered sender data will be saved as a sender library file by clicking *Create Cool Settings File* and entering a file name and specifying a location to save the file.
6. Click *Send Settings* in BESTCOMS*Plus* to send the sender settings to the IEM-2020.

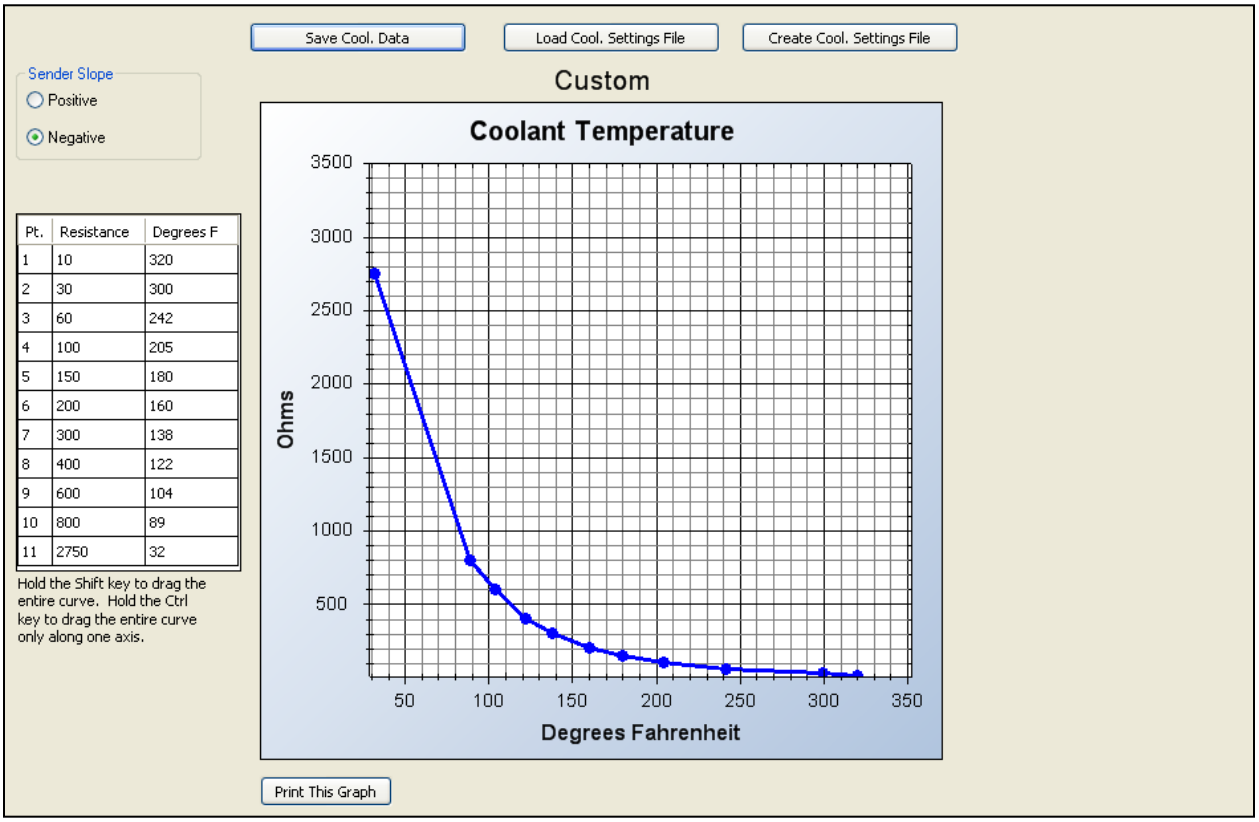


Figure 7-12. Programmable Senders, Coolant Temperature Screen

Oil Pressure (Figure 7-13)

1. The oil pressure sender is configured by selecting one of the sender types that come as a part of the BESTCOMS*Plus* sender library by clicking *Load Oil Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to oil pressure may be modified by entering numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Oil Data* to save the data in the current settings file.
5. Manually entered sender data will be saved as a sender library file by clicking *Create Oil Settings File* and entering a file name and specifying a location to save the file.
6. Click *Send Settings* in BESTCOMS*Plus* to send the sender settings to the IEM-2020.

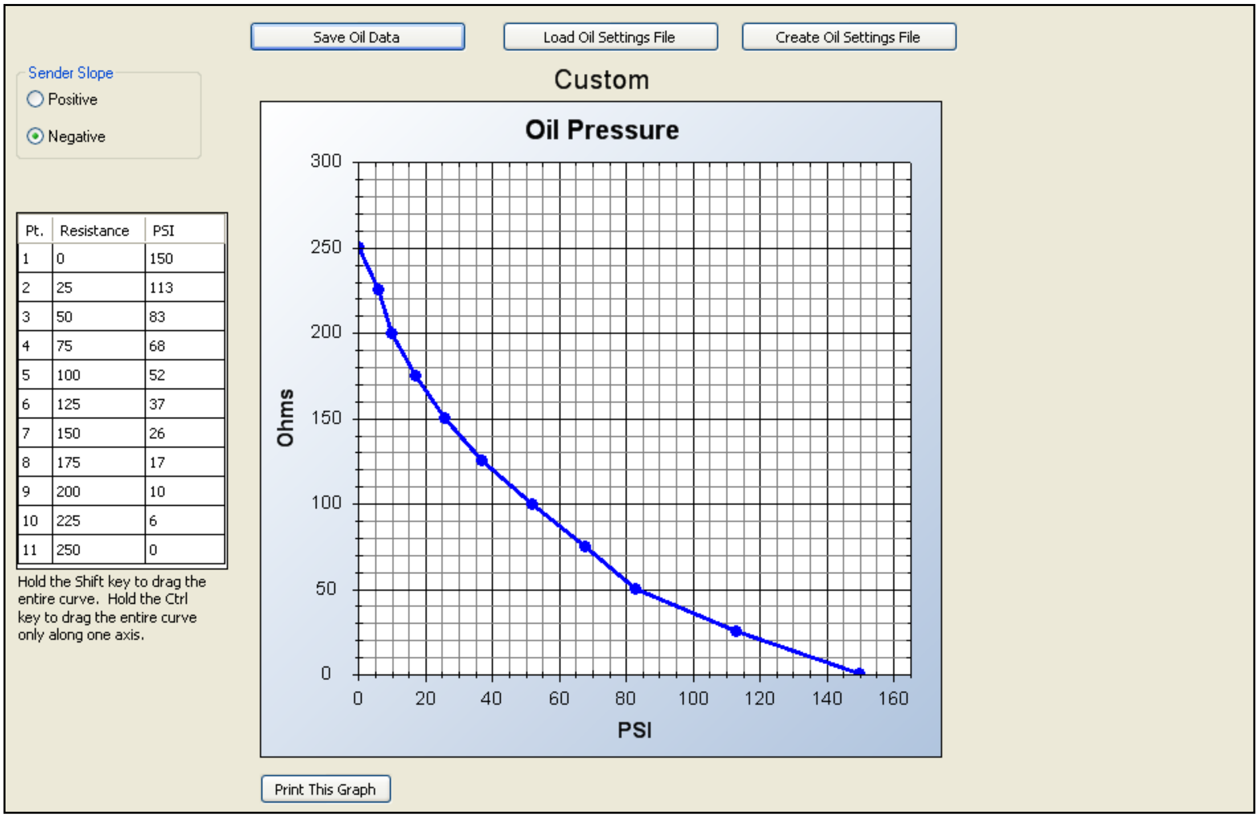


Figure 7-13. Programmable Senders, Oil Pressure Screen

Percent Fuel Level (Figure 7-14)

1. The percent fuel level sender is configured by selecting one of the sender types that come as a part of the BESTCOMS*Plus* sender library by clicking *Load Fuel Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to fuel level may be modified by entering numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Fuel Data* to save the data in the current settings file.
5. Manually entered sender data will be saved as a sender library file by clicking *Create Fuel Settings File* and entering a file name and specifying a location to save the file.
6. Click *Send Settings* in BESTCOMS*Plus* to send the sender settings to the IEM-2020.

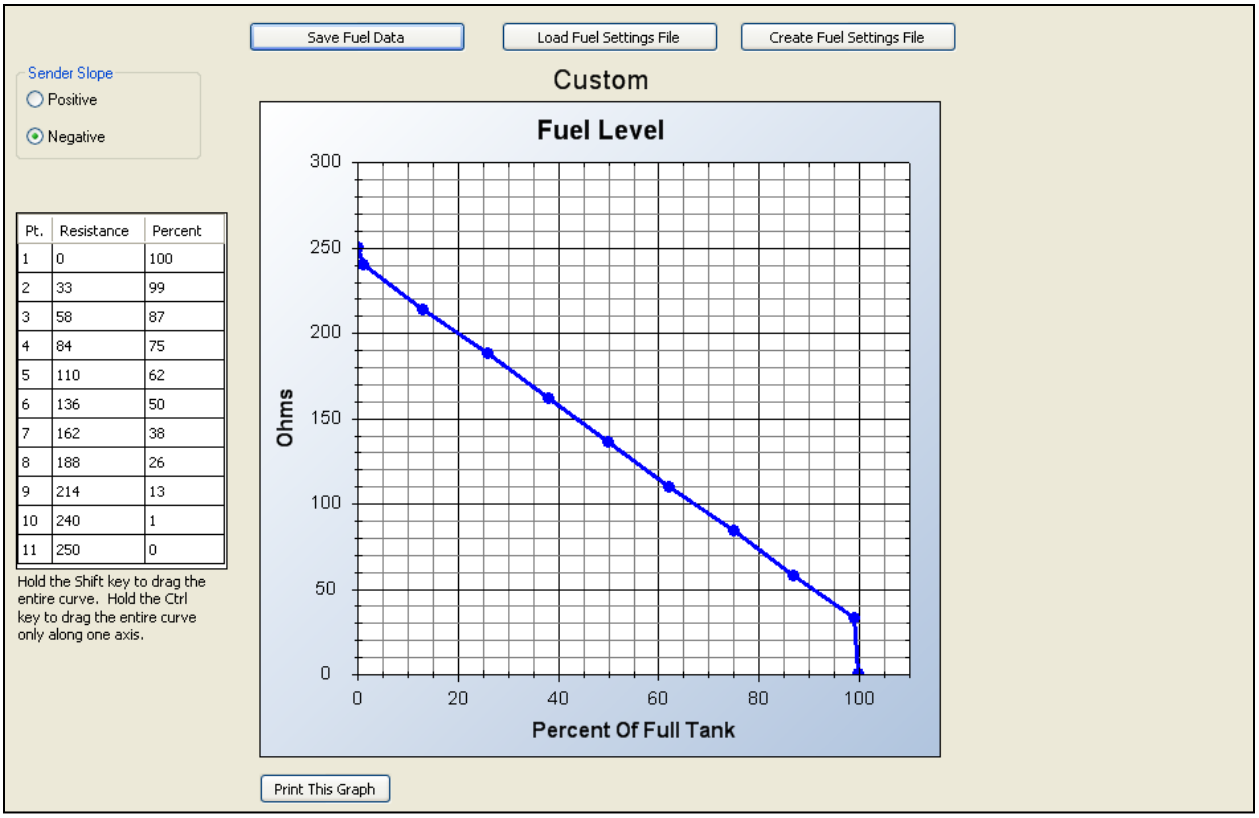


Figure 7-14. Programmable Senders, Percent Fuel Level Screen

This completes the discussion of initial IEM-2020 setup parameters that are required prior to running a unit.

Initial Setup (Optional)

This section discusses basic setup parameters that are not required to start and run the unit, but may be set up to further customize the IEM-2020 to a specific application. This discussion only presents some of the basic setup parameters. Advanced users can customize the IEM-2020 through BESTLogic*Plus* Programmable Logic, configurable inputs, configurable protection, configurable elements, and numerous other features designed for IEM-2020 configurability.

The parameters are listed in accordance with the Settings Explorer of BESTCOMS*Plus*. These parameters can also be set from the front panel of the IEM-2020.

General Settings

Front Panel HMI (Figure 7-15)

1. LCD Contrast - This setting changes the contrast of the LCD.
2. Front Panel Sleep Mode - When sleep mode is enabled, the LEDs and LCD backlight turn off after 15 minutes of inactivity on the front panel to minimize battery drain.
3. Language Selection - This setting selects the desired language.
4. Scrolling Screens - Scrolling screen settings are not accessible via the front panel. If it is desired to change the default overview screen, the user can specify scrolling screens and configure which parameters are to appear on the front panel LCD display by configuring the *Configurable HMI Summary Settings*.
    a. Select the *Configurable HMI Summary* screens.
    b. Set the *Scrolling Screen Enable* to *Enable*.
    c. Define the *Scrolling Screen Scroll Delay*.
5. Initializing Message 1 - This parameter defines the first line of text that appears on the front panel of the IEM-2020 as it is going through its power up and initializing sequence.
6. Initializing Message 2 - This parameter defines the second line of text that appears on the front panel of the IEM-2020 as it is going through its power up and initializing sequence.

Figure 7-15. General Settings, Front Panel HMI Screen

Device Security Setup (Figure 7-16)

If changing of the default passwords is desired, connect to the IEM-2020 with BESTCOMS*Plus*, enter the passwords on the *Device Security Setup* screen, and click *Upload Security* from the *Communications* pull-down menu to load the passwords.

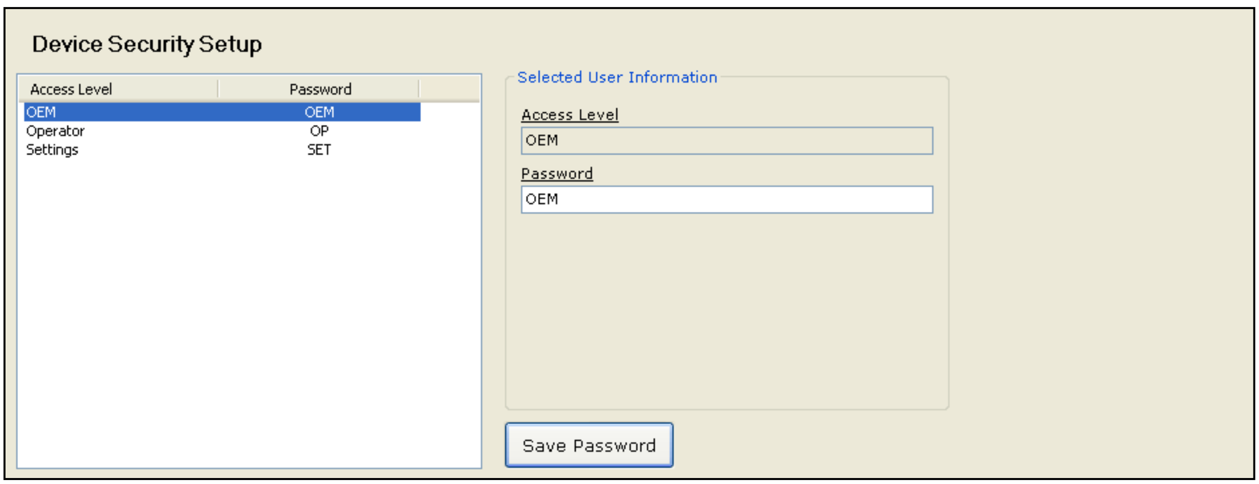


Figure 7-16. General Settings, Device Security Setup Screen

Clock Setup (Figure 7-17)

This screen configures the date and time for the IEM-2020 and the daylight savings time parameters.

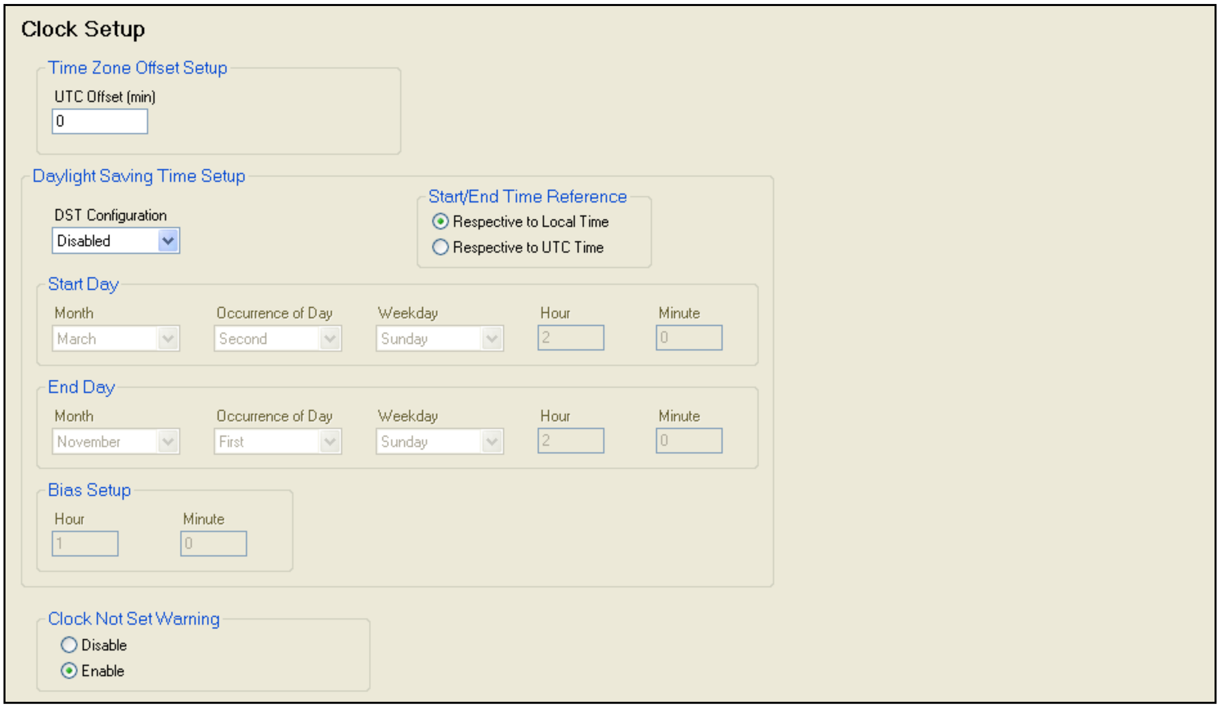


Figure 7-17. General Settings, Clock Setup Screen

This completes the discussion of IEM-2020 setup parameters that are optional prior to running a unit. This discussion presents only some of the basic setup parameters. Advanced users can customize the IEM-2020 through BESTLogic*Plus* Programmable Logic, configurable inputs, configurable protection, configurable elements, and numerous other features designed for IEM-2020 configurability.

Setting Up IEM-2020 Programmable Inputs and Outputs

The IEM-2020 along with the CEM-2020/H (Contact Expansion Module) and AEM-2020 (Analog Expansion Module) provide a variety of programmable input and output capabilities. The IEM-2020 and the CEM-2020/H include contact inputs that will be configured as pre-alarms or alarms and are available as inputs to BESTLogic*Plus* Programmable Logic. They also contain dry contact relay outputs which are driven by BESTLogic*Plus* Programmable Logic.

The AEM-2020 has eight analog inputs, eight resistive temperature device (RTD) inputs, two thermocouple inputs, and four analog outputs. Each analog input can be configured for a 4 to 20 mA current input or a 0 to 10 Vdc voltage input to accommodate most readily available industrial transducers; the RTD and thermocouple inputs are pre-configured for temperature measurement. Each analog, RTD, and/or thermocouple input can be programmed with a user adjustable range and assigned a label along with up to four thresholds to implement protective schemes or BESTLogic*Plus* Programmable Logic programming utilizing the measured parameter. This allows for enhanced protection of the engine and protection of external devices.

The analog outputs can be configured as 4 to 20 mA current outputs or 0 to 10 Vdc voltage outputs. Each output can be mapped to metered parameters in the IEM-2020 to implement meter driver functionality or provide signals for analog inputs of other equipment.

Instructions regarding configuration and setup of each type of programmable input and output are presented below, along with instructions for enabling the expansion modules.

Enable LSM-2020, CEM-2020/H, and AEM-2020

The parameters for remote inputs and remote outputs are disabled and cannot be configured in BESTCOMS*Plus* unless the appropriate module has been enabled. Thus, expansion modules connected to the IEM-2020 must be enabled before the parameters associated with them can be modified. See Figure 7-18.

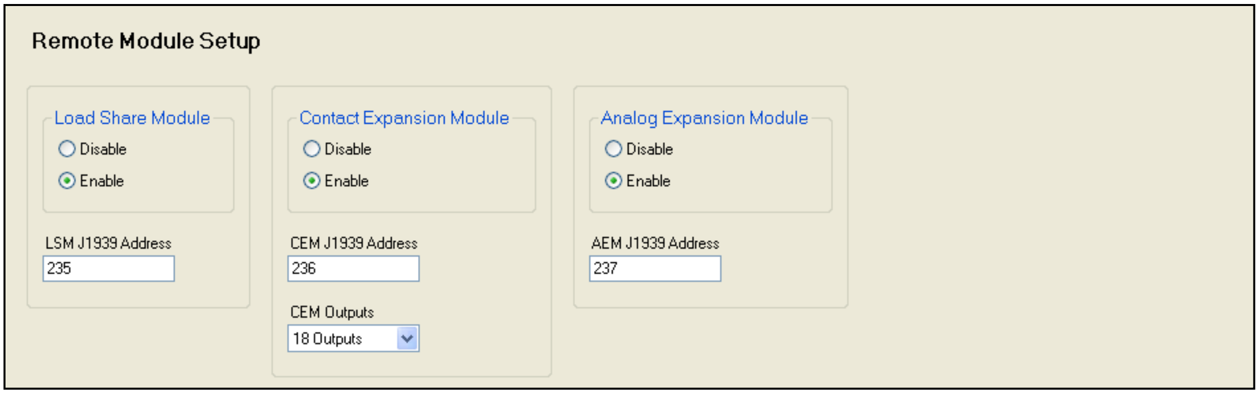


Figure 7-18. System Parameters, Remote Module Setup Screen

Configure the following parameters:

1. Load Share Module Enable/Disable - This setting enables the LSM-2020 when connected.
2. LSM J1939 Address - This setting defines the J1939 address to be used by the LSM-2020. Normally this address will not have to be changed unless it is already in use by another device on the CANBus network.
3. Contact Expansion Module Enable/Disable - This setting enables the CEM-2020/H when connected.
4. CEM J1939 Address - This setting defines the J1939 address to be used by the CEM-2020/H. Normally this address will not have to be changed unless it is already in use by another device on the CANbus network.
5. CEM Outputs - This parameter selects the number of output relays on the CEM-2020/H. The two possibilities are *18* and *24*. Refer to the style chart in Section 1, *General Information*, of the IEM-2020 instruction manual to determine if 18 or 24 output relays are present on the CEM-2020/H.

Programmable Inputs

The programmable inputs consist of:

- Contact inputs on the IEM-2020
- Local analog inputs on the IEM-2020
- Programmable functions on the IEM-2020. The programmable functions allow mapping of particular inputs to certain functions. For example, an input can be selected for the auto start function, or a low fuel level indication function.
- Remote LSM inputs on the LSM-2020. The LSM-2020 has one analog input.
- Remote contact inputs on the CEM-2020/H.
- Remote analog inputs on the AEM-2020.
- Remote RTD inputs on the AEM-2020.
- Remote thermocouple inputs on the AEM-2020.

Configuration Instructions

Configuring contact inputs on the IEM-2020 (Figure 7-19)

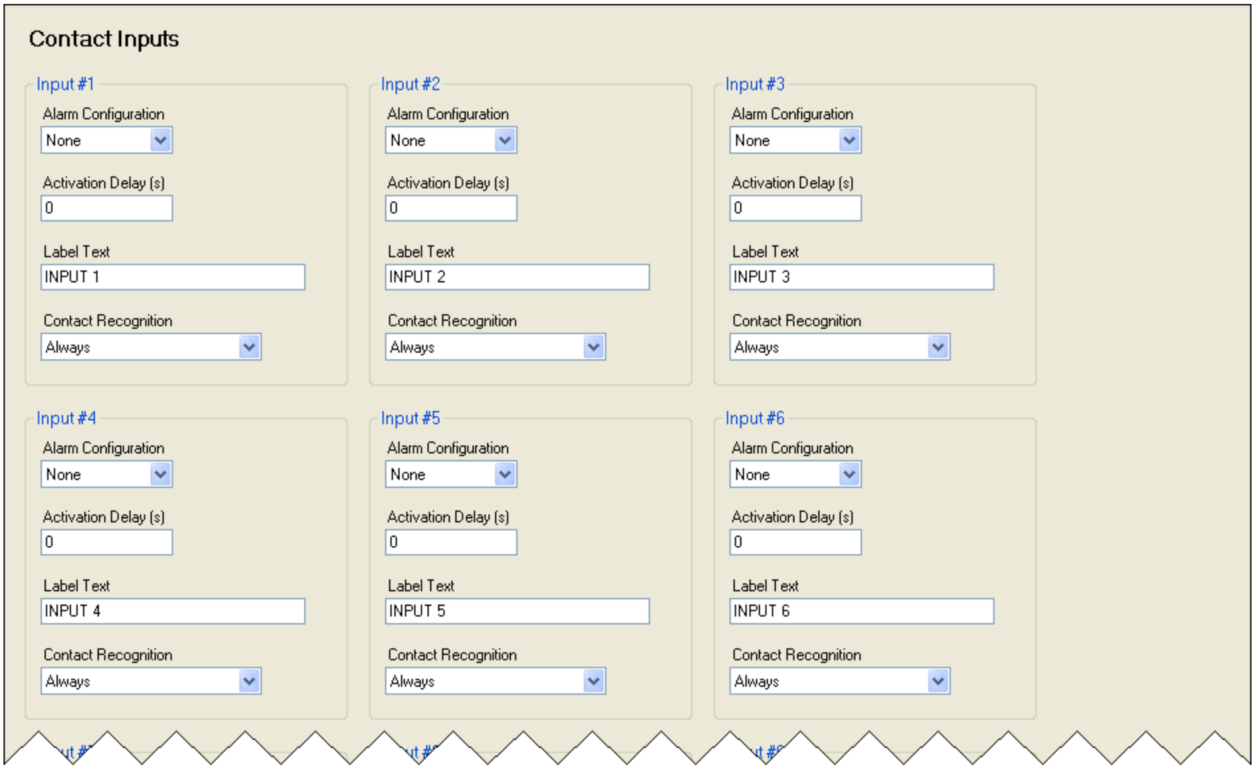


Figure 7-19. Programmable Inputs, Contact Inputs Screen

For each contact input, configure the following parameters:

1. Alarm Configuration - Select the alarm configuration of *None, Alarm,* or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant beep and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine will remain running. If *None* is selected, the input is status only. The status is available to BESTLogic*Plus* Programmable Logic regardless of the setting of the *Alarm Configuration*.
2. Activation Delay - This setting defines the duration that the input remains on before annunciation occurs.
3. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTLogic*Plus* Programmable Logic and in the event log if the input is configured as an alarm or pre-alarm.
4. Contact Recognition - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closing when oil pressure is low should be monitored only while the engine is running. This switch would be closed when the engine is not running but a low oil pressure alarm or pre-alarm should not be annunciated unless the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

Configuring local analog inputs on the IEM-2020 (Figure 7-20)

Each input is configured with a user assignable string and parameter range to map the analog input signal range to a user defined parameter range. Thus, external conditions can be metered and displayed on the IEM-2020. Each input can be configured with up to four thresholds (two over thresholds and two under thresholds) which make their status available to BESTLogic*Plus* Programmable Logic. In addition, each threshold can trigger alarms or pre-alarms to protect the engine and associated equipment based on these measured external conditions. Settings are shown for the local voltage input. The local current input settings are similar.

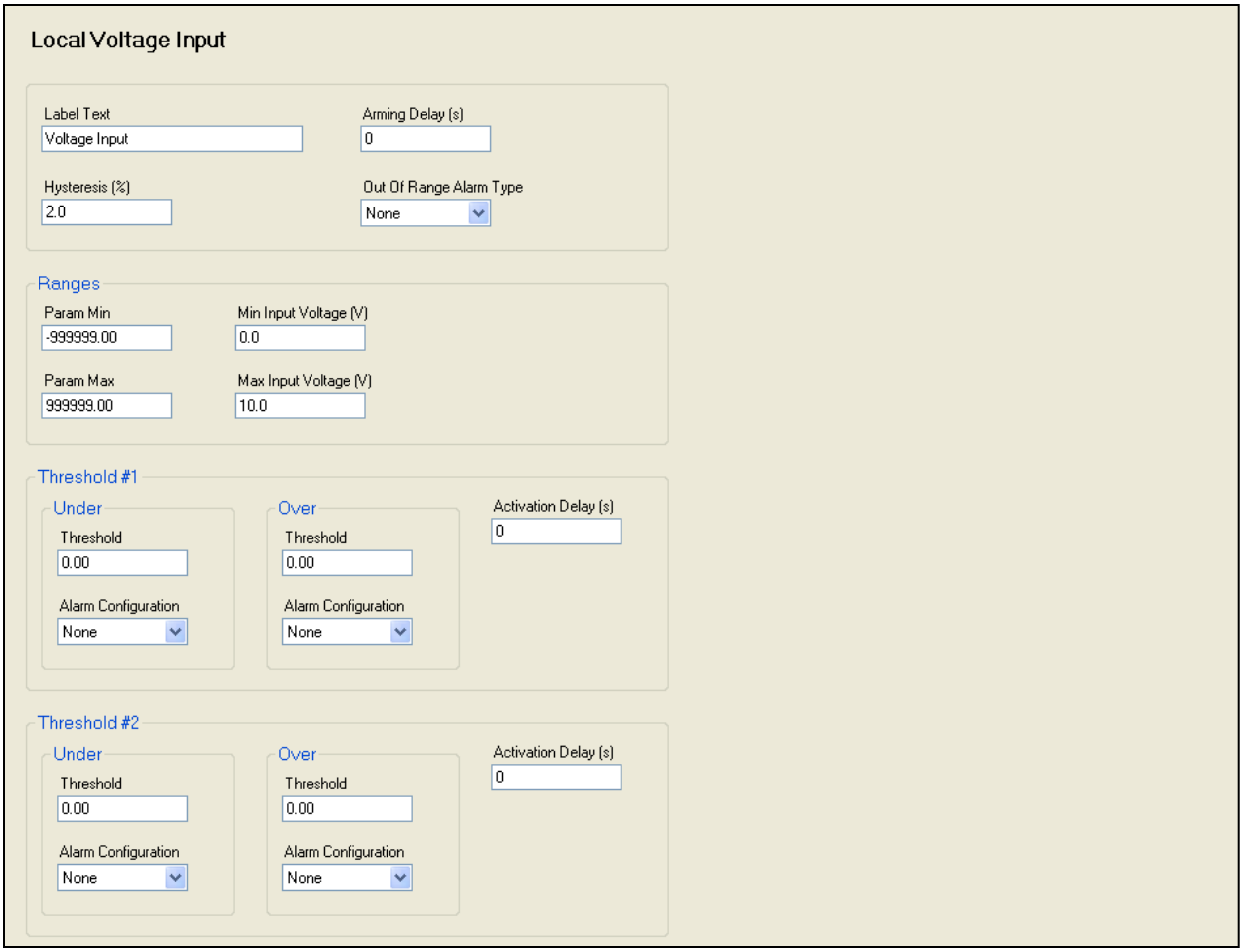


Figure 7-20. Programmable Inputs, Local Voltage Input Screen

Configure the following parameters:

1. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTLogic*Plus* Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.
3. Arming Delay - The *Arming Delay* is the wait time after engine startup before input monitoring begins. Set the arming delay to 0 if constant monitoring is desired, including while the engine is not running. Non-zero values will cause the input to be monitored after the programmed time has elapsed after engine startup.
4. Out-of-Range Alarm Type - When the analog input goes outside of its programmed range (as determined by the *Min* and *Max Input* voltage or current settings) an out-of-range indication is can be annunciated. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status will be available to BESTLogic*Plus* Programmable Logic but annunciation will not occur.
5. Parameter Minimum (Param Min) - This setting defines the value of the measured parameter when the analog input is at its programmed minimum level. If the analog input is below its programmed minimum level, the measured parameter will be limited to the *Parameter Minimum* setting. However, the raw analog input value will display the actual voltage or current measured at the analog input if it is within the voltage or current range that can be detected by the input circuit.
6. Parameter Maximum (Param Max) - This setting defines the value of the measured parameter when the analog input is at its programmed maximum level. If the analog input is above its programmed maximum level, the measured parameter will be limited to the *Parameter Maximum* setting. However, the raw analog input value will display the actual voltage or current measured at the analog input if it is within the voltage or current range that can be detected by the input circuit.

7. Min Input Voltage (V) - This setting defines the minimum input voltage level expected for the input. When the input is below this level, the out-of-range condition will be annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.
8. Max Input Voltage (V) - This setting defines the maximum input voltage level expected for the input. When the input is above this level, the out-of-range condition will be annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.

Up to four thresholds can be set for each analog input. There can be two “Over” thresholds and two “Under” thresholds. Each threshold can be configured as an *Alarm, Pre-Alarm,* or *as Status Only*. If any type other than *None* is selected, the threshold status is available to BESTLogic*Plus* Programmable Logic. This allows the user to set up an over and under pre-alarm threshold, and over and under alarm threshold.

An *Activation Delay* can be set for the thresholds. Over Threshold 1 and Under Threshold 1 share a common activation delay. Similarly, Over Threshold 2 and Under Threshold 2 share a second activation delay.

9. Threshold 1
    a. Under Threshold - Set a threshold below which Status, Alarm, or Pre-Alarm annunciation is desired.
    b. Under Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    c. Over Threshold - Set a threshold above which Status, Alarm, or Pre-Alarm annunciation is desired.
    d. Over Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    e. Activation Delay(s) - This setting defines the duration that a Threshold 1 condition must be true before an alarm or pre-alarm is annunciated. This time is shared by both Over Threshold 1 and Under Threshold 1 detection.
10. Threshold 2
    a. Under Threshold - Set a threshold below which Status, Alarm, or Pre-Alarm annunciation is desired.
    b. Under Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    c. Over Threshold - Set a threshold above which Status, Alarm, or Pre-Alarm annunciation is desired.
    d. Over Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    e. Activation Delay(s) - This setting defines the duration Threshold 2 must be exceeded before an alarm or pre-alarm is annunciated. This time is shared by both Over Threshold 2 and Under Threshold 2 detection.

Configurable Programmable Functions on the IEM-2020 (See Figure 7-21)

Programmable functions are predefined functions in the IEM-2020 and are initiated by a contact input. An input must be mapped to a programmable function for that function to operate. In addition, some of the programmable functions will be configured as alarms or pre-alarms and cause annunciation to occur on the RDP-110 (Remote Display Panel).

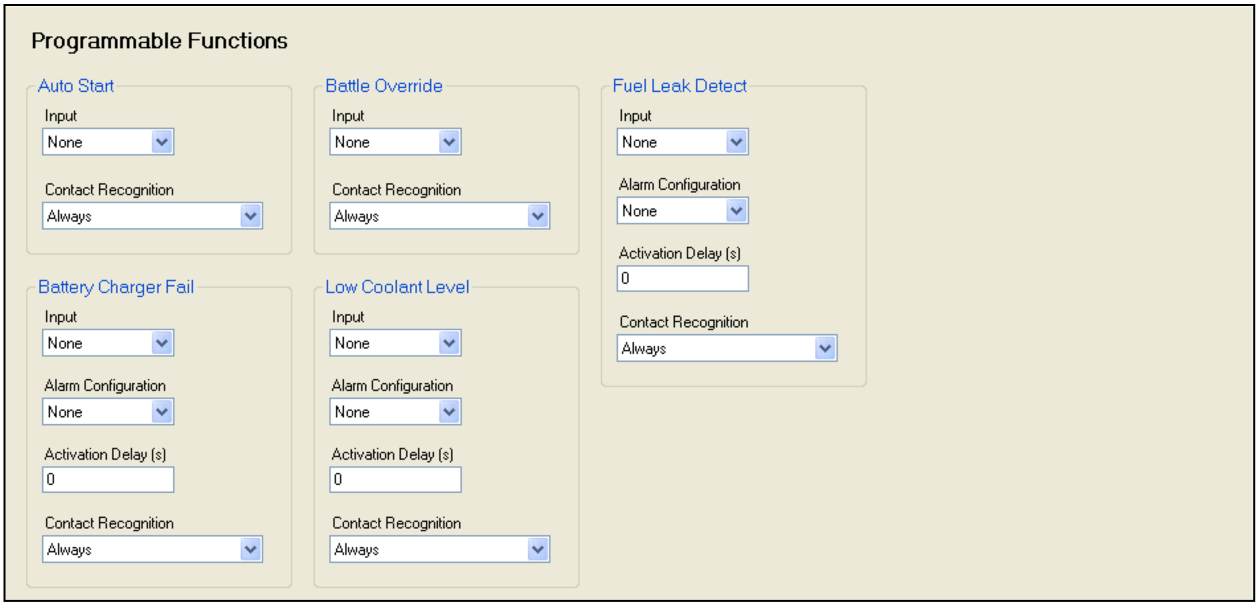


Figure 7-21. Programmable Inputs, Programmable Functions Screen

Configure the following parameters:

1. Auto Start
   a. Input - This function starts the engine from a contact input when the IEM-2020 is in AUTO mode. Select the desired input or select *None* to disable the auto start programmable function.
   b. Contact Recognition - Selecting *Always* will recognize the contact whether the engine is running or not. Selecting *While Engine Running Only* will recognize the contact only while the engine is running.
2. Battle Override
   a. Input - An input should be selected for the battle override function if a battle override initiated from a contact input is required. For some applications, the ability to remove all system shutdowns may be a requirement. Selecting battle override will prevent all alarms from stopping the engine. Caution should be taken before selecting this option as machine warranties could be voided if enabled. Select *None* to disable the programmable function.
   b. Contact Recognition - Selecting *Always* will recognize the contact whether the engine is running or not. Selecting *While Engine Running Only* will recognize the contact only while the engine is running.
3. Battery Charger Fail
   a. Input - Select an input for this function to indicate a battery charger failure. When this input is true, an alarm or pre-alarm will be announced based on the alarm configuration, and the *Battery Charger Fail* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.
   b. Alarm Configuration - Select *None, Alarm,* or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.
   c. Activation Delay - Set the delay for which the input must be true before the alarm or pre-alarm will be annunciated. This is used to prevent “glitches” on the input from causing spurious annunciation.
   d. Contact Recognition - Selecting *Always* will recognize the contact whether the engine is running or not. Selecting *While Engine Running Only* will recognize the contact only while the engine is running.
4. Low Coolant Level
   a. Input - Select an input for this function to indicate a low coolant level. When this input is true, an alarm or pre-alarm will be announced based on the alarm configuration, and the *Low Coolant Level* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.

b. Alarm Configuration - Select *None, Alarm,* or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.

c. Activation Delay - Set the delay for which the input must be true before the alarm or pre-alarm will be annunciated. This is used to prevent "glitches" on the input from causing spurious annunciation.

d. Contact Recognition - Selecting *Always* will recognize the contact whether the engine is running or not. Selecting *While Engine Running Only* will recognize the contact only while the engine is running.

5. Fuel Leak Detect

a. Input - Select an input for this function to indicate when a fuel leak has been detected. When this input is true, an alarm or pre-alarm will be announced based on the alarm configuration and the *Fuel Leak* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.

b. Alarm Configuration - Select *None, Alarm,* or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.

c. Activation Delay - Set the delay for which the input must be true before the alarm or pre-alarm will be annunciated. This is used to prevent "glitches" on the input from causing spurious annunciation.

d. Contact Recognition - Selecting *Always* will recognize the contact whether the engine is running or not. Selecting *While Engine Running Only* will recognize the contact only while the engine is running.

Configuring Remote LSM Inputs on the LSM-2020 (Load Share Module) (Figure 7-22)

The LSM-2020 has a single analog input. The input type (4-20 mA or 0-10 Vdc) and the input range must be set on the *Remote LSM Inputs* screen in BESTCOMS*Plus*.

Figure 7-22. Programmable Inputs, Remote LSM Inputs Screen

The parameters to be configured are:

1. Input Type - Select *Voltage* for a 0-10 Vdc input or *Current* for a 4-20 mA input.
2. Min Input Voltage (V) - Set this for the minimum valid voltage expected from the transducer or device connected to this input. Voltage below this threshold will be limited to this value. The minimum input voltage can be set only when the *Input Type* parameter is set to *Voltage*.

3. Max Input Voltage (V) - Set this for the maximum valid voltage expected from the transducer or device connected to this input. Voltage above this threshold will be limited to this value. The maximum input voltage can be set only when the *Input Type* parameter is set to *Voltage*.
4. Min Input Current (mA) - Set this for the minimum valid current expected from the transducer or device connected to this input. Current below this threshold will be limited to this value. The minimum input current can be set only when the *Input Type* parameter is set to *Current*.
5. Max Input Current (mA) - Set this for the maximum valid current expected from the transducer or device connected to this input. Current above this threshold will be limited to this value. The maximum input current can be set only when the *Input Type* parameter is set to *Current*.

Configuring Remote Contact Inputs on the CEM-2020/H (See Figure 7-23)

The settings of this screen are disabled unless the CEM-2020/H (Contact Expansion Module) has been enabled as previously explained.

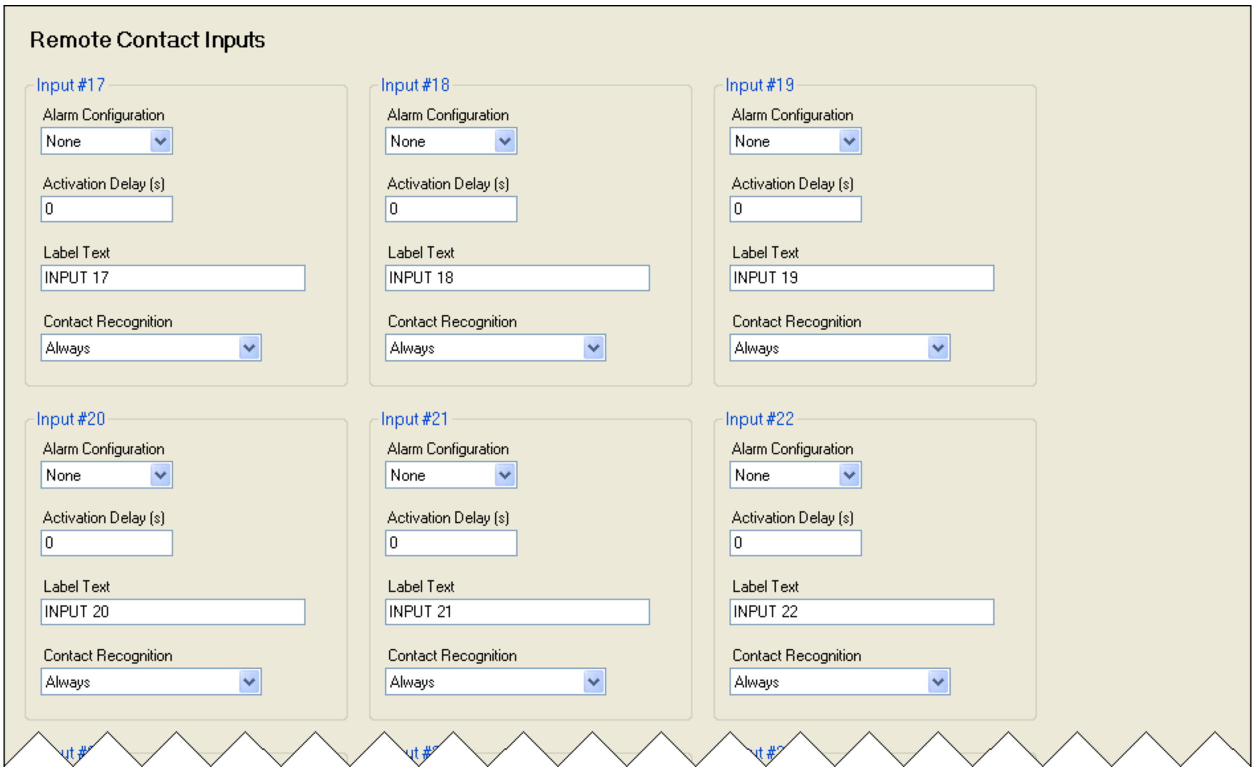


Figure 7-23. Programmable Inputs, Remote Contact Inputs Screen

For each contact input, configure the following parameters:

1. Alarm Configuration - Select an alarm configuration of *None, Alarm,* or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant beep and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine can remain running. If *None* is selected, the input is status only. The status is available to BESTLogic*Plus* Programmable Logic regardless of the setting of the *Alarm Configuration*.
2. Activation Delay - This setting defines the duration that the input should remain on before annunciation occurs.
3. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTLogic*Plus* Programmable Logic and in the event log if the input is configured as an *Alarm* or *Pre-Alarm*.
4. Contact Recognition - Select whether the contact input should be recognized always or only while the engine is running. For example, a switch that closes when the oil pressure is low should only be monitored while the engine is running. This type of switch would be closed when the engine is not running and should be blocked. However, a low oil pressure alarm or pre-alarm should be annunciated when a low oil pressure condition exists and the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

Configuring Remote Analog Inputs on the AEM-2020 (Figure 7-24)

Each input is configured with a user assignable string and parameter range to map the analog input signal range to a user defined parameter range. Thus, external conditions can be metered and displayed on the IEM-2020. Each input can be configured with up to four thresholds (two over thresholds and two under thresholds) which make their status available to BESTLogic*Plus* Programmable Logic. In addition, each threshold can trigger alarms or pre-alarms to protect the engine and associated equipment based on these measured external conditions.

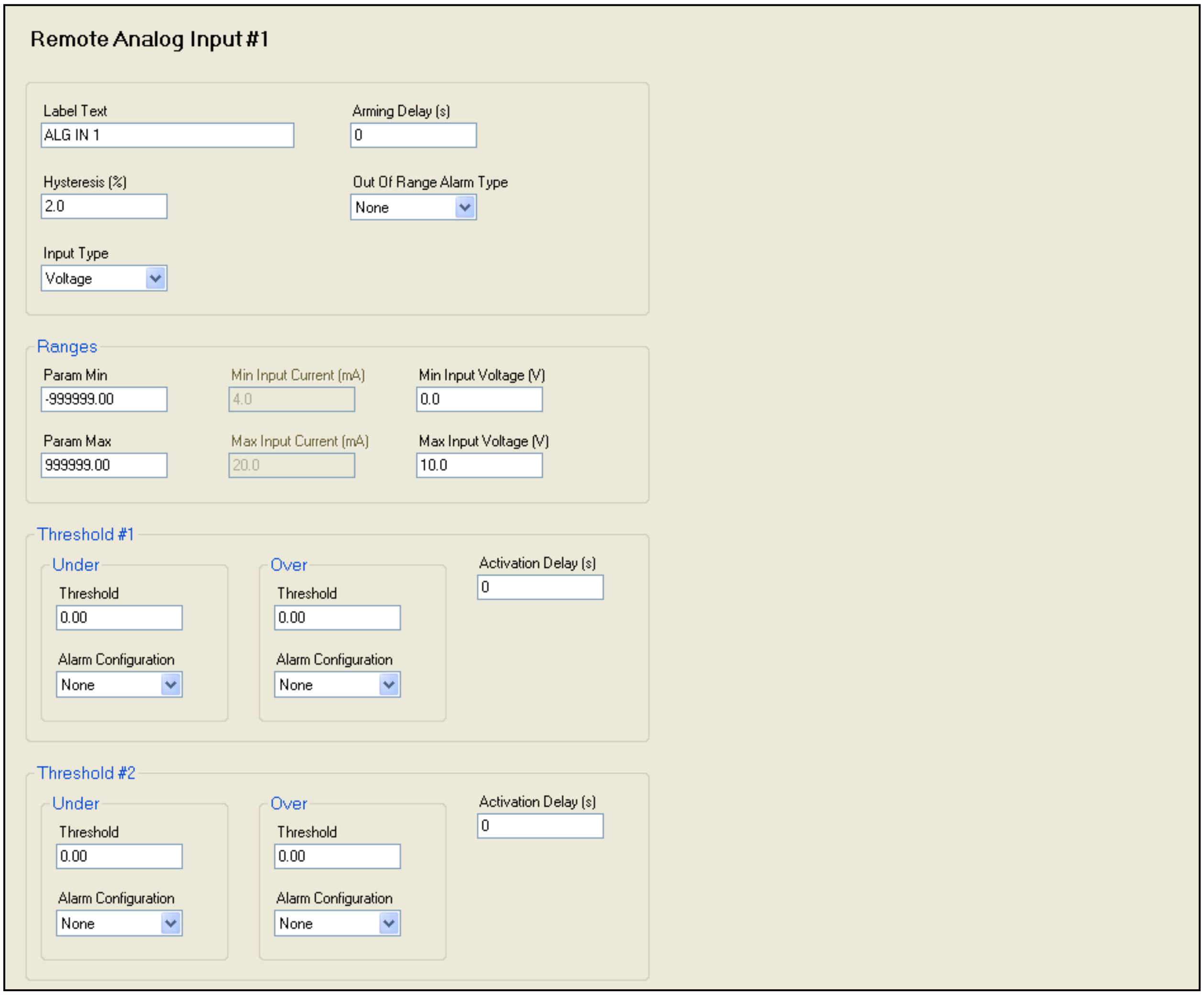


Figure 7-24. Programmable Inputs, Remote Analog Inputs Screen

Configure the following parameters:

1. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTLogic*Plus* Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.
3. Input Type - Set to *Voltage* for 0-10 Vdc inputs or set to *Current* for 4-20 mA current inputs.
4. Arming Delay - The *Arming Delay* is the wait time after engine startup before input monitoring begins. Set the arming delay to 0 if constant monitoring is desired, including while the engine is not running. Non-zero values will cause the input to be monitored after the programmed time has elapsed after engine startup.
5. Out-of-Range Alarm Type - When the analog input goes outside of its programmed range (as determined by the *Min* and *Max Input* voltage or current settings) an out-of-range indication is annunciated. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status will be available to BESTlogic*Plus* Programmable Logic but annunciation will not occur.

6. Parameter Minimum (Param Min) - This setting defines the value of the measured parameter when the analog input is at its programmed minimum level. If the analog input is below its programmed minimum level, the measured parameter will be limited to the *Parameter Minimum* setting. However, the raw analog input value will display the actual voltage or current measured at the analog input if it is within the voltage or current range that can be detected by the input circuit.
7. Parameter Maximum (Param Max) - This setting defines the value of the measured parameter when the analog input is at its programmed maximum level. If the analog input is above its programmed maximum level, the measured parameter will be limited to the *Parameter Maximum* setting. However, the raw analog input value will display the actual voltage or current measured at the analog input if it is within the voltage or current range that can be detected by the input circuit.
8. Min Input Current (mA) - This setting defines the minimum input current level expected for the input. When the input current is below this level, the out-of-range condition will be annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Voltage,* this setting is disabled.
9. Max Input Current (mA) - This setting defines the maximum input current level expected for the input. When the input current is above this level, the out-of-range condition will be annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Voltage*, this setting is disabled.
10. Min Input Voltage (V) - This setting defines the minimum input voltage level expected for the input. When the input is below this level, the out-of-range condition will be annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.
11. Max Input Voltage (V) - This setting defines the maximum input voltage level expected for the input. When the input is above this level, the out-of-range condition will be annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.

Up to four thresholds can be set for each analog input. There can be two "over" thresholds and two "Under" thresholds. Each threshold can be configured as an *Alarm, Pre-Alarm,* or *as Status Only*. If any type other than *None* is selected, the threshold status is available to BESTLogic*Plus* Programmable Logic. This allows the user to set up an over and under pre-alarm threshold, and over and under alarm threshold.

An *Activation Delay* can be set for the thresholds. Over Threshold 1 and Under Threshold 1 share a common activation delay. Similarly, Over Threshold 2 and Under Threshold 2 share a second activation delay.

12. Threshold 1
    a. Under Threshold - Set a threshold below which Status, Alarm, or Pre-Alarm annunciation is desired.
    b. Under Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    c. Over Threshold - Set a threshold above which Status, Alarm, or Pre-Alarm annunciation is desired.
    d. Over Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    e. Activation Delay(s) - This setting defines the duration that a Threshold 1 condition must be true before an alarm or pre-alarm is annunciated. This time is shared by both Over Threshold 1 and Under Threshold 1 detection.
13. Threshold 2
    a. Under Threshold - Set a threshold below which Status, Alarm, or Pre-Alarm annunciation is desired.
    b. Under Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
    c. Over Threshold - Set a threshold above which Status, Alarm, or Pre-Alarm annunciation is desired.
    d. Over Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTLogic*Plus* Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.

e. Activation Delay(s) - This setting defines the duration Threshold 2 must be exceeded before an alarm or pre-alarm is annunciated. This time is shared by both Over Threshold 2 and Under Threshold 2 detection.

Configuring Remote RTD Inputs on the AEM-2020 (Figure 7-25)

Many of the settings for the Remote RTD Inputs are similar to settings for the Remote Analog Input settings.

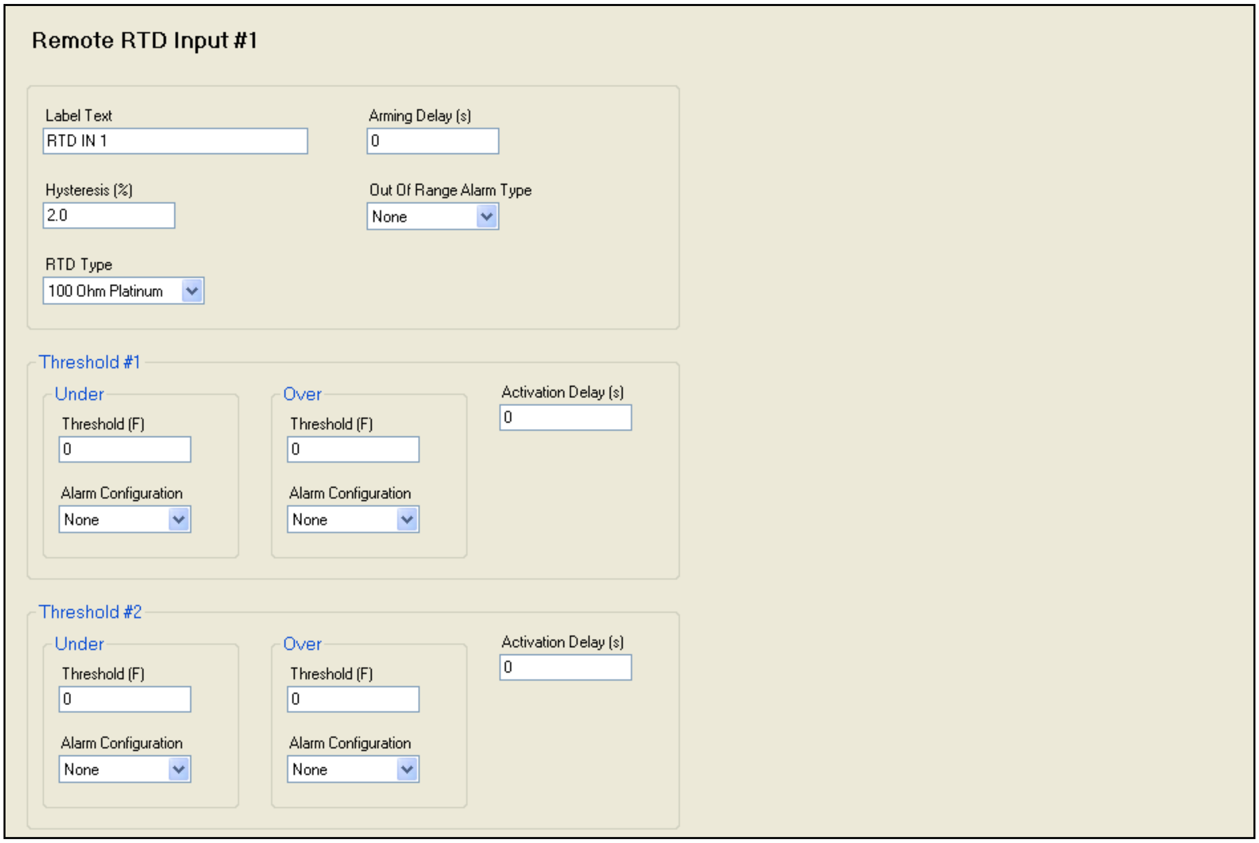


Figure 7-25. Programmable Inputs, Remote RTD Inputs Screen

Configure the following parameters:

1. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTLogic*Plus* Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. Hysteresis (%) - This setting defines the desired hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.
3. RTD Type - Select *100 Ohm Platinum* or *10 Ohm Copper* to match the RTD that is driving the input.
4. Arming Delay - The *Arming Delay* is the wait time after engine startup before the input monitoring begins. Set the arming delay to 0 if constant monitoring is desired, including when the engine is not running. Non-zero values will cause the input to be monitored after the programmed time has elapsed after engine startup.
5. Out-of-Range Alarm Type - An out-of-range condition occurs when the IEM-2020 detects that the input is outside of the normal range of what would be detected for the RTD type. Primarily this provides indication that the RTD circuit is open or shorted. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status will be available to BESTlogic*Plus* Programmable Logic but annunciation will not occur.
6. Threshold 1 and Threshold 2 settings - The threshold settings are identical to those for the remote analog inputs. Refer to the setup instructions for the remote analog inputs to configure these thresholds.

Configuring Remote Thermocouple Inputs on the AEM-2020 (Figure 7-26)

Many of the settings for the Remote Thermocouple Inputs are similar to the settings for the Remote Analog Inputs.

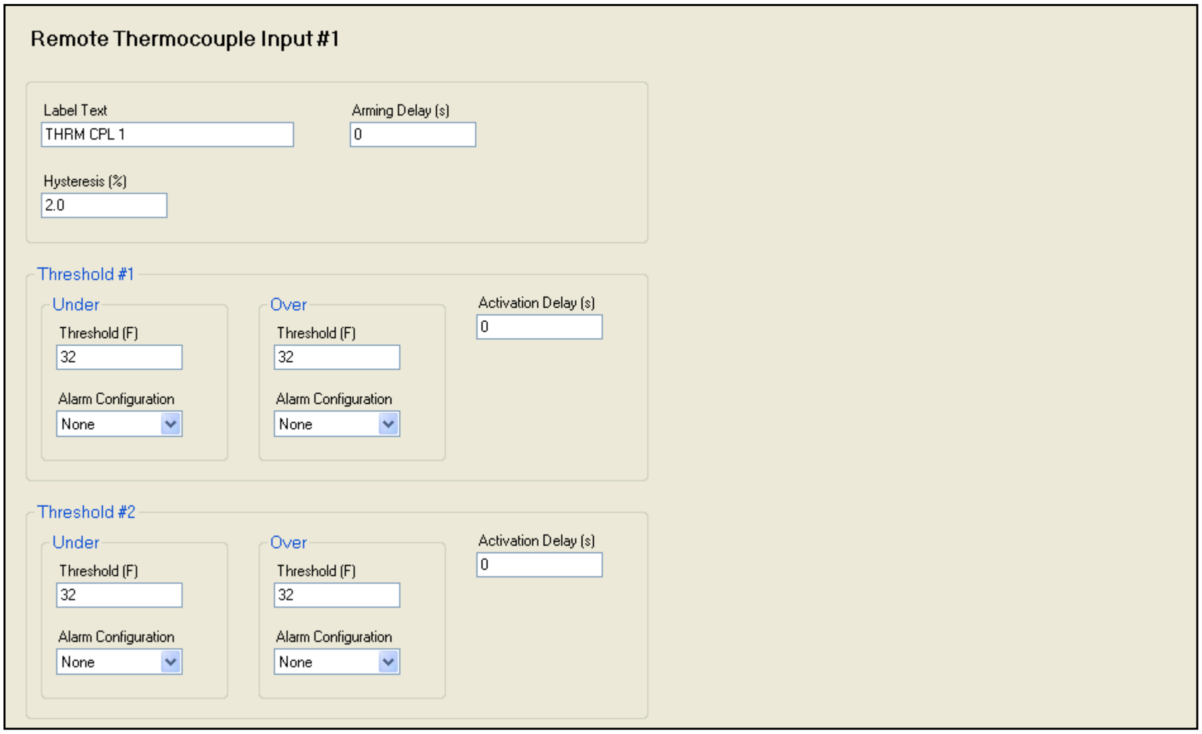


Figure 7-26. Programmable Inputs, Remote Thermocouple Inputs Screen

Configure the following parameters:

1. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input status and associated alarm and pre-alarm status in BESTlogic*Plus* Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. Hysteresis (%) - This setting defines the hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.
3. Arming Delay - The *Arming Delay* is the wait time after engine startup before input monitoring begins. Set the arming delay to 0 if constant monitoring is desired, including when the engine is not running. Non-zero values will cause the input to be monitored after the programmed time has elapsed after engine startup.
4. Threshold 1 and Threshold 2 settings - The threshold settings are identical to those for the remote analog inputs. Refer to the setup instructions in for the remote analog inputs to configure these thresholds.

Programmable Outputs

The programmable outputs consist of:

- Contact outputs internal to the IEM-2020
    - Programmable Contact Outputs
    - Run Relay, Pre-Start Relay, and Run Relay Outputs
- Configurable Elements in the IEM-2020. The configurable elements make it possible to take an output from BESTLogic*Plus* Programmable Logic and set it up as a pre-alarm or alarm condition, as well as an input for subsequent logic in the PLC program.
- Remote Contact Outputs on the CEM-2020/H
- Remote Analog Outputs on the AEM-2020

Configuring Contact Outputs on the IEM-2020.

Programmable Contact Outputs (See Figure 7-27)

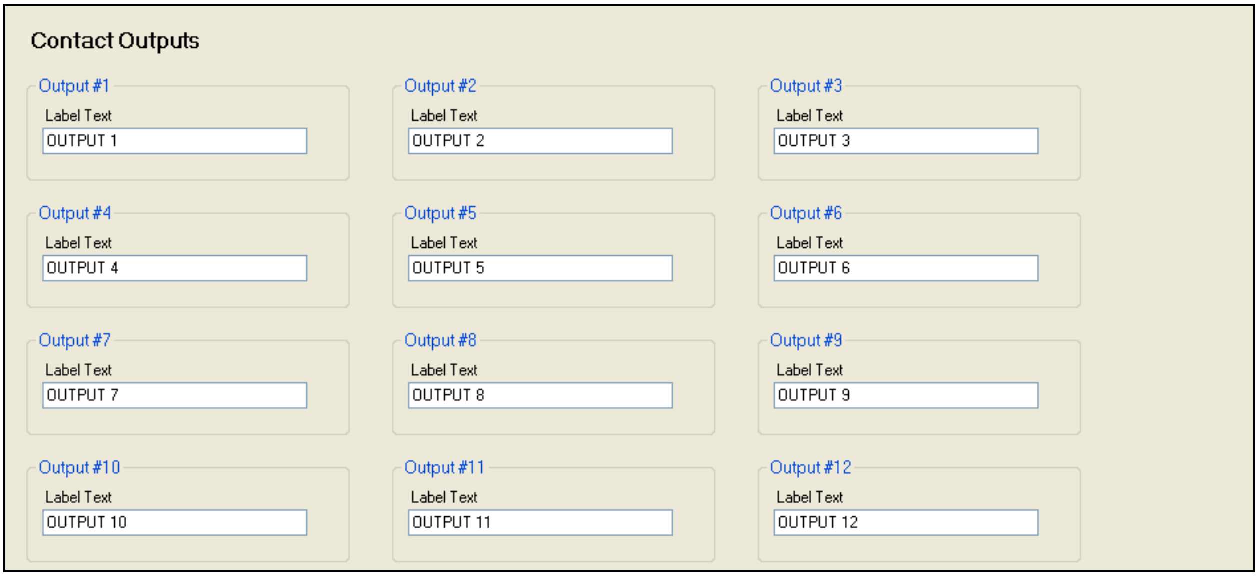


Figure 7-27. Programmable Outputs, Contact Outputs Screen

Each output can be programmed with a text label describing its use; this label appears in BESTLogic*Plus* Programmable Logic where the output is used to aid in program clarity and ease of programming.

Run Relay, Pre-Start Relay, and Start Relay (Figure 7-28)

In some systems it may be beneficial to modify the standard functionality implemented by the IEM-2020 for the Run, Pre-Start, or Start relays. If your engine does not require a pre-start function, it may be desired to use the 30A relay assigned to it for other purposes. These relays can be configured in one of two ways. The first is to operate under their predefined functionality, making them a dedicated output. The second way is to select them to be programmable, in which case they become available to BESTLogic*Plus* Programmable Logic to be used in the same manner as the programmable relay outputs.

Figure 7-28. System Parameters, Relay Control Screen

For each relay (Start, Run, and Pre-Start), select whether it should use its predefined functionality or be programmable.

When *Programmable* is selected for a relay, it becomes available to BESTLogic*Plus* Programmable Logic as a logic element. The elements are titled *Start Output, PreStart Out,* and *Run Output*. The predefined functionality is available as an input to the logic. If *Programmable* is selected as the relay control mode, connect the corresponding predefined input function to it. This would behave exactly as if *Predefined* were selected as its relay control type. However, other logic can be combined with it to create more versatile operation. If *Programmable* is selected for a relay, but it is not used in the logic, that relay will never close.

A logic example connecting the predefined inputs directly to the “programmable” relay outputs for all three relays is shown in Figure 7-29.

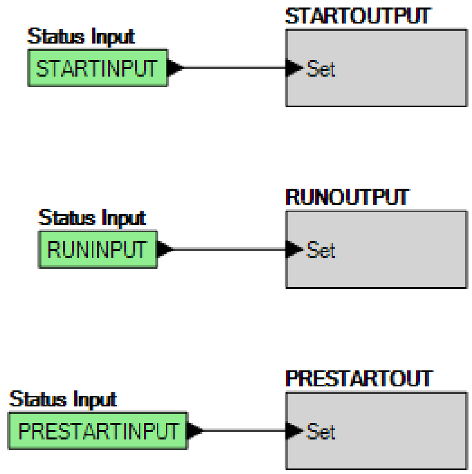


Figure 7-29. Logic Example of Programmable Relays

Setting Up Configurable Elements in the IEM-2020 (Figure 7-30)

Configurable elements are used with the BESTLogic*Plus* Programmable Logic to allow a user to implement logic to cause an alarm or pre-alarm. This can be used to build protection that is not part of the standard protection in the IEM-2020.

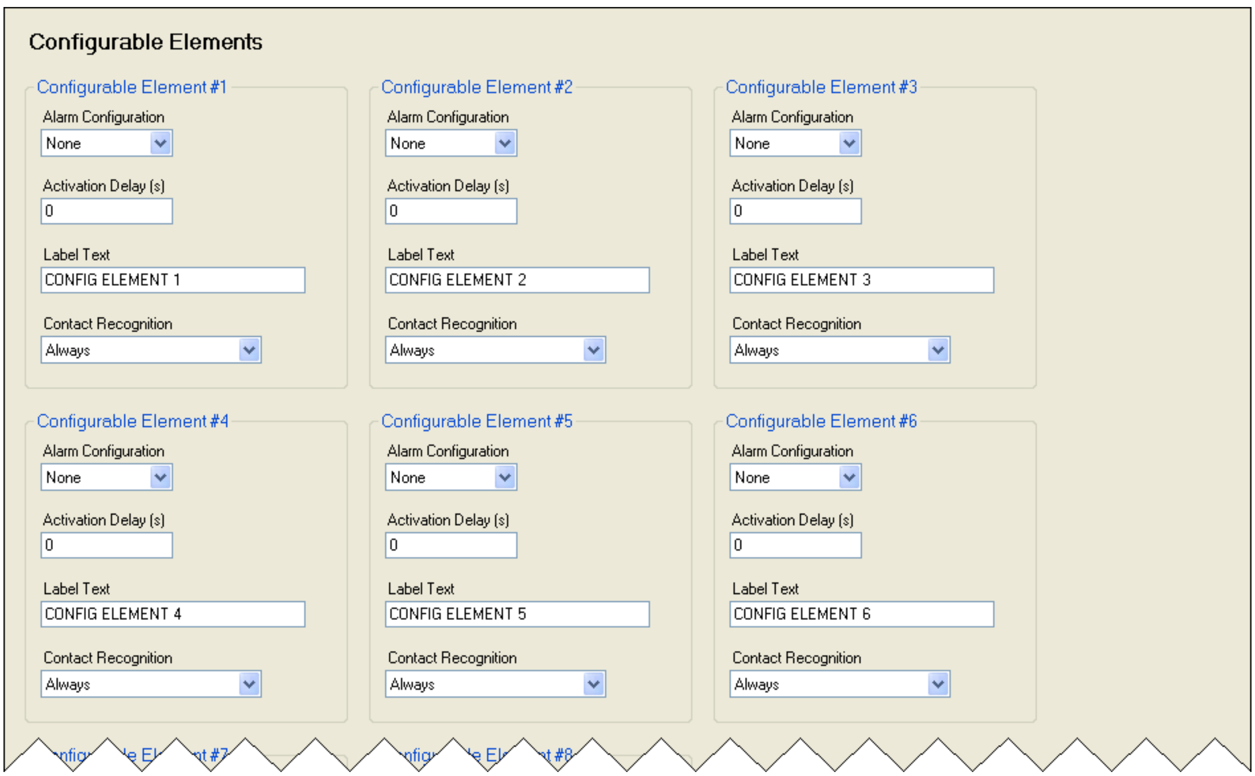


Figure 7-30. Programmable Outputs, Configurable Elements Screen

The parameters for each configurable element are similar to those for a programmable input. Set the following parameters for each configurable element:

1. Alarm Configuration - Select the alarm configuration of *None, Alarm,* or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant high-pitched sound and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine can remain running. If *None* is selected, the element is status only. The status is available as an input to BESTlogic*Plus* Programmable Logic regardless of the setting of the *Alarm Configuration.*
2. Activation Delay - This setting defines the duration that the configurable element is true before alarm or pre-alarm annunciation occurs.

3. Label Text - Enter descriptive text to describe how the configurable element functions. This text appears next to the configurable element status in BESTlogic*Plus* Programmable Logic and in the event log if the *Alarm Configuration* is set as an *Alarm* or *Pre-Alarm*.
4. Contact Recognition - Select whether the configurable element should be recognized always, or only while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

For example, a configurable element could be used when it is desired to have an alarm or pre-alarm occur when the engine room door is opened to alert the control room that someone is inside the engine room. In addition, suppose for safety reasons any running machines should be shut down when someone enters the engine room. Assume Input 5 is labeled to indicate “DOOR OPEN” and it is configured as a *Pre-Alarm*. In BESTLogic*Plus* Programmable Logic, Input 5 could be ANDed with ENGINE RUNNING to drive Configurable Element 1, which is configured as an alarm. The logic diagram is shown in Figure 7-31.

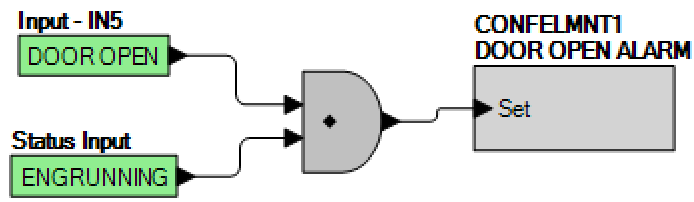


Figure 7-31. Using a Configurable Element Logic Diagram

When Input 5 is configured as a *Pre-Alarm*, it triggers a pre-alarm if the door is opened whether the engine is running or not. When Configurable Element 1 is configured as an *Alarm*, it triggers an alarm if the door was opened while the engine was running.

Configuring Remote Contact Outputs on the CEM-2020/H (Figure 7-32)

Each output can be programmed with a text label describing the function of the output. This label appears in BESTlogic*Plus* Programmable Logic where the output is used to aid in program clarity and ease of programming.

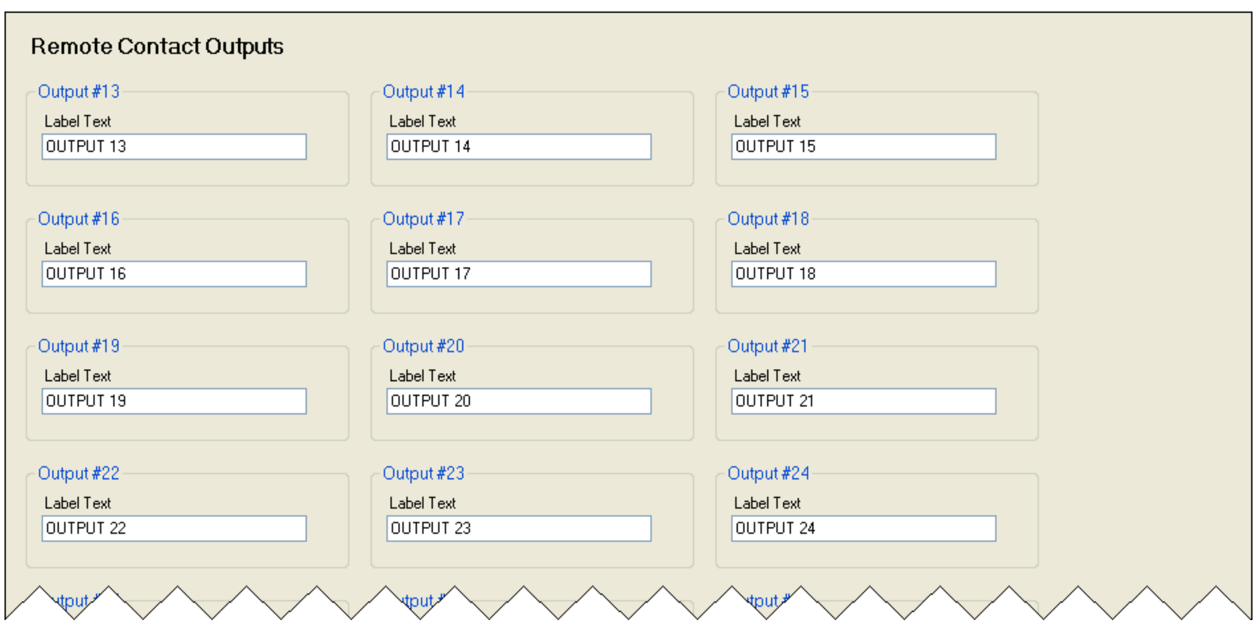


Figure 7-32. Programmable Outputs, Remote Contact Outputs Screen

Configuring Remote Analog Outputs on the AEM-2020 (Figure 7-33)

There are four remote analog outputs that are configured on separate screens in BESTCOMS*Plus*. Parameters metered by the IEM-2020 are mapped to these outputs, enabling them to be used as meter drivers or they can drive analog inputs of external equipment. Ranges for the metered parameter and the analog output are set up so that when the metered parameter is at the minimum of the parameter range, the analog output is at the minimum of its output range. Similarly, when the metered parameter is at the maximum of the parameter range, the analog output is at the maximum of its output range.

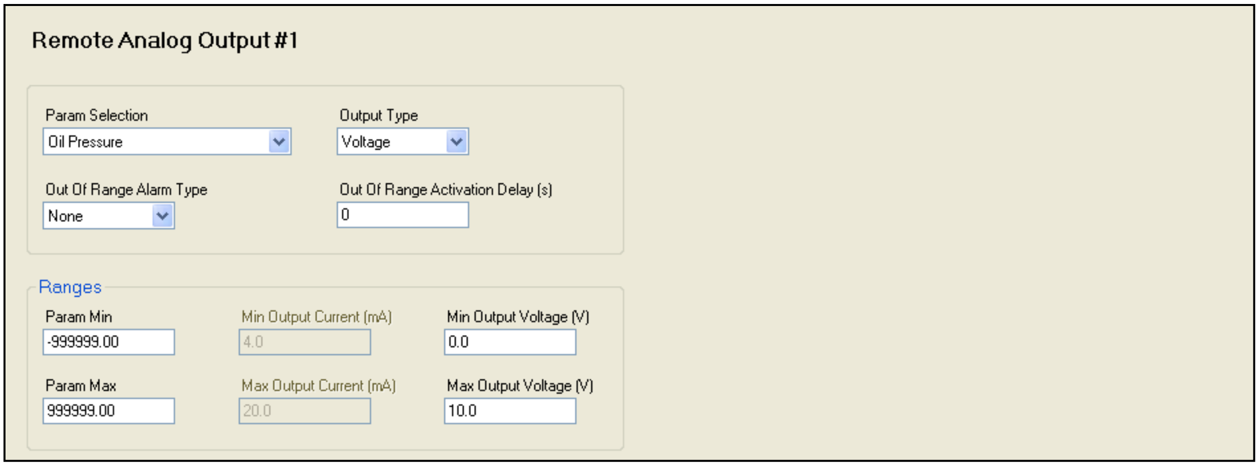


Figure 7-33. Programmable Outputs, Remote Analog Outputs Screen

Configure the following parameters:

1. Parameter Selection - This setting defines the metered parameter within the IEM-2020 (e.g. oil pressure, coolant temp, etc.) that is assigned to drive the analog output. The parameter range and the output range are configured so the range of the metered parameter is scaled to the range of the analog output. Thus, when the metered parameter is at the minimum of the parameter range, the analog output is at the minimum of its output range. Similarly, when the metered parameter is at the maximum of the parameter range, the analog output is at the maximum of its output range.
2. Output Type - Select *Voltage* or *Current* as the analog output type.
3. Out-of-Range Alarm Type - This setting specifies whether to annunciate an alarm or pre-alarm if the metered parameter is outside of the range assigned by the parameter minimum and parameter maximum settings.
4. Out-of-Range Alarm Activation Delay - This setting defines the duration that an out-of-range condition must be true before an alarm or pre-alarm is annunciated.
5. Parameter Minimum - This setting defines the minimum value that will be shown for the parameter being metered.
6. Parameter Maximum - This setting defines the maximum value that will be shown for the parameter being metered.
7. Min Output Current (mA) - If the *Analog Output Type* is configured as *Current*, set this to the output current level to be sourced when the metered parameter is at minimum. This setting is disabled when the output type is set to *Voltage*.
8. Max Output Current (mA) - If the *Analog Output Type* is configured as *Current,* set this to the output current level to be sourced when the metered parameter is at maximum. This setting is disabled when the output type is set to *Voltage*.
9. Min Output Voltage (V) - If the *Analog Output Type* is configured as *Voltage*, set this to the output voltage to be sourced when the metered parameter is at minimum. This setting is disabled when the output type is set to *Current*.
10. Max Output Voltage (V) - If the *Analog Output Type* is configured as *Voltage*, set this to the output voltage level to be sourced when the metered parameter is at maximum. This setting is disabled when the output type is set to *Current*.

SECTION 8 • MAINTENANCE AND TROUBLESHOOTING

TABLE OF CONTENTS

SECTION 8 • MAINTENANCE AND TROUBLESHOOTING

Maintenance

Preventative maintenance consists of periodic replacement of the backup battery and periodically checking that the connections between the IEM-2020 and the system are clean and tight. IEM-2020 units are manufactured using state-of-the-art, surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

Backup Battery for the Real Time Clock

The backup battery for the real time clock is a standard feature for the IEM-2020 Industrial Engine Module. A 3.0 Vdc, 195-mAh lithium battery (type Rayovac BR2032) is used to maintain clock function during loss of power supply voltage. The primary battery system that supplies the IEM-2020 power supply may be disconnected for extended periods (weeks, months) between uses. Without battery backup for the real time clock, clock functions will cease if battery input power is removed.

The backup battery has a life expectancy of approximately 10 years. After this time, you should contact Basler Electric to order a new battery, Basler Electric P/N 38526.

Battery access is located on the rear side of the IEM-2020.

CAUTION

Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings on the battery socket while inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.

It is recommended that the battery be removed if the IEM-2020 is to be operated in a salt-fog environment. Salt fog is known to be conductive and may short-circuit the battery.

NOTE

Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

Storage

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

Troubleshooting

If you do not get the results that you expect from the IEM-2020, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your engine control system.

Communications

Ethernet Port Does Not Operate Properly

Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.

Step 2. Verify the network configuration of the LSM-2020 and IEM-2020 are set up properly. For more information, refer to Section 4, *BESTCOMSPlus Software, Communication.*

Step 3. Verify that all Ethernet devices comply with IEC 61000-4 series of specifications for Industrial Ethernet Devices. Commercial devices are not recommended and may result in erratic network communications.

USB Port Does Not Operate Properly

Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus Software, Communication*.

CAN Bus Communication Does Not Operate Properly

Step 1: Verify that there is a 120-ohm termination resistor on each end of the bus section of the wiring, and that there are not any termination resistors at any node connections that are on stubs from the main bus.

Step 2: Check all CAN Bus wiring for loose connections, and verify that the CAN H and CAN L wires have not gotten switched somewhere on the network.

Step 3: Verify that the cable length of the bus section of the wiring does not exceed 40 meters, and verify that any stubs from the main bus do not exceed 3 meters in length.

Step 4: If the Engine ECU is a Volvo or MTU ECU, verify that the ECU Configuration setting is set to match the ECU configuration.

Inputs and Outputs

Programmable Inputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.

Step 2. Confirm that the inputs are programmed properly.

Step 3. Ensure that the input at the IEM-2020 is actually connected to the BATT– terminal (2).

Programmable Outputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.

Step 2. Confirm that the outputs are programmed properly.

Metering/Display

Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level

Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections.*

Step 2. Confirm that the SENDER COM terminal (11) is connected to the negative battery terminal and the engine-block side of the senders. Current from other devices sharing this connection can cause erroneous readings.

Step 3. If the displayed battery voltage is incorrect, ensure that the proper voltage is present between the BATT+ terminal (3) and the SENDER COM terminal (11).

Step 4. Verify that the correct senders are being used.

Step 5. Use a voltmeter connected between the BATT-terminal (2) and the SENDER COM terminal (11) on the IEM 2020 to verify that there is no voltage difference at any time. Any voltage differences may manifest themselves as erratic sender readings. Wiring should be corrected so that no differences exist.

Step 6: Check the sender wiring and isolate sender wiring from any of the AC wiring in the system. The sender wiring should be located away from any ignition wiring. Separate conduits should be used for sender wiring and any AC wiring.

Incorrect Display of Engine RPM

Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.

Step 2. Verify that the flywheel teeth setting is correct.

Step 3. Verify that the prime mover governor is operating properly.

Step 4. Verify that the measured frequency of the voltage at the MPU input (31 and 32) is correct.

Step 5. If the MPU is shared with the governor, verify that the polarity of the MPU input to the governor matches the polarity of the MPU input to the IEM-2020.

LCD is Blank and all LEDs are Flashing at Approximately 2 Second Intervals

This indicates that the IEM-2020 does not detect that valid application firmware is installed. The unit is running its boot loader program, waiting to accept a firmware upload.

Step 1. Start BESTCOMS*Plus.* Use the top pull-down menu and select FILE > NEW > IEM-2020.

Step 2. Select COMMUNICATIONS > UPLOAD DEVICE FILES and select the device package file that contains the firmware and language you want to upload.

Step 3. Check the boxes for IEM-2020 Firmware and IEM-2020 Language Module. Click the UPLOAD button to start the upload process.

IEM-2020 Front Panel Debug Screens

There are several debug screens in the IEM-2020 that can be useful for debugging and I/O module related issues. The following debug screens are available: LOAD SHARE DEBUG, CEM DEBUG, and AEM DEBUG.

LOAD SHARE DEBUG

This screen is gives visibility into the parameters metered and controlled by the LSM-2020.

The LOAD SHARE DEBUG screen is located on the front panel at SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > LSM SETUP > LOAD SHARE DEBUG.

The following parameters are visible on the LOAD SHARE DEBUG screen:

- AUX VOLT: Voltage the LSM-2020 sees on its analog input. Terminals P2-8 (IN–) and P2-9 (V+).
- AUX CURRENT: Current the LSM-2020 sees on its analog input. Terminals P2-7 (IN+) and P2-8 (IN–).
- LSM_RT_BIN: LSM-2020 Real Time Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted between the LSM-2020 and IEM-2020. Debug at this level is not necessary.

CEM DEBUG

This screen shows the binary data that is being sent between the CEM-2020 (Contact Expansion Module) and the IEM-2020.

The CEM DEBUG screen is located on the front panel at SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > CEM SETUP > CEM DEBUG MENU.

The following parameters are visible on the CEM DEBUG screen:

- IEM_TO_CEM_BP: IEM-2020 to CEM-2020 Binary Points. This is the status of the CEM-2020 output relays being transmitted from the IEM-2020 to the CEM-2020. This is a 32-bit, bit packed number representing the desired states of the CEM-2020 outputs. The left most bit is the first output, etc.
- CEM_TO_IEM_BP: CEM-2020 to IEM-2020 Binary Points. This is the status of the CEM-2020 inputs being transmitted from the CEM-2020 to the IEM-2020. This is a 32-bit, bit packed number representing the metered states of the CEM-2020 inputs. The left most bit is the first input, etc.

AEM DEBUG

This screen shows the binary data that is being sent between the AEM-2020 (Analog Expansion Module) and the IEM-2020.

The AEM DEBUG screen is located on the front panel at SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > AEM SETUP > AEM DEBUG MENU.

The following parameters are visible on the AEM DEBUG screen:

- IEM_TO_AEM_BP: IEM-2020 to AEM-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the IEM-2020 to the AEM-2020. Debug at this level is not necessary.
- AEM_TO_IEM_BP: AEM-2020 to IEM-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the AEM-2020 to the IEM-2020. Debug at this level is not necessary.

- ANALOG INPUTS: For each analog input, the raw metered input value is displayed, and the scaled metered input value. This is useful to check if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 volt voltage input or 4 to 20 ma current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input settings.
- THERMAL INPUTS: For each RTD input, the resistance in ohms measured by the RTD input is displayed as well as the temperature calculated from the resistance measurement. For each thermocouple input, the voltage in millivolts is displayed as well as the temperature calculated from the resistance measurement.

SECTION 9 • LSM-2020 (LOAD SHARE MODULE)

TABLE OF CONTENTS

Figures

Tables

SECTION 9 • LSM-2020 (LOAD SHARE MODULE)

General Information

The LSM-2020 is an optional remote auxiliary device.

LSM-2020 – IEM-2020 Interface

The LSM-2020 communicates through an Ethernet port and provides access to the IEM-2020 (Industrial Engine Module) via Ethernet. The LSM-2020 provides an analog input that can be configured to accept voltage or current.

LSM-2020 – DGC-2020 Interface

The LSM-2020 communicates through an Ethernet port and provides access to the DGC-2020 (Digital Genset Controller) via Ethernet. In certain applications the LSM-2020 provides analog outputs to the power system in the form of analog bias signals to the voltage regulator and speed governor. When the breaker is closed and Load Sharing is enabled, the LSM-2020 will share real power load proportionally with the other generators on the Analog Load Share Line.

Refer the DGC-2020 instruction manual for more information.

Specifications

Operating Power

Nominal..................................... 12 or 24 Vdc
Range .... 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)
Maximum Consumption............. 4 W
Terminals .... P2-3 (–), P2-2 (+), P2-1 (chassis ground)

Analog Inputs

Voltage Configuration .... 0-10 Vdc
Current Configuration .... 4-20 mAdc
Terminals .... P2-7 (IN+), P2-8 (IN–), P2-9 (V+)

Burden

4 to 20 mAdc............................. 470 Ω maximum
±10 Vdc..................................... 9.65k Ω minimum

Communication Interface

CAN Bus

Differential Bus Voltage .... 1.5 to 3 Vdc
Maximum Voltage .... –32 to +32 Vdc with respect to negative battery terminal
Communication Rate .... 250 kb/s
Terminals .... P2-12 (low), P2-11 (high), and P2-10 (shield)

Ethernet

Rear-panel RJ-45 connector provides remote communications via BESTCOMS*Plus*® to the LSM-2020 and to the IEM-2020 that the module is connected to.

Type:

10/100BASE-T

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

Type Tests

Shock

Withstands 15 G in 3 perpendicular planes.

Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz .... 1.5 G peak for 5 min.
29 to 52 to 29 Hz .... 0.036” Double Amplitude for 2.5 min.
52 to 500 to 52 Hz .... 5 G peak for 7.5 min.

Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the LSM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the LSM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

Environment

Humidity.................................... IEC 68-2-38

Temperature

Operating .... –40 to +70°C (–40 to +158°F)
Storage .... –40 to +85°C (–40 to +185°F)

Agency Information

UL Certification

The LSM-2020 is a Recognized Component applicable to Canadian and US safety standards and requirements by UL.

Standards used for evaluation:

File E97035 CCN# FTPM2 / FTPM8

- UL 6200
- CSA Standard C22.2 No.14

File E470837 CCN# FTWD2 / FTWD8

- ISA 12.12.01 Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous Locations
- C22.2 No. 213-M1987 Class I, Division 2 Hazardous Locations.

CSA Certification

The LSM-2020 was tested and has met the certification requirements for electrical, plumbing and/or mechanical products.

Standards used for evaluation:

- CSA C22.2 No. 14

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

EU Compliance

This product has been evaluated and complies with the requirements set forth by the EU legislation:

- Low Voltage Devices (LVD) – 2006/95/EC
- Electromagnetic Compatibility (EMC) – 2004/108/EC

Harmonized Standards used for evaluation:

- EN 50178: *Electronic Equipment for use in Power Installations*

- EN 61000-6-4: *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2: *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

EAC Mark (Eurasian Conformity)

TC RU C-US.HO03.B.00210

- TP TC 004/2011
- TP TC 020/2011

Physical

Weight....................................... 1.45 lb (657 g)
Dimensions .... See *Installation* later in this section.

Functional Description

Analog Inputs

The analog inputs can be configured to accept voltage or current. The inputs are configured by using the Settings Explorer in BESTCOMS*Plus* to open the *Programmable Input, Remote LSM Inputs screen.*

Communications

The LSM-2020 communication ports include CAN terminals and an Ethernet port.

CAN Bus

A Control Area Network (CAN) is a standard interface that enables communication between the LSM-2020 and the IEM-2020.

Ethernet Port

An Ethernet port provides communications via BESTCOMS*Plus* to the LSM-2020 and to the IEM-2020 that the module is connected to. Firmware updates to the LSM-2020 are made through the Ethernet port. Firmware updates to the IEM-2020 are only available through the USB port of the IEM-2020. Refer to Section 4, *BESTCOMSPlus,* for information on configuring Ethernet communication and updating firmware in the IEM-2020.

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

Status LED

This red LED flashes to indicate that the LSM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

BESTCOMSPlus® Software

BESTCOMS*Plus* provides the user with a point-and-click means to set and monitor the LSM-2020. Installation and operation of BESTCOMS*Plus* is described in Section 4, *BESTCOMSPlus Software.*

LSM-2020 Plugin for BESTCOMS*Plus*®

The setup utility that installs BESTCOMS*Plus* on your PC also installs the LSM-2020 plug-in. Refer to Section 4, *BESTCOMSPlus Software,* for information on activating the plugin.

The LSM-2020 plugin is used to set device security and view device information such as firmware version and serial number.

LSM-2020 operational settings are found in the IEM-2020 plugin for BESTCOMS*Plus*. Refer to Section 4, *BESTCOMSPlus Software,* for a detailed description of each setting.

The LSM-2020 plugin has two screens: *Device Info* and *Device Security Setup.*

Device Info

Information about a LSM-2020 communicating with BESTCOMS*Plus* can be obtained on the Device Info tab of BESTCOMS*Plus*.

Select application version[A] when configuring LSM-2020 settings off-line. When on-line, read-only information includes application version[B], boot code version[C], application build[D], serial number[E], application part number[F], and model number[G].

BESTCOMS*Plus* device information values and settings are illustrated in Figure 9-1.

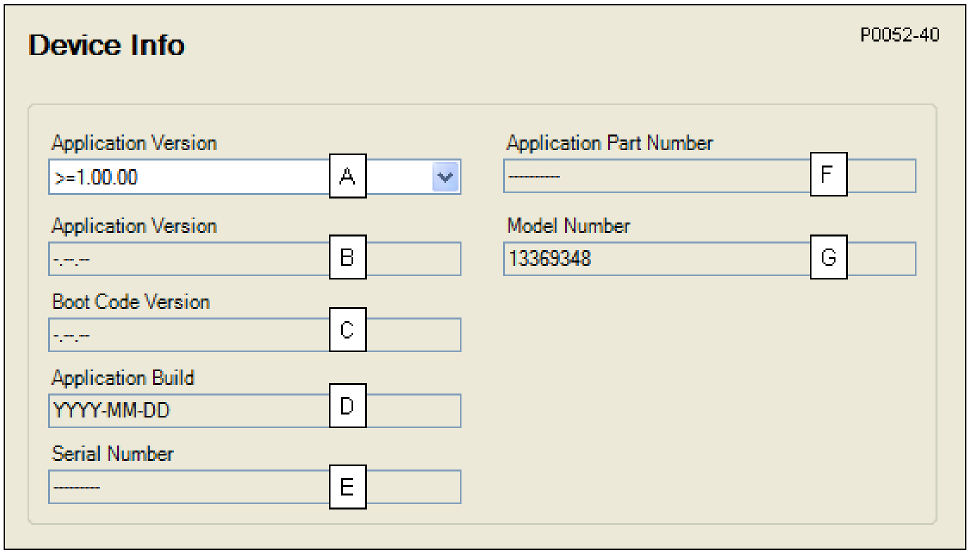


Figure 9-1. Device Info Screen

[A] *Application Version:* When configuring Load Share Module settings off-line, the application version for the unit to be configured must be selected.
[B] *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.
[C] *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.
[D] *Application Build:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.
[E] *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.
[F] *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.
[G] *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.

Device Security Setup

Password protection guards against unauthorized changing of LSM-2020 communication settings. Passwords are case sensitive. *OEM Access* is the only level of password protection available. This password level allows access to all settings made using the LSM-2020 plugin for BESTCOMS*Plus*. The default, OEM-access password is **OEM**.

Passwords can be changed only after communication between the PC and LSM-2020 is established. A change to the password is made through the *Device Security Setup* screen. Use the Settings Explorer in BESTCOMS*Plus* to open the *General Settings, Device Security Setup* screen. See Figure 9-2.

A password is changed by clicking on the access level[A], entering the new password[B], and then clicking on the *Save Password* button[C].

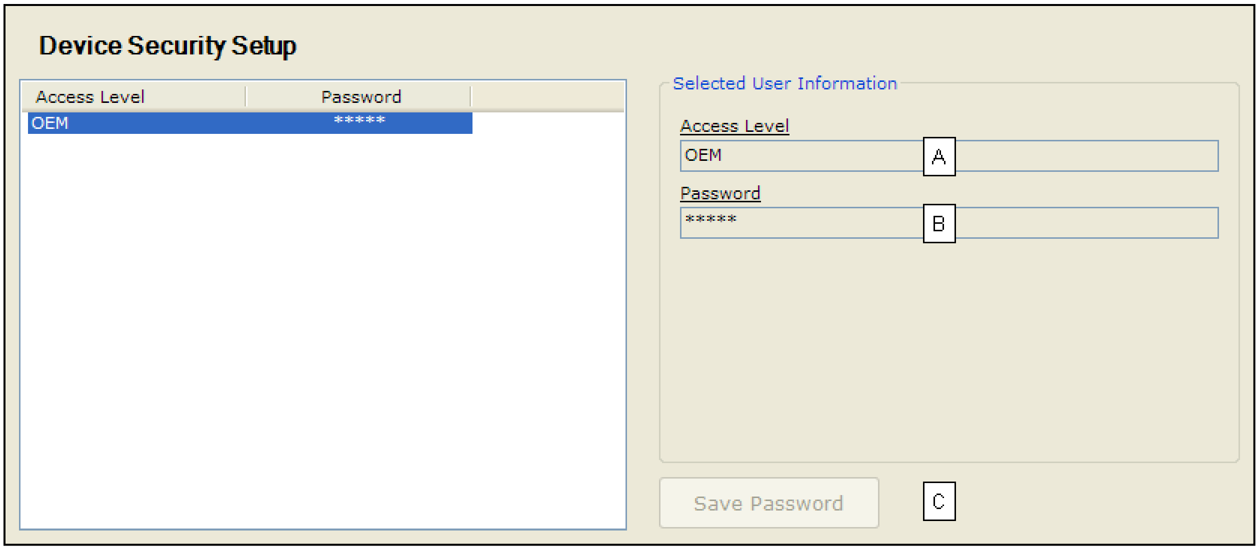


Figure 9-2. Device Security Setup Screen

[A] *Access Level/Password:* Read-only value obtained when BESTCOMS*Plus* is communicating with the Load Share Module.
[B] *Password:* Accepts an alphanumeric character string of up to 16 characters.
[C] *Save Password:* Clicking this button will save the password changes in BESTCOMSPlus memory.

Installation

LSM-2020's are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Mounting

LSM-2020's are contained in a potted plastic case and may be mounted in any convenient position. The construction of a LSM-2020 is durable enough to mount directly on a engine using UNF ¼-20 or equivalent hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 9-3 for LSM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

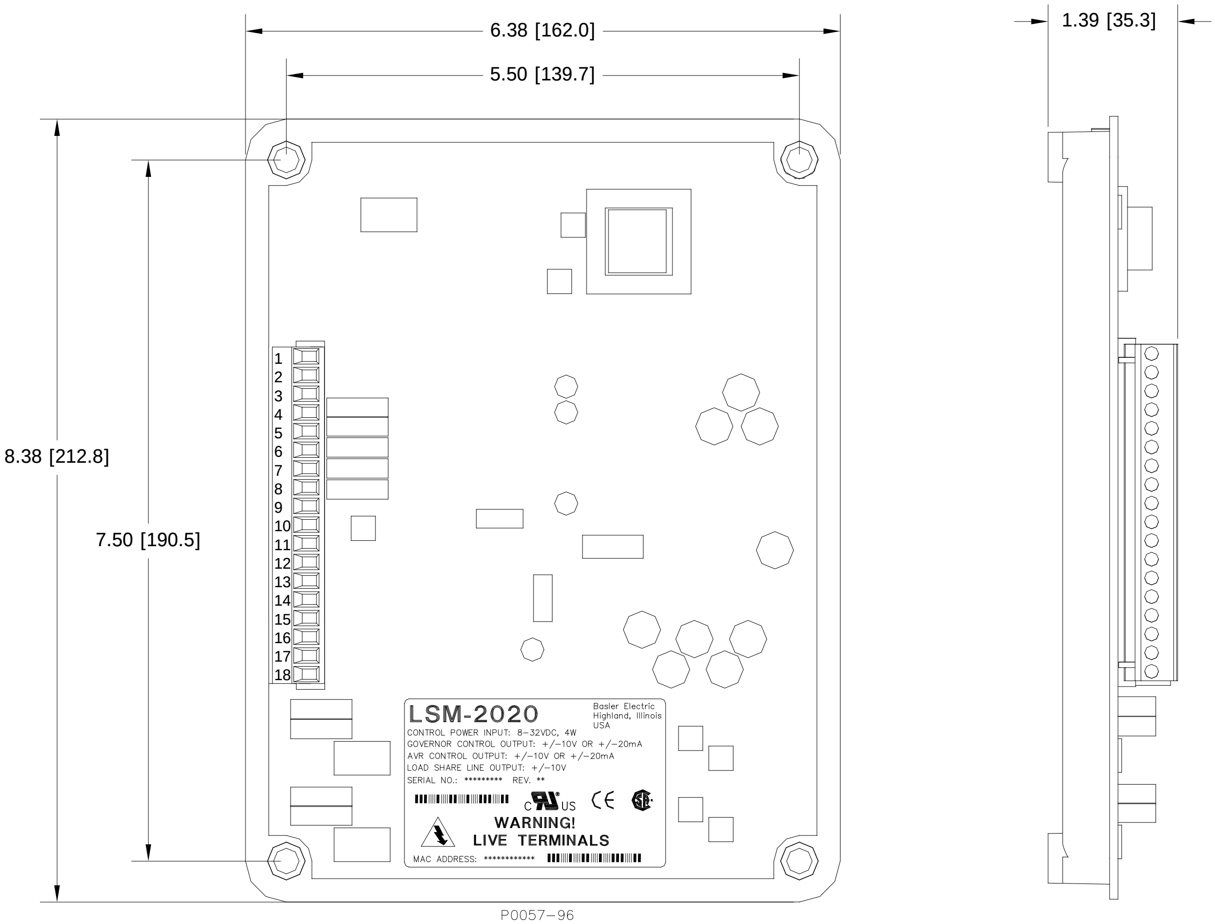


Figure 9-3. LSM-2020 Overall Dimensions

Connections

LSM-2020 connections are dependent on the application. Incorrect wiring may result in damage to the module.

Note
Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate. Be sure that the LSM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

Terminations

There are two types of interface terminals: plug-in connectors with screw-down compression terminals and an RJ-45 socket.

The RJ-45 socket mates with a standard Ethernet cable and provides local communication between the LSM-2020 and a PC running BESTCOMS*Plus* software. This allows for setting of the LSM-2020 and for the IEM-2020 that the module is connected to.

LSM-2020 connections are made with an 18-position connector with screw-down compression terminals. This connector plugs into a header on the LSM-2020. The connector and header have a dovetailed edge that ensures proper connector orientation. Also, the connector and header are uniquely keyed to ensure that the connector mates only with the correct header.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Caution
By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 4 inch-pounds (0.45 N•m).

Operating Power

The LSM-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate. Operating power terminals are listed in Table 9-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the LSM-2020. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 9-1. Operating Power Terminals

Terminal	Description
P2-1 (CHASSIS)	Chassis ground connection
P2-2 (BATT+)	Positive side of operating power input
P2-3 (BATT–)	Negative side of operating power input

Analog Inputs

Analog input terminals are listed in Table 9-2. Voltage input connections are shown in Figure 9-4 and current input connections are shown in Figure 9-5.

Table 9-2. Analog Input Terminals

Terminal	Description
P2-9 (V+)	Voltage input
P2-8 (IN–)	Common for voltage or current
P2-7 (I+)	Current input

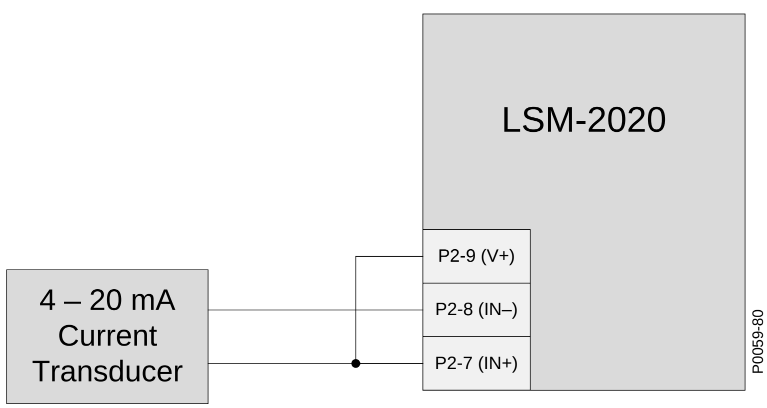


Figure 9-4. Analog Inputs - Current Input Connections

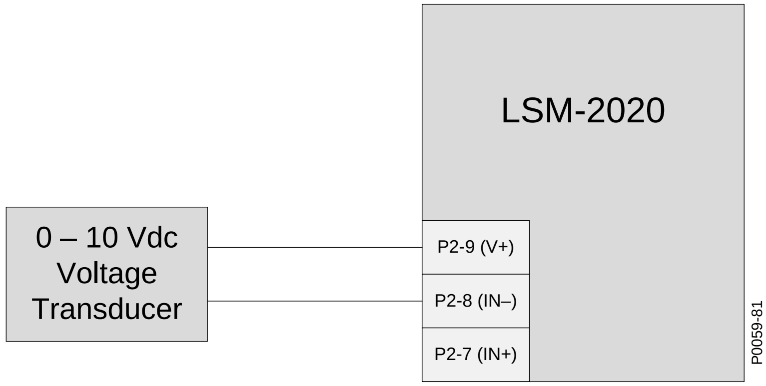


Figure 9-5. Analog Inputs - Voltage Input Connections

CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the LSM-2020 and the IEM-2020. Connections between the LSM-2020 and IEM-2020 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 9-3. Refer to Figure 9-6 and Figure 9-7.

Table 9-3. CAN Bus Interface Terminals

Terminal	Description
P2-12 (CAN L)	CAN low connection (green wire)
P2-11 (CAN H)	CAN high connection (yellow wire)
P2-10 (SHIELD)	CAN drain connection

NOTES

1. If the LSM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals P2-12 (CANL) and P2-11 (CANH).
2. If the LSM-2020 is not part of the J1939 bus, the stub connecting the LSM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the LSM-2020.

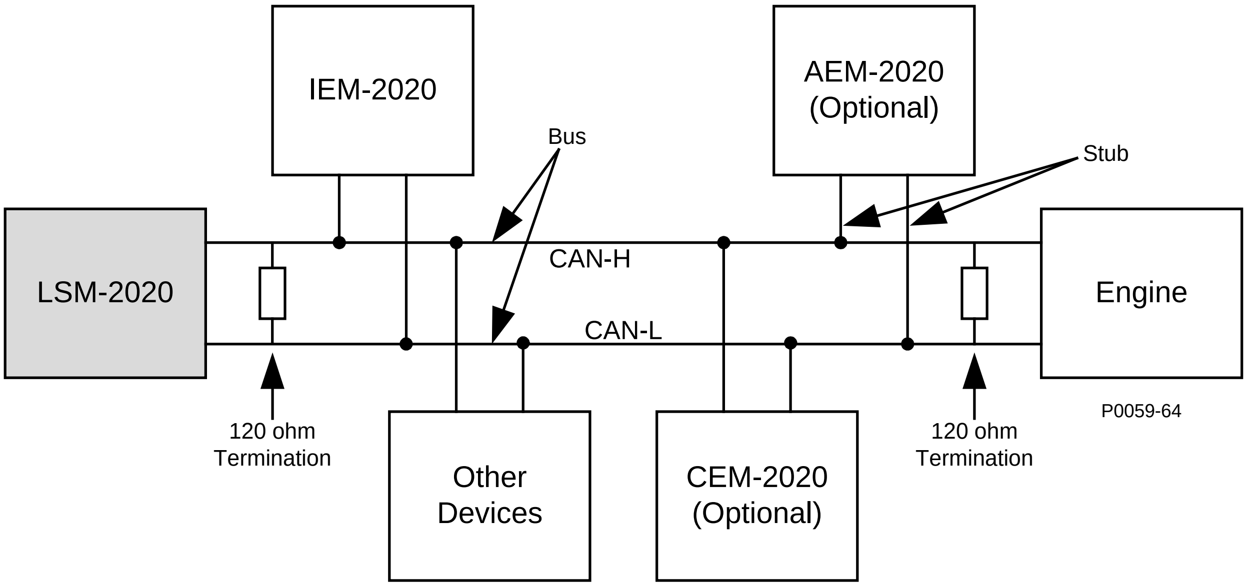


Figure 9-6. CAN Bus Interface with LSM-2020 providing One End of the Bus

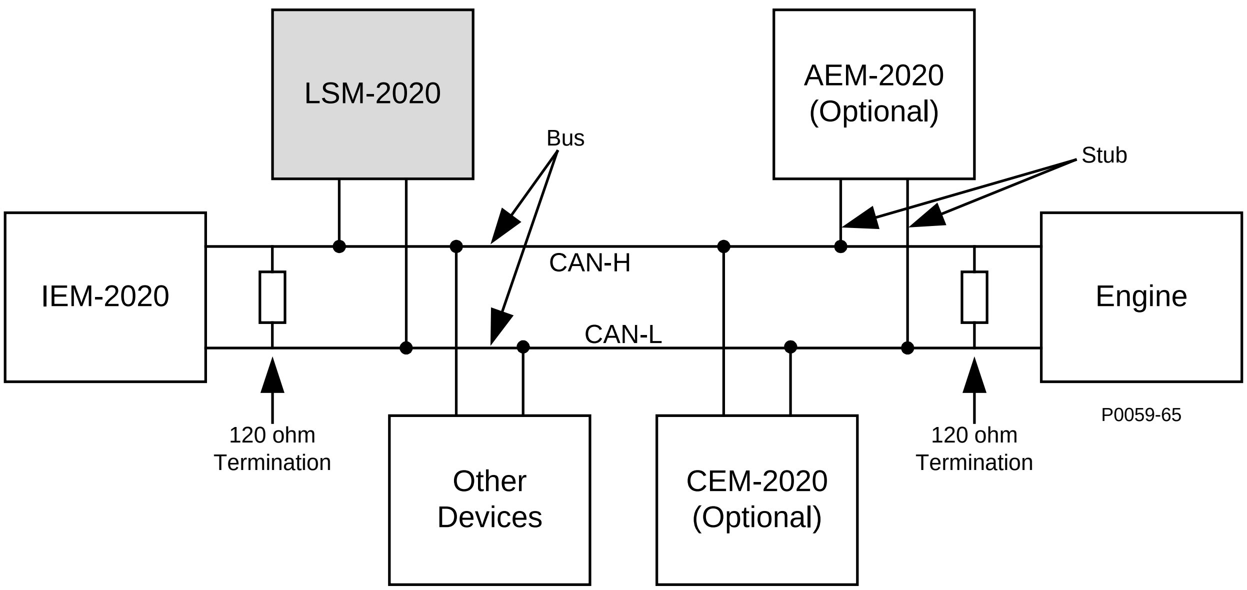


Figure 9-7. CAN Bus Interface with IEM-2020 providing One End of the Bus

Ethernet Port

The LSM-2020 has Ethernet capability. The LSM-2020 connects to a PC through a RJ-45 jack (J3). Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

Connections for Typical Applications

Figure 9-8 illustrates typical LSM-2020 connections.

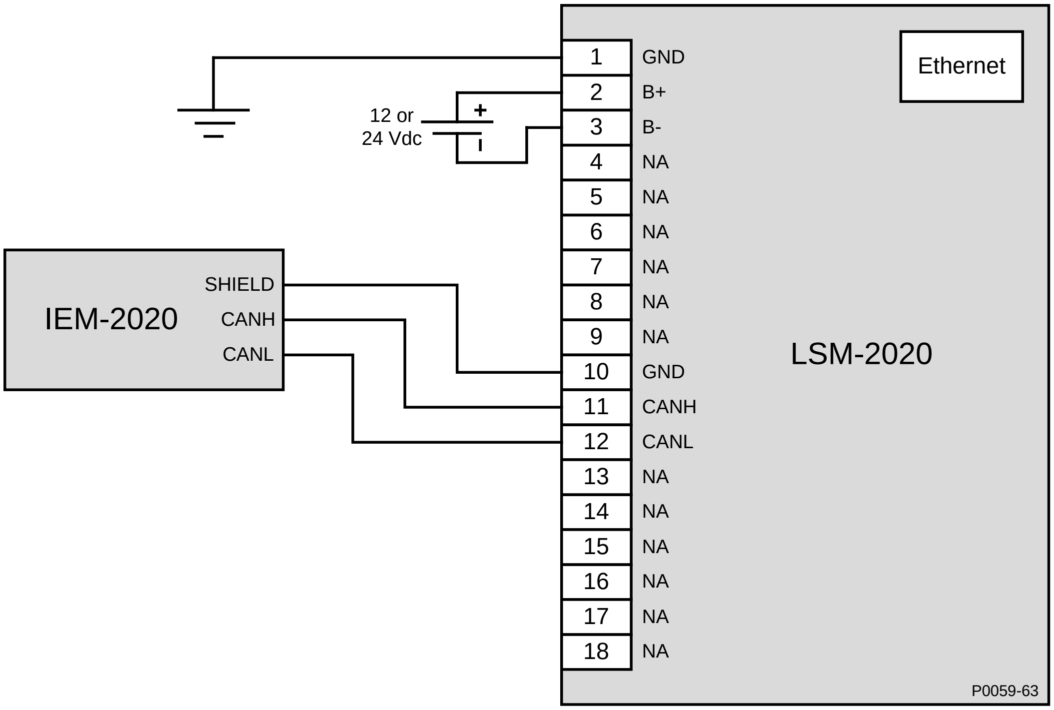


Figure 9-8. Typical LSM-2020 Connections

Maintenance

Preventive maintenance consists of periodically checking that the connections between the LSM-2020 and the system are clean and tight. LSM-2020s are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE)

TABLE OF CONTENTS

Figures

Tables

SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE)

General Information

The optional CEM-2020 is a remote auxiliary device that provides additional IEM-2020 contact inputs and outputs. Two types of modules are available. A low current module (CEM-2020) provides 24 output contacts and a high current module (CEM-2020H) provides 18 output contacts.

Features

CEM-2020s have the following features:

- 10 Contact Inputs
- 18 Output Contacts (CEM-2020H) or 24 Output Contacts (CEM-2020)
- Functionality of Inputs and Outputs assigned by BESTlogic*Plus* programmable logic
- Communications via CAN Bus

Specifications

Operating Power

Nominal.................................... 12 or 24 Vdc
Range .... 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)

Maximum Consumption

CEM-2020................................ 14 W
CEM-2020H .... 8 W

Contact Inputs

The CEM-2020 contains 10 programmable inputs that accept normally open and normally closed, dry contacts.

Time from a CEM-2020 input going high to:

Shutdown the engine via an alarm .... 700 ms max
Close a relay on board the IEM-2020..... 300 ms max

Output Contacts

Ratings

CEM-2020

Outputs 13 through 24 .... 1 Adc at 30 Vdc, Form C, gold contacts
Outputs 25 through 36 .... 4 Adc at 30 Vdc, Form C

CEM-2020H

Outputs 13 through 24 .... 2 Adc at 30 Vdc, Form C, gold contacts
Outputs 25 through 30 .... 10 Adc at 30 Vdc, Form C

Communication Interface

CAN Bus

Differential Bus Voltage .... 1.5 to 3 Vdc
Maximum Voltage .... –32 to +32 Vdc with respect to negative battery terminal
Communication Rate .... 250 kb/s

Type Tests

Shock

Withstands 15 G in 3 perpendicular planes.

Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz .... 1.5 G peak for 5 min.
29 to 52 to 29 Hz .... 0.036” Double Amplitude for 2.5 min.
52 to 500 to 52 Hz .... 5 G peak for 7.5 min.

Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the CEM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the CEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

Environment

Humidity.................................... IEC 68-2-38

Temperature

Operating .... –40 to +70°C (–40 to +158°F)
Storage .... –40 to +85°C (–40 to +185°F)

Agency Information

UL Approval

The CEM-2020 is a Recognized Component for the US and Canada under UL file E97035

(CCN-FTPM2/FTPM8) covered under the Standards below:

- UL 6200
- CSA C22.2 No.14-13

The CEM-2020 is a Recognized Component for the US and Canada under UL file E470837

(CCN-FTWD2/FTWD8) for use in Hazardous Locations:

- Class I Division 2
- Groups A, B, C & D

CSA Approval

The CEM-2020 is covered under CSA file 1042505 (LR23131-138S).

- CSA C22.2 No. 14-13

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
- Hazardous Substances (RoHS 2) -2011/65/EU

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*

- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*
- EN 50581:2012, Ed. 12 - *Technical Documentation for the Assessment of Electrical and Electronic Products with respect to the Restriction of Hazardous Substan*ces.

EAC Mark (Eurasian Conformity)

TC RU C-US.HO03.B.00210

- TP TC 004/2011
- TP TC 020/2011

Physical

Dimensions .... See *Installation* later in this section.

Weight

CEM-2020................................. 2.25 lb (1.02 kg)
CEM-2020H .... 1.90 lb (0.86 kg)

Functional Description

Contact Inputs

The CEM-2020 provides 10 programmable contact inputs with the same functionality as the contact inputs on the IEM-2020.

Output Contacts

CEM-2020

The CEM-2020 provides 24 programmable output contacts with the same functionality as the output contacts on the IEM-2020. Outputs 13 through 24 can carry 1 A. Outputs 25 through 36 can carry 4 A.

CEM-2020H

The CEM-2020H provides 18 programmable output contacts with the same functionality as the output contacts on the IEM-2020. Outputs 13 through 24 can carry 2 A. Outputs 25 through 30 can carry 10 A.

Communications

CAN Bus

A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the IEM-2020.

Status LED

This red LED flashes to indicate that the CEM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

BESTCOMSPlus® Software

BESTCOMS*Plus*® provides the user with a point-and-click means to set and monitor the Contact Expansion Module. Installation and operation of BESTCOMS*Plus* is described in Section 4, *BESTCOMSPlus Software.*

Installation

Contact Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Mounting

Contact Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a engine using UNF ¼-20 or equivalent hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 10-1 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

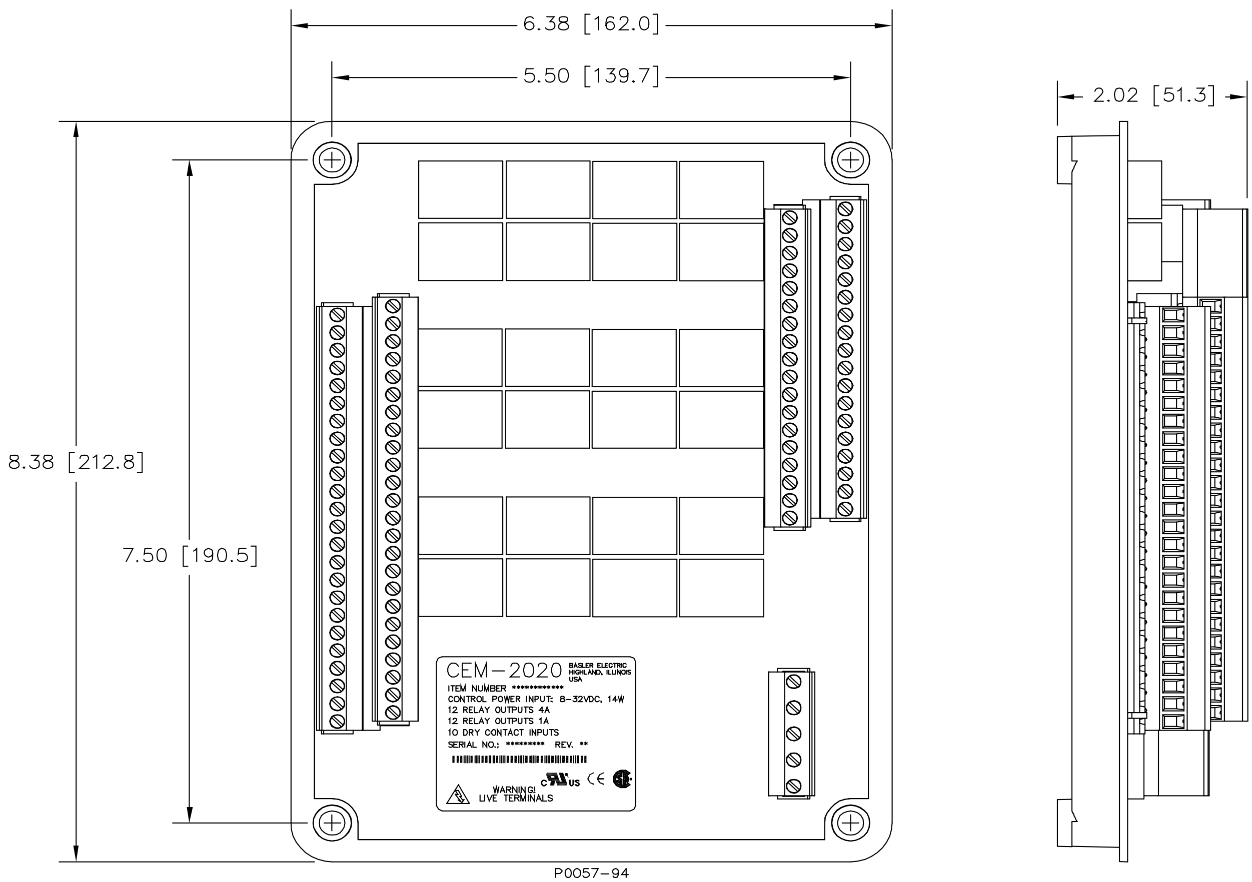


Figure 10-1. CEM-2020 Overall Dimensions

See Figure 10-2 for CEM-2020H overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

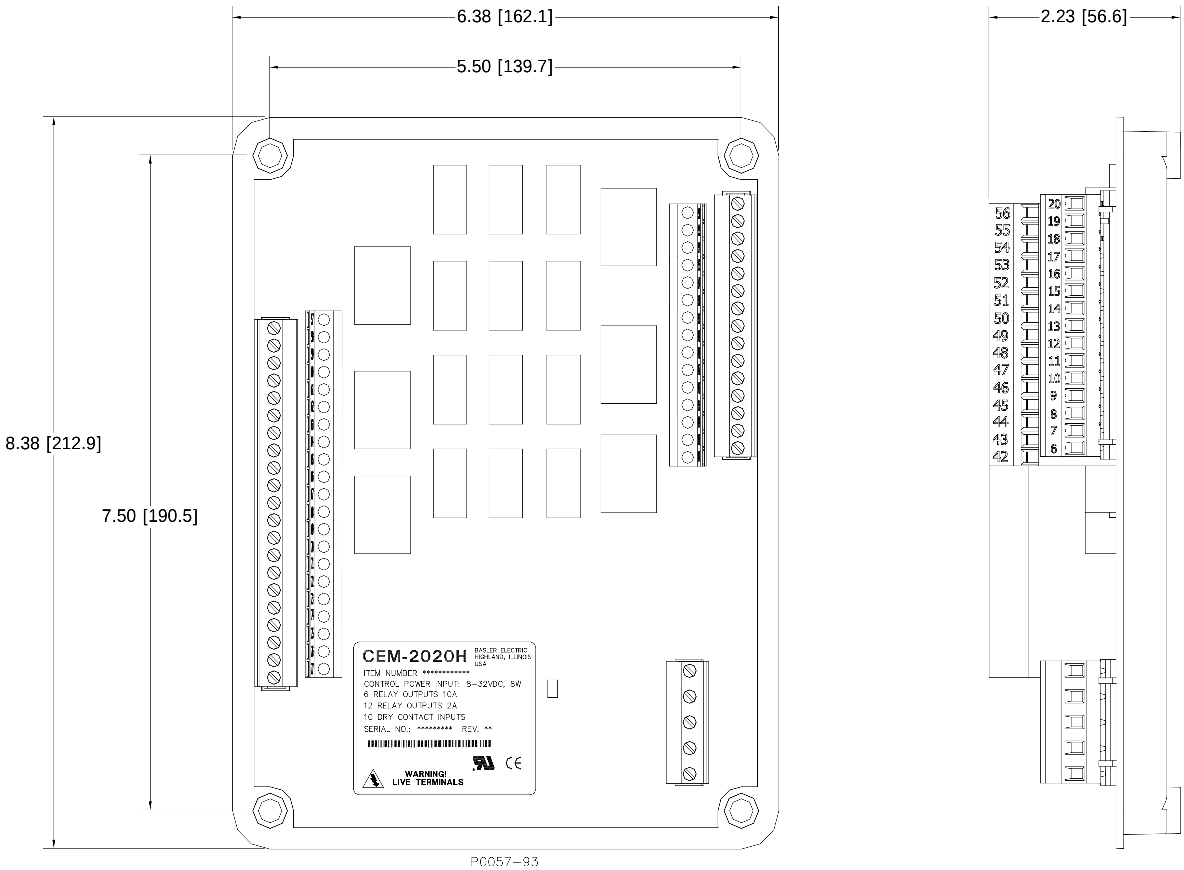


Figure 10-2. CEM-2020H Overall Dimensions

Connections

Contact Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

> **Note**
>
> Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.
>
> Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers.

> **Caution**
>
> By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Contact Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Operating power terminals are listed in Table 10-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 10-1. Operating Power Terminals

Terminal	Description
P1- ⏚ (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

Contact Inputs and Output Contacts

The CEM-2020 (Figure 10-3) has 10 contact inputs and 24 output contacts. The CEM-2020H (Figure 10-4) has 10 contact inputs and 18 output contacts.

Note
To follow UL guidelines, a fuse must be implemented in the 2Adc contact circuits (Outputs 13 through 24) of the CEM-2020H used in hazardous locations. The suggested fuse size in Adc = (100/Contact Voltage) with a maximum fuse size of 5Adc.

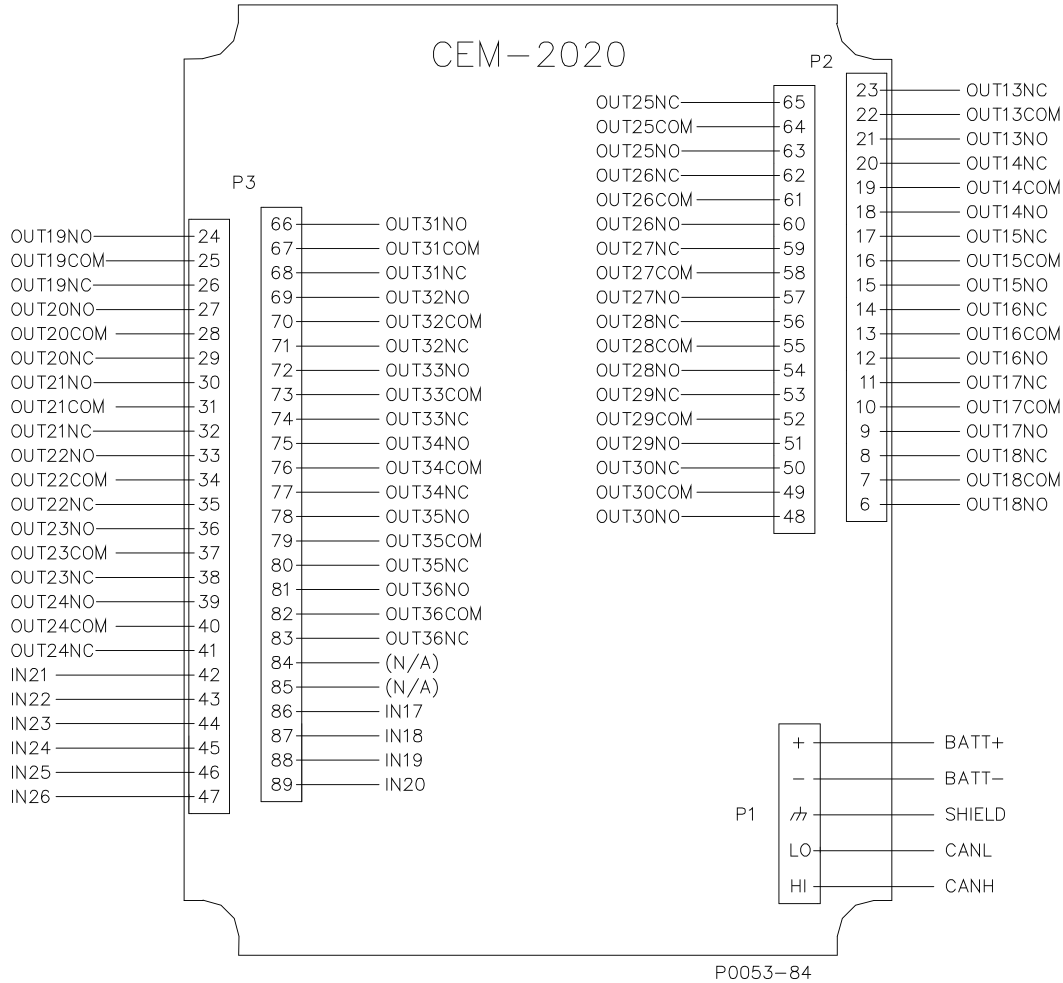


Figure 10-3. CEM-2020 Input Contact and Output Contact Terminals

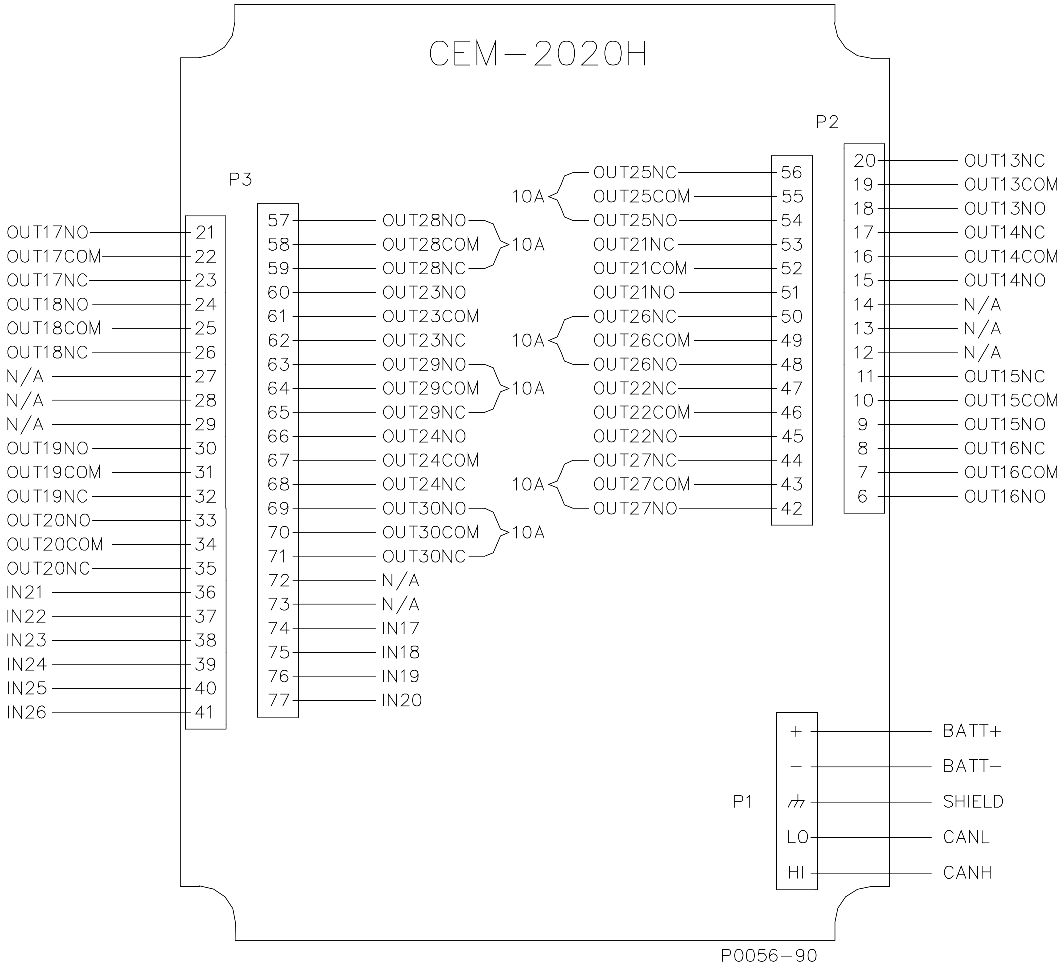


Figure 10-4. CEM-2020H Input Contact and Output Contact Terminals

CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Contact Expansion Module and the IEM-2020. Connections between the CEM-2020 and IEM-2020 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 10-2. Refer to Figure 10-5 and Figure 10-6.

Table 10-2. CAN Bus Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1- ⏚ (SHIELD)	CAN drain connection

Note
1. If the CEM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH). 2. If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length. 3. The maximum bus length, not including stubs, is 40 m (131 ft). 4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

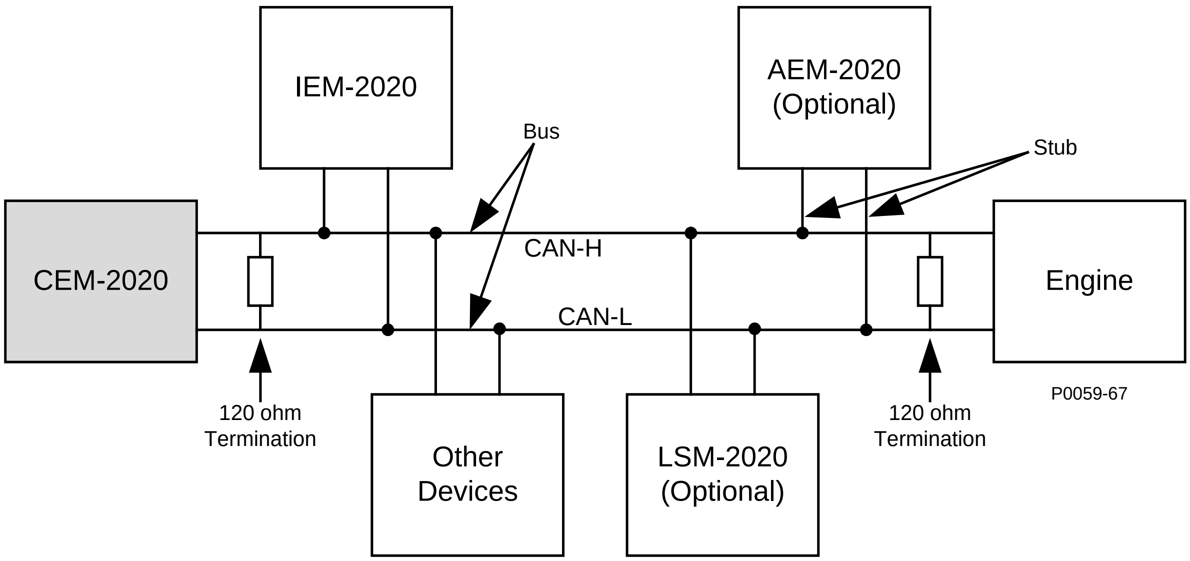


Figure 10-5. CAN Bus Interface with CEM-2020 providing One End of the Bus

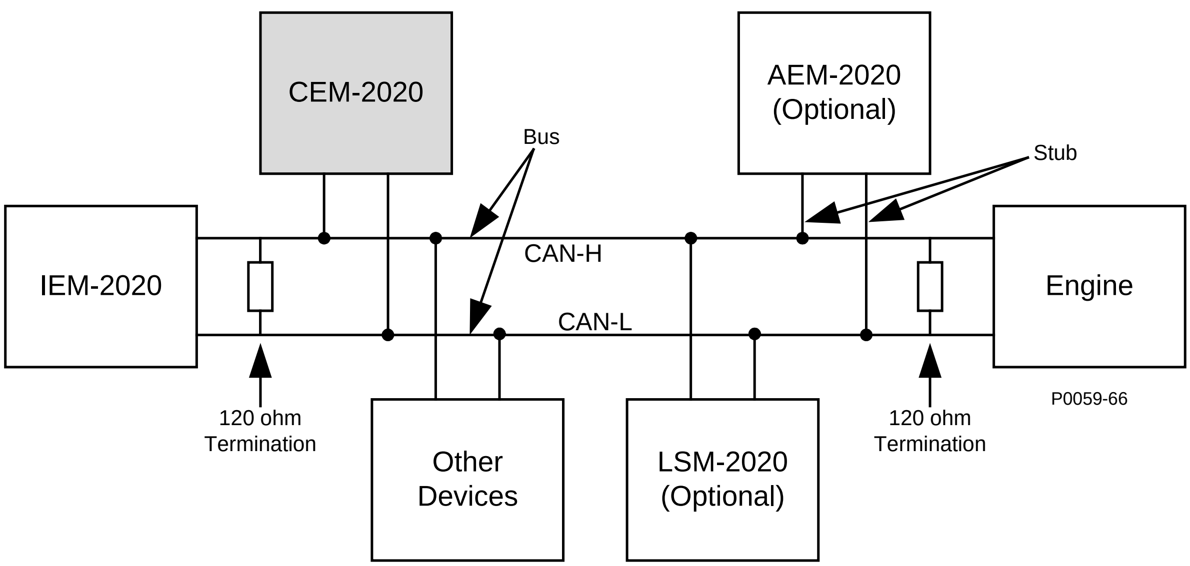


Figure 10-6. CAN Bus Interface with IEM-2020 providing One End of the Bus

Maintenance

Preventive maintenance consists of periodically checking that the connections between the CEM-2020 and the system are clean and tight. Contact Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE)

TABLE OF CONTENTS

Figures

Tables

SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE)

General Information

The optional AEM-2020 is a remote auxiliary device that provides additional IEM-2020 analog inputs and outputs.

Features

AEM-2020s have the following features:

- 8 Analog Inputs
- 8 RTD Inputs
- 2 Thermocouple Inputs
- 4 Analog Outputs
- Functionality of Inputs and Outputs assigned by BESTlogic*Plus* programmable logic
- Communications via CAN Bus

Specifications

Operating Power

Nominal.................................... 12 or 24 Vdc
Range .... 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)
Maximum Consumption............. 5.1 W

Analog Inputs

The AEM-2020 contains eight programmable analog inputs.

Rating .... 4 to 20 mAdc or 0 to 10 Vdc (user-selectable)

Burden

4 to 20 mAdc............................. 470 Ω maximum
±10 Vdc.................................... 9.65k Ω minimum

RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

Rating .... 100 Ω Platinum or 10 Ω Copper (user-selectable)
Setting Range .... –50 to +250°C or –58 to +482°F
Accuracy (10 Ω Copper)............ +/-0.044 Ω @ 25°C, +/-0.005 Ω/°C drift over ambient temperature
Accuracy (100 Ω Platinum)........ +/-0.39 Ω @ 25°C, +/-0.047Ω/°C drift over ambient temperature

Thermocouple Inputs

The AEM-2020 contains two thermocouple inputs.

Rating .... 2 K Type Thermocouples
Setting Range .... 0 to 1,375°C or 32 to 2,507°F
Display Range .... Ambient to 1,375°C or Ambient to 2,507°F
Accuracy .... +/-40uV @ 25°C, +/-5 uV/°C drift over ambient temperature

Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating .... 4 to 20 mAdc or 0 to 10 Vdc (user-selectable)

Communication Interface

CAN Bus

Differential Bus Voltage .... 1.5 to 3 Vdc
Maximum Voltage .... –32 to +32 Vdc with respect to negative battery terminal
Communication Rate .... 250 kb/s

Type Tests

Shock

Withstands 15 G in 3 perpendicular planes.

Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz .... 1.5 G peak for 5 min.
29 to 52 to 29 Hz .... 0.036" Double Amplitude for 2.5 min.
52 to 500 to 52 Hz .... 5 G peak for 7.5 min.

Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the AEM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the AEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

Environment

Humidity.................................... IEC 68-2-38

Temperature

Operating .... –40 to +70°C (–40 to +158°F)
Storage .... –40 to +85°C (–40 to +185°F)

Agency Information

UL Approval

The AEM-2020 is a Recognized Component for the US and Canada under UL file E97035

(CCN-FTPM2/FTPM8) covered under the Standards below:

- UL 6200
- CSA C22.2 No.14-13

The AEM-2020 is a Recognized Component for the US and Canada under UL file E470837

(CCN-FTWD2/FTWD8) for use in Hazardous Locations:

- Class I Division 2
- Groups A, B, C & D

CSA Approval

The AEM-2020 is covered under CSA file 1042505 (LR23131-138S).

- CSA C22.2 No. 14-13

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
- Hazardous Substances (RoHS 2) -2011/65/EU

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*
- EN 50581:2012, Ed. 12 - *Technical Documentation for the Assessment of Electrical and Electronic Products with respect to the Restriction of Hazardous Substan*ces.

EAC Mark (Eurasian Conformity)

TC RU C-US.HO03.B.00210

- TP TC 004/2011
- TP TC 020/2011

Physical

Weight....................................... 1.80 lb (816 g)
Dimensions .... See *Installation* later in this section.

Functional Description

A functional description of the AEM-2020's inputs and outputs is provided below.

Analog Inputs

The AEM-2020 provides eight analog inputs that are user-selectable for 4 to 20 mAdc or 0 to 10 Vdc. Each analog input has under/over thresholds that can be configured as status only, alarm, or pre-alarm. When enabled, an out of range alarm alerts the user of an open or damaged analog input wire. The label text of each analog input is customizable.

RTD Inputs

The AEM-2020 provides eight user-configurable RTD inputs for monitoring engine temperature. Each RTD input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged RTD input wire. The label text of each RTD input is customizable.

Thermocouple Inputs

The AEM-2020 provides two thermocouple inputs for monitoring engine temperature. Each thermocouple input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged thermocouple input wire. The label text of each thermocouple input is customizable.

Analog Outputs

The AEM-2020 provides four analog outputs that are user-selectable for 4 to 20 mAdc or 0 to 10 Vdc. A wide selection of parameters including oil pressure and fuel level can be configured as analog outputs. Refer to Section 4, *BESTCOMSPlus® Software,* for a full list of parameter selections.

Communications

CAN Bus

A Control Area Network (CAN) is a standard interface that enables communication between the AEM-2020 and the IEM-2020.

Status LED

This red LED flashes to indicate that the AEM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

BESTCOMSPlus® Software

BESTCOMS*Plus* provides the user with a point-and-click means to set and monitor the Analog Expansion Module. Installation and operation of BESTCOMS*Plus* is described in Section 4, *BESTCOMSPlus Software.*

Installation

Analog Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Mounting

Analog Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of an Analog Expansion Module is durable enough to mount directly on a engine using UNF ¼-20 or equivalent hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 11-1 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

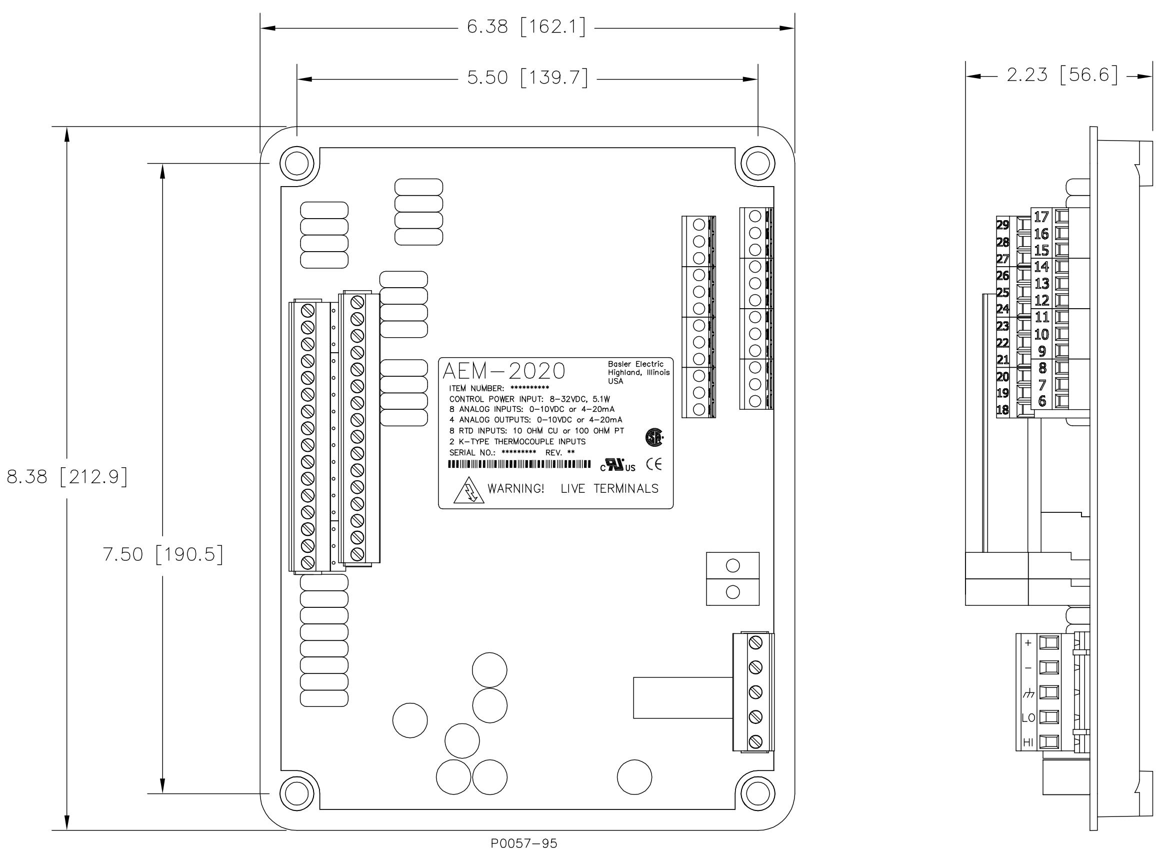


Figure 11-1. AEM-2020 Overall Dimensions

Connections

Analog Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

Note
Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate. Be sure that the AEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

Terminations

The terminal interface consists of both plug-in connectors and a permanently mounted connector with screw-down compression terminals.

AEM-2020 connections are made with one 5-position connector, two 12-position connectors, two 16-position connectors, and two 2-position thermocouple connectors. The 16, 5, and 2-position connectors plug into headers on the AEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. The 12-position connector is not a plug-in connector and is mounted permanently to the board.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Caution
By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connector screw terminals accept a maximum wire size of 12 AWG. Thermocouple connectors accept a maximum thermocouple wire diameter of 0.177 inches (4.5 mm). Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Analog Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate. Operating power terminals are listed in Table 11-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Analog Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 11-1. Operating Power Terminals

Terminal	Description
P1- ⏚ (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

AEM-2020 Inputs and Outputs

Input and output terminals are shown in Figure 11-2 and listed in Table 11-2.

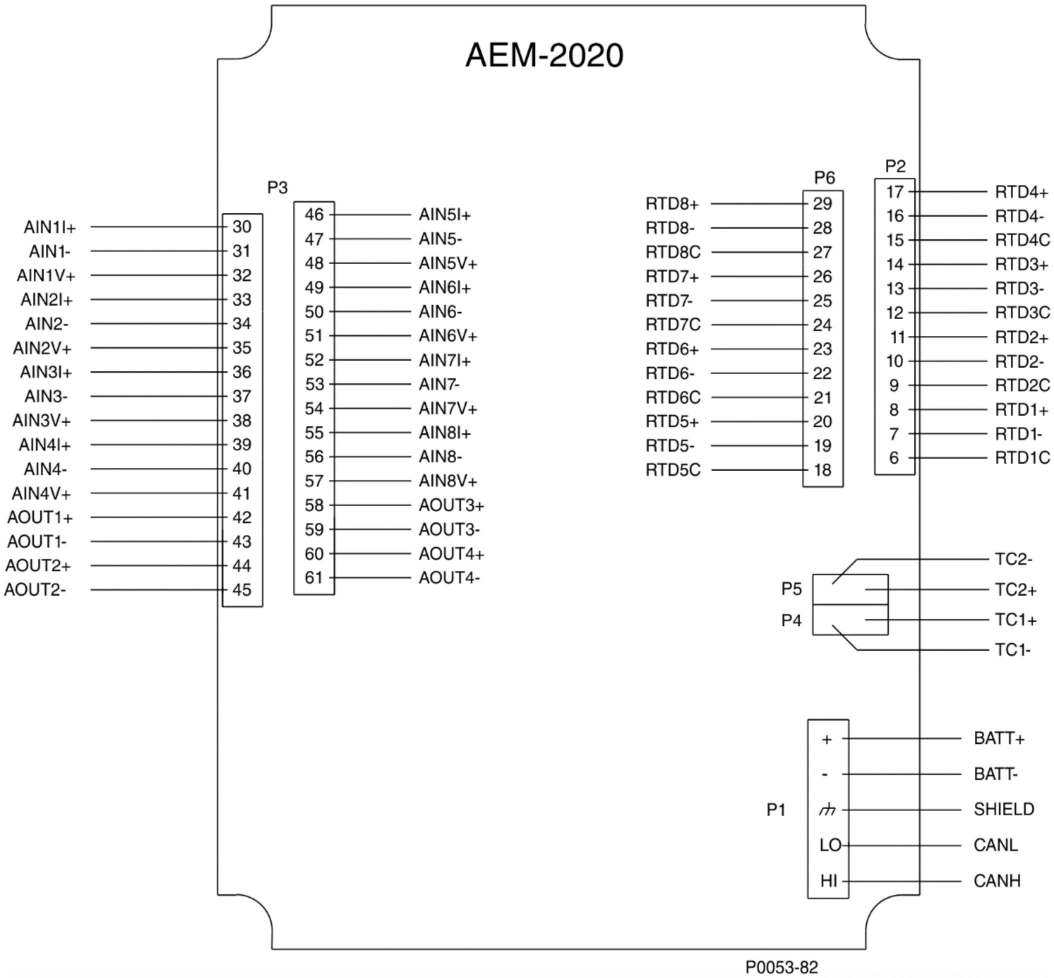


Figure 11-2. Input and Output Terminals

Table 11-2. Input and Output Terminals

Connector	Description
P1	Operating Power and CAN Bus
P2	RTD Inputs 1 - 8
P3	Analog Inputs 1 - 8 and Analog Outputs 1 - 4
P4	Thermocouple 1 Input
P5	Thermocouple 2 Input
P6	RTD Inputs 5 - 8

External Analog Input Connections

Voltage input connections are shown in Figure 11-3 and current input connections are shown in Figure 11-4. When using the current input, AIN V+ and AIN I+ must be tied together.

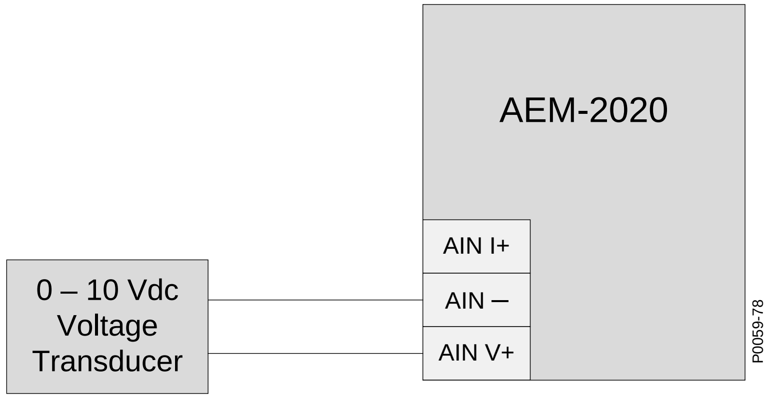


Figure 11-3. Analog Inputs - Voltage Input Connections

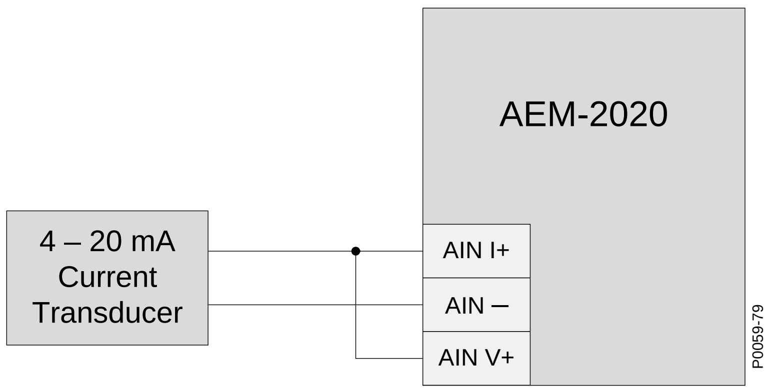


Figure 11-4. Analog Inputs - Current Input Connections

External RTD Input Connections

External 2-wire RTD input connections are shown in Figure 11-5. Figure 11-6 shows external 3-wire RTD input connections.

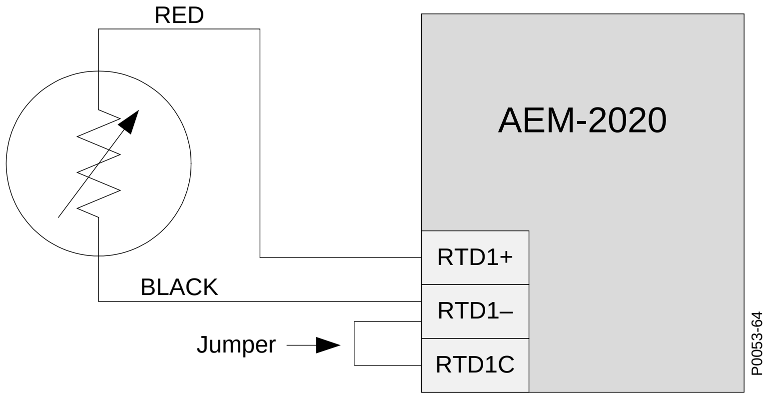


Figure 11-5. External Two-Wire RTD Input Connections

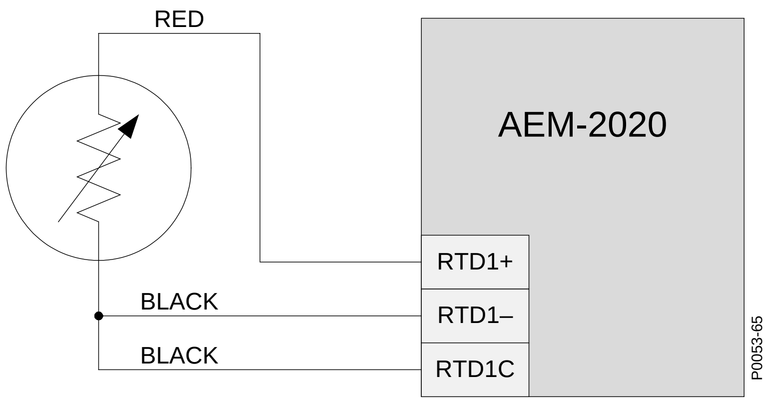


Figure 11-6. External Three-Wire RTD Input Connections

CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Analog Expansion Module and the IEM-2020. Connections between the AEM-2020 and IEM-2020 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 11-3. Refer to Figure 11-7 and Figure 11-8.

Table 11-3. CAN Bus Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1- ⏚ (SHIELD)	CAN drain connection

Note
1. If the AEM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH). 2. If the AEM-2020 is not part of the J1939 bus, the stub connecting the AEM-2020 to the bus should not exceed 914 mm (3 ft) in length. 3. The maximum bus length, not including stubs, is 40 m (131 ft). 4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the AEM-2020.

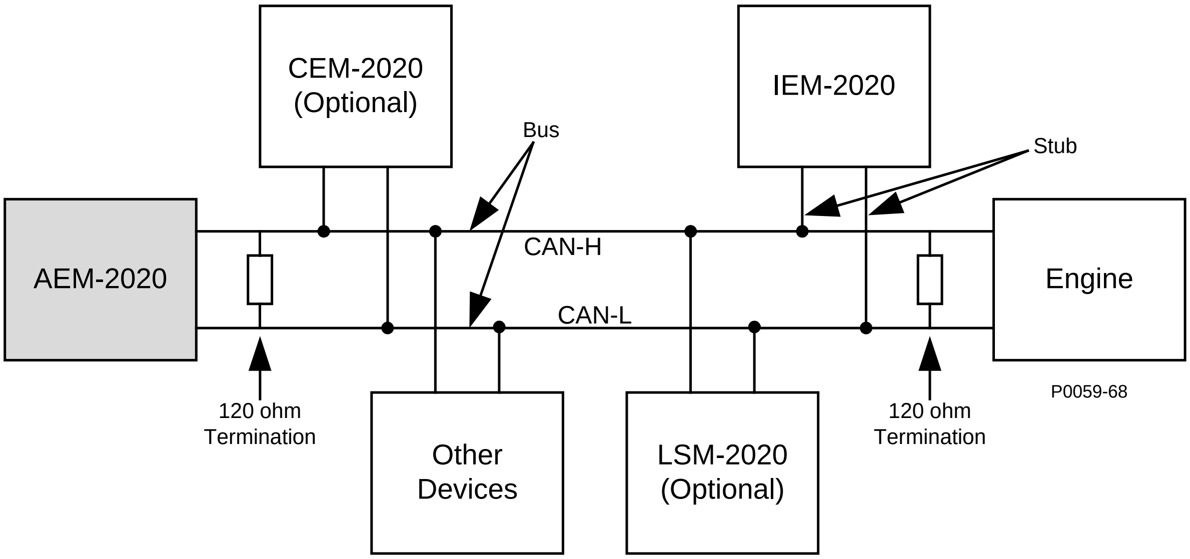


Figure 11-7. CAN Bus Interface with AEM-2020 providing One End of the Bus

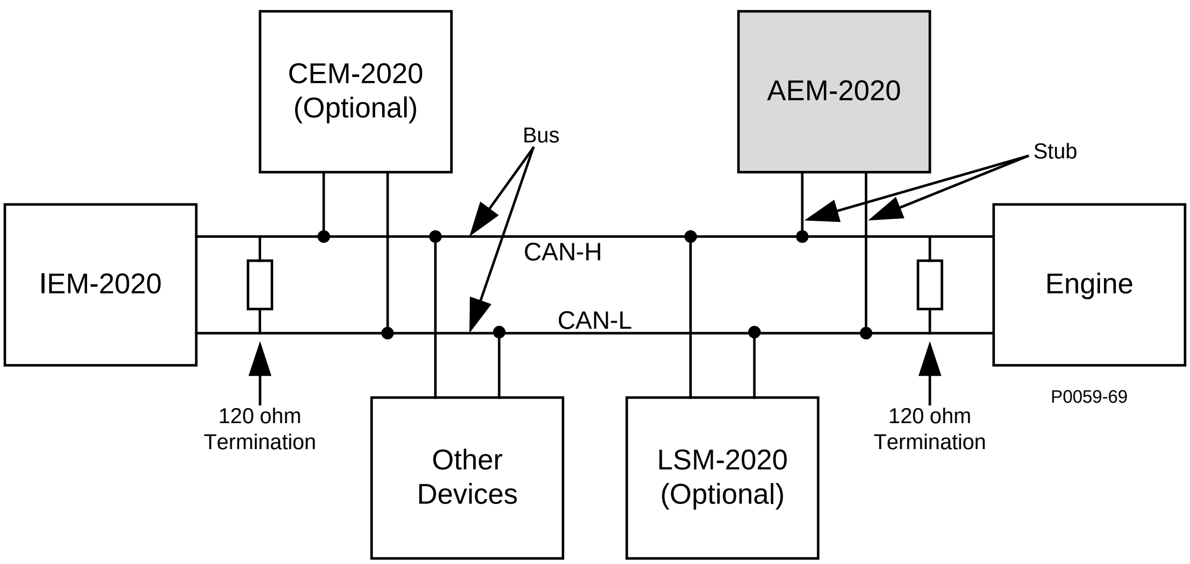


Figure 11-8. CAN Bus Interface with IEM-2020 providing One End of the Bus

Maintenance

Preventive maintenance consists of periodically checking that the connections between the AEM-2020 and the system are clean and tight. Analog Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

APPENDIX A • MODBUS® COMMUNICATION

TABLE OF CONTENTS

Figures

Tables

APPENDIX A • MODBUS® COMMUNICATION

Introduction

General Overview

An optional feature of the IEM-2020 performs Modbus® communications by emulating a subset of the Modicon 984 Programmable Controller. This document describes the Modbus communications protocol employed by the IEM-2020 and how to exchange information with the IEM-2020 over a Modbus network.

The IEM-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX). Refer to *MAPPING - IEM 2020 Parameters into MODICON ADDRESS SPACE* in this section.Intended Use of the Communications Protocol

This document provides the necessary information for 3rd party OEMs to develop in-house software to communicate with the IEM-2020 via Modbus protocol. This will allow the exchange of setup information and measured data between a Modbus Master Station and the IEM-2020.

The IEM-2020 data supported for remote access is listed in *MAPPING - IEM 2020 Parameters into MODICON ADDRESS SPACE* in this section.

CAUTION
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 10,000 erase/write cycles for Rev. 1 hardware and 100,000 erase/write cycles for Rev. 2 hardware. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Detailed Description of IEM-2020 Modbus® Protocol

Modbus® Protocol Overview

Modbus communications use a master-slave technique in which only the master can initiate a transaction, called a query. The slave addressed by the query will respond by either supplying the requested data to the master or by performing the requested action. A slave device never initiates communications on the Modbus, and will always generate a response to the query unless certain error conditions occur. The IEM-2020 is designed to communicate on the Modbus only as a slave device.

A master can query slaves individually or query all slaves collectively by initiating a broadcast message. A slave does not send a response message to a broadcast query.

If a query requests actions unable to be performed by the slave, the slave response message will contain an Exception Response Code defining the error detected.

Query and response messages share the same message structure. Each message is comprised of four message fields: the Device Address, the Function Code, the Data Block, and the Error Check field. Subsequent sections in this document detail each message field and the corresponding functionality supported by the IEM-2020.

Query / Response Message Structure:

- Device Address
- Function Code
- Eight-Bit Data Bytes
- Error Check

Device Address Field

The Device Address field contains the unique Modbus address of the slave being queried. The addressed slave will repeat its address in the Device Address field of the response message. This field is 1 byte.

Function Code Field

The Function Code field in the Query message defines the action to be taken by the addressed slave. This field is echoed in the Response message, and will be altered by setting the MSB of the field to "1" if the response is an error response. This field is 1 byte.

Data Block Field

The query Data block contains additional information needed by the slave to perform the requested function. The response Data block contains data collected by the slave for the queried function. An error response will substitute an Exception Response Code for the Data Block. The length of this field varies with each query.

Error Check Field

The Error Check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

Serial Transmission Details

A standard Modbus network offers 2 transmission modes for communication: ASCII or RTU. The IEM-2020 supports only the RTU (Remote Terminal Unit) mode.

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with 1 start bit and 1 stop bit. A ninth data bit is added when parity is selected. Parity checking is user-configurable to even, odd or none. The transmission baud rate is also user-configurable, and both parity and baud rate can be altered during real-time operation. If altered, the new baud rate and/or parity will not be enforced until the response message to the current query has completed. The IEM-2020 supported baud rates are 9600, 4800, 2400, and 1200.

Message Framing / Timing Considerations

When receiving a message, the IEM-2020 will allow maximum inter-byte latency up to 3.5 - 4.0 character times before considering the message complete.

Once a valid query is received, the IEM-2020 waits 10 msec. before responding.

Error Handling and Exception Responses

Any query received that contains a non-existent device address, a framing error or CRC error will be ignored - no response will be transmitted. Queries addressed to an IEM-2020 with an unsupported function code, unsupported register references, or illegal values in the data block will result in an error response message with an Exception Response Code. The Exception Response codes supported by the IEM-2020 are listed in Table A-1.

Table A-1. Exception Response Codes

Code	Name	Meaning
01	Illegal Function	The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers
02	Illegal Data Address	A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group.
03	Illegal Data Value	A preset register data block contains an incorrect number of bytes or one or more data values out of range.

Detailed IEM-2020 Message Definition

Device Address

The IEM-2020 Device Address can be any value in the Modbus protocol Device Address range (1 - 247). A query with a Device Address of 0 signifies a Broadcast message to all slaves - the connected IEM-2020s will not respond to the broadcast query.

Function Code and Data Block

The IEM-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX) and supports the following Function Codes:

- Function 03 - Read Holding Registers
- Function 6 - Preset Single Register, Non-Broadcast & Broadcast
- Function 08, Subfunction 00 - Diagnostics: Return Query Data
- Function 16 - Preset Multiple Registers, Non-Broadcast & Broadcast

The only Broadcast query supported by the IEM-2020 is the Preset Multiple Registers query.

Read Holding Registers

Read Holding Registers - General

QUERY:

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read Holding Register N+1.

Device Address
Function Code 03 (hex)
Starting Address Hi
Starting Address Lo
No. of Registers Hi
No. of Registers Lo
CRC Error Check

The number of registers cannot exceed 125 without causing an error response with Exception Code "Illegal Function".

Queries to read Write Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.

RESPONSE:

The response message contains the data queried, respectively. The data block contains the block length in bytes followed by the data for each requested register. Attempting to read an unused register or a register which does not support read results in an error response with Exception Code of "Illegal Data Address".

Device Address
Function Code 03 (hex)
Byte Count
Data Hi
Data Lo
.
.
.
Data Hi
Data Lo
CRC Error Check

Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical.

Device Address	
Function Code	08 (hex)
Subfunction Hi	00 (hex)
Subfunction Lo	00 (hex)
Data Hi	
Data Lo	
CRC Error Check	

Preset Multiple Registers, Non-Broadcast & Broadcast

Preset Multiple Registers - General

QUERY:

This query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.
- Queries attempting to write more than 100 registers cause an error response with Exception Code “Illegal Function”.
- An incorrect Byte Count will result in an error response with Exception Code of “Illegal Data Value”.
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) IEM-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address”.
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address
Function Code 10 (hex)
Starting Address Hi
Starting Address Lo
No. of Registers Hi
No. of Registers Lo
Byte Count
Data Hi
Data Lo
.
.
.
Data Hi
Data Lo
CRC Error Check

RESPONSE:

The response message echoes the starting address and the number of registers. There is no response message when the query is broadcast.

Device Address	
Function Code	10 (hex)
Starting Address Hi	
Starting Address Lo	

No. of Registers Hi
No. of Registers Lo
CRC Error Check

Preset Single Register, Non-Broadcast & Broadcast

QUERY:

This query message requests a register to be written. A device address is 0 for a broadcast query.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) IEM-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address”.
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address	
Function Code	06 (hex)
Address Hi	
Address Lo	
Data Hi	
Data Lo	
CRC Error Check	

RESPONSE:

The response message echoes the address and the value written. There is no response message when the query is broadcast.

Device Address	
Function Code	06 (hex)
Address Hi	
Address Lo	
Data Hi	
Data Lo	
CRC Error Check	

Data Formats

Short Integer Data Format (INT8)

The Modbus short integer data format uses a single holding register to represent an 8 bit data value. The holding register high byte will always be zero.

Example: The value 132 represented in short integer format is hexadecimal 0x84. This number will read from a holding register as follows:

Holding Register	Value
K (Hi Byte)	hex 00
K (Lo Byte)	hex 84

The same byte alignments are required to write.

Integer Data Format (INT16)

The Modbus integer data format uses a single holding register to represent a 16-bit data value.

Example: The value 4660 represented in integer format is hexadecimal 0x1234. This number will read from a holding register as follows:

Holding Register	Value
K (Hi Byte)	hex 12
K (Lo Byte)	hex 34

The same byte alignments are required to write.

Long Integer Data Format (INT32)

The Modbus long integer data format uses two consecutive holding registers to represent a 32-bit data value. The first register contains the low-order 16 bits and the second register contains the high-order 16 bits.

Example: The value 95,800 represented in long integer format is hexadecimal 0x00017638. This number will read from two consecutive holding registers as follows:

Holding Register	Value
K (Hi Byte)	hex 76
K (Lo Byte)	hex 38
K+1 (Hi Byte)	hex 00
K+1 (Lo Byte)	hex 01

The same byte alignments are required to write.

32-bit Bit-Mapped Parameter Mapping

The register arrangement for 32-bit bit-mapped parameters is illustrated in Figure A-1. The Alarm Metering registers (44812/44813) are shown as an example. In this example, Bit 25 is set indicating an Overcrank condition and Bit 17 is set indicating a Global Alarm.

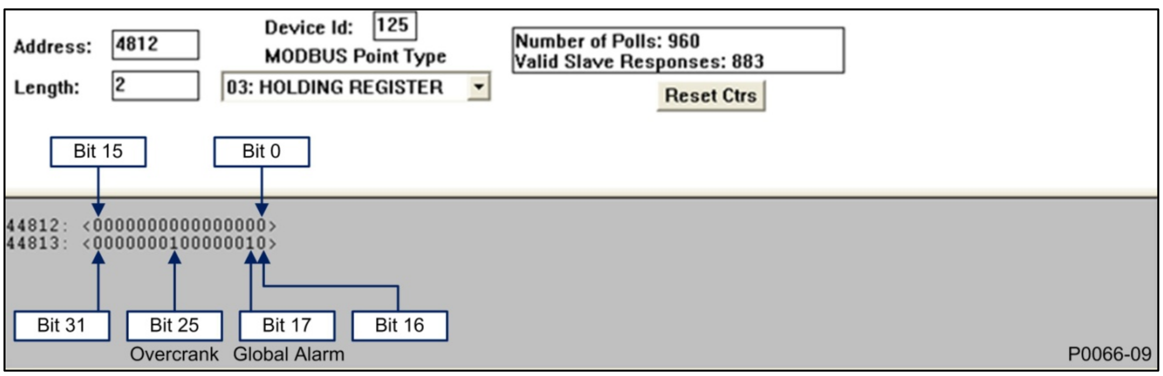


Figure A-1. 32-Bit Bit-Mapped Parameter Mapping

The Alarm Metering register bits are defined as follows:

- Bit 0 through Bit 16 = Not Used
- Bit 17 = Global Alarm
- Bit 18 = Auto Restart Failure
- Bit 19 = Fuel Leak Detect
- Bit 20 = Battery Charger Failure
- Bit 21 = Transfer Fail
- Bit 22 = Low Coolant Level
- Bit 23 = ECU Shutdown
- Bit 24 = Emergency Shutdown
- Bit 25 = Overcrank
- Bit 26 = Loss of ECU Comms
- Bit 27 = Global Sender Fail
- Bit 28 = Low Fuel Level
- Bit 29 = Low Oil Pressure
- Bit 30 = Hi Coolant Temp
- Bit 31 = Overspeed

Floating Point Data Format

The Modbus floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).
- The next 8 bits are the exponent biased by 127 decimal.
- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table A-2 shows the floating-point format.

Table A-2. Floating Point Format

Sign	Exponent + 127	Mantissa
1 bit	8 bits	23 bits

The floating-point format allows for values ranging from approximately $8.43X10^{-37}$ to $3.38X10^{38}$. A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

Example: The value 95,800 represented in floating point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

Holding Register	Value
K (Hi Byte)	hex 1C
K (Lo Byte)	hex 00
K+1 (Hi Byte)	hex 47
K+1 (Lo Byte)	hex BB

The same byte alignments are required to write.

Double Precision Data Format (DP)

The Modbus Double Precision data format (DP) uses 2 consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value / 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000.

Triple Precision Data Format (TP)

The Modbus Triple Precision data format (TP) uses 3 consecutive registers to represent a data value. The first register contains the high-order 16 bits of triple precision data, and is the actual data value / 100,000,000. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision).

Error Check

This field contains a 2-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The IEM-2020 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. Otherwise, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

Reference the "Modicon Modbus Protocol Reference Guide", PI-MBUS-300 Rev. E, pages 112 - 115 for an excellent explanation and implementation of the CRC-16 algorithm.

The CRC calculation is performed using all bytes of the Device Address, Function Code, and Data Block fields. A 16-bit CRC-register is initialized to all 1's. Then each 8-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted 8 times. The CRC-register MSB is zero-filled with each shift. After each shift the CRC-register LSB is examined: if 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the Error Check field.

Interdependence of Preset Multiple Register Data

Preset Multiple Register data is collectively written only after the query has been determined to be legal, which includes a range-check of the entire data block. Therefore, data which must be written prior to other data must use a separate query. For example, a Preset Multiple Register Query of the entire Contiguous Write Block (44588-44689) to set the Battery Overvoltage Pre-alarm Threshold atop the 24V range and change the Battery Volts from 12V to 24V will fail. The change to 24V would occur simultaneously to setting the Pre-alarm Threshold, and the threshold value range-check will use the current 12V range.

Mapping - IEM-2020 Parameters into Modicon Address Space

Parameter Table

The IEM-2020 maps all non-legacy parameters into the Holding Register address space (42250 and above). Query address N will access the Holding Register N+1.

Bias Control Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
42250	Governor Kp Proportional Gain	Float	N/A	N/A	RW	0 - 1000
42252	Governor Ki Integral Gain	Float	N/A	N/A	RW	0 - 1000
42254	Governor Kd Derivative Gain	Float	N/A	N/A	RW	0 - 1000
42256	Governor Td Filter Constant	Float	N/A	N/A	RW	0 - 1
42258	Governor Kg Loop Gain	Float	N/A	N/A	RW	0 - 1000
42260	Governor Windup Limit	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42262	Governor Integrator Limit Plus	Float	N/A	N/A	RW	0 - 1000
42264	Governor Integrator Limit Minus	Float	N/A	N/A	RW	(-1000) - 0
42266	Governor Output Upper Limit	Float	N/A	N/A	RW	0 - 1000
42268	Governor Output Lower Limit	Float	N/A	N/A	RW	(-1000) - 0
42270	RESERVED					
42272	Governor Bias Control Output Type	Int32	N/A	N/A	RW	0 = Contact 1 = ECU
42274	Speed PID Output	Float	N/A	N/A	R	0 - 100
42276	Speed PID Error	Float	N/A	N/A	R	(-1000000) - 1000000
42278	Parameter Input Source	Uint32	N/A	N/A	RW	0 = IEM Analog Voltage 1 = IEM Analog Current 2 = LSM Analog Input 1 3 = AEM Analog Input 1 4 = AEM Analog Input 2 5 = AEM Analog Input 3 6 = AEM Analog Input 4 7 = AEM Analog Input 5 8 = AEM Analog Input 6 9 = AEM Analog Input 7 10 = AEM Analog Input 8

Register	Description	Type	Units	Scaling Factor	R/W	Range
42280	Parameter Setpoint Source	Uint32	N/A	N/A	RW	0 = User Setting 1 = IEM Analog Voltage 2 = IEM Analog Current 3 = LSM Analog Input 1 4 = AEM Analog Input 1 5 = AEM Analog Input 2 6 = AEM Analog Input 3 7 = AEM Analog Input 4 8 = AEM Analog Input 5 9 = AEM Analog Input 6 10 = AEM Analog Input 7 11 = AEM Analog Input 8
42282	Parameter Setpoint	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
42284	Parameter Setpoint Analog Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
42286	Parameter Setpoint Analog Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
42288	Parameter Deadband	Int32	Centiunit	Centi	RW	0 - 99999900
42290	Rpm Traverse Rate	Uint32	N/A	N/A	RW	0 - 4000
42292	Parameter Traverse Rate	Int32	Centiunit	Centi	RW	0 - 99999900
42294	Front Panel Raise Lower Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
42296	Auto Mode Running State Param Control Enable	Uint32	N/A	N/A	RW	0 = RPM 1 = Parameter
42298	Rpm Bandwidth	Uint32	Rpm	N/A	RW	0 - 1000
42300	Run Mode Running State Param Control Enable	Uint32	N/A	N/A	RW	0 = RPM 1 = Parameter
42302-2499	RESERVED					
42500	Governor Correction Pulse Width	Int32	Decisecond	Deci	RW	0 - 999
42502	Governor Correction Pulse Interval	Int32	Decisecond	Deci	RW	0 - 999
42504	Governor Bias Contact Type	Int32	N/A	N/A	RW	0 = Continuous 1 = Proportional
42506	RESERVED					
42508	Governor Correction Pulse Rpm Bandwidth	Uint32	Rpm	N/A	RW	0 - 4000
42510	Governor RMP Deadband	Uint32	Rpm	N/A	RW	0 - 100
42514-749	RESERVED					

Run Profile Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
42750	Speed Control Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42752	Auto Mode Idle State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42754	Auto Mode Idle State Time	Uint32	Second	N/A	RW	0 - 7200
42756	Auto Mode Ramp Up 1 State Time	Unit32	Second	N/A	RW	0 - 600
42758	Auto Mode Intermediate State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42760	Auto Mode Intermediate State Time	Uint32	Second	N/A	RW	0 - 7200
42762	Auto Mode Ramp Up 2 State Time	Uint32	Second	N/A	RW	0 - 600
42764	Auto Mode Running State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42766	Auto Mode Ramp Down State Time	Uint32	Second	N/A	RW	0 - 600
42768	Auto Mode Cooling State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42770	Auto Mode Cooling State Time	Uint32	Minute	N/A	RW	0 - 60
42772	Run Mode Idle State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42774	Run Mode Idle State Time	Uint32	Second	N/A	RW	0 - 7200
42776	Run Mode Ramp Up 1 State Time	Unit32	Second	N/A	RW	0 - 600
42778	Run Mode Intermediate State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42780	Run Mode Intermediate State Time	Uint32	Second	N/A	RW	0 - 7200
42782	Run Mode Ramp Up 2 State Time	Uint32	Second	N/A	RW	0 - 600
42784	Run Mode Running State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42786	Run Mode Ramp Down State Time	Uint32	Second	N/A	RW	0 - 600
42788	Run Mode Cooling State Rpm	Uint32	Rpm	N/A	RW	100 - 4000
42790	Run Mode Cooling State Time	Uint32	Minute	N/A	RW	0 - 60
42792-3249	RESERVED					

Programmable Inputs Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
43250	Configurable Input 1 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43252	Configurable Input 1 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43254	Configurable Input 1 Time Delay	Int32	Second	N/A	RW	0 - 300
43256	RESERVED					
43258	Configurable Input 2 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43260	Configurable Input 2 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43262	Configurable Input 2 Time Delay	Int32	Second	N/A	RW	0 - 300
43264	RESERVED					
43266	Configurable Input 3 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43268	Configurable Input 3 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43270	Configurable Input 3 Time Delay	Int32	Second	N/A	RW	0 - 300
43272	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
43274	Configurable Input 4 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43276	Configurable Input 4 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43278	Configurable Input 4 Time Delay	Int32	Second	N/A	RW	0 - 300
43280	RESERVED					
43282	Configurable Input 5 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43284	Configurable Input 5 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43286	Configurable Input 5 Time Delay	Int32	Second	N/A	RW	0 - 300
43288	RESERVED					
43290	Configurable Input 6 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43292	Configurable Input 6 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43294	Configurable Input 6 Time Delay	Int32	Second	N/A	RW	0 - 300
43296	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
43298	Configurable Input 7 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43300	Configurable Input 7 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43302	Configurable Input 7 Time Delay	Int32	Second	N/A	RW	0 - 300
43304	RESERVED					
43306	Configurable Input 8 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43308	Configurable Input 8 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43310	Configurable Input 8 Time Delay	Int32	Second	N/A	RW	0 - 300
43312	RESERVED					
43314	Configurable Input 9 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43316	Configurable Input 9 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43318	Configurable Input 9 Time Delay	Int32	Second	N/A	RW	0 - 300
43320	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
43322	Configurable Input 10 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43324	Configurable Input 10 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43326	Configurable Input 10 Time Delay	Int32	Second	N/A	RW	0 - 300
43328	RESERVED					
43330	Configurable Input 11 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43332	Configurable Input 11 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43334	Configurable Input 11 Time Delay	Int32	Second	N/A	RW	0 - 300
43336	RESERVED					
43338	Configurable Input 12 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43340	Configurable Input 12 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43342	Configurable Input 12 Time Delay	Int32	Second	N/A	RW	0 - 300
43344	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
43346	Configurable Input 13 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43348	Configurable Input 13 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43350	Configurable Input 13 Time Delay	Int32	Second	N/A	RW	0 - 300
43352	RESERVED					
43354	Configurable Input 14 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43356	Configurable Input 14 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43358	Configurable Input 14 Time Delay	Int32	Second	N/A	RW	0 - 300
43360	RESERVED					
43362	Configurable Input 15 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43364	Configurable Input 15 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43366	Configurable Input 15 Time Delay	Int32	Second	N/A	RW	0 - 300
43368	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
43370	Configurable Input 16 Contact	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43372	Configurable Input 16 Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43374	Configurable Input 16 Time Delay	Int32	Second	N/A	RW	0 - 300
43376-409	RESERVED					
43410	Auto Start Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43412	Auto Start Time Delay	Int32	Second	N/A	RW	0 - 300
43414-24	RESERVED					
43426	Battle Override Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43428	Battle Override Time Delay	Int32	Second	N/A	RW	0 - 300
43430-33	RESERVED					
43434	Coolant Temperature Sender Fail Configuration Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43436	Coolant Temperature Sender Fail Activation Delay	Int32	Minute	N/A	RW	5 - 30
43438	Oil Pressure Sender Fail Configuration Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43440	Oil Pressure Sender Fail Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
43442	Fuel Level Sender Fail Configuration Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43444	Fuel Level Sender Fail Activation Delay	Int32	Second	N/A	RW	0 - 300
43446-49	RESERVED					
43450	Low Coolant Level Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43452	Low Coolant Level Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43454	Low Coolant Level Time Delay	Int32	Second	N/A	RW	0 - 300
43456	Battery Charge Failed Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43458	Battery Charge Failed Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43460	Battery Charge Failed Time Delay	Int32	Second	N/A	RW	0 - 300
43462	Fuel Leak Detect Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43464	Fuel Leak Detect Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43466	Fuel Leak Detect Time Delay	Int32	Second	N/A	RW	0 - 300
43468-99	RESERVED					

System Configuration and Status

Register	Description	Type	Units	Scaling Factor	R/W	Range
43500	Pre-Start Contact Config	Int32	N/A	N/A	RW	0 = Open After Disconnect 1 = Closed While Running
43502	System Units	Int32	N/A	N/A	RW	0 = English 1 = Metric
43504	Battery Volts	Int32	N/A	N/A	RW	0 = 12V 1 = 24V
43506	Off Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43508	Run Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43510	Auto Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43512	Virtual Input 1 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43514	Virtual Input 2 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43516	Virtual Input 3 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43518	Virtual Input 4 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43520	RTC Clock Hour	Int32	Hour	N/A	RW	0 - 23
43522	RTC Minute	Int32	Minute	N/A	RW	0 - 59
43524	RTC Second	Int32	Second	N/A	RW	0 - 59
43526	RTC Month	Int32	N/A	N/A	RW	1 - 12
43528	RTC Day	Int32	N/A	N/A	RW	1 - 31
43530	RTC Year	Int32	N/A	N/A	RW	0 - 99
43532	RTC DST Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43534	Cranking Style	Uint32	N/A	N/A	RW	0 = Continuous 1 = Cycle
43536	Number of Crank Cycles	Uint32	N/A	N/A	RW	1 - 7
43538	Cycle Crank Time	Unit32	Second	N/A	RW	5 - 15
43540	Continuous Crank Time	Unit32	Second	N/A	RW	5 - 60
43542	Crank Disconnect Limit	Uint32	Percent	N/A	RW	10 - 100
43544	Pre Crank Delay	Uint32	Second	N/A	RW	0 - 30
43546	Rated Engine RPM	Uint32	Rpm	N/A	RW	750 - 4000
43548	No Load Cool Down Time	Uint32	Minute	N/A	RW	0 - 60
43550	Fuel Level Function	Uint32	N/A	N/A	RW	0 = Disable 1 = Fuel Lvl 2 = Natural Gas 3 = Propane
43552	Number Flywheel Teeth	Uint32	N/A	N/A	RW	1 - 500
43554	Horn Enable	Int32	N/A	N/A	RW	0 = Disabled 1 = Enabled
43556	RESERVED					
43558	LCD Contrast Value	Uint32	N/A	N/A	RW	0 - 100
43560	Front Panel Sleep Mode	Uint32	N/A	N/A	RW	0 = Disabled 1 = Enabled
43562	RESERVED					
43564	UTC Offset	Int32	Minute	N/A	RW	(-1440) - 1440
43566	DST Configuration	Int32	N/A	N/A	RW	0 = Disabled 1 = Floating 2 = Fixed
43568	Start/End Time Reference	Int32	N/A	N/A	RW	0 = Local Time 1 = UTC Time
43570	DST Bias Hours	Int32	N/A	N/A	RW	0 - 23
43572	DSP Bias Minutes	Int32	N/A	N/A	RW	0 - 59

Register	Description	Type	Units	Scaling Factor	R/W	Range
43574	DST Start Month	Int32	N/A	N/A	RW	1 = January 2 = February 3 = March 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
43576	DST Start Day	Int32	N/A	N/A	RW	1 - 31
43578	DST Start Week of Month	In32	N/A	N/A	RW	0 = First 1 = Second 2 = Third 3 = Fourth 4 = Last
43580	DST Start Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday
43582	DST Start Hour	Int32	N/A	N/A	RW	0 - 23
43584	DST Start Minute	Int32	N/A	N/A	RW	0 - 59
43586	DST End Month	Int32	N/A	N/A	RW	1 = January 2 = February 3 = March 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
43588	DST End Day	Int32	N/A	N/A	RW	1 - 31
43590	DST End Week of Month	Int32	N/A	N/A	RW	0 = First 1 = Second 2 = Third 3 = Fourth 4 = Last
43592	DST End Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday
43594	DST End Hour	Int32	N/A	N/A	RW	0 - 23
43596	DST End Minute	Int32	N/A	N/A	RW	0 - 59
43598	Prestart Rest Configuration	Int32	N/A	N/A	RW	0 = Off During Rest 1 = On During Rest 2 = Preheat before Crank
43600	Oil Pressure Crank Disconnect	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
43602	Crank Disconnect Pressure	Uint32	PSI	Deci	RW	29 - 1500
43604	Crank Disconnect Pressure in kPa	Uin32	kPa	Deci	RW	200 - 10345
43606	Power Up Delay	Uint32	Second	N/A	RW	0 - 60
43608	Start Relay Control	Uint32	N/A	N/A	RW	0 = Predefined 1 = Programmable
43610	Run Relay Control	Uint32	N/A	N/A	RW	0 = Predefined 1 = Programmable
43612	Prestart Relay Control	Uint32	N/A	N/A	RW	0 = Predefined 1 = Programmable

Register	Description	Type	Units	Scaling Factor	R/W	Range
43614	Off Mode Cool Down Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43616	Not In Auto Horn Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43618	Clock Not Set Warning Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43620-22	RESERVED					
43624	Metric Pressure Units	Int32	N/A	N/A	RW	0 = Bar 1 = kPa
43626	System Units	Int32	N/A	N/A	RW	0 = English 1 = Metric
43628	kPa/Bar Config	Int32	N/A	N/A	RW	0 = Bar 1 = kPa
43630	Crank Disconnect Pressure Bar	Uint32	Bar	Deci	RW	2 - 103
43632	Rpm Bandwidth Data	Int32	N/A	N/A	RW	0 - 1000
43634	Number Flywheel Teeth	Uint32	N/A	Deci	RW	10 - 5000
43636	Max Rpm	Uint32	Rpm	N/A	RW	0 - 4000
43638	Min Rpm	Uint32	Rpm	N/A	RW	0 - 4000
43640-48	RESERVED					

Control Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
43750	Emergency Stop: Writing a 1 will toggle emergency stop from off to on. Writing a 1 again will toggle emergency stop from on to off.	Int32	N/A	N/A	RW	1 = Toggle On/Off
43752	Remote Start	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43754	Remote Stop	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43756	Run Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43758	Off Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43760	Auto Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43762	Alarm Reset	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43764	RESERVED					
43766	Virtual Input 1 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43768	Virtual Input 1 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43770	Virtual Input 2 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43772	Virtual Input 2 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43774	Virtual Input 3 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43776	Virtual Input 3 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43778	Virtual Input 4 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43780	Virtual Input 4 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43782	ESTOP Latch Status	Int32	N/A	N/A	R	0 = Disabled 1 = Enabled
43784-4017	RESERVED					

Communication Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
44018	Modem Inter Dialout Activation Delay	Int32	Second	N/A	RW	0 = 15 1 = 30 2 = 60 3 = 120
44020	Modem Pager Buffer Limit	Int32	N/A	N/A	RW	0 = 80 Chars 1 = 120 Chars 2 = 160 Chars 3 = 200 Chars
44022	Modem Pager Coms Data Format	Int32	N/A	N/A	RW	0 = 8 bit, no parity 1 = 7 bit, even parity
44024-25	Modem Dialout Conditions 1	Uint32	N/A	N/A	RW	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Auxiliary Input 5 Closed Bit 3 = Auxiliary Input 4 Closed Bit 4 = Auxiliary Input 3 Closed Bit 5 = Auxiliary Input 2 Closed Bit 6 = Auxiliary Input 1 Closed Bit 7 = Cooldown Timer Active Bit 8 = Switch Not in Auto Bit 9 = Scheduled Maintenance Pre-Alarm Bit 10 = Weak Battery Voltage Pre-Alarm Bit 11 = Low Battery Voltage Pre-Alarm Bit 12 = Low Oil Pressure Pre-Alarm Bit 13 = High Coolant Temp Pre-Alarm Bit 14 = Battery Overvoltage Pre-Alarm Bit 15 = Fuel Level Sender Fail Pre-Alarm Bit 16 = Oil Pressure Sender Fail Pre-Alarm Bit 17 = Coolant Temp Sender Fail Pre-Alarm Bit 18 = Low Coolant Temp Pre-Alarm Bit 19 = High Fuel Pre-Alarm Bit 20 = Low Fuel Pre-Alarm Bit 21 = Overspeed Alarm Bit 22 = Emergency Stop Alarm Bit 23 = Overcrank Alarm Bit 24 = Low Coolant Level Bit 25 = Low Fuel Alarm Bit 26 = MPU Speed Sender Fail Alarm Bit 27 = Fuel Level Sender Fail Alarm Bit 28 = Oil Pressure Sender Fail Alarm Bit 29 = Coolant Temp Sender Fail Alarm Bit 30 = Low Oil Pressure Alarm Bit 31 = High Coolant Temperature Alarm

Register	Description	Type	Units	Scaling Factor	R/W	Range
44026-27	Modem Dialout Conditions 2	Uint32	N/A	N/A	RW	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Engine Running Bit 17 = Battery Charger Fail Bit 18 = Fuel Leak Detect Bit 19 = Loss of ECU Comms Pre-Alarm Bit 20 = Loss of ECU Comms Alarm Bit 21 = Auxiliary Input 16 Closed Bit 22 = Auxiliary Input 15 Closed Bit 23 = Auxiliary Input 14 Closed Bit 24 = Auxiliary Input 13 Closed Bit 25 = Auxiliary Input 12 Closed Bit 26 = Auxiliary Input 11 Closed Bit 27 = Auxiliary Input 10 Closed Bit 28 = Auxiliary Input 9 Closed Bit 29 = Auxiliary Input 8 Closed Bit 30 = Auxiliary Input 7 Closed Bit 31 = Auxiliary Input 6 Closed
44028-30	RESERVED					
44032	CANbus Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44034	DTC Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44036	Rings for Modem Answer	Int32	N/A	N/A	RW	1 - 9
44038	Modem Offline Delay	Int32	Minute	N/A	RW	1 - 240
44040	Modbus Baud Rate	Int32	N/A	N/A	RW	0 = 9600 Baud 1 = 4800 Baud 2 = 2400 Baud 3 = 1200 Baud
44042	Modbus Parity	Int32	N/A	N/A	RW	0 = No Parity 1 = Odd Parity 2 = Even Parity
44044	Modbus Address	Int32	N/A	N/A	RW	1 - 247

Register	Description	Type	Units	Scaling Factor	R/W	Range
44046-47	Modem Dialout Conditions 3	Uint32	N/A	N/A	RW	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Engine Running Bit 17 = Battery Charger Fail Bit 18 = AEM Comms Fail Bit 19 = Duplicate CEM Bit 20 = CEM Comms Fail Bit 21 = Duplicate LSM Bit 22 = Config Element 8 Status Bit 23 = Config Element 7 Status Bit 24 = Config Element 6 Status Bit 25 = Config Element 5 Status Bit 26 = Config Element 4 Status Bit 27 = Config Element 3 Status Bit 28 = Config Element 2 Status Bit 29 = Config Element 1 Status Bit 30 = LSM Comms Failure Bit 31 = Auto Restart Failure Alarm
44048	LSM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44050	DHCP Enabled	Uint32	N/A	N/A	R	0 = Disabled 1 = Enabled
44052-56	RESERVED					
44058	CEM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44060	RESERVED					
44062	AEM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44064	CEM Outputs	Int32	N/A	N/A	RW	0 = 18 Outputs 1 = 24 Outputs

Register	Description	Type	Units	Scaling Factor	R/W	Range
44066-67	Modem Dialout Conditions 4	Uint32	N/A	N/A	RW	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = DEF Inducement Override Pre-Alarm Bit 19 = DEF Severe Inducement Pre-Alarm Bit 20 = DEF Pre-Severe Inducement Pre-Alarm Bit 21 = DEF Engine Derate Pre-Alarm Bit 22 = DEF Fluid Empty Pre-Alarm Bit 23 = DEF Fluid Low Pre-Alarm Bit 24 = DPF Soot Level Severely High Pre-Alarm Bit 25 = DPF Soot Level Moderately High Pre-Alarm Bit 26 = DPF Soot Level High Pre-Alarm Bit 27 = High Exhaust Temperature Pre-Alarm Bit 28 = DPF Regeneration Inhibited Pre-Alarm Bit 29 = DPF Regeneration Required Pre-Alarm Bit 30 = Max RPM Limit Pre-Alarm Bit 31 = Min RPM Limit Pre-Alarm
44068	Active IP Address	Uint32	N/A	N/A	R	0 - 4294967295
44070	Gateway IP Address	Uint32	N/A	N/A	R	0 - 4294967295
44072	Subnet Mask	Uint32	N/A	N/A	R	0 - 4294967295
44074-499	RESERVED					

Alarms Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
44500	High Coolant Temp Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44502	High Coolant Temp Alarm Threshold	Uint32	Deg F	N/A	RW	100 - 280
44504	Metric High Coolant Temp Alarm Threshold	Int32	Deg C	N/A	RW	38 - 138
44506	High Coolant Temp Alarm Activation Delay	Uint32	Second	N/A	RW	0 - 150
44508	Low Oil Press. Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44510	Low Oil Press. Alarm Threshold	Uint32	PSI	Deci	RW	29 - 1500
44512	Metric Low Oil Press. Alarm Threshold	Uint32	kPa	Deci	RW	200 - 10345
44514	Low Oil Press. Alarm Arming Delay	Uint32	Second	N/A	RW	5 - 60
44516	Overspeed Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44518	Overspeed Alarm Threshold	Uint32	Percent	N/A	RW	105 - 140
44520	Overspeed Alarm Activation Delay	Uint32	Millisecond	Milli	RW	0 - 500
44522	Low Fuel Level Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44524	Low Fuel Level Alarm Threshold	Uint32	Percent	N/A	RW	0 - 100
44526	Low Fuel Level Alarm Activation Delay	Int32	Second	N/A	RW	0 - 30

Register	Description	Type	Units	Scaling Factor	R/W	Range
44528	High Coolant Temp Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44530	High Coolant Temp Pre-Alarm Threshold	Uint32	Deg F	N/A	RW	100 - 280
44532	Metric High Coolant Temp Pre-Alarm Threshold	Int32	Deg C	N/A	RW	38 - 138
44534	Low Coolant Temp Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44536	Low Coolant Temp Pre-Alarm Threshold	Uint32	Deg F	N/A	RW	35 - 151
44538	Metric Low Coolant Temp Pre-Alarm Threshold	Int32	Deg C	N/A	RW	2 - 66
44540	High Fuel Level Pre-Alarm Threshold	Int32	Percent	N/A	RW	0 - 150
44542	High Fuel Level Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44544	High Fuel Level Pre-Alarm Activation Delay	Int32	Second	N/A	RW	0 - 30
44546	Low Fuel Level Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44548	Low Fuel Level Pre-Alarm Threshold	Uint32	Percent	N/A	RW	10 - 100
44550	Low Battery Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44552	Low Battery Pre-Alarm Threshold	Uint32	DeciVolt	Deci	RW	60 - 240
44554	Low Battery Pre-Alarm Activation Delay	Uint32	Second	N/A	RW	1 - 10
44556	Weak Battery Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44558	Weak Battery Pre-Alarm Threshold	Uint32	DeciVolt	Deci	RW	40 - 160
44560	Weak Battery Pre-Alarm Activation Delay	Uint32	Second	Deci	RW	0 - 100
44562	Battery Overvoltage Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44564	Low Oil Press. Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44566	Low Oil Press. Pre-Alarm Threshold	Uint32	PSI	Deci	RW	29 - 1500
44568	Metric Low Oil Press. Pre-Alarm Threshold	Int32	kPa	Deci	RW	20 - 10345
44570	Engine Overload 1 Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44572	Engine Overload 1 Pre-Alarm Threshold	Int32	Percent	N/A	RW	0 - 200
44570	ECU Comms Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44572	Active DTC Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44574	Maintenance Interval Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44576	Maintenance Interval Pre-Alarm Threshold	Uint32	Hour	N/A	RW	0 - 5000
44578	Speed Sender Fail Activation Delay	Int32	Second	N/A	RW	0 - 300
44580	ECU Low Coolant Level Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44582	ECU Low Coolant Level Alarm Threshold	Uint32	Percent	N/A	RW	1 - 99
44584	ECU Low Coolant Level Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44586	ECU Low Coolant Level Pre-Alarm Threshold	Uint32	Percent	N/A	RW	1 - 99
44588	Battery Overvoltage Pre-Alarm Threshold	Int32	DeciVolt	Deci	RW	120 - 320
44590	LSM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44592-95	RESERVED					
44596	CEM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44598	AEM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44600	Checksum Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44602-05	RESERVED					
44606	RPM Limit Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44608-649	RESERVED					

Metering

Register	Description	Type	Units	Scaling Factor	R/W	Range
44750	Engine Speed Metering	Uint32	RPM	N/A	R	0 - 65535
44752	Oil Pressure Metering	Int32	PSI	N/A	R	(-32768) - 32767
44754	Battery Voltage Metering	Int32	DeciVolt	N/A	R	(-32768) - 32767
44756	Fuel Level Metering	Int32	N/A	N/A	R	(-32768) - 32767
44758	ECU Coolant Level Metering	Uint32	N/A	N/A	R	0 - 255
44760	Cool Down Time Remaining	Int32	Minute	N/A	R	(-128) - 127
44762	Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Analog Current Input Under 2 Bit 8 = Analog Current Input Under 1 Bit 9 = Analog Current Input Over 2 Bit 10 = Analog Current Input Over 1 Bit 11 = Analog Current Input Out of Range Bit 12 = Analog Voltage Input Under 2 Bit 13 = Analog Voltage Input Under 1 Bit 14 = Analog Voltage Input Over 2 Bit 15 = Analog Voltage Input Over 1 Bit 16 = Analog Voltage Input Out of Range Bit 17 = Global Alarm Bit 18 = Auto Restart Failure Bit 19 = Fuel Leak Detect Bit 20 = Battery Charger Failure Bit 21 = Transfer Fail Bit 22 = Low Coolant Level Bit 23 = ECU Shutdown Bit 24 = Emergency Shutdown Bit 25 = Overcrank Bit 26 = Loss of ECU Comms Bit 27 = Global Sender Fail Bit 28 = Low Fuel Level Bit 29 = Low Oil Pressure Bit 30 = Hi Coolant Temp Bit 31 = Overspeed

Register	Description	Type	Units	Scaling Factor	R/W	Range
44764	Pre-Alarm Metering 1	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Serial Flash Read Failure Bit 3 = Checksum Fail Bit 4 = Global Pre-Alarm Bit 5 = Fuel Filter 2 Leak Bit 6 = Fuel Filter 1 Leak Bit 7 = Reserved Bit 8 = Reserved Bit 9 = MPU Fail Bit 10 = Fuel Leak Detect Bit 11 = Battery Charger Failure Bit 12 = Low Coolant Level Bit 13 = Reserved Bit 14 = Reserved Bit 15 = Reserved Bit 16 = Reserved Bit 17 = Reserved Bit 18 = Reserved Bit 19 = High Fuel Level Bit 20 = Loss of Rem. Mod. Com Bit 21 = Reserved Bit 22 = Diagnostic Trouble Code Bit 23 = Loss of ECU Comms Bit 24 = Maintenance Due Bit 25 = Battery Overvoltage Bit 26 = Weak Battery Bit 27 = Low Battery Voltage Bit 28 = Low Coolant Temperature Bit 29 = Low Fuel Level Bit 30 = Low Oil Pressure Bit 31 = Hi Coolant Temperature
44766	MTU Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = High ECU Supply Bit 24 = Combined Red Bit 25 = Overspeed Bit 26 = Low Oil Pressure Bit 27 = Low Fuel Delivery Pressure Bit 28 = Low Aftercooler Coolant Level Bit 29 = High Coolant Temperature Bit 30 = High Oil Temperature Bit 31 = High Charge Air Temperature

Register	Description	Type	Units	Scaling Factor	R/W	Range
44768	MTU Pre-Alarm Metering 2	Int32	N/A	N/A	R	Bit 0 = Low Storage Tank Bit 1 = High Storage Tank Bit 2 = Low Day Tank Bit 3 = High Day Tank Bit 4 = Alternator Winding Temp Bit 5 = Idle Speed Low Bit 6 = Run Up Speed Low Bit 7 = Start Speed Low Bit 8 = Priming Fault Bit 9 = Low Charge Air Coolant Level Bit 10 = High Fuel Temperature Bit 11 = High Exhaust Temperature B Bit 12 = High Exhaust Temperature A Bit 13 = Low ECU Supply Voltage Bit 14 = Engine Speed Too Low Bit 15 = High Voltage Supply Bit 16 = Low Voltage Supply Bit 17 = Speed Demand Fail Bit 18 = ECU Faulty Bit 19 = Combined Yellow Bit 20 = Low Oil Pressure Bit 21 = Low Fuel Delivery Pressure Bit 22 = Low Charge Air Pressure Bit 23 = Low Coolant Level Bit 24 = Low Fuel Rail Pressure Bit 25 = High Fuel Rail Pressure Bit 26 = Shutdown Override Bit 27 = High Coolant Temperature Bit 28 = High Charge Air Temperature Bit 29 = High Intercooler Temperature Bit 30 = High Oil Temperature Bit 31 = High ECU Temperature
44770	Sender Fail Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Reserved Bit 28 = Fuel Level Bit 29 = Coolant Temp Bit 30 = Oil Pressure Bit 31 = Speed

Register	Description	Type	Units	Scaling Factor	R/W	Range
44772	Local Input Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1
44774	Local Output Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Pre Start Output Bit 18 = Run Output Bit 19 = Start Output Bit 20 = Output 12 Bit 21 = Output 11 Bit 22 = Output 10 Bit 23 = Output 9 Bit 24 = Output 8 Bit 25 = Output 7 Bit 26 = Output 6 Bit 27 = Output 5 Bit 28 = Output 4 Bit 29 = Output 3 Bit 30 = Output 2 Bit 31 = Output 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44776	Status Metering 1	Int32	N/A	N/A	R	Bit 0 = Idle Request Bit 1 = Lamp Test Bit 2 = Alarm Silence Bit 3 = Reset Bit 4 = Reserved Bit 5 = Start Delay Bypass Bit 6 = Cooldown and Stop Request from Logic Bit 7 = Cooldown Request from Logic Bit 8 = External Start Delay Bit 9 = Off Mode Cooldown Bit 10 = Reserved Bit 11 = Reserved Bit 12 = Cooldown Timer Active Bit 13 = Engine Running Bit 14 = Fuel Leak Detect Bit 15 = Battery Charger Failure Bit 16 = Low Coolant Level Bit 17 = Reserved Bit 18 = Reserved Bit 19 = Reserved Bit 20 = Reserved Bit 21 = Reserved Bit 22 = Reserved Bit 23 = Reserved Bit 24 = Reserved Bit 25 = Reserved Bit 26 = Battle Override Bit 27 = Auto Start Bit 28 = Reserved Bit 29 = Reserved Bit 30 = Reserved Bit 31 = Reserved
44778	Hours Until Maintenance	Int32	N/A	N/A	RW	0 - 5000
44780	Cum. Total Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44782	Cum. Total Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44784	Commission Date Month	Uint32	N/A	N/A	RW	1 - 12
44786	Commission Date Day	Uint32	N/A	N/A	RW	1 - 31
44788	Commission Date Year	Uint32	N/A	N/A	RW	0 - 99
44790	Session Total Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44792	Session Total Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44794	Cumulative Number of Engine Starts	Uint32	N/A	N/A	RW	0 - 65535
44796	Session Start Date Month	Uint32	N/A	N/A	RW	1 - 12
44798	Session Start Date Day	Uint32	N/A	N/A	RW	1 - 31
44800	Session Start Date Year	Uint32	N/A	N/A	RW	0 - 99
44802-54	RESERVED					
44856	Cumulative Stats - Total Run Hours	Uint32	Hour	N/A	RW	0 - 5999940
44858	Run Stats - Total Run Hours	Uint32	Hour	N/A	RW	0 - 5999940

Register	Description	Type	Units	Scaling Factor	R/W	Range
44860	LSM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Duplicate LSM Bit 26 = Reserved Bit 27 = Reserved Bit 28 = LSM Comms Failure Bit 29 = Reserved Bit 30 = Reserved Bit 31 = Reserved
44862	Global Alarm	Uint32	N/A	N/A	R	Bit 0 = No system alarms in effect Bit 1 = System alarm(s) in effect
44864	Global Pre-Alarm	Uint32	N/A	N/A	R	Bit 0 = No system pre-alarms in effect Bit 1 = System pre-alarm(s) in effect

Register	Description	Type	Units	Scaling Factor	R/W	Range
44866	Local Configurable Inputs Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1
44868	Local Configurable Inputs Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44870	Configurable Elements Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1
44872	Configurable Elements Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44874	Configurable Elements Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1
44876	Remote Inputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17

Register	Description	Type	Units	Scaling Factor	R/W	Range
44878	Remote Outputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Remote Output 36 Bit 9 = Remote Output 35 Bit 10 = Remote Output 34 Bit 11 = Remote Output 33 Bit 12 = Remote Output 32 Bit 13 = Remote Output 31 Bit 14 = Remote Output 30 Bit 15 = Remote Output 29 Bit 16 = Remote Output 28 Bit 17 = Remote Output 27 Bit 18 = Remote Output 26 Bit 19 = Remote Output 25 Bit 20 = Remote Output 24 Bit 21 = Remote Output 23 Bit 22 = Remote Output 22 Bit 23 = Remote Output 21 Bit 24 = Remote Output 20 Bit 25 = Remote Output 19 Bit 26 = Remote Output 18 Bit 27 = Remote Output 17 Bit 28 = Remote Output 16 Bit 29 = Remote Output 15 Bit 30 = Remote Output 14 Bit 31 = Remote Output 13
44880	CEM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = CEM Hardware Mismatch Bit 30 = Duplicate CEM Bit 31 = CEM Comm Fail

Register	Description	Type	Units	Scaling Factor	R/W	Range
44882	Remote Configurable Inputs Pre-Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17
44884	Remote Configurable Inputs Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17

Register	Description	Type	Units	Scaling Factor	R/W	Range
44886	AEM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Duplicate AEM Bit 31 = AEM Comm Fail
44888	MDEC Pre-Alarms	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = High Fuel Filter Diff Pressure Bit 25 = Overspeed Test On Bit 26 = Ambient Temp Bit 27 = High Temp Coil 3 Bit 28 = High Temp Coil 2 Bit 29 = High Temp Coil 1 Bit 30 = High Pressure Input 2 Bit 31 = High Pressure Input 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44890	MTU Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = ECU Shutdown Bit 21 = Priming Pump ON Bit 22 = CAN Mode Feedback Bit 23 = Preheat Temp Not Reached Bit 24 = Load Gen On Bit 25 = Cylinder Cutout Bit 26 = Engine Running Bit 27 = Speed Decrease Bit 28 = Speed Increase Bit 29 = Speed Demand Fail Mode Bit 30 = External Stop Active Bit 31 = ECU Override
44892	Coolant Temp	Int32	Deg F	N/A	R	(-32768) - 32767
44894-999	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
45000	ECU Lamp Status	Int32	N/A	N/A	R	Bit 0 = Protect Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Warning Bit 4 = Stop Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Malfunction Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used Bit 31 = Not Used
45002	DTC Lamp Status Note: Odd bits are always a zero value.	Int32	N/A	N/A	R	The data in register 45002 is bit-packed data, shown below. The data is actually repeated twice. Bits 0 through 7 and Bits 8 through 15 are identical. Bit 0 = Protect Lamp Bit 1 = 0 Bit 2 = Amber Warning Lamp Bit 3 = 0 Bit 4 = Red Stop Lamp Bit 5 = 0 Bit 6 = Malfunction Indicator Lamp Bit 7 = 0 Bit 8 = Protect Lamp Bit 9 = 0 Bit 10 = Amber Warning Lamp Bit 11 = 0 Bit 12 = Red Stop Lamp Bit 13 = 0 Bit 14 = Malfunction Indicator Lamp Bit 15 = 0 The two bytes in register 45003 contain zeros.
45004	Number of DTC's	Int32	N/A	N/A	R	The Active DTC count is stored in the lower byte of register 45004. The Previously Active DTC count is stored in the upper byte of register 45004. The two bytes in register 45005 contain zeros. The Active DTC count is also available in register 45170. The Previously Active DTC count data is also available in register 45172. Please refer to the descriptions of those registers for more information.

Register	Description	Type	Units	Scaling Factor	R/W	Range
45106	Active DTC 1	Uint32	N/A	N/A	R	Suppose the 32 bits of DTC Data is in Register N and N+1. SPN = (Register N: Most Significant 3 bits * 65536) + (Register N+1: LS Byte * 256) + (Register N+1: MS Byte) FMI = Register N: Bits 8-12 Occurrence Count = Register N: Bits 0 through 6
45108	Active DTC 2	Uint32	N/A	N/A	R	
45110	Active DTC 3	Uint32	N/A	N/A	R	
45112	Active DTC 4	Uint32	N/A	N/A	R	
45114	Active DTC 5	Uint32	N/A	N/A	R	
45116	Active DTC 6	Uint32	N/A	N/A	R	
45118	Active DTC 7	Uint32	N/A	N/A	R	
45120	Active DTC 8	Uint32	N/A	N/A	R	
45122	Active DTC 9	Uint32	N/A	N/A	R	
45124	Active DTC 10	Uint32	N/A	N/A	R	
45126	Active DTC 11	Uint32	N/A	N/A	R	
45128	Active DTC 12	Uint32	N/A	N/A	R	
45130	Active DTC 13	Uint32	N/A	N/A	R	
45132	Active DTC 14	Uint32	N/A	N/A	R	
45134	Active DTC 15	Uint32	N/A	N/A	R	
45136	Active DTC 16	Uint32	N/A	N/A	R	
45138	Previously Active DTC 1	Uint32	N/A	N/A	R	
45140	Previously Active DTC 2	Uint32	N/A	N/A	R	
45142	Previously Active DTC 3	Uint32	N/A	N/A	R	
41544	Previously Active DTC 4	Uint32	N/A	N/A	R	
45146	Previously Active DTC 5	Uint32	N/A	N/A	R	
45148	Previously Active DTC 6	Uint32	N/A	N/A	R	
45150	Previously Active DTC 7	Uint32	N/A	N/A	R	
45152	Previously Active DTC 8	Uint32	N/A	N/A	R	
45154	Previously Active DTC 9	Uint32	N/A	N/A	R	
45156	Previously Active DTC 10	Uint32	N/A	N/A	R	
45158	Previously Active DTC 11	Uint32	N/A	N/A	R	
45160	Previously Active DTC 12	Uint32	N/A	N/A	R	
45162	Previously Active DTC 13	Uint32	N/A	N/A	R	
45164	Previously Active DTC 14	Uint32	N/A	N/A	R	
45166	Previously Active DTC 15	Uint32	N/A	N/A	R	
45168	Previously Active DTC 16	Uint32	N/A	N/A	R	

ECU Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
45250	CANbus Enabled	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45252	DTC Enabled	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45254	J1939 Source Address	Int32	N/A	N/A	RW	1 - 253
45256	ECU Control Output	Uint32	N/A	N/A	RW	0 = Fuel Relay Controls 1 = Preheat Relay Controls
45258	ECU Pulsing Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45260	MTU ECU7 Module Type	Uint32	N/A	N/A	RW	1 = CAN Module 201 2 = CAN Module 302 3 = CAN Module 303 4 = CAN Module 304
45262	MTU Speed Demand Switch	Uint32	N/A	N/A	RW	0 = Analog CAN 1 = Up/Down ECU 2 = Up/Down CAN 3 = Analog ECU 4 = Frequency 5 = No CAN Demand
45264	MTU Engine RPM	Uint32	N/A	N/A	RW	1400 - 2000
45266	Reserved					
45268	Volvo Penta Speed Select	Uint32	N/A	N/A	RW	0 = Primary 1 = Secondary

Register	Description	Type	Units	Scaling Factor	R/W	Range
45270	ECU Type	Uint32	N/A	N/A	RW	0 = Standard 1 = Volvo Penta 2 = MTU MDEC 3 = MTU ADEC 4 = MTU ECU7 5 = GM 6 = Cummins 7 - MTU Smart Connect
45272	ECU Settling Time	Uint32	Millisecond	Milli	RW	5500 - 30000
45274	ECU Pulse Cycle Time	Uint32	Minute	N/A	RW	1 - 60
45276	ECU Engine Shut Down	Uint32	Second	N/A	RW	1 - 60
45278	ECU Response Timeout	Uint32	Second	N/A	RW	1 - 60
45280	MTU Overspeed Test	Uint32	N/A	N/A	RW	0 = Off 1 = On
45282	MTU Governor Param Switch Over	Uint32	N/A	N/A	RW	0 = Off 1 = On
45284	MTU Intermittent Oil Prime Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45286	MTU Trip Reset Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45288	MTU Speed Up Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45290	MTU Speed Down Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45292	MTU Speed Demand Limit	Uint32	N/A	N/A	RW	0 = Off 1 = On
45294	MTU Mode Switch	Uint32	N/A	N/A	RW	0 = Off 1 = On
45296	MTU Increased Idle	Uint32	N/A	N/A	RW	0 - 1000
45298	MTU Governor Param Set Select	Uint32	N/A	N/A	RW	0 - 1000
45300	MTU Fan Override	Uint32	N/A	N/A	RW	0 = Off 1 = On
45302	MTU Engine Start Prime	Uint32	N/A	N/A	RW	0 = Off 1 = On
45304	MTU CAN Rating Switch 1	Uint32	N/A	N/A	RW	0 = Off 1 = On
45306	MTU CAN Rating Switch 2	Uint32	N/A	N/A	RW	0 = Off 1 = On
45308	MTU Cylinder Cutout Disable 1	Uint32	N/A	N/A	RW	0 = Off 1 = On
45310	MTU Cylinder Cutout Disable 2	Uint32	N/A	N/A	RW	0 = Off 1 = On
45312	MTU ECU7 Module Type	Int32	N/A	N/A	RW	0 = 501 1 = 502
45314	MTU 50 Hz 60 Hz Switch Setting	Int32	N/A	N/A	RW	0 = 50 Hz 1 = 60 Hz
45316	NMT Alive Transmit Rate	Int32	N/A	N/A	RW	100 - 500
45318	DPF Manual Regeneration	Int32	N/A	N/A	RW	0 = Off 1 = On
45320	DPF Regeneration Disable	Int32	N/A	N/A	RW	0 = Off 1 = On
45322	Speed Torque Transmit Enable	Int32	N/A	N/A	RW	0 = Off 1 = On
45324	Engine Idle RPM Data	Uint32	N/A	N/A	RW	100 - 4000
45326	Engine Ctrl Param Transmit Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45328	MTU Smart Connect Engine Operating Mode	Int32	N/A	N/A	RW	1 = Mode 1 2 = Mode 2
45330	SPN Conversion Method	Int32	N/A	N/A	RW	1 - 4
45332-499	RESERVED					

Metering 2

Register	Description	Type	Units	Scaling Factor	R/W	Range
45500	Analog Input 1 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45502	Analog Input 2 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45504	Analog Input 3 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45506	Analog Input 4 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45508	Analog Input 5 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45510	Analog Input 6 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45512	Analog Input 7 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45514	Analog Input 8 Metering Value	Int32	Deciunit	Deci	R	(-99990) - 99990
45516	RTD Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45518	RTD Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45520	RTD Input 3 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45522	RTD Input 4 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45524	RTD Input 5 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45526	RTD Input 6 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45528	RTD Input 7 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45530	RTD Input 8 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45532	Thermocouple Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45534	Thermocouple Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45536	AEM Input Threshold Status Bits Reg 1	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Analog Input 6 Under 2 Bit 3 = Analog Input 6 Under 1 Bit 4 = Analog Input 6 Over 2 Bit 5 = Analog Input 6 Over 1 Bit 6 = Analog Input 6 Out of Range Bit 7 = Analog Input 5 Under 2 Bit 8 = Analog Input 5 Under 1 Bit 9 = Analog Input 5 Over 2 Bit 10 = Analog Input 5 Over 1 Bit 11 = Analog Input 5 Out of Range Bit 12 = Analog Input 4 Under 2 Bit 13 = Analog Input 4 Under 1 Bit 14 = Analog Input 4 Over 2 Bit 15 = Analog Input 4 Over 1 Bit 16 = Analog Input 4 Out of Range Bit 17 = Analog Input 3 Under 2 Bit 18 = Analog Input 3 Under 1 Bit 19 = Analog Input 3 Over 2 Bit 20 = Analog Input 3 Over 1 Bit 21 = Analog Input 3 Out of Range Bit 22 = Analog Input 2 Under 2 Bit 23 = Analog Input 2 Under 1 Bit 24 = Analog Input 2 Over 2 Bit 25 = Analog Input 2 Over 1 Bit 26 = Analog Input 2 Out of Range Bit 27 = Analog Input 1 Under 2 Bit 28 = Analog Input 1 Under 1 Bit 29 = Analog Input 1 Over 2 Bit 30 = Analog Input 1 Over 1 Bit 31 = Analog Input 1 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45538	AEM Input Threshold Status Bits Reg 2	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = RTD Input 4 Under 2 Bit 3 = RTD Input 4 Under 1 Bit 4 = RTD Input 4 Over 2 Bit 5 = RTD Input 4 Over 1 Bit 6 = RTD Input 4 Out of Range Bit 7 = RTD Input 3 Under 2 Bit 8 = RTD Input 3 Under 1 Bit 9 = RTD Input 3 Over 2 Bit 10 = RTD Input 3 Over 1 Bit 11 = RTD Input 3 Out of Range Bit 12 = RTD Input 2 Under 2 Bit 13 = RTD Input 2 Under 1 Bit 14 = RTD Input 2 Over 2 Bit 15 = RTD Input 2 Over 1 Bit 16 = RTD Input 2 Out of Range Bit 17 = RTD Input 1 Under 2 Bit 18 = RTD Input 1 Under 1 Bit 19 = RTD Input 1 Over 2 Bit 20 = RTD Input 1 Over 1 Bit 21 = RTD Input 1 Out of Range Bit 22 = Analog Input 8 Under 2 Bit 23 = Analog Input 8 Under 1 Bit 24 = Analog Input 8 Over 2 Bit 25 = Analog Input 8 Over 1 Bit 26 = Analog Input 8 Out of Range Bit 27 = Analog Input 7 Under 2 Bit 28 = Analog Input 7 Under 1 Bit 29 = Analog Input 7 Over 2 Bit 30 = Analog Input 7 Over 1 Bit 31 = Analog Input 7 Out of Range
45540	AEM Input Threshold Status Bits Reg 3	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Thermocouple 2 Under 2 Bit 3 = Thermocouple 2 Under 1 Bit 4 = Thermocouple 2 Over 2 Bit 5 = Thermocouple 2 Over 1 Bit 6 = Thermocouple 2 Out of Range Bit 7 = Thermocouple 1 Under 2 Bit 8 = Thermocouple 1 Under 1 Bit 9 = Thermocouple 1 Over 2 Bit 10 = Thermocouple 1 Over 1 Bit 11 = Thermocouple 1 Out of Range Bit 12 = RTD Input 8 Under 2 Bit 13 = RTD Input 8 Under 1 Bit 14 = RTD Input 8 Over 2 Bit 15 = RTD Input 8 Over 1 Bit 16 = RTD Input 8 Out of Range Bit 17 = RTD Input 7 Under 2 Bit 18 = RTD Input 7 Under 1 Bit 19 = RTD Input 7 Over 2 Bit 20 = RTD Input 7 Over 1 Bit 21 = RTD Input 7 Out of Range Bit 22 = RTD Input 6 Under 2 Bit 23 = RTD Input 6 Under 1 Bit 24 = RTD Input 6 Over 2 Bit 25 = RTD Input 6 Over 1 Bit 26 = RTD Input 6 Out of Range Bit 27 = RTD Input 5 Under 2 Bit 28 = RTD Input 5 Under 1 Bit 29= RTD Input 5 Over 2 Bit 30 = RTD Input 5 Over 1 Bit 31 = RTD Input 5 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45542	AEM Input Threshold Status Bits Reg 4	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Analog Output 4 Out of Range Bit 29 = Analog Output 3 Out of Range Bit 30 = Analog Output 2 Out of Range Bit 31 = Analog Output 1 Out of Range
45544	AEM Input Threshold Alarm Bits Reg 1	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Analog Input 6 Under 2 Bit 3 = Analog Input 6 Under 1 Bit 4 = Analog Input 6 Over 2 Bit 5 = Analog Input 6 Over 1 Bit 6 = Analog Input 6 Out of Range Bit 7 = Analog Input 5 Under 2 Bit 8 = Analog Input 5 Under 1 Bit 9 = Analog Input 5 Over 2 Bit 10 = Analog Input 5 Over 1 Bit 11 = Analog Input 5 Out of Range Bit 12 = Analog Input 4 Under 2 Bit 13 = Analog Input 4 Under 1 Bit 14 = Analog Input 4 Over 2 Bit 15 = Analog Input 4 Over 1 Bit 16 = Analog Input 4 Out of Range Bit 17 = Analog Input 3 Under 2 Bit 18 = Analog Input 3 Under 1 Bit 19 = Analog Input 3 Over 2 Bit 20 = Analog Input 3 Over 1 Bit 21 = Analog Input 3 Out of Range Bit 22 = Analog Input 2 Under 2 Bit 23 = Analog Input 2 Under 1 Bit 24 = Analog Input 2 Over 2 Bit 25 = Analog Input 2 Over 1 Bit 26 = Analog Input 2 Out of Range Bit 27 = Analog Input 1 Under 2 Bit 28 = Analog Input 1 Under 1 Bit 29 = Analog Input 1 Over 2 Bit 30 = Analog Input 1 Over 1 Bit 31 = Analog Input 1 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45546	AEM Input Threshold Alarm Bits Reg 2	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = RTD Input 4 Under 2 Bit 3 = RTD Input 4 Under 1 Bit 4 = RTD Input 4 Over 2 Bit 5 = RTD Input 4 Over 1 Bit 6 = RTD Input 4 Out of Range Bit 7 = RTD Input 3 Under 2 Bit 8 = RTD Input 3 Under 1 Bit 9 = RTD Input 3 Over 2 Bit 10 = RTD Input 3 Over 1 Bit 11 = RTD Input 3 Out of Range Bit 12 = RTD Input 2 Under 2 Bit 13 = RTD Input 2 Under 1 Bit 14 = RTD Input 2 Over 2 Bit 15 = RTD Input 2 Over 1 Bit 16 = RTD Input 2 Out of Range Bit 17 = RTD Input 1 Under 2 Bit 18 = RTD Input 1 Under 1 Bit 19 = RTD Input 1 Over 2 Bit 20 = RTD Input 1 Over 1 Bit 21 = RTD Input 1 Out of Range Bit 22 = Analog Input 8 Under 2 Bit 23 = Analog Input 8 Under 1 Bit 24 = Analog Input 8 Over 2 Bit 25 = Analog Input 8 Over 1 Bit 26 = Analog Input 8 Out of Range Bit 27 = Analog Input 7 Under 2 Bit 28 = Analog Input 7 Under 1 Bit 29 = Analog Input 7 Over 2 Bit 30 = Analog Input 7 Over 1 Bit 31 = Analog Input 7 Out of Range
45548	AEM Input Threshold Alarm Bits Reg 3	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Thermocouple 2 Under 2 Bit 3 = Thermocouple 2 Under 1 Bit 4 = Thermocouple 2 Over 2 Bit 5 = Thermocouple 2 Over 1 Bit 6 = Thermocouple 2 Out of Range Bit 7 = Thermocouple 1 Under 2 Bit 8 = Thermocouple 1 Under 1 Bit 9 = Thermocouple 1 Over 2 Bit 10 = Thermocouple 1 Over 1 Bit 11 = Thermocouple 1 Out of Range Bit 12 = RTD Input 8 Under 2 Bit 13 = RTD Input 8 Under 1 Bit 14 = RTD Input 8 Over 2 Bit 15 = RTD Input 8 Over 1 Bit 16 = RTD Input 8 Out of Range Bit 17 = RTD Input 7 Under 2 Bit 18 = RTD Input 7 Under 1 Bit 19 = RTD Input 7 Over 2 Bit 20 = RTD Input 7 Over 1 Bit 21 = RTD Input 7 Out of Range Bit 22 = RTD Input 6 Under 2 Bit 23 = RTD Input 6 Under 1 Bit 24 = RTD Input 6 Over 2 Bit 25 = RTD Input 6 Over 1 Bit 26 = RTD Input 6 Out of Range Bit 27 = RTD Input 5 Under 2 Bit 28 = RTD Input 5 Under 1 Bit 29= RTD Input 5 Over 2 Bit 30 = RTD Input 5 Over 1 Bit 31 = RTD Input 5 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45550	AEM Input Threshold Alarm Bits Reg 4	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Analog Output 4 Out of Range Bit 29 = Analog Output 3 Out of Range Bit 30 = Analog Output 2 Out of Range Bit 31 = Analog Output 1 Out of Range
45552	AEM Input Threshold Pre-Alarm Bits Reg 1	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Analog Input 6 Under 2 Bit 3 = Analog Input 6 Under 1 Bit 4 = Analog Input 6 Over 2 Bit 5 = Analog Input 6 Over 1 Bit 6 = Analog Input 6 Out of Range Bit 7 = Analog Input 5 Under 2 Bit 8 = Analog Input 5 Under 1 Bit 9 = Analog Input 5 Over 2 Bit 10 = Analog Input 5 Over 1 Bit 11 = Analog Input 5 Out of Range Bit 12 = Analog Input 4 Under 2 Bit 13 = Analog Input 4 Under 1 Bit 14 = Analog Input 4 Over 2 Bit 15 = Analog Input 4 Over 1 Bit 16 = Analog Input 4 Out of Range Bit 17 = Analog Input 3 Under 2 Bit 18 = Analog Input 3 Under 1 Bit 19 = Analog Input 3 Over 2 Bit 20 = Analog Input 3 Over 1 Bit 21 = Analog Input 3 Out of Range Bit 22 = Analog Input 2 Under 2 Bit 23 = Analog Input 2 Under 1 Bit 24 = Analog Input 2 Over 2 Bit 25 = Analog Input 2 Over 1 Bit 26 = Analog Input 2 Out of Range Bit 27 = Analog Input 1 Under 2 Bit 28 = Analog Input 1 Under 1 Bit 29 = Analog Input 1 Over 2 Bit 30 = Analog Input 1 Over 1 Bit 31 = Analog Input 1 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45554	AEM Input Threshold Pre-Alarm Bits Reg 2	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = RTD Input 4 Under 2 Bit 3 = RTD Input 4 Under 1 Bit 4 = RTD Input 4 Over 2 Bit 5 = RTD Input 4 Over 1 Bit 6 = RTD Input 4 Out of Range Bit 7 = RTD Input 3 Under 2 Bit 8 = RTD Input 3 Under 1 Bit 9 = RTD Input 3 Over 2 Bit 10 = RTD Input 3 Over 1 Bit 11 = RTD Input 3 Out of Range Bit 12 = RTD Input 2 Under 2 Bit 13 = RTD Input 2 Under 1 Bit 14 = RTD Input 2 Over 2 Bit 15 = RTD Input 2 Over 1 Bit 16 = RTD Input 2 Out of Range Bit 17 = RTD Input 1 Under 2 Bit 18 = RTD Input 1 Under 1 Bit 19 = RTD Input 1 Over 2 Bit 20 = RTD Input 1 Over 1 Bit 21 = RTD Input 1 Out of Range Bit 22 = Analog Input 8 Under 2 Bit 23 = Analog Input 8 Under 1 Bit 24 = Analog Input 8 Over 2 Bit 25 = Analog Input 8 Over 1 Bit 26 = Analog Input 8 Out of Range Bit 27 = Analog Input 7 Under 2 Bit 28 = Analog Input 7 Under 1 Bit 29 = Analog Input 7 Over 2 Bit 30 = Analog Input 7 Over 1 Bit 31 = Analog Input 7 Out of Range
45556	AEM Input Threshold Pre-Alarm Bits Reg 3	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Thermocouple 2 Under 2 Bit 3 = Thermocouple 2 Under 1 Bit 4 = Thermocouple 2 Over 2 Bit 5 = Thermocouple 2 Over 1 Bit 6 = Thermocouple 2 Out of Range Bit 7 = Thermocouple 1 Under 2 Bit 8 = Thermocouple 1 Under 1 Bit 9 = Thermocouple 1 Over 2 Bit 10 = Thermocouple 1 Over 1 Bit 11 = Thermocouple 1 Out of Range Bit 12 = RTD Input 8 Under 2 Bit 13 = RTD Input 8 Under 1 Bit 14 = RTD Input 8 Over 2 Bit 15 = RTD Input 8 Over 1 Bit 16 = RTD Input 8 Out of Range Bit 17 = RTD Input 7 Under 2 Bit 18 = RTD Input 7 Under 1 Bit 19 = RTD Input 7 Over 2 Bit 20 = RTD Input 7 Over 1 Bit 21 = RTD Input 7 Out of Range Bit 22 = RTD Input 6 Under 2 Bit 23 = RTD Input 6 Under 1 Bit 24 = RTD Input 6 Over 2 Bit 25 = RTD Input 6 Over 1 Bit 26 = RTD Input 6 Out of Range Bit 27 = RTD Input 5 Under 2 Bit 28 = RTD Input 5 Under 1 Bit 29= RTD Input 5 Over 2 Bit 30 = RTD Input 5 Over 1 Bit 31 = RTD Input 5 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45558	AEM Input Threshold Pre-Alarm Bits Reg 4	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Analog Output 4 Out of Range Bit 29 = Analog Output 3 Out of Range Bit 30 = Analog Output 2 Out of Range Bit 31 = Analog Output 1 Out of Range
45560	Analog Output 1 Metering Value	Int32	Centiunit	Centi	R	(-999990) - 999990
45562	Analog Output 2 Metering Value	Int32	Centiunit	Centi	R	(-999990) - 999990
45564	Analog Output 3 Metering Value	Int32	Centiunit	Centi	R	(-999990) - 999990
45566	Analog Output 4 Metering Value	Int32	Centiunit	Centi	R	(-999990) - 999990

Register	Description	Type	Units	Scaling Factor	R/W	Range
45568	Configurable Protection Threshold Status Bits	Uint32	N/A	N/A	R	Bit 0 = Conf Protection 8 Under 2 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 Bit 31 = Conf Protection 1 Over 1
45570	Configurable Protection Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Conf Protection 8 Under 2 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 Bit 31 = Conf Protection 1 Over 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
45572	Configurable Protection Pre-Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Conf Protection 8 Under 2 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 Bit 31 = Conf Protection 1 Over 1
45574	Logic Control Relay Status	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Logic Control Relay 16 Bit 17 = Logic Control Relay 15 Bit 18 = Logic Control Relay 14 Bit 19 = Logic Control Relay 13 Bit 20 = Logic Control Relay 12 Bit 21 = Logic Control Relay 11 Bit 22 = Logic Control Relay 10 Bit 23 = Logic Control Relay 9 Bit 24 = Logic Control Relay 8 Bit 25 = Logic Control Relay 7 Bit 26 = Logic Control Relay 6 Bit 27 = Logic Control Relay 5 Bit 28 = Logic Control Relay 4 Bit 29 = Logic Control Relay 3 Bit 30 = Logic Control Relay 2 Bit 31 = Logic Control Relay 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
45576	I/O Modules Connected	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = AEM Connected Bit 30 = CEM Connected Bit 31 = LSM Connected
45578	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
45580	Pre-Alarm Metering 2	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = DEF Inducement Override Bit 9 = DEF Severe Inducement Bit 10 = DEF Pre-Severe Inducement Bit 11 = DEF Engine Derate Bit 12 = DEF Fluid Level Empty Bit 13 = DEF Fluid Level Low Bit 14 = Maximum RPM Limit Bit 15 = Minimum RPM Limit Bit 16 = Analog Current Input Under 2 Bit 17 = Analog Current Input Under 1 Bit 18 = Analog Current Input Over 2 Bit 19 = Analog Current Input Over 1 Bit 20 = Analog Current Input Out of Range Bit 21 = Analog Voltage Input Under 2 Bit 22 = Analog Voltage Input Under 1 Bit 23 = Analog Voltage Input Over 2 Bit 24 = Analog Voltage Input Over 1 Bit 25 = Analog Voltage Input Out of Range Bit 26 = DPF Soot Level Severely High Bit 27 = DPF Soot Level Moderately High Bit 28 = DPF Soot Level High Bit 29 = High Exhaust Temperature Bit 30 = DPF Regenerate Disabled Bit 31 = DPF Regenerate Required
45582	Local Analog Input Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 22 = Analog Current Input Under 2 Bit 23 = Analog Current Input Under 1 Bit 24 = Analog Current Input Over 2 Bit 25 = Analog Current Input Over 1 Bit 26 = Analog Current Input Out of Range Bit 27 = Analog Voltage Input Under 2 Bit 28 = Analog Voltage Input Under 1 Bit 29 = Analog Voltage Input Over 2 Bit 30 = Analog Voltage Input Over 1 Bit 31 = Analog Voltage Input Out of Range
45584	Analog Voltage Data	Int32	Centiunit	Centi	R	(-99999900) - 99999900
45586	Analog Current Data	Int32	Centiunit	Centi	R	(-99999900) - 99999900
45588	Raw Analog Voltage Data	Int32	Milliunit	Milli	R	(-2147483648) - 2147483647

Register	Description	Type	Units	Scaling Factor	R/W	Range
45590	Raw Analog Current Data	Int32	Milliunit	Milli	R	(-2147483648) - 2147483647
45592	Operating RPM Setpoint x100 Data	Int32	CentiRPM	Centi	R	(-2147483648) - 2147483647
45594	Operating Parameter Setpoint Data	Int32	Centiunit	Centi	R	(-2147483648) - 2147483647
45596	Operating Parameter Data	Int32	Centiunit	Centi	R	(-2147483648) - 2147483647
45598	LSM-2020 Input Data	Int32	Centiunit	Centi	R	(-99999900) - 99999900
45600-749	RESERVED					

Miscellaneous Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
45750	Device Address	Int32	N/A	N/A	RW	(-128) - 127
45752	pc Emergency Stop	Uint32	N/A	N/A	RW	0 = Stop 1 = Start
45754	pc Relay Closed: Runs when in Auto mode	Uint32	N/A	N/A	RW	0 = Stop 1 = Start
45756	Test Buttons Image	Uint32	N/A	N/A	RW	0 - 255
45758-61	RESERVED					
45762	Embedded Code Version Number	Uint32	N/A	N/A	R	
45764	Boot Code Version Number	Int32	N/A	N/A	R	
45766	Model Number	Uint32	N/A	N/A	R	
45768	Embedded Code Part Number	Uint32	N/A	N/A	R	

Configurable Protection Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
45770	Conf Prot 1 Param Select	Unit32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45772	Conf Prot 1 Hysteresis	Int32	Percent	Deci	RW	0 - 1000

Register	Description	Type	Units	Scaling Factor	R/W	Range
45774	Conf Prot 1 Arming Delay	Int32	Second	N/A	RW	0 - 300
45776	Conf Prot 1 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45778	Conf Prot 1 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45780	Conf Prot 1 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45782	Conf Prot 1 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45784	Conf Prot 1 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45786	Conf Prot 1 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45788	Conf Prot 1 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45790	Conf Prot 1 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45792	Conf Prot 1 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45794	Conf Prot 1 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45796	Conf Prot 2 Param Select	Unit32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45798	Conf Prot 2 Hysteresis	Int32	Percent	Deci	RW	0 - 1000
45800	Conf Prot 2 Arming Delay	Int32	Second	N/A	RW	0 - 300
45802	Conf Prot 2 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45804	Conf Prot 2 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45806	Conf Prot 2 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45808	Conf Prot 2 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45810	Conf Prot 2 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45812	Conf Prot 2 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45814	Conf Prot 2 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45816	Conf Prot 2 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
458818	Conf Prot 2 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45820	Conf Prot 2 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45822	Conf Prot 3 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45824	Conf Prot 3 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45826	Conf Prot 3 Arming Delay	Int32	Second	N/A	RW	0 - 300
45828	Conf Prot 3 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45830	Conf Prot 3 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45832	Conf Prot 3 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45834	Conf Prot 3 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45836	Conf Prot 3 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45838	Conf Prot 3 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45840	Conf Prot 3 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45842	Conf Prot 3 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45844	Conf Prot 3 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45846	Conf Prot 3 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45848	Conf Prot 4 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45850	Conf Prot 4 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45852	Conf Prot 4 Arming Delay	Int32	Second	N/A	RW	0 - 300
45854	Conf Prot 4 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45856	Conf Prot 4 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45858	Conf Prot 4 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45860	Conf Prot 4 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45862	Conf Prot 4 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45864	Conf Prot 4 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45866	Conf Prot 4 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45868	Conf Prot 4 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45870	Conf Prot 4 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45872	Conf Prot 4 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45874	Conf Prot 5 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45876	Conf Prot 5 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45878	Conf Prot 5 Arming Delay	Int32	Second	N/A	RW	0 - 300
45880	Conf Prot 5 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45882	Conf Prot 5 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45884	Conf Prot 5 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45886	Conf Prot 5 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45888	Conf Prot 5 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45890	Conf Prot 5 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45892	Conf Prot 5 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45894	Conf Prot 5 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45896	Conf Prot 5 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45898	Conf Prot 5 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45900	Conf Prot 6 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45902	Conf Prot 6 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45904	Conf Prot 6 Arming Delay	Int32	Second	N/A	RW	0 - 300
45906	Conf Prot 6 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45908	Conf Prot 6 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45910	Conf Prot 6 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45912	Conf Prot 6 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45914	Conf Prot 6 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45916	Conf Prot 6 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45918	Conf Prot 6 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45920	Conf Prot 6 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45922	Conf Prot 6 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45924	Conf Prot 6 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45926	Conf Prot 7 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45928	Conf Prot 7 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45930	Conf Prot 7 Arming Delay	Int32	Second	N/A	RW	0 - 300
45932	Conf Prot 7 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45934	Conf Prot 7 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45936	Conf Prot 7 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45938	Conf Prot 7 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45940	Conf Prot 7 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45942	Conf Prot 7 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45944	Conf Prot 7 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45946	Conf Prot 7 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45948	Conf Prot 7 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45950	Conf Prot 7 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45952	Conf Prot 8 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Analog Input 1 6 = Analog Input 2 7 = Analog Input 3 8 = Analog Input 4 9 = Analog Input 5 10 = Analog Input 6 11 = Analog Input 7 12 = Analog Input 8 13 = RTD Input 1 14 = RTD Input 2 15 = RTD Input 3 16 = RTD Input 4 17 = RTD Input 5 18 = RTD Input 6 19 = RTD Input 7 20 = RTD Input 8 21 = Thermocouple 1 22 = Thermocouple 2 23 = Fuel Delivery Pressure 24 = Injector Metering Rail Pressure 25 = Total Fuel Used 26 = Fuel Temperature 27 = Engine Oil Temperature 28 = Engine Intercooler Temperature 29 = Coolant Pressure 30 = Fuel Rate 31 = Boost Pressure 32 = Intake Manifold Temperature 33 = Charge Air Temperature 34 = IEM-2020 Local Analog Input Voltage 35 = IEM-2020 Local Analog Input Current
45954	Conf Prot 8 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45956	Conf Prot 8 Arming Delay	Int32	Second	N/A	RW	0 - 300
45958	Conf Prot 8 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45960	Conf Prot 8 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
45962	Conf Prot 8 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45964	Conf Prot 8 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45966	Conf Prot 8 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45968	Conf Prot 8 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45970	Conf Prot 8 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45972	Conf Prot 8 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45974	Conf Prot 8 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45976	Conf Prot 8 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45978-6249	RESERVED					

PLC Timers Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
46250	PLC Timer 1 Seconds	Int32	Second	Deci	RW	0 - 18000
46252	PLC Timer 2 Seconds	Int32	Second	Deci	RW	0 - 18000
46254	PLC Timer 3 Seconds	Int32	Second	Deci	RW	0 - 18000
46256	PLC Timer 4 Seconds	Int32	Second	Deci	RW	0 - 18000
46258	PLC Timer 5 Seconds	Int32	Second	Deci	RW	0 - 18000
46260	PLC Timer 6 Seconds	Int32	Second	Deci	RW	0 - 18000
46262	PLC Timer 7 Seconds	Int32	Second	Deci	RW	0 - 18000
46264	PLC Timer 8 Seconds	Int32	Second	Deci	RW	0 - 18000
46266	PLC Timer 9 Seconds	Int32	Second	Deci	RW	0 - 18000
46268	PLC Timer 10 Seconds	Int32	Second	Deci	RW	0 - 18000
46270	PLC Timer 1 Minutes	Uint32	Minute	N/A	RW	0 - 250
46272	PLC Timer 2 Minutes	Uint32	Minute	N/A	RW	0 - 250
46274	PLC Timer 3 Minutes	Uint32	Minute	N/A	RW	0 - 250
46276	PLC Timer 4 Minutes	Uint32	Minute	N/A	RW	0 - 250
46278	PLC Timer 5 Minutes	Uint32	Minute	N/A	RW	0 - 250
46280	PLC Timer 6 Minutes	Uint32	Minute	N/A	RW	0 - 250
46282	PLC Timer 7 Minutes	Uint32	Minute	N/A	RW	0 - 250
46284	PLC Timer 8 Minutes	Uint32	Minute	N/A	RW	0 - 250
46286	PLC Timer 9 Minutes	Uint32	Minute	N/A	RW	0 - 250
46288	PLC Timer 10 Minutes	Uint32	Minute	N/A	RW	0 - 250
46290	PLC Timer 1 Hours	Uint32	Hour	N/A	RW	0 - 250
46292	PLC Timer 2 Hours	Uint32	Hour	N/A	RW	0 - 250
46294	PLC Timer 3 Hours	Uint32	Hour	N/A	RW	0 - 250
46296	PLC Timer 4 Hours	Uint32	Hour	N/A	RW	0 - 250
46298	PLC Timer 5 Hours	Uint32	Hour	N/A	RW	0 - 250
46300	PLC Timer 6 Hours	Uint32	Hour	N/A	RW	0 - 250
46302	PLC Timer 7 Hours	Uint32	Hour	N/A	RW	0 - 250
46304	PLC Timer 8 Hours	Uint32	Hour	N/A	RW	0 - 250
46306	PLC Timer 9 Hours	Uint32	Hour	N/A	RW	0 - 250
46308	PLC Timer 10 Hours	Uint32	Hour	N/A	RW	0 - 250

Remote Analog Inputs Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
46310	Input 1 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46312	Input 1 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46314	Input 1 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46316	Input 1 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46318	Input 1 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46320	Input 1 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46322	Input 1 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46324	Input 1 Arming Delay	Int32	Second	N/A	RW	0 - 300
46326	Input 1 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46328	Input 1 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46330	Input 1 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46332	Input 1 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46334	Input 1 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46336	Input 1 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46338	Input 1 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46340	Input 1 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46342	Input 1 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46344	Input 1 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46346	Input 1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46348	Input 2 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46350	Input 2 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46352	Input 2 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46354	Input 2 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46356	Input 2 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46358	Input 2 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46360	Input 2 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46362	Input 2 Arming Delay	Int32	Second	N/A	RW	0 - 300
46364	Input 2 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46366	Input 2 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46368	Input 2 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46370	Input 2 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46372	Input 2 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46374	Input 2 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46376	Input 2 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46378	Input 2 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46380	Input 2 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46382	Input 2Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46384	Input 2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46386	Input 3 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46388	Input 3 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46390	Input 3 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46392	Input 3 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46394	Input 3 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46396	Input 3 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46398	Input 3 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46400	Input 3 Arming Delay	Int32	Second	N/A	RW	0 - 300
46402	Input 3 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46404	Input 3 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46406	Input 3 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46408	Input 3 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46410	Input 3 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46412	Input 3 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46414	Input 3 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46416	Input 3 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46418	Input 3 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46420	Input 3 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46422	Input 3 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46424	Input 4 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46426	Input 4 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46428	Input 4 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46430	Input 4 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46432	Input 4 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46434	Input 4 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46436	Input 4 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46438	Input 4 Arming Delay	Int32	Second	N/A	RW	0 - 300
46440	Input 4 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46442	Input 4 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46444	Input 4 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46446	Input 4 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46448	Input 4 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46450	Input 4 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46452	Input 4 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46454	Input 4 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46456	Input 4 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46458	Input 4 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46460	Input 4 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46462-99	RESERVED					
46500	Input 5 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46502	Input 5 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46504	Input 5 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46506	Input 5 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46508	Input 5 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46510	Input 5 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46512	Input 5 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46514	Input 5 Arming Delay	Int32	Second	N/A	RW	0 - 300
46516	Input 5 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46518	Input 5 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46520	Input 5 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46522	Input 5 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46524	Input 5 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46526	Input 5 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46528	Input 5 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46530	Input 5 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46532	Input 5 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46534	Input 5 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46536	Input 5 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46538	Input 6 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46540	Input 6 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46542	Input 6 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46544	Input 6 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46546	Input 6 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46548	Input 6 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46550	Input 6 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46552	Input 6 Arming Delay	Int32	Second	N/A	RW	0 - 300
46554	Input 6 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46556	Input 6 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46558	Input 6 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46560	Input 6 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46562	Input 6 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46564	Input 6 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46566	Input 6 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46568	Input 6 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46570	Input 6 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46572	Input 6 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46574	Input 6 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46576	Input 7 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46578	Input 7 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46580	Input 7 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46582	Input 7 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46584	Input 7 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46586	Input 7 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46588	Input 7 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46590	Input 7 Arming Delay	Int32	Second	N/A	RW	0 - 300
46592	Input 7 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46594	Input 7 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46596	Input 7 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46598	Input 7 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46600	Input 7 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46602	Input 7 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46604	Input 7 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46606	Input 7 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46608	Input 7 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46610	Input 7 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46612	Input 7 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46614	Input 8 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46616	Input 8 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46618	Input 8 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46620	Input 8 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46622	Input 8 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46624	Input 8 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46626	Input 8 Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
46628	Input 8 Arming Delay	Int32	Second	N/A	RW	0 - 300
46630	Input 8 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46632	Input 8 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46634	Input 8 Threshold 1 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46636	Input 8 Threshold 2 Over	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46638	Input 8 Threshold 1 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46640	Input 8 Threshold 2 Under	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46642	Input 8 Threshold 1 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46644	Input 8 Threshold 2 Over Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46646	Input 8 Threshold 1 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46648	Input 8 Threshold 2 Under Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46650	Input 8 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Remote Analog Outputs Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
46652	Output 1 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46654	Output 1 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46656	Output 1 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46658	Output 1 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200

46660	Output 1 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46662	Output 1 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46664	Output 1 Param Selection					0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Run Time 6 = Analog Input 1 7 = Analog Input 2 8 = Analog Input 3 9 = Analog Input 4 10 = Analog Input 5 11 = Analog Input 6 12 = Analog Input 7 13 = Analog Input 8 14 = RTD Input 1 15 = RTD Input 2 16 = RTD Input 3 17 = RTD Input 4 18 = RTD Input 5 19 = RTD Input 6 20 = RTD Input 7 21 = RTD Input 8 22 = Thermocouple 1 23 = Thermocouple 2 24 = Fuel Delivery Pressure 25 = Injector Metering Rail Pressure 26 = Total Fuel Used 27 = Fuel Temperature 28 = Engine Oil Temperature 29 = Engine Intercooler Temperature 30 = Coolant Pressure 31 = Fuel Rate 32 = Boost Pressure 33 = Intake Manifold Temperature 34 = Charge Air Temperature 35 = IEM-2020 Local Analog Input Voltage 36 = IEM-2020 Local Analog Input Current
46666	Output 1 Out of Range Alarm Type					0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46668	Output 1 Out of Range Time Delay					0 - 300
46670	Output 2 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46672	Output 2 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46674	Output 2 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46676	Output 2 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46678	Output 2 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46680	Output 2 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900

46682	Output 2 Param Selection					0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Run Time 6 = Analog Input 1 7 = Analog Input 2 8 = Analog Input 3 9 = Analog Input 4 10 = Analog Input 5 11 = Analog Input 6 12 = Analog Input 7 13 = Analog Input 8 14 = RTD Input 1 15 = RTD Input 2 16 = RTD Input 3 17 = RTD Input 4 18 = RTD Input 5 19 = RTD Input 6 20 = RTD Input 7 21 = RTD Input 8 22 = Thermocouple 1 23 = Thermocouple 2 24 = Fuel Delivery Pressure 25 = Injector Metering Rail Pressure 26 = Total Fuel Used 27 = Fuel Temperature 28 = Engine Oil Temperature 29 = Engine Intercooler Temperature 30 = Coolant Pressure 31 = Fuel Rate 32 = Boost Pressure 33 = Intake Manifold Temperature 34 = Charge Air Temperature 35 = IEM-2020 Local Analog Input Voltage 36 = IEM-2020 Local Analog Input Current
46684	Output 2 Out of Range Alarm Type					0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46686	Output 2 Out of Range Time Delay					0 - 300
46688	Output 3 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46690	Output 3 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46692	Output 3 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46694	Output 3 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46696	Output 3 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46698	Output 3 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900

46700	Output 3 Param Selection					0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Run Time 6 = Analog Input 1 7 = Analog Input 2 8 = Analog Input 3 9 = Analog Input 4 10 = Analog Input 5 11 = Analog Input 6 12 = Analog Input 7 13 = Analog Input 8 14 = RTD Input 1 15 = RTD Input 2 16 = RTD Input 3 17 = RTD Input 4 18 = RTD Input 5 19 = RTD Input 6 20 = RTD Input 7 21 = RTD Input 8 22 = Thermocouple 1 23 = Thermocouple 2 24 = Fuel Delivery Pressure 25 = Injector Metering Rail Pressure 26 = Total Fuel Used 27 = Fuel Temperature 28 = Engine Oil Temperature 29 = Engine Intercooler Temperature 30 = Coolant Pressure 31 = Fuel Rate 32 = Boost Pressure 33 = Intake Manifold Temperature 34 = Charge Air Temperature 35 = IEM-2020 Local Analog Input Voltage 36 = IEM-2020 Local Analog Input Current
46702	Output 3 Out of Range Alarm Type					0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46704	Output 3 Out of Range Time Delay					0 - 300
46706	Output 4 Max Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46708	Output 4 Max Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46710	Output 4 Min Input Voltage	Int32	Decivolt	Deci	RW	0 - 100
46712	Output 4 Min Input Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46714	Output 4 Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
46716	Output 4 Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900

46718	Output 4 Param Selection					0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Run Time 6 = Analog Input 1 7 = Analog Input 2 8 = Analog Input 3 9 = Analog Input 4 10 = Analog Input 5 11 = Analog Input 6 12 = Analog Input 7 13 = Analog Input 8 14 = RTD Input 1 15 = RTD Input 2 16 = RTD Input 3 17 = RTD Input 4 18 = RTD Input 5 19 = RTD Input 6 20 = RTD Input 7 21 = RTD Input 8 22 = Thermocouple 1 23 = Thermocouple 2 24 = Fuel Delivery Pressure 25 = Injector Metering Rail Pressure 26 = Total Fuel Used 27 = Fuel Temperature 28 = Engine Oil Temperature 29 = Engine Intercooler Temperature 30 = Coolant Pressure 31 = Fuel Rate 32 = Boost Pressure 33 = Intake Manifold Temperature 34 = Charge Air Temperature 35 = IEM-2020 Local Analog Input Voltage 36 = IEM-2020 Local Analog Input Current
46720	Output 4 Out of Range Alarm Type					0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46722	Output 4 Out of Range Time Delay					0 - 300
46724-49	RESERVED					

Contact Inputs Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
46750	Input 1 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46752	Input 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
46754	Input 1 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46756	Input 2 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46758	Input 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
46760	Input 2 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46762	Input 3 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46764	Input 3 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46766	Input 3 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46768	Input 4 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46770	Input 4 Activation Delay	Int32	Second	N/A	RW	0 - 300
46772	Input 4 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46774	Input 5 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46776	Input 5 Activation Delay	Int32	Second	N/A	RW	0 - 300
46778	Input 5 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46780	Input 6 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46782	Input 6 Activation Delay	Int32	Second	N/A	RW	0 - 300
46784	Input 6 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46786	Input 7 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46788	Input 7 Activation Delay	Int32	Second	N/A	RW	0 - 300
46790	Input 7 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46792	Input 8 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46794	Input 8 Activation Delay	Int32	Second	N/A	RW	0 - 300
46796	Input 8 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46798	Input 9 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46800	Input 9 Activation Delay	Int32	Second	N/A	RW	0 - 300
46802	Input 9 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46804	Input 10 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46806	Input 10 Activation Delay	Int32	Second	N/A	RW	0 - 300
46808	Input 10 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46810	Input 11 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46812	Input 11 Activation Delay	Int32	Second	N/A	RW	0 - 300
46814	Input 11 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46816	Input 12 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46818	Input 12 Activation Delay	Int32	Second	N/A	RW	0 - 300
46820	Input 12 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46822	Configurable Input 13 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46824	Input 13 Activation Delay	Int32	Second	N/A	RW	0 - 300
46826	Input 13 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46828	Input 14 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46830	Input 14 Activation Delay	Int32	Second	N/A	RW	0 - 300
46832	Input 14 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46834	Input 15 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46836	Input 15 Activation Delay	Int32	Second	N/A	RW	0 - 300
46838	Input 15 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46840	Input 16 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46842	Input 16 Activation Delay	Int32	Second	N/A	RW	0 - 300
46844	Input 16 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46846	Input 17 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46848	Input 17 Activation Delay	Int32	Second	N/A	RW	0 - 300
46850	Input 17 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46852	Input 18 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46854	Input 18 Activation Delay	Int32	Second	N/A	RW	0 - 300
46856	Input 18 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46858	Input 19 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46860	Input 19 Activation Delay	Int32	Second	N/A	RW	0 - 300
46862	Input 19 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46864	Input 20 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46866	Input 20 Activation Delay	Int32	Second	N/A	RW	0 - 300
46868	Input 20 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46870	Input 21 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46872	Input 21 Activation Delay	Int32	Second	N/A	RW	0 - 300
46874	Input 21 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46876	Input 22 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm

Register	Description	Type	Units	Scaling Factor	R/W	Range
46878	Input 22 Activation Delay	Int32	Second	N/A	RW	0 - 300
46880	Configurable Input 22 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46882	Input 23 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46884	Input 23 Activation Delay	Int32	Second	N/A	RW	0 - 300
46886	Input 23 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46888	Input 24 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46890	Input 24 Activation Delay	Int32	Second	N/A	RW	0 - 300
46892	Input 24 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46894	Input 25 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46896	Input 25 Activation Delay	Int32	Second	N/A	RW	0 - 300
46898	Input 25 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46900	Input 26 Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46902	Input 26 Activation Delay	Int32	Second	N/A	RW	0 - 300
46904	Input 26 Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46906	Auto Start Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46908	Auto Start Time Delay	Int32	Second	N/A	RW	0 - 300
46910	Auto Start Contact Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46912	Battle Override Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46914	Battle Override Time Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46916	Battle Override Contact Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46918	Low Coolant Level Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46920	Low Coolant Level Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46922	Low Coolant Level Time Delay	Int32	Second	N/A	RW	0 - 300
46924	Low Coolant Level Contact Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46926	Battery Charger Fail Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46928	Battery Charger Fail Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46930	Battery Charger Fail Time Delay	Int32	Second	N/A	RW	0 - 300
46932	Battery Charger Fail Contact Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46934	Fuel Leak Detect Contact Input	Int32	N/A	N/A	RW	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46936	Fuel Leak Detect Alarm Configuration	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46938	Fuel Leak Detect Time Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46940	Fuel Leak Detect Contact Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
6942-7000	RESERVED					

Local Analog Inputs Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
47000	Voltage Input Max Voltage	Int32	Decivolt	Deci	RW	0 - 100
47002	Voltage Input Min Voltage	Int32	Decivolt	Deci	RW	0 - 100
47004	Voltage Input Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47006	Voltage Input Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47008	Voltage Input Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
47010	Voltage Input Arming Delay	Int32	Second	N/A	RW	0 - 300
47012	Voltage Input Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
47014	Voltage Input Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
47016	Voltage Input Over 1 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47018	Voltage Input Over 2 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47020	Voltage Input Under 1 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47022	Voltage Input Under 2 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47024	Voltage Input Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47026	Voltage Input Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47028	Voltage Input Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47030	Voltage Input Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47032	Voltage Input Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47034	Current Input Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
47036	Current Input Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
47038	Current Input Param Max	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47040	Current Input Param Min	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47042	Current Input Hysteresis	Int32	Decipercent	Deci	RW	0 - 1000
47044	Current Input Arming Delay	Int32	Second	N/A	RW	0 - 300
47046	Current Input Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
47048	Current Input Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300
47050	Current Input Over 1 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
47052	Current Input Over 2 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47054	Current Input Under 1 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47056	Current Input Under 2 Threshold	Int32	Centiunit	Centi	RW	(-99999900) - 99999900
47058	Current Input Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47060	Current Input Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47062	Current Input Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47064	Current Input Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
47066	Current Input Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Exercise Timer Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
47250	Start Day of Month	Int32	N/A	N/A	RW	1 - 31
47252	Start Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday
47254	Start Hour	Int32	N/A	N/A	RW	0 - 23
47256	Start Minute	Int32	N/A	N/A	RW	0 - 59
47258	Run Period Hours	Int32	N/A	N/A	RW	0 - 23
47260	Run Period Minutes	Int32	N/A	N/A	RW	0 - 59
47262	Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Monthly 2 = Weekly 3 = Daily

Daily Exercise Timers Configuration

Register	Description	Type	Units	Scaling Factor	R/W	Range
47264	Sunday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47266	Sunday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47268	Sunday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47270	Sunday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47272	Sunday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47274	Sunday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47276	Sunday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47278	Sunday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47280	Sunday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47282	Sunday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47284	Sunday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47286	Sunday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47288	Sunday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47290	Sunday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47292	Sunday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47294	Sunday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23

Register	Description	Type	Units	Scaling Factor	R/W	Range
47296	Sunday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47298	Sunday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47300	Sunday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47302	Sunday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47304	Sunday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47306	Sunday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47308	Sunday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47310	Sunday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47312	Sunday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47314	Sunday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47316	Sunday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47318	Sunday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47320	Sunday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47322	Sunday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47324	Sunday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47326	Sunday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47328	Monday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47330	Monday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47332	Monday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47334	Monday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47336	Monday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47338	Monday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47340	Monday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47342	Monday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47344	Monday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47346	Monday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47348	Monday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47350	Monday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47352	Monday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47354	Monday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47356	Monday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47358	Monday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47360	Monday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47362	Monday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47364	Monday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47366	Monday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47368	Monday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47370	Monday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47372	Monday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47374	Monday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47376	Monday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47378	Monday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47380	Monday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47382	Monday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47384	Monday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47386	Monday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47388	Monday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47390	Monday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47392	Tuesday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47394	Tuesday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47396	Tuesday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47398	Tuesday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47400	Tuesday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47402	Tuesday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47404	Tuesday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47406	Tuesday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47408	Tuesday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47410	Tuesday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47412	Tuesday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23

Register	Description	Type	Units	Scaling Factor	R/W	Range
47414	Tuesday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47416	Tuesday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47418	Tuesday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47420	Tuesday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47422	Tuesday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47424	Tuesday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47426	Tuesday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47428	Tuesday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47430	Tuesday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47432	Tuesday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47434	Tuesday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47436	Tuesday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47438	Tuesday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47440	Tuesday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47442	Tuesday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47444	Tuesday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47446	Tuesday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47448	Tuesday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47450	Tuesday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47452	Tuesday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47454	Tuesday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47456	Wednesday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47458	Wednesday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47460	Wednesday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47462	Wednesday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47464	Wednesday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47466	Wednesday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47468	Wednesday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47470	Wednesday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47472	Wednesday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47474	Wednesday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47476	Wednesday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47478	Wednesday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47480	Wednesday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47482	Wednesday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47484	Wednesday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47486	Wednesday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47488	Wednesday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47490	Wednesday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47492	Wednesday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47494	Wednesday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47496	Wednesday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47498	Wednesday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47500	Wednesday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47502	Wednesday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47504	Wednesday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47506	Wednesday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47508	Wednesday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47510	Wednesday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47512	Wednesday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47514	Wednesday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47516	Wednesday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47518	Wednesday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47520	Thursday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47522	Thursday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47524	Thursday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47526	Thursday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47528	Thursday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47530	Thursday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59

Register	Description	Type	Units	Scaling Factor	R/W	Range
47532	Thursday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47534	Thursday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47536	Thursday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47538	Thursday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47540	Thursday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47542	Thursday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47544	Thursday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47546	Thursday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47548	Thursday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47550	Thursday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47552	Thursday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47554	Thursday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47556	Thursday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47558	Thursday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47560	Thursday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47562	Thursday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47564	Thursday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47566	Thursday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47568	Thursday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47570	Thursday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47572	Thursday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47574	Thursday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47576	Thursday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47578	Thursday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47580	Thursday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47582	Thursday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47584	Friday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47586	Friday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47588	Friday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47590	Friday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47592	Friday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47594	Friday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47596	Friday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47598	Friday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47600	Friday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47602	Friday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47604	Friday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47606	Friday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47608	Friday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47610	Friday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47612	Friday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47614	Friday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47616	Friday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47618	Friday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47620	Friday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47622	Friday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47624	Friday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47626	Friday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47628	Friday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47630	Friday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47632	Friday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47634	Friday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47636	Friday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47638	Friday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47640	Friday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47642	Friday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47644	Friday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47646	Friday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47648	Saturday Timer 1 - Start Hour	Int32	N/A	N/A	RW	0 - 23

Register	Description	Type	Units	Scaling Factor	R/W	Range
47650	Saturday Timer 1 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47652	Saturday Timer 1 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47654	Saturday Timer 1 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47656	Saturday Timer 2 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47658	Saturday Timer 2 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47660	Saturday Timer 2 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47662	Saturday Timer 2 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47664	Saturday Timer 3 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47666	Saturday Timer 3 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47668	Saturday Timer 3 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47670	Saturday Timer 3 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47672	Saturday Timer 4 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47674	Saturday Timer 4 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47676	Saturday Timer 4 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47678	Saturday Timer 4 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47680	Saturday Timer 5 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47682	Saturday Timer 5 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47684	Saturday Timer 5 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47686	Saturday Timer 5 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47688	Saturday Timer 6 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47690	Saturday Timer 6 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47692	Saturday Timer 6 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47694	Saturday Timer 6 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47696	Saturday Timer 7 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47698	Saturday Timer 7 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47700	Saturday Timer 7 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47702	Saturday Timer 7 - Run Minutes	Int32	N/A	N/A	RW	0 - 23
47704	Saturday Timer 8 - Start Hour	Int32	N/A	N/A	RW	0 - 23
47706	Saturday Timer 8 - Start Minute	Int32	N/A	N/A	RW	0 - 59
47708	Saturday Timer 8 - Run Hours	Int32	N/A	N/A	RW	0 - 23
47710	Saturday Timer 8 - Run Minutes	Int32	N/A	N/A	RW	0 - 23

APPENDIX B • LOGIC LIBRARY FILES

TABLE OF CONTENTS

Figures

APPENDIX B • LOGIC LIBRARY FILES

Introduction

This appendix discusses application of the IEM-2020 Industrial Engine Module using the logic library files. The *Details of Logic Library Files* subsection describes each logic library file and how they combine to create an industrial engine module for a variety of pump applications. Any scheme can be modified if necessary to fit a particular application.

The logic library files are designed to accommodate most common pump applications. The engineer can choose a logic library file that most closely meets his application practices and adapt it by changing the function block operation and settings. This eliminates the need to create a custom logic scheme.

WARNING!
The logic library files defined in this manual are intended to be used as basic logic configurations on which to build a complete logic scheme suitable for the application. The default logic scheme and logic library files may not be configured with adequate protection, time delays, and/or limits for every application. Carefully review these files and other settings within the IEM-2020 to be certain that they are appropriate for your application.

NOTE
These logic schemes were developed for the initial release of the IEM-2020 and implement a variety of typical pump applications. However, with the addition of the RPM profile features, many of the features in these schemes are now standard functionality. It is anticipated that much simpler logic can now accomplish most of the features that are implemented in the pre-programmed logic schemes.

The following Logic Library Files are available:

- Maintain Speed with Constant Outputs
- Maintain Speed with Pulsed Outputs
- Maintain Pressure with Constant Outputs
- Maintain Pressure with Pulsed Outputs
- Maintain Speed with Time Based Valve Control and Constant Outputs
- Maintain Speed with Time Based Valve Control and Pulsed Outputs
- Maintain Speed with Contact Feedback Valve Control with Constant Outputs
- Maintain Speed with Contact Feedback Valve Control with Pulsed Outputs
- Maintain Pressure with Time Based Valve Control and Constant Outputs
- Maintain Pressure with Time Based Valve Control and Pulsed Outputs
- Maintain Pressure with Contact Feedback Valve Control with Constant Outputs
- Maintain Pressure with Contact Feedback Valve Control with Pulsed Outputs

All of the above logic library files implement the following start and stop characteristics:

- AUTO START – The run session begins when Contact Input 1 is closed and runs until Contact Input 1 is opened. Then a cool down and stop sequence is initiated.
- AUTO STOP – The run session is started when Contact Input 2 is pulsed. The unit will run for the time delay programmed into Logic Timer 1.

- SINGLE FLOAT – The engine runs while the FLOAT switch is closed and begins its cool down and stop sequence when the FLOAT switch opens. This is can be implemented by connecting the FLOAT switch to Contact Input 1.
- TWO FLOAT – The engine starts when a HIGH FLOAT input is closed and runs until a LOW FLOAT switch closes. Then a cool down and stop sequence is initiated. This can be implemented by connecting the HIGH FLOAT to Contact Input 3 and the LOW FLOAT to Contact Input 4.

The operating modes of the logic library files fall into two categories: (1) Maintain speed for applications where it is desired to maintain engine RPM and (2) Maintain pressure where it is necessary to keep pressure within a range defined by a low pressure and high pressure contact input.

Two types of raise and lower contact output characteristics are implemented. (1) Constant on outputs hold the raise or lower contact on continuously when it is desired to apply a raise or lower input to the engine. (2) Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant or lower input is applied. The pulsing effectively implements a lower slew rate. The IEM-2020 can be configured to provide pulsed raise and lower signals. The pulse on and off times are configurable through logic timers.

Two types of valve control are implemented. (1) Time based valve control schemes keep the engine at the desired speed for valve open or close for a user specified time implemented by individual logic timers. (2) Contact feedback based valve control schemes maintain the engine at the desired speed for valve open or close until a contact input indicates an open or closed valve.

Logic library files can be loaded into BESTCOMS*Plus*® memory by selecting *View Device's Logic Library Files* from the *Logic Library* drop-down menu in BESTLogic*Plus*. See Figure B-1.

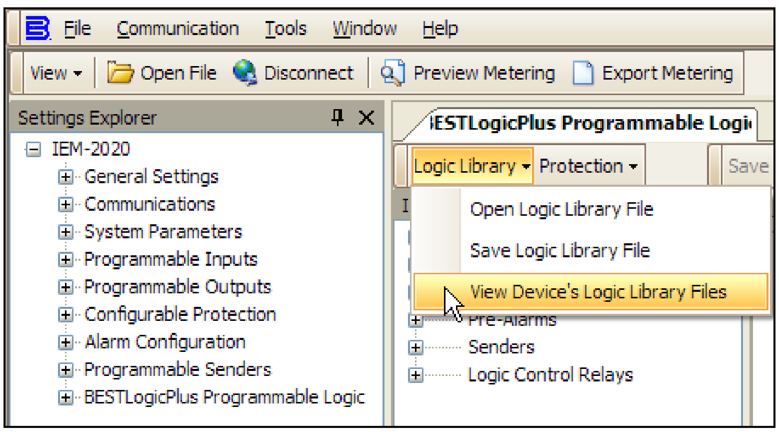


Figure B-1. View Device's Logic Library Files

Details of Logic Library Files

Each logic library file is described in detail in the following paragraphs. Engine start and stop are implemented according to the preceding paragraphs that describe the start and stop characteristics for all schemes.

Default Settings and Logic

Default IEM-2020 logic provides annunciation of alarm, pre-alarm, and not in auto indications. An audible horn can be connected to Output 1 to allow the horn to sound continuously for alarm or not in auto indication, and beep in an alternating on- off pattern for pre-Alarm indication. Output 2 is closed when the unit is not in the AUTO mode. Output 3 is closed when any alarm is in effect and Output 4 is closed when any pre-alarm is in effect.

Maintain Speed with Constant Contact Outputs (Logic Library File #1)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
3. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.

4. Logic Timer 3 specifies the duration of engine warm up in Step 3.
5. Configurable Protection Element 1, Threshold 2 specifies the upper speed limit that the engine should maintain at during normal operation.
6. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
7. Logic Timer 4 specifies the duration of engine cool down in Step 6.

After cooldown, the machine shuts down and remains ready to be activated the next time it receives a start indication.

Refer to Figures B-2 and B-3 for main logic diagrams of Logic Library File #1.

INPUT 1 PUMP ON - RUN PUMP WHILE INPUT IS ON. PUMP RUNS UNTIL THE INPUT IS OFF.

INPUT 2 START TIMED RUN - PULSE INPUT 2 TO START A TIMED RUN SESSION.
THE TIME IS SET BY LOGIC TIMER 1

INPUT 3 - HIGH FLOAT FOR TWO FLOAT APPLICATIONS. INPUT 3 STARTS PUMP

INPUT 4 - LOW FLOAT FOR TWO FLOAT APPLICATIONS. INPUT4 STOPS PUMP THAT
WAS STARTED BY INPUT 3.

SINGLE FLOAT APPLICATIONS SHOULD USE INPUT 1 CONTROLLED BY FLOAT CONTACTS.
WHEN THE CONTACTS ARE CLOSED THE PUMP RUNS. IT RUNS UNTIL THE CONTACTS
ARE OPENED.

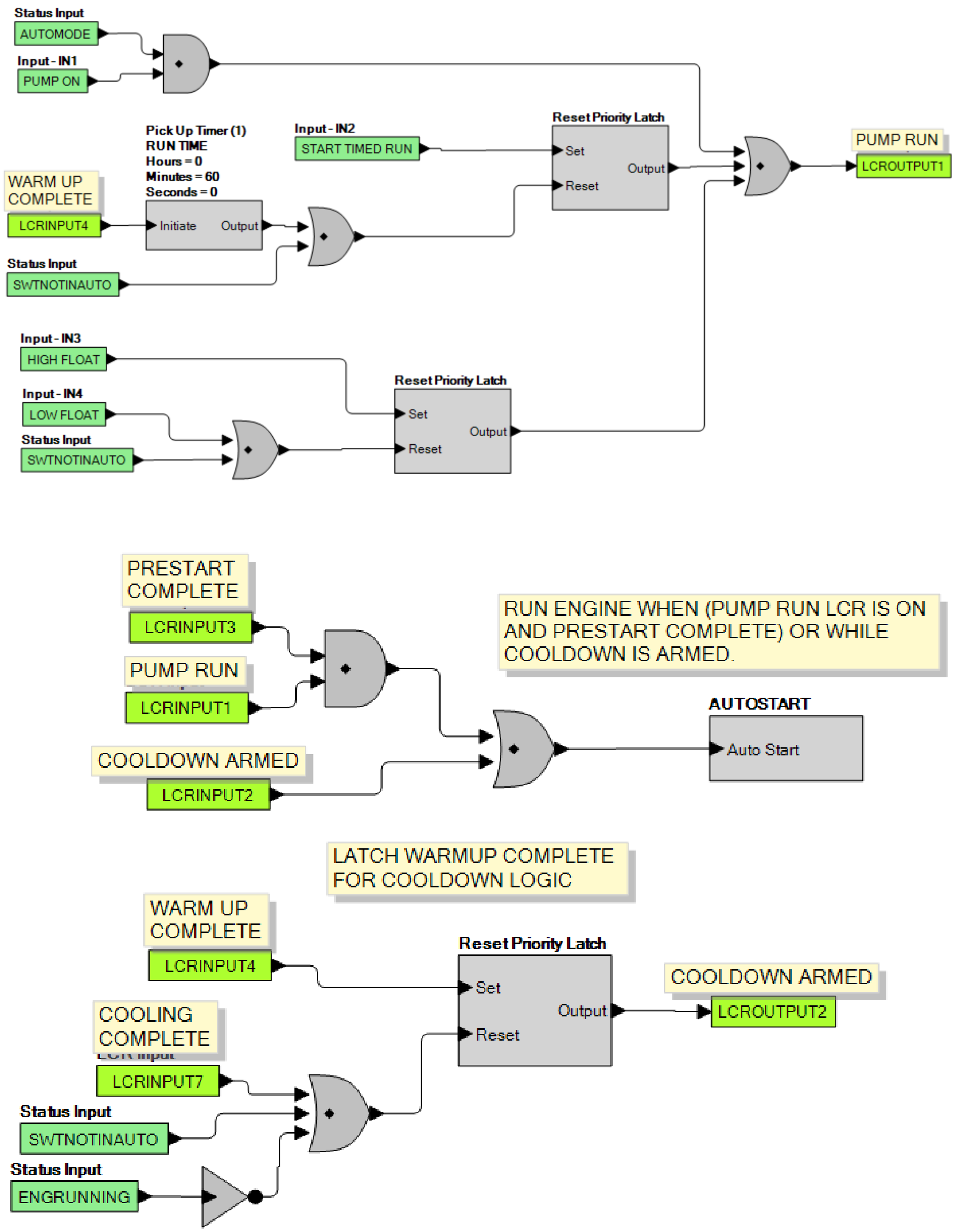


Figure B-2. Logic Library File #1 Main Logic (1 of 2)

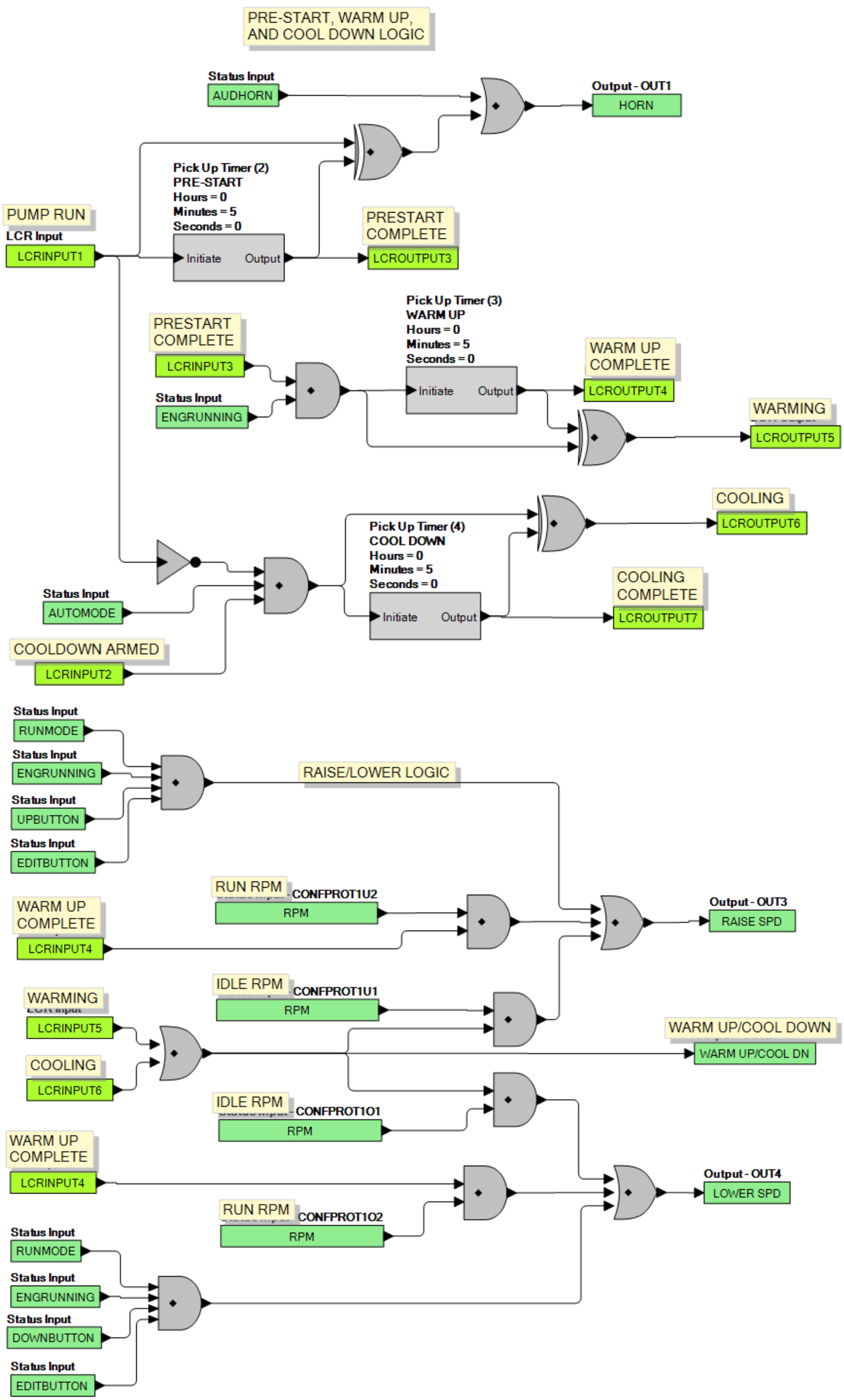


Figure B-3. Logic Library File #1 Main Logic (2 of 2)

Maintain Speed with Pulsed Contact Outputs (Logic Library File #2)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timers 5 and 6 specify the on and off times for the raise and lower outputs. Raise and Lower outputs are pulsed in this scheme. Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant raise or lower input is applied. The pulsing effectively implements a lower slew rate.
3. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
4. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
5. Logic Timer 3 specifies the duration of engine warm up in Step 3.
6. Configurable Protection Element 1, Threshold 2 specifies the upper speed limit that the engine should maintain during normal operation.
7. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
8. Logic Timer 4 specifies the duration of engine cool down in Step 7.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-4 through B-6 for main logic diagrams of Logic Library File #2.

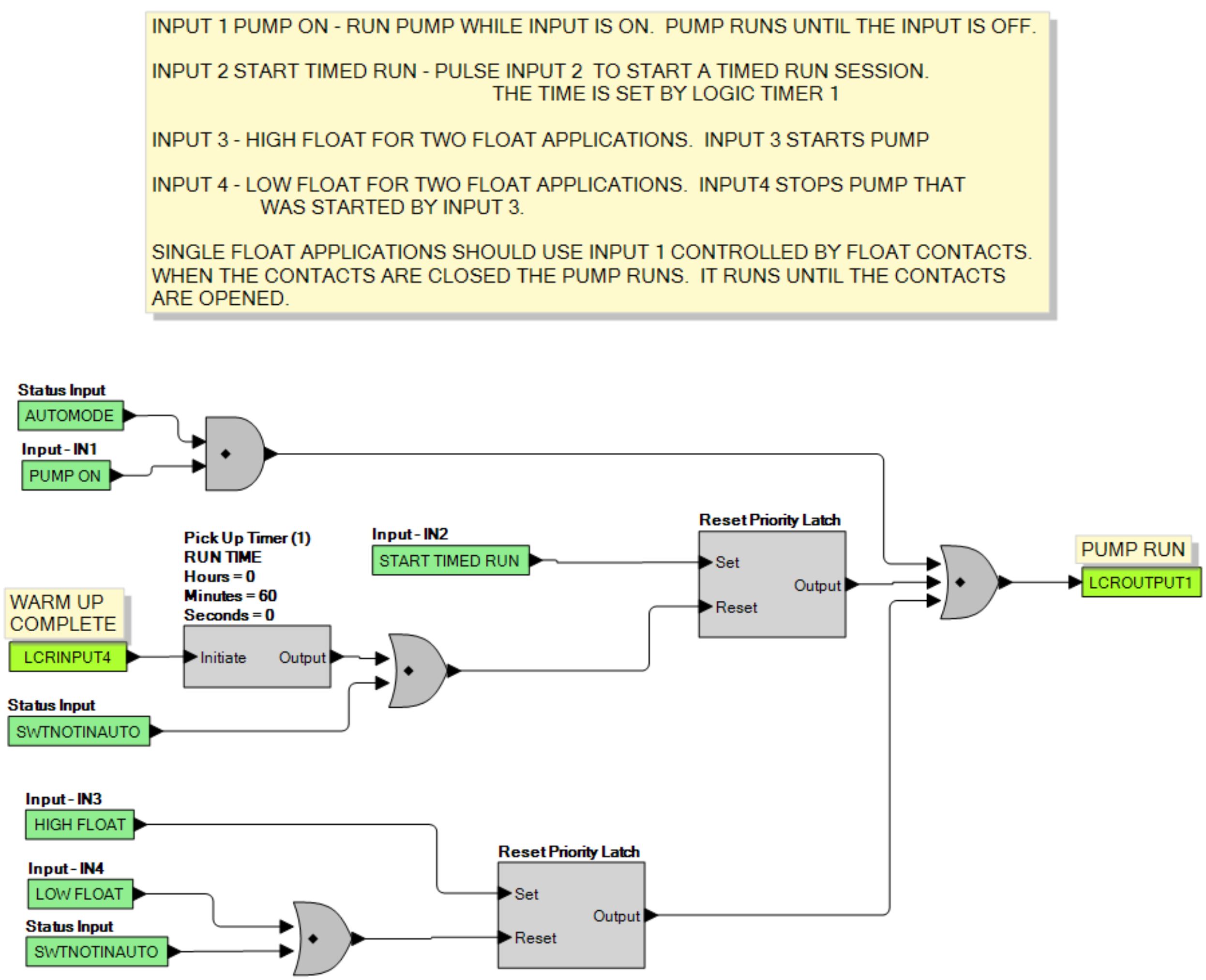


Figure B-4. Logic Library File #2 Main Logic (1 of 3)

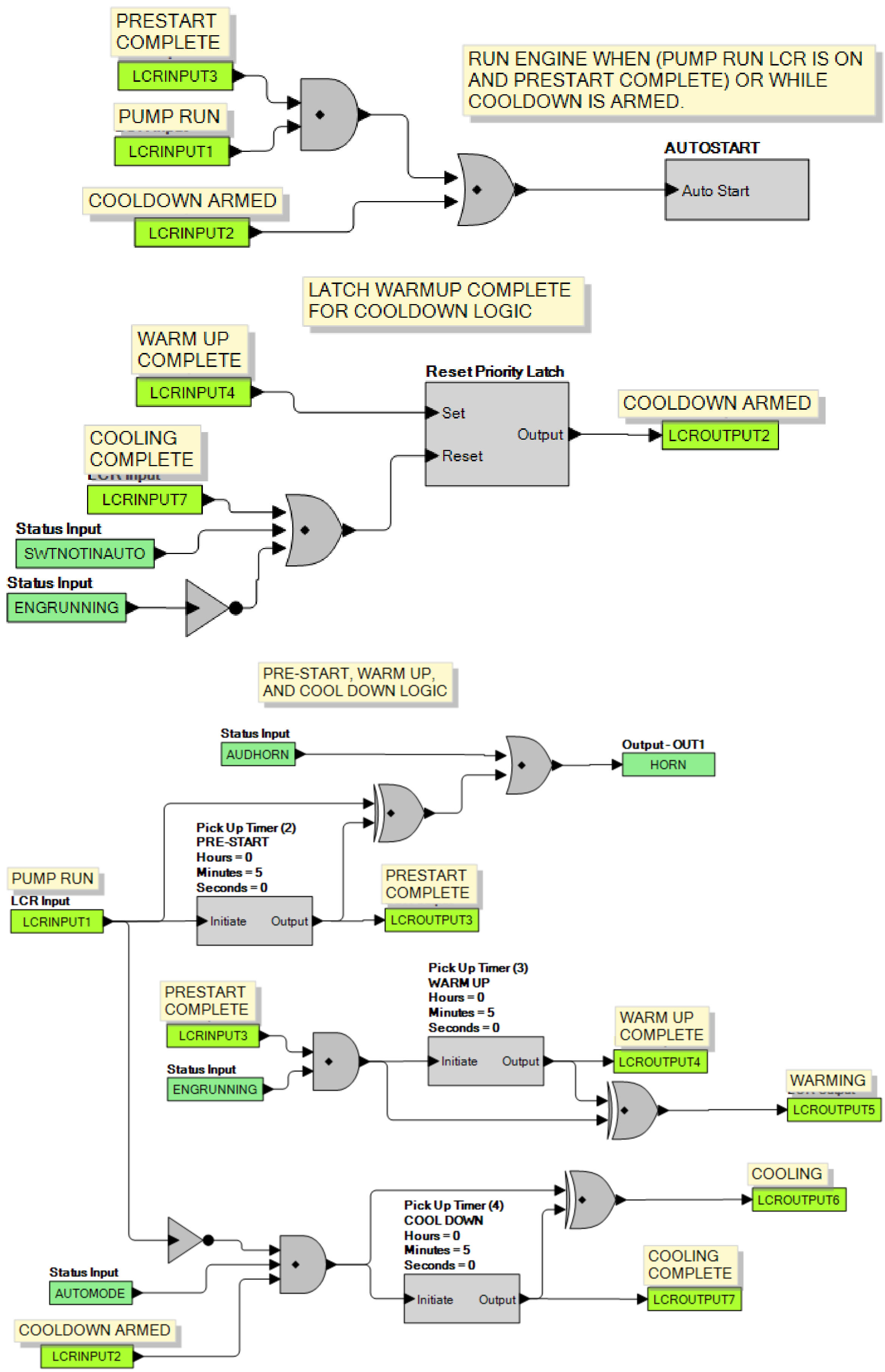


Figure B-5. Logic Library File #2 Main Logic (2 of 3)

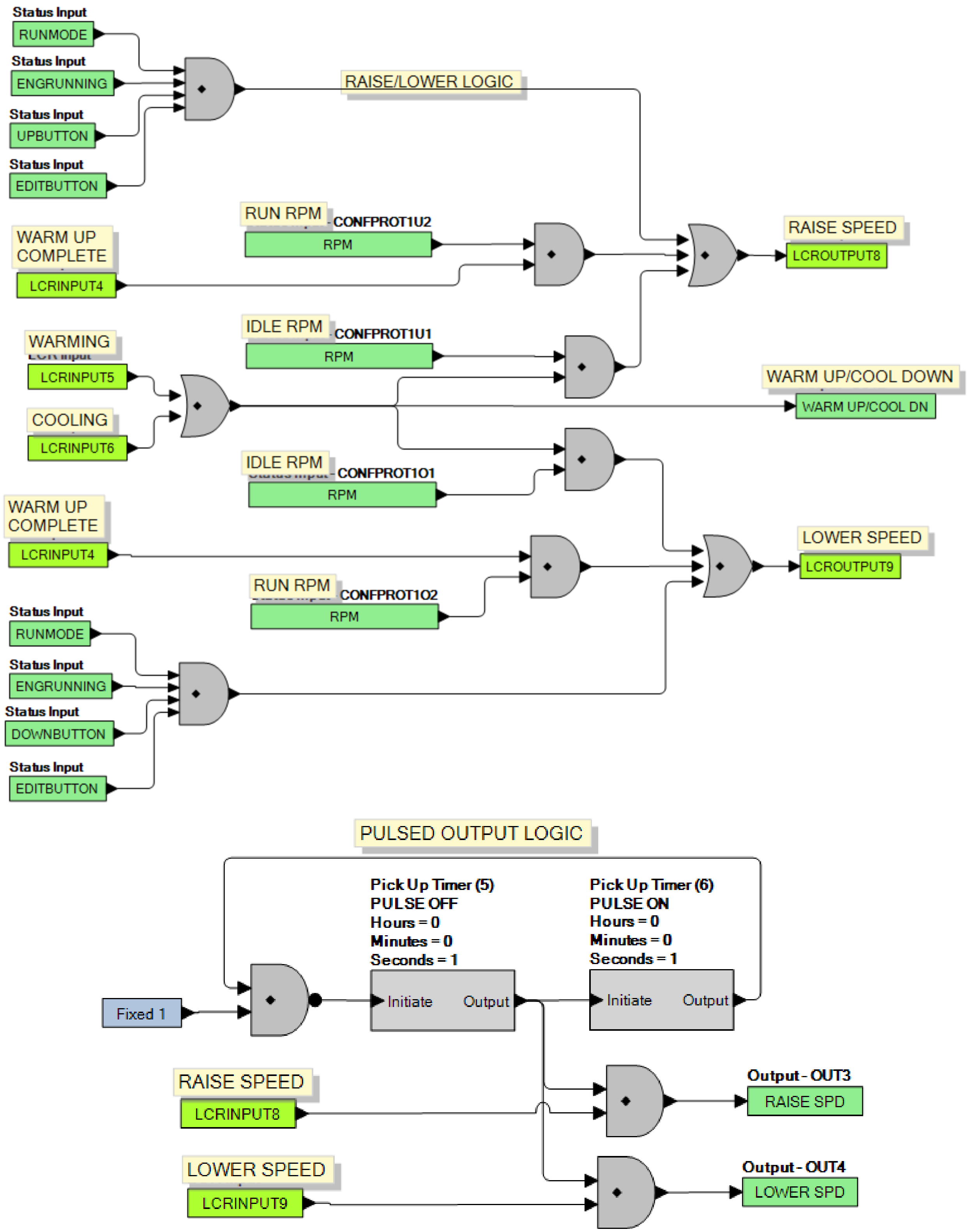


Figure B-6. Logic Library File #2 Main Logic (3 of 3)

Maintain Pressure with Constant Outputs (Logic Library File #3)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
3. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
4. Logic Timer 3 specifies the duration of engine warm up in Step 3.
5. Contact Input 5 (Low Pressure Input) and Contact Input 6 (High Pressure Input) specify the pressure limits that the engine should maintain during normal operation.
6. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
7. Logic Timer 4 specifies the duration of engine cool down in Step 6.

After cooldown, the machine shuts down and remains ready to be activated the next time it receives a start indication.

Refer to Figures B-7 through B-9.

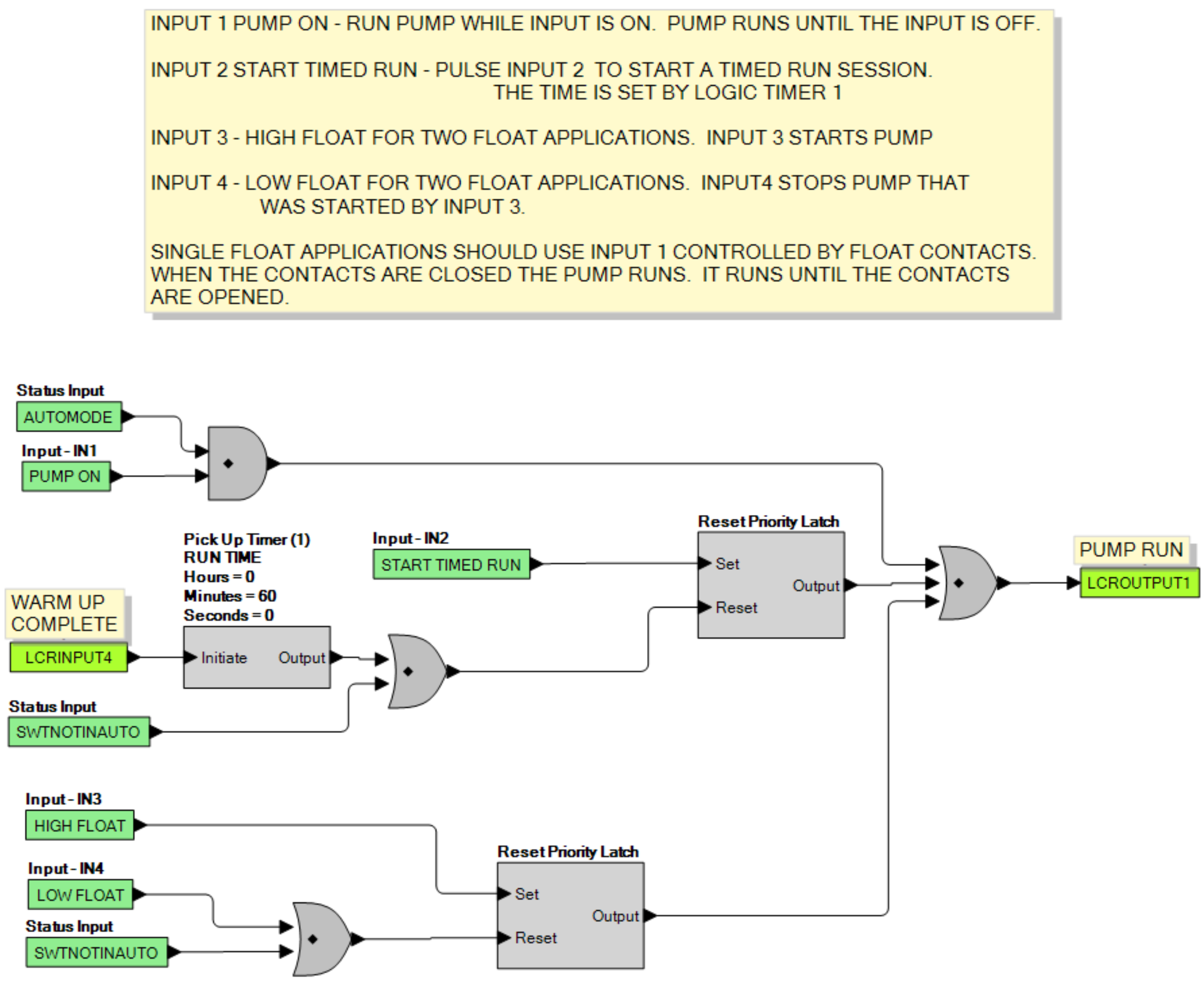


Figure B-7. Logic Library File #3 Main Logic (1 of 3)

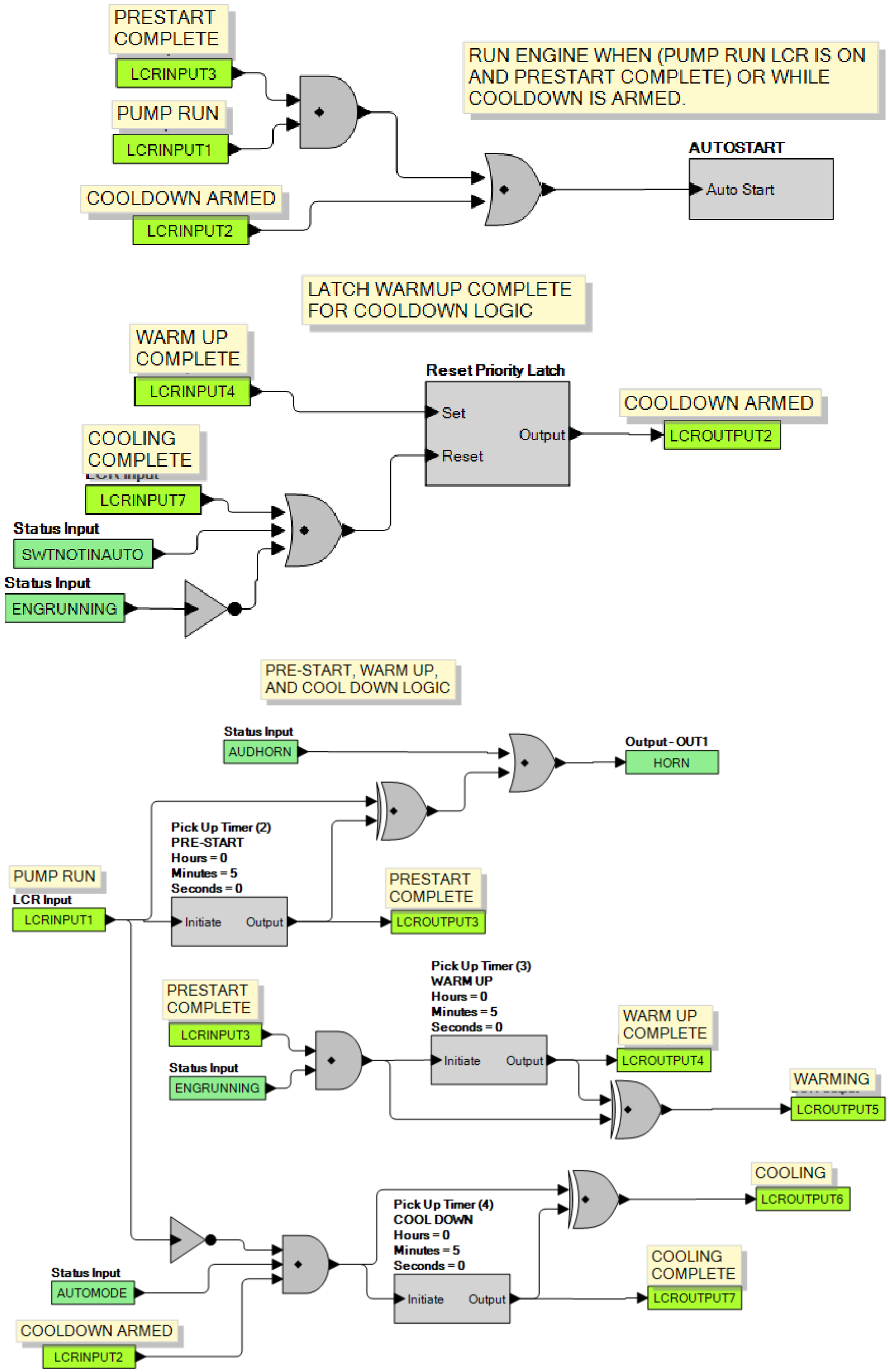


Figure B-8. Logic Library File #3 Main Logic (2 of 3)

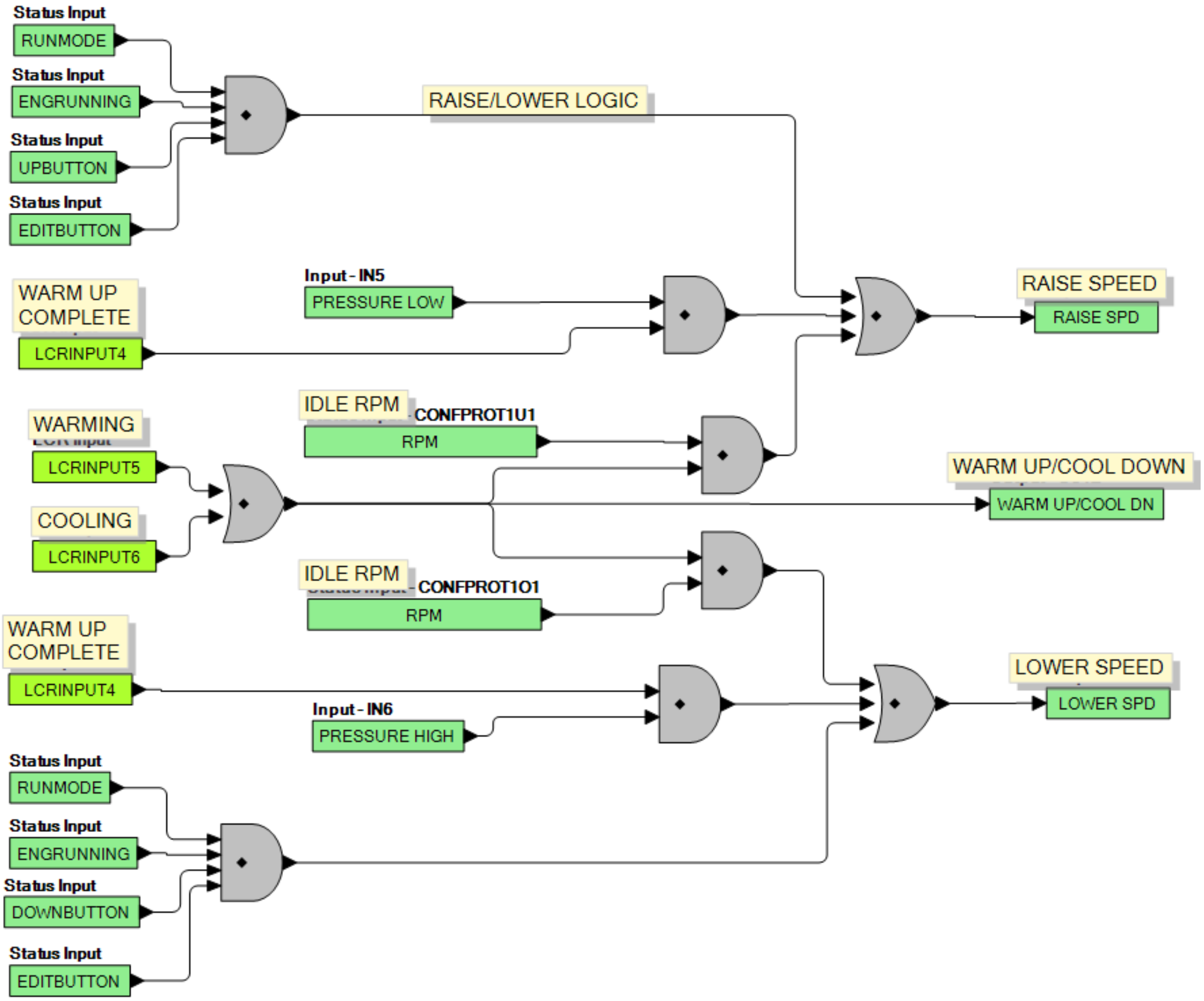


Figure B-9. Logic Library File #3 Main Logic (3 of 3)

Maintain Pressure with Pulsed Outputs (Logic Library File #4)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timers 5 and 6 specify the on and off times for the raise and lower outputs. Raise and Lower outputs are pulsed in this scheme. Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant raise or lower input is applied. The pulsing effectively implements a lower slew rate.
3. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
4. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
5. Logic Timer 3 specifies the duration of engine warm up in Step 4.
6. Contact Input 5 (Low Pressure Input) and Contact Input 6 (High Pressure Input) specify the pressure limits that the engine should maintain during normal operation.
7. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
8. Logic Timer 4 specifies the duration of engine cool down in Step 7.

After cooldown, the machine shuts down and remains ready to be activated the next time it receives a start indication.

Refer to Figures B-10 through B-12 for main logic diagrams of Logic Library File #4.

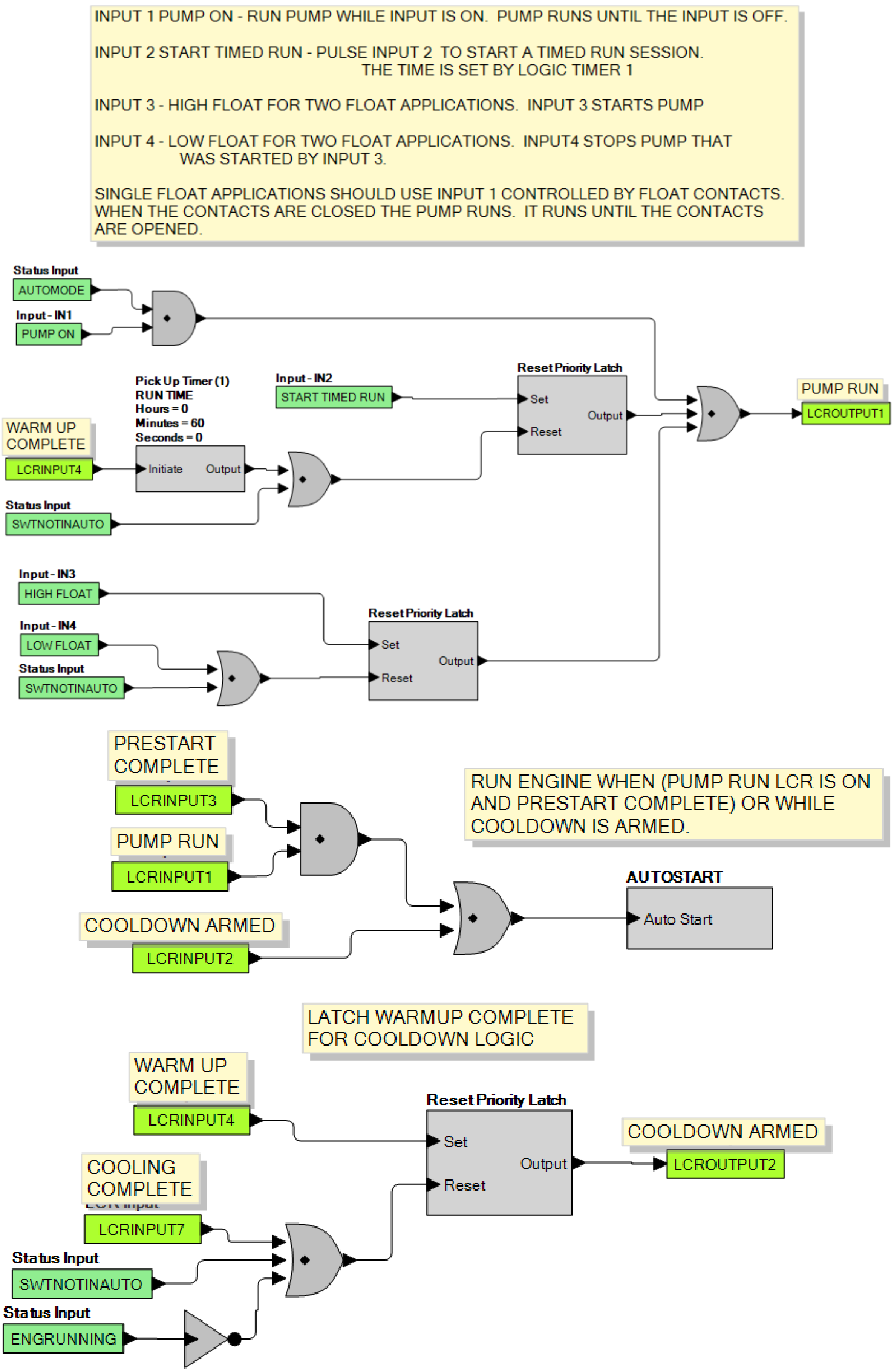


Figure B-10. Logic Library File #4 Main Logic (1 of 3)

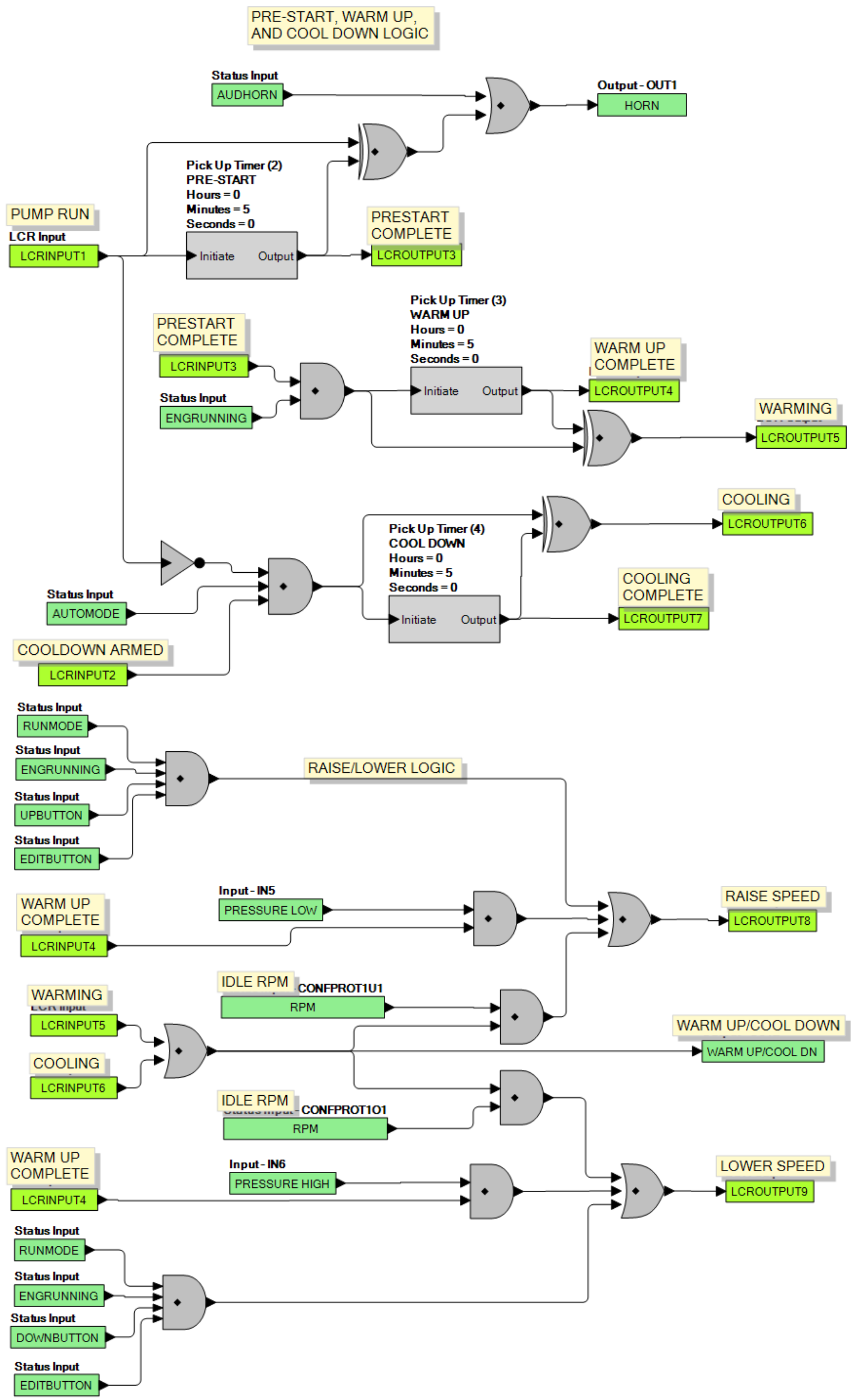


Figure B-11. Logic Library File #4 Main Logic (2 of 3)

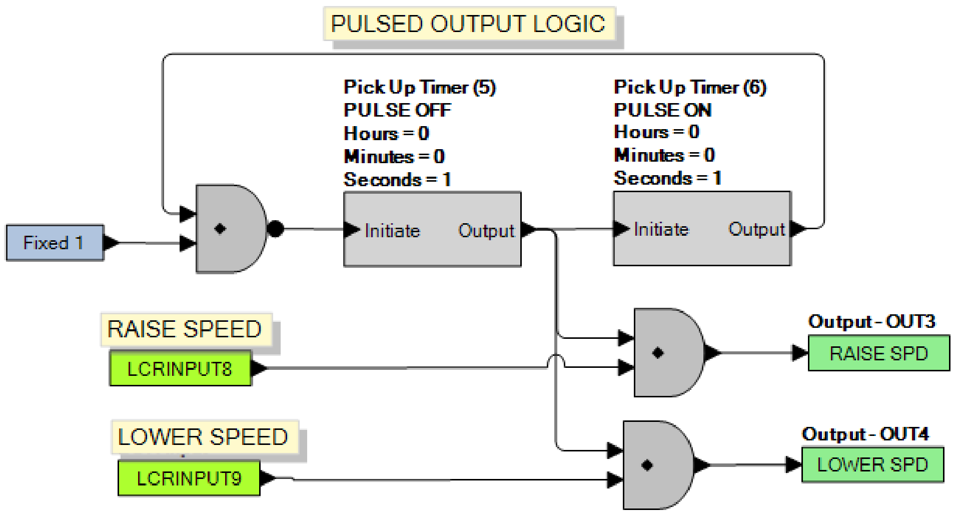


Figure B-12. Logic Library File #4 Main Logic (3 of 3)

Maintain Speed with Time Based Valve Control and Constant Outputs (Logic Library File #5)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
3. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
4. Logic Timer 3 specifies the duration of engine warm up in Step 3.
5. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed.
6. Logic Timer 5 specifies the duration of the valve closing process in Step 5.
7. Configurable Protection Element 1, Threshold 2 specifies the upper speed limit that the engine should maintain during normal operation.
8. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run.
9. Logic Timer 6 specifies the duration of the valve opening process in Step 8.
10. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
11. Logic Timer 4 specifies the duration of engine cool down in Step 10.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-13 through B-15 for main logic diagrams of Logic Library File #5.

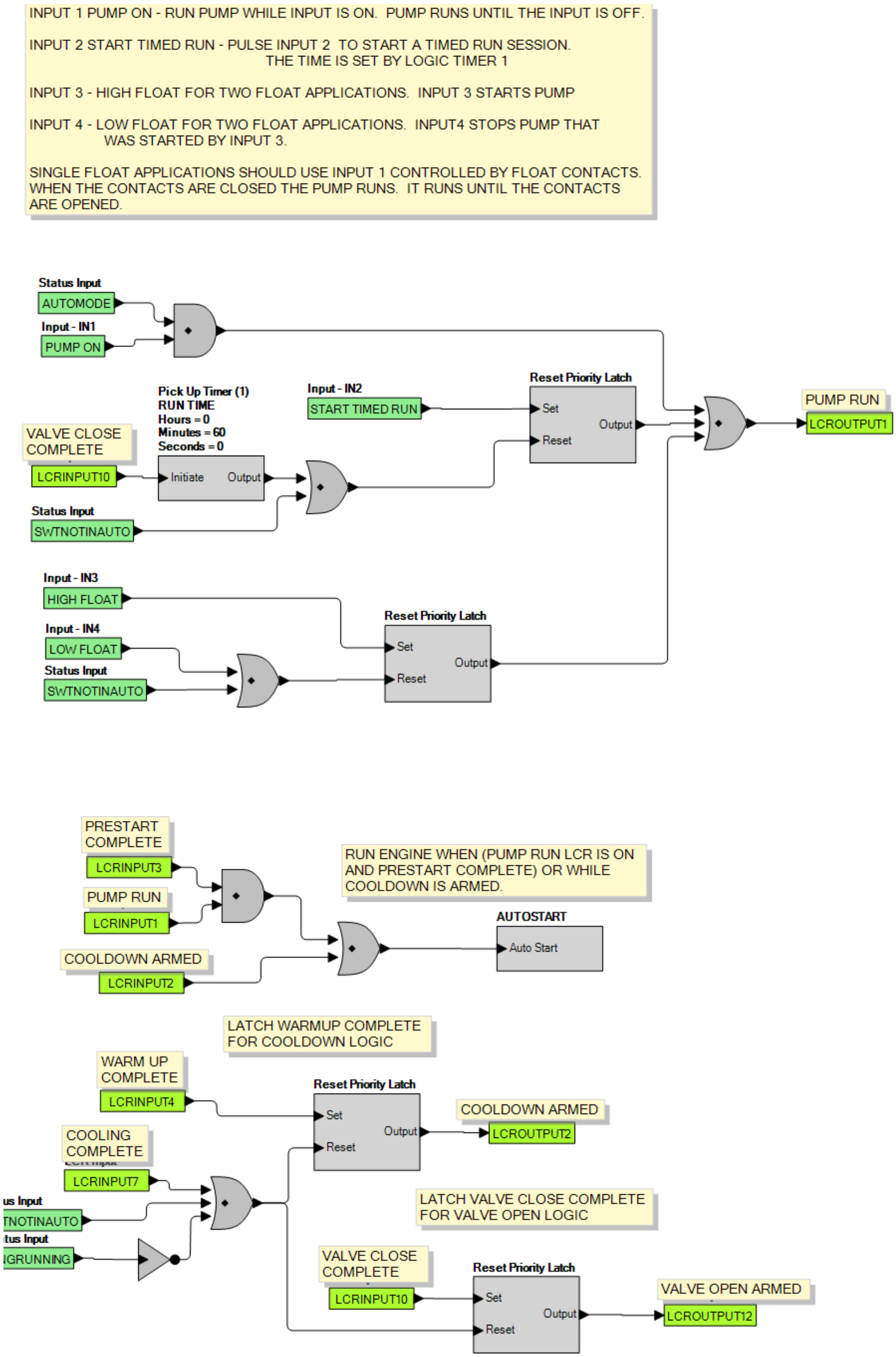


Figure B-13. Logic Library File #5 Main Logic (1 of 3)

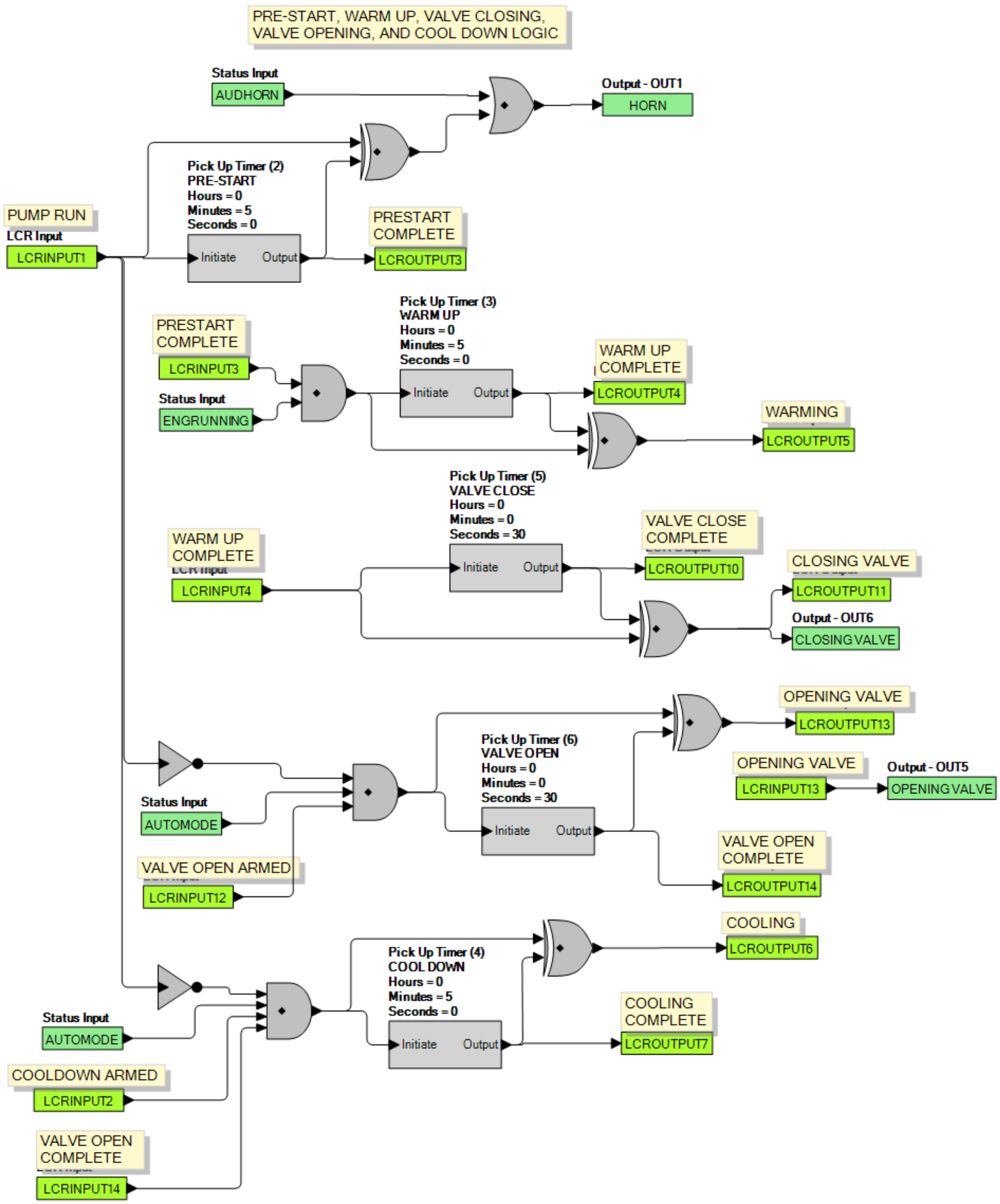


Figure B-14. Logic Library File #5 Main Logic (2 of 3)

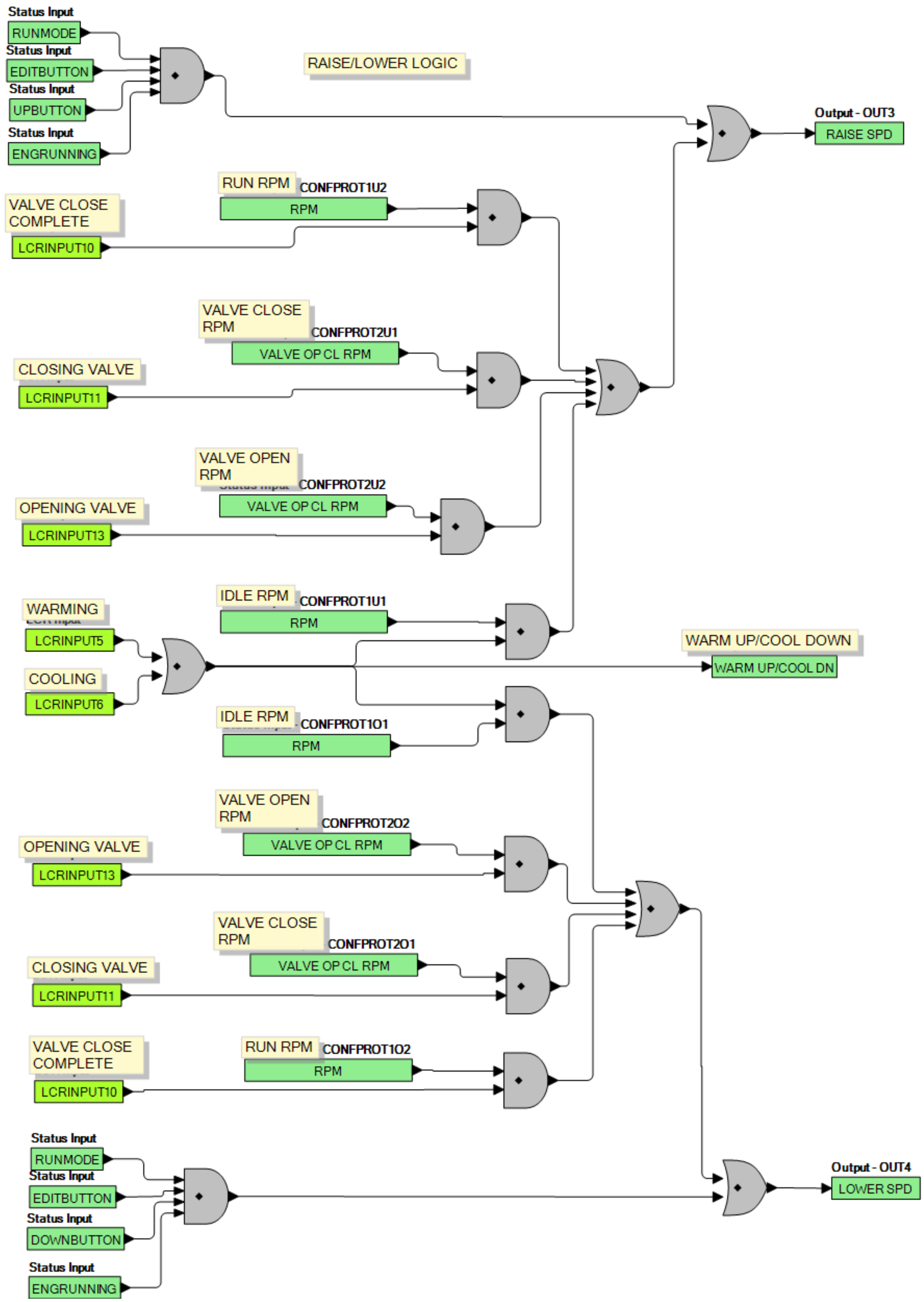


Figure B-15. Logic Library File #5 Main Logic (3 of 3)

Maintain Speed with Time Based Valve Control and Pulsed Outputs (Logic Library File #6)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timers 7 and 8 specify the on and off times for the raise and lower outputs. Raise and Lower outputs are pulsed in this scheme. Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant raise or lower input is applied. The pulsing effectively implements a lower slew rate.
3. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
4. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
5. Logic Timer 3 specifies the duration of engine warm up in Step 4.
6. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed.
7. Logic Timer 5 specifies the duration of the valve closing process in Step 6.
8. Configurable Protection Element 1, Threshold 2 specifies the upper speed limit that the engine should maintain during normal operation.
9. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run.
10. Logic Timer 6 specifies the duration of the valve opening process in Step 9.
11. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
12. Logic Timer 4 specifies the duration of engine cool down in Step 11.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-16 through B-18 for main logic diagrams of Logic Library File #6.

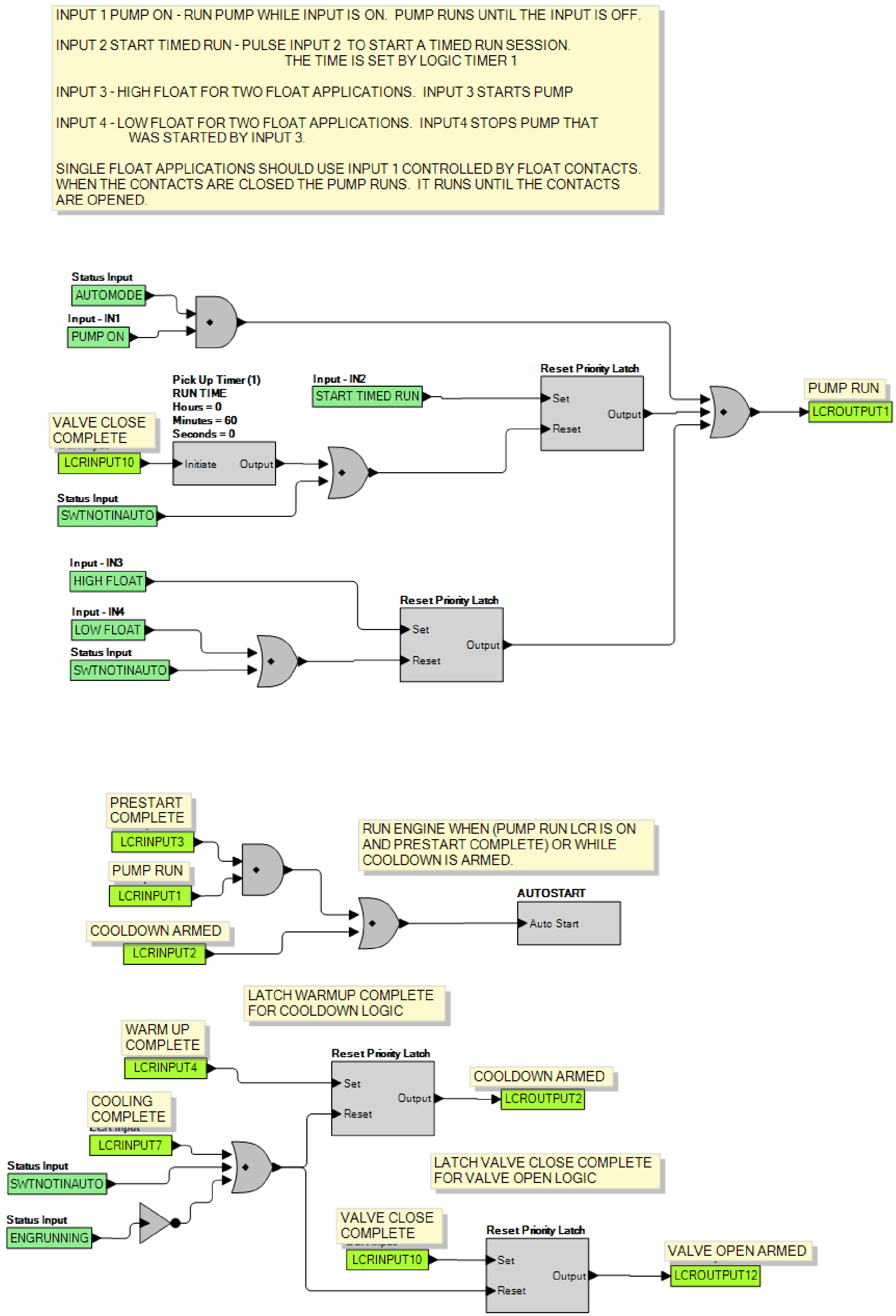


Figure B-16. Logic Library File #6 Main Logic (1 of 3)

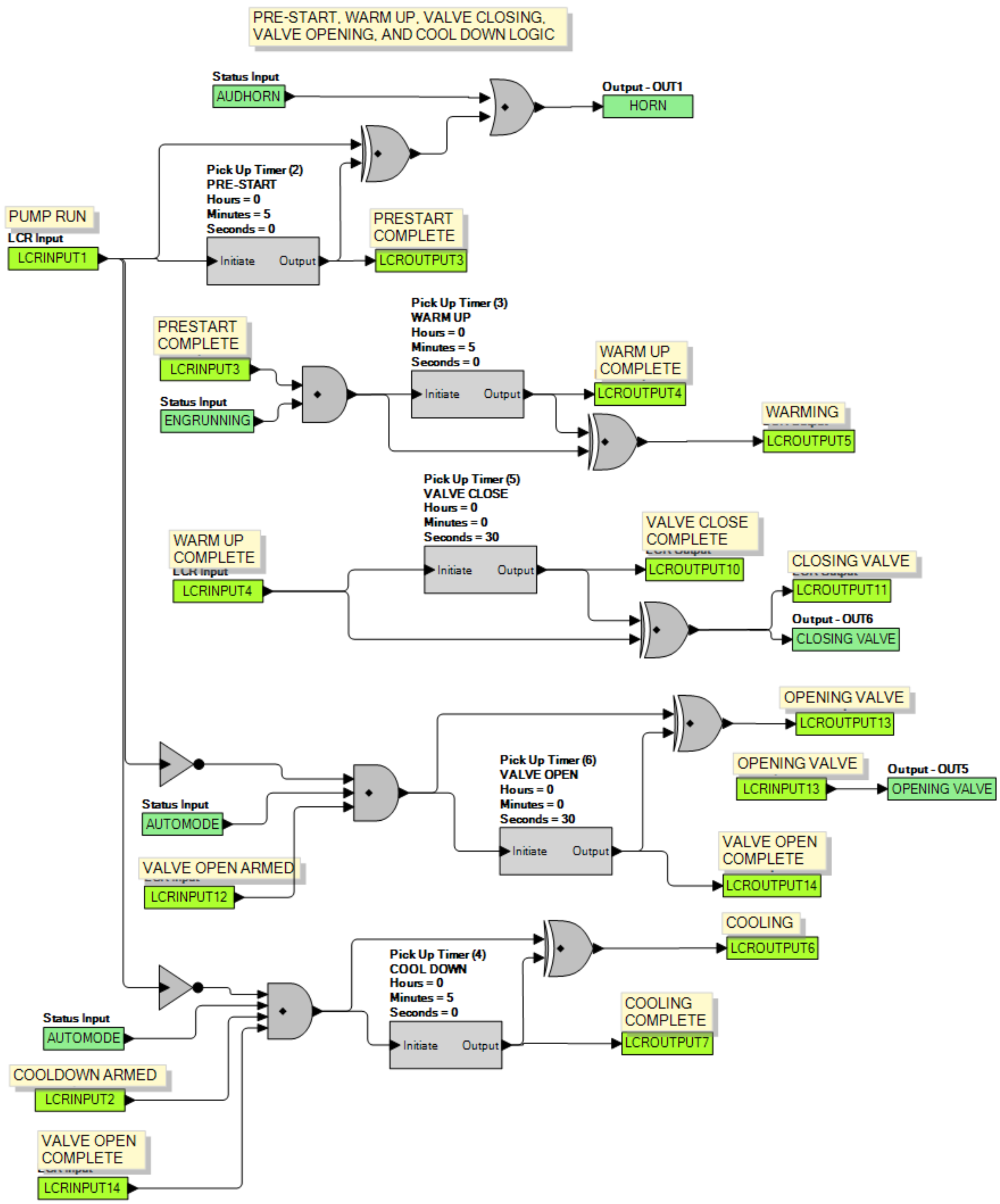


Figure B-17. Logic Library File #6 Main Logic (2 of 3)

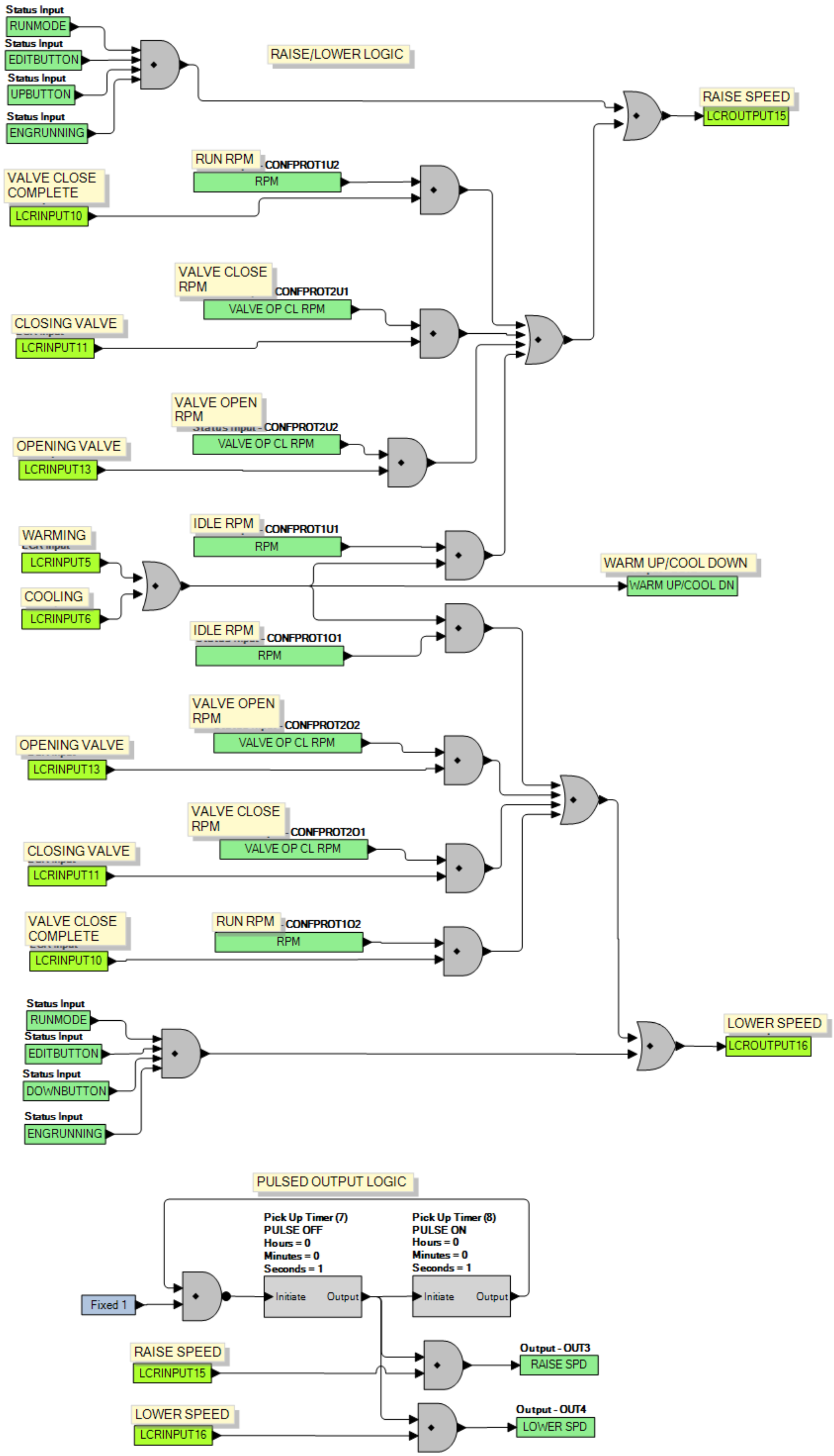


Figure B-18. Logic Library File #6 Main Logic (3 of 3)

Maintain Speed with Contact Feedback Valve Control with Constant Outputs (Logic Library File #7)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
3. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
4. Logic Timer 3 specifies the duration of engine warm up in Step 3.
5. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed. The machine remains in this state until it receives a closure on Contact Input 5 indicating a closed valve.
6. Configurable Protection Element 1, Threshold 2 specifies the upper speed limit that the engine should maintain during normal operation.
7. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run. The machine remains in this state until it receives a closure on Contact Input 6 indicating an open valve.
8. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
9. Logic Timer 4 specifies the duration of engine cool down in Step 8.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-19 through B-21 for main logic diagrams of Logic Library File #7.

INPUT 1 PUMP ON - RUN PUMP WHILE INPUT IS ON. PUMP RUNS UNTIL THE INPUT IS OFF.

INPUT 2 START TIMED RUN - PULSE INPUT 2 TO START A TIMED RUN SESSION.
THE TIME IS SET BY LOGIC TIMER 1

INPUT 3 - HIGH FLOAT FOR TWO FLOAT APPLICATIONS. INPUT 3 STARTS PUMP

INPUT 4 - LOW FLOAT FOR TWO FLOAT APPLICATIONS. INPUT4 STOPS PUMP THAT
WAS STARTED BY INPUT 3.

SINGLE FLOAT APPLICATIONS SHOULD USE INPUT 1 CONTROLLED BY FLOAT CONTACTS. WHEN THE CONTACTS ARE CLOSED THE PUMP RUNS. IT RUNS UNTIL THE CONTACTS ARE OPENED.

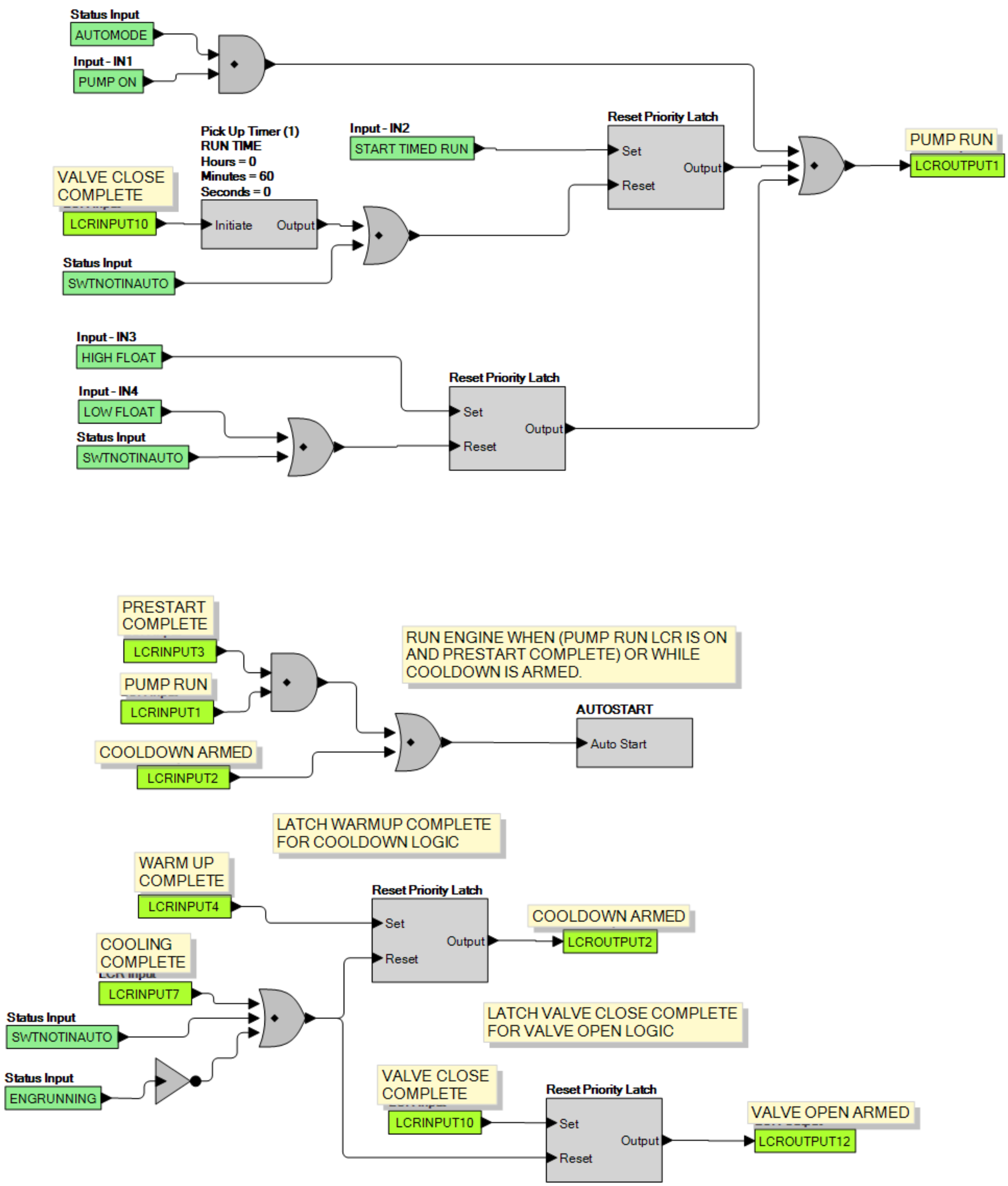


Figure B-19. Logic Library File #7 Main Logic (1 of 3)

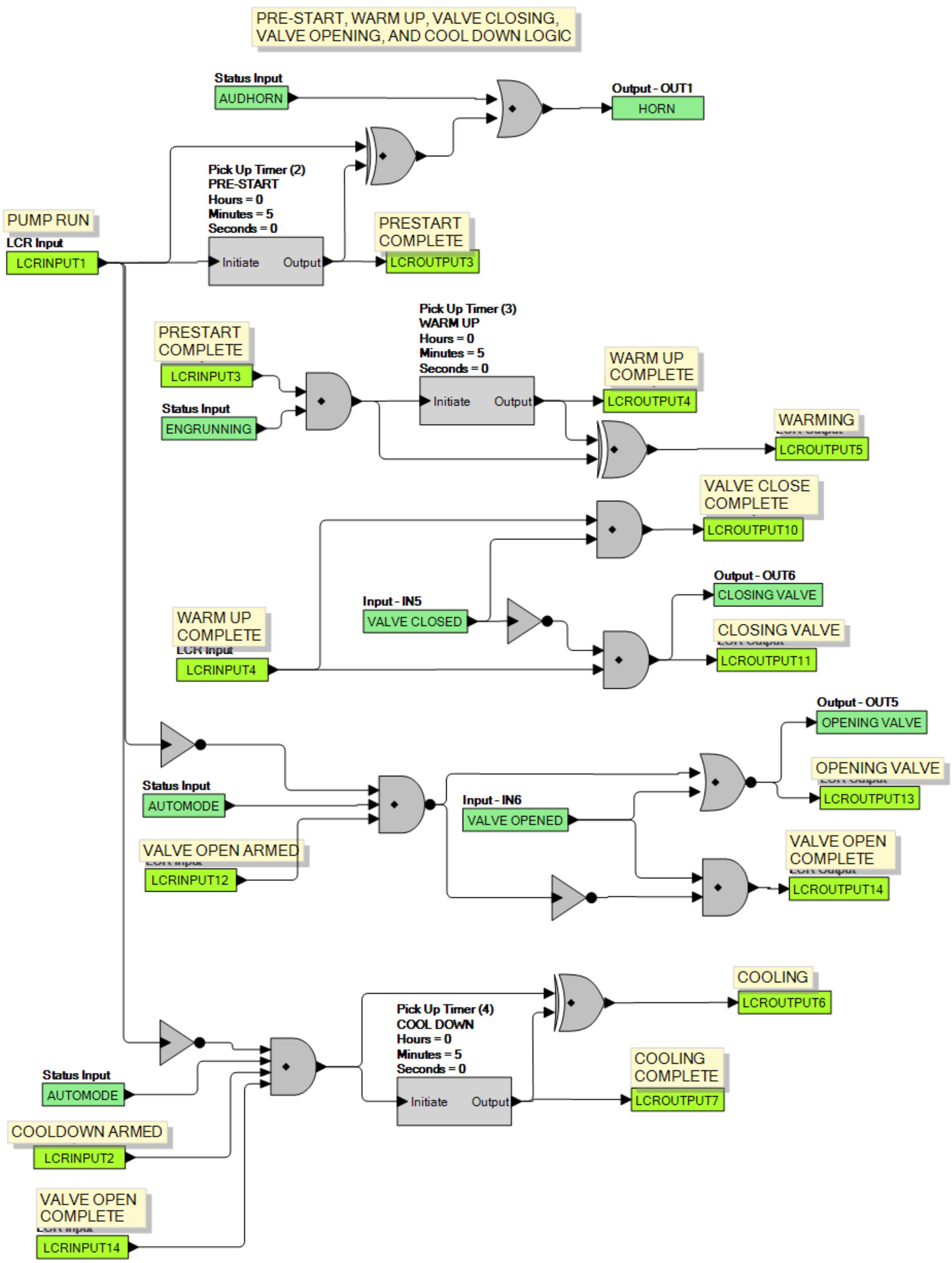


Figure B-20. Logic Library File #7 Main Logic (2 of 3)

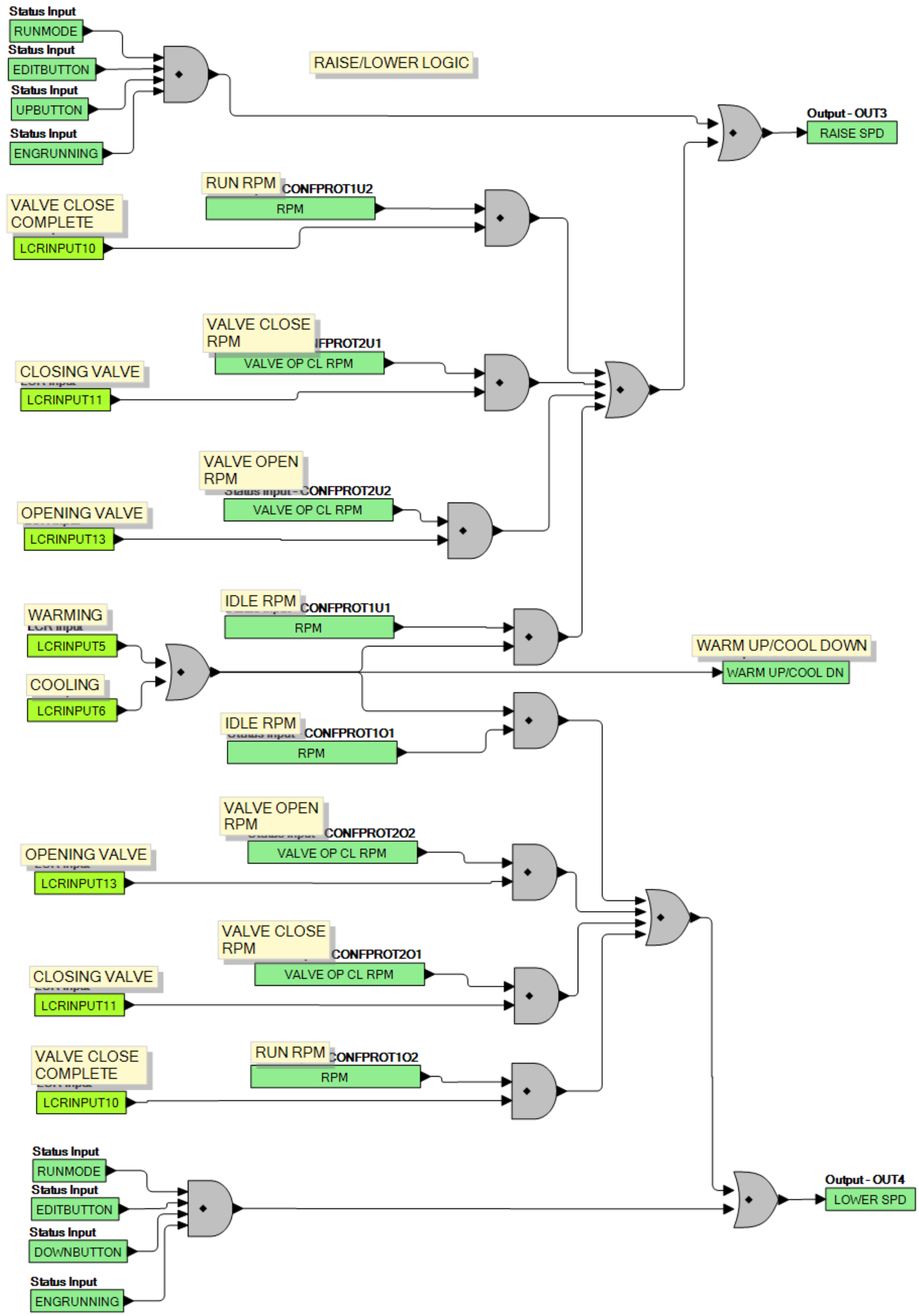


Figure B-21. Logic Library File #7 Main Logic (3 of 3)

Maintain Speed with Contact Feedback Valve Control with Pulsed Outputs (Logic Library File #8)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timers 5 and 6 specify the on and off times for the raise and lower outputs. Raise and Lower outputs are pulsed in this scheme. Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant raise or lower input is applied. The pulsing effectively implements a lower slew rate.
3. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
4. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
5. Logic Timer 3 specifies the duration of engine warm up in Step 4.
6. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed. The machine remains in this state until it receives a closure on Contact Input 5 indicating a closed valve.
7. Configurable Protection Element 1, Threshold 2 specifies the upper speed limit that the engine should maintain during normal operation.
8. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run. The machine remains in this state until it receives a closure on Contact Input 6 indicating an open valve.
9. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
10. Logic Timer 4 specifies the duration of engine cool down in Step 9.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-22 through B-24 for main logic diagrams of Logic Library File #8.

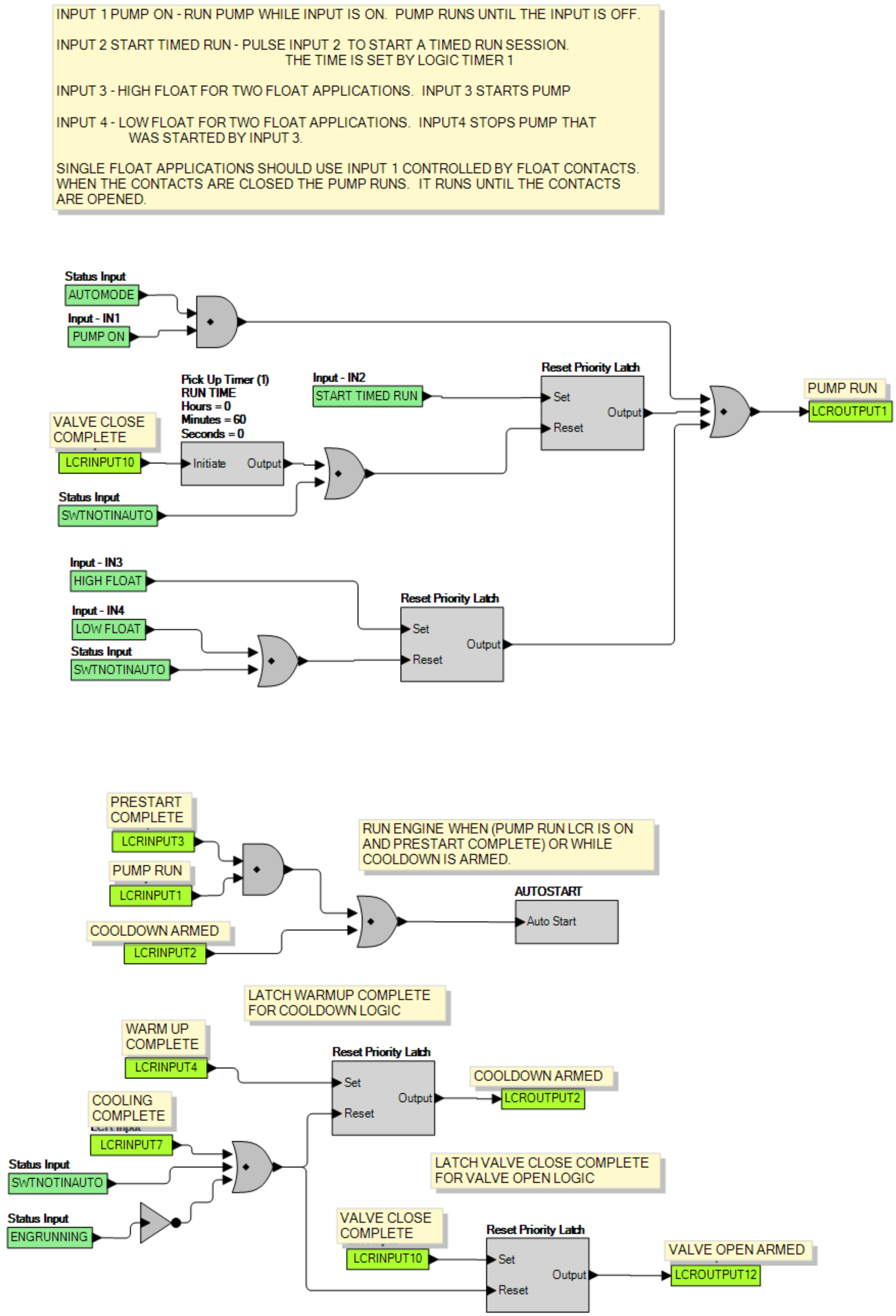


Figure B-22. Logic Library File #8 Main Logic (1 of 3)

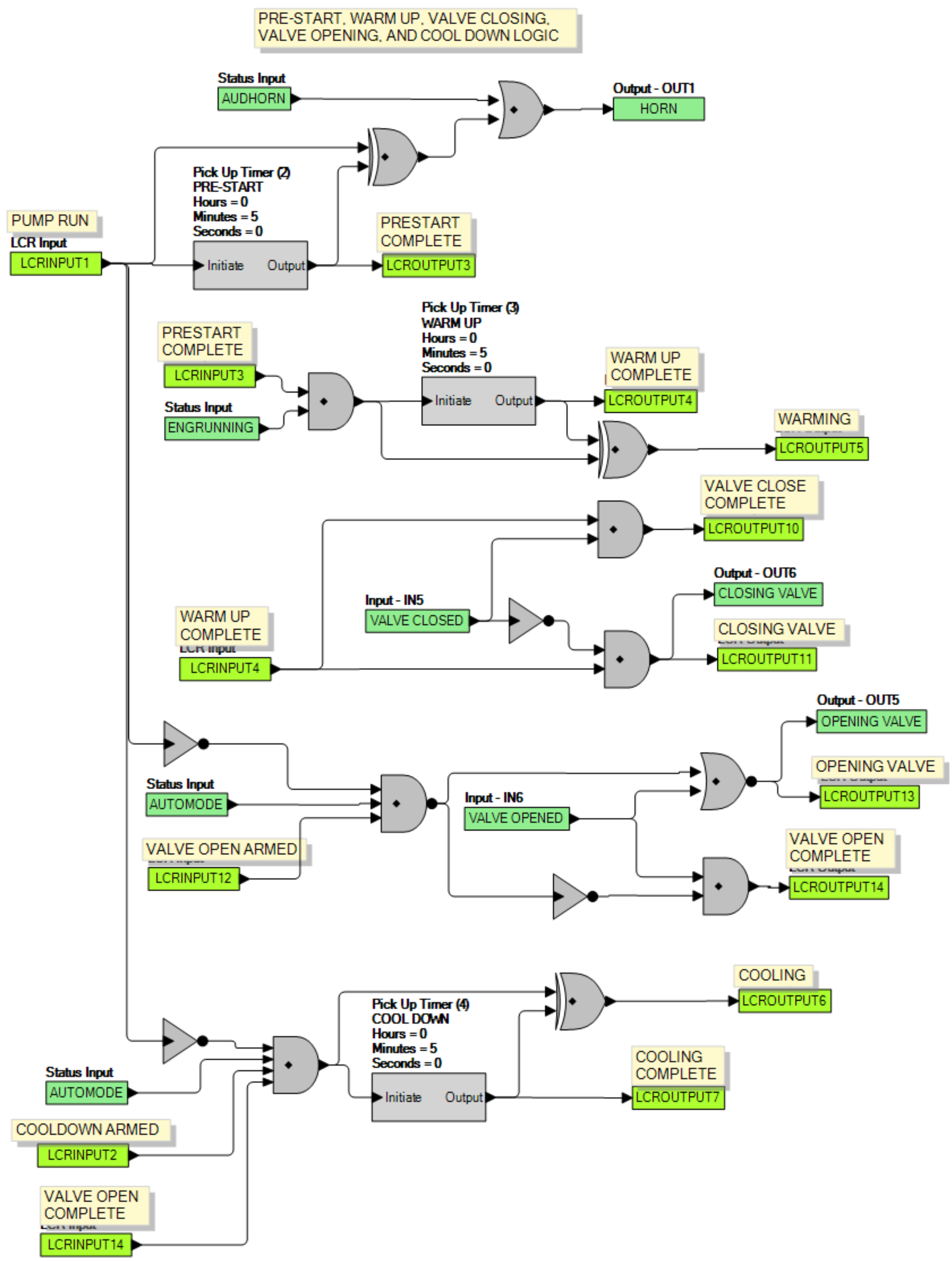


Figure B-23. Logic Library File #8 Main Logic (2 of 3)

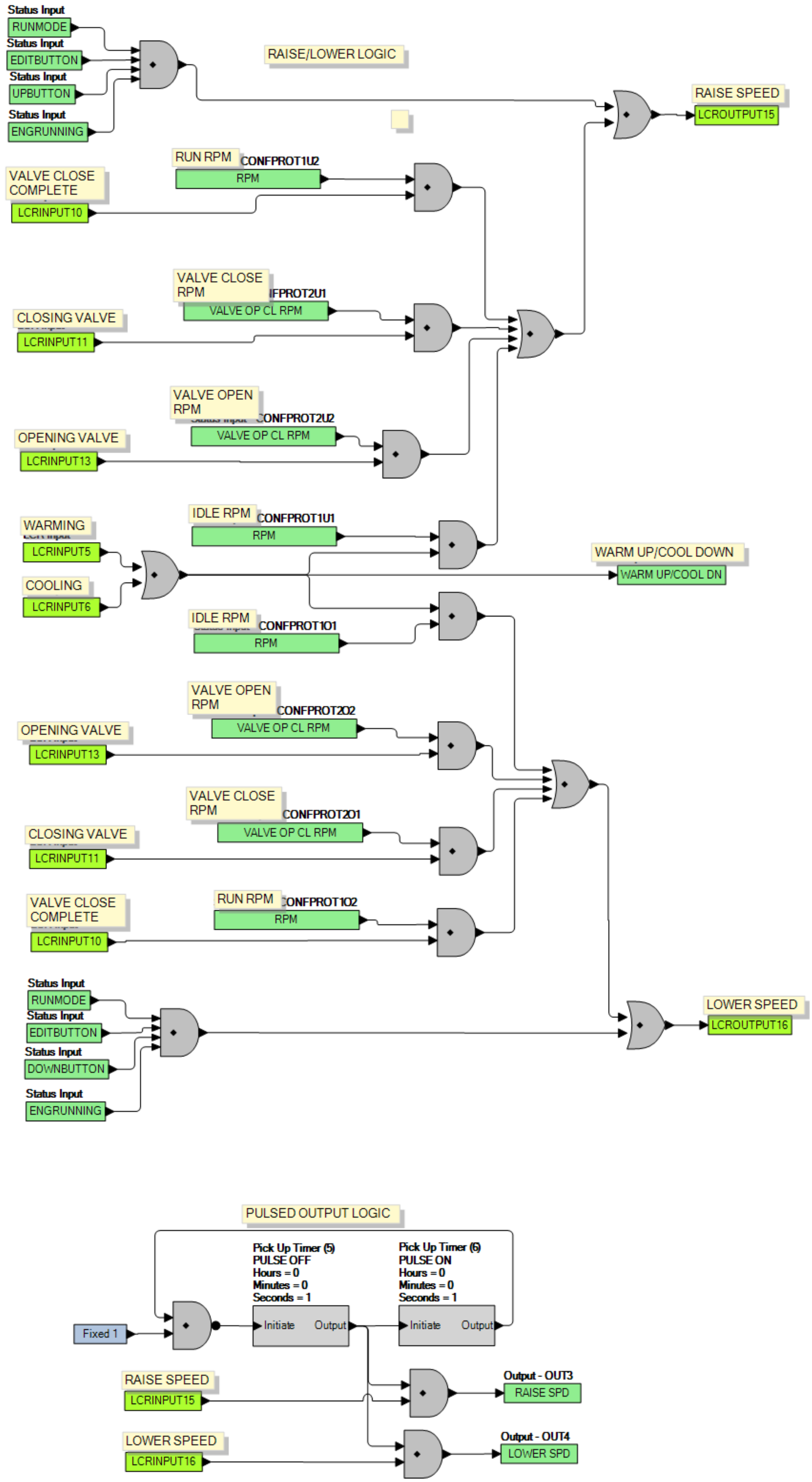


Figure B-24. Logic Library File #8 Main Logic (3 of 3)

Maintain Pressure with Time Based Valve Control and Constant Outputs (Logic Library File #9)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
3. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
4. Logic Timer 3 specifies the duration of engine warm up in Step 3.
5. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed.
6. Logic Timer 5 specifies the duration of the valve closing process in Step 5.
7. Contact Input 5 (Low Pressure Input) and Contact Input 6 (High Pressure Input) specify the upper and lower limits that the engine should stay between during normal operation.
8. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run.
9. Logic Timer 6 specifies the duration of the valve opening process in Step 8.
10. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
11. Logic Timer 4 specifies the duration of engine cool down in Step 10.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-25 through B-27 for main logic diagrams of Logic Library File #9.

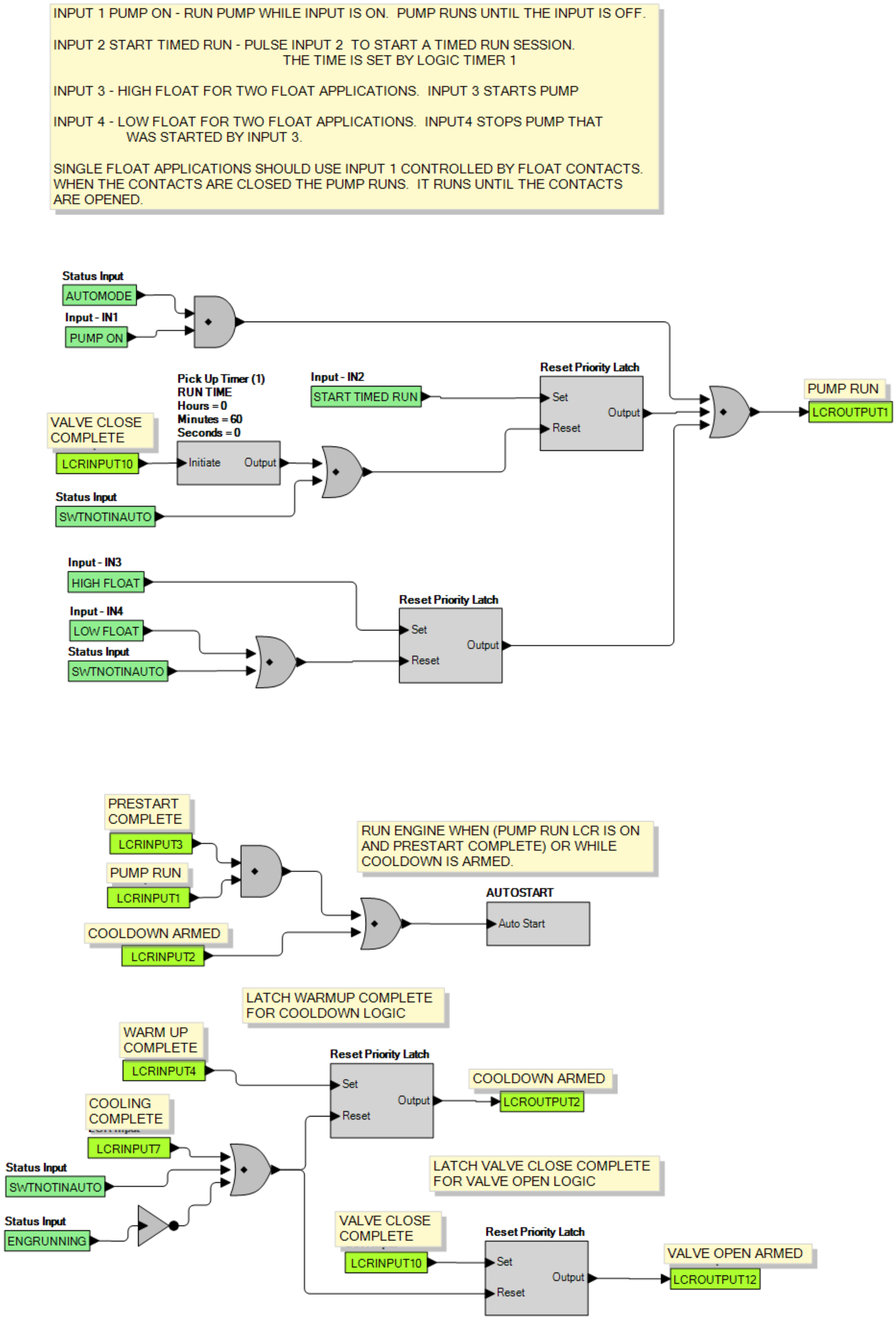


Figure B-25. Logic Library File #9 Main Logic (1 of 3)

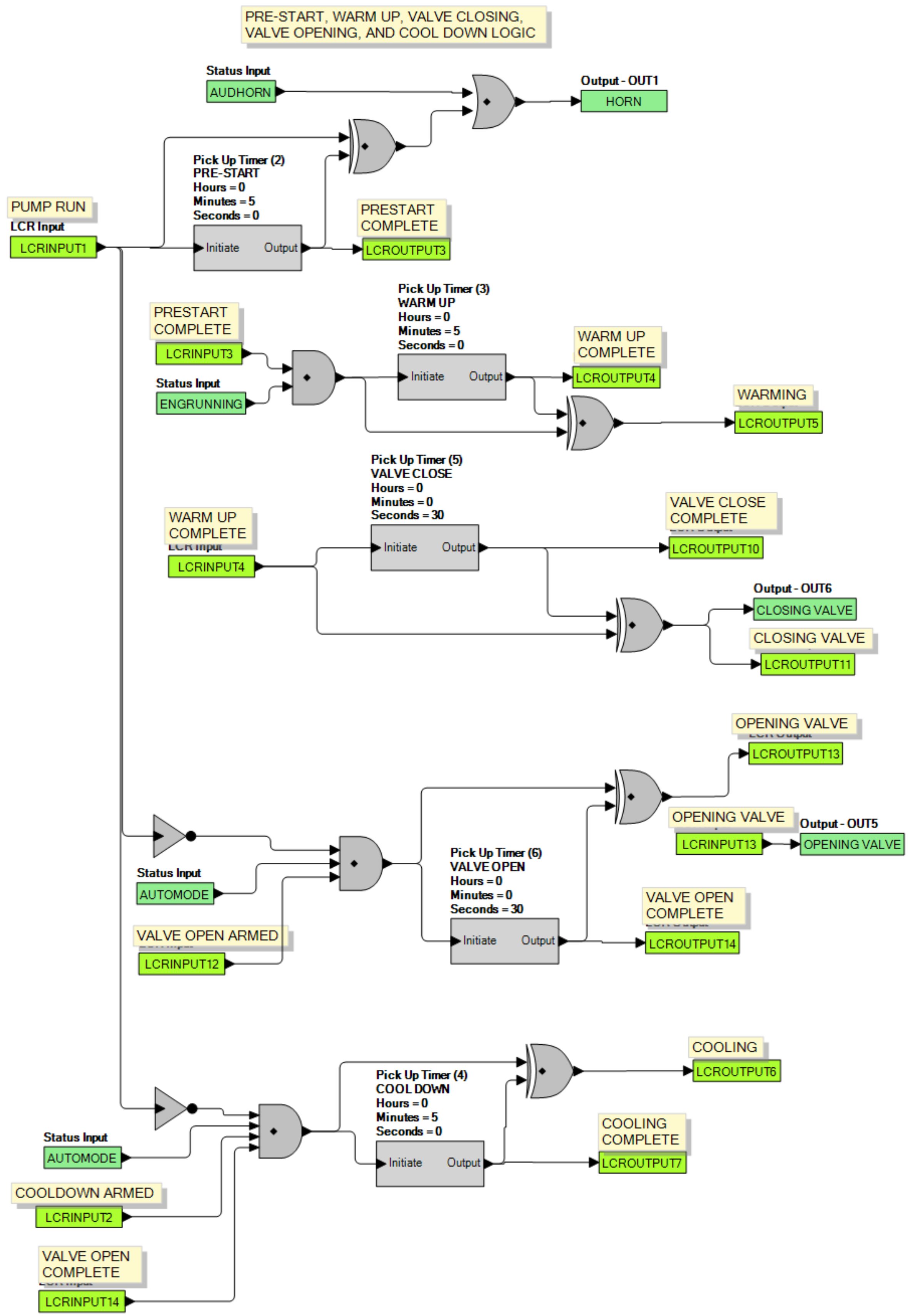


Figure B-26. Logic Library File #9 Main Logic (2 of 3)

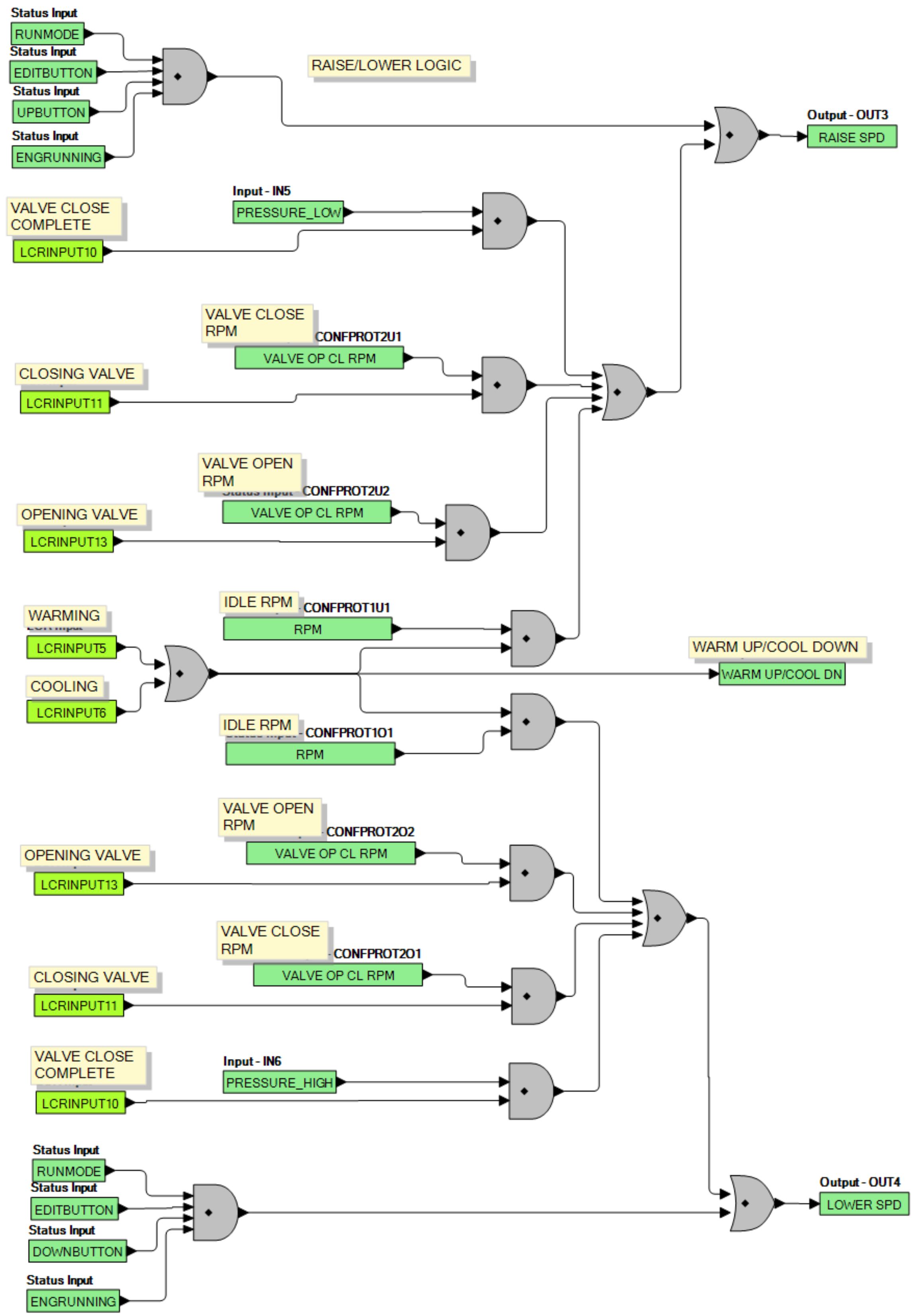


Figure B-27. Logic Library File #9 Main Logic (3 of 3)

Maintain Pressure with Time Based Valve Control and Pulsed Outputs (Logic Library File #10)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timers 7 and 8 specify the on and off times for the raise and lower outputs. Raise and Lower outputs are pulsed in this scheme. Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant raise or lower input is applied. The pulsing effectively implements a lower slew rate.
3. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
4. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
5. Logic Timer 3 specifies the duration of engine warm up in Step 4.
6. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed.
7. Logic Timer 5 specifies the duration of the valve closing process in Step 6.
8. Contact Input 5 (Low Pressure Input) and Contact Input 6 (High Pressure Input) specify the upper and lower limits that the engine should stay between during normal operation.
9. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run.
10. Logic Timer 6 specifies the duration of the valve opening process in Step 9.
11. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
12. Logic Timer 4 specifies the duration of engine cool down in Step 10.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-28 through B-30 for main logic diagrams of Logic Library File #10.

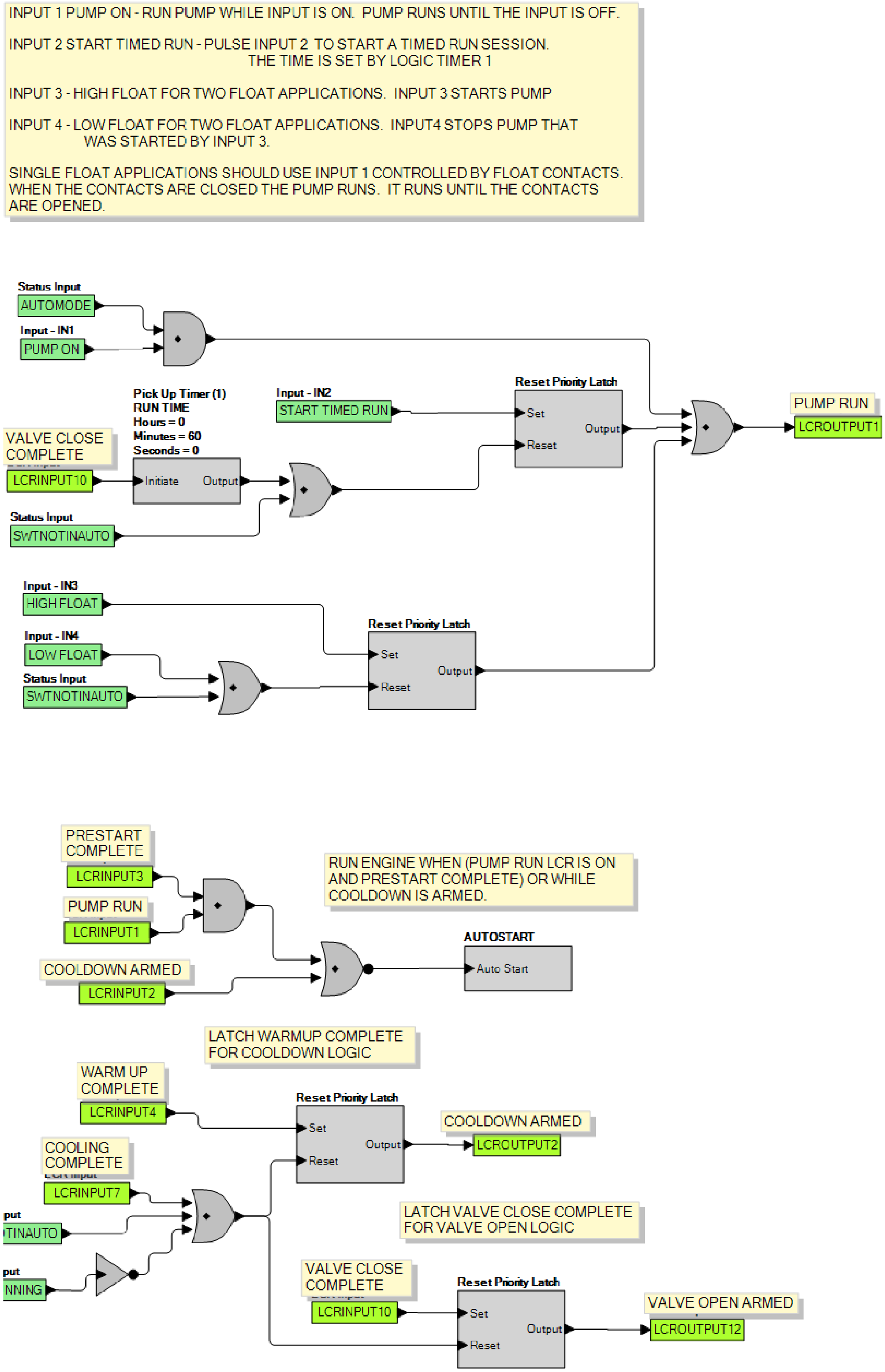


Figure B-28. Logic Library File #10 Main Logic (1 of 3)

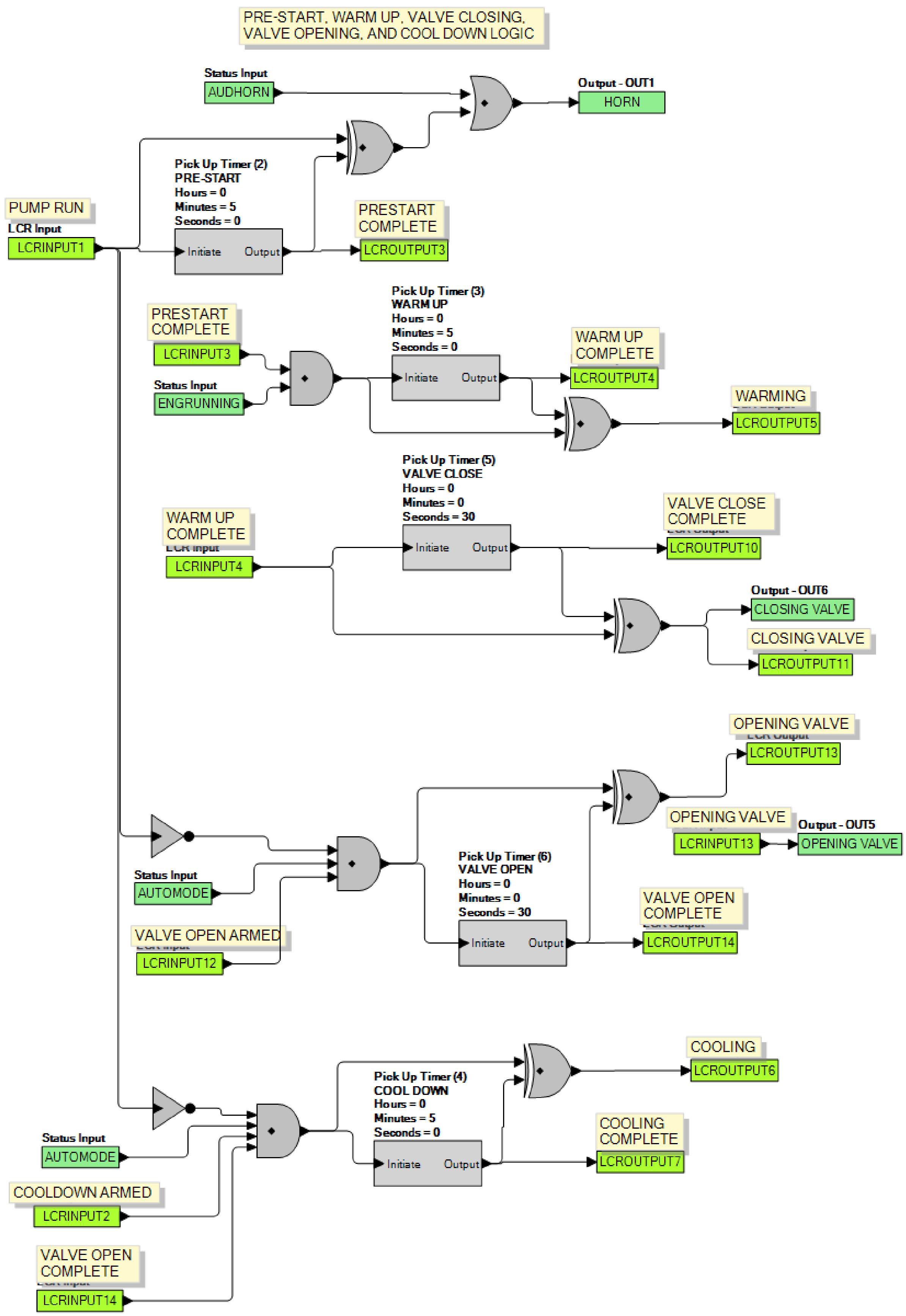


Figure B-29. Logic Library File #10 Main Logic (2 of 3)

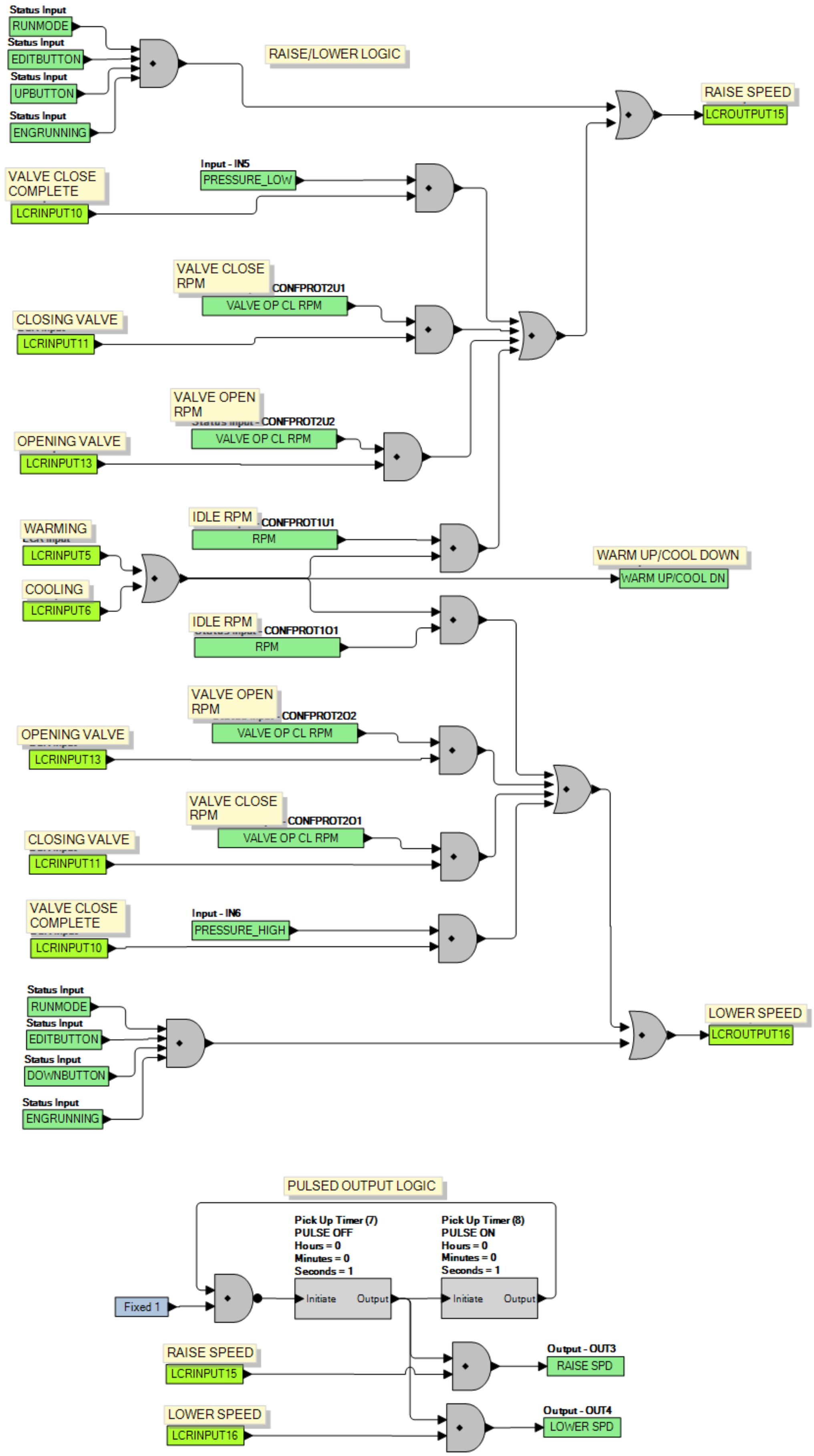


Figure B-30. Logic Library File #10 Main Logic (3 of 3)

Maintain Pressure with Contact Feedback Valve Control with Constant Outputs (Logic Library File #11)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
3. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
4. Logic Timer 3 specifies the duration of engine warm up in Step 3.
5. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed. The machine remains in this state until it receives a closure on Contact Input 5 indicating a closed valve.
6. Contact Input 5 (Low Pressure Input) and Contact Input 6 (High Pressure Input) specify the upper and lower limits that the engine should stay between during normal operation.
7. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run. The machine remains in this state until it receives a closure on Contact Input 6 indicating an open valve.
8. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
9. Logic Timer 4 specifies the duration of engine cool down in Step 8.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-31 through B-33 for main logic diagrams of Logic Library File #11.

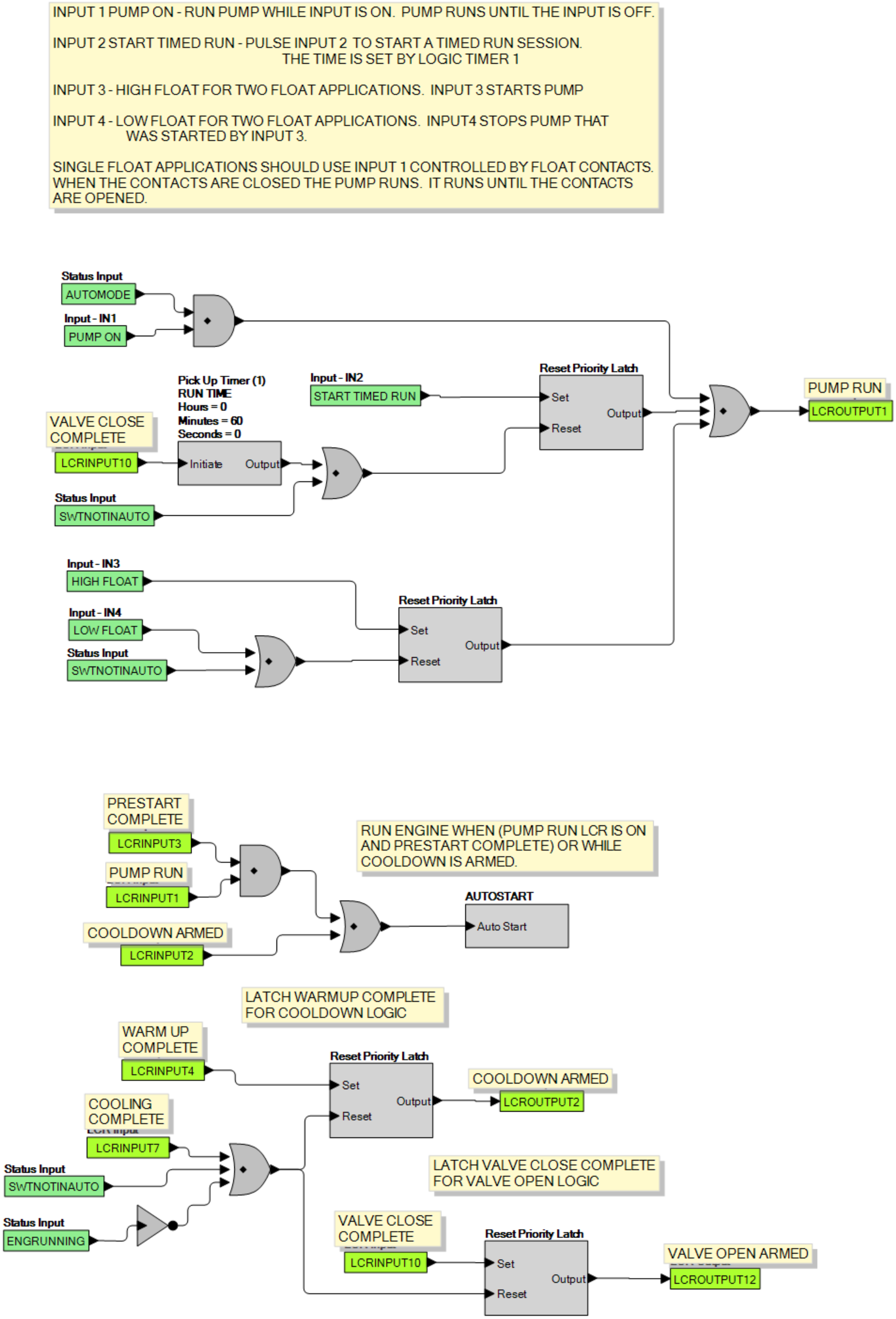


Figure B-31. Logic Library File #11 Main Logic (1 of 3)

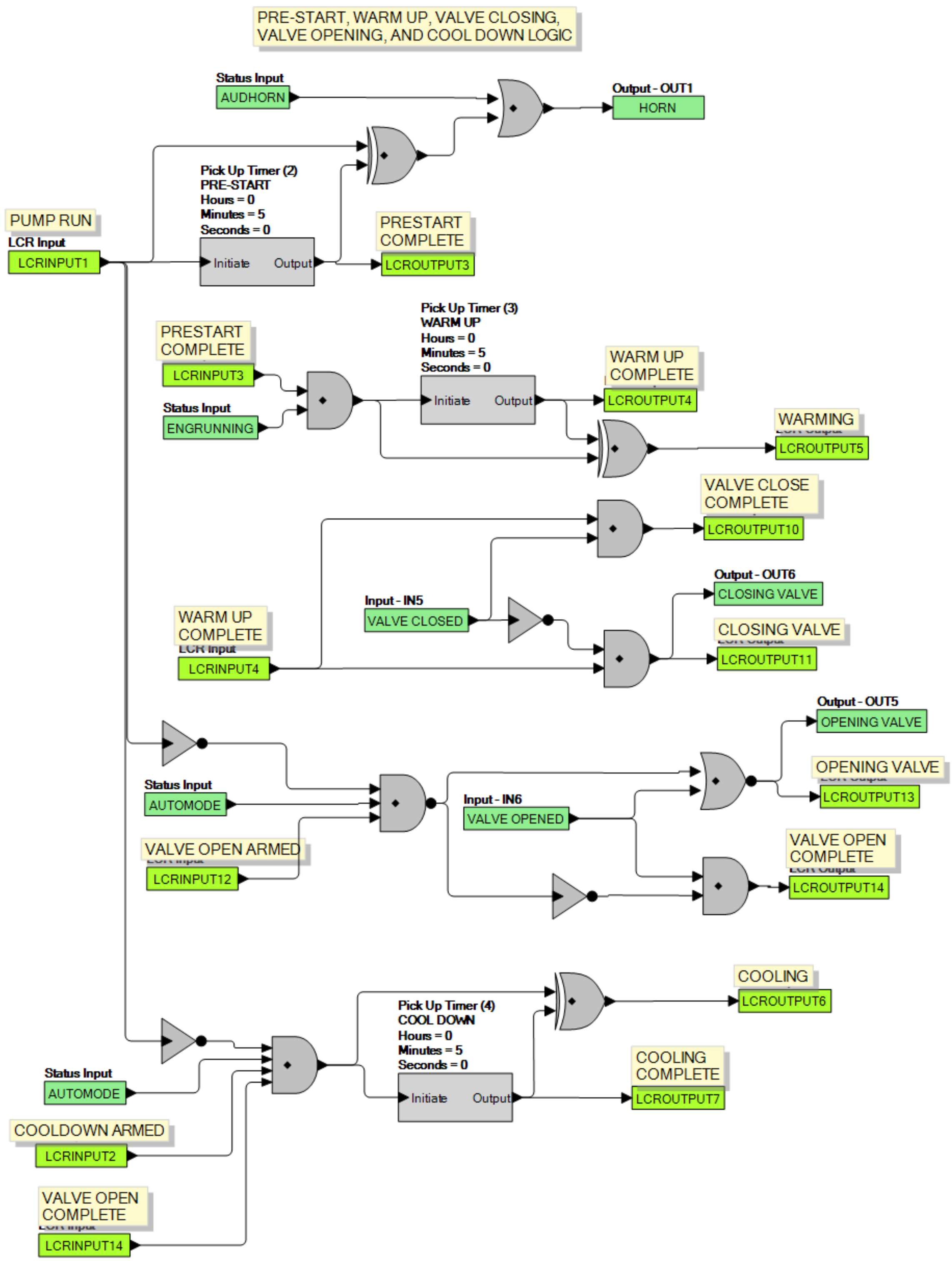


Figure B-32. Logic Library File #11 Main Logic (2 of 3)

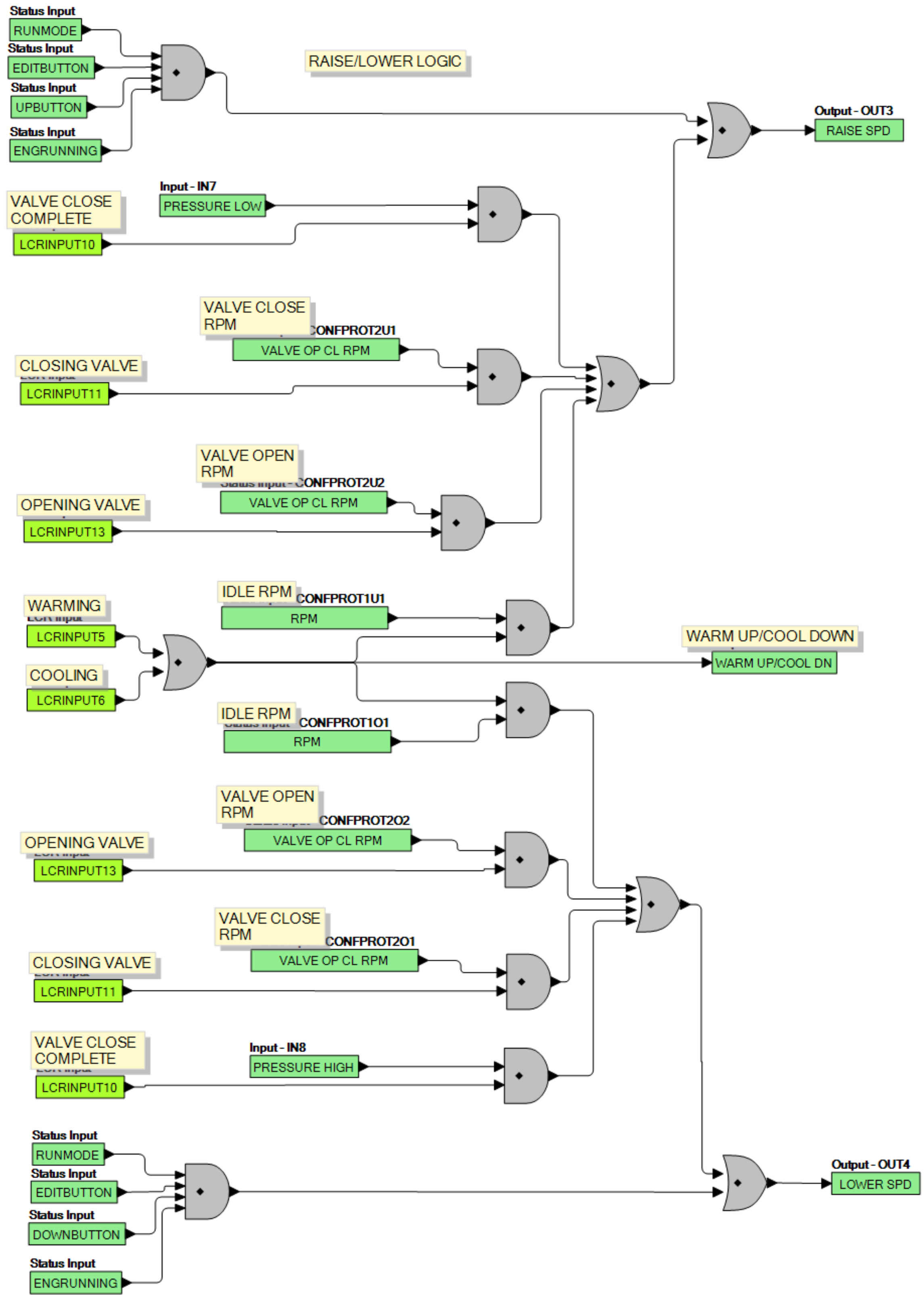


Figure B-33. Logic Library File #11 Main Logic (3 of 3)

Maintain Pressure with Contact Feedback Valve Control with Pulsed Outputs (Logic Library File #12)

1. Logic Timer 1 specifies the duration of the run session when a time based AUTO STOP scheme is desired.
2. Logic Timers 5 and 6 specify the on and off times for the raise and lower outputs. Raise and Lower outputs are pulsed in this scheme. Pulsed schemes are used when the engine's slew rate on the throttle is too high when a constant raise or lower input is applied. The pulsing effectively implements a lower slew rate.
3. Logic Timer 2 specifies the duration of horn annunciation during engine startup.
4. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to warm up.
5. Logic Timer 3 specifies the duration of engine warm up in Step 4.
6. Configurable Protection Element 2, Threshold 1 specifies the RPM that the engine should be held at while the valve is being closed. The machine remains in this state until it receives a closure on Contact Input 5 indicating a closed valve.
7. Contact Input 5 (Low Pressure Input) and Contact Input 6 (High Pressure Input) specify the upper and lower limits that the engine should stay between during normal operation.
8. Configurable Protection Element 2, Threshold 2 specifies the RPM that the engine should slow down to while the valve is being opened. This takes place when the engine is no longer required to run. The machine remains in this state until it receives a closure on Contact Input 6 indicating an open valve.
9. Configurable Protection Element 1, Threshold 1 specifies the RPM that the engine should run at idle to cool down.
10. Logic Timer 4 specifies the duration of engine cool down in Step 9.

After cooldown, the machine shuts down and remains ready to be activated the next time is receives a start indication.

Refer to Figures B-34 through B-36 for main logic diagrams of Logic Library File #12.

INPUT 1 PUMP ON - RUN PUMP WHILE INPUT IS ON. PUMP RUNS UNTIL THE INPUT IS OFF.

INPUT 2 START TIMED RUN - PULSE INPUT 2 TO START A TIMED RUN SESSION.
THE TIME IS SET BY LOGIC TIMER 1

INPUT 3 - HIGH FLOAT FOR TWO FLOAT APPLICATIONS. INPUT 3 STARTS PUMP

INPUT 4 - LOW FLOAT FOR TWO FLOAT APPLICATIONS. INPUT4 STOPS PUMP THAT
WAS STARTED BY INPUT 3.

SINGLE FLOAT APPLICATIONS SHOULD USE INPUT 1 CONTROLLED BY FLOAT CONTACTS.
WHEN THE CONTACTS ARE CLOSED THE PUMP RUNS. IT RUNS UNTIL THE CONTACTS
ARE OPENED.

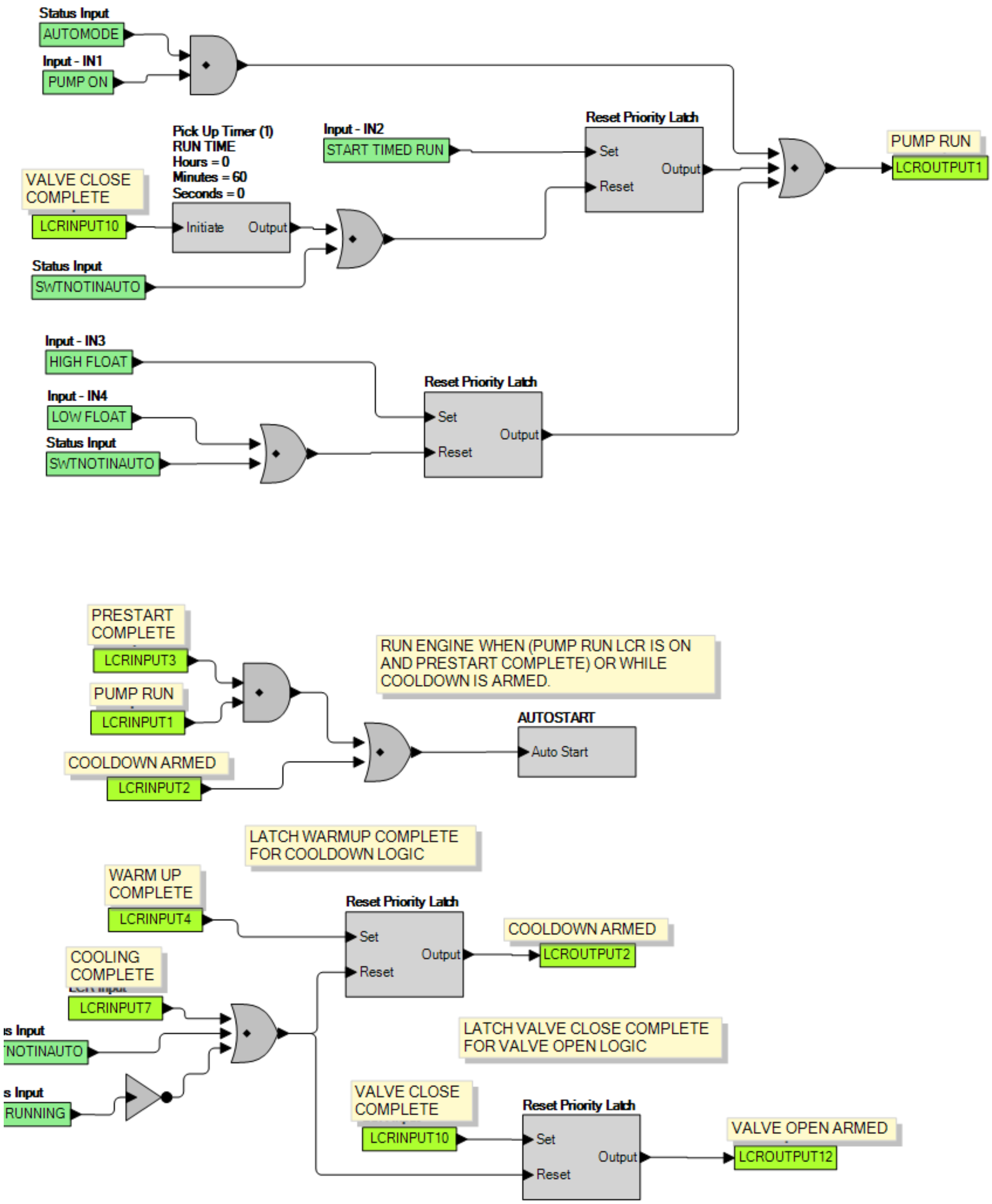


Figure B-34. Logic Library File #12 Main Logic (1 of 3)

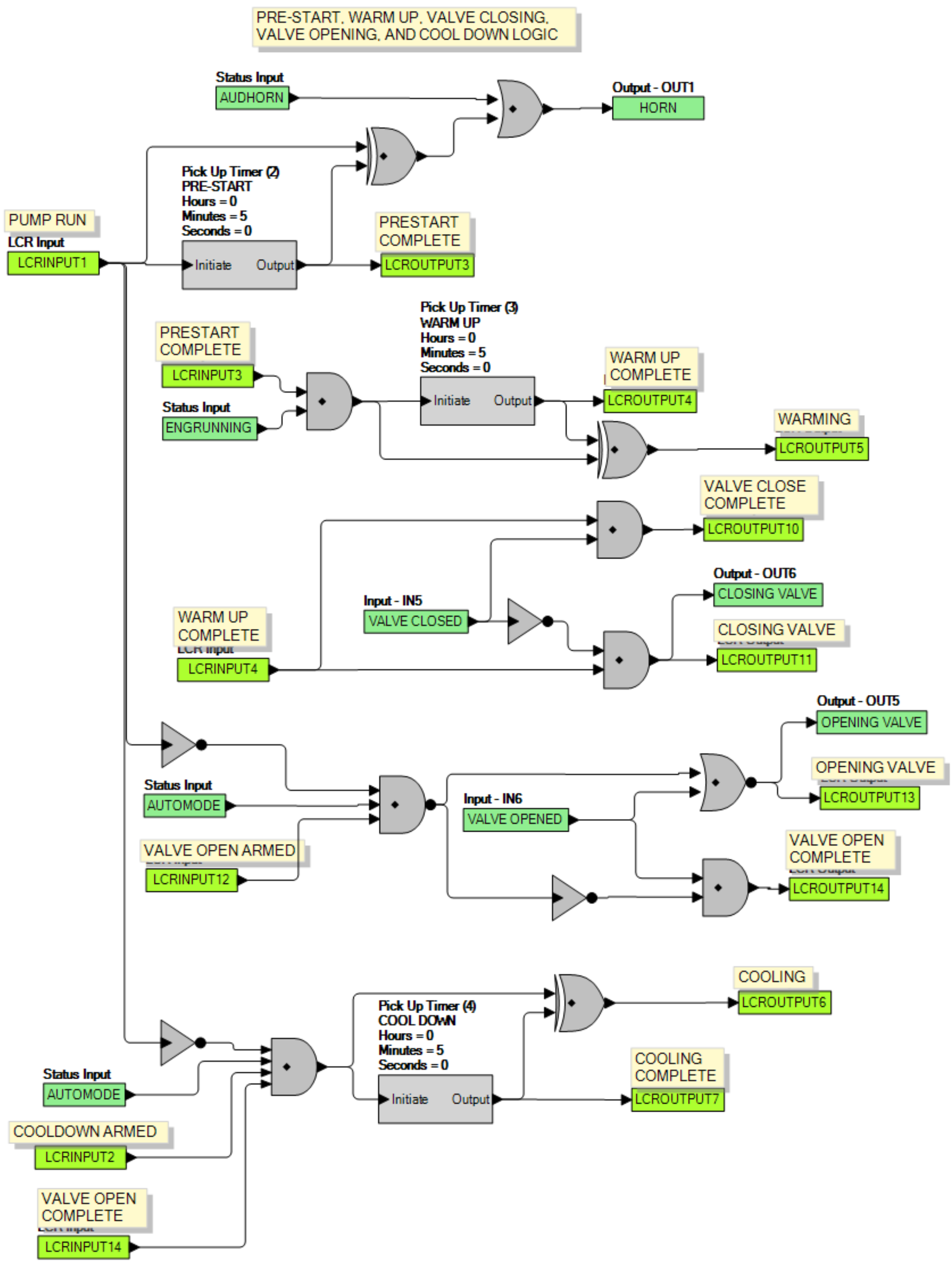


Figure B-35. Logic Library File #12 Main Logic (2 of 3)

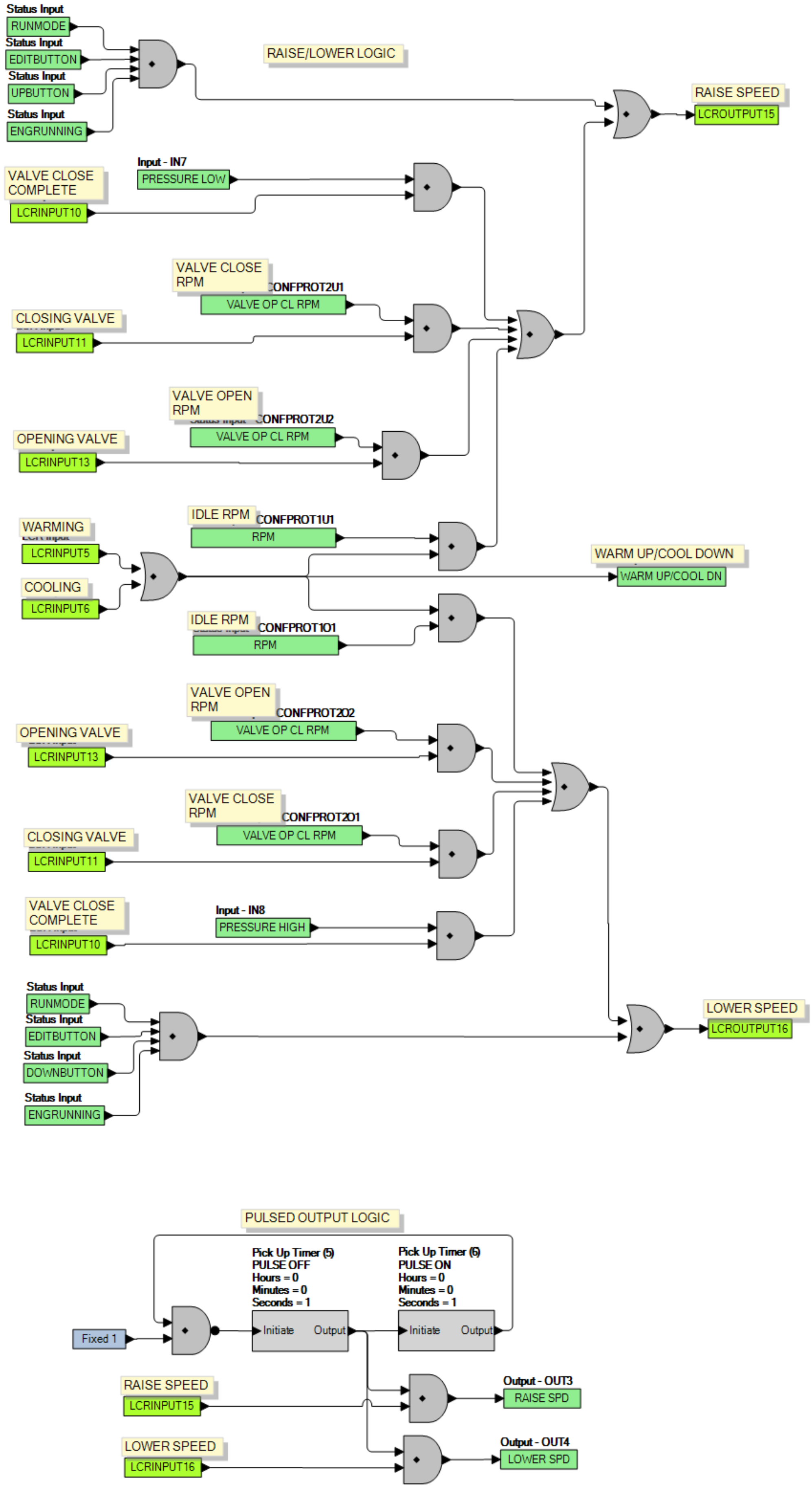


Figure B-36. Logic Library File #12 Main Logic (3 of 3)

APPENDIX C • MTU FAULT CODES

Introduction

MTU fault codes displayed by the IEM-2020 are listed in Table C-1.

Table C-1. MTU Fault Codes

Fault Code Number	String	Description
3	HI T FUEL	Fuel temperature too high (limit 1).
4	SS T FUEL	Fuel temperature too high (limit 2).
5	HI T CHRG AIR	Charge air temperature too high (limit 1).
6	SS T CHRG AIR	Air temperature too high (limit 2).
9	HI T INTERCOOLER	Coolant temperature of InterCooler too high (limit 1).
10	SS T INTERCOOLER	Coolant temperature of InterCooler too high (limit 2)
15	LO P LUBE OIL	Pressure of lube oil too low (limit 1).
16	SS P LUBE OIL	Pressure of lube oil too low (limit 2).
19	HI T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 1).
20	SS T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 2)
21	HIT T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 1).
22	SS T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 2).
23	LO COOLANT LEVEL	Coolant level too low (limit 1).
24	SS COOLANT LEVEL	Coolant level too low (limit 2).
25	HI P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 1).
26	SS P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 2).
27	HI LEVEL LEAKAGE FUEL	Level of leakage fuel too high (limit 1).
29	HI ETC IDLE SPD TOO HI	Idle speed of one of the switchable chargers too high.
30	SS ENGINE OVERSPEED	Engine overspeed (limit 2).
31	HI ETC1 OVERSPEED	Speed of basic charger too high (limit 1).
32	SS ETC1 OVERSPEED	Speed of basic charger too high (limit 2).
33	L1 P FUELFLT DIF	Differential pressure of fuel filter too high (limit 1).
36	HI ETC2 OVERSPEED	Speed of 1st switchable charger too high (limit 1).
37	SS ETC2 OVERSPEED	Speed of 1st switchable charger too high (limit 2).
38	AL ETC SPEED DEVIATION	Speed deviation between basic turbo charger and one of the switchable chargers.
39	AL ETC2 CUTIN FAIL	Switching of charger ETC2 failed.
44	LO LEVEL INTRCLR	Coolant level of intercooler too low (limit 1).
45	FAULT L2 LEVEL INTRCLR	Coolant level of intercooler too low (limit 2).
51	HI T LUBE OIL	Lube oil temperature too high (limit 1).
52	SS T LUBE OIL	Lube oil temperature too high (limit 2).
57	LO P COOLANT	Coolant pressure too low (limit 1).
58	SS P COOLANT	Coolant pressure too low (limit 2).
59	SS T COOLANT L3	Coolant temperature too high/too low (limit 3).
60	SS T COOLANT L4	Coolant temperature too high/too low (limit 4).
63	HI P CRANKCASE	Crankcase pressure too high (limit 1).
64	SS P CRANK CASE	Crankcase pressure too high (limit 2).
65	LO P FUEL	Fuel supply pressure too low (limit 1).
66	SS P FUEL	Fuel supply pressure too low (limit 2).
67	HI T COOLANT	Coolant temperature too high (limit 1).
68	SS T COOLANT	Coolant temperature too high (limit 2).
69	L1 T EXTERN 1	Limit 1, out of range.

Fault Code Number	String	Description
70	L2 T EXTERN 1	Limit 2, out of range.
71	L1 T EXTERN 2	Limit 1, out of range.
72	L2 T EXTERN 2	Limit 2, out of range.
73	L1 P EXTERN 1	Limit 1, out of range.
74	L2 P EXTERN 1	Limit 2, out of range.
75	L1 P EXTERN 2	Limit 1, out of range.
76	L2 P EXTERN 2	Limit 2, out of range.
77	LIM EXT CLNT LEV	Binary signal 1 Plant active.
78	LIM INTERCLR LEV	Binary signal 2 Plant active.
79	L BIN EXTERN 3	Binary signal 3 Plant active.
80	L BIN EXTERN 4	Binary signal 4 Plant active.
81	AL RAIL LEAKAGE	Rail pressure gradient too low for Start or too high for Stop.
82	HI P FUEL COMON RAIL	Rail pressure > setpoint value.
83	LO P FUEL COMMON RAIL	Rail pressure < setpoint value.
85	HI T UMBLASSEN	‘Umblasen’ temperature too high (limit 1).
86	SS T UMBLASSEN	‘Umblasen’ temperature too high (limit 2).
89	SS SPEED TOO LOW	Engine is being stalled. The engine speed of the normally operating engine dropped below the limit from parameter 2.2500.027 Limit Engine Speed Low without any stop request. For safety reason the engine is stopped when this event occurs.
90	SS IDLE SPEED LOW	Idle speed not reached.
91	SS RELEASE SPEED LO	Acceleration speed not reached.
92	SS STARTER SPEED LO	Starter speed not reached.
93	SS PREHT TMP	Preheat temperature too low (limit 2).
94	LO PREHT TMP	Preheat temperature too low (limit 1).
95	AL PRELUBE FAULT	Prelubrication fault.
100	EDM NOT VALID	Checksum fault EDM.
101	IDM NOT VALID	Checksum fault IDM.
102	INVLD FUEL CNS 1	Fuel consumption counter detect.
103	INVLD FUEL CNS 2	Consumption monitoring 2 not valid.
104	ENG HRS INVALID 1	Engine Hours Counter defect.
105	ENG HRS INVALID 2	Checksum fault.
106	ERR REC1 INVALID	Checksum fault.
107	ERR REC2 INVALID	Checksum fault.
118	LO ECU SUPPLY VOLTS	Power supply voltage too low (limit 1).
119	LOLO ECU SUPPLY VOLTS	Power supply voltage too low (limit 2).
120	HI ECU SUPPLY VOLTS	Power supply voltage too high (limit 1).
121	HIHI ECU SUPPLY VOLTS	Power supply voltage too high (limit 2).
122	HI T ECU	Temperature of electronic too high (limit 1).
134	15v POSECU DEFCT	Internal electronic fault.
136	15V NEGECU DEFCT	Internal electronic fault.
137	L1 5V BUFFR TEST	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
138	SENSOR PWR DEFCT	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
139	L1 TE BUFFR TEST	Internal electronic fault.
140	TE BUF ECU DEFCT	Internal electronic fault.
141	AL POWER TOO HIGH	AL power too high.
142	MCR EXCEEDED 1 HR STR	AL MCR exceeded 1 hour.
143	BANK1 ECU DEFECT	Internal electronic fault.

Fault Code Number	String	Description
144	BANK2 ECU DEFECT	Internal electronic fault.
145	15V GOODECU DFCT	Internal electronic fault.
147	AD TST1ECU DEFCT	Internal electronic fault.
149	AD TST2ECU DEFCT	Internal electronic fault.
151	AD TST3ECU DEFCT	Internal electronic fault.
170	MI MODULE FAIL	Module in maintenance indicator defect.
171	MI NOT ACTIVE	WI not active anymore.
172	TBO EXPIRED	TBO expired.
173	MODL WRITE LIMIT	EEPROM write limit reached.
176	AL LIFE DATA NA	No (fitting) LifeData-Backup-System is available within a delay time after ECU Reset.
177	AL LIFE DATA INCPLT	If the ADEC has to restore the LifeData from the backup-system and at least one checksum is wrong after the upload or the upload is incomplete, then this failure is set.
180	AL CAN1 NODE LOST	Connection to a node on CAN 1 lost.
181	AL CAN2 NODE LOST	Connection to a node on CAN 2 lost.
182	AL CAN WRONG PARAMS	Incorrect CAN parameter values have been entered.
183	AL CAN NO PU DATA	A CAN mode is selected which the communication is initialized aided of the PU data module. However, required PU data module is not present or is not valid.
184	AL CAN PUDATA ERR	During attempt to copy a received PU data module to Flash module, a program error occurred.
185	CAN LESS MAILBXS	CAN less mailboxes.
186	AL CAN1 BUS OFF	CAN controller 1 is in “Bus Off” state.
187	AL CAN1 ERR PASSV	CAN controller 1 has signaled a warning.
188	AL CAN2 BUS OFF	CAN controller 2 is in “Bus Off” state.
189	AL CAN2 ERROR PASSV	CAN controller 2 has signaled a warning.
190	AL EMU PARAM NO SUPPORT	EMU parameters are not supported.
201	SD T COOLANT	Coolant temperature-sensor defect.
202	SD T FUEL	Fuel temperature-sensor defect.
203	SD T CHARGE AIR	Charge air temperature-sensor defect.
205	SD T CLNT INTERC	Intercooler coolant temperature-sensor defect.
206	SD T EXHAUST A	Exhaust gas temperature-sensor on A-side defect.
207	SD T EXHAUST B	Exhaust gas temperature-sensor on B-side defect.
208	SD P CHARGE AIR	Charge air pressure-sensor defect.
211	SD P LUBE OIL	Lube oil pressure-sensor defect.
212	SD P COOLANT	Coolant pressure-sensor defect.
213	SD P COOLANT INTRCOOLR	Intercooler coolant pressure-sensor defect.
214	SD P CRANKCASE	Crankcase pressure-sensor defect.
215	SD P HD	Rail pressure-sensor defect.
216	SD T LUBE OIL	Lube oil temperature-sensor defect.
219	SD T INTAKE AIR	Intake air temperature-sensor defect.
220	SD COOLANT LEVEL	Sensor for coolant level defect.
221	SD P DIFF LUBE OIL	Sensor for differential pressure of lube oil defect.
222	SL LVL LKG FUEL	Sensor for leakage level of fuel defect.
223	SD LVL INTERCLR	Sensor for coolant level of intercooler defect.
227	SD PRE FILT P LUBE OIL	Pressure sensor for lube oil before filter defect.
229	AL SD CAM STOP	Sensor of Camshaft defect and sensor of crankshaft defect before.
230	SD CRANKSHFT SPD	Sensor defect on crankshaft.
231	SD CAMSHAFT SPD	Sensor defect on camshaft.
232	SD CHARGER1 SPEED	Speed-sensor of basic charger defect.

Fault Code Number	String	Description
233	SD CHARGER2 SPEED	Speed-sensor of switching charger defect.
240	SD P FUEL	Fuel pressure-sensor defect.
241	SD T UMBLASSEN	Temperature-sensor of recirculated charge air defect.
242	SD T COOLANT R	Redundant coolant temperature-sensor defect.
244	SD P LUBE OIL R	Redundant pressure sensor for lube oil defect.
245	SD POWER SUPPLY	Internal ECU error.
246	SD T ELECTRONIC	Internal ECU fault.
249	SD CAN STOP	Missing data CAN.
250	SD CAN SPD DEMND	Missing data CAN.
251	SD CAN UP DOWN	Missing data CAN.
252	SD CAN NOTCH POS	Missing data CAN.
253	SD CAN OVERRIDE	Missing data CAN.
254	SD CAN TST OVRSP	Missing data CAN.
255	SD CAN ENGAGE SIG	Missing data CAN.
256	SD CAN CYL CUTOUT	Missing data CAN.
257	SD CAN LOCAL	Missing data CAN.
258	SD CAN RCS ENGAGE	Missing data CAN.
259	SD CAN RCS CYL CT	Missing data CAN.
260	SD 15V POS SPPLY	Internal ECU fault.
261	15V POS SPPLY	Internal ECU fault.
262	SD 5V BUFFR TEST	Internal ECU fault.
263	SD TE BUFFR TEST	Internal ECU fault.
264	SD BANK 1 TEST	Internal ECU fault.
265	SD BANK 2 TEST	Internal ECU fault.
266	SD SPD DEMAND AN	Analog speed demand defect.
267	SD SPDMTEST BNCH	Short circuit, cable breakage.
268	SD SPINUT	Analog spinning value defect.
269	SD LOAD ANLG FLT	Filtered analog load pulse signal not available.
270	SD FREQUENCY INPUT	Frequency input defect.
271	SD T EXTERN 1	Missing data CAN.
272	SD T EXTERN 2	Missing data CAN.
273	SD P EXTERN 1	Missing data CAN.
274	SD P EXTERN 2	Missing data CAN.
275	SD EXT CLNT LVL	Missing data CAN.
276	SD INTERCLER LVL	Missing data CAN.
277	SD BIN EXT3	Missing data CAN.
278	SD BIN EXT4	Missing data CAN.
279	SD CANRES TRIPFL	Missing data CAN.
280	SD CAN ALRM RST	Missing data CAN.
281	SD ADTEST1 SPPLY	Internal ECU fault.
282	SD ADTEST 2 SPPLY	Internal ECU fault.
283	SD ADTEST3 SPPLY	Internal ECU fault.
284	SD CAN LAMP TEST	Missing data CAN.
285	SD CAN IDLE RQ SR	Missing data CAN.
286	SD CAN IDLE REQ	Missing data CAN.
287	SD CAN IDLE REQ	Missing data CAN.
288	SD CAN TRBOSW LCK	Missing data CAN.
301	TIMING CYLNDR A1	Error in timing of injector cylinder A1: timing value too low/high.
302	TIMING CYLNDR A2	Error in timing of injector cylinder A2: timing value too low/high.

Fault Code Number	String	Description
303	TIMING CYLNDR A3	Error in timing of injector cylinder A3: timing value too low/high.
304	TIMING CYLNDR A4	Error in timing of injector cylinder A4: timing value too low/high.
305	TIMING CYLNDR A5	Error in timing of injector cylinder A5: timing value too low/high.
306	TIMING CYLNDR A6	Error in timing of injector cylinder A6: timing value too low/high.
307	TIMING CYLNDR A7	Error in timing of injector cylinder A7: timing value too low/high.
308	TIMING CYLNDR A8	Error in timing of injector cylinder A8: timing value too low/high.
309	TIMING CYLNDR A9	Error in timing of injector cylinder A9: timing value too low/high.
310	TIMING CYLNDR A10	Error in timing of injector cylinder A10: timing value too low/high.
311	TIMING CYLNDR B1	Error in timing of injector cylinder B1: timing value too low/high.
312	TIMING CYLNDR B2	Error in timing of injector cylinder B2: timing value too low/high.
313	TIMING CYLNDR B3	Error in timing of injector cylinder B3: timing value too low/high.
314	TIMING CYLNDR B4	Error in timing of injector cylinder B4: timing value too low/high.
315	TIMING CYLNDR B5	Error in timing of injector cylinder B5: timing value too low/high.
316	TIMING CYLNDR B6	Error in timing of injector cylinder B6: timing value too low/high.
317	TIMING CYLNDR B7	Error in timing of injector cylinder B7: timing value too low/high.
318	TIMING CYLNDR B8	Error in timing of injector cylinder B8: timing value too low/high.
319	TIMING CYLNDR B9	Error in timing of injector cylinder B9: timing value too low/high.
320	TIMING CYLNDR B10	Error in timing of injector cylinder B10: timing value too low/high.
321	WIRING CYLNDR A1	Short circuit in injector cable of cylinder A1.
322	WIRING CYLNDR A2	Short circuit in injector cable of cylinder A2.
323	WIRING CYLNDR A3	Short circuit in injector cable of cylinder A3.
324	WIRING CYLNDR A4	Short circuit in injector cable of cylinder A4.
325	WIRING CYLNDR A5	Short circuit in injector cable of cylinder A5.
326	WIRING CYLNDR A6	Short circuit in injector cable of cylinder A6.
327	WIRING CYLNDR A7	Short circuit in injector cable of cylinder A7.
328	WIRING CYLNDR A8	Short circuit in injector cable of cylinder A8.
329	WIRING CYLNDR A9	Short circuit in injector cable of cylinder A9.
330	WIRING CYLNDR A10	Short circuit in injector cable of cylinder A10.
331	WIRING CYLNDR B1	Short circuit in injector cable of cylinder B1.
332	WIRING CYLNDR B2	Short circuit in injector cable of cylinder B2.
333	WIRING CYLNDR B3	Short circuit in injector cable of cylinder B3.
334	WIRING CYLNDR B4	Short circuit in injector cable of cylinder B4.
335	WIRING CYLNDR B5	Short circuit in injector cable of cylinder B5.
336	WIRING CYLNDR B6	Short circuit in injector cable of cylinder B6.
337	WIRING CYLNDR B7	Short circuit in injector cable of cylinder B7.
338	WIRING CYLNDR B8	Short circuit in injector cable of cylinder B8.
339	WIRING CYLNDR B9	Short circuit in injector cable of cylinder B9.
340	WIRING CYLNDR B10	Short circuit in injector cable of cylinder B10.
341	OPN LD CYLNDR A1	Open load in injector cable of cylinder A1.
342	OPN LD CYLNDR A2	Open load in injector cable of cylinder A2.
343	OPN LD CYLNDR A3	Open load in injector cable of cylinder A3.
344	OPN LD CYLNDR A4	Open load in injector cable of cylinder A4.
345	OPN LD CYLNDR A5	Open load in injector cable of cylinder A5.
346	OPN LD CYLNDR A6	Open load in injector cable of cylinder A6.
347	OPN LD CYLNDR A7	Open load in injector cable of cylinder A7.
348	OPN LD CYLNDR A8	Open load in injector cable of cylinder A8.
349	OPN LD CYLNDR A9	Open load in injector cable of cylinder A9.
350	OPN LD CYLNDR A10	Open load in injector cable of cylinder A10.
351	OPN LD CYLNDR B1	Open load in injector cable of cylinder B1.

Fault Code Number	String	Description
352	OPN LD CYLNDR B2	Open load in injector cable of cylinder B2.
353	OPN LD CYLNDR B3	Open load in injector cable of cylinder B3.
354	OPN LD CYLNDR B4	Open load in injector cable of cylinder B4.
355	OPN LD CYLNDR B5	Open load in injector cable of cylinder B5.
356	OPN LD CYLNDR B6	Open load in injector cable of cylinder B6.
357	OPN LD CYLNDR B7	Open load in injector cable of cylinder B7.
358	OPN LD CYLNDR B8	Open load in injector cable of cylinder B8.
359	OPN LD CYLNDR B9	Open load in injector cable of cylinder B9.
360	OPN LD CYLNDR B10	Open load in injector cable of cylinder B10.
361	AL POWER STAGE LOW	Internal error of electronic.
362	AL POWER STAGE HIGH	Internal error of electronic.
363	AL STOP POWER STAGE	Internal error of electronic.
364	AL STOP POWER STAGE 2	Internal error of electronic.
365	AL MV WIRING GND	Cable line error.
371	AL WIRING TO 1	Short circuit or open load on transistor output 1 (TO 1).
372	AL WIRING TO 2	Short circuit or open load on transistor output 2 (TO 2).
373	AL WIRING TO 3	Short circuit or open load on transistor output 3 (TO 3).
374	AL WIRING TO 4	Short circuit or open load on transistor output 4 (TO 4).
381	AL WIRING TOP 1	Short circuit or open load on transistor output plant 1 (TOP 1).
382	AL WIRING TOP 2	Short circuit or open load on transistor output plant 2 (TOP 2).
383	AL WIRING TOP 3	Short circuit or open load on transistor output plant 3 (TOP 3).
384	AL WIRING TOP 4	Short circuit or open load on transistor output plant 4 (TOP 4).
385	AL WIRING TOP 5	Short circuit or open load on transistor output plant 5 (TOP 5).
386	AL WIRING TOP 6	Short circuit or open load on transistor output plant 6 (TOP 6).
390	AL MCR EXCEEDED	DBR/MCR Function: MCR (Maximum Continuous Rating) in exceeded.
392	HI T COOLNT R	Redundant coolant temperature too high (limit 1).
393	SS T COOLNT R	Redundant coolant temperature too high (limit 2).
394	LO P LUBE OIL R	Redundant pressure of lube oil too low (limit 1).
395	SS P LUBE OIL R	Redundant pressure of lube oil too low (limit 2).
396	TD T COOLANT	Maximum deviation of T-Coolant sensors.
397	TD P LUBE OIL	Maximum deviation of P-Oil sensors.
399	AL INTERFACE ECU	Interface ECU.
400	AL OPN LD DIGIN 1	Open load on digital input 1.
401	AL OPN LD DIGIN 2	Open load on digital input 2.
402	AL OPN LD DIGIN 3	Open load on digital input 3.
403	AL OPN LD DIGIN 4	Open load on digital input 4.
404	AL OPN LD DIGIN 5	Open load on digital input 5.
405	AL OPN LD DIGIN 6	Open load on digital input 6.
406	AL OPN LD DIGIN 7	Open load on digital input 7.
407	AL OPN LD DIGIN 8	Open load on digital input 8.
408	AL OPN LD E STOP	Open load on input for emergency stop.
410	LO U PDU	Power driver voltage (injectors) too low (limit 1).
411	LOLO U PDU	Power driver voltage (injectors) too low (limit 2).
412	HI U PDU	Power driver voltage (injectors) too high (limit 1).
413	HIHI U PDU	Power driver voltage (injectors) too high (limit 2).
414	HI L WATER FUEL PREFILT	Water level of fuel prefilter too high (limit 1).
415	LO P COOLANT INTRCOOLR	Coolant pressure of InterCooler too low (limit 1).
416	SS P COOLANT INTRCOOLR	Coolant pressure of InterCooler too low (limit 2).
417	SD L WATER FUEL PREFILT	Water level-sensor of fuel prefilter defect.

Fault Code Number	String	Description
420	AL L1 AUX 1	Input of Aux 1 injured limit 1.
421	AL L2 AUX 1	Input of Aux 1 injured limit 2.
428	AL L1 T AUX 1	Temperature input of Aux 1 injured limit 1.
438	LO P FUEL RAIL 2 STR	Low pressure on fuel rail 2.
439	HI P FUEL RAIL 2 STR	Hi pressure on fuel rail 2.
440	AL L1 P AUX 1	Pressure input of Aux 1 injured limit 1.
441	AL RAIL 2 LEAKAGE STR	Alarm fuel rail 2 leak detected.
442	AL L2 P AUX 1	Pressure input of Aux 1 injured limit 2.
444	SD U PDU	Sensor defect of Injector Power driver unit.
445	SD P AMBIENT AIR	Ambient air pressure-sensor defect.
448	HI P CHARGE AIR	Pressure of charge air too high (limit 1).
449	SS P CHARGE AIR	Pressure of charge air too high (limit 2).
450	SD IDLE END TRQ IN	Input of Idle/End-Torque defect
454	SS PWR RED ACT	Power Reduction is activated.
455	AL L1 AUX1 PLANT	Input of Aux 1 (plant) injured limit 1.
456	AL L2 AUX1 PLANT	Input of Aux 1 (plant) injured limit 2.
461	LO T EXHAUST EMU	Exhaust gas temperature of EMU too low (limit 1).
462	HI T COOLANT EMU	Coolant temperature of EMU injured limit 1.
463	SD AUX 2	Sensor defect on Aux 2.
464	SD P AUX 1	Analog input for pressure Aux 1 defect.
467	AL L2 T AUX 1	Temperature input of Aux 1 injured limit 2.
468	SD T AUX 1	Analog input for Temperature Aux 1 defect.
469	SD AUX 1	Analog input for Aux 1 defect.
470	SD T ECU	ECU temperature-sensor defect.
471	SD COIL CURRENT	Coil Current sensor defect.
472	AL STOP SD	Engine stop, because critical channel has sensor defect.
473	AL WIRING PWM CM2	Open load or short circuit on channel PWM_CM2.
474	AL WIRING FREQ OUT	Open load or short circuit on frequency output (FO) channel.
475	AL CR TRIG ENG ST	Released in case of an engine stop in order to trigger the crash recorder.
476	AL CRASH REC ERR	Initial error of crash recorder.
478	AL COMB ALM YEL	Combined Alarm YELLOW (Plant).
479	AL COMB ALM RED	Combined Alarm RED (Plant).
480	AL EXT ENG PROT	External Engine Protection function active.
500	AL WIRING POM STARTER 1	A wiring fault has been detected in the connection of starter 1 of POM.
501	AL WIRING POM STARTER 2	A wiring fault has been detected in the connection of starter 2 of POM.
502	AL OPEN LD POM ALTRNATR	An open load on POM's alternator output has been detected.
503	AL BATT NOT CHARGING	Battery is not being charged by alternator.
504	AL CAN POM NODE LOST	POM is missing on CAN bus.
505	AL NEW POM FOUND	New POM found.
506	AL LOW STARTER VOLTS	Battery voltage is too low for starting.
507	AL POM ERROR	A general POM error has been detected.
508	AL WRONG POM ID	POM sends a different identification number (ID) than expected.
509	AL CHECK POM FUSE	Check POM fuse.
510	AL OVERRIDE APPLIED	Override applied.
515	STARTER NOT ENGAGED	Starter of POM could not be engaged.
543	MULTIPLE FDH SLAVES	There is more than one device which is configured as Backup for FDH-Functionality.

Fault Code Number	String	Description
544	CONFIGURATION CHANGED	Gets active in case of changing system configuration e.g. by changing ECU- or SAM-Device. Remains until undo procedure or data is transferred by a valid maintenance case. Is cancelled automatically.
549	AL PWR CUTOFF STR	This is the alarm from the function Emergency Stop Counter. ECU power was disconnected while the engine was still running. This could lead to a possible overpressure in the high pressure system which might damage the engine.
555	AL CALL FIELD SERVICE	Gets active in case of completing a maintenance-case which manipulates Engine-Parameters. Remains also after switching on-off ECU until a valid release code is entered via Display- and Button-Control of SAM-Device. Release Code is available via Internet by a special procedure.
576	AL ESCM OVERRIDE STR	Exceeding of the corrected current MCR - odr DBR/MCR value.
594	AL L1 PRV 1 DEFECT STR	Yellow alarm pressure relief valve first rail.
595	AL L2 PRV 1 DEFECT STR	Red alarm pressure relief valve first rail.
598	AL L1 PRV 2 DEFECT STR	Yellow alarm pressure relief valve second rail.
599	AL L2 PRV 2 DEFECT STR	Red alarm pressure relief valve second rail.
610	AL WIRING SUCK RESTRCT 1 STR	Open load or short circuit on PWM HP fuel control block channel.
611	AL WIRING SUCK RESTRCT 2 STR	Open load or short circuit on PWM HP fuel control block channel 2.
612	AL WIRING PRESS CTRL VLV 1 STR	Open load or short circuit on PWM pressure regulating valve channel.
613	AL WIRING PRESS CTRL VLV 2 STR	Open load or short circuit on PWM pressure regulating valve channel 2.
615	AL EIL PROTECTION STR	Alarm for Protection Module in response to faulty or manipulated EIL.
692	AL ECU PWR OFF ON REQ STR	ECU configuration changed, switch power off/on.
696	AL SMARTCONCT USB ERR STR	Alarm configuration parameter.
697	AL SMARTCONCT RS485 ERR STR	Alarm configuration parameter.
698	AL SD STOP BUTTON STR	Channel signals open load or internal error.
700	AL SD START BUTTON STR	Channel signals open load.
701	AL SD UP BUTTON STR	Channel signals open load.
702	AL SD DN BUTTON STR	Channel signals open load or internal error.
703	AL SD EXT SPEED DMD SW STR	Channel signals open load.
704	AL SD SPEED DMD INCREASE STR	Channel signals open load or internal error.
705	AL SD BINARY SPD DMD LMT STR	Channel signals open load or internal error.
706	AL SD DROOP 2 SWITCH STR	Channel signals open load or internal error.
707	AL SD FREQUENCY SWITCH STR	Channel signals open load or internal error.
709	AL SD OVERRIDE BUTTON STR	Channel signals open load or internal error.
710	AL SD ALARM RESET STR	Channel signals open load or internal error.
711	AL SD CYLINDER CUTOUT STR	Channel signals open load or internal error.
712	AL SD RQST BIN OUT TST STR	Channel signals open load or internal error.
713	AL SD EXT ENGINE PROTECTN STR	Channel signals open load or internal error.
714	AL SD PRELUBE SIGNAL STR	Channel signals open load.
715	AL SD EXT INC IDLE BIN STR	Channel signals open load.
716	AL SD EXT INC IDLE BIN BRK STR	Channel signals open load.
717	AL SD RQST PLANT DBR STR	Channel signals open load.

APPENDIX D • EXHAUST TREATMENT

TABLE OF CONTENTS

APPENDIX D • EXHAUST TREATMENT

Diesel Particulate Filter (DPF)

In order to meet Tier 4 emission requirements, some engine manufacturers are employing Diesel Particulate Filters (DPF) to the exhaust system of the engine. A Diesel Particulate Filter is a device that acts similarly to a catalytic converter of a car. It traps particulate matter contained in diesel exhaust and prevents it from distributing into the air. The particulate matter is later burned off during a regeneration process.

The IEM-2020 communicates DPF control and status information to and from the engine ECU via J1939 communications in the form of various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). These are summarized in the following paragraphs.

Regeneration

Regeneration is accomplished by operating the engine at elevated exhaust temperatures where the accumulated particulate is burned off. If, in normal operation, the engine can be loaded to a high enough level to achieve the elevated exhaust temperature, then regeneration can occur as a part of normal operation. This is known as *passive regeneration*.

High exhaust temperatures can also be accomplished by methods such as providing dampers in the exhaust stream or heating the exhaust through the burning of fuel. This is known as *active regeneration* since it is outside of normal engine operation.

Heavily loaded engines will seldom require active regeneration. A lightly loaded engine will likely undergo active regeneration when regeneration is required.

DPF Control

DPF control information is sent from the IEM-2020 to the Engine ECU through PGN Number 57244 (0xE000). A manual regeneration request is sent using SPN 3695, Diesel Particulate Filter Regeneration Force Switch. Regeneration can be inhibited by SPN 3695, Diesel Particulate Filter Regeneration Inhibit Switch.

Manual Regeneration

The operator can force a regeneration cycle by turning on the Manual Regeneration setting found on the front panel under Settings > Communication > CAN Bus Setup > ECU Setup > DPF Regenerate Setup. The parameter will remain on for a few seconds then go off. The ECU will respond to the momentary setting by logging the request to force a manual regeneration. A continuous request is not used because this can be problematic for some engine ECUs.

Manual regeneration can also be initiated by clicking the *Manual Regeneration* button on the ECU Setup screen in BESTCOMS*Plus*. BESTlogic*Plus* programmable logic can also be used to initiate manual regeneration by setting the DPF Manual Regeneration (DPFMANREGEN) logic element true.

Regeneration Inhibit

The operator can inhibit regeneration by turning on the DPF Regeneration Disable setting found on the ECU Setup screen in BESTCOMS*Plus*.

Regeneration can also be disabled by turning on the Disable Regeneration setting on the ECU Setup screen in BESTCOMS*Plus*.

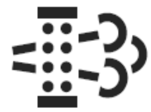
BESTlogicPlus programmable logic can also be used to inhibit regeneration by setting the DPF Regeneration Inhibit (DPFREGENINHIBIT) logic element true.

DPF Status and Pre-Alarms

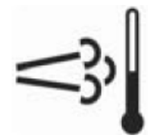
The IEM-2020 receives DPF status information which is broadcast from the engine ECU in various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). The IEM-2020 displays this information on the front panel, and in BESTCOMS*Plus*, via DPF related pre-alarms. The J1939 parameters and the resulting IEM-2020 pre-alarms are summarized in the following paragraphs.

- PGN 64892 (0xFD7C) Diesel Particulate Filter Control 1
  - *SPN 3697, Diesel Particulate Filter Lamp Command*

    DPF REGEN REQUIRED Pre-Alarm: When SPN 3697 has a value of 1 or 4 indicating the DPF lamp is on, the IEM-2020 will annunciate a pre-alarm with text of DPF REGEN REQUIRED. The DPF symbol, shown to the right, will accompany the text when the pre-alarm appears on the IEM-2020 front panel.

    
  - *SPN 3698, Exhaust System High Temperature Lamp Command*

    HIGH EXHAUST TEMP Pre-Alarm: When SPN 3698 has a value of 1 indicating the high exhaust temperature lamp is on, the IEM-2020 will annunciate a pre-alarm with text of HIGH EXHAUST TEMP. The high exhaust temperature symbol, shown to the right, will accompany the text when the pre-alarm appears on the IEM-2020 front panel.

    
  - *SPN 3703 Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch*

    DPF REGEN INHIBITED Pre-Alarm: When SPN 3703 has a value of 1 indicating the DPF Regeneration is inhibited due to the inhibit switch being set, the IEM-2020 will annunciate a pre-alarm with text of DPF REGEN INHBTD. The DPF regeneration inhibited symbol, shown to the right, will accompany the text when the pre-alarm appears on the IEM-2020 front panel.

    
- DPF Soot Level Annunciation via Diagnostic Trouble Code (DTC) SPN 3719 Diesel Particulate Filter Soot Load Percent

  In addition to the standard diagnostic trouble code annunciation, the IEM-2020 will annunciate a pre-alarm under circumstances described below.
  - *FMI = 15: Data Valid But Above Normal Operating Range Least Severe Level*

    DPF SOOT LEVEL HIGH Pre-Alarm: When the FMI is equal to 15, the IEM-2020 will annunciate a pre-alarm with text of DPF SOOT LVL HI. The DPF symbol, shown to the right, will accompany the text when the pre-alarm appears on the IEM-2020 front panel.

    
  - *FMI = 16: Data Valid But Above Normal Operating Range Moderately Severe Level*

    DPF SOOT LEVEL MODERATELY HIGH Pre-Alarm: When the FMI is equal to 16, the IEM-2020 will annunciate a pre-alarm with text of DPF SOOT LVL MOD HI. The DPF warning symbol, shown to the right, will accompany the text when the pre-alarm appears on the IEM-2020 front panel.

    
  - *FMI = 0: Data Valid But Above Normal Operating Range Most Severe Level*

    DPF SOOT LEVEL EXTREMELY HIGH Pre-Alarm: When the FMI is equal to 0, the IEM-2020 will annunciate a pre-alarm with text of DPF SOOT LVL EXT HI. The DPF stop symbol, shown to the right, will accompany the text when the pre-alarm appears on the IEM-2020 front panel. If the DPF soot level reaches the most severe level, the engine ECU may shut the engine down and prevent it from running or it may allow it to run, but at a reduced level. The IEM-2020 only indicates a pre-alarm. It does not prevent the engine from running or cause operation at a reduced power level, but the operator should be aware that the engine ECU or after treatment system may cause such behavior.

Exhaust After Treatment Systems (EATS)

In order to meet Tier 4 emission requirements, some engine manufacturers are adding exhaust after treatment systems (EATS) which treat the engine exhaust within the exhaust system to reduce particulate matter and harmful contaminants prior to releasing the exhaust into the atmosphere. One such system uses urea-based Diesel Exhaust Fluid (DEF) catalyst which is combined with the exhaust gasses in the EATS to bring the emissions to acceptable levels.

The IEM-2020 meters EATS information from the engine ECU via J1939 CAN Bus and displays the DEF level within the DEF tank(s), and also displays several pre-alarms related to the EATS system. Any DEF related pre-alarms annunciated on the front panel display the symbol used for DEF functions which is shown to the right.

Most systems will contain one DEF tank, while some may contain two tanks. The IEM-2020 front panel displays the level of DEF in each tank under Metering > Alarms-Status > J1939 Status > DEF Tank1 LVL% and Metering > Alarms-Status > J1939 Status > DEF Tank2 LVL%. The tank 1 level is sent from the ECU via SPS 1761 in J1939 PGN 65110 - After Treatment 1 Reagent Tank 1 Information. The tank 2 level is sent from the ECU via SPN 4367 in J1939 PGN 64829 - After Treatment 1 Reagent Tank 2 Information.

Pre-Alarms

There are several pre-alarms related to the EATS. They are always enabled and will annunciate when received from the engine ECU. Each of them contains the symbol for DEF functions when annunciated on the front panel; however it will not be displayed in BESTCOMS*Plus*. The pre-alarms are summarized in the following paragraphs.

- DEF FLUID LOW: This pre-alarm displays when SPN 1761 had a value of 1 indicating that the DEF tank level is low. A DEF level of 8% to 23% causes this annunciation.
- DEF FLUID EMPTY: This pre-alarm displays when SPN 1761 had a value of 4 indicating that the DEF tank level is low. The low condition is announced when the tank level is below 8%. When this occurs and is not remedied, the engine ECU may enter a mode of inducement not to operate the engine where some of the conditions in the pre-alarms descriptions below may occur.
- DEF ENGINE DERATE: This indicates that the engine is going into a reduced power mode indicating the lowest level of inducement not to operate the engine when the EATS is not functioning properly or out of DEF.
- DEF PRESEVERE INDUCEMENT: This indicates that the engine has entered the second highest level of inducement not to operate the engine when the EATS is not functioning properly or the DEF level is low. The ECU will allow the engine to run for a maximum of 3 hours in this condition. After expiration of the 3 hours, the engine will enter the severe inducement state and cannot be restarted until the DEF level is raised above 14%.
- DEF SEVERE INDUCEMENT: This indicates that the engine has entered the highest level of inducement not to operate the engine when the EATS is not functioning properly or DEF level is low. The ECU will allow the engine to run for a maximum of 3 hours in this condition. After expiration of the 3 hours, the engine will enter the severe inducement state and cannot be restarted until the DEF level is raised above 14%.
- DEF INDUCEMENT OVERRIDE: The DEF inducement is temporarily overridden. The engine may operate with reduced power, or for a limited time, after which time it may re-enter the SEVERE INDUCEMENT state.

Exit Conditions for DEF Severe Inducement

- First Restart: Return to 0% torque reduction in exit condition, until proper DEF level and quality evaluation. If low level or poor DEF quality is detected during the next monitoring cycle, the severe inducement will be active after the next restart. After the second restart, a service tool is required to exit the severe inducement.
- With Service Tool Clearing: Invoke 0% torque reduction with service tool clearing until proper DEF level and quality evaluation. If low level or poor DEF quality is detected during the next monitoring cycle, the severe inducement will be active after the next restart.

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