3500B Series II

MARINE ENGINES

Supplemental Application and Installation Guide

- Electronics
- Electrical Power Supply
- Data Transmission
- Electronic Attachments
- Electronic Features

CATERPILLAR®

3500B Series II

MARINE ENGINES

Application and Installation Guide

Introduction

The first Caterpillar® 3500B marine engines were introduced in mid-1995. Their acceptance by the marine marketplace has exceeded all expectations, due to their high power, superior emissions, superb fuel efficiency, and long life-before-overhaul. The Series II engines take the already popular engine and make it even better.

New Electronic Features

The Series II engine has a new generation Engine Control Module (ECU), the A3, with more speed, memory, and connections. The Series II engine has a more durable, reliable, and adaptable rigid wiring harness; making the 3500B engine even more useful to its operators.

The Series II engine has a new fully graphical engine performance-monitoring instrument in its instrument panel. This monitoring instrument builds on the proven foundation of the marine classification society type approved Marine Power Display (MPD) and adds new software to take full advantage of the broad array of performance transducers to give the most complete range of performance-related data in the industry.

The 3500B Series II has the following features/ benefits in addition to all its prior advantages.

Redundant Electronic Overspeed Shutdown

This feature is in accordance with marine classification society requirements for an independent overspeed shutdown. It is part of both the propulsion and auxiliary standard engines. This feature trips air inlet shutoffs, if fitted, and also de-energizes both the primary and secondary ECUs. An overspeed condition is latched and annunciated on the engine-mounted instrument panel. Reset of an overspeed shutdown can only be performed locally at the engine by momentarily setting the Engine Control Switch (ECS) on the engine-mounted instrument panel to OFF.

Emergency Stop (E-Stop)

As on the earlier engine with ADEM™ II, the Series II engine has two Emergency Stop systems:

A. The first is an ECU feature that turns the fuel off and trips the air inlet shutoffs if they are fitted. In this case the ECU is responding to two simultaneous open circuits on two external connections to the engine harness. These are labeled “Shutdown C” and “Shutdown D.”

   Latching relay logic within the power distribution box also de-energizes both of the ECUs in response to the ECU tripping the air inlet shutoffs.

B. A second, purely relay logic based system that, in response to activation of an engine mounted E-Stop pushbutton, trips the air inlet shutoffs if they are fitted and de-energizes and latches off the power to both of the ECUs.

On Series II engines there is a new, third system:

C. If battery plus power is connected to an input pin on the customer connector, this also trips the air inlet shutoffs if they are fitted and de-energizes and latches off the power to both of the ECUs.

Reset of an E-Stop shutdown can only be performed locally at the engine by momentarily setting the ECS on the engine-mounted instrument panel to OFF.

To avoid a single point of failure, it is recommended that both system shutdown “A” and system shutdown “C” are wired via multi-pole (both Normally Closed & Normally Open contacts) external E-Stop pushbuttons.

Local Speed Control

This optional feature provides a means of controlling the engine speed at the engine-mounted instrument panel of propulsion engines. A switch labeled “Local/Remote Throttle” is mounted inside the engine-mounted instrument panel. With the local/remote throttle switch in the local position, the secondary throttle signals to both primary and secondary engine control modules will be controlled by a 10-turn potentiometer on the face of the instrument panel.

The transition between local and remote throttle is inhibited when the two throttle sources do not match speed within a small window.

When the local speed control option is installed, it is not possible to use the ECU’s speed matching transition logic to “sync” the throttle inputs to multiple engines to a single external throttle signal source.

If both local throttle control and also syncing of multi-engine throttle signals to a single throttle signal is required then it is recommended that the throttle syncing be done by an external multi-engine control system.

Remote Pre-lube Override Capability

With Series II, there is the capability to override the pre-lube function when starting remotely. This is a valuable feature when restarting engines that have shut down while maneuvering.

Engine Protection System Override — Remote and Local

Local engine protection system override has been available from first production, using a switch contained in the engine-mounted instrument panel. With Series II, the feature is also available for use from a remote control/instrument panel.

Ground Fault Protection on All Components

All Series II engine components are equipped with circuitry that prevents nuisance tripping of ground fault detection equipment.

Remote Pilot House Panel, Using Marine Power Display

This feature will become available approximately nine months after production. Until then, the engine will use the current EMS-II pilothouse panel.

Prioritization of Alarms in Marine Power Display (MPD)

The alarms displayed on the MPD (located on the face of the engine-mounted instrument panel) will be prioritized into three categories. The lowest will announce failures that do not force the engine to reduce power and which will allow indefinite operation without further action. The next highest category of alarm will announce failures that demand power reduction, but the engine can continue to operate. The highest or most severe level of alarm announces failures that demand immediate engine shutdown to avoid engine failure.

Serviceable, Long-lived, Rigid Wiring Harness

The wiring harness of the 3500B Series II engine is designed to be re-useable indefinitely. It is easily removed and reinstalled when the engine requires disassembly. The harness will meet the requirements previously met by today's engines' premium wiring harness. The main rails of the rigid wiring harness contain space to add approximately 30 percent more wires before the available space is filled. There will be 13 unused wires in the crossover duct around the back of the engine. These wires will be readily useable should additional functions need to be added to the engine wiring. A terminal strip box will be available as an option that will allow installers to use a numbered, screw-type terminal strip to make their installing wiring connections to the ship. The box is available with a 3, 10, or 15 meter harness, attached at one end to the mating connector of the customer connector and the terminal blocks in the box at the other. This is to allow the terminal strip box to be conveniently located.

Waterproof ECU Connections

The design of the connectors to the ECUs is unique to the Series II engine. The connecting wires are supported in a shell that prevents water from reaching either the conductors or their insulation.

Power Distribution Box with Isolation of Control Power from Starter/ Alternator Power

Allows use of an uninterruptible power supply for control power. The power distribution box may be optionally mounted off the engine.

Individual Cylinder Exhaust Temperatures on a Data link

The individual cylinder exhaust temperature scanner, available at first production of Series II, has an RS485 data link allowing display of individual cylinder exhaust temperatures in the pilothouse.

Engine-Mounted Instrument Panel with and without Individual Cylinder Thermocouples and Pyrometer is Remountable on Either Side of the Engine.

This feature is best used when stock engines must be reconfigured to change the side of the instrumentation.

Start/Run/Stop Features

The Series II engine will have two modes of start/run/stop logic. The mode is selected by adding and deleting jumper wires within the engine-mounted instrument panel.

ADEM II MODE: The engine may be started and stopped using the Engine Control Switch (ECS) and remote start/run/stop signals exactly as on the previous ADEM II ECU-equipped engines.

There is a difference, however, with respect to the Cat Data Link start/stop (e.g. from Engine Vision or a CCM). As on ADEM II ECU engines, remote start is disabled on Series II engines with the ECS on the engine-mounted instrument panel being in either of the two LOCAL positions.

The difference is with the ECS in the 4th position (labeled AUTO on ADEM II ECU engines and REMOTE on A3 engines). On ADEM II ECU engines the Data Link START/STOP is enabled whenever the ECS is in this 4th position, but on Series II engines there also needs to be a connection between two pins on the customer connector. The customer can either permanently wire them together or extend the connections out to a remote switch.

REMOTE MOMENTARY (PULSE) START/STOP:

- Local start/stop using the ECS on the engine-mounted instrument panel as on today's engine.
- Remote "hard wired" start/stop signals arranged for "pulse or momentary" signal to control start/stop logic. This feature allows the operator to start and stop the engine from any number of remote (outside the engine room) locations, using pushbutton switches. The pushbuttons need to be double pole because there are two momentary START signals and TWO momentary STOP signals; if there is a wiring fault causing any one signal not to match state with its mate, the ECU will detect and log this as a diagnostic fault.
- Start/stop via the data link. Same as described above under ADEM II ECU.

Annunciation of ECS-in-remote is available.

New Indicator Lamps on the Front of the Engine-Mounted Instrument Panel

An overspeed shutdown or an E-Stop shutdown de-energizes power to both Engine Control Modules. There is therefore no way of logging either of these events in the ECU memory or displaying this condition on the Marine Power Display. Therefore, two RED lamps are provided on the front face of the engine-mounted instrument panel to annunciate these two shutdown conditions.

Both auxiliary and propulsion engines have connections on the customer interface connector for remote annunciation of:

- Overspeed Latched
- E-Stop Latched

On the propulsion engine, the traditional green lamp indicates the secondary ECU is ready and an amber lamp indicates the secondary ECU is active.

Propulsion engines also have two additional connections on the customer interface connector for remote annunciation of:

- Secondary ECU is Ready
- Secondary ECU is Active

Starter Lockout Feature

The Series II engine is wired so that the connections for the drive signal between the Engine Control Module and the starter motor magnetic switches (or the air start solenoid) are brought out to the customer connector. This enables the customer to include a starter lockout relay to prevent engine cranking during maintenance.

Please Note: It is imperative after exercising the starter lockout feature that the ECS switch is set to OFF prior to disengaging the lockout.

Remote Prelube Pump

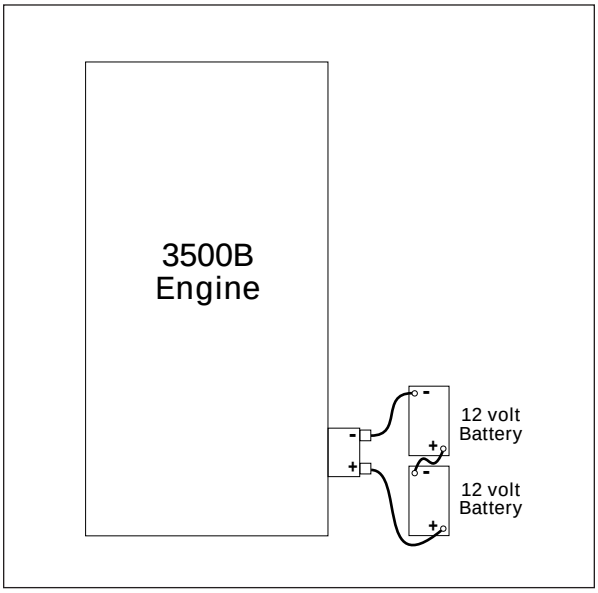
The Series II engine includes a slave relay with voltage-free or dry contacts that is energized during the prelube cycle. These contacts are brought out onto the customer connector. This allows the customer to connect a remote prelube pump (e.g. with a three-phase motor).

Minimum Electrical Requirements for Installation of 3500B Marine Engines

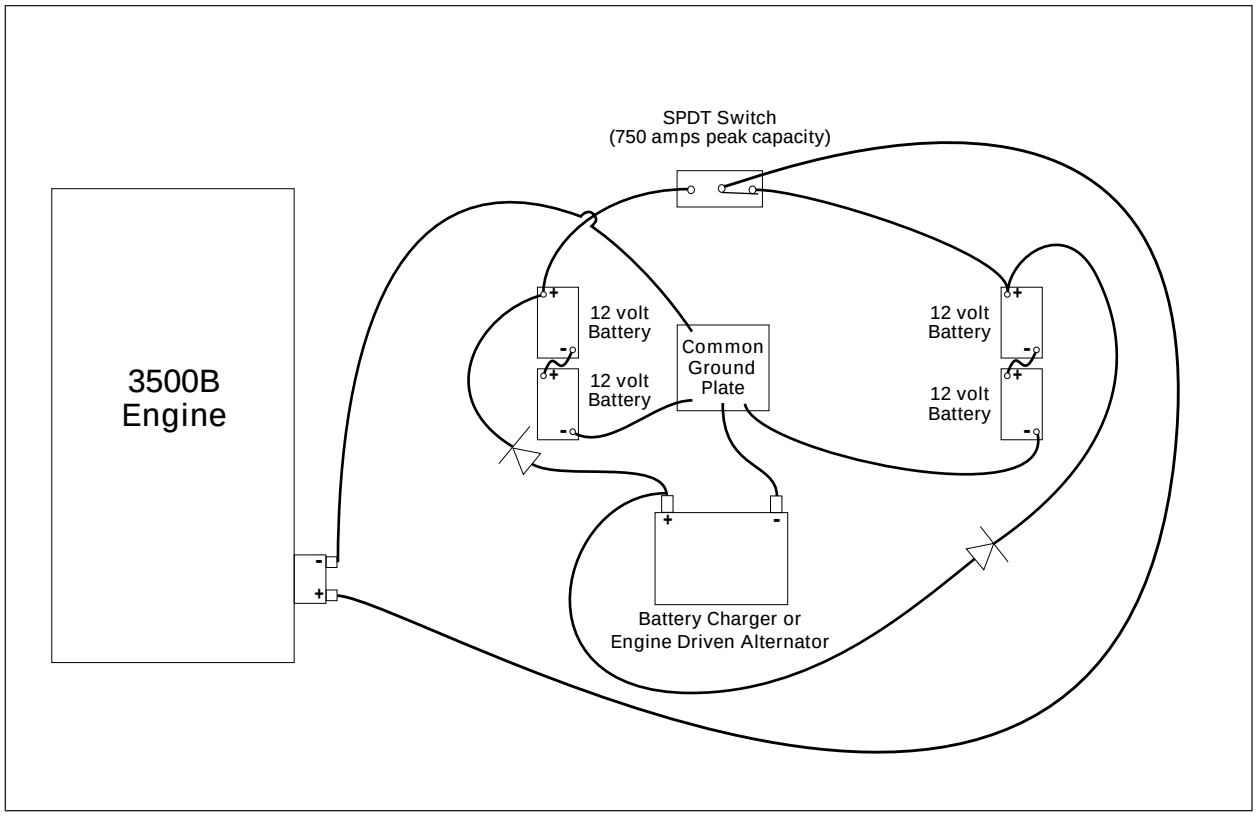
System	Remarks	Reference
Power Supply: 3500B Series II engines must be supplied with a reliable source of direct current electricity, with a minimum of one alternative power source to provide redundancy.	The engine's A3 Electronic Control Module (ECU) needs 10 amps of 24 VDC supplied via a dedicated battery set. Interrupting this power will shut off the engine. Alternative power supplies include, but are not limited to, back-up battery sets, engine-driven alternators and battery chargers with voltage-regulated power supplies.	See pages 9-12 for details.
Data Transmission: If a pilothouse instrument panel is desired to monitor the engine, the panel must be connected via wires. The path for the wires must be free of significant electromagnetic interference.	The engine's ECU uses a twisted pair of wires with low capacitance to transmit its performance data. If the Cat Link Data Link is to be used, use shielded data link cable (P/N 123-2376) with a Customer Communications Module (CCM) to boost the data link signal for distances up to 300 meters (1000 feet). If the J1939 data link is to be used, use part number 153-2707 cable and keep the length below 30 meters. In either case, the wire path must not contain wires going to radar or radio antennas, generator output leads or battery charger's power conductors.	See pages 14-16 for details.
Throttle Signal: The engine uses a Pulse-Width Modulated (PWM) electronic signal to control its speed.	Caterpillar offers a throttle signal generator to generate the required, regularly spaced, "square wave" pulses of varying width that the engine uses as a throttle signal in response to the angular movement of a lever. Several pilot house control vendors offer products that also supply the PWM signal.	See pages 38 and 52 for details.

Electrical Power Requirements

A well-designed power supply to the 3500B Series II engine includes a 24-volt battery set, usually composed of two 12-volt batteries connected in series and capable of continuous supply of 10 amps to each engine to drive its injectors, regardless of whether the engine is equipped with a backup ECU or not. It is important that each engine have its own set of batteries in the manner of the sketch below. Note that the following sketches are not intended to illustrate ALL the features or components of a fully operational system. The sketches are designed to illustrate specific aspects of the installation and are simplified for ease of understanding.

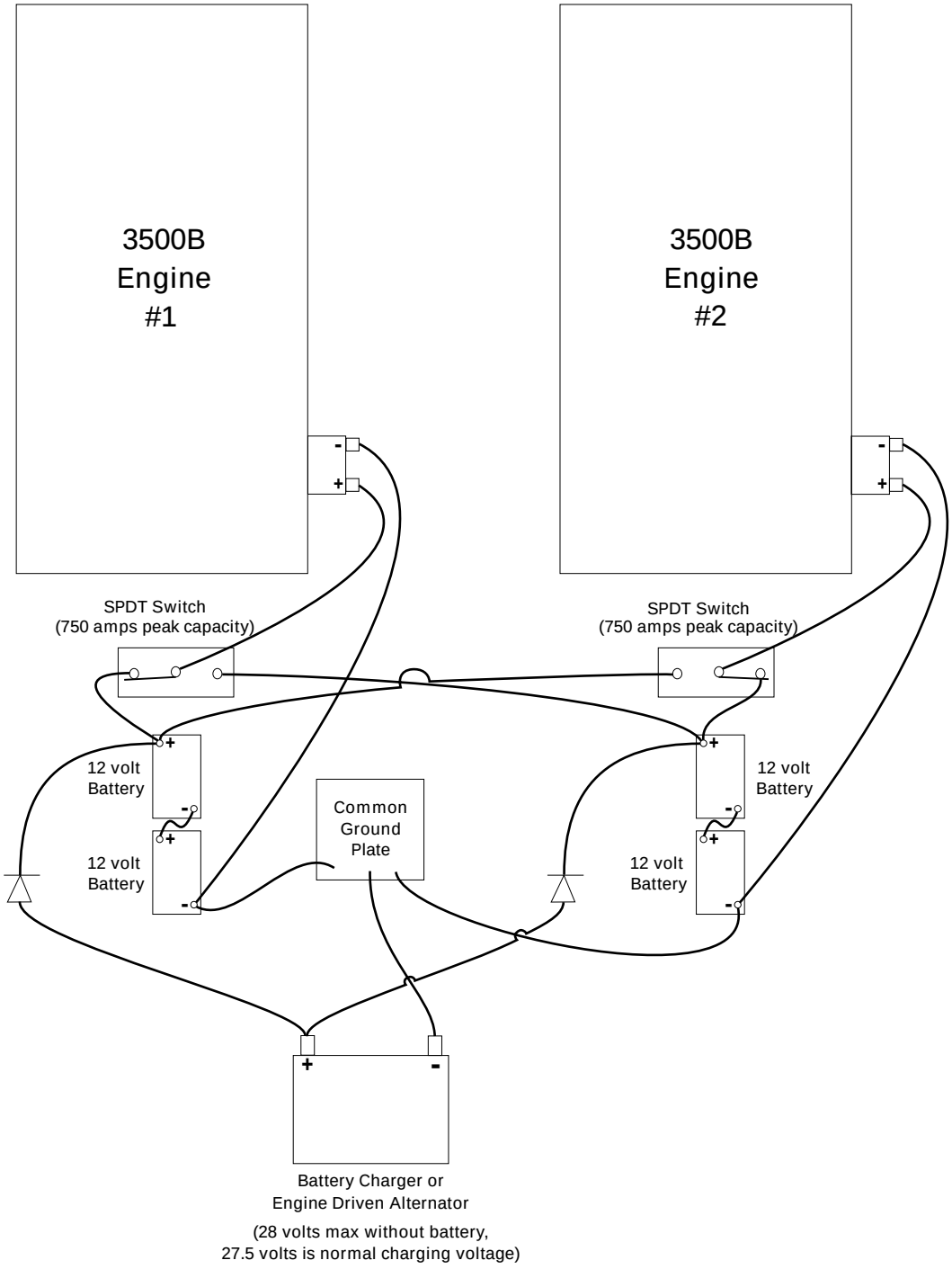


The engine must also have a redundant or alternative power supply to the engine to protect from loss of power because of a failure of a single component. The alternative power supply might be, but is not limited to, a second 24-volt battery set, a battery charger, or a separate engine-driven alternator for each engine. If a single battery charger is used to charge the batteries for more than one engine, the lines connecting the positive post of each of the batteries to the positive terminal of the battery charger must include properly oriented diodes. The diodes serve to prevent an adequately charged battery discharging through a failed battery charger or an adequately charged battery discharging through a failed battery. The negative terminal of each battery set is to be connected to a single point on the metal hull or to the common ground plate on a non-metallic hull. Under no circumstances should the positive poles of each battery set be connected together. They must remain independent so a failure in any one battery does not drain the other batteries in the system.



In the application of multiple engines, it is desirable to be able to operate any engine from any set of batteries or battery charger. The sketch below illustrates the use of redundant batteries.

Notice the diodes are required in the application because the battery chargers/alternators are not dedicated to a specific set of batteries.



Power Distribution Box

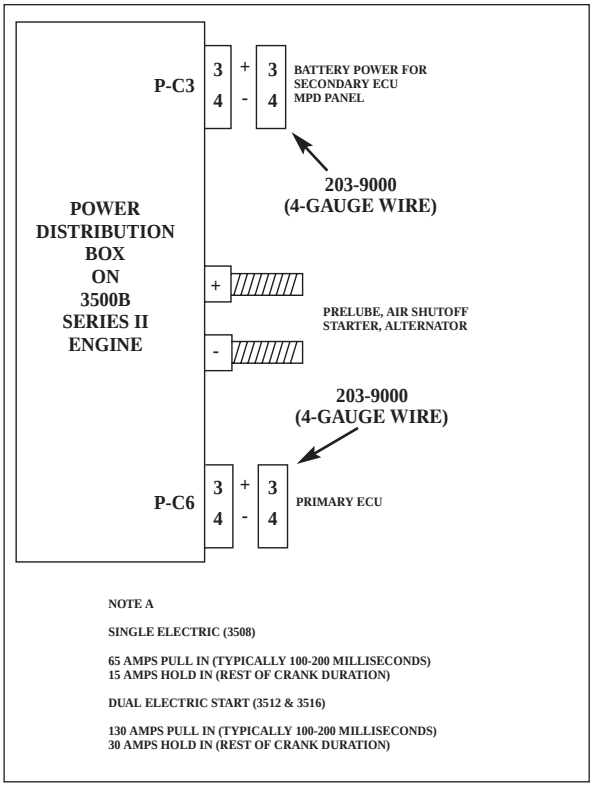
Power Connections & the Power Distribution Box

The power connections to the Series II engine are made at the power distribution box and fall into three physically separate groupings; these are shown on the following diagram and also photograph below.

These groupings are made to allow the customer to have separate power sources for maintaining operation of the engine in the event of a loss of one or more of the power sources.

On many engines, separation of the power sources is not a requirement. As a convenience, therefore, each engine is equipped with two jumper harnesses, 242-0105 and 242-0106, that connect between the three groups of connections so that the two main power lugs on the front of the PD box serve as a single set of battery plus and battery minus connections.

Please note: the current values specified on the diagram are the circuit breaker settings. They are included to help the customer/installer select the wire gauge for external power connections that is appropriate for the trip levels of the various circuit breakers within the power distribution box; they do not necessarily reflect the typical current consumption of the circuits.



Acceptable Voltage Range

The recommended continuous voltage range to provide power to a 3500B Series II marine engine is 20 to 28 volts. The engine's monitoring system will annunciate an alarm condition if the voltage falls below this range. A back-up battery set should be brought on line as soon as the primary system voltage falls outside the recommended range. Make-before-break contacts are preferred.

The engine's monitoring system will annunciate an alarm condition if the voltage exceeds 32.5 Volts DC.

Many battery chargers are capable of dangerously high voltages if operated without a functioning battery to provide an electrical load. Engine operation with ECU voltage above 30 volts will damage the ECU. Engine-driven alternators include a voltage regulator and will not damage the ECU should a battery failure occur. Engine-driven alternators are to be preferred over battery chargers as a redundant power source.

The monitoring system will not function correctly below 18 volts. The engine will continue to run to as low as 12 volts. The engine is designed to handle momentary drops in system voltage to as low as 9.6 VDC. However, components are not designed to operate in this mode indefinitely and continued operation at this voltage level will result in system damage. A temporary loss of power (as in one or two milliseconds when switching from primary to backup power batteries) will not affect engine operation. The engine will continue to run normally.

Current Requirements

A 3500B Series II engine requires 10 amps of 24-volt direct current power to run. Battery chargers must be capable of providing that plus an additional 2 to 5 amperes of power, over the total normal electrical load, to charge batteries if the batteries are in a discharged state. The ECU requires 80 amps of inrush current for 2 milliseconds to initialize its injector drivers. Any engine power supply must be capable of supplying this requirement: power supplies that include batteries **are** capable of meeting this requirement.

Current Requirements (System is nominally 24 Volts DC)

Subsystem Component Installed by Customer	Continuous (Amps)	Intermittent (Amps)
Pilot house panel	1	1
Throttle position sensor	0.04	0.04
Programmable Relay Control Module (PRCM)	0.5	0.5
Relay Driver Module (RDM)	1.8	1.8
Customer Communication Module (CCM)	0.3	0.3
Non-electric started engines supply from batteries to power distribution box	10	24 (for 2.5 seconds during actuation of air inlet shutoff)
24 volt prelube pump motor	40	
Air inlet shutoff		30 (for 2.5 seconds during actuation at shutoff)
Electrical starter motors		130 amps for 100-200 milliseconds followed by 30 amps for remainder of cranking

Ground Cable Wire

Ground cable wire should be two wire sizes larger than other cables in the system. A ground wire can carry a lot of current. If there is resistance in the wire or any of the connections, a voltage drop can develop according to Ohm's Law (V=IR). For sensors, this voltage drop, created on the ground wire, can cause problems in engine performance measurements.

Electrical System Grounding Requirements

Power Circuits

Proper grounding for vessel and engine electrical systems is necessary for proper performance and reliability.

Notice: *Improper grounding will cause uncontrolled and unreliable circuit paths.*

This can result in damage to the engine's crankshaft main bearings, crankshaft journal surfaces or other engine components, and can cause electrical activity that may degrade the boat's electronics and electrical communication equipment.

The negative terminal of the battery that feeds 24 volt power to the engine and connects to the engine's alternator, starting motor, and other electrical systems MUST be grounded to the vessel's single, common ground point. Apart from this single ground connection, the alternator, starting motor and other electrical systems must remain electrically isolated from the engine block and any other item that could provide an electrical path to the vessel's hull.

For engines that utilize the throttle synchronization capability, it is critical that there be a very good low resistance path between the negative (-) battery connections of each engine's battery sets. The wire should have a minimum diameter of 9.27 mm and a cross section of no less than 67.4 mm^2 (00 AWG), to ensure proper synchronization operation.

Ground Plate

A ground plate with a direct path to the negative (-) battery terminal is permissible to use as a common ground point for the components of one or more engine systems whose battery negative connections ultimately are connected to each other (e.g., due to data links between them or for some other operational need). The size of a wire that connects the battery negative terminal to the ground plate MUST be of adequate size to handle full alternator charging current.

Ground Fault Detection Equipment

Modern ground fault detection equipment will alarm on leakage currents that would have gone undetected by older incandescent lamp ground fault detection equipment. Use ground fault detection equipment whose sensitivity is adjustable to deal with the insignificant leakage currents associated with flyback diodes and modern solid state power supplies.

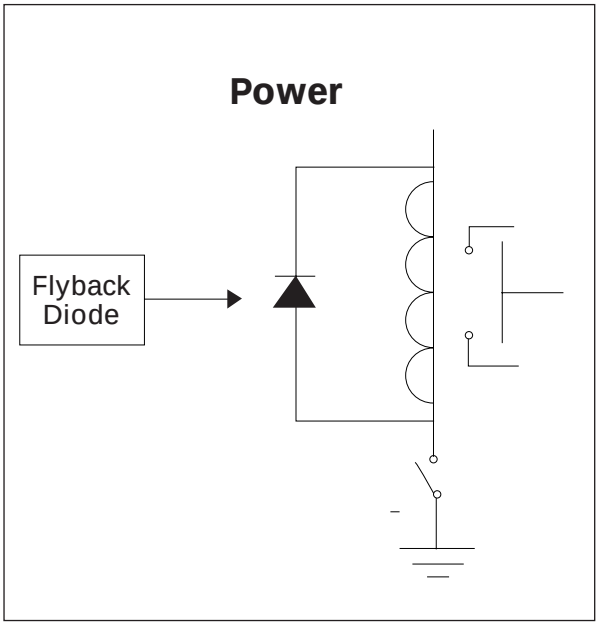
Ground Faults

The 3500B Series II ECU is mounted in electrically insulating rubber bushings. The housing of the ECU, as shipped from the factory, is bonded to the engine block with a woven metal strap. The ECU contains an internal protection circuit that connects between the negative connection of the input power to the ECU and its metal housing. This circuit protects the ECU's electronic components from damage during the engine's electrostatic painting process in the factory. At the much lower voltages that are typically used by Marine Vessel's Ground Fault Detection Systems, this protection circuit is essentially open circuit and provides a high enough resistance path to avoid nuisance tripping of ground fault detection equipment.

Wiring Practices

When connecting to inductive loads such as solenoids, relays, and motors, always use flyback diodes to avoid the damaging effects of transient voltage spikes.

A flyback diode allows current in a coil to decay to zero without causing damage when the switch is opened.



In general, relays driven by the ECU or PRCM do not need external flyback diodes since the ECU contains flyback diodes. It is good practice to maximize the distance between solenoids, relays and other electrically noisy components from engine controls or wiring.

Wire Gauge Cross Reference Table							
AWG	Diameter		Cross Section		Ohms / km		Mass
	mm	mils	mm^2	cmils	@ 25°C	@ 105°C	kg/km
250 MCM	12.7	500	126.6	250000	0.138	0.181	1126
4/0	11.7	460	107.4	212000	0.164	0.214	953
2/0	9.27	365	67.4	133000	0.261	0.341	600
1/0	8.26	325	53.5	105600	0.328	0.429	475
1	7.35	289	42.4	87700	0.415	0.542	377
2	6.54	258	33.6	66400	0.522	0.683	300
3	5.83	229	26.6	52600	0.659	0.862	237
4	5.18	204	21.1	41600	0.833	1.09	187
5	4.62	182	16.8	33120	1.05	1.37	149
6	4.11	162	13.3	26240	1.32	1.73	118
8	3.25	128	8.30	16380	2.12	2.90	73.8
10	2.59	102	5.27	100400	3.35	4.36	46.9
12	2.05	80.8	3.31	6530	5.31	6.95	29.5
14	1.63	64.1	2.08	4110	8.43	11.10	18.5
16	1.29	50.8	1.31	2580	13.4	17.6	11.6
18	1.02	40.3	0.821	1620	21.4	27.9	7.31
20	0.81	32.0	0.517	1.20	33.8	44.3	4.61

3500B Marine Engine Control Systems

The following manufacturers have successfully supplied engine speed and transmission controls for use with Caterpillar 3500B marine engines.

Vendor Home Office, Name, and Address

ZF Mathers LLC.
12125 Harbour Reach Drive
Mukilteo, WA 98275
Tel: 360-757-6265,66
800-546-5455
Fax: 360-757-2500
Colin Anscomb
Engineering Manager
E-mail: colin.anscomb@zf.com

Kobelt Manufacturing Company, Ltd.
8238 129th Street
Surrey
British Columbia, Canada V3W 0A6
Phone: 604 572 3935
Fax: 604 590 8313
E-mail: hicham@kobelt.com

Vendor Home Office, Name, and Address

Prime Mover Controls Ltd.
3600 Gilmore Way
Burnaby, British Columbia V5G 4R8
Canada
Phone: 604-433-4644
Fax: 604-433-5570

Hydraudyne Pneumatiek bv
P.O.Box 9236
3007 AE Rotterdam
The Netherlands
Phone: +31-10-4970300
Fax: +31-10-4821210

Sturdy Controls Div
1822 Carolina Beach Rd.
Wilmington, NC 28401-6599
Phone: (910) 763-2500
Mike Jones
General Manager, Marine Division
E-mail: mjones@sturdycorp.com

While all the manufacturers above have successfully controlled Caterpillar 3500B marine engines, Caterpillar does not accept responsibility for successful use of products it does not sell or control.

Data Transmission

The 3500B Series II engine uses sets of voltage pulses in pairs of wires to communicate. Impedance of the wires, especially the capacitance aspect of the impedance, will determine the maximum wire length over which communications are practical.

3500B Series II Data Links

The Series II engine uses two data links.

- The global data link, usually used for off-engine communications, is SAE J1939 and uses the CAN electronic components. Without external devices to extend the allowable length of communications, J1939 is limited to 30 meters (98 feet).
- The local data link is the proprietary Cat Data Link (CDL). This data link is usually used for communications with on-engine devices, such as some of the engine's performance sensors. It can also be used to communicate with an EMS II pilot house instrument panel or Engine Vision.

Either of the two data links can be used for off-engine communications.

Data Link Cable Specification

Caterpillar's testing has determined the following will provide reliable data link communications.

Cat Link Data Link	
Property	**Specification**
Conductor-to-conductor capacitance	not more than 23 picofarads per foot
Conductor-to-shield capacitance	not more than 44 picofarads per foot
Wire diameter	not less than 1.29 mm (16 AWG)
Wire data	Wires should be tinned, stranded and twisted
Insulation	Rated for 600 volts and a temperature range of -65°C to 110°C

J1939 Data Link					
Parameter	**Minimum**	**Nominal**	**Maximum**	**Unit**	**Conditions**
Impedance	108	120	132	ohm	Three meter sample length measured at 1 Mhz between the two signal wires with shield grounded using open/short method
Specific Resistance	0	25	50	milliohm per meter	Measured at 20°C(1)
Specific Line Delay		5.0		ns/m	67% V_p(2)
Specific Capacitance	0	40	75	picofarads per meter	Between conductors
	0	70	110	picofarads per meter	Conductor to shield
Cable Size					See note (3)
0.5 mm^2 Conductor (20 AWG)	0.508			mm^2	See note (4)
Wire Insulation Diameter	2.23		3.05	mm	
Cable Diameter	6.0		8.5	mm	
0.8 mm^2 Conductor (18 AWG)	0.760			mm^2	See note (4)
Wire Insulation Diameter	2.5		3.5	mm	
Cable Diameter	8.5		11.0	mm	
Shield Effectiveness		200	225	milliohm per meter	Surface transfer impedance up to 1 Mhz Test method per MIL-C-85485
Temperature Range	-40		+125	°C	Heat aging: 3000 hours per ISO 6722, test with a mandrel 4-5X diameter of cable.(5)
Cable Bend Radius	4 x dia. of cable			mm	90° bend radius without cable performance or physical degradation.

(1) The differential voltage on the bus line seen by a receiving Electronic Control Unit (ECU) depends on the line resistance between it and the transmitting ECU. Therefore, the total resistance of the signal wires is limited by the bus level parameters of each ECU.

(2) The minimum delay time between two points of the bus line may be zero. The maximum value is determined by the bit time and the delay time of the transmitting and receiving circuitry.

(3) Other conductor sizes available. Component insulation dimensions may be larger than those specified in SAE J1128. Design engineers should ensure compatibility between cables, connectors, and contacts.

(4) Meet performance requirements of SAE J1128 for types GXL or SXL (includes drain wire where applicable).

(5) 125°C or per OEM specification.

BUS LINE – The J1939 bus line consists of a CAN_H, CAN_L and CAN_SHLD conductors. The CAN_H should be yellow in color while the CAN_L should be green. In addition, the cable must meet the following minimum requirements.

TOPOLOGY: The wiring topology of a J1939 network should be as close as possible to a linear structure in order to avoid cable reflections. In practice, it may be necessary to connect short cable stubs to a main backbone (or main trunk) cable, as shown in the figure on page 18. To minimize standing waves, nodes should not be all the same length.

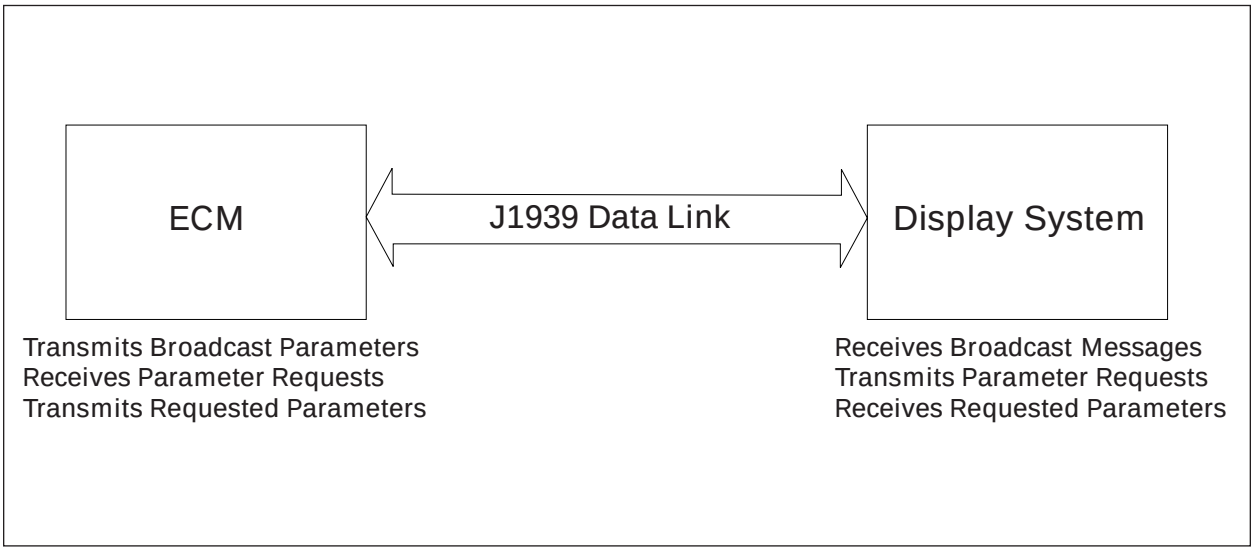
Caterpillar offers wire of the required capacitance. For Cat Link Data Links less than 30 meters or 100 feet in length, use part number 143-5018 — unshielded data link cable. For Cat Link Data Links from 30 meters to 457 meters (100 to 1500 feet), use part number 123-2376 — shielded data link cable together with a Customer Communications Module (CCM). The CCM boosts the data link signal, making reliable communication over distances of up to 457 meters or 1500 feet possible. See the section on the CCM for additional information. For J1939 data links, use part number 153-2707. For J1939 data links on 3500B Series II engines longer than 30 meters (98 feet), contact the factory.

Cat Data Link Protocol

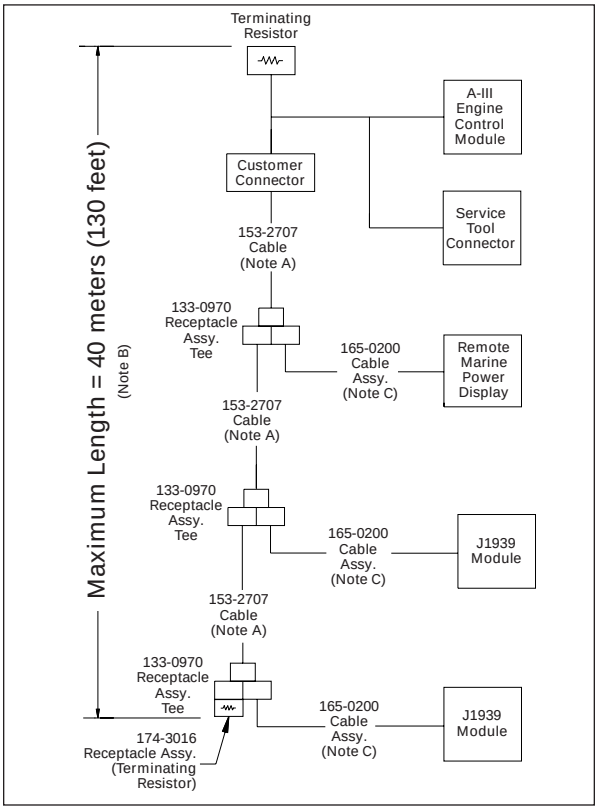
Cat Data Link is a proprietary network protocol that uses a variation of the RS-485 wiring requirements. Since the Cat Data Link is a proprietary (closed) protocol, outside devices can only communicate to the engine network by going through the Customer Communications Module (CCM), a protocol converter that translates the protocol of the engine network and converts it an ASCII-based M5X protocol.

J1939 (CAN) Data Link

The SAE J1939 CAN data link is used to communication engine information to the Marine Power Display. It broadcasts at the baud rate of 250 K bits per second from the ECU to the engine's display system. The display system consists of a single engine with one or more display devices. Each engine has its own data link and display devices operating stand-alone, separate from all other engines. The J1939 data link broadcasts the following parameters.



J1939 Data Link Installation Guidance



Note A: Fabricate 153-2707 cable to length

Note B: The main trunk is defined as that part of the network between the two terminating resistors.

Note C: Branches from main J1939 bus should NOT be all the same length. None should exceed 1 meter (3.3 feet) in length.

Parameters on 3500B Marine Engines

Parameters	Data Range	Transmission Rate (milliseconds)	3500B/C		Marine Power Display
			A3	A3 Backup	
Status Parameters					
Percent Load	0 to 125%	50	X		X
Primary Throttle Position	0 to 100%	50	X		X
Secondary Throttle Position	0 to 100%	50	X		X
Aftercooler Coolant Temperature	-40 to +210°C	50	X		X
Air Filter Differential Pressure #1	0 to 12.5 kPa	50	X		X
Air Filter Differential Pressure #2	0 to 12.5 kPa	500	X		X
Battery Voltage	0 to +3212.75 V	1000	X	X	X
Boost Pressure	0 to +500 kPa	50	X		X
Coolant Temperature	-40 to +210°C	50	X		X
Coolant Level	0 to 100%	500	X		X
Crankcase Pressure	-250 to 251.99 kPa	500	X		X
Engine Hours	0 to +210,554,060.75 h	50	X		X
Engine Speed	0 to 8031.875 rpm	15	X	X	X
Right Manifold Exhaust Gas Temperature	-273 to +1735°C	500	X		X
Left Manifold Exhaust Gas Temperature	-273 to +1735°C	500	X		X
Fuel Filter Differential Pressure	0 to +500 kPa	1000	X		X
Fuel Pressure	0 to +1000 kPa	50	X		X
Fuel Rate	0 to +3212.75 L/h	100	X		X
Fuel Level	0 to 100%	1000	X		X
Oil Filter Differential Pressure	0 to +125 kPa	1000	X		X
Oil Pressure	0 to +1000 kPa	50	X		X
Pre-Filter Fuel Pressure	0 to +500 kPa	500	X		X
Pre-Filter Oil Pressure	0 to 1000 kPa	100	X		X
Transmission Pressure	0 to +4000 kPa	50	X		X
Transmission Temperature	-273 to +1735°C	50	X		X
Turbocharger #1 Compressor Inlet Pressure	-250 to 251.99 kPa	1000	X		X
Turbocharger #2 Compressor Inlet Pressure	-250 to 251.99 kPa	1000	X		X

Data Link Terminations

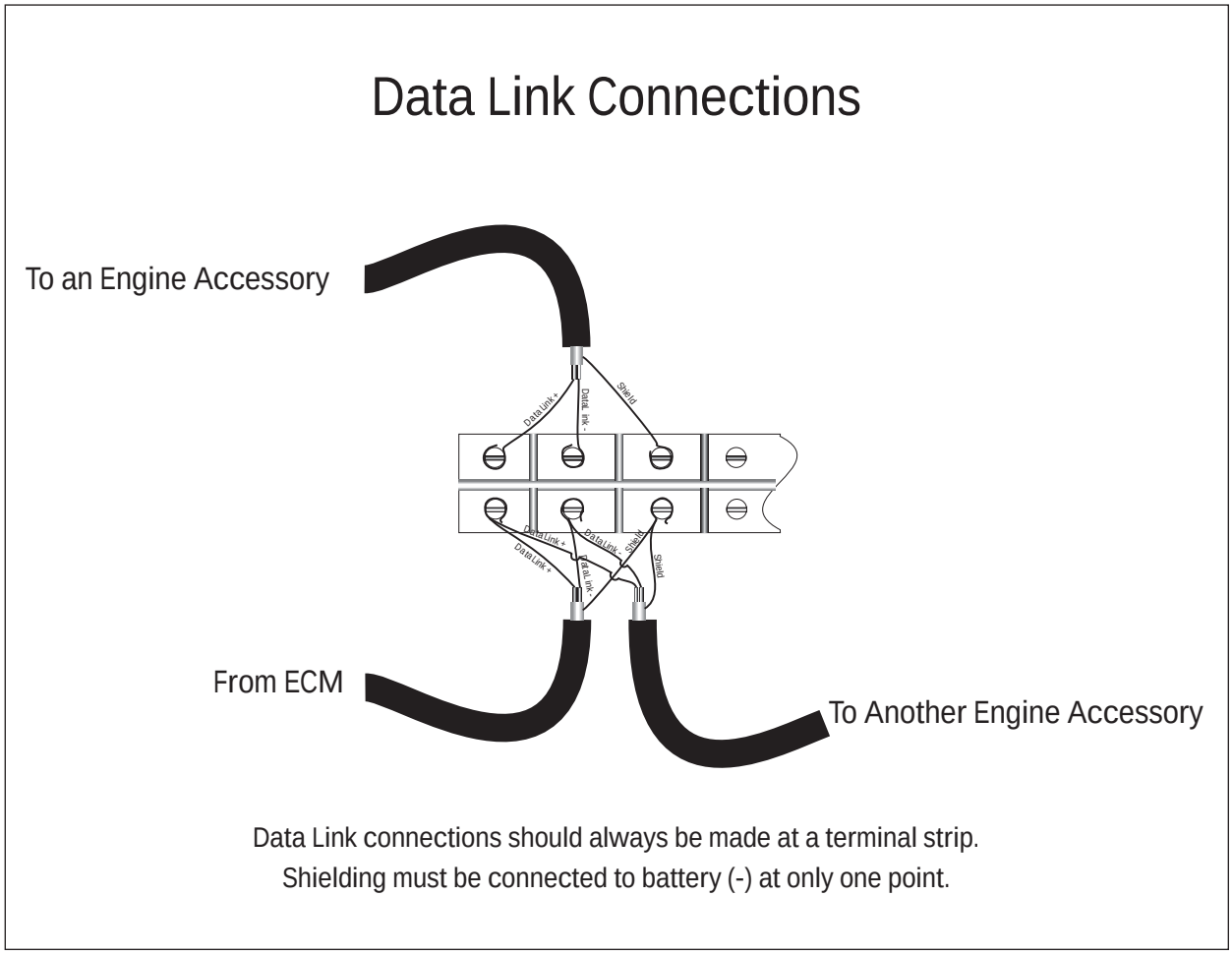
Avoid splicing or soldering wire connections. Cat Data Link connections should terminate at a dedicated data link terminal strip to ensure engine and communications systems reliability. J1939 data link connections must terminate using a terminating resistor. Locate all data links to minimize the length of the wire run. Running data link wiring in the same raceway as high power cabling, such as generator leads, radar or radio antenna wires, or any AC cabling is strictly forbidden.

Connections to Shielding of Data Transmitting Wire

The shield of data link cable must not be left isolated or “floating”; it must be connected to a point in the electrical system. For best results it should be connected to the battery negative connection that is common between all of the devices that connect to the data link, preferably near the middle and not at one of the ends of the main trunk.

It is important that this connection is made at only one point along the shield. Ground loops will be created if the shield is connected to battery negative at multiple points along its path.

If the data lines are spliced, the shields should be spliced also.



Avoid Connecting Unused Lengths of Data Transmitting Wire

It is common practice to install lengths of wire for future needs, but do not connect unused data link wire to the customer connection points for data transmission until the other end of the data link wire is connected to the remote displays. If lengths of unused wire are connected at the engine, without connecting the other end of the wire to the remote displays, the capacitance of the unused wire may cause malfunction of connected equipment.

Troubleshooting Electrical Interference

Observe what happens to the interference when:

- Other devices are turned on and off.
- Equipment is moved closer to or further from other devices.
- Different wire paths are used.
- A different or separate power source is used to power a device.

The effects of interference will be minimized or eliminated by good wiring practice on:

- The battery negative connections between the various devices that share the same battery power.
- The connection between this battery negative and the vessel's single, common ground connection.

Use large wire gauges for these connections with a minimum diameter of 9.27 mm (AWG 00). This is especially true with remote devices such as a remote pilot house panel. It shares the same battery negative connection and ground connection as the ECU. These connections must be kept clean.

3500B Series II engines' ECUs are protected from damage during electrostatic painting by a transistor network which protects the ECU from high DC voltage while preventing nuisance tripping of modern, highly-sensitive, ground fault detection equipment.

The ECUs of 3500B engines built prior to Series II are mounted using electrically insulating rubber bushings. The housing of the ECU, as shipped from the factory, is grounded to the engine block with a woven ground strap. The negative post of the input power to the ECU is grounded to the housing through a 150-K Ohm resistor. That grounding resistor is to protect the ECU's electronic components from the high DC voltage imposed on the engine during its electrostatic painting process. If electromagnetic interference from this source is a problem in a specific installation, confirm the ground strap between the engine block and the ECU housing is intact and its terminals are clean and making good contact.

Limits on the Number of Data Link Devices

The number of devices on a **Cat Data Link** is limited to 11. Exceeding this number will "overload" the data link driver circuits in the devices. The most common symptom of data link driver circuit overload is the error message "Can Not Communicate" after an additional device is added. Some devices load the data link more than others. Generally, no more than 10 devices should be placed permanently on the data link; that leaves the 11th for the ET service tool. When data links from two or more engines are connected together, as when Engine Vision is used, that combined data link has the 10 device limit, not the 20 devices as would have been expected, had the data links remained separate. Some devices load more than others, so the 10 device limit is an estimate.

Up to 30 devices may be connected to the **J1939 data link.** The **J1939 data link** may be connected to only one engine.

REMOTE KEY SWITCH CONTROLLED EXTERNAL SWITCHED POWER

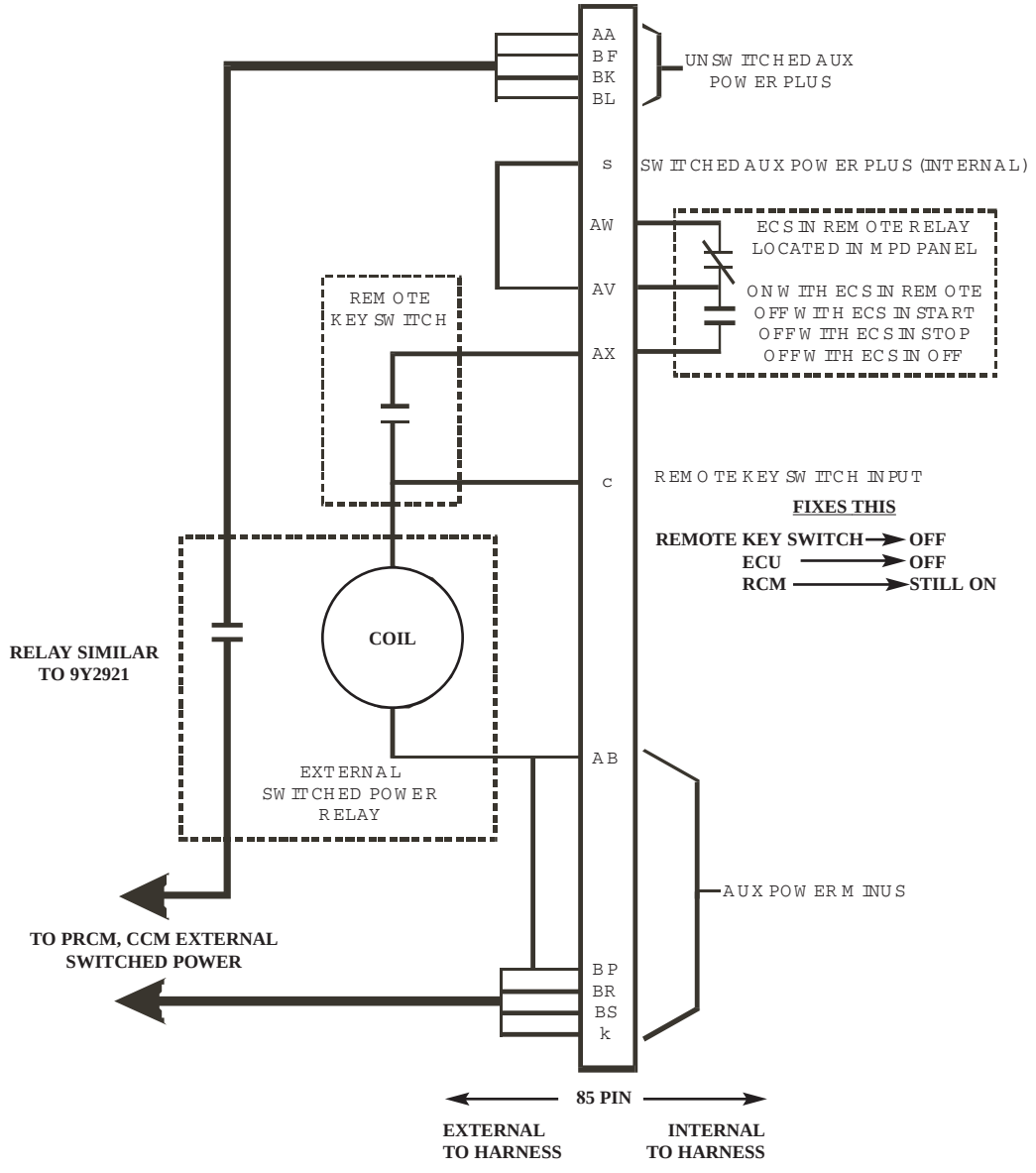
The switched auxiliary power that is on the 85-way customer interface connector is controlled by the engine-mounted ECS switch.

ECS OFF	SWITCHED AUXILIARY POWER OFF
ECS STOP	SWITCHED AUXILIARY POWER ON
ECS START	SWITCHED AUXILIARY POWER ON
ECS REMOTE	SWITCHED AUXILIARY POWER ON

The two ECUs and the engine-mounted MPD Display Unit are energized according to the following logic:

ECS OFF	REMOTE KEYSWITCH ON or OFF	SWITCHED AUXILIARY POWER OFF
ECS STOP	REMOTE KEYSWITCH ON or OFF	SWITCHED AUXILIARY POWER ON
ECS START	REMOTE KEYSWITCH ON or OFF	SWITCHED AUXILIARY POWER ON
ECS REMOTE	REMOTE KEYSWITCH ON	SWITCHED AUXILIARY POWER ON
ECS REMOTE	REMOTE KEYSWITCH OFF	SWITCHED AUXILIARY POWER OFF

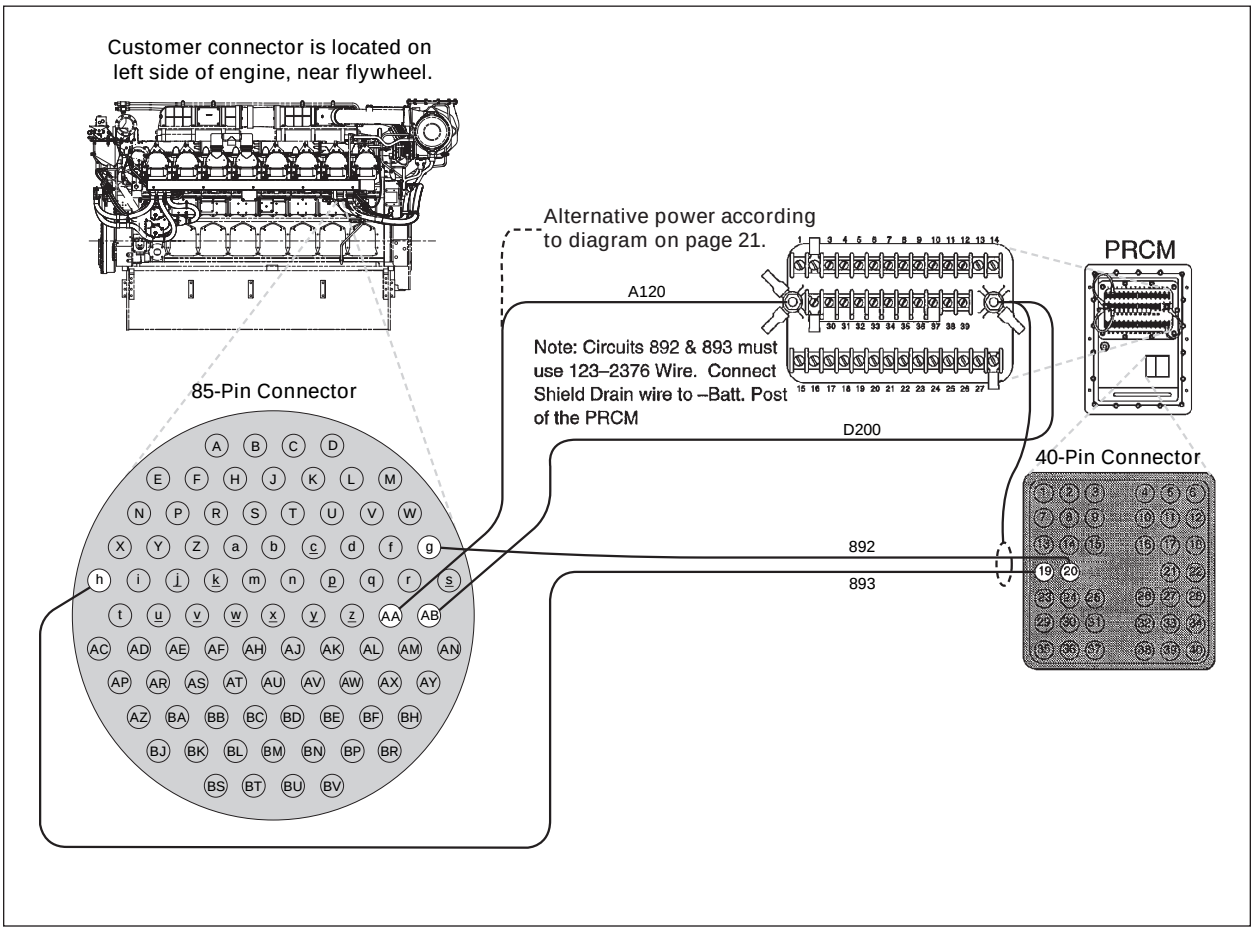
External equipment such as the PRCM or CCM can be energized with the above logic with the following circuit:



Functions of Data Links

3500B Series II Propulsion Engines Manufactured after September 2003	3500B Propulsion Engines Manufactured after April 1997	3500B Propulsion Engines Manufactured before April 1997
J1939 CAN Data Link • MPD in Engine-Mtd. Instrument Panel • MPD Pilot House Panel	**Primary Cat Data Link** • Pilot House Panel • Cat ET and Flashing	**Cat Data Link** • Pilot House Instrument Panel • Cat ET (Not flashing software) • CCM
Cat Data Link • CCM • Engine Vision • Cat ET and Flashing • EMS II Pilot House Monitoring Panel	**Secondary Cat Data Link** • Engine Vision • CCM	**ATA Data Link** • Software Flashing

Connecting Programmable Relay Control Module (PRCM) to Series II



Purpose

To provide a communication link between the ADEM II/EMS-II System and the PRCM. The PRCM is used by the customer to provide 25 relay outputs and six LED outputs from eight switch inputs and A3/EMS-II system parameters. The PRCM alone controls seven relays and six LEDs. For expansion, the user can add one or two relay driver modules to add an additional nine or 18 relays. The outputs are customer programmable through a keypad and display on the PRCM.

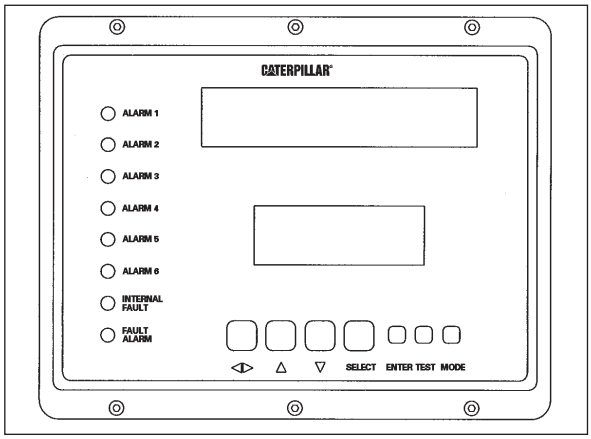
Value

Provides for customized warning systems using the following A3 system parameters:

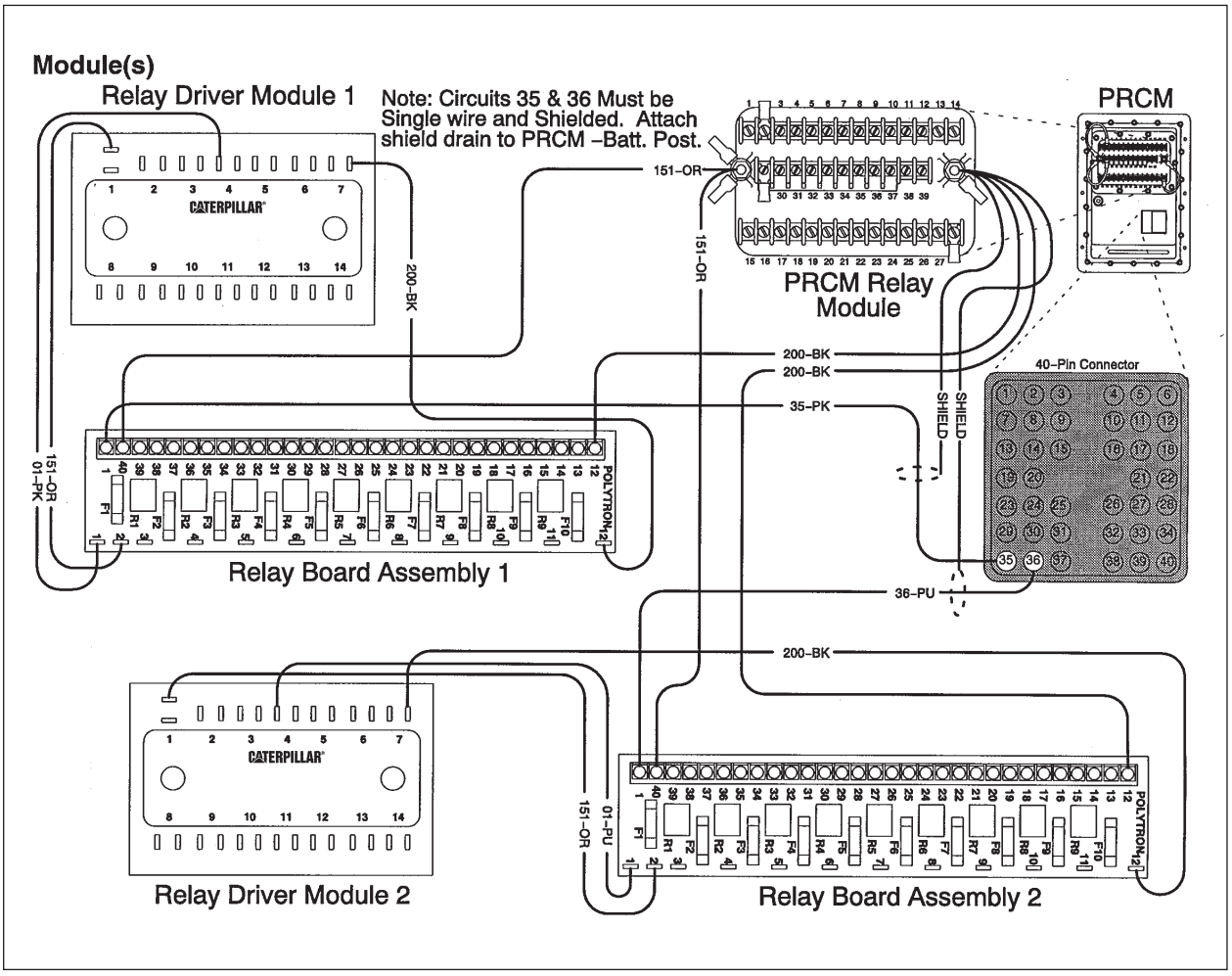
ECU Active Diagnostic Present
ECU Voltage Warning
Engine Oil Pressure Warning
Engine Jacket Water Temperature High Warning
Engine Jacket Water Temperature Low Warning
Engine Overspeed Warning
Engine Air Inlet Restriction Warning
Engine Exhaust Temperature High Warning
Engine Oil Filter Differential Pressure Warning
Engine Fuel Filter Differential Pressure Warning
Engine Crankcase Pressure High Warning
Engine Aftercooler Temperature High Warning
Engine Low Coolant Level Warning
Marine Gear Oil Temperature High Warning
Marine Gear Oil Pressure Low Warning
Engine Electronic Fuel Injection Disabled
Engine @ 100% Load Factor (i.e. in Rack Limit)
Engine Speed above 50 rpm
Engine Starter Overcrank
Engine Starter Motor Relay Active
AUTO system not in AUTO
Engine Power Derating Active
Engine Power Derating Active but not for Altitude
Engine Shutdown
Engine Low Oil Pressure Shutdown
Engine Jacket Water Temperature High Shutdown
Engine Overspeed Shutdown
Engine Crankcase Pressure High Shutdown
Engine Aftercooler Temperature High Shutdown

Function

The operator will use the PRCM keypad and display panel to program the various input/output functions. These programmed functions will turn on/off the various LEDs and relays. Refer to Caterpillar publication SENR6588 Service Manual, Programmable Relay Control Module for more details.

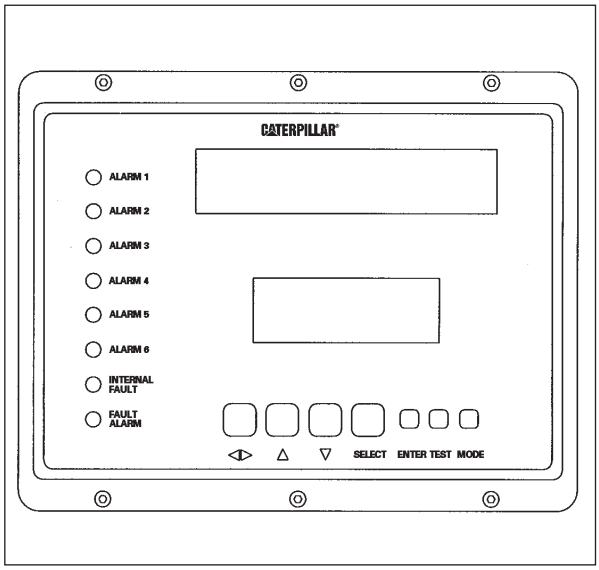


Connecting Programmable Relay Control Module (PCRM) to One or Two Relay Driver Modules



Purpose

To provide an additional 9 or 18 relays. The outputs are customer programmable through a keypad and display on the PRCM.



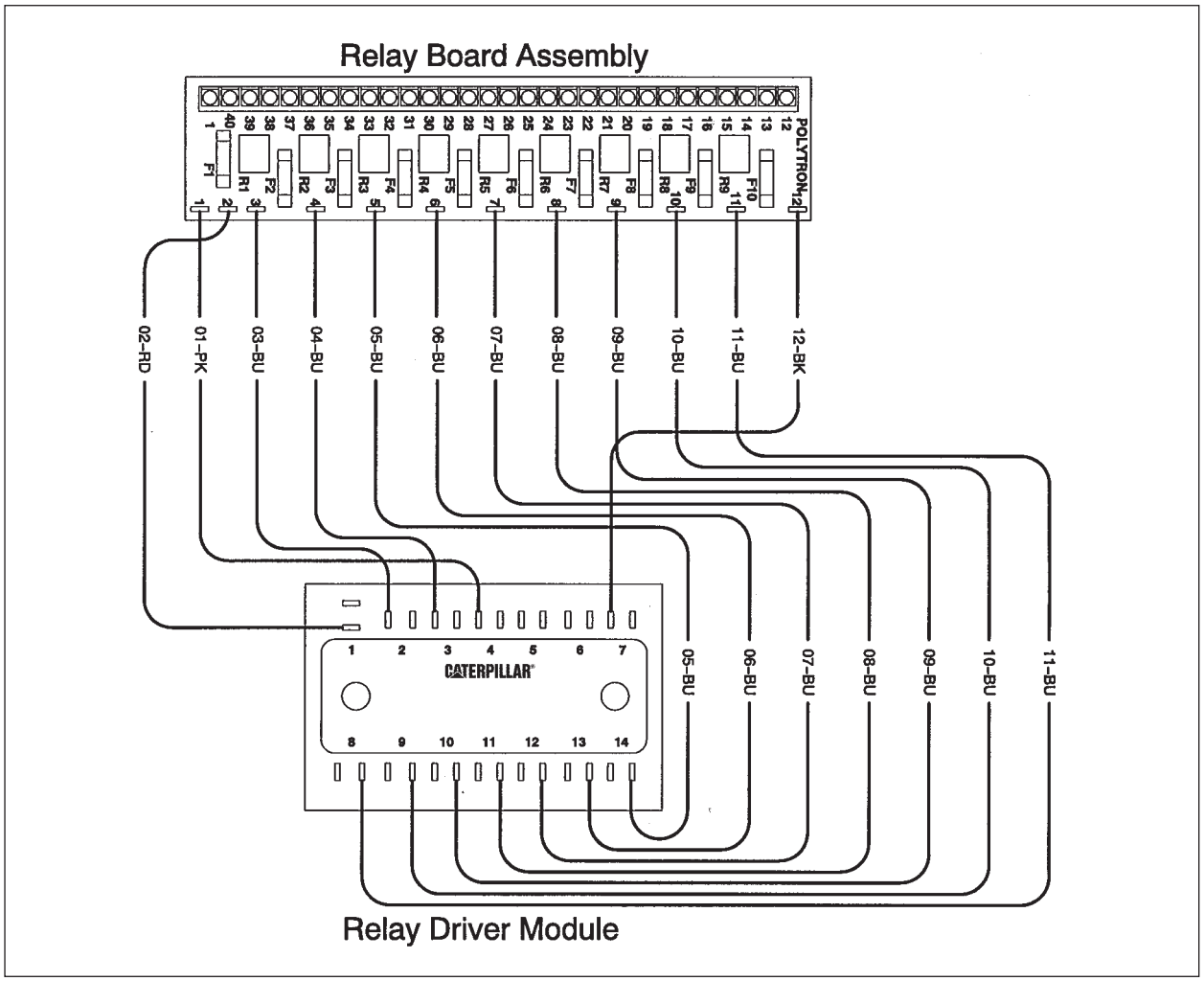
Value

Allows customer to expand the number of engine parameters monitored through the PRCM.

Function

The operator will use the PRCM keypad and display panel to program the various input/output functions. These programmed functions will turn on/off the relays. Refer to Caterpillar publication SENR6588 Service Manual, Programmable Relay Control Module for more details.

Connecting Relay Driver Module to Relay Board Assembly



Purpose

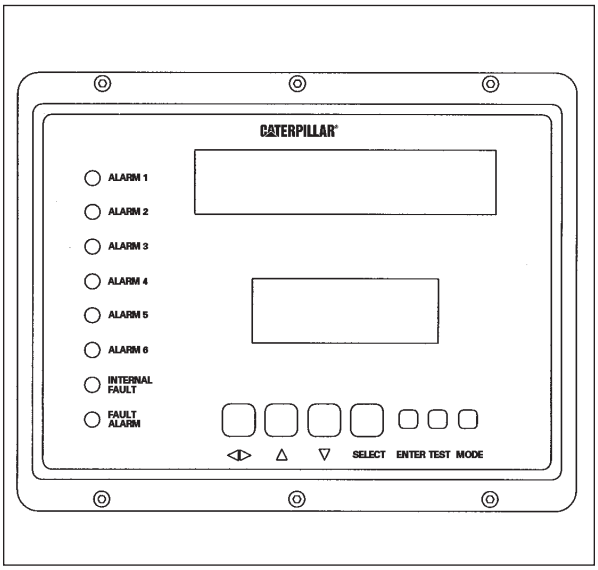
To provide an additional 9 or 18 relays. The outputs are customer programmable through a keypad and display on the PRCM.

Value

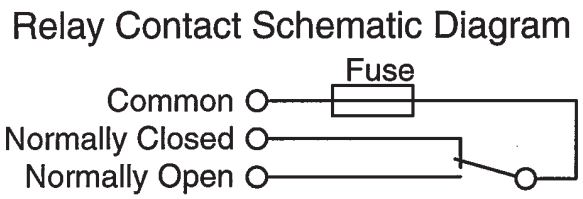
Allows customer to expand the number of engine parameters monitored through the PRCM.

Function

The operator will use the PRCM keypad and display panel to program the various input/output functions. These programmed functions will turn on/off the relays. Refer to Caterpillar publication SENR6588 Service Manual, Programmable Relay Control Module for more details.



Connecting to Relay Contacts on Relay Board Assembly



Note: *Do not connect relay board assembly terminals 1, 2, 12, or 40 to the relay contact circuits. The relay circuits must be kept separate from the relay driver module power, ground and control signals. Also note that each common connection is fused (see schematic diagram above).*

Purpose

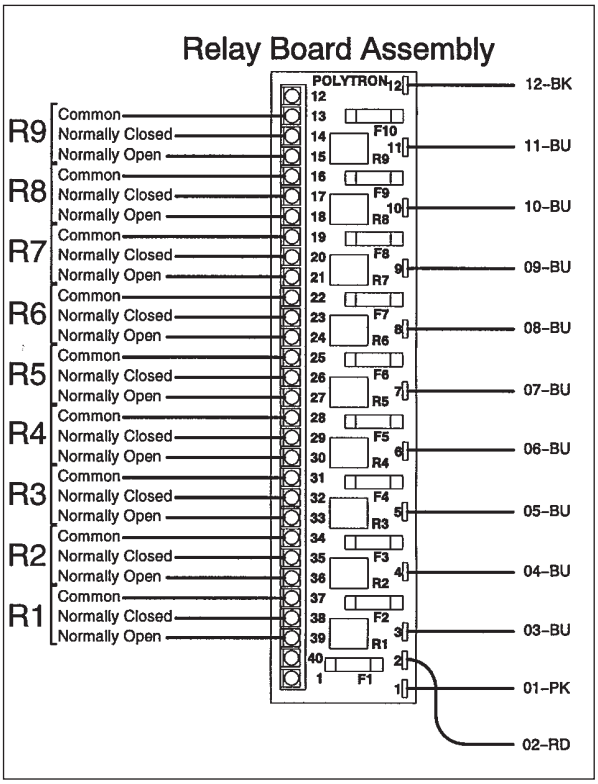
To provide an additional 9 or 18 relays. The outputs are customer programmable through a keypad and display on the PRCM.

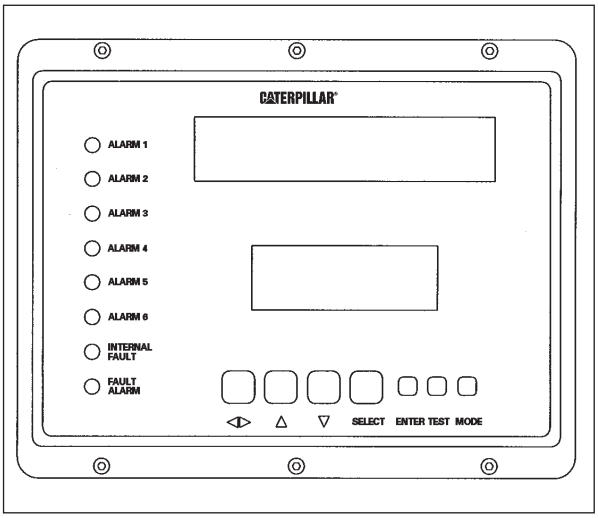
Value

Allows customer to expand the number of engine parameters monitored through the PRCM.

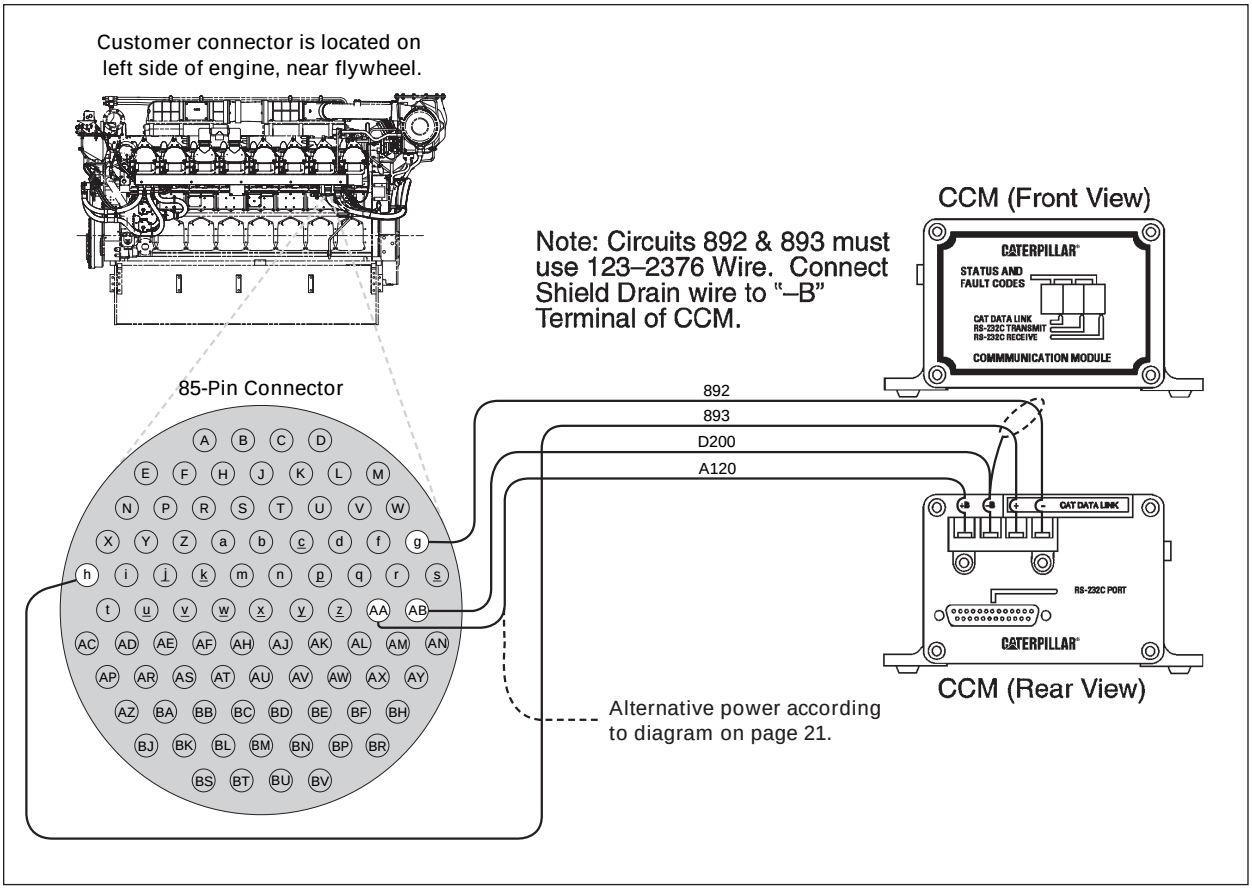
Function

The operator will use the PRCM keypad and display panel to program the various input/output functions. These programmed functions will turn on/off the relays. Refer to Caterpillar publication SENR6588 Service Manual, Programmable Relay Control Module for more details.





Connecting Customer Communication Module (CCM) to Series II



Purpose

To provide a two-way communication link between the A3 System and the operator of a personal computer or programmable logic controller or other device with a RS-232C port.

Value

Allows customer to remotely control and monitor the engine.

Function

The operator will use Caterpillar supplied *basic* PC software to create customer specific programs. The CCM software can be easily upgraded via *Flash* memory programming. Refer to Caterpillar publication SEBU6874 Operation and Maintenance Manual, Customer Communication Module for more details. The following is a list of parameters that can be communicated via CCM.

Status Parameters

Fault Present
ECU Voltage Warning
Engine Jacket Water Temp High Warning
Engine Jacket Water Temp High Shutdown
Engine Jacket Water Temp High Derate
Engine Jacket Water Temp Low Warning
Engine Oil Pressure Low Warning
Engine Oil Pressure Low Shutdown
Engine Oil Pressure Derate
Engine Overspeed Warning
Engine Overspeed Shutdown
Air Inlet Restriction Warning
Air Inlet Restriction Derate
Exhaust Temperature Warning
Exhaust Temperature Derate
Oil Filter Differential Pressure Warning
Fuel Filter Differential Pressure Warning
Crankcase Pressure Warning
Crankcase Pressure Shutdown
Crankcase Pressure Derate
Aftercooler Water Temperature Warning
Aftercooler Water Temperature Shutdown
Aftercooler Water Temperature Derate
Fuel Injection Disabled
Engine Overcrank
Air Shut-off Relay Active
Start Motor Relay Active
Battery Charger Fault Warning (customer wired)
Engine Running
Engine At Full Load (i.e. at rack limit)
System not in Auto
High Altitude Derate
Low Engine Coolant Level Warning (if wired)
Low Fuel Level Warning (if wired)
Engine Diagnostic Active
Backup ECU Ready
Backup ECU Online
Marine Gear Oil Pressure Warning (customer wired)
Marine Gear Oil Temperature Warning (customer wired)

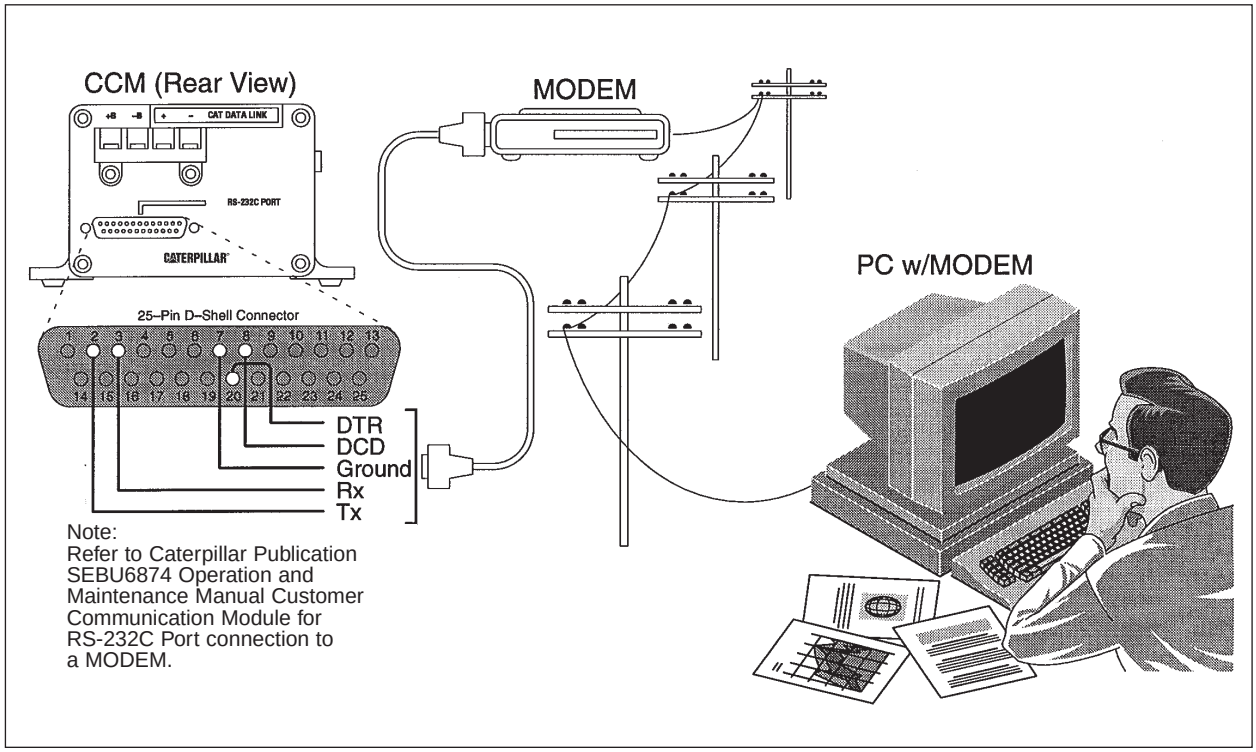
Operating Parameters

1) Engine Speed
2) Instantaneous Fuel Rate
3) Total Fuel Consumed
4) Engine Hours
5) Engine Oil Pressure
6) Engine Coolant Temperature
7) System Voltage
8) Engine Fuel Pressure
9) Exhaust Manifold Temperature (Turbine Inlet) — RH
10) Exhaust Manifold Temperature (Turbine Inlet) — LH
11) Air Inlet Restriction — RH
12) Air Inlet Restriction — LH
13) Fuel Filter Differential Pressure
14) Oil Filter Differential Pressure
15) Turbo Outlet Pressure (Boost)
16) Separate Circuit Aftercooler Coolant Temperature
17) Engine Oil Temperature
18) Inlet Air Temperature
19) Marine Gear Oil Pressure (if sensor installed/wired)
20) Marine Gear Oil Temperature (if sensor installed/wired)
21) Crankcase Pressure

Control Parameters:

1) Remote Start/Stop — EPG Only
2) Emergency Stop — EPG Only
3) Fault Reset
4) Activate Idle/Rated Speed Contact (w/EMCP 11) — EPG Only
5) Activate Circuit Breaker Shunt Trip (w/EMCP 11) — EPG Only
6) Override Cooldown Timer — EPG Only

Connecting Customer Communication Module (CCM) to a Modem



Purpose

To provide a two-way communication link between the CCM and a remote operator of a personal computer or programmable logic controller or other device with a RS-232C port.

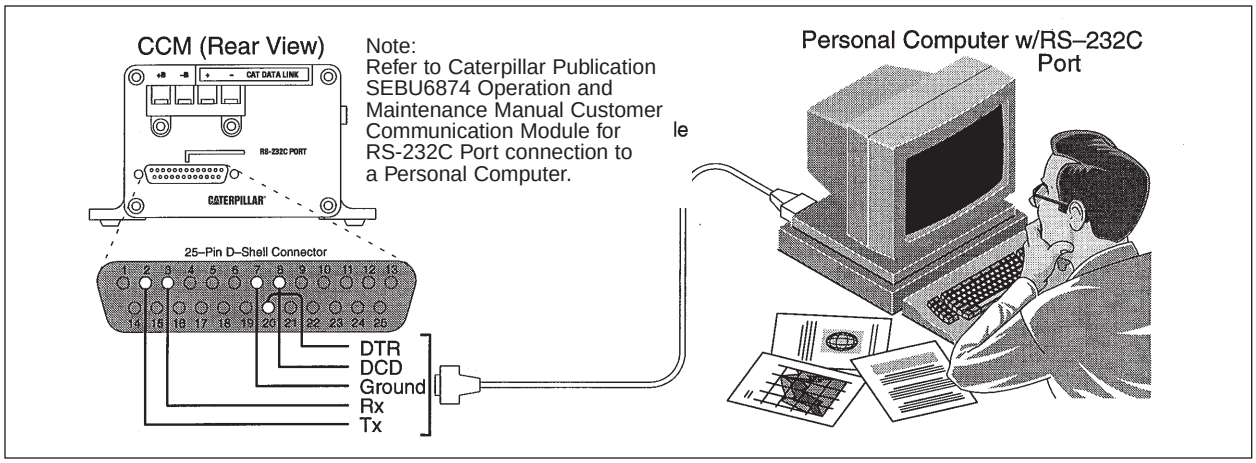
Value

Allows customer to remotely control and monitor the engine.

Function

The operator will use Caterpillar supplied *basic* PC software to create customer specific programs. The CCM software can be easily upgraded via *Flash* memory programming. Refer to Caterpillar publication SEBU6874 Operation and Maintenance Manual, Customer Communication Module for more details.

Connecting Customer Communication Module (CCM) to a Personal Computer



Purpose

To provide a two-way communication link between the CCM and an operator of a personal computer or programmable logic controller or other device with a RS-232C port.

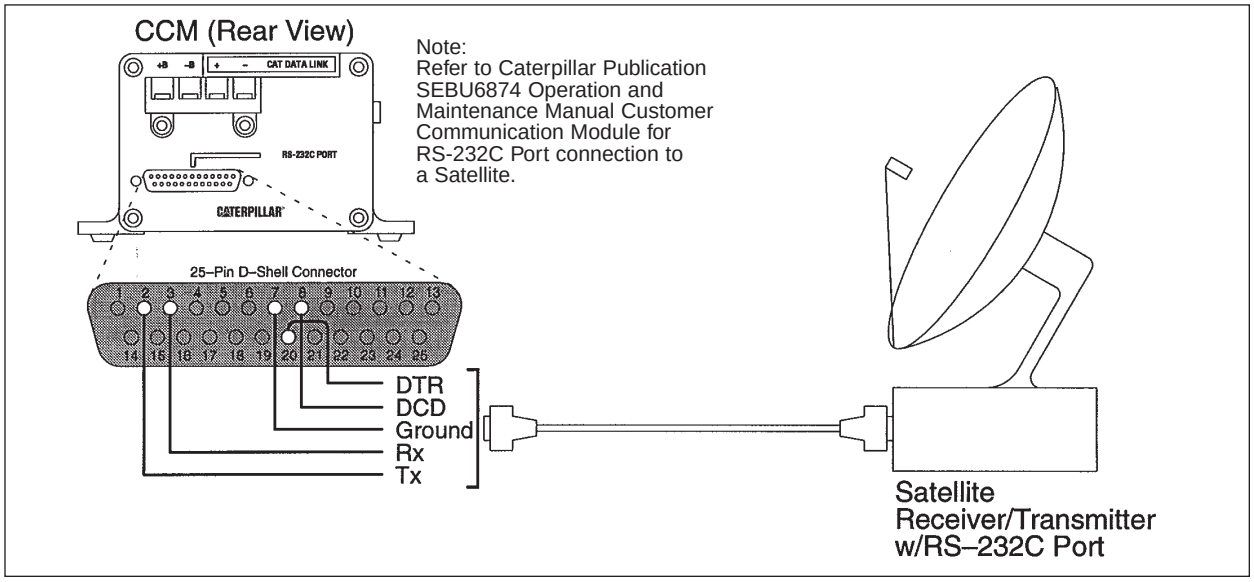
Value

Allows customer to control and monitor the engine from another location in close proximity to the engine.

Function

The operator will use Caterpillar supplied *basic* PC software to create customer specific programs. The CCM software can be easily upgraded via *Flash* memory programming. Refer to Caterpillar publication SEBU6874 Operation and Maintenance Manual, Customer Communication Module for more details.

Connecting Customer Communication Module (CCM) to a Satellite Receiver/Transmitter



Purpose

To provide a two-way communication link between the CCM and a remote operator of a personal computer or programmable logic controller or other device with a RS-232C port via satellite.

Value

Allows customer to remotely control and monitor the engine.

Function

The operator will use Caterpillar supplied *basic* PC software to create customer specific programs. The CCM software can be easily upgraded via *Flash* memory programming. Refer to Caterpillar publication SEBU6874 Operation and Maintenance Manual, Customer Communication Module for more details.

Cat® PL1000 Communication Modules

The new PL1000T and PL1000E communication modules are now available to order. These communication modules have the processing power, memory, communications interfaces, and software to integrate many onboard applications. They have flexible communications capabilities and replace many of today's purpose-built products.

PL1000T

The PL1000T provides multiple communication interfaces between the engine electronic control module (ECU) and other devices, as well as providing Cat data link (CDL) boost, embedded communications adapter, J1939 bridge, and seawater temperature and depth data. PL1000T will repeat the J1939 data link signal (J1939 bridge) for an additional 130 feet. Two units used in conjunction will extend the J1939 data link signal an additional 1000 feet. PL1000T replaces the Global Positioning System Interface Module (GPSIM) and he Customer Communication Module (CCM).

PL1000E

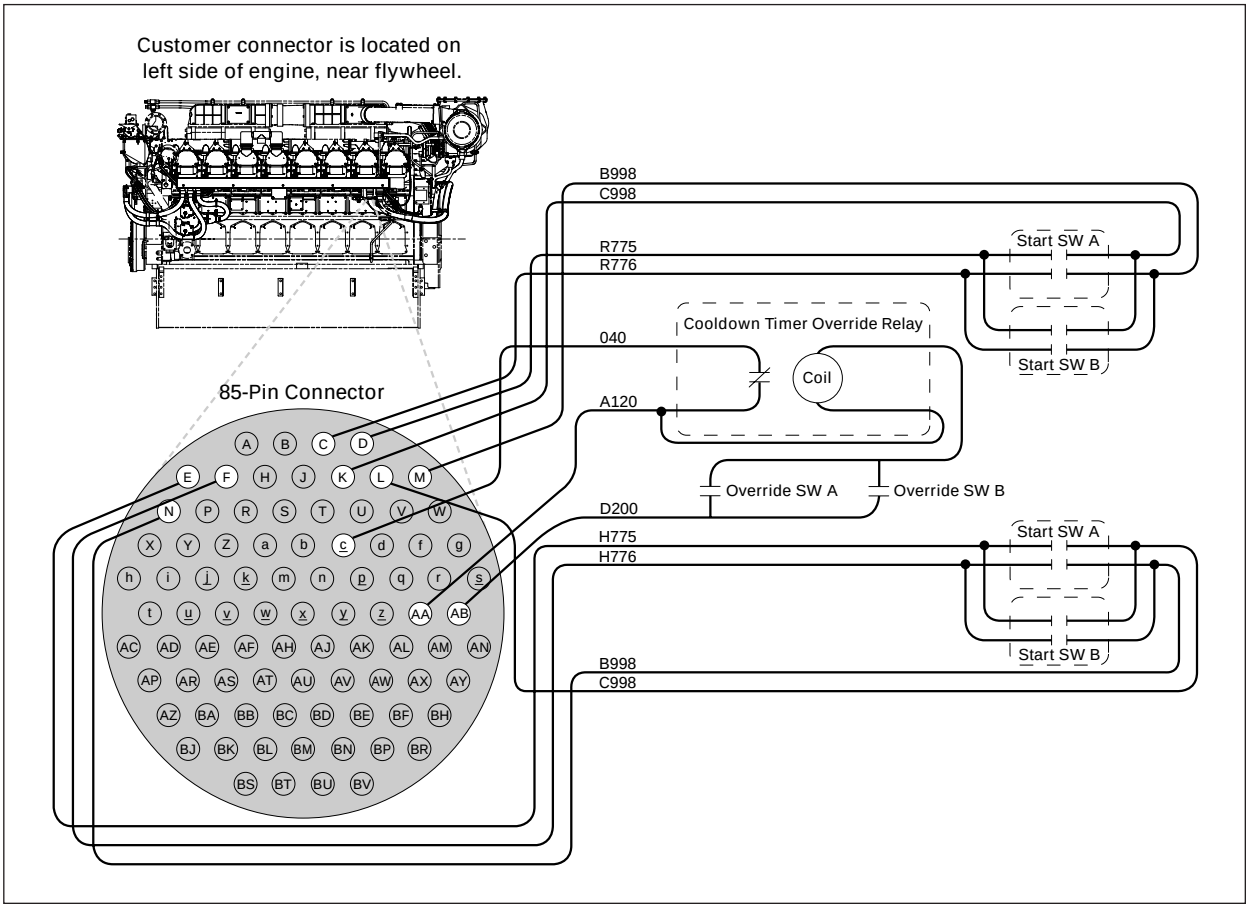
The PL1000E provides communication interface between engine ECU and MODBUS devices and also provides remote monitoring capability through an Internet connection.

PL1000T and PL1000E Documentation

The features, operation, and installation information for PL1000T and PL1000E are provided in the following documentation.

Product News
LEXM5341
Sales Flyers available on Cat Power Net
PL1000T
Installation Guide REHS2125
Systems Operation, Test & Adjust . . RENR7945
PL1000E
Installation Guide REHS2362
Systems Operation, Test & Adjust . . RENR8091
PL1000ET and PL1000E
EERP1000 is a CD media that includes REHS2125, RENR7945, REHS2362, and RENR8091 along with the PTE files for all applications. This CD comes with the PL1000 but can also be ordered from media logistics.

Connecting a Remote Momentary Start/Run/Stop Switch to Marine Engines



Purpose

Provides a remote means to start, run, and cool down/stop the engine.

Note: *This function is only available while the Marine Power Display Panel (MPDP)-mounted Engine Control Switch (ECS) is in the REMOTE (3 o'clock) position.*

Value

Adds operator convenience. Start/Run/Stop control of the engine can be accomplished from any number of remote locations.

Function

Warning: *Starting the engine when a person is working on or near the unit could result in injury or death. Always ensure that no one is near the engine when it is started or whenever the ECS is placed in REMOTE (3 o'clock) position.*

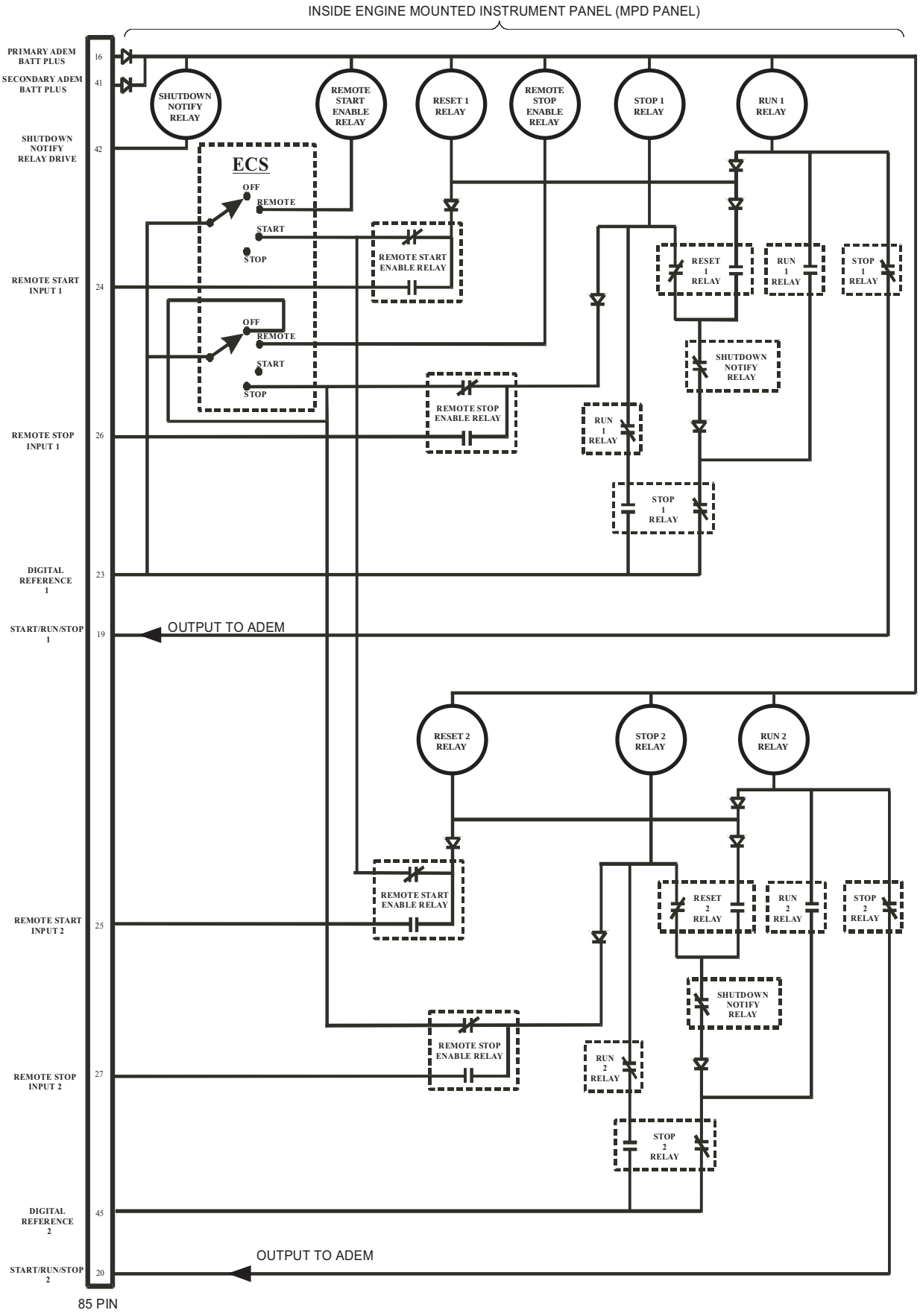
The operator will set the MPDP-mounted ECS to the *REMOTE* (3 o'clock) position. Then, to start/run the engine, the operator must momentarily depress one of the Remote Start switches. To cool down/stop the engine the operator will momentarily depress one of the Remote Stop switches.

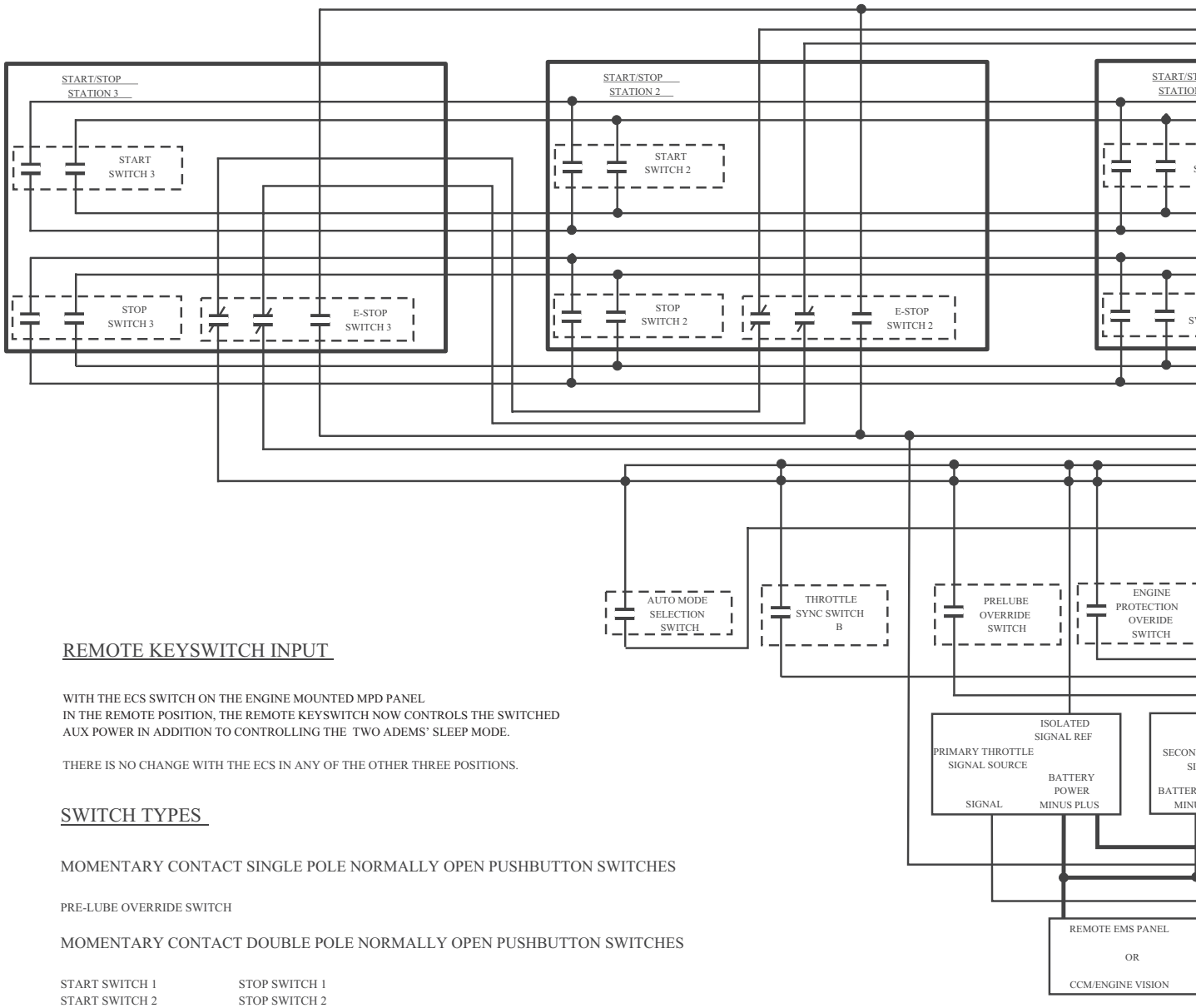
The idle/cool down timer can be overridden while it is timing out by:

- Turning off the remote keyswitch.
- Turning off the engine-mounted ECS switch

Note: *There can be any number of remote start/stop stations. The diagram above shows only two sets. Because they connect in parallel there is no limit to the quantity (see diagrams on pages 32 through 35).*

Momentary Start/Stop Relay Logic — A simplified schematic is shown below





REMOTE KEYSWITCH INPUT

WITH THE ECS SWITCH ON THE ENGINE MOUNTED MPD PANEL
IN THE REMOTE POSITION, THE REMOTE KEYSWITCH NOW CONTROLS THE SWITCHED
AUX POWER IN ADDITION TO CONTROLLING THE TWO ADEMS' SLEEP MODE.

THERE IS NO CHANGE WITH THE ECS IN ANY OF THE OTHER THREE POSITIONS.

SWITCH TYPES

MOMENTARY CONTACT SINGLE POLE NORMALLY OPEN PUSHBUTTON SWITCHES

PRE-LUBE OVERRIDE SWITCH

MOMENTARY CONTACT DOUBLE POLE NORMALLY OPEN PUSHBUTTON SWITCHES

START SWITCH 1	STOP SWITCH 1
START SWITCH 2	STOP SWITCH 2
START SWITCH 3	STOP SWITCH 3

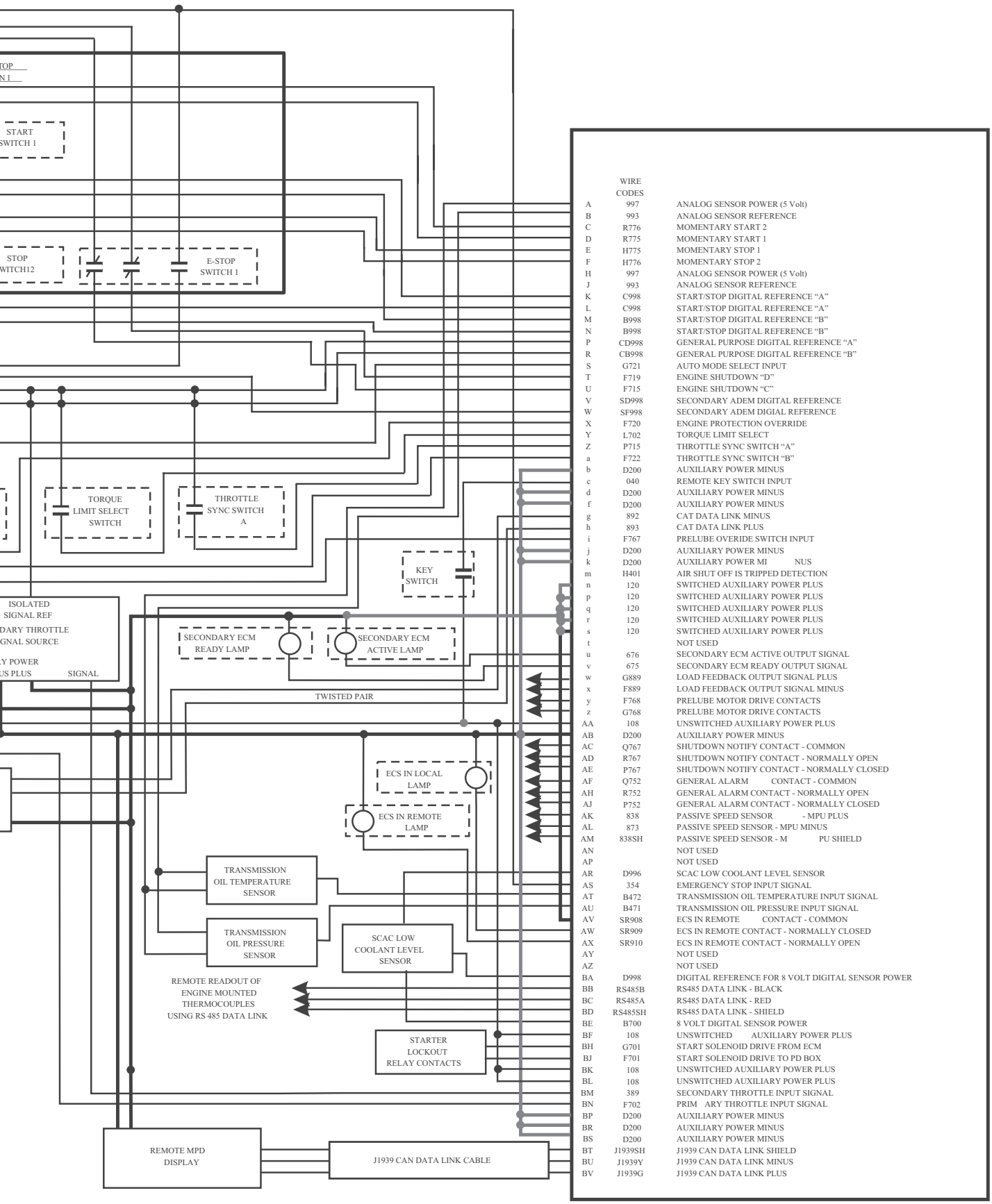
MOMENTARY CONTACT THREE POLE (TWO NORMALLY CLOSED, ONE NORMALLY OPEN) PUSHBUTTON SWITCHES

E-STOP SWITCH 1
E-STOP SWITCH 2
E-STOP SWITCH 3

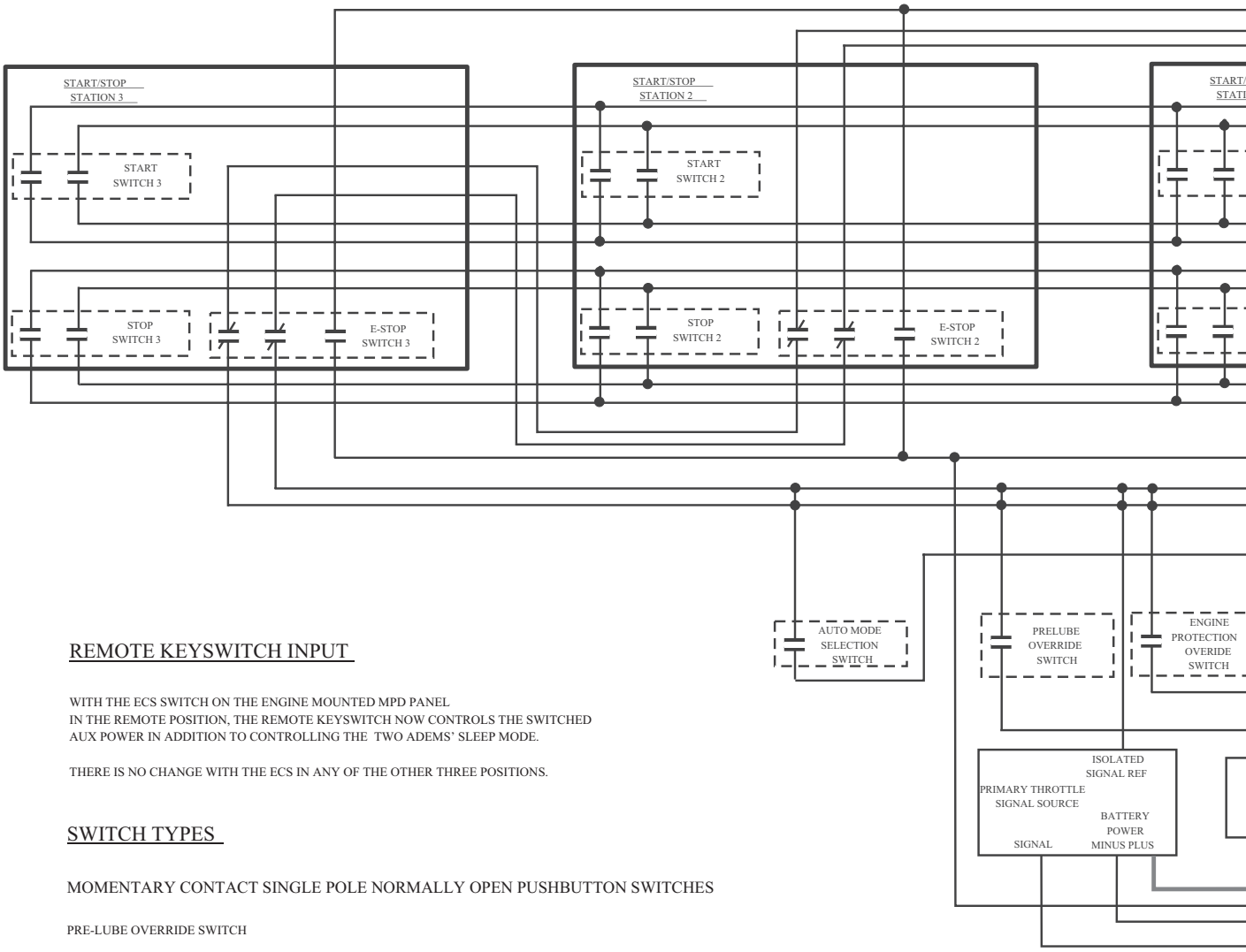
SINGLE POLE NORMALLY OPEN TOGGLE SWITCHES

AUTO MODE SELECTION SWITCH
THROTTLE SYNC SWITCH "A"
THROTTLE SYNC SWITCH "B"
TORQUE LIMIT SELECT SWITCH
KEY SWITCH
ENGINE PROTECTION OVERRIDE SWITCH

SERIES II MARINE PROPULSION CUSTOMER CONNECTIONS WITH MOMENTARY START/STOP SIGNALS



	WIRE CODES	
A	997	ANALOG SENSOR POWER (5 Volt)
B	993	ANALOG SENSOR REFERENCE
C	R776	MOMENTARY START 2
D	R775	MOMENTARY START 1
E	H775	MOMENTARY STOP 1
F	H776	MOMENTARY STOP 2
H	997	ANALOG SENSOR POWER (5 Volt)
J	993	ANALOG SENSOR REFERENCE
K	C998	START/STOP DIGITAL REFERENCE “A”
L	C998	START/STOP DIGITAL REFERENCE “A”
M	B998	START/STOP DIGITAL REFERENCE “B”
N	B998	START/STOP DIGITAL REFERENCE “B”
P	CD998	GENERAL PURPOSE DIGITAL REFERENCE “A”
R	CB998	GENERAL PURPOSE DIGITAL REFERENCE “B”
S	G721	AUTO MODE SELECT INPUT
T	F719	ENGINE SHUTDOWN “D”
U	F715	ENGINE SHUTDOWN “C”
V	SD998	SECONDARY ADEM DIGITAL REFERENCE
W	SF998	SECONDARY ADEM DIGIAL REFERENCE
X	F720	ENGINE PROTECTION OVERRIDE
Y	L702	TORQUE LIMIT SELECT
Z	P715	THROTTLE SYNC SWITCH “A”
a	F722	THROTTLE SYNC SWITCH “B”
b	D200	AUXILIARY POWER MINUS
c	040	REMOTE KEY SWITCH INPUT
d	D200	AUXILIARY POWER MINUS
f	D200	AUXILIARY POWER MINUS
g	892	CAT DATA LINK MINUS
h	893	CAT DATA LINK PLUS
i	F767	PRELUBE OVERIDE SWITCH INPUT
j	D200	AUXILIARY POWER MINUS
k	D200	AUXILIARY POWER MI NUS
m	H401	AIR SHUT OFF IS TRIPPED DETECTION
n	120	SWITCHED AUXILIARY POWER PLUS
p	120	SWITCHED AUXILIARY POWER PLUS
q	120	SWITCHED AUXILIARY POWER PLUS
r	120	SWITCHED AUXILIARY POWER PLUS
s	120	SWITCHED AUXILIARY POWER PLUS
t		NOT USED
u	676	SECONDARY ECM ACTIVE OUTPUT SIGNAL
v	675	SECONDARY ECM READY OUTPUT SIGNAL
w	G889	LOAD FEEDBACK OUTPUT SIGNAL PLUS
x	F889	LOAD FEEDBACK OUTPUT SIGNAL MINUS
y	F768	PRELUBE MOTOR DRIVE CONTACTS
z	G768	PRELUBE MOTOR DRIVE CONTACTS
AA	108	UNSWITCHED AUXILIARY POWER PLUS
AB	D200	AUXILIARY POWER MINUS
AC	Q767	SHUTDOWN NOTIFY CONTACT - COMMON
AD	R767	SHUTDOWN NOTIFY CONTACT - NORMALLY OPEN
AE	P767	SHUTDOWN NOTIFY CONTACT - NORMALLY CLOSED
AF	Q752	GENERAL ALARM CONTACT - COMMON
AH	R752	GENERAL ALARM CONTACT - NORMALLY OPEN
AJ	P752	GENERAL ALARM CONTACT - NORMALLY CLOSED
AK	838	PASSIVE SPEED SENSOR - MPU PLUS
AL	873	PASSIVE SPEED SENSOR - MPU MINUS
AM	838SH	PASSIVE SPEED SENSOR - M PU SHIELD
AN		NOT USED
AP		NOT USED
AR	D996	SCAC LOW COOLANT LEVEL SENSOR
AS	354	EMERGENCY STOP INPUT SIGNAL
AT	B472	TRANSMISSION OIL TEMPERATURE INPUT SIGNAL
AU	B471	TRANSMISSION OIL PRESSURE INPUT SIGNAL
AV	SR908	ECS IN REMOTE CONTACT - COMMON
AW	SR909	ECS IN REMOTE CONTACT - NORMALLY CLOSED
AX	SR910	ECS IN REMOTE CONTACT - NORMALLY OPEN
AY		NOT USED
AZ		NOT USED
BA	D998	DIGITAL REFERENCE FOR 8 VOLT DIGITAL SENSOR POWER
BB	RS485B	RS485 DATA LINK - BLACK
BC	RS485A	RS485 DATA LINK - RED
BD	RS485SH	RS485 DATA LINK - SHIELD
BE	B700	8 VOLT DIGITAL SENSOR POWER
BF	108	UNSWITCHED AUXILIARY POWER PLUS
BH	G701	START SOLENOID DRIVE FROM ECM
BJ	F701	START SOLENOID DRIVE TO PD BOX
BK	108	UNSWITCHED AUXILIARY POWER PLUS
BL	108	UNSWITCHED AUXILIARY POWER PLUS
BM	389	SECONDARY THROTTLE INPUT SIGNAL
BN	F702	PRIM ARY THROTTLE INPUT SIGNAL
BP	D200	AUXILIARY POWER MINUS
BR	D200	AUXILIARY POWER MINUS
BS	D200	AUXILIARY POWER MINUS
BT	J1939SH	J1939 CAN DATA LINK SHIELD
BU	J1939Y	J1939 CAN DATA LINK MINUS
BV	J1939G	J1939 CAN DATA LINK PLUS



REMOTE KEYSWITCH INPUT

WITH THE ECS SWITCH ON THE ENGINE MOUNTED MPD PANEL
IN THE REMOTE POSITION, THE REMOTE KEYSWITCH NOW CONTROLS THE SWITCHED
AUX POWER IN ADDITION TO CONTROLLING THE TWO ADEMS' SLEEP MODE.

THERE IS NO CHANGE WITH THE ECS IN ANY OF THE OTHER THREE POSITIONS.

SWITCH TYPES

MOMENTARY CONTACT SINGLE POLE NORMALLY OPEN PUSHBUTTON SWITCHES

PRE-LUBE OVERRIDE SWITCH

MOMENTARY CONTACT DOUBLE POLE NORMALLY OPEN PUSHBUTTON SWITCHES

START SWITCH 1 STOP SWITCH 1
START SWITCH 2 STOP SWITCH 2
START SWITCH 3 STOP SWITCH 3

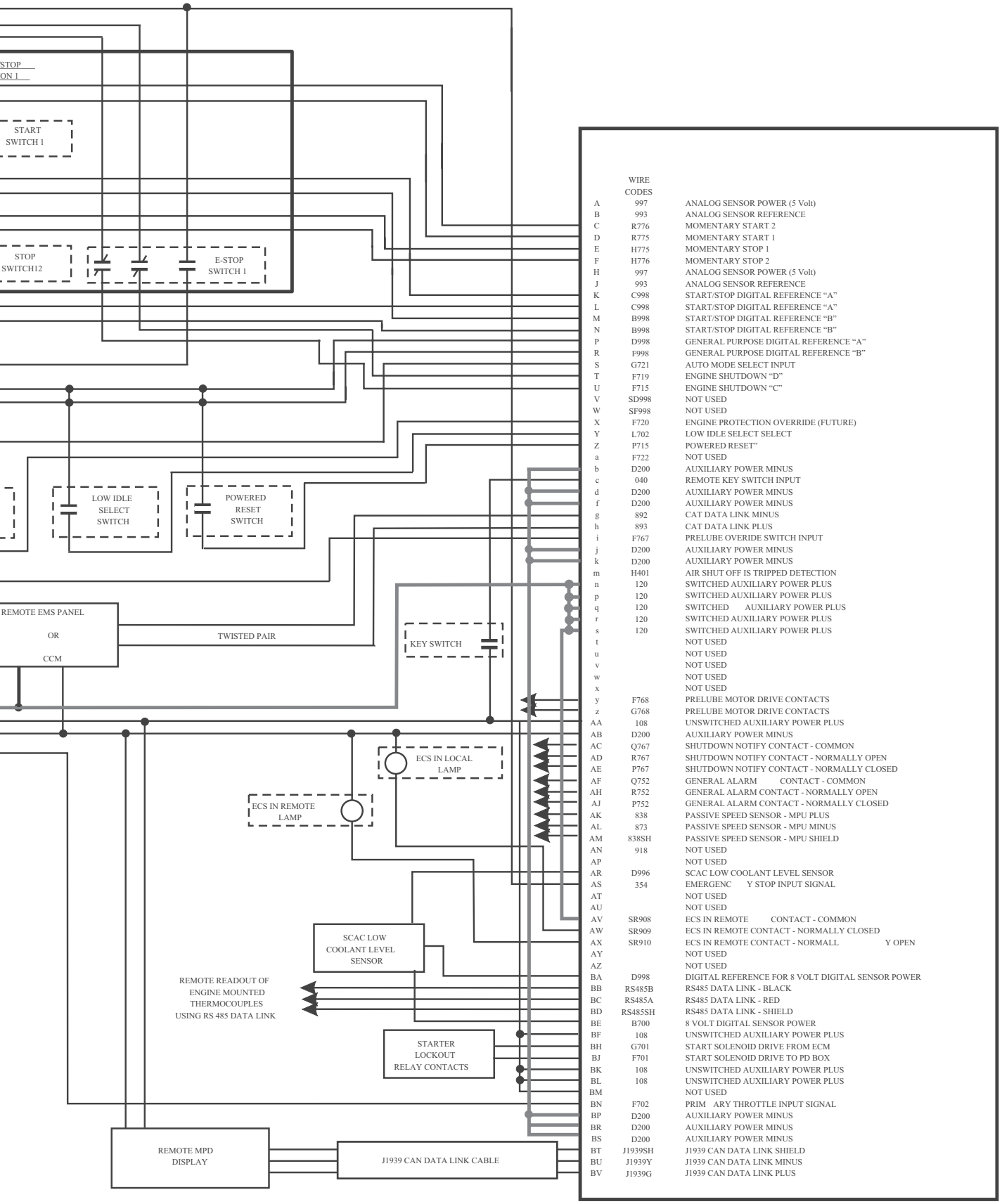
MOMENTARY CONTACT THREE POLE (TWO NORMALLY CLOSED, ONE NORMALLY OPEN) PUSHBUTTON SWITCHES

E-STOP SWITCH 1
E-STOP SWITCH 2
E-STOP SWITCH 3

SINGLE POLE NORMALLY OPEN TOGGLE SWITCHES

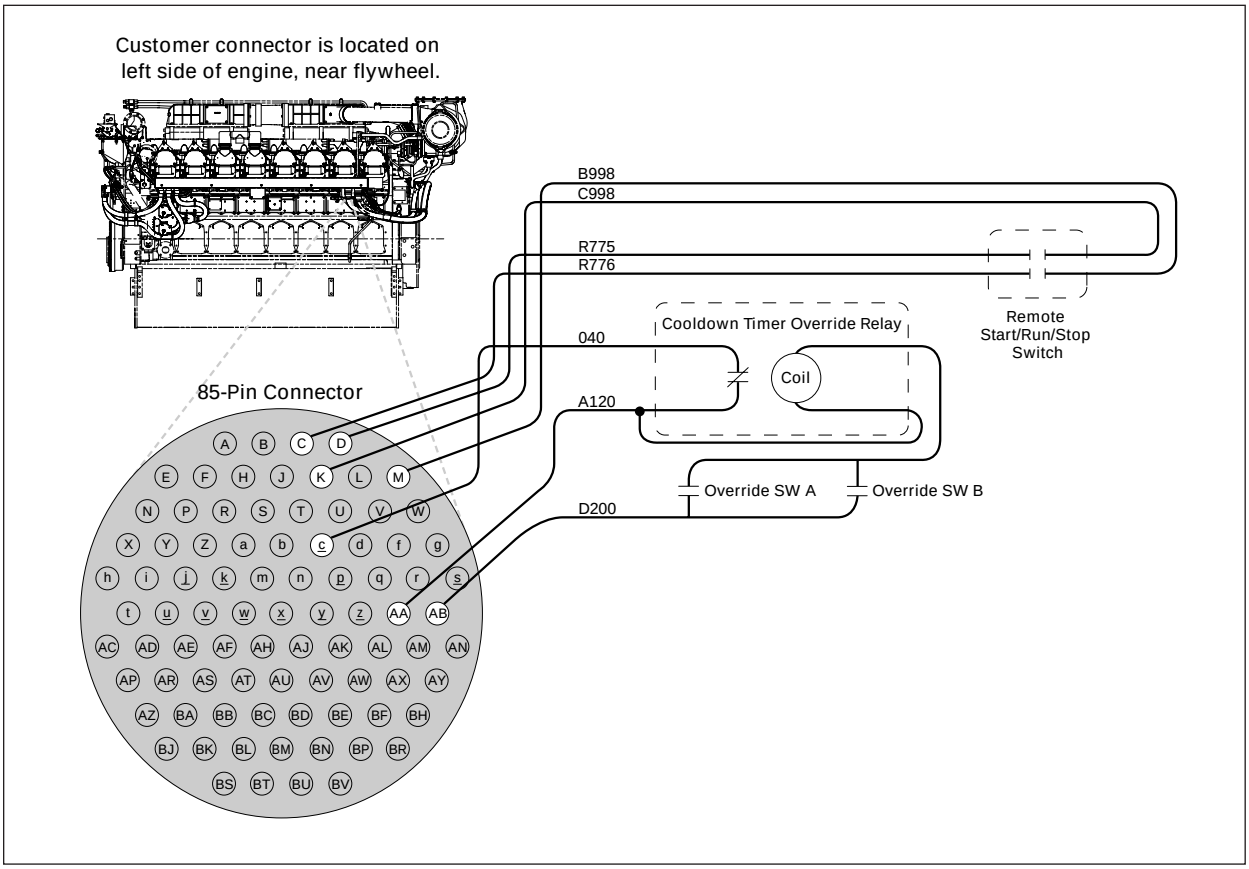
AUTO MODE SELECTION SWITCH
LOW IDLE SELECT SWITCH
POWERED RESET SWITCH
KEY SWITCH
ENGINE PROTECTION OVERRIDE SWITCH (FUTURE)

SERIES II MARINE AUXILIARY CUSTOMER CONNECTIONS WITH MOMENTARY START/STOP SIGNALS



	WIRE CODES	
A	997	ANALOG SENSOR POWER (5 Volt)
B	993	ANALOG SENSOR REFERENCE
C	R776	MOMENTARY START 2
D	R775	MOMENTARY START 1
E	H775	MOMENTARY STOP 1
F	H776	MOMENTARY STOP 2
H	997	ANALOG SENSOR POWER (5 Volt)
J	993	ANALOG SENSOR REFERENCE
K	C998	START/STOP DIGITAL REFERENCE “A”
L	C998	START/STOP DIGITAL REFERENCE “A”
M	B998	START/STOP DIGITAL REFERENCE “B”
N	B998	START/STOP DIGITAL REFERENCE “B”
P	D998	GENERAL PURPOSE DIGITAL REFERENCE “A”
R	F998	GENERAL PURPOSE DIGITAL REFERENCE “B”
S	G721	AUTO MODE SELECT INPUT
T	F719	ENGINE SHUTDOWN “D”
U	F715	ENGINE SHUTDOWN “C”
V	SD998	NOT USED
W	SF998	NOT USED
X	F720	ENGINE PROTECTION OVERRIDE (FUTURE)
Y	L702	LOW IDLE SELECT SELECT
Z	P715	POWERED RESET”
a	F722	NOT USED
b	D200	AUXILIARY POWER MINUS
c	040	REMOTE KEY SWITCH INPUT
d	D200	AUXILIARY POWER MINUS
f	D200	AUXILIARY POWER MINUS
g	892	CAT DATA LINK MINUS
h	893	CAT DATA LINK PLUS
i	F767	PRELUBE OVERIDE SWITCH INPUT
j	D200	AUXILIARY POWER MINUS
k	D200	AUXILIARY POWER MINUS
m	H401	AIR SHUT OFF IS TRIPPED DETECTION
n	120	SWITCHED AUXILIARY POWER PLUS
p	120	SWITCHED AUXILIARY POWER PLUS
q	120	SWITCHED AUXILIARY POWER PLUS
r	120	SWITCHED AUXILIARY POWER PLUS
s	120	SWITCHED AUXILIARY POWER PLUS
t		NOT USED
u		NOT USED
v		NOT USED
w		NOT USED
x		NOT USED
y	F768	PRELUBE MOTOR DRIVE CONTACTS
z	G768	PRELUBE MOTOR DRIVE CONTACTS
AA	108	UNSWITCHED AUXILIARY POWER PLUS
AB	D200	AUXILIARY POWER MINUS
AC	Q767	SHUTDOWN NOTIFY CONTACT - COMMON
AD	R767	SHUTDOWN NOTIFY CONTACT - NORMALLY OPEN
AE	P767	SHUTDOWN NOTIFY CONTACT - NORMALLY CLOSED
AF	Q752	GENERAL ALARM CONTACT - COMMON
AH	R752	GENERAL ALARM CONTACT - NORMALLY OPEN
AJ	P752	GENERAL ALARM CONTACT - NORMALLY CLOSED
AK	838	PASSIVE SPEED SENSOR - MPU PLUS
AL	873	PASSIVE SPEED SENSOR - MPU MINUS
AM	838SH	PASSIVE SPEED SENSOR - MPU SHIELD
AN	918	NOT USED
AP		NOT USED
AR	D996	SCAC LOW COOLANT LEVEL SENSOR
AS	354	EMERGENC Y STOP INPUT SIGNAL
AT		NOT USED
AU		NOT USED
AV	SR908	ECS IN REMOTE CONTACT - COMMON
AW	SR909	ECS IN REMOTE CONTACT - NORMALLY CLOSED
AX	SR910	ECS IN REMOTE CONTACT - NORMALL Y OPEN
AY		NOT USED
AZ		NOT USED
BA	D998	DIGITAL REFERENCE FOR 8 VOLT DIGITAL SENSOR POWER
BB	RS485B	RS485 DATA LINK - BLACK
BC	RS485A	RS485 DATA LINK - RED
BD	RS485SH	RS485 DATA LINK - SHIELD
BE	B700	8 VOLT DIGITAL SENSOR POWER
BF	108	UNSWITCHED AUXILIARY POWER PLUS
BH	G701	START SOLENOID DRIVE FROM ECM
BJ	F701	START SOLENOID DRIVE TO PD BOX
BK	108	UNSWITCHED AUXILIARY POWER PLUS
BL	108	UNSWITCHED AUXILIARY POWER PLUS
BM		NOT USED
BN	F702	PRIM ARY THROTTLE INPUT SIGNAL
BP	D200	AUXILIARY POWER MINUS
BR	D200	AUXILIARY POWER MINUS
BS	D200	AUXILIARY POWER MINUS
BT	J1939SH	J1939 CAN DATA LINK SHIELD
BU	J1939Y	J1939 CAN DATA LINK MINUS
BV	J1939G	J1939 CAN DATA LINK PLUS

Connecting a Remote Legacy Start/Run/Stop Switch to Marine Engines



Purpose

Provides a remote means to start, run, and cool down/stop the engine.

Note: *This function is only available while the Marine Power Display Panel (MPDP)-mounted Engine Control Switch (ECS) is in the REMOTE (3 o'clock) position.*

Function

Warning: *Starting the engine when a person is working on or near the unit could result in injury or death. Always ensure that no one is near the engine when it is started or whenever the ECS is placed in REMOTE (3 o'clock) position.*

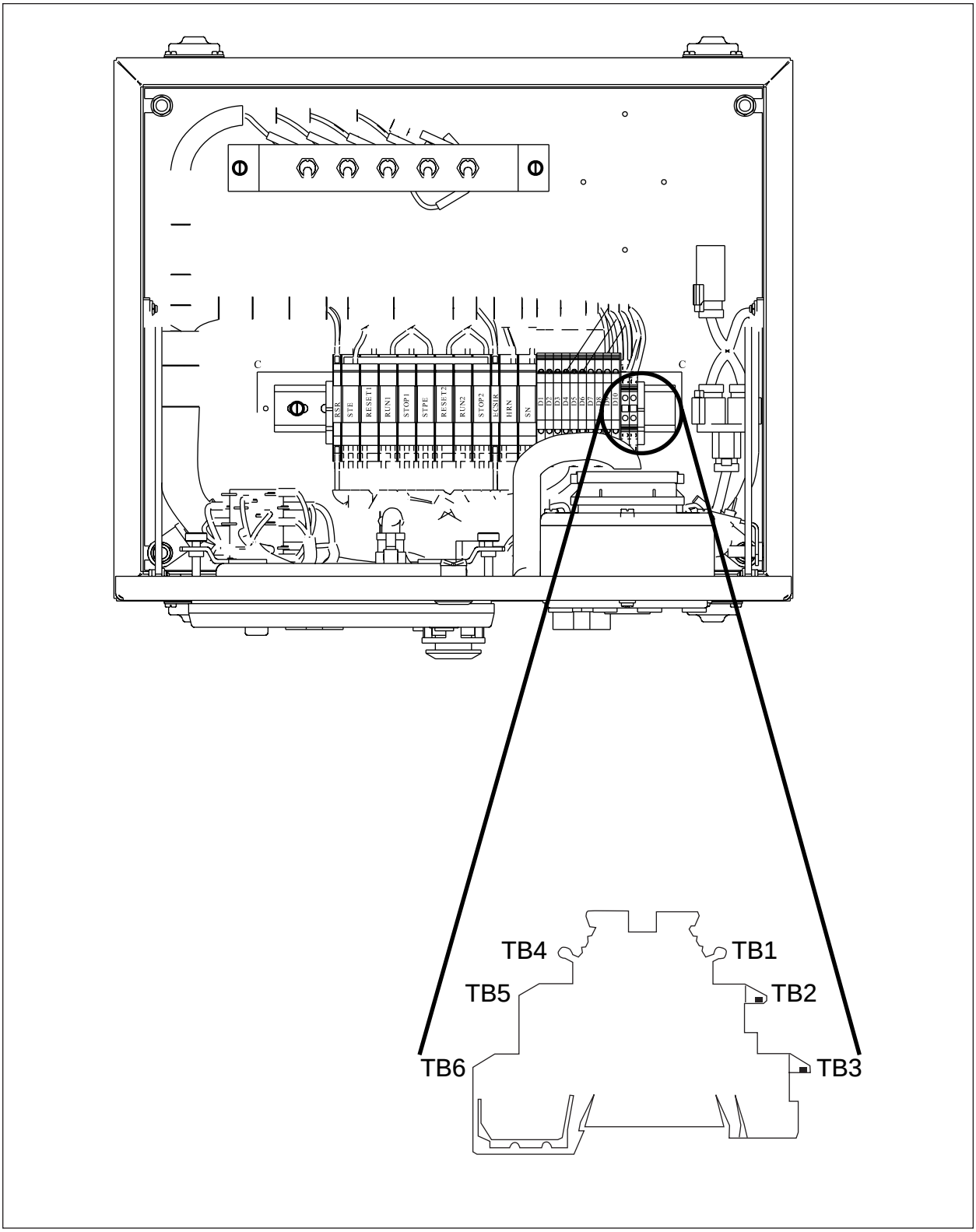
The operator will set the MPDP-mounted ECS to the *REMOTE* (3 o'clock) position.

The idle/cool down timer can be overridden while it is timing out by:

- Turning off the remote keyswitch.
- Turning off the engine-mounted ECS switch

Note: *There can only be one remote start-stop station with legacy mode (see diagrams on pages 38 through 41).*

Modifications to Engine Instrument/ Control Panel for Legacy Mode



Legacy Start/Stop Switch Conversion

This procedure is intended for converting the Series II instrument panel to accept remote start/stop signals utilizing a rotary switch. It has been determined that the relay logic inside the local instrument panel must be bypassed to disable the momentary input and latching of the remote start/stop signals.

1) A connection between Terminal Block (TB) 3 and TB-1 must be made. To make this connection the following must be done.
   - Remove wire F716-G283 from topside of TB-2. Place wire end into Terminal Block TB-1. Leave existing wire PM775 in TB-1.
2) A connection between Terminal Block (TB) 6 and TB-4 must be made. To make this connection the following must be done.
   - Remove wire F717-G280 from topside of TB-5. Place wire end into Terminal Block TB-4. Leave existing wire PM776 in TB-4.
3) A wire on the engine control switch must be moved to reverse the start/stop inputs from the local start/stop rotary switch. To make this change the following must be done.
   - Remove wire LH775-G400 from local rotary switch. The wire will be located between terminals 12 and 15 of the rotary switch.
   - Move wire LH775-G111 from terminal 15 of the rotary switch to terminal 14.
4) When the previous changes have been made the relay logic will still be active inside the instrument panel. The relay logic must be disabled for proper operation of the start/stop switches. The following diode plugs must be moved permanently for this change.
   - Remove diode plugs for the following diodes: D7, D8, D11, and D12.

NOTE:

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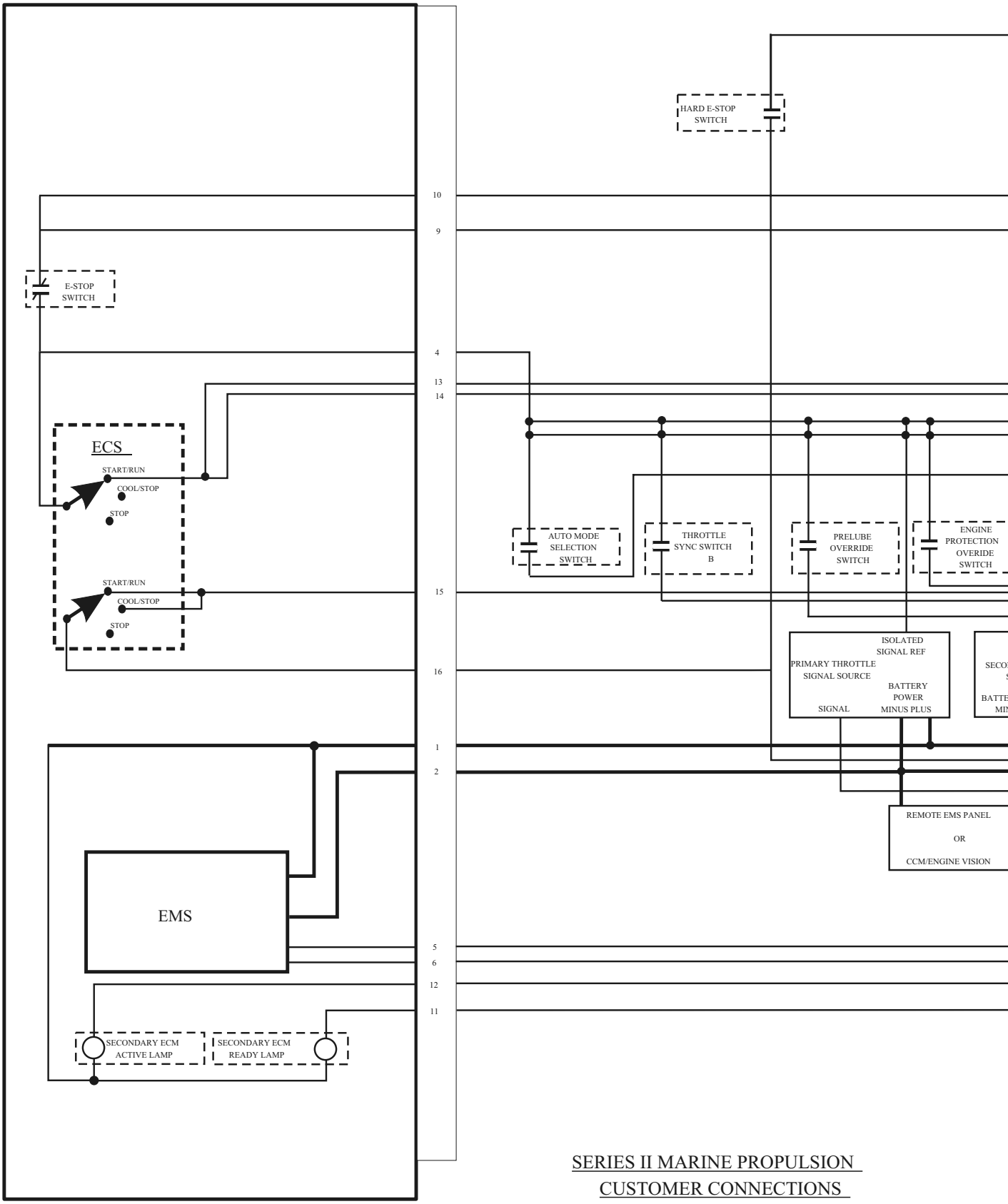
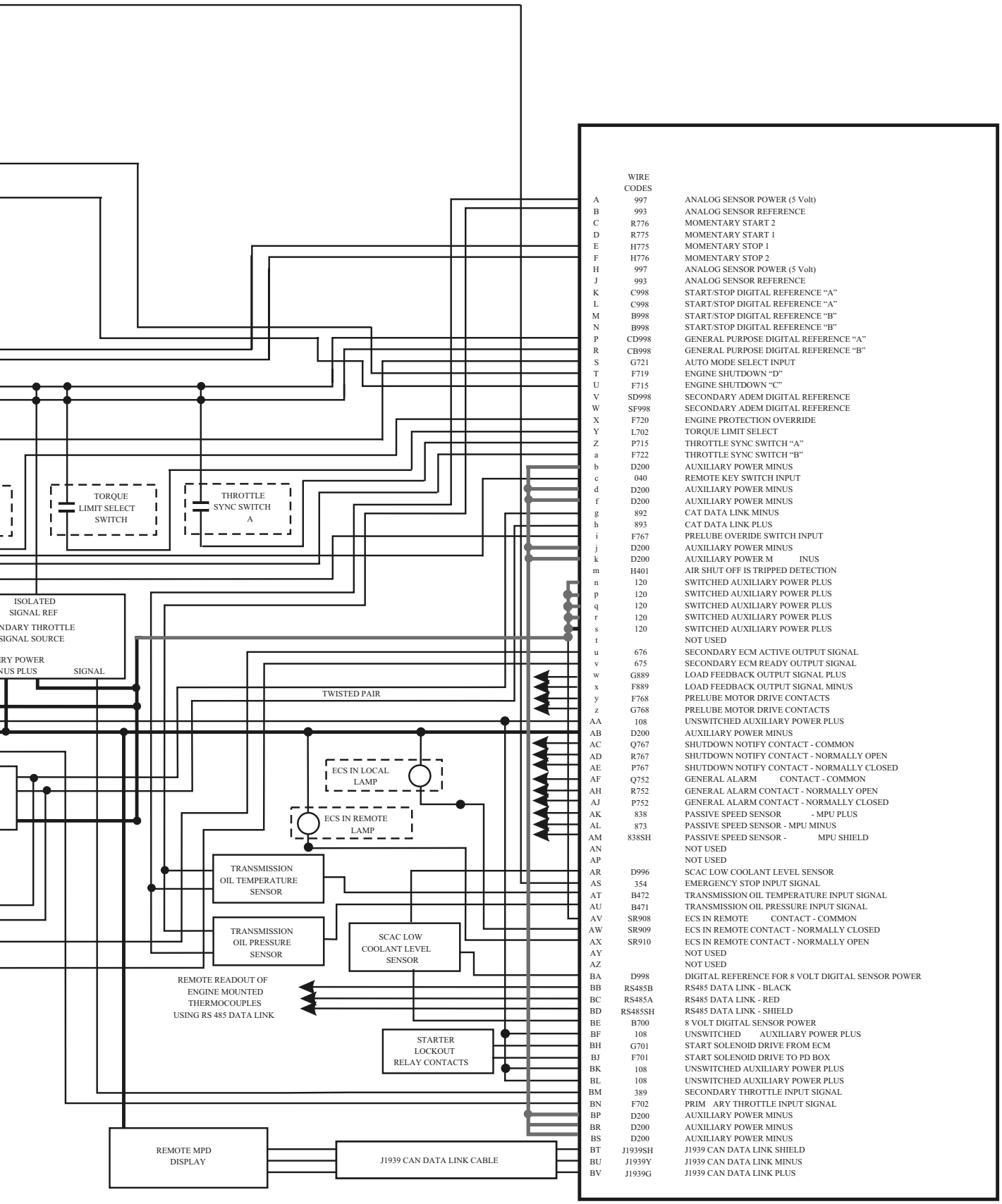
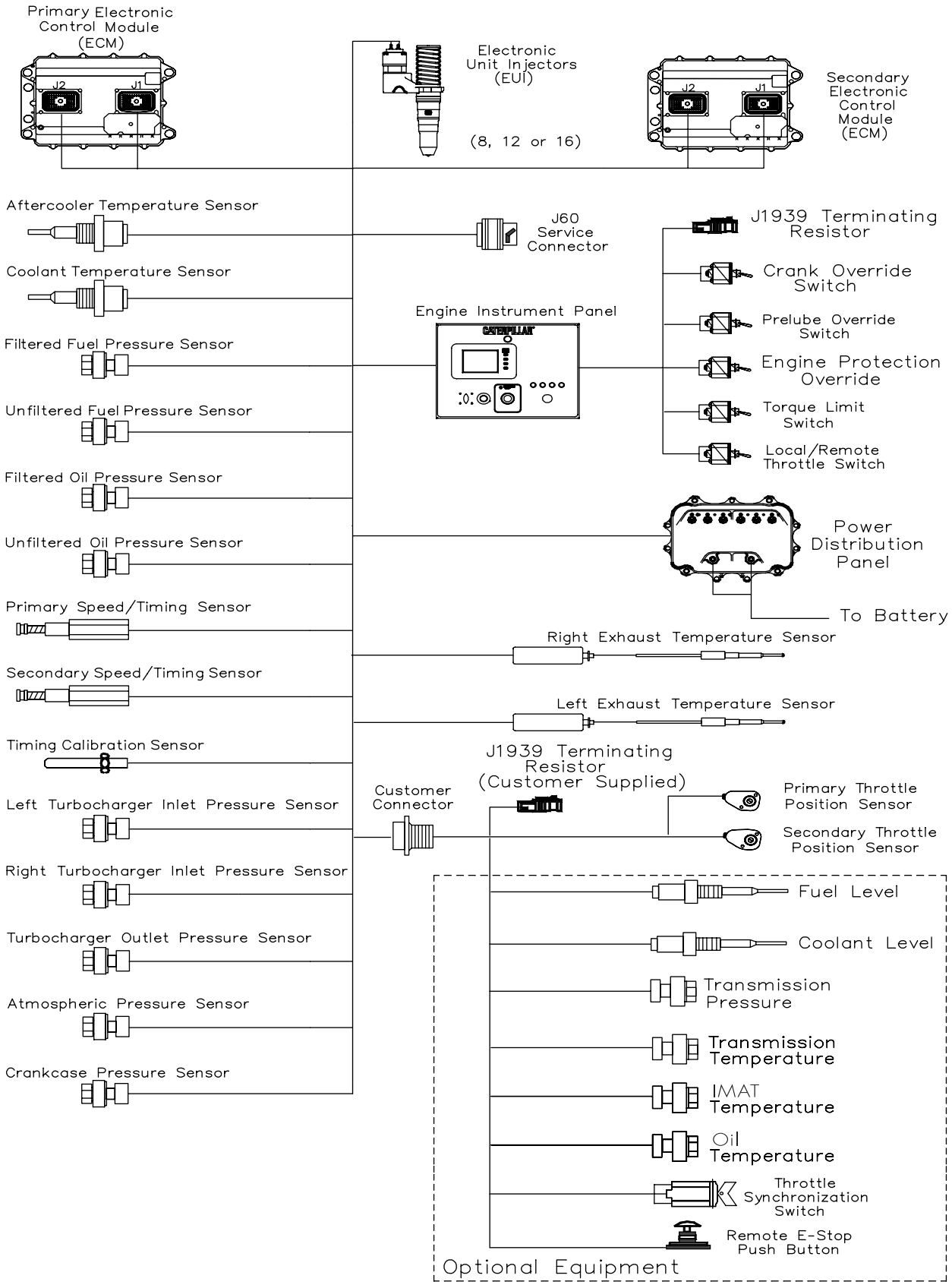


SERIES II MARINE PROPULSION
CUSTOMER CONNECTIONS
WITH LEGACY START/STOP SIGNALS
CONNECTED TO AN EMS PILOT HOUSE PANEL

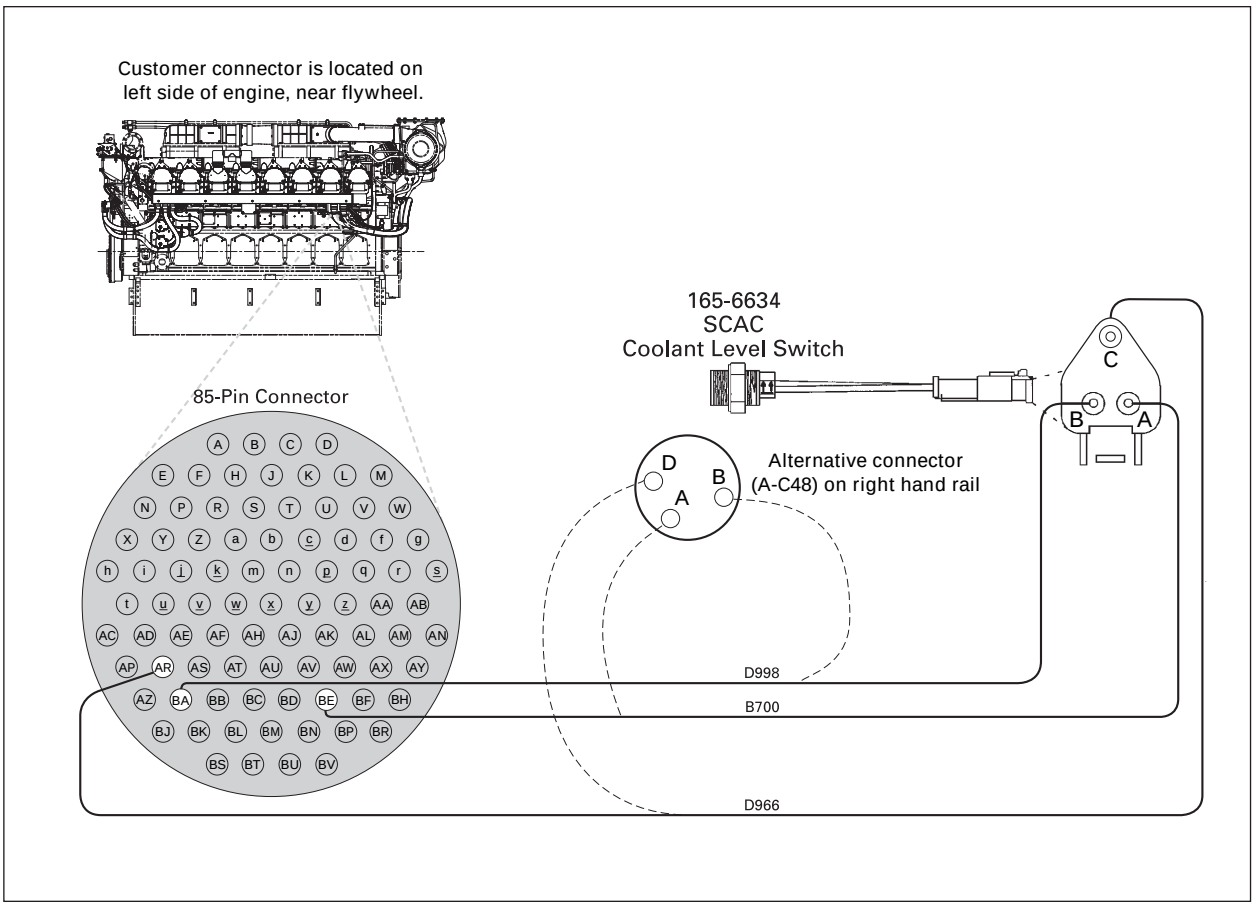


	WIRE CODES	
A	997	ANALOG SENSOR POWER (5 Volt)
B	993	ANALOG SENSOR REFERENCE
C	R776	MOMENTARY START 2
D	R775	MOMENTARY START 1
E	H775	MOMENTARY STOP 1
F	H776	MOMENTARY STOP 2
H	997	ANALOG SENSOR POWER (5 Volt)
J	993	ANALOG SENSOR REFERENCE
K	C998	START/STOP DIGITAL REFERENCE “A”
L	C998	START/STOP DIGITAL REFERENCE “A”
M	B998	START/STOP DIGITAL REFERENCE “B”
N	B998	START/STOP DIGITAL REFERENCE “B”
P	CD998	GENERAL PURPOSE DIGITAL REFERENCE “A”
R	CB998	GENERAL PURPOSE DIGITAL REFERENCE “B”
S	G721	AUTO MODE SELECT INPUT
T	F719	ENGINE SHUTDOWN “D”
U	F715	ENGINE SHUTDOWN “C”
V	SD998	SECONDARY ADEM DIGITAL REFERENCE
W	SF998	SECONDARY ADEM DIGITAL REFERENCE
X	F720	ENGINE PROTECTION OVERRIDE
Y	L702	TORQUE LIMIT SELECT
Z	P715	THROTTLE SYNC SWITCH “A”
a	F722	THROTTLE SYNC SWITCH “B”
b	D200	AUXILIARY POWER MINUS
c	040	REMOTE KEY SWITCH INPUT
d	D200	AUXILIARY POWER MINUS
f	D200	AUXILIARY POWER MINUS
g	892	CAT DATA LINK MINUS
h	893	CAT DATA LINK PLUS
i	F767	PRELUBE OVERIDE SWITCH INPUT
j	D200	AUXILIARY POWER MINUS
k	D200	AUXILIARY POWER M INUS
m	H401	AIR SHUT OFF IS TRIPPED DETECTION
n	120	SWITCHED AUXILIARY POWER PLUS
p	120	SWITCHED AUXILIARY POWER PLUS
q	120	SWITCHED AUXILIARY POWER PLUS
r	120	SWITCHED AUXILIARY POWER PLUS
s	120	SWITCHED AUXILIARY POWER PLUS
t		NOT USED
u	676	SECONDARY ECM ACTIVE OUTPUT SIGNAL
v	675	SECONDARY ECM READY OUTPUT SIGNAL
w	G889	LOAD FEEDBACK OUTPUT SIGNAL PLUS
x	F889	LOAD FEEDBACK OUTPUT SIGNAL MINUS
y	F768	PRELUBE MOTOR DRIVE CONTACTS
z	G768	PRELUBE MOTOR DRIVE CONTACTS
AA	108	UNSWITCHED AUXILIARY POWER PLUS
AB	D200	AUXILIARY POWER MINUS
AC	Q767	SHUTDOWN NOTIFY CONTACT - COMMON
AD	R767	SHUTDOWN NOTIFY CONTACT - NORMALLY OPEN
AE	P767	SHUTDOWN NOTIFY CONTACT - NORMALLY CLOSED
AF	Q752	GENERAL ALARM CONTACT - COMMON
AH	R752	GENERAL ALARM CONTACT - NORMALLY OPEN
AJ	P752	GENERAL ALARM CONTACT - NORMALLY CLOSED
AK	838	PASSIVE SPEED SENSOR - MPU PLUS
AL	873	PASSIVE SPEED SENSOR - MPU MINUS
AM	838SH	PASSIVE SPEED SENSOR - MPU SHIELD
AN		NOT USED
AP		NOT USED
AR	D996	SCAC LOW COOLANT LEVEL SENSOR
AS	354	EMERGENCY STOP INPUT SIGNAL
AT	B472	TRANSMISSION OIL TEMPERATURE INPUT SIGNAL
AU	B471	TRANSMISSION OIL PRESSURE INPUT SIGNAL
AV	SR908	ECS IN REMOTE CONTACT - COMMON
AW	SR909	ECS IN REMOTE CONTACT - NORMALLY CLOSED
AX	SR910	ECS IN REMOTE CONTACT - NORMALLY OPEN
AY		NOT USED
AZ		NOT USED
BA	D998	DIGITAL REFERENCE FOR 8 VOLT DIGITAL SENSOR POWER
BB	RS485B	RS485 DATA LINK - BLACK
BC	RS485A	RS485 DATA LINK - RED
BD	RS485SH	RS485 DATA LINK - SHIELD
BE	B700	8 VOLT DIGITAL SENSOR POWER
BF	108	UNSWITCHED AUXILIARY POWER PLUS
BH	G701	START SOLENOID DRIVE FROM ECM
BJ	F701	START SOLENOID DRIVE TO PD BOX
BK	108	UNSWITCHED AUXILIARY POWER PLUS
BL	108	UNSWITCHED AUXILIARY POWER PLUS
BM	389	SECONDARY THROTTLE INPUT SIGNAL
BN	F702	PRIM ARY THROTTLE INPUT SIGNAL
BP	D200	AUXILIARY POWER MINUS
BR	D200	AUXILIARY POWER MINUS
BS	D200	AUXILIARY POWER MINUS
BT	J1939SH	J1939 CAN DATA LINK SHIELD
BU	J1939Y	J1939 CAN DATA LINK MINUS
BV	J1939G	J1939 CAN DATA LINK PLUS

Sensor Chart



Connecting a SCAC Coolant Level Sensor to Marine Engines*



Purpose

Provides a Low SCAC Coolant Level indication to the operator.

Value

Adds a monitoring function to aid the operator in maintaining proper coolant volume in the engine and therefore preventing engine overheating.

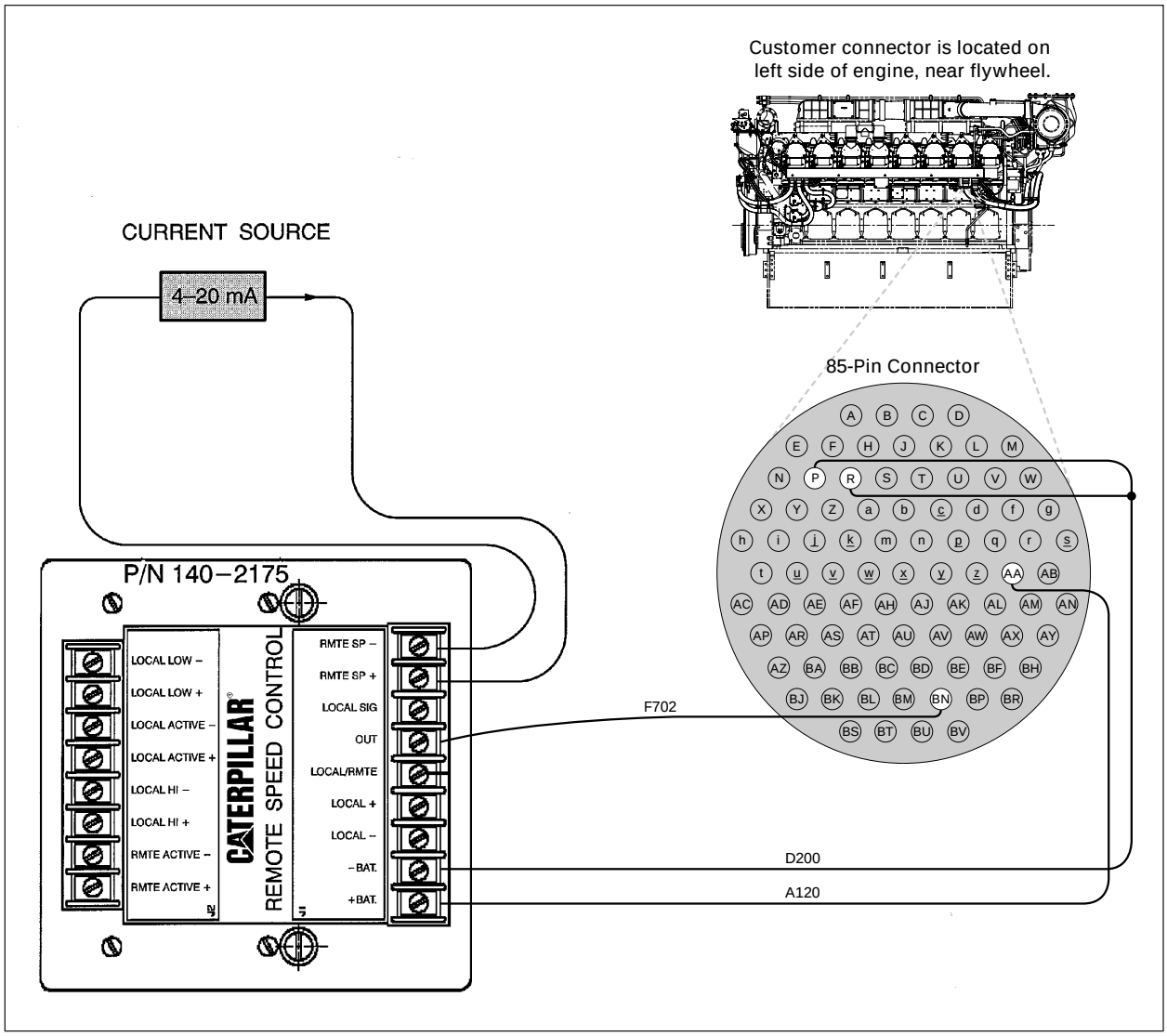
Function

The operator will use the MPD on the MPDP to monitor low coolant level in the expansion tank. Low coolant level will have a negative impact on engine life.

The engine harness includes a Low Coolant Level sensor for the main engine block.

***NOTE:** The SCAC low coolant level sensor needs J1939 SPN to be transmitted and read by the MPD. Currently this SPN is not available and the process of obtaining one is underway. Spring 2006 release of marine auxiliary software will enable generic coolant event for SCAC and JW over J1939.

Connecting a 4-20 mA Convertor for Throttle Input to Engine Electronic Control System (Marine Propulsion Only)



Purpose

Provides an isolated interface between industry standard 4-20 mA analog input signal and the Caterpillar Standard Pulse Width Modulated format.

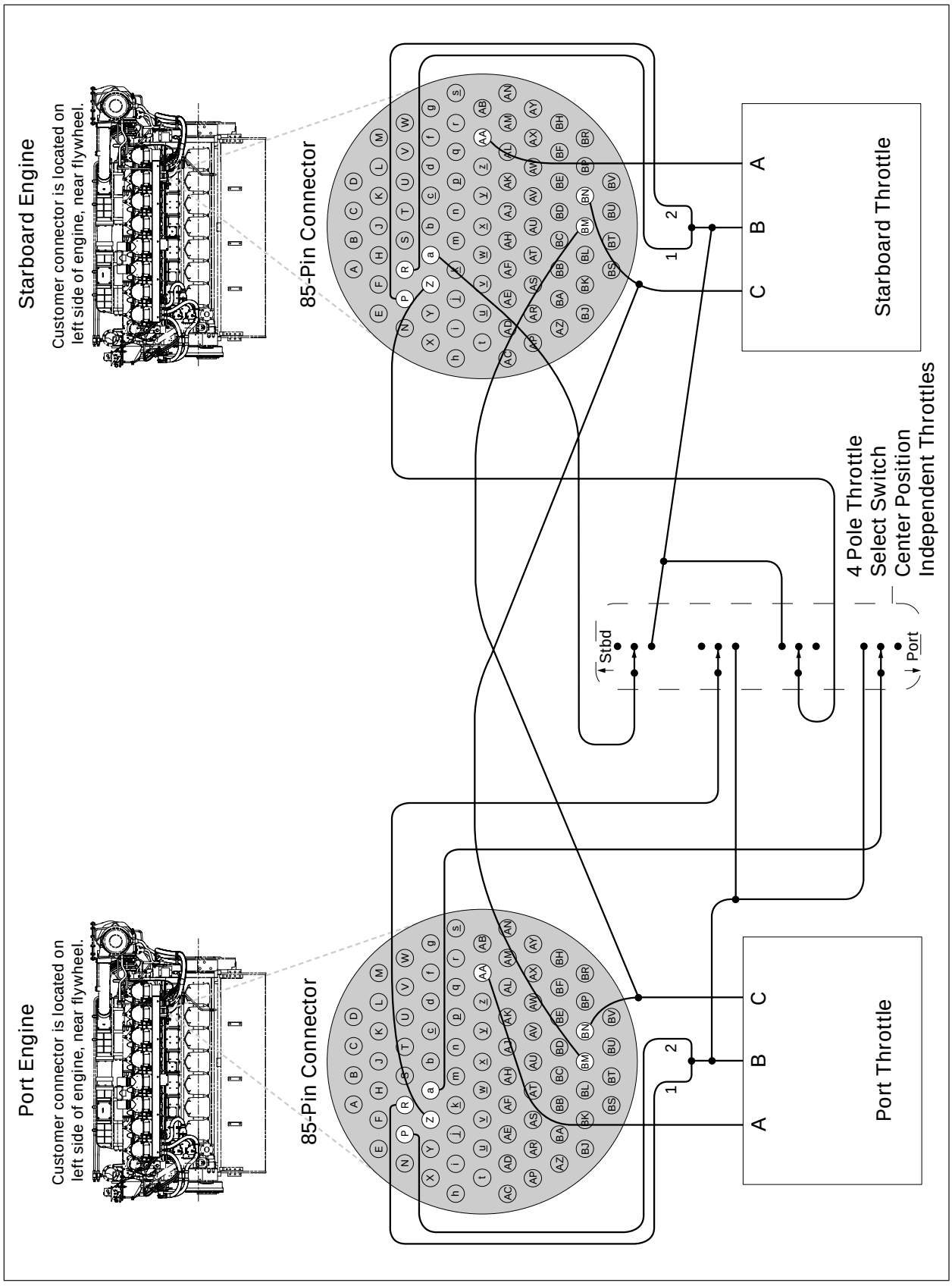
Value

Eliminates the need for customer to custom design pulse width modulated driver modules.

Function

Converts 4-20 mA throttle signal to Caterpillar Standard Pulse Width Modulated format.

Throttle and Engine Synchronization System for Dual Engine control (Marine Propulsion Only)



Purpose

To link the engine controls of both engines to a single throttle.

Value

Adds operator convenience and vessel control, and is a standard practice in marine applications.

Function

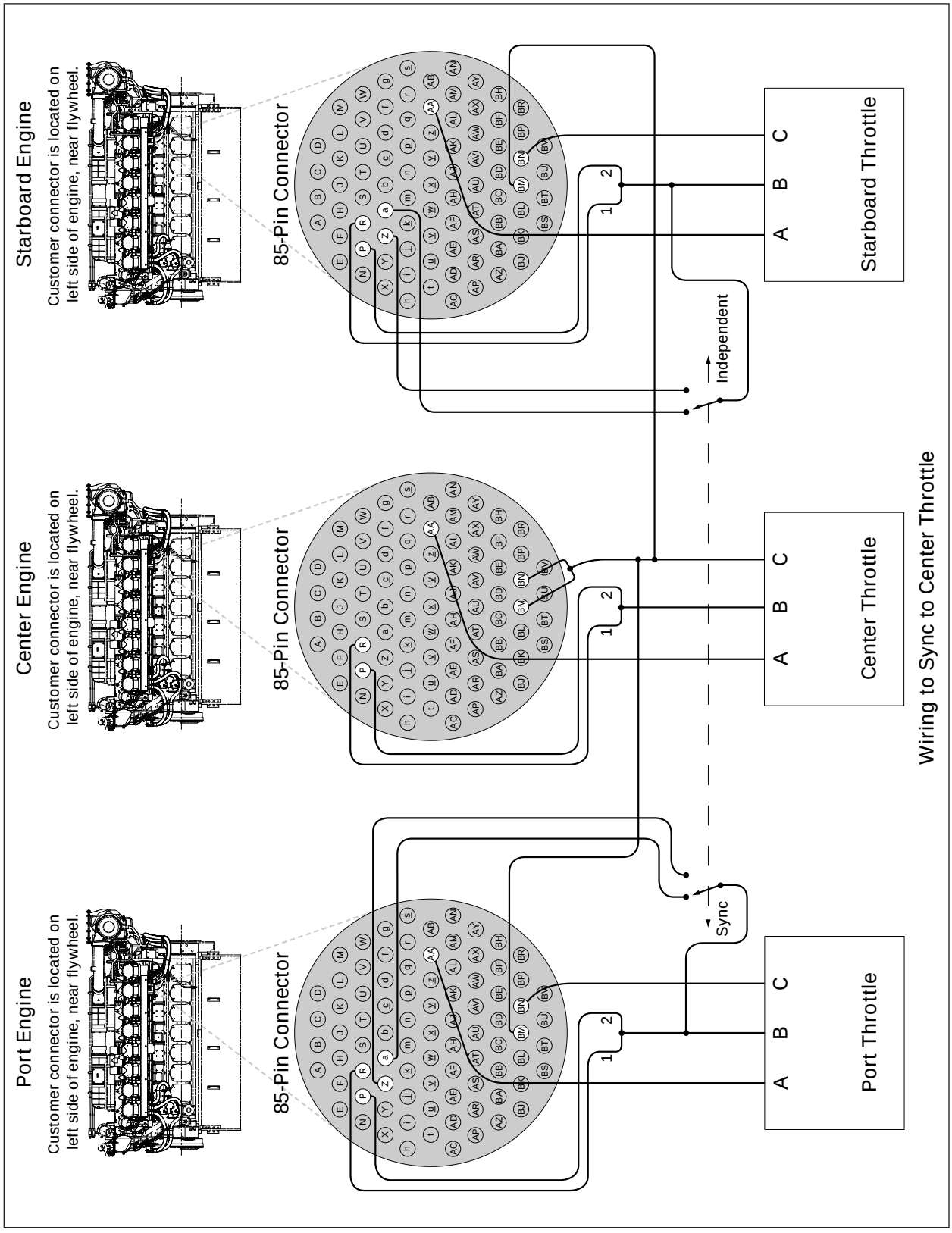
The operator will use the Synchronization switch to transfer the control of both engines to a single throttle lever. The ECU will then control engine speed from the *Master* throttle lever. Engine synchronization can be transferred to either the PORT or STARBOARD (STBD) throttle.

The operator will set the Synchronization switch and then adjust the throttles to bring the engine speeds within 50 rpm of each other. The engine controls will detect if and when the engine speeds are within 50 rpm of one another and then lock onto the *Master* throttle for engine speed control.

Note: *Synchronization can only occur when both engine speeds are within 50 rpm of each other. Likewise, unsynchronization can only occur when both engine speeds are within 50 rpm of each other.*

Note also: *Local throttle control is not possible with the engine's external throttle connections being used for throttle syncing. If both throttle syncing and also local throttle control functions are required it is recommended that the throttle syncing function be done by an external multi-engine control system.*

Throttle and Engine Synchronization System for Triple Engine Control by CENTER Throttle (Marine Propulsion Only)



Purpose

To link the engine controls of all three engines to a single throttle.

Value

Adds operator convenience and vessel control, and is a standard practice in marine applications.

Function

The operator will use the Throttle Synchronization switch to transfer the control of all three engines to the *center* throttle lever. The ECU of each engine will then govern engine speed from the *center* engine throttle signal.

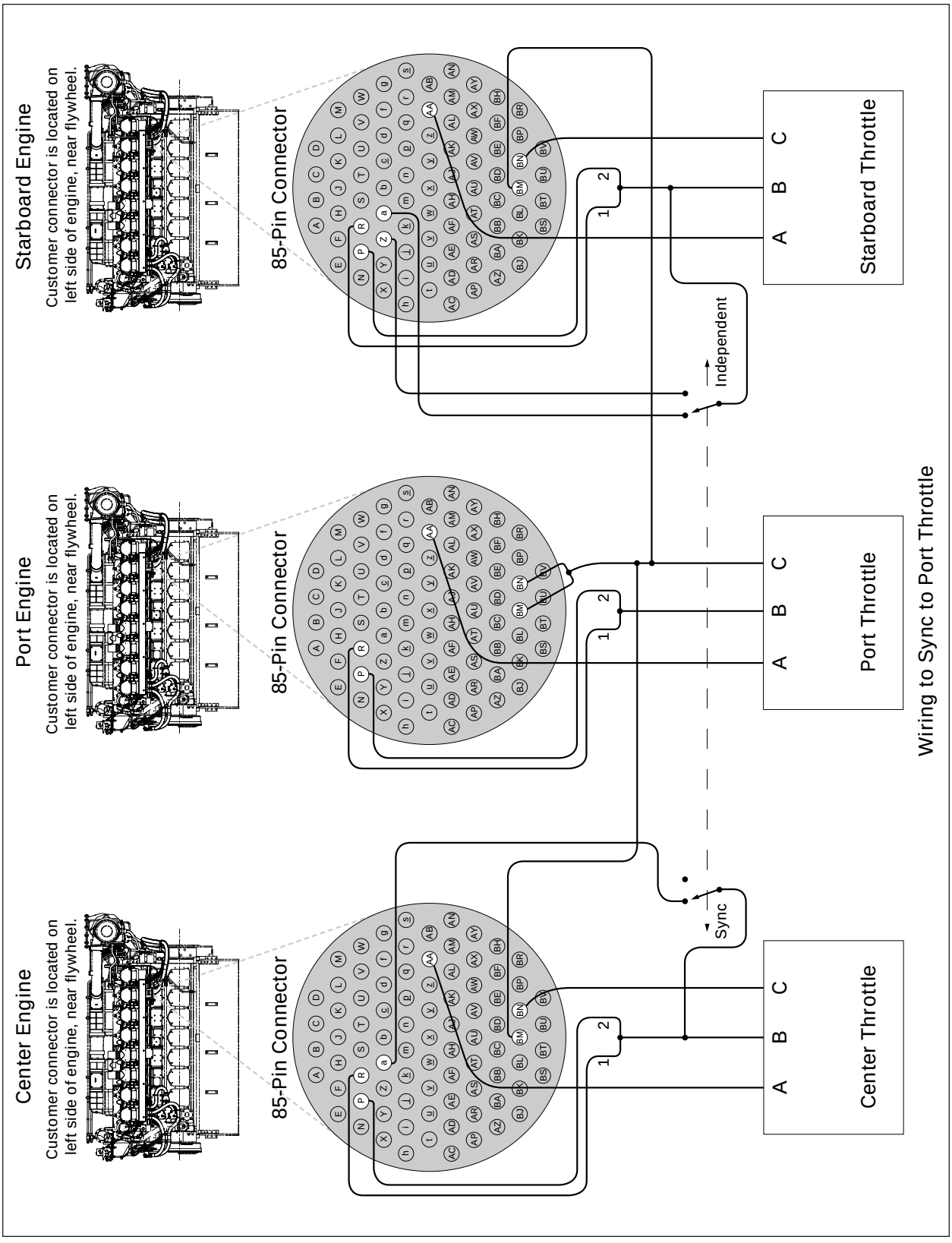
Note: *Engine synchronization cannot be transferred to either the port or starboard (STBD) throttle control. Engine speeds can only be synchronized to the center throttle control.*

The operator will set the Synchronization switch and then adjust the *port* and *starboard* throttles to bring their engine speeds to within 50 rpm of the *center* engine. The engine controls will detect if and when the *port* and *starboard* engine speeds are within 50 rpm of the *center* engine and then lock onto the *center* throttle for engine speed control.

Note: *Synchronization can only occur when all engine speeds are within 50 rpm of one another. Likewise, unsynchronization can only occur when all engine speeds are within 50 rpm of one another.*

Note also: *Local throttle control is not possible with the engine's external throttle connections being used for throttle syncing. If both throttle syncing and also local throttle control functions are required it is recommended that the throttle syncing function be done by an external multi-engine control system.*

Throttle and Engine Synchronization System for Triple Engine Control by Port Throttle (Marine Propulsion Only)



Throttle Position Sensor Calibration (Marine Propulsion Only)

Inspect Throttle Linkage

Inspect the throttle linkage for:

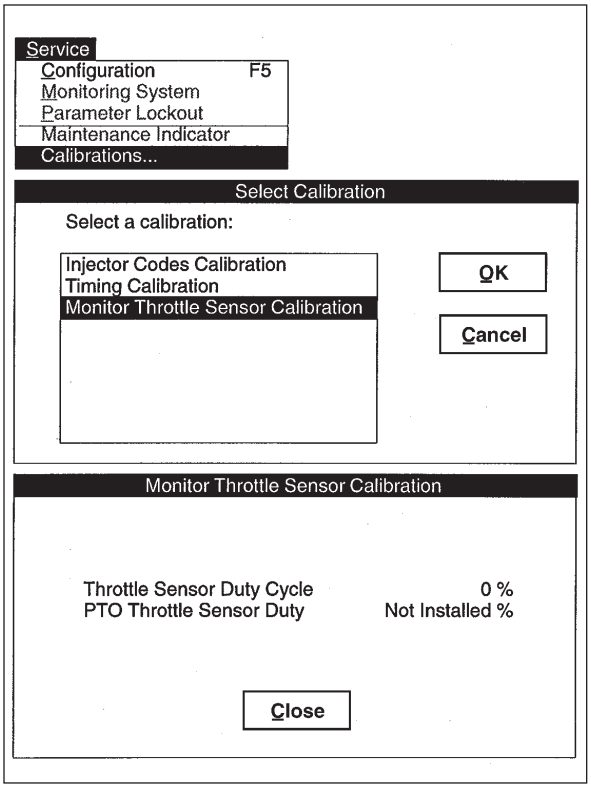
- Loose, bent, broken, missing, worn components.

Also, inspect for interface with the linkage or return spring.

Throttle linkage should work smoothly without excessive drag, and return to *low idle* position *without* assistance in less than one second.

Adjustment at Low Idle Stop Position (Minimum Throttle)

The calibration of the throttle position sensor requires the use of an IBM PC compatible laptop computer/communication adapter and Caterpillar ET software. Run ET and from the first screen *Click* on the *Service* pull-down menu.



- Turn ECS (Engine Control Switch) to *off* position.
- Connect to the ECAP or ET System.
- Turn ECS to *Cooldown/Stop* (9 o'clock) position.
- Access the Monitor Throttle Position sensor Signal screen to display the Duty Cycle.

Adjust the throttle linkage, with the throttle at LOW IDLE position, until:

- The Duty Cycle reading (display) is 7.50%.

Note: *After adjustment, a slight movement OFF (away from) the LOW IDLE linkage stop should increase the Duty Cycle reading.*

When properly adjusted, the rotary disc should be positioned as shown in Illustration 1 when the throttle is in the *low idle* position.

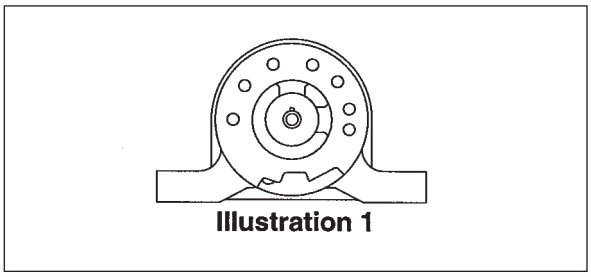


Illustration 1

Adjustment at High Idle Stop Position (Maximum Throttle)

Adjust the throttle linkage, with the throttle at *low idle* position, until:

- The Duty Cycle reading (display) is 92.50%.

When properly adjusted, the rotary disc should be positioned as shown in Illustration 2 when the throttle is in the *high idle* position.

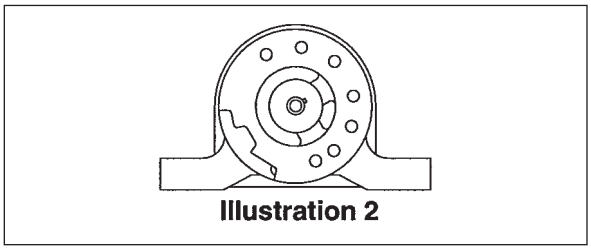
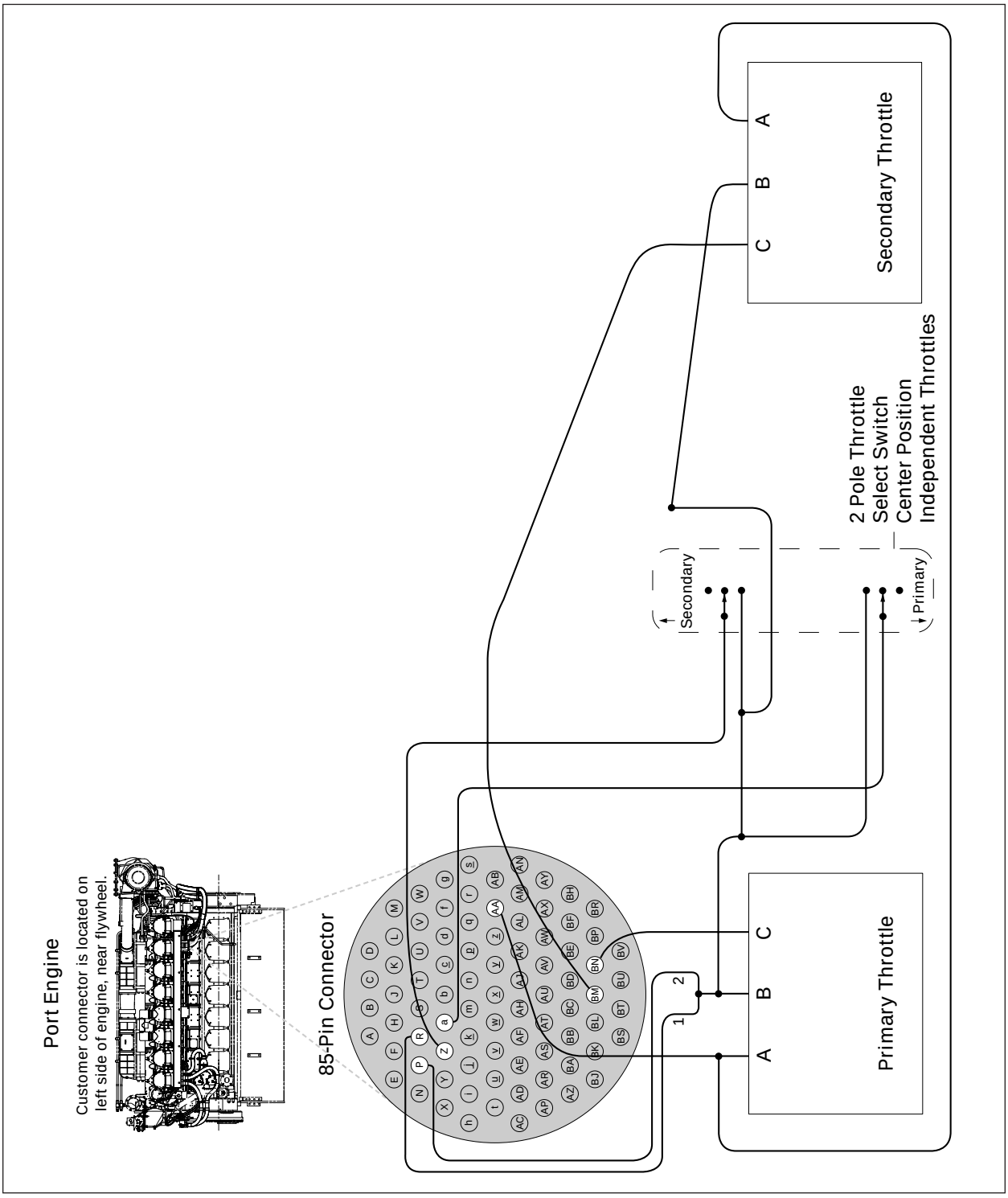


Illustration 2

Repeat the adjustment at *low idle* position to verify that the *low idle* stop is still properly adjusted.

Connecting Remote Backup Throttle Position Sensor for Single Engine Installation (Marine Propulsion Only)



Purpose

To provide Throttle Position Sensor redundancy.

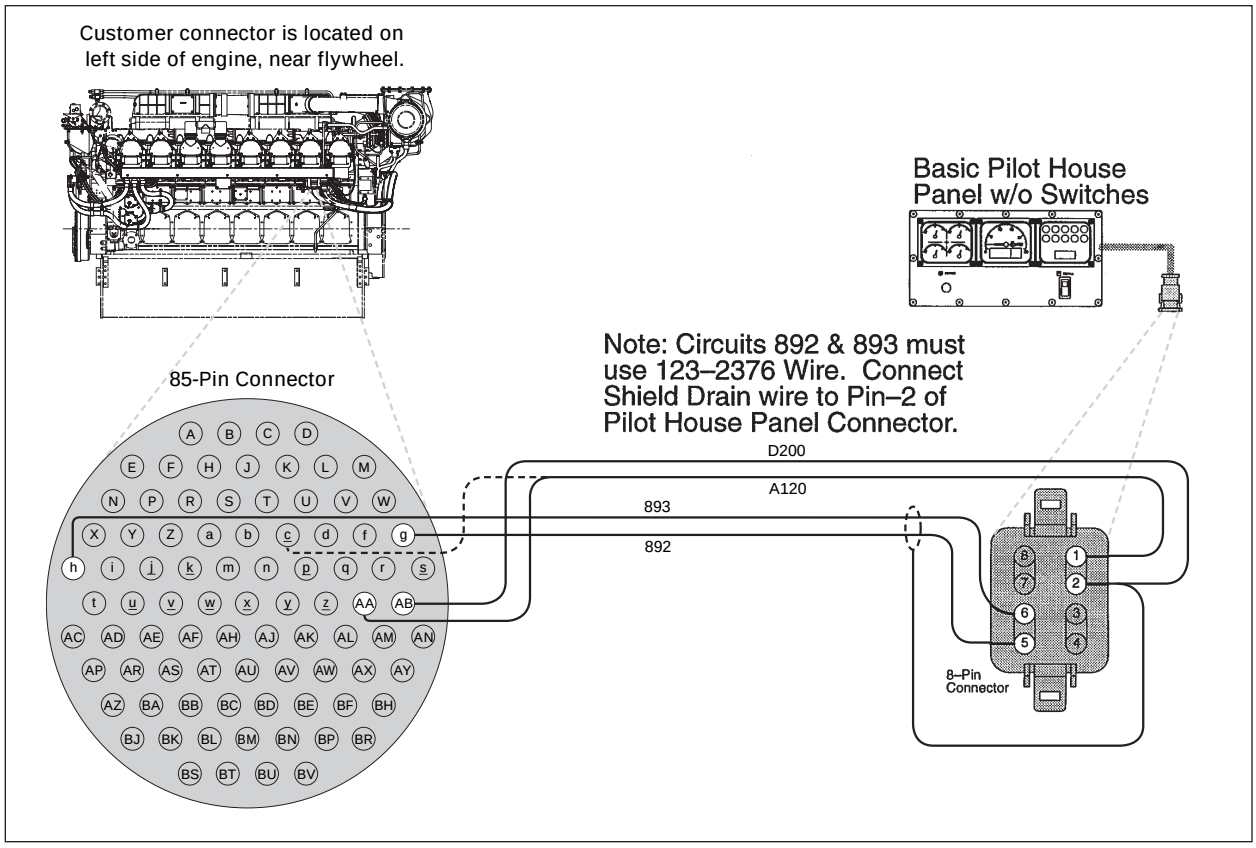
Value

Adds operator convenience. If diagnostic problem is identified on Primary Throttle then simply select the Backup Throttle via the Throttle Selection switch.

Function

The operator will use a switch to transfer the control of the engine to the Backup Throttle Position Sensor. The ECU will then control engine speed from the Backup Throttle lever.

Connecting Basic Pilot House Panel w/o Switches to EIP (Marine Propulsion Only)



Purpose

To provide basic engine monitoring information to the Pilot House.

Value

Provides for monitoring of the following information:

Warning Indicator Lights

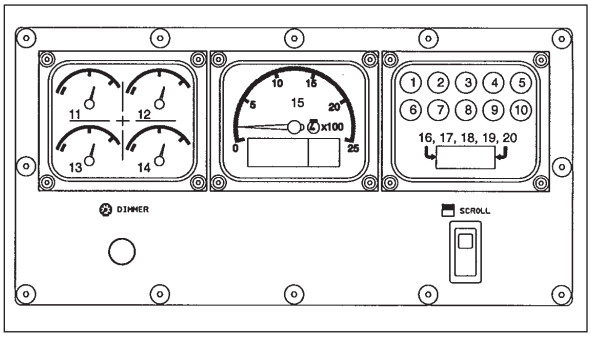
1. Shutdown/Diagnostic
2. System Voltage
3. Overspeed
4. Low Transmission Oil Pressure
5. High Transmission Oil Temperature
6. Low Oil Pressure
7. High Coolant Temperature
8. Low Coolant Temperature
9. Low Coolant Level
10. Low Fuel Level

Gauges

11. Engine Oil Pressure
12. Engine Coolant Temperature
13. Marine Gear Oil Pressure
14. Marine Gear Oil Temperature
15. Tachometer

LCD Display

16. Engine Speed in rpm
17. Instantaneous Fuel Consumption
18. Percent Load
19. Engine Hours
20. Active Gauge Value

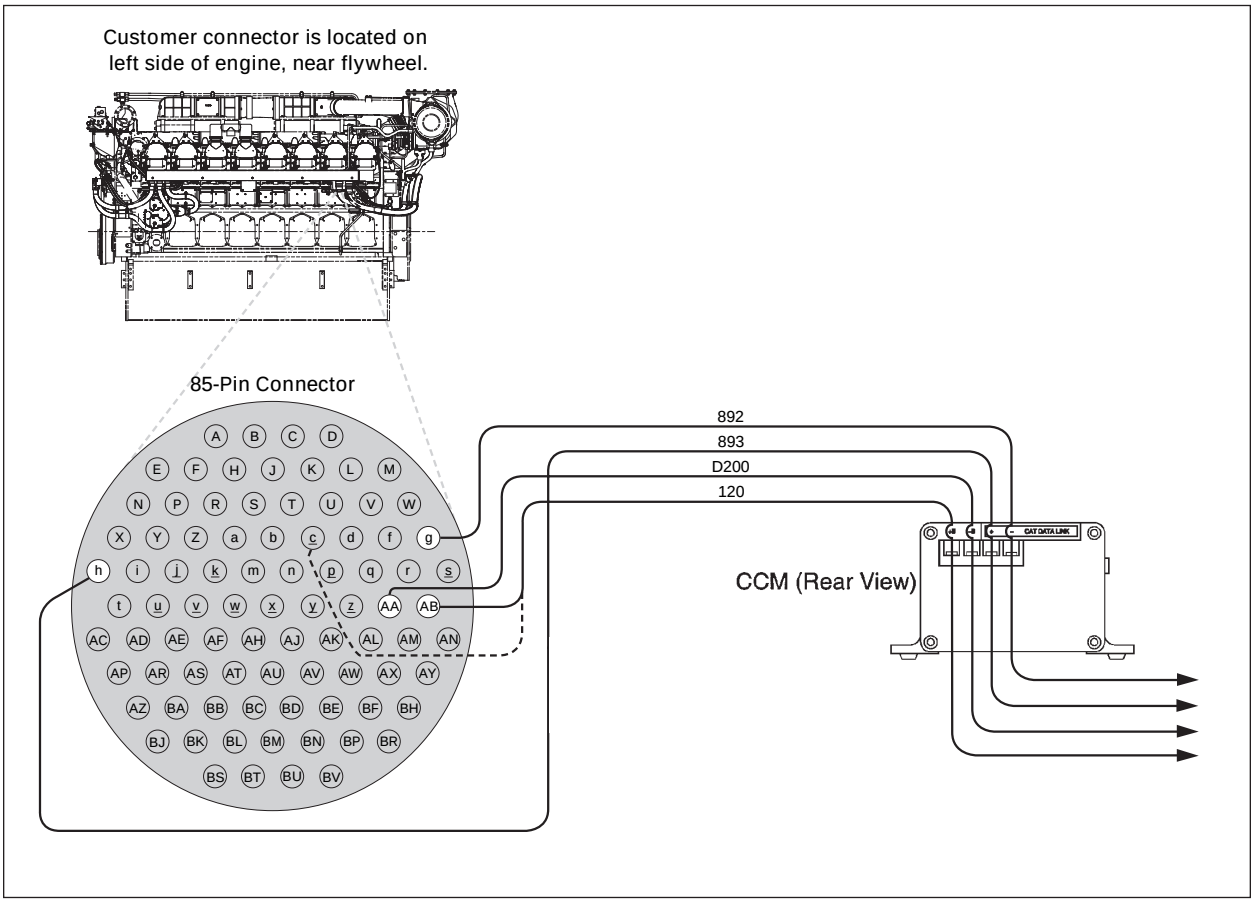


Function

The operator will use the Scroll switch to access the various LCD and LCD/Gauge functions and a dimmer knob to darken/lighten the backlighting.

Note: *To select, use scale on the display panel, connect a wire from batt (-) to pin 20 of the 40 pin connector at the back of the display panel EMS Module. For metric scale, remove the wire.*

Using CCM as a Cat Data Link Signal Booster



Purpose

To provide a boosted Cat Data Link signal.

Value

Allows customer to remotely control and monitor the engine at distances beyond the standard 30 m (100 ft) Data Link limit.

Function

The limitation on the distance to mount Pilot House Panel and PRCM components is currently 30 m (100 ft). A CCM can be added to the system to allow the devices to be installed up to 455 m (1500 ft) from the engine. The CCM acts as a constant current source to overcome the impedance of extended length of communication link wire.

The illustration on the following page shows a sample installation using multiple Pilot House Panels. The CCM may be connected wherever it is convenient to do so, and does not necessarily need to be in series with the panel or PRCM. Segment length may vary and does not necessarily need to be in equal proportions between modules. The sum of all segments must be less than or equal to 305 m (1000 ft).

General CCM Installation Information

When a CCM is installed, these requirements must be met:

- The environmental, mounting, wiring, and cable specifications must be met.
- The connections diagrams must be followed.

Specifications

- The ambient operating temperature range is from -40°C to +70°C (-40°F to +158°F).
- The storage temperature range is from -40°C to +85°C (-40°F to +185°F).
- The unit must be protected from direct contacts with liquids (splash-proof). If sealing is required, the CCM must be in a water-tight enclosure.

Mounting

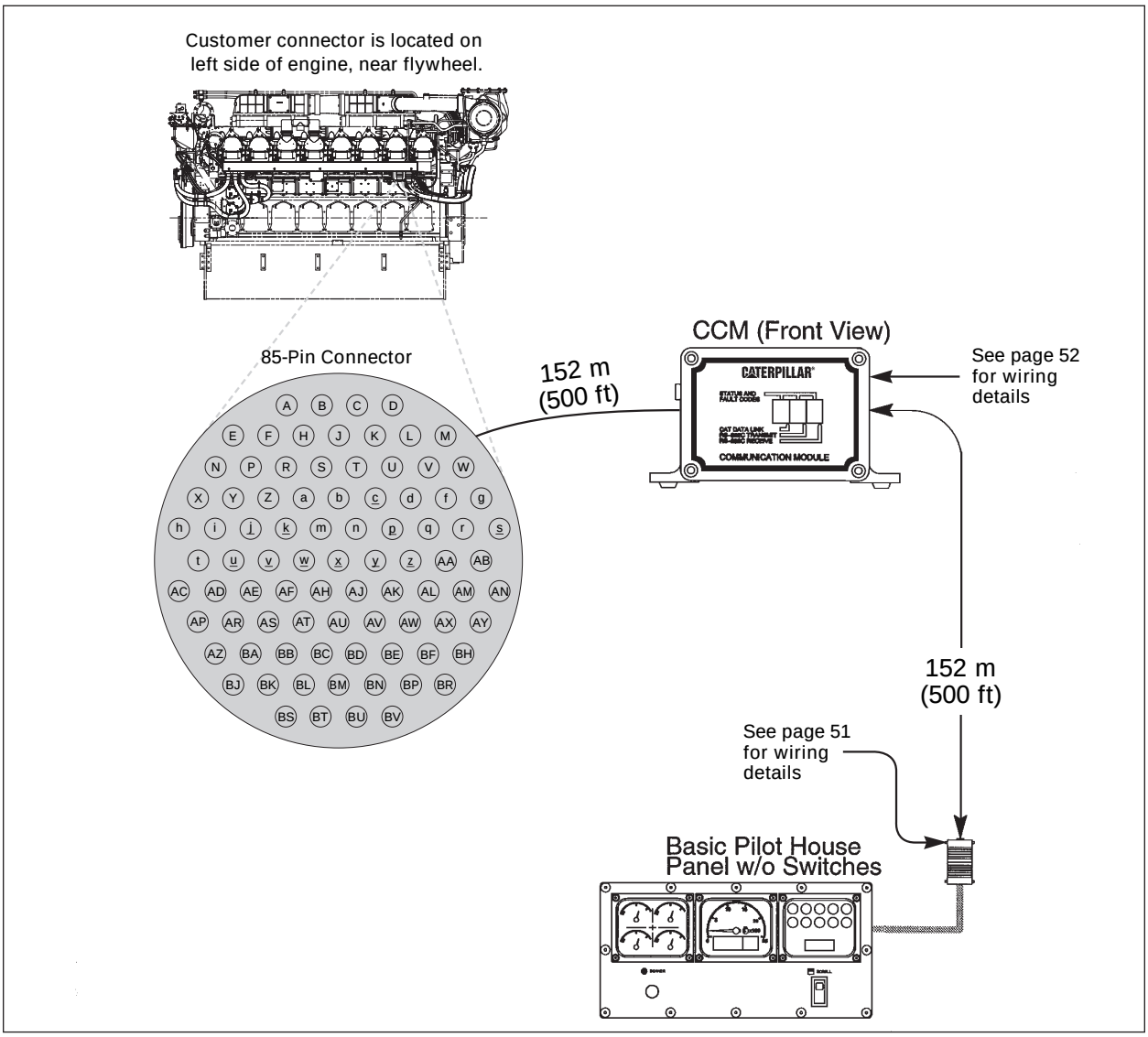
Locate the CCM on a desk or shelf. The rubber feet on the bottom of the CCM can also be removed to allow panel mounting.

Note: *Do not mount the CCM on an engine or within an engine-mounted enclosure. It is not designed for this environment.*

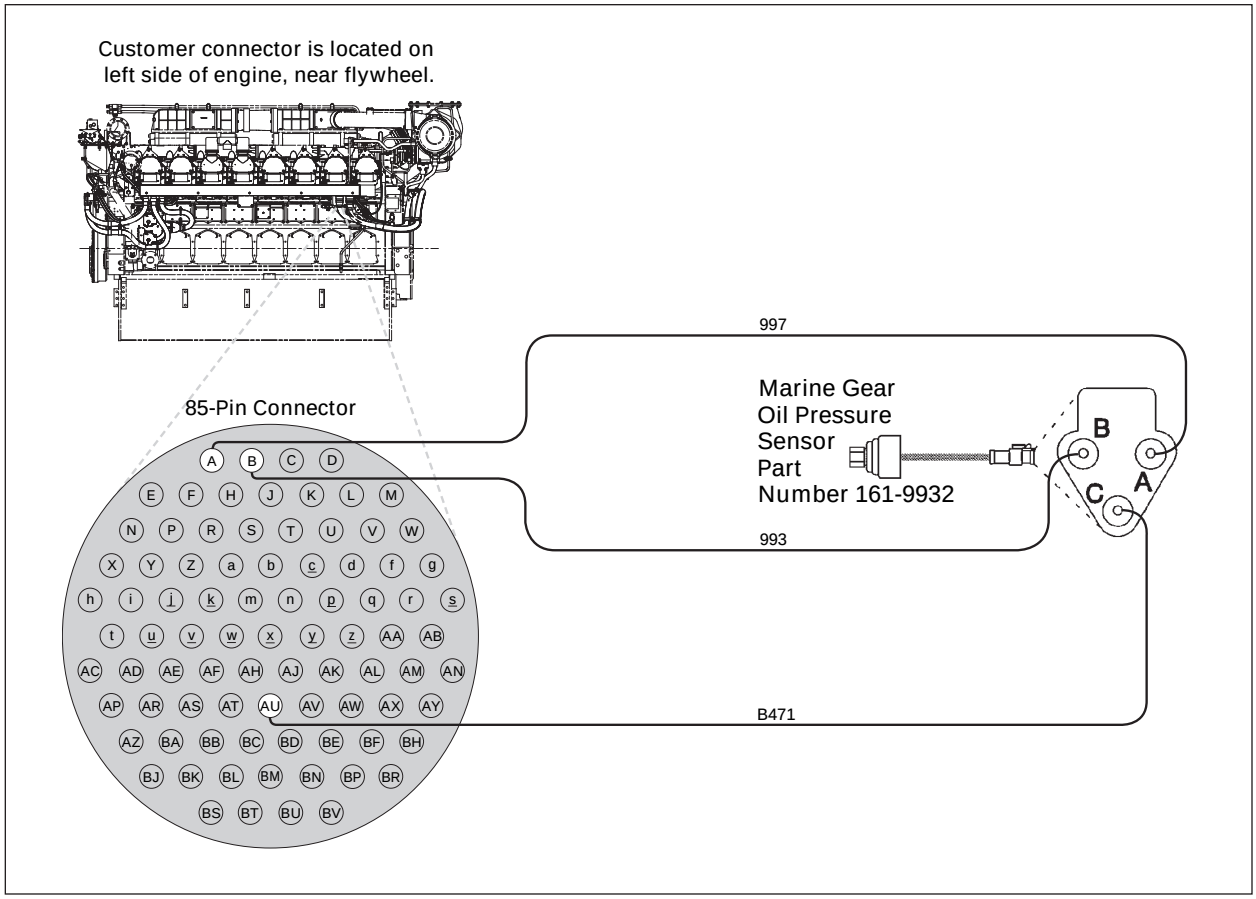
General Wire and Cable Specifications

The following specifications for wire and cable are given to reduce voltage drops over long runs of wire and to reduce EMI/RFI interference.

- The wires connected to B+ and B- on the CCM must be at least 16 AWG.
- Maximum Cat Data Link cable and ± B wire length is 455 m (1500 ft.), including wire runs between any multiple panels.
- No terminations or splices allowed on the above wires, except as noted in the connection diagrams.
- The cable connected to Cat Data Link ± must be 16 AWG, shielded twisted pair cable. Use 123-2376 electric cable, Belden 8719 cable, or equivalent.



Connecting a Marine Gear Oil Pressure Sensor to Marine Propulsion Engine



Purpose

To provide a Marine Gear Oil Pressure indication to the operator.

Value

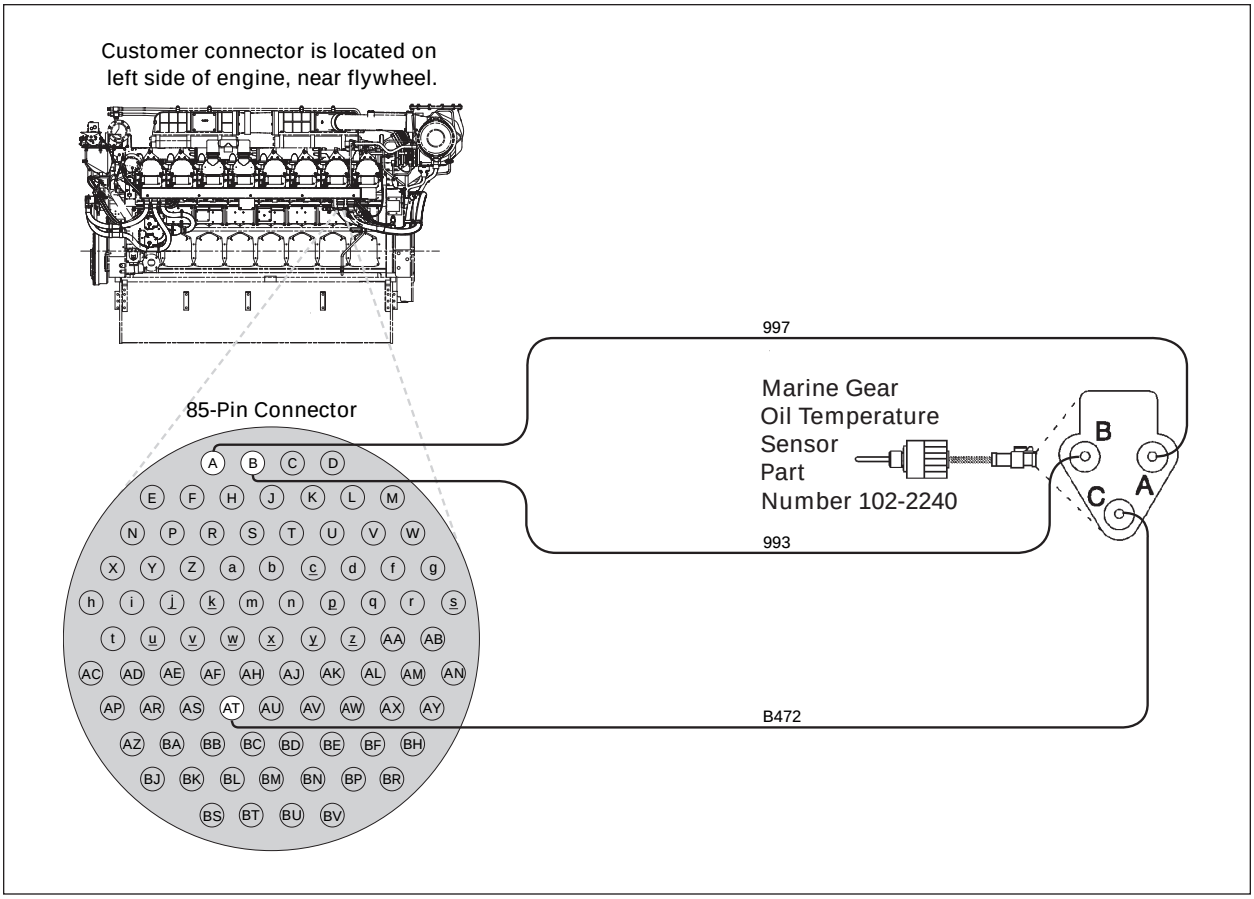
Aids the operator in maintaining proper marine gear oil pressure.

Function

The operator will use the MPD on the MPDP to monitor marine gear oil pressure.

Note: *Using this sensor, the operator can also receive a Marine Gear Oil Pressure Low Warning indication via the PRCM.*

Connecting a Marine Gear Oil Temperature Sensor to Marine Propulsion Engine



Purpose

To provide a Marine Gear Oil Temperature indication to the operator.

Value

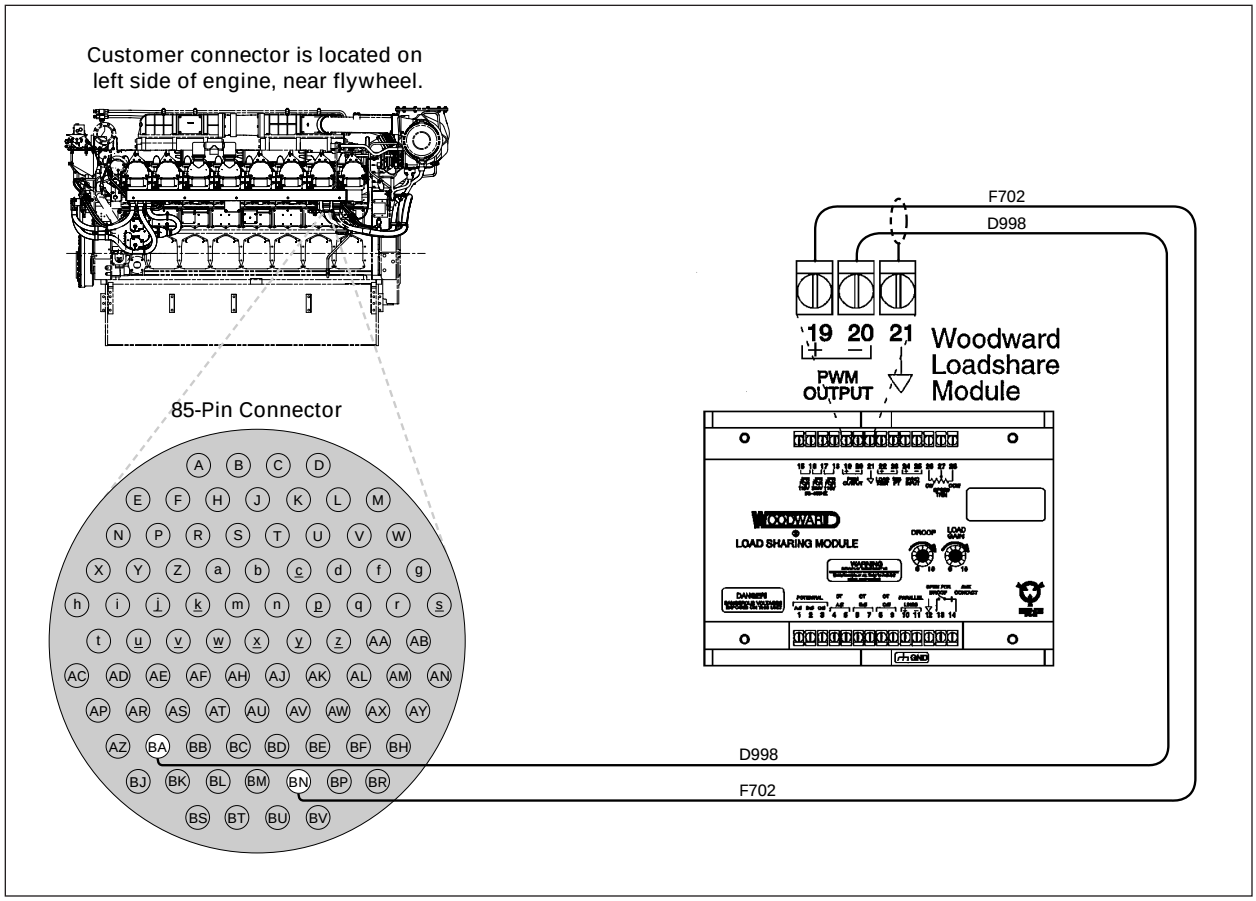
Aids the operator in maintaining proper marine gear oil temperature.

Function

The operator will use the MPD on the MPDP to monitor marine gear oil temperature.

Note: *Using this sensor, the operator can also receive a Marine Gear Oil Temperature High Warning indication via the PRCM.*

Connecting a Woodward Loadshare Module to Marine Auxiliary Engine



Purpose

To provide a means of sharing load with multiple generator sets.

Value

Allows Woodward Loadshare Module to control engine speed.

Function

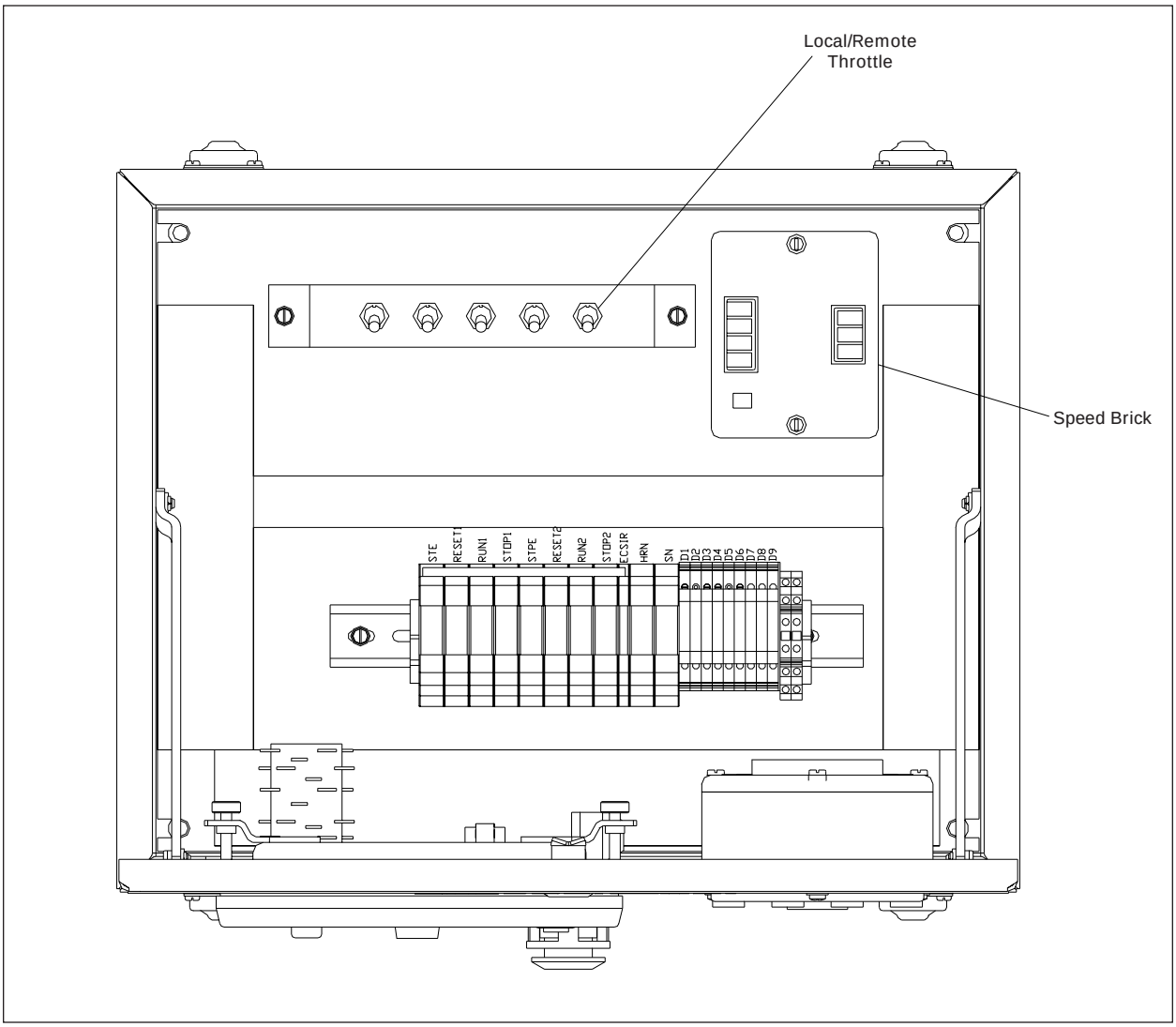
The operator will use the Woodward Loadshare Module's PWM OUTPUT SIGNALS (+) and (-) to provide a *Desired Engine Speed* signal to the A3 ECU.

Note: *The 9X-9591 Speed Control inside of the Electronic Instrument Panel (EIP) must be removed if present and the "F702-GN" wire connected to the "S" terminal of the 9X-9591 must then be connected to Pin-36 of the 40-Pin customer connector.*

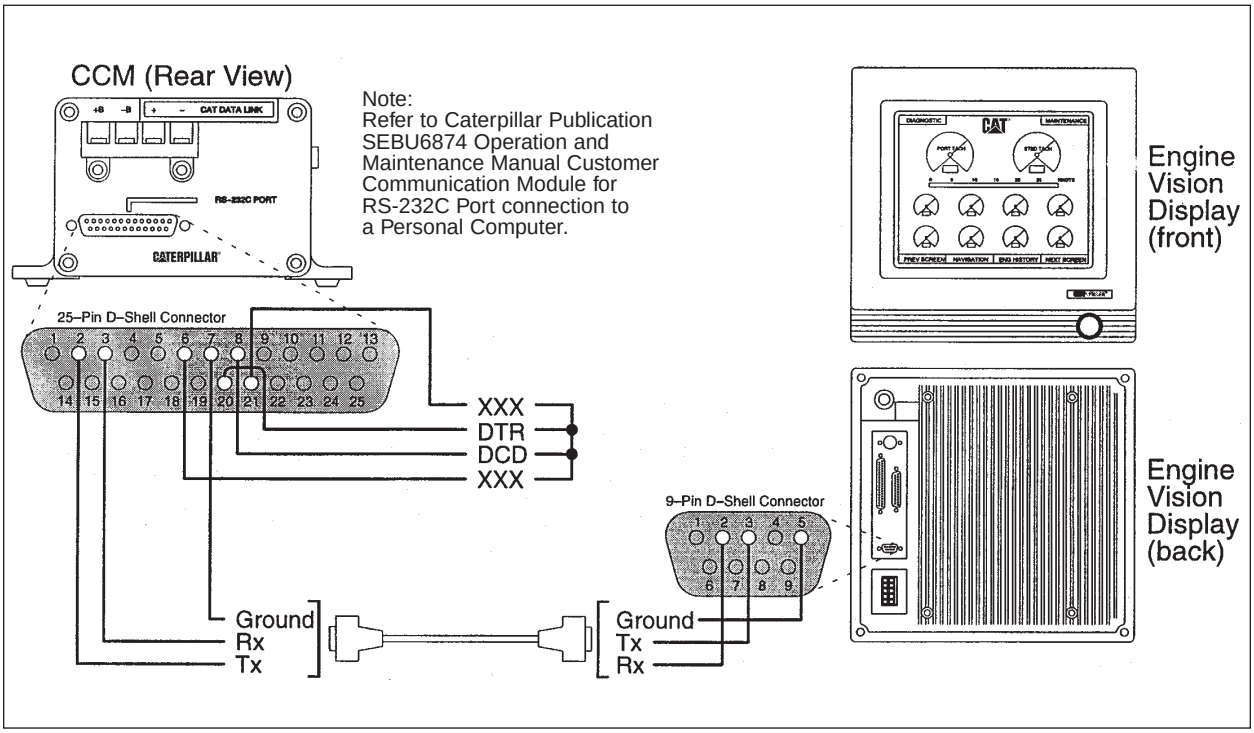
Local Throttle Control (Propulsion Only)

The 3500B Series II has an optional local throttle control available. When in local throttle mode, achieved by moving a switch inside the MPD panel from the remote position to the local position, the engine receives its throttle signal from a “speed brick” and potentiometer. The local/remote throttle switch is shown in the figure below.

When the local throttle control is ordered, the potentiometer is installed in the cover of the MPD panel and has ten turns from low idle to full throttle.



Connecting Customer Communication Module (CCM) to an Engine Vision Display (Marine Propulsion Only)



Purpose

To provide a two-way communication link between the CCM and the Engine Vision display.

Value

Allows customer to remotely monitor the engine.

Function

The operator will use Caterpillar supplied *basic* PC software to create customer specific programs. The CCM software can be easily upgraded via *Flash* memory programming. Refer to Caterpillar Publication SEBU6874 Operation and Maintenance Manual, Customer Communication Module for more details.

Programmable Droop

(An option for use with shaft generators)

Description

This feature is used in applications of propulsion engines that drive shaft generators and require the engine speed governor to operate in one of two selectable modes: isochronous or various degrees of droop. This feature also allows the user to program the droop value (expressed as percentage) via the Caterpillar ET service tool.

Droop will cause the engine speed to slow as load increases and vice versa. For a given amount of load change, the resultant speed change will depend on the droop value that has been programmed. The valid values that can be programmed are:

- 0% (Restores Isochronous Mode)
- 2.5% to 8.00% in increments of 0.1%
- Values between 0% and 2.5% cannot be programmed in.

Once installed, the high idle speed in isochronous mode is permanently changed from 108% of rated speed to 100% of rated speed. Furthermore, as the throttle is reduced toward low idle, the effective droop value is progressively reduced from its ET setting such that it is reduced to zero at low idle and the engine governing is isochronous at low idle.

The final desired speed signal into the engine speed governor algorithm is defined by the following equation:

Final Desired Engine Speed = Idle + (Rated – Idle)*(Throttle/100) + Rated*(Throttle/100)* (Droop/100)

Where

Idle . . . . . Low Idle rpm Setting
Rated . . . . . Rated rpm Setting
Throttle . . . . . % Throttle
Droop . . . . . % Droop

Programmable droop is compatible with all ratings of propulsion engines (dual engine control modules).

Where Used

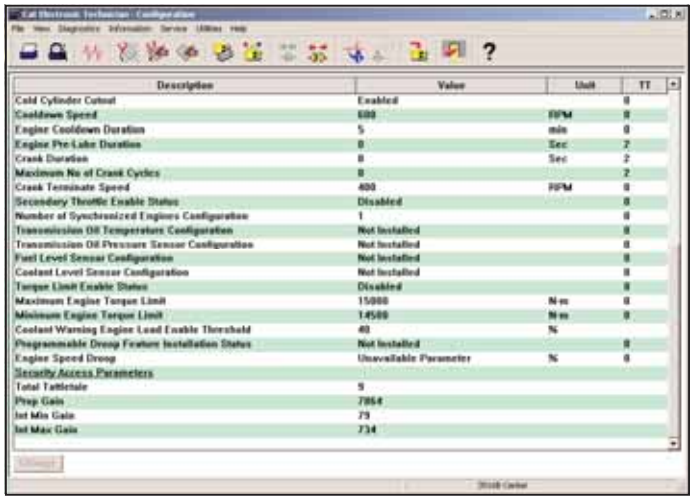
(An option for use with shaft generators)

It is not recommended that the 3500B marine propulsion engine be coupled to generators for the sole purpose of electric power generation. This is due to fundamental differences in the turbochargers, fuel injectors, and software of the marine propulsion engines versus the analogous components of an electric power or marine auxiliary engine.

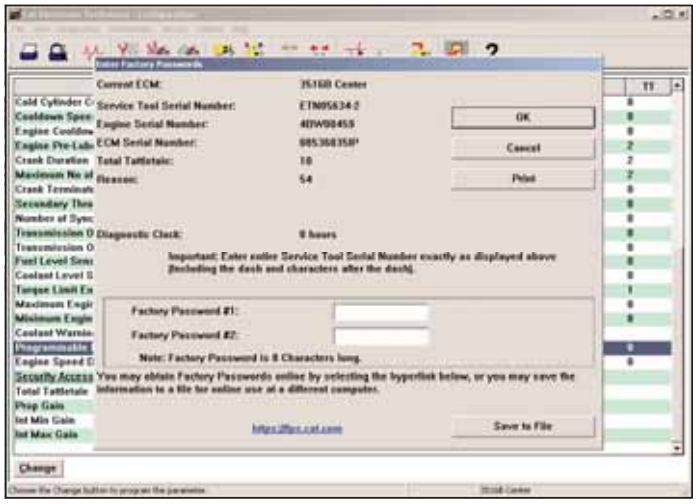
However, in certain applications it may be desirable or required by ship design to use a shaft generator either from a power-take-off on the marine gear or coupled directly to the front of the marine propulsion engine. ***When coupling a shaft generator to a marine propulsion engine it is critically important that the installer complete a torsional vibration analysis.***

In these installations, temporary or long-term load sharing with other shipboard auxiliary engines may be required. This programmable droop function allows this to be accomplished by setting the droop value within the range 2.5% to 8%.

The ET screens that follow illustrate the process of setting the programmable droop feature.

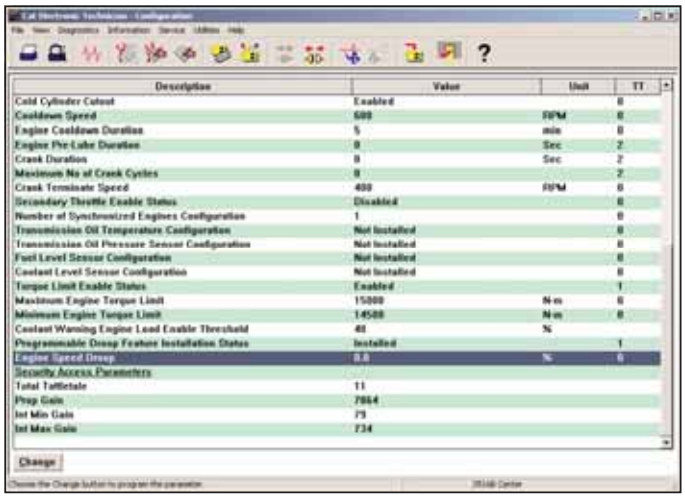


The above screen displays the “Programmable Droop Feature Installation Status” and indicates it is not installed. Installation requires a factory password as shown on the next screen.



This password requires a fee because the Programmable Droop feature is one of the premium software features.

The next screen shows the feature installed and the droop value ready to be entered.



Load Feedback

When Used

Load feedback is used in applications when the engine speed must be adjusted in response to the engine load. An example might be an engine driving a controllable pitch propeller (CPP). Using this feature can automatically prevent potentially dangerous engine overload by reducing propeller pitch in response to the load feedback signal.

Description:

The engine's Electronic Control Module (ECU) produces an electronic signal that is proportional to the engine load. 3500B engines do not have a physical rack, but the electronic equivalent of the familiar concept of fuel rack position (injection duration) is used in the service tools and in the discussion below.

If the engine is operated below rated speed, the percent load is calculated using the following formula:

$$\text{Percent Load (as a decimal fraction)} = \frac{\text{Current Fuel (Rack) Position - Idle Fuel Position}}{\text{Max. Allowable Fuel (Rack) Position (At this speed) - Idle Fuel Position}}$$

If the engine is operated above rated speed, the percent load is calculated with the formula shown below.

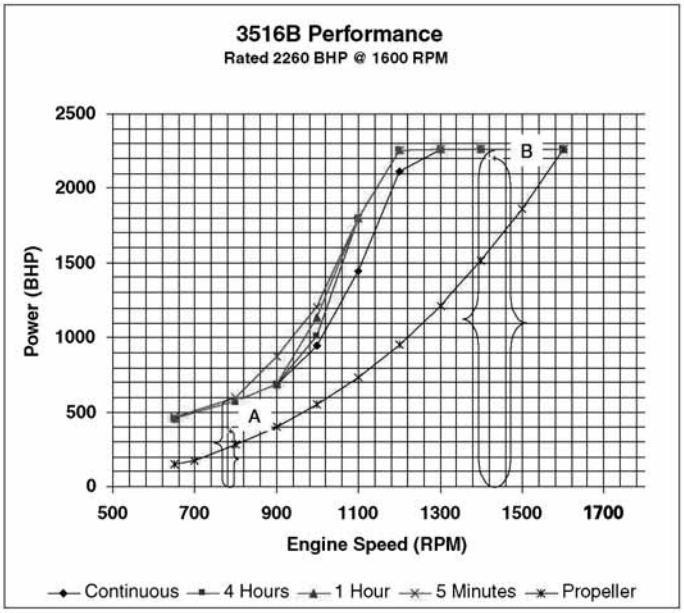
$$\text{Percent Load (as a decimal fraction)} = \frac{\text{Current Fuel (Rack) Position - Idle Fuel Position}}{\text{Max. Allowable Fuel (Rack) Position (At Rated Speed) - Idle Fuel Position}}$$

Idle Fuel Position should be set to 5.0mm.

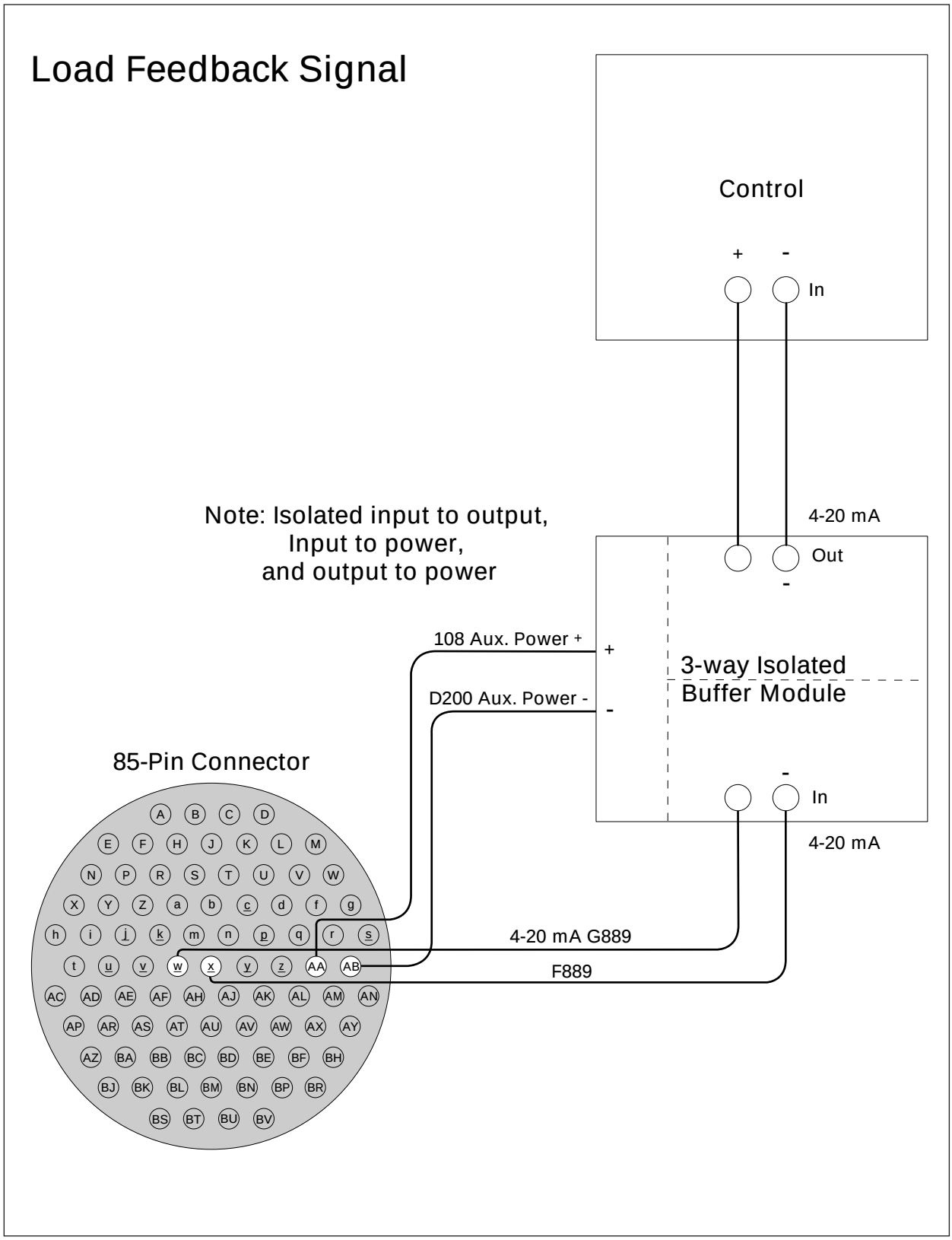
This signal has an error of as much as ± 10%.

Notice from the 3516B performance curve below that the percent load calculation is closely related to the engine speed. On the curve, there are two operating points illustrated by way of example. Assume, in the case illustrated by the shorter brackets on the left side of the curve that the engine is operating at a rack position shown by the shorter of the two brackets. The maximum allowable rack position, for that speed, is illustrated by the longer of the two brackets. The percent load (ratio of the two rack positions) is approximately 0.60 or 60%.

The taller pair of brackets on the right side of the curve illustrates a load percent of approximately 90+% since the engine is running at a very high percentage of its maximum rack position, as illustrated by the two longer brackets.



Wiring Diagram



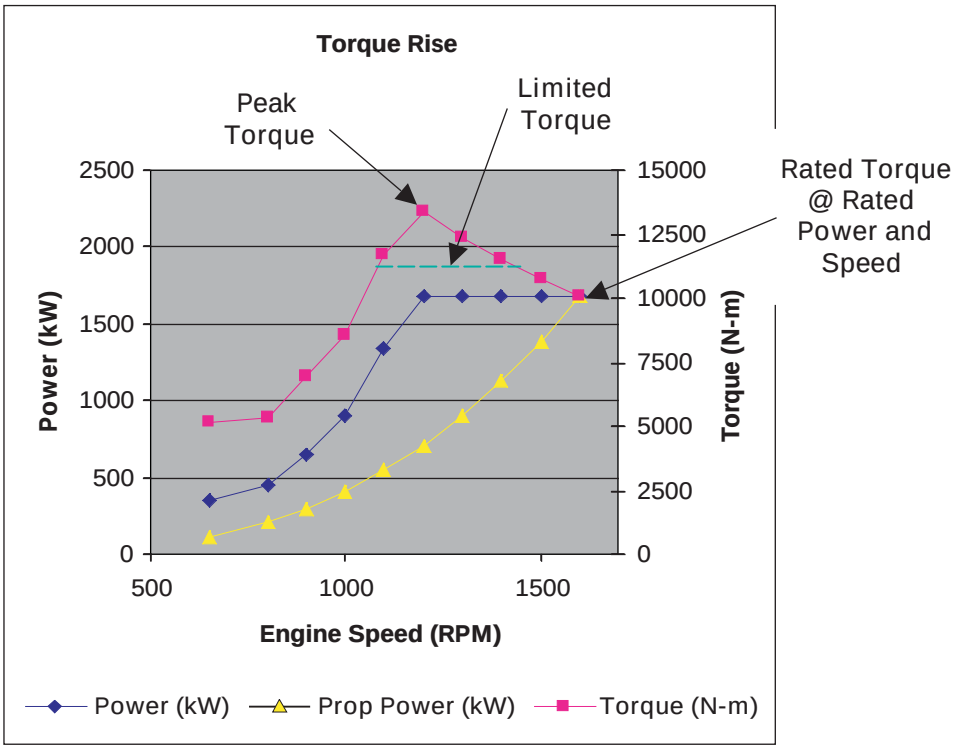
Note: *3-way isolated buffer is not supplied by Caterpillar.*

Torque Limit

When Used

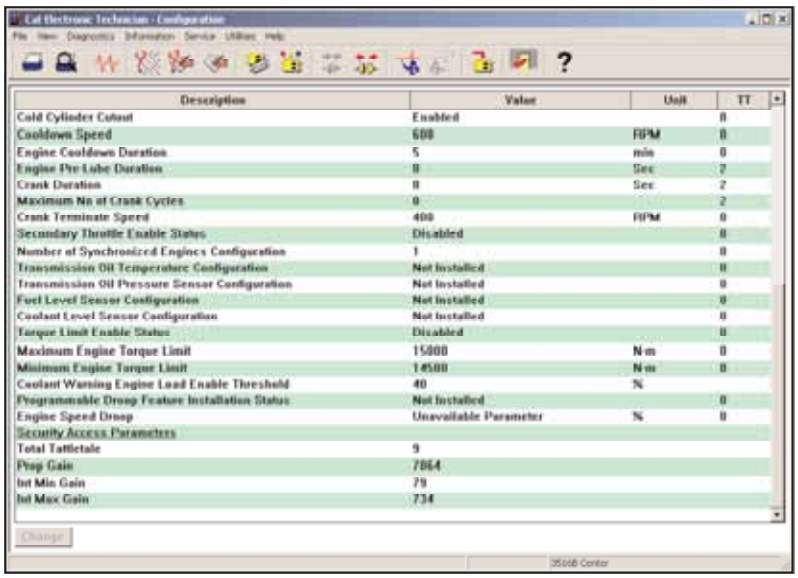
This feature is used in applications where it is desirable to limit the torque rise of the engine. Examples include:

- In repowering vessels that were originally powered by lower powered engines and with gears and shafts sized to the lower powered engines, it is desirable to limit the torque rise of the new engine to protect the marine gear and shafting until such time as they can be replaced. Torque limit will be very useful in this instance.
- Some equipment demands the power characteristics of mechanically governed engines. Electronic engines generally have very high torque rise, as described in the graph below. If successful operation depends on the power characteristics of mechanically governed engines (where the power is a maximum only at rated speed and where power decreases at both higher and lower speeds from rated speed), the torque limit feature can restore to the electronic engine the power characteristic of mechanically governed engines. This feature allows the technician who sets up the engines with Cat Electronic Technician (ET), the electronic service tool, to set the maximum torque to any level of torque from rated torque at rated power and speed up to peak torque.

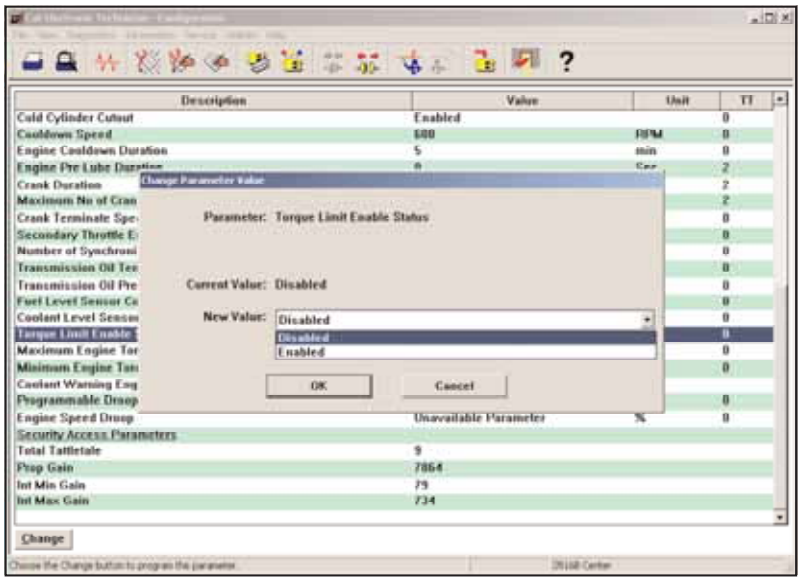


Instructions

3 lines on the ET screen are used to enable and set the programmable torque limit. These as shown in the following screen:



The feature is enabled or disabled by selecting the “Torque Limit Enable Status” line and then selecting “Enable or Disable” according to the following screen:



When the torque limit function is enabled, the engine’s torque is limited to one of the two values set by the ET screen.

- Maximum Engine Torque Limit
- Minimum Engine Torque Limit

The active limit is selected by the torque selection switch that connects to Pin Y of the Customer Connector.

This function must be disabled via ET in order to restore the normal torque provided by the normal performance settings within the ECU’s software.

Throttle Position Sensor

Where Used

The Throttle Position Sensor is used to provide an engine throttle signal. Some control system suppliers are able to provide usable engine throttle signals directly without using the Cat Throttle Position Sensor.

Description

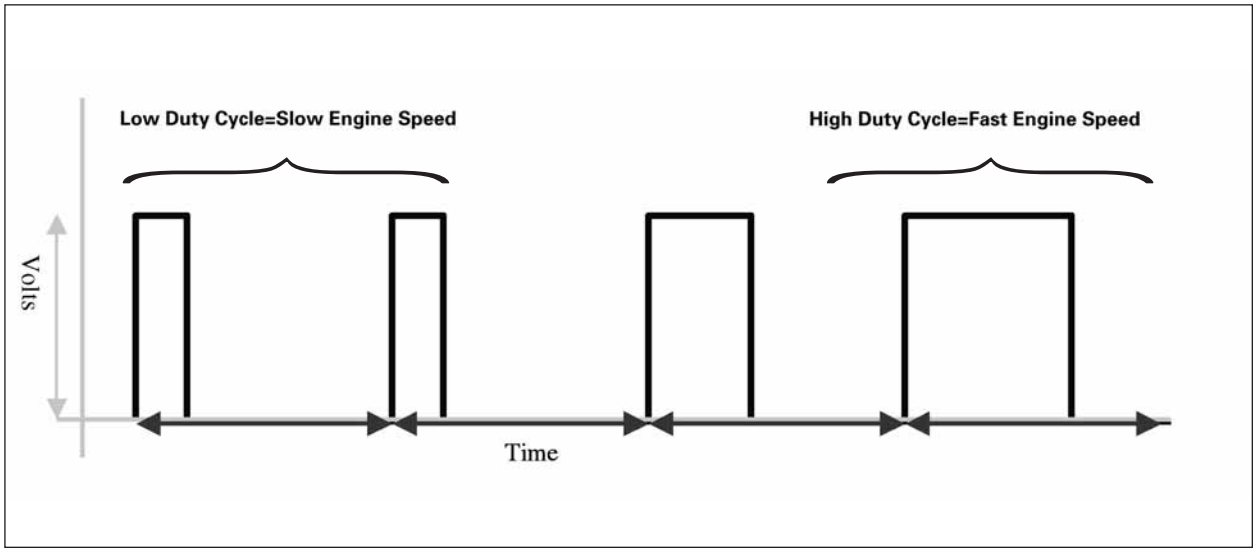
The Throttle Position Sensor converts rotational motion into a variable-duty-cycle, pulse-width-modulated signal. The duty cycle of the signal determines the desired speed of the 3500B propulsion engine.

PWM Definition

The 3500B marine engines use a series of evenly-spaced voltage pulses as a throttle signal (to convey the pilot's desired engine speed). The pulses are emitted at the rate of 500 pulses per second. The voltage pulses can be varied in their width. This width variability, changing the duty cycle of the signal, gives the signal its ability to convey information. When the pulses are very short (low duty cycle), the engine throttle signal is for a slow engine speed. When the pulses are very wide (high duty cycle), the engine throttle signal indicates a fast engine speed. These signals are called Pulse-Width-Modulated (PWM).

PWM signals are generally resistant to problems associated with ground faults, excessive capacitance and voltage fluctuations. These make a PWM signal ideally suited as a throttle signal.

Notice that even though the frequency (wavelength) of the voltage pulses shown below is constant, their width varies. It is that width variation the engine uses to determine its desired speed.



Programmable Relay Control Module (PRCM)

Where Used

The PRCM is most often used to drive alarm lights/horns in response to alarm conditions detected by the engine's control and monitoring system. The following system parameters may be annunciated using the PRCM.

ECU Active Diagnostic Present	High Crankcase Pressure
ECU Voltage Warning	High Aftercooler Water Temperature
Engine Oil Pressure Warning	Low Coolant Level
High Jacket Water Temperature	Low Fuel Level
Low Jacket Water Temperature	Battery Charger Low Voltage
Overspeed	High Marine Gear Oil Temperature
High Air Inlet Restriction	Low Marine Gear Oil Temperature
High Exhaust Temperature	Disabled Fuel Injection
High Oil Filter Differential Pressure	Engine at 100% Load
High Fuel Filter Differential Pressure	Engine Speed Above 50 rpm
Starter Over-crank	Active Starter Motor Relay
Engine Control Switch Not in AUTO Position	Power Derate Active
Power Derate Active, but Not for Altitude	Shutdown (2070*)
Shutdown Because of Low Oil Pressure	Shutdown Because of High Jacket Water Temp
Shutdown Because of Overspeed	Shutdown Because of High Crankcase Pressure
Shutdown Because of High Aftercooler Temp	

***Note:** 2070 is a summary alarm (2071-2075).*

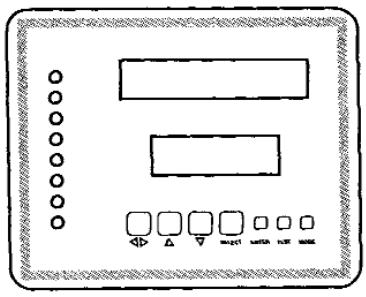
Description

The PRCM will provide up to 25 sets of relay dry contacts and six alarm lights (LEDs) from eight switch inputs and the data link parameters. The basic PRCM controls seven relays and six alarm lights. If desired, up to two add-on Relay Driver Modules can provide nine additional relay dry contacts each, for a total of 18 relay dry contacts. All the relays and alarm lights are customer programmable through a keypad and display on the PRCM. The PRCM receives information via a Cat Data Link from the Engine Control Module (ECU) and from eight switched inputs on the PRCM to control the outputs. The PRCM always outputs the present state of the selected input, if available. If the communications between the PRCM and the ECU are disrupted, the PRCM can either output the last data received or reset the data.

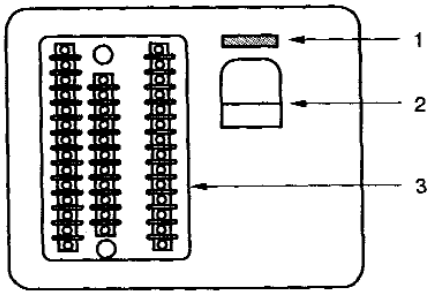
- Ambient operating temperature range: -40 to +70°C (-40 to +158°F)
- Voltages: The operating voltage range is from 15 to 45 volts DC. The Relay Driver Module is designed to only operate when powered by 24 or 32 volts DC battery systems.
- Relays: The relay coils draw 20 mA at 24 VDC. Three relays provide normally open and normally closed contacts. Four relays provide normally open contacts only. The relay contacts are silver flashed, fuse protected, and rated for 10 amps at 28 VDC.
- The PRCM case is electrically isolated from its internal circuitry.
- All inputs and outputs are protected against shorts to + or – battery. Exceptions are terminals 2, 13 and 14 on the relay driver module which are not fused and therefore are not protected from short circuits to + or – battery.
- The PRCM is capable of operating with or without an earth ground.
- The PRCM must share common ground with the optional relay driver modules and relay boards.
- The PRCM is intended to be located in an instrument panel or on a shelf.

Programmable Relay Control Module

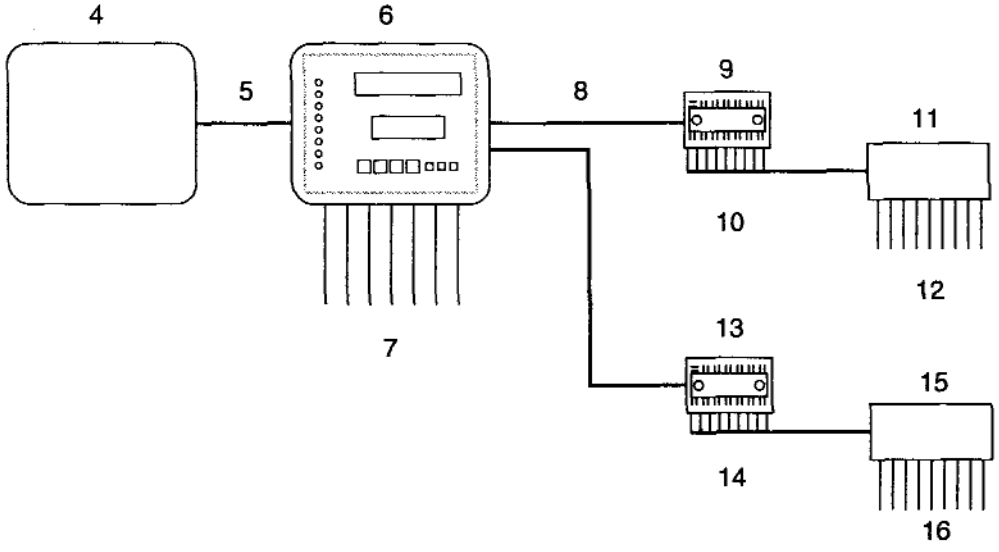
(For more details, see Owners Manual)



Programmable Relay Control Module (Front View)



Programmable Relay Control Module (Rear View)
(1) Location of part number. (2) 40-pin connector.
(3) Relay module.



Typical installation Of Programmable Relay Control Module, Relay Driver Module, And Relay Board
(4) ECM. (5) CAT data link. (6)PRCM. (7) Seven relays with outputs for customer use. (8) Serial data link. (9) RDM No.1 optional. (10) Nine driver relays. (11) Relay board No.1, optionsl (12 Nine relays with outputs for customer use. (13) RDM No. 2, optional. (14) Nine driver relays. (15) Relay board No.2, optional. (16) Nine relays with outputs for customer use.

General Alarm Relay (Propulsion Only)

When Used

The General Alarm Relay is contained within the power distribution box. It provides *dry, voltage-free contacts* with which an alarm annunciation system may be controlled. The normal state of the General Alarm Relay is “de-energized”; it energizes whenever there is an active event (warning, derate, or shutdown) or when there is an active/logged diagnostic. It is important to define these terms used in understanding the function of the General Alarm Relay.

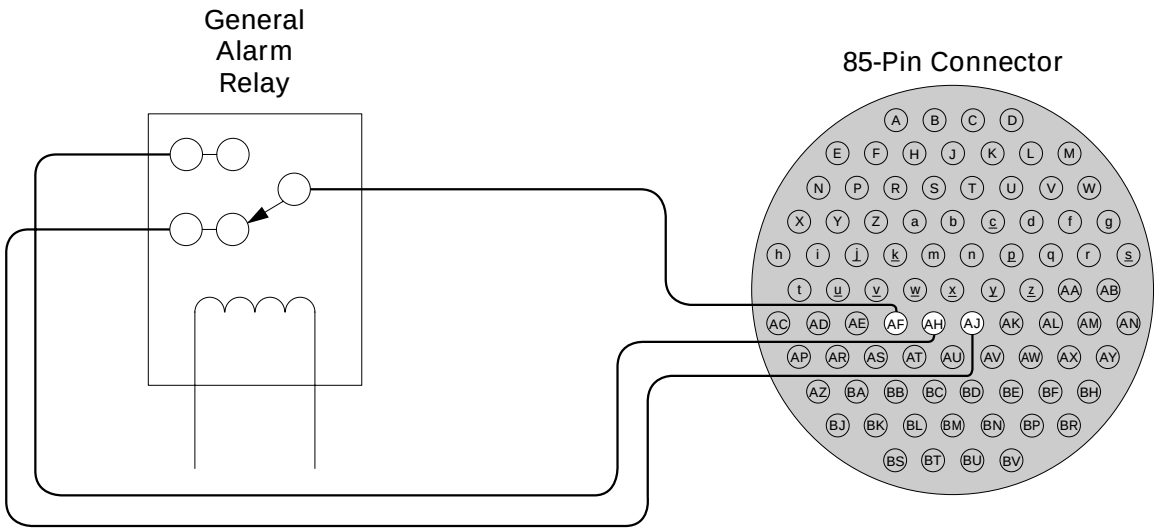
- Events are situations where the engine’s performance parameters (exhaust temperature, jacket water temperature, and oil pressure to name a few) are outside limits set for the rating and application. Active Events are occurring at the current moment, while Logged Events have occurred at some time in the past. Logged events are saved within the ECU along with the engine service meter reading at the time of the event.
- Diagnostics are warnings of failure of some electrical engine component. They may indicate a short circuit, unintentional ground, open circuit or improper response of an engine performance transducer or sensor. As with events, diagnostics may be active or logged.
- In the presence of active events of a potentially catastrophic nature, the engine may automatically shut off. In the presence of active events of a somewhat lesser importance, the engine may automatically lower its power output up to 25% for each parameter out of its safe range. This is called Derating. In the presence of still less important active events, the engine may issue a warning via its monitoring system. The performance parameter levels at which shut-off, derate, and warning occur are set at the factory.

Description:

The General Alarm Relay contacts are rated for 20 amps at 24 volts DC.

Wiring Diagram

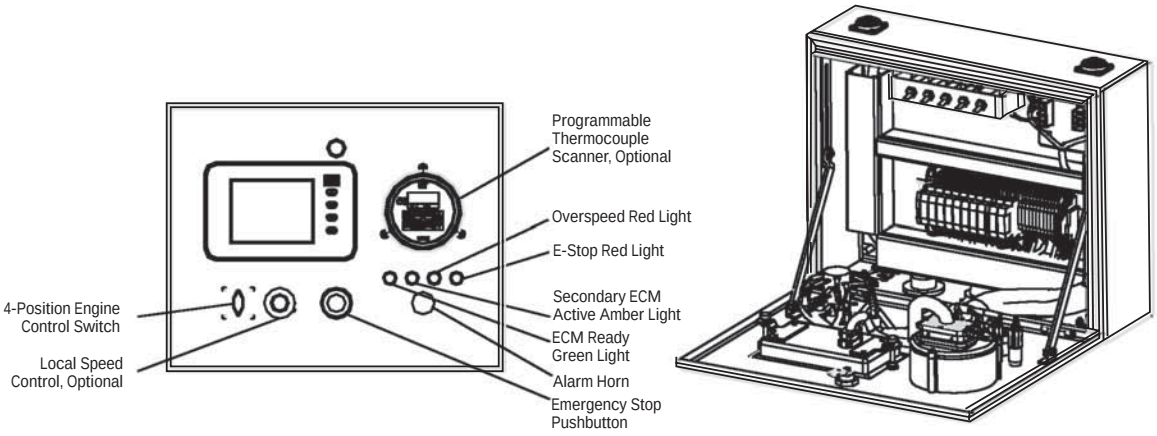
General Alarm Relay Connection Diagram



The General Alarm Relay energizes when:
There is a failure in some portion of the engine's electronics systems - or -
There is a condition that is potentially harmful to the engine or its performance. The details of the particular alarm and its level of severity are displayed on the MPD unit. It is the responsibility of the engine operator to respond appropriately to the severity level.

Note: The relay shown on the diagram is actually part of the engine harness and is NOT reflective of any external connections required by the customer. The customer wires to the three pins indicated connect to the Normally Closed, Common, and Normally Open Contacts of the General Alarm Relay as needed to meet customer requirements.

Engine Instrument/Control Panel



The 3500B Series II engines come equipped with a version of the panel depicted above. All propulsion engines will include all the features above except the individual thermocouple scanner and the local speed control, both of which are optional. Auxiliary engines are similarly equipped.

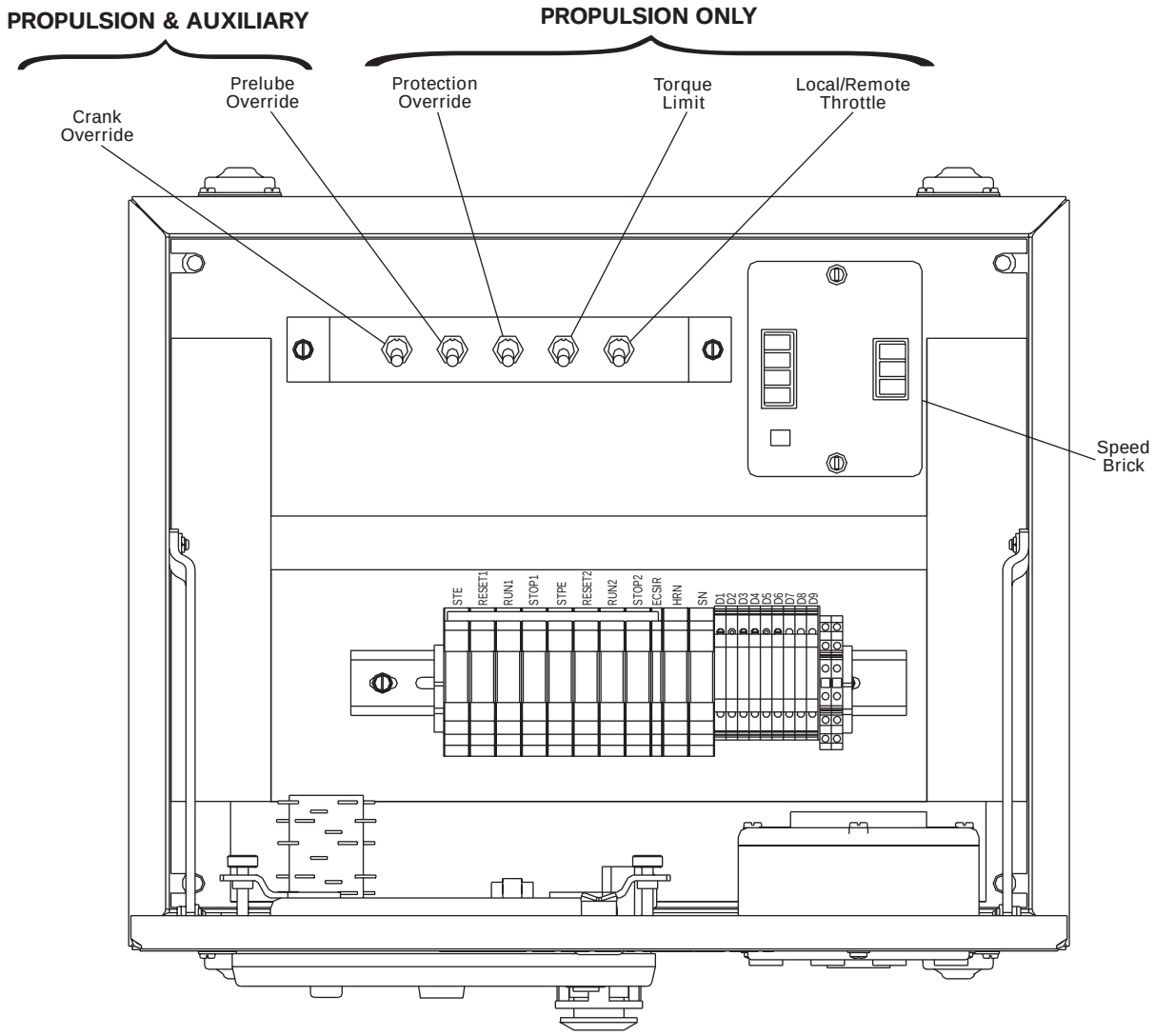
The Local Speed Control knob on the front face of the panel is used for manual engine speed adjustment on single engine applications that do not require a load share module. On marine propulsion, this is manual speed adjustment. On marine auxiliary, manual speed control adjusts from approximately 74-108% of rated speed.

Instrument and Control Panel Lamps	
ECU Ready	This green lamp is normally illuminated. It indicates the primary ECU is in control and the backup ECU is ready to take control in the event of a failure of the primary ECU.
ECU Active	This amber lamp is illuminated only when the backup ECU is in control. It indicates a problem with the primary ECU. While the backup ECU is in control, the engine remains capable of full power, but will cease displaying some engine performance parameters. When this lamp is illuminated, a problem exists that requires attention as soon as the vessel returns to port and repair facilities become available.
Overspeed Shutdown	When this red lamp is illuminated, the engine has shut down because of overspeed.
Emergency Shutdown	When this red lamp is illuminated, a shutdown has occurred because an emergency stop pushbutton was pushed.

The panel is usually mounted on the engine, but using optional extension harnesses, may be mounted up to 15 meters (49 feet) away from the engine.

The door of the engine instrument and control panel includes several controls, as follows:

- E-stop pushbutton switch
- Engine control switch (four-position)
- Local throttle adjust potentiometer (optional)
- An alarm horn



Inside the engine instrument and control panel are five switches which offer additional control features:

Auxiliary and Propulsion

- Crank override switch
- Prelube override switch

Propulsion only

- Marine protection override switch
- Torque limit switch
- Local throttle select switch

The **Crank Override Switch** allows the operator to crank the engine using the engine starters and overriding any other control or protection systems. Therefore, the starters can be engaged even when the ECU has completed the cycle crank sequence. The manual starter crank switch is intended to be used for system troubleshooting and engine maintenance. It can also be used to start the engine in an emergency when the ECU fails to crank the engine or when the primary ECU has failed and the engine needs to be started and run with the secondary ECU. The crank override switch should not be used for normal operation of the engine.

The **Prelube Override Switch** allows the operator to override the prelube pump sequence at the beginning of the cycle crank sequence during engine start-up (if there is an attached prelube pump as part of the engine system). When the prelube override switch is activated, the ECU will not initiate an engine prelube prior to cranking the engine: the ECU will immediately begin to crank the engine without prelubing. The prelube override switch is intended to be used for troubleshooting and to provide for immediate engine starting during emergency situations. The prelube override switch is present only if the prelube pump attachment is part of the engine package.

The **Engine Protection Override Switch** is used in circumstances where it is absolutely necessary to continue to operate an engine, even though that engine may be seriously damaged or destroyed by continued operation. An example might be during a storm at sea where loss of engine power might result in loss of the vessel along with loss of the crew. In any case, the decision to continue to operate a crippled engine must be that of the ship's master. The engine protection override switch gives the ship's master that option. If an engine is operating and a fault occurs; the operator may move the switch from the normal to the override position. In the override position, the engine will not shut off, regardless of alarms or faults. If an engine has already shut off because of a fault, the engine may be restarted, without protection, by moving the switch from the normal to the override position.

There are three shutdown conditions that are not inhibited with the engine protection override switch.

- E-Stop
- Overspeed
- Shutdown following detection of an air inlet shutoff trip.

The **Torque Limit Switch**, when actuated, enables or disables the torque limit feature. The torque limit feature is especially useful in the event that some component, such as the propeller shaft or marine gear is not able to withstand the standard engine torque capability. In that event, the torque of the engine can be limited to protect the low capacity driveline component. The torque limit feature is set from within Electronic Technician (ET), the electronic service tool.

The **Local Throttle Select Switch**, when actuated, disables all remote control of engine speed and allows engine speed to be controlled from a ten-turn potentiometer in the panel face.

Selection between local and remote throttle uses the speed matching logic of selecting between primary and secondary throttle. The local throttle is wired to the secondary throttle inputs; therefore, “syncing” multiple engines to a single throttle cannot be achieved with the local throttle option fitted.

The engine instrument and control panel also includes a fully graphic display device (Marine Power Display).

Screen:

- Positive image LCD, fully graphic, monochrome transflective, 320 by 240 pixels
- Double edgelit, red LED backlighting

Illumination:

- Stable over voltage range
- Adjustable by user, including off

Buttons:

- Marked with SAE Standard icons
- Red LED back lighting

Data Link:

- SAE J1939 CAN (Full Support)

Operating Range:

- Input system voltage of 12 or 24 VDC
- Full functionality from -20°C to +70°C (-4°F to 158°F)
- Sealed to 34.48 kPa (5 PSI)
- Maximum viewing angle ± 35 degrees vertical, ± 50 degrees horizontal

Alarm:

- Piezoelectric alarm is sealed in the interior of case
- External output for Relay Driver (100mA) — applicable to MPD hardware part# 212-6187 and up

Mounting System:

- Panel mounting system for display module with side mounted brackets and mounting screws
- Refer to Installation Guide SENR5002-03 or higher revision level
- Optional above-dash mounting bracket

Engine parameter data can be displayed in Analog, Bar Graph, or Digital gauges in English or metric units.

Marine Power Display Configuration and Operation

The Marine Power Display can accommodate up to three users with five screens for each. Three users can set up the Power Display screens to their preferences. The buttons have multiple functions dependent on which screen is displayed.

The button primary functions for the gauge screens are:

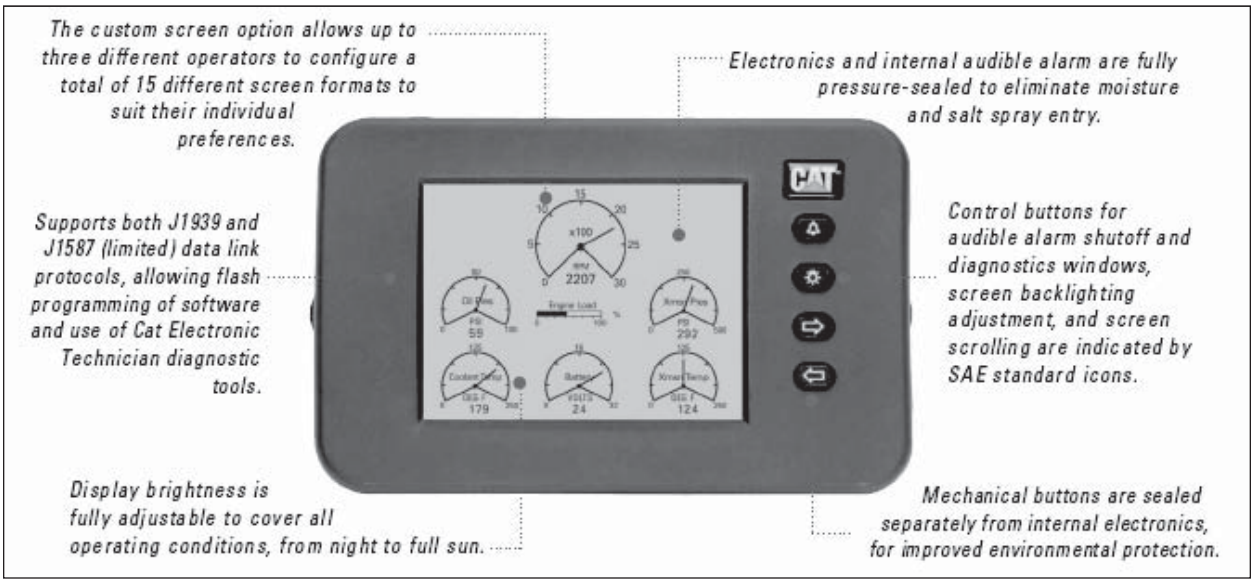
Alarm acknowledgment for all displays on that specific data link, silences audible alarm, and recalls active diagnostics

Screen display

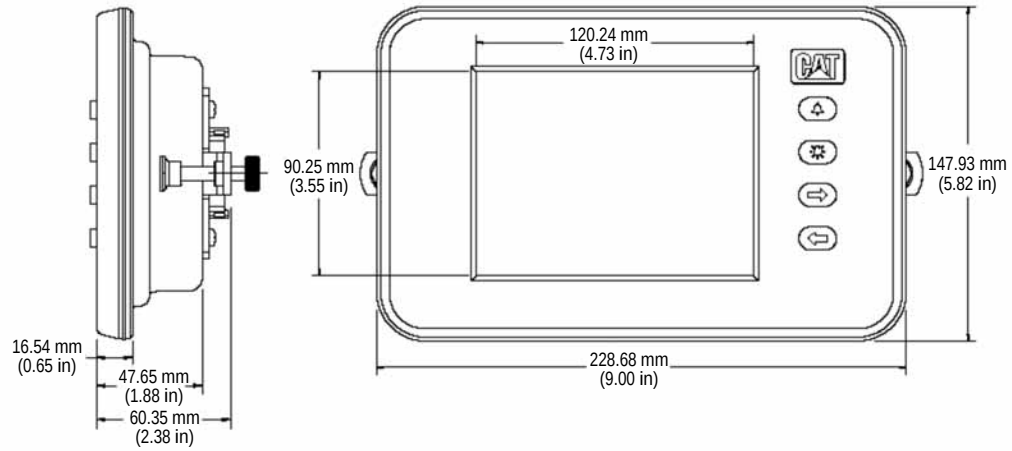
Normal (black letters with white background) Day Mode - or - Reverse (white letters with black ground)

Next screen

Previous screen



Hardware Features

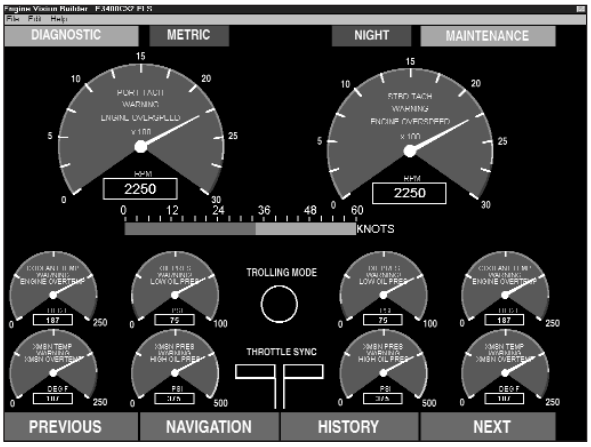


The Cat Marine Power Display (MPD) is a self-contained engine monitoring and display system that is simple to install and provides more information to the operator than previously available single-engine monitoring systems.

- High-resolution, 320 x 240 dots-per-inch image.
- Transflective screen improves readability by reflecting more or less light as ambient light conditions change.
- Fully graphic LCD display screen — as opposed to a fixed display — allows use of optional screen builder software to customize screen formatting.
- Screen builder software is compatible with Windows 95/98/NT 4.0, Windows 2000 PC, and Windows XP operating systems.
- Flash programming from user's PC (with Cat Electronic Technician service tool) to MPD provides fast software updates and use of custom screens.
- System deign allows future expansion, via Cat ET Winflash and Commadapter II, plus added features through software updates.
- Operates on both 12- and 24-volt systems.

Cat Engine Vision

(An optional attachment)



Description

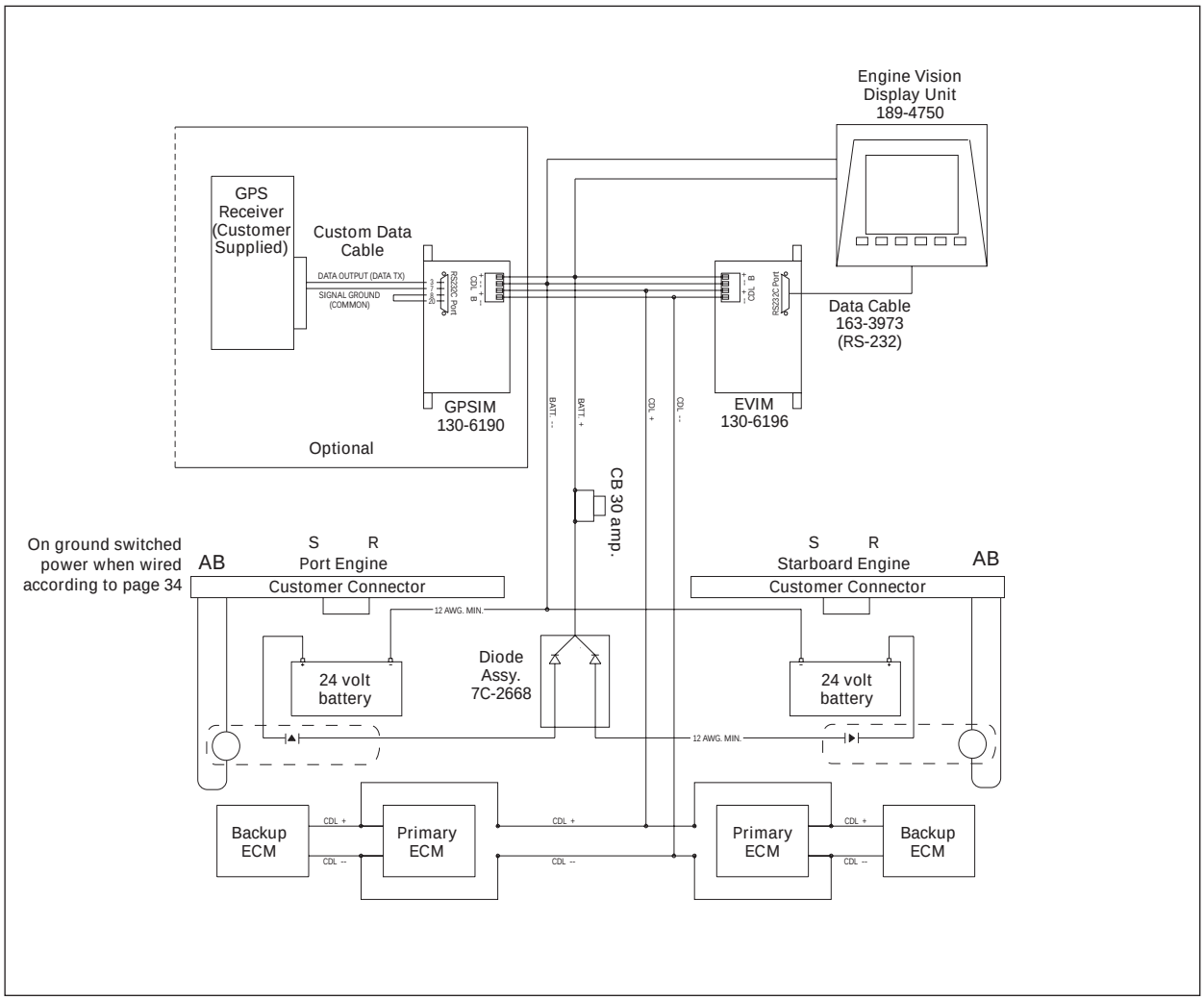
The Engine Vision System displays current engine and transmission data, trip data, historical data, maintenance and diagnostic information, and troubleshooting information. It can also interface with vessel global positioning systems to display vessel position and speed. A single Engine Vision System can simultaneously display data for up to three engines. Each engine's ECU is connected via Cat Data Link and the Engine Vision Interface Module to Engine Vision. Touch screen technology provides fast, easy access to desired information.

- Function keys mounted on the housing below the screen provide additional access to desired information.
- The high resolution, multi-colored LCD screen provides superior readability in all lighting conditions.
- Displays current engine operating parameters
- Continually updates engine historical data
- Global positioning display with GPS Interface Module
- Graphic displays of critical operating parameters
- Trip and lifetime totals for engine operating hours, load factors, and fuel rates
- Diagnostic information
- Maintenance information

For further reference see the following:

- Installation Guide SENR5002
- Engine Vision 4.0 Software LERM8401
- Engine Vision Operator's Guide LEKM8504

Engine Vision Display Unit



Note: The jumper between pins “S” and “R” on each one of the engine’s customer connections is necessary if the Engine Vision is intended to remote start and stop the engine.

This diagram shows how to drive Engine Vision off switched power from starboard or port engine. This way it is powered when either one of the engines is on.

ECU Data/Histograms

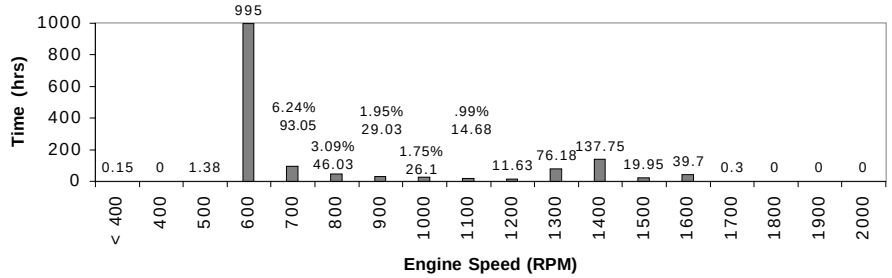
The 3500B Marine Engine collects and stores operational and performance information within its Engine Control Module (ECU). The data is stored in the form of histograms. The histograms graphically display the percentage of total operating time spent at various:

- Engine Speeds
- Percent of Engine Loads
- Right Exhaust Manifold Temperatures
- Left Exhaust Manifold Temperatures

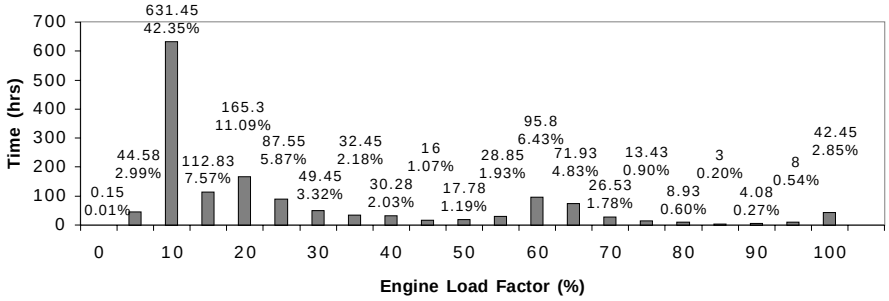
See the charts below for examples.

These charts are available for download from the engine's ECU using the Electronic Technician (ET) service tool. The charts are extremely useful for confirmation of proper engine rating level. They can also be used, by comparing a histogram taken at one point in time to the same histogram taken later, to compare the way various operators use the engine and vessel. If the ECU is replaced, the histogram data will be lost.

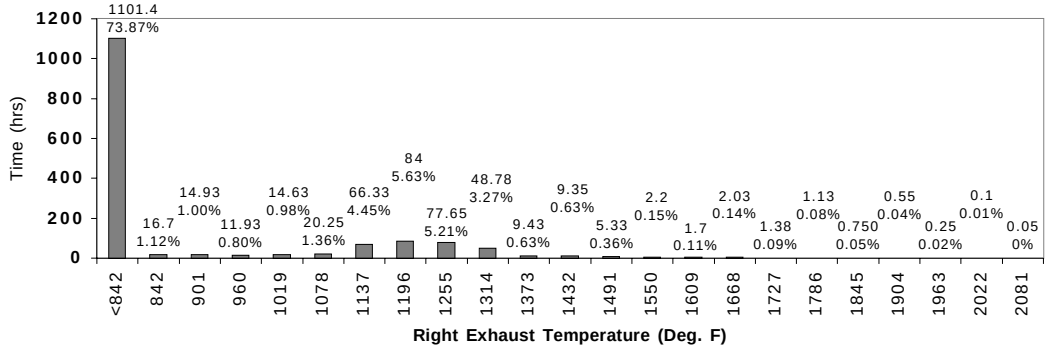
Electronic Engine Lifetime



Electronic Engine Load Factor



Electronic Engine Exhaust Temperature



Shutdown Notify Relay

Where Used

In circumstances where it is desirable to provide an electrical signal that the engines is not ready for work, the shutdown notify relay can be used. The Shutdown Notify Relay has both normally open and normally closed contacts and is energized when the engine is running and de-energized when the engine is shut down. It can be used to disengage equipment and notify the operator if there is an engine shutdown.

Description

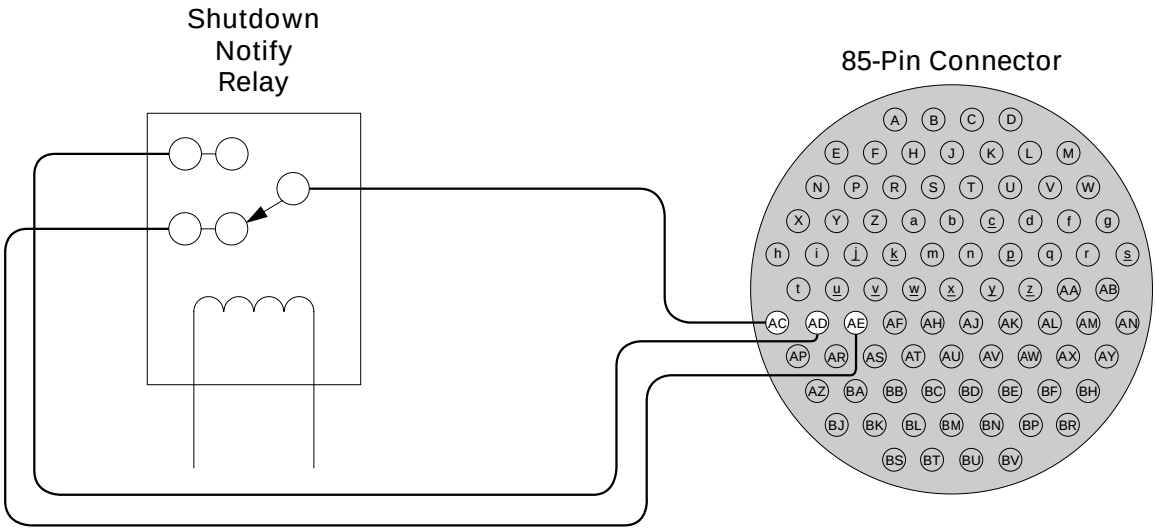
The relay is de-energized under the following conditions:

- Engine is in a shutdown state with the fuel injectors disabled.
- Personality Module Interlock occurs. This condition will prevent engine from running because incorrect software was loaded into the Engine Control Module (ECU).
- Engine speed drops below crank terminate speed. This would normally happen if the engine ran out of fuel.
- The engine is being started (ie, the injectors are enabled) but the speed has not yet reached crank terminate speed.

The relay is energized under the following conditions:

- The engine is running with the injectors enabled and the engine speed above crank terminate speed.

Wiring Diagram



Note: The relay shown on the diagram is actually part of the engine harness and is NOT reflective of any external connections required by the customer. The customer wires to the three pins indicated connect to the Normally Closed, Common, and Normally Open Contacts of the Shutdown Notify Relay as needed to meet customer requirements.

Customer Communication Module (CCM)

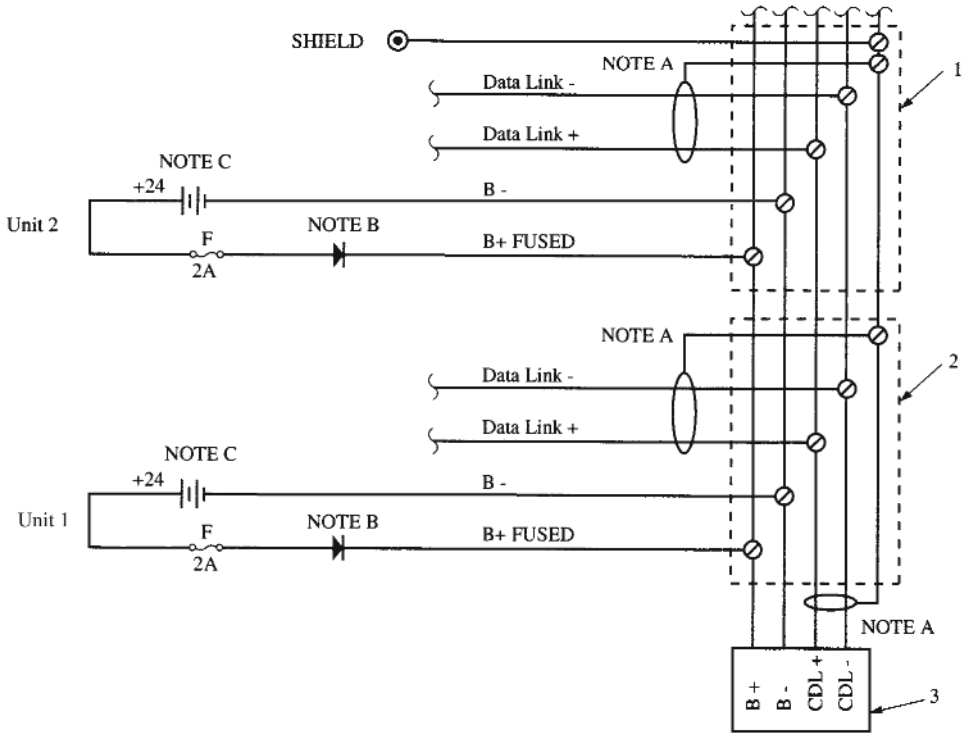
Installation Requirements

When a CCM is installed, these requirements must be met:

- The battery voltage input requirements are from 15 to 45 volts DC (24 or 32 volt DC nominal power).
- Battery (±) power dissipation is approximately 3.0 watts at 24 volts.
- The battery sets of multiple engines must share a common ground [Battery (-)].
- Multiple engines must use diodes to prevent power sharing between units. See CCM Wiring Connections for Multiple Engines. When multiple engines are to be connected to the CCM, junction boxes must be installed as shown in the following illustration. This allows for any engine to be disconnected for service or maintenance without power interruption to the CCM or the other engines.

CCM Wiring Connections for Multiple Engines

(1) Junction box for unit 2, (2) Junction box for unit 1, (3) CCM

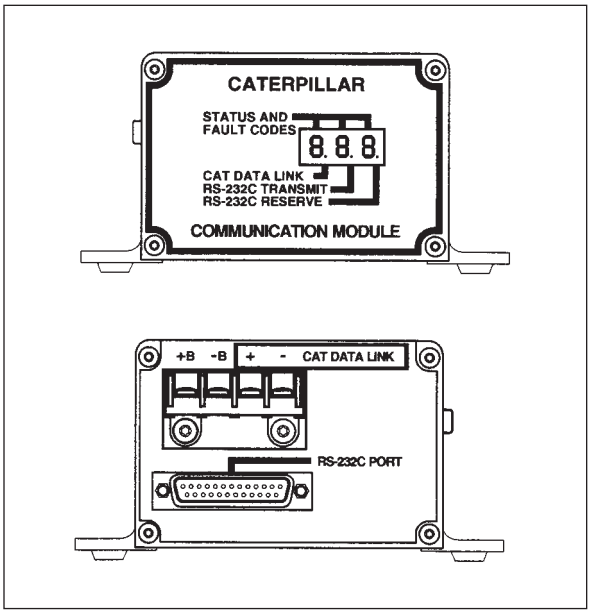


Note A: *Ground shield in one location only, as near as possible to battery negative.*

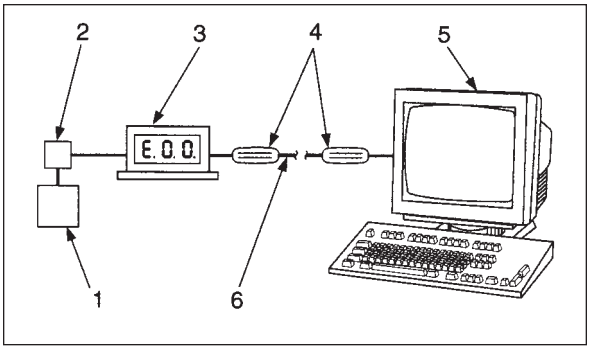
Note B: *Diodes are necessary when connecting multiple engines.*

Note C: *Battery plus and minus are to be taken from 85-way customer interface connector unswitched.*

Auxiliary power Plus and Minus:
Plus — AA, BF, BK, BL
Minus — b, d, f, j, k, AB, BP, BR, BS



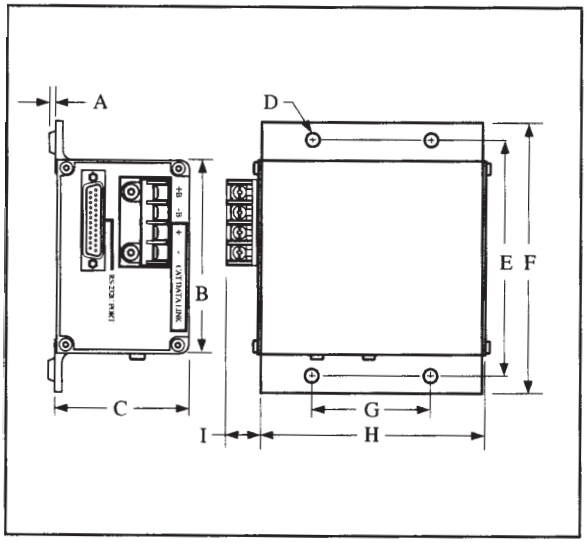
The CCM provides a two-way communication link between the engine and its ECU and some host device, such as a personal computer (PC), a Programmable Logic Controller (PLC) or any other device with an RS-232C port. The operator of the host device is able to remotely monitor or program the engine in much the same way an operator does from the panel. The host device can connect directly to the CCM or remotely, by means of two modems. CCM compatible software is available from Caterpillar for use with a PC (See Caterpillar CCM PC for Windows: Getting Started manual, included with the software package, for more information on the PC software). The CCM can also be used with vendor-supplied software. The serial data format is provided in the CCM Owners Manual (See SEBU6874-04 for installation instructions) to help a user program their device to communicate with the CCM. Refer to the RS-232C M5X Communication Protocol and the Parameter Identifiers (PID) section in the owners manual for additional information.



(1) Engine, (2) Customer Connection on Eng.-Mtd. Instrument Panel, (3) CCM, (4) Modem/s, (5) Personal Computer, (6) Phone Line

Environmental Specifications

- The ambient operating temperature range is from -40° to +70°C (-40° to 158°F)
- The unit must be protected from direct contact with liquids (splash proof). If sealing the unit is required, the CCM must be in a watertight enclosure.



CCM Mounting Dimensions

CCM MOUNTING DIMENSIONS	
Item	**Dimension**
A	3.5 mm (.14 in)
B	106.5 mm (4.19 in)
C	73.0 mm (2.87 in)
D	7.5 mm (.29 in) diameter holes (4)
E	130.0 mm (5.12 in)
F	149.0 mm (5.87 in)
G	66.2 mm (2.61 in)
H	125.5 mm (4.94 in)
I	17.8 mm (.70 in)

Mounting

The CCM can be located on a desk or shelf. The rubber feet on the bottom of the CCM can also be removed to allow panel mounting. *Do not mount the CCM on the engine,* or within the engine-mounted instrument panel. It is not designed for this environment.

CCM Battery (Internal)

The CCM contains a battery (current part number 101-1785) that supplies power for internal memory whenever the CCM power is turned off. The battery can be expected to last for five years.

In marine applications, the CCM has the ability to communicate with up to three engines. The CCM identifies each engine by its Module Identifier (MID). Each engine connected to a CCM must have a unique MID.

Version C of the ECU has primary data link for use with the CCM. This data link is called the Cat Data Link. The MID of this ECU is a fixed value. Because each ECU must have a unique MID as mentioned previously, the CCM can only be connected to one Version C ECU on the Cat Data Link.

Version D of the ECU has the same primary data link (Cat Data Link) as Version C with a fixed MID value. In addition, Version D also has a secondary data link (secondary Cat Data Link) for use with the CCM. The secondary Cat Data Link has a programmable MID value (up to three different values).

To determine if your engine has a Version C or Version D ECU, see the serial number break table in the section entitled Engine Control Module Changes (Version C to Version D).

There is a maximum of one CCM per data link.

There is a maximum of one CCM per engine.

General Wire and Cable Specifications

The following specifications for wire and cable are given to minimize voltage drops over long runs of wire and to minimize both Electromagnetic and Radio Frequency Interference (EMI/RFI).

- Do not run data link wiring in the same raceway as high power cables, such as generator leads or any alternating current cabling.
- The wires connected to (+) Battery and (-) Battery on the CCM must be at least 16 AWG.
- Maximum Cat Data Link cable and (±) Battery wire length is 455 m (1500 ft), including wire runs between any multiple engines when a CCM is present. A system that does not include a CCM is limited to a maximum wire length of 30.5 m (100 ft).
- Maximum total wire length of the RS-323C cable is 15 m (50 ft).

Conformance to the European Economic Community (EEC) 336 Directive Demands the RS-232C Cable Be Shielded.

- No terminations or splices are allowed on the above wires, except as noted on the connection diagrams.
- The cable connected to the (±) Cat Data Link must be a 16 AWG, shielded twisted pair cable. Use 123-2376 Electric Cable, Belden 8719 Cable, or equivalent.

CAT DATA LINK CABLE SPECIFICATIONS - RESISTANCE AND CAPACITANCE

	Parameter Being Measured		
	C to C[1]	C to S[1]	SCSR[1]
Nominal Capacitance per meter (foot)	75 pF (23 pF)	144 pF (44 pF)	—
Total Nominal Capacitance 455 m (1500 ft)	0.035 µF	0.066 µF	—
Nominal Resistance per m (ft) at 20°C (68°F)	—	—	14.0 mΩ (4.27 mΩ)
Total Nominal Resistance 455 m (1500 ft) at 20°C (68°F)	—	—	6.41 Ω

[1] C to C = Conductor to conductor. C to S = Conductor to shield. SCSR = Single conductor series resistance (16 AWG, 19/29 stranding)

RS-232C Cable Requirements

The CCM is classed as Data Terminal Equipment (DTE) for RS-232C communication.

- The CCM RS-232C connector is a standard 25-pin D-shell connector with pins.
- The RS-232C cable must be shielded.
- When connected to other DTE devices, such as personal computers, a null modem cable or adapter is required to connect the two devices.
- When the CCM is connected to Data Communication Equipment (DCE), such as modems, printers or terminals, no null modem cable or adapter should be used.

RS-232C PIN DEFINITIONS	
Pin Number	**Description**
2	Data Transmit (TX)
3	Data Receive (RX)
7	Ground
8	Data Carrier Detect (DCD)
20	Data Terminal Ready (DTR)

RS-232C Communication Protocol for Customized Systems

As purchased, the CCM comes with Windows compatible software that utilizes M5X protocol to all the CCM to communicate with a remote personal computer. In some installations, the user will require customized software when a host device other than a personal computer [such as a programmable logic controller (PLC)] is used or when the application requires enhancements to the PC software provided.

The CCM communicates with the host computer via a standard RS-232C serial data link. This serial data link uses M5X protocol to send and receive data. The M5X commands allow the user to periodically request a broadcast of multiple engine parameters for monitoring by the host device. Single parameter read-and-write commands allow the user to control the engine from the host device.

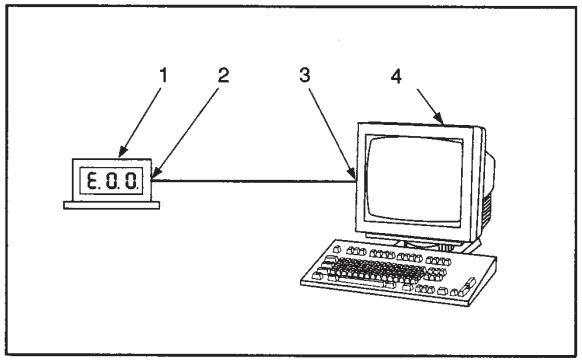
The Remote PC software creates up to eight lists that are stored in non-volatile memory in the CCM. These lists contain multiple engine parameters that are broadcast to the host device from the CCM through the RS-232C network. The engine parameters are given a unique parameter identifier (PID).

Most Caterpillar electronic systems using the CCM with provide 40-50 parameters every second (1200 - 19,200 Baud) to a remote computer system through the RS-232C connection, but other limits may be encountered. When connecting through a modem operating as less than 4800 baud, the throughput will be reduced. For example, using a cellular phone connection operating a 2400-baud reduces the throughput to 29 parameters per second. In applications that use several other modules, such as multiple remote pilothouse instrument panels, and/or programmable relay control modules, the throughput can be reduced to 40 parameters per second. To optimize data transfer and minimize communication loading, stable parameters like hour meters, temperatures, and diagnostics should be requested less frequently. Parameters that are more dynamic such as engine speed and oil pressure can be requested more frequently. Use good design judgment to determine the update rate of individual parameters.

Initializing Communication

The initialization procedure differs depending on the type of connection. It is necessary to ensure proper communication between the CCM and the host computer.

When modems are installed between the CCM and the host computer, the complexity of the communication network is greatly increased. This is because there are several more possibilities for error when modems and phone lines are used. For this reason, it is recommended to begin the initialization of modem communication by making a direct connection between the host computer and the CCM. This will enable the user to become familiar with the PC software and verify proper operation of the engine while at the engine. This is illustrated below.



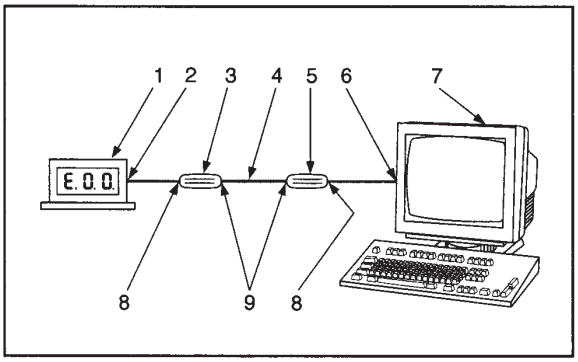
CCM/Host Computer Direct Connection without Modems
(1) CCM. (2) CCM RS-232C port. (3) Computer RS-232C port. (4) Host computer.

Make sure all the components are ready: the personal computer, RS-232C cables (See RS-232C Cable Requirements section of the CCM Owners Manual) and the software CCM PC For Windows is installed on the PC. In the following steps, the PC should be turned OFF before connecting or disconnecting cables to the serial ports.

- Install the CCM with all wiring attached. Refer to Wiring Connections and Battery Power and General Wire and Cable Specifications
- Determine the communications parameters to be used in the installation. The factory default parameters stored in the CCM are 9600 serial port communication rate (bits per second or bps), no parity, 8 data bits and 1 stop bit. These parameters will work well in most installations.
- Load the CCM PC for Windows software into the PC.
- Go to the data link pull-down menu, select Select ECU, CCM. Select the Utilities pull-down menu and select CCM Configuration. Set up the communication parameters of the CCM to match those in Step 2.
- Go to the Phone Book pull-down menu and select Add or Edit. Set up the communication parameters of the PC to match those in Step 2.
- The ECU of each engine must be programmed with the correct engine number to identify them to the CCM. The ECU is programmed to Engine Number 1 at the factory.
- After the CCM and the PC are all properly connected, see the CCM PC software Users Manual for instruction on monitoring and controlling the engine remotely.

Three conditions must be met before the ECU will allow control (starting and stopping) by the CCM. The Engine Control Switch (ECS) must be in REMOTE position, pins S and R on the customer connector must be connected together, and, if wired for legacy, the remote initiate contacts must be open and stay open. It is imperative that no remote momentary start signal is received. The engine may be monitored with the ECS in any position.

To connect using modems follow the instructions following the illustration below:



CCM/Host Computer Remote Connection with Modems
(1) CCM. (2) CCM RS-232C port. (3) Answering modem.
(4) Telephone line. (5) Originating modem.
(6) Computer's RS-232C port. (7) PC computer.
(8) Modem RS-232C port. (9) Modem phone line port.

Make sure the following equipment is available:

- A PC with a terminal emulator software program installed. Examples of terminal emulators include: ProComm®, PC-VT®, or Terminal under the Accessories window in Microsoft Windows®. Refer to the Caterpillar CCM PC for Windows: Getting Started Manual, for further specifications.
- The proper RS-232C cables. Also, a cable must be temporarily connected from the PC to the Answering Modem RS-232C port.
- Two modems that support the Hayes AT command set. This is necessary for both the Answering Modem and the Originating Modem. Some PC's will have a built-in modem. It is possible to use these internal modems as the originating modem as long as it is compatible with the answering modem. Consult the instructions for the two modems.
- The CCM PC for Windows software is available from Caterpillar for use with the CCM.

The following steps set up proper communication between the CCM and the answering modem. The originating modem is set up later by the PC software.

1. Install the CCM with all wiring attached.

2. Determine the communication parameters to be used in the installation. The factory default parameters stored in the CCM are 9600 serial port communication rate (bits per second or bps), no parity, 8 data bits and 1 stop bit. These parameters will work well in most installations.

Note: RS-232C serial port communication rate is often referred to as DTE speed or bits per second (bps). The phone port communication rate of the modems is often referred to as DCE speed or bps.

3. Using the proper cable, connect the RS-232C port of the answering modem directly to the RS-232C port of the PC. This connection is temporary and must be done to set up the answering modem.

4. Using the terminal emulator on the PC, set the serial RS-232C port for the communication parameters determined in Step 2.

5. Several commands must be sent to the answering modem that set the communication parameters to the proper values. The examples given are Hayes AT commands and are for illustration purposes only. Actual command sets vary widely between modem manufacturers. Consult the manual for the modem. If desired, enter the proper command for the particular modem in the blank User's Modem Command column of the chart on the following page.

Note: *In the following AT commands, the symbol "0" indicates the number zero.*

TYPICAL ANSWERING MODEM SETUP COMMANDS			
Item	**Explanation**	**Command Example**	**Command for User's Modem**
a	Set modem to factory defaults. This is particularly important if the modem setup is unknown or is questionable.	AT&F	
b	Set to communicate in error control and in asynchronous mode. **NOTE:** If the modem does not support this command, enter the AT command for error control. Set to communicate in asynchronous mode with a separate command (Step d.).	AT&Q5	
c	Set to communicate in asynchronous mode. **NOTE:** If the &Q5 command is supported, the modem is already in asynchronous mode, and this command should not be sent.	AT&Q0	
d	Set Auto Answer to ON. This tells the modem to answer the phone line after the first ring. If left at 0, the modem will never answer an incoming call. The value of this register can be seen with the ATS0? command.	ATS0=1	
e	Set Flow Control to XON/XOFF. This turns off RTS/CTS hardware handshaking between the modem and CCM, since the CCM does not have RTS or CTS lines. It turns on the XON/XOFF software handshaking.	AT&K4	
f	Set DCD to track status of carrier detect signal. This causes the DCD line from the modem to follow the state of the phone line carrier. When the call to the CCM's modem has been made and the modem to modem handshaking is done, the DCD line will change and allow the CCM to receive data. **NOTE:** This is very important. If the DCD line is not at the right state, the CCM cannot receive data.	AT&C1	
g	Set DTR to monitor DTR signal, and hang up and reset modem on an on-to-off DTR transition. This causes the modem to hang up and reset if the CCM drops the DTR line.	AT&D3	
h	Result codes do not have to be returned. Or, if they are returned, they must be in originate mode, but not in answer mode.	ATQ2	
i	Set DTR transition response delay to maximum value less than 10 seconds. This example would cause the modem to hang up the line 2.5 seconds after the DTR line from the CCM changes. **NOTE:** Refer to your particular manual. Some modems specify the time in 1/100th of a second and some in 1/10th of a second.	ATS25=250	
j	Set delay before forced hang-up to maximum value less than 3 seconds.	ATS38=2	
k	Write the set-up parameters into memory 0. When the setup parameters are written, any that were not changed are stored into the memory in their original state.	AT&W0	
l	Set to recall memory 0 on reset.	AT&Y0	
m	View the modem active profile. This is an optional command that allows the user to view the above parameters stored in the modem. They should be written down and saved for future reference.	AT&V	

This completes the setup of the answering modem.

6. Disconnect the PC from the answering modem. Temporarily connect the PC directly to the CCM.

7. Load CCM PC for Windows software into the PC.

8. Go to the Data Link pull-down menu, select Select ECU, CCM. Select the Utilities pull-down menu and select CCM Configuration. Set up the communication parameters of the CCM to match those chosen in Step 2.

9. Go to the Phone Book pull-down menu and select Add or Edit. Set up the communication parameters of the PC to match those chosen in Step 2.

10. The ECU of each engine must be programmed with the correct engine number to identify them to the CCM. The ECU is programmed to Engine Number 1 at the factory.

11. Disconnect the PC from the CCM. Connect the PC, modems and CCM. Make sure the answering modem and the CCM are both powered up (turned ON) and that they are connected by the proper RS-232C cable.

12. Turn OFF (power down) the CCM (remove the wire connected to the Battery + terminal of the CCM) and then turn ON (power up) the CCM (reconnect the wire on the Battery + terminal). During this step, make sure that the CCM remains powered up for a minimum of 30 seconds. The CCM sends commands at power-up that set the DTE speed of the answering modem to the same as that of the CCM.

13. After the CCM, the modems, and the PC are all properly connected, refer to the CCM PC for Windows Users Manual for instruction on monitoring the engine remotely. If desired, the PC and the originating modem can be connected to a local phone line at the same site as the engine(s), CCM, and answering modem, to make certain of proper communication before attempting remote monitoring.

Monitoring System Providers

The following suppliers have worked with the Caterpillar factory and have had one or more versions of their equipment confirmed compatible with the 3500B.

Vendor Home Office
Name and Address

MACSEA Ltd.
163 Water Street
Stonington, CT 06378
Phone: 860 535 3885
Fax: 860 535 3357
Kevin Logan
President

Monico, Inc.
Mail: P.O. Box 90189
Austin, Texas 78709-0189
Street: 7500 Highway 71 West
Suite 104
Austin Texas 78735
Phone: 512 288 0195
Fax: 512 301 2724
Larry Peterson
President

ServoWatch Systems
Drakes Lane Ind. Est.
Boreham
Chelmsford, Essex CM3 3BE
United Kingdom
Phone: 44 1245 360019
Fax: 44 1245 362129
Steve Smith
Director

Techsol
Electrotechnique Industrielle et Maritime
127, rue Goyette
Beauport, Quebec
Phone: 418 666 5619
Fax: 418 666 5482
Claude Messiaen
President

DMP–Member of the Radio Zeeland Group
DMP International B.V.

Industrieweg 17
P.O. Box 1070, 4530 GB terneuzen

The Netherlands
Phone: 31 115 630 400
Fax: 31 115 630 500
William Bloomart
President

Demonstration of the 3500B Engine Monitoring System

Method to Demonstrate 3500B Protection and Monitoring System to Customers and Society Surveyors

- Use a 10k potentiometer to simulate analog sensors
- Use a 3E-7700 Throttle Position Sensor to simulate digital PWM sensors
- Engine overspeed condition must be simulated using the 75% overspeed verify feature. This feature is involved via E7 and in the future can also be involved via the MPD. A true engine overspeed condition should never be attempted. A square wave signal generator or throttle position sensor cannot be used to simulate the speed/timing sensor due to the unique tooth pattern on the gear read by the sensor.
- Refer to the following chart to determine which method should be used to simulate the different sensor types and part numbers.

Sensor	Sensor Type	Simulate With
Turbo Outlet (Boost) Pressure	Analog	10k Potentiometer
Oil and Fuel Pressure	Analog	10k Potentiometer
Atmospheric, Crank Case, and Inlet Air Restriction Pressure	Analog	10k Potentiometer
Coolant and Aftercooler Temperature	Analog	10k Potentiometer
Exhaust Temperature	Digital PWM	3E-7700 8V Throttle Position Sensor
Marine Gear Oil Pressure	Digital PWM	3E-7700 8V Throttle Position Sensor
Marine Gear Oil Temperature	Digital PWM	3E-7700 8V Throttle Position Sensor
Speed/Timing	Digital	Overspeed Verify Feature on E7
Air Inlet Manifold Temperature	Analog	10K Pot
Engine Oil Temperature*	Analog	10K Pot

Note: *ET calibration function does not work on A3 ECU. Automatic calibration is performed at A3 ECU power-up.*

Procedure for using 10k potentiometer to simulate analog sensors

Note: *Factory passwords may be needed to clear any events logged during this demonstration.*

- Attach an 8T-8731 3-pin Deutsch connector to the 10k potentiometer.
- Solder three leads approximately 3 feet in length to the three lugs on the potentiometer
- Attach the 8T-8731 3-pin Deutsch connector to the other end of these three leads
- Pin C of the Deutsch connector should be connected to the wiper on the potentiometer. The wiper is usually the center lug.
- Pins A and B of the Deutsch connector should be connected to the other 2 leads. These two pins can be connected in either order as long as Pin C is connected to the wiper.

  Note: *The way pins A and B are connected to the potentiometer will determine whether clockwise or counter-clockwise rotation results in raising or lowering of the parameter being simulated*
- Disconnect the sensor to be simulated from the engine wiring harness
- Connect the 10k potentiometer in place of the sensor
- Demonstrate changing conditions and sensor short and open circuit diagnostics
  - With the engine OFF and the engine control switch in the COOLDOWN/STOP position, rotate the potentiometer back and forth. Use ET status screen to watch the value of the sensor being simulated change.
  - If the potentiometer is rotated fully in one direction either a short or open circuit diagnostic will be generated after several seconds.
  - If the potentiometer is rotated fully in the opposite direction the opposite diagnostic will be generated.
  - Some diagnostics such as 273-00, “Turbocharger Compressor Outlet Pressure Above Normal,” may be logged even with the potentiometer in the middle of its range.

Demonstrate an engine de-rate or shutdown

- The protection and monitoring system must be enabled using ET. Refer to the Troubleshooting guide for instructions on how to set these parameters.
- Rotate the potentiometer to the center of its range.
- Start the engine and allow it to warm up. The engine must be running for this portion of the demonstration.
- While monitoring the status of the sensor being simulated using ET, slowly rotate the potentiometer until the status screen shows a sensor reading that will cause a de-rate condition. This point will vary according to the sensor being simulated and the parameter values programmed into the protection and monitoring system.
- After a delay time of several seconds the de-rate flag should appear at the top of the ET status screen. The delay time required to cause a de-rate will vary according to the times programmed into the protection and monitoring system.
- A shutdown will occur if the condition being simulated persists. Refer to the Operation and Maintenance manual for specific conditions required for a de-rate or shutdown.

  Note: *If the potentiometer is rotated too far an active open or short circuit diagnostic will be generated. This will cause the protection and monitoring feature associated with that sensor to be DEACTIVATED.*

Note: *3500B Marine Propulsion engines built prior to April 97 do not have an engine shutdown override switch. Due to safety concerns the engine shutdowns were removed from the engine software to prevent engine shutdowns that could not be overridden in an emergency. Therefore, if demonstrating the engine protection and monitoring system on one of these engines only de-rates will be possible.*

If desired, the engine derate % can be viewed on an ET status screen.

Note: *Some parameters in the 3500B Protection and Monitoring system do not cause an engine de-rate. Refer to the Operation and Maintenance guide or Troubleshooting guide for information regarding specific parameters.*

- Derate and shutdown events can be viewed in the logged events screen on ET.
- After finishing the demonstration, re-connect all wiring and sensors to original condition and clear any logged codes or events. Then allow the ECU to auto calibrate the sensors. Do this by rotating the engine control switch to START, STOP, or AUTO position for at least 5 seconds while the engine is not running.

The procedure for using throttle position sensor to simulate digital PWM sensors is the same except that the 3E-7700 throttle position sensor is used instead of the 10k potentiometer.

Electronic Technician (ET)

(A software tool for use with Caterpillar electronic engines)

Where Used

Electronic Technician (ET) is a tool, allowing the user to:

- Flash new engine software on an engine, changing or modifying its rating and/or its operating characteristics
- Examine the engine's history by downloading histograms
- Determine if there are or have been any engine fault or diagnostic messages
- Observe the engine's performance
- Perform sea trials
- Initially set up the engine, customizing its parameters to the owners specific needs or desires

ET allows the operator to:

- Display parameter status
- View active diagnostics
- View and clear logged diagnostics
- View events where irregularities occurred and where logged by the ECU
- Perform diagnostic tests
- Perform calibrations
- Retrieve engine totals for fuel used
- An on-line help system is available.
  For additional help, contact the PC Hotline:
  USA and Canada – 800 765 0999
  Other countries – 309 675 0999
  Fax: 309 675 0725
  e-mail: ssschelp@cat.com

Description

To use Electronic Technician, the user must have:

- A IBM-PC compatible, laptop computer which contains a Pentium 133 MHz processor with no less than 24 Mb of random access memory.
- Microsoft Windows
- A Single User License for ET Ver. 1.4 or later. This is the main ET program.
- A data subscription for all engines and machines.
- A communications adapter group
- A RS-232 Connector Cable. This connects the PC to the Communications Adapter.
- A Connector Cable (Unicable) to connect the ECU to the Communications Adapter.

Versions of Electronic Technician

There are two versions of Electronic Technician: one for dealer technicians and another for use by engine owners and operators.

A brochure describing the dealer version has the form number NEDG6013. A brochure describing the engine owner/operator version has the form number NEDG6015.

Form number NEDG6013 has all of the ordering information for the dealer and engine owners and operators versions.

Reference Material for 3500B Marine Engines

CONTENTS	MEDIA NUMBER
Marine Engine A & I Guide (Performance, Mounting, Cooling, Vibration, Fuel System, etc.)	LEKM7142-7147
Marine Electronic Engine Control & Monitoring System	LEDM2647
Marine Power Display (MPD)	LEBM0189
Multi-Station Control System (MSCS)	LEDM2787
Customer Communication Module (CCM)	SEBU6874
Marine Power Design Pro, Software CD	LERM6503
MCS Certification Requirements, Engine Data Sheet	LEKM5389
MCS Approved Ratings, Engine Data Sheet	LEKM6749
Cold Weather Recommendations, Lubricants	SEBU5898
S·O·S℠ Fluid Analysis Cornerstone, Lubricants	PEDP7036
CAT Diesel Engine Oils (DEO) (CH-4) (N.A. & selected International), Data Sheet	PEHP8038
Caterpillar Diesel Engine Oil (DEO) (CH-4) (International only), Data Sheet	PEHP9536
Multipurpose Lithium Complex Grease with Molybdenum (MPGM), Data Sheet	PEHP0002
Multipurpose Lithium Complex Grease (MPG), Data Sheet	NEDG6022
Special Purpose Grease (SPG) Bearing Lubricant, Data Sheet	NEHP6015
Oil and Your Engine, Special Publication	SEBD0640
How To Take A Good Oil Sample, Special Publication	PEHP6001
Caterpillar Commercial Diesel Engine Fluids Recommendations, Supplement	SEBU6251
Diesel Fuels and Your Engine, Special Publication	SEBD0717
Fuel Recommendations for Caterpillar Diesel Engines, Engine Data Sheet	LEKQ4219
S·O·S Fluid Analysis, Special Publication	PEDP7036
Coolant and Your Engine, Special Publication	SEBD0970
Know Your Cooling System, Special Publication	SEBD0518
Coolant Analysis, Data Sheet	PEHP7057
Extended Life Coolant, Data Sheet	PEHP4036
3500B Series II Marine Engines Service Manual	RENR5075
3500B Series II Marine Engines Disassembly and Assembly	SENR6564
3500B Series II Marine Propulsion Engines Electrical Schematic	RENR5010
3500B Series II Marine Engines Troubleshooting Guide	RENR5009
3500B Series II Marine Engines Specifications	RENR5077
3500B Series II Marine Engines Sys Operations Testing & Adjusting	RENR5078
3500B Series II Marine Engines Parts Manual (S2D - B5G)	SEBP3909 - 4033
Caterpillar Marine Parts and Service Locations, Special Publication	LEDM5615
Service Technician Application Guide, Special Publication	NEHS0526
Tools and Shop Products Guide, Special Publication	NENG2500
Index to Guidelines for Reusable Parts and Salvage Operations, Special Publication	SEBF8029
One Safe Source, Special Publication	PECP9067
Guideline for Reusable Parts - Cleaning and Inspection of Air Filters	SEBF8062
Torque Specifications, Specifications	SENR3130
Use of 6V-2150 Starting/Charging Analyzer, Special Instruction	SEHS7768
Storage Procedure for Caterpillar Products, Special Instruction	SEHS9031
Battery Test Procedure, Special Instruction	SEHS7633

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