CATERPILLAR®

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Owner's Manual

Customer Communication Module (CCM)

For the following applications:
EMCP II, EMCP II+, EMCP II+P Gensets
3500B EUI Engines
3500 with EUI Option Engines

Table of Contents

Acronym Definitions

ADEM	Advanced Diesel Engine Management
CCM	Customer Communication Module
CID	Component Identifier
CTS	Clear To Send
DCE	Data Communication Equipment
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
ECM	Electronic Control Module
ECS	Engine Control Switch
EIP	Electronic Instrument Panel
EMCP	Electronic Modular Control Panel
EMI/RFI	Electro-Magnetic Interference/ Radio-Frequency Interference
EPG	Electric Power Generation
ET	Electronic Technician
EUI	Electronic Unit Injector
F	Fuse
FID	Fault Identifier
FMI	Failure Mode Identifier
GSC	Generator Set Control
IID	Instruction Identifier
LSB	Least Significant Byte
MID	Module Identifier
MSB	Most Significant Byte
MUI	Mechanical Unit Injector
PC	Personal Computer
PID	Parameter Identifier
PLC	Programmable Logic Controller
RTS	Request To Send

Foreword

Literature Information

This manual contains safety, installation, operation, and troubleshooting information for the Customer Communication Module (CCM). Read, study, and keep this manual with the other product literature.

Continuing improvement and advancement of product design may have caused changes to the Customer Communication Module which are not included in this manual. Whenever a question arises regarding this manual, please contact your Caterpillar dealer for the latest available information.

Additional information can also be found in the following literature for CCM PC software: JERD2157, JERD2162 (Windows version manual and software)

NOTE: All references in this manual to EMCP II apply to EMCP II, EMCP II+, and EMCP II+P unless otherwise stated. All references to EMCP II+ also apply to EMCP II+P unless otherwise stated. These rules similarly apply to GSC, GSC+, and GSC+P.

NOTE: All references in this manual to 3500B EUI Engines also apply to 3500 with EUI option engines.

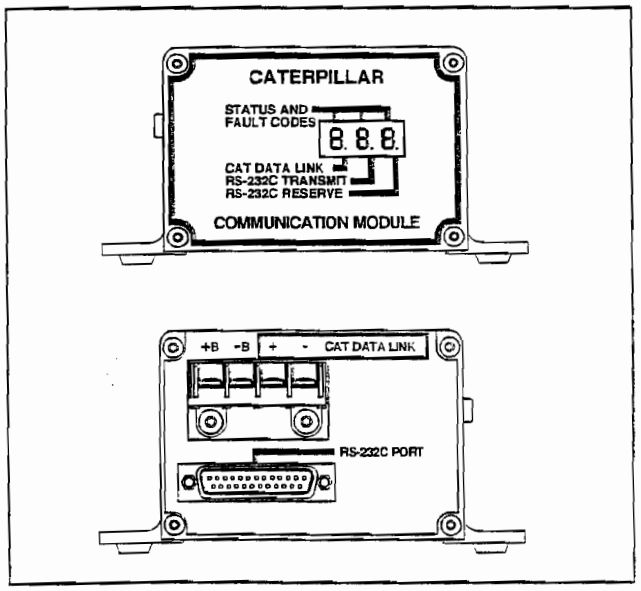
Safety

The safety section lists basic safety precautions. Read and understand the basic precautions listed in the safety section and throughout this manual before installing or operating this product.

Description and Function of the Customer Communication Module

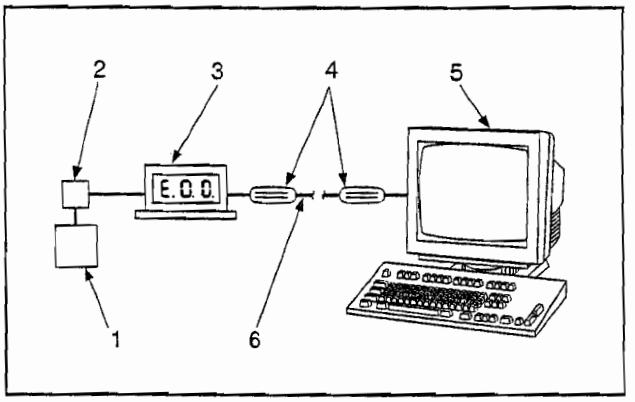
The Customer Communication Module (CCM) provides a two-way communication link between the electronic controller (GSC or ECM) and a host device. The operator of the host device is able to remotely control, monitor, or program the engine equipped with electronic engine control in much the same way an operator does from the panel (3500B Marine application does not allow remote control capabilities).

The host device can connect directly to the CCM or remotely, by means of two modems. The host device can be a personal computer (PC), Programmable Logic Controller (PLC), or any other device with a RS-232C port. CCM compatible software is available from Caterpillar Inc. for use with a PC (refer to the 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 customized software, and the serial data format is provided, allowing the user to program their device to communicate with the CCM. Refer to the RS-232C M5X Communication Protocol and the Parameter Identifiers (PID) sections for additional information.



Customer Communication Module (front and rear view)

Each CCM is serialized. On the bottom of one flange is a 5 digit number preceded by the letters "SN". The Caterpillar part number is located on the same flange, and is a 7 digit number (XXX-XXXX).



CCM System Connection. See Installation section of this manual for complete configuration options.
(1) Electronic Engine Controller. (2) Junction boxes.
(3) CCM. (4) Optional modems. (5) Host computer.
(6) Phone connection.

Important Safety Information

Most accidents involving product operation, maintenance and repair, are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING", as shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

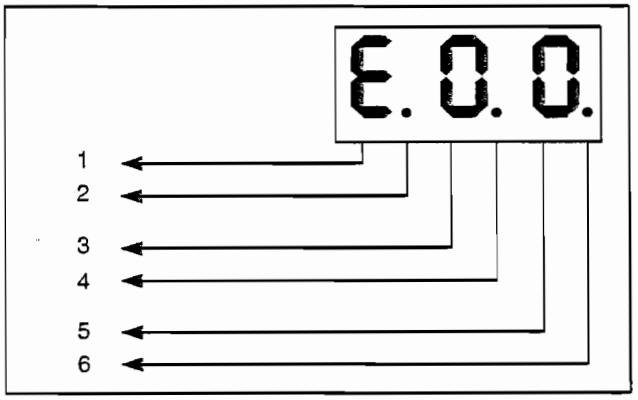
Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Display Description

During normal operation, the CCM display shows the status of the data link and RS-232C activity, as well as some of the current communication parameters:



Description of Display Characters
(1) Error code. (2) CAT Data Link activity. (3) First digit of error code. (4) RS-232C transmit by CCM. (5) Second digit of error code. (6) RS-232C receive by CCM.

The values "E", "0", and "0" indicate an error code of "00" that means no faults are present, and the CCM is in normal operating mode. The complete list of error codes are in the Troubleshooting section. The periods on the display may be either flashing or steady to indicate activity on the CAT Data Link or RS-232C port. No period indicates that no activity is taking place.

NOTE: For the older CCM (Caterpillar part number 117-6170), the logged faults will appear on the CCM display every 60 seconds, each for 2 seconds. This flashing fault log will not appear for any other version of CCM. This log can be cleared using the CCM PC software.

Display at Power-Up

During the power-up sequence, the CCM display undergoes a lamp test (8.8.8.), followed by the communication protocol parameters (n81 9600 E00) that have been programmed into it.

An example of the power-up sequence would be:

8.8.8. n81 9600 E00	
8.8.8.	All segments turned on for two second lamp test
n81	
n	No parity (default value)
8	Eight data bits (default value)
1	One stop bit (default value)
9600	Communication rate (default value)
E00	Error code indicating no faults are present

Refer to the Caterpillar CCM PC For Windows: Getting Started Manual for more information on changing the communication values. It is important that these communication values match those for the modems (if used) and the host device.

General Information

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

- The environmental, mounting, wiring, and cable specifications must be met.
- The connection diagrams must be followed.
- It is possible to use modems to increase the communication distance between the host PC and the CCM. It is the user's responsibility to provide and properly set up the modems.

Specifications

Environmental

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

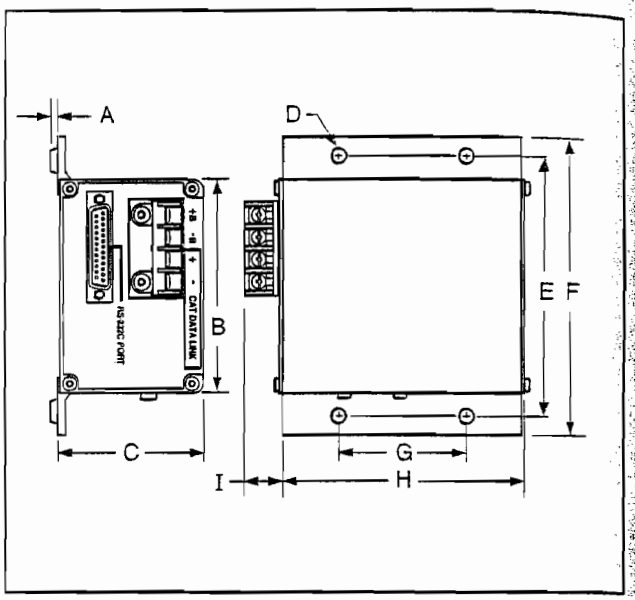
Mounting

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.

NOTE: 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 that supplies power for internal memory whenever the CCM power is turned off. For additional information, refer to the "Replacing the CCM Battery" section.



CCM Mounting Dimensions

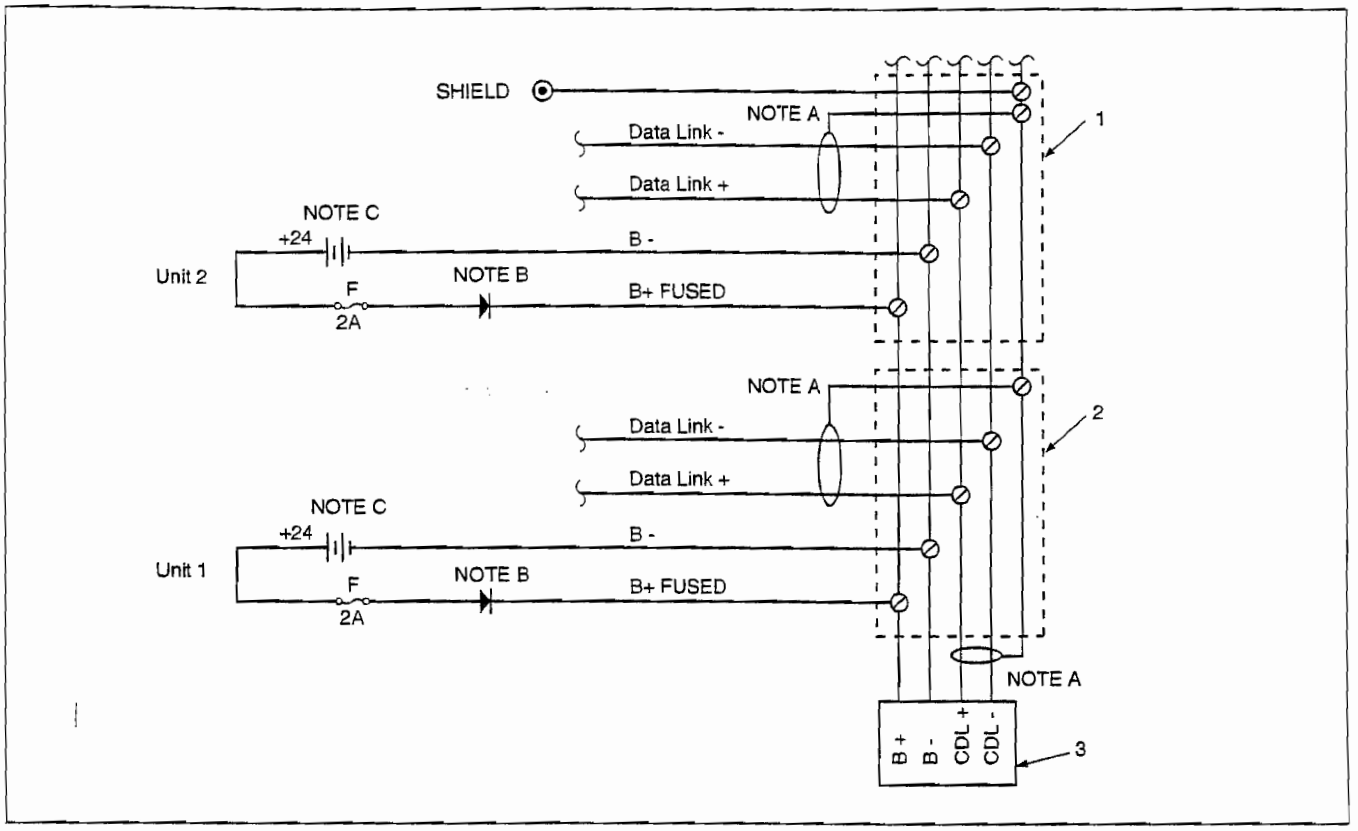
CCM MOUNTING DIMENSIONS	
Item	**Dimension**
A	3.5 mm (.14 in)
B	106.5 mm (4.19 in)
C	73.0 mm (2.87 in)
D	7.5 mm (.29 in) diameter holes (4)
E	130.0 mm (5.12 in)
F	149.0 mm (5.87 in)
G	66.2 mm (2.61 in)
H	125.5 mm (4.94 in)
I	17.8 mm (.70 in)

Wiring Connections and Battery Power

- The Battery voltage input requirements are from 15 to 45 volts DC (24 or 32 volt DC nominal power).
- B+/- power dissipation is approximately 3.0 watts at 24 volts.
- Multiple engines must share common ground (B-).
- Multiple engines must use diodes to prevent power-sharing between units. See "CCM Wiring Connections for Multiple Gensets" diagram on following page.

When multiple units are to be connected to the CCM, junction boxes must be installed as shown in the following illustration. This allows any engine to be disconnected for service or maintenance without power interruption to the CCM and the other engines.

General Wiring Connections



CCM Wiring Connections for Multiple Gensets
(1) Junction box for Unit 2. (2) Junction box for Unit 1. (3) CCM.
NOTE A: Shield should be ground in one location only, as near as possible to battery negative.
NOTE B: Diode is only necessary when connecting multiple gensets.
NOTE C: Battery positive and negative are to be taken from the EMCP II (if equipped) or from the 24 pin customer connector located on the bottom of the Electronic Instrument Panel (EIP).

CCM/Data Link Guidelines

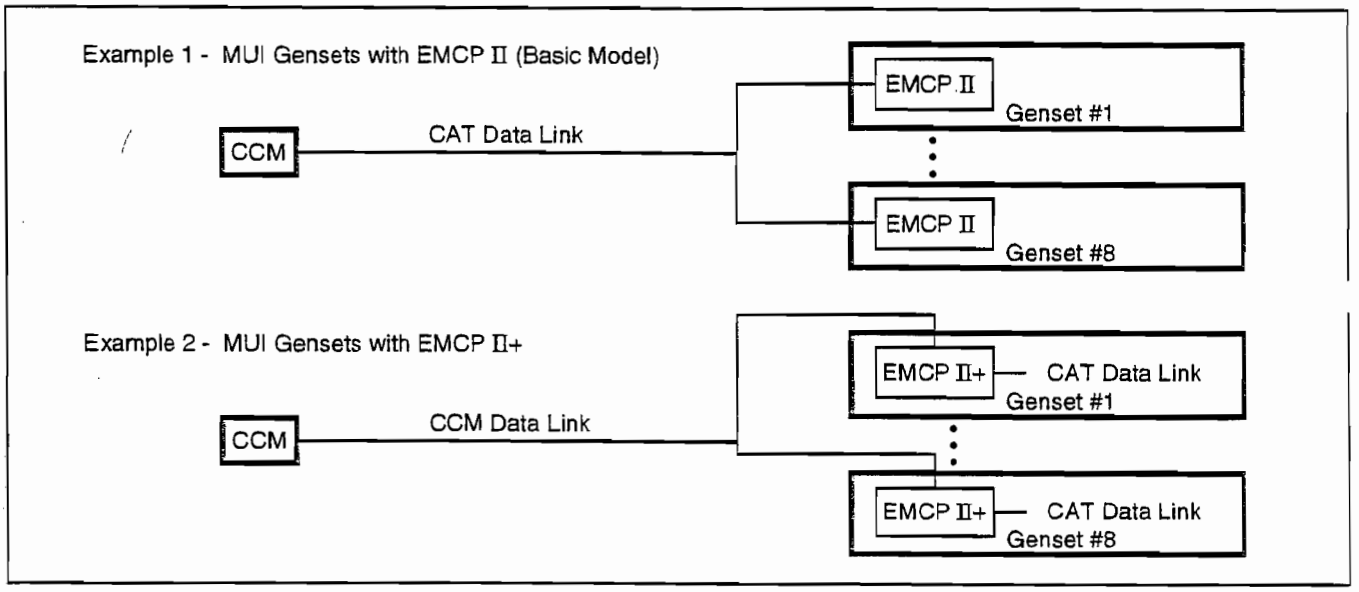
The CCM has the ability to communicate with up to eight other controllers. The number of connections available depends on the type of device to be connected. For genset applications up to eight controllers can be connected to the CCM. Marine applications are limited to a maximum of three connections. The CCM identifies different controllers on the data link by their Module Identifier (MID). The MID's, in some cases, are programmable. Refer to the Programming the Engine Number section in this manual for more detailed information on programming the MID's. Each controller connected to the CCM must have a unique MID.

There are two versions of ECM's for 3500B EUI Engines. To properly understand CCM/data link connections for 3500B EUI Engines, it is necessary to know the version of the engine's ECM. The version of the ECM is based on the serial number of the engine as listed on the engine nameplate. Use the following chart to determine the correct version of controller for each engine.

Serial Numbers	
Version C	**Version D**
N/A	1NW00001 & Up
N/A	1PW00001 & Up
N/A	1TW00001 & Up
2BM00001 to 2BM00122	2BM00123 & Up
N/A	2FW00001 & Up
N/A	2GW00001 & Up
N/A	2HW00001 & Up
N/A	3CW00001 & Up
3DM00001 to 3DM00092	3DM00093 & Up
N/A	3DW00001 & Up
N/A	4AW00001 & Up
4GM00001 to 4GM00211	4GM00212 & Up
4TN00001 to 4TN00095	4TN00096 & Up
6HN00001 to 6HN00155	6HN00156 & Up
6PN00001 to 6PN00284	6PN00285 & Up
6WN00001 to 6WN00134	6WN00135 & Up
7HM00001 to 7HM00173	7HM00174 & Up
7RN00001 to 7RN00462	7RN00463 & Up
7SM00001 to 7SM00076	7SM00077 & Up
8CN00001 to 8CN00143	8CN00144 & Up
8EM00001 to 8EM00257	8EM00258 & Up
8KN00001 to 8KN00142	8KN00143 & Up
8RM00001 to 8RM00199	8RM00200 & Up
9AN00001 to 9AN00120	9AN00121 & Up

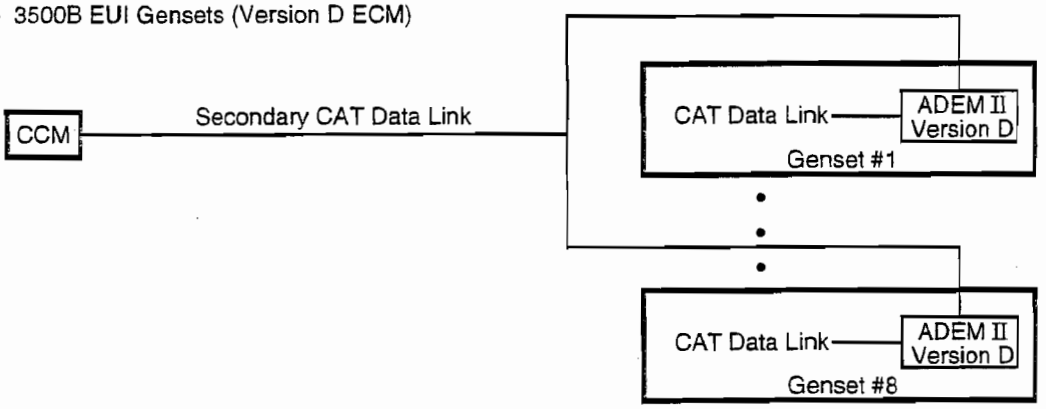
- Version C of the ADEM II controller (ECM) has a primary data link for use with the CCM. This data link is called the CAT Data Link. The MID of this controller, on the CAT Data Link, is a fixed value. Because each controller must have a unique MID as mentioned previously, the CCM can only be connected to one Version C ECM on the CAT Data Link.
- Version D of the ADEM II controller (ECM) has the same primary data link as Version C (CAT Data Link) 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 eight different values for genset applications, three different values for marine applications).
- EMCP II (basic model) has a primary data link for use with the CCM. This data link is called the CAT Data Link and has a programmable MID value (up to eight different values).
- EMCP II+ has the same primary data link as EMCP II (CAT Data Link) with a programmable MID value. In addition the EMCP II+ also has a secondary data link (CCM Data Link) for use with the CCM. The CCM Data Link has a programmable MID value (up to eight different values).
- Although the terminology differs between 3500B Version D and EMCP II+ applications, the Secondary CAT Data Link and CCM Data Link, respectively, can be treated in the same manner.
- There is a maximum of one CCM per data link.
- There is a maximum of one CCM per engine.

The previous electronic controller descriptions govern how the devices can be connected to the CCM. When an ADEM II controller (Version C or D) is connected with an EMCP II (or EMCP II+) controller, the CAT Data Link is always used for the connection between the two controllers. All subsequent connections to the CCM (ADEM II Version D or EMCP II+) are made using the secondary data link. The following examples will illustrate some valid CCM connections with multiple electronic controllers. These examples are only a representation of most possible valid connections or combinations. There are many other valid combinations based on these examples.

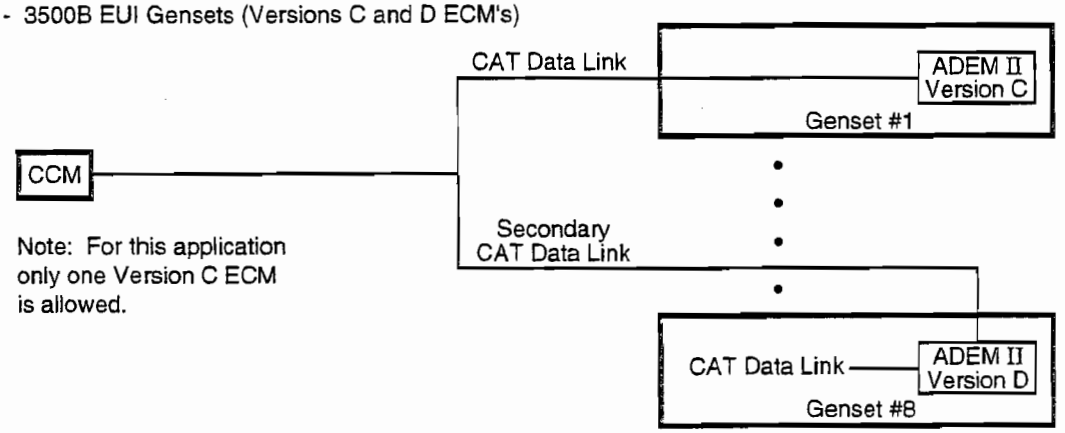


Example 3 - 3500B EUI Genset (Version C ECM)

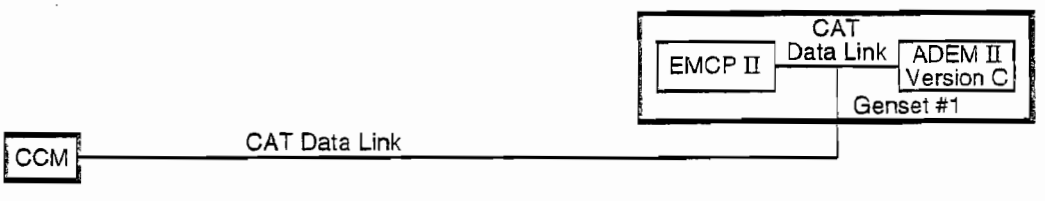
Example 4 - 3500B EUI Gensets (Version D ECM)



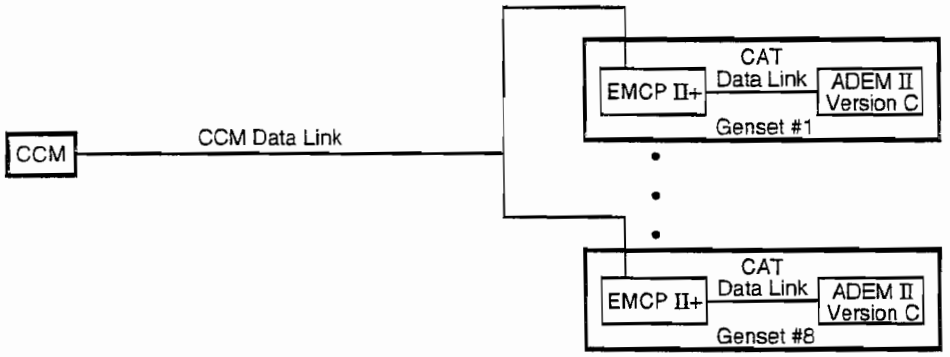
Example 5 - 3500B EUI Gensets (Versions C and D ECM's)



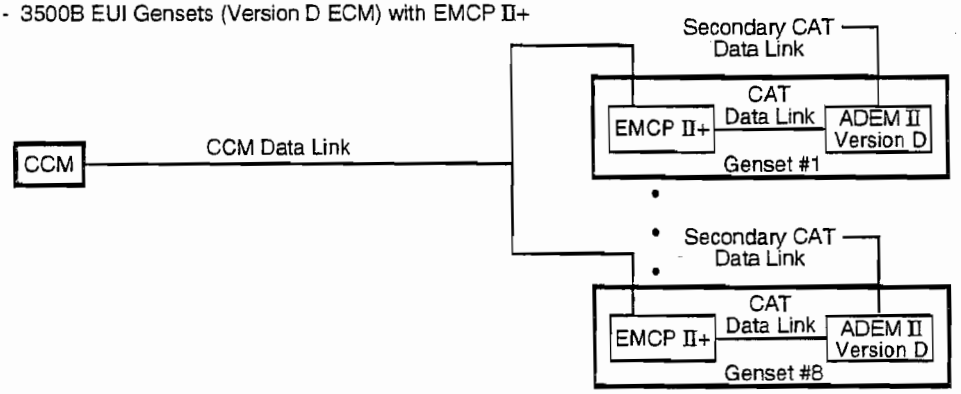
Example 6 - 3500B EUI Genset (Version C ECM) with EMCP II (Basic Model)



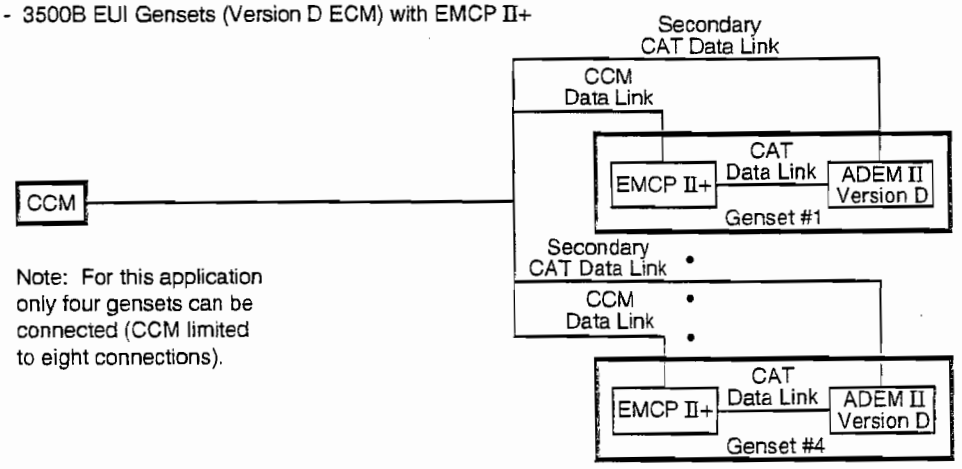
Example 7 - 3500B EUI Gensets (Version C ECM) with EMCP II+



Example 8 - 3500B EUI Gensets (Version D ECM) with EMCP II+



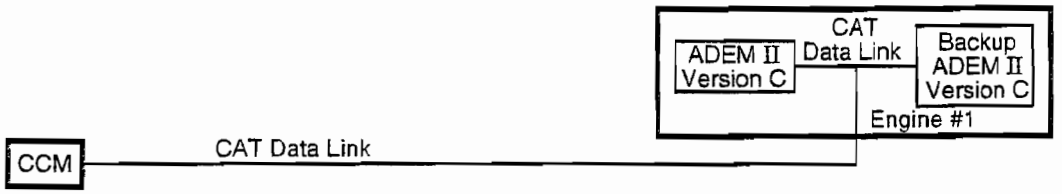
Example 9 - 3500B EUI Gensets (Version D ECM) with EMCP II+



Note: For this application only four gensets can be connected (CCM limited to eight connections).

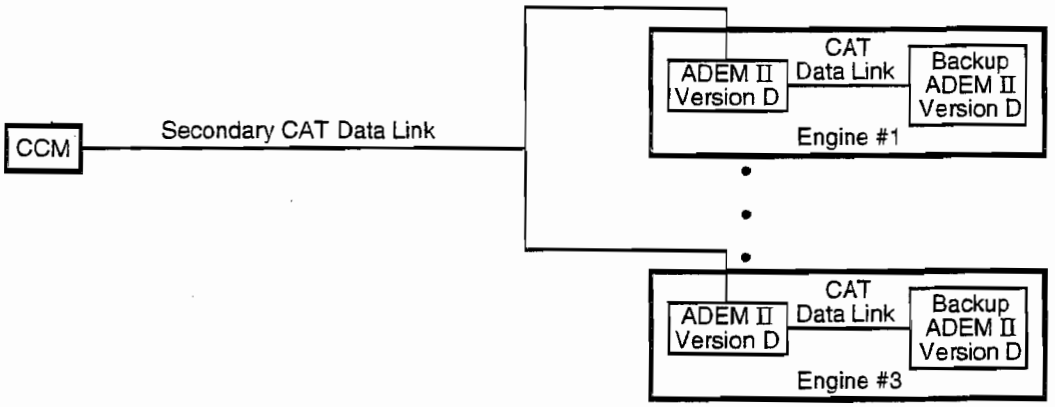
Note: The two configurations shown in Examples 8 and 9 offer trade offs. In Example 8, eight gensets can be connected. However, in Example 9, more detailed information can be obtained from the ADEM II controller. However, in this configuration, only four gensets can be connected.

Example 10 - 3500B EUI Marine Engine (Version C ECM)



Note: One CCM is required per engine for Version C ECM.

Example 11 - 3500B EUI Marine Engine (Version D ECM)



General Wire and Cable Specifications

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

- Do not run data link wiring in the same raceway as high power cabling, such as generator leads, or any AC cabling.
- 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 engines when a CCM is present. Otherwise, maximum wire length is 30.5 m (100 ft).
- Maximum total wire length for the RS-232C cable is 15 m (50 ft).

NOTE: In order to conform to the European Economic Community (EEC) 336 Directive, the RS-232 cable must be shielded.

- 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.

NOTE: For 3500B additional wiring information, refer to SEHS9951, Customer Communication Module and Programmable Relay Control Model Installed on 3500B Engines with Electronic Instrument Panel.

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

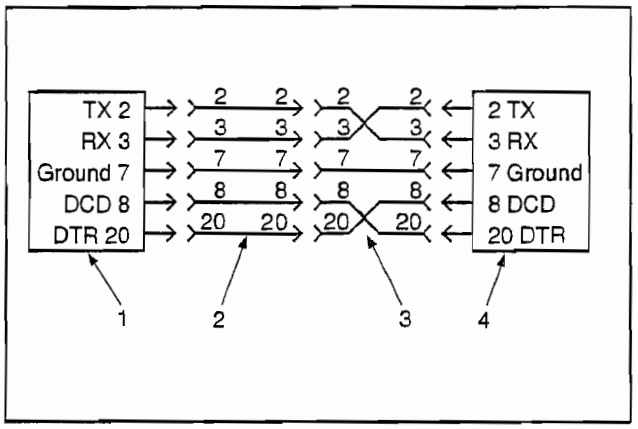
Pin Number	Description
2	Data Transmit (TX)
3	Data Receive (RX)
7	Ground
8	Data Carrier Detect (DCD)
20	Data Terminal Ready (DTR)

If the CCM is connected directly to a PC with a 25-pin RS-232C connector, then a 25-to-25 pin cable is needed in addition to the Null Modem adapter (refer to the following illustration with 25-pin connectors).

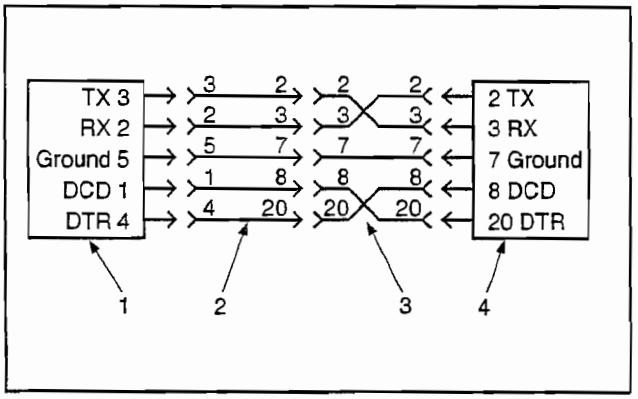
If the PC has a 9-pin RS-232C connector it requires a 9-to-25 pin cable with a Null Modem adapter (refer to the following illustration with 9-pin connectors).

The Null Modem adapter correctly connects the Data Transmit of one device to Data Receive of the other and vice versa. It connects the Data Carrier Detect and Data Terminal Ready pins in a similar manner. Ready-made cables can be purchased from most personal computer suppliers.

NOTE: Make sure that the purchased cables and Null Modem adapters support ALL pin connections noted in the "RS-232C Pin Definitions" chart above.



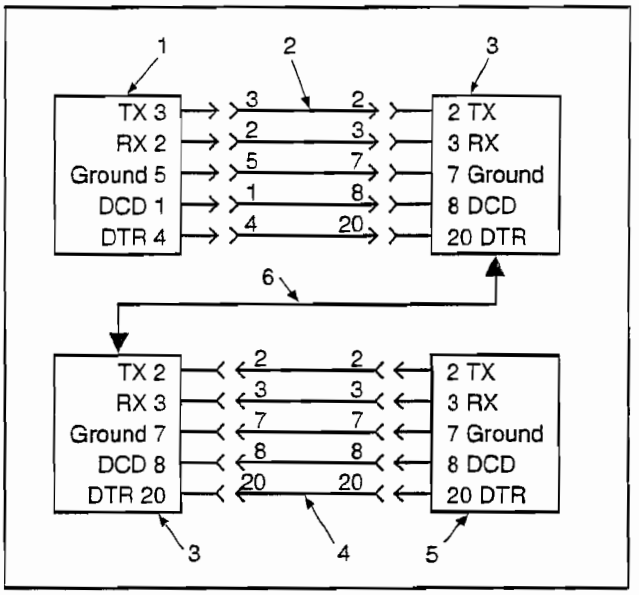
CCM|Cable Requirements for Direct Connection to PC with 25-Pin Connector
(1) PC with 25-pin RS-232C connector. (2) 25-to-25 pin female to male cable. (3) Null modem adapter.
(4) CCM with 25-pin RS-232C connector.



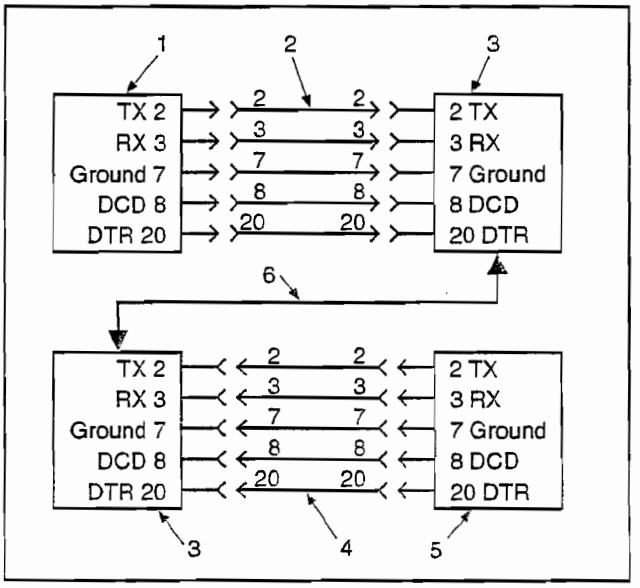
CCM Cable Requirements for Direct Connection to PC with 9-Pin Connector
(1) PC with 9-pin RS-232C connector. (2) 9-to-25 pin female to male cable. (3) Null modem adapter.
(4) CCM with 25-pin RS-232C connector.

If the CCM is to be used with modems, then either a 25-to-25 pin cable or a 9-to-25 pin cable is needed to connect to the modem depending on the number of pins on the RS-232C connector of the PC.

NOTE: Null Modem adapters should not be used when connecting a modem to either the PC or the CCM.



CCM Cable Requirements for Modem Connecting to PC with 9-Pin Connector
(1) PC with 9-pin RS-232C connector. (2) 9-to-25 pin female to male cable. (3) Modems connected by telephone lines. (4) 25-to-25 pin male to female cable.
(5) CCM with 25-pin RS-232C connector. (6) Telephone line.



CCM Cable Requirements for Modem Connecting to PC with 25-Pin Connector
(1) PC with 25-pin RS-232C connector. (2) 25-to-25 pin female to male cable. (3) Modems connected by telephone lines. (4) 25-to-25 pin male to female cable.
(5) CCM with 25-pin RS-232C connector. (6) Telephone line.

Programming the Engine Number

The electronic controller of each engine must be programmed with the correct engine number to identify them to the CCM. The electronic controller is programmed to Engine Number 1 at the factory. Installations with one genset per CCM will normally leave the electronic controller engine number programmed to number one. Refer to CCM/Data Link Guidelines section for details on which controllers are programmable. To change the engine number of the electronic controller, follow these steps:

For EMCP II Applications

1. Refer to the topic Engine Setpoints - OP5 in the Systems Operation section of the appropriate EMCP II or EMCP II+ Service Manual. Follow the procedure for adjusting setpoints. The setpoint number is P22 - GSC Engine Number. The default value is 1, corresponding to Engine Number 1.

2. Following the procedure in the EMCP II manual, change the value of P22 - GSC to the desired value. The range of possible values are 1 through 8, corresponding to the engine number. Each unit connected on the same data link must have a unique number (MID).

3. Power cycle the GSC.

For 3500B Applications

1. Using the Electronic Technician (ET) service tool, go to the Service pull-down menu and select Configuration.

2. Change the Secondary CAT Data Link Identifier configuration parameter (Cat Data-Link #2) to the desired value.

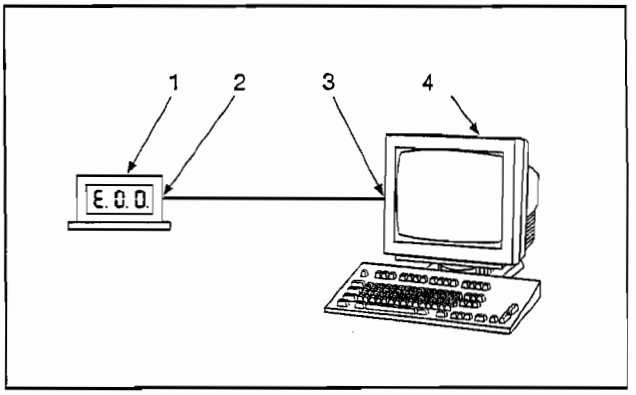
NOTE: The Windows version of CCM PC software detects all electronic engine controllers and programs the PC with the correct unit addresses.

Communication Initialization

The CCM may be connected directly or remotely (by means of modems) to the host computer. The initialization procedure differs depending on the type of connection and 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 increased (refer to the "CCM/Host Computer Remote Connection With Modems" illustration). The RS-232C ports of the host computer, the modems, and the CCM must be set to the proper communication parameters. In addition, the phone line ports of the modems must be compatible. To connect the modems, consult the manufacturer's instructions.

Direct Connection Initialization



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

Make sure the following equipment is available:

- A personal computer. Refer to the Caterpillar CCM PC For Windows: Getting Started Manual for specifications on the PC. It is the user's responsibility to adequately understand the operation of the PC.
- The proper RS-232C cables are required for the particular installation. Refer to the "RS-232C Cable Requirements section" in this manual
- The CCM PC For Windows software is available from Caterpillar for use with the CCM.

Procedure

Perform the following procedure to initialize communication with the host computer connected directly to the CCM.

NOTE: In the following steps the PC should be turned OFF before connecting or disconnecting cables to the serial ports.

1. The CCM should be installed with all wiring attached. Refer to sections on "Wiring Connections and Battery Power" and "General Wire and Cable Specifications" section.

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. Refer to "Determining Programmed Communication Parameters in CCM" section in this manual for help in determining the communication parameters stored in the CCM.

3. Load the CCM PC For Windows software into the PC. Refer to Caterpillar CCM PC For Windows: Getting Started Manual for additional instructions.

4. Go to the Data Link pull-down menu, select Select ECM, 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.

5. 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.

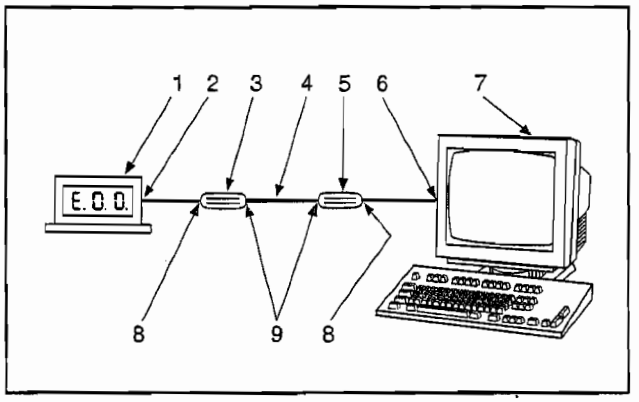
6. The electronic controller of each engine must be programmed with the correct engine number to identify them to the CCM. The electronic controller is programmed to Engine Number 1 at the factory. Refer to Programming the Engine Number section in this manual to change the engine number programmed into the electronic controller.

7. After the CCM and the PC are all properly connected, refer to the CCM PC software Users Manual for instructions on monitoring and controlling the engine remotely.

NOTE: Two conditions must be met before the electronic engine controller will allow control (starting and stopping, for example) by the CCM. The Engine Control Switch must be in the AUTO position, and the remote initiate contacts must be open (no other remote start signal received). The engine may be monitored with the ECS in any position.

NOTE: For EMCP II applications, the CCM cannot control the genset if the GSC is in Service Mode, however the genset can still be monitored.

Remote (Modem) Connection Initialization



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.

If desired, follow the instructions in the previous section to connect the CCM directly to the host computer before attempting modem connections. This enables the user to become familiar with the PC software and verify proper operation of the genset while at the site.

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. It is the user's responsibility to adequately understand the operation of the PC.
- The proper RS-232C cables. Also, a cable must be temporarily connected from the PC to the Answering Modem RS-232C port. Refer to the "RS-232C Cable Requirements" section.

- Two modems that support the Hayes AT command set. This is necessary for both the Answering Modem and the Originating Modem.
- The CCM PC For Windows software is available from Caterpillar for use with the CCM.

NOTE: Some PC's will have a built-in modem. It is possible to use one of these internal modems as the Originating Modem as long as it is compatible with the Answering Modem. Consult the instructions for the two modems.

Procedure

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 (refer to the CCM PC software Users Manual).

NOTE: In the following steps the PC and the modems should be turned OFF before connecting or disconnecting cables to the serial ports.

1. The CCM should be installed with all wiring attached. Refer to sections on "Wiring Connections and Battery Power" and "General Wire and Cable Specifications".

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. Refer to "Determining Programmed Communication Parameters in CCM" section in this manual for help in determining the communication parameters stored in the CCM.

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. Refer to the "RS-232C Cable Requirements" section.

7. Load CCM PC For Windows software into the PC. Refer to the Caterpillar CCM PC For Windows: Getting Started Manual, for instruction on monitoring and controlling the engine remotely (Marine applications do not allow remote control ability, only monitoring is provided).

8. Go to the Data Link pull-down menu, select Select ECM, 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 electronic engine controller of each engine must be programmed with the correct engine number to identify them to the CCM. The electronic engine controller is programmed to Engine Number 1 at the factory. Refer to Programming the Engine Number section in this manual to change the engine number programmed into the electronic engine controller.

11. Disconnect the PC from the CCM. Connect the PC, modems, and CCM, as noted in the RS-232C Cable Requirements section of this manual. Make sure that the Answering Modem and the CCM are both powered up and that they are connected by the proper RS-232C cable.

12. Power-down the CCM (remove the wire connected to the B+ terminal of the CCM) and then power-up the CCM (reconnect the wire on the B+ 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 software Users Manual for instructions on monitoring and controlling the engine remotely.

NOTE: Two conditions must be met before the electronic engine controller will allow control (starting and stopping, for example) by the CCM. The Engine Control Switch must be in the AUTO position, and the remote initiate contacts must be open. The engine may be monitored with the ECS in any position.

NOTE: For EMCP II applications, the CCM cannot control the genset if the GSC is in Service Mode, however the genset can still be monitored.

NOTE: If desired, the PC and the Originating Modem can be connected to a local phone line at the same site as the genset, CCM, and Answering Modem, to make certain of proper communication before attempting remote operation.

Troubleshooting

CCM Error Code Troubleshooting

The CCM has internal troubleshooting to aid the operator in solving various system problems such as CAT Data Link or RS-232C communication errors and/or CCM battery failure. Other types of faults are included in the "Additional Troubleshooting" section. Also, refer to the Caterpillar CCM PC For Windows: Getting Started Manual, for additional information.

NOTE: For the older CCM (Caterpillar part number 117-6170), the logged faults will appear on the CCM display every 60 seconds, each for 2 seconds. This flashing fault log will not appear for any other version of CCM. This log can be cleared using the CCM PC software.

CCM ERROR CODES		
CCM Error Code	**Explanation**	**Action Required**
E00	No fault, normal operating mode	None
E01	Setpoint (EEPROM) fault	CCM passwords, unit addresses, communication set-ups are corrupted. Reprogram from Phone Book and Utilities pull-down menus (Windows version) or contact your local Caterpillar Technical Representative.
E02	M5X message error (checksum or byte count error)	Check customer-generated M5X code.
E03	Memory back-up battery is weak	Change battery (refer to "Replacing the CCM Battery" section).
E04	RS-232C link short circuit fault	Check RS-232C cable, PC port, and CCM port.
E05	Internal buffer overflow on RS-232C or Data Link fault	Possibly caused by a slower than acceptable communication rate from the RS-232C port or an open CAT Data Link connection during RS-232C transmission. Increase communication rate and check CAT Data Link wires.
E06	Invalid CAT Data Link Message fault	Caused by: 1. Too much traffic on CAT Data Link (eg. Caterpillar electronic service tool). 2. CAT Data Link wires too long. Remove ECAP or other Caterpillar electronic service tool devices overloading CAT Data Link and check CAT Data Link wires.
E07	Miscellaneous CAT Data Link fault	Caused by: 1. (+/-) CAT Data Link shorted to (+/-) battery. 2. Internal hardware fault in CCM. Check CAT Data Link wiring.
E08	RS-232C link message fault (parity, data size)	Check RS-232C protocol (communication rate, data bits, stop bits, parity) of the CCM and PC.
888	Internal CCM fault	Replace the CCM.

Additional System Troubleshooting

The purpose of this section is to aid the operator in solving those problems that are NOT accompanied by an error code on the CCM and are NOT included in the Caterpillar CCM PC For Windows: Getting Started Manual.

ADDITIONAL SYSTEM TROUBLESHOOTING		
Problem	**Possible Explanation**	**Action Required**
Direct Connections		
PC unable to connect to CCM.	PC configured improperly or a cabling error is present.	Determine if the proper serial port on the PC has been selected. Make sure the correct RS-232C cable is being used. Null modem is required. Match the PC with the CCM configuration.
Modem Connections		
PC unable to connect to CCM.	PC configured improperly, modem not set up properly, or cabling error is present. PC modem and CCM modem are not compatible. Password was not entered within 60 seconds.	Determine if proper serial port on the PC is selected. Make sure that the Communication Specifications are being met and consult the modem manual. Make sure the correct RS-232C cable is being used. No null modem is required. Match the CCM, PC, and modem configurations.
Modem disconnects during remote start.	System battery voltage is low.	Make sure that the (+/-) Battery Power Specifications are being met. It may be necessary to disconnect the phone line on the local modem temporarily to force it to hang up.
Direct or Modem Connections		
PC can connect to only one electronic controller in a multiple unit installation.	Electronic controller MID has not been programmed. Electronic controllers are not connected on the correct data link.	Refer to the Programming the Engine Number section and CCM/Data Link Guidelines section in this manual.
PC will not connect to 3500B marine propulsion engine when using the CCM PC software.	CCM has been installed on the wrong data link.	CCM PC software version 1.2 and earlier will not communicate with the CCM if the CCM is connected via the primary Data Link on 3500B Marine Engines built after 4/97. The CCM should be connected on the Secondary CAT Data Link on these engines when used as a communications interface. Refer to the CCM Data Link Guidelines section in this manual.

M5X Communication Troubleshooting

The purpose of this section is to aid the operator in solving some common problems associated with M5X communication protocol.

M5X COMMUNICATION TROUBLESHOOTING		
Problem	**Possible Explanation**	**Action Required**
Direct Connections		
CCM shows error codes E02 and E08 when receiving data from the PC/PLC and will not communicate.	There is a protocol error. The data is not in ASCII format. An incorrect checksum was sent.	Correct the message being sent to the CCM.
RS-232 receive lights are not lit, and the CCM will not communicate with the PC/PLC even though no error codes are appearing.	Hardware connection between the PC/PLC and CCM is corrupted or disconnected.	Using the CCM PC software, connected to the CCM, determine if the connection to the PC/PLC is valid.
Cannot log into the CCM.	Connection problem exists or using the wrong M5X protocol for logging in.	Use a read request (PID $F0 $12) to verify that the PC/PLC is available to communicate with the CCM. If a valid response is returned, proceed to "log in" as described in the Logging In section in this manual. If the password has been forgotten, call the CCM Help Desk.
Cannot get data from the CCM.	The "logged in" security level is not high enough to support the request. The CCM does not support the PID.	Verify that the "logged in" security level is high enough to support the request. Verify that the CCM supports the PID being requested.
Cannot get data from the electronic controller.	The electronic controller specified is not available. The "logged in" security level is not high enough to support the request. The electronic controller does not support the PID.	Verify that the electronic controller and the CCM are connected on the same data link. Verify that the "logged in" security level is high enough to support the request. Verify that the electronic controller supports the PID being requested.
Multiple responses are being generated from a single electronic controller.	Multiple electronic controllers have the same MID.	Program the engine number of the electronic controller. Refer to the CCM/Data Link Guidelines section and Programming the Engine Number section in this manual.
An entire broadcast list is not returned.	The electronic controller specified is not available. The electronic controller does not support any one of the PID's. The PID contains greater than two bytes of data. More than 48 parameters are being requested from one electronic controller.	Verify the number of parameters requested from the electronic controller is equal to or less than 48. Refer to the CCM Customized System section, IID 10 in this manual.
A broadcast list is returned, but is incomplete.	More than 48 parameters are being requested from one electronic controller. An unused PID ($00 $00) has been entered in the middle of the broadcast list.	Verify that the total number of parameters requested from the electronic controller is equal to or less than 48. Put all unused PID's ($00 $00) at the end of a broadcast list. Refer to the CCM Customized System section, IID 13 in this manual.
A broadcast list update rate is too slow or inconsistent.	Too many parameters are being requested. RS-232 cable is slow.	Verify that the RS-232 and modem baud rates are at least 9600 baud. CCM cannot broadcast more than 40 parameters per second. Use IID 13, Byte 7 to slow the update rate for stable parameters such as hour meter, temperature, diagnostics, etc. Use a faster rate for more dynamic parameters such as engine speed, oil pressure, etc. Refer to the RS-232 Communication Protocol for Customized Systems section in this manual for further information.

Determining Programmed Communication Parameters in CCM

The communication parameters (communication rate, parity, number of data bits, and number of stop bits) are stored in non-volatile memory within the CCM. To read these communication parameters, follow these steps:

1. Power down the CCM (remove the wire connected to the (+) B terminal).

2. Power-up the CCM [reconnect the wire to the (+) B terminal]. During the power-up sequence, the CCM display undergoes a lamp test (8.8.8.), followed by the communication protocol parameters (n81 9600 E00) that have been programmed into it.

8.8.8. n81 9600 E00	
8.8.8.	All segments turned on for two second lamp test
n81	
n	No parity (default value)
8	Eight data bits (default value)
1	One stop bit (default value)
9600	Communication rate (default value)
E00	Error code indicating no faults are present

These parameters can be programmed to different values. For the reprogramming procedures, refer to the Phone Book Tool section in the Caterpillar CCM PC For Windows: Getting Started Manual.

Replacing the CCM Battery

The CCM contains a battery (Caterpillar part number 101-1785) that supplies power for internal memory whenever the CCM is powered-down. In single unit installations, the CCM power is OFF whenever the genset control power is OFF. The battery has an expected life of five years.

The battery is mounted to the inside of the front plate of the CCM behind the three-digit display. To replace the battery, follow these steps:

1. Remove the four screws securing the front plate to the housing.

2. The battery is held in place by two small tabs on the upper and lower side of the battery. A tie-wrap provides additional support.

- **a**. Remove the tie-wrap.
- **b**. With a small screwdriver carefully pry one tab and lift that side of the battery slightly.
- **c**. Repeat for the other tabs and remove the battery.

3. Carefully press the replacement battery into the holder until tabs are securing the battery.

- **a**. The battery has one corner that is angled to make sure proper polarity is maintained during installation.
- **b**. Make sure the battery pins are entering the sockets of the holder properly.
- **c**. Install the new tie-wrap.

4. Replace the front plate of the CCM.

RS-232C Communication Protocol for Customized Systems

As purchased, the Customer Communication Module (CCM) comes with Windows compatible software that utilizes M5X protocol to allow the CCM to communicate with a remote personal computer (PC). 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 or generator 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 or generator 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), refer to Parameter Identifiers (PID) section for the appropriate application. The CCM provides the communication link between the host device and the engine governed by the electronic controller.

Most Caterpillar electronic systems using the CCM will provide 40 to 50 parameters every second to a remote computer system through the RS-232C connection, but other limits may be encountered. When connecting through a modem operating at less than 4800 baud, the throughput will be reduced. For example, using a cellular phone connection operating at 2400 baud reduces the throughput to 29 parameters per second.

CAT Data Link loading can also cause reduced system throughput. In some complex systems, such as the marine propulsion application, other modules on the CAT Data Link utilize system resources and may reduce the system throughput 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.

The M5X command messages sent to the CCM must always be sent in ASCII format, and the M5X status replies will always be returned in ASCII format. The command message contains an Instruction Identifier (IID). Numbers preceded by $ are in hexadecimal form.

Standard Preamble

The first four bytes of every IID contain a standard preamble.

The standard preamble is 50 xx yy zz.

The 50 indicates M5X protocol.

The xx is the sending module identifier (CCM or PC).
- $00 = User's host device
- $01 = Customer Communication Module

The yy is the Instruction Identifier (IID).
- $00 = Special Parameter Command
- $10 = Broadcast Response
- $11 = Activate A Broadcast List
- $12 = Deactivate A Broadcast List
- $13 = Create A Broadcast List
- $15 = Status Reply To IID 11, 12, 13
- $24 = Single Parameter Read Request
- $25 = Single Parameter Read Response
- $34 = Single Parameter Write Request
- $35 = Single Parameter Write Response

The zz is the number of bytes in the message after this byte. It does not include the checksum or carriage return.

IID 00, IID 24, and IID 34 all read or write data values of certain PID's.

M5X Message Checksums

The second to last byte of every IID is the checksum, followed by an ASCII carriage return ($0D). The checksum is the 2's complement of the sum of the preceding bytes of the message, truncated to the least significant byte. The sum of the checksum and the preceding bytes will equal 0 in the least significant byte.

Example: The following message is sent:

5000240400580082AE<cr>

The checksum for this message is AE. Although the message is sent in ASCII, the checksum must be calculated using the hexadecimal values.

Byte	ASCII Value	Hexadecimal Value
50	$35 $30	$50
00	$30 $30	$00
24	$32 $34	$24
04	$30 $34	$04
00	$30 $30	$00
58	$35 $38	$58
00	$30 $30	$00
82	$38 $32	$82
Total		$152
Truncated to LSB		$52
2's Complement (Checksum)	$41 $45	$AE
Total		$100
Truncated to LSB		$00

PID Security Levels

Every PID has an associated security level (0, 1, 2, or 3) within the CCM. A user within a particular security level may use PID's in that level or lower levels. PID's cannot be accessed by the user in levels higher than the password allows. For example, a user with security 2 level can access level 2, 1, and 0 but, not level 3.

The answering modem will be hung up if the password is not entered (sets the security level) within one minute. Specifically, if DCD is held low by the PC, and the security level is at 0 for more than one minute, DTR will be toggled by the CCM (answering modem hung up). Also, if the RS-232C cable is disconnected for more than five seconds, DTR will be toggled, and the security level will be set to 0.

The following chart defines the PID's within each security level for CCM parameters.

PID SECURITY LEVELS	
Level No.	**PID**
0	$00 $80 (R), $AA $8A (W), $F0 $12 (RW)[1], $F8 $14 (R)
1	$00 $0D (R), $00 $82 (R), $F0 $12 (W)[1], $F6 $01 (R)
2	$00 $0D (W), $F0 $12 (W)[1]
3	$AA $12 (RW), $AA $87 (RW), $AA $88 (RW), $AA $89 (RW), $F0 $12 (W)[1], $F6 $01 (W), $F8 $14 (W)

[1]User can write this parameter only at a level equal to or less than the logged in security level.
NOTE: R = Read. W = Write.

Logging In to the CCM

Before any parameters can be read or written to the CCM/electronic engine controller, the appropriate security level must be established. This process is called Logging In. The factory default password for all security levels is blank for all security levels. Thus, if no passwords are assigned (use IID 34 with PID $AA87, PID $AA88, or PID $AA89 to set these passwords) there will be an established security level of 3.

To "log in" using the factory default blank password, use IID 34 for PID $AA $8A:
500034040061AA8AE3

IID 34 - Single Parameter Write Request		
Byte(s)	**Byte Contents**	**Detailed Description**
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$34	IID 34
4	$04	Number of bytes
5	$00	Reply in ASCII format
6	$61	MID for CCM
7, 8	$AA $8A	PID $AA $8A Login Password
9	$E3	Checksum

To login using a password 11112222, use IID 34 for PID $AA $8A:
500034040061AA8A31313131323232324F

IID 34 - Single Parameter Write Request	
Byte(s)	**Description**
1	$50 indicates M5X protocol
2	$00 = User's PC is the sending module
3	$34 = IID 34
4	$0C = Number of bytes
5	$00 = Reply in ASCII format
6	$61 = CCM
7, 8	$AA,$8A = PID $AA $8A Login Password
9-16	3131313132323232 = Password (ASCII text)
17	$4F = Checksum

Instruction Identifiers (IID)

IID 00 - Special Parameter Command

The response to an IID 00 will be IID 25 Single Parameter Read Response.
A typical IID 00 example is $500000zz00580083dddddddcs. This example contains three bytes of data.

IID 00 - Special Parameter Command	
Byte(s)	**Description**
1-4	Standard preamble
5	Reply format $00 = ASCII
6	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit No. $61 = CCM
7, 8	PID
9, 10, 11[1]	Data value of parameter
12	Checksum of message followed by an ASCII carriage return ($0D)

[1]The number of bytes will depend on the PID.

See M5X Example section, "Reading Faults from EMCP II GSC", Step 3.

IID 10 - Broadcast Response

A typical IID 10 example is
$500110zz0124ddd120ddd220ddd320ddd420 ddd520ddd620ddd720ddd8cs

NOTE: Data within each PID must be two bytes or less.

IID 10 - BROADCAST RESPONSE	
Byte (s)	**Description**
1-4	Standard preamble
5	Parameter List Number $01 - $08 show what list 1 through 8 is being sent.
6	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit Number $61 = CCM
7	Separator 1[1]
8, 9	1st PID
10	Separator 2[1]
11, 12	2nd PID
13	Separator 3[1]
14, 15	3rd PID
16	Separator 4[1]
17, 18	4th PID
19	Separator 5[1]
20, 21	5th PID
22	Separator 6[1]
23, 24	6th PID
25	Separator 7[1]
26, 27	7th PID
28	Separator 8[1]
29, 30	8th PID
31	Checksum of message followed by an ASCII carriage return ($0D)

[1]A separator may or may not be present depending on bytes 8 and 9 of IID 13.

NOTE: The entire broadcast list will not be returned if any of the following conditions is met:
1. The GSC or ECM number is not available
2. The GSC or ECM does not support the PID
3. The PID contains more than 2 bytes of data

Refer to PID $00 $80 for device ID information. Refer to IID 13 for information on creating broadcast lists.

See M5X Example section, "Create a Broadcast List", Step 5.

IID 11 - Activate a Broadcast List

The response to IID 11 will be IID 15 Status Reply.
A typical IID 11 example is $5000110101

IID 11 - ACTIVATE A BROADCAST LIST	
Byte(s)	**Description**
1-4	Standard preamble
5	Parameter List Number $01 - $08 show what list(s) 1 through 8 are being activated.
6	Checksum of message followed by $0D (ASCII carriage return)

IID 12 - Deactivate a Broadcast List

The response to IID 12 will be IID 15 Status Reply.
A typical IID 12 example is $5000120101cs

IID 12 - DEACTIVATE A BROADCAST LIST	
Byte(s)	**Description**
1-4	Standard preamble
5	Parameter List Number $01 - $08 show what list(s) 1 through 8 are being deactivated.
6	Checksum of message followed by an ASCII carriage return ($0D)

See M5X Example section, "Create a Broadcast List", Step 3.

IID 13 - Create a Broadcast List[2]

The response to IID 13 will be IID 15 Status Reply.
A typical IID 13 example is
$5000131501240100000dd1dd2dd3dd4dd5dd6dd7dd8cs

NOTE: Data within each PID must be two bytes or less.

IID 13 - CREATE A BROADCAST LIST	
Byte(s)	**Description**
1-4	Standard preamble
5	Parameter List Number $01 - $08 show what list 1 through 8 is being programmed.
6	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit Number $61 = CCM
7	Update rate for this list. Resolution: 0.5 second per bit Data range: 0.5 ($01- $FE)
8, 9	Programming flags bit 0 = 0 = ASCII bit 2, 1 = 00 = Message terminated by carriage return bit 3 = 0 = Always bit 5, 4 = 00 = Comma separator 01 = Space separator 10= No separator
10, 11	1st PID[1]
12, 13	2nd PID[1]
14, 15	3rd PID[1]
16, 17	4th PID[1]
18, 19	5th PID[1]
20, 21	6th PID[1]
22, 23	7th PID[1]
24, 25	8th PID[1]
26	Checksum of message followed by an ASCII carriage return ($0D)

[1] If a PID is not used, 0000 must be entered for that PID. The CCM will ignore any PID's after the first PID entered as 0000. Therefore all unused PID's must be at the end of the broadcast list. Refer to IID 10 for more information on broadcast responses.

[2] Each CCM will support up to a total of eight lists for all GSC's and ECM's. Each list may contain up to eight PID's. The CCM, therefore, will support up to 64 parameters. However, the total number of PID's able to be broadcast is limited to 48 per controller.

Note: For the older version of CCM (Caterpillar part number 117-6170), the total number of PID's able to be broadcasted is limited to 31 per module.

See M5X Example section, "Create a Broadcast List", Step 1.

IID 15 - Status Reply to IID 11, IID 12, and IID 13

A typical IID 15 example is $5001150100cs

IID 15 - STATUS REPLY TO IID 11, IID 12, AND IID 13	
Byte(s)	**Description**
1-4	Standard preamble
5	Status Reply $00 = IID data is OK $10 = Invalid list number (greater than 8 or less than 1) $20 = List is not programmed $30 = Faulty checksum or command format
6	Checksum of message followed by an ASCII carriage return ($0D)

See M5X Example section.

IID 24 - Single Parameter Read Request

The response to an IID 24 will be IID 25 Single Parameter Read Response.

A typical IID 24 example is $500024040024F515cs

IID 24 - SINGLE PARAMETER READ REQUEST	
Byte(s)	**Description**
1-4	Standard preamble
5	Reply format $00 = ASCII
6	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit Number $61 = CCM
7, 8	PID
9	Checksum of message followed by an ASCII carriage return ($0D)

See M5X Example section, "Reading Faults from EMCP II GSC", Step 1.

IID 25 - Single Parameter Read Response

A typical IID 25 example is $500125zz24F515ddddcs

IID 25 SINGLE PARAMETER READ RESPONSE	
Byte(s)	**Description**
1-4	Standard preamble
5	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit Number $61 = CCM
6, 7	PID
8, 9	Data value of requested parameter. Data value may be from 1 through 27 bytes. This example shows two bytes.
10	Checksum of message followed by an ASCII carriage return ($0D)

See M5X Example section, "Reading Faults from EMCP II GSC", Steps 2 and 4.

IID 34 - Single Parameter Write Request

The response to an IID 34 will be IID 35 Single Parameter Write Response.

A typical IID 34 example is $500034zz0024F515ddddcs

IID 34 - SINGLE PARAMETER WRITE REQUEST	
Byte(s)	**Description**
1-4	Standard preamble
5	Reply format $00 = ASCII
6	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit Number $61 = CCM
7, 8	PID
9, 10	Data value of parameter. Data value may be from 1 through 27 bytes. This example shows two bytes.
11	Checksum of message followed by an ASCII carriage return ($0D)

See M5X Example section, "How to select which generator phase the GSC monitors", Step 1.

IID 35 - Single Parameter Write Response

A typical IID 35 example is $500135zz24F515ddddcs

IID 35 - SINGLE PARAMETER WRITE RESPONSE	
Byte(s)	**Description**
1-4	Standard preamble
5	Unit Number Data is being written to 3500B Marine Engine Unit Number $21 = Electronic engine controller (Port) $22 = Electronic engine controller (Starboard) $24 = Electronic engine controller (Single of Center) 3500B Generator Set Unit Number $21 - $26, = Electronic engine controller $28, $29 (number 1 - 8) EMCP II Generator Set Unit Number $58 - $5F = GSC (number 1 - 8) Customer Communication Module Unit Number $61 = CCM
6, 7	PID
8, 9	Data value of parameter. Data value may be from 1 through 27 bytes. This example shows two bytes.
10	Checksum of message followed by an ASCII carriage return ($0D)

See M5X Example section, "Monitoring Generator Phase", Step 2.

Fault Identifiers (FID)

The following chart contains the Fault Identifiers listed previously for various PID's.

FAULT IDENTIFIERS (FID)							
FID	Signed Byte	Unsigned Byte	Signed Word	Unsigned Word	Signed Long Word	Unsigned long Word	Fault Description
0 - 1	$80 - $81	$E0 - $E1	$8000 - $8001	$FFE0 - $FFE1	$80000000 - $80000001	$FFFFFFE0 - $FFFFFFE1	Not used
2	$82	$E2	$8002	$FFE2	$80000002	$FFFFFFE2	Data erratic, intermittent or incorrect
3	$83	$E3	$8003	$FFE3	$80000003	$FFFFFFE3	Shorted high or open circuit
4	$84	$E4	$8004	$FFE4	$80000004	$FFFFFFE4	Shorted low
5	$85	$E5	$8005	$FFE5	$80000005	$FFFFFFE5	Open circuit or current below normal
6	$86	$E6	$8006	$FFE6	$80000006	$FFFFFFE6	Current above normal or grounded circuit
7	$87	$E7	$8007	$FFE7	$80000007	$FFFFFFE7	Not used
8	$88	$E8	$8008	$FFE8	$80000008	$FFFFFFE8	Abnormal frequency, pulse width, or period
9	$89	$E9	$8009	$FFE9	$80000009	$FFFFFFE9	Abnormal update
10	$8A	$EA	$800A	$FFEA	$8000000A	$FFFFFFEA	Not used
11	$8B	$EB	$800B	$FFEB	$8000000B	$FFFFFFEB	Failure mode not identified
12	$8C	$EC	$800C	$FFEC	$8000000C	$FFFFFFEC	Bad device or component
13 - 15	$8D - $8F	$ED - $EF	$800D - $800F	$FFED - $FFEF	$8000000D - $8000000F	$FFFFFFED - $FFFFFFEF	Not used
16	$90	$F0	$8010	$FFF0	$80000010	$FFFFFFF0	Parameter not available
17	$91	$F1	$8011	$FFF1	$80000011	$FFFFFFF1	Module not responding
18	$92	$F2	$8012	$FFF2	$80000012	$FFFFFFF2	Sensor supply fault
19 - 31	$93 - $9F	$F3 - $FF	$8013 - $801F	$FFF3 - $FFFF	$80000013 - $8000001F	$FFFFFFF3 - $FFFFFFFF	Not used

Parameter Identifier (PID) for CCM (MID $61)

Each Parameter Identifier (PID) has a one or two byte identifier (given in hexadecimal). The PID is followed by one or two data bytes. For example, the CCM Error Code PID is $00 $82. It is followed by two bytes of data (ab) that contain the CCM fault information. Data bits are given in binary form unless the number is preceeded by "$". All data is sent with the most significant byte first.

The following chart is a quick reference list of the Parameter Identifiers (PID) along with a brief description.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS

PID	Description
$00 $0D a	Remote Fault Reset Used to reset faults on the CCM.
$00 $80 aabbcc	Device ID Code Used to read the device ID code from the CCM as well as from other components on the data link. Each pair of bytes (aa, bb, cc) is sent LSB first.
$00 $82 a	CCM Error Codes Used to read the CCM error codes.
$AA $12 a	CCM Communication Rate Change Enable Used to determine if the CCM is connected to the host computer directly or remotely using a modem. It is also used to enable or disable the host computers ability to change the communication rate of the RS-232C serial port.
$AA $87 aaaaaaaa	Access Level 1 Password Used to read or program the Level 1 Password.
$AA $88 aaaaaaaa	Access Level 2 Password Used to read or program the Level 2 Password.
$AA $89 aaaaaaaa	Access Level 3 Password Used to read or program the Level 3 Password.
$AA $8A aaaaaaaa	Login Password Password used to log in when host device is connecting to the CCM.
$F0 $12 a	Security Access Level Used to read or program the password level.
$F6 $01 ab	CCM RS-232C Serial Port Configuration Used to read or program RS-232C port configuration on the CCM.
$F8 $14 aaaaa aaaaa	Application Software Part Number Used to read and write the application software part number for the CCM.

Remote Fault Reset $00 $0D a

Used to reset faults on the CCM.

(a)	$00 - $7F = Retain current CCM inactive fault status $80 - $FF = Reset CCM inactive fault

Device ID Code $00 $80 aabbcc

Used to read the device ID code from the CCM as well as other components on the data link. Each pair of bytes (aa, bb, cc) is sent LSB first.

(aa)	Module ID: will always equal $61, data will be sent as $61 $00
(bb)	Service Tool Support Change Level: $01, data will be sent as $01 $00
(cc)	Application type: $FF $E0, data will be sent as $E0 $FF

Note: Device ID Code cannot be read from the older version of CCM (Caterpillar part number 117-6170).

CCM Error Codes $00 $82 ab

Used to read the CCM Error Codes.

a	bit 1 = Reserved
(b)[1]	Fault Code Status bit 8 1 = RS-232C link message fault exists bit 7 1 = Miscellaneous Cat Data Link fault bit 6 1 = Invalid Cat Data message fault bit 5 1 = Internal buffer overflow on RS-232C or Cat Data link fault bit 4 1 = RS-232C short circuit fault bit 3 1 = Memory back-up battery is weak bit 2 1 = M5X message error (checksum or byte count error) bit 1 1 = EEPROM fault

[1] A value of 0 (zero) in bits 1 through 8 indicates that particular fault does not exist.

CCM Communication Rate Change Enable
$AA $12 a

Used to determine if the CCM is connected to the host computer directly or remotely using a modem. It is also used to enable or disable the host computer's ability to change the communication rate of the RS-232C serial port.

(a)	bit 1 0 = Direct connect 1 = Modem connect bit 2 0 = Enable communication rate change 1 = Disable communication rate change bit 3 0 = login password required 1 = login password not required bit 4 = Reserved

Access Level 1 Password
$AA $87 aaaaaaaa

Used to read or program the Level 1 Password.

(aaaaaaaa)	Level 1 password in printable ASCII upper and lower case alphanumeric characters, and including "_" (underscore) and "." (period), Valid password lengths are 0, or from 6 to 8.

Access Level 2 Password
$AA $88 aaaaaaaa

Used to read or program the Level 2 Password.

(aaaaaaaa)	Level 2 password in printable ASCII upper and lower case alphanumeric characters, and including "_" (underscore) and "." (period), Valid password lengths are 0, or from 6 to 8.

Access Level 3 Password
$AA $89 aaaaaaaa

Used to read or program the Level 3 Password.

(aaaaaaaa)	Level 3 password in printable ASCII upper and lower case alphanumeric characters, and including "_" (underscore) and "." (period), Valid password lengths are 0, or from 6 to 8.

Login Password
$AA $8A aaaaaaaa

Password used to login when host device is connecting to the CCM.

(aaaaaaaa)	Login password in printable ASCII upper and lower case alphanumeric characters, and including "_" (underscore) and "." (period), Valid password lengths are 0, or from 6 to 8.

Security Access Level
$F0 $12 a

Used to read or program the security level.

(a)	$00 = Security level 00 $01 = Security level 01 $02 = Security level 02 $03 = Security level 03

NOTE: User can write this parameter only at a level equal to or less than the logged in security level.

CCM RS-232C Serial Port Configuration
$F6 $01 ab

Used to program RS-232C port configuration on the CCM.

(a)	bits 7,8 Not used bit 6 0 = 1 Stop bit 1 = 2 Stop bits bit 5 0 = No echo 1 = Echo enabled bits 4 - 1 0110 = 1200 baud 1000 = 2400 baud 1010 = 4800 baud 1100 = 9600 baud 1101 = 19200 baud
(b)	bit 8 Not used bits 7 - 6 10 = 7 data bits 11 = 8 data bits bits 5 - 3 000 = No parity 001 = Odd parity 011 = Even parity bits 2-1 Not used

Application Software Part Number
$F8 $14 aaaaaaaaaa

Used to read the application software part number of the CCM.

(aaaaaaaaaa)	Application software part number in printable ASCII (part numbers less than 10 characters are padded with an ASCII space $20 at the beginning of part number).

NOTE: Application software part number cannot be read from the older version of CCM (Caterpillar part number 117-6170).

RS-232C Communication Protocol for Customized EMCP II Systems

PID Security Levels

The following chart defines the PID's within each security level for EMCP II applications.

PID SECURITY LEVELS	
Level No.	**PID**
0	
1	$00 $0D (R), $00 $40 (R), $00 $42 (R), $00 $44 (R), $00 $54 (R), $00 $5E (R), $00 $80 (R) $00 $82 (R), $00 $83 (R), $00 $84 (R), $F0 $13 (R), F0 $14 (R), $F0 $2A (R), $F0 $8F (R), $F0 $B0 (RW), $F0 $B1 (R), $F0 $B2 (R), $F0 $B3 (R), $F0 $B4 (R), $F1 $D3 (R), $F1 $D4 (R), $F1 $D5 (R), $F1 $D6 (R), $F2 $13 (R), $F2 $CB (R), $F2 $CC (R), $F2 $D6 (R), $F2 $D7 (R), $F4 $40 (R), $F4 $41 (R), $F4 $42 (R), $F4 $43 (R), $F4 $44 (R), $F4 $45 (R), $F4 $46 (R), $F4 $47 (R), $F4 $48 (R), $F4 $49 (R), $F4 $4A (R), $F4 $4B (R), $F4 $4C (R), $F4 $4D (R), $F4 $60 (R), $F4 $61 (R), $F4 $62 (R), $F4 $63 (R), $F4 $64 (R), $F4 $65 (R), $F4 $66 (R), $F4 $67 (R), $F4 $68 (R), $F4 $69 (R), $F4 $6A (R), $F4 $6B (R), $F4 $6C (R), $F4 $6D (R), $F4 $C3 (R), $F4 $C4 (R), $F4 $C7 (R), $F4 $C8 (R), $F4 $C9 (R), $F4 $CA (R), $F4 $CB (R), $F4 $CF (R), $F4 $D0 (R), $F4 $D1 (R), $F4 $D2 (R), $F5 $0B (R), $F5 0C (R), $F5 $0D (R), $F5 $3E (R), $F5 $57 (R), $F8 $14 (R), $FC $0D (R), $FC $0F (R), $FC $10 (R), $FC $11 (R), $FC $12 (R), $FC $13 (R), $FC $14 (R), $FC $15 (R), $FC $16 (R), $FC $17 (R), $FC $18 (R), $FC $19 (R), $FC $1A (R), $FC 1B (R), $FC $1C (R), $FC $1D (R), $FC $1E (R), $FC $1F (R)
2	$00 $0D (W), $00 $83 (W), $F0 $B1 (W), $F0 $B2 (W), $F2 $13 (W), $F2 $CC (W), $F4 $4D (W), $FC $0D (W), $FC $10 (W),
3	

NOTE: R = Read. W = Write.

Parameter Identifiers (PID) for EMCP II (MID $58 - $5F)

Each Parameter Identifier (PID) has a one or two byte identifier (given in hexadecimal). The PID is followed by one or more data bytes. For example, the Relay Control PID is $F4 $4C. It is followed by two bytes of data (aa) that contain the status of the Genset Status Control (GSC) relays. Data bits are given in binary form unless the number is preceded by "$". All data is sent with the most significant byte first.

The following chart is a quick reference list of the Parameter Identifiers (PID) along with a brief description.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS	
PID	**Description**
$00 $0D a	Remote Fault Reset Used to read the status of or reset inactive shutdown and alarm faults on the GSC.
$00 $40 aa	Generator Set Engine RPM Used to read the genset engine rpm.
$00 $42 aa	Generator Set Ring Gear Teeth Setpoint Used to read the number of ring gear teeth the GSC uses to calculate engine speed.
$00 $44 aa	Engine Coolant Temperature (°C) Used to read the temperature of the engine coolant.
$00 $54 aa	Engine Oil Pressure kPa Used to read the oil pressure of the engine in kPa.
$00 $5E aa	Generator Set Hourmeter Used to read number of hours the genset has run.
$00 $80 aabbcc	Device ID Code Used to read the device ID code from components on the data link. Each pair of bytes (aa, bb, cc) is sent LSB first.
$00 $82 aab [c]	GSC Fault Log Codes, Status, and Number of Occurrences Used to read component identifier (CID), status (active or inactive) of diagnostic codes stored in the GSC fault log, and number of occurrences.
$00 $83 aab	GSC Fault Log Request for Additional Data Used to request additional information about a given logged diagnostic code or to clear a particular diagnostic code.
$00 $84 aab [cddee]	GSC Fault Log Response for Additional Information Used to acknowledge the diagnostic codes being cleared in the GSC fault log or to supply additional information about a given diagnostic code requested by PID $83.
$F0 $13 a	System Battery Voltage Used to read the system battery voltage of a genset.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F0 $14 a	GSC Cooldown Timer Setpoint Used to read the amount of time the GSC allows the engine to run after a normal shutdown is initiated.
$F0 $2A a	Remote Start Status Used to read the status of the remote start input of the GSC.
$F0 $8F a	Engine Control Switch Position Used to read the status of the Engine Control Switch (ECS).
$F0 $B0 a	Generator Phase Select Used to read or select what generator phase is being monitored.
$F0 $B1 a	Remote Emergency Stop Used to read the status of or request a remote emergency stop.
$F0 $B2 a	Cooldown Override Control Used to read the status of or select a shutdown that aborts the cooldown timer.
$F0 $B3 a	Generator AC Voltage Full Scale and External Potential Transformer Setpoint Used to read the AC full scale voltage and the ratio of the external potential transformer.
$F0 $B4 a	Generator AC Current Full Scale Setpoint Used to read the AC full scale current.
$F1 $D3 a	Generator Phase A Power Factor Lead/ Lag Status Used to read the lead or lag status of the phase current versus the phase voltage for phase A.
$F1 $D4 a	Generator Phase B Power Factor Lead/Lag Status Used to read the lead or lag status of the phase current versus the phase voltage for phase B.
$F1 $D5 a	Generator Phase C Power Factor Lead/Lag Status Used to read the lead or lag status of the phase current versus the phase voltage for phase C.
$F1 $D6 a	Generator Average Power Factor Lead/Lag Status Used to read the lead or lag status of the average power factor lead or lag status of the average power factor of the generator.
$F2 $13 a	Remote Start Initiate Used to read the status of or start or stop the engine remotely.
$F2 $CB a	EPG Circuit Breaker Status (GSC+P only) Used to read the status of the breaker.
$F2 $CC a	Remote Generator Synchronizer Control (GSC+P only) Used to read and program the synchronization function to be performed.
$F2 $D6 a	Remote Synchronization Control Readiness (GSC+P only) Used to read if the remote synchronization is available. If it is not available, used to read the reason why.
$F2 $D7 a	Generator Synchronizer Control Status (GSC+P only) Used to read the status of the synchronizer control system.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F4 $40 aa	Right Exhaust Temperature (GSC+) Used to read the temperature of the exhaust air on the right side of the engine.
$F4 $41 aa	Left Exhaust Temperature (GSC+) Used to read the temperature of the exhaust air on the left side of the engine.
$F4 $42 aa	Generator RMS Voltage Phase A-B (GSC+) Used to read the RMS voltage from phase A to phase B.
$F4 $43 aa	Generator RMS Voltage Phase B-C (GSC+) Used to read the RMS voltage from phase B to phase C.
$F4 $44 aa	Generator RMS Voltage Phase C-A (GSC+) Used to read the RMS voltage from phase C to phase A.
$F4 $45 aa	Generator RMS Voltage Phase A to Neutral (GSC+) Used to read the RMS voltage from phase A to neutral.
$F4 $46 aa	Generator RMS Voltage Phase B to Neutral (GSC+) Used to read the RMS voltage from phase B to neutral.
$F4 $47 aa	Generator RMS Voltage Phase C to Neutral (GSC+) Used to read the RMS voltage from phase C to neutral.
$F4 $48 aa	Generator Phase A RMS Current (GSC+) Used to read the phase A RMS current.
$F4 $49 aa	Generator Phase B RMS Current (GSC+) Used to read the phase B RMS current.
$F4 $4A aa	Generator Phase C RMS Current (GSC+) Used to read the phase C RMS current.
$F4 $4B aa	Generator Frequency Used to read the generator output frequency.
$F4 $4C aa	GSC Relay Status Used to read the status of GSC relays.
$F4 $4D aa	GSC Relay Control Used to read the status of or control the GSC relays.
$F4 $60 aa	GSC Alarm Status Used to read status of GSC alarm faults.
$F4 $61 aa	GSC Shutdown Status Used to read status of GSC shutdown faults.
$F4 $62 aa	GSC Spare Fault Alarm Status Used to read status of spare fault alarms.
$F4 $63 aa	GSC Spare Fault Shutdown Status Used to read status of spare fault shutdowns.
$F4 $64 aa	Generator Line-Line Voltage Used to read AC generator voltage of a pre-selected phase. PID $F0 $B0 is used to select generator phase.
$F4 $65 aa	Generator Line Current Used to read AC generator current of a selected phase. PID $F0 $B0 selects generator phase.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F4 $66 aa	Engine Overspeed Setpoint Used to read setpoint where GSC declares an overspeed fault to exist.
$F4 $67 aa	Engine Oil Step Speed Setpoint Used to read the speed the GSC uses to distinguish between rated speed and idle speed when a low engine oil pressure fault occurs.
$F4 $68 aa	Low Engine Oil Pressure at Rated Speed Setpoint Used to read the setpoint where the GSC declares a low oil pressure fault to exist at rated speed.
$F4 $69 aa	Low Engine Oil Pressure at Idle Speed Setpoint Used to read the setpoint where the GSC declares a low oil pressure fault to exist at idle speed.
$F4 $6A aa	High Engine Coolant Temperature Setpoint Used to read the setpoint where the GSC declares a high coolant temperature fault exists.
$F4 $6B aa	Low Engine Coolant Temperature Setpoint Used to read the setpoint where the GSC declares a low coolant temperature alarm exists.
$F4 $6C aa	GSC Configuration Used to read GSC setpoints.
$F4 $6D aa	Remaining Cooldown Time Used to read the amount of time left in the GSC cooldown period before the engine is shut down.
$F4 $C3 aa	Generator Average RMS Voltage (GSC+) Used to read the average RMS voltage being delivered by the generator.
$F4 $C4 aa	Generator Total RMS Current (GSC+) Used to read to the total RMS current being delivered by the generator.
$F4 $C7 aa	Generator Power (Percent Of Rated, GSC+) Used to read the real power delivered by the generator as a percentage of the rated power.
$F4 $C8 aa	Generator Phase A Power Factor (GSC+) Used to read the generator phase A power factor.
$F4 $C9 aa	Generator Phase B Power Factor (GSC+) Used to read the generator phase B power factor.
$F4 $CA aa	Generator Phase C Power Factor (GSC+) Used to read the generator phase C power factor.
$F4 $CB aa	Generator Average Power Factor (GSC+) Used to read the generator average power factor.
$F4 $CF aa	Generator Bus Frequency (GSC+P only) Used to read the frequency of the generator bus.
$F4 $D0 aa	Generator Bus RMS Voltage (GSC+P only) Used to read the RMS voltage of the generator bus.
$F4 $D1 aa	Generator Set Control Output Status (GSC+) Used to read the status of the outputs on the generator set control.
$F4 $D2 aa	Generator Set Shutdown Status - Extension # 1 (GSC+) Used to read the status of the generator set shutdowns. This is an extension to the list of shutdowns in PID $F4 $61.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F5 $0B aa	Cycle Crank Time Setpoint Used to read the amount of time the GSC allows the engine to crank and then to rest the starting motor during a single crank cycle.
$F5 $0C aa	GSC Total Crank Time Setpoint Used to read the elapsed time when the GSC declares an overcrank fault to exist.
$F5 $0D aa	GSC Crank Terminate Speed Setpoint Used to read engine speed when the GSC will disengage starter motor during engine cranking.
$F5 $3E aa	Engine Oil Temperature (GSC+) Used to read the oil temperature in the engine.
$F5 $57 aa	Bus to Generator Phase Difference (GSC+P only) Used to read the phase difference between the bus and the generator.
$F8 $14 aaaaa aaaaa	Application Software Part Number Used to read the application software part number of the GSC. (Personality Module)
$FC $0D abcd	Spare Outputs (GSC+) Used to read or change the state of the spare output of the GSC+.
$FC $0F aaaa	Generator Total Real Power (GSC+) Used to read the total real power being delivered by the generator.
$FC $10 abcd	Relay Driver Module Relay State Used to read or change the state of outputs or relays on the Relay Driver Module.
$FC $11 aaaa	Generator Phase A Real Power (GSC+) Used to read the real power delivered by phase A of the generator.
$FC $12 aaaa	Generator Phase B Real Power (GSC+) Used to read the real power delivered by phase B of the generator.
$FC $13 aaaa	Generator Phase C Real Power (GSC+) Used to read the real power delivered by phase C of the generator.
$FC $14 aaaa	Generator Phase A Reactive Power (GSC+) Used to read the reactive power delivered by phase A of the generator.
$FC $15 aaaa	Generator Phase B Reactive Power (GSC+) Used to read the reactive power delivered by phase B of the generator.
$FC $16 aaaa	Generator Phase C Reactive Power (GSC+) Used to read the reactive power delivered by phase C of the generator.
$FC $17 aaaa	Generator Total Reactive Power (GSC+) Used to read the total reactive power delivered by the generator.
$FC $18 aaaa	Generator Phase A Apparent Power (GSC+) Used to read the apparent power delivered by phase A of the generator.
$FC $19 aaaa	Generator Phase B Apparent Power (GSC+) Used to read the apparent power delivered by phase B of the generator.
$FC $1A aaaa	Generator Phase C Apparent Power (GSC+) Used to read the apparent power delivered by phase C of the generator.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$FC $1B aaaa	Generator Total Apparent Power (GSC+) Used to read the total apparent power delivered by the generator.
$FC $1C aaaa	Generator Total kW-hours (GSC+) Used to read the kilowatt-hours which have been accumulated by the generator.
$FC $1D aaaa	Generator Total kVAR-hours (GSC+) Used to read the kiloVAR-hours which have been accumulated by the generator.
$FC $1E abcd	Generator Shutdown Status (GSC+) Used to read the reason(s) for the GSC+ fault shutdown being ON.
$FC $1F abcd	Generator Alarm Status (GSC+) Used to read the reason(s) for the GSC+ fault alarm being ON.

Remote Fault Reset $00 $0D a

Used to read the status of or reset inactive shutdown and alarm faults on the GSC.

(a)	$00 - $7F = Retain current GSC inactive fault status $80 - $FF = Reset GSC inactive fault

Generator Set Engine RPM $00 $40 aa

Used to read the genset engine rpm.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 16383.5 rpm $0000 - $7FFF is valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Set Ring Gear Teeth Setpoint $00 $42 aa

Used to read the number of ring gear teeth the GSC uses to calculate engine speed.

(aa)	Resolution : 1 tooth per bit Data range : 0 through 65535 teeth $0000 - $FFFF is valid data range

Engine Coolant Temperature (°C) $00 $44 aa

Used to read the temperature of the engine coolant.

(aa)	Resolution: 1°C per bit Data range: –32736 through –1°C or 0 through 32767 °C $8020 - $FFFF is valid negative data range $0000 - $7FFF is valid positive data range $8000 - $801F are Fault Identifiers (FID)[1].

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Engine Oil Pressure kPa $00 $54 aa

Used to read the oil pressure of the engine in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $0000 - $7FFF is valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Set Hourmeter $00 $5E aa

Used to read number of hours the genset has run.

(aa)	Resolution : 1 hour per bit Data range : 0 through 65535 hours[1] $0000 - $FFFF is valid data range

[1] The number of hours the genset has run is determined by the GSC. The PID is limited to 65535 hours . The actual number of operating hours may be greater. When the GSC hourmeter reading is greater than 65535 hours, the value for PID $00 $5E will always be 0 hours.

Device ID Code $00 $80 aabbcc

Used to read the device ID code from the components on the data link. Each pair of bytes (aa, bb, cc) is sent LSB first.

(aa)	Module ID: will always equal $58 - $5F (for example: when MID = $58, data will be sent as $58 $00)
(bb)	Module Change Level: $00 = basic version of GSC; $01 = RDM; $10 = GSC+ (for example: when change level = $10, data will be sent as $10, $00)
(cc)	Application type: For EMCP II will always be $60 for generator sets (for example: application type = $60, data will be sent as $60 $00)

Note: Device ID Code cannot be read from the older version of CCM (Caterpillar part number 117-6170).

GSC Fault Log Codes, Status, and Number of Occurrences $00 $82 aab [c] . . . aab [c]

Used to read up to 9 component identifier (CID), status (active or inactive) of diagnostic codes stored in the GSC fault log, and number of occurrences.

(a)	Upper byte of CID
(a)	Lower byte of CID
(b)	Fault Code Status bit 8 0 = Count not included 1 = Count is included bit 7 0 = Fault is active 1 = Fault is inactive bit 6 0 = Fault is logged 1 = Fault is not logged bit 5 0 = Standard FMI 1 = Extended FMI bits 4-1 Failure Mode Identifier (FMI) of a fault code
(c)	Occurrence count for fault code, optional as defined by bit 8

GSC Fault Log Request for Additional Data $00 $83 aab

This PID should be used only for requesting additional information about a given logged diagnostic code or to clear a particular diagnostic code. Use IID 00 Special Parameter Command to request this PID. Use the $00 $82 PID to request preliminary information, such as existence of active or inactive diagnostic codes.

Refer to M5X Communication Protocol Programming Examples section, "Reading Faults from EMCP II GSC", Step 3.

(a)	Upper byte of CID Component Identifier when more information is being requested, or is being cleared
(a)	Lower byte of CID Component Identifier when more information is being requested, or is being cleared
(b)	Information Requested bit 8, 7 00 = Request ASCII descriptive message for given diagnostic code 01 = Request to clear given diagnostic code in GSC fault log 10 = Request to clear all diagnostic codes in GSC fault log 11 = Request additional diagnostic information about given diagnostic code bit 6, 5 Not used bits 4-1 Failure Mode Identifier (FMI) of a fault code

GSC Fault Log Response for Additional Information $00 $84 aab [cddee]

Used to acknowledge the diagnostic codes being cleared in the GSC fault log or to supply additional information about a given diagnostic code requested by PID $83.

(a)	Upper byte of CID Component Identifier receiving the response
(a)	Lower byte of CID Component Identifier receiving the response
(b)	Information Requested bits 8, 7 Response Identifier 01 = Count has been cleared for given CID 10 = All counts have been cleared 11 = Message contains additional information for given diagnostic code bit 6 0 = Request to clear logged fault granted 1 = Request to clear logged fault denied bits 5-1 Failure Mode Identifier (FMI) fault code
(c)	Number of occurrences[1] (MSB first)
(dd)	Time of first occurrence[1] (MSB first)
(ee)	Time of last occurrence[1] (MSB first)

[1] Bytes c, dd, and ee are omitted, if the response identifier is 01 or 10. Its format is $00 $84 in aab.

System Battery Voltage $F0 $13 a

Used to read system battery voltage of a genset.

(a)	Resolution: 0.5 volts per bit Data Range: 0.0 volts through 127.5 volts $00 - $FF is the valid data range

GSC Cooldown Timer Setpoint $F0 $14 a

Used to read the amount of time the GSC allows the engine to run after a normal shutdown is initiated.

(a)	Resolution: 1 minute per bit Data range: 0 through 223 minutes $00 - $DF is the valid data range

Remote Start Status $F0 $2A a

Used to read the status of the remote start input of the GSC.

(a)	$00 = Remote start is OFF $01- $7F = Remote start is ON $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Note: Only a remote initiate contact closure to the GSC will activate this PID (not a remote start signal from the CCM).

Engine Control Switch Position $F0 $8F a

Used to read status of Engine Control Switch (ECS)

(a)	$00 = Off/reset $02 = Start $03 = Stop $04 = Auto $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase Select $F0 $B0 a

Used to read or select what generator phase is being monitored.

(a)	$00 = Phase A-B voltage, phase A current $01 = Phase B-C voltage, phase B current $02 = Phase C-A voltage, phase C current $03 - $FF = Undefined

Remote Emergency Stop $F0 $B1 a

Used to read the status of or request a remote emergency stop.

(a)	$00 = Remote emergency stop is OFF $01 - $7F = Remote emergency stop is ON $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Note: Engine Control Switch must be in AUTO.

Cooldown Override Control $F0 $B2 a

Used to read the status of or select a shutdown that aborts the cooldown timer.

(a)	$00 = Continue cooldown $01 - $7F = Abort cooldown $80 - 9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator AC Voltage Full Scale and External Potential Transformer Setpoint $F0 $B3 a

Used to read the AC full scale voltage and the ratio of the external potential transformer.

(a)	$00 = 700 volts full scale, jumper installed, no external PT $01 = 150 volts full scale, no jumper, no external PT $02 = 300 volts full scale, no jumper, 2:1 PT $03 = 500 volts full scale, no jumper, 3.33:1 PT $04 = 600 volts full scale, no jumper, 4:1 PT $05 = 750 volts full scale, no jumper, 5:1 PT $06 = 3.0k volts full scale, no jumper, 20:1 external PT $07 = 4.5k volts full scale, no jumper, 30:1 external PT $08 = 5.25k volts full scale, no jumper, 35:1 external PT $09 = 9.0k volts full scale, no jumper, 60:1 external PT $0A = 15.0k volts full scale, no jumper, 100:1 external PT $0B = 18.0k volts full scale, no jumper, 120:1 external PT $0C = 30.0k volts full scale, no jumper, 200:1 external PT

Generator AC Current Full Scale Setpoint $F0 $B4 a

Used to read the AC full scale current.

(a)	$00 = 75:5, 75 Amps full scale $01 = 100:5, 100 Amps full scale $02 = 150:5, 200 Amps full scale $03 = 200:5, 200 Amps full scale $04 = 300:5, 300 Amps full scale $05 = 400:5, 400 Amps full scale $06 = 600:5, 600 Amps full scale $07 = 800:5, 800 Amps full scale $08 = 1000:5, 1000 Amps full scale $09 = 1200:5, 1200 Amps full scale $0A = 1500:5, 1500 Amps full scale $0B = 2000:5, 2000 Amps full scale $0C = 2500:5, 2500 Amps full scale $0D = 3000:5, 3000 Amps full scale $0E = 4000:5, 4000 Amps full scale

Generator Phase A Power Factor Lead/Lag Status (GSC+) $F1 $D3 a

Used to read the lead or lag status of the phase current versus the phase voltage for phase A.

(a)	$00 = current lags voltage $01= current leads voltage $02-$DF = undefined $E0-$FF = Fault ID's

Generator Phase B Power Factor Lead/Lag Status (GSC+) $F1 $D4 a

Used to read the lead or lag status of the phase current versus the phase voltage for phase B.

(a)	$00 = current lags voltage $01= current leads voltage $02-$DF = undefined $E0-$FF = Fault ID's

Generator Phase C Power Factor Lead/Lag Status (GSC+) $F1 $D5 a

Used to read the lead or lag status of the phase current versus the phase voltage for phase C.

(a)	$00 = current lags voltage $01= current leads voltage $02-$DF = undefined $E0-$FF = Fault ID's

Generator Average Power Factor Lead/Lag Status (GSC+) $F1 $D6 a

Used to read the lead or lag status of the average power factor lead or lag status of the average power factor of the generator.

(a)	$00 = current lags voltage $01= current leads voltage $02-$DF = undefined $E0-$FF = Fault ID's

Remote Start Initiate $F2 $13 a

Used to read the status of or start or stop the engine remotely.

(a)	$00 = Start engine $7F = Stop engine

EPG Circuit Breaker Status (GSC+P only) $F2 $CB a

Used to read the status of the breaker.

(a)	$00 = Breaker open $01 = Breaker closed $E4 = Breaker sensor input shorted low

Remote Generator Synchronizer Control (GSC+P only) $F2 $CC a

Used to read and program the synchronization function to be performed.

(a)	$00 = Off $01 = Remote synchronization test $02 = Automatic synchronization

Remote Synchronization Control Readiness (GSC+P only) $F2 $D6 a

Used to read if the remote synchronization is available. If it is not available, used to read the reason.

(a)	$00 = Not installed $01 = Ready for remote command $02 = Synchronizing switch not in auto $03 = Engine control switch not in auto $04 = Engine was not started remotely $05 = Engine not running

Generator Synchronizer Control Status (GSC+P only) $F2 $D7 a

Used to read the status of the synchronizer control system.

(a)	$00 = Not installed $01 = Inactive $02 = Semiautomatic paralleling $03 = Permissive paralleling $04 = Remote synchronization testing $05 = Synchronizing $06 = Synchronization system alarm or diagnostic $07 = Remote synchronization testing passed $08 = Dead bus time delay $09 = Closing to dead bus

Right Exhaust Temperature (GSC+) $F4 $40 aa

Used to read the temperature of the exhaust air on the right side of the engine.

(aa)	Resolution: 1 degree C/bit Valid Data Range: -32736 to +32767 degree C $8020 - $7FFF is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Left Exhaust Temperature (GSC+) $F4 $41 aa

Used to read the temperature of the exhaust air on the left side of the engine.

(aa)	Resolution: 1 degree C/bit Valid Data Range: -32736 to +32767 degree C $8020 - $7FFF is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator RMS Voltage Phase A-B (GSC+) $F4 $42 aa

Used to read the RMS voltage from phase A to phase B.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator RMS Voltage Phase B-C (GSC+) $F4 $43 aa

Used to read the RMS voltage from phase B to phase C.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator RMS Voltage Phase C-A (GSC+) $F4 $44 aa

Used to read the RMS voltage from phase C to phase A.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator RMS Voltage Phase A to Neutral (GSC+) $F4 $45 aa

Used to read the RMS voltage from phase A to neutral.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator RMS Voltage Phase B to Neutral (GSC+) $F4 $46 aa

Used to read the RMS voltage from phase B to neutral.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator RMS Voltage Phase C to Neutral (GSC+) $F4 $47 aa

Used to read the RMS voltage from phase C to neutral.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase A RMS Current (GSC+) $F4 $48 aa

Used to read the phase A RMS current.

(aa)	Resolution: 1 A(rms)/bit Valid Data Range: 0 - 65503 A(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase B RMS Current (GSC+) $F4 $49 aa

Used to read the phase B RMS current.

(aa)	Resolution: 1 A(rms)/bit Valid Data Range: 0 - 65503 A(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase C RMS current (GSC+) $F4 $4A aa

Used to read the phase C RMS current.

(aa)	Resolution: 1 A(rms)/bit Valid Data Range: 0 - 65503 A(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Frequency $F4 $4B aa

Used to read the generator output frequency.

(aa)	Resolution: 0.1 Hz per bit Data range: 0 through 6550.3 Hz $0000 - $FFDF is the valid data range

GSC Relay Status $F4 $4C aa

Used to read the status of GSC relays.

16, 15	Electronic Governor Relay
14, 13	Program Spare Relay
12, 11	Run Relay
10, 9	Genset Fault Relay
8, 7	Starter Motor Relay
6, 5	Crank Terminate Relay
4, 3	Fuel Control Relay
2, 1	Air Shutoff Relay

For each group of bits: 00 = Off/de-energized; 01 = On/energized; 11 = Relay not installed.

GSC Relay Control $F4 $4D aa

Used to read the status of or control the GSC relays.

16, 15	Electronic Governor Relay
14, 13	Programmable Spare Relay
12, 11	Run Relay[1]
10, 9	Genset Fault Relay
8, 7	Starter Motor Relay[1]
6, 5	Crank Terminate Relay[1]
4, 3	Fuel Control Relay[1]
2, 1	Air Shutoff Relay[1]

For each group of bits: 00 = Off/de-energized; 01 = On/energized; 11 = Relay not installed, keep same state.

[1] Cannot control with CCM.

NOTE: Must read $F4 $4C to determine the true status. $F4 $4D echoes back the status requested by $F4 $4D. Some relays cannot be controlled by $F4 $4D, and may not change state.

NOTE: The CCM can control the electronic governor relay if actual engine oil pressure is higher than the Low Oil Pressure Idle Speed setpoint, but cannot control the electronic governor relay if engine oil pressure is not higher than this setpoint. Refer to Module SENR5809 more information on engine setpoints.

NOTE: The CCM can control the generator fault relay if no fault shutdown condition exists. If a fault condition exists, the generator fault relay will activate regardless of the CCM command. Refer to Module SENR5809 more information on engine setpoints.

GSC Alarm Status $F4 $60 aa

Used to read status of GSC alarm faults.

16 - 13	Undefined (future use)
12, 11	Engine Control Alarm
10, 9	High Oil Temperature (GSC+ only)
8, 7	Engine Control Switch not in "Auto" or "Manual"
6, 5	Low Oil Pressure
4, 3	Low Coolant Temperature
2, 1	High Coolant Temperature

For each group of bits: 00 = Alarm is OFF; 01 = Alarm is ON 10 = Undefined; 11 = Not available, or not installed.

GSC Shutdown Status $F4 $61 aa

Used to read status of GSC shutdown faults.

16, 15	Overspeed
14, 13	Overcrank
12, 11	Low Oil Pressure
10, 9	High Coolant Temperature
8, 7	Spare Fault
6, 5	Emergency Stop
4, 3	Coolant Loss
2, 1	Diagnostic Code

For each group of bits: 00 = Shutdown inactive; 01 = Shutdown active; 10 = Undefined; 11 = Not available, or not installed.

NOTE: Low oil pressure, high coolant temperature, and coolant loss faults can be overridden by correctly programming the GSC (refer to EMCP II Service Manual SENR5809). The GSC configuration byte $F4 $6C, should be requested to determine whether these faults have been overridden.

GSC Spare Fault Alarm Status $F4 $62 aa

Used to read status of spare fault alarms.

16 - 9	Undefined (future use)
8, 7	Spare Fault 4 (GSC+ only)
6, 5	Spare Fault 3
4, 3	Spare Fault 2
2, 1	Spare Fault 1

For each group of bits: 00 = Alarm is OFF; 01 = Alarm is ON; 10 = Undefined; 11 = Not available, or not installed.

GSC Spare Fault Shutdown Status $F4 $63 aa

Used to read status of spare fault shutdowns.

16 - 9	Undefined (future use)
8, 7	Spare Fault 4 (GSC+ only)
6, 5	Spare Fault 3
4, 3	Spare Fault 2
2, 1	Spare Fault 1

For each group of bits: 00 = Shutdown inactive; 01 = Shutdown active; 10 = Undefined; 11 = Not available, or not installed.

Generator Line-Line Voltage $F4 $64 aa

Used to read AC generator voltage of a pre-selected phase. PID $F0 $B0 is used to select generator phase.

(aa)	Resolution: 1 volt RMS per bit Data range: 0 through 65503 V RMS $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Line Current $F4 $65 aa

Used to read AC generator current of a selected phase. PID $F0 $B0 selects generator phase.

(aa)	Resolution: 1 Amp RMS per bit Data range: 0 through 65503 Amps RMS $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Engine Overspeed Setpoint $F4 $66 aa

Used to read setpoint where GSC declares an overspeed fault to exist.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 32751.5 rpm $0000 - $FFDF is the valid data range

Engine Oil Step Speed Setpoint $F4 $67 aa

Used to read the speed GSC uses to distinguish between rated speed and idle speed when a low engine oil pressure fault occurs.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 32751.5 rpm $0000 - $FFDF is the valid data range

Low Engine Oil Pressure at Rated Speed Setpoint $F4 $68 aa

Used to read setpoint where GSC declares a low oil pressure fault to exist at rated speed.

(aa)	Resolution: 1 kPa per bit Data range: 0 through 65503 kPa $0000 - $FFDF is the valid data range

Low Engine Oil Pressure at Idle Speed Setpoint $F4 $69 aa

Used to read setpoint where GSC declares a low oil pressure fault to exist at idle speed.

(aa)	Resolution: 1 kPa per bit Data range: 0 through 65503 kPa $0000 - $FFDF is the valid data range

High Engine Coolant Temperature Setpoint $F4 $6A aa

Used to read setpoint where GSC declares a high coolant temperature fault exists.

(aa)	Resolution: 1°C per bit Data range: 0 through 65503°C $0000 - $FFDF is the valid data range

Low Engine Coolant Temperature Setpoint $F4 $6B aa

Used to read setpoint where GSC declares a low coolant temperature alarm exists.

(aa)	Resolution: 1°C per bit Data range: 0 through 65503°C $0000 - $FFDF is the valid data range

GSC Configuration $F4 $6C aa

Used to read GSC setpoints.

(a)	Undefined
(a)	GSC Setpoints bit 8 AC metering 1 = AC metering disabled 0 = AC metering enabled bit 7 Battery system 1 = 32 volt battery system 0 = 24 volt battery system bit 6 Engine coolant loss action 1 = Shutdown override for engine coolant loss fault 0 = Shutdown enabled for engine coolant loss fault bit 5 Engine coolant loss sensor 1 = Engine coolant loss sensor installed 0 = Engine coolant loss sensor not installed bit 4 Sensor faults 1 = Shutdown enable for sensor faults 0 = Shutdown override for sensor faults bit 3 Engine coolant temperature and oil pressure faults 1 = Shutdown override for high engine coolant temperature and low engine oil pressure faults 0 = Shutdown enable for high engine coolant temperature and low engine oil pressure faults bit 2 Display units 1 = Metric units displayed for engine oil pressure and coolant temperature 0 = English units displayed for engine oil pressure and coolant temperature bit 1 Fuel system 1 = Energize to run fuel system 0 = Energize to shutdown fuel system

Remaining Cooldown Time $F4 $6D aa

Used to read the amount of time left in the GSC cooldown period before the engine is shut down.

(aa)	Resolution: 1 second per bit Data range: 0 through 65535 seconds $0000 - $FFFF is the valid data range

Generator Average RMS Voltage (GSC+) $F4 $C3 aa

Used to read the average RMS voltage being delivered by the generator.

(aa)	Resolution: 1 V(rms)/bit Valid Data Range: 0 - 65503 V(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Total RMS Current (GSC+) $F4 $C4 aa

Used to read the total RMS current being delivered by the generator.

(aa)	Resolution: 1 A(rms)/bit Valid Data Range: 0 - 65503 A(rms) $0000 - $FFDF is the valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Power (Percent Of Rated, GSC+) $F4 $C7 aa

Used to read the real power delivered by the generator as a percentage of the rated power.

(aa)	Resolution: 0.1%/bit Valid Data Range: -3273.6% to +3276.7% $8020 - $7FFF is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase A Power Factor (GSC+) $F4 $C8 aa

Used to read the generator phase A power factor.

(aa)	Resolution: 0.0001/bit Valid Data Range: -1.0000 to 1.0000 $D8F0 - $FFFF and $0000 - $2710 is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase B Power Factor (GSC+) $F4 $C9 aa

Used to read the generator phase B power factor.

(aa)	Resolution: 0.0001/bit Valid Data Range: -1.0000 to 1.0000 $D8F0 - $FFFF and $0000 - $2710 is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase C Power Factor (GSC+) $F4 $CA aa

Used to read the generator phase C power factor.

(aa)	Resolution: 0.0001/bit Valid Data Range: -1.0000 to 1.0000 $D8F0 - $FFFF and $0000 - $2710 is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Average Power Factor (GSC+) $F4 $CB aa

Used to read the generator average power factor.

(aa)	Resolution: 0.0001/bit Valid Data Range: -1.0000 to 1.0000 $D8F0 - $FFFF and $0000 - $2710 is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Bus Frequency (GSC+P only) $F4 $CF aa

Used to read the frequency of the generator bus.

(aa)	Resolution: 0.1 Hz per bit Data Range: 0 through 6550.3 Hz $0000 - $FFDF is valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Bus RMS Voltage (GSC+P only) $F4 $D0 aa

Used to read the RMS voltage of the generator bus.

(aa)	Resolution: 1 Volt per bit Data Range: 0 through 65503 V $0000 - $FFDF is valid data range $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Set Control Output Status (GSC+) $F4 $D1 aa

Used to read the status of the outputs on the generator set control.

(aa)	Bits 16-15 = Undefined, future use Bits 14-13 = Undefined, future use Bits 12-11 = Undefined, future use Bits 10-9 = Undefined, future use Bits 8-7 = Undefined, future use Bits 6-5 = Undefined, future use Bits 4-3 = Kilowatt Relay Control Output Bits 2-1 = Close Breaker Output

For each group of bits: 00 = Off/de-energized; 01 = On/energized; 10 = Output fault; 11 = Output not defined.

Generator Set Shutdown Status - Extension #1 (GSC+) $F4 $D2 aa

Used to read the status of the generator set shutdowns. This is an extension to the list of shutdowns in PID $F4 61.

(aa)	Bits 16-15: High Engine Oil Temperature Bits 14-13: Engine Control Shutdown Bits 12-11: Undefined, future use Bits 10-9: Undefined, future use Bits 8-7: Undefined, future use Bits 6-5: Undefined, future use Bits 4-3: Undefined, future use Bits 2-1: Undefined, future use

For each group of bits: 00 = Shutdown inactive; 01 = Shutdown active; 10 = Undefined; 11 = Not available, or not installed.

Cycle Crank Time Setpoint $F5 $0B aa

Used to read the amount of time the GSC allows the engine to crank and then to rest the starting motor during a single crank cycle.

(aa)	Resolution: 1 second per bit Data range: 0 through 65503 seconds $0000 - $FFDF is the valid data range

GSC Total Crank Time Setpoint $F5 $0C aa

Used to read the elapsed time when the GSC declares an overcrank fault to exist.

(aa)	Resolution: 1 second per bit Data range: 0 through 65503 seconds $0000 - $FFDF is the valid data range

GSC Crank Terminate Speed Setpoint $F5 $0D aa

Used to read engine speed when GSC will disengage starter motor during engine cranking.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 32751.5 rpm $0000 - $FFDF is the valid data range

Engine Oil Temperature (GSC+) $F5 $3E aa

Used to read the oil temperature in the engine.

(aa)	Resolution: 1 degree C/bit Valid Data Range: -32736 to +32767 degree C $8020 - $7FFF is the valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Bus to Generator Phase Difference (GSC+P only) $F5 $57 aa

Used to read the phase difference between the bus and generator.

(aa)	Resolution: 0.1 degrees per bit Data range: -360.0 to +360.0 degrees $F1F0 - $FFFF and $0000 - $0E10 is valid data range $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Application Software Part Number $F8 $14 aaaaaaaaaa

Used to read the application software part number of the GSC. (Personality Module)

(aaaaaaaaaa)	Application software part number in printable ASCII (part numbers less than 10 characters are padded with an ASCII space $20 at the beginning of part number).

Spare Outputs (GSC+) $FC $0D abcd

Used to read or change the state of the spare output of the GSC+.

(a)	Bits 32-31: Undefined, future use Bits 30-29: Undefined, future use Bits 28-27: Undefined, future use Bits 26-25: Spare Output
(b)	Bits 24-23: Undefined, future use Bits 22-21: Undefined, future use Bits 20-19: Undefined, future use Bits 18-17: Undefined, future use
(c)	Bits 16-15: Undefined, future use Bits 14-13: Undefined, future use Bits 12-11: Undefined, future use Bits 10-9: Undefined, future use
(d)	Bits 8-7: Undefined, future use Bits 6-5: Undefined, future use Bits 4-3: Undefined, future use Bits 2-1: Undefined, future use

For each group of bits: 00 = OFF/DE-ENERGIZED; 01 = ON/ENERGIZED; 10 = Output fault; 11[1] = Output not available/Don't change state

[1] When performing a parameter write ($B2) to change an individual relay's state, set all other relay bits to "11" in order to not change their state.

NOTE: The CCM can only control the spare output in an active low type of configuration. See the Service Manual module SENR5832 EMCP II+ (Spare Input/Output Programming - OP6 under the topic Service Mode) for more information.

Generator Total Real Power (GSC+) $FC $0F aaaa

Used to read the total real power being delivered by the generator.

(aaaa)	Resolution: 1 Watt/bit Valid Data Range: -2147483616 to 2147483647 Watts $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Relay Driver Module Relay State $FC $10 abcd

Used to read or change the state of outputs or relays on the Relay Driver Module.

(a)	Bits 32-31: Output 4 Bits 30-29: Output 3 Bits 28-27: Output 2 Bits 26-25: Output 1
(b)	Bits 24-23: Output 8 Bits 22-21: Output 7 Bits 20-19: Output 6 Bits 18-17: Output 5
(c)	Bits 16-15: Undefined, future use Bits 14-13: Undefined, future use Bits 12-11: Undefined, future use Bits 10-9: Output 9
(d)	Bits 8-7: Undefined, future use Bits 6-5: Undefined, future use Bits 4-3: Undefined, future use Bits 2-1: Undefined, future use

For each group of bits: 00 = OFF/DE-ENERGIZED; 01 = ON/ENERGIZED; 10 = Output fault; 11[1] = Output not available/Don't change state

[1] When performing a parameter write ($B2) to change an individual relay's state, set all other relay bits to "11" in order to not change their state.

Generator Phase A Real Power (GSC+) $FC $11 aaaa

Used to read the real power delivered by phase A of the generator.

(aaaa)	Resolution: 1 Watt/bit Valid Data Range: -2147483616 to 2147483647 Watts $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase B Real Power (GSC+) $FC $12 aaaa

Used to read the real power delivered by phase B of the generator.

(aaaa)	Resolution: 1 Watt/bit Valid Data Range: -2147483616 to 2147483647 Watts $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase C Real Power (GSC+) $FC $13 aaaa

Used to read the real power delivered by phase C of the generator.

(aaaa)	Resolution: 1 Watt/bit Valid Data Range: -2147483616 to 2147483647 Watts $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase A Reactive Power (GSC+) $FC $14 aaaa

Used to read the reactive power delivered by phase A of the generator.

(aaaa)	Resolution: 1 VAR/bit Valid Data Range: -2147483616 to 2147483647 VAR $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase B Reactive Power (GSC+) $FC $15 aaaa

Used to read the reactive power delivered by phase B of the generator.

(aaaa)	Resolution: 1 VAR/bit Valid Data Range: -2147483616 to 2147483647 VAR $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase C Reactive Power (GSC+) $FC $16 aaaa

Used to read the reactive power delivered by phase C of the generator.

(aaaa)	Resolution: 1 VAR/bit Valid Data Range: -2147483616 to 2147483647 VAR $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Total Reactive Power (GSC+) $FC $17 aaaa

Used to read the total reactive power delivered by the generator.

(aaaa)	Resolution: 1 VAR/bit Valid Data Range: -2147483616 to 2147483647 VAR $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase A Apparent Power (GSC+) $FC $18 aaaa

Used to read the apparent power delivered by phase A of the generator.

(aaaa)	Resolution: 1 VA/bit Valid Data Range: -2147483616 to 2147483647 VA $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase B Apparent Power (GSC+) $FC $19 aaaa

Used to read the apparent power delivered by phase B of the generator.

(aaaa)	Resolution: 1 VA/bit Valid Data Range: -2147483616 to 2147483647 VA $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Phase C Apparent Power (GSC+) $FC $1A aaaa

Used to read the apparent power delivered by phase C of the generator.

(aaaa)	Resolution: 1 VA/bit Valid Data Range: -2147483616 to 2147483647 VA $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Total Apparent Power (GSC+) $FC $1B aaaa

Used to read the total apparent power delivered by the generator.

(aaaa)	Resolution: 1 VA/bit Valid Data Range: -2147483616 to 2147483647 VA $80000020 - $7FFFFFFF is the valid data range $80000000 - $8000001F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Total kW-hours (GSC+) $FC $1C aaaa

Used to read the kilowatt-hours which have been accumulated by the generator.

(aaaa)	Resolution: 1 kW-hr/bit Valid Data Range: 0 - 4,294,967,263 kW-hrs $00000000 - $FFFFFFDF is the valid data range $FFFFFFE0 - $FFFFFFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Total kVAR-hours (GSC+) $FC $1D aaaa

Used to read the kiloVAR-hours which have been accumulated by the generator.

(aaaa)	Resolution: 1 kVAR-hr/bit Valid Data Range: 0 - 4,294,967,263 kVAR-hrs $00000000 - $FFFFFFDF is the valid data range $FFFFFFE0 - $FFFFFFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Generator Shutdown Status (GSC+) $FC $1E abcd

Used to read the reason(s) for the GSC+ fault shutdown being ON.

(a)	Bits 32 - 31: Undefined, future use Bits 30 - 29: Undefined, future use Bits 28 - 27: Undefined, future use Bits 26 - 25: Undefined, future use
(b)	Bits 24 - 23: Generator Freq. inconsistent w/Eng Speed Bits 22 - 21: Phase Rotation Misrnatch (GSC+P only) Bits 20 - 19: Synchronization Timeout (GSC+P only) Bits 18 - 17: Inappropriate Bus or Generator Voltage (GSC+P only)
(c)	Bits 16 - 15: Reverse Power Bits 14 - 13: Single Phase Overcurrent Bits 12 - 11: Generator Total Overcurrent Bits 10 - 9: Generator Frequency Sensing Fault
(d)	Bits 8 - 7: Overvoltage Bits 6 - 5: Undervoltage Bits 4 - 3: Overfrequency Bits 2 - 1: Underfrequency

For each group of bits: 00 = Shutdown inactive; 01 = Shutdown active; 10 = Undefined; 11 = Not available, or not installed.

Generator Alarm Status (GSC+) $FC $1F abcd

Used to read the reason(s) for the GSC+ fault alarm being ON.

(a)	Bits 32 - 31: Undefined, future use Bits 30 - 29: Undefined, future use Bits 28 - 27: Undefined, future use Bits 26 - 25: Undefined, future use
(b)	Bits 24 - 23: Generator Freq. inconsistent w/ Eng Speed Bits 22 - 21: Phase Rotation Mismatch (GSC+P only) Bits 20 - 19: Synchronization Timeout (GSC+P only) Bits 18 - 17: Inappropriate Bus or Generator Voltage (GSC+P only)
(c)	Bits 16 - 15: Reverse Power Bits 14 - 13: Single Phase Overcurrent Bits 12 - 11: Generator Total Overcurrent Bits 10 - 9: Generator Frequency Sensing Fault
(d)	Bits 8 - 7: Overvoltage Bits 6 - 5: Undervoltage Bits 4 - 3: Overfrequency Bits 2 - 1: Underfrequency

For each group of bits: 00 = Alarm inactive; 01 = Alarm active; 10 = Undefined; 11 = Not available, or not installed.

RS-232C Communication Protocol for Customized 3500B Systems

PID Security Levels

The following chart defines the PID's within each security level for 3500B applications.

NOTE: For all 3500B Write Requests (IID 34):

- For 3500B systems the CCM will not automatically respond to a Write Request with a Write Response. Therefore, a Write Request (IID 34) should always be followed with a Read Request (IID 24) for verification after approximately 1 second.
- If the written value is greater than the maximum value of the parameter, the ECM will adjust the parameter to the maximum value allowed.
- If the written value is less than the minimum value of the parameter, the ECM will adjust the parameter to the minimum value allowed.

PID SECURITY LEVELS	
Level No.	**PID**
0	
1	$00 $08 (R), $00 $15 (R), $00 $40 (R), $00 $44 (R), $00 $46 (R), $00 $4D (R), $00 $4E (R), $00 $53 (R), $00 $54 (R), $00 $55 (R), $00 $58 (R), $00 $5A (R), $00 $5B (R), $00 $5C (R), $00 $5E (R), $00 $5F (R), $00 $82 (R), $00 $83 (R), $00 $84 (R), $00 $C8 (R), $F0 $13 (R), $F0 $14 (R), $F0 $16 (R), $F0 $1B (R), $F0 $2A (R), $F0 $2C (R), $F0 $8F (R), $F0 $9C (R), $F0 $A6 (R), $F0 $A8 (R), $F0 $A9 (R), $F0 $AA (R), $F0 $AC (R), $F0 $B1 (R), $F0 $B2 (R), $F0 $B5 (R), $F0 $B6 (R), $F0 $C1 (R), $F0 $C2 (R), $F1 $18 (R), $F1 $4F (R), $F1 $89 (R), $F2 $13 (R), $F2 $4D (R), $F2 $4F (R), $F4 $0E (R), $F4 $10 (R), $F4 $11 (R), $F4 $12 (R), $F4 $15 (R), $F4 $17 (R), $F4 $19 (R), $F4 $1C (R), $F4 $1F (R), $F4 $20 (R), $F4 $40 (R), $F4 $41 (R) $F4 $5B (R), $F4 $6D (R), $F5 $08 (R), $F5 $09 (R), $F5 0A (R), $F5 $0B (R), $F5 $0D (R), $F5 $0E (R), $F5 $0F (R), $F5 $10 (R), $F5 $11 (R), $F5 $15 (R), $F5 1F (R), $F5 $20 (R), $F5 $25 (R), $F5 $3E (R), $F8 $14 (R), $F8 $1A (R), $FC $07 (R), $FC $08 (R), $FC $09 (R)
2	$00 $0D (W), $00 $83 (W), $F0 $14 (W), $F0 $1B (W), $F0 $AC (W), $F0 $B1 (W), $F0 $B2 (W), $F0 $C1 (W), $F0 $C2 (W), $F2 $13 (W), $F2 $4F (W), $F4 $5B (W), $F5 $0A (W), $F5 $0B (W), $F5 $0D (W), $F5 $10 (W), $F8 $1A (W)
3	

NOTE: R = Read. W = Write.

Parameter Identifiers (PID) for 3500B ECM's (MID $21-$26, $28-$29)

Each Parameter Identifier (PID) has a one or two byte identifier (given in hexadecimal). The PID is followed by one or two data bytes. For example, the Engine RPM PID is $00 40. It is followed by two bytes of data (aa) that contain the current engine speed. Data bits are given in binary form unless the number is preceded by "$". All data is sent with the most significant byte first.

The following chart is a quick reference list of the Parameter Identifiers (PID) along with a brief description.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS	
PID	**Description**
$00 $08 a	Engine Configuration Used to read the engine configuration.
$00 $0D a	Remote Fault Reset (Generator Set Only) Used to reset the remote E-stop shutdown.
$00 $15 a	Throttle Position Used to read the position of the throttle position sensor (speed adjust pot).
$00 $40 aa	Engine RPM Used to read the engine rpm.
$00 $44 aa	Engine Coolant Temperature Used to read the engine coolant temperature in degrees C.
$00 $46 aa	Desired Engine Speed Used to read the desired engine speed of the engine controller.
$00 $4D aa	Transmission Oil Temperature (Marine Only) Used to read the transmission oil temperature in degrees C.
$00 $4E aa	Transmission Oil Pressure (absolute) (Marine Only) Used to read the absolute transmission oil pressure of the engine in kPa.
$00 $53 aa	Atmospheric Pressure Used to read atmospheric pressure in kPa.
$00 $54 aa	Filtered Engine Oil Pressure (gauge) Used to read the gauge filtered oil pressure of the engine in kPa.
$00 $55 aa	Boost Pressure (gauge) Used to read engine boost pressure in kPa.
$00 $58 aa	Air Filter Restriction Used to read the current filter restriction in kPa of the left or right air filter. The greater of the two restrictions is displayed.
$00 $5A aa	Filtered Engine Oil Pressure (absolute) Used to read the absolute filtered engine oil pressure in kPa.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$00 $5B aa	Boost Pressure (absolute) Used to read the absolute boost pressure of the engine in kPa.
$00 $5C aa	Left Turbocharger Inlet Pressure (absolute) Used to read left turbocharger pressure in kPa.
00 $5E aa	ECM Hour Meter Used to read how many hours the engine has run.
00 $5F aa	Right Turbocharger Inlet Pressure (absolute) Used to read right turbocharger inlet pressure in kPa.
$00 $82 aab (c)	ECM Fault Codes and Status Used to read component identifier (CID), and status (active or inactive) of diagnostic codes stored in the ECM fault log.
$00 $83 aab	ECM Fault Log Request for Additional Data Used to request additional information about a given logged diagnostic code or to clear a particular diagnostic code.
$00 $84 aab [cddee]	ECM Fault Log Response for Additional Information Used to acknowledge the diagnostic codes being cleared in the ECM fault log or to supply additional information about a given diagnostic code requested by PID $83.
$00 $C8 aaaa	Total Fuel Used to read total fuel the engine has burned.
$F0 $13 a	System Battery Voltage Used to read the system battery voltage of the engine control system.
$F0 $14 a	Cooldown Duration Used to read or program the amount of time (minutes) the ECM allows the engine to run after a normal shutdown is initiated.
$F0 $16 a	Cold Mode Status Used to read the cold mode status of the engine.
$F0 $1B a	Engine Prelube Duration Used to read or program the amount of time (seconds) the ECM will prelube the engine before the crank cycle is entered.
$F0 $2A a	Remote Start Status Used to read the status of the remote start/stop switch. This data is valid only when the Engine Control switch is in the AUTO position.
$F0 $2C a	Engine Coolant Level Status Used to read the status of the engine level coolant switch. This data is read from the SEMS module.
$F0 $8F a	Engine Control Switch Position Used to read the status of the Engine Control Switch (ECS).
$F0 $9C a	Shutdown Notify Relay Status (Generator Set Only) Used to read the status of the Shutdown Notify Relay.
$F0 $A6 a	Overspeed Verify Switch Position Used to read the status of the overspeed verify switch.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F0 $A8 a	Remote E-stop Switch Position Used to read the status of the remote E-stop switch.
$F0 $A9 a	Start-up Mode Status Used to read the status of the start-up mode.
$F0 $AA a	Air Shutoff Status (Generator Set Only) Used to read the status of air shutoff system.
$F0 $AC a	Maximum Number of Crank Cycles Used to read or program the number of times the engine will try to start before an Overcrank condition is annunciated.
$F0 $B1 a	Remote Emergency Stop Used to read or request a remote emergency stop.
$F0 $B2 a	Cooldown Override Control Used to read or override the cooldown timer to 0.
$F0 $B5 a	Engine Prelube Status Used to read the status of the prelube system.
$F0 $B6 a	Engine Fuel Level Status Used to read the status of the engine fuel level switch. This data is read from the SEMS module.
$F0 $C1 a	Acceleration Delay Time (Generator Set Only) Used to read or program the time (seconds) the engine will wait at low idle before accelerating to rated speed. The engine waits at low idle until oil pressure increases to 70 kPa or until Acceleration Delay time is reached.
$F0 $C2 a	Remote Throttle Override Used by a remote communication module to read or override desired engine speed to low idle.
$F0 $F2 a	ECM in Control (Marine Only) Used to determine whether primary ECM, or backup ECM, is currently controlling the engine.
$F1 $18 a	Percent Engine Load Used to read the percentage of engine load.
$F1 $4F a	Backup ECM Status (Marine Only) Used to read whether the backup ECM is ready to take over control of the engine, should the primary ECM fail.
$F1 $89 a	Used to read the current engine power derate percentage.
$F2 $13 a	Remote Start Initiate Used to read or start or stop the engine remotely.
$F2 $4D a	Shutdown Emergency Override Switch Status (Marine Only) Used to read the state of the Shutdown Emergency Overrride Switch. The switch is used to override the derates and shutdowns to continue operation during emergency conditions.
$F2 $4F a	General Alarm Output Status/Override (Marine Only) Used to read and override the state of the General Alarm Output.
$F4 $0E aa	Engine Oil Pressure Differential Used to read the pressure drop across the oil filter(s) in kPa.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F4 $10 aa	Effective Rack Used to read the distance traveled by a nonexistent rack actuator. This value gives an indication of fuel flow.
$F4 $11 aa	Effective Rack Limit Used to read the maximum distance the nonexistent rack actuator may travel. This value gives an indication of maximum fuel flow.
$F4 $12 aa	Effective Smoke Rack Limit Used to read the distance the nonexistent rack actuator may travel, taking into account the current Turbocharger Outlet (Boost) pressure.
$F4 $15 aa	Peak Air Filter Restriction Used to read the peak air filter restriction that has occurred since power up in kPa. This value is latched and is reset only by power cycling the engine controller.
$F4 $17 ab	Engine Status Used to read the engine status.
$F4 $19 aa	Unfiltered Engine Oil Pressure (absolute) Used to read the absolute unfiltered engine oil pressure in kPa. This data comes from the oil pressure sensor placed before the oil filter(s).
$F4 $1C aa	Engine Fuel Pressure Differential Used to read the pressure drop across the fuel filters in kPa.
$F4 $1F aa	Unfiltered Engine Fuel Pressure (absolute) Used to read the absolute unfiltered engine fuel pressure in kPa. This data comes from the fuel pressure sensor placed before the fuel filter(s).
$F4 $20 aa	Engine Aftercoolant Temperature Used to read the temperature of the liquid in the engine aftercooler system in degrees C.
$F4 $40 aa	Right Exhaust Temperature Used to read the temperature of the exhaust air on the right side of the engine in degrees C.
$F4 $41 aa	Left Exhaust Temperature Used to read the temperature of the exhaust air on the left side of the engine in degrees C.
$F4 $5B aa	Acceleration Ramp Rate (Generator Set Only) Used to read or program the maximum rate at which the engine will accelerate from the crank terminate speed to the speed that is requested by the throttle.
$F4 $6D aa	Cooldown Time Remaining Used to read how much time is left in the cooldown period before the engine shuts down.
$F5 $08 aa	Crankcase Air Pressure (absolute) Used to read the absolute pressure of the air inside the crankcase in kPa.
$F5 $09 aa	Crankcase Air Pressure (gauge) Used to read the gauge pressure of the air inside the crankcase in kPa.
$F5 $0A aa	Cooldown Engine Speed Used to read or program the speed at which the engine will idle when in the cooldown mode.

QUICK REFERENCE CHART WITH DESCRIPTION OF PARAMETER IDENTIFIERS (cont.)	
PID	**Description**
$F5 $0B aa	Cycle Crank Time Setpoint Used to read or program the amount of time the ECM allows the engine to crank and then to rest the starting motor during a single crank cycle.
$F5 $0D aa	Crank Terminate Speed Setpoint Used to read or program the engine speed at which the ECM will disengage the starting motor during engine cranking.
$F5 $0E aa	Filtered Engine Fuel Pressure (absolute) Used to read the absolute filtered engine fuel pressure in kPa. This data comes from the fuel pressure sensor placed after the fuel filter(s).
$F5 $0F aa	Filtered Engine Fuel Pressure (gauge) Used to read the gauge filtered engine fuel pressure in kPa. This data comes from the fuel pressure sensor placed after the fuel filter(s).
$F5 $10 aa	Low Idle Speed Used to read or program the speed at which the engine will run when the throttle is overridden or the throttle is disconnected.
$F5 $11 aa	Intake Manifold Air Temperature (Generator Set Only) Used to read the temperature of the precombustion chamber air found in the intake manifold of the engine air supply system in degrees C. This data is read from the SEMS module.
$F5 $15 aa	Percent Droop (Generator Set Only) Used to read how much engine drops when full load is applied.
$F5 $1F aa	Right Air Filter Restriction Used to read the right air filter restriction in kPa.
$F5 $20 aa	Left Air Filter Restriction Used to read the left air filter restriction in kPa.
$F5$25 aa	Fuel Consumption Rate Used to read the rate at which fuel is being consumed.
$F5 $3E aa	Engine Oil Temperature (Generator Set Only) Used to read the temperature of the oil in the engine in degrees C. This data is read from the SEMS module.
$F8 $14 aaaaa aaaaa	Application Software Part Number Used to read the application software part number for ECM. (Personality Module)
$F8 $1A aaaaaaaaa aaaaaaaa	Vehicle System ID Used to read or program the engine ID.
$FC $07 abcd	Warning Status Used to read various warning status conditions of the engine.
$FC $08 abcd	Shutdown Status Used to read the cause of an engine shutdown.
$FC $09 abcd	Engine Derate Status Used to read the cause of the engine being derated.

Engine Configuration
$00 $08 a

Used to read the engine configuration.

(a)	High nibble: Liter size (example: 3500 =5) Low nibble: (# cylinders - 1 (Example: 3512B =11)

Remote Fault Reset (Generator Set Only)
$00 $0D a

Used to reset the remote E-stop shutdown.

(a)	$00 - $7F = Retain current ECM inactive fault status $80 - $FF = Reset ECM inactive fault

NOTE: This parameter is write only. Write a negative value to reset fault.

Throttle Position
$00 $15 a

Used to read the position of the throttle position sensor (speed adjust pot).

(a)	Resolution: 0.4 percent per bit Data range: 0 through 102 percent

Engine RPM
$00 $40 aa

Used to read the engine rpm.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 16383.5 rpm $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Coolant Temperature
$00 $44 aa

Used to read the temperature of the engine coolant in degrees C.

(aa)	Resolution: 1°C per bit Data range: -32736 through 32767°C $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Desired Engine Speed
$00 $46 aa

Used to read the desired engine speed of the engine controller.

(aa)	Resolution : 0.5 rpm per bit Data range : 0 through 16383.5 rpm $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Transmission Oil Temperature (Marine Only)
$00 $4D aa

Used to read the transmission oil temperature in degrees C.

(aa)	Resolution : 1°C per bit Data range : -32736 through 32767°C $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Transmission Oil Pressure (absolute) (Marine Only)
$00 $4E aa

Used to read the absolute transmission oil pressure of the engine in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Atmospheric Pressure
$00 $53 aa

Used to read atmospheric pressure in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 through $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Filtered Engine Oil Pressure (gauge)
$00 $54 aa

Used to read the gauge filtered oil pressure of the engine in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 through $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Boost Pressure (gauge) $00 $55 aa

Used to read the boost pressure of the engine in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Air Filter Restriction $00 $58 aa

Used to read the current filter restriction in kPa of the left or right air filter. The greater of the two restrictions is displayed.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Filtered Engine Oil Pressure (absolute) $00 $5A aa

Used to read the absolute filtered engine oil pressure in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Boost Pressure (absolute) $00 $5B aa

Used to read the absolute boost pressure of the engine in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Left Turbocharger Inlet Pressure (absolute) $00 $5C aa

Used to read the left turbocharger inlet pressure in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range : 0 through 16383.5 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

ECM Hourmeter $00 $5E aa

Used to read how many hours the engine has run.

(aa)	Resolution : 1 hour per bit $0000 - $FFFF is the valid data range (0 through 65535 hours)

NOTE: The number of hours that the generator set has run is determined by the ECM, and this number could be greater than the 65535 hours that this PID is limited to. When the ECM hourmeter reading is greater than 65535 hours, the value for PID $00 5E will always be 0 hours.

Right Turbocharger Inlet Pressure (absolute) $00 $5F aa

Used to read right turbocharger inlet pressure in kPa.

(aa)	Resolution : 0.5 kPa per bit Data range: 0 through 163483.5 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

ECM Fault Log Codes and Status $00 $82 aab(C) ... aab(c)

Used to read component identifier (CID), and status (active or inactive) of diagnostic codes stored in the ECM fault log.

(a)	Bit 24 - 17 Upper byte of CID
(a)	Bit 16 - 9 Lower byte of CID
(b)	Fault Code Status bit 8 0 = Count not included 1 = Count is included bit 7 0 = Fault is active 1 = Fault is inactive bit 6 0 = Fault is logged 1 = Fault is not logged bit 5 0 = Standard FMI 1 = Extended FMI bit 4-1 Fault mode identifier (FMI) or a fault code
(c)	Occurrence count for fault code, optional as defined by bit 8

ECM Fault Log Request for Additional Data $00 $83 aab

This PID should be used only for requesting additional information about a given logged diagnostic code or to clear a particular diagnostic code. Use the $00 $82 PID to request preliminary information, such as existence of active or inactive diagnostic codes.

(a)	Upper byte of CID Component Identifier when more information is being requested, or is being cleared
(a)	Lower byte of CID Component Identifier when more information is being requested, or is being cleared
(b)	Information Requested bit 8, 7 00 = Request ASCII descriptive message for given diagnostic code 01 = Request to clear given diagnostic code in GSC fault log 10 = Request to clear all diagnostic codes in GSC fault log 11 = Request additional diagnostic information about given diagnostic code bit 6, 5 Not used bits 4-1 Failure Mode Identifier (FMI) of a fault code

ECM Fault Log Response for Additional Information $00 $84 aab [cddee]

Used to acknowledge the diagnostic codes being cleared in the ECM fault log or to supply additional information about a given diagnostic code requested by PID $83.

(a)	Upper byte of CID Component Identifier receiving the response
(a)	Lower byte of CID Component Identifier receiving the response
(b)	Information Requested bits 8, 7 Response Identifier 01 = Count has been cleared for given CID 10 = All counts have been cleared 11 = Message contains additional information for given diagnostic code bit 6 0 = Request to clear logged fault granted 1 = Request to clear logged fault denied bits 5-1 Failure Mode Identifier (FMI) fault code
(c)	Number of occurrences[1] (MSB first)
(dd)	Time of first occurrence[1] (MSB first)
(ee)	Time of last occurrence[1] (MSB first)

[1] Bytes c, dd, and ee are omitted, if the response identifier is 01 or 10. Its format is $00 $84 in aab.

Total Fuel $00 $C8 aaaa

Used to read total fuel the engine has burned.

(aaaa)	Resolution: 0.125 gallon per bit Data range: 0 through 268,435,456

System Battery Voltage $F0 $13 a

Used to read the system battery voltage of the engine control system.

(a)	Resolution: 0.5 volts per bit Data Range: 0.0 volts through 127.5 volts

Cooldown Duration
$F0 $14 a

Used to read or program the amount of time (minutes) the ECM allows the engine to run after a normal shutdown is initiated.

(a)	Resolution: 1 minute per bit Data range: 0 through 233 minutes $E0 - $FF are Fault Identifiers (FID)[1]

[1]For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Cold Mode Status
$F0 $16 a

Used to read the cold mode status of the engine.

(a)	$00 = Cold mode inactive $80 = Cold mode active

Engine Prelube Duration
$F0 $1B a

Used to read or program the amount of time (seconds) the ECM will prelube the engine before the crank cycle is entered.

(a)	Resolution: 1 second per bit Data range: 0 through 233 seconds $E0 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Remote Start Status
$F0 $2A a

Used to read the status of the remote start/stop switch. This data is valid only when the Engine Control switch is in the AUTO position.

(a)	$00 = Remote start is OFF $01- $7F = Remote start is ON $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Engine Coolant Level Status
$F0 $2C a

Used to read the status of the engine coolant level switch. This data is read from the SEMS module.

(a)	$00 = Coolant level is OK $01 - $7E = not used $7F = Coolant level is Low $80 - $DF = not used $E0 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Engine Control Switch Position
$F0 $8F a

Used to read the status of the Engine Control Switch (ECS).

(a)	$00 = Off/reset $02 = Start $03 = Stop $04 = Auto $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Shutdown Notify Relay Status (Generator Set Only)
$F0 $9C a

Used to read the status of the Shutdown Notify Relay.

(a)	$00 = Relay is OFF $01 = Relay is ON $02 - $DF = Not used $E0 - $FF = are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Overspeed Verify Switch Position
$F0 $A6 a

Used to read the status of the overspeed verify switch.

(a)	$00 = Switch is in the OFF position $01 - $7F = Switch is in the ON position $80 - $9F are Fault Identifiers (FID)

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Remote E-stop Switch Position $F0 $A8 a

Used to read the status of the remote E-stop switch.

(a)	$00 = Switch is in the OFF position $01 - $7F = Switch is in the ON position $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Start-up Mode Status $F0 $A9 a

Used to read the status of the start-up mode.

(a)	$00 = Starter is OFF $01= Starter is ON (cranking) $02 = Overcrank $03 = Start-up was successful $04 = $DF = Not used $E0 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the "Fault Identifiers (FID)" section.

Air Shutoff Status (Generator Set Only) $F0 $AA a

Used to read status of air shutoff system.

(a)	$00 = Air shutoff relay is OFF $01 - $7F = Air shutoff relay is ON $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Maximum Number of Crank Cycles $F0 $AC a

Used to read or program the number of times the engine will try to start before an overcrank condition is annunciated.

(a)	Data range: 0 through 223 counts $E0 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Remote Emergency Stop $F0 $B1 a

Used to read or request a remote emergency stop.

(a)	$00 = Remote emergency stop is OFF $01 - $7F = Remote emergency stop is ON $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Cooldown Override Control $F0 $B2 a

Used to read or override the cooldown timer to 0.

(a)	$00 = Continue cooldown $01 - $7F = Abort cooldown $80 - $9F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Prelube Status $F0 $B5 a

Used to read the status of the prelube system.

(a)	$00 = Prelube is OFF $01= Prelube is ON $02 = Prelube is DISABLED $03 = Prelube is COMPLETED $04 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Fuel Level Status $F0 $B6 a

Used to read the status of the engine fuel level switch. This data is read from the SEMS module.

(a)	$00 = Fuel level is OK $01= Fuel level is LOW $02 - $DF = Not used $E0 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Acceleration Delay Time (Generator Set Only) $F0 $C1 a

Used to read or program the time (seconds) the engine will wait at low idle before accelerating to rated speed. The engine waits at low idle until oil pressure increases to 70 kPa or until Acceleration Delay time is reached.

(a)	Data range: $0 - 255 seconds

Remote Throttle Override
$F0 $C2 a

Used by a remote communication module to read or override desired engine speed to low idle.

(a)	$00 = Normal throttle setting $01 = Low idle setting $02 - $DF = Not used $E0 - $FF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

ECM In Control (Marine Only)
$F0 $F2 a

Used to determine whether the primary ECM or backup ECM is currently controlling the engine.

(a)	$00 = Primary ECM is in control of engine $01 = BACKUP ECM is in control of engine $02 - $FF = Not used

Percent Engine Load
$F1 $18 a

Used to read the percentage of engine load.

(a)	Resolution: 1.0 percent per bit Data range: 0 through 255 percent

Backup ECM Status (Marine Only)
$F1 $4F a

Used to read whether the backup ECM is ready to take over control of the engine, should the primary ECM fail.

(a)	$00 = Backup ECM is READY $01= Backup ECM is NOT READY $02 - $FF = Not used

Engine Power Derate Percentage
$F1 $89 a

Used to read the current engine power derate percentage.

(a)	Resolution: 0.5 percent per bit Data range: 0 through 100 percent

Remote Start Initiate
$F2 $13 a

Used to read or start or stop the engine remotely.

(a)	$00 = Start engine $7F = Stop engine

Emergency Override Switch Status (Marine Only)
$F2 $4D a

Used to read the state of the Emergency Overrride Switch. The switch is used to override the derates and shutdowns to continue operation during emergency conditions.

(a)	Emergency Override Switch Status $00 = Emergency override off $01= Emergency override on $02-$DF = Not Used

General Alarm Output Status/Override (Marine Only)
$F2 $4F a

Used to read and override the state of the General Alarm Output.

(a)	General Alarm Output bit 8 Override 1 = override 0 = normal bit 7-1 Output Status $00 = Output is off $01 = Output is on $02-$7F = Not Used

Engine Oil Pressure Differential
$F4 $0E aa

Used to read the pressure drop across the oil filter(s) in kPa.

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Effective Rack
$F4 $10 aa

Used to read the distance traveled by a nonexistent rack actuator. This value gives an indication of fuel flow.

(aa)	Resolution: 0.005 mm per bit Data range: 0 through 60.00 mm

Effective Rack Limit
$F4 $11 aa

Used to read the maximum distance the nonexistent rack actuator may travel. This value gives an indication of maximum fuel flow.

(aa)	Resolution: 0.005 mm per bit Data range: 0 through 60.00 mm

Effective Smoke Rack Limit
$F4 $12 aa

Used to read the distance the nonexistent rack actuator may travel, taking into account the current Turbocharger Outlet (Boost) pressure.

(aa)	Resolution: 0.005 mm per bit Data range: 0 through 60.00 mm

Peak Air Filter Restriction
$F4 $15 aa

Used to read the peak air filter restriction in kPa that has occurred since power up. This value is latched and is reset only by power cycling the engine controller.

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 16383.5 kPa $8000 through $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Status
$F4 $17 ab

Used to read the engine status.

(a)	Engine Status Set 1 bit 8 = Reserved bit 7 = Reserved bit 6 = Not Used bit 5 = Not Used bit 4 = Not Used bit 3 = Reserved bit 2 = Reserved bit 1 = Engine Speed 1 = No engine speed 0 = Engine speed
(b)	Engine Status Set 2 bit 8 = Not Used bit 7 = Reserved bit 6 = Reserved bit 5 = E-Stop Shutdown[1] 1 = E-stop shutdown 0 = No E-stop shutdown bit 4 = Fuel Injection 1 = Fuel injection disabled 0 = No injection disabled bit 3 = Reserved bit 2 = Reserved bit 1 = Reserved

[1]Not available for Version C (Caterpillar part number 7X-6321) ECM.

Unfiltered Engine Oil Pressure (absolute)
$F4 $19 aa

Used to read the absolute unfiltered engine oil pressure in kPa. This data comes from the oil pressure sensor placed before the oil filter(s).

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Fuel Pressure Differential
$F4 $1C aa

Used to read the pressure drop across the fuel filter(s) in kPa.

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Unfiltered Engine Fuel Pressure (absolute) $F4 $1F aa

Used to read the absolute unfiltered engine fuel pressure in kPa. This data comes from the fuel pressure sensor placed before the fuel filter(s).

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Aftercoolant Temperature $F4 $20 aa

Used to read the temperature of the liquid in the engine aftercooler system in degrees C.

(aa)	Resolution: 1°C per bit Data range: -32736 through 32767°C $8000 through $801F are Fault Identifiers[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Right Exhaust Temperature $F4 $40 aa

Used to read the temperature of the exhaust air on the right side of the engine in degrees C.

(aa)	Resolution: 1.0°C per bit Data range: -32736 to 32767°C $8000 through $801F are Fault Identifiers[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Left Exhaust Temperature $F4 $41 aa

Used to read the temperature of the exhaust air on the left side of the engine in degrees C.

(aa)	Resolution: 1.0°C per bit Data range: -32736 to 3277°C $8000 through $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Acceleration Ramp Rate (Generator Set Only) $F4 $5B aa

Used to read or program the maximum rate at which the engine will accelerate from the crank terminate speed to the speed that is requested by the throttle.

(aa)	Resolution: 1 rpm per second per bit Data range: 0 through 65535 rpm/sec

Cooldown Time Remaining $F4 $6D aa

Used to read the amount of time left in the cooldown period before the engine shuts down.

(aa)	Resolution: 1 second per bit Data range: 0 through 65535 seconds

Crankcase Air Pressure (absolute) $F5 $08 aa

Used to read the absolute pressure of the air inside the crankcase in kPa.

(aa)	Resolution: 0.1 kPa per bit Data range: 0 through 6550.3 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Crankcase Air Pressure (gauge) $F5 $09 aa

Used to read the gauge pressure of the air inside the crankcase in kPa.

(aa)	Resolution: 0.1 kPa per bit Data range: -3273.6 through 3276.7 kPa $8000 - $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Cooldown Engine Speed $F5 $0A aa

Used to read or program the speed at which the engine will idle when in the cooldown mode.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 32751.5 rpm $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Cycle Crank Time Setpoint $F5 $0B aa

Used to read or program the amount of time the ECM allows the engine to crank and then to rest the starting motor during a single crank cycle.

(aa)	Resolution: 1 second per bit Data range: 0 through 65503 seconds $FFE0 - $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Crank Terminate Speed Setpoint $F5 $0D aa

Used to read or program the engine speed at which the ECM will disengage the starting motor during engine cranking.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 32751.5 rpm

Filtered Engine Fuel Pressure (absolute) $F5 $0E aa

Used to read the absolute filtered engine fuel pressure in kPa. This data comes from the fuel pressure sensor placed after the fuel filter(s).

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Filtered Engine Fuel Pressure (gauge) $F5 $0F aa

Used to read the gauge filtered engine fuel pressure in kPa. This data comes from the fuel pressure sensor placed after the fuel filter(s).

(aa)	Resolution: 0.5 kPa per bit Data range: 0 through 32751.5 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Low Idle Speed $F5 $10 aa

Used to read or program the speed at which the engine will run when the throttle is overridden or the throttle is disconnected.

(aa)	Resolution: 0.5 rpm per bit Data range: 0 through 32767.5 rpm

Intake Manifold Air Temperature (Generator Set Only) $F5 $11 aa

Used to read the temperature in degrees C of the precombustion air found in the intake manifold of the engine air supply system. This data is read from the SEMS module.

(aa)	Resolution: 0.1°C per bit Data range: -3273.6 through 3276.7°C $8000 through $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Percent Droop (Generator Set Only) $F5 $15 aa

Used to read how much engine drops when full load is applied.

(aa)	Resolution: 0.1 percent per bit Data range: 0 through 6550.3 percent $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Right Air Filter Restriction $F5 $1F aa

Used to read the right air filter restriction in kPa.

(aa)	Resolution: 0.1 kPa per bit Data range: 0 through 6550.3 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Left Air Filter Restriction $F5 $20 aa

Used to read the left air filter restriction in kPa.

(aa)	Resolution: 0.1 kPa per bit Data range: 0 through 6550.3 kPa $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Fuel Consumption Rate
$F5 $25 aa

Used to read the rate at which fuel is being consumed.

(aa)	Resolution: 0.05 liter/hour/bit Data range: 0.00 to 3275.15 liter/hour $FFE0 through $FFFF are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Engine Oil Temperature (Generator Set Only)
$F5 $3E aa

Used to read the temperature in degrees C of the oil in the engine. This data is read from the SEMS module.

(aa)	Resolution: 1°C per bit Data range: -32736 through 32767°C $8000 through $801F are Fault Identifiers (FID)[1]

[1] For a complete list of the Fault Identifiers (FID), refer to the Fault Identifiers (FID) section.

Application Software Part Number
$F8 $14 aaaaaaaaaa

Used to read the application software part number of the ECM. (Personality Module)

(aaaaaaaaaa)	Application software part number in printable ASCII (part numbers less than 10 characters are padded with an ASCII space $20 at the beginning of part number).

NOTE: Application software part number cannot be read from the older version of CCM (Caterpillar part number 117-6170).

Vehicle System ID
$F8 $1A aaaaaaaaaaaaaaaaa

Used to read or program the engine ID.

(aaaaaaa aaaaaa aaaaaa)	Engine ID (must be 17 ASCII characters)

Warning Status
$FC $07 abcd

Used to read various warning status conditions of the engine.

(a)	Warning subset number 4 0 = Warning is NOT ACTIVE 1 = Warning is ACTIVE Bit 8 - 1 Not used
(b)	Warning subset number 3 0 = Warning is NOT ACTIVE 1 = Warning is ACTIVE Bit 8 = High transmission oil temperature[1] Bit 7 = Low transmission oil pressure[1] Bit 6 = Not Used Bit 5 = Not Used Bit 4 = Not Used Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used
(c)	Warning Subset number 2 0 = Warning is NOT ACTIVE 1 = Warning is ACTIVE Bit 8 = Oil filter plugged Bit 7 = Fuel filter plugged Bit 6 = High crankcase pressure Bit 5 = High aftercooler coolant temperature Bit 4 = Not Used Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used
(d)	Warning subset number 1 0 = Warning is NOT ACTIVE 1 = Warning is ACTIVE Bit 8 = Low system voltage Bit 7 = Low engine oil pressure Bit 6 = High engine coolant temperature Bit 5 = Low engine coolant temperature Bit 4 = Engine overspeed Bit 3 = Air filter plugged Bit 2 = Not Used Bit 1 = High exhaust temperature

[1] This bit is used for Marine applications only.

Shutdown Status $FC $08 abcd

Used to read the cause of an engine shutdown.

(a)	Engine shutdown subset number 4 0 = Engine Shutdown is NOT ACTIVE 1 = Engine Shutdown is ACTIVE Bit 8 - 1 = Not used
(b)	Engine shutdown subset #3 0 = Engine shutdown is NOT ACTIVE 1 = Engine shutdown is ACTIVE Bit 8 = Not Used Bit 7 = Not Used Bit 6 = Not Used Bit 5 = Not Used Bit 4 = Not Used Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used
(c)	Engine shutdown subset number 2 0 = Engine shutdown is NOT ACTIVE 1 = Engine shutdown is ACTIVE Bit 8 = Not Used Bit 7 = Not Used Bit 6 = High crankcase pressure Bit 5 = High aftercooler coolant temperature Bit 4 = Not Used Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used
(d)	Engine shutdown subset number 1 0 = Engine shutdown is NOT ACTIVE 1 = Engine shutdown is ACTIVE Bit 8 = Not Used Bit 7 = Low engine oil pressure Bit 6 = High engine coolant temperature Bit 5 = Not Used Bit 4 = Engine overspeed Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used

Engine Derate Status $FC $09 abcd

Used to read the cause of the engine being derated.

(a)	Engine derate subset number 4 0 = Engine derate is NOT ACTIVE 1 = Engine derate is ACTIVE Bit 8 - 1 = Not Used
(b)	Engine derate subset number 3 0 = Engine derate is NOT ACTIVE 1 = Engine derate is ACTIVE Bit 8 = Not Used Bit 7 = Not Used Bit 6 = Not Used Bit 5 = Not Used Bit 4 = Not Used Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used
(c)	Engine derate subset number 2 0 = Engine derate is NOT ACTIVE 1 = Engine derate is ACTIVE Bit 8 = Not Used Bit 7 = Not Used Bit 6 = High crankcase pressure Bit 5 = High aftercooler coolant temperature Bit 4 = Not Used Bit 3 = Not Used Bit 2 = Not Used Bit 1 = Not Used
(d)	Warning subset number 1 0 = Warning is NOT ACTIVE 1 = Warning is ACTIVE Bit 8 = Not Used Bit 7 = Not Used Bit 6 = High engine coolant temperature Bit 5 = Not Used Bit 4 = Not Used Bit 3 = Air filter plugged Bit 2 = High altitude (atmospheric pressure) Bit 1 = High exhaust temperature

M5X Communication Protocol Programming Examples

The following examples reference EMCP II applications. However, the format will be similar for other applications.

Before any M5X programming can be started, the user must first "log in" to the CCM. Refer to the Logging In to the CCM section of this manual for more specific information.

Create a Broadcast List

The following example shows how to create and activate a broadcast list in which $00 $40 (engine rpm) and $00 $54 (engine oil pressure) are requested every 2 seconds from the EMCP II GSC, and then deactivate the list.

STEP 1. Create a Broadcast List - IID 13:

500013150258040020004000540000000000000000000000086

IID 13 - Used to create a broadcast list. There are a total of eight lists allowed by the CCM. This example assumes list number 2.

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$13	IID 13
4	$15	Number of bytes
5	$02	List number
6	$58	GSC number 1
7	$04	Response will be sent every 2 seconds (increments of 0.5 seconds)
8	$00	These bits are unused (always = 0)
9	$20	Programming flags: no separator, message terminated by carriage return, in ASCII form.
10, 11	$00 $40	1st PID - Generator Set Engine RPM
12, 13	$00 $54	2nd PID - Engine Oil Pressure (kPa)
14, 15	$00 $00	Filler for unused PID
16, 17	$00 $00	Filler for unused PID
18, 19	$00 $00	Filler for unused PID
20, 21	$00 $00	Filler for unused PID
22, 23	$00 $00	Filler for unused PID
24, 25	$00 $00	Filler for unused PID
26	$86	Checksum

STEP 2. IID 15 is the response from the CCM confirming that the list has been successfully created: 500115010099

IID 15 - The CCM's reply to IID 11, IID 12, or IID 13.

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$15	IID 15
4	$01	Number of bytes
5	$00	IID data is OK
6	$99	Checksum

STEP 3. Activate the Broadcast List - IID 11: 50001101029C

IID 11 - Used to activate a broadcast list.

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$11	IID 11
4	$01	Number of bytes
5	$02	List number
6	$9C	Checksum

STEP 4. Again, IID 15 is the response from the CCM confirming that the list has been successfully activated: 500115010099

IID 15 - The CCM's reply to IID 11, IID 12, or IID 13.

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$15	IID 15
4	$01	Number of bytes
5	$00	IID data is OK
6	$99	Checksum

TEP 5. IID 10 is the broadcast response
)m the CCM: 5001100602580BB800C8B4

) 10 - The data will now start flowing from the
SC to the CCM and then to the user's PC at
e rate of once every two seconds. The entire
oadcast list will not be returned if any of the
lowing conditions is met:

The GSC number is not available.

The GSC does not support the PID.

The PID contains more than 2 bytes of data.

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$10	IID 10
4	$06	Number of bytes
5	$02	List number
6	$58	GSC number 1
7, 8	$0BB8	1500 rpm
9, 10	$00C8	100 kPa
11	$B4	Checksum

TEP 6. IID 12 will Deactivate the list, if
sired: 50001201029B

) 12 - Used to deactivate a list.

Byte No.	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$12	IID 12
4	$01	Number of bytes
5	$02	List number
6	$9B	Checksum

STEP 7. IID 15 is the response from the CCM confirming that the list has been successfully deactivated: 500115010099

IID 15 - The CCM's reply to IID 11, IID 12, or IID 13.

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$15	IID 15
4	$01	Number of bytes
5	$00	IID data is OK
6	$99	Checksum

Reading Faults from EMCP II GSC

The following example shows how to read faults from the EMCP II GSC.

STEP 1. Use IID 24 to send PID $0082 to the GSC: 5000240400580082AE

IID 24 - Single Parameter Read Request

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$24	IID 24
4	$04	Number of bytes
5	$00	Reply in ASCII format
6	$58	GSC number 1
7, 8	$00 $82	PID $0082 GSC Fault Log Codes, Status, And Number Of Occurrences
9	$AE	Checksum

STEP 2. IID 25 is the response from the CCM: 5001250758008200BEC30424.

IID 25 - Single Parameter Read Response

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$25	IID 25
4	$07	Number of bytes
5	$58	GSC number 1
6, 7	$0082	PID $0082 GSC Fault Log Codes, Status, And Number Of Occurrences
8, 9	$00 $BE	CID 190 (engine speed sensor fault)
10	$C3	Count included, inactive fault, logged fault, standard FMI (3)
11	$04	Occurrence count of 4
12	$24	Checksum

STEP 3. IID 00 is used to request additional information on a fault 500000070058008300BEC34D.

IID 00 - Special Parameter Command

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$00	IID 00
4	$07	Number of bytes
5	$00	Reply in ASCII format
6	$58	GSC number 1
7, 8	$00 $83	PID $0083 GSC Fault Log Request For Additional Data
9, 10, 11	$00 $BE $C3	More information requested on CID 190 FMI 3
12	$4D	Checksum

STEP 4. IID 25 will contain the reply as PID $0084 5001250B58008400BEC303000C001102

IID 25 - Single Parameter Read Response

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$25	IID 25
4	$0B	Number of bytes
5	$58	GSC number 1
6, 7	$00 $84	PID $0084 GSC Fault Log Response For Additional Information
8, 9	$00 $BE	CID 190
10	$C3	More information on FMI 3
11	$03	Three occurrences of this fault
12, 13	$00 $0C	First occurrence at 12 hours
14, 15	$00 $11	Last occurrence at 17 hours
16	$02	Checksum

Monitoring Generator Phase

The following example shows how to select which generator phase the GSC monitors.

STEP 1. Use IID 34 to write the parameters of PID $F0B0: 500034050058F0B007F.

IID 34 - Single Parameter Write Request

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$00	User's PC is the sending module
3	$34	IID 34
4	$05	Number of bytes
5	$00	Reply in ASCII format
6	$58	GSC number 1
7, 8	$F0 $B0	PID $F0B0 Generator Phase Select
9	$00	Phase A-B Voltage, Phase A Current
10	$7F	Checksum

STEP 2. IID 35 is the response from the CCM: 5001350458F0B0007E.

IID 35 - Single Parameter Write Response

Byte(s)	Byte Contents	Detailed Description
1	$50	Indicates M5X protocol
2	$01	CCM is the sending module
3	$35	IID 35
4	$04	Number of bytes
5	$58	GSC number 1
6, 7	$F0 $B0	PID $F0B0 Generator Phase Select
8	$00	Phase A-B Voltage, Phase A Current
9	$7E	Checksum

NOTES

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