Driver Manual

FS-8700-56 Caterpillar M5X

APPLICABILITY & EFFECTIVITY
Effective for all systems manufactured after June 2023.

Driver Revision: 1.04
Document Revision: 2.B

MSA Safety
1000 Cranberry Woods Drive
Cranberry Township, PA 16066 USA
Website: www.MSAsafety.com

U.S. Support Information:
+1 408 964-4443
+1 800 727-4377
Email: smc-support@msasafety.com

EMEA Support Information:
+31 33 808 0590
Email: smc-support.emea@msasafety.com

Contents

1 Description

The Caterpillar M5X driver allows the FieldServer to transfer data to and from devices over RS-232 using Caterpillar M5X protocol. The FieldServer can emulate either a Server or Client.

The driver is capable of communications with any device that uses the Caterpillar M5X protocol but has been designed primarily for connection to a Caterpillar CCM which is in turn connected to the Caterpillar engines to be monitored/controlled.

The driver provides a limited set of M5X protocol commands and may address a sub-set of the parameters available in each device. Details are available in **Section 8.2**.

The driver provides formal support for 3500 engines and EMCPII devices only. Other devices may be polled using the address of the parameter required as opposed to user friendly parameter names. Establishing the correct Node_ID's for the engines being communicated with can be challenging and requires careful research. See **Section 8.1** for further details.

2 Driver Scope of Supply

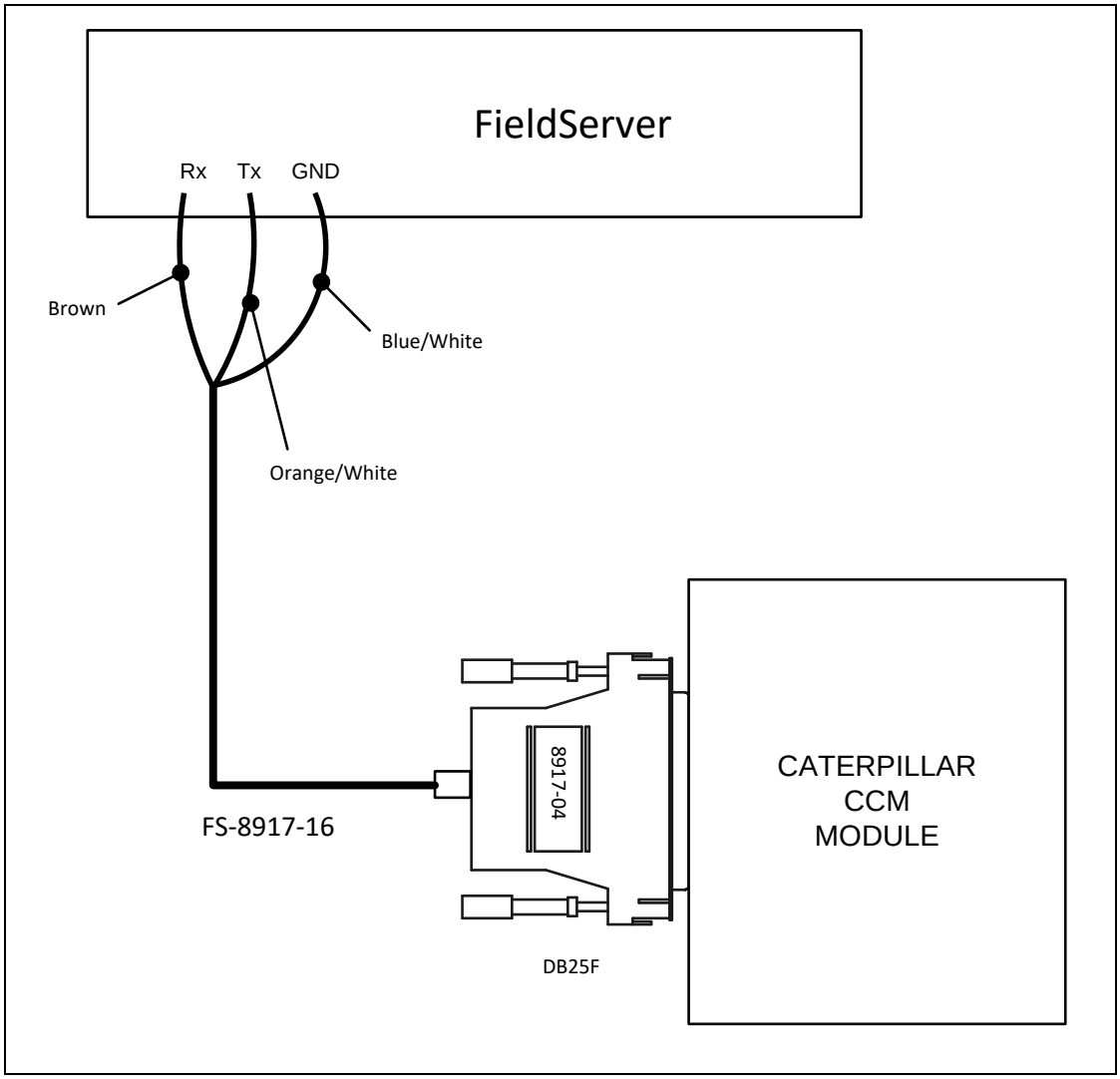
2.1 Provided by the Supplier of 3rd Party Equipment

Description
Caterpillar CCM Module
Power Supply

3 Hardware Connections

The FieldServer is connected to the Caterpillar CCM module as shown below.

Configure the Caterpillar CCM module according to manufacturer's instructions.



3.1 Hardware Connection Hints/Tips

- The FieldServer cannot be connected directly to the generator/engine controller but must be connected via the CCM module.
- To establish the caterpillar Node ID, set the Node_ID to 0 in the configuration. Watch the error screen on reboot - the remote device will send a message back with an error stating that it cannot accept a response message from a certain Node ID. That Node ID is the relevant Node ID.

4 Data Array Parameters

Data Arrays are “protocol neutral” data buffers for storage of data to be passed between protocols. It is necessary to declare the data format of each of the Data Arrays to facilitate correct storage of the relevant data.

Section Title		
Data_Arrays		
Column Title	**Function**	**Legal Values**
Data_Array_Name	Provide name for Data Array.	Up to 15 alphanumeric characters
Data_Array_Format	Provide data format. Each Data Array can only take on one format.	Float, Bit, Byte, Uint16, Uint32, Sint16, Sint32
Data_Array_Length	Number of Data Objects. Must be larger than the data storage area required by the Map Descriptors for the data being placed in this array.	1-10000

Example

```
//    Data Arrays
Data_Arrays
Data_Array_Name    , Data_Array_Format    , Data_Array_Length
DA_AI_01           , UInt16,              , 200
DA_AO_01           , UInt16               , 200
DA_DI_01           , Bit                  , 200
DA_DO_01           , Bit                  , 200
```

5 Client Side Configuration

For detailed information on FieldServer configuration, refer to the FieldServer Configuration Manual. The information that follows describes how to expand upon the factory defaults provided in the configuration files included with the FieldServer (see ".csv" files provided).

This section documents and describes the parameters necessary for configuring the FieldServer to communicate with a Caterpillar M5X Server.

The configuration file tells the FieldServer about its interfaces, and the routing of data required. In order to enable the FieldServer for Caterpillar M5X communications, the driver independent FieldServer buffers need to be declared in the "Data Arrays" section, the destination device addresses need to be declared in the "Client Side Nodes" section, and the data required from the servers needs to be mapped in the "Client Side Map Descriptors" section. Details on how to do this can be found below.

NOTE: In the following tables, * indicates an optional parameter and bold legal values are default.

5.1 Client Side Connection Parameters

Section Title
Connections

Column Title	Function	Legal Values
Port	Specify which port the device is connected to the FieldServer.	R1 & R2
Baud*	Specify baud rate.	110 – 115200, standard baud rates only, **9600**
Parity*	Specify parity.	None
Data_Bits*	Specify data bits.	7, **8**
Stop_Bits*	Specify stop bits.	1
Protocol	Specify protocol used.	CATM5X
Poll Delay*	Time between internal polls.	0-32000s, **1s**
Application	Specify whether it is necessary to re-login for next transaction if target Node is different from current node. See **Section 7.1** for detail.	**Single_Node**, Multidrop

Example

```
//  Client Side Connections

Connections
Port        , Baud    , Parity  , Protocol  , Poll_Delay  , Application
R1          , 9600    , None    , CatM5X    , 0.100s      , Multidrop
```

5.2 Client Side Node Parameters

Section Title
Nodes

Column Title	Function	Legal Values
Node_Name	Provide name for node.	Up to 32 alphanumeric characters
Node_ID	The address of the device (engine) connected to the CCM module to be polled. This is also termed the UNIT number or UNIT ID of the engine being polled. Refer to **Section 8.1** for more information.	1-255
Protocol	Specify protocol used.	CATM5X
Port	Specify which port the device is connected to the FieldServer.	R1 & R2
Password*	Specify the node password. The driver logs in to the Cat device before it starts polling. Additional notes provided in **Section 7.2**.	Max 8 Alpha-Numeric characters, no-login, **-**

Example

```
//    Client Side Nodes

Nodes
Node_Name     , Node_ID     , Protocol     , Port
Engine1       , 33          , CATM5X       , R1
Generator     , 88          , CATM5X       , R1
```

5.3 Client Side Map Descriptor Parameters

5.3.1 FieldServer Specific Map Descriptor Parameters

Column Title	Function	Legal Values
Map_Descriptor_Name	Name of this Map Descriptor.	Up to 32 alphanumeric characters
Data_Array_Name	Name of Data Array where data is to be stored in the FieldServer.	One of the Data Array names from **Section 4**
Data_Array_Offset	Starting location in Data Array.	0 to (Data_Array_Length -1) as specified in **Section 4**
Function	Function of Client Map Descriptor.	Rdbc, Wrbc, Wrbx

5.3.2 Driver Related Map Descriptor Parameters

Column Title	Function	Legal Values
Node_Name	Name of Node to fetch data from.	One of the Node names specified in **Section 5.2**
Length	Defines how many Data Array storage locations are reserved for the Map Descriptor. Additional information is provided in **Section 7.4**.	1, 2 ….
CatParam	Each parameter has been allocated a name. Use the parameter name with this keyword to tell the driver which parameter in the engine or generator to be read / written.	Refer to **Section 5.4**
CatPID1*	The parameter may be specified in this alternate format in case parameters are added by Caterpillar for which this driver has no keyword description and for engines unknown to this driver. Use catPID1 & catPID2. Specify the values in the hexadecimal format provided in the caterpillar documentation.	E.g. CatPID1 = 00 CatPID2 = F8
CatPID2*	Length of read block.	1-255
CatMethod*	Used to override the data extraction method - allows the driver to parse messages with unknown parameters. The method parameter depends on the number and arrangement of data bytes. A table is provided in **Section 8.3**.	Non-zero positive integers.

5.3.3 Timing Parameters

Column Title	Function	Legal Values
Scan_Interval	Rate at which data is polled	>0.1s

5.4 Map Descriptor Examples

5.4.1 General Example

In this example the driver reads the hour meter from a node called Engine 5.

```
//    Client Side Map Descriptors

Map Descriptors
Map_Descriptor_Name  , Data_Array_Name  , Data_Array_Offset  , Function  , Node_Name
ENGINE5_HOURS        , HOUR_DATA        , 5                   , Rdbc      , Engine5
```

```
, Scan_Interval  , CatParam          , Length
, 5              , ECM Hourmeter     , 1
```

In the above example:

- Map_Descriptor_Name – Map Descriptor names are used by the driver when printing validation errors.
- Data_Array_Name – Data read by this Map Descriptor will be placed in a Data Array called HOUR_DATA.
- Data_Array_Offset – The result of this poll will be stored in array element index 5 (6th element as the first element has an index of zero).
- Function – Read continuously.
- Node_Name – This node name connects this Map Descriptor to a Node definition which in turn is connected to a port. This Map Descriptor is thus uniquely tied to a port. It is thus possible to process engines with duplicate unit numbers (Node_ID) as long as they are connected to different ports.
- CatParam – This Map Descriptor reads one parameter from the engine. The parameter must be spelled in exactly the same way as in **Section 8.2**. The single space between ECM and Hourmeter is important as is the lack of a space between Hour & meter. The space preceding ECM and following Hourmeter is not important.

5.4.2 Parameter Specified by Caterpillar PID

In this example, the driver reads the hour meter from a node called engine 5 but the parameter being read has been specified by the Caterpillar PID rather than the keyword values provided by the driver. A consequence of specifying a parameter that must be read by its ID rather than by its name is that the driver may not know how to extract data from the response.

This can be overcome by specifying the CatMethod.

- In this example the CatMethod has been set to 2.
- The reason that 2 was specified is that on inspection of the CAT manual which describes the parameter, we found that the response data takes the form 'AA'. From **Section 8.3** the method extraction parameter is 2 and the length setting is 1.

If a parameter is specified by its ID and not its name, but the driver recognizes the parameter it will be able to deduce the extraction method automatically. In this example, the driver would find that '00 5E' corresponds to the ECM Hourmeter and thus it would know the extraction method. The list of parameters known to the driver is presented as **Section 8.2**.

```
//    Client Side Map Descriptors

Map Descriptors
Map_Descriptor_Name  , Data_Array_Name  , Data_Array_Offset  , Function  , Node_Name  , Scan_Interval
ENGINE5_HOURS        , HOUR_DATA        , 5                    , Rdbc      , Engine5       , 5
```

```
, CatMethod  , CatPid1  , CatPid2  , Length
, 2              , 00         , 5e         , 1
```

In the above example:

- CatMethod – The CatMethod tells the Driver which method to use to extract data from the response.
- CatPid1 – The parameter with PID = 00 5e is being read from the engine.

6 Server Side Configuration

For detailed information on FieldServer configuration, refer to the instruction manual for the FieldServer. The information that follows describes how to expand upon the factory defaults provided in the configuration files included with the FieldServer (see ".csv" files provided).

This section documents and describes the parameters necessary for configuring the FieldServer to communicate with a Caterpillar M5X Client.

The configuration file tells the FieldServer about its interfaces, and the routing of data required. In order to enable the FieldServer for Caterpillar M5X communications, the driver independent FieldServer buffers need to be declared in the "Data Arrays" section, the FieldServer virtual node(s) needs to be declared in the "Server Side Nodes" section, and the data to be provided to the clients needs to be mapped in the "Server Side Map Descriptors" section. Details on how to do this can be found below.

NOTE: In the tables below, * indicates an optional parameter with the bold legal value as default.

6.1 Server Side Connection Parameters

Section Title		
Connections		
Column Title	**Function**	**Legal Values**
Port	Specify which port the device is connected to the FieldServer.	R1 & R2
Baud*	Specify baud rate.	110 – 115200, **9600**
Parity*	Specify parity.	None
Data_Bits*	Specify data bits.	7, **8**
Stop_Bits*	Specify stop bits.	1
Protocol	Specify protocol used.	CATM5X

Example

```
//  Server Side Connections

Connections
Port          , Baud   , Parity   , Protocol
R1            , 9600   , None     , CATM5X
```

6.2 Server Side Node Parameters

Section Title
Nodes

Column Title	Function	Legal Values
Node_Name	Provide name for node.	Up to 32 alphanumeric characters
Node_ID	The address of the device (engine) connected to the CCM module to be polled. This is also termed the UNIT number or UNIT ID of the engine being polled. Refer to **Section 8.1** for more information.	0-255
Protocol	Specify protocol used.	CATM5X
Port	Specify which port the device is connected to the FieldServer.	R1 & R2

Example

```
//    Server Side Nodes

Nodes
Node_Name          , Node_ID    , Protocol
Engine1            , 33         , CATM5X
```

6.3 Server Side Map Descriptor Parameters

6.3.1 FieldServer Specific Map Descriptor Parameters

Column Title	Function	Legal Values
Map_Descriptor_Name	Name of this Map Descriptor.	Up to 32 alphanumeric characters[1]
Data_Array_Name	Name of Data Array where data is to be stored in the FieldServer.	One of the Data Array names from **Section 4**
Data_Array_Offset	Starting location in Data Array.	0 to (Data_Array_Length-1) as specified in **Section 4**
Function	Function of Server Map Descriptor.	Passive

6.3.2 Driver Specific Map Descriptor Parameters

Column Title	Function	Legal Values
Node_Name	Name of Node to fetch data from.	One of the Node names specified in **Section 6.2**
CatParam	Each parameter has been allocated a name. Use the parameter name with this keyword to tell the driver which parameter in the engine or generator to be read / written.	Refer to **Section 6.4**
CatPID1*	The parameter may be specified in this alternate format in case parameters are added by Caterpillar for which this driver has no keyword description and for engines unknown to this driver. Use catPID1 & catPID2. Specify the values in the hexadecimal format provided in the caterpillar documentation.	E.g. CatPID1 = 00 CatPID2 = F8
CatPID2*		
CatMethod*	Used to override the data extraction method - allows the driver to parse messages with unknown parameters. The method parameter depends on the number and arrangement of data bytes. A table is provided in **Section 8.3**.	Non-zero positive integers.

6.3.1 Timing Parameters

Column Title	Function	Legal Values
Scada_Hold_Timeout	Specifies time Server side waits before responding to Client that Node is offline on FieldServer Client side.	>1.0s

[1] Object_Name values of any length may be written via BACnet (subject only to memory and message length constraints).

6.4 Map Descriptor Examples

In this example, the FieldServer acts a Passive Server capable of responding to queries for its ECM hourmeter.

```
//  Server Side Map Descriptors

Map Descriptors
Map_Descriptor_Name   , Data_Array_Name   , Data_Array_Offset   , Function   , Node_Name   , CatParam
E1_Hour               , DA_AI3            , 0                   , Passive    , ENG1        , ECM Hourmeter
```

In the above example:

- Data_Array_Name – The Data Array named DA_AI3 will be used to provide data to any poll's processed using this Map Descriptor.
- Data_Array_Offset – The first element of the array's value will be served as the ECM Hourmeter.
- Function – The Map Descriptor is passive. It responds to poll's (read or write) received for this node.
- CatParam – The driver is not capable of processing requests for other Caterpillar parameters until they too have been given a Server Side Map Descriptor.

7 Useful Features

7.1 Data Retrieval from Multiple Hosts

Caterpillar protocol only allows the retrieval of data from one host per port at a time. If a module (like CCM) connected to the FieldServer is in turn connected to multiple devices, the FieldServer may need to log in and out of these devices sequentially in order to collect data from each device. To facilitate this, the Driver uses the "application" keyword on connection (**Section 5.1**) to determine whether FieldServer should re-login for the next transaction. If the application type is "Multidrop" then FieldServer will re-login whenever the next transaction is for a different Node, otherwise, whether specified or not, the application type is considered as "Single_Node" and FieldServer will not re-login.

7.2 Passwords

7.2.1 Cat Device has Blank Password

To configure a Node to poll a Cat device with a blank password define the client node as follows:

```
//  Client Side Nodes
Nodes
Node_Name   , Node_ID   , Protocol   , Port   , Password
Engine1     , 33        , CATM5X     , R1     , -
```

The parameter can also be specified as "no-login".

7.2.2 Example – Cat Device has Password

Every variable (PID) in the Cat device has an associated security level (0, 1, 2 or 3). A user with a particular security level may access variables of the same or lower level. The Caterpillar vendor documentation provides details of the security level of each variable. Most variables can be read by a user of any level.

The password protection of the CCM device is initially enabled. Changing the password protection and passwords can be done with the PC software for the CCM. This software is provided by Caterpillar.

We note that in many places in the Caterpillar vendor documentation we have seen references to a password of "11112222" and suspect that this password may be commonly used.

```
Client Side Nodes
Nodes
Node_Name   , Node_ID   , Protocol   , Port   , Password
Engine1     , 33        , CATM5X     , R1     , 11112222
```

7.2.3 Example – Password Causes Configuration File Errors

A node definition which will produce configuration file errors is provided. The problem can easily be rectified by using a client node definition similar to example 1 or 2.

```
//  Client Side Nodes
Nodes
Node_Name   , Node_ID   , Protocol   , Port   , Password
Engine1     , 33        , CATM5X     , R1     ,
```

If the FieldServer is configured to emulate a Caterpillar device (driver acts as server), then any password can be specified as the driver does not perform password verification when a remote device logs in prior to polling.

7.3 Scaling

When the driver is configured as a Client and reads data from a Caterpillar device the response contains values for each parameter that is read. These 'raw' values are scaled by the driver to represent engineering values before storing. This scaling activity is not configurable. The scaling is only applied for variables known to the driver. Some variables may be read by specifying the PID1/2 parameters but if the variable is unknown to the driver (not listed in **Section 8.2**) – no scaling is applied to these variables.

Example

"Generator Bus Value" returns a value of 0-65503 representing 0-6535.3 Hz. The driver stores the scaled engineering value in Hertz as a floating point number.

The driver ignores the Map Descriptor keywords "Data_Array_Low_Scale, Data_Array_High_Scale, Device_Low_Scale, Device_High_Scale" as it has already performed the scaling.

7.3.1 Using the Driver as a Server

No scaling is applied. The diver transmits the values it finds in the Data Arrays.

7.4 Map Descriptor Lengths

When a Client Side Map Descriptor is defined it is necessary to specify the 'Length' (**Section 5.3.2**). For this driver, length is the number of Data Array locations reserved for storage of the data read by the Map Descriptor. In most cases a single value of data is returned for each read of the Caterpillar device. For some read's, however, the data returned consists of several values which are separated by the driver and stored in multiple consecutive locations in the specified Data Array. **Section 8.3** lists the format of the data returned by the Caterpillar device and the required length.

Example: Read Warning Status

Look up Warning Status in **Section** 8.2. The Data extraction method is 8.

3500B	fc	07	8	Warning Status

From **Section** 8.3, data extraction method 8 requires a length of 4.

8	ABCD	Yes	4

8 Reference

8.1 Node ID's

The following are the node ID's defined by the CATM5X protocol. The value is specified in decimal. Thus Engine 21H should be specified with a node ID of 33. The value of zero has a special meaning.

Hex Value	Decimal Value	Description
Engine Unit Type		
61	97	CCM
3500B Marine Engine Unit Number		
21	33	Electronic Engine Controller (Port)
22	34	Electronic Engine Controller (Starboard)
24	36	Electronic Engine Controller (Single or Center)
3500B Gen Set		
21	33	Electronic Engine Controller - Unit 1
22	34	Electronic Engine Controller - Unit 2
23	35	Electronic Engine Controller - Unit 3
24	36	Electronic Engine Controller - Unit 4
25	37	Electronic Engine Controller - Unit 5
26	38	Electronic Engine Controller - Unit 6
27	39	Electronic Engine Controller - Unit 7
28	40	Electronic Engine Controller - Unit 8
EMCP II Gen Set		
58	88	GSC - Unit 1
59	89	GSC - Unit 2
5A	90	GSC - Unit 3
5B	91	GSC - Unit 4
5C	92	GSC - Unit 5
5D	93	GSC - Unit 6
5E	94	GSC - Unit 7
5F	95	GSC - Unit 8
0	0	Auto Discover Node number Under normal operation the driver compares the polled Node_ID to the Node_ID contained in the response. If only 1 Cat engine is connected to the port, the Node_ID can be specified as zero and the driver will ignore the Node number in the responses.

8.2 Engine Parameter Keywords & PID's

The following table provides a list of all the keywords that may be used in the catParam field of the CSV file. The keywords are not case specific BUT no tabs may be used between the keywords and they must be spelled exactly as in the table.

Engine Type	PID1	PID2	Extraction Method (see Section 8.3)	Keyword / Parameter
3500B	00	08	1	Engine Configuration
3500B	00	0d	1	Remote Fault Reset
3500B	00	15	1	Throttle Position
3500B	00	40	2	Engine RPM
3500B	00	44	2	Engine Coolant Temp
3500B	00	46	2	Desired Engine Speed
3500B	00	4d	2	Transmission Oil Temp
3500B	00	4e	2	Transmission Oil Press
3500B	00	53	2	Atmospheric Press
3500B	00	54	2	Filtered Engine Oil Press Gauge
3500B	00	55	2	Boost Press Gauge
3500B	00	58	2	Air Filter Restriction
3500B	00	5a	2	Filtered Engine Oil Press Absolute
3500B	00	5b	2	Boost Press Absolute
3500B	00	5c	2	Left Turbo Inlet Press Absolute
3500B	00	5e	2	ECM Hourmeter
3500B	00	5f	2	Right Turbo Inlet Press Absolute
3500B	00	82	3	ECM Fault Log Codes
3500B	00	83	3	ECM Fault Log Request Additional
3500B	00	84	4	ECM Fault Log Request Additional Response
3500B	00	c8	5	Total Fuel
3500B	f0	13	1	System Battery Voltage
3500B	f0	14	1	Cooldown Duration
3500B	f0	16	1	Cold Mode Status
3500B	f0	1b	1	Engine Prelube Duration
3500B	f0	2a	1	Remote Start Status
3500B	f0	2c	1	Engine Coolant Level Status
3500B	f0	8f	1	Engine Control Switch Position
3500B	f0	9c	1	Shutdown Notify Relay Status
3500B	f0	a6	1	Overspeed Verify Switch Position
3500B	f0	a8	1	Remote Emergency Stop Switch Position
3500B	f0	a9	1	Start-up Mode Status
3500B	f0	aa	1	Air Shutoff Status
3500B	f0	ac	1	Max Number of Crank Cycles
3500B	f0	b1	1	Remote Emergency Stop
3500B	f0	b2	1	Cooldown Override Control
3500B	f0	b5	1	Engine Prelube Status
3500B	f0	b6	1	Engine Fuel Level Status
3500B	f0	c1	1	Acceleration Delay Time
3500B	f0	c2	1	Remote Throttle Override
3500B	f0	f2	1	ECM in Control
3500B	f0	fd	1	Low Idle Switch
3500B	f1	18	1	Percent Engine Load
3500B	f1	4f	1	Backup ECM Status
3500B	f1	89	1	Engine Power Derate Percentage

Engine Type	PID1	PID2	Extraction Method (see Section 8.3)	Keyword / Parameter
3500B	f2	13	1	Remote Start Initiate
3500B	f2	4d	1	Emergency Override Switch Status
3500B	f2	4f	1	General Alarm Output Status
3500B	f4	0e	2	Engine Oil Press Differential
3500B	f4	10	2	Effective Rack
3500B	f4	11	2	Effective Rack Limit
3500B	f4	12	2	Effective Smoke Rack Limit
3500B	f4	15	2	Peak Air Filter Restriction
3500B	f4	17	10	Engine Status
3500B	f4	19	2	Unfiltered Engine Oil Press Absolute
3500B	f4	1c	2	Engine Fuel Press Differential
3500B	f4	1f	2	Unfiltered Engine Fuel Press Absolute
3500B	f4	20	2	Engine Aftercooler Temp
3500B	f4	40	2	Right Exhaust Temp
3500B	f4	41	2	Left Exhaust Temp
3500B	f4	5b	2	Acceleration Ramp Rate
3500B	f4	6d	2	Cooldown Time Remaining
3500B	f5	08	2	Crankcase Air Pressure Absolute
3500B	f5	09	2	Crankcase Air Pressure Gauge
3500B	f5	0a	2	Cooldown Engine Speed
3500B	f5	0b	2	Cycle Crank Time Setpoint
3500B	f5	0d	2	Crank Terminate Speed Setpoint
3500B	f5	0e	2	Filtered Engine Fuel Press Absolute
3500B	f5	0f	2	Filtered Engine Fuel Press Gauge
3500B	f5	10	2	Low Idle Speed
3500B	f5	11	2	Intake Manifold Air Temp
3500B	f5	15	2	Percent Droop
3500B	f5	1f	2	Right Air Filter Restriction
3500B	f5	20	2	Left Air Filter Restriction
3500B	f5	25	2	Fuel Consumption Rate
3500B	f5	3e	2	Engine Oil Temp
3500B	f8	14	6	Application Software Part Number
3500B	f8	1a	7	Vehicle System ID
3500B	fc	07	8	Warning Status
3500B	fc	08	8	Shutdown Status
3500B	fc	09	8	Engine Derate Status
EMCP2	00	0d	1	EMCP2 Remote Fault Reset
EMCP2	00	40	2	EMCP2 Generator Set Engine RPM
EMCP2	00	42	2	EMCP2 Generator Set Ring Gear Teeth Setpoint
EMCP2	00	44	2	EMCP2 Engine Coolant Temperature
EMCP2	00	54	2	EMCP2 Engine Oil Pressure kPa
EMCP2	00	5e	2	EMCP2 Generator Set Hourmeter
EMCP2	00	80	11	EMCP2 Device ID Code
EMCP2	00	82	12	EMCP2 GSC Fault Log Codes Status and Number of Occurrences
EMCP2	00	83	3	EMCP2 GSC Fault Log Request for Additional Data
EMCP2	00	84	13	EMCP2 GSC Fault Log Response for Additional Information
EMCP2	f0	13	1	EMCP2 System Battery Voltage
EMCP2	f0	14	1	EMCP2 GSC Cooldown Timer Setpoint

Engine Type	PID1	PID2	Extraction Method (see Section 8.3)	Keyword / Parameter
EMCP2	f0	2a	1	EMCP2 Remote Start Status
EMCP2	f0	8f	1	EMCP2 Engine Control Switch Position
EMCP2	f0	b0	1	EMCP2 Generator Phase Select
EMCP2	f0	b1	1	EMCP2 Remote Emergency Stop
EMCP2	f0	b2	1	EMCP2 Cooldown Override Control
EMCP2	f0	b3	1	EMCP2 Generator AC Voltage Full Scale and External Potential Transformer Setpoint
EMCP2	f0	b4	1	EMCP2 Generator AC Current Full Scale Setpoint
EMCP2	f1	d3	1	EMCP2 Generator Phase A Power Factor Lead/Lag Status
EMCP2	f1	d4	1	EMCP2 Generator Phase B Power Factor Lead/Lag Status
EMCP2	f1	d5	1	EMCP2 Generator Phase C Power Factor Lead/Lag Status
EMCP2	f1	d6	1	EMCP2 Generator Average Power Factor Lead/Lag Status
EMCP2	f2	13	1	EMCP2 Remote Start Initiate
EMCP2	f2	cb	1	EMCP2 EPG Circuit Breaker Status
EMCP2	f2	cc	1	EMCP2 Remote Generator Synchronizer Control
EMCP2	f2	d6	1	EMCP2 Remote Synchronization Control Readiness
EMCP2	f2	d7	1	EMCP2 Generator Synchronizer Control Status
EMCP2	f4	40	2	EMCP2 Right Exhaust Temperature
EMCP2	f4	41	2	EMCP2 Left Exhaust Temperature
EMCP2	f4	42	2	EMCP2 Generator RMS Voltage Phase A-B
EMCP2	f4	43	2	EMCP2 Generator RMS Voltage Phase B-C
EMCP2	f4	44	2	EMCP2 Generator RMS Voltage Phase C-A
EMCP2	f4	45	2	EMCP2 Generator RMS Voltage Phase A to Neutral
EMCP2	f4	46	2	EMCP2 Generator RMS Voltage Phase B to Neutral
EMCP2	f4	47	2	EMCP2 Generator RMS Voltage Phase C to Neutral
EMCP2	f4	48	2	EMCP2 Generator Phase A RMS Current
EMCP2	f4	49	2	EMCP2 Generator Phase B RMS Current
EMCP2	f4	4a	2	EMCP2 Generator Phase C RMS Current
EMCP2	f4	4b	2	EMCP2 Generator Frequency
EMCP2	f4	4c	2	EMCP2 GSC Relay Status
EMCP2	f4	4d	2	EMCP2 GSC Relay Control
EMCP2	f4	60	2	EMCP2 GSC Alarm Status
EMCP2	f4	61	2	EMCP2 GSC Shutdown Status
EMCP2	f4	62	2	EMCP2 GSC Spare Fault Alarm Status
EMCP2	f4	63	2	EMCP2 GSC Spare Fault Shutdown Status
EMCP2	f4	64	2	EMCP2 Generator Line-Line Voltage
EMCP2	f4	65	2	EMCP2 Generator Line Current
EMCP2	f4	66	2	EMCP2 Engine Overspeed Setpoint
EMCP2	f4	67	2	EMCP2 Engine Oil Step Speed Setpoint
EMCP2	f4	68	2	EMCP2 Low Engine Oil Pressure at Rated Speed Setpoint
EMCP2	f4	69	2	EMCP2 Low Engine Oil Pressure at Idle Speed Setpoint
EMCP2	f4	6a	2	EMCP2 High Engine Coolant Temperature Setpoint
EMCP2	f4	6b	2	EMCP2 Low Engine Coolant Temperature Setpoint
EMCP2	f4	6c	2	EMCP2 GSC Configuration
EMCP2	f4	6d	2	EMCP2 Remaining Cooldown Time

Engine Type	PID1	PID2	Extraction Method (see Section 8.3)	Keyword / Parameter
EMCP2	f4	c3	2	EMCP2 Generator Average RMS Voltage
EMCP2	f4	c4	2	EMCP2 Generator Total RMS Current
EMCP2	f4	c7	2	EMCP2 Generator Power
EMCP2	f4	c8	2	EMCP2 Generator Phase A Power Factor
EMCP2	f4	c9	2	EMCP2 Generator Phase B Power Factor
EMCP2	f4	ca	2	EMCP2 Generator Phase C Power Factor
EMCP2	f4	cb	2	EMCP2 Generator Average Power Factor
EMCP2	f4	cf	2	EMCP2 Generator Bus Frequency
EMCP2	f4	d0	2	EMCP2 Generator Bus RMS Voltage
EMCP2	f4	d1	2	EMCP2 Generator Set Control Output Status
EMCP2	f4	d2	2	EMCP2 Generator Set Shutdown Status Extension #1
EMCP2	f5	0b	2	EMCP2 Cycle Crank Time Setpoint
EMCP2	f5	0c	2	EMCP2 GSC Total Crank Time Setpoint
EMCP2	f5	0d	2	EMCP2 GSC Crank Terminate Speed Setpoint
EMCP2	f5	3e	2	EMCP2 Engine Oil Temperature
EMCP2	f5	57	2	EMCP2 Bus to Generator Phase Difference
EMCP2	f8	14	9	EMCP2 Application Software Part Number
EMCP2	fc	0d	8	EMCP2 Spare Outputs
EMCP2	fc	0f	5	EMCP2 Generator Total Real Power
EMCP2	fc	10	8	EMCP2 Relay Driver Module Relay State
EMCP2	fc	11	5	EMCP2 Generator Phase A Real Power
EMCP2	fc	12	5	EMCP2 Generator Phase B Real Power
EMCP2	fc	13	5	EMCP2 Generator Phase C Real Power
EMCP2	fc	14	5	EMCP2 Generator Phase A Reactive Power
EMCP2	fc	15	5	EMCP2 Generator Phase B Reactive Power
EMCP2	fc	16	5	EMCP2 Generator Phase C Reactive Power
EMCP2	fc	17	5	EMCP2 Generator Total Reactive Power
EMCP2	fc	18	5	EMCP2 Generator Phase A Apparent Power
EMCP2	fc	19	5	EMCP2 Generator Phase B Apparent Power
EMCP2	fc	1a	5	EMCP2 Generator Phase C Apparent Power
EMCP2	fc	1b	5	EMCP2 Generator Total Apparent Power
EMCP2	fc	1c	5	EMCP2 Generator Total kW hours
EMCP2	fc	1d	5	EMCP2 Generator Total kVAR hours
EMCP2	fc	1e	8	EMCP2 Generator Shutdown Status
EMCP2	fc	1f	8	EMCP2 Generator Alarm Status

8.3 Data Extraction Methods

These methods correspond to data formats described in the CATM5X protocol document. Each parameter (PID) is assigned a data format by Caterpillar. The format defines the number of data bytes and their internal arrangement.

#	Format	Implemented	Length
1	A	Yes	1
2	AA	Yes	1
3	AAB	Yes	2
4	CDDEE	No	3
5	AAAA	Yes	1
6	10 x A	Yes	10
7	17 x A	No	17
8	ABCD	Yes	4
9	8 x A	Yes	10
10	AB	Yes	2
11	AABBCC	Yes	3
12	AAB[C]	Yes	3
13	AAB[CDDEE]	Yes	5
14	AABB	No	2

8.4 Driver Error Messages

Message	Explanation
CatM5X:#1 Error. Node=<%s> not connected to a port.	This protocol requires that Nodes are connected to ports as the driver checks the relationship between the port, the Node_ID and port a message was received on. [2]
CatM5X:#2 Error. Node=<%s> Station Rqd/Actual=(0-255)/%d.	Valid Node_ID are 0–255. Not all of the values correspond to legal Unit ID's defined by Caterpillar, however. The Node_ID must be specified as a decimal number. Thus engine $21 should be specified as 33. [2]
CatM5X:#3 Error. Invalid PID. Map Descriptor=<%s> requires a catParam.	The PID provided is not recognized by the driver. The keyword may have been misspelled or mis-spaced. If using the catPID1/2 parameters, then specify a method also. [2] OR A PID1/2 was specified that is not available in the list of supported PID's. This problem can be avoided by specifying a catMethod. See **Section 8.3**. [2]
CATM5X:#4 Error. Polls from Masters only	CATM5X messages contain a field indicating whether the poll is from a Client or Server. If the driver receives a message from a Server when it isn't expecting one then this message is printed. This could occur if a response was received after the driver acting as a Client timed out waiting for the response. In these circumstances, the incoming message is sent to the Server side of the driver which then prints this message because the Server side expects a poll not a response. This message is printed once and then suppressed. It can be monitored by watching the driver specific stats (**Section 8.5**). If this event occurs repeatedly then capture a serial log and contact Tech Support. Run the log for long enough to capture one of these events. You can determine this by watching the stats and ensuring the stat which monitors this event increases by at least one count during the course of the log. If the event occurs infrequently and the data from the engine is still updating, the message may be ignored.
CATM5X.#5 Error. Expected/Rcvd Function (34 or 24)/%c%c	These messages are associated with driver events that cause the FieldServer to panic. You cannot correct the problem and should call FieldServer support.
CATM5X:#6 Error. Driver cannot process IID=%x(h)	
CATM5X:#7 Error. Storing. Method for PID %x %x is unknown.	

[2] Download the CSV file, make the necessary adjustments, upload the file and reset the FieldServer.

Message	Explanation
CATM5X:#8 Error. Incoming data from unit=%x(hex) is being abandoned.	This message is produced when data is being written to the FieldServer but the FieldServer cannot find a Map Descriptor to process the message with. For example, an ECM Hourmeter is being written to the FieldServer but a Map Descriptor with catParam = “ECM Hourmeter” cannot be found. The error message will identify the unit the message originated from and the PID1/2 of the incoming data. [3]
CATM5X:#9 Error. Responses from CCM's only	These messages are associated with driver events that cause the FieldServer to panic. Take a log and contact FieldServer support.
CATM5X:#10 Error. Expected/Rcvd Function 35/%c%c	
CATM5X:#11 Error. Expected/Rcvd Unit 61/%c%c	
CATM5:X#12 Error. Expected/Rcvd PID F012/%c%c%c%c	
CATM5X:#13 Error. Responses from CCM's only	
CATM5X:#14 Error. Expected/Rcvd Function (25 or 35)/%c%c	
CATM5X:#15 Error. Driver cannot process IID=%x(h)	
CATM5X#16 Error. Cannot Login. Incorrect Password.	Determine the correct password for the Caterpillar device.[3]
CATM5X:#17. FYI. Logged in. Level= %d	The driver is reporting the access level at which it has logged into the remote device. This is an information message which may be ignored.
CatM5X:#18 Error. Method Not Supported. Map Descriptor=<%s>	The data extraction method specified in the csv file is not supported. **Section 8.3** lists supported methods. [3]
CATM5X:19 Error. Data Method for PID %x %x is unknown.	This error should have been prevented by the driver. If an invalid method has been specified in the CSV file then error 18 should be produced. If this error is produced without error 18 in the log file then call FieldServer support.
CATM5X:#20.%d Err.Retriving. Array <%s> too short. Index=%d	The Data Array offset specified is too large as its points beyond the end of the Data Array. When sending a response (as a Server) the driver is trying to extract data beyond the end of the array. This could arise as some methods use more than one array location to get data to build the response. For example, if the method requires 4 consecutive array locations and the offset specified is that last location in the array then this will produce an error. [3]
CATM5X:#21.%d Err. Storing. Array <%s> too short. Index=%d	

[3] Download the CSV file, make the necessary adjustments, upload the file and reset the FieldServer.

Message	Explanation
CATM5X:#22 FYI. Node is responding with Node_ID=%d	This message is printed when a node is polled as Node_ID zero but responds with another Node_ID. This is part of the auto discovery system. The message can be ignored, but it is recommended that the configuration file is changed to specify the Node_ID of the station that is responding. Once specifically configured there is no possibility of confusion if a second engine controller is introduced on the same communications port.

8.5 Driver Stats

In addition to the standard FieldServer communication statistics described in the FieldServer Configuration Manual, the driver can expose certain key stats by writing data to a Data Array. A special Map Descriptor named “catm5x-stats” is required.

The following lines may be added to the configuration file to activate these stats.

```
// Expose Driver Operating Stats.

Data_Arrays
Data_Array_Name          , Data_Format   , Data_Array_Length
catm5x-stats             , UINT32        , 200
```

In the table below, Stat # refers to the ***relative*** offset into the “catm5x-stats” Data Array where the data will be stored. To determine the actual offset, add a Base Offset to the Stat #. The Base Offset is calculated by multiplying the port handle number by 100.

Stat #	Stats	Description
1	CAT_STAT_NO_START	The driver received a message which contained an invalid byte in the 1st byte of the message. All catm5x messages begin with a fixed header of 2 bytes. If this occurs repeatedly then it may indicate that the connections setting such as baud or parity are incorrect. This stat increments by 1 each time this occurs.
2	CAT_STAT_NO_START2	The driver received a message which contained an invalid byte in the 2nd byte of the message. All catm5x messages begin with a fixed header of 2 bytes. If this occurs repeatedly then it may indicate that the connections setting such as baud or parity are incorrect. This stat increments by 1 each time this occurs.
3	CAT_STAT_COMPL_CR_BAD	The driver received a message that was not correctly formatted. More than 132 bytes had been received but a 'CR' had still not been found. The message will be rejected.
4	CAT_LOGIN_RESPONSE	This stat increments by 1 each time a valid login response is received.
5	CAT_LOGIN_RESPONSE_BAD	This stat increments by 1 each time a invalid login response is received.
6	CAT_STAT_COMPL_CHKSUM	This stat increments by 1 each time a message with an invalid checksum is received. The message will be rejected.

Stat #	Stats	Description
7	CAT_STAT_STORE_NO_MAP	This stat increments by 1 each time a message with a data payload is processed but the driver cannot find a Map Descriptor to use to determine where to store the data. This stat is associated with Error message CATM5X:#8 which is only printed once and then suppressed.
8	CAT_STAT_BAD_PASSWORD	Increments by 1 each time a login attempt was rejected by the CCM because the password was invalid.
9	CAT_STAT_NOT_FROM_ MASTER	Increments by 1 each time the Server side of the driver receives a message that didn't come from a Client. The driver stores the two bytes which indicate the message origin in stat 10 and stat 11. These two stat locations are overwritten each time this event occurs. Read the notes associated with error message CATM5X:#4.
10	CAT_STAT_NOT_FROM_ MASTER_BYTE0	
11	CAT_STAT_NOT_FROM_ MASTER_BYTE1	