

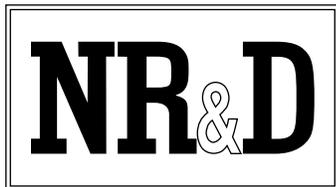
# MUCM Modbus CCM

## Installation and Programming Manual

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This Manual describes the MUCM application for interfacing the Caterpillar Modbus CCM Gateway to a PowerLogic Modbus serial network.

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## Introduction

The Niobrara MUCM is a Modicon Momentum<sup>®</sup> compatible module that is capable of running multiple applications for performing data translations between serial protocols. The Caterpillar MCCM provides a Modbus RTU serial slave for a GENSET. Many of the data structures presented by the MCCM require the Modbus master to perform complex mathematical conversions to get the data into useful forms. This document covers an MUCM application which polls up to 32 MCCMs and performs the math on the data to allow easier access by the Modbus Master.

The MUCM connects to the MCCMs through serial port two using 2-wire RS-485. The MUCM automatically polls the gensets, observing its limitations on register starting address and count. This data is then presented to the port one using RS-485 connector of the MUCM to connect to any standard Modbus RTU network.

The MUCM is configured by altering a block of Holding Registers (4x) through port one using any Modbus register editor such as ZAPREG32.EXE or NRDTOOL.EXE. This configuration consists of the setup for the Modbus RTU master and slave ports.

Port one of the MUCM connects to a standard Modbus RTU network in either 2-wire or 4-wire mode. The default Modbus address for the MUCM is 100. The address can be changed by editing register 500 in the MUCM. Any valid and available Modbus address may be used for the MUCM. No two devices may have the same Modbus address on the Modbus network. The baud rate (default=19200), data bits (default=8), parity (default=NONE).

This MUCM application does not support a Momentum communications tophat. It is advisable to cover the opening where a tophat would normally connect to protect the exposed circuit board. NR&D part number METH-001 is an inexpensive empty tophat case sold for this purpose.

Only one of the two application areas are used for this data concentrator application: `mucm_mccm_app1.qcm` is compiled and loaded into application area 1 of the MUCM.

The MUCM a source of 9 to 30 Volts, AC or DC. An ideal 12VAC transformer is available from NR&D as part number TR121-ST.

A complete kit may be ordered from Niobrara that includes the MUCM with this application pre-loaded, METH, MU1, and TR121-ST. The Niobrara for a part number for the kit is MCP-174.

## Installation

Installation of the MUCM should go quickly, with the necessary materials. The following items are necessary:

- MUCM+103
- MU1 cable (or equivalent can be built; see Figure 2-1) for connecting to a PC for configuration and loading of the application and module firmware.
- Power source for MUCM (use NR&D part TR121-ST or available power).
- Cabling between MUCM and Modbus Master may be built or purchased.
- PC with RS-232 port.

The following may be used:

- DIN rail for mounting.
- Empty Momentum tophat plastic to close MUCM case (NR&D part METH-001).

### Module Installation

- 1 Mount the MUCM on a DIN rail, or mount as desired using screws through the two holes provided. The DIN rail or mounting screws should be Earth-grounded for the MUCM serial ports' transient suppression.
- 2 Supply power to the MUCM; NR&D's TR121-ST may be used, or any available power source 9-30 Volts AC or DC.

### Software Installation

The application files for the MUCM are included in the MUCM\_MCCM\_APP1.EXE file. The latest version of this file is located at <http://www.niobrara.com>

Follow the link for "Application Notes", select "MUCM", and "MCCM".

# Serial Connections to the MUCM

## Port 1 to PC

The Niobrara MU1 cable is used to connect the MUCM to a standard PC-style 9-pin RS-232 serial port. For other standard connections, see the MUCM manual, or contact NR&D's technical support.

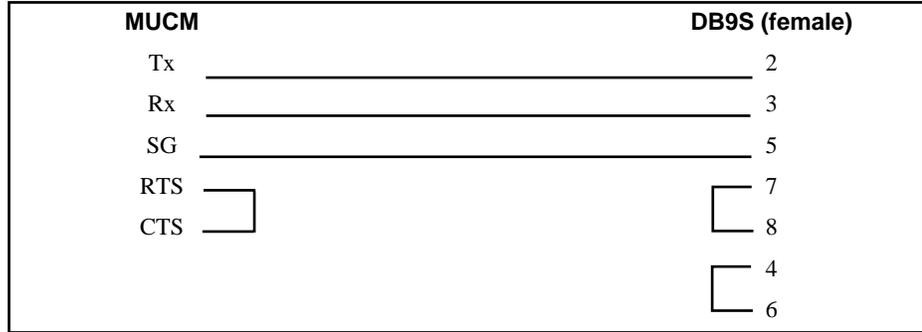


Figure 2-1 MUCM to PC RS-232 (MU1 Cable)

## Ports 1 and 2 to Modbus RS-485 Network

Ports 1 and 2 of the MUCM can be RS-485 and supports a 4-wire or 2-wire cable network. Twisted pair cable should be used. 2-wire RS-485 slaves are supported by the MUCM by jumpering the TX+ and RX+ together to make the (+) connection and the TX- and RX- together for the (-) connection.

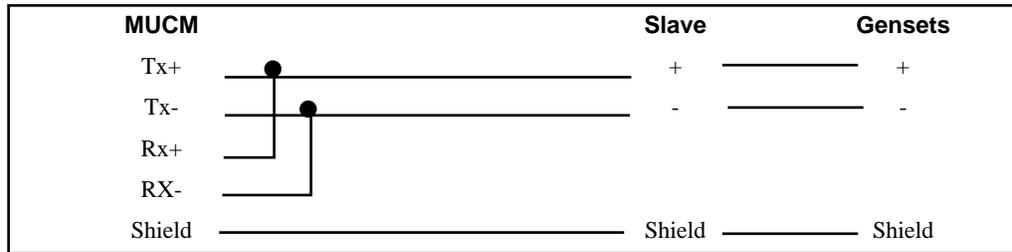


Figure 2-2 MUCM to 2-wire Modbus Network

4-wire RS-485 networks are directly supported by the MUCM. Connect the MUCM RX+ to the Master's TX+, RX- to TX-, TX+ to RX+, and finally TX- to RX-.

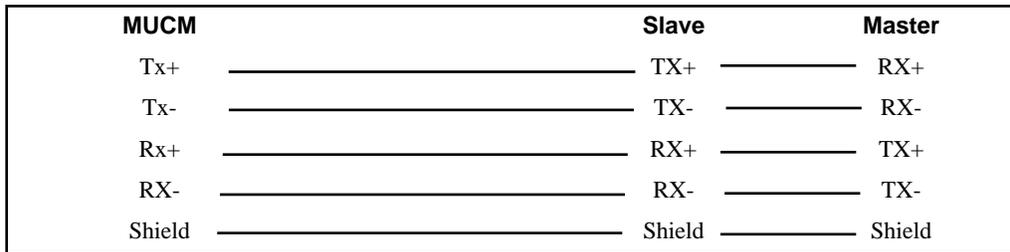


Figure 2-3 MUCM to 4-wire Modbus Network

## Loading the Applications into the MUCM

**NOTICE:** *If the kit MCP-174 was ordered, then the application is already installed and this section may be skipped.*

The MUCM is rapidly evolving so be sure to upgrade the firmware in the module before loading the latest version of MUCM\_MCCM\_APP1.QCC. Most likely the QCOMPILE.EXE has been updated so be sure to use the newest version. Firmware upload is as follows:

### FWLOAD MUCM Firmware Update.

If the MUCM has corrupt firmware or completely non-responsive then new firmware may be loaded with the program FWLOAD.

Firmware upload is as follows:

- 1 Move the yellow RUN/LOAD switch near the power connector to LOAD.
- 2 Only the light 3 should be on.
- 3 Connect the PC to the MUCM, RS-232 connector of Port 1 with a MU1 cable.
- 4 Set the Mode selection switch of Port 1 to RS-232 mode.
- 5 Locate the and start the program FWLOAD.EXE. This program may be accessed by "Start, Programs, Niobrara, MUCM, Fwload MUCM Firmware".
- 6 If the above start menu link was followed, the proper MUCM.FWL file will be loaded. Otherwise, click on the Browse button and select c:\Niobrara\Firmware\mucm.fwl for an MUCM.
- 7 Select the PC's serial port (COM1).
- 8 Press START to begin the download process. If difficulty is experienced in completing the download, try marking the Slow box and pressing start again.
- 9 When the download is completed, move the yellow LOAD/RUN switch back to RUN.

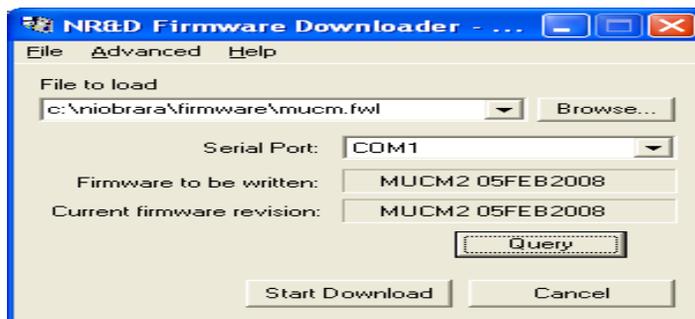
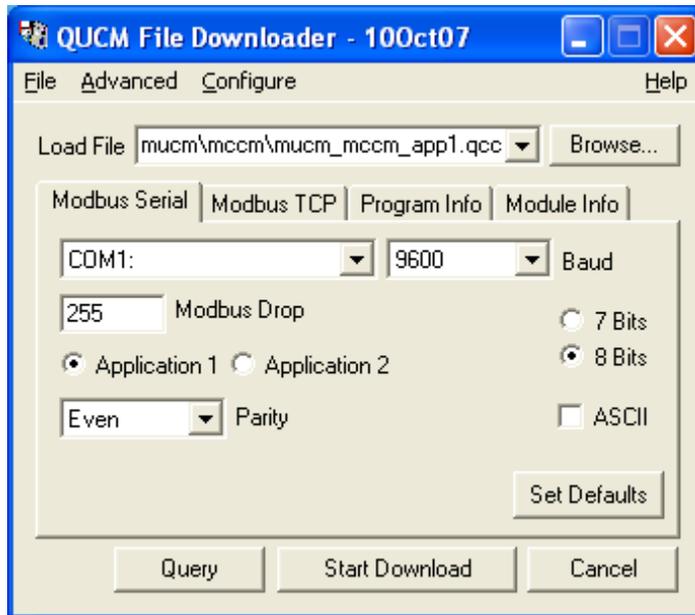


Figure 2-4 FWLOAD

## QLOAD MUCM\_MCCM\_APP1

If the MCCM application is already loaded into the MUCM goto Setup Ports section of the manual.



**Figure 2-5 QLOAD of APP1**

- 1 The RUN/LOAD switch must be in RUN.
- 2 Application Switches 1 (left) and 2 (right) must be in HALT.
- 3 Start QLOAD.EXE The Start Menu link is "Start, Programs, Niobrara, MUCM, Apps, Mccm, QLOAD Mccm Application 1".
- 4 Click on the Browse button and select the file MUCM\_MCCM\_APP1.QCC.
- 5 Select the Application 1 Radio Button.
- 6 Verify the following:
  - (1) The Modbus Serial tab is selected.
  - (2) The PC's com port is selected (COM1).
  - (3) The baud rate is set for 9600.
  - (4) The Modbus Drop is set to 255.
  - (5) The ASCII button is **NOT** checked.
  - (6) The 8 bits button is selected.
  - (7) The parity is set for EVEN.
- 7 Press the Start Download button. QLOAD will open a progress window to show the status of the download.

- 8 After downloading the application, Move Switch 1 to RUN. The RN1 light should be on and red light number 4 should be flashing very rapidly this happens because there are no slave devices configured.

## Setup Ports and MUCM address

Several registers need to be modified in the MUCM for proper operation of the MCCM software. The settings for ports 1 and 2, the address for the MUCM, and the slave index for each genset. These register can be easily edited with NRD-TOOL.EXE. The default address for the MUCM is 100. The default port settings for the MUCM are shown in Table 2-1.

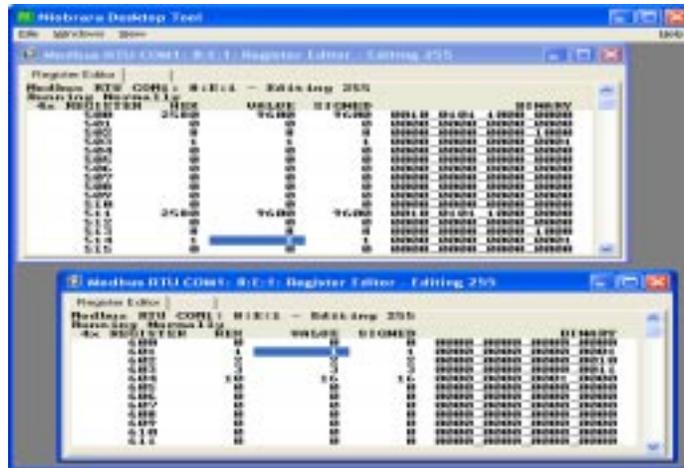


Figure 2-6 NRDTOOL.EXE

Table 2-1 MUCM Port Default Settings

Setting	Port 1 Value	Port 2 Value
Protocol Mode	Modbus RTU	Modbus RTU
Baud Rate	19200	19200
Parity	NONE	NONE
Data Bits	8	8
Stop Bits	1	1

Do the following to change the port settings and MUCM address:

- 1 Application Switches 1 (left) must be in RUN and 2 (right) must be in HALT.
- 2 Port 1 mode selection switch needs to be in RS-232 mode.
- 3 Start NRDTOOL.EXE The Start Menu link is "Start, Programs, Niobrara, NRD-TOOL".
- 4 Select the File Menu, Open Connection.
- 5 Verify the following in the Open Connection window.
  - a. Click the Modbus RTU tab.
    - (1) Port is COM1:.

- (2) Baud is 19200.
  - (3) Parity is NONE.
  - (4) Data Bits is 8.
  - (5) Stop Bits is 1.
  - (6) Max is 5000.
  - (7) Default Slave is 100 or 255.
  - (8) 4x Registers radio button is selected.
  - (9) Enable Register Editor is checked.
  - (10) Do not process XML is checked.
  - (11) Slave Address is 100.
  - (12) Starting Register is 1.
  - (13) Read Count is 0.
- b. Click the Connect button or press Enter to make the connection.
- 6 Use the arrow keys to place the cursor in the 4x Register column.
- a. To move quickly to the correct registers type the number 500 in this column and press Enter.
- 7 Register 500 is the address for the MUCM. Any available Modbus address may be used.
- a. Using the arrow keys move over to the Value column, Enter the new setting and press enter. Accessing this address will allow the modification of the MUCM setup parameters while it is in service..
- 8 Using the Tables 2-2, and 2-3 below setup Ports 1 and 2.
- a. Using the arrow keys move over to the Value column, Enter the new setting and press enter. Do this for each of the registers and for each port.

**Table 2-2 MUCM Port 1 register list.**

Port 2	Register	Range
Baud	501	2400-38400
Parity	502	0=NONE, 1=EVEN, 2=ODD

**Table 2-3 MUCM Port 2 register list.**

Port 1	Register	Range
Baud	511	2400-38400
Parity	512	0=NONE, 1=EVEN, 2=ODD

## Setup Slave Addresses

The slave index or address needs to be set so the MCCM software can begin polling the gensets. Use NRDTOOL.EXE to setup these registers.

Do the following to setup the slaves:

- 1 Application Switches 1 (left) must be in RUN and 2 (right) must be in HALT.
- 2 Port 1 mode selection switch needs to be in RS-232 mode.
- 3 Start NRDTOOL.EXE The Start Menu link is "Start, Programs, Niobrara, NRD-TOOL".
- 4 Select the File Menu, Open Connection.
- 5 Verify the following in the Open Connection window.
  - a. Click the Modbus RTU tab.
    - (1) Port is COM1:.
    - (2) Baud is 19200.
    - (3) Parity is NONE.
    - (4) Data Bits is 8.
    - (5) Stop Bits is 1.
    - (6) Max is 5000.
    - (7) Default Slave 100.
    - (8) 4x Registers radio button is selected.
    - (9) Enable Register Editor is checked.
    - (10) Do not process XML is checked.
    - (11) Slave Address is 100.
    - (12) Starting Register is 1.
    - (13) Read Count is 0.
  - b. Click the Connect button or press Enter to make the connection.
- 6 Using the arrow keys, move the cursor over to the 4x Register column and type in 521. This allows quick movement to the desired register.
  - a. Registers 521-552 contain the slave indexes for the connected gensets. Example: If the first genset is slave 1 then you would put the number 1 in register 521. If the second genset is at slave 5 then you would put the number 5 in register 522. Any available slave address 1-254 maybe used.
- 7 Setup is complete.
- 8 Disconnect the PC.
- 9 Move the Port 1 mode selection switch into RS-485 mode.
- 10 Move the Application Switches 1 (left) into RUN.

The MUCM will immediately start polling the gensets connected to port 2. If it is successful in communicating with the gensets then it will present the data to port 1. If the gensets are not responsive, then the MUCM will ignore Modbus RTU messages.

## Modbus Operation

This MUCM application uses Port 1 and Port 2 for Modbus communication. By default, Ports 1 and 2 are set for Modbus RTU, 19200 baud, 8 data bits, 1 stop bit, NONE parity. Port 1 is connected to the HMI or SCADA system. Port 2 is connected to the MUCM slave devices. The MUCM will poll the down stream devices, do conversions, and present the data to Port 1. If the original data without the conversion is needed. Use Modbus opcode 4 - Read Input Registers. The MUCM will receive this command, poll the generator and pass the data to port 1.

### Device Register List

**Table 3-1 MUCM and Genset register list.**

CCM Register	Description of Register	MUCM Register	Range/ Value	Units
100	Average line-line AC RMS Voltage	1	0 to 64255	V
101	Avg. AC RMS Current	2	0 to 64255	A
102	Avg. AC RMS Frequency	3	0 to 501 times 100	Hz
103	Overall Power Factor	4	-1 to 1 times 100	
104	Overall Power Factor Lagging	5	00 = Power factor leading 01 = Power factor lagging 10 = Error 11 = Not Available	
105	Total percent kW	6	-251 to 250	%
106-107	Total Real Power	7-8	-2000000000 to 2211081215	W
108	Phase A line-line AC RMS Voltage	9	0 to 64255	V
109	Phase B line-line AC RMS Voltage	10	0 to 64255	V
110	Phase C line-line AC RMS Voltage	11	0 to 64255	V
111	Phase A AC RMS Current	12	0 to 64255	V

CCM Register	Description of Register	MUCM Register	Range/ Value	Units
112	Phase B AC RMS Current	13	0 to 64255	A
113	Phase C AC RMS Current	14	0 to 64255	A
114	Phase A line-neutral AC RMS Voltage	15	0 to 64255	V
115	Phase B line-neutral AC RMS Voltage	16	0 to 64255	V
116	Phase C line-neutral AC RMS Voltage	17	0 to 64255	V
117-118	Phase A Real Power	18-19	-2000000000 to 2211081215	W
119-120	Phase B Real Power	20-21	-2000000000 to 2211081215	W
121-122	Phase C Real Power	22-23	-2000000000 to 2211081215	W
123-124	Phase A Apparent Power	24-25	-2000000000 to 2211081215	VA
125-126	Phase B Apparent Power	26-27	-2000000000 to 2211081215	VA
127-128	Phase C Apparent Power	28-29	-2000000000 to 2211081215	VA
129-130	Phase A Reactive Power	30-31	-2000000000 to 2211081215	VA
131-132	Phase B Reactive Power	32-33	-2000000000 to 2211081215	VA
133-134	Phase C Reactive Power	34-35	-2000000000 to 2211081215	VA
135	Phase A Power Factor	36	-1 to 1 times 100	
136	Phase B Power Factor	37	-1 to 1 times 100	
137	Phase C Power Factor	38	-1 to 1 times 100	
138-139	Total Apparent Power	39-40	-2000000000 to 2211081215	VA
140	Total Percent kVA	41	-251 to 250	%
141-142	Total Reactive Power	42-43	-2000000000 to 2211081215	VA
143	Total Percent kVAr	44	-251 to 250	%
144-145	Total kW Hours Export	45-46	0 to 4211081215	kWh
146-147	Total kVAr Hours Export	47-48	0 to 4211081215	kVArh
148	Avg. line-neutral AC RMS Voltage	49	0 to 64255	V
149	Front Bearing Temp. from Data Link	50	-273 to 1735 times 10	C
		211	-459 to 3155 times 10	F
150	Rear Bearing Temp. from Data Link	51	-273 to 1735 times 10	C
		212	-459 to 3155 times 10	F
151	Phase A Winding Temp. from Data Link	52	-273 to 1735 times 10	C
		213	-459 to 3155 times 10	F
152	Phase B Winding Temp. from Data Link	53	-273 to 1735 times 10	C
		214	-459 to 3155 times 10	F
153	Phase C Winding Temp. from Data Link	54	-273 to 1735 times 10	C
		215	-459 to 3155 times 10	F
159	Phase A Power Factor Lagging	60	00 = Power factor leading 01 = Power factor lagging 10 = Error 11 = Not Available	
160	Phase B Power Factor Lagging	61	00 = Power factor leading 01 = Power factor lagging 10 = Error 11 = Not Available	

CCM Register	Description of Register	MUCM Register	Range/ Value	Units
161	Phase C Power Factor Lagging	62	00 = Power factor leading 01 = Power factor lagging 10 = Error 11 = Not Available	
162	Rear Bearing Temp. from I/O Pin	63 216	-273 to 1735 times 10 -459 to 3155 times 10	C F
163	Avg. line-line AC RMS Voltage Percent	64	-251 to 250	%
200	Engine Oil Pressure	65 264	0 to 8031 0 to 1165 times 10	kPa PSI
201	Engine Coolant Temp.	66 217	-273 to 1735 times 10 -459 to 3155 times 10	C F
202	Battery Voltage	67	0 to 3212 times 100	V
203	Engine rpm	68	0 to 8031	RPM
204-205	Engine operating Hours	69-70	0 to 210554060	Hours
206	Automatic Start/Stop State	71	0000 = INIT 0001 = PRE_CRANK 0010 = STARTING 0011 = RUNNING 0100 = PRE_COOLDOWN 0101 = COOLDOWN 0110 = STOPPING 0111 = STOPPED 1000 = IDLING	
207	Spare Analog Input Percentage	72	-251 to 250	%
208	Spare Analog Input Temp.	73 218	-273 to 1735 times 10 -459 to 3155 times 10	C F
209	Spare Analog Input Pressure	74 265	0 to 8031 0 to 1165 times 10	kPa PSI
210	Service Maintenance Interval Hours Remaining	75	-32127 to 32128	Hours
212	Service Maintenance Interval Days Remaining	76	-32127 to 32128	Days
213-214	Number of Crank Attempts	77-78	0 to 4211081215	
215-216	Number of Successful Starts	79-80	0 to 4211081215	
217	Engine Oil Pressure from Data Link	81 266	0 to 8031 0 to 1165 times 10	kPa PSI
219	Engine Coolant Temp. from Data Link	82 219	-273 to 1735 times 10 -459 to 3155 times 10	C F
221	Cylinder #1 Exhaust Port Temp. from Data Link	83 220	-273 to 1735 times 10 -459 to 3155 times 10	C F
222	Cylinder #2 Exhaust Port Temp. from Data Link	84 221	-273 to 1735 times 10 -459 to 3155 times 10	C F
223	Cylinder #3 Exhaust Port Temp. from Data Link	85 222	-273 to 1735 times 10 -459 to 3155 times 10	C F
224	Cylinder #4 Exhaust Port Temp. from Data Link	86 223	-273 to 1735 times 10 -459 to 3155 times 10	C F
225	Cylinder #5 Exhaust Port Temp. from Data Link	87 224	-273 to 1735 times 10 -459 to 3155 times 10	C F

CCM Register	Description of Register	MUCM Register	Range/ Value	Units
226	Cylinder #6 Exhaust Port Temp. from Data Link	88 225	-273 to 1735 times 10 -459 to 3155 times 10	C F
227	Cylinder #7 Exhaust Port Temp. from Data Link	89 226	-273 to 1735 times 10 -459 to 3155 times 10	C F
228	Cylinder #8 Exhaust Port Temp. from Data Link	90 227	-273 to 1735 times 10 -459 to 3155 times 10	C F
229	Cylinder #9 Exhaust Port Temp. from Data Link	91 228	-273 to 1735 times 10 -459 to 3155 times 10	C F
230	Cylinder #10 Exhaust Port Temp. from Data Link	92 229	-273 to 1735 times 10 -459 to 3155 times 10	C F
231	Cylinder #11 Exhaust Port Temp. from Data Link	93 230	-273 to 1735 times 10 -459 to 3155 times 10	C F
232	Cylinder #12 Exhaust Port Temp. from Data Link	94 231	-273 to 1735 times 10 -459 to 3155 times 10	C F
233	Cylinder #13 Exhaust Port Temp. from Data Link	95 232	-273 to 1735 times 10 -459 to 3155 times 10	C F
234	Cylinder #14 Exhaust Port Temp. from Data Link	96 233	-273 to 1735 times 10 -459 to 3155 times 10	C F
235	Cylinder #15 Exhaust Port Temp. from Data Link	97 234	-273 to 1735 times 10 -459 to 3155 times 10	C F
236	Cylinder #16 Exhaust Port Temp. from Data Link	98 235	-273 to 1735 times 10 -459 to 3155 times 10	C F
237	Cylinder #17 Exhaust Port Temp. from Data Link	99 236	-273 to 1735 times 10 -459 to 3155 times 10	C F
238	Cylinder #18 Exhaust Port Temp. from Data Link	100 237	-273 to 1735 times 10 -459 to 3155 times 10	C F
239	Cylinder #19 Exhaust Port Temp. from Data Link	101 238	-273 to 1735 times 10 -459 to 3155 times 10	C F
240	Cylinder #20 Exhaust Port Temp. from Data Link	102 239	-273 to 1735 times 10 -459 to 3155 times 10	C F
241	Exhaust Manifold #1 Temp. from Data Link	103 240	-273 to 1735 times 10 -459 to 3155 times 10	C F
242	Exhaust Manifold #2 Temp. from Data Link	104 241	-273 to 1735 times 10 -459 to 3155 times 10	C F
243	Intake Manifold #1 Temp. from Data Link	105 242	-273 to 1735 times 10 -459 to 3155 times 10	C F
244	Intake Manifold #2 Temp. from Data Link	106 243	-273 to 1735 times 10 -459 to 3155 times 10	C F
245	Engine Oil Temp. from Data Link	107 244	-273 to 1735 times 10 -459 to 3155 times 10	C F
246	Engine Fuel Temp. from Data Link	108 245	-273 to 1735 times 10 -459 to 3155 times 10	C F
247	Fuel Pressure from Data Link	109 267	0 to 8031 0 to 1165 times 10	kPa PSI
248	Crankcase Pressure from Data Link	110 268	-250 to 251 -362 to 364 times 10	kPa PSI
249	Boost Pressure from Data Link	111 269	0 to 8031 0 to 1165 times 10	kPa PSI

CCM Register	Description of Register	MUCM Register	Range/ Value	Units
251	Oil Filter Differential Pressure from Data Link	112 270	0 to 8031 0 to 1165 times 10	kPa PSI
252	Fuel Filter Differential Pressure from Data Link	113 271	0 to 8031 0 to 1165 times 10	kPa PSI
253	Air Filter 1 Differential Pressure from Data Link	114 272	-250 to 251 -362 to 364 times 10	kPa PSI
254-255	Total Fuel Consumption from Data Link	115-116 280-281	0 to 2105540607 0 to 556221764	L GAL
256	Instantaneous Fuel Consumption from Data Link	117 279	0 to 3212 times 100 0 to 848 times 100	L/h GAL/h
257	Atmospheric Pressure from Data Link	118 273	0 to 8031 0 to 1165 times 10	kPa PSI
258	Fuel Level from Data Link	119	-251 to 250	%
259	Net Battery Current from Data Link	120	-125 to 125	A
299	Service Maintenance Interval Weeks Remaining	121	-125 to 125	Weeks
334	System Event Count	128	0 to 99	
335	System Event Lamp Status	129	Bits 15:4 UNUSED Bits 3:2 Amber Lamp:00=OFF, 01=ON Bits 1:2 Red Lamp:00=OFF, 01=ON	
600	Digital Input #1 Active State	130	00 = FALSE 01 = TRUE	
601	Digital Input #2 Active State	131	00 = FALSE 01 = TRUE	
602	Digital Input #3 Active State	132	00 = FALSE 01 = TRUE	
603	Digital Input #4 Active State	133	00 = FALSE 01 = TRUE	
604	Digital Input #5 Active State	134	00 = FALSE 01 = TRUE	
605	Digital Input #6 Active State	135	00 = FALSE 01 = TRUE	
606	Digital Input #7 Active State	136	00 = FALSE 01 = TRUE	
607	Digital Input #8 Active State	137	00 = FALSE 01 = TRUE	
616	Relay Output #1 Active State	138	00 = FALSE 01 = TRUE	
617	Relay Output #2 Active State	139	00 = FALSE 01 = TRUE	
618	Relay Output #3 Active State	140	00 = FALSE 01 = TRUE	
619	Relay Output #4 Active State	141	00 = FALSE 01 = TRUE	
620	Relay Output #5 Active State	142	00 = FALSE 01 = TRUE	

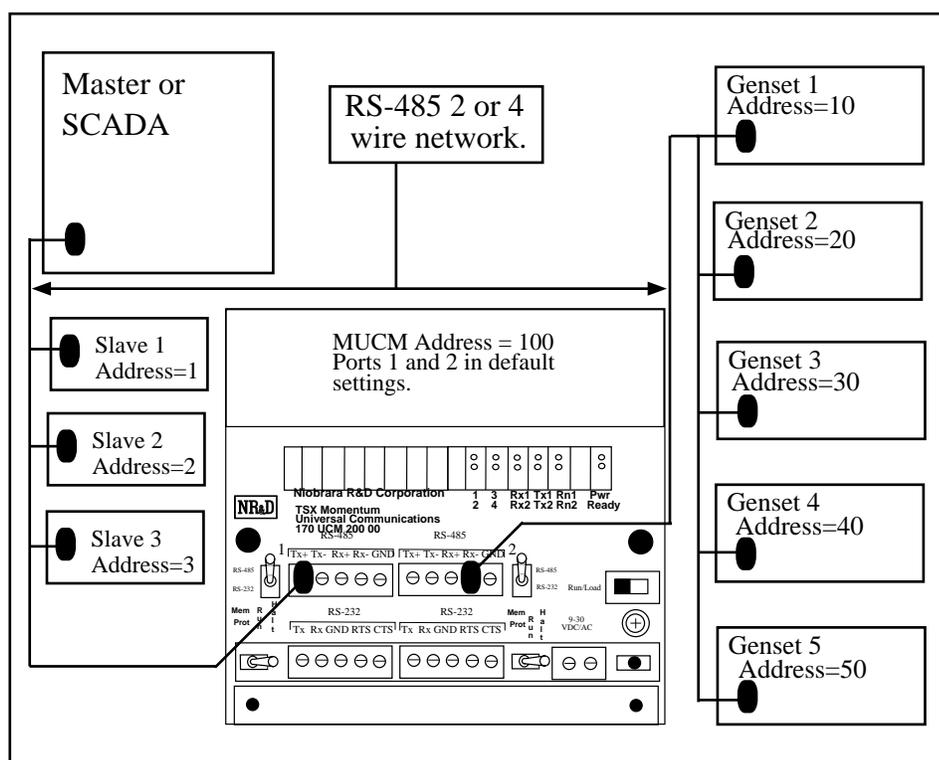
CCM Register	Description of Register	MUCM Register	Range/ Value	Units
621	Relay Output #6 Active State	143	00 = FALSE 01 = TRUE	
622	Relay Output #7 Active State	144	00 = FALSE 01 = TRUE	
623	Relay Output #8 Active State	145	00 = FALSE 01 = TRUE	
624	Digital Output #1 Active State	146	00 = FALSE 01 = TRUE	
625	Digital Output #2 Active State	147	00 = FALSE 01 = TRUE	
800	Engine Oil Temp. from I/O Pin	148 246	-273 to 1735 times 10 -459 to 3155 times 10	C F
801	Exhaust Temp. from I/O Pin	149 247	-273 to 1735 times 10 -459 to 3155 times 10	C F
802	Left Manifold Exhaust Temp. from I/O Pin	150 248	-273 to 1735 times 10 -459 to 3155 times 10	C F
803	Right Manifold Exhaust Temp. from I/O Pin	151 249	-273 to 1735 times 10 -459 to 3155 times 10	C F
804	Fuel Level from I/O Pin	152	-251 to 250	%
805	External Fuel Level from I/O Pin	153	-251 to 250	%
806	Engine Oil Level from I/O Pin	154	-251 to 250	%
807	Engine Coolant Level from I/O Pin	155	-251 to 250	%
808	Fire Extinguisher Pressure from I/O Pin	156 274	0 to 8031 0 to 1165 times 10	kPa PSI
809	Oil Filter Differential Pressure from I/O Pin	157 275	0 to 8031 0 to 1165 times 10	kPa PSI
810	Air Filter Differential Pressure from I/O Pin	158 276	-250 to 251 -362 to 364 times 10	kPa PSI
811	Fuel Filter Differential Pressure from I/O Pin	159 277	0 to 8031 0 to 1165 times 10	kPa PSI
813	Starting Air Pressure from I/O Pin	161 278	0 to 8031 0 to 1165 times 10	kPa PSI
814	Ambient Air Temp. from I/O Pin	162 250	-273 to 1735 times 10 -459 to 3155 times 10	C F
1053	Engine Status	168	000 = NOT READY TO GO 001 = GOING IN AUTO 010 = GOING IN RUN 011 = READY IN AUTO 100 = STOPPING IN AUTO 101 = STOPPING NOT READY TO GO	
1054	Cooldown Duration Remaining	169	0 to 64255	Seconds
1057	Desired Genset Output Voltage	172	0 to 64255	V
1058	AVR Bias Percent	173	-251 to 250	%
1060	Request Engine Speed	175	0 to 8031	RPM
1061	Speed Bias Percent	176	-251 to 250	%
1067	Generator Frequency within Limits	182	00 = FALSE 01 = TRUE	

<b>CCM Register</b>	<b>Description of Register</b>	<b>MUCM Register</b>	<b>Range/ Value</b>	<b>Units</b>
1068	Generator Voltage within Limits	183	00 = FALSE 01 = TRUE	
1090	Genset Control Online	184	00 = FALSE 01 = TRUE	
1091	Engine Control Online	185	00 = FALSE 01 = TRUE	
1092	Secondary Control Online	186	00 = FALSE 01 = TRUE	
1093	External I/O #1 Online	187	00 = FALSE 01 = TRUE	
1094	External I/O #2 Online	188	00 = FALSE 01 = TRUE	
1095	External I/O #3 Online	189	00 = FALSE 01 = TRUE	
1096	External I/O #4 Online	190	00 = FALSE 01 = TRUE	
1097	Digital AVR Online	191	00 = FALSE 01 = TRUE	
1098	RTD Module Online	192	00 = FALSE 01 = TRUE	
1099	Thermocouple #1 Online	193	00 = FALSE 01 = TRUE	
1100	Thermocouple #2 Online	194	00 = FALSE 01 = TRUE	

CCM Register	Description of Register	MUCM Register	Range/ Value	Units
1275	Engine Protection has been Shut Down	195	00 = FALSE 01 = TRUE	
1276	Control S/N	196	Reads Serial Number	
2074	Turbocharger 1 Compressor Inlet Temp.	197 251	-273 to 1735 times 10 -459 to 3155 times 10	C F
2075	Turbocharger 2 Compressor Inlet Temp.	198 252	-273 to 1735 times 10 -459 to 3155 times 10	C F
2076	Turbocharger 3 Compressor Inlet Temp.	199 253	-273 to 1735 times 10 -459 to 3155 times 10	C F
2077	Turbocharger 4 Compressor Inlet Temp.	200 254	-273 to 1735 times 10 -459 to 3155 times 10	C F
2078	Turbocharger 1 Turbine Inlet Temp.	201 255	-273 to 1735 times 10 -459 to 3155 times 10	C F
2079	Turbocharger 1 Turbine Outlet Temp.	202 256	-273 to 1735 times 10 -459 to 3155 times 10	C F
2080	Turbocharger 2 Turbine Inlet Temp.	203 257	-273 to 1735 times 10 -459 to 3155 times 10	C F
2081	Turbocharger 2 Turbine Outlet Temp.	204 258	-273 to 1735 times 10 -459 to 3155 times 10	C F
2082	Turbocharger 3 Turbine Inlet Temp.	205 259	-273 to 1735 times 10 -459 to 3155 times 10	C F
2083	Turbocharger 3 Turbine Outlet Temp.	206 260	-273 to 1735 times 10 -459 to 3155 times 10	C F
2084	Turbocharger 4 Turbine Inlet Temp.	207 261	-273 to 1735 times 10 -459 to 3155 times 10	C F
2085	Turbocharger 4 Turbine Outlet Temp.	208 262	-273 to 1735 times 10 -459 to 3155 times 10	C F
2086	Exhaust Temp. from Data Link	209 263	-273 to 1735 times 10 -459 to 3155 times 10	C F

## Example 1

Example 1 Layout shows system with a Modbus Master or SCADA system, three slaves, an MUCM with five Gensets. The MUCM continuously polls the gensets and stores the register values internally. When the master requests the data from the gensets the MUCM responds with the data stored in its memory. If the master sends a write instruction the MUCM passes the instruction through to the genset.



Example 1 Layout

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The Table 4-1 below shows the values of the holding (4x) registers of the MUCM which need to be set to allow the MUCM to poll the gensets. Any valid unused address may be used for the gensets. The genset at MUCM register 521 address 10 will be polled first, then genset at MUCM register 522 address 20 will be polled next, etc. until the last genset is polled. MUCM will start at the top of the list and poll all the gensets continuously.

**Table 4-1 Example 1 MUCM Register Setup**

MUCM Register	Genset Address
521	10
522	20
523	30
524	40
525	50

In the example above the genset addresses were consecutive, however this is not necessary. Table 4-2 shows a MUCM register which will perform equally well as the previous example however the genset at address 20 will be polled first.

**Table 4-2 Example 2 MUCM Register Setup**

MUCM Register	Genset Address
521	20
522	10
523	50
524	40
525	30

## Testing and Troubleshooting

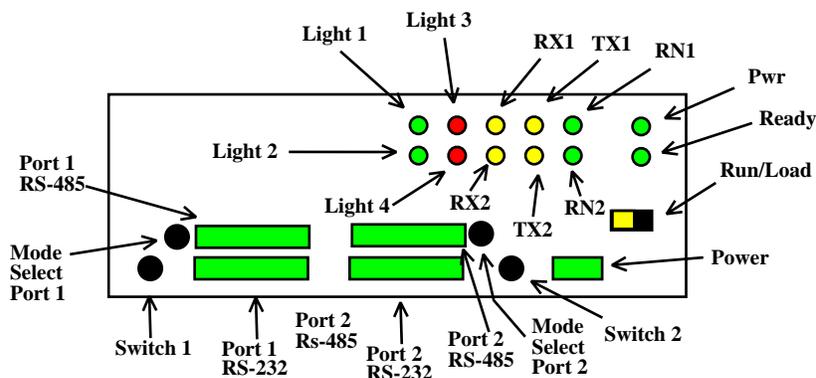


Figure 5-1 MUCM Lights and Switches

### Switches

- Switch 1 controls the running of the MUCM application.
  - Mem Prot - Not used.
  - Run - The middle position is the normal running setting for this switch. The RN1 light should be on and other lights may be on or flashing to indicate operation.
  - Halt - The right position of this switch halts the application.
- Switch 2 - Not Used.
  - Mem Prot - Not Used
  - Run - Not Used.
  - Halt - Not Used.
- The Run/Load switch is used for loading firmware into the MUCM with FWLOAD. Normally, this switch is in RUN but is moved to LOAD before starting the download. Light 3 is ON when the switch is in LOAD.

### MUCM Lights

The MUCM has several lights to give indication of activity of the application and serial ports.

- The **Pwr** light is green and indicates that the MUCM is powered and booted.

- 
- The **Ready** light is green and indicates that the MUCM is communicating with a tophat adapter. This light will not be on because the a tophat is not used.
  - The green **RN1** light indicates that the application is running. This lights should be on when the switch 1 is in RUN or MEM PROT. If the switch is in a run position but the RN1 light is off then qload the application.
  - The green **RN2** light indicates that an application 2 is running. This light should always be off in the MCCM application.
  - The yellow **Tx1** light indicates that the MUCM port 1 is transmitting data. This light should be occasionally flashing as the MUCM responds to queries from the Modbus Master.
  - The yellow **Rx1** light indicates that the MUCM port 1 is receiving data. This light should be occasionally flashing as the Modbus Master requests data from the MUCM.
  - The yellow **Tx2** light indicates that the MUCM port 2 is transmitting data. This light should be occasionally flashing as the MUCM polls the slaves on a RS-485 network.
  - The yellow **Rx2** light indicates that the MUCM port 2 is receiving data. This light should be occasionally flashing as the MUCM is receiving data from the slaves on the RS-485 network.
  - **Light 1** is a green light controlled by the application. Light 1 will flash when any good Modbus messages are received on the RS-485 port 1.
  - **Light 2** is a green light controlled by the application. Light 2 will flash when any good Modbus message is received on the RS-485 port 2.
  - **Light 3** is a red light controlled by the application. Light 3 is normally off but comes on briefly to indicate that the MUCM encountered an error and could not process the message from the master on port 1. If light 3 turns on for approximately half of a second then a framing error occurred on port 1.
  - **Light 4** is a red light controlled by the application. Light 4 is normally off but comes on briefly to indicate an error in the Modbus message from the gensets on port 2.

## Testing the Modbus Connection

The program ZAPREG32.EXE may be used to quickly test the Modbus settings on the MUCM.

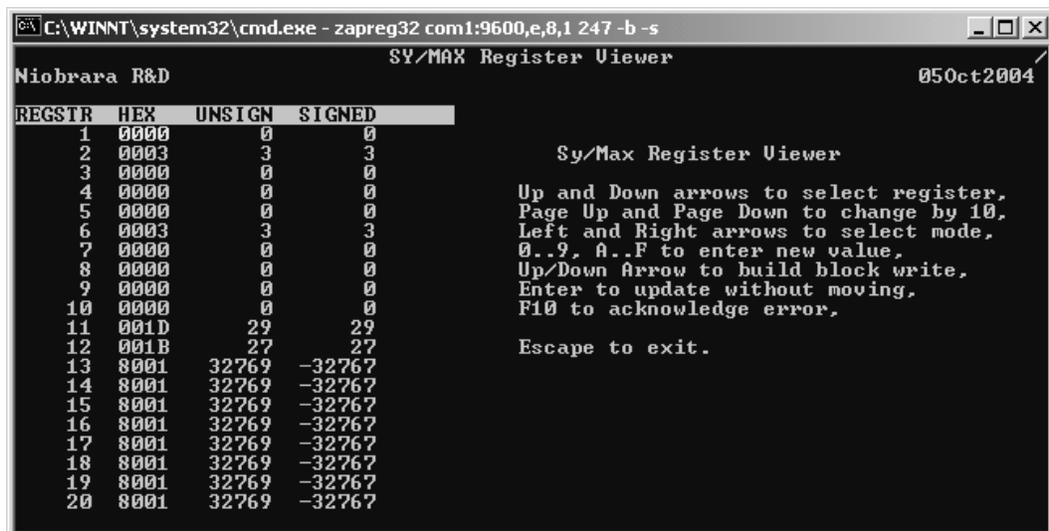
- 1 Application Switches 1 (left) must be in RUN.
- 2 Port 1 mode selection switch needs to be in RS-232 mode.
- 3 Connect the Niobrara MU1 cable to the MUCM port 1 in the RS-232 connector.
- 4 Open a Command Prompt. On most Windows systems do a Start, Programs, Accessories, Command Prompt.
- 5 From the command line enter the following:  
>zapreg32 com1:19200,n,8,1 255 -b

where com1: is the PC's com port, 19200,n,8,1 are the settings of the MUCM's RS-232 port, 255 is a special drop number that the MUCM will respond to whether it is talking to the gateway or not, and the -b tells zapreg to use Modbus RTU.

A screen like Figure <zap> should appear. The left column is the Holding Register number, the data is shown in the HEX, SIGNED, and UNSIGNED columns. The arrow keys and Page UP/Down may be used to move around. Values may be entered directly and the change occurs when the Enter key is pressed.

When finished verifying that the communication is good, press ESC and the program will exit.

To verify that the genset data is present, substitute the Modbus Slave address (default=1) for the 255 in the command line above. If the MUCM is talking to the gateway then the data will be displayed. If the MUCM is not talking to the gateway then "Read Reply Timeout" will be displayed on zapreg.



The screenshot shows a Windows command prompt window titled "C:\WINNT\system32\cmd.exe - zapreg32 com1:9600,e,8,1 247 -b -s". The application window is titled "Niobrara R&D SY/MAX Register Viewer" and shows a table of registers. The table has four columns: REGSTR, HEX, UNSIGN, and SIGNED. The data is as follows:

REGSTR	HEX	UNSIGN	SIGNED
1	0000	0	0
2	0003	3	3
3	0000	0	0
4	0000	0	0
5	0000	0	0
6	0003	3	3
7	0000	0	0
8	0000	0	0
9	0000	0	0
10	0000	0	0
11	001D	29	29
12	001B	27	27
13	8001	32769	-32767
14	8001	32769	-32767
15	8001	32769	-32767
16	8001	32769	-32767
17	8001	32769	-32767
18	8001	32769	-32767
19	8001	32769	-32767
20	8001	32769	-32767

On the right side of the window, there is a legend for the Sy/Max Register Viewer:

- Up and Down arrows to select register,
- Page Up and Page Down to change by 10.
- Left and Right arrows to select mode,
- 0..9, A..F to enter new value,
- Up/Down Arrow to build block write,
- Enter to update without moving,
- F10 to acknowledge error,
- Escape to exit.

Figure 5-2 ZAPREG32 Screen

NRD TOOL.EXE may also be used for this purpose. Follow the directions in the Setup Ports section.

## Useful Diagnostic Registers

These are 4x registers and are very useful for trouble shooting problems with the Modbus communications to the gensets. NRDTOOL.EXE, ZAPREG32.EXE, or any software that can read 4x registers may be used to examine or clear these registers. Connect to the drop number of the MUCM or number 255 using Modbus RTU as directed in the Setup Ports or Testing Modbus Connection sections of this document.

**Table 5-1 Diagnostic Register List.**

4x Register	Description	Range/Value
600, 650, 700, 750, 800, 850, 900, 1000, 1050	Registers used to reset ALL counters. To reset the counters write a non-zero number to one of these registers.	Any non-zero number
601-632	Timeout Counter for slaves 1-32	0 to 65536
649	Time in Seconds to Poll ALL slaves on MUCM	0 to 65536
651-682	Good Reply Counter for slaves 1-32	0 to 65536
701-732	Bad Slave Address Counter for slaves 1-32	0 to 65536
751-782	Opcode Mismatch Counter for slaves 1-32	0 to 65536
801-832	Reply Exception Counter for slaves 1-32	0 to 65536
851-882	Reply Exception Pointer for slaves 1-32	1 to 20
901-932	Reply Exception Value for slaves 1-32	0 to 65536
1001-1032	(FID counter) Signal Saturated or Out of Range for device 1-32	0 to 65536
1051-1082	(FID counter) Parameter is not applicable to current state for device 1-32	0 to 65536

Examples: If thirty-two slaves are connected and replying with good messages then registers 651-682 should be counting up. Each device is polled twenty times in order to collect all the data, so each register will count up by twenty before moving to the next register. If some of the devices stop replying then the registers related to those devices in 651-682 will stop counting up and the registers related to the devices in 601-632 will begin counting up. To reset the counters write any non-zero number to any of the registers 600, 650, 700, 750, 800, 850, 900. This will reset all the register counters. Register 649 will show the time in seconds needed to poll and receive every register for all thirty-two devices.



