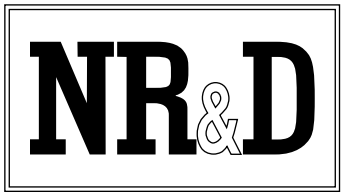
MUCM Modbus/Mitsubishi UPS

Installation and Programming Manual

This Manual describes the MUCM application for interfacing a Mitsubishi UPS to a Modbus serial network.

Effective: 01 December, 2005



Niobrara Research & Development Corporation
P.O. Box 3418 Joplin, MO 64803 USA
Telephone: (800) 235-6723 or (417) 624-8918
Facsimile: (417) 624-8920
www.niobrara.com

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Contents

Figures

Tables

1
Introduction

The Niobrara MUCM is a Modicon Momentum® compatible module that is capable of running multiple applications for performing communication translations between serial protocols. This document covers an application that allows Modbus serial masters to gather data from a Mitsubishi Uninterruptible Power Supply (UPS).

Support is provided for Mitsubishi 2033A, 2033C, 2033D, 7011A, 9800AD models. UPS data is presented as Modbus Holding Registers (4x). Analog values are stored as 16-bit integers and alarm values are stored as bits of 16-bit registers. The MUCM may be configured as a Modbus RTU (default) or Modbus ASCII slave. The Modbus Slave Address (default=1), baud rate (default=9600), data bits (default=8), and parity (default=EVEN) may all be configured from the RS-485 Modbus port or through a built-in terminal server on the RS-232 port.

Although the MUCM hardware supports a communications tophat, this communication option is not used in this application. In most installations, 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_MITSU_APP1.qcm is compiled and loaded into application area 1 of the MUCM.

Port 1 of the MUCM is RS-232 and is to be connected to the UPS. The Niobrara MU1 cable is usually used for the connection to the UPS 9-pin RS-232 port. The Niobrara MU17 cable or the MU1 with an SD013 adapter may be used to connect to a 25-pin port of the UPS. Port 2 of the MUCM is RS-485 and is to be connected to the Modbus network. The Niobrara SC912 cable is handy for testing the Modbus RS-485 connection from a PC.

The MUCM contains its own power supply and needs a minimum 6W source of 9 to 30 Volts, AC or DC. An ideal 12VAC transformer is available from NR&D as part number TR121-ST.

2
Installation

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

- MUCM
- MU1 cable (or equivalent can be built; see Figure 2-1)
- Power source for MUCM (use NR&D part TR121-ST or available power)
- Cabling between MUCM and Modbus Master may be built or purchased
- Cabling between MUCM and UPS equipment may be built or purchased. The MU1 cable may be used to connect to the UPS 9-pin RS-232 port on models 2033C, 2033D, 7011, and 9800AD. The SD013 9-25 pin adapter may be used with the MU1 cable, or the MU17 cable may be used to connect the MUCM to the 25 pin port on Models 2033A and 9700.
- PC with terminal emulator, or terminal 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 of minimum 6W 9-30 Volts AC or DC.

Software Installation

The application files for the MUCM are included in the MUCM_MITSU_SETUP.EXE file. This self-extracting file is included on the standard NR&D software CD and is also available at www.niobrara.com.

It is required that the MUCM_SETUP.EXE file also be installed on the computer to ensure that QLOAD and FWLOAD are properly installed.

Serial Connections to the MUCM

Port 1 to 9-pin UPS

Port 1 of the MUCM is RS-232 so a simple 3-wire cable is required to connect to the UPS. In general, the UPS's Tx signal will connect to the MUCM's Rx, and the UPS's Rx signal will connect to the MUCM's Tx. Signal ground must run from the UPS to the MUCM, and each device will have its RTS and CTS handshaking pins shorted together.

Mitsubishi UPS models 2033C, 2033D, 7011, and 9800AD use a standard 9-pin RS-232 serial port and thus the Niobrara MU1 cable may be used. For other standard connections, see the MUCM manual, or contact NR&D's technical support.

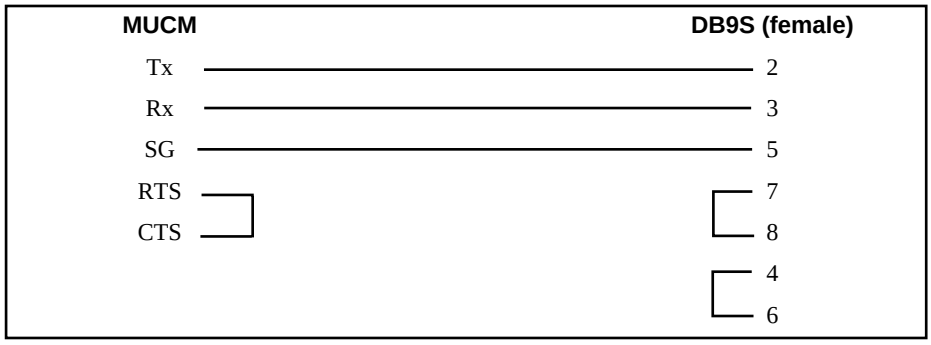

Figure 2-1 MUCM to 9-pin UPS RS-232 (MU1 Cable)

Port 1 to 25-pin UPS

Port 1 of the MUCM is RS-232 so a simple 3-wire cable is required to connect to the UPS. In general, the UPS's Tx signal will connect to the MUCM's Rx, and the UPS's Rx signal will connect to the MUCM's Tx. Signal ground must run from the UPS to the MUCM, and each device will have its RTS and CTS handshaking pins shorted together.

Mitsubishi UPS models 2033A, and 9700 use a 25-pin RS-232 serial port and thus the Niobrara MU1 with the SD013 adapter or the MU17 cable may be used. For other standard connections, see the MUCM manual, or contact NR&D's technical support.

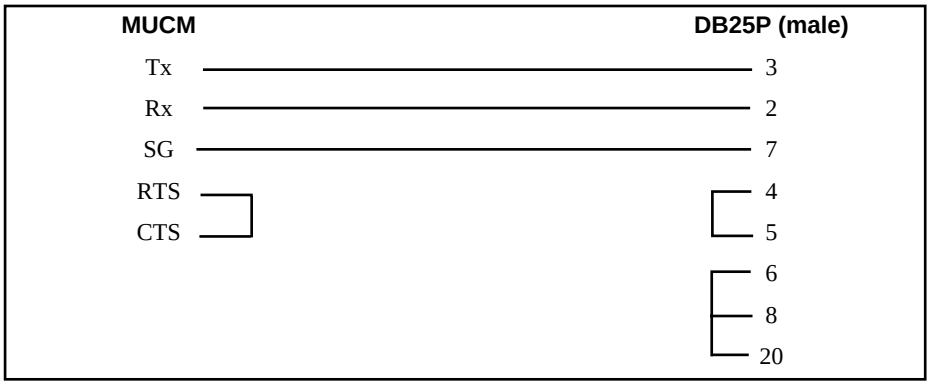

Figure 2-2 MUCM to 25-pin UPS RS-232 (MU17 Cable)

Port 2 to Modbus Network

Port 2 of the MUCM is RS-422/485 so a simple 4-wire cable is required to connect to most Modbus equipment. Twisted pair cable should be used.

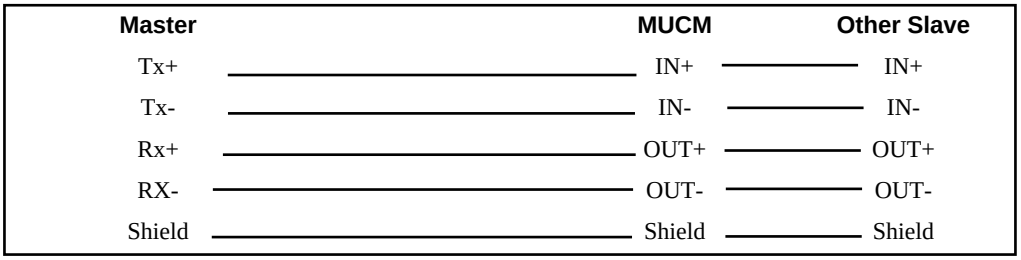

Figure 2-3 MUCM to 4-wire Modbus Slaves

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.

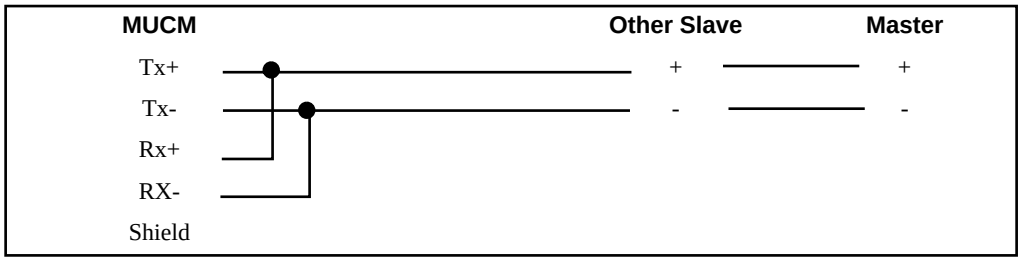

Figure 2-4 MUCM to 2-wire Modbus Slaves

A physical connection must be made from the personal computer to the MUCM in order to download the applications. This link is a serial connection from a COM port on the personal computer to the RS-232 port on the MUCM. The Niobrara MU1 cable may be used for this connection. This cable is shown in Figure 2-1.

Loading the Applications into the MUCM

NOTE: If the MUCM were ordered with the part number MCP-104 then the latest Mitsubishi application is already loaded. These steps 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_MITSU_APP1.QCC. Most likely the QCOMPILE.EXE has been updated so be sure to use the newest version. The MUCM-001 and MUCM-002 use different firmware files: MUCM1.FWL (or MUCM1.QCC) is for the MUCM-001; MUCM.FWL (or MUCM.QCC) is for the MUCM-002. Firmware upload is as follows:

FWLOAD MUCM Firmware Update.

Firmware upload is as follows:

1 Move the yellow RUN/LOAD switch near the power connector to LOAD.

2 Only the 3 light should be on.

3 Connect the PC to QUCM Port 1 with a MU1 cable.

4 Locate the and start the program FWLOAD.EXE. There is a start menu item under "Start, Programs, Niobrara, MUCM, Apps, Mitsubishi, FWLOAD MUCM Firmware".

5 Click on the Browse button and select MUCM.FWL for an MUCM-002 or MUCM1.FWL for an MUCM-001.

6 Select the PC's serial port (COM1).

7 Press START to begin the download process. If difficulty is experienced in completing the download, try marking the Slow box and pressing start again.

8 When the download is completed, move the yellow LOAD/RUN switch back to RUN.

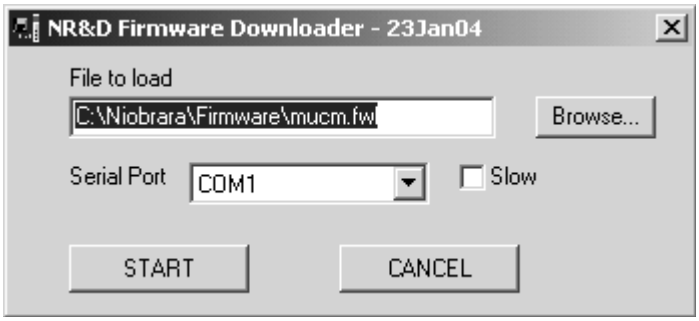

Figure 2-5 FWLOAD

QLOAD MUCM_MITSU_APP1

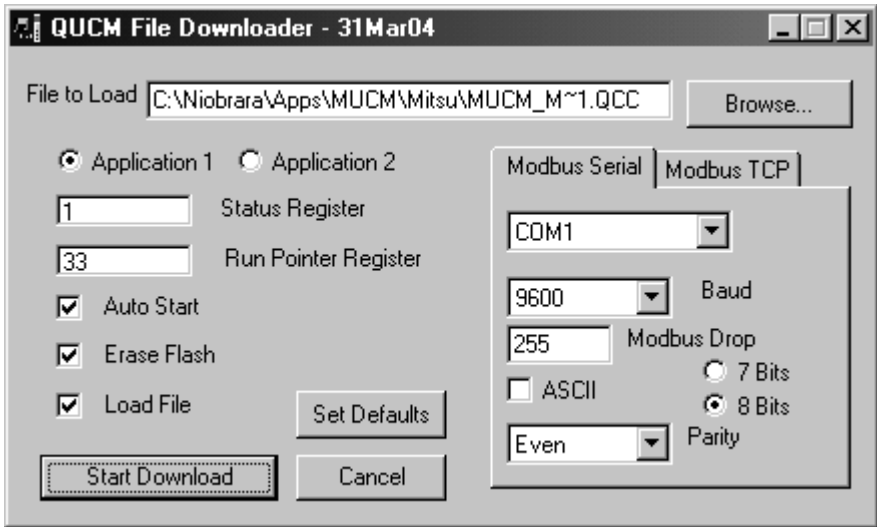

Figure 2-6 QLOAD of MUCM_MITSU_APP1

1 Application Switch 1 (left) must be in HALT.

2 Start QLOAD.EXE There is a start menu item for this operation: "Start, Programs, Niobrara, MUCM, Apps, Mitsubishi, QLOAD Mitsubishi App1".

3 Click on the Browse button and select the file MUCM_MITSU_APP1.qcc.

4 Select the Application 1 Radio Button.

5 Verify that the Modbus Serial tab is selected.

   (1) The PC's com port is selected (COM1).

   (2) The baud rate is set for 9600.

   (3) The Modbus Drop is set to 255.

   (4) The ASCII button is **NOT** checked.

   (5) The 8 bits button is selected.

   (6) The parity is set for EVEN.

6 Press the Start Download button. QLOAD will open a progress window to show the status of the download.

7 After downloading the application, Move Switch 1 to RUN. The RN1 light should be on.

8 The MUCM defaults to Auto-Detect the UPS. If it finds an SEC device it will turn on the green light 1. A Mitsubishi protocol UPS will result in light 1 turned off.

NOTE: The position of switch 2 is now ignored by the MUCM application. The specific UPS must be set in the terminal setup routine.

Connect the UPS to MUCM port 1 and the Modbus Master to MUCM port 2. The default settings for the MUCM are shown in Table 2-1. These settings may be modified by using a terminal on MUCM port 1 with switch 1 in MEM PROT or by writing Modbus registers from the RS-485 port.

Table 2-1 MUCM Port Default Settings

Setting	Port 1 Value	Port 2 Value
Protocol Mode	2033A UPS	Modbus RTU
Baud Rate	9600	9600
Parity	Auto Select for UPS	EVEN
Data Bits	8	8
Stop Bits	1	1
Modbus Slave Address	N/A	1

The MUCM will answer Modbus RTU requests on its RS-485 port that are directed to its Modbus Slave Address only if it can communicate with the UPS. If the MUCM is not able to communicate with the UPS then it will not respond to queries to the slave address.

The MUCM will respond to queries directed to a special Modbus slave address of 254, even if it cannot communicate with the UPS. This special address allows modification of the MUCM port parameters for trouble-shooting.

Terminal Setup

The setup parameters may be inspected and modified by connecting a terminal or emulator such has Hyperterminal to MUCM port 1 with an MU1 cable.

1 Connect the PC to the MUCM port 1 with the MU1 cable.

2 Move switch 1 to MEM PROT on the MUCM. All four user lights will come on.

3 Start Hyperterminal. This program is usually in Start, Programs, Accessories, Communications, Hyperterminal. Make sure the connection is for the proper COM port at 9600, N, 8, 1 and VT100 emulation.

Pressing ESC or Enter on the keyboard should bring up a screen as shown in Figure 2-7. Pressing the "P" key will allow the ports to be edited. Each entry to edit is adjusted by pressing the space bar. When the correct entry is selected then press the Enter key. Pressing the ESC will back out without changing the parameter. Pressing the "W" key will write the setup to FLASH. The keys are not case sensitive.

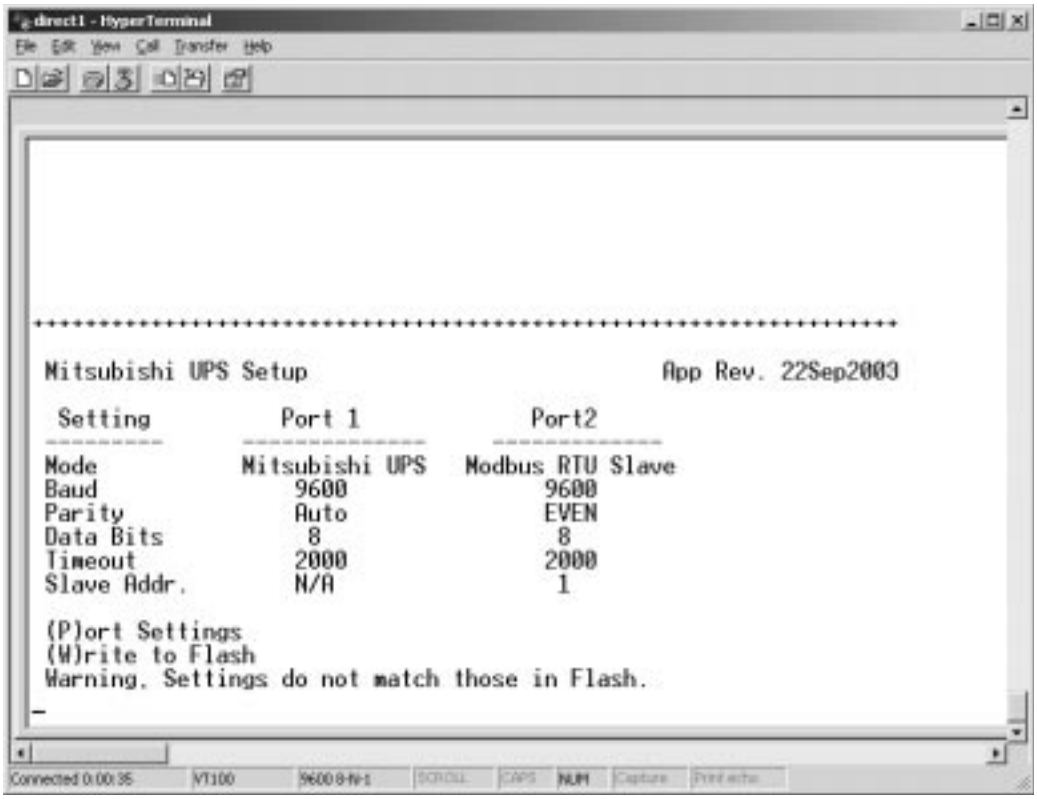

Figure 2-7 Hyperterminal Setup Main Screen

3

Modbus Operation

The Mitsubishi MUCM application uses Port 2 for Modbus communication. Port 2 is RS-485 and may be connected as a 4-wire multidrop slave or 2-wire multidrop slave. By default, Port 2 is set for Modbus RTU Slave, 9600 baud, 8 data bits, EVEN parity, and Slave Address 1.

The MUCM will always answer Modbus messages directed to slave address 255 or 254.

The MUCM will briefly light the green led 2 when any valid Modbus message is received on the RS-485 port. If the message is intended for the MUCM then the green led 2 will stay on slightly longer and the yellow tx2 light will come on as the MUCM replies if the UPS is online. If the UPS is not responding to the MUCM then the MUCM will not respond and will turn on the red light 4 for 1 second. If a parity or framing error is detected in the received message then the red light 4 will come on for 1/4 second.

UPS Device Types

The following Mitsubishi devices are supported by the MUCM. The device type must be set in the setup terminal emulator accessed by setting the RS-232 switch to MEM PROT.

Table 3-1 UPS Protocol List

UPS Model	Protocol
2033A	MIT
2033C and 2033D	SEC
7011A	SEC
9700 Series	MIT
9800AD	SEC

2033C Register List

The data from the UPS is presented as Holding Registers (4x). Registers 1 through 66 are read only 16-bit unsigned integers that provide data on the UPS System, Battery, Input, Output, and Bypass circuits. Several data points have an implied decimal place to give a greater precision for the reading. For example, register 17 indicates the frequency of Input Line A times 0.1. A value of 599 indicates a frequency of 59.9Hz.

The mapping in the following tables provides data for 3-phase models. UPS models that provide fewer phases will have the unused values set to zero. The number of phases may be checked by reading registers 500 through 502.

Table 3-2 2033C Register List (Battery)

Register	Measurement	Notes
4x0001	UPS Device Type	Integer Value 1=SEC
4x0002	Battery Condition	Integer Value 0=Good 1=Weak 2=Replace
4x0003	Battery Status	Integer Value 0=OK 1=Low 2=Depleted
4x0004	Battery Charge	Integer Value 0=Floating 1=Charging 2=Resting 3=Discharging
4x0005	Seconds on Battery	Seconds
4x0006	Estimated Minutes Remaining	Minutes
4x0007	% Battery Charge Left	0-100%

Table 3-3 2033C Register List (Input)

Register	Measurement	Notes
4x0014	Input Line Bads	Count
4x0016	Input Frequency	x0.1 Hz
4x0022	Input Voltage	x0.1 VAC
4x0025	Input Current	x0.1 A
4x0029	Input Power	W

Table 3-4 2033C Register List (Output)

Register	Measurement	Notes
4x0032	Output Source	Integer Value 0=Normal 1=On Battery 2=On Bypass 3=Reducing 4=Boosting 5=Other
4x0036	Output Voltage	x0.1 VAC
4x0039	Output Current	x0.1 A
4x0045	Output Power	W
4x0048	Output % Load	0-100%
4x0051	Output Frequency	x0.1 Hz

The Alarms are mapped as bits in registers. If the alarm is active then its bit will be set. The bits are labeled in IEC format where bit 0 is the LSB and 15 is the MSB.

Table 3-5 2033C Register List (Alarms)

Register	Bit	Description
4x0067	0	Temperature Alarm
	1	Input Bad Alarm
	2	Output Bad Alarm
	3	Overload Alarm
	4	Bypass Bad Alarm
	5	Output Off Alarm
	6	UPS Shutdown Alarm
	7	Charger Failure Alarm
	8	System Off Alarm
	9	Fan Failure Alarm
	10	Fuse Failure Alarm
	11	General Fault Alarm
	12	Awaiting Power Alarm
	13	Shutdown Pending Alarm
	14	Shutdown Imminent Alarm
	15	Reserved

The UPS configuration is stored in registers 500 through 652. Some registers are read only and some are writeable. Care must be exercised on writing configuration parameters. The values are sent to the UPS upon reception of a Modbus write to the MUCM, therefore, it is important to only send a write when the configuration needs to be changed. Do not configure the Master to continuously send writes to the MUCM.

Table 3-6 2033C Register List (UPS Setup)

Register	R/W	Measurement	Notes
4x0499	R	Read Only Bitmap of pending writes to UPS	Bit 0 = Auto Reboot [503] Bit 1 = Nominal Setting [504-517] Bit 2 = Shutdown After Delay [518] Bit 3 = Reboot with Duration [519] Bit 4 = Action taken at Shutdown [520] Bit 5 = Startup After Delay [521] Bit 6 = Test [522] Bit 7 = UPS Baud Rate [523] Bit 8 = UPS Identification [524-555]
4x0500	R	Number of Input Lines	1-3
4x0501	R	Number of Output Lines	1-3
4x0504	RW	Nominal Input Voltage	Volts
4x0505	RW	Nominal Input Frequency	x0.1 Hz
4x0506	RW	Nominal Output Voltage	Volts
4x0507	RW	Nominal Output Frequency	x0.1 Hz
4x0508	RW	Nominal VA Rating	VA
4x0509	RW	Nominal Output Power	W
4x0510	RW	Low Battery Time	Minutes
4x0511	RW	Audible Alarm	Integer Value 1=Disabled 2=Enabled 3=Muted 4=Disabled until Low Battery
4x0512	RW	Low Voltage Transfer Point	Volts
4x0513	RW	High Voltage Transfer Point	Volts
4x0514	RW	Battery Installed Month	1-12
4x0515	RW	Battery Installed Day	1-31
4x0516	RW	Battery Installed Year	xxxx
4x0517	RW	Nominal Battery Life	Days
4x0518	RW	Shutdown After Delay	-1 = Abort 0 = Immediate >0 = Seconds until shutdown
4x0519	RW	Reboot with Duration	>0 = Seconds after shutdown
4x0520	RW	Action Taken at Shutdown	1=UPS Output OFF 2=UPS System OFF
4x0521	RW	Startup After Delay	-1 = Abort 0 = Immediate >0 = Seconds until shutdown
4x0522	RW	Test	-1 = Abort 0 = No Effect 1 = General Test 2 = Battery Test 3 = Deep Test
4x0523	RW	UPS Baud Rate	1200, 2400, 4800, 9600, or 19200

Table 3-7 2033C Register List (UPS Setup)

Register	R/W	Measurement	Notes
4x0524 - 4x0555	RW	Identification String	Packed ASCII
4x05556	R	Test Results	Integer Value 0 = No Tests Performed 1 = Test Passed 2 = Test In Progress 3 = General Test Failed 4 = Battery Test Failed 5 = Deep Test Failed
4x0557 - 4x0588	R	Test Results String	Packed ASCII
4x0589 - 4x0604	R	UPS Manufacturer String	Packed ASCII
4x0605 - 4x0636	R	UPS Model String	Packed ASCII
4x0637 - 4x0652	R	UPS Software Version String	Packed ASCII

The MUCM serial port setup is stored in registers 653 through 676. Some of these registers are read only while some may be altered by sending writes to the MUCM. Care must be exercised when modifying these values because the serial ports will change their settings immediately and possibly cause a loss of communications.

Note: New values are stored to FLASH upon completion of the Modbus Write. Do not allow the Master to continuously send writes to the MUCM.

Table 3-8 MUCM Setup Register List

Register	R/W	Measurement	Notes
4x0653 - 4x0668	RW	MUCM Application Revision String	Packed ASCII
4x0669	RW	MUCM Port 1 Mode	Integer Value 0 = Auto Detect 1 = SEC 2 = MIT (default = 0)
4x0670	RW	MUCM Port 1 Baud Rate	1200, 2400, 4800, 9600, 19200 (default = 9600)
4x0671	R	MUCM Port 1 Parity	0 = NONE 1 = EVEN SEC always uses NONE MIT always uses EVEN
4x0672	RW	MUCM Port 2 Mode	5 = Modbus RTU Slave 6 = Modbus ASCII Slave (default = 5)
4x0673	RW	MUCM Port 2 Baud Rate	1200, 2400, 4800, 9600, 19200 (default = 9600)
4x0674	RW	MUCM Port 2 Parity	0 = NONE 1 = EVEN (default = EVEN)
4x0675	RW	MUCM Port 2 Modbus Slave Address	1-254 (default = 1) Always responds to address 255.
4x0676	RW	MUCM Port 2 Data Bits	7 (valid for Modbus ASCII only) 8 (valid for RTU or ASCII) (default = 8)

2033D, 7011A, and 9800AD Register List

The data from the UPS is presented as Holding Registers (4x). Registers 1 through 66 are read only 16-bit unsigned integers that provide data on the UPS System, Battery, Input, Output, and Bypass circuits. Several data points have an implied decimal place to give a greater precision for the reading. For example, register 17 indicates the frequency of Input Line A times 0.1. A value of 599 indicates a frequency of 59.9Hz.

The mapping in the following tables provides data for 3-phase models. UPS models that provide fewer phases will have the unused values set to zero. The number of phases may be checked by reading registers 500 through 502.

Table 3-9 2033D, 7011A, 9800AD Register List (Battery)

Register	Measurement	Notes
4x0001	UPS Device Type	Integer Value 1=SEC
4x0003	Battery Status	Integer Value 0=OK 1=Low 2=Depleted
4x0004	Battery Charge	Integer Value 0=Floating 1=Charging 2=Resting 3=Discharging
4x0005	Seconds on Battery	Seconds
4x0007	% Battery Charge Left	0-100%
4x0008	Battery Voltage	x0.1 VDC

Table 3-10 2033D, 7011A, 9800AD Register List (Input)

Register	Measurement	Notes
4x0014	Input Line Bads	Count
4x0016	Input Frequency	x0.1 Hz
4x0022	Input Voltage	x0.1 VAC

Table 3-11 2033D, 7011A, 9800AD Register List (Output)

Register	Measurement	Notes
4x0032	Output Source	Integer Value 0=Normal 1=On Battery 2=On Bypass 3=Reducing 4=Boosting 5=Other
4x0036	Output Voltage Phase A-N	x0.1 VAC
4x0037	Output Voltage Phase B-N	x0.1 VAC
4x0038	Output Voltage Phase C-N	x0.1 VAC
4x0039	Output Current Phase A	x0.1 A
4x0040	Output Current Phase B	x0.1 A
4x0041	Output Current Phase C	x0.1 A
4x0045	Output Power	W
4x0048	Output % Load Phase A	0-100%
4x0049	Output % Load Phase B	0-100%
4x0050	Output % Load Phase C	0-100%
4x0051	Output Frequency	x0.1 Hz

Table 3-12 2033D, 7011A, 9800AD Register List (BYPASS)

Register	Measurement	Notes
4x0057	Bypass Voltage Phase A-N	x0.1 VAC
4x0058	Bypass Voltage Phase B-N	x0.1 VAC
4x0059	Bypass Voltage Phase C-N	x0.1 VAC
4x0060	Bypass Current Phase A	x0.1 A
4x0061	Bypass Current Phase B	x0.1 A
4x0062	Bypass Current Phase C	x0.1 A
4x0063	Bypass Power Phase	W
4x0066	Bypass Frequency	x0.1 Hz

The Alarms are mapped as bits in registers. If the alarm is active then its bit will be set. The bits are labeled in IEC format where bit 0 is the LSB and 15 is the MSB

Table 3-13 2033D, 7011A, 9800AD Register List (Alarms)

Register	Bit	Description
4x0067	0	Temperature Alarm
	1	Input Bad Alarm
	2	Output Bad Alarm
	3	Overload Alarm
	4	Bypass Bad Alarm
	5	Output Off Alarm
	6	UPS Shutdown Alarm
	7	Charger Failure Alarm
	8	System Off Alarm
	9	Fan Failure Alarm
	10	Fuse Failure Alarm
	11	General Fault Alarm
	12	Awaiting Power Alarm
	13	Shutdown Pending Alarm
	14	Shutdown Imminent Alarm
	15	Reserved

The UPS configuration is stored in registers 500 through 652. Some registers are read only and some are writeable. Care must be exercised on writing configuration parameters. The values are sent to the UPS upon reception of a Modbus write to the MUCM, therefore, it is important to only send a write when the configuration needs to be changed. Do not configure the Master to continuously send writes to the MUCM.

Table 3-14 2033D, 7011A, 9800AD Register List (UPS Setup)

Register	R/W	Measurement	Notes
4x0499	R	Read Only Bitmap of pending writes to UPS	Bit 0 = Auto Reboot [503] Bit 1 = Nominal Setting [504-517] Bit 2 = Shutdown After Delay [518] Bit 3 = Reboot with Duration [519] Bit 4 = Action taken at Shutdown [520] Bit 5 = Startup After Delay [521] Bit 6 = Test [522] Bit 7 = UPS Baud Rate [523] Bit 8 = UPS Identification [524-555]
4x0500	R	Number of Input Lines	1-3
4x0501	R	Number of Output Lines	1-3
4x0502	R	Number of Bypass Lines	0-3
4x0504	RW	Nominal Input Voltage	Volts
4x0505	RW	Nominal Input Frequency	x0.1 Hz
4x0506	RW	Nominal Output Voltage	Volts
4x0507	RW	Nominal Output Frequency	x0.1 Hz
4x0508	RW	Nominal VA Rating	VA
4x0509	RW	Nominal Output Power	W
4x0511	RW	Audible Alarm	Integer Value 1=Disabled 2=Enabled 3=Muted 4=Disabled until Low Battery
4x0514	RW	Battery Installed Month	1-12
4x0515	RW	Battery Installed Day	1-31
4x0516	RW	Battery Installed Year	xxxx
4x0520	RW	Action Taken at Shutdown	1=UPS Output OFF 2=UPS System OFF
4x0522	RW	Test	-1 = Abort 0 = No Effect 1 = General Test 2 = Battery Test 3 = Deep Test
4x0523	RW	UPS Baud Rate	1200, 2400, 4800, 9600, or 19200

Table 3-15 2033D, 7011A, 9800AD Register List (UPS Setup)

Register	R/W	Measurement	Notes
4x0524 - 4x0555	RW	Identification String	Packed ASCII
4x05556	R	Test Results	Integer Value 0 = No Tests Performed 1 = Test Passed 2 = Test In Progress 3 = General Test Failed 4 = Battery Test Failed 5 = Deep Test Failed
4x0557 - 4x0588	R	Test Results String	Packed ASCII
4x0589 - 4x0604	R	UPS Manufacturer String	Packed ASCII
4x0605 - 4x0636	R	UPS Model String	Packed ASCII
4x0637 - 4x0652	R	UPS Software Version String	Packed ASCII

The MUCM serial port setup is stored in registers 653 through 676. Some of these registers are read only while some may be altered by sending writes to the MUCM. Care must be exercised when modifying these values because the serial ports will change their settings immediately and possibly cause a loss of communications.

Note: New values are stored to FLASH upon completion of the Modbus Write. Do not allow the Master to continuously send writes to the MUCM.

Table 3-16 MUCM Setup Register List

Register	R/W	Measurement	Notes
4x0653 - 4x0668	RW	MUCM Application Revision String	Packed ASCII
4x0669	RW	MUCM Port 1 Mode	Integer Value 0 = Auto Detect 1 = SEC 2 = MIT (default = 0)
4x0670	RW	MUCM Port 1 Baud Rate	1200, 2400, 4800, 9600, 19200 (default = 9600)
4x0671	R	MUCM Port 1 Parity	0 = NONE 1 = EVEN SEC always uses NONE MIT always uses EVEN
4x0672	RW	MUCM Port 2 Mode	5 = Modbus RTU Slave 6 = Modbus ASCII Slave (default = 5)
4x0673	RW	MUCM Port 2 Baud Rate	1200, 2400, 4800, 9600, 19200 (default = 9600)
4x0674	RW	MUCM Port 2 Parity	0 = NONE 1 = EVEN (default = EVEN)
4x0675	RW	MUCM Port 2 Modbus Slave Address	1-254 (default = 1) Always responds to address 255.
4x0676	RW	MUCM Port 2 Data Bits	7 (valid for Modbus ASCII only) 8 (valid for RTU or ASCII) (default = 8)

2033A and 9700 Register List

The data from the UPS is presented as Holding Registers (4x). Registers 1 through 66 are read only 16-bit unsigned integers that provide data on the UPS System, Battery, Input, Output, and Bypass circuits. Several data points have an implied decimal place to give a greater precision for the reading. For example, register 15 indicates the frequency of Input times 0.1. A value of 599 indicates a frequency of 59.9Hz.

Table 3-17 2033A, 9700 Register List (Battery)

Register	Measurement	Notes
4x0001	UPS Device Type	Integer Value 2=MIT
4x0007	% Battery Charge Left	0-100%
4x0008	Battery Voltage	x0.1 VDC
4x0009	Battery Current	x0.1 A
4x0011	Discharge Time	Hours
4x0012	Discharge Time	Minutes
4x0013	Discharge Time	Seconds

Table 3-18 2033A, 9700 Register List (Input)

Register	Measurement	Notes
4x0014	Input Line Bads	Count
4x0015	Input Frequency	x0.1 Hz
4x0019	Input Voltage Phase A-B	x0.1 VAC
4x0020	Input Voltage Phase B-C	x0.1 VAC
4x0021	Input Voltage Phase C-A	x0.1 VAC
4x0022	Input Voltage Phase A-N	x0.1 VAC
4x0023	Input Voltage Phase B-N	x0.1 VAC
4x0024	Input Voltage Phase C-N	x0.1 VAC
4x0025	Input Current Phase A	x0.1 A
4x0026	Input Current Phase B	x0.1 A
4x0027	Input Current Phase C	x0.1 A

Table 3-19 2033A, 9700 Register List (Output)

Register	Measurement	Notes
4x0033	Output Voltage Phase A-B	x0.1 VAC
4x0034	Output Voltage Phase B-C	x0.1 VAC
4x0035	Output Voltage Phase C-A	x0.1 VAC
4x0036	Output Voltage Phase A-N	x0.1 VAC
4x0037	Output Voltage Phase B-N	x0.1 VAC
4x0038	Output Voltage Phase C-N	x0.1 VAC
4x0039	Output Current Phase A	x0.1 A
4x0040	Output Current Phase B	x0.1 A
4x0041	Output Current Phase C	x0.1 A
4x0042	Output Peak Current Phase A	x0.1 A
4x0043	Output Peak Current Phase B	x0.1 A
4x0044	Output Peak Current Phase C	x0.1 A
4x0051	Output Frequency	x0.1 Hz
4x0052	Output Power	0.1 W
4x0053	Output Power Factor	x0.01%
4x0092	Output Current Phase N	x0.1 A

Table 3-20 2033A, 9700 Register List (BYPASS)

Register	Measurement	Notes
4x0054	Bypass Voltage Phase A-B	x0.1 VAC
4x0055	Bypass Voltage Phase B-C	x0.1 VAC
4x0056	Bypass Voltage Phase C-A	x0.1 VAC
4x0057	Bypass Voltage Phase A-N	x0.1 VAC
4x0058	Bypass Voltage Phase B-N	x0.1 VAC
4x0059	Bypass Voltage Phase C-N	x0.1 VAC
4x0066	Bypass Frequency	x0.1 Hz

The Alarms are mapped as bits in registers. If the alarm is active then its bit will be set. The bits are labeled in IEC format where bit 0 is the LSB and 15 is the MSB. Unused bits are forced to zero.

Table 3-21 2033A, 9700 Register List (Alarms)

Register	Bit	Code	Description
4x0068 Fault 1 (Bits 0-15)	1	UF007	Converter Input Current Sensor Abnormal
	2	UF105	DC Voltage Sensor Circuit Abnormal
	5	UF102	DC Undervoltage
	6	UF103	DC Overvoltage
	11	UF216	Inverter Output Current Sensor Abnormal
	12	UF201	Inverter Output Overvoltage +15%
	13	UF202	Inverter Output Undervoltage -15%
4x0069 Fault 1 (Bits 16-31)	0	UF306	UPS Control Power Circuit Error
	3	UF301	UPS Control Microprocessor Circuit Error
	5	UF305	UPS Control Circuit Error
	10	UF203	Inverter Output Overcurrent
	12	UF302	UPS Control Microprocessor Circuit Error
	13	UF303	UPS Control Microprocessor Circuit Error
	15	UF304	UPS Control Microprocessor Circuit Error
4x0070 Fault 2 (Bits 0-15)	2	UF216	Sensor Abnormal
4x0071 Fault 2 (Bits 16-31)	None	None	Reserved, No alarms
4x0072 Fault 3 (Bits 0-15)	0	UF003	Converter Abnormal
	1	UF212	Fan Power Source Abnormal
	2	UF107	CB2 Abnormal
	3	UF214	Cooling Fan Thermal Relay Abnormal
	5	UF213	Inverter or Converter Overtemperature
	9	UF307	UPS Control Circuit Error
	11	UF209	52C Abnormal (Not Closed)
	12	UF210	52C Abnormal (Not Open)
	13	UF106	DC Capacitor Abnormal
	15	UF255	52C Abnormal
4x0073 Fault 3 (Bits 16-31)	3	UF309	Inverter Output Voltage Sensed before 52C Closed
	4	UF401	52S Abnormal (Not Closed or Closed without command)
	5	UF402	52S Abnormal (Not Opened or Open without command)
	6	UF215	Frequent Overload

Table 3-22 2033A, 9700 Register List (Alarms)

Register	Bit	Code	Description
4x0074 Fault 4 (Bits 0-15)	0	UF053	Input Contactor CB1 not Open under correct sequence
	1	UF052	Input Circuit Breaker CB1 Tripped
	2	UF257	52C Abnormal, did NOT Open after manual transfer to bypass.
	3	UF451	52S Abnormal NOT closed, or closed with no manual transfer command.
	4	UF153	CB2 DC Circuit Breaker Tripped
	5	UF154	CB2 Abnormal
	9	UF158	Battery Liquid Level Low
	10	UF157	Battery Overtemperature
	11	UF156	CB2 Tripped (after prolonged battery overtemperature 2Hr)
	13	UF256	Output Voltage Abnormal outside +/- 5%
	15	UF352	Control Power Supply Abnormal
4x0075 Fault 4 (Bits 16-31)	0	FU159	DC Ground Fault
	2	UF160	DC Circuit Sensor Abnormal
	3	UF351	DC Control Fuse Blown
	4	UF151	DC Voltage Abnormal, DC Buss does not return to Float after power restored (24Hr)
	5	UF152	DC Voltage Abnormal, DC Buss does not return to Equalize after power restored (24Hr)
	9	UF162	DC Circuit Abnormal
	11	UF356	UPS Control Circuit Error
	12	UF357	"Inverter Start" Switch Abnormal
	13	UF358	"Inverter Stop" Switch Abnormal
	14	UF359	"Inverter Operation" Switch Abnormal
	15	UF360	"Bypass Operation" Switch Abnormal
4x0076 Fault 5 (Bits 0-15)	0	UF255	52C Abnormal, Opened during Inverter Load Supply
	2	UF355	UPS Control Circuit Error
4x0077 Fault 5 (Bits 16-31)	None	None	Reserved, No alarms
4x0078 Fault 6 (Bits 0-15)	1	UA802	AC Input Frequency Out of Range
4x0079 Fault 6 (Bits 16-31)	None	None	Reserved, No alarms

Table 3-23 2033A, 9700 Register List (Alarms)

Register	Bit	Code	Description
4x0080 Fault 7 (Bits 0-15)	0	UF056	Converter Input Current Overload
	1	UF058	Cooling Fan Abnormal (Converter Circuit)
	2	UF057	Converter Overtemperature
	3	UF362	UPS Control Circuit Error
	4	UF161	CB2 Tripped (DC Voltage Abnormal) DC Buss does not return to Float after power restored (48Hr)
	5	UF254	88C Abnormal - Fan AC Source Abnormal during Inverter Operation
	6	UF059	Converter Abnormal, Preliminary Charge Impossible
	7	UF060	Converter Abnormal
	8	UF363	Voltage Adjust Error
	9	UF258	Frequent Overload
4x0081 Fault 7 (Bits 16-31)	8	UF806	Inverter Overload > 100%
	9	UF807	Inverter Overload > 110%
	10	UF808	Inverter Overload > 125%
	11	UF809	Inverter Overload > 150%
	12	UF810	Inverter Overload, Momentary Overcurrent while load powered by inverter
	13	UF836	Converter Overload
4x0082 Fault 8 (Bits 0-15)	0	UA823	CB1 OFF, AC Input Contactor OPEN
	1	US824	CB2 OFF, DC Contactor OPEN
	2	UA826	CB101 OFF, Control Breaker Opened During Inverter Load Supply.
	5	UA819	Remote Start Button Abnormal
	6	UA820	Remote Stop button Abnormal
	7	UA812	Bypass Voltage Out of Range +-20%
	8	UA817	Emergency Stop Activated
	9	UA827	52C Not Permitted, Transfer Permitted switch open
	10	UA830	AC Input Undervoltage
	11	None	Manual Bypass Switch ON
	12	UA803	AC Input Phase Rotation Error
	13	UA805	Ambient Temperature Abnormal HIGH
	14	UA804	Battery DC Precharge Circuit Abnormal
	15	UA801	AC Input Voltage Out of Range - Fell below -18% threshold.

Table 3-24 2033A, 9700 Register List (Alarms and Status)

Register	Bit	Code	Description
4x0083 Fault 8 (Bits 16-31)	0	UA811	Bypass Voltage Out of Range +/-15%
	1	NONE	Transfer Failure (Load Stop)
	2	UA813	Bypass Phase Rotation Error
	3	UA814	Bypass Frequency Out of Range
	4	UA816	Extended Bypass Operation (10 minutes)
	5	UA831	Emergency Bypass Switch ON
	6	UA822	Generator Operation (Transfer to Bypass not permitted)
	8	UA832	Interrupted Transfer to Bypass
	9	UA821	UPS Stopped (Transfer Inhibited, Bypass Voltage out of range)
	10	UA835	UPS Stopped (Transfer Inhibited, Inverter Asynchronous)
	11	UA804	Battery Abnormal
4x0084 Status 1 (Bits 0-15)	0		Inverter is operating and powering the load
	1		Ex. Alarm, Minor Fault
	2		Inverter Running
	3		Inverter S/S, Inverter is Started from Local or Remote
	4		Battery Operation 1, 3 minute alarm time delay after battery backup
	5		Battery Low Voltage, near depletion due to prolonged AC Fail
	6		Overload, UPS Output Capacity Exceeded
	7		Overload, (Level Reached)
	8		Enable to Remote Operation
	9		Remote Operation
	10		Battery Depletion, Shutdown Imminent
	11		Battery Abnormal, Overtemperature or Low Liquid Level
	12		Converter Operation, 1=Running
	13		Battery Operation 2, UPS in Battery Backup Mode
	14		CB1 1=Closed
	15		CB2 1=Closed
4x0085 Status 1 (Bits 16-31)	0		Converter is operating and supplying Inverter
	1		Battery Operation 3, No alarm time delay after battery backup initiated
	2		52C 1=Closed
	3		AC Input Abnormal, Voltage or Frequency out of range
	4		Equalize Charge, UPS in Equalize Mode
	5		Output Overload, (Inverter Stop)
	6		Test Mode
	7		Output Switch Abnormal, 52S or 52C Abnormal
	8		Battery Charge

Table 3-25 2033A, 9700 Register List (Status)

Register	Bit	Description
4x0086 Status 2 (Bits 0-15)	0	CB1 Alarm
	1	CB2 Alarm
	2	52C Alarm
4x0087 Status 2 (Bits 16-31)	NONE	Reserved
4x0088 Status 3 (Bits 0-15)	0	Synchronism, Inverter is synchronized to external source
	1	Asnychronism, Inverter is in the free running mode
	2	Voltage Equalize Answer, DC Voltage reached equalizing voltage level
	5	52S 1=Closed
	6	CB3 1=Closed
	7	Bypass Operation, Load powered via static Bypass Line
	8	Bypass Input Abnormal, Voltage or Frequency Out of Range
	10	Bypass Abnormal
	12	Synchronism 2
	13	Load Supply, Load powered by UPS (Inverter or Bypass)
	14	Generator Operation, 1=UPS on Generator
4x0089 Status 3 (Bits 16-31)	NONE	Reserved
4x0090 EX Status (Bits 0-15)	0	Direction of Battery Current (1=Discharge, 0=Charging)
	1	Battery Floating
	2	Input Power Failure Detection
	3	Input Power Failure
4x0091 EX Status (Bits 16-31)	NONE	Reserved

The MUCM serial port setup is stored in registers 653 through 676. Some of these registers are read only while some may be altered by sending writes to the MUCM. Care must be exercised when modifying these values because the serial ports will change their settings immediately and possibly cause a loss of communications.

Note: New values are stored to FLASH upon completion of the Modbus Write. Do not allow the Master to continuously send writes to the MUCM.

Table 3-26 MUCM Setup Register List

Register	R/W	Measurement	Notes
4x0653 - 4x0668	RW	MUCM Application Revision String	Packed ASCII
4x0669	RW	MUCM Port 1 Mode	Integer Value 0 = Auto Detect 1 = SEC 2 = MIT (default = 0)
4x0670	RW	MUCM Port 1 Baud Rate	1200, 2400, 4800, 9600, 19200 (default = 9600)
4x0671	R	MUCM Port 1 Parity	0 = NONE 1 = EVEN SEC always uses NONE MIT always uses EVEN
4x0672	RW	MUCM Port 2 Mode	5 = Modbus RTU Slave 6 = Modbus ASCII Slave (default = 5)
4x0673	RW	MUCM Port 2 Baud Rate	1200, 2400, 4800, 9600, 19200 (default = 9600)
4x0674	RW	MUCM Port 2 Parity	0 = NONE 1 = EVEN (default = EVEN)
4x0675	RW	MUCM Port 2 Modbus Slave Address	1-254 (default = 1) Always responds to address 255.
4x0676	RW	MUCM Port 2 Data Bits	7 (valid for Modbus ASCII only) 8 (valid for RTU or ASCII) (default = 8)

4

Examples

Example 1

Figure 4-1 shows system with three UPSs to be connected to a Modbus master. UPS 1 is a 2033C, UPS 2 is a 9700, and UPS 3 is a 9800AD. Each UPS has its own MUCM connected via an MU1 RS-232 cable. The Modbus RTU Master has an RS-485 port and is configured for 19200 baud, 8 data bits, 1 stop bit and NONE parity. Each MUCM is configured as shown in Table 4-1.

Table 4-1 Example 1 Settings

Parameter	MUCM 1		MUCM 2		MUCM 3	
	Port 1	Port 2	Port 1	Port 2	Port 1	Port 2
Mem/Run/Halt Switch	Run	Ignored	Run	Ignored	Run	Ignored
Protocol Mode	2033C UPS	Modbus RTU	9700 UPS	Modbus RTU	9800AD UPS	Modbus RTU
Baud Rate	9600	19200	9600	19200	9600	19200
Parity	Auto	NONE	Auto	NONE	Auto	NONE
Data Bits	8	8	8	8	8	8
Stop Bits	1	1	1	1	1	1
Slave Address	N/A	1	N/A	2	N/A	3

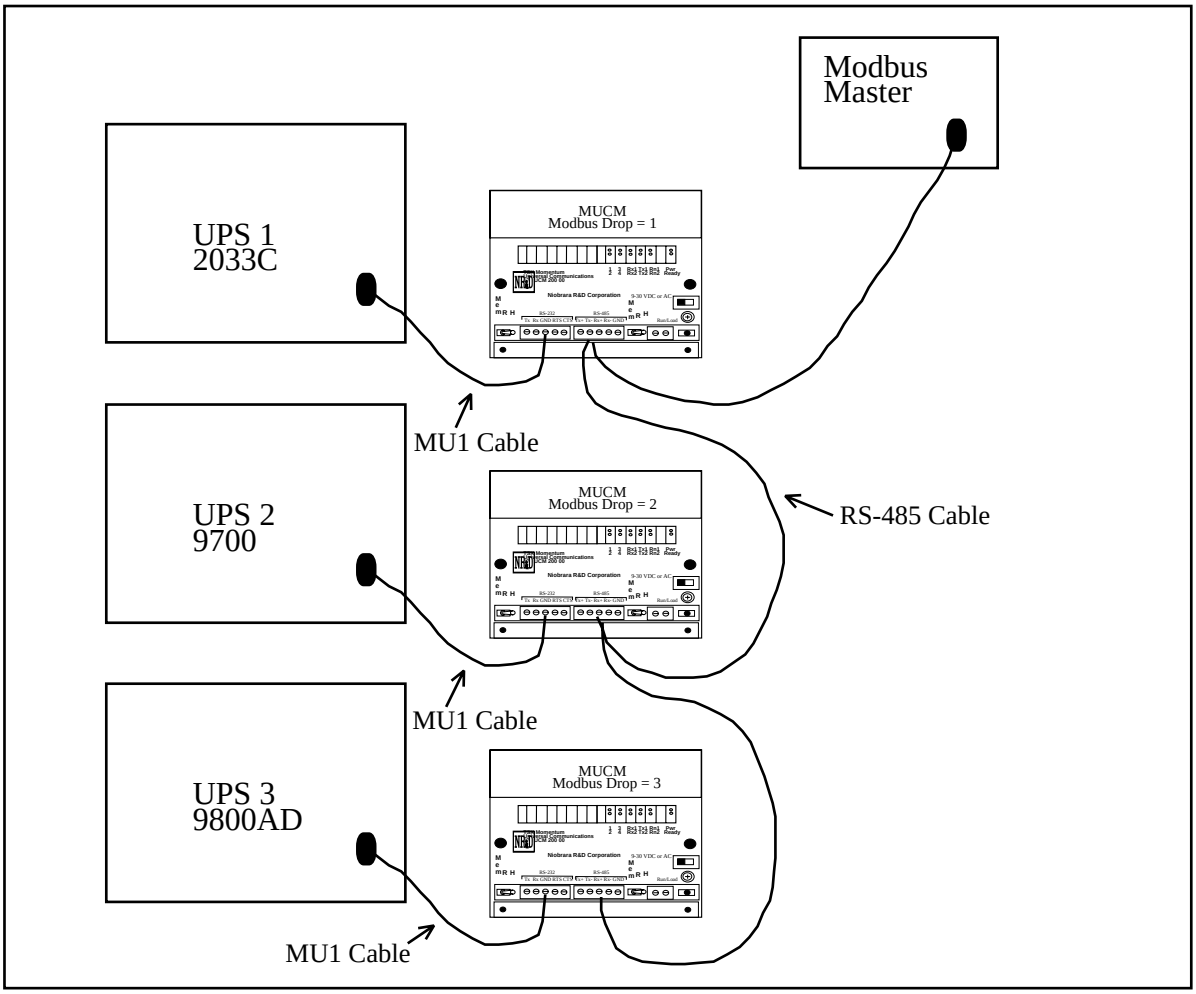

Figure 4-1 Example 1 Layout

Port 2 of the MUCM is RS-485 so a simple 4-wire cable is required to connect to most Modbus equipment. A twisted pair cable such as Belden 8723 should be used with one pair on the TX and the other pair on the RX circuit.

Master		MUCM 1		MUCM 2		MUCM 3
Tx+	———	IN+	———	IN+	———	IN+
Tx-	———	IN-	———	IN-	———	IN-
Rx+	———	OUT+	———	OUT+	———	OUT+
RX-	———	OUT-	———	OUT-	———	OUT-
Shield	———	Shield	———	Shield	———	Shield

Figure 4-2 4-wire RS-485 Example

If the Modbus Master has a 2-wire RS-485 port then use a single twisted pair cable and jumper the IN+ to OUT+ at each MUCM for the (+) connection as well as jumper the IN- to OUT- for the (-) connection.

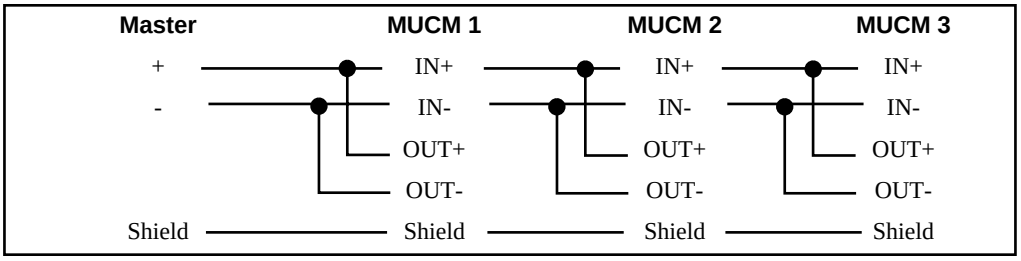

Figure 4-3 2-wire RS-485 Example

5

Testing and Troubleshooting

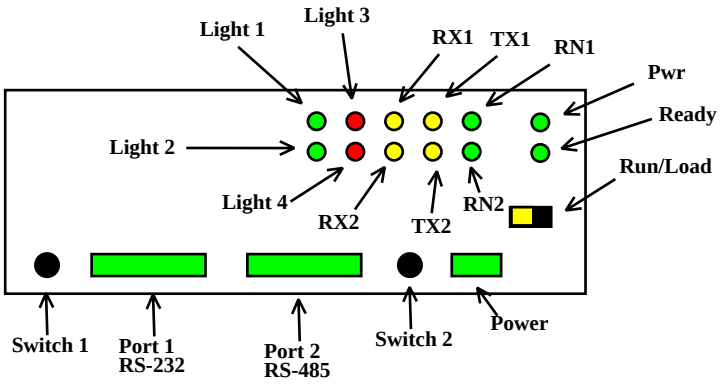

Figure 5-1 MUCM Lights and Switches

Switches

- Switch 1 controls the running of the Mitsubishi application.
  - — Mem Prot - The far left position forces the unit to enable the configuration terminal server on the RS-232 port or set the RS-485 port to debug mode.

    For the terminal setup mode set Switch 2 to RUN or MEM PROT. The RN1 light will be on and lights 1, 2, 3, and 4 will all be on to indicate the terminal server is enabled. Connect an MU1 cable to the RS-232 port to a PC and run a terminal emulator (Hyperterminal) at 9600,N,8,1, with VT100 emulation.

    For the RS-485 port debug mode set Switch 2 to Halt. Then connect Hyperterminal to the RS-485 mode at 9600,N,8,1 with VT100 emulation for debugging data from the UPS connection.
  - — 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. Move to this position when loading new versions of the application with qload.

- Switch 2 is ignored by the MUCM.
- 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 adaptor. 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 Mitsubishi application.
- The yellow **Tx1** light indicates that the MUCM RS-232 port is transmitting data. This light should normally be quickly flashing as the MUCM polls the UPS.
- The yellow **Rx1** light indicates that the MUCM RS-232 port is receiving data. This light should normally be quickly flashing as the MUCM polls the UPS.
- The yellow **Tx2** light indicates that the MUCM RS-485 port is transmitting data. This light should normally be occasionally flashing as the Modbus Master polls the MUCM.
- The yellow **Rx2** light indicates that the MUCM RS-485 port is receiving data. This light should normally be occasionally flashing as the Modbus Master polls the MUCM. This light may flash without the Tx2 light as the Modbus Master polls other devices on the RS-485 network.
- **Light 1** is a green light controlled by the application. If light 1 is on but light 3 is off the MUCM is communicating with the UPS and the device is SEC If lights 1, 2, 3, and 4 are all on then the unit is in the configuration terminal server mode.
- **Light 2** is a green light controlled by the application. Light 2 should come on briefly with each Modbus message that is received by the MUCM. This light will flash very quickly if the message is not intended for the MUCM. It will be on briefly longer if the MUCM processes the message. If lights 1, 2, 3, and 4 are all on then the unit is in the configuration terminal server mode. If lights 2 and 3 are on then the unit is in the RS-485 port debug terminal server mode.
- **Light 3** is a red light controlled by the application. Light 3 indicates an error in the communication with the UPS. If lights 1, 2, 3, and 4 are all on then the unit is in the configuration terminal server mode.

- **Light 4** is a red light controlled by the application. Light 4 indicates an error in the Modbus RS-485 communication. If the MUCM detects a parity or framing error on the RS-485 port then it will turn on light 4 for 250mS. If the MUCM receives a Modbus message for the UPS but the UPS is not responding then the MUCM will turn on light 4 for 1 second. If lights 1, 2, 3, and 4 are all on then the unit is in the configuration terminal server mode. If lights 2 and 3 are on then the unit is in the RS-485 port debug terminal server mode.

Testing the UPS Connection

Hyperterminal and an RS-232<>RS-485 converter may be used to verify the data from the UPS.

1 Connect the PC to the MUCM RS-232 port with an MU1 cable.

2 Start Hyperterminal and set it for 9600 baud, 8 data bits, 1 stop bit, NONE parity.

3 Move switch 1 to MEM PROT to set the MUCM for setup terminal server. Lights 1, 2, 3, and 4 should come on.

4 Press the "p" key to edit the ports.

5 Press the space bar to select port 2, then press Enter.

6 Press the space bar to select "Debug Server" and press Enter.

7 Press Enter until the port settings are finished. Make note of the baud rate and parity of port 2.

8 Now move switch 1 to RUN. The 1, 2, 3, and 4 lights should go out and then the 2 and 4 lights should come on.

9 Disconnect the RS-232 cable from the PC and connect it back to the UPS. The MUCM should start communicating with the UPS and the 3 light should not be blinking. The tx2 light should be blinking with each blink of the tx1 light.

10 Connect the PC to the RS-485 port of the MUCM through an RS-232<>RS-485 converter.

11 Adjust the settings of Hyperterminal to match the baud rate and parity of the MUCM port 2. Data from the UPS should start appearing in the Hyperterminal screen.

12 When finished with the debugging, set port 2 back to Modbus RTU Slave through the setup server.

Testing the Modbus Connection

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

1 Connect the Niobrara SC912 cable or other RS-232<>RS-422 converter to the MUCM port 2 and the serial port of the PC. The SC912 external power supply must be used.

2 Open a Command Prompt and change directories to the location where the mitsubishi.zip file was extracted. On most Windows systems do a Start, Programs, Accessories, Command Prompt.

3 From the command line enter the following:

>zapreg32 com1:9600,e,8,1 254 -b

where com1: is the PC's com port, 9600,e,8,1 are the settings of the MUCM's RS-485 port, 254 is a special drop number that the MUCM will respond to whether it is talking to the UPS or not, and the -b tells zapreg to use Modbus RTU.

A screen like Figure 5-2 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 UPS data is present, substitute the Modbus Slave address (default=1) for the 254 in the command line above. If the MUCM is talking to the UPS then the UPS data will be displayed. If the MUCM is not talking to the UPS then "Read Reply Timeout" will be displayed on zapreg.

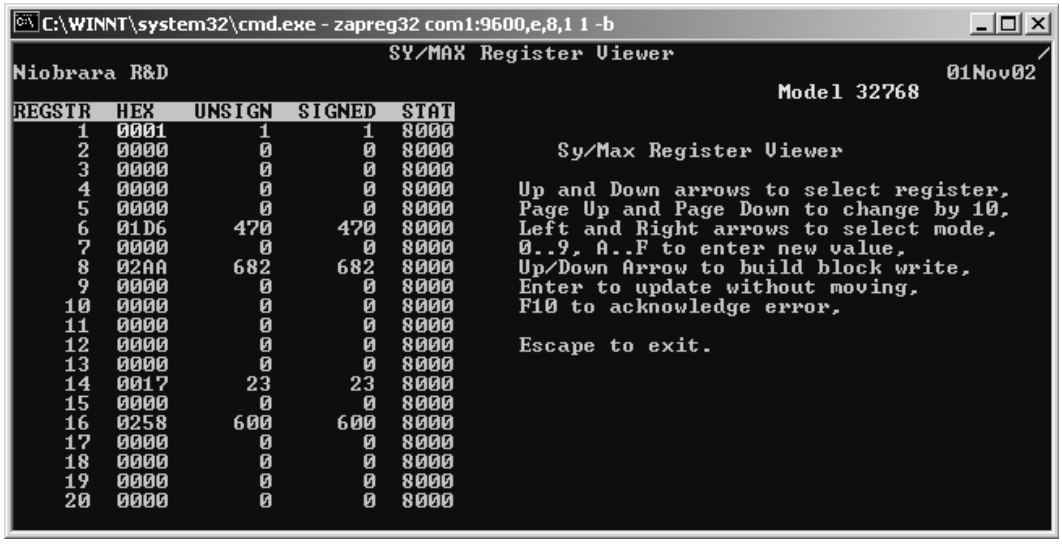

Figure 5-2 ZAPREG32 Screen