MUCM Modbus/DNP 3.0 Slave

Installation and Programming Manual

This Manual describes the MUCM application for interfacing Modbus devices onto a DNP 3.0 system.

Effective: 12 June, 2002

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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 makes multiple Modbus RTU slave devices appear as multiple DNP 3.0 slave devices. Up to 10 devices may be configured within the MUCM.

The DNP mapping is user configured by dowloading a formatted text file to the MUCM. The application presently supports mapping Modbus 3x (16-bit Analog Inputs) and 4x (16-bit Holding Registers) to DNP 16-bit Analog Inputs and/or 16-bit Binary Counters. Aditionally, the application is aware of the Niobrara MSTD-008 KYZ counter module and provides a pre-configured DNP map for this slave.

Though 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: 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 a DNP 3.0 network. Port 2 of the MUCM is RS-485 and is to be connected to the Modbus network. Both ports may be individually configured for baud rate, parity, and timeout values.

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

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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 DNP Master-may be built or purchased
- Cabling between MUCM and Powerlogic equipment may be built or purchased. All mating connectors are supplied with MUCM; network cabling is not provided.
- 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 9-30 Volts AC or DC.

Software Installation

The application files for the MUCM are included in the DNPS.ZIP file. This file must be unzipped using PKUNZIP.EXE. A copy of PKUNZIP is included on the standard NR&D software disk and is also available at www.niobrara.com. The latest version of

the DNPS.ZIP file is located at

http://www.niobrara.com/ftp/mucm/mdnps/mdnps.zip

The latest version of this document in pdf format is located at:

http://www.niobrara.com/ftp/mucm/mdnps/mdnps.pdf

Serial Connections to the MUCM

Port 1 to DNP Master

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

In the event the DNP master is a personal computer with a standard 9-pin RS-232 port, the Niobrara MU1 cable may be used. If the DNP master is connected through a modem then the MU4 cable may work. (See Figure 2-2). For other standard connections, see the MUCM manual, or contact NR&D's technical support.

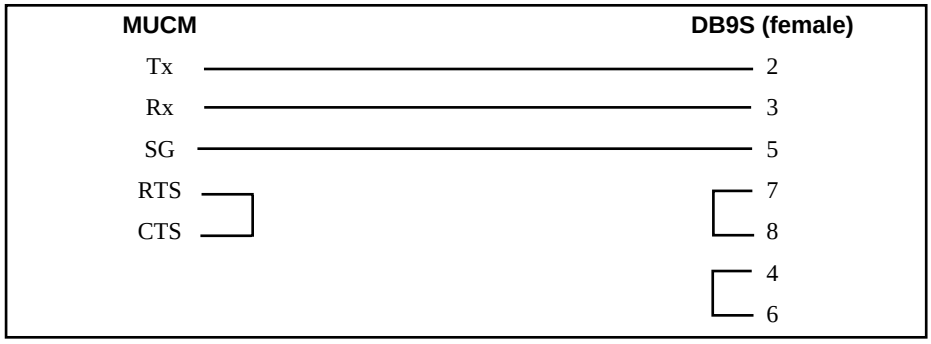

Figure 2-1 MUCM to PC RS-232 (MU1 Cable)

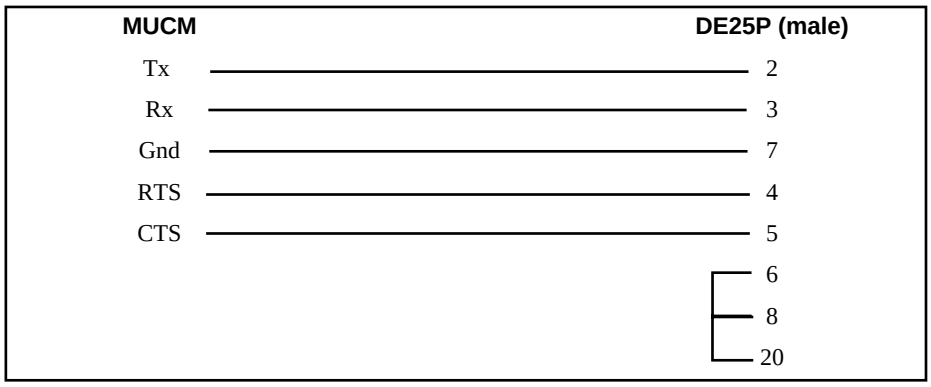

Figure 2-2 MUCM to RS-232 DTE Port (25-pin modem) (MU4 Cable)

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.

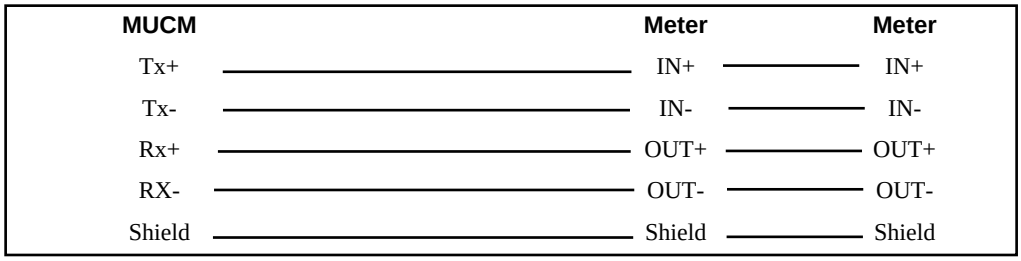

Figure 2-3 MUCM to 4-wire Modbus Slaves

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.

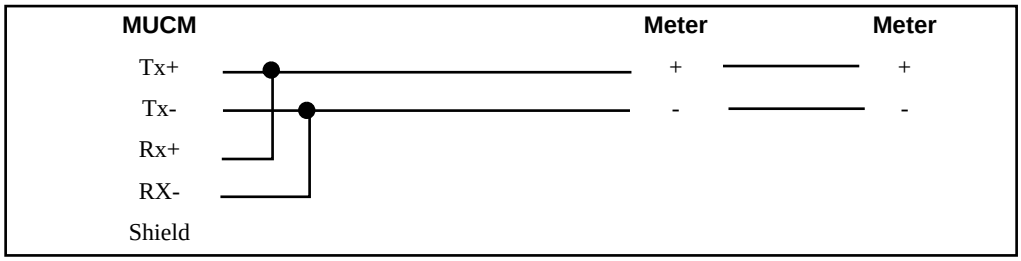

Figure 2-4 MUCM to 2-wire Modbus Slaves

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

The MUCM is rapidly evolving so be sure to upgrade the firmware in the module before loading the latest version of APP1.QCC and APP2.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 is for the MUCM-001; MUCM.FWL is for the MUCM-002. Firmware upload is as follows:

1 Move the RUN/LOAD switch on the module to LOAD. The MUCM may reboot, and the Tx1 LED should flash once per second, very briefly.

2 Connect the PC to MUCM Port 1 with a MU1 cable.

3 From the command line enter

> fwload mucm.fwl com1: [for an MUCM-002]

or

> fwload mucm1.fwl com1: [for an MUCM-001]

Be sure to have the colon after the PC's com port name. The download will only take a few minutes and will inform when finished.

4 Change the switch back to RUN.

5 It is a good idea to press the RESET button after a firmware change.

Next, load APP1.QCC into the MUCM:

1 Move Switches 1 and 2 to Halt.

2 Connect the PC to MUCM Port 1 with a MU1 cable.

3 Load the DNP files with qload:

> qload 1 app1 com1: -a

Will load the file into application 1's flash and set the program to automatically start on power-up. Again, it is important to include the colon after the PC's COM port name.

4 Place Switche 1 in RUN. The RN1 light should come on and light 2 will blink.

Configure the application by connecting a terminal emulator (like Hyperterminal) to the COM: port of the MUCM. See the Configuration Chapter for details.

DNP Slave Address Configuration

The MUCM may be configured to answer to multiple DNP slave addresses. Each configured DNP address will correspond to a single Modbus device. Each device will have its own register mapping assigned in the configuration text file.

DNP Object List

The data from the Modbus slaves is presented as Analog Input Objects and Binary Counter Objects.

Table 2-1 Binary Counter Objects for MSTD-008

(16-bit Binary Counter without Flag) (Object 20, Variation 6)	
Point	**Measurement**
0	KYZ Inputs 1 & 2 Raw Count
1	KYZ Inputs 3 & 4 Raw Count
2	KYZ Inputs 5 & 6 Raw Count
3	KYZ Inputs 7 & 8 Raw Count
4	KYZ Inputs 9 & 10 Raw Count
5	KYZ Inputs 11 & 12 Raw Count
6	KYZ Inputs 13 & 14 Raw Count
7	KYZ Inputs 15 & 16 Raw Count
8	KYZ Inputs 1 & 2 Scaled Count
9	KYZ Inputs 3 & 4 Scaled Count
10	KYZ Inputs 5 & 6 Scaled Count
11	KYZ Inputs 7 & 8 Scaled Count
12	KYZ Inputs 9 & 10 Scaled Count
13	KYZ Inputs 11 & 12 Scaled Count
14	KYZ Inputs 13 & 14 Scaled Count
15	KYZ Inputs 15 & 16 Scaled Count

Table 2-2 Analog Input Objects For MSTD-008

(16-bit Analog Input without Flag) (Object 30, Variation 4)	
Point	**Measurement**
0	KYZ Inputs 1 & 2 Time Averaged Data
1	KYZ Inputs 3 & 4 Time Averaged Data
2	KYZ Inputs 5 & 6 Time Averaged Data
3	KYZ Inputs 7 & 8 Time Averaged Data
4	KYZ Inputs 9 & 10 Time Averaged Data
5	KYZ Inputs 11 & 12 Time Averaged Data
6	KYZ Inputs 13 & 14 Time Averaged Data
7	KYZ Inputs 15 & 16 Time Averaged Data

See Chapter 4 for complete DNP information.

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Configuration

The MUCM application requires some basic configuration. This is done via a Terminal session through the MUCM's serial port 1. When switch 2 is in the MEM PROTECT position, the MUCM is in configuration mode, and the user light 1 will blink rapidly.

For configuration, connect a PC with a terminal emulator (such as Hyperterminal) to the MUCM's port 1 using a MU1 cable (as described in Figure 2-1 on page 8). The configuration terminal should be set to 9600 baud, No parity, 8 data bits. Pressing ENTER will cause the MUCM to display the main menu.

Main Page

The main page allows the configuration of DNP baud rate and parity, and Powerlogic network settings. (See Figure 3-1). This page also provides the means to store the configuration permanently to Flash memory.

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
DNP 3.0 Setup                                        App Rev. 04Jun2002

 Setting          Port 1             Port 2
---------      --------------     -------------
Mode           DNP 3.0 Slave    Modbus RTU Master
Baud               9600               9600
Parity             NONE               EVEN
Data Bits           8                  8
Stop Bits           1                  1
Timeout            2000               2000

(D)ownload New Settings from PC
(U)pload New Settings to PC
(S)how data from Devices
(W)rite to Flash
```

Figure 3-1 Configuration Main Page

Press "D" to download the module settings. From the Terminal Emulator (Hyperterm) select Transfer, Send Text File, and then send the text file with the configuration data.

Press "U" to upload the module settings to the PC. From the Terminal Emulator select Transfer, Capture Text and enter a filename for the settings. Be aware that Hyperterm defaults to appending the data to an existing file. Press the space bar to begin the upload.

Press "S" to dump the current parameters with the data values from the meters.

Press "W" to write the current paramers to flash.

Map Text File Format

The exact format of the mapping text file is critical. Follow the structure of MAP.TXT included in the MDNPS.ZIP file.

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DNP Device Profile

DNP V3.00 **DEVICE PROFILE DOCUMENT**	
Vendor Name: **Niobrara R&D Corp**	
Device Name: MUCM-001 Powerlogic Application	
Highest DNP Level Supported: For Requests Level 2 For Responses Level 2	Device Function: ☐Master ■Slave
Maximum Data Link Frame Size (octets) Transmitted 292 Received 292	Maximum Application Fragment Size (octets): Transmitted 2048 Received 2048
Maximum Data Link Re-tries: ■None ☐Fixed at _____ ☐Configurable	Maximum Application Layer Re-tries: ■None ☐Configurable range ____ to ____

Requires Data Link Layer Confirmation:

- ■ Never
- □ Always
- □ Sometimes If 'Sometimes', when?_____
- □ Configurable If 'Configurable', how?_____

Requires Application Layer Confirmation:

- ■ Never
- □ Always
- □ When reporting Event Data
- □ When sending multi-fragment responses
- □ Sometimes If 'Sometimes', when?_____
- □ Configurable If 'Configurable', how?_____

Timeouts while waiting for:

Data Link Confirm	□ None	□ Fixed at ____	□ Variable	■ Configurable
Complete Appl. Fragment	■ None	□ Fixed at ____	□ Variable	□ Configurable
Application Confirm	■ None	□ Fixed at ____	□ Variable	□ Configurable
Complete Appl. Response	■ None	□ Fixed at ____	□ Variable	□ Configurable

Others _____

Data Link Confirm timeout is configurable: 1 to 5 seconds.

Sends/executes Control Operations

WRITE Binary Outputs	■ None	□ Always	□ Sometimes	□ Configurable
SELECT/OPERATE	■ None	□ Always	□ Sometimes	□ Configurable
DIRECT OPERATE	■ None	□ Always	□ Sometimes	□ Configurable
DIRECT OPERATE - NO ACK	■ None	□ Always	□ Sometimes	□ Configurable
Count > 1	■ None	□ Always	□ Sometimes	□ Configurable
Pulse On	■ None	□ Always	□ Sometimes	□ Configurable
Pulse Off	■ None	□ Always	□ Sometimes	□ Configurable
Latch On	■ None	□ Always	□ Sometimes	□ Configurable
Latch Off	■ None	□ Always	□ Sometimes	□ Configurable
Queue	■ None	□ Always	□ Sometimes	□ Configurable
Clear Queue	■ None	□ Always	□ Sometimes	□ Configurable

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY

Reports Binary Input Change Events when no specific variation requested:

- ■ Never
- □ Only time-tagged
- □ Only non-time-tagged
- □ Configurable to send both, one, or the other

Reports time-tagged Binary Input Change Events when no specific variation requested:

- ■ Never
- □ Binary Input Change With Time
- □ Binary Input Change Withe Relative Time
- □ Configurable

Sends Unsolicited Responses:

- ■ Never
- □ Configurable
- □ Only certain objects
- □ Sometimes
- □ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses:

- ■ Never
- □ When Device Restarts
- □ When Status Flags Change

Default Counter Object/Variation:

- □ No Counters Reported
- □ Configurable
- ■ Default Object 30
  Default Variation 1
- □ Point-by-point list attached

Counters Roll Over at:

- □ No Counters Reported
- □ Configurable
- □ 16 Bits
- ■ 32 Bits
- □ Other Value _____
  Point-by-point list attached

Sends Multi-Fragment Responses □ Yes ■ No

Implementation Table

OBJECT			REQUEST (Slave must parse)		RESPONSE (Master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
1	0	Binary Input - All Variations				
1	1	Binary Input				
1	2	Binary Input with Status				
2	0	Binary Input Change - All Variations				
2	1	Binary Input Change without Time				
2	2	Binary Input Change with Time				
2	3	Binary Input Change with Relative Time				
10	0	Binary Output - All Variations				
10	1	Binary Output				
10	2	Binary Output Status				
12	0	Control Block - All Variations				
12	1	Control Relay Output Block				
12	2	Pattern Control Block				
12	3	Pattern Mask				
20	0	Binary Counter - All Variations	1,7,8,9,10	00,01,06		
20	1	32-Bit Binary Counter				
20	2	16-Bit Binary Counter	1	00,01,06	129	00,01
20	3	32-Bit Delta Counter				
20	4	16-Bit Delta Counter				
20	5	32-Bit Binary Counter without Flag				
20	6	16-Bit Binary Counter without Flag	1	00,01,06	129	00,01
20	7	32-Bit Delta Counter without Flag				
20	8	16-Bit Delta Counter without Flag				
21	0	Frozen Counter - All Variations				
21	1	32-Bit Frozen Counter				
21	2	16-Bit Frozen Counter				
21	3	32-Bit Frozen Delta Counter				
21	4	16-Bit Frozen Delta Counter				
21	5	32-Bit Frozen Counter with Time of Freeze				
21	6	16-Bit Frozen Counter with Time of Freeze				
21	7	32-Bit Frozen Delta Counter with Time of Freeze				
21	8	16-Bit Frozen Delta Counter with Time of Freeze				
21	9	32-Bit Frozen Counter without Flag				
21	10	16-Bit Frozen Delta Counter without Flag				
21	11	32-Bit Frozen Delta Counter without Flag				
21	12	16-Bit Frozen Delta Counter without Flag				

OBJECT			REQUEST (Slave must parse)		RESPONSE (Master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
22	0	Counter Change Event - All Variations				
22	1	32-Bit Counter Change Event without Time				
22	2	16-Bit Counter Change Event without Time				
22	3	32-Bit Delta Counter Change Event without Time				
22	4	16-Bit Delta Counter Change Event without Time				
22	5	32-Bit Counter Change Event with Time				
22	6	16-Bit Counter Change Event with Time				
22	7	32-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter without Flag				
23	0	Frozen Counter Event - All Variations				
23	1	32-Bit Frozen Counter Event without Time				
23	2	16-Bit Frozen Counter Event without Time				
23	3	32-Bit Frozen Delta Counter Event without Time				
23	4	16-Bit Frozen Delta Counter Event without Time				
23	5	32-Bit Frozen Counter Event with Time				
23	6	16-Bit Frozen Counter Event with Time				
23	7	32-Bit Frozen Delta Counter Event with Time				
23	8	16-Bit Frozen Delta Counter Event with Time				
30	0	Analog Input - All Variations	1,7,8	00,01,06		
30	1	32-Bit Analog Input				
30	2	16-Bit Analog Input	1	00,01,06	129	00,01
30	3	32-Bit Analog Input without Flag				
30	4	16-Bit Analog Input without Flag	1	00,01,06	129	00,01
31	0	Frozen Analog Input - All Variations				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input with time of Freeze				
31	4	16-Bit Frozen Analog Input with time of Freeze				
31	5	32-Bit Frozen Analog Input without Flag				
31	6	16-Bit Frozen Analog Input without Flag				
32	0	Analog Change Event - All Variations				
32	1	32-Bit Analog Change Event without Time				
32	2	16-Bit Analog Change Event without Time				
32	3	32-Bit Analog Change Event with Time				
32	4	16-Bit Analog Change Event with Time				

OBJECT			REQUEST (Slave must parse)		RESPONSE (Master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
33	0	Frozen Analog Event - All Variations				
33	1	32-Bit Frozen Analog Event without Time				
33	2	16-Bit Frozen Analog Event without Time				
33	3	32-Bit Frozen Analog Event with Time				
33	4	16-Bit Frozen Analog Event with Time				
40	0	Analog Output Status - All Variations				
40	1	32-Bit Analog Output Status				
40	2	16-Bit Analog Output Status				
41	0	Analog Output Block - All Variations				
41	1	32-Bit Analog Output Block				
41	2	16-Bit Analog Output Block				
50	0	Time and Date - All Variations				
50	1	Time and Date				
50	2	Time and Date with Interval				
51	0	Time and Date CTO - All Variations				
51	1	Time and Date CTO				
51	2	Unsynchronized Time and Date CTO				
52	0	Time Delay - All Variations				
52	1	Time Delay Course				
52	2	Time Delay Fine				
60	0					
60	1	Class 0 Data	1	06,07,08		
60	2	Class 1 Data	1	06,07,08		
60	3	Class 2 Data	1	06,07,08		
60	4	Class 3 Data	1	06,07,08		
70	1	File Identifier				
80	1	Internal Indications	2	00 index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
101	2	Medium Packed Binary-Coded Decimal				
101	3	Large Packed Binary-Coded Decimal				

OBJECT			REQUEST (Slave must parse)		RESPONSE (Master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
No Object (Cold Restart)			13			
No Object (Warm Restart)			14			
No Object (Delay Measurement)						

DNP Object List

The data from the user type slaves is presented as Analog Input Objects and Binary Counter Objects and completely determined by the map file downloaded to the QUCM. The MSTD-008 device type uses the following objects..

Table 4-1 Binary Counter Objects for MSTD-008

(16-bit Binary Counter without Flag) (Object 20, Variation 6)	
Point	**Measurement**
0	KYZ Inputs 1 & 2 Raw Count
1	KYZ Inputs 3 & 4 Raw Count
2	KYZ Inputs 5 & 6 Raw Count
3	KYZ Inputs 7 & 8 Raw Count
4	KYZ Inputs 9 & 10 Raw Count
5	KYZ Inputs 11 & 12 Raw Count
6	KYZ Inputs 13 & 14 Raw Count
7	KYZ Inputs 15 & 16 Raw Count
8	KYZ Inputs 1 & 2 Scaled Count
9	KYZ Inputs 3 & 4 Scaled Count
10	KYZ Inputs 5 & 6 Scaled Count
11	KYZ Inputs 7 & 8 Scaled Count
12	KYZ Inputs 9 & 10 Scaled Count
13	KYZ Inputs 11 & 12 Scaled Count
14	KYZ Inputs 13 & 14 Scaled Count
15	KYZ Inputs 15 & 16 Scaled Count

Table 4-2 Analog Input Objects For MSTD-008

(16-bit Analog Input without Flag) (Object 30, Variation 4)	
Point	**Measurement**
0	KYZ Inputs 1 & 2 Time Averaged Data
1	KYZ Inputs 3 & 4 Time Averaged Data
2	KYZ Inputs 5 & 6 Time Averaged Data
3	KYZ Inputs 7 & 8 Time Averaged Data
4	KYZ Inputs 9 & 10 Time Averaged Data
5	KYZ Inputs 11 & 12 Time Averaged Data
6	KYZ Inputs 13 & 14 Time Averaged Data
7	KYZ Inputs 15 & 16 Time Averaged Data