ABB **Application Note**

Substation Automation and Protection Division

MSOC Communication Commonality with DPU/TPU/GPU 2000R Protective Relays

Introduction

There seems to be some confusion with ABB's implementation of Modbus on the 2000R and MSOC product lines. This Application Note is intended to dispel the ambiguities. The DPU/TPU/GPU 2000R and MSOC devices allow connectivity as a slave device (receiving commands and responding to a host request) on the Modbus Network. The DPU/TPU/GPU protective devices allow for both emulations of Modbus, namely RTU and ASCII. The MSOC allows for one single emulation of Modbus, namely ASCII. The DPU 2000R and the MSOC can communicate on the same network if both devices are configured as MODBUS ASCII slave nodes. This application note illustrates the step by step method of configuring the MSOC and DPU/TPU/GPU 2000R units attached to the same network.

RS 485 Device Connectivity

An RS 232 physical interface offers point to point connectivity. If multiple devices must be interconnected (multi-drop architecture), the physical interface must be changed from RS 232 to a physical interface configuration which allows for a multi-drop architecture.

Both the MSOC and DPU/TPU/DPU 2000R products have isolated RS 485 ports (MSOC through terminals 8,9, and 10. and the DPU/TPU/GPU products through the AUX com port as a standard via terminals 55,56 and 57). Communications in a multi-dropped architecture can occur via an RS 485 network with DPU/TPU/GPU 2000R's and MSOC's attached within the wiring constraints of the RS 485 ANSI standards. Figure 1 illustrates the RS 485 connectivity to a host device connected via a RS 485 network. Figure 2 illustrates the RS 232 cable connecting the PC with the RS 485 physical interface converter.
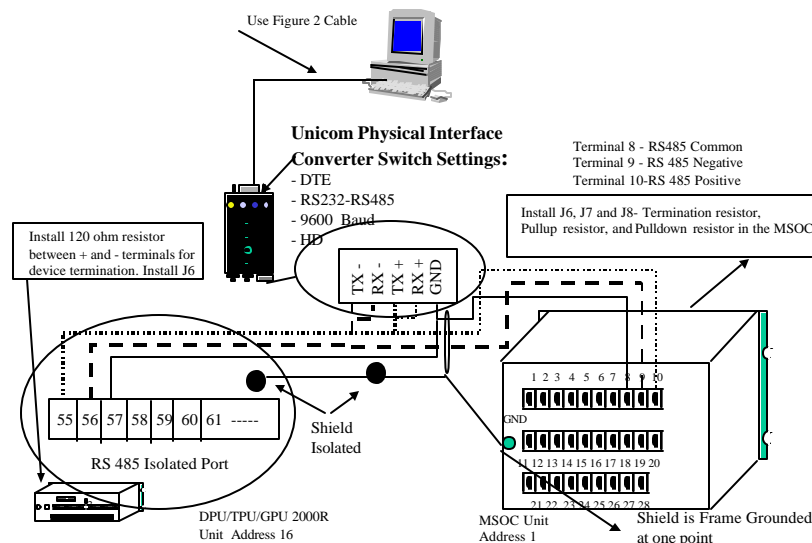

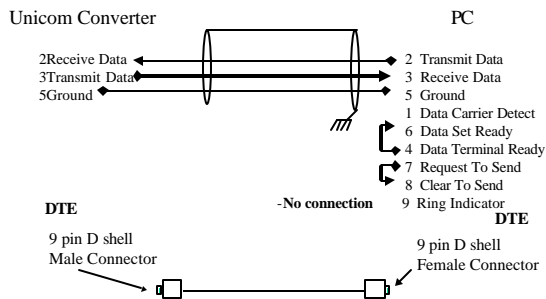*Figure 1 - RS 485 Architecture for example system.*

Unicom Converter   PC

```
2 Receive Data    ◄──────────────►   2 Transmit Data
3 Transmit Data   ◄──────────────►   3 Receive Data
5 Ground          ◄──────────────►   5 Ground
                                     1 Data Carrier Detect
                                     6 Data Set Ready
                                     4 Data Terminal Ready
                                     7 Request To Send
                                     8 Clear To Send
                     -No connection  9 Ring Indicator
```

DTE   DTE

9 pin D shell
Male Connector   9 pin D shell
                                 Female Connector

Figure 2 - Unicom RS 485 Converter to PC Cable 9 to 9 Pin-out

Device Configuration Via The Front Panel Interface

To further allow communications between the devices, a common port set-up must be configured, namely, baud rate, stop bits, data bits, and parity. The MSOC and the DPU/TPU/GPU 2000R share the following configurations:

Shared baud rates are:
- 1200
- 2400
- 4800
- 9600
- 19200

Shared recommended frame configurations are:
- Odd parity, 7 Data Bits, One stop Bit.
- Even parity, 7 Data Bits, One stop Bit.

With each device on the network configured in one shared and common configuration (as referenced above), communications between a Host device and MSOC's and DPU/TPU/GPU 2000R's shall occur. The MSOC and DPU/TPU/GPU product families are designed to communicate on a common Modbus network. This example shall illustrate a network configuration with two devices attached communicating at 9600 baud 7 data bits, one stop bit, and odd parity. This is only one of several combinations which may be used in a communication configuration.

MSOC Configuration Of MODBUS ASCII

The MSOC allows communication through the rear port, however, the front port (RS 232) must be disabled. To disable the front port the following procedure must be followed:

To direct the communications from the front RS 232 port to the rear RS 485 port the following procedure must be followed in addition to the aforementioned procedure for the native ASCII and the Modbus ASCII protocols.
        A. Depress E
        B. Depress the down arrow 4 times to display the OPERATIONS MENU
        C. Depress E
        D. Depress the down arrow 7 times to display the selection ENABLE FP COM
        E. Depress E

F. Enter the Password as described in the previous illustrations.
G. The user shall be prompted, with the selection ENABLE FP < >. If the selection is YES, then the Front Port (RS 232) shall have the communications options configured via the above process. If the Selection is NO then the Rear Port (RS 485) shall be enabled with the protocol configured via the above process. Enter the correct password for the unit. Then Depress E to accept the password. Select "NO" and the RS 485 port shall be enabled for communication.

The MSOC process for Baud Rate and Frame Size configuration is as follows:

A. Depress E
B. Main Menu heading should be visible.
C. Depress E.
D. The Operations menu will be visible. Depress the C pushbutton to go to the Main Menu.
E. Depress the up arrow pushbutton twice to attain the Settings menu selection.
F. Depress E. The Settings menu shall be visible.
G. Depress the down arrow once. The Change Settings will be visible.
H. Depress E.
I. Depress the down arrow 5 times. The Com selection shall be visible.
J. Depress the E pushbutton. The password selection shall be visible. Enter the correct password for the unit. Depress E.
K. Select the appropriate address for the unit . For this instance it shall be 1. To change – Depress E, right arrow to the correct value, depress E and then depress C.
L. Depress the down arrow once. FP Baud rate shall be visible. Select 9600. To change – Depress E, right arrow to the correct value, depress E and then depress C.
M. Depress the down arrow once. FP Frm shall be visible. Select O,7,1. This sets the port to 7 data bits, Odd Parity, and one stop bit. To change – Depress E, right arrow to the correct value, depress E and then depress C.
N. Depress the down arrow once. FP Prot shall be visible. Select MODBUS. This enables the MODBUS protocol resident in the unit. To change – Depress E, right arrow to the correct value, depress E and then depress C.
O. Depress the down arrow once. RP Baud rate shall be visible. Select 9600. To change – Depress E, right arrow to the correct value, depress E and then depress C.
P. Depress the down arrow once. RP Frm shall be visible. Select O,7,1. This sets the port to 7 data bits, Odd Parity, and one stop bit. To change – Depress E, right arrow to the correct value, depress E and then depress C.
Q. Depress the down arrow once. RP Prot shall be visible. Select MODBUS.   This enables the MODBUS protocol resident in the unit. To change – Depress E, right arrow to the correct value, depress E and then depress C
R. .Depress the down arrow once. Local Echo shall be visible. Select OFF. These selections shall place the unit in the native MODBUS protocol mode. To change – Depress E, right arrow to the correct value, depress E and then depress C.
S. After each of the settings, perform a unit save to maintain the unit settings entered in this session.

The above process has configured the front and the rear port for Modbus communication as 9600 baud, 7 data bits, one stop bit, odd parity. As per the previous section, the Rear Port has been enabled.

DPU/TPU/GPU 2000R Configuration Of MODBUS ASCII

The DPU/TPU/GPU 2000R allows for Modbus communication over Com 3 or the AUXCOM port. If the Type 2 Option board is within the unit, Com 3 contains the RS 232 Physical interface and the AUXCOM

board communicates via RS 485. If the Type 8 Option board is contained within the unit, both Com 3 and the AUX COM port allow for RS 485 Communications. The following configuration shall enable Com 3 and AUX COM for MODBUS ASCII communications. It should be noted that the configuration sequence is outlined for units having a Front Panel interface. Similar communication configuration steps could be followed when using ECP software. The communication procedure is the same for DPU/TPU/GPU 2000R units.

With the front panel showing metering values:

A. Depress E to display the configuration menu.
B. Depress the down arrow to display the Settings Selection Depress E.
C. Depress the down arrow to display the Change Setting. Depress E.
D. Depress the down arrow seven times to display the Communication Display. Depress E.
E. The query Enter Password shall be displayed. Enter the correct password for the unit and depress E.
F. The first selection in the Communication section shall be unit address. This address is to be entered in HEX. This example shall address the unit as Decimal 16. Enter the hex value 10 for this unit.
G. Right arrow ($\rightarrow$) and left arrow ($\leftarrow$) keys select the digit to change. The up arrow and down arrow keys increment and decrement the digit. Depress C to exit.
H. Depress the down arrow three times to select the RP RS 232 Baud menu item. Depress E.
I. A menu item for RP RS 232 baud rate selection shall appear. The present baud rate NOW < > and NEW < > is displayed. Depress the Right Arrow ($\rightarrow$) or Left Arrow ($\leftarrow$) to select the baud rate of 9600 baud. Depress C to exit the menu.
J. Depress the down arrow once and select the RP RS 232 frame size menu item. Depress E.
K. The Right Arrow ($\rightarrow$) and Left Arrow ($\leftarrow$) buttons must be depressed to select the frame size : <Odd, 7,1>, which is odd parity, 7 data bits, one stop bit. Depress C.
L. Depress the down arrow to select RP 485 Baud. Depress E to display selection.
M. A menu item for RP RS 485 baud rate selection shall appear. The present baud rate NOW < > and NEW < > is displayed. Depress the Right Arrow ($\rightarrow$) or Left Arrow ($\leftarrow$) to select the baud rate of 9600 baud. Depress C to exit the menu.
N. Depress the down arrow to display the RP 485 Frame menu selection. Depress E.
O. The Right Arrow ($\rightarrow$) and Left Arrow ($\leftarrow$) buttons must be depressed to select the frame size : <Odd, 7,1>, which is odd parity, 7 data bits, one stop bit. Depress C.
P. Depress the down arrow twice to display the Parameter 1 option. Depress E to enter the selection menu.
Q. Enter the number 3 to enable the both ports to communicate in MODBUS. Depressing the Left Arrow ($\leftarrow$) or Right Arrow ($\rightarrow$) decrements or increments the selection. Depress C to enter.
R. Depress the down arrow ten times to display the Mode Parameter 1 selection. Depress E to enter the submenu.
S. This selection must be enabled to allow Modbus ASCII communication through Com 3. Depress the Left Arrow ($\leftarrow$) or Right Arrow ($\rightarrow$) to select the Enable Option. Depress C to exit the menu.
T. Depress the down arrow once to select the Mode 2 Parameter selection. This selection must be enabled to allow Modbus ASCII communications through the AUX COM Port. Depress E.
U. Enable the Mode 2 Parameter by depressing the Left Arrow ($\leftarrow$) or Right Arrow ($\rightarrow$) to select the Enable parameter. Depress C to exit the menu.
V. Depress C to save the changes to the communication port changes made.
W. The user shall be prompted with the question " Enter <YES> to save settings?" Depress the right arrow button ($\rightarrow$) and depress E. which will save the unit communication settings.

X. Depress the black system reset pushbutton which is recessed and located at the lower left hand side of the unit.

The DPU/TPU/ GPU unit is now configured at 9600 baud, odd parity, 7 data bits, 1 stop bit for Modbus ASCII communications through Com 3 or the Aux COM port.

Network Communication Test

A host PC shall be connected to the RS 485-converter unit as illustrated in Figure 1 of this document. This section shall further illustrate the method of test for the unit connection verification. The units to be polled are Unit 1 (MSOC) and Unit 16 (DPU/TPU/GPU 2000R).

The easiest method to initiate communications in the MODBUS protocol is to read known discrete and register data. As per the MSOC Modbus register documentation, the unit catalog number is resident at register 40132. Appendix A of this document lists the register definitions of the MSOC. A Read Holding Register Modbus Command is explained. Appendix A of this document includes the Modbus Register Definition for the MSOC.   Additionally, documentation is available from Groupe Schneider further describing the Modbus ASCII emulation characteristics. The explanation contained within this document is intended to be a quick start guide to communication initiation.

The length of the catalog number is 12 characters or 6 registers. The following command string format, when sent will retrieve the catalog number from the unit.

: 01 03 00 83 00 06 73 lf cr

The above string in MODBUS ASCII format should be sent:

3A 30 31 30 33 30 30 38 33 30 30 30 36 37 33 0D 0A

The string is translated as such:

Colon (in HEX) , unit address = 01 (in HEX) , Read Holding Registers (Code 3 in HEX), data memory address −1 = 131 decimal (0083 in HEX), number of registers read = 6 (0006 in HEX), message calculated LRC code 73 (37 33), and line feed (0D) and (0A).

A typical response shall include the following:

: Address number (01), Read Holding Registers Command (Code 3 in HEX), Byte Count Returned 12 in decimal (OC in HEX) , Data Register 40132 = 47, Data Register 40133= 4M , Data Register 40134 = 14 Data Register 40135 = 11, Data Register 40136 = 60 Data Register 40137 = 10, and calculated LRC =77 (HEX) and line feed with carriage return (0D 0A).

The aforementioned response would be returned as such:

3A 30 31 30 33 30 43 34 37 34 4D 31 34 31 31 36 30 31 30 37 37 0A 0D.

As per the DPU/TPU/GPU 2000 R Modbus register documentation (each protective relay has a different register map, however, in this example the catalog number address is common between all units), the unit catalog number is resident at register 40133.

The length of the catalog number is 20 characters or 10 registers. The following command string format, when sent will retrieve the catalog number from the unit.

: 10 03 00 84 00 0A 73 lf cr

The above string in MODBUS ASCII format should be sent:

3A 31 30 30 33 30 30 38 34 30 30 30 41 37 33 0D 0A

The string is translated as such:

Colon (in HEX) , unit address = 01 (in HEX) , Read Holding Registers (Code 3 in HEX), data memory address −1 = 132 decimal (0084 in HEX), number of registers read = 10 (000A in HEX), message calculated LRC code 73 (37 33), and line feed (0D) and (0A).

A typical response shall include the following:

: Address number (10 in hex 16 in decimal), Read Holding Registers Command (Code 3 in HEX), Byte Count Returned 12 in decimal (OC in HEX) , Data Register 40132 = 47, Data Register 40133= 4M , Data Register 40134 = 14 Data Register 40135 = 11, Data Register 40136 = 60 Data Register 40137 = 10, and calculated LRC =77 (HEX) and line feed with carriage return (0D 0A).

The aforementioned response would be returned as such:

3A 31 30 30 33 30 43 34 37 34 4D 31 34 31 31 36 30 31 30 37 37 0A 0D.

The Unicom converter used for this test has 3 LED's which show the communication state of the Transmit and Receive RS 232 lines. Visual indication allows for determination of successful communication transmission and reception independently of the PC program monitoring.

A variety of commercially available packages are capable of sending Modbus ASCII commands. The intent of this example is not to review or recommend a specific vendor's Modbus software platform for sending commands, but to allow analysis of data received and viewed via a communication analyzer.

Conclusion

Connectivity of the MSOC and DPU/TPU/GPU product families is possible with the knowledge of RS 485 device connectivity, memory map register addressing, Modbus ASCII protocol and the host package sending the command strings.   Following a set procedure as outlined in this presentation shall enable the reader to easily and effectively initiate communications between host and relay devices.

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