MAGNETROL®

HART® to Modbus® Adaptor

Operating Manual

Firmware Version 1.7

SE-V3.0 Modbus ORGANIZATION CONFORMANCE TESTED

Eclipse® Model 706
Guided Wave Radar Level Transmitter

Jupiter® Model JM4
Magnetostrictive Level Transmitter

Pulsar® Model R96
Pulse Burst Radar Level Transmitter

TABLE OF CONTENTS

INTRODUCTION

This document is intended to provide a guide for utilizing the various features of the Magnetrol HART to Modbus Adaptor (HMA). For each feature, a step-by-step procedure is provided to demonstrate how to set up the HMA and attached HART devices for a particular configuration. Other configurations are possible with various combinations of the number of HART to Modbus Adapters on a single RS-485 line and the number and type of Magnetrol HART devices attached to those HMAs. The operations in those configurations can be accomplished by extending the procedures provided in this document. Additionally, it is not required to use the Modbus RTUs or host applications shown in this document. Any RTU or host application that allows for reading and writing Modbus registers to a slave device can be used.

The HART to Modbus Adaptor (HMA) is designed to allow Magnetrol HART transmitters to be utilized in a Modbus®[1] system. The following Modbus protocols are supported:

- Modbus RTU – Function codes 3, 4, 6, and 16
- Modbus ASCII – Function codes 3, 4, 6, and 16
- Levelmaster – Commands Uxx?, UxxF?, UxxOL?, and UxxOLxxxx?

A unique feature of the HMA is that it will support up to five attached HART devices; one in the same housing as the HMA, and up to four external devices attached through a 4-20 mA loop.

- The attached devices do not have to all the same type transmitter.
- The HMA provides power for all attached HART units.
- The attached units should be set to a fixed 4 mA loop current.

Communication

Within the above protocols, it is possible to configure communications parameters such as baud rate, parity, stop bits, etc. to match the settings for a particular Modbus Remote Terminal Unit (RTU) or host.

To ensure a standard method to communicate with the HMA, setting DIP switch positions 1 – 3 to OFF, and 4 to ON, (see Appendix A) will configure the HMA to communicate via Modbus RTU with the default communications settings shown in Appendix F.

[1] Modbus® is a registered trademark of Schneider Electric, licensed to the Modbus Organization, Inc.

Operating Modes

Modbus RTU and Modbus ASCII

When using the Modbus RTU and ASCII protocols, the HMA can be used in several ways:

1. HMA with a single transmitter (HMA mode) – The Modbus host addresses the HMA directly, using the address of the HMA. The registers in the HMA for the attached device follow the numbers listed for Slave 1 in the device register appendices L through S. In this mode, the allowable Modbus addresses are in the range of 1 through 247. **This is the default configuration for the HMA.**
2. HMA with multiple transmitters and one Modbus address (HMA mode) – The Modbus host addresses the HMA directly, using only the address of the HMA. The registers in the HMA for each attached device depend on the slave number of the attached devices as listed in Appendices L through S. The HMA will appear to be a Modbus device capable of providing multiple level measurements. In this mode, the allowable Modbus addresses are in the range of 1 through 247.
3. Single Modbus Device – The HMA is connected to only the HART device present in the same transmitter housing. The HART poll address of the HART device and the Modbus poll address of the HMA are the same. Changing the HART poll address of the attached transmitter will automatically change the Modbus poll address of the HMA to match. Essentially, they appear to a Modbus master as a single native Modbus device. The registers in the HMA for the attached device follow the numbers listed for Slave 1 in the device register appendices L through S. In this mode, the allowable Modbus/HART addresses are limited to the range of 1 through 62.

LevelMaster

When using the LevelMaster protocol, the HMA will appear to be invisible to the LevelMaster host. This is due to the limited command set available with LevelMaster. Instead, the attached HART devices will appear to be native LevelMaster devices. They will respond to the Modbus poll address equivalent to their HART poll address. In this mode, the allowable Modbus/HART addresses are limited to the range of 1 through 62.

Supported Device Parameters

Not all of the parameters for a particular Magnetrol HART transmitter are supported by the HMA using Modbus communication. For each device type, the parameters that are available have been chosen to represent the most commonly for optimization and troubleshooting. The available parameters are listed in Appendices L through S.

Full Device Configuration

Using a HART DD or DTM, the full range of HART transmitter parameters can be accessed to configure an attached HART device. There are two ways to connect a HART host to the transmitter enclosed with the HMA. In each case, the HART Poll Address of the attached device must be used for communication rather than the Modbus poll address of the connected HMA.

1. A HART modem can be connected directly to the HART terminal block on the HMA. The HMA will always act as a primary master on the HART loop. Therefore, if connecting another HART host to the terminal HART block, that additional host must either be capable of automatically setting itself to be a secondary master, or be manually configured as a secondary master. Note that the HART terminal block has a built-in 250-ohm resistor to facilitate HART communication. See the section on using a DTM with the HMA.
2. The HMA is capable of passing HART commands using the RS-485 connection to the attached devices.

QUICK START PROCEDURE

The following procedure demonstrates basic steps for configuring a Magnetrol transmitter containing a HART to Modbus Adaptor (HMA) for use with a Modbus system. The example given is for an installation where a single HART transmitter is attached to the HMA.

More complete instructions are provided in the SETUP PROCEDURES section as well as other configurations and communication protocols.

1. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA:
   1.1. Receive/Transmit Data lead (+, A) connected to the positive terminal
   1.2. Receive/Transmit Data lead (–, B) connected to the negative terminal.
   1.3. Connect a 120Ω resistor between the two RS-485 terminal block positions.
   1.4. Connect the other end of the cable to a PC which has a Modbus host application installed.
2. Ensure that the DIP switches on the HMA are set as follows:
   2.1. 1 == OFF (Default Config Mode)
   2.2. 2 == OFF
   2.3. 3 == OFF
   2.4. 4 == ON.

   See Appendix A for the location of the DIP switch, and Appendix B for a legend of the four switch positions.
3. Connect the device containing the HMA to a power supply via the power terminal block.
4. Apply power to the HMA.
5. Set the Modbus host application to communicate via the default Modbus RTU communication settings shown in Appendix F.
6. Set registers 3000 through 3006 to the desired communication settings for use with the host system. **Register 3001 (Slave address) should be set to the Modbus address desired for communicating with the HMA.**
7. Ensure that register 3007 (HMA Mode) is set to 0.
8. Change register 3012 to a value of 0. This will cause the HMA to scan the attached HART device at initial start-up, and record the poll address and other information for the device.
9. If RS-232 communication is to be used, set DIP switch 3 to ON, and DIP switch 4 to OFF.
10. Change DIP switch 1 to ON. The HMA will automatically reboot, scan for the attached device, and configure itself for the communication protocol and Modbus address selected in step 6.
11. By viewing the appropriate registers, verify that the desired transmitter measured values are being actively read by the Modbus host.
12. The device is ready to use.

SETUP PROCEDURES

1. Configuring communications settings in the HMA

1.1. Purpose

This procedure instructs how to configure HART to Modbus Adaptor (HMA) communications using a basic Modbus master simulator application. The procedure can also be performed using any Modbus master that permits reading and writing of the appropriate registers in the HMA.

To ensure that there is a known communication configuration for the HMA, position 1 of the DIP switch is used to select between a fixed communication setting and a user-configurable setting. When the switch is set to OFF, the HMA communicates using Modbus RTU with a poll address of 247 at 9600 baud, 8 data bits, no parity, and 1 stop bit. When in the default configuration, the user-selectable communication settings can be adjusted. When the user communication settings are desired to be used, position 1 of the DIP switch should be set to ON, and then input power cycled. Changing back to the fixed default settings also requires a power cycle.

1.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
USB Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A

1.3. Setup

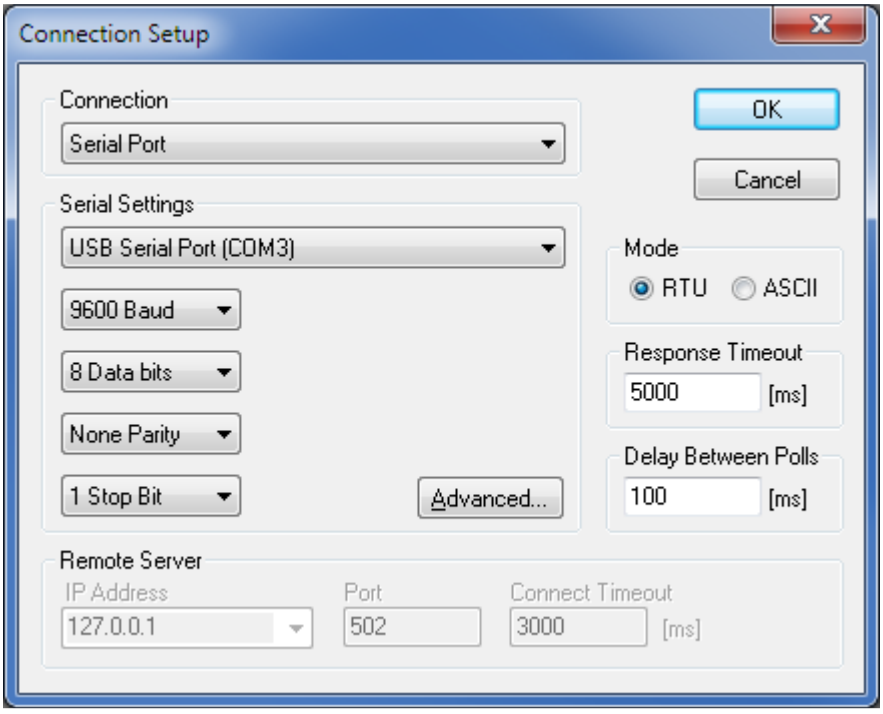
Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

1.4. Procedure

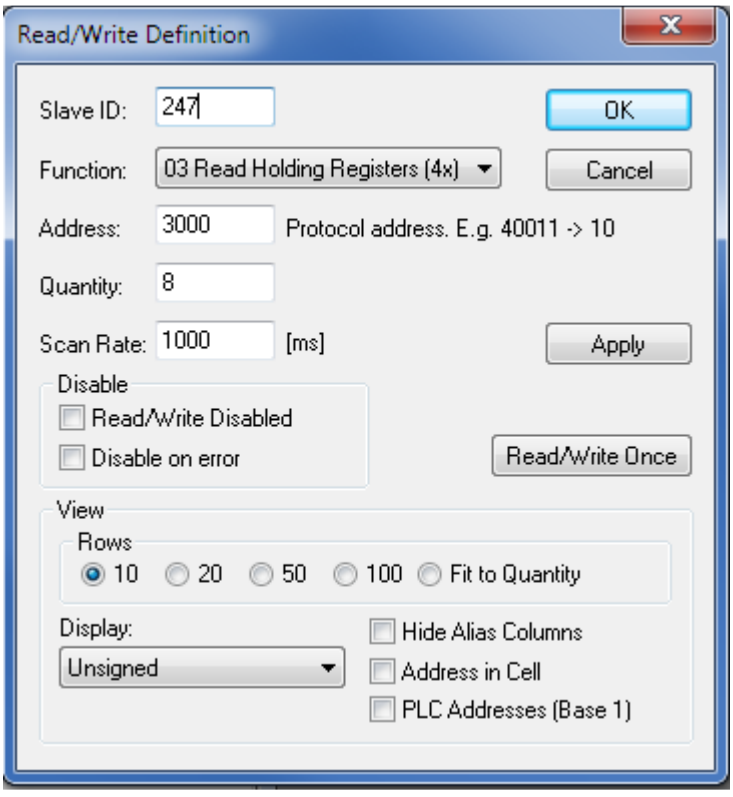
1.4.1 Ensure that the DIP switches on the HMA are set to 1 == OFF (Default Config Mode), 2 == OFF, 3 == OFF, 4 == ON. See Appendix A for the location of the DIP switch, and Appendix B for a legend of the four switch positions.

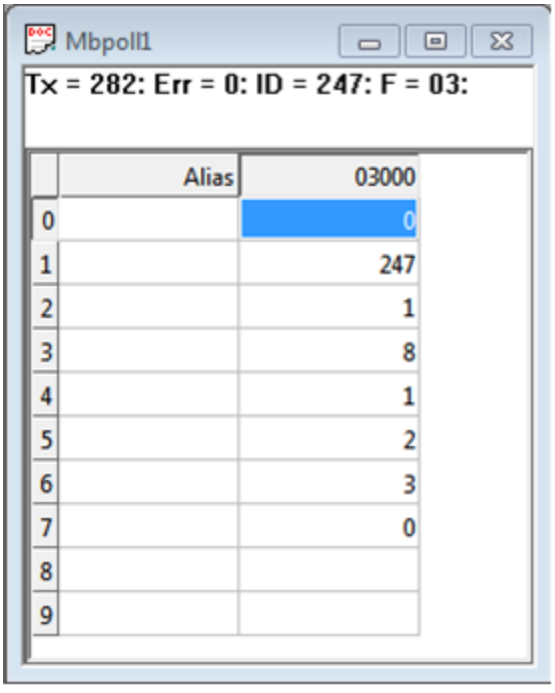
1.4.2 Open the Modbus Poll application.

1.4.3 Select Connection\Connect from the menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.



1.4.4 Open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:





1.4.5 Verify that the values in the registers listed in the Mbpoll window match the values for the desired Modbus protocol settings. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

1.4.6 Change DIP switch 1 to ON. This sets the device to run in the selected communications mode.

1.4.7 If communication at the new settings is not achieved, change DIP switch 1 to OFF. This sets the device to run in the default Modbus RTU communications mode. Check the communication setting registers to ensure that the desired values are present.

2. Reading and writing registers in the HMA

2.1. Purpose

This procedure instructs how to read and write HART to Modbus Adaptor (HMA) registers using a basic Modbus master simulator application. The procedure can also be performed using any Modbus master that permits reading and writing of the appropriate registers in the HMA.

2.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
USB Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A

2.3. Setup

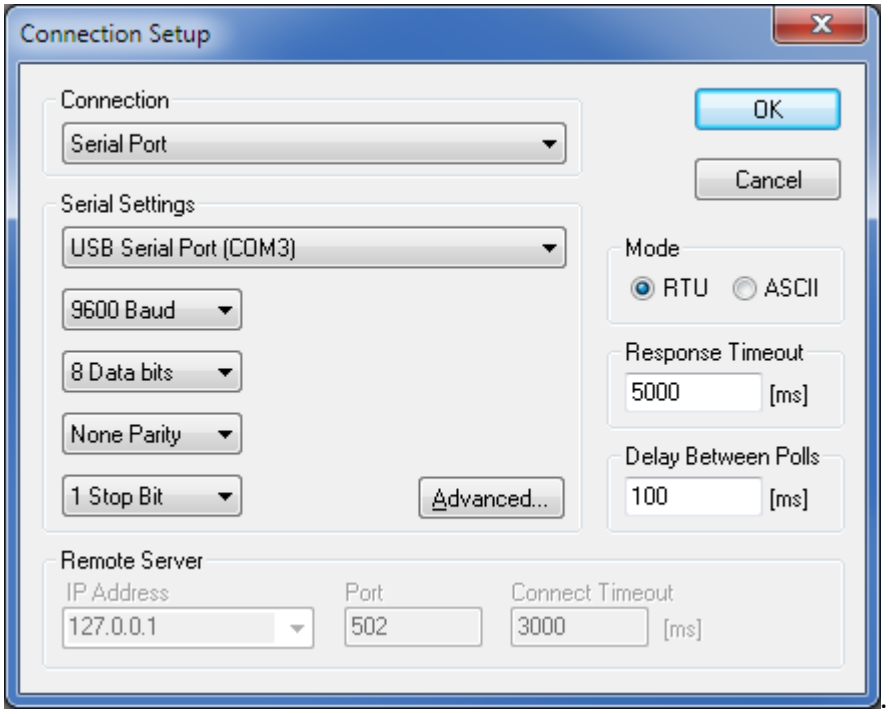
Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

2.4. Procedure

2.4.1 Ensure that the DIP switches on the HMA are set to 1 == OFF (Default Config Mode), 2 == OFF, 3 == OFF, 4 == ON. See Appendix A for the location of the DIP switch, and Appendix B for a legend of the four switch positions.

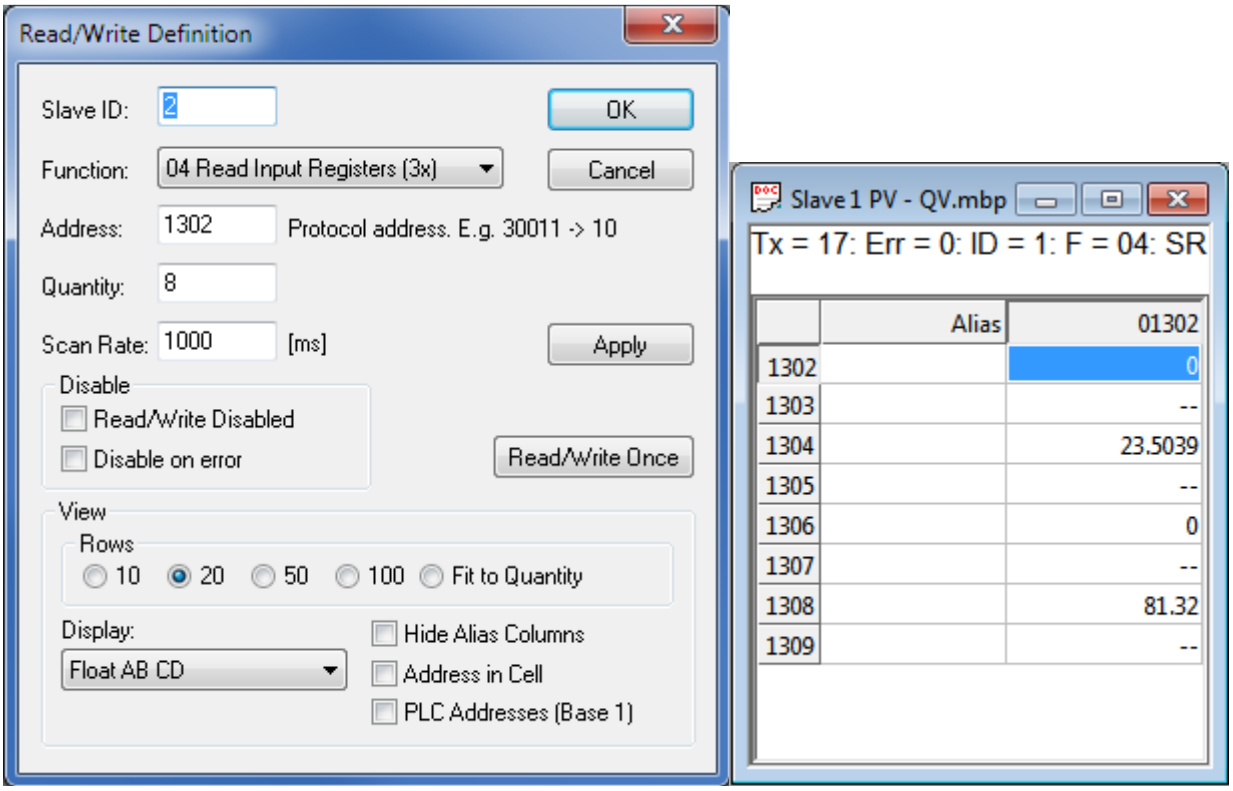
2.4.2 Open the Modbus Poll application.

2.4.3 Select Connection\Connect from the menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.

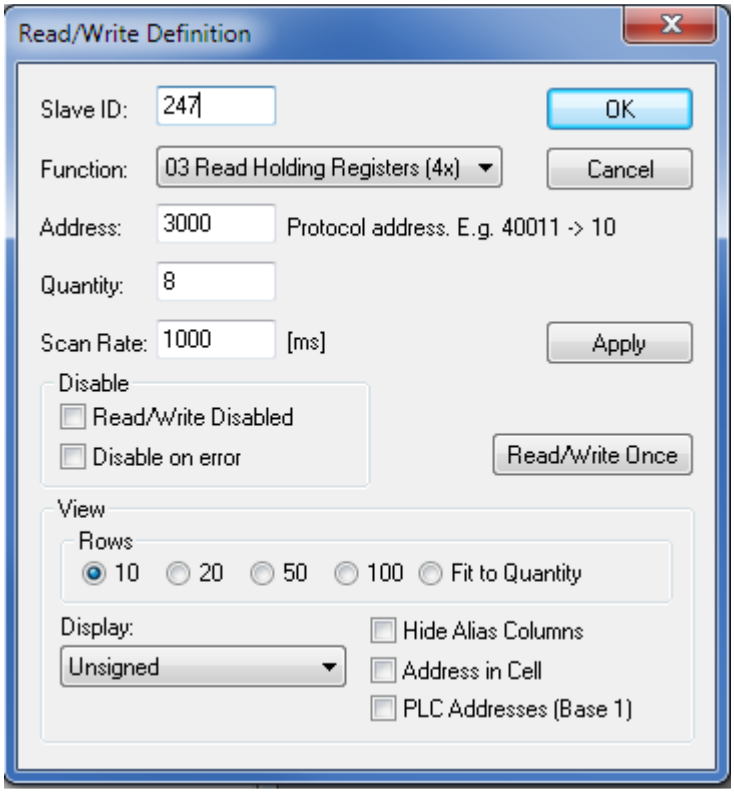


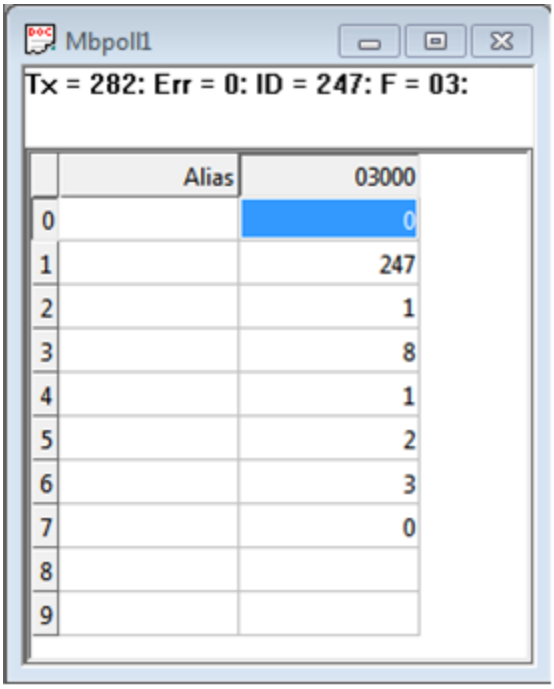
2.4.4 To read an input register, open or click on an Mbpoll window, and select Setup\Read\Write Definition from the menu bar. Set the Slave ID to match the Modbus Poll Address of the HMA. Set the Function to '04 Read Input Registers (3x)'. Using Appendices L through S, set the Address, Quantity and Display type in the pop-up dialog as required. Then click OK. The register value should appear in the Mbpoll window.

In general, the Address should be set to the number of the first register to be accessed. (Address numbers are listed in the Modbus Register Number columns in the appendices.) The Quantity should be set to the sum of the individual sizes of sequential registers to be accessed. In the below example, four registers are to be read and since each have a size of 2 (listed in the Number column in the appendices).



2.4.5 To read a holding register, open or click on an Mbpoll window, and select Setup\Read\Write Definition from the menu bar. Set the Slave ID to match the Modbus Poll Address of the HMA. Set the Function to '03 Read Holding Registers (4x)'. Using Appendices L through S, set the Address, Quantity and Display type in the pop-up dialog as required. Then click OK. The register value should appear in the Mbpoll window.





2.4.6 To write a holding register, double-click on the register value displayed in step 2.4.6. Enter the new value and click on 'Send. Confirm that the new value appears in the Mbpoll window.

3. Using a DTM with the HMA

3.1. Purpose

This procedure instructs how to connect a HART DTM to the HMA to configure or troubleshoot an attached HART transmitter.

3.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
HART Modem	MacTek	Viator
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

3.3. Setup

Connect the HMA, with an attached HART transmitter, to a power supply via the power terminal block. Connect the HART Modem to the HART terminal block on the HMA. Note that the HMA provides 24 VDC on the terminal block and contains an internal 250-ohm resistor, so the modem can be directly connected to the terminal block.

3.4. Procedure

3.4.1 Start PACTware.

3.4.2 Add a HART Comm DTM to the Project.

3.4.3 Right click on the Comm DTM in the Project tree and select 'Add device' to add a DTM to the Project for the connected transmitter.

3.4.4 Right-click on the Comm DTM item and select Parameter. Select the correct COM port for the HART modem, set the Start address and End address to match the HART Poll Address for the attached transmitter. (The Poll Address can be read from the Device Setup\Advanced Config\Analog Output menu on the transmitter's local display.) Set the Comm DTM to be a secondary master, then click OK.

3.4.5 Right-click on the Comm DTM item and select Additional functions\Change DTM address. Click on the Change address button. Select the address number corresponding to the attached Model 706 device, then click Close.

3.4.6 Right-click on the device DTM item and select Connect.

3.4.7 Double click on the transmitter entry in the Project tree to open the Online parameterization window.

3.4.8 All features of the DTM will be available. Note that since the DTM is acting as a secondary master and the HMA is periodically sending commands as the primary master, the response of the DTM will be slower than when it is connected directly to a transmitter.

4. Using a Handheld Field Communicator with the HMA

4.1. Purpose

This procedure instructs how to connect a handheld communicator, such as the Emerson 475, to the HMA to configure or troubleshoot an attached HART transmitter.

4.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
Field Communicator	Emerson	475
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

4.3. Setup

Connect the HMA, with an attached HART transmitter, to a power supply via the power terminal block. Connect the field communicator to the HART terminal block on the HMA. Note that the HMA provides 24 VDC on the terminal block and contains an internal 250-ohm resistor, so the field communicator can be directly connected to the terminal block.

4.4. Procedure

4.4.1 Start the field communicator.

4.4.2 Ensure that the field communicator is configured to scan for the HART Poll Address of the transmitter. (The Poll Address can be read from the Device Setup\Advanced Config\Analog Output menu on the transmitter's local display.)

4.4.3 When the field communicator finds the device, select it from the communicator's menu.

4.4.4 All features of the HART DD for the transmitter will be available. Note that since the field communicator is acting as a secondary master and the HMA is periodically sending commands as the primary master, the response of the field communicator will be slower than when it is connected directly to a transmitter.

5. Basic Modbus RTU Communication over RS-485

5.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the Modbus RTU protocol over RS-485.

5.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

5.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

5.4. Procedure

5.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values for the Modbus RTU protocol settings used by the intended Modbus master. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

5.4.2 Change DIP switch 1 to ON.

5.4.3 Connect the HMA to a Modbus master.

5.4.4 Apply power to the HMA.

5.4.5 Verify that the Modbus master is receiving responses from the HMA (Tx is increasing) and that there are no communication errors being reported.

7. Basic Modbus ASCII Communication over RS-485

7.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the Modbus ASCII protocol.

7.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A

7.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

7.4. Procedure

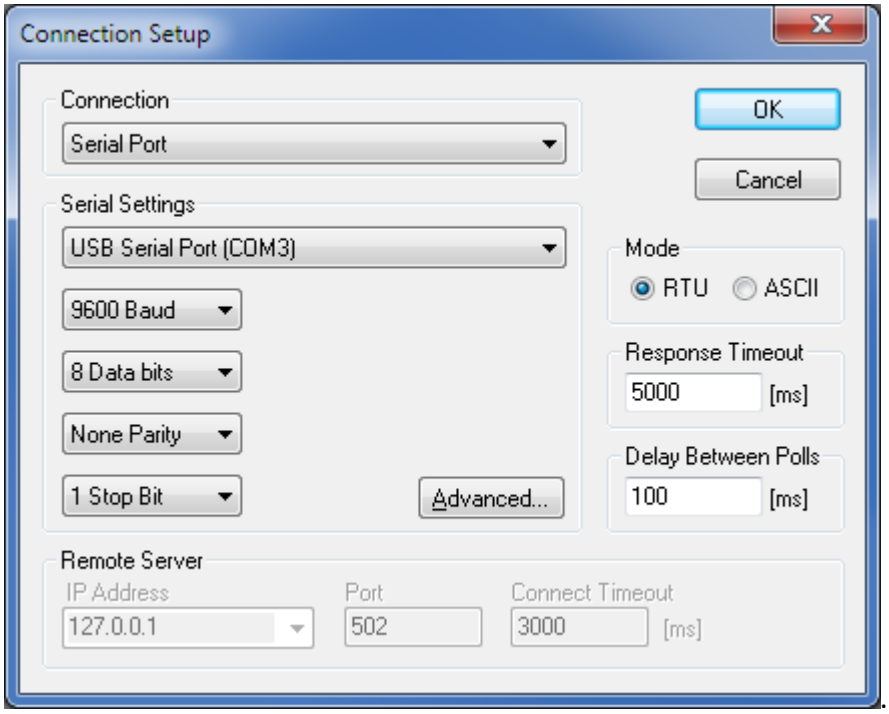
7.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values for the Modbus ASCII protocol settings used by the intended Modbus master. Refer to Appendix G for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

7.4.2 Change DIP switch 1 to ON. This sets the device to run in the selected communications mode.

7.4.3 Verify that the device is not communicating with the Modbus Poll application.

7.4.4 Select Connection\Disconnect from the Modbus Poll menu bar.

7.4.5 Select Connection\Connect from the menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.



7.4.6 Verify that the Modbus Poll application is receiving responses from the HMA (Tx is increasing) and that there are no communication errors being reported.

8. Modbus RTU Communication in HMA Mode

8.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA), when in the HMA mode, to support the various registers defined for one or multiple devices attached to a single HMA.

In the HMA mode (register 3007 set to 0), the HMA will be the only device directly visible to the Modbus RTU/master. This mode can be useful when more devices are attached to the same RS-485 line then there are available Modbus addresses. With each HMA supporting up to 5 HART devices, far fewer Modbus addresses are required for a given number of HART devices. All commands to read or write to a device are accomplished by using only HMA registers. In effect, the HART devices will invisible to the Modbus master, and the HMAs will appear to be able to provide multiple level readings. For the attached devices, the HMA register number to access various parameters in the attached HART devices will be different from HART device to HART device and will depend on the slave number of the device on the HMA.

The following procedure is an example of connecting two HART devices to a single HMA.

8.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible
Level transmitter	MII	Model 705 3x
Probe	MII	Model 705 3x compatible
Level transmitter	MII	Model 355
Level transmitter	MII	Model R82 R2
Level transmitter	MII	Model RX5
Level transmitter	MII	Enhanced Jupiter
Level transmitter	MII	E3 Modulevel

8.3. Setup

8.3.1 Single HMA

Connect an HMAs to a power supply via the power terminal block. Connect an RS-485 communications cable to a PC which has a Modbus host application. Connect the other end of the cable to the RS-485 terminal block of the HMA1. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect additional supported Magnetrol HART devices to the HART loop terminal block of the HMA. There can be any combination of devices including the Model 706, Model 705 3x, Model 355, Model R82 R2, Model RX5, Enhanced Jupiter and E3 Modulevel. Note that each device's Poll Address can be set to any value between 1 and 62 as long as it has a unique address from others connected to the same HMA, and there can be a maximum of 5 devices connected to an HMA including the device in the housing containing the HMA. It is suggested that the devices' poll addresses

be set to the range of 1 to 5 so that they correspond to the slave numbers shown in the registers tables of Sections L through S.

8.3.2 Multiple HMAs

Install jumper wires connecting the positive terminal of the RS-485 terminal block of HMA1 and the positive terminal of the RS-485 terminal block of HMA2 as well as the negative terminal of the two terminal blocks. Continue for the number of HMAs to be used on the line. Connect a 120Ω resistor between the two RS-485 terminal block positions of the last device on the RS485 line.

8.4. **Procedure**

8.4.1 Connect the HMA to a power supply, Modbus host and MII HART transmitters as specified in section 8.3.1.

8.4.2 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values for the Modbus RTU protocol settings used by the intended Modbus master. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

8.4.3 Using Procedure 2, change register 3001 to a value of 15. This changes the address of the HMA to 15 to be unique from other HMAs and from the attached devices. Note that the choice of address for the HMA is not critical as long as it is different from other HMAs to be used in the same system.

8.4.4 Change register 3007 to a value of 0. This sets the HMA to run in the HMA mode in which only the HMAs are directly addressed by the Modbus master.

8.4.5 Change register 3013 to a value of 2. This will cause the HMA to scan poll addresses 0 to 15 for attached devices at start-up, and record the poll address and other information for each device.

8.4.6 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each device.

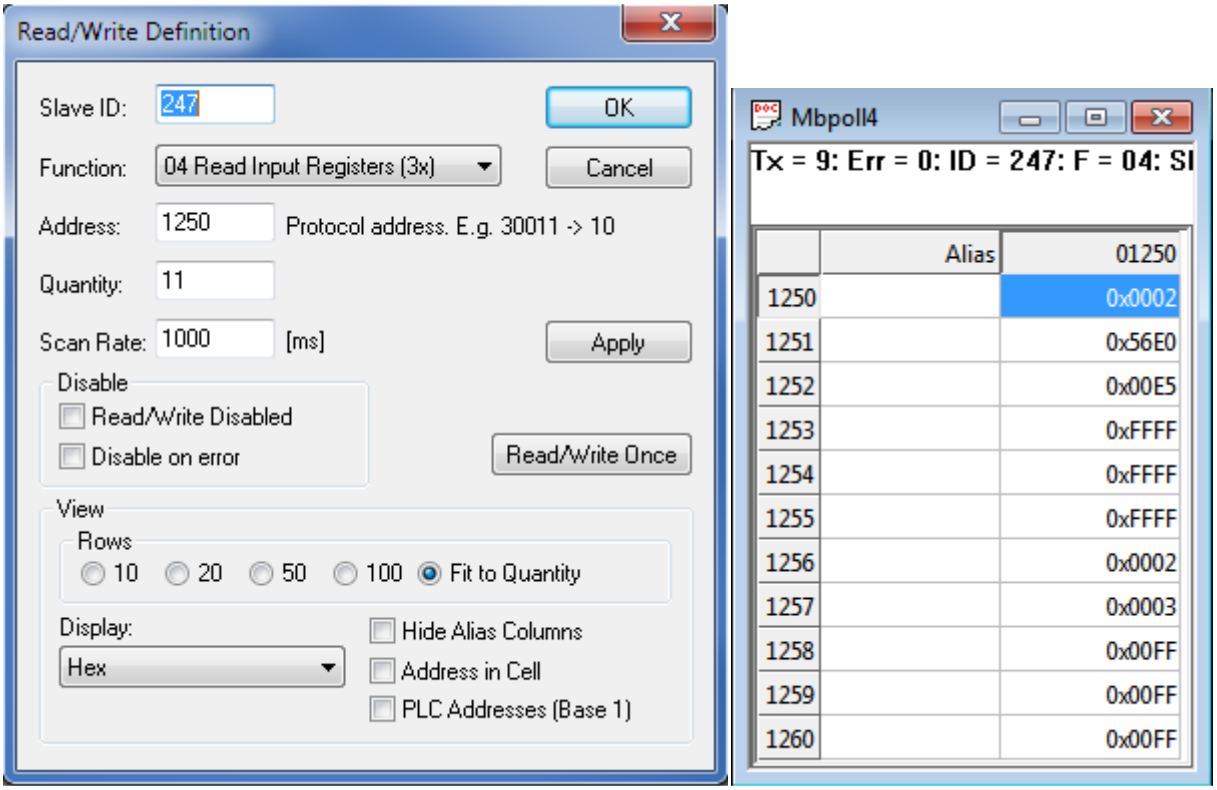
8.4.7 Change DIP switch 1 to ON.

8.4.8 Change the slave ID for the Read/Write Definition from 247 to 15 (or the Modbus address selected for the HMA).

8.4.9 Verify that register 3012 on each HMA has automatically changed to a value of 1 indicating that the HMA has found devices and stored their information in memory.

8.4.10 Verify that register 1250 on each HMA displays the correct number of attached devices.

8.4.11 Check that the Device Type (1251 – 1255) and Polling Address (1256 – 1260) registers display the correct values for the attached devices. All eight registers along with register 1250 can be displayed in one Mbpoll window if the Display parameter is set to 'Hex' in the Read/Write Definition dialog. Refer to Appendix K for the register numbers. For example, with two devices attached:



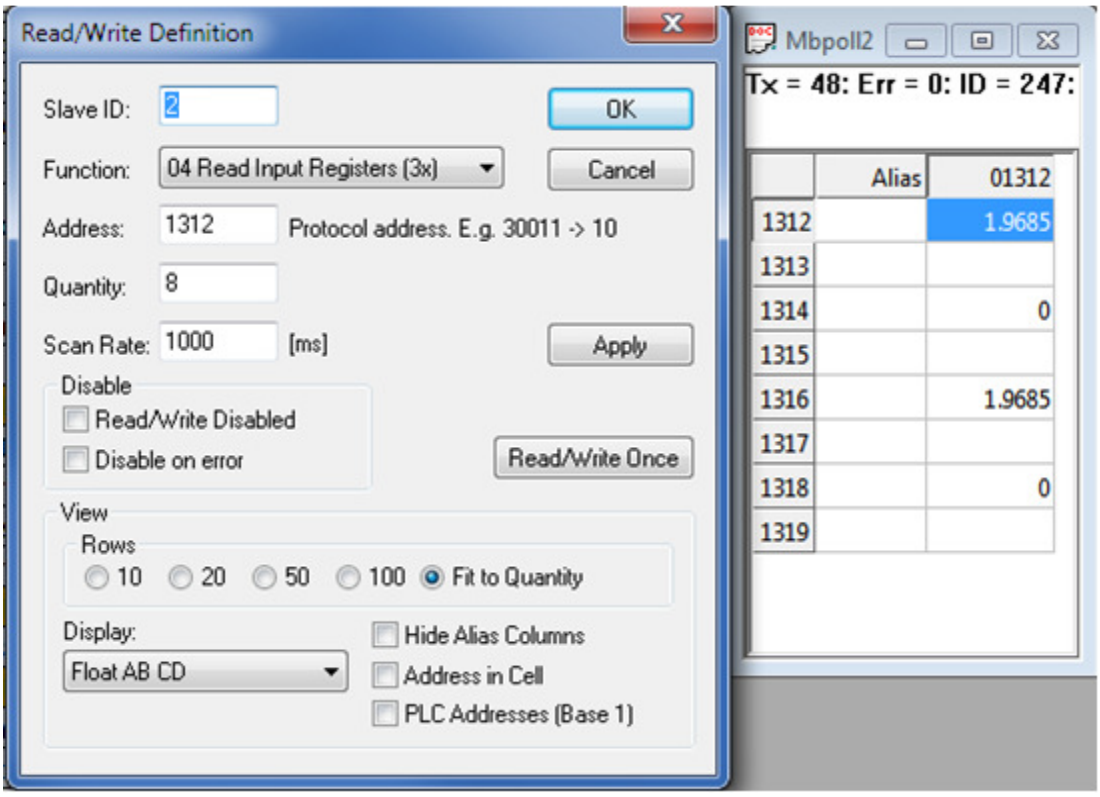
8.4.12 Note that Poll Address and Device Type registers corresponding to Slave IDs with no attached device will show 0xFFFF and 0x00FF respectively.

8.4.13 If using more than one HMA, repeat steps 8.4.1 through 8.4.12 except disconnecting HMA1 and connecting another HMA. Set the Poll Address of the new HMA to something other than to be used for the other HMAs. Repeat for any additional HMAs.

8.4.14 Reconnect all HMAs to be used, following the setup in section 8.3.2.

8.4.15 Open a new Mbpoll window.

8.4.16 The supported parameters for the HART devices are listed in Appendices L through S. For each device, use the appropriate table and the Modbus Register number column labeled with the Slave ID number of the device. Read the registers for each parameter. Note that the Slave ID number for the Mbpoll window must match the Slave ID of the HMA, not the attached HART device(s). For example, to read the PV through QV values for Slave ID 2, set the Read/Write Definition to:



8.4.17 Ensure that the values displayed match the values shown on the selected transmitter's local user interface.

9. Modbus RTU Communication in Single Modbus Device Mode

9.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA), when in the Single Modbus Device mode, to support the various parameter registers defined for the attached device.

In the Single Modbus Device mode (register 3012 set to 2), the HMA and attached HART device will appear to be a single native Modbus device to the Modbus RTU/master. This mode is for instances where an HMA is used with a single HART device and is designed to simplify the commissioning process. When the HART poll address of the device is changed, the HMA will automatically change its Modbus address to match the HART address when it starts up. Note that the range of Modbus/HART addresses is limited to 1 through 62.

9.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

9.3. Setup

Connect the HMA (mounted in a housing with a HART device) to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application.

9.4. Procedure

9.4.1 Using Procedure 1 (with position 1 of the DIP switch set to OFF), configure the communication settings HMA to match the settings for the Modbus host.

9.4.2 Using Procedure 2 (with position 1 of the DIP switch set to OFF), verify that register 3012 on the HMA is set to a value of 2 – Single Device.

9.4.3 Using the device's local display, change the HART Poll Address to the desired Modbus address (within the range of 1 to 62). On 4-button, multi-line displays, the Poll Address parameter can be found by navigating to the Device Setup\Advanced Config\Analog Output menu. On 3-button, 2-line displays, the Poll Address parameter can be found by repeatedly pressing the Up or Down arrow button.

9.4.4 Set position 1 of the DIP switch to ON.

9.4.5 The HMA will search through the 1 to 62 poll range for the attached HART device. Once the device is found, the HMA will automatically change its Modbus address to match, and then restart itself to use the new Modbus address.

9.4.6 The HMA / HART device can be communicated with using the Modbus address and the registers for Slave 1 as shown in Appendices L through S.

10. Basic LevelMaster Communication

10.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the Modbus LevelMaster protocol.

In the LevelMaster configuration, the HMA will appear to be invisible to the LevelMaster host. This is due to the limited command set available with LevelMaster. Instead, the attached HART devices will appear to be native LevelMaster devices. They will respond to the Modbus poll address equivalent to their HART poll address. The devices will return the HART PV and SV as the two D (float) values in the Uxx? command response. The F value corresponds to the Echo Signal strength. The E and W values correspond to the highest active Error and Warning diagnostic in each category.

10.2. Equipment

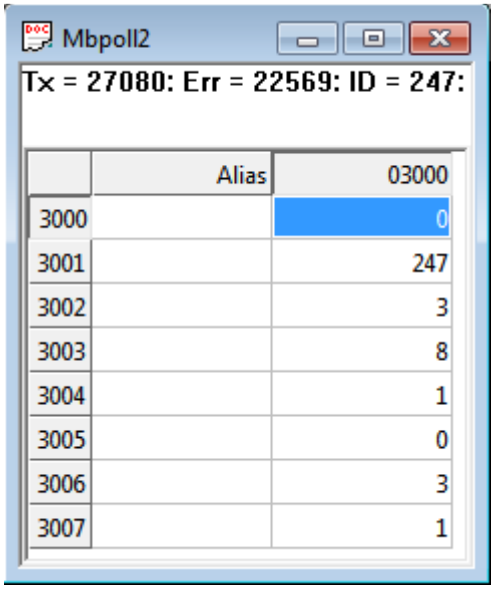
Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Terminal v1.9b application	hw-server.com	Version 1.9b - 20040204
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

10.3. Setup

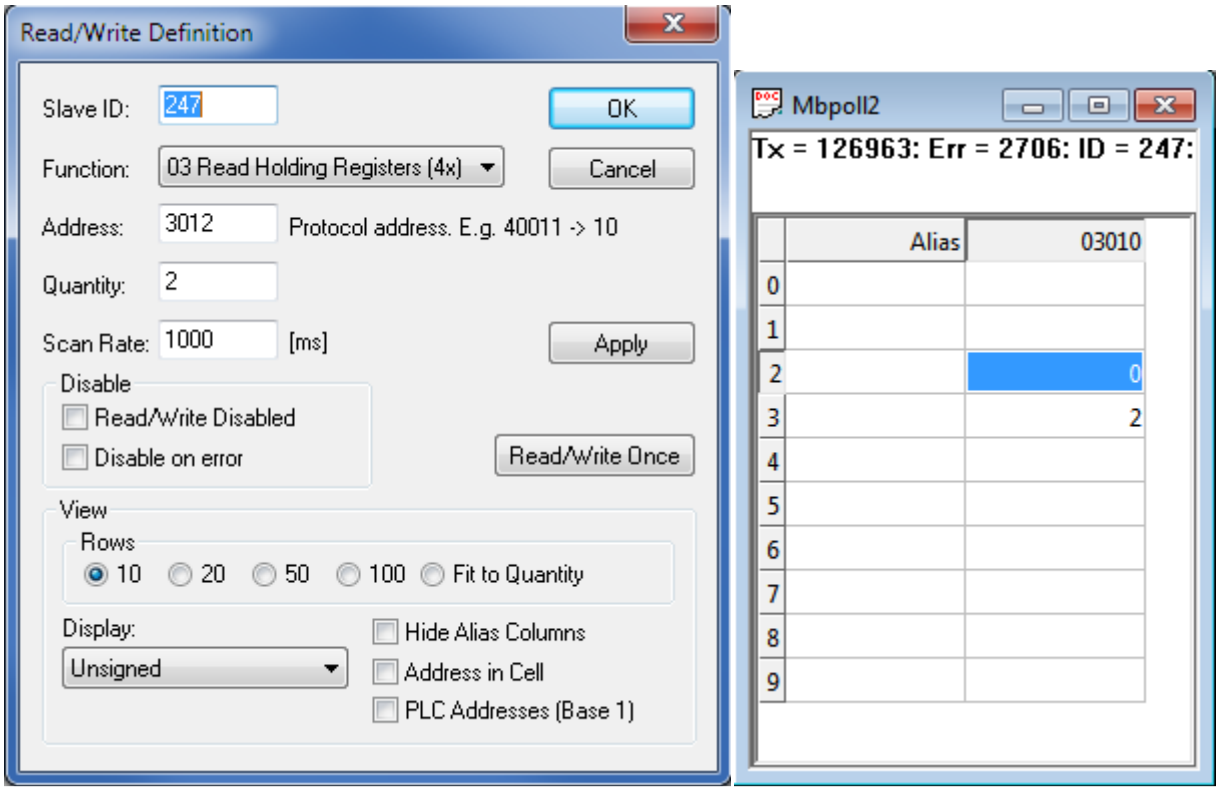
Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Besides the Model 706 in the housing, connect any additional HART devices to the HART loop terminal block of the HMA. Set the HART Poll Address of the internal Model 706 device to 2. Set the HART Poll Address of the other attached devices to different, unique values. Note that other Magnetrol HART transmitters and HART poll addresses can be used.

10.4. **Procedure**

10.4.1 Using Procedure 1, ensure that registers 3002 through 3007 of the HMA match the values shown for the Modbus LevelMaster protocol default settings. Refer to Appendix H for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send. Register 3001 can be left at 247.

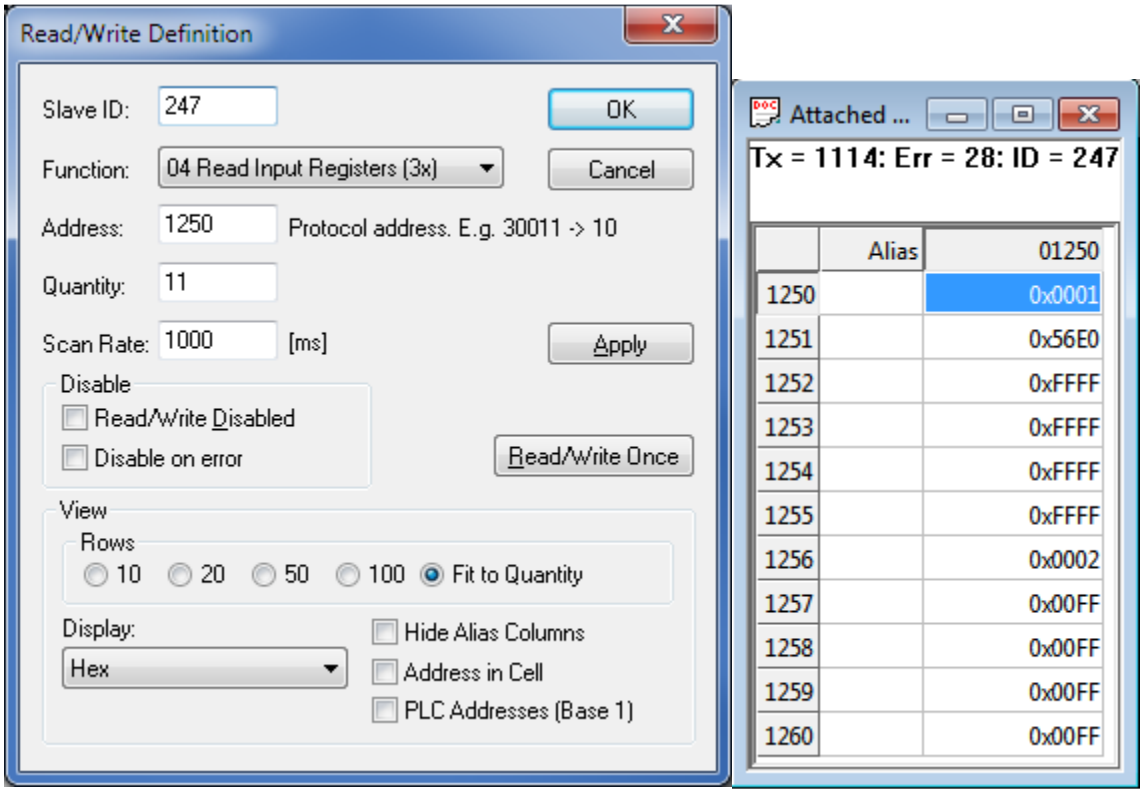


10.4.2 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each attached HART device.



10.4.3 Change DIP switch 1 to ON and then back to OFF.

10.4.4 Set up a window to read 11 registers starting at address 1250.



10.4.5 Verify that register 1251 shows the correct device type and register 1256 shows the HART Poll Address of the attached transmitter.

10.4.6 Change DIP switch 1 to ON.

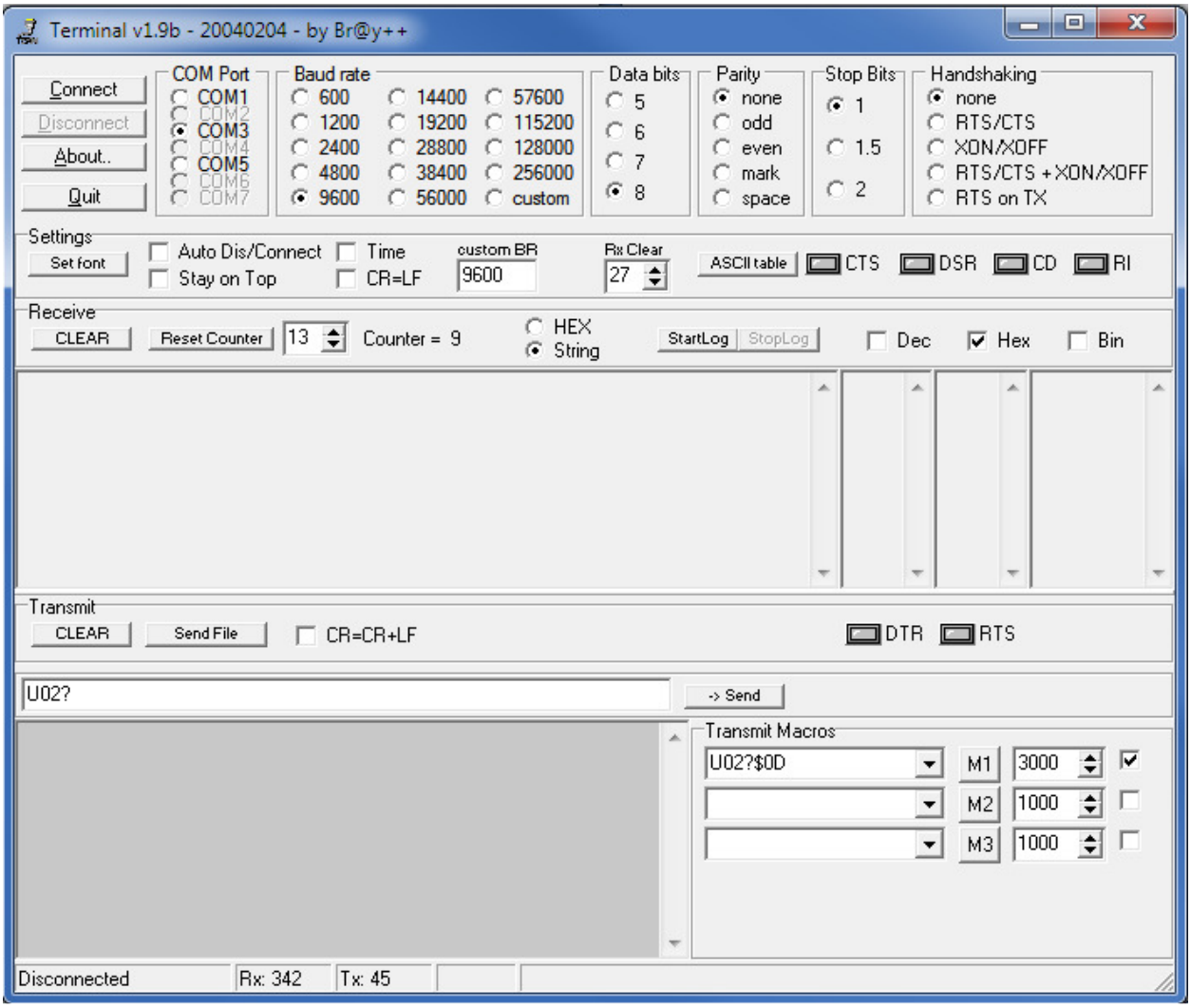
10.4.7 Select Connection\Disconnect from the menu bar.

10.4.8 Start the Terminal v1.9b application. Note that any similar application that supports transmission/reception of ASCII characters over the RS-485 connection may be used.

10.4.9 Set the COM Port to match the COM port used for the communication cable (the same number as with the Modbus Poll application).

10.4.10 Set the Baud rate, Data bits, Parity, Stop Bits and Handshaking parameters to match the settings made in the HMA for LevelMaster communication.

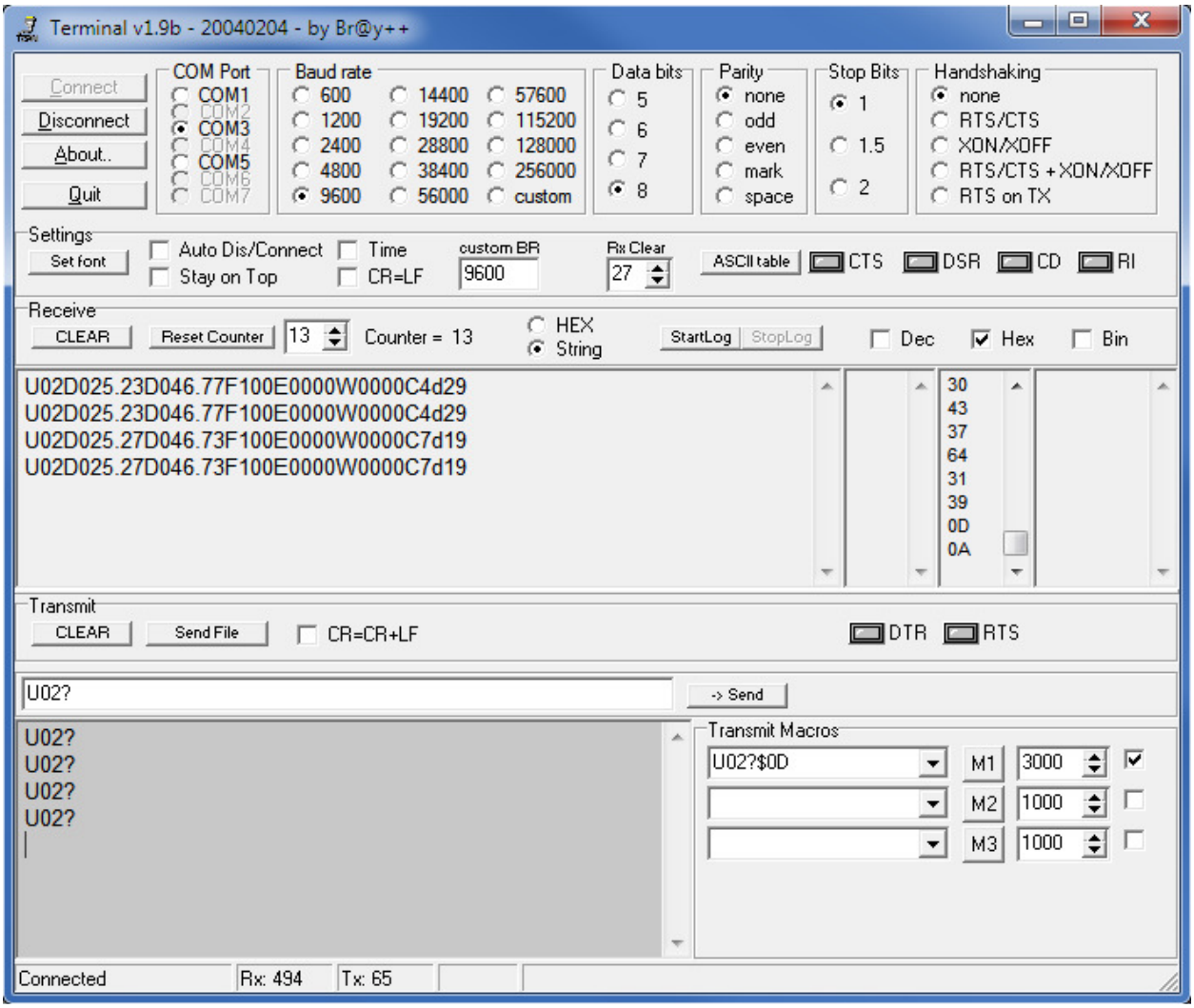
10.4.11 The Terminal application settings should be as below.



10.4.12 Click Connect.

10.4.13 Create a Transmit Macro that will send U02?$0D and check the checkbox to the right of the macro definition. Note that the 02 in the macro represents the Poll Address of the Model 706 device.

10.4.14 Verify that the Terminal application is receiving responses from the HMA and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



10.4.15 Verify that the value after the U in the response matches the Poll Address of the Model 706 device.

10.4.16 Verify that the value after the first D in the response matches the PV value shown on the local display of the Model 706 device.

10.4.17 Verify that the value after the second D in the response matches the SV value shown on the local display of the Model 706 device.

10.4.18 Verify that the value after the F in the response matches the Echo Strength value shown on the local display of the Model 706 device.

10.4.19 Verify that the values after the E and W in the response match the highest priority of any active diagnostics in the attached device. See Appendix T for a listing of codes. Typically, the code should match the active diagnostic displayed on the device's LCD home screen.

11. Additional LevelMaster Commands

11.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to support the additional Modbus LevelMaster protocol commands implemented in the HMA.

Using this procedure, the Number of Floats (UxxF?) can be read from the attached HART device and the Level Offset parameter can be read (UxxOL?) and changed (UxxOLxxxx?).

Note that the returned value for Level Offset, as well as the value for writing to the device, is multiplied by a factor of 10. For instance, a value of 0015 in the UxxOL? command represents a value of 1.5 in the HART device. This is to allow a more precise adjustment capability within the context of the command being limited to whole numbers.

11.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Terminal v1.9b application	hw-server.com	Version 1.9b - 20040204
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

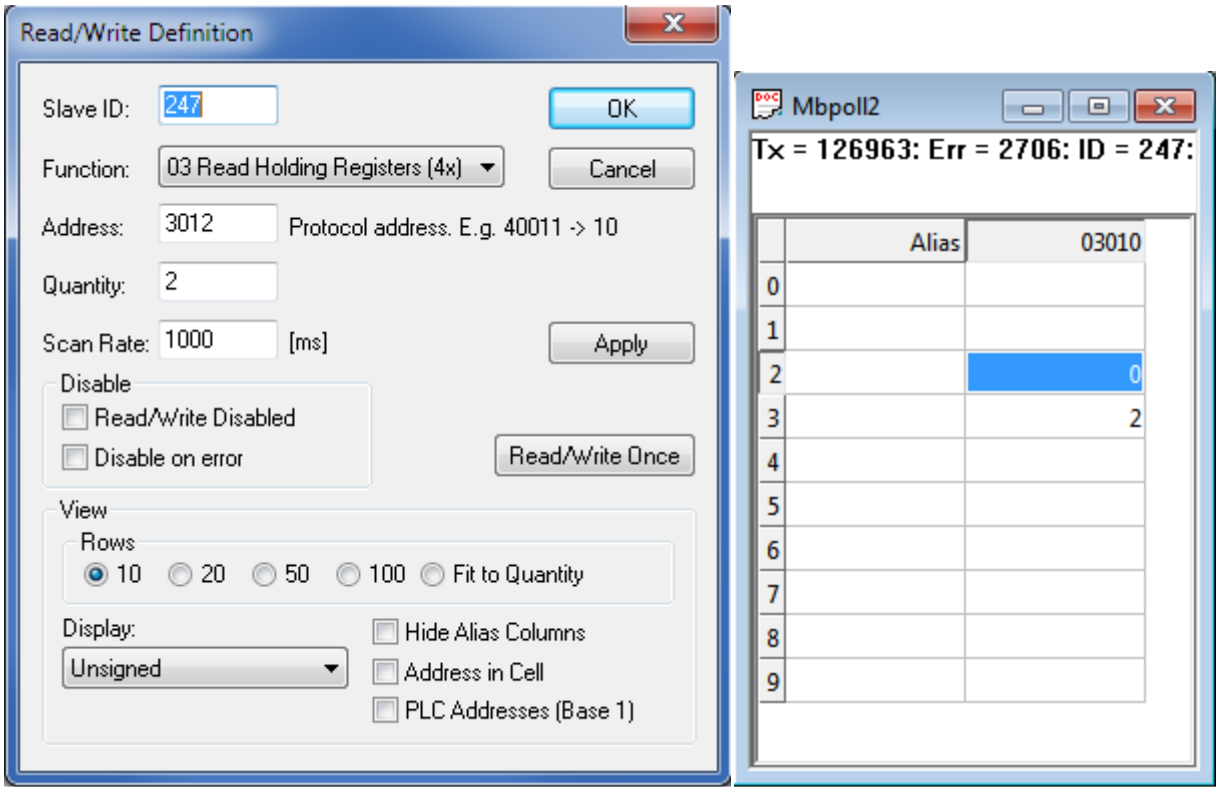
11.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect a Model 706 level transmitter to the HART loop terminal block of the HMA. Set the HART Poll Address of the Model 706 device to 3. Note that other Magnetrol HART transmitters and HART poll addresses can be used.

11.4. Procedure

11.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus LevelMaster protocol default settings. Refer to Appendix H for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

11.4.2 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each device.



11.4.3 Change DIP switch 1 to ON.

11.4.4 Select Connection\Disconnect from the Modbus Poll menu bar.

11.4.5 Start the Terminal v1.9b application.

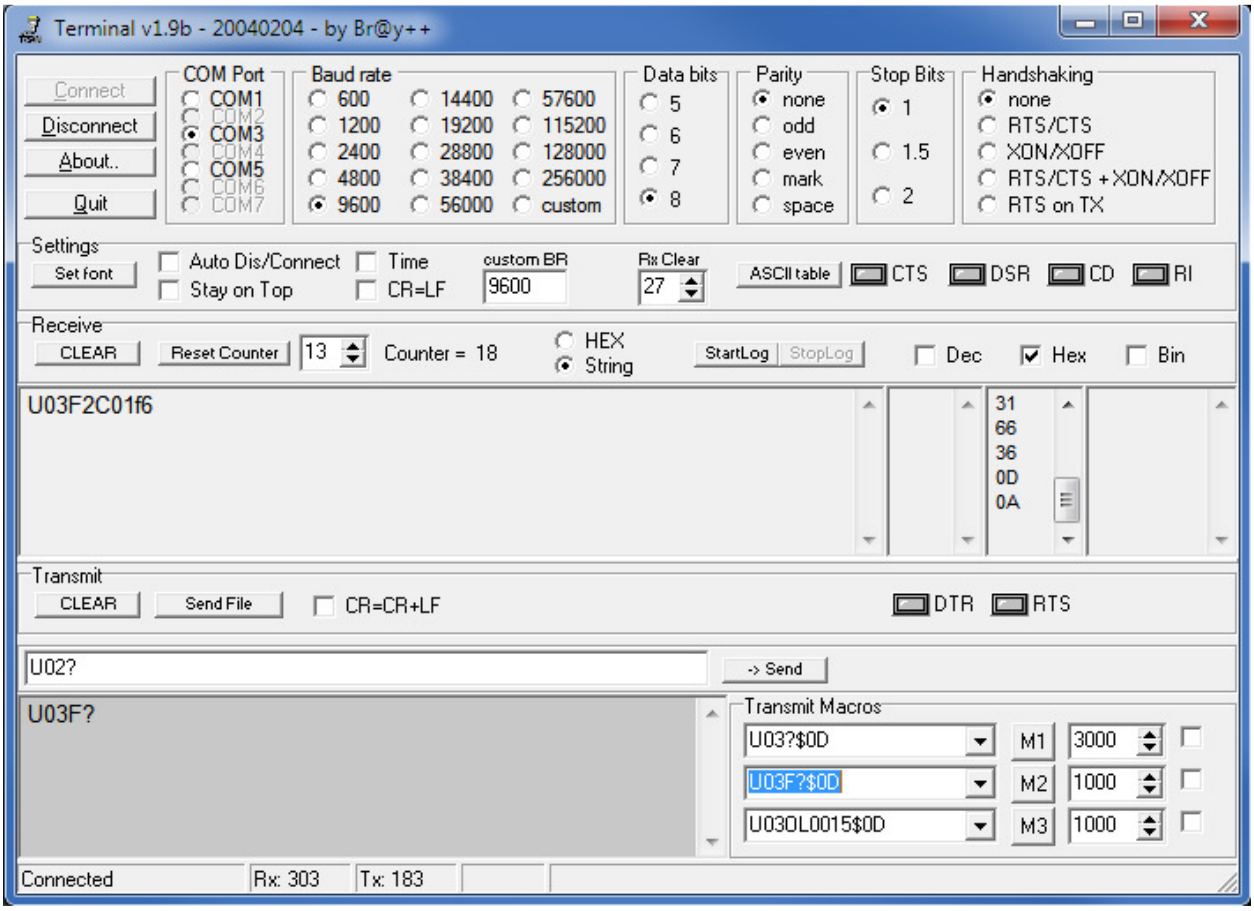
11.4.6 Set the COM Port to match the COM port used for the communication cable (the same number as with the Modbus Poll application).

11.4.7 Set the Baud rate, Data bits, Parity, Stop Bits and Handshaking parameters to match the settings made in the HMA for LevelMaster communication.

11.4.8 Click Connect.

11.4.9 Create a Transmit Macro that will send U03F?$0D and click on the Mx button to the right of the macro definition. This command requests the number of floating point numbers that the attached device will return when responding to the Uxx? command. For the HMA implementation, there will always be two floating point numbers returned so '2' should always be returned by the UxxF? Command. Note that the 03 in the macro represents the Poll Address of the Model 706 device.

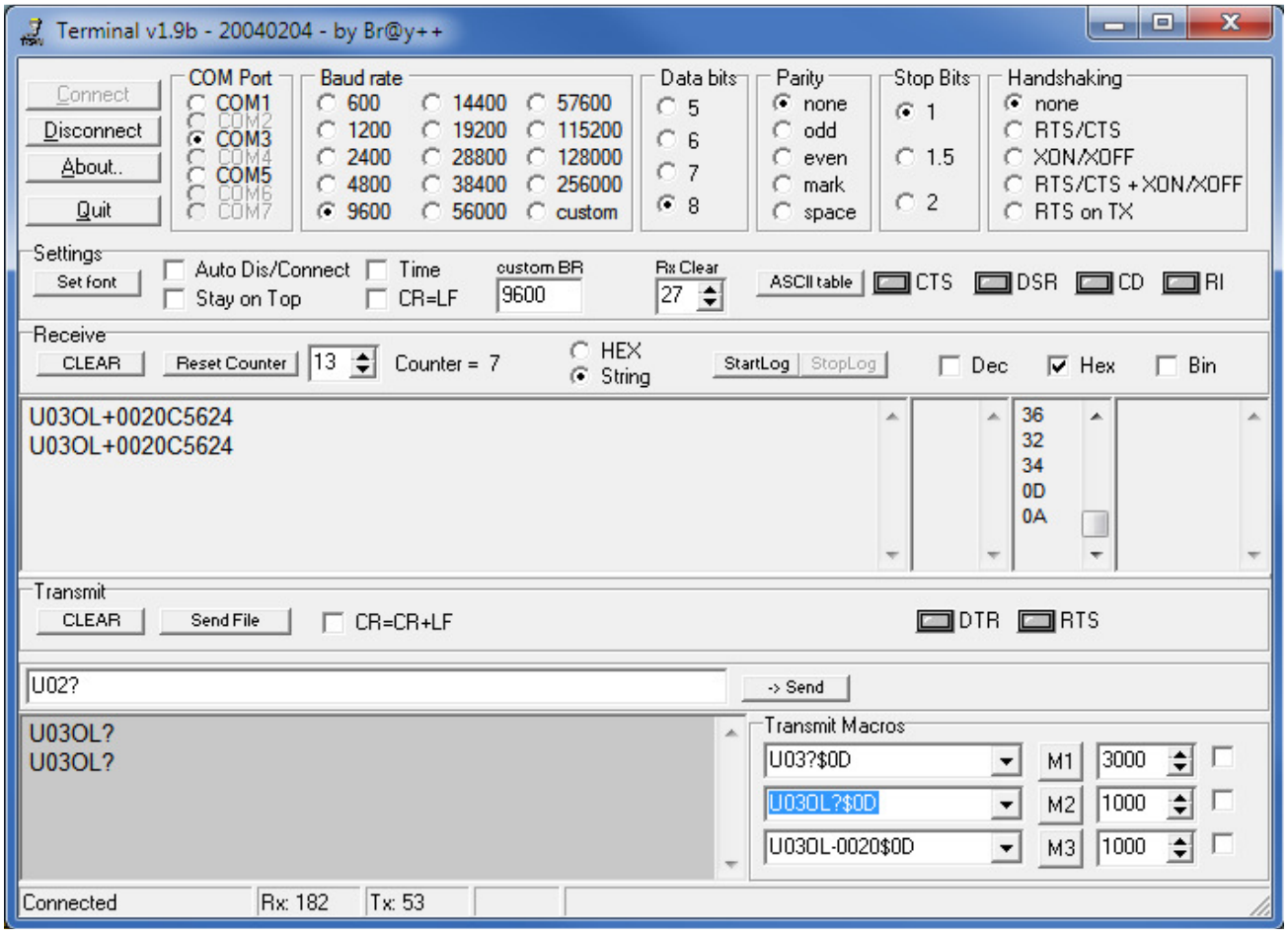
11.4.10 Verify that the Terminal application receives a response from the HMA each time the Mx button is clicked, and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



11.4.11 Verify that the value after the F in the response (indicating the number of floating point values that will be returned) equals '2' (from the above, U03F201f6).

11.4.12 Create a Transmit Macro that will send U03OL?$0D and click on the Mx button to the right of the macro definition. This command requests the value for Level Offset in the attached device. Note that the 03 in the macro represents the Poll Address of the Model 706 device.

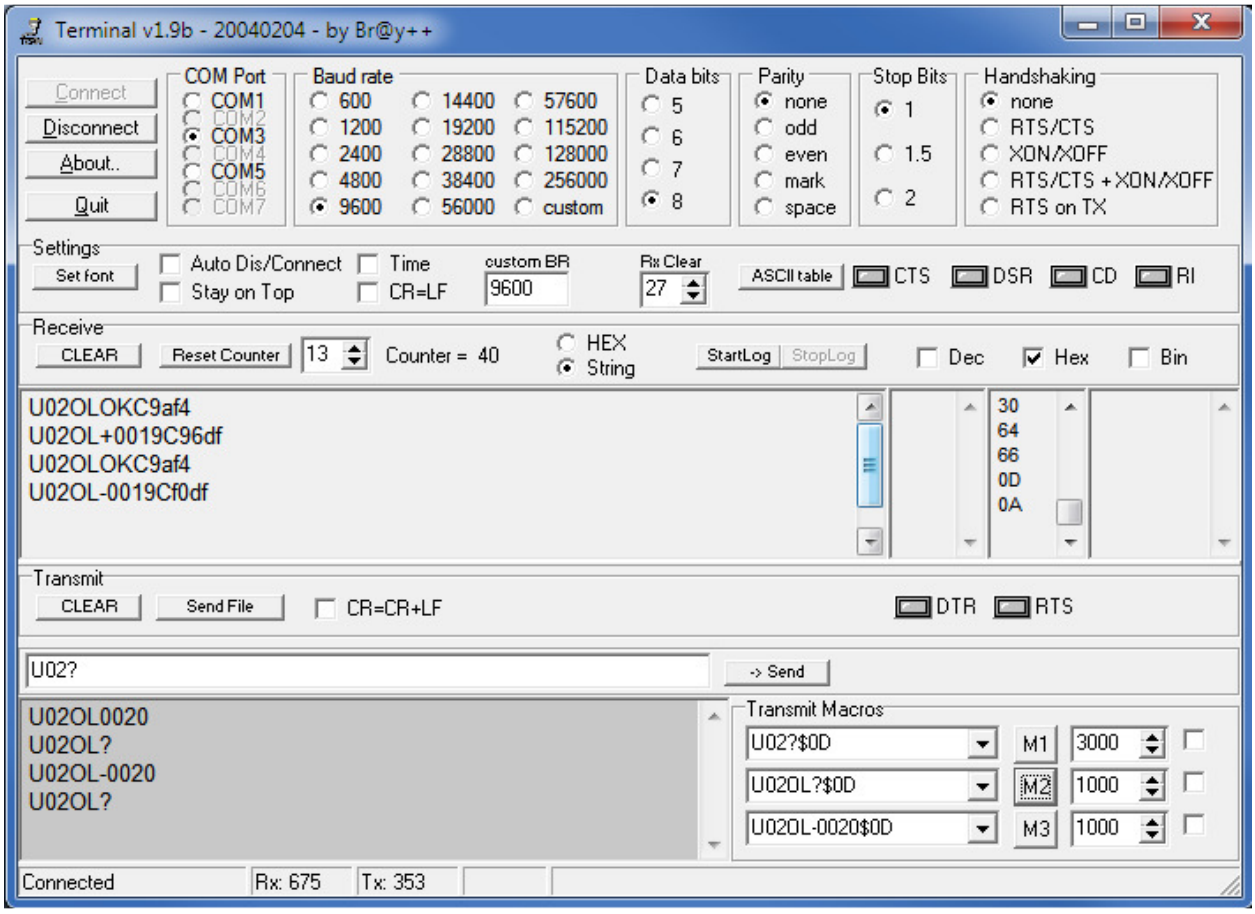
11.4.13 Verify that the Terminal application receives a response from the HMA each time the Mx button is clicked, and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



11.4.14 Verify that the value after the OL in the response matches the Level Offset value shown on the local display of the Model 706 device. The value displayed is shown as an integer number to conform to the command requirements, but actually represents the Level Offset multiplied by 10. For example, a Level Offset of 1.5 inches will be displayed in the command response as 0015. The value returned by the command may vary from the value shown on the local display by a value of 1 due to rounding. The value returned will be in terms of Level Units.

11.4.15 Create a Transmit Macro that will send U03OL0020$0D and click on the Mx button to the right of the macro definition. This command requests that the sent value be saved for Level Offset in the attached device. The value is in terms of Level Units.

11.4.16 Verify that the Terminal application receives a response from the HMA each time the Mx button is clicked, and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



11.4.17 Verify that the value after the OL in the response to command U03OL?$0D matches the Level Offset value sent by the U03OL0020$0D command and shown on the local display of the Model 706 device. The value returned by command U03OL?$0D may vary from the value shown on the local display by a value of 1 due to the effects of rounding.

11.4.18 Repeat steps 12.4.15 through 12.4.17 while sending U03OL-0020$0D to cause the writing of -2.0 as the Level Offset.

12. Auto Switching Between Modbus RTU/ASCII and HART over RS-485 Communication

12.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to automatically switch between Modbus RTU and HART over RS-485 communication when it receives the appropriate commands. This procedure uses a Model 706 as the attached device as an example; other Magnetrol HART devices can also be used with this procedure.

This provides a convenient method for configuring or troubleshooting an attached HART device using PACTware. The process is to set a register to a value of 1 while the HMA is in a Modbus communication mode. The HMA will automatically switch to the HART over RS-485 mode. No cycling of power is required. PACTware can then be connected to a device through the RS-485 terminal block on the HMA. Once the PACTware session is completed, by sending a HART command 0 with a poll address of 63, a user can cause the HMA to automatically revert to the previous Modbus configuration protocol settings. Again, no cycling of power is required.

This procedure demonstrates the auto-switching feature using the Modbus RTU protocol. The process can be used for the Modbus ASCII protocol by setting the HMA for that protocol in step 13.4.2.

12.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

12.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect a Model 706 transmitter and probe, or other supported Magnetrol HART transmitter, to the HART loop terminal block of the HMA. The device's Poll Address can be set to any value between 0 and 14.

12.4. Procedure

12.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus RTU protocol default settings. The address shown in register 3001 can be between 0 and 14. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

12.4.2 Note that when the HMA is in the Single Device Mode (register 3012 set to 2), the HMA address shown in register 3001 will match the HART Poll Address of the attached HART device.

12.4.3 Change DIP switch 1 to ON.

12.4.4 Click on the Mbpoll window, select Setup\Read\Write Definition from the menu bar, change the Slave ID to match the address shown in step 13.4.2 for register 3001, and then click OK.

12.4.5 Verify that the Modbus Poll application is communicating with the HMA.

12.4.6 Change to value of register 3008 to 1. This causes the HMA to automatically reboot into the HART over RS-485 mode.

12.4.7 Verify that the HMA is not communicating with the Modbus Poll application.

12.4.8 Select Connection\Disconnect from the Modbus Poll menu bar.

12.4.9 Start PACTware.

12.4.10 Add a HART Comm DTM to the Project.

12.4.11 Left click on the Comm DTM in the Project tree and add a DTM to the Project for one of the listed devices.

12.4.12 Right-click on the Comm DTM Project item and select Parameter. Select the correct COM port for the RS-485 communications cable, set the Start address and End address to cover the range of addresses for the attached devices. Set the Comm DTM to be a secondary master, then click OK.

12.4.13 Right-click on the Comm DTM Project item and select Additional functions\Change dtm address. Click on the Change address button. Select the poll address number corresponding to the attached Model 706 device, then click Close.

12.4.14 Right-click on the Comm DTM Project item and select Connect.

12.4.15 Right-click on the Comm DTM Project item and select Additional functions\Change device address. The DTM will scan for attached devices and display them in a list. If necessary, click on the Refresh button.

12.4.16 Verify that the attached Model 706 is listed and is shown with the correct Poll Address.

12.4.17 Right-click on the Comm DTM Project item and select Connect.

12.4.18 Double click on the device entry in the Project tree to open the Online parameterization window.

12.4.19 Verify that the DTM communicates with the device and features such are changing parameters and viewing Echo Curves, Echo History (as appropriate) and Trend Data are operational.

12.4.20 Close the Online parameterization window.

12.4.21 Right-click on the Comm DTM Project item and select Disconnect.

12.4.22 Right-click on the Comm DTM Project item and select Parameter. Set both the Start address and End address to 63, then click OK.

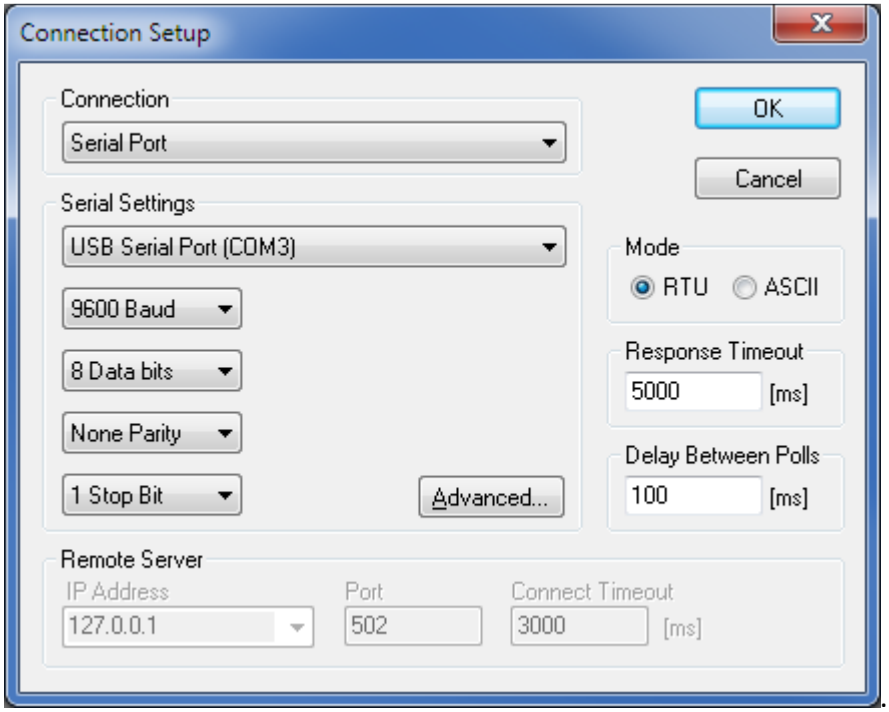
12.4.23 Right-click on the Comm DTM Project item and select Connect.

12.4.24 Right-click on the Comm DTM Project item and select Additional functions\Scan list. The DTM will scan for attached device, sending a HART Command 0 with an address of 63. Receipt of that command by the HMA will cause it to reboot into the Normal operating mode.

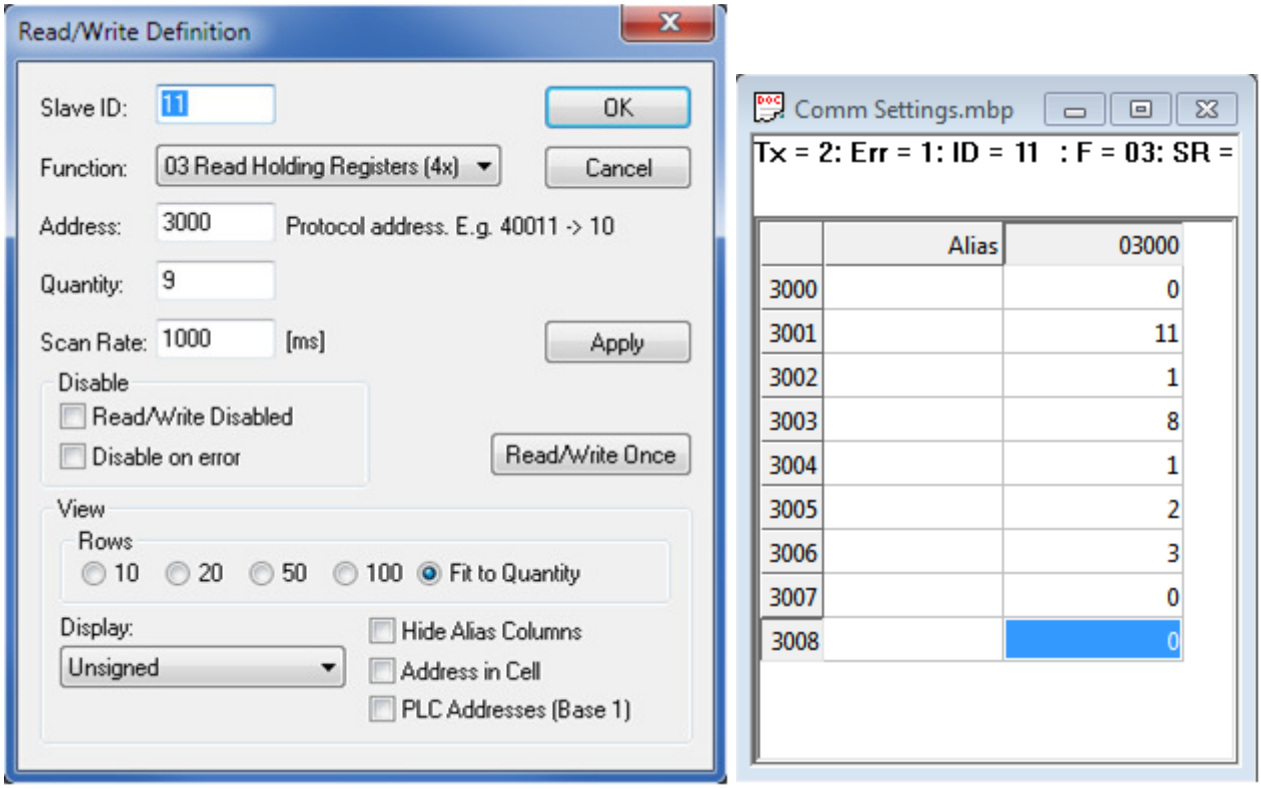
12.4.25 Shut down PACTware.

12.4.26 Open the Modbus Poll application.

12.4.27 Select Connection\Connect from the Modbus Poll menu bar, ensure that the connection settings are as follows, and then click OK. Note that the USB Serial Port setting needs to match the port number for the communication cable that is being used.



12.4.28 Open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows (the Slave ID should match the address entered into register 3001 in step 13.4.1), and then click OK:



12.4.29 Verify that the Tx count in the Mbpoll window is increasing, the Err count is not increasing and there are no reported communication errors.

12.4.30 Verify that register 3008 is set to 0.

12.4.31 If unable to establish communication in the HART over RS-485 mode, the HMA can be reset to normal Modbus operating mode by switching DIP switch 1 to OFF. The HMA will switch into the default communication mode. Using Procedure 1, set register 3008 to 0. The HMA can be used either in that mode, or by setting DIP switch 1 to ON it can be used in its normal Modbus configuration mode.

13. Auto Switching Between LevelMaster and HART over RS-485 Communication

13.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to automatically switch between Modbus and HART over RS-485 communication when it receives the appropriate commands. This procedure uses a Model 706 as the attached device as an example; other Magnetrol HART devices can also be used with this procedure.

13.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Terminal v1.9b application	hw-server.com	Version 1.9b - 20040204
Power Supply	-	20-24V, 0.5A
PACTware	PACTware Consortium	Version 4.1 or higher
HART Modem	MacTek	Viator
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

13.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect a Model 706 transmitter and probe, or other supported Magnetrol HART transmitter, to the HART loop terminal block of the HMA. The device's Poll Address can be set to any value between 1 and 62.

13.4. Procedure

13.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus LevelMaster protocol default settings. The address shown in register 3001 can be between 1 and 62. Refer to Appendix H for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

13.4.2 Change DIP switch 1 to ON.

13.4.3 Ensure that the Modbus Poll application is not communicating with the HMA.

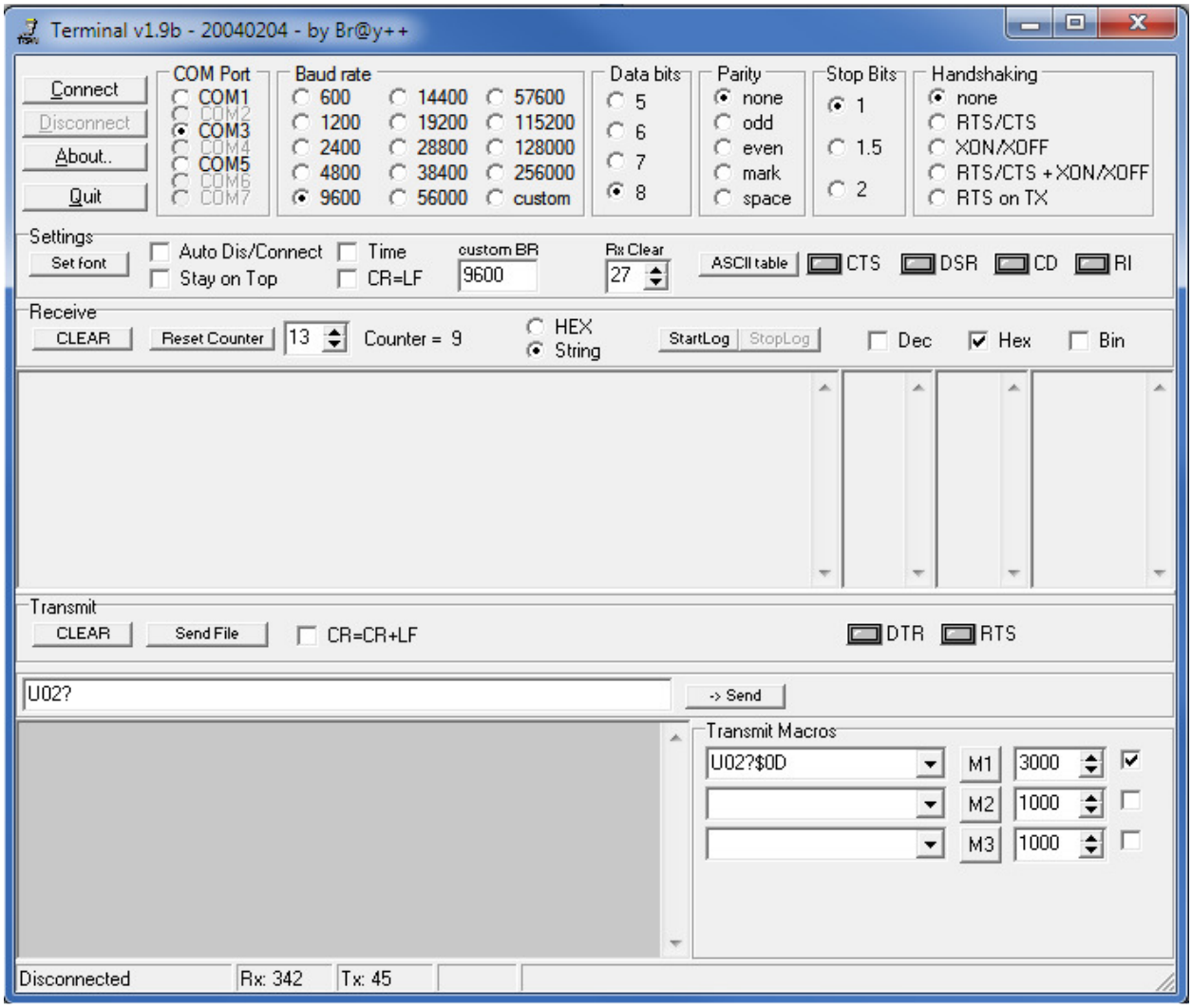
13.4.4 Select Connection\Disconnect from the Modbus Poll menu bar.

13.4.5 Start the Terminal v1.9b application.

13.4.6 Set the COM Port to match the COM port used for the communication cable (the same number as with the Modbus Poll application).

13.4.7 Set the Baud rate, Data bits, Parity, Stop Bits and Handshaking parameters to match the settings made in the HMA for LevelMaster communication.

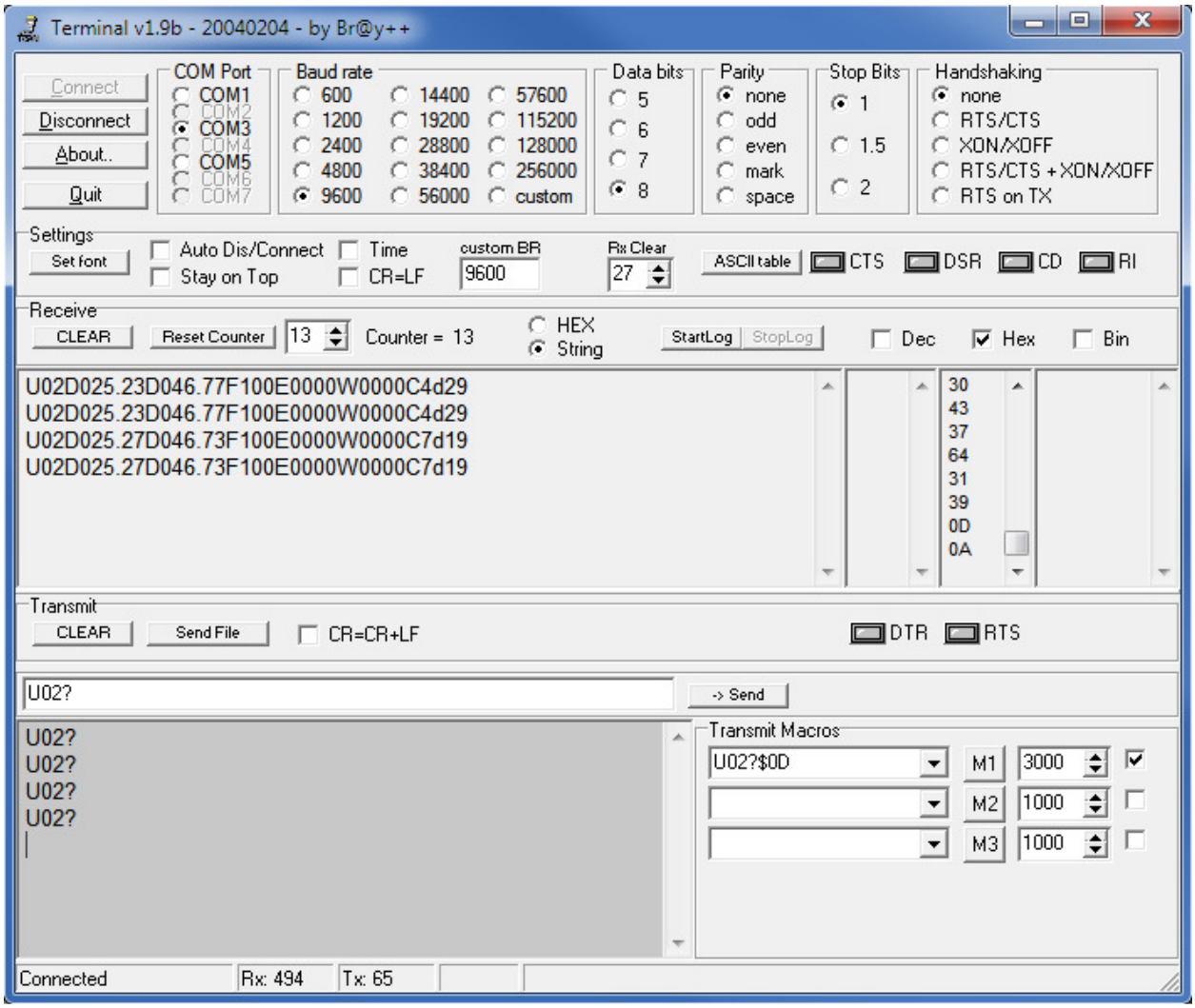
13.4.8 The Terminal application settings should be as below.



13.4.9 Click Connect.

13.4.10 Create a Transmit Macro that will send U02?$0D and check the checkbox to the right of the macro definition. Note that the 02 in the macro represents the Poll Address of the Model 706 device, so the number used should match the actual Poll Address of the attached device.

13.4.11 Verify that the Terminal application is receiving responses from the HMA and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



13.4.12 Uncheck the checkbox to stop the macro from repeating.

13.4.13 Create another Transmit Macro that will send U63?$0D and click on the Mx button to the right of the macro definition. This causes the HMA to automatically reboot into the HART over RS-485 mode. There shall be no response from the HMA.

13.4.14 Check the checkbox to the right of the U02?$0D macro definition.

13.4.15 Ensure that there is no response from the HMA.

13.4.16 Click on the Disconnect button.

13.4.17 Start PACTware.

13.4.18 Add a HART Comm DTM to the Project.

13.4.19 Left click on the Comm DTM in the Project tree and add a DTM to the Project for one of the listed devices.

13.4.20 Right-click on the Comm DTM Project item and select Parameter. Select the correct COM port for the RS-485 communications cable, set the Start address and End address to cover the range of addresses for the attached devices. Set the Comm DTM to be a secondary master, then click OK.

13.4.21 Right-click on the Comm DTM Project item and select Additional functions\Change dtm address. Click on the Change address button. Select the address number corresponding to the attached Model 706 device, then click Close.

13.4.22 Right-click on the Comm DTM Project item and select Connect.

13.4.23 Right-click on the Comm DTM Project item and select Additional functions\Change device address. The DTM will scan for attached devices and display them in a list. If necessary, click on the Refresh button.

13.4.24 Ensure that the attached Model 706 is listed and is shown with the correct Poll Address.

13.4.25 Right-click on the Comm DTM Project item and select Connect.

13.4.26 Double click on the device entry in the Project tree to open the Online parameterization window.

13.4.27 Ensure that the DTM communicates with the device and features such are changing parameters and viewing Echo Curves, Echo History (as appropriate) and Trend Data are operational.

13.4.28 Close the Online parameterization window.

13.4.29 Right-click on the Comm DTM Project item and select Disconnect.

13.4.30 Right-click on the Comm DTM Project item and select Parameter. Set both the Start address and End address to 63, then click OK.

13.4.31 Right-click on the Comm DTM Project item and select Connect.

13.4.32 Right-click on the Comm DTM Project item and select Additional functions\Scan list. The DTM will scan for attached device, sending a HART Command 0 with an address of 63. Receipt of that command by the HMA will cause it to reboot into the Normal operating mode.

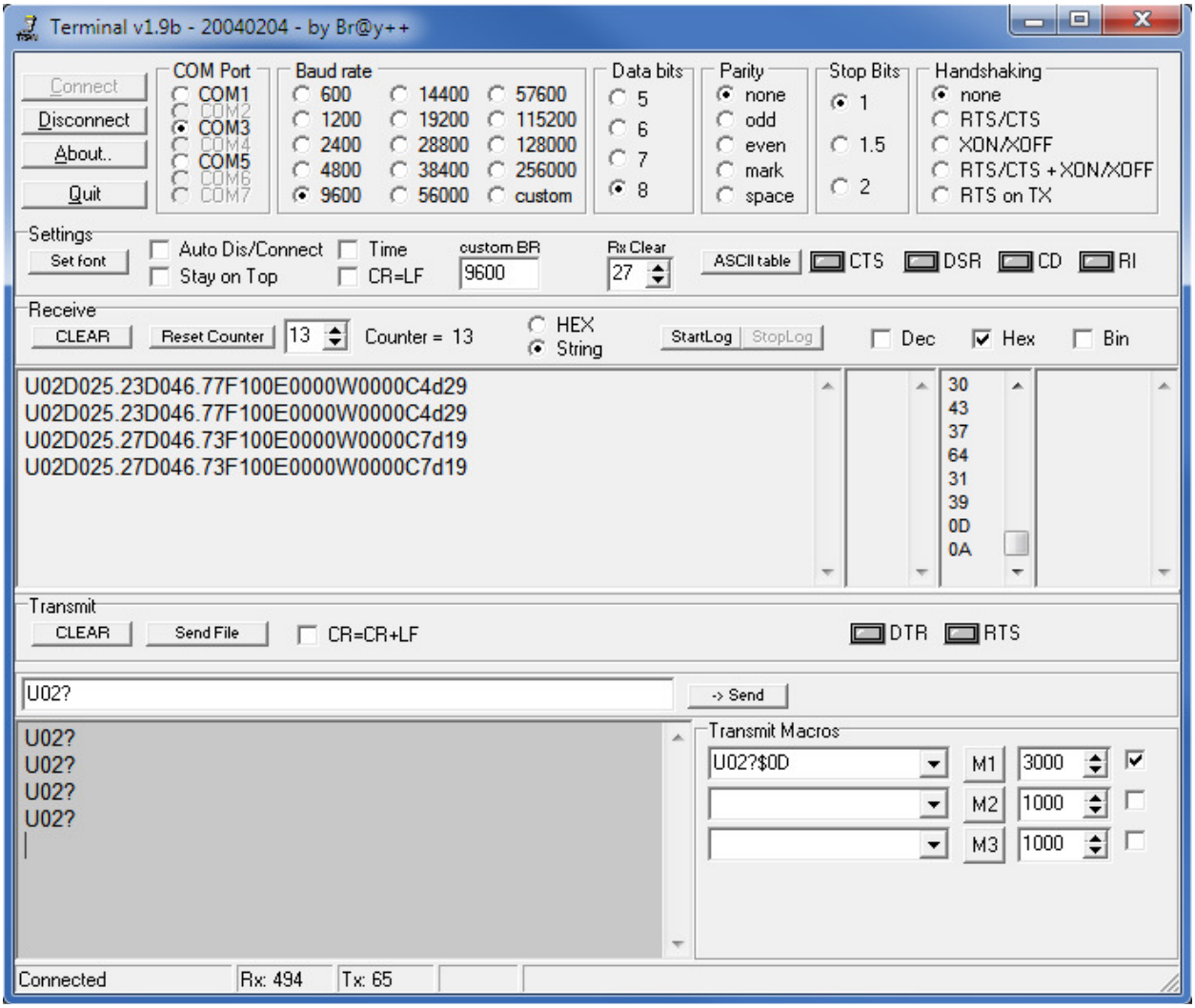
13.4.33 Shut down PACTware.

13.4.34 Open the Terminal application.

13.4.35 Click on the Connect button.

13.4.36 Create a Transmit Macro that will send Uxx?$0D to an attached device and check the checkbox to the right of the macro definition. Note that the xx in the macro represents the Poll Address of the target device.

13.4.37 Ensure that the Terminal application is receiving responses from the HMA and that there are no communication errors being reported. The Receive buffer section should have the same number of responses as the Transmit buffer section.



13.4.38 If unable to establish communication in the HART over RS-485 mode, the HMA can be reset to the default Modbus RTU operating mode by switching DIP switch 1 to OFF. The HMA will switch to the default communication mode. Using Procedure 1, set register 3008 to 0. The HMA can be used either in that mode, or by setting DIP switch 1 to ON it can be used in its normal Modbus configuration mode.

14. HMA Diagnostics

14.1. Purpose

This procedure instructs how to configure the HART to Modbus Adaptor (HMA) to display diagnostic information. While the default Modbus RTU protocol is used to communicate with the HMA in this procedure, any supported Modbus RTU or ASCII communication configuration can be used.

14.2. Equipment

Item	Manufacturer	Model
HART to Modbus Adaptor	MII	031-2859-001
RS485 Communications cable	FDTIchip	USB-RS485-WE
Termination resistor	-	120Ω
Modbus host application	www.modbustools.com	Modbus Poll
Power Supply	-	20-24V, 0.5A
Level transmitter	MII	Model 706
Probe	MII	Model 706 compatible

14.3. Setup

Connect the HMA to a power supply via the power terminal block. Connect an RS-485 communications cable to the RS-485 terminal block of the HMA, with the Receive/Transmit Data+ A lead (orange) on the positive terminal and the Receive/Transmit Data– B lead (yellow) on the negative terminal. Connect a 120Ω resistor between the two RS-485 terminal block positions. Connect the other end of the cable to a PC which has a Modbus host application. Connect up to five Magnetrol HART level transmitters (including the transmitter in the housing containing the HMA) to the HART loop terminal block of the HMA.

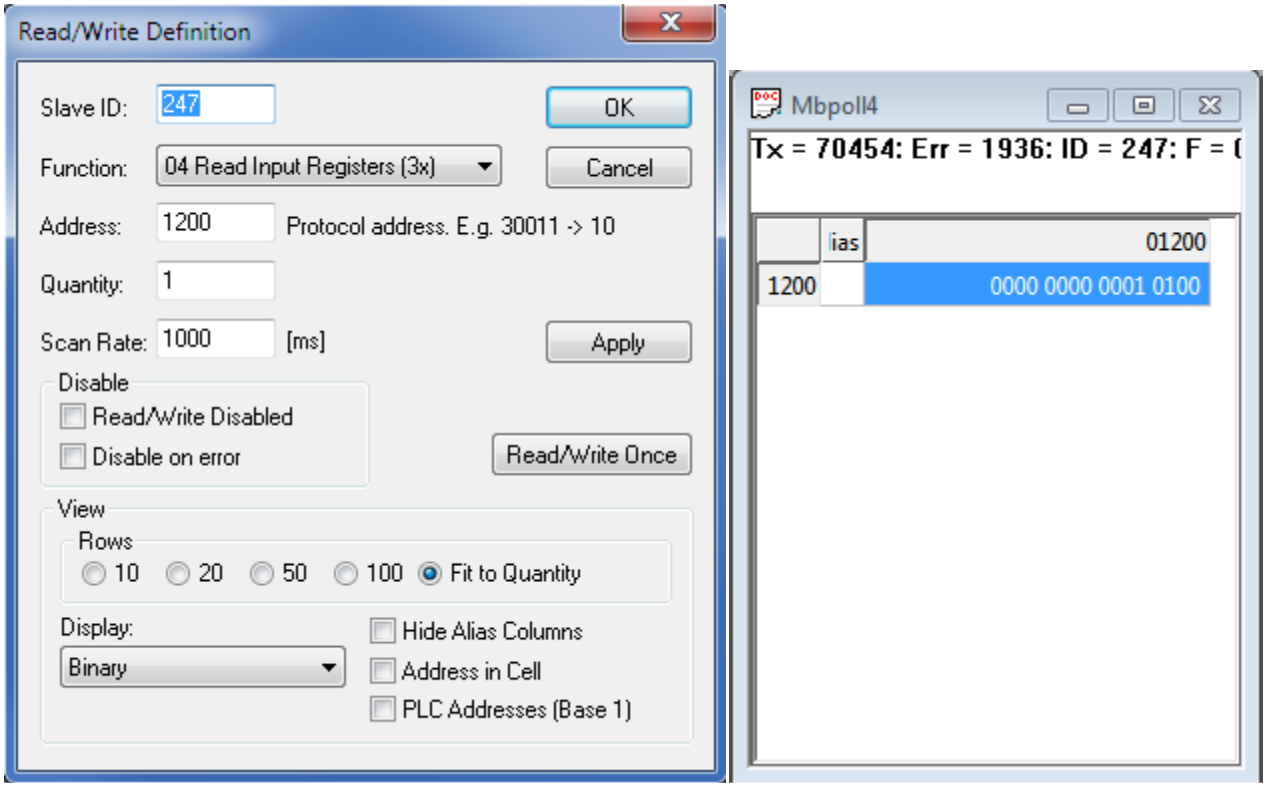
14.4. Procedure

14.4.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for the Modbus RTU protocol default settings. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

14.4.2 Change register 3012 to a value of 0. This will cause the HMA to scan the attached devices at start-up, and record the poll address and other information for each device.

14.4.3 Power cycle the HMA, or move DIP switch 1 to ON and then back to OFF.

14.4.4 **To check the slave malfunction diagnostics**, open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:



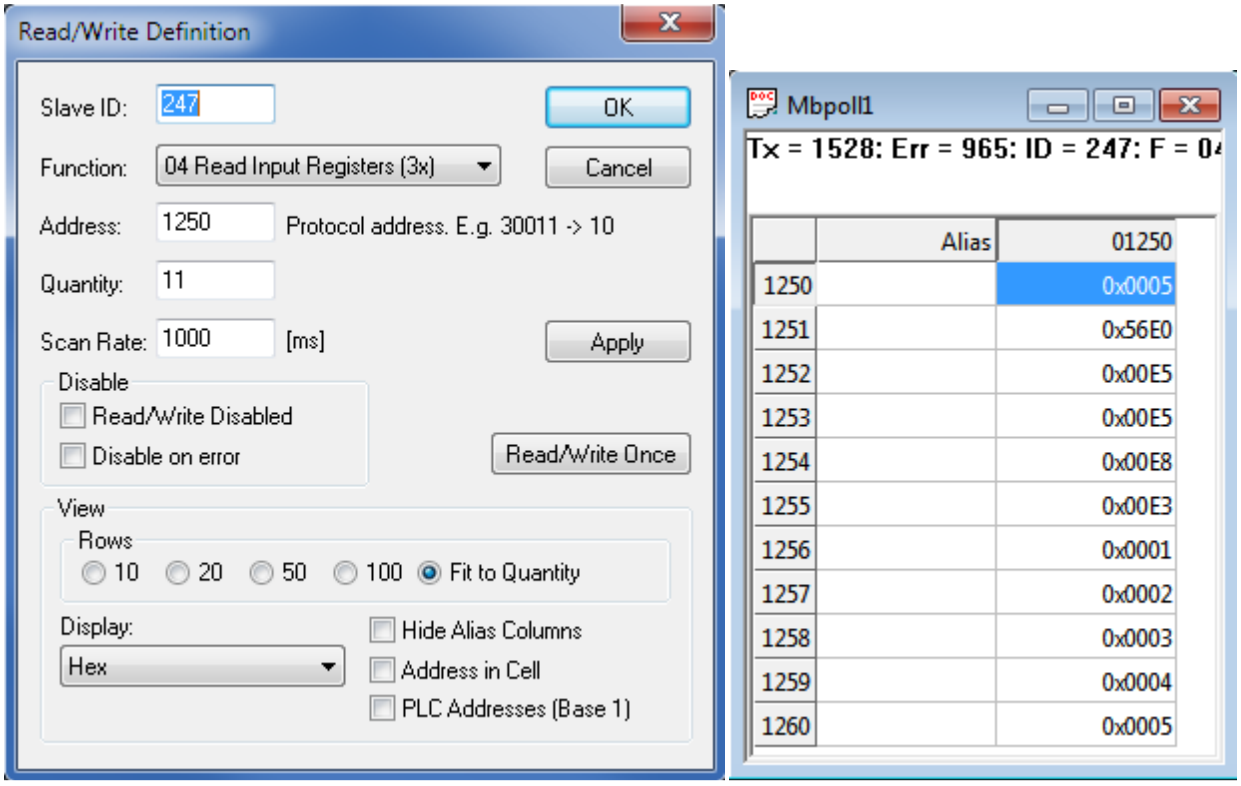
14.4.5 Remove one of the attached HART devices.

14.4.6 Verify that the corresponding slave malfunction bit (see Appendix J) changes to 1.

14.4.7 Reconnect the disconnected device.

14.4.8 Verify that the corresponding slave malfunction bit changes to 0.

14.4.9 **To check the types and poll addresses of the attached HART devices**, open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:

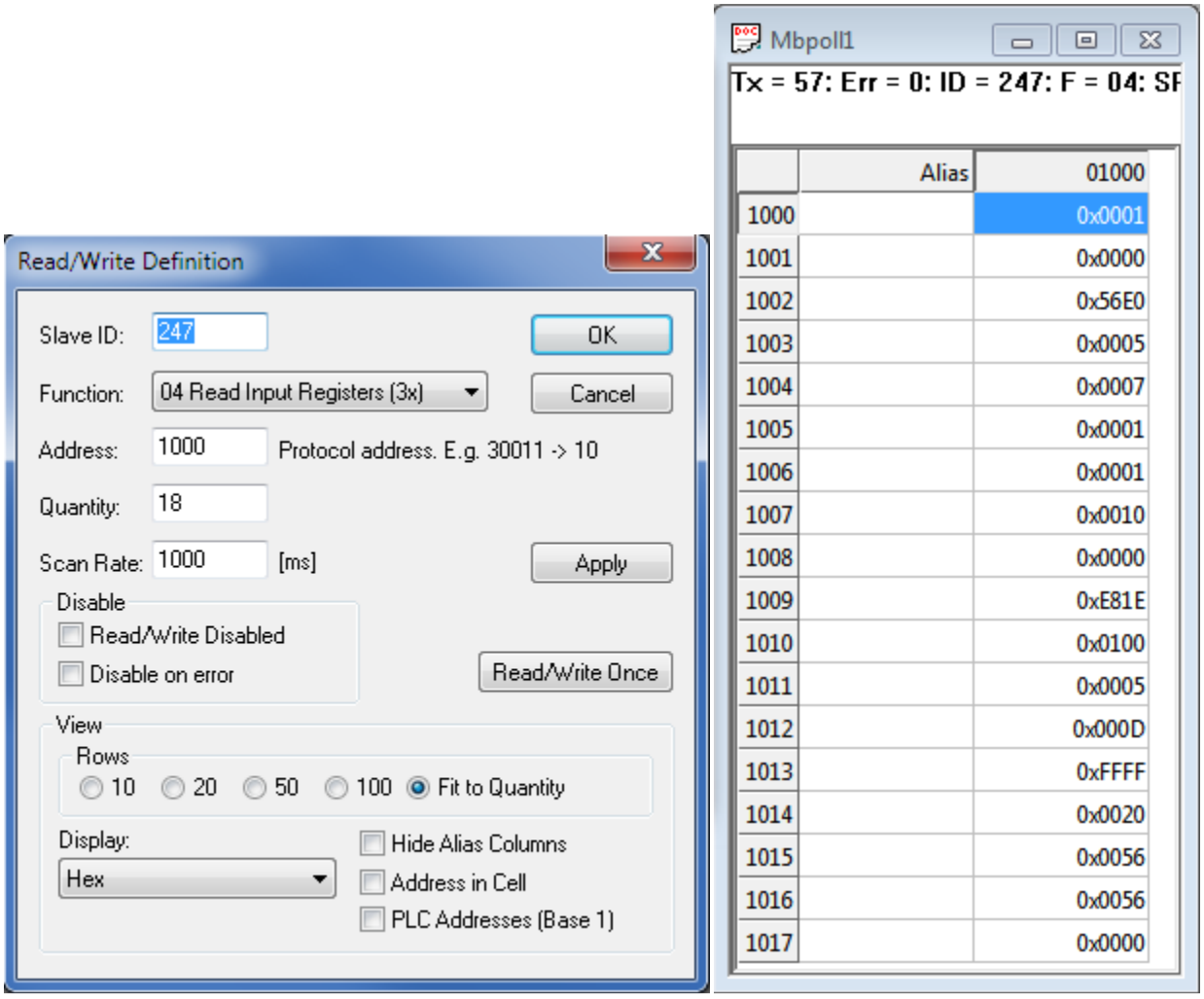


14.4.10 Verify that register 1250 indicates the correct number of attached devices.

14.4.11 Verify that registers 1251 through 1255 show the correct Device Types of the attached devices for each corresponding Poll Address.

14.4.12 Verify that registers 1256 through 1260 show the correct Poll Addresses of the attached devices.

14.4.13 **To check the device information for the attached HART devices**, open or click on an Mbpoll window, select Setup\Read\Write Definition from the menu bar, ensure that the settings are as follows, and then click OK:



14.4.14 Verify that registers 1000 through 1017 show the correct information for the attached device as listed in Appendix K.

14.4.15 Repeat steps 15.4.14 and 15.4.15 for the remaining four devices, changing the register addresses as appropriate.

15. Emerson ROC 800

15.1. Initial HMA Configuration

15.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values desired for communication with the ROC 800. Refer to Appendix F for the HMA RTU Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

15.2. Physical Connections

15.2.1 Connect the ROC 800 to a computer using an LOI RS-232 cable.

15.2.2 Connect an appropriate power supply to the power supply module of the ROC 800.

15.2.3 Connect the HMA to a 9 – 30 VDC power supply via terminal block TB1.

15.2.4 Connect an RS-485 communications cable between terminals A and B of the ROC 800 RS-485 module and the RS-485 terminal block (TB2) of the HMA.

15.2.5 Connect a 120Ω resistor between the two RS-485 terminal block positions of the last HMA on the bus

15.3. Initial ROC 800 Configuration

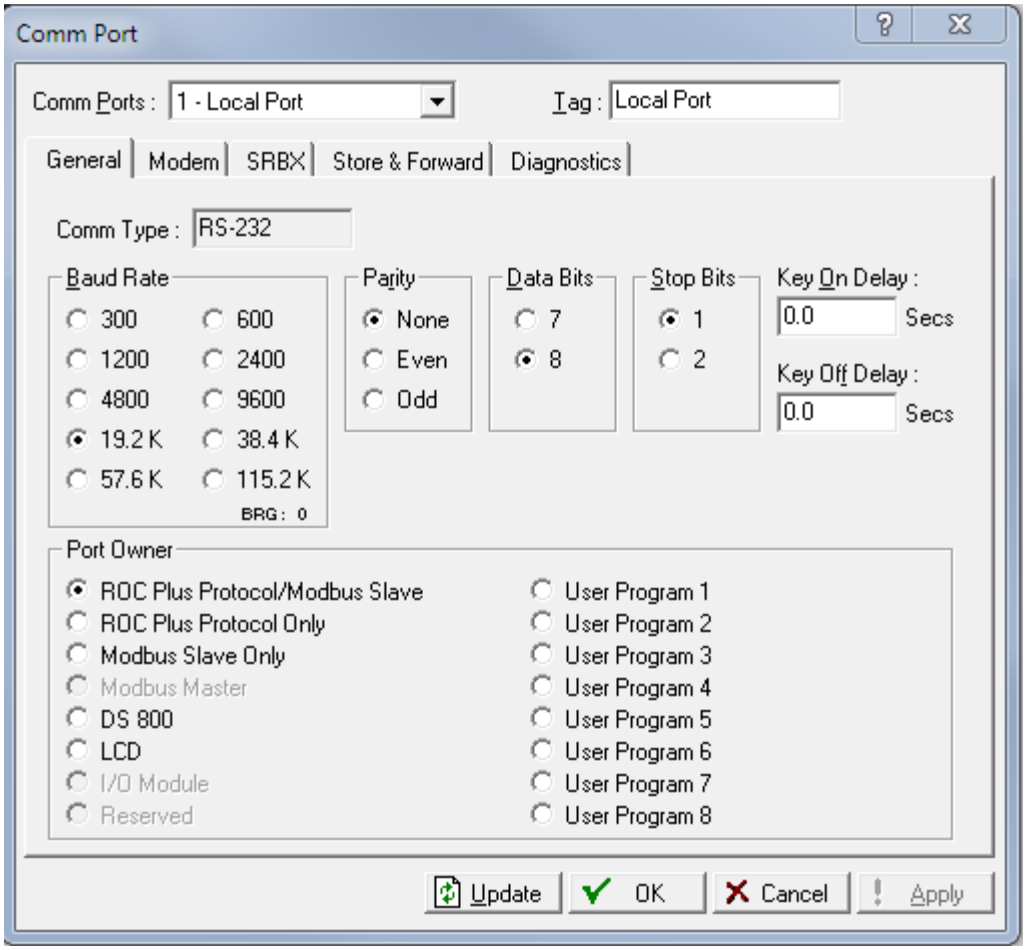
15.3.1 Start the ROCLINK 800 application.

15.3.2 Select ROC \ Direct Connect in the ROCLINK 800 Menu bar. An image of the front of the ROC 800 will appear.

15.3.3 Mouse over the image of the RS-485 module. A flyover text box will appear that identified the Comm Port used for RS-485 communication with the HMA.

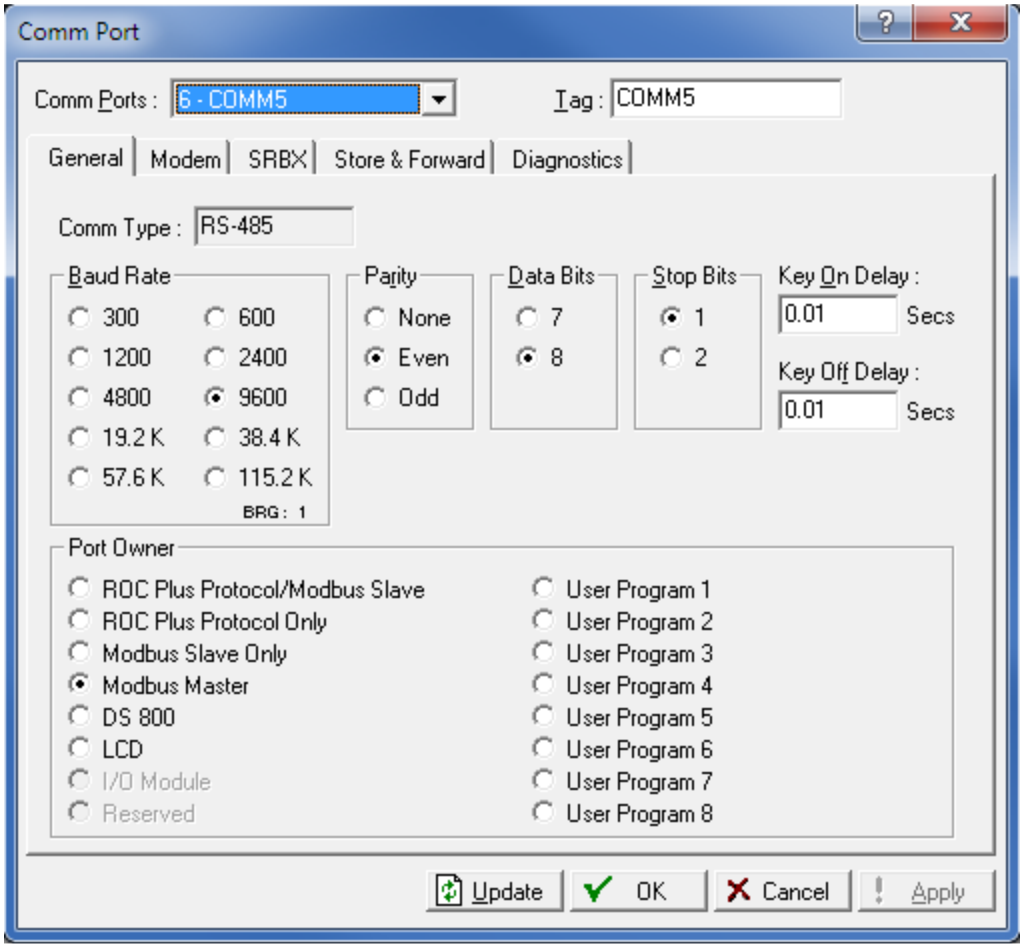
15.3.4 Click on ROC \ Comm Ports in the ROCLINK 800 Menu bar.

15.3.5 Ensure that the communication settings for 1 – Local Port are as follows.



15.3.6 For Comm Ports, select the port number displayed in step 16.3.3.

15.3.7 Ensure that the communications settings match the settings of the HMA performed in step 16.1.1, then click OK. Ensure that the Port Owner is set to Modbus Master. For example,



15.4. **Reading registers from the HMA**

15.4.1 Select Configure \ MODBUS from the ROCLINK 800 Menu bar.

15.4.2 Change the Comm Port to match the port to which the HMA is connected.

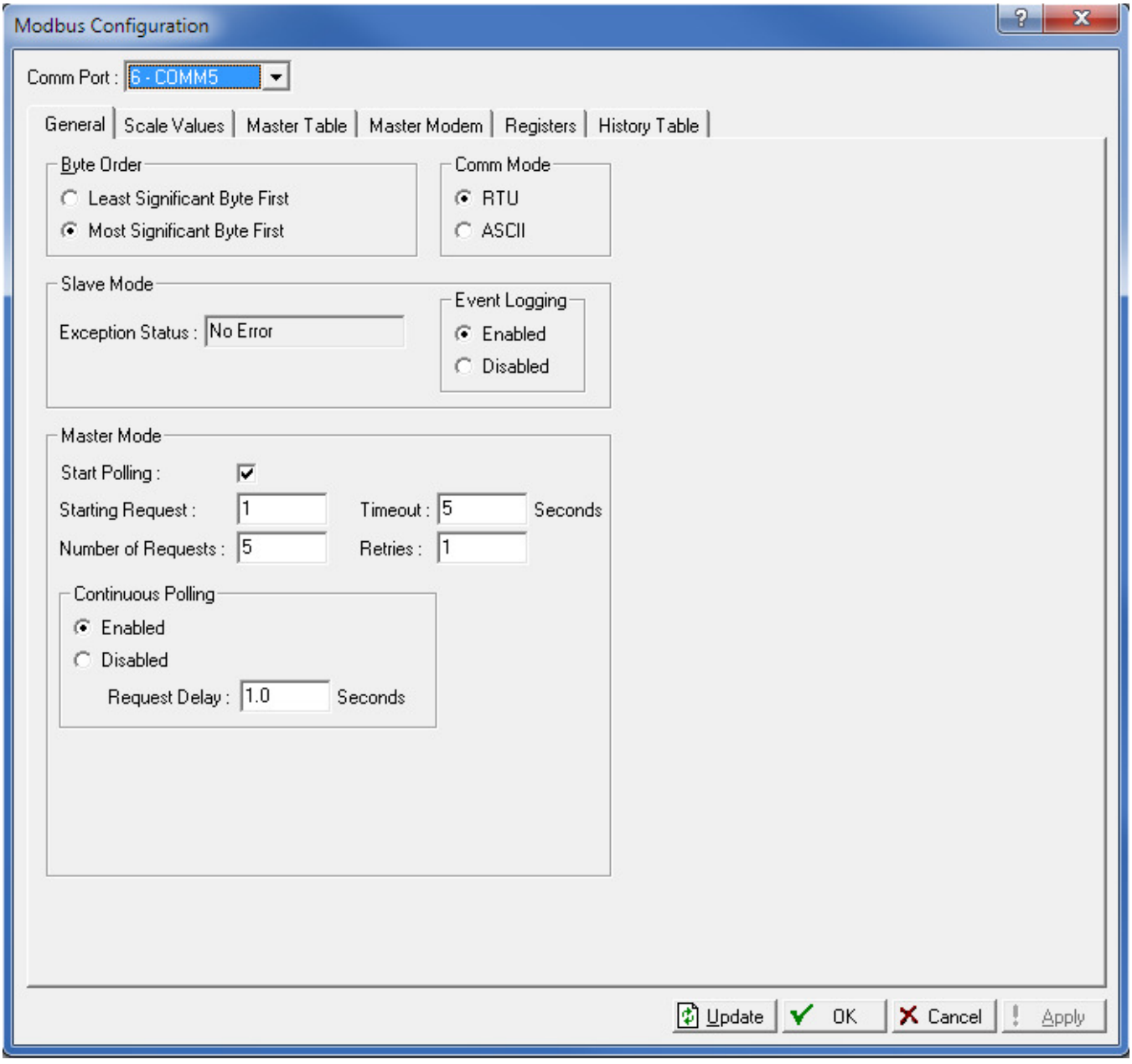
15.4.3 The followings steps demonstrate how to read the PV, SV, TV and QV as well as the Blocking Distance from a HART device attached to the HMA.

15.4.4 For the General tab,

15.4.5 Ensure that the Byte Order and Comm Mode match the selections made in step 16.1.1.

15.4.6 Check ‘Start Polling’. Set the Starting Request to 1 and the Number of Requests to match the total number of separate rows defined in the Master Table tab below.

15.4.7 Select the Enabled radio button in the Continuous Polling group box.

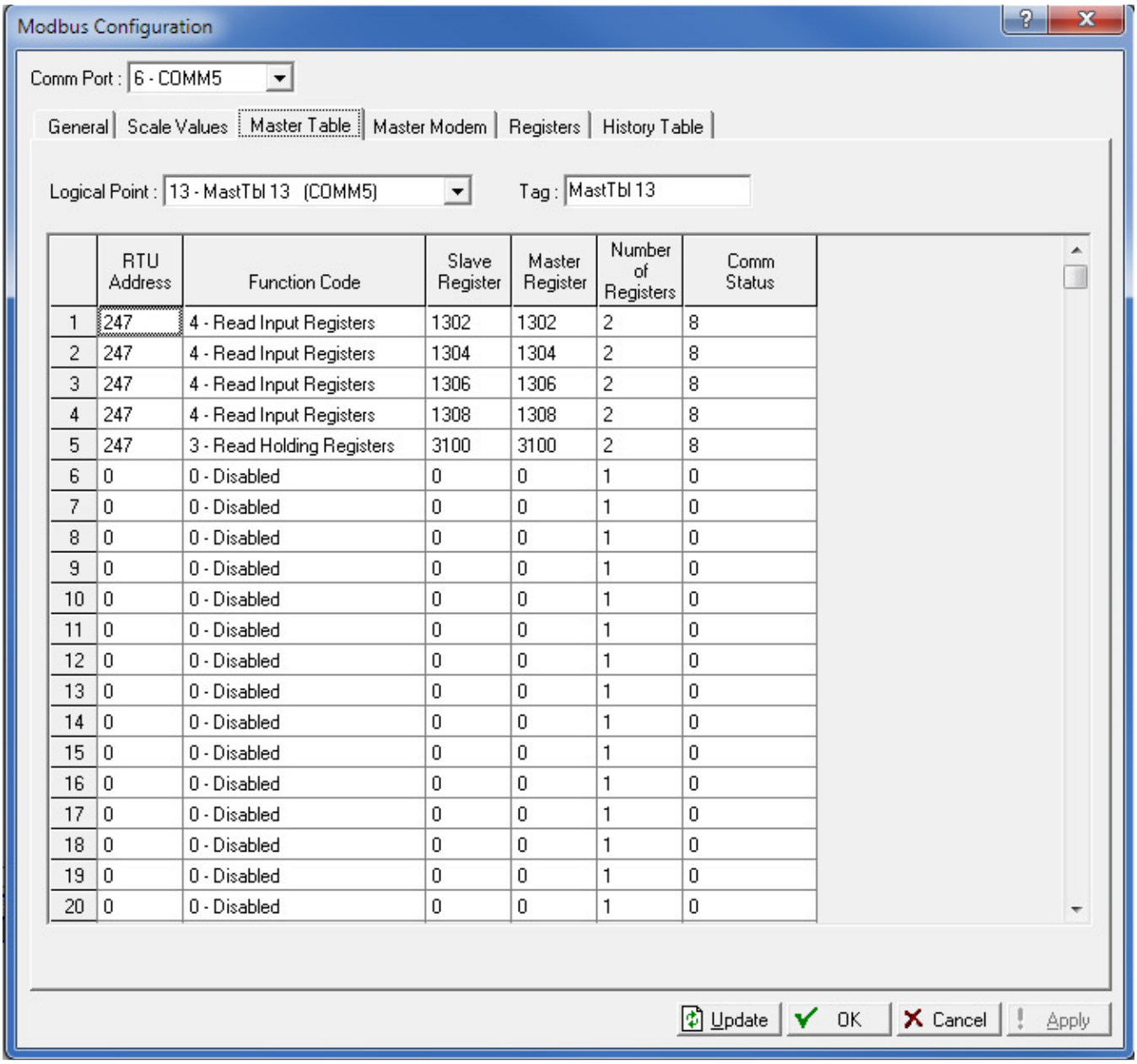


15.4.8 For the Master Table tab,

15.4.9 Set the Logical Point to 13 – MastTbl 13 (COMM5).

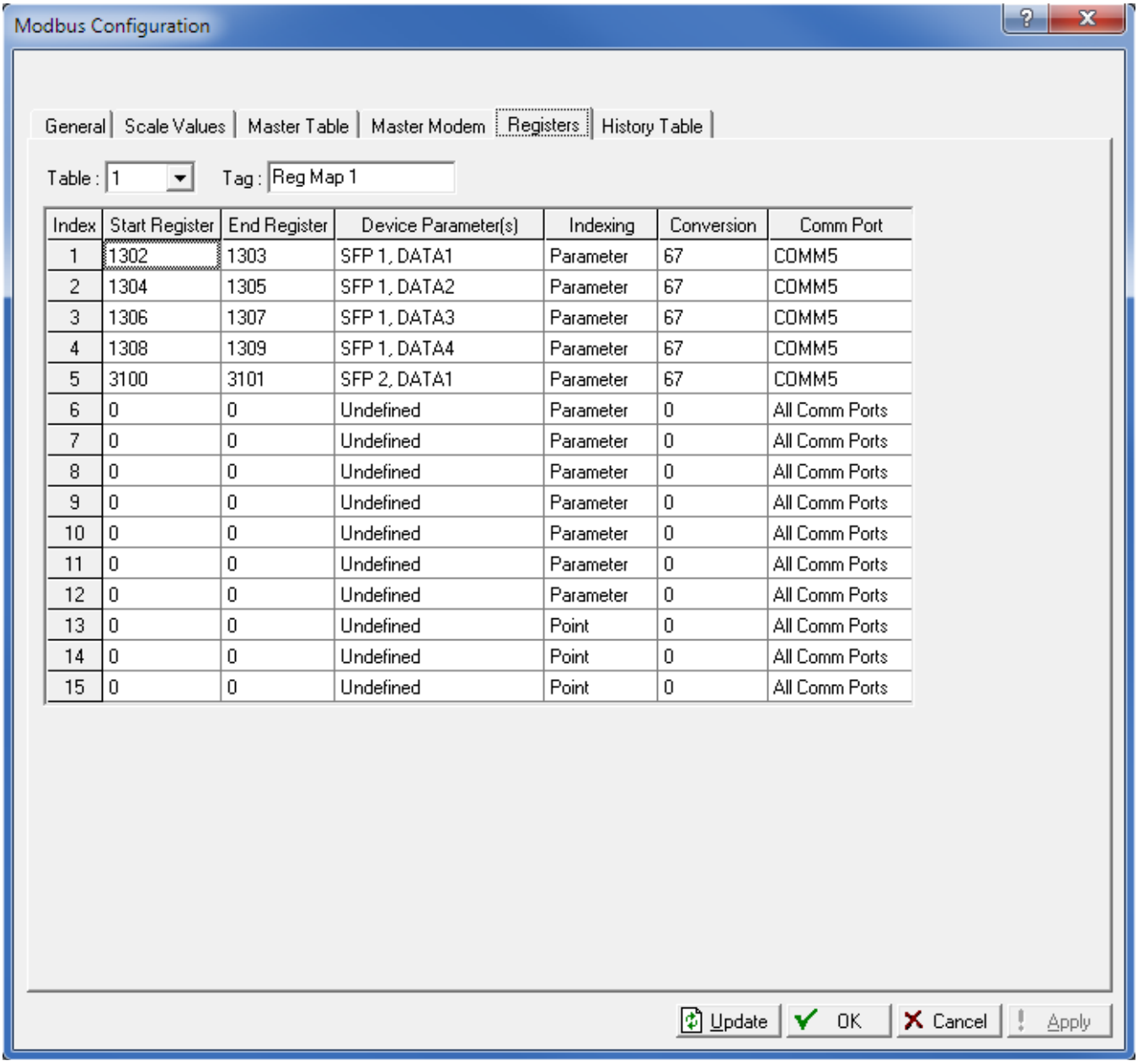
15.4.10 Enter into the table the sets of registers to be read from the device. Set the RTU Address to that of the HMA when it is in the 'HMA' mode. Set the RTU Address to that of the individual attached HART device to be queried when the HMA is in the 'Device' mode.

15.4.11 In the example below, the HMA is in 'HMA' mode and has an address of 247.



	RTU Address	Function Code	Slave Register	Master Register	Number of Registers	Comm Status
1	247	4 - Read Input Registers	1302	1302	2	8
2	247	4 - Read Input Registers	1304	1304	2	8
3	247	4 - Read Input Registers	1306	1306	2	8
4	247	4 - Read Input Registers	1308	1308	2	8
5	247	3 - Read Holding Registers	3100	3100	2	8
6	0	0 - Disabled	0	0	1	0
7	0	0 - Disabled	0	0	1	0
8	0	0 - Disabled	0	0	1	0
9	0	0 - Disabled	0	0	1	0
10	0	0 - Disabled	0	0	1	0
11	0	0 - Disabled	0	0	1	0
12	0	0 - Disabled	0	0	1	0
13	0	0 - Disabled	0	0	1	0
14	0	0 - Disabled	0	0	1	0
15	0	0 - Disabled	0	0	1	0
16	0	0 - Disabled	0	0	1	0
17	0	0 - Disabled	0	0	1	0
18	0	0 - Disabled	0	0	1	0
19	0	0 - Disabled	0	0	1	0
20	0	0 - Disabled	0	0	1	0

15.4.12 For the Registers tab,

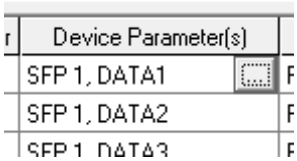


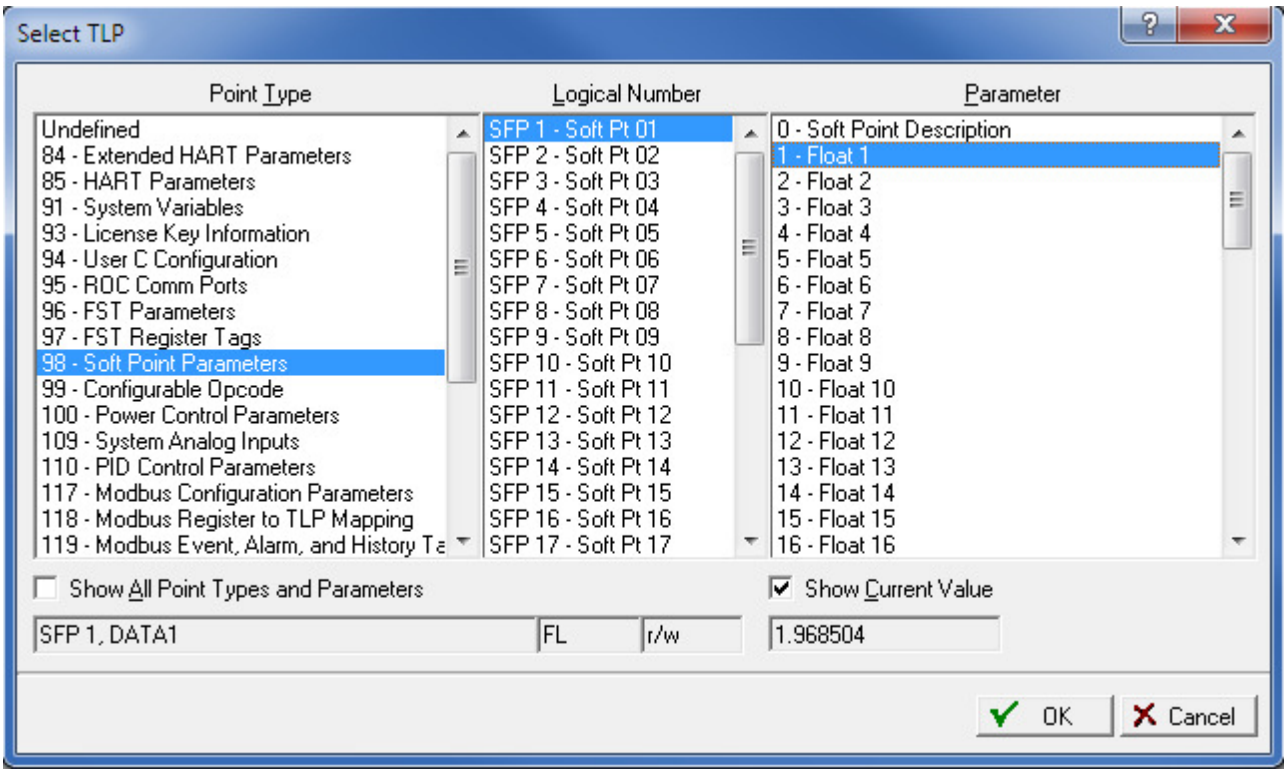
Index	Start Register	End Register	Device Parameter(s)	Indexing	Conversion	Comm Port
1	1302	1303	SFP 1, DATA1	Parameter	67	COMM5
2	1304	1305	SFP 1, DATA2	Parameter	67	COMM5
3	1306	1307	SFP 1, DATA3	Parameter	67	COMM5
4	1308	1309	SFP 1, DATA4	Parameter	67	COMM5
5	3100	3101	SFP 2, DATA1	Parameter	67	COMM5
6	0	0	Undefined	Parameter	0	All Comm Ports
7	0	0	Undefined	Parameter	0	All Comm Ports
8	0	0	Undefined	Parameter	0	All Comm Ports
9	0	0	Undefined	Parameter	0	All Comm Ports
10	0	0	Undefined	Parameter	0	All Comm Ports
11	0	0	Undefined	Parameter	0	All Comm Ports
12	0	0	Undefined	Parameter	0	All Comm Ports
13	0	0	Undefined	Point	0	All Comm Ports
14	0	0	Undefined	Point	0	All Comm Ports
15	0	0	Undefined	Point	0	All Comm Ports

15.4.13 Set the Table to 1, and for each variable to be read,

15.4.14 Enter the Start and End Register numbers. Refer to Appendices F through S for register numbers of the HMA and attached HART devices.

15.4.15 Create a Soft Point and Data number in the Device Parameter(s) column. Click on the ellipsis button that appears at the right side of the cell to open the 'Select TLP' dialog.





15.4.16 Select 98 – Soft Point Parameters for the Point Type, SFP 1 – Soft Point 01 for the Logical Number, and 1 – Float 1 for the Parameter. Note the name for the point, for example, SPF 1, DATA 1. By checking 'Show Current Value', one can confirm that the desired parameter is being read correctly. Then click 'OK' to close the Select TLP dialog.[2]

15.4.17 Set a Convert Code (see ROCLINK 800 Help) in the Conversion column () to properly interpret the data bytes into the correct numerical format.

15.4.18 Assign the correct Comm Port number.

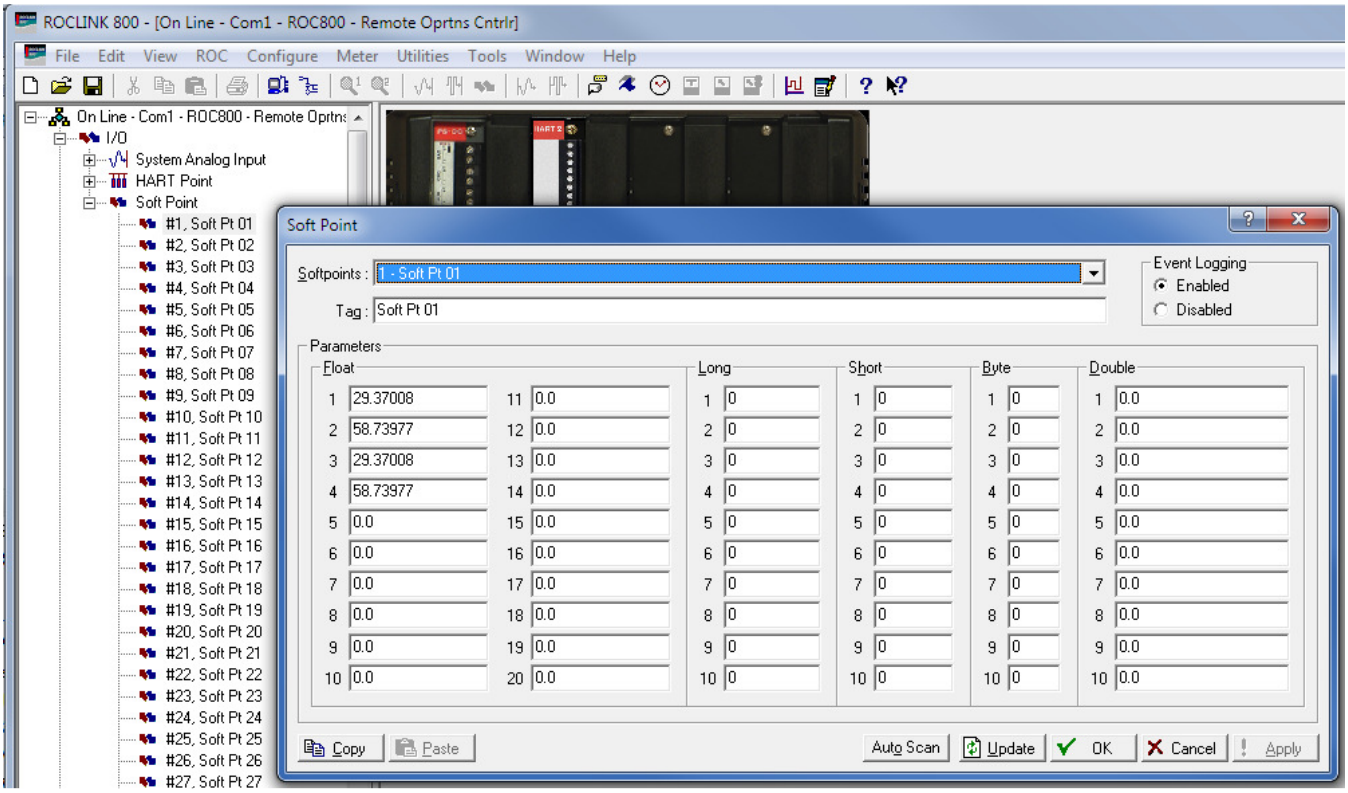
15.4.19 Repeat as required for the remaining parameters to be read from the device.

15.4.20 Return to Master Table tab and ensure that the Comm Status for each line is 8, indicating a Valid Slave Response.

[2] Select 'Short' for the Parameter type when setting up to read the unsigned integer communication registers 3000 through 3007 in the HMA.

15.4.21 To display the values,

15.4.22 Open the Soft Point dialog by selecting I/O \ Soft Point in the Configuration Tree window, then double-clicking on #1, Soft Pt 01.



15.4.23 Click on Update to read a single set of values from the device, or Auto Scan to repeatedly update the displayed values.

15.5. **Writing registers to the HMA**

15.5.1 Configure the ROC 800 to access a register in the HMA or attached HART device as for reading a register from the HMA (section 16.4).

15.5.2 When setting up the row in the Configure \ MODBUS \ Master Table tab, use Function Code 16 – Preset Multiple Registers for multi-byte parameters, or 6 – Preset Single Register for single-byte parameters.

15.5.3 Click Update to send the new setting to the ROC 800.

15.5.4 Open the Soft Point dialog by selecting I/O \ Soft Point in the Configuration Tree window, then double-clicking on #1, Soft Pt 01.

15.5.5 Highlight the value to be changed and enter the new value.

15.5.6 Click on Update to send the new value to the device.

15.5.7 Return to the Configure \ MODBUS \ Master Table tab.

15.5.8 Change the Function Code for the parameter to 3 – Read Holding Registers or 4 – Read Input Registers as appropriate.

15.5.9 Click on Update to send the new setting to the device.

15.5.10 Return to the Soft Point dialog by selecting I/O \ Soft Point in the Configuration Tree window, then double-clicking on #1, Soft Pt 01.

15.5.11 Click on Update to confirm that the device has accepted the new value.

16. ABB Totalflow XRC – Modbus RTU / ASCII

The following procedure applies to operation with both RTU and ASCII communication. The choice of communication protocol is made in step 17.1.1 for the HMA settings and in step 17.3.10 for the ABB Totalflow XRC. The Modbus RTU protocol is used for the following.

16.1. Initial HMA Configuration

16.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values desired for Modbus communication with the XRC. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

16.2. Physical Connections

16.2.1 Connect the XRC to a computer using a USB-A to USB-B cable.

16.2.2 Connect an appropriate power supply to the battery terminal (J16) of the XRC.

16.2.3 Connect the HMA to a 9 – 30 VDC power supply via terminal block TB1.

16.2.4 Connect an RS-485 communications cable between the COM1 terminal block (lower position of J6) of the XRC and the RS-485 terminal block (TB2) of the HMA. The RS485+ terminal of the HMA should be connected to the BUS+ of the TotalFlow terminal block. The – terminals should be connected correspondingly. See section 17.3.11.

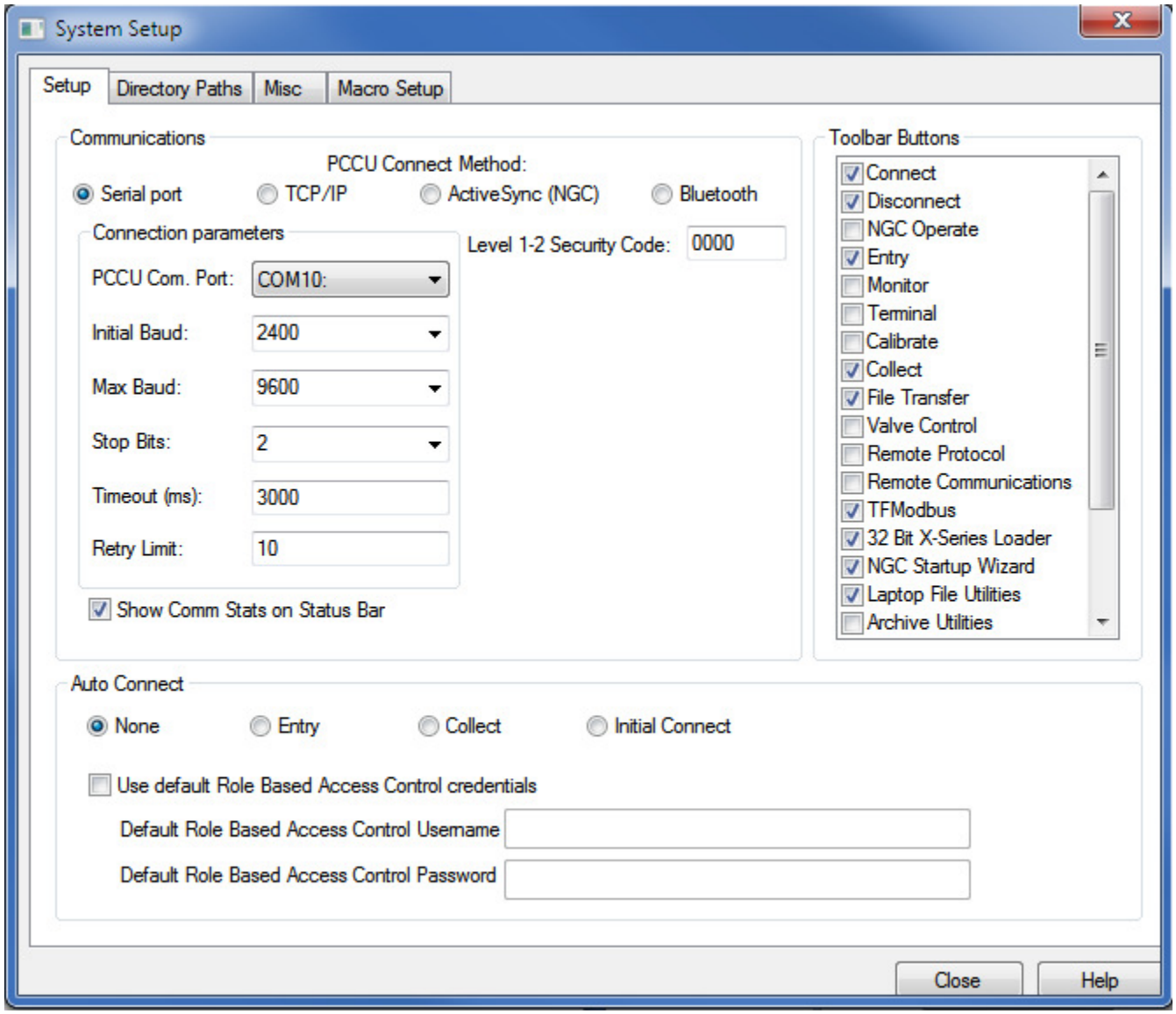
16.2.5 Ensure that the appropriate communication module is inserted into the Comm 1 receptacle (XA1).

16.2.6 Connect a 120Ω resistor between the two RS-485 terminal block positions of the last HMA on the bus.

16.3. Initial XRC Configuration

16.3.1 Start the PCCU32 application.

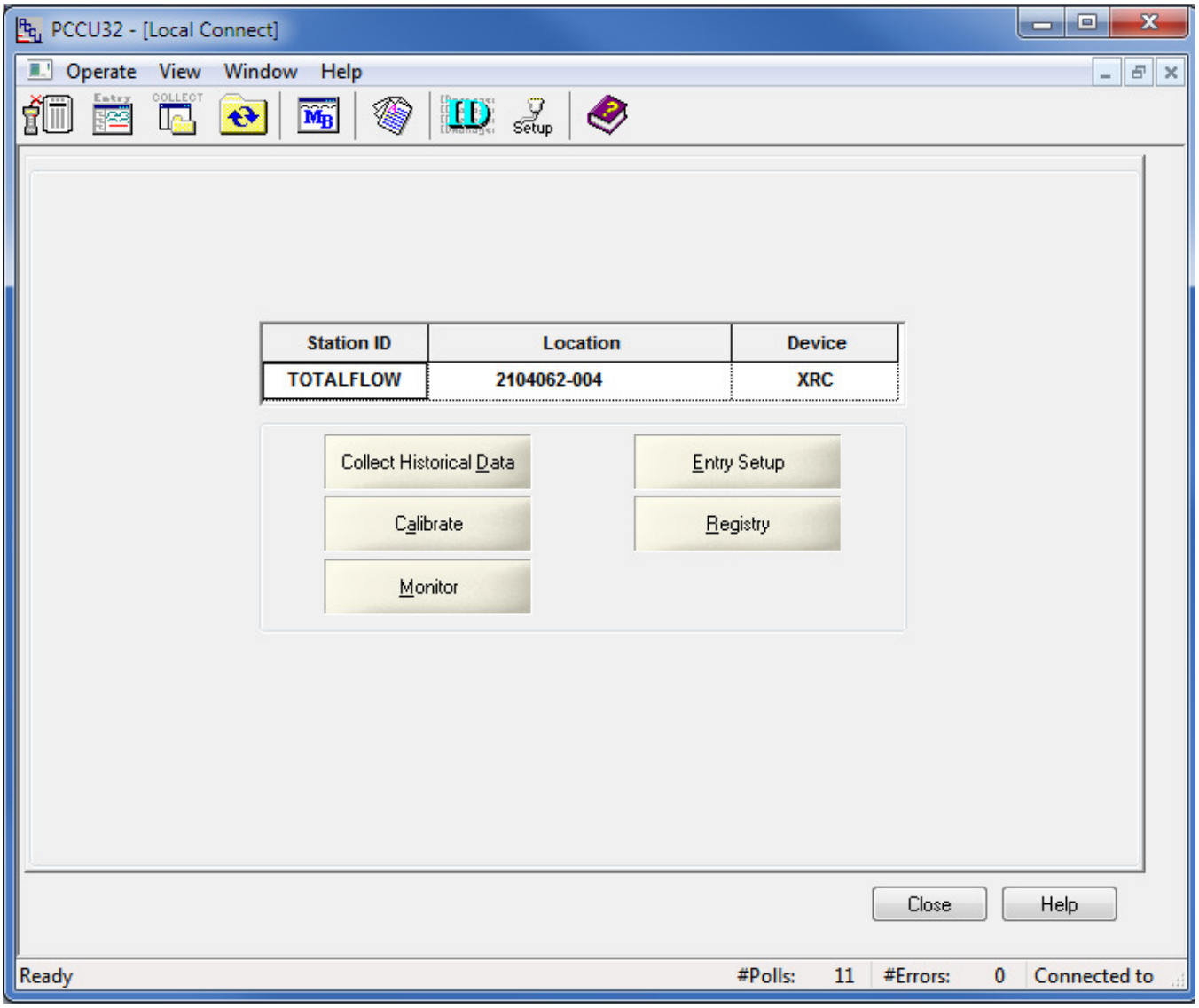
16.3.2 Select on Operate \ Setup \ System Setup in the PCCU32 Menu bar. A dialog will appear allowing for communication settings between the PCCU32 application and the XRC.



16.3.3 Select the COM port number corresponding to the XRC. The proper COM port number can be identified by navigating to the Device Manager in Windows and expanding the Ports entry.

16.3.4 Click Close.

16.3.5 Select on Operate \ Connect to Totalflow in the PCCU32 Menu bar.



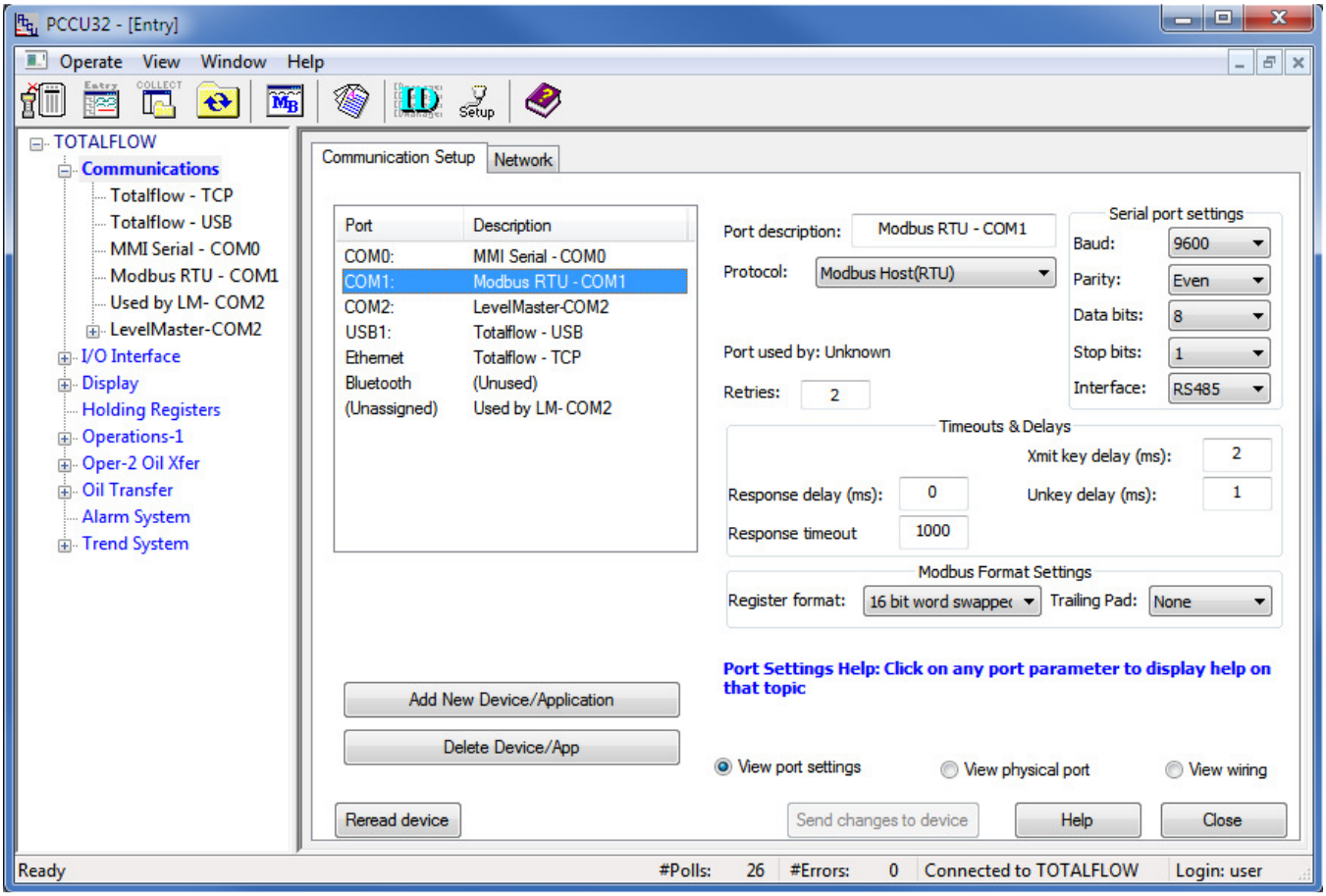
16.3.6 Select Entry Setup from the Local Connect initial dialog.

16.3.7 Select View \ Advanced from the PCCU32 menu bar.

16.3.8 Click on Communications in the tree-view window.

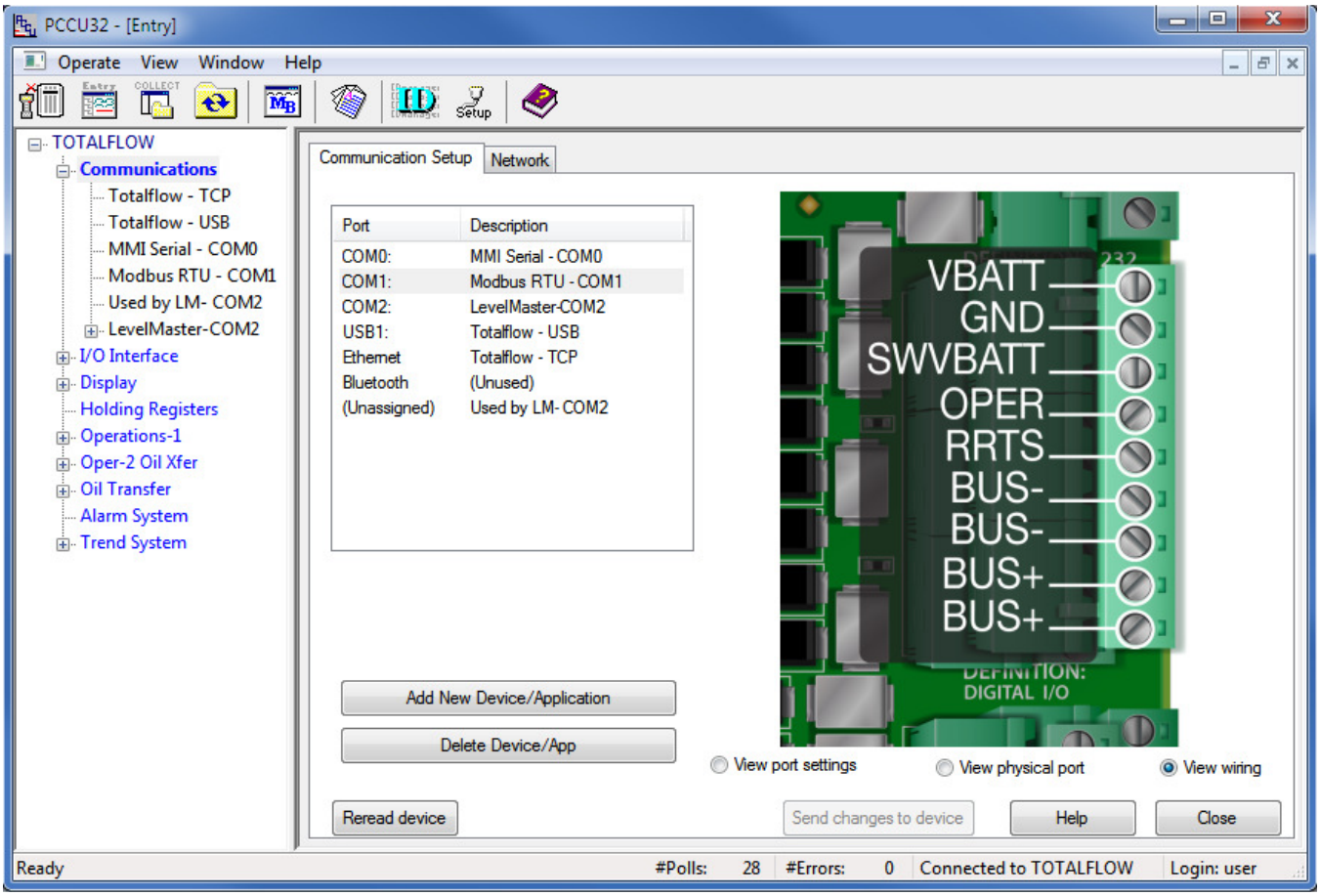
16.3.9 Click on the Port name associated with Modbus RTU.

16.3.10 Ensure that the communications settings match the settings of the HMA performed in step 17.1.1. For example,



16.3.11 Click on ‘Send changes to device’ after all settings are changed and verified.

16.3.12 The terminal block connections on the XRC can be verified by clicking on the View wiring radio button. Note that the RS485+ terminal of the HMA should be connected to the CTS/BUS+ position of the TotalFlow terminal block. The – terminals should be connected to the DCD/BUS- position of the TotalFlow terminal block.



16.4. **Reading registers from the HMA**

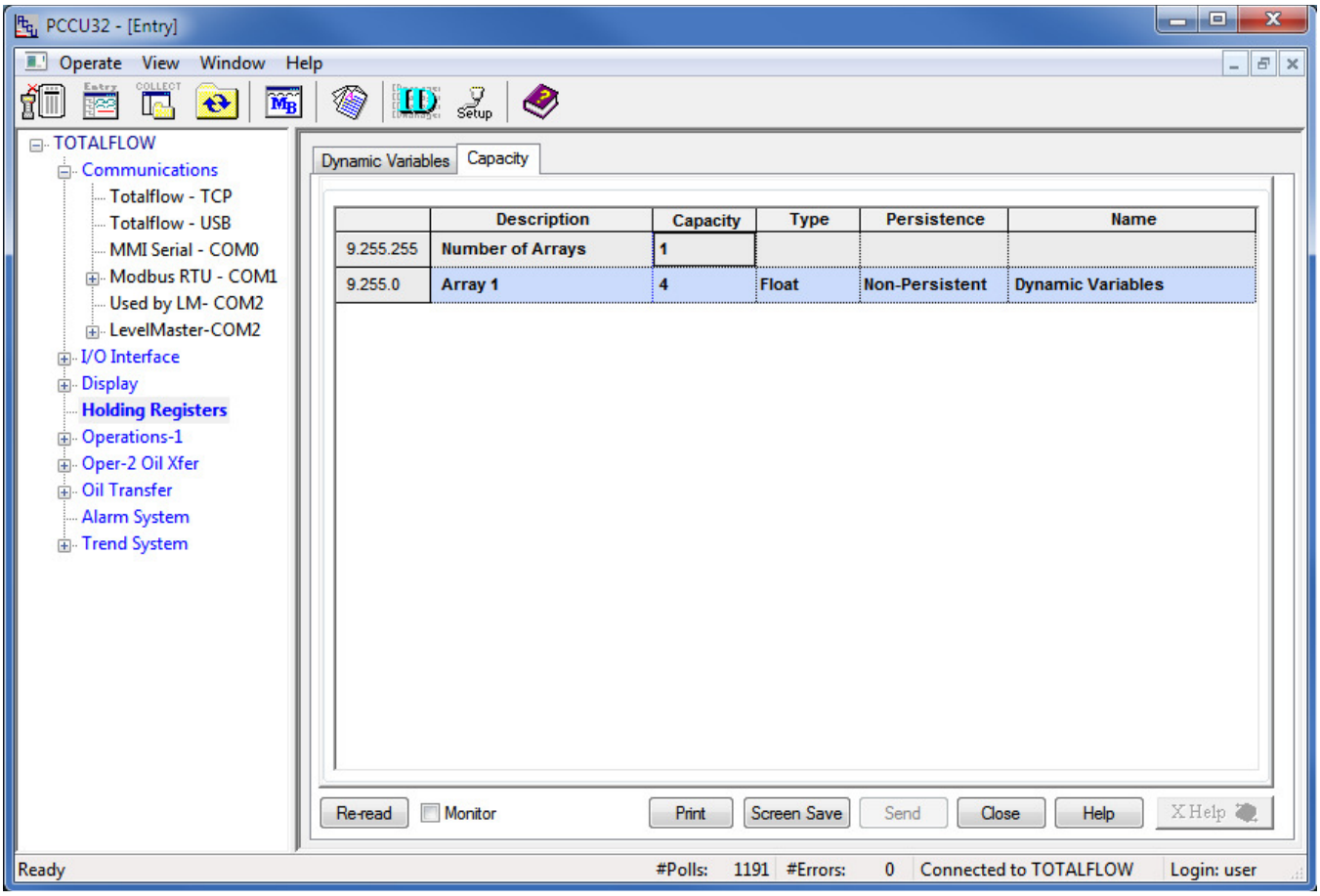
16.4.1 The followings steps demonstrate how to read the PV, SV, TV and QV from a HART device attached to the HMA. When making any changes to the settings, click on Send at the bottom of the window to write them to the XRC.

16.4.2 Select Holding Registers from the tree-view window of the PCCU32.

16.4.3 Select the Capacity tab.

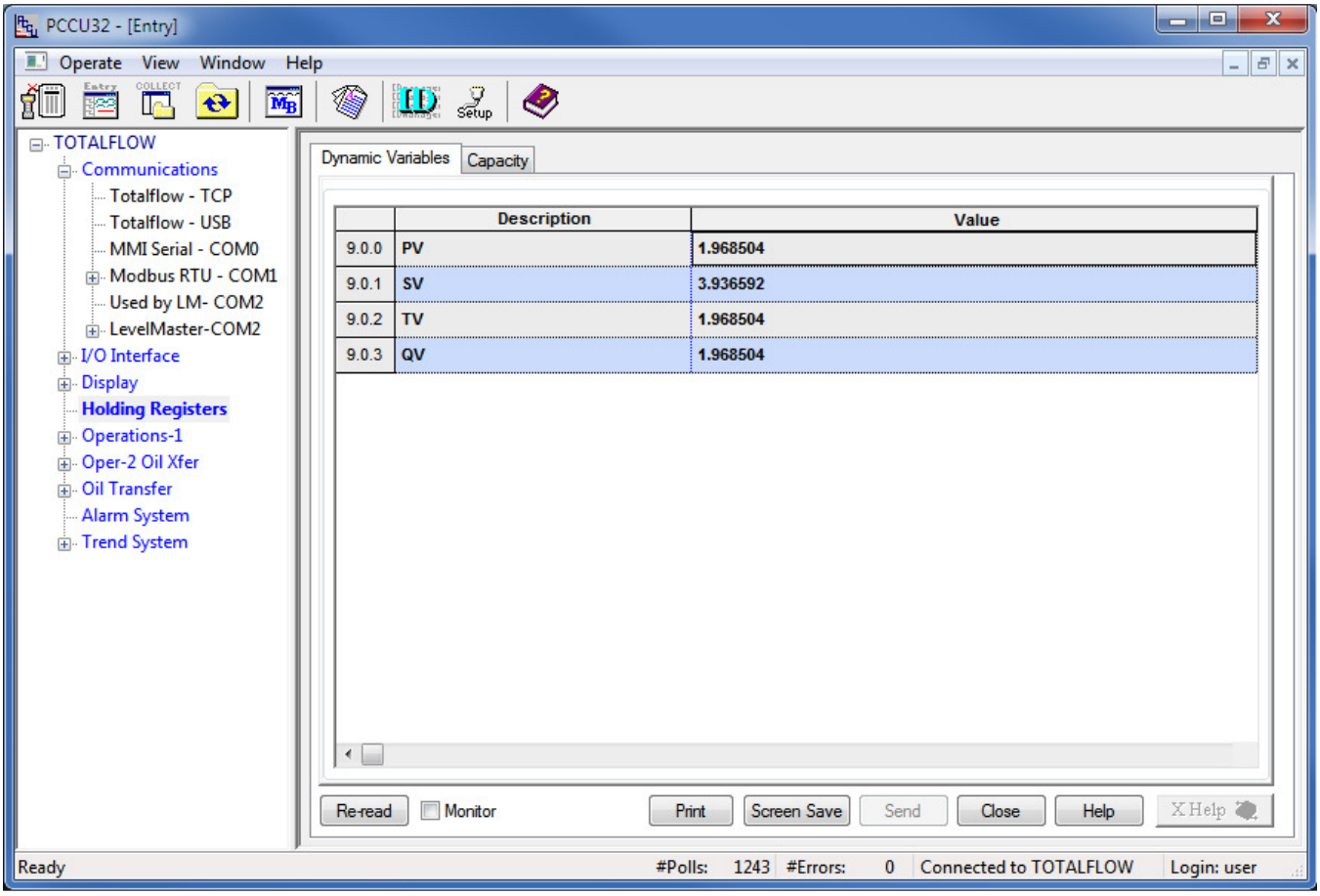
16.4.4 Set the Capacity for the Number of Arrays to 1.

16.4.5 Set the Capacity for Array 1 to '4', the Type to 'Float', the 'Persistence' to 'Non-Persistent', and the Name to 'Dynamic Variables'.



16.4.6 Select the Dynamic Variables tab.

16.4.7 Change the description of the four registers to ‘PV’ through ‘QV’.

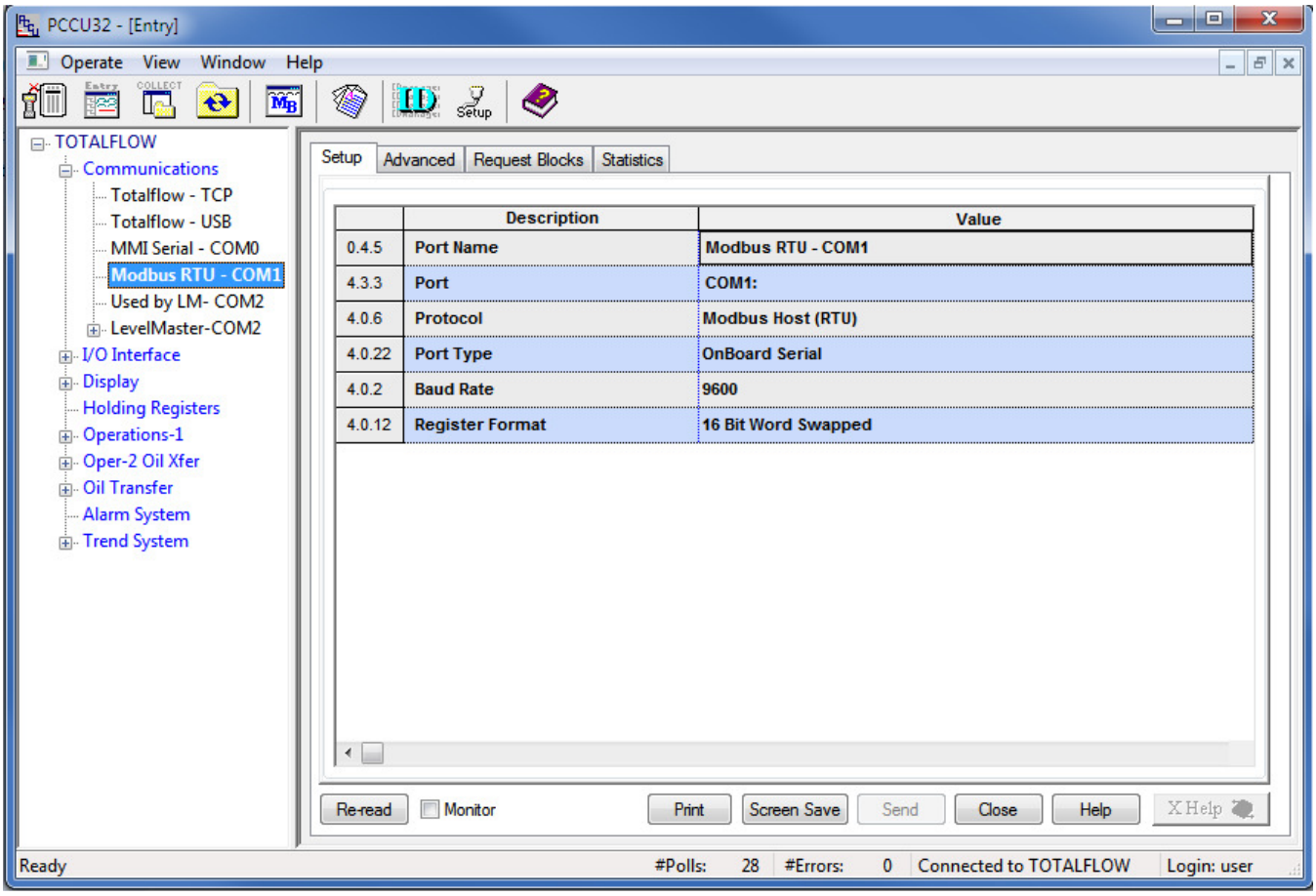


16.4.8 Note the Register numbers displayed in the first column of the table. They will be used when setting the Request Blocks in a later step.

16.4.9 Select Communications \ Modbus RTU in the tree-view window.

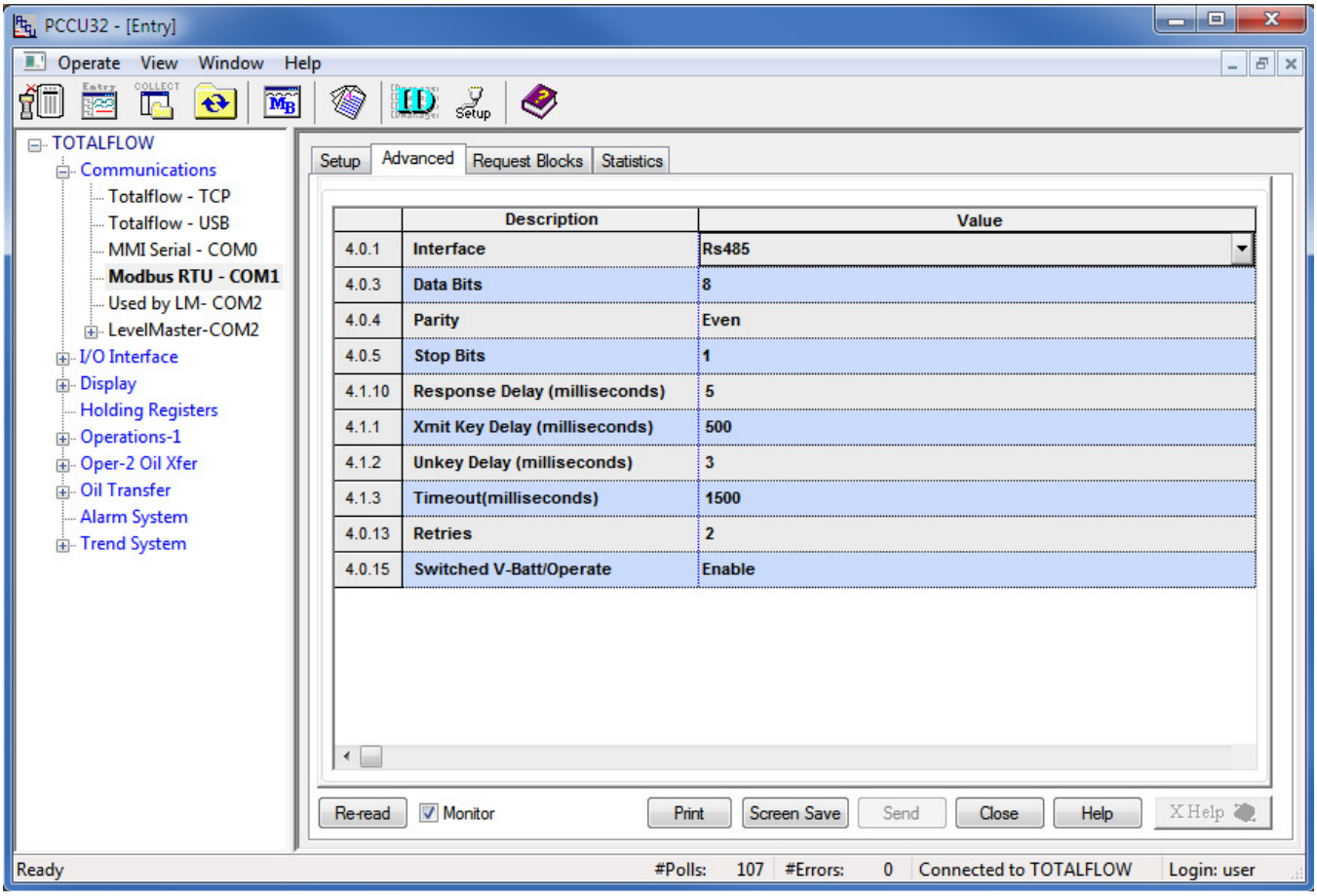
16.4.10 For the Setup tab,

16.4.11 Ensure that the Protocol and Baud Rate match the selections made in step 17.1.1.



16.4.12 For the Advanced tab,

16.4.13 Ensure that the Data Bits, Parity and Stop Bits match the selections made in step 17.1.1.



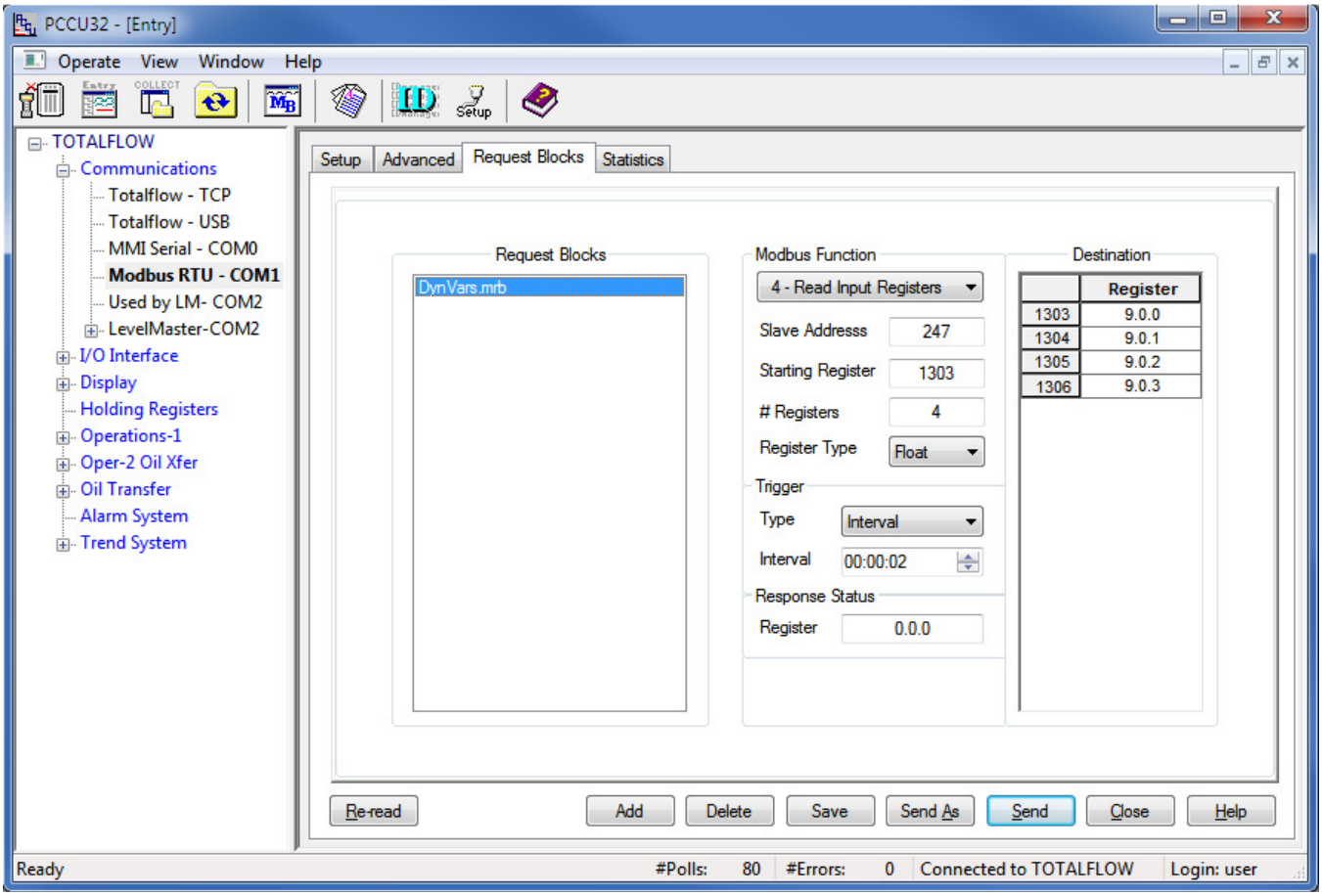
16.4.14 Ensure that the Unkey Delay is less than 7 milliseconds as the HMA typically responds within about 8 milliseconds. If the Unkey Delay time is too long, the XRC will start listening for a response after the HMA has already started transmitting. As a result, the XRC will not recognize the response.

16.4.15 For the Request Blocks tab,

16.4.16 Set the Slave Address to match the address of the HMA (if in HMA mode), or an attached device (if in Device mode).

16.4.17 Select '4 – Read Input Registers' from the Modbus function drop-down.

16.4.18 Set the Starting Register to a value 1 greater than the desired starting Modbus register. Refer to Appendices F through S for register numbers of the HMA and attached HART devices.



16.4.19 Set the # Registers to equal the total number of Dynamic Variables to be read. Note that in this case, 4 Dynamic Variables are to be read so that a value of 4 is entered even though the total number of 16-bit Modbus registers that will be read is 8.

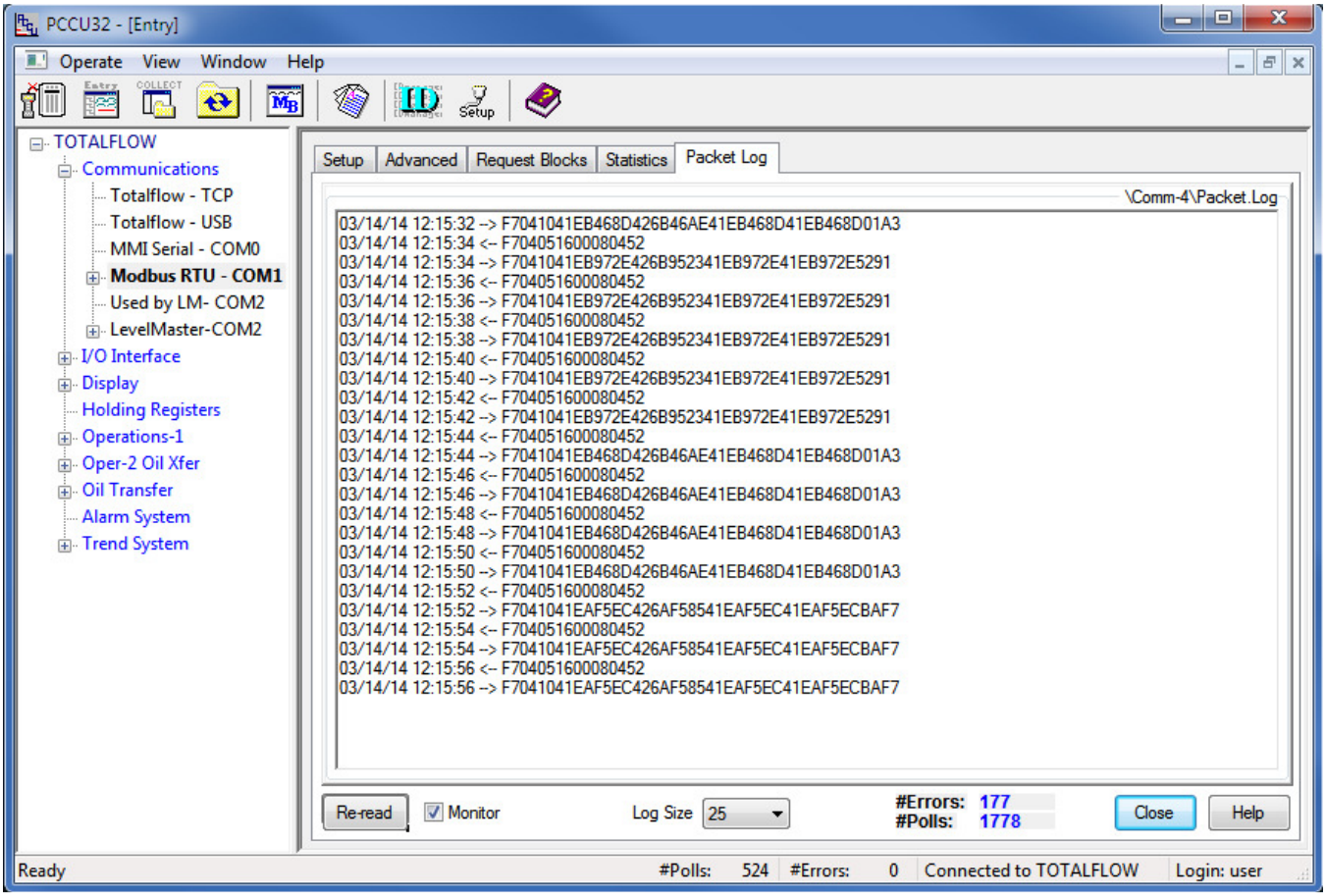
16.4.20 Set the Register Type to Float.

16.4.21 Set the Trigger Type to Interval and the Interval time to the desired sampling rate.

16.4.22 Set the Destination Registers to the register numbers from step 17.4.8.

16.4.23 Click on Send to update the RTU.

16.4.24 To check if transmissions and responses are being made, select View \ Expert from the PCCU32 Menu bar. This mode displays a Packet Log tab when selecting Communications \ Modbus RTU from the tree-view window.



16.4.25 Set the Log Size to 25, and check the Monitor checkbox. The log should start updating with the XRC commands being sent out and the responses from the HMA.

16.4.26 Right-click in the clear area between the Monitor checkbox and the Log Size drop-down. Select a shorter interval screen refresh interval if desired

16.4.27 To display the values,

16.4.28 Select Holding Registers from the tree-view window of the PCCU32.

16.4.29 Select the Dynamic Variables tab.

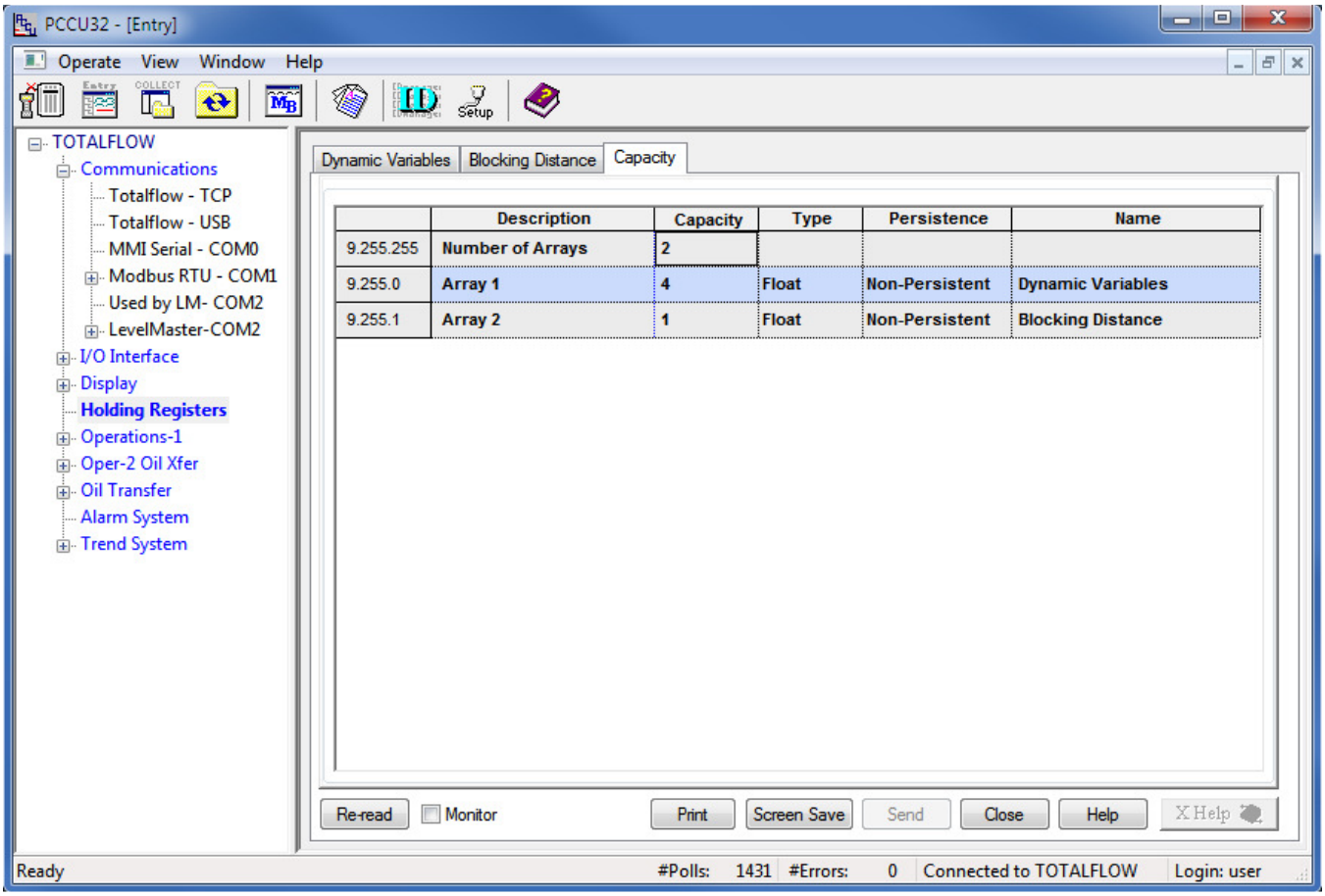
16.4.30 Click on Re-read to obtain a single set of readings from the HMA, or check the Monitor checkbox to repeatedly read values from the HMA at the Interval specified in the Request Blocks tabs in step 17.4.21.

16.5. **Writing registers to the HMA**

16.5.1 The followings steps demonstrate how to change a parameter in a HART device attached to the HMA. The Blocking Distance parameter is used as the example. When making any changes to the settings, click on Send at the bottom of the window to write them to the XRC.

16.5.2 Select Holding Registers from the tree-view window of the PCCU32.

16.5.3 Select the Capacity tab.

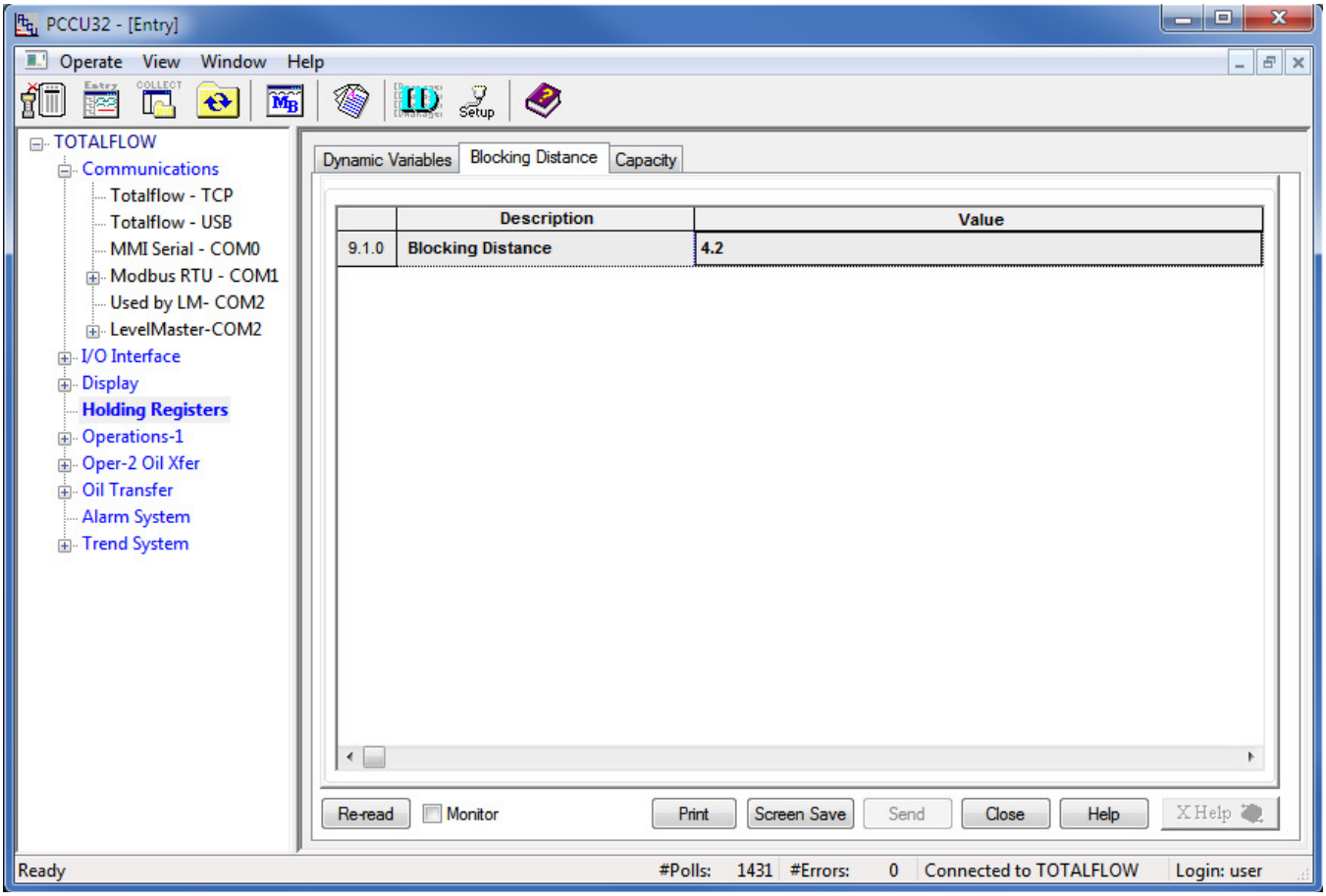


16.5.4 Set the Capacity for the Number of Arrays to 2.

16.5.5 Set the Capacity for Array 2 to ‘1’, the Type to ‘Float’, the ‘Persistence’ to ‘Non-Persistent’, and the Name to ‘Blocking Distance’.

16.5.6 Select the Blocking Distance tab.

16.5.7 Change the description of the register to ‘Blocking Distance’.

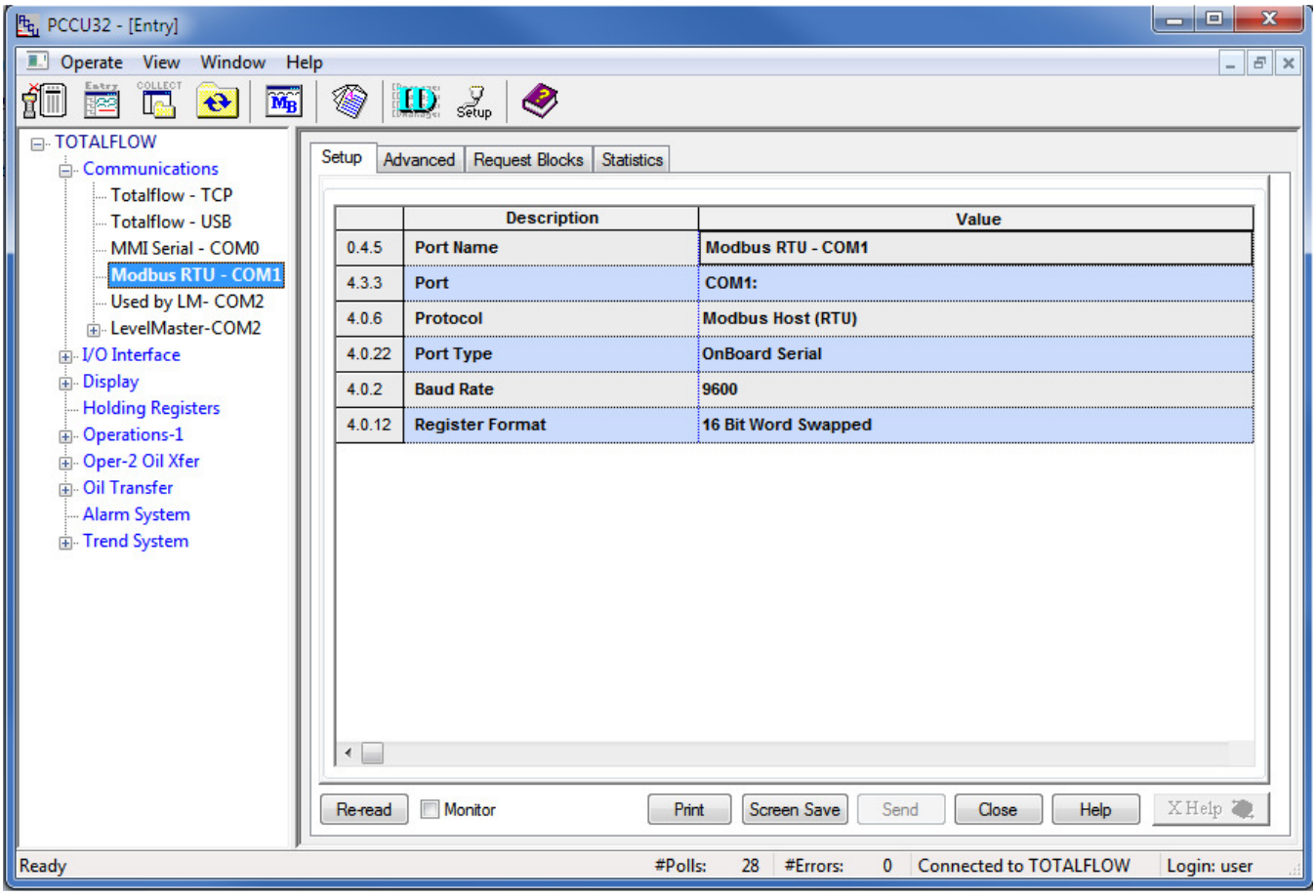


16.5.8 Note the Register number displayed in the first column of the table. It will be used when setting the Request Block in a later step.

16.5.9 Select Communications \ Modbus RTU in the tree-view window.

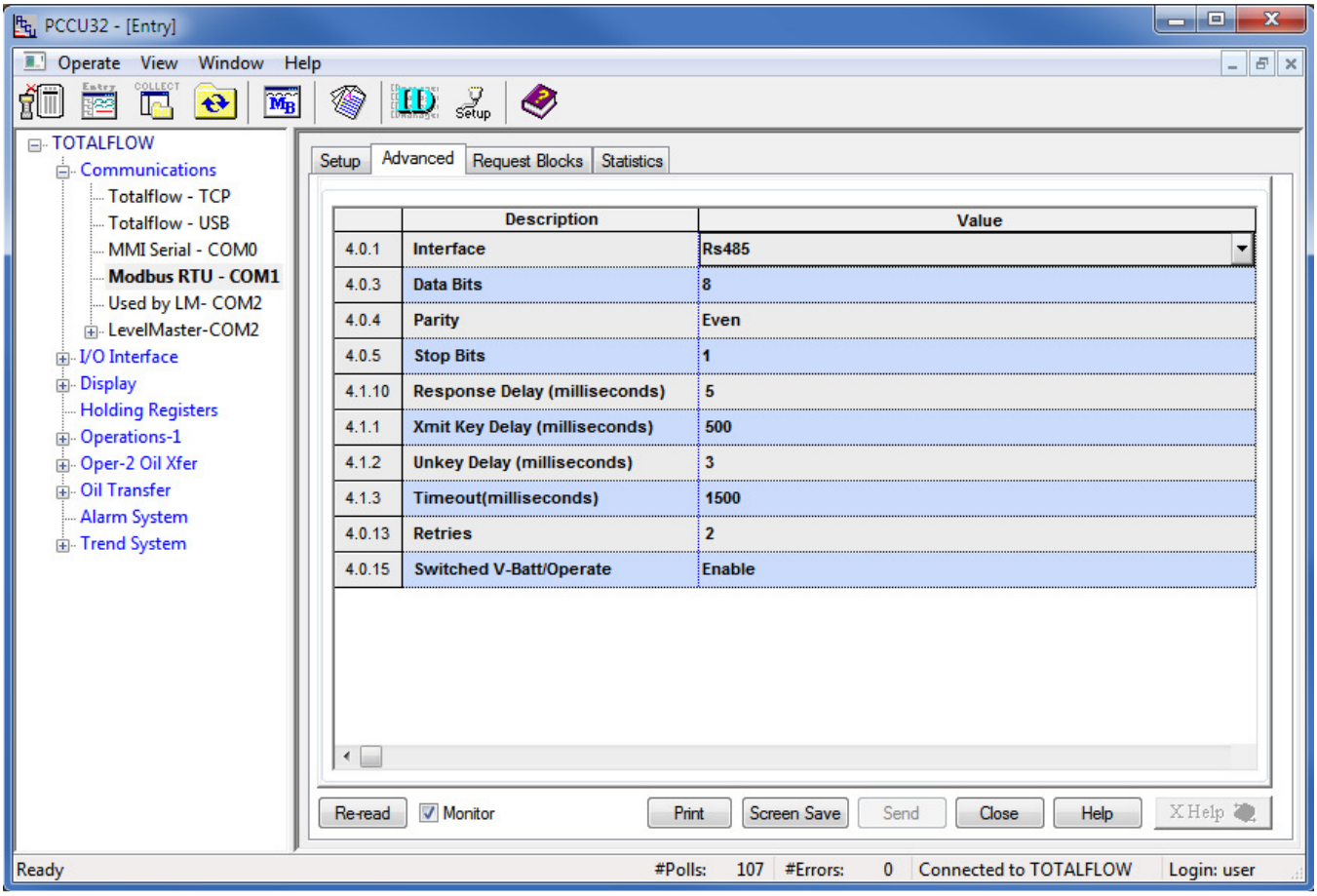
16.5.10 For the Setup tab,

16.5.11 Ensure that the Protocol and Baud Rate match the selections made in step 17.1.1.



16.5.12 For the Advanced tab,

16.5.13 Ensure that the Data Bits, Parity and Stop Bits match the selections made in step 17.1.1.



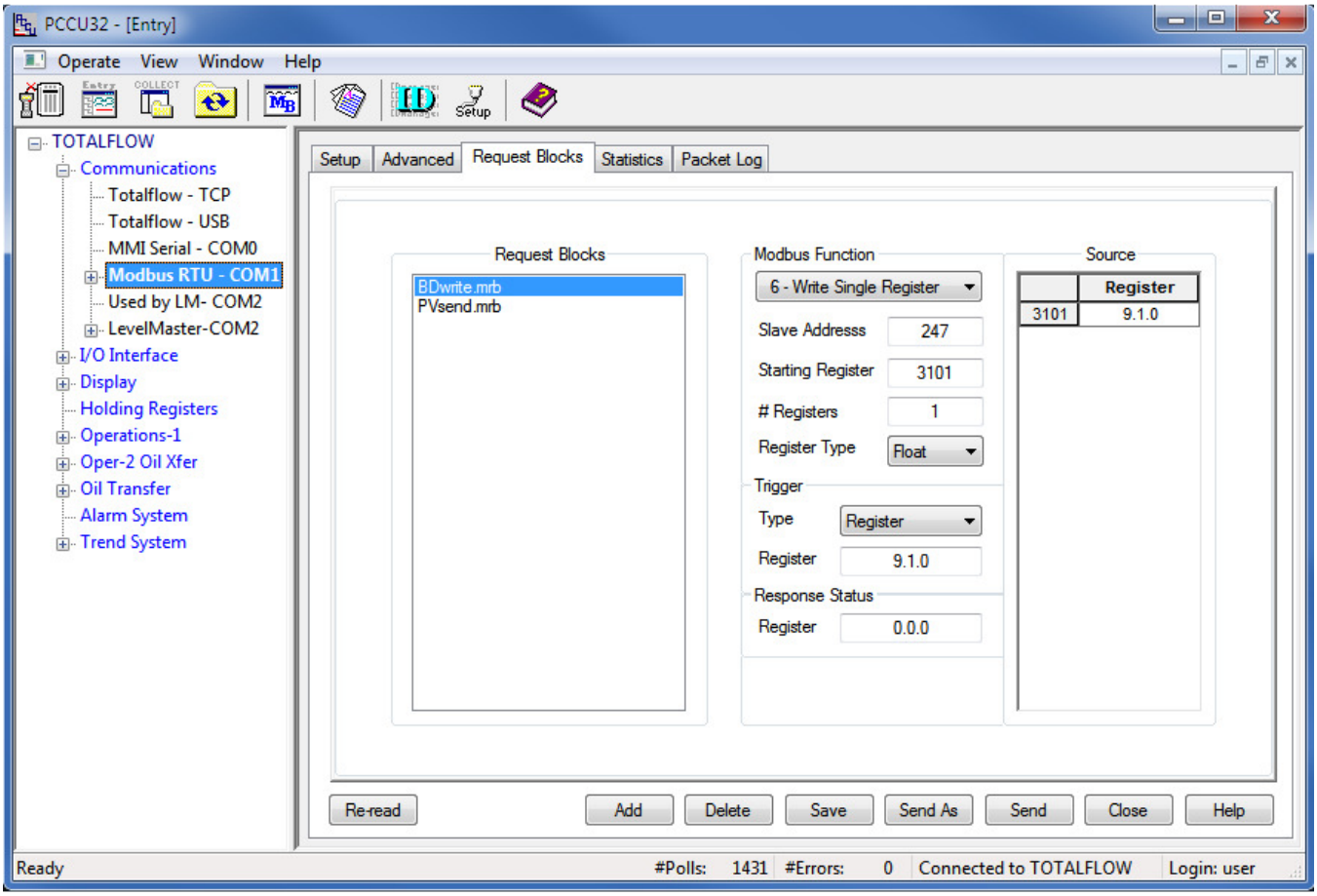
16.5.14 Ensure that the Unkey Delay is less than 7 milliseconds as the HMA typically responds within about 8 milliseconds. If the Unkey Delay time is too long, the XRC will start listening for a response after the HMA has already started transmitting. As a result, the XRC will not recognize the response.

16.5.15 For the Request Blocks tab,

16.5.16 Select '6 – Write Single Register' from the Modbus function drop-down.

16.5.17 Set the Slave Address to match the address of the HMA (if in HMA mode), or an attached device (if in Device mode).

16.5.18 Set the Starting Register to a value 1 greater than the desired starting Modbus register. Refer to Appendices F through S for register numbers of the HMA and attached HART devices.



16.5.19 Set the # Registers to 1. Note that in this case, 1 float value is to be written so that a value of 1 is entered even though the total number of 16-bit Modbus registers that will be read is 2.

16.5.20 Set the Register Type to Float.

16.5.21 Set the Trigger Type to Register and the Register number to the register number from step 17.5.8. This will cause the write to be sent when the assigned register is changed from the Holding Registers menu.

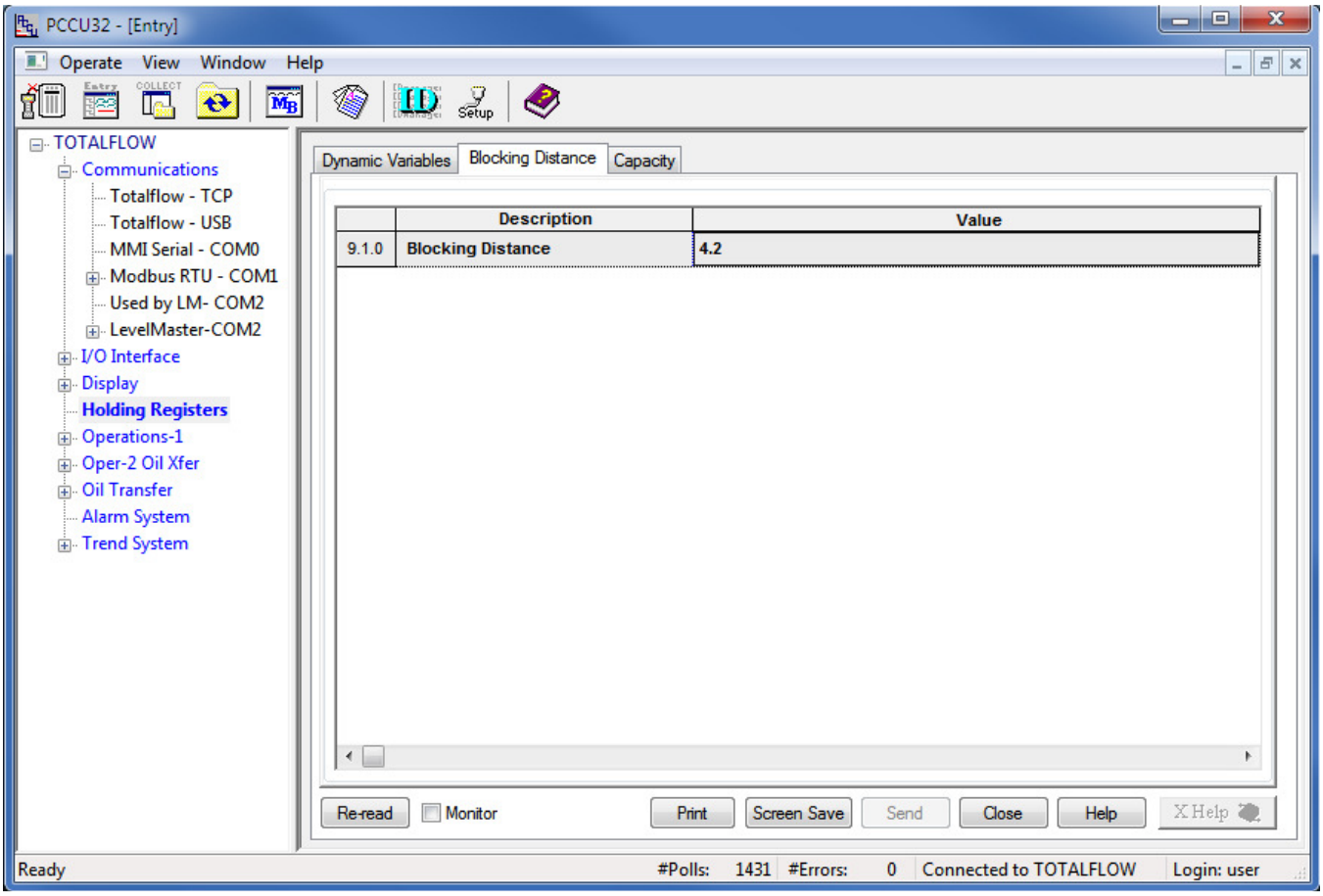
16.5.22 Set the Source to the register number from step 17.5.8.

16.5.23 Select a name for the Request Block if prompted.

16.5.24 Select Holding Registers from the tree-view window of the PCCU32.

16.5.25 Select the Blocking Distance tab.

16.5.26 Change the Value to the desired distance.



16.5.27 Click on Send at the bottom of the window.

16.5.28 To check if the value has been accepted, follow the steps in section 17.4 changing selections as needed to create a request block to read the Blocking Distance parameter from the HMA or attached HART device.

17. ABB Totalflow XRC – LevelMaster

The ABB Totalflow XRC is only capable of sending and receiving command Uxx?. Note that with the LevelMaster protocol, the HMA operates only in the Device mode. Therefore, the ID in the request blocks must be set to the attached HART device's Poll Address rather than that of the HMA. The XRC displays the first float value returned by Command Uxx? as Level 1 (the Upper Level for Magnetrol Devices) and the second float value as Level 2 (typically the Interface Level for Magnetrol devices). Accordingly, it is recommended to configure the attached Magnetrol HART device for PV as Level, and SV as Interface level. The Echo Strength from the attached transmitter is displayed as the Temperature in the tank view diagram of the Communications \ LevelMaster menu in the PCCU application.

17.1. Initial HMA Configuration

17.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for LevelMaster communication with the XRC. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed in order to open the Write Single Register dialog, enter the new value, and then click on Send.

17.2. Physical Connections

17.2.1 Connect the XRC to a computer using USB-A to USB-B cable.

17.2.2 Connect an appropriate power supply to the battery terminal (J16) of the XRC.

17.2.3 Connect the HMA to a 9 – 30 VDC power supply via terminal block TB1.

17.2.4 Connect an RS-485 communications cable between the COM2 terminal block (upper position of J6) of the XRC and the RS-485 terminal block (TB2) of the HMA. The RS485+ terminal of the HMA should be connected to the BUS+ of the TotalFlow terminal block. The – terminals should be connected correspondingly. See section 18.3.14.

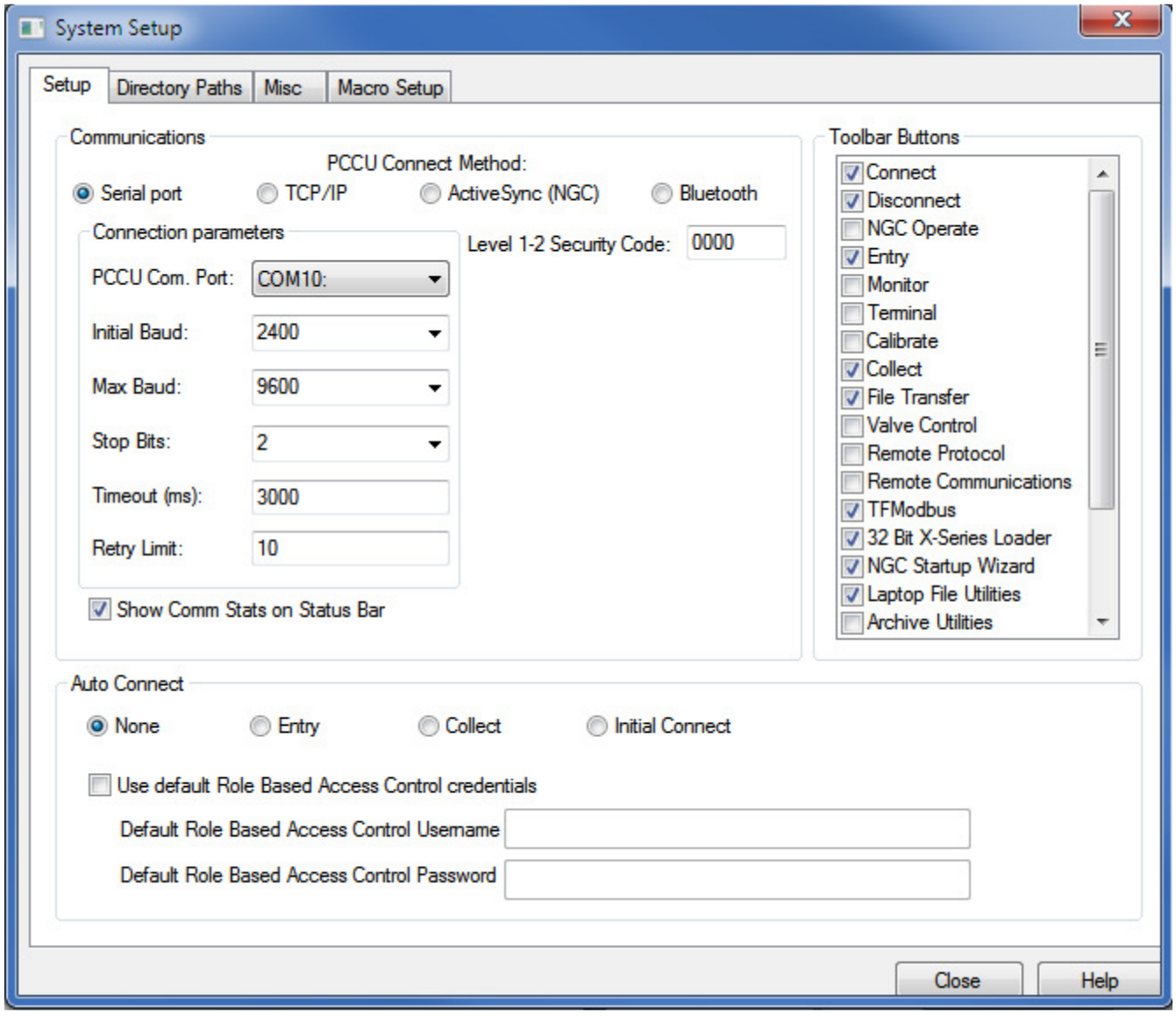
17.2.5 Ensure that the appropriate communication module is inserted into the Comm 2 receptacle (XA2).

17.2.6 Connect a 120Ω resistor between the two RS-485 terminal block positions of the last HMA on the bus.

17.3. **Initial XRC Configuration**

17.3.1 Start the PCCU32 application.

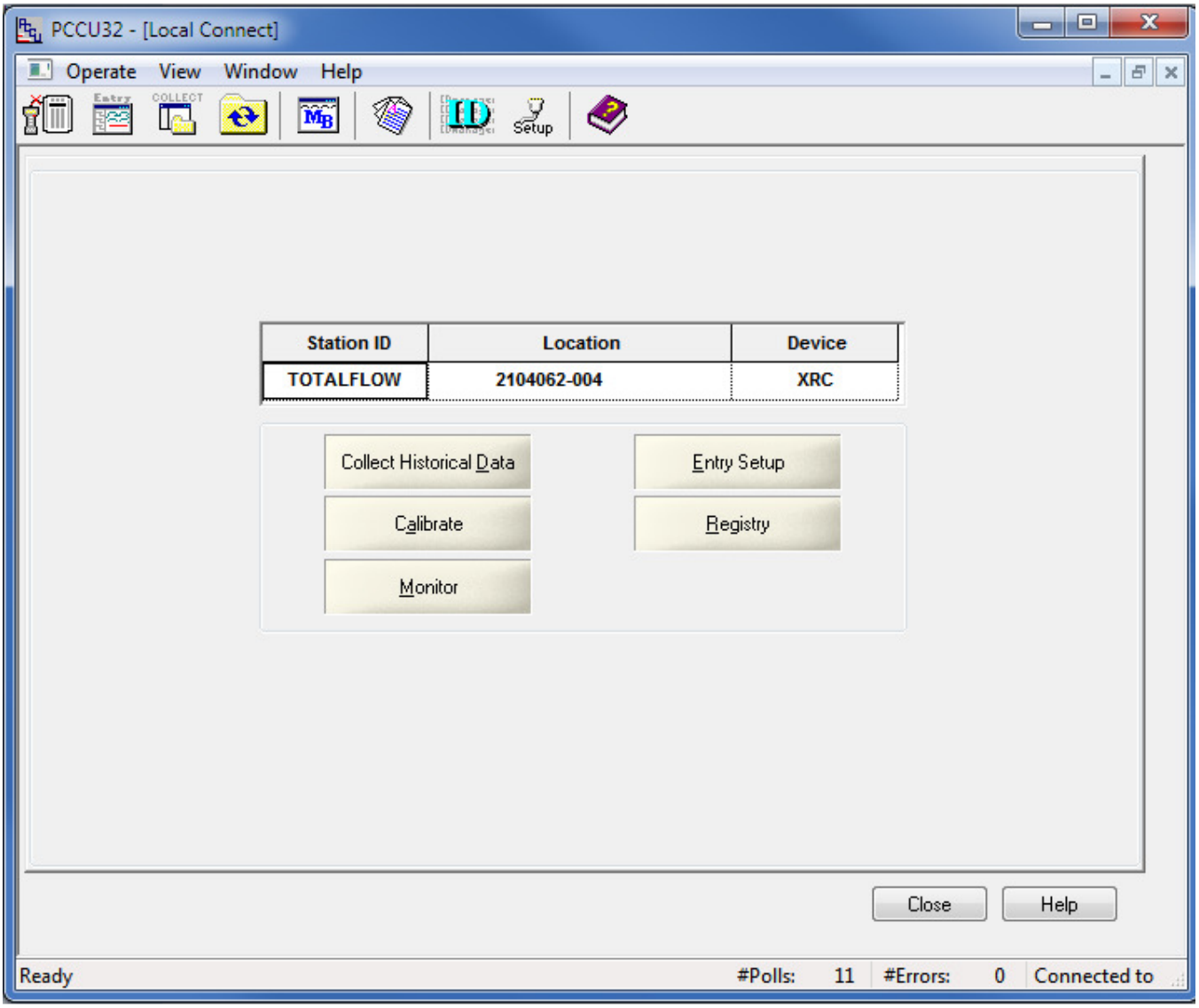
17.3.2 Select on Operate \ Setup \ System Setup in the PCCU32 Menu bar. A dialog will appear allowing for communication settings between the PCCU32 application and the XRC.



17.3.3 Select the COM port number corresponding to the XRC. The proper COM port number can be identified by navigating to the Device Manager in Windows and expanding the Ports entry.

17.3.4 Click Close.

17.3.5 Select on Operate \ Connect to Totalflow in the PCCU32 Menu bar.



17.3.6 Select Entry Setup from the Local Connect initial dialog.

17.3.7 Select View \ Advanced from the PCCU32 menu bar.

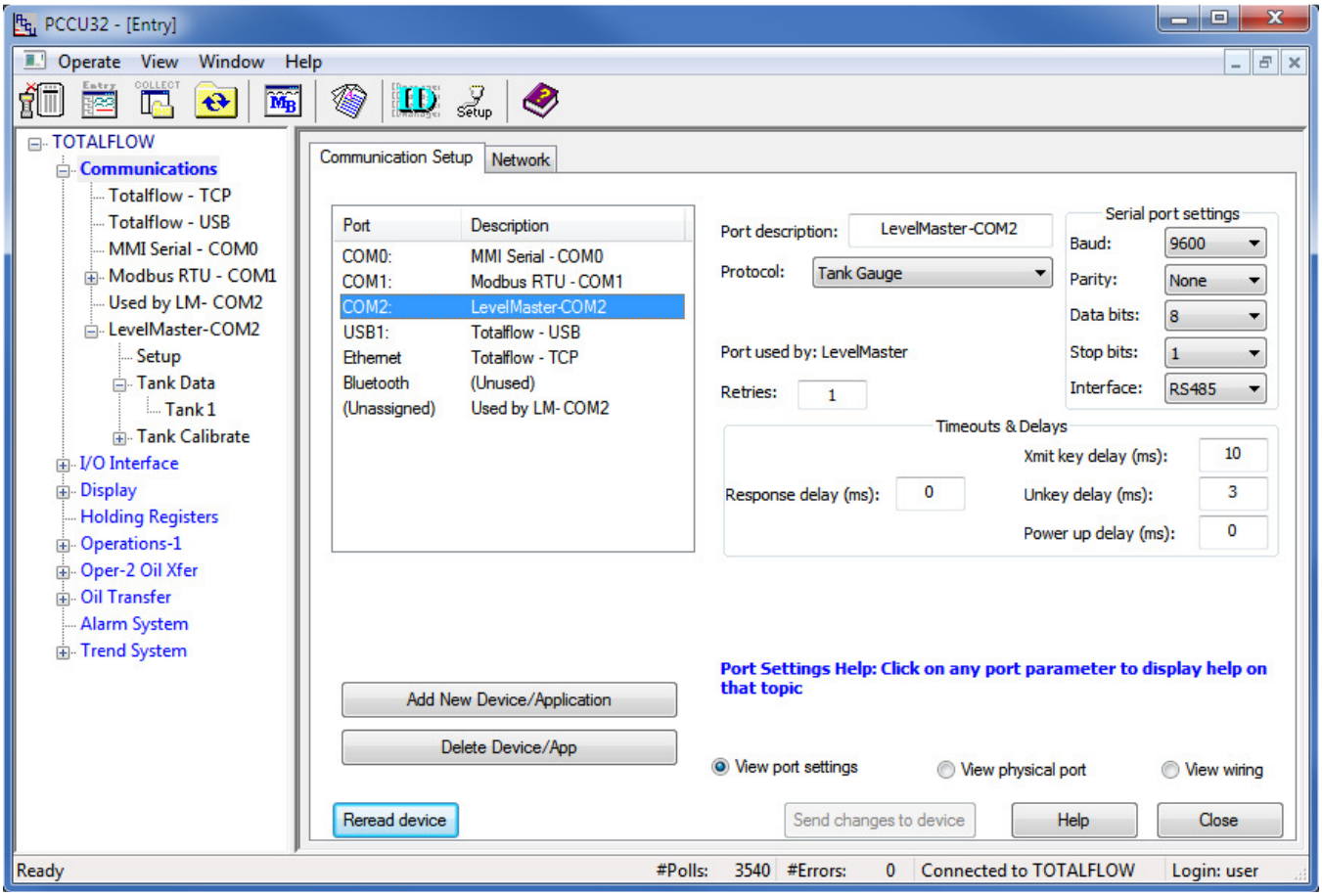
17.3.8 Click on Communications in the tree-view window.

17.3.9 Click on the Port name associated with Modbus RTU.

17.3.10 Select 'Tank Gauge' for the Protocol.

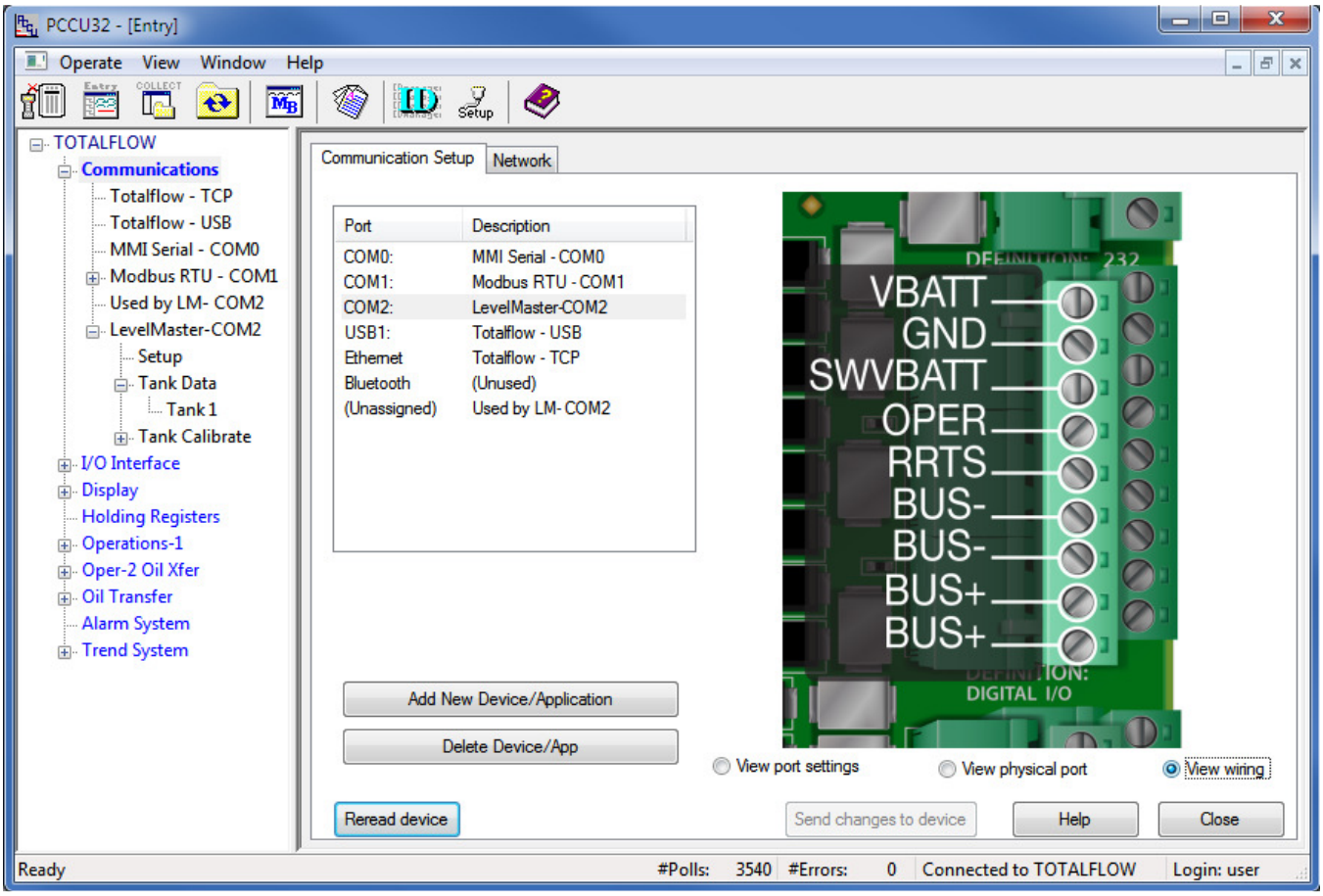
17.3.11 Set the Unkey delay to 3 ms.

17.3.12 Ensure that the communications settings match the settings of the HMA performed in step 18.1.1. For example,



17.3.13 Click on 'Send changes to device' after all settings are changed and verified.

17.3.14 The terminal block connections on the XRC can be verified by clicking on the View Wiring radio button. Note that the RS485+ terminal of the HMA should be connected to the CTS/BUS+ position of the TotalFlow terminal block. The – terminals should be connected to the DCD/BUS- position of the TotalFlow terminal block.



17.4. **Reading registers from the HMA**

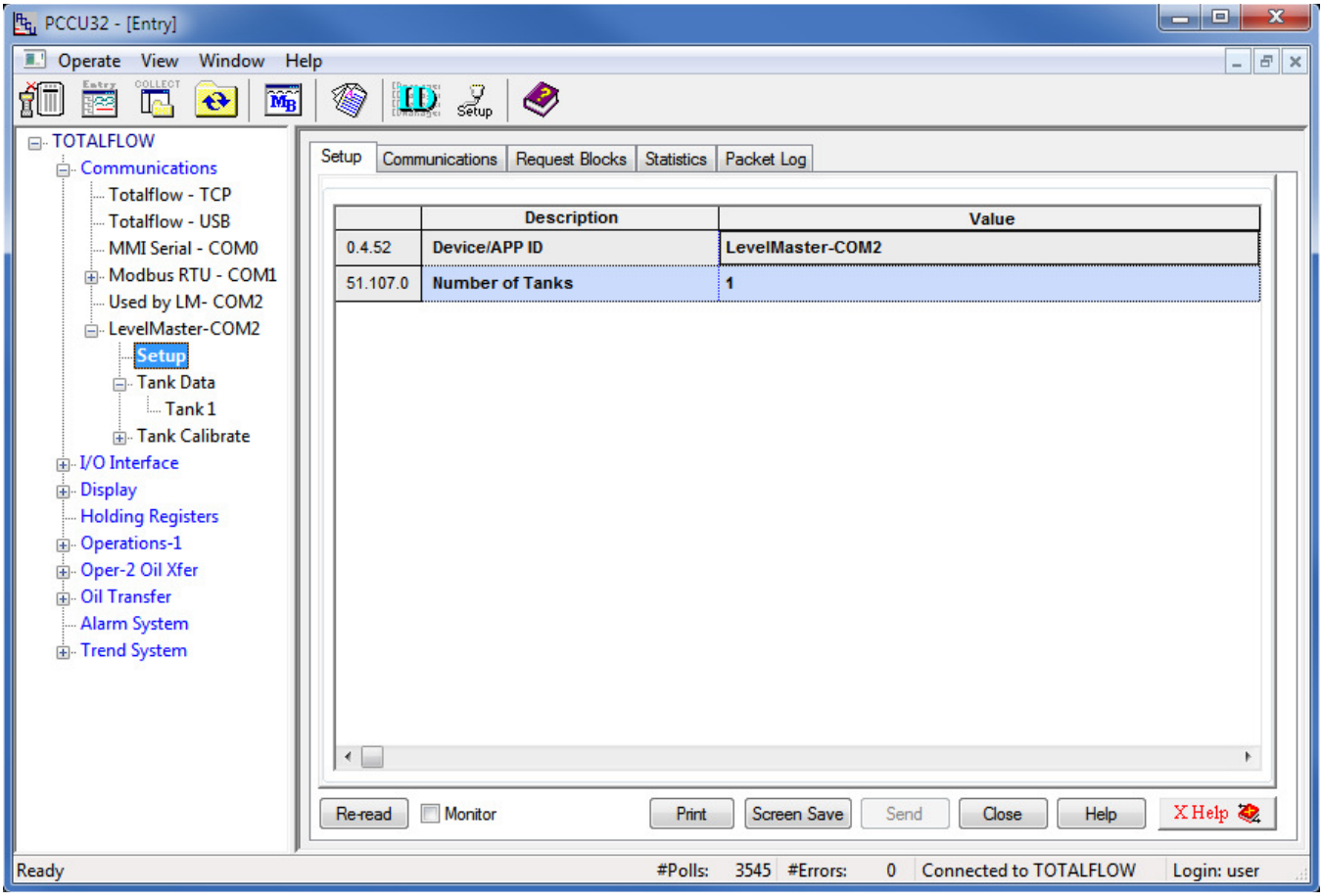
17.4.1 The followings steps demonstrate how to read the PV, SV, Echo Strength, Errors and Warnings from a HART device attached to the HMA. When making any changes to the settings, click on Send at the bottom of the window to write them to the XRC.

17.4.2 Select Communications \ LevelMaster \ Setup in the tree-view window of the PCCU32.

17.4.3 For the Setup tab,

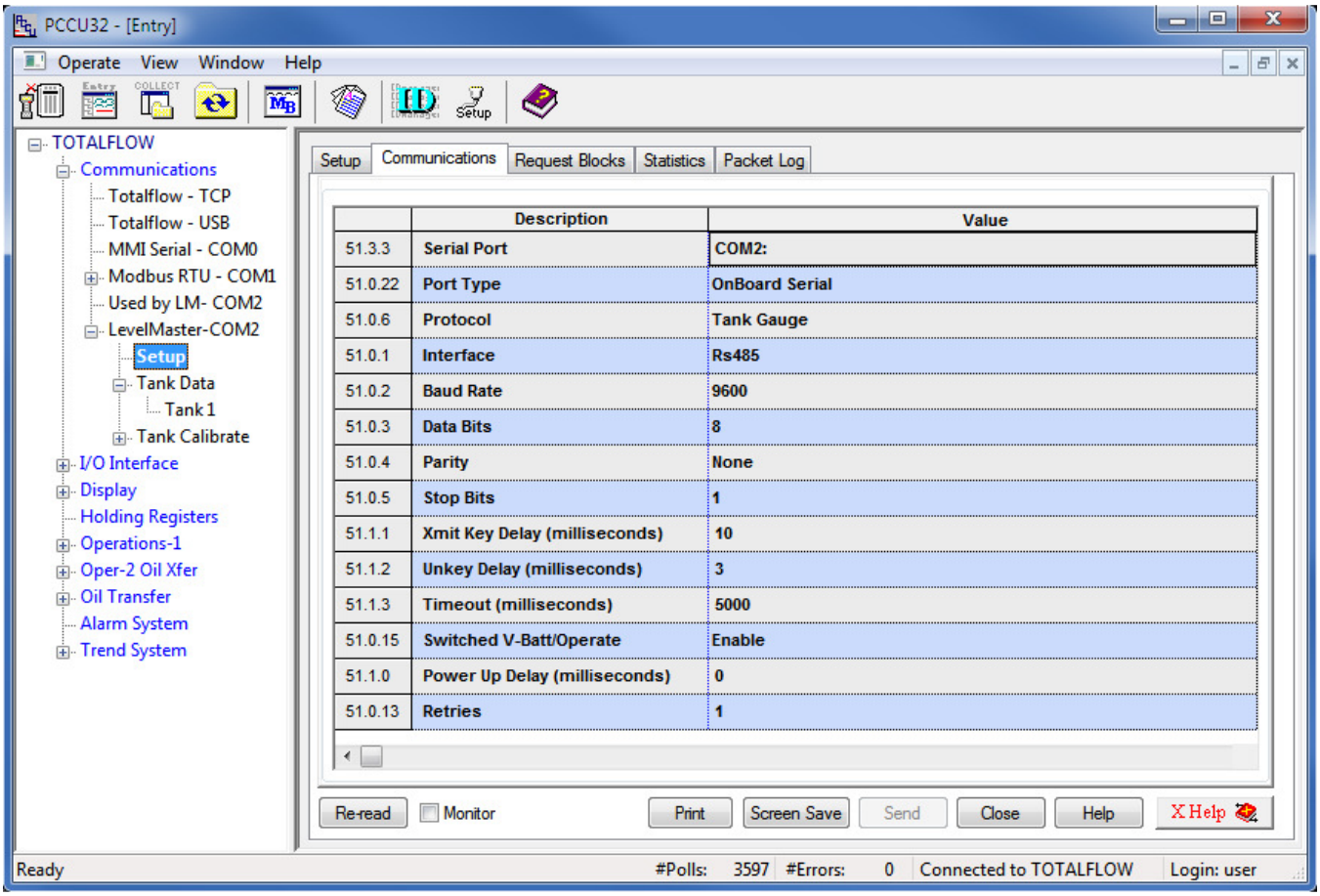
17.4.4 Set the Number of Tanks to the number of attached HART devices to be read.

17.4.5 Click on 'Send'.



17.4.6 For the Communications tab,

17.4.7 Ensure that the communication settings match the selections made in steps 18.1.1 and 18.3.12.

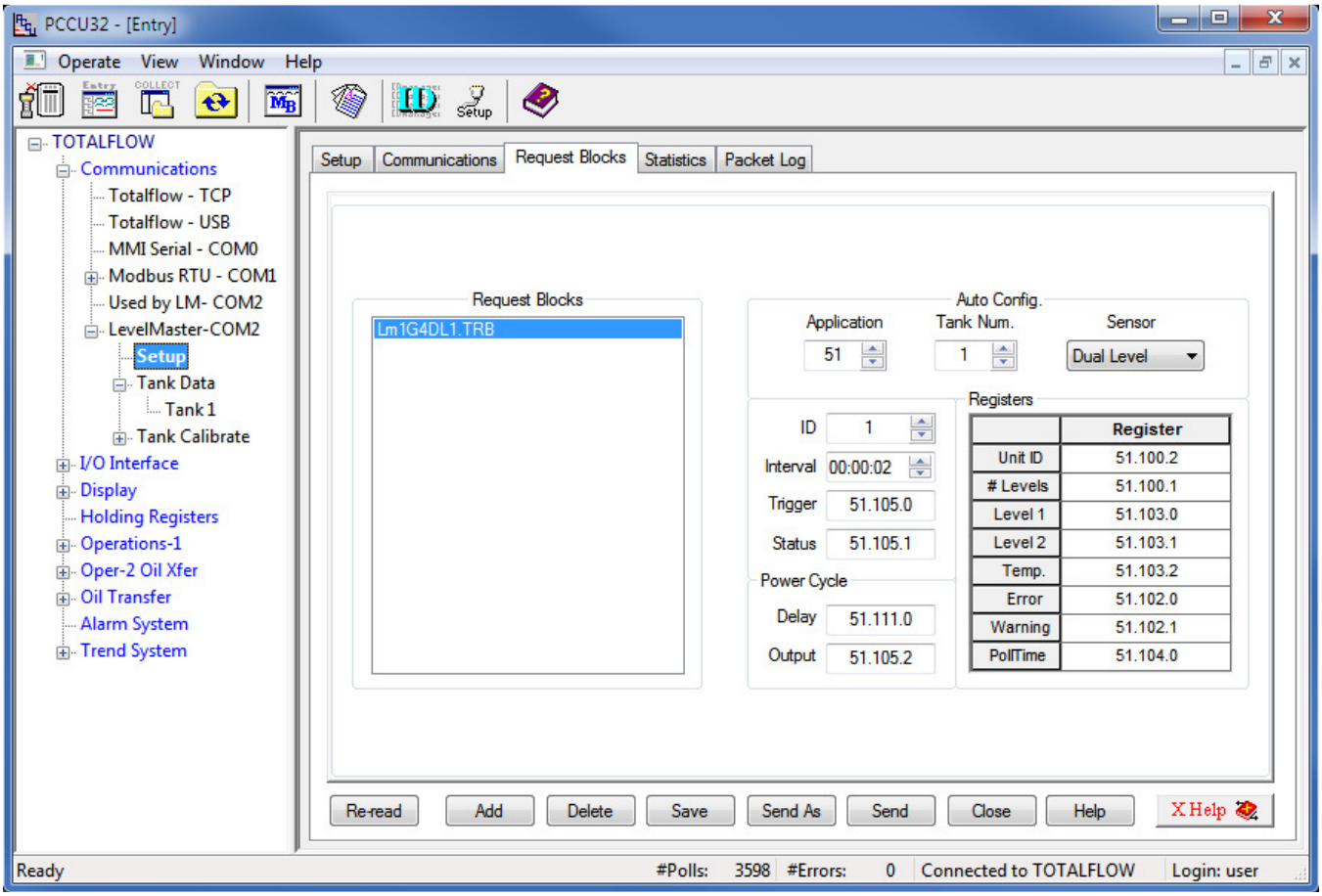


17.4.8 For the Request Blocks tab,

17.4.9 In the Auto Config group menu, set the Application to 51, the Tank Num. to the appropriate value for the attached HART device, and the Sensor to 'Dual Level'. The HMA always returns a Dual Level response to Command Uxx? to provide data for the SV output of the attached HART device.

17.4.10 In the Registers group menu, set the ID to the Poll Address of the attached HART device to be read for that Tank Num. (Note that due to limitations of the LevelMaster protocol, the HMA only operates in the Device mode for that protocol.)

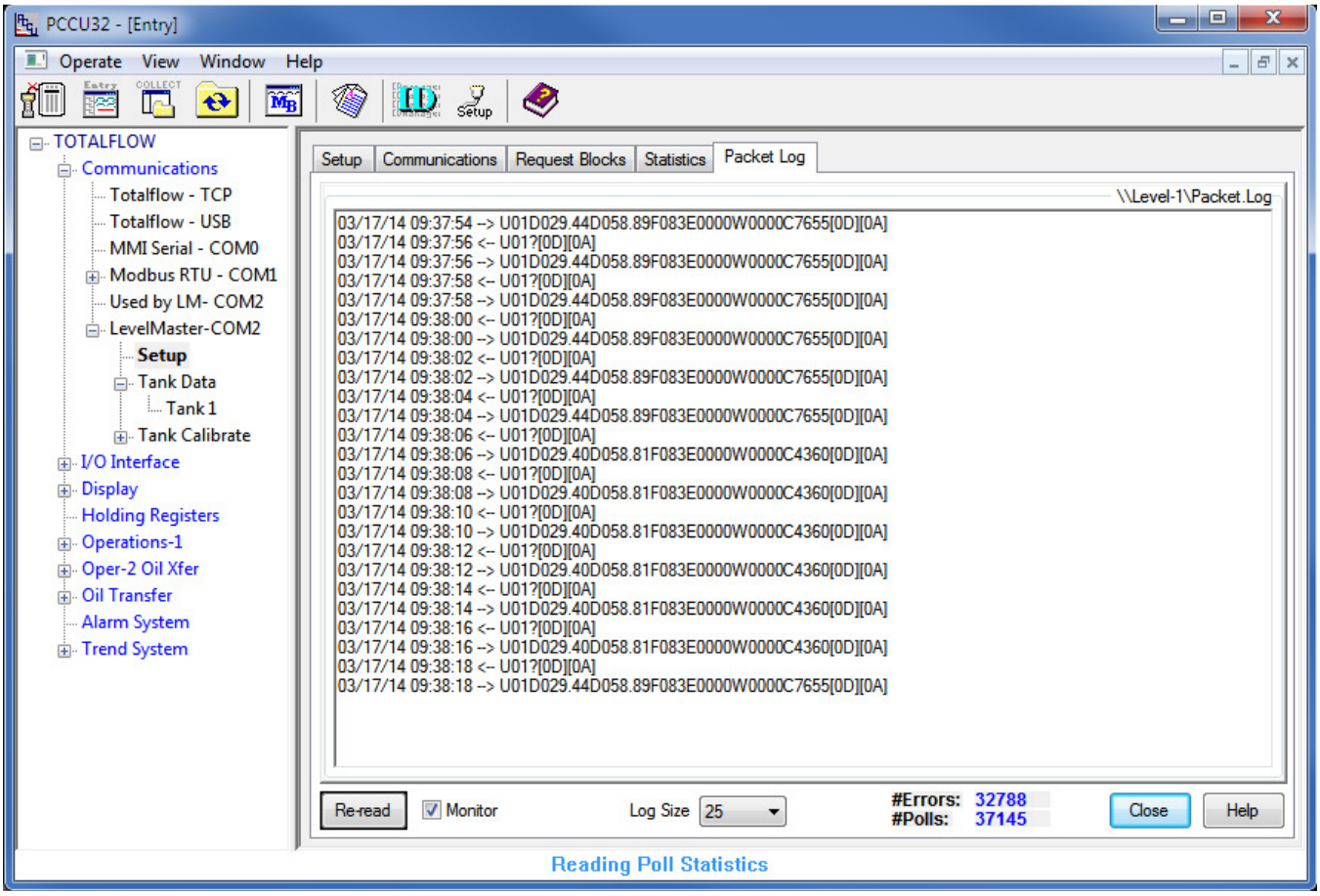
17.4.11 Click on 'Send'.



17.4.12 To check if transmissions and responses are being made, select View \ Expert from the PCCU32 Menu bar. This mode displays a Packet Log tab when selecting Communications \ Modbus RTU from the tree-view window.

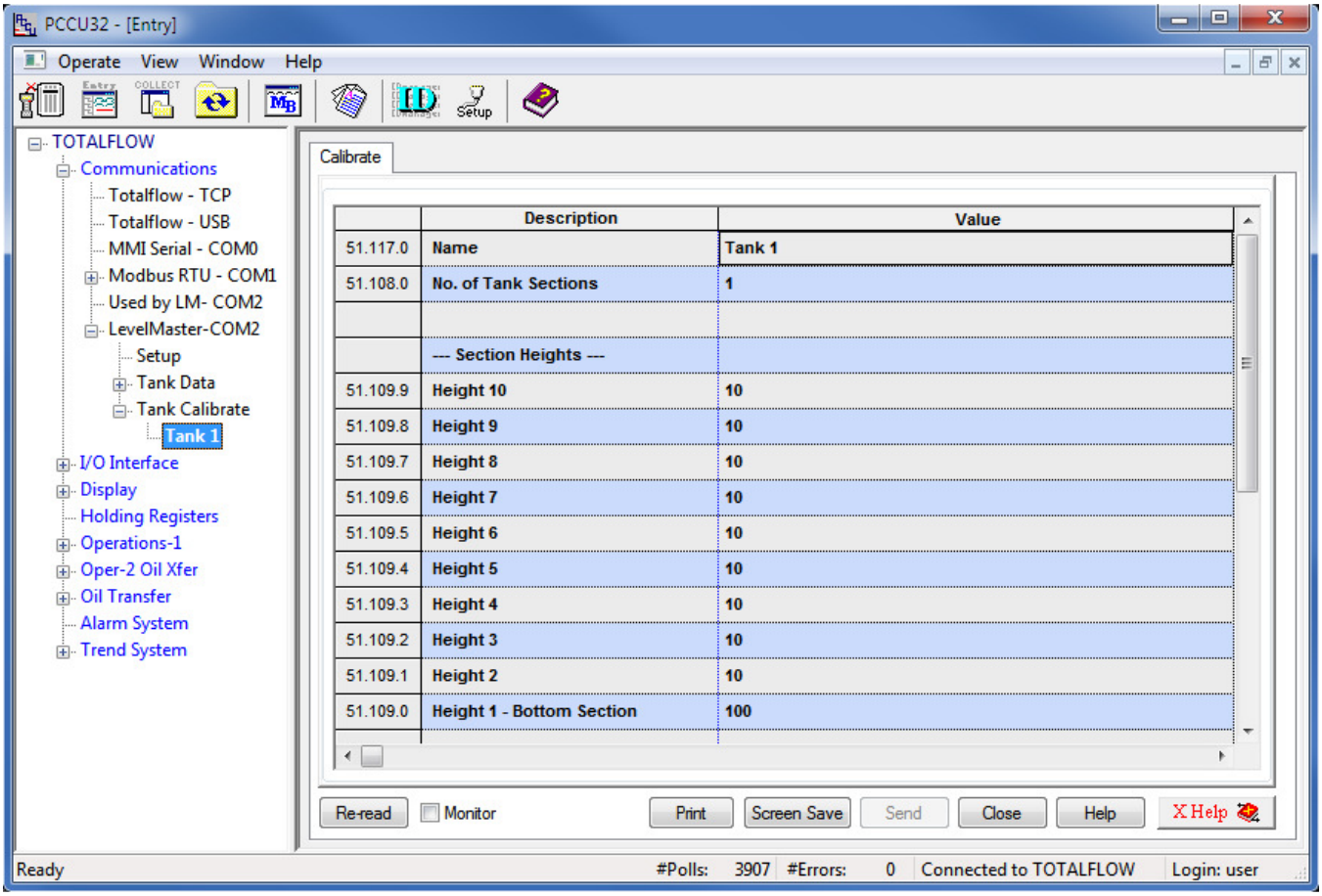
17.4.13 Set the Log Size to 25 and check the Monitor checkbox. The log should start updating with the XRC commands being sent out and the responses from the HMA.

17.4.14 Right-click in the clear area between the Monitor checkbox and the Log Size drop-down. Select a shorter interval screen refresh interval if desired.



17.4.15 To display the values,

17.4.16 Select Communications \ LevelMaster \ Tank Calibrate \ Tank x from the tree-view window of the PCCU32.

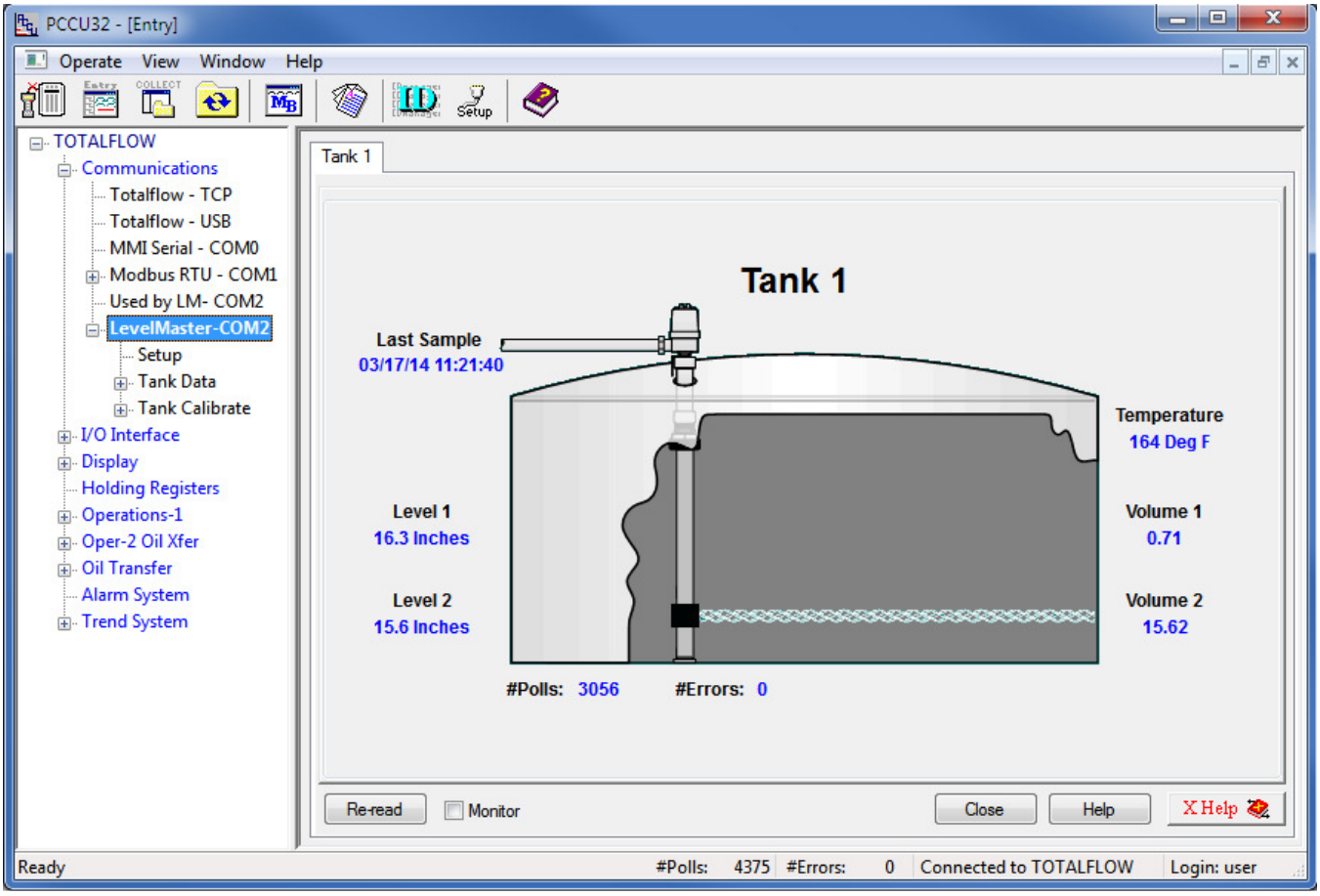


17.4.17 Set the number of Tank Sections in row 51.108.x.

17.4.18 For each tank section, set the height of that section in rows 51.109.x

17.4.19 For each tank section, enter the Factor in rows 51.110.x. The Factor value is the number of barrels per ¼ inch of height in that section. By clicking on the Help button of the PCCU32 and searching for 'tank calibration', a more detailed explanation of the calibration process can be obtained.

17.4.20 Select Communications \ LevelMaster from the tree-view window of the PCCU32.



17.4.21 Click on Re-read to obtain a single set of readings from the HMA, or check the Monitor checkbox to repeatedly read values from the HMA at the Interval specified in the Request Blocks tabs in step 18.4.9.

17.4.22 In the example above, the attached device has the Measurement Type set to Interface, the PV set to the Level reading and SV set to the Interface Level reading. The Upper Level reading from the device (PV is sent as Float 1 of Command Uxx?) is displayed as Level 1. The Interface Level reading from the device is displayed as Level 2. The Echo Strength from the device is displayed as the Temperature. The Volume 1 value is computed from the difference between the Level 1 and Level 2 readings. The Volume 2 value is computed from the Level 2 reading. The level to volume conversion is determined by the settings made in steps 18.4.15 through 18.4.19.

17.4.23 If the Measurement Type of the device is set to Level, the Level 1 and Level 2 readings will be the same, Volume 1 will always be 0 and Volume 2 will represent the total volume.

17.4.24 Any Errors or Warnings from the attached HART device will appear under the bottom right section of the tank image.

17.5. **Writing registers to the HMA**

The ABB Totalflow XRC has no provisions for sending commands to LevelMaster devices other than the Uxx? command. Therefore, it is not possible to write registers in the attached HART devices.

18. ThermoScientific AutoPILOT PRO – Modbus RTU / ASCII

The following procedure applies to operation with both RTU and ASCII communication. The choice of communication protocol is made in step 19.1.1 for the HMA settings, and step 19.4.5. The Modbus RTU protocol is used for the following.

18.1. Initial HMA Configuration

18.1.1 Using Procedure 1, ensure that registers 3000 through 3007 of the HMA match the values shown for RTU communication with the AutoPILOT PRO. Refer to Appendix F for the HMA Communication settings. If the settings do not match, double-click on a value that needs to be changed to open the Write Single Register dialog, enter the new value, and then click on Send.

18.2. Physical Connections

18.2.1 Connect the AutoPILOT PRO to a computer using a CHIT computer connection cable (ThermoScientific p/n 3-0446-090).

18.2.2 Connect an appropriate 12 VDC power supply to the terminals of TB-1 on the inside of the AutoPILOT PRO front panel.

18.2.3 Connect an RS-485 communications cable between the terminals of TB-16 of the AutoPILOT PRO and the RS-485 terminal block (TB2) of the HMA. The '+' terminal of the HMA should be connected to the TX+ terminal of TB-16. The '-' terminal of the HMA should be connected to the TX- terminal of TB-16.

18.2.4 On the main board of the AutoPILOT PRO, add a jumper to pins 15-16 of J39 to select 2-wire mode.

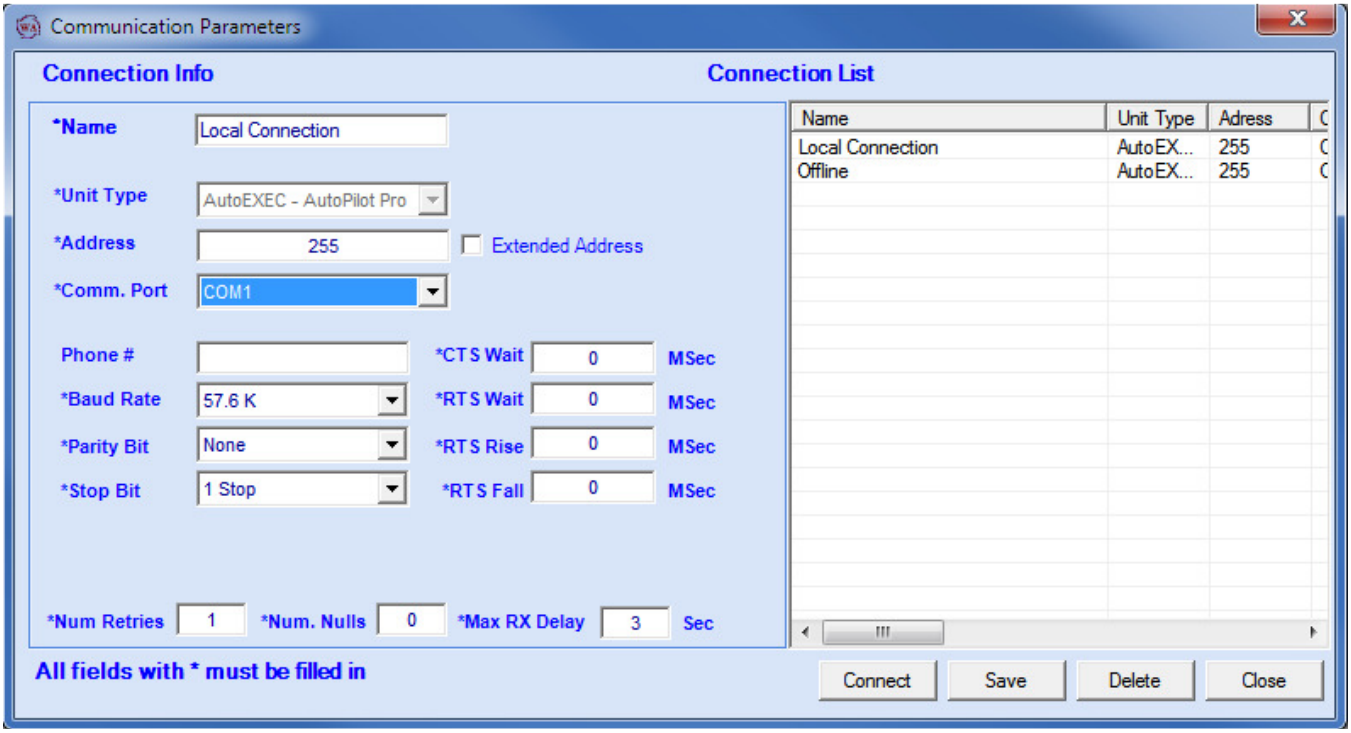
18.2.5 On the main board of the AutoPILOT PRO, add a jumper to J40 to select RS-485 mode.

18.2.6 Connect a 120Ω resistor between the two RS-485 terminal block (TB2) positions of the last HMA on the bus.

18.3. **Initial AutoPILOT PRO Configuration**

18.3.1 Start the AutoCONFIG application.

18.3.2 A dialog will appear allowing for communication settings between the AutoCONFIG application and the AutoPILOT PRO. This example uses 'Local Connection' as the connection profile name.



18.3.3 Select the COM port number corresponding to the CHIT cable.

18.3.4 Ensure that the other communication settings are set as desired. Note: The settings displayed above have been found to result in successful connection to the AutoPILOT PRO.

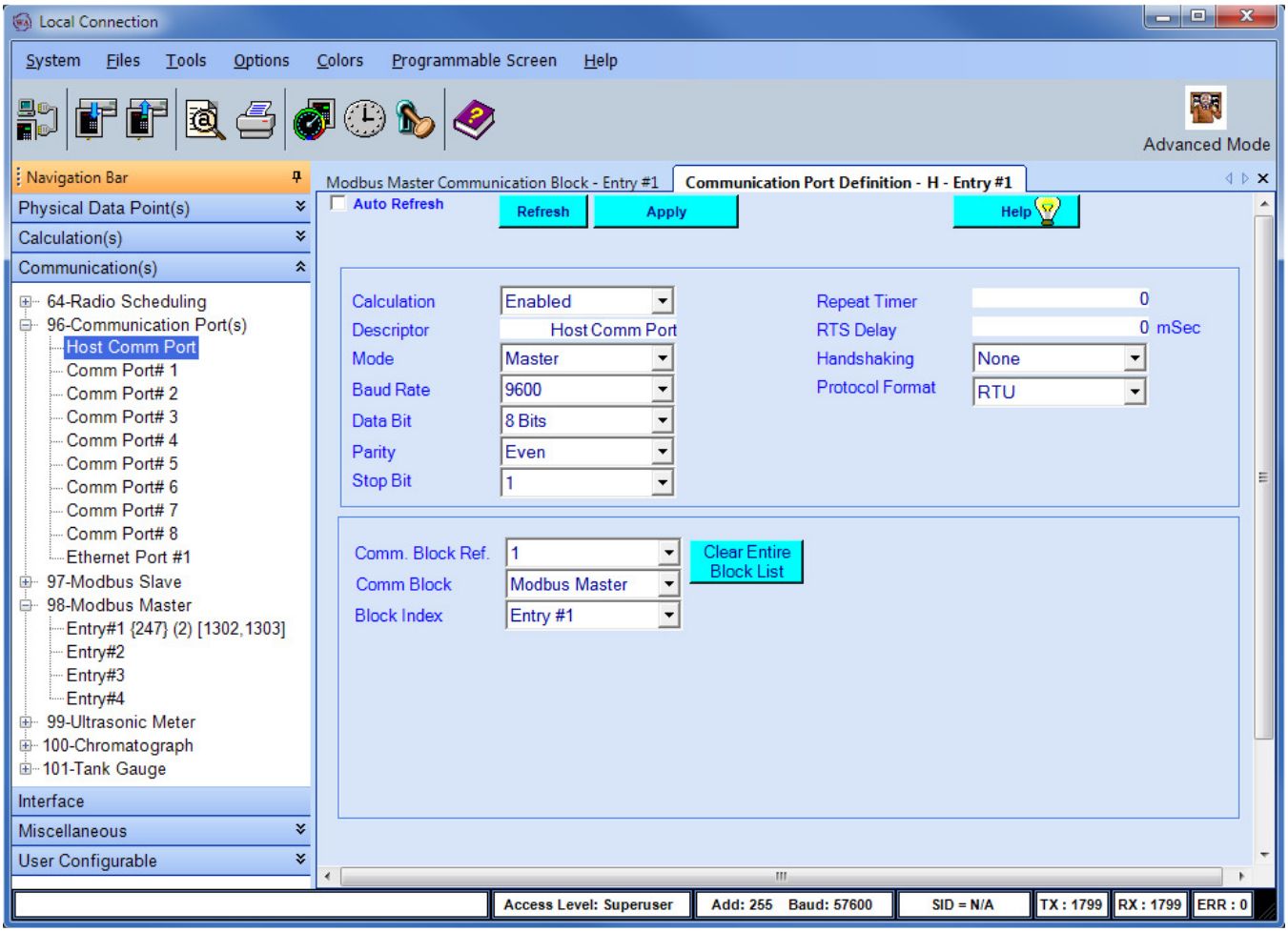
18.3.5 If any changes to the settings have been made, click on Save.

18.3.6 Click on Connect to establish communication with the AutoPILOT PRO.

18.4. **Reading registers from the HMA**

18.4.1 The followings steps demonstrate how to read the PV, SV, TV and QV from a HART device attached to the HMA. When making any changes to the settings, click on Apply at the top of the window to write them to the AutoPILOT PRO.

18.4.2 In the Navigation Bar, click on Communication(s), expand the 96-Communication Port(s) item, and then double-click on Host Comm Port.



18.4.3 Set Calculation to Enabled.

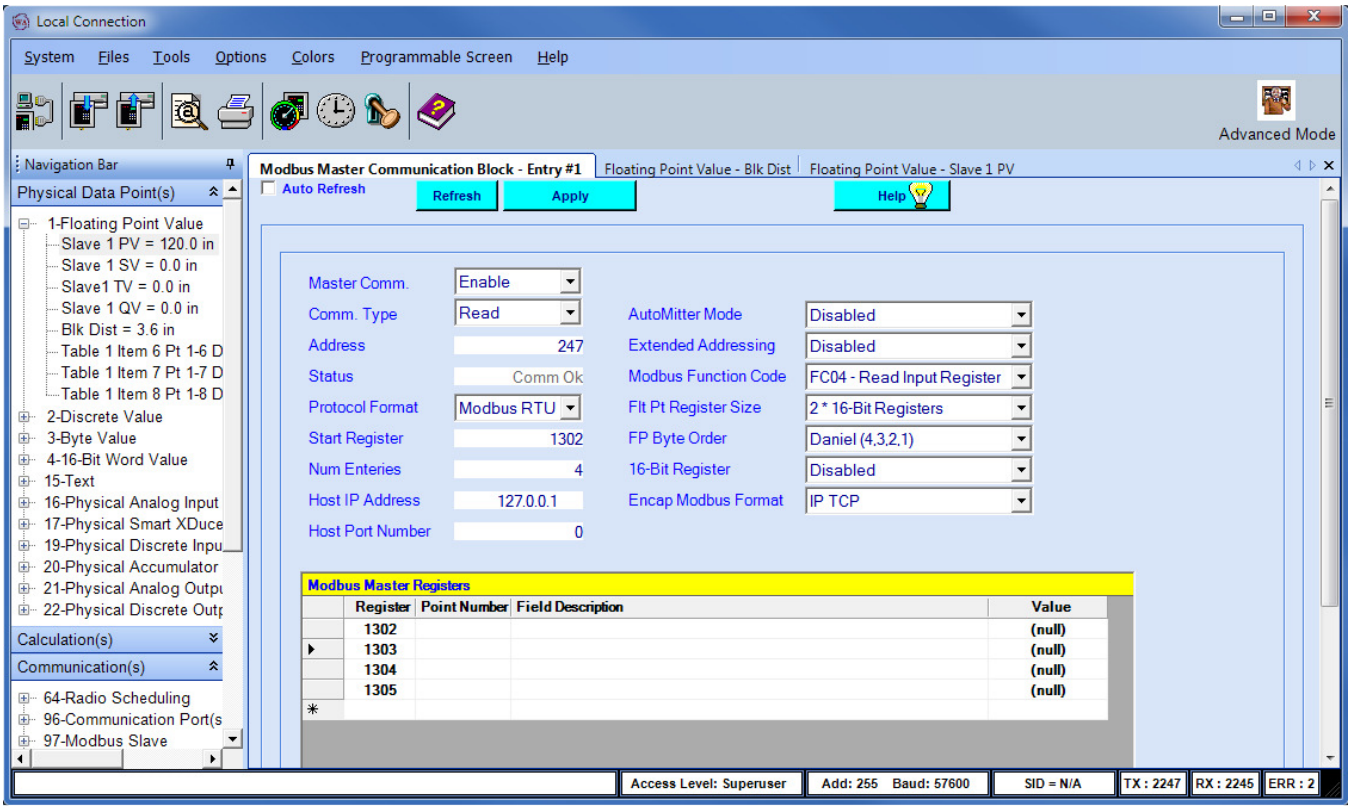
18.4.4 Set the Repeat Timer to the desired sampling interval in seconds.

18.4.5 Ensure that the communication settings match the selections made in step 19.1.1.

18.4.6 Set the Comm. Block Ref to 1, the Comm Block to Modbus Master, and the Block Index to Entry #1.

18.4.7 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.8 In the Navigation Bar, click on Communication(s), expand the 98-Modbus Master item, and then double-click on Entry#1.



18.4.9 Set Master Comm. to Enable.

18.4.10 Set Comm. Type to Read.

18.4.11 Set the Address to the Modbus address of the HMA.

18.4.12 Set the Start Register to 1302 (the start of the PV register for Slave 1 in the HMA).

18.4.13 Set the Num Entries to 4 (four 32-bit floating point numbers).

18.4.14 The Host IP Address, Host Port Number, AutoMitter Mode, Extended Addressing and Encap Modbus Format can be ignored.

18.4.15 Set the Modbus Function Code to FC04 - Read Input Register.

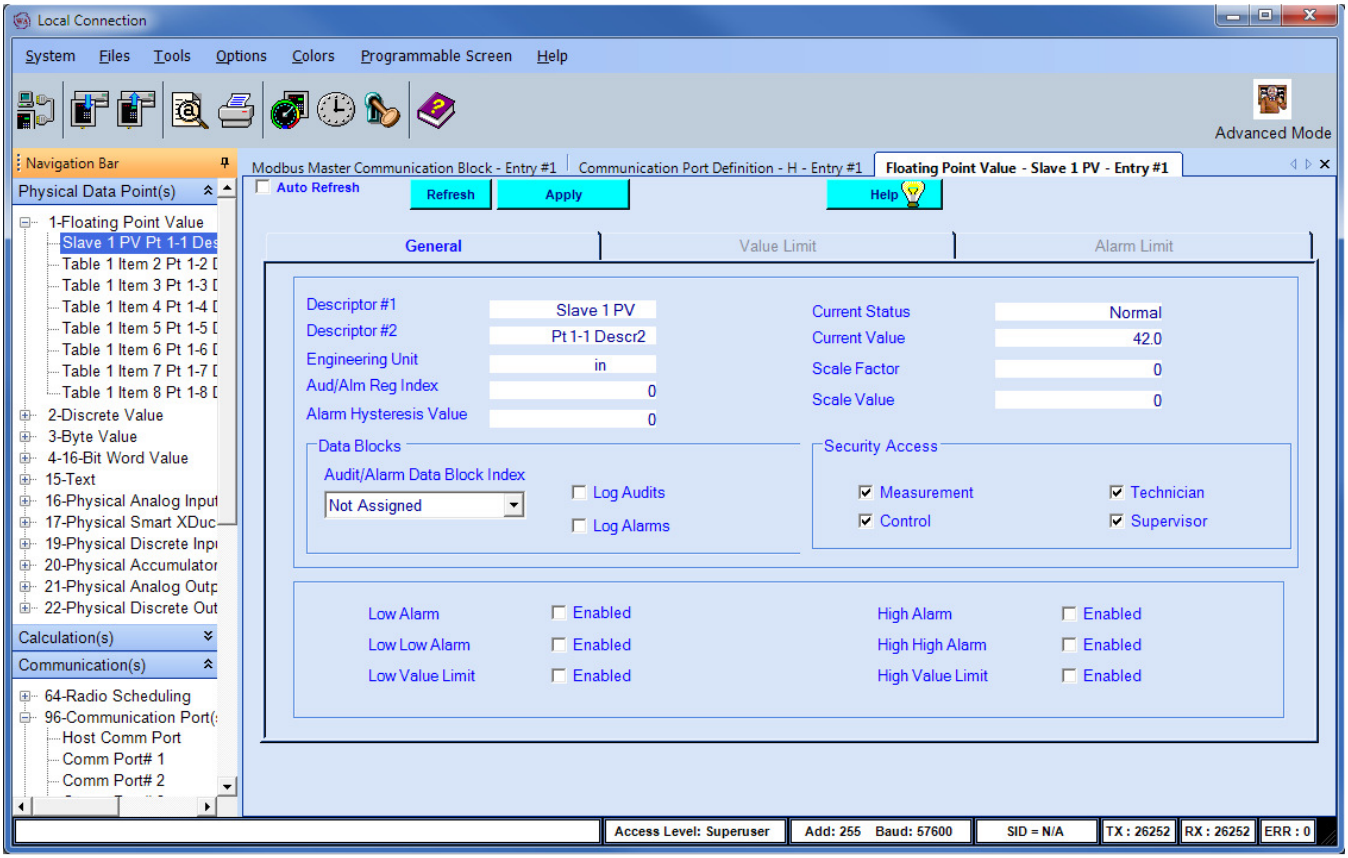
18.4.16 Set the Flt Pt Register Size to 2 * 16-Bit register, and the FP Byte Order to Daniel (4,3,2,1).

18.4.17 Set the 16-Bit Register to Disabled.

18.4.18 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.19 In the Navigation Bar, click on Physical Data Point(s), and expand the 1-Floating Point Value item.

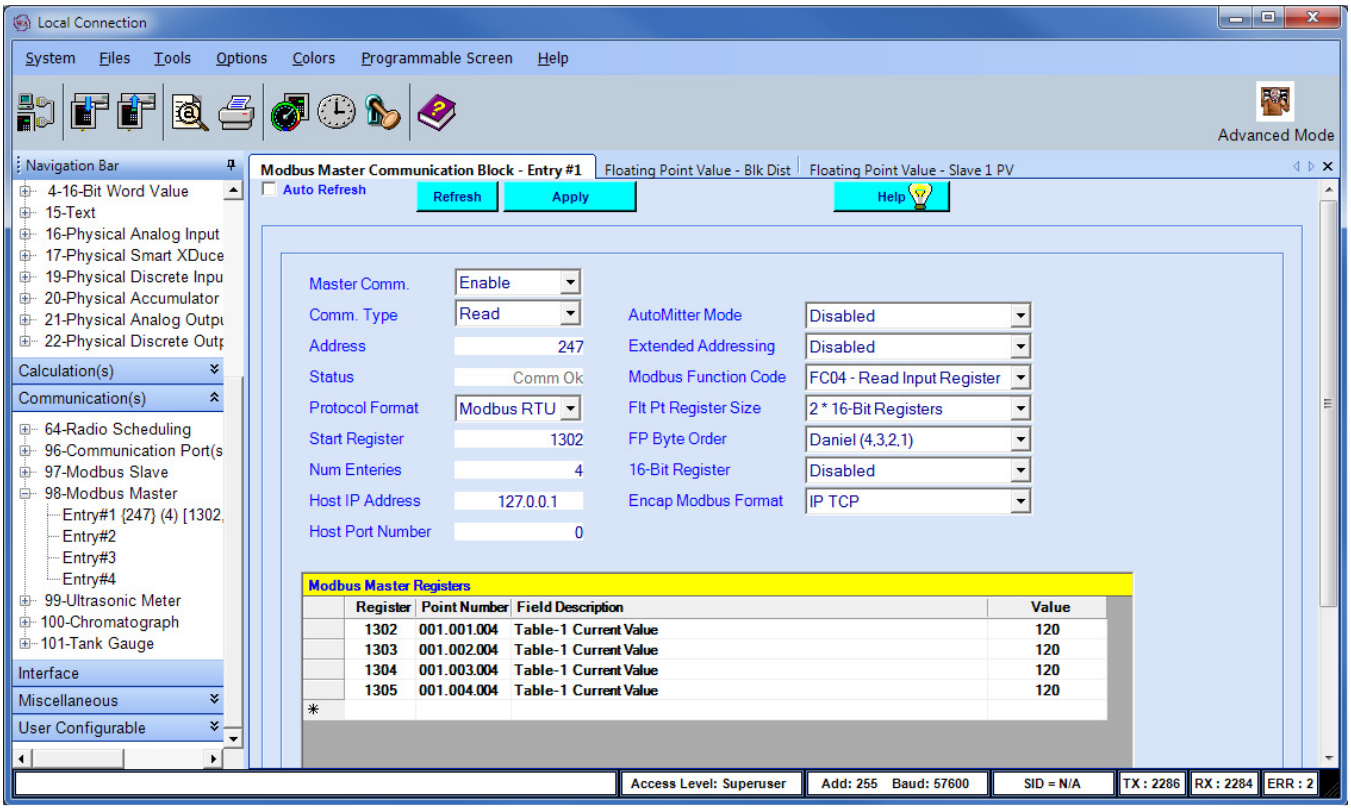
18.4.20 Double click on the Table 1 Item 1 entry, change Descriptor #1 to 'PV', and Engineering Unit to correspond to the level units in use by the HART transmitter to be read.



18.4.21 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.22 Right click on the Slave 1 PV entry in the Navigation Bar and select Copy.

18.4.23 Double click on the Entry #1 listing in the Communication(s) \ 98-Modbus Master section of the Navigation Bar.



18.4.24 Right click on the Register number 1302 cell and select Paste.

18.4.25 To set up the SV, TV and QV readings, repeat steps 19.4.19 through 19.4.24 using Table 1 items 2 to 4. Paste the SV into address 1304, TV into address 1306 and QV into address 1308.

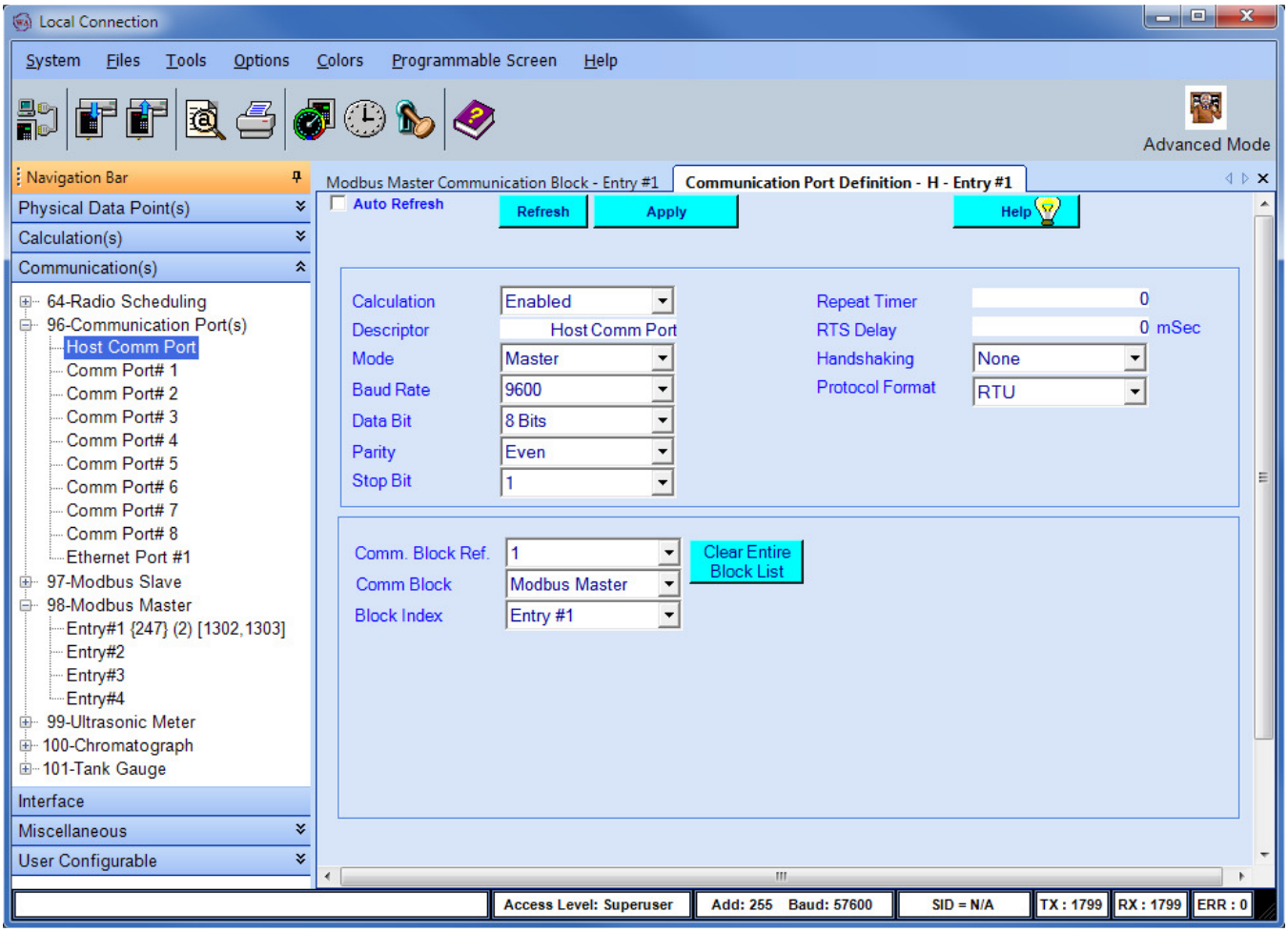
18.4.26 Click on Apply to send the settings to the AutoPILOT PRO.

18.4.27 Check on Auto Refresh to start the AutoPILOT PRO to repeatedly read the values from the device.

18.5. **Writing registers to the HMA**

18.5.1 The followings steps demonstrate how to write the Blocking Distance to a HART device attached to the HMA. When making any changes to the settings, click on Apply at the top of the window to write them to the AutoPILOT PRO.

18.5.2 In the Navigation Bar, click on Communication(s), expand the 96-Communication Port(s) item, and then double-click on Host Comm Port.



18.5.3 Set Calculation to Enabled.

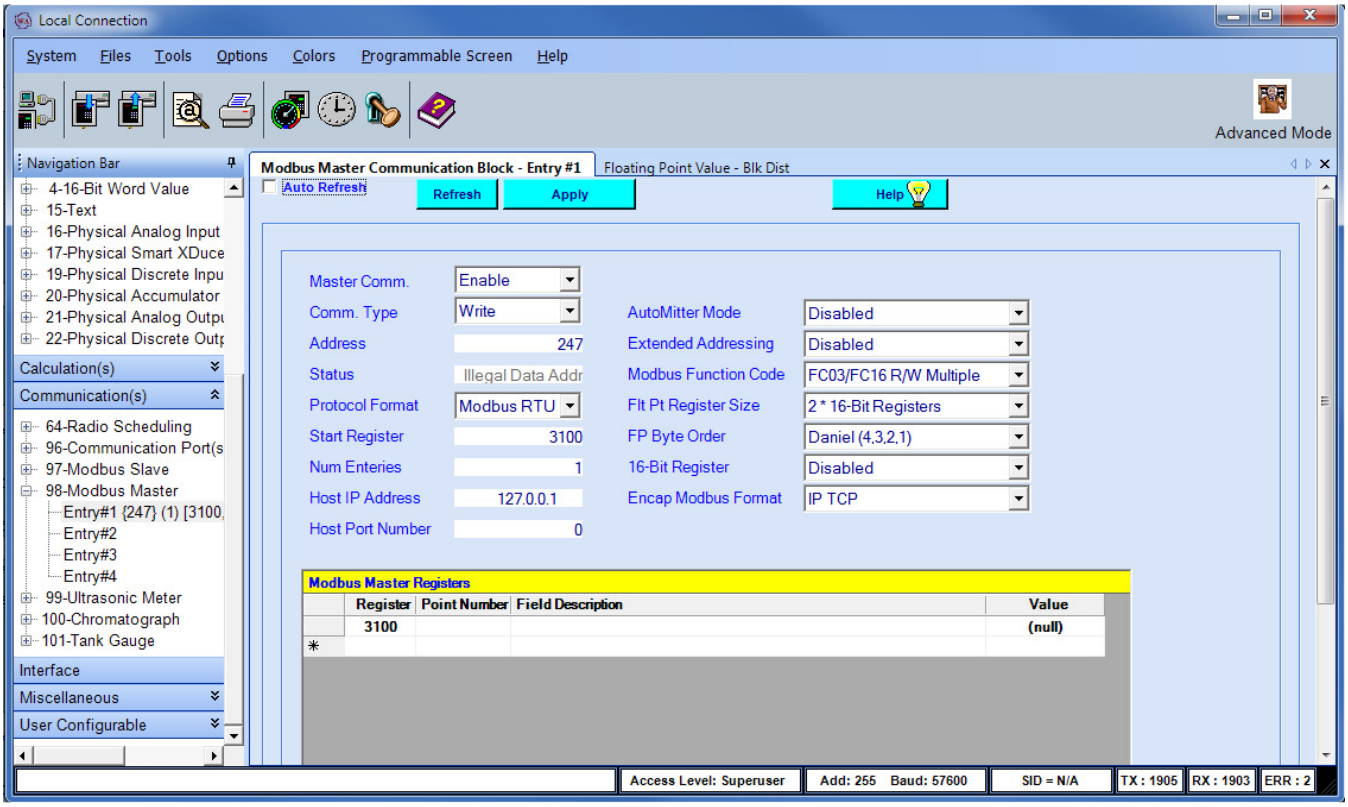
18.5.4 Set the Repeat Timer to the desired sampling interval in seconds.

18.5.5 Ensure that the communication settings match the selections made in step 19.1.1.

18.5.6 Set the Comm. Block Ref to 1, the Comm Block to Modbus Master, and the Block Index to Entry #1.

18.5.7 Click on Apply to send the settings to the AutoPILOT PRO.

In the Navigation Bar, click on Communication(s), expand the 98-Modbus Master item, and then double-click on Entry#1.



18.5.8 Set Master Comm. to Enable.

18.5.9 Set Comm. Type to Write.

18.5.10 Set the Address to the Modbus address of the HMA.

18.5.11 Set the Start Register to 3100 (the start of the Blocking Distance register for Slave 1 in the HMA).

18.5.12 Set the Num Entries to 1 (one 32-bit floating point number).

18.5.13 The Host IP Address, Host Port Number, AutoMitter Mode, Extended Addressing and Encap Modbus Format can be ignored.

18.5.14 Set the Modbus Function Code to FC03/FC16 R/W Multiple for reading input registers.

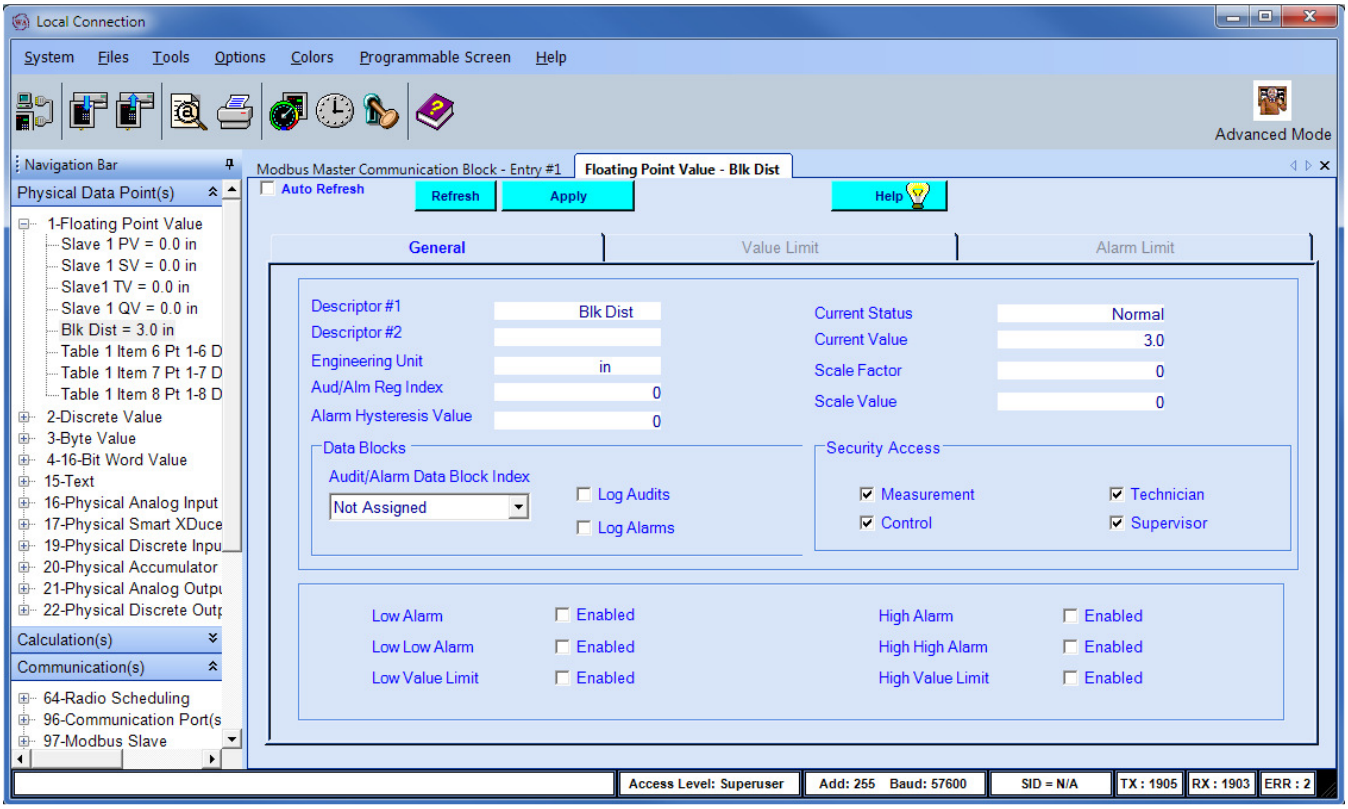
18.5.15 Set the Flt Pt Register Size to 2 * 16-Bit Registers, and the FP Byte Order to Daniel (4,3,2,1).

18.5.16 Set the 16-Bit Register to Disabled.

18.5.17 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.18 In the Navigation Bar, click on Physical Data Point(s), and expand the 1-Floating Point Value item.

18.5.19 Double click on the Table 1 Item 5 entry, and change Descriptor #1 to 'Blk Dist' and Engineering Unit to correspond to the level units in use by the HART transmitter to be read.

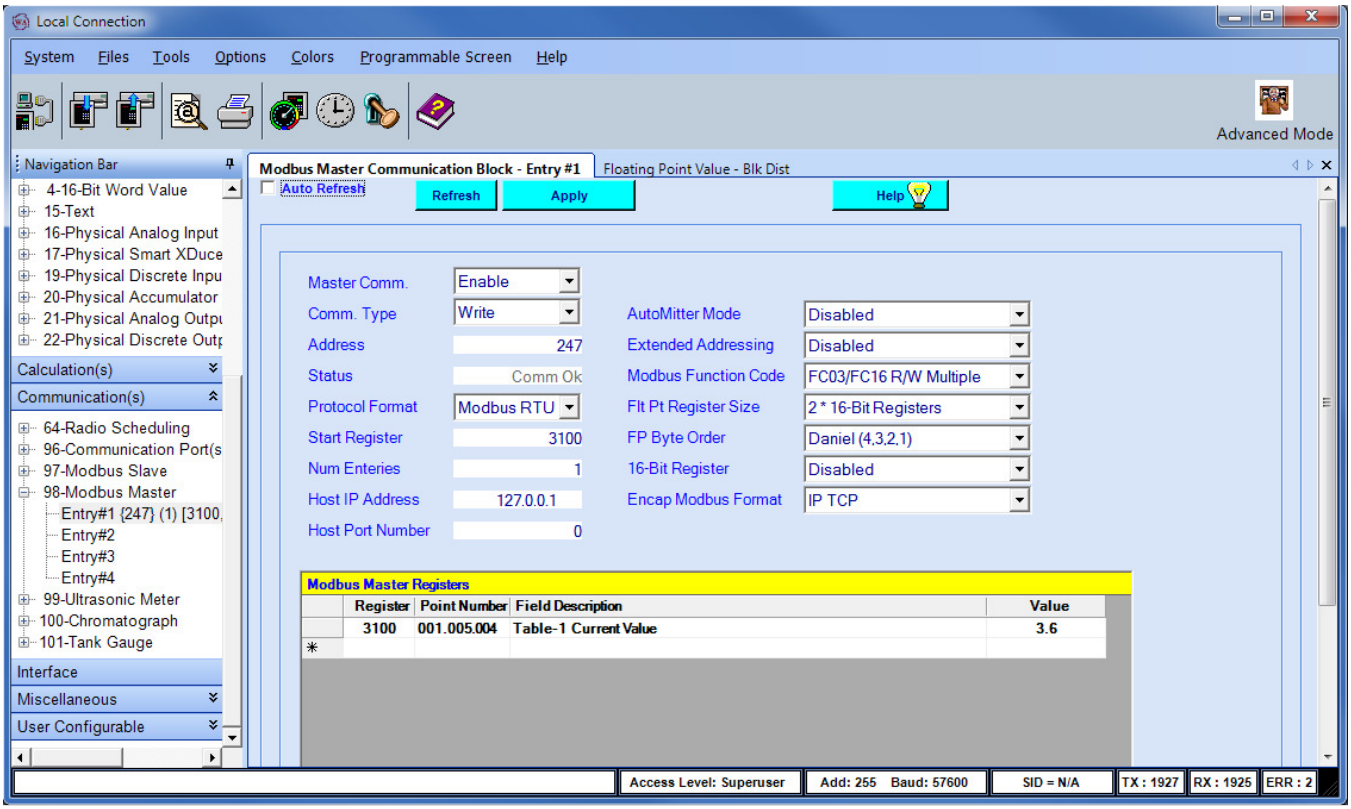


18.5.20 Enter the value to be sent to the device in the Current Value textbox.

18.5.21 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.22 Right click on the Slave 1 Blk Dist entry in the Navigation Bar and select Copy.

18.5.23 Double click on the Entry #1 listing in the Communication(s) \ 98-Modbus Master section of the Navigation Bar.



18.5.24 Right click on the Register number 3100 cell and select Paste.

18.5.25 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.26 Click on Refresh to command the AutoPILOT PRO to send the value to the device.

18.5.27 Change the Comm. Type to Read.

18.5.28 Click on Apply to send the settings to the AutoPILOT PRO.

18.5.29 Click on Refresh to confirm that the device has accepted the new value.

APPENDICES

A. HMA Terminal Block Layout

Notes:

A. For Modbus devices using ‘A’ and ‘B’ for the RS-485 connection, connect ‘A’ to the ‘+‘ position of the RS-485 terminal block, and ‘B’ to the ‘-‘ position.
B. The RS-485 terminal block is used as the RS-232 terminal block when the positions 3 and 4 DIP switches are set to the RS-232 mode. See Appendix B. Connect the RS-232 TX line to the ‘+‘ position of the RS-485 terminal block, and the RX line to the ‘-‘ position.
C. It is recommended that any wires connected to the HART terminal block be dressed such that there is some exposed wire. This will permit connecting a HART modem without breaking the HART loop if additional device configuration or troubleshooting is required.

B. HMA DIP Switch Settings

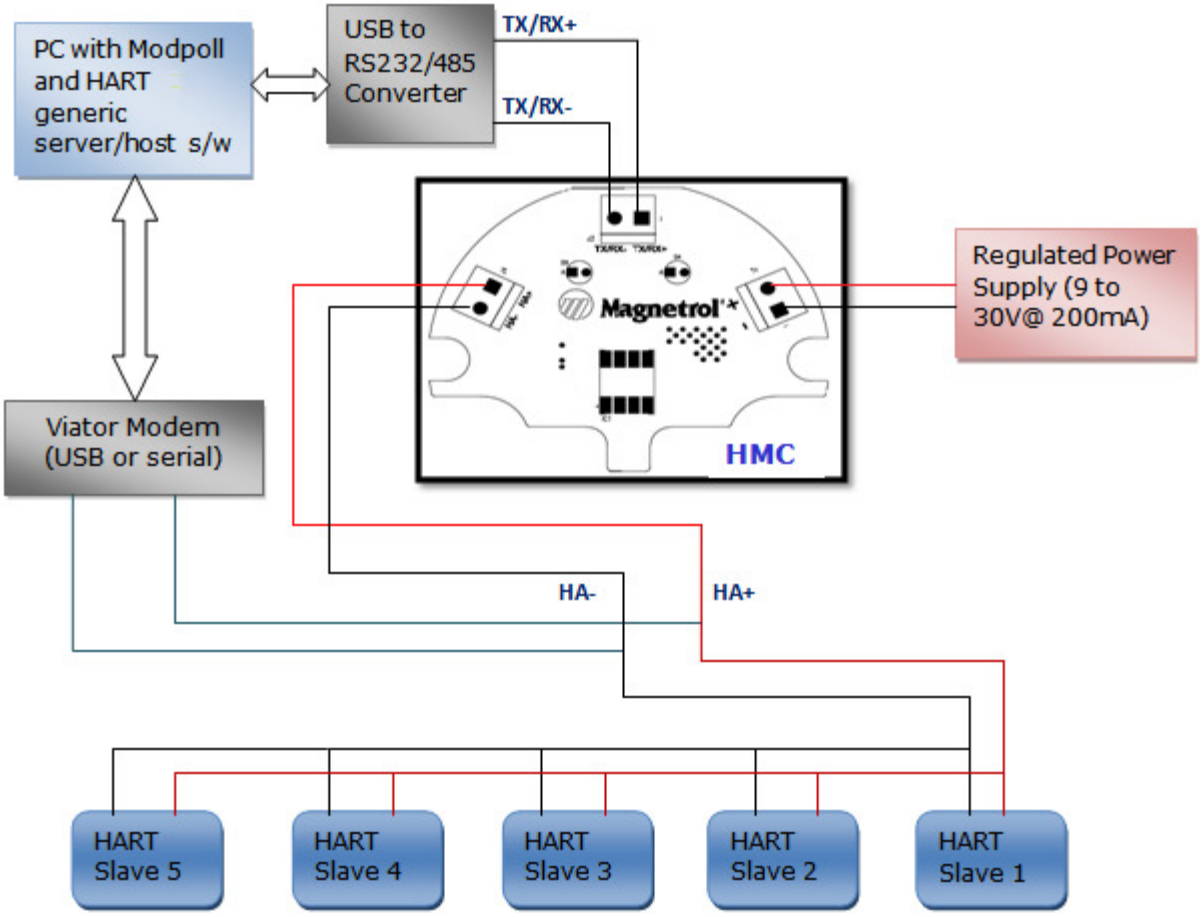
Position 1	ON	Normal mode
	OFF	Default configuration mode
Position 2	ON	Program mode
	OFF	Run mode
Position 3	OFF	RS485 mode
Position 4	ON	
Position 3	ON	RS232 mode
Position 4	OFF	

C. HMA LED Indicators

LED D5	Green: Indicates Power ON
LED D4	Red: Indicates Error (indicated by HMA status bits)

After power on, check the LED status. If the Red LED is ON then check the HMA status by reading Modbus register 1200.

D. HMA System Connection Diagram



E. Nomenclature Table

HMA Nomenclature	Modbus Poll Nomenclature
Data Type	Display
Number of Registers	Quantity
Modbus Register Type	Function
Modbus Register Number	Address

F. Modbus RTU Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	0
Slave address	UINT8	1	Holding	3001	1 to 247	247
Protocol Type	UINT8	1	Holding	3002	1	1
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	8
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	0
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	3
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	0
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	0
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

G. Modbus ASCII Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	0
Slave address	UINT8	1	Holding	3001	1 to 99	1
Protocol Type	UINT8	1	Holding	3002	2	2
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	7
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	0
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	3
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	0
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	0
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

H. LevelMaster Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	0
Slave address	UINT8	1	Holding	3001	1 to 247	247
Protocol Type	UINT8	1	Holding	3002	3	3
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	8
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	0
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	3
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	1
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	0
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

I. HART over RS485 Communication Registers

Parameter	Data Type	Number of Registers	Modbus Register type	Modbus Register number	Values	Default
Floating Point Format Code	UINT8	1	Holding	3000	0 - AB CD 1 - CD AB 2 - DC BA 3 - BA DC	
Slave address	UINT8	1	Holding	3001	1 to 247	
Protocol Type	UINT8	1	Holding	3002	2	4
No of Data bits	UINT8	1	Holding	3003	7 - 7 bits 8 - 8 bits	8
Stop bits	UINT8	1	Holding	3004	1 - 1 bit 2 - 2 bits	1
Parity	UINT8	1	Holding	3005	0 - None 1 - Odd 2 - Even	1
Baud rate	UINT8	1	Holding	3006	0 - 1200 1 - 2400 2 - 4800 3 - 9600 4 - 19200	0
HMA Mode	UINT8	1	Holding	3007	0 - HMA 1 - Device	1
Auto-switch to HART over RS-485	UINT8	1	Holding	3008	0 - no switch 1 - switch	1
Reserved/ Unused						
No of retries (General)	UINT8	1	Holding	3010	0, 1, 2, 3	
Reserved/Unused						
Device Discovery mode (DDM)	UINT8	1	Holding	3012	0 - Polled 1 - Saved 2 - Single	
Polling Range (if DDM = 0, 2)	UINT8	1	Holding	3013	0 - 0 only 1 - Find first only 2 - search 0-15 3 - search 0-31 4 - search 0-63	

J. HMA Diagnostics Modbus Registers

Parameter	Modbus Register Info			Modbus Register	
	Data type	Number	Type	Number	Bit
Configuration data error	UINT8	1	Input	1200	0
No HART communications					1
Communication Mode (0 == RS232, 1 == RS485)					2
EEPROM failure					3
HMA Ready					4
Reserved/Unused					5
Reserved/Unused					6
Configured & connected Slaves mismatch (mismatch in number or mismatch in device identification)					7
Reserved/Unused	UINT8	1	Input		8
Buckboost Fail					9
Slave 1 malfunction (Comm error)					10
Slave 2 malfunction (Comm error)					11
Slave 3 malfunction (Comm error)					12
Slave 4 malfunction (Comm error)					13
Slave 5 malfunction (Comm error)					14
Configuration data area checksum error					15
Byte 3 bits - Reserved	UINT8	1	Input	1201	
Byte 4 bits - Reserved	UINT8	1	Input		
HMA Firmware Version	UINT8	8	Input	1205	
HMA Serial Number	UINT8	6	Input	1213	
Number of attached devices	UINT8	1	Input	1250	
Slave 1 Device Type	UINT8	1	Input	1251	
Slave 2 Device Type	UINT8	1	Input	1252	
Slave 3 Device Type	UINT8	1	Input	1253	
Slave 4 Device Type	UINT8	1	Input	1254	
Slave 5 Device Type	UINT8	1	Input	1255	
Slave 1 Poll Address	UINT8	1	Input	1256	
Slave 2 Poll Address	UINT8	1	Input	1257	
Slave 3 Poll Address	UINT8	1	Input	1258	
Slave 4 Poll Address	UINT8	1	Input	1259	
Slave 5 Poll Address	UINT8	1	Input	1260	

K. HMA Device Information Modbus Registers

Parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
Polling Address	UINT8	1	Input	1000	1000	1020	1040	1060	1080
Loop Current Mode	UINT8	1	Input	1001	1001	1021	1041	1061	1081
Device Type	UINT16	1	Input	1002	1002	1022	1042	1062	1082
Min Preambles in request	UINT8	1	Input	1003	1003	1023	1043	1063	1083
Protocol Rev	UINT8	1	Input	1004	1004	1024	1044	1064	1084
Device rev	UINT8	1	Input	1005	1005	1025	1045	1065	1085
S/w rev	UINT8	1	Input	1006	1006	1026	1046	1066	1086
H/W rev/physical sign code	UINT8	1	Input	1007	1007	1027	1047	1067	1087
Flags	UINT8	1	Input	1008	1008	1028	1048	1068	1088
Device ID	HEX	2	Input	1009	1009	1029	1049	1069	1089
Minimum Preambles in response	UINT8	1	Input	1011	1011	1031	1051	1071	1091
Max Device Variables	UINT8	1	Input	1012	1012	1032	1052	1072	1092
Reserved/Unused									
Extended field device status	UINT8	1	Input	1014	1014	1034	1054	1074	1094
Manufacturer code	UINT8	1	Input	1015	1015	1035	1055	1075	1095
Pvt Label Distributor code	UINT8	1	Input	1016	1016	1036	1056	1076	1096
Device Profile	UINT8	1	Input	1017	1017	1037	1057	1077	1097

L. Model 706, Model JM4 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	5	Input	1101-1105	1101 1105	1111-1115	1121-1125	1131-1135	1141-1145
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	8	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Advanced Password	UINT32	2	Input	2156	2156	2256	2356	2456	2556
Reserved/Unused									
HART entered password	UINT32	2	Holding	3110	3110	3210	3310	3410	3510
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Sensitivity	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Level Threshold code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Interface Level Threshold code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Level Threshold Amplitude	UINT8	1	Holding	3134	3134	3234	3334	3434	3534
Interface Threshold Amplitude	UINT8	1	Holding	3135	3135	3235	3335	3435	3535

Note: Reference Appendices U and V for SV and parameter code definitions.

M. Model 705 3x Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
	Data Type	Number	Type	Device Mode	HMA Mode				
					Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	4	Input	1101-1104	1101-1104	1111-1114	1121-1124	1131-1134	1141-1144
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	4	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Reserved/Unused									
User Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Sensitivity	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Negative Threshold code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Negative Threshold Amplitude	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Interface Lvl Thresh code	UINT8	1	Holding	3134	3134	3234	3334	3434	3534
Interface Lvl Thresh Amplitude	UINT8	1	Holding	3135	3135	3235	3335	3435	3535

N. Model R82 R2 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value				1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	2	Input	1101-1102	1101-1102	1111-1112	1121-1122	1131 - 1132	1141-1142
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	6	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Reference Distance	Float	2	Holding	3104	3104	3204	3304	3404	3504
Level Unit code	UINT8	1	Input	2142	2142	2242	2342	2442	2542
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
TVG Min	UINT16	1	Holding	3122	3122	3230	3330	3430	3530
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Dielectric Range code	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Turbulence code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Rate of Change code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Foam code	UINT8	1	Holding	3134	3134	3234	3334	3434	3534

O. Model RX5 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value				1302	1302	1312	1322	1332	1342
PV units code	UINT8	1	Input	104	104	124	144	164	184
Command 48 status bytes	UINT8	1	Input	1101	1101	1111	1121	1131	1141
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	6	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Distance	Float	2	Input	2150	2150	2250	2350	2450	2550
Echo Strength	Float	2	Input	2153	2153	2253	2353	2453	2553
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Dielectric Range code	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Turbulence code	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Rate of Change code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Foam code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533

P. Model 355 Modbus Registers

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	2	Input	1101-1102	1101-1102	1111-1112	1121-1122	1131-1132	1141-1142
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	6	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Level Offset	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Range	Float	2	Holding	3104	3104	3204	3304	3404	3504
Level Unit code	UINT8	1	Input	2142	2142	2242	2342	2442	2542
Damping Value	Float	2	Holding	3106	3106	3206	3306	3406	3506
Reference Distance	Float	2	Holding	3108	3108	3208	3308	3408	3508
Level Unit code	UINT8	1	Input	2144	2144	2244	2344	2444	2544
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Peak Threshold	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
TVG	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Reserved/Unused									
Echo Strength	UINT8	1	Input	2160	2160	2260	2360	2460	2560

Q. Enhanced Jupiter Modbus Registers

HART parameter	Modbus Register Info			Modbus Register number					
	Data type	Number	Type		Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
Command 48 status bytes	UINT8	1	Input	1101	1101	1111-	1121	1131-	1141
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	4	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Trim Level	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Trim Ifc Level	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530

R. E3 Modulevel Modbus Registers

HART parameter	Modbus Register Info			Modbus Register number					
					HMA Mode				
	Data type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
PV units code	UINT8	1	Input	104	104	124	144	164	184
Command 48 status bytes	UINT8	4	Input	1101-1104	1101-1104	1111-1114	1121-1124	1131-1134	1141-1144
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	4	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Trim Level	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit Code	UINT16	1	Input	2140	2140	2240	2340	2440	2540
Process SG	Float	2	Holding	3102	3102	3202	3302	3402	3502
Trim SG	Float	2	Holding	3104	3104	3204	3304	3404	3504
Reserved/Unused									
Password	UINT16	1	Holding	3120	3120	3220	3320	3420	3520
Operating Temperature	UINT16	1	Holding	3122	3122	3222	3322	3422	3522
Temperature units code	UINT8	1	Input	2160	2160	2260	2360	2460	2560

S. Model R96 Modbus Registers[3]

HART parameter	Modbus Register Info			Modbus Register Number					
					HMA Mode				
	Data Type	Number	Type	Device Mode	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5
PV value	Float	2	Input	1302	1302	1312	1322	1332	1342
SV value	Float	2	Input	1304	1304	1314	1324	1334	1344
TV value	Float	2	Input	1306	1306	1316	1326	1336	1346
QV value	Float	2	Input	1308	1308	1318	1328	1338	1348
PV units code	UINT8	1	Input	104	104	124	144	164	184
SV units code	UINT8	1	Input	108	108	128	148	168	188
TV units code	UINT8	1	Input	112	112	132	152	172	192
QV units code	UINT8	1	Input	116	116	136	156	176	196
Command 48 status bytes	UINT8	5	Input	1101-1105	1101 1105	1111-1115	1121-1125	1131-1135	1141-1145
Serial Number	UINT8	6	Input	2100	2100	2200	2300	2400	2500
Software version	UINT8	8	Input	2112	2112	2212	2312	2412	2512
Reserved/Unused									
Top Blocking Distance	Float	2	Holding	3100	3100	3200	3300	3400	3500
Level Unit code	UINT8	1	Input	2140	2140	2240	2340	2440	2540
Bottom Blocking Distance	Float	2	Holding	3102	3102	3202	3302	3402	3502
Level Unit code	UINT8	1	Input	2141	2141	2241	2341	2441	2541
Advanced Password	UINT32	2	Input	2156	2156	2256	2356	2456	2556
Reserved/Unused									
HART entered password	UINT32	2	Holding	3110	3110	3210	3310	3410	3510
Reserved/Unused									
Device variable assigned to SV	UINT8	1	Holding	3130	3130	3230	3330	3430	3530
Dielectric Range code	UINT8	1	Holding	3131	3131	3231	3331	3431	3531
Turbulence code	UINT8	1	Holding	3132	3132	3232	3332	3432	3532
Rate of Change code	UINT8	1	Holding	3133	3133	3233	3333	3433	3533
Foam code	UINT8	1	Holding	3134	3134	3234	3334	3434	3534
Target Algorithm code	UINT8	1	Holding	3135	3135	3235	3335	3435	3535
Level Threshold Mode code	UINT8	1	Holding	3137	3137	3237	3337	3437	3537
Auto Threshold value	UINT8	1	Holding	3138	3138	3238	3338	3438	3538
Fixed Threshold value	UINT8	1	Holding	3139	3139	3239	3339	3439	3539

[3] For firmware version 1.6a0 and later.

T. LevelMaster Error and Warning Codes

Error Code	Model 705 3x R2	Model R82	Model 355	Enhanced Jupiter	E3 Madulevel	Model RX5
1	Software Fault	Dflt Parm Fact	Dflt Parm Sys	Snsr Brd Failed	Fault	Default Params
2	ADC Failure	Dflt Parm Sys	Dflt Parm Adv	No Signal	Fault 2	No Fiducial
3	EEPROM Error	Dflt Parm Adv	Dflt Parm I/O	Float 1 Fail	Secondary Fault Lo	Echo Lost
4	Default Params	Dflt Parm I/O	Dflt Parm Fact	Default Params	Default Params	Safety Zone Alarm
5	No Ramp	Dflt Parm HART	Dflt Parm HART	Loop Failure	Loop Failure	CPU Failure
6	Loop Fail	Dflt Strap Tbl	Dflt Strap Tbl	Float 2 Fail	Secondary Fault Hi	EE Read Failure
7	Fid Shift	Dflt Parm Total	Dflt Parm Total	Fault 2	Primary Fault	EE Write Failure
8	Ramp Slope	Cnfg Conflict	Cnfg Conflict	Fault1	Core Drop	Software Erro
9	Lvl Below Probe End	RF Brd Failure	Hardware Failure			
10	No Probe	Loop Failure	Fa			
11	No Fiducial	Fault 2	Temperature Failure			
12	Safety Zone Alarm	Safe Zone Alrm	Blocking Distance			
13	No Signal	Echo Lost	Hi Volume Alrm			
14	EoP < Probe End	High Flow Alrm	High Flow Alrm			
15	EoP > Probe End	Hi Volume Alrm	Safe Zone Alarm			
16	High Vol Alarm	Fault 1	Echo Lost			
Warning Code						
1	Warning 1	Initializing	Warning 1	Warning 2	Warning 1	Factory Cal Req'd
2	Seal Leak	Warning 4	Low VDC at 20 mA	Warning 1	Cal Span Warning	Fiducial Unclear
3	Fid Spread	LowVDC@20mA	Noise	Hi Temperature	Calib Req'd	Corrupt Targ Rej
4	Warning 2	Warning 3	High Elec Temp	Low Temperature	Hi Temperature	No False Targ Rej
5	High Elec Temp	No Echo Rej	Low Elec Temp	System Warning	Lo Temperature	Button Failure
6	Low Elec Temp	Echo Rej Crpt	Echo Rej Crpt	Trim Req'd	Trim Req'd	Warning 04
7	Cal Req'd	Echo Rej Invl	Echo Rej Invl	Initializing	Initilaizing	Warning 02
8	EoP Low	Echo Rej Disable	Initializing	Calib Req'd	Warning 2	Warning 01
9	Trim Req'd	Echo Rej Insf	System Code			
10	No Target	Warning 2				
11	Warning 4	High Elec Temp				
12	Initializing	Low Elec Temp				
13	May Be Flooded	Rate Of Change				
14	Dry Probe	Warning 1				
15	Weak Signal	System Code				
16	System Warning					

Error Code	Model 706	Model JM4	Model R96
1	Software Error	SW Error (Main)	Software Error
2	RAM Error	RAM Error (Main)	RAM Error
3	ADC Failure	ADC Error (Main)	ADC Failure
4	EEPROM Error	EEPROM Error	EEPROM Error
5	Analog Board Error	CoP in Flash Mode	Analog Board Error
6	Analog Output Error	SW Conflict (CoP)	Analog Output Error
7	Spare 1	Spare 1	Spare 1
8	Default Parameters	Analog Board Error	Default Parameters
9	No Probe	SW Error (CoP)	No Antenna
10	No Fiducial	RAM Error (CoP)	Spare 2
11	No Echoes	ADC Error (CoP)	No Fiducial
12	Upper Echo Lost	Spare 2	Too Many Echoes
13	Spare 2	Analog Ouput Error	Safety Zone Alarm
14	EoP > Probe End	No Probe	Echo Lost
15	Level Below Probe End	Probe Memory Error	Spare Indicator 3
16	EoP Below Probe End	Probe Info Corrupt	Configuration Conflict
17	Safety Zone Alarm	Spare 3	High Volume Alarm
18	Config Conflict	New Probe	Spare Indicator 4
19	Hi Volume Alarm	Default Parameters	Initializing
20	Hi Flow Alarm	No Float Detected	Configuration Changed
21	Spare 3	Spare 4	Spare Indicator 5
22	Initializing	Config Conflict	Ramp Slope Error
23	Analog Output Fixed	Hi Volume Alarm	High Electronics Temp
24	Config Changed	Spare 5	Low Electronics Temp
25	Spare 4	Extra Float Detected	Calibration Required
26	Spare 5	2nd Float Missing	Echo Rejection Invalid
27	Spare 6	Initializing	Spare Indicator 6
28	Ramp Interval Error	Config Changed	Inferred Level
29	Hi Elec Temp	Spare 6	Adjust Analog Output
30	Lo Elec Temp	Xmtr Calib Req'd	Low Supply Voltage
31	Calib Req'd	Spare 7	Spare Indicator 7
32	Echo Rej Invalid	Temp Calib Req'd	Spare Indicator 8
33	Spare 7	Hi Elec Temp	Marginal Echo
34	Inferred Level	Lo Elec Temp	Hi Surface Velocity
35	Adj Analog Output	Spare 8	Spare Indicator 9
36	Totalizer Data Lost	Spare 9	Spare Indicator 10
37	No Probe Target	Adj Analog Output	Sequence Record
38	Low Supply Voltage	Low Supply Voltage	
39	Dry Probe	Spare 10	
40	Spare 8	Lo Echo Strength	
41	Lo Echo Strength	Lo Ifc Echo Strength	
42	Lo Ifc Echo Strength	Hi Noise / LvlThresh	
43	Spare 9	Hi Noise / IfcThresh	
44	Spare 10	Spare 10	
45	Sequence Record	Sequence Record	

Note: Diagnostics mapped to the NE 107 Failure category will appear as a LM Error, those mapped to other categories will appear as a LM Warning.

U. Level Unit Codes

Code	44	45	47	48	49
Unit	feet	meters	inches	centimeters	millimeters

V. Parameter Codes

SV Code	Model 706	Model JM4	Model 705 3x R2	Model R82 R2	Model 355	E3 Modulevel
0	Level	Level	Level	Level	Level	Level
1	Ifc Level	Ifc Level	Volume	Volume	Flow	Ifc Level
2	Ifc Thickness	Ifc Thickness	Ifc Level	Distance	Volume	Density
3	Volume	Volume	Ifc Volume	Echo Strength	Head	
4	Flow	Fill Rate		Flow	Distance	
5	Distance	Distance		Head	Totalizer R	
6	Echo Strength	Echo Strength		Totalizer R	Totalizer NR	
7	Head	Elec Temp		Totalizer NR	Process Temp	
8	Totalizer R	Ifc Echo Strength			Custom Unit	
9	Totalizer NR					
10	Elec Temp					
11	Ifc Echo Strength					
12	Probe Buildup					

SV Code	Enhanced Jupiter	Model R96				
0	Level	Level				
1	Ifc Level	Volume				
2		Distance				
3		Echo Strength				
4		Temperature				
5		Signal Margin				
6						
7						
8						
9						
10						
11						
12						

Threshold Code	Model 706	Model JM4	Model 705 3x R2			
0	Auto Largest	Auto Largest	Fixed			
1	Fixed	Fixed	CFD			
2	Auto Upper	Sloped				
3	Sloped					

Dielectric Range Code	Model R82 R2	Model RX5	Model R96			
0	1.7 - 3	1.7 - 3	Below 1.7			
1	3 - 10	3 - 10	1.7 - 3			
2	10 - 100	10 - 100	3 - 10			
			10 - 100			

Turbulence Code	Model R82 R2	Model RX5	Model R96			
0	None	None	None			
1	Light	Light	Light			
2	Medium	Medium	Medium			
3	Heavy	Heavy	Heavy			

Rate of Change Code	Model R82 R2	Model RX5	Model R96			
0	< 5 in/min	< 5 in/min	< 5 in/min			
1	5 - 20 in/min	5 - 20 in/min	5 - 20 in/min			
2	20 - 60 in/min	20 - 60 in/min	20 - 60 in/min			
3	> 60 in/min	> 60 in/min	> 60 in/min			

Foam Code	Model R82 R2	Model RX5	Model R96			
0	None	None	None			
1	Light	Light	Light			
2	Medium	Medium	Medium			
3	Heavy	Heavy	Heavy			

Target Algorithm	Model R96					
0	First Peak					
1	Largest Peak					

Lvl Thresh Mode	Model R96					
0	Auto Largest					
1	Fixed					

About Modbus

Our Mission

The Modbus Organization is a group of independent users and suppliers of automation devices that seeks to drive the adoption of the Modbus communication protocol suite and the evolution to address architectures for distributed automation systems across multiple market segments. The Modbus Organization will also provide the infrastructure to obtain and share information about the protocols, their application and certification to simplify implementation by users resulting in reduced costs.

Organization

The Modbus Organization is a membership-based trade association, incorporated as "Modbus Organization, Inc." under the laws of the Commonwealth of Massachusetts, USA and recognized by the U.S. Internal Revenue Service as a nonprofit organization under Internal Revenue Code 501(c)(6). Donations to the organization are not deductible as charitable contributions but may be deductible as a business expense. The Modbus Organization's annual IRS Form 990 is available upon request via our contact page, providing the complete name, address, and e-mail address of the requesting organization or individual.

Our Member Logo

Our membership logo symbolizes a round table, meaning that we invite all our members to participate in the technical and educational activities of our organization. Suppliers large and small, system integrators, end users, open source developers, educators and other interested parties are all invited to join in the discussions that will take the Modbus protocol into the future.

Our Activities

The Modbus Organization engages in a broad range of activities relating to the maintenance and proliferation of the Modbus protocol. Some of these activities include:

- Participation in standards activities worldwide.
- Leading the evolution of the Modbus protocol and its variants.
- Encouraging and assisting the use of Modbus across a broad spectrum of physical layers and transmission media.
- Maintaining and evolving a conformance testing program to insure greater interoperability of Modbus devices.
- Providing information to users and supplers alike to help them be successful in their use of Modbus.
- Engaging in educational and promotional efforts including trade shows, newsletters, this website, and other outreach activities.

Our Invitation

Our invitation is to you, as a Modbus user or supplier, to join in our activities, share in the benefits of Modbus Organization membership, and help us bring Modbus into the future. We are committed to maintaining Modbus as the world's leading protocol for industrial automation, and invite you to take your place at our roundtable.

For more information about Modbus Organization membership, please see our Membership Flyer and Membership Application. Refer to our contact page (http://modbus.org/contact.php) for ways to get in touch - we'd be glad to hear from you!

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