Manual Supplement
00809-0500-4530, Rev AA
October 2010

Rosemount 5300/5400 Series with HART to Modbus Converter

This instruction is a supplement to the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530), and the Rosemount 5400 Series Reference Manual (Document No. 00809-0100-4026).

SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Please refer to the following safety messages before performing an operation preceded by this symbol.

⚠WARNING

Failure to follow safe installation and service guidelines could result in death or serious injury

- Make sure the transmitter is installed by qualified personnel and in accordance with applicable code of practice.
- Use the equipment only as specified in the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530), the Rosemount 5400 Series Reference Manual (Document No. 00809-0100-4026), and in this Manual Supplement. Failure to do so may impair the protection provided by the equipment.
- Do not perform any services other than those contained in this manual unless you are qualified.

Explosions could result in death or serious injury

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations specifications.
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.
- Before connecting a HART® or FOUNDATION™ fieldbus based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- To avoid process leaks, only use o-ring designed to seal with the corresponding flange adapter.

Electrical shock can result in death or serious injury

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.
- Make sure the main power to the Rosemount 5300 Series transmitter or Rosemount 5400 Series transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the transmitter.

Probes with non-conducting surfaces

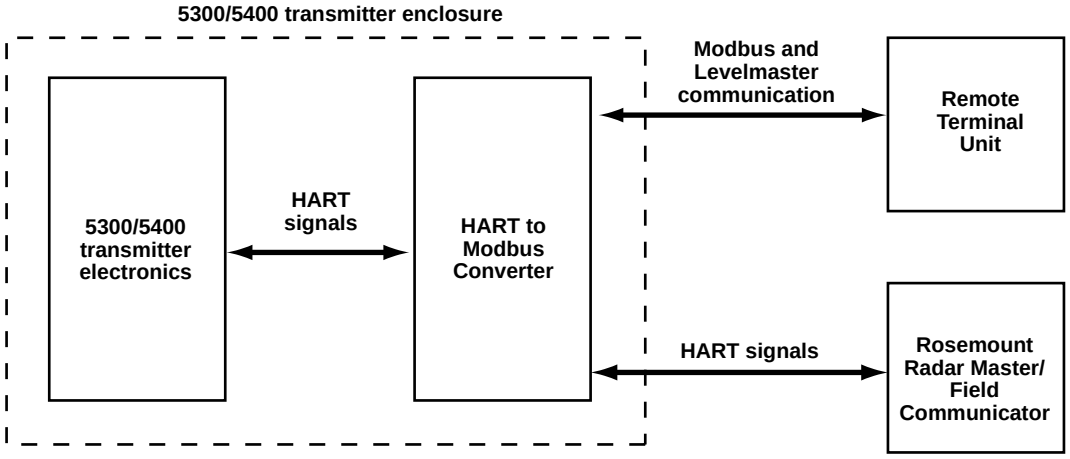
- Probes covered with plastic and/or with plastic discs may generate an ignition-capable level of electrostatic charge under certain extreme conditions. Therefore, when the probe is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

INTRODUCTION

The Rosemount 5300 Series and Rosemount 5400 Series transmitters are Modbus compatible measurement devices that support communication with a Remote Terminal Unit (RTU) using a subset of read, write, and diagnostic commands used by most Modbus compatible host controllers. The transmitters also support communication through Levelmaster and Modbus ASCII protocols.

The HART® to Modbus Converter (HMC) module is located inside the Rosemount 5300 and Rosemount 5400 transmitter enclosure and provides power to and communicates with the transmitter through a HART interface.

Figure 1-1. System Overview



During normal operation, the HMC “mirrors” the contents of process variables from the 5300/5400 transmitter to the Modbus registers. To configure the 5300/5400 transmitter, it is possible to connect a configuration tool to the HMC. See *“Transmitter Configuration” on page 1-13* for more information.

WORKFLOW

Overview of workflow for commissioning a Rosemount 5300 or a Rosemount 5400 transmitter with Modbus protocol:

1. Mount the transmitter on the tank.
2. Connect the power and communication wires.
3. Establish HART communication with the transmitter through Rosemount Radar Master, or a Field Communicator. This is done by:
   - Connecting to the HART terminals, or
   - Connecting to the MA/MB terminals (tunneling mode)
4. Configure the transmitter.
5. Configure the Modbus communication.
6. Configure Modbus host.
7. Verify output values as reported by the transmitter.

MECHANICAL INSTALLATION

For instructions on how to mount the Rosemount 5300/5400 transmitter, refer to the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530), and the Rosemount 5400 Series Reference Manual (Document No. 00809-0100-4026).

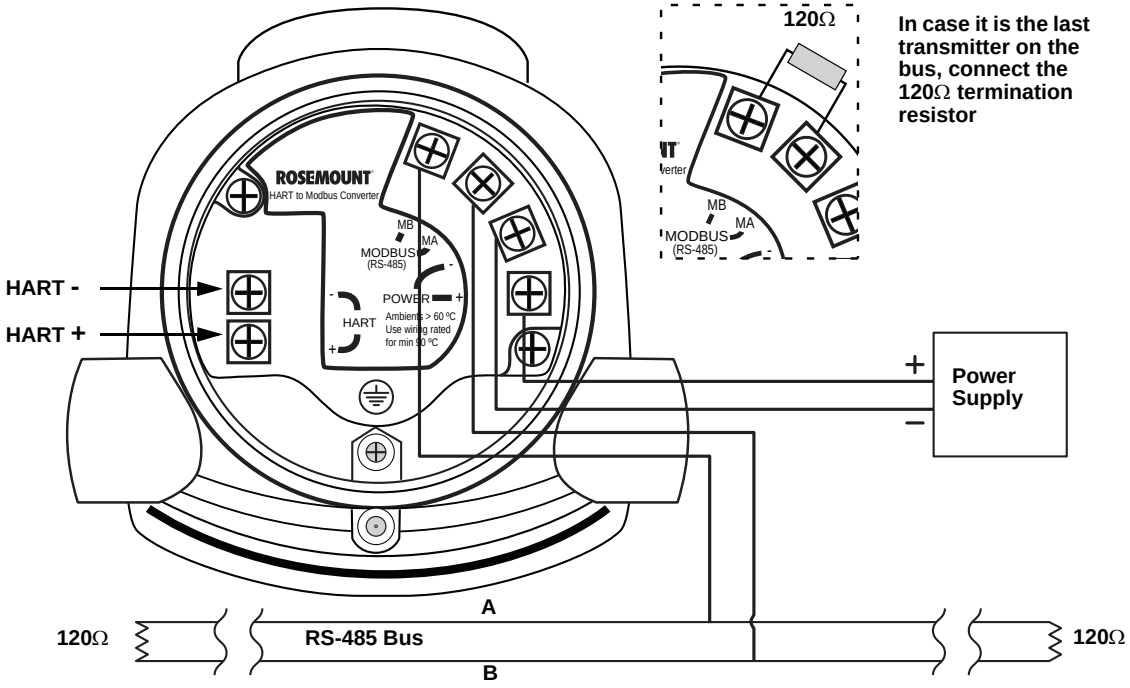
ELECTRICAL INSTALLATION

NOTE
For general electrical installation requirements, including grounding requirements, refer to Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530), and the Rosemount 5400 Series Reference Manual (Document No. 00809-0100-4026).

To connect the Rosemount 5300/5400:

1. Disconnect/shut off the electrical power to transmitter head and then open the instrument cover. Do not remove the cover in an explosive atmosphere with a live circuit.
2. Pull the cable through the cable gland/conduit. For the RS-485 bus, use shielded twisted pair wiring, preferably with an impedance of 120Ω (typically 24 AWG) in order to comply with the EIA-485 standard and EMC regulations. The maximum cable length is 4000 ft/1200 m.
3. Make sure that the transmitter housing is grounded, then connect wires according to Figure 1-2 and Table 1-1. Connect the lead that originates from the “A” line from the RS-485 bus to the terminal marked MB, and the lead that originates from the “B” line to the terminal marked MA.
4. If it is the last transmitter on the bus, connect the 120Ω termination resistor.
5. Connect the leads from the positive side of the power supply to the terminal marked POWER +, and the leads from the negative side of the power supply to the terminal marked POWER -. The power supply cables must be suitable for the supply voltage and ambient temperature, and approved for use in hazardous areas, where applicable.
6. Attach and tighten the housing cover. Tighten the cable gland, then plug and seal any unused terminals, and connect the power supply.

Figure 1-2. Field Wiring Connections



Connection Terminals

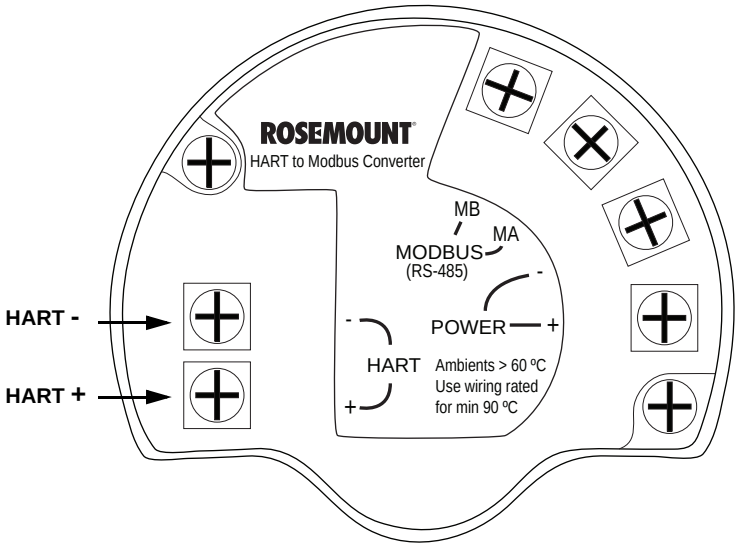
The connection terminals are described in Table 1-1 below:

Table 1-1. Connection Terminals

Connector label	Description	Comment
HART +	Positive HART connector	Connect to PC with RRM software, Field Communicator, or other HART configurators.
HART -	Negative HART connector	
MA	Modbus RS-485 **B** connection (RX/TX+)(1)	Connect to RTU
MB	Modbus RS-485 **A** connection (RX/TX-)(1)	
POWER +	Positive Power input terminal	Apply +8 Vdc to +30 Vdc (max. rating)
POWER -	Negative Power input terminal	

(1) The designation of the connectors do not follow the EIA-485 standard, which states that RX/TX- should be referred to as 'A' and RX/TX+ as 'B'.

Figure 1-3. Connection Terminals for Rosemount 5300/5400 with HART to Modbus Converter



RS-485 Bus

- The 5300/5400 transmitters do not provide electrical isolation between the RS-485 bus and the transmitter power supply
- Maintain a bus topology and minimize stub length
- Figure 1-4 identifies multidrop wiring topology, where up to 32 devices may be wired on one RS-485 bus
- The RS-485 bus needs to be terminated once at each end, but should not be terminated elsewhere on the bus

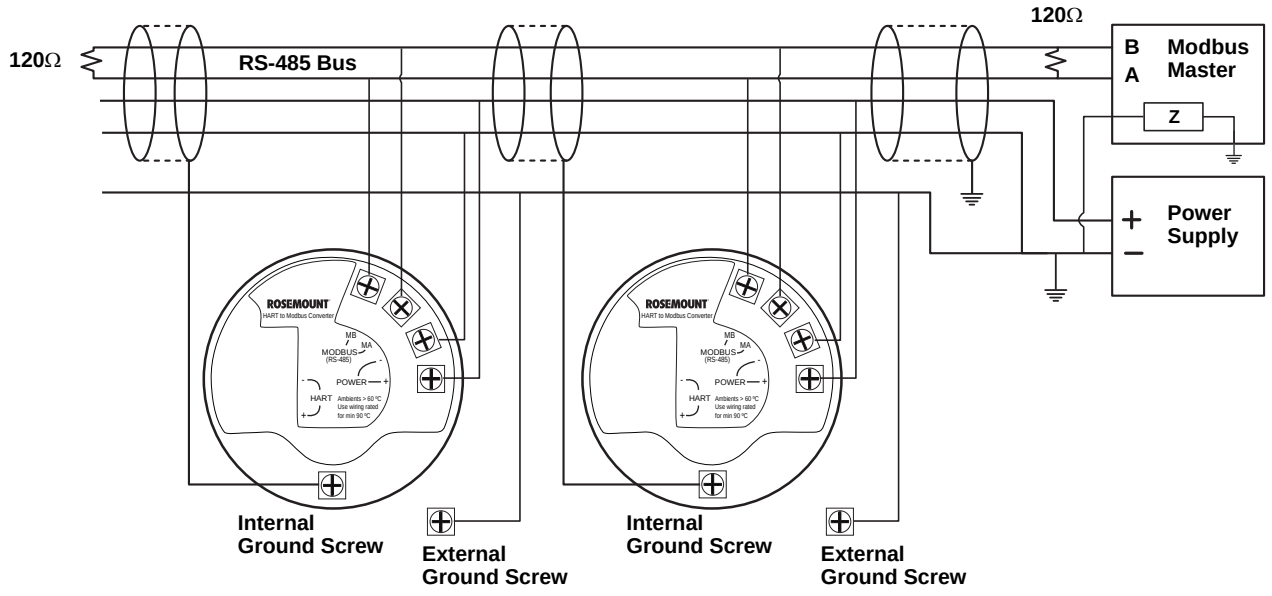
Installation cases

Install the Rosemount 5300/5400 Series Transmitters as shown in Figure 1-4.

- Use common ground for Modbus Master and Power Supply
- The Power cables and RS-485 Bus are in the same cable installation
- An ground cable is installed and shall be used (cable size ≥4 mm according to IEC60079-14, or size according to applicable national regulations and standards). A properly installed threaded conduit connection may provide sufficient ground.
- The cable shielding is grounded at master site (optional)

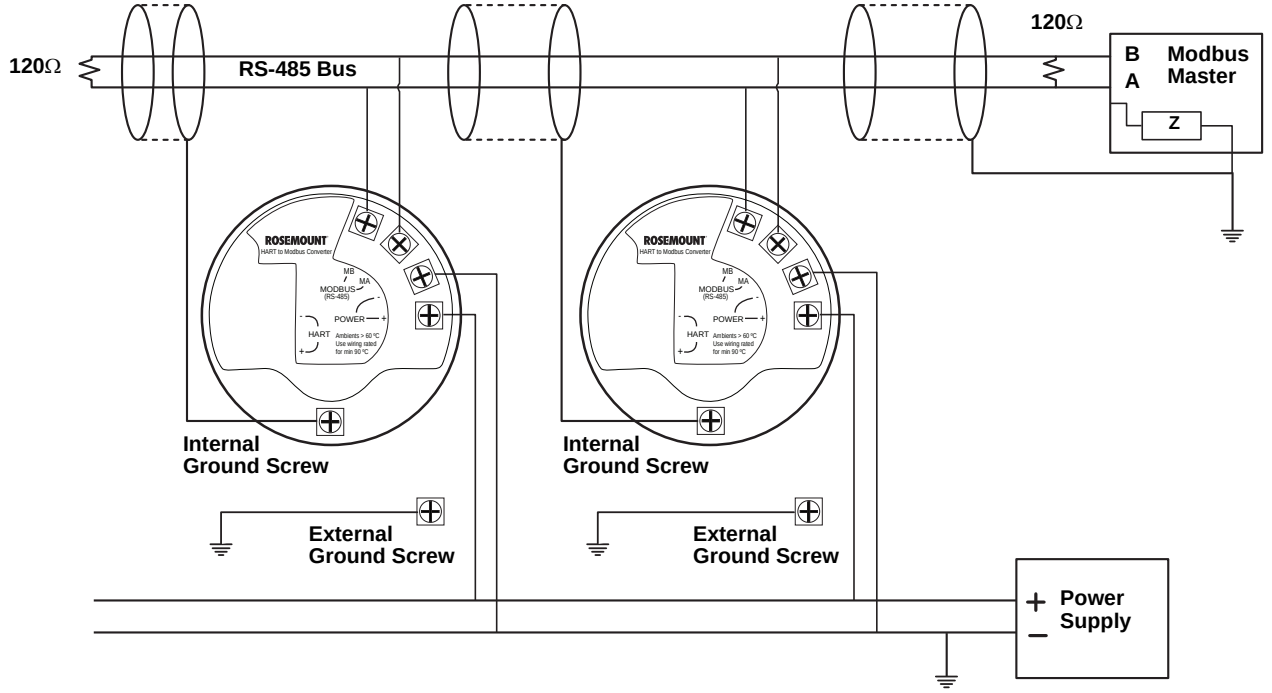
NOTE
The HMC equipped transmitter contains intrinsically safe circuits that require the housing to be grounded in accordance with national and local electrical codes. Failure to do so may impair the protection provided by the equipment.

Figure 1-4. Multidrop Connection of 5300/5400 Transmitters



Alternatively, the Rosemount 5300/5400 Series Transmitters can be installed as shown in Figure 1-5. If this wiring layout is used, there is an increased risk for communication disturbances due to differences in potential between grounding points. By using the same grounding point for Modbus Master and Power Supply, this risk is reduced.

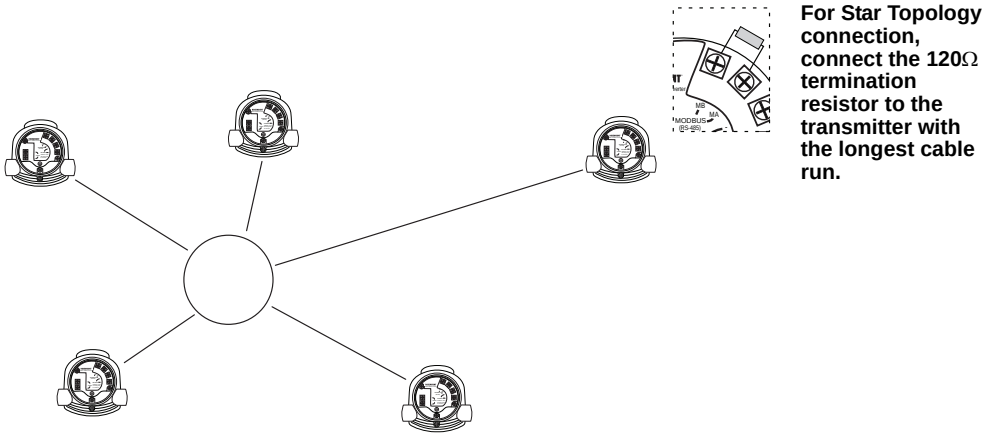
Figure 1-5. Alternative Multidrop Connection of 5300/5400 Transmitters



Star Topology

For a Star Topology Connection of the 5300/5400 transmitters, the transmitter with the longest cable run needs to be fitted with a 120-Ω termination resistor.

Figure 1-6. Star Topology Connection of 5300/5400 Transmitters



For Star Topology connection, connect the 120Ω termination resistor to the transmitter with the longest cable run.

External HART Devices (Slaves)

The HMC supports up to four external HART devices. The external devices are separated by using the HART address. The address must be different between the external devices and only addresses 1 to 5 are allowed for multiple slaves. Connect the devices one at a time and change the short address prior to connecting the next device by using a HART Configuration Tool such as RRM, or a Field Communicator.

NOTE

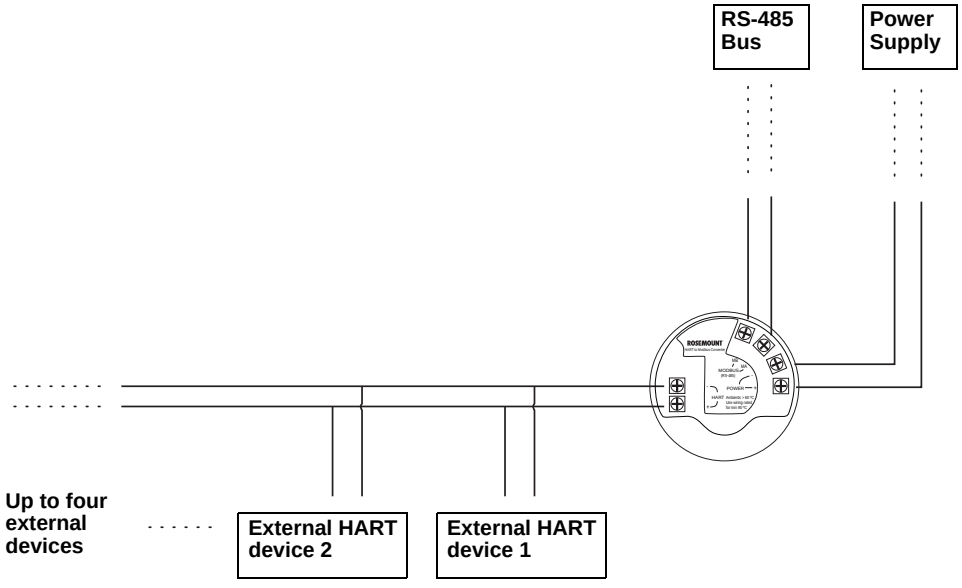
The power supply from the HMC to external HART devices is not intrinsically safe. In a hazardous environment, any external HART device connected to the HMC must have Flameproof/Explosion-proof certification.

The HMC cyclically polls the HART devices for measurement values. The update rate depends on the number of connected devices and is shown in Table 1-2.

Table 1-2. Approximate update rates for measurement values

No. of devices (slaves)	Approx. update rate
1	2 seconds
2	3 seconds
3	4 seconds
4	5 seconds
5	5 seconds

Figure 1-7. The HMC Module supports up to four external devices (slaves)



ESTABLISH HART COMMUNICATION

The Rosemount 5300 Series and Rosemount 5400 Series can be configured using the Rosemount Radar Master (RRM) PC software or a Field Communicator. Configuration is done by sending HART commands through the HART to Modbus Converter (HMC) to the 5300/5400 transmitter electronics. To establish HART communication, connect to the MA/MB terminals, or to the HART terminals. Both alternatives are described below.

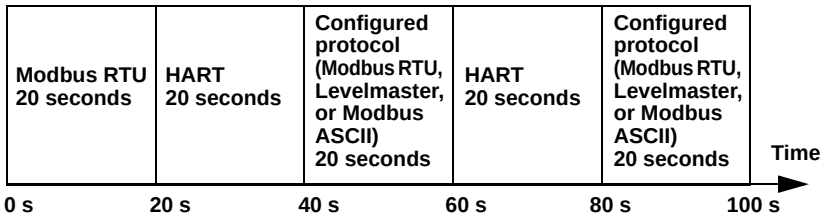
Connect to the MA/MB terminals

The 5300/5400 level transmitter can be configured with RRM using the MA, MB terminals.

An RS-485 Converter is required to connect to the transmitter.

The transmitter will try to establish communication using different protocols during 20 second timeslots from time of startup.

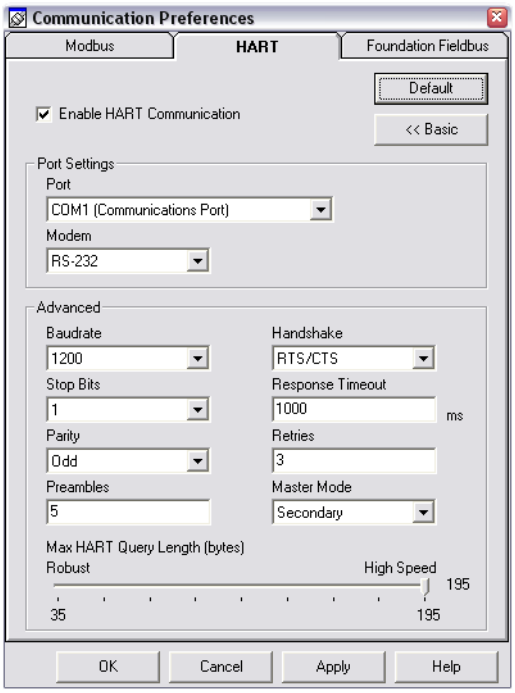
Figure 1-8. RS-485 Communication after startup



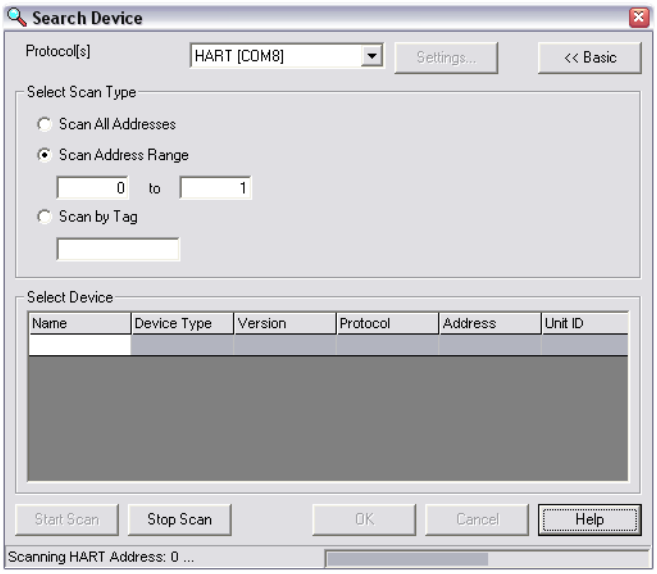
The transmitter will continue to use a communication protocol once communication has been established.

To configure the 5300/5400 level transmitter using RRM and the MA, MB terminals, do the following:

1. Connect the RS-485 Converter to the MA, MB connectors.
2. Start RRM and open Communication Preferences.
3. Enable HART communication and make sure the port for the RS-485 Converter is selected. Use the following settings:



4. Connect the power wires (or cycle power) to the transmitter.
5. Wait 20 seconds and then open the Search Device window in RRM (also see note below). Make sure HART address 1 is being scanned.



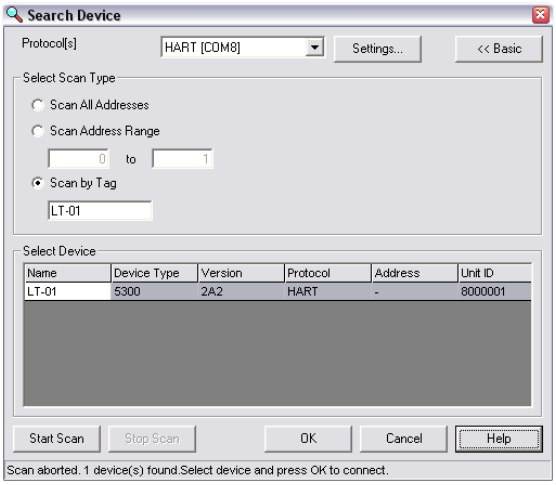
6. Connect to the transmitter and perform the necessary configuration.
7. After completing the configuration, disconnect the RS-485 Converter, connect the Modbus communication wires and cycle power to the transmitter
8. Verify communication between the transmitter and the RTU is established (can take up to 60 seconds from startup).

NOTE

Take the following into consideration if there are multiple 5300/5400 Modbus units on the bus:

By default, the transmitters have HART address 1. It will not be possible to establish communication on HART address 1 if several transmitters have the same address. In this case, there are alternative solutions to establish communication:

1. Select the **Scan by Tag** option in the Search Device window in RRM and enter the HART Device Tag of the transmitter. Communication can now be established with an individual transmitter even if several devices have the same HART address.



2. Make sure the 5300/5400 transmitter is alone on bus. Disconnect or turn off power from any other devices.

Connect to the HART terminals

To configure the 5300/5400 transmitter, connect the communicator or PC to the HART terminals using a HART modem, see Figure 1-3 on page 1-6. Both the configuration tool and the RS-485 bus can be connected simultaneously. Configuration data is sent with HART commands through the HMC to the 5300/5400 transmitter electronics, as illustrated in Figure 1-1 on page 1-3. Note that the power supply must be connected during configuration, see also “Electrical Installation” on page 1-4.

NOTE
Measurement data is not updated to the Modbus Master when a configuration tool is connected.

TRANSMITTER CONFIGURATION

Configuration data such as Tank Height, Upper Null Zone, dielectric constants, and other basic parameters are configured in the same way as for a standard Rosemount 5300/5400 transmitter. For more information, see the Rosemount 5300 Series Quick Installation Guide (Document No. 00825-0100-4530), and the Rosemount 5400 Series Quick Installation Guide (Document No. 00825-0100-4026).

Make sure that the measurement unit of the Primary Variable (PV) matches the configuration of the Modbus Host since the transmitter output value does not include any information on associated measurement units.

For further information on basic configuration, see the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530), and the Rosemount 5400 Series Reference Manual (Document No. 00809-0100-4026).

NOTE
The 5300/5400 transmitter with Modbus protocol is configured to HART address 1 at factory. This reduces power consumption by locking the analog output at 4 mA.

MODBUS COMMUNICATION PROTOCOL CONFIGURATION

The Rosemount 5300/5400 level transmitter can communicate with RTUs using Modbus RTU (often referred to as just “Modbus”), Modbus ASCII, and Levelmaster (also known as “ROS,” “Siemens,” or “Tank” protocol).

Table 1-3. List of RTUs’ Supported Protocols

RTU	Protocols
ABB Totalflow	Modbus RTU, Levelmaster
Bristol ControlWave Micro	Modbus RTU
Emerson Process Management ROC800 Series	Modbus RTU, Levelmaster(1)
Emerson Process Management FloBoss 107	Modbus RTU, Levelmaster(1)
Kimray DACC 2000/3000	Levelmaster
ScadaPack	Modbus RTU
Thermo Electron Autopilot	Modbus RTU, Levelmaster

(1) Levelmaster protocol should be used when using the Emerson Process Management Digital Level Sensor (DLS) User Program or Application Module together with the device. Use Modbus RTU in other cases.

Modbus ASCII is not commonly used, since it doubles the amount of bytes for the same message as the Modbus RTU.

If you do not have any of these RTUs, check your RTU manual to see which protocols it supports.

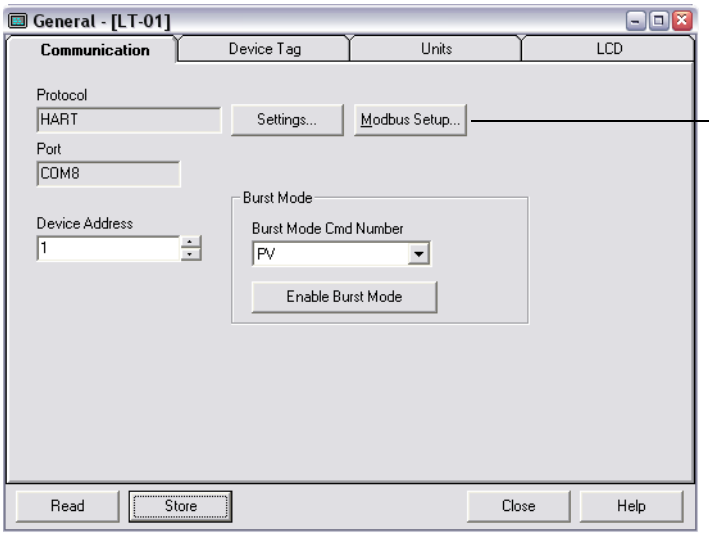
Using RRM to change communication parameters

NOTE
To change Modbus communication parameters, the Rosemount 5300/5400 must use HART address 1, the default address.

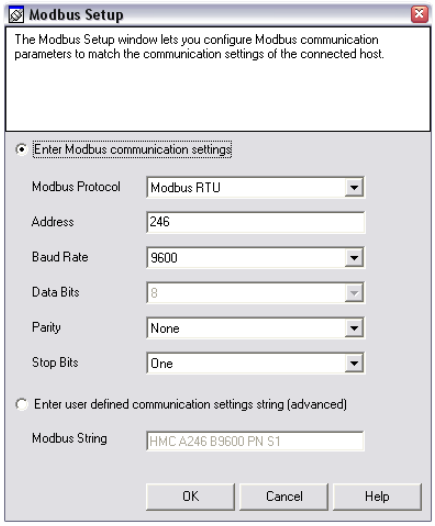
NOTE
After changing communication parameters, disconnect the HART modem and wait at least 60 seconds for the change to take effect.
In case the MA/MB terminals are used for connection to the HMC, disconnect the RS-485 Converter, cycle power to the transmitter and wait up to 60 seconds for the change to take effect.

To change the Modbus address and communication parameters in Rosemount Radar Master (RRM):

1. Start RRM and connect to the transmitter.
2. In RRM, select **Setup>General**.



3. Select the **Communication** tab.
4. Click the **Modbus Setup** button.



5. In the *Modbus Setup* window, select Modbus protocol and type the desired Modbus address.
6. Enter the baud rate, parity, and stop bits, then click the **OK** button.

It is also possible to enter a user-defined Modbus Message in the Modbus String area.

See separate sections below for more details regarding each Modbus protocol.

Using a Field Communicator to change communication parameters

NOTE
To change Modbus communication parameters, the Rosemount 5300/5400 must use HART address 1, the default address.

NOTE
After changing communication parameters, disconnect the Field Communicator and wait up to 60 seconds for the change to take effect.

The Modbus communication parameters can be changed by entering a text string in the HART Message parameter. See separate sections below for details regarding each Modbus protocol and what strings to use.

When using the **Field Communicator,** the Message Area is reached using HART command [2,2,1], and then selecting Message (menu item 11 for Rosemount 5300 and menu item 10 for Rosemount 5400).

Modbus RTU Communication Setup

The Rosemount 5300/5400 is configured with the default Modbus RTU address 246, and with the following Modbus RTU communication parameter default settings:

Table 1-4. Modbus RTU Communication Parameters

Parameter	Default Value	Configurable Values
Baud Rate	9600	1200, 2400, 4800, 9600, 19200
Start Bits(1)	One	One
Data Bits(1)	Eight	Eight
Parity	None	None, Odd, Even
Stop Bits	One	One or Two
Address range	246	1-255

(1) Start Bits and Data Bits cannot be changed.

To reset the communication parameters to default Modbus RTU settings, use the following Modbus Message:

HMC

Modbus RTU Parameter Configuration Example

You want to use address 44 for the 5300/5400 transmitter, and the following communication parameters are used by the host:

Table 1-5. Communication Parameters Used by the Host (example)

Parameter	Value
Baud Rate	4800
Start Bits	One
Data Bits	Eight
Parity	Odd
Stop Bits	Two

To configure the 5300/5400 transmitter to communicate with the Host in this example, the following text string is written to the HART Slave 1 Message Area:

HMC A44 B4800 PO S2.

HMC: These three letters are used for safety and will eliminate the risk of changing the configuration data by mistake.

A44: **A** indicates that the following number is the new address (address 44). Leading zeroes are not needed.

B4800: **B** indicates that the following number is the new baud rate (1200, 2400, 4800, 9600, 19200).

PO: **P** identifies the following letter as parity type (O = odd, E = even, and N = none).

S2: **S** indicates that the following figure is the number of stop bits (1 = one, 2 = two).

Only values that differ from the current values need to be included. For example, if only the address is changed, the following text string is written into the 5300/5400 (HART Slave 1) Message Area:

HMC A127,

indicates that 127 is the new address.

Levelmaster Communication Setup

The default and configurable parameter values can be found in Table 1-6.

Table 1-6. Levelmaster Communication Parameters

Parameter	Default value	Configurable value
Baud Rate	9600	1200, 2400, 4800, 9600, 19200
Start Bits	One	One
Data Bits	Seven	Seven, Eight
Parity	None	None, Odd, Even
Stop Bits	One	One or Two
Address	1	1-99

To reset the communication parameters to default Levelmaster settings, use the following Modbus Message:

HMC M2

Levelmaster Parameter Configuration Example

You want to use address 2 for the 5300/5400 transmitter and the host uses the following parameters:

Table 1-7. Parameters Used by the Host (in case of Levelmaster, example)

Parameter	Value
Baud Rate	9600
Start Bits	One
Data Bits	Seven
Parity	None
Stop Bits	One

To configure the 5300/5400 transmitter to communicate with the Host in this example, the following text string is written to the Modbus Message area.

HMC M2 A2 B9600 D7 PN S1.

NOTE
Include all the parameters when writing to the message area.

Note that an address must be unique on the bus.

HMC: These three letters are used for safety and will eliminate the risk of changing the configuration data by mistake.

M2: This means that the Levelmaster protocol is to be used.

A2: **A** indicates that the following is the new address (address 2). Leading zeroes are not needed.

B9600: **B** indicates that the following number is the new baud rate (1200, 2400, 4800, 9600, 19200).

D7: **D** indicates that the following data bits are to be used (7 = seven, 8 = eight).

PN: **P** identifies the following letter as parity type (O = odd, E = even, and N = none).

S1: **S** indicates that the following figure is the number of stop bits (1 = one, 2 = two).

Note: Start Bits are not configurable and cannot be set.

In Table 1-8 and Table 1-9 is a description of the implemented functions of Levelmaster protocol in the HMC.

Table 1-8. Implemented Functions of Levelmaster Protocol

Input format	Description	Output format
UnnN?	Return ID number	UnnNnnCcccc
UnnNmm	Set ID number	UnnNOKCcccc
UnnF?	Return number of floats	UnnFxCcccc
UnnFx?	Set number of floats	UnnFOKCcccc
Unn?	Return floats and other data	UnnDddd.ddFfffEeeee WwwwCcccc(1)

(1) In this case, number of floats is set to 1. If number of floats is set to 2, the Output Format would be: UnnDddd.ddDddd.ddFfffEeeeeWwwwCcccc

NOTE
If one float is sent, it is “Float1”. If two floats are sent, it is “Float 1” before “Float 0”.

Table 1-9. Letters and Expressions Used in Previous Tables

Letter	Description
nn	nn is used to identify slave to respond, nn is a number 00-99 or ** (wildcard). The EmulCtrl Address Holding register can be configured to a higher value than 99. In that case, the address will be truncated to 99.
mm	mm is the new ID number for the slave; mm is a number 00-99.
x	x is the number of floats returned when slave receives Unn?, x is a number 0-2.
cccc	Is the 16 bit CRC checksum, cccc are hexadecimal characters.
ddd.dd	ddd.dd is the distance value from slave 1. Note that the first d can also be a ‘-’ (minus).
Float 1	Slave 1 PV.
Float 0	Slave 1 SV.
fff	The temperature value. Configured by Holding Register 3208 in HMC.(1)
eeee	An error value. Bit 0: Invalid SV value (Float 0). Bit 8: Invalid Temperature value. Bit 12: Invalid PV value (Float 1).
Wwww	A warning value, not used in this implementation.

(1) Any of the four available variables from any of the five HART slaves can be selected as the temperature source.
The least four significant bits (bit 0-3) select the variable number. Bits 4-7 select the HART slave address. If invalid values are used, the temperature value will be invalid, with no Error bit set.
For example, if we want to use FV from HART Slave 3 as temperature source, we have to write the value 34 Hex (52 decimal).

Modbus ASCII Communication Setup

The parameter, default, and configurable values are shown in Table 1-10 below.

Table 1-10. Modbus ASCII Communication Parameters

Parameter	Default value	Configurable values
Baud Rate	9600	1200, 2400, 4800, 9600, 19200
Start Bits	One	One
Data Bits	Seven	Seven, Eight
Parity	None	None, Odd, even
Stop Bits	One	One or Two
Address	1	1-255

To reset the communication parameters to default Modbus ASCII settings, use the following Modbus Message:

HMC M1

Modbus ASCII Parameter Configuration Example

You want to use address 246 for the 5300/5400 transmitter and the host uses the following parameters:

Table 1-11. Parameters Used by the Host (in case of Modbus ASCII, example)

Parameter	Value
Baud Rate	9600
Start Bits	One
Data Bits	Seven
Parity	None
Stop Bits	One

To configure the 5300/5400 transmitter to communicate with the Host in this example, the following text string is written to the Modbus Message area.

HMC M1 A246 B9600 D7 PN S1.

NOTE
Include all the parameters when writing to the message area.

Note that an address must be unique on the bus.

HMC: These three letters are used for safety and will eliminate the risk of changing the configuration data by mistake.

M1: This means that the Modbus ASCII protocol is to be used.

A246: **A** indicates that the following number is the new address (address 246). Leading zeroes are not needed.

B9600: **B** indicates that the following number is the new baud rate (1200, 2400, 4800, 9600, 19200).

D7: **D** indicates that the following data bits are to be used (7 = seven, 8 = eight).

PN: **P** identifies the following letter as parity type (O = odd, E = even, and N = none).

S1: **S** indicates that the following figure is the number of stop bits (1 = one, 2 = two).

Note: Start Bits are not configurable and cannot be set.

ALARM HANDLING

NOTE
If the Modbus communication setup has been changed, but the transmitter has not yet started to use the new configuration, then you need to disconnect the HART modem and wait up to 60 seconds for the change to take effect.

In case the MA/MB terminals are used for connection to the HMC, disconnect the RS-485 Converter, cycle power to the transmitter and wait up to 60 seconds for the change to take effect.

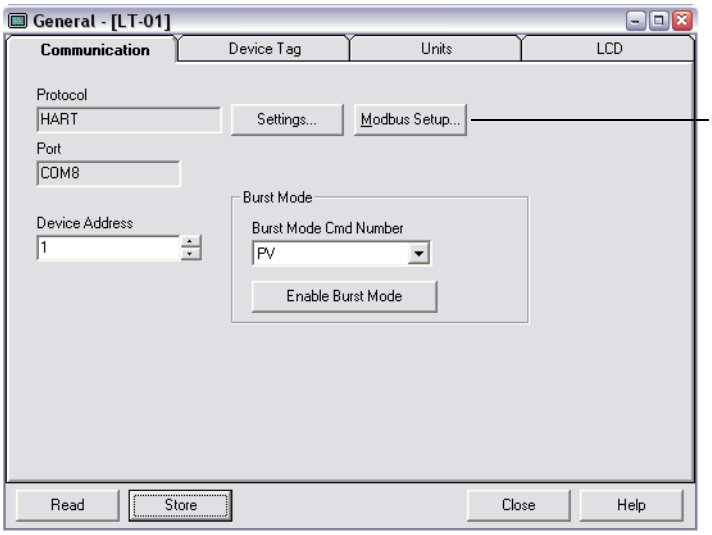
The Modbus communication settings will otherwise be lost if you write a new message to the transmitter.

The output from the Modbus transmitter in case of an error (such as a field device malfunction) can be configured. The values for Modbus registers corresponding to PV, SV, TV, and QV will be changed accordingly (applicable registers in area 1300, 2000, 2100, and 2200).

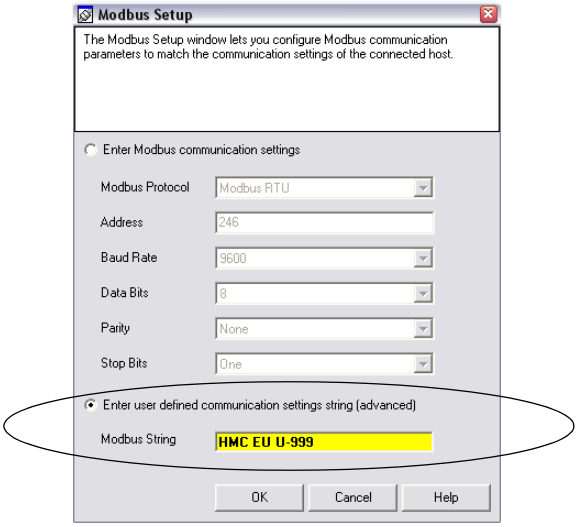
The default alarm output value for each protocol is defined on the next page. Configuring alarm output value is optional.

Use the Modbus string to configure the alarm output. To enter a Modbus string in RRM, do the following (Modbus RTU shown):

1. Start RRM and connect to the transmitter.
2. In RRM, select **Setup>General**.



3. Select the **Communication** tab.
4. Click the **Modbus Setup** button.



5. Enter the Modbus string, and click **OK**.
   See below for available Alarm Output Modbus strings.

Modbus RTU

String	Alarm Output
HMC EN	Not a number (NaN), default
HMC EF	Freeze, hold last value
HMC EU U-0.1	User defined value, -0.1 in this example

Levelmaster

String	Alarm Output
HMC M2 EH	High value, 999.99, default
HMC M2 EL	Low value, -99.99
HMC M2 EF	Freeze, hold last value
HMC M2 EU U0	User defined value (range -99.99 to 999.99), 0 in this example

Modbus ASCII

String	Alarm Output
HMC M1 EN	Not a number (NaN), default
HMC M1 EF	Freeze, hold last value
HMC M1 EU U-0.1	User defined value (range -99.99 to 999.99), -0.1 in this example

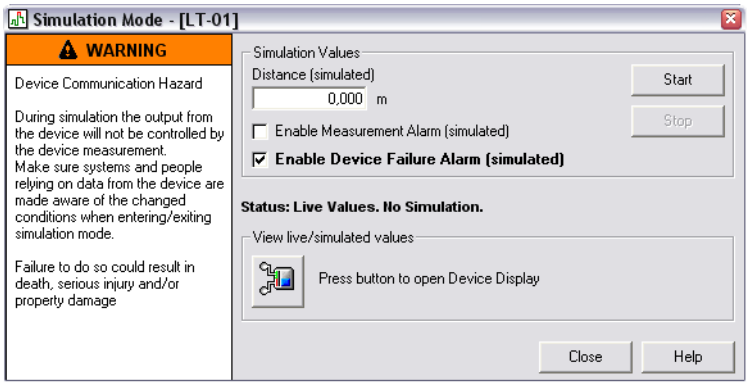
NOTE
After changing the Alarm Output configuration, disconnect the HART modem and wait up to 60 seconds for the change to take effect.

In case the MA/MB terminals are used for connection to the HMC, disconnect the RS-485 Converter, cycle power to the transmitter, and wait up to 60 seconds for the change to take effect.

Verify Alarm Output

To verify the Alarm Output, use RRM to simulate a device failure:

1. Establish HART communication with the transmitter through RRM.
2. Select **Simulation Mode** in the **Tools** menu.



3. Click **Enable Device Failure Alarm (simulated)**.
4. Click the **Start** button.
5. Disconnect HART modem.
6. Verify that the configured alarm output is available in the Modbus host.
7. Use RRM to turn off simulation mode.

Use status information to evaluate measurement validity

The transmitter updates status information about the current measurement, and this status information is available as a bitfield register through Modbus communication.

By monitoring the status information it is possible to determine if the current measurement output value is valid. See “Common Modbus Host Configuration” on page 1-25 for details about the individual status bits.

Use Heartbeat to detect errors

By reading and evaluating the Heartbeat value from the device, it is possible to verify that the communication link between the transmitter, HMC, RTU and even the control system communicating with the RTU is working.

Assign Heartbeat to one of the transmitter variables (SV, TV, or QV). Heartbeat is increased by one for each measurement cycle in the device (until it eventually starts over at zero again).

In case this value is not updated, it means that the communication link is broken.

COMMON MODBUS HOST CONFIGURATION

When using Modbus RTU or Modbus ASCII, the registers to receive status and variables must be configured in the host system.

The transmission of single-precision (4 bytes) IEEE 754 floating point numbers can be rearranged in different byte orders specified by the Floating Point Format Code. The format code information, stated for each Remote Terminal Unit (RTU) respectively, specifies which registers to poll from the 5300/5400 transmitter in order for the RTU to correctly interpret floating point numbers. The byte transmission order for each format code is demonstrated in Table 1-12 below.

Table 1-12. Byte Transmission Order is specified by the Floating Point Format Code

Format Code	Byte transmission order	Description
0	[AB] [CD]	Straight word order, most significant byte first
1	[CD] [AB]	Inverse word order, most significant byte first
2	[DC] [BA]	Inverse word order, least significant byte first
3	[BA] [DC]	Straight word order, least significant byte first

NOTE
Some Modbus hosts cannot read the information described here using Input Registers (Modbus function code 4). The Input Register information can also be read using Holding Register (Function code 3). In this case, Input Register number + 5000 is used as Holding Register number.

Between host system and device, it is recommended to use 60 seconds or less between polls, and three retries.

Input Registers

The register area starting with 1300 can be configured to have any of the four format codes. The configuration is done by setting FloatingPointFormatCode register (holding register 3000) to 0-3, as shown in Table 1-12. This configuration can be done with the Rosemount Radar Master program.

NOTE
Depending on the slave number the 5300/5400 transmitter is using, different registers must be used with the default slave number being 1. Slave number is determined by the HART address.

Table 1-13. Output Variables for the Configurable Floating Point Format (default code 1)

Register Name	Register Number	Note
Slave 1 Status Conf	1300	Bit information in bitfield. Bit 0: Invalid Measurement Slave 1 PV. Bit 1: Invalid Measurement Slave 1 Non PV. Bit 2: Invalid Measurement Slave 1 Non PV. Bit 3: Invalid Measurement Slave 1 Non PV. Bit 14: HART bus busy (slave in burst or other master present) Bit 15: HTM Task not running (option not available). Note: Bit 1-3 is set when Invalid Measurement of Slave 1 Non PV. i.e. all three bits are set simultaneously.
Slave 1 PV Conf	1302	Primary variable from slave 1 represented in IEEE 754 format, using the byte order set in the FloatingPointFormatCode register.
Slave 1 SV Conf	1304	Secondary variable from slave 1 represented in IEEE 754 format, using the byte order set in the FloatingPointFormatCode register.
Slave 1 TV Conf	1306	Tertiary variable from slave 1 represented in IEEE 754 format, using the byte order set in the FloatingPointFormatCode register.
Slave 1 FV Conf	1308	Fourth variable from slave 1 represented in IEEE 754 format, using the byte order set in the FloatingPointFormatCode register.
Slave 2 data	1310-1318	Same data as for Slave 1.
Slave 3 data	1320-1328	Same data as for Slave 1.
Slave 4 data	1330-1338	Same data as for Slave 1.
Slave 5 data	1340-1348	Same data as for Slave 1.

The Rosemount 5300/5400 register area starting with register 2000 is used for hosts that require Floating Point Format Code 0 (see Table 1-14).

Floating Point Format Codes 2 and 3 use register areas 2100 and 2200, respectively (see Table 1-15 and Table 1-16).

Table 1-14. Output Variables for Floating Point Format Code 0

Register Name	Register Number	Note
Slave 1 Status	2000	Bit information in bitfield: Bit 0: Invalid Measurement Slave 1 PV. Bit 1: Invalid Measurement Slave 1 SV. Bit 2: Invalid Measurement Slave 1 TV. Bit 3: Invalid Measurement Slave 1 FV. Bit 14: HART bus busy (slave in burst or other master present) Bit 15: HTM Task not running (option not available). Note: Bit 1-3 is set when Invalid Measurement of Slave 1 Non PV, i.e. all three bits are set simultaneously.
Slave 1 PV	2002	Primary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 0.
Slave 1 SV	2004	Secondary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 0.
Slave 1 TV	2006	Tertiary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 0.
Slave 1 FV (QV)	2008	Fourth variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 0.

Table 1-15. Output Variables for Floating Point Format Code 2

Register Name	Register Number	Note
Slave 1 Status	2100	Bit information in bitfield: Bit 0: Invalid Measurement Slave 1 PV. Bit 1: Invalid Measurement Slave 1 SV. Bit 2: Invalid Measurement Slave 1 TV. Bit 3: Invalid Measurement Slave 1 FV. Bit 14: HART bus busy (slave in burst or other master present) Bit 15: HTM Task not running (option not available). Note: Bit 1-3 is set when Invalid Measurement of Slave 1 Non PV, i.e. all three bits are set simultaneously.
Slave 1 PV	2102	Primary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 2.

Register Name	Register Number	Note
Slave 1 SV	2104	Secondary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 2.
Slave 1 TV	2106	Tertiary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 2.
Slave 1 FV (QV)	2108	Fourth variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 2.

Table 1-16. Output Variables for Floating Point Format Code 3

Register Name	Register Number	Note
Slave 1 Status	2200	Bit information in bitfield: Bit 0: Invalid Measurement Slave 1 PV. Bit 1: Invalid Measurement Slave 1 SV. Bit 2: Invalid Measurement Slave 1 TV. Bit 3: Invalid Measurement Slave 1 FV. Bit 14: HART bus busy (slave in burst or other master present) Bit 15: HTM Task not running (option not available). Note: Bit 1-3 is set when Invalid Measurement of Slave 1 Non PV, i.e. all three bits are set simultaneously.
Slave 1 PV	2202	Primary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 3.
Slave 1 SV	2204	Secondary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 3.
Slave 1 TV	2206	Tertiary variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 3.
Slave 1 FV (QV)	2208	Fourth variable from slave 1 represented in IEEE 754 format, using Floating Point Format Code 3.

Measurement Units

Measurement units for the various HART slaves are stored in input registers as a Unit Code presented in Table 1-17. Conversion from Unit Code to measurement unit is given in Table 1-18 on page 1-29.

Table 1-17. Measurement units and corresponding input registers

Register Name	Register Number	Note
Slave 1 PV Units	104	See Table 1-18 for conversion from Unit Code to Measurement Unit.
Slave 1 SV Units	108	
Slave 1 TV Units	112	
Slave 1 FV (QV) Units	116	

Table 1-18. Conversion of Unit Code to Measurement Unit

Unit Code	Measurement Unit	Unit Code	Measurement Unit
Volume		**Length**	
40	US Gallon	44	Feet
41	Liters	45	Meters
42	Imperial Gallons	47	Inches
43	Cubic Meters	48	Centimeters
46	Barrels	49	Millimeters
111	Cubic Yards	**Temperature**	
112	Cubic Feet	33	Degree Fahrenheit
113	Cubic Inches	32	Degree Celsius

SPECIFIC MODBUS HOST CONFIGURATION

The Remote Terminal Unit needs to be configured to communicate and correctly interpret data when reading input registers from the Rosemount 5300/5400 transmitter.

Baud Rate

The specified Baud Rates below are recommendations. If other Baud Rates are used, make sure that the 5300/5400 and the RTU are configured for the same communication speed.

Floating Point Format Code

See Section “Common Modbus Host Configuration” on page 1-25.

RTU Data Type

The RTU Data Type specifies which configuration to use in the RTU in order for the RTU to correctly interpret a floating point number transmitted from the 5300/5400 transmitter with Modbus.

Input Register Base Number

Data registers in the 5300/5400 transmitter with Modbus are numbered exactly as they are transmitted in the Modbus communication. Some RTUs use different naming conventions and to configure the RTU to poll the correct registers from the 5300/5400 Modbus, an Input Register Base Number is stated for each RTU respectively. E.g. if the input register base number is 1 for the RTU, the 5300/5400 Modbus input register 1302 has to be entered in the RTU address as input register 1303.

Emerson Process Management ROC800 Series

Figure 1-9. Wiring Diagram for Connecting 5300/5400 Modbus to Emerson Process Management ROC800 Series

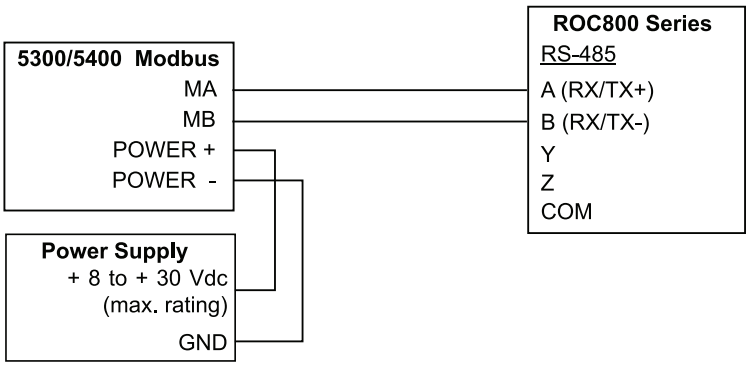


Table 1-19. Parameter Values (in case of Emerson Process Management ROC800 Series)

Parameter	Value
Baud Rate	9600
Floating Point Format Code	0
RTU Data Type	Conversion Code 66
Input Register Base Number	0

The Input Register Base Number needs to be added to the Input Register address of the 5300/5400 transmitter. In this case, register 1300 needs to have 1300 entered as the address.

Emerson Process Management FloBoss 107

Figure 1-10. Wiring Diagram for Connecting 5300/5400 Modbus to Emerson Process Management FloBoss 107

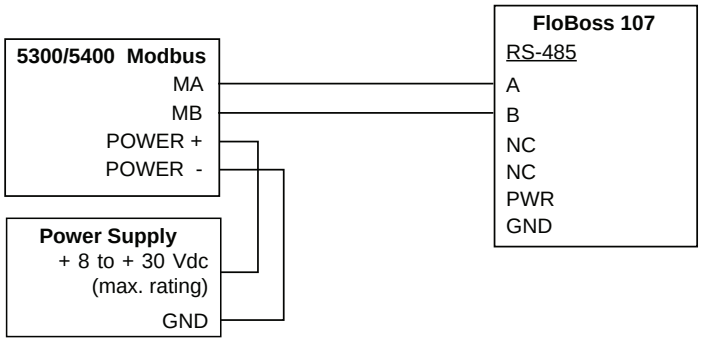


Table 1-20. Parameter Values (in case of Emerson Process Management FloBoss 107)

Parameter	Value
Baud Rate	9600
Floating Point Format Code	0
RTU Data Type	Conversion Code 66
Input Register Base Number	0

The Input Register Base Number needs to be added to the Input Register address of the 5300/5400 transmitter. In this case, register 1300 needs to have 1300 entered as the address.

ABB TotalFlow

Figure 1-11. Wiring diagram for connecting 5300/5400 Modbus to ABB TotalFlow

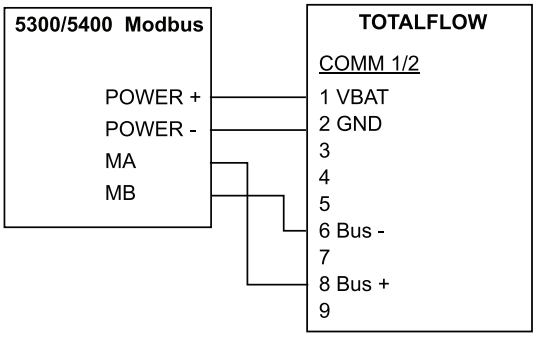


Table 1-21. Parameter Values (in case of ABB TotalFlow)

Parameter	Value
Baud Rate	9600
Floating Point Format Code	0
RTU Data Type	16 Bit Modicon
Input Register Base Number	1

The Input Register Base Number needs to be added to the Input Register address of the 5300/5400 transmitter. In this case, register 1302 needs to have 1303 entered as the address etc.

Thermo Electron Autopilot

Figure 1-12. Wiring Diagram for Connecting 5300/5400 Modbus to Thermo Electron Autopilot

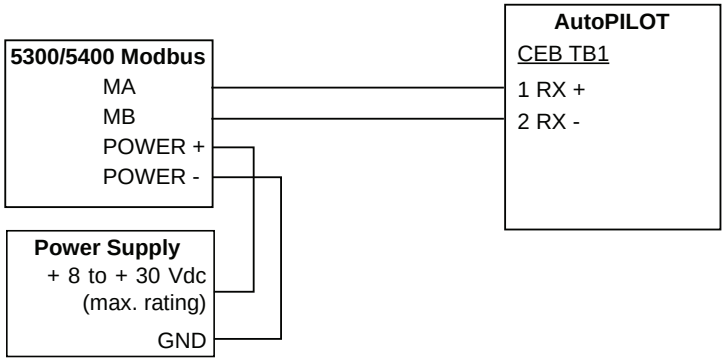


Table 1-22. Parameter Values (in case of Thermo Electron Autopilot)

Parameter	Value
Baud Rate	9600
Floating Point Format Code	1
RTU Data Type	IEEE Flt 2R
Input Register Base Number	0

The Input Register Base Number needs to be added to the Input Register address of the 5300/5400 transmitter. In this case, register 1302 needs to have 1302 entered as the address etc.

Bristol ControlWave Micro

Figure 1-13. Wiring Diagram for Connecting 5300/5400 Modbus to Bristol ControlWave Micro

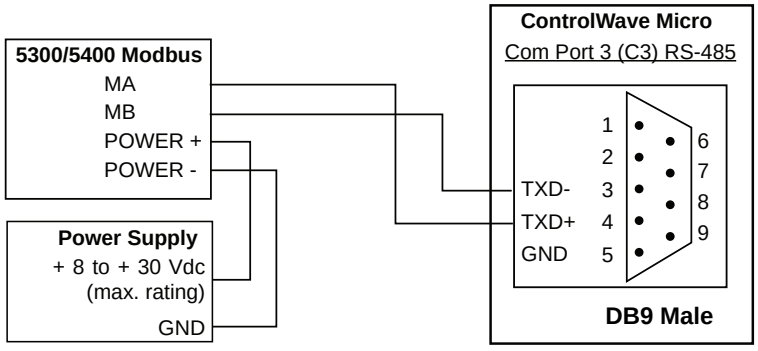


Table 1-23. Parameter Values (in case of Bristol ControlWave Micro)

Parameter	Value
Baud Rate	9600
Floating Point Format Code	2 (FC 4)
RTU Data Type	32-bit registers as 2 16-bit registers
Input Register Base Number	1

The Input Register Base Number needs to be added to the Input Register address of the 5300/5400 transmitter. In this case, register 1302 needs to have 1303 entered as the address etc.

ScadaPack

Figure 1-14. Wiring Diagram for Connecting 5300/5400 Modbus to SCADAPack 32

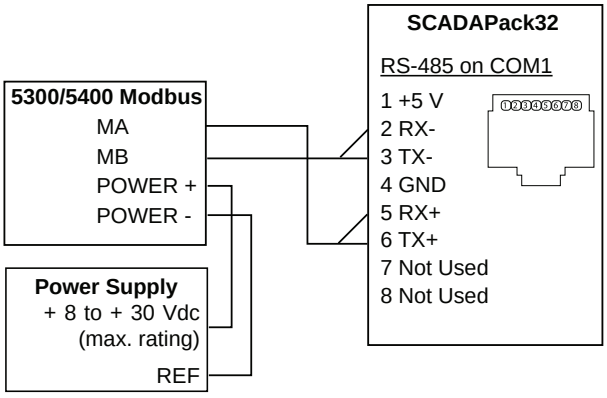


Table 1-24. Parameter Values (in case of SCADAPack 32)

Parameter	Value
Baud Rate	9600
Floating Point Format Code	0
RTU Data Type	Floating Point
Input Register Base Number	30001

The Input Register Base Number needs to be added to the Input Register address of the 5300/5400 transmitter. In this case, register 1302 needs to have 31303 entered as the address etc.

Kimray DACC 2000/3000

This table shows input types in Kimray IMI software and the corresponding value. The communication port must be configured to use “Tank Levels” protocol.

Table 1-25. Kimray Input Types and Corresponding Values

Kimray Inp type	5300/5400 variable	Format
Tank Level1	PV	ddd.dd.alt. -dd.dd
Tank Level2	SV	ddd.dd.alt -dd.dd

TROUBLESHOOTING

No communication on RS-485 bus (MA, MB)

- Check that the cables are connected
- Check that PWR+ is connected to + and PWR- is connected to - on the power supply
- Make sure the 5300/5400 transmitter is supplied with 8-30 Vdc (max. rating)
- Try alternating MA/MB if you are unsure of the polarity
- If an RS-485 converter is used, make sure it is properly installed and configured
- The last 5300/5400 transmitter may need a terminating 120-Ω resistor connected between MA and MB

No 5300/5400 communication in RRM

- Using HART+, HART-
  - HART modem is not properly connected
  - Polling address is incorrect in RRM (default 1)
- Using MA, MB
  - See *No communication on RS-485 bus*
  - Polling address is incorrect in RRM (default 1)
  - Cycle the power and wait 20 seconds before polling

No communication with Modbus RTU protocol

- See *No communication on RS-485 bus*
- Make sure the “Modbus Communication Protocol Configuration” is done properly
- Make sure the Modbus RTU address is unique on the bus
- Cycle the power and try to connect
- Check the RTU communication settings

No communication with Modbus ASCII protocol

- See *No communication on RS-485 bus*
- Make sure the “Modbus Communication Protocol Configuration” is done properly
- Make sure the Modbus ASCII address is unique on the bus
- Cycle the power, waiting 40 seconds before communication begins
- Check the RTU communication settings

No communication with Levelmaster protocol

- See *No communication on RS-485 bus*
- Make sure the “Modbus Communication Protocol Configuration” is done properly
- Make sure the Levelmaster address is unique on the bus
- Cycle the power, waiting 40 seconds before communication begins
- Check the RTU communication settings

HMC FIRMWARE UPGRADE IN ROSEMOUNT RADAR MASTER

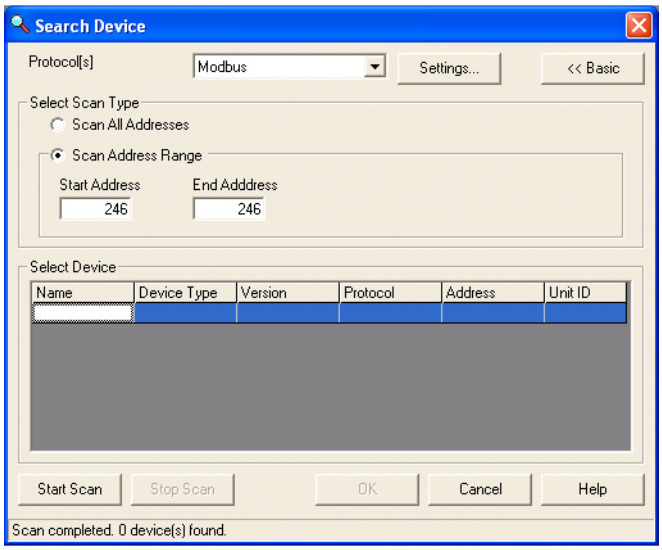
The HMC's firmware is upgraded using Rosemount Radar Master (RRM). A detailed description on how to carry out the firmware upgrade is shown on the following pages.

NOTE
All settings in the HMC will be lost after upgrading the transmitter. Reconfiguration of Modbus communication setup and alarm handling is required after completing the upgrade.

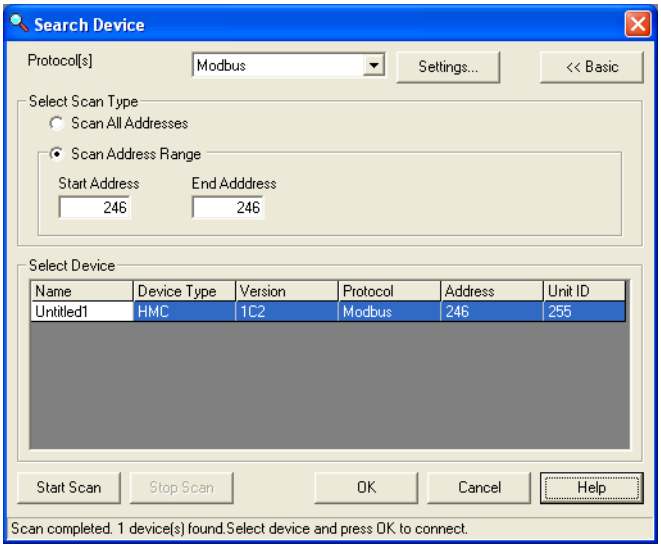
NOTE
During firmware upgrade, the HMC Modbus RTU address must be 246, the default address. Make sure to disconnect other Modbus RTU devices that are connected and have address 246.

NOTE
Do not interrupt communication between the PC and the 5300/5400 level transmitter during the firmware upload.

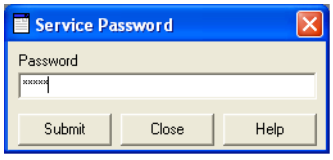
1. Start RRM and select **Communication Preferences** in the **View** menu.
2. Navigate to the Modbus tab and use the following settings:
   - Modem: RS-485
   - Baudrate: According to configuration in HMC (default 9600)
   - Stop Bits: According to configuration in HMC (default 1)
   - Parity: According to configuration in HMC (default None)
   - Handshake: RTS/CTS
   - Response Timeout: 1000 ms
   - Retries: 3
3. Select **Enable Modbus Communication** and click **OK**.



4. If the HMC is configured for Modbus ASCII or Levelmaster communication cycle the power to the transmitter (the HMC will then communicate using Modbus RTU for 20 seconds and under that time it is possible to connect with RRM).
5. Open the *Search Device* window and make sure Modbus is selected in the Protocol list.

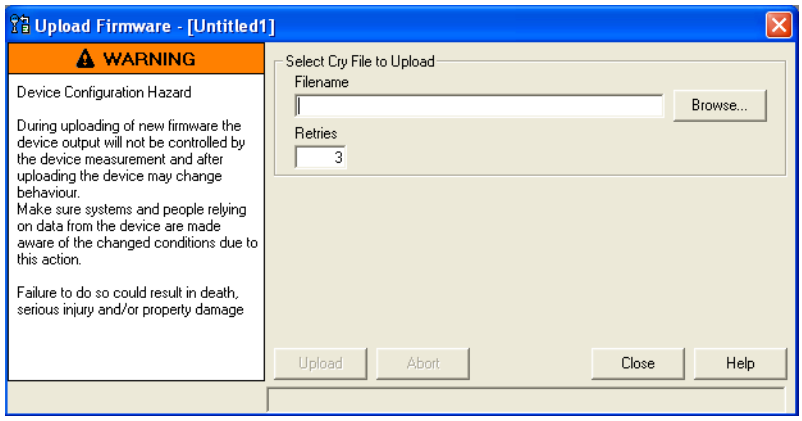


6. Search for HMCs by selecting “Scan Address Range”, and choose a start and end address for Modbus. The default HMC Modbus address is 246.
7. Click the **Start Scan** button.
8. Click **OK** to connect when the device is found.
9. From the Service menu, choose the **Enter Service Mode** option.

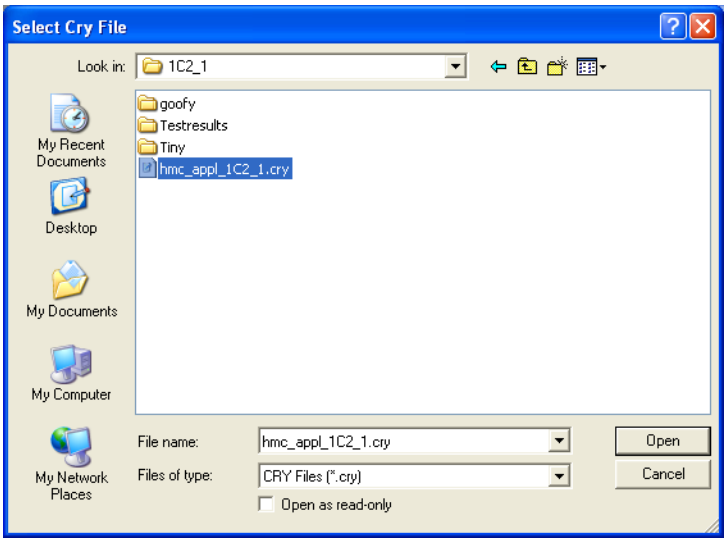


10. Type password, “admin”.

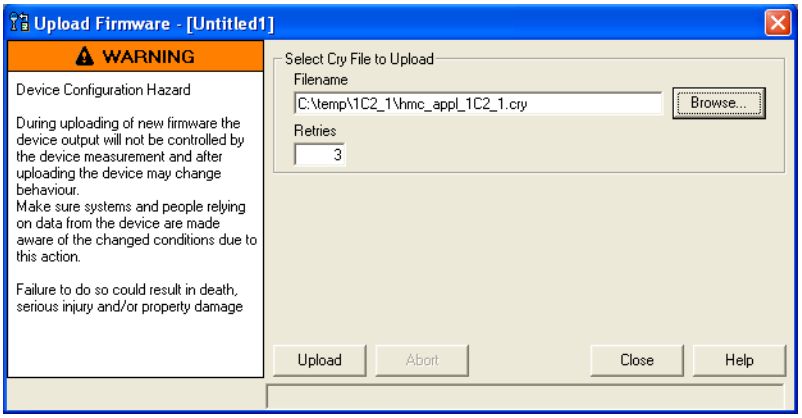
11. From the Service menu, choose the **Upload Firmware** option.



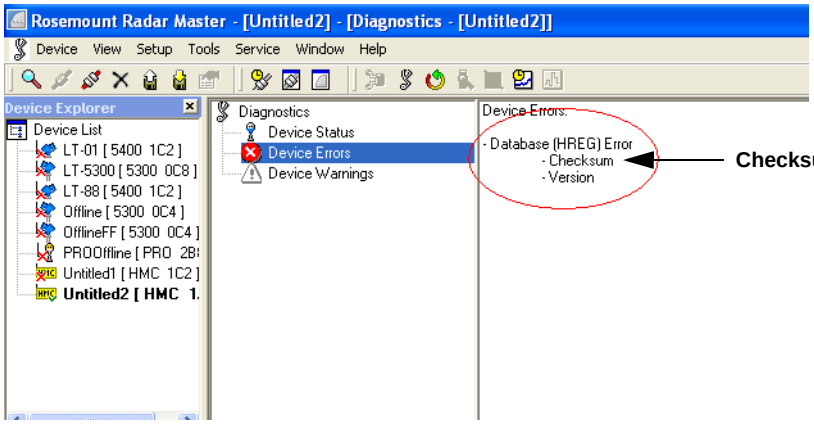
12. Click **Browse.**



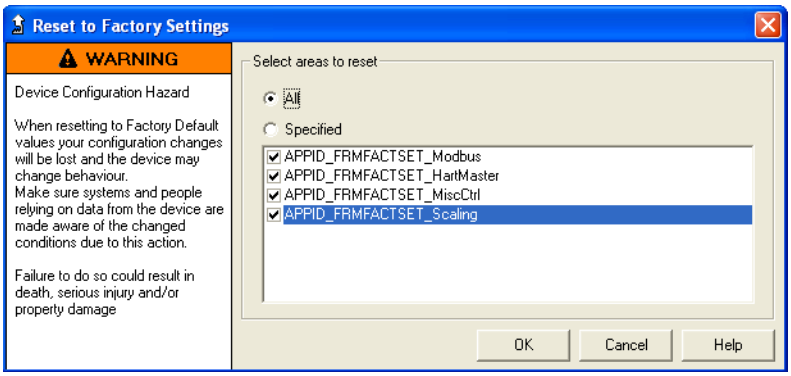
13. Select the upgrade **".cry"** file.
14. Click **Open**.



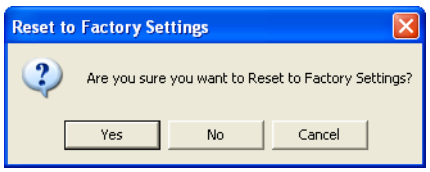
15. Click the **Upload** button to start the firmware upgrade.
16. When upload is finished, select **Diagnostics** in the **Tools** menu.



17. Click **Device Errors** and check for “Checksum”.
18. If it is on the list, choose the **Factory Settings** option from the Tools menu.



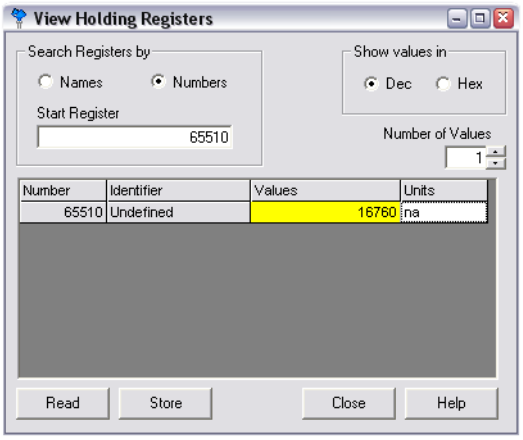
19. Select **All** and click **OK**.



20. Select **“Yes”**.

NOTE
An error message might be displayed when performing the Reset to Factory Settings operation. The operation has been successful if the checksum error has been cleared.

21. Select **Restart** in the **Tools** menu to restart the HMC.
22. The checksum error should no longer be present (select **Diagnostics** in the **Tools** menu to verify, see Step 16). If it still persists, follow the next steps.
23. Select **View Holding Registers** in the **Service** menu and write the value 16760 to register 65510.



24. Restart the HMC.
25. If the HMC is configured for Modbus ASCII or Levelmaster communication after upload has been completed, proceed with the following:
    1. Close RRM and disconnect the RS-485 converter from the HMC.
    2. Cycle the power to the HMC to have it exit Modbus RTU communication mode.

SPECIFICATIONS

Table 1-26. Specifications

Power supply	8-30 Vdc (max. rating)
Power consumption	< 0.5 W (with HART address=1) < 1.2 W (incl. four HART slaves)
Signal wiring	Two-wire half duplex RS-485 Modbus. Use shielded twisted pair wiring, preferably with an impedance of 120Ω (typically 24 AWG), in order to comply with EIA-485 standard and EMC regulations.
Power supply cabling	The power supply cables must be suitable for the supply voltage and ambient temperature, and approved for use in hazardous areas, where applicable.
Ground (common mode) voltage limit	± 7 V
Bus termination	Standard RS-485 bus termination per EIA-485

See the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530), and the Rosemount 5400 Series Reference Manual (Document No. 00809-0100-4026) for further specifications.

Rosemount 5300/5400 Series

Manual Supplement
00809-0500-4530, Rev AA
October 2010

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