



600/700 Series Modbus

Instruction Manual

Modbus Device Specification for Models:
620S, 620S-BT, 640S, 760S, 780S, and 780S-UHP
Thermal Mass Flow Meters



Part Number: IM600/700 Modbus, Rev. V1.1
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Warnings and Cautions



Warning! Agency approval for hazardous location installations varies between flow meter models. Consult the flow meter nameplate for specific flow meter approvals before any hazardous location installation.

Warning! Hot tapping must be performed by a trained professional. U.S. regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such a permit.

Warning! All wiring procedures must be performed with the power off.

Warning! To avoid potential electric shock, follow National Electric Code safety practices or your local code when wiring this unit to a power source and to peripheral devices. Failure to do so could result in injury or death. All AC power connections must be in accordance with published CE directives.

Warning! Do not power the flow meter with the sensor remote (if applicable) wires disconnected. This could cause over-heating of the sensors and/or damage to the electronics.

Warning! Before attempting any flow meter repair, verify that the line is de-pressurized.

Warning! Always remove main power before disassembling any part of the mass flow meter.



Caution! Before making adjustments to the device, verify the flow meter is not actively monitoring or reporting to any master control system. Adjustments to the electronics will cause direct changes to flow control settings.

Caution! All flow meter connections, isolation valves and fittings for hot tapping must have the same or higher pressure rating as the main pipeline.

Caution! Changing the length of cables or interchanging sensors or sensor wiring will affect the accuracy of the flow meter. You cannot add or subtract wire length without returning the meter to the factory for re-calibration.

Caution! When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the meter.

Caution! The AC wire insulation temperature rating must meet or exceed 80°C (176°F).

Caution! Printed circuit boards are sensitive to electrostatic discharge. To avoid damaging the board, follow these precautions to minimize the risk of damage:

- before handling the assembly, discharge your body by touching a grounded, metal object
- handle all cards by their edges unless otherwise required
- when possible, use grounded electrostatic discharge wrist straps when handling sensitive components

Note and Safety Information

We use caution and warning statements throughout this book to draw your attention to important information.



Warning!

This statement appears with information that is important to protect people and equipment from damage. Pay very close attention to all warnings that apply to your application.



Caution!

This statement appears with information that is important for protecting your equipment and performance. Read and follow all cautions that apply to your application.

Receipt of System Components

When receiving a Sierra mass flow meter, carefully check the outside packing carton for damage incurred in shipment. If the carton is damaged, notify the local carrier and submit a report to the factory or distributor. Remove the packing slip and check that all ordered components are present. Make sure any spare parts or accessories are not discarded with the packing material. Do not return any equipment to the factory without first contacting Sierra Customer Service.

Technical Assistance

If you encounter a problem with your flow meter, review the configuration information for each step of the installation, operation, and setup procedures. Verify that your settings and adjustments are consistent with factory recommendations. Installation and troubleshooting information can be found in the [SteelMass™ 640S](#) and [FlatTrak™ 780S \(includes 760S and 780S-UHP\)](#) Series product manuals.

If the problem persists after following the troubleshooting procedures outlined in the 640S or 780S product manuals, contact Sierra Instruments by fax or by E-mail (see inside front cover). For urgent phone support you may call (800) 866-0200 or (831) 373-0200 between 8:00 a.m. and 5:00 p.m. PST. In Europe, contact Sierra Instruments Europe at +31 20 6145810. In the Asia-Pacific region, contact Sierra Instruments Asia at +86-21-58798521. When contacting Technical Support, make sure to include this information:

- The flow range, serial number, and Sierra order number (all marked on the meter nameplate)
- The software version (visible at start up)
- The problem you are encountering and any corrective action taken
- Application information (gas, pressure, temperature and piping configuration)

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Chapter 1: Introduction

Modbus is a serial communications protocol first published by Modicon in 1979 for use with its programmable logic controllers (PLCs). It's simple and robust, royalty free and it has since become a de facto standard communication protocol, and it is now a commonly available means of connecting industrial electronic devices in the USA.

Modbus allows for communication between many devices (nodes) connected to the same network. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. It supports many data types, including:

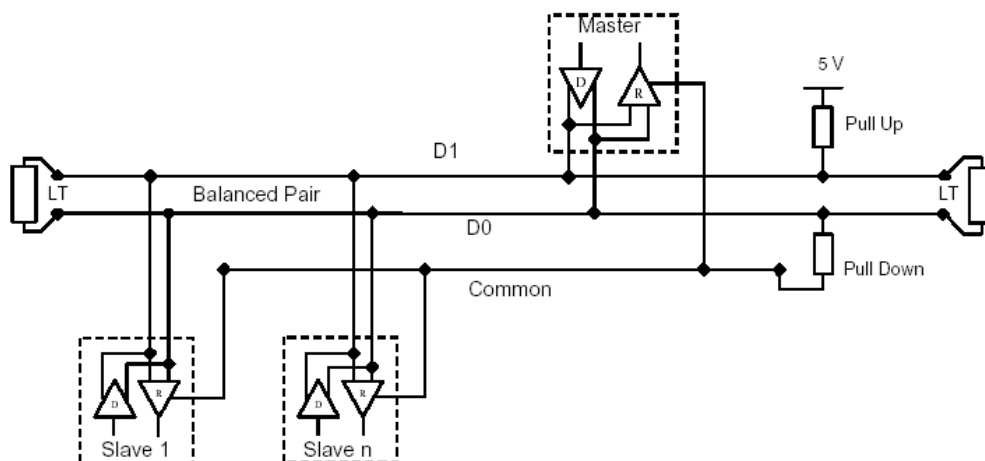
- Floating point IEEE 754 (Real)
- 32-bit integer
- 8-bit ASCII data
- 16-bit integer
- Mixed data types
- Bit fields in integers
- Multipliers to change data to/from integer. 10, 100, 1000, 256 ...

For more information about MODBUS see; <http://www.Modbus.org/>

RS-485 Network

The 640S/780S MODBUS-RTU interface option uses a common 2 wire RS-485 bus. RS-485 only specifies electrical characteristics of the generator and the receiver. It does not specify or recommend any communications protocol or Data link layer. It only describes the physical layer. However unlike proprietary RS-485 based field buses, MODBUS uses the same Data Link layer used by PCs. This allows the MODBUS RS-485 Master interface to be cheap and widely available.

MODBUS-RTU uses a 2 wire RS-485 network as shown below:



The “RS-485 – A” (also referred as ‘-’) is connected with the D0 line. The “RS-485 – B” (also referred as ‘+’) is connected with the D1 line. The shield is typically connected to the common line of the network.

A maximum of 32 devices per segment is authorized on an RS-485 system without the need of a repeater. Using repeaters, 240 nodes may be used.

Cable

It is recommended to use a twisted pair type of cable (reduces radiated and received EMI). Category 5 cables may be used to a maximum length of 600 meters. To operate at cable lengths of 1000 meter it is advised to use AWG 26 or lower.

Terminator

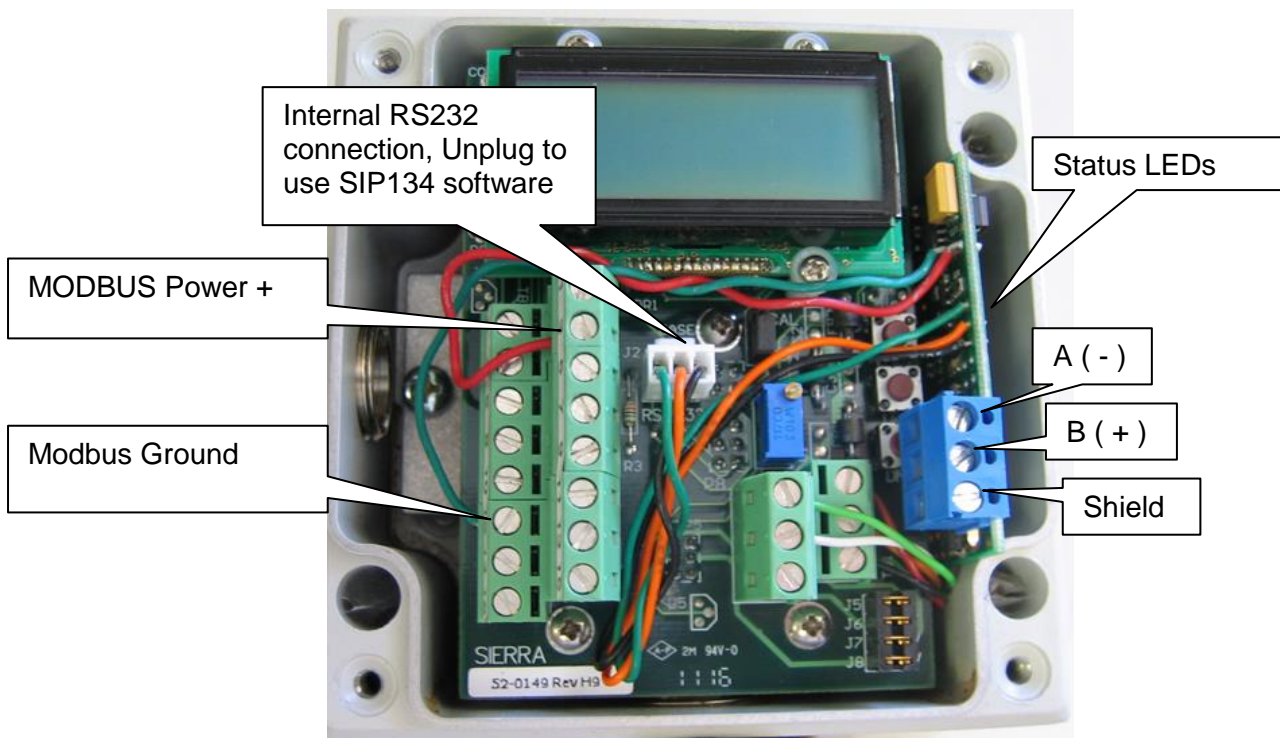
Reflections in a transmission line can cause communication errors. To minimize the reflection it is required to place terminator resistors at both ends of the cable. Never place a terminator resistor somewhere along the cable; they need to be at the end of the bus. The use of line terminators depends on cable lengths and should be determined on site. Typical values for terminator resistors are 120-150 ohm * (0.5 W).

Line Polarization

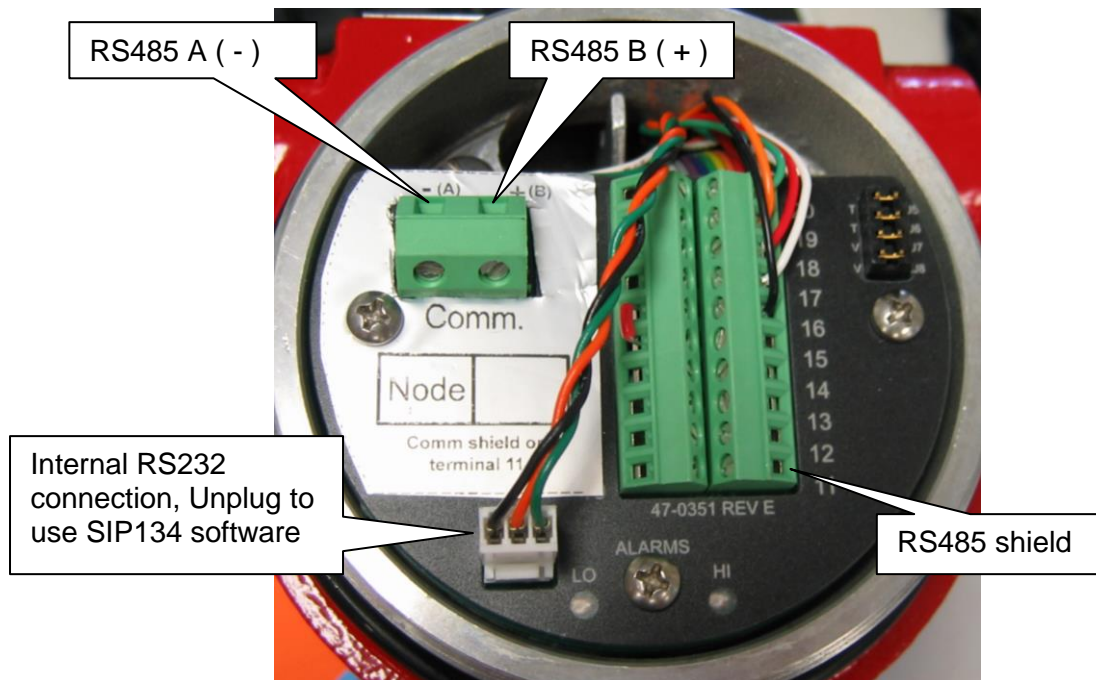
In noisy environments it may be necessary to polarize the lines to ensure that the receivers stay in a constant state when no signal is present. The polarization must be implemented at one location for the whole bus. The value for the pull up and pull down resistors is between 450 and 650 ohms * (a higher value permits more devices to be connected to the bus).

* For specific resistor values and other bus requirements consult your RS-485 master's documentation.

NEMA 4X (EN2) Enclosure Version Modbus Connections



Explosion Proof (E2/E4) Enclosure Version Modbus Connections



The Modbus PCA is mounted on the other side of the enclosure. Unscrew display side lid to view Status LEDs if necessary.

The Modbus Interface Board

The Modbus PCA is mounted on alongside the terminal board on the EN2 enclosure and under the LCD where the AC Power Supply would be mounted on the E2/E4 enclosures.

The Modbus board is a small PCA measuring 35 x 55 mm. Communication with the MODBUS network is done through an optical isolated RS-485 driver. The MODBUS translates the 640S internal RS232 into MODBUS.

Status LED's on the MODBUS:

LED 1	LED 2	Status
2 Green flashes	Off then Red	Boot loader window sequence
Red	Red	Initializing after Boot loader sequence
Blinking Green	Off	RS232 working, RS-485 not working
Blinking Green	Red	RS232 working, RS-485 working (blink each poll)

Board Overview

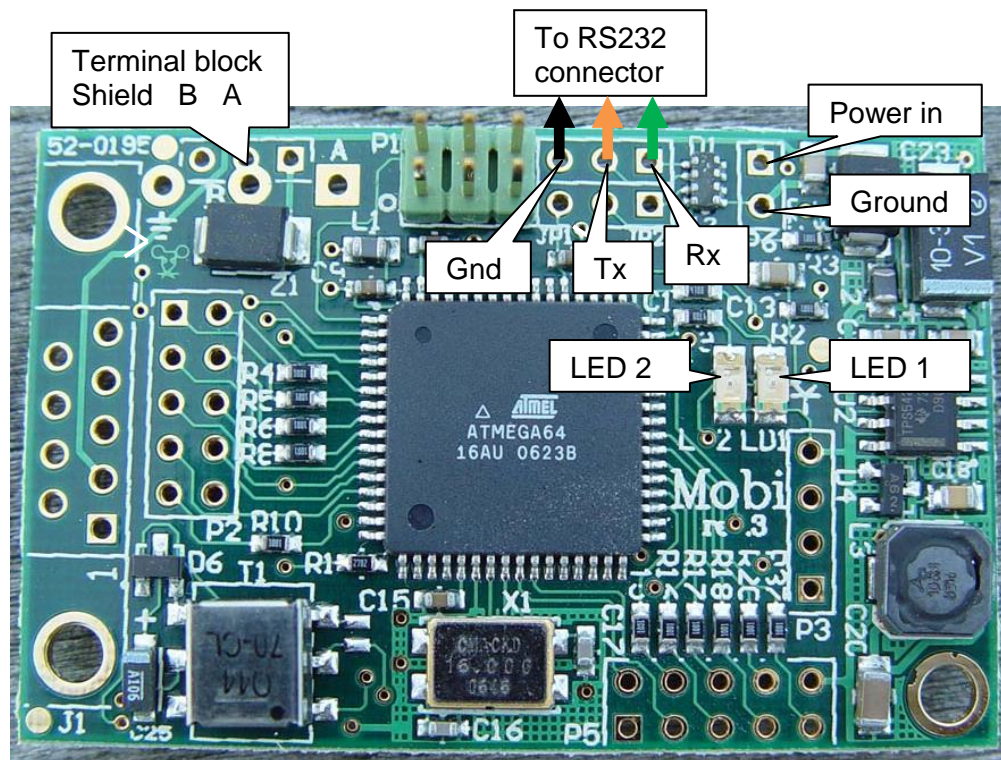


Figure 1 Top View

Power Supply

Pin	Function
1□*	Power in (8 ~ 30 VDC)
2	Ground


RS-232 Port

Pin	Function
1□*	Receive (input)
2	Transmit (output)
3	Ground

Isolated RS-485

Pin	Function
1□*	A - Non-inverting output / input
2	B - Inverting output / input
3	Shield (RS-485 GND)

The shield can be connected to the ground/shielding of the network cable. Don't connect shield with ground when electrical isolation is required.

	<p>*Important Tip! Pin 1 on the PCA is identified by a square pad (□).</p>
---	---

Chapter 2 - Interface Setup

Modbus is setup using the internal boot loader program rather than DIP switches. The boot loader can be accessed using a terminal program. In order to setup Modbus a PC needs to be equipped with an RS-485 interface.

In this example 'HyperTerminal' from Microsoft will be used.

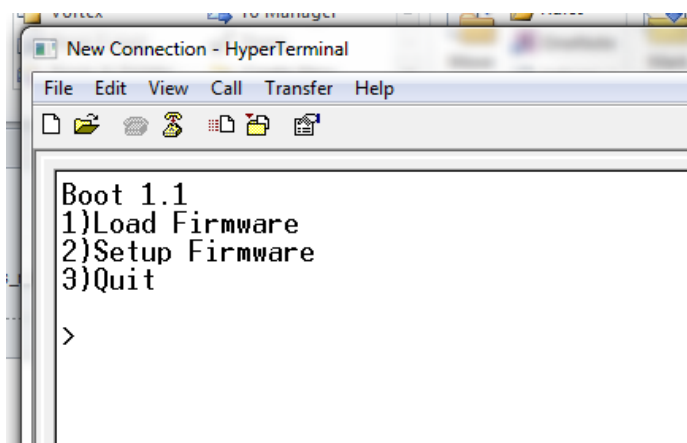
Start HyperTerminal from Windows and select the com port to which the RS-485 interface is connected. Use the following settings:

Baud rate:	9600
Number of bits:	8
Parity:	N
Stop bits:	1
Flow Control	None

The boot loader window will only be active during the first 2 seconds after a power-up or reset. During power-up on the MODBUS the green LED will blink twice before executing the MODBUS application. To enter the boot loader, follow the next steps:

1. Power up the unit
2. In HyperTerminal press the Enter key within 2 seconds of power up. If you miss the 2 second boot loader window, cycle the power and try again.

The following menu should be presented on the screen once the boot loader has started:



Firmware Setup:

Press the '2' key, 2) Setup Firmware to set up the firmware.

Enter C, to change the option, or N to skip to the next option.

In the example below, the ID code (address) of the unit can be set between 1-247 and the current setting is 1.

Other available options are also shown.

```

Boot 1.1
1)Load Firmware
2)Setup Firmware
3)Quit


>2
Firmware:v1.4
ID (1-247)=1
(C)hange (N)ext
Baudrate (1=4800,2=9600,3=19K2,4=38K4,5=57K6)=3
(C)hange (N)ext
Parity (1=None,2=Odd,3=Even)=3
(C)hange (N)ext
Response delay (ms)=4
(C)hange (N)ext
Tag=Inds-v13
(C)hange (N)ext
FP byte order (0=4321,1=2143,2=1234,3=3412)=3
(C)hange (N)ext_

```

Pressing the “C” or “c” key will prompt for a new value. Enter a new value and press the “Enter” key. The new value will be stored and the next option will be presented (if available). Data which can be entered must match the type presented. So in the above example only numbers can be entered. Characters will be ignored. Also the size of the entry will be limited depending on the maximum size allowed.

When all options have been viewed the default boot menu will be presented again. The options presented will depend on the firmware.

Hint: While entering a new value the “Backspace” key can be used to erase entered values

	<p>Note It is advised to only enter values which are shown between the brackets. Other values may be entered but could result in the unit not functioning correctly.</p>
---	---

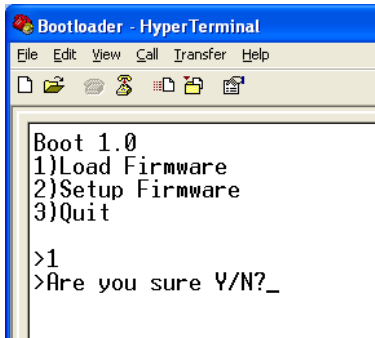
Quit

This option will quit the boot loader and will start the MODBUS application.

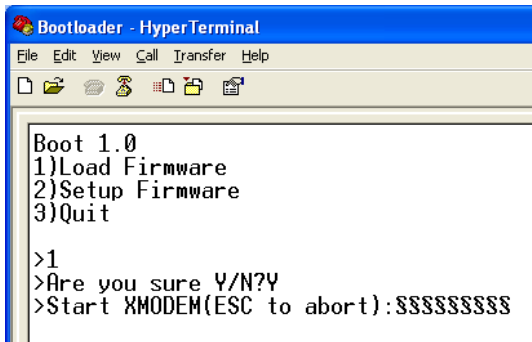
Press the ‘3’ key (Quit) to run the application or perform a power cycle to start the application. If you do not the MODBUS application will not start.

Loading New Firmware

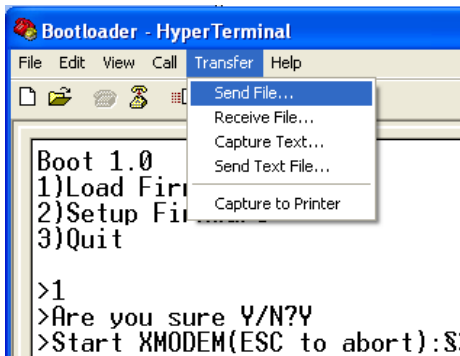
This option is used to download firmware to the unit. When pressing the “1” key the following screen will be presented:



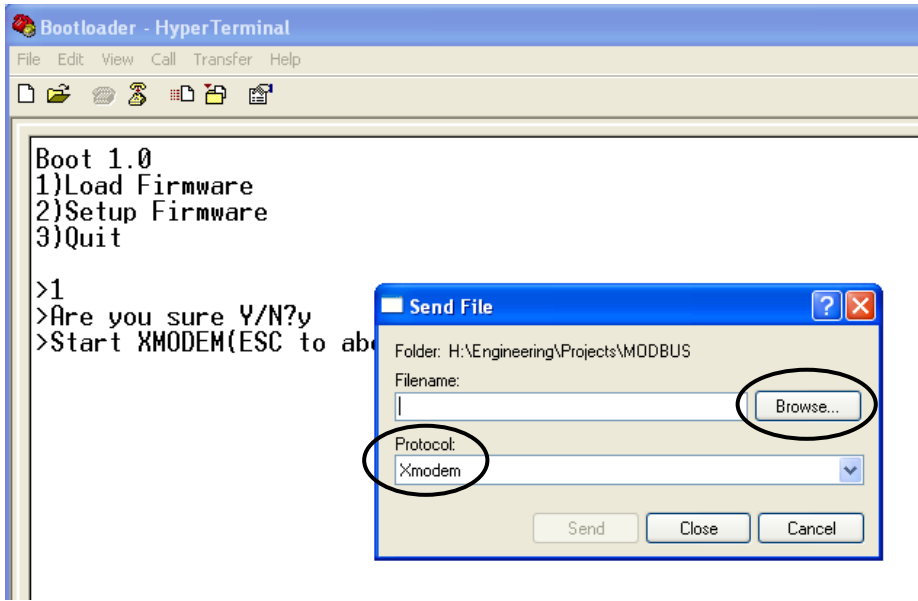
A question is presented asking to continue. Press the “Y” or “y” key to continue. Press “N” or “n” to abort. When continuing the following screen will be presented:



The screen will start to fill up with the “\$” character indicating that the XMODEM transfer can be started. Press the “ESC” key to abort. From the “Transfer” menu select “Send file”




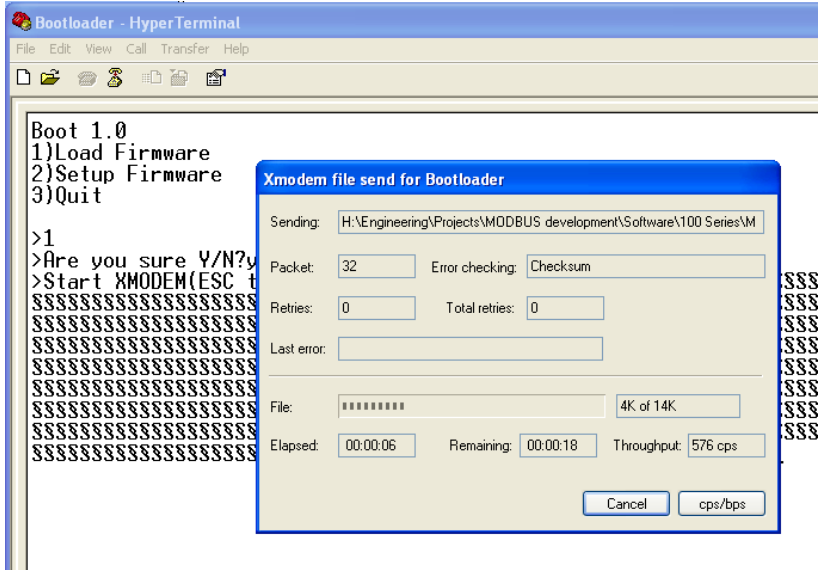
A new screen will be presented asking for the file to be transferred:



Use the “Browse” button to select the file to download. Only files with the “.hex” extension can be downloaded to the unit. Also make sure that the “Xmodem” protocol is selected. When the file is selected, press the “Send” button. The transfer screen pops up and the file download status can be monitored. During the download the green LED will be off will the red LED will be on.

If the download needs to be cancelled then simple press the “Cancel” button and then press the “Esc” key to return to the boot menu.

	<p>Note Once the download has started it isn't possible to stop it. Doing so will result in losing the current application.</p>
---	--



When the download is finished the start-up screen will be shown again presenting three options.

Chapter 3 - Modbus Commands

The implemented commands are all according to the Modbus protocol as described in document “MODBUS Application Protocol Specification V1.1” available from the MODBUS organization (www.Modbus.org). The commands can be tested using software tools like MODBUS Poll from Wittecom (www.wittecom.com) or Kepserver from Kepware (www.kepware.com).

Implemented Commands

The following commands are implemented:

Function	Sub Function	Description
0x03	N/A	Read holding registers
0x06	N/A	Write single holding register
0x08		Diagnostics
	0x00	Return query data
	0x01	Restart communications option
	0x04	Force listen only mode
	0x0A	Clear counters
	0x0B	Return bus message count
	0x0C	Return bus communication error count
	0x0D	Return bus exception error count
	0x0E	Return slave message count
	0x0F	Return slave no response count
	0x10	Return slave NAK count
	0x11	Return slave busy count
	0x12	Return bus character overrun count
	0x14	Clear overrun counter and flag

Holding Registers Overview Table

Register	Read	Write	Type	No. Registers
40001	Actual flow - low word		32 bit float	2
40002	Actual flow - high word			
40003	Totalizer - low word		32 bits int	2
40004	Totalizer - high word			
40005	User full scale	User full scale	16 bits int	1
40006	Factory full scale		16 bits int	1
40007	K factor	K factor	16 bits int	1
40008	Dummy (reads \$0001)	Reset totalizer	16 bits int	1
40009	Calibration - high word *		32 bits Int	2
40010	Calibration - low word *			
40011	Flow unit - char 1,2		String	3
40012	Flow unit - char 3,4			
40013	Flow unit - char 5,6			
40014	Totalizer unit- char 1,2		String	2
40015	Totalizer unit- char 3,4			
40016	Serial number – char 1,2		String	6
40017	Serial number – char 3,4			
40018	Serial number – char 5,6			
40019	Serial number – char 7,8			
40020	Serial number – char 9,10			
40021	Serial number – char 11,12			
40022	Tag number - char 1,2		String	5
40023	Tag number - char 3,4			
40024	Tag number - char 5,6			
40025	Tag number - char 7,8			
40026	Tag number - char 9,10			
40027	Decimal point – flow/totalizer		16 bits int	1
40032	Totalizer, alternate low word		32 bit float	2
40033	Totalizer, alternate high word			

* Format = mmdyyyy (decimal)

Read Holding Register Overview

Each register holds a specific type of data. Sometimes more registers are required to obtain the desired information.

40001 – 40002: Actual flow

The actual flow as displayed on the LCD of the unit (if available). The flow is IEEE-754 encoded. Commonly called Real or 32 bit Float

Example: \$44C34599 = 1562.175

40003 - 40004: Totalizer value

The totalizer value as displayed on the LCD of the unit (if available). The value isn't scaled and might need correction. Read register 40027 to determine the location of the decimal point or scale the value in the OPC/HMI software

Use data type 32 bit long integer. This returns the will allows a maximum number of 2^{32} . The decimal point, if used is stored in register 40027.

Example: Reading register 40027 returns \$0002 \Rightarrow totalizer decimal point = \$02 \Rightarrow #.## The value of the totalizer becomes: 27031.17

40005: User full scale

The returned word contains the full scale of the unit as set by the user.

Returned: User full scale hexadecimal encoded

Example: \$4E20 = 20000

40006: Factory Full Scale

Returned word contains the full scale of the unit as set by the manufacturer.

Returned: Factory full scale hexadecimal encoded

Example: \$5DC0 = 24000

40007: K Factor

The returned word contains the K factor of the used gas as set by the user.

Returned: K factor hexadecimal encoded

Example: \$03E8= 1000 \Rightarrow the value needs to be divided by 1000 to get the correct factor \Rightarrow 1.000

40008: Dummy

Reading this address will return fixed data (\$0001).

40009 – 40010: Calibration date

The returned data contains the calibration date of the unit.

Returned: calibration date hexadecimal encoded

Example: Reading 0x8D2CA3 which equals 9252003 in decimal. This equals to 9 25 2003 = September 25, 2003

40011 – 40013: Flow Unit

Each register contains two characters of the flow unit. The returned word is encoded in ASCII.

Returned: Characters

Example: \$534C ⇒ “SL”

40014 - 40015: Totalizer Unit

Each register contains two characters of the totalizer unit. The returned word is encoded in ASCII.

Returned: Characters

Example: \$534C ⇒ “SL”

40016 - 40021: Serial Number

Each register contains two characters of the serial number. The returned word is encoded in ASCII.

Returned: Characters

Example: \$5339 ⇒ “S9”

The serial number is 12 characters long. It always starts with “SN:”

40022 – 40026: Tag Number

Each register contains two characters of the tag number. The returned word is encoded in ASCII.

Returned: Characters

Example: \$5330 ⇒ “S0”

The tag number is set through the configuration software

40027: Decimal Point Of The Flow/Totalizer

Location of the decimal point in the actual flow/totalizer

Returned: 2 bytes (high byte = flow, low byte = totalizer)

Example: \$0201 ⇒ decimal point flow = \$02, decimal point totalizer = \$01

Data	Point Location	Divide By
0	00000000	0
1	0000000.0	10
2	000000.00	100
3	00000.000	1000
Etc.		

40032 – 40033: Alternate Totalizer

Some PLCs can’t use 32 bit long integer so this has been added in the 32 bit float format.

Example: \$4640E666 = 1235.6

Write Holding Register Overview

40005: User Full scale

The sent word contains the full scale of the unit as set by the user.

Example: Writing \$5DC0 will set the scale to 24000

40007: K factor

Set the K factor of the unit.

Example: Writing \$4B0 will set the K factor to 1.2 (1200)

40008: Reset totalizer

Reset the totalizer by writing the value \$0001.

Note: Sometimes it needs two write attempts to get the value written to the unit

Trouble Shooting

Problem	Solution
During the firmware transfer the download has halted and nothing is happening anymore (or an error message appears)	Reset the unit and try again. Make sure that only .hex files intended for the unit are selected
When trying to enter data the length is limited. No more data is accepted	For each option the data type and length are predefined. When data isn't accepted anymore then the maximum is reached. Also it's not possible to enter characters when numbers are expected (and visa-versa)
The characters on the screen are all messed up	Check the communication settings. They should be 9600,8,N,1
The unit doesn't enter the boot loader although the enter key is pressed within 2 seconds after start-up	Try swapping the "A" & "B" lines of the RS-485 connection and try again