SmartTrak® 100 Series Foundation Fieldbus

Instruction Manual

Foundation Fieldbus Device Specification for SmartTrak®
Models: 100, 101 and 140
Mass Flow Meters & Controllers

Part Number: IM-100 FF-BUS Rev.V1
November 2013

SIERRA®
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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! 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! 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! 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

Notes 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 SmartTrak 100 Series manual.

If the problem persists after following the troubleshooting procedures outlined in the SmartTrak 100 Series manual, 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 (0)72-5071400. 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)

Table of Contents

Chapter 1: Introduction

This manual will explain how to add a Sierra flow meter or controller equipped with Foundation Fieldbus to your network. The Foundation Fieldbus interface allows access to all relevant data available in the flow meter.

This manual is intended to document the configuration of the Sierra Instruments SmartTrak® 100 Series mass flow meters and controllers with the Foundation Fieldbus Communication Module. It assumes the reader already has a working knowledge of Foundation Fieldbus. For specific operations of the Sierra Instruments' SmartTrak® 100 Series consult the SmartTrak® 100 Series Instruction manual.

For detailed information about Foundation Fieldbus go to: http://www.fieldbus.org/

The Sierra Instruments SmartTrak® 100 flow meters and controllers can be ordered with the optional Foundation Fieldbus (FF-BUS) Communication Interface Module for use on a Foundation Fieldbus H1 network. This Interface complies with the new ITK ver. 6.

FF-BUS differs from other digital communication protocols in that it is designed for process control rather than just transfer of data between a device and a central controller. It supports peer-to-peer communication and allows for functional blocks to operate independently between themselves without main controller intervention.

Foundation Fieldbus H1 networks are connected using a shielded twisted wire pair. For more information about FF-BUS H1 wiring see:
http://www.fieldbus.org/images/stories/enduserresources/technicalreferences/documents/wiringinstallationguide.pdf

Chapter 2: Connecting the SmartTrak 100 to Your FF-BUS Network

The instrument power, 24 VDC (±10%) may be supplied via the DB15 connector (see SmartTrak® 100 Instruction Manual, Chapter 4) or the lower terminal blocks on the FF-BUS Module. The unit uses more current than can be supplied by the H1 network. See current requirements in Table 1 below:

SmartTrak® Instrument	Minimum mA Current Requirements
M100L	230
M100M	230
M100H	230
C100L	500
C100M	800
C100H	1260

Table 1: Minimum Current Requirements

The Foundation Fieldbus H1 network connections are labeled as FF-1 and FF-2 on the top terminal blocks. These are not polarity dependent. All electrical connections for the SmartTrak® Instrument and Foundation Fieldbus are made on the left (inlet) side:

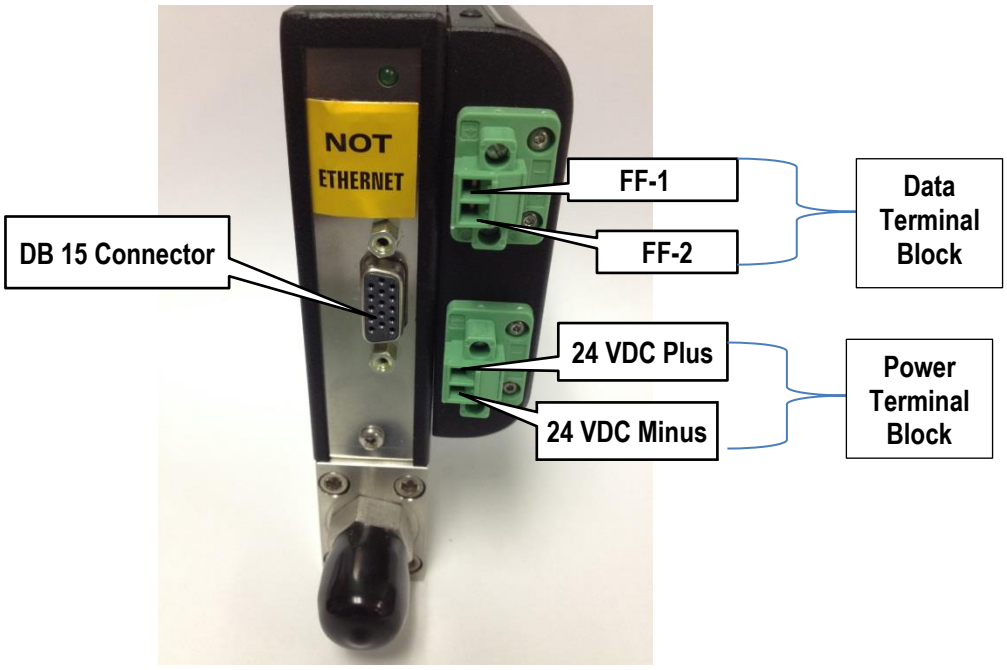


Figure 1: Connection Points

Chapter 3: Definitions

DD: Device Description files that are necessary to configure your FF-BUS host software. The DD files explain the specific configuration and features to your host network so it understands how to use the device.

Resource Block (RS): This function block contains basic information about the FF-BUS interface.

Transducer Block (TB): This block makes the connection to the meter and presents the process variables to the lower blocks. Most of the configuration setup is done in this block.

AI (Analog Input) Block: Although this is actual cyclic digital process data (output) coming from the 100 Series, Foundation Fieldbus still refers to it as an AI or Analog Input Block. This FF-BUS interface has four analog input blocks: AI1, AI2, AI3, and AI4.

AO (Analog Output) Block: This is a cyclic digital command being sent to the 100 Series (input). Foundation Fieldbus refers to it as an AO or Analog Output Block. The C100 FF-BUS interface has one labeled AO.

Modbus: Modbus is another digital communication protocol and is only relevant here because the Sierra FF-BUS interface uses Modbus as an intermediary between the meter and the FF-BUS interface. For special configuration, you will only need a rudimentary knowledge of MODBUS.

MODBUS_REG_SETUP_1 to 4: This is where AI1,2,3,4 and AO are configured as PV1,2,3,4, and Final Value. These are 32 bit registers that can be configured multiple data types in various byte order.

MODBUS_REGS_1 to 4: There are four groups of ten Modbus R/W registers that can be used for static variables such as serial number, gas type, total reset, and zeroing of unit. These only have limited use and may not be able to be seen with all FF-BUS devices.

32 bit float: Also known as Real or IEEE-754 single precision. The 32 bit float is a common data encoding scheme that provides 1 bit for the sign, 8 bits for an exponent, and 23 bits of significant numbers. In MODBUS the byte order is normally 1-0,3-2, however FF-BUS interface allows it to be changed if needed.

16 bit short integer: This is a 16 bit number ranging from 0-65,535 (2^{16}) The byte order is 0,1.

32 bit long integer: This combines two 16 bit Modbus registers to make a number as high as 4,294,967,296 (2^{32}). The byte order is 1-0,3-2. The FF-BUS will see this as one 32 bit integer.

String (Character): A 16 bit Modbus register would contain 2 ASCII characters (8 bits each) in 0-1 byte order. So ox 41 42 would equal "A B".

SmartTrak® Software: This software is used to configure the SmartTrak® 100 Series meter or controller via a standard PC COM port. It can be used to change the flow units and configure analog inputs and outputs. The software functions much like a Pilot Module, which is not available with the FF-BUS option. See Chapter 5 of the SmartTrak® 100 Series manual for details. NOTE: This software is not necessary for FF-BUS configuration or operation. Also, the software cannot be used while FF-BUS communication is active.

Chapter 4: Foundation Fieldbus Interface Configuration

The SmartTrak®100 FF-BUS interface module uses a Modbus to FF-BUS translator board. This allows the user to configure most of the many variables accessible to the MODBUS interface. For the most part, the Modbus to FF-BUS translation is invisible to the end user unless they want to reconfigure the Transducer Block (TB) to access other Modbus variables.

AI/AO Blocks

The Foundation Fieldbus Transducer Block (SIERRA_DEVICE TB) provides four analog inputs (AI1 through AI4) and one analog output (AO). These are all configurable as 16 or 32 bit integer or Float data types. We have pre-configured these blocks as shown below in Table2. However, the user can reconfigure them as needed.

AI/AO Blocks	Primary Value	Channel	Data Type	Data
AI1	PV1	1	Float (2 two bytes registers), Byte order 1-0-3-2	Flow Rate
AI2	PV2	2	Unsigned long integer, Byte order 1-0-3-2	Total
AI3	PV3	3	Float (2 two bytes registers), Byte order 1-0-3-2	Set Point Read
AI4	PV4	4	Float (2 two bytes registers), Byte order 1-0-3-2	Full Scale
AO	Final Value	5	Float (2 two bytes registers), Byte order 1-0-3-2	Set Point Write

Table 2: Preconfigured AI/AO Blocks

MODBUS_REGS_ (1 through 4)

The Transducer Block also has four groups of Modbus registers that can be used for static setup inputs and outputs for variables such as gas type, valve mode, units, resetting totalizer, or zeroing instrument (See Table 3 for *all* available choices). This data is not cyclic because it only updates occasionally and might not be accessible to all devices on the fieldbus. These variables are limited to an unsigned short integer, Byte order 0-1. There are four groups of ten. Each group can only be configured in consecutive Modbus address order. To use these groups, a starting register number (MODBUS_REG_START_ADDRESS) and the number of registers after (NUM_OF_MODBUS_REG) is needed. These have been pre-configured as shown below in Table 3. However, the user can reconfigure them as needed

MODBUS_REG Factory Defaults	MODBUS_REGS	REG_START ADDRESS	NUM_OF_REGS
Valve Power	1	8	1
Gas Type Index	2	33	4
Valve Mode Index			
Flow Unit Index			
Set Point Source Index			
Sensor Health Data	3	131	3
Zero Instrument			
Meter Factory Defaults			
Total Decimal Points	4	141	6
Firmware Rev.			
Device Type			
Serial Number Low Word			
Serial Number Hi Word			
Reset Total			

Table 3: Pre-Configured Modbus Registers

Chapter 5 – Configuring the device using NI-FBUS Configurator

The National Instruments FBUS Configurator software is widely used for testing and configuration of FF-BUS devices. Consult your NI-FBUS Configurator manual for more information on this NI software (included in NI-FBUS help on the software).

Before starting the NI-FBUS Configurator, you must import the DD using the NI-FBUS Interface Configurator Utility. The DD files are available at Fieldbus.org and can also be downloaded from our web site at: http://www.sierrainstruments.com/products/downloads/foundation-fieldbus

Getting Started Configuring FF-Bus Using NI-FBUS Configurator

1. Start the NI-FBUS COM manager then start the NI-FBUS Configurator.
2. When NI-FBUS Configurator starts, choose the FF-BUS interface used.
3. If the SmartTrak® is connected correctly, SIERRA_DEVICE should appear on your screen as shown below.
4. The node address (factory set) is set to 247. We suggest it be changed to suit the FF-BUS application.
   Change the Tag names as needed.
5. Make configuration changes as needed.

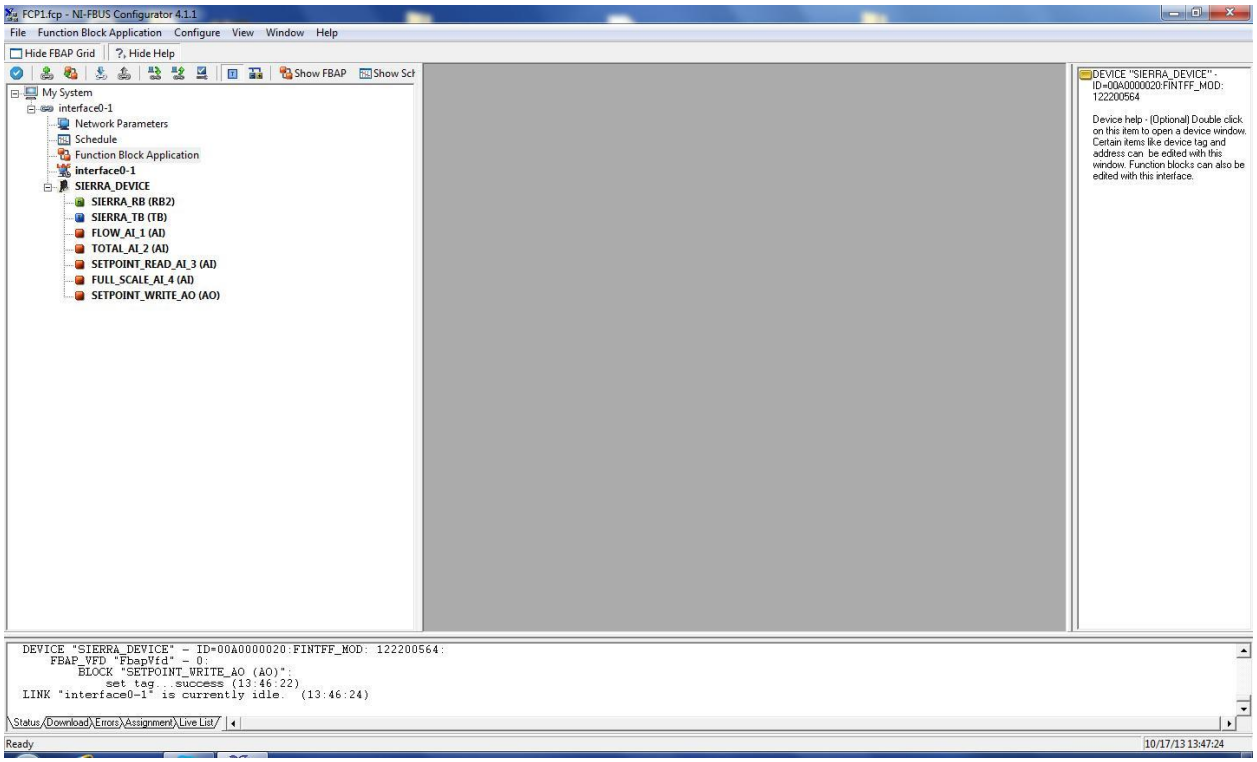


Figure 2: NI Screen After SIERRA_DEVICE Is Found

Configuration

Most of the configuration will be in the Transducer Block (SIERRA_TB) under the "Others" tab (see the screen shots below). In order to write any changes, the Block Mode must be set to OOS (out of service). Make your changes and click "Write Changes." Once the yellow highlights disappear, click Auto mode. The configuration below was already done at the factory.

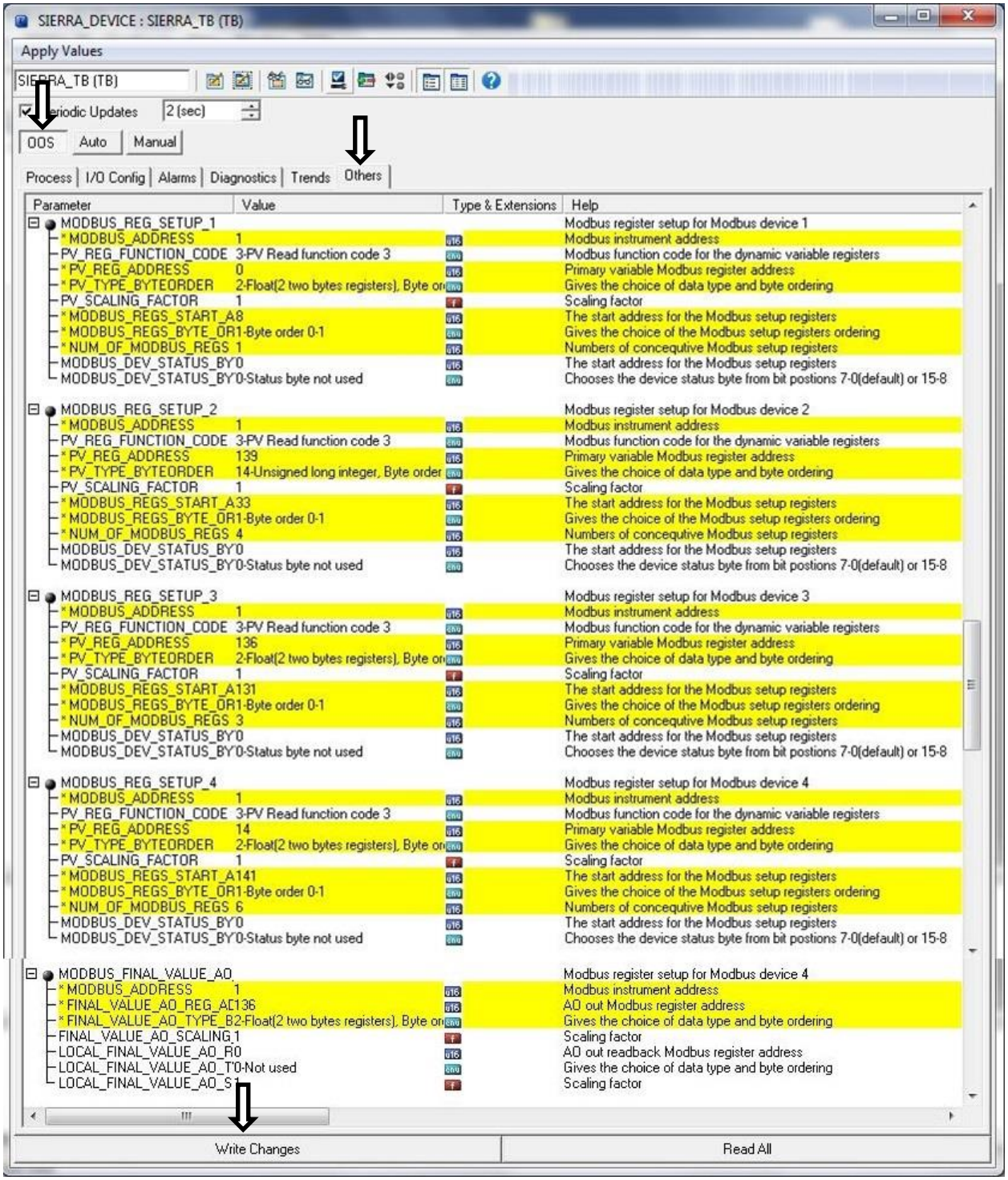


Figure 3: Screen Before Writing Changes

After completing the configuration, you should be able to read the variables being returned from your SmartTrak® controller or meter on the same SIERRA_TB (TB) block on the "Others" tab. Flow (PV_1), Total (PV_2), Set Point Read (PV_3), and Factory Full Scale shown below. If you scroll down futher you'll also see the static MODBUS_REGS_ values being read from the instrument.

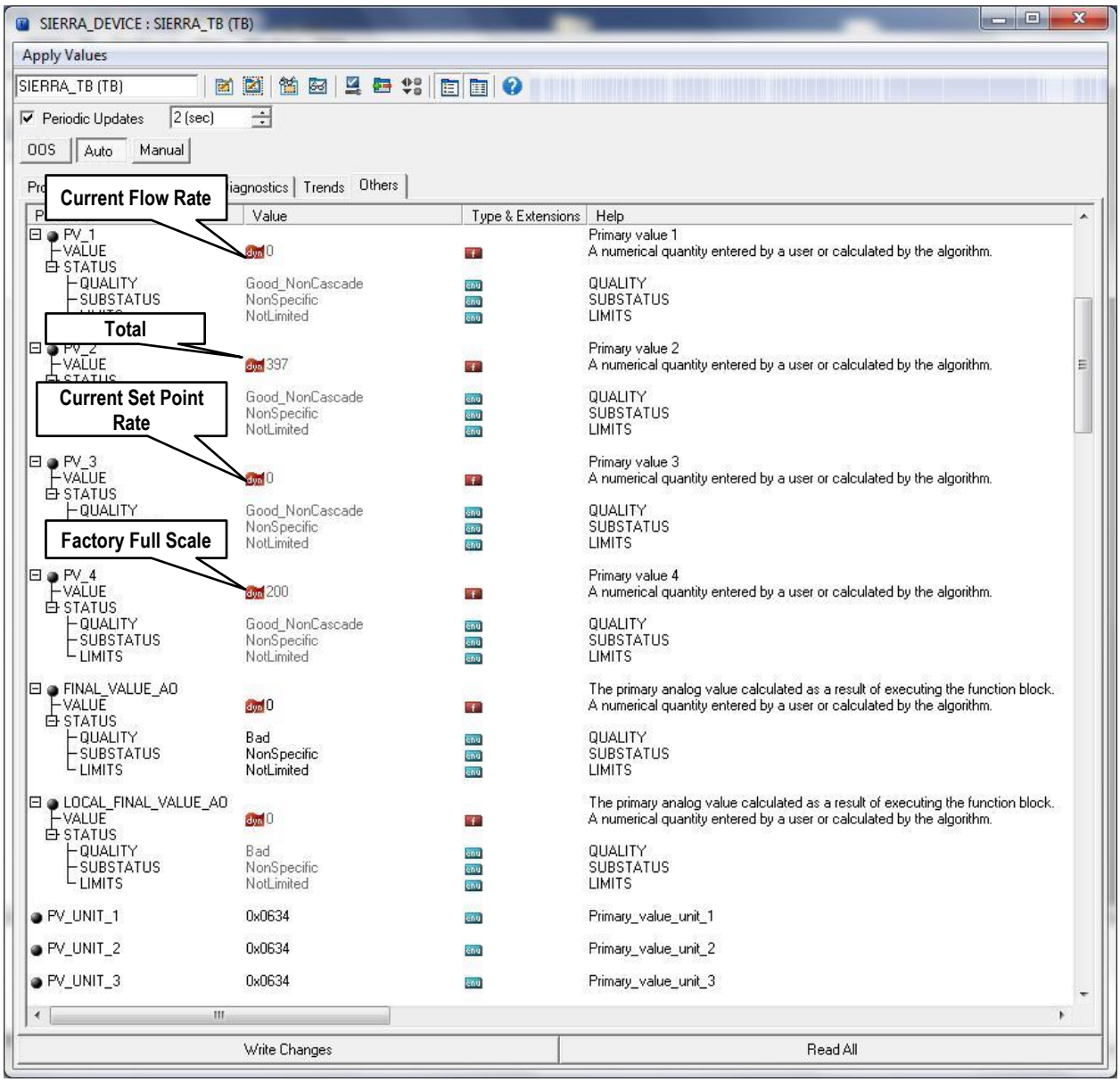
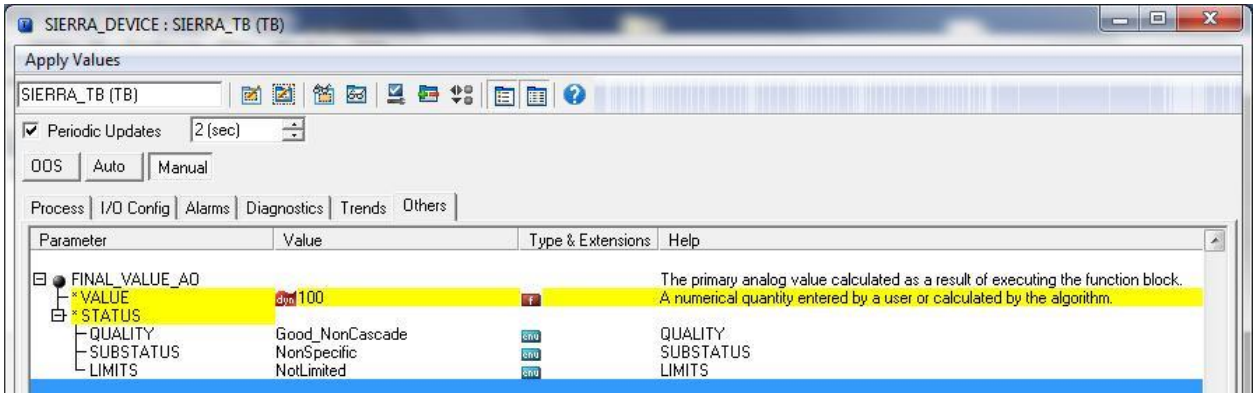


Figure 4: Screen after Writing Changes

Following is an example of writing a set point using a NI-FBUS Configurator under SIERRA_TB (TB). In this example, we will give the SmartTrak a set point of 100. The mode must be in "Manual" to do this.

1. Write the new set point in FINAL_VALUE_A0 and set the QUALITY to Good_NonCascade.
2. Then click on "Write Changes." Once the yellow highlights disappear, change the mode back to "Auto".



3. Scroll back up to see PV_1, PV_2, PV_3, and PV_4 and you will see the flow rate is now 99.947, the accumulated total has increased, and the set point is now 100. Note: this assumes you have a gas source connected to the controller.

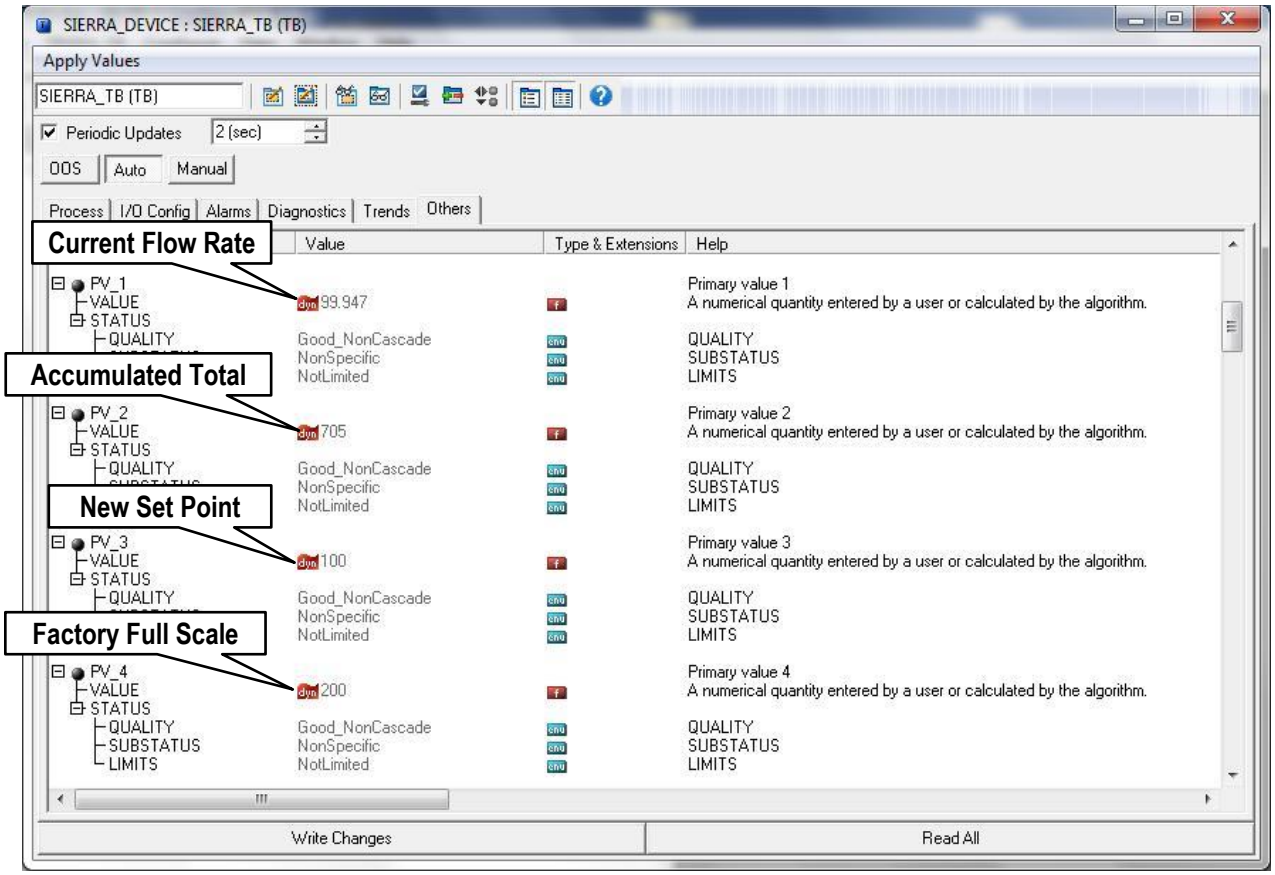


Figure 6: Screen after writing set point

You may also set the engineering units used by your SmartTrak in the NI-FBUS Configurator so they can be read by the FF-BUS under PV_UNIT_1,2,3,4 and FINAL_VALUE_AO_UNIT.

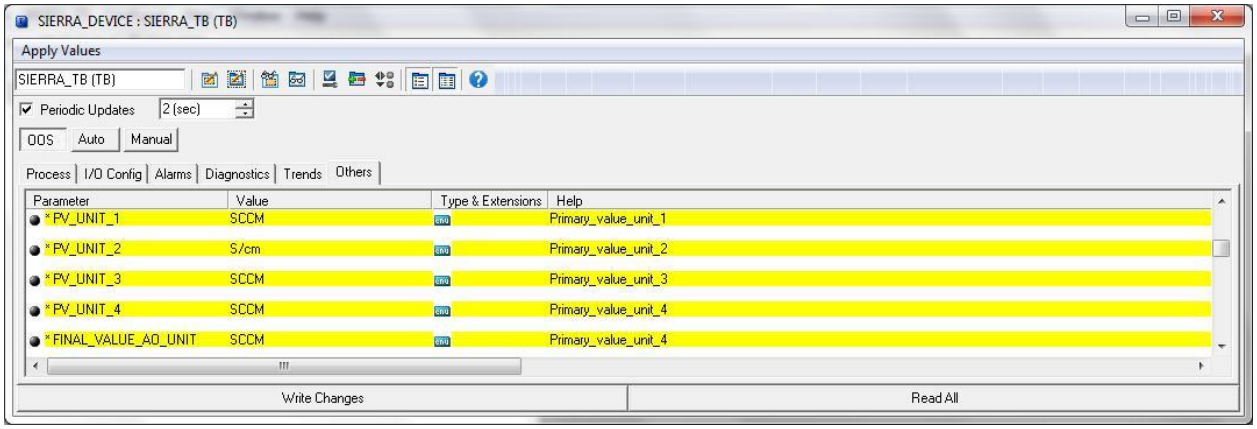


Figure 7: TB Block Engineering Units Setup

MODBUS_COM_SETUP

The Modbus Com settings are needed the for communication connection between the Modbus and the FF-BUS electronics inside the SmartTrak. The Modbus Instrument Address ***must*** always be set to 1. The MODBUS _COM_SETUP ***must*** always set as shown below:

BaudRate: 9600 Baud
Stop_Bits: 1
Parity: None
CRC_ORDER: Normal

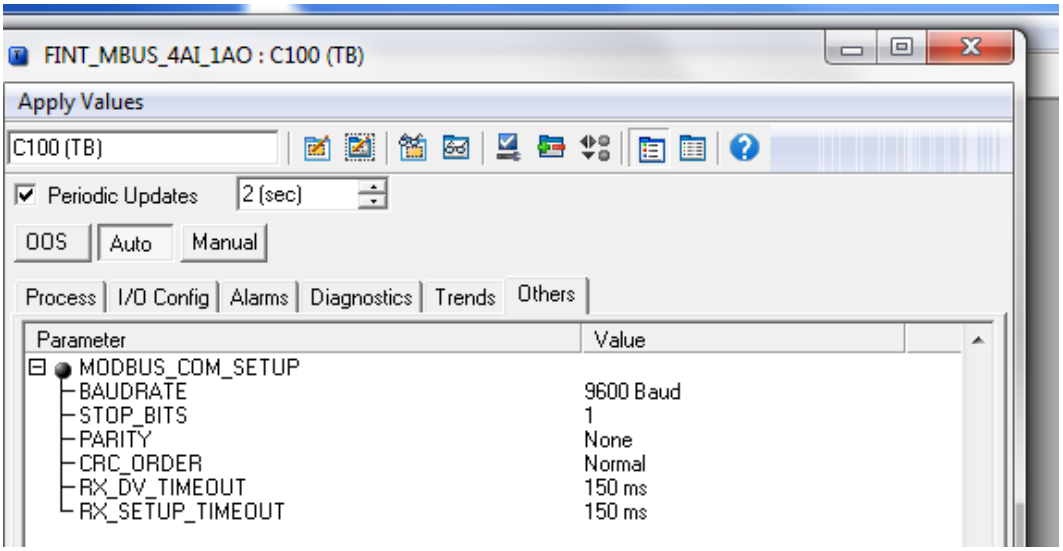


Figure 8: Screen Showing MODBUS_COM_SETUP

Chapter 6 – Available Modbus Registers

Although most users will be satisfied using the default configuration, other Modbus registers can be configured for Foundation Fieldbus access. Below in Table 4 is a list of all available Modbus registers. These would need to be configured in the transducer block.

Adr	Description	Read/Write	Data type	Default Config
0	Actual flow - low word	R	32 bit float	AI1/PV1
1	Actual flow - high word		"	"
2	Set point flash - low word	R/W	32 bit float	Unassigned
3	Set point flash- high word			
8	Valve power	R	Short unsigned integer	MB_REGS_1 , 1
14	Factory f.s – low word	R	32 bit float	AI4
15	Factory f.s – high word		"	"
16	User f.s – low word	R/W	32 bit float	Unassigned
17	User f.s – high word		"	"
18	Gas span – low word	R/W	32 bit float	Unassigned
19	Gas span – high word		"	"
28	Control	R/W	Short unsigned integer	off ox30
33	Gas index	R/W	Short unsigned integer	MB_REGS_2 , 4
34	Valve position index	R/W	Short unsigned integer	"
35	Flow unit index	R/W	Short unsigned integer	"
37	Input set point index	R/W	Short unsigned integer	"
39	Device firm rev – low word	R	32 bit float	Unassigned
40	Device firm rev – high word		"	"
131	Sensor health data	R	Short unsigned integer	MB_REGS_3 , 3
132	Set unit to zero	R/W	Short unsigned integer	"
133	Reset meter factory default	R/W	Short unsigned integer	"
136	RAM set point low word	R/W	32 bit float	AI3/PV1 R, AO W
137	RAM set point high word	R/W	32 bit float	
138	Watch Dog	R/W	Short unsigned integer	Unassigned
139	Totalizer-Low Word	R	Long unsigned integer	AI2/PV2
140	Totalizer-Hi Word		"	"
141	Total Decimal Points	R	Short unsigned integer	MB_REGS_4 , 6
142	Firmware rev.	R	Short unsigned integer	"
143	Device type	R	Short unsigned integer	"
144	Serial number Low word	R	Short unsigned integer	"
145	Serial number Hi word	R	Short unsigned integer	"
146	Reset Total	R/W	Short unsigned integer	"

Table 4: Available Modbus Registers

Chapter 7 – Modbus Holding Register Defined

0-1 : Actual Flow
This register contains actual flow readings from the instrument. The flow is in a 32 bit float format, Byte order 1-0-3-2 (IEEE-754 encoded). We have pre-configured it to AI1, PV1, and Channel 1.

2-3 : Set Point Flash
The Set Point Flash is a read/write register in persistent flash memory. This will be the default set point when the controller powers up. If you want the set point to go to zero after a power cycle, use Registers 136-137. If you want to retain your set point on power-up, reconfigure PV3 to Set Point Flash (2-3). The data type is a 32 bit float format, Byte order 1-0-3-2.

8 : Valve Power
The value representing the power injected into the valve (when using a mass flow controller). The value will range between 0 and 3200 (4095 when purging the valve). The data type used is a 16 bit unsigned short integer and byte order 0,1.

14-15 : Factory Full Scale
This is the calibrated full scale under calibration conditions value of the instrument. The data type used is a 32 bit float format, Byte order 1-0-3-2.

16-17 : User Full Scale
The user full scale value allows you to re-range the instrument. Any value between 50% and 100% of the factory full scale under calibration conditions is allowed. This is only useful when using an analog signal from the SmartTrak, and not relevant to FF-BUS operation. The data type used is a 32 bit Float format, Byte order 1-0-3-2.

18-19 : Gas Span
The Gas Span value allows you to adjust the reading by the factor entered here. This factor has an acceptable range of .500 to 2.00. It is useful for adjusting the calibration or correcting the reading for another gas. See the SmartTrak 100 Series Instruction Manual, Chapter 4 for more information on the use of the span and K-Factors. This value will be returned to 1.000, if factory defaults are reset. The data type used is a 32 bit float format, Byte order 1-0-3-2.

28 : Control Register
Most of the functions in Control Register are not applicable on the FF-BUS option. However, there is a function that will make the set point zero after 5 minutes if the gas supply is turned off. Note: The factory default disables this function. You may re-activate it, if you like, by writing a 0 to this register. Writing a ox0300 (768 dec.) will turn it back off again.

33 : Gas Type Index
This value shows which Dial-A-Gas® was selected on the instrument. The Gas Type Index value can range between 1 and 10. This specific index can be customized when ordering. The data type used is a 16 bit unsigned short integer, byte order 0,1.

Value	Gas
1	Air
2	Argon (Ar)
3	Carbon Dioxide (CO2)
4	Carbon Monoxide (CO)
5	Methane (CH4)
6	Helium (He)
7	Hydrogen (H2)
8	Oxygen (O2)
9	Nitrogen (N2)
10	Nitrous Oxide (N20)

Table 5: Default Gas Index List

34 : Valve Position Index

The Valve Position Index is the mode at which the valve of the controller will operate. The data type used is a 16 bit unsigned short integer, byte order 0,1. The table below shows the available values:

Value	Mode
0 or 1	Automatic
2	Closed
3	Purge

Table 6: Valve Mode List

35: Flow Unit Index

This value indicates the selected flow engineering units on the SmartTrak. The data type used is a 16 bit unsigned short integer, byte order 0,1. **Note: This Flow Unit Index is internal to the SmartTrak and is not the same as the FF-BUS UNITS Index.** The table shows the available SmartTrak flow units:

Value	Unit	Value	Unit	Value	Unit
1	Scc/s	11	NM3/m	21	Nl/h
2	Scc/m	12	NM3/h	22	g/s
3	Scc/h	13	SM3/s	23	g/m
4	Ncc/s	14	SM3/m	24	g/h
5	Ncc/m	15	SM3/h	25	Kg/s
6	Ncc/h	16	Sl/s	26	Kg/m
7	SCF/s	17	Sl/m	27	Kg/h
8	SCF/m	18	Sl/h	28	Lb/s
9	SCF/h	19	Nl/s	29	Lb/m
10	NM3/s	20	Nl/m	30	Lb/h

Table 7: SmartTrak® Flow Units

37: Set Point Source Index

The Set Point Source Index indicates the source for the set point. Set to Digital* for FF-BUS operation. The table below shows the available values:

Value	Source
0 or 1	* Digital
2	0 – 5 volts
3	0 – 10 volts
4	1 – 5 volts
5	4 – 20 mA
6	0 – 20 mA

Table 8: Set Point Source

38: Analog Output Index
The analog output index is the value which indicates the current selected analog output of the instrument. This index does not affect the FF-BUS operation, only the analog output on the DB 15 connector. The table below shows the available values:

Value	Output Option
1	0 – 5 vdc / 4 – 20 mA
2	0 – 10 vdc / 4 – 20 mA
3	1 – 5 vdc / 4 – 20 mA
4	0 – 5 vdc / 0 – 20 mA
5	0 – 10 vdc / 0 – 20 mA
6	1 – 5 vdc / 0 – 20 mA

Table 9: SmartTrak Analog Output Selection

39-40: SmartTrak Firmware Revision
Firmware revision numbers of the instrument in a 32 bit float format. Example 2.044

131: Sensor Health Data
This is the sensor data from the instrument. The high Byte represents the bridge voltage and the low Byte represents the bridge current.

132: Set SmartTrak to Zero
Writing the value 165 (0xA5) to this register will zero the flow readings. Before using this command, make sure there is zero flow and the pressure is at your application pressure. Register 133 below will return the unit back to the factory default zero.

133: Reset SmartTrak to Factory Defaults
Writing the value 0xA5 to this register will reset ***all*** your custom settings to factory defaults. The zero value (132) and gas span values are also cleared.

136-137: Set Point RAM
This is the register used to control the set point. We have pre-configured it to AI3, PV3, and Channel 3. This set point will revert to zero when the power is cycled. The data type is a 32 bit float format, Byte order 1-0-3-2.

138: Watch Dog
If communication is interrupted, this 16 bit register controls a "time out". Only the lower 8 bits are used (0-255). Each bit equals 0.5 seconds. Zero=off, 10=5 second time out, etc. When this timeout is reached, the set point is forced to zero. This is normally turned off by default.

139-140: Totalizer
This is a read only 32 bit float integer value that holds the total of gas that has flowed since the last totalizer reset in the same engineering units as the flow rate.

141: Totalizer Decimal Points
If needed, the totalizer can support decimal fractions. This 16 bit R/W register supports 0, 1, or 2 decimals. Example: If you need 100X more resolution on the total count, you may write a 2 to this register. This will cause the totalizer to count 100 times faster. 123 would become 123.45. The decimal point cannot be displayed on 139-140, because it is an integer. You will have to account for the decimal using the FF-BUS scaling feature or at the Host level.

142: Firmware Revision
This 16 bit read only integer register displays the firmware revision of the SmartTrak without the decimal. Currently 2044 (2.0.44)

143: Device Type
This 16 bit read only integer register displays the Sierra Instrument basic model series (100).

144: Serial Number Low Word
The SmartTrak serial number is coded as a 32 bit unsigned integer split between 2 -16 bit registers, 144 and 145. 144 is the low word.

145: Serial Number High Word
The SmartTrak serial number is coded as a 32 bit integer. 145 is the high word. These two registers can be read as one 32 bit unsigned integer using one of the AIs, or split between two of the MODBUS_REGS and added together externally. This is easy using hex data. S/N 131906 would equal ox 00 02 (hi word) 03 42 (low word). Converted to decimal, it would be 131906 (S/N 131906).

146: Totalizer Reset
This is a 16 bit R/W short integer register used to reset the totalizer. It always returns a dummy value of 1. Writing a 3 will cause the totalizer to reset to zero.