

Fox Thermal

THERMAL MASS FLOW METER
& TEMPERATURE TRANSMITTER

**Model FT3
Modbus**



Notice

This publication must be read in its entirety before performing any operation. Failure to understand and follow these instructions could result in serious personal injury and/or damage to the equipment. Should this equipment require repair or adjustment beyond the procedures given herein, contact the factory at:

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Fox FT3 Manuals:

- **Model FT3 Instruction Manual**
- **Fox FT3 View™ Instruction Manual**
- **Fox FT3 HART Manual**
- **Fox FT3 Data Logger Manual**

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Modbus Introduction

Scope

Thank you for purchasing the model FT3 thermal gas mass flow meter from Fox Thermal. The model FT3 is one of the most technically advanced flow meters in the world. Extensive engineering effort has been invested to deliver advanced features, accuracy measurement performance and outstanding reliability.

This document describes the Modbus implementation using RS485 serial communication physical layer for the Fox Thermal FT3 mass flow meter based on the Modicon Modbus Protocol (PI-MBUS-300 Rev. J).

Modbus Protocol

MODBUS Protocol is an application layer messaging protocol that provides client/server communications between devices. MODBUS is a request/reply protocol and offers services specified by function codes.

The size of the MODBUS Protocol Data Unit is limited by the size constraint inherited from the first MODBUS implementation on Serial Line network (max. RS485 Application Data Unit = 256 bytes).

Therefore, MODBUS PDU for serial line communication = 256 – Server address (1 byte) – CRC (2 bytes) = 253 bytes.

RS485 ADU = 253 + Server address (1 byte) + CRC (2 bytes) = 256 bytes.

For more information on MODBUS go to the web site <http://www.modbus.org/>.

Command Request:

<Meter Address> <Function code> <Register start address high> <Register start address low> <Register count high> <Register count low> <CRC high> <CRC low>

Command Response:

<Meter Address> <Function code> <Data byte count> <Data register high> <Data register low> ... <Data register high> <Data register low> <CRC high> <CRC low>



Note: The data in shown in brackets < > represents one byte of data.



RS485 Wiring: Modbus

RS485 Wiring for Modbus

Wiring connections are made to terminal block TS5 for RS485 communication.

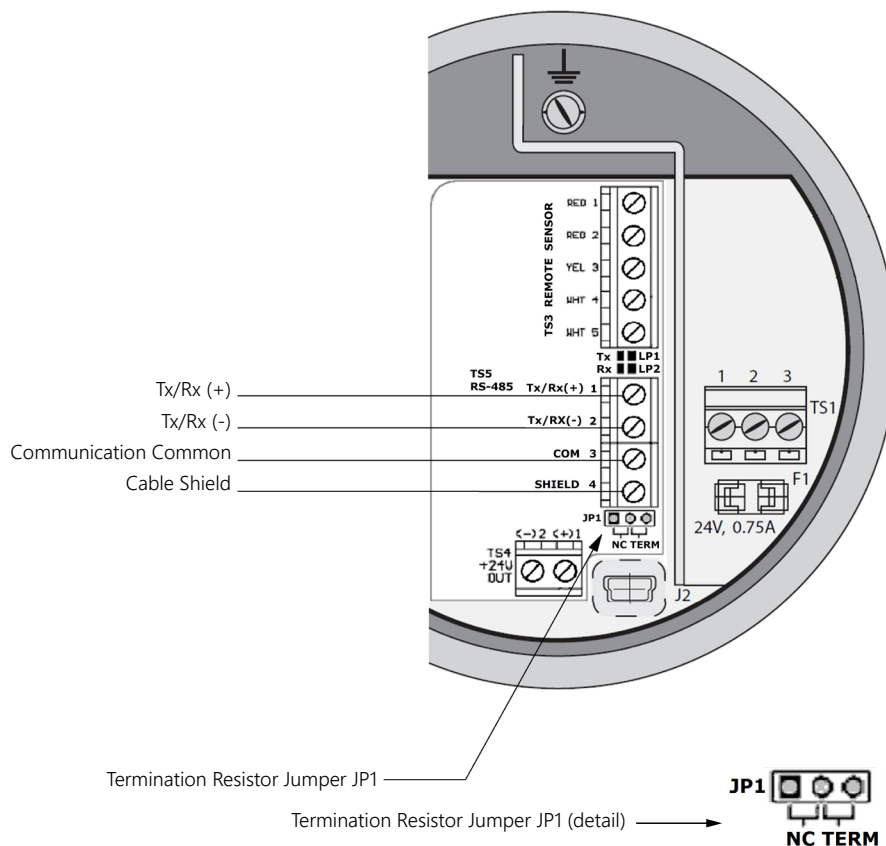
The Tx/Rx+ signal connects to pin 1, Tx/Rx- connects to pin 2 and communication common to pin 3, and the cable shield to pin 4 as shown in Figure 3.1.

Termination Resistor

Connect a termination resistor across the receive/transmit signals of the last device on the RS485 communication line. To connect the 121 ohm termination resistor on the FT3, set JP1 to the TERM position.

Disconnect the termination resistor on all other external RS485 devices. The termination resistor of the FT3 is disconnected by setting JP1 to the NC (Not Connected) position.

Fig. 3.1: RS485 Wiring



Note: JP1 jumper will either be in the NC or TERM position. It should be in the TERM position on the last meter in the Modbus daisy chain.

FT3 Commands Supported by Modbus

FT3 Commands Supported

The FT3 supports the following commands:

- 1) Command 03: Read holding registers
- 2) Command 04: Read input register.
- 3) Command 06: Preset single register

Read Holding Registers (command 03)

This command reads the basic variable from the FT3 and has the following format:

Request:

<Meter Address> <Command code=03> <Register start address high> <Register start address low> <Register count high> <Register count low> <CRC high> <CRC low>

Response:

<Meter Address> <Command code=03> <Byte count> <Data high> <Data low> ... <Data high> <Data low> <CRC high> <CRC low>

Example:

Request data register at starting address 0x0000 and specifying only 1 register

<0x01> <0x03> <0x00> <0x00> <0x00> <0x01> <0x0a> <0x84>

Response:

<0x01> <0x03> <0x02> <xx> <xx> <CRC high> <CRC low>

Where xx xx is the data register value.

Table 4.1: FT3 Modbus Holding Registers

Register Address	Modbus Address	Data Type	Scaling	Comment
0x00	40001	Flow in Eng units (low)	No	Mass flow in selected units
0x01	40002	Flow in Eng units (high)	No	
0x02	40003	Total (low)	No	Total in selected units
0x03	40004	Total (High)	No	
0x04	40005	Temperature (low)	*10	Temperature in selected units * 10
0x05	40006	Temperature (high)	*10	
0x06	40007	Elapsed time (low)	*10	Elapsed time in hours * 10
0x07	40008	Elapsed time (high)	*10	
0x08	40009	Velocity (Low)	No	Velocity in nm/hr

FT3 Commands Supported by Modbus

Register Address	Modbus Address	Data Type	Scaling	Comment
0x09	40010	Velocity (high)	No	
0x0A	40011	Flow in Eng units * 10	10	Mass flow in selected units * 10
0x0B	40012	Flow in Eng units *100	100	Mass flow in selected units * 100
0x0C	40013	Total *100	100	Total in selected units * 100
0x0D	40014	Total2 (low, 2 gas curves only)	No	Total #2 for 2 gas curves
0x0E	40015	Total2 (high, 2 gas curves only)	No	Total #2 for 2 gas curves
0x0F	40016	Status	No	Status
0x10	40017	Status2	No	Status 2
0x11	40018	Spare/ Not used		
0x12	40019	Spare/ Not used		
0x13	40020	Flow in Eng units (float, upper 16 bits)	No	Mass flow in selected units
0x14	40021	Flow in Eng units (float, lower 16 bits)	No	Mass flow in selected units
0x15	40022	Total in Eng units (float, upper 16 bits)	No	Total in selected units
0x16	40023	Total in Eng units (float, lower 16 bits)	No	Total in selected units
0x17	40024	Total#2 for 2 gas curve (float, upper 16 bits)	No	Total in selected units
0x18	40025	Total#2 for 2 gas curve (float, lower 16 bits)	No	Total in selected units
0x19	40026	Temperature in selected units (float, upper 16 bits)	No	Temperature in selected units
0x1A	40027	Temperature in selected units (float, lower 16 bits)	No	Temperature in selected units
0x1B	40028	Elapsed time in hours (float, upper 16 bits)	No	Elapsed time in hours
0x1C	40029	Elapsed time in hours (float, lower 16 bits)	No	Elapsed time in hours
0x1D	40030	Velocity in selected units (float, upper 16 bits)	No	Velocity in selected units
0x1E	40031	Velocity in selected units (float, lower 16 bits)	No	Velocity in selected units
0x1F	40032	CAL-V Diff (float, upper 16 bits)	No	CAL-V Diff
0x20	40033	CAL-V Diff (float, lower 16 bits)	No	CAL-V Diff
0x21	40034	CAL-V Set (float, upper 16 bits)	No	CAL-V Set
0x22	40035	CAL-V Set (float, lower 16 bits)	No	CAL-V Set
0x23	40036	Spare/ Not used		
0x24	40037	Total 24 hrs, Last total record, low register	No	Tot24hrs: Last total record
0x25	40038	Total 24 hrs, Last total record, high register	No	Tot24hrs: Last total record
0x26	40039	Total 24 hrs, Current Day (0-6)	No	Tot24hrs: Current Day
0x27	40040	Total 24 hrs, Current Hour (0-23)	No	Tot24hrs: Current Hour
0x28	40041	Total 24 hrs, Record day 1, low register	No	Tot24hrs: Record day 1
0x29	40042	Total 24 hrs, Record day 1, high register	No	Tot24hrs: Record day 1
0x2A	40043	Total 24 hrs, Record day 2, low register	No	Tot24hrs: Record day 2
0x2B	40044	Total 24 hrs, Record day 2, high register	No	Tot24hrs: Record day 2
0x2C	40045	Total 24 hrs, Record day 3, low register	No	Tot24hrs: Record day 3
0x2D	40046	Total 24 hrs, Record day 3, high register	No	Tot24hrs: Record day 3
0x2E	40047	Total 24 hrs, Record day 4, low register	No	Tot24hrs: Record day 4
0x2F	40048	Total 24 hrs, Record day 4, high register	No	Tot24hrs: Record day 4

FT3 Commands Supported by Modbus

Register Address	Modbus Address	Data Type	Scaling	Comment
0x30	40049	Total 24 hrs, Record day 5, low register	No	Tot24hrs: Record day 5
0x31	40050	Total 24 hrs, Record day 5, high register	No	Tot24hrs: Record day 5
0x32	40051	Total 24 hrs, Record day 6, low register	No	Tot24hrs: Record day 6
0x33	40052	Total 24 hrs, Record day 6, high register	No	Tot24hrs: Record day 6
0x34	40053	Total 24 hrs, Record day 7, low register	No	Tot24hrs: Record day 7
0x35	40054	Total 24 hrs, Record day 7, high register	No	Tot24hrs: Record day 7
0x36	40055	Total 24 hrs, Last Total, low register	No	Tot24hrs: Last Total
0x37	40056	Total 24 hrs, Last Total, high register	No	Tot24hrs: Last Total
0x38	40057	Zero Check Mean (float, float upper 16 bits)	No	Zero Check Mean value
0x39	40058	Zero Check Mean (float, float lower 16 bits)	No	Zero Check Mean value
0x3A	40059	Zero Check Stdev (float, float upper 16 bits)	No	Zero Check Standard deviation
0x3B	40060	Zero Check Stdev (float, float lower 16 bits)	No	Zero Check Standard deviation
0x3C	40061	Zero Check Pipe Ref (float, float upper 16 bits)	No	Zero Check Pipe Reference
0x3D	40062	Zero Check Pipe Ref (float, float lower 16 bits)	No	Zero Check Pipe Reference
0x3E	40063	Zero Check Pipe Diff (float, float upper 16 bits)	No	Zero Check Pipe Difference %
0x3F	40064	Zero Check Pipe Diff (float, float lower 16 bits)	No	Zero Check Pipe Difference %
0x40	40065	Zero Check Bottle Ref (float, float upper 16 bits)	No	Zero Check Bottle Reference
0x41	40066	Zero Check Bottle Ref (float, float lower 16 bits)	No	Zero Check Bottle Reference
0x42	40067	Zero Check Bottle Diff (float, float upper 16 bits)	No	Zero Check Bottle Difference %
0x43	40068	Zero Check Bottle Diff (float, float lower 16 bits)	No	Zero Check Bottle Difference %
0x44	40069	Zero Check Test Time (integer, lower 16 bits)	No	Zero Check Test Time (sec)

* The data in registers with scaling must be multiplied by 10 or 100 as indicated to be scaled properly.



Note: Registers A, B & C are provided to get more resolution for low flow and total. When value exceeds the 16 bit registers, they will be frozen with all 16 bits set. It is also possible to use the velocity to calculate the flow in engineering units by using the pipe area and conversion factor for the selected units.

Example:

Request data register at starting address 0x0000 and specifying only 1 register:
 <0x01> <0x03> <0x00> <0x00> <0x00> <0x01> <0x0a> <0x84>

Command Response

<0x01> <0x03> <0x02> <xx> <xx> <CRC high> <CRC low>
 Where xx is the data register value.

FT3 Commands Supported by Modbus

Read Input Register (FT3 Status and Status 2, Command 04)

This command is used to report the FT3 status information.

Request:

<Meter Address> <Command code=04> <Register address =0> <Register address =0>
<Register count =0> <Register count =1> <CRC high> <CRC low>

Response:

<Meter Address> <Command code=04> <Byte count =2> <Status High> <Status Low>
<CRC high> <CRC low>

The FT3 supports only reading of the FT3 status. The register address must be set to zero (Modbus Address 30001) and the register count must be set to 1.

Table 4.2: Status Bits Definitions for Command 04, Modbus Address 30001

Bit	Definition	Comment
0	Power up indication	Cleared when out of the power up sequence
1	Flow rate reached high limit threshold	Set limit to zero to disable
2	Flow rate reached low limit threshold	Set limit to zero to disable
3	Temperature reached high limit threshold	Set limit to zero to disable
4	Temperature reached low limit threshold	Set limit to zero to disable
5	Sensor reading is out of range	Check sensor wiring
6	Velocity flow rate outside of calibration table	Check sensor wiring
7	Incorrect Settings	Check settings
8	In simulation mode	Set simulation value to 0 to disable
9	Frequency output is out of range	Check frequency output settings
10	Analog 4-20 mA for flow is out of range	Check analog output settings
11	Analog 4-20 mA for temperature is out of range	Check analog output settings
12	Anybus error	Replace display board
13	Bridge Shut Down	Check sensor wiring
14	CRC error	Check parameters and reset CRC
15	Error in Total	Reset total to clear alarm

FT3 Commands Supported by Modbus

Table 4.3: Status 2 Bits Definitions for Command 04, Modbus Address 30002

Bit	Definition	Comment
0	CAL-V in progress	CAL-V in progress
1	ADC12 <> ADC24 too far apart	Internal ADC calibration out of range
2	CAL-V Diff out of range	CAL-V Diff out of range
3	Curve #2 Selected (for 2 gas curves only)	Curve #2 Selected (for 2 gas curves only)
4	Zero Check Failed	Zero Check Failed
5	CAL-V/Zero Check Aborted	CAL-V/Zero Check Aborted

Preset Single Register (Command 06)

This command is used to perform miscellaneous functions such as clearing the totalizer and initiating diagnostic operations. The register address is 0x0a (10 decimal, Modbus=40011) and the data to write is described below.

Request:

<Meter Address> <Command code=06> <Register address high=0x00> <Register address low=0x0a> <Register data high=0x00> <Register data low =0x02> <CRC high> <CRC low>

Response:

<Meter Address> <Command code=06> <Register address =0x00> <Register address =0x0a> <Register data=0x00> <Register data =0x02> <CRC high> <CRC low>

Reset Total:

Address = 40011, data = 0x02

This command is used to clear the Totalizer and elapsed time registers

Reset 24 hours Total:

Address=40011, data = 180 (0xB4)

This command reset the 24 hours 7 days record including the day and hours counters

Reset 24 hour time:

Address=40011, data = 181 (0xB5)

This command reset the 24 hours day and hours counters.

FT3 Commands Supported by Modbus

24 hours Event:

Address=40011, data = 182 (0xB6)

This command generates a 24 hours event, the same way as when the 24 hours counter rolls over. This may be useful to record total over a shorter period.

CAL-V Verify:

Address=40011, data = 161 (0xA1)

This command initiates a "CAL_V Verify". This operation may take 4 minutes to complete and will stop the meter from calculation flow. The Status2 bit D0 may be monitored to check for completion.

Zero Check In-Pipe Verify:

Address=40011, data = 173 (0xAD)

This command initiates a "Zero Check In-Pipe Verify". This operation does not affect flow calculations. The register 40069 may be monitored to check for completion.

Zero Check In-Bottle Verify:

Address=40011, data = 176 (0xB0)

This command initiates a "Zero Check In-Bottle Verify". This operation does not affect flow calculations. The register 40069 may be monitored to check for completion.

Switch to Curve #1:

Address=40011, data = 170 (0xAA)

This command initiates a command to switch to gas curve 1 when configured for 2 gas curves. Make sure that the input contact is not programmed for curve switching

Switch to Curve #2:

Address=40018, data = 171 (0xAB)

This command initiates a command to switch to gas curve 2 when configured for 2 gas curves. Make sure that the input contact is not programmed for curve switching.

Modbus Programming

Enter the Programming Mode

Press the F1 or the F2 key repeatedly, in the normal running mode, until the following screen is shown. This enters the programming mode:

SET PARAMETERS?	
NO	YES

F1 F2 F3 F4

Press YES (F4) and then the following screen will prompt the user to enter the password if enabled:

PASWD: _			
UP	DN	NXT	OK

F1 F2 F3 F4

Enter the correct password. Default password for Level 1 is 1234.

Press the UP (F1) or DN (F2) key to select a new digit or character, the cursor points to the selected digit. Press NXT (F3) to select the next digit and OK (F4) to accept the entry.

If the UP (F1) or DN (F2) keys are held down for more than 1 second, new digits will be selected at an increasing rate.

If the wrong password is entered, the message "Wrong Password" will be displayed for a few seconds and then return to the programming entry screen. If the password is accepted, the following screen will be shown:

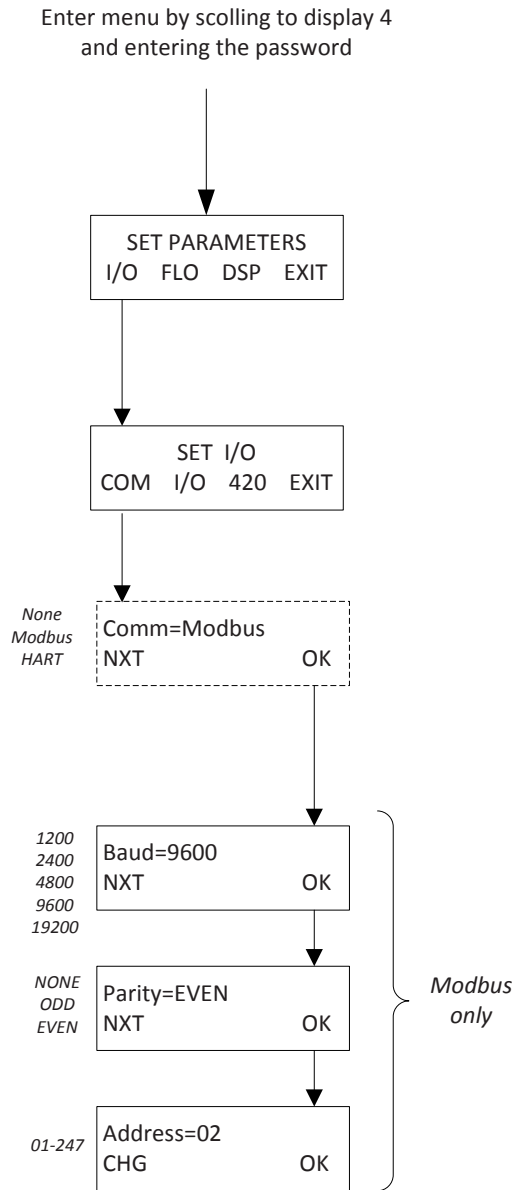
SET PARAMETERS?			
I/O	FLO	DSP	EXIT

F1 F2 F3 F4

This is the base screen for the programming mode. To exit the programming mode, press EXIT (F4) repeatedly until "Normal Mode" screen is displayed.

Modbus Programming

Fig. 5.1: Menu Tree: Comm Selection and Programming



Modbus Programming

Communication Protocol and Parameters

To program the communication parameters, press I/O (F1) key from the base menu.

SET I/O			
I/O	FEQ	420	EXIT

Then press I/O (F1) again:

SET I/O			
COM	CTC		EXIT

Then press COM (F1) to select communication parameters.

Set Bus protocol for Modbus:

Bus=Modbus	
NXT	OK

Press NXT (F1) repeatedly until Modbus is selected as shown and then press OK (F4) to accept the setting.

Selections are: "Modbus"
 "HART"
 "None"

Set Baud Rate communication parameter:

Baud=9600	
NXT	OK

Modbus Programming

Press NXT (F1) repeatedly until the correct Baud Rate is shown and then press OK (F4) to accept the setting.

Selections are: "19200"
 "9600"
 "4800"
 "2400"
 "1200"

Parity=EVEN	
NXT	OK

F1 F2 F3 F4

Press NXT (F1) repeatedly until the correct selection is shown and then press OK (F4) to accept the setting.

Selections are: "NONE"
 "ODD"
 "EVEN"

Set Unit Address:

Address=02	
CHG	OK

F1 F2 F3 F4

Press CHG (F1) to change the Modbus communication Address.

Press the UP (F1) or DN (F2) keys to select the value for the Modbus Address. The cursor points to the selected digit. Press NXT (F3) to select the next digit and OK (F4) to accept the setting.

It is very important that there are not two devices with the same Modbus address. To avoid conflicts, each Modbus slave must have a unique address. Range is from 01 and 247.

Note: Power to the FT3 must be cycled off and on for the new Modbus settings to take effect.

Definitions

Glossary of Terms
and Definitions



ADD
ADU
COM
CRC
NC
PC
PDU
NRT
TERM

Address
Application Data Unit
Communication
Cyclic Redundancy Check
Not Connected
Personal Computer
Protocol Data Units
Non Resetting Totalizer
Terminal

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Information



Caution



Wiring



Definition of Terms