

Fox Thermal Instruments, Inc.

THERMAL MASS FLOW METER & TEMPERATURE TRANSMITTER

Model FT2A
Modbus & BACnet MS/TP



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 FT2A Manuals:

- **Model FT2A Instruction Manual**
- **Fox FT2A View™ Instruction Manual**
- **Fox FT2A Profibus, DeviceNet & Ethernet Manual**

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Modbus Introduction

Modbus Introduction

Scope

Thank you for purchasing the Model FT2A Thermal Gas Mass Flow meter and Temperature Transmitter from Fox Thermal Instruments. The Model FT2A 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 Instruments FT2A Mass flow meter based on the Modicon Modbus Protocol (PI-MBUS-300 Rev. J).

Modbus Protocol

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

RS485 Wiring for Modbus

Wiring connections are made to terminal block TS2 for Modbus communication.

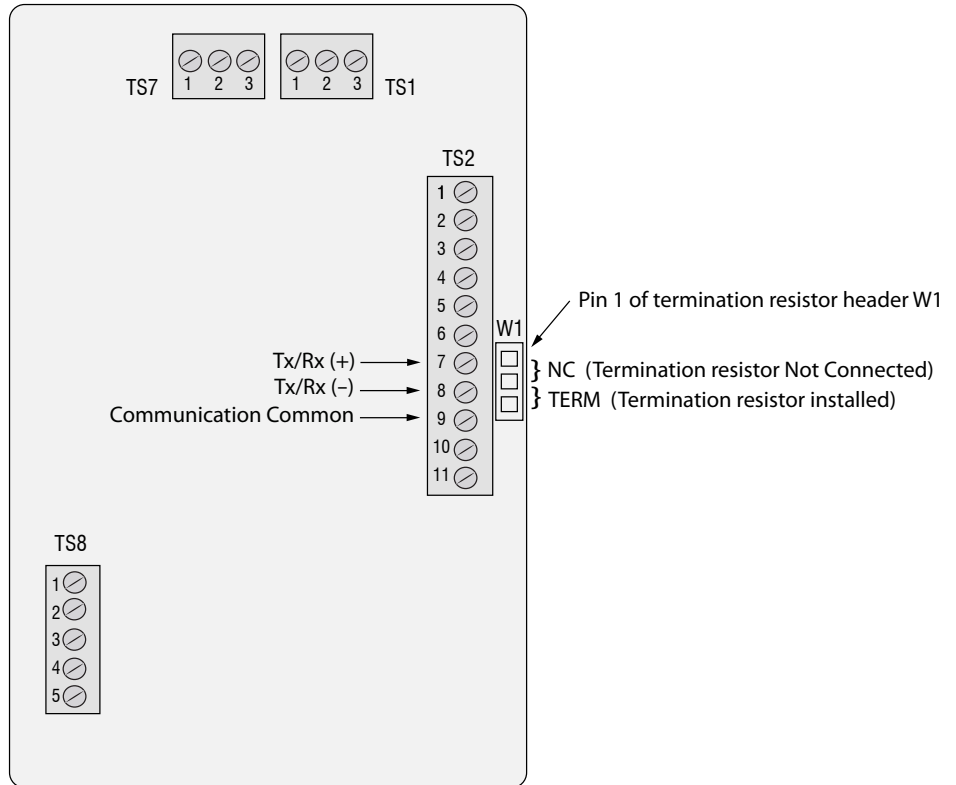
The Tx/Rx+ signal connects to pin 7, Tx/Rx- connects to pin 8 and communication common to pin 9 as shown in Figure 3.1.

Termination Resistor

Connect a termination resistor across the receive/transmit signals of the last device on the Modbus communication line. To connect the 121 ohm termination resistor on the FT2A, set jumper W1 to the TERM position.

Disconnect the termination resistor on all other external Modbus devices. The termination resistor of the FT2A is disconnected by setting jumper W1 to the NC (Not Connected) position.

Fig. 3.1: Modbus Wiring



Note: W1 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.



FT2A Commands Supported by Modbus

FT2A Commands Supported

FT2A Commands Supported

The FT2A 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 FT2A 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: FT2A 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

FT2A Commands Supported by Modbus

Register Address	Modbus Address	Data Type	Scaling	Comment
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
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	Spare/ Not used		
0x11	40018	Control Register (Write Only)	No	Control Register
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	Spare/ Not used		
0x20	40033	Spare/ Not used		
0x21	40034	Spare/ Not used		
0x22	40035	Spare/ Not used		
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

FT2A Commands Supported by Modbus

Register Address	Modbus Address	Data Type	Scaling	Comment
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
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	Reserved	No	
0x39	40058	Reserved	No	
0x3A	40059	Reserved	No	
0x3B	40060	Reserved	No	
0x3C	40061	Reserved	No	
0x3D	40062	Reserved	No	
0x3E	40063	Reserved	No	
0x3F	40064	Reserved	No	
0x40	40065	Reserved	No	
0x41	40066	Reserved	No	
0x42	40067	Reserved	No	
0x43	40068	Reserved	No	
0x44	40069	Reserved	No	

* 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.



FT2A Commands Supported by Modbus

Read Input Register **Read Input Register (FT2A Status, Command 04)**

This command is used to report the FT2A 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>

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

FT2A Commands Supported by Modbus

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

Bit	Definition	Comment
0	Not used	Not used
1	Busy	Busy
2	Not used	Not used
3	Curve #2 Selected (for 2 gas curves only)	Curve #2 Selected (for 2 gas curves only)
4	Not used	Not used
5	Not used	Not used
6	Not used	Not used

FT2A Commands Supported by Modbus

Preset Single Register

Preset Single Register (Command 06)

This command is used to perform miscellaneous functions such as clearing the totalizer and elapsed time. The register address is Modbus=40018 and the data to write is described below.

Request:

<Meter Address> <Command code=06> <Register address high=0x00> <Register address low=0x11> <Register data high=0x00> <Register data low =0x02> <CRC high> <CRC low>

Response:

<Meter Address> <Command code=06> <Register address =0x00> <Register address =0x11> <Register data=0x00> <Register data =0x02> <CRC high> <CRC low>

Reset Total:

Address = 40018, data = 0x02

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

Reset 24 hours Total:

Address=40018, data = 180 (0xB4)

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

Reset 24 hour time:

Address=40018, data = 181 (0xB5)

This command reset the 24 hours day and hours counters

24 hours Event:

Address=40018, 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.

FT2A Commands Supported by Modbus

Preset Single Register

Switch to Curve #1:

Address=40018, 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.

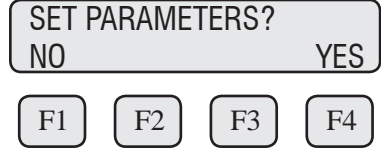
Make sure that the input contact is not programmed for curve switching

Modbus Programming

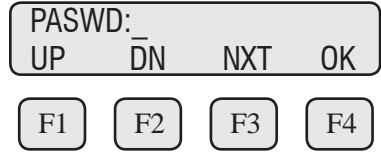
Programming

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:



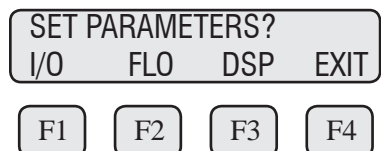
Press YES (F4) and then the following screen will prompt the user to enter the password if enabled:



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 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:

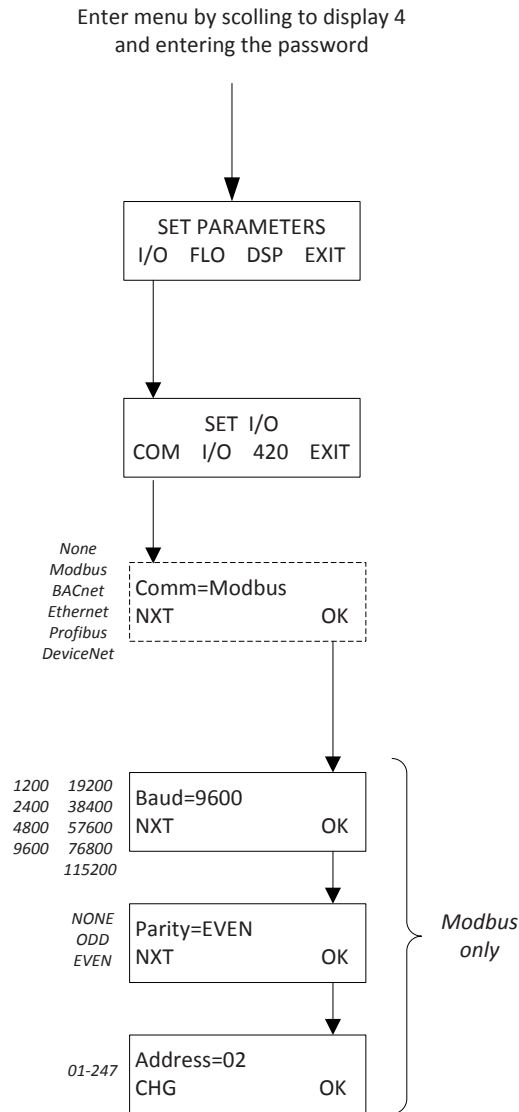


This is the base screen for the programming mode. To exit the programming mode, press EXIT (F4) repeatedly until "Normal Mode" is seen briefly.

Modbus Programming

Menu Tree

Fig. 5.1: Menu Tree: Comm Selection and Programming



MODBUS PROGRAMMING

Modbus Programming

Modbus Communication Parameters

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

F1 F2 F3 F4

Then press I/O (F1) again:

SET I/O			
COM	CTC		EXIT

F1 F2 F3 F4

Then press COM (F1) to select communication parameters.

Set Bus protocol for Modbus:

Bus=Modbus			
NXT			OK

F1 F2 F3 F4

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

The following communication parameters are only available for MODBUS:

Baud=9600			
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: "115200"
 "76800"

Modbus Programming

Modbus	"57600"
Communication	"38400"
Parameters	"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"

Address=02	
CHG	OK

F1	F2	F3	F4
----	----	----	----

Press CHG (F1) to change the address and then press OK (F4) to accept the setting.

Selections are between 01 and 247.

Note: Power cycle is required for the new settings to take effect.



BACnet Introduction

BACnet Introduction **Scope**

Thank you for purchasing the Model FT2A Thermal Gas Mass Flow meter and Temperature Transmitter from Fox Thermal Instruments. The Model FT2A 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 BACnet MS/TP implementation using RS485 serial communication physical layer for the Fox Thermal Instruments FT2A Mass flow meter.

BACnet Protocol

BACnet Protocol

BACnet MS/TP (Building Automation and Control Network /Master Slave Token Passing) is a data link layer protocol designed for communication between devices in building automation control systems. The protocol is based on devices, objects, properties, and services. Information inside a BACnet device is organized into a series of objects. Properties allow the data from the object to be written or read. The actions that a BACnet device uses to interact with another device are the services.

The FT2A Device profile: BACnet Smart Sensor (B-SS)

FT2A supports the following device binding methods:

Receive Who-Is, send I-Am (BIBB DM-DDB-B) Receive Who-Has, send I-Have (BIBB DM-DOB-B)

Objects for FT2A:

Analog Input 1 = Flow Analog Input 2 = Gas Temperature Analog Input 3 = Total Flow / Reset Total Analog Input 4 = Elapsed Time since reset

BACnet Protocol

BACnet Protocol

Device object property identifiers and restrictions: (properties that are writable)

Object _ Name	< 10 bytes
Object _ Identifier	Device Type only
Max _ info _ Frames	< =255
Max _ Master	< =127

BACnet Interoperability Building Blocks (BIBB'S) provide function capabilities for data exchange between devices.

FT2A BIBB's supported:

DS-RP-B Read Property DS-WP-B Write Property DM-DDB-B Dynamic Device Binding DM-DOB-B Dynamic Object Binding DM-DCC-B Device Communication Control DS-RPM-B ReadPropertyMultiple DM-RD-B Reinitialize Device
--

MS/TP baud rates:

9600, 19200, 38400, 57600, 76800, 115200
--

FT2A Character sets supported:

ANSI X3.4, UTF-8

Fox Thermal Instruments BACnet vendor ID: 650

For more information about BACnet visit <http://www.bacnet.org/>.

RS485 Wiring: BACnet MS/TP



RS485 Wiring

RS485 Wiring: BACnet MS/TP

Wiring connections are made to terminal block TS2 for BACnet MS/TP communication.

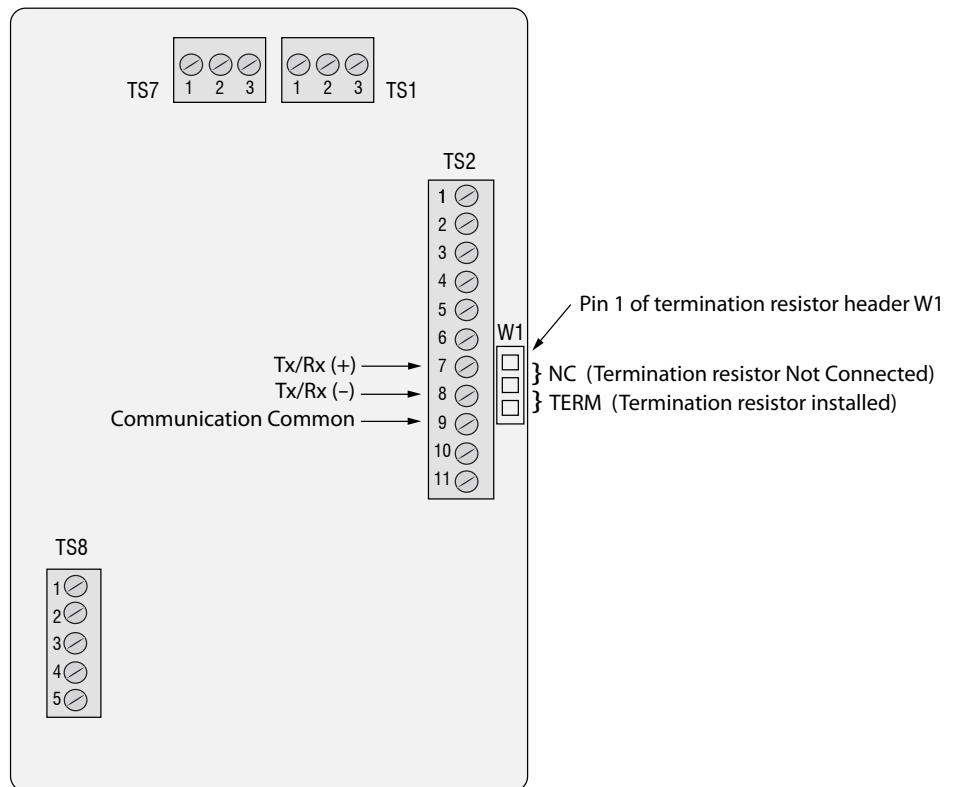
The Tx/Rx+ signal connects to pin 7, Tx/Rx- connects to pin 8 and communication common to pin 9 as shown in Figure 8.1.

Termination Resistor

Connect a termination resistor across the receive/transmit signals of the last device on the BACnet MS/TP communication line. To connect the 121 ohm termination resistor on the FT2A, set jumper W1 to the TERM position.

Disconnect the termination resistor on all other external BACnet MS/TP devices. The termination resistor of the FT2A is disconnected by setting jumper W1 to the NC (Not Connected) position.

Fig. 8.1: BACnet MS/TP Wiring



Note: W1 jumper will either be in the NC or TERM position. It should be in the TERM position on the last meter in the BACnet MS/TP daisy chain.



BACnet Programming

BACnet 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 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

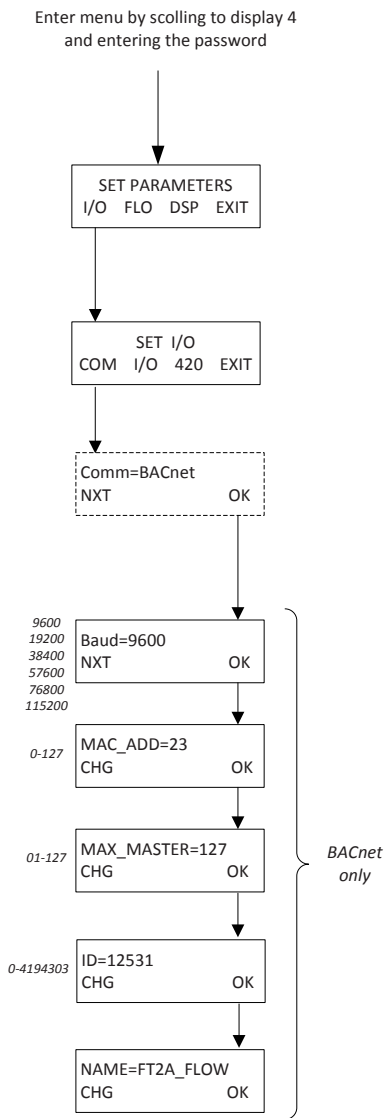
F1 F2 F3 F4

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

BACnet Programming

Menu Tree

Fig. 9.1: Menu Tree: Comm Selection and Programming



BACnet Programming

BACnet Communication Parameters

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
```

F1 F2 F3 F4

Then press I/O (F1) again:

```
SET I/O
COM  CTC           EXIT
```

F1 F2 F3 F4

Then press COM (F1) to select communication parameters

Set Bus protocol for BACnet:

```
Bus=BACnet
NXT           OK
```

F1 F2 F3 F4

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

```
Baud=9600
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: "9600"
 "19200"
 "38400"
 "57600"
 "76800"
 "115200"

BACnet Programming

BACnet Communication Parameters

Next select the MS/TP Mac address. The selection is from 0-127. Please note that only one device can be on a MS/TP Mac address.

MAC_ADD=23
CHG OK

- F1
- F2
- F3
- F4

Next select the MS/TP Max Master. The selection is from 0-127.

MAX_MASTER=127
CHG OK

- F1
- F2
- F3
- F4

Next input the device object instance. Selection is from 0-4194303.

ID=12531
CHG OK

- F1
- F2
- F3
- F4

Next enter the device object name (9 characters maximum).

NAME=FT2A_FLOW
CHG OK

- F1
- F2
- F3
- F4



Note: Power cycle is required for the new settings to take effect.

Definitions

Glossary of Terms and Definitions



ADD
ADU
B-SS
BIBB
COM
CRC
NC
PC
PDU
NRT
TERM

Address
Application Data Unit
BACnet - Smart Sensor
BACnet Interoperability Building Blocks
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