MODBUS MANUAL
For the
Micro TOL
Series Turbidimeter

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Catalog No. 19777 (2/04)
Rev. 1.4

1.0 Overview

The HF Scientific Micro TOL uses a communication protocol called Modbus. A company called Modicon, for use with their programmable controllers, developed the Modbus protocol. Since that time Modbus has evolved into common communication protocol in industry.

The communication method involves using a master-slave technique, in which there is one master and several slaves. The Micro TOL is a slave device. Only the master can initiate queries. These queries are directed to an individual slave device and the appropriate slave responds with the requested data.

A broadcast message can be sent to all slaves. The slave devices do not answer these broadcasts.

There are two transmission modes. These modes are known as RTU (Remote Terminal Unit) and ASCII (American Standard Code for Information Interchange).

The Micro TOL can be setup in a network of up to 255 slave devices. Each device must have a different address (1-255). The Micro TOL can be set for either RTU or ASCII mode.

2.0 Electrical Connections

All of the electrical connections to the instrument are made through the field terminal box, which should be located directly under the sensor portion of the instrument. The connections are labeled within the terminal box and are self-descriptive (see Figure 1). Please follow all local and government recommendations and methods for installation of electrical connections to and between the instrument and other peripheral devices.

A plug is inserted into the RS-485 cable bulkhead when shipped, to ensure a watertight seal. This plug should be removed and discarded when cabling to this connection.

The bulkhead will accept cable diameters from 5.8mm (.230 in.) up to 10 mm (.395 in.). The terminals are designed to accept wires in the range of 14-28 AWG. All wires should be stripped to a length of 6 mm

It is the user's responsibility to assure that the watertight seal is maintained after the terminal box has been wired for operation. If any of the bulkheads are not tightened properly around a cable or plug, the ratings of the instrument will be jeopardized and there is a possibility of creating a shock hazard.

Note: Only qualified electricians should be allowed to perform the installation of the instrument as it involves a line voltage that could endanger life.

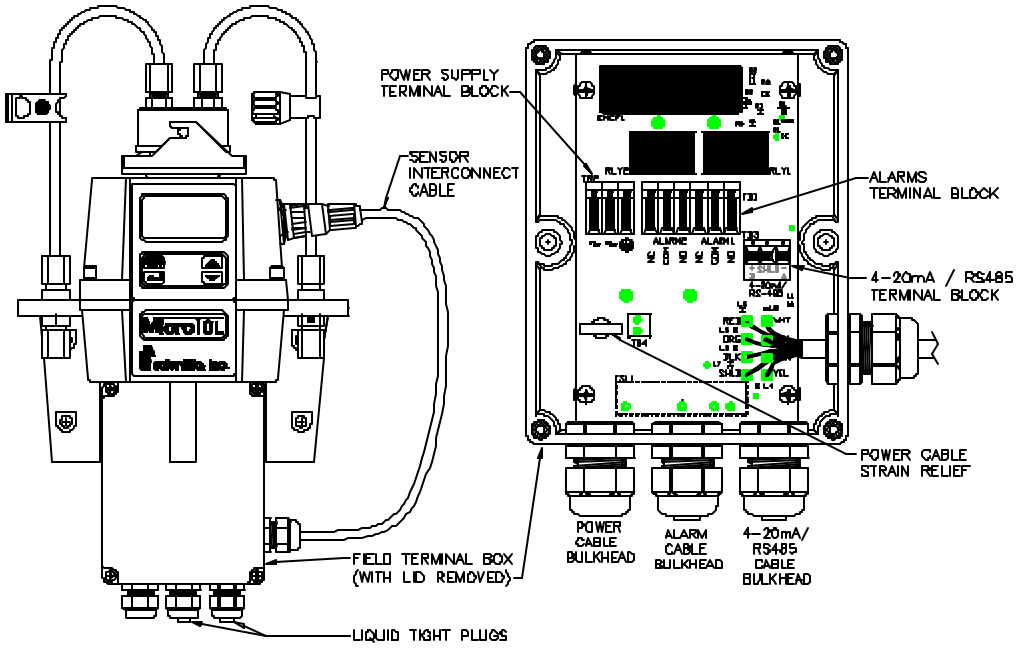


Figure 1: Electrical Connections for the Instrument

2.1 RS-485 (Optional Part # 19615 on Model 20023 & 20024): The RS-485 half-duplex (2-wire) digital interface operates with differential levels that are not susceptible to electrical interferences. This is why cable lengths up to 3000 ft can be implemented. The last device on every bus may require a 120-ohm termination resistor to eliminate the possibilities of signal reflection on the line. Do not run RS-485 cables in the same conduit as power.

Ensure each instrument is not powered when connecting the RS-485 line. To prevent damage to the instrument, ensure that power is disconnected prior to making connections.

3.0 Operation

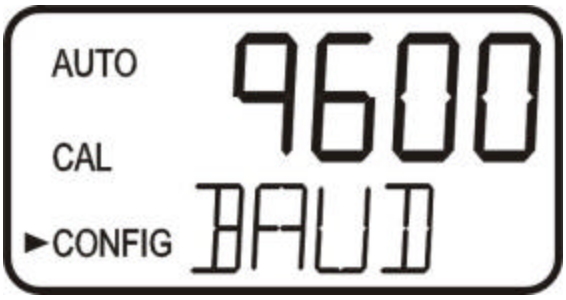
3.1 Selecting the Output (O/P)

The first configuration selection is the O/P. The selections are **4-20** for the 4-20 mA output, **485** for the RS-485 and **OFF** if no outputs are required. Please note that the RS-485 is optional on Model 20023 & 20024. Select the desired output by using the ▲ and ▼ buttons. Once the desired output has been set, press the ¿ button to accept it. The next prompts will depend on the output selected.

3.2 Configuring the RS–485 Port

If the instrument is equipped with this option, and the I/O selection is changed to **485**, prompts will appear for setting the baud rate and the address.

Select the correct baud rate (1200, 2400, 4800, 9600, or 19200) for operation of the I/O port by pressing the ▲ or ▼ buttons to change the displayed baud rate.

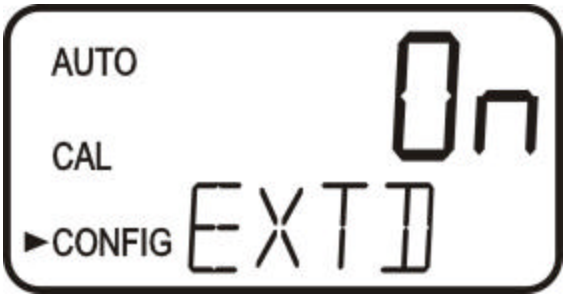


Press the ¿ button to continue on and select the desired instrument address (1-255) using the ▲ or ▼ buttons. Once the selection is satisfactory, press the ↵ button.

Select the operating mode either ASCII or RTU using the ▲ or ▼ buttons. Press the **MODE** key to complete the Modbus setup.

3.2 Configuring the RS–485 Port (continued)
For Modbus some applications, especially involving the ASCII operation mode, it may be necessary to set a different protocol than the default setting (8 bits, 1 stop bit, no parity). Menus are available for this in the Extended Settings portion of the configuration **CONFIG** mode**.**

While in the **CONFIG** mode, press the ↵ button, several times until the Extended Settings is as shown below. Select **On** using the ▲ or ▼ buttons.



Press the ¿ button a few times until the menus appear for **BITS, PRTY (**Parity) and **STOP** (Stop Bits). Set each one to the desired setting using the ▲ and ▼ buttons.

4.0 The Modbus RS-485 Output & Commands Implemented

The default communication parameters are 8 bits, no parity and 1 stop bit. Please note that all Modbus communication is via RS-485. The instruments can support a two wire multidrop network of 255 units. If the connection is to the master on RS-232 serial port, an RS-485 to RS-232 converter is required.

4.1 Coils

These single-bit values are readable and changeable from the master. The data will be returned with the lowest addressed coil in the LSB of the data. Unused bits in the data will be set to 0. True is a 1 and False is 0.

4.1.1 Valid Command(s)

Code	Name	Broadcast
0x01	Read Coil Status	No
0X05	Force Single Coil	Yes

4.1.2 Format

16-bit word format

MSB															LSB
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

4.1.3 Valid Addresses

00001 – 00XXX

Definitions

Address	Function	Default
00001	Offset added	False
00002	Flow alarm selected	False
00003	Access code enabled	False
00004	Ultrasonic cleaning enabled (if available)	True
00005	Desiccant set as error (True) or warnings (False)	True

4.2 Input Status

These single-bit values are readable from the master. The data will be returned with the lowest addressed input status in the LSB of the data. Unused bits in the data will be set to 0.

4.2.1 Valid Command(s)

Code	Name	Broadcast
0x02	Read Input Status	No

4.2.2 Format

16-bit word format

MSB															LSB
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

4.2.3.Valid Addresses

10001 – 10XXX

4.2.4 Definitions

Address	Function
10001	Instrument error
10002	Alarm 1 active
10003	Alarm 2 active
10004	Calibration error
10005	Desiccant error

4.3 Holding Registers

These 16-bit values are readable and changeable from the master. The data is stored and transmitted with the MSB first and then the LSB.

4.3.1 Valid Command(s)

Code	Name	Broadcast
0x03	Read Holding Registers	No
0x06	Preset Single Register	Yes
0X16	Preset Multiple Registers	Yes

4.3.2 Format

Float – stored in two consecutive addresses, with the first address containing the least significant word (lower part of mantissa) and the second address containing the most significant word (sign, exponent, and upper part of mantissa).

4.3.3 Valid Addresses

40001 – 40XXX

4.3.4 Definitions

Address	Type	Register	Value	Default	Function
40001, 40002	Float	Offset value	--	0.0	0.0 – 2.0
40003	Int	Decimal places	0	2	XXXXX.
			1		XXXX.X
			2		XXX.XX
			3		XX.XXX
			4		X.XXXX
40004	Int	Response time	--	10	1-100 seconds
40005	Int	Units (scaling)	1	1	NTU
			2		FNU
40006	Int	LCD backlight	--	8	1 – 10 (brightest)
40007	Int	Not used	--	--	--
40008	Int	Output option	0	0	None
			1		4-20 mA
			2		RS-485 (if available)
40009, 40010	Float	4-20 mA minimum value	--	0.02	0.0 to max range of instrument
40011, 40012	Float	4-20 mA maximum value	--	10.0	0.0 to max range of instrument
40013	Int	RS-485 baud rate	0	3	1200
			1		2400
			2		4800
			3		9600
			4		19200
40014	Int	RS-485 data bits	0	1	7 bits
			1		8 bits
40015	Int	RS-485 parity	0	0	None
			1		Even

Address	Type	Register	Value	Default	Function
			2		Odd

Address	Type	Register	Value	Default	Function
40016	Int	RS-485 stop bits	0	0	1 stop bit
			1		2 stop bits
40017	Int	Instrument address	--	1	1 – 255
40018	Int	Modbus serial mode	0	0	RTU
			1		ASCII
40019	Int	Not used	--	--	--
40020	Int	Alarm 1 function	0	0	Off
			1		Low alarm
			2		High alarm
40021, 40022	Float	Alarm 1 set point	--	1.0	0.0 to max range of instrument
40023	Int	Alarm 1 delay on	--	1	1 – 30 seconds
40024	Int	Alarm 1 delay off	--	1	1 – 30 seconds
40025	Int	Not used	--	--	--
40026	Int	Alarm 2 function	0	0	Off
			1		Low alarm
			2		High alarm
40027, 40028	Float	Alarm 2 set point	--	1.0	0.0 to max range of instrument
40029	Int	Alarm 2 delay on	--	1	1 – 30 seconds
40030	Int	Alarm 2 delay off	--	1	1 – 30 seconds
40031,40032[2]	Float	Sensor reading	--	--	The meter reading
40033,40034[2]	Float	Sensor reading raw	--	--	Sensor reading to six significant places
40035[2]	Int	Version major	--	--	Software version major number
40036[2]	Int	Version minor	--	--	Software version minor number
40037[2]	Int	Version revision	--	--	Software version revision number
40038[2]	Int	Model number	--	--	Product number
40039[2]	Int	Model suffix number	--	--	0 if no options
40040[2]	Int	Reading status	1	--	Good
			2		Over-range
			3		Under-range
			6		Error
40041[2]	Int	Instrument error summary (bit-mapped)	0x0000	--	Normal
			0x0001	--	Error (see error register for details)
			0x0002		Alarm 1 active
			0x0004		Alarm 2 active
			0x0008		Calibration error

Address	Type	Register	Value	Default	Function
40042[2]	Int	Errors (bit-mapped)	0x0000	--	Normal
			0x0001		Replace desiccant
			0x0002		Break in 4-20 mA current loop
			0x0004		Calibration error
			0x0010		Data over-range
			0x0020		Flow switch alarm (if applicable)
			0x0040		Lamp failure
			0x0080		Ultrasonic cleaning problem (if applicable)
			0x0100		General error
			0x0200		General error
40043[2]	Int	PCB Revision	0	--	Revision 1
			1		Revision 2

[2]Duplicate of 30XXX addresses (input registers). These values in these registers cannot be changed from the master.

4.4 Input Registers

These 16-bit values are readable by the master. The data is stored with the MSB first and then the LSB.

4.4.1 Valid Command(s)

Code	Name	Broadcast
0x04	Read Input Registers	No

4.4.2 Format

Float – stored in two consecutive addresses, with the first address containing the least significant word (lower part of mantissa) and the second address containing the most significant word (sign, exponent, and upper part of mantissa).

4.4.3 Valid Addresses

30001 – 30XXX

4.4.4 Definitions

Address	Type	Register	Value	Function
30001, 30002	Float	Sensor reading	--	The meter reading
30003, 30004	Float	Sensor reading raw	--	Sensor reading to six significant places
30005	Int	Version major	--	Software version major number
30006	Int	Version minor	--	Software version minor number
30007	Int	Version revision	--	Software version revision number
30008	Int	Model number	--	Product number
30009	Int	Model suffix number	--	Options (value is option dependant 1-9)
30010	Int	Reading status	1	Normal
			2	Over-range
			3	Under-range
			6	Error
30011	Int	Instrument error summary (bit-mapped)	0x0000	Normal
			0x0001	Error (see error register for details)
			0x0002	Alarm 1 active
			0x0004	Alarm 2 active
			0x0008	Calibration error
30012	Int	Errors (bit-mapped)	0x0000	Normal
			0x0001	Replace desiccant
			0x0002	Break in 4-20 mA current loop
			0x0004	Calibration error
			0x0010	Data over-range
			0x0020	Flow switch alarm (if applicable)
			0x0040	Lamp failure
			0x0080	Ultrasonic cleaning problem (if applicable)
			0x0100	General error
			0x0200	General error

Address	Type	Register	Value	Function
30013	Int	PCB Revision	0	Revision 1
			1	Revision 2

4.5 Exception Responses Implemented

Code	Name	Meaning
00	--	No error
01	ILLEGAL FUNCTION	The function code is not allowed in the device.
02	ILLEGAL DATA ADDRESS	The data address is not allowed in the device
03	ILLEGAL DATA VALUE	A value contained in the query field is wrong for the device

5.0 Warranty

HF scientific, inc., as vendor, warrants to the original purchaser of this instrument that it will be free of defects in material and workmanship, in normal use and service, for a period of one year from date of delivery to the original purchaser. HF scientific, inc.'s, obligation under this warranty is limited to replacing, at its factory, the instrument or any part thereof. Parts, which by their nature are normally required to be replaced periodically, consistent with normal maintenance, specifically reagent, desiccant, sensors, electrodes and fuses are excluded. Also excluded are accessories and supply type items.

Original purchaser is responsible for return of the instruments, or parts thereof, to HF scientific, inc.'s factory. This includes all freight charges incurred in shipping to and from HF scientific, inc.'s factory.

HF scientific, inc. is not responsible for damage to the instrument, or parts thereof, resulting from misuse, environmental corrosion, negligence or accident, or defects resulting from repairs, alterations or installation made by any person or company not authorized by HF scientific, inc.

HF scientific, inc. assumes no liability for consequential damage of any kind, and the original purchaser, by placement of any order for the instrument, or parts thereof, shall be deemed liable for any and all damages incurred by the use or misuse of the instruments, or parts thereof, by the purchaser, its employees, or others, following receipt thereof.

Carefully inspect this product for shipping damage, if damaged, immediately notify the shipping company and arrange an on-site inspection. HF scientific, inc. cannot be responsible for damage in shipment and cannot assist with claims without an on-site inspection of the damage.

This warranty is given expressly and in lieu of all other warranties, expressed or implied. Purchaser agrees that there is no warranty on merchantability and that there are no other warranties, expressed or implied. No agent is authorized to assume for HF scientific, inc. any liability except as set forth above.

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