Modbus Protocol
COMMUNICATIONS MANUAL

For Series 2 Laureate Digital Panel Meters, Counters, Timers & DIN-Rail Transmitters

Now with Ethernet

CE RoHS c ETL LISTED US Intertek 4006497

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1. TABLE OF CONTENTS

2. INTRODUCTION, MODBUS PROTOCOL

The Modbus Protocol is an industry-standard communications protocol that is selectable with all our serial communications signal options: Ethernet, USB, RS485 and RS232. It is implemented by the microcomputer on the main board and is compliant with Modbus RTU or ASCII transmission modes (software selectable), as specified in Modbus over Serial Line Specification V1.0 (2002).

Digital panel meters, counters and timers require a plug-in option board for Modbus communications. This board can be any of the following:

- RS232 board
- RS485 board with dual RJ11 jacks.
- RS485 LMOD board with dual RJ45 jacks
- USB board
- USB-to-RS485 converter board
- Ethernet board
- Ethernet-to-RS485 converter board

Our RS485 and LMOD RS485 boards are both Modbus compliant, but the RS485 board uses RJ11 jacks while the LMOD board uses RJ45 jacks as recommended in the Modbus Specification. With either board, the two jacks are wired in parallel to allow daisy chaining of meters with no need for a hub.

Our USB-to-RS485 and Ethernet-to-RS485 converter boards allow the host meter to function as a normal meter, be connected to a host computer or Ethernet local area network (LAN), and also act as the device server for an RS485 network with up to 31 other meters equipped with an RS485 board. These meters can then be daisy-chained using readily available, straight-through 6-wire data cables (not 4-wire telephone cables or crossover cables). Use repeaters to increase the number of addressable meters.

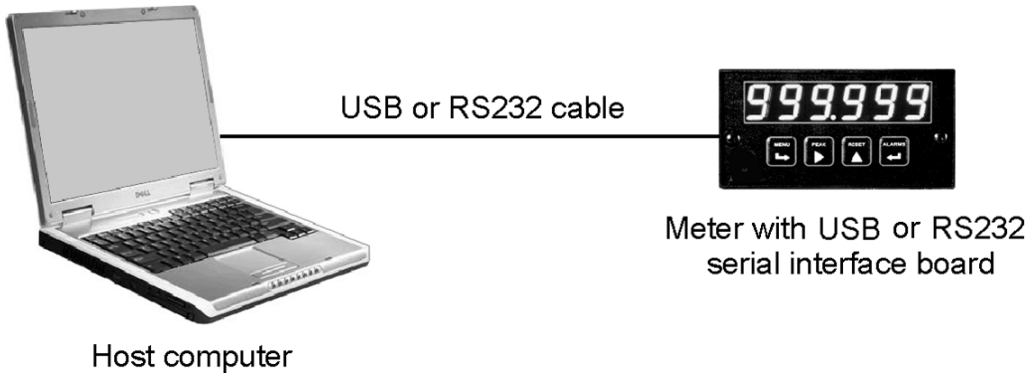
Our DIN-rail transmitters come with a user-selectable Ethernet or RS232/RS485 I/O port in addition to a scalable 4-20 mA output, which is standard.

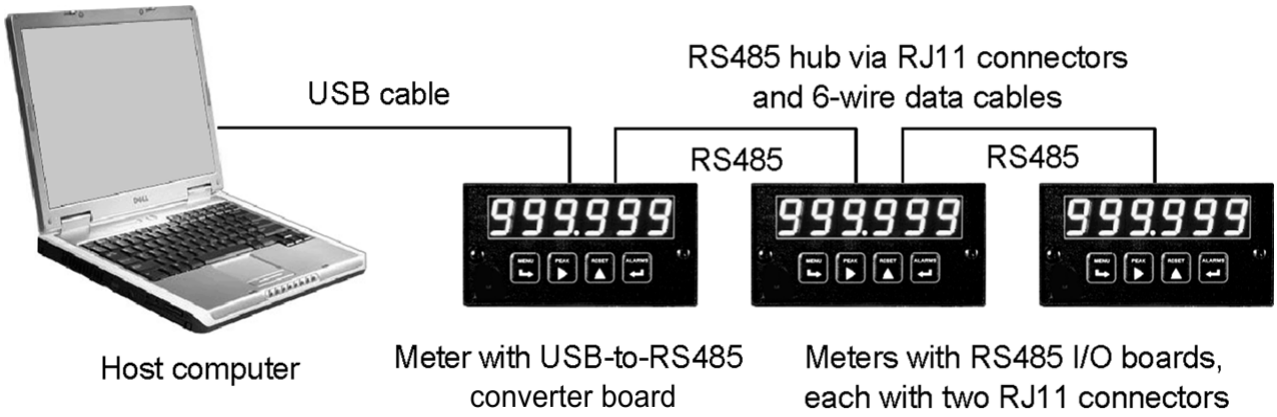
Our DIN-rail Ethernet-to-RS485 device server provides an RJ45 jack for connection to the Ethernet, an RJ11 jack to support an RS485 network of meters, plus screw terminals to support an RS485 network of DIN-rail transmitters via a set of 3 or 5 parallel wires (half- or full-duplex).

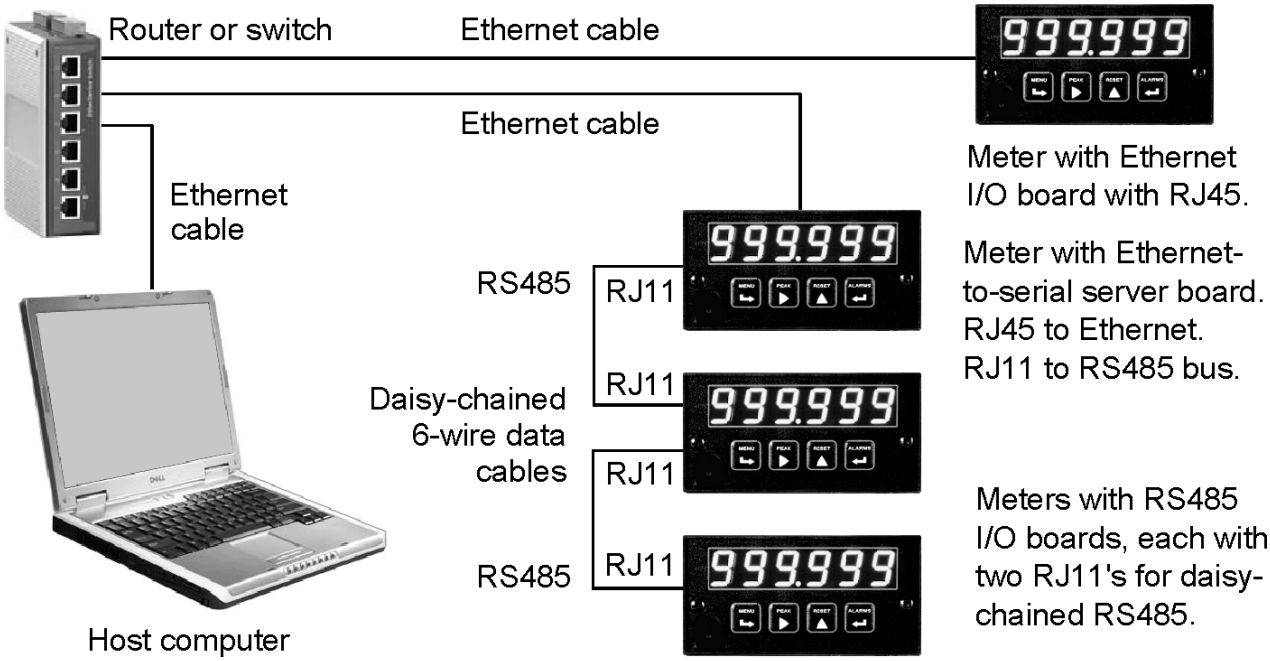
The Modbus TCP protocol is seamlessly converted by our Ethernet Nodes to Modbus RTU or Modbus ASCII for communication with meters and transmitters on an RS485 bus. Please see our Ethernet Manual for more information.

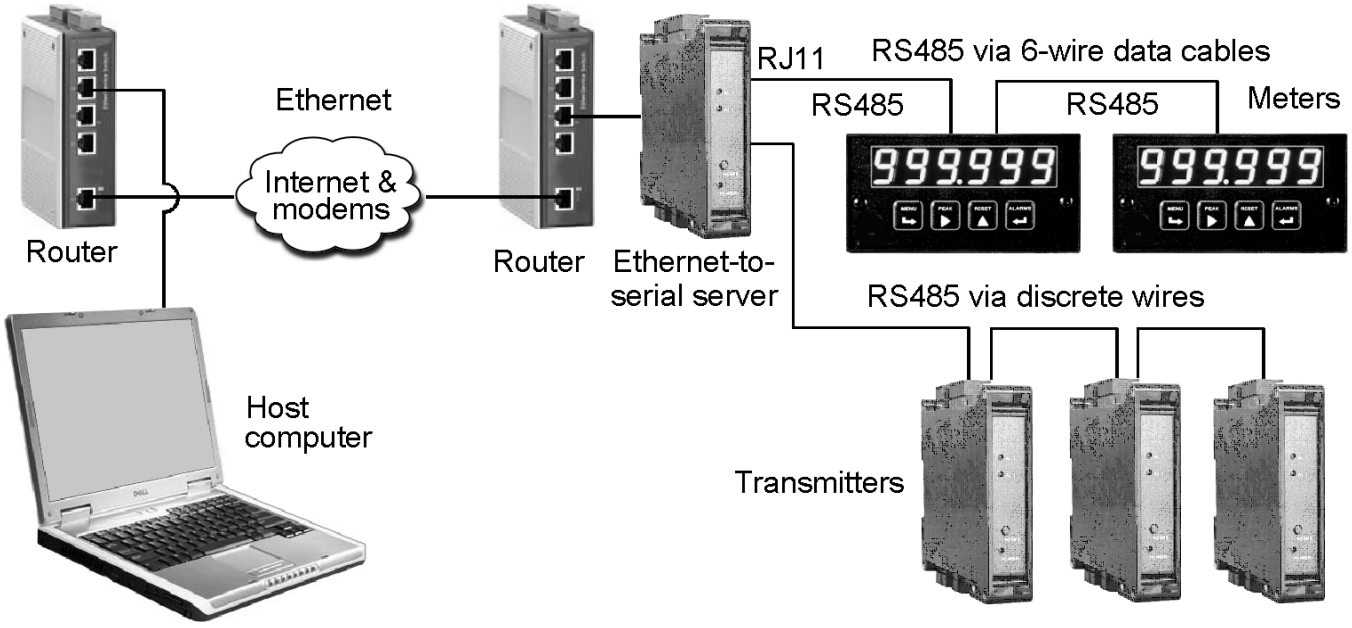
The Custom ASCII Protocol is a software-selectable alternative to the Modbus Protocol. It also allows device addressing of up to 31 devices. It is less complex than the Modbus protocol, but is limited to use with our devices. Please see our Custom ASCII Protocol Communications Manual.

3. MODBUS CONNECTION EXAMPLESS









With an Ethernet connection, our Nodes and the host PC can be connected directly to the same LAN, and our software will automatically discover all our Nodes in the LAN. A Node cannot be connected directly to a PC via an Ethernet cable.

For connection via the Internet, the PC can be plugged into a local LAN, and the remote instruments can be plugged into a remote LAN. Laureate Ethernet Nodes and any Devices attached to them via an RS485 bus are automatically discovered by our Ethernet software when the IP address of the remote router is supplied. Laurel software can be our Node Manager Software, Instrument Setup Software, or XLOG Datalogging Software.

4. JUMPER SETTINGS & FIELD WIRING

1. SAFETY WARNINGS

Digital panel meters, counters, timers and transmitters may be powered with AC (mains) from 85-264 Vac or 95-300 Vdc with standard high voltage power, or 12-34V ac or 10-48 Vdc with the low voltage power supply option. To avoid the possibility of electrical shock or damaging short circuits, always unplug the device before opening the case. Please refer to the respective device manuals for full safety information and instruction on how to open the case. Signal wiring changes external to the case can be made safely while the units are under power.

2. JUMPERS ON SERIAL METER BOARDS

USB Board &
Basic Ethernet Board

No jumpers needed.

RS232 Board

e - Externally enabled RTS (otherwise always enabled)
f - Remote display (or slave) operation.
g - Normal operation (other than remote display).

Note: Board is shipped with jumper **g** installed.

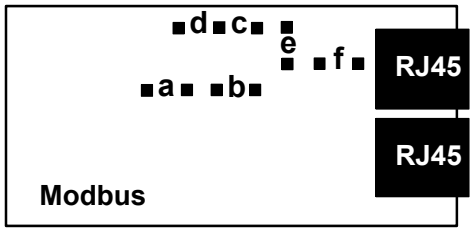
RS485-Modbus Board, Full Duplex Operation

b & e - Bias jumpers should be installed on 1 board.
a & d - Installed on last meter in long cable run.

RS485-Modbus Board, Half Duplex Operation

b & e - bias jumpers installed on 1 board.
c & f - installed for half duplex operation.
a - installed on last meter in line with long cable runs.

Note: Board is shipped with no jumpers installed.



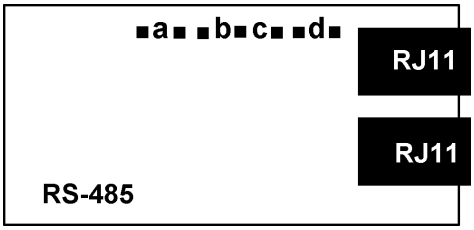
RS485 Board, Full Duplex Operation

b & d - Installed on last meter in long cable run.

RS485 Board, Half Duplex Operation

a & c - Installed for half duplex operation.
d - Installed on last meter in line with long cable runs.

Note: Board is shipped with no jumpers installed.



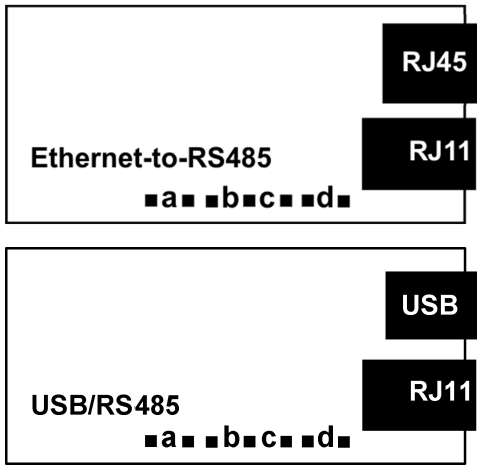
Ethernet-to-RS485 Converter Board
& USB-to-RS485 Converter Board

Full Duplex Operation

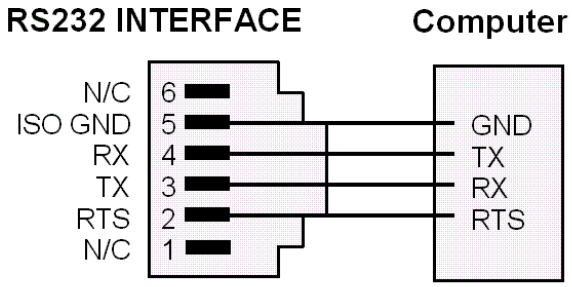
No jumpers for short cable runs.
Add **b & d** for long cable runs.

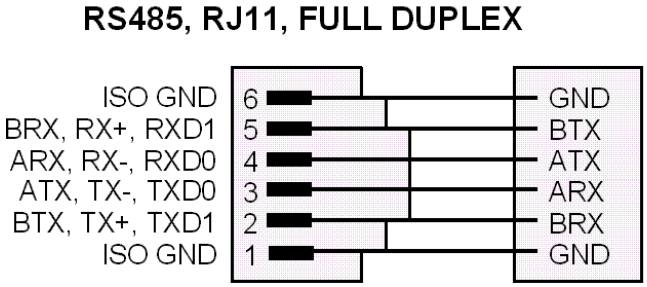
Half Duplex Operation

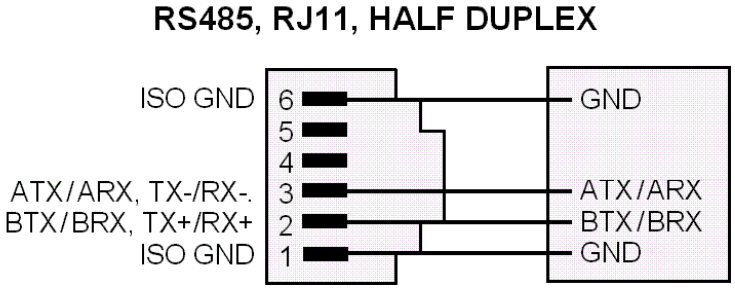
a & c for short cable runs.
d - Installed on last meter in line with long cable runs.

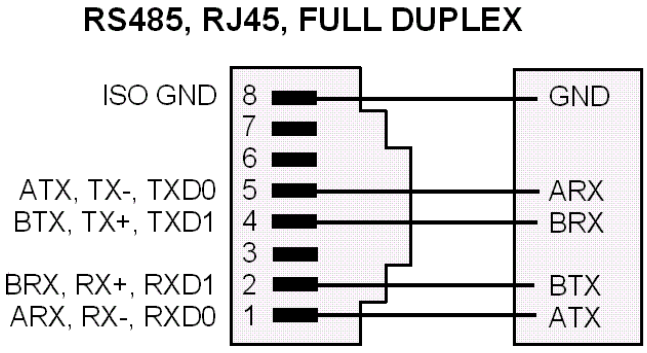


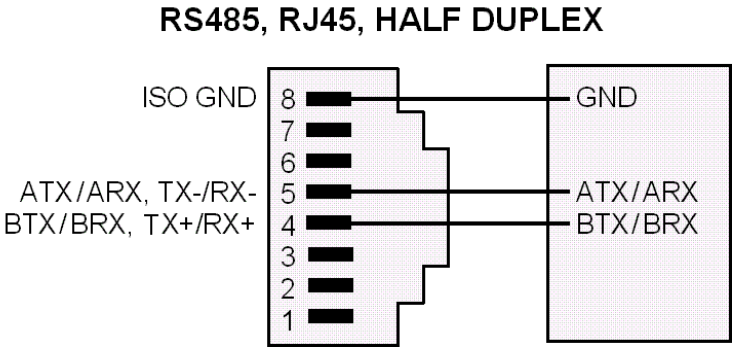
3. CONNECTOR WIRING, SERIAL BOARD TO COMPUTER



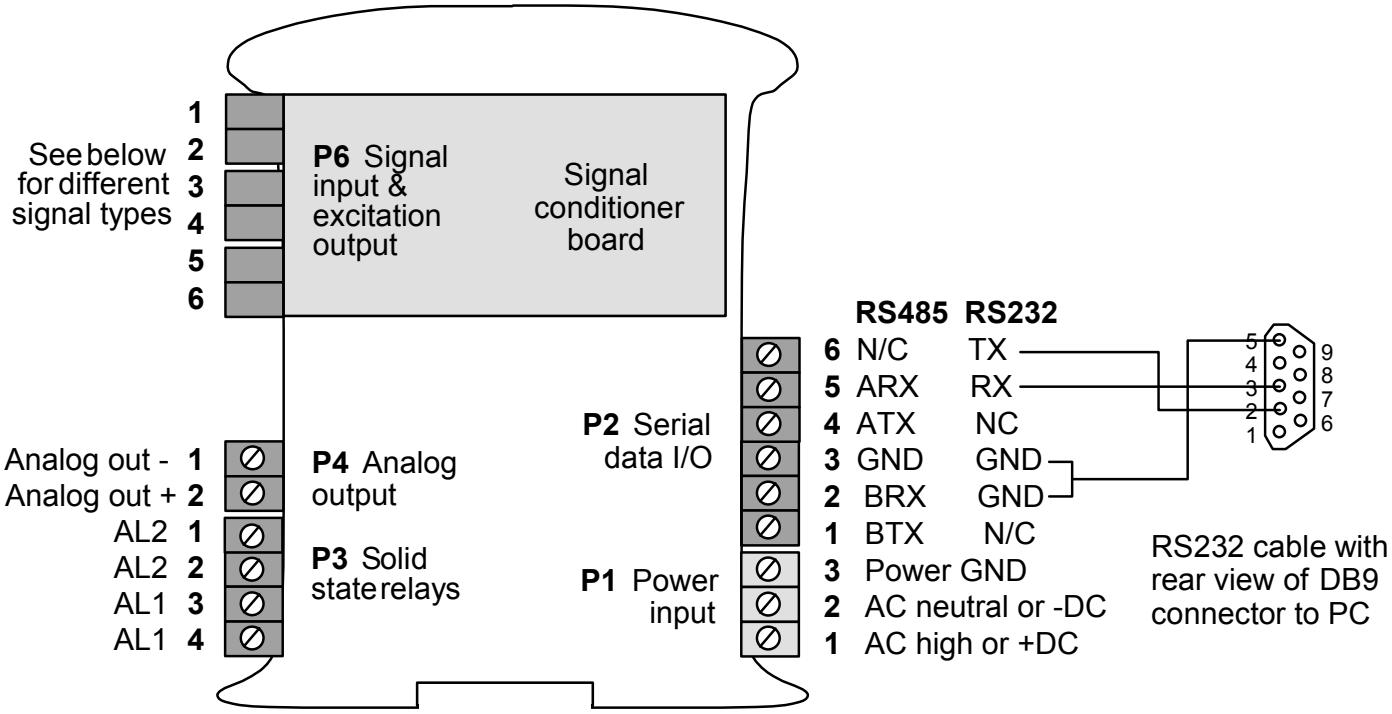


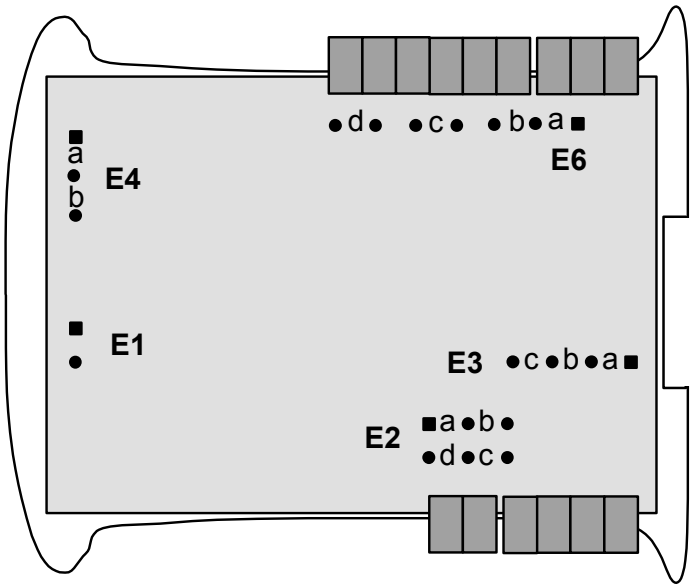






4. TRANSMITTER CONNECTOR WIRING





* The termination resistor jumper settings should only be selected if the transmitter is the last device on an RS485 line longer than 200 feet (60 m).

** Or jumper external BTX to BRX and ATX to ARX (same effect as internal jumpers).

Serial Signal	Duplex	Jumpers	Termination Resistor*
RS485	Full	None	E6 a = Transmit E6 c = Receive
	Half	E6 b + d**	E6 c
RS232	Full	None	None

Serial Signal	Duplex	Jumpers	Termination Resistor*
RS485	Full	None	E6 a = Transmit E6 c = Receive
	Half	E6 b + d**	E6 c
RS232	Full	None	None

* The termination resistor jumper settings should only be selected if the transmitter is the last device on an RS485 line longer than 200 feet (60 m).

** Attempting to draw more than the rated current will shut down the output.

To reset communications to 9600 baud, command mode, Custom ASCII protocol, and Address 1, place a jumper at E1 and power up the transmitter.

Analog Output	Jumpers
Current	E2 a + d
Voltage	E2 b + c

Excitation Output*	Jumpers
5V, 100 mA	E3 a + c; E4 a
10V, 120 mA	E3 a + c; E4 b
24V, 50 mA	E3 b, E4 none

5. PROGRAMMING YOUR MODBUS DEVICE

OVERVIEW

Modbus digital panel meters, counters, timers and transmitters are easily programmed via their serial port using Windows-based **Instrument Setup (IS)** software, which provides a graphical user interface and is available at no charge. This software allows uploading, editing, downloading and saving of setup data, execution of commands under computer control, listing, plotting and graphing of data, and computer prompted calibration. Digital panel meters, counters and timers can also be programmed via their 4-key front panel as explained in their respective manuals; however, online programming is easier. For Ethernet, please see our separate **Ethernet Manual**.

GETTING STARTED WITH INSTRUMENT SETUP SOFTWARE

To install IS software, download the file *instrument.exe* from our website, double-click on the file name to extract three files, double-click *on setup.exe*, and follow the prompts. To launch IS software, press *Start* => *Programs* => *IS2* => *IS2*. Establish communications by selecting matching settings between the instrument and PC, and click on *Establish*. Once communications have been established, click on *Main Menu*.

The best way to learn IS software is to experiment with it. From the Main Menu, click on *Get Setup* to retrieve (or get) the existing setup data from your device. Click on *View* = > *Setup* to bring up screens which allow you to edit the setup file using pull-down menus and other selection tools. You can save your file to disk by clicking on *File* = > *Save Setup*. You can download (or put) your edited file into the device by clicking on *Put Setup*. Programmable items will only be displayed if the appropriate hardware has been detected, such as the dual relay option for meters. Pressing the *F1* key at any time will bring up detailed help information.

An analog output is defined in two steps. The input to the device is first scaled to a digital reading in engineering units, and this reading is then scaled to the analog output. The digital reading is also used for setpoint control and can be transmitted as serial data.

ADDITIONAL FEATURES

- **The Commands pull-down menu** allows you to execute certain functions by using your computer mouse. The *Commands* pull-down menu will be grayed out unless a *Get Setup* has been executed.
- **The Readings pull-down menu** provides three formats to display input data on your PC monitor. In all formats, use the *Pause* and *Continue* buttons to control the timing of data collection, then press *Print* for a hardcopy on your PC printer. **List** presents the latest digital readings in a 20-row by 10-column table. **Plot** generates a plot of digital readings vs. time in seconds, like an oscilloscope. **Graph** generates a histogram, where the horizontal axis is the reading and the vertical axis is the number of readings.

6. MODBUS PROTOCOL IMPLEMENTATION

1. GENERAL

The Modbus capability conforms to the Modbus over Serial Line Specification & Implementation guide, V1.0. Both the Modbus RTU and Modbus ASCII protocols are implemented:

Modbus RTU

Baud Rate..... 300, 600, 1200, 2400, 4800, 9600 or 19200
Data Format .....1 start bit, 8 data bits, 1 parity bit, 1 stop bit (11 bits total)
Parity..... None, Odd, Even (if None, then 2 Stop bits for 11 total)
Address.....0 for broadcast, 1-247 for individual meters

Modbus ASCII

Baud Rate..... 300, 600, 1200, 2400, 4800, 9600 or 19200
Data Format ..... 1 Start bit, 7 Data bits, 1 Parity bit, 1 Stop bit (10 bits total)
Parity..... None, Odd, Even (if None, then 2 Stop bits for 10 total)
Address.....0 for broadcast, 1-247 for individual meters

2. FRAMING

Modbus RTU

Message frames are separated by a silent interval of at least 3.5 character times. If a silent interval of more than 1.5 character times occurs between two characters of the message frame, the message frame is considered incomplete and is discarded. Frame Check = 16 bit CRC of the complete message excluding CRC characters.

Modbus ASCII

The message begins immediately following a colon (:) and ends just before a Carriage Return/ Line Feed (CRLF). All message characters are hexadecimal 0-9, A-F (ASCII coded). The system allowable time interval between characters may be set to 1, 3, 5 or 10 seconds. Frame Check = 1 byte (2 hexadecimal characters) LRC of the message excluding the initial colon (:) and trailing LRC and CRLF characters.

3. ELECTRICAL INTERFACE

Four-wire (plus common) full-duplex or two-wire (plus common) half-duplex RS485 signal levels are jumper selectable for digital panel meters, counters and timers. A polarization resistor and termination resistor are also jumper selectable. In case of a long line (greater then 500 ft) to the first device, a termination resistor should be selected for the first device. In case of a long line length (greater then 500 ft) between the first and last devices, a termination resistor should be selected for the first and last devices. Never add termination resistors to more than two devices on the same line. A two-wire, half-duplex RS485 signal level is jumper selectable for transmitters.

4. PARAMETERS SELECTABLE VIA INSTRUMENT SETUP (IS) SOFTWARE

Serial Protocol .....Custom ASCII, Modbus RTU, Modbus ASCII
Modbus ASCII Gap Timeout..... 1 sec, 3 sec, 5 sec, 10 sec
Baud Rate.....300, 600, 1200, 2400, 4800, 9600, 19200
Parity .....No parity, 2 stop bits; odd parity,1 stop bit; even parity, 1 stop bit
Device Address .....0 to 247

5. PARAMETERS SELECTABLE VIA FRONT PANEL METER SETUP

The two menu items related specifically to Modbus setup are SEr_4 and Addr.

SEr_4 Serial Comm 4	**0**00 Modbus ASCII Gap Timeout	**0** 1 Sec **2** 5 Sec **1** 3 Sec **3** 10 Sec
	0**0**0 Serial Protocol	**0** Customl ASCII (Non-Modbus) **1** Modbus RTU **2** Modbus ASCII
	00**0** Parity	**0** No Parity, 2 or more stop bits **1** Odd Parity, 1 or more stop bits **2** Even Parity, 1 or more stop bits
Addr	**000** Meter Address	Set to desired address 1-247

The baud rate is set in SEr_1 per the Meter manual. The selection of Modbus RTU or Modbus ASCII in SEr_4 above overrides any LF or Command Mode selections that have been made, since they are determined by the Modbus protocol.

6. READINGS RETURNED FROM METERS OR COUNTERS

Digital panel meters with an analog input can only display and transmit one reading, which is called Item #1. Analog input transmitters can only transmit, not display, this Item.

Counters with a pulse input, including VF voltage-to-frequency models, can display and transmit up to three readings called Item #1, Item #2 or Item #3. These are variables whose meaning changes based on the instrument type (Type), programmed operating mode (Mode), and sub-mode (Function). Basic and Counter / Timer Internal Register Addresses instrument Types have the same hardware, but only the Extended Types offer advanced programmable features. Pulse input transmitters can transmit, not display, Items.

As detailed in the separate Counter User Manual, the three Items can also be associated with different Scale and Offset selections (Sc/Off) and different Decimal Point (DP) selections. When an Item is the mathematical combination of two other items, such as Ratio A/B, the individual Items A and B are typically scaled with Scale and Offset, but their mathematical combination can only be scaled using a Resolution multiplier R from 0.00001 to 100000 in decade steps.

In the tables below, Items can correspond to "# Overflows". This is the number of millions preceding large readings over 999,999. For example, 2,000,003 would be displayed as 3, and there would be 2 Overflows. Readings to be displayed are normally scaled so that they are 999,999 or less (with any decimal point), but values up to 999,999,999,999 (999,999 Overflows) + 999,999 can be transmitted serially using the # Overflows feature.

In the tables below, "*" indicates that the value can be a Filtered or a Peak or Valley value. "^" indicates that the value can be an Unfiltered or a Peak or Valley value, as explained in the Counter User Manual. This normally applies to the mathematical combination of two items, such as Ratio A/B.

Counter Functions with the FR Dual Pulse Input Signal Conditioner

Type	Mode	Function	Item 1	Sc/Off	DP	Item 2	Sc/Off	DP	Item 3	Sc/Off	DP
Basic	_rAtE_	A__b_	*Rate A	1	1	Rate B	2	2			
Basic	_rAtE_	A Only	*Rate A	1	1						
Extended	_rAtE_	_bAtCH	Total	1	1	Grand Total or # Batches			*Rate	2	2
Extended	_rAtE_	A_Atot	*Rate A	1	1	Total A	2	2	# Overflows		
Extended	_rAtE_	A_btot	*Rate A	1	1	Total B	2	2			
Extended	_rAtE_	_A_+_b	*SumAB	R	2	Rate A	1	1	Rate B	2	1
Extended	_rAtE_	_A_-_b	*DiffAB	R	2	Rate A	1	1	Rate B	2	1
Extended	_rAtE_	_A_x_b	*ProdAB	R	2	Rate A	1	1	Rate B	2	1
Extended	_rAtE_	_A_/_b	*RatioAB	R	2	Rate A	1	1	Rate B	2	1
Extended	_rAtE_	_A_/_b-1	*DrawAB	R	2	Rate A	1	1	Rate B	2	1
Basic	PEriod	A__b_	*Period A	1	1	Period B	2	2			
Basic	PEriod	A Only	*Period A	1	1						
Extended	PEriod	_A_+_b	*SumAB	R	2	Period A	1	1	Period B	2	1
Extended	PEriod	_A_-_b	*DiffAB	R	2	Period A	1	1	Period B	2	1
Extended	PEriod	_A_x_b	*ProdAB	R	2	Period A	1	1	Period B	2	1
Extended	PEriod	_A_/_b	*RatioAB	R	2	Period A	1	1	Period B	2	1
Basic	_totAL	A__b_	Total A	1	1	Total B	2	2			
Basic	_totAL	A Only	Total A	1	1	# Overflows					
Extended	_totAL	A-b Ud	^DiffAB	1	1						
Extended	_totAL	_burSt	Total A	2	2	*Rate A	1	1			
Extended	_totAL	b_ArAt	Total B	2	2	*Rate A	1	1			
Extended	_totAL	A_bU/d	^Total A	1	1						
Extended	_totAL	A_bInH	Total A	1	1	# Overflows					
Extended	_totAL	_A_+_b	^SumAB	R	2	Total A	1	1	Total B	2	1
Extended	_totAL	_A_-_b	^DiffAB	R	2	Total A	1	1	Total B	2	1
Extended	_totAL	_A_x_b	^ProdAB	R	2	Total A	1	1	Total B	2	1
Extended	_totAL	_A_/_b	^RatioAB	R	2	Total A	1	1	Total B	2	1
Basic	ti_Int	A__b_	*Time	1	1						
Extended	ti_Int	_1/Ab	*Time	1	1						
Basic	StoP_t	A_to_A	Time	1	1	Total Time	2	2	# Overflows		
Basic	Stop_t	A_to_b	Time	1	1	Total Time	2	2	# Overflows		
Basic	StoP_t	_1/AA	Time	1	1	Total Time	2	2	# Overflows		
Basic	StoP_t	_1/Ab	Time	1	1	Total Time	2	2	# Overflows		
Extended	_PHASE	A_to_b	*Deg360	1	1						
Extended	_PHASE	A_to_b	*Deg180	1	1						
Extended	duty_C	A_to_b	*Percent	1	1						

Counter Functions with the VF Voltage-to-Frequency Signal Conditioner

Type	Mode	Function	Item 1	Sc/Off	DP	Item 2	Sc/Off	DP	Item 3	Sc/Off	DP
Basic	VF 4_20	A_Only	*Rate A	1	1						
Extended	VF 4_20	bAtCH	*Batch total	2	2	Grand Total or # Batches	R		*Rate A	1	1
Basic	VF 4_20	A_Atot	*Rate A	1	1	Total A	2	2	# Overflows		
Extended	VF 4_20	__1/A__	*1/Rate	1	1						
Basic	VF 0-1V	A_Only	*Rate A	1	1						
Extended	VF 0-1V	bAtCH	*Batch total	2	2	Grand Total or # Batches	R		*Rate A	1	1
Basic	VF 0-1V	A_Atot	*Rate A	1	1	Total A	2	2	# Overflows		
Extended	VF 0-1V	__1/A__	*1/Rate	1	1						
Basic	VF 0-10V	A_Only	*Rate A	1	1						
Extended	VF 0-10V	bAtCH	*Batch total	2	2	Grand Total or # Batches	R		*Rate A	1	1
Basic	VF 0-10V	A_Atot	*Rate A	1	1	Total A	2	2	# Overflows		
Extended	VF 0-10V	__1/A__	*1/Rate	1	1						

Counter Functions with the QD Quadrature Signal Conditioner

Type	Mode	Function	Item 1	Sc/Off	DP	Item 2	Sc/Off	DP	Item 3	Sc/Off	DP
Basic	_quAdr	_totAL	^Up-Dn	1	1						
Extended	_quAdr	_rAtE	*Rate	1	1						

7. SUPPORTED FUNCTION CODES

FC03: Read Holding Registers. Reads internal registers containing setup parameters (Scale, Offset, Setpoints, etc.)

FC04: Read Input Registers. Reads measurement values and alarm status

FC05: Write Single Coil. Action command to device

FC08: Diagnostics. Checks communications between Master and Slave.

FC10: Write Multiple Registers (FC10 = 16 dec). Writes internal registers containing setup parameters (Scale, Offset, Setpoints, etc.)

8. REGISTER NUMBERS VS. METER ADDRESSES

Some Master devices (e.g., Modicon) require that the desired Register Number and not the Register Address be entered. The Register Number is 1 higher than the Register Address. For entry to these devices, add 1 to the Register Address shown in the tables below. The Register Address shown will then be output from these devices.

FC04: Read Input Registers

Reads measurement values and alarm status. Returns values in M31 or 2C32 format without decimal point (see Sec 11, p 16). The displayed system decimal point can be read with FC03 at addr 0057. Use only **high word** Starting Register Addresses and an **even** number of Registers.

Register Address		Meter or Analog Input Transmitter Response (M31 format)	Counter, Timer, or Pulse Input Transmitter Response (2C32 format)
Base 1 Std addr.	Base 0 PLC addr.		
00 01	00 02	Hi word of Alarm status	Hi word of Alarm status [3]
00 02	00 03	Lo word of Alarm status	Lo word of Alarm status [3]
00 03	00 04	Hi word of Measurement value [1]	Hi word of Item 1 value
00 04	00 05	Lo word of Measurement value [1]	Lo word of Item 1 value
00 05	00 06	Hi word of Peak value	Hi word of Peak value
00 06	00 07	Lo word of Peak value	Lo word of Peak value
00 07	00 08	Hi word of Valley value [2]	Hi word of Valley value
00 08	00 09	Lo word of Valley value [2]	Lo word of Valley value
00 09	00 0A	N/A	Hi word of Item 2 value
00 0A	00 0B	N/A	Lo word of Item 2 value
00 0B	00 0C	N/A	Hi word of Item 3 value
00 0C	00 0D	N/A	Lo word of Item 3 value

[1] Net value for scale meter. [2] Gross value for scale meter. [3] 0-F, bit 0 = alarm 1, bit 1 = alarm 2 bit 2 = alarm 3, bit 3 = alarm 4

FC05: Write Single Coil: Action command to device

Output Address		Output Value	Action Command
Base 1	Base 0		
00 01	00 02	FF 00	Device Reset (No Response)
00 02	00 03	FF 00	Function Reset (Peak, Valley, latched alarms, total)
00 03	00 04	FF 00	Latched Alarm Reset (only)
00 04	00 05	FF 00	Peak Reset
00 05	00 06	FF 00	Valley Reset
00 06	00 07	FF 00	Remote Display Reset (Counters in Remote Display Mode)
00 07	00 08	FF 00	Display Item 1 (Meters, Counters, Timers)
00 08	00 09	FF 00	Display Item 2 (Counters, Timers)
00 09	00 0A	FF 00	Display Item 3 (Counters, Timers)
00 0A	00 0B	FF 00	Display Peak (Meters, Counters, Timers)
00 0B	00 0C	FF 00	Display Valley (Meters except Weight, Counters, Timers)
00 0C	00 0D	FF 00	Tare (Meters, Value = 00 00 resets Tare)
00 0D	00 0E	FF 00	Meter Hold (output value = 00 00 resets Meter Hold)
00 0E	00 0F	FF 00	Blank Display (output value = 00 00 resets Display Blank)
00 0F	00 10	FF 00	Activate External Input A (output value = 00 00 deactivates)
00 10	00 11	FF 00	Activate External Input B (output value = 00 00 deactivates)

FC08: Diagnostics

Checks communications between the Master and Slave, and returns the count in the Modbus Slave counters (which are reset when the meter is reset).

Hex Sub Function Code	Data Sent	Response Data	Description
00 00	Any	Same	Returns Query Data (N x 2 bytes). Echo Request.
00 01	FF 00 00 00	FF 00 00 00	Restarts Communications. If in the Listen-Only mode, no response occurs. Takes Slave out of the Listen-Only mode and one of the following: — Clears communications event counters. — Does not clear communications event counters.
00 04	00 00	None	Forces Listen-Only. All addressed and broadcast Messages are monitored and counters are incremented, but no action is taken or response sent. Only Sub-Function 00 01 causes removal of this Listen-Only state.
00 0A	00 00	00 00	Clears all Modbus slave counters.
00 0B	00 00	Total Message Count	Returns total number of messages detected on the bus, including those not addressed to this Slave. Excludes bad LRC/CRC, parity error or length < 3.
00 0C	00 00	Checksum Error Count	Returns total number of messages with bad LRC/CRC, parity or length < 3 errors detected on the bus including those not addressed to the Slave.
00 0D	00 00	Exception Error Count	Returns total number of Exception responses returned by the Addressed Slave or that would have been returned if not a broadcast message or if the Slave was not in a Listen-Only mode.
00 0E	00 00	Slave Message Count	Returns total number of messages, either broadcast or addressed to the Slave. Excludes bad LRC/CRC, parity or length < 3 errors.
00 0F	00 00	No Response Count	Returns total number of messages, either broadcast or addressed to the Slave, for which Slave has returned No Response, neither a normal response nor an exception response. Excludes bad LRC/CRC, parity or length < 3 errors.
00 11	00 00	Slave Busy	Returns total number of Exception Code 6 (Slave Busy) responses.

9. SUPPORTED EXCEPTION RESPONSE CODES

Code	Name	Error Description
01	Illegal Function	Illegal Function Code for this Slave. Only hex Function Codes 03, 04, 05, 08, 10 (dec 16) are allowed.
02	Illegal Data Address	Illegal Register Address for this Slave and/or Register Length.
03	Illegal Data Value	Illegal data value or data length for the Modbus protocol.
04	Slave Device Failure	Slave device failure (eg. Device set for external gate).

10. MESSAGE FORMATTING

MA = Meter Address
FC = Function Code
RA = Register Address
NR = Number of Registers
NB = Number of bytes
DD = Data (Hex)
WW = Data (On/Off)
SF = Sub-Function
EC = Error Code
LRC = ASCII Checksum
CL = CRC Lo Byte
CH = CRC Hi Byte
CR = Carriage Return
LF = Line Feed

Modbus RTU Format

FC	Action	> 3.5 Char	Byte Number										
			1	2	3	4	5	6	7	8	9	10	11
03	Request	NoTx	MA	FC	RA	RA	NR	NR	CL	CH			
03	Response	NoTx	MA	FC	NB	DD*	DD*	CL	CH				
04	Request	NoTx	MA	FC	RA	RA	NR	NR	CL	CH			
04	Response	NoTx	MA	FC	NB	DD*	DD*	CL	CH				
05	Request	NoTx	MA	FC	RA	RA	WW	WW	CL	CH			
05	Response	NoTx	MA	FC	RA	RA	WW	WW	CL	CH			
08	Request	NoTx	MA	FC	SF	SF	WW	WW	CL	CH			
08	Response	NoTx	MA	FC	SF	SF	DD	DD	CL	CH			
10	Request	NoTx	MA	FC	RA	RA	NR	NR	NB	DD*	DD*	CL	CH
10	Response	NoTx	MA	FC	RA	RA	NR	NR	CL	CH			
Exception Response		NoTx	MA	FC +80	EC	CL	CH						

DD* = (DD DD) times NR (Number of Registers)

Modbus ASCII Format

Except for the colon, CR and LF, each column is 2 hex character bytes.
DD* = (DD DD) times NR (Number of Registers)

FC	Action	Column Number												
		1	2	3	4	5	6	7	8	9	10	11	12	13
03	Request	:	MA	FC	RA	RA	NR	NR	LRC	CR	LF			
03	Response	:	MA	FC	NB	DD*	DD*	LRC	CR	LF				
04	Request	:	MA	FC	RA	RA	NR	NR	LRC	CR	LF			
04	Response	:	MA	FC	NB	DD*	DD*	LRC	CR	LF				
05	Request	:	MA	FC	RA	RA	WW	WW	LRC	CR	LF			
05	Response	:	MA	FC	RA	RA	WW	WW	LRC	CR	LF			
08	Request	:	MA	FC	SF	SF	WW	WW	LRC	CR	LF			
08	Response	:	MA	FC	SF	SF	DD*	DD*	LRC	CR	LF			
10	Request	:	MA	FC	RA	RA	NR	NR	NB	DD*	DD*	LRC	CR	LF
10	Response	:	MA	FC	RA	RA	NR	NR	LRC	CR	LF			
Exception Response		:	MA	FC +80	EC	LRC	CR	LF						

11. MESSAGE EXAMPLES FOR DEVICE ADDRESS = 01, NO PARITY

Example	Action	Modbus RTU	Modbus ASCII
		Ser_4 = 010 Addr = 001	Ser_4 = 020 Addr = 001
Restart Communications*	Request	010800010000**B1CB**	:010800010000**F6**crlf
	Response	010800010000**B1CB**	:010800010000**F6**crlf
Meter Reset	Request	01050001FF00**DDFA**	:01050001FF00**FA**crlf
	Response	None	None
Digital Reading = +25.18	Request	0104000300002**81CB**	:010400030002**F6**crlf
	Response	010404000009D67**C4A**	:010404000009D6**18**crlf
Write Setpoint 1 = +37.00	Request	011000010002040000E74**3624**	:011000010002040000E74**66**crlf
	Response	0110000100021**008**	:011000010002**EC**crlf
Read Setpoint 1 = +37.00	Request	0103000100021**95CB**	:010300010002**F9**crlf
	Response	01030400000E74**FE74**	:01030400000E74**76**crlf
Send -12.34 to Remote Display or LTS **	First send decimal point, address 0057 as 00 03.		
	Request	0110006900020 4FFFFFB2E**F6E5**	:0110006900020 4FFFFFB2E**59**crlf
	Response	0110006900021**91D4**	:0110006900021**84**crlf

* Suggested as first message after power-up. If device is in Listen-Only mode, no response is returned.

** 1234 decimal = 000004D2 hex. -1234 = FF FF FB 2E in 4-byte 2's complement hex. Decimal point is ignored.

RTU: Bolded last 4 characters indicate the CRC (added automatically by the device).
ASCII: Bolded last 2 characters indicate the LRC ((added automatically by the device).

Because the Counter/Timer can provide up to 3 display items during normal operation, it can be used to provide additional features when used as a Remote Display. It is possible to send Remote Data to Item 3 using addresses 006B,C or 006D,E. If the Counter/Timer is set up with the "Source" menu item set to Item 3, it will make alarm comparisons to its Setpoints using the Remote Data. Likewise, the Analog Output will respond to the Remote Data if "AnSEt" selects Item 3 for the Analog Output source and the Display mode (Config Dig 3 = 7).

Address 0069,A sends Remote Data to the display only (any Display mode).
Address 006B,C sends Remote Data to Item 3 only for Alarms and/or Analog Out.
Address 006D,E sends Remote Data to both the display and Item 3.

12. DATA TYPES INTERNAL REGISTERS

S = Sign Bit, 0 = Positive, 1 = Negative.

DDD = Decimal Point
XXXXXX. = 1 (Magnitude x 10^0)
XXXXX.X = 2 (Magnitude x 10^-1)
XXXX.XX = 3 (Magnitude x 10^-2)
XXX.XXX = 4 (Magnitude x 10^-3)
XX.XXXX = 5 (Magnitude x 10^-4)
X.XXXXX = 6 (Magnitude x 10^-5)

Note: Meters and the analog input transmitter only have 5 digits and 5 decimal points.

C = Bits of 2's Complement Binary Value
M = Bits of Positive Binary Magnitude
B = Bits of Configuration Data

For Modbus RTU, each data character (2 hex characters) consists of 8 bits (or 1 byte).
For Modbus ASCII, each data character (2 hex characters) consists of 1 byte for each hex character.
Data characters are sent most significant first, lease significant last.

2C32 Two's Complement (4 bytes)

Hi Word (Register)	Lo Word (Register)
CCCC CCCC CCCC CCCC	CCCC CCCC CCCC CCCC

M32 Binary Magnitude (4 bytes)

Hi Word (Register)	Lo Word (Register)
MMMM MMMM MMMM MMMM	MMMM MMMM MMMM MMMM

M31 Sign + Binary Magnitude (4 bytes)

Hi Word (Register)	Lo Word (Register)
SMMM MMMM MMMM MMMM	MMMM MMMM MMMM MMMM

M48 Binary Magnitude (6 bytes

Hi Word (Register)	Mid Word (Register)	Lo Word (Register)
XXXX XXXX MMMM MMMM	MMMM MMMM MMMM MMMM	MMMM MMMM MMMM MMMM

Ignore XXXX XXXX - Use LS 5-byte result

B16 Bit Significance		M16 Binary Magnitude		M15 Sign + Binary Magnitude	
Hi Byte	Lo Byte	Hi Byte	Lo Byte	Hi Byte	Lo Byte
0000 0000	BBBB BBBB 7654 3210	XXXX XXXX	XXXX XXXX	SXXX XXXX	XXXX XXXX

13. METER & ANALOG INPUT TRANSMITTER INTERNAL REGISTER ADDRESSES

Warning: DPM type devices (meters & transmitters) reset after all data is read or written.

Data Types - as shown: FC03 READ and FC10 (dec16) WRITE

Use high word starting Register Addresses and an even number of Registers.

Register Address		Register Name	Data Type	Scaling & Dec Point
Dec*	Hex*			
1	0001	Setpoint 1 (Hi word)	2C32	Dec pt same as displayed
2	0002	Setpoint 1 (Lo word)		
3	0003	Setpoint 2 (Hi word)	2C32	Dec pt same as displayed
4	0004	Setpoint 2 (Lo word)		
5	0005	Setpoint 3 (Hi word) (not for Scale Meter)	2C32	Dec pt same as displayed
6	0006	Setpoint 3 (Lo word) (not for Scale Meter)		
7	0007	Setpoint 4 (Hi word) (not for Scale Meter)	2C32	Dec pt same as displayed
8	0008	Setpoint 4 (Lo word) (not for Scale Meter)		
9	0009	Scale (Hi word)	2C32	** See footnote
10	000A	Scale (Low word)		
11	000B	Offset (Hi word)	2C32	Dec pt same as displayed
12	000C	Offset (Low word)		
17	0011	Lo In (Hi word)	2C32	Uses dec pt of input range
18	0012	Lo In (Low word)		
19	0013	Lo Rd (Hi word)	2C32	Dec pt same as displayed
20	0014	Lo Rd (Low word)		
21	0015	Hi In (Hi word)	2C32	Uses dec pt of input range
22	0016	Hi In (Low word)		
23	0017	Hi Rd (Hi word)	2C32	Dec pt same as displayed
24	0018	Hi Rd (Low word)		
25	0019	Rd0 (Hi word) (tare for Scale Meter)	2C32	Dec pt same as displayed
26	001A	Rd0 (Lo word) (tare for Scale Meter)		
33	0021	Deviation 1 (Hi word) (SP1DIFF for Sc M)	2C32	Dec pt same as displayed
34	0022	Deviation 1 (Lo word) (SP1DIFF for Sc M)		
35	0023	Deviation 2 (Hi word) (SP2DIFF for Sc M)	2C32	Dec pt same as displayed
36	0024	Deviation 2 (Lo word) (SP2DIFF for Sc M)		
37	0025	Deviation 3 (Hi word) (not for Scale Meter)	2C32	Dec pt same as displayed
38	0026	Deviation 3 (Lo word) (not for Scale Meter)		

39	0027	Deviation 4 (Hi word) (not for Scale Meter)	2C32	Dec pt same as displayed
40	0028	Deviation 4 (Lo word) (not for Scale Meter)		
41	0029	Analog Lo (Hi word)	2C32	Dec pt same as displayed
42	002A	Analog Lo (Lo word)		
43	002B	Analog Hi (Hi word)	2C32	Dec pt same as displayed
44	002C	Analog Hi (Lo word)		

* Values are for Base 1 Standard addressing. Add 1 for Base 0 PLC addressing.
** Scale = .0001 x dec value of (Hi word + Lo word)

Data Type B16
For the following, use any starting Register Address and any number of Registers.

Register Address		Register Name	Bit Significance
Dec	Hex		
65	0041	Alarm Config 1	Bit 0 0 = AL1 Hi Active 1 = Lo Active Bit 1 0 = AL1 Enabled, 1 = Disabled Bit 2 0 = AL2 Hi Active 1 = Lo Active Bit 3 0 = AL2 Enabled 1 = Disabled Bit 4 0 = AL1 Non-Latched 1 = Latched Bit 5 0 = AL2 Non-Latched 1 = Latched Bit 6 0 = Relay1 Active On 1 = Off Bit 7 0 = Relay2 Active On 1 = Off

66	0042	Alarm Config 2	Bits 2:0 # Readings before Alarms 1 & 2.
			000 = 1, 001 = 2, 010 = 4, 011 = 8, 100 = 16,
			101 = 32, 110 = 64, 111 = 128
			Bit 3 AL1 0 = Deviation 1 = Hysteresis
			Bit 4 AL2 0 = Deviation 1 = Hysteresis
			Bit 5 0 = Deviation in Menu 1 = Omitted

67	0043	Alarm Config 3 (not applicable to Scale Meter)	Bit 0 0 = AL3 Hi Active 1 = Lo Active Bit 1 0 = AL3 Enabled 1 = Disabled Bit 2 0 = AL4 Hi Active 1 = Lo Active Bit 3 0 = AL4 Enabled 1 = Disabled Bit 4 0 = AL3 Non-Latched 1 = Latched Bit 5 0 = AL4 Non-Latched 1 = Latched Bit 6 0 = Relay3 Active On 1 = Off Bit 7 0 = Relay4 Active On 1 = Off

68	0044	Alarm Config 4 (not applicable to Scale Meter)	Bits 2:0 = # Readings before Alarm 3 & 4
			000 = 1, 001 = 2, 010 = 4, 011 = 8, 100 = 16,
			101 = 32 110 = 64 111 = 128
			Bit 3 AL3 0 = Deviation 1 = Hysteresis
			Bit 4 AL4 0 = Deviation 1 = Hysteresis
			Bit 5 0 = Deviation in Menu 1 = Omitted

69	0045	Input Type	Lo Byte Hex value 40-4D Thermocouple JF, C, KF, KC, NF, NC, EF, EC, TF, TC, SF, SC, RF, RC 50-5C RTD pre-2009: 4-wire DIN°F, 4-wire DIN°C, 4-wire ANSI°F, 4-wire°C, 3-wire DIN°F, 3-wire DIN°C, 3-wire ANSI°F, 3-wire ANSI°C, 2-wire DIN°F, 2-wire DIN°C, 2-wire ANSI°F, 2-wire ANSI°C, Short 50-57 RTD post-2009: DIN°F, DIN°C, ANSI°F, ANSI°C, Ni°F, Ni°C, Cu°F, Cu°C, 60-64 DC 0.2V, 2V, 20V, 200V, 660V 70-73 DC 2 mA, 20 mA, 200 mA, 5A A0-A2 Ratio 0.2V, 2V, 20V 80-84 RMS 0.2V, 2V, 20V, 200V, 660V 90-93 RMS 2 mA, 20 mA, 200 mA, 5A C0-C4 Strain 20, 50, 100, 250, 500 mV D0-D4 Load Cell 20, 50, 100, 250, 500 mV E0-E4 Ohms 20, 200, 2000, 20K, 200K
70	0046	Setup (applicable to DPM) M = Meter F = Function D = Display	Bits 3:0 Ctrl In 1 Ctrl In 2 Both Reset Hex 0 M Reset M Hold M Reset Hex 1 F Reset Pk, Vy M Reset Hex 2 M Hold Pk, Vy F Reset Hex 3 M Hold Tare M Reset Hex 4 Pk, Vy Tare FReset Hex 5 Tare M Reset M Reset Hex 6 DP2 DP3 DP5 Neither = DP1 Hex 7 DP3 DP4 DP6 Neither = DP2 Hex 8 F Reset D Blank M Reset Hex 9 M Hold D Blank M Reset Hex A Pk, Vy D Blank F Reset Hex B Tare D Blank M Reset Hex C Valley Peak F Reset Hex D Tare T Reset M Reset Bits 5:4 Hex 00 Scale using Scale, Offset Hex 01 Scale using Coordinates of 2 Points Hex 10 Scale using Reading Coordinates Bit 6 Spare Bit 7 0 = 60 Hz, 1 = 50 Hz

70	0046	Setup (applicable to Scale Meter) M = Meter F = Function D = Display T = Tare	Bits 3:0 Ctrl In 1 Ctrl In 2 Both Reset Hex 0 M Reset M Hold M Reset Hex 1 F Reset Peak D M Reset Hex 2 M Hold Peak D F Reset Hex 3 M Hold Tare Tare Hex 4 Peak Tare F Reset Hex 5 M Reset Tare M Reset Hex 6 F Reset Tare M Reset Hex 7 T Reset Tare M Reset Hex 8 D Blank Tare M Reset Hex 9 M Reset D Blank M Reset Hex A F Reset D Blank M Reset Hex B D Item Tare Tare Hex C D Item D Blank F Reset Hex D M Reset D Item M Reset Hex E F Reset D Item M Reset Hex F M Hold D Item M Reset Bit 4 0 = Scale, Offset 1 = Coord of 2 Points Bit 5 0 = Peak key is Peak 1 = Peak key is Tare Bit 6 0 = 60 Hz 1 = 50 Hz Bit 7 0 = No dummy zero 1 = Dummy zero
71	0047	Filter	Bits 3:0 Filtering Hex 0 = Auto Filter, 1 = Batch 16, 2-9 = Moving Avg, 2 = .08S, 3 = .15S, 4 = .3S, 5 = .6S, 6 = 1.2S, 7 = 2.4S, 8 = 4.8S, 9 = 9.6S, A = Unfiltered Bit 4 0 = Low Adaptive 1 = High Adaptive Bit 5 0 = Display Batch of 16 1 = Display Filtered Bit 6 0 = Peak of Unfiltered 1 = Peak of Filtered Bit 7 0 = Alarm source Unfiltered, 1 = Filtered
72	0048	Options	Do Not Use.
73	0049	Serial Config 1	Bits 3:0 Time between Continuous Serial Outputs Hex 0=.017S, 1=.28S, 2=.57S, 3=1.1S, 4=2.3S, 5=4.5S, 6=9.1S, 7=18.1S, 8=36.3S, 9=1M13S, A=2M25S, B=4M50S, C=9M40S, D=19M20S, E=38M41S, F=77M21S Bits 6:4 Baud Rate 000 = 300, 001 = 600, 010 = 1200, 011 = 2400, 100 = 4800, 101 = 9600, 110 = 19200 Bit 7 0 = Send Unfiltered value, 1 = Send Filtered Val

74	004A	Serial Config 2	Bits 4:0 Meter Serial Address (0-31) [Non-Modbus] Hex 0 = Broadcast (01 = 1 to 0A = 10), 0F = 15, 10 = 16, 1F = 31 Bit 5 0 = Continuous Mode, 1 = Command Mode Bit 6 0 = No Alarm data with readings, 1 = Alarm data Bit 7 0 = No LF following CR, 1 = LF following CR
75	004B	Serial Config 3	Bits 2:0 for DPM. Data sent in serial output 0 = Reading, 1 = Peak, 2 = Valley, 3 = Rdg + Peak, 4 = Rdg + Valley, 5 = Rdg + Peak + Valley Bits 2:0 for Scale Meter 0 = Net + Gross 1 = Net only 2 = Gross only 3 = Peak only 4 = Net + Gross + Peak Bit 3 0 = Termination chars at end of all items 1 = " " at end of each item Bit 4 0 = Non-latching RTS, 1 = Latching RTS Bit 5 0 = Normal continuous serial transmission 1 = Special Start & Stop characters Bit 6 0 = Full Duplex 1 = Half Duplex
76	004C	Serial Config 4	Bits 1:0 00 = No Parity 01 = Odd Parity 10 = Even Parity Bits 3:2 00 = Custom ASCII 01 = Modbus RTU 10 = Modbus ASCII Bits 5:4 Modbus ASCII Gap Timeout 00 = 1S, 01 = 3S, 10 = 5S, 11 = 10S
77	004D	Config (applicable to DPM)	Bit 0 0 = Linear Curve 1 = Custom Curve Bit 1 0 = 2-wire RTD Read 1= 2-wire RTD Short Bits 2 0 = No Auto-tare 1 = Auto-tare Bits 4:3 Peak button display response 00 = Peak 01 = Valley 10 = Peak then Vall. 11 = Tare Bits 7:5 000 = Not Rate 001 = Rate x 0.1, 010 = Rate x 1 011 = Rate x 10, 100 = Rate x 100 101 = Rate x 1000 110 = Rate x 10000
77	004D	Config (applicable to Scale Meter)	Bit 1 0 = Peak of net value 1 = peak of gross value Bit 2 0 = Dribble enabled 1 = Dribble disabled Bit 3 0 = Scale & offset setup method 1 = Reading coordinates of 2 points method

78	004E	Lockout 1 (applicable to DPM)		0 = Enabled, 1 = Locked out		
			Bit 0	Offset, Lo, Hi Rd	Bit 1	Scale, Lo In, Hi In
			Bit 2	Filter	Bit 3	Setup, Config, DP
			Bit 4	Input Type		
78	004E	Lockout 1 (applicable to Scale Meter)		0 = Enabled, 1 = Locked out		
			Bit 0	Count	Bit 1	Setup, Config, DP
			Bit 2	Input Type	Bit 3	Change Display Item#
			Bit 4	Tare	Bit 5	Offset, Lo Rd, Hi Rd
			Bit 6	Scale, Lo, Hi In	Bit 7	Filter
79	004F	Lockout 2	Bit 0	Serial Comm Config		
			Bit 1	Analog Out Scaling		
			Bit 2	Alarm Setpoint Programming		
			Bit 3	Alarm Config		
			Bit 4	Front Panel Meter Reset		
			Bit 5	Front Panel Function Reset		
			Bit 6	View Setpoints	Bit 7	View Peak
81	0051	Setup 1 (not for Scale Meter)	Bits 1:0	00 = 4-1/2 Digits, 0.1 degree		
				01 = Slave Remote Display		
				10 = 4-1/2 Dig/10, 0.01 degree		
				11 = 3-1/2 Digits,1 degree		
81	0051	Count (applies to Scale Meter)	Bits 3:0	0 = No auto-zero band		1= 1-count zero band
				2 = 2-count zero band		3 = 3-count zero band
				Etc.		9 = 9-count zero band
			Bits 6:4	0 = Count by 1		1 = Count by 2
				2 = Count by 5		3 = Count by 10
				4 = Count by 20		5 = Count by 50
				6 = Count by 100		
82	0052	Analog Output Setup (applies to DPM)	Bit 0	0 = Source Unfiltered		1 = Filtered
			Bit 1	0 = Current Output		1 = Voltage Output
			Bits 2:1	00 = Current (0-20 mA)		10 = Curr. (4-20 mA)
				01 = Voltage (0-10V)		11 = Voltage (±10V)
82	0052	Analog Output Setup (applies to Scale Meter)	Bit 0	0 = Net Value		1 = Gross Value
			Bit 1	0 = Filtered		1 = Unfiltered
			Bits 3:2	00 = Current (0-20 mA)		10 = Curr. (4-20 mA)
				01 = Voltage (0-10V)		11 = Voltage (±10V)
87	0057	System Decimal Point	Bits 2:0	001 = ddddd.		010 = dddd.d
				011 = ddd.dd		100 = dd.ddd
				101 = d.dddd		110 = .ddddd
93	005D	Start Character	Bits 7:0	ASCII Hex Character		
94	005E	Stop Character	Bits 7:0	ASCII Hex Character		
95	005F	Modbus Addr.	Bits 7:0	Hex value of Decimal Address from 1-255		

READ ONLY (FC03) – Data Type B16

100	0064	Analog Output DAC Type	Bits 7:0	0 = none, 1 = 1 output, unipolar (12-bit, pre 2009) 2 = 1 output, unipolar (16-bit, pre 2009) 3 = 1 output, uni or bipolar (16-bit, post 2009) 4 = 2 outputs, unipolar (16-bit, post 2009, not for Scale Meter)
101	0065	Device Type	Bits 7:0	01 = DPM meter 02 = Scale meter 03 = Counter/timer met. 05 = DPM transmitter 06 = Scale transmitter 07 = Counter/timer transmitter
102	0066	Revision	Bits 7:0	Hex value of Decimal Revision number
103	0067	Overload Value	Bits 7:0	Hex overload value
104	0068	Signal Conditioner Type	Bits 7:0	01 = DC, TC/RTD (pre 2009) 02 = RMS (pre 2009) 03 = Load Cell 22 = RMS (post 2009) 31 = TC (post 2009) 41 = RTD or Ohms (post 2009)

WRITE ONLY (FC10 dec16) – Data Type 2C32

105	0069	Display Data (Hi Word)	Hi word of Remote Data to be displayed.
106	006A	Display Data (Lo Word)	Lo word of Remote Data to be displayed.

14. COUNTER / TIMER REGISTER ADDRESSES FC03 & FC10 (dec16)

Warning: Counter devices (meters & transmitters) reset after all data is read or written.

Data Types - as shown

Use high word starting Register Addresses and an even number of Registers.

Register Address		Register Name	Data Type	Scaling & Decimal Point
Dec*	Hex*			
1	0001	Setpoint 1 (Hi word)	2C32	Dec point same as displayed.
2	0002	Setpoint 1 (Lo word)	2C32	
3	0003	Setpoint 2 (Hi word)	2C32	Dec point same as displayed.
4	0004	Setpoint 2 (Lo word)	2C32	
5	0005	Setpoint 3 (Hi word)	2C32	Dec point same as displayed.
6	0006	Setpoint 3 (Lo word)	2C32	
7	0007	Setpoint 4 (Hi word)	2C32	Dec point same as displayed.
8	0008	Setpoint 4 (Lo word)	2C32	
9	0009	Scale 1Y (Hi word)	M32	Scale = .00001 x dec value

10	000A	Scale 1Y (Lo word)	M32	of (Hi word + Lo word)**
11	000B	Offset 1 (Hi word)	2C32	Dec point same as displayed.
12	000C	Offset 1 (Lo word)	2C32	
13	000D	Scale 2Y (Hi word)	M32	Scale = .00001 x dec value
14	000E	Scale 2Y (Lo word)	M32	of (Hi word + Lo word)**
15	000F	Offset 2 (Hi word)	2C32	Dec point same as displayed.
16	0010	Offset 2 (Lo word)	2C32	
17	0011	Lo In 1 (Hi word)	2C32	Lo In = .00001 x dec value
18	0012	Lo In 1 (Lo word)	2C32	of (Hi word + Lo word)**
19	0013	Lo Rd 1 (Hi word)	2C32	Dec point same as displayed.
20	0014	Lo Rd 1 (Lo word)	2C32	
21	0015	Hi In 1 (Hi word)	2C32	Hi In = .00001 x dec value
22	0016	Hi In 1 (Lo word)	2C32	of (Hi word + Lo word)**
23	0017	Hi Rd 1 (Hi word)	2C32	Dec point same as displayed.
24	0018	Hi Rd 1 (Lo word)	2C32	
25	0019	Lo In 2 (Hi word)	2C32	Lo In = .00001 x dec value
26	001A	Lo In 2 (Lo word)	2C32	of (Hi word + Lo word)**
27	001B	Lo Rd 2 (Hi word)	2C32	Dec point same as displayed.
28	001C	Lo Rd 2 (Lo word)	2C32	
29	001D	Hi In 2 (Hi word)	2C32	Hi In = .00001 x dec value
30	001E	Hi In 2 (Lo word)	2C32	of (Hi word + Lo word)**
31	001F	Hi Rd 2 (Hi word)	2C32	Dec point same as displayed.
32	0020	Hi Rd 2 (Lo word)	2C32	
33	0021	Deviation 1 (Hi word)	M32	Dec point same as displayed.
34	0022	Deviation 1 (Lo word)	M32	
35	0023	Deviation 2 (Hi word)	M32	Dec point same as displayed.
36	0024	Deviation 2 (Lo word)	M32	
37	0025	Deviation 3 (Hi word)	M32	Dec point same as displayed.
38	0026	Deviation 3 (Lo word)	M32	
39	0027	Deviation 4 (Hi word)	M32	Dec point same as displayed.
40	0028	Deviation 4 Lo word)	M32	
41	0029	Analog Lo 1 (Hi word)	2C32	Dec point same as displayed.
42	002A	Analog Lo 1 (Lo word)	2C32	
43	002B	Analog Hi 1 (Hi word)	2C32	Dec point same as displayed.
44	002C	Analog Hi 1 (Lo word)	2C32	
45	002D	Analog Lo 2 (Hi word)	2C32	Dec point same as displayed.
46	002E	Analog Lo 2 (Lo word)	2C32	
47	002F	Analog Hi 2 (Hi word)	2C32	Dec point same as displayed.
48	0030	Analog Hi 2 (Lo word)	2C32	

* Values are for Base 1 Standard addressing. Add 1 for Base 0 PLC addressing.
** Max Value = 21,474.1

For the following, use any starting Register Addresses and any number of Registers.

Register Addr		Register Name	Data Type	Scaling & Decimal Point
Dec	Hex			
49	0031	GateTime	M16	1-19999 (4E1F) Dec Pt =XXX.XX
50	0032	TimeOut	M16	1-19999 (4E1F) Dec Pt =XX.XXX
51	0033	Pulses	M16	1-59999 (4E1F) Dec Pt =XXXXX.
52	0034	Total B (Hi word)	M48	
53	0035	Total B (Mid word)	M48	
54	0036	Total B (Lo word)	M48	
55	0037	Total A (Hi word)	M48	
56	0038	Total A (Mid word)	M48	
57	0039	Total A (Lo word)	M48	
58	003A	Cutoff	M16	0-65535
50	003B	Calibration	M15	SXXX XXXX XXXX XXXX Sign + Magnitude (PPM)

Data Type B16

Register Addr		Register Name	Bit Significance		
Dec	Hex				
65	0041	Alarm Config 1	Bit 0	0 = AL1 Hi Active	1 = Lo Active
			Bit 1	0 = AL1 Enabled,	1 = Disabled
			Bit 2	0 = AL2 Hi Active	1 = Lo Active
			Bit 3	0 = AL2 Enabled	1 = Disabled
			Bit 4	0 = AL1 Non-Latched	1 = Latched
			Bit 5	0 = AL2 Non-Latched	1 = Latched
			Bit 6	0 = Relay1 Active On	1 = Off
			Bit 7	0 = Relay2 Active On	1 = Off

66	0042	Alarm Config 2	Bits 2:0	# Readings before Alarms 1 & 2.
				000 = 1, 001 = 2, 010 = 4, 011 = 8, 100 = 16,
				101 = 32, 110 = 64, 111 = 128	

			Bits 4:3	Setpoint Compare Source	
			Bit 3	AL1 0 = Deviation	1 = Hysteresis
			Bit 4	AL2 0 = Deviation	1 = Hysteresis
			Bit 5	0 = Deviation in Menu	1 = Omitted
67	0043	Alarm Config 3	Bit 0	0 = AL3 Hi Active	1 = Lo Active
			Bit 1	0 = AL3 Enabled	1 = Disabled
			Bit 2	0 = AL4 Hi Active	1 = Lo Active
			Bit 3	0 = AL4 Enabled	1 = Disabled
			Bit 4	0 = AL3 Non-Latched	1 = Latched
			Bit 5	0 = AL4 Non-Latched	1 = Latched

			Bit 6	0 = Relay3 Active On	1 = Off	
			Bit 7	0 = Relay4 Active On	1 = Off	

68	0044	Alarm Config 4	Bits 2:0 = # Readings before Alarms 3 & 4.
			000 = 1, 001 = 2, 010 = 4, 011 = 8, 100 = 16,
			101 = 32 110 = 64 111 = 128			

			Bit 3	AL3 0 = Deviation	1 = Hysteresis	
			Bit 4	AL4 0 = Deviation	1 = Hysteresis	
			Bit 5	0 = Deviation in Menu	1 = Omitted	
69	0045 Input Type	Rate	00-0F	00 = A&B, 01 = AOnly, 02 = Batch, 03 = A_Atot, 05 = A_Btot, 0B = A+B, 0C = A-B, 0D = A*B, 0E = A/B, 0F = A/B-1		
		Period	10-1E	10 = A&B, 11 = AOnly 1B = A+B, 1C = A-B, 1D = A*B, 1E = A/B		
		Total	20-2E	20 = Total A&B, 21 = AOnly 24 = A-B_ud, 26 = Burst=26, 27 = B_Arat, 29 = A_Bud, 2A = A_Binh, 2B = A+B, 2C = A-B, 2D = A*B, 2E = A/B		
		Time Interval	41-42	41 = Time Interval A to B 42 = 1 / (A to B)		
		Stopwatch	50-53	50 = A to A, 51 = A to B 52 = 1 / (A to A) 53 = 1 / (A to B)		
		Phase	61-62	61 = 0-360 62 = -180 to +180		
		Duty Cycle	71	A to B		
		V-to-F Signal Conditioner	XY	X = 8, 4-20 mA input X = 9, 0-1 mA input X = A, 0-10V input Y = 1, A only Y = 2, Batch Y = 3, A to A total Y = F, 1/A		
		Quadrature	C0-C1	C0 = Total C1 = Rate		
70	0046	Setup M = Meter F = Function D = Display	Bits 3:0	Ctrl In 1	Ctrl In 2	Both Reset
			Hex 0	Meter Reset	Function Reset	MReset
			Hex 1	Meter Reset	Meter Hold	MReset
			Hex 2	Meter Reset	Peak or Valley	MReset
			Hex 3	Meter Reset	External Gate	MReset
			Hex 4	Function Reset	Meter Hold	MReset

			Hex 5 Valley Peak FRest Hex 6 Function Reset External Gate MReset Hex 7 Meter Hold Peak or Valley FReset Hex 8 Reset Total A Reset Total B FReset Hex 9 Force Alarm1 Force Alarm2 No Action Hex A Meter Reset Display Blank MReset Hex B Function Reset Display Blank MReset Hex C Meter Hold Display Blank MReset Hex D Peak or Valley Display Blank FReset Hex E Display Blank External Gate MReset Hex F Item2 Item3 Item 1 = Neither/Both Hex F Tare Enable Tare (Remote Display Only) Bit 4 0 = Scale2 using Scale, Offset 1 = Scale2 using Coordinates of 2 Points Bit 5 0 = Scale1 using Scale, Offset 1 = Scale1 using Coordinates of 2 Points Bit 6 0 = Blank leading zeros 1 = Display leading zeros Bit 7 0 = Zero Total upon Power-On 1 = Restore Total upon Power-On
71	0047	Filter	Bits 2:0 1 = .1S, 2 = .2S, 3 = .4S, 4=.8S, 5=1.6S, 6 = 3.2S, 7=6.4S Bit 3 0 = Low Adaptive, 1 = High Adaptive Bit 4 0 = Display Unfiltered, 1=Display Filtered Bit 5 0 = Peak, Valley of Unfiltered 1 = Peak,Valley of Filtered Bit 6 0 = Adaptive Filter 1 = Conventional Filter
72	0048	Options	Do Not Use.
73	0049	Serial Config 1	Bits 3:0 Time between Continuous Serial Outputs Hex 0=.017S, 1=.28S, 2=.57S, 3=1.1S, 4=2.3S, 5=4.5S, 6=9.1S, 7=18.1S, 8=36.3S, 9=1M13S, A=2M25S, B=4M50S, C=9M40S, D=19M20S, E=38M41S, F=77M21S Bits 6:4 Baud Rate 000 = 300, 001 = 600, 010 = 1200, 011 = 2400, 100 = 4800, 101 = 9600, 110 = 19200 Bit 7 0 = Send Unfiltered value, 1 = Send Filtered Val

74	004A	Serial Config 2	Bits 4:0	Meter Serial Address (0-31) [Non-Modbus] Hex 0 = Broadcast (01 = 1 to 0A = 10), 0F = 15, 10 = 16, 1F = 31
			Bit 5	0 = Continuous Mode, 1 = Command Mode
			Bit 6	0 = No Alarm data w/ readings, 1 = Alarm data
			Bit 7	0 = No LF following CR, 1 = LF following CR
75	004B	Serial Config 3	Bits 2:0	Data sent in serial output 0 = All active Items, 1 = Item1, 2 = Item2, 3 = Item3, 4 = Peak, 5 = All active Items+ Peak, 6 = Valley, 7 = All active Items + Peak + Valley
			Bit 3	0 = Termination chars at end of all items 1 = Termination chars at end of each item
			Bit 4	0 = Non-latching RTS 1 = Latching RTS
			Bit 5	0 = * is Recognition Character 1 = Custom Recognition Character
			Bit 6	0 = No Serial Start / Stop Characters 1 = Start / Stop Characters
			Bit 7	0 = Full Duplex, 1 = Half Duplex
76	004C	Serial Config 4	Bits 1:0	00 = No Parity 01 = Odd Parity 11 = Even Parity
			Bits 3:2	00 = Custom ASCII 01 = Modbus RTU, 10 = Modbus ASCII
			Bits 5:4	Modbus ASCII Gap Timeout 00 = 1S, 01 = 3S, 10 = 5S, 11 = 10S
77	004D	Config	Bit 0	0 = VF Batch, Atot zero cutoff 1 = Allow negative values
			Bit 1	0 = Calculate Rate value 1 = Calculate Square Root of Rate
			Bits 3:2	00 = Basic Counter, 01 = Extended Counter 10 = Custom Curve #1 11=Custom Curve #2 (if V-to-F)
			Bits 7:4	0 = Exponential Overload 1 = 999999 Overload 2 = One Right Hand Dummy Zero 3 = Two Right Hand Dummy Zeros 4 = Clock Time in Seconds 5 = Clock Time in HH.MM.SS Format 6 = Remote Display, HKL Command

				7 = Remote Display, Value 8 = 1st Value in String 9 = 2nd Value in String A = 3rd Value in String B = 4th Value in String C = Remote Display using Start, Stop, Skip, Show Characters
78	004E	Lockout 1		0 = Enabled, 1 = Locked out
			Bit 0	Filter
			Bit 1	Gate Time, Timeout, Batch, Preset, Pulses, Cutoff
			Bit 2	Setup, Config, Display Number
			Bit 3	Input Type
			Bit 4	Setpoint Programming
			Bit 5	Alarm Config, Deviation / Hysteresis
			Bit 6	Scale, Offset, Resolution, 2 Coordinates
			Bit 7	Slope, Decimal Points
79	004F	Lockout 2		0 = Enabled, 1 = Locked out
			Bit 0	Change Item# displayed
			Bit 1	Calibration
			Bit 2	Serial Comm Config
			Bit 3	Analog Out Scaling & Setup
			Bit 4	Front Panel Meter Reset
			Bit 5	Front Panel Function Reset
			Bit 6	View Setpoints
			Bit 7	View Peak
80	50	Batch Operation	Bit 0	0 = Display “rEADy” after Reset 1 = Start
			Bit 1	0 = Item2 is Grand Total 1 = Item2 is Total Number of Batches
			Bit 2	0 = Gate Time resets 1 = Control Input 2 resets
			Bit 3	0 = Reset to Zero, Count Up 1 = Reset to SETPT1, Count Down
			Bits 5:4	Residual Input 0,2 = Input Discard, Grand Total Discard 1 = Input Accept, Grand Total Discard 3 = Input Accept, Grand Total Accept

81	0051	Alarm Source	Bits 1:0 Bits 3:2 Bits 5:4 Bits 7:6	Setpoint 2 Setpoint 1 Setpoint 4 Setpoint 3 For each Setpoint: 00 = Filtered Item, 01 = Item1, 10 = Item2, 11 = Item3
82	0052	Analog Out Setup	Bits1:0 Bit 2	0 = Filtered Item, 1 = Item1, 2 = Item2, 3 = Item3 0 = Current Output, 1 = Voltage Output
83	0053	Scale Multiplier	Bits 3:0 Bits 7:4	Scale1 Multiplier Scale2 Multiplier 0 = .00001, 1 = .0001, 2 = .001, 3 = .01, 4 = .1, 5 = 1, 6 = 10, 7 = 100, 8 = 1000, 9 = 10000, A = 100000
84	0054	Trigger Slope	Bit 0 Bit 1	0 = Positive Slope, B Input 1 = Negative Slope, B Input 0 = Positive Slope, A Input 1 = Negative Slope, A Input
85	0055	Display Item	Bits 1:0 Bits 3:2	1 = Item1, 2 = Item2, 3 =Item3 Display Response to Peak Button: 00 = Peak, 01 = Valley, 10 = Peak then Valley
86	0056	Resolution	Bits 3:0	0 = .00001, 1= .0001, 2 = .001, 3 = .01, 4 = .1, 5 = 1, 6 = 10, 7 = 100, 8 = 1000, 9 = 10000, A = 100000
87	0057	System Decimal Point	Bits 3:0 Bits 7:4	DecPt1 DecPt2 1 = dddddd., 2 = ddddd.d, 3 = dddd.dd, 4 = ddd.ddd, 5 = dd.dddd, 6 = d.ddddd

Special Characters

88	0058	Recognition	Bits 7:0 ASCII Hex Character
89	0059	Remote Start	Bits 7:0 ASCII Hex Character
90	005A	Remote Stop	Bits 7:0 ASCII Hex Character
91	005B	Remote Skip	Bits 7:0 ASCII Hex Character
92	005C	Remote Show	Bits 7:0 ASCII Hex Character
93	005D	Serial Transm. Start	Bits 7:0 ASCII Hex Character
94	005E	Serial Transm. Stop	Bits 7:0 ASCII Hex Character
95	005F	Modbus Address	Bits 7:0 Hex Value of Decimal Address 1-255
96	60	Reserved	
97	61	Reserved	Do not use

READ ONLY (FC03) – Data Type B16

100	0064	Analog Output DAC Type	0 = none, 1 = 1 output, unipolar (12-bit, pre 2009) 2 = 1 output, unipolar (16-bit, pre 2009) 3 = 1 output, uni or bipolar (16-bit, post 2009) 4 = 2 outputs, unipolar (16-bit, post 2009)
101	0065	Device Type	Bits 7:0 01 = DPM meter 03 = Counter/Timer meter 05 = DPM transmitter 07 = Counter/Timer transmitter
102	0066	Revision	Bits 7:0 Hex value of Decimal Revision number

WRITE ONLY FC10 (dec16) – Data Type 2C32

105	0069	Display Data	Hi Word Displayed
106	006A	Display Data	Lo Word Displayed
107	006B	Data to Item3	Hi Word Applied to Item3
108	006C	Data to Item3	Lo Word Applied to Item3
109	006D	Data to Both	Hi Word Displayed and Applied to Item3
110	006E	Data to Both	Lo Word Displayed and Applied to Item3

WRITE ONLY FC10 (dec16) – Data Type B16

111	006F	Force Alarms, Remote Display Mode	Bit 0 = Alarm 1 Bit 1 = Alarm 2 Bit 2 = Alarm 3 Bit 3 = Alarm 4

Please see the description at the end of Section 10 for comparing the Remote Data to the Relay Setpoints or using it as the source for setting the Analog Output.

7. WARRANTY

Laurel Electronics Inc. warrants its products against defects in materials or workmanship for a period of one year from the date of purchase. In the event of a defect during the warranty period, the unit should be returned, freight prepaid (and all duties and taxes) by the Buyer, to the authorized Laurel distributor where the unit was purchased. The distributor, at its option, will repair or replace the defective unit. The unit will be returned to the buyer with freight charges prepaid by the distributor.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from 1) Improper or inadequate maintenance by Buyer, 2) Unauthorized modification or misuse, 3) Operation outside the environmental specifications of the product, 4) Mishandling or abuse. The warranty is exclusive and no other warranty, whether written or oral, is expressed or implied. Laurel specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

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