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Excel® XR Series

Electronic Metering Pump
Modbus RTU Manual

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Note: For basic control features see manual 54038 and enhanced control features see manual 54189

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1.0 Precautions

The following precautions should be taken when working with LMI metering pumps. Please read this section carefully prior to installation.

Protective Clothing

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to Safety Data Sheets (SDS) precautions from your solution supplier.

Water Pre-Prime

All LMI pumps are pre-primed with water when shipped from the factory. If your solution is not compatible with water, disassemble the Pump Head Assembly. Thoroughly dry the pump head, valves, O-rings, balls and diaphragm. Reassemble head assembly tightening screws in a crisscross pattern. Refill the pump head with the solution to be pumped before priming the pump. (This will aid in priming.)

Liquid Compatibility

CAUTION: The evaluation performed by ETL was tested with water only. The pumps are certified to NSF 61 with: sodium hypochlorite (12.5%), sulfuric acid (98.5%), sodium hydroxide (50%), and hydrochloric acid (30%). Determine if the materials of construction included in the liquid handling portion of your pump are adequate for the solution (chemical) to be pumped. Always refer to the solution supplier and the LMI Chemical Resistance Chart for compatibility of your specific LMI metering pump. Contact your local LMI distributor for further information.

Tubing Connections

Inlet and outlet tubing or pipe sizes must not be reduced. Outlet tubing size must not be increased. Make certain that all tubing is SECURELY ATTACHED to fittings prior to start-up (see section 3.3 Tubing Connections). ALWAYS use LMI supplied tubing with your pump, as the tubing is specifically designed for use with the pump fittings. It is recommended that all tubing be shielded and secure to prevent possible injury in case of rupture or accidental damage. If tubing is exposed to sunlight, black UV resistant tubing should be installed. Check tubing frequently for cracks and replace as necessary.

Fittings and Machine Threads

All fittings should be hand-tightened. An additional 1/8 - 1/4 turn after the fitting is snug may be necessary to provide a leak-proof seal. Excessive overtightening or use of a pipe wrench can cause damage to the fittings, seals, or pump head.

Most LMI pumps have straight screw machine threads on the head and fittings and are sealed by the O-rings. DO NOT use PTFE tape or pipe dope to seal these threads. PTFE Tape may only be used on NPT threads.

Plumbing

Always adhere to your local plumbing codes and requirements. Be sure installation does not constitute a cross connection. Check local plumbing codes for guidelines. LMI is not responsible for improper installations.

PRECAUTIONS

Back Pressure/Anti-Syphon Valve

If you are pumping downhill or into low or no system pressure, a backpressure /anti-syphon device should be installed to prevent over pumping or syphoning. Contact your LMI distributor for further information.

Electrical Connections

WARNING: To reduce the risk of electrical shock, the metering pump must be plugged into a properly grounded grounding-type receptacle with ratings conforming to the data on the pump control panel. The pump must be connected to a good ground. ***Do not use adapters!*** All wiring must conform to local electrical codes. If the supply cord is damaged, it must be replaced by the manufacturer, stocking distributor, or authorized repair center in order to avoid a hazard.

Fuse and Battery

CAUTION: Battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire. The battery and fuse are internal, factory serviceable parts, and must be replaced by the factory or a qualified distributor with parts of the same type and rating.

Flooding

WARNING: Install this pump in a location where flooding cannot occur.

Ground Fault Circuit Interrupter

WARNING: To reduce the risk of electric shock, install only on a circuit protected by a Ground Fault Circuit Interrupter (GFCI).

Line Depressurization

To reduce the risk of chemical splash during disassembly or maintenance, all installations should be equipped with line depressurization capability.

Over Pressure Protection

To ensure safe operation of the pump it is recommended that some type of safety / pressure-relief valve be installed to protect the piping and other system components from failing due to excessive pressure.

Chemical Concentration

There is a potential for elevated chemical concentration during periods of no flow, for example, during backwash in the system. Steps, such as turning the pump off, should be taken during operation or installation to prevent this.

See your distributor about other external control options to help mitigate this risk.

Retightening Components

Plastic materials will typically exhibit creep characteristics when under pressure over a period of time and to insure a proper fit it may be necessary to retighten the head bolts periodically. To insure proper operation, we recommend tightening the bolts to 25 inch-pounds after the first week of operation and on a monthly basis thereafter.

Flow Display

The accuracy of the flow value as shown on the pump display is highly dependent on the specific application. Calibration is necessary in order to display an accurate measure of the flow.

Spills

CAUTION: Spills of Dangerous chemicals should be cleaned up immediately.

2.0 Introduction

LMI's metering pumps deliver the highest level of repetitive accuracy and reliability with the capability to pump a wide range of chemicals. Our comprehensive selection of pumps means you get the right pump for the right application. Every one of our pumps is engineered to exceed expectations and is backed by a global network of highly trained field engineers and aftersales support.

This manual assumes the reader is familiar with commissioning and programming Modbus RTU devices.

2.1 Specifications

Table 1: Modbus RTU Specifications

Modbus RTU Connector	5 Pin Reverse Key Female M12 (B-Code)
Maximum Cable Length	1200 meters at 9.6 Kbits/s 1000 meters at 115.2 Kbits/s
Slave Address Range	1-125
Line Termination	On/Off (Software Configurable)
Supported transmission speeds	9600, 19200, 38400, 115200 (selectable or automatically detected)
Stop Bits	1 or 2 (Software Configurable)
Parity	Even, Odd, or None (Software Configurable)

3.0 Local Operation

This manual covers basic features supported in the Excel® XR Series pumps and complete descriptions of Modbus features.

3.1 Display Navigation

Navigation through display screens is done using the **Up**, **Down,** and **Multi-Function** buttons. The settings screen is shown in the example below (

Figure 1). The scroll bar on the side of the display screen indicates there are more settings available on another page.

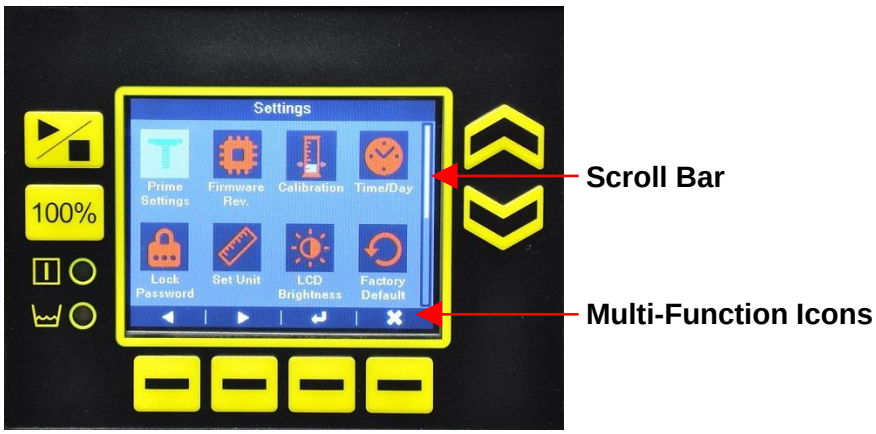


Figure 1: Display Navigation

3.2 Settings

To access the settings screen (Figure 2) press **Settings** in the home screen. Navigate to the function desired and press **Enter**. Follow the prompts to enter new settings. New settings will need to be saved by pressing **Save**. Press **Exit** to return to the previous screen without saving.

Figure 2: Settings

3.2.1 Modbus Communication Settings

From the *Settings* screen, navigate to the **Communication Settings** icon and press **Enter** ↵. The *Communication Settings* screen (Figure 3) will allow for the following settings to be adjusted:

- The Slave Address can be configured via software in the range of 1-125.
- The Bit Rate can be selected as 9600, 19200, 38400, 115200, or Auto. If the network bit rate is known, it is recommended to manually select the bit rate. If Auto is selected, the Excel® XR Pump will change its bit rate for each message that cannot be read until the correct bit rate is detected. As a result, the first few commands may fail in autobaud mode.
- Parity can be configured as No Parity, Even Parity, or Odd Parity
- Stop Bits can be configured as 1 Stop Bit or 2 Stop Bits.
- The Internal Line Termination can also be enabled/disabled on this screen. The final device on the communication bus must have line termination enabled. This can be accomplished externally or using the software enabled internal line termination. The Internal Line Termination will engage the following internal termination resistors:
  - 562 Ohm between +5V and D1 (Positive Data Signal)
  - 121 Ohm between D0 (Negative Data Signal) and D1 (Positive Data Signal)
  - 562 Ohm between DGND and D0 (Negative Data Signal)

Figure 3: Communication Settings

4.0 Modbus Software Definition

Start Hex Address	Quantity	Type	Description
0x0001	14	Coils	Coils are used to execute basic commands such as toggling on/off status, setting operating mode, or setting units.
0x0001	76	Holding Registers	Holding Registers are 2 bytes each and used to read/write data such as flow rate, time, and setting values.
0x0001	27	Discrete Inputs	Discrete Inputs are read-only bits used to determine the status of items such as on/off status, current operation mode, digital I/O status, or homescreen display.
0x0065	11	Discrete Inputs	Discrete Inputs are read-only bits and this range is used to determine the status of alarms. Each alarm has its own discrete input bit that can be monitored.
0x0001	43	Input Registers	Input Registers are read-only and are used for general information such as current flow rate, analog I/O values, totalizer information, and firmware revisions.

4.1 Supported Modbus RTU Functions

Code	Hex	Name	Description
01	0x01	Read Coil Status	Read the status of contiguous coils.
02	0x02	Read Discrete Inputs	Read the status of contiguous discrete inputs.
03	0x03	Read Holding Registers	Read the contents from a contiguous block of holding registers.
04	0x04	Read Input Register	Read the contents from a contiguous block of input registers.
05	0x05	Write Single Coil	Write the status of a single coil.
06	0x06	Write Single Holding Register	Write the contents a single holding register.
07	0x07	Read Exception Status	Read the exception status for the following Exception Codes: 01: ILLEGAL FUNCTION 02: ILLEGAL DATA ADDRESS 03: ILLEGAL DATA VALUE
15	0x0F	Write Multiple Coils	Write the status of contiguous coils.
16	0x10	Write Multiple Registers	Write the contents of contiguous holding registers.
17	0x11	Report Server ID	Read the device slave ID.

4.2 Modbus Coil Addresses

Coils are read/write single bit data fields. The coil can be set to 0xFF00 (ON) or to 0x0000 (OFF). Coils are read with Function 01 (0x01) Read Coils and written with Function 05 (0x05) Write Single Coil or Function 15 (0x0F) Write Multiple Coils.

Note that PLC Addressing (Base 1) is used.

Dec	Hex	Function	Description
1	0x0001	On/Off	Set ON to toggle the On/Off status
2	0x0002	Prime	Set ON to initiate the prime sequence. Set OFF to end the prime sequence.
3	0x0003	100Pct	Set ON to run the pump at 100%. Set OFF to end the prime sequence.
4	0x0004	Force Internal / External Mode	Set ON to force Internal Control Mode. Set OFF force External Control Mode. The specific mode for each internal and external are configured in settings on the pump or by using Modbus Holding Registers 0x0048 and 0x0049.
5	0x0005	Force Home	Set ON to force the pump to return to the homescreen on the display
6	0x0006	Manual Operation Mode	Set ON to select the Manual Operation Mode
7	0x0007	Analog Operation Mode	Set ON to select the Analog Operation Mode
8	0x0008	Pulse Operation Mode	Set ON to select the Pulse Operation Mode
9	0x0009	Batch Operation Mode	Set ON to select the Batch Operation Mode
10	0x000A	Cycle Operation Mode	Set ON to select the Cycle Timer Operation Mode
11	0x000B	Timed Event Operation Mode	Set ON to select the Timed Event Operation Mode
12	0x000C	Slow Mode	Set ON to enable Slow Mode. Set OFF to disable Slow Mode.
13	0x000D	Units	Set ON to select Metric units. Set OFF to select English units
14	0x000E	Reset User Totalizer	Set ON to reset the user totalizer

4.3 Modbus Holding Register Addresses

The Holding Registers are read-write data fields with messages packed as two bytes per register, with the binary contents right justified within each byte. For each register the first byte contains the high-order bits, and the second contains the low-order bits. Holding Registers are read with Function 03 (0x03) Read Holding Registers and written with Function 06 (0x06) Write Single Register or Function 16 (0x10) Write Multiple Registers.

The request specifies the starting address and the number of registers to read. If a function spans multiple registers, the first register contains the high order value.

Note that PLC Addressing (Base 1) is used.

Dec	Hex	Function	Description
1	0x0001	Flow Rate for Manual Mode	Read/write the flowrate for manual mode as a four digit integer that represents XX.XX GPH/LPH format. The range is 0000-9999.
2	0x0002	Flow Rate for Prime Mode	Read/write the prime mode flow rate XX.XX GPH/LPH format. The range is 0000-9999.
3	0x0003	Prime Mode Duration	Read/write the prime mode duration in seconds (1-3600).
4	0x0004	Power Loss Mode	Read/write the Power Loss Setting as an enumeration: 0: Resume Operation 1: Stay Idle 2: Run at a configured speed
5	0x0005	Power Loss Resume Speed	Read/write the Power Loss Resume Speed as XX.XX GPH/LPH format. The range is 0000-9999. This flowrate is applied on power up if the power loss option is set to 'Run at a configured speed'.
6	0x0006	Slow Mode Setpoint	Read/write the Slow Mode Setpoint as a percentage in the range of 10-90 in increments of 10.
7	0x0007	RTC DOW	Read/write the Day of the Week in the Real Time Clock as an integer (1-7) that represents a day of the week.
8	0x0008	RTC Hour	Read/write the Hour in the Real Time Clock as an integer (1-12).
9	0x0009	RTC Minute	Read/write the Minutes in the Real Time Clock as an integer (0-60).
10	0x000A	RTC Second	Read/write the Seconds in the Real Time Clock an integer (0-60).
11	0x000B	RTC AM/PM	Read/write AM/PM in the Real Time Clock an enumeration (0 = AM, 1 = PM).
12	0x000C	Pulse Mode Count	Read/write the Pulse Mode Count setting as an integer with a valid range of 1 – 10000. This is used to determine the number of pulses to receive for each delivery.
13	0x000D, 0x000E	Pulse Mode Volume	Read/write the volume to deliver in Pulse Mode as an integer with a valid range is 0.0 to 10000.00. This value spans two registers.
15	0x000F	Pulse Mode Units	Read/write the units setting for Pulse Mode enumeration (0=Small, 1=Large). Large will use Gallons or Liters based on global units setting. Small will use fl oz. or mL based on global units setting.

16	0x0010	Pulse Mode Pulse Width	Read/write the pulse width for Pulse Mode as an integer representing msec. The valid range is 4 - 60 in increments of 4.
17	0x0011	Batch Mode Volume	Read/write the volume to deliver in Batch Mode with a valid range of 0.0 to 10000.00. This value spans two registers.
19	0x0013	Batch Mode Time	Read/write the dosing time for Batch Mode with a valid range of 1-86400 Seconds. This value spans two registers.
21	0x0015	Batch Mode Units	Read/write the units setting for Batch Mode as an enumeration (0=Small, 1=Large). Large will use Gallons or Liters based on global units setting. Small will use fl oz. or mL based on global units setting.
22	0x0016	Batch Mode Pulse Width	Read/write the pulse width for Batch Mode as an integer representing msec. The valid range is 4 - 60 in increments of 4.
23	0x0017	Batch Mode Accumulate	Read/write the Pulse Accumulator for Batch Mode as an enumeration (0 = Off, 1 = On).
24	0x0018	Analog Mode P1 Volume	Read/write the flowrate for P1 in Analog Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
25	0x0019	Analog Mode P1 Current	Read/write the Current for P1 in Analog Mode as an integer representing XX.X mA. The valid range is 0.0-20.0.
26	0x001A	Analog Mode P2 Volume	Read/write the flowrate for P2 in Analog Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
27	0x001B	Analog Mode P2 Current	Read/write the Current for P2 in Analog Mode as an integer representing XX.X mA. The valid range is 0.0-20.0.
28	0x001C	Cycle Mode Cycle Time	Read/write the Cycle Time for Cycle Timer Mode as an integer representing minutes with a valid range of 1-1439.
29	0x001D	Cycle Mode Duration	Read/write the Duration for Cycle Timer Mode as an integer representing minutes with a valid range of 1-1439 The Duration is the inactive period in Cycle Mode.
30	0x001E	Cycle Mode Delay	Read/write the Delay Time for Cycle Timer Mode as an integer representing minutes with a valid range of 0-1439. The Delay Timer is the first inactive period prior to starting the cycle.
31	0x001F	Cycle Mode Flow	Read/write the flowrate for Cycle Timer Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
32	0x0020	Timed Event Day	Read/write the Day of the Week for Timed Event Mode as an integer (1-7) that represents a day of the week. This must be set prior to configuring event parameters. The other timed events will be based on the set day.
33	0x0021	Timed Event1 Start Time Hour	Read/write the Hour for Timed Event 1 on the currently set day for Timed Event Mode as an integer (1-12).
34	0x0022	Timed Event1 Start Time Minute	Read/write the Minutes for Timed Event 1 on the currently set day for Timed Event Mode as an integer (0-60).

35	0x0023	Timed Event1 Start Time AM/PM	Read/write AM/PM for Timed Event 1 on the currently set day for Timed Event Mode as an enumeration (0 = AM, 1 = PM).
36	0x0024	Timed Event1 Duration	Read/write the duration for Timed Event 1 on the currently set day for Timed Event Mode an integer representing minutes with a valid range of 1-1439.
37	0x0025	Timed Event1 Flow	Read/write the flowrate for Timed Event 1 on the currently set day for Timed Event Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
38	0x0026	Timed Event1 Enabled	Read/write the status of Timed Event 1 on the currently set day for Timed Event Mode as an enumeration (0 = OFF, 1 = ON).
39	0x0027	Timed Event2 Start Time Hour	Read/write the Hour for Timed Event 2 on the currently set day for Timed Event Mode as an integer (1-12).
40	0x0028	Timed Event2 Start Time Minute	Read/write the Minutes for Timed Event 2 on the currently set day for Timed Event Mode as an integer (0-60).
41	0x0029	Timed Event2 Start Time AM/PM	Read/write AM/PM for Timed Event 2 on the currently set day for Timed Event Mode as an enumeration (0 = AM, 1 = PM).
42	0x002A	Timed Event2 Duration	Read/write the duration for Timed Event 2 on the currently set day for Timed Event Mode as an integer representing minutes with a valid range of 1-1439.
43	0x002B	Timed Event2 Flow	Read/write the flowrate for Timed Event 2 on the currently set day for Timed Event Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
44	0x002C	Timed Event2 Enabled	Read/write the status of Timed Event 2 on the currently set day for Timed Event Mode as an enumeration (0 = OFF, 1 = ON).
45	0x002D	Timed Event3 Start Time Hour	Read/write the Hour for Timed Event 3 on the currently set day for Timed Event Mode as an integer (1-12).
46	0x002E	Timed Event3 Start Time Minute	Read/write the Minutes for Timed Event 3 on the currently set day for Timed Event Mode as an integer (0-60).
47	0x002F	Timed Event3 Start Time AM/PM	Read/write AM/PM for Timed Event 3 on the currently set day for Timed Event Mode as an enumeration (0 = AM, 1 = PM).
48	0x0030	Timed Event3 Duration	Read/write the duration for Timed Event 3 on the currently set day for Timed Event Mode as an integer representing minutes with a valid range of 1-1439.
49	0x0031	Timed Event3 Flow	Read/write the flowrate for Timed Event 3 on the currently set day for Timed Event Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
50	0x0032	Timed Event3 Enabled	Read/write the status of Timed Event 3 on the currently set day for Timed Event Mode as an enumeration (0 = OFF, 1 = ON).
51	0x0033	Timed Event4 Start Time Hour	Read/write the Hour for Timed Event 4 on the currently set day for Timed Event Mode as an integer (1-12).

52	0x0034	Timed Event4 Start Time Minute	Read/write the Minutes for Timed Event 4 on the currently set day for Timed Event Mode as an integer (0-60).
53	0x0035	Timed Event4 Start Time AM/PM	Read/write AM/PM for Timed Event 4 on the currently set day for Timed Event Mode as an enumeration (0 = AM, 1 = PM).
54	0x0036	Timed Event4 Duration	Read/write the duration for Timed Event 4 on the currently set day for Timed Event Mode as an integer representing minutes with a valid range of 1-1439.
55	0x0037	Timed Event4 Flow	Read/write the flowrate for Timed Event 4 on the currently set day for Timed Event Mode as an integer representing XX.XX GPH/LPH format. The range is 0000-9999.
56	0x0038	Timed Event4 Enabled	Read/write the status of Timed Event 4 on the currently set day for Timed Event Mode as an enumeration (0 = OFF, 1 = ON).
57	0x0039	Digital Input 1 Config	Read/write the configuration for Digital Input 1 an enumeration with a range 0-5: 0: Digital Input = Disabled 1: Digital Input = RemoteOnOff 2: Digital Input = FloatSwitch_Empty 3: Digital Input = FloatSwitch_Low 4: Digital Input = RemoteIntExtMode 5: Digital Input = PacingPulse
58	0x003A	Digital Input 1 State	Read/write the Contact State for Digital Input 1 as an integer representing an enumeration (0=NO - Normally Open, 1=NC - Normally Closed).
59	0x003B	Digital Input 2 Config	Read/write the configuration for Digital Input 2 an enumeration with a range 0-5: 0: Digital Input = Disabled 1: Digital Input = RemoteOnOff 2: Digital Input = FloatSwitch_Empty 3: Digital Input = FloatSwitch_Low 4: Digital Input = RemoteIntExtMode 5: Digital Input = PacingPulse
60	0x003C	Digital Input 2 State	Read/write the Contact State for Digital Input 2 as an integer representing an enumeration (0=NO - Normally Open, 1=NC - Normally Closed).
61	0x003D	Digital Input 3 Config	Read/write the configuration for Digital Input 3 an enumeration with a range 0-5: 0: Digital Input = Disabled 1: Digital Input = RemoteOnOff 2: Digital Input = FloatSwitch_Empty 3: Digital Input = FloatSwitch_Low 4: Digital Input = RemoteIntExtMode 5: Digital Input = PacingPulse
62	0x003E	Digital Input 3 State	Read/write the Contact State for Digital Input 3 as an integer representing an enumeration (0=NO - Normally Open, 1=NC - Normally Closed).
63	0x003F	Digital Input 4 Config	Read/write the configuration for Digital Input 4 an enumeration with a range 0-5: 0: Digital Input = Disabled 1: Digital Input = RemoteOnOff 2: Digital Input = FloatSwitch_Empty 3: Digital Input = FloatSwitch_Low

			4: Digital Input = RemoteIntExtMode 5: Digital Input = PacingPulse
64	0x0040	Digital Input 4 State	Read/write the Contact State for Digital Input 4 as an integer representing an enumeration (0=NO - Normally Open, 1=NC - Normally Closed).
65	0x0041	Analog Input 1 Config	Read/write the configuration for Analog Input 1 as an enumeration: 0: Analog Input = Disabled 1: Analog Input = Pacing 2: Analog Input = Level
66	0x0042	Analog Input 2 Config	Read/write the configuration for Analog Input 2 as an enumeration: 0: Analog Input = Disabled 1: Analog Input = Pacing 2: Analog Input = Level
67	0x0043	Digital Output 1 Config	Read/write the configuration for Digital Output 1 as an enumeration: 0: Digital Output = Disabled 1: Digital Output = StrokePulse 2: Digital Output = PumpRunning 3: Digital Output = PumpStandby 4: Digital Output = AlarmOut 5: Digital Output = INTEXTMode 6: Digital Output = UserAlarmOut 7: Digital Output = PumpStopped 8: Digital Output = TimedEvent
68	0x0044	Digital Output 1 State	Read/write the Contact State for Digital Output 1 as an enumeration: 0=NO - Normally Open 1=NC - Normally Closed
69	0x0045	Digital Output 2 Config	Read/write the configuration for Digital Output 2 as an enumeration: 0: Digital Output = Disabled 1: Digital Output = StrokePulse 2: Digital Output = PumpRunning 3: Digital Output = PumpStandby 4: Digital Output = AlarmOut 5: Digital Output = INTEXTMode 6: Digital Output = UserAlarmOut 7: Digital Output = PumpStopped 8: Digital Output = TimedEvent
70	0x0046	Digital Output 2 State	Read/write the Contact State for Digital Output 2 as an enumeration: 0=NO - Normally Open 1=NC - Normally Closed
71	0x0047	Analog Output Config	Read/write the configuration for the Analog Output as an enumeration: 0: Analog Output = Disabled 1: Analog Output = Flow 2: Analog Output = MirrorInput
72	0x0048	Remote Internal Mode	Read/write the operation mode that is assigned to Internal Control as an enumeration: 0 = Manual 1 = Cycle Timer 2=Weekly Timer).

73	0x0049	Remote External Mode	Read/write the operation mode that is assigned to External Control as an enumeration: 0= mA 1= Pulse 2 = Batch
74	0x004A	Lock Style	Read/write the Keypad Lock Style as an enumeration: 1=No_Lock 2=All_Lock 3=All_Lock_Power_Unlock 4=All_Lock_Password
75	0x004B	Password	Read/write the Password as an integer with a range of 0000-9999.
76	0x004C	User Alarm Mask	Read/write the configuration for the User Alarm Mask as a bitmask with a high bit to indicate the status of each item: Bit 0 - Reserved Bit 1 - Reserved Bit 2 - Tank Empty Bit 3 - Tank Low Bit 4 - Internal System Error Bit 5 - Motor Stall Bit 6 - Analog Loss of Signal Bit 7 - Analog Overrange Bit 8 - Motor Homing Error Bit 9 - Pulse Signal not Present Bit 10 - Pulse Signal Overrange NOTE: Setting a bit high will cause the associated alarm to trigger the user alarm.

4.4 Modbus Input Registers

Input registers are read-only registers with data packed as two bytes per register, with the binary contents right justified within each byte. For each register the first byte contains the high-order bits, and the second contains the low-order bits. They are read with Function 04 (0x04) Read Input Registers.

The request specifies the starting address and the number of registers to read. If a function spans multiple registers, the first register contains the high order value.

Note that PLC Addressing (Base 1) is used.

Dec	Hex	Function	Description
1	0x0001	Model ID	Read the Model ID as an enumeration associated with the maximum flow rate of the pump: Output Code 2 - 5.6 GPH (21.2 l/h) 175 psi (12.0 bar) Output Code 3 - 14.0 GPH (53.0 l/h) 75 psi (5.0 bar) Output Code 4 - 18.0 GPH (68.1 l/h) 50 psi (3.5 bar)
2	0x0002	Language	Read the Language Setting as an enumeration: 1=English 2=French 3=Portuguese 4=Spanish

			5=Chinese)
3	0x0003	Current Flow Rate	Read the Current Flow Rate as an integer representing XX.XX GPH/LPH. The range is 0000-9999.
4	0x0004	Flow Percentage	Read the Flow Percentage as an integer representing XXX.XX%. The range is 00000-10000.
5	0x0005	Analog Input 1	Read Analog Input 1 as an integer representing XX.X mA. The range is 000-200.
6	0x0006	Analog Input 2	Read Analog Input 2 an integer representing XX.X mA. The range is 000-200.
7	0x0007	Analog Output	Read Analog Output an integer representing XX.X mA. The range is 000-200.
8	0x0008, 0x0009	Totalizer User Strokes	Read Totalizer User Strokes as an integer. This is stored in two registers.
10	0x000A, 0x000B, 0x000C, 0x000D	Totalizer User Volume	Read Totalizer User Volume as an integer representing Gal or L depending on current unit setting. This is stored in four registers.
14	0x000E, 0x000F	Totalizer User Hours	Read Totalizer User Hours an integer representing the number of hours the motor has been operated. This uses two registers.
16	0x0010	Totalizer User Power Cycles	Read Totalizer User Power Cycles as an integer.
17	0x0011, 0x0012	Totalizer Unit Strokes	Read Totalizer Unit Strokes as an integer. This is stored in two registers.
19	0x0013, 0x0014, 0x0015, 0x0016	Totalizer Unit Volume	Read Totalizer Unit Volume as an integer representing Gal or L depending on current unit setting. This is stored in four registers.
23	0x0017	Totalizer Unit Hours	Read Totalizer Unit Hours an integer representing the number of hours the motor has been operated. This uses two registers.
25	0x0019	Totalizer Unit Power Cycles	Read Totalizer Unit Power Cycles as an integer.
26	0x001A	Calibrated Volume	Read the Calibrated Volume as an integer representing XX.XX mL. This volume of a single stroke based on the calibration.
27	0x001B, 0x001C	Batch Mode Remaining Volume	Read Batch Mode Remaining Volume as an integer representing Gal or L depending on current unit setting. This uses two registers.
29	0x001D, 0x001E	Batch Mode Remaining Dosing Time	Read Batch Mode Remaining Dosing Time in seconds. This uses two registers.
31	0x001F, 0x0020	Cycle Time Mode Startup Delay Left	Read Cycle Time Mode Startup Delay Remaining in seconds. This uses two registers.
33	0x0021, 0x0022	Cycle Time Mode Run Time Left	Read Cycle Time Mode Run Time Remaining in seconds. This uses two registers.
35	0x0023	Cycle Time Mode Cycle Time Left	Read Cycle Time Mode Cycle Time Remaining in seconds. This uses two registers.

37	0x0025	Weekly Event Remaining Run Time	Read Weekly Event Remaining Run Time in seconds. This uses two registers.
39	0x0027	LCD Contrast	Read the LCD Contrast as an integer representing 0-100%
40	0x0028	Main Firmware Version	Read the Main Firmware Version as an integer that must be converted to hex to be read as 0000-FFFF representing X.X.X.X.
41	0x0029	I/O Firmware Version	Read the I/O Firmware Version as an integer that must be converted to hex to be read as 0000-FFFF representing X.X.X.X.
42	0x002A	Display Firmware Version	Read the Display Firmware Version as an integer that must be converted to hex to be read as 0000-FFFF representing X.X.X.X.
43	0x002B	Display EEPROM Firmware Version	Read the Display EEPROM Firmware Version as an integer that must be converted to hex to be read as 0000-FFFF representing X.X.X.X.

4.5 Modbus Discrete Inputs

Discrete Inputs are read-only, single bit data fields that are used to provide access to status information. Status is indicated as: 1 is the value ON, and 0 is the value OFF. The Discrete Inputs are read with Function 02(0x02) Read Discrete Inputs.

Note that PLC Addressing (Base 1) is used.

Dec	Hex	Function	Description
1	0x0001	Running Status	Read the Running Status Discrete Input: (0 = stopped, 1 = running).
2	0x0002	Int/Ext Operating Mode	Read the Internal/External Operating Mode Discrete Input: (0 = internal, 1 = external).
3	0x0003	Tank Low	Read the Tank Low Discrete Input: (0 = Not low, 1 = Tank Low).
4	0x0004	Tank Empty	Read the Tank Empty Discrete Input: (0 = Not empty, 1 = Empty).
5	0x0005	Manual Mode	Read the Manual Mode Discrete Input: (0 = Not in manual mode, 1 = In manual mode).
6	0x0006	Analog Mode	Read the Analog Mode Discrete Input: (0 = Not in analog mode, 1 = In analog mode).
7	0x0007	Pulse Mode	Read the Pulse Mode Discrete Input: (0 = Not in pulse mode, 1 = In pulse mode).
8	0x0008	Batch Mode	Read the Batch Mode Discrete Input: (0 = Not in batch mode, 1 = In batch mode).
9	0x0009	Cycle Timer Mode	Read the Cycle Timer Mode Discrete Input: (0 = Not in cycle timer mode, 1 = In cycle timer mode).
10	0x000A	Timed Event Mode	Read the Timed Event Mode Discrete Input: (0 = Not in timed event mode, 1 = In timed event mode).
11	0x000B	100% Mode	Read the 100% Mode Discrete Input: (0 = Not in 100% mode, 1 = In 100% mode).
12	0x000C	Prime Mode	Read the Prime Mode Discrete Input: (0 = Not in prime mode, 1 = In prime mode).
13	0x000D	Slow Mode	Read the Slow Mode Discrete Input: (0 = Not in slow mode, 1 = In slow mode).

14	0x000E	Units	Read the Units Discrete Input: (0 = English, 1 = Metric).
15	0x000F	Pump Calibrated	Read the Pump Calibrated Discrete Input: (0 = Not calibrated, 1 = Calibrated).
16	0x0010	Keypad Locked	Read the Keypad Locked Discrete Input: (0 = unlocked, 1 = locked).
17	0x0011	Digital Output 1	Read the Digital Output 1 Discrete Input: (0 = Unswitched, 1 = Switched).
18	0x0012	Digital Output 2	Read the Digital Output 2 Discrete Input: (0 = Unswitched, 1 = Switched).
19	0x0013	Digital Input 1	Read the Digital Input 1 Discrete Input: (0 = Unswitched, 1 = Switched).
20	0x0014	Digital Input 2	Read the Digital Input 2 Discrete Input: (0 = Unswitched, 1 = Switched).
21	0x0015	Digital Input 3	Read the Digital Input 3 Discrete Input: (0 = Unswitched, 1 = Switched).
22	0x0016	Digital Input 4	Read the Digital Input 4 Discrete Input: (0 = Unswitched, 1 = Switched).
23	0x0017	Home Screen	Read the Home Screen Discrete Input: (0=homescreen not displayed, 1=homescreen displayed).
24	0x0018	Batch Mode Dosing	Read the Batch Mode Dosing Discrete Input: (0=No, 1=Yes).
25	0x0019	Cycle Timer Startup Delay	Read the Cycle Timer Startup Delay Discrete Input: (0=No, 1=Yes).
26	0x001A	Cycle Timer Pump Active	Read the Cycle Timer Pump Active Discrete Input: (0=No, 1=Yes).
27	0x001B	Weekly Timed Event Active	Read the Weekly Timed Event Active Discrete Input: (0=No, 1=Yes).

4.6 Modbus Alarm Discrete Inputs

The Excel® XR Pump Alarms are stored as a separate range of Discrete Inputs. Discrete Inputs are read-only, single bit data fields that are used to provide access to status information. Status is indicated as: 1 is the value ON, and 0 is the value OFF. The Discrete Inputs are read with Function 02(0x02) Read Discrete Inputs.

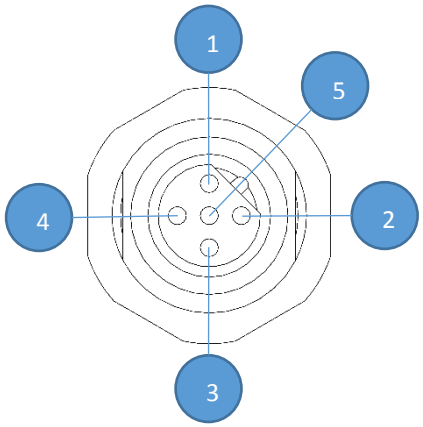
Note that PLC Addressing (Base 1) is used.

Dec	Hex	Function	Description
101	0x0065	Global Alarm	Read the Global Alarm Status:(0 = OFF, 1=ON). The Global Alarm is enabled if there is any alarm condition.
102	0x0066	User Alarm	Read the User Alarm Status: (0 = OFF, 1=ON)
103	0x0067	Tank Empty Alarm	Read the Tank Empty Alarm Status: (0 = OFF, 1=ON).
104	0x0068	Tank Low Alarm	Read the Tank Low Alarm Status: (0 = OFF, 1=ON).
105	0x0069	Internal System Error Alarm	Read the Internal System Error Alarm Status: (0 = OFF, 1=ON).
106	0x006A	Motor Stall Alarm	Read the Motor Stall Alarm Status: (0 = OFF, 1=ON).
107	0x006B	Analog Loss of Signal Alarm	Read the Analog Loss of Signal Alarm Status: (0 = OFF, 1=ON).
108	0x006C	Analog Overrange Alarm	Read the Analog Overrange Alarm Status: (0 = OFF, 1=ON).

109	0x006D	Motor Homing Error Alarm	Read the Motor Homing Error Alarm Status: (0 = OFF, 1=ON).
110	0x006E	Pulse Signal not Present Alarm	Read the Pulse Signal not Present Alarm Status: (0 = OFF, 1=ON).
111	0x006F	Pulse Signal Overrange Alarm	Read the Pulse Signal Overrange Alarm Status: (0 = OFF, 1=ON).

5.0 Cable Wiring

The Excel® XR pump provides a 5-pin Reverse Key Female M12 (B-Code) connector with the following pin-out:



Connector	Pin #	Function
C	1	VP (5 V)
	2	D0 (Negative Data) Signal)
	3	DGND
	4	D1 (Positive Data) Signal)
	5	N/A
	Thread: Shield (earth ground)	

Figure 4: Connector C Pin Diagram

The M12 circular connector conforms to IEC 60947-5-2 or IEC 61076-2-101. The shield of the cable should be connected to protective ground on both sides and with good conductivity. The following parts have been verified:

Description	Manufacturer	Part Number
2 meter cable with M12 Mating connector and Flying Leads	Turck	RSSW 590-2M

6.0 Troubleshooting

PROBLEM	POSSIBLE CAUSE	SOLUTION
Slave not found	1. Incorrect Slave Address	1. Verify the slave address on the pump UI matches the slave address on the master
	2. Improper line termination	2. If the pump is the last slave on the bus, enable the internal line termination or use an external terminating resistor
	3. Incorrect Wiring	3. Verify wiring is correct per Figure 4: Connector C Pin Diagram
	4. Pump not powered	4. Verify the pump is powered on
Pump does not start when commanded via Modbus	1. Homescreen is not displayed on pump	1. Check the pump display and press the X button to return to the homescreen. Alternatively, use Modbus Discrete Input 0x0017 to query whether the homescreen is displayed and set Modbus Coil 0x0005 to force the homescreen to be displayed.
	2. Pump is not in manual mode	2. If the pump is in an external mode or a timed event or timed cycle mode, starting the pump will activate the pump, but the pump will not run unless the external trigger is provided (i.e. pulse, analog input, time of day). Change the pump to manual mode with Modbus Coil 0x0006.

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