LWIFI & LWFIX

Laureate High-Speed Wireless Communications User Manual

LAUREL Electronics, LLC
3183-G Airway Ave, Costa Mesa, CA, 92626, USA
Tel: (714) 434-6131 • Fax: (714) 434-3766 • Website: https://www.laurels.com

1. TABLE OF CONTENTS

1. Table of Contents 2
2. LWIFI & LWIFIX Board Overview 3
3. Board Installation 4
4. Meter Installation & Range Considerations 5
5. Network Setup Utility 6
6. Entry into Instrument Setup (IS) Software 9
7. Data Caching, Data Rates & Read Rates 11
8. Modbus Implementation 12
9. Diagnostic Tool QModMaster 22
10. Specifications 32
11. Warranty 34

2. LWIFI & LWIFIX OVERVIEW

LWIFI and LWIFIX are communication options for Laureate digital panel meters, counters and remote displays (or meters for short). They fit into the middle slot that is reserved for option boards. Both boards operate with the Modbus protocol and can operate at high data rates, as documented in this manual.

LWIFI is a circuit board with an integral WiFi antenna. It is intended for WiFi applications where the meter can be mounted on a benchtop or inside a plastic enclosure that does not block radio waves. It is ideal for communication distances of 30 m (100 ft) or less. It also includes a USB 2.0 port. Use of that port is required for board setup using our Network Setup (NS) utility. That port can also be used for data transfer in parallel with the WiFi data, and for meter programming using our Instrument Setup (IS) software.

LWIFIX is an assembly which consists of a WiFi board, an external antenna, and an antenna cable that is 760 mm (30") long. This assembly is designed for WiFi applications where the meter is mounted inside a metal cabinet that would block radio waves. By using an outside antenna over a ground plane, LWIFIX provides more range than LWIFI. It provides the same USB port as LWIFI for programming and for data transfer.

High data rates are a major advantage of the two WiFi boards compared to legacy Laureate communication boards when used with data polling. The legacy communications boards, which include RS232, RS485, USB and Ethernet, are limited to about 2 updates per second when used in a polling command mode since they only operate at up to 9600 baud and the same 8-bit processor performs multiple operations in sequence. In the two WiFi boards, which are second generation, a more powerful on-board processor polls the meter's microcomputer board at 19200 baud at rates up to 60 readings per sec and stores this data in cache memory. The cached data can then be read asynchronously by an external master every 10 msec at the maximum bit rates allowed by WiFi or USB. Please see the Data Update Rates section of this manual.

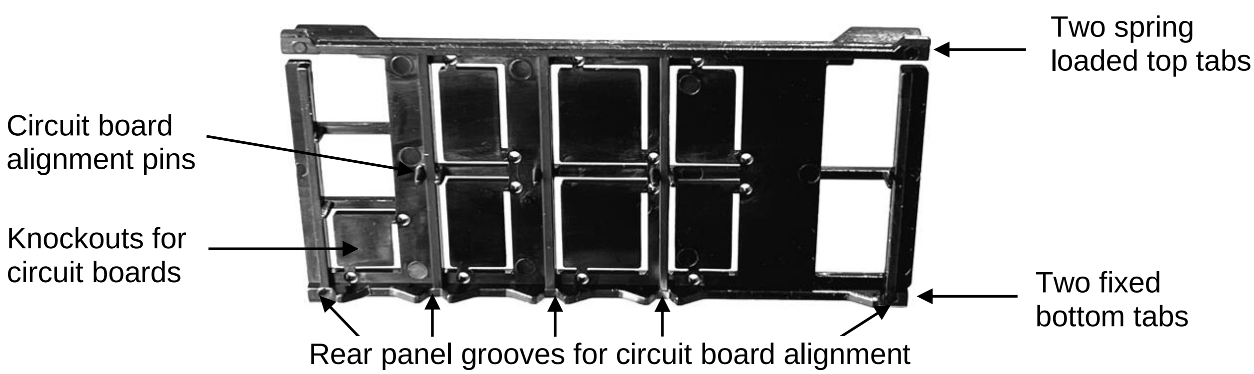
The Modbus protocol is used for all WiFi communications and USB data communications using the WiFi board. That protocol is a master-slave protocol, where a master (typically a PC or PLC) issues commands, and a slave (or instrument) responds to these commands, for example by supplying data. The protocol is named Modbus RTU when used with USB and Modbus TCP/IP when used with WiFi or Ethernet. The command set is the same, as documented in the Modbus Implementation section of this manual. WiFi or Ethernet do not support communications with Laurel's Custom ASCII protocol. However, that robust protocol is used for internal communications between the WiFi board and the microcomputer board of the host meter.

3. LWIFI & LWIFIX BOARD INSTALLATION

The LWIFI or LWFIX boards come installed in the meter when the meter is ordered with communications ordering codes C or D. They can also be installed later by the user by inserting them into the middle backplane slot that is reserved for communications boards. Please see the photo to the right of a meter with a WIFI board in the middle slot. All that is visible is the Mini-USB connector.

Disassembling your meter

To remove the electronics assembly from its case, first remove any connectors. Use a flat blade screwdriver to press down on two spring-loaded tabs at the top of the rear panel to free the panel from slits at the top the case. Then lift up the rear panel to free it from the slits at the bottom. This will unhook the rear panel, and the electronics assembly will slide out.

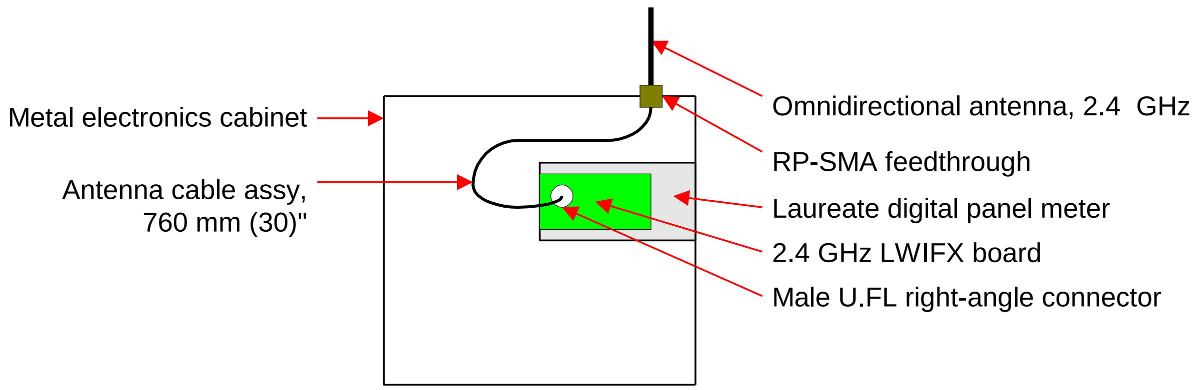


Reassembling your meter

1. Verify that the top and bottom edges of all circuit boards are at the same horizontal level. If boards are inserted one electrical pin off, this may burn out the electronics.
2. Slide the electronics assembly back into the case until the display board is seated flush against the front of the case.
3. Carefully insert the fixed bottom tabs of the rear panel into the bottom of the case, then nudge the circuit boards from side to side with a flat-blade screwdriver until each board is held firmly by an alignment groove in the rear panel. Also note the alignment pins in the middle of the rear panel.
4. Once all boards are held firmly, insert the top tabs of the rear panel into the case.
5. Verify that the installed rear panel is flat. If it is bulging out, if the top tabs cannot be inserted, or if there is no room for connectors, realign the rear panel.
6. Once the rear panel is in place, reinstall the connectors.

4. METER INSTALLATION & RANGE CONSIDERATIONS

A meter with an LWIFI board, which has an integral antenna, needs to be mounted on a benchtop or in a plastic enclosure that is transparent to radio waves. It is ideal for communication distances of 30 m (100 ft) or less. The presence of nearby circuit board traces reduces power radiated by LWIFI by about 10 dB compared LWIFIX.



A meter with an LWIFIX board, which comes with an external antenna and a 760 mm (30") long antenna cable, can be mounted inside a metal cabinet that blocks radio waves. The antenna should be vertical and be mounted on the top surface of the cabinet, which will then act as the antenna's ground plane and help shape an antenna pattern, which is omnidirectional in the horizontal plane. The antenna gain in the horizontal direction is 5 dBi. Also consider using LWFIX, as opposed to LWIFI, since it has about 10 dB higher output.

WiFi range depend on many factors, which include the radiated power and sensitivities not only of the WiFi board but also of the WiFi router. Received radio power on either end is increased by the sum of gains in dB of both antennas. It is decreased by loss in dB of the antenna cable inside the cabinet and most significantly by loss in dB along the radio path. Every -3 dB reduces power by a factor of 2. Every -10 dB reduces power by a factor of 10.

WiFi range can be 90 m (300 ft) with an antenna and an unobstructed line-of-sight connection outdoors, but it is half of that or less indoors. Substantial signal loss is caused by materials like concrete, bricks or plaster that absorb radio waves, and by nearby metal objects that reflect and scatter radio waves. To maximize range, minimize any obstructions between the WiFi router and meter antennas, and maximize antenna heights. If possible, place the WiFi router in a raised, central location to eliminate WiFi dead zones. WiFi range is also reduced by interference from competing 2.4 GHz signals from other WiFi networks, IoT devices, and products like microwave ovens.

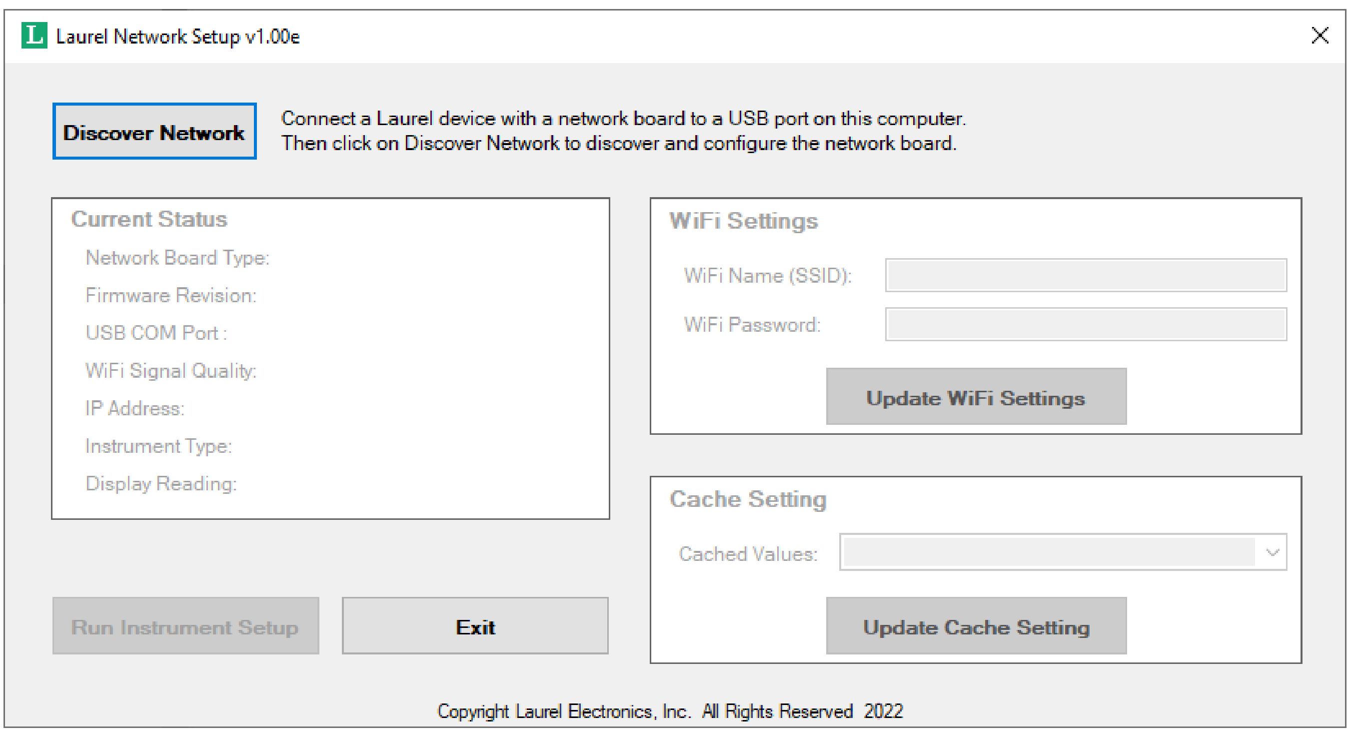
5. NETWORK SETUP UTILITY

Network Setup is a software utility that must be run to set up Laureate LWIFI or LWIFIX boards so that these can work with a specific WiFi network. It allows users to enter the WiFi's SSID and password, which will then be stored in the WiFi board. It automatically discovers the board's IP address assigned by the WiFi router, the COM port used for USB communications, the meter type, and the signal conditioner type.

To install, download the compressed file NetworkSetup_1_00.exe (500 kB) from Laurel's software downloads web page or click here. Copy the downloaded file into a directory of your choice and double click on the file name. This will unzip the compressed file into the files below. At the virus warning, click on "More info" then on "Run anyway." If you are installing a newer version, first use Windows to uninstall the older version. To install, click on setup.exe.

Name	Date modified	Type	Size
Application Files	3/8/2022 5:01 AM	File folder	
NetworkSetup.application	3/8/2022 5:01 AM	Application Manifest	6 KB
NetworkSetup_1_00.exe	3/8/2022 9:56 AM	Application	520 KB
setup.exe	3/8/2022 5:01 AM	Application	541 KB

You will be presented with the "Discover Network" screen below:

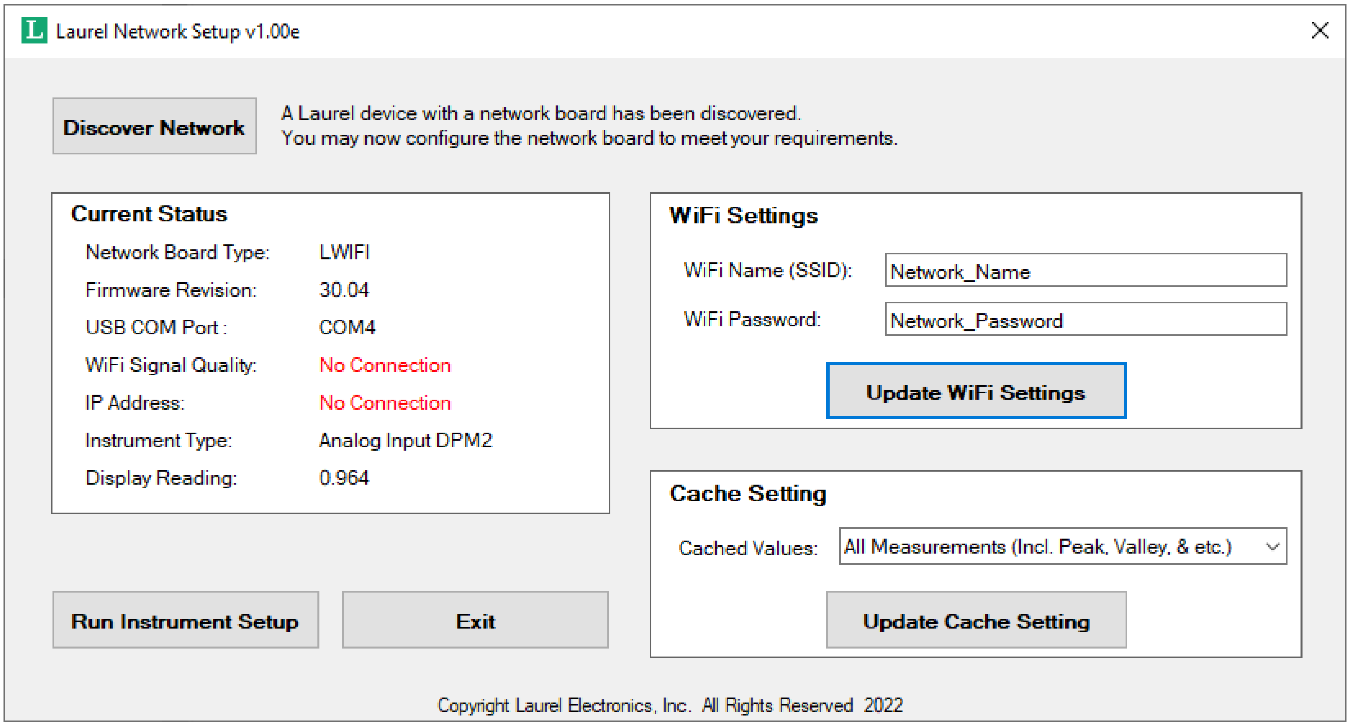


Before "Discover Network" can be executed, you must connect your meter with the LWIFI or LWIFIX board to the USB port of your PC with a USB cable like our cable CBL07, and also set up communications of your Laureate meter to the following:

19200 baud, Custom ASCII protocol, no parity, 8 data bits, 1 stop bit (N81), address 1. To do so, enter these settings from the meter front panel:

SEr 1: 160	SEr 2: 0111
SEr 3: 00000	SEr 4: 000

Click on "Discover Network." After about 10 seconds, the screen below will appear:

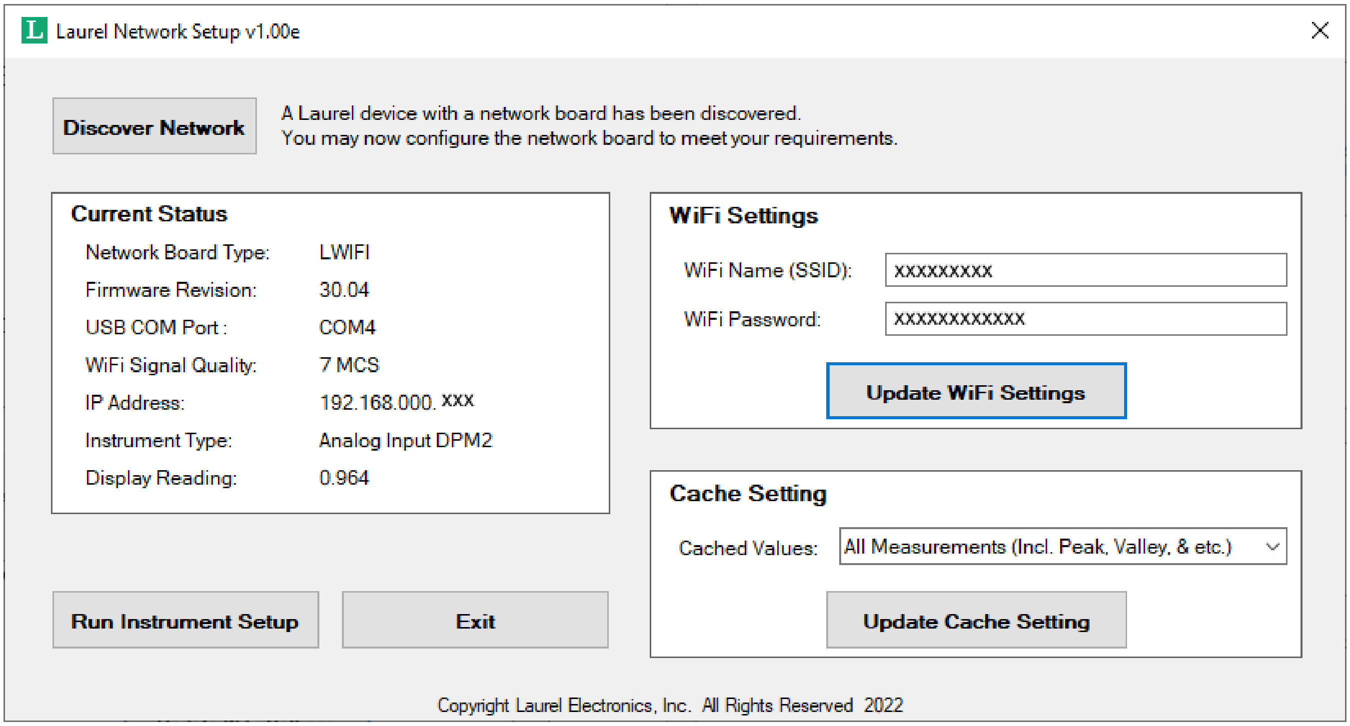


Current Status

The above screen shows that the Network Setup utility has discovered the Network Board Type, the board's Firmware Revision, the USB COM Port, the Instrument Type, and the meter's Display Reading. All this is via the USB connection. At this point the board is ready to communicate with the outside world at 38400 baud using the discovered COM port. The "WiFi Signal Quality" and "IP address" are still shown as "No Connection" because there is yet no WiFi connection.

WiFi Settings

To connect to your WiFi network, replace "Network_Name" with the name of your WiFi network, and replace "Network_Password" with the password of your WiFi network. Then click on "Update WiFi Settings." After about 10 seconds, the screen below will appear. The WiFi Signal Quality and the IP Address of your WiFi board as assigned by the WiFi router will then be displayed, indicating that your meter is now on the WiFi network. In the example shown, a WiFi Signal Quality of 7 MCS indicates a WiFi data rate of 72.2 Mbits/sec.



Cache Setting

Select "Displayed Measurement Only" to cause the WiFi board to only retrieve the latest reading, called "display value," from the host meter into cache.

Select "All Measurements" to cause WiFi board to retrieve 6 values from the host meter into cache. The 6 values depend on the meter type:

- Analog input meter (model numbers starting with L1-L4):
  alarm status, display value, peak value, valley value, display value, display value.
- Scale/weight meter (model numbers starting with LW):
  alarm status, display value, peak value, net value, gross value, display value.
- Counter/timer (model numbers starting with L5-L8):
  alarm status, display (item 1) value, peak value, valley value, item 2 value, item 3 value.

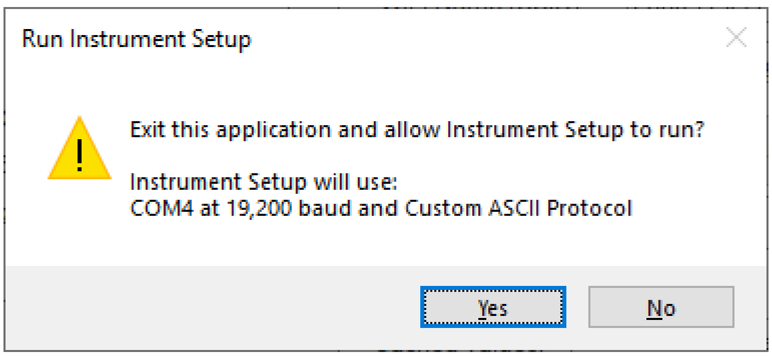
Alarm and overload status are contained in the lower 5 bits of holding registers 7000 and 7800. If a bit is set to 1, the alarm or overload condition exists. If a bit is set to 0, the condition does not exist. Bit 1 is the least significant (or right-most) bit.

- Bit 5 indicates signal overload, like 21V being applied to the 20V range.
- Bit 4 indicates an alarm condition on alarm 4.
- Bit 3 indicates an alarm condition on alarm 3.
- Bit 2 indicates an alarm condition on alarm 2.
- Bit 1 indicates an alarm condition on alarm 1.

6. ENTRY INTO INSTRUMENT SETUP (IS) SOFTWARE

Instrument Setup (IS) software is a PC based Windows graphical user interface (GUI) with pull-down menus that can be used as an alternative to front panel programming to set up Laureate panel meters. It is required to program Laureate DIN-rail mounted transmitters. It saves time and avoids human error when multiple meters are to be programmed in the same way. Please see our separate Instrument Setup (IS) Software Manual.

To access IS software through the USB port of a WiFi board, you must first run the Network Setup (NS) utility and click on the “Run Instrument Setup” button at the bottom of the “Laurel Network Setup” screen, or you cannot establish communications. You will be prompted to exit the Network Setup (NS) utility. Click on “Yes” to do so.



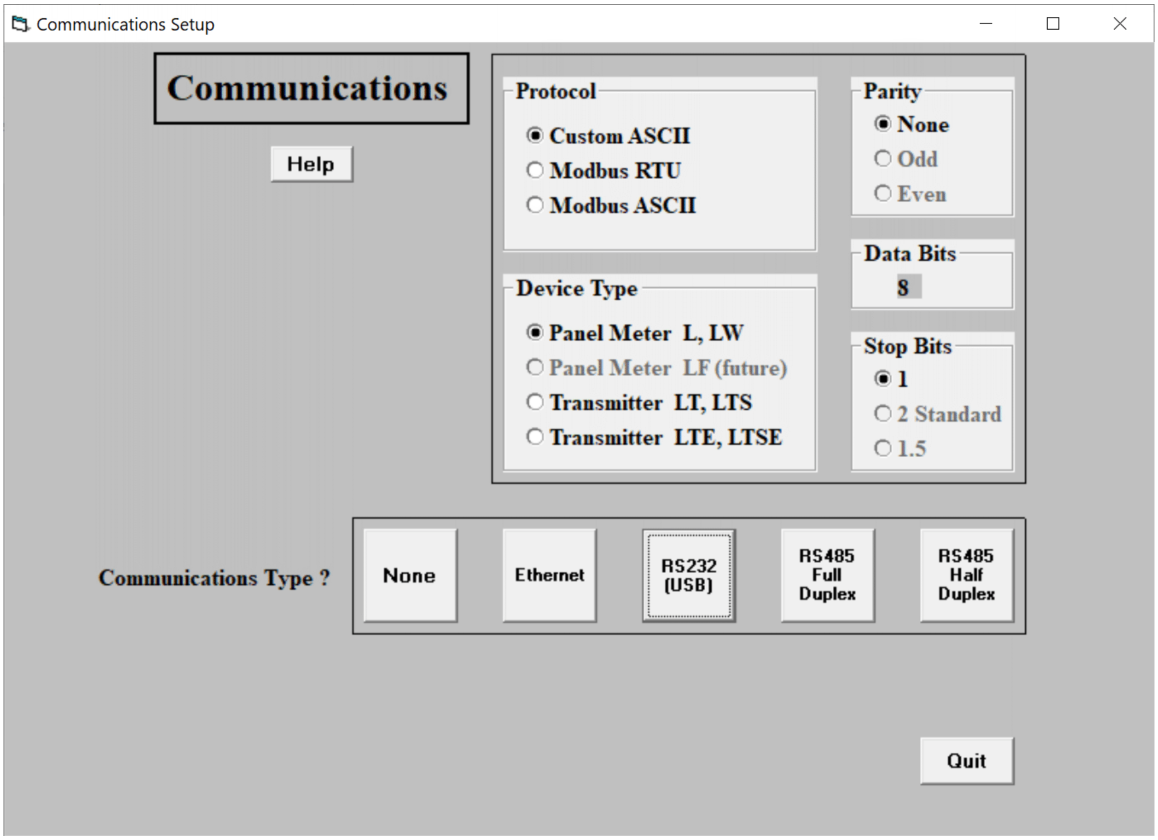
IS software will present Communications Setup screen. Select “Custom ASCII” as the Protocol and “Panel Meter L, LW” as the Device Type, then click on “RS232 (USB)” for Communications Type, since you IS software communications will be via USB.

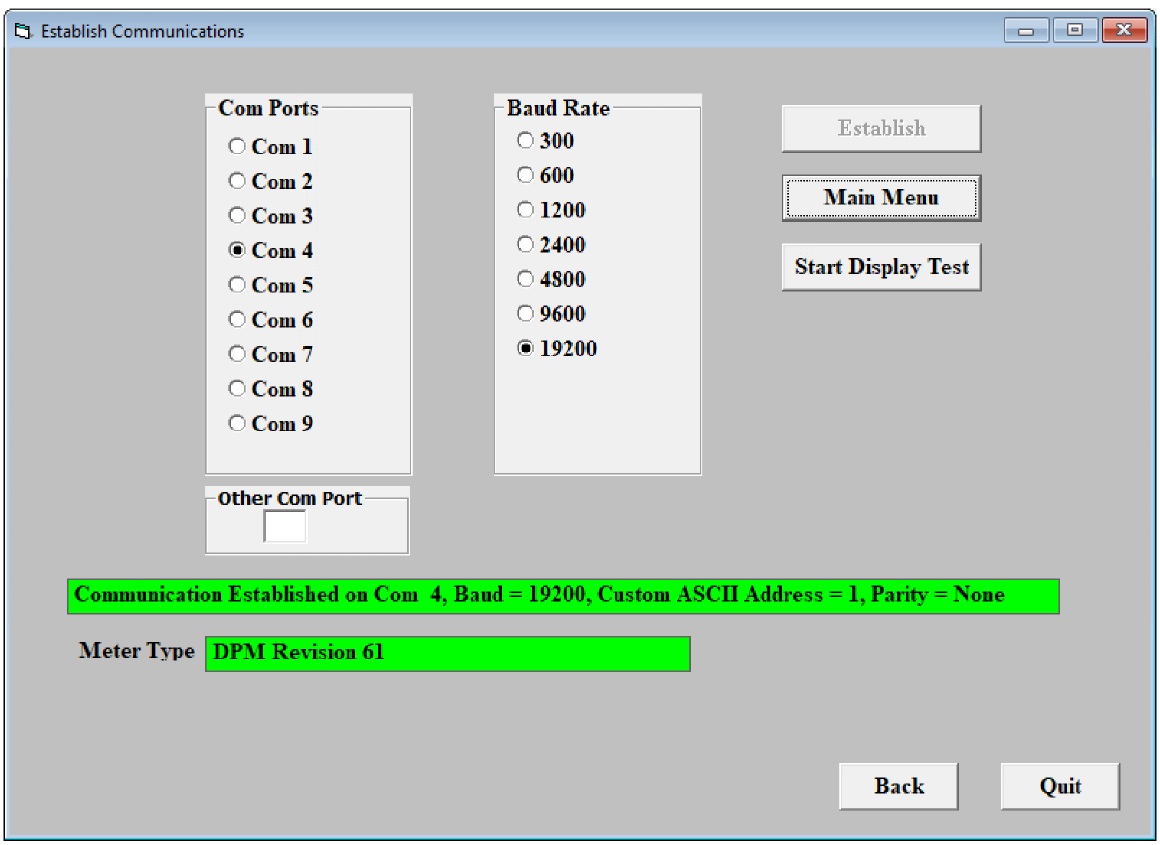
In the resulting Establish Communications screen, select the COM port discovered by the Network Setup utility and 19200 baud, then click on Establish. After you see “Communications Established,” click on “Main Menu” to enter the main section of IS software.

From the Main Menu, click on DPM or Counter in the top menu bard, and click on “Get Setup” to upload the setup data in the meter to IS software. Click on “View Setup” to view that Setup using IS software. You can then change meter settings. When done, click on “Put Setup” to download your changes into your meter.

Do not change anything under the Communication tab of IS software. USB communications outside of IS software will always use the Modbus protocol, address 1, and 38400 baud. WiFi communications will also use the Modbus but at much higher data rates.

If you need to reenter the Network Setup utility after running IS software, cycle power to your meter, or the Network Setup utility will display the message “No Network Board Found.”


Communications Setup
Communications
Help
Protocol
Custom ASCII
Modbus RTU
Modbus ASCII
Parity
None
Odd
Even
Data Bits
8
Device Type
Panel Meter L, LW
Panel Meter LF (future)
Transmitter LT, LTS
Transmitter LTE, LTSE
Stop Bits
1
2 Standard
1.5
Communications Type ?
None
Ethernet
RS232 (USB)
RS485 Full Duplex
RS485 Half Duplex
Quit


Establish Communications
Com Ports
Com 1
Com 2
Com 3
Com 4
Com 5
Com 6
Com 7
Com 8
Com 9
Baud Rate
300
600
1200
2400
4800
9600
19200
Establish
Main Menu
Start Display Test
Other Com Port
Communication Established on Com 4, Baud = 19200, Custom ASCII Address = 1, Parity = None
Meter Type
DPM Revision 61
Back
Quit

7. DATA CACHING, DATA RATES & READ RATES

Cached operation is a key feature of LWIFI and LWIFIX boards. Using the Custom ASCII protocol at 19200 baud and address 1, these boards poll the host meter every **16.666 msec**, except when the host meter is an analog input meter or a scale/weight meter programmed for 50 Hz noise rejection, in which case data is polled every **20.000 msec**. The latest values are written into cache. Using the Modbus protocol, an external Modbus Master can then read the cached data as fast as every **10 msec**.

These time intervals apply regardless of the meter's display update rate, and whether the meter is an analog input DPM or weight/scale meter, or a pulse input counter/timer. If the "Cache Setting" is set to "Displayed Measurement Only," the meter's single displayed value is written into cache every **16.666 msec** or **20.000 msec**. If the "Cache Setting" is set to "All Measurements," a set of 6 values is written into cache every **100 msec** or **120 msec**.

Data can be read from cache by an external Modbus Master as fast as every 10 msec whether the "Cache Setting" is set to "Displayed Measurement Only" for a single value or to "All Measurements" for a set of 6 values. WiFi data rates can be up to 72.2 Mbits/sec. USB data rates are fixed at 38400 baud for Modbus operation.

The fastest rate at which updated values can be read via Modbus is paced by the measurement intervals of the meter. Unchanged values are read by the external Modbus Master when data is read from cache at a rate faster than that at which readings are updated into cache.

Measurement intervals for an analog input meter (model numbers starting with L1-L4 or LW) are every 16.666 msec or 20.000 msec, depending on the meter's 60 Hz or 50 Hz noise rejection setting. Each 17^{th} interval is used to zero the meter, so that the measurement is then not updated. For counters (model numbers starting with L5-L8) used in totalizing mode, the measurement interval (or display update interval) is a gate time which can be user programmed from 10 msec to 199.99 sec. For counters used in frequency/rate mode, the measurement interval (or display update interval) is gate time + 30 msec + 1-2 signal periods.

Internal communications between the LWIFI and LWFIX boards and the host meter use the Custom ASCII protocol, 19200 baud and address 1. These parameters need to be entered into the meter from its front panel for setup using Instrument Setup (IS) software.

USB communications between an LWIFI or LWFIX board and an external Modbus Master use the Modbus RTU protocol, 38400 baud and address 1. These parameters cannot be changed and cannot be read by Instrument Setup (IS) software.

WiFi communications between an LWIFI or LWFIX board and an external Modbus Master use the Modbus TCP protocol at a baud rate allowed by IEEE 802.11 b/g/n. Addressing uses an IP address assigned by the WiFi router and discovered by our Network Setup utility.

8. MODBUS IMPLEMENTATION

1. Modbus Protocol Overview

The Modbus protocol is used with LWIFI and LWIFIX boards, not the Custom ASCII protocol or Ethernet/IP protocol. The same Modbus function codes and registers apply to Modbus TCP, which is used with WiFi, and to Modbus RTU, which is used with USB. The Modbus protocol implementation described in this manual is simpler than that for Laurel's legacy communication boards.

Modbus is a master/slave protocol, where a master writes data to a slave's registers and reads data from a slave's registers. A register is a memory location. A master is a device like a PC or PLC that initiates requests. A slave is typically an instrument, like a Laurel meter, that responds to requests. A slave cannot initiate requests. Each slave that is addressed over an Ethernet or WiFi network has an IP address and will only respond if addressed. A slave that is connected via USB has address 1 since USB is not designed for multipoint addressing.

- **A Holding Register** is a 16-bit memory location that may be read or written. If a 32-bit value is to be held in Holding Registers, two 16-bit register addresses must be specified.
- **A Coil** is a 1-bit memory location that is used to control a specific outcome. It may be read or written.
- **An Input Register** is a 16-bit register that may only be read.

Decimal memory addresses are stated in this manual, not hexadecimal. Use an online tool to switch from decimal to hexadecimal if required.

Base 1 memory addresses are stated in this manual, not Base 0. With Base 1, numbering starts with 1, not 0. To switch from Base 1 to Base 0, add 1 to the address.

A Function Code specifies the type of register. The following Function Codes are described in this manual:

- **FC01** is used to read multiple 1-bit coils.
- **FC03** is used to read multiple16-bit holding registers.
- **FC04** is used to read multiple 16-bit input registers.
- **FC05** is used to write to a single 1-bit coil.
- **FC0F** is used to write to multiple 1-bit coils.
- **FC06** is used to write to a single 16-bit holding register.
- **FC10** is used to write to multiple 16-bit holding registers.

Signed integers in two's complement format are binary numbers where the most significant (or leftmost) bit represents a minus sign when it is a 1. See Wikipedia for a more detailed description.

2. Reading the Display Value with Cached "Displayed Measurement Only"

If the Network Setup utility is set to cache "Displayed Measurement Only," the cached meter reading will be available for retrieval via Modbus every 10 msec.

Use the table below if the reading is desired as a 32-bit signed two's complement integers with a separately read decimal point.

Funct. Code	Input Register Base 1 Address	Register Contents	Data Format
FC04	0105	Read decimal point position	0001 = xxxxxx. 0002 = xxxxx.x 0003 = xxxx.xx 0004 = xxx.xxx 0005 = xx.xxxx 0006 = x.xxxxx
FC03	7400-7401	Low address is most significant word. High address is least significant word.	Combine 16-bit words to form a 32-bit integer.

Use the table below applies if the reading is desired as a 32-bit real number in IEEE 754 floating point format.

Funct. Code	Input Register Base 1 Address	Holding Register Contents	Data Format
FC03	8200-8201	Low address is most significant word. High address is least significant word.	Combine 16-bit words to form a 32-bit floating point number.

3. Reading Six Parameters with Cached "All Measurements"

If the Network Setup utility is set to cache "All Measurements," six readings will be available for retrieval via Modbus every 100 msec.

Use the table below if readings are desired as 32-bit signed two's complement integers with a separately read decimal point.

Funct. Code	Input Register Base 1 Address	Register Contents	Data Format
FC04	0105	Read decimal point position	0001 = xxxxxx. 0002 = xxxxx.x 0003 = xxxx.xx 0004 = xxx.xxx 0005 = xx.xxxx 0006 = x.xxxxx
FC03	7000	Alarm and overload status in bits 1-5: - - - - - - - - - - - 5 4 3 2 1	Bit 1 = Alarm 1 Bit 2 = Alarm 2 Bit 3 = Alarm 3 Bit 4 = Alarm 4 Bit 5 = Overload
FC03	7002-7003	Display measurement value	Low address is most significant word. High address is least significant word. Combine 16-bit words to form a 32-bit integer.
FC03	7004-7005	Peak Value	
FC03	7006-7007	Valley value for analog DPMs. Net weight for scale meters. Valley for counter/timers.	
FC03	7008-7009	Display value for analog DPMs. Gross weight for scale meters. Item 2 for counter/timers.	
FC03	7010-7011	Display value for analog DPMs. Display value for scale meters. Item 3 for counter/timers.	

Use the table below applies if readings are desired as 32-bit real numbers in IEEE 754 floating point format.

Funct. Code	Input Register Base 1 Address	Holding Register Contents	Data Format
FC03	7800	Alarm and overload status in bits 1-5: - - - - - - - - - - - 5 4 3 2 1	Bit 1 = Alarm 1 Bit 2 = Alarm 2 Bit 3 = Alarm 3 Bit 4 = Alarm 4 Bit 5 = Overload
FC03	7802-7803	Display measurement value	Low address is most significant word. High address is least significant word. Combine 16-bit words to form a 32-bit floating point number.
FC03	7804-7805	Peak Value	
FC03	7806-7807	Valley value for analog DPMs. Net weight for scale meters. Valley for counter/timers.	
FC03	7808-7809	Display value for analog DPMs. Gross weight for scale meters. Item 2 for counter/timers.	
FC03	7810-7811	Display value for analog DPMs. Display value for scale meters. Item 3 for counter/timers.	

4. Reading and Writing DPM Relay Setpoints, Scale and Offset

Use the table below to read or write these Holding Registers. Use Function Code FC03 to read, and Functions codes FC06 or FC10 to write. Any read or write involving these registers will cause the meter to reset.

Input Register Base 1 Address	Holding Register Contents	Data Format
0502-0503	Setpoint 1 value	Low address is most significant word. High address is least significant word. Combine 16-bit words to form a 32-bit signed integer in 2’s complement format.
0504-0505	Setpoint 2 value	
0506-0507	Setpoint 3 value	
0508-0509	Setpoint 4 value	
0510-0511	Scale factor value	
0512 & 0517	Offset value	

5. Reading and Writing to Coils

Coils are 1-bit memory addresses that are used to control specific outcomes. They may be read or written. Use Function Code FC01 to read. Use Function Codes FC05 or FC0F to write. Any write involving these coils will cause the meter to reset.

Analog input DPM & Scale/Weight Meter	Coil #
Cold reset	1
Latched alarms reset	3 (Coil # 2 is skipped)
Peak value reset	4
Remote display reset	5
External Input B true	6
External Input B false	7
External Input A true	8
External Input A false	9
Valley reset	10
Tare function	11
Tare reset	12

Pulse Input Counter/Timer	Coil #
Cold reset	1
Function reset	2
Latched alarms reset	3
Peak value reset	4
Remote display reset	5
External Input B true	6
External Input B false	7
External Input A true	8
External Input A false	9
Valley value reset	10
Store totals & reset	11

6. Non-Volatile Memory Addresses for Advanced Reading or Writing

Use Function Code FC03 to read and Function Codes FC06 or FC10 to write. Any read or write to these registers causes a meter reset.

<table>
<tr><th></th><th colspan="3">Byte 3</th><th>Byte 2</th><th>Byte 1</th><th></th></tr>
<tr><td>Magnitude (Mag)</td><td colspan="3">XXXX XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td><td rowspan="6">S = Sign
Sign = 1 for negative
DP = 1 for DDDDDD.
DP = 6 for D.DDDDD</td></tr>
<tr><td rowspan="2">Sign + Magnitude
(S+M)</td><td>X</td><td colspan="2">XXX XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td></tr>
<tr><td>S</td><td colspan="4">Magnitude</td></tr>
<tr><td rowspan="2">Sign + DP + Magnitude
(S+DP+M)</td><td>X</td><td>XXX</td><td>XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td></tr>
<tr><td>S</td><td>DP</td><td colspan="3">Magnitude</td></tr>
<tr><td>2’s Complement (2’s C)</td><td colspan="3">XXXX XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td></tr>
</table>

DPM NONVOLATILE MEMORY ADDRESSES (2 bytes/address)

DPM Non-volatile Memory Addresses (2 bytes/address)

Dec Addr	MS Byte	LS Byte	Stored As
617	Setup1	Serial Confg3	Bits
616	Deviation4 Byte 3	Deviation4 Byte 2	Magnitude
615	Deviation4 Byte 1	Deviation3 Byte 3	Magnitude
614	Deviation3 Byte 2	Deviation3 Byte 1	Magnitude
613	Setpoint4 Byte 3	Setpoint4 Byte 2	2's Complement
612	Setpoint4 Byte 1	Setpoint Byte 3	2's Complement
611	Setpoint3 Byte 2	Setpoint3 Byte 1	2's Complement
610	Alarm Cnfg4	Alarm Confg 3	Bits
609	Version (read only)	M Type (read only)	Byte
554	Tare Setup	Analog Type	Bits
558	Serial Cnfg4 (Bits)	Modbus Address (Byte)	
524	Deviation2 Byte 3	Deviation2 Byte 2	Magnitude
523	Deviation2 Byte 1	Deviation1 Byte 3	Magnitude
522	Deviation1 Byte 2	Deviation1 Byte 1	Magnitude
521	Configuration	Sig Cond Type (do not change)	Bits
520	Analog Setup	System Decimal Point	Bits
519	Lockout2	Lockout1	Bits
518	Serial Cnfg2	Serial Cnfg1	Bits
517	Options	Filter	Bits
516	Setup	Input Type	Bits
515	Alarm Cnfg Byte 2	Alarm Cnfg1	Bits
514	Analog High Byte 3	Analog High Byte 2	2's Complement
513	Analog High Byte 1	Analog Low Byte 3	2's Complement
512	Analog Low Byte 2	Analog Low Byte 1	2's Complement
511	High Read Byte 3	High Read Byte 2	2's Complement
510	High Read Byte 1	High In Byte 3	2's Complement
509	High In Byte 2	High In Byte 1	2's Complement
508	Low Read Byte 3	Low Read Byte 2	2's Complement
507	Low Read Byte 1	Low In Byte 3	2's Complement
506	Low In Byte 2	Low In Byte 1	2's Complement
505	Offset Byte 3	Offset Byte 2	2's Complement
504	Offset1 (2's Comp)	Scale Factor3 (Sign+DP+Mag)	
503	Scale Factor2	Scale Factor1	Sign+DP+Mag
502	Setpoint2 Byte 3	Setpoint2 Byte 2	2's Complement
501	Setpoint2 Byte 1	Setpoint1 Byte 3	2's Complement
500	Setpoint1 Byte 2	Setpoint1 Byte 1	2's Complement

Counter/Timer Non-volatile Memory Addresses (2 bytes/address)

Dec Addr	MS Byte of NV RAM	Stored As	LS Byte of NV RAM	Stored As
616	Deviation4 Byte 3	Mag	Deviation4 Byte 2	Mag
615	Deviation4 Byte 1	Mag	Deviation3 Byte 3	Mag
614	Deviation3 Byte 2	Mag	Deviation3 Byte 1	Mag
613	Setpoint4 Byte 3	2's C	Setpoint4 Byte 2	2's C
612	Setpoint4 Byte 1	2's C	Setpoint3 Byte 3	2's C
611	Setpoint3 Byte 2	2's C	Setpoint3 Byte 1	2's C
610	Alarm Confg4	Bits	Alarm Confg3	Bits
609	Version (read only)	Byte	M Type (read only)	Byte
608	T Stop	Byte	T Start	Byte
607	R Show	Byte	R Skip	Byte
606	R Stop	Byte	R Start	Byte
553	Analog High2 Byte 3	2's C	Analog High2 Byte 2	2's C
552	Analog High2 Byte 1	2's C	Analog Low2 Byte 3	2's C
551	Analog Low3 Byte 2	2's C	Analog Low2 Byte 1	2's C
550	Serial Confg4	Bits	Modbus Address	Byte
548	Total A Byte 6	Mag	Total A Byte 5	Mag
548	Total A Byte 4	Mag	Total A Byte 3	Mag
547	Total A Byte 2	Mag	Total A Byte 1	Mag
546	Total B Byte 6	Mag	Total B Byte 5	Mag
545	Total B Byte 4	Mag	Total B Byte 3	Mag
544	Total B Byte 2	Mag	Total B Byte 1	Mag
542	Do not use	---	Analog Type	Bits
541	Cutoff Byte 2	Mag	Cutoff Byte 1	Mag
540	Recog Character	Byte	System Decimal Point	Bits
539	Do not use	Bits	Resolution	Bits
538	Display Item	Bits	Slope	Bits
537	Pulses Byte 2	Mag	Pulses Byte 1	Mag
536	Scale Multiplier	Bits	Analog Output Setup	Bits
535	Source	Bits	Batch	Bits
534	Timeout Byte 2	Mag	Timeout Byte 1	Mag
533	Gate Time Byte 2	Mag	Gate Time Byte 1	Mag
532	Lockout2	Bits	Lockout1	Bits
531	Config	Bits	Serial Config3	Bits
530	Serial Config2	Bits	Serial Config1	Bits
529	Options	Bits	Filter	Bits
528	Setup	Bits	Input Type	Bits
527	Alarm Config 2	Bits	Alarm Config1	Bits
526	Analog High Byte 3	2's C	Analog High Byte 2	2's C

525	Analog High Byte 1	2's C	Analog Low Byte 3	2's C
524	Analog Low Byte 2	2's C	Analog Low Byte 1	2's C
523	Deviation 2 Byte 3	Mag	Deviation2 Byte 2	Mag
522	Deviation 2 Byte 1	Mag	Deviation1 Byte 3	Mag
521	Deviation 1 Byte 2	Mag	Deviation1 Byte 1	Mag
520	Offset2 Byte 3	2's C	Offset2 Byte 2	2's C
519	Offset2 Byte 1	2's C	Scale2 Byte 3	S+M
518	Scale2 Byte 2	S+M	Scale2 Byte 1	S+M
517	Offset1 Byte 3	2's C	Offset1 Byte 2	2's C
516	Offset1 Byte 1	2's C	Scale1 Byte 3	S+M
515	Scale1 Byte 2	S+M	Scale1 Byte 1	S+M
514	Setpoint2 Byte 3	2's C	Setpoint2 Byte 2	2's C
513	Setpoint2 Byte 1	2's C	Setpoint1 Byte 3	2's C
512	Setpoint1 Byte 2	2's C	Setpoint1 Byte 1	2's C
511	High Read2 Byte 3	2's C	High Read2 Byte 2	2's C
510	High Read2 Byte 1	2's C	High In2 Byte 3	S+DP+M
509	High In2 Byte 2	S+DP+M 2's	High In2 Byte 1	S+DP+M
508	Low Read2 Byte 3	C	Low Read2 Byte 2	2's C
507	Low Read2 Byte 1	2's C	Low In2 Byte 3	S+DP+M
506	Low In2 Byte 2	S+DP+M 2's	Low In2 Byte 1	S+DP+M
505	High Read1 Byte 3	C	High Read1 Byte 2	2's C
504	High Read1 Byte 1	2's C	High In1 Byte 3	S+DP+M
503	High In1 Byte 2	S+DP+M	High In1 Byte 1	S+DP+M
502	Low Read1 Byte 3	2's C	Low Read1 Byte 2	2's C
501	Low Read1 Byte 1	2's C	Low In1 Byte 3	S+DP+M
500	Low In1 Byte 2	S+DP+M	Low In1 Byte 1	S+DP+M

Scale/Weight Meter Non-volatile Memory Addresses (2 bytes/address)

Dec Address	MS Byte	LS Byte
529	Tare3	Tare2
528	Tare1	Spare
527	Serial Cnfg 3	Count
524	Setpoint2 Diff 3	Setpoint2 Diff 2
523	Setpoint2 Diff 1	Setpoint1 Diff 3
522	Setpoint1 Diff 2	Setpoint1 Diff 1
521	Configuration	Signal Conditioner Type (do not change)
520	Analog Setup	System Decimal Point
519	Lockout 2	Lockout 1
518	Serial Cnfg 2	Serial Cnfg 1
517	Options	Filter
516	Setup	Input Type
515	Alarm Cnfg 2	Alarm Cnfg 1
514	Analog High 3	Analog High 2
513	Analog High 1	Analog Low 3
512	Analog Low 2	Analog Low 1
511	High Reading 3	High Reading 2
510	High Reading 1	High Input 3
509	High Input 2	High Input 1
508	Low Reading 3	Low Reading 2
507	Low Reading 1	Low Input 3
506	Low Input 2	Low Input 1
505	Offset 3	Offset 2
504	Offset 1	Scale Factor 3
503	Scale Factor 2	Scale Factor 1
502	Setpoint2 3	Setpoint2 2
501	Setpoint2 1	Setpoint1 3
500	Setpoint 1 2	Setpoint1 1
553	Serial Cnfg 4	Modbus Address
554	Spare	Analog Output Type

9. DIAGNOSTIC TOOL QMODMASTER

1. About QModMaster

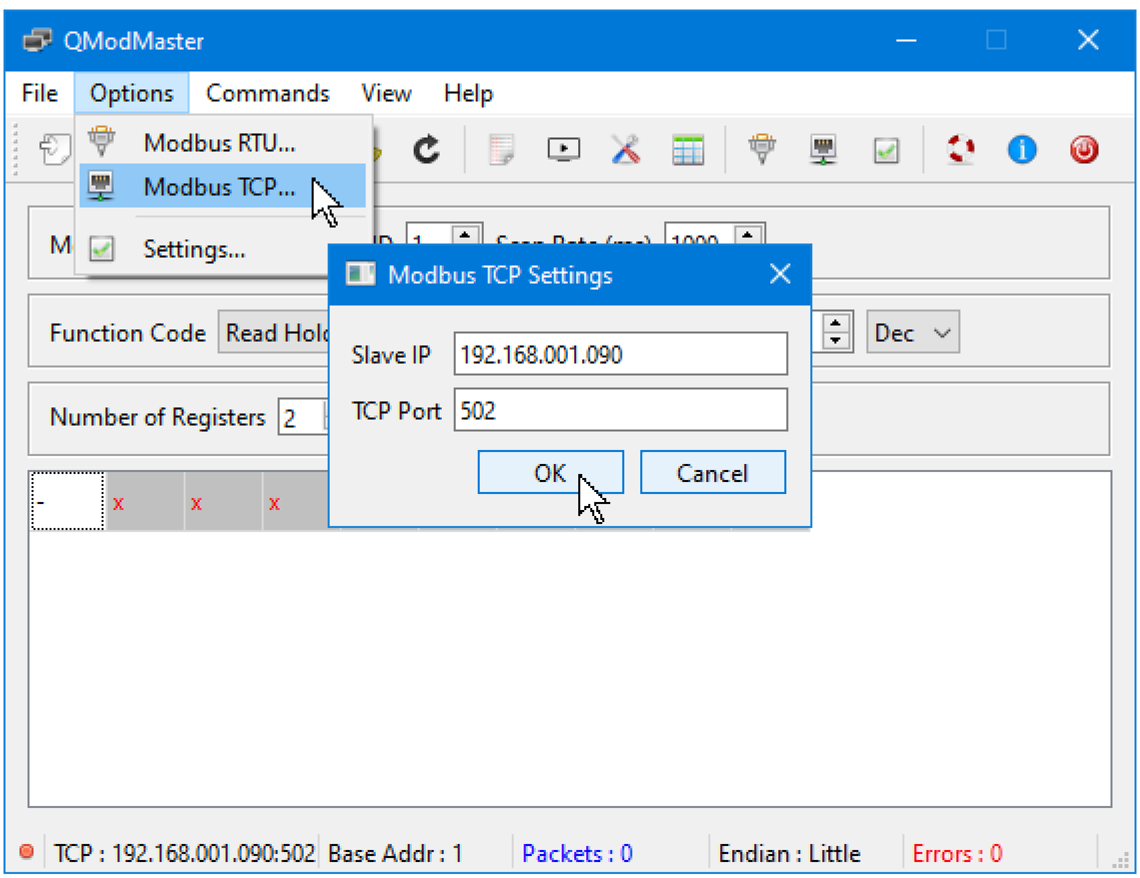
QModMaster.exe is a freeware Windows program which allows a PC to serve as a Modbus Master. It is an easy tool to verify communications, send requests to Modbus Slaves, and view their responses. The current version handles Base 1 and allows the viewing of IEEE 754 floating point values.

2. QModMaster Download and Launch

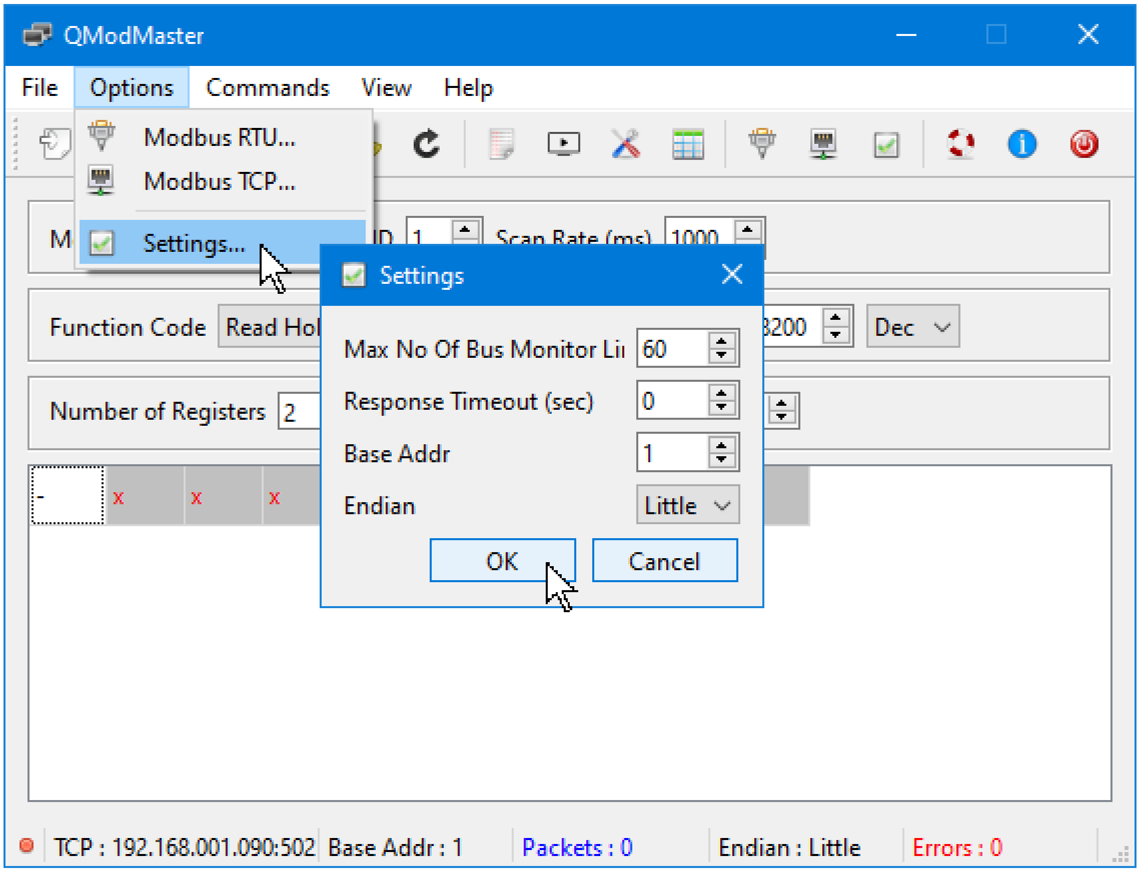
Download QModMaster-Win64-exe-0.5.3-beta.zip from https://sourceforge.net/projects/qmodmaster/files/latest/download and copy it into a directory of your choice. Do an “Extract All” to unzip it. The executable file will be QModMaster.exe. Click on it to launch QModMaster. You may wish to create a shortcut to that file.

3. QModMaster Configuration

a. The first step is to click on *Options > Modbus TCP.* In the *Modbus TCP Settings* dialog window, enter the IP address of the LWIFI and click on *OK*.



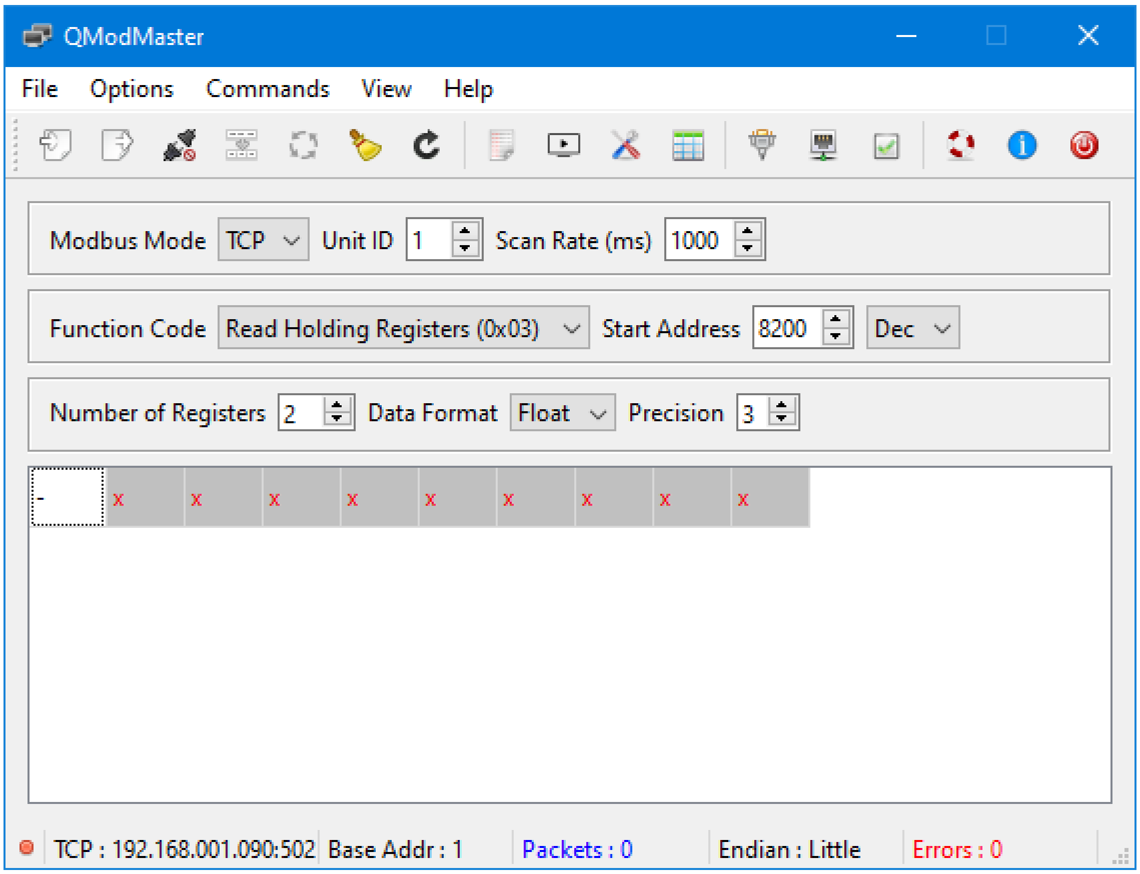
b. The second step is to click on *Options* > *Settings*. In the *Settings* dialog window, ensure that everything is configured as shown and click on *OK*. These are the default settings:



4. Example 1: Obtaining a Floating Point Measurement from a DC Voltmeter

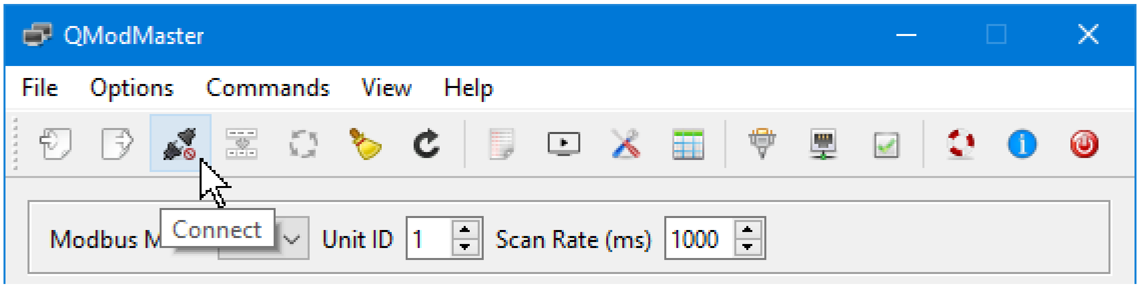
The screen capture below demonstrates the setup to read the currently displayed measurement in floating point format. The critical items are:

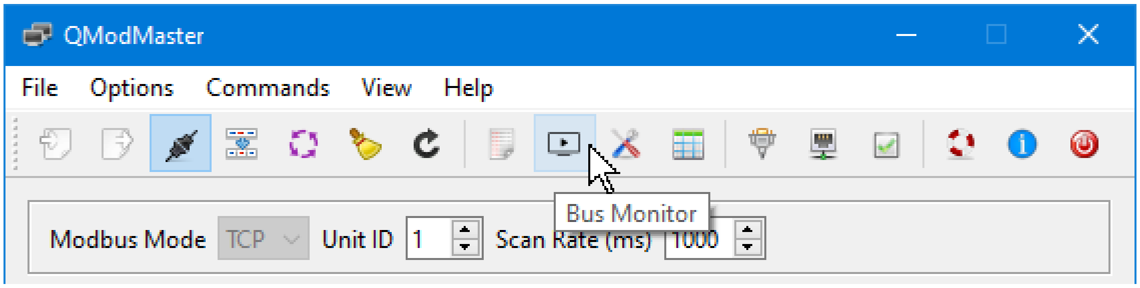
- Modbus Mode = **TCP**
- Function Code = **Read Holding Registers (0x03)**
- Start Address = **8200** (dec)
- Number of Registers = **2**
- Data Format = **Float**

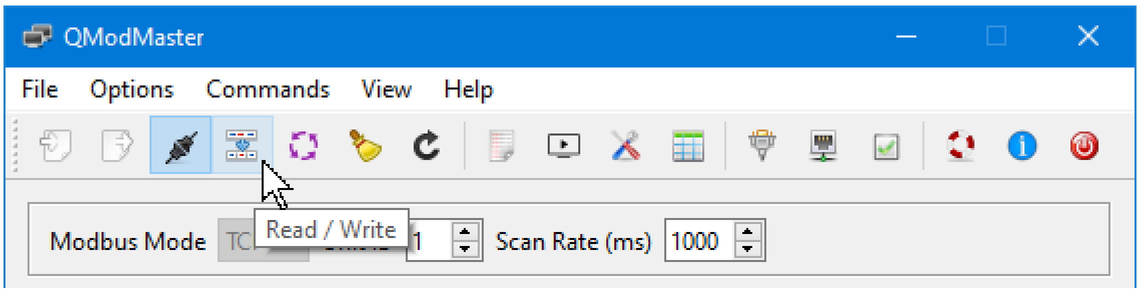


After QModMaster has been set up to read the floating point value:

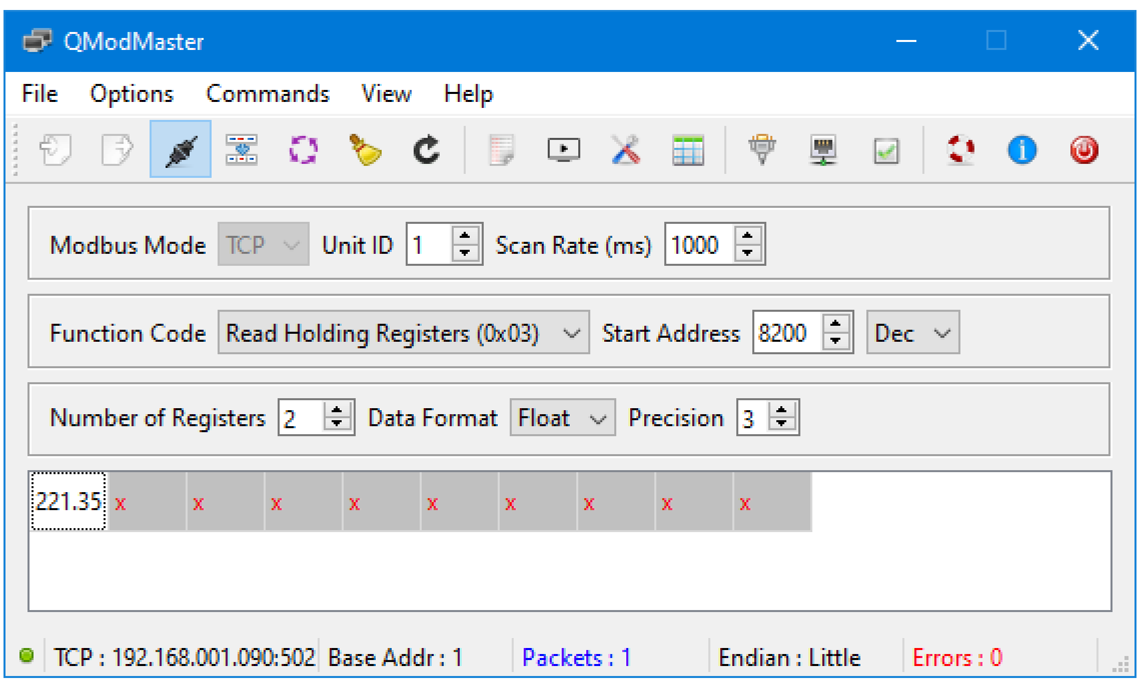
- Click on the **Connect** icon to establish a TCP/IP connection to the LWIFI equipped instrument.
- Click on the **Bus Monitor** icon to view the command/response operation.
- And finally, click on the **Read/Write** icon to perform the operation.



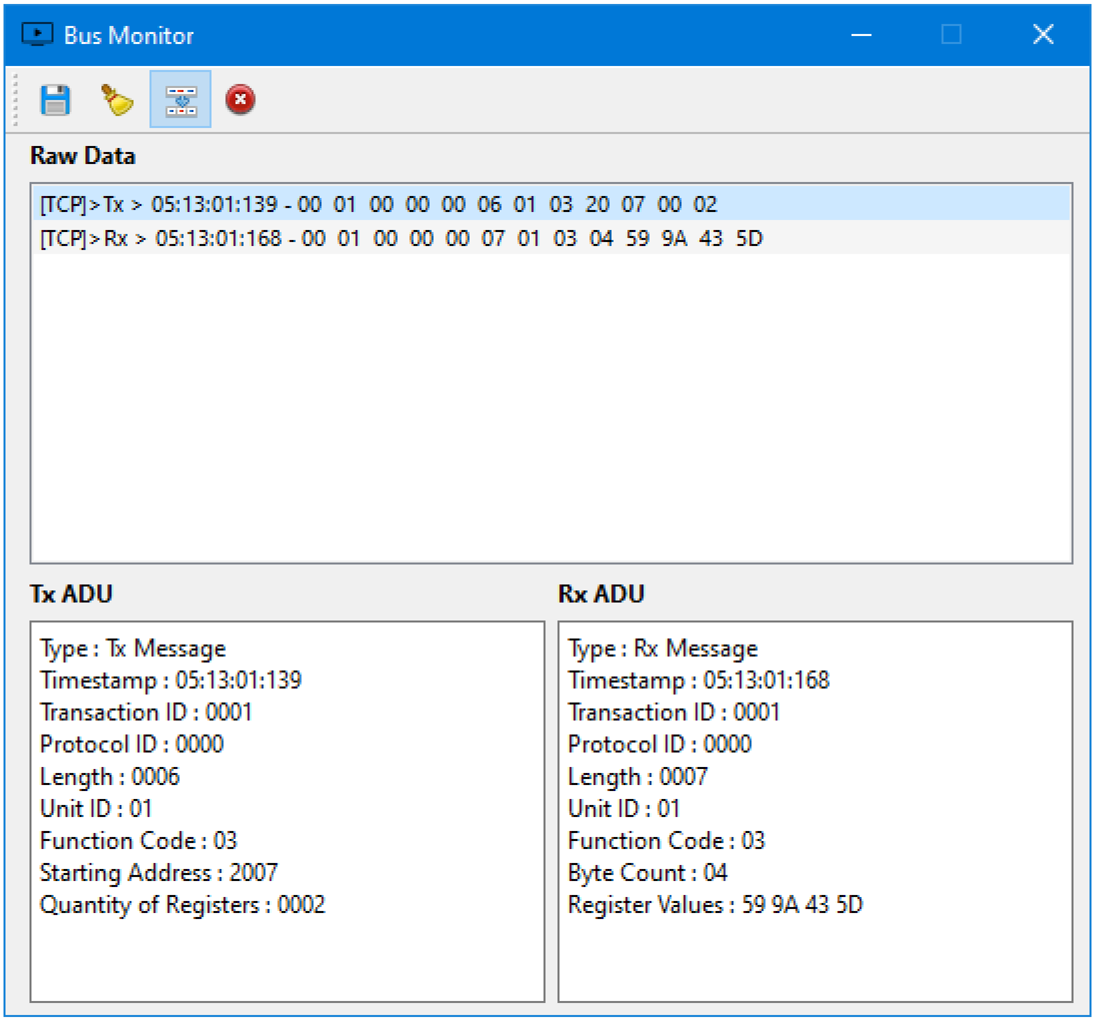




The instrument's displayed value of 221.35 is read and presented in the main QModMaster window. The values in holding registers 8200 and 8201 are combined to form a 32-bit value and are displayed in floating point format.



The QModMaster Bus Monitor window below presents the Modbus Command transmitted to the LWIFI and its response. Note that the hexadecimal values of **59 9A 43 5D** represent the value in IEEE 754 floating point format (little endian). See Wikipedia for a condensed description of IEEE 754.



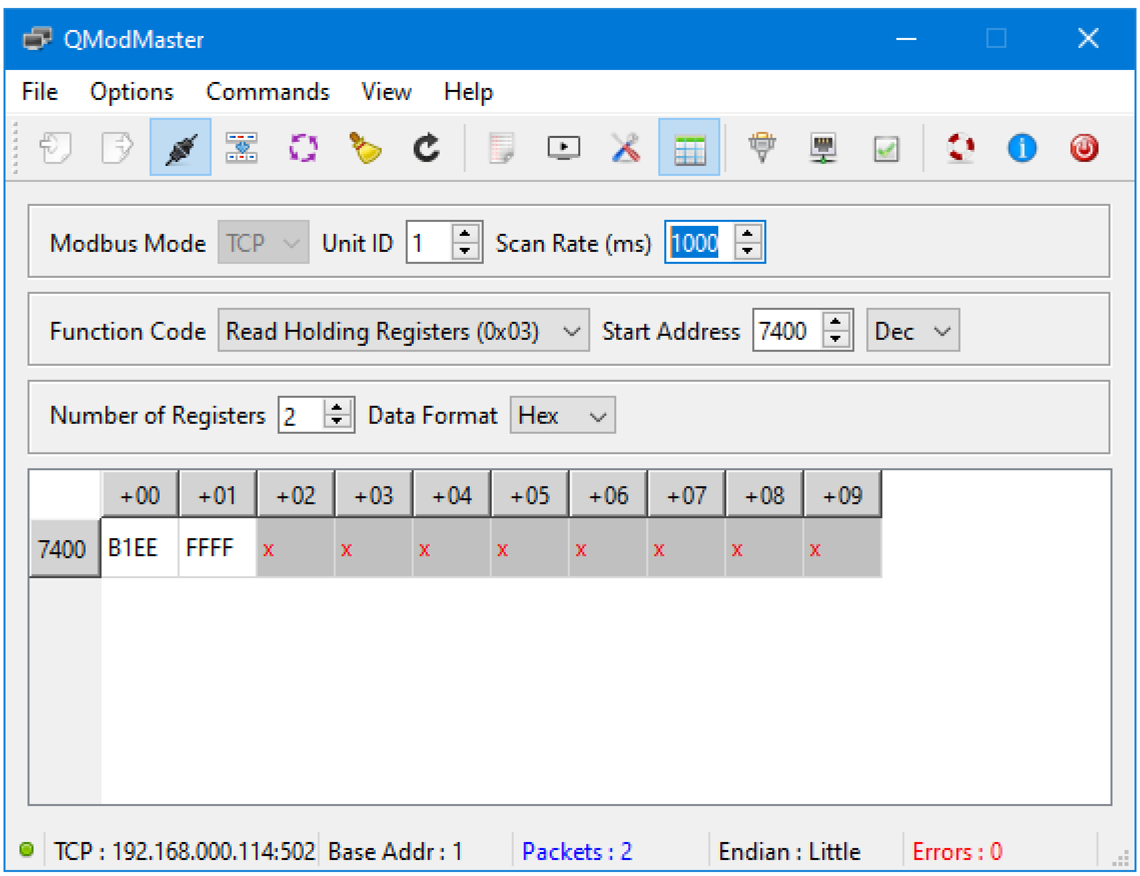
5. Example 2: Obtaining a Signed Integer Measurement from a DC Voltmeter

This example uses a Modbus command to read the currently displayed signed integer value from an LWIFI equipped DC voltmeter. The TCP configuration of QModMaster is the same as for the previous example. In this case, the instrument is displaying -199.86. The screen capture below shows the main window of QModMaster which is setup to read the displayed integer value.

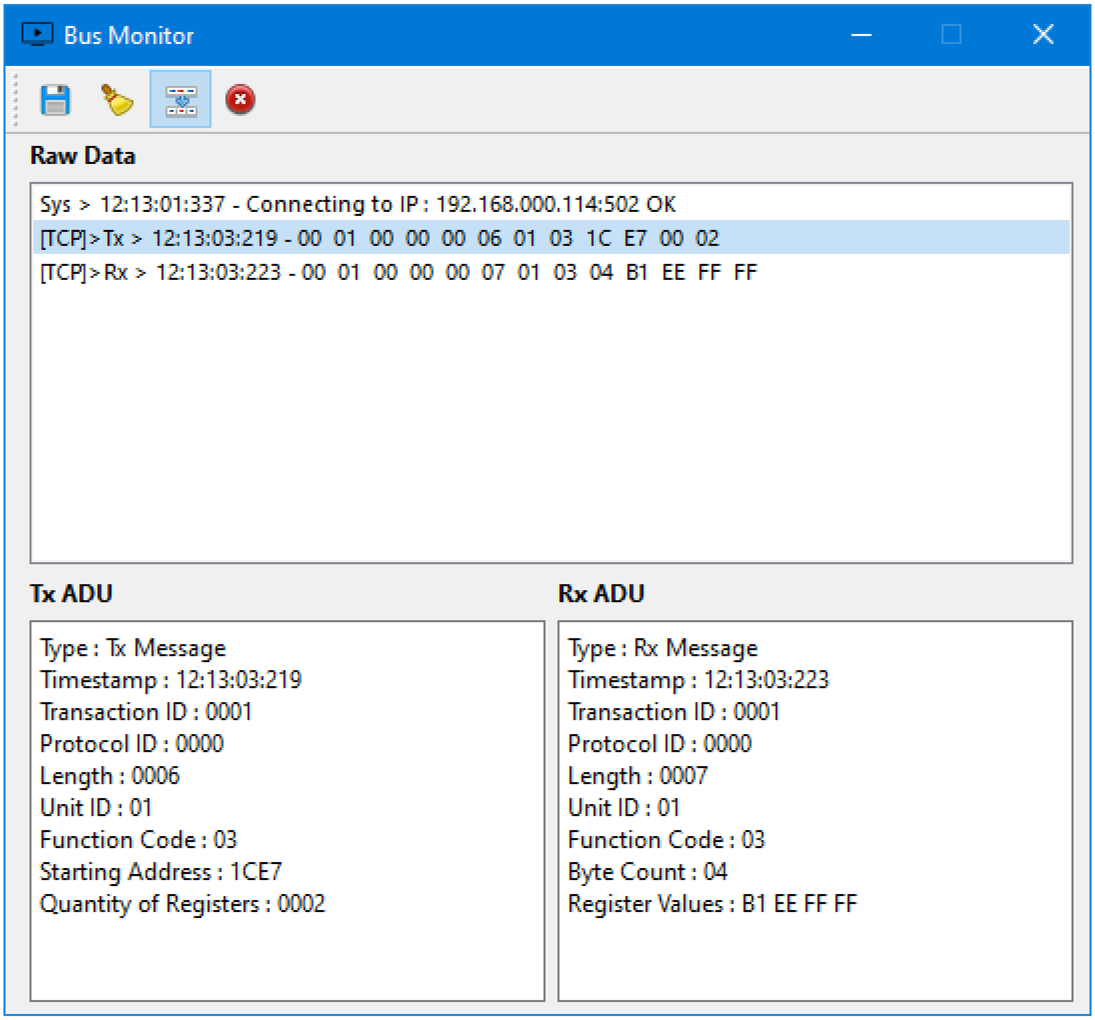
The critical items are:

- Modbus Mode = **TCP**
- Function Code = **Read Holding Registers (0x03)**
- Start Address = **7400** (Dec)
- Number of Registers = **2**
- Data Format = **Hex**

The **Read/Write** icon has been clicked and the values of holding registers 7400 and 7401 are displayed.



The QModMaster Bus Monitor window below presents the Modbus Command transmitted to the LWIFI and its response. Note that the hexadecimal byte values of **B1 EE FF FF** represent the 32-bit signed two's complement display value. The four bytes are combined as **FFFFB1EE** to form the 32-bit value which is -19986 decimal. A condensed description of two's complement is available on Wikipedia.


Bus Monitor
Raw Data
Sys > 12:13:01:337 - Connecting to IP : 192.168.000.114:502 OK
[TCP] > Tx > 12:13:03:219 - 00 01 00 00 00 06 01 03 1C E7 00 02
[TCP] > Rx > 12:13:03:223 - 00 01 00 00 00 07 01 03 04 B1 EE FF FF
Tx ADU
Type : Tx Message
Timestamp : 12:13:03:219
Transaction ID : 0001
Protocol ID : 0000
Length : 0006
Unit ID : 01
Function Code : 03
Starting Address : 1CE7
Quantity of Registers : 0002
Rx ADU
Type : Rx Message
Timestamp : 12:13:03:223
Transaction ID : 0001
Protocol ID : 0000
Length : 0007
Unit ID : 01
Function Code : 03
Byte Count : 04
Register Values : B1 EE FF FF

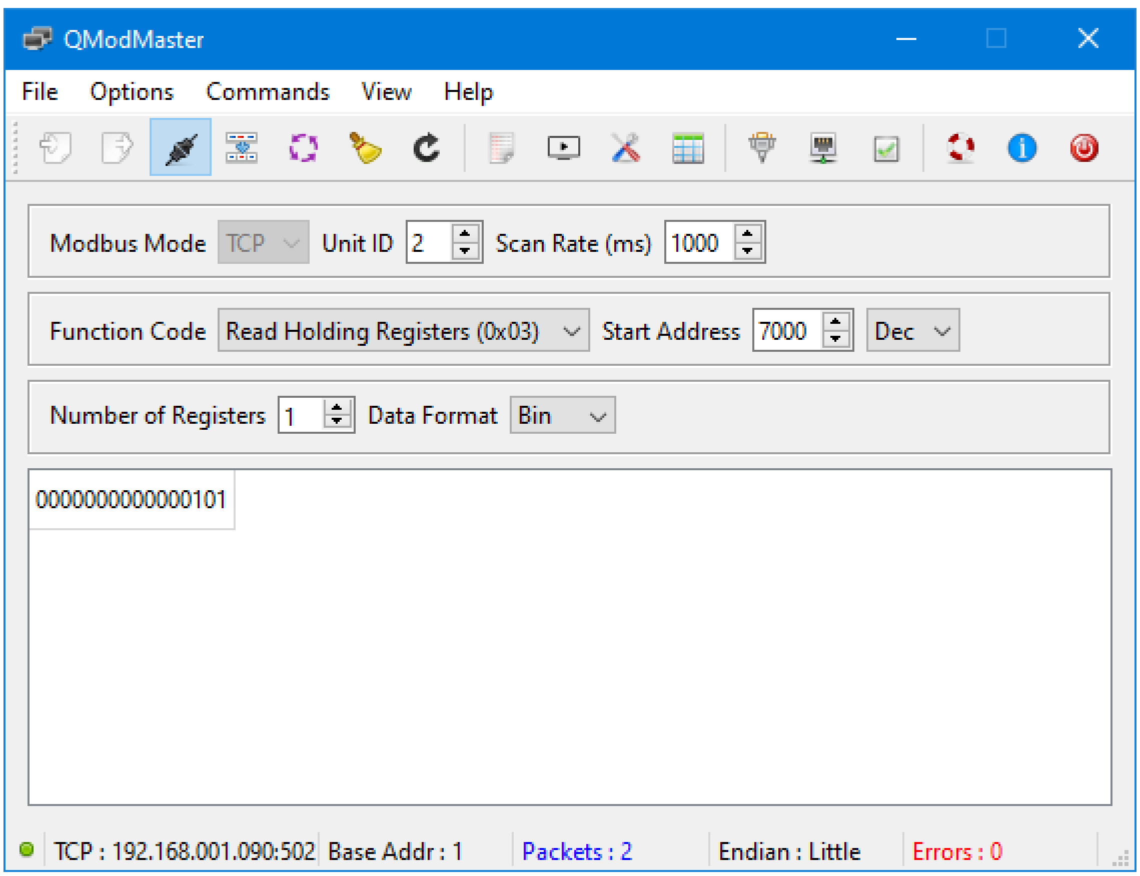
6. Example 3: Reading Alarm & Overload Status from a DC Voltmeter

This example uses a Modbus command to read the alarm and overload status from an LWIFI equipped DC voltmeter. The TCP configuration of QModMaster is the same as for the previous example.

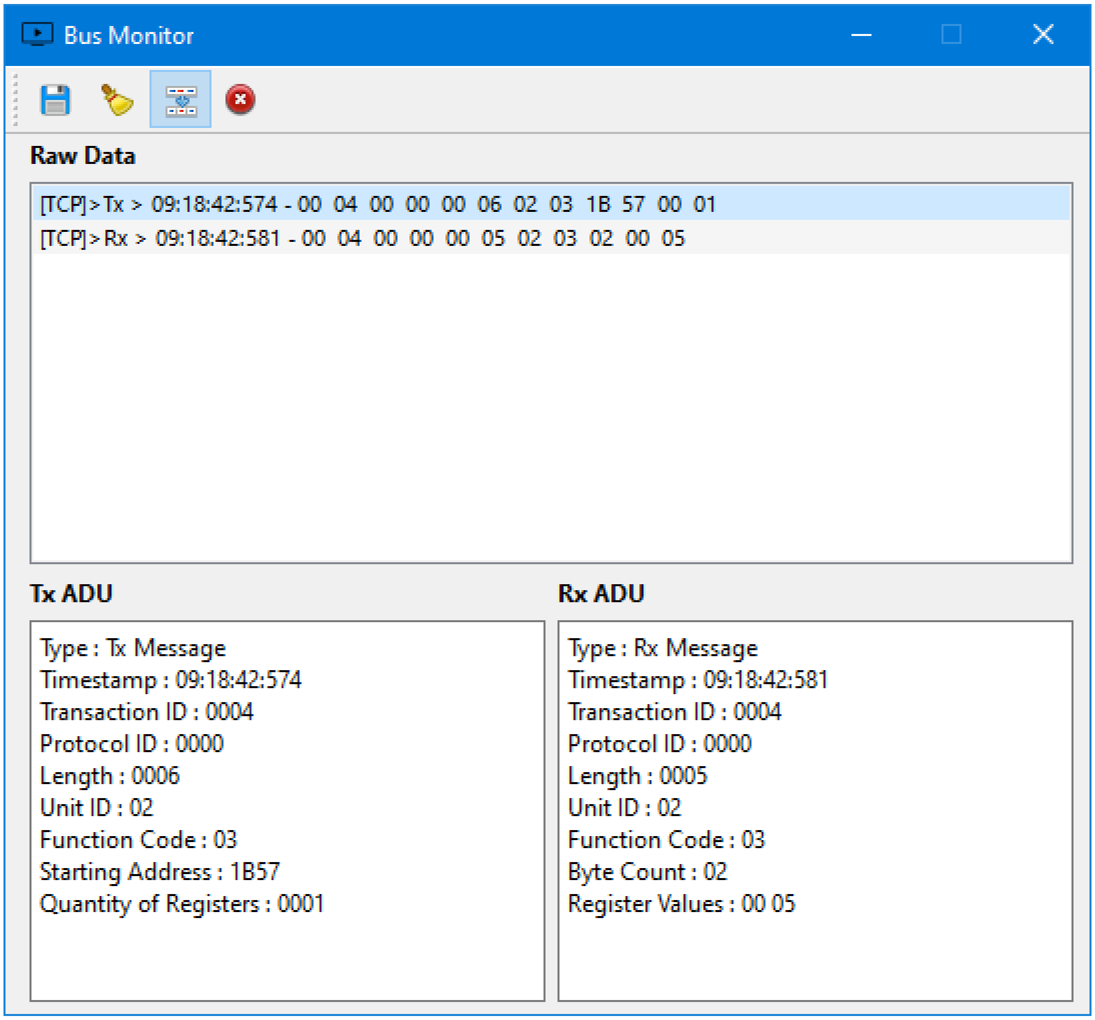
The screen capture below shows the main window of QModMaster which is setup to read the alarm and overload status. The critical items are:

- Modbus Mode = **TCP**
- Function Code = **Read Holding Registers (0x03)**
- Start Address = **7000** (Dec)
- Number of Registers = **1**
- Data Format = **Binary**

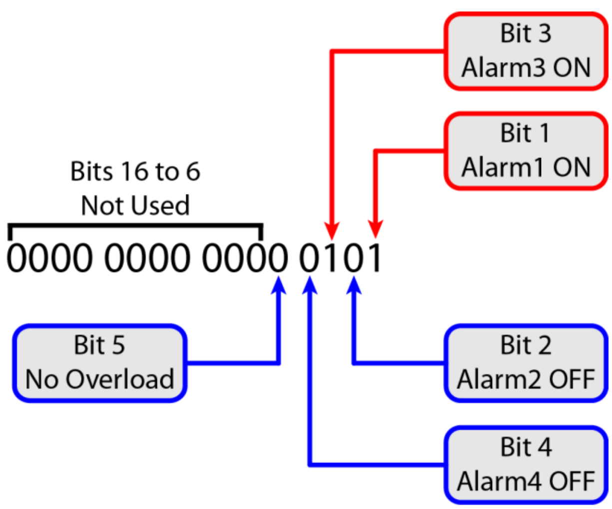
The **Read/Write** icon has been clicked and the 16-bit value of holding register 7000 is displayed.



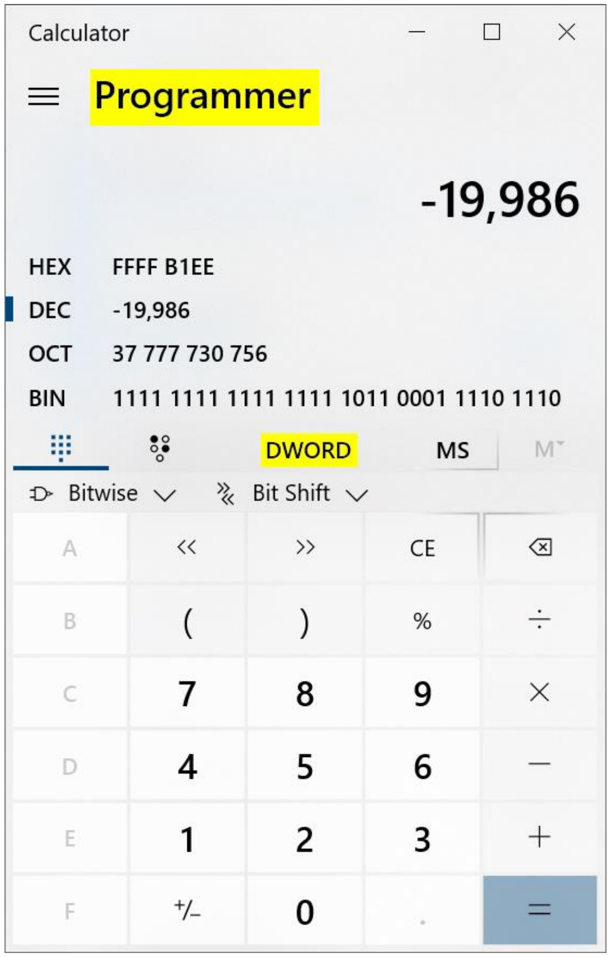
The QModMaster Bus Monitor window presents the Modbus Command transmitted to the LWIFI and its response. Note that the hexadecimal byte values of **00 05** represent the same alarm and overload status shown above in binary.



The diagram below describes how each of the bits is interpreted:



You may wish to use the Windows calculator to convert two's complement values to decimal and vice versa.



10. SPECIFICATIONS

Communication Interfaces, LWIFI Board

Included with LWIFI .... WiFi board, integral antenna, USB 2.0 port
WiFi module ....ATWINC1510-MR210PB (with integral antenna)
Antenna .... 2.4 GHz printed antenna
USB interface .... USB 2.0 via mini-USB connector

Communication Interfaces, LWIFIX Board

Included with LWIFIX ....WiFi board, external antenna, antenna cable, USB 2.0 port
WiFi module ....ATWINC1510-MR210UB (for external antenna)
Connector to external antenna .... Hirose male U.FL
Antenna cable type..50 ohm RG174
Cable length ....760 mm (30”)
Cable loss at 2.4 GHz ....2 dB
Cable connectors ....Female U.FL to circuit board, RP-SMA to antenna
Antenna .... External omnidirectional 2.4 GHz dipole
Antenna polarization.. Vertical
Antenna gain .... 5 dBi
Antenna height ....200 mm (8”)
Recommended antenna location..................... Top horizontal surface of metal cabinet
USB interface .... USB 2.0 via mini-USB connector

WiFi Performance

Wireless LAN standard... IEEE 802.11 b/g/n
Transmit/receive frequency .... 2.4 GHz license-free ISM band
Maximum data rate with 802.11 n ....72.2 Mbits/sec, MCS index 7
Maximum radio range, unobstructed outdoors...90 m (300 ft)

USB Performance

USB applications ....Meter programming and data polling
USB connector .... Mini-USB
USB cable .... Mini-USB to USB Type A connectors (CBL07 or customer furnished)
USB data rate..............38400 baud for Modbus, 19200 for Instrument Setup software
COM port.. Discovered by Laurel Network Setup (NS) utility

Cache Operation

Data written into cache...Display value or set of 6 values
6 values for analog input DPM ....
..........................Alarm status, display value, peak, valley, display value, display value
6 values for scale/ weight meter...
...................Alarm status, display value, peak, net weight, gross weight, display value
6 values for pulse input counter/timer ....
..................................Alarm status, item 1 (display value), peak, valley, item 2, item 3

Write interval into cache for 1 value .... 16.666 msec or 20.000 msec
Write interval into cache for 6 values .... 100 msec or 120 msec
Read interval from cache .... Set by external Modus Master, 10 msec minimum

Data Rates

Modbus polling rate .... Set by polling Master, 10 msec minimum
WiFi data rate .... Up to 72.2 Mbits/sec (IEEE 802.11 b/g/n)
Modbus data rate .... 38400 baud

Measurement Update Intervals

Analog input meter .... 16.666 or 20.000 msec (set for 60 or 50 Hz noise rejection)
Totalized pulse readings .... Signal period or gate time from 10 to 199.99 sec
Frequency/rate pulse readings.................... Gate time + 30 msec + 1-2 signal periods

Communication Protocols

Meter polling via WiFi .... Modbus TCP/IP (same command set as RTU)
Meter polling via USB... Modbus RTU
For meter programming with Instrument Setup software .... Custom ASCII protocol

Mechanical

LWIFI and LWIFIX board dimensions ....79 x 39 mm
Mounting location .... Middle slot of Laureate Series 2 panel meter or counter

Environmental

Operating temperature .... -40°C to 85°C
Relative humidity .... 95% from 0°C to 85°C, non-condensing

11. WARRANTY

Laurel Electronics, LLC 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 defective unit may be returned to the seller, which may be Laurel or a Laurel distributor. The seller may then repair or replace the defective unit at its option. In the event of such a return, freight charges from the buyer shall be paid by the buyer, and freight charges from the seller shall be paid by the seller.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from:

1. Improper installation or miswiring.
2. Improper or inadequate maintenance.
3. Unauthorized modification or misuse.
4. Operation outside the environmental specifications.
5. Mishandling or abuse.

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. Laurel specifically disclaims implied warranties of merchantability and fitness for a particular purpose.

Any electronic product may fail or malfunction over time. To minimize risks associated with reliance on Laurel products, users are expected to provide adequate system-level design and operating safeguards. Laurel's products are intended for general purpose industrial or laboratory use. They are not intended nor certified for use in life-critical medical, nuclear, or aerospace applications, or for use in hazardous locations.

Exclusive Remedies

The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall Laurel be liable for direct, indirect, incidental or consequential damages (including loss of profits) whether based on contract, tort, or any other legal theory.