LNET1, LNET1485, LWIFI, LWIFIX, LWIFI485, LWIFIX485

Generation 2 Laureate Communication Boards

User Manual

CE

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2. GEN 2 COMMUNICATION BOARDS OVERVIEW

Laurel Gen 2 (generation 2) communication boards were introduced in 2022 and fit in the middle board slot of 1/8 DIN sized Laureate Series 2 digital panel meters, counters and timers. LNET1 is a faster alternative to the legacy Gen 1 (generation 1) LNET board. LNET1485 is a faster alternative to the Gen 1 LNET485 board. LWIFI, LWIFI485, LWIFIX and LWIFIX485 are new WiFi boards. All Gen 2 communication boards are low in cost and use cache memory for high read rates.

Gen 2 communication boards covered by this manual:

- **LNET1** connects its host meter to an Ethernet local area network (LAN) via an RJ45 connector and a standard 10/100 Base-T Ethernet cable. It also has a mini-USB for connection to a PC or HMI. USB is used for discovery with Laurel Network Setup (LNS) software. It can also be used for data transfer to a PC or HMI at 38400 baud. The board's host (or Main) meter can be programmed over the USB port using our Instrument Setup (IS) software.

- **LWIFI** comes with an internal (or printed) 2.4 GHz WiFi antenna and is an easy way to connect a host meter to a WiFi network. It is suited for WiFi applications where the meter is mounted on a benchtop or inside a plastic enclosure that does not block radio waves. LWIFI also comes with a mini-USB jack. USB is used for discovery with Laurel Network Setup (LNS) software and can also be used for data transfer to a PC or HMI at 38400 baud. The board's host (or Main) meter can be programmed over the USB port using our Instrument Setup (IS) software.

- **LWIFIX** has the same capabilities as LWIFI but comes with an external 5 dBi antenna and a 30" antenna cable instead of a printed internal antenna. Use of an external antenna allows meter installation inside a metal cabinet and increases range up to 30 m (100 ft).

- **LNET1485** has the same Ethernet capabilities as LNET1 but has an RS485 port in lieu of USB. Connection to the USB port of a PC uses Laurel's RS485-to-USB converter cable CBL06. Programming with Laurel Network Setup (LNS) software also requires RS485 splitter cable CBL08. The RS485 port can be used for programming, for data transfer at up to 115 kbits/sec, and as an Ethernet-to-RS485 gateway to an RS485 bus with up to 31 meters or transmitters. LNET1485 is a faster replacement for the Gen 1 LNET485 board.

- **LWIFI485** has the same capabilities as LWIFI but comes with an added RS485 port. That port can be used for programming, for data transfer at up to 115 kbits/sec, or as a WiFi-to-RS485 gateway to an RS485 bus with up to 31 Laureate meters or transmitters. The RS485 bus can reach locations that WiFi cannot reach.

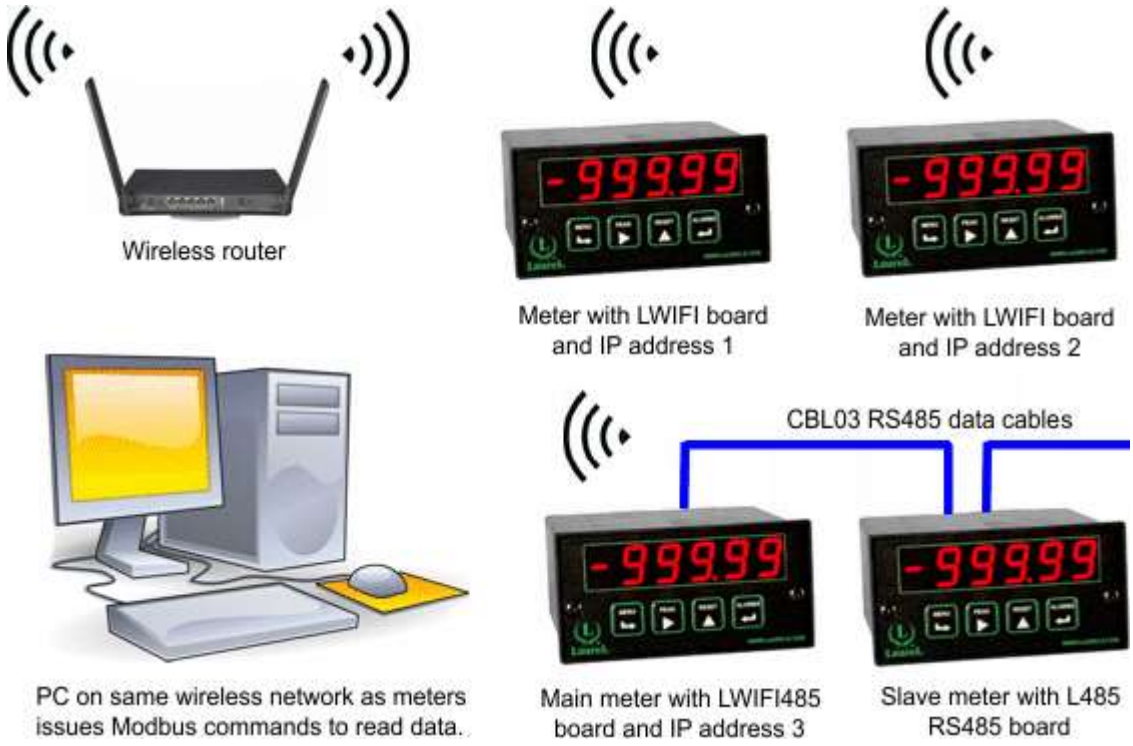
- **LWIFIX485** has the same capabilities and antenna as LWIFIX but comes with an added RS485 port. That port can be used for programming, for data transfer at up to 115 kbits/sec, or as a Wifi-to-RS485 gateway to an RS485 bus with up to 31 Laureate meters or transmitters.

High data rates are a major advantage of Gen 2 communication boards compared to legacy Gen 1 boards when used for data polling. The legacy communications boards, which include RS232, RS485, USB and Ethernet, are limited to about 2 or 3 updates per second when used in a polling command mode since they only operate at up to 9600 baud, and the meter's 8-bit processor has to perform meter operation and communication operations in sequence. In Gen 2 communication boards, 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 data in cache memory. The cached data can then be read asynchronously by an external master as fast as every 2 msec with Ethernet or every 10 msec with WiFi or USB. Please see the Data Update Rates section of this manual.

The Modbus protocol is used for all external communications with Gen 2 boards. That protocol is a master-slave protocol, where a master (typically a PC or HMI) issues commands, and a slave (or instrument) responds to these commands, for example by supplying data. The protocol is named Modbus TCP/IP when used with WiFi or Ethernet, and Modbus RTU when used with USB or RS485. The command set is the same, as documented in the Modbus Implementation section of this manual.

Laurel's Custom ASCII protocol is not available for external commands with Gen 2 products, and there is no data streaming. However, Modbus commands are seamlessly translated by the Gen 2 board processor to Custom ASCII commands for internal operation, which includes communications between the Gen 2 board and the host meter, and between the Gen 2 board and remote instruments on an RS485 bus. This explains why the host meter and Slave meters on an RS485 bus have to be set up for the Custom ASCII protocol.

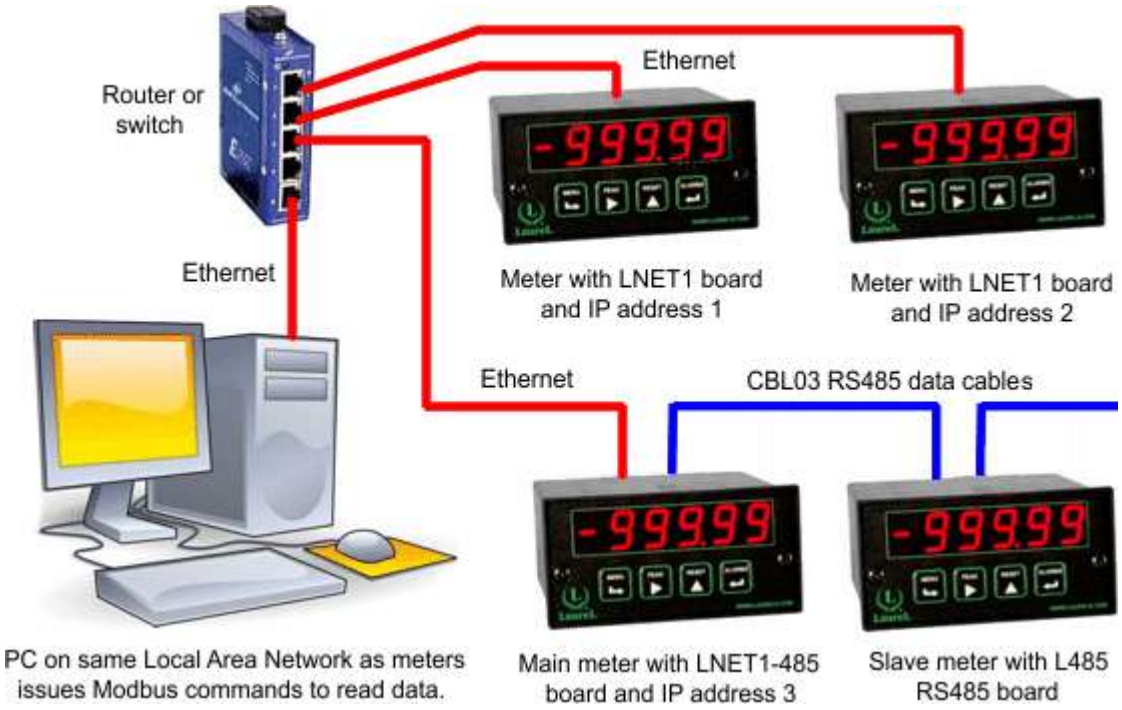
3. GEN 2 COMMUNICATION BOARDS OPERATION



LWIFI & LWIFIX operate the same, but LWIFI has an onboard printed antenna while LWIFIX comes with an external antenna and a 30" (76 cm) antenna cable. The external antenna is designed for mounting on the top surface of a metal cabinet that would block the radio signal of the onboard antenna. It also provides greater range than the onboard antenna.

Operation of an LWIFI or LWIFIX board requires that these be logged into the same wireless network as a PC or HMI that serves a Modbus Master. Logging into the wireless network requires entry of the network's WiFi Name (SSID) and Password via the board's USB connection. Once the PC or HMI and all wireless instruments are on the same WiFi network, the PC or HMI can issue Modbus TCP commands as detailed in this manual to collect data from the instruments and change setup parameters. Devices by different manufacturers can be on the same wireless network. All devices on the network are addressed by their IP address.

LWIFI485 & LWIFIX485 add an RJ11 connector for RS485 communications. RS485 can be used for programming and for data transfer as Slave to a PC. It can also serve as a Master and support an RS485 bus with Laureate Modbus Slave instruments with a half-duplex RS485 interface and an address from 2 to 31. Reasons to use RS485 cabling when WiFi is available is that RS485 can reach distances up to 2000 feet (600 meters) at 19200 baud, and that it can be fed into metal cabinets and overcome obstructions that would block radio signals.



LNET1 & LNET1485 allow a Laureate meter, counter or timer to be plugged into the same wired LAN as a PC or HMI that serves a Modbus Master. As or WiFi, devices by different manufacturers can be on the same network and are addressed by their IP address. That address is typically assigned by the router, but with LNET1 and LNET1485 it can also be entered by the user with our Laurel Network Setup (LNS) software, as explained in this manual.

LNET1 comes with an RJ45 connector for Ethernet and a mini-USB connector for programming or for data transfer in parallel with Ethernet.

LNET1485 comes with an RJ45 connector for Ethernet and an RJ11 connector for RS485, but no mini-USB connector. The RS485 port can be used for programming, for data transfer at up to 115 kbits/sec, and as an Ethernet-to-RS485 gateway to an RS485 bus with up to 31 Modbus Slave meters or transmitters whose Modbus address has been set to different values from 2 to 31. Slave meters must be equipped with an L485 RS485 communication board and can be daisy-chained using our non-reversing 6-wire data cables CBL03-7 (7 feet) or CBL03-1 (1 foot). The use of daisy-chained RS485 wiring minimize the need for Ethernet ports and cabling.

4. GEN 2 BOARD INSTALLATION

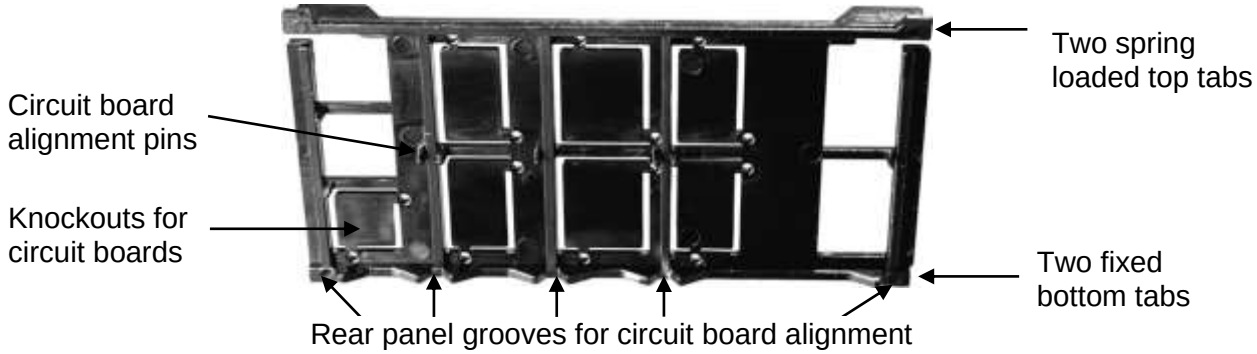
Laurel Gen 1 or Gen 2 communication boards come installed in a Laureate meter or counter when called out in the 6th digit position of the meter or counter model number. For example, an L2000**C**DCV1 meter includes a WiFi board P/N LWIFI with an internal antenna and USB. Please see the photo to the right of a meter with an LWIFI485 board in the middle slot. Visible are the Mini-USB and RS485 connectors.

6th Digit	Board Description	Gen 1 P/N	Gen 2 P/N
0	None (no communications board)		
1	RS232 with one RJ11 jack	L232	
2	RS485 with two RJ11 jacks for daisy chaining (recommended for RS485 bus)	L485	
4	RS485 with two RJ45 Jacks (use RJ11 jacks for new designs)	LMOD	
5	USB with one USB Type B jack	LUSB	
6	USB + RS485 for USB-to-RS485 gateway	LUSB485	
7	Ethernet (not for new designs)	LNET	
8	Ethernet + RS485 for Ethernet-to-RS485 gateway (not for new designs)	LNET485	
A	Ethernet + USB for programming or data		LNET1
B	Ethernet + RS485 for programming, data, or Ethernet-to-RS485 gateway		LNET1485
C	WiFi with internal antenna + USB		LWIFI
D	WiFi with external antenna + USB		LWIFIX
E	WiFi with internal antenna + USB +RS485		LWIFI485
F	WiFi with external antenna + USB + RS485		LWIFIX485

Communication boards can also be installed later by the user by inserting them into the middle backplane slot that is reserved for communications boards. The boards are automatically recognized by the meter's processor, but software setup is required as detailed in this manual.

Disassembling your meter

To install a new board, first remove the electronics assembly from its case. The first step of disassembly is to remove any connectors. Then 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. 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.

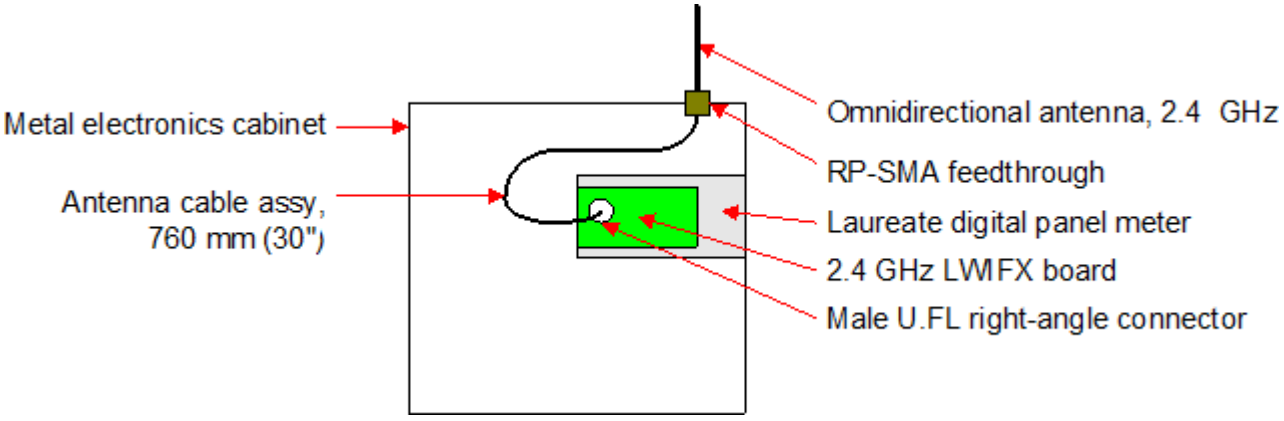


Reassembling your meter

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. If the added board is an LNET1, use wire cutters to snip off the horizontal plastic divider.
4. 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.
5. Once all boards are held firmly, insert the top tabs of the rear panel into the case.
6. Verify that the installed rear panel is flat. Reinstall the rear panel if it bulges out, if the top tabs cannot be inserted, or if there is no room for connectors.
7. Once the rear panel is in place, reinsert the connectors.

5. WIFI BOARD & RANGE CONSIDERATIONS

A digital panel meter with an LWIFI or LWIFI485 board, which comes with an internal printed antenna, needs to be mounted on a benchtop or in a plastic enclosure that is transparent to 2.4 GHz radio waves. WiFi is suitable for indoor 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 to LWIFIX with an external antenna.



A meter with an LWIFIX or LWIFIX485 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 in lieu of LWIFI, since it has about 10 dB higher output.

WiFi range depends on many factors. These 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. Each -3 dB reduces power by a factor of 2. Each -10 dB reduces power by a factor of 10.

WiFi range can be 90 m (300 ft) with an external antenna and an unobstructed line-of-sight connection outdoors, but it is half of that or less indoors. Signal loss is caused by materials like concrete, bricks, plaster and flooring that absorb radio waves, and by nearby metal objects that reflect and scatter radio waves. To maximize range, minimize obstructions between the WiFi router and meter antennas. Also maximize the height of both antennas. 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 leaked radiation from products like microwave ovens.

6. NETWORK SETUP UTILITY INSTALLATION

Laurel Network Setup (LNS) is a software utility that must be run on a PC to set up Gen 2 communication boards prior to their use. This utility works with the micro-controller used in Gen 2 boards, not in older Gen 1 boards.

Download the file NetworkSetup_2_1.exe (100 kB) from Laurel's software downloads web page or click here. Copy the downloaded file into a PC directory of your choice. You may also wish to paste a shortcut on your Windows desktop. To execute, double-click on the file name or on your shortcut.

Before you can run LNS software on a PC, the Gen 2 communications board must be set by connecting it to the USB port of a PC on which LNS software has been installed.

If your Gen 2 board has a mini-USB Type B jack, use a readily available USB cable with a mini-USB Type B connector and a USB Type A connector like our CBL07 USB cable.

If your Gen 2 board is a P/N LNET1485 which does not have USB but has RS485, use our CBL06 RS485-to-USB adapter cable. It is possible to use that cable for LNS software with any Gen 2 board that has an RS485 jack.

Before you can run LNS software on a PC, the host meter of the Gen 2 communications board must be set up 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, as illustrated on the next page:

- SEr 1: 160 The digit 6 selects 19200 baud.
- SEr 2: 0111 The second to last 1 selects the Custom ASCII command mode. The last digit 1 selects address 1.
- SEr 3: 00000
- SEr 4: 000

You will get the error message "No Network Board Found" if the connecting cable (USB or RS485) to the PC is missing, if the communication settings of the host meter are not correct, or if the host meter is not under power,

KEYSTROKES FOR SERIAL COMMUNICATIONS SETUP

If the *MENU* ↵ key does not work, see Section 9 "Enabling & Locking Out Menu Items."

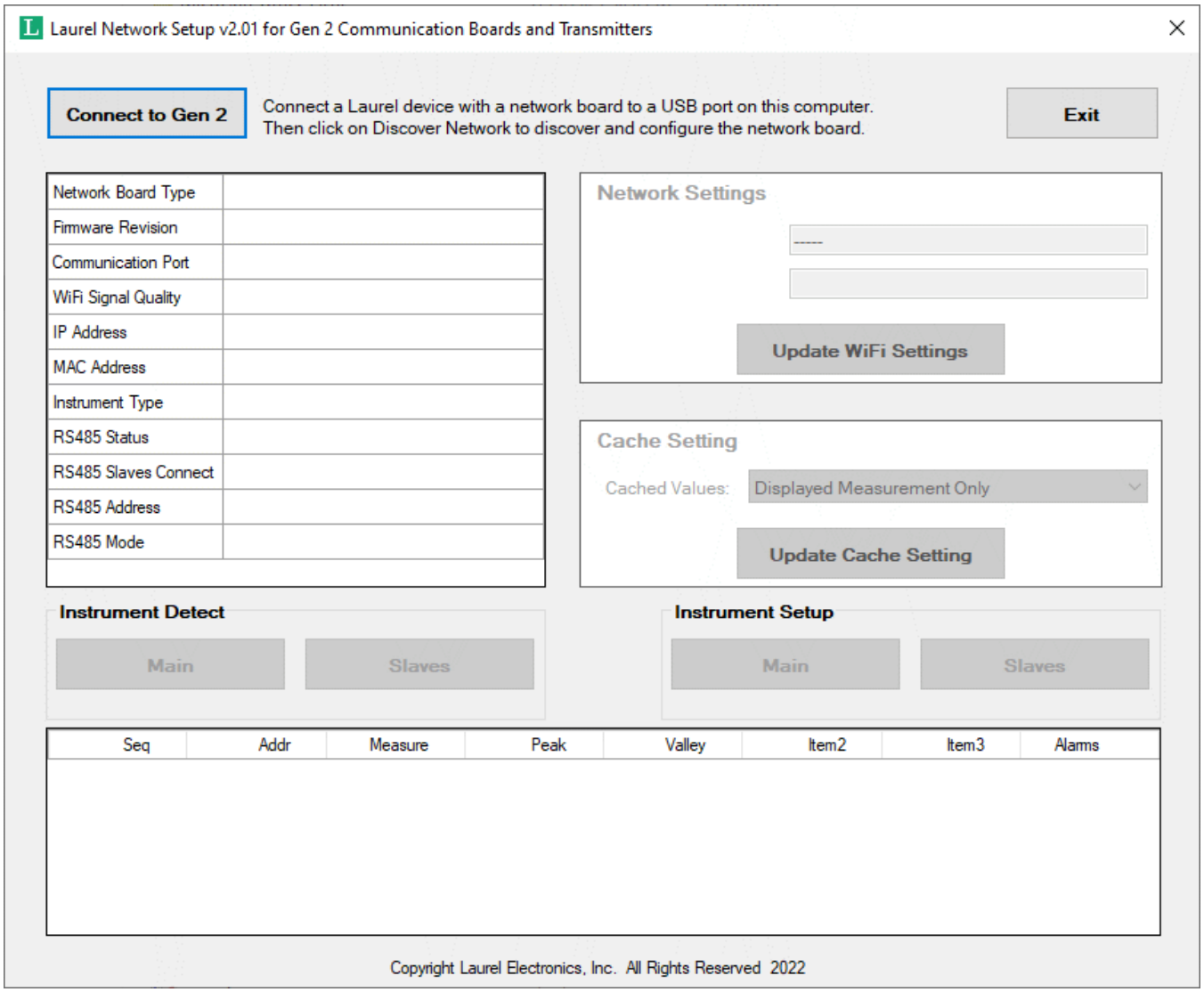
MENU ↵ ***Press Menu Select Key***	PEAK ▶ ***Press Digit Select Key***	RESET ▲ ***Press Value Select Key***
SEr 1 Fixed Parameters: No parity 8 data bits 1 stop bit	**0**00 Output filtering	**0** Send unfiltered signal **1** Send filtered signal
	0**0**0 Baud rate	**0** 300 baud **1** 600 baud **2** 1200 baud **3** 2400 baud **4** 4800 baud **5** 9600 baud **6** **19200 baud**
	00**0** Output update rate	60 Hz / 50 Hz **0** **Line frequency** / **Line frequency** **1** 0.28 sec / 0.34 sec **2** 0.57 sec / 0.68 sec **3** 1.1 sec / 1.4 sec
SEr 2 Serial Setup 2	**0**0000 Line feed	**0** **No line feed after carriage return** **1** Line feed after carriage return
	0**0**00 Alarm data with readings	**0** No alarm data **1** **Alarm data with reading**
	0**0**00 Control of data output	**0** Continuous data output **1** **Data output on ASCII command only**
	0**0**00 Meter address with Custom ASCII protocol	Select **1** thru **F** for addresses **1** thru 15. Select **0.** thru **F.** (with decimal point) for addresses 16 thru 31.
SEr 3 Serial Setup 346	**0**0000 Half or full duplex	**0** **Half or full duplex** **1** Do not use
	00000 Special start & stop char.	**0** **Standard continuous mode** **1** Special start & stop characters
	00**0**00 RTS mode (for RS232)	**0** **Normal RS232 operation** **1** Single RS232 transmission mode with -e jumper on RS232 board
	0000**0** Termination characters	**0** **Only at end of all items** **1** At end of each item
	0000**0** Data sent in continuous mode	**0** **Reading** **1** Peak **2** Valley **3** Reading + peak **4** Reading + valley **5** Reading + peak + valley

SEr 4 Serial Setup 4.	**__0**00 Modbus ASCII gap timeout	**0** 1 sec **1** 3 sec **2** 5 sec **3** 10 sec
	__000 Serial protocol	**0** Custom ASCII **1** Modbus RTU **2** Modbus ASCII
	__000 Parity	**0** None, 2 or more stop bits **1** Odd, 1 or more stop bits **2** Even, 1 or more stop bits

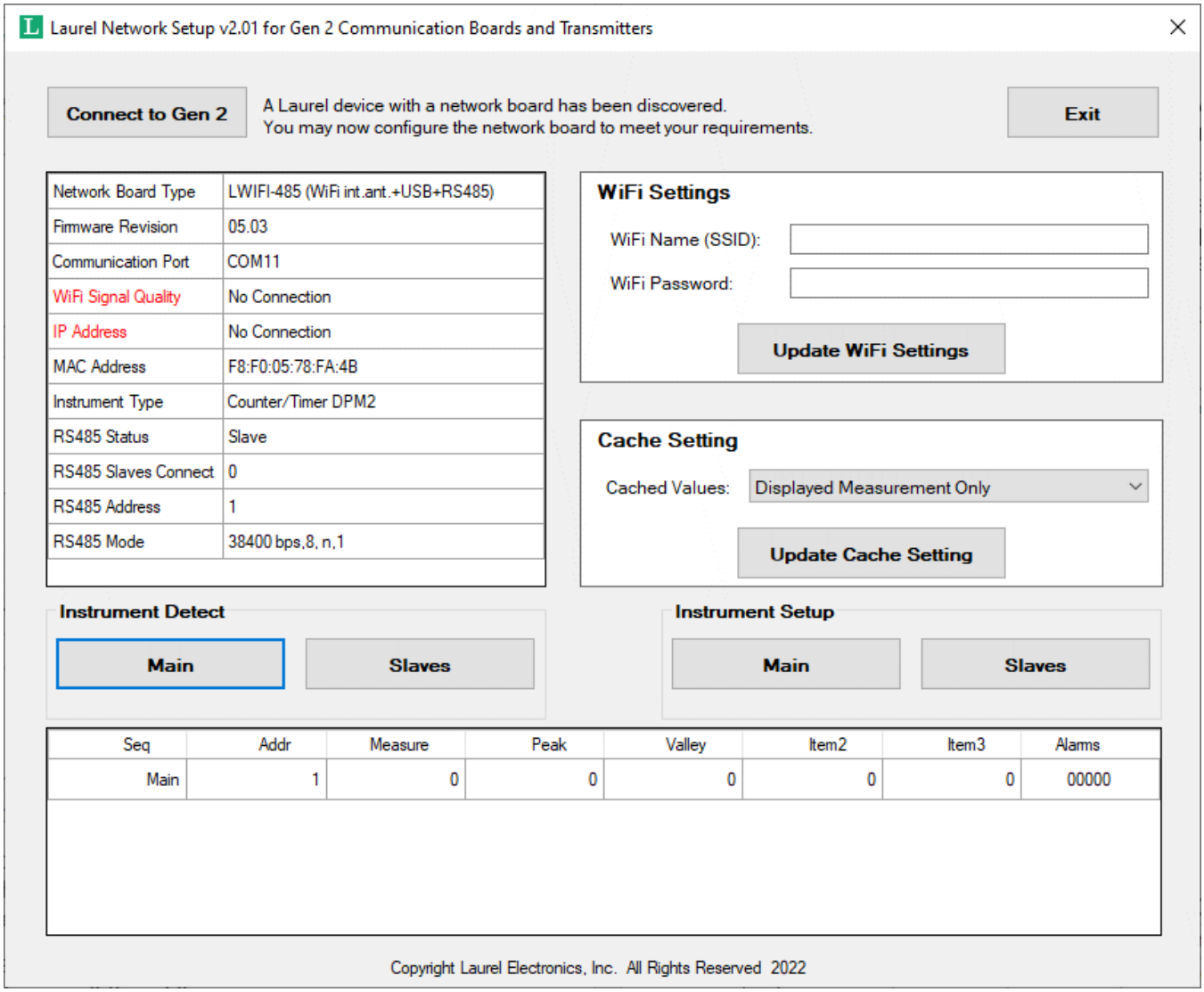
7. LWIFI SERIES NETWORK SETUP DISCOVERY SCREEN

LWIFI Series Gen 2 boards come with a wireless WiFi connection for use with Modbus TCP/IP commands, plus a USB port for connection to a PC for programming or data transfer. Model numbers ending with **485** include an RS485 port which can be used for connection as a Slave to a PC or as a Master and gateway to an RS485 bus with up to 31 Laureate meters or transmitters.

Connect the USB port of your LWIFI series board to the USB port of a PC on which the Laurel Network Setup (LNS) utility has already been installed. Upon launch, the LNS utility will present you with a blank discovery screen.

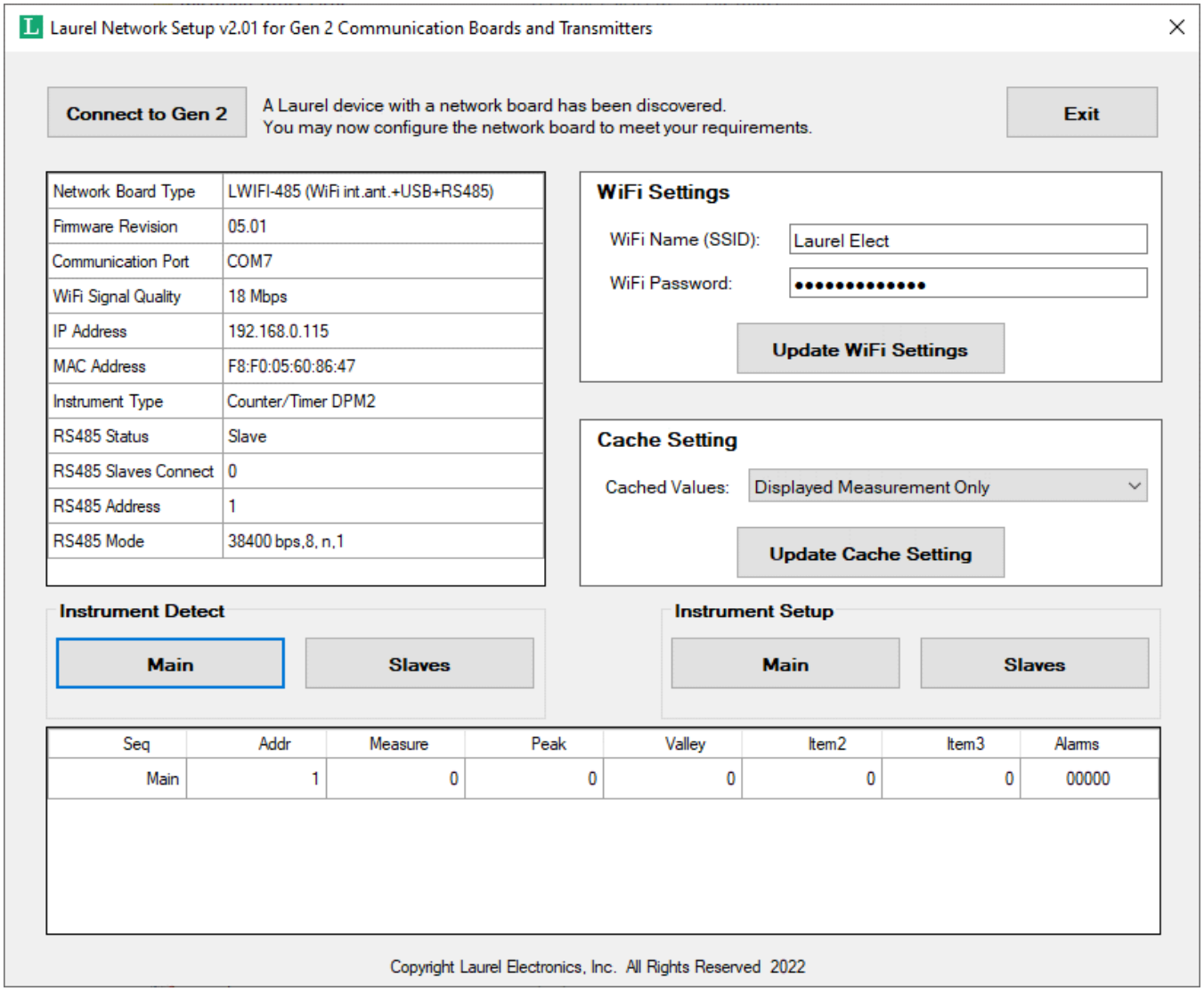


Click on “Connect to Gen 2” in the upper left of the screen, and the LNS screen will start to self-populate.



The LNS screen will now show the Network Board Type, the COM port used by the PC, and the MAC address of the WiFi chip. At this point the IP Address and WiFi Signal Quality are still shown as “No Connection.”

Enter WiFi Name (SSID) and WiFi Password of your WiFi network, and click on “Update WiFi Settings.” This will initiate the WiFi connection, and the missing WiFi items will fill in.



Click on Main under “Instrument Detect” to update the LNS screen and delete previously discovered items which do not apply.

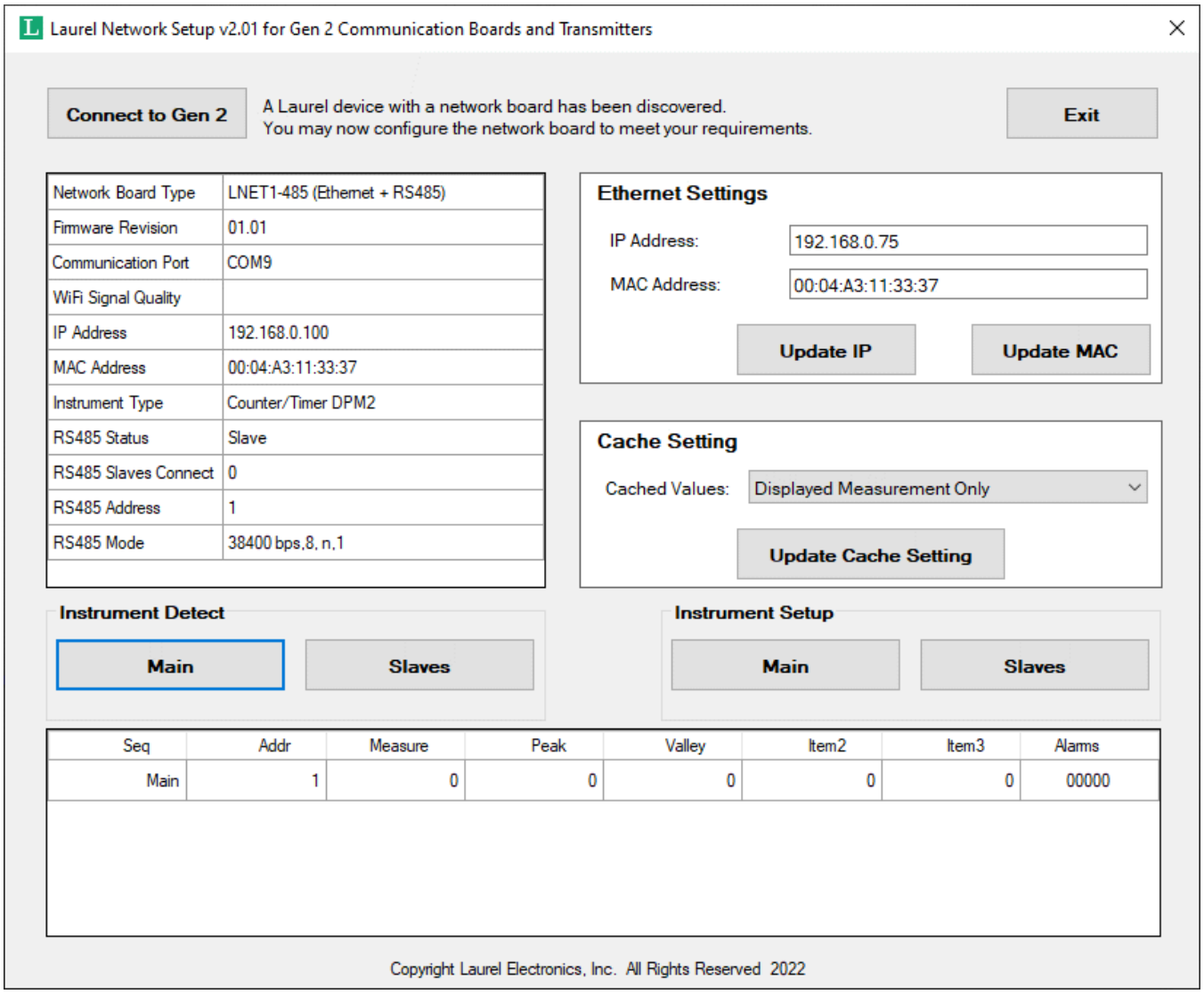
In WiFi networks, the IP address is assigned by the WiFi router with DHCP. Knowledge of the IP address is essential since it is part of Modbus TCP commands.

8. LNET1 SERIES SETUP DISCOVERY SCREEN

The LNET1 board comes with an Ethernet connection for use with Modbus TCP/IP commands, and a USB port for connection to a PC for programming or data transfer using Laurel's cable CBL07 or equivalent.

The LNET1485 board comes with Ethernet and an RS485 port in lieu of USB. The RS485 port can be connected to a PC with Laurel's cable CBL06 for programming or for connection as a Slave to a PC, or for connection as a Master and gateway to an RS485 bus with up to 31 daisy-chained Laureate instruments.

Connect the board to the PC on which the Laurel Network Setup (LNS) utility has already been installed. Upon launch, the LNS utility will present you with a blank LNS discovery screen. Click on the "Connect to Gen 2" button in the upper left, and the screen will self-populate. The right side of the screen display the IP address assigned by the router using DHCP, but it also allows a static IP address to be assigned. The MAC address is displayed but cannot be changed.

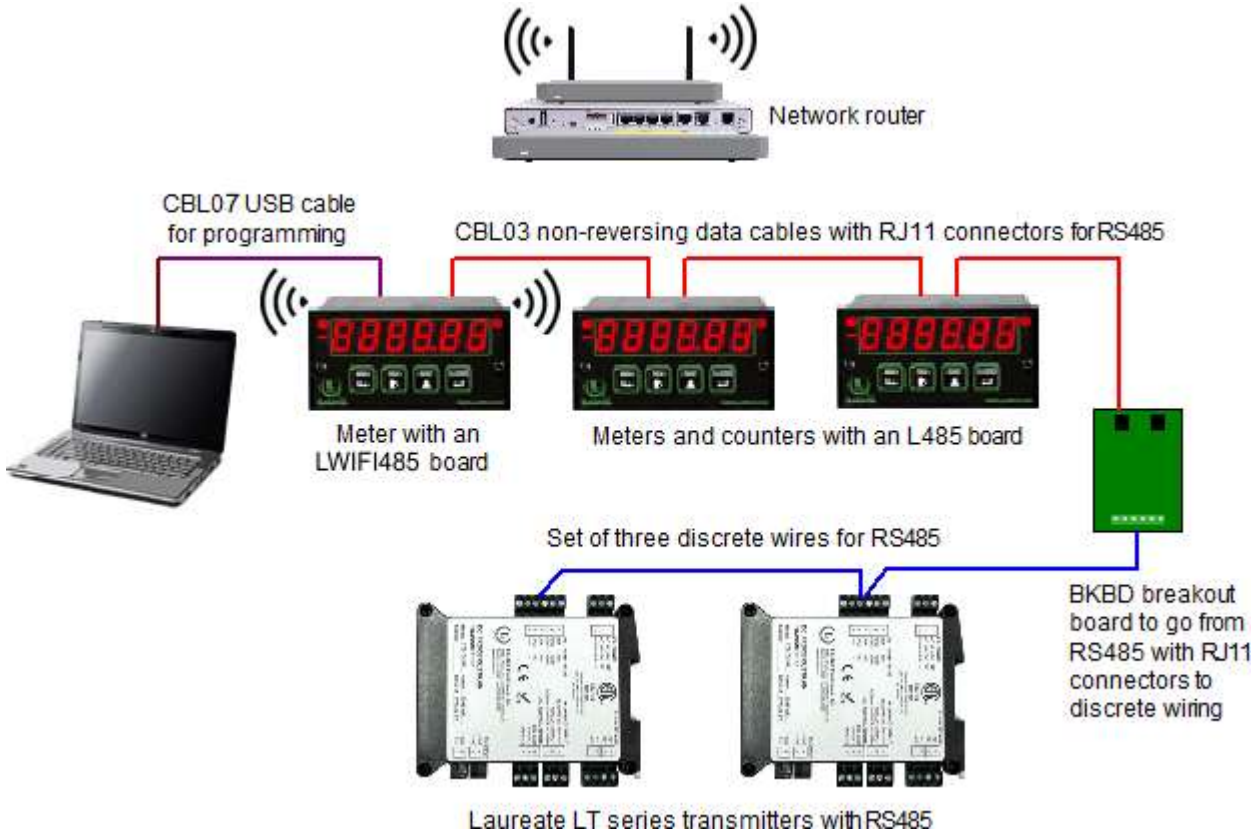


9. Gen 2 Board Use as an RS485 Gateway

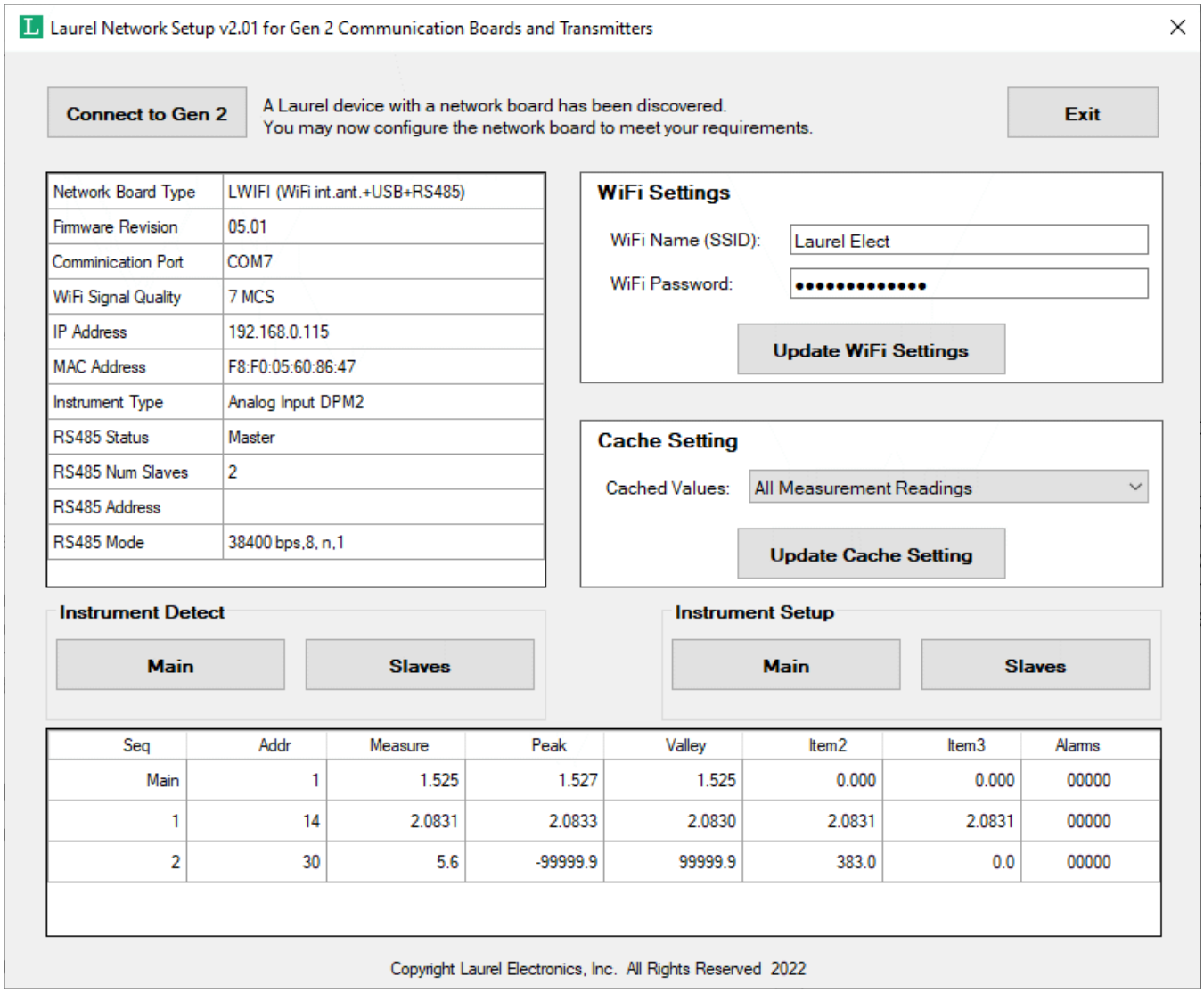
Gen 2 communication boards LNET1485, LWIFI485 and LWIFIX485 include an RJ11 connector for RS485. That port can be connected to the USB port of a PC using Laurel's cable CBL06 to program the host meter and to transfer data at rates up to 115 kbits/sec.

The main reason for the RS485 port is to serve as gateway to an RS485 bus with up to 31 daisy-chained Laureate instruments called Slaves. These can be a mix of Laureate 1/8 DIN sized meters, counters and timers, plus LT series transmitters set to RS485. The host meter of the Gen 2 board and the Slave meters can be interconnected by Laurel's non-reversing, half-duplex RS485 cables, P/N CBL03. These come in a 7-foot length (CBL03-7) and a 1-foot length (CBL03-1).

Slave meters need to be set up from their front panel for 19200 baud, their own individual address between 2 and 31, and the Custom ASCII protocol, which is used for Gen 2 internal network operation. Outside commands need to be in Modbus RTU/TCP format but are seamlessly translated to Custom ASCII by our firmware.



LWIFI485 and LWIFIX485 boards provide both USB and RS485 ports. If the connection to the PC is via USB and if the connection to the remote slaves is via daisy chained RS485, press on "Slaves" under "Instrument Detect." The bottom of the screen will then self-populate with all detected slaves, their address and their measurements. The host meter and slaves can also be individually programmed via the USB link using Instrument Setup (IS) software running on the PC.



The LNET1485 board does not have a mini-USB connector but an RJ11 connector for RS485. That connector can be used for setup using Laurel Network Setup (LNS) software or Instrument Setup (IS) software, and for data transfer with an RS485 bus with a mix of up to 31 Laureate meters and transmitters.

For setup purposes only, insert an RS485 splitter at the RJ11 connector. This needs to be an RJ12 male to dual RJ12 female splitter adapter 6p6c, Laurel P/N CBL08 The male connector needs to be at the end of a cable for mechanical clearance purposes. Once the network has been set up, the RS485 splitter can be removed.

LNS software setup is as for WiFi, except that “WiFi Signal Quality” does not have an entry in the LNS screen.

10. LNS Screen Details

The items displayed by an LNS screen for a Gen 2 board with Slaves on an RS485 bus:

Network Board Type: As programmed into the Gen 2 board and discovered by the LNS utility over USB.

Firmware revision: As programmed into the Gen 2 board and discovered by the LNS utility over USB.

Communication Port: The COM port used by the PC for USB communications to the Gen 2 board, as discovered by the LNS utility.

WiFi Signal Quality: An MCS (Modulation Coding Scheme) score from 0 to 7 to indicate WiFi signal quality. An MCS score of 3 or less indicates low signal quality. An MCS sore of 7 MCS indicates a WiFi data rate of 72.2 Mbits/sec. The MCS score is only displayed after WiFi communications have been established after entering the correct WiFi SSID and password in the upper right of the screen. Otherwise “No Connection” is displayed.

IP Address: As assigned by the network router to the Gen 2 board. With WiFi, the address is always dynamic. With WiFi, the IP address is only displayed after entering the correct WiFi SSID and password in the upper right of the screen. Otherwise “No Connection” is displayed. With Ethernet in lieu of WiFi, the IP address can also be static as assigned by the router or be assigned by LNS software. The IP address needs to be known for Modbus TCP WiFi or Ethernet communications.

MAC Address: A unique 12-character hexadecimal number assigned by the manufacturer to the WiFi or Ethernet chip as discovered by the LNS utility. Laurel can change the MAC address if required.

Instrument Type: The Laureate instrument type as discovered by the LNS utility over USB.

RS485 Status: “Master” is displayed if the host meter serves as a gateway (or master) to meters on an RS485 bus. “Slave” is displayed if the host meter does not serve as a gateway to meters on an RS485 bus.

RS485 Num Slaves: The number of slave meters from 0 to 31 on the RS485 bus if the host meter serves as a gateway (or master) to meters on an RS485 bus. The number 0 indicates no slaves.

RS485 Address: The Modbus address to be used by Modbus RTU when addressing the host meter as a Modbus slave. The factory default is 1. Modbus commands can be used to assign an address from 1-255 as explained in the Appendix to this manual. The RS485 address is blank if the host meter serves as a Master to one or multiple Slaves on an RS485 bus.

RS485 Mode: The baud rate, data bits, parity and stop bits used for communications with the host meter as a Modbus slave. The factory default is 38400, 8, n, 1. As explained in the Appendix to this manual, the baud rate can be set to 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200. Baud rates above 38400 only apply to RS485 in Slave mode. Parity can be set to odd, even or none. Stop bits can be set to 1 or 2.

WiFi Settings requires entry of the correct “WiFi Name (SSID)” and “WiFi Password” to enter access the WiFi network. Press “Update WiFi Settings” after you have made your entries. If your entries are correct, the fields “WiFi Signal Quality” and “IP address” are populated, otherwise “No Connection” is displayed.

Cache Setting: Choices are “Displayed Measurement Only” or “All Measurement Readings.” The first selection only writes the latest measurement into cache and is best for high read rates. The second selection writes 6 values 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.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.

Instrument Detect: Click on “Main” to repeat discovery of the host (or Main) meter. Click on “Slaves” to repeat discovery of slaves on an RS485 bus connected to the host meter. If “Detect” is not pressed, the last findings are retrieved from EEPROM,

thereby saving about 10 seconds. Always press Detect if you have changed your host meter or have added or removed slaves.

The bottom of the LNS screen lists the Main meter (or host meter to the Gen 2 board) plus any discovered Slaves, along with their Modbus address and latest measurements. If “Cache Setting” was set to “All Measurement Readings,” real time entries will also be displayed for Peak, Valley, Item 2, Item 3 and Alarms. Check these values to verify that your network is working as expected.

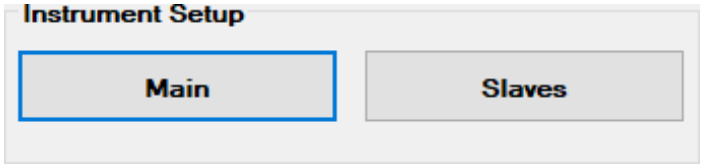
Shown below is an example of a network which includes a Main meter with an LWIFI communication board, two Slave meters on RS485 bus, and two Slave transmitters on the same RS485 bus. In this example, the LWIFI USB port is used with Laurel Network Setup (LNS) software to enter the WiFi SSID and password, and to discover the LWIFI board’s IP address. Measurement data is transferred to a PC or HMI (not shown) which is connected to the router either via an Ethernet cable or wirelessly.

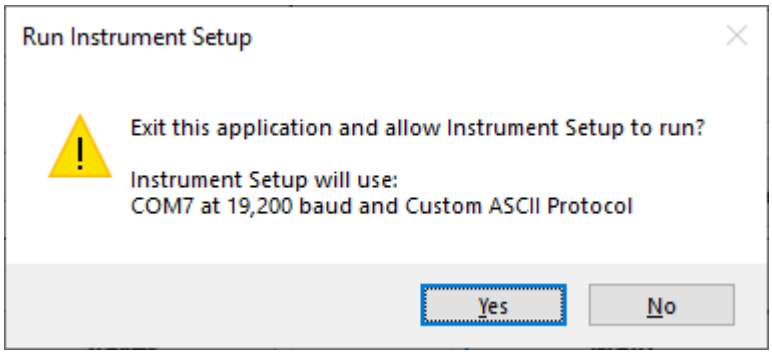
11. INSTRUMENT SETUP SOFTWARE WITH GEN 2 BOARDS

Instrument Setup (IS) software is a free PC based Windows graphical user interface (GUI) with pull-down menus that can be used as an alternative to front panel programming for Laureate meters. 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. The procedure in this section applies to an LWIFI, LWIFIX or LNET1 Gen 2 board which is connected via USB to a PC on which LNS and IS software have been installed.

1. IS software with the Gen 2 Host (or Main) Meter

To apply IS software to the host or "Main" meter of the Gen 2 board from the LNS discovery screen, click on "Main" under "Instrument Setup." You will be prompted to click on "Yes" to exit the LNS utility and launch IS software.



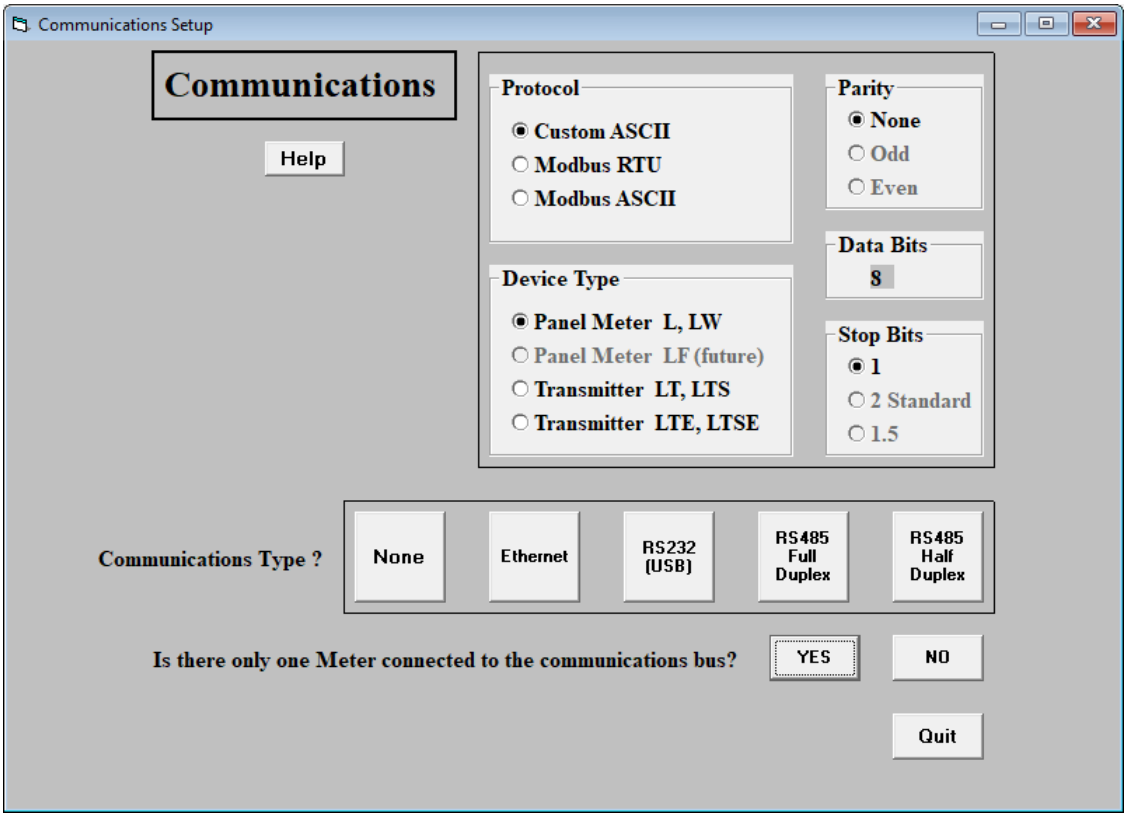


In the "Communications Setup" screen of IS software, select the "Custom ASCII" protocol, click on "RS485 Full Duplex," and click on "Yes" to indicate that there is only one meter on the RS485 bus.

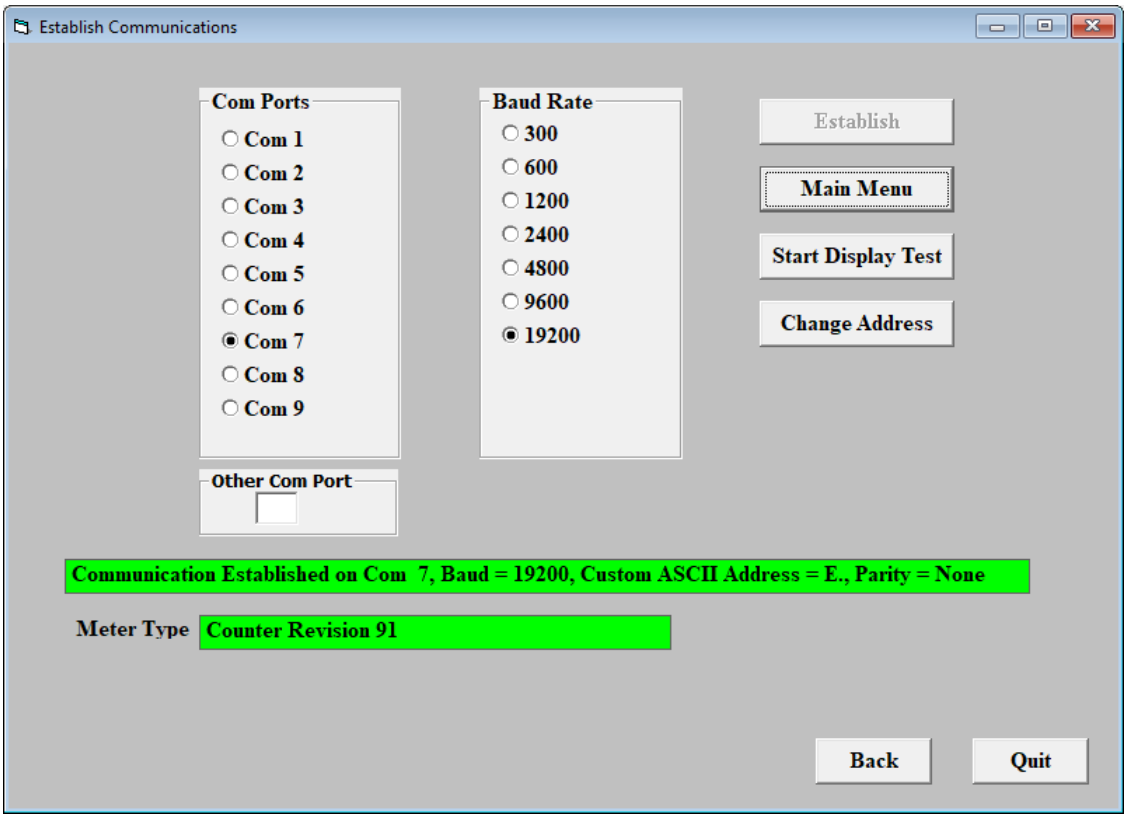
In the "Establish Communications" screen, select the COM port discovered by the LNS utility and 19200 baud. Click on "Establish" to establish communications. Two lines highlighted in green should appear at the bottom of the screen to indicate success. Click on "Main Menu" to enter main IS software screens.

To get started with IS software, click on "DPM" or "Counter" in the top menu bar and then on "Get Setup" to upload setup information from the DPM our Counter to your PC. Click on "Put Setup" to download any changes to your PC.

You must recycle power to the host (or Main) meter to reenter the LNS utility after running IS software, or the LNS utility will return the message "No Network Board Found."



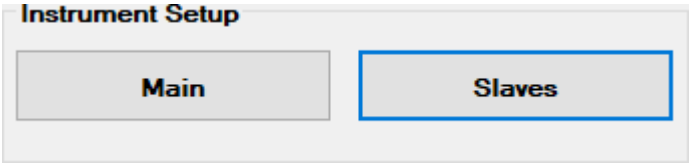
IS software Communication Setup screen for host (or Main) meter.

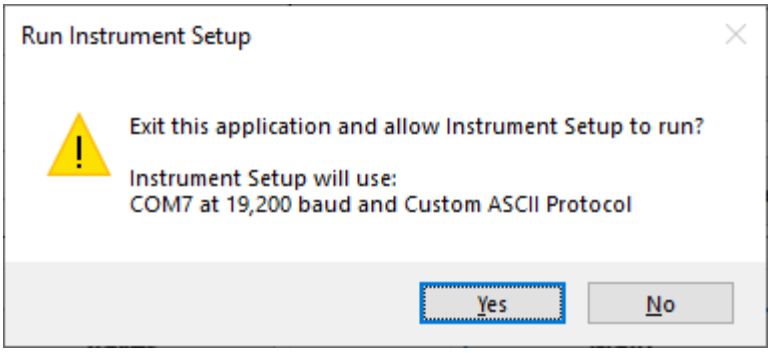


IS software Establish Communications screen for Main or Slave meters.

2. IS software with RS485 Slaves

To apply IS software to Slave meters or transmitters on the RS485 bus connected to a Gen2 LWIFI, LWIFIX or LNET1 board from the LNS discovery screen, click on “Slaves” under “Instrument Setup.” You will be prompted to click on “Yes” to exit the LNS utility and launch IS software.”



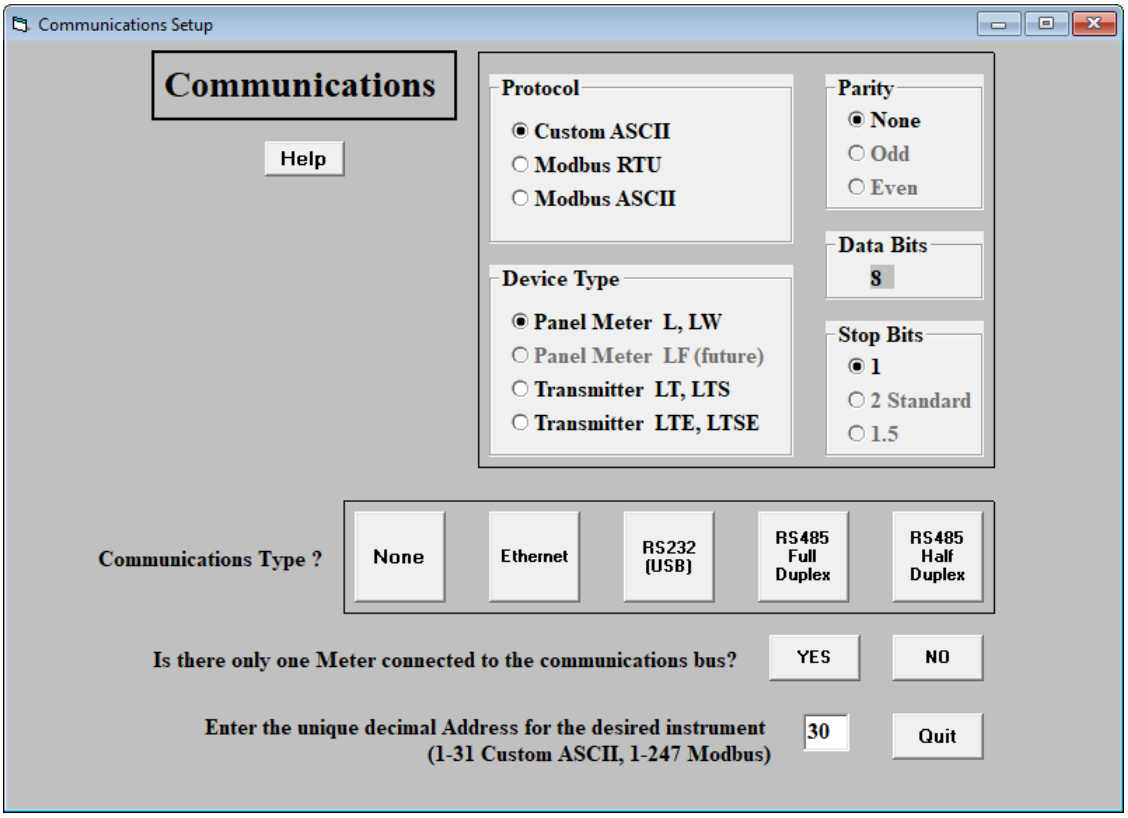


In the “Communications Setup” screen of IS software, select the “Custom ASCII” protocol, click on “RS485 Full Duplex,” click on “No” to indicate that there are multiple meters on the RS485 bus, enter the address 1-31 of the meter to be programmed, and press Enter.

The resulting “Establish Communications” screen will be as for the host (or Main) meter. Select the COM port discovered by the LNS utility and 19200 baud. Click on “Establish” to establish communications. Two lines highlighted in green should appear at the bottom of the screen to indicate success. Click on “Main Menu” to enter main IS software screens.

To get started, click on “DPM” or “Counter” and then on “Get Setup” to upload setup information from the DPM our Counter to your PC. Click on “Put Setup” to download any changes to your PC.

You must recycle power to the host (or Main) meter to reenter the LNS utility after running IS software, or you will get the message “No Network Board Found.”



IS software Communication Setup screen for Slaves.

3. Using Modbus commands to program meters on the fly

While IS software is great for initial setup of a meter, it is not suitable for changing operating parameters during normal meter operation. Examples of parameters to be changed “on the fly” are setpoints for relay action.

Operating parameters can be changed with Modbus commands. With only a few exceptions, these can modify all setup parameters entered via a meter’s front panel or via Instrument Setup (IS) software. A warning is that changing any parameter in non-volatile memory of a Laureate meter causes a meter reset. During reset, normal meter operation is suspended, and the word “Reset” may flash one or multiple times.

12. DATA CACHING, DATA RATES & READ RATES

Cached operation is a key feature of LWIFI, LWIFIX and LNET1 Gen 2 communication boards. It allows much faster command mode operation than for Gen 1 communication boards. The use cache decouples the rate at which the Gen 2 board can poll its host meter as a Master from the rate at which the Gen 2 board can be polled as a Slave by external Modbus commands.

If the host meter is an analog input meter, a Gen 2 board can get updated readings from its host meter as fast as every **16.666 msec** if the meter is set for 60 Hz noise rejection or every **20.000 msec** if the meter is set for 50 Hz noise rejection. Note that every 17th reading is not updated since the meter then zeroes itself.

If the host meter is a counter set to frequency or rate mode, a Gen 2 board can get updated readings from its host meter every programmed gate time from 10 msec to 199.99 sec + 30 msec + 0-2 signal periods.

The fastest rate at which updated values can be read via external Modbus commands is paced by the measurement update 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.

Single values written into cache can be retrieved via WiFi, Ethernet, USB or RS485 using Modbus commands at these maximum rates:

- Ethernet: every 2 msec
- WiFi: every 10 msec
- USB: every 10 msec (at 38400 baud)
- RS485: every 5 msec (at 115200 baud)

A set of 6 analog values are written into cache every **100 msec** (60 Hz filtering) or **120 msec** (50 Hz filtering) if the "Cache Setting" is set to "All Measurements."

USB communications between an LWIFI, LWFIX or LNET1 board and an external Modbus Master use the Modbus RTU protocol, 38400 baud and address 1. These parameters cannot be changed.

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.

Ethernet communications between an LNET1 or LNET-485 board and an external Modbus Master use the Modbus TCP protocol at a 10 or 100 Mbits/sec.

System-internal communications between a Gen 2 board and its host meter use the Custom ASCII protocol, 19200 baud, N81, and address 1. These parameters need to be entered into the host meter from its front panel or with IS software.

System-internal communications between a Gen 2 board and Slave meters on an RS485 bus use the Custom ASCII protocol, 19200 baud, and N81. These parameters and the meter address need to be entered into each Slave meter in advance.

13. GEN 2 MODBUS IMPLEMENTATION

1. Modbus Protocol Overview

The Modbus protocol is used for external commands with Gen 2 communication boards, not Laurel's Custom ASCII protocol or the Ethernet/IP protocol. The same Modbus function codes and registers apply to Modbus TCP, which is used with Ethernet or WiFi, and to Modbus RTU, which is used with USB or RS485.

The Gen 2 Modbus protocol implementation described in this manual is simpler than that for Laurel's legacy Gen 1 boards. However, all Gen 1 Modbus protocol commands also work with Gen 2 boards. Please see our Gen 1 Modbus Protocol Communications Manual, Analog Input and our Gen 1 Modbus Protocol Communications Manual, Pulse Input.

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. Gen 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. Gen 2 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 10 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. Gen 2 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. Gen 2 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
skipped	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 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. Gen 2 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="4">Byte 3</th><th>Byte 2</th><th>Byte 1</th><th></th></tr>
<tr><td>Magnitude (Mag)</td><td colspan="4">XXXX XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td><td rowspan="5">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="3">XXX XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td></tr>
<tr><td>S</td><td colspan="5">Magnitude</td></tr>
<tr><td rowspan="2">Sign + DP + Magnitude (S+DP+M)</td><td>X</td><td>XXX</td><td colspan="2">XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td></tr>
<tr><td>S</td><td>DP</td><td colspan="4">Magnitude</td></tr>
<tr><td>2’s Complement (2’s C)</td><td colspan="4">XXXX XXXX</td><td>XXXX XXXX</td><td>XXXX XXXX</td></tr>
</table>

DPM NONVOLATILE MEMORY ADDRESSES (2 bytes/address)

Gen 2 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

Gen 2 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

Gen 2 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

13. DIAGNOSTIC TOOL QMODMASTER

1. About QModMaster

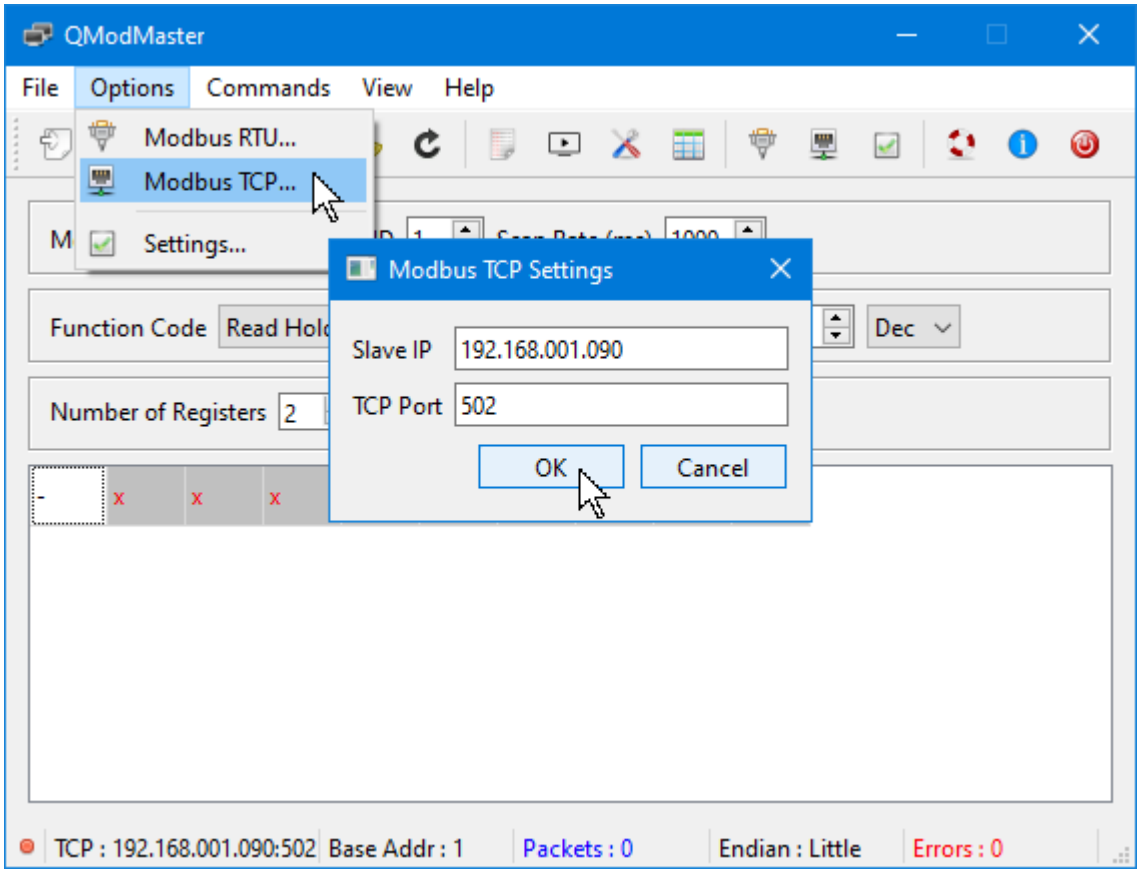
QModMaster.exe is a freeware Windows program which allows a PC to serve as a Modbus Master. It is an easy tool to verify communications, send requests to Modbus Slaves, and view their responses. The current version handles Base 1 and allows the viewing of IEEE 754 floating point values.

2. QModMaster Download and Launch

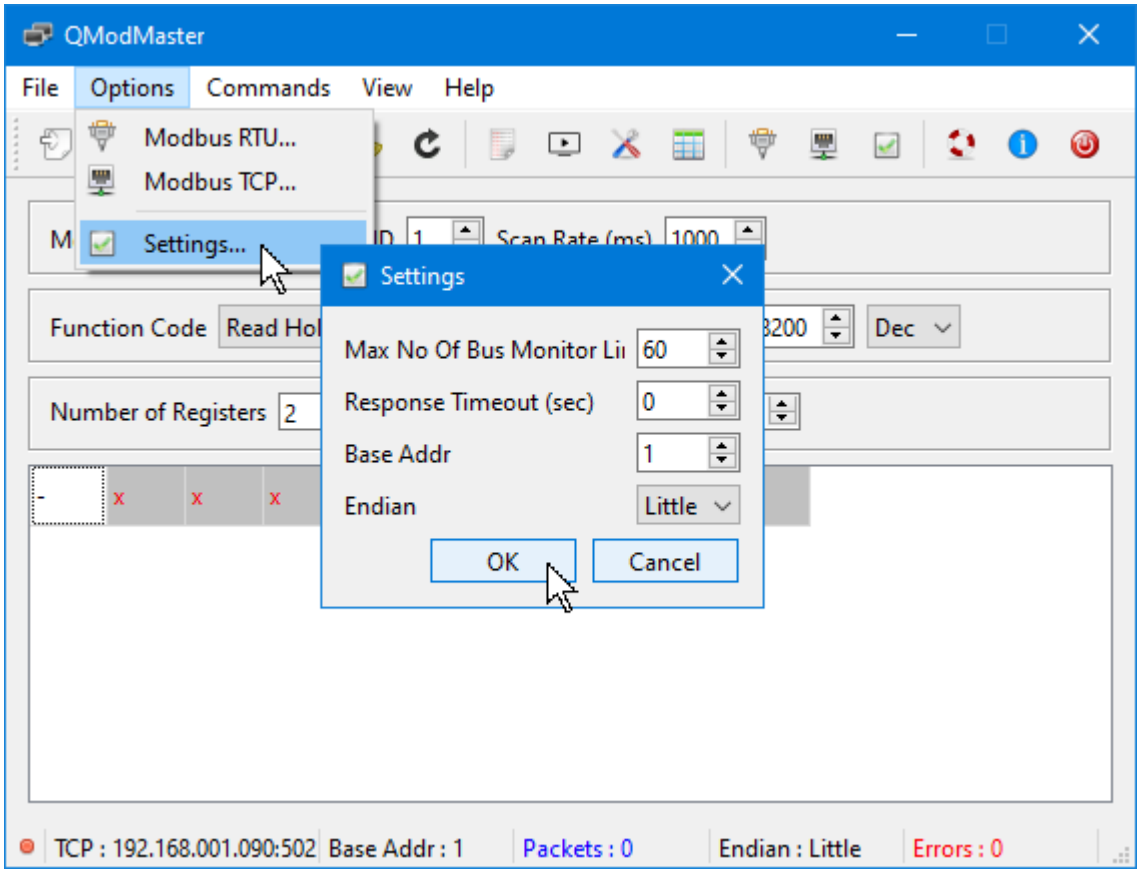
Download QModMaster-Win64-exe-0.5.3-beta.zip from https://sourceforge.net/projects/qmodmaster/files/latest/download and copy it into a directory of your choice. Do an “Extract All” to unzip it. The executable file will be QModMaster.exe. Click on it to launch QModMaster. You may wish to create a shortcut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



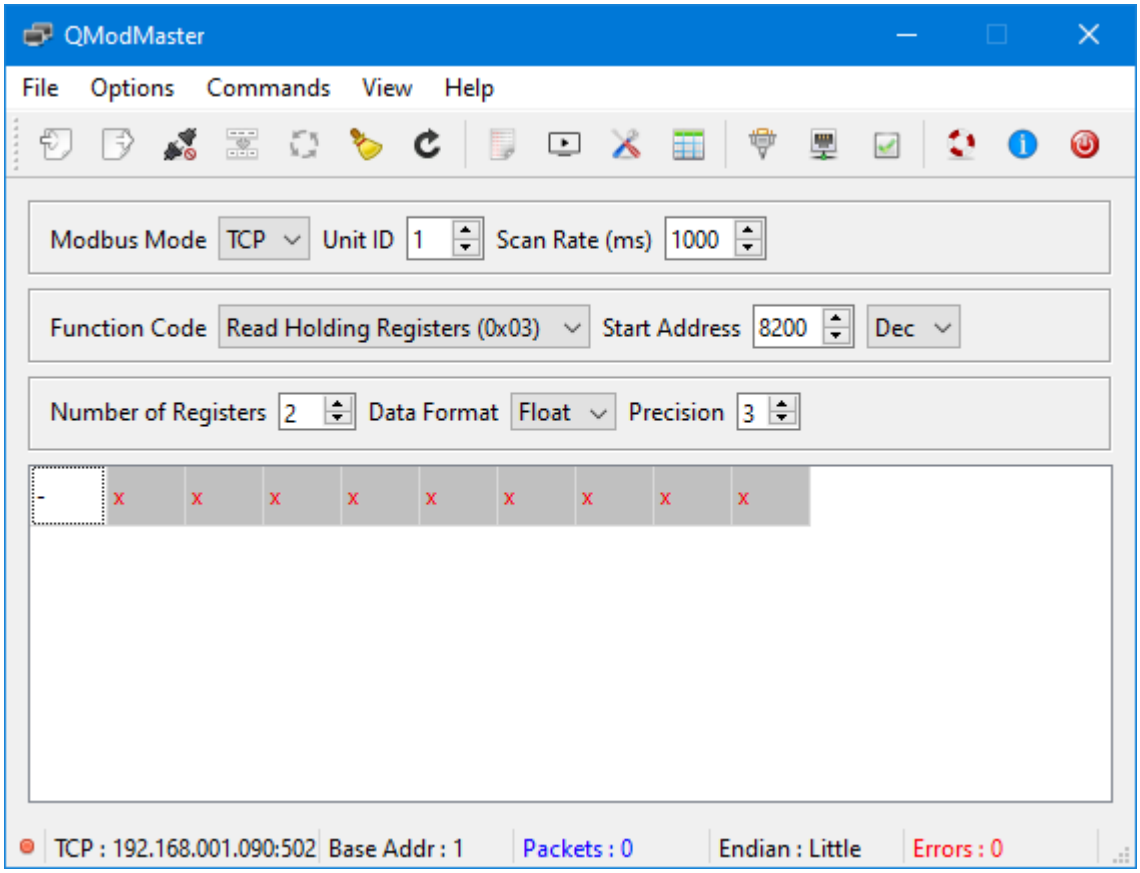
b. The second step is to click on *Options* > *Settings*. In the *Settings* dialog window, ensure that everything is configured as shown and click on *OK*. These are the default settings:



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

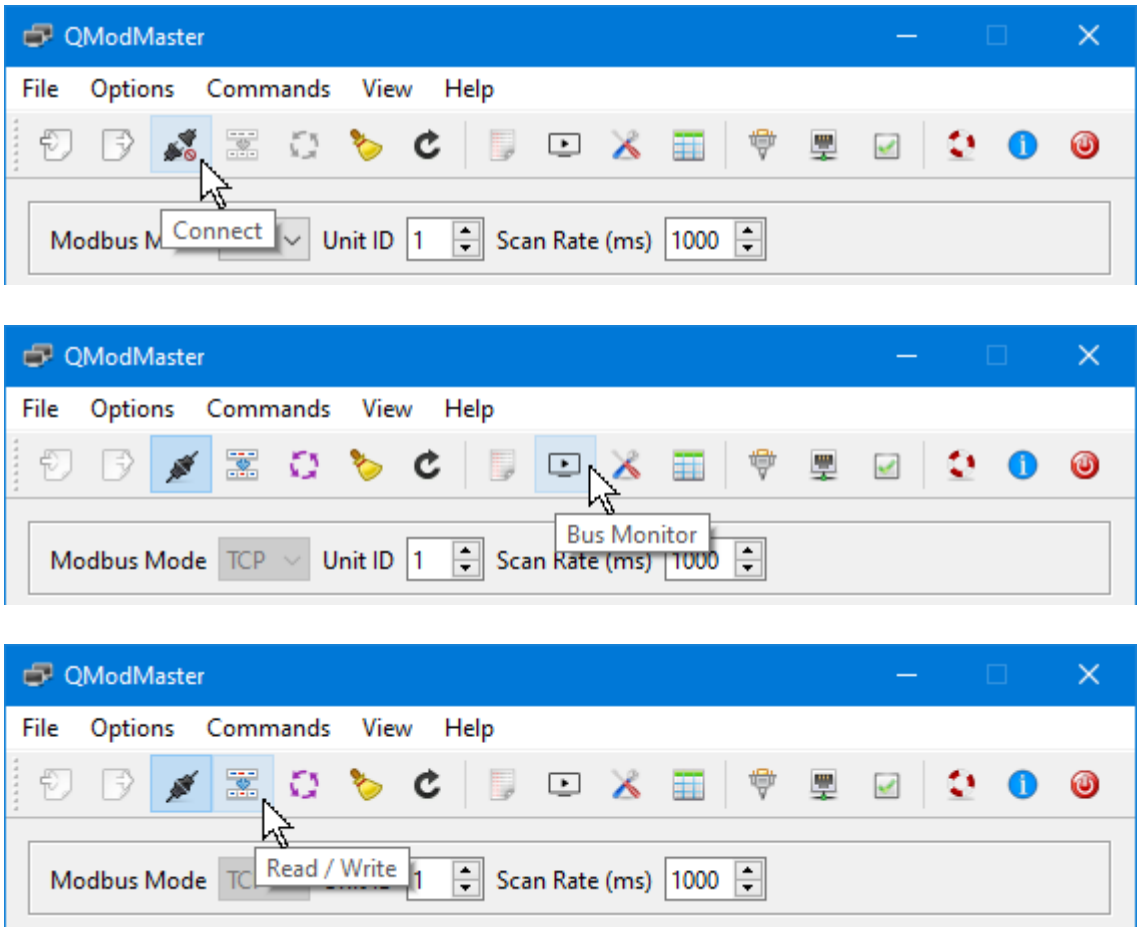
The screen capture below demonstrates the setup to read the currently displayed measurement in floating point format. The critical items are:

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

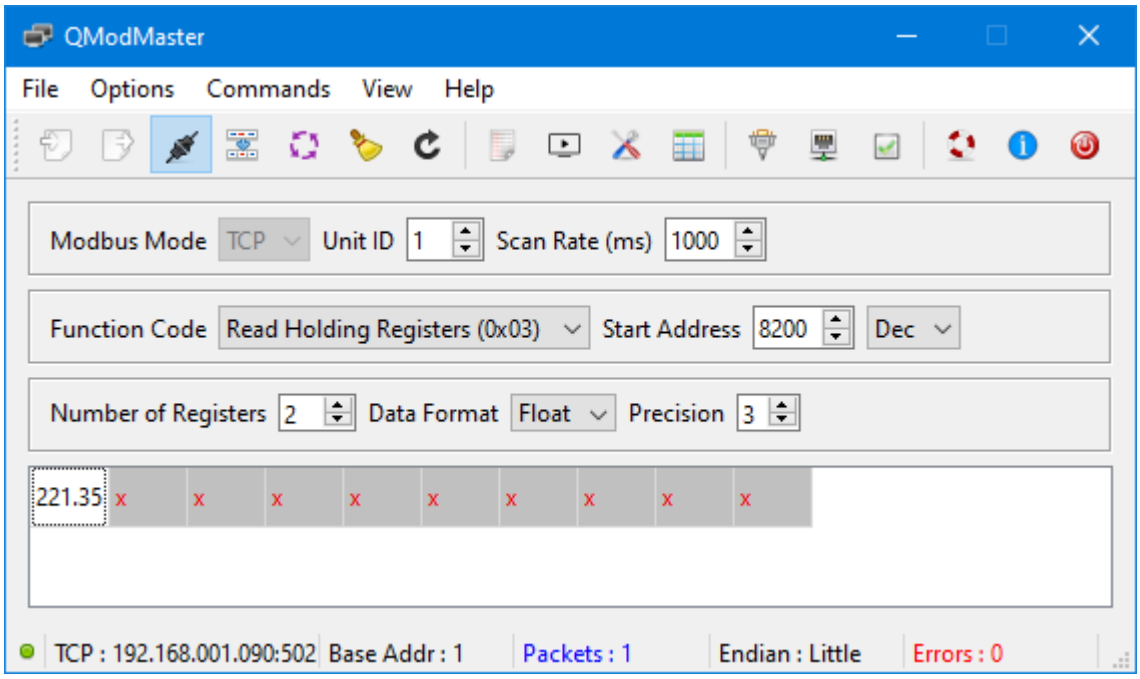


After QModMaster has been set up to read the floating point value:

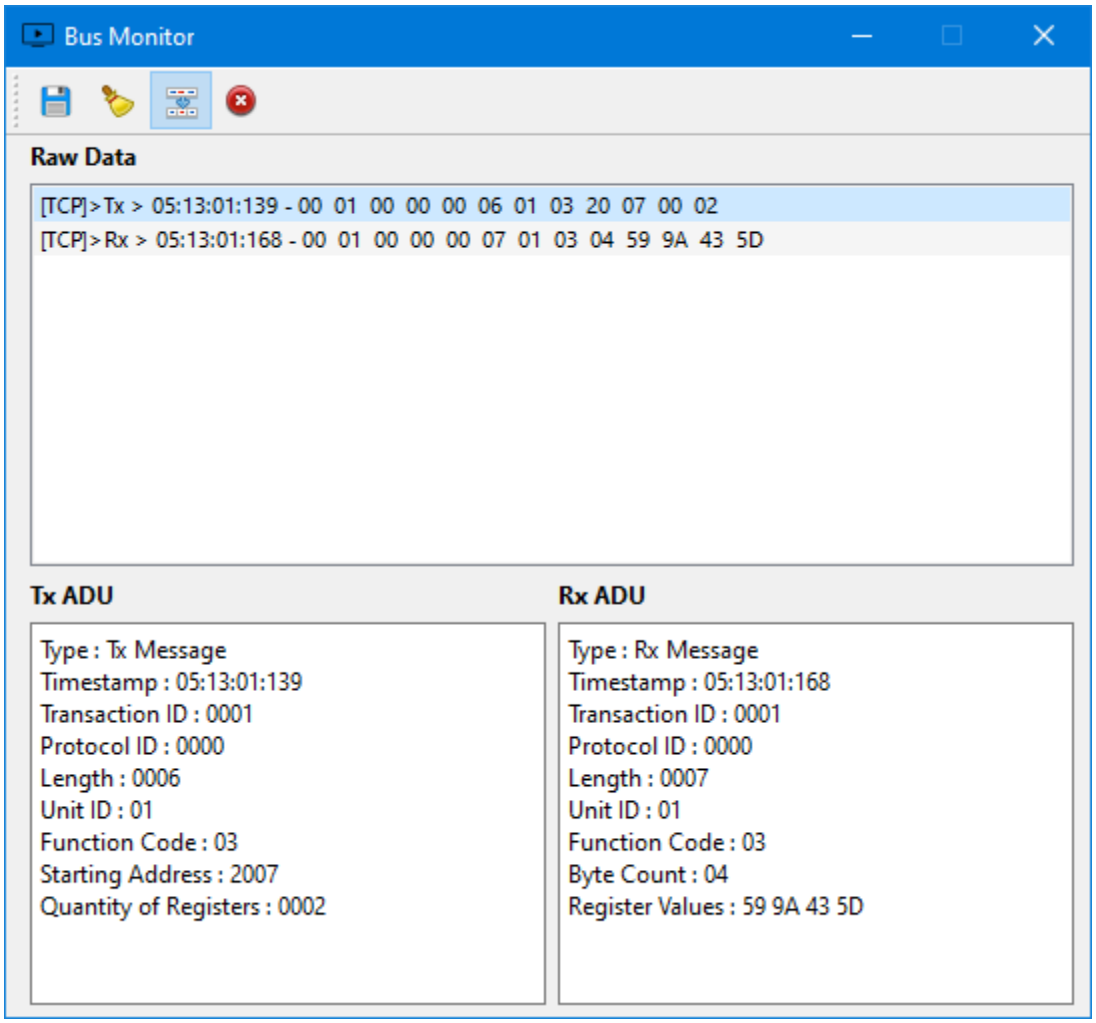
- Click on the **Connect** icon to establish a TCP/IP connection to the LWIFI equipped instrument.
- Click on the **Bus Monitor** icon to view the command/response operation.
- And finally, click on the **Read/Write** icon to perform the operation.



The instrument's displayed value of 221.35 is read and presented in the main QMod-Master 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.



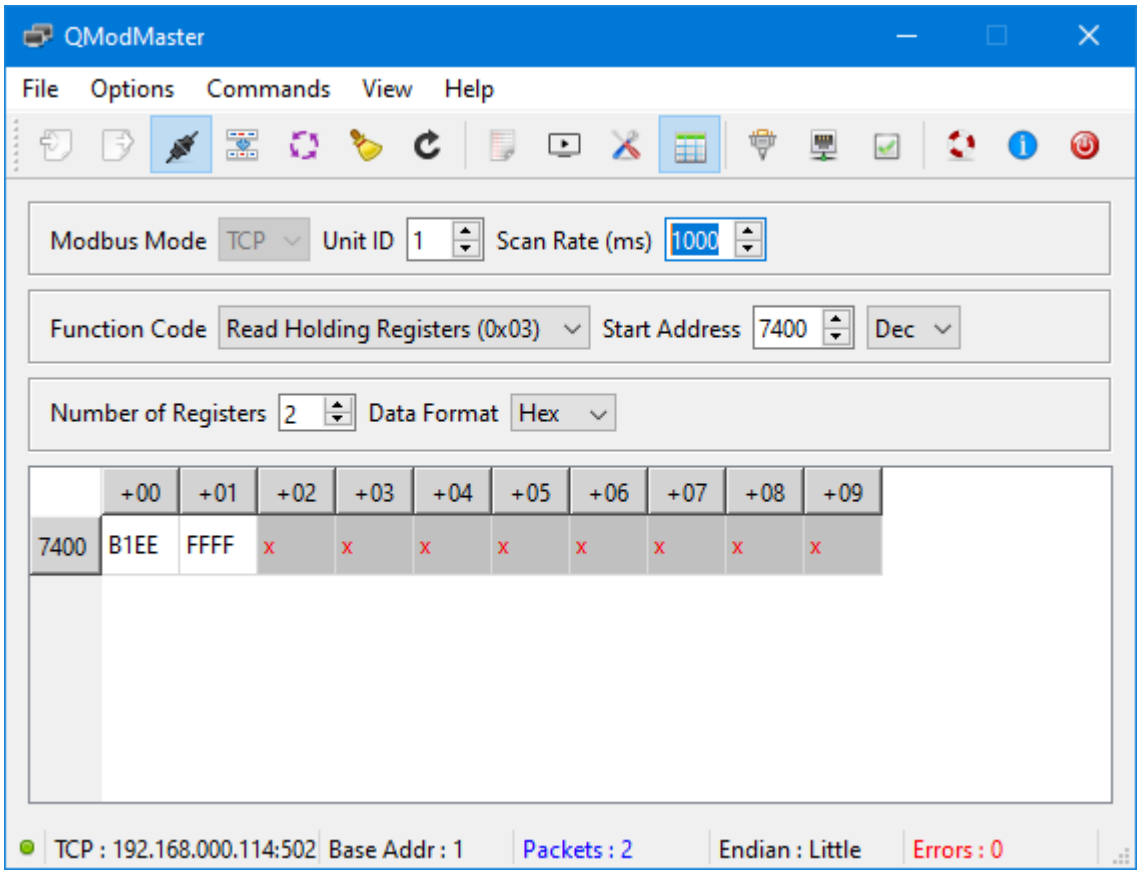
5. Example 2: Obtaining a Signed Integer Measurement from a DC Voltmeter

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.

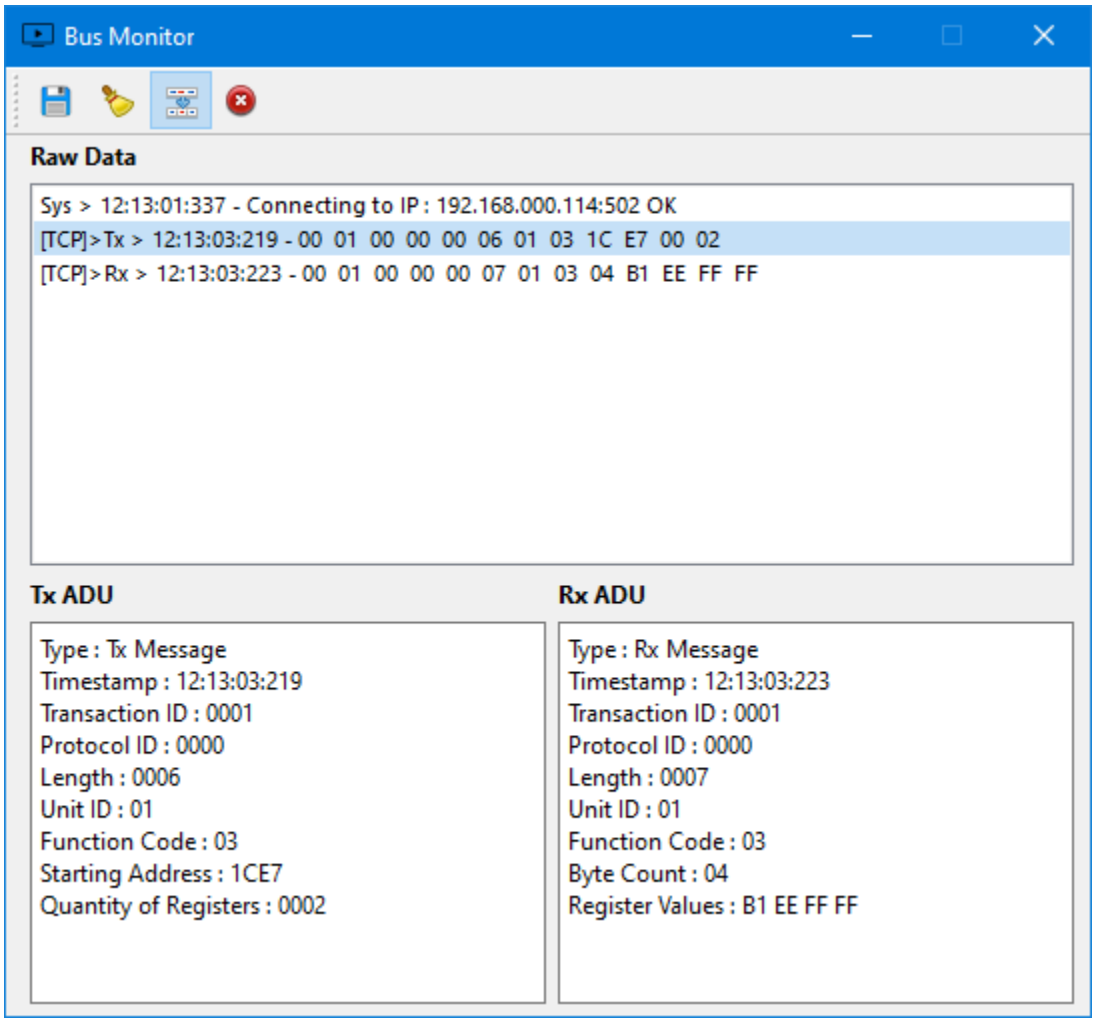
The critical items are:

- 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

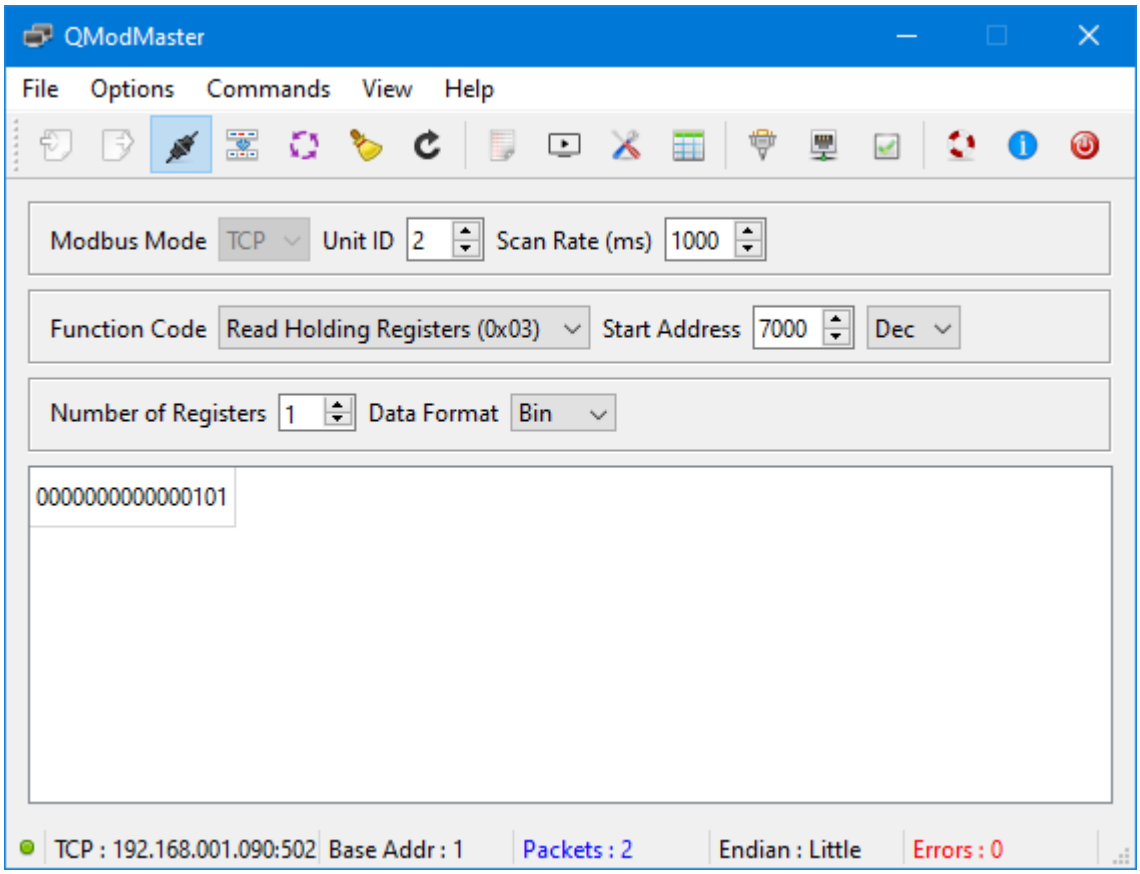
6. Example 3: Reading Alarm & Overload Status from a DC Voltmeter

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.

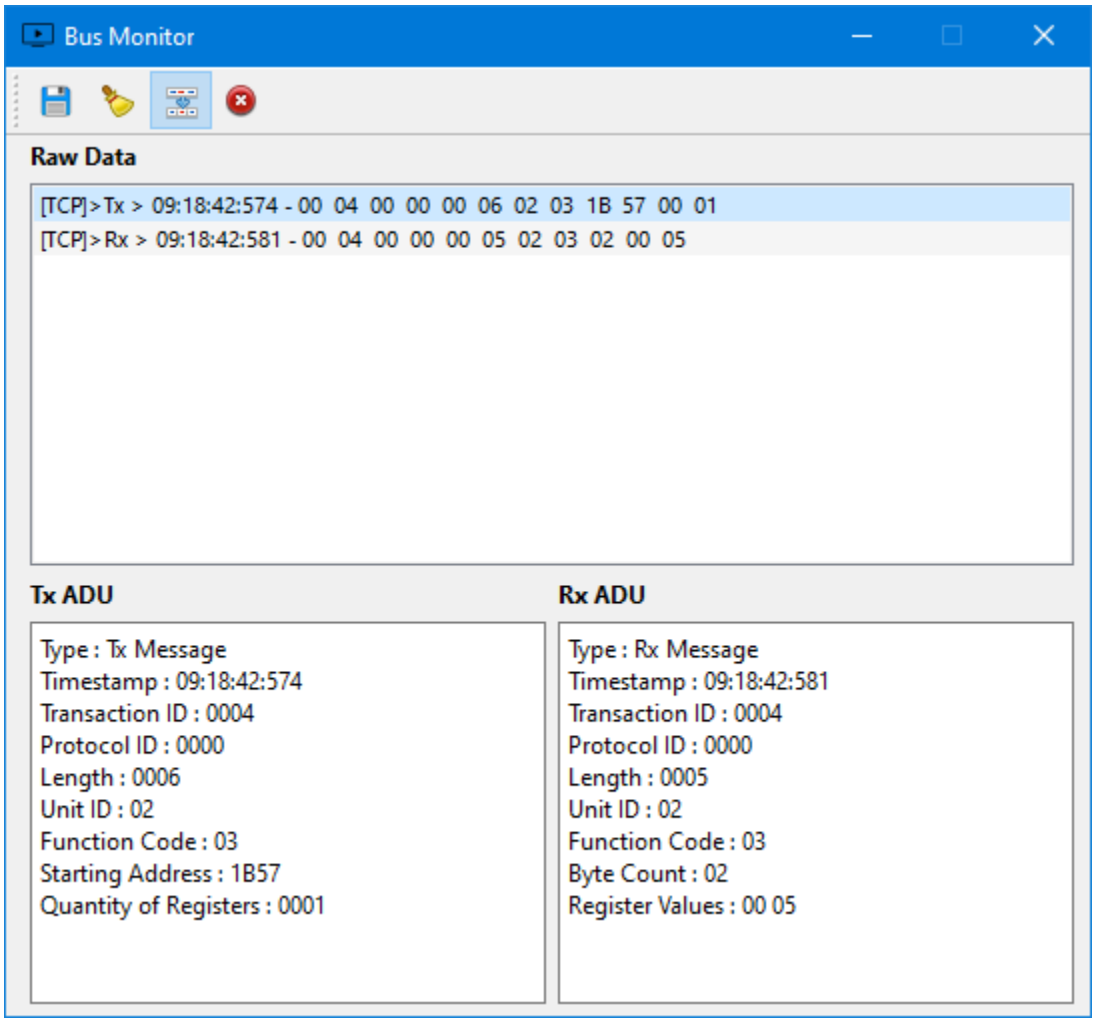
The screen capture below shows the main window of QModMaster which is setup to read the alarm and overload status. The critical items are:

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

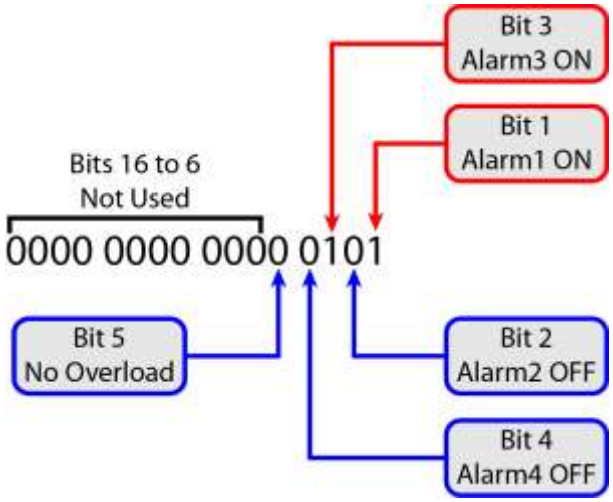
The **Read/Write** icon has been clicked and the 16-bit value of holding register 7000 is displayed.



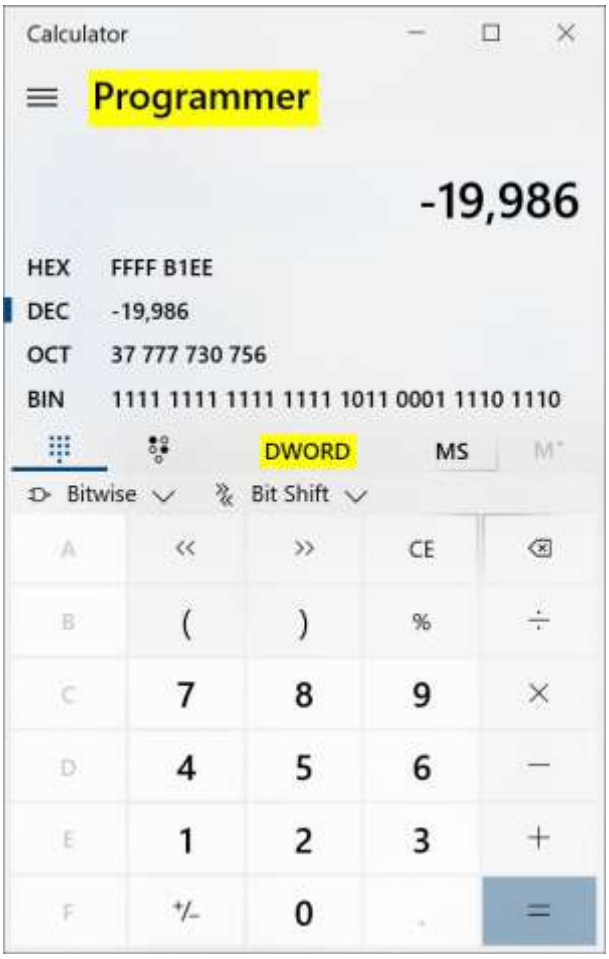
The QModMaster Bus Monitor window presents the Modbus Command transmitted to the LWIFI and its response. Note that the hexadecimal byte values of **00 05** represent the same alarm and overload status shown above in binary.



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.



15. GEN 2 COMMUNICATION BOARD SPECIFICATIONS

Communication Interfaces, LWIFI Board

Communication ports ..... WiFi with integral antenna, USB 2.0 port, RS485 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

Communication ports ..... WiFi with external antenna, USB 2.0 port, RS485 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 connector ..... Mini-USB Type B
RS485 connector RJ11

Communication Interfaces, LNET1 Board

Communication ports ..... Ethernet port, RS485 port
Ethernet connector RJ45
RS485 connector RJ11

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

RS485 Performance

RS485 applications ..... WiFi or Ethernet to RS485 gateway, or polling by PC

RS485 connector 6-pin RJ11
RS485 cable ..... Non-reversing 6-wire data cable with RJ11 connectors (CBL03)
RS485 data rate ..... 19200 for Instrument Setup software or RS485 gateway,
1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200 baud for polling by PC
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

Measurement Update Intervals

Analog input meter ..... 16.666 or 20.000 msec (set for 60 or 50 Hz noise rejection)
Frequency/rate pulse readings ..... Gate time + 30 msec + 1-2 signal periods

Communication Protocols

Meter polling via Ethernet or WiFi ..... Modbus TCP/IP (same command set as RTU)
Meter polling via USB or RS485 ..... Modbus RTU
System internal ..... Custom ASCII protocol

Mechanical

Gen 2 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

16. APPENDIX: ETHERNET PRIMER & DEFINITIONS

Node refers to an Ethernet or WiFi connection point that is receive and send data on a network. As used by Laurel, Node (with a capital N) refers to the chip that processes Ethernet or WiFi data. Each Node has a unique MAC address.

MAC address is a 12-digit hexadecimal number that is most often displayed with a colon separating every two digits (or octets), like 2C:54:91:88:C9:E3. MAC addresses are allocated by IEEE and are programmed in by the factory. Do no change a Node's MAC address, since non-allocated values may be blocked by a managed switch.

An IP address (e.g., 192.168.0.19) is used to address Ethernet or WiFi nodes on a LAN (local area network) or WAN (Internet or Wide Area Network). With wired Ethernet, an IP address can be Static or Public so that it can be addressed on a WAN. It can also be dynamic as assigned by a router or other DHCP device for addressing on the same LAN. Dynamic IP addresses on a LAN are also called private or local. With WiFi, and IP address is always dynamic as assigned by the wireless router.

Device, as used by Laurel in context of Nodes, refers to an instrument supported by a Node. That can be the single host (or main) meter or transmitter that holds the Node. That can also be one of multiple meters or transmitters on an RS485 bus supported by the Node when the part number of the Gen 2 board ends in 485.

A port number is associated with each software application and serves as a password for two-way packet transmissions. Default port numbers assigned to our Nodes are TCP port **502** for Modbus TCP transmissions, UDP port **63179** for UDP transmissions, and TCP port **80** for web server http:// transmissions.

A router is a device that bridges two networks and forwards data packets to their destinations on a LAN. Transmissions are passed based on the destination IP addresses and the port number of the application. Normally a router will use its built-in DHCP server capability, and network devices will use their built-in DHCP client capability to negotiate private (or local) IP addresses for all devices on the LAN.

A switch is a device that forwards and branches data packets between different segments of the same LAN. An "unmanaged switch" is a simple plug-and-play device. A "managed switch" or "smart switch" adds programmable capabilities and security features.

A DHCP server dynamically assigns an IP address and other network configuration parameters to nodes on the LAN so that they can communication with each other and with other networks. A dynamic IP address is assigned by a wireless router to each WiFi node on the network. On a WAN (Internet or Wide Area Network) where the host computer is outside of the remote LAN, the public IP address of the router of the remote LAN must be entered for all nodes on its LAN.

Instrument Setup (IS) software is a free Window-based application that runs on a host PC. It and is designed to program Laureate meters or transmitters that communicate with that PC, for example to set scale factors. It is an alternative to front panel programming for meters. It is the only way to program transmitters, which do not have a front panel. The only way to access IS software via a Gen 2 communication board is to click on “Main” or on “Slaves” under “Instrument Setup” in the LNS (Laurel Network Setup) screen. This allows the IS software to be applied to the Main (or host meter) or Slave meters on an RS485 bus. IS software has “Node Discovery” and “Device Discovery” functionalities, but these only work with Gen 1 LNET or LNET485 boards and with LTE transmitters. Access to Gen 2 boards by IS software can only be via LNS software.

Node Manager (NM) software is a free Windows-based application, but it only works with Gen 1 Ethernet products, like LNET or LNET485 boards and LTE transmitters. It does not work with Gen 2 communication boards.

17. 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.

