Model LTSE

ANALOG OUTPUT FROM MODBUS TCP/IP COMMANDS

OWNERS MANUAL

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1. ORDERING GUIDE, SERIAL INPUT TRANSMITTER

Configure a model number in this format: **LTSE60**

LTSE6… Transmitter with Ethernet serial data input, 4-20 mA, 0-20 mA or 0-10V isolated analog output, and dual 120 mA solid state relays.

Power

0..... 85-264 Vac or 90-300 Vdc
1..... 12-30 Vac or 10-48 Vdc

2. TABLE OF CONTENTS

3. INTRODUCTION, LTSE ETHERNET INPUT TRANSMITTER

The LTSE Ethernet input to analog output transmitter (or Ethernet-to-analog converter) accepts Modbus TCP/IP commands to generate an isolated, scalable 4-20 mA, 0-20 mA or 0-10V analog output. The LTSE utilizes an Ethernet counter transmitter main board, but no signal conditioner board. It is factory set to the Modbus TCP protocol. Unlike the LTS serial-to-analog converter, it does not work with the Custom ASCII protocol, which supports data streaming. Model LTSE60 is normally powered by AC (85-264 Vac). Model LTSE61 is powered by low voltage AC or DC (typically 24 Vdc).

The analog output can be set by jumpers to current (4-20 mA or 0-20 mA) or voltage output (0-10V). The analog output is transformer isolated to avoid ground loops, provides 16-bit resolution of the output span, and is ultra-linear to within one bit. The output is scaled to the serial input in software. Output accuracy is ±0.02% of span. The factory default setting is 4-20 mA.

Dual solid state relays rated 120 mA at 140 Vac or 180 Vdc are standard. The relays can respond to the transmitted serial values or to transmitted control characters, which override the internal setpoints. The relays can also be controlled independently of the serial input by applying signals to control inputs 1 and 2.

Isolation to 250V rms is provided for power, the Ethernet input, analog output, and relay outputs. Isolation adds safety and avoids ground loops.

Transmitter setup is via the unit's Ethernet port using an external PC and our Instrument Setup (IS) software, which is at no charge.

4. COMPLEMENTARY MANUALS

- **Modbus Manual for Counters** at https://www.laurels.com/downloadfiles/Modbus-Manual-CTR.pdf.
- **Ethernet Manual** at https://www.laurels.com/downloadfiles/ethernet_manual.pdf. Covers Ethernet Node discovery and setup using Node Manager PC software or Web Server software built into each Node. Node Manager software can set up the sending of emails or text messages either periodically or in the event of an alarm.

5. RECEIVING & UNPACKING YOUR TRANSMITTER

Your LTSE transmitter was carefully tested and inspected prior to shipment. Should the transmitter be damaged in shipment, notify the freight carrier immediately. In the event the transmitter is not configured as ordered or is inoperable, return it to the place of purchase for repair or replacement. Please include a detailed description of the problem.

6. SAFETY CONSIDERATIONS

Warning: Use of this transmitter in a manner other than specified may impair the protection of the device and subject the user to a hazard. Visually inspect the unit for signs of damage. If the unit is damaged, do not attempt to operate.

Caution:

- This unit may be powered with AC (mains) from 85-264 Vac or 90-300 Vdc with the high voltage power supply option, or from 12-30 Vac or 10-48 Vdc with the low voltage power supply option. This transmitter has no AC (mains) switch. It will be in operation as soon as power is applied.
- The 85-264 Vac or 90-300 Vdc mains connector (P1 Pins 1-3) is colored **green** to differentiate it from other input and output connectors. The 12-30 Vac or 10-48 Vdc mains connector is colored **black**.
- To avoid dangers of electrocution and/or short circuit, do not attempt to open the case while the unit is under power. However, signal wiring changes external to the case can be made safely while the unit is under power.
- To prevent electrical or fire hazard, do not expose the transmitter to excessive moisture.
- Do not operate the transmitter in the presence of flammable gases or fumes. Such an environment constitutes an explosion hazard.
- Secure the transmitter to a 35 mm DIN rail.

Symbols used:

Caution (refer to accompanying documents)

Caution, risk of electric shock.

Equipment protected throughout by double insulation or reinforced insulation.

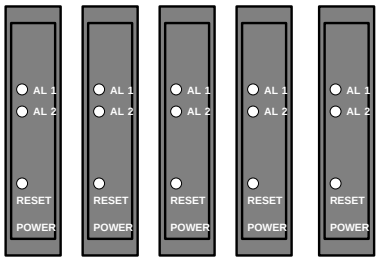
Earth (ground) terminal.

Both direct and alternating current.

Operating environment:

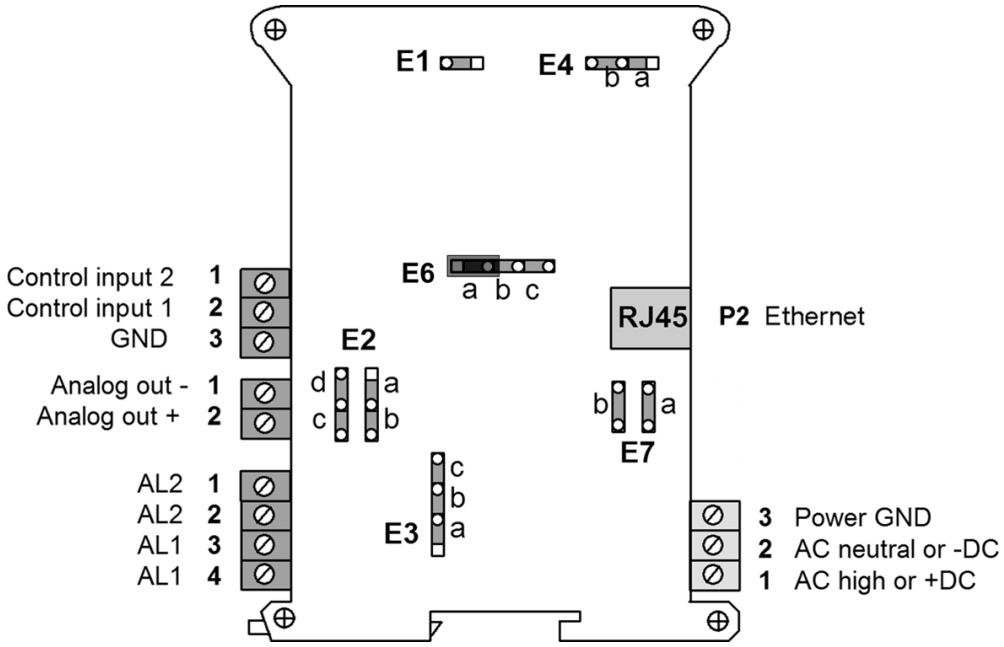
- Class II (double insulated) equipment designed for use in Pollution degree 2.

PROVISION FOR COOLING



To avoid overheating, mount transmitters with ventilation holes at top and bottom. Leave a minimum of 6 mm (1/4") between transmitters, or force air with a fan.

7. LTSE TRANSMITTER FIELD WIRING & JUMPER SETTINGS



E2 jumpers a + d set the analog output to 4-20 mA or 0-20 mA current (factory default setting).
E2 jumpers b + c set the analog output to 0-10V voltage.

The analog output is sourcing. Do not put an external voltage source in series with it. Applying an external 24 Vdc source will burn out the analog output board.

Do not change E1, E3, E4, E6 or E7 jumpers.

HOW TO OPEN & CLOSE THE CASE

The only reason to open the case would be to change the factory default 4-20 mA or 0-20 mA analog output to 0-10V. To open the case, remove the four screws at the LTSE corners. When closing the case, make sure that the ventilation grills are properly aligned.

8. SETTING UP YOUR LTSE TRANSMITTER WITH IS SOFTWARE

OVERVIEW

The analog output and relay output functions of an LTSE transmitter are set up initially with Laurel's free Instrument Setup (IS) software, a Windows-based application that runs on a PC. For setup, the LTSE can be connected to the PC via a direct Ethernet connection, or the LTSE can be plugged into the same LAN as the PC. The IS software running on the PC will discover the LTSE's Ethernet Node (or Ethernet chip) and the host Device (or the LTSE transmitter proper) that houses the Node.

To set up the analog output, jumpers on the LTSE main board are used to select current output (4-20 mA or 0-20 mA) or voltage output (0-10V). Current output is the factory default. To scale the analog output, the values for the high and low endpoints of the range are entered using IS software. A variable called "Item 3" is entered via a Modbus command and is compared to the two endpoints to generate the analog output by linear interpolation.

To set up relay operation, relay setpoints and relay operation modes are programmed into the LTSE using IS software. For relay operation, the same "Item 3" variable that is used for the analog output is compared to the setpoints. The relays can also be actuated directly via Modbus commands, as explained in this manual.

Following initial setup, the endpoints used to generate the analog output and the parameters used to control relay operation can be changed on the fly using Modbus commands shown in our Modbus Manual for Counters at https://www.laurels.com/downloadfiles/Modbus-Manual-CTR.pdf.

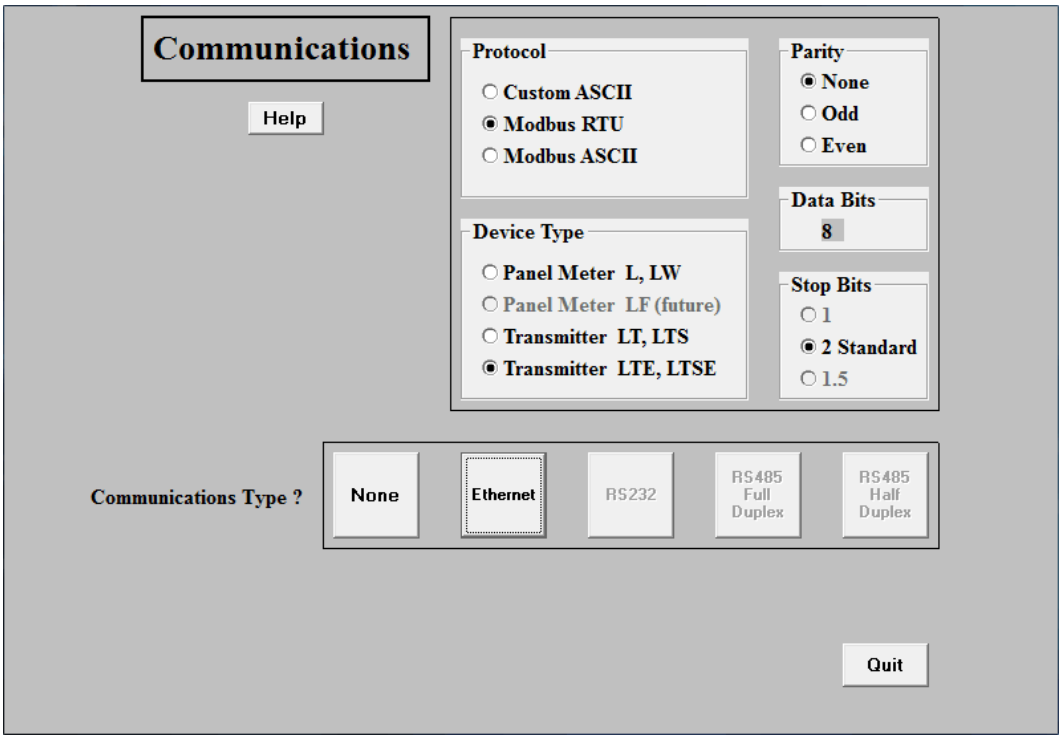
INSTALLING INSTRUMENT SETUP (IS) SOFTWARE

Under Windows 7 or 10, set User Account Control (UAC) to "Never Notify" so that IS software can write files. Use Google for instruction on how to change UAC for your version of Windows. Turn off and restart your computer. Download IS3_5_4.exe onto your PC from our website. Double-click on the downloaded file to unzip it into a directory, like C:\temp. Within that directory, double-click on setup.exe to install the software on your PC. IS software works with all versions of Windows. If you cannot complete the installation, this may be because of software firewalls at your company. Please see the troubleshooting section at the back of this manual. Your executable file will be C:\Program Files(x86)\IS2\Instrument Setup.exe. Copy that file and paste a shortcut on your Desktop.

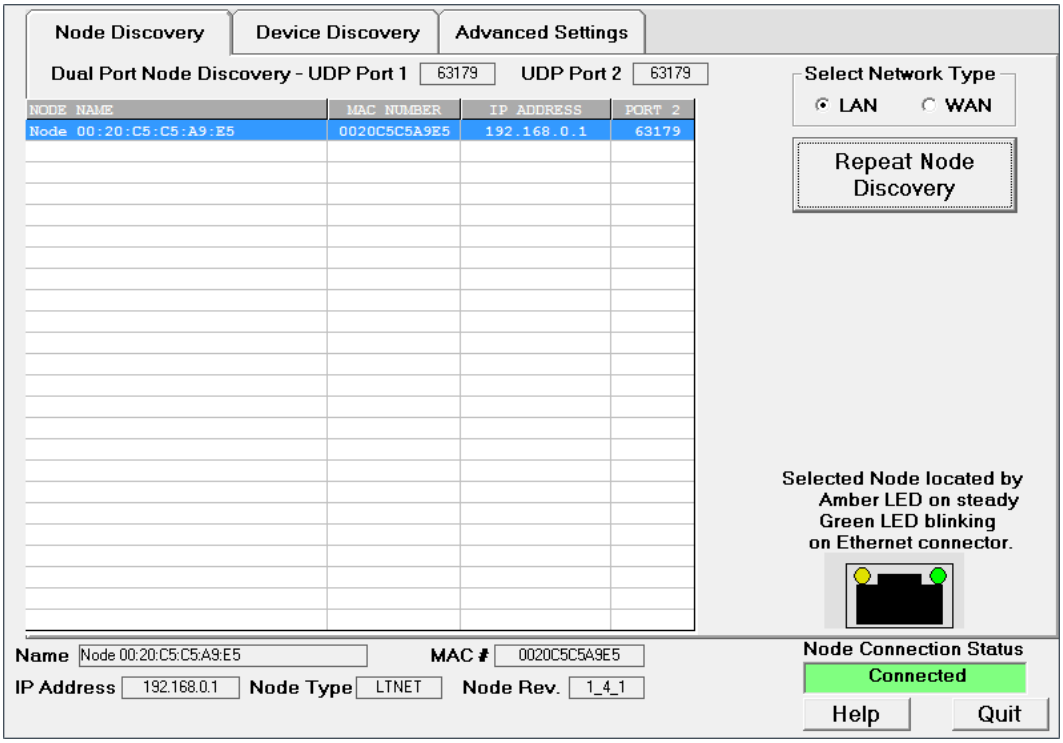
ESTABLISHING ETHERNET COMMUNICATIONS

Connect the PC to the LTSE directly via an Ethernet cable, or connect the PC and LTSE via Ethernet cables into the same Local Area Network. Ethernet cables (CAT5 or better) can be straight-through or crossover. Our Ethernet Nodes automatically adapt for either. Apply power to the LTSE, and click on the IS shortcut that you have created in the previous step.

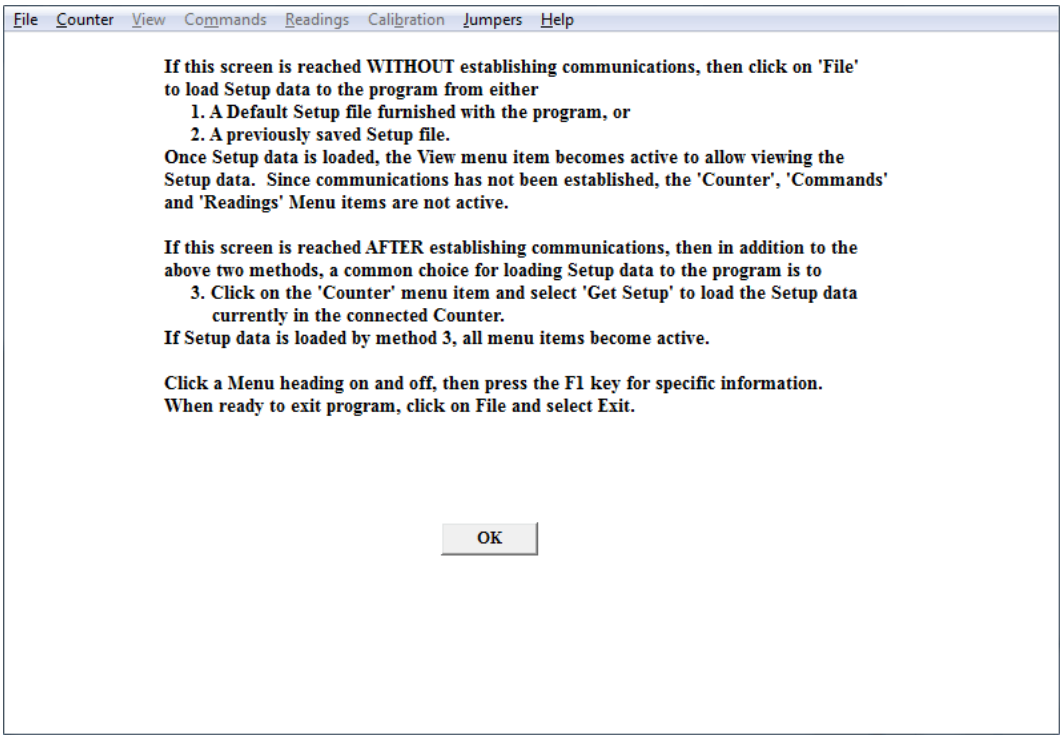
Following a brief splash screen, IS software will open the *Communications* screen. Make selections as shown below, and click on *Ethernet*.



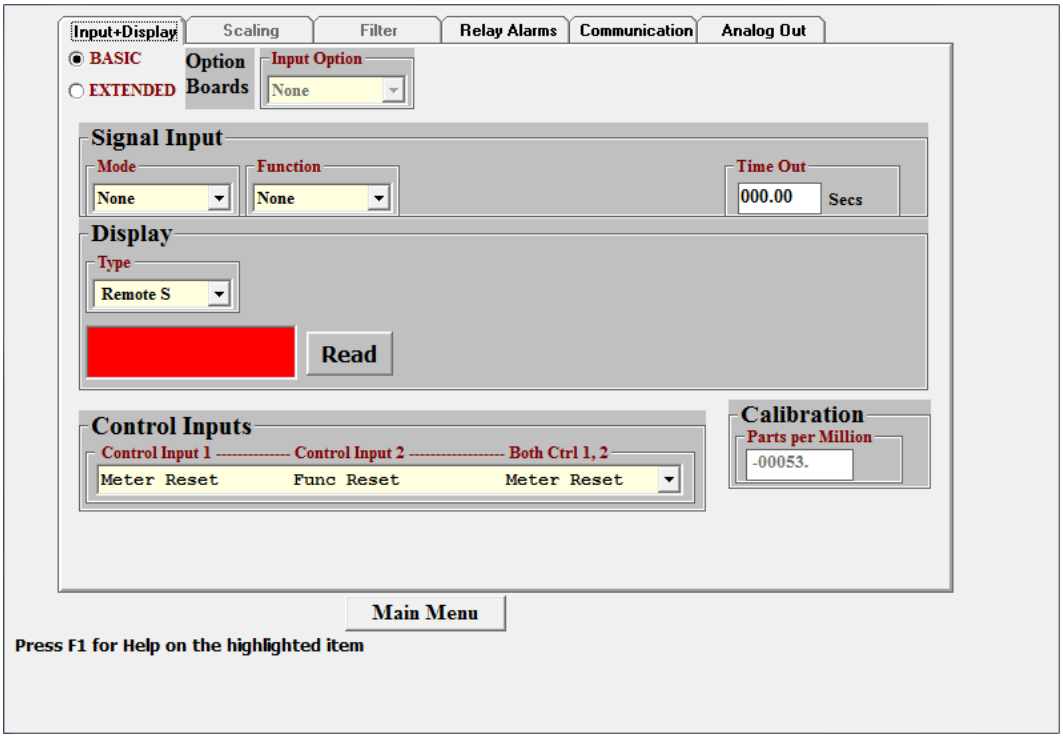
In the resulting *Node Discovery* screen, all Laurel Nodes discovered by your PC will be listed. Highlight the Node that corresponds to your LTSE.



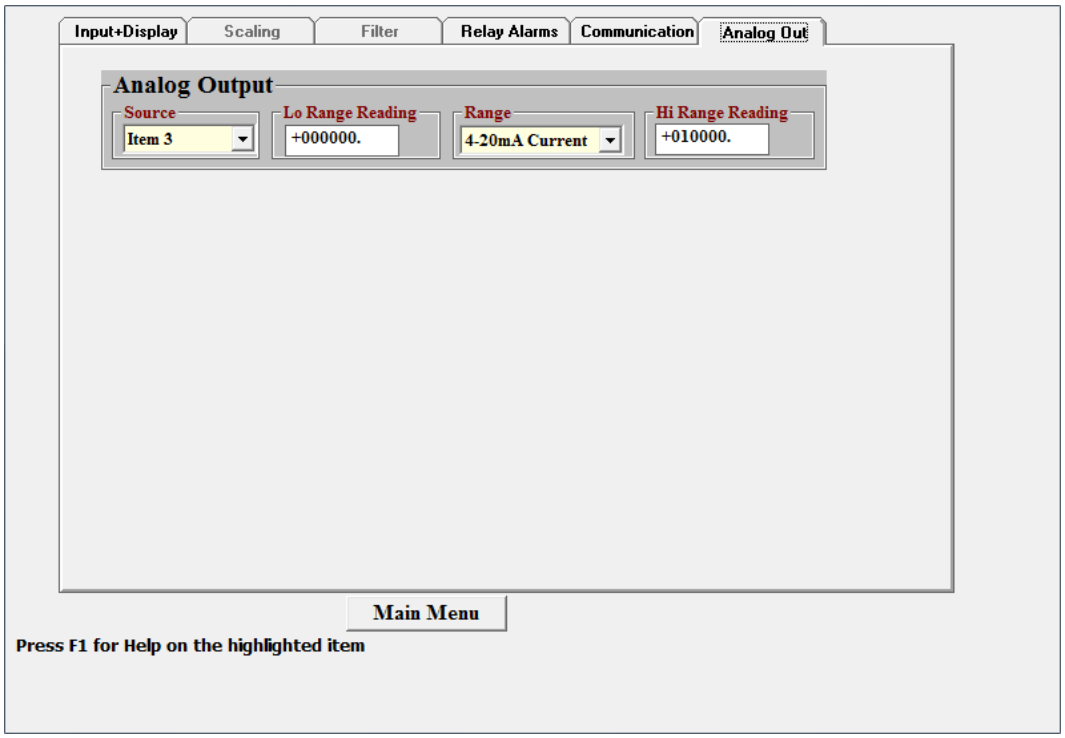
After highlighting the Node corresponding to your LTSE, click on the *Device Discovery* tab. Only the LTSE host of your Node should be listed. Highlight that Device, and press *Main Menu*.



From the *Main Menu* screen, press on *Counter* and on *Get* to upload the setup program from your LTSE into your PC. Press on *View* then *Setup* to view the setup parameters of your LTSE. Available Main Menu tabs will then be displayed. The first tab is *Input+Display*. Clicking on *Read* will allow you to view the latest reading transmitted via Modbus.

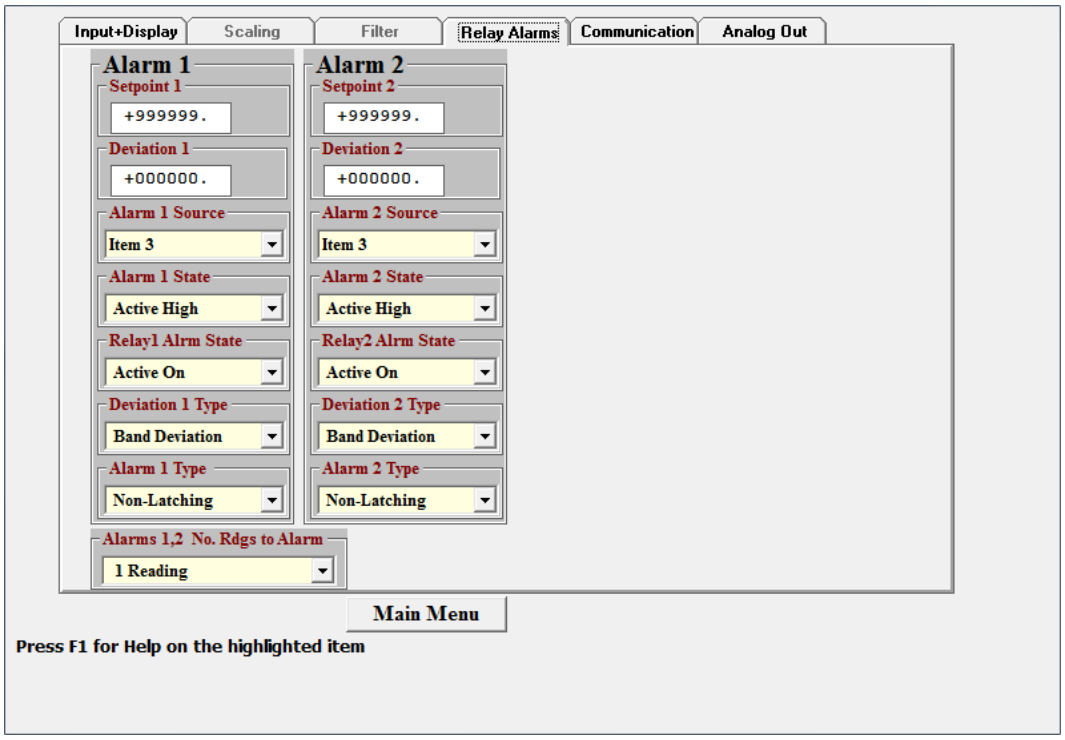


Click on the *Analog Out* tab to scale your analog output. The factory default output is 4-20 mA, which is set by jumpers as explained previously in this manual. Enter the *Lo Range Reading* that is to produce the low analog out, such as 4 mA, and the *Hi Range Reading* that is to produce the high analog output, such as 20 mA. This will create the two endpoint values of your analog output range. Only enter numerical values. The decimal point is ignored.

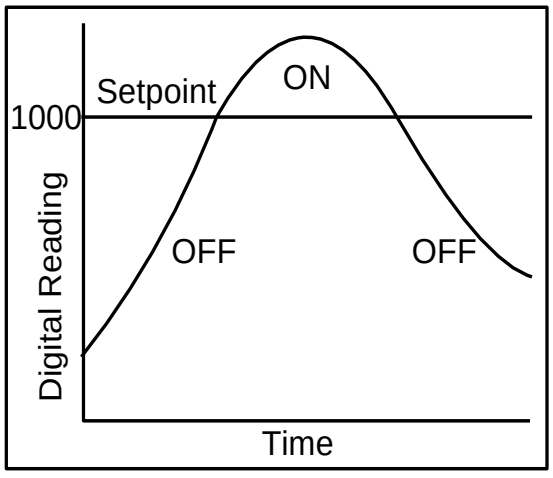


The analog output is sourcing. Do not put an external voltage source in series with it. Applying an external 24 Vdc source as would be required for a 2-wire transmitter will burn out the LTSE's analog output circuit.

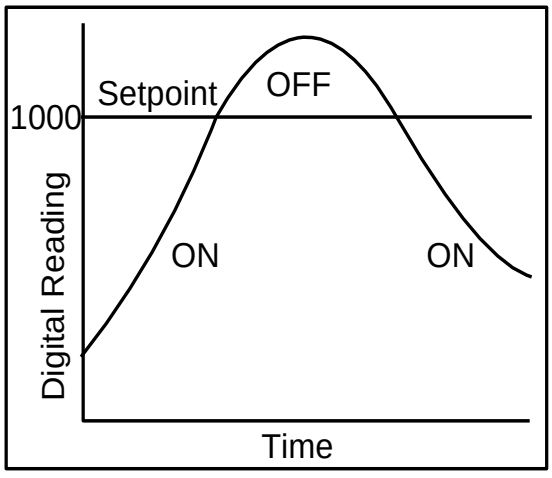
Click on the *Relay Alarms* tab to set up the LTSE's two solid state relays, which are standard.



The two relays can operate in a basic alarm mode, in a hysteresis band mode, or in a deviation band mode, as explained below. Setpoint operation is referenced to the digital reading that is received as serial data. For example, temperature alarm or control would be referenced to a setpoint in °C or °F.

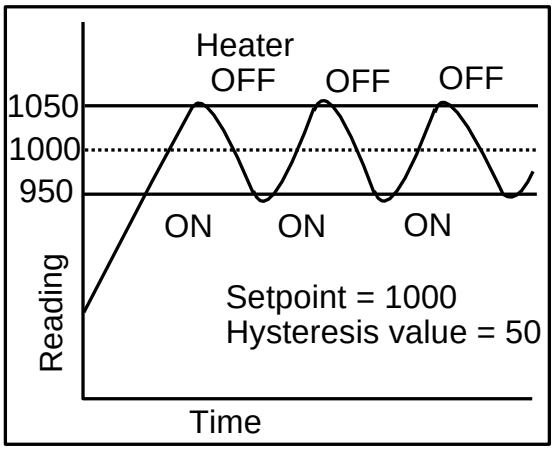


Active High Basic Alarm

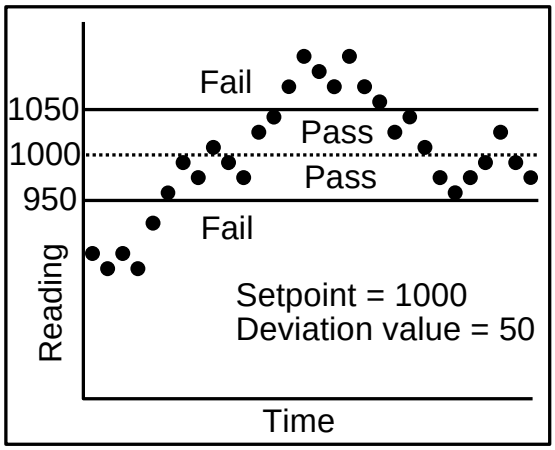


Active Low Basic Alarm

A basic alarm changes state automatically when the reading rises above a specified limit, and changes back automatically when the reading falls below that limit. A red LED indicates the relay is in an alarm condition, which can be active high or active low, as programmed.



Hysteresis Band Alarm

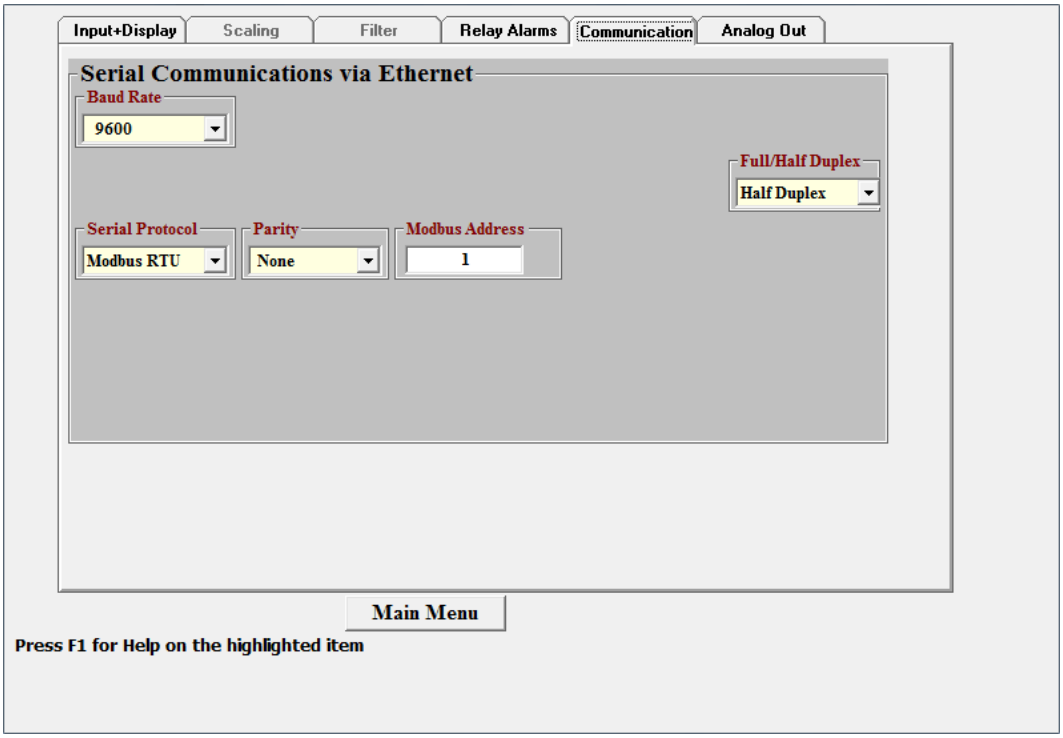


Deviation Band Alarm

A hysteresis band alarm controls relay action symmetrically around a setpoint. The relay closes (or opens) when the reading goes above the setpoint plus one hysteresis value, and opens (or closes) when the reading falls below the setpoint less one hysteresis value. A narrow hysteresis can be used to minimize relay chatter. A wide hysteresis band can be used for on-off control applications.

A deviation band alarm controls relay action symmetrically around a setpoint. The relay actuates when the reading falls within the deviation band, and de-actuates when the reading falls outside. A deviation value (such as 50 counts) is set up around both sides of the setpoint to create the deviation band. Passbands around a setpoint are often used for component testing.

Click on the *Communications* tab to set the Modbus TCP/IP address of your LTSE,

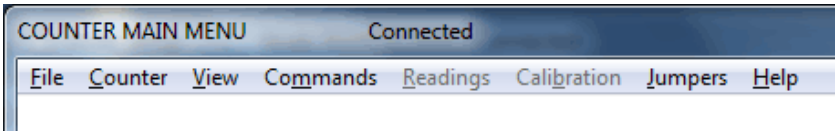


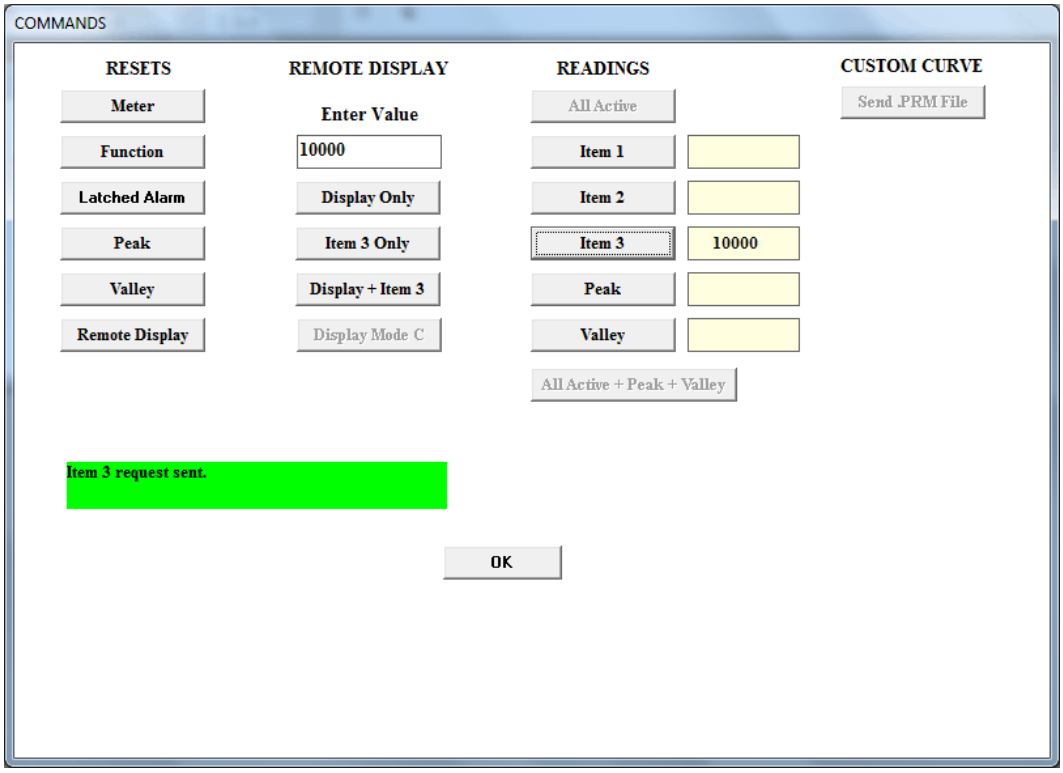
To download your entries from your PC into your LTSE, click on *Main Menu*. From the *Main Menu* screen, click on the *Counter* tab and do a *Put Setup*. This will download your setup file from the PC into your LTSE. Then exit IS software completely. Your LTSE will then be ready to convert Modbus commands to analog outputs and relay outputs.

Your IS setup file can also be saved to disk using the IS *File* menu, and setup files can be retrieved from disk using the IS *File* menu. The factory default setup file for the LTSE is named LTSE6x.CT2.

IS SOFTWARE COMMAND MODE

IS software has a Command Mode, which allows values to be sent to "Item 3", so that the LTSE can output a specific analog current from 4 to 20 mA or activate relays. For example, if the LTSE has been set up to output 4 mA when Item 3 is 0 counts and 20 mA when Item 3 is 10000 counts, entering a value of 10000 under REMOTE DISPLAY and pressing "Item 3 Only" will cause 20 mA to be output. Pressing "Item 3" under READINGS will read back the Item 3 value of 10000 counts. The IS software Command Mode works with Ethernet and TCP/IP. It is an easy way to test system operation. To enter the Command Mode, press "Commands" in the top menu bar of IS software.





9. MODBUS COMMANDS FOR THE LTSE

1. GENERAL

Most Modbus commands will be used to load values into the variable named “Item 3”, which is then be used by the LTSE for analog output and for setpoint comparisons for relay action. Modbus commands are also available to overwrite setup parameters entered with IS Software “on the fly,” including the following:

1. Change scale and offset or coordinates of 2 points parameters to generate the analog output derived from Item 3.
2. Change setpoints to control relay action derived from Item 3.
3. Force relay action regardless of Item 3
4. Reset latched alarms by forcing a Function Reset.

See our Modbus Manual for Counters at https://www.laurels.com/downloadfiles/Modbus-Manual-CTR.pdf for a Modbus TCP/IP overview and for all available Modbus commands, not just those for the LTSE. In particular, see the long section entitled, “FC03 (READ) & FC10 (WRITE) HOLDING REGISTER ADDRESSES.” Use Hi Word starting Register Addresses and an even number of Registers. The Register Addresses shown in this section apply to both FC03 and FC10, and are for Modbus numbering systems that start at 00 01 (Base 1). Subtract 1 from each Register Address for Modbus numbering systems that start at 00 00 (Base 0).

To write values to Item 3 with Base1 addressing, write the Hi Word applied to Item3 to hex register address 006C, and the Lo Word applied to Item3 to hex register address 006D. With Base 0 addressing, the Hi Word address becomes 006B, and the Lo Word address becomes 006C. The qModMaster example on the next page illustrates how to use Base 0 addressing to generate 4, 12 and 20 mA analog outputs.

10. USING 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-to-use tool to verify communications, send requests to Modbus Slaves, and view their responses. qModMaster works well with Base 0, but not with Base 1, so use it only with Base 0 and subtract 1 from the Register addresses listed in our Modbus Manual for Counters. For more information, see the qModMaster section of our Modbus Manual for Counters at https://www.laurels.com/downloadfiles/Modbus-Manual-CTR.pdf.

Download qModMaster from SourceForge at:
https://sourceforge.net/projects/qmodmaster/files/latest/download

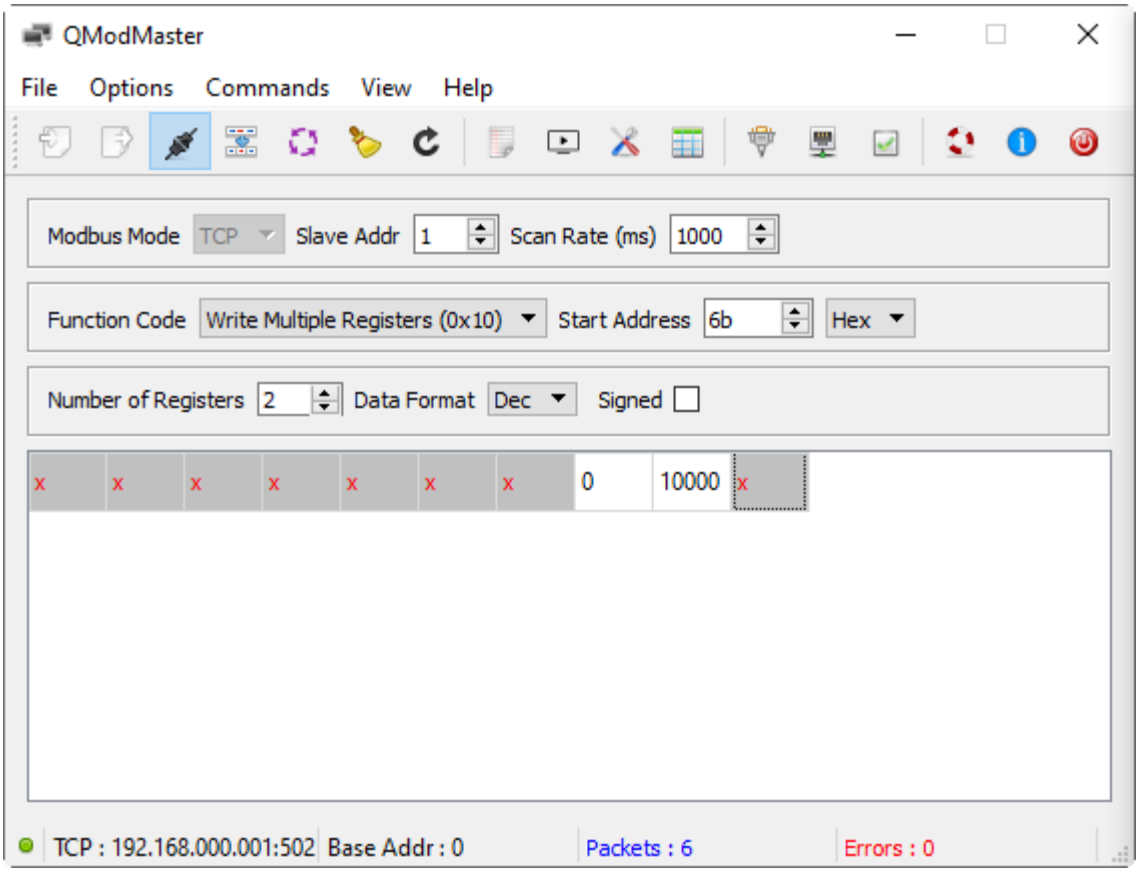
Click on the downloaded file and install it in a directory of your choice. Create a desktop icon from the installed executable. Before using qModMaster, ensure that your LTSE transmitter has been set to Modbus RTU as explained in the Instrument Setup (IS) software section of this manual.

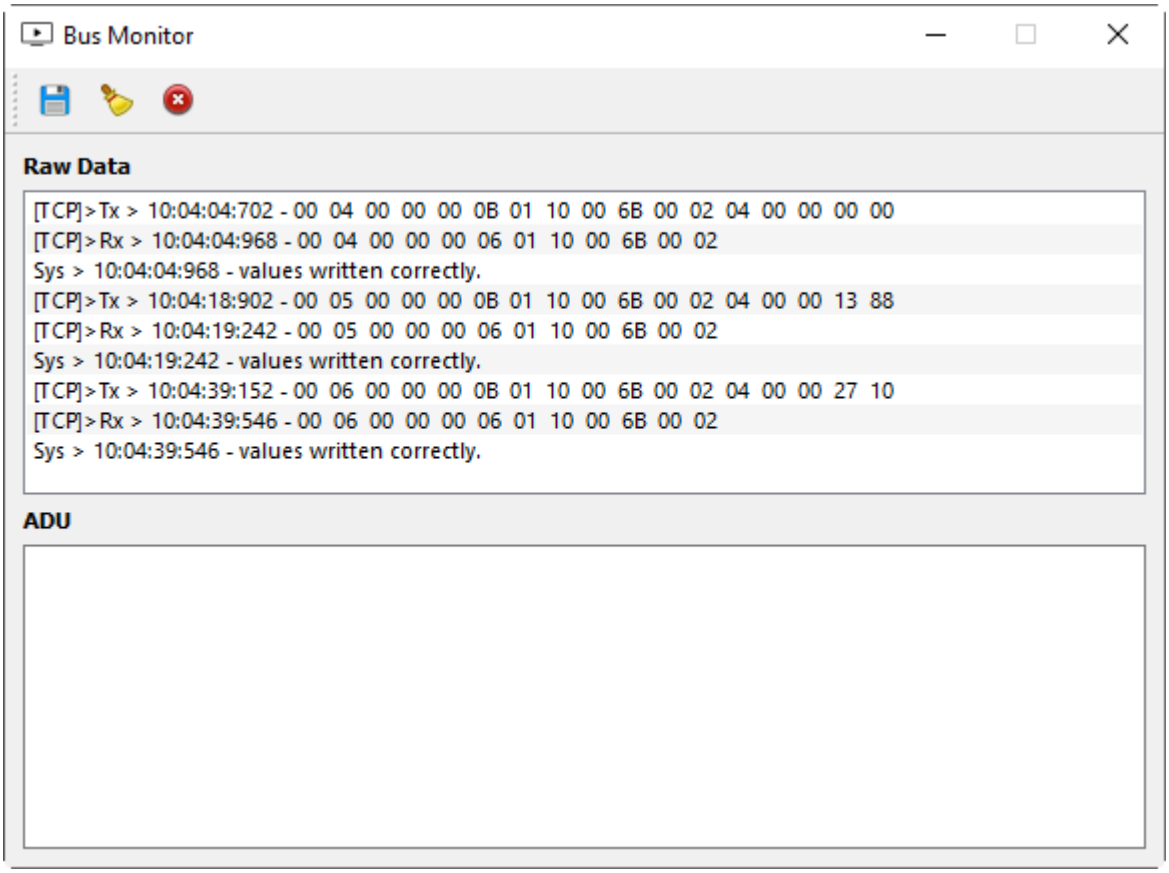
2. EXAMPLE: USE MODBUS COMMANDS TO OUTPUT 4, 12 OR 20 MA

The task is to configure qModMaster to generate analog outputs of 4, 12 and 20 mA. This assumes that Instrument Setup (IS) software has already been used to set up the analog output as 4-20 mA with an Item 3 Lo Range Reading (for 0 mA) of +000000 and an Item 3 Hi Range Reading (for 20 mA) of +010000. These decimal values of 0, 5000 and 10000 form 32 bit hex values of 0000 0000, 0000 1388 and 0000 2710.

Launch qModMaster. A screen of the type shown below will appears. Under *View*, press *Bus Monitor*. Under *Options*, select *Modbus TCP*. Make entries as shown. Note that that the entry in counts to be sent to Item 3 can be in Hex or Dec formats. Under *Commands*, press *Connect* to make the data connection. The Bus Monitor should show Tx and Rx "values written correctly." For information on these values, please see our Modbus Manual for Counters at https://www.laurels.com/downloadfiles/Modbus-Manual-CTR.pdf.

An external panel meter or multimeter connected to the analog output should show the desired output currents.


QModMaster
File
Options
Commands
View
Help
Modbus Mode
TCP
Slave Addr
1
Scan Rate (ms)
1000
Function Code
Write Multiple Registers (0x10)
Start Address
6b
Hex
Number of Registers
2
Data Format
Dec
Signed
x
0
10000
TCP : 192.168.000.001:502
Base Addr : 0
Packets : 6
Errors : 0


Bus Monitor
Raw Data
[TCP]>Tx > 10:04:04:702 - 00 04 00 00 00 0B 01 10 00 6B 00 02 04 00 00 00 00
[TCP]>Rx > 10:04:04:968 - 00 04 00 00 00 06 01 10 00 6B 00 02
Sys > 10:04:04:968 - values written correctly.
[TCP]>Tx > 10:04:18:902 - 00 05 00 00 00 0B 01 10 00 6B 00 02 04 00 00 13 88
[TCP]>Rx > 10:04:19:242 - 00 05 00 00 00 06 01 10 00 6B 00 02
Sys > 10:04:19:242 - values written correctly.
[TCP]>Tx > 10:04:39:152 - 00 06 00 00 00 0B 01 10 00 6B 00 02 04 00 00 27 10
[TCP]>Rx > 10:04:39:546 - 00 06 00 00 00 06 01 10 00 6B 00 02
Sys > 10:04:39:546 - values written correctly.
ADU

3. EXAMPLE: USE MODBUS COMMANDS TO CONTROL TWO RELAYS

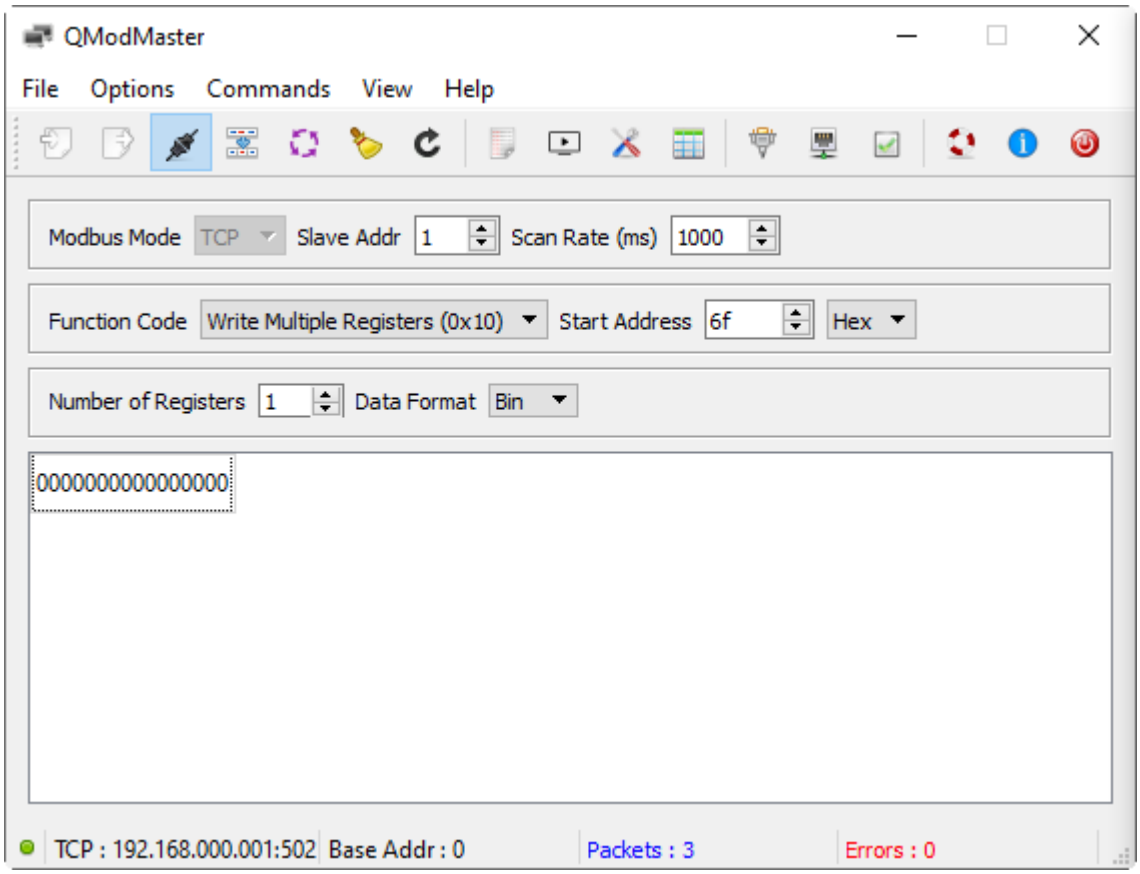
Using BASE 0 addressing, alarm relays are controlled by writing to holding register 0x006F. Bit 0 controls Relay 1. Bit 1 controls Relay 2.

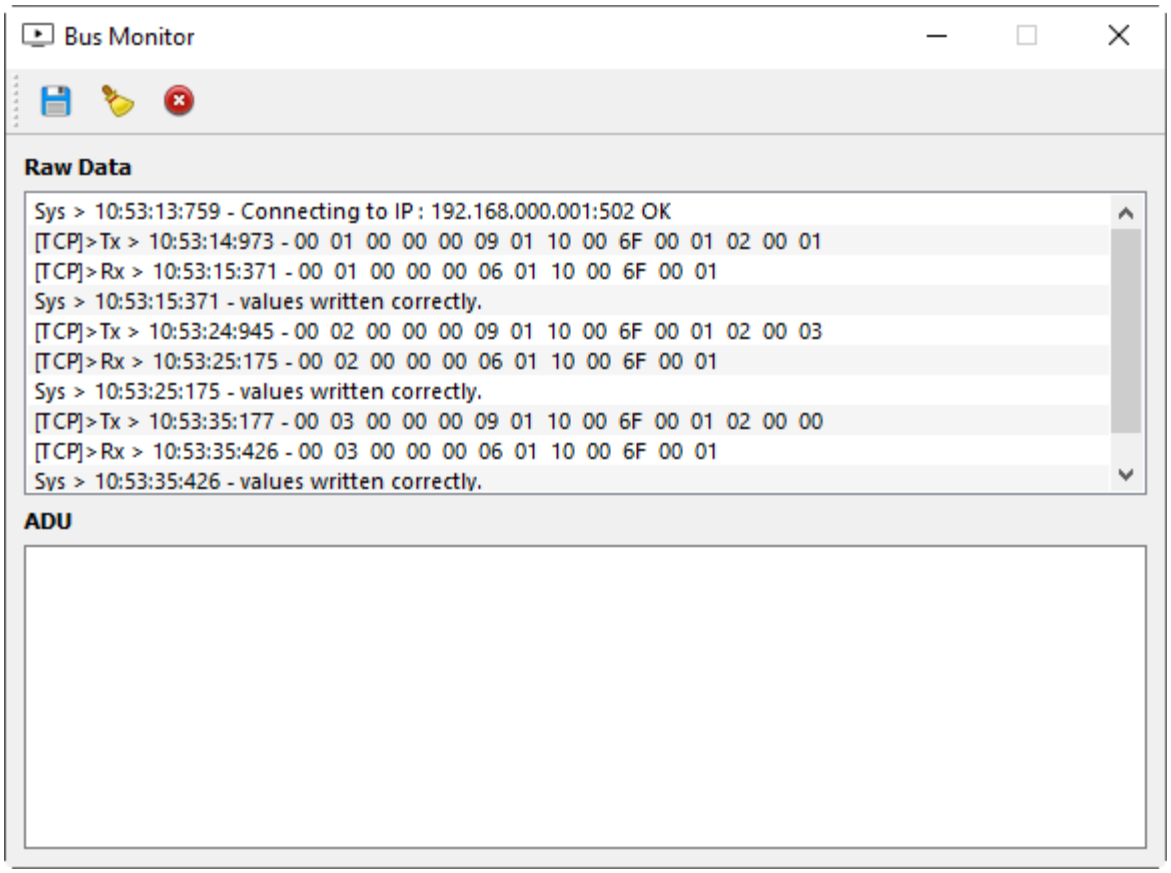
First Alarm1 is forced by writing 01 to holding register 0x006. This turns Relay1 on.

Then Alarm2 is forced by writing 03 to holding register 0x006. This turns Relay2 on.

Both relays are turned off by writing 00 to holding register 0x006. The setup for this last command is seen in the qModMaster window.

The Bus Monitor window displays the result of all three write commands.




Bus Monitor
Raw Data
Sys > 10:53:13:759 - Connecting to IP : 192.168.000.001:502 OK
[TCP]>Tx > 10:53:14:973 - 00 01 00 00 00 09 01 10 00 6F 00 01 02 00 01
[TCP]>Rx > 10:53:15:371 - 00 01 00 00 00 06 01 10 00 6F 00 01
Sys > 10:53:15:371 - values written correctly.
[TCP]>Tx > 10:53:24:945 - 00 02 00 00 00 09 01 10 00 6F 00 01 02 00 03
[TCP]>Rx > 10:53:25:175 - 00 02 00 00 00 06 01 10 00 6F 00 01
Sys > 10:53:25:175 - values written correctly.
[TCP]>Tx > 10:53:35:177 - 00 03 00 00 00 09 01 10 00 6F 00 01 02 00 00
[TCP]>Rx > 10:53:35:426 - 00 03 00 00 00 06 01 10 00 6F 00 01
Sys > 10:53:35:426 - values written correctly.
ADU

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11. LTSE TROUBLESHOOTING HINTS

Inability to install IS software is most often due to User Account Control (UAC), a Windows security feature. To allow IS software installation, first set UAC of your version of Windows to "Never notify" so that the installation can create directories. Use Google for instructions on how to change UAC with your version of Windows. Power down and restart your computer for the UAC change to take effect. Following installation of IS software, you may return UAC to its previous setting.

Inability to open the IS Software Main Menu for a discovered and highlighted Device is most often caused by a Windows Defender firewall, which prevents IS software executable components from running and results in a variety of error messages. To open the firewall of your version of Windows for IS software, enter “firewall” into the search field of the MS Windows icon in the lower left of your monitor. Or click on “Windows Firewall” from the Windows Control Panel. Follow the links and ensure that Instrument Setup and its executable .exe components are allowed. With normal IS installation, the executable IS files are listed in the directory C:\Program Files (x86)\IS2 and are as follows:

- Ctr5T.exe
- CtrW.exe
- DPM5T.exe
- DPMW.exe
- Instrument Setup.exe
- WT5T.EXE
- WtW.exe

Firewall issues can also be caused by third-party firewall and antivirus protection software like McAfee or Norton. Do a Google search on how to change such third-party firewall settings to allow our specific software to run.

The IT departments of large companies often set tight firewall rules. If you suspect a firewall issue and work for a large company, call in an IT representative for help.

Inability to open the IS Software Main Menu can also be caused by the factory default choice of Custom ASCII protocol. That protocol works great with RS232, RS485 or USB, but not with Ethernet, which requires Modbus TCP/IP. Modbus RTU is seamlessly converted to Modbus TCP/IP and back by our Nodes.

If your Laureate is a panel meter or counter that was set to Custom ASCII, the easiest way to change it to Modbus is from the front panel by setting the menu item “Ser 4” to 010.

If your Laureate is an LTE or LTE transmitter that was set to Custom ASCII, you can change it to Modbus with Node Manager software or IS software. With IS software:

1. In the “Communication” screen, select “Custom ASCII” and “Transmitter LTE, LTSE.”
2. Press “Ethernet.”
3. In the resulting “Node Discovery” screen, highlight your Node and press “Device Discovery.”
4. In the resulting “Device Discovery” screen, checkmark “Force discovered devices to Node’s Settings,” highlight your Device, and press “Main Menu.”
5. In the Main Menu, press “Counter” or “DPM” in the top menu bar depending on your Device, and press “Get Setup.”
6. In the resulting IS software main screen, press “View” and then “Setup.”
7. Press the “Communication” tab and verify that “Serial Protocol” is set to “Modbus RTU.” If not, set it to “Modbus RTU,” click on “Main Menu,” and execute a “Put” to download your Modbus RTU selection into your Device.

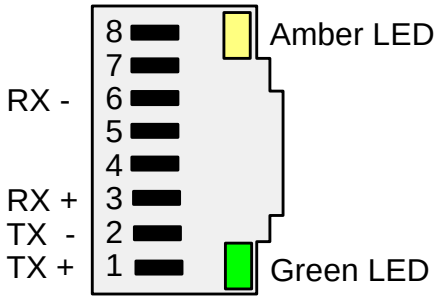
Get and Put commands will not work as expected when multiple copies of IS software are running on your PC. Ensure that only one copy of IS software is active on your PC at the same time.

As an aid to diagnostics, the Ethernet connector for all of our Ethernet Nodes is provided by an RJ45 jack, where green and amber LEDs on the jack indicate network operation:

1) Following power-up, the green and amber LEDs are on steady until an IP address has been assigned to the Node.

2) Once an IP address has been assigned to the Node, the amber LED is turned off. It will light up whenever the Node detects data packet activity.

3) When the Node has made a TCP connection, the green LED alternates on (1 sec) and off (1 sec), while the amber LED is on steady.



Ethernet cables (CAT5 or better) can be straight-through or crossover. Our Ethernet Nodes automatically adapt for either.

12. SPECIFICATIONS, LTSE ETHERNET -TO-SERIAL CONVERTER

Ethernet Data Input

Serial protocols..... Modbus TCP
Serial connector..... RJ45
Data rates .....300 to 9600 baud

Analog Output (standard)

Output Levels..... 0-20 mA, 4-20 mA or 0-10V
Voltage or Current Selection .....Via jumpers
Compliance at 20 mA.....12V (0-600 ohm load)
Compliance at 10V.....2 mA (5 kohm minimum load)
Output Resolution.....16 bits (65,535 steps)
Output Error.....< 0.02% of full span
Output Update Rate, Max..... Approx 10/sec max at 9600 baud

Dual Relay Output (standard)

Relay Type .....Two solid state relays, SPST, normally open, Form A
Load rating ..... 120 mA at 140 Vac or 180 Vdc
Relay modes ..... Active high or low, latching or non-latching, hysteresis or band deviation

Power & Electrical

Power to Transmitter..... 95-240 Vac ±10% or 90-300 Vdc (standard power)
12-30 Vac or 10-48 Vdc (low voltage power option)
Power Isolation..... 250 Vrms between power, analog output, signal input, and serial I/O

Transmitter Setup

Ethernet Node Discovery ..... Node Manager Software in host PC
Transmitter Setup .....Instrument Setup Software in host PC

Mechanical

Case Dimensions .....129 x 104 x 22.5 mm
Case Mounting.....35 mm DIN rail per EN 50022
Electrical Connections..... Detachable screw plug connectors

Environmental

Operating Temperature .....0°C to 55°C
Storage Temperature .....-40°C to 85°C
Relative Humidity..... 95% from 0°C to 40°C, non-condensing

13. WARRANTY

Laurel Electronics Inc. warrants its products against defects in materials or workmanship for a period of one year from the date of purchase.

In the event of a defect during the warranty period, the 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.

