

TLX-400 Wireless I/O Module

User Manual



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Thank you for your selection of the TLX-400 module. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may cause internal damage and will void warranty.

To ensure your TLX-400 enjoys a long life,

double check ALL your connections with

the user's manual

before turning the power on.

All equipment must be properly grounded

for safe operation.

All equipment should be serviced only

by a qualified technician.

Important Notice

ELPRO products are designed to be used in industrial environments, by experienced industrial engineering personnel with adequate knowledge of safety design considerations. These products should not be used in non-industrial applications, or life-support systems without consulting ELPRO Technologies first.

Limited Lifetime Warranty, Disclaimer and Limitation of Remedies

ELPRO products are warranted to be free from manufacturing defects for the “serviceable lifetime” of the product. The “serviceable lifetime” is limited to the availability of electronic components. If the serviceable life is reached in less than three years following the original purchase from ELPRO, ELPRO will replace the product with an equivalent product if an equivalent product is available.

This warranty does not extend to:

- failures caused by operation of the equipment outside the particular product's specification, or
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- abuse, misuse, neglect or damage by external causes, or
- repairs, alterations, or modifications undertaken other than by an authorized Service Agent.

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How to Use This Manual

This manual has been written to enable the quick look-up of information, as well as detailed descriptions of the TLX features.

The section FEATURES & CONFIGURATION provides detailed information about the TLX functions and how to configure them. Use this section to find out about a particular feature or what the TLX can do.

The section MENU ITEMS provides a way to look up specific items from the menu to find out what they do or how to configure them. Use this section as a quick reference to the menu items.

The TROUBLESHOOTING section provides a list of common problems and configuration mistakes. Check this section if MENU ITEMS and FEATURES & CONFIGURATION don't help with configuration problems.

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Chapter 1

INTRODUCTION

1.1 Overview

The TLX-400 is an advanced telemetry unit ideal for a wide range of applications. It is equally suited to small-scale systems with a few units and simple control, or large and complex computer-controlled systems. It is highly flexible, offering the following configuration options:

- Remote terminal unit (RTU) with local I/O
- Pre-processor (PP)
- Standalone monitoring facility (SMF)
- Store and forward repeater functionality with multi-hop capability
- Local control options
- Modbus RTU communications
- RS232 (DB9 or RJ45), RS485 serial connections
- Modem option
- Pager option
- Radio communications with user-configurable options
- Comms fail message logging
- Message logging via local control commands
- Dual-redundant configuration

The TLX-400 is fully compatible with the ELPRO TLC product line, and supports several TLC emulation modes for easy system upgrades.

The Modbus interface on the TLX allows a variety of I/O expansion options. The ELPRO 115S product line of I/O modules has been developed for use with the TLX. The TLX menu system provides convenient automatic configuration of the 115S modules.

Chapter 2 FEATURES & CONFIGURATION

This chapter describes in detail the features of the TLX, and how to configure them.

2.1 Menu

The TLX-400 is configured via a built-in menu. The menu is accessed by connecting one of the serial ports to a PC and using a terminal program (such as PROCOMM or HyperTerminal) to communicate in ASCII. The menu is invoked by pressing <enter> 3 times in quick succession.

The rest of this chapter describes how to configure the TLX using the built-in menu. For information on specific menu items, refer to the chapter MENU ITEMS later in this document.

To invoke the TLX menu:

1. Connect a serial cable to the TLX (DB9 connector or RJ45 connector) and to the PC
2. Start PROCOMM or HyperTerminal
3. Choose port, baud rate, parity (TLX default is 9600, N-8-1)
4. Hit <enter> three times in quick succession and the menu should appear on screen. Operation

2.2 LED Indicators

- Power LED - red when power is on, turns green after self test/initialization passed ok.
- Rx LED - active when receiving, normally green or yellow, red if low signal strength.
- Tx LED - on when radio is transmitting.
- Link LED on the RTU - green when comms OK and red when in comms fail (ie. when not polled longer than timeout or cannot send messages to the computer).
- Link LED on pre-processor - red when PP disabled, green when PP enabled.
- Link LED on control unit - the LED turns GREEN if all of the configured remote devices are communicating successfully. It turns RED if some of the configured remote devices are in commfail, and goes OFF if all of the configured devices are in commfail.
- RS232 LED - Flashes during Host (RS232) port activity (Tx or Rx).
- RS485 LED - as above but for Expansion (RS485) port.
- I/O LED - indicates state of onboard digital in/output in normal mode, in dual redundant mode the duty cycle of the I/O LED gives a visual indication of the status of the dual-redundancy system. In redundant mode, with the primary active and the secondary on standby, the led shows a long-on, short-off cycle. If primary fails and the secondary takes over the I/O LED then shows a short-on, long-off duty cycle. If

the primary is active and the secondary fails, the I/O LED shows an equal on / off time, to indicate there is no functioning backup unit.

2.3 Operating Modes

The TLX-400 may operate in one of several different modes, or combinations of these modes. Note that the TLX must be reset after setting any menu items relating to these operating modes (addresses, routing lists etc).

2.3.1 RTU

As an RTU (remote terminal unit), the TLX will relay incoming messages according to its configured routing list. It may also have some digital or analog I/O connected, which it controls according to messages received. To set the RTU address, choose the menu option:

Configure site / Address of local RTU

A valid RTU address is less than 255. An address of 255 disables the RTU and all monitoring and control of its local I/O.

Fill in the routing list for the RTU under the menu item:

Configure site /Routing

Enter the *COS addresses* where change-of-state messages should be routed to. For more information on routing, see the section Message Routing.

2.3.2 PP

The TLX may be configured as a pre-processor (PP), where it operates as an interface between a SCADA computer and the network of RTUs. The PP may be configured as dual-state, where its communications become restricted after a specified timeout. To re-activate a dual-state PP it must receive an enable message from the SCADA computer. To set the PP address, choose the menu option:

Configure site / Address of pre-processor

A valid PP address is less than 255. An address of 255 disables the pre-processor function of the TLX. Choose single or dual-state from the menu, and the dual-state disable timeout if relevant.

The next question asks about the presence of an SMF (standalone monitoring facility) in the system. If the PP has a serial connection to another device, these messages will not be registered by the SMF. The PP needs to send out these messages via radio for the SMF to register them. Answer *yes* to this question if there is an SMF anywhere in the system.

Fill in the routing list for the PP under the menu item:

Configure site /Routing

The *Enabled* routing list refers to when the pre-processor has been enabled by a message from the SCADA computer. The *Disabled* routing list reflects the routing supported when the pre-processor has timed out and disabled itself. The Disabled routing list would usually be quite short and possibly only include routing to the SCADA computer, while the Enabled

routine list would include the other RTUs in the system. For more information on routing, see the section Message Routing.

2.3.3 SMF

A standalone monitoring facility (SMF) enables a technician to view all communications messages occurring in a system via a computer set up anywhere in the system. An SMF consists of a TLX set to SMF mode and connected to a PC by the DB9 (*HOST*) port. An SMF TLX does not relay any incoming messages out its radio port, but routes all radio messages to the connected PC. The messages can be viewed by a terminal program such as PROCOMM or HyperTerminal, without invoking the menu.

The computer may send SCADA commands to the system via the SMF TLX if necessary.

To set up the TLX to function as an SMF, use menu item

Configure site / SMF option

Set the routing list as required.

2.3.4 Local Control

A TLX may be configured to provide control in a system. This may be in a system where the control is simple and a SCADA computer is not required, or it may be some confined, local control in a small part of a system to simplify the overall SCADA computer's tasks. Set the control address by the menu item

Configure site / Address of Control RTU

For more information on control within a TLX, refer to the section Local Control.

2.4 Message Routing

The routing list specifies to the TLX how to locate other devices in the system. Specify the routing list using menu option

Configure site / Routing

The menu will then prompt for which devices are connected via the Terminal port (RJ45 connector). Enter the device addresses separated by space characters or commas. If there are no devices connected to the port press enter. The menu will also prompt for Host port (DB9 connector), Radio, and Expansion port (RS485).

If the TLX has been given an RTU address, the menu will also prompt for a list of COS (change-of-state) addresses. Enter the device addresses which should receive COS messages.

Configure site / Store and Forward Configuration

In some radio networks it is necessary to pass radio messages to the CMF via an intervening RTU due to the radio path not being good enough. This process is call a store and forward (S&F). Enter the store and forward addresses here. Note that the SCADA database must also be set to have this store and forward information. Radio Signal Strength

2.5 Messaging Protocol

The type of messaging frames used by the TLC communications protocol may be selected from the menu option

Configure site / Frame type

An ELPRO TLC frame is composed of a header, a data section, and an error check. The data section contains a list of digital I/O and analog I/O information. For more detail on TLC frames, consult the document *Prot_Protocol_1.1.pdf*.

The TLX replaces some of the I/O information in the frame with special information relating to its operating conditions. The tables below show the special information the TLX adds to the frame. See the section TLC Emulation for situations where this data is different.

2.5.1 Digital Data Space

No redundancy:

Mains fail	Battery low	Antenna fault	On-board DIO
Last DIN	2 nd -last DIN	3 rd -last DIN	4 th -last DIN

Dual-redundancy mode:

Mains fail	Battery low	Secondary fail	Primary fail
Last DIN	2 nd -last DIN	3 rd -last DIN	4 th -last DIN

2.5.2 Analog Data Space

Radio temperature	RSSI	Battery level (volts * 10)
3 rd -last AIN	2 nd -last AIN	Last AIN

The messages received by the TLX in a system may be viewed via the menu item:

Service Menu / Monitor Comms

The Monitor Comms function displays the messages received by the firmware's internal messaging center, and the channels or ports they were received on. The messages transmitted by the RTU are not displayed. Each message is appended with a special symbol indicating the following:

- ~ Internally generated message.
- < A valid message received on the serial port.
- << A valid message received on the radio port.
- * A corrupted message received on the serial port.
- ** A corrupted message received on the radio port
- ? Received a message from an invalid port. This usually occurs when an upgrade in firmware has been issued and the unit has been configured but not turned off and then on again.

2.6 I/O

The TLX contains only one on-board digital I/O pin, but is able to interface with external I/O modules via Modbus communications. The ELPRO 115S I/O expansion modules are developed for use with the TLX, and can be easily set up via the Modbus menu. However any 3rd-party Modbus I/O device can be configured for use with the TLX.

A change in an input connected to a TLX will cause a change-of-state message to be generated (with the exception of pulsed inputs). This message reflects the state of the TLX's inputs at the current time, and is routed to any devices listed in the COS routing list (see the section Message Routing).

2.6.1 On-board Digital I/O Pin

There is one on-board digital I/O pin on the TLX which may be used as multi-purpose I/O. Input is given priority over output, so if a '1' input (ground) has been applied to the pin, the DIO cannot be cleared if the TLX receives a message with '0' as an on-board DIO output. If there is no input applied to the pin (0 = open pin), DIO can be controlled as a digital output via TLC messages or the Test I/O menu function.

The on-board DIO is mapped to the 4th-last digital input or output in the message frame, in native TLX mode. In the other TLC emulation modes (TLC 01-05, TLC 02-01, TLC 09-02), the on-board DIO is not used, and does not appear in the message frame.

If the TLX is operating in dual-redundancy mode, the DIO pin is used to control redundancy operation between the dual units. In this situation it is not sent in the message frame and cannot be controlled via messages or the Test I/O menu function.

2.6.2 Using ELPRO 115S I/O modules with the TLX

The 115S serial I/O units are designed to provide I/O for a TLX module. The available I/O from 115S includes digital input / output, analog input, and analog output. A combination of 115S modules may be connected to the TLX to provide the appropriate set of I/O.

The 115S units communicate with the TLX using MODBUS over the RS485 port. The 115S must be set up to use MODBUS RTU protocol as the TLX does not support MODBUS ASCII.

A maximum of 16 115S modules may be connected to any TLX. The 115S addresses must be in the range 1 to 16. Addresses outside of this range will not be recognized by the TLX.

Steps to set up one or more 115S units with a TLX:

1. Configure the 115S modules for the desired I/O functionality according to the 115S user manual.
2. Set the 115S units to communicate in MODBUS RTU protocol. This may be done using the 115S configuration software, or write 0x0101 to MODBUS register 30201 (Holding register) using ModScan.
3. Set the address switches on each 115S to a unique address.
4. Connect the 115S modules to the TLX via the RS485 port and apply power.
5. From the TLX menu, choose *Modbus Configuration*.
6. Choose *Auto Detect 115S Configuration*. The software will attempt to detect the 115S modules connected.
7. The user will be asked to decide on the combination of digital inputs and outputs required. The software will prompt for the number of digital inputs. These will start from DIO1. The remaining digital I/O pins will be designated as digital outputs.
8. Modbus must now be set up to read the I/O information from the 115S. Choose *Set Modbus Slave Address*, and set it to zero for Modbus master.
9. The delay between polls reflects how quickly the TLX will update its internal information relating to its local I/O. Set this delay to an appropriate value for the speed of the system being implemented (eg. 500mS).
10. If required, set the 115S analog range to E-series (*Set 115S Analog Range*). This means that the data from the 115S, which is in the range \$4000 to \$C000, will be seamlessly translated to \$00 to \$FF in the TLX, for easy interpretation by the SCADA computer.

2.6.3 Using Other Modbus Devices with the TLX

TLX as Modbus slave

The TLX can be configured to operate as a Modbus slave by giving it a slave address via the *Modbus Configuration* menu. Upon receiving a poll message from a Modbus master, the TLX reports its inputs or outputs (digital or analog) starting from Modbus address 1. The maximum number of digitals or analogs supported by the TLX Modbus protocol is governed by the I/O limits given in SPECIFICATIONS.

2.6.4 TLX as Modbus master

The TLX can be manually configured to operate as a Modbus master by setting its slave address to 0. The delay between polls should also be set (eg. 500mS), and master poll commands must be added. The TLX then sends the poll commands and stores the response data according to the command configuration.

2.6.5 Digital Inputs

All digital inputs connected to the TLX are affected by the input debounce time. This is the amount of time an input must be set before a change-of-state is triggered. It is set via the menu option

Configure Site / Input Debounce Time

If an input changes and remains in its new state for longer than the debounce time, a COS message is generated (except when the input is set as pulsed input) and routed to any addresses in the COS routing list. The input debounce time may range from 0.01 seconds to 600 seconds.

2.6.6 Digital Outputs

Digital outputs are set or cleared whenever the TLX receives a command message. The digital outputs are updated with the appropriate data in the message. Masking may be used to prevent outputs from being changed in response to command messages. See the section Masking for more information.

2.6.7 Pulsed Inputs

The TLX supports three types of native pulsed inputs (accumulators):

1. Counting the pulses of the digital input.
2. Accumulating the “On” time of digital input.
3. Integrating (accumulating) the analog input value.

TLX-400 also supports dedicated pulsed inputs on ELPRO 115S-11 modules (these act as pulse counters only). The main difference between TLX native pulse accumulators and dedicated 115S-11 pulse accumulators is speed – 115S-11 can count shorter and faster rate pulses comparing to TLX (the limitation is caused by Modbus polling frequency).

Any digital input will not cause change-of-state message when configured as pulsed input. On the other hand analog inputs work as usual even when used as a source of an accumulator.

The pulsed inputs count from 0 to 4,294,967,295 and then wrap around back to 0. When TLX-400 is depowered the counts are lost and start from 0 after powering up.

2.6.7.1 TLX-400 native pulse counters

This pulsed input will count a number of pulses on a digital input, the count is incremented on low to high pulse edge. Typically a plant run signal is used as source and the accumulator shows total number of starts. Any of the first 32 DINs can be configured as pulsed input, the configuration value for the sensitivity message is simply the input number.

TLX-400 Pulse Counter Input Addressing												
DIN	1	2	3	4	5	6	7	8	9	10	11	12
cfg. value	1	2	3	4	5	6	7	8	9	10	11	12
DIN	13	14	15	16	17	18	19	20	21	22	23	24
cfg. value	13	14	15	16	17	18	19	20	21	22	23	24
DIN	25	26	27	28	29	30	31	32				
cfg. value	25	26	27	28	29	30	31	32				

2.6.7.2 “On” time accumulators

This accumulator will increment by 1 every second when relevant digital input is on/high state. The resulting count is the total number of seconds the input was on – typically used for accumulating plants’ runtimes. The source input can be any of first 32 DINs and the configuration value is input number plus 88.

TLX-400 On Time Accumulator Addressing												
DIN	1	2	3	4	5	6	7	8	9	10	11	12
cfg. value	89	90	91	92	93	94	95	96	97	98	99	100
DIN	13	14	15	16	17	18	19	20	21	22	23	24
cfg. value	101	102	103	104	105	106	107	108	109	110	111	112
DIN	25	26	27	28	29	30	31	32				
cfg. value	113	114	115	116	117	118	119	120				

2.6.7.3 Integrating analog inputs

Analog input raw 8 bit value is added to the accumulator every minute. Typically it is used to work out total flows on the older flowmeters which provided flowrate but not pulsed outputs. Any of 24 analog inputs can be integrated, the configuration value is input number plus 64.

TLX-400 Analog Integrating Addressing												
AIN	1	2	3	4	5	6	7	8	9	10	11	12
cfg. value	65	66	67	68	69	70	71	72	73	74	75	76
AIN	13	14	15	16	17	18	19	20	21	22	23	24
cfg. value	77	78	79	80	81	82	83	84	85	86	87	88

2.6.7.4 115S-11 dedicated pulsed inputs

115S-11 DIO module has dedicated pulsed inputs on its first 4 digital inputs, these can count short and frequent pulses, the count increments on the falling edge of the pulse. TLX-400 supports up to 8 115S-11 pulsed inputs so two 115S-11 units with the lowest Modbus addresses are seen by the TLX. The configuration value depends on Modbus address of the unit and input used, they range from 153 to 216.

115S-11 Pulsed Inputs Addressing				
Unit Modbus Address	DIN on the 115S-11 unit			
	1	2	3	4
1	153	154	155	156
2	157	158	159	160
3	161	162	163	164
4	165	166	167	168
5	169	170	171	172
6	173	174	175	176
7	177	178	179	180
8	181	182	183	184
9	185	186	187	188
10	189	190	191	192
11	193	194	195	196
12	197	198	199	200
13	201	202	203	204
14	205	206	207	208
15	209	210	211	212
16	213	214	215	216

2.6.8 Analog Inputs

The TLX accepts and stores analog inputs as 16-bit numbers. In frames which only allow 8-bit representation of analogs, the most-significant 8 bits are used.

The analog sensitivity is also treated as a 16-bit number. The default sensitivity may be entered into the menu, and this should be a 16-bit number in decimal format. To convert from a percentage to a 16-bit sensitivity number, multiply the percentage by 655, so 2% would result in a sensitivity number $2\% \times 655 \text{ scale} = 1310$.

The default sensitivity is set by choosing menu items:

Configure Site / Default sensitivity

The sensitivity may also be set via a sensitivity message. If the sensitivity message contains 8-bit values, these are stored as the most significant 8 bits in the sensitivity variables. See the protocol document for more detail on sensitivity messages.

The sensitivity values are absolute values, in the same units as the analog inputs. So if an input increases or decreases by more than the sensitivity value, a change-of-state message may be generated.

The configured Input Debounce Time also applies to the analog inputs. This is set via the menu items:

Configure Site / Input Debounce Time

The analog input value must change by at least its sensitivity amount, and remain there for at least the debounce time, in order for a change-of-state message to be generated.

The analog inputs may also be filtered, or the square root taken. These functions are selectable from the menu items:

Configure Site / Analog inputs to square root

Configure Site / Analog inputs to filter

The square root option gives the analog input values a square-root relationship with the actual analog stimulus on the pins. With some analog transducers it is necessary to linearise the input. This is most prevalent with flow meters which give a square law output. The analog input square root option provides an easy way to linearise these devices.

Filtering allows an analog input signal to be smoothed out. The filter time-constant is entered into the menu in arbitrary units ranging from 1 to 255. A time-constant of 255 results in approximately a 75-second step response.

The input analog signal is always filtered with a short time constant, even if no filtering is specified.

The square-root or filtered analog values can be seen via the menu option:

Test I/O / Show All Inputs

Note that the menu item below shows the actual analog input values from the 115S, and not the square root or filtered values.

Test I/O / Read 115S-12 @ n

2.6.9 Analog Outputs

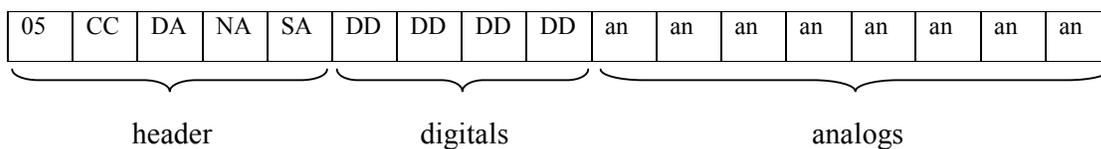
Analog outputs are also stored as 16-bit numbers. The 8 most significant bits are used in data message frames which do not support 16-bit analogs.

Analog outputs are updated each time a command message is received. The output is assigned the appropriate value from the message. See the section Masking for how to prevent analog outputs from being changed every time a command message is received.

2.7 Masking

Where there is more than one controller in a system, conflicts may arise in the transmission of command messages. If two controllers send command messages to the same RTU, they will each change the other's settings of the RTU's I/O, because a command message must contain data for every output. If a controller does not wish to change all of the I/O of an RTU, it can first send a mask message specifying which I/O it would like control of. By sending a mask message, a controller tells an RTU that it only wants control of specific outputs, and that no-one else is allowed to control these outputs. They are for the exclusive use of the requesting controller. The masking settings apply for as long as the RTU has power.

The format of a mask message follows the mod frame type as shown (mod1 shown):



The frame flag for a mask message is 0x05.

DD refers to eight bits representing eight digital outputs. A digital 1 signifies that the corresponding digital output should be masked for exclusive use by the sender of the message.

an refers to one analog output. A value of 0xFF signifies that the corresponding analog output should be masked for exclusive use by the sender of the message. Any other value signifies the output is not masked.

Note that the on-board DIO can also be masked by writing a 1 to its location in the frame (3rd-last position for Native TLX emulation).

2.8 Ports

The TLX-400 has three physical ports, all of which can be used for routing messages.

The Terminal port, also known as Config, is an RS232 port and requires an RJ45 connector. This port is most commonly used to invoke the on-board menu and configure the TLX. It can also be used to route messages, by adding the appropriate addresses to the routing list. This port is fixed at 9600 baud, no parity, 8 data bits, and 1 stop bit.

The Host port is also an RS232 port and requires a DB9 connector. This port may be used to configure the TLX via the on-board menu, and is also able to route messages according to the routing list. The baud rate and data format of this port may be configured via the menu items:

Serial Ports Configuration / Set HOST Port Baudrate

Serial Ports Configuration / Set HOST Port Data Format

The Host port may also be configured to route messages via a modem or a pager. Use the following menu items to set up modem or pager operation:

Serial Ports Configuration / Configure HOST for modem

Serial Ports Configuration / Configure HOST for pager

See the section Pager Feature for more detail.

The Expansion port is an RS485 port and connection is made via two screw-terminals. This port is intended for I/O expansion and communicates using Modbus for this purpose. The data format and baud rate of this port are configurable via the menu items:

Serial Ports Configuration / Set EXPANSION Port Baud rate

Serial Ports Configuration / Set EXPANSION Port Data Format

2.9 Radio

The radio is the main method for routing messages in a system. It uses V.23 signaling, and may be configured via the menu item:

Configure Radio /

The radio supports V.23 or “NotV.23” tones, and 300 or 1200 baud. The receive and transmit frequencies can be set by the user, within the allowable range and only on the frequency step. The allowable range and frequency step can be modified by an ELPRO service technician. The transmit power is also configurable via the menu.

A radio signal is preceded by a lead-in tone in order to facilitate receiver lock. The lead-in is adjustable via the menu and may range from 30 to 1000 mS.

The software measures the radio’s received signal strength for each message. The RSSI is displayed after each message in Monitor Comms mode. The RSSI can be calibrated via the menu:

Service Menu / RSSI menu / Automatic RSSI Calibration

If the calibration values are already known, they can be entered via the menu:

Service Menu / RSSI menu / Manual RSSI Calibration

Radio status and temperature are reported from the menu item:

Service Menu / Radio Status and Temp

The radio can report four alarms as follows:

VSWR: High antenna VSWR has been detected. There is a problem with the antenna, feeding cable or antenna connections. Could be an open or short circuit.

PLL-Lock: There is an internal problem with the phase lock loop system and it is out of lock. Return to ELPRO for repair or re-alignment.

PTT-Timeout: The transmitter has been on for longer than the maximum timeout time (usually 2 minutes). There might be a problem with the microprocessor circuits driving this signal.

Over-temperature: The radio temperature has exceeded the maximum temperature allowed (default is 85degC). The transmitter will not operate once this maximum temperature has been exceeded and will return to normal operation once the temperature returns to normal.

2.10 Pager Feature

The TLX may be configured to send messages to pager units. This is done via a modem connected to the HOST port. The modem is configured with the phone number of the paging service via the menu item:

Serial Ports Configuration / Configure HOST for pager

The paging function of the TLX has its own unique address. This is set via the menu

Configure Site / Address of Pager RTU

Command messages sent to the pager address are routed to the paging system.

A sensitivity message should be sent to the pager address to set up its internal pager list. This message consists of a list of 24-bit pager identification numbers, which the TLX may send messages to. There may be up to 8 pagers in the sensitivity message.

A POLL message sent to the pager address results in a response message containing the current pager status. The polling software should decode the status byte, as listed here:

0x01: Modem did not respond

0x02: Modem failed to connect after dialing

0x04: Pager computer did not respond

0x08: Password not accepted

0x10: Pager number or message not accepted

0x00: Message accepted

A command message to the pager address should contain the 24-bit pager ID, and the pager message to be sent. Upon receipt of such a command message, the TLX dials the paging service via the modem, and sends the message to the specified pager using PET protocol.

The paging setup may be tested via the menu

Pager/modem options / Test Pager/Modem

2.11 Modem Feature

A modem may be connected to the HOST port for routing messages via a telephone line. Modem setup is done via the menu items:

Serial Ports Configuration / Configure HOST for modem

Set the telephone number the modem is to dial, and extra modem initialisation here.

Supported modem line communication rates are 300, 1200, and 2400bps. The HOST port must therefore also be set to the required communication rate (eg. 2400). The modem may have to be restricted to a maximum rate of 2400bps using AT commands, to ensure it connects at the correct rate. The AT commands to restrict the line rate generally vary between modems, and may appear in an s-register.

Any AT commands required for modem setup or initialisation can be added to the initialisation string accessible from the menu.

A tail-circuit cable is preferred for connecting the modem to the TLX. This cable provides the necessary loop-back signals for a DCE-DCE connection.

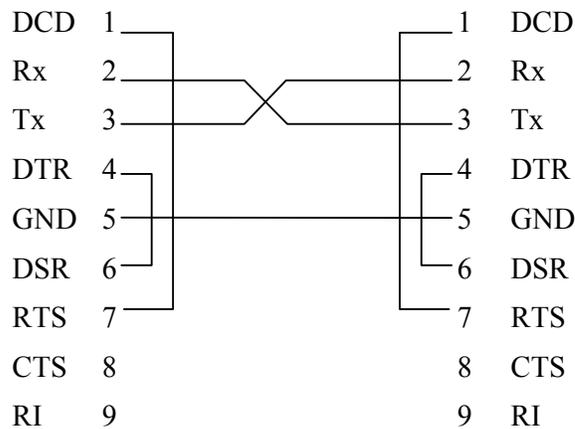


Figure 1: Wiring diagram for tail-circuit cable.

If a tail-circuit cable is used, modem factory defaults (AT&F) are generally OK for flow-control and signal settings. These should be:

Hardware flow control (AT&K3)

Standard DTR operation (AT&D2)

Note that these AT commands may not be the same for all modems.

A simple crossover cable may also be used to connect the TLX to the modem if required.

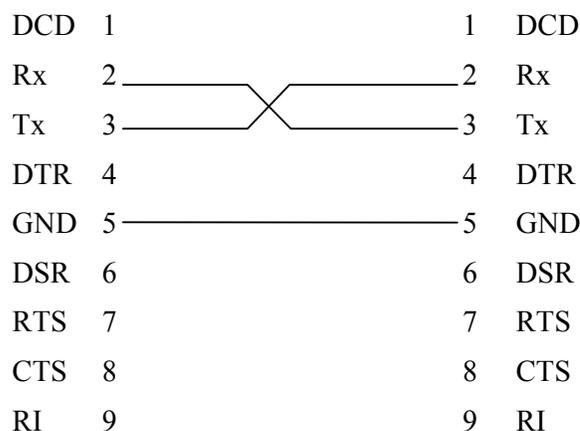


Figure 2: Wiring diagram for simple crossover cable.

If a simple crossover cable is used, the following settings must be applied:

Disable flow control (AT&K0)

Ignore DTR (AT&D0)

Note that these AT commands may not be the same for all modems.

These AT settings may be added to the modem initialisation string in the menu.

The modem is initialised at startup, with various modem settings and the initialisation string specified in the menu. When a message is to be routed out the HOST port, the modem dials the number and connects, and sends the message. It stays connected and hangs up after a timeout of 60 to 90 seconds if no more messages are sent or received.

2.12 Redundancy

The TLX-400 offers a dual-redundancy mode where a pair of units provides redundant backup in any of the operational modes (RTU, PP, etc). The status of the redundant pair is indicated by the DIO pin, which also serves as the communication link between the two units.

Under normal operation, the *Primary* unit performs the functions of the site, when in the *active* state. The *Secondary* unit has all the same connections as the *Primary*, but does not communicate any external messages. It waits in the *standby* state, and is connected to the *Primary* via the DIO pin.. Both units monitor and control the DIO signal, to indicate normal operation, and to sense any faults that may occur.

If the *Primary* suffers a fault, the *Secondary* will detect this and change to the *active* state. The *Primary* will change to the *standby* state to allow the *Secondary* to take control. A change-of-state message is generated whenever changes in redundancy states occur.

If the *Primary* then recovers, it regains control from the *Secondary*, and the *Secondary* returns to the *standby* state.

The status of the redundant pair is indicated by the duty cycle of the DIO led as follows:

Condition	DIO LED behaviour
Primary active, Secondary standby	Long on, short off
Secondary active, primary fault	Short on, long off
Primary active, secondary fault	Equal on - off

The condition of the Primary and Secondary units is passed in the TLC message frame in response to a change-of-state. The Primary fail and Secondary fail bits constitute the 4th-last and 3rd-last bits of the digital I/O data, as shown:

Mains fail	Battery low	Secondary fail	Primary fail
Last DIO	2 nd -last DIO	3 rd -last DIO	4 th -last DIO

To set up a pair of dual-redundant units:

1. Connect the DIO pin of both units together. Ensure also that the units have a common ground.

2. Set up the primary unit with the menu, allocating unit address, routing, I/O, and other setup items. Generate some COS messages and ensure there is no antenna fail flag, and at least one power input is not in fail.
3. Once the module has been set up, go to the redundancy menu and select Primary. Switch this unit off while configuring the secondary.
4. Set up the secondary unit with the same configuration as the primary. Generate some COS messages and ensure the module is not in fail, as for the primary.
5. Once the module has been set up, go to the redundancy menu and select Secondary.

Reset both units. If no module faults exist, the DIO led should have a long-on, short-off duty cycle. If faults exist, the modules will attempt to set the Secondary active, and will generate a COS message in doing so.

The *Force changeover* menu function allows the user to force the active and standby units to swap roles. The *Force active to standby* menu selection should only be applied to a unit that is currently in the active state.

When applied to the Primary unit, a primary fault condition is simulated to cause the Secondary to become active. If the Secondary develops a fault while active, it remains as the active unit since it believes the primary is in fault. However if the Secondary incurs a serious fault and loses power, the Primary senses this and takes over the active role.

The *Forced Changeover Timeout* allows the user to specify a time interval, after which the Primary will regain control and active status.

If, in normal operation, the Primary incurs a module fault, the Secondary will become the active unit. If a *Force changeover* command is then given to the active Secondary, it will attempt to relinquish control to the Primary. If the Primary is still in fail, it will refuse control and the Secondary will remain active. However if the Primary has recovered, it will take over the active role. This is useful in cases where the Primary has failed due to an antenna fault. A module cannot detect that its antenna has recovered unless it attempts to transmit (which is illegal for a module on standby). The *Force changeover* command, when applied to an active Secondary, allows the Primary to attempt to gain control and check its own antenna after a repair.

2.13 Logging

The logging feature in the TLX allows messages or data to be stored in flash RAM for later retrieval. 128k of flash has been allocated for logging storage. If more than 128k of logging events occurs, the new log records will overwrite the oldest log records.

Data logging may be initiated in two ways: either from the Logging Options menu, or via the local control code.

The logging options menu enables logging of TLX messages under comms fail conditions. To initiate this logging, choose menu item:

Logging Options / Enable Automatic Logging of Commfail Data

Messages are logged under two different conditions:

1. If a “comms fail” message is received in response to sending a message, the current I/O state is logged in the form of a radio message. Note that this is NOT the actual message

that caused the comms fail, but a snapshot of the I/O state at the time the module registered the comms fail. This type of logged message is identified by the absence of a frame flag and destination / next addresses in the message header (see the section on TLC frames for an explanation of message parts). This log record is also identified as coming from source 1.

2. If the module is already in comms fail and a COS or other factor triggers a message transmit, that message is logged prior to transmit. This ensures that messages generated while in comms fail are not lost. This type of logged message has a valid frame flag and destination / next addresses. It is identified as coming from source 2.

The local control code allows the user to log different types of data and messages via the *log_data* command. The data type must be specified as either radio message, string, bits, bytes, words, longs, or floats, and a user-defined source is given to the log record.

The logged data is retrieved via the menu:

Logging Options / Recover Logged Data

The menu allows the user to search for records with particular parameters, list all records, and clear all records. The output display may be set for on-screen viewing or .csv format if the data is to be imported into a software package such as Excel.

2.14 Local Control

The Local Control feature allows a TLX unit to provide custom control functions. The customer specifies the control behaviour by writing a C program which includes libraries provided by ELPRO. The program is downloaded into the TLX, and once a Control address is assigned, the control code begins executing. For more information consult the manual for TLX Distributed Local Control.

Control programs may also be written in-house at ELPRO to provide custom control functions. The control code is downloaded to the TLX by the following steps:

Obtain the file to download. It should have extension “.sx”.

1. Bring up the TLX menu and ensure the controller is off by disabling the control address and resetting the unit.
2. Choose Configure Local Control / Load Control from File. You will be prompted to send the data.
3. Use the terminal’s function to send the .sx file to the TLX.
4. To activate the control code, a control address must be assigned and the unit reset. The control code will then execute automatically.

2.14.1 Control Parameters

A set of eight parameters are provided to enable simple changes to the control behaviour via the menu. The parameters are 32-bit variables and their values may be edited via the menu. The parameters are accessible by the control code, which may perform specific functions according to the parameter values. The control code may only read the parameters; it cannot change their values.

2.15 TLC Emulation

The TLX may be used as a direct replacement for an older TLC unit. For this purpose the TLX can be configured to emulate specific models of TLC. The TLX emulates the TLC by treating message frames in the same way the TLC would have used them. The TLX emulates 3 kinds of TLC frames, and has its own native TLX frame. The different emulation modes include module information such as battery low or power fail in different locations in the frame as shown:

2.15.1 Digital Frames

Native TLX:

No redundancy:

Mains fail	Battery low	Antenna fault	On-board DIO
Last DIN	2 nd -last DIN	3 rd -last DIN	4 th -last DIN

Dual-redundancy mode:

Mains fail	Battery low	Secondary fail	Primary fail
Last DIN	2 nd -last DIN	3 rd -last DIN	4 th -last DIN

TLC-01-05 emulation

Mains fail	Battery low
Last DIN	2 nd -last DIN

TLC-02-01 emulation

Mains fail	Battery low
DIN16	DIN15

TLC-09-02 emulation

Mains fail	Battery low
DIN8	DIN7

2.15.2 Analog Frames

Native TLX:

Radio temperature	RSSI	Battery level (volts * 10)
3 rd -last AIN	2 nd -last AIN	Last AIN

TLC-02-01 emulation

AIN1	AIN2	Battery level (volts * 10)
AIN1	AIN2	AIN3

The emulation mode is chosen from the menu item:

Configure Site / TLC Emulation Mode

2.16 Test Functions

The test I/O menu function allows a user to manipulate outputs and alarms for testing. Analog and digital inputs can also be read. Choose the menu option:

Service Menu / Test I/O

Digital and analog outputs on a local 115S are written to via the “Write Digital Outputs” and “Write Analog Outputs” menu selections.

The “Write on-board DIO” menu selection is used to set or reset the single on-board digital output.

Note that for the I/O to function properly during testing the unit must be given a local RTU address.

The “Test Local Alarms” menu option allows a user to manipulate and test the unit’s warnings and alarms. Once this menu is entered, the alarms are not updated via the normal software operation, but are controlled by the user via the menu. The unit still responds to the alarms as if they had occurred during normal operation. The effect of each alarm can be checked by reading the module fault flag via the “Read alarms” menu option. Once the Test Local Alarms menu is exited, the alarms will be updated by the software as normal.

2.16.1 Tone Reversals

The radio can be tuned and tested via the Tone Reversals menu. This menu is located at:

Service Menu / Tone Reversals menu

This menu can be used to transmit tone reversals (alternating marks and spaces) from the radio, or a constant mark tone or a space tone.

Chapter 3

INSTALLATION

3.1 General

The TLX-400 is housed in a plastic case suitable for DIN-rail mounting. Terminals will accept wires up to 2.5 sqmm (12 gauge) in size.

Normal 110-240V AC supply should not be connected to any terminal of the TLX-400 module.

To operate this equipment legally the user must operate on a designated license-free radio channel and within the operating parameters of the license-free channel, or obtain a radio operating license from the responsible government agency. This is done so the government can coordinate radio users in order to minimize interference.

Before installing a new system, it is preferable to bench test the complete system. Configuration problems are easier to recognize when the system units are adjacent. Following installation, the most common problem is poor communications caused by incorrectly installed antennas, or radio interference on the same channel, or the radio path being inadequate. If the radio path is a problem (e.g. path too long, or obstructions in the way) then higher performance antennas or a higher mounting point for the antenna may rectify the problem. Alternately, use an intermediate TLX-400 as a repeater.

The TLX-400 *Installation Guide* included with the product provides an installation drawing appropriate to most applications. Further information is detailed below.

Each TLX-400 should be earthed via the "GND" terminal on the module. This is to ensure that the surge protection circuits inside the module are effective.

The TLX has two RS232 ports which allow configuration via a PC. The CONFIG port requires an RJ45 connector and the HOST port requires a DB9 connector. Both ports expect a standard straight-through RS232 cable. Either port may be used to configure the TLX via the menu. Use a terminal program such as ProComm or HyperTerminal to communicate with the TLX. The menu is invoked by hitting the <enter> key three times in quick succession.

3.2 Power Supply

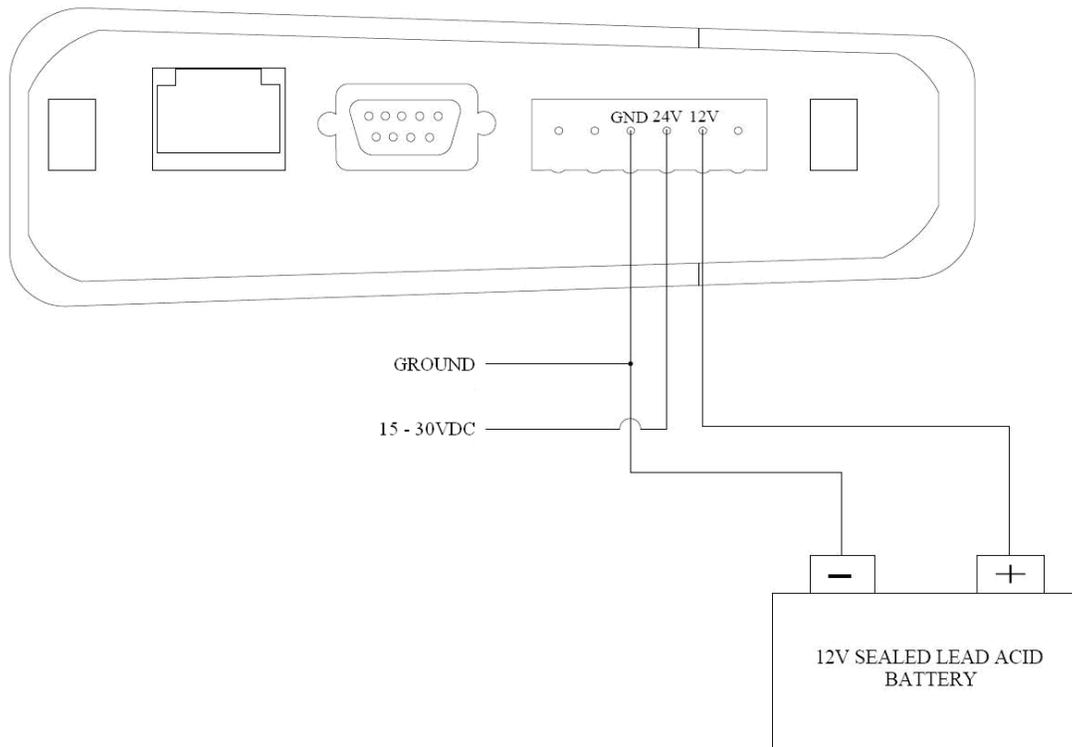
There are several options for powering the TLX-400. Power may be derived from the mains or a solar array and applied to the +24VDC power input. The +12VDC pin may be used for a back-up battery. The battery is charged while the +24V input is powered; otherwise the battery powers the TLX. The following table shows the input voltage requirements.

VOLTAGE INPUT	+24VDC	+12VDC
Allowable Input Voltage Range	15 – 30VDC	9 – 15VDC
Maximum current draw/supply	2.5A	1.8A

Only DC voltages are accepted. Inputting AC power can damage the TLX-400.

3.2.1 Mains Power for the TLX-400.

The TLX-400 has two inputs for power: +24VDC and +12VDC. The +24VDC input is the mains (and solar) input and accepts 15 – 30VDC. The +12VDC input is usually connected to a 12V SLA (sealed lead acid) battery and can also output current to charge the battery if required. For mains powered sites, the battery typically should range between 7Ah and 30Ah depending on the expected transmission duty cycle and I/O connected. Below is a wiring diagram showing how to connect the TLX-400 to power and battery.



For sites with small amounts of I/O (up to 8 digitals and 8 analogs) and low transmission duty cycles (does not transmit frequently) then a 7 or 12Ah battery should be sufficient with 7Ah being the bare minimum. If the TLX-400 is to be setup as a store and forward/repeater, is expecting a high transmission duty cycle or has large amounts of I/O then a 20 - 30Ah battery is recommended.

3.2.2 Solar Power for the TLX-400

In some remote sites, solar power is the only option to supply the TLX-400. Due to the effects of night-cycles and weather, solar powered sites require larger batteries than their mains-powered counterparts. Battery sizes are mainly dependant on the transmission power, the transmission duty cycle and I/O connected to the TLX-400 (such as the 115S-xx modules). The TLX-400 has an onboard regulator which is only suitable for recharging the battery of a standard remote site (one TLX-400 with 8 DIO and 8 analog I/O). The maximum current that the battery can be charged at via the onboard regulator is 1.8A.

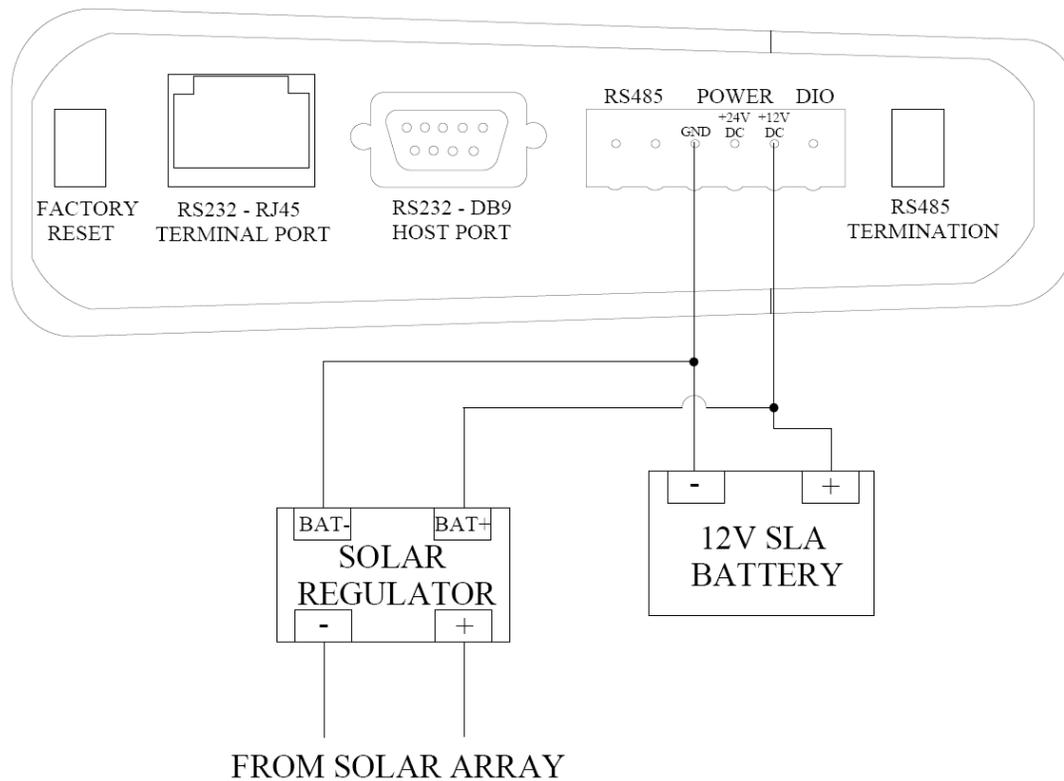
3.2.3 Solar Panel and Battery Sizing

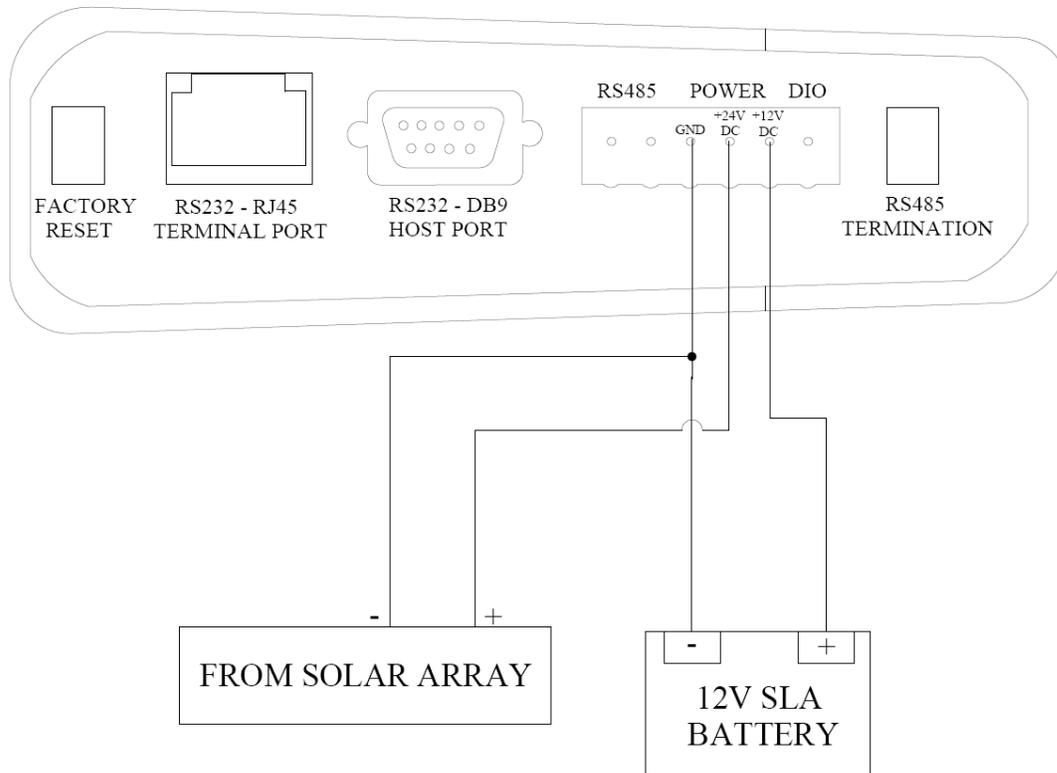
A TLX-400 when charging a low battery can require up to 2.5A (from 16V supply) so it is important to ensure that any solar panels can supply at least 2.5A at 16V. This gives a minimum rated panel of 40W. A 40W panel with a 40-50Ah battery will support a standard site (low transmit duty cycle with about 8 DIO and 8 analog I/O). For such sites, the TLX-

400's onboard regulator can be used to charge the battery. If a larger solar panel is used then an external solar regulator is recommended to get the full benefit of the panel.

If the TLX-400 is to be used as a store and forward/repeater, is transmitting large amounts of data or has large amounts of I/O then a high-current external regulator must be used in conjunction with a larger battery. Having an external regulator ensures that the battery can be charged at a reasonable rate and can support high power solar panels. For a large/busy site, the solar panel power could be increased to 80W – 100W with an 80Ahr battery and an external regulator to match the selected battery and panel. These figures should be increased/reduced to match the site conditions as each site will be different. It is often better to overpower store and forward/repeaters due to several sites being affected if it loses power. Extremely remote sites should also fall under this category as accessing them due to a power failure is difficult.

See below for wiring diagrams with and without a regulator.





3.3 Antenna Installation

The TLX-400 will operate reliably over large distances. The distance which may be reliably achieved will vary with each application, depending on the type and location of antennas, the degree of radio interference, and obstructions (such as hills or trees) to the radio path. The expected range for radio data rates of 4800 bits/sec is up to 60km (40 miles), depending on installation, site and path terrain. The expected range at 19200 bits/sec (with 25KHz bandwidth) or 9600 bit/sec (with 12.5KHz), is up to 30 km (20 miles) line-of-sight.

Where it is not possible to achieve reliable communications between two TLX-400 modules, then a third module may be used to receive the message and re-transmit it using the Store-and-Forward function. This module is referred to as a repeater.

An antenna must be connected to each TLX using the female SMA connector at the top of the module.

To achieve the maximum transmission distance, the antennas should be raised above intermediate obstructions such that the radio path is true “line of sight”. Because of the curvature of the earth, the antennas will need to be elevated at least 5 metres (15 feet) above ground for paths of 5 km (3 miles). For short distances, the modules will operate reliably with some obstruction of the radio path. Obstructions which are close to either antenna will have more of a blocking effect than obstructions in the middle of the radio path. For example, a group of trees around the antenna is a large obstruction, and the antenna should be raised above the trees. However if there is at least 100 metres (300 feet) of clear path before a group of trees, the trees will have less effect on the radio path. To help in planning radio systems, ELPRO provides a free utility for estimating path performance.

The modules provide test diagnostics to test the radio path and display radio signal strength.

An antenna should be connected to the module via 50 ohm coaxial cable (eg RG58, Cellfoil or RG213) terminated with a male SMA connector. The higher the antenna is mounted, the greater the transmission range will be, however as the length of coaxial cable increases so do cable losses. For use on unlicensed frequency channels, there are several types of antennas suitable for use. It is important antennas are chosen carefully to avoid contravening the maximum allowed power limit on the on the radio channel. If in doubt refer to an authorized service provider.

The gains and losses of some typical antennas and cable types are

Antenna	Gain (dB)
Dipole with integral cable	0
3dBd Collinear	5
6dBd Collinear	8
6 element Yagi	9
9 element Yagi	12
16 element Yagi	15
Cable type	Loss (dB per 10 m)
RG58	-4.5
RG213	-1.65
Cellfoil	-2.25

The net gain of the antenna/cable configuration is determined by adding the antenna gain and the cable loss. For example, a 6dBd Collinear with 20 metres of RG58 has a net loss of 1 dB ($8\text{dB} - ((20/10) \times 4.5) \text{dB} = 8\text{dB} - 9\text{dB} = -1\text{dB}$)

Another important consideration when installing the antenna system is RF exposure. The antenna can radiate a large amount of RF energy. It is important to ensure that a person cannot approach the antennas within the recommended minimum safe distances in the table below.

Antenna Type	Minimum safe distance
Dipole	0.4 metres
3dBd Collinear	0.7 metres
6dBd Collinear	0.9 metres
6 element Yagi	1.2 metres
9 element Yagi	1.5 metres
16 element Yagi	2.3 metres

Connections between the antenna and coaxial cable should be carefully taped to prevent ingress of moisture. Moisture ingress in the coaxial cable is a common cause for problems with radio systems, as it greatly increases the radio losses. We recommend that the connection be taped with a layer of PVC insulating tape, then a layer of vulcanizing tape such as “3M 23 tape”, with a final layer of PVC insulating tape.

Where antennas are mounted on elevated masts, the masts should be effectively earthed to avoid lightning surges. Although the TLX-400 is fitted with surge protection, additional surge suppression devices are recommended if lightning surge problems are experienced. If the antenna is not already shielded from lightning strike by an adjacent earthed structure, a lightning rod may be installed above the antenna to provide shielding.

Figure 3 shows a diagram of the antenna installation.

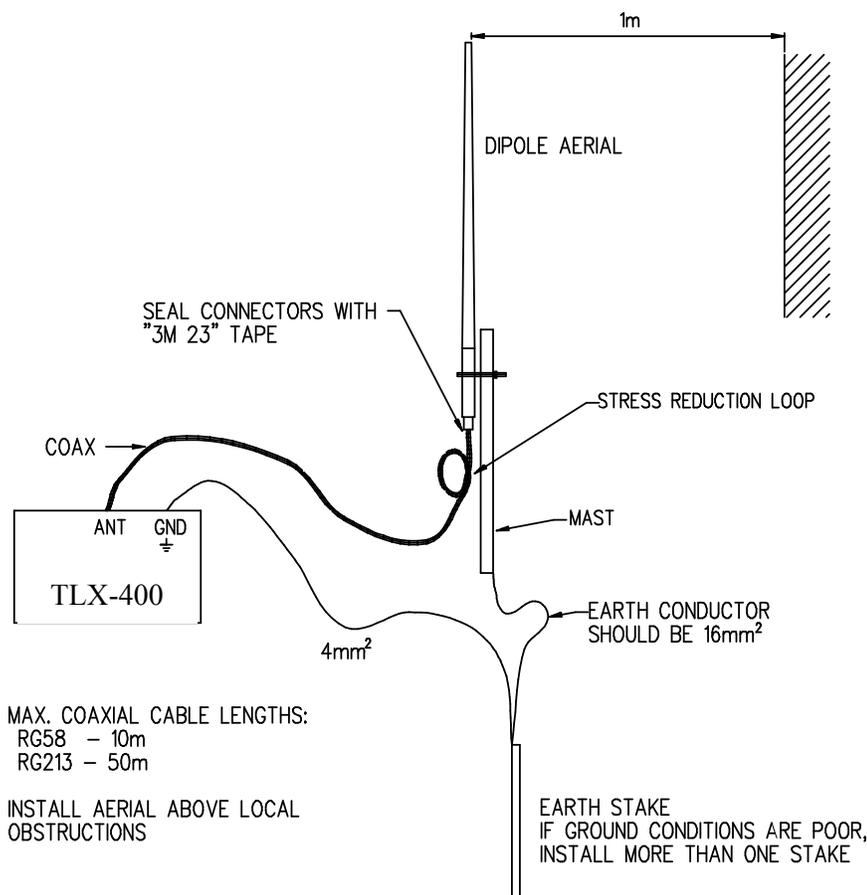


Figure 3: Antenna installation for TLX-40

Chapter 4

MENU ITEMS

This chapter provides information about each menu item available on the TLX. It describes each menu item's function and acceptable values to enter as inputs.

4.1 Configure Site

Display Configuration

Displays the current configuration from all the menus located under the Configure Site menu.

TLC Emulation Mode

TLX native mode

No TLC emulation. See the chapter Messaging Protocol for local data inserted into message frame in TLX native mode.

TLC 01-05

Adds module data in the message frame to emulate that of a TLC 01-05 (an existing ELPRO product) for backwards compatibility with existing SCADA systems.

TLC 02-01

Adds module data in the message frame to emulate that of a TLC 02-01 (an existing ELPRO product) for backwards compatibility with existing SCADA systems.

TLC 09-02

Adds module data in the message frame to emulate that of a TLC 09-02 (an existing ELPRO product) for backwards compatibility with existing SCADA systems.

See the section TLC Emulation for more detail on the data added to the message frames.

Redundancy Options

Configures redundancy between two TLX modules. If the primary unit fails, the secondary unit will assume control. See the chapter Redundancy for more information.

Redundancy Mode

No Redundancy

Disable redundancy.

Primary

Enable redundancy with the unit as the primary controller.

Secondary

Enable redundancy with the unit as the secondary controller.

Forced Changeover Timeout

Restores original Primary / Secondary operation after a Force Changeover has been initiated by the menu, and the set timeout has elapsed.

Valid Input format: hh:mm:ss

Force changeover

Applied to active unit only, force the module to give control to the standby unit. Also use this menu to cancel a forced changeover that does not time out.

Address of Pre-Processor

Configures the unit as a Pre-Processor which is commonly used for the computer to TLX interface.

Valid Address: Integer in the range 0 – 255 (entering 255 disables the pre-processor)

Address of Pager RTU

Configures the unit to use an external modem to dial into a paging network. The pager must be connected to the RS-232 DB9 port and configured in the pager/modem menu.

Valid Address: Integer in the range 0 – 255 (entering 255 disables the pager)

Address of Control RTU

Configures the unit as a controller resembling a basic SCADA system. When given a valid Control RTU address, the unit executes the user control code, previously downloaded via the menu. See the chapter Local Control for more information.

Valid Address: Integer in the range 0 – 255 (entering 255 disables the controller)

SMF option

Configures the unit to connect to an SMF (standalone monitoring facility). In practice, this option inhibits radio transmission from the unit. The receiver is still enabled, sending received data out of the HOST port so that a computer can utilise the data.

Valid Input: y/n

Address of local RTU

Gives the unit its own address and activates I/O and change-of-state detection. Other RTUs use this address to communicate with the unit.

Valid Address: Integer in the range 0 – 255 (entering 255 disables the RTU address)

Input Debounce Time

Specifies the amount of time (in seconds) an input must remain constant before generating a COS (change of state) message.

Valid Input: 0.01 to 100.00 (seconds)

Comms Fail Timeout

Specifies the amount of time (in minutes) that the local RTU will wait before deciding it is in comms fail. At this point it clears its outputs.

Valid Input: Integer in the range 0 – 35 (minutes)

Frame type

Sets the frame type that the unit will transmit (from MOD1 to SB05). Different frame types contain different amounts of IO. See the protocol document for more information on frame types.

Default sensitivity

Sets the minimum change that must occur in an analog input for a COS message to be generated. This initial value can be altered if a sensitivity frame addressed to the unit is received.

Valid input: Integer in the range 1 – 65535. (1966 ~ 3%)

Analogue inputs to square root

Specifies which analog inputs should have their square root taken before processing or storage. Refer to the section Analog Inputs for more information.

Valid Inputs: Integers referring to the analogs (separated by spaces).

Analogue inputs to filter

This option provides extra filtering for the analog inputs. If this option is not selected, the TLX will take an average of the last 10 seconds from the analog reading to give the present reading. If a larger running average is required, this menu is used to setup specific analogs to change the running average time. The time constant refers to the time over which the averaging process will take place. Refer to the section Analog Inputs for more information.

Routing

Configures which addresses the unit can communicate with on radio, host, terminal and expansion ports. Also sets the COS (change of state) address which is typically the control unit in the network (0 in a SCADA-C system).

Valid inputs: Integers in the range 0 – 255

Store and Forward Configuration

Specifies which address the radio messages from the unit are to route through to get to the destination. Useful if a poor radio path prevents direct communication. The message is sent to the store and forward address which then relays the message to its destination.

Valid inputs: Integers in the range 0 – 255

4.2 Configure Radio

Display Configuration

Displays the current radio configuration, including transmit and receive frequency, baud rate, tones and Power.

Tx/Rx Frequency

Alters the Transmit and Receive frequencies. Valid inputs will vary depending on the radio frequency range

Example Input: 461.08125

Tx Power

Sets transmit power. The unit can transmit at 500mW, 1.0W, 2.0W or 5.0W.

Baud Rate

Sets data transmission speed over the radio, either 300 baud or 1200 baud.

Radio Tones

Selects the protocol for communication: *V.23* or *Not V.23*.

Lead-in

Specifies the amount of lead-in time (in milliseconds) the unit will transmit for prior to sending the message. Lead-in time allows other units to lock on to the transmission before receiving the message.

Valid inputs: Integers in the range 30-1000 (milliseconds)

4.3 Configure Local Control

The TLX can be programmed to exhibit basic SCADA functions that would normally be controlled by a PLC such as toggling inputs when certain analog setpoints have been reached.

Load Control From File

Upload a pre-prepared control program to the TLX. See the section Local Control in this manual more information.

Save Control To File

Download the current control program stored in the TLX to a computer.

Control Parameters

Edits values specified in the control program such as analog setpoints.

Show Masks

Displays which inputs and outputs are currently masked by the given control RTU. If an input is masked, it can only be written to by the unit that masked it.

4.4 Load Configuration From File

Configures the TLX using a text file stored on the computer. Upload the text file using the send text file option in HyperTerminal. Radio settings will remain unchanged as they are not stored in the text file.

4.5 Save Configuration To File

Saves a text file containing configuration data to the computer which can be uploaded to the TLX at a later date. The radio settings are not transferred. Store data by using the capture text menu in HyperTerminal or an equivalent program.

4.6 Service Menu

The service menu contains a number of tools to test communications and TLX IO status.

Monitor Comms

Displays communications being sent and received from both the radio and serial ports frame by frame.

Send Tone Reversals

Transmits alternating mark / space tones for radio calibration purposes. Mark-only or space-only tones can also be selected.

RSSI menu***Display RSSI***

Displays the current received signal strength in dBm.

Automatic RSSI Calibration

Calibrates the offset and span for the RSSI automatically by requesting and internally comparing set signal power levels (-70dBm and -100dBm). An RF generator is required to perform this task.

Manual RSSI Calibration

Calibrates the RSSI by requesting direct input of the offset and span.

Radio Status and Temp

Displays the current temperature of the radio in degrees Celsius followed by any active radio alarms.

Set Clock

Sets the internal clock of the TLX in 24hr time format. The clock will reset if the TLX remains un-powered for more than approximately two days.

Input Format: hh:mm:ss dd/mm/yyyy

Notepad

Basic two-line text storage. Useful for making notes and storing general information about the site.

Test I/O

In this menu, internal alarms and added IO can be read from and written to. This section is primarily used for testing.

Test Local Alarms***Write mains fail alarm***

Sets or clears a mains fail alarm. This alarm typically occurs if the main supply is switched off whilst the battery is connected and operational.

Write battery alarm

Sets or clears a battery low alarm. This alarm typically occurs when the battery voltage drops below 11.7V

Write antenna alarm

Sets or clears an antenna alarm (VSWR). This alarm typically occurs when there is no antenna connected or the antenna is faulty.

Write radio ptt timeout alarm

Sets or clears a transmission timeout alarm. This alarm is typically generated if the radio transmitter has been on continuously for a long period (usually two minutes).

Write radio PLL alarm

Forces a Phase Locked Loop alarm. This alarm is typically generated when the onboard PLL frequency is out of lock. This alarm usually results in the radio having trouble detecting tones.

Write radio overtemperature alarm

Sets or clears an overtemperature alarm. This typically occurs due to a high temperature at the radio transmitter.

Read alarms

Displays all of the onboard alarms' current states (1 = on, 0 = off).

Clear all

Clear all onboard alarms.

The applied alarm settings remain until the Test Local Alarms menu is exited. The alarms are then set normally by the firmware.

Write Digital Outputs

Sets or clears a digital output on the attached I/O expansion module. To exit, enter digital input 0 and press enter.

Write on-board DIO

Sets the on-board DIO pin to either on or off. The state of this pin can be seen by the IO light on the TLX.

Write Analog Outputs

Writes a value to the specified analog output. The value will be reflected in whatever I/O expansion module is attached to the TLX, providing it has analog outputs.

Show All Inputs

Displays all the input mappings in TLX memory (128 digitals, 40 Analogs and 16 pulsed inputs). All inputs will be displayed regardless of what IO may actually be attached to the TLX.

Read 115S-XX @ #

Displays the input on a specific 115S module connected to the TLX. XXX is replaced by the board type (DIO, AIN or AOT) and # is the address assigned to the 115S (01 – 16).

Display serial number

Displays the 11 digit product serial number (example: 03061030000).

Display hardware version

Displays the hardware version of the TLX (example: 1.4J)

Enter Elpro Password

ELPRO internal usage, gives additional options used for factory configuration.

4.7 Pager/Modem Options

This menu selection can be used to ensure that the attached pager modem is working correctly. The modem must be attached to the HOST port (DB9) and the menu brought up via the CONFIG port (RJ45).

Test Pager/Modem

Tests the pager modem by sending a test pager message to the first configured pager.

Monitor Pager/Modem

Displays the status of the pager modem during the process of sending a page message.

4.8 Logging Options

The TLX can store data locally if a comms fail error has occurred.

Enable Automatic Logging Of Commfail Data

Enable or disable the storage of data generated whilst in comms-fail. The maximum amount of memory that the comms-fail log can occupy on the unit is 128kb. Once this limit has been reached, data will be overwritten starting with the oldest entry.

Recover Logged Data***Set search parameters***

Allows filtering for certain events (such as radio messages or COS messages) by time period.

Search by parameters

Shows the results corresponding to the settings in Set Search Parameters.

List all

Shows all messages stored in the TLX

Clear all

Clears all the messages stored in the TLX memory.

Display options

Specifies how the log records should be displayed on the screen. *Display for Screen* lists the records in a format that is easy to read on the screen. *CSV format* lists the records in a comma-separated format that is convenient if the data is to be saved to file and viewed with a spreadsheet program.

4.9 Serial Ports Configuration

The DB9 RS-232 (HOST) and RS485 (EXPANSION) port settings can be changed to match a wide array of connection options. This menu gives access to the BAUD rates, data format and modem/pager setup.

Display Port Configuration

Displays port settings for the HOST and EXPANSION ports in addition to modem/pager configurations on the HOST port

Set HOST Port Baudrate

Sets the port speed for the HOST (DB9) port. There are pre-set selections available in addition to a custom BAUD rate option.

Set HOST Port Data Format

Sets the number of data bits, stop bits and type of parity for the HOST (DB9) port from preset selections.

Set EXPANSION Port Baudrate

Sets the number of data bits, stop bits and type of parity for the EXPANSION (two-wire RS485) port from preset selections.

Set EXPANSION Port Data Format

Sets the number of data bits, stop bits and type of parity for the EXPANSION (two-wire RS485) port from preset selections.

Configure HOST for modem

This menu option is used to configure a modem attached to the HOST (DB9) port. Initialization strings and phone number settings can be stored using this menu. For more detail on how to properly interface a modem to a TLX, see the section Modem Feature in this manual.

Modem on HOST port

Configures the unit to support a modem connected to the HOST (DB9) port.

Valid Input: y/n

Set phone number

Stores a phone number to dial and send the message to if an event occurs (such as a change of state).

Set extra modem initialization

Allows the addition of modem initialization strings to allow alternate configuration of the modem. These strings are run prior to dialing the given number.

Configure HOST for pager

Set phone number

Stores the phone number to dial for the paging network.

Set password

Stores the password required for the paging network.

4.10 Modbus Configuration

This menu item configures the TLX to communicate with additional hardware (such as 115S IO modules) using the Modbus protocol.

Show 115S module Configuration

Displays the current 115S modules that have been setup on the TLX including their type, their address and the number of digital inputs configured.

Auto Detect 115S Configuration

Auto-detects 115S IO modules which have been connected to the TLX. Requests number of digital inputs for each detected 115S.

Valid Input: Integer in range 0 – 8 for AIN and AOT boards
Integer in range 0 – 16 for DIO boards

Manually Configure 115S Modules

Allows configuration of 115S units by manually entering in the address, 115S type and number of digital inputs.

Valid Address: Integer in range 1 – 16
Valid Type: D, I, O or N (D=DIO, I=AIN, O=AOT, N=None)
Valid DIN: Integer in range 0 – 8 for AIN and AOT boards
Integer in range 0 – 16 for DIO boards

Show Modbus Configuration

Displays the specifics of the master poll commands in addition to poll time and current Modbus address.

Set Modbus Slave Address (0 for master. 255 for disable)

Sets the Modbus address of the TLX. In order to communicate with IO modules, this must be set to 0 (Master).

Valid Input: Integer in range 0 – 255

Set Delay Between Polls (mSec)

Sets the time between Modbus poll queries. The TLX will poll all configured 115S modules sequentially with this delay between polls. The greater the number of 115S modules attached, the smaller this time should be.

Valid Inputs: 0 - 10000

Add Master Poll Commands

Used to map IO from an entered Modbus address to different memory locations on the TLX. This enables greater customization of IO.

Valid Address: Integer in range 1 – 128
Valid Timeout: Integer in range 1 – 50000 (ms)

Valid Retries: Integer in range 0 – 10

Valid Location: Integer in range 1 – 49999 (see selection for IO)

Valid TLX Location: Integer in range 0 – 100

Valid Number Points: Integer in range 0 - 128

Edit an existing command

As more master poll commands are entered, they are given a unique index. To edit a chosen command, select the index number corresponding to the entry for editing.

Valid Input: Integer with range dependant on number of poll commands entered.

Delete the final command

Deletes the master poll command with the highest index (usually the most recent one entered).

4.11 Factory Defaults

Resets the TLX configuration to factory default settings. The radio is not affected by this, retaining its calibration and Tx/Rx frequencies.

4.12 Reset

Resets the TLX without disconnecting power. It is recommended to reset via this menu option after any setting changes.

4.13 Exit

Exits completely out of the TLX menu. The menu must be invoked again if any additional changes are to be made.

Chapter 5 TROUBLESHOOTING

This chapter provides information about each menu item available on the TLX. It describes each menu item's function and acceptable values to enter as inputs.

5.1 115S Connection

- **TLX does not auto-detect 115S module(s)**
The 115S may not be set for MODBUS RTU protocol. Set the 115S modules to use MODBUS RTU as described in the manual. Also check that the address switches on the 115S unit(s) are between 01 and 16. A change in address requires a reset on the 115S (power off and on again).
- **TLX autodetects 115S modules but will not poll them**
This problem can occur if the TLX Modbus slave address is not set to 0 (master). Set this to 0 via the MODBUS configuration menu.
- **After removing a 115S, the TLX continues trying to poll**
Go into Manual Configuration located in the Modbus Configuration menu, enter the address of the unit recently removed and select its type as none (N).
- **TLX does not detect more than one 115S**
Check to ensure that each attached 115S has a different address via the address switches (between 1 and 16). Also ensure that each 115S has been connected to the TLX's RS485 port. If the connection wires are particularly long (several meters) then try turning on the RS485 termination switch on the 115S in question.
- **Digital or Analog XX doesn't read correctly on the TLX**
This problem could be caused by using an emulation mode. Different IO locations have been reserved for alarms such as Mains Fail and Battery Low. For example DIN 15 and DIN 16 are reserved when emulating a TLC 02-01. This problem can be solved by either utilizing the master poll commands to change input locations or not using those particular IO locations. For a list of reserved locations, see the TLC Emulation section. Another cause of this problem could be that the 115S is not setup to accommodate the desired analog input range. See the 115S Manual for instruction on how to configure the 115S analog I/O.
- **Pulsed inputs are not being displayed accurately on the TLX**
If using a digital input other than 1-4 on an 115S, check to ensure that the poll time is higher than that of the maximum expected pulse rate.

5.2 Local Control

- **User control code does not download completely, or does not run properly**
The downloading program may be supplying characters too quickly. Try increasing the character time and line time of the terminal program.

5.3 Menu

- **The menu does not come up when 3 [CR] characters are pressed**
The com port, baud rate, or data format could be wrong. Turn off flow control. Also check that the TLX to computer cable is a straight-through serial cable.

5.4 Communications

- **Radio messages do not get through**
Ensure the radio settings match that of the network (Tx and Rx frequencies, baud rate and tones). Try raising the power level. Check for antenna fault (via Test I/O menu) and try elevating the antenna (by a few meters). Ensure routing list is correct. Try transmitting a MARK tone, and check the Rx LED glows on the receiving unit. Also ensure that the unit has adequate power (20W minimum).
- **Serial messages do not get through**
Ensure the menu is not running on the serial port. Check the routing list is correct. Check the baud rate and data format settings. If expecting messages to be sent over the serial port (e.g. a pre-processor) check the routing to ensure that the unit is enabled to talk over the tested port.
- **Modem does not function properly under TLX control**
Ensure that the modem is correctly connected to the HOST port and does not require any additional initialization (this can be entered in the menu). Check the TLX is configured to talk to the modem.

Chapter 6 SPECIFICATIONS

Power

Supply Voltage: 15 – 30VDC on 24V input, 11 – 15VDC on 12V input

Current @ 13.5VDC:

Receive: 150mA;

Transmit: 450mA @ 0.5W, 800mA @ 1W, 1.25A @ 2W, 2A @5W

Battery Charger: Float charge voltage 13.8VDC with 1.6A current limit (minimum supply voltage 15V)

Operating environment

Temp Range: -30°C to +60°C / -22 to +140 °F

Humidity: 0 to 99% non-condensing

Menu

ASCII via either RS-232 serial port.

Invoke menu by 3 successive [CR] characters separated by min 50mS and max 500mS.

I/O Capabilities

Connects to Modbus devices via Modbus RTU protocol.

Auto-configurable with ELPRO 115S- series, analog and digital I/O.

General

Numbers of I/O limited by frame type.

Supported frame types: sb_06, sb_05, mod_1, mod_2, mod_3, mod_5, mod_6, mod_7, mod_8, mod_9, mod_10, mod_11

Maximum I/O limits (frame type Mod3)

Digital inputs: 16 bytes (128 digitals)

Digital outputs: 16 bytes (128 digitals)

Analog inputs: 40

Analog outputs: 40

Input debounce time: 0.01 seconds to 600 seconds.

Sensitivity: 0 to \$FFFF (0 to 65535)

115S expansion

Maximum number of 115S units connected to one TLX: 16

Modbus

Supported Modbus commands:

- 1: Read coil status
- 2: Read input status
- 3: Read holding registers
- 4: Read input registers
- 5: Force single coil
- 6: Preset single register
- 7: Read exception status
- 8: Loopback diagnostic test
- 11: Fetch event counter
- 15: Force multiple coils

16: Preset multiple registers

Master poll time: 0 to 10 seconds.

Ports

RS-232 Terminal / Config port (RJ45)

Baud rate: 9600

Parity: None

Data bits: 8

Stop bits: 1

Not configurable.

RS-232 Host port (DB9)

Configurable baud rates:

300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200, Custom

Configurable data formats:

Data bits	Parity	Stop bits
8	None	1
8	None	2
7	Even	1
7	Odd	1
8	Even	1
8	Odd	1

RS-485 Expansion port

Configurable baud rates:

300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200, Custom

Configurable data formats:

Data bits	Parity	Stop bits
8	None	1
8	None	2
7	Even	1
7	Odd	1
8	Even	1
8	Odd	1

Radio

Transceiver:

Single channel

Synthesized, fixed band 12.5, 20 or 25KHz
380 –520 MHz (In 20 MHz bands)

Transmit power:

Four levels 5W, 2W, 1W and 0.5W

Lightning surge protection:

Internal gas discharge arrester

Signal detect / RSSI:

-120 to -60 dBm

Antenna Connector:

Female SMA.

Standards:

Australia: AS 4768.1, AS4295
Europe: EN 300 113, EN 300 220
USA / Canada: RSS-119, FCC Part 90

Logging

Logging memory available: 128kbyte
Log record overhead: 14 bytes
Log record data size: 2 - 498 bytes
Number of log records: 8191 (2 bytes data) - 4096 (Mod 1)
Additional log records overwrite the oldest records.

Local Control

User configurable control allows control of the local module and other remote modules to implement full-time local control or as fall-back in case of main computer fail. Max code size: 16k bytes

TLC Emulation

Emulation options:

- TLX native
- TLC 01-05
- TLC 02-01
- TLC 09-02

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