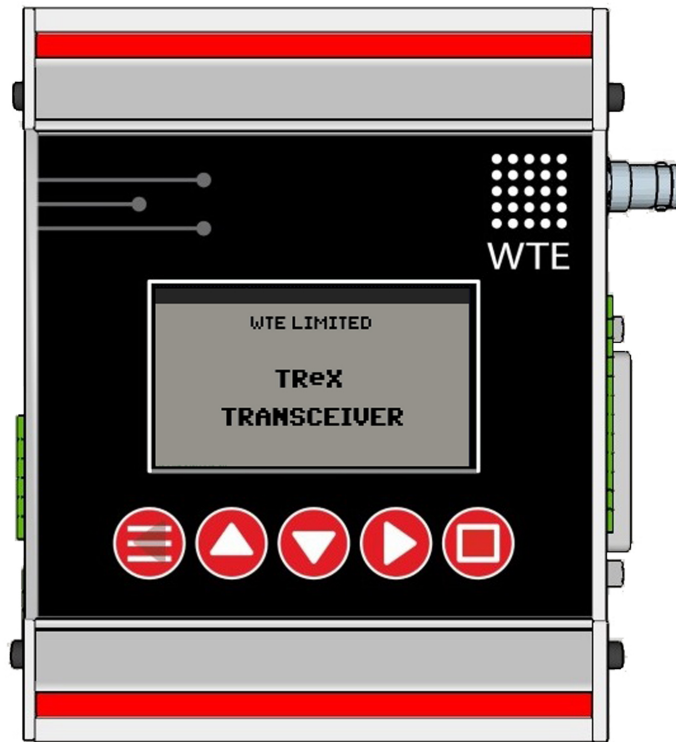




# WTE TReX

## TELEMETRY, DATA AND PAGING I/O TRANSCEIVER



### User Manual



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## Introduction

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Thank you for choosing the TReX.

The TReX is an Ethernet, Serial (RS232 plus RS485/RS422) and USB capable transceiver for data, paging (one and two-way) and general telemetry use. The TReX can be configured through; a simple integrated display and keypad, serial commands, TCP, USB or via a web browser. The TReX is suitable for commercial, industrial and remotely managed control/monitoring applications.

Use the TReX when high reliability, long range and high speed control or messaging is required .

### The TReX can be used to:

- Transmit and receive paging messages.
- Connect to third party SCADA control and monitoring systems using Modbus protocols.
- Log messages to internal memory to meet auditing requirements.
- Mirror analog and digital inputs to a remote unit.
- Inspect potential site interference using the integrated spectrum analyser.
- Report system and installation errors, such as loss of communications, and battery states.
- Detect antenna faults during normal operation.
- Transmit and receive serial and telemetry data at high data rates.
- Act as a repeater for forwarding telemetry and paging messages in poor coverage areas.

### TReX Features

- Up to 4W power output.
- DIN rail mountable aluminium enclosure that also allows simple mounting from top, bottom or sides.
- Data transmit rates from 512 baud to 32K baud. Supported channel spacing of 25kHz, 12.5kHz and 6.25kHz.
- Support for **two-way** paging. Provides receipt of delivery and optionally receipt for accepted jobs.
- Supports 512, 1200, 2400, 4800 and 9600 baud POCSAG paging messages.
- Receives 1600 baud 2 level FLEX™ paging messages.
- Modbus RTU and TCP support for easy SCADA system integration.
- Paging store and forward repeater operation with configurable duplicate reject.
- 8 digital inputs and outputs.
- Two 0-10V/4-20mA analog outputs
- Two 0-10V analog inputs.
- Integrated spectrum analyser (optional).



- Simple to configure back to back mirroring and monitoring of analog and digital IO.
- Extended SCADA system expansion supporting up to 11 wirelessly connected units per system (optional).
- Optional logging to SD card of all received and transmitted messages.
- Graphics display shows all radio activity including I/O state.
- Multi language support (English and Spanish) and additional languages available on request.
- Fully configurable via front panel without the need for an external PC connection.
- Configurable via serial port, direct USB connection or Ethernet.
- RS232, RS422 and RS485 (both 4 and 2 wire) support.
- USB connection allows downloading of message logs or direct access to configuration files.
- Configured inputs can be programmed to output messages when triggered.
- Configured digital and analog outputs can be controlled via received messages.
- Any output can be assigned to indicate:
  - Channel busy. The channel busy output level is configurable.
  - Alert on filtered match of message payload.
  - Comms link fail.
  - Antenna fault.
  - Low output power.
  - High temperature.
- Periodic message support to ensure radio link integrity.
- Low battery messaging.
- Inclusion of the WTE “CUSTOM” protocol, that allows support of many existing paging protocols without the need for new firmware.
- Support for additional protocols upon request and negotiation.
- Firmware upgradable.
- High stability oscillator ensuring a maximum of 80Hz drift (at 160MHz) over the entire specified temperature range.
- Antenna mismatch detection capability.
- High sensitivity receiver.
- Internal real time clock.
- Long-life design uses no moving or electromechanical parts. No limited life components such as electrolytic capacitors.

## ***TReX Versions***

### **TReX-460, TReX-461:**

Telemetry, I/O and Messaging Transceiver



**TReX-460-P, TReX-461-P:**

Ethernet Paging I/O Transceiver.

**TReX-460-R, TReX-461-R:**

Ethernet Paging I/O Receiver (no transmit capability)

The TReX can be supplied to operate within these bands:

- TReX-16x (142MHz to 175MHz)
- TReX-46x (421MHz to 480MHz). Variants TReX-460 (USA), TReX-461 (Europe, AU and NZ).

## Safety Information

---

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it.

The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



This is the safety alert symbol. It is used to alert you to a potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

### **!WARNING**

**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.

### **!CAUTION**

**CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury

### **NOTICE**

**NOTICE** is used to address practices not related to physical injury.





**!WARNING**

**LOSS OF CONTROL**

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and over travel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failures of the link.

**Failure to follow these instructions can result in death or serious injury**

**!WARNING**

**THIS EQUIPMENT IS NOT INTENDED FOR MAINS VOLTAGES**

- TReX was **NOT** designed to operate and/or be connected directly to live main voltages. The TReX must be connected to a certified, suitably rated low voltage DC supply.

**Failure to follow these instructions can result in death or serious injury**

## NOTICE

### HAZARD OF EQUIPMENT DAMAGE

- This product is not chemical resistant, detergent, alcohol, aerosol sprays, and/or petroleum products may damage the front panel. Clean using a soft cloth moistened in water.
- The radio can be damaged if there is any potential difference between the chassis-ground, Serial signal ground, power (-) input, or antenna coaxial shield. Before connecting any wiring, ensure that all components are earthed to a common ground point.
- The antenna port will be damaged if signals greater than 13 dBm are injected/received.
- Do not connect any other transmitter to the RF connector or share the antenna with any other device.
- Extreme Heat or High temperatures can damage TReX components. DO NOT expose or operate the unit in extreme heat (above 70 degrees Celsius) or leave in direct sunlight or any other UV source.
- Although this product is designed to be rugged, it will not survive excessive shock or vibration abuse. The TReX is intended to be mounted permanently either in a land based location or in a vehicle. When fitting in a vehicle, vibration damping mounts may be required.
- The TReX IP rating is IP-51. TReX is not waterproof or dustproof. DO NOT directly expose to rain or use in a condensation forming environment.
- When antennas are co-located on a community (shared) site the correct site engineering must be performed to ensure that RF exposure limits are met.

## NOTICE

### CARE REQUIRED WHEN TRANSPORTING

Safety and care must be taken when transporting, handling, installing and/or replacing radio equipment.

- Packaging should be adequate to ensure connectors are not damaged
- Store and handle the radio equipment in dry, clean safe environment
- Handle the equipment with care
- Avoid intrusion of any object/material into the radio case
- Care when stacking TReX boxes must be taken to not damage part of the radio, such as connectors.

**NOTICE** introduction of foreign object into the TReX radio enclosure will void warranty.

### FCC NOTICE

This device complies with Part 15.247 of the FCC Rules.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference and
2. This device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by the equipment supplier. Any changes or modifications made to the device without the written consent of the equipment supplier may void the user's authority to operate the device.

End user products that have this device embedded must be installed by experienced radio and antenna personnel, or supplied with non-standard antenna connectors, and antennas available from vendors specified by the equipment supplier. Please contact the equipment supplier for end user antenna and connector recommendations.

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in General Docket 79-144 on March 13, 1996.

This equipment complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 43cm between the radiator and any part of your body.

### NOTICE



This symbol on the product or its packaging indicates that this product must not be disposed of with other waste.

Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment.

The separate collection and recycling of your waste equipment at the time of disposal will help conserve natural resources and help ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, contact the dealer from whom you originally purchased the product.

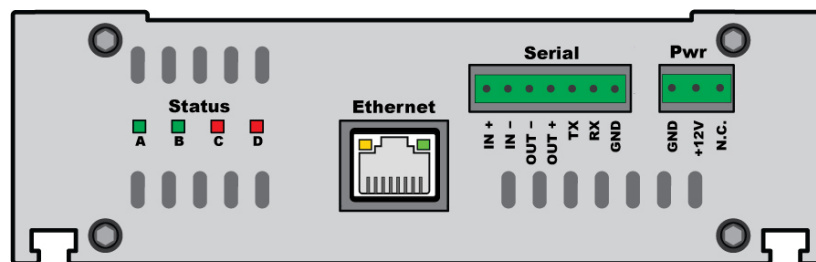
## Operation

Once a 13.8V source has been connected to the power connector the TReX start-up status is displayed on the LCD.

When the TReX is operating normally, the two green status LEDs flash briefly once every second.

When decoding messages, the “A” green LED is held on for approximately one second.

The “C” red LED is held on for the duration of a transmission, while processing TCP data, Modbus protocol commands and decoding received messages. Both the “C” and ‘D’ red LEDs light while starting.



On start-up under normal operation there is a message sent out the serial port. The message indicates the firmware revision, serial number other software related information.

After finishing the start-up procedure and loading of configuration settings the TReX enters its receive and decode mode of operation. The TReX now waits for commands to be entered serially for processing or inputs to be triggered. These may be either protocol messages to be processed or commands related to the configuration of the device. Serial messages may arrive on any serial port, or may also arrive through a TCP connection.

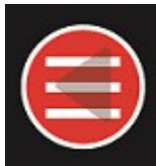
When messages are received and decoded, they are immediately sent out the serial port in the format of the configured protocol in use.

Messages are transmitted as per the input configuration when inputs change state. Please refer to **Input Output Hardware Connection** or **Input Handling** sections on this manual for further information.

The TReX outputs are driven high or low, or for a particular period of time depending on configuration. The outputs are controlled via the **WTE Output Control Protocol** message received and decoded. Each output can be configured to operate under various error states (Refer to **Outputs**).

## Buttons

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### ***MENU/BACK:***

When on the MAIN SCREENS used to enter the MENU. When inside the MENU, used to return back one level from within the MENU, until returning back to the MAIN SCREENS.



### ***UP:***

When on the MAIN SCREENS used to cycle between sub-screens. When in the MENU used to navigate or alter selected configuration items.



### ***DOWN:***

When on file related screens of the MAIN SCREENS shifts between entries. When in the MENU used to navigate or alter selected configuration items.



### ***RIGHT:***

When on the MAIN SCREENS used to cycle between main screen. Within the MENU used to enter sub MENU items or select items for configuration.



### ***ENTER:***

Used to select file related items from within the MAIN SCREENS.

## Main Screens

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The TReX top icon bar provides information about the display screen and operating status. The far right text indicates the selected main screen. This is either “IO” (inputs and outputs), “TX” (transmit) or “RX” (receive).



The far left icon indicates system voltage as a proportion of the configured high and low battery levels (MENU->INPUTS->BATT HIGH/LOW V).

The “X” icon is visible when no messages have been received for 2 minutes and on start-up.

The time in the middle is the current RTC time (MENU->SYSTEM->TIME).

The “S” letter indicates that the master or slave SCADA telemetry modes are in operation.

The “M” letter, when present indicates that a Modbus telemetry request packet has been processed within the last 2 seconds.



The “Incoming” down arrow indicates that the TReX is receiving (absent when RX is DISABLED). The “Outgoing” up arrow indicates that the TReX is transmitting (if a transmitter enabled TReX).



The Icon “T” below indicates the TReX has been configured for telemetry stand-alone “Back-to-Back Mirror Mode”.



The back to back arrows indicate the unit is operating in “Serial Link” Telemetry mode.

## IO Screens

Screens that relate to inputs and outputs.

### IO (1):

All input and output states. Each IO highlighted state changes if the IO level is HIGH or LOW. There is a small line above each input or output if HIGH, and a line below if LOW. All ADCs (analog inputs) and DACs (analog outputs) show a bar graph as a proportion of full scale and display a raw count from 0-1023. When scaling has been applied to an analog output, the DAC value shown is the unscaled value.

In the middle, shown in larger text is “01”. The number “01” in this case is the telemetry UNIT ID. When TELEMETRY->MODE is configured to SCADA\_MASTER a small down arrow may be visible if the TELEMETRY->REMOTES have been configured to be more than 0. Pressing the down arrow (when configured as a SCADA\_MASTER) allows the UNIT ID to be cycled to view the IO of each remote slave in the system – allowing a possible system of up to 88 digital IO, 22 ADCs and 22 DACs to be viewed.

Next to the UNIT ID is the smaller number “123”. Each TReX resets this number to the LINK FAIL TIME each time a message is decoded. This “link count” reduces, and if reaches 0, the link fail output can be operated.

SCADA\_MASTER TReX units allow the “link count” to be viewed for all remote TReX SCADA\_SLAVE units.

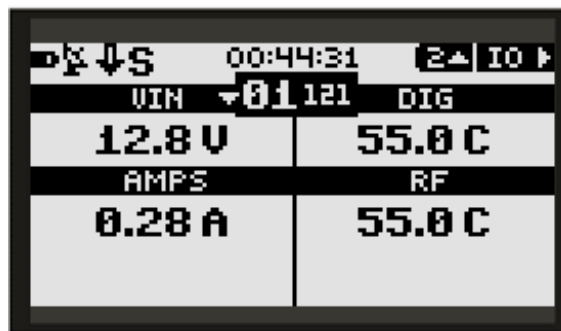




**IO (2):**

System voltage, current and internal operating temperature. RF is the temperature read directly next to the RF power stage and will be higher than than the DIG board temperature while the TReX is transmitting (not applicable for receiver only TReX units). Temperatures of the RF power stage may reach 100 degrees Celsius under normal long term operation. These temperatures are not the ambient temperature. The case of the TReX will NOT reach these temperatures.

As with the previous IO screen, systems voltages and temperatures of all SCADA\_SLAVE TReX units (up to 10 SLAVE units) can be viewed by pressing the down button if the TReX is configured to be a SCADA\_MASTER.





## TX Screens

Screens that relate to messages transmitted.

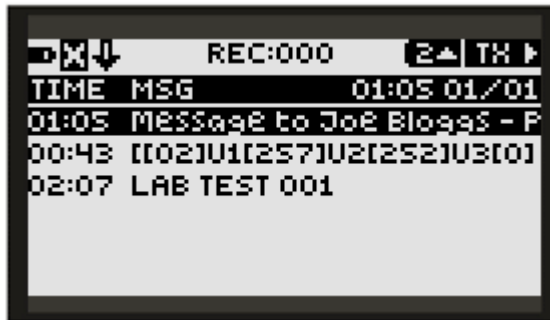
### TX (1):

Last message transmitted. Includes the time the message was transmitted, message RIC (radio identifying code/CAP Code) and level (0-3). To the right the modulation type and rate is displayed also with the transmit frequency.

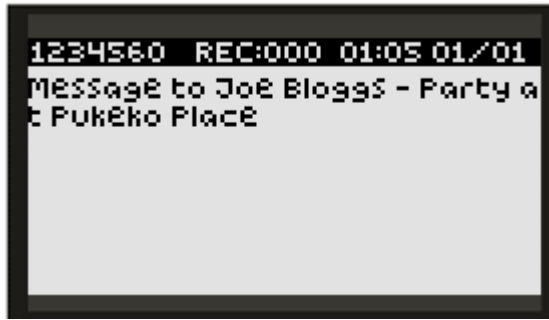


### TX (2):

List of all time-stamped messages retrieved from internal storage. Most recent message displayed at top. Next sub-screen can only be selected when top entry is displayed. Note that messages are only available here when TX logging has been enabled (MENU->TX->MSG LOG).



When an entry is selected pressing the UP/DOWN buttons, pressing the ENTER button displays the entire message.



**TX (3):**

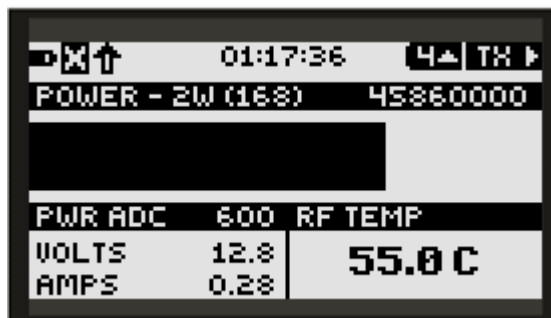
Displays the last transmitted message in large font. If the message exceeds the screen size, the DOWN button allows scrolling.



**TX (4):**

A TX power bar graph is displayed as a proportion of full power during a message transmission. Above the power bar is the text “POWER – 2W (168)”. “2W” relates to the power setting in use. In brackets is the power amplifier DAC setting which is for factory use only.

The POWER ADC count is used to indicate forward power. RF TEMP relates to the RF amplifier temperature (not ambient) in degrees Celsius. VOLTS is the supply voltage and AMPS is the total supply current.



## RX Screens

Screens that relate to messages received. Note, when messages are received, additional icons may be displayed in the top bar.

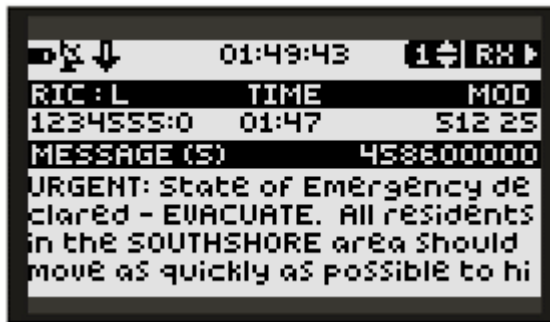


The second left icon changes from the “X” icon to the satellite icon when a message has been received. This indicates that the receiver is operational.

When the “BELL” icon is displayed with a following number, this means that system ALERTS are enabled. See ALERTS for ALERT configuration and operation.

### RX (1):

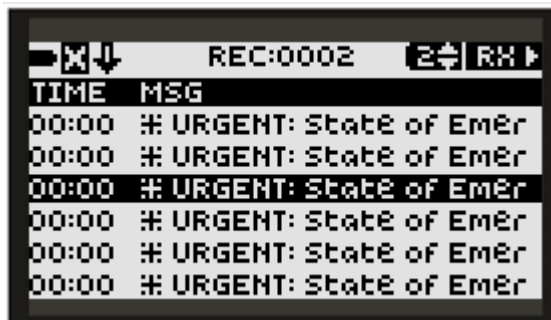
Basic summary of last received message. If the message is too large to fit on the screen the DOWN arrow will be visible in the title bar. Pressing the DOWN button will now scroll through the rest of the message.



### RX (2):

List of all time-stamped received messages retrieved from internal storage. Most recent message displayed at top. Next sub-screen can only be selected when top entry is displayed. Note that messages are only available here when RX logging has been enabled (MENU->RX->MSG LOG).

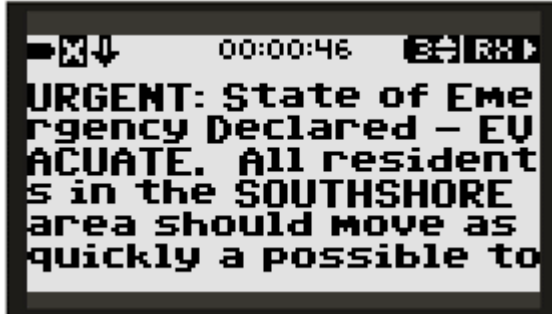
Messages starting with “\*” are messages that met the ALERT filter requirements, and were eligible to operate the ALERT output when logged.





**RX (3):**

Displays the last received message in large font. If the message exceeds the screen size, the DOWN button allows scrolling.



**RX (4):**

Displays the signal strength of the configured channel in real time. Displays signal strength from -128dBm to 0dBm.



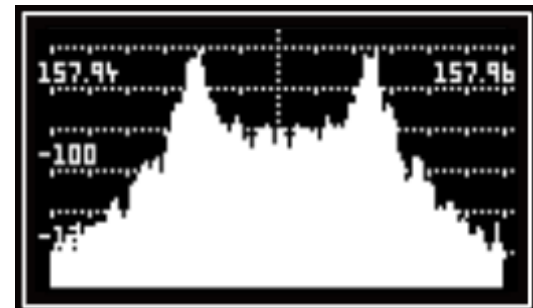
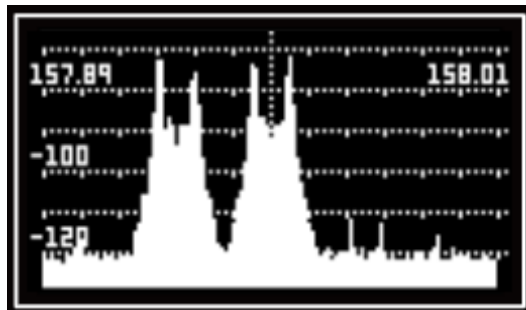
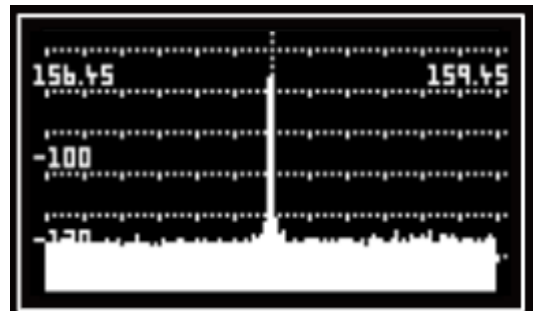
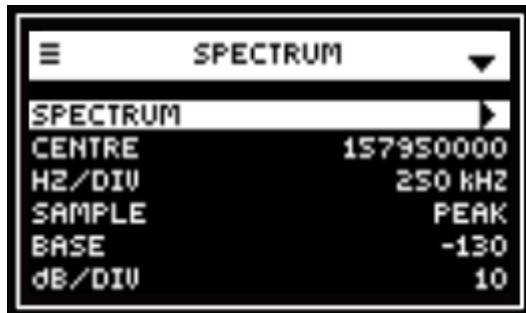


## Site Configuration Tools

The TReX includes tools to ensure suitability for use at the current location and quality of the installation.

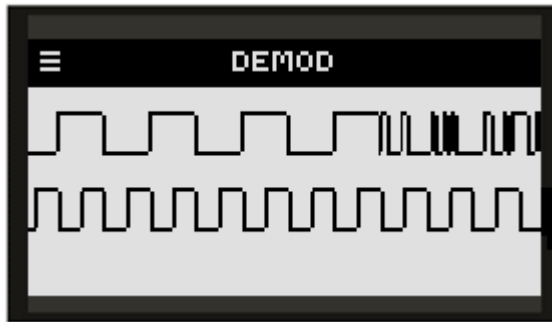
### ***Spectrum Analyser***

The optional spectrum analyser is a very simple to use tool that provides a span of either 3MHz, 120kHz or 24kHz around a configured test frequency. The receive bandwidth down to 500Hz is suitable for inspection of potentially interfering adjacent channel signals. The analyser can display signals as low as -125dBm making and is suitable for site inspection. This is an optional feature that requires a feature key to be purchased.



## ***Demodulated Signal Viewer***

The demodulated signal viewer allows inspection of raw demodulated data and the recovered clock from that data. This is useful for viewing channel activity. This facility is available for 2 level modulation modes of operation. 4 level modulation modes will display as straight lines.



## Two-Way Paging

---

The TReX supports two-way paging. The TReX can return responses via serial or TCP connections. Transmitter capable TReX units can additionally respond at high power across the air.

Not only can acknowledgements be returned from the TReX, but confirmation of job acceptance receipts can be returned. This means that messages can be sent to single or multiple TReX units and clear details can be returned to notify if a message has been read or an action is being performed.

### Example:

An emergency dispatch system may send a paging message to a group of ambulances for attendance at an emergency. The message will be displayed on a TReX unit within the ambulance with prompt to attend if possible. Accepting the job can be performed with a simple keypress that will send receipt to the dispatch system that the vehicle is on-route.

See **WTE Ack and Confirm Protocol** for usage details.



With a single keypress, key messages can be responded to. Details of the responder are returned and logged.



## Configuration Methods

---

There are several methods to configure the TReX unit, such as:

- Directly from the front panel
- Via a web browser
- Via Serial terminal over the RS232, RS422 and or RS485.
- Via a TCP terminal (either client or server).
- USB connection and editing of the WTE\_CONF.INI configuration file.

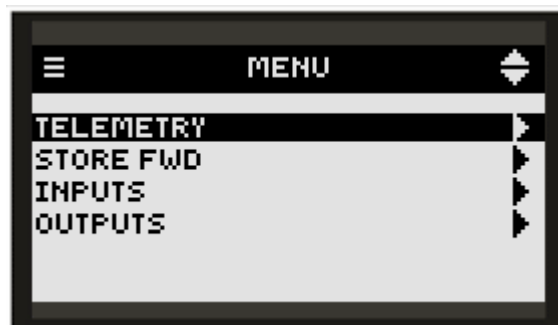


## Front Panel Menu Configuration

All typical configuration items are accessible and configurable via the on-board menu system. This includes the ability to configure input messages. Through the use of the menu system the TReX is able to be set up and configured without any PC connection.

To enter the menu, press the MENU button. The top line icon bar shows when the DOWN button can be used when the DOWN arrow is visible. When scrolling down and the DOWN arrow disappears, then the end of the menu section has been reached. The UP arrow will be visible when navigation in the up direction is permissible. The RIGHT arrow indicates that the RIGHT button can be pressed to enter a MENU category when highlighted.

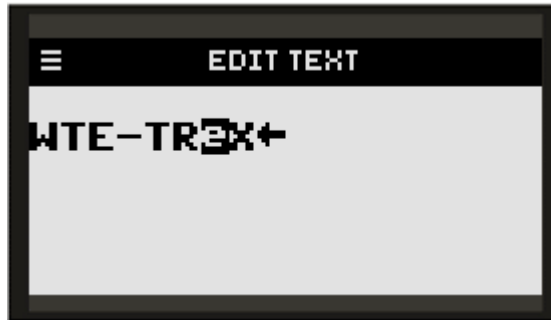
Pressing the MENU button again moves back one level, until the top is reached, and then the TReX leaves the MENU mode. If any change has been made, changes will only be written to internal storage when leaving the MENU mode.





To edit any field, first move to the item, press RIGHT to select the field. Once highlighted, the UP/DOWN arrows change the field. On completion, pressing RIGHT again will deselect the field.

Some fields are text that can be edited. There is a built-in text editor. Fields that are edited by the text editor are presented with the title “EDIT TEXT”.

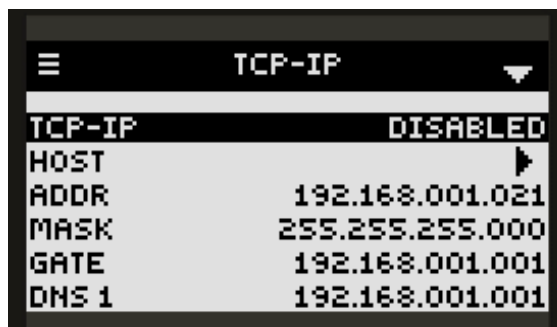
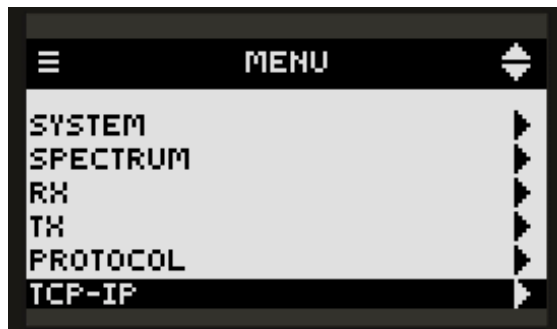


Each character can be selected by pressing the RIGHT button. The selected character is inverted. Pressing the UP/DOWN buttons allows the character to be changed to any printable character. The BACK arrow indicates the end of the text. This arrow is not part of the actual text but present as a marker. To make the text longer, highlight the BACK arrow and change the character using the UP/DOWN buttons. To make the text shorter or to delete a character, highlight the BACK arrow and press the ENTER button. Press the BACK button to exit the editor.

## Web Browser Configuration

For web browser configuration to be possible (using browsers that support SVG such as “Chrome”, “Firefox” etc.), the Ethernet/IP must be ENABLED via the menu (ENABLED by default). This is located in SYSTEM->IP. In this menu section network parameters can be configured such as the IP, Mask and gateway.

Only a single connection to the TReX should be allowed. Multiple connections will result in impaired responsiveness.

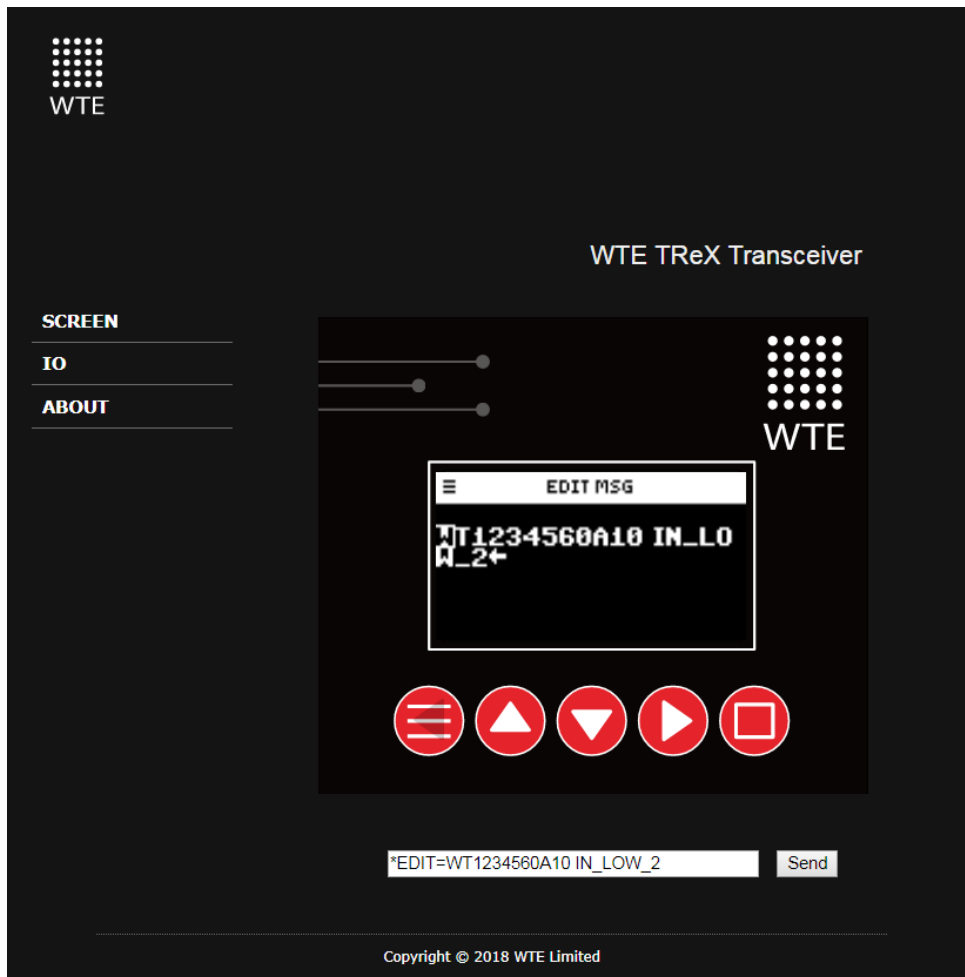




After the unit has been enabled to be use over the web, a web browser address matching the configured IP should be used. e.g.

<http://192.168.1.20>

This IP address is shown as a pop-up each time the TReX starts up.



Using the web browser the TReX can be remotely configured. When moving to a text field, the text box at the bottom of the browser is automatically loaded. Changes can now be made and committed by pressing the SEND button. This text box can also be used to transmit messages for a configured protocol.



## Serial Command Configuration

Parameters can be changed using any common serial terminal (available on request if required) program using the RS232 or RS422/485 ports.

Start-up baud rate is determined by the baud rate as configured through the MENU.

All configuration commands always start with the asterisk '\*' character.

All messages that do not start with the \* character are processed by the protocol decoder.

All messages are terminated by a Carriage Return character, shown in this manual as <CR>

All commands that accept a value, can have that value read back by using the '?' suffix.

*Typical usage:*

```
*RX_FREQ?
```

*Typical response:*

```
*RX_FREQ=16000000
```

There are some commands that support multiple entries (such as the same command but for different ranges). In this case the question mark can be followed by the parameter to be interrogated. E.g.

```
*RX_RANGE?<CR>
```

Returns (lists all ranges)

```
*RX_RANGE=1:8,2000000
```

```
*RX_RANGE=2:0,0
```

```
*RX_RANGE=3:0,0
```

```
*RX_RANGE=4:0,0
```

```
*RX_RANGE=5:0,0
```

```
*RX_RANGE=6:0,0
```

```
*RX_RANGE=7:0,0
```

```
*RX_RANGE=8:0,0
```

To find the first range only:

*Usage:*

```
*RX_RANGE?1<CR>
```

*Response:*

```
*RX_RANGE=1:8,2000000
```

In order for any configuration changes made via serial to be saved the command `*SAVE<CR>` must be sent to the TReX before removing power or restarting.

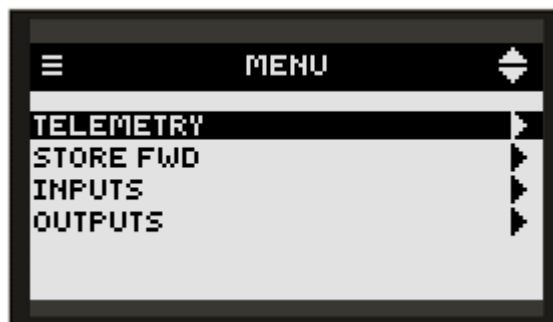
**Note:** Although most configuration changes are applied immediately, it is a good practice to



restart the unit after changing configuration. This can be achieved by removing power to the unit or sending the *\*REBOOT<CR>* command.

## MENU Configuration

---



### SYSTEM

Configures language, backlight, time, unit ID, sound, baud rates, factory test, main operating screens and menu lockout.

### TX

Transmitter configuration items. Includes frequency, baud rates and logging settings.

### RX

Receiver configuration items. Includes frequency, baud rates and logging settings.

### SPECTRUM

Configures and allows access to the spectrum analyser.

### PROTOCOL

Control of the formatting in and out of the TReX for incoming and outgoing messages.

### TCP-IP

Control of all aspects of internet connectivity. Allows remote configuration and operation through the use of the “Chrome” or “Firefox” web browser, TCP client or TCP server.

### TELEMETRY



Determines if operation is on a controlled protocol basis, or autonomously operating input states to a remote TReX device.

**STORE FWD**

Configuration of the paging store and forward repeater operation including duplicate reject.

**INPUTS**

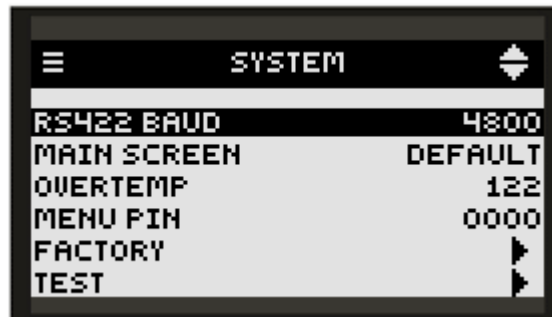
Configuration of all inputs.

**OUTPUTS**

Configuration of all outputs. Also responsible for assigning of alerting functions to any output.



## SYSTEM Menu



### LANGUAGE

Items ENGLISH plus others can be selected. To incorporate specific language support please contact WTE Limited directly.

### BACKLIGHT

The backlight setting is how long in seconds the backlight is lit after each key press and also when a message is received. Setting to 0 disables the backlight completely.

### TIME

Sets the internal clock.



## **ID**

This is the unit ID that is used by the WTE output control protocol. This can be any number of alpha numeric description. e.g. "01" or "Unit-A"

## **SOUND**

Allows control of system sounds that may be heard on an ALERT and also key beeps.  
Items ON and OFF can be selected.

## **RS232 BAUD**

Allows configuration of the RS232 port baud rate. All settings are N:8:1. Available rates are: 2400, 4800, 9600, 38400, 57600 and 115200.

*Note: that for the most efficient transmission, the serial baud rate should be higher than the transmit over the air baud rate.*

## **RS422 BAUD**

Allows configuration of the RS422 port baud rate. All settings are N:8:1. Available rates are: 2400, 4800, 9600, 38400, 57600 and 115200

*Note: that for the most efficient transmission, the serial baud rate should be higher than the transmit over the air baud rate.*

## **MAIN SCREEN**

This allows any page on any main screen to be set as the default main screen. This results in this screen being the screen that is first seen when powering up the unit, or after any period of inactivity the TReX will automatically revert to this screen.

Setting to DEFAULT will unset the last custom set screen and will return to the factory default main screen. Setting to SET will set the screen to be the screen that was last used before entering the menu.

## **MENU PIN**

When the MENU PIN is set to a non-zero value, the MENU will be prevented from opening until the PIN is entered. Prevents accidental or unauthorised misconfiguration. If the PIN is ever forgotten, the PIN is visible using the command \*CONFIG or viewing the WTE\_CONF.INI file through a USB connection. Once the MENU is unlocked, it will remain unlocked until the unit is restarted.

## **FACTORY**

Sub menu responsible for calibration screens and setting of feature unlock keys.

## **TEST**

Test sub menu for generation of test messages and testing of outputs.



**REGULATORY**

Regulatory items such as FCC-ID\*.

\*Note: Publication number 784748-D01, FCC-Part 90 allows for devices with integrated display to not require a printed label on the device holding this information.

### ***TEST Sub Menu***



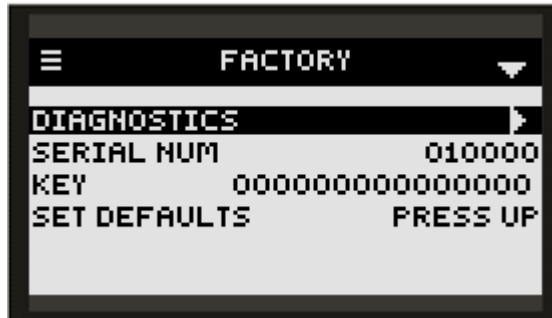
TEST	
1	0 ms
2	0 ms
3	0 ms
4	0 ms
5	0 ms
6	0 ms

#### **1-8**

Digital output to test. Pressing up pulls the output to ground for 60 seconds. Pressing down releases the output.

## **FACTORY Sub Menu**

This menu is typically for factory use only or to return the unit to a factory new state.



### **DIAGNOSTICS**

Debug for factory use only.

### **SERIAL NUM**

Read only unit serial number.

### **KEY**

The key used to unlock unit features. If features are purchased after sale, a new key may be required to be entered here. The key is unique to the unit serial number.

### **SET DEFAULTS**

Used to set the TReX back to factory defaults. Calibration data is not cleared. This may be used at any time to restore the unit to a known starting point.

## ***TIME Sub Menu***



### **HOUR, MIN, DAY, MONTH and YEAR**

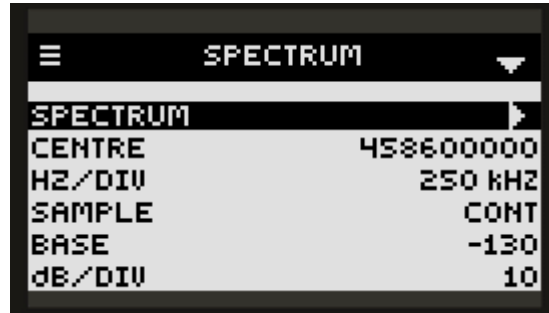
Configuration of the real time clock.

### **SOURCE**

Determines how time is maintained in the TReX.

- RTC uses the internal real time clock to keep time.
- FLEX takes the time from the FLEX transmission time details (if present).
- SEQ TEST takes the time from national paging network (used in N.Z. only).
- NONE only uses the internal processor clock. This will only be the time since last reset.

## SPECTRUM Menu



### SPECTRUM

Displays the radio spectrum using the settings in this menu. Signals between -128dBm and 0dBm can be displayed. **Power levels above 17dBm (50mW) will destroy the receiver input.**

### CENTRE

Displays the centre frequency to be displayed on the screen.

### HZ/DIV

Either 250kHz, 10kHz or 2kHz. The screen is 6 divisions wide in 120 steps.

The RBW (receiver bandwidth) and frequency span is automatically set when the Hz/Div changes.

HZ/DIV	RBW	Frequency Span
250kHz	25kHz	3MHz
10kHz	1kHz	120kHz
2kHz	500Hz	24kHz

### SAMPLE

When set to CONT the spectrum analyser screen will be updated with new values approximately twice a second. When set to PEAK only higher values will be written to the screen. At any time, the ENTER button can be pressed on the SCREEN to clear the screen and load new PEAK values.

### BASE

Defines the base signal level on the screen. When set to -100, only signals with a strength greater than -100 dBm will be displayed. Range is -130 dBm to -60 dBm.

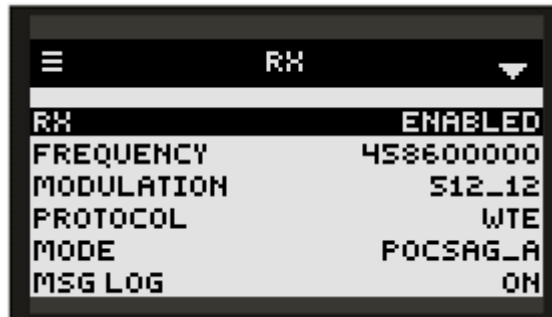
### dB/DIV



Scales the signal level displayed. Either 10 dB/DIV or 20 dB/DIV can be set. When 20 is set a dynamic range of 120 dB is possible.



## RX Menu



### RX

When ENABLED the TReX receiver is enabled. When DISABLED an operating current reduction of 50mA is typical.

### FREQUENCY

Specifies the receive frequency in Hz (range limited to the variant of product).

### MODULATION

Specifies modulation parameters. This includes whether the modulation is 2 or 4 levels GFSK plus the channel width. 512\_25 indicates 512 baud with 25kHz channel spacing (2 level GFSK). 9600-4L\_6 indicates 9600 baud with a 6.25kHz channel spacing (4 level GFSK). Modulation rates from 512 baud to 48K baud can be set.

### PROTOCOL

Specifies the protocol to apply for serial output, accepts WTE, CUSTOM, RAW and AUX. Other protocols may be added and supported upon request.

### MODE



Specifies the transport mode of the receiver (how the information is received over the air).

- **POCSAG\_A** must be used in order to receive alphanumeric messages.
- **POCSAG\_N** must be used in order to receive numeric messages.
- **WTE\_EN** must be used in order to receive 8 bit characters (POCSAG\_A transmits 7 bit characters only).
- **FLEX** must be used in order to receive and decode 2 level 1600 baud FLEX messages.

### MSG LOG

When ENABLED all received messages are written to RX-LOG.TXT on the SD card. Should be set to DISABLED in critical applications when the SD card cannot be allowed to completely filled (such as when unsupervised).

DISABLED:

Messages are not logged.

ENABLED:

All messages displayed are written to internal SD card and can be viewed on the message history screen.

CLEAR:

Setting to CLEAR will result in RX-LOG.TXT being deleted when exiting the menu.

### RIC RANGES

Specifies up to 8 RIC RX ranges for decoding. Messages received with RIC codes not allowed with the RX\_RANGE will be discarded by the receiver.

**Note:** When configuring the RIC RANGE, the LOW RIC must not be higher than the HIGH RIC and the HIGH RIC must not be lower than the LOW. Any attempt to configure illegally will reset the RIC RANGE to ensure these rules are not broken. Any RIC RANGE with a LOW RIC set to 0000000 will NOT be used.

### BUSY LEVEL

Specifies the busy level for the configured channel.

The configured value is the signal level from 0 to -130 (in dBm). If the signal strength on the receiving channel is above this configured value, the channel will be considered to be busy. Transmissions will not be possible if the channel is considered to be busy. After a period of 5 seconds of the channel being busy, the transmitter will transmit anyway.

**Note:** If the TReX continually reports BUSY, issue the command *\*RSSI<CR>* (or view the *RSSI screen*) to inspect the noise floor and adjust the busy level appropriately.



### **LINK FAIL TIME**

This is the number of seconds (up to 240) that is allowed to pass in-between received messages without setting the LINK FAIL output (if LINK FAIL output is configured).

### **ALERT**

Visual notification and repeating beep (at a configurable interval) when a message is received that meets the conditions for raising an alert. See **ALERT FILTER**.

If the ALERT output is enabled the configured output will also operate.

Can be configured from 0-250 seconds. When set to 0 the alert is disabled.

### **DEMODO**

Access to the raw signal demodulation screen allowing raw data and recovered clock signals to be viewed in real time.

### **FILTERS**

The TReX supports the use of message filters. These filters inspect the content of incoming messages and then make decisions on whether to ignore or pay attention to these messages based on filter setting.

There are 3 types of supported filters:

- Include filters (messages must include one or more of the matching entries).
- Exclude filters (messages must NOT include any of the matching entries).
- Alerts filters (Alerts are raised for message with any of the matching entries).

Alert filters take priority over Exclude filters. This means that if “PUKEKO” has been specified in ALERT.TXT and “FIRE” is specified in EXCL.TXT then a message with “FIRE AT PUKEKO PLACE”, although it would normally be excluded, would still raise an alert and display the message.

Each of the filter matching entries are NOT case sensitive and can be part of a longer word or phrase.

Entries are allowed to be more than one word e.g.

THIS IS A TEST

This will match on “ThiS is a TEST” but not the single words in the entry, unless they have been added as separate match entries.

Up to 15 key words can be stored, each up to 20 characters in length. There must be no ASCII



control characters within the key words used and each matching phrase must be on a new line.

### ALERT FILTER

This filter option allows the use of a text file called “ALERT.TXT” to be stored and modified on the SD card (accessible via the USB port). If the feature is enabled (ALERT set to value), this file (if present) will be searched for key words. If any of these key words are found then an alert is raised based on the alert configuration (beep plus operation of a configured output).

#### *Example:*

A text file named ALERT.TXT is added to the SD card root directory that has the following contents:

TSUNAMI

MAJOR EMERGENCY

All messages WITH these key words will result in an alert being raised. These messages will be displayed and logged normally as per the system configuration.

All other messages will still be decoded and displayed based on RIC range settings.

#### **ALERT** set to DISABLED:

Messages are not filtered to raise an alert. When DISABLED messages can still raise alerts based on the alert settings within the menu.

#### **ALERT** set to a value:

Messages are filtered to raise an alert. When set to a value only the messages found in the ALERT.TXT file will raise an alert. No other messages, even if displayed will raise an alert.

NOTE: Filtered messages must still fall within configured RIC ranges in order to be displayed.

**NOTE:** When the ALERT.TXT filter option has been set a value (enabled), alerts are raised by matching key words in arriving messages that are within the specified RIC range. When this option is ENABLED, only the messages matching these key words will raise an alert (beep and or output changing state). All other incoming messages within the RIC range configured will no longer raise any alert (as is the case when ALERT.TXT is absent).

*NOTE: Restarting is required in order to load the ALERT.TXT settings. This applies both when enabled via the serial port or from the menu.*

### INCL FILTER

This filter option allows the use of a text file called “INCL.TXT” to be stored and modified on the SD card (accessible via the USB port). If the feature is ENABLED, this file (if present) will be searched for key words. Any of these key words MUST be present in order for the message to be processed.

NOTE: messages received for filtering must still fall within configured RIC ranges.

#### *Example:*

A text file named INCL.TXT is added to the SD card root directory that has the following



contents:

**FIRE**

**EMERGENCY**

All messages **WITHOUT** these key words **WILL BE DISCARDED**. Even though non matching messages are discarded, the receiver OK indicators and timers will continue to operate normally.

**INCL FILT** set to **DISABLED**:

Messages are not filtered

**INCL FILT** set to **ENABLED**:

Messages are filtered

### **EXCL FILTER**

This filter option allows the use of a text file called “EXCL.TXT” to be stored and modified on the SD card (accessible via the USB port). If the feature is **ENABLED**, this file (if present) will be searched for key words. Any of these key words **MUST NOT** be present in order for the message to be processed.

#### *Example:*

A text file named EXCL.TXT is added to the SD card root directory that has the following contents:

**THIS IS A TEST**

**DISCARD**

All messages **WITH** these key words **WILL BE DISCARDED**. Even though non matching messages are discarded, the receiver OK indicators and timers will continue to operate normally.

**EXCL FILT** set to **DISABLED**:

Messages are not filtered

**EXCL FILT** set to **ENABLED**:

Messages are filtered

## Protocol Menu



### TX

Specifies the protocol to apply for serial input. Accepts WTE, CUSTOM, RAW, AUX and in some cases others as required or specified.

### RX

Specifies the protocol to apply for serial output. Accepts WTE, CUSTOM, RAW, AUX and in some cases others as required or specified.

### SENT RESP

This the response out the serial port at the completion of each transmitted message. By default this is “Page Sent”.

*Note: The default overriding response for WT protocol is “WT[xxx]”. To change the sent response to “Page Sent” a leading “\*” character must be used. e.g. “\*Page Sent”.*

### MODBUS

Specifies parameters used for the “MODBUS” protocol.

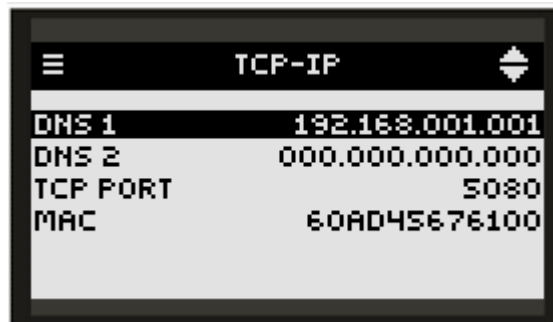
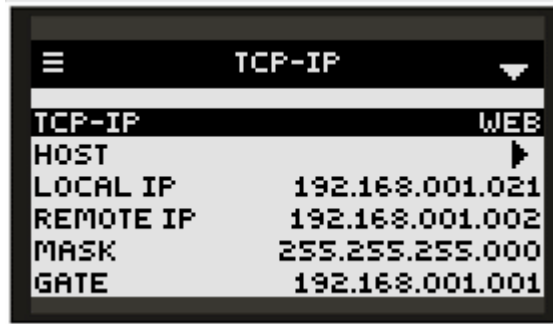
### RAW

Specifies parameters used for the “RAW” protocol.

### CUSTOM

Specifies parameters used for the “CUSTOM” protocol.

## TCP-IP Menu



### TCP-IP

The TCP-IP configuration lets you choose the TCP protocol for use on the TReX.

#### WEB:

This setting allows the TReX to be monitored and configured from a Chrome web browser either on a PC or mobile device.

#### SERVER:

This setting allows the TReX to be operated as a TCP server on the specified TCP port. SERVER would typically be used if a short term connection was required, such as to change a configuration item or send a message for transmitting. Only a single connection is allowed, however multiple users can conceivably connect in this mode for short durations in order to offload content to be transmitted. A long term or held connection will allow decoded messages to be viewed in real-time (preventing further connections).

#### CLIENT:

This setting allows the TReX to be operated as a TCP client on the specified TCP port and REMOTE IP. SERVER would typically be used if a remote device required a long duration or permanent connection. This would be desirable if monitoring decoded messages.

#### WEB+SERVER:

Concurrent WEB and SERVER functionality.

#### WEB+CLIENT:



Concurrent WEB and CLIENT functionality.

**DISABLED:**

Setting to **DISABLED** ensures the maximum possible power savings even when an Ethernet cable has been connected. When IP is **DISABLED**, current consumption will reduce by approximately 150mA and disable the TCP stack.

**HOST**

This is the name that can be associated to the TReX. This name can be used directly instead of the IP address to address the TReX. By default is “WTE-TReX”

**ADDR**

IP Address for access to the TReX.

**MASK**

IP Mask

**GATE**

IP Gateway

**DNS1**

Primary Domain Name Server

**DNS2**

Secondary Domain Name Server.

**PORT**

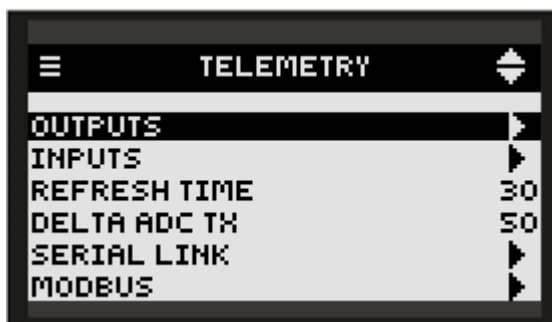
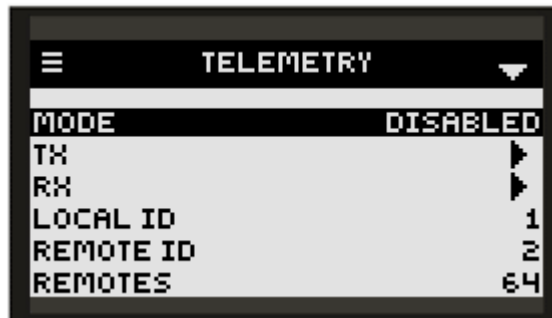
The port to use for TCP client TCP server connections. Default is 5080.

**MAC**

Non-editable MAC address.



## Telemetry Menu



### MODE

#### DISABLED:

there are no autonomous transmissions.

#### SERIAL LINK:

Serial arriving on an enabled serial port is sent to a remote TReX unit.

#### IO MIRROR:

All local unit enabled inputs are mirrored to outputs of a remote device based on the IO MIRROR configuration. IO\_MIRROR can only support 2 TReX units. SCADA monitoring and controlling is not possible in this MODE.

#### SCADA\_MASTER (Optional feature only):

The TReX unit can be connected via Modbus (TCP or RTU serial). This unit can then optionally report the status (and control) SCADA\_SLAVE TReX units.

#### SCADA\_SLAVE (Optional feature only):

The TReX can be installed in a remote location and wirelessly controlled by a SCADA\_MASTER. See **SCADA Configuration**.

### LOCAL ID

It is possible to have many TReX units operating on the same frequency. This is the ID that the REMOTE TReX needs to use in its REMOTE ID field in order to communicate.

### REMOTE ID



This is the ID of the remote device that all inputs will be sent to. When the MODE is configured to be SCADA\_MASTER this is the ID of the first SCADA\_SLAVE TReX. All SCADA\_SLAVES must be consecutively numbered following this ID.

When the MODE SCADA\_SLAVE is used, the REMOTE\_ID is configured to be the same as the LOCAL\_ID (this is required by the SCADA\_MASTER to identify the source of the transmission).

## REMOTES

This parameter is only used when the MODE is SCADA\_MASTER. This is the number of wireless SCADA\_SLAVE units that the SCADA\_MASTER will communicate with.

## INPUTS

This is a shortcut to the INPUT configuration menu.

## OUTPUTS

This is a shortcut to the OUTPUT configuration menu. If the OUTPUT is DISABLED, then messages from a remote unit can NOT change the units outputs. This may be desired if the OUTPUT is already configured for another purpose such as LINK FAIL OUTPUT. Outputs to be used should be set to LATCHED.

## REFRESH TIME

How long in seconds before sending all input information again. If any INPUT changes then there is an immediate transmission. The REFRESH TIME ensures that if a message is lost, the remote device will eventually resynchronise its OUTPUTS with the local device INPUTS.

## DELTA ADC TX

Analog data is transmitted after each REFRESH TIME count elapses. This field allows an immediate transmission if it has changed by a certain amount since its last transmission. This is the raw ADC count that is a value up to 1023. Min value is 10 to ensure that very small changes do not result in continuous transmissions in an electrically noisy environment.

## SERIAL LINK

Configuration of all SERIAL LINK Settings

## MODBUS

Configuration of all MODBUS Settings

## **SERIAL LINK Menu**



This a duplication to settings used by the RAW protocol. These settings allow the transmission to be optimised.

### **TX TIMEOUT**

This is the period of serial port inactivity in 10mS steps that the TReX will wait before transmitting. In this case, placing a small delay between characters will result in poor transmission efficiency.

### **TX LEN**

This configures how many characters must be buffered before transmission. If the TX TIMEOUT has been configured, then the TX TIMEOUT will take priority.

### **TX CHAR**

This configures a special character that can be used to mark the end of a serial message. This could be configured to be a carriage return for example (value to use is 13 for a carriage return). When any carriage return character is seen, then an immediate transmission would be forced. The TX LEN and TX TIMEOUT items take priority. The value of this configuration item is the decimal value of the ASCII character. Please refer to a standard ASCII chart for decimal values for ASCII characters (1-127).

## STORE FWD Menu



### OPERATION

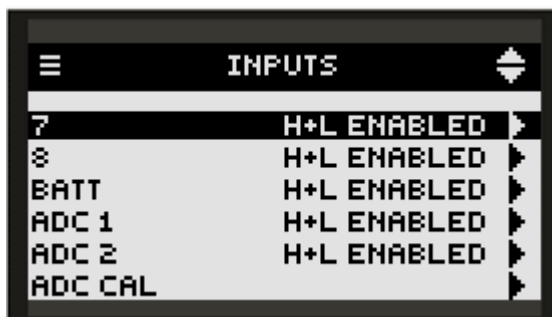
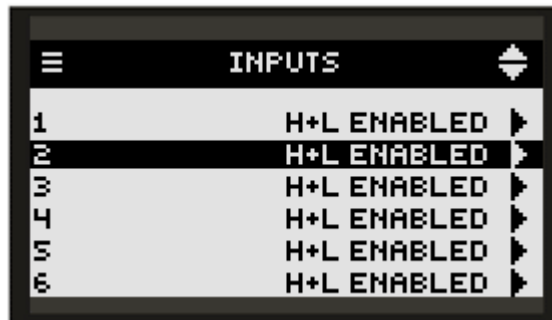
When store forward operation ENABLED the unit is used to listen to transmissions in the area, decode the messages and retransmit again to provide greater coverage than would normally be possible.

When DISABLED there is no store and forward function. The non zero value set is the delay in 100ms steps after each transmission. This delay allows time for any downstream forwarding equipment to clear the message. All messages received are immediately queued for transmission, and up to 5 messages may be retransmitted after the store forward delay.

### DUPL REJECT

Setting to 0 disables the feature, otherwise this is the number of seconds to reject identical messages for up to 60 seconds. Duplicate rejection operates only on messages decoded for forwarding. This means that receiving of duplicate messages is not prevented (nor the transmission of same messages resulting from a protocol command), but when used as part of a simple store forward system re-queueing of messages can be controlled. Duplicate reject only tests the previous 10 messages in the historic transmit queue.

## Inputs Menu



### 1-8

Configuration of messages that are transmitted when an input changes. Receiver only TReX units instead of transmitting can directly send WT protocol messages via serial ports or a TCP connection.

### BATT

Treated as the 9<sup>th</sup> input. Messages transmitted when system voltage is high or low (high and low levels configurable).

### ADC 1-2

Treated as Inputs 10 and 11. Messages transmitted when ADC levels are above or below set thresholds.

### ADC CAL

This manages calibration of analog inputs.

## ADC CAL Sub-Menu



When the analog inputs are being read, scaling can be applied that allows the user to specify an INPUT from 0-1023 over a useful range from MIN to MAX. For example, if MIN is 200 and MAX is 400, then any analog INPUT below 200 will be SCALED to 0. Any INPUT above 400 will be SCALED to 1023. An INPUT of 300 will return a SCALED value of 512.

This is useful if a small voltage range is of interest, such as 1-5V instead of 0-10V. See following calibration procedure for full example.

### 1-2

Access to calibration items for ADC 1 and ADC 2.

### MIN

This is the minimum used INPUT ADC value. If no scaling is to be applied set to 0.

### MAX

This is the maximum used INPUT ADC value. If no scaling is to be applied set to 1023.

### SCALED

This is a read only field that displays a value from 0-1023.

### INPUT

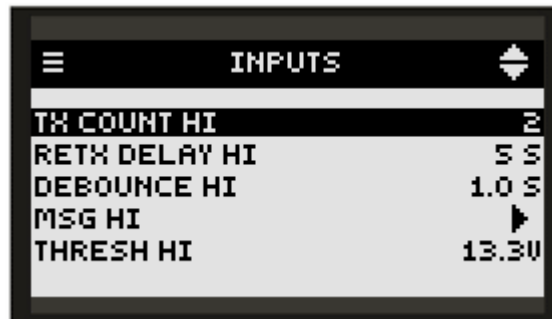
This is a read only field that displays the raw analog input value from 0-1023. The INPUT is not scaled.



Calibration Procedure for Voltage Inputs:

1. Connect a voltage source (with an input resistance not more than 2 k ohm).
2. Set the voltage source to the minimum voltage that will be used.
3. Set ADC CAL->MIN to the value shown in the INPUT field.
4. Set the voltage source to the maximum voltage that will be used (up to 16V).
5. Set ADC CAL->MAX to the value shown in the INPUT field.
6. Check that when the minimum voltage is connected, the SCALED field displays close to 0.
7. Check that when the maximum voltage is connected, the SCALED field displays close to 1023.
8. Check that when a mid voltage between the maximum and minimum is connected, the SCALED field displays a mid value between 0 and 1023.
9. Exit MENU and settings will be saved.

## Input Config Sub-Menu



These input configuration screens repeat for each of the 8 inputs plus the BATT and ADC inputs.

### INIT STATE

Input messages are transmitted when the input changes from one state to another. On start-up the first transmitted message depends on this configuration. UNSET will ensure that there is never a transmission on start, whereas the HIGH or LOW states assume a certain start condition, so that an immediate transmission on start is possible.

### UNSET

The input state is read on start-up. There will not be a transmission until the input changes (if configured to transmit on that HIGH or LOW level).

### HIGH

The input is considered to be HIGH on start. If on start the input is read and found to be LOW, then there will be an immediate transmission (if configured to transmit).

### LOW

The input is considered to be LOW on start. If on start the input is read and found to be HIGH, then there will be an immediate transmission (if configured to transmit).





### **TX COUNT LOW**

If set to 0, then there will be NO transmissions when moving to the LOW state. If non-zero then this is the number of times the LOW message will be transmitted.

If there is a change of state again, then any remaining transmissions are cancelled.

When set to a non-zero TX COUNT, the input level is considered to be ENABLED, and displayed as ENABLED on the upper menu level.

### **RETX DELAY LOW**

How long in seconds before sending the next message if set to more than 1.

### **DEBOUNCE LOW**

How long in seconds that the input must be settled at a LOW level before transmitting

### **THRESH LOW**

When configuring inputs 1-8, this field has no function.

On the BATT input this is the voltage that the TReX BATT input is considered to be low. A voltage below this may result in a BATT transmission if configured.

On the ADC 1 and ADC 2 inputs this is the ADC count that the TReX ADC input is considered to be low. An ADC count below this may result in an ADC input transmission if configured.

### **MSG LOW**

The message that is transmitted (formatted for the selected protocol) when the input moves to the LOW level. Input messages must always use WT Protocol.

### **TX COUNT HI**

If set to 0, then there will be NO transmissions when moving to the HIGH state. If non-zero then this is the number of times the HIGH message will be transmitted.

If there is a change of state again, then any remaining transmissions are cancelled.

When set to a non-zero TX COUNT, the input level is considered to be ENABLED, and displayed as ENABLED on the upper menu level.

### **RETX DELAY HI**

How long in seconds before sending the next message if set to more than 1.

### **DEBOUNCE HI**

How long in seconds that the input must be settled at a HIGH level before transmitting

### **THRESH HI**

When configuring inputs 1-8, this field has no function.

On the BATT input this is the voltage that the TReX BATT input is considered to be high. A voltage above this may result in a BATT transmission if configured.

On the ADC 1 and ADC 2 inputs this is the ADC count that the TReX ADC input is considered to be HIGH. An ADC count above this may result in an ADC input transmission if configured.

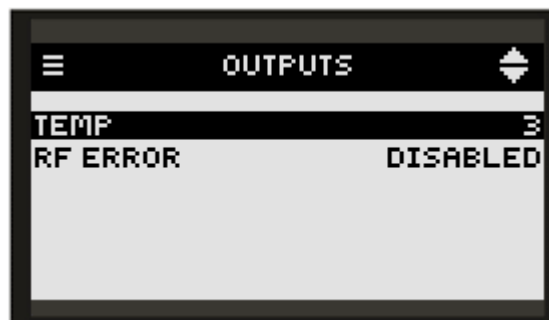


Note: The BATT input threshold settings are also used to set the battery icon on the main screens.

**MSG HI**

The message that is transmitted (formatted for the selected protocol) when the input moves to the HIGH level. Input messages must always use WT Protocol.

## Outputs Menu



### 1-8

The output to configure. If the output has been configured for general output control through telemetry or messaging the output must be configured to LATCHED or MSHOT. In order to set to LATCHED or MSHOT the output mode must be set to **TELEMETRY** in the Output Config Sub-Menu.

If the output has already been assigned for a special output function, the function will be displayed against the output e.g. RF ERROR. If the output has been configured to more than one function, the output setting will display MULTI. The output can be configured to operate on many actions at once.

*Note: Care must be taken when assigning an output to more than one function as the behaviour of the output can be difficult to predict or determine the trigger for the output change. In general, assignment of an output to more than one function is not recommended.*



**DAC CAL**

Configures calibration of analog output 1 and 2. See DAC CAL Sub-Menu.

**ALERT**

When DISABLED there is no output change when an ALERT condition is met. When set to 1-8 this is the output that will operate when an ALERT is signalled.

**BUSY**

When DISABLED there is no output change when receive channel is BUSY. When set to 1-8 this is the output that will be high when the signal strength on the channel exceeds the RX BUSY LEVEL.

**LINK FAIL**

When DISABLED there is no output change when the RX LINK FAIL time is exceeded between received messages. When set to 1-8 this is the output that will be high indicating no activity on the channel.

Typically the LINK FAIL output would be used in conjunction with a known periodic message from another transmitter.

**TEMP**

This is the over temperature output. When DISABLED there is no output change when the TReX has reached the max temperature. The max temperature is set in MENU->SYSTEM->OVERTEMP. This is the TReX board operating temperature and NOT the ambient temperature.

When set to 1-8 this is the output that will be high when the board temperature exceeds the OVERTEMP setting.

**RF ERROR**

When DISABLED there is no output change when an RF ERROR has been detected.

When set to 1-8 this is the output that will be high when there an antenna mismatch or low power condition at the beginning of a transmission. The output will be set high for 3 seconds by default.

This output is linked to MENU->TX->MIN PWR, MAX PWR and MAX I.

## Output Config Sub-Menu



### MODE

When set to TELEMTRY the output can be controlled through TELEMTRY settings or through output control messages that may be received. Setting to TELEMTRY will show the output to be configured to either LATCHED or MSHOT depending on the MSHOT setting.

On start outputs are ALWAYS LOW. After the expiration of any MONOSHOT period for an output, the OUTPUT will return to the LOW state.

When RIC RANGE X, then the output is configured to close, either LATCHED or MSHOT when a message is received with a RIC within that RANGE. RIC RANGE N controls OUTPUT N.

### MONOSHOT

If LATCHED or RIC RANGE the output will remain in the set state until another message is received to change the state. If set to a time, then after receiving a message to operate HIGH the output will return to a LOW state after this period of time has passed.

## DAC CAL Sub-Menu



Analog outputs can be configured to operate as constant voltage or constant current. This makes the outputs suitable for outputs such as 0-10V or 4-20mA. The analog output is current limited internally at approx 35mA. DAC Output impedance is 5 ohms.

In VOLTAGE mode:

Ensure that the wiring SERIES impedance is as low as possible. There will be a voltage drop across any series resistance that will affect the output voltage. How much the output will vary will depend on the load of the connected equipment. This load resistance preferably should not be less than 2k ohms.

In CURRENT mode:

Ensure that the full loop impedance is less than 500 ohms and at least 100 ohms. Add a small series resistor if required since the internal series resistance is only 5 ohms.

When the analog outputs are being controlled, scaling can be applied that allows the user to specify an OUTPUT from 0-1023 over a useful range from MIN to MAX. For example, if MIN is 200 and MAX is 400, then setting the analog output to a SET value of 1023 will in fact set the OUTPUT to the MAX value of 400. SET configured to 0 will set the OUTPUT to the MIN value of 200. A SET value of 512 will set the OUTPUT to a value of 300. See following calibration procedure for full example.

### MIN

This is the minimum used unscaled DAC count of interest. If no scaling is to be applied set to 0.

### MAX

This is the maximum used unscaled DAC count of interest. If no scaling is to be applied set to 1023.

### SET

This sets the output as a value between 0-1023 that is scaled and applied between the MIN and



MAX OUTPUT values. Regardless of the MIN and MAX settings, the full control range of 0-1023 can be used. This is a test parameter only, useful for calibration. This is the value that the user would send to the TReX in order to control the outputs.

### **OUTPUT**

This is a read only field showing the current flowing and unscaled raw output. This value will sit between MIN and MAX.

### **MODE**

Sets either constant VOLTAGE or CURRENT mode. When in VOLTAGE mode the output is fixed depending on the output set value. This mode is used for outputs such as 1-10V, 1-5V or any other voltage as configured. When in CURRENT mode the set value is the desired current that is to be maintained. This is used for outputs such as 4-20mA, 0-20mA or any other current up to 30mA as configured.

### **CAL mA**

This how much to adjust the output current sense to read correctly. This field has no function when the MODE is set to VOLTAGE. This must be set by connecting an ammeter through a small series resistor such as 100 ohms. This setting would then be adjusted until the reading is the same as the reading from the ammeter.

### **Calibration Procedure for Voltage Output**

1. Connect load (a resistance not less than 2 k ohm).
2. Set DAC output to 0 using the DAC->OUT parameter.
3. Alter DAC->MIN until the low limit output can be obtained.
4. Set DAC output to 1023 (maximum) using DAC->OUT
5. Alter DAC->MAX until the high limit output has been set. The output voltage does not vary with power supply, but the maximum output IS based on the TReX input supply voltage. Typically with a supply voltage of 12V the DAC max output is 10.0V.
6. Exit MENU and settings will be saved.

### **Calibration Procedure for 4-20mA Current Output**

1. Connect load with ammeter in series through a 100R resistor.
2. Set DAC->MIN to 117 and DAC->MAX to 583
3. Set DAC output to 0
4. Adjust DAC->MIN until output current is approximately 4mA.
5. Set DAC output to 1023
6. Adjust DAC->MAX until output current is approximately 20mA.
7. Exit MENU and settings will be saved.



## Serial Command Configuration

---

Most items that can be changed via the MENU can also be changed through serial commands. There are some additional commands that make the TReX more usable when being managed via a serial connection. These are listed immediately below.

These commands must begin with the character ‘\*’ and are processed with a carriage return character. Any characters before the ‘\*’ may result in the command not being processed.

### **Main Commands**

#### **\*REBOOT**

Forces the unit to immediately restart.

*Usage:*

*\*REBOOT<CR>*

#### **\*CONFIG**

Displays current configuration.

*Usage:*

*\*CONFIG<CR>*

#### **\*SAVE**

Saves all configuration settings (all configuration changes are restored on start-up).

*Usage:*

*\*SAVE <CR>*

#### **\*LIST**

Displays all available commands. This command also lists many specific field names that need to be used with listed commands.

*Usage:*

*\*LIST<CR>*

#### **\*DEFAULTS**

Forces to reset temporary to factory default settings. The user must issue the *\*SAVE<CR>* command in order to write these default settings to internal memory.

*Usage:*

*\*DEFAULTS<CR>*





### \*RSSI

Returns the receiver signal strength in -dBm. (returns between 0 and -130).

*Usage:*

*\*RSSI<CR>*

### \*USERPASS

Sets the web and TCP user and password. User must be at least 3 letters and password must be at least 4 letters. These credentials are requested for each new web and TCP connection.

*Typical usage:*

*\*USERPASS=admin:TReX<CR>*

When prompted for a login when using a TCP connection (not through web browser), login with the full user and password together.

e.g. in response to “login:”

enter

*“admin:TReX”*

The TReX will immediately report if successfully logged in.

To completely disable all web and TCP connection user and passwords, enter

*\*USERPASS=**none:none**<CR>*

*\*SAVE<CR>*

*By default the user and password is set to “**none:none**”*

### \*IO

Returns all input and output states.

*Typical usage:*

*\*IO<CR>*

*Typical output:*

*IO=I:01000000--- O:00000000 ADC:257,252 DAC:0,0*

In this typical output, there are 11 inputs shown. First 8 are the digital inputs. The 9<sup>th</sup> input is 1 or 0 based on battery high/low thresholds set. Inputs 10 and 11 are ADCs, again displayed as 1 or 0 based on set thresholds. The ‘-’ is shown when the input level is unknown, such as when an input is between the high and low configured thresholds. Output states for all 8 outputs follow, then ADC inputs 1 and 2 and finally the current DAC settings.



**\*TEMP**

Returns temperature of first the digital board, then the RF temperature sensor. This is NOT the ambient temperature. Temperatures in excess of 100 degrees C are completely normal under typical transmitting operation.

Usage:

*\*TEMP<CR>*

Typical output:

*TEMP=DIG:55.0C RF:60.1C*

**\*PWR**

Returns current forward power ADC count and system current both at the time of reading and recorded during the last transmission.

Usage:

*\*PWR<CR>*

Typical output:

*PWR=0,34,0.28,1.23*

*The first parameter is the forward power ADC count at the time of reading. The second value is the forward power recorded during the last message transmission. Parameter 3 is the system current. Parameter 4 is the system current recorded during the last message transmission.*

**\*VER**

Sends the TReX sign on message back to the user. This is useful to determine the model and serial number of the unit.

Usage:

*\*VER<CR>*

**\*BYPASS**

This a command that is useful for test and special serial control cases. This command specifies a RIC code and beep level that allows processing as if arriving from the receiver. In order for the message (in the case below “Test Message”) to arrive as a message, a RIC range must be configured in the TReX to suit.

*\*BYPASS=[NNNNNNN:L]MMMMMMMM<CR>*

where:

[ is the character ‘[’



NNNNNNN are 7 digits specifying the RIC code to be used for the message

: is the character ‘:’

L is beep level for the message to be processed from 0-3.

] is the character ‘]’

MMMMMM is the payload of the message to be processed.

*Typical Usage 1:*

*\*BYPASS=[1234567:1]Test Message<CR>*

“Test Message” will be added to the RX message screens, logged etc, as if received across the air.

*Typical Usage 2:*

*\*BYPASS=[1234567:1][[01]12345-8]<CR>*

“[[01]12345-8]” will be added to the RX message screens, logged etc., as if received across the air. In this case, the message will also be processed as a **WTE Output Protocol** message and immediately operate the TReX outputs.

**\*LAB**

Set the unit in transmit mode, it can be configured to transmit carrier only or modulated. This feature together with the \*RSSI command are useful when antenna alignment is necessary.

\*LAB syntax:

*\*LAB=x,y<CR>*

Where:

x is used to enable (1) or disable (0) the carrier; Setting to 2 enables random modulation for the configured transmit modulation.

y is the time in seconds which the TReX will be transmitting for.

*Typical usage:*

*\*LAB=1,10<CR>*

**Note:** \*LAB=1<CR> can be used, as it will enable carrier for 60 seconds



## **Transmit Commands**

### **\*TX\_FREQ**

Specifies the transmit frequency in Hz e.g.

*\*TX\_FREQ=160000000<CR>*

### **\*TX\_PROTO**

Specifies the protocol to apply for serial input. Accepts WTE, CUSTOM, RAW and AUX.

*Typical usage:*

*\*TX\_PROTO=WTE<CR>*

**Note: See protocol section for more details on protocols and configuration.**

### **\*TX\_BAUD**

Specifies the baud rate of the transmitter when using a protocol that does not permit a baud rate to be specified.

Accepts: 512\_25, 512\_12, 512\_6, 1200\_25, 1200\_12, 1200\_6, 1600\_25, 2400\_25, 2400\_12, 2400\_6, 3200-4L\_25, 4800\_25, 4800\_12, 4800-4L\_6, 9600\_25, 9600\_12, 9600-4L\_25, 9600-4L\_12, 16K-4L\_25, 16K-4L\_12, 32K-4L\_25

*Typical usage:*

*\*TX\_BAUD=512\_25<CR>*

### **\*TX\_MODE**

Specifies the transport method of the transmitter (how the information is transmitted over the air).

- POCSAG\_A must be used in order to transmit alphanumeric messages.
- POCSAG\_N must be used in order to transmit numeric messages.
- WTE\_EN must be used in order to transmit 8 bit characters (POCSAG\_A transmits 7 bit characters only).

Accepts POCSAG\_A, POCSAG\_N and WTE\_EN.

*Typical usage:*

*\*TX\_MODE=POCSAG\_A<CR>*



### **\*TX\_LEVEL**

Specifies the default level of messages transmitted. This is sometimes referred to as “Beep Level”. This is a value 0-9, however, when POCSAG is the transport method, only 0-3 will be used.

*Typical usage:*

`*TX_LEVEL=3<CR>`

### **\*TX\_CAP**

Specifies the default code used to identify transmissions (same as the RIC code).

The TX\_CAP code would only be used by protocols that do not require the CAP code to be specified.

TX\_CAP syntax:

`*TX_CAP=X:nnnnnnn<CR>`

Where:

X, is the input range index from 1 to 9

nnnnnnn, This code can be any number between 8 and 2000000.

*Typical usage:*

`*TX_CAP=1:1324560<CR>`

### **\*TX\_PERIODIC**

Allows a periodic message to be transmitted. This could be used as a “heartbeat” to confirm that the system is continuing to operate as expected. WT protocol must be used for the periodic message.

`*TX_PERIODIC=TT,MMMM<CR>`

where:

TT is the time in seconds between transmissions (0-255. 0 disables the feature).

MMMM is the periodic message to transmit (up to 50 characters).

*Typical usage:*

`*TX_PERIODIC=10,WT1234560A10 Test_Message<CR>`

### **\*TX\_PREAMBLE**

Sets the preamble length in multiples of 32 bits.

Short preambles allows the messages to be transmitted quickly.

Long preambles are typically used in conjunction with a matching receiver to save battery



power when the receivers is in deep sleep mode.

The POCSAG standard uses a setting of 18 (576 bits – configured in steps of 32). This very long preamble means that paging receivers need only to wake briefly once per second (at 512 baud) in order to check for an incoming message. If the receiver is always powered and receiving, then much shorter preambles can be used, and in some cases halve the channel activity. When the TReX is used as transmitter and receiver at both ends of the link, a setting of 2 (64 bits) will work equally well.

*Typical usage:*

```
*TX_PREAMBLE=18<CR>
```

## **\*TX\_LEAD**

Sets the transmit lead-in and lead-out time in multiples of 10ms.

Some receivers require time to settle when a transmitter is keyed up. The command allows the lead-in and lead-out times to be set.

```
*TX_LEAD=II,OO<CR>
```

where:

II is the lead-in time. This is the duration after the carrier is applied BEFORE data is transmitted. Default is 0, max is 50 (500ms).

OO is the lead-out time. This is the duration AFTER data is transmitted that the carrier is applied before keying down the transmitter. Default is 0, max is 50 (500ms).

*Typical usage:*

```
*TX_LEAD=5,5<CR>
```



## Receive Commands

### \*RX\_ENABLE

Allows the receiver to be disabled to save power if required.

*Typical usage:*

```
*RX_ENABLE=1<CR>
```

### \*RX\_FREQ

Specifies the receive frequency in Hz (range limited to the variant of product).

*Typical usage:*

```
*RX_FREQ=16000000<CR>
```

### \*RX\_BAUD

Specifies the baud rate of the receiver.

Accepts: 512\_25, 512\_12, 512\_6, 1200\_25, 1200\_12, 1200\_6, 1600\_25, 2400\_25, 2400\_12, 2400\_6, 3200-4L\_25, 4800\_25, 4800\_12, 4800-4L\_6, 9600\_25, 9600\_12, 9600-4L\_25, 9600-4L\_12, 16K-4L\_25, 16K-4L\_12, 32K-4L\_25

*Typical usage:*

```
*RX_BAUD=512_25<CR>
```

### \*RX\_PROTO

Specifies the protocol to apply for serial output, accepts WTE, CUSTOM, RAW and AUX. See protocol section for more detail on protocols and configuration.

*Typical usage:*

```
*RX_PROTO=WTE<CR>
```

### \*RX\_MODE

Specifies the transport method of the receiver (how the information is received over the air).

- POCSAG\_A must be used in order to receive alphanumeric messages.
- POCSAG\_N must be used in order to receive numeric messages.
- WTE\_EN must be used in order to receive 8 bit characters (POCSAG\_A transmits 7 bit characters only).

Accepts POCSAG\_A, POCSAG\_N, WTE\_EN and FLEX.

*Typical usage:*



`*RX_MODE=POCSAG_A<CR>`

### **\*RX\_RANGE**

Specifies up to 8 CAP RX ranges for decoding. Messages received with CAP codes not within the RX\_RANGE will be discarded by the receiver.

CAP codes should not fall within multiple ranges. If an output has been configured to operate on a range match, a second output configured for another range with the same CAP code will not operate.

`*RX_RANGE=N:LLLLLLL,HHHHHHH` (where N is the range between 1 and 8, LLLLLLL is the lowest cap code to match, HHHHHHH is the highest).

*Typical usage:*

`*RX_RANGE=1:8,200<CR>`

### **\*RX\_BUSY**

Specifies the output to operate and channel busy level for the configured channel. First parameter is the output to operate (from 1-8). The second parameter is the signal level from 0 to -130 (in dBm). If the signal strength on the receiving channel is above this configured value, the channel will be considered to be busy. Transmissions will not be possible if the channel is considered to be busy. After a period of 5 seconds of the channel being busy, the transmitter will transmit anyway.

In this example the channel will be considered “busy” if signal strength is above -80dBm.

*Typical usage:*

`*RX_BUSY=1,-80<CR>`

**Note:** If the TReX continually reports BUSY, issue the command `*RSSI<CR>` to view the current noise floor and adjust the busy level appropriately.





## Store Forward Commands

Store forward operation is when the unit is used to listen to transmissions in the area, decode the messages and retransmit again to provide greater coverage than would normally be possible.

**Note:** In order to forward messages the decoded message CAP codes must fall within the configured CAP ranges.

### **\*STORE\_FWD**

Configures the store forward operation, this command uses 2 parameters as follows:

```
*STORE_FWD=XX,YY<CR>
```

Where:

XX is the **Store Forward Operation**

YY is the **Duplicate Reject Operation**

#### **Store Forward Operation:**

Setting to 0 disables the feature. The non zero value set is the delay in 100ms steps after each transmission. This delay allows time for any downstream forwarding equipment to clear the message. Max store forward delay is 24 seconds. All messages are immediately queued for transmission, and up to 5 messages may be retransmitted after the store forward delay.

#### **Duplicate Reject Operation:**

Setting to 0 disables the feature, otherwise this is the number of seconds to reject identical messages for up to 60 seconds. Duplicate rejection operates only on messages decoded for forwarding. This means that receiving of duplicate messages is not prevented (nor the transmission of same messages resulting from a protocol command), but when used as part of a simple store forward system re-queueing of messages can be controlled. Duplicate reject only tests the previous 5 messages in the historic transmit queue.

For example, to configure to use a 2 second clearing delay after each transmission and 10 second message duplicate reject:

```
*STORE_FWD=20,10<CR>
```



## Input Commands

The input commands allow messages to be configured for transmission when changing state. Debouncing (how long an input is settled before acting on the new level) can be configured with the number of times to transmit the input message.

**Note:** Even if an input is configured to transmit a certain number of messages, should the input level change before all messages are transmitted, then the remaining transmissions will be cancelled.

Please refer to **Input Output Hardware Connection** section on this manual for examples of how to connect the input and output pins on the TRex.

### \*IN\_CONFIG\_L

Specifies all input Low configuration parameters. Inputs are triggered by connecting the input to ground for a time exceeding the specified debounce period. The input message is configured using the \*IN\_MSG\_L command. Usage is as follows:

\*IN\_CONFIG\_L=I:N,D,R

Where:

I = The input to configure (1-11 valid). Input 9 is the VIN input, 10 is ADC 1 and 11 is ADC 2.

: = the colon character ‘:’

N = number of transmissions (0 = no transmissions, 9 is max tx count)

, = the comma character ‘,’

D = debounce in 100 ms steps (from 0-255)

, = the comma character ‘,’

R = time in seconds between retransmissions.

Example. Configure input 1 to send two message after input is debounced by 300 milliseconds and repeat/retransmit this message 4 times.

*Typical usage:*

```
*IN_CONFIG_L=1:2,3,4<CR>
```

### \*IN\_CONFIG\_H

Specifies all input High configuration parameters. Inputs are triggered by moving the input to a high state or released from GND for a time exceeding the specified debounce period. The input message is configured using the \*IN\_MSG\_H command. Usage is as follows:

\*IN\_CONFIG\_H=I:N,D,R



Where:

I = The input to configure (1-11 valid). Input 9 is the VIN input, 10 is ADC 1 and 11 is ADC 2.

: = the colon character ‘:’

N = number of transmissions (0 = no transmissions, 9 is max transmission count)

, = the comma character ‘,’

D = debounce in 100 ms steps (from 0-255)

, = the comma character ‘,’

R = time in seconds between retransmissions.

*Typical usage:*

`*IN_CONFIG_H=1:1,10,15<CR>`

### **\*IN\_MSG\_L**

Specifies the low level message that will be transmitted if configured. Input messages must always use WT Protocol.

*Typical usage:*

`*IN_MSG_L=1:WT1234560A10 IN_1_LOW<CR>`

### **\*IN\_MSG\_H**

Specifies the high level message that will be transmitted if configured. Input messages must always use WT Protocol.

*Typical usage:*

`*IN_MSG_H=1:WT1234560A10 IN_1_HIGH<CR>`

### **\*IN\_ANALOG**

Specifies the high and low ADC count thresholds for an analog input to be considered a digital HIGH or digital LOW. When these thresholds are exceeded, then programmed messages for HIGH and LOW levels can be transmitted. All ADC counts are the SCALED ADC counts.

`*IN_ANALOG=1H,1L,2H,2L,3H,3L`

Where:

1H = Input voltage high (x10)

1L = Input voltage low (x10)

2H = ADC1 voltage high ADC count

2L = ADC1 voltage low ADC count

3H = ADC2 voltage high ADC count



3L = ADC2 voltage low ADC count

*Typical usage:*

*\*IN\_ANALOG=138,114,200,100,500,400<CR>*



## Output Commands

The output commands allow the GPIO pins to be configured as outputs or inputs. Following configuration of the pins as outputs, they are controlled using the **WTE Output Control Protocol**.

**Note:** Please refer to **Input Output Hardware Connection** section on this manual for examples of how to connect the input and output pins on the TReX board.

### \*OUT\_CONFIG

Specifies all output configuration items, usage as follows:

\*OUT\_CONFIG=O:E,T <CR>

Where:

O = The output to configure (1-2 valid)

: = the character ‘:’

E = 1 to enable the set GPIO pin to an output.

T = time for output to close for in 100ms steps. E.g. 100 is 10 seconds. Max value is 32000. Setting to 0 disables the timer and output is latched indefinitely.

*Typical usage:*

\*IN\_CONFIG\_L=1:1,10<CR>

### \*UNIT\_ID

Specifies the output unit ID

\*UNIT\_ID=XX<CR>

where:

XX are any characters (up to 12 either numeric or alphanumeric) that are used to uniquely address each TReX when used in conjunction with the **WTE Output Control Protocol**. By default this ID is “01”, allowing numeric paging to be used to transmit messages.

*Typical usage:*

\*UNIT\_ID=Unit-A<CR>



## System Commands

### **\*TREX\_LANG**

Specifies the language used by the unit

**\*TREX\_LANG=X**

where:

0 = English

1 = Spanish

2 = French

*Typical usage:*

**\*TREX\_LANG=0<CR>**

### **\*TREX\_BACKLIGHT**

Specifies the time in seconds which the display LED backlight will be lit for after a key is pressed. Setting to 0 disables. Setting to 30 enables permanently.

*Typical usage:*

**\*TREX\_BACKLIGHT=10<CR>**

### **\*TREX\_SOUND**

Controls sounds made when a key is pressed or when a message is received that results in an ALERT being raised.

*Typical usage:*

**\*TREX\_SOUND=1<CR>**

### **\*TREX\_RS232\_BAUD**

Sets the serial baud rate of the RS232 port.

*Typical usage:*

**\*TREX\_RS232\_BAUD=9600<CR>**



### **\*TREX\_RS422\_BAUD**

Sets the serial baud rate of the RS422 port.

*Typical usage:*

```
*TREX_RS422_BAUD=4800<CR>
```

### **\*TREX\_ALERT\_OUT**

Sets the output that will operate when a message is received that results in an ALERT being raised. Setting to 0 disables the ALERT output. Accepts outputs 1-8.

*Typical usage:*

```
*TREX_ALERT_OUT=0<CR>
```

### **\*TREX\_ALERT**

Sets the output to operate (0-8) and the time in seconds between sounding the buzzer (if TREX\_SOUND has been set to 1). Alerting will continue until a key is pressed to acknowledge the ALERT. . Setting the output to 0 does not disable the alert.

*Typical usage:*

```
*TREX_ALERT=1,60<CR>
```

### **\*TREX\_FILTERS**

Sets the message filters that are in use when a message is received.

```
*TREX_FILTERS =I,E,A<CR>
```

where:

I is set to 1 if the INCL.TXT filter is to be used.

E is set to 1 if the EXCL.TXT filter is to be used.

A is set to 1 if the ALERT.TXT filter is to be used.

See **FILTERS** for details of use.

*Typical usage:*

```
*TREX_FILTERS =0,0,0<CR>
```



### **\*TReX\_TELEMETRY**

Sets all parameters necessary to enable either the point to point serial link or back to back mirror mode of operation.

**\*TReX\_TELEMETRY=M,R,A,B,C**

where:

M is telemetry mode of operation

- 0 = DISABLED,
- 1 = SERIAL\_LINK,
- 2 = IO\_MIRROR,
- 3 = SCADA\_SLAVE,
- 4 = SCADA\_MASTER

R is the number of remote TReX units when the telemetry mode is SCADA\_MASTER (valid 0-10)

A is the local unit ID (from 1-255).

B is the remote unit ID (from 1-255).

C is how long in seconds before sending all input information again.

*Typical usage:*

**\*TReX\_TELEMETRY=0,0,1,2,10<CR>**

### **\*TReX\_SCREEN**

Sets the default main screen and the page for that main screen. On start-up the first screen viewed is this screen. After a period of keypress inactivity, this is the return screen. This is shown here only for completeness. Typically this would only be set through the MENU system, and has no relevance when the TReX is being serially controlled.

**\*TReX\_SCREEN=X,Y**

where:

- X = main screen
- Y = page for that main screen.

*Typical usage:*

**\*TReX\_SCREEN=0,0<CR>**

### **\*TReX\_PIN**

Sets the Personal Identification Number, which can be used to unlock the unit. The PIN prevents accidental mis-configuration or changes by unauthorised users.





\*TREX\_PIN=nnnn

where:

nnnn = 4 digit PIN number.

*Typical usage:*

\*TREX\_PIN=0000<CR>

### \*TREX\_AN\_CAL

Sets parameters used to calibrate the analog outputs and inputs. See DAC and ADC CAL Sub-Menus for more information.

\*TREX\_DAC\_CAL=AA,BB,CC,DD

where:

AA = DAC1 minimum count. Default 0.

BB = DAC1 maximum count. Default 1023.

CC = DAC2 minimum count. Default 0.

DD = DAC2 maximum count. Default 1023.

EE = ADC1 minimum count. Default 0.

FF = ADC1 maximum count. Default 1023.

GG = ADC2 minimum count. Default 0.

HH = ADC2 maximum count. Default 1023.

*Typical usage:*

\*TREX\_AN\_CAL=0,1023,0,1023,0,1023,0,1023,

### \*TREX\_MISMATCH

Sets parameters that control the antenna mismatch detection feature.

When an antenna is missing, damaged or mismatched, the following may be observed; The current may increase, the RF power detected may increase/decrease through reflection, or the output power may be low. Should any of these be detected, the mismatch output can be configured to operate.

\*TREX\_MISMATCH=AA,BB,CC,DD,MM

where:

AA = the output to operate on mismatch detection.

BB = the max forward power permitted (ADC count).

CC = the max system current permitted in mA.



DD = the number of seconds to operate the output.

MM = the min permitted output power (ADC count).

*Typical usage:*

*\*TReX\_MISMATCH=2,300,1500,5,200<CR>*



## **TCP-IP Commands**

### **\*IP\_ENABLE**

Enable/disable the Ethernet subsystem of the radio.

Use:

- 1 to enable WEB only.
- 2 to enable WEB plus TCP SERVER
- 3 to enable WEB plus TCP CLIENT
- 4 to enable TCP SERVER only.
- 5 to enable TCP CLIENT only.

*Typical usage:*

```
*IP_ENABLE=1<CR>
```

### **\*IP\_HOST**

Configures the name used by the DNS server to allocate name to IP translation on the network.

*Typical usage:*

```
*IP_HOST=WTE-TReX<CR>
```

### **\*IP\_ADD**

Specifies the default IP number set to be used by the network.

*Typical usage:*

```
*IP_ADD=192.168.1.20<CR>
```

### **\*IP\_PORT**

Specifies TCP Port used by the TCP server and client. Port for web configuration is fixed at 80.

*Typical usage:*

```
*IP_PORT=5080<CR>
```



### **\*IP\_MASK**

Specifies default network mask number.

*Typical usage:*

```
*IP_MASK=255.255.255.0<CR>
```

### **\*IP\_GATE**

Specifies the address used for the gateway.

*Typical usage:*

```
*IP_GATE=192.168.1.1<CR>
```

### **\*IP\_DNS**

Specifies the IP number used to connect to the DNS server, up to 2 DNS servers can be set.

```
*IP_DNS=aaa.bbb.ccc.ddd,eee.fff.ggg.hhh
```

where:

aaa.bbb.ccc.ddd = first DNS server IP,

eee.fff.ggg.hhh = second DNS server IP

*Typical usage:*

```
*IP_DNS=192.168.1.1,0.0.0.0<CR>
```

Note: The IPs are separated by the use a “,” (COMMA)

### **\*IP\_MAC**

Returns the MAC (Media Access Code) number of the unit, this is a readable field only.

*Typical usage:*

```
*IP_MAC?<CR>
```

*Typical output:*

```
*IP_MAC=60AD45676000<CR>
```



## Protocols

---

Serial input into and out of the TReX can be formatted differently by selecting an appropriate protocol handler.

### ***WT Protocol***

---

The **WT Protocol** is the default protocol used by WTE products. It allows for a variety of over the air transport methods (such as POCSAG paging) to be used and a variety of baud rates. The WT Protocol also supports the use of macros to embed variable information in messages such as system voltage, time etc. – see **Variable Content Macros**.

#### **Transmitting Messages**

Message format:

WTNNNNNNNABC<SPACE>MMMMM<CR>

Where:

**WT** are the 2 characters WT

**NNNNNNN** are 7 ASCII digits from 0000000-9999999

**A** is the Transport method:

A = POCSAG Alpha

N= POCSAG Numeric

W= POCSAG WTE (WTE 8 bit format allowing all 8 bit characters to be transmitted)

S= Message Payload sent directly to serial port without transmission. See note “Serial Only Transport of Messages”.

**B** is the Level 1-9. Note that POCSAG only supports levels 1-4 which is the same as the “Beep Level”.

**C** is the data rate (specified in channel width ranges):

#### ***25 kHz Channel Space Settings***

0 = 512 Baud 2 Level FSK

1 = 1200 Baud 2 Level FSK

2 = 1600 Baud 2 Level FSK

3 = 2400 Baud 2 Level FSK

4 = 3200 Baud 4 Level GFSK

5 = 4800 Baud 2 Level GFSK

6 = 9600 Baud 2 Level GFSK

7 = 9600 Baud 4 Level GFSK

8 = 16000 Baud 4 Level GFSK



9 = 32000 Baud 4 Level GFSK

**12.5 kHz Channel Space Settings**

A = 512 Baud 2 Level FSK

B = 1200 2 Level FSK

C = 2400 2 Level FSK

D = 4800 2 Level GFSK

E = 9600 2 Level GFSK

F = 9600 4 Level GFSK

G = 16000 4 Level GFSK

**6.25 kHz Channel Space Settings**

a = 512 Baud 2 Level FSK

b = 1200 2 Level GFSK

c = 2400 2 Level GFSK

d = 4800 4 Level GFSK

*NOTE: Although the protocol supports the following modulation types and channel spacings, the supplied WTE product may only support a subset of these modulation rates (determined by regional restrictions).*

<SPACE> is a single space character.

MMM... is the payload, up to 240 characters.

<CR> is the carriage return character

Example:

To send a 512 baud alpha message to 1234567 level 1 with payload of "TEST"

*WT1234567A10<SPACE>TEST<CR>*

After processing/transmitting responds with:

*WT[TTT,NNN]<CR>*

where:

TTT is the "ticket ID" that was assigned to the transmission. Rotates from 999 to 0.

NNN is the number of characters from W until, but not including <CR> , the test message above results in the following response

*WT[123,017]<CR>*

If a user specified response is required this response can be changed. To change the sent



response to “Page Sent” a leading ‘\*’ character must be used in the PROTOCOL->SENT RESP config item. e.g. “\*Page Sent”.

### Received Messages

All messages received come out via the serial port as configured in by the \*RX\_PROTO setting:

If \*RX\_PROTO=WTE then the output will look like:

```
WT1234567A10<SPACE>TEST<CR>
```

The exact same format allows units to be connected together, or protocols to be converted from one type to another.

### Serial Only Transport of Messages

There is sometimes a need to only send WT protocol messages out a serial port and not transmitted on a particular event. For example, if an input changes state, it might be desirable to send a message out the serial port to control another piece of equipment, or. it might be useful to use the periodic message to send a health check message out the serial port once every 5 seconds. Receiver only TReX units use this method to output messages.

The transport type ‘S’ has been assigned for this purpose.

Example:

To send the message “INPUT 1 LOW” out the serial port when input 1 moves low program the input 1 low message with:

```
WT1234567S10<SPACE>INPUT 1 LOW<CR>
```

All aspects of the message are ignored except for the message payload “*INPUT 1 LOW*”.



## Variable Content Macros

WT Protocol can use several macro tags to display variable content. This may be useful as part of a periodic message for example to report battery voltage or IO conditions. Any number of macros can be used in any location of the message until the max message length has been reached.

Macro Tag	Description	Example Output
**01	Auto Incremented Ticket ID (3 digits rotating)	123
**02	Time/Date	23:34 01/02
**03	Digital IO	I:11110000--- O:1111000000
**04	Analog IO	ADC:1023,1003 DAC:1023,1003
**05	System Voltage	12.1
**06	Temperature (Digital, RF degrees Celsius)	23.4, 44.5

Example:

To transmit the system voltage when input 1 goes low, program the input 1 low message with:

*WT1234567A10<SPACE>INPUT 1 \*\*05V<CR>*

The message that will be transmitted and then received will look approximately like:

*INPUT 1 12.1V*





## **Modbus**

---

The TReX supports both RTU and TCP modbus protocol options. These are well established and defined protocols used primarily in SCADA control and monitoring applications.

These Modbus protocols can be used over any of the RS232, RS422, RS485 and Ethernet interfaces.

Baud-rates, IP configuration and Modbus specific configuration items are through: MENU->PROTOCOL->MODBUS. This is an optional feature.

Note that the Modbus TCP protocol by default uses port 502. This is not a firm requirement, and this can be changed to another port. The TReX defaults to port 5080.

### **Modbus RTU**

The Modbus RTU protocol, as well as the TCP extension, are well documented in the specifications which are available at <http://www.modbus.org>, a website established by the Modbus Organization for supporting and organizing the Modbus protocol. Only the use of the protocol is documented here.

The first byte of the Modbus RTU protocol is a single byte Modbus Slave ID. The TReX uses the Slave ID as the Unit ID when the Modbus TCP protocol is used. These ID codes allow multiple units to be addressed, or in the case of Modbus TCP, multiple units to be used on the same IP address.

### **Modbus TCP**

The Modbus/TCP extension includes 6 additional bytes to the original Modbus RTU protocol, which allows for transport over the TCP/IP layers.  
Only a single TCP connection is permitted at any one time.

The TReX sends these 6 bytes PLUS the entire RTU protocol payload (except the last two CRC bytes). The first byte of the RTU protocol is the unit ID (usually described as part of the Modbus MBAP header)

### **Function Codes**

Listed are the supported Modbus function codes. All function codes not specified will return a Modbus standard error response.

The TReX supports 1 MASTER plus up to 10 SLAVES wirelessly connected.

*Note: in the following mapping, provision has been allowed for multiple SLAVE units. The first single register (and in the case of discrete I/O, 8 registers) are for the MASTER unit, and following registers are for the installed SLAVE units in the system.*



Function Code	Description	Valid Address Range	Registers
01 – Read Coils	Code to read the 8 TReX digital outputs (MASTER TReX plus up to 10 wireless SLAVE TReX units)	0x0000 - 0x0057	1 to 88
02- Read Digital Inputs	Code to read the up to 88 TReX digital inputs (MASTER TReX plus up to 10 wireless SLAVE TReX units)	0x0000 - 0x0057	10001 to 10088
03- Read Holding Registers	Read DAC1 registers Read DAC2 registers	0x0000 – 0x000A 0x0100 - 0x010A	40001 to 40011 40257 to 40267
04 – Read Input Registers	Code to read the ADC1 Code to read the ADC 2 Code to read Temperature Reserved Code to read BattV Read Link Status Count	0x0000 – 0x000A 0x0100 – 0x010A 0x0200 – 0x020A 0x0300 – 0x030A 0x0400 – 0x040A 0x0500 – 0x050A	30001 to 30011 30257 to 30267 30513 to 30523 30769 to 30779 31025 to 31035 31281 to 31291
05 – Write Single Coil	Code to write to the 8 TReX outputs(MASTER TReX plus up to 10 wireless SLAVE TReX units)	0x0000 - 0x0057	1 to 88
06 – Write Single Register	Code to write DAC1 Code to write DAC2 Special Command Code	0x0000 – 0x000A 0x0100 – 0x010A 0x0200 – 0x020A	40001 to 40011 40257 to 40267 40513 to 40523
15 – Write Multiple Coils	Code to write to up to 8 outputs at once (MASTER TReX plus up to 10 wireless SLAVE TReX units)	0x0000 - 0x0057	1 to 88
16- Write Multiple Registers	Message TX Buffer (see below)	0x0300 – 0x03FA	40769 to 40892

### Modbus Mapping Table

Base Address	Num Registers	Description	R/W	Bits
1	88	Digital Out (discrete)	R/W	1
10001	88	Digital In (discrete)	R	1
30001	11	ADC 1 (raw count 0-1023)	R	16
30257	11	ADC 2(raw count 0-1023 )	R	16
30513	11	Temperature 1(signed short x 10)	R	16



30769	11	Status(signed short x 10)	R	16
31025	11	Battery(signed short x 10)	R	16
40001	11	DAC 1 (value from 0-1023)	R/W	16
40257	11	DAC 2 (value from 0-1023)	R/W	16
40513	11	Special Function Commands 1 – Reboot Unit 2 – Request Slave I/O to be returned to Master.	W	2
40769	125	Message Tx Buffer (variable len up to 250 bytes)	W	16

**Message Tx Buffer (On Request):**

The TReX is a Modbus capable paging transmitter. This means that not only can the generic third party SCADA application control and monitor IO using standard Modbus commands, but the SCADA application can also send paging messages using the **WT Protocol**. This allows the SCADA application to directly message to pager, send information to devices such as LED signs or to output serial data from any TReX unit.

In order to send a pager message, the SCADA application should send content such as “WT1234560A10 Test Message” to Modbus address 0x300 and function code 16. The message must conform to the documented **WT Protocol**.



## Custom Protocol

---

This protocol allows many existing protocols provided by other vendors to be supported by the parsing of fields based on configuration (without new firmware being required).

The custom protocol takes as a starting point various default values that may or may not be replaced depending on how the unit is configured:

- Preconfigured default cap code (\*TX\_CAP=1234567).
- Preconfigured default level or priority (\*TX\_LEVEL=0).
- Preconfigured default baud rate (\*TX\_BAUD=2400\_25).
- Preconfigured default transport mode (\*TX\_MODE=POCSAG\_A).

For each of these fields a command is set to specify the content (up to 9 fields)

### \*CUST\_FIELD

\*CUST\_FIELD=F:S,L,“match”,I, T

Where:

**F** is the field number (1-9 permitted)

**:** is the colon character ‘:’

**S** is the start index in message (from 0-255). This field rule will start looking at this index in the incoming message (index is 0 based).

**,** is the comma character ‘,’

**L** is the length of the field to parse (0-255. If 0 is specified, then parsing will continue until the first non printable character is found).

**“match”** is any string that should be matched in the incoming message. This may or may not be used as described below (not all field attribute types inspect this field)

**I** is the case insensitive flag. ‘I’ means that the match string previously described is case insensitive (“test” will match on incoming messages with “tEst” and “TEST”). ‘’ meaning that the match field is case sensitive.

**T** is field attribute as described below (e.g. MATCH, CAP etc.).

**Each field may have any of the following attributes (displayed in the command \*LIST).**

**MATCH** - the field must exactly match the specified match string. Message is rejected if not found.



- CAP** - the field is parsed into the cap code to use (match string ignored).
- LEVEL** - the field is parsed into the priority of beep level (match string ignored).
- MSG** - the field is parsed into the message field (match string ignored).
- BAUD\_512** - the field is parsed and if matches 512 baud is set for outgoing message.
- BAUD\_1200** - the field is parsed and if matches 1200 baud is set for outgoing message.
- MODE\_A** - the field is parsed and if matches, Transport method (POCSAG Alphanumeric) is set for outgoing message.
- MODE\_N** - the field is parsed and if matches, Transport method (POCSAG Numeric) is set for outgoing message.
- UNUSED** - the field is unused.

**Full Example:**

To support a serial input of:

ET1234567-1-TEST<CR>

In this example (from an unspecified third party) the number 1234567 is a POCSAG CAP code. The 1 between the '-' characters specifies the beep level and "TEST" is the message payload. If the "ET" at the start is in capitals, then the message is transmitted at 512 baud. If the message starts with "et" then the message is transmitted at 1200 baud.

**Implementation:**

- Set match field 1, start index 0 for a length of 2 characters. If the match string is found, then BAUD rate of 1200 is used.  
*\*CUST\_FIELD=1:0,2,"et",,BAUD\_1200<CR>*
- Set match field 2, start index 0 for a length of 2 characters. If the match string is found, then BAUD rate of 512 is used.  
*\*CUST\_FIELD=2:0,2,"ET",,BAUD\_512<CR>*
- Set match field 3, start index 2 for a length of 7 characters. This field is parsed into the capcode  
*\*CUST\_FIELD=3:2,7,"",,CAP<CR>*
- Set match field 4, start index 10 for a length of 1 characters. This field is parsed into the priority  
*\*CUST\_FIELD=4:10,1,"",,LEVEL<CR>*
- Set match field 5, start index 12 for a length of 0 characters. This field is parsed into the message payload. Note that a length of 0 means that parsing will continue until a non printable character is found.



*\*CUST\_FIELD=5:12,0,"",MSG<CR>*

To make more robust, further checks on the input can be made in this case to look for ‘-’ characters (at index 9 and 11):

- Set match field 6, start at index 9 for a length of 1 character. If the “-” string is not matched, the entire message will be considered invalid and discarded.

*\*CUST\_FIELD=6:9,1,"-",MATCH<CR>*

- Set match field 7, start at index 11 for a length of 1 character. If the “-” string is not matched, the entire message will be considered invalid and discarded.

*\*CUST\_FIELD=7:11,1,"-",MATCH<CR>*

- Say how many fields are in use. UNUSED ignores all following fields.

Note that field 9 and 10 in this example do not need to be set to UNUSED, but only done here to reduce confusion.

*\*CUST\_FIELD=8:0,0,"",UNUSED<CR>*

*\*CUST\_FIELD=9:0,0,"",UNUSED<CR>*

*\*CUST\_FIELD=10:0,0,"",UNUSED<CR>*

**Full Example of Minimum Configuration:**

If default fields are configured (setting cap code, level etc.), then for the same input of:

ET1234567-1-TEST<CR>

The very least configuration required to transmit is (ignoring all parameters except the message payload to transmit):

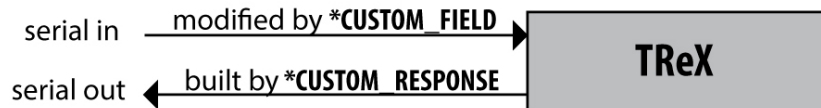
- Set match field 1, start index 12. Length is 0 so the MSG is parsed until the first non printable character is seen. This field is parsed into the MSG field that is transmitted.

*\*CUST\_FIELD=1:12,0,"",MSG<CR>*

*\*CUST\_FIELD=2:0,0,"",UNUSED<CR>*

## Custom Protocol Response

This section defines the serial output from the TReX back to the user when a message has been accepted for transmission.



Responds with up to 3 custom response fields followed by a <CR>

### Supported attributes are:

**CONST** (includes in the response exactly the content configured between “”).

**CAP** (includes the CAP code of the transmitted message in the response).

**LEVEL**(includes the beep level of the transmitted message in the response).

**MSG** (includes the message payload transmitted in the response)

### Example 1:

e.g. if response of SENT<CR> is desired

*\*CUST\_RESP=1:"SENT",CONST<CR>*

*\*CUST\_RESP=2:" ",UNUSED<CR>*

*\*CUST\_RESP=3:" ",UNUSED<CR>*

### Example 2:

e.g. if response of JX1234567<CR> is desired (where 1234567 is the CAP code of the transmitted message and JX are the characters “JX”).

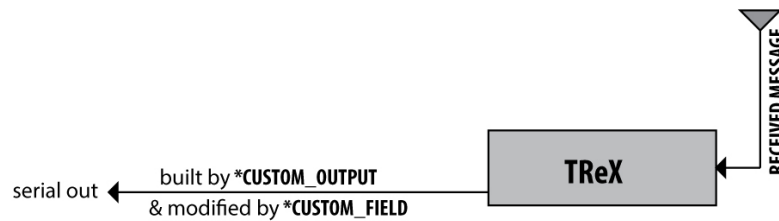
*\*CUST\_RESP=1:"JX",CONST<CR>*

*\*CUST\_RESP=2:" ",CAP<CR>*

*\*CUST\_RESP=3:" ",UNUSED<CR>*

## Custom Protocol Output

The custom protocol output is used to quickly format the output of any message decoded across the air. The application for this is to allow the serial output to match an input that is expected for a third party connected system.



**\*CUST\_OUTPUT**

**\*CUST\_OUTPUT** is the start point to construct the serial output message. This command holds constant text that may then be modified by the CUST\_FIELDS commands if required.

For example, when an over the air message is received the serial output may need to be forwarded to another providers’ equipment. Imagine that the required output to drive this equipment is “AABBCCCCMMM”. Full understanding of the providers third party protocol format is not required, only that “MMM” is the message.

The TReX custom output is accordingly set to “AABBCCCCMMM” and the CUSTOM\_FIELD commands are then used to insert/replace the decoded message into the position of “MMM”. If all CUSTOM\_FIELDS are UNUSED then the output will ALWAYS be the constant “AABBCCCCMMM”.

Consider an example where the decoded over the air message will have a CAP code of 1234567, LEVEL of 1 and message body of “TEST”. It is required in this example that output should have the format “ET1234567-1-TEST”. First configure the expected message format as follows:

```
*CUST_OUTPUT=ET1111111-2-TEST<CR>
```

With the **\*CUST\_OUTPUT** set the TReX can now be configured to replace part of this text with the text received from an over the air message received. This example was also used/described previously.

```
*CUST_FIELD=3:2,7,"",CAP<CR>
*CUST_FIELD=4:10,1,"",LEVEL<CR>
*CUST_FIELD=5:12,0,"",MSG<CR>
```

All the over the air received messages will now be output serially with the required/configured format.

Please contact customer support at WTE Limited if assistance is required configuring the CUSTOM protocol ([info@wte.co.nz](mailto:info@wte.co.nz)). WTE Limited can also implement support for your existing protocols through negotiation.





## **RAW Protocol**

---

The Raw protocol uses all default settings to determine the data rate, transport method, cap code etc. This protocol is the protocol used when using a point to point serial link.

Default transmission settings are configured with the commands:

\*TX\_BAUD  
\*TX\_CAP  
\*TX\_LEVEL

In addition, the following commands are used with RAW protocol:

### **\*RAW\_TIMEOUT**

Specifies the time of inactivity in 25ms steps before sending all stored data (max 255), example for a timeout of 100mS:

*Typical usage:*

*\*RAW\_TIMEOUT=4<CR>*

### **\*RAW\_LEN**

Specifies the number of characters to transmit at once. Messages exceeding the length can still be sent, but there will be a small delay between each transmission. Transmission delays may be longer than expected if the TReX determines that the channel is busy.

*Typical usage:*

*\*RAW\_LEN=100<CR>*

### **\*RAW\_END**

Specifies a character that results in immediate transmission, or displayed after reception (0 if unused). Decimal value of ASCII character.

*Typical usage:*

*\*RAW\_END=13<CR>*

This means transmit immediately after the carriage return character is seen. Also after decoding each message, the carriage return character is also displayed.

### **\*RAW\_CONFIG**

Specifies all RAW protocol parameters.

**Parameter 1** specifies the time of inactivity in 25ms steps before sending all stored data (max 255).

**Parameter 2** specifies the number of characters to transmit at once. Messages exceeding



the length can still be sent, but there will be a small delay between each transmission. Transmission delays may be longer than expected if the TReX determines that the channel is busy.

**Parameter 3** specifies a character that results in immediate transmission (0 if unused).  
Decimal value of ASCII character,

*Typical usage:*

```
*RAW_CONFIG=4,100,13<CR>
```



## SCADA Support

---

SCADA (Supervisory Control And Data Acquisition) is a term used widely in many industries relating to monitoring and control systems. This section deals with the integration of the TReX into a SCADA system. This is an optional feature, that requires a feature key to be purchased.

### **Terminology**

SCADA application:

This is a software package that is used to control and monitor devices. This could be free open source packages such as “Rapid SCADA” or “openSCADA”. Alternatively, this could be industry standard applications such as “WonderWare” or “LabView”.

SCADA system:

This is a system comprising of one or many TReX units monitoring equipment that the TReX units are connected to. This includes also the SCADA application.

MASTER:

This is the unit that is connected through Ethernet or another interface to a SCADA monitoring application.

This master unit can now control and hold the details of up to 10 TReX slaves. Input and output status of all units can be immediately requested or modified directly by the SCADA application.

To set the TReX as a master set MENU->TELEMETRY->MODE to SCADA\_MASTER.

SLAVE:

These TReX units are directly controlled by the TReX master. The slave’s primary function is to report input changes and/or operate its outputs upon a master request.

There may be up to 10 slave units, all located in different locations around a site, all monitoring and controlling different aspects of the SCADA system.

To set the TReX as a slave set MENU->TELEMETRY->MODE to SCADA\_SLAVE.



### Working Example

As a simple working example shown below, web content is being served to a PC and mobile devices using the open source application “RapidSCADA”.

SCADA applications have the advantages to provide a means to notify through; email, paging messages, SMS or to generate alarms of critical system events.

The screenshot shows the Rapid SCADA web interface. At the top, there is a navigation bar with a menu icon, the text "Rapid SCADA", and user information "admin Logout". Below this is a date and time filter for "16 September 2018" with a time range from "00:00" to "07:00".

The main data table has the following structure:

Item	Current	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00
● TReX-0460 - ADC 1	0	---	---	---	---	---	---	---	---
● TReX-0460 - ADC 2	0	---	---	---	---	---	---	---	---
● TReX-0460 - TEMP DIG	34.6	---	---	---	---	---	---	---	---
● TReX-0460 - TEMP RF	30.0	---	---	---	---	---	---	---	---
● TReX-0460 - BATTV	12.1	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 1	Off	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 2	On	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 3	Off	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 4	Off	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 5	Off	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 6	Off	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 7	On	---	---	---	---	---	---	---	---
● TReX-0460 - Digital Out 8	Off	---	---	---	---	---	---	---	---
● TReX-0460 - Digital In 1	On	---	---	---	---	---	---	---	---
● TReX-0460 - Digital In 2	On	---	---	---	---	---	---	---	---
● TReX-0460 - Digital In 3	On	---	---	---	---	---	---	---	---

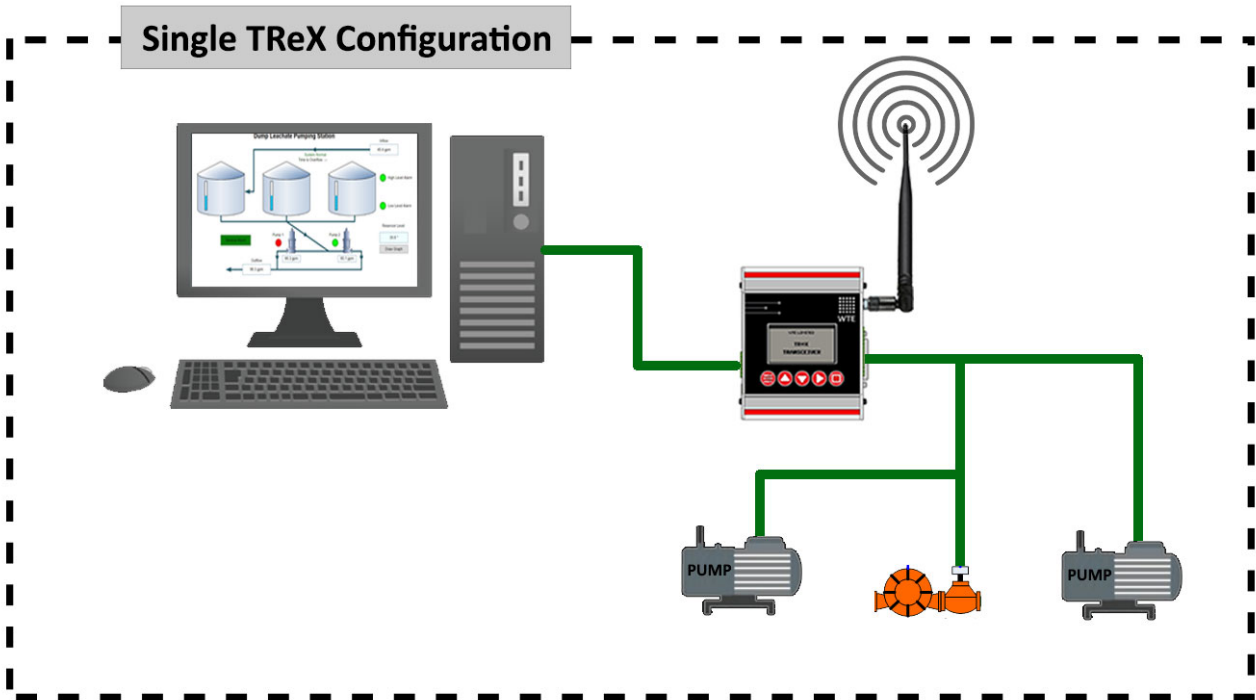
Below the data table is an "Events" section with a date filter for "16 September 2018" and tabs for "All Events" and "Events by View". The "Events by View" tab is active, showing a table of events:

Number	Date and Time	Object	Device	Channel	Description	Ack
35	16/09/2018 19:41:14		TReX-0460	TReX-0460 - Digital Out 2	Changed: On	No
36	16/09/2018 19:41:45		TReX-0460	TReX-0460 - Digital Out 7	Changed: On	No

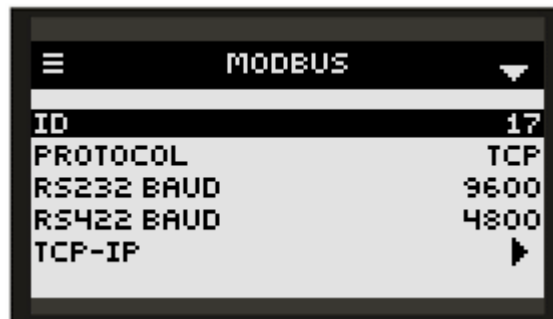
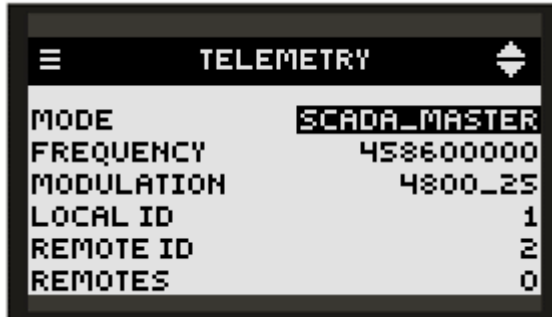
At the bottom of the events section, there is a label "Events" with a dropdown arrow.

## SCADA System Single TReX Configuration

This is a system that requires no expansion through use of SLAVE units.



## Unit Configuration



Since this system configuration is only for a single TReX unit, the LOCAL ID and REMOTE ID fields are not used and can be set to anything. The MODBUS ID can be any value from 0-127 (except 42 or 87).

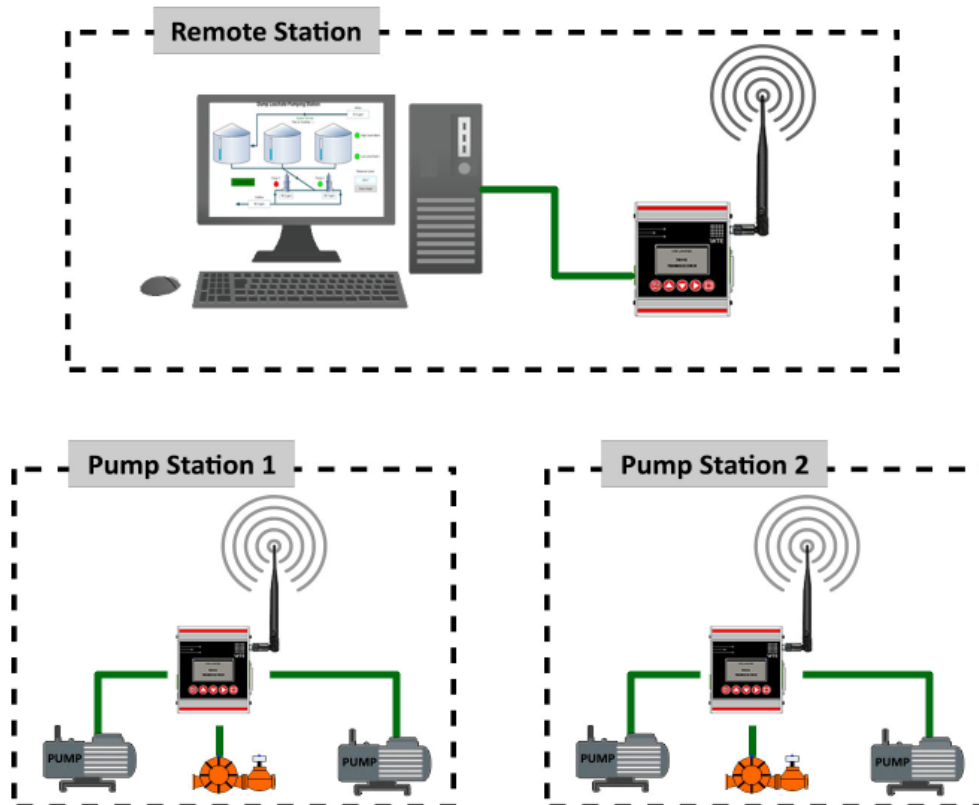
MENU->PROTOCOL->MODBUS is used to configure the key SCADA parameters, such as unit ID and the protocol. Typically, if an Ethernet connection is used, the TCP protocol will be used.

See **MODBUS Protocol** for more Modbus information.

## SCADA System Multiple TReX Configuration

Up to 10 wireless SLAVES can be controlled by a MASTER.

A SCADA application will be able to monitor and control all TReX IO on the MASTER and SLAVE TReX units.



### Simple Example

A remote station controlling two separate pump stations, where the “Remote Station” has a TReX units connected to a SCADA system and the “Pump Stations” may have several pumps and other I/O devices connected. Here the “Remote Station” is configured as MASTER and the “Pump Station” are configured as SLAVE units.

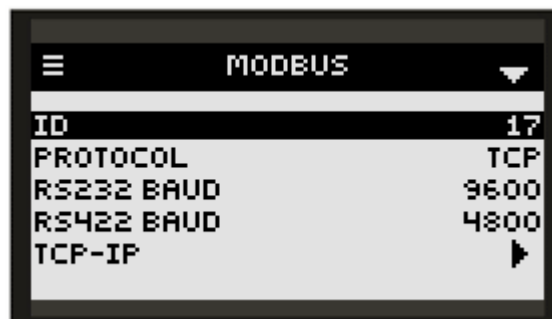
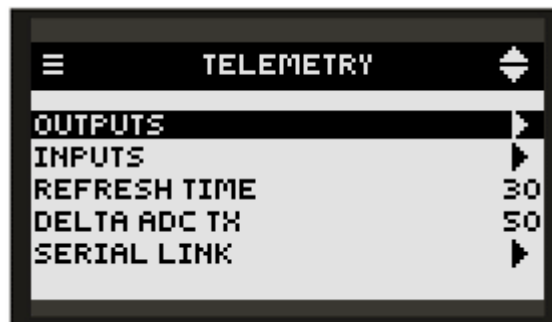
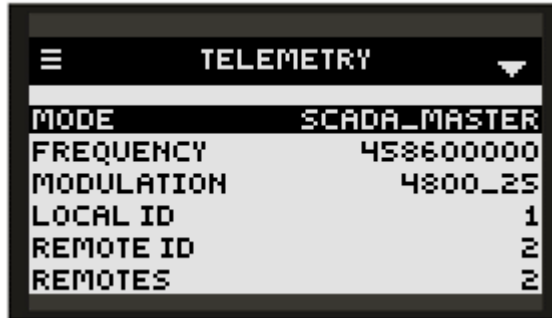
Example Configuration:

- “Remote Station” has a LOCAL ID configured to be 01.
- “Pump Station 1” SCADA\_SLAVE has a LOCAL ID of 02,
- “Pump Station 2” SCADA\_SLAVE has a LOCAL ID of 03,
- All Units have been configured to refresh I/O each 30 seconds (REFRESH TIME).

Note: Refreshing of SCADA status is immediate on any digital input change or any analogue input that changes by more than ADC counts configured in DELTA ADC TX.

## Units Configuration

### “Remote Station” Configuration



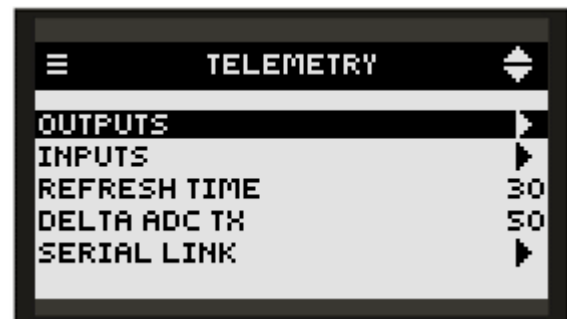
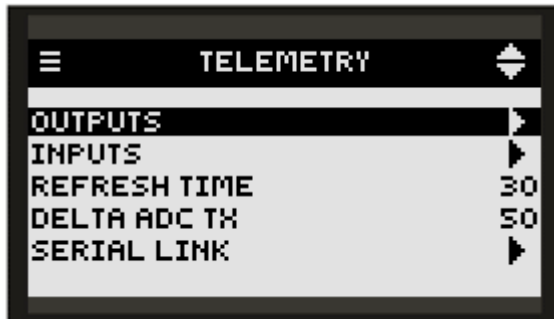
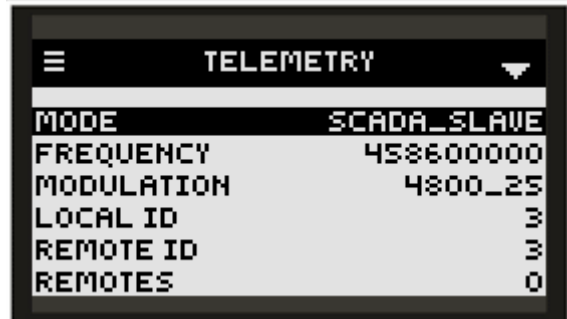
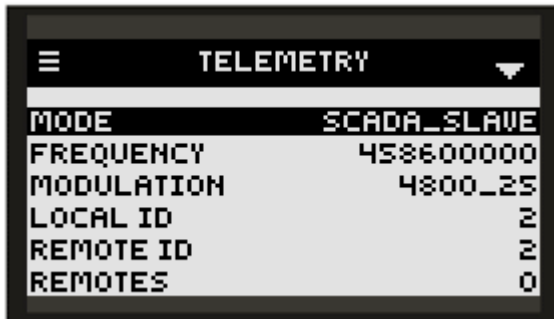
The LOCAL ID must be configured to a system unique value (default “01”). REMOTE ID must be configured to the ID of the **first** SLAVE LOCAL ID.

MODBUS ID can be any value from 0-127 (except 42 or 87).



“Pump Station 1” Configuration

“Pump Station 2” Configuration



The MASTER unit has configured REMOTES to a value of 2 (meaning there are 2 SLAVE units). Note that each SLAVE must start at the REMOTE ID configured on the MASTER, and each SLAVE in the system must be consecutively numbered.

The SLAVE configuration is unique in that both the LOCAL ID and REMOTE ID need to be the same. In this configuration, the MASTER unit requires these settings in order to identify the SLAVE unit messages.

The SCADA application will report inputs 1-8 to be from “Remote Station”, inputs 9-16 from “Pump Station 1” and inputs 17-24 from “Pump Station 2”.

See **Modbus Protocol** for more information.

### Viewing Multiple TReX Unit IO on the MASTER Unit.

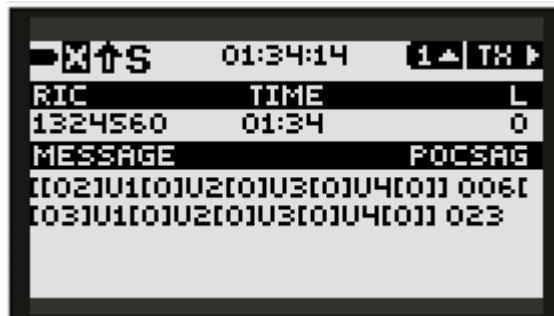
The MASTER on the IO screens can view all system inputs and outputs without the need for a SCADA application. This is useful for debugging and installation.



Shown in this case is the number “01”, followed by “069”, where “01” in this case is the UNIT ID in the system. The “069” is a “link fail” counter used to determine loss of communication for a unit. This number is reset whenever a new message is decoded from a SLAVE unit. Pressing the DOWN button will cycle through all the remote UNIT IDs in the system, displaying all system IO, link states, temperatures and battery voltages.

## SCADA Communication Between MASTER and SLAVE

All communication between the MASTER and SLAVE units can be viewed on the RX and TX screens.



These messages are of little application to the user, and documented here purely for clarity of function and debugging if required.

These messages are a variation of the **WTE Output Control Protocol**. There are however special codes used reserved for internal use only.

### Messages from MASTER to SLAVE:

Code	Description
U1	DAC 1 Control Value
U2	DAC 2 Control Value
U3	Digital Output Bitmap
U4	Special Slave Commands

### Messages from SLAVE to MASTER:

Code	Description
U1	DAC 1 Control Value
U2	DAC 2 Control Value
U3	Digital Output Bitmap
U4	Digital Input Bitmap
U5	ADC 1 Value
U6	ADC 2 Value
U7	Temperature * 10
U8	Battery V * 10

## IO Mirror Operation

The IO MIRROR is the simplest self managed telemetry mode that mirrors the inputs of one TReX unit to the outputs of another TReX unit.

SCADA monitoring and control is not possible in this mode of operation (see **SCADA Configuration and Operation**). This mode is intended for a simple system that allows remote outputs to be controlled and inputs monitored without any supervising equipment.

When TELEMETRY->MODE is set to IO MIRROR the small “T” icon is displayed in the title bar.



The IO MIRROR mode can map a single TReX unit to another TReX unit or to many selectively configured TReX units.

When enabled, the REMOTE ID device outputs are mirrored to the state of LOCAL ID device inputs. In order for a REMOTE ID device to have its outputs changed through the MIRROR MODE, the output must be configured to be TELEMETRY. It is possible to restrict outputs(s) that are updated by **DISABLING** outputs on the REMOTE ID device.

REMOTE ID devices are automatically controlled using the **WTE output control protocol**. When there is any input change, or an analog input changes by more than a configured threshold amount, there is an immediate transmission that updates a REMOTE ID device outputs.

A periodic refresh time can also be configured to ensure that outputs and inputs remain synchronised. On a REMOTE ID device inputs may optionally be tied to outputs to allow the actual remote output state to be displayed on the originating ID unit.

Mirrored INPUTS use the same TX DEBOUNCE and TX COUNT configuration items as normal message inputs. To prevent inputs from being mirrored, set the TX COUNT to 0. In some cases multiple transmissions may be desired. The default configuration is to transmit an input after being debounced for 200mS.



When IO MIRROR is enabled, configurable messages cannot be transmitted from inputs. If mirroring of some inputs and messages transmitted on other inputs is a requirement, this can be achieved by configuring some input message using the **WTE output control protocol**.

After selecting a frequency to transmit on, the default settings will in many cases be enough for the system to be ready to test before deployment.

NOTE: Make sure the REMOTE ID of one device matches the LOCAL ID of the other.



## Input Handling

---

**Note:** Please refer to **Input Output Hardware Connection** section on this manual for examples of how to connect the input and output pins on the TReX board.

The TReX supports 8 programmable inputs. Each input can be programmed with a short message up to 50 characters in length. **Input messages must always be formatted as WT Protocol.**

On start-up each input is read. By default only inputs that change from the start-up input state are processed. The expected initial state of each input can be configured, so that on start the input is not in its expected state there can be an immediate transmission.

Commands relating to input handling (if preferred, all input options can be configured through the menu system):

\***IN\_INIT** specifies the expected level on start.

\***IN\_CONFIG\_H** specifies all input transition to high level configuration parameters.

\***IN\_CONFIG\_L** specifies all input transition to low level configuration parameters.

\***IN\_MSG\_H** specifies the high level message that will be transmitted if configured.

\***IN\_MSG\_L** specifies the low level message that will be transmitted if configured.

The \***IN\_CONFIG\_H** and \***IN\_CONFIG\_L** commands allow the input to specify:

- How many messages are transmitted once triggered.
- The debounce period (how long the input must be in a new state continuously in order to transmit) before the input is triggered.
- How long to wait until the message is retransmitted.

The \***IN\_MSG\_H** and \***IN\_MSG\_L** commands allow the input to specify the message which will be transmitted when the input is triggered.

### Full example:

In this example both inputs are configured to transmit only when moving from high to low (no high level transmissions). Transmit 5 times, 10 seconds between each transmission. Debounce period is to be configured to 2 seconds (input must have transitioned from a stable low level to constant high level for two whole seconds).

The protocol being used is WT protocol, and the message for each input message is “IN 1 LOW” and “IN 2 LOW”. Message is to be transmitted as POCSAG alphanumeric to cap code 1234560, beep level 1 and 512 baud.

Both Input 1 and 2 configured to disable all high level processing.

```
*IN_CONFIG_H=1:0,0,0<CR>
```



```
*IN_CONFIG_H=2:0,0,0<CR>
```

Both input 1 and 2 are configured as per the full example details above.

```
*IN_CONFIG_L=1:5,20,10<CR>
```

```
*IN_CONFIG_L=2:5,20,10<CR>
```

Configured messages to be transmitted once triggered.

```
*IN_MSG_L=1:WT1234560A10 IN 1 LOW<CR>
```

```
*IN_MSG_L=2:WT1234560A10 IN 2 LOW<CR>
```

High level messages can be set to anything since they are configured not to be used

```
*IN_MSG_H=1:<CR>
```

```
*IN_MSG_H=2:<CR>
```

For more details on command usage please refer to the Configuration section if required.



## Output Handling

---

**Note:** Please refer to **Input Output Hardware Connection** section on this manual for examples of how to connect inputs and outputs to the TReX.

The TReX supports up to 8 outputs. These outputs can be shared with special output functions such as the LINK FAIL output.

Outputs are configured using the commands:

\*OUT\_CONFIG

\*OUT\_ID

The outputs are controlled through messages received that conform to the **WTE output control protocol**.





## WTE Output Control Protocol

---

### **Introduction**

This section describes how to control the outputs of WTE Products via transmission payloads. The WTE protocol needs to be able to switch many outputs on, and many off in a single message. Receivers need to be able to be uniquely addressed, and in a manner that is maintainable.

It may be likely that the payload is transmitted as part of a paging payload, such as POCSAG or FLEX, but ultimately the transport method is irrelevant as long as it is capable of transmitting the characters used by the protocol.

Once an output has been activated, it will remain in its activated state for its configured period. This may be many seconds, or permanently latched.

The control message can be placed in any position in the message payload, and there can be multiple control messages in the same payload.

### **Digital Output Format**

The payload of a message must fit the following format in order to operate the unit outputs. Note that this description is extended below to describe how this format is extended to also allow control of analog outputs.

[[ID]EEEE-DDDD]

Where:

[ is the character '['

] is the character ']'

**ID** is the OUT\_ID that has been programmed (e.g "01" or "Unit\_A").

**E** is the output to enable (1-8 for the TReX). Up to 2 outputs can be specified.

- is the hyphen character '-' All digits following the '-' are outputs that are disabled

**D** is the output to disable

### **Examples:**

Consider an TReX configured with OUT\_ID of "Unit\_A" and both pins configured as outputs:

*\*OUT\_ID=Unit\_A<CR>*



*\*OUT\_CONFIG=1:1,0<CR>*

*\*OUT\_CONFIG=2:1,0<CR>*

**Scenario 1:** To turn output 1 ON and turn OFF output 2;

Message payload:

[[Unit\_A]1-2]

**Scenario 2:** To turn output 2 ON and turn OFF output 1;

Message payload:

[[Unit\_A]2-1]

**Scenario 3:** To turn output 1 and 2 ON;

Message payload:

[[Unit\_A]12-]

**Scenario 4:** To turn output 1 and 2 OFF;

Message payload:

[[Unit\_A]-12]

Consider that we have several TReX Units and each one is configured with a different OUT\_ID; “Unit\_A”, “Unit\_B” and “Unit\_C”

**Scenario 5:** To turn output 1 and 2 ON in the Unit\_A:

Message payload:

[[Unit\_A]12-]

**Scenario 6:** We want:

to turn output 1 and 2 ON in the Unit\_A,

to turn output 1 ON and turn OFF output 2 on the Unit\_B,

turn OFF output1 and 2 on the Unit\_C;

Message payload:

[[Unit\_A]12-] [[Unit\_B]1-2] [[Unit\_C]-12]

## **Analog & Digital Output Format**

The WTE output control protocol allows the direct control of analog outputs.



[[ID]UZ[AA]CCC-OOOO]

Where:

[ is the character '['

] is the character ']'

ID is the UNIT\_ID that must match the TReX to be controlled..

U is the character 'U' and is used to mark that an analog or special output follows

Z is the analog output (1-2). 3 is used to write a digital output bitmap.

C is output to close (1-8). Up to 8 outputs can be specified.

- is the character '-'

O is the output to open

AA is the value to set an analog output to (0-1023). When a digital output bitmap value is used this value can be a value from 0-255. When an analog output is set to higher than 1023, the value 1023 is used.

When square brackets are after an analog output specifier ('U'), then the value specified is the DAC value to set. Note that both a digital output and analog output can have the same output number.

**When analog outputs are controlled they must always be before any digital outputs.**

Example 1:

Unit configured to have WTE\_ID of "UNIT-1". Digital outputs 2 and 4 are to be set, and output 1 cleared. Analog Output 2 is to have the DAC set a value of 927

Message payload:

[[UNIT-1]U2[927]24-1]

Example 2:

Unit configured to have WTE\_ID of 01. Analog Output 1 is to have the DAC set a value of 18, analog output 2 is to have a DAC value of 145.

Message payload:

[[01]U1[18]U2[145]]

**Notes:**

- The unit will only process the Output Control Protocol for the unit configured in the OUT\_ID and will ignore the other Output Control Protocol contained in the message
- Additional security to prevent false activation can be achieved through CAP restriction via the RX\_RANGE and/or a more complex OUT\_ID.



## WTE Ack and Confirm Protocol

---

### Introduction

This section describes how to use this protocol to invoke automatic acknowledging and optionally manual confirmation of messages sent/received. This protocol can also be used to message TReX units to display confirmation prompts. The use of this protocol is the heart of making two-way paging or messaging possible.

Monitoring equipment can make decisions based on acknowledge responses whether to retransmit or notify a communications link issue. Acknowledgements can be either transmitted or sent through a TCP/IP connection.

A typical application for a confirmation request would be an emergency communications room messaging several ambulances with TReX units fitted. The message would provide an on-screen prompt requesting attendance to an event. Any ambulance can then accept the message, and details of the attending vehicle would then be sent to the communications room.

The **WTE Ack and Confirm Protocol** can be embedded into the payload of any message.

Typically the protocol message would be attached to the end of a message, so that paging messages would display normally for typical users.

*Note: In order for a TReX unit to acknowledge any message, the receiving TReX RIC codes used must fall within allowed normal RX receive ranges.*

### Protocol Usage

-[TTT-A-XXX]

where:

- is the character '-' (marks the start of the ticket ID and ACK Mode)

[ is the character '['

TTT is a 3 digit ticket id

A is the ACK Mode

1 = acknowledge required

2 = acknowledge and confirmation required

3 = confirmation without acknowledgement (when sent to many stations.)

- is the character '-' marking the start of the optional confirmation title.

XXX is the optional confirm title (e.g. "Accept?"). Not specifying this field results in default of "CONFIRM". This field is only meaningful when ACK mode is 2 or 3. Max length is 14



characters.

] is the character ']'

Responses are all transmitted using the default settings for modulation type and protocol. The payload is also sent directly out the serial port and TCP sockets for when acknowledgement is required via IP.

### Typical Operation

The base-station TReX sends single messages, or many batched together as required. The transmitter can send an auto incremented ticket ID, or the ticket ID can be manually selected as part of the Acknowledge and Confirm Protocol.

Using WT Protocol allows the use of the **Variable Content Macro \*\*01** to be used to transmit with an automatically incrementing ticket ID.

Receiving TReX units can acknowledge multiple messages if messages have been received in a batch.

e.g. The remote TReX unit receives 3 messages all to be acknowledged (ticket IDs 345, 346 and 347). The following is transmitted.

*ACK[345,346,347]*

Upon reception of any message requiring confirmation, the TReX shifts from any screen currently on, and does not allow leaving of the confirmation message screen until the message has either been accepted or rejected. Any messages received while waiting for confirmation will be logged and can be inspected at a later time.

### Example 1:

Message payload to have delivery acknowledged is transmitted.

Message Payload:

*Bob, go to Pukeko Place urgently.-[345-1]<CR>*

Remote TReX responds with:

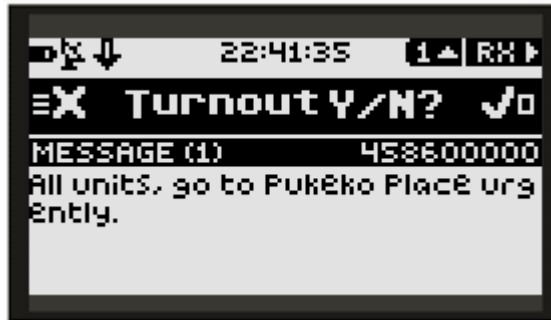
*ACK[345]*

**Example 2:**

Message payload to have delivery acknowledged and confirmed is transmitted.

*All units, go to Pukeko Place urgently.-[347-2-Turnout Y/N?]<CR>*

The remote TReX unit immediately displays:



Remote TReX immediately responds with:

*ACK[347]*

If message has been accepted (by pressing the square “ENTER/ACCEPT” button) remote TReX responds with:

*ACC[347-Unit 41]*

*Note that the “Unit 41” in the confirmation response is the TReX programmed unit ID.*

**Example 3:**

Message is transmitted from base station using **WT Protocol** together with the **Acknowledge and Confirm Protocol** added to the end to the message.

*WT1234567A10 HEART ATTACK, 45 YO MALE, 12 PUKEKO PL.-[\*\*01-3-ATTEND?]<CR>*

*Note: The **WT Protocol** must be used to automatically expand the \*\*01 macro to an automatically incremented ticket id.*

The remote TReX unit immediately displays:



In this case, the received message has not requested delivery confirmation, only confirmation



of acceptance.

Should the user ACCEPT the message to attend, the remote TReX transmits to the base-station the message:

*ACC[666-Unit A]*

where:

666 is the ticket id.

- is the character '-'

“Unit A” is the unit ID programmed through SYSTEM->ID



## Store Forward Operation

---

The TReX can operate as a stand-alone repeater to forward paging messages and also extend wireless serial operation.

Transmit and receive configuration should be configured to be the same when forwarding messages. \*RX\_PROTO should equal the \*TX\_PROTO and \*RX\_MODE should equal \*TX\_MODE.

Typically the TReX would be configured as follows:

Delay of 2 second before forwarding, reject duplicate messages for 10 seconds.

```
*STORE_FWD=20,10<CR>
```

Ensure all store forward units have RX\_RANGES set to allow all possible CAP codes that are of interest to forward.

The duplicate reject feature is essential to use when the TReX is been used in a multi-hop store forward system. If this is set to 0, rejection of duplicated messages are not possible, and messages may bounce back and forward between repeaters.

The duplicate reject period, if used, ALWAYS must be of a longer duration than the store forward delay for reliable operation.

Multiple repeaters can be used, but increase message delivery time. Use of more than a single repeater in a system is generally less than ideal and typically more powerful transmitters should be used if multiple store forward repeaters are required.

See the Configuration section on this document for more details on command usage if required.





## Installation

---

The TReX should be situated away from direct sunlight, extreme vibration and heat sources, and high power transmission sources.

An external antenna correctly designed to operate at your intended frequency of operation will result in best performance. Dual VHF/UHF antennas may operate acceptably for your requirements. Do not situate the antenna immediately next to the antenna of a high power transmission source – position greater than 2 M from any other antenna. Mount the external antenna with as much elevation as possible for best results (see “Antenna Elevation” below).

Maximum tolerated input power into the RF connector is 17 dBm. Levels above this will destroy the receiver RF input and invalidate the unit warranty.

## *Cables Supplied*

---

By default NO cables are supplied on purchase. Because there are so many possible frequencies and variations in installation an antenna is NOT supplied by default. If an antenna is supplied, it will be a generic variety that will not perform as well as an antenna produced for the intended frequency of operation, or a high gain externally mounted type.

If cables are to be supplied, this must be ordered at time of purchase.



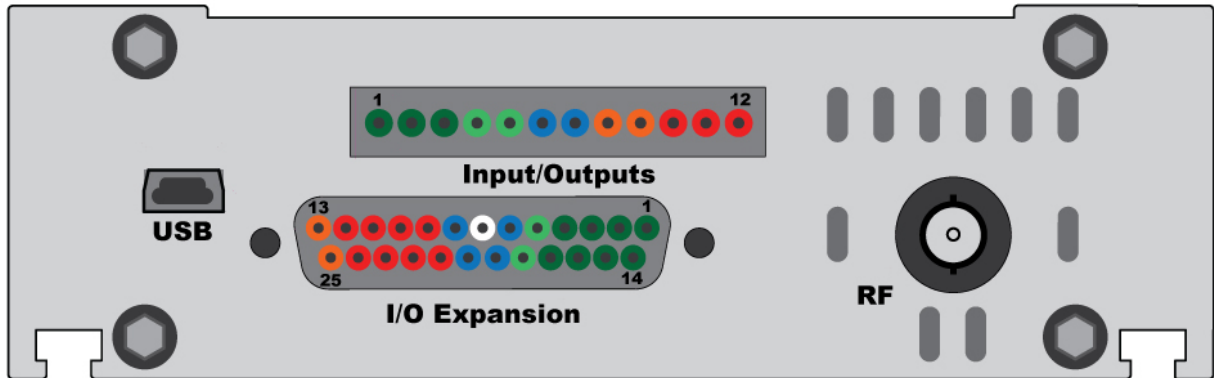
## ***Connecting to the TReX***

---

The minimum required connections for a usable system:

1. Connection to a 50 ohm antenna constructed for the frequency of interest. Mismatched antennas may result in increased current draw and reduced power output.
2. 13.8V, 3A supply connected to the power terminals

## Connector Pin descriptions



### RHS (Right Panel)

#### RF

BNC connector (50 ohms)

#### USB

Mini type B connector

#### Input/Output Connector:

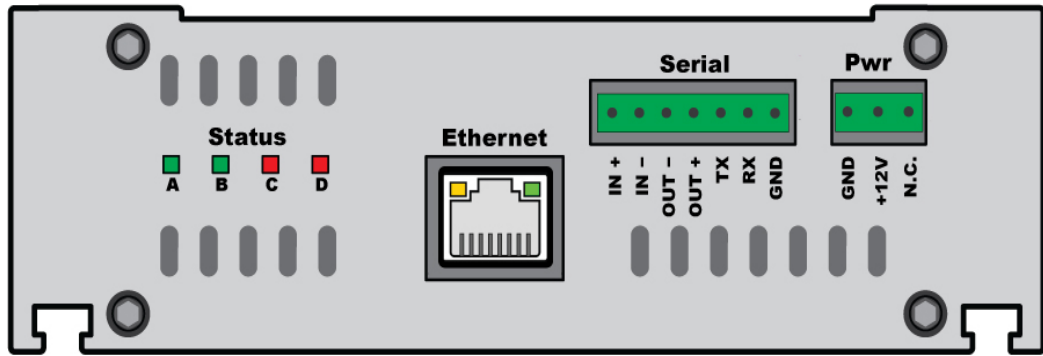
Inputs/Outputs Pin Number	Description
1	Input – Digital 1
2	Input – Digital 2
3	Input – Digital 3
4	Input – Analog 1
5	Input – Analog 2
6	GND
7	GND
8	Output – Analog 1
9	Output – Analog 2
10	Output – Digital 1
11	Output – Digital 2
12	Output – Digital 3



**I/O Expansion Connector:**

<b>I/O Expansion (DB25) Pin Number</b>	<b>Description</b>
<b>1</b>	<b>Input – Digital 1</b>
<b>2</b>	<b>Input – Digital 3</b>
<b>3</b>	<b>Input – Digital 5</b>
<b>4</b>	<b>Input – Digital 7</b>
<b>5</b>	<b>Input – Analog 1</b>
<b>6</b>	<b>GND</b>
<b>7</b>	<b>Reserved - Do NOT Connect</b>
<b>8</b>	<b>GND</b>
<b>9</b>	<b>Output – Digital 1</b>
<b>10</b>	<b>Output – Digital 3</b>
<b>11</b>	<b>Output – Digital 5</b>
<b>12</b>	<b>Output – Digital 7</b>
<b>13</b>	<b>Output – Analog 1</b>
<b>14</b>	<b>Input – Digital 2</b>
<b>15</b>	<b>Input – Digital 4</b>
<b>16</b>	<b>Input – Digital 6</b>
<b>17</b>	<b>Input – Digital 8</b>
<b>18</b>	<b>Input – Analog 2</b>
<b>19</b>	<b>GND</b>
<b>20</b>	<b>GND</b>
<b>21</b>	<b>Output – Digital 2</b>
<b>22</b>	<b>Output – Digital 4</b>
<b>23</b>	<b>Output – Digital 6</b>
<b>24</b>	<b>Output – Digital 8</b>
<b>25</b>	<b>Output – Analog 2</b>

### LHS (Left Panel)



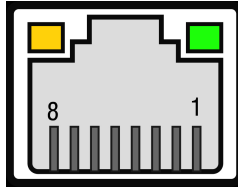
#### Serial Connector:

Serial Connector Pin Number	Description
1	RS422 RX+ (IN+)
2	RS422 RX- (IN-)
3	RS422 TX- (OUT-)
4	RS422 TX+ (OUT+)
5	RS232 TX
6	RS232 RX
7	Ground (GND)

#### Power Connector:

Power Connector Pin Number	Description
1	Ground (GND)
2	+13.8V
3	Not Connected (N.C.)

**Ethernet Connector:**



Connector Pin Number	Description
1	TX+
2	TX-
3	RX+
4	NC
5	NC
6	RX-
7	NC
8	NC

**Note:** pins: 4 and 5 are connected to ground via a 75R resistor  
 7 and 8 are connected to ground via a 75R resistor

**Do not connect a Power over Ethernet (PoE) connection to the TReX Ethernet port as this will result in damage.**

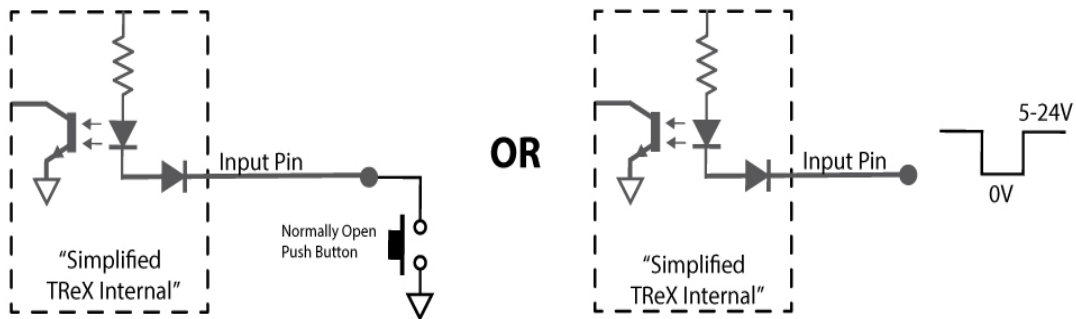
## Input Output Hardware Connection

---

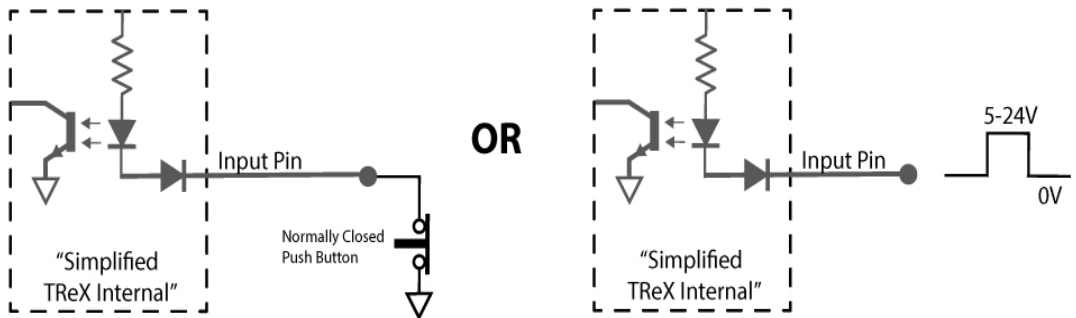
Examples of how to connect external devices to the TReX input/output pins.

### Inputs

#### Input Low Trig

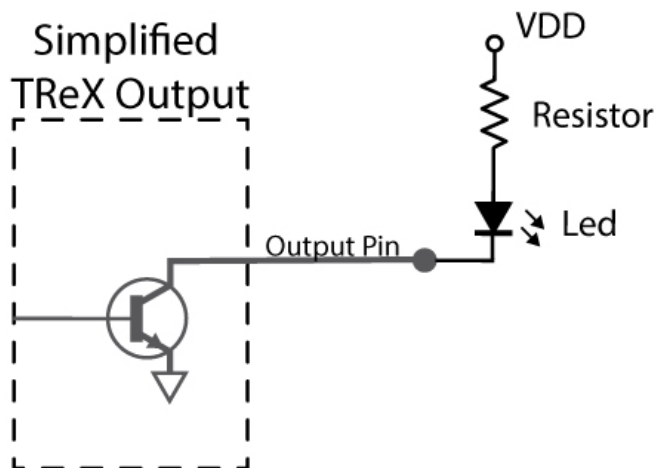
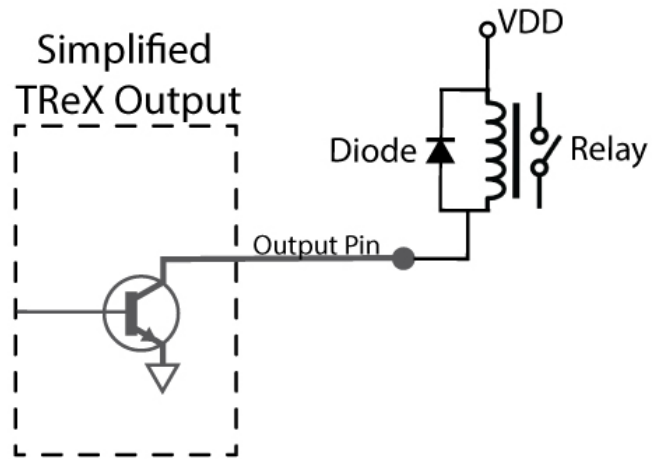


#### Input High Trig



## Outputs

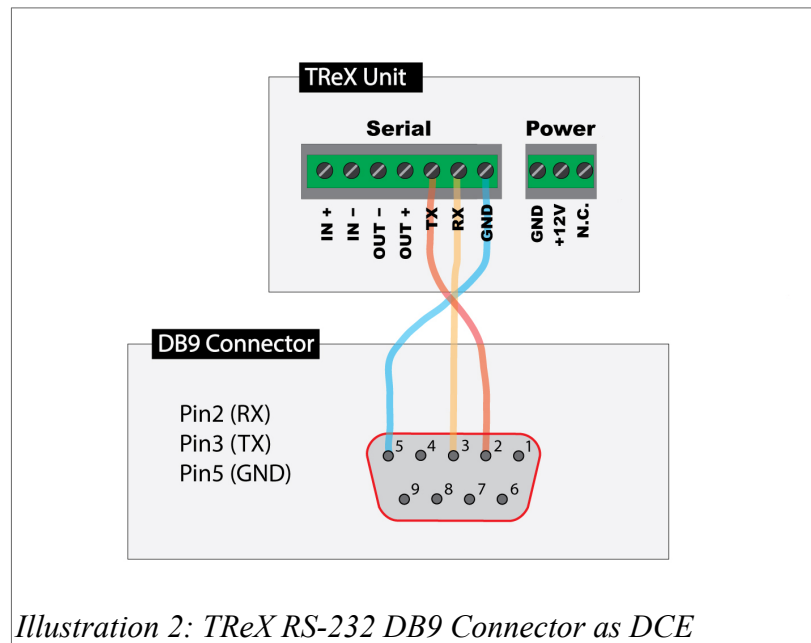
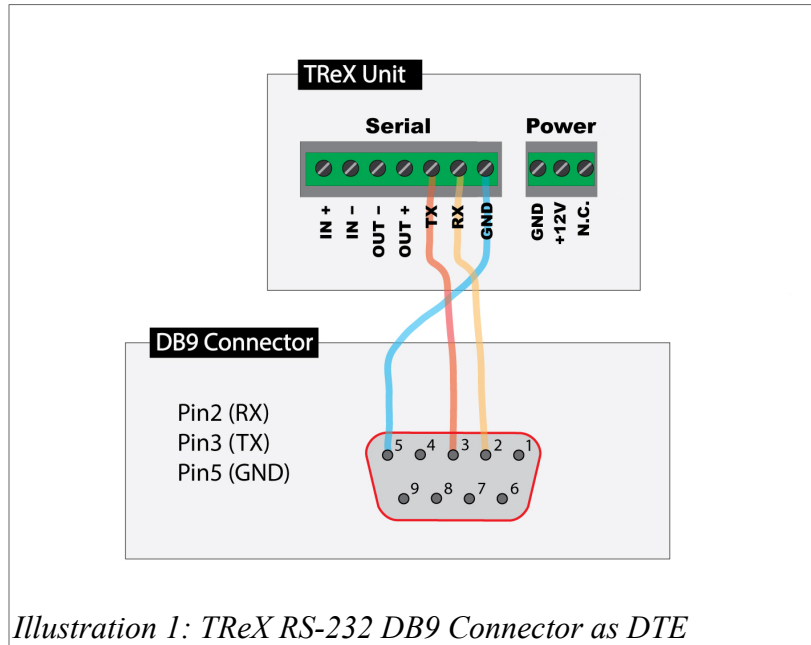
Care must be taken to ensure the sinking output current does not exceed 100mA. When using inductive loads, such as relay coils, flyback diodes must be fitted to prevent damage to the TReX. VDD is voltage source externally provided between 5 and 24VDC depending on the control application.





## Serial Connections

### RS-232





## **RS-422/RS-485**

RS-422 and RS-485 use a differential electrical signal, as opposed to unbalanced signals referenced to ground as used by RS-232. Differential transmission uses two lines each for transmit and receive signals which results in greater noise immunity and longer distances between devices. These advantages make RS-422/RS-485 a better fit for industrial applications.

RS-422 is point to point interface that allows for up to 10 receivers but only a single transmitter. This would be a common serial interface for NMEA devices all sharing GPS data from a single GPS receiver for example.

RS-485 is a multipoint interface that allows each device to be a transmitter and also a receiver. This interface also allows for more devices to be connected on a common serial bus. Because each device on the same bus can transmit, each device must be capable of setting all transmit lines to a high impedance state when not in use to ensure that all devices have the ability to transmit. RS-485 interfaces can be presented as 4 or 2 wires. When there are 2 wires required, the RS-485 device must also be able to isolate its own receiver when transmitting to prevent looping data back to itself.

The TReX satisfies the requirements for both 4 and 2 wire RS-485 communications. The TReX will also be able to operate on a RS-422 bus.

### Point To Point Connection

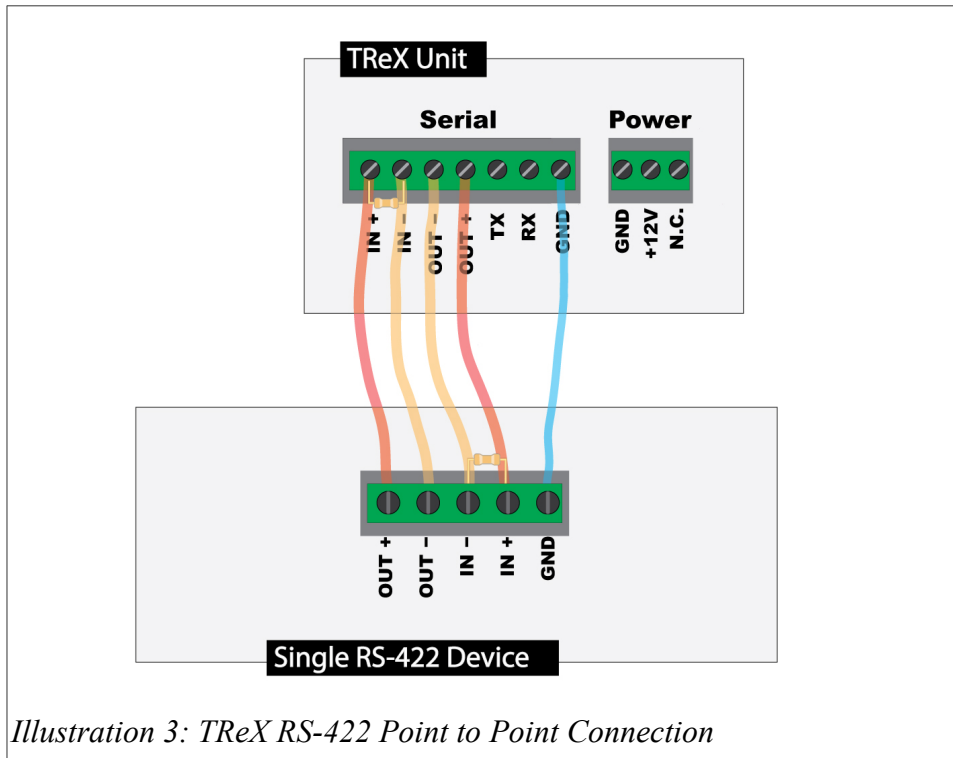


Illustration 3: TReX RS-422 Point to Point Connection

### Multi-Point Connection

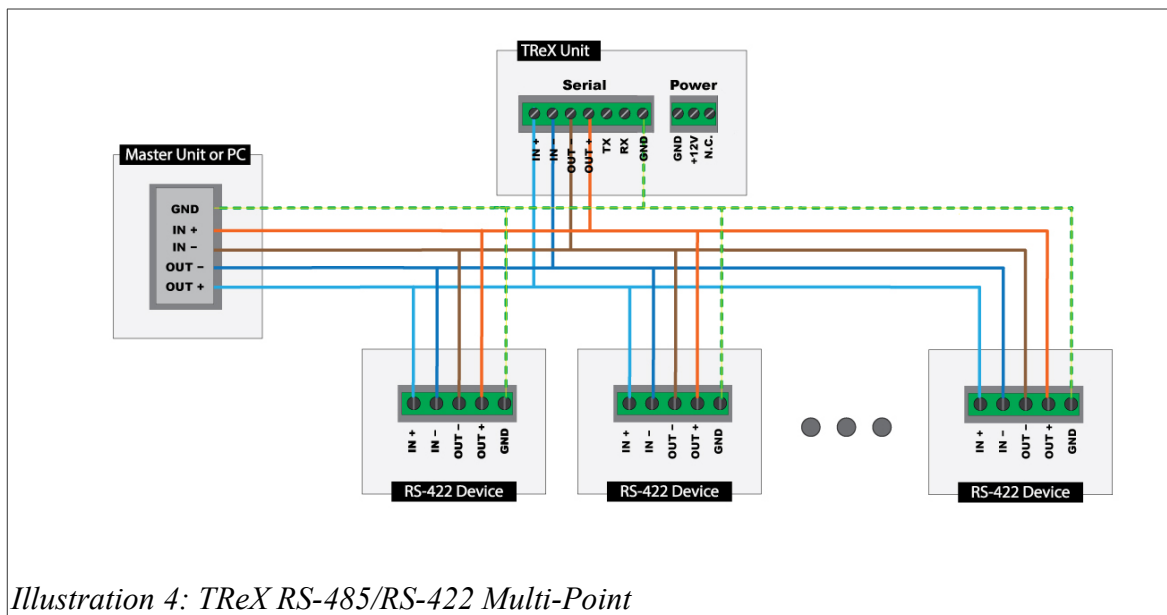


Illustration 4: TReX RS-485/RS-422 Multi-Point

**Note:** this configuration only applies if driving less than 10 listeners/receivers when using RS-422 devices or less than 32 devices for RS-485 devices.

## 2 Wire Connection

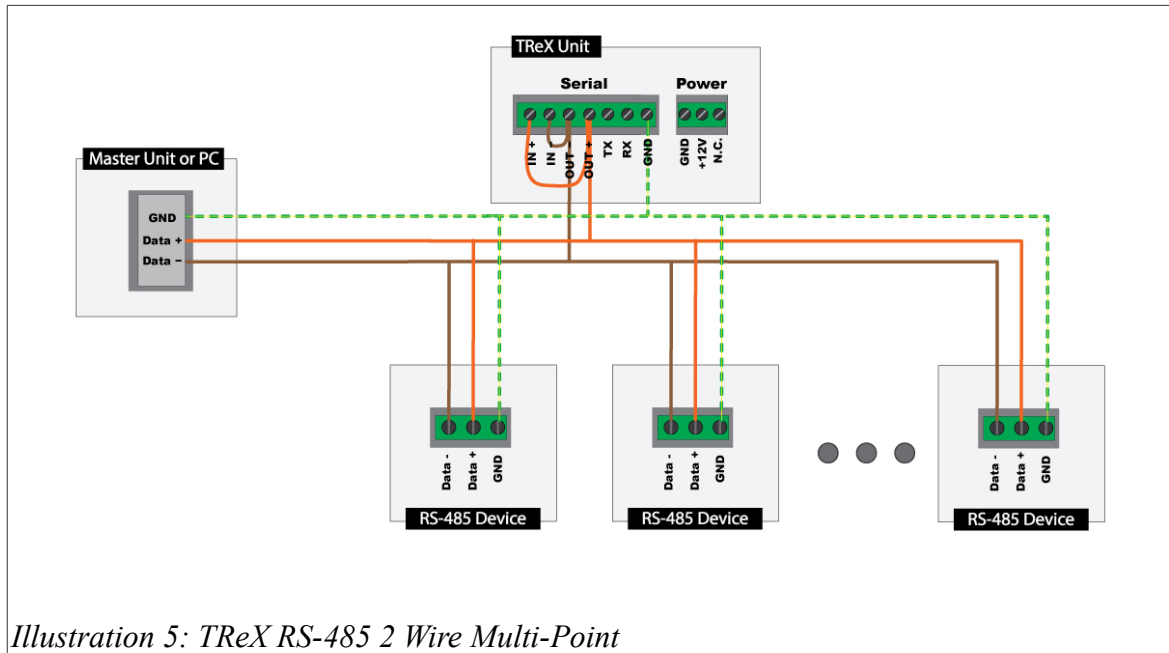


Illustration 5: TReX RS-485 2 Wire Multi-Point

*Note: the TReX must have wire links fitted as shown in order to operate correctly in this configuration.*

### Bus Terminating Resistor

RS422/RS485 may require the fitting of a terminating resistor. The purpose of termination is to match the impedance of a transmission line to the hardware impedance of the interface it is connected to. There is more than one way to add termination to an RS485/422 serial connection. The most commonly used is DC Termination, accomplished by attaching a resistor between the signal lines on the extreme ends of the transmission line.

The rule of thumb for termination is:

- If the propagation delay of the data line is much less than one bit (pulse) width, termination is not needed.

This assumes reflections will damp out in several trips back and forth on the data line.

Typically for slow speeds of 9600bps or below, no termination resistor is required.

If termination is required a resistor value of 120Ω or greater should be used, and no more than 2 termination resistors should be used, one at each end of the RS422 transmission line.

Do not use termination resistors with a value of less than 90Ω.



There are many online references available to calculate these resistors if required.



## RF Connections

---

A 50 ohm matched load must be fitted to the TReX antenna port.

Note: Earth the antenna tower, feeders and lightning protection devices in accordance with the appropriate local and national standards. Use grounding kits as specified or supplied by the coaxial cable manufacturer to properly ground or bond the cable outer.

### **!CAUTION**

When the TReX is operating, there is RF energy radiated from the antenna.

Do not stand in front of the antenna while the radio is operating (see the 'RF Exposure Warning')

### **!CAUTION**

Lightning will destroy electronic equipment.

To avoid this risk, install primary lightning protection devices on any interfaces that are reticulated in the local cable network.

You should also install a coaxial surge suppressor on the radio antenna port.



## Power Connections

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Power to the TReX is achieved via the power connector as described in the section [16.3.Connecting to the TReX](#)

### **!WARNING**

#### **EXPLOSION HAZARD**

TReX was **NOT** designed to operate and/or be connected to voltages above what has been specified.

**Failure to follow these instructions can result in death or serious injury**



## Ethernet Interface

---

The TReX supports a 10/100 Base-T Ethernet connection.

To simplify network setup, the TReX supports auto-negotiation and auto-sensing MDI/MDIX crossover.

General	Interface	RJ45
	Cabling	CAT-5/6 UTP, supports auto MDIX (Standard Ethernet)
	Bandwidth allocation	The Ethernet capacity maximum is determined by the available radio link capacity.
	Ethernet mode	10Base-T or 100Base-TX Full duplex or half duplex (Auto-negotiating and auto-sensing)
Diagnostics	Green LED	Off: No data present on the interface. On: Data present on the interface.
	Orange LED	Off: no Ethernet connection On: Ethernet signal received



## TReX Firmware Upgrade

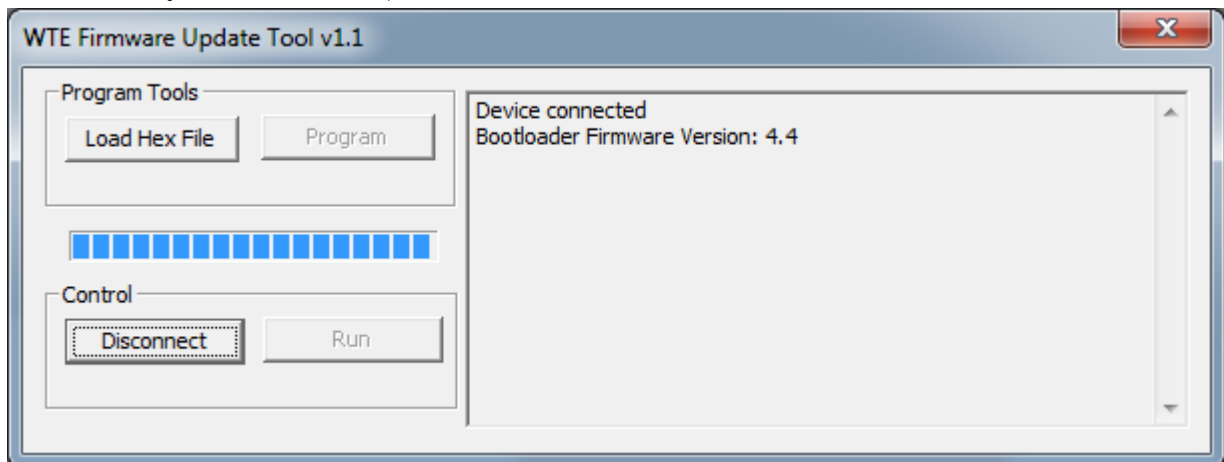
In order to update the TReX primary firmware you will need:

1. The WTE Firmware Update Tool (available from <http://www.wte.co.nz> or provided if required from [info@wte.co.nz](mailto:info@wte.co.nz)).
2. One USB mini B cable.
3. An appropriate encrypted hex file supplied by WTE Limited.

*Note: Attempting to load a hex file not intended for use with the TReX will render the TReX inoperable. Uploading firmware should only be performed if instructed to do so by WTE Limited or an authorised agent.*

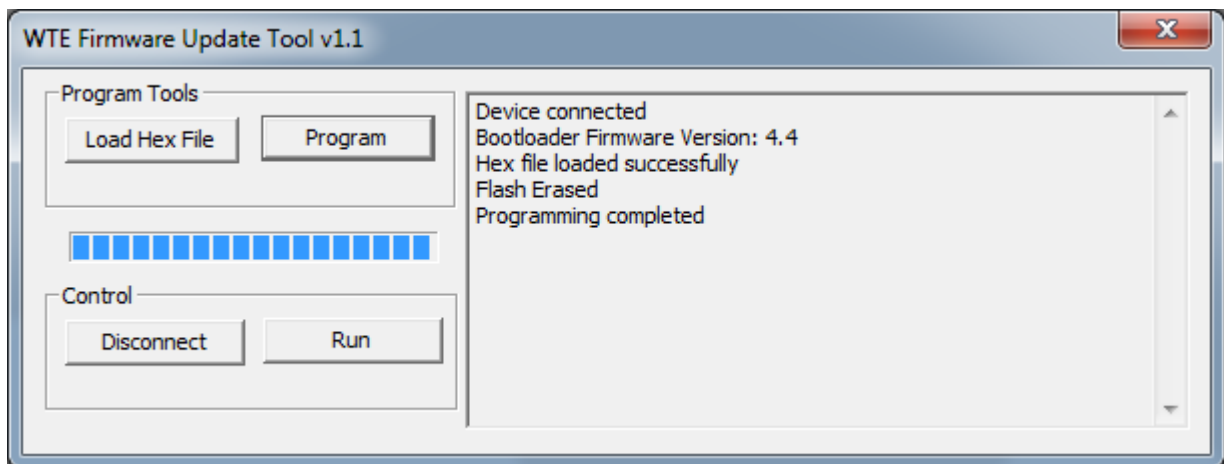
### Firmware Upgrade Utility

This bootloader software has been customised by WTE to simplify the firmware replacement process for the TReX. This application automatically handles erasing and verifying of uploaded firmware. This utility does not perform any decryption function (decryption is carried out by the TReX itself).



## Upgrade Process

1. Run the application WTE-UBL.exe – this is the WTE Firmware Update Tool as shown above.
2. **BEFORE** applying power to the TReX, press the “UP” button, and **HOLD** the button down.
3. Apply power to the TReX.
4. The TReX backlight will flash on and off (approximately once every second) – **keep the “UP” button pressed**. You now have 10 seconds to press the PC application “Connect” button on the WTE Firmware Update Tool before the TReX exits the bootloader mode of operation.
5. Press the WTE Firmware Update Tool “Connect” button. If connected, the PC application will display the message saying “Device Connected”. The TReX backlight will now stay constantly on.
6. You can now **RELEASE** the TReX “UP” button.
7. On the PC application press the “Load Hex File” button.
8. Select the supplied TReX hex file. NOTE: the firmware used must **MATCH** the TReX receiver variant. A TReX can only be used with TReX encrypted firmware. Failure to comply will leave the device inoperable.
9. Press the WTE Firmware Update Tool “Program” button.
10. Wait for the WTE Firmware Update Tool to indicate that programming has been completed.



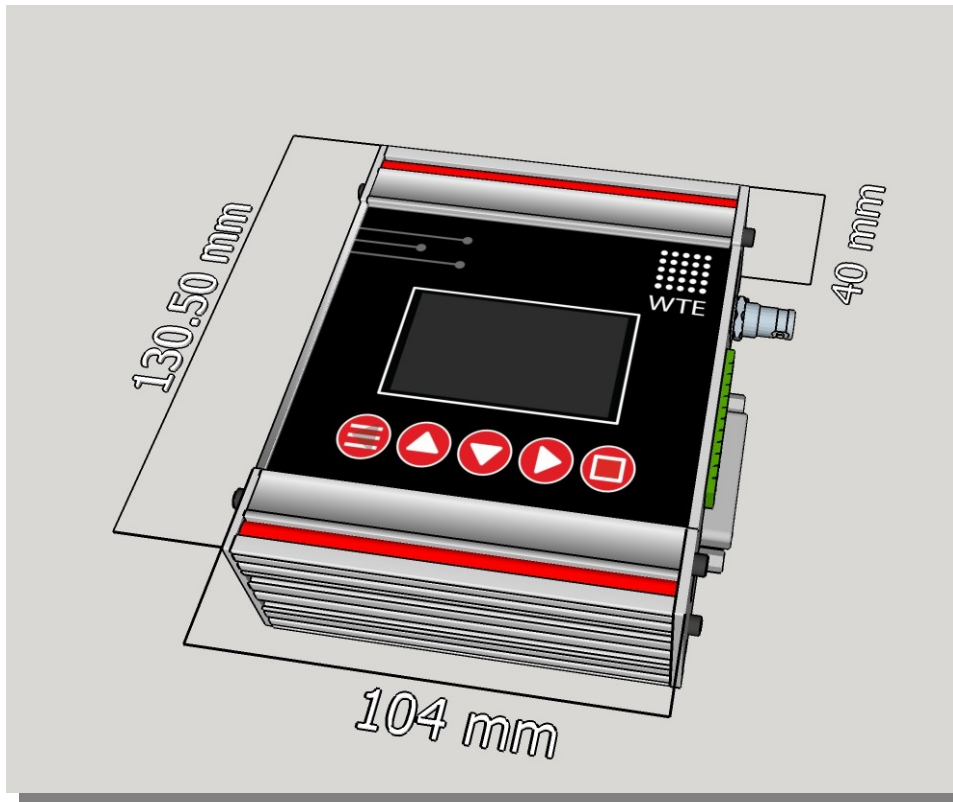
11. When programming is complete press the “Run” Button, or remove power to the TReX and apply power again.
12. If successful the TReX will start normally when power is applied. If the TReX does not correctly start, then repeat the procedure.

## Physical Dimensions

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TReX physical dimensions are 104mm x 130.5mm x 40mm (Length x Width x Height)

Weight: 550 grams



## Mounting Hardware

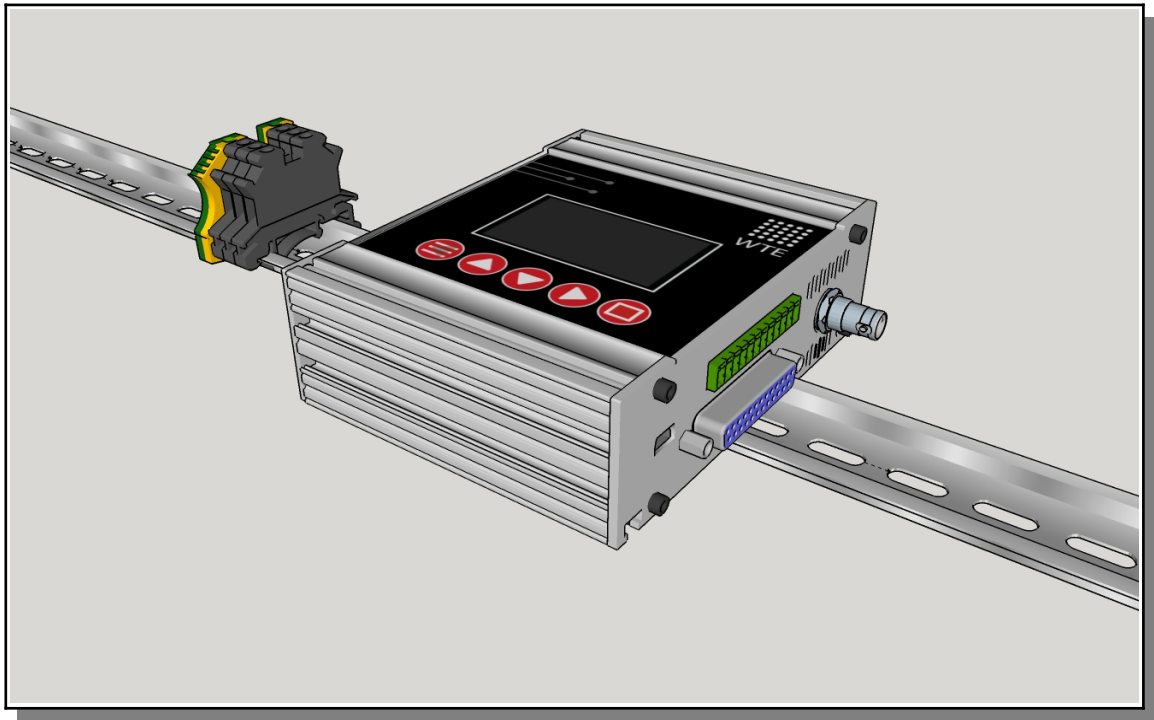
---

The TReX enclosure was designed to be mounted via:

- DIN Rails
- Left or Right M4 nuts and bolts channels
- Top or Bottom M4 nuts and bolts channels
- Supplied nut slot inserts.

Please look the following images and descriptions to correctly mount the TReX radio

### *DIN Rail*



Inbuilt into the TReX custom extrusion there is a DIN rail slot (patent pending) for easy snap fit DIN rail mounting. After location on the DIN rail, 2.5mm locking pins may optionally be fitted from each end plate if desired (a 2.5mm split pin is a perfect fit).

## Mounting Channels

The TReX has channel strips on the front, rear, top and bottom. In order to access the front, top and bottom channels (less common mounting option) the end plate on the power cable side will need first to be removed using a hex key. Mounting from the rear does not require the removal of the end plate.

The mounting channel allows an M4 bolt head or M4 nut to lock inside.

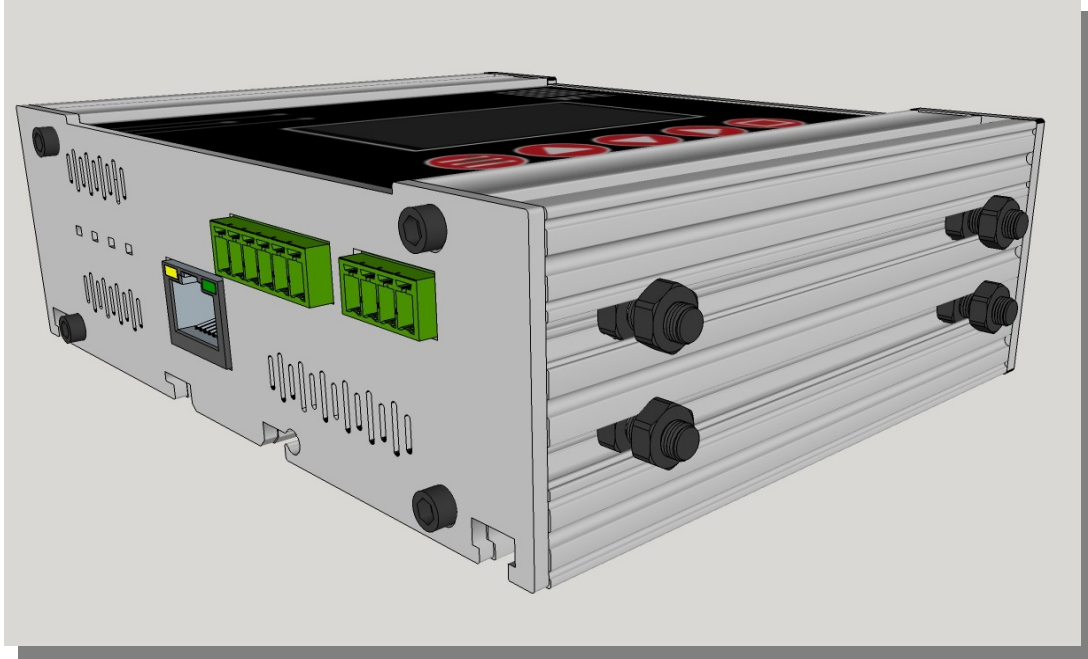
**If an M4 nut is used inside the channels (instead of a M4 bolt head) attention must be taken to NOT use a bolt or screw longer than the channels depth. Not paying attention to this detail may result in damage to the TReX and invalidate the product warranty.**

## TOP Mount

The flush mount option is suitable for an installation such as onto the front panel of a case or cabinet.



## *SIDE Mount*





## *Bottom Mount*

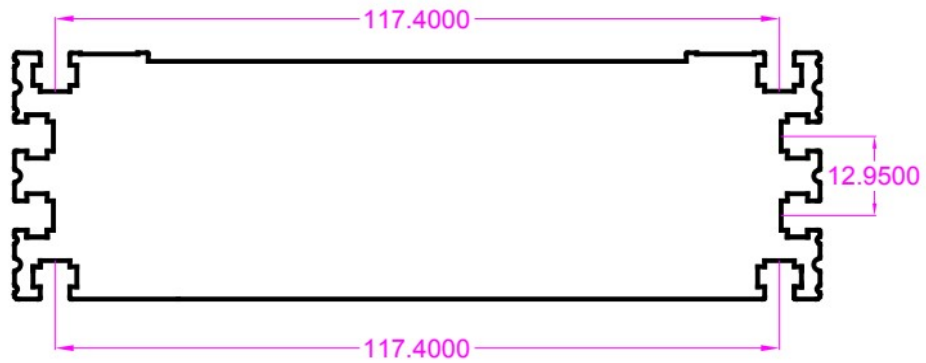


### *Mount Bolts Dimensions*

Both top and bottom are symmetric as are the left and right sides of the TReX radio, this allows a wide range of mounting configurations.

The channels space from centre to centre in the top and bottom of the radio is 117.40mm

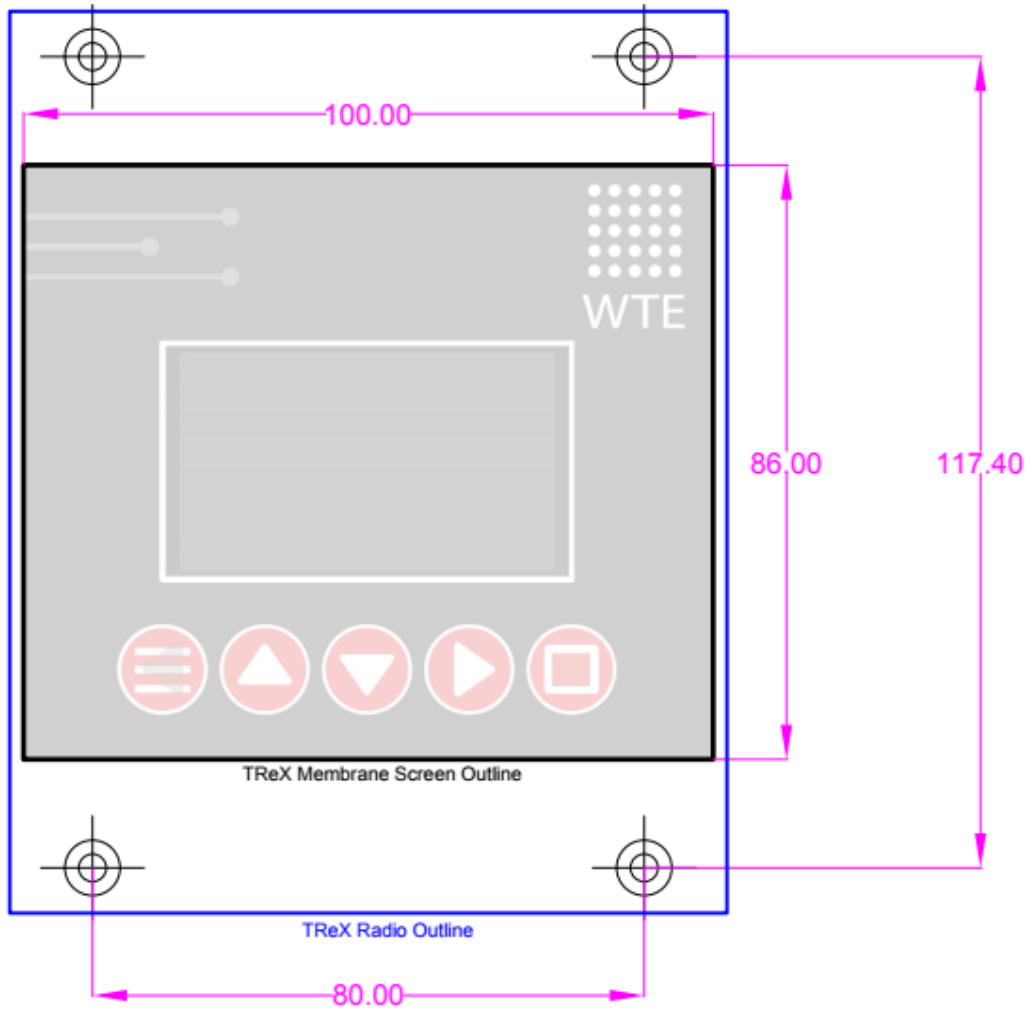
Dimension are in millimetres





## Top and Bottom Drilling Template

# TOP



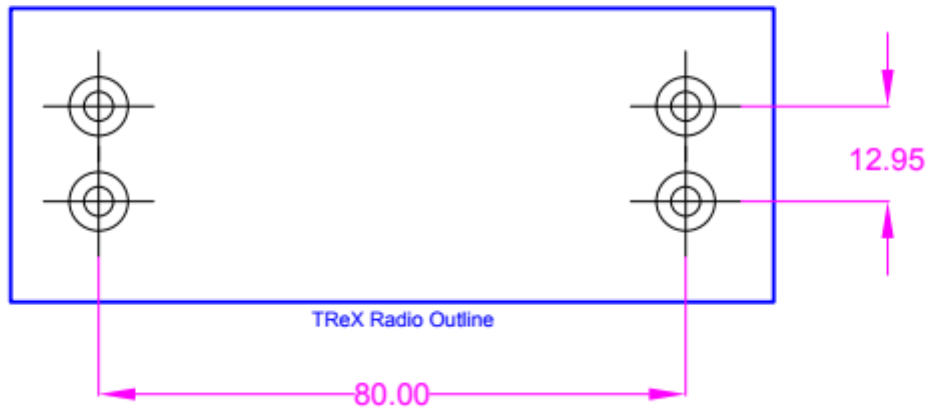
**Note:**

- All dimensions are in millimetres.
- The drilling template will need to be scaled depending on your printer settings.



## Side Drilling Template

# Side



**Note:**

- All dimensions are in millimetres.
- The drilling template will need to be scaled depending on your printer settings.
- Depending on installation, not all mounting points may be required.



## Omni or Directional Antenna

---

It is common in radio systems to consider an omni or directional antenna. Both have their advantages and disadvantages as follows.

If in doubt, consult a local antenna specialist who will be able to advise and construct an antenna best suited to your application.

### ***Omni antenna***

Omni antenna have the advantage of transmitting and receiving signals equally well in all horizontal directions. This means that if the transmitter or the receiver moves, the antenna will not need to be changed/adjusted to compensate.

This is the common antenna used in cellular phones and handhelds radios.

### ***Directional antenna***

Directional antenna have the ability to focus energy in a particular direction. This advantage increasing the maximum distance between transmitter and receiver units. Since the signals are focused/concentrated into a direction it also increase the overall performance of the system.

This is mainly used for fixed transmitter and receiver locations.



## Antenna Elevation

---

As with any radio receiver, raising the height of either the transmitter or receiver antenna will result in dramatic improvements to the maximum possible receive distance. Although a high power transmission will increase distance, the installed height of the receiver antenna is the key to a high performing system.

When close to the ground the major obstacle to overcome, since radio signals are mainly “line of sight”, is the curvature of the earth. The typical distance to expect can be approximately calculated as follows:

$$D = \sqrt{\frac{2r_0 h_f}{6076.1 \beta_0}}$$

Where:

- $D$  is the distance to the horizon in NM,
- $r_0$  is the mean radius of the earth (3440.1 NM),
- $h_f$  is the height of your antenna,
- $\beta_0$  (0.8279) accounts for terrestrial refraction.

This formula can be simplified to:

$$d = 1.17 * \sqrt{h_f}$$

Where:

- $d$  = range in nautical miles,
- $h_f$  = the height of your antenna in feet.

Working with metric units this formula becomes:

$$km = 2.17 * \sqrt{0.305 * h_m}$$

Where:

- $km$  = range in kilometres,
- $h_m$  = the height of your antenna in metres.

Therefore:



Antenna Elevation (metres)	Clear Line of Sight Distance (km)
1	1.2
5	2.7
100	12

The Antenna Elevation is the combined elevation of both the transmitter and the receiver (transmitter at 1m and receiver at 9m will behave similarly as the transmitter at 5m and receiver at 5m).

Changes in power level will help to address a less than ideal antenna or poor line of sight conditions.

When line of sight or elevation is poor, the range can also be approximately doubled with every 6dB increase in link budget (either increase in TX power, or increase in RX sensitivity).

From testing, these ranges can be expected from a **20dBm** transmitter at the indicated elevation.

The TReX has an output power of **36dBm** (4W).

(credit to [www.offshoreblue.com](http://www.offshoreblue.com) for some range calculation details)



## Disclaimer

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THE RESPONSIBILITY LIES COMPLETELY ON THE USER TO ENSURE THAT THIS DEVICE IS TESTED, THROUGH METHODS THAT ARE APPROPRIATE, TO CONFIRM THAT ALL SYSTEM COMPONENTS (THAT THIS DEVICE AND PC SOFTWARE MAY BE PART OF) ARE WORKING CORRECTLY.

This document has been prepared in good faith and produced to assist in the use of this product, however WTE Limited reserves the right to modify, add or remove features without notice.

FLEX™ is a trademark of Motorola, Inc. This unit does not transmit any information in the FLEX format.

When product is supplied, it is the user who is responsible for payment of any customs fees/taxes that are imposed on importation.

Please note that the maximum permitted transmit power level may vary from country to country. It is the users responsibility to ensure local regulations are adhered to.

No User-Serviceable Components. There are no user-serviceable components within the radio

### RoHS and WEEE Compliance

TReX is fully compliant with the European Commission's RoHS (Restriction of Certain Hazardous

Substances in Electrical and Electronic Equipment) and WEEE (Waste Electrical and Electronic Equipment) environmental directives.

### Restriction of hazardous substances (RoHS)

The RoHS Directive prohibits the sale in the European Union of electronic equipment containing these hazardous substances: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs).

### End-of-life recycling programme (WEEE)

The WEEE Directive concerns the recovery, reuse, and recycling of electronic and electrical equipment. Under the Directive, used equipment must be marked, collected separately, and disposed of properly.



## Manufacturing marking and labels

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TReX serial number can found on the unit, also serial number and model information are displayed on start-up or accessible via:

MENU->SYSTEM->FACTORY.

FCC Regulations allow for electronic labelling.

FCC details can be found via:

MENU->SYSTEM->REGULATORY

\*Note: Publication number 784748-D02, FCC-Part 90 allows for devices with integrated display to not require a printed label on the device holding this information.

## Maintenance

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No User-Serviceable Components. Servicing is only to be performed by WTE Limited, or agent appointed by WTE Limited. Servicing outside of the warranty period is at the discretion of WTE Limited.

## Product End Of Life

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It is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help conserve natural resources and help ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling contact your local dealer or city council



Please recycle this device responsibly. The TReX has a residual scrap value that includes 400g of Aluminium.





## Product Warranty

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WTE Limited products are warranted for a period of 12 months after purchase date against faulty workmanship or materials. Return the product, all freight paid by the customer and the product will be repaired or replaced.

The product warranty will be invalidated through evidence of:

- Unauthorised work carried out.
- Tampering, including evidence of removal of internal electronics from the case.
- Installation in wet or corrosive environments.
- Exposure to impact or excessive vibration.
- Use or installation outside of the specified operating parameters.



## Abbreviations and Glossary

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<b>CAP (CAPCODE)</b> - Channel Access Protocol (CAP) code	<b>kbit/s</b> Kilobits per second
<b>RIC -(Radio Identification Code)</b> - an address used in the POCSAG protocol for pagers	<b>kHz</b> Kilohertz
<b>POCSAG (Post Office Code Standardisation Advisory Group)</b> - A standard set of code and signalling formats for radio paging.	<b>LAN</b> Local Area Network
<b>USB (Universal Serial Bus)</b> - A common interface that enables communication between devices and a host controller such as a personal computer (PC).	<b>LED</b> Light Emitting Diode
<b>ASCII</b> American Standard Code for Information Interchange	<b>mA</b> Milliamps
<b>BER</b> Bit Error Rate	<b>MAC</b> Media Access Control
<b>CBC</b> Cipher Block Chaining	<b>Mbit/s</b> Megabits per second
<b>DCE</b> Data Communications Equipment	<b>MHz</b> Megahertz
<b>DTE</b> Data Radio Equipment	<b>ms</b> milliseconds
<b>EMC</b> Electro-Magnetic Compatibility	<b>PC</b> Personal Computer
<b>EMI</b> Electro-Magnetic Interference	<b>RF</b> Radio Frequency
<b>ESD</b> Electro-Static Discharge	<b>RoHS</b> Restriction of Hazardous Substances
<b>ETSI</b> European Telecommunications Standards Institute	<b>RSSI</b> Received Signal Strength Indication
<b>FW</b> Firmware	<b>RX</b> Receiver
<b>HW</b> Hardware	<b>SCADA</b> Supervisory Control and Data Acquisition
<b>IP</b> Internet Protocol	<b>SWR</b> Standing Wave Ratio
<b>I/O</b> Input/Output	<b>TCP/IP</b> Transmission Control Protocol/Internet Protocol
<b>ISP</b> Internet Service Provider	<b>TCXO</b> Temperature Compensated Crystal Oscillator
	<b>TFTP</b> Trivial File Transfer Protocol
	<b>TMR</b> Trunk Mobile Radio
	<b>TX</b> Transmitter
	<b>UTP</b> Unshielded Twisted Pair
	<b>VDC</b> Volts DC
	<b>WEEE</b> Waste Electrical and Electronic Equipment



## Specifications

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### Transmit and Receive Frequency Range:

- 421MHz – 480MHz

### Spectrum Analyser (Optional):

- Frequency range: 142-175, 350 - 499 MHz
- RBW: 500Hz, 1kHz and 25kHz
- Span: 3MHz, 120kHz and 24kHz
- Continual or peak display.
- Min signal -120dBm, max signal -10dBm.
- Input Power accuracy: 421-480MHz +/-2 dB, 142-175MHz -8dB.

### Supply Voltage

- Nominal 13.8V. Min 10.8. Max 15.6V.
- Must be supplied with a DC power lead less than 3m in length in order to comply with ETSI EN 301-489-1.
- Supply cable should be of a cross sectional area of at least 1mm<sup>2</sup>

### Operating Current at 13.8V:

- Ethernet plus TX standby and RX – 240mA
- RX only - 65mA
- TX standby plus RX – 105mA
- TX standby (RX disabled) – 65mA
- TX operating at 4W – Additional 1.0A (for correctly matched antenna)
- External fusing should be 2A.

### Digital Inputs:

- 8 optically isolated. To operate pull to ground or may be driven high or low. High level from 5-24V. Low Level less than 1V.

### Analog Inputs:

- 2. 0-16 V. Input impedance approx. 50K. Slope and offset configurable (e.g. to support 1-5V or 1-10V).

### Digital Outputs:

- 8 open drain. Max allowed supply voltage 24V. Max rated current 100mA. Digital outputs are NOT short circuit protected.

### Analog Outputs:

- 2. 0-10V (for 12V supply voltage).
- Output impedance 5 ohms.
- Max current 30mA. May be configured for 4-20mA operation. Minimum loop resistance 100 ohms, maximum 500 ohms. If loop resistance is too low, a 100 ohm series resistor should be fitted.
- Configurable. to support 1-5V, 1-10V or non-standard currents up to 30mA.
- Short circuit protected. Short circuit current approximately 35mA.



**Protocols Supported:**

- Modbus RTU
- Modbus TCP
- WTE
- WTE Custom
- PET/TAP
- ESPA 4.4.4
- Multitone
- Scope
- SAL
- Ascom
- TPP
- TNPP
- TNPPB-NZFS

**Input Messages:**

- Input max configured message length 50 characters

**Temperature Limits:**

- Operating -30 to + 55 degrees Celsius ambient.
- Storage/Transit -70 to +70 degrees Celsius.

**Fault Reporting:**

- High/low supply voltage.
- High temperature.
- RF Power fault
- Antenna fault
- Comms link fail

**Max Rx Input Power:**

- 17dBm. Direct connection above 17dBm (50mW) will destroy the receiver.

**Receiver at 450.5MHz, 512 baud 12.5kHz (compliant with EN300113):**

- Sensitivity: -123dBm. Desensitised at frequency multiples of 26MHz (and within 50kHz).
- Selectivity @ +/- 1 channel: 61dB
- Blocking at 1MHz offset: Tolerates -20dBm
- Co-channel Rejection Ratio: Rejects unwanted signal at -4dB
- Error Behaviour at high signal levels: Decodes wanted signal at +13dBm.

**Antenna Connector:**

- BNC

**Firmware**

- Field upgradable.

**Communication Interfaces:**

- 1 x RS232



- 1 x RS422/485 (2 or 4 wire)
- 1 x Ethernet (TCP/IP)

**FLEX™ Decode Support:**

- Decoding of all Alphanumeric and numeric messages at 1600 baud (2 level only).

**POCSAG Encode and Decode Support**

- POCSAG 512 either alpha or numeric including batched.
- POCSAG 1200 either alpha or numeric including batched.
- POCSAG 2400 either alpha or numeric including batched.
- POCSAG 4800 either alpha or numeric including batched.
- POCSAG 9600 either alpha or numeric including batched.

**USA Model (TReX-460) Modulations Supported:**

25kHz Channel Width:

512 baud (FSK), 1200 (FSK), 1600 (FSK), 2400 (GFSK), 3200 (4GFSK), 4800 (2GFSK), 9600 (GFSK), 9600 (4GFSK), 16K (4GFSK), 32K (4GFSK)

12.5kHz Channel Width:

512 baud (FSK), 1200 (FSK), 2400 (GFSK), 4800 (GFSK), 9600 (GFSK), 9600 (4GFSK), 16K (4GFSK)

6.25kHz Channel Width:

512 baud (FSK), 1200 (GFSK), 2400 (GFSK), 4800 (4GFSK)

**Europe, AU and NZ Model (TReX-461) Modulations Supported:**

25kHz Channel Width:

512 baud (GFSK), 1200 (FSK), 1600 (FSK), 2400 (GFSK), 3200 (4GFSK), 4800 (2GFSK), 9600 (GFSK), 9600 (4GFSK), 16K (4GFSK)

12.5kHz Channel Width:

512 baud (FSK), 1200 (FSK), 2400 (GFSK), 4800 (GFSK), 9600 (4GFSK)

6.25kHz Channel Width:

512 baud (FSK), 1200 (GFSK), 2400 (GFSK), 4800 (4GFSK)

**Ethernet Connection:**

- Permitted simultaneous connections = 1.
- Google Chrome (64 bit Version 72.0.3626.121) or FireFox (64 bit version 65.0.2) web configuration and monitoring.
- TCP socket (both client and server) for both message protocol support and configuration.
- Cable length should be less than 3m in length in order to comply with ETSI EN 301-489-1.

**Mechanical:**

- Length: 104mm or 125mm including BNC connector
- Width: 131mm
- Height: 41mm
- Weight: 550grams



**Mounting:**

- Rack
- Wall
- DIN rail

**IP rating:**

- IP51.

**Environmental:**

- Operating temperature range: -40 to +70° C (-40 to +158° F)
- Storage temperature range: -40 to +80° C (-40 to +176° F)
- Operating humidity: Maximum 95% non-condensing
- Acoustic noise emission. No emission when sounder is disabled. Maximum sound output from sounder is less than 80dBA.

**Compliance Standards:**

- EN 300 113 (base-station and portable/mobile compliant).
- EN 301 489
- EN 60950 + IEC 62368-1
- EN 50385
- FCC part 90
- AS/NZ 4768

**Testing Laboratory**

- Base-station and mobile compliant, testing completed 8/2/2019.