:::WTE
Wireless Technologies

MReX-SF
TELEMETRY and MESSAGING
STORE FORWARD REPEATER

User Manual

Table of Contents

Introduction

Thank you for choosing the MReX-SF.

The MReX-SF is a very high sensitivity transceiver for paging and general telemetry use. The MReX-SF is a compliant mobile and base station transmitter and a store and forward repeater.

MReX-SF Features

- Sends and receives 512, 1200 and 2400 baud POCSAG paging messages.
- Transmits DMR Tier 1 text messages (optional).
- Sends telemetry data from 512 baud to 9600 baud using 4GFSK.
- Paging store and forward repeater operation with configurable duplicate reject.
- Up to 5 inputs. One Input may be reconfigured to be an open collector output or relay output.
- Configured inputs can be programmed to send messages when triggered.
- Configured outputs can be controlled via paging message.
- Periodic message support to ensure link integrity.
- Firmware upgradable.
- High stability 0.5PPM oscillator ensuring minimal drift over the entire specified temperature range.
- Output power up 100mW.
- Very high sensitivity receiver (-127dBm at 512 baud).
- Operation through external power supply (5-9VDC).
- RS232 port with support for WT protocol for simple system integration.
- Can be supplied with internally housed (default) or external screw terminals.

MReX Versions

The MReX can be supplied as these variants:

- MReX-460 (421MHz to 480MHz) Telemetry and Messaging Module.
- MReX-460-SF Store and Forward Repeater with IO.
- MReX-460-5IO Telemetry and messaging Transceiver.
- MReX-460-5B 5 Button Handheld Messaging Transmitter.

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

To comply with both **FCC RF Exposure** requirements in section 1.1310 of the FCC Rules and EN50383, antennas used with this device must be installed to provide a separation distance of at least 8 cm from all persons to satisfy RF exposure compliance.

DO NOT:

- Operate the transmitter when someone is within 8cm of the antenna. EN50383 regulatory limits have deemed that 8cm is a safe clearance distance from this product while operating at full power.

- Operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.

- Use within 15cm of sensitive electronic devices and medical equipment while operating at full power.

- Operate the equipment near electrical blasting caps or in an explosive atmosphere. All equipment must be properly grounded for safe operations.

!WARNING

THIS EQUIPMENT IS NOT INTENDED FOR MAINS VOLTAGES

- The MReX was **NOT** designed to operate and/or be connected directly to live main voltages. The MReX 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 MReX 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 MReX IP rating is IP-51. This product 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
- Care when stacking MReX boxes must be taken to not damage part of the radio, such as connectors.

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 11cm 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

When power is applied to the MReX-SF, there is a start-up period of 10 seconds. During this time, the green LED is on continuously.

When the MReX-SF is operating normally, the status green LED flashes briefly once every second. When Decoding messages, the green LED is held on for approximately one second. When transmitting the green LED flashes approximately 3 times a second and if fitted, the red LED will illuminate for the duration of the transmission.

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

After start-up the MReX enters its receive and decode mode of operation, waits for commands to be entered serially for processing or inputs to be triggered. These may be either protocol messages to be transmitted or commands related to the configuration of the device.

> **Note:** If the MReX is being used in SERIAL_LINK mode the MReX will only accept configuration commands on its first 10 seconds after power up to prevent accidental misconfiguration. After this time configuration commands will be ignored. Please refer to **Serial Point to Point Operation** in this manual for further information.

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 output is driven high or low, or for a particular period of time depending on configuration. The output is controlled via the **WTE Output Control Protocol** message that is received and decoded.

Ensure an antenna is attached before transmitting.

DMR Messaging

The MReX supports the transmission of short Digital Mobile Radio text messages, allowing direct messaging to DMR radios. This is an optional feature.

The MReX has a partial implementation of the ETSI TS 102 361-1 DMR standard allowing for DMR "Tier 1" messaging and therefore cannot be used in systems that have repeaters.

This is not a full implementation, and as a result has the following restrictions:

- Messages are limited to a maximum length of 50 characters.

DMR messages can be sent when an input is triggered or through use of the WT protocol in a similar manner as sending POCSAG paging messages. Refer to WT Protocol for usage information.

The MReX concurrently supports POCSAG and DMR paging, allowing an input to send messages to both legacy paging systems and newer DMR radios.

Different DMR manufacturers have interoperability limitations. The MReX is similar in this regard. Please refer to the Specification section for a list of tested DMR radios. The MReX WT protocol allows for switching between supported radio types to allow support for Hytera, Kirisun, Motorola and other brands.

Configuration

Parameters can be changed using any common serial terminal program. A serial terminal program that also allows saving and loading of configuration files can be downloaded from wte.co.nz/tools.html

Start-up operation is always at 9600:8-N-1.

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. E.g.

TX_FREQ?

Returns

TX_FREQ=460000000 (for example)

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

To find the first range only, usage would be:

RX_RANGE?1<CR>

Returns

RX_RANGE=1:8,2000000

Note: 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.

Transmit Commands

*TX_FREQ

*TX_FREQ specifies the transmit frequency in Hz e.g.

> **TX_FREQ=458600000<CR>*

*TX_BAUD

*TX_BAUD Specifies the baud rate and channel width of the transmitter when using a protocol that does not permit a baud rate and channel width to be specified.

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).
>
> 1200_12 indicates 1200 baud with 12.5kHz channel spacing (2 level GFSK).
>
> 4800-4L_6 indicates 4800 baud with a 6.25kHz channel spacing (4 level GFSK).

Accepts: 512_25, 512_12, 512_6, 1200_25, 1200_12, 1800_12, 2400_12,
> *4800_12, 4800-4L_6, 9600-4L_12*

Typical usage:

*TX_BAUD=512_25<CR>

*TX_PROTO

*TX_PROTO specifies the protocol to apply for serial input. Accepts WTE and RAW e.g.

> **TX_PROTO=WTE<CR>*

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

*TX_MODE

*TX_MODE specifies the transport method of the transmitter (how the information is transmitted over the air).

- POSCAG_A must be used in order to transmit alphanumeric messages.
- POSCAG_N must be used in order to transmit numeric messages.
- WTE_EN must be used in order to transmit 8 bit characters (POSCAG_A transmits 7 bit characters only).

Accepts POSCAG_A, POCSAG_N and WTE_EN. E.g.

TX_MODE=POSCAG_A<CR>

*TX_LEVEL

*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. E.g.

TX_LEVEL=3<CR>

*TX_CAP

*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. This code can be any number between 8 and 2000000. E.g.

TX_CAP=1234567<CR>

*TX_PERIODIC

*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.

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). E.g.

TX_PERIODIC=10,WT1234560A10 Test_Message<CR>

*TX_PREAMBLE

*TX_PREAMBLE set 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). This very long preamble means that paging receivers need only to wake 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.

Typical usage:

      TX_PREAMBLE=18<CR>*

*TX_PWR

*TX_PWR set the Transmitter Power Output levels. Levels value ranges from 0 to 127, please use the following graph to determine the transmitter level value to use. Note that settings above 80 will have very little effect on output power.

Output Tx Power vs Set Level
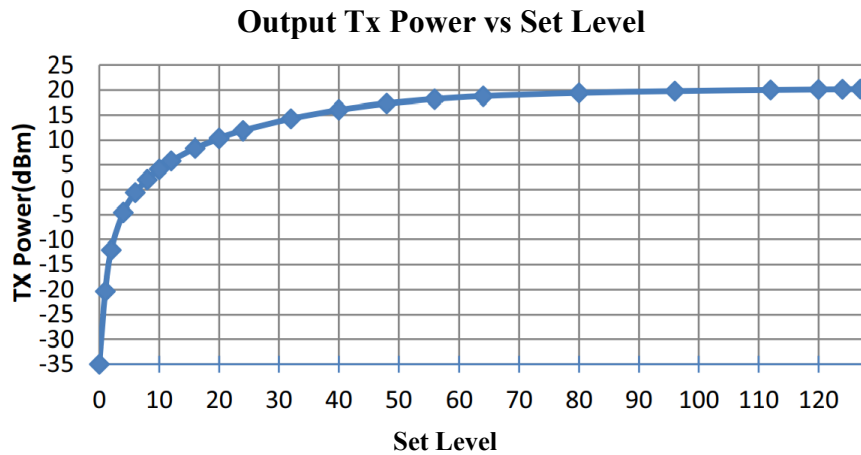
Examples :

Setting MReX to transmit at 10mW (10dBm ±2dBm):

*TX_PWR=20<CR>

Setting MReX to transmit at 50mW (17dBm ±2dBm):

*TX_PWR=55<CR>

Setting MReX to transmit at 100mW (20dBm ±2dBm):

*TX_PWR=80<CR>

Receive Commands

*RX_FREQ

***RX_FREQ** specifies the receive frequency in Hz (range limited to the variant of product) e.g.

RX_FREQ=460000000<CR>

*RX_BAUD

***RX_BAUD** specifies the baud rate and channel width of the receiver.

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).

1200_12 indicates 1200 baud with 12.5kHz channel spacing (2 level GFSK).

4800-4L_6 indicates 4800 baud with a 6.25kHz channel spacing (4 level GFSK).

Accepts: 512_25, 512_12, 512_6, 1200_25, 1200_12, 1800_12, 2400_12,
4800_12, 4800-4L_6, 9600-4L_12

Where:

Typical usage:

RX_BAUD=512_25<CR>

*RX_PROTO

***RX_PROTO** specifies the protocol to apply for serial output, accepts WTE, RAW. See protocol section for more detail on protocols and configuration. E.g.

RX_PROTO=WTE<CR>

*RX_MODE

*RX_MODE specifies the transport method of the receiver (how the information is received over the air).

- POSCAG_A must be used in order to receive alphanumeric messages.
- POSCAG_N must be used in order to receive numeric messages.
- WTE_EN must be used in order to receive 8 bit characters (POSCAG_A transmits 7 bit characters only).

Accepts POSCAG_A, POCSAG_N, WTE_EN and FLEX. E.g.

> **RX_MODE=POSCAG_A<CR>*

*RX_RANGE

*RX_RANGE specifies up to 4 CAP RX ranges for decoding. Messages received with CAP codes not allowed on the RX_RANGE will be discarded by the receiver.

*RX_RANGE=N:LLLLLLL,HHHHHHH (where N is the range between 1 and 4, LLLLLLL is the lowest cap code to match, HHHHHHH is the highest).   E.g.

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

*RX_BUSY

*RX_BUSY Enables the BUSY alert and channel busy level for the configured channel.

*RX_BUSY=BB

Where:

> BB is the signal level from 0 to -130 (in dBm).

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

Typical usage:

> **RX_BUSY=-80<CR>*

*RX_ENABLE

*RX_ENABLE Enables or disables the receiver. When the receiver has been disabled, the MReX will use less than 1uA standby current. By default the receiver is enabled. When the receiver is disabled, the green LED will only flash prior to a transmission.

Typical Usage:

   RX_ENABLE=0<CR>

Base Commands

*REBOOT

*REBOOT forces the unit to immediately restart.

Usage:

> **REBOOT<CR>*

*CONFIG

*CONFIG displays current configuration.

> **CONFIG<CR>*

*SAVE

*SAVE saves all configuration settings (all config changes are restored on start-up).

Usage:

> **SAVE <CR>*

*LIST

*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

*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>*

*FREQ_OFFSET

*FREQ_OFFSET specifies an offset to compensate for errors and to allow calibration of the internal frequency reference (in Hz). E.g.

> **FREQ_OFFSET =-200<CR>*

*SERIAL_LINK

*SERIAL_LINK sets default RS232 point to point configuration. See **Serial Point To Point Operation**

Usage:

> **SERIAL_LINK<CR>*

*VER

*VER sends the MReX sign on message back to the user. This is useful to determine the model and serial number of the unit.

Usage:

> **VER<CR>*

*IO

Returns all input and output states.

Typical usage:

> **IO<CR>*

Typical output:

> *IO=I:01000 O:0*

In this typical output, there are 5 inputs shown. Output state follows (valid only if output is configured)

*BYPASS

Allows messages to be entered via serial to simulate as if decoded across the air. This can be useful for testing.

Commands take the format:

*BYPASS=[1234567:1]Message_Payload

Where:

[is the character '['

1234567 is the simulated RIC

: is the character ':'

1 is the beep level of the messages

] is the character ']'

Message_Payload is any message to inject as if received across the air.

This message will now be processed according to the configured RX_PROTO configuration.

Typical Usage 1:

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

"Test Message" will be added to the received message serial output, as if received across the air.

Typical Usage 2:

> **BYPASS=[1234567:1][[01]U0[*REBOOT]]<CR>*

The unit will reboot the unit, please refer to WTE Output Control Protocol section on this manual for more information.

*RSSI

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

Usage:

> **RSSI<CR>*

*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:

> > 1 – Enable Carrier only,
> >
> > 2 – Enable Carrier with random modulation,
> >
> > 0 – Disable Carrier

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

Example carrier only for 60 seconds:

> *LAB=1<CR>

Example carrier only for 20 seconds:

> *LAB=1,20<CR>

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 240 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 requeueing 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 inputs and output.

*IN_CONFIG_L

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 (1-5 valid)
>
> : = 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.

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

*IN_CONFIG_H

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 (1-5 valid)

: = 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.

Example:

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

*IN_MSG_L specifies the low level message that will be transmitted if configured. E.g.

    IN_MSG_L=1:WT1234560A10 IN_1_LOW<CR>

*IN_MSG_H specifies the high level message that will be transmitted if configured. E.g.

    IN_MSG_H=1:WT1234560A10 IN_1_HIGH<CR>

Output Commands

The output commands allows the output to be enabled (disabling input 1). 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 MReX board.

*OUT_CONFIG

*OUT_CONFIG specifies all output configuration items, usage as follows:

*OUT_CONFIG=O:E,T *<CR>*

Where:

> O = The output to configure (only 1 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.

Example:

> **OUT_CONFIG=1:1,100<CR>*

*UNIT_ID

*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 MReX 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.

Example:

> **UNIT_ID=01<CR>*

Note: Inputs can still be enabled while the GPIO is configured to be an output. This has been allowed to permit a message to be received, then reply immediately with a preprogrammed message that has been configured on that same pin. In this manner the MReX can transmit any message reporting when an output has changed state.

Protocols

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

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.

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
>>
>> D = DMR Text Message (directed to a group)
>>
>> d = DMR Text Message (directed to an individual)
>>
>> W= POCSAG WTE (WTE 8 bit format allowing all 8 bit characters to be transmitted)

B is the Level 1-9. Note that POCSAG only supports levels 1-4 which is the same as the "Beep Level". When the Transport method is 'D' this is the DMR "colour code"

> **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

> ### *12.5 kHz Channel Space Settings*
> A = 512 Baud 2 Level FSK

B = 1200 Baud 2 Level FSK

C = 2400 Baud 2 Level GFSK

D = 4800 Baud 2 Level GFSK

X = 9600 Baud 4 Level GFSK

Y = 1800 Baud 2 Level GFSK

6.25 kHz Channel Space Settings

a = 512 Baud 2 Level FSK

d = 4800 Baud 4 Level GFSK

<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[NNN]<CR>

where:

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

WT[017]<CR>

Support for Multiple Messages

The WT protocol allows for the same message to be sent to a variety of different radio types. This allows for an efficient way to send to several different RIC codes or technology types. Many message transmissions can be supported, until the max message length for the message is exceeded.

Example:

To send the message "TEST" to RIC codes 1234560 and 1222222 as a 512 baud POCSAG mes-

sage.

WT1234560A10*WT1222222A10*<SPACE>TEST<CR>

2 messages will be transmitted, batched in a single transmission.

Note: The format is the standard WT Protocol format, but repeated without a space in-between headers.

Example:

To send the message "TEST" to RIC code 1234560 as a 512 baud POCSAG message and also a DMR message to group 1001, colour code 6 for a Hytera radio.

WT1234560A10**WT0001001D60**<SPACE>TEST<CR>

2 messages will be transmitted, as 2 transmissions. First message is in a POCSAG format, second transmission is in a DMR format.

Example:

To send the message "TEST" to RIC codes 1234560 and 1222222 as a 512 baud POCSAG message and also RIC codes 0201234 and 0005647 as a 1200 baud POCSAG message.

WT1234560A10*WT1222222A10***WT0201234A11***WT0005647A11*<SPACE>TEST<CR>

4 messages will be transmitted, batched in 2 transmissions, one for 512 baud messages and another transmission for the 1200 baud messages.

DMR Message Format

The WT Protocol can be used for sending DMR tier 1 messages. The protocol allows for an ID (group or individual), colour code, radio type and message to be specified.

Different DMR Radio manufacturers frequently have differing DMR implementations that often allows only same brand to same brand communication.

The WT protocol uses the commonly used "baud" field to set the DMR radio type. Sending a DMR message to an incorrect radio type may result in the radio not receiving messages, or the message being corrupted. Ensure that the group ID used is common to all same brand radios.

Basic Format:

WT1234567D6**x** TEST\r

Where all fields are previously defined, but '**x**' is now a DMR "Type".

Type '0' – This is a short message type, often used by Hytera.

Type '1' – This is a short message type, often used by Kirisun.

Type '2' – This is a compressed UDP type, often used by Hytera and Motorola.

Motorola Radio Usage:

No messages are transmitted using any Motorola format. Motorola radios must be configured as follows:

- Compressed UDP Data Header: **DMR Standard**
- Text Message Type: **DMR Standard**

Example:

To send a DMR message to group ID 1001, colour code 6 with payload of "TEST MESSAGE" and to a type '0' radio (Hytera)

> *WT0001001D6**0**<SPACE>TEST MESSAGE<CR>*

Example:

To send a DMR message to individual ID 104, colour code 6 with payload of "TEST MESSAGE" and to a type '0' radio (Hytera)

WT00001041d60<SPACE>TEST MESSAGE<CR>

Input Handling

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

The MReX supports 5 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**.

By default IO pins are all configured as inputs. The output function is determined by the *OUT_CONFIG command. See "**Output Handling**".

On start-up each input is read. Only inputs that change from the start-up input state are processed.

Commands relating to input handling:

*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 the inputs and output.

The MReX supports a single output shared on the same pins as input 1. This is the output that directly controls the relay.

Outputs are configured using the commands:

*OUT_CONFIG

*UNIT_ID

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

NOTE: Inputs can be configured to operate at the same time as outputs, allowing preprogrammed input messages to be transmitted when a message has been received to change the state of an output.

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.

Format

The payload of a message must fit the following format in order to operate the unit outputs. Note that this is a general format used by WTE products that may have many more than a single output.

[[ID]EEEE-DDDD]

    Where:

    [is the character '['

    ] is the character ']'

    ID is the UNIT_ID that has been programmed (e.g "01" or "Unit_A").

    E is the output to enable (1 for the MReX).

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

    D is the output to disable

Examples:

Consider an MReX configured with UNIT_ID of "Unit_A" and configured as output:

UNIT_ID=Unit_A<CR>

OUT_CONFIG=1:1,0<CR>

Scenario 1: To turn output 1 ON;

Message payload:

[[Unit_A]1]

Scenario 2: To turn OFF output 1;

Message payload:

[[Unit_A]-1]

Consider that we have several MReX Units and each one is configured with a different UNIT_ID; "Unit_A", "Unit_B" and "Unit_C"

Scenario 3: To turn output 1 for Unit_A:

Message payload:

[[Unit_A]1]

Scenario 4: We want:

to turn output 1 ON in the Unit_A,

to turn output 1 ON on the Unit_B,

turn OFF output1 Unit_C;

Message payload:

[[Unit_A]1] [[Unit_B]1] [[Unit_C]-1]

Notes:

- The unit will only process the Output Control Protocol for the unit configured in the UNIT_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 UNIT_ID.

Remote Command Output Format

The WTE output control protocol allows the direct control of remote units. This allows specific MReX units to accept commands or protocols for processing "over the air". Care must be taken issuing commands that leave the MReX unable to process further remote commands (such as changing frequency, RIC range, modulation settings).

[[ID]U0[AA]]

Where:

[is the character '['

] is the character ']'

ID is the *UNIT_ID* that must match the MReX to be controlled.

U0 are the characters "U0" (U followed by zero) and is used to indicate that directed content for processing follows.

Examples:

 Example applications for this may be:

- Restarting of a remote unit
- Changing configuration of a remote unit over the air
- Retransmitting a message at a different rate.

Example 1 - To restart a remote unit:

Remote unit configured to have UNIT_ID of "UNIT-10".

Message payload:

[[UNIT-10]U0[*REBOOT]]

Example 2 - To change a RIC range on a remote unit:

Remote unit configured to have UNIT_ID of "UNIT-10".

Message payload:

[[UNIT-10]U0[*RX_RANGE=1:1234560,1234567]]

Example 3 - To transmit a message only from a specific remote unit:

In this case, the remote unit is configured to accept WT protocol.

Remote unit configured to have UNIT_ID of "UNIT-10".

Message payload:

[[UNIT-10]U0[WT1234560A10 Test Message]]

The message transmitted by UNIT-10 will be "Test Message" at 512 baud, but the message may have been received at a different configured baud rate.

Application of this may be:
A full network operating in a telemetry mode may be transmitting data at 9600 baud. This method allows a message to be sent through the network at high speed, yet still able to be retransmitted from a specific unit at a standard low rate for a common POCSAG belt pager.

Store Forward Operation

The MReX can operate as a stand-alone repeater to forward paging messages and also extend wireless serial operation. This is an optional feature for the MReX that is not supplied by default.

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 MReX 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 key to use when the MReX 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.

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 MReX-SF should be situated away from direct sunlight, extreme vibration and heat sources, and high power transmission sources.

An external aerial correctly designed to operate at your intended frequency of operation will result in best performance. Do not situate the aerial immediately next to the aerial of a high power transmission source – position greater than 2 M from any other aerial. Mount the external aerial with as much elevation as possible for best results (see "Aerial Elevation" below).

Maximum tolerated input power into the RF connector is 13 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 aerial is NOT supplied by default. If an aerial is supplied, it will be a generic variety that will not perform as well as an aerial produced for the intended frequency of operation, or a high gain externally mounted type.

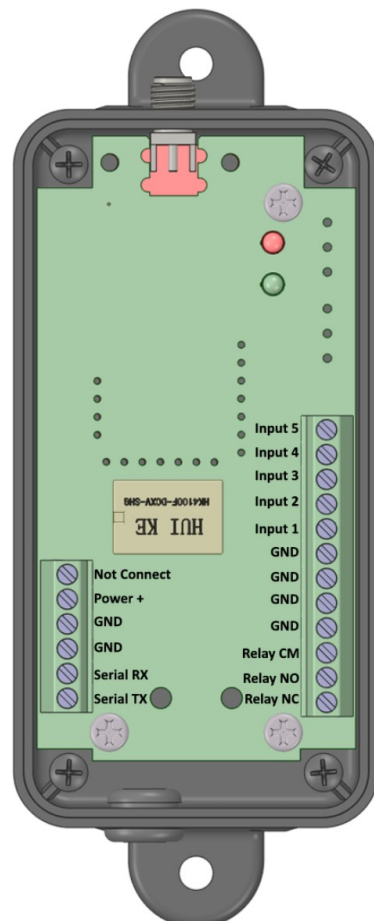If cables are to be supplied, this must be ordered at time of purchase.

Connecting to the MReX

The minimum required connections for a usable system:

1. Connection to an antenna.
2. Power supply of 5-9VDC.
3. Connection to a GND pin.
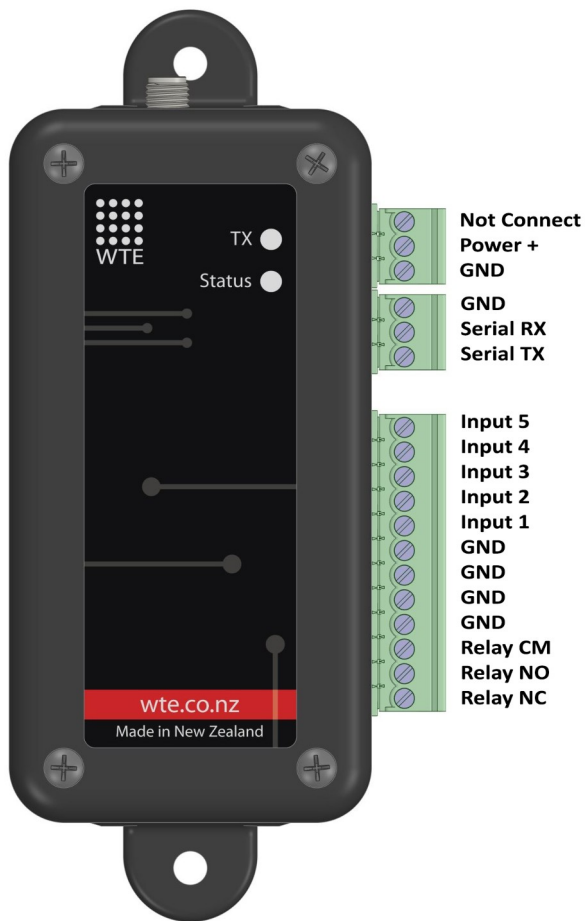
Optional external access screw terminals

Default Presentation with internal screw terminals

SMA connector is female type. The module must be connect to a 50 ohm antenna designed for use at the intended frequency of operation.

There are multiple GND connection terminals available. A minimum of one must be used for the supply GND.
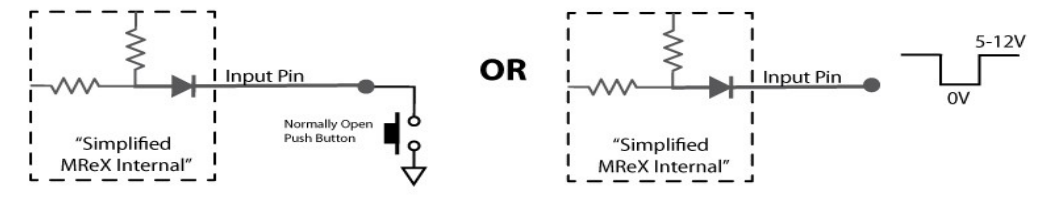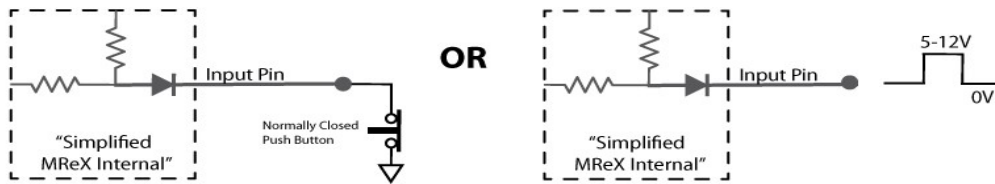
Input Hardware Connection

Example:

Inputs are driven high or low from an external source. Inputs will tolerate up to 12V as a high input level. The external driving source must have a 0V GND common to the MReX.

Output Hardware Connection

The output is a single relay with normally closed and normally open contacts exposed. There are no special connection requirements with the exceptions:

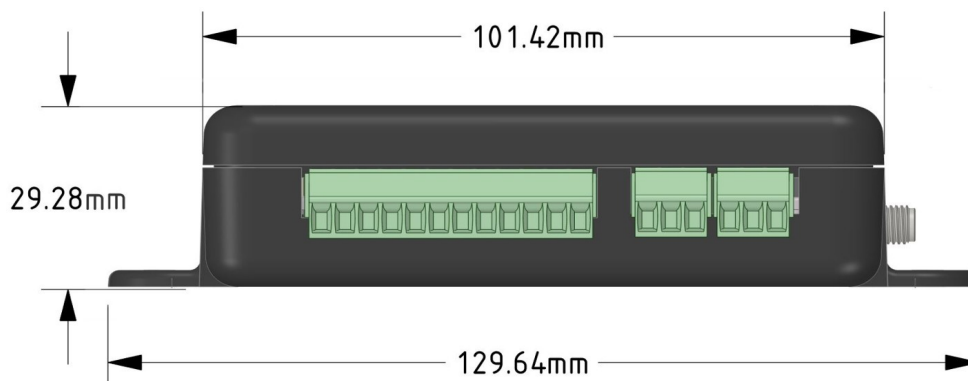- Must not exceed 50vdc.
- Must not exceed 1A.

MReX SF Dimensions

Shown below are dimension for the external access terminal option. The default internal access model dimensions are identical with the exception there are no green connectors visible externally.

Top view
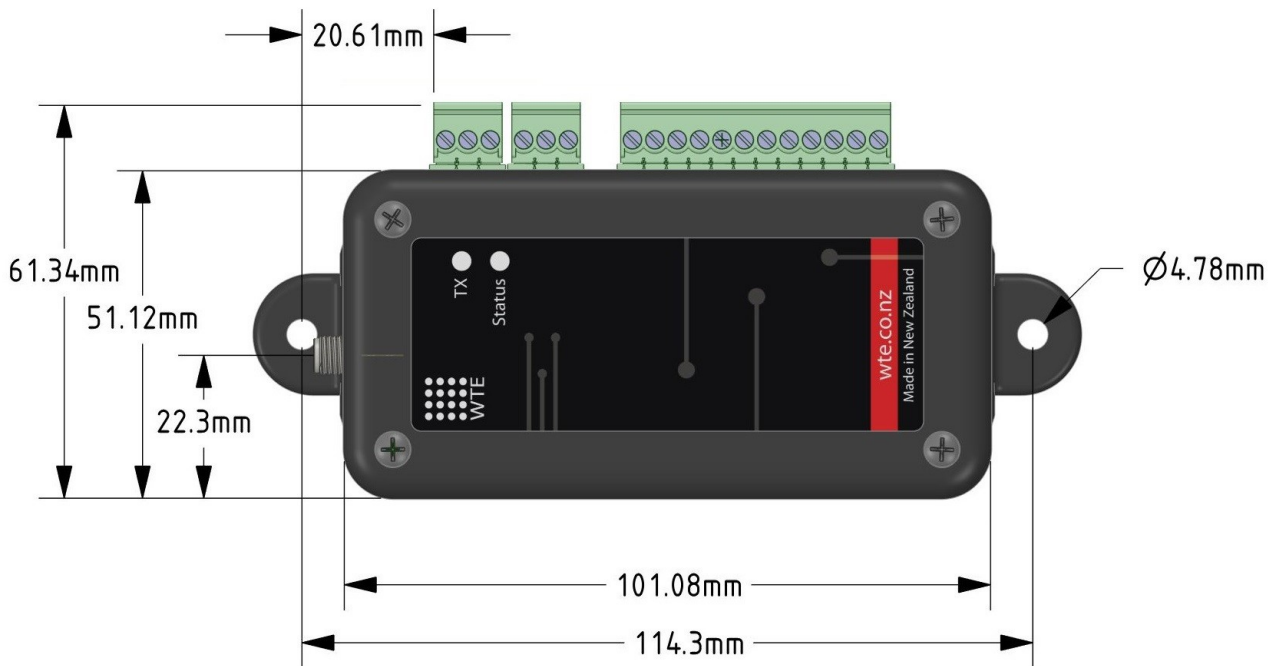
Side View

Note: Images are not to scale. Minor differences to the SMA connector may be possible depending on manufacturer variations and tolerances.

All dimensions are in millimetres (mm)

Please visit the MReX page on the www.wte.co.nz for Gerber footprint and DWG CAD files.
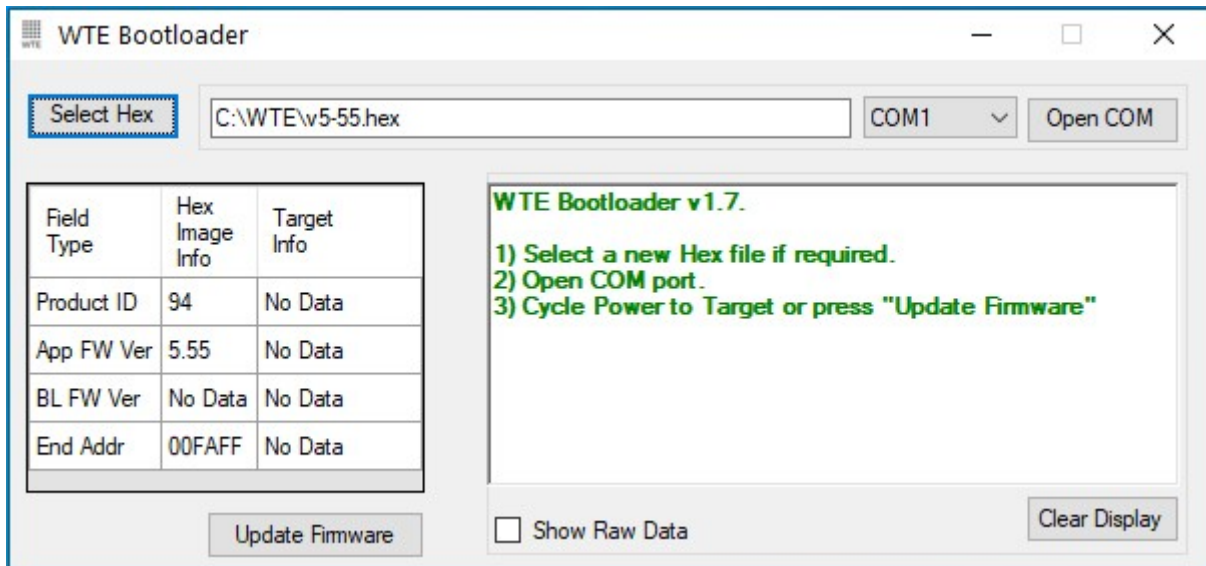
MReX Firmware Upgrade

In order to update the MReX firmware you will need:

1. The WTE Bootloader Tool (available from http://www.wte.co.nz or provided if required from info@wte.co.nz).
2. RS232 Serial cable.
3. An appropriate encrypted hex file supplied by WTE Limited.

Note: Attempting to load a hex file not intended for use with the MReX-SF will render the MReX 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 MReX, This application automatically handles erasing and verifying of uploaded firmware.

Firmware Upgrade Process

1. Run the application WTEBoot.exe – this is the WTE Firmware Update Tool as shown above.

2. MReX must be powered and connected to a RS232 serial cable, please refer to **Connecting to the MReX** section of this manual for more information.

3. Press the "**Select Hex"** button on the WTE Firmware Update Tool and select the appropriated MReX firmware file.

4. Confirm that the App FW Ver displayed is the version described in the file name.

5. Select the correct COM port on the WTE Firmware Update Tool

6. Press "**Open COM**" button on the WTE Firmware Update Tool

7. Press "**Update Firmware**" on the WTE Firmware Update Tool to send the new firmware to the MReX.

8. Wait for the WTE Firmware Update Tool to indicate that programming has been completed.
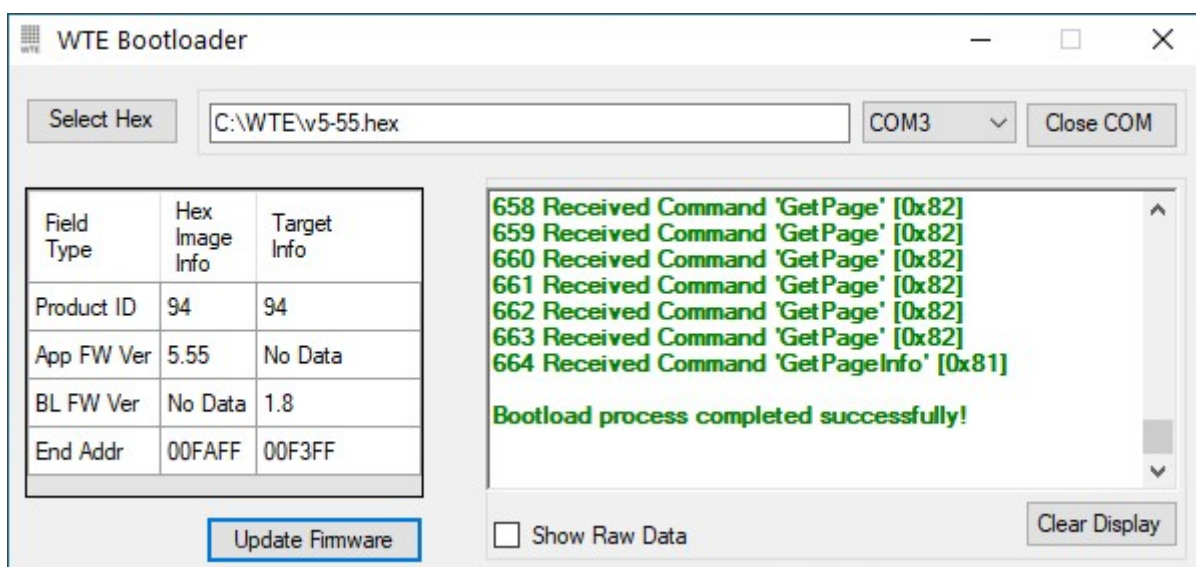
The MReX now is ready and the WTE Firmware Update Tool can be closed.

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 aerial specialist who will be able to advise and construct an aerial 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:

$$D = \sqrt{\frac{2 r_0 h_f}{6076.1 \, \beta_0}}$$

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,

β_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.

(credit to www.offshoreblue.com for some range calculation details)

Disclaimer

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.

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.

In no event shall WTE Limited be liable for any incidental, special, indirect or consequential damages, harm to any person, lost profits or lost data, harm to your equipment, cost of procurement of substitute goods, technology or services, any claims by third parties (including but not limited to any defense thereof), any claims for indemnity or contribution, or other similar costs.
The maximum financial liability is limited to the price paid for the supplied product.

No User-Serviceable Components. There are no user-serviceable components within the radio

RoHS and WEEE Compliance
MReX 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

MReX serial number can found on the certified and internally fitted MReX module. Also serial number and model information are sent to serial on start-up.

Maintenance

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

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.

Product Warranty

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.

Specification

Frequency Range:
- MReX-460: 421 - 480 MHz

Tx/Rx Frequency Accuracy:
- 0.5ppm. 235Hz max error at 470MHz over entire temperature range.

Fixed Supply Voltage:
- 6-15V Internally fused at 250mA (not self resetting)

Inputs:
- Five. To operate tie to GND. Max input voltage is 24V. Input 1 is lost when configured to operate as an output.

Message length:
- Input max configured message length 50 characters

Temperature Limits:
- -10 to + 55 degrees Celsius.

Max Tx Power: (+/- 1dB)
- 20dBm (100mW)

Max Rx Input Power:
- 13dBm (any level above this will destroy the receiver)

Receiver Sensitivity (+/- 1dB) @ 450MHz
- -126 dBm (512 baud),
- -124 dBm (1200 baud),

Serial Input Max message length:
- Up to 5 messages with 128 character can be queued for decoding or transmitting.

Antenna Connector:
- SMA female.

Operating Current:
- 30mA receiving, up to 95mA (depending on configured TX power) transmitting into matched 50 ohm antenna.

Firmware:
- Field upgradable.

Physical Dimensions (L x W x H)
- 130mm x 51mm x 28mm

Serial Output:
- Serial 9600:8-N-1 baud.
- WTE protocol format.

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.
- Adjustable POCSAG preamble from 64 to 5000 bits (576 default).

DMR Support:
- Partial ETSI TS 102 361-1 (Tier 1 direct mode).
- Text Message Types:
  - Short message, unconfirmed
  - UDP compressed header, unconfirmed.
- Max message length 50.
- Tested DMR radios:
  - Hytera – PD565, PD665
  - Kirisun DP770, TM840H
  - Motorola SL4010e

Modulations Supported:
25kHz Channel Width:
512 baud (FSK 4.4kHz), 1200 (FSK 4.4kHz)

12.5kHz Channel Width:
512 baud (FSK 2.2kHz), 1200 (FSK 2.2kHz), 1800 (GFSK 3kHz), 2400 (GFSK 2.2kHz), 4800 (GFSK 2.2kHz), 9600 (4GFSK)

6.25kHz Channel Width:
512 (GFSK 1.1kHz), 4800 (4GFSK)

Compliance Standards:
- EN 300 224-2. (base station and mobile transceiver compliant).
- EN 301 489,
- EN 62368
- EN 50385
- FCC part 90.217
- AS/NZ 4769

Laboratory Test Results:
- Base and mobile station compliant. Testing completed March 2020. This product incorporates the WTE MReX-460 Telemetry Transceiver Module, upon which compliance is based.

Declaration of Conformity CE

Manufacturer:

Wireless Technologies (WTE Limited)
Christchurch, New Zealand

WTE Limited hereby declares the MReX Telemetry, Data and Messaging Transceiver module satisfies all the technical regulations applicable to the product within the scope of Directive 2014/53/EU (Radio Equipment Directive) of the European Parliament and Councils.

The products covered by this declaration:
MReX-460, MReX-5B, MReX-SF and MReX-5IO

The basis on which conformity is being declared:
The products identified above comply with the above directive based on lab testing results from the EMC Competent Body: EMC Technologies (NZ) Ltd.

The manufacturer has applied the following harmonised standards:

- **EN 300 224-2. (base station and mobile transceiver compliant).**
  Electromagnetic compatibility and Radio spectrum Matters (ERM); On-site paging service

- **EN 301 489-1 V2.1.1 (2017-02)** Electro Magnetic Compatibility (EMC) standard for radio equipment and services.

- **EN 62368-1:2018** Safety of information technology equipment

- **EN 50385:2017** RF exposure compliance for base station equipment.

The CE mark was first applied in: May 2020

Contact:
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Date: 05/05/2020

Shannon Reardon
Engineer/Director

Rodrigo Pellizzari
Engineer/Director