

MReX-SatLink LOW POWER SATELLITE IOT GATEWAY



User Manual

Table of Contents

Introduction.....	4	Modbus RTU.....	34
MReX-SatLink Features.....	4	Function Codes.....	35
Safety Information.....	5	Modbus Mapping Table.....	36
Operation.....	9	Minimum Operation Requirements.....	37
Configuration.....	10	Optional Robust System Operations.....	37
Transmit Commands.....	12	Optional Recovery Operations.....	37
*TX_FREQ.....	12	Efficient Transmission Mode.....	38
*TX_PROTO.....	12	Examples.....	38
*PERIODIC_MSG.....	13	ASCII Protocol.....	39
*PERIODIC_ALARM.....	14	Overview.....	39
*ALARM_TIMEZONE.....	16	Periodic Message Integration.....	40
*TX_PWR.....	17	Multiple Message Queuing.....	40
*TX_BAUD.....	18	Modbus Master Operation.....	42
Receive Commands.....	19	RF Link Message Queuing.....	43
*RX_FREQ.....	19	Overview.....	43
*RX_BAUD.....	19	Example – Single Message.....	43
*RX_ENABLE.....	20	Example – Appended Messages.....	44
*RX_MODE.....	20	Variable Content Macros.....	45
*RX_RANGE.....	21	Examples.....	46
*CH_BUSY.....	21	Timestamp Macros.....	47
*RX_SUFFIX.....	22	Modbus Register Macros.....	48
Base Commands.....	23	Optional Modems.....	49
*REBOOT.....	23	Swarm M138 Modem.....	49
*CONFIG.....	23	WTE-Cell-PCIe Modem.....	49
*SAVE.....	23	WTE-MReX-PCIe Modem.....	49
*DEFAULTS.....	23	Modem Indicators.....	50
*VER.....	23	Internal Hardware.....	51
*RSSI.....	24	Internal Board.....	51
*RS422_OPTS.....	24	Status LEDs.....	52
Store Forward Commands.....	25	Modem Installation.....	53
*STORE_FWD.....	25	Power Connection.....	55
Swarm Modem Commands.....	26	RS422 Serial Connection.....	56
*SWARM_OPTS.....	26	Internal TTL Serial Connection.....	57
Modbus Protocol Commands.....	28	Unit I/O.....	59
*MODBUS.....	28	Digital Inputs.....	60
*MASTER_MODBUS.....	28	Analog Inputs.....	61
ASCII Protocol Commands.....	29	Digital Outputs.....	62
*ASCII_OPTS.....	29	12-Volt Switched Power Supply.....	63
*ASCII_CMD.....	29	Example Implementation.....	64
*ASCII_STATUS.....	30	External Modbus Sensor.....	64
Protocols.....	31	Additional Notes.....	67
WT Protocol.....	31	Low Battery Protection.....	67
Support for Multiple Messages.....	32	System Error Codes.....	67
Serial Only Output.....	33	Troubleshooting.....	67

Updating Unit Firmware.....	68	Antenna Elevation.....	80
Installation.....	74	Disclaimer.....	82
Cables Supplied.....	74	Manufacturing marking and labels.....	83
Connecting to the MReX-SatLink.....	75	Maintenance.....	83
MReX SatLink Dimensions.....	77	Product End Of Life.....	84
Antenna.....	79	Product Warranty.....	85
Omni antenna.....	79	Specifications.....	86
Directional antenna.....	79		

Introduction

Thank you for choosing the MReX-SatLink.

The MReX-SatLink is a weatherproof, solar powered remote data gateway ideal for shifting data out of isolated and/or hazardous locations.

The unit can be fitted with a range of modems, allowing for the use of satellite, cellular or short-range messaging options.

The unit incorporates the Wireless Technologies MReX, which allows full time receiving of data from a network of IoT sensors, or alternatively forward serial data bursts from third party devices such as dataloggers.

External sensors can be directly connected via analog or digital input connections or through an RS422 serial connection.

MReX-SatLink Features

- Wirelessly transmits data via user-fitted modem.
- Simple integration with existing products, through either posting of ASCII-encoded serial data or through the Modbus RTU protocol.
- Forwarding of received RF messages via fitted modem, with optional batching functionality.
- Modbus Master operation for automated querying from a wide variety of external sensors.
- Multiple analog and digital inputs for direct connection to and reading of external sensors.
- Built-in 12V 100mA switched power supply to independently power external sensors.
- Variable content macros allow for the formatting of I/O, Modbus and system data into transmitted messages.
- MReX Output power up to 20 dBm and receiver sensitivity of -127 dBm (link to remote sensors).
- “Polite” operation, checking the channel is clear before transmission.
- Acknowledges transmissions - clear LED indication of transmission success.
- Low operating frequency and modulation provides range coverage up to 2km in bush – and greater than 15km line of sight with small elevation.
- Rapid installation.
- Directly integrates with all WTE radio products.
- Optionally sends POCSAG and proprietary data formats, giving many options over range, performance and the final intended application.

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 65 degrees Celsius).
- Although this product is designed to be rugged, it will not survive excessive shock or vibration abuse.
- 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 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-SatLink, there is a start-up period of 6 seconds before the modem is checked for queued messages to transmit.

On startup the following string is transmitted via both the RS422 serial connection and the internal TTL connection:

```
WTE MReX-SatLink vXX.XX - vXX.XX\r\n
```

where each XX can be a variable number. These are the major and minor version numbers for the MReX unit and coprocessor firmware respectively.

If there are no messages queued, the MReX will move to a low power state of operation and power down the modem. The unit will wake when:

- Receiving serial commands via the RS422 connection.
- A configured periodic transmission time has elapsed.
- The MReX transceiver module has received a message via RF.

If the satellite modem is switched off or otherwise unable to receive message payloads for transmission, up to 7 messages will be queued in the MReX processor. When able, queued messages will be shifted to the modem for transmission. The modem may not actually transmit for several hours depending on satellite position.

When the modem has transmitted all queued messages, the modem will be powered down, and the MReX-SatLink will return to its normal low power mode of operation. If the configured maximum awake time has passed without transmission, the MReX-SatLink will return to its normal low power mode for the configured sleep time before waking up and attempting to transmit again.

Note: All messages queued for transmission over the Swarm network are appended with a single byte that represents a sequence number from 0-255. This can be used to track any potential failures to transmit. This sequence number is reset on system startup and when 255 messages have been queued for transmission.

For information on using the various options for transmitting outgoing data via satellite network or via MReX RF transmission, refer to the **Protocols** section.

For information regarding hardware setup and I/O connections, refer to the **Internal Hardware** and **Installation** sections.

For a full implementation example, refer to the **Example Implementation** section.

Configuration

To configure the MReX-SatLink unit, connect to the unit RS422 serial port. Alternatively, configuration can be performed through the internal TTL connector. For details on using this connection, refer to section **Internal Hardware -> Internal TTL Serial Connection**. Parameters can be changed using any common serial terminal program. The free WTE Serial Terminal program also allows saving and loading of configuration files, and can be downloaded from wte.co.nz/tools.html. By default, the RS422 connection operates at 9600:8-N-1.

All configuration commands always start with the asterisk (*) character. All messages that do not start with the asterisk character are processed by the protocol decoder.

All messages (except Modbus RTU) 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: Some configuration options are only applied to the unit on startup. It is a good practice to restart the unit after changing configuration to avoid unexpected behaviour. This can be achieved by removing power to the unit or sending the **REBOOT<CR>* command.

Transmit Commands

Transmit commands can relate to either the MReX transceiver or the user-installed modem.

***TX_FREQ**

***TX_FREQ** specifies the transmit frequency of the MReX transceiver in Hz.

Usage:

***TX_FREQ=XXXXXXXX<CR>**

Where:

XXXXXXXX is the desired transmitted frequency in Hz, limited to a range of 421000000 – 480000000 Hz. Default value 458600000.

Example:

***TX_FREQ=458600000<CR>**

***TX_PROTO**

***TX_PROTO** selects the format in which the unit will accept messages for transmission via the fitted modem. This setting applies to the RS422 connection and to periodic messages.

Usage:

***TX_PROTO=PPPP<CR>**

Where:

PPPP is the protocol to be used, either ASCII or MODBUS. Default value MODBUS.

Example:

***TX_PROTO=MODBUS<CR>**

***PERIODIC_MSG**

***PERIODIC_MSG** allows a periodic command to be evaluated. This could include a WT protocol transmission command or an ASCII protocol message queue command. This has a variety of uses, from acting as a simple “heartbeat” to indicate that the device is still online to managing periodic measurement and transmission of input states.

Periodic messages and their outputs can additionally be set to evaluate at specific times. For more information, see ***PERIODIC_ALARMS** documentation.

Usage:

***PERIODIC_MSG=TT,LL,O,MMMM<CR>**

Where:

TT is the time in seconds between transmissions (0-65535. 0 disables the feature). Default value 0 (disabled).

LL is the corresponding output lead-in time (1 – 65535 seconds, 0 to disable). If specified, a configured output will be enabled for this duration (in seconds) prior to the evaluation of the periodic message. This may be used to temporarily enable power to an external device that may require a settling time before reading (in some cases, this may be several minutes). Default value 0 (disabled).

O is the lead-in output to be enabled if an output lead-in time is configured (1 – 4 for digital open-drain outputs, 5 for 12V output). For more information about outputs, see section **Unit I/O**. Default value 0 (disabled).

MMMM is the periodic command to be evaluated (up to 160 characters). Default message is “WT0001478A10 --”.

Example:

***PERIODIC_MSG =60,5,1,WT1234560A10 Test_Message<CR>**

Will transmit the POCSAG message “Test_Message” once every 60 seconds. 5 seconds before each transmission, output 1 will be enabled up until the transmission is complete.

Periodic messages are compatible with the variable content macro system, as described in the section **Protocols->Variable Content Macros**.

*PERIODIC_ALARM

***PERIODIC_ALARM** configures the alarm behaviour for periodic messages. If enabled, alarms allow for periodic messages to be evaluated at either specified times on a daily basis, or at regular intervals that are synchronised to midnight. Configured alarm values correlate to the time zone set by the ***ALARM_TIMEZONE** command. Up to 3 alarms can be configured.

Alarms require the acquisition of GPS time before they can begin being evaluated. After GPS time has been acquired, the SatLink unit's internal real-time clock (RTC) will keep time for future alarms.

If a periodic message has an output configured, this output will be enabled at the configured time **before** the alarm time. For example, if an alarm is configured for 12:00 and the periodic output is configured to switch on 5 minutes before evaluating the message, the output will be switched on at 11:55 and the message will be evaluated at 12:00.

Note that while periodic alarms evaluate periodic messages, the two systems run independently. This means that a periodic message will still operate as normal if both it and a periodic alarm pointing to it are enabled. It is recommended to set the periodic message time to 0 using ***PERIODIC_MSG** if using an alarm to avoid confusion.

Usage:

***PERIODIC_ALARM=N:E,P,M,HH:MM<CR>**

Where:

N is the alarm index to be configured (1 – 3). Default 1.

E is 1 to enable the alarm, 0 to disable. Default 0 (disabled).

P is the index of the periodic message to be evaluated when the alarm is triggered (1 – 3). Any outputs configured for this periodic message will also be enabled. Default 1.

M is the alarm mode. If set to 0, then the alarm will operate in absolute time mode. If set to 1, the alarm will operate in periodic mode. Default 0.

HH is, if the alarm mode has been configured for absolute time mode, the absolute hour at which the alarm will trigger on a daily basis (0 – 23). Otherwise, if the alarm has been configured for periodic mode, this represents the spacing in hours between periodic alarms (1, 2, 3, 4, 6, 8). All valid values for this mode will align with midnight (00:00) in the configured time zone. Default 0.

MM is the absolute minute value at which the alarm will trigger, regardless of configured alarm mode. If alarm is configured for periodic mode, this will **not** affect the spacing between alarms. Default 0.

Examples:

To enable alarm 1 to evaluate periodic message 1 at 12:00 PM every day:

```
*PERIODIC_ALARM=1:1,1,0,12:00<CR>
```

To enable alarm 1 to evaluate periodic message 1 at 5:30 PM every day:

```
*PERIODIC_ALARM=1:1,1,0,17:30<CR>
```

To enable alarm 2 to evaluate periodic message 3 once every two hours on the hour (i.e. 00:00, 02:00, 04:00, 06:00 etc.):

```
*PERIODIC_ALARM=2:1,3,1,2:00<CR>
```

To enable alarm 3 to evaluate periodic message 2 every 6 hours on the half-hour mark (i.e. 00:30, 6:30, 12:30, 18:30):

```
*PERIODIC_ALARM=3:,1,2,1,06:30<CR>
```

Note that when configuring periodic alarms using shorter periods (1 – 3 hours), it is recommended to enable partial message appending for modem-transmitted messages to avoid unnecessarily high battery consumption. For more information see section **ASCII Protocol -> Multiple Message Queueing**.

***ALARM_TIMEZONE**

***ALARM_TIMEZONE** is used to configure the time zone offset that is applied to configured alarm times. This should generally be set to either the local time zone of the installation or to zero to keep all alarms in UTC time.

Note that this command does not affect the output of the current epoch variable content macro, which always represents the number of seconds since 00:00 1/1/1970 UTC time.

Usage:

```
*ALARM_TIMEZONE=SHH:MM<CR>
```

Where:

S is the sign of the time zone offset ('+' or '-'). Default '+'.
HH is the time zone offset in hours (0 – 14). Default 0.
MM is the time zone offset in minutes (0 – 59). Default 0.

Examples:

To set the time zone to NZST (UTC + 12):

```
*ALARM_TIMEZONE=+12:00<CR>
```

To set the time zone to ACST (UTC + 9:30):

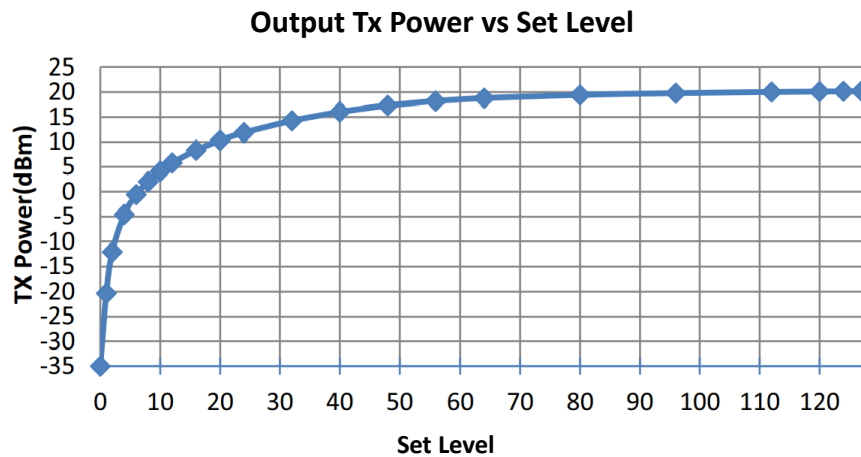
```
*ALARM_TIMEZONE=+09:30<CR>
```

To set the time zone to EST (UTC – 5):

```
*ALARM_TIMEZONE=-05:00<CR>
```


*TX_PWR

*TX_PWR sets the MReX module Transmitter Power Output levels. Level value ranges from 0 to 127. Use the following graph to determine the transmitter level value to configure. Note that settings above 80 will have very little effect on output power. This setting does not affect the transmission power of the user-installed modem. Default value is 64.



Usage:

*TX_PWR=X<CR>

Where:

X is the desired set level.

Examples :

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

*TX_PWR=20<CR>

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

*TX_PWR=55<CR>

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

*TX_PWR=80<CR>

***TX_BAUD**

***TX_BAUD** selects the baud rate used for transmissions under store forward operation (see section **Store Forward Operation** for details).

Usage:

***TX_BAUD=XXXX<CR>**

Where:

XXXX is the desired baud rate, either 512_12 for 512 baud with 12kHz channel spacing or 1200_12 for 1200 baud with 12kHz channel spacing. Both baud rates use 2 level FSK modulation. Default value 1200_12.

Example:

***TX_BAUD=1200_12<CR>**

Receive Commands

Receive commands relate only to the MReX transceiver, and do not affect operation of the user-installed modem.

***RX_FREQ**

***RX_FREQ** specifies the transceiver receive frequency in Hz.

Usage:

***RX_FREQ=XXXXXXXXX<CR>**

Where:

XXXXXXXXXX is the desired receiver frequency in Hz, limited to a range of 421000000 – 480000000 Hz. Default value 458600000.

Example:

***RX_FREQ=458600000<CR>**

***RX_BAUD**

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

Usage:

***RX_BAUD=XXXX<CR>**

Where:

XXXX is the desired baud rate, either 512_12 for 512 baud with 12kHz channel spacing or 1200_12 for 1200 baud with 12kHz channel spacing. Both baud rates use 2 level FSK modulation. Default value 1200_12.

Example:

***RX_BAUD=1200_12<CR>**

***RX_ENABLE**

***RX_ENABLE** configures the MReX radio receiver behaviour.

Usage:

***RX_ENABLE=X<CR>**

Where:

X is the desired receiver setting:

- 0 disables the receiver (<50uA operating current, default)
- 1 enables the receiver and allows configuration commands at any time (~18mA operating current)
- 3 enables the ultra low current receiver mode (<200uA operating current)

Example:

RX_ENABLE=3<CR>

***RX_MODE**

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

Usage:

***RX_MODE=XXXX<CR>**

Where:

XXXX is the desired receiver mode:

- POSCAG_A must be used in order to receive alphanumeric messages (default).
- 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).

Example:

***RX_MODE=POSCAG_A<CR>**

***RX_RANGE**

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

Usage:

***RX_RANGE=N:LLLLLL,HHHHHHH<CR>**

Where:

N is the index of the RIC range to be configured, 1 - 4.

LLLLLL is the lowest RIC code to match for the specified range (default 8 for N=1, 0 otherwise).

HHHHHHH is the highest RIC code to match for the specified range (default 2000000 for N=1, 0 otherwise).

Example:

***RX_RANGE=1:8,2000000<CR>**

***CH_BUSY**

***CH_BUSY** sets the channel busy level for the configured channel.

Usage:

***CH_BUSY=BB<CR>**

Where:

BB is the signal level from 0 to -130 (in dBm) (default -80).

Example:

***CH_BUSY=-100<CR>**

***RX_SUFFIX**

***RX_SUFFIX** configures the string that is appended to received RF messages that will be forwarded via the fitted modem.

Usage:

***RX_SUFFIX=SS<CR>**

Where:

SS is the string to be appended to all received RF messages that follow the ASCII protocol format before being queued for transmission via the fitted modem. Strings can contain variable content macros that will be expanded before transmission (see **Protocols -> Variable Content Macros** for more information). Strings can be up to 100 characters long. Default value is an empty (zero-length) string. For more information about how this feature operates, see **Protocols -> RF Link Message Queuing**.

Example:

***RX_SUFFIX=BATT:**05<CR>**

Base Commands

***REBOOT**

***REBOOT** triggers an immediate restart of the unit. This command should be called after performing any configuration.

Usage:

***REBOOT<CR>**

***CONFIG**

***CONFIG** displays current configuration as a list of commands and parameters.

Usage:

***CONFIG<CR>**

***SAVE**

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

Usage:

***SAVE <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>**

***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>**

***RSSI**

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

Usage:

***RSSI<CR>**

***RS422_OPTS**

***RS422_OPTS** configures the baud rate and sleep behaviour of the RS422 connection. This allows for low power operation to be enabled/disabled. When disabled, no leading character is required to wake the device from sleep. When enabled, a leading character is required to precede any serial communication to the device and overall current consumption is reduced by 1.6mA when not actively sending or receiving serial data. By default, baud rate is 9600 and low power serial is disabled.

Usage:

***RS422_OPTS=A,B<CR>**

Where:

A is the desired baud rate for the RS422 connection. Available rates are:

- 4800
- 9600 (default)
- 19200
- 38400
- 57600
- 115200

B enables or disables low power serial operation:

- 0 to disable low power serial operation (default)
- 1 to enable low power serial operation

Example:

***RS422_OPTS=9600,1<CR>**

Store Forward Commands

Store forward operation is used to listen to transmissions in the area, decode the messages and re-transmit again to provide greater coverage than would normally be possible. This is an optional licensed feature.

Note: In order to forward messages the decoded message RIC codes must fall within the configured RIC ranges (see ***RX_RANGE** command documentation).

***STORE_FWD**

Configures the store forward operation.

Usage:

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

Where:

XX is the **Store Forward Operation** (default 0).

YY is the **Duplicate Reject Operation** (default 0).

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 re-queuing of messages can be controlled. Duplicate reject only tests the previous 5 messages in the historic transmit queue.

Example:

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

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

Swarm Modem Commands

Swarm Modem commands allow control over modem operating parameters, in particular dealing with power savings.

Normally a Swarm modem message is sent in around 1-2 hours, however depending on satellite position, it is possible for up to 4 hours to pass before a message can be transmitted. If the antenna is damaged or other factors are at play preventing messages being sent, the modem can possibly be powered for extended periods, potentially depleting its battery. The following options give the user control over the behaviour of the unit to manage battery usage during unexpected conditions.

Through the MODBUS command, Modbus added messages can be configured to auto delete from the message queue if they could not be transmitted.

*SWARM_OPTS

*SWARM_OPTS specifies Swarm modem control options

Usage:

*SWARM_OPTS=AA,BB,CC,DD,EE,FF<CR>

Where:

AA is the Shutdown duration in seconds. Should the Swarm modem fail to transmit its queued messages (after being on for the Awake duration), the modem will enter a low power state for this entire duration. If at any time a new message is added to the Swarm message queue, the shutdown duration will be cancelled, and the modem will be powered up immediately and attempt a transmission. Default value is 21600 (6 hours).

BB is the Sleep duration in seconds. If set to greater than 0, the Swarm modem will cycle between its sleep mode and awake mode while in its active state. The awake time is always 60 seconds after acquiring a valid timestamp. Setting the sleep time to its maximum value of 240 seconds (4 minutes) will give a minimum waking duty cycle of 20%. This allows for further power saving while the unit is active, but will prevent transmission while the unit is asleep and will require some time on wakeup to re-acquire a valid timestamp. Default value is 0 (unit does not sleep while active).

CC is the Awake duration in seconds. This is the maximum duration that the modem will remain powered on waiting for a message to be transmitted. If a message cannot be transmitted within this period, the modem will be held in a low power state for the Shutdown period before attempting the transmission again. Default value is 21600 (6 hours). A value of less than 15000 is not recommended. A value of 0 is legitimate, and will result in the modem remaining powered indefinitely.

DD is reserved for future use.

EE configures the modem message appending behaviour of the SatLink. If set to 0, then each individual message is queued as a separate transmission via the fitted modem. If above 0, then this number represents the maximum number of messages queued via the ASCII protocol that will be appended together into a single transmission. If a message being appended will cause the existing group of appended messages to overrun the modem transmit buffer, then the existing group of appended messages will be queued for transmission via the modem and the new message will become the first part of a new appended group of messages (see **Protocols -> ASCII Protocol -> Multiple Message Queuing** for further details). Messages received via RF link that conform to the ASCII protocol are also appended (see **Protocols -> RF Link Message Queuing** for details on this behaviour).

FF is reserved for future use.

Example:

```
*SWARM_OPTS=21600,0,21600,0,0,0,0<CR>
```

Modbus Protocol Commands

*MODBUS

*MODBUS configures the Modbus Slave behaviour of the SatLink.

Usage:

*MODBUS=A,B

Where:

A = Modbus ID (default 78 (0x4E)). Valid 0-255 (excluding 0x2A and 0x57).

B = Swarm Tx Expiry Time in seconds for Modbus added messages (default 43200). Valid 0 – 65536. The value of 0 is assigned to set queued messages to never expire (removed only manually via Modbus command or after successful transmission). Messages that expire are dropped from the Swarm transmission queue. This option is useful if there is a condition that prevents normal transmission, ensuring that stale historic data is not sent through the satellite network.

Example:

*MODBUS=78,43200<CR>

*MASTER_MODBUS

*MASTER_MODBUS configures the Modbus master behaviour of the SatLink. Up to 3 different Modbus requests can be configured. Do not use this option if the SatLink is operating as a Modbus slave device. For further information, refer to the **Protocols ->Modbus Master Operation** section of this manual.

Usage:

*MASTER_MODBUS=N:A,B,C

Where:

N = Index of the modbus request to be configured (1 – 3).

A = Target device address for request (0 – 255) (default 0).

B = Starting register to read from device (0 – 65535) (default 0).

C = Number of registers to be read from device (1 – 2, 0 to disable this request) (default 0).

Example:

*MASTER_MODBUS=1:10,0,2<CR>

ASCII Protocol Commands

ASCII Protocol commands allow control over formatting of raw ASCII data that can be sent the satellite modem. See ASCII Protocol for full protocol and formatting details.

When using the ASCII protocol for transmitting messages using the satellite modem, most of the functionality available when using the Modbus protocol is available through the standard system commands. Functionality that is not available in this manner is instead provided by the following commands:

***ASCII_OPTS**

***ASCII_OPTS** specifies the starting character used when formatting ASCII protocol commands.

Usage:

***ASCII_OPTS=S<CR>**

Where:

S = Starting character for ASCII protocol commands (default '\$').

Example:

***ASCII_OPTS=\$<CR>**

***ASCII_CMD**

***ASCII_CMD** allows specific functions that are available through the Modbus protocol but unavailable through standard system commands to be used.

Usage:

***ASCII_CMD=N<CR>**

Where:

N = Number corresponding to a specific operation:

- **1** to cycle power to installed modem
- **2** to clear all queued messages

Example:

***ASCII_CMD=2<CR>**

***ASCII_STATUS**

***ASCII_STATUS** provides runtime information for the unit. Sending the command ***ASCII_STATUS** returns the following:

Usage:

***ASCII_STATUS?<CR>**

Returns:

***ASCII_STATUS=A,B,C,D,E,F<CR>**

Where:

A = System status bitmap:

- 0x02 = Unit has one or more messages queued on MReX.
- 0x04 = Unit has one or more messages queued on Swarm modem.
- 0x08 = Unit has acquired a valid time. Cleared on reset or sleep.
- 0x20 = Swarm modem has completed at least one transmission since last message was queued. Cleared when any message is sent to the modem for transmission.
- 0x40 = MReX uptime has exceeded 65535 seconds and the uptime value has wrapped. Cleared on system restart.
- 0x80 = Swarm modem uptime has exceeded 65535 seconds and the uptime value has wrapped. Cleared on system restart.

B = Swarm modem uptime (in seconds). Reset when modem is powered down.

C = Total unit uptime (in seconds). Reset when power is applied to the MReX-Satlink.

D = Successful Swarm transmission count.

E = Number of messages queued to Swarm modem.

F = Number of messages queued by MReX locally.

Protocols

The MReX supports several protocols for transmitting data via the fitted modem. The desired protocol (Modbus or ASCII) can be selected using the ***TX_PROTO** command. Both protocols accept WT protocol messages and standard configuration commands in addition to their specific formats.

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 user may choose to use this protocol for direct message transmissions.

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)

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):

- 0 = 512 Baud 2 Level FSK (25 kHz channel spacing)
- 1 = 1200 Baud 2 Level FSK (25 kHz channel spacing)

<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 message.

WT1234560A10WT1222222A10<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 codes 1234560 and 1222222 as a 512 baud POCSAG message and also RIC codes 0201234 and 0005647 as a 1200 baud POCSAG message.

WT1234560A10WT1222222A10WT0201234A11WT0005647A11<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.

Serial Only Output

There is sometimes a need to only send WT protocol messages out a serial port and not transmit on a particular event. For example, it might be useful to use the periodic message to send a health check message out the serial port once every 30 seconds.

Example:

To send the message “HEARTBEAT” out the serial port once every 30 seconds, use the following command:

```
*TX_PERIODIC=1:30,0,0,WTS<SPACE>HEARTBEAT<CR>
```

This will result in the following message

```
HEARTBEAT<CR>
```

being send out of the RS422 connection by the SatLink unit once every 30 seconds.

Modbus RTU

The MReX-SatLink can accept messages for transmission using the Modbus RTU protocol, connected through the RS422 port.

Default configuration sets a Modbus device ID of **0x4E** (configurable using the ***MODBUS** command). On power reset all Swarm messages not transmitted after the Swarm Tx Expiry Time will be dropped from the outgoing message queue.

All communications are via a RS422 serial interface, operating by default at **9600:N:8:1**. Baud rate can be configured via the ***RS422_OPTS** command.

If low power RS422 configuration option is enabled, RS422 serial activity will wake the MReX-Sat-link from its low power mode of operation. To ensure the first character after waking is not corrupted, a NULL character (**0x00**) is recommended to precede all Modbus packets. For further information about this setting, see ***RS422_OPTS** command documentation.

Function Codes

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

Function Code	Description	Valid Address Range	Register(s)
02- Read Discrete Inputs	Read Digital Inputs	0x0000 – 0x0003	10001-10004
03- Read Holding Registers	Read Status register Read Swarm Uptime Read MReX Uptime Read Swarm Tx Count Read MReX queue len Read Swarm queue len Read System Voltage Read Modem RSSI Read Modem SNR Read MReX RSSI Read Message Buffer Len Read Message Buffer	0x0000 0x0001 0x0002 0x0003 0x0004 0x0005 0x0006 0x0007 0x0008 0x0009 0x02FF 0x0300 – 0x034F	40001 40002 40003 40004 40005 40006 40007 40008 40009 40010 40768 40769-40848
04 – Read Input Registers	Read Analog Inputs	0x0000 – 0x0007	30001-30008
06 – Write Single Register	Write Special Function Command	0x0100	40257
16- Write Multiple Registers	Write Message Buffer (192 bytes) Write Message Buffer And Transmit (192 bytes)	0x0300 – 0x03BF 0x0400 – 0x04BF	40769-40960 41025-41216

Modbus Mapping Table

Base Address	Num Registers	Description	R/W	Bits
40001	1	Status Bitmap 0x02 – MReX Messages queued 0x04 – Swarm Messages queued 0x08 – Valid Time 0x20 – TX Complete (1 when at least one message tx and tx queue is 0) 0x40 – MReX uptime has exceeded 65535 seconds (uptime register wrapped) 0x80 – Swarm modem uptime has exceeded 65535 seconds (uptime register wrapped)	R	16
40002	1	Swarm Up Time (seconds)	R	16
40003	1	MReX Up Time (seconds)	R	16
40004	1	Swarm Message Tx Count (messages successfully transmitted since last MReX reboot)	R	16
40005	1	MReX message queue len (messages accepted by MReX, but not yet by Swarm)	R	16
40006	1	Swarm message queue len (messages accepted, but not yet transmitted)	R	16
40007	1	System Voltage (dV)	R	16
40008	1	Last RSSI value received from modem (dB, two's complement signed integer)	R	16
40009	1	Last SnR value received from modem (dB, two's complement signed integer)	R	16
40010	1	Current RSSI detected by the MReX RF module (dB, two's complement signed integer). This will always return -128 if the receiver is disabled	R	16
40257	1	Special Function Command 0x01 – Reboot MReX (plus Swarm) 0x02 – Reboot Swarm 0x03 – MReX Process Buffer 0x04 – Clear Message Buffer 0x11 – Swarm Transmit Buffer 0x12 – Clear Swarm Queue	W	8
40768	1	Message Buffer Len (set when loading the message buffer)	R	16
40769	96	Append to Message Buffer (Send after special function command 0x11). Allows multiple messages to be sent per swarm transmission.	R/W	16

Base Address	Num Registers	Description	R/W	Bits
41025	96	Message Buffer (Immediate send once written, write clears existing appended messages)	W	16

Minimum Operation Requirements

1) Send Modbus message (message type 0x10 Address 0x0400) up to 192 bytes.)

Example:

Device ID is 0x4E (default) payload is "Hello" (0x48, 0x65, 0x6c, 0x6c, 0x6f)

Packet payload in example is 3 registers (each of 2 bytes), and message length is 6 bytes (5 for message plus one padding). There is one trailing padding byte of value 00 (since payload length must be a multiple of 2), followed by 2 CRC bytes. Note the leading 0x00 character to reliably wake the unit from deep sleep. This character should not be considered during calculation of the 2 CRC bytes.

00 4E 10 04 00 00 03 06 48 65 6c 6c 6f 00 XX XX

2) Minimum sequence complete. The unit will now apply power to the modem and remain in its standby state until either the message has been transmitted or the configured maximum awake time has passed. The message transmitted to the Swarm network will be:

Hello<0><N>

Where:

<0> is a null character added by the trailing 00 byte in the Modbus request.

<N> is the current message sequence number (0x00-0xFF).

Optional Robust System Operations

- Check length of queued message
- Check if message transmitted
- Check number of messages queued (on Swarm tile or MReX)
- Check Swarm device up time

Optional Recovery Operations

- Reset the unit(s)
- Clear message queues (Swarm message queue is non-volatile). Message queue can become very long. Message queues are automatically cleared on successful transmission.
- Change auto drop expiry times. Provides options for auto discarding messages should they become old.

Efficient Transmission Mode

To reduce message costs, multiple messages can be appended to the same outgoing message (up to a length of 192 bytes). The appended message buffer can be read before adding a message to the outgoing message buffer to prevent an overflow. Once the message is of a suitable length, a Modbus command can be issued to invoke a queuing to the modem.

Examples

Transmit a Simple Message (odd length payload):

In this example the Modbus ID is configured to be 0x4e (default). Payload is “Hello” (with single trailing padding byte).

4E 10 04 00 00 03 06 48 65 6C 6C 6F 00 AA 42

Transmit a Simple Message (even length payload):

In this example the Modbus ID is configured to be 0x4e (default). Payload is “Hello2” (with NO trailing padding byte).

4E 10 04 00 00 03 06 48 65 6C 6C 6F 32 2B 97

ASCII Protocol

Overview

The MReX-SatLink can accept messages for transmission over the Swarm network using the plain-text ASCII protocol. This protocol is used over the external RS422 connection, and consists of a configurable start character, followed by the message payload. The default start character for the ASCII protocol is '\$'.

Message Format:

<S><P...P>

Where:

<S> is the configured ASCII protocol start character (default '\$').

<P...P> is the message payload to be transmitted. This can include non-printable characters such as carriage returns, line feeds and record separator characters.

Note that transmitted messages do not include the ASCII start character. Any trailing carriage return character will be included in the transmitted payload.

For example, to queue the string "THIS IS A TEST MESSAGE" for transmission over the Swarm network, the following command should be used (assuming a default starting character configuration of '\$'):

\$THIS IS A TEST MESSAGE

This will result in the following message being transmitted over the Swarm network:

THIS IS A TEST MESSAGE<N>

Where:

<N> is the current message sequence number (0x00 - 0xFF).

While the start character is configurable, the two characters '*' and 'W' are unavailable as configuration options due to their use by the WT protocol and command handlers.

Periodic Message Integration

ASCII protocol message commands can also be used in conjunction with the ***TX_PERIODIC** command. Using the configuration command

```
*TX_PERIODIC=7200,0,0,$THIS IS A PERIODIC MESSAGE<CR>
```

will result in the message

```
THIS IS A PERIODIC MESSAGE<N>
```

being queued for transmission over the Swarm network once every two hours. Note that the carriage return included at the end of the ***TX_PERIODIC** command is not included in the final transmitted payload.

Multiple Message Queuing

If partial message queuing has been enabled via the ***SWARM_OPTS** command, then a minimum number ASCII protocol messages will be appended into a single transmission via the fitted modem. If an ASCII protocol message will cause the existing partial message to become too long for the fitted modem, then the existing partial message will be transmitted and the new ASCII protocol message will become the basis of a new appended transmission.

For example, using the configuration command

```
*SWARM_OPTS=7200,0,21600,0,4,0<CR>
```

will configure the SatLink unit to append 4 ASCII protocol messages into a single transmission if possible. As a result, the ASCII protocol commands

```
$TEST MESSAGE 1,  
$TEST MESSAGE 2,  
$TEST MESSAGE 3,  
$TEST MESSAGE 4,
```

repeated 4 times will result in the appended payload

```
TEST MESSAGE 1,TEST MESSAGE 2,TEST MESSAGE 3,TEST MESSAGE 4,<N>
```

being transmitted via the fitted modem. Note that the transmission sequence byte is only applied to the very end of the transmission, and not for each appended message.

When configuring this functionality, it is recommended to consider the expected number of messages over the desired modem transmission period. For example, if expecting 3 messages in a day then configuring the unit to append 3 messages will result in more predictable modem transmission behaviour.

For ease of use, it is recommended to include an easily recognisable separator at the start or end of each message, as the partial message appending functionality does not apply any additional formatting. The above example uses a comma character for this purpose.

Modbus Master Operation

The SatLink optionally supports the reading of Modbus holding registers from connected devices as a master unit. Up to three read operations can be defined, with each reading up to two consecutive registers. Some devices may store a single value across multiple registers. For example, a 32-bit analog float value would be stored across two consecutive 16-bit registers. These read operations could all read from the same connected device, or each could be reading from a separate device on the RS422/485 bus. For configuration of Modbus read operations, refer to the **Configuration -> *MASTER_MODBUS** section of this manual. For usage of read Modbus registers, refer to **Protocols -> Variable Content Macros**.

If configured, each Modbus request is executed automatically in the background once every 1-6 seconds (depending on the number of requests configured), with the corresponding macro giving the most recent read value for that request. Currently, the SatLink only supports the Read Holding Registers (**03**) command.

The SatLink unit cannot operate as a Modbus master unit while also being utilised as a Modbus slave device, as this may result in conflicts between the SatLink and the external master unit. Configuring the SatLink to operate with the ASCII protocol instead allows for easy access and reading of external Modbus slave devices.

RF Link Message Queuing

Overview

The MReX-SatLink supports the queuing messages received over its RF link for transmission via the fitted modem. This mode of operation is useful for monitoring one or more remote sensors that are not easily accessible under normal circumstances.

On receiving an RF Link message, the SatLink will attempt to process the message using the ASCII Protocol (see **Protocols** -> **ASCII Protocol** for more information regarding this protocol). Additionally, if the user has configured a suffix string for received RF link messages (see **Receive Commands** -> ***RX_SUFFIX** for configuration instructions), this will be appended to the message before processing. This suffix can contain variable content macros which will be processed before transmission via the installed modem.

Note that for this feature to function, the unit must be configured to operate with the **ASCII Protocol** (see **Transmit Commands** -> ***TX_PROTO** for configuration instructions).

Example – Single Message

For example, receiving the message

\$TEST MESSAGE

via the RF link will result in the message

TEST MESSAGE<N>

being queued for transmission via the fitted modem. If the ***RX_SUFFIX** configuration has been set using

RX_SUFFIX=,05<CR>**

then assuming a system battery voltage of 3.6V, receiving the above message will result in the message

TEST MESSAGE,3.60<N>

being queued for transmission via the fitted modem.

Example – Appended Messages

In another example, if the modem message appending option has been set to three messages (see **Swarm Commands** -> ***SWARM_OPTS** for configuration instructions) and the ***RX_SUFFIX** configuration has been set using

```
*RX_SUFFIX=, "batt": "***05", "time": "***EEEEEE" }<CR>
```

Assuming a constant SatLink battery voltage of 3.60V, receiving the messages

```
${ "id": "unit_1"  
${ "id": "unit_2"  
${ "id": "unit_3"
```

at Unix epoch times of **1695351117**, **1695351138** and **1695351253** respectively will result in a final payload of

```
{ "id": "unit_1", "batt": "3.60", "time": "650D014D" }  
{ "id": "unit_2", "batt": "3.60", "time": "650D0162" }  
{ "id": "unit_3", "batt": "3.60", "time": "650D01D5" }<N>
```

being transmitted via the fitted modem.

Note that if message appending is enabled, then ASCII protocol messages queued both through local periodic messages and incoming RF messages will all be appended into the same transmission.

Variable Content Macros

Both the WT and ASCII protocols support a series of variable content macros that allow for current system information to be included in messages transmitted over POCSAG or the Swarm network. The usage of tags for both protocols is identical. A list of available tag types and ranges is outlined in the table below:

Tag	Description	Typical Output
**05	Returns the current system battery voltage, rounded to 2 decimal places (V)	3.60
**06	Returns the current internal temperature of the SatLink unit, rounded to 1 decimal place (°C)	25.0
**II	Returns the current state of all digital inputs as a 4-digit binary number	1010
**A(X)	Returns a specified analog input as a 2-byte hex value, index specified by (X) (1 - 4)	01FA
**MMMM0(X)	<p>Returns the most recent value read by the configured Modbus master request specified by (X) (1 - 3) For further details on configuration, see Configuration -> *MASTER_MODBUS.</p> <p>Note that even if a configured Modbus request only reads out a single 16-bit register, the macro representation will still be in the form of a 32-bit hex value with leading zeros.</p> <p>If an error has occurred when reading from an external sensor, the macro will instead be replaced with an error message. All error messages begin with "ERR".</p> <p>ERR-TOUT indicates no reply was received from the external device.</p> <p>ERR--CRC indicates that the received reply was corrupted.</p> <p>ERR-EXNN indicates that an exception code was received from the external device, where NN is the received exception code. All exception codes are outlined in the Modbus standard.</p>	12FE45AC ERR-TOUT ERR--CRC ERR-EX02
**EEEEEE	<p>If a valid GPS UTC timestamp has been acquired by the fitted modem at any point since startup, this will return the current Unix epoch time (seconds since January 1st, 1970) as a 4-byte hex value.</p> <p>If no timestamp has been acquired since startup, this macro will return the number of seconds since the unit powered up, also formatted as a 4-byte hex value</p>	650D01D5

Tag	Description	Typical Output
**TTTTTTTTTTTT	If a valid GPS UTC timestamp has been acquired by the fitted modem at any point since startup, this will return that timestamp in YYYYMMDDHHmmSS format. Output is always UTC time.	20230112134123
**TM	Returns the number of minutes since the last valid GPS timestamp has been acquired from the fitted modem. If no timestamp has been acquired, then the returned value represents the number of minutes since the unit was powered on. Output format is a 2-byte hex value.	001F
**R(X)	Returns the contents of the Modbus register specified by (X). Available (X) values are 0-9, corresponding to registers 40001 – 40010 . See section Modbus RTU -> Modbus Mapping Table for descriptions of these registers. All returned values are represented in 2-byte hex format.	12FE

Examples

For example, to queue a message containing the system battery voltage, the current level of analog input 3 and the value returned by an external Modbus sensor assigned to Modbus master configuration index 1, the following message can be used:

\$ BATT: **05, VOLTAGE: **A3, M1: **MMMM01

Assuming a current battery voltage of 3.6V, an input voltage level of 2.5V on analog input 3 (read value of 511) and a Modbus external sensor that returns the value 32516, the resulting queued message would be:

BATT: 3.60, VOLTAGE: 01FF, M1: 00007F04

The variable content macro functionality can also be used to assemble message formats used by other services, such as the JSON format commonly used by IOT services. The above example could be easily be modified to produce a JSON string with the command

\${ "BATT": "05", "VOLTAGE": "**A3", "M1": "**MMMM01" }**

which will produce the message

{ "BATT": "3.60", "VOLTAGE": "01FF", "M1": "00007F04" }

Timestamp Macros

When using the current epoch time macro (****EEEEEE**) if the SatLink unit has not acquired a valid GPS timestamp from the fitted modem, then the returned value will represent the current number of seconds since startup.

For example, if the message

\$EEEEEE**

is evaluated 30 seconds after startup and before acquiring a valid GPS timestamp, the resulting message would be

0000001E

If a valid UTC timestamp with an equivalent Unix epoch of **1695354533** is acquired, then the immediate resulting message would be

650D0EA5

This value counts up by 1 every second and is refreshed with each new UTC timestamp received.

When using the current timestamp macro (****TTTTTTTTTTTT**) if the fitted modem has not yet acquired a valid timestamp since restart this macro will always produce a timestamp of all zeros. If the fitted modem has at some point acquired a valid timestamp since the SatLink unit powered up, then this will produce the most recently received timestamp in YYYYMMDDHHmmSS format. This can be combined with the ****TM** macro (minutes since receiving the last valid timestamp) to determine the time that a message was transmitted.

For example, if the message

\${ "timeRef":"TTTTTTTTTTTT", "minCount":"**TM" }**

is evaluated 20 minutes after startup and the unit has not yet acquired a valid timestamp from the fitted modem, then the resulting message will be

{ "timeRef":"00000000000000", "minCount":"0014" }

If a valid timestamp is received from the fitted modem at **12:34:56 on 15/4/2023** (UTC time), then the resulting message (if evaluated immediately) will be

{ "timeRef":"20230415123456", "minCount":"0000" }

2 hours later, if no other timestamp has been received from the modem, then the resulting message will be

{ "timeRef":"20230415123456", "minCount":"0078" }

Where the **minCount** value of **0078** represents 120 minutes since receiving the timestamp specified by **timeRef**.

Modbus Register Macros

The Modbus Register macro (****RX**) is useful for providing diagnostic information from the unit remotely without requiring a direct serial connection. For example, configuring the message

\$R0 **R1 **R2 **R3 **R4 **R5 **R6 **R7 **R8 **R9**

to be evaluated once per day would provide valuable information about the general operation and health of the unit.

An example of one of these messages would be:

002C 0258 5460 0014 0000 0004 0026 FF9F FFFE FF80

Where:

002C is the current status bitmap (modem messages queued, valid time acquired, at least one modem transmission has occurred).

0258 is the current modem uptime (600 seconds or 10 minutes).

5460 is the current SatLink unit uptime (21600 seconds or 6 hours).

0014 is the number of modem transmissions (20).

0000 is the number of messages queued on the MReX module (0).

0004 is the number of messages queued on the fitted modem, awaiting transmission (4).

0026 is the current system battery voltage in dV (38 dV or 3.8V).

FF9F is the last RSSI reported by the fitted modem (-97dBm, represented as two's complement).

FFFE is the last SNR reported by the fitted modem (-3 dBm, represented as two's complement).

FF80 is the current RSSI detected by the MReX module transceiver (-128 dBm, represented as two's complement).

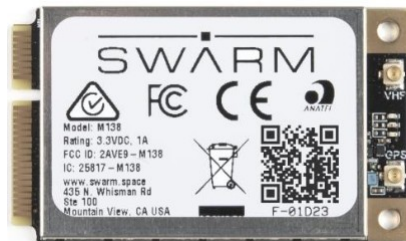
Optional Modems

Swarm M138 Modem

The Swarm M138 modem allows data to be shifted using the Swarm satellite network (owned by SpaceX).

Advantages: Global coverage.

Disadvantages: Can take up to several hours to send a message. High average power use.



WTE-Cell-PCIe Modem

This modem uses a near global SIM card to shift data using a cellular data connection.

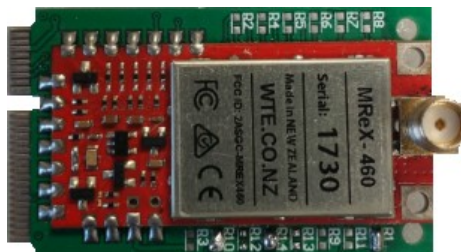
Advantages: Much lower average power requirements. Messages delivered in less than a minute.

Disadvantage: Must be range of a cell tower in order to exchange data.



WTE-MReX-PCIe Modem

This modem can be used for a second UHF radio link. Uses the Swarm M138 command set, and is a direct M138 replacement. Typically would be used to rapidly test a Swarm M138 system without needing to wait up to 2 hours for data to be exchanged.



Modem Indicators

Swarm M138:

Various LEDs indicate current state of operation. Described in Swarm M138 user documentation from the manufacturer.

WTE-PCI-Cell Modem:

Once powered (indicated by the blue MReX-Satlink LED) the red LED is initially OFF.

While waiting for network registration, the red LED is turned ON (for up to one minute typically).

After registration failure, or successful operation, the red LED is turned OFF.

If message transmission has been successful, the red LED will flash to indicate the number of messages transmitted (typically a single flash, but up to 7).

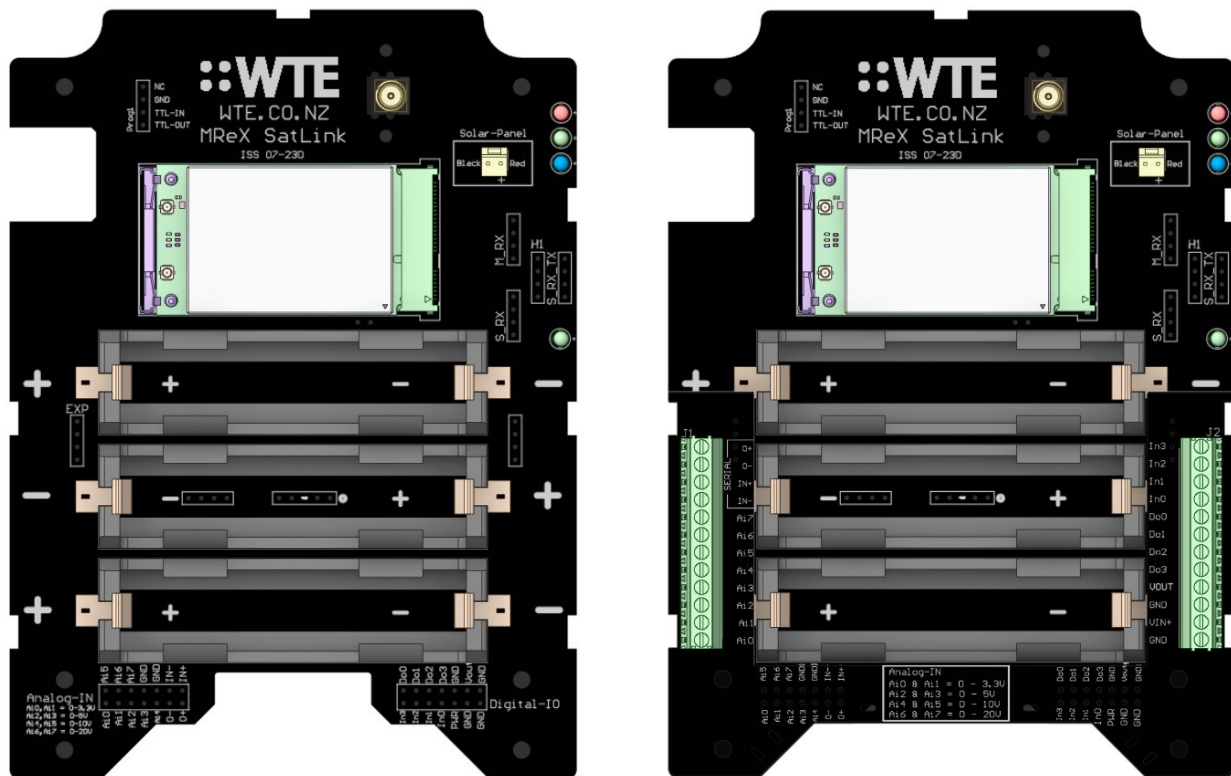
WTE-MReX-PCIe Modem:

The red LED is ON during UHF transmission. When channel is busy during transmission attempt, the red LED will flash rapidly until the channel is clear.

Internal Hardware

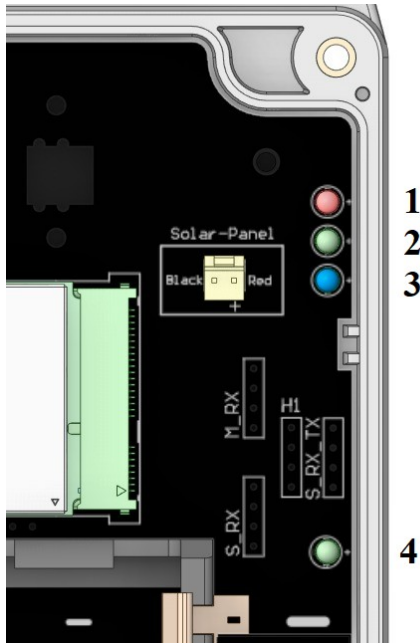
Internal Board

The MReX-SatLink internals consist of one main board (pictured left) containing a WTE-MReX module, a PCIe slot for a modem and holders for 3 HHR-380A NiMH batteries. The unit optionally includes an additional breakout board (pictured right, fitted onto the main board) which contains screw terminals for analog and digital I/O, power input, power output and RS422 connections.



Status LEDs

The MReX-SatLink is fitted with four status LEDs on the top-right corner of the internal PCB. The function of each LED is outlined in the table below:

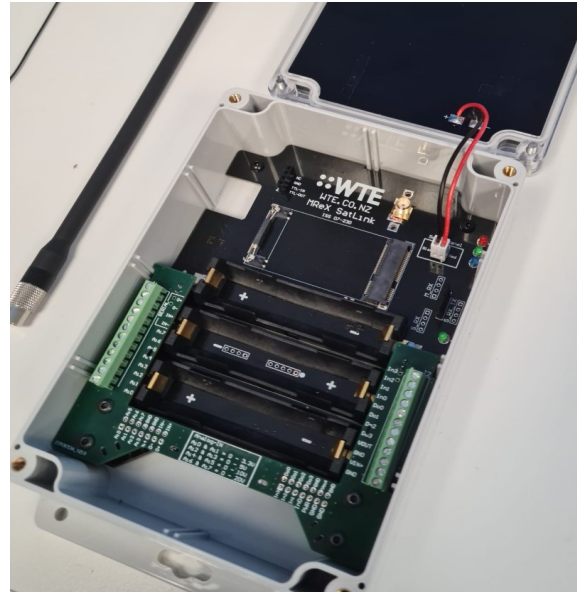
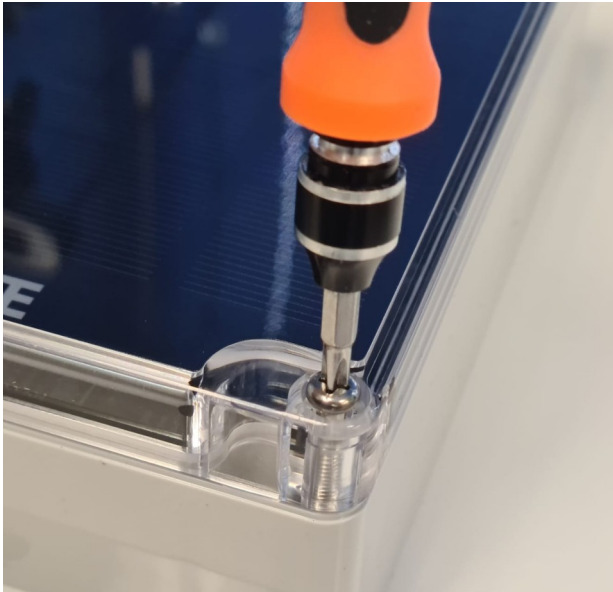


Ref #	Color	Function
1	Red	<p>Solid on indicates that the MReX module is currently transmitting via RF. This could be either a POCSAG or DMR message.</p> <p>Brief flash indicates that the SatLink is performing a battery voltage or temperature check.</p> <p>Double flash once every 30 seconds indicates that the battery is critically low (see Additional Notes -> Low Battery Protection for further details).</p>
2	Green	<p>General status LED – blinks periodically (once per second) while the unit is powered on.</p> <p>If the battery voltage falls below critical level, no flashing will occur.</p>
3	Blue	<p>Indicates that the fitted modem is currently powered up to transmit a message.</p>
4	Green	<p>Indicates communication between primary and secondary processor of the SatLink. Blinks periodically or when processing RS422 data.</p> <p>If the battery voltage falls below critical level, this LED will flash twice every 30 seconds.</p>

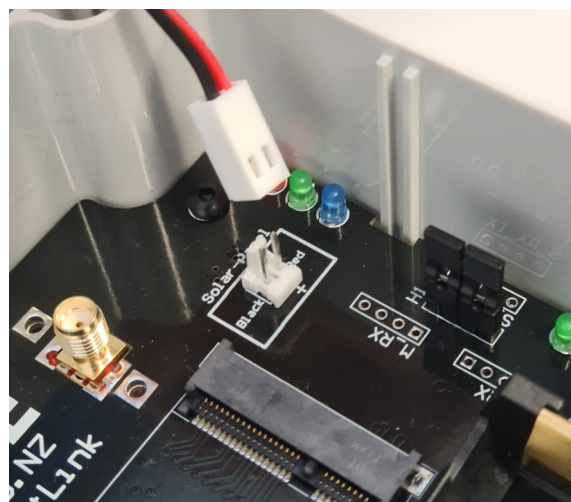
Modem Installation

By default, the MReX-SatLink does not come pre-installed with any form of modem, satellite or otherwise. It is recommended when installing a modem to use anti-static measures to reduce the risk of static damage to the SatLink or the modem being installed.

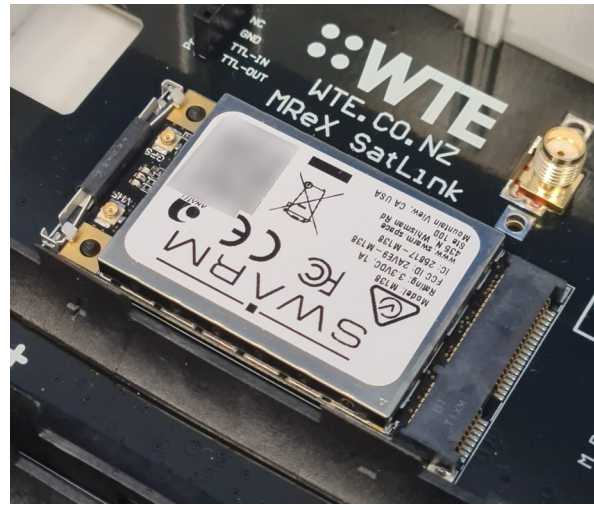
To install a supported modem, first remove the lid of the unit by unscrewing the four screws on the front of the unit and lifting the lid.



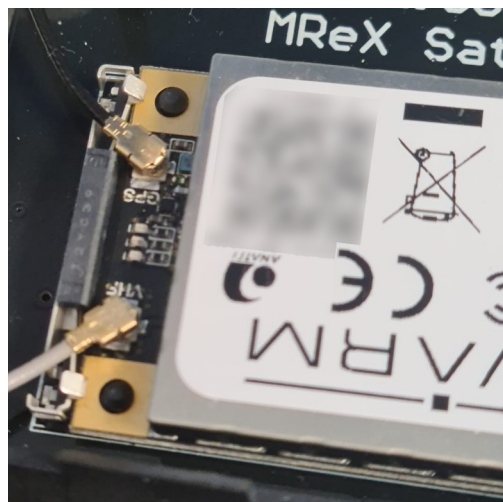
Disconnect the solar panel by pulling the keyed connector out of the header marked “Solar Panel” in the top right-hand corner of the unit.



Ensure that all batteries are removed and the device is completely powered off. Place the modem into the PCIe slot and firmly push down until it clicks into place.

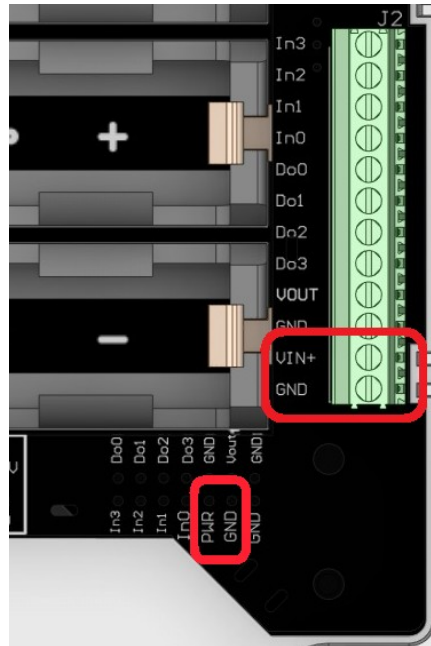


Connect any antennae that may be required by the installed modem. In this example, both a VHF antenna and a GPS antenna are required for a Swarm modem to function. For specific instructions/specifications for antennae, refer to the user manual for the modem being installed.



Power Connection

The MReX-SatLink can optionally be powered by an external 12V 3A power supply, accessible via either the internal VIN+/GND pins or to the corresponding screw terminals (if fitted with the I/O breakout board). Note that if batteries are fitted internally, they will be charged by the external power supply and will provide temporary power to the unit in the event of external power loss.

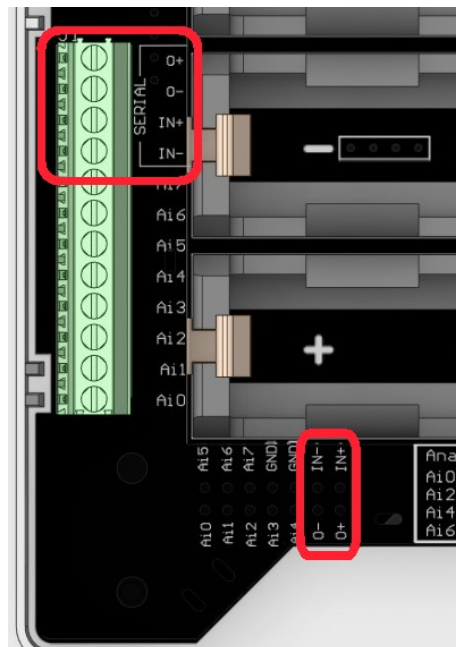


RS422 Serial Connection

The MReX-SatLink is fitted with an RS422 serial output, accessible via either the pictured pins or through the corresponding screw terminals (if fitted with the I/O breakout board). The default baud rate for this connection is 9600. For configuration information, see the section **Base Commands -> *RS422_OPTS**.

This serial connection is also used to connect to external devices if the SatLink unit is operating in a Modbus Master configuration (see **Modbus Protocol Commands -> *MASTER_MODBUS** for information regarding configuration and usage of this feature).

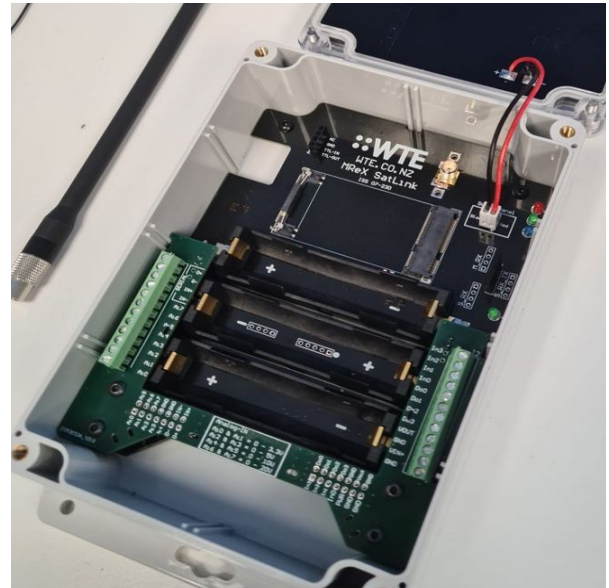
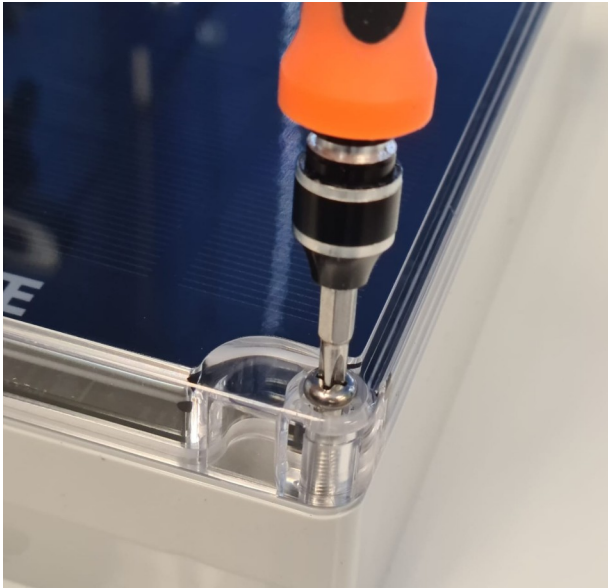
Usage of the RS422 serial connection is a licensed feature. The SatLink will not respond to commands, output any data or transmit Modbus Master requests via the RS422 connection if the feature is not enabled by the purchased license key. Configuration will have to be performed via the internal TTL serial connection (see **Internal Hardware -> Internal TTL Serial Connection**).



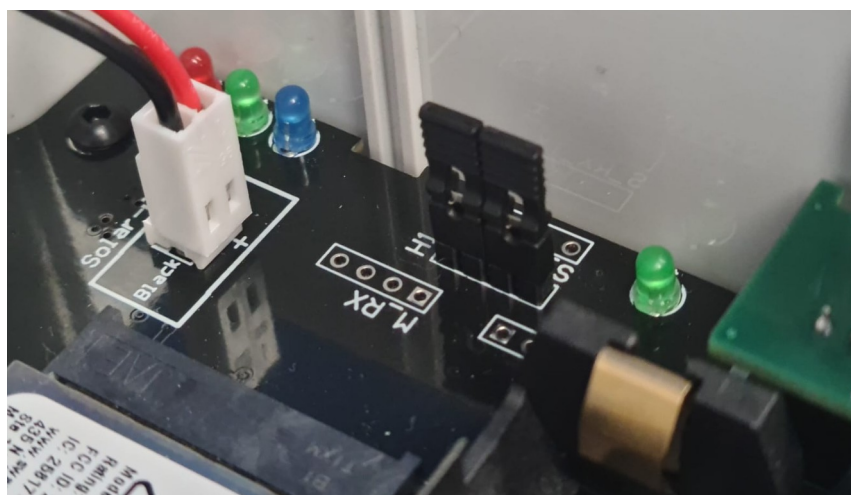
Internal TTL Serial Connection

Although the MReX-SatLink can be configured via the RS422 interface, the unit may also be configured via the internal serial connection that can be accessed using the optional TTL to USB adapter board. This connector can be accessed via the following procedure.

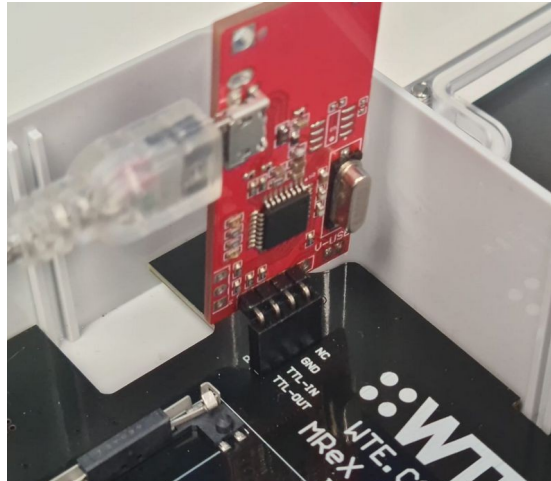
Remove the four screws holding the lid of the unit in place and lift the lid, taking care not to strain the cable connecting the solar panel to the main board of the unit.



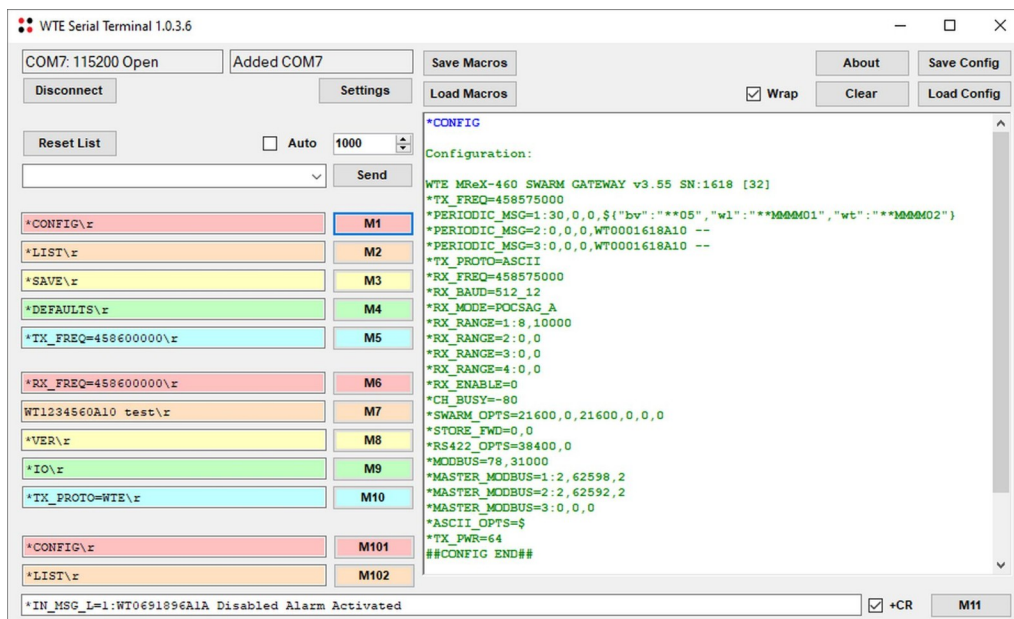
Remove the two jumpers from the header labelled **H1**, found below the status LEDs. These jumpers must be replaced before closing the unit.



Insert the TTL to USB adapter into the header labelled **Prog1**, found in the top-left corner of the device.



Connect to the SatLink using the WTE Serial Terminal with a baud rate of 115200. The WTE Serial Terminal is available for download at <https://www.wte.co.nz/tools>. This baud rate is fixed and cannot be reconfigured. All commands described in the **Configuration** section of this manual can be used.



Unit I/O

NOTICE

EXCEEDING THE RATED MAXIMUM VOLTAGE OR CURRENT FOR ANY I/O CONNECTION WILL RESULT IN EQUIPMENT DAMAGE.

- Before connecting any input or output to the MReX-SatLink, consult the **Specifications** section for maximum voltage/current ratings.

Failure to follow these instructions will result in equipment failure and will void the unit warranty.

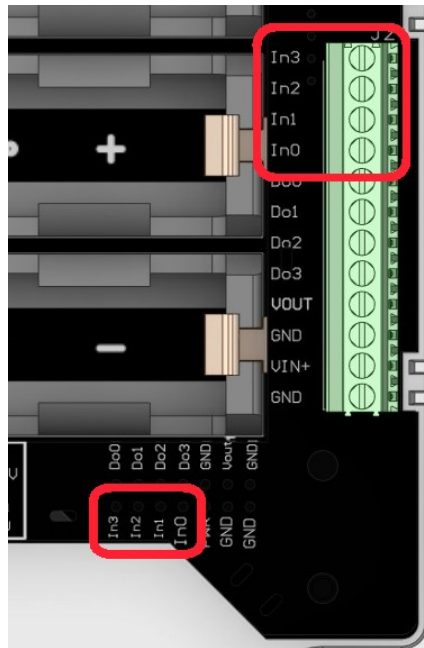
The WTE SatLink is equipped with multiple input and output options for the purposes of measurement and control. These include four digital inputs, four open-drain outputs and eight analog inputs. When used in conjunction with the built-in message append option and configurable periodic messages, the analog and inputs can provide powerful remote sensing capabilities while the digital outputs provide a means of pre-emptively powering external sensors and devices only when needed.

For information regarding the reading and transmission of unit I/O, refer to section **Protocols -> Variable Content Macros**.

For information regarding the maximum voltage/current that can be applied to any particular I/O connection, refer to section **Specifications**.

Digital Inputs

The four digital inputs available on the SatLink. Digital inputs are pulled up internally, and can be switched by pulling them to ground. These inputs are available to be read either via Modbus command (see section **Modbus** for further details) or through the message macro functionality (see sub-section **Macros** of the **Protocols** section for further details). Digital inputs are accessible via the terminals labelled **In0 – In3**.



Analog Inputs

NOTICE

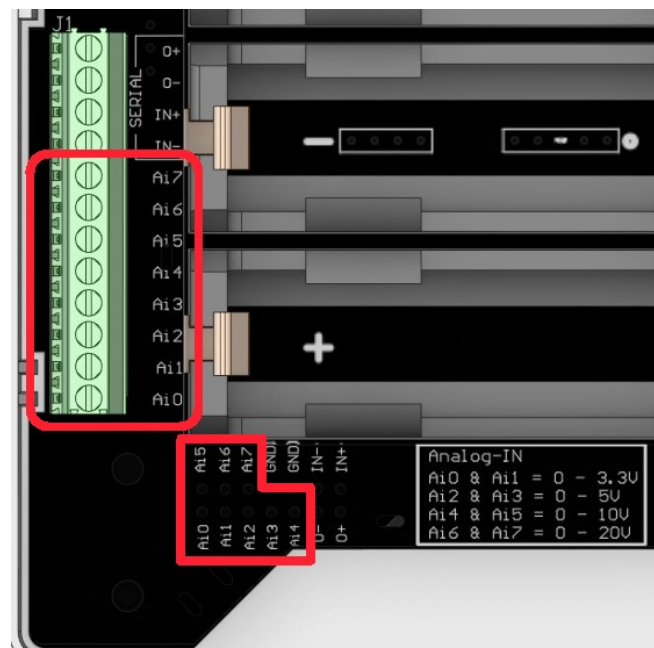
EXCEEDING THE RATED MAXIMUM VOLTAGE FOR ANY INPUT WILL RESULT IN EQUIPMENT DAMAGE.

- The MReX-SatLink has been designed for maximum analog input resolution over various voltage ranges. DO NOT EXCEED the specified maximum for any input as listed in the **Specifications** section.

Failure to follow these instructions will result in equipment failure and will void the unit warranty.

There are 8 analog inputs available on the MReX-SatLink, with different inputs designed to operate over different input voltage ranges. Analog input values are represented as 10-bit integers (0-1024) which range proportionally between 0V and the maximum allowed voltage of a given input. For example, a value of 1024 on analog input 1 represents an input voltage of approximately 3.3V, while a value of 1024 on analog input 8 represents an input voltage of approximately 20V.

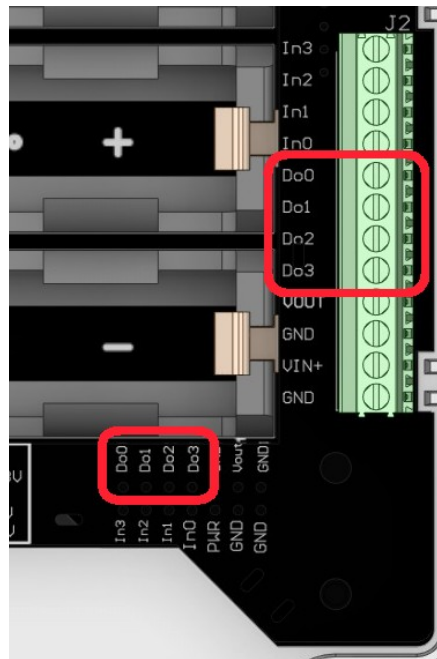
The analog inputs are accessible via the terminals labelled **Ai0 – Ai7**.



Note that the voltage limits for each analog input are printed on both the main internal PCB (to the left of the analog inputs pin header) and the I/O breakout board (in the bottom-center of the board).

Digital Outputs

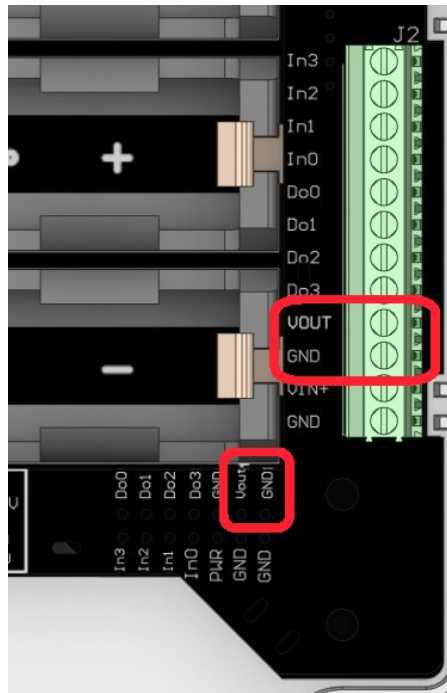
There are four open-drain digital outputs available for use on the SatLink. These outputs can be controlled via the output lead-in functionality of the periodic messaging utility. For further details on configuration and usage of digital outputs, see the **Transmit Commands -> *PERIODIC_MSG** section. The four outputs are accessible via the terminals labelled **Do0 – Do3**.



Enabling an output (setting it to the “on” state) will shift the corresponding pin into an open-drain state. This can be used to control power to an external device, such as a sensor, which may otherwise consume a large amount of current unnecessarily. The maximum rated sink current of each individual output is 100mA.

12-Volt Switched Power Supply

The MReX-SatLink is equipped with a 12V 100mA switched supply, which can be used to power external devices such as sensors directly. This output is accessible via the terminal labelled **VOUT**.



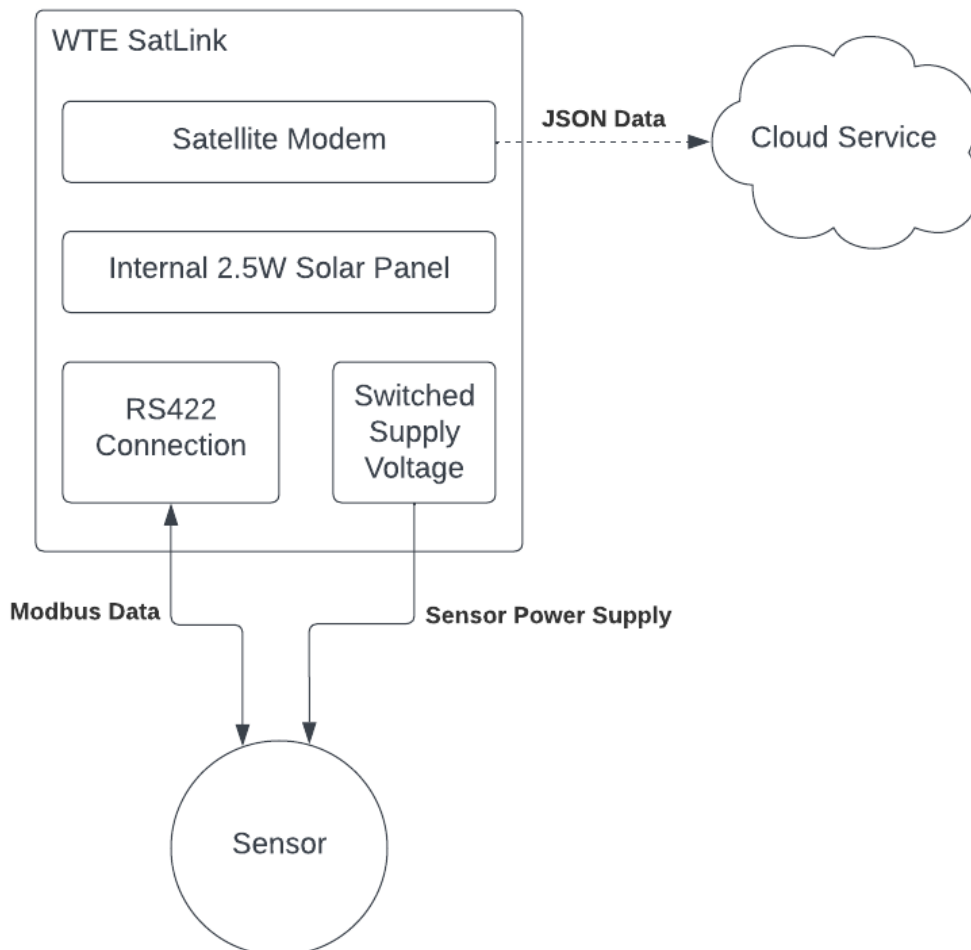
This functionality is used in the same manner as the open-drain digital outputs and is represented as Digital Output 5. For further information on the general use of digital outputs (and the 12V output), see section **Transmit Commands -> *PERIODIC_MSG**.

Usage of this feature will result in higher battery consumption. Ensure that the 12V output is not enabled any more than is necessary for a given application.

Example Implementation

External Modbus Sensor

In this example, the SatLink unit is connected to an external sensor via a 9600-N-1 RS422 connection. The sensor acts as a Modbus slave device with an address of 20, and contains a 32-bit analog data value stored across two 16-bit registers starting at address 10. The goal of this implementation is to read this analog value once every 6 hours and transmit the read value over the Swarm network in the form of a JSON string, along with the unit battery voltage. The sensor is powered from the 12V 100mA switched supply voltage for 30 seconds prior to reading out the sensor value. A block diagram for this system is shown below:



The configuration for this system is listed below:

```
WTE MReX-460 SWARM GATEWAY v3.54 SN:1618 [32]  
*TX_FREQ=458600000  
*TX_BAUD=1200_12  
*PERIODIC_MSG=1:21600,30,5,{"DATA":"**MMMM01", "BATT":"**05"}  
*PERIODIC_MSG=2:0,0,0,  
*PERIODIC_MSG=3:0,0,0,  
*TX_PROTO=ASCII  
*RX_FREQ=458600000  
*RX_BAUD=1200_12  
*RX_MODE=POCSAG_A  
*RX_RANGE=1:8,2000000  
*RX_RANGE=2:0,0  
*RX_RANGE=3:0,0  
*RX_RANGE=4:0,0  
*RX_ENABLE=0  
*CH_BUSY=-80  
*SWARM_OPTS=21600,0,10800,0,0  
*STORE_FWD=0,0  
*RS422_OPTS=9600,0  
*MODBUS=78,31000  
*MASTER_MODBUS=1:20,10,2  
*MASTER_MODBUS=2:0,0,0  
*MASTER_MODBUS=3:0,0,0  
*ASCII_OPTS=$  
*TX_PWR=64  
##CONFIG END##
```

Specific configuration items to note:

- ***TX_PROTO=ASCII<CR>**
The ASCII protocol is required for this configuration, as it makes use of the macro functionality to transmit Modbus and battery data.
- ***ASCII_OPTS=\$<CR>**
For this example, the character denoting the start of an ASCII protocol message is '\$'.
- ***RS422_OPTS=9600,0<CR>**
The SatLink unit must be configured to operate at 9600 baud over the RS422 connection. Low power operation is disabled.

- ***MASTER_MODBUS=1:20,10,2<CR>**

The SatLink unit is configured to periodically read two consecutive 16-bit registers, starting at register address 10, from the sensor which has a device address of 20. This request is assigned to Modbus master request index 1.

- ***PERIODIC_MSG=1:21600,30,5,\${"DATA":"**MMMM01", "BATT":"**05"}<CR>**

For Modbus data to be periodically transmitted to the Swarm network, periodic message 1 is configured to trigger once every 21600 seconds (6 hours) and consists of an ASCII protocol message (denoted by the '\$' character) with a JSON payload containing macros for Modbus master value number 1 (corresponding to the above configuration command) and the battery voltage. 30 seconds before the Modbus read operation is performed, the sensor is powered on using the 12V 100mA switched power supply. Once the message has been queued for transmission, the power supply is switched off.

- ***SWARM_OPTS=21600,0,10800,0,0,0<CR>**

For this application, the Swarm modem will remain powered for up to 10800 seconds (3 hours) while waiting to transmit queued messages. If a failure to transmit occurs, the SatLink will reattempt transmission when queuing the next message. Sleep cycling and RF Link message queuing options are not used in this example and are left disabled.

With this configuration, a message containing the most recent Modbus register value from the sensor as well as the SatLink battery voltage will be transmitted to the Swarm network every 6 hours. An example message (assuming a sensor Modbus register value of 250000 and a battery voltage of 3.6V) would be:

{"DATA":"0003D090", "BATT":"3.60V"}

Additional Notes

Low Battery Protection

The MReX-SatLink includes a built-in low battery protection feature. If the system battery voltage falls below 3.45V, the unit will enter hibernation mode, and will not accept any external commands or perform any transmissions. Additionally, no periodic messages will be evaluated when in this state. Once every 30 seconds, the battery voltage is rechecked. If the battery voltage is still too low, the red LED will flash twice. This gives the system time to recharge it's internal battery via the solar panel.

System Error Codes

If the MReX-SatLink encounters an error condition at runtime, the following message will be transmitted over the internal TTL serial port:

ERR:RCXX

Where XX is a number corresponding to one of the following error codes:

Error Code	Error Condition
04	The system battery voltage is too low to operate. Device enters low-power hibernation mode after transmitting this error code.
05	The onboard message FIFO is full and has had to discard the most recent message.
10	The SatLink unit coprocessor does not have any firmware loaded.

Any error codes not listed in the above table are for WTE internal use only and should be reported to support if encountered.

Troubleshooting

There are several tools for diagnosing issues with an installation/configuration. These include current status and error bitmaps, uptime counters and message queue counters.

If using the Modbus protocol for modem transmissions see section **Modbus RTU -> Modbus Mapping Table** for a list of available Modbus registers that can be used to diagnose issues.

If the ASCII protocol is used instead, the same information available in the listed Modbus registers is available via the ***ASCII_STATUS** command (see section **ASCII Protocol Commands -> *ASCII_STATUS**). Additionally, special commands (restarting the fitted modem or clearing any messages queued to the modem) can be performed using the ***ASCII_CMD** command (see **ASCII Protocol Commands -> *ASCII_CMD**).

Updating Unit Firmware

NOTICE

Only perform firmware updates if directed to by WTE Ltd. or an associated distributor. Damage to the unit resulting from failure to follow these instructions will void the unit warranty.

If possible, perform firmware updates with an external 12V power supply attached to avoid loss of power during the firmware update process. If this is not possible, ensure that the unit batteries are fully charged by exposing the fitted solar panel to full sunlight for 8 hours before attempting to update unit firmware.

Under **NO** circumstances:

- Attempt to load a firmware file not provided by WTE Ltd. or associated distributors.
- Attempt to load any firmware file not explicitly designed for use with the MReX-SatLink.
- Attempt to load firmware using any tool other than the WTE MReX Firmware Uploader program.
- Remove power from the unit or disconnect the USB to TTL adapter while updating unit firmware.
- Attempt to load firmware when the SatLink is in its low battery power saving state (see section **Additional Notes -> Low Battery Protection**).

Failure to follow these instructions may result in the unit becoming permanently inoperable.

NOTICE

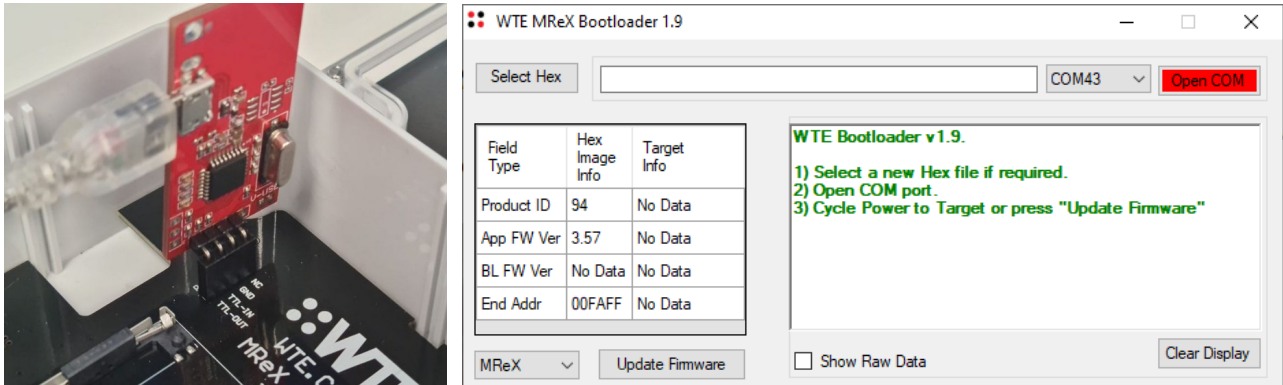
Updating the MReX module firmware may result in a loss of unit configuration.

Before performing any kind of firmware update, ensure that the unit configuration has been backed up to a safe location.

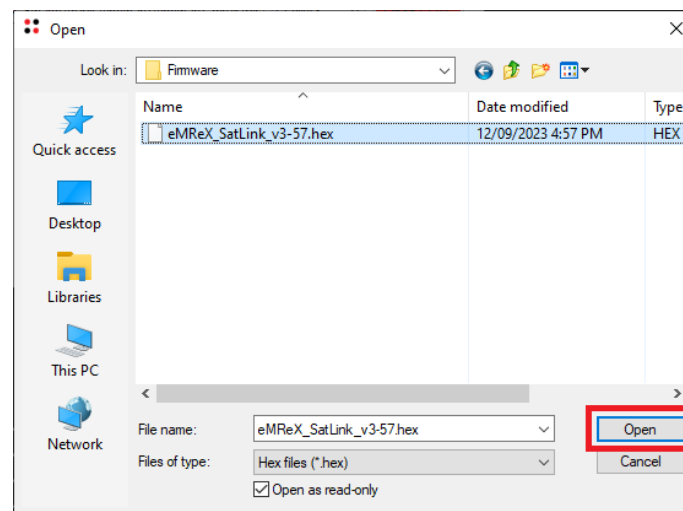
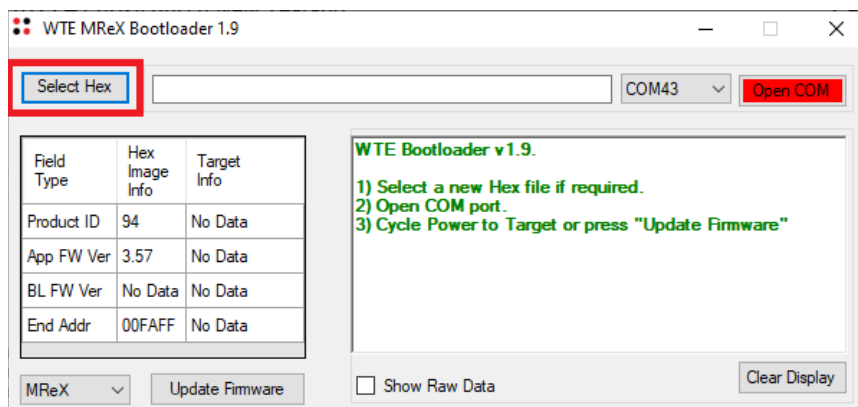
Updating the MReX-SatLink requires the WTE MReX Firmware Uploader version 1.9 or above, available to download from www.wte.co.nz/tools. Before any firmware updates can be performed, the internal TTL serial port must be accessed (see section **Internal Hardware -> Internal TTL Serial Connection** for instructions).

Updating MReX Module Firmware

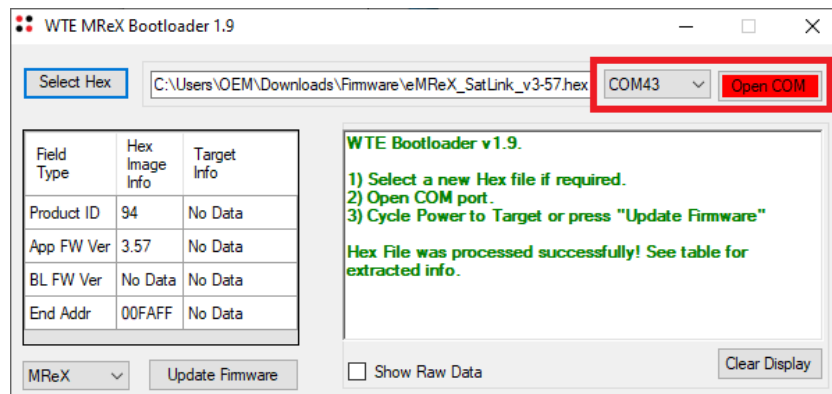
With the USB TTL adapter connected to the internal TTL Serial connector, open the WTE MReX Firmware Uploader.



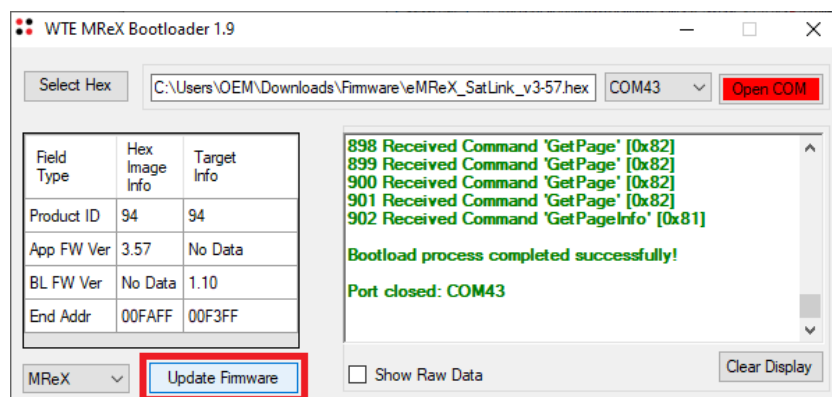
Press **Select Hex** and navigate to the .hex file provided by WTE Ltd. or associated distributor. The hex file should follow the naming convention **eMReX-SatLink_vXX-XX.hex** where **XX-XX** is the revision number of the provided firmware hex file. Select the file and press **Open**.



Select the COM port corresponding to the connected USB to TTL adapter and select **Open COM**.



With the COM port now open, select **Update Firmware**. The firmware update process should begin within a few seconds. Do not power off the unit until the **Bootload process complete successfully!** message is seen and the COM port has closed automatically.



If the firmware update process has not started within 10 seconds of selecting the **Update Firmware** button or the update process failed early or was aborted:

1. Close the COM port.
2. Completely power down the unit for 10 seconds (see section **Internal Hardware -> Modem Installation** for instructions on how to completely power down the unit).
3. Open the COM port.
4. Power up the unit.

The firmware update process will then commence within a few seconds of powering up the unit.

After the update process is complete, verify that the firmware was successfully updated by checking the current firmware version via the ***VER** command using the WTE Serial Terminal program.

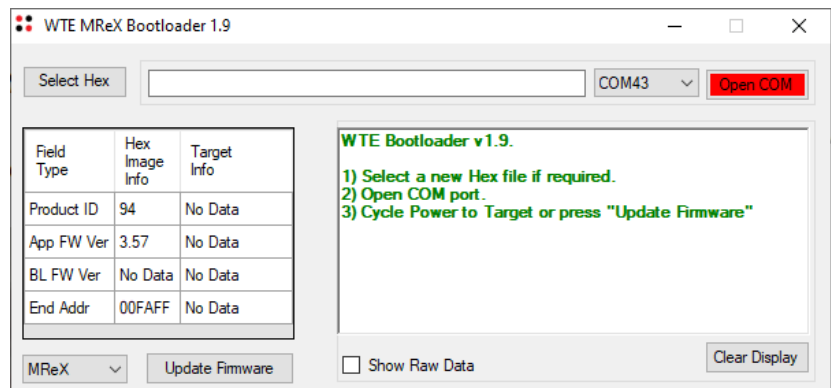
***VER**

WTE MReX-460 SWARM GATEWAY v3.57 SN:3549 [32]

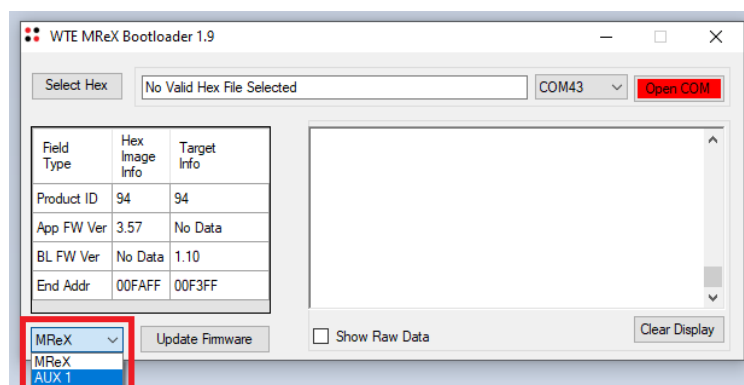
If the unit has lost its configuration as a result of the update process, apply the backed up configuration using the WTE Serial Terminal program and restart the unit using the ***REBOOT** command.

Updating Coprocessor Firmware

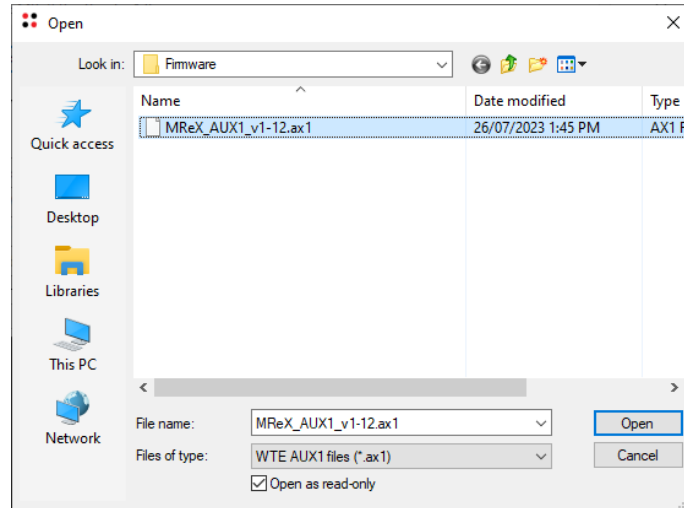
With the USB TTL adapter connected to the internal TTL Serial connector, open the WTE MReX Firmware Uploader.



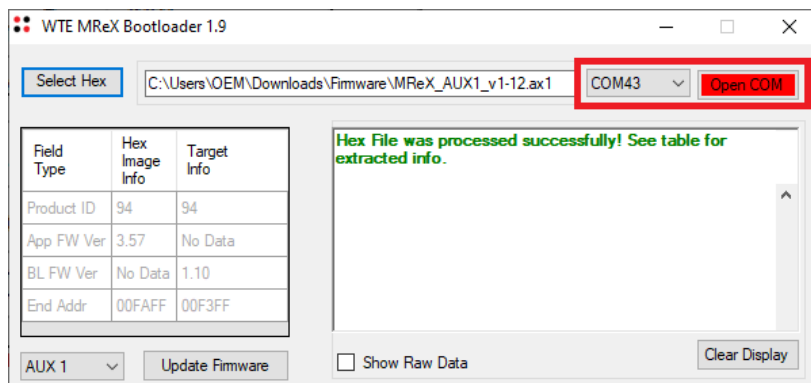
In the bottom-left corner of the application, select the drop-down menu labelled **MReX** and select the option **AUX1**. This informs the Firmware Uploader application that a SatLink Coprocessor is being updated.



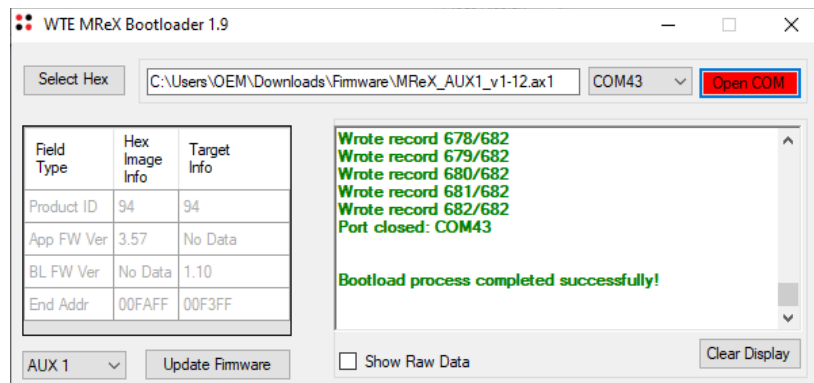
Press the **Select Hex** button and navigate to the .ax1 file provided by WTE or associated distributor. Note that only .ax1 format files will be available for selection. All SatLink coprocessor firmware files have this format.



Select the COM port corresponding to the connected TTL to USB adapter and press **Open COM**. The firmware update process will begin automatically with no further user input.



Once the process has completed, the COM port will close and the SatLink unit will reboot automatically. Do not disconnect or power down the unit until the **Bootload process completed successfully!** message has been seen. If the process is cancelled or fails before all records are written, fully power down the unit for 10 seconds (see section **Internal Hardware -> Modem Installation** for instructions on how to fully power down the unit) before powering the unit up and repeating the above steps.



Verify that the coprocessor firmware has been updated by checking the sign-on string sent over the RS422 serial connection on restart. This can be done by sending a ***REBOOT** command via the RS422 connection. The string printed on restart will include two version numbers. The first version number is the MReX module firmware revision, while the second number is the coprocessor firmware revision.

***REBOOT**

WTE-SatLink v3.57 - v1.12

If nothing is transmitted via the serial port on restart, or the unit does not respond to commands via the RS422 connection, fully power down the unit for 10 seconds (see section **Internal Hardware -> Modem Installation** for instructions on how to fully power down the unit) before powering the unit up and repeating the above steps.

Installation

The MReX-SatLink typically is supplied with an integrated solar panel. In order to charge the internal battery, it should be located so that it receives at least a few hours of direct sunlight each day. The units should be situated away from 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 MReX module 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.

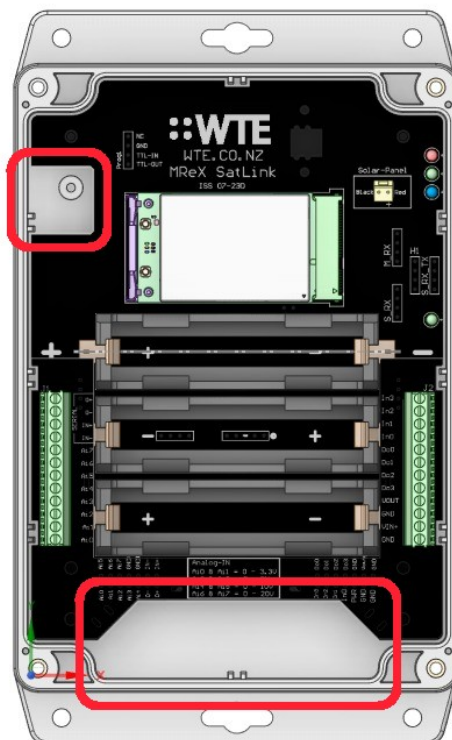
Connecting to the MReX-SatLink

NOTICE

FAILING TO REMOVE THE INTERNAL PCB BEFORE DRILLING HOLES IN THE CASE MAY RESULT IN IRREPARABLE DAMAGE TO THE UNIT.

Damage to the unit caused by failure to follow these instructions will void the unit warranty.

By default, the MReX-SatLink has no external connectors fitted due to the wide variety of potential use-cases. The internal PCB of the SatLink has been designed with the ability to drill holes for connectors into the sides and back of the case in mind. Space has been left clear at the bottom and in the top-left corner of the unit to allow for holes to be drilled for routing power, antenna and I/O cables.

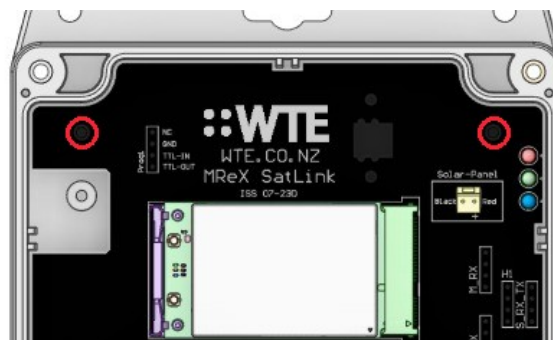


Holes may also be drilled into the sides of the case, though care should be taken to avoid damaging the internal PCB. To minimise the chance of damaging the unit, mark hole locations with the internal PCB in place and remove the PCB before drilling holes in marked locations. Any damage to the internal PCB from incorrect drilling procedure will void the unit warranty. The procedure to remove the internal PCB is outlined in following steps:

First remove the 4 screws holding the I/O breakout board in place (if the breakout board is fitted). Remove the breakout board. There are 4 threaded standoffs underneath the previously removed screws that hold the main board in place. Remove these standoffs. If the breakout board is not fitted, in there will be 4 screws in the place of the standoffs.



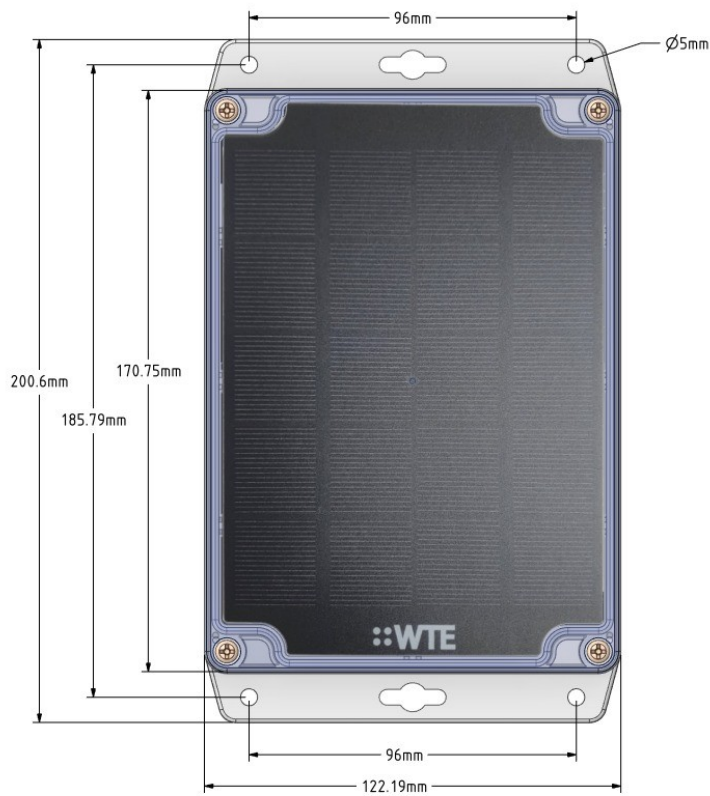
Remove the 2 screws at the top of the main board. Once removed, the main board can be lifted from the case. After removing, place the PCB on a soft, anti-static surface to avoid damage to internal components.



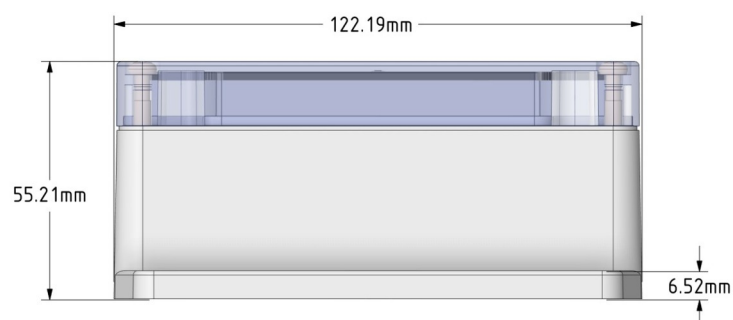
For information regarding internal connectors and their functions, see **Internal Hardware**.

MReX SatLink Dimensions

Top view



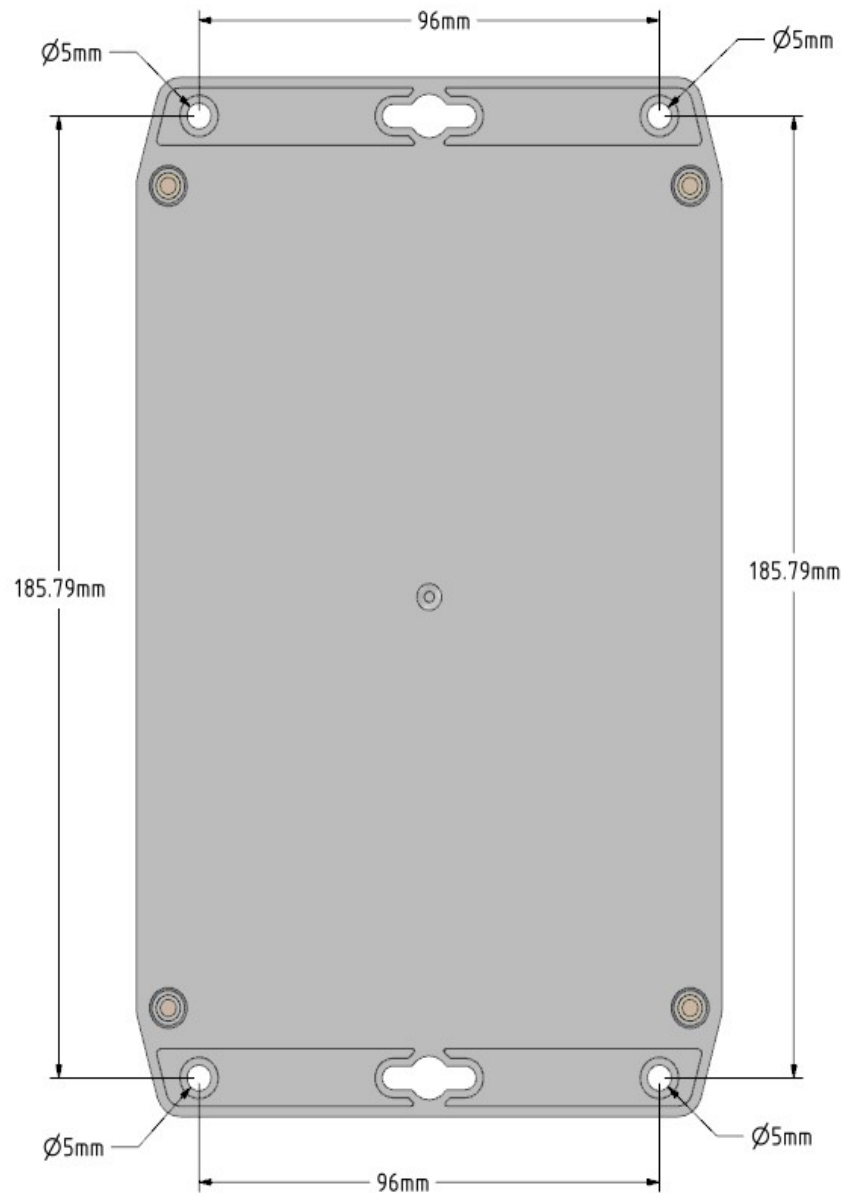
Bottom View



Note: Images are not to scale.

All dimensions are in millimetres (mm)

Drilling template



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 increases the maximum distance between transmitter and receiver units. Since the signals are focused/concentrated into a direction it also increases 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,
- 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 damage to internal electronics.
- Installation in excessively wet or corrosive environments.
- Exposure to impact or excessive vibration.
- Use or installation outside of the specified operating parameters.

Specifications

Fixed Supply Voltage:

- 6-15V Internally fused.

Temperature Limits:

- -10 to + 65 degrees Celsius.

MReX-460 Transceiver:

Frequency Range:	MReX-460: 421 - 480 MHz
Tx/Rx Frequency Accuracy:	0.5ppm.
Max Tx Power:	20dBm (100mW) (+/- 1dB)
Max Rx Input Power:	13dBm (any level above this will destroy the receiver)
Receiver Sensitivity:	(+/- 1dB) @ 450MHz -126 dBm (512 baud)

Optional Swarm M138 Modem:

Downlink Frequency:	137 - 138 MHz
Uplink Frequency:	148 - 150 MHz
Bit Rate:	1 kbps
Max Packet Size:	192 bytes
Tx Power:	1.1W

Antenna Connector:

- SMA female.

Operating Current:

Mode	Typical Current
Modem Transmit	850mA (typical 4s)
Modem Receive	30mA
Standby (MReX Receive + RS422 low power operation)	0.2mA
Standby (MReX Receive + RS422 standard operation)	1.8mA
Standby (MReX Rx Disabled + RS422 low power operation)	0.05mA
Standby (MReX Rx Disabled + RS422 standard operation)	1.65mA
MReX Transmit (20dBm)	90mA (typical 1s)

Transmit current depends on power setting and assumes connection to matched 50 Ohm antenna.

Integrated Solar Panel:

5V, 530mA in full sunlight. Full battery charge from depleted in approximately 8 hours full sun.

Internal Battery:

NiMH 3.6V, 3700 mAh (3 x HHR-380A cells)

Swarm Modem Max Delivery Time:

< 3 hours to transmit any number of queued messages. Modem operates in Standby mode for this duration. Delivery time is reducing as the number of satellites increase in the constellation.

Max Operating Time without Solar Recharge:

3 hours modem receive per day, approximately 40 days.

Firmware:

- Field upgradable.

Physical Dimensions (L x W x H):

- 201mm x 122mm x 55mm

Serial Communication:

- RS422 8-N-1, supported baud rates: 4800, 9600, 19200, 38400, 57600, 115200 baud.
- WTE protocol format.
- Modbus RTU.
- ASCII protocol format.

POCSAG Encode and Decode Support:

- POCSAG 512 either alpha or numeric including batched.
- POCSAG 1200 either alpha or numeric including batched.

Modulations Supported:**25kHz Channel Width:**

512 baud (FSK 4.4kHz), 1200 (FSK 4.4kHz)

MReX 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.

Swarm Modem Compliance Standards:

- FCC CFR Parts 2, 15 and 25
- CISPR 16-23:2010/A1:2010
- EN 55032:2012 EN 6100-4-2/EN55024:2010
- EN 6100-4-3/EN55024:2010
- EN 6100-4-8/EN55024:2010
- EN 62368-1:2014/A11:2017

Digital Inputs:

- Maximum input voltage 24V.
- Minimum input voltage 0V.
- Low level voltage $\leq 0.1V$.
- High level voltage $\geq 3.0V$.
- Pulled up internally.

Analog Inputs:

Inputs	Voltage Range
Ai0, Ai1	0V - 3.3V
Ai2, Ai3	0V - 5.0V
Ai4, Ai5	0V - 10.0V
Ai6, Ai7	0 V- 20.0V

Digital Outputs:

- Open-drain.
- Maximum rated sink current 100mA per output.
- Maximum rated voltage 24V.

Switched 12V Output:

- 12V output.
- Maximum source current 100mA.

Declaration of Conformity



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:

Shannon Reardon or Rodrigo Pellizzari
info@wte.co.nz

Date: 05/05/2020

Shannon Reardon
Engineer/Director

Rodrigo Pellizzari
Engineer/Director