Quest™ and Connect™ Modem User Interface Manual

V1.3.4, July 2021

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Contents

1 Introduction

TXMission's **Quest™** onboard and **Connect™** ground station modems are shown in **Figure 1-1**.

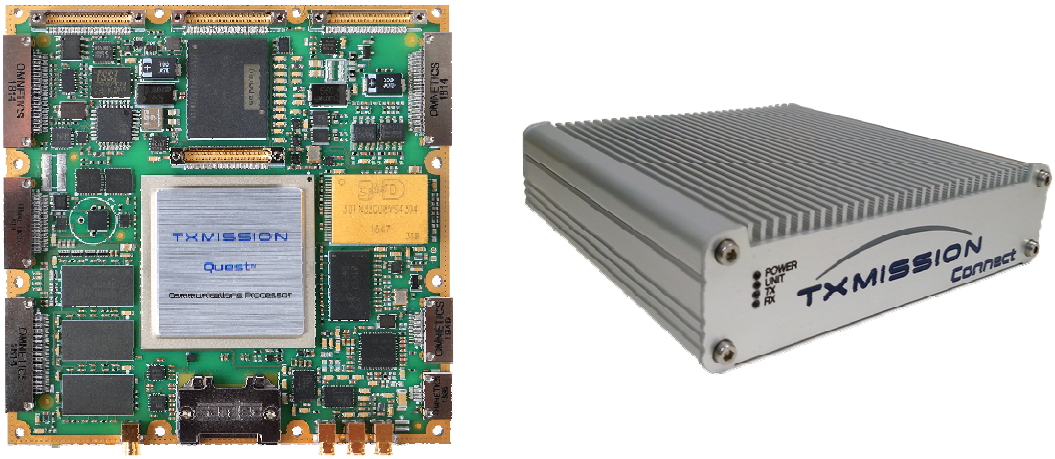

Figure 1-1: Quest™ Onboard Modem and Connect™ Ground Station Modem

Quest™ and **Connect™** are DVB-S2/S2X and CCSDS-compliant Software Defined Radios for smallsats and airborne applications. They support a built-in web server that can be used for configuring the equipment and is compatible with most web browsers. The modems can also be configured via our **MissionSpan™ NMS**.

This manual will guide you through the process of using the modem web interface from a web browser. Multiple users may log into a modem concurrently, each with the same or unique usernames.

2 User Guide

2.1 Accessing the Web User Interface

Ensure the modem is powered up and is connected by an Ethernet cable to your computer or network. The use of Chrome or Firefox web browser is recommended, as the modems are extensively tested in these environments.

The factory default IP address for the modem is 192.168.70.100 with a subnet mask of 255.255.255.0 and with no default gateway (i.e., the gateway is 0.0.0.0). The first time the modem is accessed, your computer will need to be configured with a compatible address and subnet mask. Once you have logged into the modem for the first time, you can change the IP address as required and thereafter use your choice of IP address when accessing the modem.

Enter the IP address of the modem in the browser address bar (**Figure 2-1**) ensuring that the port number that the web server is listening on (i.e., *:3000*) is appended to the example address as shown.

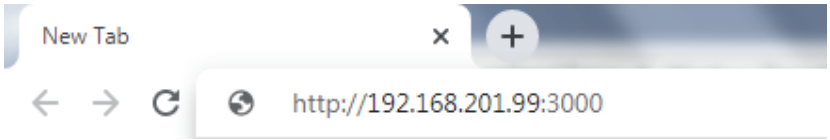

Figure 2-1 Entering the Modem IP Address

This will bring up a login screen as shown in **Figure 2-2**.

*It is strongly recommended that to ensure security, the default admin password is changed immediately on first logging in. Note that the admin user c*annot be deleted. *Other user login names can be added as required.*

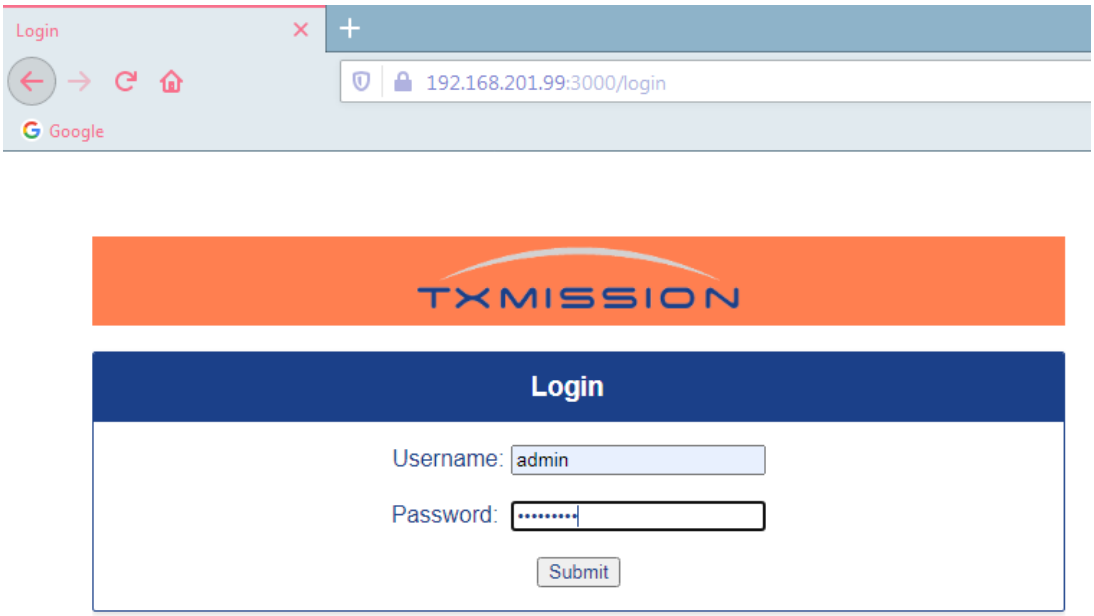

Figure 2-2 Modem Login Screen

The default username and password are *admin* and *txmission*, respectively. After logging in, the screen shown in **Figure 2-3** will be displayed.

Figure 2-3 Modem Configuration (Home) Screen

2.2 User Interface Layout

The modem user interface comprises two elements as described in the following sections.

2.2.1 Collapsible Configuration Menus

The main part of the screen is used to display various configuration and status controls arranged in a series of collapsible/expandable sections. The different sections of each menu can be collapsed or expanded using the -/+ icon located at the top right of each section header title. For example, the modem configuration menu shown of **Figure 2-3** is shown with all sections in their collapsed state in **Figure 2-4**.

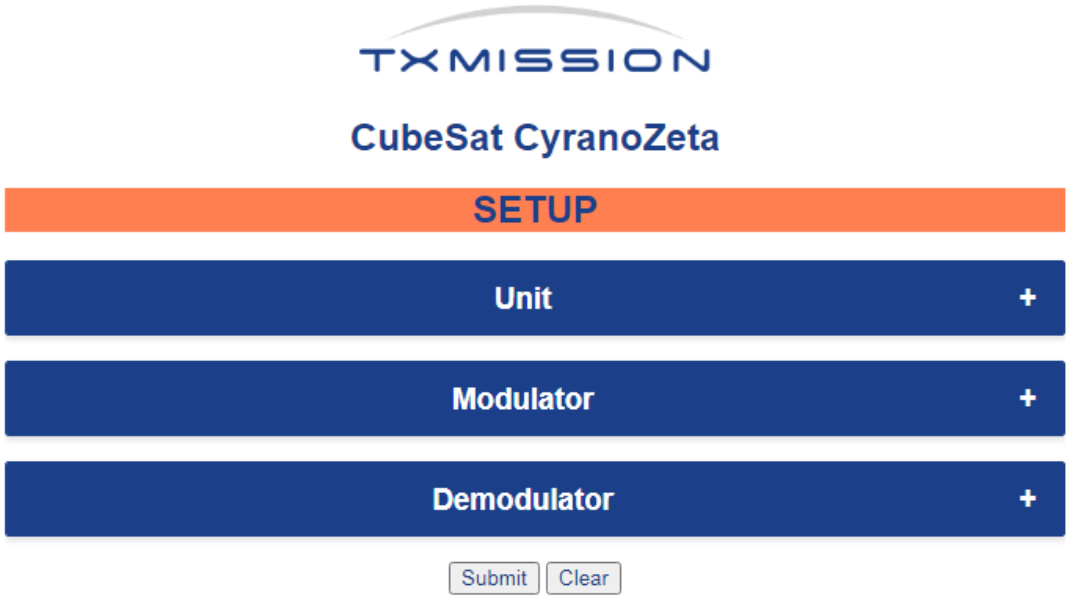

Figure 2-4 Modem Configuration Screen – collapsed state

2.2.2 Navigation Menu

As can be seen, a fly-out side navigation menu (**Figure 2-5**) is located on the left-hand side of the display area.

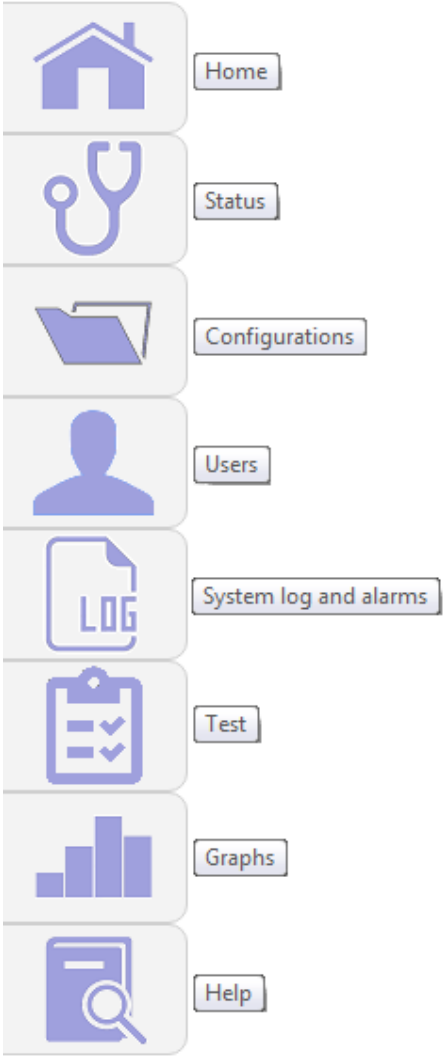

Figure 2-5 Fly-out Side Navigation Menu

The fly-out menu provides options for:

- Modem configuration (*Home* menu)
- Status
- Configuration management
- User management
- System log and alarms
- Test configuration
- Modem graphs
- A Help menu (provides access to this manual)

These menus are described in the following sections.

2.3 Configuration Database

An SQLite database (**Figure 2-6**) is used to hold any number of modem configurations, along with user details. The database, in whole or in part, is transferrable between modems in the network, allowing all the configurations to be maintained centrally and then distributed throughout the network whenever required.

MissionSpan NMS is a convenient tool for managing the network and the MissionSpan database is interchangeable with the database on the modems. A typical scenario is that each modem will store several alternate configurations (comprising transmission frequencies, data rates, waveforms, etc.), representing different network services, which can be switched on demand.

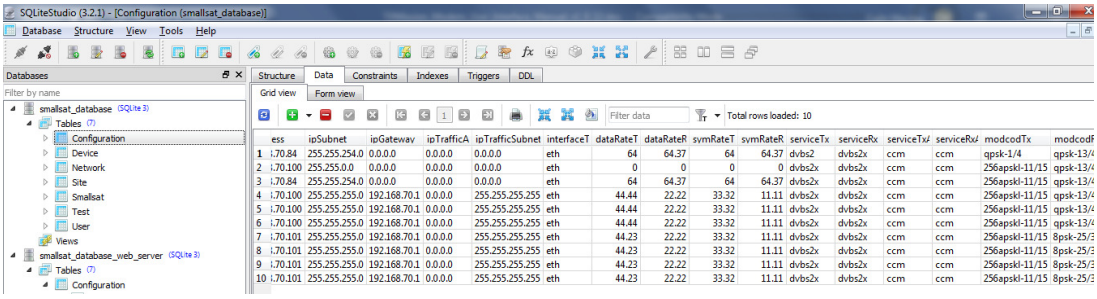

Figure 2-6 Modem Database

2.4 OOPS! Command Handler

An alternative to using the modem web user interface is to use TXMission's OOPS! command line protocol (documented in *Interface Control Document Part 1: One and Only Protocol for Smallsats!*).

All modems listen for incoming OOPS! commands on TCP port 5555.

A command line terminal emulator is provided as part of our MissionSpan NMS (**Figure 2-7**) and provides a convenient off-the-shelf client implementation of the protocol. However, we can provide example code for organisations that want to implement their own client-side network control system.

When using MissionSpan's terminal emulator, the operator can choose whether to send commands to update MissionSpan's local database (to create or edit modem configurations) or to send the commands directly to a network device (which will action and update its own database when it receives the commands).

```
OOPS! # get sr [path]
OOPS! # get status [path]
OOPS! # get summary [path]
OOPS! # get test [path]
OOPS! # get video
OOPS! # help
OOPS! # list
OOPS! # load <config>
OOPS! # reset [--hw] [--sw] [--log] [--alarms] [--counts]
OOPS! # save <config>
OOPS! # set acm <state>
OOPS! # set carrier <state>
OOPS! # set dr <value> [path]
OOPS! # set encrypt <state> [--pass <password>]
OOPS! # set frequency <value> [path]
OOPS! # set identity <name>
OOPS! # set interface <type> [path]
OOPS! # set ip <address> [--subnet <mask>] [--gateway <gateway>]
OOPS! # set modcod <value> [path] [--frame <size>] [--pilots <state>]
OOPS! # set power <value>
OOPS! # set rolloff <value> [path]
OOPS! # set service <mode> [path]
OOPS! # set sr <value> [path]
OOPS! # set test [path] [--loop <state>] [--mode <state>] [--pattern <
```

Figure 2-7 MissionSpan's Command Line Terminal Emulator

2.5 Configuration Menus

The configuration menus are accessible from the fly-out side navigation menu (**Figure 2-5**) located to the left-hand side of the display area.

This section describes these menus.

2.5.1 Modem Configuration (Home) Menu

This menu (**Figure 2-8**) allows operators to create modem configurations that can be stored in the modem's database and recalled when required.

Note that in addition to the standard side navigation menu, this web page provides a top navigation menu to allow configuration of advanced modem features such as traffic shaping. The advanced menus are described in the sections following this one.

Figure 2-8 Modem Configuration (Home) Screen

2.5.1.1 Unit Menu Options

The *Unit* menu allows entry of the following:

- **Modem ID**

  The *Modem ID* is a meaningful name allocated to the modem. Its location or the service it provides is often used for this purpose. The name format supports the space key and all visible keyboard characters.

  Note that this is not the same as the name of the configuration under which the information is stored in the database.

- **Address**

  This is the IP address of the modem and is entered in dotted decimal notation (e.g., 10.1.0.1).

  Onboard modems support a single Ethernet port whereas ground modems support two. In the case of onboard modems, link traffic and monitor and control use the same address. For ground modems, the address is associated with the monitor and control port (referred to as the M&C or TT&C port) and is used when the operator wants to access the modem's web server or command line function. The ground modem traffic port is not allocated an IP address but nevertheless functions independently of the M&C port since traffic packets are simply bridged over the port as required.

  Note that TXMission modems currently support only an Ethernet bridging function. Even when routing is used elsewhere in the network, the satellite link can always be implemented as a bridge.

  When Ethernet is used with DVB-S2/X, user traffic is encapsulated using the Generic Stream Encapsulation (GSE) protocol (ETSI TS 102 606-1), which provides a way of carrying packet-oriented traffic inside DVB-S2/X satellite frames.

  Care should be taken not to lose access to a modem by changing its IP address to one that is not compatible with the wider control network.

- **Subnet Mask**

  The subnet mask of the modem is entered in dotted decimal notation (e.g. 10.1.0.1).

- **Gateway**

  The gateway of the modem provides access to the wider network beyond the immediate satellite network (such as the internet) and is entered in dotted decimal notation (e.g. 10.1.0.1).

- **Data Interface**

  The data interface is the physical interface used to route user traffic in and out of the modem.

  The following interfaces are selectable:

  - *Ethernet*
  - *LVDS*
  - *RS485*

  The following interfaces are physically available but currently reserved:

  - *SDI/ASI*
  - *USB*
  - *UART*
  - *CAN*
  - *I2C*
  - *SPI*
  - *SpaceWire*

  Even when a non-Ethernet interface is used then the modem's Ethernet port remains accessible for monitor and control purposes.

2.5.1.2 Modulator Menu Options

The *Modulator* menu allows entry of the following:

- **Tx service**

  The *Tx service* can be set to the following:

  - *Off*: this switches the transmit service off.
  - *DVB-S2*: this switches the transmit service to DVB-S2 operation (EN 302 307-1).
  - *DVB-S2X*: this switches the transmit service to DVB-S2X operation (EN 302 307-2).
  - *CCSDS DVB-S2*: this switches the transmit service to CCSDS over DVB-S2 operation (CCSDS 131.3-B-1). This is currently only valid when the data interface is set to LVDS.
  - *CCSDS DVB-S2X*: this switches the transmit service to CCSDS over DVB-S2X operation (proprietary extension to CCSDS 131.3-B-1). This is currently only valid when the data interface is set to LVDS.

- *CCSDS Viterbi*: this switches the transmit service to CCSDS operation (CCSDS 131.0-B-1) using Viterbi only.
- *CCSD Viterbi-RS*: this switches the transmit service to CCSDS operation (CCSDS 131.0-B-1) using both Viterbi and Reed-Solomon encoding.

- **Tx modcod**

  A modcod is the combination of a modulation and Forward Error Correction (FEC) rate. The following transmit modcods are supported:

  - DVB-S2 Normal frame:

    QPSK 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
    8PSK 3/5, 2/3, 3/4, 5/6, 8/9, 9/10
    16APSK 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
    32APSK 3/4, 4/5, 5/6, 8/9, 9/10

  - DVB-S2 Short frame:

    QPSK 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9
    8PSK 3/5, 2/3, 3/4, 5/6, 8/9
    16APSK 2/3, 3/4, 4/5, 5/6, 8/9
    32APSK 3/4, 4/5, 5/6, 8/9

  - DVB-S2X Normal frame:

    QPSK 13/45, 9/20, 11/20
    8PSK 23/36, 25/36, 13/18
    8APSK-L 5/9, 26/45
    16APSK 26/45, 3/5, 28/45, 23/36, 25/36, 13/18, 7/9, 77/90
    16APSK-L 5/9, 8/15, 1/2, 3/5, 2/3
    32APSK 32/45, 11/15, 7/9
    32APSK-L 2/3
    64APSK 11/15, 7/9, 4/5, 5/6
    64APSK-L 32/45
    128APSK 3/4, 7/9
    256APSK 32/45, 3/4
    256APSK-L 29/45, 2/3, 31/45, 11/15

  - DVB-S2X Short frame:

    QPSK 11/45, 4/15, 14/45, 7/15, 8/15, 32/45
    8PSK 7/15, 8/15, 26/45, 32/45
    16APSK 7/15, 8/15, 26/45, 3/5, 32/45
    32APSK 2/3, 32/45

  - CCSDS Viterbi-RS:

    Viterbi: BPSK, QPSK & OQPSK 1/2, 2/3, 3/4, 5/6, 7/8
    Reed-Solomon:
    Symbols per codeword: 255

Error correction values: 8 & 16
Codes include (255, 233) & (255, 239) plus shortened codeblocks
Interleaver depth: 1, 2, 3, 4, 5 & 8

- **Tx frame size**

  This is used only in DVB-S2/S2X modes of operation and can be set to:

  - *Normal*

    Normal operation uses a satellite frame size of 64,800 bits. This allows the error correction to work more efficiently and therefore has better Es/No performance than the equivalent modcod using the short frame size.

    A downside is that latency through the encoder/decoder is four times that of short frames. Latency halves as data rate doubles therefore for high data rate links, or latency insensitive traffic, the use of normal frames is recommended.

  - *Short*

    Short operation uses a satellite frame size of 16,200 bits.

- **Tx pilots**

  Pilots are used only in DVB-S2/S2X modes of operation and can be set *On* or *Off*.

  Pilots are a signal that is added to the transmitted carrier to make it easier for the receiver to lock onto the carrier. Pilots are typically used when there is a poor signal at the receiver. The receiver can usually stay locked onto a carrier containing pilot tones lower down into the noise.

  The downside of using pilots is that they take up around 2.4% of the carrier bandwidth. When comparing the spectral efficiency versus Es/No of carriers using pilots they generally lie on the same straight line as carriers that are not using pilots, therefore the choice whether to use them will come down to practical considerations such as the satellite link budget calculation or the need to overcome interference on a link caused by the prevailing conditions.

- **Tx data rate**

  Transmit data rate and symbol rate are interlinked. If the operator enters a non-zero symbol rate then the data rate will be calculated automatically using the current settings (modcod, frame size, etc.).

  If a data rate is entered then the symbol rate will be automatically calculated.

  Minimum and maximum data rates are determined by the specific model of modem and vary with the modcod being used (since the choice of modcod changes the symbol rate). Typically, data rates of up to 1Gbps are supported subject to the choice of modcod.

Data rates are entered in Mbps with up to six figures after the decimal point (e.g. 500.123456 Mbps).

- **Tx symbol rate**

  As discussed above, symbol rate and data rate are interlinked and the symbol rate will be automatically set from the data rate unless it is entered by the operator.

  Minimum and maximum symbol rates are determined by the specific model of modem and the carrier roll-off factor being used. Typically, an occupied bandwidth of 125MHz is supported, which equates to a maximum of 119Msps when 5% roll-off is used.

  Symbol rates are entered in Msps with up to six figures after the decimal point (e.g. 100.123456 Msps).

- **Tx frequency**

  Minimum and maximum frequencies are determined by the specific model of modem. Typically, frequencies between 75MHz up to 6GHz are supported.

  Frequencies are entered in MHz with up to six figures after the decimal point (e.g. 1220.123456 MHz).

  Note that in some older models of modems, there is a single LO synthesizer shared between transmit and receive and consequently the transmit and receive centre frequencies must be the same (carriers can still be transmitted and received on different frequencies but this then becomes a function of the off-board frequency conversion).

  Further up/down frequency conversion may optionally be performed externally to the modem (e.g to and from X-band) in which case the modem provides an intermediate frequency to the external equipment and must receive a carrier from the equipment at a suitable frequency.

  Care should be taken not to lose access to a modem by changing its frequency to one that does not match the control network. The use of pre-defined configurations is recommended in this regard, as it elimates the potential for mistakes when manually entering information.

- **Tx carrier roll-off**

  The carrier roll-off can be set to the following values:

  - 5%
  - 10%
  - 15%
  - 20%
  - 25%
  - 35%
  - 40%

Use of a lower roll-off will result in a lower occupied bandwidth for the carrier. However, the peak-to-average-power ratio (crest factor) of the carrier increases for lower values, meaning that a higher back-off is required for the transmit amplifier in order not to overdrive it and distort the carrier.

- **Tx output power**

  The modem outputs a very small signal, around a milliwatt or less. This needs to be fed into a power amplifier for onward transmission. (TXMission provides a variety of RF solutions covering offboard frequency conversion, power amplification, LNAs and bandpass filters – contact us for details.)

  Minimum and maximum power levels are determined by the specific model of modem but are typically in the range of -40dBm to -5dBm (or 0dBm).

  The power level is entered as a negative number in dBm with one figure after the decimal point (e.g. -15.7 dBm).

- **Tx carrier**

  This control allows the transmit carrier to be switched *Off* or *On*.

2.5.1.3 Demodulator Menu Options

The *Demodulator* menu allows entry of the following:

- **Rx service**

  The *Rx service* can be set to the following:

  - *Off*: this switches the receive service off.
  - *DVB-S2*: this switches the receive service to DVB-S2 operation (EN 302 307-1).
  - *DVB-S2X*: this switches the receive service to DVB-S2X operation (EN 302 307-2).
  - *CCSDS DVB-S2*: this switches the receive service to CCSDS over DVB-S2 operation (CCSDS 131.3-B-1). This is currently only valid when the data interface is set to LVDS.
  - *CCSDS DVB-S2X*: this switches the receive service to CCSDS over DVB-S2X operation (proprietary extension to CCSDS 131.3-B-1). This is currently only valid when the data interface is set to LVDS.
  - *CCSDS Viterbi*: this switches the receive service to CCSDS operation (CCSDS 131.0-B-1) using Viterbi only.

- *CCSD Viterbi-RS*: this switches the receive service to CCSDS operation (CCSDS 131.0-B-1) using both Viterbi and Reed-Solomon encoding.

- **Rx modcod**

  A modcod is the combination of a modulation and Forward Error Correction (FEC) rate. The following receive modcods are supported:

  - DVB-S2 Normal frame:

    QPSK 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
    8PSK 3/5, 2/3, 3/4, 5/6, 8/9, 9/10
    16APSK 2/3, 3/4, 4/5, 5/6, 8/9, 9/10
    32APSK 3/4, 4/5, 5/6, 8/9, 9/10

  - DVB-S2 Short frame:

    QPSK 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9
    8PSK 3/5, 2/3, 3/4, 5/6, 8/9
    16APSK 2/3, 3/4, 4/5, 5/6, 8/9
    32APSK 3/4, 4/5, 5/6, 8/9

  - DVB-S2X Normal frame:

    QPSK 13/45, 9/20, 11/20
    8PSK 23/36, 25/36, 13/18
    8APSK-L 5/9, 26/45
    16APSK 26/45, 3/5, 28/45, 23/36, 25/36, 13/18, 7/9, 77/90
    16APSK-L 5/9, 8/15, 1/2, 3/5, 2/3
    32APSK 32/45, 11/15, 7/9
    32APSK-L 2/3
    64APSK 11/15, 7/9, 4/5, 5/6
    64APSK-L 32/45
    128APSK 3/4, 7/9
    256APSK 32/45, 3/4
    256APSK-L 29/45, 2/3, 31/45, 11/15

  - DVB-S2X Short frame:

    QPSK 11/45, 4/15, 14/45, 7/15, 8/15, 32/45
    8PSK 7/15, 8/15, 26/45, 32/45
    16APSK 7/15, 8/15, 26/45, 3/5, 32/45
    32APSK 2/3, 32/45

  - CCSDS Viterbi-RS:

    Viterbi: BPSK, QPSK & OQPSK 1/2, 2/3, 3/4, 5/6, 7/8
    Reed-Solomon:
    Symbols per codeword: 255
    Error correction values: 8 & 16
    Codes include (255, 233) & (255, 239) plus shortened codeblocks
    Interleaver depth: 1, 2, 3, 4, 5 & 8

- **Rx frame size**

  This is used only in DVB-S2/S2X modes of operation and can be set to:

  - *Normal*

    Normal operation uses a satellite frame size of 64,800 bits. This allows the error correction to work more efficiently and therefore has better Es/No performance than the equivalent modcod using the short frame size.

    A downside is that latency through the encoder/decoder is four times that of short frames. Latency halves as data rate doubles therefore for high data rate links, or latency insensitive traffic, the use of normal frames is recommended.

  - *Short*

    Short operation uses a satellite frame size of 16,200 bits.

- **Rx pilots**

  Pilots are used only in DVB-S2/S2X modes of operation and can be set *On* or *Off*.

  Pilots are a signal that is added to the transmitted carrier to make it easier for the receiver to lock onto the carrier. Pilots are typically used when there is a poor signal at the receiver. The receiver can usually stay locked onto a carrier containing pilot tones lower down into the noise.

  The downside of using pilots is that they take up around 2.4% of the carrier bandwidth. When comparing the spectral efficiency versus Es/No of carriers using pilots they generally lie on the same straight line as carriers that are not using pilots, therefore the choice whether to use them will come down to practical considerations such as the satellite link budget calculation or the need to overcome interference on a link caused by the prevailing conditions.

- **Rx data rate**

  Receive data rate and symbol rate are interlinked. If the operator enters a non-zero symbol rate then the data rate will be calculated automatically using the current settings (modcod, frame size, etc.).

  If a data rate is entered then the symbol rate will be automatically calculated.

  Minimum and maximum data rates are determined by the specific model of modem and vary with the modcod being used (since the choice of modcod changes the symbol rate). Typically, data rates of up to 1Gbps are supported subject to the choice of modcod.

  Data rates are entered in Mbps with up to six figures after the decimal point (e.g. 500.123456 Mbps).

- **Rx symbol rate**

  As discussed above, symbol rate and data rate are interlinked and the symbol rate will be automatically set from the data rate unless it is entered by the operator.

  Minimum and maximum symbol rates are determined by the specific model of modem and the carrier roll-off factor being used. Typically, an occupied bandwidth of 125MHz is supported, which equates to a maximum of 119Msps when 5% roll-off is used.

  Symbol rates are entered in Msps with up to six figures after the decimal point (e.g., 100.123456 Msps).

- **Rx frequency**

  Minimum and maximum frequencies are determined by the specific model of modem. Typically, frequencies between 75MHz up to 6GHz are supported.

  Frequencies are entered in MHz with up to six figures after the decimal point (e.g., 1220.123456 MHz).

  Note that in some older models of modems, there is a single LO synthesizer shared between transmit and receive and consequently the transmit and receive centre frequencies must be the same (carriers can still be transmitted and received on different frequencies but this then becomes a function of the off-board frequency conversion).

  Further up/down frequency conversion may optionally be performed externally to the modem (e.g to and from X-band) in which case the modem provides an intermediate frequency to the external equipment and must receive a carrier from the equipment at a suitable frequency.

  Care should be taken not to lose access to a modem by changing its frequency to one that does not match the control network. The use of pre-defined configurations is recommended in this regard, as it elimates the potential for mistakes when manually entering information.

- **Rx carrier roll-off**

  The carrier roll-off can be set to the following values:

  - 5%
  - 10%
  - 15%
  - 20%
  - 25%
  - 35%
  - 40%

  Use of a lower roll-off will result in a lower occupied bandwidth for the carrier. However, the peak-to-average-power ratio (crest factor) of the carrier increases for lower values, meaning that a higher back-off is required for the transmit amplifier in order not to overdrive it and distort the carrier.

2.5.2 Modem Configuration Traffic Shaper Menu

The *Traffic Shaper* menu (**Figure 2-9**) allows the allocation of bandwidth between competing TCP/IP traffic streams that have been classified using DiffServ DSCP markings.

TXMISSION

Modem Traffic Shaper Advanced

TXMission satellite modem

QUALITY OF SERVICE

DiffServ -

DSCP Class	CIR		BIR		Priority
CS0	6	%	40	%	3
CS1	1	%	25	%	0
CS2	3	%	100	%	0
CS3	4	%	100	%	0
CS4	5	%	100	%	0
CS5	6	%	100	%	0
CS6	7	%	100	%	0
CS7	1	%	100	%	0
AF11	1	%	100	%	0
AF12	0	%	100	%	0
AF13	1	%	100	%	0
AF21	8	%	100	%	1
AF22	7	%	100	%	0
AF23	6	%	100	%	1
AF31	5	%	100	%	0
AF32	4	%	100	%	0
AF33	3	%	100	%	0
AF41	2	%	100	%	6
AF42	1	%	100	%	3
AF43	2.25	%	100	%	0
EF	3	%	100	%	5
LE	4	%	100	%	0
Default	1	%	100	%	7

Submit Clear

Figure 2-9 Modem Configuration Traffic Shaper Menu

The traffic shaping function manages TCP/IP packets within the modulator and provides a guaranteed quality of service for defined IP data streams. The implementation supports Layer 3 classification using the 6-bit Differentiated Services Code Point (DSCP) value in the 8-bit Differentiated Services (DS) field in the IP header.

Traffic shaping allows the quality-of-service mechanism used on terrestrial services to be extended over (pseudo) satellite to create fully provisioned end-to-end services. It supports the implementation and monitoring (through a comprehensive set of per stream packet metrics) of customer service level agreements.

Being packet based, IP naturally supports multiplexing of different data streams. These streams often have different inherent priority levels and competing demands for bandwidth. Traffic shaping controls access to bandwidth for each stream and the relative priority levels of different streams (which affects packet delay and jitter).

The interface controls and concepts that are supported are as follows.

Guaranteed Bandwidth

The *Commited Information Rate* (CIR) is the guaranteed bandwidth, as a percentage of the overall bandwidth, that will be allocated to the specified data stream. Percentages, rather than absolute values, are used because the values remain valid even when the transmit data rate changes dynamically (for example, when ACM is active).

The sum of all CIRs for all classified data streams cannot exceed 100% (which equates to the transmit data rate of the modulator).

Note that a CIR of 0 causes the classification rule to be disabled. Consequently, a stream must be guaranteed bandwidth before shaping of the stream occurs. Traffic shaping can be switched off by setting all CIRs to zero. (To switch quickly between overall traffic shaping being on or off, two modem configurations should be created – one with the required traffic shaping settings and the other with all CIRs set to zero. The desired configuration can then be loaded as required.)

Maximum Bandwidth

If excess bandwidth becomes available (i.e., one or more streams do not require their allocated bandwidth) or some of the overall bandwidth has not been allocated to specific streams, then it can be allocated in a controlled manner between competing streams.

This setting is called the *Burst Information Rate* (BIR), also specified as a percentage. It defines the maximum amount of bandwidth, beyond the guaranteed bandwidth, that a stream can be allocated, should spare bandwidth become available. Each BIR must be less than or equal to 100%.

Priority

Once all guaranteed bandwidths have been met then excess bandwidth may become available. If several streams have BIRs set, then it means that they are all potentially competing for the same excess bandwidth. The allocation of bandwidth in these circumstances is determined by the stream *Priority* setting.

In this situation, the allocation of the spare bandwidth between competing schemes will be done based on the priority level allocated to each stream. If a stream has a higher priority than another then its full BIR will be met before any excess bandwidth is allocated to the lower priority stream.

The priority setting also controls latency and jitter. If there are packets in different priority queues for transmission then the packets will be sent based on their priority, with the packets from the highest priority queue being sent first.

Priority values range from zero to seven, with zero being the highest priority (note that this is the opposite order of prioritization to IEEE 802.1p priority tagging where seven is the highest priority).

Default Class

A default data stream exists for any packets that are not explicitly part of a classified data stream. Normally, the default class should be assigned the lowest available priority, namely, seven, and have its BIR value set to 100%. However, these settings are not compulsory.

Each incoming packet is assigned to the first class for which a match is found. If no match is found, then the packet is assigned to the default class.

DiffServ DSCP Class

The DSCP classes that are supported are CS0, CS1, CS2, CS3, CS4, CS5, CS6, CS7, AF11, AF12, AF13, AF21, AF22, AF23, AF31, AF32, AF33, AF41, AF42, AF43, EF and LE.

When traffic shaping is enabled, each packet passed to the modem that has one of these values will be recognised and processed by the traffic shaper and all other packets will be processed as part of the default class.

Traffic Shaper Metrics

The traffic shaper stores the following metrics, which can be accessed through the web user interface status screens and the OOPS! command line protocol:

- **Number of packets transmitted for each DSCP stream**
- **Number of bytes transmitted for each DSCP stream**
- **Number of packets dropped for each DSCP stream**
- **Number of packets over the limit for each DSCP stream (command line only)**
- **Total number of packets transmitted for all streams**
- **Total number of bytes transmitted for all streams**
- **Total number of packets dropped for all streams**

2.5.3 Modem Configuration Advanced Menu

The *Advanced* menu (**Figure 2-10**) supports configuration of ACM, encryption and power saving features. It also supports setting modem time/date, performing software upgrades and allows the modem to be reset.

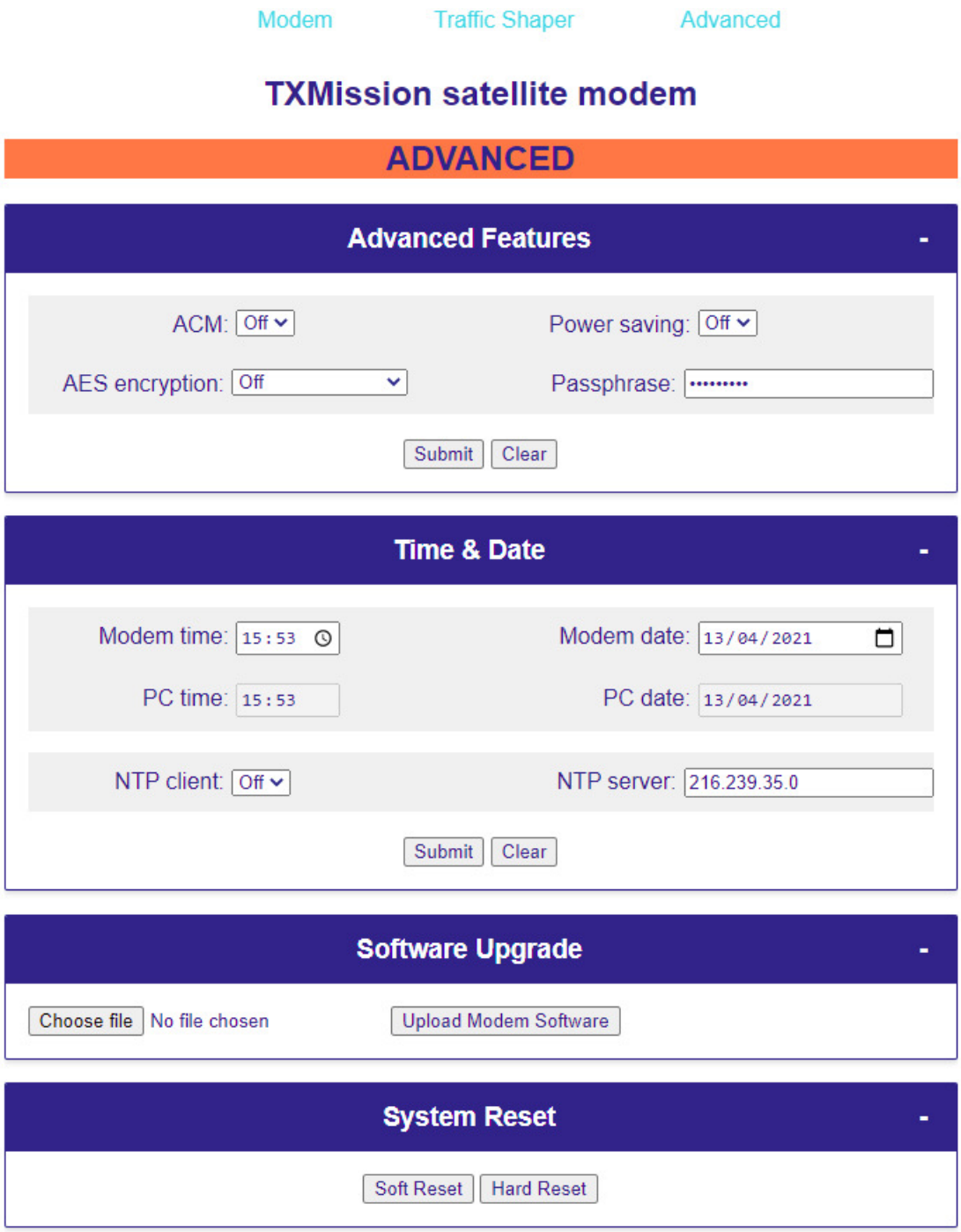

Figure 2-10 Modem Configuration Advanced Menu

2.5.3.1 Advanced Features Menu Options

The *Advanced Features* menu (**Figure 2-10**) supports the following:

- **ACM**

  ACM can be set to the following:

  - *Off*: this switches ACM off.
  - *On*: this switches ACM on.

  When off, the modem operates in DVB-S2/S2X CCM mode. ACM and CCM modes of operation are explained in the DVB-S2/S2X standards (EN 302 307-1 and EN 302 307-2). When ACM is on, the transmit modcod is selected based on the Es/No value reported by the receiver, assuming a feedback channel is available between the receiver and transmitter. ACM cannot be used if this feedback channel does not exist, as there is nothing to base the choice of modcod on. ACM should be switched on in both the transmitter and receiver. The ACM feedback mechanism is proprietary; the message format is available on request.

- **Power saving**

  Power saving can be set to the following:

  - *Off*: this switches power saving off.
  - *On*: this switches power saving on. When on, the modem attempts to limit prime power consumption to the minimum using various techniques, such as reducing the number of processor cores that are enabled. These may have a marginial, but measurable, impact on efficiency and performance of the modem. This trade-off may be deemed acceptable in situations where minimizing power consumption is critical, or for periods where normal operation is suspended, or throughput performance requirements are reduced.

- **AES encryption**

  AES encryption can be set to the following:

  - *Off*: this switches AES-256 encryption off.
  - *On*: this switches AES-256 encryption on.

  Encryption is an export-controlled feature and must be ordered at the time of the original purchase of the modem, as it cannot be provided as a software upgrade later.

When encryption is on, all TCP/IP traffic is securely encrypted in a VPN tunnel between the modems. Encryption adds an overhead of around 3% compared to when encryption is disabled.

- **Passphrase**

  The passphrase is used to generate an encryption key. The passphrase must be the same on both modems that are exchanging TCP/IP data.

  If the passphrase is changed while encryption is enabled, then encryption must be switched off and on again for the new passphrase to be actively used.

  The passphrase can consist of any characters other than spaces. It is recommended that a passphrase of at least 15 characters in length is used and that it is changed from its default value.

  Caution should be taken when enabling and disabling encryption, and when changing the encryption key, to make sure that communications with the other modem are not lost due to incompatible settings between the two modems.

2.5.3.2 Time & Date Menu Options

The *Time & Date* menu (**Figure 2-10**) supports setting the modem's time and date manually or automatically using the Network Time Protocol (NTP).

Whenever the NTP function is switched off, the manual time and date controls are enabled. These allow the year, month, day, hour and minutes to be set on the modem.

Note that because the use of batteries creates a fire hazard in satellite and airborne applications, the modem does not have a battery fitted and the time and data therefore must be initialized every time the modem is power cycled.

The time and date of the computer on which the web pages are being displayed is also shown to give a convenient reference point.

When the NTP client is switched on, the modem will immediately fetch the time and date from the specified NTP server and use these to set the modem's time and date. Updates to the time and date will continue in the background at regular intervals (currently fixed at once every six hours).

- **Modem time**

  This allows the time (hour and minutes) to be set.

- **Modem date**

  This allows the date (year, month and day) to be set.

- **PC time**

  This shows the current time of the computer that is displaying the web page. (Note that the time does not continue to be updated once the page has been displayed).

- **PC date**

  This shows the current date of the computer that is displaying the web page. (Note that the date does not continue to be updated once the page has been displayed).

- **NTP client**

  The *NTP client* can be set to the following:

  - *Off*: this switches the NTP feature off.
  - *On*: this switches the NTP client on. When on, the modem will immediately fetch the time and date from the specified NTP server and use these to set the modem's time and date. Updates will continue in the background at regular intervals (currently fixed at once every six hours).

- **NTP server**

  This is the IP address of the NTP server in dotted decimal notation (e.g., 10.1.0.1).

  The default IP address is 216.239.35.0, which is the address of the NTP server at *time.google.com*. Lists of publically accessible NTP servers are published online.

  The wider network in which the modems are being used needs to be set up to route the NTP requests and responses appropriately. A simple way of testing that the modem NTP feature is working when connected to a Windows computer is as follows:

  1. Select the *Network & Internet Connections* option from the Windows *Settings* menu.
  2. Select *Ethernet* and then *Change adapter options*.
  3. Right-click the relevant Ethernet network adapter (that is connected to the modem) and select *Properties*.
  4. Click *Sharing*. (If this tab is not visible it is because there is no internet connection to share, or the internet connection is already being shared with another network adapter.)
  5. Click the option to allow other network users to use this computer's internet connection and then click *OK*.
  6. Switch on the modem's NTP client and then check the modem's date and time (these are displayed on the *Status* page) or look at the modem's system log for an entry relating to fetching the time from the NTP server.

2.5.3.3 Software Upgrade Menu Options

The *Software Upgrade* menu (**Figure 2-10**) allows the modem software to be upgraded or downgraded.

If the modem is onboard, as opposed to on the ground, then the upgrade will take place over the air.

The software upgrade process will interrupt normal modem operation and should therefore be carried out either pre-deployment or during an operational maintenance window.

The length of time taken for the upgrade depends on the time it takes to transfer the software file to the modem. Software files are generally between 100MB and 130MB in size. For over-the-air upgrades at low bit rates, the time taken to transfer the file can be substantial. However, the upgrade process itself does not interfere with the normal operation of the modem until the transfer is complete.

The procedure for upgrading the modem software is as follows:

- Browse to the software upgrade file using the *Choose file* button. **(**The software is provided as a compressed file and the filename will end with *.tar.gz*.) The chosen filename should now be displayed as in **Figure 2-11**.

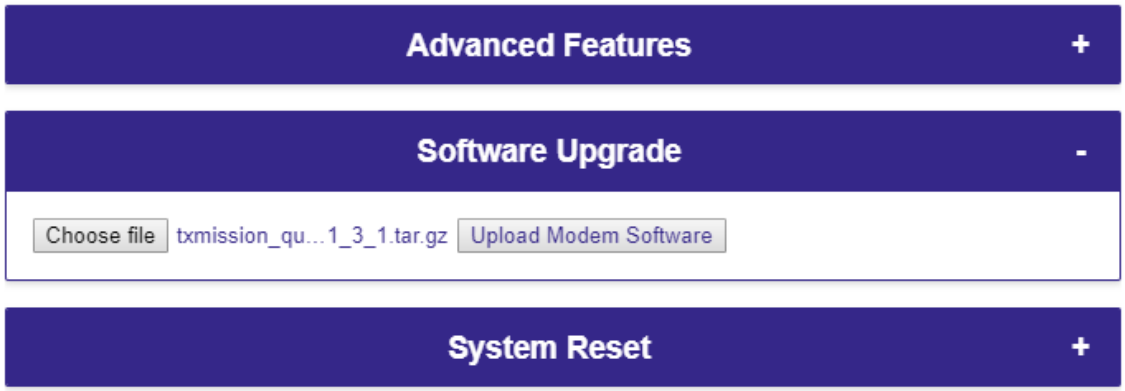

Figure 2-11 Modem Configuration Software Upgrade (file selection)

- Click the *Upload Modem Software* button. During the file transfer process, the status of the transfer will be displayed, as shown in **Figure 2-12**.

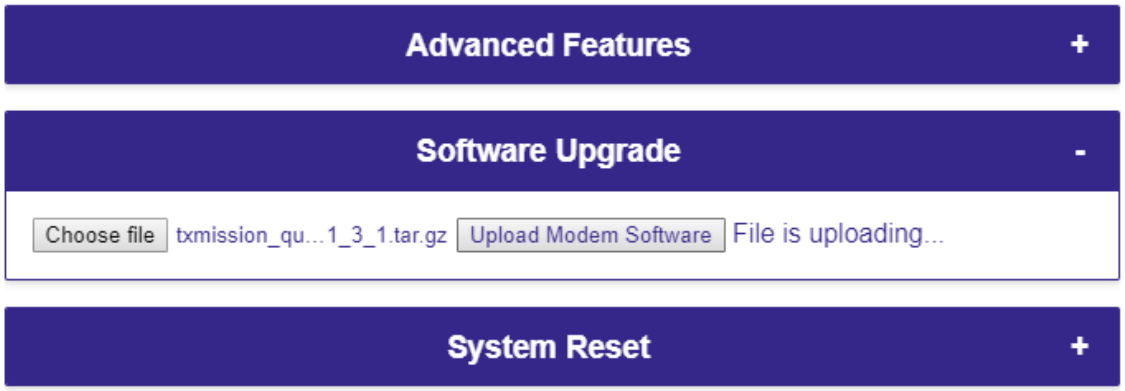

Figure 2-12 Modem Configuration Software Upgrade (file upload in progress)

- When the transfer is completed successfully, this will be reflected in the status message (**Figure 2-13**).

  As soon as the file upload completes, the modem will initiate the upgrade of the software and move the new software from its temporary location used for the file transfer to permanent storage in non-volatile memory. The modem will then reset automatically to load and run the new software version.

  The user interface should refresh automatically once the modem has completed powering up. The process will take around a minute from when the reset is initiated.

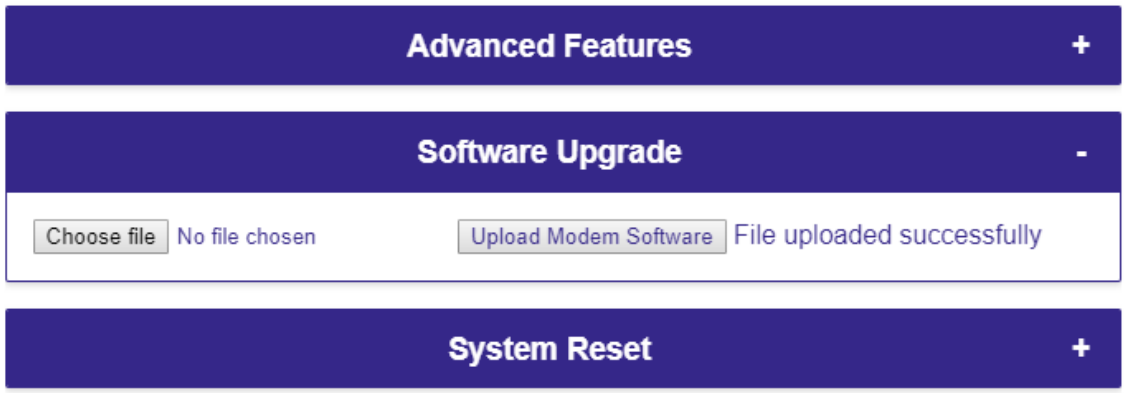

Figure 2-13 Modem Configuration Software Upgrade (file uploaded successfully)

- If an error occurs during the file transfer, then the status will be displayed as shown in **Figure 2-14**. The file transfer should be repeated until it completes successfully. Modem operation will continue normally until the file is transferred successfully.

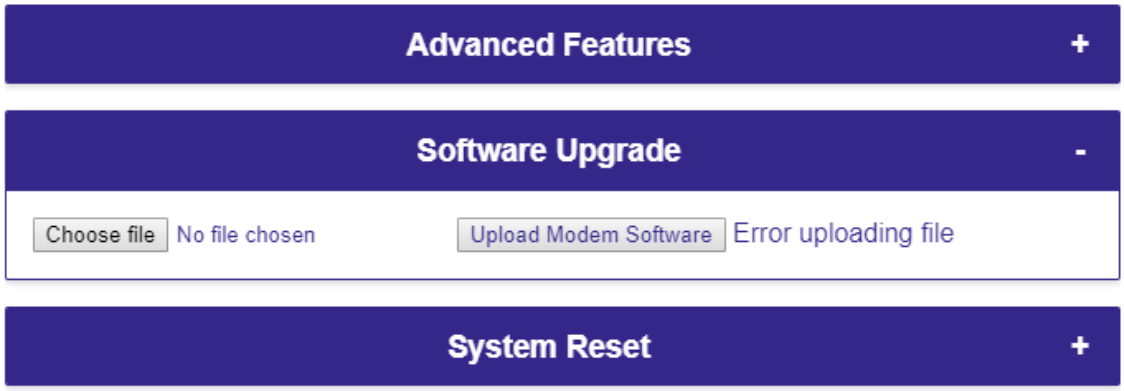

Figure 2-14 Modem Configuration Software Upgrade (file upload error)

2.5.3.4 System Reset Menu Options

The *System Reset* menu (**Figure 2-10**) supports the following:

- **Soft Reset**

  A soft reset reboots the operating system and restarts the modem application.

- **Hard Reset**

  A hard reset restarts the modem by applying a reset signal, which causes it to go through a similar sequence of operations to what occurs when it powers up.

2.5.4 Status Screen

The *Status* screen (**Figure 2-15A**) shows the dynamic status of the modem.

Note that in addition to the standard side navigation menu, this web page provides a top navigation menu that allows access to metrics information related to the modem's traffic shaping feature, as well as factory information (such as the modem's serial number). The traffic metrics and factory screens are described in the section following this one.

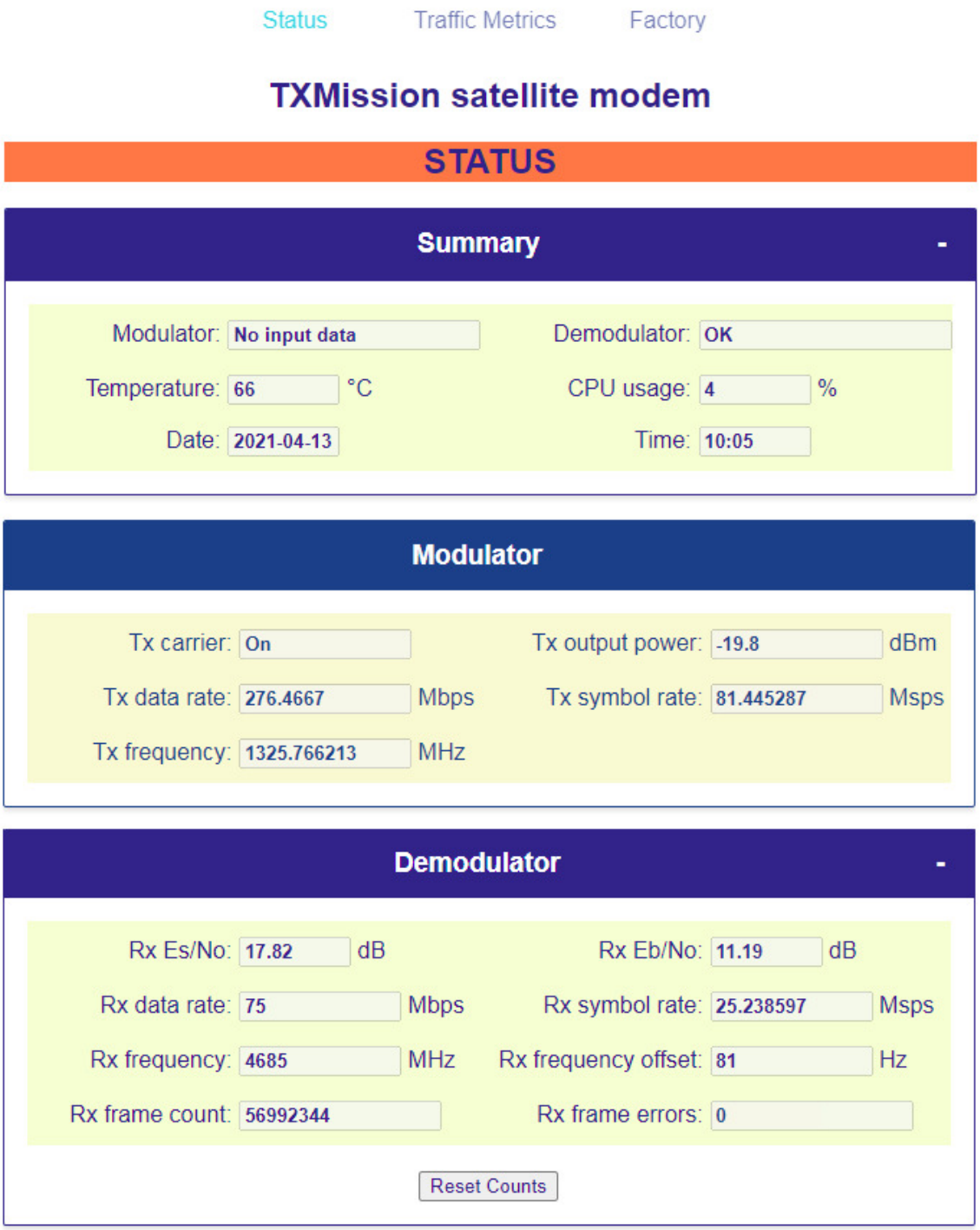

Figure 2-15A Status Screen

The information that is provided is as follows:

- Modulator status (*OK, Off, Muted, No input data*)
- Demodulator status (*OK, Off, Unlocked, Intermittent errors*)

- Modem internal ambient temperature (°C)
- CPU usage percentage
- Modem time and date
- Transmit carrier status (on/off)
- Transmit output power (dBm)
- Transmit data rate (Mbps)
- Transmit symbol rate (Msps)
- Transmit frequency (MHz)
- Received Es/No (dB)
- Received Eb/No (dB)
- Receive symbol rate (Msps)
- Receive frequency (MHz)
- Receive frequency offset (Hz), which is the amount that the received carrier is offset from the nominal centre frequency
- Receiver frame count, which is the number of satellite frames received since the demodulator acquired lock (only valid in DVB-S2/S2X modes)
- Receiver frame error count, which is the number of received satellite frames that have contained errors since the demodulator acquired lock (only valid in DVB-S2/S2X modes)

Note that when a CCSDS transmit or receive service is enabled then CCSDS status is appended to the *Modulator* and/or *Demodulator* status sections as shown in **Figure 2-15B**. The CCSDS status is as follows:

- Tx CCSDS (*OK, No input data, Sync loss*)
- Rx CCSDS (*OK, No input data, Sync loss, Intermittent errors*)

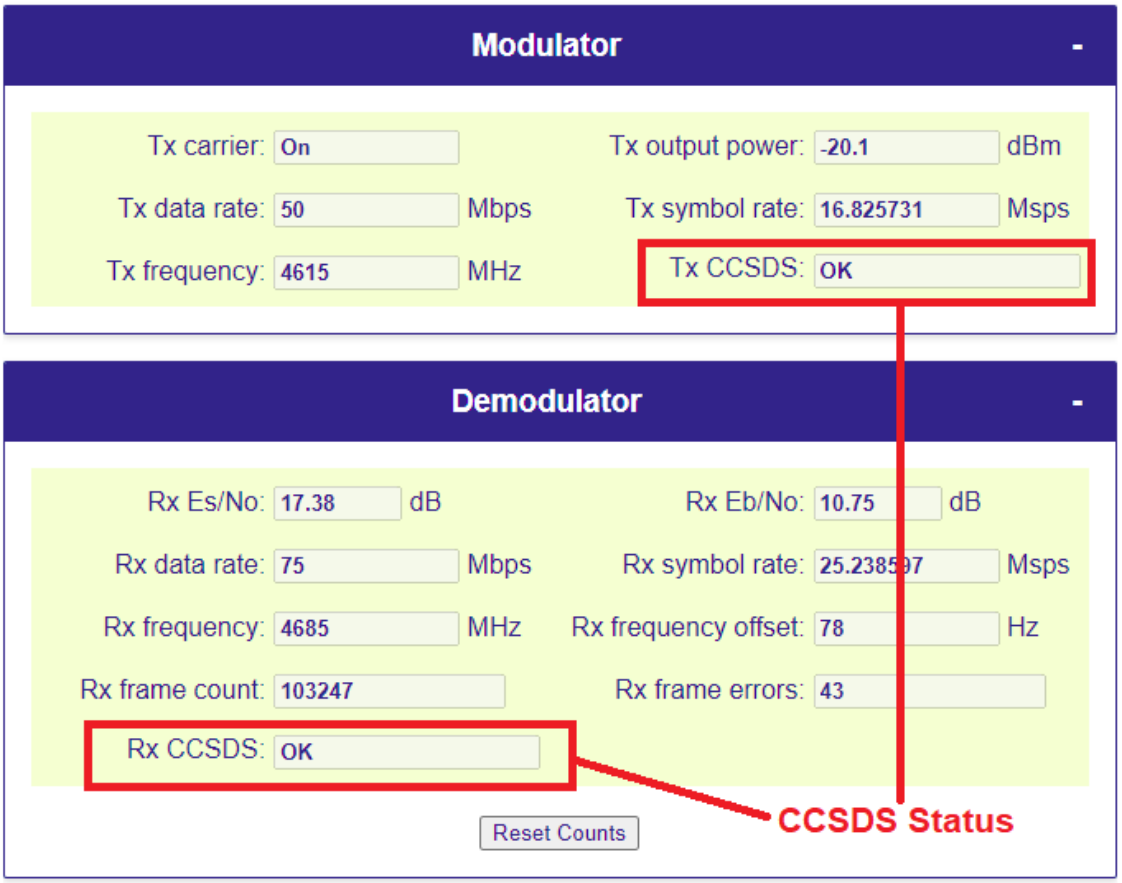

Figure 2-15B Status Screen (showing addition of CCSDS status)

All information on the status screen is updated every two seconds.

2.5.5 Status Traffic Metrics Screen

The *Traffic Metrics* screen (**Figure 2-16**) displays the following when the modem's traffic shaping feature is enabled:

- Number of packets transmitted for each DiffServ DSCP stream
- Number of bytes transmitted for each DiffServ DSCP stream
- Number of packets dropped for each DiffServ DSCP stream
- Total number of packets transmitted for all streams
- Total number of bytes transmitted for all streams
- Total number of packets dropped for all streams

Status Traffic Metrics Factory

TXMission satellite modem

TRAFFIC SHAPER METRICS

DiffServ -

DSCP Class	Packets	Bytes	Dropped
CS0	0	0	0
CS1	18780	28395360	1768344
CS2	0	0	0
CS3	150368	2233692	3886
CS4	17122	29381652	1662539
CS5	0	0	0
CS6	1972	2448123	5118
CS7	0	0	0
AF11	18654	20289164	1273201
AF12	0	0	0
AF13	1008	2776841	3127
AF21	0	0	0
AF22	18704	28966310	1774318
AF23	0	0	0
AF31	1564	2235339	3883
AF32	0	0	0
AF33	17664	28397693	1645195
AF41	0	0	0
AF42	1453	2276731	3125
AF43	0	0	0
EF	18676	29565214	1786551
LE	0	0	0
Default	0	0	0
Total:	265965	176966119	9929287

Reset Counts

Figure 2-16 Status Traffic Metrics Screen

2.5.6 Status Factory Screen

The *Factory* screen (**Figure 2-17**) displays the following:

- The current software version
- The current firmware version
- The Ethernet MAC address assigned to the modem's Ethernet port
- The Ethernet MAC address assigned to the modem's satellite port
- The build revision number of the modem's main PCB
- The build revision number of the modem's RF mezzanine PCB

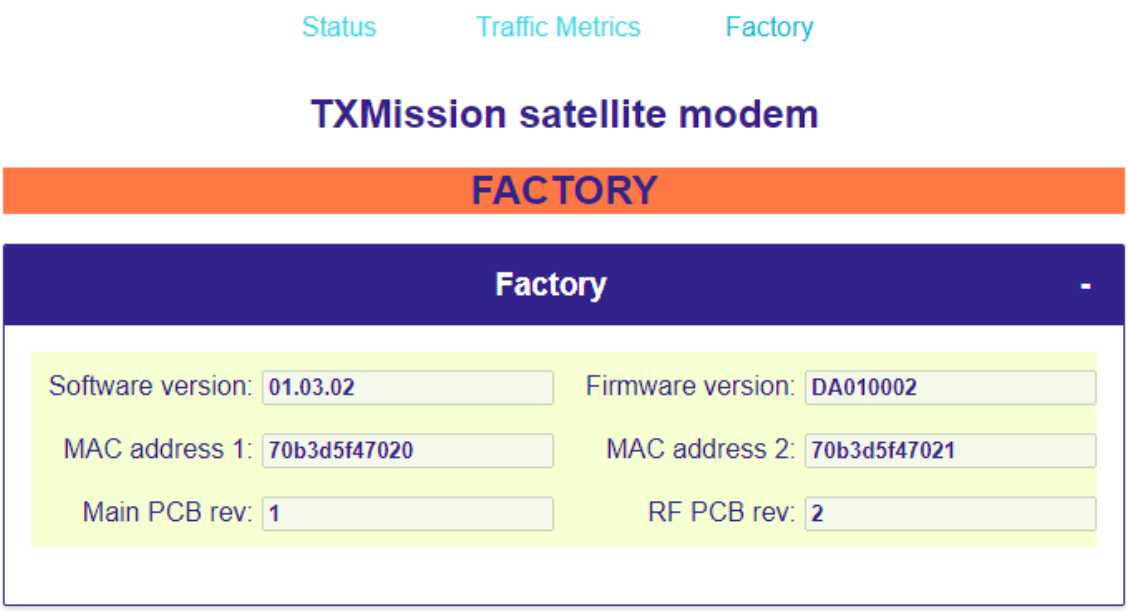

Figure 2-17 Factory Screen

2.5.7 Configurations Management Menu

The *Configurations Management* menu (**Figure 2-18**) is used to store, load and delete modem configurations.

Modem configurations are managed independently of other network resources, such as sites and devices and are held in a separate table within the application database. Modem configurations are therefore available to be used with all devices in the network.

The easiest way of transferring modem configurations around the network is to FTP the MissionSpan database to each modem manually (contact us for details). (In future, this feature will be supported within MissionSpan.)

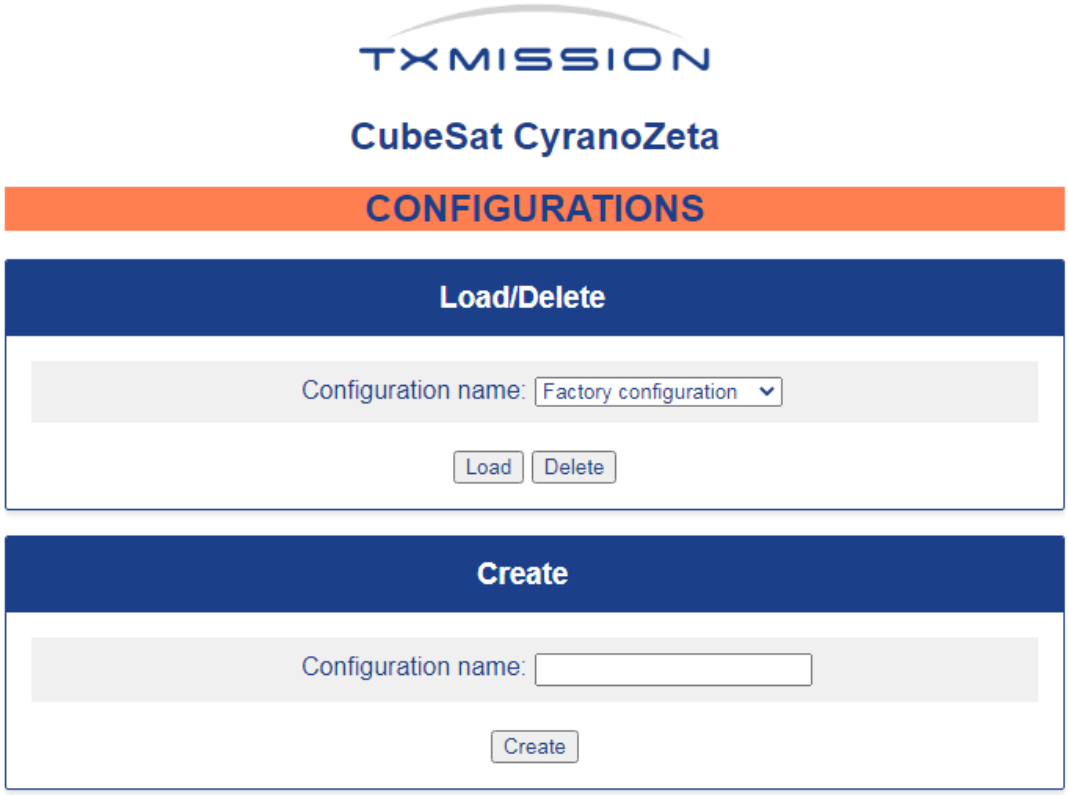

Figure 2-18 Configurations Management Menu

To load a configuration, select it from the dropdown box and click on the *Load* button. The configuration can now be viewed and edited using the *Modem Configuration (Home)* menu.

*When a configuration is loaded, it is copied from the database to the **current** configuration. The title of each configuration screen will show the Modem ID from the **current** configuration and the original configuration name (in the case of **Figure 2-18**, these are CubeSat CyranoZeta and Orbital Configuration 1, respectively).*

*When the modem is power cycled, it is the **current** configuration that is loaded. Changes to configurations can only be made through the **current** configuration. The operator will therefore typically load a configuration, edit it as the **current** configuration and then store the **current** configuration as a named configuration (either as the original configuration name or to a configuration with a new name).*

*Changes made to the **current** configuration are stored immediately into the database as they are made. However, if another configuration were to be loaded without saving any changes to the **current** configuration beforehand, then the changes would be lost since the **current** configuration is overwritten at this point.*

Note that *Factory configuration* is a special configuration. By loading the factory configuration, the operator can create a new configuration starting from the factory default settings.

To delete a configuration, select it from the dropdown box and click on the *Delete* button. Click *OK* on the resulting dialog to confirm the deletion. The factory configuration cannot be deleted.

To save a new configuration, or overwrite an existing configuration, enter the configuration name in the *Create* section and click the *Create* button.

2.5.8 Users Menu

The *Users* menu (**Figure 2-19**) is used to add, delete and edit user details and can also be used to log out of the application.

The default modem user is *admin* (default password *txmission*). There are no limits on the number of users that can be added.

Currently, the modem does not support different levels of administration rights and all users have equal access and permissions.

All passwords are stored in encrypted form in the database.

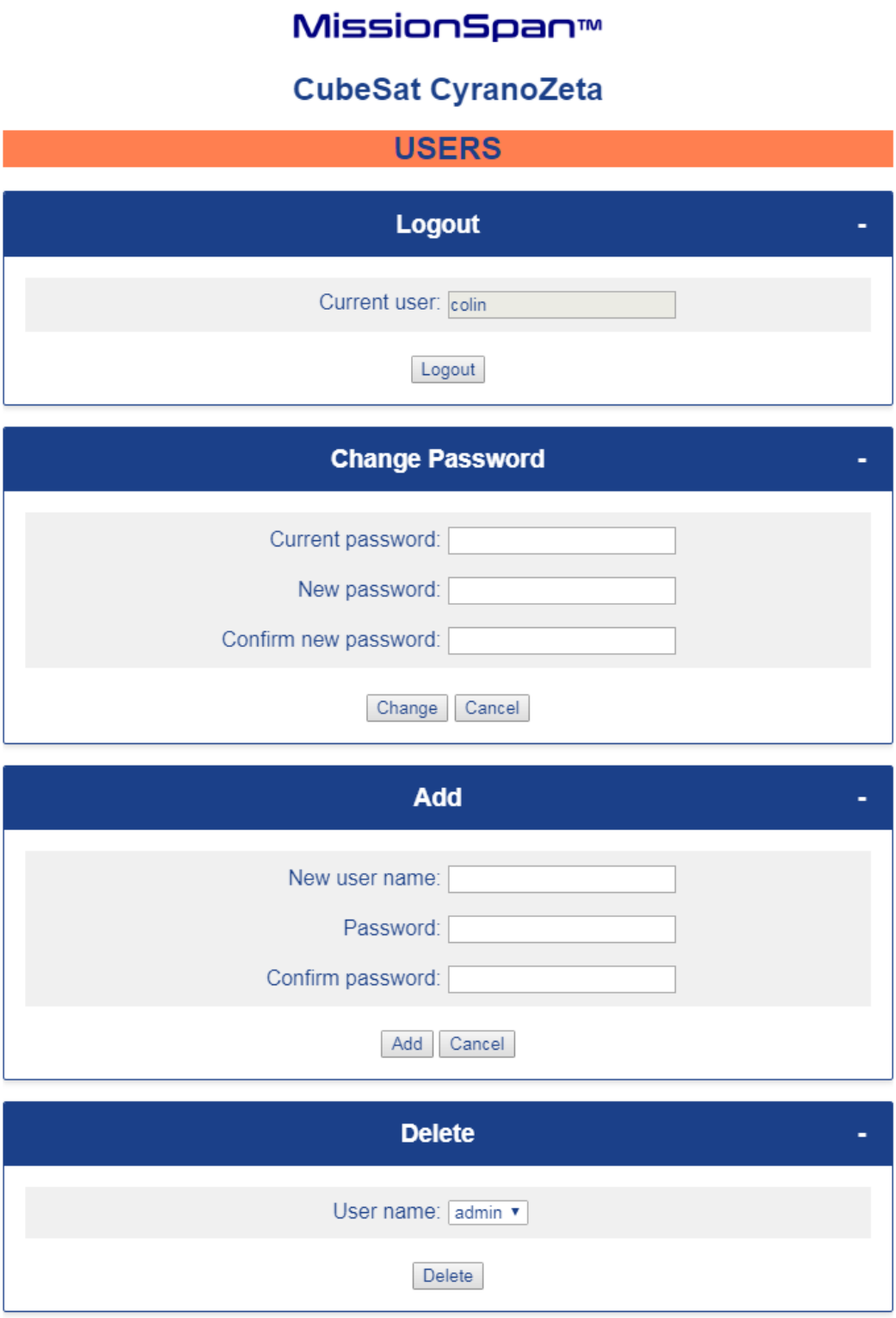

Figure 2-19 Users Menu

The name of the current user is shown in the *Logout* section. Clicking on the *Logout* button logs the current user out and displays the login screen.

The current user's password can be changed in the *Change Password* section by entering the current password and new password and confirming the new password before clicking on the *Change* button. Passwords must be at least eight characters long.

A new user can be added in the *Add* section by entering a username, password and confirming the password before clicking on the *Add* button. There are no restrictions on the types or number of characters that can be part of a user's name. Passwords must be at least eight characters long.

A user can be deleted by selecting the user's name from the dropdown box in the *Delete* section before clicking on the *Delete* button.

There are no facilities for resetting forgotten passwords. It is recommended that the modem database (*smallsat_database.db* stored in the usr/lib/webserver folder) is backed up regularly. By backing up the database, it may be possible to revert to logging in using an older username or password if required.

2.5.9 System Alarms and Log Screen

The *System Alarms and Log* screen (**Figure 2-20**) provides access to the modem's alarms and system log. The log shows local activity including operator logins, logouts, screen and database accesses and any errors that occur.

The information on the screen is updated every two seconds. The information is written to log files (one each for alarms and system log) that are stored in non-volatile memory. These have a maximum size of 5Mbytes each. When this size is exceeded then the log file is copied to a backup file and the current log is reset (cleared). The backup file remains accessible via command line utilities, for example, for download purposes. Only one backup file is maintained for alarms and one for system log.

The operator can clear the alarms and system log independently of each other. Clearing alarms simply clears the historic information held in the alarms log – it does not clear the actual alarms in the modem, which can only be cleared by the underlying causes being rectified.

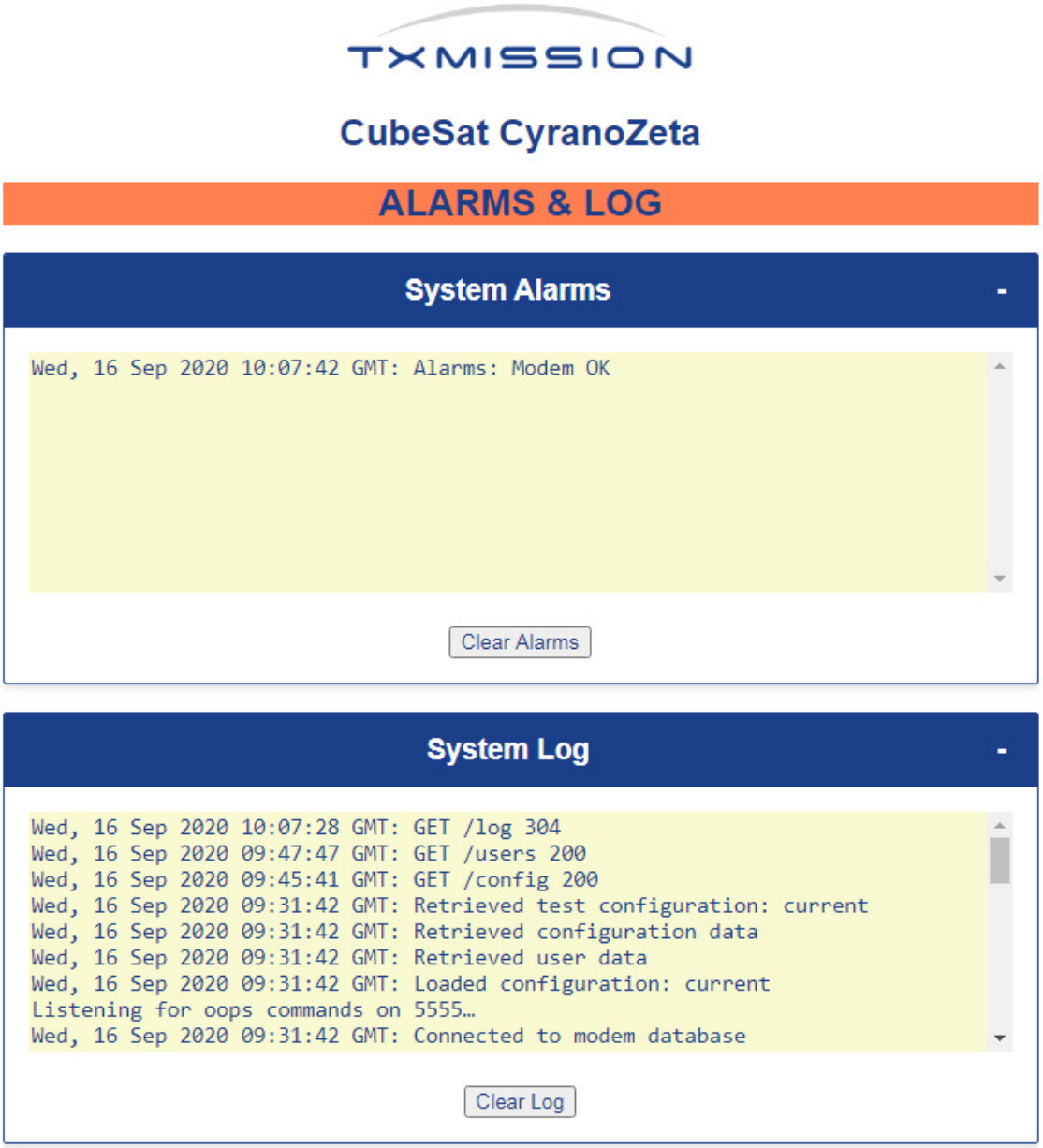

Figure 2-20 System Alarms and Log Screen

2.5.10 Test Menu

The *Test* menu (**Figure 2-21**) provides access to various test features of the modem, as follows:

- RF loopback mode provides loops back the transmit path to receive, causing the modem to receive its own transmitted carrier. Loopback can be set off or on.
- A Psuedo Random Binary Sequence (PRBS) Bit Error Rate (BER) test can be run in the transmit and or receive paths of the modem. In transmit, the modulator generates a PRBS test pattern of bits that replace the normal data traffic. In

receive, the demodulator analyses the received data stream and attempts to match the incoming data to the expected pattern of bits. Any bits that do not match are reported as errors. Patterns that are supported are PRBS11, PRBS15, PRBS20 and PRBS23.

- PRBS BER test results are shown as follows:
    - *Sync status*: this is shown as either *Rx PRBS inactive*, when the PRBS test feature is switched off, *Waiting for sync*, when the feature is active but the receiver has failed to synchronize to the incoming pattern, or *Sync OK*, when the receiver has synchronized successfully to the incoming pattern.
    - *Sync losses*: A loss of sync (*yes*/*no*) is declared if at any point the receiver loses lock in relation to the incoming PRBS pattern. The sync loss status is latched and continues to be reported even after sync is regained. It can be cleared by selecting *Restart* or switching the PRBS test off and back on.
    - *Bits received*: This is the total number of bits received since the PRBS test started.
    - *Bit errors*: This is the number of bits in error since the PRBS test started.
    - *Bit error rate*: This is the number of bits received divided by the number of bits in error since the PRBS test started.

The *Restart* button can be used to clear the PRBS BER results and restart the pattern synchronization process.

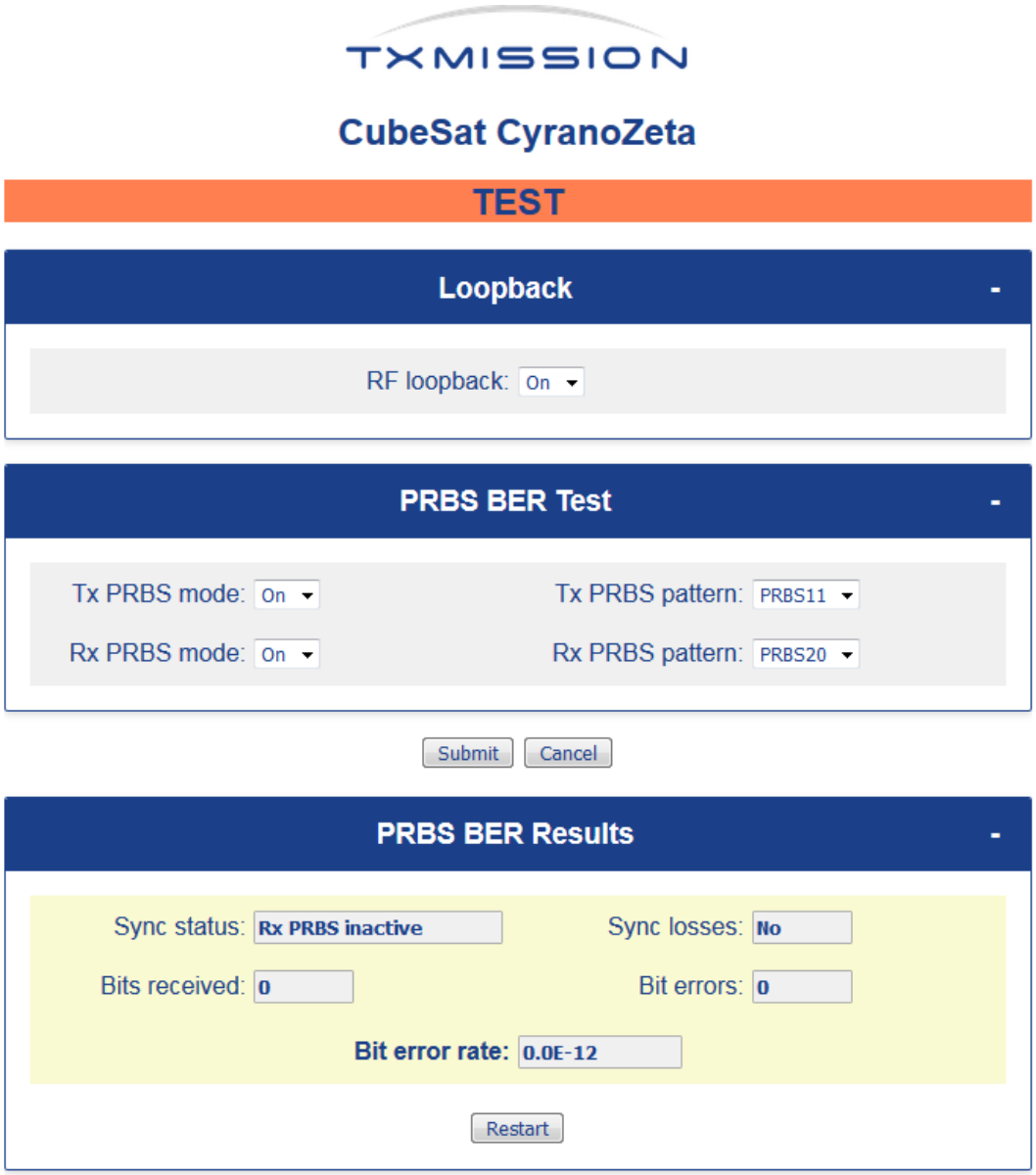

Figure 2-21 Test Menu

2.5.11 Graph Menu

The *Graph* menu provides access to receive I/Q constellation and spectrum graphs (**Figure 2-22**).

TXMISSION

CubeSat CyranoZeta

GRAPHS

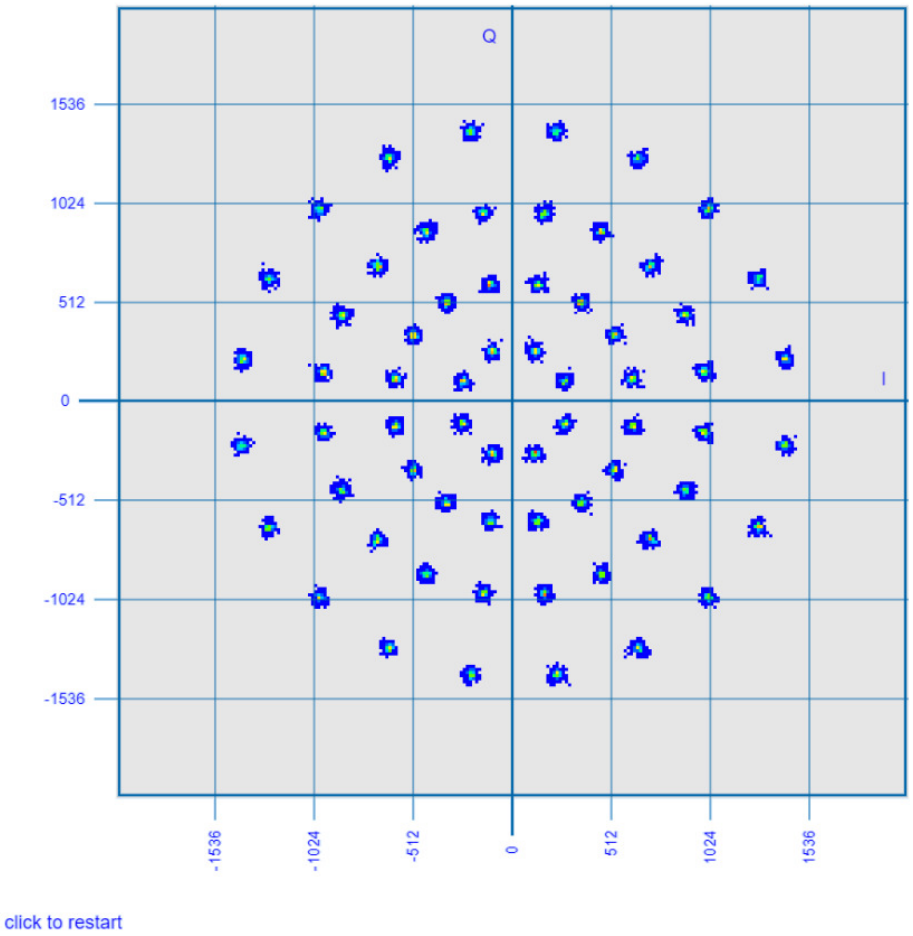

Figure 2-22 Receive I/Q Constellation Graph – showing DVB-S2 64APSK

2.5.12 Help Menu

The *Help* menu provides access to this manual.

3 Appendix: Modem Simulator

A modem simulator is available, primarily for use with MissionSpan NMS. This can be used to check the operation of newly created modem configurations prior to their deployment in a live network. The use of a modem simulator is also useful when training operators. The modem simulator is provided free of charge to all MissionSpan users.

The modem simulator can run on the same computer as MissionSpan and/or any number of other computers. The modem simulator comprises TXMission's modem web server, OOPS! command line handler, modem database, system log and logic that simulates modem operation, such as the output of status information.

3.1 Installing the Modem Simulator

The modem simulator is a web server that runs on Windows, Linux and other computers that support a **node.js** environment. Node.js is a framework for running JavaScript applications. The modem simulator installation zip file includes node.js for 64-bit Windows environments. Versions of node.js for other environments can be downloaded from https://nodejs.org/en/download/.

The modem simulator, as shipped, is dependent on a specific version of node.js being installed. Please install the version of node.js included in the installation zip file. If you already have a later version of node.js installed then you will have to uninstall it and install the version provided by TXMission. Some node.js modules have been cross-compiled for an Intel processor environment – please contact us if you intend installing the modem simulator onto a computer that has a non-Intel processor.

A Windows computer should meet the following specification as a minimum (when used with other operating systems, the computer should provide equivalent resources):

1. Microsoft Windows 10 (recommended but not essential)
2. Intel i5 processor (recommended but not essential)
3. 8GB memory
4. 100MB of free disk space

*The modem simulator is provided as a compressed 7-Zip file (**Figure 4-1**). 7-Zip is an archiving tool that can be downloaded freely from the internet. WinZip can also be used. Ensure that 7-Zip or a compatible archive tool is available before proceeding.*

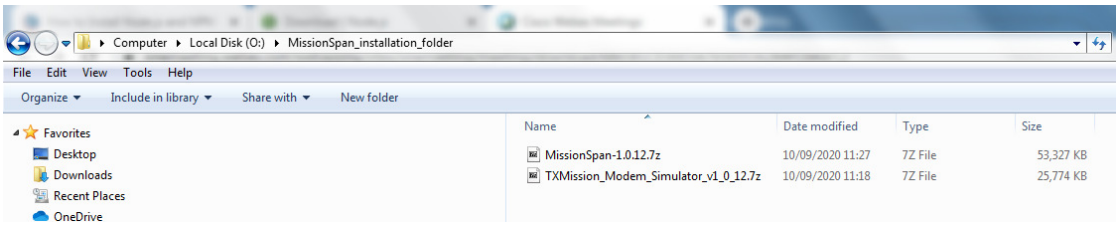

Figure 4-1 Modem Simulator Installation Zip File

The installation process for the application is as follows:

1. Navigate to the destination folder where the modem simulator is to be installed and open the archive TXMission_Modem_Simulator_vx_x_x.7z (you may need to right-click on the file and select '*Open*' or '*Open archive*'). The archive tool will display the contents of the zip file (see **Figure 4-2**).

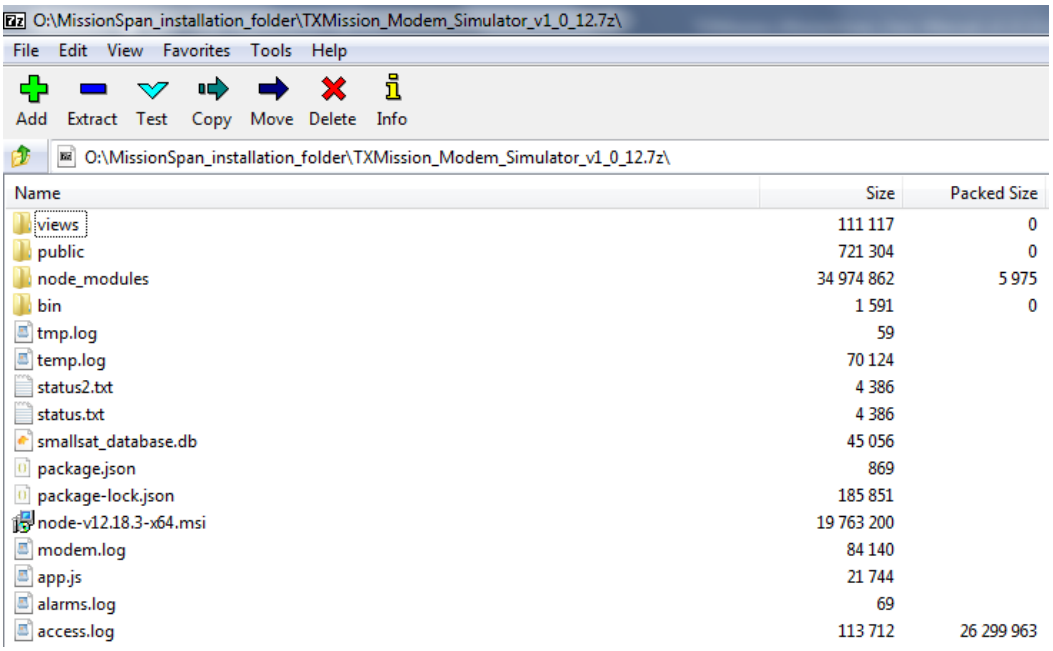

Figure 4-2 Modem Simulator Installation Zip File Contents

2. Select the *Extract* button in order to extract all files and choose the destination folder as shown in **Figure 4-3**.

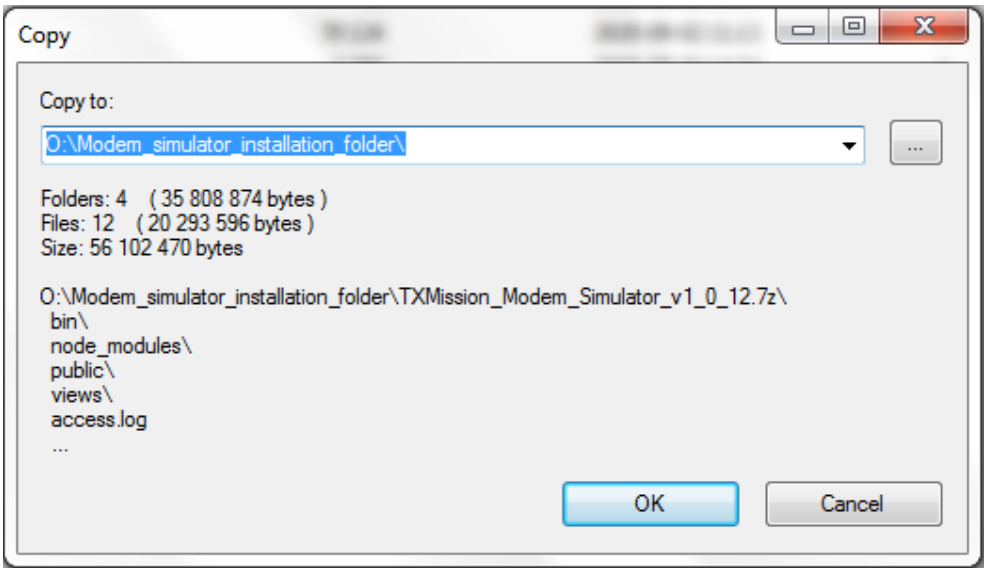

Figure 4-3 Extracting the Installation Zip File Contents

3. Following extraction, the contents of the destination folder should now look like **Figure 4-4**.

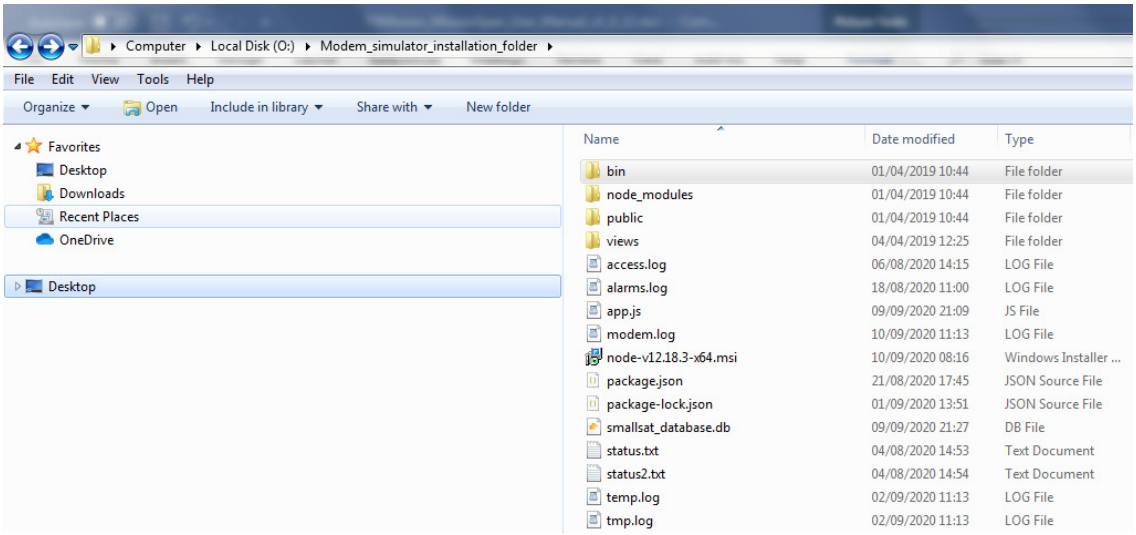

Figure 4-4 Installation Folder Contents

4. Before the modem simulator can be run, it is necessary to install the node.js runtime environment. Double click on the *node-vx.x.x-x64.msi* file to start the installation.

5. Click *Next* on the node.js setup wizard Welcome screen.

6. Review and accept the license agreement before clicking *Next*.

7. The installer will prompt for a installation location. When this has been selected click on *Next*.

8. The wizard will let you select components to include or remove from the installation. Accept the defaults by clicking *Next*.

9. Finally, click the *Install* button to run the installer and when it finishes, click *Finish*.

3.2 Runing the Modem Simulator

To run the modem simulator following installation, do the following.

1. Start a Windows command prompt by entering *command prompt* into Windows Start Menu search box and then select the *Command Prompt* application, right click and select *Run as administrator* (**Figure 4-5**).

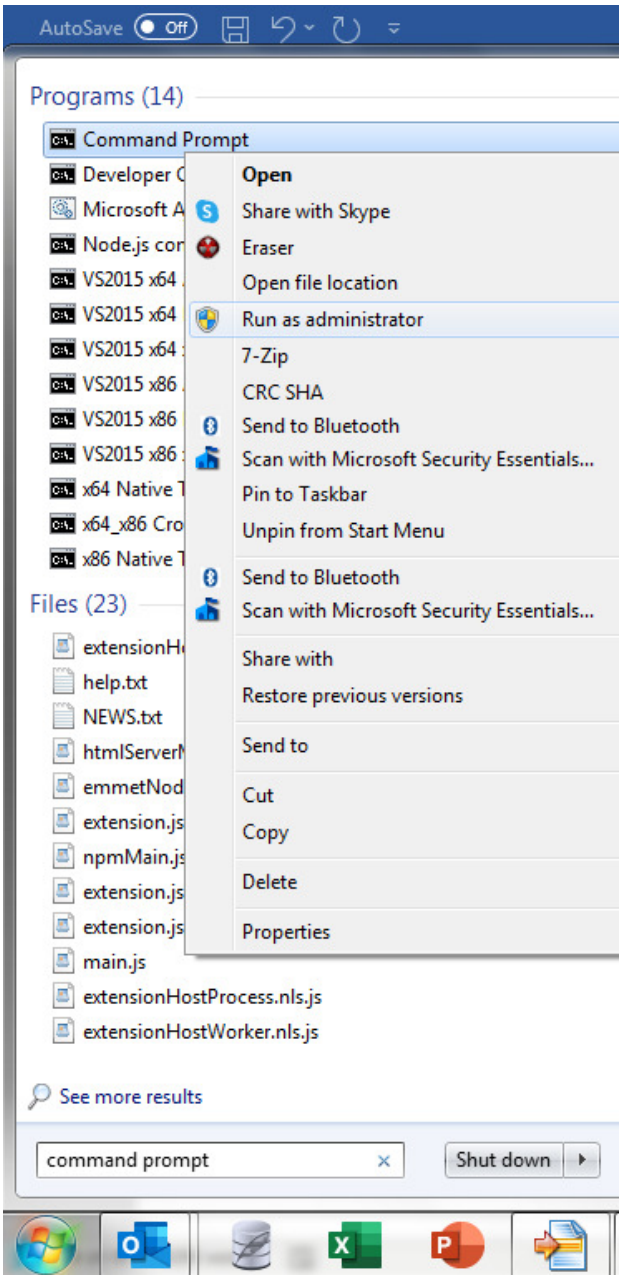

Figure 4-5 Starting a Command Prompt Window

2. Change to the installation folder by entering *cd install_folder* where *install_folder* is the pathname of your modem simulator installation folder.

3. Then enter *node bin\www* to start the modem simulator (**Figure 4-6**). Note that a firewall warning screen like that of **Figure 3-2** will be displayed – allow the modem simulator to communicate over at least the local network. Various messages will then be displayed, as shown, in the console window (**Figure 4-6**) as it starts up.

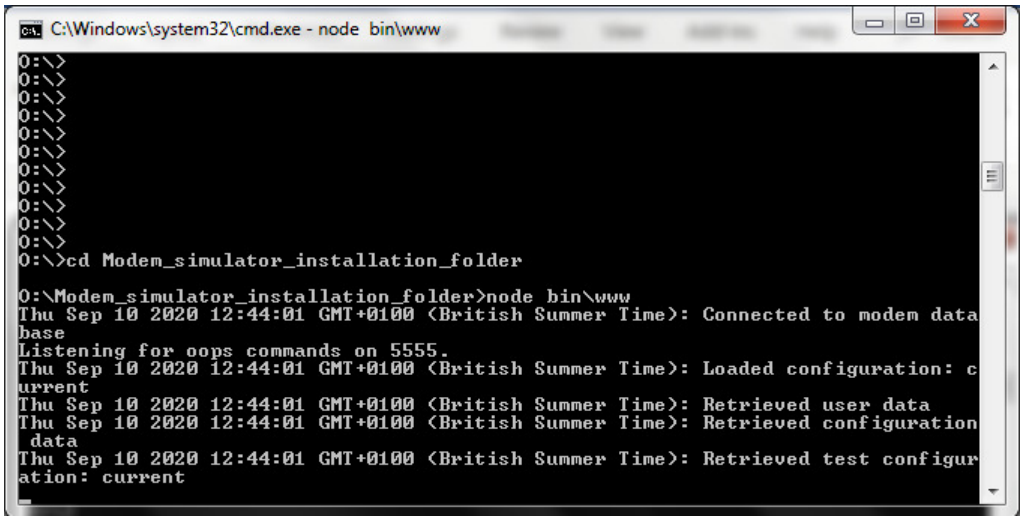

Figure 4-6 Starting the Modem Simulator in Node.js

4. The web server element of the modem simulator is accessible via port 3000 on the localhost address. To check the web server is running correctly, access it using any web browser on the computer using the address *127.0.0.1:3000* (**Figure 4-7**).

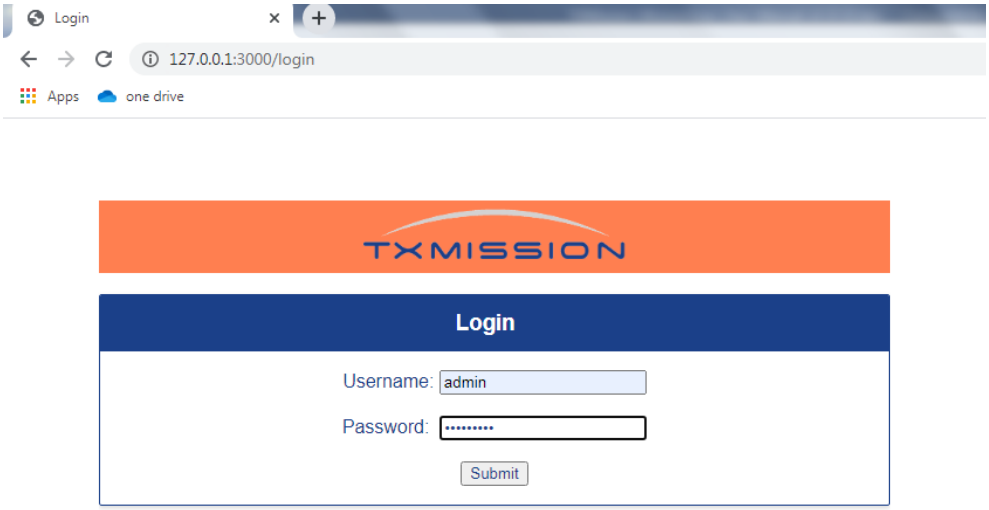

Figure 4-7 Checking the Modem Simulator in a Web Browser

5. If the modem simulator is running on the same computer as MissionSpan then it can be accessed by loading *Constellation 1* inside MissionSpan and selecting any device (**Figure 4-8**) from the navigation tree (which are all set up to use the local host address).

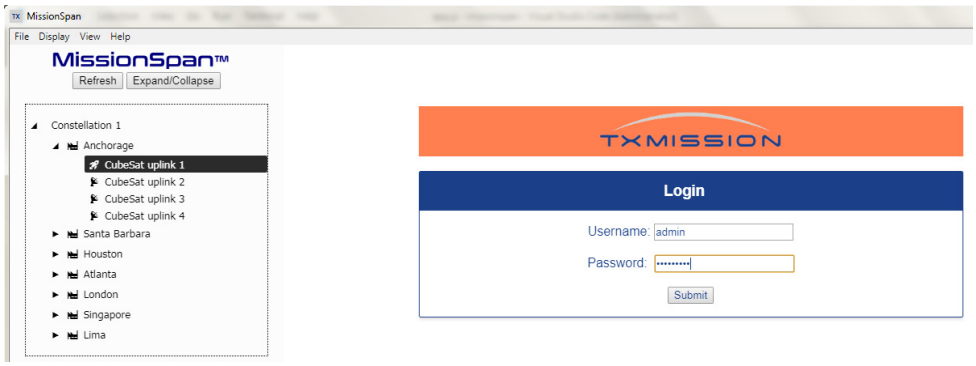

Figure 4-8 Accessing local version of Modem Simulator from MissionSpan

6. To access the modem simulator on a different computer from MissionSpan then change the device's IP address within MissionSpan accordingly (as described earlier in this manual). An example is shown in **Figure 4-9**. Note that it may be necessary to provide access through any firewalls on both computers (the modem simulator web server runs on port 3000 and an OOPS! command handler listens for commands on port 5555).

Figure 4-9 Setting MissionSpan to access Modem Simulator on another computer