TELEDYNE PARADISE DATACOM
A Teledyne Technologies Company

QMultiFlex-400 MCPC/SCPC Hub
Installation and Operating Handbook

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Chapter 1 Welcome

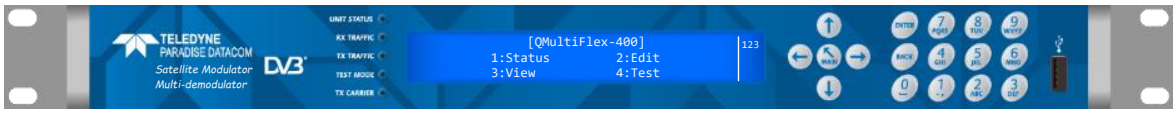


Figure 1-1 QMultiFlex-400™ Advanced Satellite Modem

The **QMultiFlex-400™** (**Figure 1-1**), a variant of our versatile **QFlex-400™** satellite modem, is a modulator/multi-demodulator system that supports efficient, cost-effective point-to-multipoint IP operation.

This handbook will guide you through the process of setting up and using your **QMultiFlex-400™** satellite modem and point-to-multipoint network.

We refer to the **QMultiFlex-400™** as a '**hub-in-a-box**' because it incorporates all the following functions in a single rack unit, which replaces a whole rack of traditional hub equipment:

- Modulator
- Multiple demodulators
- Ethernet managed switch
- Router
- IP bandwidth optimizer
- ACM controller
- Packet encapsulator/decapsulator
- Spectrum analyser
- Oscilloscope (constellation monitor)
- Traffic generator/analyser
- Redundancy system controller
- Embedded hub canceller

The **QMultiFlex-400™** supports a highly efficient shared DVB-S2/S2X outbound carrier with multiple DVB-S2/S2X inbounds and can be used for star, full mesh and hybrid networks.

The **QMultiFlex-400™** supports a layer 2 bridge (Star Topology) and a layer 3 router (Mesh Topology). **QMultiFlex-400™** can therefore act as either a transparent bridge for all protocols (including tunneling protocols, VPNs & VLAN trunks etc) or it can perform explicit packet forwarding, as required.

The **QMultiFlex-400™** and associated **QFlex-400™** remote modems can be controlled from a web browser using the built-in web user interface that is supported on each device. Alternatively, a **QMultiFlex-400™** network can be controlled via our **Q-NET™ Navigator,** to visualize the status of a complete network at-a-glance. The **QMultiFlex-400™** interoperates with **Q-Lite™** and **Q-Flex™/QFlex-400™ P2MP** remote network modems.

The satellite bandwidth-saving features include:

- **DVB-S2** and **DVB-S2X** state-of-the-art Forward Error Correction (FEC) representing the most bandwidth-efficient FEC technology available. Now available for both inbounds and outbounds.
- **Spectral roll-off factors down to 5%**, saving up to 15% bandwidth compared with 20% roll-off.
- **Embedded Hub Canceller** allowing satellite BW savings of up to 50%.
- **Adaptive Coding and Modulation (ACM)**, saving up to 50% bandwidth.
- **Variable Coding and Modulation (VCM)**, up to 6 IP streams with individual MODCODS for optimal per-site throughput.
- **9-tap Rx adaptive equaliser**, providing compensation for linear distortion in the channel, such as from group delay. The equaliser is automatically switched on in all modes of operation above 10Msps.

New levels of usability are provided by a leading set of built-in diagnostic tools including spectrum and constellation monitors that facilitate the detection of any link degradation.

DVB-S2X, the successor to DVB-S2, is the most efficient and robust coding and modulation standard available for satellite transmission and supports transmission of modulations up to 64APSK.

Redundancy Switch operation is documented in '*Q-NET™ PDQS Redundancy Switch Installation and Operating Handbook*'.

Chapter 2 About This Handbook

2.1 Conventions

This warning symbol is intended to alert the user to the presence of a hazard that may cause death or serious injury.

This information symbol is intended to alert the user to the presence of important operating instructions critical to correct system function.

2.2 Trademarks

All trademarks used in this handbook are acknowledged to be the property of their respective owners.

2.3 Disclaimer

Although every effort is made to ensure the accuracy and completeness of the information in this handbook, this cannot be guaranteed, and the information contained herein does not constitute a product warranty. A separate product warranty statement is available. Teledyne Paradise Datacom maintains a programme of continuous product improvement and reserves the right to change specifications without prior notice.

Chapter 3 Safety and Compliance Information

PLEASE READ THE FOLLOWING INFORMATION BEFORE INSTALLATION AND USE.

3.1 Safety Compliance

To ensure operator safety, this satellite modem conforms to the provisions of EMC Low Voltage Directive 2006/95/EC and complies with the following standard:

- EN 60950-1:2006 'Safety of Information Technology Equipment, Including Electrical Business Equipment'.

Prior to installation and at all points during operation the following points must be observed.

- ***This satellite modem must be operated with its cover on at all times in order to provide protection from potentially lethal internal voltages. Never operate the unit with the cover removed.***

- ***This satellite modem must be directly connected to a protective earth ground at all times using the chassis ground stud situated on the rear of the unit.***

- ***The power system to which this satellite modem is connected must provide separate ground, neutral and line conductors. The power system must have a direct ground connection. Note that the ground stud in itself does not provide a protective earth connection until the satellite modem is coupled to a suitable power supply cord containing a protective earth terminal.***

- ***This satellite modem has double pole/neutral fusing. To ensure operator safety, fuses should always be replaced with identical type and rating.***

- ***To allow rapid disconnection from the mains in an emergency, the equipment should be installed near the mains socket outlet, which should be easily accessible.***

3.2 Environmental Compliance

All Teledyne Paradise Datacom satellite modem products are compliant with the following EC environmental directives:

- The Reduction of Hazardous Substances (RoHS) Directive 2011/65/EU.
- The Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU

The equipment is designed to operate in a static 19-inch rack system conforming to IEC 297-2.

The equipment should not be directly connected to the Public Telecommunications Network.

Operation of the equipment in an environment other than that stated will invalidate the safety standards.

The equipment must not be operated in an environment in which it is exposed to:

- ***Unpressurised altitudes greater than 3000 metres (9842ft).***
- ***Extreme temperatures outside the stated operating range.***
- ***Excessive dust.***
- ***Moisture or humid atmosphere above 95% relative humidity.***
- ***Excessive vibration.***
- ***Flammable gases.***
- ***Corrosive or explosive atmosphere.***

3.3 Electromagnetic Compatibility (EMC) Compliance

This satellite modem conforms to the provisions of EMC Directive 2004/108/EC and complies with the following EC and FCC standards:

- Emissions: EN 55022:2010 Class B – 'Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement'.

- Immunity: EN 55024:2010 (incorporating EN61000-4-2:2009; EN61000-4-3:2006, A1, A2; EN61000-4-4:2012; EN61000-4-6:2009) – 'Information Technology Equipment – Immunity Characteristics – Limits and Methods of Measurement'.

- Federal Communications Commission (FCC) Federal Code of Regulation Part 15, Subpart B.

All D-type connectors must have grounding fingers on the plug shell to guarantee continuous shielding. The back-shells must comply with the requirements of VDE 0871 and FCC 20708, providing at least 40dB of attenuation from 30MHz to 1GHz. A good quality cable with a continuous outer shield, correctly grounded, must be used.

Connections to transmit and receive IF interfaces must be made with double-screened coaxial cable (for example, RG223/U).

The modem Ethernet ports should not be connected directly to outdoor Ethernet cables that may be subject to transient overvoltages due to atmospheric discharges and faults in the power distribution network. Instead, the modem should be connected via an Ethernet switch or router to provide isolation from overvoltages as recommended in clause 6 of EN 60950-1.

Chapter 4 Installation

4.1 Unpacking

Prior to unpacking, inspect the exterior of the shipping container for any sign of damage during transit. If damage is evident, contact the carrier immediately and submit a damage report.

Carefully unpack all items, taking care not to discard any packing materials. Should the unit need to be returned to Teledyne Paradise Datacom then you should use the original packing carton as it is designed to provide the necessary level of protection during shipment.

Once unpacked, visually inspect the contents to ensure all parts are present and that there is no visible damage.

4.2 Line Supply

This satellite modem is classified by the EN 60950-1 safety standard as a 'pluggable equipment Class A'. The mains operating range is 90V to 264V. A 48V DC input option is available. Power consumption ranges from 50W to a maximum of 300W (when a BUC PSU is fitted).

Parameter	PSU used in QMultiFlex-400™
Input Voltage - Operating	90 to 264 VAC
Input Frequency	47Hz to 63Hz
Power Factor	>0.5 (230VAC, 100% Load EN61000-3-2 class A compliant)
Input Current - No Load	20mA (115VAC) | 40mA (230VAC)
Input Current - Full Load	1.5A (115VAC) | 0.9A (230VAC)
Inrush Current	Max: 40A (230VAC - cold start @25°C)
No Load Input Power	300mA (115VAC) | 400mA (230VAC) - Max: 500mA
Earth Leakage Current	100µA (115VAC 50Hz) | 214µA (230VAC 50Hz) Max: 230µA (264 VAC 60Hz)
Input protection	T3.15A/250V Fuses - Phase and Neutral.

Table 4-1 – Power Supply Specifications

A power cord that is suitable for use in the country of operation is provided.

The installation of the satellite modem and the connection to the line supply must be made in compliance with local and national wiring regulations for a Category II 'impulse over-voltage' installation. The satellite modem should be positioned to allow a convenient means of disconnection from the line supply.

4.3 Rack Mounting

If the unit is being installed in a user-provided rack, then adequate ventilation and cooling should be provided. There must be adequate clearance around the rear and side-mounted fans and the ventilation holes on the left side of the unit.

For rack mounting, there are screw positions on the unit's front panel for attaching it to the rack, which prevent the unit from moving, which must always be used in conjunction with full-length L-brackets fitted on both sides of the unit (or a tray underneath the unit) to support its weight.

A 1U gap between units in the rack is not necessary but if extra space is available then any gap will help minimise the temperature inside each unit, which may contribute to improving long-term reliability (due to the well-known relationship between the temperature and reliability of electronic components).

4.4 Getting Started

Connect the appropriate cables to the transmit and receive N-Type connectors at the rear of the unit.

Connect an IP patch cable from the bottom IP traffic port (next to M&C port) to the IP processing port IP4. IP1 (upper position) will become the main IP Traffic port.

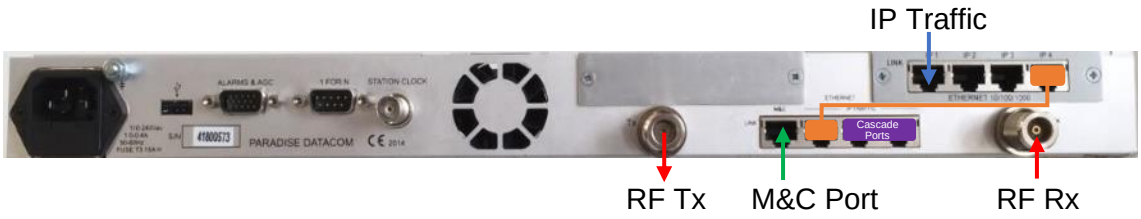


Figure 4-1 Rear of Modem with IP Ports

Power the unit and wait for it to complete its initialization. Once booted the top menu will display on the front panel and the modem is ready to connect to an M&C IP network.

The unit can be configured from a web browser as described in Section 6.2 or it can be configured using the front-panel menus by selecting **Edit** and then **Service->General** and configuring all of the submenu settings (covering System, Service, MODCOD, Carrier and Demods).

Once configured, connect network traffic to the IP Traffic port (in this case IP1).

When configuring a number of units that have similar settings, the configuration settings of one unit can be saved, extracted and then transferred to each of the other units in turn, using either the web user interface or the USB interface at the front of the modem. See Sections 6.2.25 and 6.3.4.

Chapter 5 Introduction

5.1 Overview

The **QMultiFlex-400™** satellite modulator/multi-demodulator is designed for point-to-multipoint IP networks and supports any network topology including star, mesh and hybrid star/mesh networks. **QMultiFlex-400™** units can be daisy chained to create arbitrarily large networks supporting up to 128 remote sites. Layer 2 and layer 3 solutions are supported.

Features include:

- DVB-S2 (EN 302 307-1) and DVB-S2X (EN 302 307-2) shared outbound, including Adaptive Coding and Modulation (ACM).
- A single modulator and up to 16 demodulators. **Q-MultiFlex-400™** units can be cascaded together to provide a single transmit carrier to many remote sites, each of which provides a return carrier to the hub. Multi-transponder/satellite solutions are supported.
- DVB-S2 and DVB-S2X only returns.
- Embeded Hub Canceller – Up to 200Mbps (Occupied bandwidth 100kHz to72mhz). Allows carriers in a point-to-multipoint system to operate in the same satellite bandwidth, providing satellite BW savings of up to 50%.
- Redundancy modes: 1:1, 1:N and Geographical Redundacy features.
- Dual IF/L-band operation. N-Type connectors are used for IF **or** L-Band operation.
- Data rates up to 345Mbps (70Msps) outbound. Aggregate in-bound up to 338Mbps (70Msps with 5% roll off used).
- Spectral roll-off factors of 5%, 10%, 15%, 20%, 25% and 35%.
- **Q-NET™ Navigator** control application, included as standard, allows all elements of the network to be controlled from a single multi-operator application.
- Supports low-cost **Q-Lite™**, **QFlex™** & **QFlex-400™ P2MP** remote modems.
- Built-in spectrum and constellation monitors.
- DVB Carrier ID. Fully compliant with DVB-CID standard.
- IF frequency ranges of 50 to 90MHz and 100 to 180MHz; L-band frequency range of 950MHz to 2450MHz.
- Automatic Uplink Power Control (AUPC) automatically adjusts modem output power to maintain a constant Eb/No at the distant end of the satellite link. Available for the shared outbound and for up to 16 individual inbounds.
- Front panel display and keypad for local control.
- Remote equipment can be controlled via the M&C IP port via an M&C VLAN. Remote modem control is supported via the web GUI, the Simple Network Management Protocol (SNMP), SSH, Telnet and the proprietary Paradise Universal Protocol (PUP) command protocol. As well as supporting the development of third-party user interfaces for modem control, the PUP protocol includes many useful hooks for satellite listening applications. Remote control is supported using a specific VLAN (separate from any traffic VLANs) where all the M&C packets are sent over satellite in a VLAN that is received by all the remote modems.
- Compact 1U chassis, 285mm deep (11¼ inches).
- **XStream IP™**, providing an advanced integrated suite of IP optimisation and traffic management features. These include Transport Control Protocol (TCP) acceleration, header and payload compression, encryption, static and dynamic routing, Dynamic Host Control Protocol (DHCP), IEEE 802.1p Quality of Service

(QoS) support, IEEE 802.1q VLAN support, traffic shaping and Adaptive Coding and Modulation (ACM). A dual IPv4/IPv6 TCP/IP stack is provided. IPv4 support is provided for all IP functions as the default. With respect to IPv6, bridging and routing are supported along with an IPv6 embedded web server. Modem IP addresses and static routes can also be entered and displayed in IPv6 format. **TCP acceleration** is supported at up to 100 Mbps and up to 4,400 concurrent accelerated TCP connections are supported along with up to 40,000 unaccelerated TCP connections.

- Trunk and access VLAN modes are supported, along with filtering on specific VLANs at the remote modems.

5.2 Standard-Fit Hardware

5.2.1 IF/L-band Operation

The following are provided as standard:

- IF operation, via transmit and receive N-Type connectors (supporting 50Ω operation at 50 to 90MHz and 100 to 180MHz).
- L-band operation, via transmit and receive N-type connectors (supporting 50Ω operation at 950 to 2450MHz).
- A high-stability L-band 10MHz reference signal is available for output to a Block Up Converter (BUC) or Low-Noise Block (LNB) in order to phase-lock the BUC or LNB's local oscillator to a highly stable frequency reference.
- A Frequency Shift Keying (FSK) capability for performing FSK communications to and from a compatible BUC or IF transceiver. This allows remote monitoring and control of the BUC or transceiver via a modulated FSK signal on the Inter-Facility Link (IFL) cable.

Note that a single Rx N-type connector is provided. The inbound carriers must all be contained within a 72MHz frequency span in order for the different carriers to be processed correctly by the multiple demodulators.

5.2.2 Ethernet Operation

To increase processing power in order to support the highest throughput possible, an IP processing card is installed as standard. This needs to be connected to the main modem IP traffic port via an ethernet patch cable. With the modem configured for 'trunking' mode (our high-speed bridge mode) 345Mbps bi-directional traffic throughput is possible – up to 200,000 packets per second with zero jitter.

Ethernet speed, duplex and cable termination (crossover versus straight-through) are auto-negotiated. Speed and duplex can be set to fixed values if desired.

5.3 Hardware Options

5.3.1 BUC Power Supply Options

The satellite modem may optionally be fitted with a Power Supply Unit (PSU) for powering a Block Up Converter (BUC) when operated in L-band mode. Refer to **Table 5-1** for the available BUC power supply options.

Part Number	BUC PSU	Type
P3553	200W 24V output	A.C. in/D.C. out
P3554	200W 48V output	A.C. in/D.C. out
P3555	24V/48V input, 200W 24V output	D.C. in/D.C. out
P3556	24V/48V input, 200W 48V output	D.C. in/D.C. out

Table 5-1 BUC Power Supply Options

5.4 Software Options

Several software options, known as Software Activated Features (SAF), are available as shown in **Table 5-2**. These can be purchased on a pay-as-you-go basis and retrospectively activated in deployed units as required. The SAF concept (including time-limited free access to most features) is explained in Section 6.2.7.10.

In the table, the *SAF Code* column lists the acronyms by which features are referred to on the modem's local user interface.

Feature	SAF Code	Description
Tx Terrestrial data rate to 100Mbps	Tx	Enables Tx data rates to 100Mbps (Standard with Tx DVB-S2/S2X features).
Tx Terrestrial data rate to 200Mbps	n/a*	Increases Tx data rate to 200Mbps (from 100Mbps)
Tx Terrestrial data rate to 345Mbps	n/a*	Increases Tx data rate to 345Mbps (from 200Mbps)
DVB-S2X CCM Tx	S2XT	Enables DVB-S2X Tx operation for all supported modulations. Includes XStream IP™ Tier 1 (Tx only). Bundled with **Tx** SAF.
DVB-S2 CCM Tx	DVB2T	Enables DVB-S2 Tx operation for all supported modulations. Includes XStream IP™ Tier 1 (Tx only). Bundled together with **DVB-S2X Tx.**
4x Demodulators	RX=4	Controls access to the Rx service for multi-demodulators numbers 1 to 4.
8x Demodulators	RX=8	Controls access to the Rx service for multi-demodulators numbers 1 to 8.
12x Demodulators	RX=12	Controls access to the Rx service for multi-demodulators numbers 1 to 12.
16x Demodulators	RX=16	Controls access to the Rx service for multi-demodulators numbers 1 to 16.
XStream IP™ Tier 1 (Tx only)	XS1	Provided as standard with **DVB-S2X CCM Tx** and **DVB-S2 CCM Tx**; includes: • **Traffic Shaping:** CIR/BIR/priority settings for IP streams classified by VLAN ID, IP address, IEEE 802.1p priority and Diffserv DSCP • **IP-over-DVB Encapsulation:** transmission of IP packets and Ethernet frames over DVB-S2/S2X using Ethernet Multistream (EMS) encapsulation.
XStream IP™ Tier 2 (Tx only)	XS2	Requires **DVB-S2X CCM Tx** or **DVB-S2 CCM Tx** option; includes: • DVB-S2/S2X point-to-multipoint ACM • DVB-S2/S2X point-to-multipoint VCM
XStream IP™ Tier 3 (Tx & Rx)	XS3	**TCP acceleration** Supports up to 4,400 concurrent accelerated TCP connections up to 100 Mbps.
Geographical Redundancy	GEO	Enables the QMultiFlex-400™ Hub Geo-redundancy feature.
Hub Canceller	PCMA	Max Data Rate Displayed. Rates from 256kbps to 200Mbps. Upgrade steps are: 256kbps, 512kbps, 1.024Mbps, 2.5Mbps, 5Mbps, 10Mbps, 15Mbps, 20Mbps, 25Mbps, 30Mbps, 40Mbps, 50Mbps, 60Mbps, 80Mbps, 100Mbps and 200Mbps
DVB-CID	CID	DVB Carrier ID. Tx carrier identification per ETSI 103 129.

*Numerical rate shown on modem if activated

Table 5-2 Software Activated Features

5.5 Front Panel

Figure 5-1 Front Panel

The front panel, shown in **Figure 5-1**, comprises:

- Light Emitting Diodes (LEDs) that provide basic modem status.
- A Liquid Crystal Display (LCD) that acts as the local user interface.
- A keypad for menu navigation and alphanumeric entry.
- USB port for software upgrades, copying configuration memories, etc.

5.5.1 Status Indicators

The five front-panel LEDs display warning and fault information as shown in **Figure 5-2** and as described in **Table 5-3**.

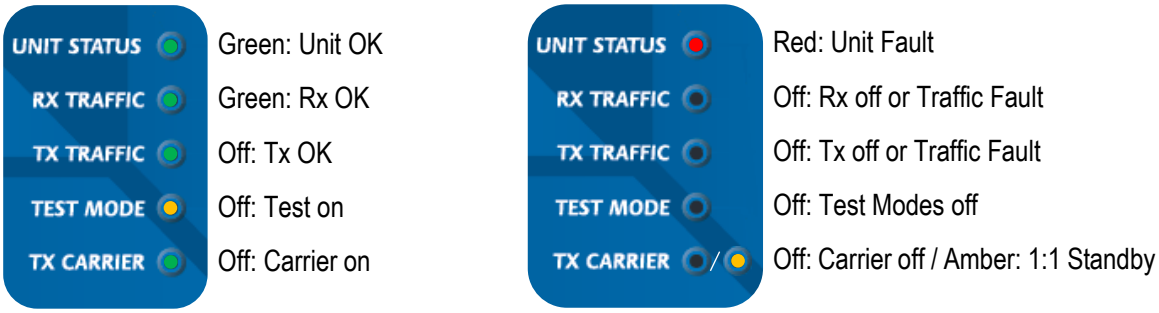


Figure 5-2 Front-panel Status Indicators

	Off	**Red**	**Amber**	**Green**
Unit Status	*Not used*	Unit fault	*Not used*	Unit OK
Rx Traffic	Rx fault or Rx disabled	*Not used*	*Not used*	Rx OK
Tx Traffic	Tx fault or Tx disabled	*Not used*	*Not used*	Tx OK
Test Mode	Normal mode	*Not used*	Test mode	*Not used*
Tx Carrier	Carrier muted	*Not used*	1:1 standby	Carrier active

Table 5-3 Front-panel LED Status

Note: The Rx Traffic LED is a summary status for all the active demodulators.

5.5.2 LCD Display

The backlit LCD is a graphical display formatted to give three lines of 40 text characters and is highly legible even in strong ambient light. The contrast is adjustable and the backlight can be dimmed or brightened as required.

5.5.3 Keypad

The keypad (see **Figure 5-3**) is incorporated into a sealed tactile membrane and allows full alphanumeric entry and navigation using arrow keys.

Figure 5-3 Front-panel Keypad

5.6 Rear Panel

The rear panel, shown in **Figure 5-4**, provides various ports for IP traffic, and local ground station integration. Connector pinouts are defined in Chapter 11.

Figure 5-4 Rear Panel

From left to right, the rear panel consists of:

- **IEC Mains Power Connector/Voltage Selector/Fuse**

  The modem is designed to operate from a mains AC supply of 90V to 264V (100W 50/60Hz). The IEC C14 appliance inlet incorporates two fuses, independently fusing both live and neutral lines. Access to the fuses is provided by a slide-out tray. Unless indicated differently on the chassis - both fuses are standard 20mm type, rated T3.15A, of the slow-blow (time-delay) type. If a BUC PSU is installed these could be 5A fuses.

Chassis Ground Stud

There is an M4 stud for connecting a safety earth conductor directly to the chassis of the unit.

- **Alarms and AGC Connector**

  This is a 15-pin D-Sub high-density (HD15) plug/male pins connector that provides access to four 'form-C' relay contacts that indicate alarm conditions. An AGC output is provided that is suitable for peaking antenna position.

  The alarm relays have the following definitions:

  Unit Fault: A fault exists on the unit indicating an equipment failure.

  Tx Traffic Prompt: A Tx traffic fault exists.

  Rx Traffic Prompt: An Rx traffic fault exists.

  Deferred Alarm: One of the following conditions exists:

  - The receive Eb/No is lower than the user-defined threshold.
  - Buffer slips are more frequent than the user-defined threshold.

- **1:1 Redundancy Connector**

  The modem has a built-in one for one redundancy controller that connects to the other modem in the 1:1 pair via a 9-pin D-type male connector. A 1:1 redundancy system requires two modems, a 1:1 control cable between the two redundancy connectors and passive splitters and combiners for the RF ports. An overview of 1:1 operation is provided in Section 8.4.

- **Station Clock**

  This is currently not used.

- **Fans**

  There are two internal high-performance fans; one at the rear and one on the right side. They draw air in through ventilation holes on the left side of the unit and expels the air outwards. The side vents must not be blocked.

- **Tx IF / L-band Output**

  This is a 50Ω N-type socket/female connector. The frequency band can be selected either IF 70MHz/140MHz or L-Band. The output power level can be varied from 0dBm to -25dBm in IF band and 0dBm to –40dBm in L-Band.

- **Ethernet IP Traffic and Remote M&C Connectors**

Four gigabit ethernet RJ45 connectors are provided on the base unit for modem Monitor and Control (M&C), satellite IP traffic and for connecting to other QMultiFlex-400™ units for demodulator expansion purposes.
Ethernet speed, duplex and cable termination (crossover versus straight-through) are auto-negotiated. Line speed and duplex can also be set to fixed values.

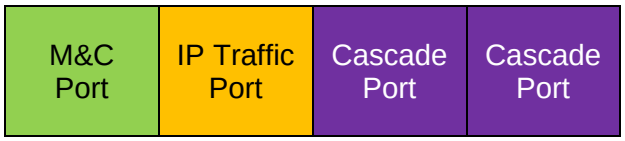


Figure 5-5 Base Modem Ethernet RJ45 Ports

M&C control can be via the Simple Network Management Protocol (SNMP), an embedded web server that sends web pages to a web browser, a Telnet-style terminal emulation application or via TCP packets that encapsulate Paradise Universal Protocol (PUP) commands.

SNMP is disabled by default and must be enabled before it can be used. Once enabled, the modem will always respond to SNMP commands regardless of whether it has been placed in a mode that restricts user control to the front panel only.

When using the M&C interface, an M&C IP address (including subnet mask and default gateway) must be set. An IP traffic address is not required when operating in Ethernet bridging modes. IP addresses are described in Section 8.7.2.

- **Terrestrial Interface Positions**

With the QMultiFlex-400™ an ethernet processing card is installed as standard. The other interface slot is not currently used. The connections are shown below. A short Ethernet cable (shown in orange) is required to connect the IP processing card and the base Modem. It is important that this connection is between the base Modem IP traffic port 1 (next to M&C port) and the IP Processing card port IP4. Do not plug anything into ports IP2 & IP3 on the IP card.

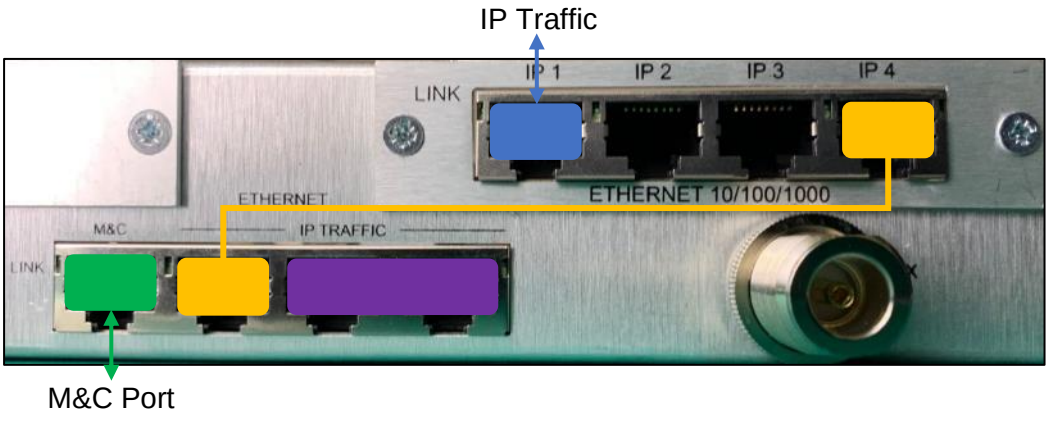


Figure 5-6 Ethernet Connections

- **Rx IF/L-Band Input**

  This is a 50Ω N-Type socket/female connector. The frequency band can be selected either IF 70MHz/140MHz or L-Band. The carrier signal level at the input of the modem must be in the following range:

  L-band minimum signal level: -140 + 10 log (symbol rate) dBm

  IF minimum signal level: -130 + 10 log (symbol rate) dBm

  IF/L-band maximum: -68 + 10 log (symbol rate) dBm

  The maximum wanted-to-composite power level that is supported with no implementation loss is defined by the equation:

  Maximum wanted-to-composite power level: -102 + 10 log (symbol rate) dBm

  The maximum composite power level is +10dBm.

Chapter 6 User Interfaces

6.1 User Control

The modem has both front-panel and web browser user interfaces.

For remote web access, there are two fixed usernames, namely, *admin* and *user*. The *admin* user can view and change the modem configuration, while *user* can only view the modem settings. Only *admin* can change the passwords associated with these two usernames. There is no restriction on the number of users (as either *admin* or *user*) that can be logged in at the same time.

6.1.1 Local

Local mode allows control of the modem from the front-panel interface only. Web users are still able to log in and view the modem settings in this mode.

6.1.2 Local+remote

In *Local+remote* mode, the modem can be controlled through the front-panel or via a remote *admin* user at the same time. When the modem is switched out of *Local+remote* mode to *Local* mode, then all remote *admin* users will be automatically logged out.

While *Local+remote* mode is very convenient, it is important for there to be operational procedures in place to avoid conflicts arising in relation to modem control.

6.2 Web User Interface

The modem includes an embedded web server that allows full monitoring and configuration of the modem via a web browser (on port 80).

Secure connections via HTTPS (on port 443) are also supported. Non-secure connections via HTTP (port 80) can optionally be disabled.

Google Chrome, Mozilla Firefox and Microsoft Internet Explorer web browsers are supported.

6.2.1 Web GUI Login

If wanting to use the web GUI on a **Q-MultiFlex-400™,** the M&C IP address in the modem will need to be set via the front panel. Press Main Key to ensure you are at the top menu level:

```
      [QMultiFlex-400]
1:Status        2:Edit
3:View          4:Test
```

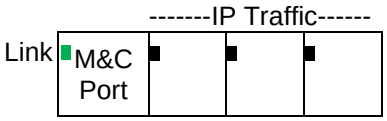
The menu options are selectable by moving the cursor using the arrow buttons on the front panel, then pressing enter on the option you would like. The faster method is just to press the number associated with the option required e.g. above the Edit option can be selected by simply pressing the '2' key.

The default IP address for all Teledyne Paradise Datacom modems is 10.0.70.1 / 16. To change M&C IP address, press: Main, 2:Edit, 3:IP, 2: Addresses - on the front panel of the **Q-MultiFlex-400™**. Use arrow keys and numerical keys to change values. Press the enter button once the address is correct.

```
M&C IP Address:
   [010.000.070.001]
   [010.000.070.001]
```

```
M&C IP subnet mask:
   [255.255.000.000]
   [255.255.000.000]
```

Press enter again to go to the next screen. Edit the subnet mask. Press enter again to move it to the top line 'applied' position.
Ensure your M&C PC is on the same subnet and connect a LAN cable to the M&C port of the modem. The connection link LED should illuminate green on the IP port.



Pinging the modem M&C IP address should show replies.

In a web browser type in the modem M&C IP address into the address bar. The browser will then request a username and password (as shown in **Figure 6-1**).
Default credentials are:
Username: admin (or user for view only)
Password: paradise

Changing default passwords is strongly recommended and will be covered later in this handbook.

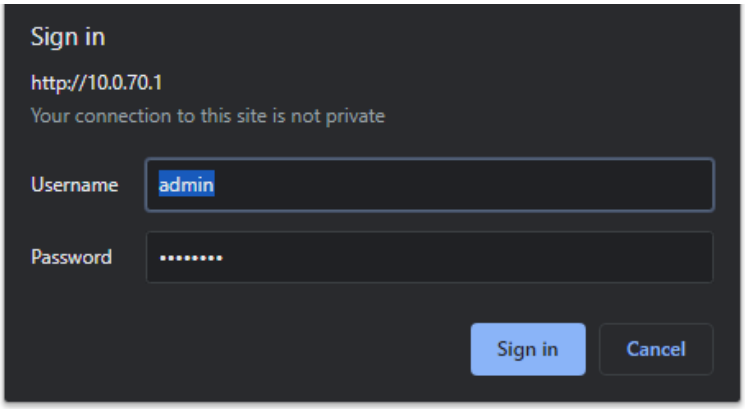


Figure 6-1 Web User Interface Login Screen

On successfully logging in, the user will be presented briefly with the screen shown in **Figure 6-2**.

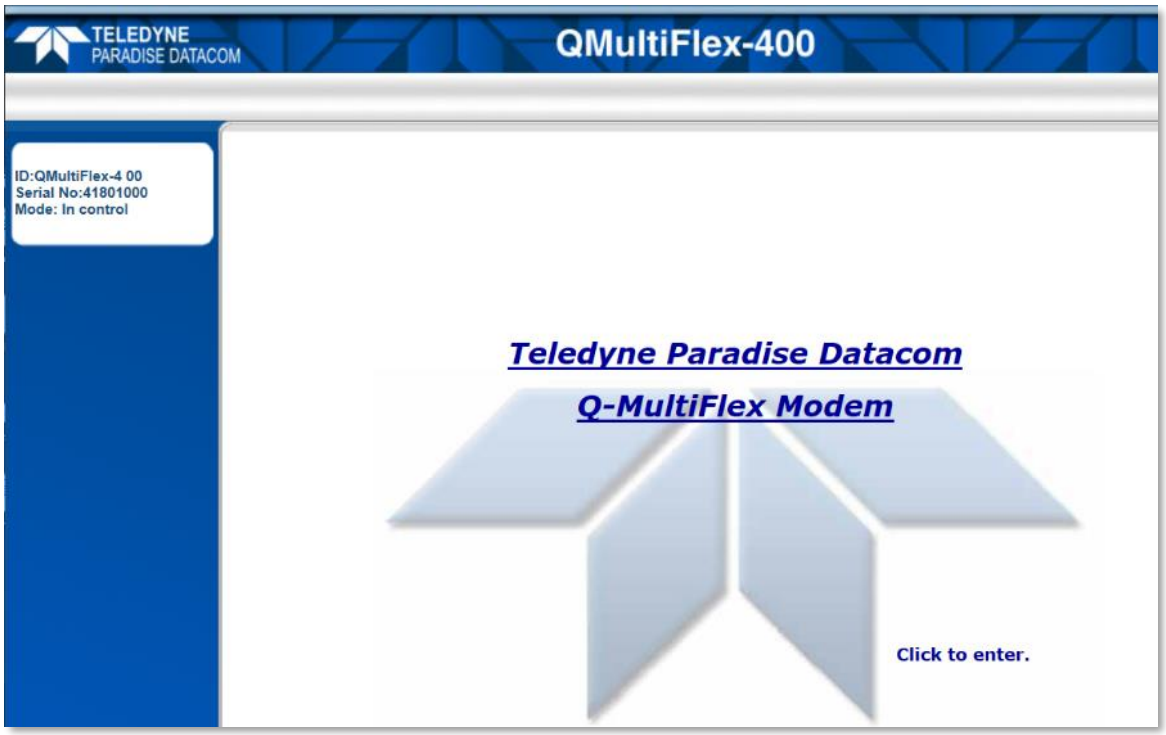


Figure 6-2 Web GUI Welcome Screen

6.2.2 Status Screen

The first screen you will see, once passed the welcome screen, is the truncated status screen (Figure 6-3). To keep screens uncluttered an accordion panel system is provided to hide unwanted information. The default for these panels is closed, so it is often necessary to open them.
Note: To see all options on a page remember to select the 'Expand All' button.

Figure 6-3 Default Status Screen

Indicators of hide/show are on the right hand of the accordion bar:
= Click on bar to hide panel.
= Click on bar to show panel.

The fully expanded status screen is shown in **Figure 6-4**.

Note that 1:N backup modems will show additional status information as defined in the document '*Q-NET™ PDQS Redundancy Switch Installation and Operating Handbook*' which is available for download from http://www.paradisedata.com

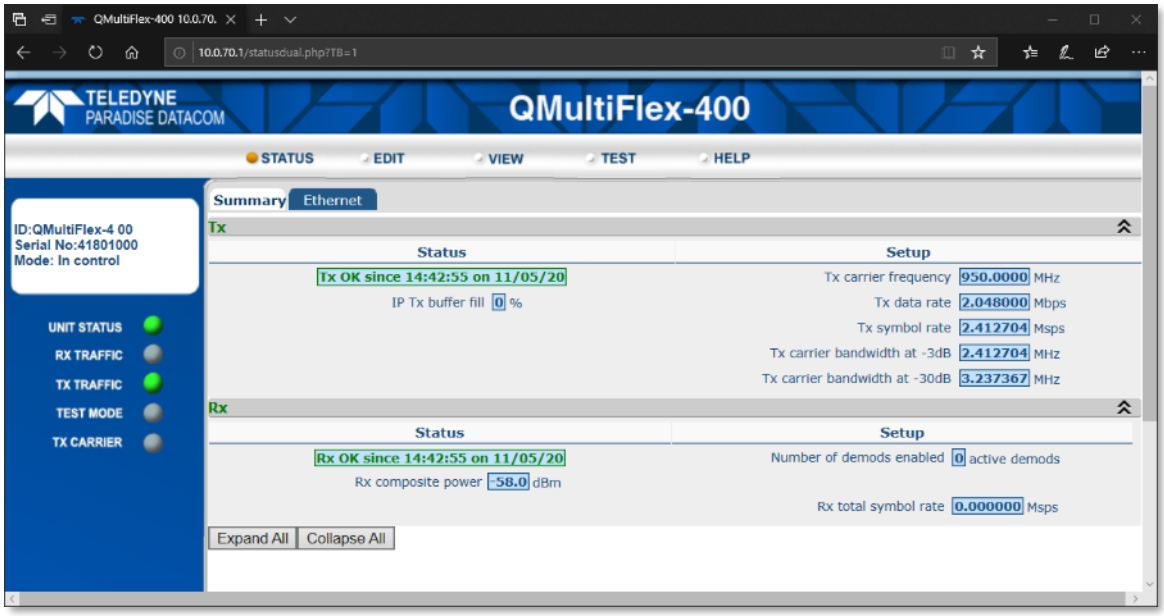


Figure 6-4 Expanded Status Screen

The line of buttons across the top of the display (i.e. STATUS, EDIT, VIEW, TEST and HELP) give access to the major modem functions, while the page tabs below the buttons give access to individual menus. Tabs are nested and several levels of tabs may be displayed at once, allowing the user to see where they currently are in relation to the overall menu system. The main part of the screen will change with the tab menu that is selected. The panel on the left-hand side of the web page contains summary status information and is always displayed. This area is also used to display Help information when the cursor is moved over individual menu options. The Light-Emitting Diodes (LEDs) displayed in the left-hand panel mimic the front-panel LED indicators of the modem.

Note that the web browser pages served by the modem will be automatically reconfigured to hide irrelevant information and options, in accordance with the available features and the current user selections. Actual web pages may therefore look slightly different to those shown in this handbook.

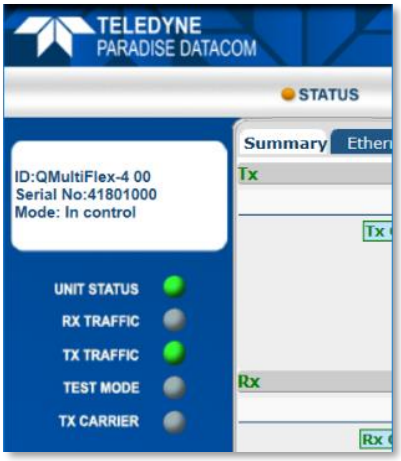


Figure 6-5 Unit Summary Status

Summary status information for the modem is shown at the top left-hand side of the screen as shown in **Figure 6-5**. This presents the following:

- 'ID': The user-entered modem-identification text string – default is 'QMultiFlex-400™'
- 'Serial No.': The modem serial number.
- 'Mode': This will show either 'In control' when the web user has full control over the modem or 'View only' when the web user is restricted to viewing modem information but cannot change the modem's configuration (i.e. the modem is set to Local mode).

The *Status* screen contains the current modem status as described in the following sections.

6.2.2.1 Setup

The *Setup* section of the *Status Summary* page (right-hand side of Figure 6-4) shows the following information:

- *Transmit carrier frequency.*
- *Transmit terrestrial data rate.*
- *Transmit symbol rate.*
- *Transmit carrier bandwidth at the -3dB point.*
- *Transmit carrier bandwidth at the -30dB point*.
- *The number of demodulators that have been enabled*.
- *The total symbol rate of the demodulator carriers*

The carrier bandwidth values are useful for performing bandwidth comparisons between different modem configurations, including the use of different spectral roll-off factors. The carrier does not contain any useful information below the -3dB point. There are various definitions of occupied and allocated bandwidth and therefore the -30dB point is used in order to provide an unambiguous reference point. When determining the bandwidth of the carrier, various cut-off points are used by satellite operators, with -30dB being the worst case. Satellite operators will also add a guard band that further increases the overall bandwidth requirements.

6.2.2.2 Status

The *Status* section (left-hand side of Figure 6-4) of the *Status Summary* page is continually updated with the following information:

- *Transmit path status*. When there is no transmit path fault then the message 'Tx OK since HH:MM:SS on DD/MM/YY' is displayed (where 'HH' indicates hours, 'MM' indicates minutes, 'SS' indicates seconds, 'DD' indicates the day of the month, 'MM' indicates the month of the year and 'YY' indicates the year). When a transmit path fault exists, then a fault message is displayed instead that indicates the nature of the fault.
- *Receive path status*. When there is no receive path fault then the message 'Rx OK since HH:MM:SS on DD/MM/YY' is displayed (where the time and date format is as above). When a receive path fault exists, then a fault message is displayed instead that indicates the nature of the fault.
- *IP Tx buffer fill status*. This shows, as a percentage, how full the modem's transmit buffer towards satellite is.
- *Receive composite power level* (i.e. All of the power in the whole receive channel, consisting of both wanted and unwanted signal).

6.2.2.3 Status AUPC

The *Automatic Uplink Power Control (AUPC)* section of the *Status* screen is displayed and continually updated with the following information when AUPC is enabled:

- *Remote Eb/No*. This is the current Eb/No reported by the remote modem.
- *Power offset*. This is the current offset that has been applied to the nominal modem power output level in order to maintain the remote Eb/No at the target level.

6.2.2.4 Status Ethernet Tab

The ethernet status tab shows the status of the base modem IP ports.

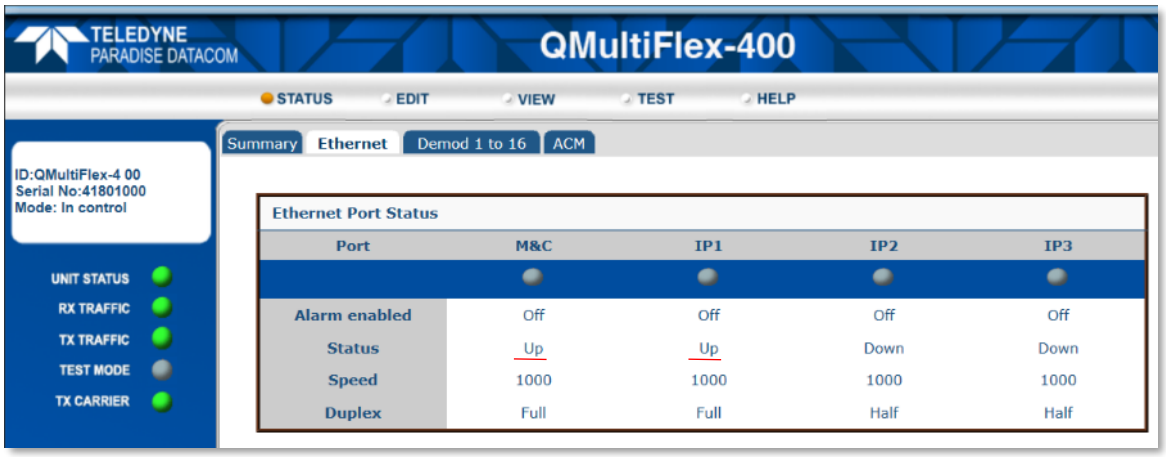


Figure 6-6 Ethernet Port Status

M&C port: Status should always be up if web GUI is connected to it.
IP1 = Main traffic port connected to IP processing card IP4 (should always be up if patch cable is connected to IP processing card)
IP2 = Cascade port 1. Status is up if connected to another **QMultiFlex-400™** cascade port.
IP3 = Cascade port 2. Status is up if connected to another **QMultiFlex-400™** cascade port.

Note: There is no status for Network traffic port (IP1) on IP processing card on the web GUI, but the physical port will have a green link light when active.

The red/green indicators are controlled by the ethernet alarm settings. They are off by default.

6.2.2.5 Status Demodulators Tab

Figure 6-7 Status Demodulators Screen

Under the *Status Demod* tab(s), the screen is continually updated with the following information for each active demodulator:

- *Receive Es/No* (i.e. energy per symbol to spectral noise density ratio).
- *Receive Eb/No* (i.e. the energy per bit to spectral noise density ratio).
- *Receive power level* (i.e. the level of the wanted signal).
- *Receive frequency offset.* This is the measured offset from the expected carrier centre frequency. It indicates any frequency shift that is introduced by the satellite and frequency conversion equipment.
- *Locked* status – shows if demodulator is locked to a signal or not.
- *Roll Off* – displays the roll-off factor detected in the receiving DVB-S2/DVB-S2X headers.

The visibility of individual demodulators is controlled by the accordion bar. Indicators of hide/show are on the right hand of the bar  or  .

6.2.2.6 Status ACM Tab

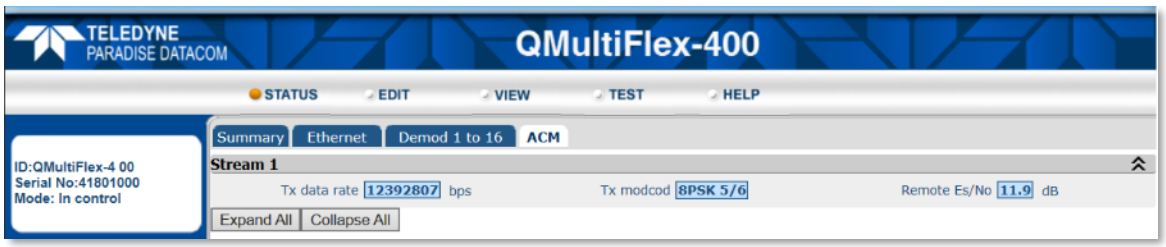


Figure 6-8 Status ACM Screen

The *Adaptive Coding and Modulation* (*ACM)* tab is available when ACM is active. The screen is continually updated with the following:

- *Transmit data rate*. This is the instantaneous transmit data rate, which varies with *MODCOD* (MODCOD is the shorthand term used to describe the combination of modulation and FEC code rate).
- *Transmit MODCOD*. This is the current transmit modulation and FEC rate, which vary with remote Es/No.
- *Remote modem Es/No* (energy per symbol to spectral noise density ratio).

Note: Demodulator information is not shown.
ACM operation is described in Section 8.2.

6.2.2.7 Status BUC/LNB Tab

If BUC or LNB services are enabled, then the *Status BUC/LNB* tab will be available.

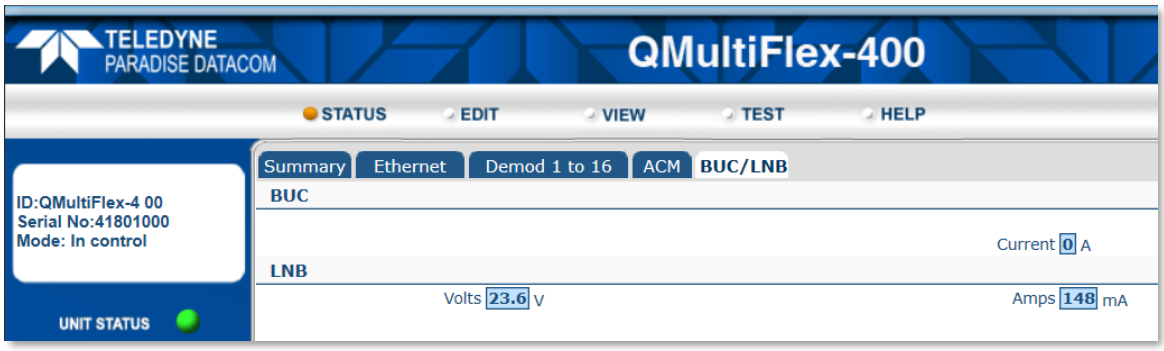


Figure 6-9 Status BUC/LNB Screen

Block Up Converter (BUC) / Low Noise Block (LNB) status is continually updated with the following information:

- *BUC output*:* This is the output power in dBm at the waveguide flange, or *Off* when the BUC is not transmitting.
- *BUC temperature** This shows the temperature in degrees Centigrade reported by the BUC.
- *BUC class** This shows the BUC power class in Watts.
- *BUC current*: Shows the BUC current level in Amperes if a BUC PSU is installed
- *LNB voltage*: Shows the LNB voltage in Volts when an LNB is connected.
- *LNB current:* Shows the LNB current in milli-Amperes when an LNB is connected.

*Requires an FSK communications link to exist between the modem and the BUC.

Note: BUC and LNB under and over-current alarms can be controlled via the Edit->Unit->Alarms screen.

6.2.3 Edit Screen

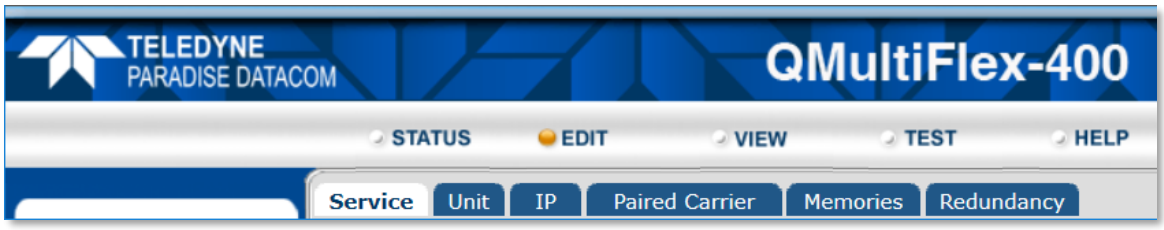
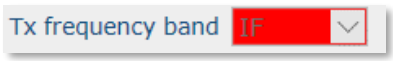


Figure 6-10 Edit tabs

The *Edit* screen contains the following tab menu options:

- *Service.* These menus allow setup of the modem transmit and receive paths plus BUC & LNB.
- *Unit.* These menus contain all the general modem configuration settings including monitor and control, alarms, Carrier ID, Software Activated Features (SAF) and RTC time settings. They also include a software upgrade facility.
- *IP.* This menu allows setup of all IP related functions.
- *Paired Carrier.* This menu controls the parameters of the Hub Canceller function.
- *Memories.* These menus support the storing, recall, deletion, upload and download of modem configurations.
- *Redundancy.* These menus control modem 1:1 and 1:N redundancy.

When a value is changed in an edit or dropdown box, the background for the box will change to red while the modem is actioning the change, as shown in the example below.



Example of Modem Actioning a User-Requested Change

The box will change back to its standard background colour when the modem has implemented the change. Note that each change must be fully completed before the next change can be made.

6.2.4 Edit->Service->General Screen

The *Edit->Service->General* screen is shown in **Figure 6-11**. Most of the transmit parameters are found here.

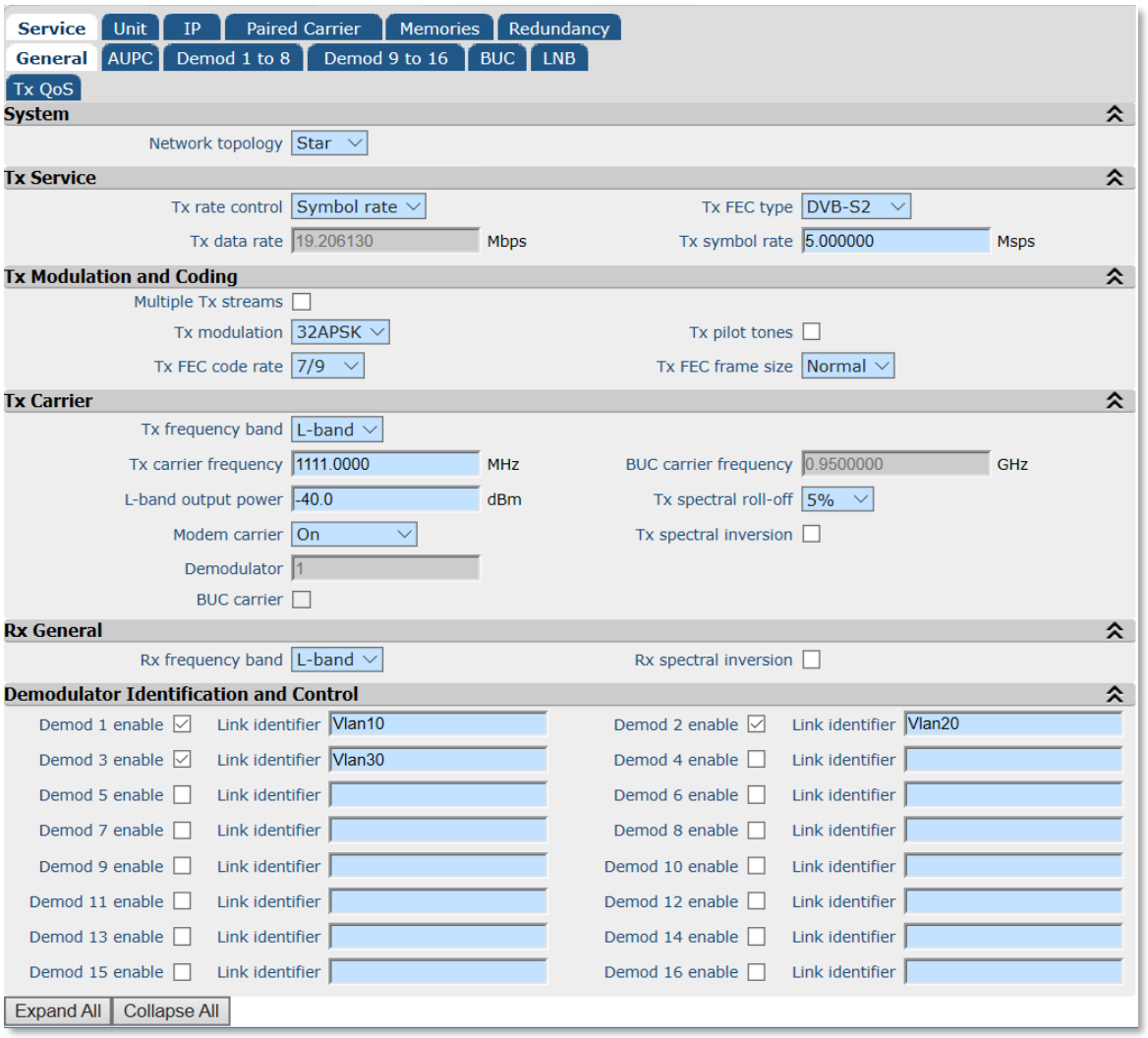


Figure 6-11 Edit->Service->General Screen

Note: All **QMultiFlex-400™** units are shipped with the hardware to support up to 16 Demodulators. Upgrades can be applied to modem in steps of 4x demodulators i.e. 4,8,12 and 16. Demod tabs will change accordingly.

6.2.4.1 Network Topology

Table 6-1 shows the *Network topology* options.

Mesh	Mesh mode supports direct site-to-site communications. DVB-S2/S2X inbound and outbounds are used as standard.
Star	Star mode supports hub and spoke communications. DVB-S2/S2X inbound and outbounds are used as standard.

Table 6-1 Network Topology

6.2.4.2 Tx Rate Control

Data rate	This allows the user to enter a data rate, from which a symbol rate is calculated.
Symbol rate	This allows the user to enter a symbol rate, from which a data rate is calculated. With ACM enabled, only symbol rate is used.

Table 6-2 Tx Rate Control

6.2.4.3 Tx Data Rate

Range:	0.05 Mbps to 345.0 Mbps; step size: 0.000001Mbps (i.e. 1bps)
Description:	The terrestrial data rate is the maximum number of data bits that the modem will process in relation to the IP interface. The relationship between the terrestrial data rate and the size of the satellite channel is complex. The modem will calculate and display the channel symbol rate for the current configuration, or alternatively, for link budget analysis, a comprehensive *Rate Calculator* is available from Technical Support. For IP, the terrestrial data rate must allow for all overhead due to IP headers and ethernet frames and DVBS2 encapsulation frames. The minimum and maximum data rate limits are determined by the MODCOD selected. The modem will generally prevent invalid data rates from being set and in the event that a limit is exceeded, then a configuration warning will be generated. As an alternative to setting the terrestrial data rate, the modem also allows the satellite-link symbol rate to be set and will use this to determine the terrestrial data rate.

Table 6-3 Tx Data Rate

6.2.4.4 Tx Symbol Rate

Range:	0.1 Msps to 69.9 Msps; step size: 0.000001Msps (i.e. 1sps)
Description:	As an alternative to setting the terrestrial data rate, it is possible to set the symbol rate for the satellite link, which will then determine the data rate. Symbol rate entry is forced if using ACM. In the absence of the user setting the symbol rate, it will be determined by other settings such as the terrestrial data rate, modulation and FEC rate.

Table 6-4 Tx Symbol Rate

6.2.4.5 Tx FEC Type

DVB-S2X	This enables DVB-S2X operation, making all of the DVB-S2X modulation and FEC rates available (from QPSK to 64APSK). DVB-S2X is not available as an option when *Mesh* network mode is selected.
DVB-S2	This enables DVB-S2 operation (from QPSK to 32APSK).

Table 6-5 Tx FEC Type

6.2.4.6 Multiple Tx Streams

This is an On/Off checkbox that controls whether the DVBS2/DVBS2X transmit carrier consists of multiple MODCOD streams.

Single stream mode allows a single MODCOD to be applied to the shared outbound carrier, whereas with multiple streams, potentially different MODCODs can be applied to the individual streams when they are transmitted over satellite in the shared outbound carrier. This is a feature known as Variable Coding and Modulation (VCM). There is no change to the overall symbol rate or power of the outbound carrier when the bandwidth is shared between several different MODCODs. The streams are usually associated with one or more VLANs in the QoS settings. Currently there is a limit of six MODCOD streams, which translates into six remote areas with individual MODCODs.

The traffic shaping options differ between single stream and multiple streams. When the shared outbound is represented by a single stream (i.e. single MODCOD) then the QoS classification methods are VLAN IDs, IP addresses, Diffserv and IEEE 802.1p priority tags. With multiple streams the only QoS classification method is VLAN ID.

When multiple streams are enabled then the single stream ‘Tx Rate Control’ and MODCOD parameters (i.e., modulation, FEC rate, pilots and frame size) is disabled. Multiple streams are configured in the ‘Modcods’ tab, described in Section 6.2.6.

6.2.4.7 Tx Modulation

The supported combinations of MODCOD are listed in **Table 6-6**.

6.2.4.8 Tx FEC Code Rate

The code rates that are available depend on the modulation selected, the frame size and DVBS2 mode. Note: DVBS2X mode includes all the DVBS2 rates.

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 **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 **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

Table 6-6 Tx Modulation and FEC Code Rates

6.2.4.9 Tx Pilot Tones

Pilots are an On/Off control that controls whether DVB-S2 pilots, which are unmodulated symbols, are injected into the carrier on a regular basis in order to help the demodulator lock onto the carrier. The pilots are 36 symbols long and are injected every 1440 symbols, representing an additional overhead of around 2.4%. Pilots are recommended for FEC rates below rate ½ and for situations where the receive signal may be degraded. Pilots are also recommended for use with ACM.

6.2.4.10 Tx Frame Size

Short	This represents a frame size of 16,200 bits per frame.
Normal	This represents a frame size of 64,800 bits per frame. This is more bandwidth efficient than short frames but has four times the latency. As a guideline, short frames have a latency of around 25ms at 1Mbps, whereas the latency for normal frames is around 100ms at 1Mbps. The latency will halve as data rate doubles.

Table 6-7 Tx Frame Size

6.2.4.11 Tx Frequency Band

The modem supports independent selection of IF and L-band operation in transmit and receive. This menu option controls the transmit frequency band.

IF	This selects the 70MHz and 140MHz IF bands, allowing operation from 50MHz to 90MHz and 100MHz to 180MHz.
L-band	This selects L-band, allowing operation from 950MHz to 2450MHz.

Table 6-8 Tx Frequency Band

6.2.4.12 Tx Carrier Frequency

There are various Tx frequency control options, depending on whether IF or L-band has been selected and whether a BUC is fitted that is being controlled via the modem. The frequency control options are presented in **Tables 6-9** through **6-11**.

Range:	50.0MHz to 180.0MHz; step size: 0.0001MHz (i.e. 100Hz)
Description:	This is the IF frequency used in transmitting to satellite. Note that values between 90MHz and 100MHz cannot be selected.

Table 6-9 Tx Carrier Frequency (IF)

Range:	950.0MHz to 2450.0MHz; step size: 0.0001MHz (i.e. 100Hz)
Description:	This is the L-band frequency used in transmitting to satellite. If the *BUC LO frequency* has been set on the *Edit->Service->BUC* menu then the L-band transmit frequency will no longer be available and will be automatically controlled by the modem to achieve the requested BUC transmit frequency.

Table 6-10 Tx Carrier Frequency (L-band)

Range:	0.0GHz to 99.999GHz; step size: 0.0000001GHz (i.e. 100Hz)
Description:	This is the BUC frequency used to transmit to satellite.

Table 6-11 BUC Carrier Frequency

6.2.4.13 IF/L-band Output Power

Range:	0.0dBm to -25.0dBm; step size: 0.1dBm
Description:	This sets the transmitted output power when using IF.

Table 6-12 IF Output Power

Range:	0.0dBm to -40.0dBm; step size: 0.1dBm From 2150MHz to 2410MHz, the lowest power limit is -30dB.
Description:	This is the transmitted output power when using L-band.

Table 6-13 L-band Output Power

6.2.4.14 Modem Carrier

This allows the modem carrier to be switched on/off.

6.2.4.15 Tx Spectral Roll-off

The spectral roll-off determines the slope of the carrier at its edges. The supported roll-off factors are listed in **Table 6-14**.

Range:	5%, 10%, 15%, 20%, 25%, 35%
Description:	All spectral roll-off factors are available for DVB-S2 & DVB-S2X

Table 6-14 Tx Spectral Roll-off

6.2.4.16 Tx Spectral Inversion

Spectral inversion is an On/Off control that controls whether the carrier I and Q components are swapped or not, allowing the modem to compensate for any other equipment in the transmit or receive chain that has introduced a spectral inversion.

6.2.4.17 BUC Carrier

This allows the BUC carrier to be switched on/off. BUC carrier control requires an FSK control channel to exist between the modem and the BUC.

6.2.4.18 Rx Frequency Band

The modem supports independent selection of IF and L-band operation in transmit and receive. This menu option controls the receive frequency band.

IF	This selects the 70MHz and 140MHz IF bands, allowing operation from 50MHz to 90MHz and 100MHz to 180MHz.
L-band	This selects L-band, allowing operation from 950MHz to 2450MHz.

Table 6-15 Rx Frequency Band

6.2.4.19 Rx Spectral Inversion

Spectral inversion is an On/Off control that controls whether the carrier I and Q components are swapped or not, allowing the modem to compensate for any other equipment in the transmit or receive chain that has introduced a spectral inversion (Typically an inverting C-Band LNB).

6.2.4.20 Demod Enable/Disable & Demod Link Identifier

Each demodulator is controlled by an individual checkbox that enables or disables the associated demodulator, as desired. Each demodulator can optionally be associated with a link identifier that represents a meaningful name (alpha-numeric text string) for the associated inbound carrier or remote site.

In order not to interfere with other active demodulators, a demodulator needs to be disabled before its configuration can be changed.

6.2.5 Edit->Service->General->Tx QoS Screen

The *Edit->Service->General->Tx QoS* screen is shown in **Figure 6-12**.

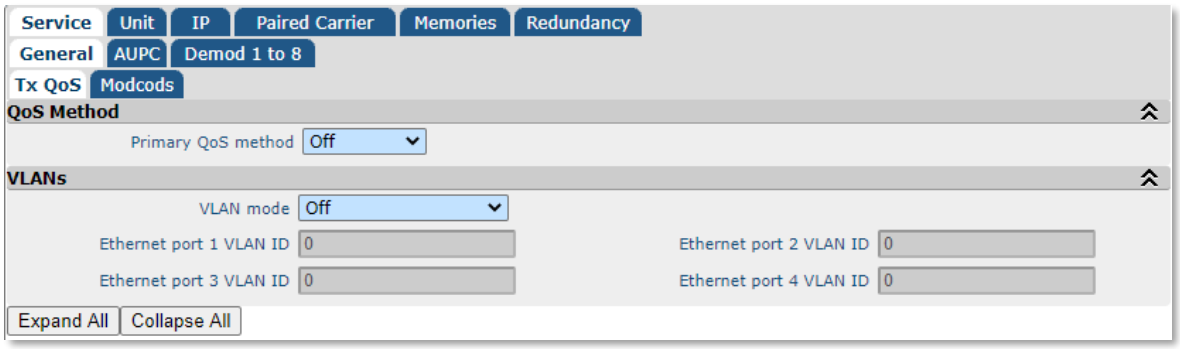


Figure 6-12 Edit->Service->General->Tx QoS Screen

Traffic shaping allows the bandwidth in the shared outbound carrier from the hub to be allocated according to the needs of the remote sites. It can be used to guarantee the level of bandwidth and also allows any excess remaining bandwidth to be shared in a defined way. When traffic shaping is disabled, the outbound bandwidth is allocated on a first-come-first-served basis.

Traffic shaping works by recognising markings (such as VLAN IDs) in the terrestrial packets coming into the **QMultiFlex-400™** for transmission. The markings may be in the Ethernet frame or the IP header and therefore both Layer 2 and Layer 3 traffic shaping is supported.

The outbound carrier can be defined by a single MODCOD that all the remote sites receive. Alternatively, the outbound carrier can consist of multiple MODCODs, where the packets for a particular remote are all transmitted using the same MODCOD. The use of a single MODCOD is referred to as ‘single stream’ mode, whereas the use of multiple MODCODs is referred to as ‘multiple stream’ mode. Traffic shaping can be used in both cases but varies in how it is applied.

There is no change to the overall symbol rate or power when the outbound carrier is transmitted using several different MODCODs.

When the shared outbound is represented by a single stream (i.e. a single MODCOD) then the QoS classification methods used in traffic shaping are VLAN IDs, IP addresses, Diffserv and IEEE 802.1p priority tags.

QoS Traffic Shaping Overview

Please see Section 8.7.8 for an overview of how traffic shaping works including definitions of terms and worked examples.

6.2.5.1 Primary QoS Method

Off	This switches traffic shaping off. When off, incoming packets are buffered and transmitted on a first-come-first-served basis. Arriving packets will be dropped when the buffers are full.
VLAN ID	Traffic shaping is based on VLAN ID.
IP address	Traffic shaping is based on IP address (any mixture of destination and source addresses and port numbers).
DIffserv	In single stream mode only, the primary QoS method can be set to Diffserv. Traffic shaping is based on the standard Diffserv classes.
IEEE 802.1p	In single stream mode only, the primary QoS method can be set to IEEE 802.1p. Traffic shaping is based on the standard IEEE 802.1p priority tags (which form part of the IEEE 802.1Q header).

Table 6-16 Primary QoS Method

6.2.5.2 VLAN Mode

Off	This switches explicit VLAN processing off. In bridge mode, any VLAN headers on incoming packets (terrestrially and over satellite) will be retained and handled transparently by the modem.
VLAN access mode	Not currently valid
VLAN trunking mode	In this mode, the VLAN tags are added externally to the modem (e.g. by a suitable Ethernet switch) and are passed transparently in all cases. VLAN filtering should be enabled on the remote modems (unless the filtering is being done by an external switch). All packets arriving over satellite that do not match the modem's VLAN ID will be dropped. All packets that have the correct VLAN ID will be forwarded onto the local network after the VLAN tag has been removed. Packets transmitted over satellite by the remote modem will be tagged with the relevant VLAN ID.

Table 6-17 VLAN Mode

VLAN Filtering

In star networks, VLAN filtering can be applied at the remote modems in order to drop unwanted packets. The remote modem does this by matching the received packets against a single VLAN of interest.

6.2.5.3 Screens for Primary QoS: VLAN ID

The *Edit->Service->General->Tx QoS* screen reconfigures itself depending on the settings for the primary QoS method.

When the primary QoS method is set to *VLAN ID* then the screen shown in **Figure 6-13** will be displayed in the case where a single stream (i.e. single MODCOD) is being used for the shared outbound carrier.

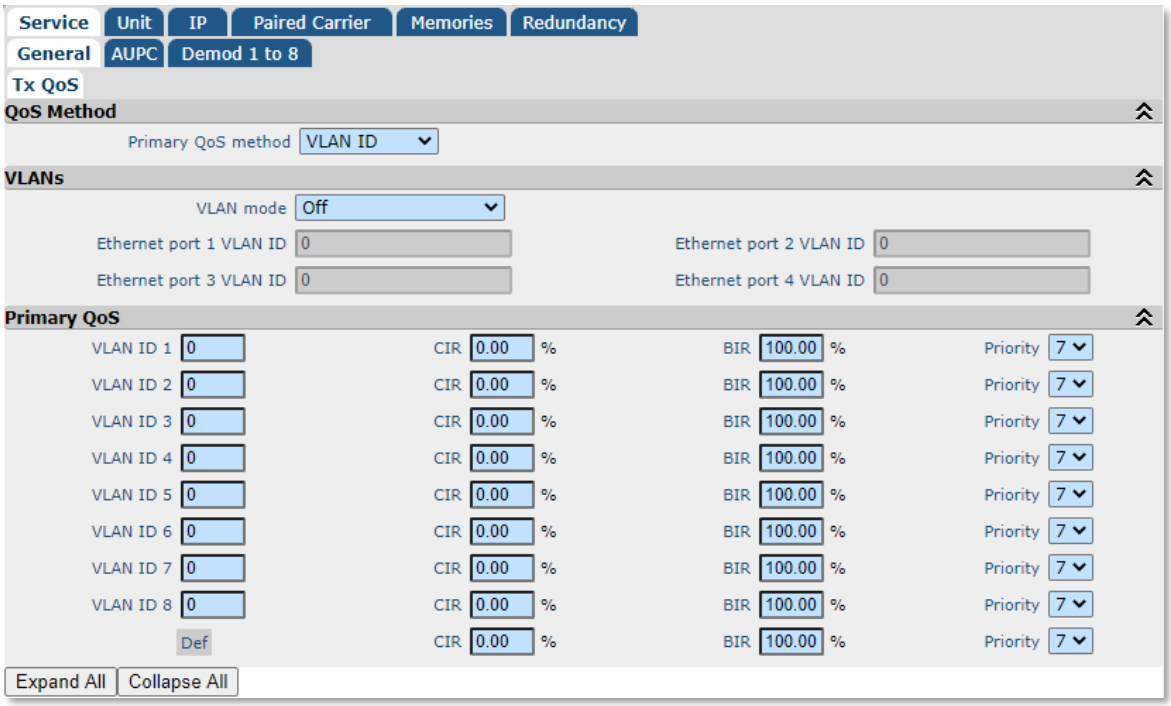


Figure 6-13 Edit->Service->General->Tx QoS Screen Primary QoS Method VLAN ID (Single Stream)

Using VLANs with Cascaded QMultiFlex-400™ Units

Multiple QMultiFlex-400™ units can be cascaded together in order to transmit a single outbound carrier to an arbitrarily large number of remote modems.

The number of supported VLAN ID rules is determined by the number of demodulators that are available and whether multiple QMultiFlex-400™ units have been cascaded together

When cascading, the number of VLAN ID QoS rules that are supported will automatically expand up to 64. When cascading more than four QMultiFlex-400™ units together, please consult Technical Support for further set up details.

For multiple streams, with the primary QoS method set to *VLAN ID*, the screen shown in **Figure 6-14** will be displayed. Note the extra Stream ID column.

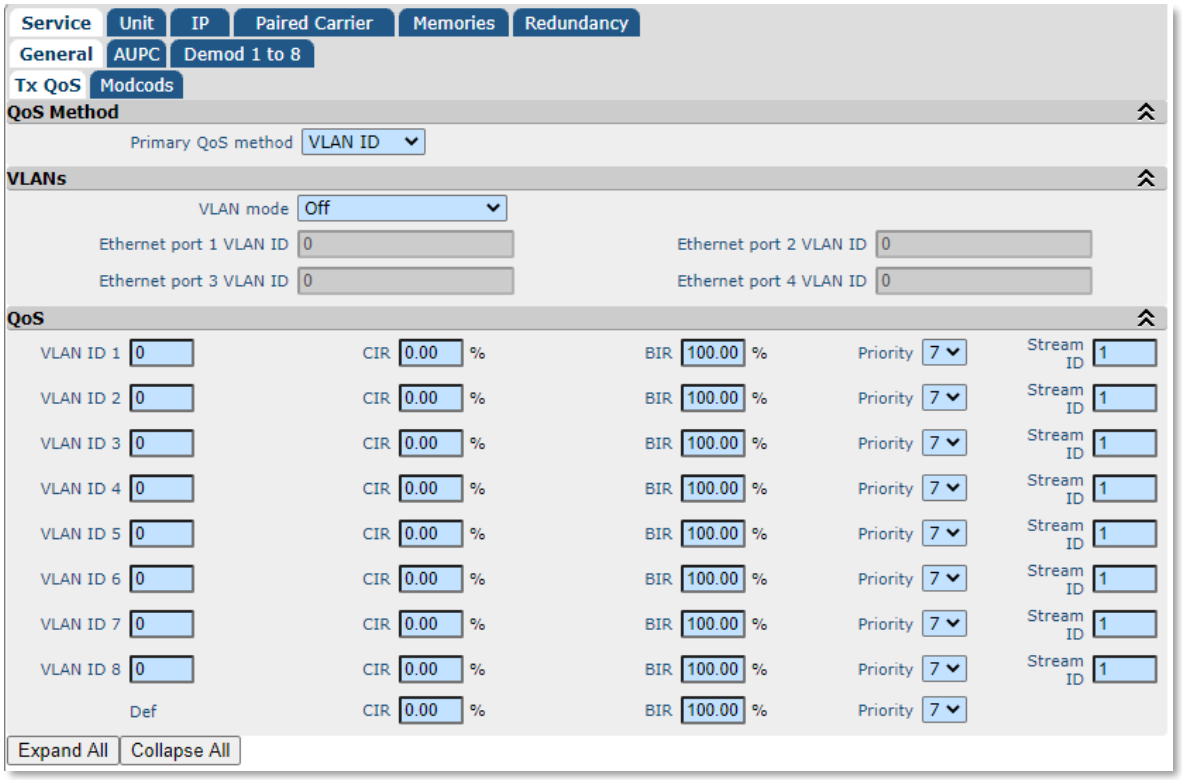


Figure 6-14 Edit->Service->General->Tx QoS Screen for Primary QoS: VLAN ID (Multiple Tx Streams)

6.2.5.4 Stream CIR, BIR and CIR/BIR Data Rates

The Committed Information Rate (CIR) is the guaranteed bandwidth for the stream. The Burst Information Rate (BIR) is the desired maximum data rate should excess bandwidth (after all the CIRs are satisfied) becomes available.

The CIR and BIR are entered as percentages of the available data rate. Using percentages has several advantages over absolute numbers:

- When the overall data rate for the outbound carrier is changed then the changes automatically ripple down to the traffic shaping rules.
- When ACM is used then the traffic shaping rules adapt automatically to changes in the absolute data rate for the shared outbound, with no user intervention required.
- Potential misconfiguration of the CIR and BIR values is reduced.

The CIR and BIR percentages are translated into an absolute data rate value. For greater accuracy in allocating bandwidth, all percentages can be entered as decimal values supporting up to two decimal places following the point.

6.2.6 Edit->Service->General->MODCODs Screen

The *Edit->Service->General->MODCODs* screen is shown in **Figure 6-15**.

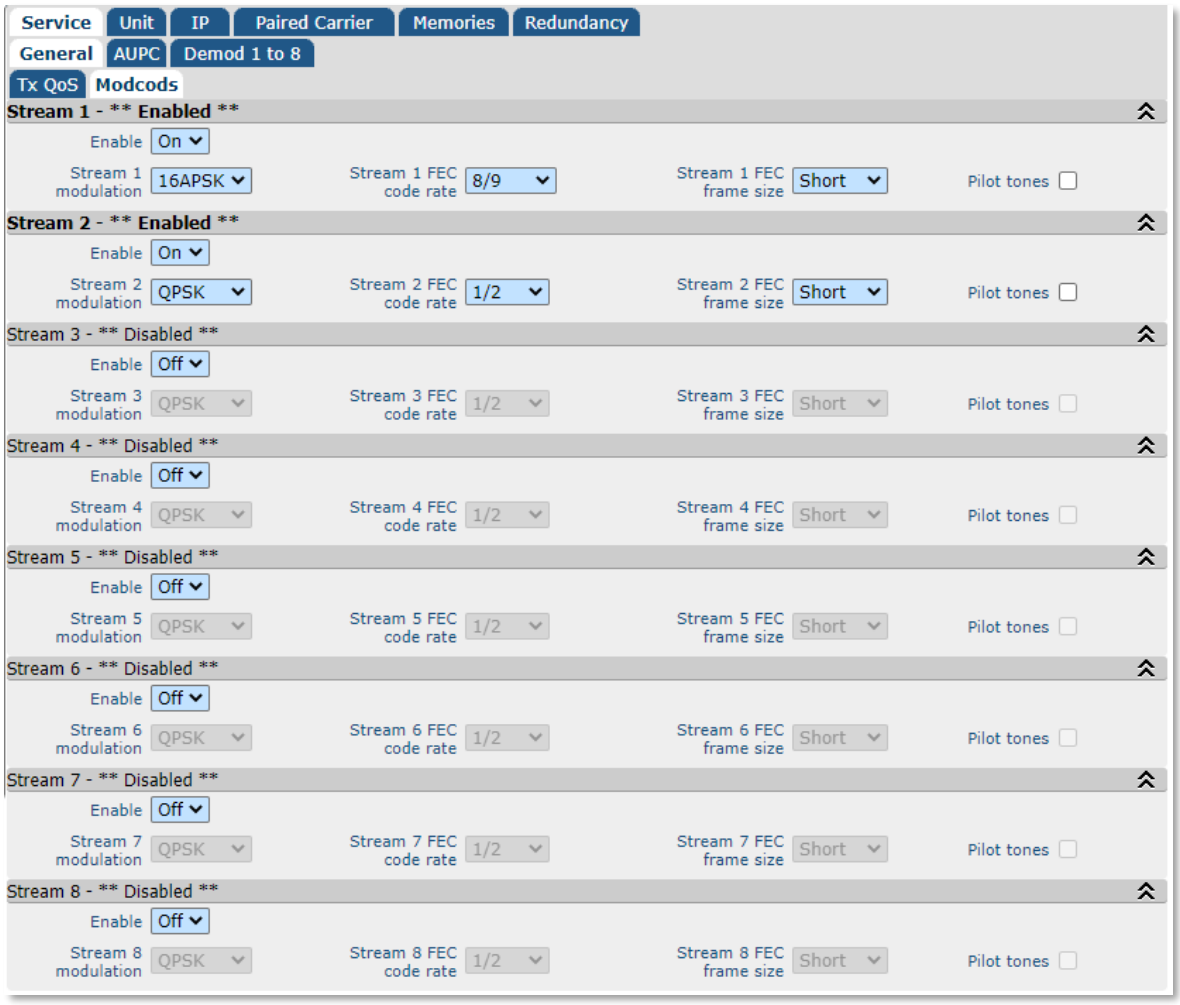


Figure 6-15 Edit->Service->General->MODCODs Screen

When multiple streams are enabled, each stream is associated with its own MODCOD. All packets that have the specified VLAN ID will be placed into the stream. A stream will be accorded the bandwidth defined by the CIR and BIR values set in the QoS rules table. The maximum number of streams that are currently supported is six.

Benefits of using Multiple Streams
Using multiple IP streams in the shared outbound carrier is a useful way of segregating data for each remote modem so that each remote modem processes only the packets in the shared outbound that are destined for the particular remote modem.

The streams allow data destined for particular remote modems to be transmitted with the optimal modulation and code rate (MODCOD) to suit the receive signal strength at the remote site/sites. Multistreaming works in conjunction with traffic shaping whereby packets for transmission can be classified according to a wide range of criteria and then transmitted using the appropriate MODCOD.

6.2.6.1 Stream Enable

This is an On/Off control that controls whether a particular stream forms part of the shared outbound or not. When enabled, all packets associated with the relevant stream will form part of the shared outbound.

When all streams are disabled, then the contents of the shared outbound is determined purely by the output of the traffic shaper, if enabled. When the traffic shaper is not used then all received packets will be transmitted up to the limit of the available bandwidth and thereafter will be dropped at random (subject to the IP buffer settings in the modem).

6.2.6.2 Stream Modulation

Each stream transmitted within the shared outbound carrier can use any of the supported DVB-S2/S2X MODCODs listed in **Table 6-6**.

6.2.6.3 Stream FEC Code Rate

Each stream can use any of the supported DVB-S2/S2X code rates listed in **Table 6-6**.

6.2.6.4 Stream Frame Size

The stream frame size is used in connection with DVB-S2/S2X.

Normal	This represents a frame size of 64,800 bits per frame. This is more bandwidth efficient than short frames but has four times the latency. As a guideline, short frames have a latency of around 25ms at 1Mbps, whereas the latency for normal frames is around 100ms at 1Mbps. The latency will halve as data rate doubles.
Short	This represents a frame size of 16,200 bits per frame.

Table 6-18 Stream Frame Size

6.2.6.5 Stream Pilot Tones

Pilots are an On/Off option that controls whether or not DVB-S2/S2X pilots, which are unmodulated symbols, are injected into the carrier on a regular basis in order to help the demodulator lock onto the carrier. The pilots are 36 symbols long and are injected every 1440 symbols, representing an additional overhead of around 2.4%.

6.2.6.6 Screens for Primary QoS: IP Address

When the primary QoS method is set to *IP address* then the screen shown in **Figure 6-16** will be displayed when using a single stream (i.e. a single MODCOD is being used for the shared outbound).

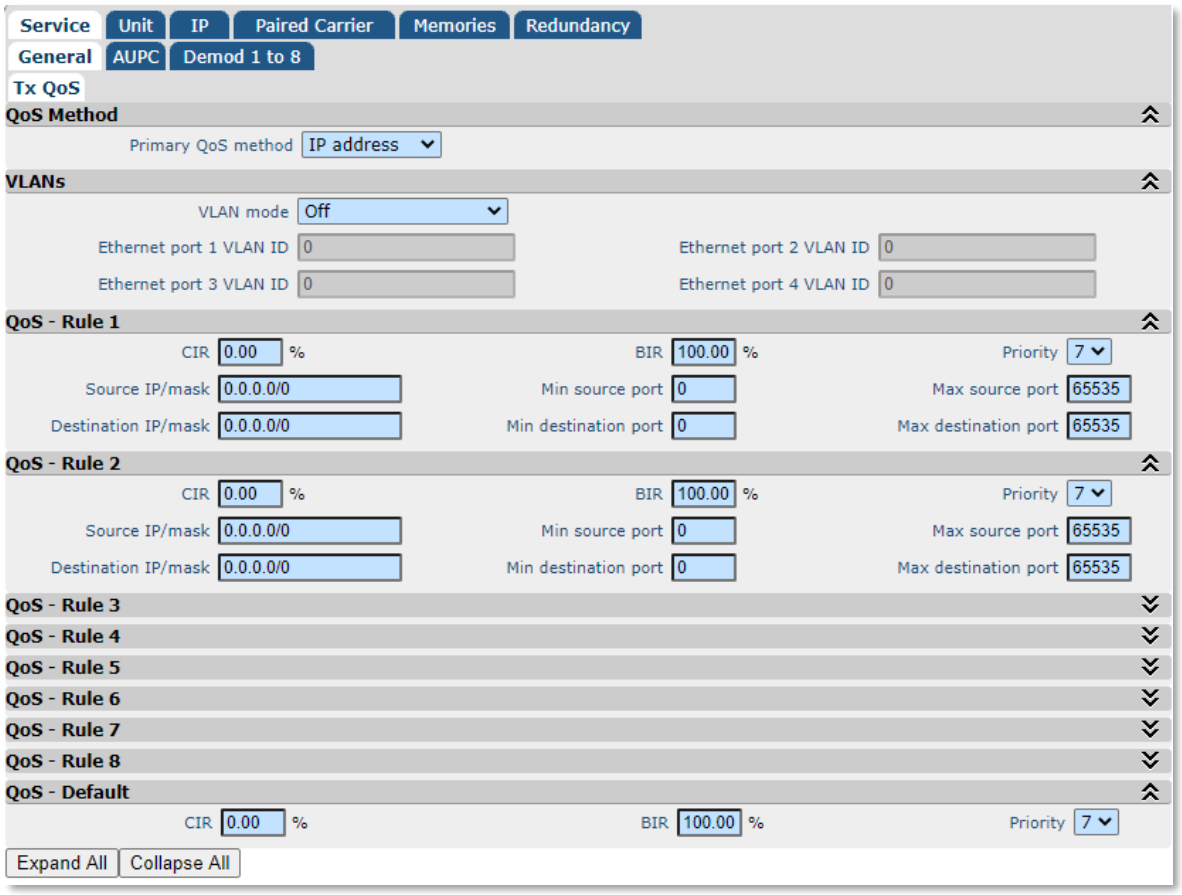


Figure 6-16 Edit->Service->General->Tx QoS Screen for Primary QoS: IP Address (Single Stream)

Any combination of source and destination addresses and ports can be used to define the packets that will be governed by each QoS rule. For each QoS rule, the bandwidth to be made available is defined by the CIR and BIR values.

For multiple streams, with the primary QoS method set to *IP address,* the screen shown in **Figure 6-17** will be displayed. The Tabs 'MODCODs' and 'Primary QoS 1 to 8' will be displayed. The MODCOD tab allows the MODCOD associated with each stream in the shared outbound carrier to be configured (See **Figure 6-18**). Selecting the Primary QoS tab then allows the IP address rules for each stream to be set up as shown in **Figure 6-19**.

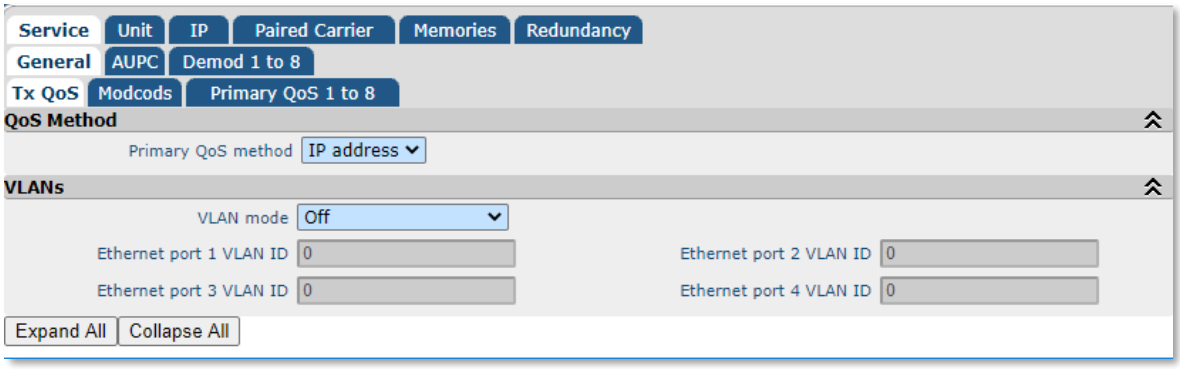


Figure 6-17 Edit->Service->General->Tx QoS Screen for Primary QoS: IP Address (Multiple Streams)

The number of available streams is determined by the number of streams that are enabled.

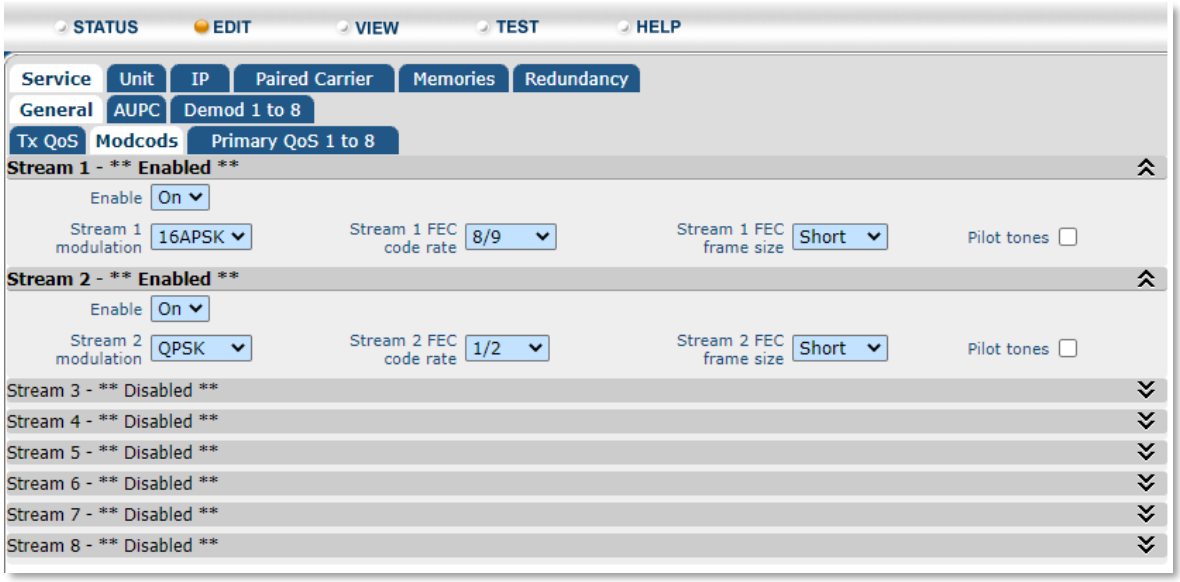


Figure 6-18 Edit->Service->General->MODCODs Screen for Primary QoS: IP Address (Multiple Streams) – Stream MODCOD Entry

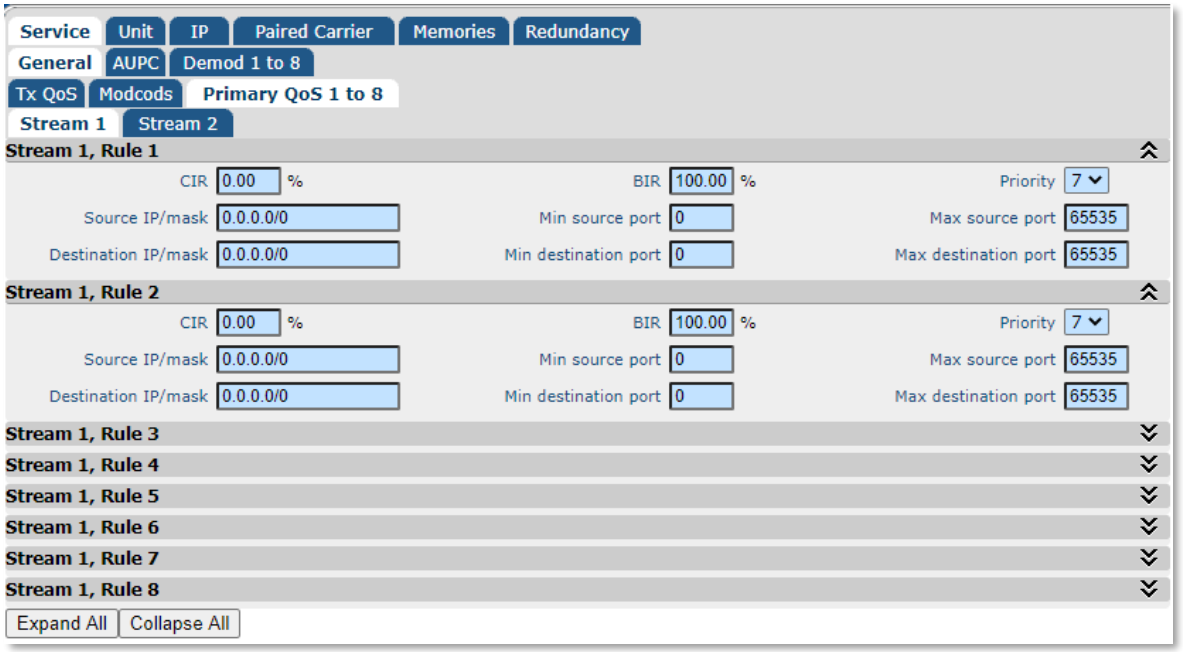


Figure 6-19 Edit->Service->General->Tx QoS Screen for Primary QoS: IP Address (Multiple Streams) – QoS Rule Entry

Any combination of source/destination addresses and a range of ports can be used to define the packets that will be governed by each QoS rule. For each QoS rule, the bandwidth to be made available is defined by the CIR and BIR values.

6.2.6.7 Screen for Primary QoS: Diffserv

When the primary QoS method is set to *Diffserv* then the screen shown in **Figure 6-20** will be displayed. Note: The QoS accordion bar may need to be clicked to expand the page. Not available for Multiple Tx Streams.

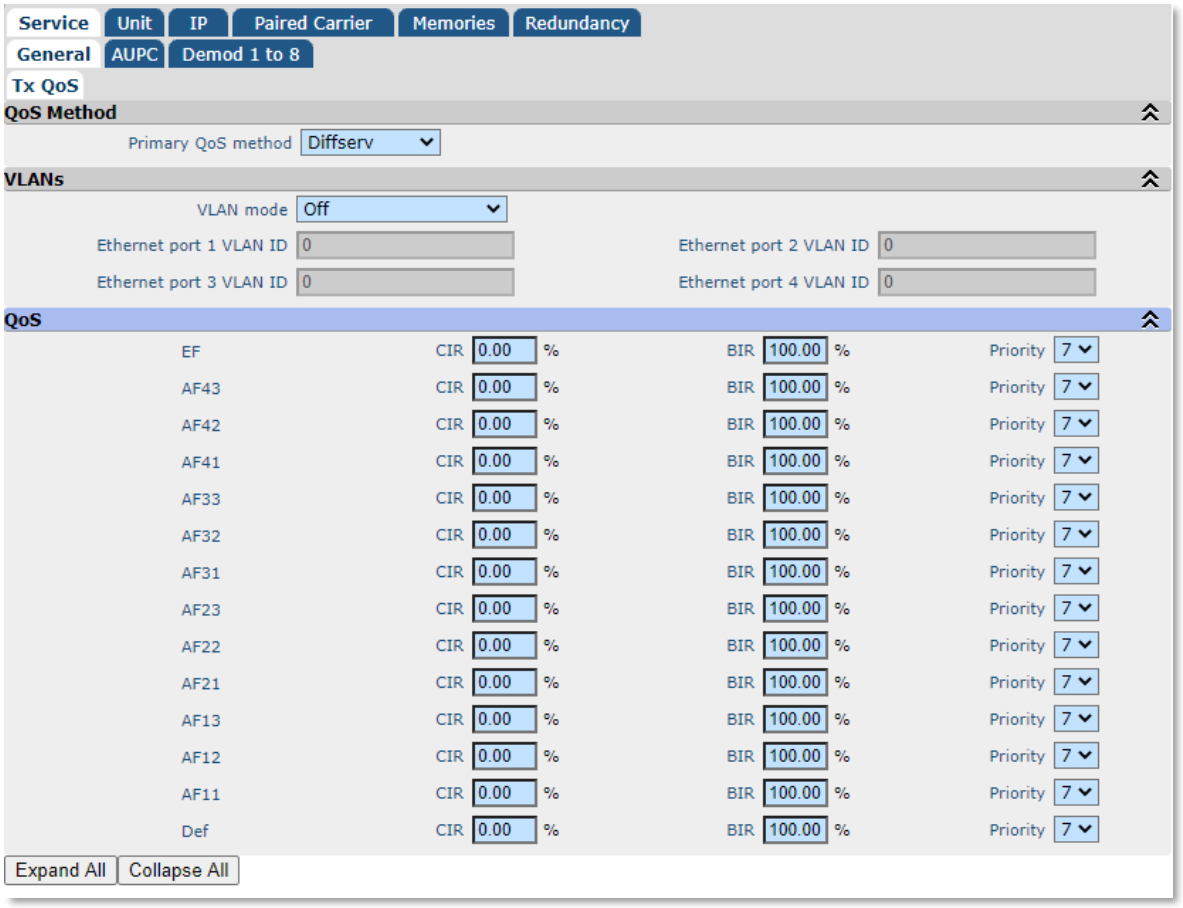


Figure 6-20 Edit->Service->General->Tx QoS Screen for Primary QoS: Diffserv (Single Stream)

The standard Diffserv classes are listed in the left-hand column. A default rule is available to explicitly reserve bandwidth for non-Diffserv packets.

6.2.6.8 Screen for Primary QoS: IEEE 802.1p

When the primary QoS method is set to *IEEE 802.1p* then the screen shown in **Figure 6-21** will be displayed. Note: The QoS accordion bar may need to be clicked to expand the page. Not available for Multiple Tx Streams.

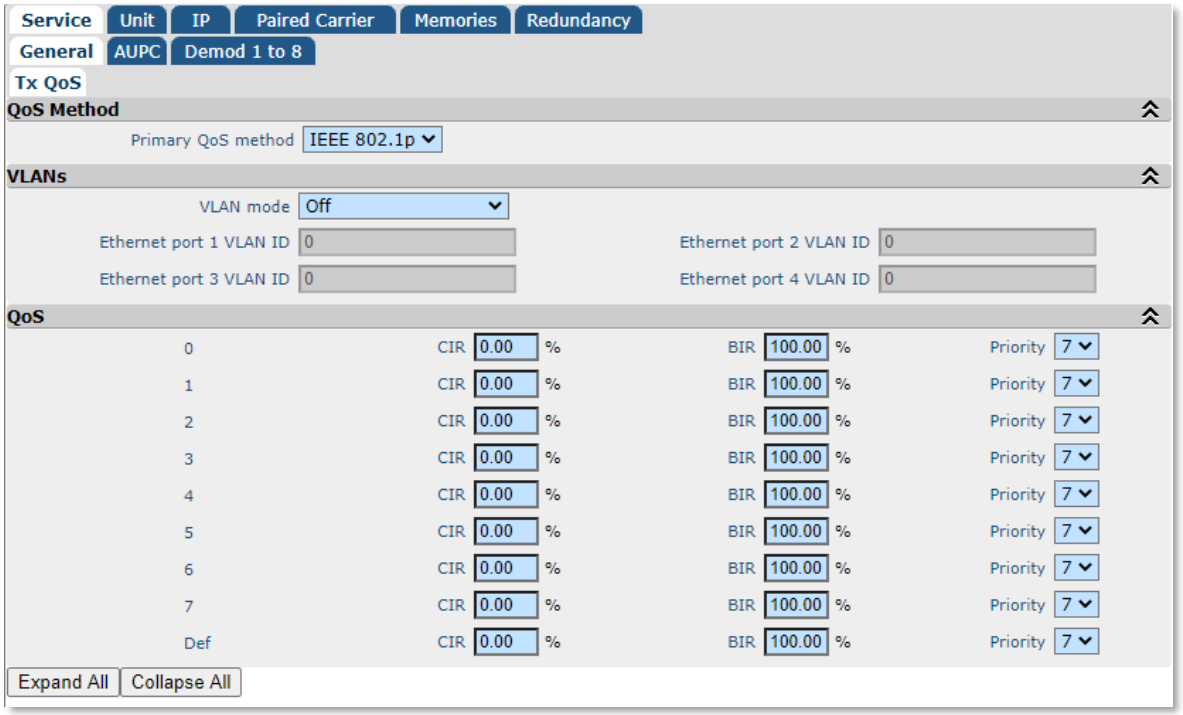


Figure 6-21 Edit->Service->General->Tx QoS Screen for Primary QoS: IEEE 802.1p (Single Stream)

The IEEE 802.1p priority classes (part of the IEEE 802.1Q header) are represented as 0 to 7 in the left-hand column. For each QoS rule, the bandwidth to be made available is defined by the CIR and BIR values. A default rule is available to explicitly reserve bandwidth for packets that do not have an IEEE 802.1p priority marking.

6.2.7 Edit->Service->Demods Screen

The *Edit->Service->Demods* screen is shown in **Figure 6-22**.

Effect of Demodulator Configuration Changes

- ***In order not to interfere with other active demodulators, a demodulator needs to be disabled before its configuration can be changed.***
- ***The receiver covers a 72MHz frequency span and this will be automatically centred based on the lowest and highest centre frequencies of the active demodulators. Configuration changes made to a demodulator will not affect the operation of the active demodulators unless the receiver centre frequency needs to be changed, in which case all demodulators will be briefly interrupted.***

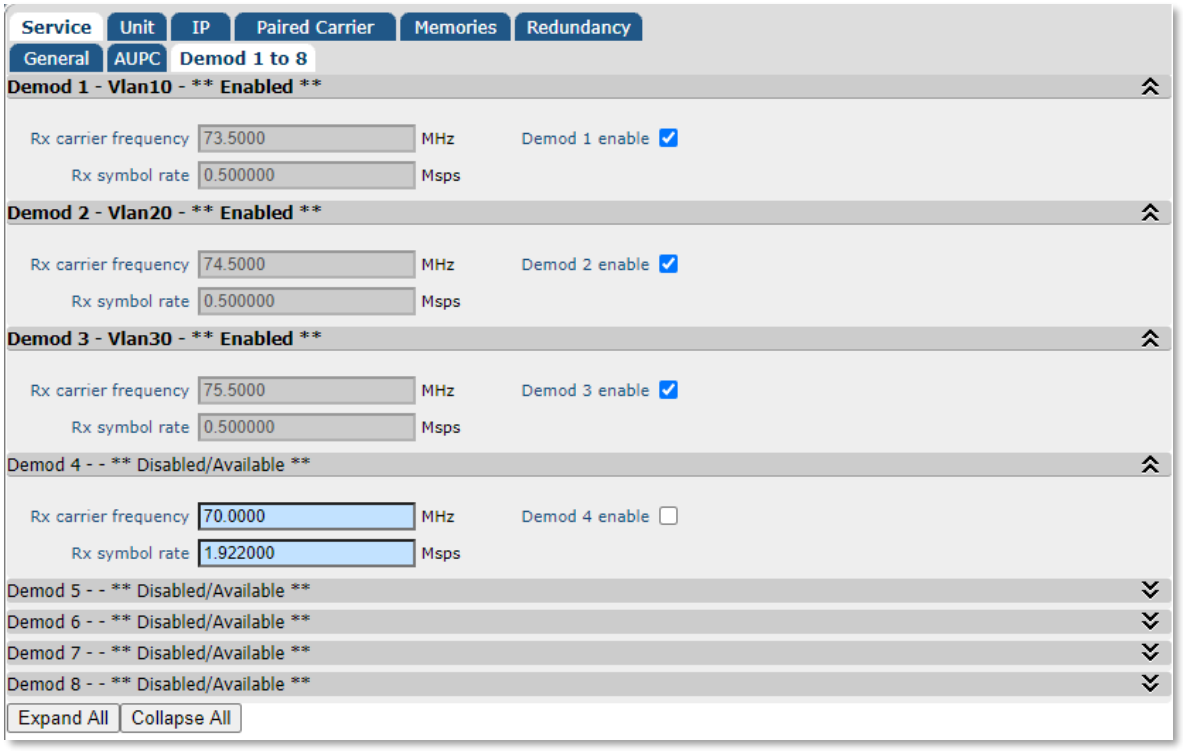


Figure 6-22 Edit->Service->Demods Screen

6.2.7.1 Rx Carrier Frequency

There are various frequency control options, depending on whether IF or L-band has been selected and whether an LNB is connected and being controlled by the modem. The frequency control options are presented in **Tables 6-19** through **6-21**.

Range:	50.0MHz to 180.0MHz; step size: 0.0001MHz (i.e. 100Hz)
Description:	This is the IF frequency used in receiving from satellite. Note that values between 90MHz and 100MHz cannot be selected.

Table 6-19 Rx Carrier Frequency (IF)

Range:	950.0MHz to 2450.0MHz; step size: 0.0001MHz (i.e. 100Hz)
Description:	This is the L-band frequency used in receiving from satellite. If the *LNB LO frequency* has been set on the *Edit->Service->LNB* menu then the L-band receive frequency will no longer be available and will be replaced by an LNB carrier frequency option.

Table 6-20 Rx Carrier Frequency (L-band)

Range:	0.0GHz to 99.999GHz; step size: 0.0000001GHz (i.e. 100Hz)
Description:	This is the LNB frequency used to receive from satellite. If the *LNB LO frequency* has been set on the *Edit->Service->LNB* menu then the L-band receive frequencies used by the individual demodulators will no longer be available and will be replaced with an LNB carrier frequency. The LNB carrier frequency is the absolute SHF frequency of the carrier.

Table 6-21 LNB Carrier Frequency

6.2.7.2 Rx Symbol Rate

Range:	0.150Msps to 40.0 Msps; step size: 0.000001Msps (i.e. 1sps)
Description:	The symbol rate is the only option when entering an information rate into the demod. Once the symbol rate is set, the other demod parameters are determined from the DVBS2 frames being received i.e. MODCOD & Pilots on or off and roll-off factor (5%, 10%, 15%, 20%, 25% & 35%).

Table 6-22 Rx Data Rate

6.2.7.3 Demod Enable/Disable

Each demodulator is controlled by an individual checkbox that is used to enable or disable the associated demodulator. In order not to interfere with other active demodulators, a demodulator needs to be disabled before its configuration is changed. See warning at beginning of this section (6.2.7) for more details.

6.2.8 Edit->Service->BUC Screen

The *Edit->Service->BUC* screen is shown in **Figure 6-23**.

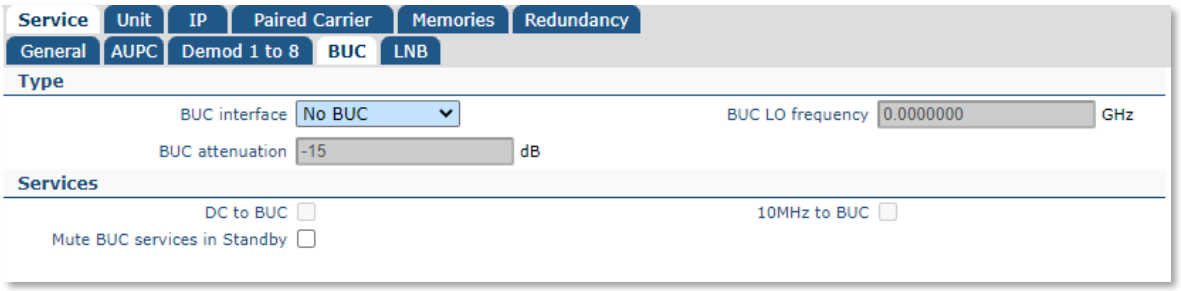


Figure 6-23 Edit->Service->BUC Screen

6.2.8.1 BUC Interface

BUC FSK	This indicates that a BUC is fitted that has FSK communications to the modem.
BUC no comms	This indicates that a BUC is fitted but has no communications to the modem.
No BUC	This indicates that no BUC is connected.

Table 6-23 BUC Interface

6.2.8.2 BUC LO Frequency

Range:	-99.999GHz to 99.999GHz; step size: 0.0000001GHz (i.e. 100Hz)
Description:	This is the local oscillator frequency of the BUC.

Table 6-24 BUC LO Frequency

6.2.8.3 BUC Attenuation

Range:	0dB to -15.0dB; step size: 1dB
Description:	This varies the front-end attenuation applied by the BUC. This is used when there is a low level of signal loss between the modem and BUC in order to prevent the modem output from saturating the BUC. FSK control required.

Table 6-25 BUC Attenuation

6.2.8.4 DC to BUC

This is an On/Off control used to enable and disable the DC power supply from the modem to the BUC. Voltage depends on what BUC PSU is installed (i.e. 24V or 48V).

6.2.8.5 10MHz to BUC

This is an On/Off control used to enable and disable the high-stability 10MHz reference from the modem to the BUC.

6.2.8.6 Mute BUC Services in Standby

This is an On/Off control used to enable and disable the transfer of BUC DC and 10MHz services from a failed modem to a backup modem in a 1:1 or 1:N redundancy system. Setting the checkbox causes the services to switch over from the online modem to the backup modem on a failure. Note that FSK communications will always be switched over.

6.2.9 Edit->Service->LNB Screen

The *Edit->Service->LNB* screen is shown in **Figure 6-24**.

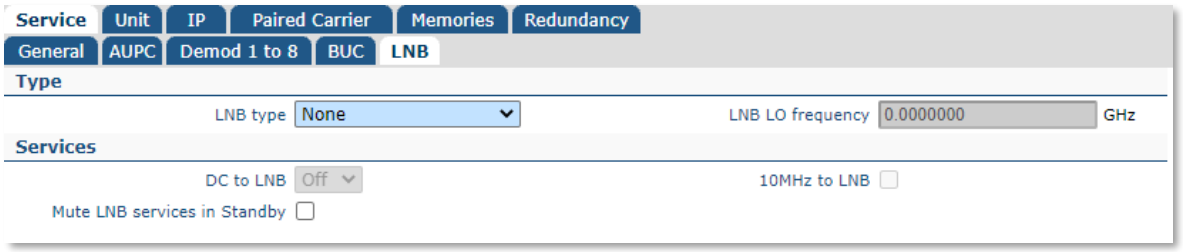


Figure 6-24 Edit->Service->LNB Screen

6.2.9.1 LNB Type

None	This indicates that no LNB is connected.
Other	This indicates that an LNB is connected but is not one of the LNBs listed below.
C 3.635 – 4.200 GHz	This presets the LNB LO frequency to -5.15 GHz (inverting)
Ku 10.95 – 11.45 GHz	This presets the LNB LO frequency to 10 GHz
Ku 11.2 – 11.7 GHz	This presets the LNB LO frequency to 10.25 GHz
Ku 11.7 – 12.2 GHz	This presets the LNB LO frequency to 10.75 GHz
Ku 12.25 – 12.75 GHz	This presets the LNB LO frequency to 11.3 GHz

Table 6-26 LNB Type

6.2.9.2 LNB LO Frequency

Range:	-99.999GHz to 99.999GHz; step size: 0.0000001GHz (i.e. 100Hz)
Description:	This is the local oscillator frequency of the LNB.

Table 6-27 LNB LO Frequency

6.2.9.3 DC to LNB

This is a control used to enable and disable DC power from the modem to the LNB. Voltage options are: 13V, 15V, 18V, 20V and 24V. Maximum current is 750mA.

6.2.9.4 10MHz to LNB

This is an On/Off control used to enable and disable the high-stability 10MHz reference from the modem to the LNB.

6.2.9.5 Mute LNB Services in Standby

This is an On/Off control used to enable and disable the transfer of LNB DC and 10MHz services from a failed modem to a backup modem in a 1:1 or 1:N redundancy system. Setting the checkbox causes the services to switch over from the online modem to the backup modem on a failure.

6.2.10 Edit->Unit Screen

The *Edit->Unit* screen contains the following tab menu options:

- *M&C.* This controls remote M&C settings including serial control settings and user passwords.
- *Alarms.* This controls alarm thresholds and actions.
- *SAF.* This allows the entry of Software Activated Feature (SAF) codes that enable modem feature activations in the field.
- *Upgrade.* This allows the modem software to be upgraded.
- *Miscellaneous.* This allows the date and time to be set on the modem, as well as allowing a modem to be reset without having to power it down.
- *Carrier ID.*

6.2.11 Edit->Unit->M&C Screen

The *Edit->Unit->M&C* screen is shown in **Figure 6-25**.

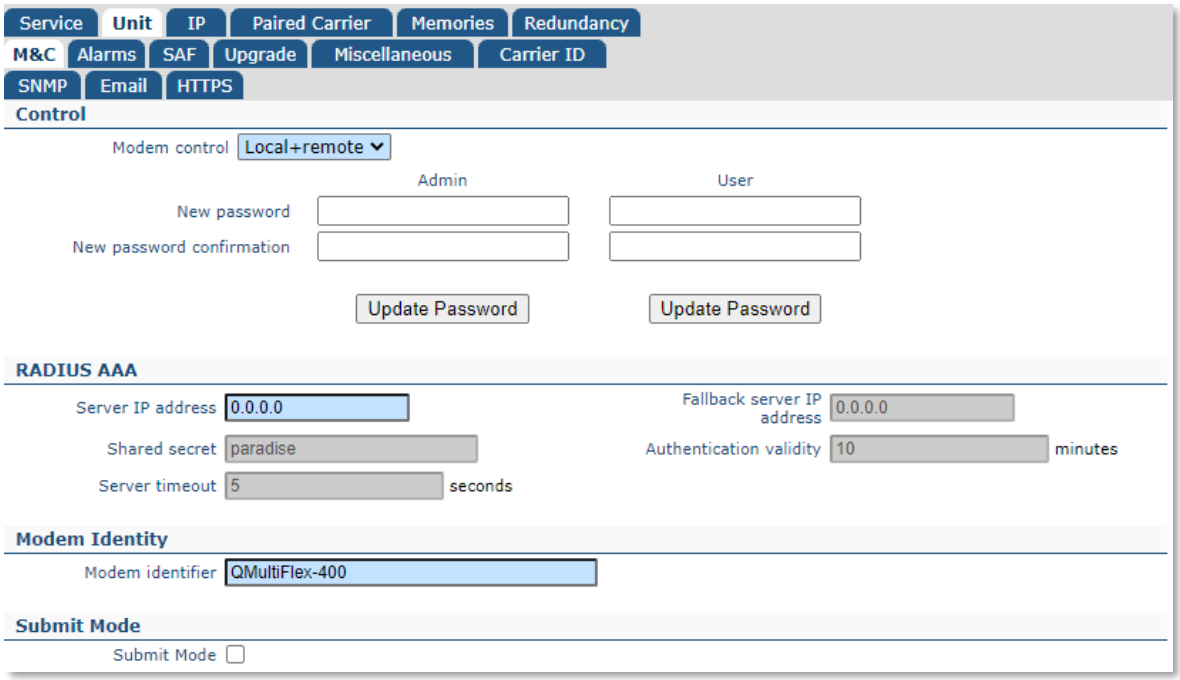


Figure 6-25 Edit->Unit->M&C Screen

The *Edit->Unit->M&C* screen is split into several parts as described in the following sections.

6.2.11.1 Modem Control and Passwords

Local	In *Local* mode only the front panel can be used to control the modem.
Local+remote	In *Local+remote* mode, the modem accepts commands from any user interface at any time.

Table 6-28 Modem Control

Passwords for the administrator (login name *admin*) and user (login name *user*) can be changed (the default password for both is *paradise*). Administrators can both view and control the modem whereas other users can only view modem web pages. Multiple users can be logged on at the same time. When the administrator password is changed then the modem's web user interface will issue an immediate new login request, which needs to be completed using the new password.

6.2.11.2 RADIUS Server IP Address and Fallback Address

The modem supports a RADIUS client that communicates with the server in order to authenticate each user and to provide the authorised level of access (administrator or view-only). This allows users to log in using their personal organization login credentials. All login and configuration change activities are recorded in the modem's log, giving greater visibility and accountability.

Server IP address	This sets the IP address for a network server that supports the RADIUS AAA server to be used for authenticating users' login credentials.
Fallback server IP address	This sets the IP address for a fallback RADIUS network server to be used in the event that the primary server cannot be contacted. The timeout period is specified by the *Server timeout* value.

Table 6-29 RADIUS Server IP Address and Fallback Address

6.2.11.3 RADIUS Shared Secret

The *Shared secret* is a user-assigned alphanumeric string, which is used as an authentication key (essentially a password) between the RADIUS client in the modem and the RADIUS server on the network.

Note for RADIUS Network Administrators

The modem RADIUS authentication feature will work out-of-the-box, subject to the modem having access to a RADIUS server on the user's network. By default, all authorised users will receive administrator privileges. If you want some users to get administrator access and some view-only access, then customisation of the RADIUS server configuration is required as explained below.

The standard RADIUS Access-Accept response from the RADIUS server can have an optional field added to it in order to distinguish between administrator and view-only user login authorisation. This involves the addition of a vendor-specific attribute using an SMI network management private enterprise code of 64534 (to denote Teledyne Paradise Datacom), which is one of a range reserved for private use. A vendor-specific attribute named 'Access-Level' is used, where a value of 0 equates to 'Modem Administrator' and a value of 1 equates to 'Modem User' (view-only). If the modem receives an Access-Accept response with no Access-Level attribute, or with an Access-Level value that is not supported, then the modem will default to administrator access being granted. The full specification of this attribute of the Access-Accept response is as follows:

a. Type: (one byte) value 0x1A - indicates a vendor-specific attribute.
b. Length: (one byte) value 0x09 – indicates the entire vendor-specific attribute field is nine bytes in length.
c. Vendor ID: (four bytes) 0x0000FC16 – indicates Paradise private-use.
d. Vendor type: (one byte) value 0x01 – indicates the vendor-specific attribute is 'Access-Level'.
e. Vendor length: (one byte) value 0x03 – indicates the remainder of the vendor-specific attribute field following the Vendor ID is three bytes in length.
f. Vendor data: (one byte) value 0='Modem Administrator'; value 1='Modem User' – indicates the authorised login access level.

6.2.11.4 RADIUS Authentication Validity

Range:	5 to 60 minutes; step size: 1 minute
Description:	Controls the period between automatic re-authentication of the connection to the RADIUS server. This is done in the background and no user intervention is necessary unless the connection to the RADIUS server has failed, when the user may be prompted to log in again using the fallback RADIUS server (or standard modem log in if no RADIUS server is available).

Table 6-30 RADIUS Authentication Validity

6.2.11.5 RADIUS Server Timeout

Range:	1 to 60 seconds; step size: 1 second
Description:	Controls the timeout when connecting to the RADIUS server. Two attempts will be made before reverting to use the fallback RADIUS server. If the fallback server connection attempts also fail then, the user will be presented with the standard (non-RADIUS) login prompt.

Table 6-31 RADIUS Server Timeout

6.2.11.6 Modem Identity

The *Modem identifier* is a user-assigned text string that is typically used to uniquely identify the modem, satellite service or location. It is displayed as the *ID* field on the left-hand-side of every web page.

6.2.11.7 Submit Mode

Submit mode is used when reconfiguring remote modems in order to simplify the process of synchronising configuration changes at both ends of the link in order not to break the link while changing multiple control parameters. When submit mode is active, a Submit button appears on the web user interface as shown in **Figure 6-26**.

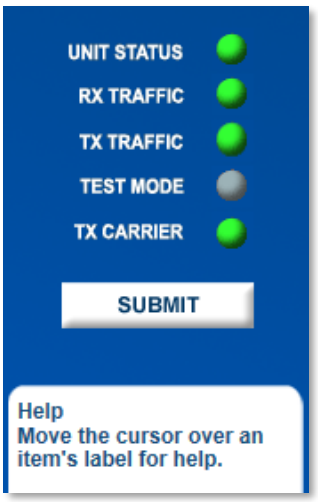


Figure 6-26 Modem Status Summary Screen with Submit Mode Button

In this mode, none of the configuration changes made to the modem will be activated until the Submit button is pressed. This is true even if the control parameters that are being changed are spread over multiple web pages. Once all the changes have been made, the Submit button should be pressed and this will activate all of the accumulated control changes. This minimises service downtime when making configuration changes. Switching off the submit mode reverts the modem to the mode where each control change is activated instantaneously.

It should be noted that the Q-NET Navigator control application (which can be downloaded freely from the Teledyne Paradise Datacom web site) has the ability to configure hub and remote modems without the user having to be concerned with how the changes are synchronised between the modems, thereby removing this problem entirely.

6.2.12 Edit->Unit->M&C-> SNMP Screen

The *Edit->Unit->M&C->SNMP* screen is shown in **Figure 6-27**.

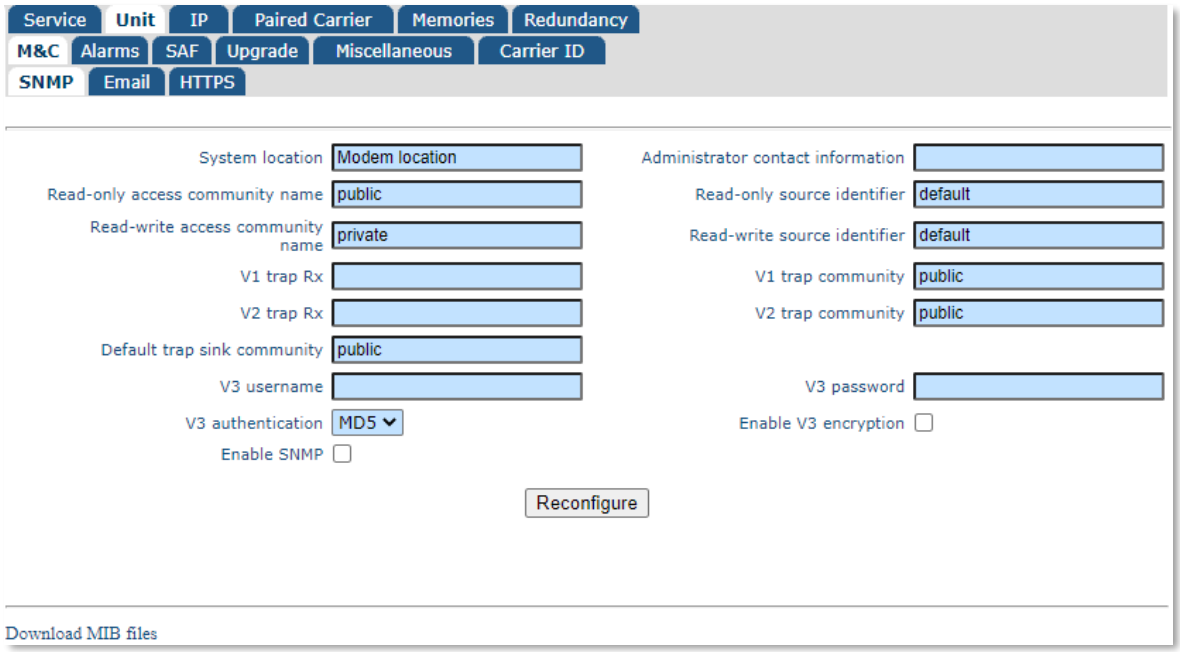


Figure 6-27 Edit->Unit->M&C->SNMP Screen

The Simple Network Management Protocol (SNMP) can be configured for use with SNMP v1, v2c and v3.

The modem's SNMP configuration settings have the standard meanings defined by the relevant SNMP standards and are therefore not described in detail. The community names represent passwords that must be present in each SNMP read or write requests in order for the commands to be executed. The source identifier fields are used to define the source IP addresses that read/write requests will be accepted from. The trap receiver fields are used to define the IP address of a trap server to which trap notifications will be sent when modem alarms arise (and when they disappear).

SNMP can be controlled by the *Enable SNMP* setting. SNMP is switched off by default. The modem does not need to be configured to tell it which version of SNMP is being used and will respond correctly to all SNMP commands regardless of the version.

The modem's SNMP Management Information Bases (MIBs) can be downloaded directly from the modem using the *Download MIB files* hyperlink at the bottom of the screen.

6.2.13 Edit->Unit->M&C-> Email Screen

The *Edit->Unit->M&C->Email* screen is shown in **Figure 6-28**.

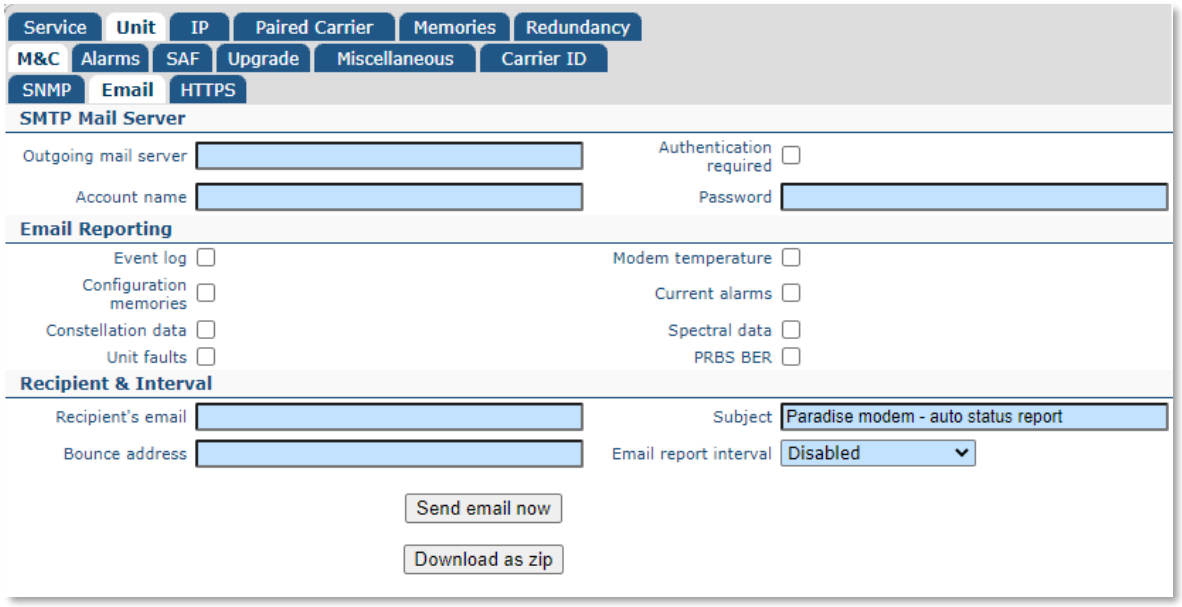


Figure 6-28 Edit->Unit->M&C->Email Screen

From power-up, the modem automatically records modem and satellite link performance information for both online and offline use. This information can be sent by email from the modem to any email address, providing a connection from the modem to an available Simple Mail Transfer Protocol (SMTP) mail server. This feature is particularly useful when providing Quality of Service reports to satellite-services end users and when investigating unexplained disruptions to the satellite service. It is also possible to fetch performance data over the satellite from a remote modem and then send this by email from the local modem.

The modem has a built-in SMTP mail client. By ticking the required checkboxes, the following information can be sent from the modem, either on demand or at preset intervals:

- Up to a month's worth of logged modem temperature values
- The contents of the modem's event log (i.e. all notable events that have occurred)
- Current system alarms (i.e. all Unit, Tx and Rx faults and warnings)
- All configuration memories
- Instantaneous spectrum data
- Instantaneous constellation data

The information is sent in Comma Separated Value (CSV) format, which allows the data to be copied into any spreadsheet from where it can be viewed in a number of formats (e.g. as a graph or a table) and from which reports can be generated.

The relevant data is appended to the email as separate attachments. The modem needs to know where to send all emails in order for them to be forwarded to individual email accounts. This is the outgoing SMTP mail server name (e.g. smtp.yourmailserver.com). An account name and password may be necessary. The recipient's email address, subject (email title) and email reporting interval should be set as required.

The *Bounce* address field is optional and is the address used to deliver failure notifications in the event that an email cannot be delivered to the recipient's email address.

The following example demonstrates how to graph modem constellation data in a spreadsheet:

- Configure the SMTP mail server and recipient email details.
- Select the *Constellation data* check box and click the *Send email now* button.
- Wait for the email to be received at the recipient's account and open it.
- To import the constellation data into a spreadsheet program (Microsoft Excel is used in this example) double click on the email attachment *constellation.csv* to open it (this should automatically start the spreadsheet application - if not, then save the attachment and open it directly from within the spreadsheet application).
- Within Excel, highlight the A and B columns.
- Select the Chart Wizard from the toolbar (or alternatively select the *Insert* menu followed by *Chart*).
- Select *XY (Scatter)* as the chart type.
- Select the *Scatter* (topmost) sub-chart type.
- Select *Next* and then accept the defaults for *Data Range* and *Series*.
- Add a chart title and X and Y titles as desired.
- Select *Finish* and then resize the resulting graph as desired.

An example of the output is shown in **Figure 6-29**.

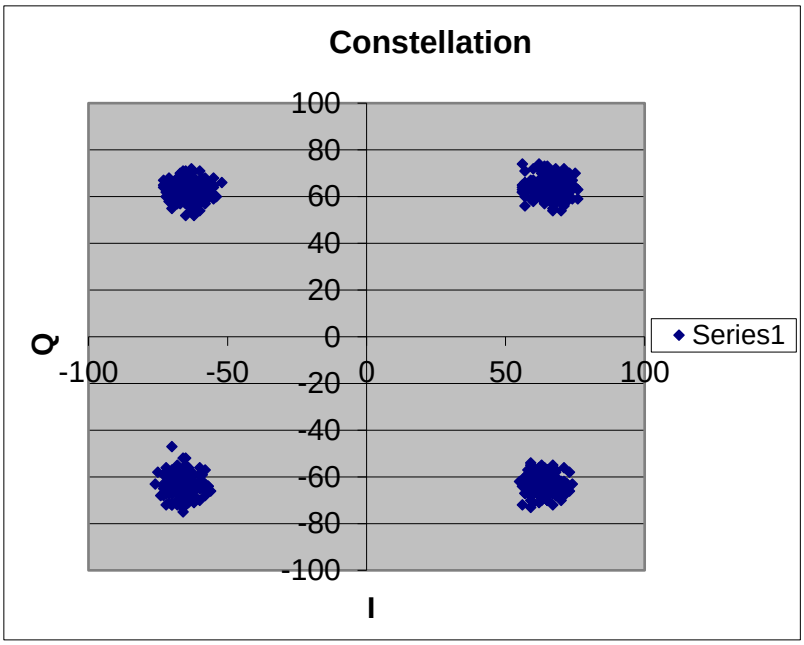


Figure 6-29 Example Constellation Graph (Microsoft Excel)

6.2.14 Edit->Unit->M&C->HTTPS Screen

The *Edit->Unit->M&C->HTTPS* screen is shown in **Figure 6-30**.

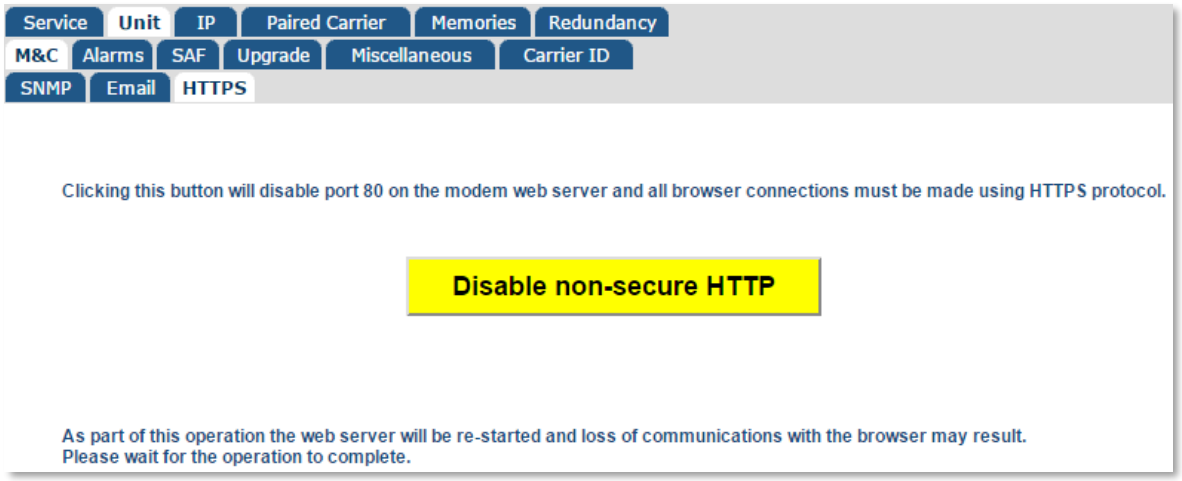


Figure 6-30 Edit->Unit->M&C->HTTPS Screen

Secure HTTPS connections to the modem's web server (on port 443) are always enabled. However, it is possible to disable (and re-enable) standard HTTP requests (on port 80) using this screen.

6.2.15 Edit->Unit->Alarms Screen

The *Edit->Unit->Alarms* screen is shown in **Figure 6-31**.

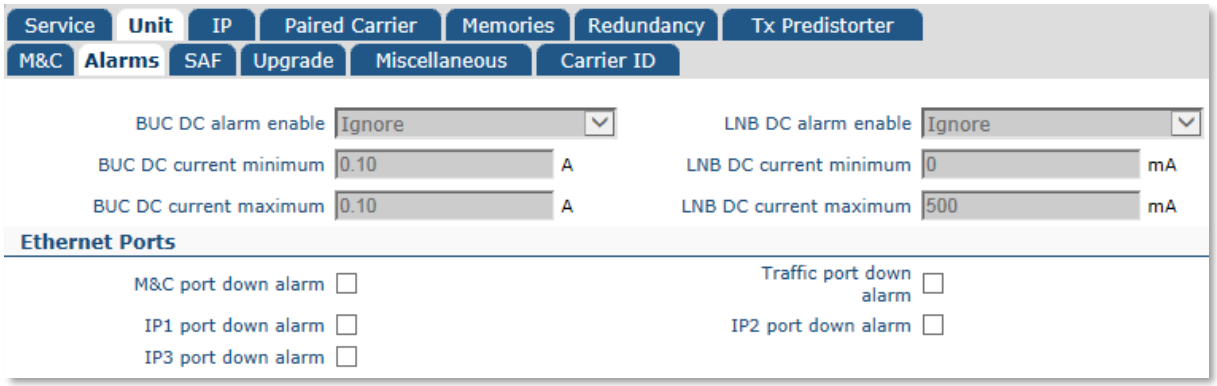


Figure 6-31 Edit->Unit->Alarms Screen

6.2.15.1 BUC DC Current Alarm

Even when there is no FSK communications path between the BUC and modem, it is still possible for the modem to monitor the BUC for under/over current that causes the BUC to overheat or become unstable. **Table 6-32** describes how to set the BUC minimum and maximum DC current levels outside of which a BUC DC current alarm will be raised if *BUC DC alarm enable* is set.

Range:	0.1A to 6.0A; step size: 0.01A (i.e. 10mA)
Description:	Sets the trip threshold at which a fault is declared when the current drawn by the Tx ODU is outside the limit. Both a minimum and a maximum current threshold can be set. These set the current thresholds outside of which an alarm will be generated.

Table 6-32 BUC DC Current Minimum/Maximum

6.2.15.2 LNB DC Current Alarm

The modem can also monitor the LNB current. **Table 6-33** describes how to set the LNB minimum and maximum DC current levels outside of which an LNB DC current alarm will be raised if *LNB DC alarm enable* is set.

Range:	0 to 500mA; step size: 1mA
Description:	Sets the trip threshold at which a fault is declared when the current drawn by the Rx LNB is outside the limit. Both a minimum and a maximum current threshold can be set. These set the current thresholds outside of which an alarm will be generated.

Table 6-33 LNB DC Current Minimum/Maximum

6.2.15.3 Ethernet Port Down Alarms

The *Ethernet port down alarm* checkboxes can be used to enable or disable individual alarms associated with each Ethernet port on the modem. These can be used to indicate that a cable has been removed or developed a fault, or that the communicating piece of equipment attached to a particular port has developed a fault.

6.2.16 Edit->Unit->SAF Screen

The *Edit->Unit->SAF* screen is shown in **Figure 6-32**.

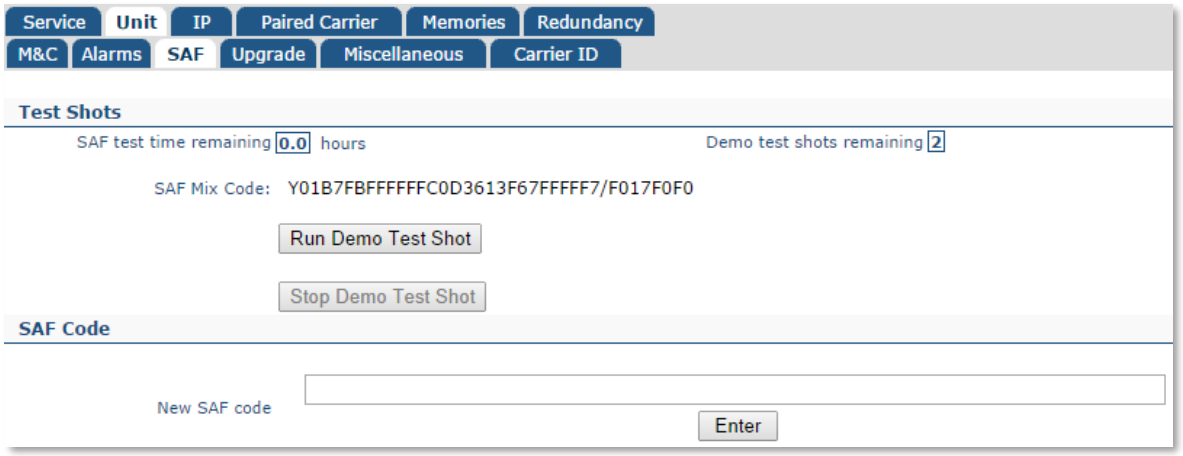


Figure 6-32 Edit->Unit->SAF Screen

This screen displays:

- The remaining time period before any temporarily-enabled SAF features time out.
- The number of unused test shots remaining. A *test shot* enables all of the possible modem features for a 10-day period (subject to suitable hardware being fitted and with some exceptions).
- The SAF Mix Code, which is a number that represents all the features that have been permanently enabled on the modem.

The *Run Demo Test Shot* button is used to start a 10-day activation of the modem's possible SAF features (this excludes the hub cancellation feature – contact customer support for a hub cancellation feature trial).

The *Stop Demo Test Shot* button is used to terminate the temporary activation of the modem's SAF features. Any remaining time of the test period is lost.

The *New SAF code* edit box is used to enter a code provided by Teledyne Paradise Datacom that unlocks additional modem features. When unlocked, the features immediately become available. The act of unlocking SAF features will not itself interfere with any services being provided by the modem. Entering a code of '0' will enable a test shot.

6.2.17 Edit->Unit->Upgrade Screen

Upgrade from web user interface

The *Edit->Unit->Upgrade* screen is shown in **Figure 6-33**. This allows the modem's software to be upgraded (and downgraded). This can also be done via the front-panel menus and a USB memory stick.

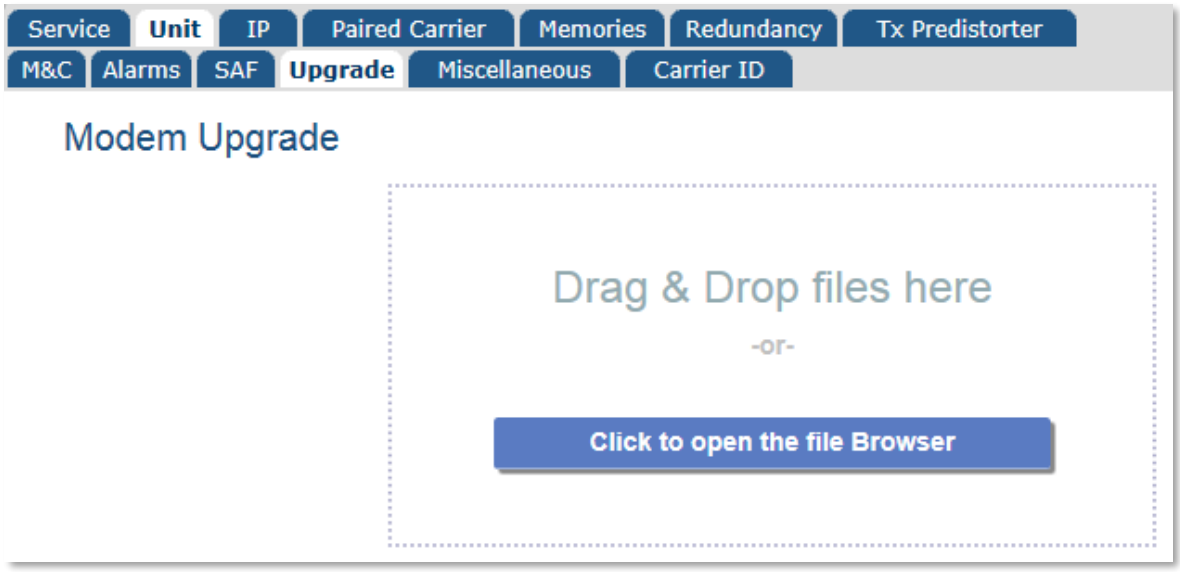


Figure 6-33 Edit->Unit->Upgrade Screen

Please contact customer support for the latest software. Follow any instructions found on www.ParadiseData.com software downloads section. The software should be downloaded to a location that can be accessed by the modem browser.

The modem should be placed into bridge mode with all advanced IP features (such as TCP acceleration, ACM, routing, etc.) switched off. If any of these are enabled, you will see the following screen:

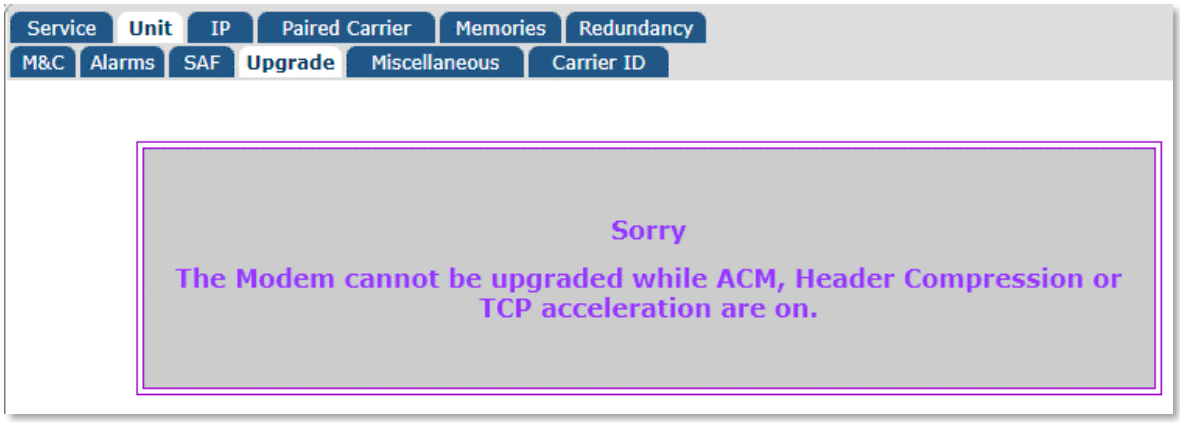


Figure 6-34 Edit->Unit->Upgrade Screen if listed options are enabled

Simply drag and drop the upgrade zip file into the 'Drag & Drop files here' section of the box, or use the 'Click to open the file Browser' button to search for the upgrade file. The modem should then upload the file.

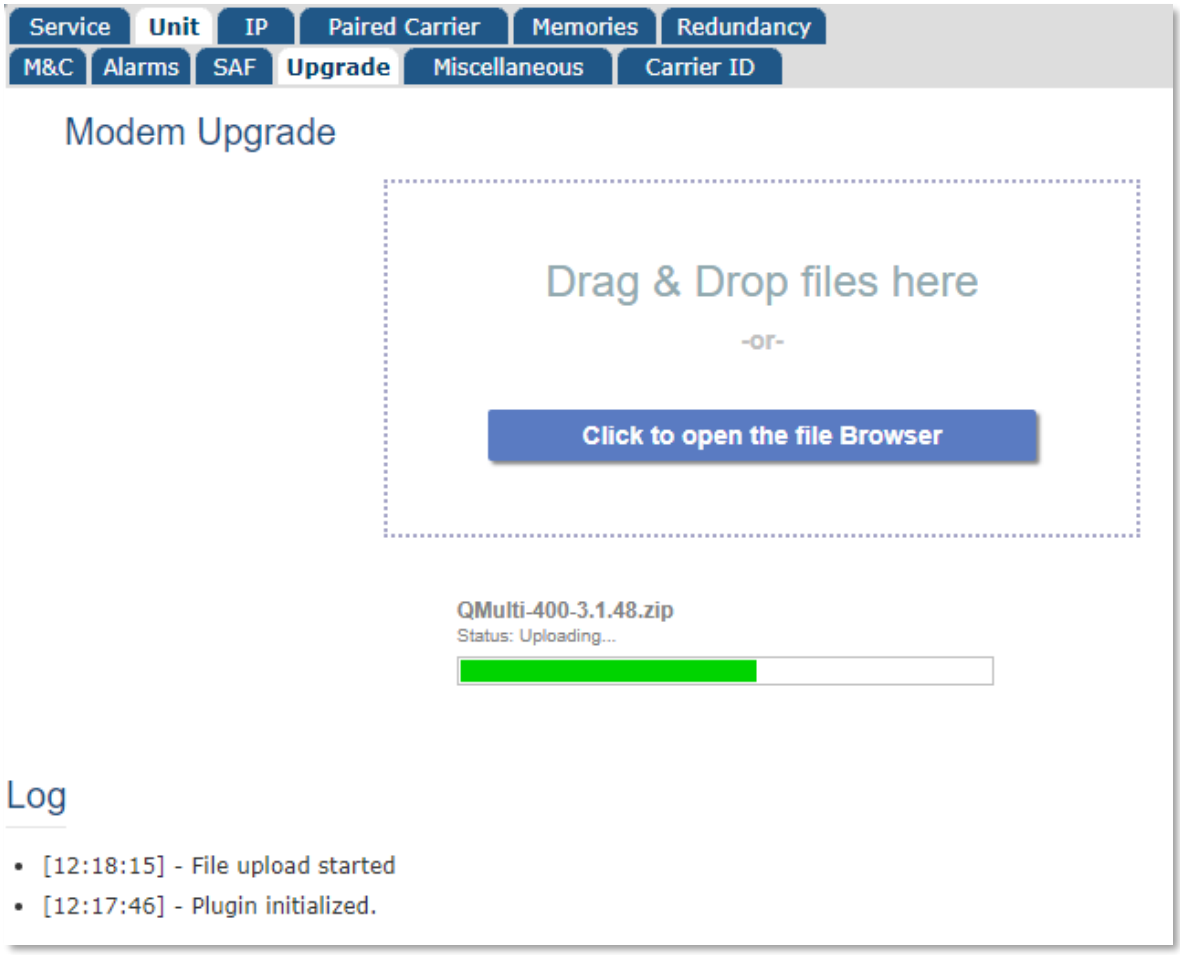


Figure 6-35 Edit->Unit->File upload

At some point of the upgrade process the modem will temporarily drop any traffic service that it was providing and reboot.

Feedback on the progress of the upgrade, which typically takes around two minutes, is provided on the screen (**Figure 6-36**). The modem will restart automatically when the upgrade is complete and will resume operation using the same configuration as prior to the upgrade.

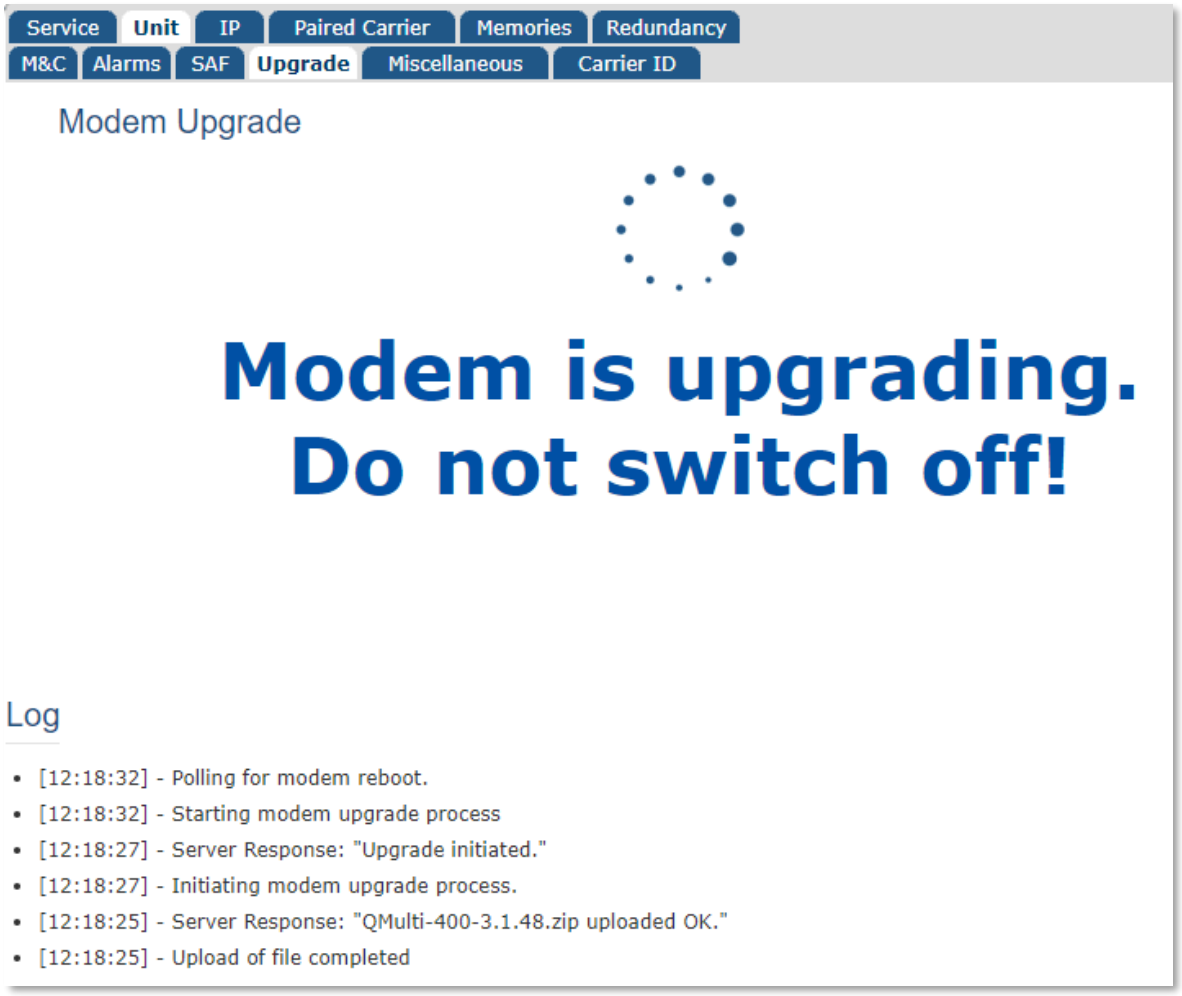


Figure 6-36 Edit->Unit->Upgrade Screen Progress Indication

A remote modem can be upgraded over the satellite link by browsing to the remote modem's IP address and following the same upgrade process. Note that the speed of the upgrade is dependent on the bandwidth available over satellite. An approximate time can be worked out by comparing the size of the upgrade file with the bandwidth available.

If an upgrade is unsuccessful, the modem will revert to a backup version of software. This will normally be the software version the modem shipped from the factory with. However, it is possible to set the fallback software to any version (please consult Technical Support for further details).

To revert to the backup version of software in the modem, hold down the MAIN key at power-up, then when the menu appears press **5:Old**. This boots the modem from a backup copy of the software stored when the modem was manufactured. Once the modem is booted, the standard upgrade process can be repeated. This is the best method to recover a modem and if unsuccessful, please contact technical support.

Upgrade from USB memory stick

- Create a new folder on the USB memory stick and name it `upgrade`.
- Unzip the contents of the software upgrade zip file 'QMulti-400-3.x.xx.zip' to this folder.
- If there is a file called 'preupgrade.sh' then delete this from the upgrade folder.
- Three files with the following names should now be present in the upgrade folder as shown in **Figure 6-37**.

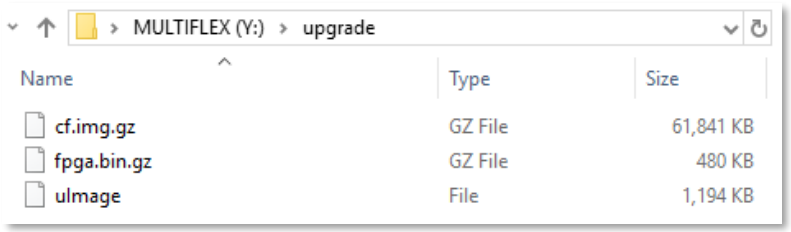


Figure 6-37 USB Memory Stick Upgrade Files in Upgrade Folder

- Plug the memory stick into the front USB port of the modem.
- On the front panel keypad select **2:Edit**, **2:Unit**, **4:Upgrade**.
- An 'Upgrading!! Do not switch off' message will then be displayed on the front-panel display.
- The modem will reboot automatically and resume normal operation when the upgrade is complete.

If the modem does not recognise the USB memory stick

To be recognised by the modem, the memory stick must have been formatted as 'FAT32'. In Windows, this can be done by right clicking on the USB drive and selecting 'Format' and then selecting 'FAT32'. Note that this will delete the existing contents of the memory stick.

6.2.18 Edit->Unit->Miscellaneous->Time Screen

The *Edit->Unit->Miscellaneous->Time* screen is shown in **Figure 6-38**. This allows the modem's real time clock to be set. The modem incudes a battery and maintains the time even when powered down. The time and date can be entered manually or can be synchronized with the PC connected to the modem.

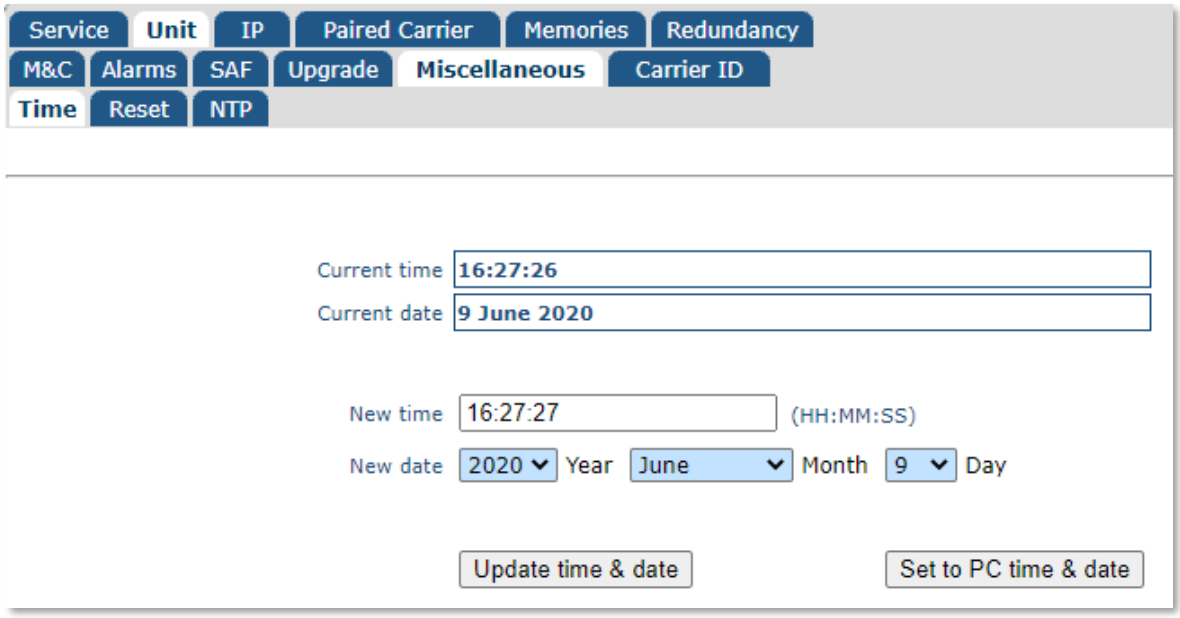


Figure 6-38 Edit->Unit->Miscellaneous->Time Screen

6.2.19 Edit->Unit->Miscellaneous->Reset Screen

The *Edit->Unit->Miscellaneous->Reset* screen is shown in **Figure 6-39**. Clicking the 'Reset modem' button allows the modem to be reset, following confirmation.

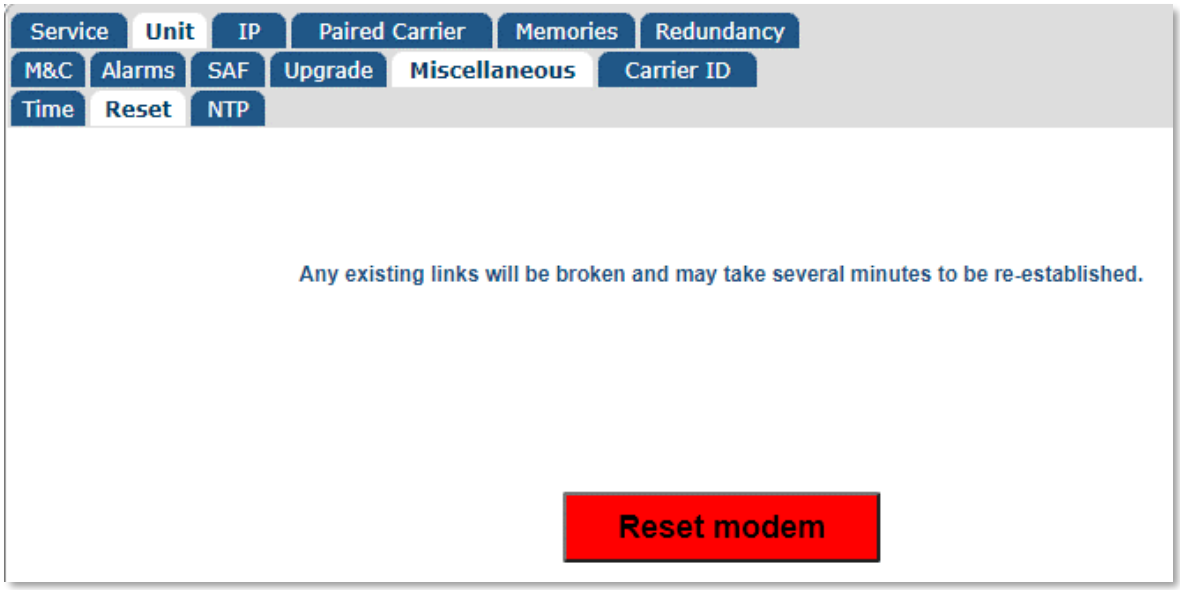


Figure 6-39 Edit->Unit->Miscellaneous->Reset Screen

6.2.20 Edit->Unit->Miscellaneous->NTP Screen

The *Edit->Unit->Miscellaneous->NTP* screen is shown in **Figure 6-40**. This supports using the Network Time Protocol (NTP) to synchronise the modem to the attached computer system. This requires the input of an NTP server IP address that provides a master source of Coordinated Universal Time (UTC). A secondary NTP server address can also be used.

The modem will request the current time from the NTP server on a regular basis. A time offset can be applied to the modem to account for any regional deviation from UTC.

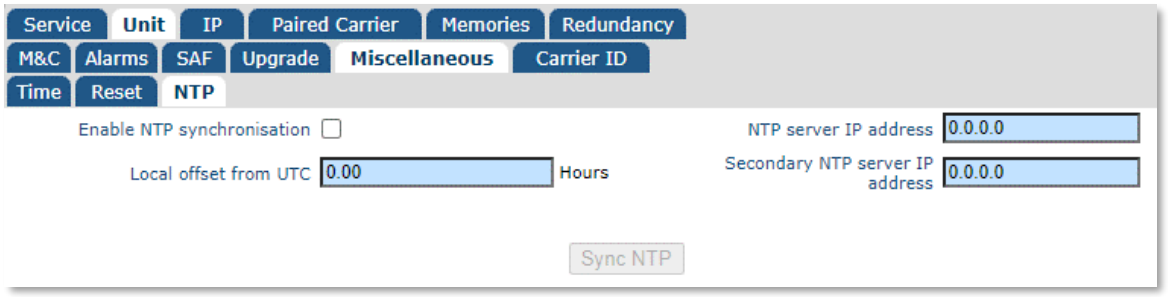


Figure 6-40 Edit->Unit->Miscellaneous->NTP Screen

6.2.21 Edit->Unit->Carrier ID Screen

The *Edit->Unit->Carrier ID* screen is shown in **Figure 6-41**. This allows a low-power spread spectrum signal containing user identification information to be superimposed on the Tx DVB-S2/S2X carrier. A suitable decoder can decode the Carrier ID information which can be used to identify the source of satellite carriers.

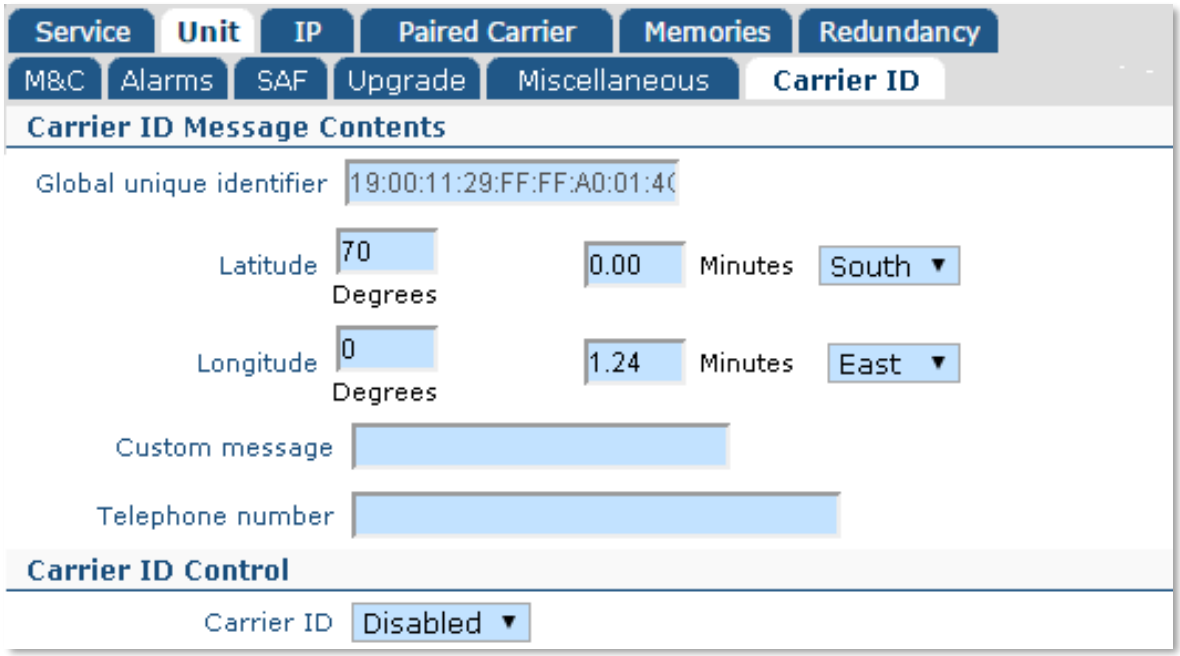


Figure 6-41 Edit->Unit->Carrier ID Screen

6.2.21.1 Carrier ID Global Unique Identifier

The Carrier ID *Global unique identifier* is a unique ID for the modem. Its value is fixed during the manufacturing process and cannot be changed. The unique identifier is transmitted as part of the Carrier ID information allows the modem manufacturer and the specific modem to be traced.

6.2.21.2 Carrier ID Latitude and Longitude

The Carrier ID *Latitude* and *Longitude* fields allow the user to enter the geographic position of the modem. This information is transmitted as part of the Carrier ID and allows a Carrier ID decoder to identify the location from which an interfering carrier is being generated.

6.2.21.3 Carrier ID Custom Message and Telephone Number

The Carrier ID *Custom message* and *Telephone number* fields are optional. If entered, this information will be transmitted as part of the Carrier ID signal and will be available for viewing via a suitable Carrier ID decoder.

6.2.21.4 Carrier ID

This is an *Enabled/Disabled* control that controls the generation of the Carrier ID spread spectrum signal. Carrier ID is an optional feature and can be made available on all Q Series modems via a software upgrade. The Carrier ID feature is not provided as standard and the Carrier ID SAF must therefore be activated on the modem for the feature to be available on the menus.

6.2.22 Edit->IP Screen

The *Edit->IP* screen (shown in **Figure 6-42**) allows the following to be configured:

- Basic and advanced IP modes and features, such as bridging, routing, acceleration and ACM.
- The modem's terrestrial and satellite traffic IP addresses.
- Miscellaneous IP features used for specialised modes of operation.
- A further tab allows the configuration of static routes.

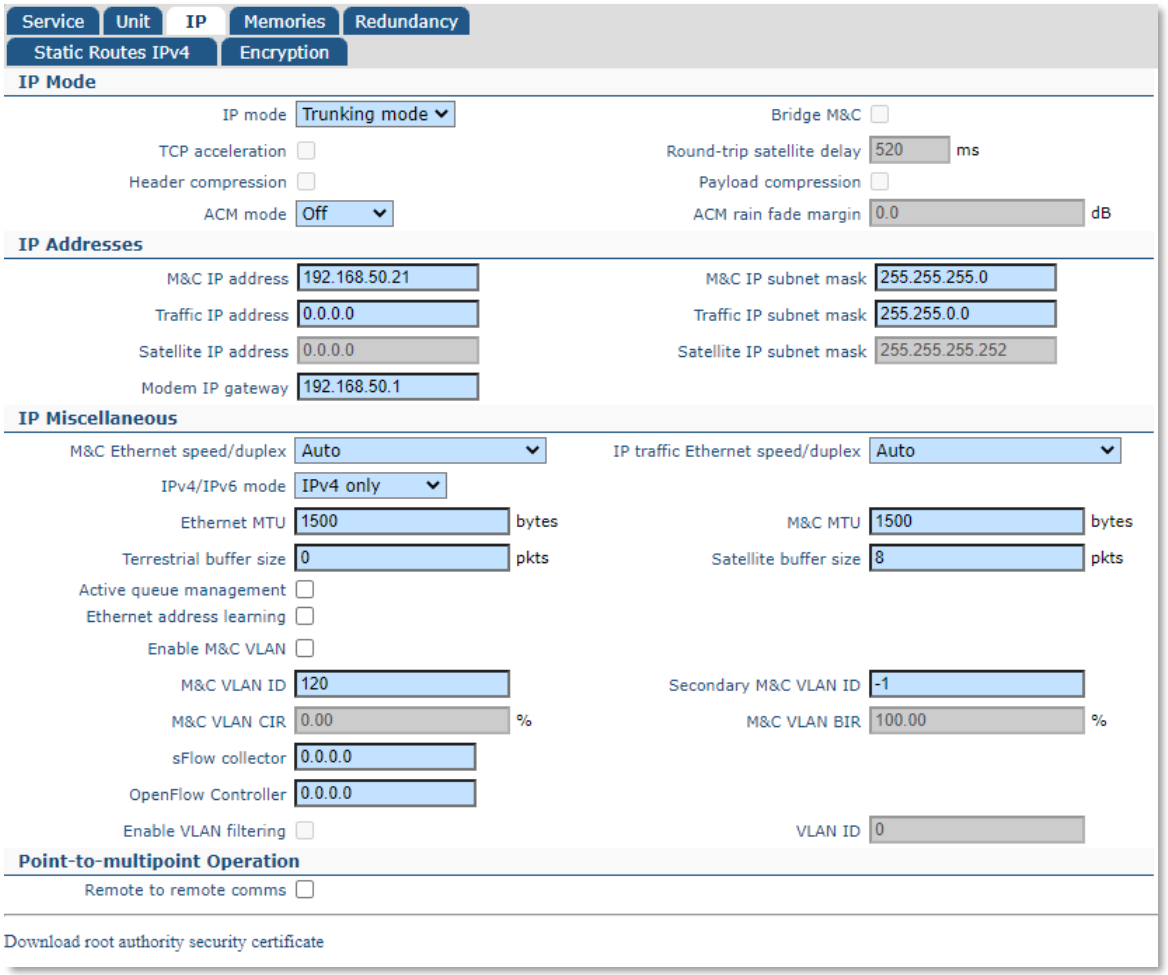


Figure 6-42 Edit->IP Screen

6.2.22.1 IP Mode

Table 6-34 shows the *IP mode* options. The operation of the M&C and IP Traffic Ethernet ports is summarized in **Table 6-34**.

Trunking mode	The **QMultiFlex-400™** comes with an IP processing card, which offloads the processing of the transmitting traffic and potentially large amount of returning packets from multiple remotes. All of the Xstream IP features will also be handled by the processing card, which includes Traffic Shaping QoS, IP over DVB encapsulation, TCP acceleration and ACM/VCM. The network traffic needs to be connected to Port 1 of the processing card. Port 4 will then need to be connected to the base modem IP traffic port. Trunking mode should be selected as the IP mode if an ethernet bridge is required (common in star topologies). Trunking mode puts the base modem into a low jitter high throughput mode, where the processing card will handle the heavy lifting on the bridging features. As a whole, the modem acts like an ethernet bridge, preserving the original ethernet frames (including additional fields such as VLAN and MPLS headers) over satellite.
Routing mode	In this mode IP packets are forwarded based on the contents of the modem's routing table, which can be configured manually with static routes. The modem operates as a two-port router in this mode, with separate terrestrial and satellite subnets. The idea being there is a common satellite subnet with the various different remote subnets being routed through it. Routing mode should be selected as the IP mode if a mesh topology is required. See separate document: *AN_057 P2MP Mesh Network Routing Mode Configuration Notes* available from technical support.
Bridge mode (No longer relevant)	Puts the base modem into an ethernet bridge mode. Since the IP processing card now performs the bridge functions, this is no longer a valid option. If for whatever reason the processing card was taken out, then this could be selected.

Table 6-34 IP Mode

6.2.22.2 Bridge M&C

This is an On/Off control that determines if the M&C port is bridged to the other traffic port on the base modem. The only reason you would ever want the M&C bridge on is if the IP traffic card needs to be upgraded (contact customer support for details).

The default for this setting is 'On' (for historical reasons). This will need to be turned 'Off' for normal operation.
Never operate the **QMultiFlex-400™** in a network with the M&C bridge tuned On (default setting). Figure 6-43 shows the check box unchecked.

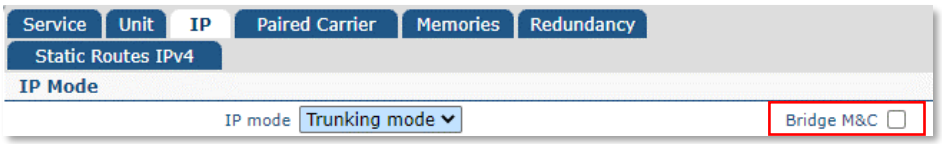


Figure 6-43 Edit->Bridge M&C Unchecked

6.2.22.3 TCP Acceleration

This is an On/Off control that controls point-to-multipoint TCP acceleration.

Packets received by the modem will be either bridged or routed as determined by the *IP mode* setting.

When on, TCP packets are processed by a Performance Enhancing Proxy (PEP) that overcomes performance problems associated with using standard TCP over satellite.

Configuring TCP Acceleration

- Bridging Mode (Trunking mode with IP Traffic card).

In order to make it easier to set up, TCP acceleration does not use an IP address for the IP traffic port when used in bridging mode (i.e. address is set to 0.0.0.0). M&C control must be provided via a separate subnet to that used for satellite traffic. The modem gateway is applied to the M&C subnet.

- Routing Mode

In this mode, the M&C Ethernet port and IP Traffic port have dedicated addresses and must be on separate subnets. All packets on both ports will be accelerated and passed over satellite as required. The modem gateway is applied to either the M&C subnet or IP Traffic subnet as specified by the user.

6.2.22.4 Round-trip Satellite Delay

Range:	0ms to 9999ms; step size: 1ms
Description:	This sets a satellite round-trip delay that is used in conjunction with TCP acceleration. It controls the size of the modem's internal packet buffer to match the bandwidth-delay product for the link (i.e. the link's data capacity multiplied by the end-to-end delay). This helps to maintain the throughput at its maximum level when TCP acceleration is on.

Table 6-35 Round-trip Satellite Delay

6.2.22.5 Header Compression

Due to processing constraints this feature is no longer usable.

6.2.22.6 Payload Compression

Due to processing constraints this feature is no longer usable.

6.2.22.7 ACM Mode

Off	No ACM data is sent or received.
On	ACM data is sent and received via a bi-directional IP link. The Es/No information is inserted into the carriers with no material effect on bandwidth. When ACM is on Es/No data is expected, which is used to dynamically match the transmitting MODCOD to suit the current conditions. Carrier symbol rate and power remain unchanged, but data rate will vary with the choice of MODCOD. With many remotes reporting their Es/No back, the **QMultiFlex-400™** will always act upon the lowest Es/No.
Monitor	ACM data is sent and received, but no action is taken to change the transmitting MODCOD. This setting would be selected if it was desired that ACM should only work in one direction - the modem with 'monitor' selected would be the side of the link that does not change the MODCOD.

Table 6-36 ACM Control Options

Note: The remote modems stream identifier needs to be the same number as the demodulator when ACM is 'On' at the remotes. i.e. Remote modem 1 needs to have stream ID of 1, Remote modem 2 needs to have stream identifier of 2 etc. See section 8.2 for more details on ACM system configuration.

6.2.22.8 ACM Rain Fade Margin

Range:	0dB to 9.9dB; step size: 0.1dB
Description:	This sets a margin used in the ACM control process when making decisions on what MODCOD to select based on the current Es/No reading of the remote modem(s). By setting the ACM rain fade margin to a non-zero value, ACM operation will cope with a faster rate of rain fade without losing demodulator lock than would otherwise be the case. Note that the ACM control process has its own non-configurable operating margin built in (which will cope with Es/No changes of up to 1dB/s) and therefore the ACM rain fade margin should be used only on links that have the potential for particularly severe rain fades. Setting an ACM margin that is higher than necessary will reduce the benefits of using ACM since non-optimal MODCODs may be used due to the need to maintain a larger margin between the actual Es/No and the Es/No required by the dynamically selected MODCODs.

Table 6-37 ACM Rain Fade Margin

6.2.22.9 M&C IP Address, Subnet Mask & Modem IP Gateway

M&C IP Address Default:	10.0.70.1
Description:	This sets the IP address for remote control. An IP address of 0.0.0.0 causes the modem to request its IP address from a Dynamic Host Control Protocol (DHCP) server on the network, removing the need to allocate static IP addresses to each modem. The allocated IP address can be seen on the *View->Unit* screen. A request to the DHCP server is made every minute until a reply is received. When IPv6 support is selected on the menus, then additional address entry options are provided. When changing the IP address, devices communicating with the modem may take several minutes to recognize the new address unless the Address Resolution Protocol (ARP) tables on the relevant devices are flushed.
M&C IP Subnet Mask Default:	255.255.0.0
Description:	Sets the remote-control port IP subnet mask.
Modem IP Gateway Default:	0.0.0.0
Description:	Sets the IP address of a default gateway. The gateway represents the 'next hop' destination, which is normally the address of a router, for packets destined for somewhere other than the local network. This is used whenever the *IP mode* is set to *Routing*. An address of 0.0.0.0 means that the gateway is not set.

Table 6-38 M&C IP Address, Subnet Mask & Modem IP Gateway

6.2.22.10 Traffic/Satellite IP Addresses and Subnet Masks

Traffic IP address default:	0.0.0.0
Description:	Normally in bridge mode the address 0.0.0.0. is used as standard to create a transparent bridge. VLAN and MPLS protocols will pass traffic with minimal setup, thus is the recommended address for most bridge mode cases. If required, a network IP address can be applied to the modem's IP Traffic port. DHCP is not supported for this address and therefore an address must be manually entered. If using routing mode, then this would need to be set to a local subnet address. See separate document: *AN_057 P2MP Mesh Network Routing Mode Configuration Notes* available from technical support. When IPv6 support is selected on the menus then additional address entry options are provided.

Traffic IP subnet mask default:	255.255.255.0
Description:	This sets the subnet mask for the modem's IP Traffic port.
Satellite IP address default:	0.0.0.0 (only available in routing mode)
Description:	This sets the IP address for the modem's satellite IP port. This is only used when in routing mode, when the modem acts as a two-port router. This address will be part of the common satellite subnet.
Satellite IP subnet mask default:	255.255.255.0 (only available in routing mode)
Description:	This sets the subnet mask for the modem's satellite IP port.

Table 6-39 Traffic/Satellite IP Address & Subnet Mask

6.2.22.11 M&C and IP Traffic Ethernet Speed/Duplex

Table 6-40 lists the different Ethernet speed and duplex settings for the modem's Ethernet interfaces. The M&C interface and IP traffic interface can be set independently of each other. Changes will be effective immediately but when an auto-negotiated mode is selected then any ethernet connection will be briefly disconnected while the change takes effect. The *Auto* setting is recommended for normal use but because ethernet auto-negotiation varies between different manufacturers it may be necessary to fix the speed and duplex in some circumstances. The type of cable (crossover or straight) is always automatically sensed by the modem, which will work with either type.

Auto	In this mode the modem will auto-negotiate the Ethernet speed and duplex settings.
10M half-duplex	In this mode the modem will auto-negotiate the Ethernet speed and duplex settings but as part of the negotiation will 'advertise' 10Mbps half-duplex as the only option available.
10M full duplex	The modem will auto-negotiate the Ethernet speed and duplex settings but as part of the negotiation will 'advertise' 10Mbps full duplex as the only option available.
100M half-duplex	The modem will auto-negotiate the Ethernet speed and duplex settings but as part of the negotiation will 'advertise' 100Mbps half-duplex as the only option available.
100M full duplex	The modem will auto-negotiate the Ethernet speed and duplex settings but as part of the negotiation will 'advertise' 100Mbps full duplex as the only option available.

1000M half-duplex	The modem will auto-negotiate the Ethernet speed and duplex settings but as part of the negotiation will 'advertise' 1000Mbps half-duplex as the only option available.
1000M full duplex	The modem will auto-negotiate the Ethernet speed and duplex settings but as part of the negotiation will 'advertise' 1000Mbps full duplex as the only option available.
10M half-duplex (fixed)	The modem's Ethernet interfaces will be fixed to 10Mbps half-duplex operation.
10M full duplex (fixed)	The modem's Ethernet interfaces will be fixed to 10Mbps full duplex operation.
100M half-duplex (fixed)	The modem's Ethernet interfaces will be fixed to 100Mbps half-duplex operation.
100M full duplex (fixed)	The modem's Ethernet interfaces will be fixed to 100Mbps full duplex operation.
1000M half-duplex (fixed)	The modem's Ethernet interfaces will be fixed to 1000Mbps half-duplex operation.
1000M full duplex (fixed)	The modem's Ethernet interfaces will be fixed to 1000Mbps full duplex operation.

Table 6-40 Ethernet Speed/Duplex

6.2.22.12 IPv4/IPv6 Mode

IPv4 only	This enables the entry and display of IP addresses in IPv4 format only. The modem will bridge IPv4 and IPv6 packets when in IPv4 mode but will route only IPv4 packets.
IPv4 and IPv6	This enables the entry and display of IP addresses in either IPv4 format or IPv6 format. The modem will bridge and route both IPv4 and IPv6 packets in this mode.

Table 6-41 IPv4/IPv6 Mode

6.2.22.13 Ethernet MTU

Range:	1,000 bytes to 10,240 bytes; step size: 1 byte (Default 1500)
Description:	This controls the Ethernet Maximum Transmission Unit (MTU) size, which defines the largest Ethernet frame that can be handled by the modem in bridging mode without fragmentation into smaller frames.

Table 6-42 Ethernet MTU

6.2.22.14 M&C MTU

Range:	1,000 bytes to 10,240 bytes; step size: 1 byte (Default 1500)
Description:	This controls the M&C Ethernet Maximum Transmission Unit (MTU) size, which defines the largest Ethernet frame that can be handled by the modem M&C port without fragmentation into smaller frames.

Table 6-43 M&C MTU

6.2.22.15 Terrestrial Buffer Size

Range:	0 to 99999 packets (Default 0)
Description:	The terrestrial buffer is used to buffer IP packets coming into the IP terrestrial ports for transmission over satellite. Satellite delay and the quality of the service in general can be controlled by the size of this buffer in conjunction with setting the size of the satellite buffer. The buffer should be set large enough to accommodate bursts of packets being received by the modem. Setting the buffer larger than necessary could result in large packet delays building up should more packets be sent to the modem than can be transmitted. The default value for this buffer is zero, which should be fine for most situations. The optimal size for the buffer depends on the link data rate, the packet sizes, the number of packets and the specific application (some applications being able to tolerate packet loss and/or delays more than others). When the buffer is full then received packets will be dropped until space in the buffer is freed up. It is generally desirable for the terrestrial buffer to be set so that packets are not dropped unnecessarily before they have been assessed by the traffic shaper as to priority, etc. At the same time, a large buffer could result in stale data being kept, which it might be better to drop by making the buffer smaller so that only the most recent data is kept in an overload situation.

Table 6-44 Terrestrial Buffer Size

6.2.22.16 Satellite Buffer Size

Range:	1 to 256 packets (Default 256)
Description:	The satellite buffer is used to buffer IP packets ready for transmission over satellite. The buffer is situated after all internal packet processing has been completed, including traffic shaping and encapsulation. Satellite delay and the quality of the service in general can be controlled by the size of this buffer. The buffer should be set large enough to even out peaks and troughs in throughput that would result from setting an extremely small buffer. Setting the buffer larger than necessary could result in large packet delays building up should more packets be available than can be transmitted. The traffic shaper can be used to ensure that the combined output from all classes of traffic does not exceed the available satellite bandwidth, even when ACM (which dynamically adjusts the data rate) is active. The optimal size for the buffer depends on the link data rate, the packet sizes, the number of packets and the specific application (some applications being able to tolerate packet loss and/or delays more than others). When the buffer is full then new packets for transmission will be dropped until space in the buffer is freed up. **However, as a general rule, it is recommended that the satellite buffer size is set to 8 for most applications, particularly when TCP acceleration or Traffic Shaping is being used, unless an alternative buffer size is found to give better performance. Setting the buffer too large can cause throughput to oscillate when TCP acceleration is being used.**

Table 6-45 Satellite Buffer Size

6.2.22.17 Active Queue Management

Although the terrestrial and satellite buffers can be tuned to match the specific needs of a particular user application, passive buffer managed has inherent limitations and drawbacks. Active Queue Management (AQM) is an intelligent and pro-active form of TCP/IP queue management that overcomes the potential for inconsistent end-to-end packet delays and the problems of 'buffer bloat'. Buffer bloat is where packet buffers in the system are over-sized in order to try to prevent packet loss. The result is often that performance at the application level suffers due to excessive buffering of packets during periods of congestion, leading to extremely high latency levels with old data being kept almost indefinitely in the hope that extra bandwidth will become available and any overload will ease.

Buffer management in TCP/IP devices is typically passive and relies on the user setting internal buffer sizes to be consistent with the needs of the application and its data rates. However, TCP/IP can be bursty by nature and if the rate of arrival of packets at the satellite modem exceeds its transmission capabilities then packets start to back up and will eventually get dropped if the overload continues. The problem with this is that the end-to-end packet delay can vary greatly, and data becomes increasingly stale as the backlog of packets to be transmitted builds up.

Active Queue Management continually measures the packet delay through the modem and rather than let the backlog of packets build up, it ensures that the delay through the modem is kept constant by dropping packets early if required. (The modem implements a form of active queue management called CoDel, which stands for Constant Delay. The delay has been preset to 5ms, from packet ingress to egress, which is suitable for most applications. It can be changed 'under the hood' – please contact Customer Support for details.) The effect of this is that transit times through the network typically continue to be constant even in an overload situation.

The use of AQM can be combined with traffic shaping to ensure that high priority traffic is unaffected when demands on bandwidth are exceeded.

The use of AQM is especially important for latency sensitive applications and where the packet latency over the satellite link is measured to ensure compliance with a Service Level Agreement (SLA). It needs to be enabled on the modems at both ends of the satellite link in order to be effective.

6.2.22.18 Ethernet Address Learning

This option is no longer relevant with the IP processing card installed. Default is 'Off'. The processing card also has ethernet address learning turned off.

6.2.22.19 M&C VLAN

This is an On/Off control that controls whether M&C traffic destined for the remote modems is transmitted in a special VLAN. When the control is checked, all M&C traffic for the remote modems is sent over satellite using the M&C VLAN ID value (default 0).

Warning: The network address range (subnet) used for the M&C VLAN should not overlap with any traffic VLANS. This could produce unwelcome effects.

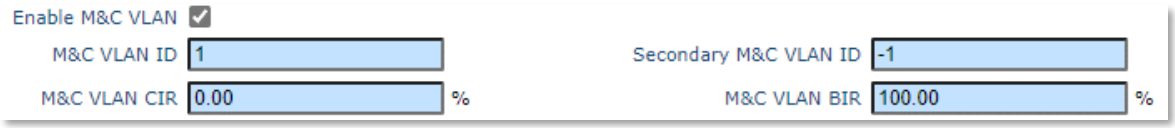


Figure 6-44 Edit->IP->M&C VLAN Settings

6.2.22.20 M&C VLAN ID

Range	0 to 4095 (default 0)
Description:	This is the VLAN ID used for the M&C VLAN. When M&C VLAN is enabled at the remote side, it creates an M&C IP link for the control of the remote modem, and anything connected to the remote modem i.e. an IP interface of a BUC. This M&C VLAN will pass through any VLAN filtering used at the remote side. **Note:** The default value of zero should be changed to a positive value more than zero, within the range, and different to any traffic VLAN IDs. Changing this value requires a power cycle of the modem for the new value to be used.

Table 6-46 M&C VLAN ID

6.2.22.21 Secondary M&C VLAN ID

Range	-1 to 4095 (default is -1 disabled).
Description:	This secondary M&C VLAN is only used when migrating a VLAN ID to a different number within a system. The idea is to use the desired VLAN ID as the main VLAN ID. The secondary one becomes the original old VLAN ID to keep the remote M&C system connected while the remotes are being changed over. More details on achieving this can be obtained through customer support for your particular scenario.

Table 6-47 Secondary M&C VLAN ID

6.2.22.22 M&C VLAN CIR / M&C VLAN BIR

With the IP processing card installed as standard, these options no longer effect the M&C VLAN and should be ignored. To prevent the modem traffic choking the M&C VLAN traffic, it is advisable to use traffic shaping and apply QoS rules. Setting the traffic BIR percentages to 98% or lower gives the M&C VLAN at least 2% of the throughput to maintain system control.

6.2.22.23 sFlow collector

Default Address:	0.0.0.0
Description:	sFlow® is an industry standard technology for monitoring high speed switched networks. It gives complete visibility into the use of networks enabling performance optimization, accounting/billing for usage and the data can be used as a defence against security threats. The address of the sFlow collector should be on the M&C subnet.

Table 6-48 sFlow Collector

6.2.22.24 OpenFlow Controller

Default Address:	0.0.0.0
Description:	OpenFlow is a protocol used in Software Defined Networks for communication between a network device and a controller server. The controller server then determines which packets flow between the terrestrial network and over satellite. The controller address, which should be on the M&C subnet, is entered here. OpenFlow 1.0 is supported.

Table 6-49 OpenFlow Collector

6.2.22.25 Enable VLAN filtering / VLAN ID

This control is used exclusively for mesh mode operation. See separate document: *AN_057 P2MP Mesh Network Routing Mode Configuration Notes* available from technical support.

6.2.22.26 Remote to Remote Comms

This is an On/Off control that controls whether traffic received from a remote modem is retransmitted over satellite to the other remote modems. By supporting double satellite hops, this enables remote-to-remote communications. Care should be taken with this mode because recirculating packets in this way could confuse intelligent ethernet switches in the system by giving the appearance that the location of the remote modem has changed, causing switches to reconfigure themselves incorrectly.

6.2.23 Edit->IP->Static Routes Screen

The *Edit->IP->Static Routes* screen, shown in **Figure 6-45,** allows up to 16 static routes to be added.

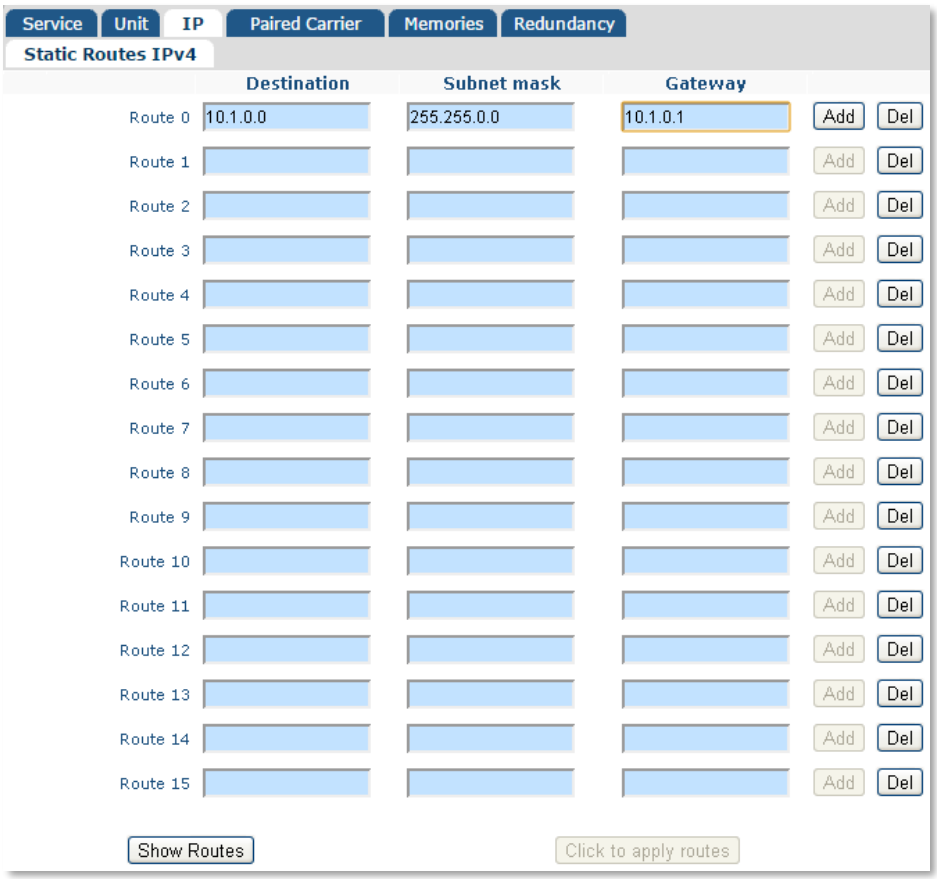


Figure 6-45 Edit->IP->Static Routes Screen

Each route consists of a destination IP address, subnet mask and a gateway address.

The *Add* button must be selected in order to enable each route.

The *Del* button is used to delete individual routes.

The *Click to apply routes* button must be selected to apply the static routes before navigating away from the web page.

The *Show Routes* button can be used to display the underlying operating system 'route add' commands applied to the TCP/IP stack, thereby providing confirmation of the active static routes.

6.2.24 Edit->Paired Carrier Screen

If **Paired Carrier** is an enabled feature, you will see the **Paired Carrier** tab where the hub cancellation settings can be configured.

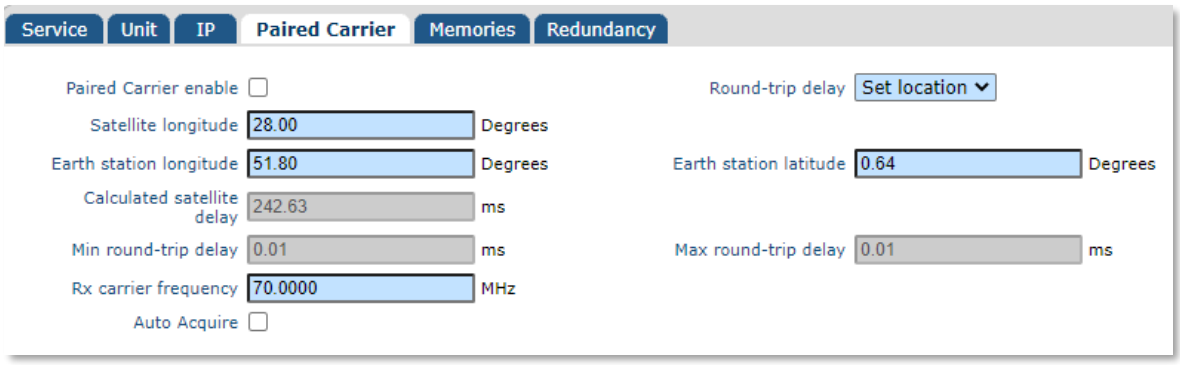


Figure 6-46 Edit->Paired Carrier Screen

6.2.24.1 Paired Carrier Enable

This is an On/Off control to enable the cancellation of the outbound carrier, so that the receive carriers can be obtained. Typically, this control will not be enabled until Paired Carrier has been correctly configured.

6.2.24.2 Round-trip Delay

The modem needs to know the delay to the satellite in order for Paired Carrier to work. The following table shows the supported methods of delay entry.

Set location	The modem automatically calculates the satellite round trip delay using the decimal latitude / longitude coordinates that are entered for the modem location and the satellite longitude.
Set delay	This mode uses user-entered minimum and maximum satellite round-trip delay times and searches for the actual satellite delay between the limits. The size of the delay window directly affects the carrier acquisition time and should be reduced to +/-0.5ms around the actual measured satellite delay (as shown on the *Status* screen) once this has been established following Paired Carrier achieving lock.
Use GPS	This mode allows mobile Paired Carrier operation (for example, on ships) without ever having to change location or satellite delay information for Paired Carrier. Any change in location will not affect Paired Carrier operation. A GPS source must be attached to the modem via the modem's remote serial control port, which will be automatically configured for RS232 at 4800 baud. The modem polls the serial port regularly for GPS position information. Two GPS protocols are supported, namely, GPS Fix Data (GGA) and Geographic position Latitude/Longitude (GLL). The modem will use whichever is provided. It uses the GPS information to calculate the minimum and maximum delays to satellite and updates these if they need to change from their existing values.

Table 6-50 Paired Carrier Round-Trip Delay

6.2.24.3 Satellite Longitude

Range	-180 Degrees to +180 Degrees; step size: 0.01 Degrees
Description:	The longitudinal position of the satellite. A positive number indicates East and a minus sign can be used to indicate West. If using the modem front panel then the *Up* and *Down* arrow keys are used for setting '+' and '-', respectively.

Table 6-51 Satellite Longitude

6.2.24.4 Earth Station Longitude

Range	-180 Degrees to +180 Degrees; step size: 0.01 Degrees
Description:	The longitudinal position corresponding to the modem location. A positive number indicates East and a minus sign can be used to indicate West. If using the modem front panel then the *Up* and *Down* arrow keys are used for setting '+' and '-', respectively.

Table 6-52 Earth Station Longitude

6.2.24.5 Earth Station Latitude

Range	-90 Degrees to +90 Degrees; step size: 0.01 Degrees
Description:	The latitudinal position corresponding to the modem location. A positive number indicates North and a minus sign can be used to indicate South of the equator. If using the modem front panel then the *Up* and *Down* arrow keys are used for setting '+' and '-', respectively.

Table 6-53 Earth Station Latitude

6.2.24.6 Calculated Satellite Delay

This is a display of the calculated satellite delay for reference purposes. This field cannot be edited.

6.2.24.7 Minimum Round-trip Delay

Range	0.01ms to 300ms ; step size: 0.01ms
Description:	When manually entering the delay using the 'Set Delay' for the *Round-trip delay* setting, then this is the minimum satellite round-trip delay. **Note:** To minimize the **Paired Carrier** acquisition time over satellite, set this to the actual measured satellite delay value (shown on the *Status* screen) **minus 0.5ms**. If using **Paired Carrier** on in a local bench test setting, (i.e. no satellite delay) then 0.01ms can use used.

Table 6-54 Minimum Round-trip Delay

6.2.24.8 Maximum Round-trip Delay

Range	0.01ms to 300ms ; step size: 0.01ms
Description:	When manually entering the delay using the 'Set Delay' for the *Round-trip delay* setting, then this is the maximum satellite round-trip delay. **Note:** To minimize the **Paired Carrier** acquisition time over satellite, set this to the actual measured satellite delay value (shown on the *Status* screen) **plus 0.5ms**. If using **Paired Carrier** on in a local bench test setting, (i.e. no satellite delay) then 0.05ms can use used.

Table 6-55 Maximum Round-trip Delay

6.2.24.9 Rx carrier frequency

Range	IF: 50MHz to 180MHz; Step: 0.0001 MHz (100Hz) L-Band: 950MHz to 2450MHz; Step: 0.0001 (100Hz)
Description:	This is the frequency used to cancel out the 'echo' of the outgoing carrier. Ascertain the centre frequency of the returned echo and enter this in the Rx Carrier Frequency field. The carriers overlap on satellite, so the returned echo centre frequency may be different to the configured Modem Tx frequency.

Table 6-56 Maximum Round-trip Delay

6.2.24.10 Auto Acquire

In addition to the Round-trip delay entries covered above, there is a fourth method, where the hub cancellation is set to `Auto Acquire`. Once enabled a large sweep window is used to find the round-trip delay for the looped satellite communications path, without any user involvement. Auto-acquisition may take a few minutes longer compared to the above methods where a narrower delay sweep range is defined. When `Auto-Acquire` is selected, the other delay methods will get greyed out. Once the round-trip delay has been determined (see *Status* screen for lock status), this value can then be used to manually enter using the 'Set Delay' method above. It is not advisable to use 'Auto Acquire' permanently and it's intended use is only for establishing a delay value.

6.2.25 Edit->Memories Screen

The *Edit->Memories* screens shown in this section allow the user to store and recall modem configurations (referred to as configuration memories). These can also be uploaded and downloaded to and from a PC or similar to allow configurations to be shared between different modems. Using the front panel will allow configurations to be saved and uploaded via a USB drive (see section 6.3 for details).

The following operations can be performed on configuration memories via the web interface:

- *Store.* This allows the current modem configuration to be stored to a named configuration memory for later use. The memories are non-volatile and will persist between successive power-ups of the modem. The maximum number of configurations that can be stored depends on available memory. Configuration memories can be assigned any desired name using the alphanumeric keypad.
- *Recall.* This allows a previously stored configuration to be selected and used in place of the current configuration.
- *Erase.* This allows configuration memories to be deleted.
- *Download.* This is used to download one or more configuration memories from the modem to a PC or equivalent.
- *Upload.* This is used to upload one or more configuration memories to the modem.

A default configuration memory called *LOAD_DEFAULTS* always exists. Recalling it will reset the modem to its factory defaults. When LOAD_DEFAULTS is recalled from the web user interface, then the modem's current M&C IP address, netmask, gateway, takeaway control, Modem ID and passwords are all retained, whereas when selected from the front panel these go back to their factory defaults. This is done in order not to lose remote control of the modem from the web user interface when using it. *LOAD_DEFAULTS* cannot be erased or overwritten.

Configuration memory names are restricted to alphanumeric characters.

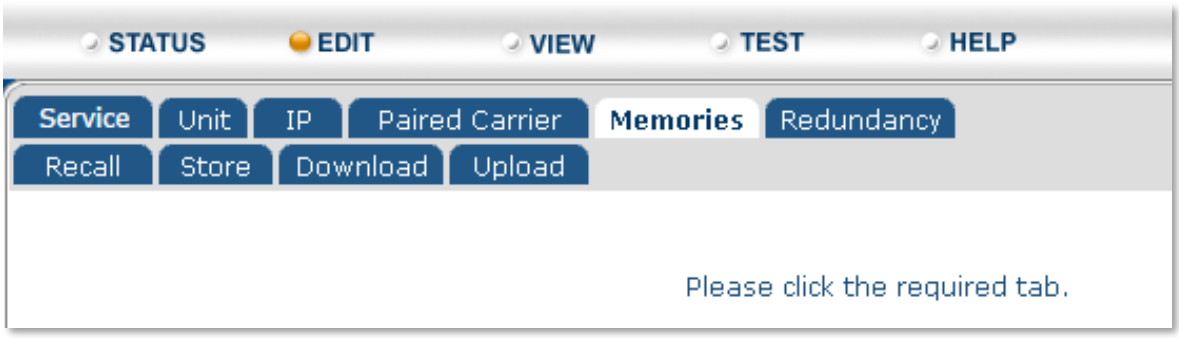


Figure 6-47 Edit->Memories Screen

6.2.25.1 Edit->Memories->Recall Screen

The *Edit->Memories->Recall* screen (shown in **Figure 6-48**) displays all of the configuration memories that are stored on the modem. A specific configuration memory can be made active by selecting the associated *Recall* button. The *Delete* button can be used to delete a configuration memory.

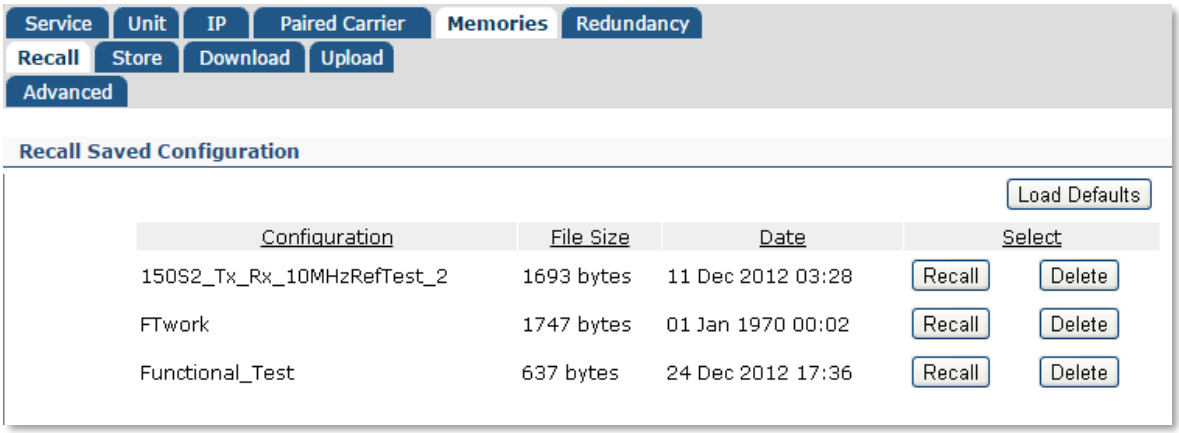


Figure 6-48 Edit->Memories->Recall Screen

6.2.25.2 Edit->Memories->Recall->Advanced Reversionary Control Screen

The *Edit->Memories->Recall->Advanced* screen (shown in **Figure 6-49**) supports a method for recovering a remote modem from a failure during a change to the modem's configuration. In essence, reversionary control works in a similar way to the Cisco Reload command, where a known trusted configuration is loaded after a defined timeout period in the event that the reload operation is not cancelled by the operator in a timely manner after completing the necessary configuration changes.

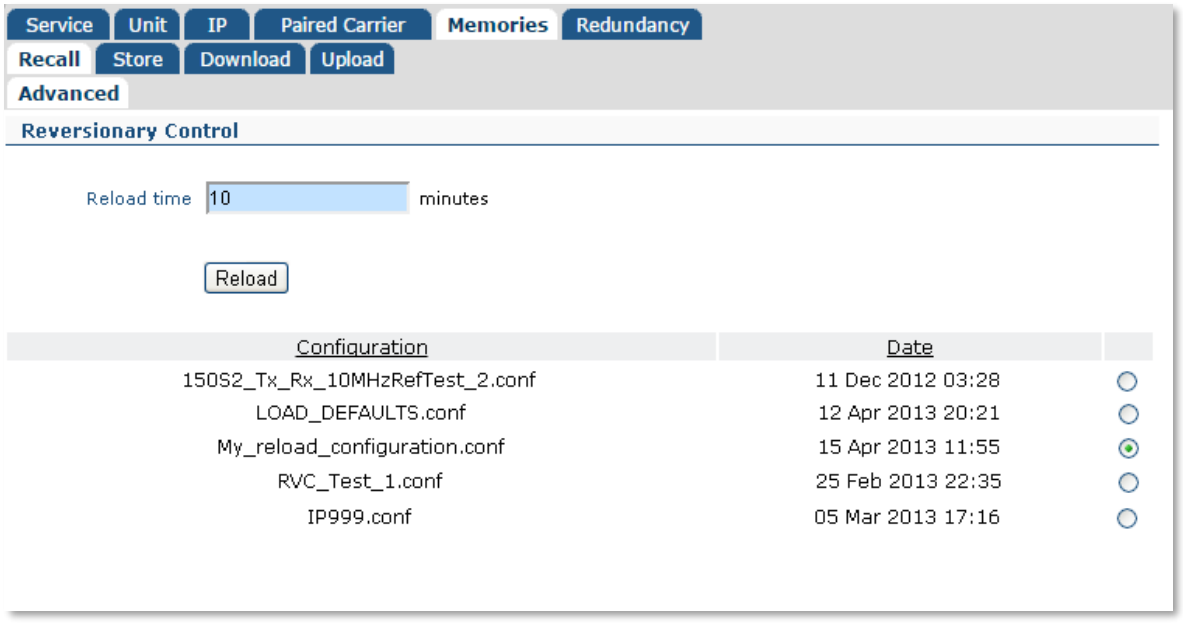


Figure 6-49 Edit->Memories->Advanced Reversionary Control Screen

The procedure for protecting and recovering a remote modem from failure during a configuration change is as follows.

1. Prepare in advance a configuration memory that represents a known 'safe' or default configuration for the remote modem. This is the configuration that will be recalled should a manual reconfiguration of the remote modem result in a loss of communications with the modem. Ensure that this configuration memory is stored on the remote modem.
2. Immediately, prior to making any manual change to the remote modem, navigate to its *Edit->Memories->Recall->Advanced* screen and select the radio button corresponding to the configuration memory to be reloaded in the event of a failure during the configuration process.
3. Set a reload time. This is the period of time in minutes that the operator has to make all the necessary configuration changes to the remote modem. It represents a timeout period after which the modem will automatically reload the selected configuration memory, unless the operator intervenes to cancel the timeout.
4. Click on the *Reload* button to start the timeout period, at which point the screen will change to that shown in **Figure 6-50**, which shows the remaining timeout period along with the name of the configuration memory that will be reloaded. In addition, the *Reload* button changes to a *Cancel* button.
5. Make any necessary changes to the remote modem's configuration.
6. After completing the configuration changes, navigate back to the *Edit->Memories->Recall->Advanced* screen and cancel the timeout by clicking on the *Cancel* button. The screen will now revert to its original format shown in **Figure 6-49**.

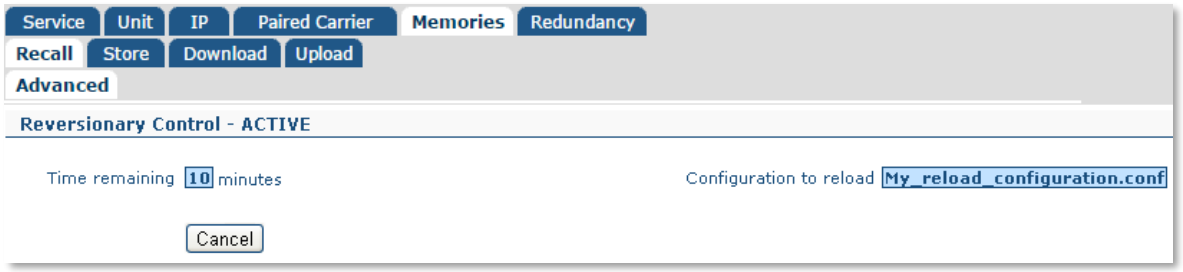


Figure 6-50 Edit->Memories->Advanced Reversionary Control Screen (Active state)

6.2.25.3 Edit->Memories->Store Screen

The *Edit->Memories->Store* screen (shown in **Figure 6-51**) allows the current modem configuration to be stored to a configuration memory under a given name. It also displays all the configurations that are already stored on the modem. The *Delete* button can be used to delete a specific configuration memory. The *Save as* button will overwrite the stored configuration with the current configuration.

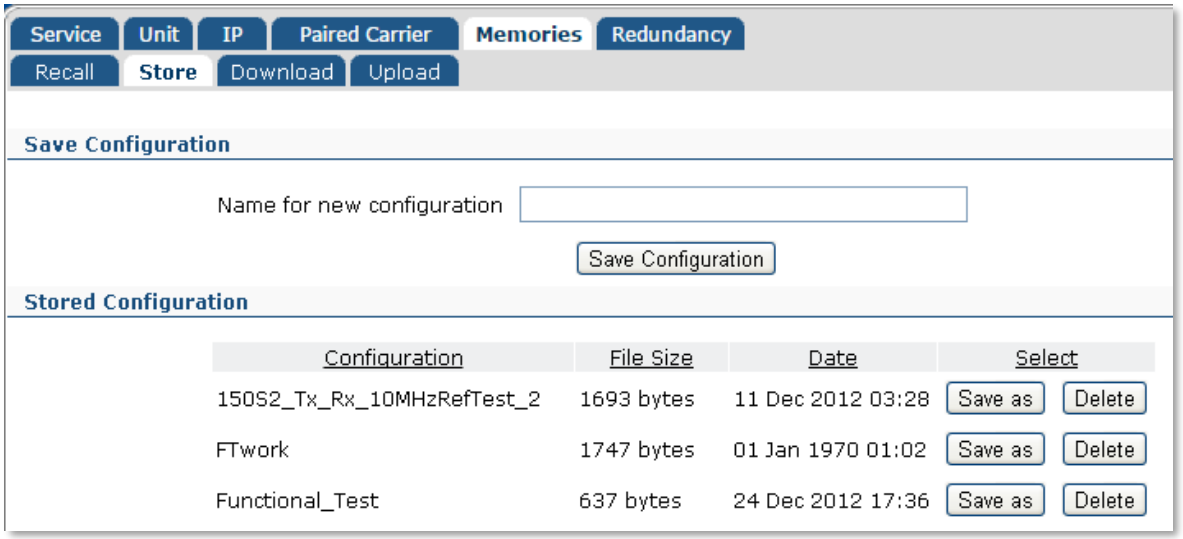


Figure 6-51 Edit->Memories->Store Screen

6.2.25.4 Edit->Memories->Download Screen

The *Edit->Memories->Download* screen (shown in **Figure 6-52**) displays all of the configuration memories that are stored on the modem and can be used to download one or all of the configurations from the modem to the user's browser device (such as a PC). The *Download All* button will download all files as a tar.gz file.

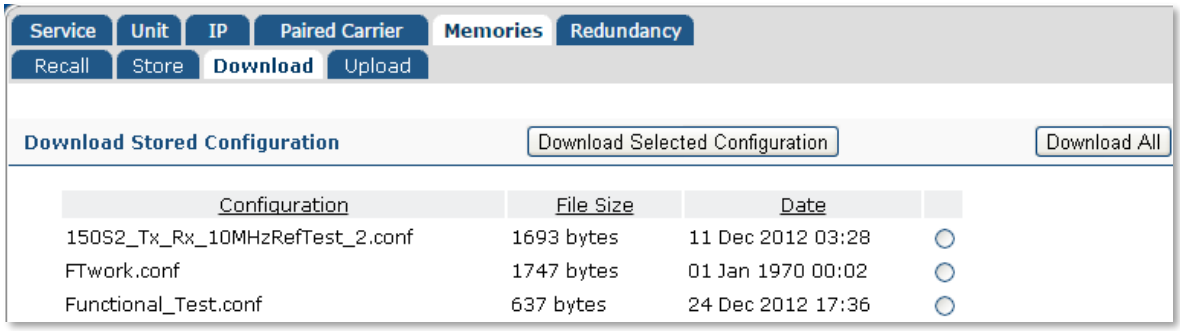


Figure 6-52 Edit->Memories->Download Screen

6.2.25.5 Edit->Memories->Upload Screen

The *Edit->Memories->Upload* screen (shown in **Figure 6-53**) allows the user to browse to a location on their file system where they have a configuration memory file that they want to upload to the modem. After selecting the file, selecting the *Upload Saved Configuration* button causes the configuration to be transferred to the modem. Once uploaded, it can then be recalled in the recall tab.

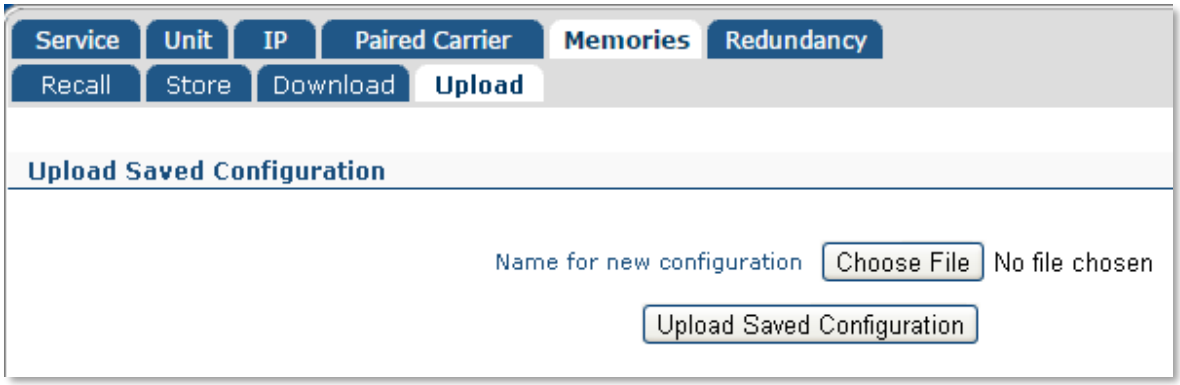


Figure 6-53 Edit->Memories->Upload Screen

6.2.26 Edit->Redundancy Screen

The *Edit->Redundancy->1-for-1* screen (shown in **Figure 6-54**) controls the operation of the modem when in a 1:1 redundancy configuration.

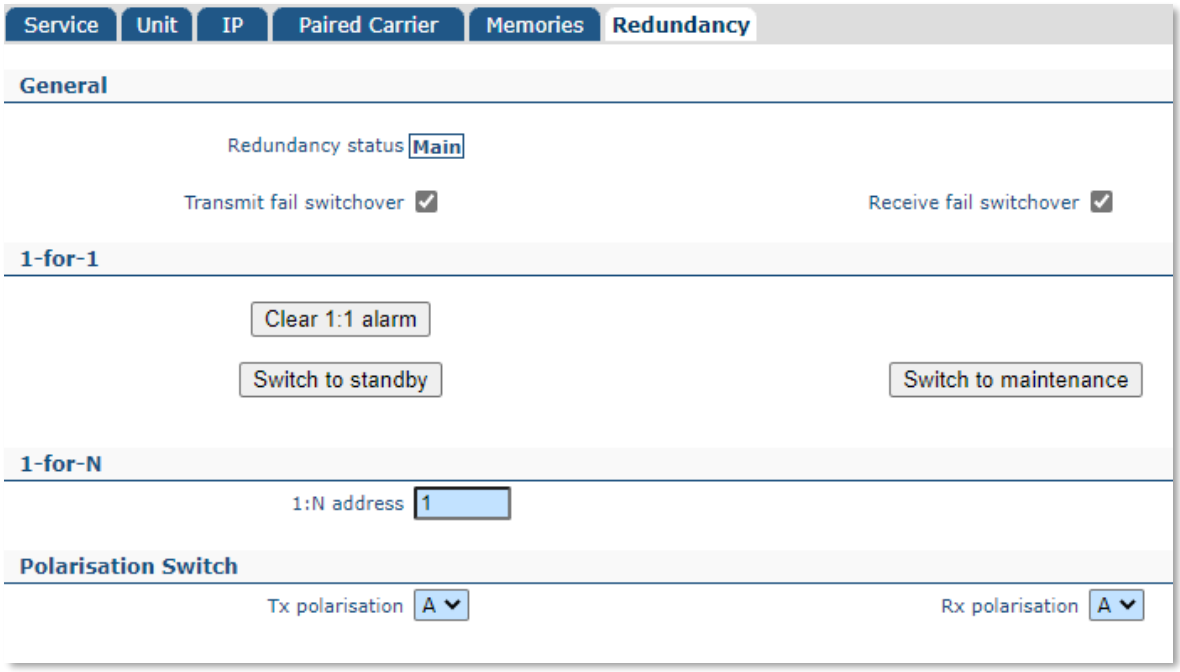


Figure 6-54 Edit->Redundancy->1-for-1 Screen

The *Redundancy status* shows the 1:1 status of the modem. This will be shown as *Main* when the modem is online, *Maintenance* when the modem has been taken out of service, and *Standby* when the modem is offline, ready to switch over on a fault occurring on the online modem.

Transmit fail switchover controls whether a switchover occurs on a transmit alarm. Likewise *Receive fail switchover* controls whether a switchover occurs on a receive alarm. Checking a checkbox activates the switchover logic, putting it in a state where the modem will switch over when a relevant transmit or receive alarm occurs.

If both transmit and receive fail switchovers are set to 'Off' then the 1:1 redundancy system will only switch over on unit faults and all transmit or receive traffic faults will be ignored.

Traffic warnings will never cause a switchover regardless of how the fail switchover settings are configured.

In a 1:1 pair, the *Clear 1:1 alarm* button can be used on the *Standby* modem, when it is exhibiting a fault, to temporarily suppress the fault condition in order to allow the *Standby* modem to be forced online. This is useful when both modems in the 1:1 pair are showing faults, but the *Standby* modem is exhibiting a less severe failure than the current online modem, thereby allowing the best possible satellite service to be maintained in the circumstances.

In a 1:1 pair, the *Switch to standby* button forces the modem that is online into *Standby* mode. This is done by momentarily creating a fault condition that forces a switchover to occur.

The *Switch to maintenance* button prevents the modem from being switched online. This facilitates the modem being removed, for example, to be repaired or upgraded.

Once the modem is in *Maintenance* mode, the *Switch to maintenance* button is replaced with a *Switch to service* button, which can be used to reverse the process by making the modem available to come online.

The 1-for-N address and Polarisation Switch options are used in 1 for N systems and are covered in the Q-NET™ PDQS Redundancy Switch Installation and Operating Handbook available at www.ParadiseData.com

6.2.26.1 Edit->Redundancy Screen – Geographical Redundancy

If the Geo Redundancy option is activated in the modem, the Redundancy Screen will look like the following (default settings shown).

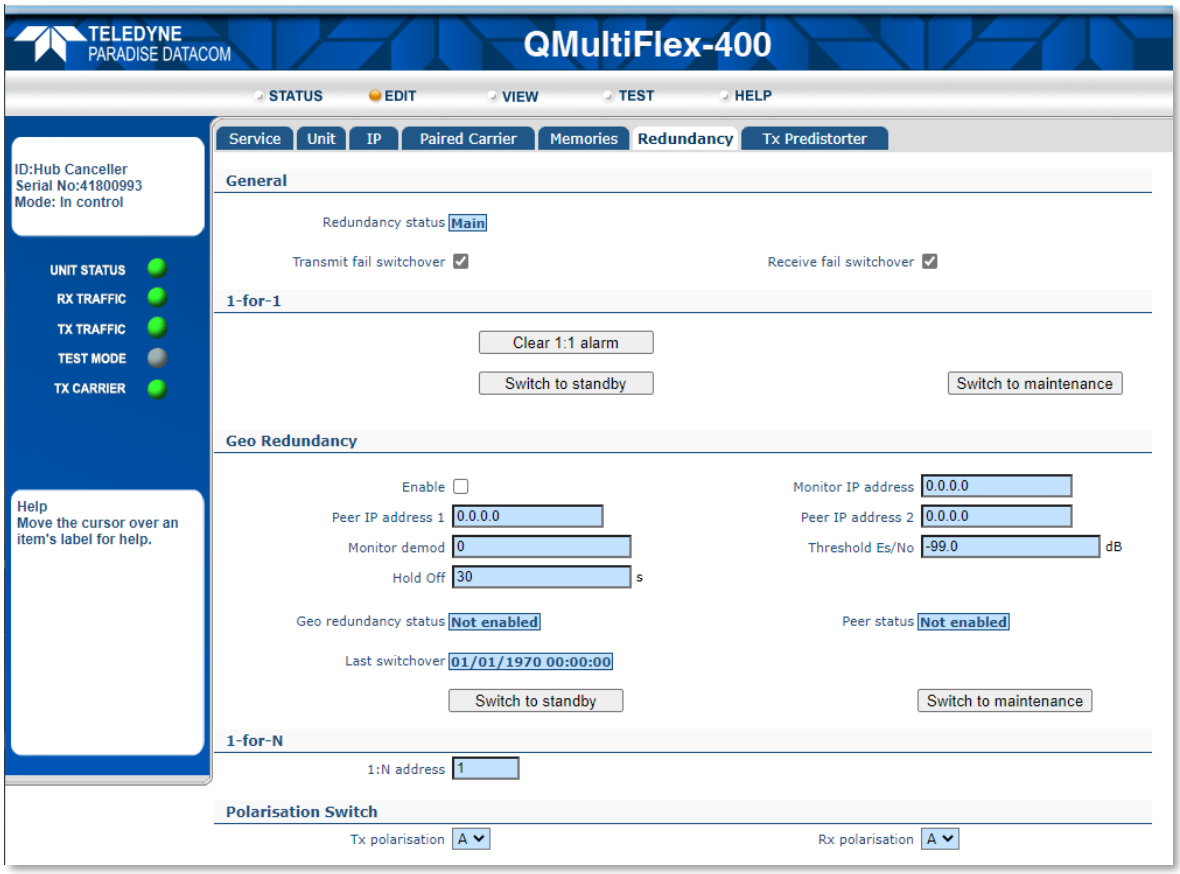


Figure 6-55 Redundancy Screen – with Geo Redundancy Option

Monitor IP address: IP address of a very high availability device, preferably located at the NOC e.g. HSRP or VRRP address of a redundant switch pair. If pings to this IP address fail, a Geo switchover will occur.

Peer IP address 1: This should be the M&C IP address of the first peer modem at the other geo site.

Peer IP address 2: This should be the M&C IP address of the second peer modem at the other geo site. If there is only one modem, leave set to 0.0.0.0

Monitor demod: Defines which demodulator will be used to detect if the hub outbound carrier has a problem. Since monitoring a demod is a mandatory requirement for Geo Redundancy to work, it is worth noting that a single demod is limited to 40Msps, thus this limits the out-bound carrier to 40Msps.
NB: The packet output of this demodulator is always disabled, so that a loop is not formed. This setting must be '0' when not using Geo Redundancy.

Threshold Es/No: Optionally set, if it is desired to switchover if the Es/No falls below this threshold. If not required, set to -99dB.

Hold Off: Timer to limit the changeover rate. Timer starts when any change-over occurs and prevents another changeover until it has expired.

The *Geo redundancy status* shows the geo redundancy status of the modem. This will be shown as *Main* when the modem is online, *Masked* when the modem has been taken out of service, and *Standby* when the modem is offline, ready to switch over on a fault occurring with the online modem. If not enabled, it will show *Not enabled.*

Peer status: Displays 'OK' if the peer can be switched to, or 'Not ready' if in the peer modem is in Maintenance mode or the Hold-off timer is running or a fault condition exists that prevents the peer from becoming active.

Last Switchover: Date and time stamp from modem RTC when last switchover occurred.

Switch to standby: If this modem is *Geo Main,* pressing this button will cause the modem to go to *Geo standby* unless the other modem is indicating a fault. Asserts fail signal in IP messages for 5 seconds.

Switch to maintenance: Holds this modem permanently in Geo standby by permanently asserting fail signal. Maintenance mode can be cancelled by pressing button to '*Switch to service'.* NB: Do not switch to 1:1 maintenance mode afterwards, as it will cause a 1:1 switchover and the newly active modem will not be in Geo maintenance.

Enable: Once all parameters are entered in both modems – enable Geo Redundancy to activate. See 'Start-up Condition' below.

Figure 6-56 Redundancy Screen – Example Settings

See Section 8.5 for system level details.

6.2.27 View Screen

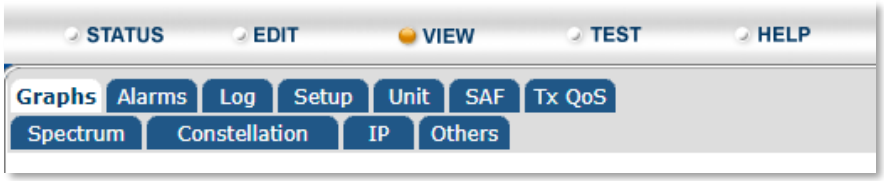


Figure 6-57 View Screen

The *View* screen allows the following to be viewed:

- *Graphs*. These include spectrum, constellation, IP throughput and time-based performance graphs. None of these interfere with the service being provided by the modem. Note that when viewing demodulator graphs, such as the constellation or spectrum, it is necessary to select the specific demodulator to be viewed. Graphs of Tx QoS stream throughput over time are also available and include the stream data rate (in packets per second and bits per second), the number of dropped packets and a count of the errored packets.
- *Alarms*. System alarms and warnings can be viewed.
- *Log*. The system log can be viewed and optionally emptied. The log contains information on all alarms and other notable events. The log contains space for thousands of entries. The oldest entries are deleted when space is required for new entries.
- *Setup*. This provides a succinct summary of the operational setup of the modem.
- *Unit*. This provides manufacturing information (including the software version number and the hardware fitted), power supply voltage levels, modem temperature indication, loopback status and the IP address of the M&C port (for when this has been set using DHCP).
- *SAF*. This displays all of the SAF features for the modem, indicating whether they are enabled or disabled. It also shows how many test shots remain along with the remaining test time. Information on temporary SAF (such as any temporary licenses) is also available.
- *Tx QoS*. This presents metrics for the shared outbound carrier in terms of total throughput and per-stream throughput, including dropped packet counts and current stream data rates (in packets per second and bits per second).

6.2.27.1 View->Graphs->Spectrum; Rx Spectrum Monitor

The Rx Spectrum Monitor shown in **Figure 6-58** is a powerful real-time spectrum analyser within the modem that is used to view the received signal spectrum.

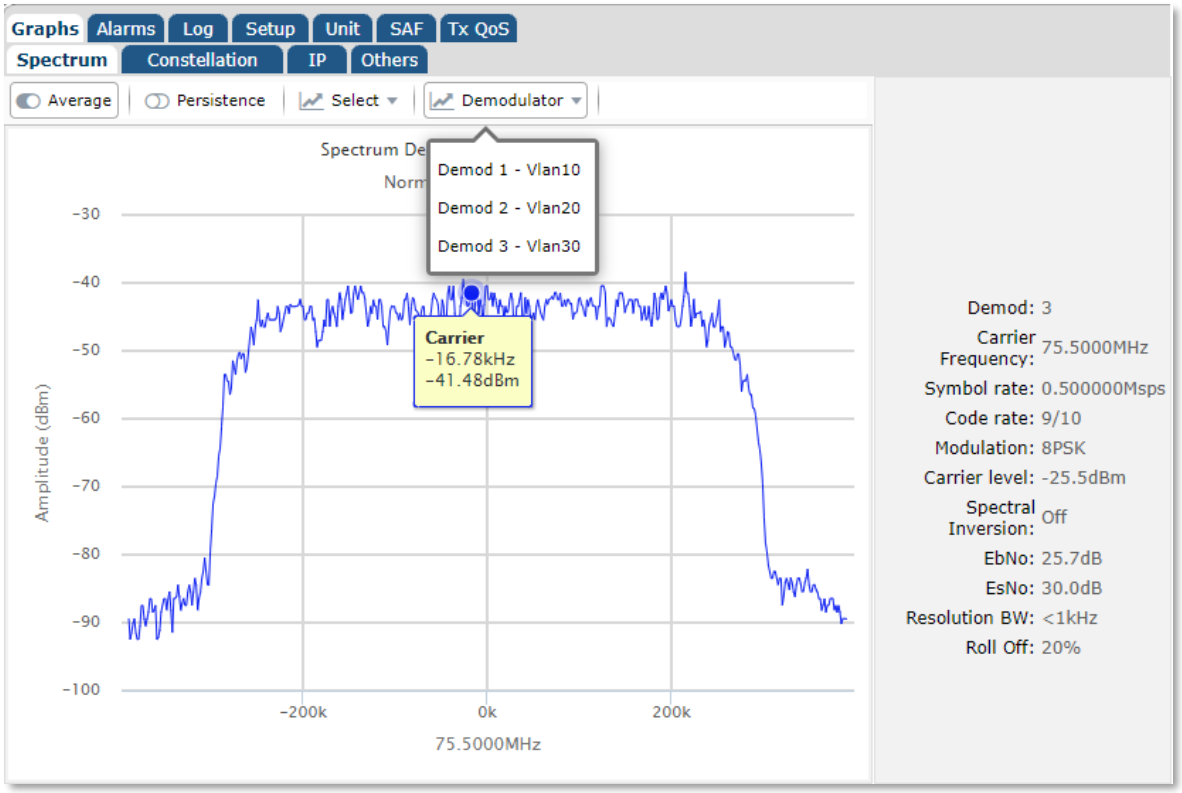


Figure 6-58 Rx Spectrum Monitor

The Rx Spectrum Monitor can be used to check for correct modem operation.

Each demodulator can be viewed individually or a wideband (*Super Wide*) mode can be selected that shows a 72MHz span of the transponder centred on the inbound carrier centre frequency (subject to the position of the carrier within the 72MHz span of the modem receiver front end).

Setting the *Span* to *Normal* limits the frequency span to that of the carrier.

A zoom control can be activated by moving the mouse over an area of the graph while the mouse button is simultaneously held down. A 'Reset zoom' button appears and can be used to revert to the normal display resolution.

The mouse right click operation can be used to save the spectrum to a file.

Persistence leaves the spectrum to build up over time and is useful for identifying transient signals such as intermittent interference. The *Persistence* button is an on/off toggle.

Average increases the number of samples that are used in forming the displayed spectrum. The *Average* button is an on/off toggle.

6.2.27.2 View->Graphs->Constellation; Rx Constellation Monitor

The Rx Constellation Monitor feature shown in **Figure 6-59** allows the modem to be used as an oscilloscope in X/Y mode to view the constellation.

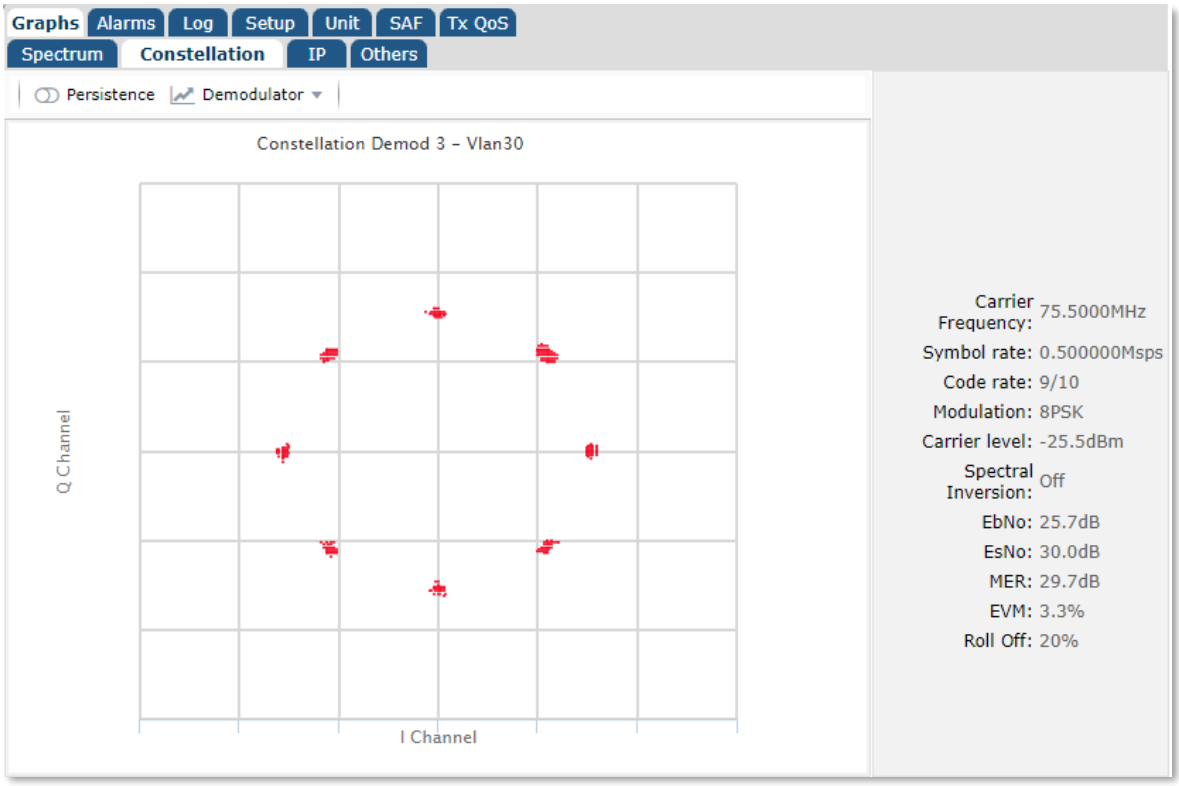


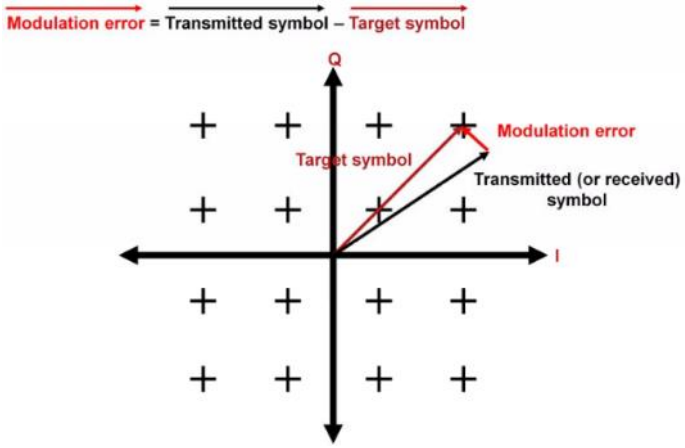
Figure 6-59 Rx Constellation Monitor

The Rx Constellation Monitor can be used to check for correct modem operation including checking for signal distortion and phase noise. The persistence mode is useful for showing any long-term effects due to phase noise and interference. Excessive phase noise can cause cycle skips, seen as unwanted rotations within the constellation.

Note that MER and EVM figures are available on the panel on the right-hand side. These concepts are explained in the following information.

Modulation Error Ratio (MER) and Error Vector Magnitude (EVM)

MER and EVM (as displayed on the Rx Constellation Monitor) measure how imperfect the received signal is in relation to an ideal signal as in the following example.



They are defined as follows:

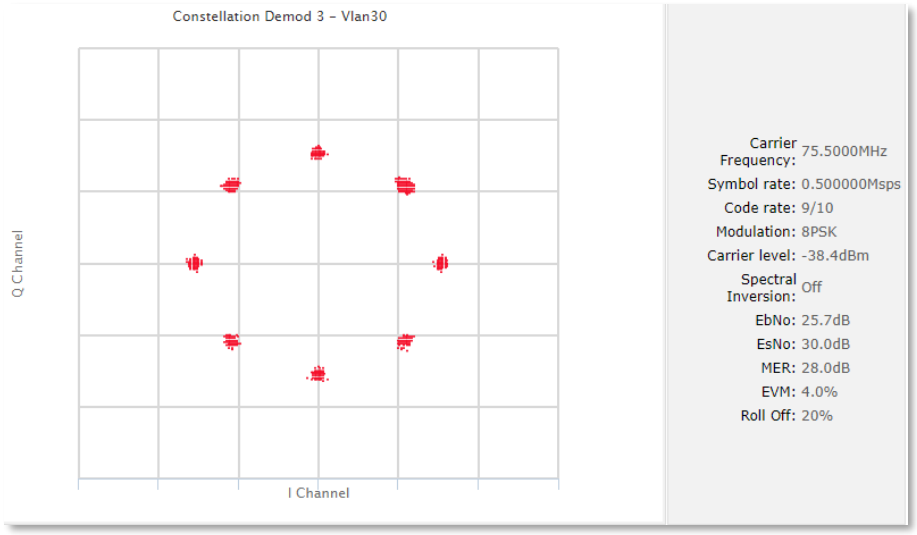
- *MER (dB) =*
  $$\frac{\text{Power of ideal signal}}{\text{Power of error signal}}$$
- *EVM (%) =*
  $$\frac{\text{Power of error signal}}{\text{Power of ideal signal}}$$

A high MER and low EVM indicate a good signal, whereas a low MER and a high EVM indicate a poor quality signal.

Why are MER and EVM important? Unless you run a BER test then you do not know what the actual BER for the link is. A 'good' Es/No can be misleading since there could be degradation from interference. Modern FECs have steep BER curves, so the difference between quasi-error free (QEF) operation and losing the link can be very small. MER and EVM give an indication of how close to the 'cliff edge' the link is and may allow remedial action to be taken before the link is lost.

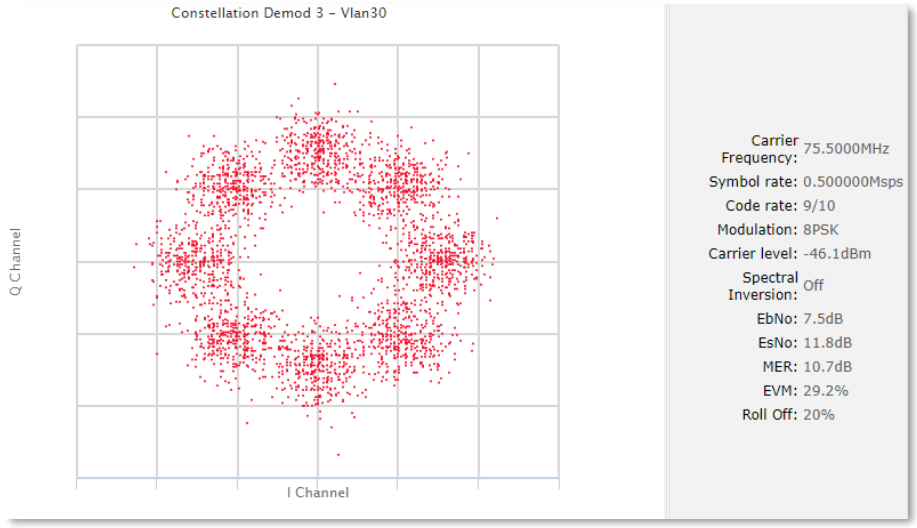
It is good practice when deploying a link to measure these two values when the link is running well. Then reduce the power level of the carrier(s) and establish the equivalent values just above the point at which the carrier unlocks. This will give a good indication of the range of potential values and can be used to establish an early warning when the link starts to degrade.

The following is an example of a good signal (no noise):



where MER=28.0dB and EVM=4.0%.

The following is an example of a worse signal (close to QEF limit):



where MER=10.7dB and EVM=29.2%.

6.2.27.3 View->Graphs->IP Graphs

Figure 6-60 shows an example of an IP throughput graph. IP graphs support the display of throughput (including errored and dropped packets) for transmit and receive in bits per second and packets per second for the terrestrial and satellite ports. The throughput can be viewed in real time and over one hour, 24 hours or 30 day time periods. The statistics for each demodulator can be viewed independently.

It is also possible to view the throughput associated with each individual traffic stream as classified by the traffic shaping feature.

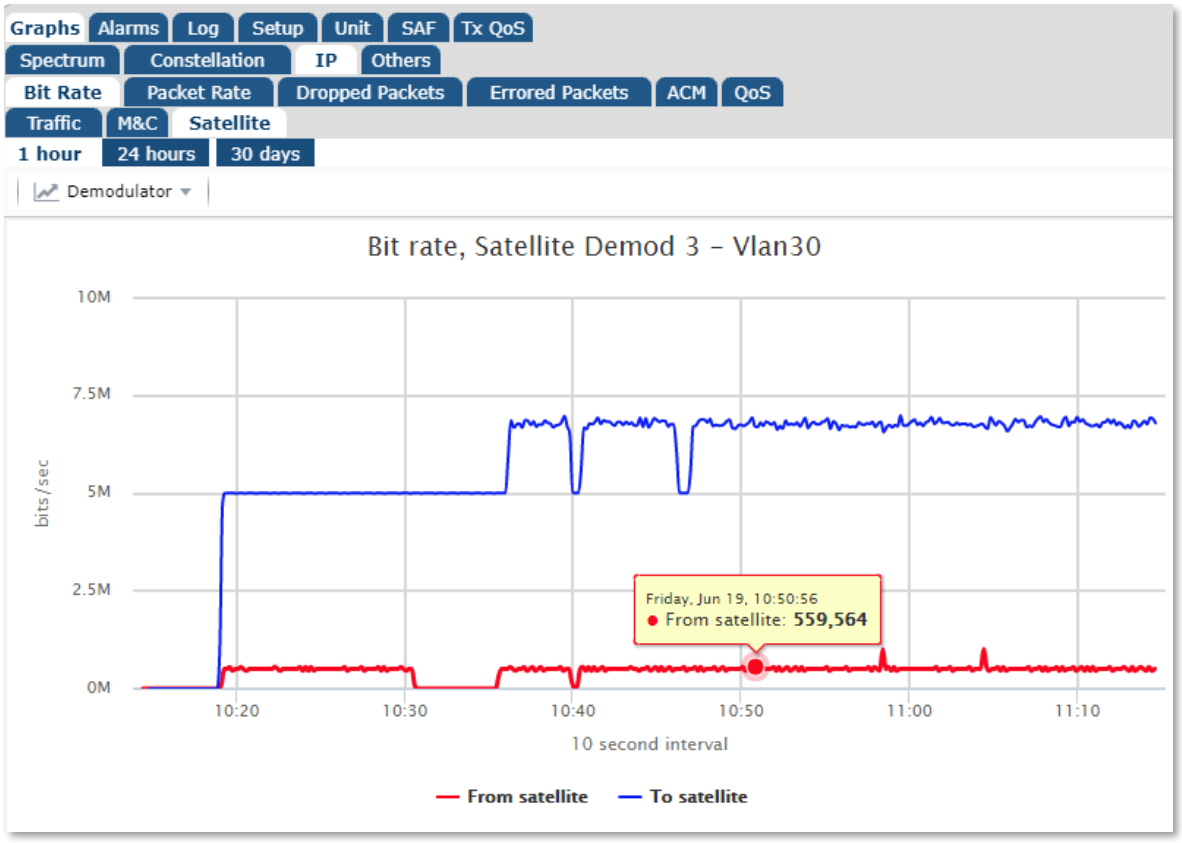


Figure 6-60 IP Throughput Graph – Satellite Traffic View

An example ACM graph is shown in **Figure 6-61**. This shows the minimum, average and maximum terrestrial data rate over the selected time period. Note that this graph shows how the terrestrial data rate varies over time in direct relation to dynamic changes of MODCOD based on a varying Es/No from the remote modem. It does not show actual IP throughput (which is available on the other IP throughput graphs). The ACM graph therefore shows the actual bandwidth available over time, which can be used to determine the benefit of using ACM, particularly when viewed over longer time periods where the effects of short-term fluctuations are removed.

By viewing the ACM graph over a long time period such as a month, an average available bandwidth figure is produced that can be factored into new or revised service level agreements that incorporate the benefits of ACM when compared to the nominal data rate of the link without ACM.

It is possible to put ACM into a monitor mode where the ACM graph logs what the terrestrial data rate would be for the prevailing conditions, without ever actually changing the MODCOD. This is useful for assessing the potential benefit of ACM on an existing link without disrupting the current service in any way, or for evaluating ACM in a representative test scenario prior to deployment.

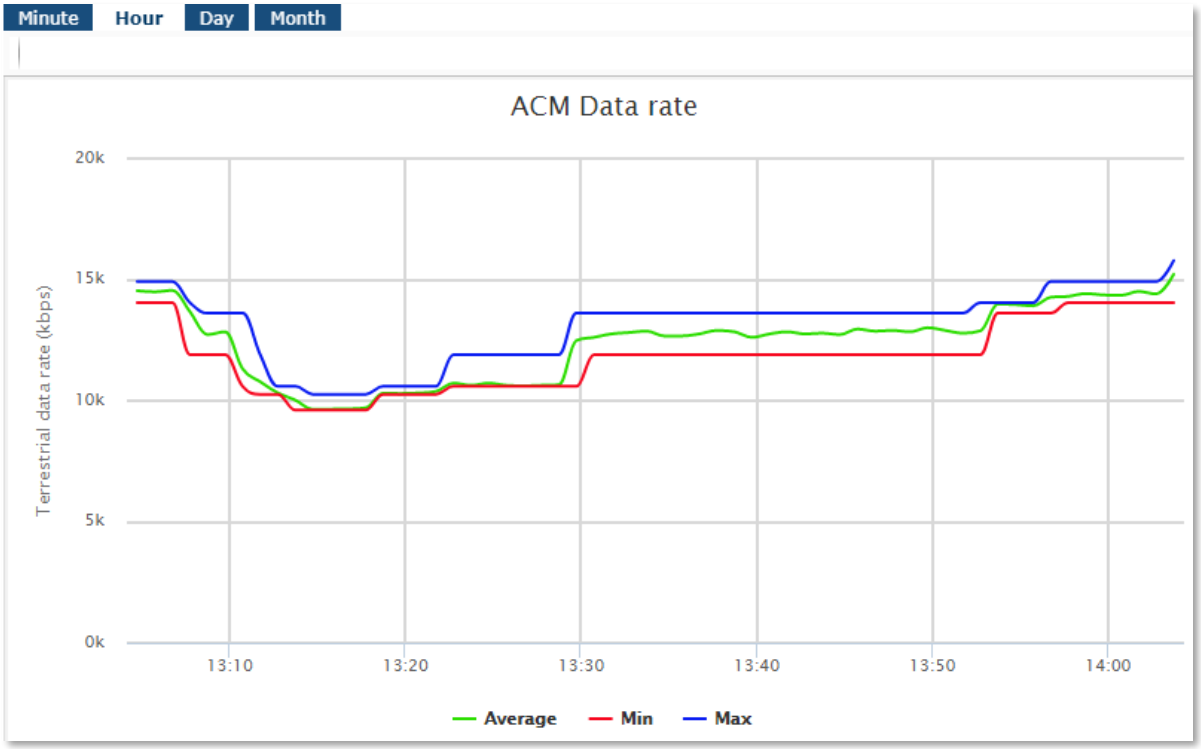


Figure 6-61 ACM Terrestrial Data Rate Graph

Other ACM graphs are available, such as the remote Es/No graph shown in **Figure 6-62,** which shows the worst remote Es/No that ACM was using to make MODCOD selections.

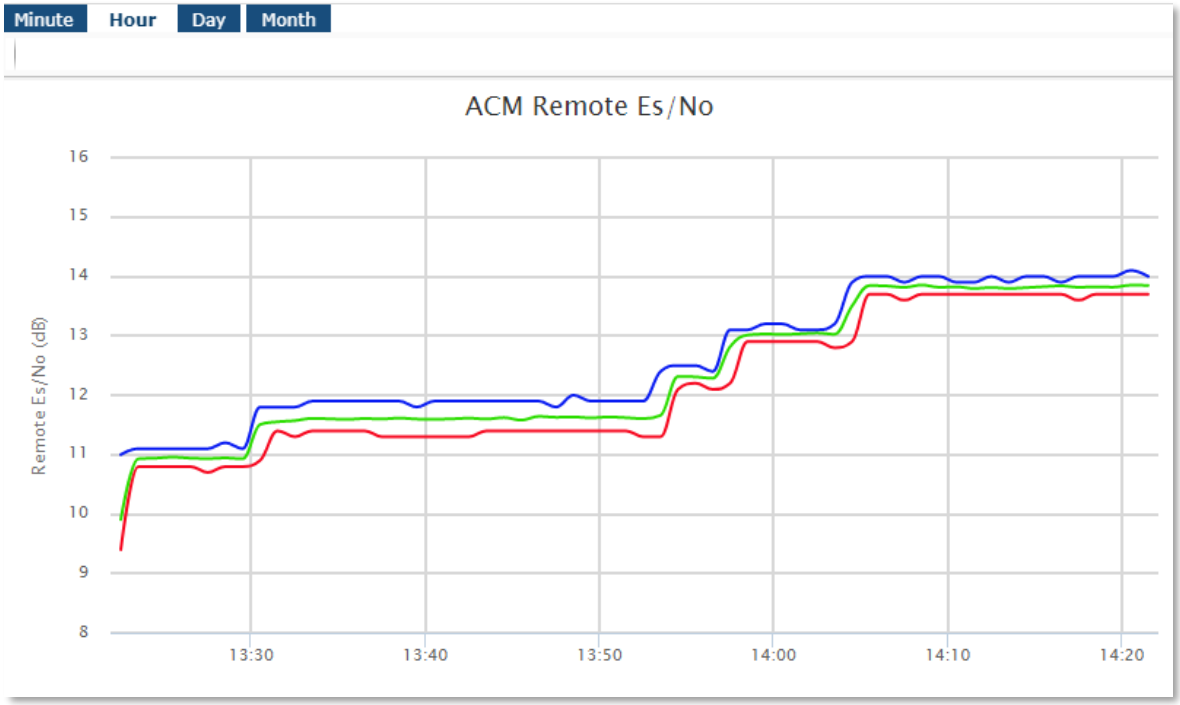


Figure 6-62 ACM Remote Es/No graph

The ACM utilisation graph shows in a percentage the link utilisation with ACM enabled. 100% would be the maximum data rate at the most efficient MODCOD that can be used on the link (the highest order MODCOD when ACM was enabled). This highest order MODCOD is normally gained through link budget analysis.

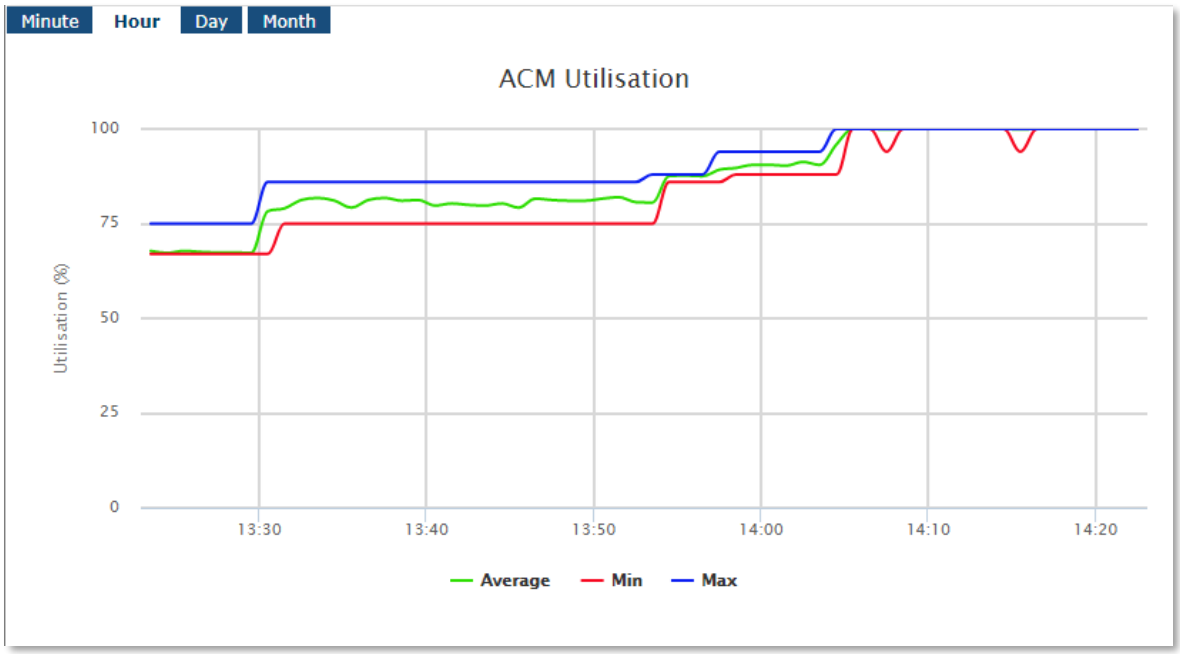


Figure 6-63 ACM Utilisation graph

Note: The ACM Availability graph is not applicable for the **QMultiFlex-400™** but is available in the remote modems to analyse the hub modems demodulator lock status.

6.2.27.4 View->Graphs->IP->QoS; Stream Graphs

Graphs of the Tx QoS stream throughputs over time are available (Bits per second). An example graph is shown in **Figure 6-64**. The individual QoS class can be selected from the drop down menu. The default graph is the 'default' class traffic.

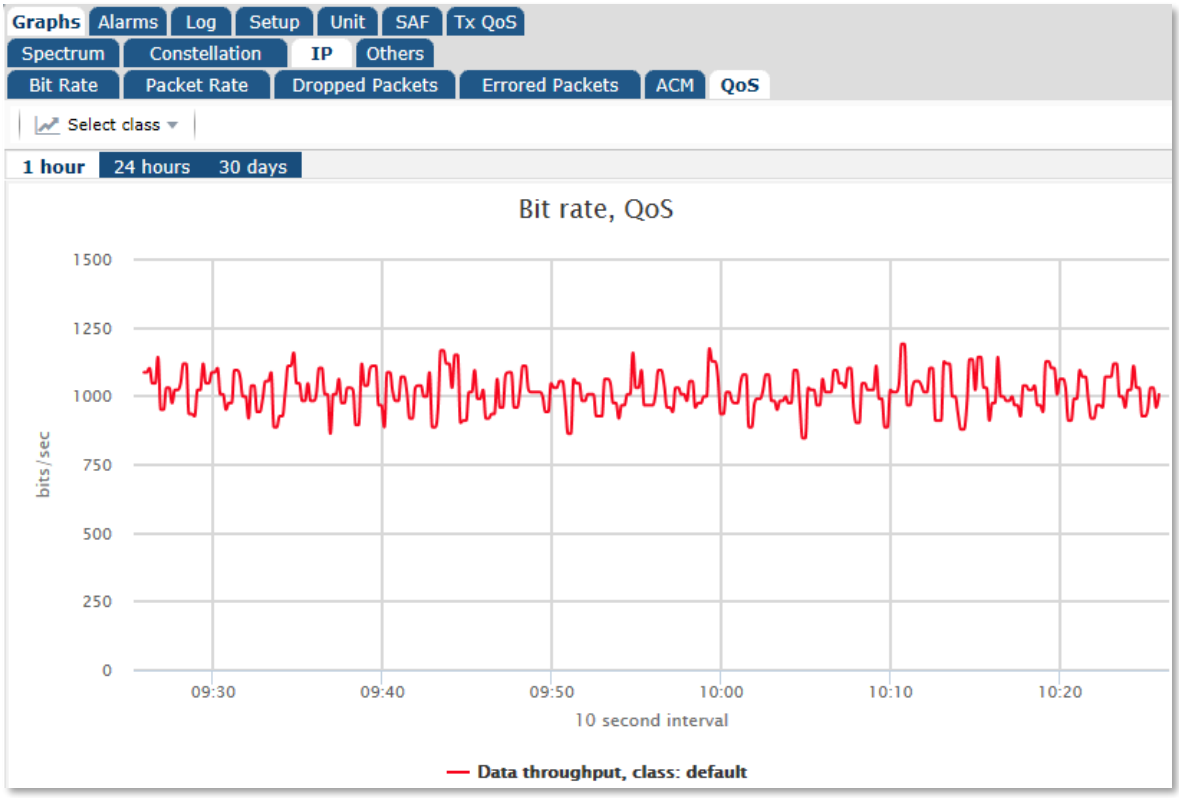


Figure 6-64 Tx QoS Stream Throughput Graph

6.2.27.5 View->Graphs->Others; Other Time-based Graphs

A number of time-based graphs can be displayed. Graphical values are stored for 31 calendar days or until the modem is powered down. The recording of all values occurs automatically at all times once the modem is powered on and is not dependent on whether the graphs are being viewed or not.

The web interface supports display of the following time-based graphs:

- Modem internal temperature.
- The modem received signal Eb/No or Es/No.
- The modem received power level.
- Receive frequency offset from centre frequency.

An example graph is shown in **Figure 6-65**.

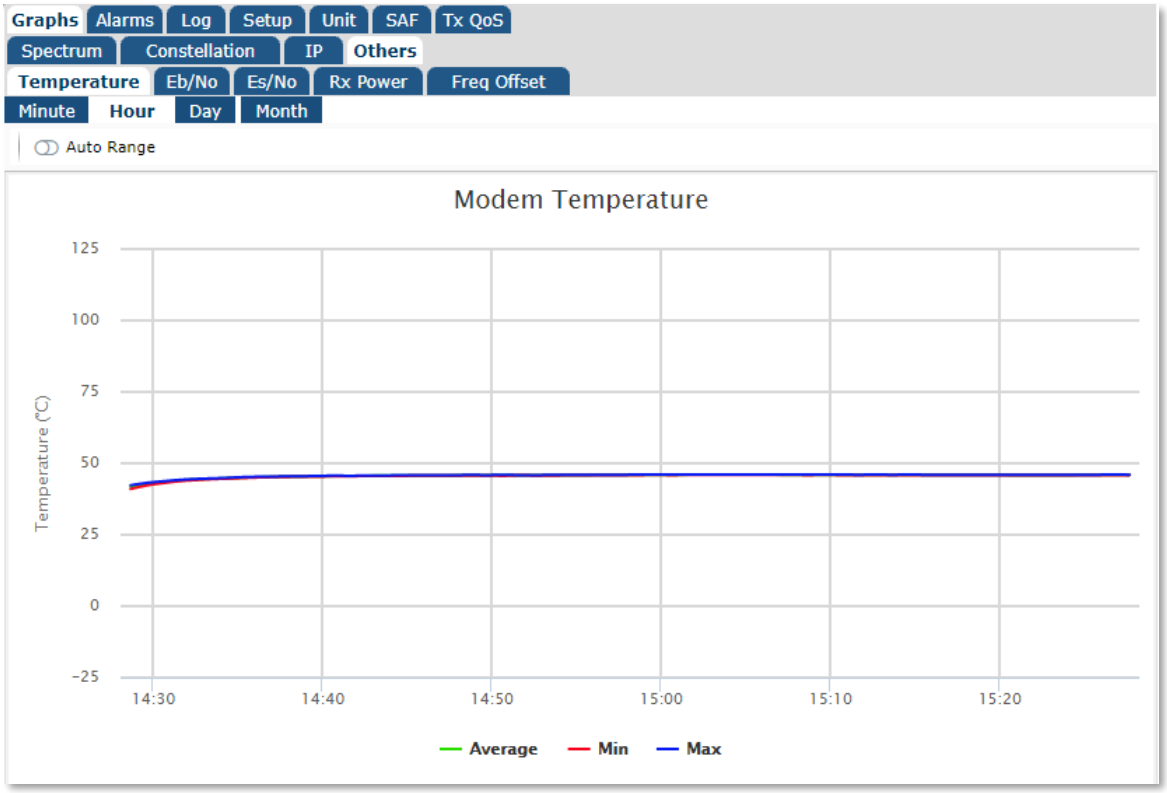


Figure 6-65 Temperature Graph – Hour Span

6.2.27.6 View->Alarms Screen

System alarms can be viewed using the *View->Alarms* screen shown in **Figure 6-66**. Alarms are latched and their status will be shown as *Off* if they are no longer active. The *Accept* button can be used to delete all the alarms after which the web page will automatically update and show details of any alarms that are still active.

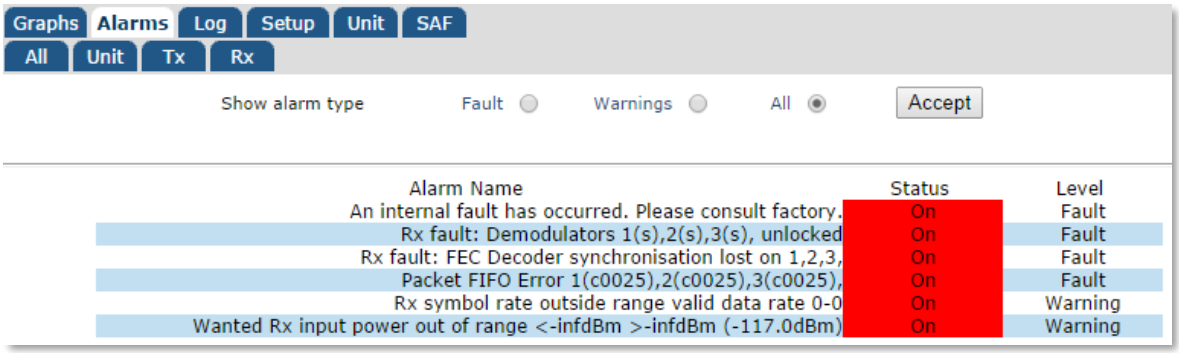


Figure 6-66 System Alarms Screen

6.2.27.7 View->System Log

The system log can be viewed using the *View->Log* screen shown in **Figure 6-67**. The *Clear* button can be used to delete all of the entries in the log. The *Download Log file* button can be used to download a text file of the log contents to the browser device.

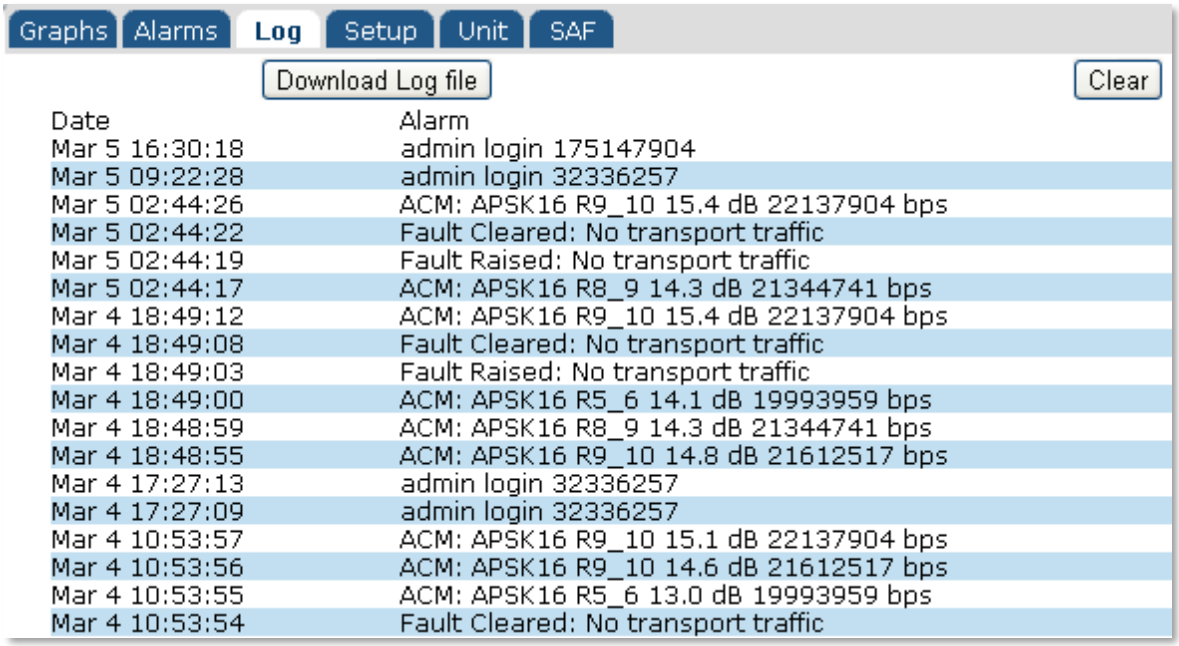


Figure 6-67 System Log Screen

6.2.27.8 View->Setup Screen

The *View->Setup* screen shown in **Figure 6-68** displays the current values of the most important configuration settings.

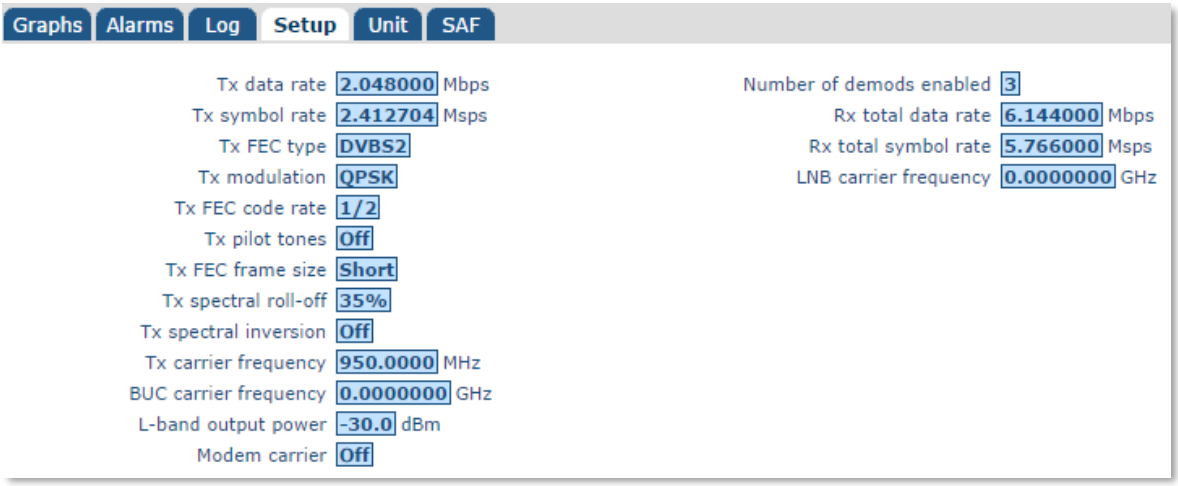


Figure 6-68 View->Setup Screen

6.2.27.9 View->Unit Screen

The *View->Unit* screen shown in **Figure 6-69** displays manufacturing information (including the software version number and the hardware fitted), power supply voltage levels, modem temperature indication, and the IP address of the M&C port, which can be useful if DHCP was used to acquire the address.

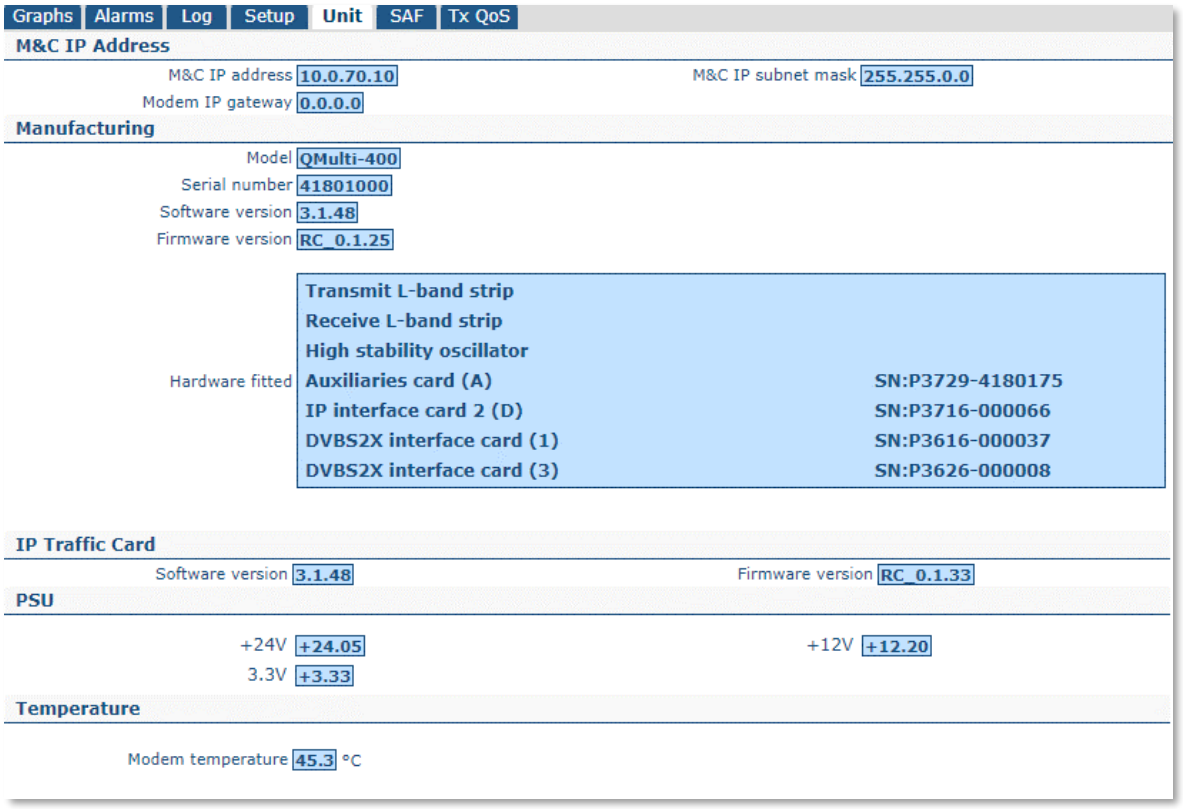


Figure 6-69 View->Unit Screen

6.2.27.10 View->SAF Screen

The *View->SAF* screen shown in **Figure 6-70** displays the status of each modem Software Activated Feature (SAF) indicating whether they are on, off or temporarily enabled. It also shows how many test shots remain along with the remaining test time. Information on temporary SAF (such as any temporary licenses) is also available.

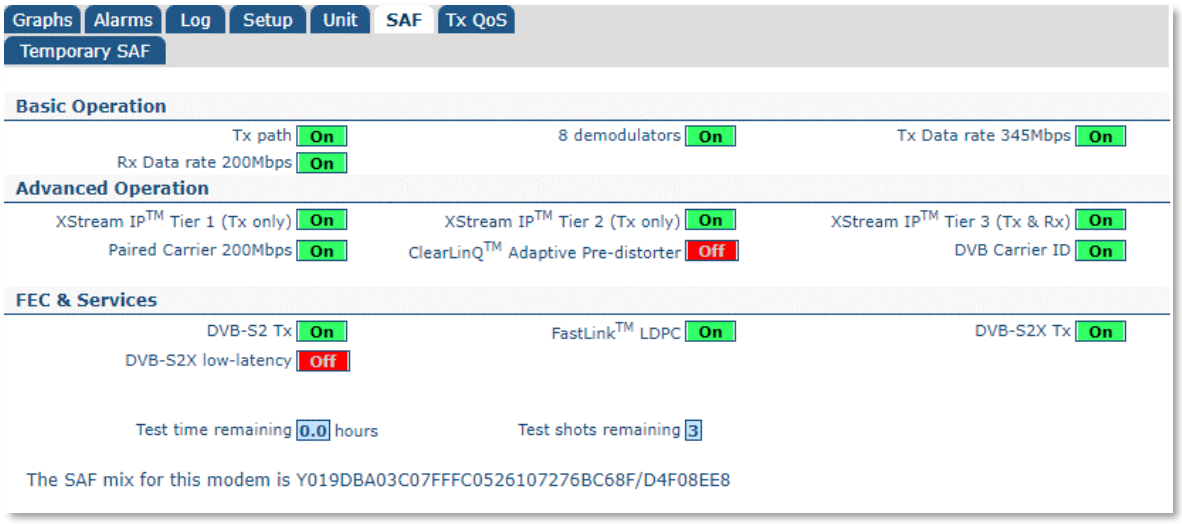


Figure 6-70 View->SAF Screen

6.2.27.11 View->Tx QoS Screen

The *View->Tx QoS* screen shown in **Figure 6-71** displays metrics for the shared outbound carrier in terms of total stream throughput, including dropped packet counts and current stream data rates (in packets per second and bits per second).

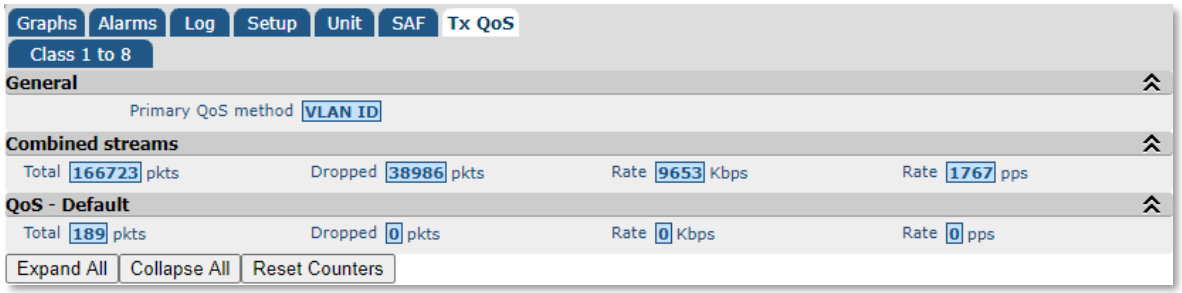


Figure 6-71 View->Tx QoS Overview Screen

Figure 6-72 shows the metrics collected for specific classes.

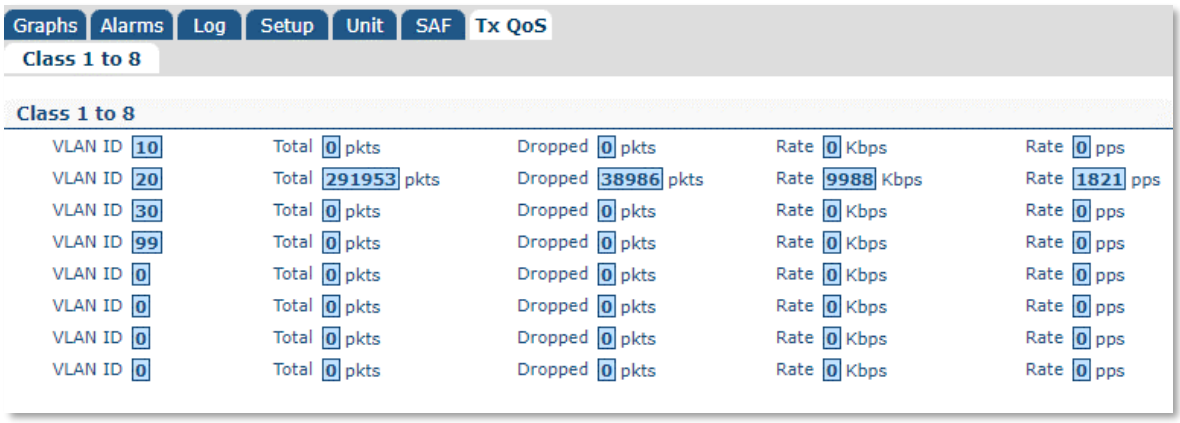


Figure 6-72 View->Tx QoS Class Screen

6.2.28 Test Screen

The *Test* screens support the following test functions:

- *RF Test Modes.* This provides two types of signal – a CW (pure carrier) signal and an alternate 1,0 signal that can be used to test modem carrier operation.
- *IP Packet Satellite Delay.* This allows a one-way satellite delay (in milliseconds) to be entered. This can be used in modem back-to-back testing to simulate the normal satellite delay. It applies to IP transmit traffic only. It should always be set to 0 when using IP over satellite. **Note**: The use of this feature is currently incompatible with the use of IP traffic shaping (as the two features compete for the same internal resources).

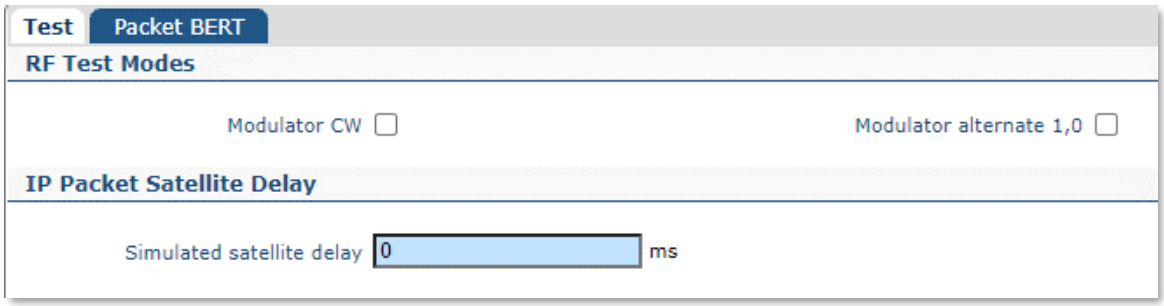


Figure 6-73 Test Screen

RF Test Modes

6.2.28.1 Modulator CW

With this enabled the modulator will emit an unmodulated CW carrier. This is useful for evaluating phase noise/spurious or running cross-pole tests. **Note**: should not be used over a live satellite link without the operator's permission.

6.2.28.2 Modulator alternate 1,0

With this enabled - an alternating 1,0,1,0 pattern is fed to the modulator at the selected symbol rate. This causes two discrete frequencies to be generated, spaced at the symbol rate about the center frequency (suppressed carrier). This is useful for evaluating the carrier suppression of the modulator but **should not** be used over a live satellite link.

6.2.28.3 Packet BERT

The 'Packet BERT' is a bit error tester that uses PRBS patterns formatted into IP packets which can be encapsulated and used with DVBS2/DVBS2X services. This useful tool can help determinie the performance of the outbound carrier path or an inbound carrier path (limited for use with one demodulator).

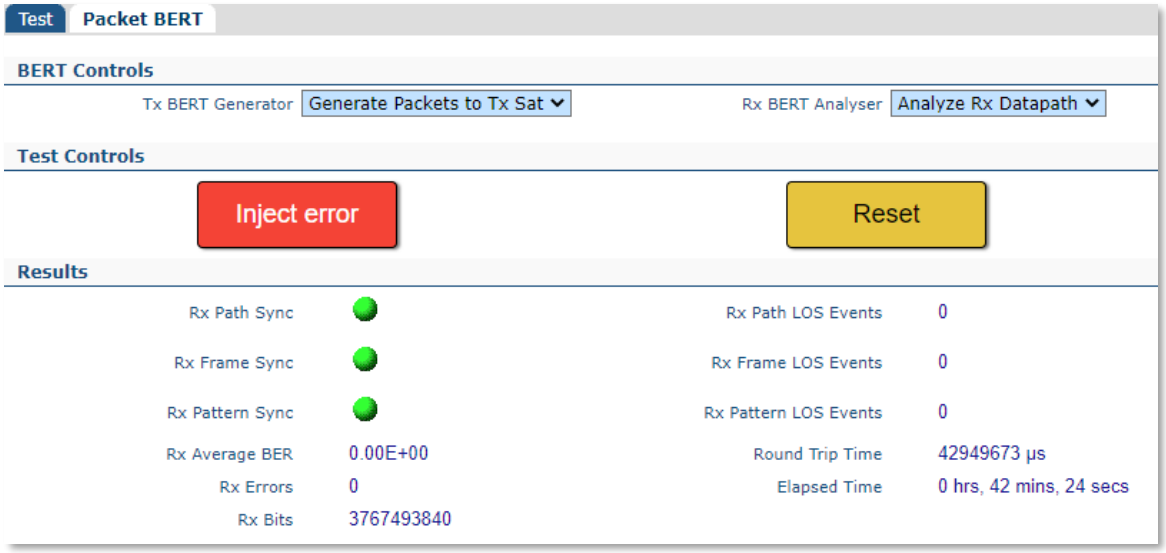


Figure 6-74 Test Screen

To enable the BERT to replace terrestrial traffic with PRBS pattern packets – select 'Generate Packets to Tx Sat' in the drop down menu.
At the other end of the link – the Rx BERT analyser should be set to 'Analyze Rx Datapath'

Inject error will inject a single error into the datastream. This is useful to test data transparency.

Reset will re-start the BERT results. Once the Rx BERT Analyser is enabled – it is worth reseting the results page to clear any previous data and reset the Events/Rx errors to zero.

The BERT will display the average BER result, the Rx Errors, the bits received, any loss of sync events, the RTT (only valid if in an RF loopback) and the Elapsed test time from the last 'Reset'.

6.3 Front-panel Interface

6.3.1 Keypad Operation

6.3.1.1 Cursor

An inverse-video cursor is used to navigate around the LCD display. See **Figure 6-74** for an example. '2:Edit' is being highlighted by the cursor.

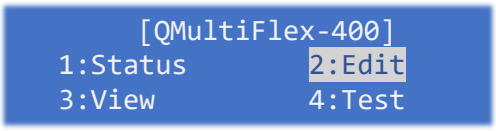


Figure 6-75 Front Panel LCD

6.3.1.2 Navigation Keys

The menu options are arranged into a hierarchy of menus. Navigation is performed using the arrow and *ENTER* keys or by entry of the number associated with each menu option.

Figure 6-76 Front Panel Keypad

Arrow Keys

The *Up arrow* key moves the cursor up one line except when entering a numeric value, when it increments the digit highlighted by the cursor.

The *Down* arrow key moves the cursor down one line except when entering a numeric value, when it decrements the digit highlighted by the cursor.

The *Left* arrow key moves the cursor to the left, both on menus and when entering alphanumeric values. The *Left* arrow key has a special function when viewing the system log, where it is used to move backwards in the log by 100 entries.

The *Right* arrow key moves the cursor to the right, both on menus and when entering alphanumeric values. The *Right* arrow key has a special function when viewing the system log, where it is used to move forwards in the log by 100 entries.

When entering alphanumeric values, pressing the 0 key and the *Right* arrow key together deletes the character at the cursor.

***MAIN* Key**

The *MAIN* key returns the user to the *MAIN* menu from anywhere in the menu hierarchy.

***ENTER* Key**

On a menu, the *ENTER* key is used to navigate to the submenu highlighted by the cursor. When entering or selecting a new value, the *ENTER* key is used to accept the new value and a further press of the *ENTER* key is (generally) required to move to the next screen

Note that when a new value is accepted, it is applied to the modem hardware immediately.

***BACK* Key**

On a menu, the *BACK* key is used to navigate to the previous screen. When entering or selecting a new value, the *BACK* key is used to cancel any change to the current value and move backwards to the previous screen.

6.3.1.3 Alphanumeric Keys

The alphanumeric keys provide numeric entry. Where it is valid to enter alphabetic characters, repeated pressing of a numeric key will cause the key to cycle through its associated lower-case and then upper-case alphabetic characters.

6.3.1.4 Special Function Keys

Help

Help information can be displayed for any M&C control by holding down the 0 key and pressing the *Left* arrow key together while the screen containing the M&C control is displayed. This brings up scrollable text that explains the M&C control's function. Pressing the 0 key and *Left* arrow key together for a second time removes the Help text and reverts the display back to its previous contents.

Keyboard Lock

The keypad can be locked against inadvertent use by holding down the 0 key and pressing the *MAIN* key together at the same time. Pressing the two keys again at the same time unlocks the keypad.

LCD Contrast

The contrast of the LCD display can be adjusted by holding down the 0 key and pressing the *Up* (or *Down*) arrow key together at the same time. The *Up arrow* key increases the contrast and the *Down* arrow key decreases the contrast.

LCD Backlight

The LCD backlight can be dimmed or brightened by holding down the 0 key and pressing the *Up* or *Down* arrow key together at the same time.

Log/Alarm Clear

The system log and system alarms can be cleared by pressing the 0 key when on the front-panel *View->Log* and *View->Alarms* screens.

6.3.2 LCD Screen Layout

The front panel user interface uses a menu system to present choices to the user. These in turn allow either the selection of a value from a list of options or require the setting of a new value. Examples of these types of screen are shown below.

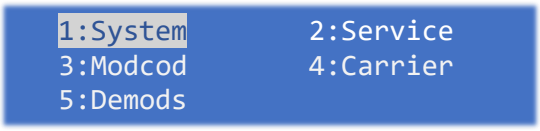


Figure 6-77 Screen Type 1: Menu Selection from Pre-defined List

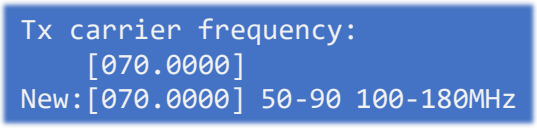


Figure 6-78 Screen Type 2: Entry of New Value

Features that are not available appear on the display are preceded by a '#'. There are several reasons why a feature may not be available:

- ***The feature is a Software Activated Feature (SAF) and the appropriate SAF code has not been enabled. Please contact Paradise Sales who can quote and issue a SAF key to unlock the feature.***
- ***The feature is available, but its use is precluded by the current operational modem settings.***

6.3.3 Front Panel Menu Structure

The front-panel menu hierarchy broadly follows the same structure as the web user interface starting with the *MAIN* menu shown in **Figure 6-75**

The *Main* menu can be accessed from any display by pressing the *MAIN* key. It is from this menu that all functions are selected.

It contains the following sub-menus:

Status Displays modem operational status summary information.

Edit Allows modification of the modem configurable properties.

View Displays detailed operational status and read-only configurable property values.

Test Controls the selection of test modes.

Please refer to the equivalent web user interface menus for further information on the front-panel menu options. Note that complex, advanced features of the web user interface such as graphs, static routes and traffic shaping are not supported via the front panel. All basic modem status and setup, as well as many advanced features, can however be accessed via the front panel.

6.3.4 Extracting Configurations to USB drive - Via the Front Panel

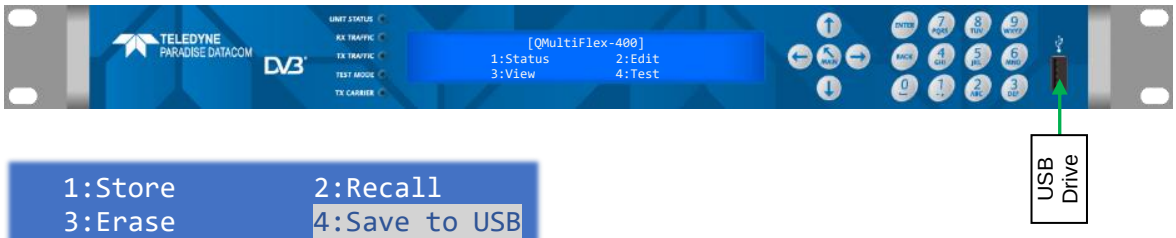
When extracting configurations, the first step is to store the configuration in memory. To navigate to the memory screen, press: Main, Edit, Memories

```
1:Store          2:Recall
3:Erase          4:Save to USB
5:Load USB
```

Select 1 for Store. Use the alphanumeric keypad to enter a configuration name and press enter. In this example it is 'TEST04142020'.

```
Store:  select name or enter new
      [TEST04142020          ]
  New:[Functional_Test]
```

A USB drive will need to be plugged into the front panel.




```
1:Store          2:Recall
3:Erase          4:Save to USB
5:Load USB
```

To transfer a stored modem configuration file to a USB drive, from the Memories menu, select '4:Save to USB'.

Use the up and down arrows to select the configuration name you want to transfer to the USB drive, then press the enter key. Once saved, the configuration name will appear within the top set of brackets.

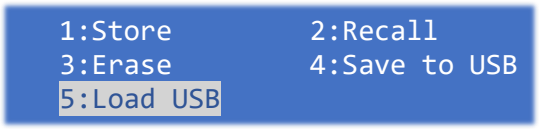
```
Save:  select config required
    [    ]
New:[TEST04142020]
```

```
Save:  select config required
    [TEST04142016]
New:[TEST04142020]
```

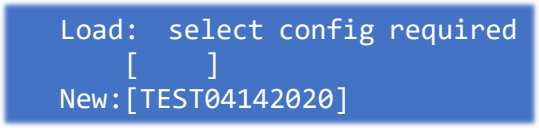
The USB memory device can now be removed. The configuration file or files can now be transferred to a PC or loaded into other modems e.g. another modem in a 1:1 pair.

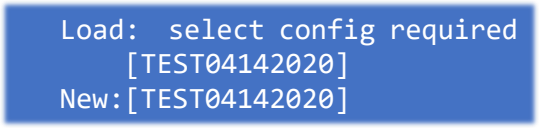
6.3.5 Uploading Configuration files to Modem - Via the Front Panel

With a USB drive inserted into the front of the modem, navigate to the memory screen.
Main, Edit, Memories.



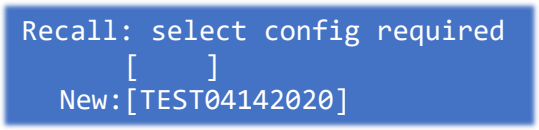
Press ‘Load USB’ to load a configuration file from the USB drive.
Use the up and down arrows to scroll through all of the .conf files in the root directory of the USB drive. Once the required file is found, press enter. Once loaded the name will appear within the top set of brackets.

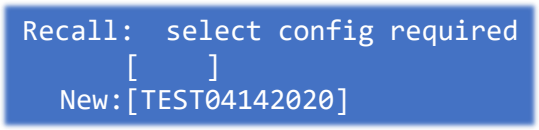




Once the configuration file is loaded into the modem, it can be recalled. From the memories menu, press ‘2:Recall’.

Use the up and down arrows to find the configuration file you require. Press enter once found and the name will appear within the top set of brackets when the configuration is applied to the modem.





Note: When a configuration is uploaded to the modem via the USB drive, the M&C address remains unchanged in the file. When the configuration is recalled, the M&C address in the configuration file will replace any M&C address you currently have set in the modem. This is not the case when uploading files via the web interface.

Chapter 7 Q-NET™ Implementation

This section shows some topologies used with Q-NET™ networks and includes some information to help implement a Q-NET™ system.

The Q-NET™ satellite network solution is a highly flexible and scalable satellite network solution designed for a broad range of markets, applications and business models. Its unique selling points directly enable operators to dramatically cut costs and generate additional revenue. Its defining characteristics are flexibility, low hardware costs and low operational running costs.

Teledyne Paradise Datacom introduced the **QMultiFlex-400™** modulator/multi-demodulator unit for point-to-multipoint operation. A variant of our flagship **QFlex-400™** satellite modem, it combines a highly efficient DVB-S2X shared outbound carrier with support for multiple DVBS2X inbound carriers.

Q-NET™ supports both Layer 2 bridging (Star) and Layer 3 routing (Mesh). Q-NET™ can therefore act as a transparent bridge for all protocols, or can be used to provide explicit packet forwarding, as required. VLANs are fully supported (including VLAN access and trunking modes and when applying traffic shaping rules).

All Paradise equipment and other network devices can be controlled from Q-NET™ Navigator, a client-side Windows application that supports a shared network database for all operators. It provides full control over all modem and multi-demodulator functions using an easy-to-navigate site map, which also displays the real-time alarm status of each modem. It can take care of automatically synchronizing all changes in the network when shared outbounds or inbounds need to be reconfigured.

7.1 Network Topologies

Star, mesh and hybrid star/mesh networks are all supported and can be combined as required.

7.1.1 Point-to-Multipoint Star Network

A star network topology is shown in **Figure 7-1**.

In this scenario, a **QMultiFlex-400™** generates a shared outbound from the hub to the remotes, which have **QFlex-400™** modems for receiving the outbound. They generate return carriers back to the hub, which are demodulated by the **QMultiFlex-400™.** The box count starts at literally one box at the hub and one at each site for the smallest network. Traffic shaping is typically used to control the content of the shared outbound. VLAN tagging is often used to keep traffic for each site separate.

The hub **QMultiFlex-400™** can be configured to support remote-to-remote communications, where relevant inbound traffic from one remote modem is retransmitted in the shared outbound to one or more of the other remote modems.

The Q-NET™ control applications will normally be located at the hub where there is connectivity to the whole network. If desired, operators can remotely access the system from any location.

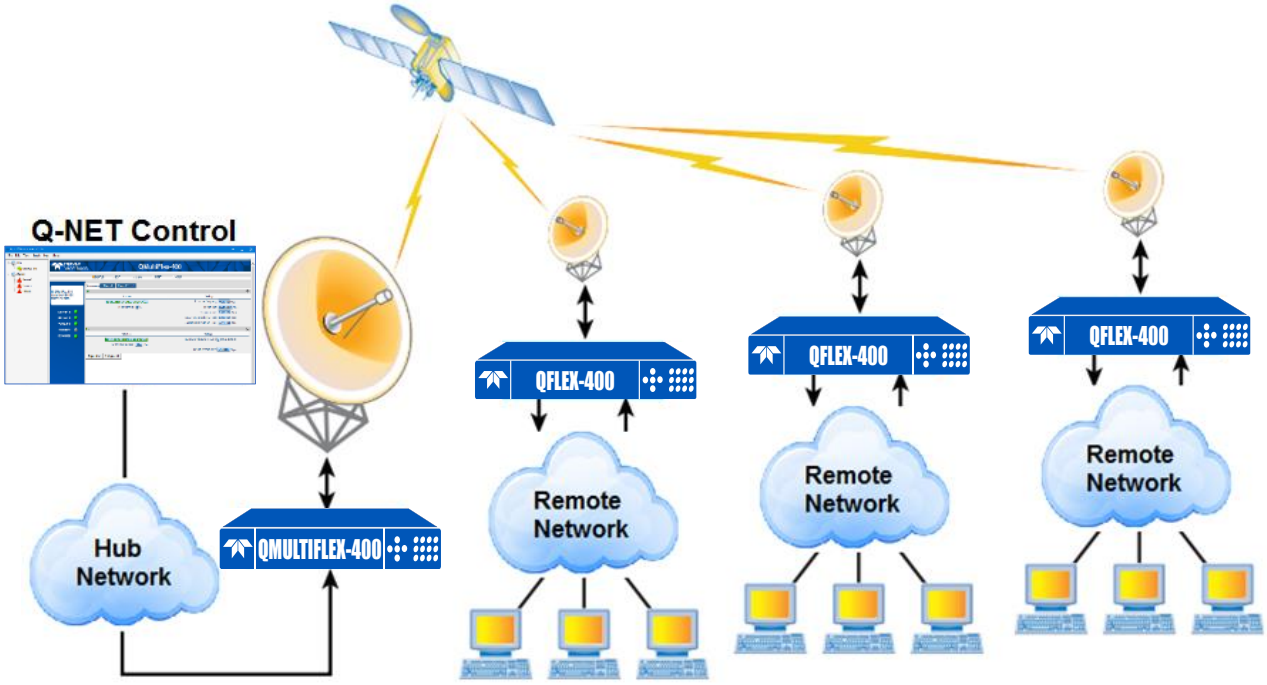


Figure 7-1 Q-NET™ Star Point-to-multipoint Network

Network devices such as routers, switches and VLAN switches can all be connected as required. Multiple **QMultiFlex-400™** devices, each supporting up to one modulator and up to 16 demodulators, can be supported at the hub. All **QMultiFlex-400™** devices can be configured to share a single outbound carrier, if desired, through a system of cascading.

7.1.2 Mesh Network

A mesh network topology is shown in **Figure 7-2**. In a mesh network there is no hub and therefore remote-to-remote communications are all single hop. In the simplest case each site has a single **QMultiFlex-400™.** In a full mesh each site transmits an outbound to every site and receives a carrier from every other site.
The **Q-NET™** control applications can be located at any site, since each has full visibility of the whole network. In a partial mesh (where some sites communication requires double satellite hops) the control applications need to be located at a point that has maximum network visibility with the least need for double hops.

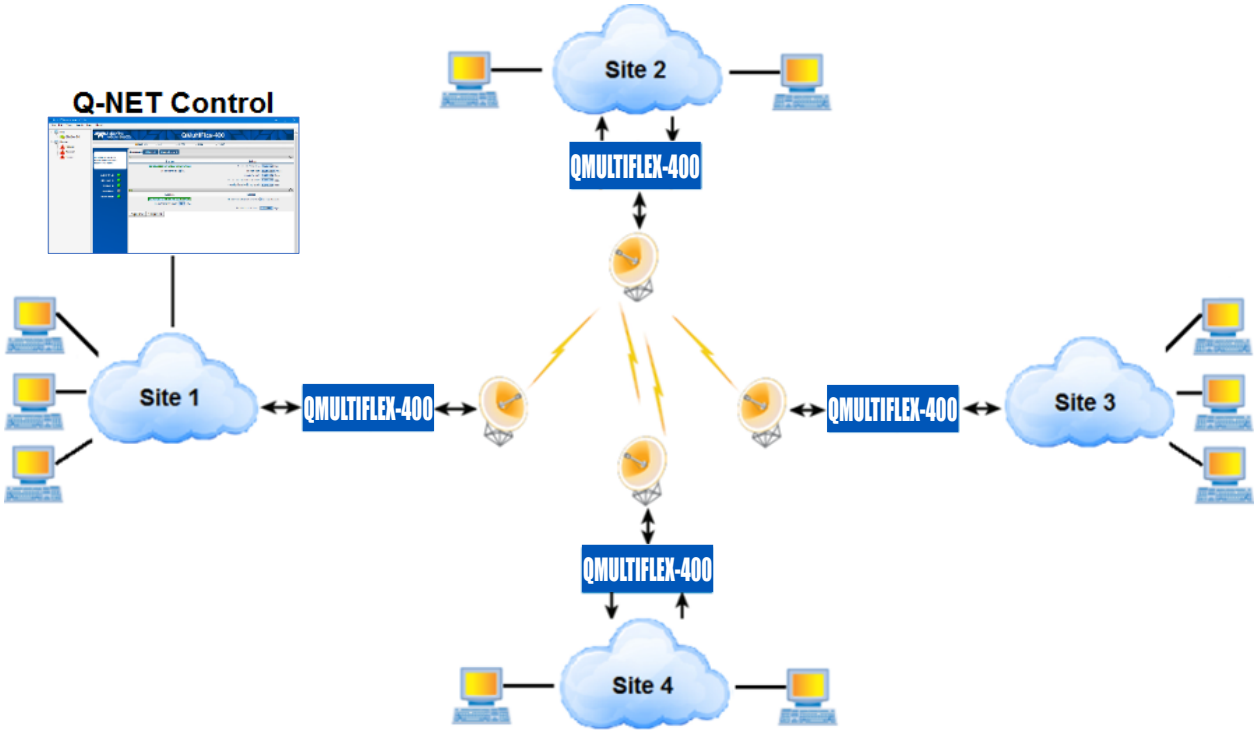


Figure 7-2 Q-NET™ Mesh Network

7.1.3 Point-to-point Network

A point-to-point network topology is shown in **Figure 7-3**. This type of network consists of a series of individual point-to-point links between **QFlex-400™** modems. As well as dedicated point-to-point networks, point-to-point links are often used for occasional-use links in larger point-to-multipoint networks or to address parts of the network that require limited connectivity.

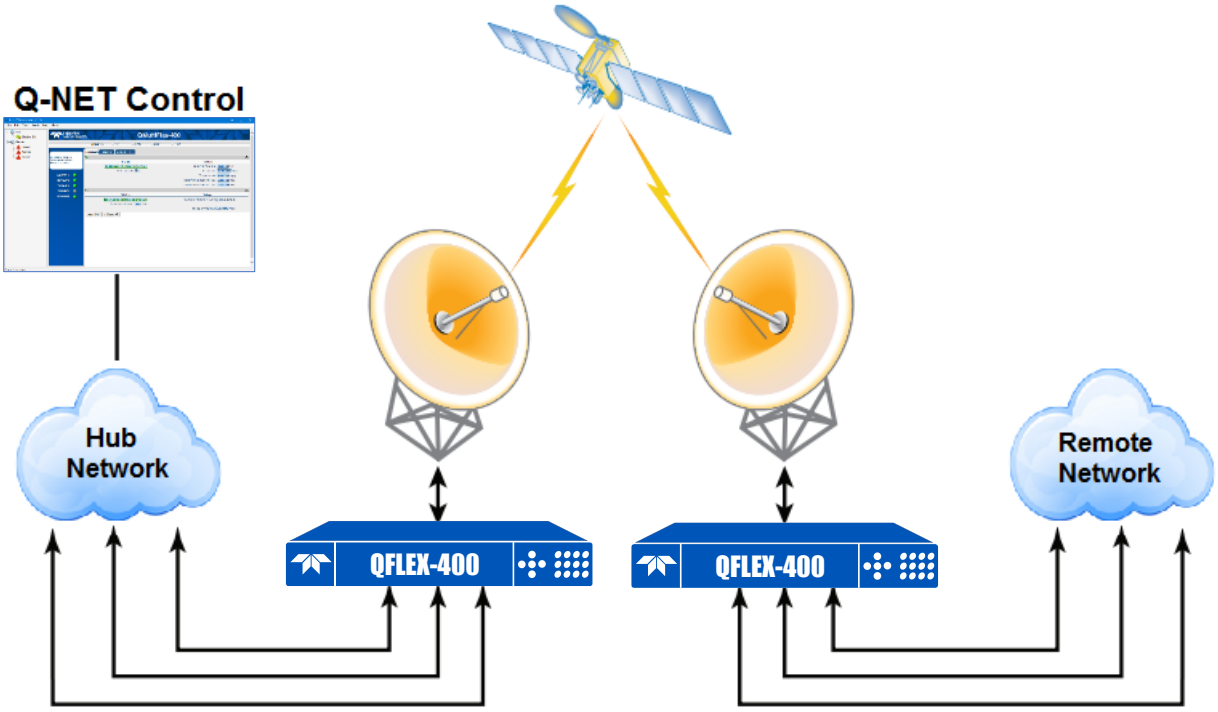


Figure 7-3 Q-NET™ Point-to-point Network

The Q-NET™ control applications will normally be located at the hub where there is connectivity to the whole network.

7.2 TCP/IP Traffic Management

Layer 2 bridging (including the use of VLANs) and Layer 3 routing are supported. Both hardware and software bridges are available. The hardware bridge (switch) is capable of processing many more packets (up to 200,000 per second) while the software bridge supports a larger range of IP optimisation features such as TCP acceleration.

7.2.1 Point-to-Multipoint Bridging

Figure 7-4 shows the most basic configuration used for a point-to-multipoint bridging solution. Ethernet switches can be deployed, as required, between the satellite devices (**QMultiFlex-400™, QFlex-400™**) and the user network (the user network being any combination of switches, routers and end-user devices). In this scenario, a single subnet is used for the satellite modem network. However, beyond the modems, routers can be used to connect to other subnets as required.

MAC address learning in the satellite modems and the hub multi-demodulator unit ensure that packets automatically find their way correctly over satellite and across the network to the destination devices.

There are several methods for filtering wanted packets from unwanted packets at the remotes. One method (explained later) is to parcel each traffic stream for different remotes (as part of a shared outbound) using Variable Coding and Modulation (VCM). In this situation each remote picks off the stream (MODCOD) that is relevant to it. Another method is to use VLAN tagging where packets are automatically tagged with the correct VLAN tag for a particular remote. This can be done regardless of whether end-user traffic also uses VLANs (in other words customer and service provider VLANs can be stacked and thereby kept separate). Each remote will then filter out all other packets except the required VLAN(s).

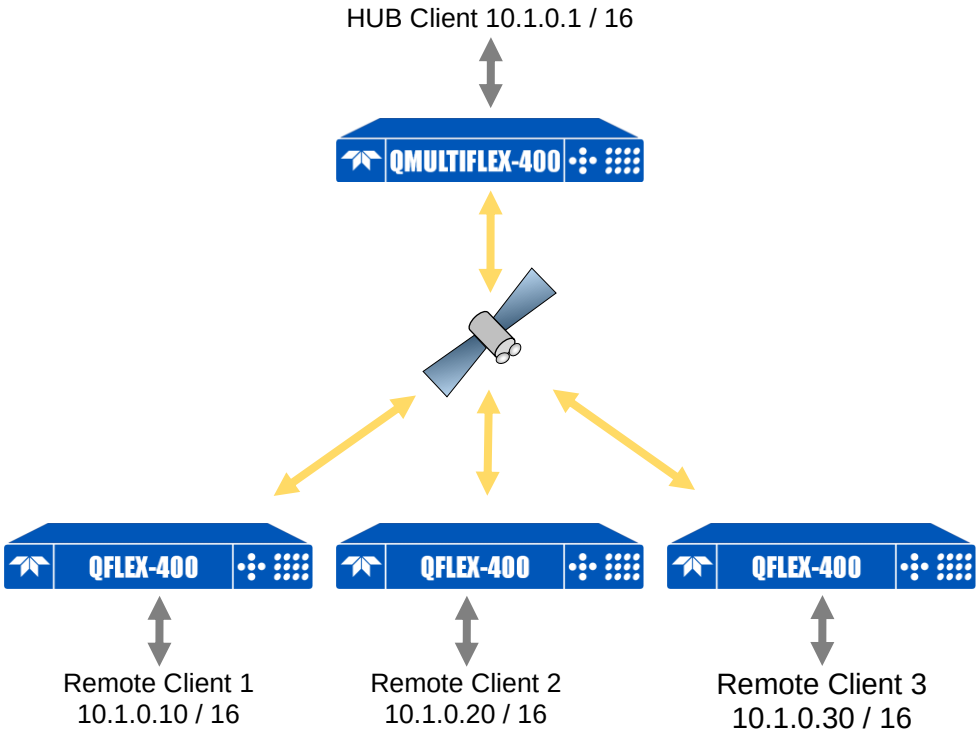


Figure 7-4 Q-NET™ Point-to-multipoint Bridged Network

Note that advanced IP features, including TCP acceleration can be used in point-to-multipoint bridging mode. In these cases, the **QMultiFlex-400™** and **QFlex-400™** terrestrial IP traffic ports are typically addressless (i.e. IP address set to 0.0.0.0).

Assigning a traffic IP address in bridging mode can be useful as part of status monitoring and fault detection. Being able to ping the IP traffic port allows a monitoring system to confirm the traffic network is accessible at each modem and can help narrow down the point in the network where there is a connectivity problem. This is particularly useful if the IP traffic is run as a separate network to the M&C network and needs its own independent monitoring system (for example, where the M&C network comes under control of the operator while the traffic network remains the responsibility of the end user).

Note also that all forms of Ethernet frame extension, including VLAN tags, MPLS labels and jumbo frames (of up to 10kbytes) are handled correctly, with fully transparent satellite operation as expected.

7.2.2 Point-to-Multipoint Routing

In routing mode, the QMultiFlex-400™ and QFlex-400™ modems act as two-port routers, with the terrestrial IP port being on one subnet and the satellite port being on another subnet. (The M&C network can be on yet another subnet.) The satellite ports of all **QMultiFlex-400™** and **QFlex-400™** devices are configured to be on the same subnet. Each **QFlex-400™** remote modem can be configured to have a unique terrestrial subnet, as required. Routers attached to the modems then allow other networks to be connected.

In **Figure 7-5**, arbitrarily complex networks (potentially with multiple subnets) exist attached to routers on both sides of the satellite network. The **QMultiFlex-400™** is configured for a unique subnet that it shares with its local router. A single subnet is used over satellite to connect the satellite ports of the **QMultiFlex-400™** and **QFlex-400™** modems. The terrestrial port of each **QFlex-400™** is configured to be a unique subnet shared with its local router.

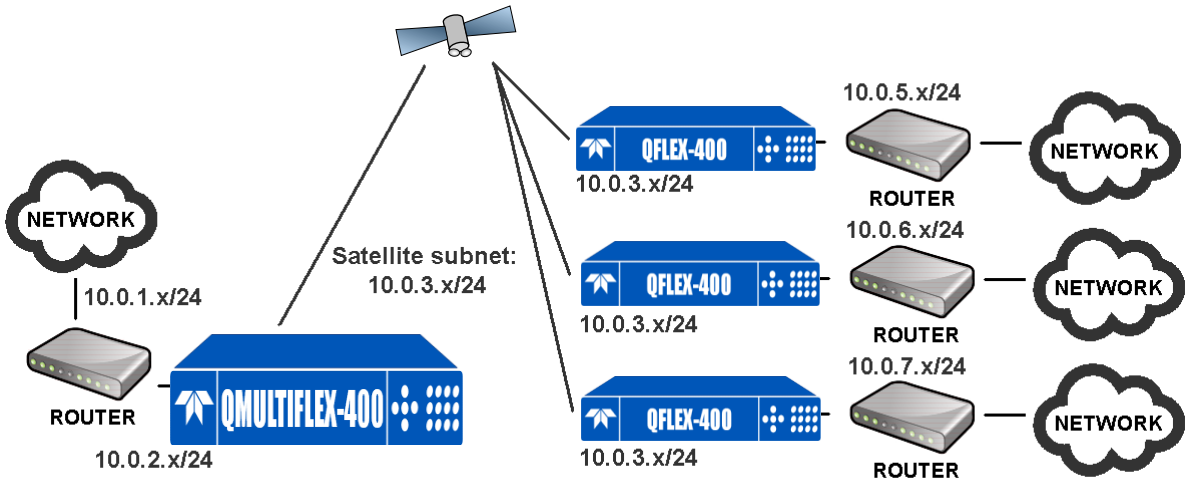


Figure 7-5 QMultiFlex-400™ Point-to-multipoint Routed Network

If static routing is being used, then static routes are set up in each Teledyne Paradise Datacom device to route packets as required. Routes can be allocated bandwidth using the traffic shaping feature and they can also be used to determine which packets are dropped or forwarded at each remote.

One method of handling unwanted packets at the remotes is to specify ‘black hole’ static routes at the remotes that route the unwanted data to non-existent gateways, causing the packets to be dropped. This prevents unwanted packets being forwarded onto the local network.

Advanced IP features, including TCP acceleration can be used in point-to-multipoint routing mode. Unlike in bridging mode, the **QMultiFlex-400™** and **QFlex-400™** terrestrial IP traffic ports use explicit IP addresses when in routing mode.

One benefit of routing is that it minimises satellite overhead and therefore increases bandwidth efficiency, since no ethernet frames are ever transmitted.

7.3 Cascading Multiple QMultiFlex-400™ Units

Multiple **QMultiFlex-400™** units can be cascaded together in order to address an arbitrarily large number of remote modems with a single outbound carrier.

There are two methods that can be used to cascade units together. The first involves cascading units directly together and involves no external equipment. **Figure 7-7** Shows an example of this. For more capacity i.e. up to 128 remotes, just follow the same connection pattern.

The second method is to use an ethernet switch to distribute the cascade links to all the **QMultiFlex-400™** units. A standard layer 2 ethernet switch would be suitable.

When configured for directly cascaded **QMultiFlex-400™** units as shown in **Figure 7-7**, the traffic shaping rules under Edit->Service->General->Tx QoS will automatically display 80 VLAN rules, allowing the bandwidth in the outbound carrier to be partitioned for each remote modem, as required.

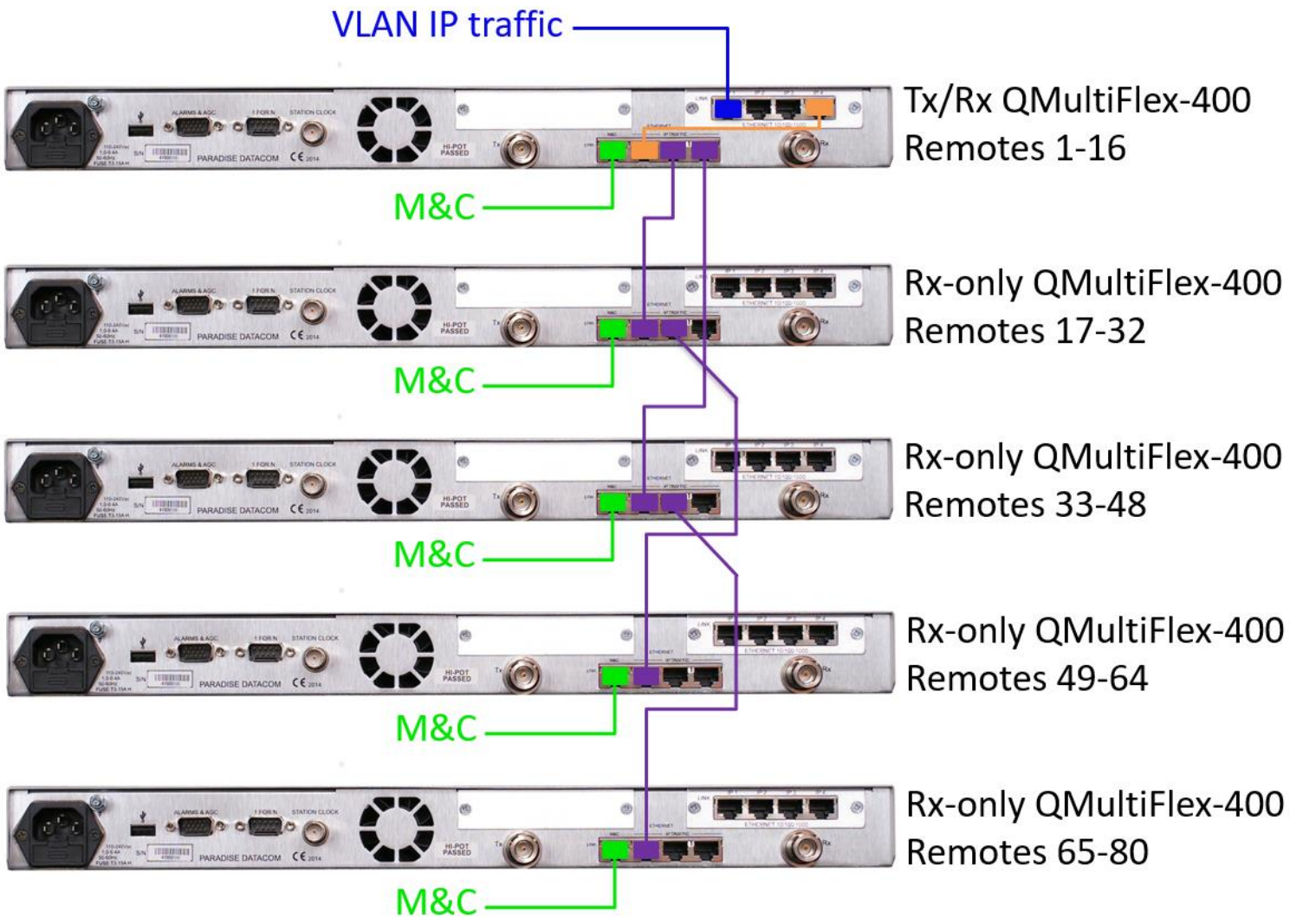


Figure 7-7 Cascaded Q-MultiFlex-400™ Units (for up to 80 remotes per shared outbound)

7.4 Modem Redundancy Protection

Various levels of redundancy are supported.

Figure 7-8 shows a typical hub redundancy setup where transmit and receive services for up to 64 remote sites are protected by a single backup unit. A PDQS redundancy switch (and backup **QMultiFlex-400™)** is used to protect four **QMultiFlex-400™.**

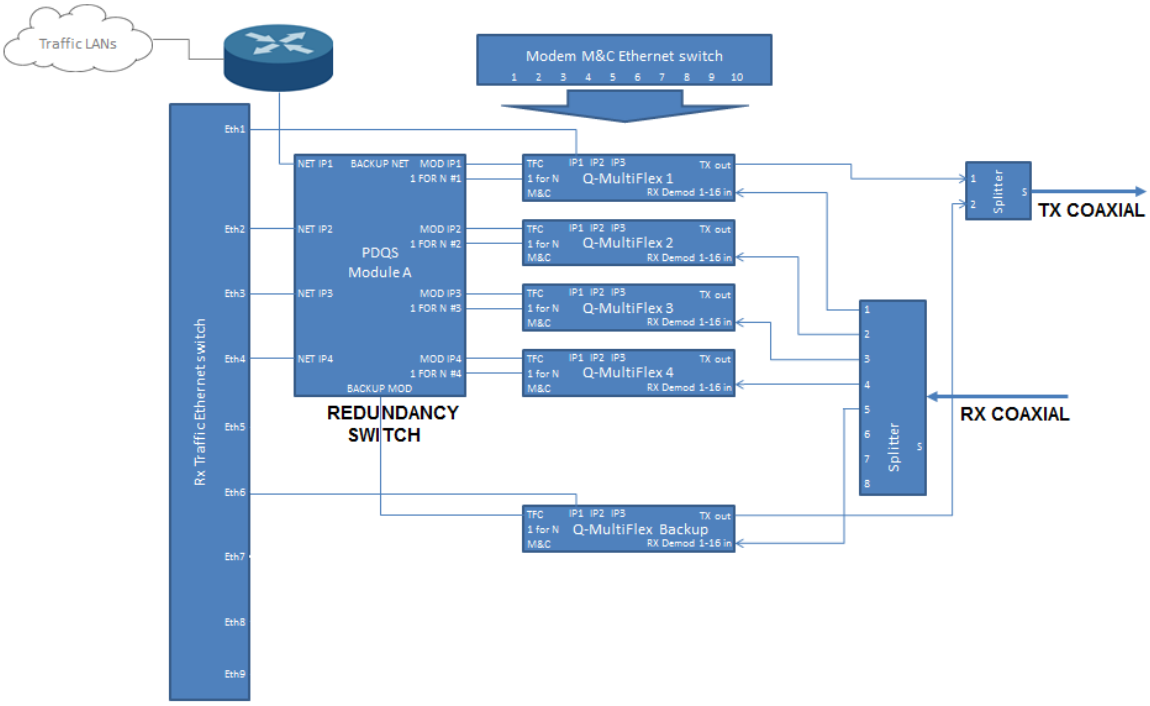


Figure 7-8 QMultiFlex-400™ 1:4 Redundancy Setup (64 remotes sharing single outbound)

However, users may want to consider independent protection for the hub Tx and Rx functions, giving each their own separate backups, allowing for continued correct system operation even in the event of multiple concurrent failures, leading to extremely high system reliability and availability. In this scenario, we recommend using 1:1 protection for the Tx services (since potentially large numbers of remotes all depend on a single shared outbound carrier) and using a separate 1:N redundancy system where one backup unit is shared between all of the Rx services, as shown in **Figure 7-9**.

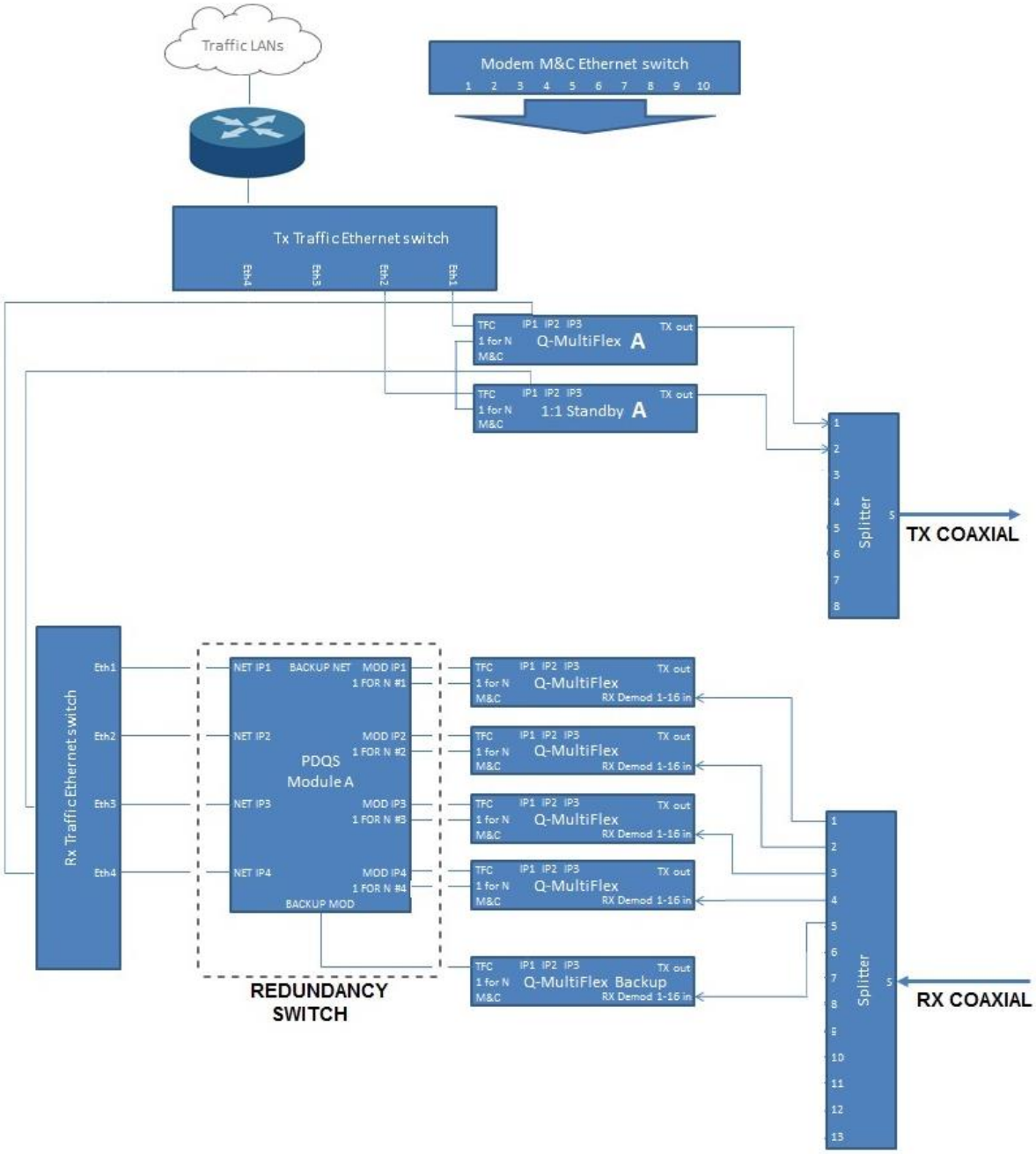


Figure 7-9 Separate Tx (1:1) and Rx (1:N) Redundancy Setup

7.5 Remote Modem M&C

It is not recommended to use the M&C bridge to bridge M&C and IP traffic together as typically there are separate VLANS involved using different networks. Bridging the M&C and traffic together limits the unit to one network, which is not typically what is desired with a point to multipoint network.

Paradise has chosen to create a special VLAN that is used just for M&C traffic. It is recommended to use any VLAN ID above 0 within the range (default is 0). This M&C VLAN can be enabled simply by setting a VLAN ID and turning it on, in the appropriate IP menu on the units at either end of the link. Each modem will then need to be power cycled to use the new VLAN ID value. The modems will thereafter ensure that M&C traffic is kept separate from user traffic and it will automatically be forwarded between hub and remote modems as required. External equipment can be attached to the remote modem M&C port to be included on the M&C network e.g. IP enabled BUCs. The M&C VLAN is filtered by each modem.

The M&C VLAN can be used in all modes (including bridging and routing) and for all waveforms, regardless of whether VLANs are being used generally or not. There is no restriction on how much bandwidth can be used for the M&C VLAN and it will consume as much or as little as required.

There is a separate menu option to enable remote-to-remote communications, where the hub re-transmits requests made from one remote modem when attempting to communicate with another remote modem.

7.6 Multiple Streams and Traffic Shaping

Single stream mode allows a single MODCOD to be applied to the shared outbound carrier, whereas with multiple streams, potentially different MODCODs can be applied to the individual streams when they are transmitted over satellite in the shared outbound carrier (a feature known as Variable Coding and Modulation (VCM)). VCM typically increases overall throughput since it takes advantage of the fact that different remote sites will be at different positions in the satellite footprint and will be capable of receiving different signal levels (hence some will be able to use more bandwidth-efficient modulations and FEC rates than others). There is no change to the overall symbol rate or power of the outbound carrier when VCM is active - the configured bandwidth is simply shared between several different MODCODs in accordance with the configured traffic shaping rules.

When the shared outbound is represented by a single stream (i.e. single MODCOD) then the QoS classification methods are VLAN IDs, IP addresses, Diffserv and IEEE 802.1p priority tags. When multiple streams are configured, the primary QoS method is VLAN ID or IP address.

One thing to note with VCM is that the modem will not show the possible throughput for each stream and this will typically need to be calculated from the set symbol rate and the CIR rates set in the QoS.

For example:
Multiple Streams
Stream 1: 16APSK Rate ¾ Normal Frames (Pilots off)
Stream 2: 8PSK Rate ¾ Normal Frames (Pilots off)
Stream 3: QPSK Rate ½ Normal Frames (Pilots off)
Tx Symbol rate is set to 5Msym.

QoS
Stream 1: 33%CIR & 99%BIR Priority 1
Stream 2: 33%CIR & 99%BIR Priority 2
Stream 3: 33%CIR & 99%BIR Priority 3

So we can see the streams will all equally get 33% of the 5Msps symbol rate.
For each stream: 5Msps: 33% x 5Msps = 1.65Msps each.

To calculate the maximum throughput, it is necessary to use a rate calculator. Please contact customer support for the bandwidth calculator (Excel spreadsheet).

Using the MODCOD for each stream and 1.65Msys as the symbol rate, the following bit rates are calculated from the from the bandwidth calculator:

Stream 1: 4,895,101 bps
Stream 2: 3,676,404 bps
Stream 3: 1,631,616 bps

Traffic shaping configuration is covered in detail in the QoS description of this handbook (see Sections 6.2.5 & 8.7.8)

Adaptive Coding and Modulation (ACM) can optionally be used to maximize the efficiency of the shared outbound. It does this by dynamically varying each VCM MODCOD (one per

stream) in the shared outbound with varying link conditions as experienced by each remote modem. ACM therefore converts any unused link margin (on a per-site basis) into additional throughput.

ACM also provides 100% link availability by allowing the use, during heavy rain fades, of MODCODs with very high error-correcting ability (down to QPSK ¼).

At the remotes, the status will show the calculated bit rate for each MODCOD used.

Chapter 8 System Considerations

8.1 Automatic Uplink Power Control

Authorisation from the satellite operator should be sought before AUPC is activated.

8.1.1 Introduction

Automatic Uplink Power Control (AUPC) provides a mechanism to counteract changes in atmospheric conditions, such as rain or snow, that degrade the performance of satellite links. It does this by monitoring the remote-end signal-to-noise ratio (Eb/No) and automatically adjusting the local power output of the satellite link in order to maintain the specified remote-end Eb/No. Note that if the rain is falling at the local end of the link then the power seen at the satellite will be unchanged. However, if the rain is falling at the remote end of the link, then the power seen by the satellite will increase, which if not controlled carefully has the potential to affect other carriers or saturate the transponder. Carrier power must be kept to the levels agreed with the satellite operator.

Remote Eb/No monitoring is performed by sending Eb/No messages via the return IP channels. The AUPC implementation has an extremely low overhead.

The modem can be set to simply monitor the remote Eb/No, or to maintain it at a specified level. A deferred alarm can be set to activate if the remote Eb/No falls below a user-set threshold.

A target Eb/No level has to be set along with a maximum transmit power level for the local end. The transmit power is adjusted to keep the remote Eb/No at the target value. If the satellite link is lost, then the transmit power can be frozen at its current level until the link is restored, or it can be returned to its nominal value.

8.1.2 Configuring AUPC

To use the AUPC function, the following procedure should be followed:

1. Prior to switching on AUPC, configure the modems at both ends of the link and ensure the satellite link is operating correctly.
2. Set the transmit power to achieve the remote Eb/No expected under clear-sky conditions.
3. To receive an indication of when the remote Eb/No falls below a defined threshold, set a target Eb/No minimum threshold (which will cause a backward alarm to be generated under these conditions).
4. Set the AUPC mode to monitor the remote Eb/No in order to determine if it is working correctly. If the remote-end Eb/No is not available on the *Status* screen, then the modems are not configured correctly.

5. Record the remote Eb/No under clear-sky conditions and then set the AUPC mode to maintain the remote Eb/No.
6. Set a target Eb/No and set the maximum power level.
7. Review the remote Eb/No to confirm that it is being maintained correctly under different atmospheric conditions. The web user interface remote Eb/No and power graphs can be used to review AUPC performance.

Note: AUPC is limited to a single **QMultiFlex-400™** unit i.e. up to 16 remotes. Cascaded units are not currently supported. There are other limitations with this feature in a Point to Multipoint system. Contact support for more information.

8.2 Adaptive Coding & Modulation (ACM)

8.2.1 Introduction

As an alternative to AUPC, ACM can be used to dynamically adapt the MODCOD of the link to better suit changing conditions. A standard DVBS2X link would have a rain-fade margin built into the link budget (typically around 3dB above QEF point of MODCOD used). Instead of running high rain-fade margins 100% of the time, ACM can be used with a minimal rain-fade margin with a larger throughput. More efficient higher order MODCODS can be used in clear sky conditions and if conditions change, the MODCOD will adjust to a lower order one to maintain link continuity.
ACM can be used in a star topology one-way (Outbound or Inbound) or in bidirectional VCM mode.

One-Way: Outbound ACM

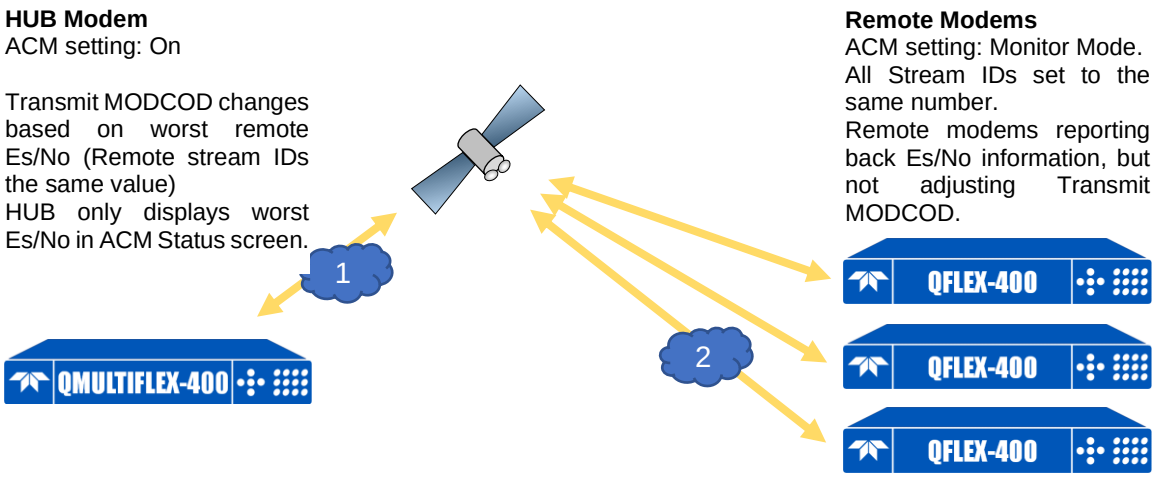


Figure 8-1 ACM One-Way - Outbound

Degradation position 1: Hub transmit MODCOD changes and reduces throughput for all remote modems, which ensures system continuity. Return carriers are degraded, hopefully within a rain fade margin.

Degradation position 2: Hub transmit MODCOD changes and reduces throughput for whole system based on one remote location. A return carrier gets degraded, hopefully within a rain fade margin.

Note: The receiving MODCOD with maximum possible throughput information can be seen on the Status (ACM) screen of the modem.

One-Way: Inbound ACM

HUB Modem
ACM setting: Monitor

All demods report their individual Es/No figure back to the respective remote modem according to stream ID.

Remote Modems
ACM setting: On

Transmit MODCOD changes based on HUB demod Es/No reported.
Stream ID has to match demod number e.g. Stream ID 1 for demod 1, ID 2 for demod 2, etc.

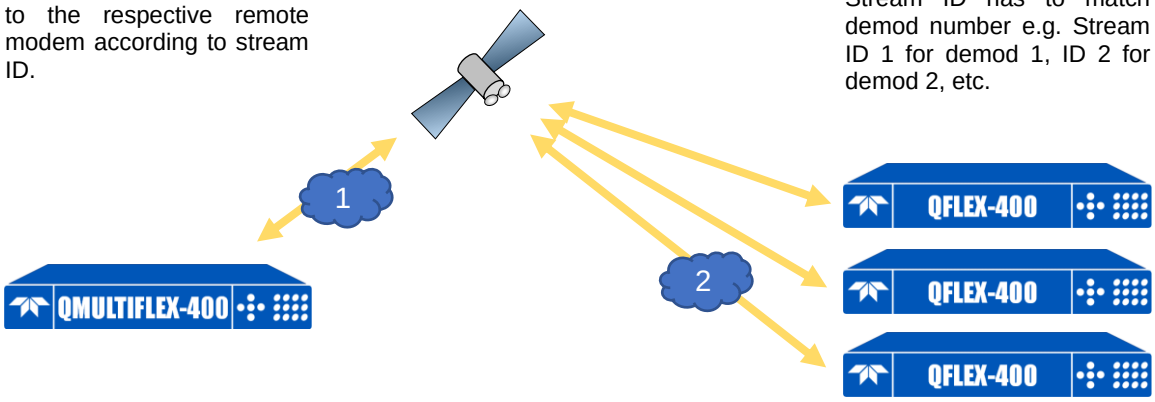


Figure 8-2 ACM One-Way - Inbound

Degradation position 1: All remote transmit MODCODS adjust to keep the respective hub demodulator in lock. Outbound hub carrier is degraded, hopefully within a rain fade margin.

Degradation position 2: One remote transmit adjusts to keep its respective demodulator in lock. The receive side is degraded, hopefully within a rain fade margin.

ACM & VCM (Bidirectional ACM)

Multiple Tx Streams can be configured in the **QMultiFlex-400™** with the remote demod matching the MODCOD for each stream. Applying ACM will make the VCM links even more robust, with each individual stream changing to adapt to environmental conditions.

HUB Modem
Multiple Streams Configured.
ACM setting: On

Individual transmit stream MODCODs change based on remote modem Es/No.
All demods report their individual Es/No figure to the respective remote modem according to stream ID.

Remote Modems
ACM setting: On

Transmit MODCOD changes based on HUB demod Es/No reported. Stream ID has to match demod number e.g. Stream ID 1 for Demod 1 etc. Remote modems reporting back Es/No information.

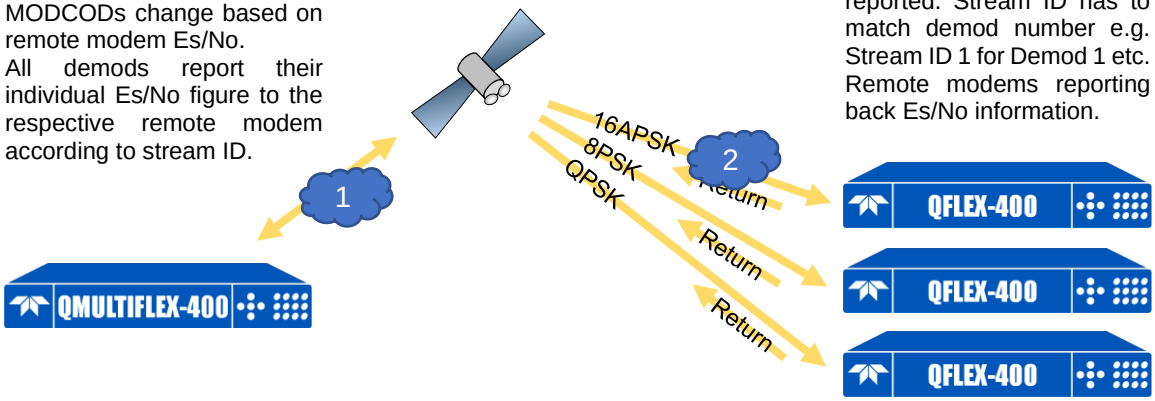


Figure 8-4 ACM Bi-Directional with VCM

Degradation position 1: Hub transmit MODCOD changes and reduces throughput for one or more individual streams if necessary, which ensures system continuity. All remote transmit MODCODs adjust to keep the respective hub demodulator in lock.

Degradation position 2: Hub individual stream MODCOD changes and reduces throughput as necessary to maintain link (other streams stay the same). The remote transmit adjusts MODCOD to keep the respective demodulator in lock.

Note: VCM can be used in the one-way outbound mode, but for maximum robustness the bi-directional ACM would be typical in a multiple stream scenario.

8.2.2 Configuring ACM

To use the ACM function, the following procedure should be followed:

1. Prior to switching on ACM, configure the modems at all link sites at the highest modulation order & code rate allowable (typically based on link budget). Ensure the satellite link is operating correctly. If VCM is being used, then set up the streams for the remote modems first and ensure stable operation for each stream.
2. Decide on a one-way or bi-directional scheme. It is possible only one side needs to adjust to maintain the link in normal operation.
3. Set the remote modem *Stream IDs* to coincide with the HUB demod. The 'Edit-> IP->Advanced' menu contains the stream ID setting. i.e. Remote 1 feeds back info to demod 1, Remote 2 to Demod 2 and so on…
4. Set the hub and remote modems to the desired ACM setting in the IP page; 'On' or 'Monitor'.
5. Review the remote Eb/No to confirm that it is being maintained correctly under different atmospheric conditions. The web user interface status screen and ACM graphs can be used to monitor performance.

8.3 Hub Cancellation

Using advanced Paired Carrier™ technology, it is possible to create a system where the outbound carrier shares the same space segment as the return carriers. With careful system planning, the remote modems will not require any delay cancellation, which is a huge cost saving for any sized system.

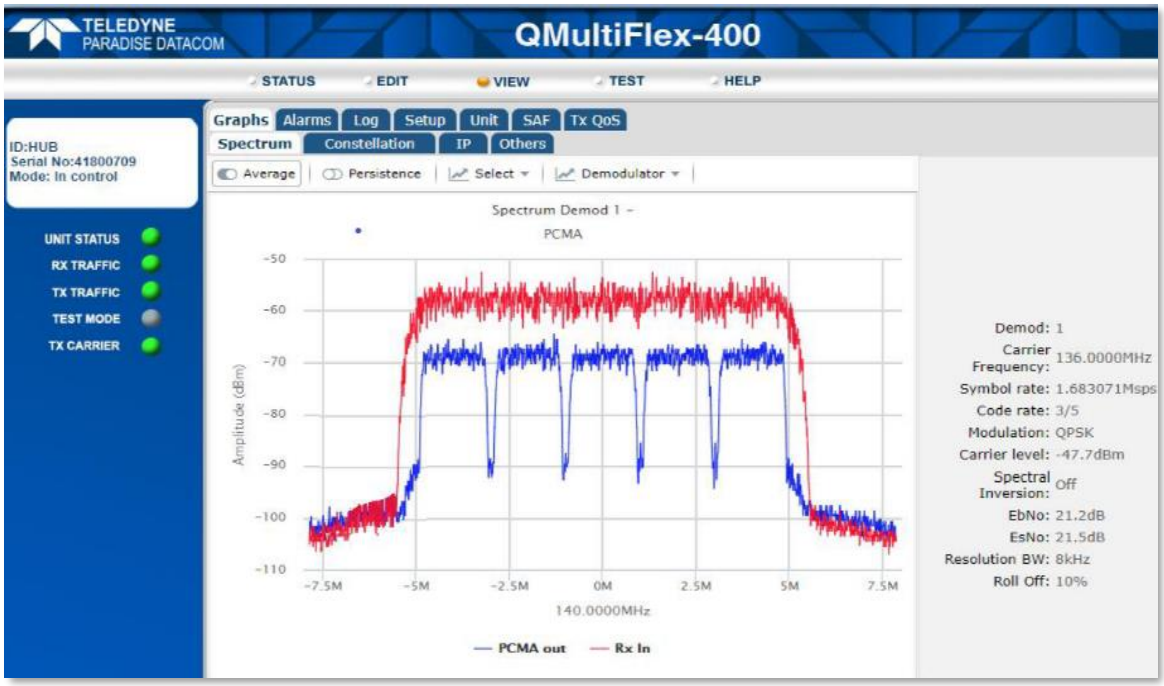


Figure 8-5 Hub Canceller Spectra

This section describes the operation and configuration of a QMultiFlex-400™ DVBS2(X) hub modem incorporating a hub canceller, operating in a star network configuration. This section will also explain the expected additional system losses, due in part, to the self-interference by the return carriers being located under the larger hub outbound carrier and ways of mitigating this additional system loss.

The Hub Canceller allows satellite carriers in a point-to-multipoint system to operate in the same satellite bandwidth providing satellite BW savings of up to 50%. The Hub Canceller uses adaptive self-interference cancellation to remove the uplink signal, which is present within the downlink signals. The resulting canceller output is the desired return signals from the remote terminals.

A single Modem containing a Hub Canceller is used at the hub, and no additional equipment is required at the remotes. The hub transmits the broadcast carrier and simultaneously receives its own transmission back from the satellite. The remote terminals receive the broadcast carrier and transmit their return signals in a managed fashion in the same carrier space as the hub broadcast carrier. The canceller at the hub removes the broadcast carrier from the composite receive signals enabling the hub to demodulate the return links.

In this broadcast network, the remote terminals use much smaller antennas than the hub. The asymmetry in the broadcast carrier to return channel data rates and hub-to-remote antenna size results in an asymmetry in the satellite EIRP. With proper system design, the satellite EIRP for all return channels can be kept sufficiently below the satellite EIRP on the

broadcast carrier to provide minimal degradation to the broadcast carrier reception at the remote terminals. Therefore, the remote terminals do not require their own canceller.
In this section, by way of example, the hub Out-Bound (OB) carrier is sized as follows: DVB-S2X, 8PSK, 23/36, Normal Frame, no Pilots, 10% roll-off, 10Msps (18.961734Mbps), occupied BW = 10.998MHz. The modem QEF Es/No for this MODCOD is 6.4dB. The hub carrier was arbitrarily placed at an IF of 140MHz.

The In-Bound (IB) carriers, of which there are five, are all sized as follows: DVB-S2, QPSK, 3/5, Normal Frame, no Pilots, 10% roll-off, 2Mb/s (1.683071Msps), occupied BW = 1.851041MHz. The modem QEF Es/No for this MODCOD is 4.1dB. The five IB carriers are placed at the following IF's: 136MHz, 138MHz 140MHz, 142MHz and 144MHz. This places all the IB carriers within the OB carrier BW.

In the example in this section, the In-Bound carriers are wholly contained within the Hub Out-Bound carrier. However, the system can equally operate with the Inbound carriers not being wholly contained within the Outbound carrier. i.e. The IB carriers collectively require more BW than the OB carrier.

The Hub Canceller must be able to receive its own uplink signal, i.e. it doesn't work with cross-strap transponders. The Link budget analysis will determine link configuration and estimated overall savings of power and bandwidth with the Hub Canceller enabled.

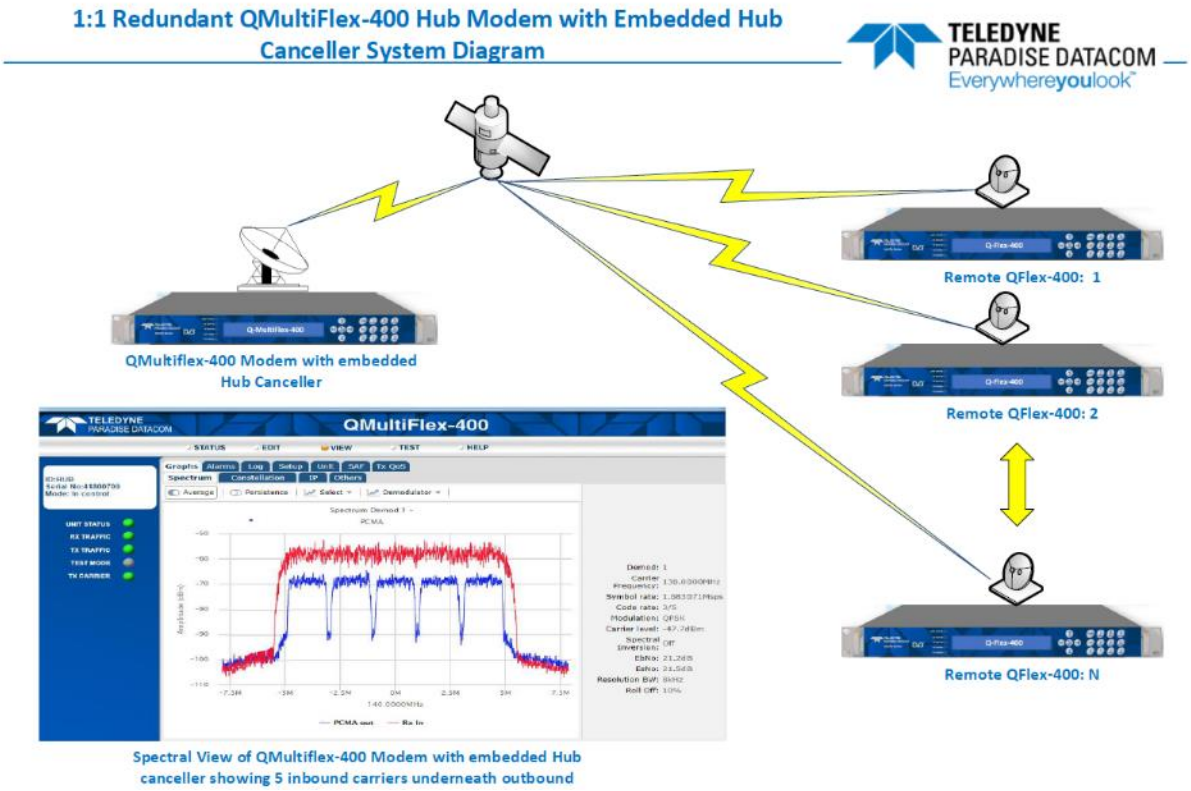


Figure 8-6 QMultiFlex-400™ Hub Canceller System Diagram

8.3.1 HUB Hardware Configuration

Check within the 'Hardware fitted' information box (View > Unit) that the QMultiFlex-400™ series hub Modem has 2x DVB-S2X interface cards installed. With the Hub canceller enabled the unit will support up to 14 demodulators, assuming all are enabled within the feature list.

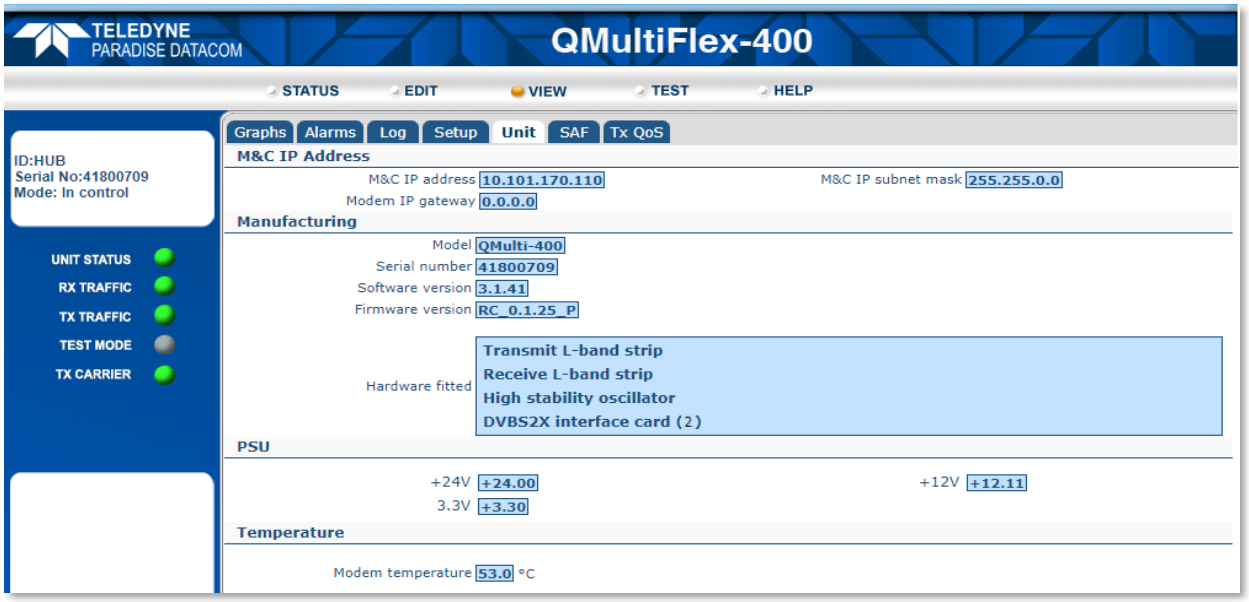


Figure 8-7 - QMultiFlex-400™ Hub Modem Unit information

Check within the feature list (View > SAF) that the QMultiFlex-400™ series hub Modem has sufficient demodulators enabled for the proposed network and that Paired Carrier™, up to the desired cancelling bit rate, is enabled.

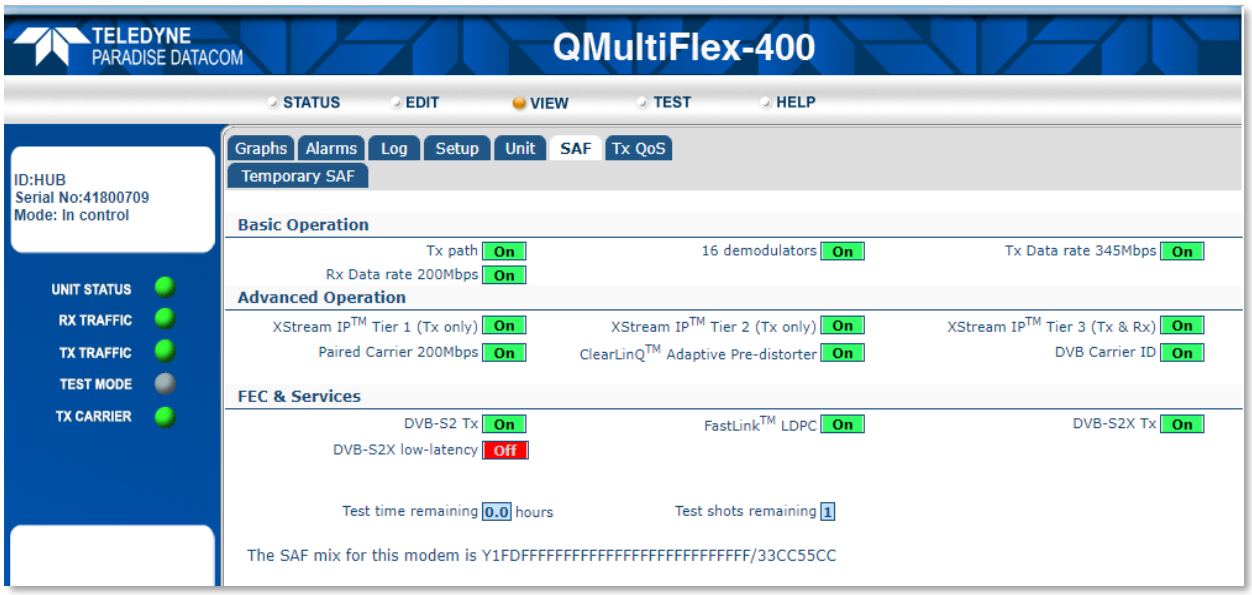


Figure 8-8 - QMultiFlex-400™ Hub Modem SAF information

8.3.2 Initial Configuration

The QMultiFlex-400™ supports the most powerful bandwidth saving technology available. With this in mind, the application note uses DVB-S2/X configurations, which are up to 60% more bandwidth efficient than any previously available modulation and coding schemes.

8.3.2.1 Hub Modem Configuration

Using the modem's embedded web server, navigate to the Edit > Service > General menu tab and configure as necessary. The following example configuration supports the hub canceller with 5 inbound carriers underneath the outbound carrier, as follows:

Heading	Parameter	Options	Configuration
System		Star / Mesh	**Star**
Tx Service	Tx Rate Control	Data / Symbol Rate	**Symbol Rate**
	Tx FEC Type	DVB-S2/X / Fastlink	**DVB-S2X**
	Tx Symbol Rate	100k – 70Msps	**10Msps**
Tx Mod and Coding	Tx Modulation	QPSK/8PSK/8/16/32 & 64APSK	**8PSK**
	Tx FEC Code Rate	Numerous, refer to Datasheet	**23/36**
	Tx FEC Frame Size	Normal / Short	**Normal**
Tx Carrier	Tx Freq Band	IF and L-Band	**IF**
	Tx Carrier Freq	50-180 MHz/950-2450MHz	**140MHz**
	IF Output Power	0 to -25dBm	**-2dBm**
	Modem Carrier	On / Off / Rx Enabled	**Initially Off**
	Tx Spectral Roll-Off	5/10/15/20/25/35%	**10%**
Receive General	Rx Freq Band	IF and L-Band	**IF**
	Rx Spectral Inversion	Normal / Inverted	**Normal**
Demod ID/Control	Demods 1 - 16	Enable / Disable	**Demods 1-4 & 7 Enabled**

Table 8-1 – Hub QMultiFlex-400™ Example Configuration

Navigate to the **Edit > Service > Demod 1 to 8** menu tab and configure each demodulator in turn:

Heading	Parameter	Options	Configuration
Demod 1	Rx Carrier Freq	50 – 180MHz	**136.0000**
	Rx Symbol Rate	180k – 40Msps	**1.683071Msps**
	Demod Enable	On / Off	**On**
Demod 2	Rx Carrier Freq	50 – 180MHz	**138.0000**
	Rx Symbol Rate	180k – 40Msps	**1.683071Msps**
	Demod Enable	On / Off	**On**
Demod 3	Rx Carrier Freq	50 – 180MHz	**140.0000**
	Rx Symbol Rate	180k – 40Msps	**1.683071Msps**
	Demod Enable	On / Off	**On**
Demod 4	Rx Carrier Freq	50 – 180MHz	**142.0000**
	Rx Symbol Rate	180k – 40Msps	**1.683071Msps**
	Demod Enable	On / Off	**On**
Demod 7	Rx Carrier Freq	50 – 180MHz	**144.0000**
	Rx Symbol Rate	180k – 40Msps	**1.683071Msps**
	Demod Enable	On / Off	**On**

Table 8-2 – Hub QMultiFlex-400™ Example Configuration

8.3.2.2 Remote Modem Configuration

Navigate to the Edit > Tx-Rx > Service tab and configure as necessary. Example remote Modem configuration, as follows:

Heading	Parameter	Options	Configuration
Service	Terrestrial Interface	IP	**IP**
	Tx Service	DVB-S2/X / Fastlink / Closed Net	**DVB-S2**

	Tx Rate Control	Data / Symbol Rate	**Data Rate**
	Tx Data Rate	120k – 60Mbps	**2Mbps**
	Tx Clock Source	Internal / Tx Clk In / Rx Ref	**Internal**
	Rx Service	DVB-S2/X / Fastlink / Closed Net	**DVB-S2X**
	Rx Rate Control	Data / Symbol Rate	**Symbol Rate**
	Rx Symbol Rate	150k – 50Msps	**10Msps**
Mod & Coding	Tx Modulation	QPSK/8PSK/16APSK/32APSK	**QPSK**
	Tx FEC Code Rate	Numerous, refer to Datasheet	**3/5**
	Tx FEC Frame Size	Normal / Short	**Normal**
	Rx Modulation	QPSK/8PSK/16/32/64APSK	**8PSK**
	Rx FEC Code Rate	Numerous, refer to Datasheet	**23/36**
	Rx FEC Frame Size	Normal / Short	**Normal**
Carrier	Tx Freq Band	IF / L-Band	**IF**
	Tx Carrier Freq	50 – 180MHz	**136MHz**
	Tx Spectral Roll Off	5/10/15/20/25/35%	**10%**
	IF Output Power	0 to -25dBm	**-20.3**
	Modem Carrier	On / Off	**Initially Off**
	Rx Freq Band	IF / L-Band	**IF**
	Rx Carrier Freq	50 – 180MHz	**140MHz**
	Rx Spectral Roll Off	5/10/15/20/25/35%	**10%**

Table 8-3 – Remote QFlex-400 Example Configuration

In addition, set Point to Multipoint mode within all remote Modems: Navigate to the Edit > IP > Advanced page and scroll down to the Point to Multipoint Operation field and set to Point to Multipoint

Note: Any parameters omitted from the tables are disabled.

8.3.3 Initial Measurements

These initial measurements are performed to ensure the hub carrier can be received by each of the intended remotes and each remote, in turn, can be received by the hub prior to the hub canceller being enabled.

8.3.3.1 Initial Performance Measurements, Hub Canceller Disabled

Enable the Hub outbound carrier and take a performance snapshot of the links in terms of the Es/No of the hub OB carrier as received by each remote. Record within the table below. Configure one of the demodulators within the Hub Modem to receive its own transmit carrier off satellite. This may mean reducing the transmit carrier to be below 40Msps if a large outbound carrier is being used (40Msps is the maximum symbol rate for each individual demodulator). Remember to reduce the Tx power too, if reducing symbol rate! Then, with a Hub demod locked to its own transmit carrier, ensure the Rx carrier offset frequency falls within the Rx demodulator carrier offset search range, which is fixed at +/-20kHz. If this is not the case, adjust the modem's Rx carrier frequency, accordingly. The reason for this is as follows:
The in-bound Rx carrier center frequencies (there could be 2 to 14 of them) are independent of the centre frequency of the received echo, which the canceller must suppress. So, when it comes to ensuring that the Rx carrier offset frequency reported by one of the demods when locked to the echo is less than ±20kHz, any correction has to be made to the Paired Carrier "Rx Carrier Frequency" entry field. So, for example, when Paired Carrier is disabled and the Tx uplink carrier is enabled. We configure one of the demods to receive and synchronise to its own transmission. We note the Rx carrier offset frequency. Let's say the carrier offset frequency is -57.329kHz away from the 140MHz we were expecting it to be.

Then we would configure the Hub Modem to use (140.0e6-57.329e3=) 139.942671MHz, the true center frequency of the echo signal.

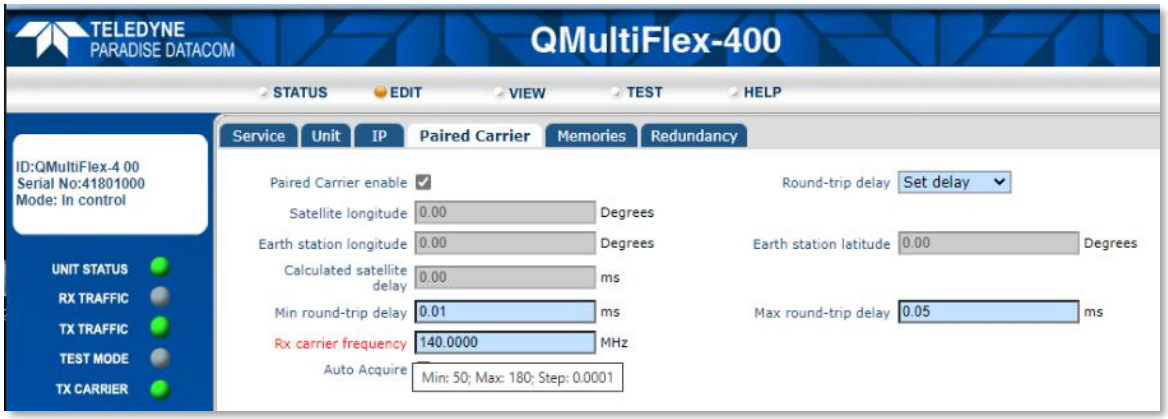


Figure 8-9 - QMultiFlex-400™ Rx Carrier Frequency Field

On completion, restore the hub demodulator configuration and drop the hub transmit carrier.

Enable the IB remote carriers one at a time and again take a performance snapshot of the links in terms of the Es/No for each remote IB carrier as received by the hub. Drop each IB carrier when enabling the next. Once each IB carrier has been measured / recorded, enable all the IB carriers. (This is to ensure there are no overlapping carriers, which will prevent the hub multi-demodulator from locking.) Ensure all Hub demods lock.

Hub Demod status can be noted from the Status > Demod 1 – 8 menu tab:

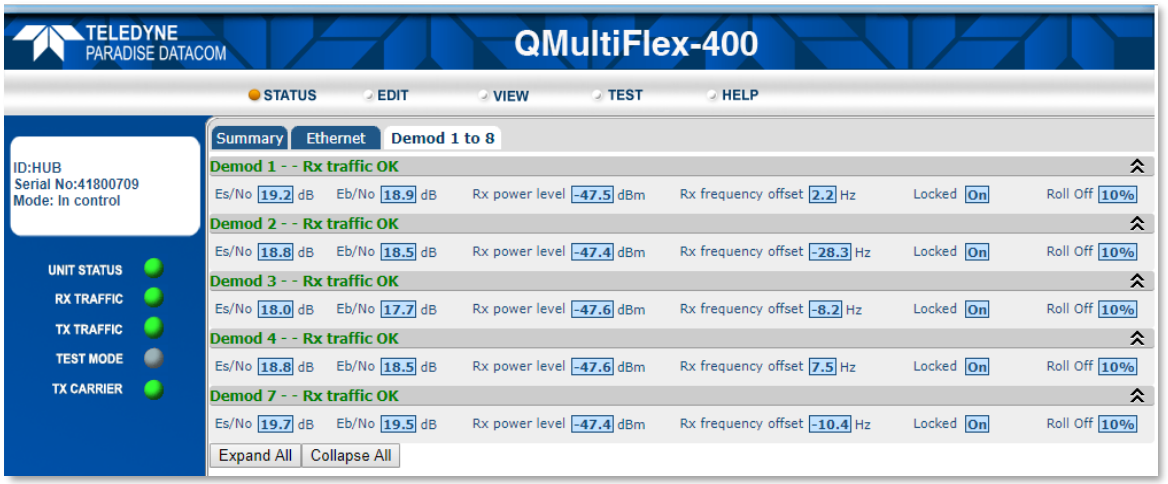


Figure 8-10 – QMultiFlex-400™ Demod Status

QFlex-400 series Remote Modem Es/No can be noted from the **Status** screen:

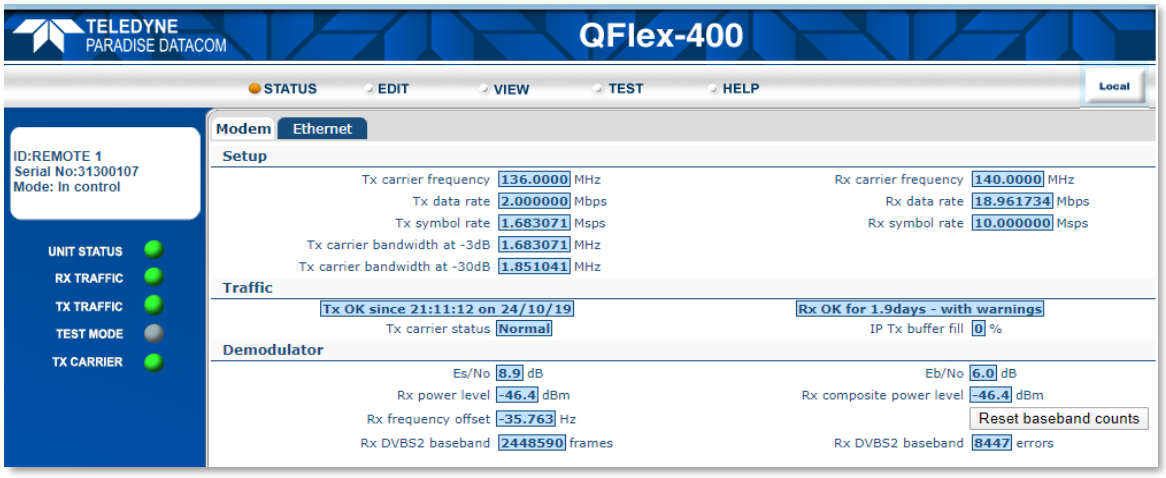


Figure 8-11 – QFlex-400 Status Screen

Record the measured levels within the table below to compare when the hub canceller is enabled.

Remote Modem	Hub Es/No	Remote Es/No
Remote Modem 1		
Remote Modem 2		
Remote Modem 3		
Remote Modem 4		
Remote Modem 5		
Remote Modem 6		
Remote Modem 7		
Remote Modem 8		
Remote Modem 9		
Remote Modem 10		
Remote Modem 11		
Remote Modem 12		
Remote Modem 13		
Remote Modem 14		

Table 8-4 – Record Initial Hub and Remote Modem Es/No Values

8.3.4 Canceller Operation

The round-trip time is used to calculate the time offset between the Local TX signal and the RX data containing the Near TX signal. The more accurately the earth station latitude/longitude, and satellite longitude configuration, or actual round trip delay parameters are entered, the faster the acquisition time will be. After initial acquisition, a continuous 24-hour period is required for the software to determine and store an accurate round-trip time. If using delay, check the canceller delay graphs to ensure the maximum and minimum excursions accurately match the entered delay parameters. If need be, the round-trip delay parameters can be honed to ensure optimum performance.

8.3.4.1 Enable Hub Outbound Carrier and Canceller

Enable the Hub Modem's carrier. The remote Modem demodulators will lock, at the same time the hub multi-demodulators will unlock. Configure the Hub Canceller: Enable the Hub Canceller: (Edit > Paired Carrier)

Heading	Parameter	Options	Configuration
Paired Carrier	Paired Carrier Enable	On / Off	**On**
	Round-trip delay	Set Location/delay/GPS	**Set delay**
	Satellite longitude	-180 to +180	**N/A**
	Earth station longitude	-180 to +180	**N/A**
	Earth station latitude	-90 to +90	**N/A**
	Min round-trip delay	0 - 300ms	**(0.01ms for Bench test)**
	Max round-trip delay	0 - 300ms	**(0.05ms for Bench test)**

Table 8-5 – Hub Canceller Menus

8.3.4.2 Hub Canceller Configuration

Round Trip Delay: The configuration of the Hub canceller round trip delay depends on whether the Round-Trip Delay (RTD) from the hub to the satellite is known or not. If you already know the RTD, simply set this to `Set delay` and enter an RTD sweep range into the canceller. This delay range needs to be wide enough to encompass the actual RTD swing, but not so wide that the canceller takes an extended time period to acquire. So, if the mean RTD is known, enter a minimum delay of 0.5ms below the mean and a maximum delay of 0.5ms above the mean.

Set Location: If you don't know what the RTD is, specify the geographical location of the Hub-station and the satellite longitude. An estimate of the RTD will be displayed given your satellite and ground-station co-ordinates. The Hub Canceller is then able to derive a suitable delay sweep range for the canceller to operate.

Use GPS: Alternatively, if the modem is connected to a GPS tracker via its rear-panel serial port, the station co-ordinates can be read by the modem from the GPS serial "NMEA" messages. With the GPS geo-location data, together with the satellite longitude entered by the user, the modem can automatically program the canceller with a suitable delay sweep range. The use of a GPS tracker is sometimes used in Comms-On-The-Move (COTM) mobile systems or terminals. As the terminal moves and its geo-location changes, the modem will update the minimum and maximum delay sweep range settings for the canceller automatically.

In addition to the Round-Trip Delay entries covered above, there is a fourth method, where the Hub canceller is set to `Auto Acquire`. Once enabled, this involves the Hub canceller finding out for itself what the RTD is for the looped satellite communications path, without any user involvement. Auto-acquisition may take a few seconds longer compared to the above methods where a narrow delay sweep range is defined. When `Auto-Acquire` is selected, it will grey out the other delay methods and prevent them from being selected.

The control page has an extra element over the standard Paired Carrier of SCPC Modems, termed `Rx Carrier Frequency`. Ascertain the centre frequency of the returned echo and enter this in the Rx Carrier Frequency field (the carriers overlap on satellite, so the returned echo frequency may be different to the configured Modem Tx frequency!).

When the method for establishing the round-trip delay is set to Set location then the satellite delay calculated by the modem will be displayed. This can be used to reduce the

acquisition time by setting minimum and maximum delay values based around the calculated value. It can also be compared to the actual satellite delay reported on the Status screen.

8.3.4.3 Lab Configuration

If initially testing the Hub canceller in a lab environment, where the hub and remote modems are co-located, the RTD will be approximately 0 (unless a satellite delay simulator is used in the signal path) as there will be no significant delay in the echoed signal. In such a case, set the RTD control to `Set delay` and simply set the minimum delay to 0.01ms (the minimum value) and the maximum delay to 0.05ms, as below:

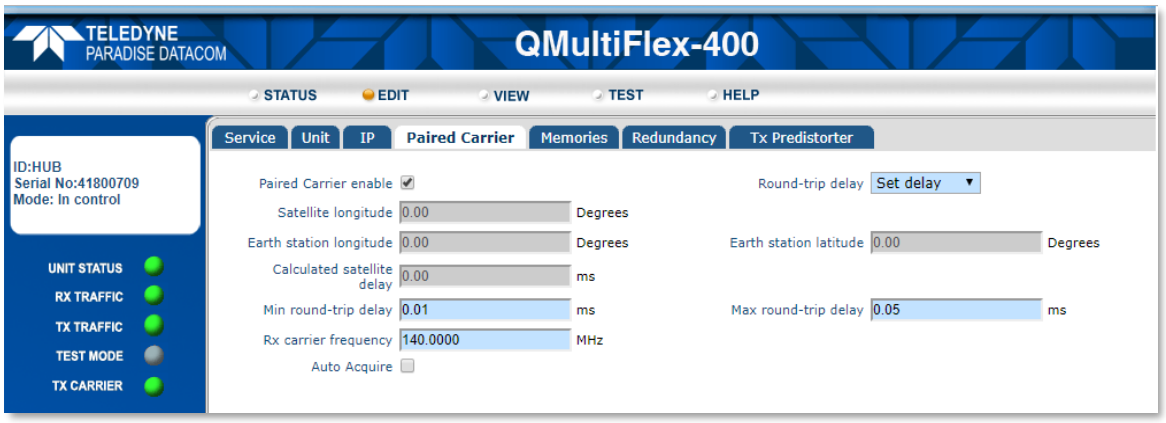


Figure 8-12 - Hub Canceller Menus - Lab Configuration

8.3.4.4 Paired Carrier Enable

Enable the canceller using the tick box. Depending on the type of Round-Trip Delay, initial acquisition usually takes between 15 to 60 seconds. The delay acquisition progress can be viewed on the modem's `Status` page. When the canceller comes into lock, the downstream demodulators should also lock, as should the down-stream FEC decoder etc.

On the status Web GUI page, the canceller will report the RTD in milliseconds to a resolution of 1µs. It will also report the near/far carrier power ratio; that is, the ratio in power between the received echo and the signal of interest being received from the far stations. Furthermore, the offset frequency of the received echoed carrier will also be displayed.

To view the Hub Canceller graph, select View > Graphs > Spectrum and use the sub menu `Select` and drop down to the PCMA graph. A two-trace spectrum will be displayed, as shown in figure 8-13. The red trace shows the signal spectrum as received by the canceller off satellite. The blue trace shows the signal spectrum exiting the canceller and being presented to the downstream demodulators. Note: the IB carriers don't all have to be contained within the OB carrier bandwidth; they can overspill if there are more carriers than will fit under the outbound. Please refer to the examples in figures 8-14 and 8-15. If the canceller fails to lock, refer to the troubleshooting guide within the following sections.

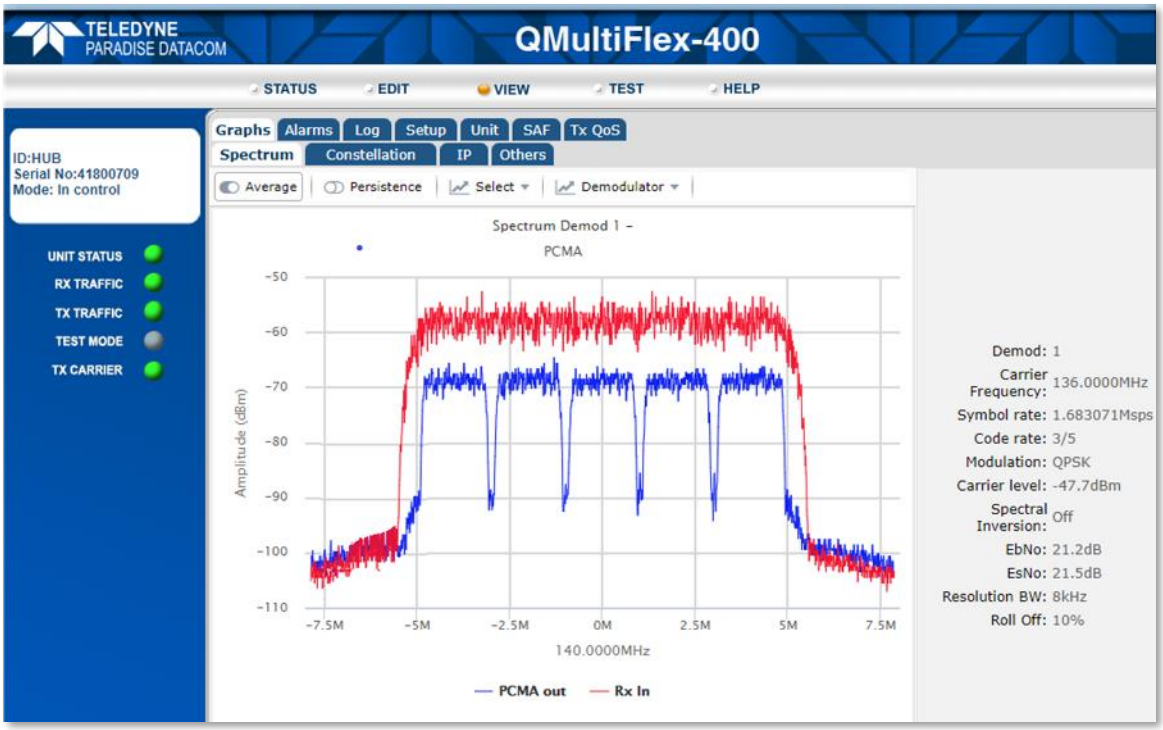


Figure 8-13 - Hub Canceller Spectra

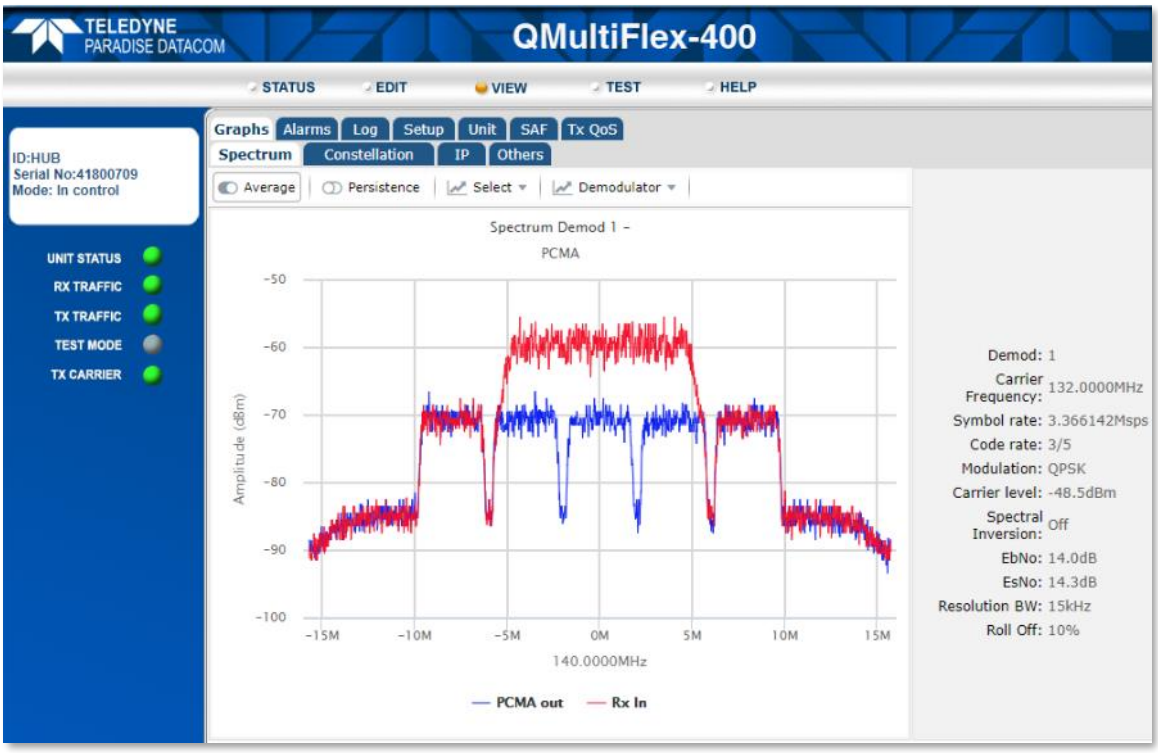


Figure 8-14 - Hub Canceller with overspill IB carriers

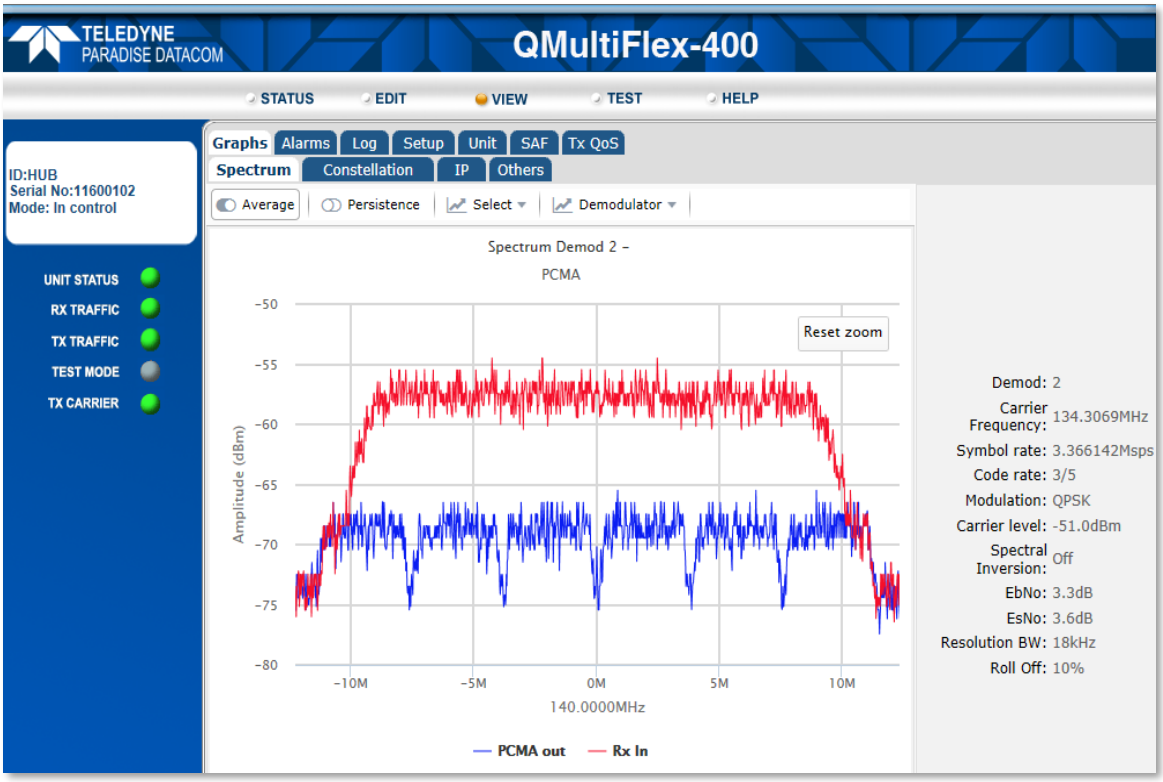


Figure 8-15 - Hub Canceller with overspill IB carriers

The typical summary status page for a QMultiFlex-400™ hub modem is shown below:

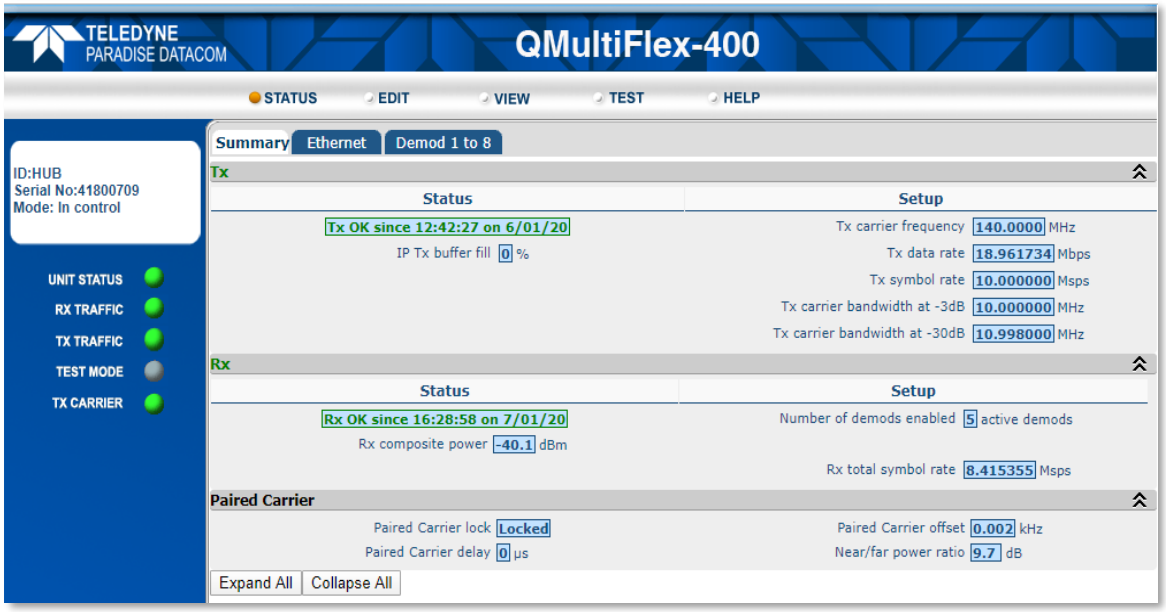


Figure 8-16 - Hub Canceller Metrics

Figure 8-16 shows four Paired Carrier hub canceller monitor values:

1. Paired Carrier Lock: Shows real-time lock status. Should the canceller lose lock, an alarm will appear on the `View > Alarms` menu. The alarm will also be registered in the log file, which can be viewed by navigating to `View > Log` menu page.

2. Paired Carrier delay: In the above example, the delay is zero because the system was running in a laboratory environment without a satellite delay simulator. If the canceller is unlocked, an indication of the delay sweep status is displayed.

3. Paired carrier offset: This represents the frequency offset of the received echo relative to its expected frequency location.

4. Near/Far power ratio: This is simply the ratio between the near power level (i.e. the power level associated with the received echo) and the sum of the IB carrier power levels from the far or remote stations. This power ratio should be in the range -10dB to 10dB for normal operation.

It is possible to zoom into an area of the plot that may be of particular interest. Use the mouse cursor to drag over the area of interests.

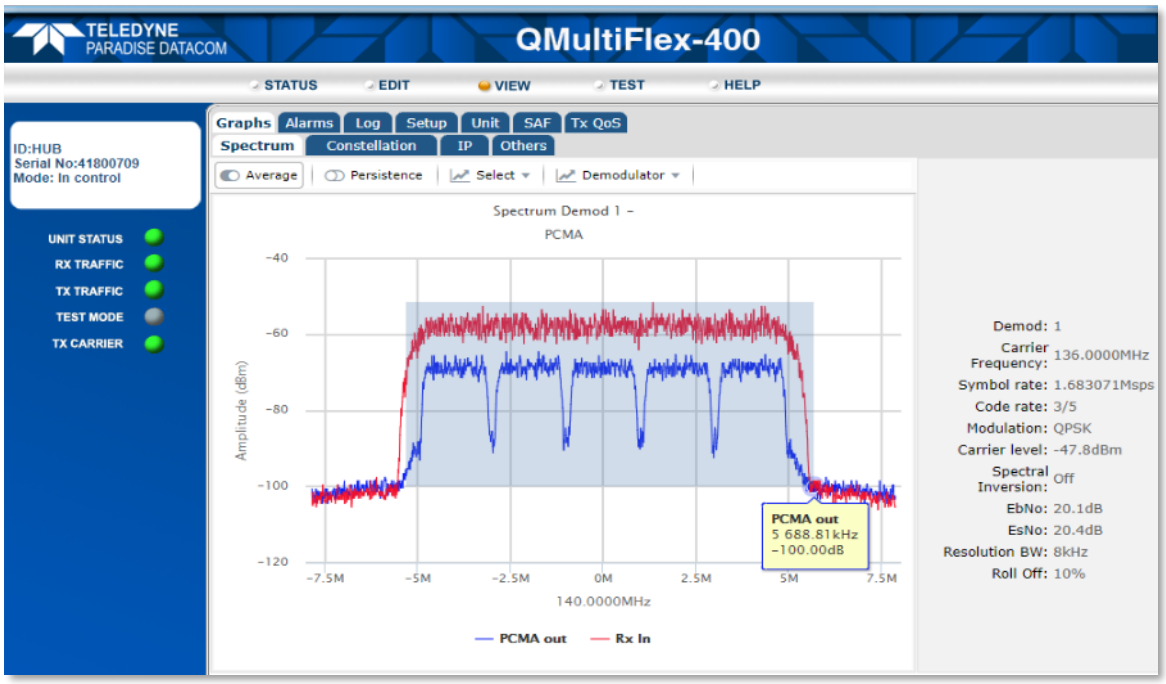


Figure 8-17 – Selecting an Area to Zoom

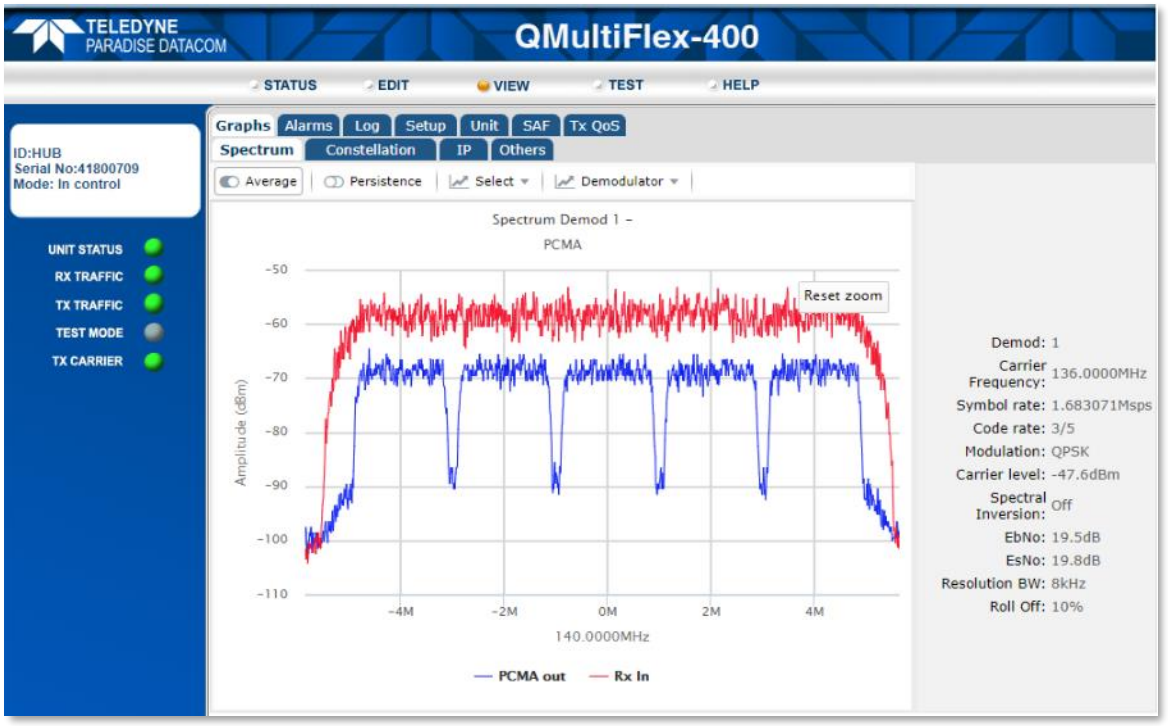


Figure 8-18 – The Selected Zoomed Area

Repeat and compare the measurements of the hub and remote Es/No metrics to those obtained prior to the canceller being enabled, as recorded in Table 8-4.

Remote Modem	Hub Es/No	Remote Es/No
Remote Modem 1		
Remote Modem 2		
Remote Modem 3		
Remote Modem 4		
Remote Modem 5		
Remote Modem 6		
Remote Modem 7		
Remote Modem 8		
Remote Modem 9		
Remote Modem 10		
Remote Modem 11		
Remote Modem 12		
Remote Modem 13		
Remote Modem 14		

Table 8-6 – Canceller Enabled, Hub and Remote Modem Es/No Values

Comparing the Rx Es/No values when the Hub Canceller is enabled, to those shown previously where the Hub Canceller was disabled, we would expect the canceller to offer approximately 0.1dB to 0.2dB of system degradation to each received channel (i.e. the Rx carriers as measured at the Hub). This is because the hub-canceller has a finite near-signal suppression performance of between 25 and 32dB depending on operational configuration. (Figure 8-17 shows that the hub canceller near-signal suppression performance is just over 30dB).

Similarly, the IB carriers are viewed as being white noise contributors and therefore these interfere with the OB carrier and will degrade each remote Modem's Rx Es/No. i.e. the remotes will see the OB carrier plus satellite channel system noise, plus self-interference from their own carriers.

If, for example the degradation to the Remote Rx Es/No is 2dB's, then the OB carrier power can be increased (if the system is not power limited) to mitigate this additional IB Noise. If the system is power limited, then it is not possible to increase the hub OB carrier power by the 2dB in the example above to mitigate the effects of the self-interference by the remotes to their own Tx carriers. In such circumstances, 2dB must be taken off the threshold C/N for the OB carrier and if necessary, the MODCOD of the OB carrier de-rated to compensate. i.e. the OB carrier MODCOD would need to be chosen with a threshold 2dB's lower than the current QEF Es/No.
For example, if 16APSK-L 2/3 is used for the outbound carrier, which has an QEF Es/No of 8.6dB, reducing this by 2dB would put the required QEF Es/No at around 6.6dB Es/No. Therefore, candidates would be:

1. 16APSK 1/2-L having a QEF Es/No of 6.3dB.
2. 8PSK 23/36 having a QEF Es/No of 6.4dB.

In this example, a de-rated OB MODCOD of 16APSK 1/2-L would have a higher spectral efficiency, than the 8PSK option. However, keeping the symbol rate of the carrier unchanged would drop the OB carrier bit rate!

8.3.5 Summary

1. The hub canceller operates very well in a linear system. In various scenarios, it added only 0.1-0.2dB of system degradation when enabled. This small degradation is caused by the finite suppression of the received hub echo signal.
2. In systems that are not power limited, the power level of the hub OB carrier can be increased as a countermeasure to the degradation caused by the presence of the IB carriers under the OB.
3. In systems that are power limited, the hub OB carrier MODCOD can be de-rated to ensure link integrity for a lower SNR received at the remote modems. This obviously has a knock-on effect to both the OB carrier spectral efficiency and hence also its data throughput which may or may not be an issue. In the scenario given in this document, the OB carrier was de-rated from 16APSK-L 2/3 (QEF Es/No = 8.6dB, spectral efficiency = 2.635236b/s/Hz) to 16APSK-1/2L (QEF Es/No = 6.3dB, spectral efficiency = 1.972253b/s/Hz), a reduction in threshold of (8.6-6.3=) 2.3dB, an amount roughly equivalent to the degradation by the IB carrier self-interference at the remote modem Rx input ports.
4. The system should always be operated under linear conditions. Consequently, the suppression performance of the hub canceller will be at its maximum. However, if the hub uplink-downlink loop – which is relied upon by the canceller - operates non-linearly, then the suppression performance of the canceller may be compromised, as illustrated in the figure below. The suppression performance will be limited to the spectral regrowth level of the OB carrier when passed through the uplink-downlink loop. There is justification in ensuring that the satellite channel and the hub uplink HPA operate as linearly as possible in these applications.

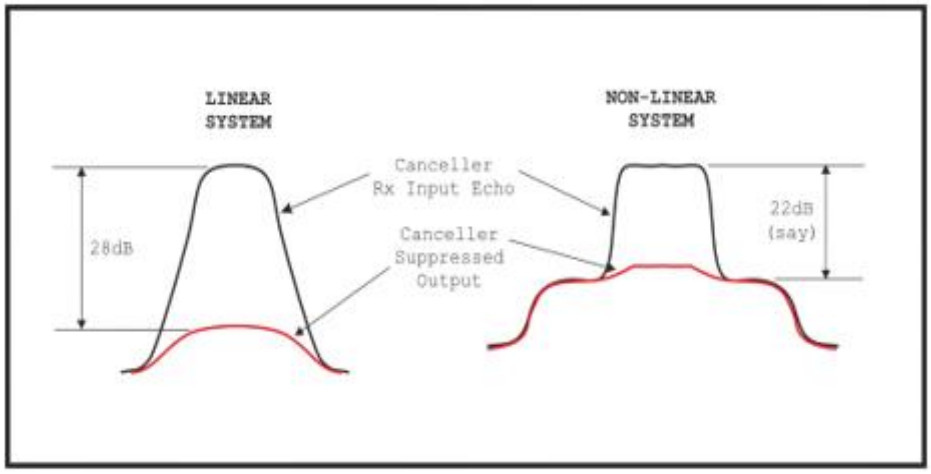


Figure 8-19 – Effect of Non-Linearity on Canceller Suppression

5. There appears to be two challenges in realising a working system:
   a. Countering the self-interference of the remote modems to their own IB carriers. In the test cases, the effect of the self-interference amounted to an equivalent 2dB increase approximately in No.
   b. Ensuring that the hub uplink-downlink signal loop is designed to run linearly to ensure the suppression performance of the hub canceller is not significantly compromised.

8.3.6 Troubleshooting Guide

8.3.6.1 Why Can I Not Enable the Hub Canceller?

For the Hub canceller to be enabled, you need the hardware to host it. To verify you have the hardware, navigate to `View > Unit` menu screen, as follows:

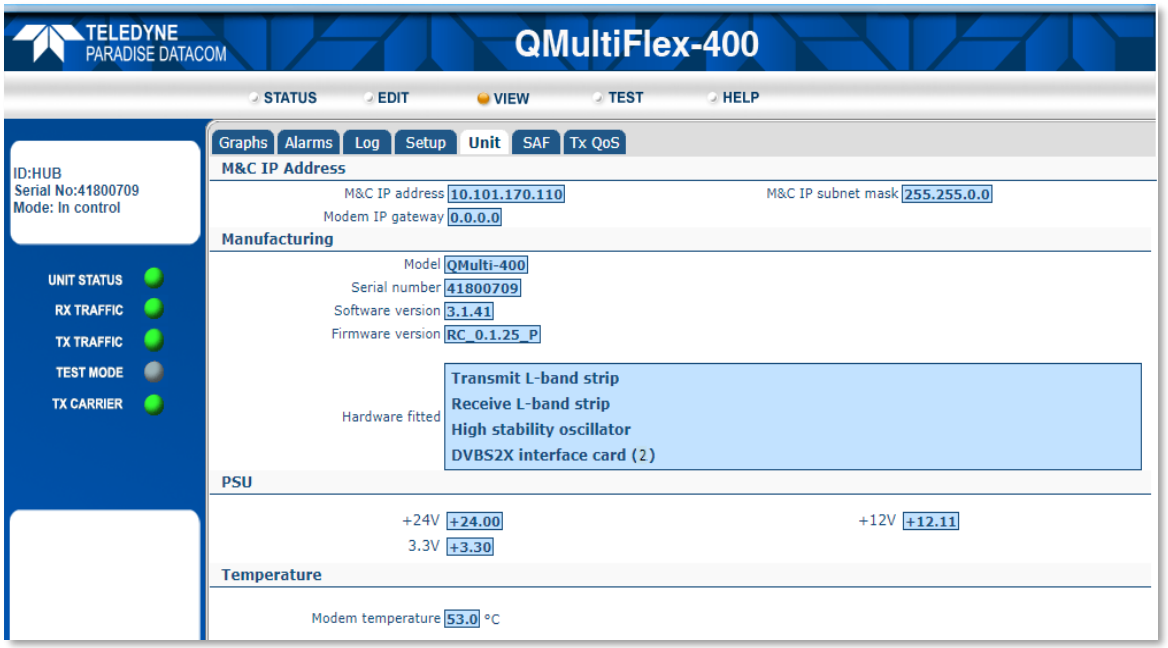


Figure 8-20 - QMultiFlex-400™ Hub Modem Unit information

Under the sub heading Manufacturing, is a Hardware Fitted list. This must contain 2x DVBS2X Interface Cards, one which provides the Hub canceller functionality. In addition to the Hardware, a software feature code is necessary (SAF). To verify whether or not you have the SAF code to run the Hub Canceller feature, navigate to View > SAF menu. An example is shown below:

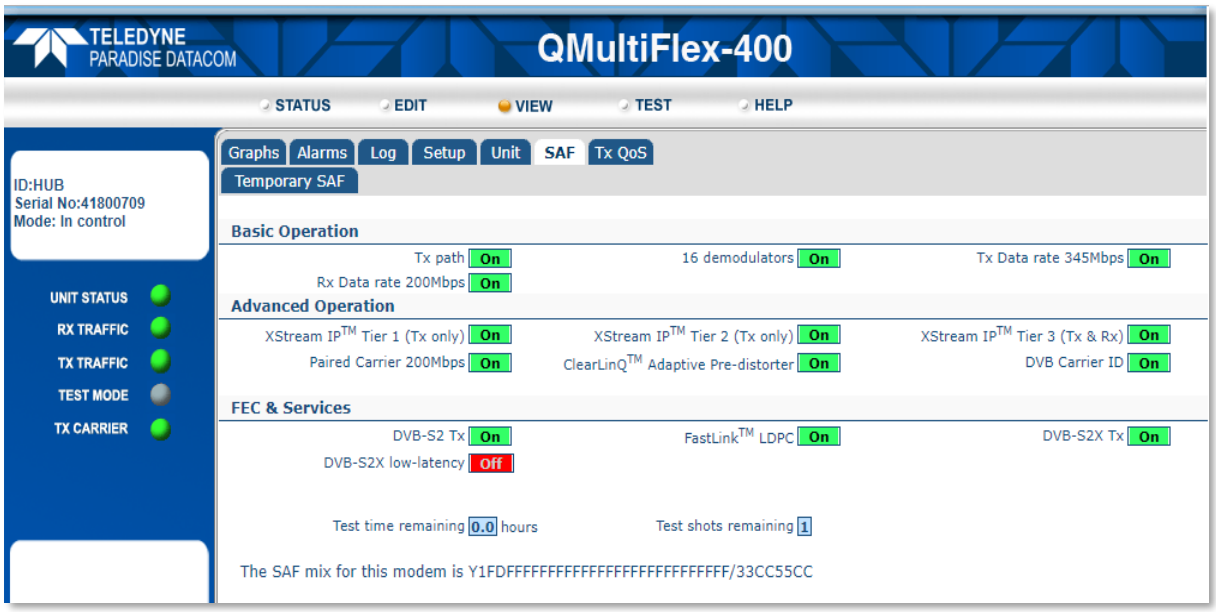


Figure 8-21 - QMultiFlex-400™ Hub Modem SAF information

Under the Advanced Operation sub menu, check to see whether you have a Paired Carrier SAF with a green On label associated with it. If you have then you should have access to the feature. If there is a red Off label against it, then you don't. Under these circumstances, please contact your distributor to purchase the necessary SAF code.

8.3.6.2 Why Does The Hub Canceller Not Lock?

The Hub canceller is a complex subsystem. It can take a while to commission it successfully. By far the best way of bringing up the Hub Canceller is to first ensure it is disabled and enable one of the inbound links at a time, then enable the outbound carrier from the hub to all of the remotes. If any link fails to meet expectations in terms of synchronisation, received signal level, signal to noise ratio, frequency offset etc. then it won't meet expectations when the Hub Canceller is enabled. Once your links are operational with the Hub Canceller disabled, you will be in a better position to diagnose any issues that may exist when the Hub Canceller is enabled. Follow the steps listed in section 4 and onwards for further details on how to commission a Hub Canceller link and how to configure the canceller's delay sweep parameters used as part of its acquisition process. The commonest reasons for failure to lock are:

1. Configuration or Frequency Planning Error

Ensure the Hub Canceller delay or geo-coordinates are entered correctly. Check the Hub Modem configuration and that the outbound carrier occupies the expected space segment on satellite. Ensure the inbound carriers are all configured correctly in terms of frequency, amplitude and that they are spaced sufficiently so as not to interfere with neighbouring carriers. Check these carriers are in the correct space segment on satellite, drop the Hub outbound carrier to facilitate this.

2. Spectral Inversions wrong
There is a spectral inversion in the communications path preventing the canceller to correlate its local reference to the received echo. This is a common problem and stems from a confusion on how to correct for spectral inversions; should they be corrected in the Tx path or Rx path? In our experience, the management of spectral inversions in a communications path can be best handled by ensuring that a datum or reference spectral inversion state exists somewhere in the system. By far the best rule is to ensure that signals arriving at (and hence also leaving from) the satellite are in a spectrally non-inverted state. This creates a datum or reference state from which everyone in the organisation can work with and easily remember. So, for example, if a C-band BUC is being used with a high-side LO frequency, it will create a spectral inversion on the uplink signal. In order for the satellite to receive and transmit a spectrally non-inverted signal (i.e., the agreed datum state), apply a Tx spectral inversion in the modem. Conversely, if an LNB is being used that spectrally inverts, then apply an Rx spectral inversion in the receive path of the modem to correct it. The user knows a modem Rx spectral inversion is needed because the datum state of signals transmitted and received by the satellite are spectrally non-inverted. This simple rule cuts through all the confusion that often accompanies spectral inversion management and control of signals in satellite communications links.

3. Delay Acquisition Sweep Width Settings
The delay acquisition sweep range has been set incorrectly. The actual RTD of the communications channel lies outside the Hub Canceller acquisition delay sweep range. Try widening the search range or using auto-acquire.

4. The Hub Canceller Rx Carrier Frequency is incorrectly configured
The hub Canceller will search a frequency sweep range identical to that of the demodulator (which is fixed by the Modem and dependent on symbol rate). If the echo frequency lies outside the frequency search range, then Hub Canceller will not acquire it. Check and update the Rx carrier frequency to the correct value.

8.3.6.3 Why does the Hub Canceller Lose Lock after Acquiring?

There are a number of potential causes for the canceller losing lock after having successfully acquired:

1. The uplink signal gets interrupted. If the uplink signal gets interrupted, then the echo in the received signal to which the canceller attempts to lock will disappear. Under these circumstances, the canceller may lose lock. Such an interruption might be caused by:
a. An object physically impeding the downlink signal, e.g., a helicopter flying in front of the antenna interrupting the received signal, a train or coach hosting a satellite communications system passing through a tunnel etc.,
b. Poor or inaccurate antenna pointing in mobile applications,
c. A muting of the uplink signal.
d. The delay acquisition sweep width settings are set too narrow. The canceller may acquire initially, but as the satellite changes orbital position throughout a 24-hour period the RTD will vary, if the RTD configuration does not cover the maximum and minimum excursions of the RTD, then the canceller may lose lock. The RTD is displayed graphically in View > Graphs > PCMA > PCMA Delay. Note the maximum and minimum RTD and use these values to refine the acquisition delay sweep specification of the canceller in the Edit > Paired Carrier menu.

2. The satellite orbit inclination is too great. Most geostationary satellites are positioned and maintained at 0° latitude to within a few tenths of a degree. Towards the end of a satellite's operational life, the ability to maintain its position diminishes as its propellant resources decrease. Consequently, the requirements on maintaining the satellite's orbit might be allowed to relax. As a result, it might be allowed to operate on a slightly inclined orbit as a way of extending its lifetime. A consequence of operating the satellite on an inclined orbit is the increase in the maximum rate of change in the carrier RTD and frequency offset Doppler. If the satellite orbit inclination becomes too great, the canceller might not be able to track these maximum rates of change. The maximum rate of change of RTD occurs twice a day, as does the maximum rate of change of frequency Doppler, but they are not in phase with one another. An example of this is shown below in Figure 8-22 and 8-23. These graphs show the simulated RTD and frequency offset Doppler profiles of Intelsat-12 observed from London.

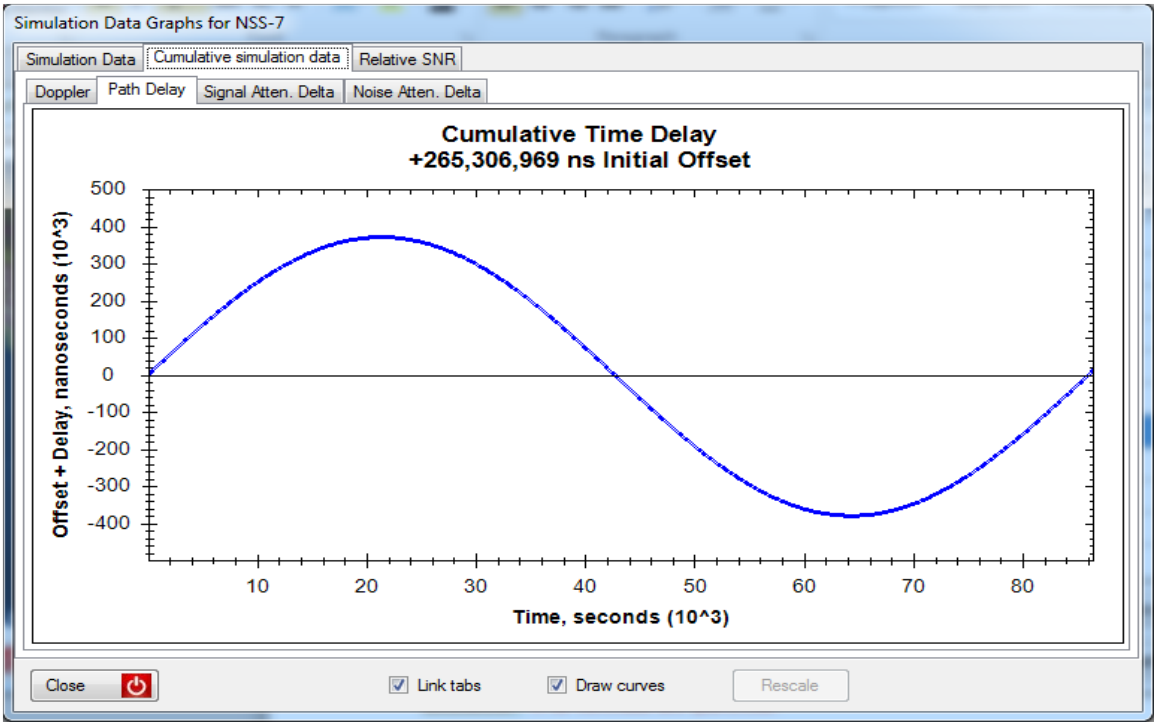


Figure 8-22 – Round Trip Delay of Intelsat-12 as seen from London

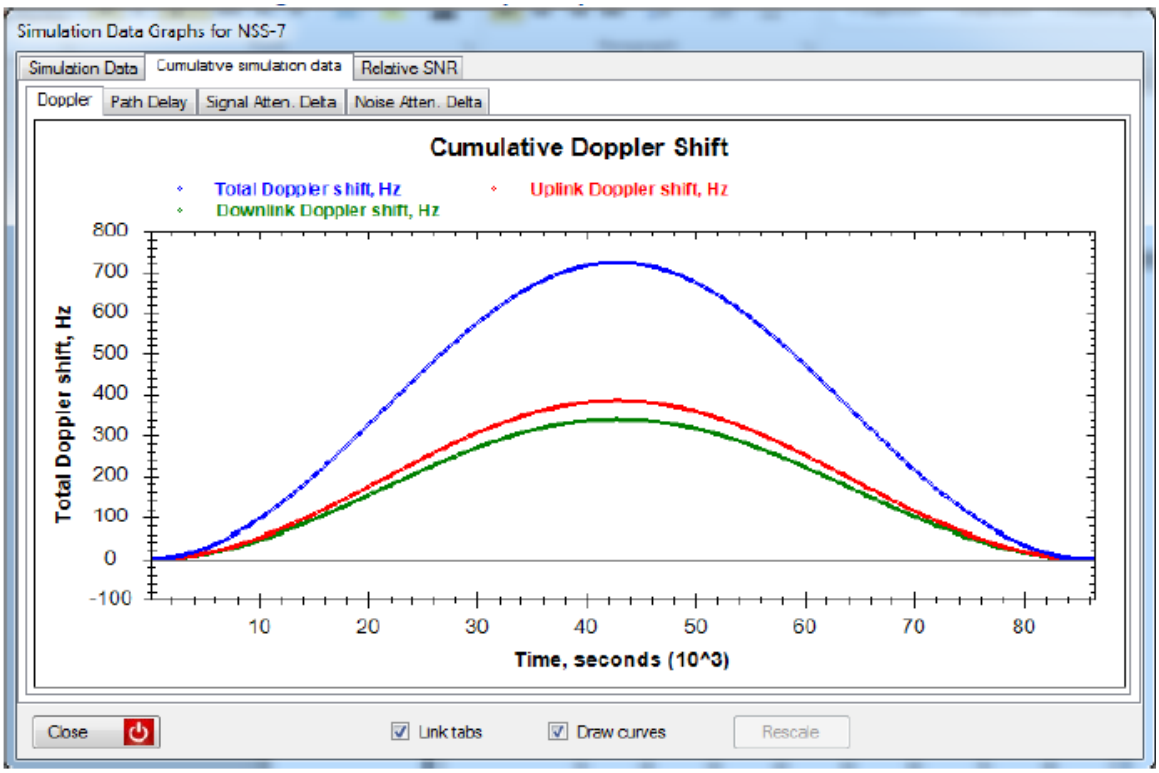


Figure 8-23 – Cumulative Doppler Shift of Intelsat-12 As Seen from London

Figure 8-22 shows the delay Doppler varying sinusoidally over the course of 24 hours (86400 seconds), as does the frequency offset Doppler in Figure 8-23. However, when the rate of change of the RTD Doppler is at a maximum in Figure 22 at t=0, the rate of change of the frequency offset Doppler is zero. So, the maximum and minimum rates of change of RTD and frequency offset Doppler occur 4 times a day spaced about 6 hours apart.
Provided the satellite orbit inclination is less than ±2.7°, the canceller will be able to maintain tracking. Thankfully, very few satellites have inclinations so large and the canceller will work reliably with most.

3. The Peak to Average Power Ratio (PAPR) of the composite carrier is too high for the satellite communications system to cope with. When two signals are combined together, as in the case with the Hub Canceller, the PAPR of the composite signal is higher compared to the PAPR of just one of the signals making up the carriers. For example, if you have a 16APSK signal with 5% roll off, the PAPR of the waveform might be say 7dB. If two such waveforms are combined to make an overlapped carrier pair, then the average power will increase by 3dB, but the sum of the peaks will increase by 6dB: a net 3dB increase in PAPR. Unless the satellite communications system has enough dynamic range to pass such signals, clipping or saturation on the peaks of the combined waveform may occur which could in turn compromise the suppression performance or tracking reliability of the canceller. In such circumstances, it might be beneficial to apply more back-off to amplifiers to prevent saturation or, alternatively, select a higher roll-off factor for the signals, which will reduce their individual and combined PAPR.

8.3.6.4 Why does the Hub Canceller Es/No Seem Unstable?

If you are operating at low symbol rates, e.g. below 512kBaud, the tracking bandwidth of the canceller becomes narrow. As a consequence, it becomes less easy for the canceller to track large phase noise variations in the received echo, if they exist. Elevated levels of phase noise sometimes occur in satellite communications links comprising low cost

downlink LNB's or uplink BUC components. If the canceller cannot adequately track the phase noise, the echo suppression performance of the canceller may become compromised, resulting in residual noise being passed on by the canceller to the downstream demodulator. This in turn can cause the received Es/No to become less stable. To mitigate this potential problem, it is advised that narrowband satellite communications links (i.e., less than 0.5MBaud) incorporating a canceller should be equipped with a low phase noise LNB in the downlink and a low phase noise BUC in the uplink. In particular, the use of LNB's and BUC's, with the ability to lock their internal local oscillators to an external reference supplied by the modem or some other low phase noise reference signal, is highly recommended, not only from a phase noise standpoint but also from a carrier frequency accuracy standpoint. Supplying LNB's and BUC's with external references ensures the phase noise associated with the uplink and downlink signals is minimised and reduces the phase noise tracking burden that would otherwise be placed on the canceller.

8.3.6.5 Why is the Es/No Worse when the Hub Canceller is enabled?

Most of the time, the Hub Canceller will provide robust operation and present only a small system degradation, in the order of 0.1 - 0.2dB.
However, signals of higher order modulations, e.g., 16APSK, 32APSK and so on, need to operate with higher signal to noise ratios in order to achieve error free link performance. As the operational signal to noise ratio increases, the residual noise exiting the canceller, due to its finite suppression performance, forms a higher proportion of the net noise passed on by it to the demodulator. Consequently, at higher SNR's, the canceller degradation will most likely increase.

There is a second potential cause of excessive degradation when the Hub Canceller is enabled. The Hub Canceller is essentially an echo canceller. Here, a reference copy of the uplink signal is suitably delayed, frequency, phase and amplitude aligned with the received unwanted echo to suppress it and reveal the signal of interest from the remote earth-stations. The amount of echo suppression - and hence canceller degradation - depends on how well the local reference correlates with the received echo. If, for whatever reason, the echo does not correlate very well with the local reference, then the suppression performance of the canceller will be compromised causing degradation to the received signal of interest. For example, if the communications link is operating non-linearly (e.g., one or more amplifiers in the communications link are being driven into saturation or clipping), then the received echo will be subjected to non-linear distortion for which the canceller is incapable of resolving: the canceller is a linear system. Hence, significant canceller degradation can arise if the satellite communications link is working non-linearly.

8.3.6.6 RTD Optimisation

If the Hub Canceller is locked, the modem will periodically log the canceller delay as a function of time. The RTD is displayed graphically in View > Graphs > PCMA > PCMA Delay. Observe how the RTD has varied over the course of several days. Note the maximum and minimum RTD and use these values to refine the acquisition delay sweep specification of the canceller in menu Edit > Paired Carrier. Refining the canceller's acquisition delay sweep will help minimise acquisition/re-acquisition times.

8.3.6.7 Hub Canceller vs No. of Rx channels

All QMultiFlex-400™ hub modems are fitted with hardware to support:
A) 14 Rx channels with a hub-canceller enabled or
B) 16 Rx channels (an extra two Rx channels) without the hub-canceller being enabled.

This allows the network to grow simply by acquiring the SAF options (licences) to get more channels rather than to purchase and install extra hardware. Logic resources are required to implement the cancellor function. The amount of logic resource to implement the canceller is the equivalent of just under two demodulators, hence, if the canceller is not being used, those logic resources can be assigned to implement two more Rx channels.
In summary, If the canceller is enabled, a maximum of 14 Rx channels can be implemented in the hub modem. If the canceller is not enabled, two more Rx channels can be implemented yielding a maximum of 16 Rx channels.

8.4 1:1 Redundancy Operation

8.4.1 Overview

Two modems can operate as a 1:1 redundant pair using a single interconnecting cable, two power splitters/combiners for both units. An IP switch for the traffic will need to be configured for fast IP switch-over. Both modems operate normally with respect to incoming data and RF signals, but only one modem enables its satellite and terrestrial outputs at any point in time. The IP port on the standby modem will be in a High-Z mode so not to interfere with network traffic.

Figure 8-24 illustrates how a 1:1 redundant pair is configured.

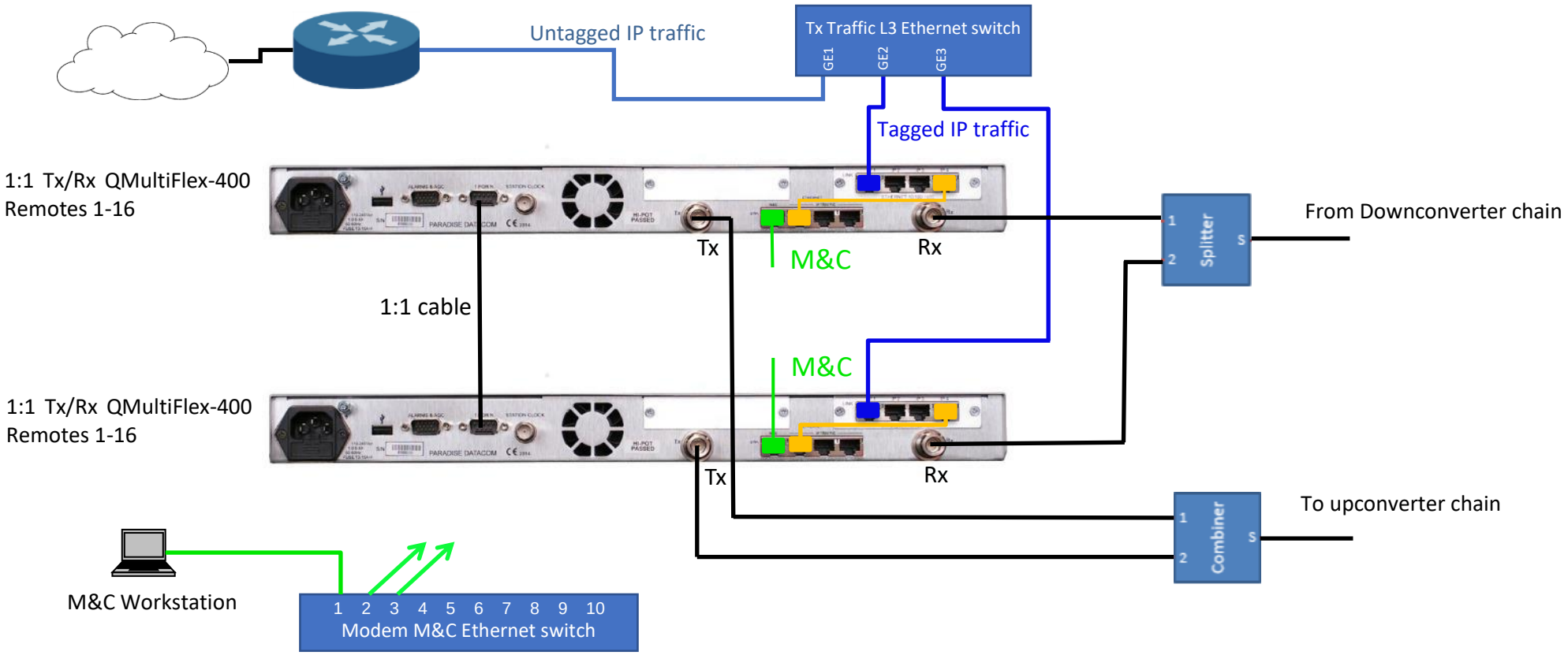


Figure 8-24 QMultiFlex-400™ 1:1 Redundancy System

8.4.2 Switching Operation

If a particular modem is required to be the 'online modem' then this should be powered up first. Alternatively, a manual switchover should be invoked once the modems have powered up. This is achieved by selecting the *Switch to standby* control on the *Edit->Redundancy->1:1* menu, which momentarily simulates a failure in the operational unit.

The Standby modem continually monitors its own status and the status of the online modem and will switch over to become the online modem automatically in the event that a fault occurs with respect to the online modem. The types of faults that will cause a switchover are configurable. Both unit and traffic faults can cause a switchover. Traffic faults that are external to the equipment that affect both units simultaneously do not result in any switchover. L-band services can be configured to switch with the modem or to remain with the online modem after it has failed.

In order to minimize unnecessary switchovers, a modem that experiences a failure will remain offline even if it returns to its normal working state. If it does return to a normal state, then it will act as the Standby unit.

8.4.3 Setup Procedure

A 1:1 redundant modem pair is set up as follows:

1. Ensure that both modems are running the same software version and are configured identically (the memory configuration can be copied over to a second modem). See next section on details of how to configure IP addresses in modem redundancy configurations.
2. Connect a suitable 1:1 cable between the 9-way 1:1 connectors on the two modems.
3. If the Ethernet traffic port is used on the modem, then the two traffic ports may be connected to a hub or other multi-port LAN device.
4. Connect the two transmit IF ports to the input ports of a suitable splitter/combiner of the correct impedance (50Ω) and the appropriate frequency range. The combined output is fed to the up-conversion equipment. Note that only one output is active at a time. Because of the signal loss associated with splitters/combiners, the power level at the output of each modem needs to be increased by approximately 3.5dB.
5. Connect the two receive IF ports to the two output ports of a suitable power splitter/combiner of the correct impedance (50Ω) and the appropriate frequency range. Both demodulators will receive an identical signal from the down-conversion equipment via the splitter/combiner. Because of the wide dynamic range of the modem AGC circuitry there should be no need to modify signal levels.
6. Check correct operation by performing a manual switch between the units (via the Edit->Redundancy menu). The pair will not switch over unless the Standby unit is fully operational. Note: the pair can be tested in loopback, but this requires the IF signals to be split and combined and looped back to both units in the one for one pair.

8.4.4 IP Addressing and Operation in Redundancy Configurations

8.4.4.1 1:1 IP Operation

The following rules should be observed when using 1:1 redundancy for IP.

1. In 1:1 mode, the M&C IP addresses need to be different for each modem.
2. In 1:1 mode, if using IP traffic addresses (e.g. in routing mode), these also need to be different for each modem. In bridging modes, the IP traffic address is not used.
3. The M&C Ethernet port must not be bridged to the IP traffic port (this is controlled via the *Bridge M&C* control on the *Edit->IP* screen).
4. The M&C IP address and the traffic IP address should be on different subnets. The modem defines one default gateway. If the second subnet also requires a gateway, then a static route should be added that defines a gateway for that subnet.

On the 1:1 Standby modem, the carrier is muted, as is the satellite receive port (in order to ensure that no received data is passed out of the terrestrial port). The M&C port and the terrestrial IP traffic port are not muted.

If a switchover occurs when in bridging mode, the Standby modem will automatically learn to bridge the traffic as necessary, once it comes online.

If static routing is being used, then the M&C system will need to detect that a switchover has occurred and update the routes accordingly for the new IP address associated with the online modem. Some network devices support route failover, which automates this process. In this case the M&C system router that supports route failover should be configured to include another route in the routing table with a higher ‘metric’ or ‘distance’ for the route that uses the Standby modem’s IP traffic address. The switchover to using the Standby modem will then be automatic when it detects the path through the primary modem is no longer available.

8.4.4.2 1:N IP Operation

The following rules should be observed when using 1:N redundancy for IP.

5. In 1:N mode, the M&C IP addresses need to be different for each modem.
6. In 1:N mode, the IP traffic addresses should be set to be the same in both modems. The IP traffic port on the Standby modem is physically isolated from the network via a relay contact, which ensures that having identical IP addresses does not cause any problems.
7. The M&C Ethernet port must not be bridged to the IP traffic port (this is controlled via the *Bridge M&C* control on the *Edit->IP* screen).
8. The M&C IP address and the traffic IP address should be on different subnets. The modem defines one default gateway. If the second subnet also requires a gateway, then a static route should be added that defines a gateway for that subnet.

On the 1:N Standby modem, the carrier is muted. The IP traffic port remains active but is physically isolated from the network. The M&C port is not muted, allowing the M&C system to always control the Standby modem.

The switchover operation in relation to bridging and routing is similar to that for 1:1 operation.

8.5 Geo Redundancy Operation

8.5.1 Geo Redundancy Overview

Building a geographically diverse network provides resiliency against natural disasters, catastrophic events or inclement weather that can cause network outages. Hot standby or 1:N redundancy is certainly appealing and protects traffic in the event of a single point of failure but doesn't protect the network when the whole earth station goes down. Geo-Redundant distributed systems tackles the core issue by providing another diverse hub that simultaneously operates with the same functionality, albeit in standby mode. The idea of Geo Redundancy is if a user's primary hub goes down, the service that is normally tied to that hub will connect to the secondary hub, thus preserving network traffic. The minimum hub equipment required would be two Q-Multiflex-400 units at different locations with a reliable network in-between, as shown below.

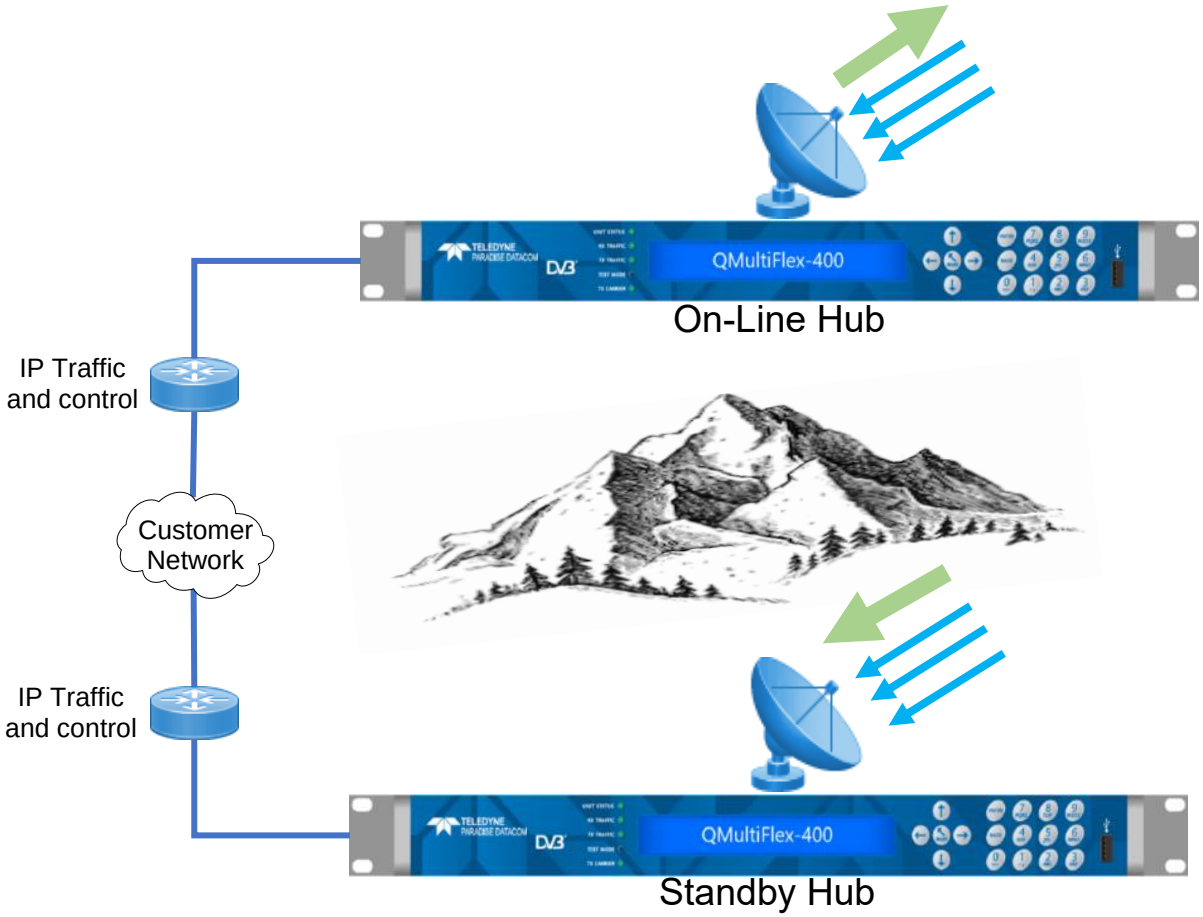


Figure 8-25 – Minimum Geo Redundancy Configuration

Both teleports need identical equipment, with the same software and hardware features. The Q-MultiFlex-400 units are connected together via an Ethernet and RF monitoring process. If the problem cannot be fixed at the main hub level, for example, if the main teleport is subject to major propagation problems or suffers from a catastrophic failure, then the geographical redundant teleport takes over.

The QMultiFlex-400™ Hub equipment will be connected to the customers Ethernet switch and Router, which will allow both sites to receive and transmit Traffic and M&C data via a common Ethernet Backbone. When in bridging mode, the Standby modem will automatically learn to bridge the traffic as necessary, once it comes on-line.

The M&C IP addressing will use unique IP addresses. The QMultiFlex-400™ will monitor the remote addresses of the other site as well as a highly available IP address.
The Hub sites will use one of the Multi Demodulators to allow the Tx outbound carrier for either site to be monitored. This requires all equipment operated over the satellite link to be able to monitor the other Hubs Tx signal. The Standby site will disable its packet output & traffic port IP addresses.

8.5.2 Geographical Redundancy Integration with 1:1 redundancy

In general, a modem in 1:1 standby does not participate in the Geo redundancy system and is not sending messages to the 'other' Geo site, but it should still listen to the messages from the other Geo Site and update its internal state so that it is ready to resume sending messages on a 1:1 switchover.

Modem alarms will generate a 1:1 switchover which should be preferred to a Geo switchover. When an alarm is detected by monitoring the '1:1 statIn signal', a delay is added before a Geo switchover is initiated, to allow the other modem in the 1:1 pair to take over. If a 1:1 switch over does not happen, for example when the same condition affects both modems in the 1:1 pair, a Geo switchover will happen.

8.5.3 Geographical Redundancy Hub Failure Modes

Six failure modes are considered, these modes are graphically shown in Figure 8-26. A dual 1:1 system is presented to show all six failure modes.

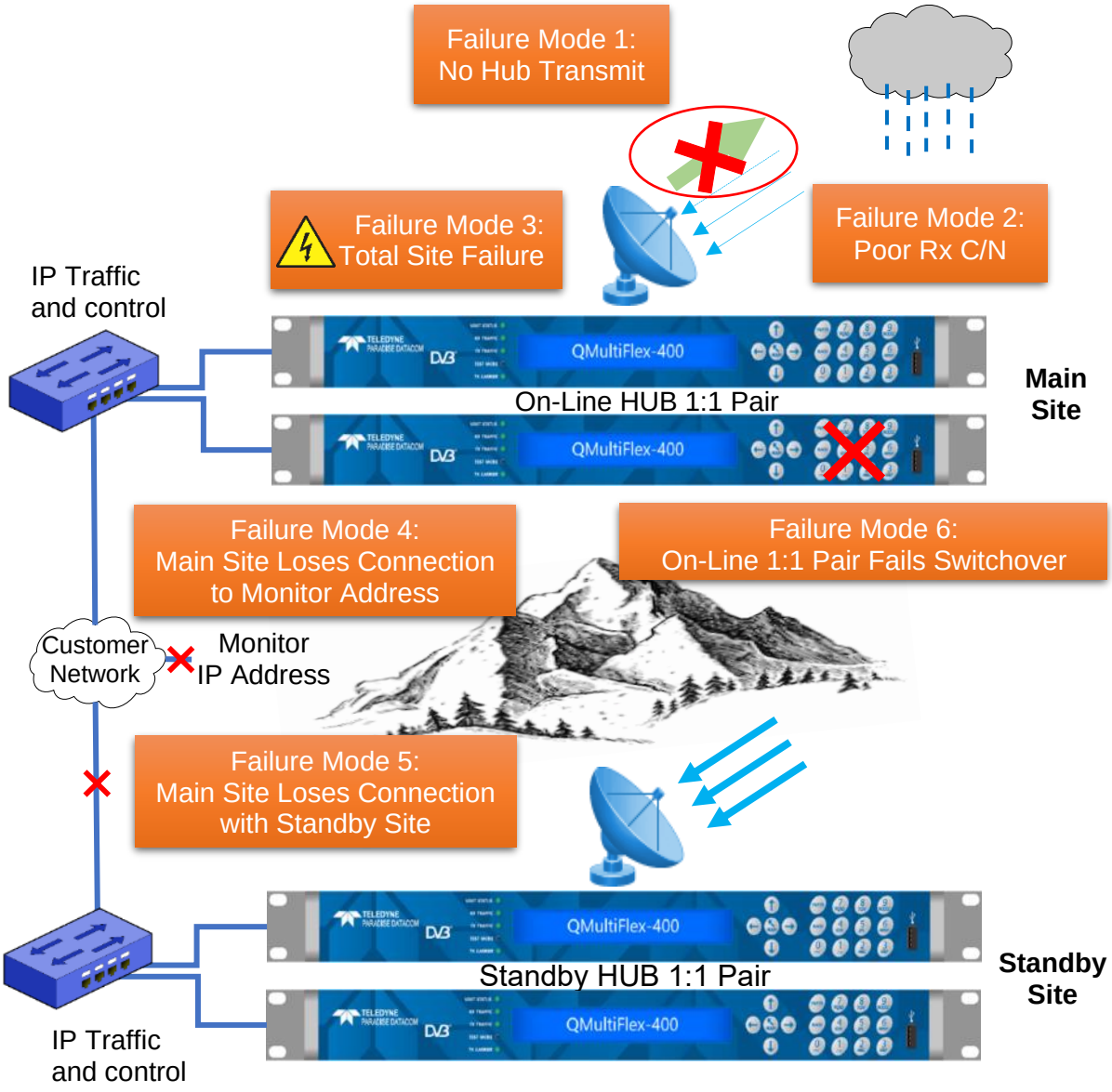


Figure 8-26 – Two Geographically Located 1:1 Pairs – All Failure Modes

Failure Mode 1

If the Main site suffers a failure in the Tx path RF equipment, the monitor demodulator will become unlocked and it will result in a switchover to the peer site after 8 seconds. The Main site Modem will still be receiving Status messages from the Standby site Modem. The monitor Demodulator will report loss of lock indicating that the Tx path has failed. This will cause the Main site Modem to switch off its carrier and change its status to Standby in the status messages. The Standby site receiving these messages will ignore the monitor Demodulator status (unlocked) and will then initiate a switch over and report that it is now the Main site Modem.

Failure Mode 1:	Tx RF Path Failure
Monitoring:	Monitor demod locked

Actions:	Switch to Geo standby IF Geo Main AND demod not locked for N seconds (N=8)
Config variables / Timeouts:	• Demod ID to use as monitor demod • Time to wait for demod lock

Failure Mode 2

If the Main site suffers from a deep rain fade, at a predetermined set carrier to noise ratio for the monitor demodulator, switchover will occur, thereby preserving network availability. The carrier to noise ratio threshold is set by the user, along with a hold-off timer function. The hold-off timer prevents oscillation between sites by ensuring that the system has time to settle between switchovers. The standby Hub will also be receiving the same outbound transmission so a switch will only occur when the rain fade is only occurring at the main site. A 'Monitor demod Es/No below threshold' alarm, with severity 'warning' will be raised when the Es/No of the monitor demod is below the threshold. The alarm shall be cleared when the Es/No rises above the threshold value. If the other site also has a the 'Monitor demod Es/No below threshold' alarm, the switchover will be blocked.
If not required, this function can be disabled by setting the threshold Es/No value to -99dB.

Failure Mode 2:	Rain Fade
Monitoring:	Monitor demod locked & Monitor demod Es/No
Actions:	• Raise warning level alarm: 'Monitor demod Es/No below threshold' • Switch to Geo standby IF Es/No below threshold for N seconds (N=8) AND demod locked AND Geo Main • Flag failure in message IF Es/No below threshold AND demod locked AND Geo Standby
Config variables / Timeouts:	• Demod ID to use as monitor demod • Rain fade Es/No threshold

Failure Mode 3

Catastrophic failure of Main site will result in no Tx carrier and no status message transmitted from the Main Modem. The Standby site Modem will respond to the status message failure by checking the monitor demodulator. If this is unlocked, this means the Main site has failed. Then, if the connectivity to the Monitor IP address is OK, the Standby site will take over the communications to the Remote Modems. If the monitor demodulator is still locked, it is assumed the Main site is healthy but just the message communication has failed and so no action should be taken. A 'Communication with peer modem lost' alarm will be raised.

Failure Mode 3:	Catastrophic failure of Main site, Standby site comms failure
Monitoring:	Monitor demod locked & Time since last message received
Actions:	• Raise warning level alarm if timeout exceeded: 'Communication with peer modem lost' • Autonomously become Main if all conditions are met: Enable carrier if 'Communication with peer modem lost' alarm is raised AND monitor demod is not locked AND 'Monitor IP address' can be reached.
Config variables / Timeouts:	• Timeout to wait for messages (30s) • 'Monitor IP address'

Failure Mode 4
If the Main site can no longer ping the Monitor IP address it will raise a 'No response from Monitor IP address' alarm, with severity 'warning', and initiate the changeover process, assuming an upstream failure in the M&C network. The Standby Modem will take over communications to the Remote sites. The alarm shall be cleared when pings are successful.

Failure Mode 4:	M&C Connection lost
Monitoring:	Ping to 'Monitor IP address'
Actions:	• Raise warning level alarm: 'No response from Monitor IP address' • Switch to Geo standby (thereby muting Tx carrier) if 'No response from Monitor IP address' alarm is raised, regardless of the Monitor demod lock state or 'Communication with peer modem lost' alarm. • The standby site will then become main, either due to receiving status messages from the failed site, or by responding to its monitor demod unlocked alarm as per Failure mode 3.
Config variables / Timeouts:	• IP Address to ping • How many pings to send (4) • Ping failure rate (at least 1 ping ok) • How long ping must fail before alarm raised (45s)

Failure Mode 5
If the Main site loses communications with the Standby, a 'Communication with peer modem lost' alarm will be raised. No changeover will occur, as the Demodulator monitoring the hub Tx carrier will report lock status as OK. Status messages reporting that it is the Main Modem will continue to be transmitted. The standby site will probably also have lost communication with the main and will also raise a 'Communication with peer modem lost' alarm, but the monitor demod will still be locked and so the site will remain in standby.

NB. Whenever a switchover occurs, a hold-off timer is started on the new standby modem. The Peer status shown on the active modem will display 'Not ready' until the hold-off timer expires. Further switchovers are not possible until then.

Failure Mode 5:	Main site comms failure
Monitoring:	Time since last status message received from peer site
Actions:	• Raise warning level alarm: 'Communication with peer modem lost' • Do not switchover as monitor demod is locked AND monitor IP address is reachable. • The standby site will also raise the 'Communication with peer modem lost' alarm and remain in standby state.
Config variables / Timeouts:	Timeout to wait for messages (30s)

Failure Mode 6
In the event of a hub unit failure, modem alarms will generate a 1:1 switchover. When an alarm is detected by monitoring the 1:1 signal, a delay is added (before this causes a Geo switchover). This extra delay allows the other modem in the 1:1 pair to take over.

If a 1:1 switch over does not happen, for example when the same condition affects both modems in the 1:1 pair, a Geo switchover is initiated.
It is recommended that the 'Transmit fail switchover' setting is enabled. Transmit or Unit fault alarms will cause a 1:1 switchover. If the 'IP1 port down alarm' is enabled on the Edit/Unit/Alarms menu, a switchover will occur if the IP traffic Ethernet cable is disconnected.
If both modems at the Geo main site have the same fault (e.g. IP traffic port down on both modems) or a 1:1 switchover cannot happen due to maintenance, the system will switchover to use the peer Geo site.

Failure Mode 6:	1:1 failure
Monitoring:	Modem alarms
Actions:	• If active fault level alarms then delay to allow 1:1 switchover • Switch to Geo standby if still 1:1 Main
Config variables / Timeouts:	1:1 delay (15s)

Graphical Representation of Failure Modes

8.5.4 Start-up condition

The Modem will start-up in *Geo standby* with the carrier disabled. If the Modem is stand-alone or 1:1 main, it will start pinging the Monitor IP address. If successful there will be a delay of 30 seconds to ensure that the monitor demodulator will have locked if a signal is present. The normal Geo Redundancy software routine will then start. If the peer site is running as *main*, this site will remain in *standby* until a switchover condition is detected. If the Monitor IP address does not respond, a '*No response from Monitor IP address*' alarm is raised and the system will continue to test the Monitor IP address until it responds.

8.5.5 IP Messaging

Both modems in a Geo pair continually send messages at approx rate of 1 per second. The message consists of a UDP datagram containing whether the modem has detected a failure and whether the modem's carrier has been muted by Geo control software. These messages will be addressed to an M&C address. If a 1:1 pair is in use, both 1:1 'peer' M&C addresses are used.

8.5.6 Restrictions

- When using the Geo-Redundancy feature, one of the sixteen demodulators is used for self-monitoring purposes. Using demod 1 is recomended.
- The hub modem must be able to receive its own Tx carrier from satellite.
- The maximum hub Tx symbol rate is limited to 40Msps, as this is the limit of an individual demodulator on QMultiFlex-400™.
- All carriers must fit inside a contiguous 72MHz of bandwidth.
- Use with expanded (cascaded) systems is not currently supported, so the maximum number of remote sites is fifteen.
- IP Routing mode is not supported.

8.6 Software Activated Features

While some modem functions are available as plug-in option cards, the majority of additional functions are made available through Software Activated Feature (SAF) support. As the name implies, these are modem features that can be enabled by entering a feature code via any of the modem's user interfaces. Feature codes are encrypted codes issued by Teledyne Paradise Datacom, uniquely associated with individual modems.

To allow evaluation of modem features, all the SAF features of the modem that it is capable of supporting can be activated for a 10-day period by entering a feature code of 0. This is referred to as a 'Demo Test Shot'. Demonstration Mode can be activated up to three times after which any further attempts to use it will be rejected. Note that it is not necessary to wait for Demonstration Mode to time out before reactivating it: it can be activated twice to give a 20-day demonstration period and three times to give 30 days. The user will be alerted shortly before the demonstration period times out with temporary SAF code warning messages in the log/alarm system. As well as allowing feature evaluation, Demonstration Mode can be used to test compatibility with other equipment and allows rapid substitution of equipment in a crisis.

To enable one or more features permanently (referred to as Permanent Mode), a modem-specific feature code needs to be obtained from Teledyne Paradise Datacom. The code is tied to the modem serial number (available via the Web GUI or Front LCD screen menus and is printed on a label the back panel).

The features that have been temporarily enabled on a modem can be viewed along with the time remaining before they become disabled, as can the features that have been permanently enabled and those that can potentially be enabled. See the View->SAF->Temporary SAF screen.

The SAF function keeps the initial cost of a modem to the minimum and allows simple field upgrading at a later date, as required.

8.7 IP Functionality

8.7.1 Base Modem IP & IP processing card

As shown in **Figure 8-27**, the base modem has four RJ45 auto-sensing Gigabit ethernet ports (in lower position). The first port (from left to right) is for M&C and the next one is for sending and receiving satellite IP traffic. The other two are for cascading purposes (show in purple). In the upper position is the additional IP processing card, which is required to be plugged into the base modem traffic port via a patch cable (shown in orange). IP2 and IP3 are not used. The main network traffic will be plugged into IP1 of this card (shown in blue).

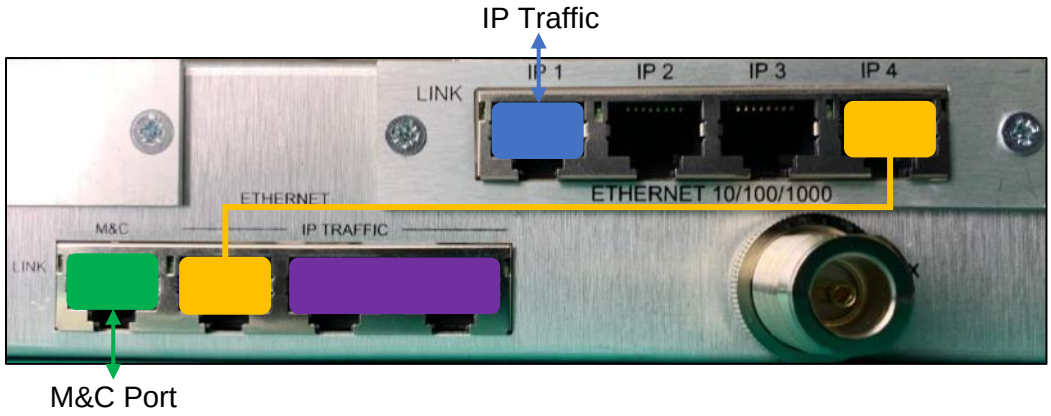


Figure 8-27 Modem Ethernet Ports

As stated previously in this handbook, the M&C should not be bridged to the traffic. The default is 'on' – which will need to be set to 'off' on the Edit->IP page. The M&C subnet needs to be separate to any traffic VLAN subnets used. Essentially if any M&C subnet traffic makes it onto the traffic port of the modem, system performance will become unpredictable.

To communicate with the modem for M&C purposes, an IP address and subnet mask must be set. Note that setting an IP address to 0.0.0.0 causes the modem to request an IP address from a Dynamic Host Control Protocol (DHCP) server on the network. Static routes are supported allowing routing decisions to be made based on a set of explicit routing rules that can be entered via the web user interface. The gateway setting in bridge mode would normally be for the M&C server.

In routing mode, the use of a default gateway IP address provides a next-hop IP address for all destinations that are not on the local subnet. This is usually the address of a router that has been set up to forward packets to the correct network.

The bridge maintains information on how to forward frames based on replies that are received from each device in the network.

8.7.2 IP Addressing

With the IP processing card, the base modem will need to be set to 'Trunking mode' which is a high-speed link that bypasses the processor for higher throughputs with minimal jitter. The IP processing card will operate in a bridge and is used to apply any other additional IP features. Traffic IP addresses can be applied to the HUB and remote modems as long as

they are on the same subnet. A layer 2 bridge uses ethernet addresses to pass ethernet frames, so IP addresses are not necessary. If multiple VLANs are being used (typical) then it is absolutely necessary not to set an IP address (i.e. 0.0.0.0).

Teledyne Paradise Datacom has produced further application notes dealing with Star topology and Mesh routing. Contact customer support for any documents listed in **Chapter 14 Further Reading.**

8.7.2.1 Gateways

There is a single gateway address for the modem which can be used either for traffic or M&C communications.

8.7.3 Throughput Performance

Actual throughput performance depends on a number of factors including one way/two-way TCP or UDP traffic, packet size, data rates and the mixture of IP features switched on. There are endless combinations and therefore it is strongly recommended that empirical testing is undertaken prior to deployment to ensure that the required level of service can be provided.

The modem can process up to 150,000 packets per second (This can be derated when internal optimisation features are enabled). It is good practice to put a switch (or router) between the modem and local network in order to minimize the number of packets the modem has to process, as incidental network traffic (not intended for satellite) has the potential to push the modem over it packet processing limit.

TCP acceleration works up to 100Mbps with up to 4,400 concurrent accelerated TCP connections and also supports at least 40,000 unaccelerated TCP connections.

8.7.4 Jumbo Ethernet Frame Support

The modem supports Ethernet frames up to 10k bytes in length.

8.7.5 IP Interoperability

The **QMultiFlex-400™** interoperates with **QFlex-400™, Q-Flex™ and Q-Lite™** remote modems. In the case of a mesh system, all sites are required to have **QMultiFlex-400™.** All **QMultiFlex-400™** IP features have been adapted to work point-to-multipoint.

8.7.6 IP Connectivity Modes

The modem software supports unidirectional and bidirectional point-to-multipoint IP operation.

8.7.7 TCP Acceleration

TCP traffic, as opposed to UDP, requires acknowledgements to be returned to the sender as part of the protocol flow control process. TCP was never intended for systems with long delays (such as satellite). With no acceleration, TCP traffic over satellite would limit itself to a few hundred kbit/s (depending on the PC TCP window size), *regardless of the actual traffic bandwidth available over satellite.* Because the satellite delay is taken as evidence of link congestion, TCP throttles back the amount of data it sends. Acceleration allows approx. 90% utilisation of the available traffic bandwidth over satellite. Acceleration can be used in point-to-multipoint bridging modes, as well as in routing mode.

When acceleration is used in bridging mode, all UDP packets are bridged. VPN packets, although they use TCP, cannot be accelerated because acceleration relies on making changes to the addresses in the original IP packet which is encrypted by the VPN as the payload of a new IP packet (tunnel mode). Even in transport mode, where only the IP packet payload is encrypted, authentication will detect when the modem alters any IP address and reject the packet at the end point.

Acceleration works by the modem spoofing TCP acknowledgements back to the local originating device as if they come from the remote end point, eliminating the satellite delay. Since there is no perceived delay, the originating PC assumes there is no congestion in the link and will therefore ramp up the level of TCP output to fill the available bandwidth.

Note that when TCP acceleration is used in both directions, the TCP acknowledgements going in each direction compete with the data in each direction. Since TCP will attempt to completely fill the data pipeline, there is a possibility that there will not be sufficient bandwidth available for the acknowledgements, which could drastically reduce the throughput level (typically in one direction). The Paradise software attempts to prioritise TCP acknowledgements in this situation to prevent this from happening. However, a better solution is to use the IP traffic shaping feature to guarantee sufficient bandwidth for the acknowledgements.

8.7.8 Traffic Shaping

Traffic shaping provides control over the management of data within the modem. Specifically it provides a guaranteed quality of service for defined IP data streams. It is aligned with all of the major quality of service schemes and can be used to extend terrestrial services over satellite to create fully provisioned end-to-end services, thereby providing direct support for the implementation of customer service level agreements. Key time-based performance metrics are gathered continuously by the modem and can be extracted in order to be assimilated into customer quality of service reports.

This section provides an overview of the traffic shaping feature, including definitions of terms and worked examples. For a detailed description of the actual traffic shaping menus, please see Edit->Service->General->Tx QoS Screen.

A satellite modem in general normally acts as a transparent pipe for data, so the data that is finally received at the destination on the terrestrial network at the far end of the link is identical to that which has been supplied to the local modem for transmission over satellite. This is not necessarily true for IP data. Being packet based, IP naturally supports multiplexing of different data streams. These streams often have different inherent priority levels and competing demands for bandwidth. What is transmitted over satellite often requires careful management, both in terms of what is actually sent (versus what is filtered out) and in relation to the order in which packets from different streams are sent (i.e. the relative priority levels of packets from different streams and the effect this has on packet jitter).

Traffic shaping essentially controls these two key aspects of traffic management, namely, access to satellite bandwidth and the level of delay and jitter that is experienced.

The Paradise traffic shaping feature is controlled via the modem web user interface under *Edit->Service->General->Tx QoS*.

8.7.8.1 Guaranteed Bandwidth

The allocation of bandwidth to a classified data stream can be controlled.

The **Committed Information Rate (CIR)** is the guaranteed bandwidth that will be allocated to the specified data stream. This is the level of bandwidth that is guaranteed under all normal circumstances where the equipment is operating correctly.

The sum of all CIRs for all classified data streams cannot be more than 100% (of the transmission data rate of the modem).

8.7.8.2 Maximum Bandwidth

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

This setting is called the **Burst Information Rate (BIR)**. It defines the maximum amount of bandwidth, beyond the guaranteed bandwidth, that a stream should be allocated, should spare bandwidth become available. Each BIR can be set up to 100% (of the transmission data rate of the modem).

8.7.8.3 Priority

What happens when excess bandwidth does become available (i.e. all guaranteed bandwidths are being met and there is spare capacity) in the situation where several streams have BIRs set (meaning that they are all potentially competing for the same excess bandwidth)? This is determined by the stream *Priority* setting.

In this case, the allocation of the spare bandwidth between competing schemes will be done based on the priority level allocated to each stream. This is done on an absolute basis: if 256kbps of bandwidth is spare and two streams both want an additional 256kbps then all 256kbps will be allocated to the stream with the higher priority.

The priority setting also controls latency and jitter. In the situation where the transmit modem has several packets in different priority queues for transmission over satellite, then the packets will be sent based on their priority, with the packets from the highest priority queue being sent first.

The priority value ranges 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).

A default data stream exists for any packets not explicitly part of a defined data stream. These get assigned the lowest available priority, namely, seven.

8.7.8.4 Stream Classification

How does the modem know which packets belong to which streams? Streams can be classified using the following methods:

- The source and/or the destination address in the IP packet along with the source and/or the destination port number of the TCP or UDP header in the packet. Any or all of these can be used in any combination at the same time, including using a range of port numbers.
- The 6-bit Differentiated Services Code Point (DSCP) value in the IP packet header.
- The 3-bit Priority Code Point field of an IEEE 802.1Q VLAN tag (also referred to as an IEEE 802.1p Priority Tag).
- The VLAN ID in an IEEE 802.1Q VLAN tag.

The key classifiers are described in the following sections. The result is that each incoming packet is assigned to one of a number of QoS classes. Data will be classified as belonging to the first class in the list for which a match is found starting from the top. If no match is found, then the packet is assigned a default class that corresponds to a priority level of seven (lowest). The default data stream gets a BIR value assigned to of 100% (equal to the transmit data rate of the modem).

In addition to the stream classification, each stream can be associated with a particular DVB-S2/S2X MODCOD when transmitted as part of the shared outbound carrier (VCM), with the MODCOD being matched to the satellite signal strength being received by a particular remote modem. When multiple streams are disabled then all packets will be transmitted using the same MODCOD.

8.7.8.4.1 IP Address

A data stream can be classified based on either the source and/or the destination addresses in the IP packet as well as by a range for the source and/or the destination port numbers in the TCP or UDP header in the packet.

The example in **Figure 8-8** shows a traffic shaping scheme based on matching on source and destination addresses and port numbers. In this example the shared outbound consists of a single MODCOD (not shown).

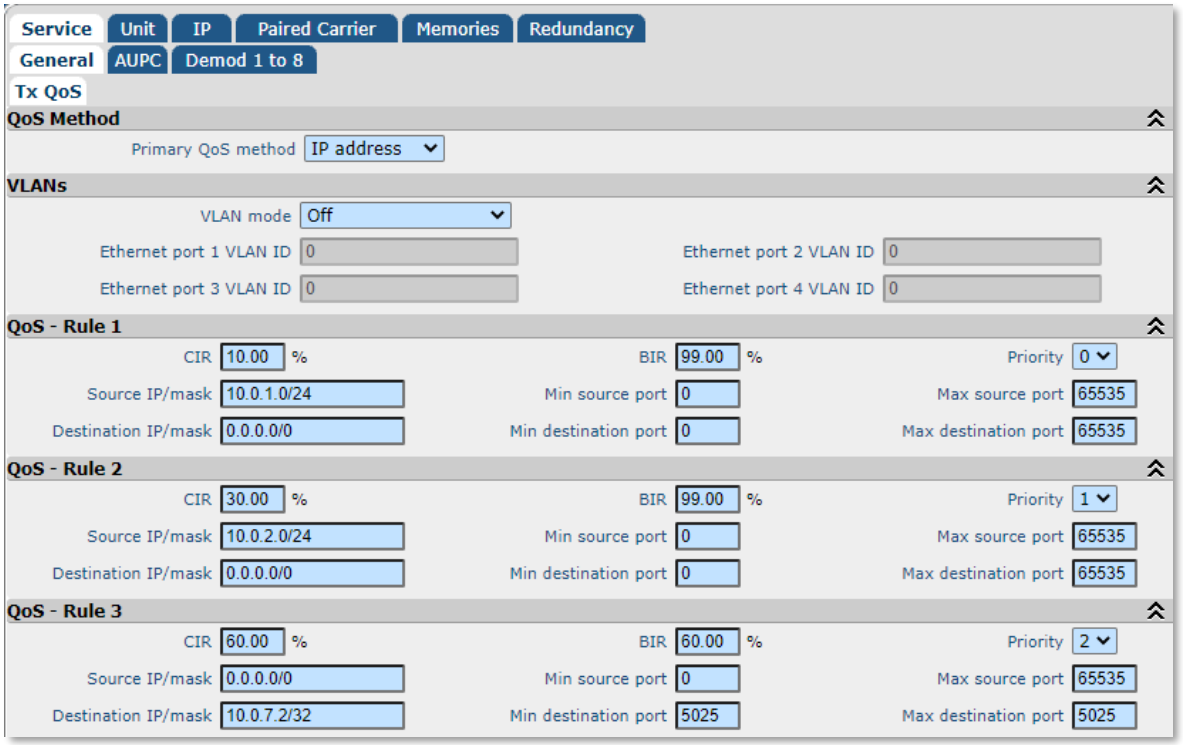


Figure 8-28 Traffic Shaping using IP Addresses

As can be seen, Rule 1 guarantees 10% of the available bandwidth to IP packets from subnet 10.0.1.0/24, which is allowed to burst up to 99% of the bandwidth should it become available. The packets have the highest priority (0).

Rule 2 guarantees 30% of the available bandwidth to IP packets from subnet 10.0.2.0/24, which is also allowed to burst up to 99% of the bandwidth. The packets have a lower priority (1) than Rule 1 and therefore associated packets will only receive BIR bandwidth if it is not required for Rule 1.

Rule 3 guarantees 60% of the available bandwidth to IP packets going to IP address 10.0.7.2/32. Since the BIR value equals the CIR value then no excess bandwidth will be allocated beyond the guaranteed level.

Since the combined CIR values of the three rules equals 100% then potentially no bandwidth will be available for any other traffic, including any M&C traffic.

8.7.8.4.2 VLAN ID

Data stream classification can be based on VLAN ID, which need to be added externally to the **QMultiFlex-400™** - usually in the form of an IEEE 802.1q trunk.

The example in **Figure 8-29** shows a set of traffic shaping rules based on VLAN ID.

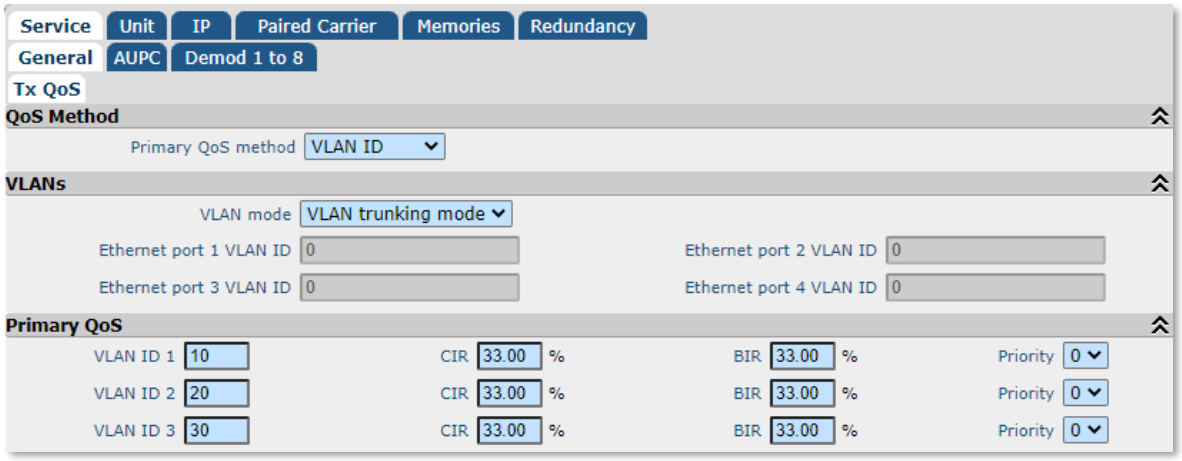


Figure 8-29 Traffic Shaping using VLAN ID

In this example, three VLANs (10, 20 and 30) are all guaranteed 33% each of the available bandwidth but none of them are allowed to exceed this. Each has the same priority, which should ensure that all of these VLANs experience similar levels of jitter. 1% of the available bandwidth will be available for other traffic, although this will increase if the three VLANs do not use their allocated bandwidth.

8.7.8.4.3 Diffserv DSCP Class

Data stream classification can be based on the six-bit Differentiated Services Code Point (DSCP) value in the IP packet header. All the standard DSCP classes are supported. An example of traffic shaping based on DSCP classification is shown in **Figure 8-30**.

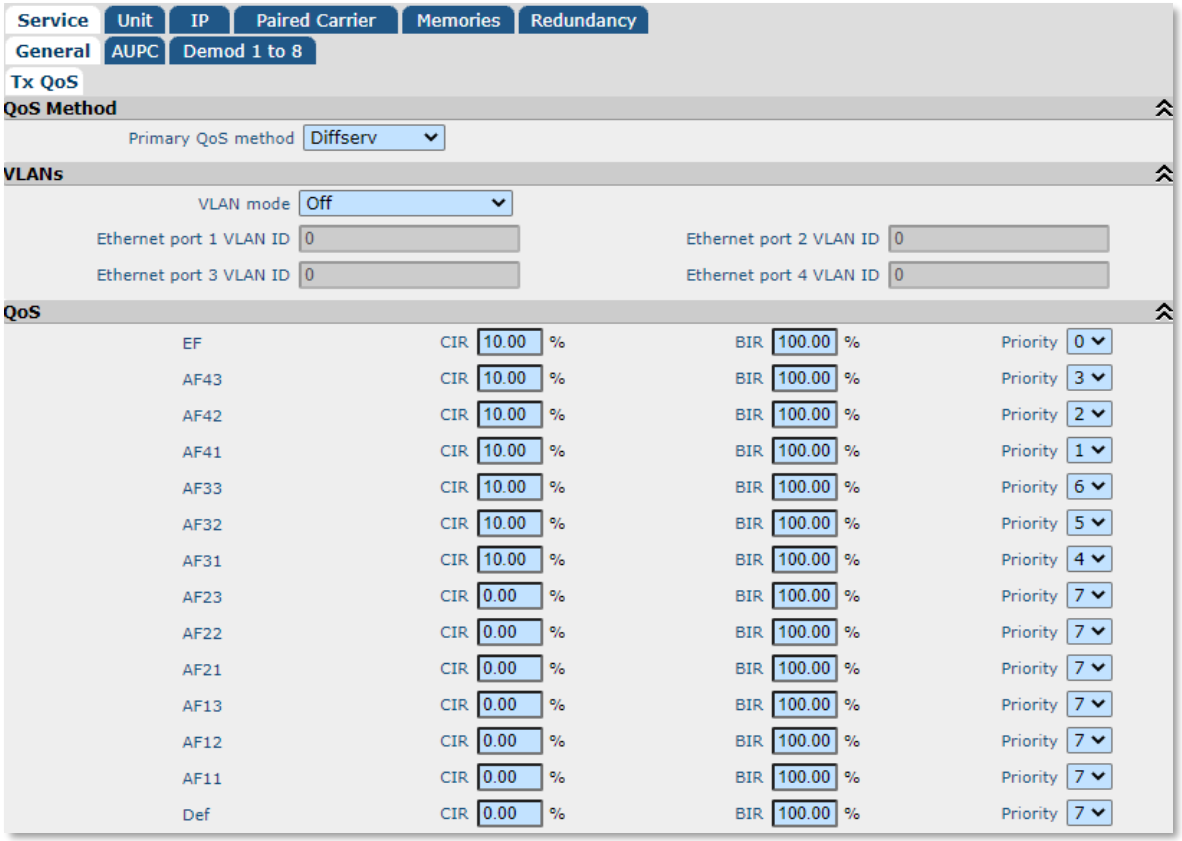


Figure 8-30 Traffic Shaping using DSCP

In this example, the Expedited Forwarding (EF) class is given the highest priority (0) and is guaranteed 10% of the available bandwidth. Two Assured Forwarding classes (3 and 4) are guaranteed 10% of the available bandwidth for each drop probability (1, 2 and 3). Each AF class is given the appropriate level of priority corresponding to its precedence and drop probability. All classes are allowed to burst up to 100% of the available bandwidth in this example. All other traffic is given lower priority. No explicit bandwidth reservations are made for any other DSCP class in this particular case.

The default class (*Def*) corresponds to the 'best effort' DSCP class 000000.

8.7.8.4.4 IEEE 802.1p Priority Tag

Classification may be done on the 3-bit Priority Code Point field of an IEEE 802.1q VLAN tag (also referred to as an IEEE 802.1p Priority Tag). This is part of a 32-bit field inserted into an Ethernet frame between the MAC address and length field.

The priority tag has eight possible values, each of which maps directly to an equivalent internal class within the modem (for which a BIR, CIR, etc. can be set). Each packet passed to the modem must have this field set to the appropriate value in order for the modem to recognize the different data streams.

The example shown in **Figure 8-31** shows traffic shaping based on priority tagging.

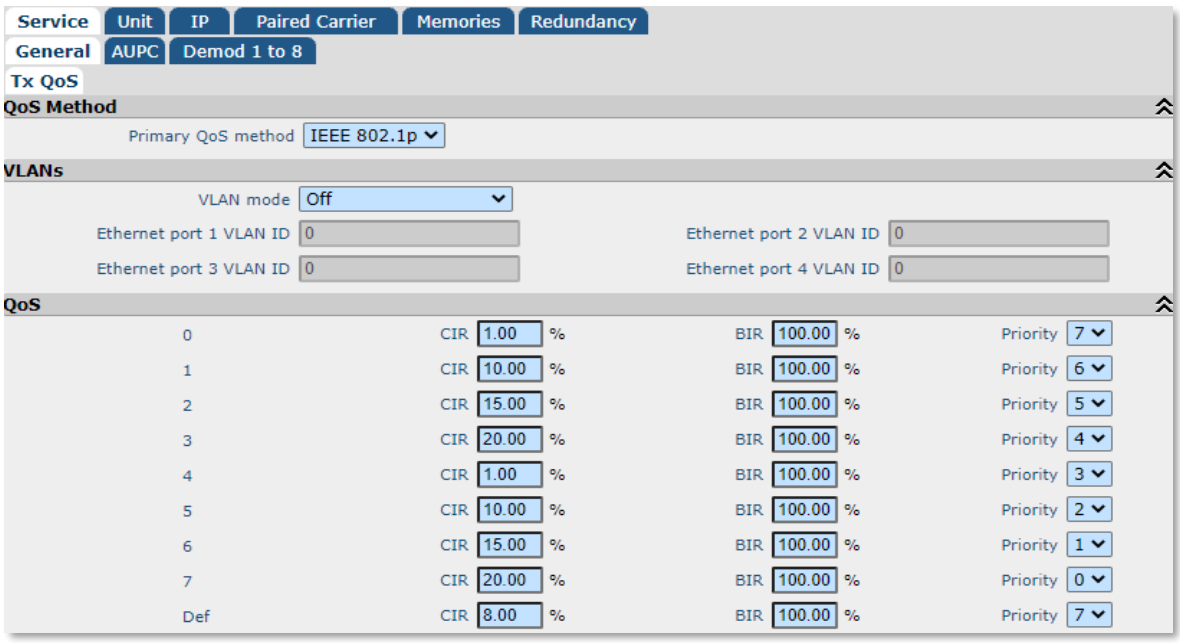


Figure 8-31 Traffic Shaping using IEEE 802.1p Priority Tags

In this example, the IEEE 802.1p priority classes are shown in the left-hand column. Each is assigned varying amounts of guaranteed bandwidth and each is allowed to burst up to the maximum bandwidth. IEEE 802.1p priorities (with 7 being the highest) are inverted in relation to those in the modem's queuing mechanism (where 0 is highest). The right-hand column

shows the modem queuing priority level. Although there is a straightforward one-to-one priority mapping between IEEE 802.1p priorities and those of the modem, explicit control of this allows priorities to be changed if required.

The default class (*Def*), allows bandwidth to be explicitly reserved for traffic that does not have an IEEE 802.1Q header attached.

8.7.8.5 Traffic Shaping Graphs

A web graphing facility exists that shows a line graph of throughput (in terms of bps) over time for each QoS class. The data for each class is not superimposed, instead it is necessary to select the particular class to be monitored graphically from a dropdown box. It is easy to switch between graphs for the different classes in order to check that the level of throughput is in line with expectations.

Graphs are time based and are shown in minute, hour, day and month formats. It is intended to add diagnostic graphs per class in the future for errored packets and dropped packets.

8.8 Worked System Example

8.8.1 Overview

This step-by-step example will show how to set up a **QMultiFlex-400™** point to multipoint system as a whole. The **QMultiFlex-400™** P2MP system comprises of a hub modem and **QFlex-400™** modems for the remotes.
The **QMultiFlex-400™** supports up to 16 DVBS2X demodulators out of the box (depending on software options). Further **QMultiFlex-400™** units can be cascaded together to expand this up to 128 demodulators. For the sake of simplicity in this example, only three remote modems will be used. Once the configuration principles are grasped, more remotes can be added.
The idea is to distribute the Internet connection at the hub to hosts at the remote sites.

Here is a general system overview diagram:

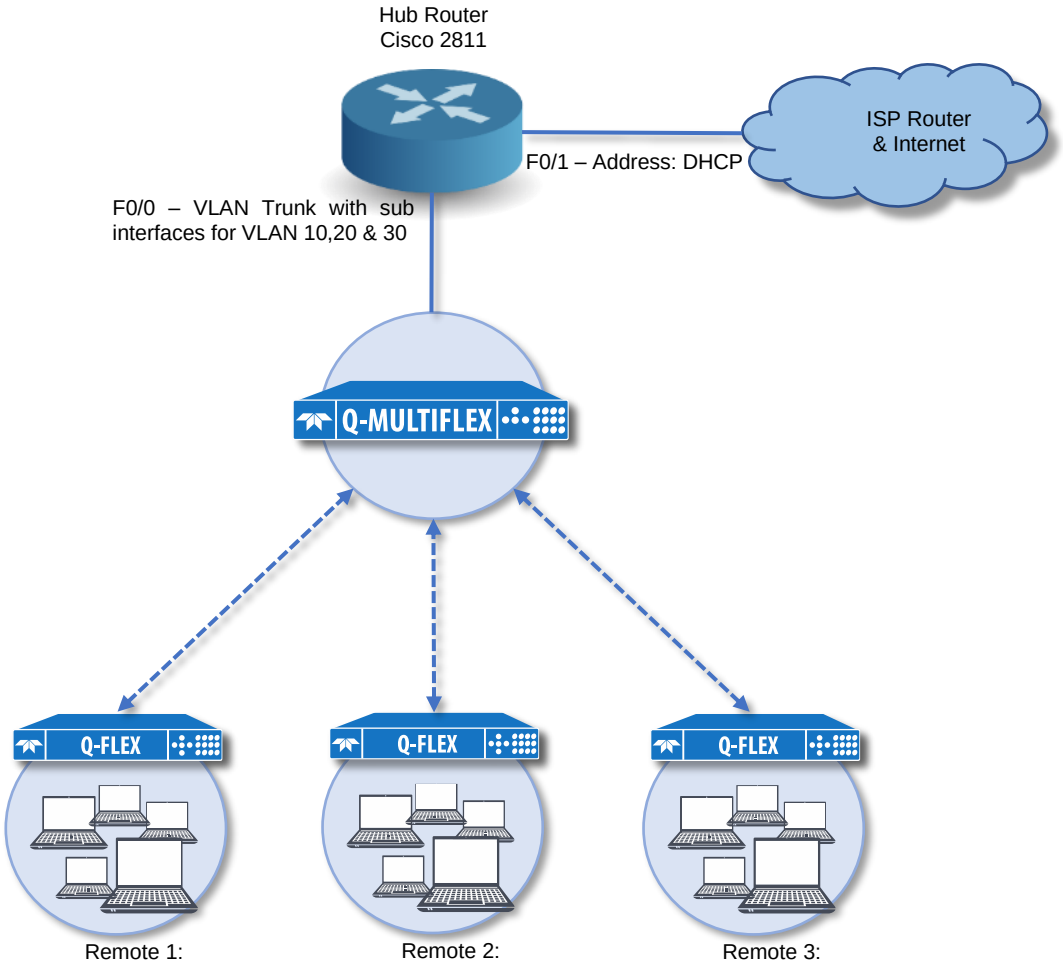


Figure 8-32 Internet Distribution to Three Remotes (Star)

The **QMultiFlex-400™** is connected to the hub router with a VLAN trunk. The hub router provides DHCP information to the remote PCs (IP, gateway and DNS addresses) and uses PAT overload to connect them to the ISP office router.

VLAN Definitions
VLAN1: 10.0.70.0 / 16 (M&C VLAN)
VLAN10: 192.168.10.0 / 24 | Gateway: 192.168.10.1
VLAN20: 192.168.20.0 / 24 | Gateway: 192.168.20.1
VLAN30: 192.168.30.0 / 24 | Gateway: 192.168.30.1

8.8.2 Test Plan

The parameters in this test plan are designed for testing in a lab environment and therefore the IF band (50MHz to 100Mhz) has been selected. The RF details can be modified to suit your preference.

This is the MODCOD / RF scheme used in this example:

Frequency (MHz)	Mode	Modulation	FEC Rate	Frame Size	Symbol Rate	Roll Off
70	DVBS2X	32APSK	2/3	Normal	5Msps	5%

Table 8-7 QMultiFlex-400™ Outbound

Demod #	Frequency (MHz)	Mode	Modulation	FEC Rate	Frame Size	Symbol Rate	Roll Off
1	73.5	DVBS2X	8PSK	9/10	Normal	0.5Msps	20%
2	74.5	DVBS2X	8PSK	9/10	Normal	0.5Msps	20%
3	75.5	DVBS2X	8PSK	9/10	Normal	0.5Msps	20%

Table 8-8 QMultiFlex-400™ Inbounds

The RF cables are organized like the following:

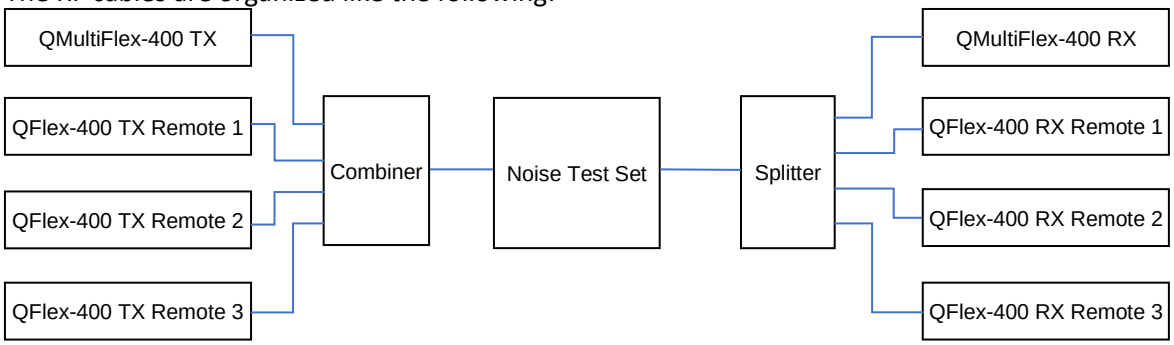


Figure 8-33 Cable Connections

Modem software above 3.1.40 for hub and remotes was used in this example.

8.8.3 QMultiFlex-400™ Hub Configuration

The starting point for modem configuration should be from factory defaults. If the modem already has a configuration, then it needs to be cleared. Once the modem is booted, defaults can be recalled on the front panel.

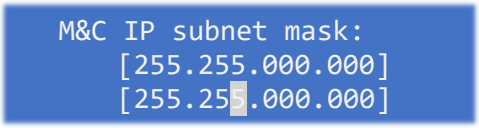
Press Main Key to return to the main menu:

The menu options are selectable by moving the cursor using the arrow buttons on the front panel. Then pressing enter on the option you would like. The faster method is just to press the number associated with that option e.g. above the Edit option can be selected by simply pressing the '2' key.

The QMultiFlex-400™ address will be changed from the default to: 10.0.70.10 / 16.

Move cursor to the end of the line and enter the '10' in the last two digits. Then press enter. The number will move to the top line to show the current value.

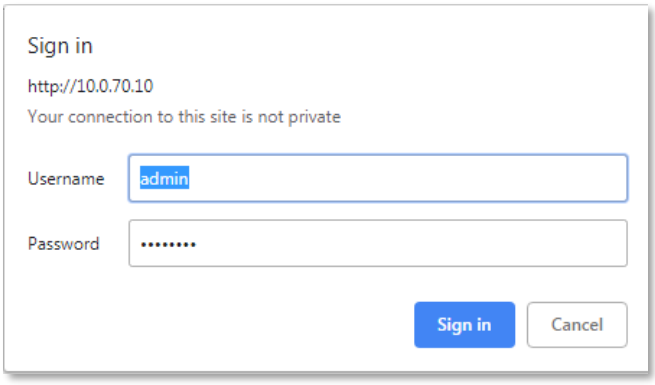
Press enter again to move to the next screen. Edit the subnet mask. Press enter again to move it to the top line position.



It will now be possible to connect to the modem using the address 10.0.70.10
In this example the PC is set to 10.0.70.100 / 16

Connect a LAN cable to the M&C port of the modem. Connection LEDs should illuminate on the IP port. Pinging 10.0.70.10 should show replies.

In a web browser type in the modem M&C address into the address bar.
Default credentials are:
Username: admin
Password: paradise



After the welcome screen, the status screen will load as default:

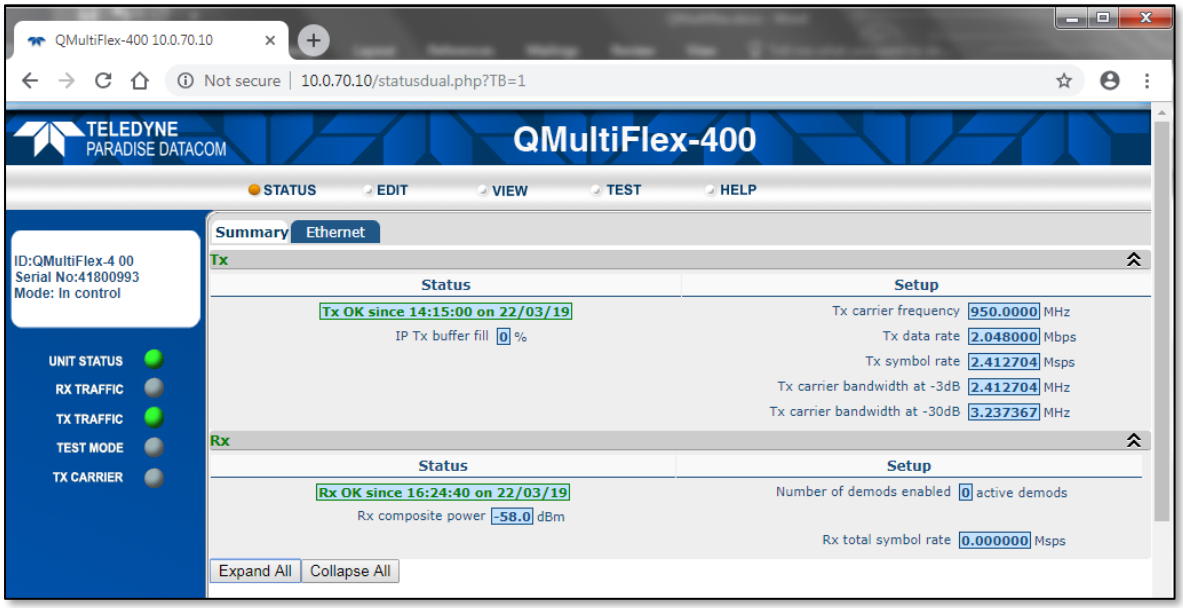
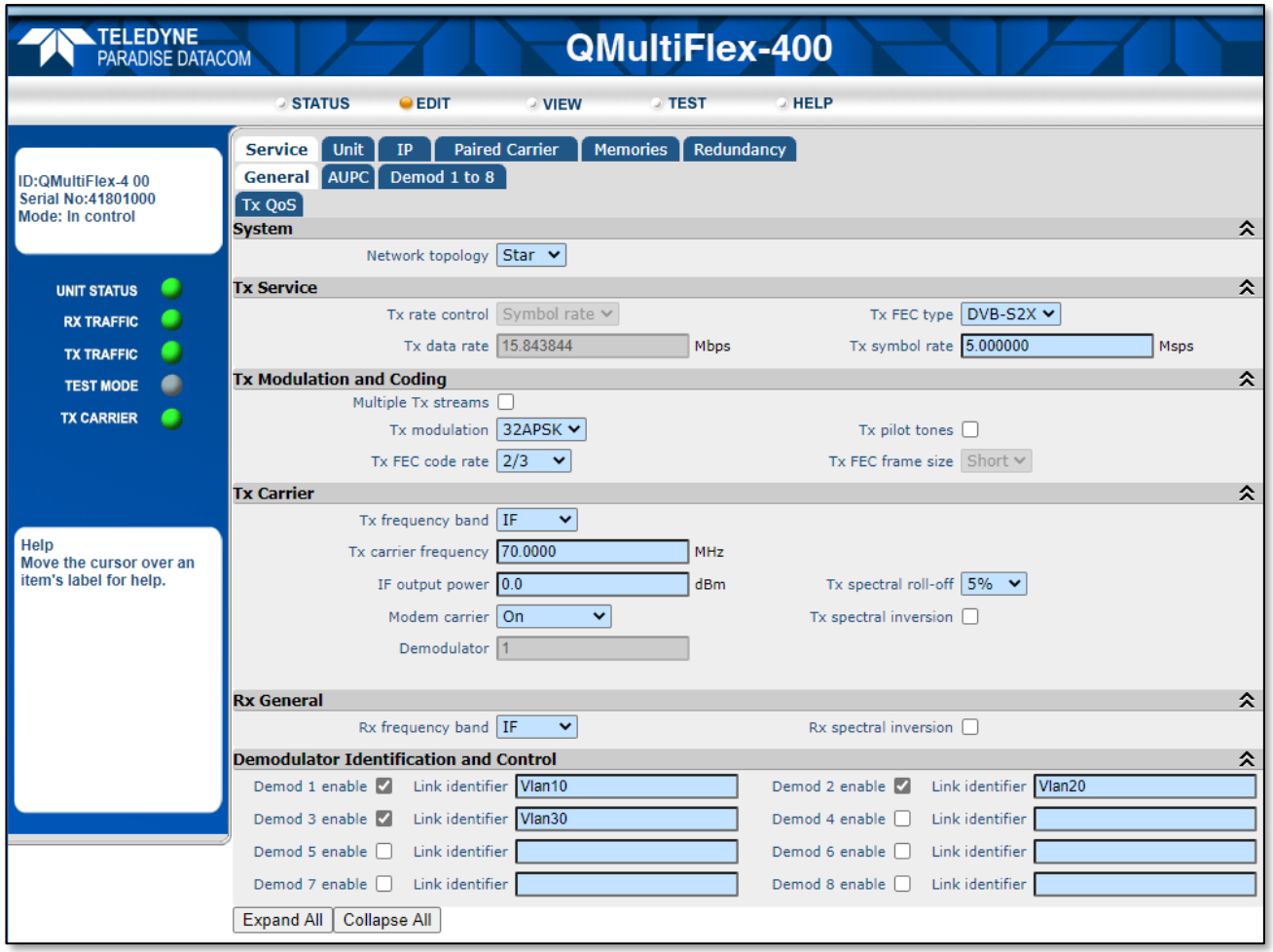


Figure 8-34 Status Screen after Login

You will see ‘Expand All’ and ‘Collapse All’ buttons. Always select ‘Expand All’ when seen. Sections can be collapsed after initial configuration to neaten up the page if desired.

For initial configuration, select the ‘Edit’ tab at the top of the page. It should default to Service / General, which is where the Tx settings are found and some top-level Rx settings.

8.8.3.1 Hub Tx Carrier Settings



System
Overall topology is Star.

Tx Service & MODCOD
These values were determined in the test plan. 32APSK was chosen so that ACM would have more range. It is good practice to check the frame size matches that set on the remote modem.

Tx Carrier
IF Bands are 50 to 90MHz and 100 to 180 MHz. Set desired roll-off factor.

RX IF band is set here.

These labels are for identification of the link and can be set to the destination name or service type. In this example VLAN IDs are used. The demods can be disabled / enabled here.

Figure 8-35 QMultiFlex-400™ Edit->Service->General Settings

8.8.3.2 Hub Rx Demodulator Settings

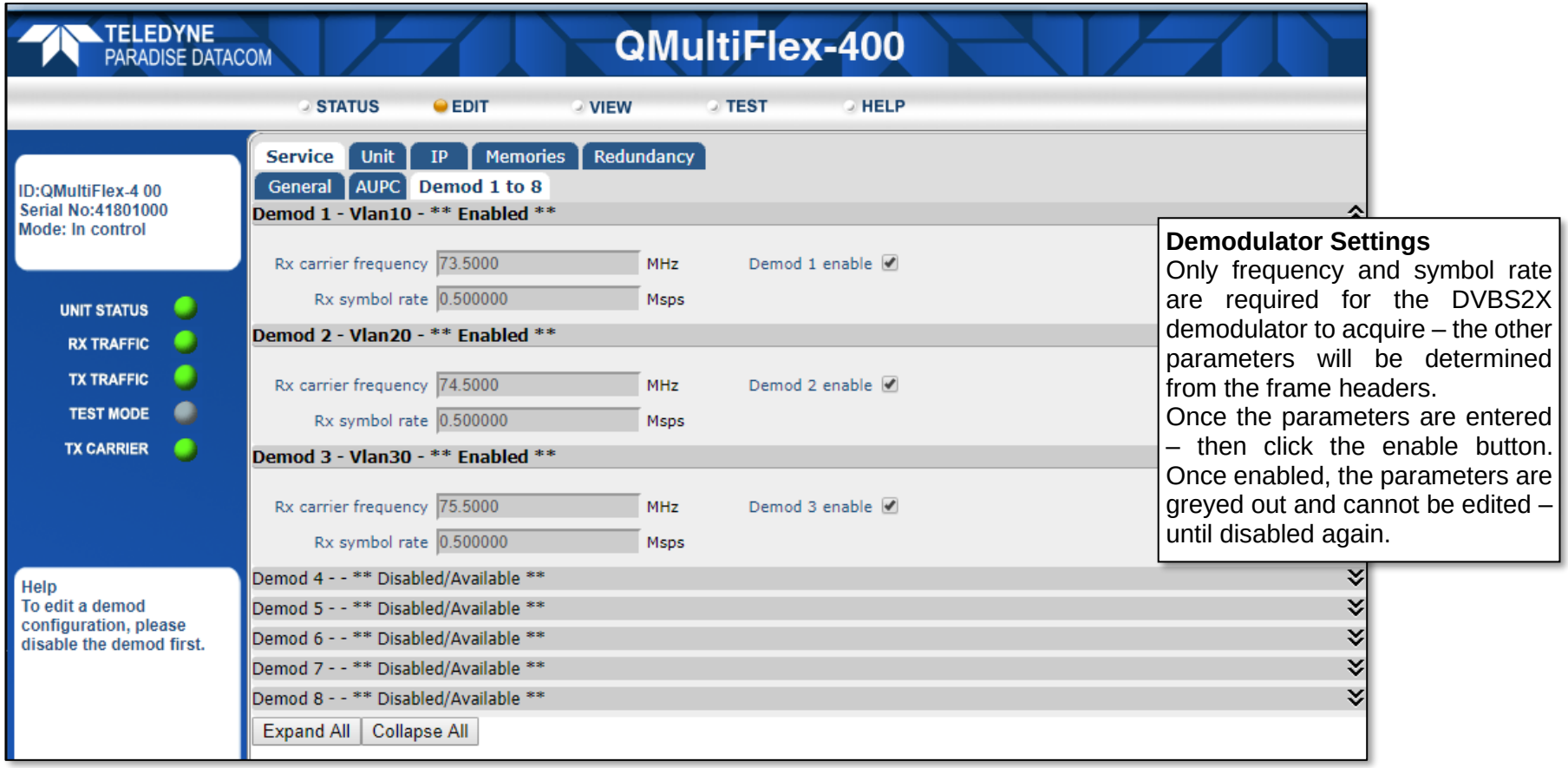


Figure 8-36 QMultiFlex-400™ Edit->Service->General Settings

8.8.3.3 Hub IP Settings

There are a few miscellaneous IP settings that need to be selected before moving on to configure the remote modems. Go to the 'IP' tab to see those settings.

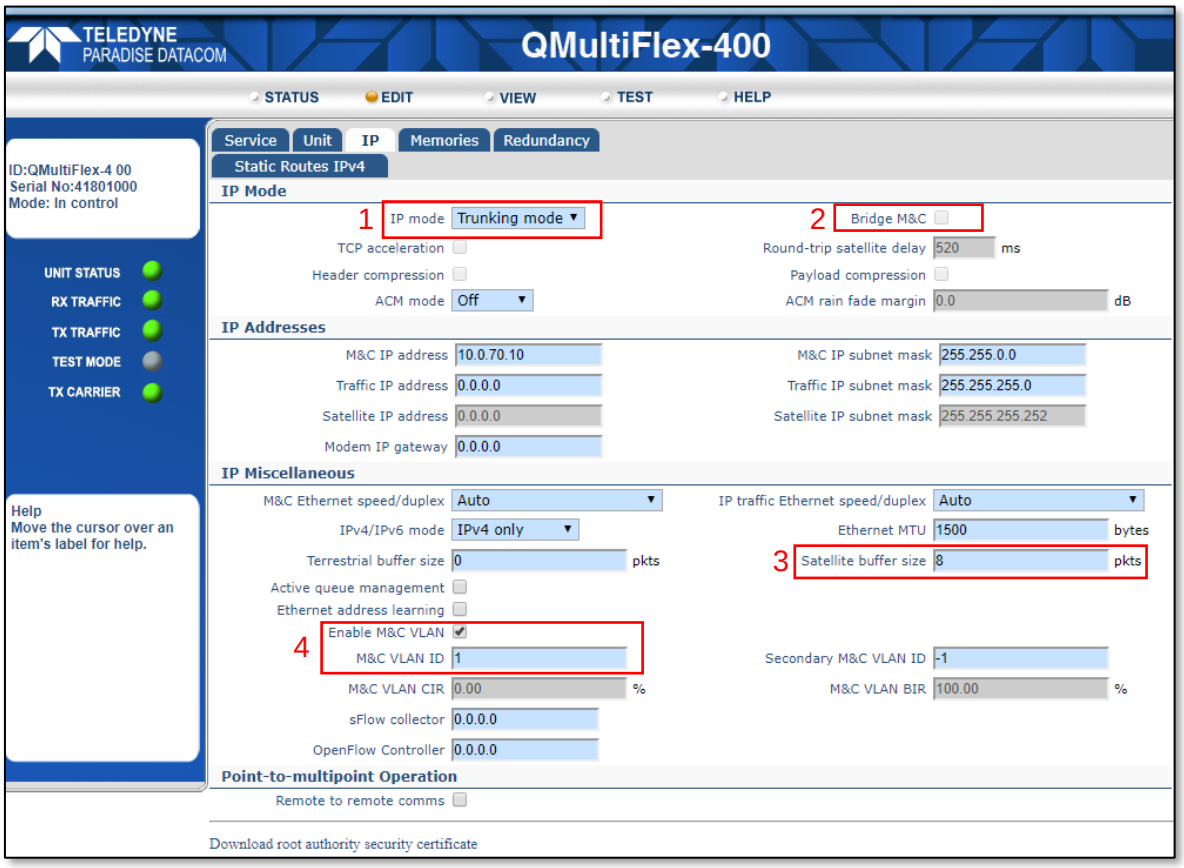


Figure 8-37 QMultiFlex-400™ Edit->IP Settings

1. The **Q-MultiFlex-400™** is shipped with an IP processing card as standard. Though it is internal to the modem, it works separate to the main motherboard. The IP traffic card will apply the QoS rules or TCP acceleration in an IP bridge mode. The processed traffic then gets inserted into the modem via a patch cable. The modem is set to what we call 'Trunking mode' – which is a low-jitter fast throughput mode.

2. The default for the 'Bridge M&C' option is on. For most applications this will need to be unchecked (off).

3. The default satellite buffer size is 256 packets. The **QMultiFlex-400™** works better with a buffer size of 8 packets, especially if implementing QoS rules.

4. The M&C VLAN default is 0. VLAN 1 has been chosen as the management VLAN and is enabled here (checked).

8.8.3.4 Hub QoS Settings

We are going to apply some QoS rules based on VLAN numbers. The VLANs will be set to the same priority, but the Burst Information Rate (BIR) will be set to 99% to allow any VLAN to use any available throughput up to 99%. At least 1% will be reserved for the M&C VLAN – which is set to the highest priority on the default traffic. This will ensure the M&C traffic does not lose connection. The committed information rate (CIR) values must total 100% - so the following will be used:

VLAN10: 33% CIR | 99% BIR | Priority 1
VLAN20: 33% CIR | 99% BIR | Priority 1
VLAN30: 33% CIR | 99% BIR | Priority 1
Default: 1% CIR | 5% BIR | Priority 0

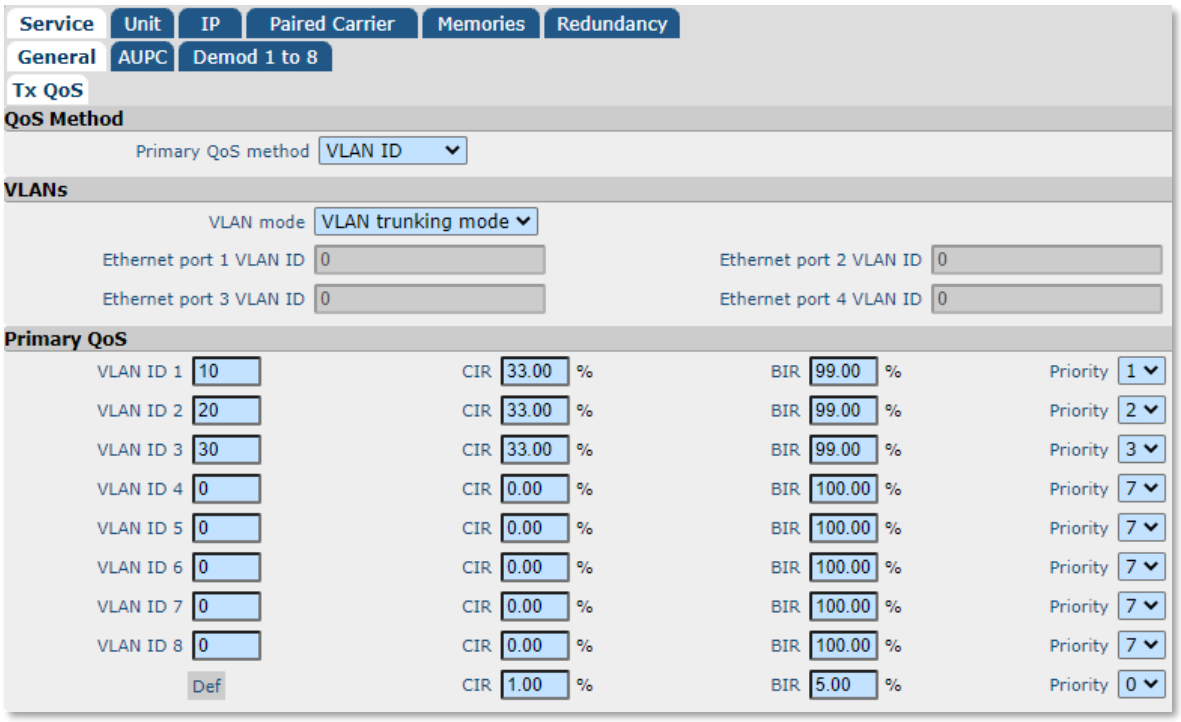


Figure 8-38 QMultiFlex-400™ Edit->General->Tx QoS Settings

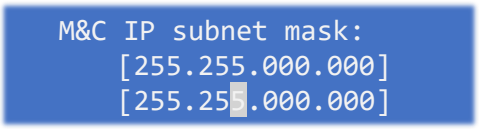
VLAN trunking mode is selected and the **QMultiFlex-400™** will expect an IEEE 802.1q trunk to be connected to the IP traffic port.

8.8.4 QFlex-400™ Remote Configurations

The remote modems will be given the following M&C IP addresses:
Remote modem 1: 10.0.70.1 / 16
Remote modem 2: 10.0.70.2 / 16
Remote modem 3: 10.0.70.3 / 16

To change the M&C IP address, press: Main, 2:Edit, 3:IP, 2: Addresses

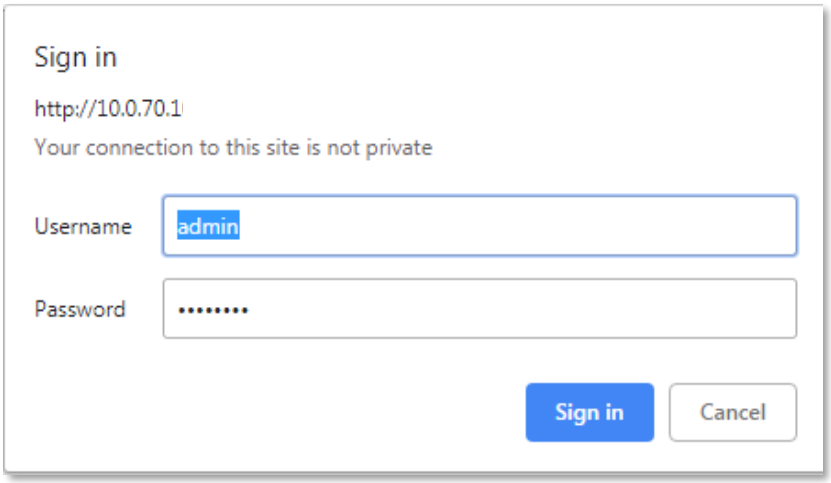
Move cursor to the end of the line and enter '1' in the last digit. Then press enter. The number will move to the top line to show the current value.



Press enter again to go to the next screen. Edit the subnet mask. Press enter again to move it to the top line position.

Do the same for remotes 2 and 3. It will now be possible to connect the PC (10.0.70.100) to the modems M&C port using the addresses 10.0.70.1 to 10.0.70.3. Pinging the modem IP address should show replies.

In a web browser type in the modem M&C address into the address bar.
Default credentials are:
Username: admin
Password: paradise



8.8.4.1 Remote 1 Modulator/Demodulator Settings

Values below are configured according to the test plan. The Tx and Rx rate controls were changed to 'Symbol rate' to make configuration easier.

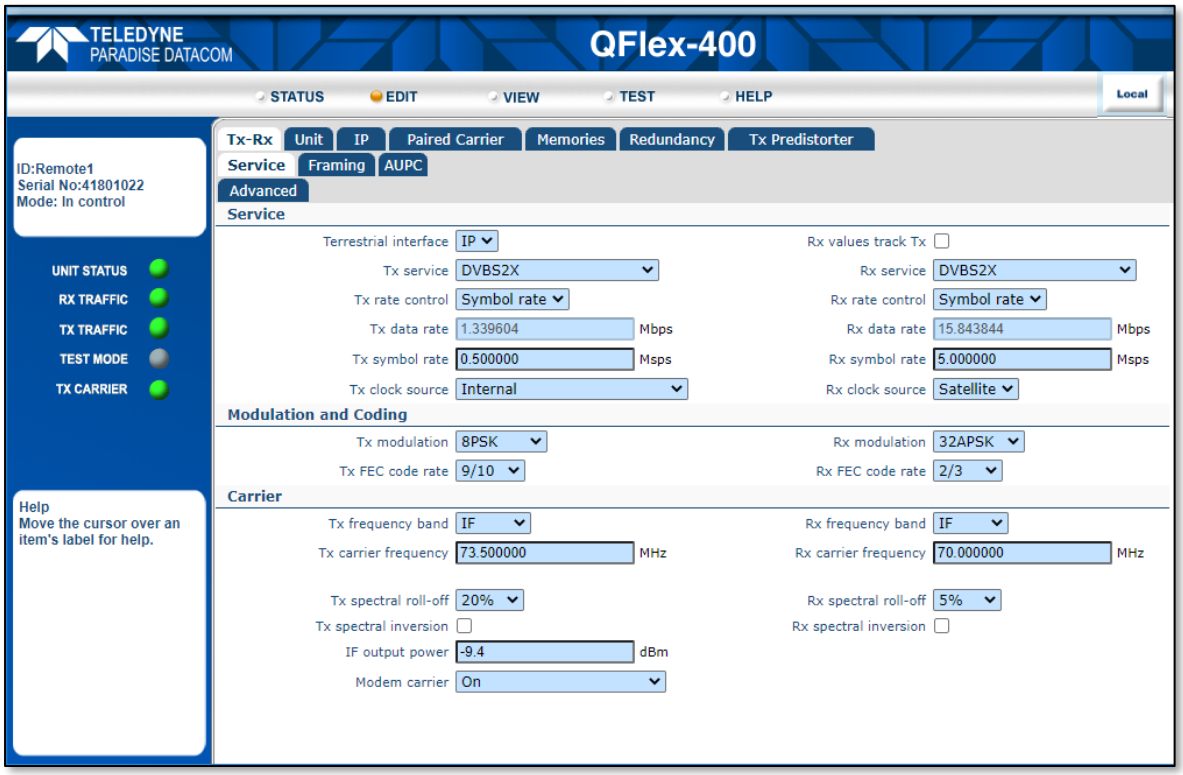


Figure 8-39 QFlex-400™ Remote 1 Edit->Tx=Rx->Service Settings

8.8.4.2 Remote 1 IP Settings

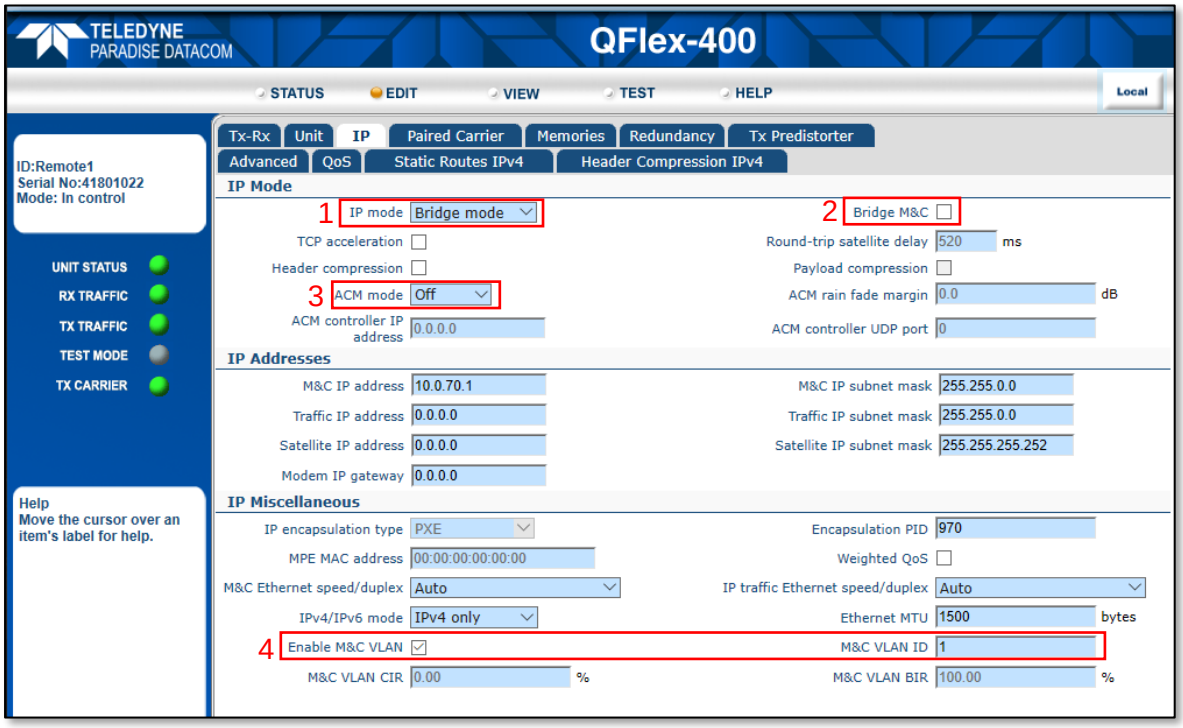


Figure 8-40 QFlex-400™ Remote 1 Edit->IP Settings

1. Even though the **QMultiFlex-400™** hub is set to 'Trunk Mode' it is actually operating like bridge mode due to the IP traffic card. **The Q-Flex400™** remote should be set to bridge mode as it is here.
2. Bridge M&C default is 'Checked' (On) and needs to be unchecked (Off).
3. ACM is off initially. This is so some preliminary testing can be completed first.
4. The M&C VLAN default is 0. I changed it to 1. A reboot of the **QMultiFlex-400™** is required to use the new M&C VLAN address.

8.8.4.3 Remote 1 Advanced IP Settings

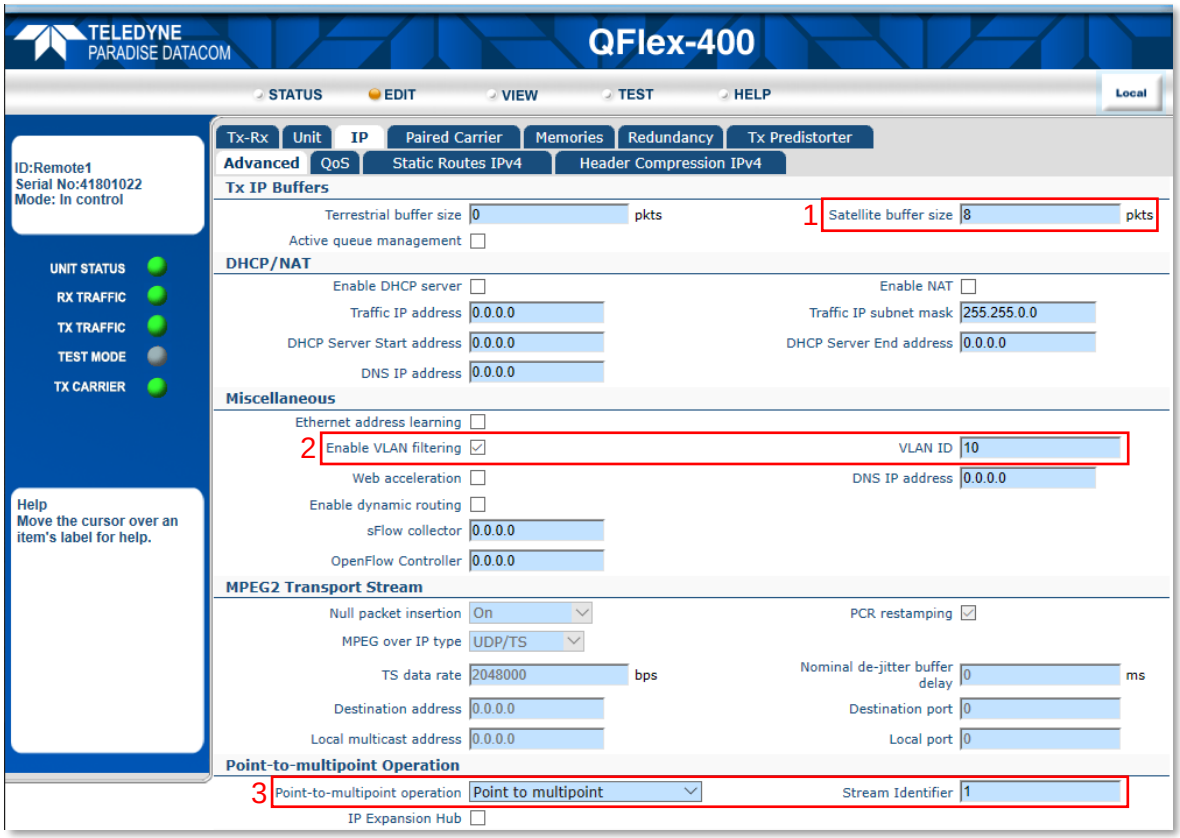


Figure 8-41 QFlex-400™ Remote 1 Edit->IP->Advanced Settings

1. Just like the hub side, the satellite buffer is set to 8 packets.
2. It is recommended for each remote site to be on a separate VLAN. The VLAN filtering control is where a single VLAN ID can be entered, which is the wanted traffic. All other traffic is dropped. From a security point of view this is typically desirable.
3. Point-to-multipoint operation: This is an essential setting for point to multipoint systems and puts the remote into a different mode of operation. The stream identifier is for ACM and will be 1 for remote 1. **Note:** All remotes can be left at the default '4' if not using ACM.

8.8.4.4 Remote 2 Modulator/Demodulator Settings

These settings are very similar to the Remote 1 ones and are shown here for reference.

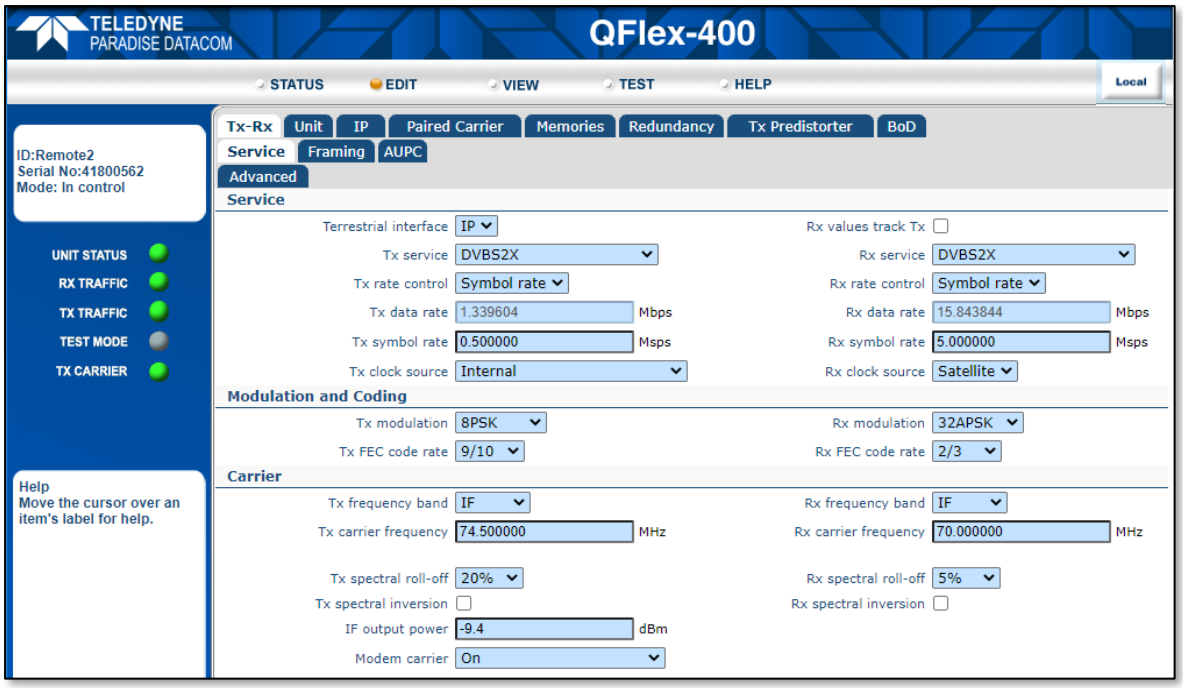


Figure 8-42 QFlex-400™ Remote 2 Edit->Tx=Rx->Service Settings

8.8.4.5 Remote 2 IP Settings

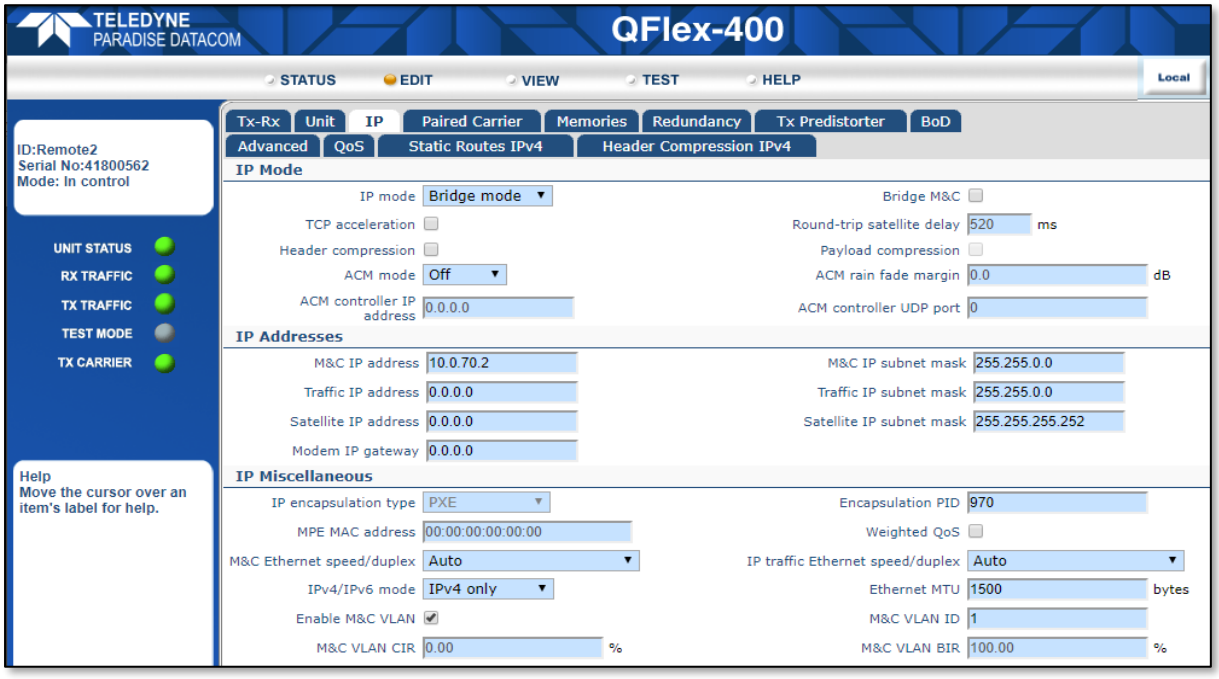


Figure 8-43 QFlex-400™ Remote 2 Edit->IP Settings

8.8.4.6 Remote 2 Advanced IP Settings

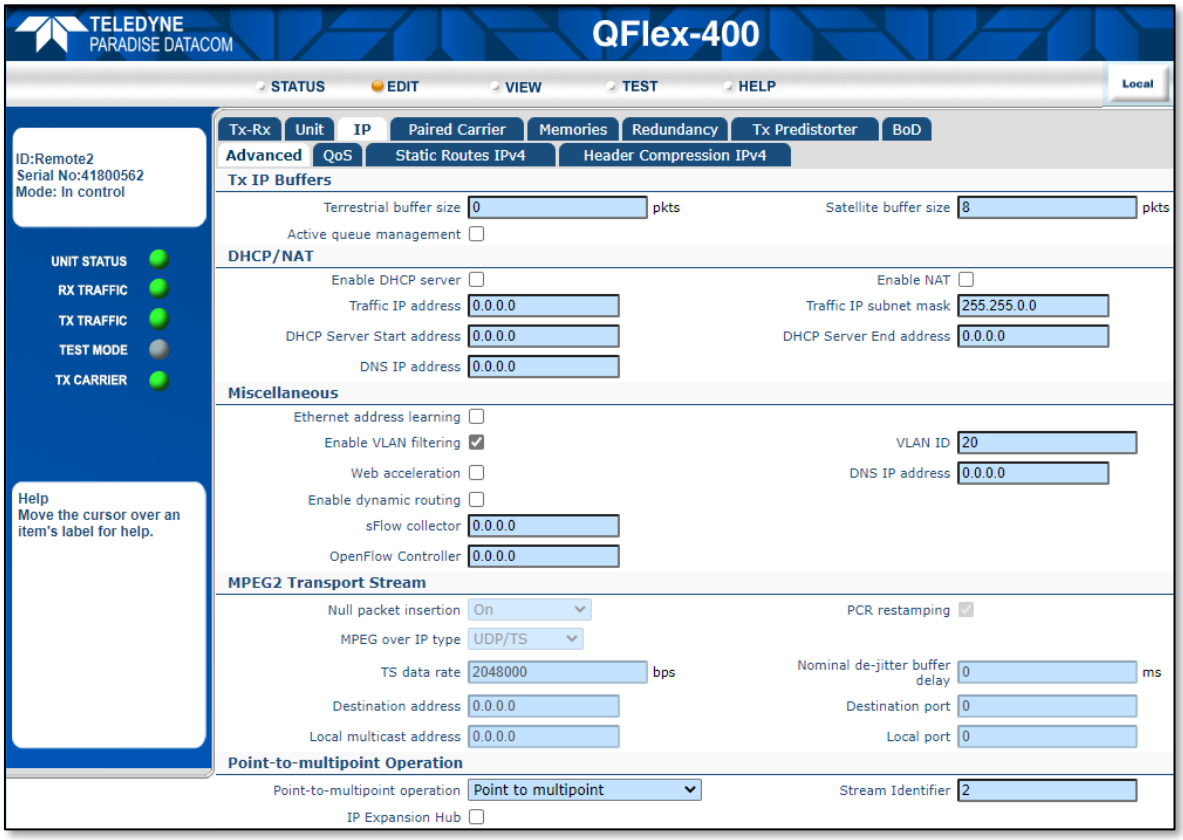


Figure 8-44 QFlex-400™ Remote 2 Edit->IP->Advanced Settings

8.8.4.7 Remote 3 Modulator/Demodulator Settings

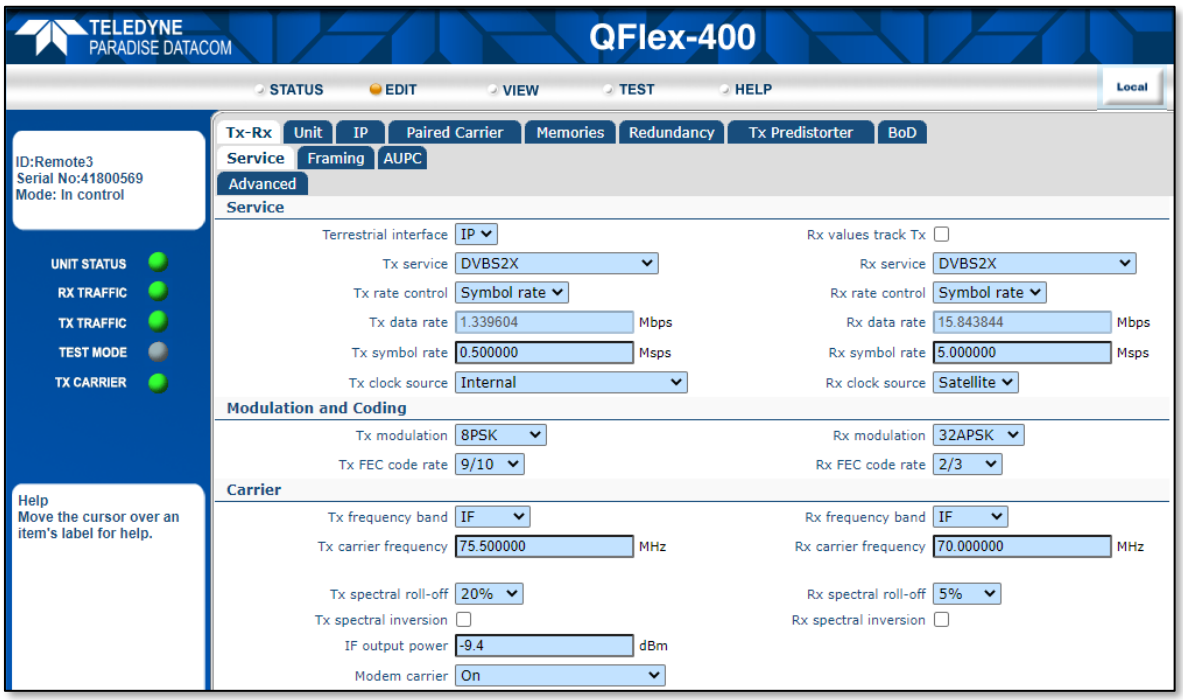


Figure 8-45 QFlex-400™ Remote 2 Edit->Tx=Rx->Service Settings

8.8.4.8 Remote 3 IP Settings

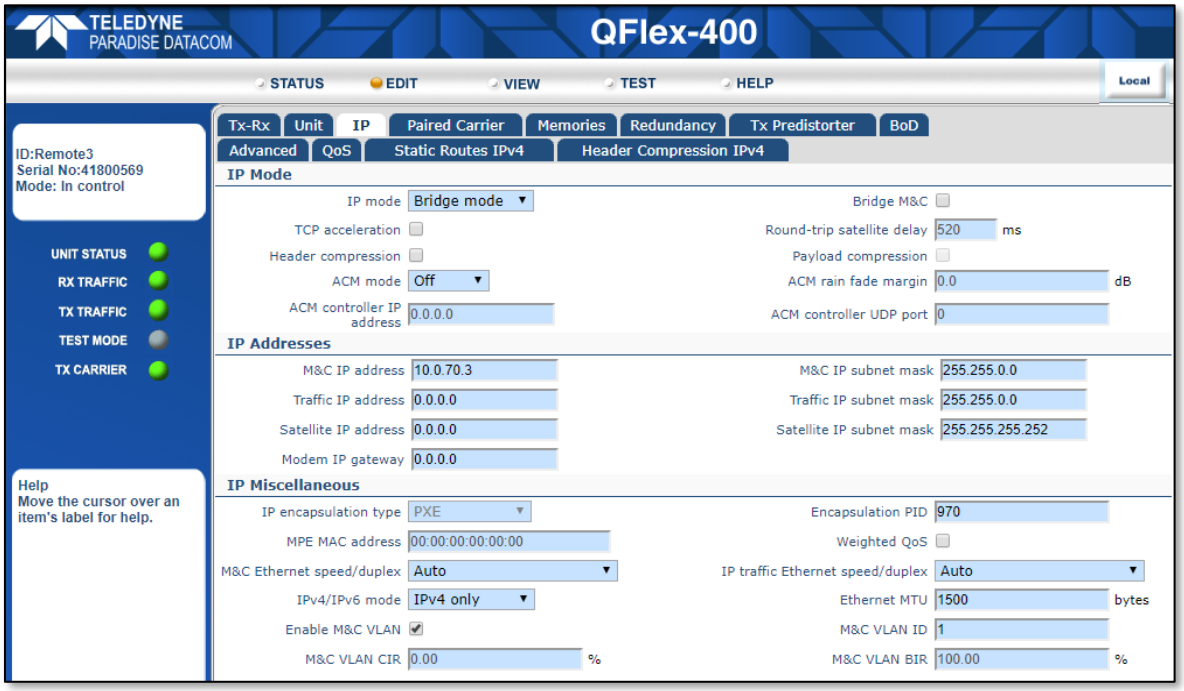


Figure 8-46 QFlex-400™ Remote 2 Edit->IP Settings

8.8.4.9 Remote 3 Advanced IP Settings

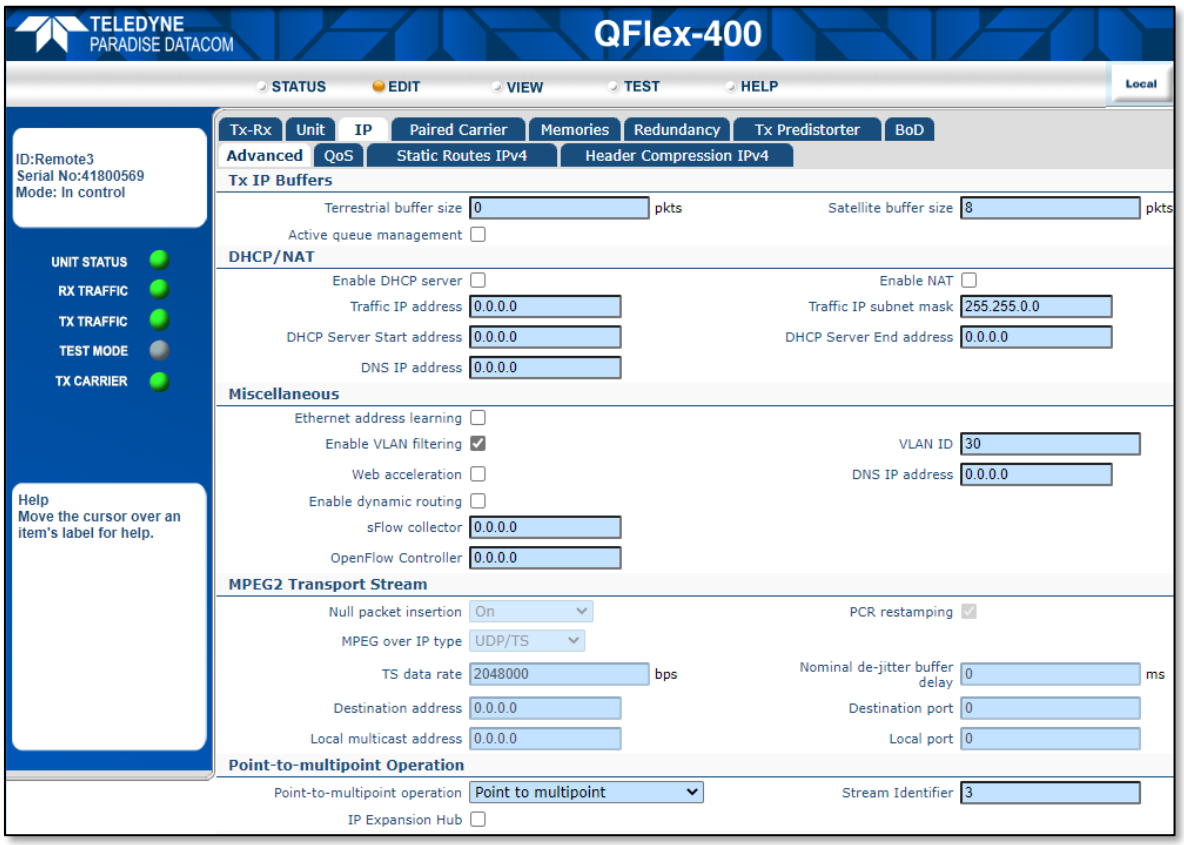


Figure 8-47 QFlex-400™ Remote 2 Edit->IP->Advanced Settings

8.8.5 Preliminary Testing

Once configured, as long as all of the RF cables are connected as shown in section 8.7.2 and no noise is applied, then all modems should be displaying green status LED lights for: Unit, Rx Traffic, Tx Traffic and Tx Carrier. **QMultiFlex-400™** Summary Status page:

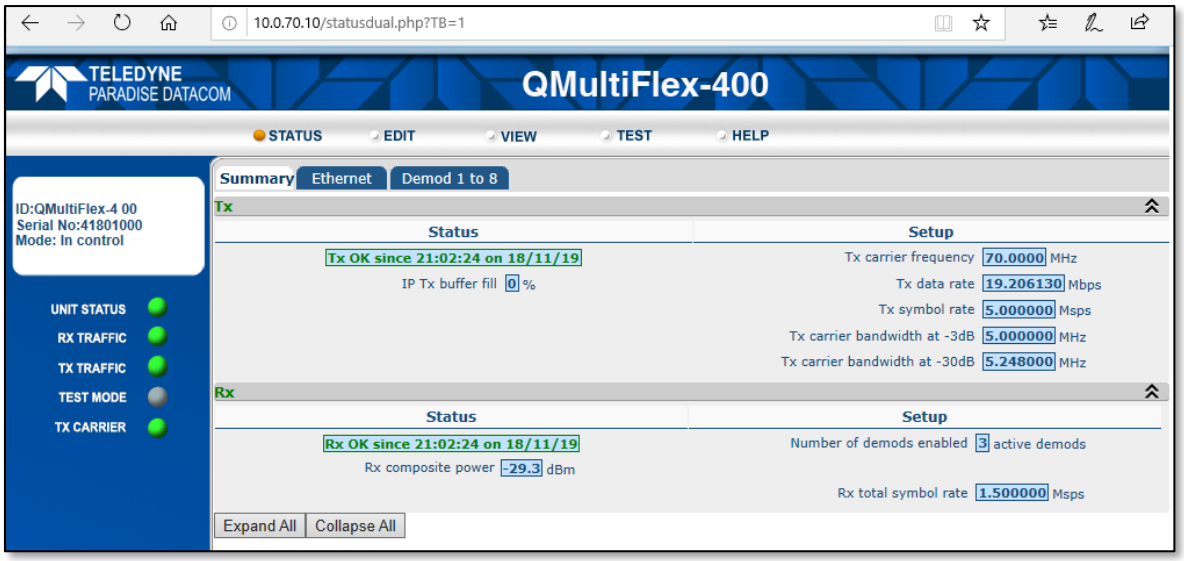


Figure 8-48 QMultiFlex-400™ Status Page

QMultiFlex-400™ Demod Status page should look something like this:

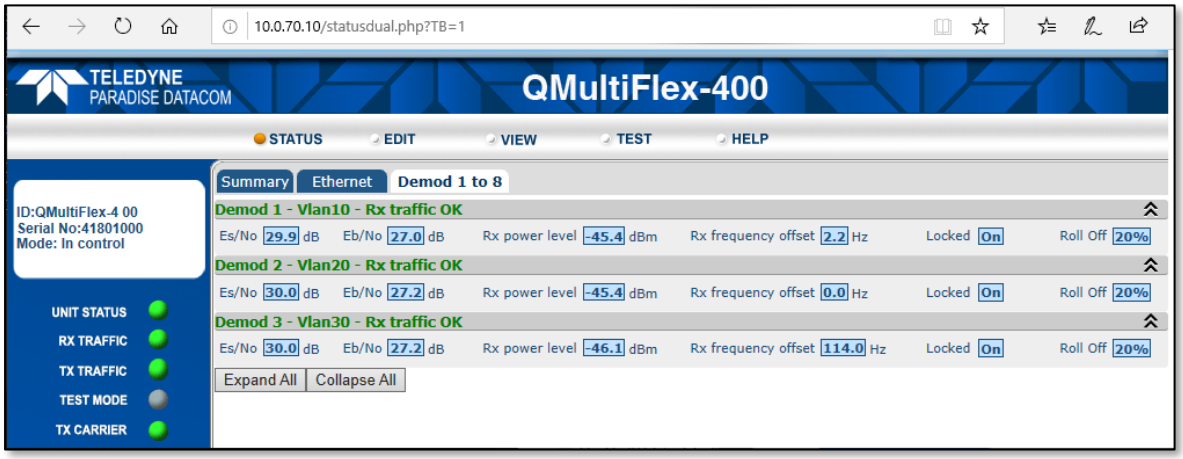


Figure 8-49 QMultiFlex-400™ Demod 1 to 8 Status Page

While connected to the **QMultiFlex-400™,** the remote M&C web GUI M&C connections should be available over the link (M&C VLAN). All remote status pages should look like the screen in **Figure 8-50** (Remote 1 shown).

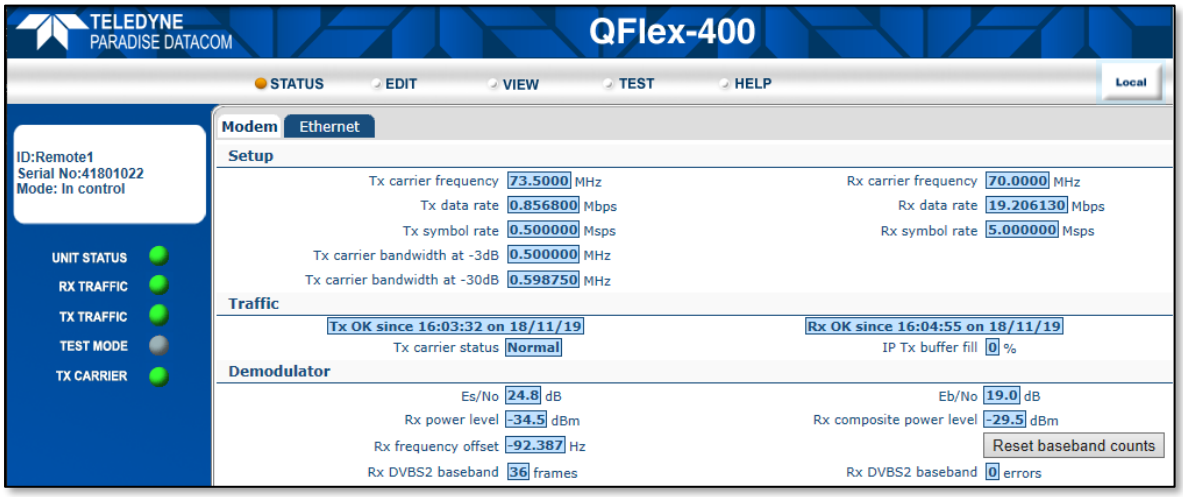


Figure 8-50 QFlex-400™ Remote 1 Status Page

With traffic applied, the spectrum at the splitter should look something like the following:

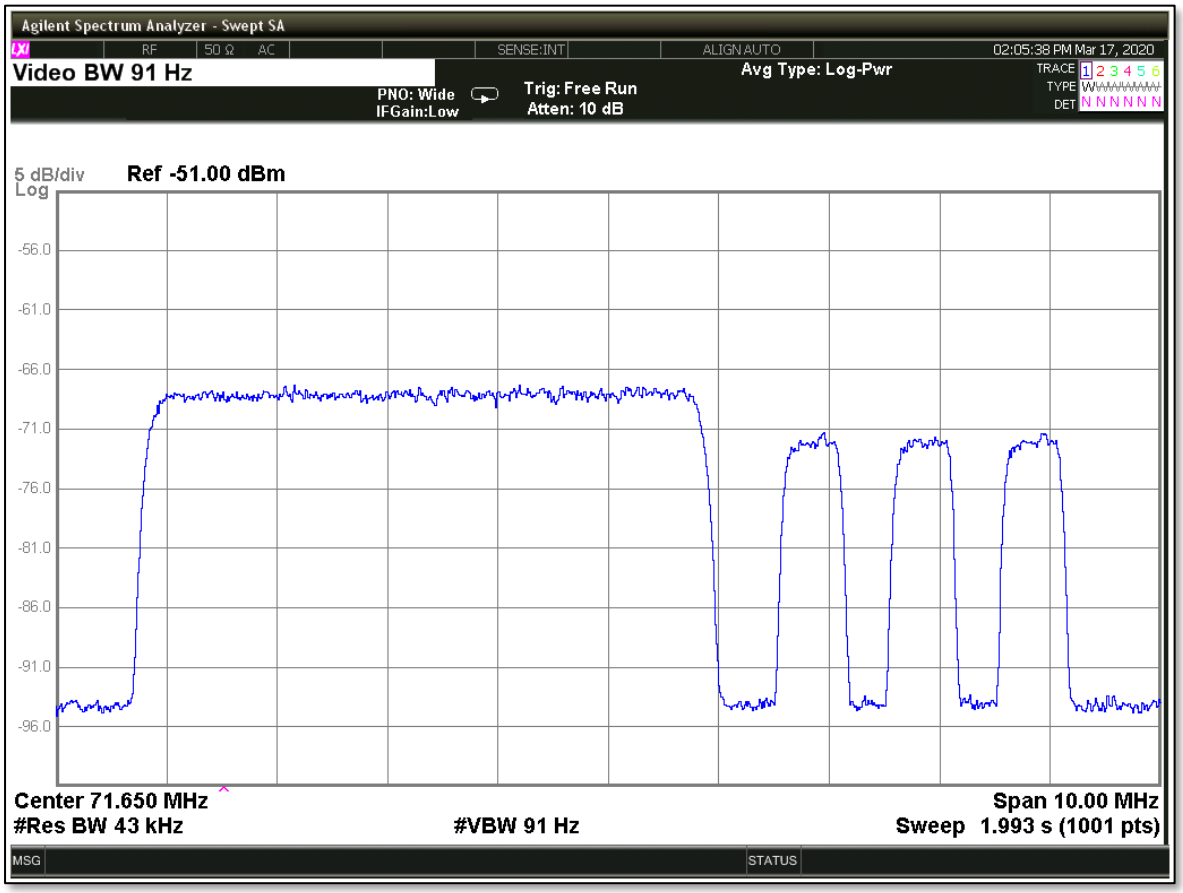
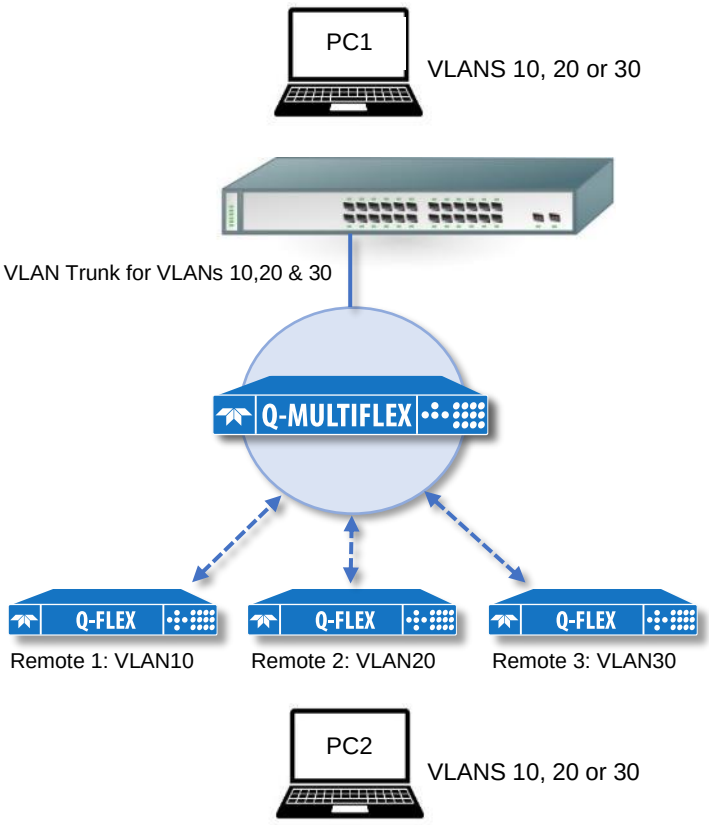


Figure 8-51 Expected Spectrum

8.8.5.1 IP Connectivity

It is possible at this stage to connect a VLAN capable switch to test traffic throughput. Ports would need to be set for VLANS 10, 20 and 30 with a trunk going to the **QMultiFlex-400™**.



To test for basic connectivity, start with connecting PC1 and PC2 to VLAN 10. That is PC1 connected to a VLAN10 port on the switch and PC2 connected to the IP traffic port on **QFlex-400™** Remote 1.
Once verified, disconnect PC1 and PC2 and change IP addresses to the VLAN 20 subnet. Then connect PC1 to a VLAN20 port on the switch and PC2 to the IP traffic port on QFlex-400™ Remote 2.
Then do the same for VLAN30.

VLAN Subnets:
VLAN10: 192.168.10.0 / 24
VLAN20: 192.168.20.0 / 24
VLAN30: 192.168.30.0 / 24

If there are connectivity problems, try rebooting all equipment and trying again. If issue persists, double check configuration.

Figure 8-52 Throughput testing

8.8.6 Router Settings

After modem IP throughput is verified, it is time to add the router. In this example a Cisco 2811 router was used. If you have a different router type, then hopefully the following settings can be duplicated.

FE 0/0 is set to have the following sub-interfaces:
0.10 - 192.168.10.1 / 24 VLAN ID set to 10
0.20 - 192.168.20.1 / 24 VLAN ID set to 20
0.30 - 192.168.30.1 / 24 VLAN ID set to 30

FE 0/1 was configured to get a DHCP address from an ISP router. NAT was enabled in overload mode to allow one address to be used for all users connected.

Full list of commands for Cisco 2811 router configuration

Base Config (All passwords are 'paradise')

```
> enable
> conf term
> hostname Paradise
> no ip domain-lookup
> service password-encryption
> enable secret paradise
> line console 0
> password paradise
> login
> logging synchronous
> line vty 0 4
> password paradise
> login
> hostname paradise
> no ip domain-lookup
> line console 0
> logging synchronous
> end
```

Configure Interface F0/1 to supply internet to all three networks using NAT overload:

```
> conf term
> int f0/1
> ip add DHCP
> desc Connection to SOHO router
> ip NAT outside
> exit
> access-list 101 permit ip 192.168.10.0 0.0.0.255 any
> access-list 101 permit ip 192.168.20.0 0.0.0.255 any
> access-list 101 permit ip 192.168.30.0 0.0.0.255 any
> ip nat inside source list 101 interface f0/1 overload
```

Configure Interface F0/0 with sub interfaces for VLANS 10, 20 &30 and set ports for NAT inside:

```
> conf term
> int 0/0
> desc connection to QMultiFlex400 traffic port
> ip nat inside
> no shut
> int f0/0.10
> encapsulation dot1Q 10
> ip address 192.168.10.1 255.255.255.0
> ip nat inside
> exit
> int f0/0.20
> encapsulation dot1Q 20
> ip address 192.168.20.1 255.255.255.0
> ip nat inside
> exit
```

```
> int f0/0.30
> encapsulation dot1Q 30
> ip address 192.168.30.1 255.255.255.0
> ip nat inside
> exit
```

NOTE: at this point it should be possible to set a laptop IP address for one of the VLAN network addresses and ping the gateway and get internet connectivity.
e.g. For VLAN10: laptop set to: 192.168.10.2 255.255.255.0 gateway: 192.168.10.1 DNS address: 8.8.8.8 (google).

DHCP servers can be setup on the router to supply IP addresses from address pools for each VLAN network. Any DHCP enabled device attached to the remote modem network will then get an address, gateway and DNS address.

DHCP configuration for remote laptops:

```
> conf term
> ip dhcp pool ParadiseRouter_VLAN10_POOL
> network 192.168.10.0 255.255.255.0
> default-router 192.168.10.1
> dns-server 8.8.8.8
> ip dhcp pool ParadiseRouter_VLAN20_POOL
> network 192.168.20.0 255.255.255.0
> default-router 192.168.20.1
> dns-server 8.8.8.8
> ip dhcp pool ParadiseRouter_VLAN30_POOL
> network 192.168.30.0 255.255.255.0
> dns-server 8.8.8.8
> default-router 192.168.30.1
> ip dhcp excluded-address 192.168.10.1 192.168.10.6
> ip dhcp excluded-address 192.168.20.1 192.168.20.7
> ip dhcp excluded-address 192.168.30.1 192.168.30.8
> exit
> int f0/0.10
> ip helper-address 192.168.10.1
> exit
> int f0/0.20
> ip helper-address 192.168.20.1
> exit
> int f0/0.30
> ip helper-address 192.168.30.1
> end
```

DHCP should give out the following addresses if one DHCP enabled laptop is connected to each remote QFlex-400™ modem:
VLAN10 Laptop - First address: 192.168.10.7
VLAN20 Laptop - First address: 192.168.20.8
VLAN30 Laptop - First address: 192.168.30.9

All laptops can ping each other due to inter-VLAN routing. This may not be desirable but can be managed via access control lists (ACLs).

ACL Configuration:

```
> ip access-list extended VLAN10
> permit tcp any any eq www
> permit udp any any eq 80
> permit tcp any 192.168.10.0 0.0.0.255
> permit udp any 192.168.10.0 0.0.0.255
> ip access-list extended VLAN20
> permit tcp any any eq www
> permit udp any any eq 80
> permit tcp any 192.168.20.0 0.0.0.255
> permit udp any 192.168.20.0 0.0.0.255
> ip access-list extended VLAN30
> permit tcp any any eq www
> permit udp any any eq 80
> permit tcp any 192.168.30.0 0.0.0.255
> permit udp any 192.168.30.0 0.0.0.255
>  int f0/0.10
> ip access-group VLAN10 out
> exit
> int f0/0.20
> ip access-group VLAN20 out
> exit
> int f0/0.30
> ip access-group VLAN30 out
> end
```

Any pings to another laptop should now be filtered.

This concludes the router configuration for the worked example, and everything should be working as expected based on figure 8-32 at the start of this Section. If not, please check router configuration and the status of the modems. If problems persist, power cycle all equipment and re-check.

When testing internet connectivity, each remote laptop can be downloading data i.e. like a video stream or large file download. It then should be possible to see traffic for each VLAN in the QoS IP graph, like below. Use 'Select class' drop down menu to switch the graph. In our case Class1 = VLAN10, Class2 = VLAN20 & Class3 = VLAN30. As you may remember we set each VLAN to take a third of the data equally when loaded, then burst to 99% when traffic was available.

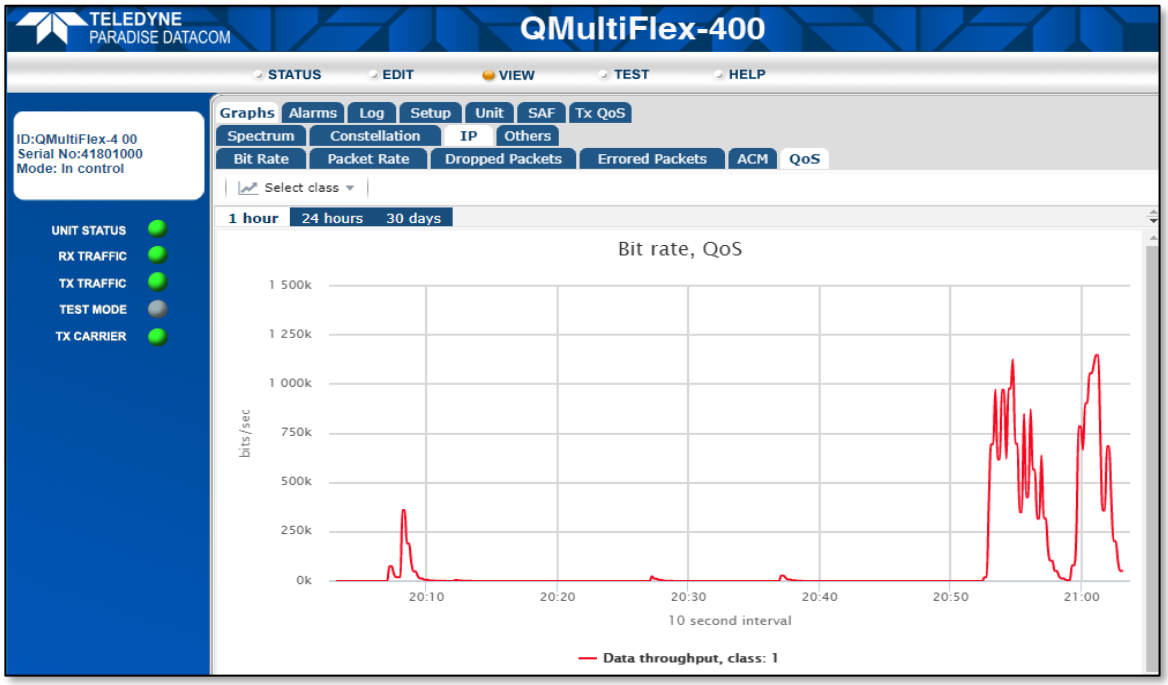


Figure 8-53 Throughput graph for VLAN 1 (Class 1)

This concludes the system worked example.

Chapter 9 Remote Control Protocol

The modem supports the following remote-control interfaces:

- A built-in remote web user interface that provides HTTP or HTTPS web pages from the modem (using a web server) to a web browser. This is accessed by entering the IP address of the modem into a web browser address bar (the web server being on ports 80 or 443).
- A serial interface (selectable between RS232 and RS485) that can be used to send and receive Paradise Universal Protocol (PUP) messages. This interface can be driven either through a generic user-entry application such as HyperTerminal (in the case of RS232) or through an application that uses a driver developed specifically to implement the PUP protocol. In the case of RS485, a message wrapper (defined in the document *'Remote M&C Specification for **Q-Flex™** Satellite Modem'*, which also covers the ***QMultiFlex-400™***) is used to encapsulate PUP commands and responses, which are incorporated into the message payload.
- An Ethernet interface that can be used to send and receive PUP messages or Simple Network Management Protocol (SNMP) messages. This interface can be used in several ways.

  Firstly, a generic user-entry application such as Telnet can be used to automatically send or manually enter PUP commands.

  Secondly, PUP messages can be encapsulated directly into TCP packets using the message format defined in the document *'Remote M&C Specification for **Q-Flex™** Satellite Modem'*. These must be sent to a specific TCP port that the modem listens on for PUP commands. Typically, this will result in much faster communications than when using Telnet. This method is referred to as 'direct encapsulation' elsewhere in this document to differentiate it from the Telnet type of communications.

  Thirdly, SNMP V1 or V2c can be used to communicate between an SNMP network manager and the SNMP agent on the modem.

The remote-control protocol for the modem is specified in the document '*Remote M&C Specification for Q-Flex™ Satellite Modem*', which also covers the *QMultiFlex-400™*.

M&C message example

The following example shows how to:

1) *get* the transmit power from a modem. (The response has a value of -25. Note that numeric text denotes the message contents as hexadecimal characters.)

```
          g e t    T  I F  T x  I  F P  w  r  *
02 15 01 09 67 65 74 20 54 49 46 54 78 49 46 50 77 72 2A 0B 03

          -  2  5  *
02 0A 01 09 2D 32 35 2A C8 03
```

2) Login to the modem to be able to make changes. (The response has a value of *.)

l o g i n p a r a d i s e *
02 15 01 09 6C 6F 67 69 6E 20 70 61 72 61 64 69 73 65 2A B6 03

*****
02 08 01 09 20 2A 54 03

3) *Set* the transmit power to a new value. (-20). (The response has a value of *.)

s e t T I F T x I F P w r - 2 0 *
02 19 01 09 73 65 74 20 54 49 46 54 78 49 46 50 77 72 20 2D 32 30 2A C6 03

*****
02 08 01 09 20 2A 54 03

4) *get* the transmit power to prove that the change has been accepted. (The response indicates a value of -20.)

g e t T I F T x I F P w r *
02 15 01 09 67 65 74 20 54 49 46 54 78 49 46 50 77 72 2A 0B 03

- 2 0 *
02 0A 01 09 2D 32 30 2A C3 03

Chapter 10 Connector Pinouts

1:N (1:1) Interface

9-pin, Male D-type

Pin #	Description
1	Ground
2	Line In
3	Line Out
4	Serial In (A)
5	Serial IN (B)
6	Fail In
7	Fail Out
8	Serial Out (A)
9	Serial Out (B)

1:1 Redundancy Cable

A standard 1:1 lead (part number P1391) is available from Teledyne Paradise Datacom. The lead is 2ft long and is designed for use when two modems are mounted vertically adjacent to each other in the rack.

The 1:1 redundancy cable is wired as follows:

Modem 1 Pin #	Modem 2 Pin #	Signal Name
1	1	Circuit ground (screen)
2	3	On-Line signal 2-1
3	2	On-Line signal 1-2
6	7	Fail signal 2-1
7	6	Fail signal 1-2

The cable must be of the shielded variety and should be kept as short as practical.

Alarms and AGC Connector

ALARMS and AGC

15-pin, Male, D-type, High density

Pin #	Description
1	Alarm 4 N/O (Deferred Alarm)
2	Alarm Common
3	Alarm 3 N/O (Rx Traffic Fault)
4	Alarm 1 N/O (Unit Fault)
5	Alarm 2 N/O (Tx Traffic Fault)
6	DAC out
7	Tx. Inhibit
8	Rx. Data
9	Alarm 4 N/C
10	Alarm 3 N/C
11	Alarm 1 N/C
12	Alarm Common
13	Alarm 2 N/C
14	Tx, Data
15	Ground

To externally inhibit the Transmit carrier, either apply a TTL/CMOS 'low' signal to pin 7, or short pin 7 to ground (for example with an external relay closure).

All relay contacts are rated 30V DC 2A, or 125VAC 0.4A.

Note: N/O means 'normally open' *in the non-fail state of the modem* (relays energised) when power is removed the relays fall back to the non-normal (i.e. non-energised) alarm state.

USB

USB Type A

Pin #	Description
1	VBUS
2	D-
3	D+
4	Ground

Chapter 11 Fault Messages

The following table lists all of the modem faults along with a description of what the fault means. It also describes relevant checks the operator might make to try to eliminate the fault condition. Note that the text shown in the table will be displayed in full on the web user interface and in the system log but may appear in an abbreviated format on the front panel LCD display due to space considerations.

The acronyms used to define the actions taken on each fault occurring are as follows:

Actions: Relays

U: Prompt unit fault relay.
T: Prompt traffic fault relay.
D: Deferred alarm relay.

Actions: Other

CM: Carrier mute.

11.1 Transmit Faults

Fault Text	Notes	Relays	To Ter	To Sat	Other
Tx fault: BUC PSU outside limits.	The current drawn by the BUC has exceeded the permissible upper & lower limits.				CM
Tx fault: Tx terrestrial DPLL unlocked.	Consult technical support if this alarm cannot be cleared.				CM
Tx fault: Tx channel DPLL unlocked.	Consult technical support if this alarm cannot be cleared.				
Tx fault: Encoder fault.	Unspecified DVB-S2 encoder fault. Consult factory.				
Tx fault: Framer sync lost.	Unspecified DVB-S2 encoder fault. Consult factory.				
Tx fault: Data failure to modulator.	Unspecified DVB-S2 modulator fault. Consult factory.				

11.2 Transmit Warnings

Fault Text	Notes	Relays	To Ter	To Sat	Other
Tx warning: Cannot hold/reach power set at BUC	The required BUC output power cannot be achieved. This alarm is only displayed when the modem is in terminal mode & the modem attempts to set the BUC output power by adjusting its output level & a attenuator in the BUC. This can be caused by too much attenuation in the cross-site cabling or inability to control the attenuator in the BUC (such as use of a non-Paradise BUC with no input attenuator)	D			
Tx warning: Carrier out of range.	The carrier frequency selected for the Tx carrier has exceeded the permissible range for the configured symbol rate.				CM
Tx warning: Tx symbol rate outside range.	The modems current configuration exceeds the permissible symbol rate, check the configuration.				CM

11.3 Receive Faults

Fault Text	Notes	Relays	To Ter	To Sat	Other
Rx fault: Demodulator unlocked. Check modem settings.	The demodulator cannot find a carrier to lock to at the specified frequency. Check the frequency, data rate and FEC settings. Check the demodulator by enabling IF loopback test mode.	R	TA,TC	SB	RF
Rx fault: FEC Decoder synchronization lost.	Synchronisation has been lost in the FEC decoder. Check inner FEC configuration.	R	TA,TC	SB	RF
Rx fault: Rx channel DPLL unlocked.	Consult technical support if this alarm cannot be cleared.	D			
Rx fault: Rx terrestrial DPLL unlocked.	Consult technical support if this alarm cannot be cleared.	D			
Rx fault: Physical layer sync lost.	DVB-S2 demodulator cannot detect valid DVB-S2 satellite frames (no data detected).				
Rx fault: PCMA unlocked.	Consult troubleshooting section of Paired Carrier quick start guide for list of potential causes.				
Rx fault: No GPS data, check connection.	GPS input to Paired Carrier (for calculating the delay to satellite) has failed. Check status of, and cable to, the external GPS system.				
Rx fault: Terrestrial muted due to sync loss.	This is as a result of setting the modem to mute terrestrial data on an Rx loss of sync (where the data is unmuted when the Eb/no threshold is exceeded). This is used to counter an excessive number of log entries due to sun outages (scintillations) causing the demod to continuously go into and out of lock.				
Rx fault: Baseband sync lost.	This is a DVB-S2 error when valid DVB-S2 baseband frames are not detected in the DVB-S2 satellite frames. This could be due to corruption due to interference, poor signal, etc.				
Rx fault: No transport traffic.	This is a DVB-S2 alarm indicating that no valid MPEG2 transport stream packets were detected within the received DVB-S2 satellite frame.				
Rx fault: Baseband CRC error.	The received DVB-S2 satellite frame does not contain a valid baseband frame, indicating the data has become corrupted (poor signal, interference, etc).				

11.4 Receive Warnings

Fault Text	Notes	Relays	To Ter	To Sat	Other
Rx warning: Rx data rate outside interface range.	Configuration error, data rate for terrestrial interface exceeded.				
Rx warning: The remote Eb/No has fallen below the user threshold.		D			
Rx warning: The receive Eb/No is worse than the user threshold set for the deferred alarm.		D			
Rx warning: Rx symbol rate outside range.	The modems current configuration exceeds the permissible symbol rate, check the configuration.				
Rx warning: Selected Rx output clock has failed.	The clock selected as the Receive data output clock has failed. The modem has switched to using a backup clock generated by the Rx PLL to preserve the receive traffic. This fault can only occur if the source is the same frequency as the Rx data rate (otherwise the clock is not used directly but is instead rate converted by the Rx PLL and would result in a different failure). Check which signal the PLL uses as a backup clock.	D			
Rx warning: Demodulator FIFO overflowed.	This should not occur in normal operating circumstances. Consult factory.				
Rx warning: Backward alarm at Insert MUX, indicating equipment downstream of Rx has failed.	This will only be displayed if the modem if fitted with an interface that provides four ports for separate input and output of separate Tx/Drop and Rx/Insert PCM bearers. It indicates a backward alarm has been detected at the Rx bearer input. This indicates that equipment downstream of the receive path has failed and is returning an alarm. This may be due to any receive downstream equipment but could be due to the modem Rx output failing. Check the modem Rx path indicates OK and that the Rx data output from the modem is connected to the downstream equipment.	D			
Rx warning: Wanted Rx input power out of range.	Indicates that the wanted signal is very low or very high.				
Rx warning: Composite Rx input power out of range.	Indicates very high level of composite power.				
Rx warning: Composite to wanted power level ratio >37dBc.	Indicates very high level of composite-to-wanted power.				

11.5 DVBS2(X) Demodulator Specific Messages

Alarm Type	Modem Alarm Message	Value of x	Alarm Interpretation listed in **priority order**
RxPLSyncAlarm	"Demod unlocked (x)"	r	"Demodulator reset by software"
		p	"Demodulator no PL lock"
		c	"Demodulator no carrier lock"
		s	"Demodulator no symbol lock"
RxDVBS2DecoderAlarm	"Rx DVBS2(X) Decoder error [x]"	0x1	"Decoder bad input signal (node1)"
		0x2	"Decoder input buffer overflow"
		0x4	"Decoder input buffer underflow"
RxDVBS2FECAlarm	"Rx DVBS2(X) FEC Decoder error [x]"	0x2000	"Decoder bad input signal (node 2)"
		0x400	"Decoder uncorrectable LDPC frame"
		0x800	"Decoder uncorrectable BCH frame"
		0x1000	"Decoder bad BBFrame CRC"
RxDVBS2DecoderAlarm	"Rx DVBS2(X) Decoder error [x]"	0x8	"Decoder bad output signal (node 3)"
		0x10	"Decoder output buffer lost sync"
		0x20	"Decoder output buffer consecutive SOF"
		0x40	"Decoder output buffer consecutive EOF"
		0x80	"Decoder output buffer missing SOF"
		0x100	"Decoder output buffer packet too long"
		0x200	"Decoder output buffer packet too long"
		0x400	"Decoder output buffer overflow"
		0x800	"Decoder output buffer underflow"
		0x20000	"Decoder output clock boundary buffer overflow"
		0x40000	"Decoder output clock boundary buffer underflow"
		0x80000	"Decoder no output signal"
		0x100000	"Decoder bad output signal (node 4)"
RxBBCRCAlarm	"Rx Mode Adapter error (x)"	0x1	"BBFrame bad input signal (node 1)"
		0x2	"BBFrame bad input signal (node 2)"
		0x4	"BBFrame bad input signal (node 3)"
		0x8	"BBFrame bad input signal (node 4)"
		0x100	"BBFrame bad CRC"

Note: SOF = Start of Frame. EOF = End of Frame.

11.6 Unit Faults

Fault Text	Notes	Relays	To Ter	To Sat	Other
Unit fault: One or more PSU rails are out of range.	A PSU line has failed. The unit has a linear supply and will fail if the mains input is below the specified minimum level. Check the mains voltage and the internal PCB-mounted low-voltage fuses.	U	TA,TC		RF, TF, CM
Unit fault: Station clock has failed. Check clock source.	A valid signal cannot be detected on the external Station clock input. Check the cable and the clock source.	U,D			
An internal fault has occurred. Please consult factory.	This indicates that the software has been unable to initialise the hardware. Power the modem down and back up to see whether this clears the problem.	U	TA,TC		TF, RF, CM
Unit fault: Rx backup clock has failed	The clock used when the selected Rx clock fails has also failed. Contact technical support for advice.	U	TA,TC		RF
Unit fault: Communications with the BUC have failed. Check connections.	Unable to communicate with the BUC, check BUC type & services are correctly configured.	U			TF
Unit fault: BUC PLL failure.	The PLL in the BUC is reporting out of lock. Check reference clock.	U			TF
Unit fault: BUC over-temperature failure.	The BUC is indicating an over-temperature fault.	U			TF
Unit fault: Modulator DPLL has lost lock.	Consult technical support if this alarm cannot be cleared	U			
Unit fault: Tx Synth has lost lock.	Consult technical support if this alarm cannot be cleared	U			TF, CM
Unit fault: Rx Synth has lost lock.	Consult technical support if this alarm cannot be cleared	U	TA,TC		RF
Unit fault (occurs initially as unit warning): Operating temperature exceeded.	This refers to the internal unit temperature, Check the modem vent slots are clear and the rear fan has not failed. This alarm is a warning beyond 60°C and becomes a fault at 70°C	U,D	TA,TC		TF,RF, CM

11.7 Unit Warnings

Fault Text	Notes	Relays	To Ter	To Sat	Other
Unit warning: One or more of the cooling fans have failed.					
Unit warning: One or more PSU rails are out of range.	One of the PSU on the redundancy switch have failed				
Unit warning: Carrier muted due to power outage. Acknowledge power-up to enable.	The Tx carrier is set to mute after a power failure. The power has failed and returned. The fault needs to be acknowledged in order to allow the carrier to be unmuted.	D			CM
Unit warning: AUPC at maximum power offset.	While attempting to maintain a constant Eb/No at the distant modem, the AUPC function has adjusted the modem power level to the maximum offset allowed. Check AUPC settings.				
Unit warning: Rental SAF features %s will expire in less than 48 hours.	Indicates that one or more SAF features (such as Paired Carrier) that have been purchased on a temporary license are about to expire. A new purchase order should be raised if the features are still required.				

11.8 Start-up Problems

Fault Text	Notes	Relays	To Ter	To Sat	Other
Unit fails to boot, due to an invalid configuration, but passes the initial built in test, proceeding to the initialising screen.	Remove the mains input lead, wait for a short period of time and then re-power the unit. As soon as the initialising screen is reached enter 1, 3, 7, and 9 using the keypad. The scrolling full stops seen after the initialising message should change to asterisks (****) and the Modem will boot. The invalid configuration will be stored to memory named 'deleted_date'.				
Software upgrade fails or unit fails to boot.	Hold down the [main] button whilst applying power, choose the front panel menu option: [rescue], connect a PC to the top Ethernet port (IP traffic) and browse to the default IP address of the modem, 10.0.70.1, login as normal then upload the new software using the upgrade button.				

Chapter 12 Specification Summary

12.1 QMultiFlex-400™ Specifications

See current QMultiFlex-400™ P2MP Satellite Modem Datasheet on the ParadiseData.com website.

12.2 FEC BER/PER Performance

Teledyne Paradise Datacom has standardised on QEF tables rather than BER curves. This reflects the fact that DVBS2 & DVBS2X has very steep curves, which makes operating at a certain point almost impossible. Therefore, the difference between the performance stated in this section and true QEF points (where there are effectively no errors) can be as little as 0.1 or 0.2dB. This level of discrimination is extremely hard to measure without a complex test set up and a great deal of care. Preferably it is best to ensure the Satellite links stay on the working side of the QEF point in all conditions. The following tables show the theoretical QEF points in Es/No and Eb/No.

Note: A packet is defined as 188 bytes x 8 bits. BER figures can be calculated from PER my dividing PER by 1504 i.e. A PER of 10e-7 is equivalent to a BER of 6.65e-11.

12.2.1 DVBS2 Normal FEC Frame Size (64.8kb)

(20% roll off) QEF PER = 10^{-7}

Modulation and Coding	Pilots Disabled			Pilots Enabled		
	Es/No (dB)	Eb/No (dB)	Spectral Efficiency	Es/No (dB)	Eb/No (dB)	Spectral Efficiency
QPSK R1/4	-1.93	1.17	0.490243	-2.20	1.00	0.478577
QPSK R1/3	-1.14	0.69	0.656448	-1.22	0.72	0.640827
QPSK R2/5	-0.05	0.98	0.789412	-0.08	1.06	0.770627
QPSK R1/2	1.18	1.22	0.988858	1.18	1.33	0.965327
QPSK R3/5	2.48	1.73	1.188304	2.48	1.84	1.160026
QPSK R2/3	3.18	1.96	1.322253	3.18	2.07	1.290788
QPSK R3/4	4.18	2.46	1.487473	4.21	2.59	1.452076
QPSK R4/5	4.81	2.80	1.587196	4.81	2.90	1.549426
QPSK R5/6	5.31	3.12	1.654663	5.33	3.25	1.615288
QPSK R8/9	6.33	3.85	1.766451	6.33	3.96	1.724416
QPSK R9/10	6.52	3.99	1.788612	6.52	4.10	1.746049
8PSK R3/5	7.18	4.67	1.779991	5.93	3.52	1.739569
8PSK R2/3	7.60	4.63	1.980636	6.87	4.00	1.935658
8PSK R3/4	8.44	4.96	2.228124	8.11	4.73	2.177525
8PSK R5/6	9.78	5.83	2.478562	9.68	5.83	2.422276
8PSK R8/9	10.92	6.69	2.646012	10.89	6.76	2.585924
8PSK R9/10	11.18	6.90	2.679207	11.21	7.02	2.618365
16APSK R2/3	10.15	5.93	2.637201	9.27	5.16	2.574613
16APSK R3/4	10.76	6.04	2.966728	10.46	5.84	2.896320
16APSK R4/5	11.41	6.40	3.165623	11.26	6.35	3.090495
16APSK R5/6	11.86	6.67	3.300184	11.81	6.73	3.221863
16APSK R8/9	13.17	7.70	3.523143	13.17	7.80	3.439530
16APSK R9/10	13.43	7.91	3.567342	13.38	7.96	3.482680
32APSK R3/4	13.63	7.94	3.703295	13.11	7.51	3.623332
32APSK R4/5	14.22	8.25	3.951571	13.99	8.12	3.866247
32APSK R5/6	14.98	8.83	4.119540	14.76	8.70	4.030589
32APSK R8/9	16.02	9.58	4.397854	16.04	9.70	4.302894
32APSK R9/10	16.40	9.91	4.453027	16.33	9.93	4.356875

12.2.2 DVBS2 Short FEC Frame Size (16.2kb)

20% roll off - QEF PER = 10^{-7}

Modulation and Coding	Pilots Disabled			Pilots Enabled		
	Es/No (dB)	Eb/No (dB)	Spectral Efficiency	Es/No (dB)	Eb/No (dB)	Spectral Efficiency
QPSK R1/4	-1.83	2.55	0.365324	-2.33	2.14	0.357467
QPSK R1/3	-0.62	1.40	0.629060	-0.67	1.44	0.615532
QPSK R2/5	0.33	1.51	0.760928	0.33	1.61	0.744564
QPSK R1/2	0.85	1.56	0.848840	0.78	1.58	0.830585
QPSK R3/5	2.73	2.10	1.156532	2.73	2.19	1.131661
QPSK R2/3	3.38	2.27	1.288400	3.48	2.47	1.260693
QPSK R3/4	4.38	2.86	1.420269	4.41	2.98	1.389725
QPSK R4/5	4.96	3.17	1.508181	4.96	3.26	1.475747
QPSK R5/6	5.63	3.60	1.596093	5.58	3.64	1.561768
QPSK R8/9	6.53	4.15	1.727961	6.55	4.27	1.690800
8PSK R3/5	7.33	4.96	1.725319	6.38	4.09	1.692033
8PSK R2/3	7.87	5.03	1.922040	7.27	4.52	1.884959
8PSK R3/4	8.81	5.55	2.118761	8.56	5.38	2.077885
8PSK R5/6	10.10	6.33	2.381056	9.95	6.27	2.335120
8PSK R8/9	11.27	7.15	2.577778	11.12	7.09	2.528046
16APSK R2/3	10.25	6.18	2.548792	9.65	5.66	2.505223
16APSK R3/4	11.14	6.65	2.809662	10.89	6.47	2.761633
16APSK R4/5	11.78	7.03	2.983575	11.66	6.98	2.932574
16APSK R5/6	12.44	7.44	3.157488	12.31	7.39	3.103514
16APSK R8/9	13.59	8.25	3.418357	13.49	8.23	3.359924
32APSK R3/4	14.03	8.60	3.493093	13.63	8.29	3.419165
32APSK R4/5	14.69	9.00	3.709309	14.57	8.96	3.630805
32APSK R5/6	15.33	9.39	3.925526	15.16	9.31	3.842446
32APSK R8/9	16.67	10.38	4.249850	16.52	10.32	4.159906

12.2.3 DVBS2X Normal FEC Frame Size (64.8kb)

(20% roll off) QEF PER = 10^{-7}

Modulation and Coding	Pilots Disabled			Pilots Enabled		
	Es/No (dB)	Eb/No (dB)	Spectral Efficiency	Es/No (dB)	Eb/No (dB)	Spectral Efficiency
QPSK R13/45	-1.31	1.15	0.567805	-1.43	1.13	0.554294
QPSK R9/20	0.50	1.01	0.889135	0.52	1.13	0.867977
QPSK R11/20	1.70	1.33	1.088581	1.70	1.44	1.062677
8APSK R5/9-L	4.86	2.69	1.647211	4.83	2.77	1.607179
8APSK R26/45-L	5.28	2.94	1.713601	5.28	3.05	1.671975
8PSK R23/36	7.72	4.94	1.896173	7.40	4.72	1.850112
8PSK R25/36	8.07	4.93	2.062148	8.00	4.96	2.012056
8PSK R13/18	8.37	5.05	2.145136	8.24	5.03	2.093027
16APSK R1/2-L	6.37	3.42	1.972253	6.25	3.40	1.925446
16APSK R8/15-L	6.88	3.64	2.104850	6.83	3.70	2.054896
16APSK R5/9-L	7.12	3.70	2.193247	7.09	3.78	2.141196
16APSK R26/45	10.04	6.45	2.281645	7.89	4.41	2.227496
16APSK R3/5	10.00	6.25	2.370043	8.25	4.61	2.313796
16APSK R3/5-L	7.94	4.19	2.370043	7.89	4.24	2.313796
16APSK R28/45	10.08	6.17	2.458441	8.83	5.02	2.400096
16APSK R23/36	9.91	5.88	2.524739	8.71	4.79	2.464821
16APSK R2/3-L	8.93	4.72	2.635236	8.96	4.85	2.572696
16APSK R25/36	10.32	5.93	2.745734	10.00	5.71	2.680571
16APSK R13/18	10.51	5.95	2.856231	10.01	5.56	2.788445
16APSK R7/9	11.20	6.32	3.077225	11.00	6.22	3.004195
16APSK R77/90	12.54	7.24	3.386618	12.47	7.27	3.306245
32APSK R2/3-L	12.78	7.60	3.291954	11.50	6.43	3.212203
32APSK R32/45	12.90	7.45	3.510192	12.23	6.88	3.425153
32APSK R11/15	13.17	7.58	3.620536	12.62	7.14	3.532825
32APSK R7/9	13.75	7.91	3.841226	13.50	7.76	3.748168
64APSK R32/45-L	14.49	8.25	4.206428	14.36	8.22	4.111291
64APSK R11/15	18.76	12.39	4.338659	15.79	9.51	4.240531
64APSK R7/9	16.47	9.84	4.603122	16.02	9.49	4.499013
64APSK R4/5	16.97	10.22	4.735354	16.45	9.79	4.628253
64APSK R5/6	17.38	10.44	4.936639	17.08	10.24	4.824987

12.2.4 DVBS2X Short FEC Frame Size (16.2kb)

(20% roll off) QEF PER = 10^{-7}

Modulation and Coding	Pilots Disabled			Pilots Enabled		
	Es/No (dB)	Eb/No (dB)	Spectral Efficiency	Es/No (dB)	Eb/No (dB)	Spectral Efficiency
QPSK R11/45	-1.58	1.86	0.453236	-1.73	1.81	0.443489
QPSK R4/15	-1.27	1.77	0.497192	-1.34	1.79	0.486499
QPSK R14/45	-0.66	1.67	0.585104	-0.76	1.66	0.572521
QPSK R7/15	1.15	1.64	0.892796	1.25	1.84	0.873596
QPSK R8/15	1.88	1.77	1.024664	1.93	1.91	1.002628
QPSK R32/45	3.94	2.55	1.376313	3.91	2.62	1.346714
8PSK 7/15	7.03	5.79	1.331876	6.11	4.94	1.306181
8PSK R8/15	7.06	5.22	1.528597	6.64	4.88	1.499107
8PSK R26/45	7.20	4.99	1.659745	6.92	4.80	1.627724
8PSK R32/45	8.59	5.47	2.053188	8.44	5.40	2.013576
16APSK R7/15	9.74	7.27	1.766184	6.74	4.34	1.735992
16APSK R8/15	9.78	6.71	2.027053	7.71	4.71	1.992403
16APSK R26/45	9.69	6.26	2.200966	8.36	5.01	2.163343
16APSK R3/5	9.80	6.21	2.287923	8.70	5.18	2.248813
16APSK R32/45	10.56	6.21	2.722705	10.31	6.03	2.676163
32APSK R2/3	12.71	7.70	3.168769	12.01	7.09	3.101705
32APSK R32/45	13.16	7.86	3.384985	12.76	7.55	3.313345

Chapter 13 Glossary

8PSK	Eight Phase Shift Keying
ACM	Adaptive Coding and Modulation
AGC	Automatic Gain Control
APSK	Amplitude and phase-shift keying
ARP	Address Resolution Protocol
AQM	Active Queue Management
AUPC	Automatic Up-link Power Control
BER	Bit Error Rate
BERT	Bit Error Rate Tester
BIR	Burst Information Rate
BUC	Block Up Converter
CIR	Committed Information Rate
COTM	Comms-on-the-move
CRC	Cyclic Redundancy Check
CW	Continuous Wave
DVB-S2	Digital Video Broadcasting – Satellite 2nd Generation
DVB-S2X	Digital Video Broadcasting – Satellite 2nd Generation Extension
FEC	Forward Error Correction
FSK	Frequency Shift Keying
IEEE	Institute of Electrical and Electronics Engineers
IESS	Intelsat Earth Station Standard
LCD	Liquid Crystal Display
LAN	Local Area Network
M&C	Monitor and Control
MIB	(SNMP) Management Information Base
MTU	Maximum Transmission Unit
NAT	Network Address Translation
NTP	Network Time Protocol
PER	Packet Error Rate
PCMA	Paired Carrier Multiple Access
PUP	Paradise Universal Protocol
PLL	Phase Locked Loop
P2MP	Point to Multi-Point
PRBS	Pseudo-Random Bit Sequence
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
Rx	Receive or Receiver
SAF	Software Activated Feature
SNMP	Simple Network Management System
STP	Spanning Tree Protocol
TCP	Transmission Control Protocol
Tx	Transmit or Transmitter
UDP	User Datagram Protocol
USB	Universal Serial Bus
VCM	Variable Coding and Modulation
VLAN	Virtual Local Area Network
VSAT	Very Small Aperture Terminal

Chapter 14 Further Reading

Teledyne Paradise Datacom has produced detailed system documents for certain concepts. Please contact customer support for the latest versions of these documents:

- **QMultiFlex-400™** Datasheet. Latest at www.ParadiseData.com
- AN_056 P2MP Star Network Routing Mode Configuration Notes
- AN_057 P2MP Mesh Network Routing Mode Configuration Notes
- AN_087 – Spectral Efficiencies for Modem Family
- AN_047 P3716 IP Traffic Software Upgrade
- Q Series Remote Control Document (General remote protocol document for Q series modems) Latest at www.ParadiseData.com
- Q-NET™ PDQS Redundancy Switch Installation and Operating Handbook. Latest at www.ParadiseData.com
- MCP Document for **QMultiFlex-400™**
- **QFlex-400™** Satellite Modem Installation and Operating Handbook
- **DVBS2X Rate Calculator –** Interactive Excel Spreadsheet for calculating occupied bandwidth and data rates.

Additional information can be found in the Whitepapers section of the website: https://www.teledynedefenseelectronics.com/paradisedatacom/Support/Pages/Whitepapers.aspx

Chapter 15 Technical Support

Technical Support can help with:

- Queries regarding equipment operation.
- The return of equipment for upgrade or repair.
- Customer training.
- Application notes and white papers.

Contact details are as follows:

Teledyne Paradise Datacom
106 Waterhouse Lane
Chelmsford, Essex,
CM1 2QU, England
Tel: +44(0)1245 847520

Worldwide support via email is available at: ParadiseModemSupport@Teledyne.com
Please include the following with any correspondence:

- Equipment model number
- Equipment serial number
- Your name and contact information (phone, email)

Repair/Return Procedure

Please visit the support section of www.ParadiseData.com to download the latest instructions.