TELEDYNE PARADISE DATACOM
A Teledyne Technologies Company

Q-Flex™ Satellite Modem

Installation and Operating Handbook

Issue 3.1.33, September 2020

CE 2017
EN 55022 - Class B
EN 55024
EN 60950

Teledyne Paradise Datacom.
2&3 The Matchyns, Rivenhall End,
Witham, Essex, CM8 3HA, England.
Tel: +44(0)1376 515636

Teledyne Paradise Datacom
328 Innovation Blvd.
State College, PA 16803, U.S.A.
Tel: +1 814 238 3450

http://www.paradisedata.com

Table of Contents

Chapter 1   Welcome

Figure 1-1 Q-Flex™ Advanced Satellite Modem

The **Q-Flex™** (**Figure 1-1**) satellite modem embodies a new concept in satellite modem technology: a flexible software-defined modem that does what you want, now and in the future. The **Q-Flex™** modem provides a flexible hardware platform with support for IF (70/140MHz) and L-band operation in one unit. Its powerful processor is ideal for handling IP traffic. However, the **Q-Flex™** modem can be fitted with virtually any type of terrestrial interface and will operate at data rates up to 160Mbps.

Low cost of ownership is supported by a pay-as-you-go feature set, where individual features can be enabled when required.

The **Q-Flex™** modem incorporates a new software suite called **XStream IP™**. This has been created in response to a perceived widespread dissatisfaction in the industry with the usability and quality of service provided by IP-over-satellite in general. Paradise has re-engineered every aspect of IP support from the ground up to ensure ease of use, a high degree of integration between features and outstanding performance and efficiency.

Specifically:

- **XStream IP™** is the most advanced integrated suite of IP optimisation and traffic management features available in any satellite modem.
- **XStream IP™** is specifically optimised to be highly efficient and reliable over satellite.
- **XStream IP™** provides up to 500,000 packets-per-second processing capability for lightning-fast IP throughput.
- **XStream IP™** is simple to set up and use.
- **XStream IP™** includes all IP features as standard making it very good value.

The design aim for the **Q-Flex™** was to create the industrys most versatile and bandwidth-efficient satellite modem. Among the satellite band-width saving features available are:

- **Paired Carrier™**, allowing two carriers to be overlapped in the space segment, saving up to 50% bandwidth.
- **DVB-S2** and **DVBS2X** state-of-the-art Forward Error Correction (FEC) representing the most bandwidth-efficient FEC technology available.
- **Spectral roll-off factors down to 5%**, saving up to 15% bandwidth compared with 20% roll-off.
- **IP compression**, saving up to 50% bandwidth.
- **Adaptive Coding and Modulation (ACM)**, saving up to 50% bandwidth.

- **TCP Acceleration**, enabling up to 93% bandwidth utilization for TCP traffic.
- **ClearLinq™ Tx adaptive pre-distorter**, providing up to 2dB compensation for linear and non-linear distortion in the channel.
- **9-tap Rx 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. In addition, **LinkGuard™** (U.S. patent 8351495) monitors underneath the received carrier for any interference, while on traffic.

The **Q-Flex™** modem is backwards compatible with all Quantum and Evolution series modems.

DVB-S2X, the successor to DVB-S2, is the most efficient and robust coding and modulation standard available for satellite transmission.

Paradise's **SmartLink™** technology allows non-packetized continuous traffic, such as G.703 E1 traffic, to be used with DVB-S2. The **Q-Flex™** therefore provides a painless migration path to newer, more efficient communications technology while fully supporting legacy services.

FastLink™ Low-Density Parity-Check (LDPC) Forward Error Correction (FEC) combines high coding gain with low latency. **FastLink™** can therefore be used to replace both conventional LDPC (which has high latency) and Turbo Product Code FEC (which has a lower coding gain).

Paired Carrier+ allows space segment reuse. It overlays transmit and receive carriers in the same space segment reducing satellite bandwidth requirements by up to 50%. It can be used at the same time as all our other bandwidth saving techniques. It incorporates ViaSat's patented PCMA technology (U.S. patents 5,596,439, 6,011,952 and 6,725,017).

This handbook will guide you through the process of installing and using your **Q-Flex™** satellite modem. This guide also covers the following variants of the **Q-Flex™**: the **Q-FlexV™**, **Q-FlexE™** and **QubeFlex™**.

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.*
- *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 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. Other than the unit itself, the shipping container should contain a power cord and a Quick Start Guide.

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 250V. A 48V DC input option is available. Power consumption ranges from 40W to a maximum of 300W (when a BUC PSU is fitted).

A power cord 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 rack then adequate ventilation and cooling should be provided. There must be adequate clearance around the two side-mounted fans and the ventilation holes on both sides 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. These 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 to minimise the temperature inside each unit, which may contribute to improving long-term reliability (due to the well-known general relationship between the temperature and reliability of electronic components).

4.4 Getting Started

Connect the appropriate cables to the transmit and receive IF and/or L-band connectors at the rear of the unit, along with the cable(s) for the traffic interface.

Power the unit and wait for it to complete its initialization when it will display summary status information.

From the front-panel menu, select *Main->Edit->All* in order to set the configuration prior to operation.

It is also possible to set up the unit from a web browser as described in Section 6.2.

When setting up a number of units that have similar configurations, 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 on the modem.

Getting started is covered in more detail in the **Q-Flex™** modem Quick Start Guide (provided with the unit).

Chapter 5   Introduction

5.1 Overview

The **Q-Flex™** satellite modem is designed for both open and closed network operation in fixed and mobile environments, providing a data link between geographically distant sites via satellite.

Features include:

- DVB-S2 (EN 302 307-1) and DVB-S2X (EN 302 307-2) operation including Adaptive Coding and Modulation (ACM).
- IF frequency ranges of 50 to 90MHz and 100 to 180MHz; L-band frequency range of 950MHz to 2150MHz.
- Open network Intelsat IBS to IESS-309 and IESS-310 and Intelsat IDR to IESS-308 and IESS-310, plus Eutelsat SMS to EESS 501. Closed network modes.
- G.703 E1 operation including Drop and Insert (D&I) via T1-D4, T1-ESF and G.732 bearer types.
- Variable data rate between 2.4kbps and 200Mbps.
- BPSK, QPSK, Offset QPSK, 8PSK, 8QAM, 16QAM, 16APSK, 32APSK, 64APSK and 64QAM modulation schemes.
- Forward Error Correction (FEC) options of Turbo Product Code (TPC), FastLink low-latency Low Density Parity Code (LDPC) and DVB-S2/S2X (as well as legacy FECs).
- Spectral roll-off factors of 5%, 10%, 15%, 20%, 25% and 35%.
- A full range of terrestrial interfaces including Internet Protocol (IP), RS422, V.35, RS232, LVDS, HSSI, STM-1, OC-3, Optical Ethernet and G.703 (T1/E1, T2/E2 and T3/E3). The Quad E1 interface card multiplexes four E1 interfaces together onto a single carrier and also serial data, G.703 and IP traffic to be multiplexed together onto a single carrier.
- Automatic Uplink Power Control (AUPC) automatically adjusts modem output power to maintain a constant Eb/No at the distant end of the satellite link.
- Front panel display and keypad for local control.
- Remote equipment can be controlled over the satellite via serial or IP traffic interfaces. Remote modem control is supported via web browsing, the Simple Network Management Protocol (SNMP), 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 (such as the output of I and Q baseband samples).
- Compact 1U chassis, 405mm deep.
- **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 the maximum data rate for the modem. Up to 10000 concurrent accelerated TCP connections are supported along with up to 40,000 unaccelerated TCP connections. Bandwidth utilization when TCP acceleration is enabled is typically over 90%. **Bridging**, **static routing** and **dynamic routing** (RIP V1 and V2, OSPF V2 and V3 and BGP V4) are all supported. Ethernet, IP, User Datagram Protocol (UDP) and Real Time Protocol (RTP) **header compression** are supported. The 14-byte Ethernet frame is typically compressed to one byte. IP/UDP/RTP headers are typically compressed to between one and three bytes. The one-way packet processing limit for header compression is 60,000 packets per second (pps); the two-way limit is 45,000 pps. IP/UDP/RTP header compression is compliant with the RFC 3095 (Robust Header Compression) standard. **IP payload compression** is provided (compliant with the RFC 1951 'DEFLATE' standard). This compresses TCP and UDP packet payloads by typically 50%.

5.2   Standard-Fit Hardware

5.2.1   IF/L-band Operation

The following are provided as standard:

- IF operation, via transmit and receive IF BNC connectors (supporting 50Ω and 75Ω operation at 50 to 90MHz and 100 to 180MHz).
- L-band operation, via transmit and receive L-band N-type connectors (supporting 50Ω operation at 950 to 2150MHz).
- A high-stability L-band 10MHz reference signal 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. The 10MHz reference can also be output through the 75Ω BNC station clock connector.
- 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.

5.2.2   Ethernet Operation

Two Gigabit Ethernet RJ45 connectors are fitted as standard. One of these is used for modem Monitor and Control (M&C) and the other is for satellite traffic. These provide a combined 150,000 packets-per-second processing capability. Layer 2 bridging and Layer 3 routing are supported in software.

Trunking mode is our name for a hardware Layer 2 switch that supports 200Mbps bi-directional traffic at up to 500,000 packets per second with zero jitter. Trunking mode supports ACM (and AUPC) but for all other **XStream IP™** features, such as compression, a non-trunking mode must be selected.

A 4-port Gigabit Ethernet switch option is available. This extends the base modem Ethernet traffic port with another 3 Ethernet ports, creating a 4-port switch.

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 Terrestrial Interface Option Cards

Four interface positions are available for fitting terrestrial interface cards. Any of the following option cards may be fitted in these interface positions (note that fitting duplicate cards of the same type is not supported).

5.3.1.1 4-port Gigabit Ethernet Switch

The 4-port Gigabit Ethernet switch card (part number P3718) extends the base modem Ethernet traffic port with three further RJ45 Ethernet ports, creating a 4-port switch.

5.3.1.2 G.703 Option Card

The G.703 option card (part number P3722) provides support for G.703 E1/T1, E2/T2 and E3/T3 traffic rates. Unbalanced G.703 is provided on two BNC 75Ω sockets and balanced G.703 is provided on two RJ45 sockets. The following software features are included as standard with the G.703 option card:

- G.703 clock extension, providing a high-stability reference clock over satellite (alternative to GPS). In this mode the G.703 card is used purely as a high-stability clock generator for some other traffic source, such as serial data.
- Timeslot Drop & Insert feature, allowing fractional E1/T1 services.

5.3.1.3 EIA-530 Option Card

The EIA-530 option card (part number P3720) provides selectable RS422, X.21, V.35 and RS232 operation up to 10Mbps via a 25-way D-type female connector.

5.3.1.4 STM-1/OC-3/Optical Ethernet Option Card

The STM-1/OC-3/Optical Ethernet option card (part number P3723) provides selectable STM-1, OC-3 and optical Ethernet operation up to 160Mbps. An open-standard SFP cage is fitted that can be used with a wide range of SFP modules. All optical connector types (such as LC and SC) and all types of optical cable (single-mode, multi-mode, all wavelengths) are supported, subject to a compatible SFP module being fitted. Due to the wide range of optical cabling and connector options, no SFP module is provided with the card.

5.3.1.5 IDR Option Card

The Intermediate Data Rate (IDR) option card (part number P3721) provides an IESS 308-compliant IDR capability including two 32kbps ADPCM ESC audio channels, multiple backward alarms support and independent ESC and Auxiliary ports that replace the shared ESC/Aux port on the base unit. The connectivity is via a 50-way D-type female connector.

The following software features are included as standard with the IDR option card:

- Advanced AUX feature providing variable rate synchronous Aux channel. This includes the option to replace IDR audio channels with serial data.
- Audio option. For IBS carriers this allows two audio streams in 64kbps or two audio and 64kbps data in 128kbps (this requires the IBS option).

5.3.1.6 LVDS Option Card

The Low Voltage Differential Signal (LVDS) option card (part number P3001) provides LVDS at data rates of up to 60Mbps via a 25-way D-type female connector.

5.3.1.7 HSSI Option Card

The High Speed Serial Interface (HSSI) option card (part number P3705) provides HSSI at data rates of up to 60Mbps via an industry-standard 50-way SCSI-2 DCE connector.

5.3.1.8 Quad E1 Option Card

The Quad E1 option card (part number P3706) supports four synchronous G.703 HDB3-encoded balanced RJ45 ports. Along with full E1 bearers, Drop and Insert of up to 32 timeslots is provided on all four interfaces. The Quad E1 card and G.703 card are compatible when used for a single full E1.

All data rates between 64kbps and 8448kbps are supported in multiples of 64kbps. The data is multiplexed onto a single carrier using either an IBS frame format (with overhead of 6.7%) or Closed Network frame format (with no overhead) or Closed Network + ESC frame format (with overhead of less than 0.5%). The absolute minimum amount of bandwidth is used in all cases, in direct proportion to the required number of timeslots.

The Quad E1 card MultiMux feature allows E1, serial and IP traffic to be multiplexed together onto a single carrier. Multimux operation is explained in the document *'Multimux Data Multiplexer Option'* (Application Note No. 205348) from the modem documentation area of http://www.paradisedata.com. It allows many different combinations of interfaces to be combined onto a single carrier including:

- Up to two E1s plus up to 2Mbps of IP and up to 2Mbps of EIA-530 data (or up to three E1s when using either IP or EIA-530 but not both).
- E1 with two separate EIA-530 interfaces.

- IP at up to 32Mbps with EIA-530 at up to 10Mbps
- IP at up to 32Mbps with 3 E1s.

5.3.2 Other Option Cards

The following feature-specific option cards are available:

- P3609 DVB-S2/S2X option card.
- P3605 **FastLink™** option card, required for **FastLink™** low-latency Low-Density Parity-Check (LDPC) Forward Error Correction (FEC) operation.
- P3607 Paired Carrier+ option card, required for Paired Carrier+ operation (which overlays transmit and receive carriers in the same space segment reducing the overall required satellite bandwidth).

5.3.3 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
P3543	200W 24V output	A.C. in/D.C. out
P3544	200W 48V output	A.C. in/D.C. out
P3545	+/-48V input, 200W 24V output	D.C. in/D.C. out
P3546	+/-48V input, 200W 48V output	D.C. in/D.C. out
P3547	+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 8.5.

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
Transmit	TX	Enables the Tx service.
Receive	RX	Enables the Rx service.
Terrestrial data rate 0 to 2048kbps	DR0	Enables data rates in the given range.
Terrestrial data rate 0 to 5Mbps	D1L	Enables data rates in the given range.
Terrestrial data rate 0 to 10Mbps	D1H	Enables data rates in the given range.
Terrestrial data rate 0 to 25Mbps	DR2	Enables data rates in the given range.
Terrestrial data rate 0 to 60Mbps	DR3	Enables data rates in the given range.
Terrestrial data rate 0 to 100Mbps	DR4	Enables data rates in the given range.
Terrestrial data rate 0 to 200Mbps	DR5	Enables data rates in the given range.
XStream IP™	XSIP	This provides the following features: • **IP traffic shaping.** Provides guaranteed throughput levels for specific IP streams using Committed Information Rate and Burst Information Rate. Stream differentiation is by IP address, IEEE 802.1p priority class, Diffserv DSCP class, MPLS EXP field, VLAN ID or PID value. • **IP header compression.** Enables Ethernet, TCP, UDP, IP and RTP packet header compression. • **IP payload compression.** Enables TCP and UDP payload compression compliant to RFC 1951 ('DEFLATE'). • **Dynamic routing.** Enables choice of RIP V1 and V2, OSPF V2 and V3 and BGP V4 dynamic routing. • **TCP acceleration.** Acceleration of TCP data over satellite to the prevailing data rate of the modem. • **HTTP web acceleration.** Speeds up download of web pages to web browsers; includes DNS caching. • **Encryption.** AES 256-bit key encryption of IP packets. *Note that encryption is export-controlled technology and is provided on the* **Q-FlexE** *model only.*

Table 5-2 Software Activated Features (continues over page)

Feature	SAF Code	Description
XStream IP™ DVB-S2X		• IP-over-DVB encapsulation. Supports the transmission of IP packets with/without Ethernet frames over DVB-S2/DVB-S2X using Multiprotocol Encapsulation (MPE) (EN 301 192), Unidirectional Lightweight Encapsulation (ULE) (RFC 4326) and Paradise XStream Encapsulation (PXE). • ACM. Enables DVB-S2/DVB-S2X Adaptive Coding and Modulation (ACM). • VCM. Allows either two ASI streams, or one ASI stream and one IP stream, to be multiplexed onto a single carrier.
DVB-S2X CCM Tx	S2XT	Enables DVB-S2X Tx operation for all supported modulations. Includes XStream IP™ DVB-S2X.
DVB-S2X CCM Rx	S2XR	Enables DVB-S2X Rx operation for all supported modulations. Includes XStream IP™ DVB-S2X.
DVB-S2 Tx	DVB2T	Enables DVB-S2 Tx operation for all supported modulations. Includes SmartLink™ and XStream IP™ DVB-S2X.
DVB-S2 Rx	DVB2R	Enables DVB-S2 Rx operation for all supported modulations. Includes SmartLink™ and XStream IP™ DVB-S2X.
ClearLinQ™ Tx Adaptive Predistorter	CLNQ	Corrects for linear and non-linear distortion in the RF chain. Applicable to all FECs and modulations.
FastLink™ LDPC	FL	Enables **FastLink™** low-latency LDPC to the prevailing data rate of the modem (subject to maximum data rate of 100Mbps). Includes all relevant modulations and FEC rates.
Paired Carrier+ 56kbps to 256kbps	PCMZ	Enables Paired Carrier+ data rates in the given range (inclusive). Incorporates ViaSat's patented PCMA technology. For all supported data rates, **Paired Carrier+** is subject to a minimum occupied bandwidth of 30kHz and a maximum of 54MHz.
Paired Carrier+ 256kbps to 512kbps	PCMA	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 512kbps to 1.024Mbps	PCMB	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 1.024Mbps to 2.5Mbps	PCMC	Enables Paired Carrier+ data rates in the given range.

Table 5-2 Software Activated Features (continues over page)

Feature	SAF Code	Description
Paired Carrier+ 2.5Mbps to 5Mbps	PCMD	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 5Mbps to 10Mbps	PCME	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 10Mbps to 15Mbps	PCMF	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 15Mbps to 20Mbps	PCMG	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 20Mbps to 25Mbps	PCMH	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 25Mbps to 30Mbps	PCMI	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 30Mbps to 40Mbps	PCMJ	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 40Mbps to 50Mbps	PCMK	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 50Mbps to 60Mbps	PCML	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 60Mbps to 80Mbps	PCMM	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 80Mbps to 100Mbps	PCMN	Enables Paired Carrier+ data rates in the given range.
Paired Carrier+ 100Mbps to 200Mbps	PCMO	Enables Paired Carrier+ data rates in the given range.
Optimised spectral roll-off	ROFF	Enables 5%, 10% and 15% spectral roll-off options.
DVB-CID	CID	**DVB Carrier ID.** Tx carrier identification per ETSI 103 129.
IBS	IBS	Enables IBS service (to IESS 309) with low-rate Intelsat ESC (to IESS 403) and high-rate IBS ESC.
Legacy FECs	IRS SEQ TCM TPL TPH	Enables **Sequential** FEC (limited to 2.048Mbps); **TCM** 8PSK 2/3 to IESS 310; **Viterbi** BPSK/QPSK/OQPSK FEC rates 1/2, 3/4 & 7/8; Intelsat **Reed-Solomon** outer codec.

Table 5-2 Software Activated Features

5.5 Front Panel

Figure 5-1 Modem 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**. (In addition to what is listed, note that a flashing green Rx traffic alarm indicates a backward alarm received from the other modem.)
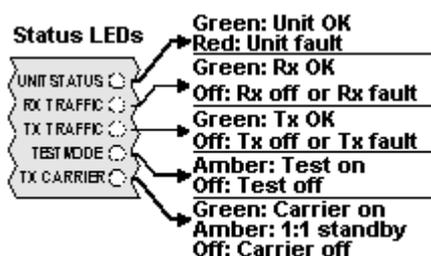
Figure 5-2 Front-panel Status Indicators

	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 (flashing green indicates backward alarm received from the other modem)
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

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.

5.5.2.1 Keypad

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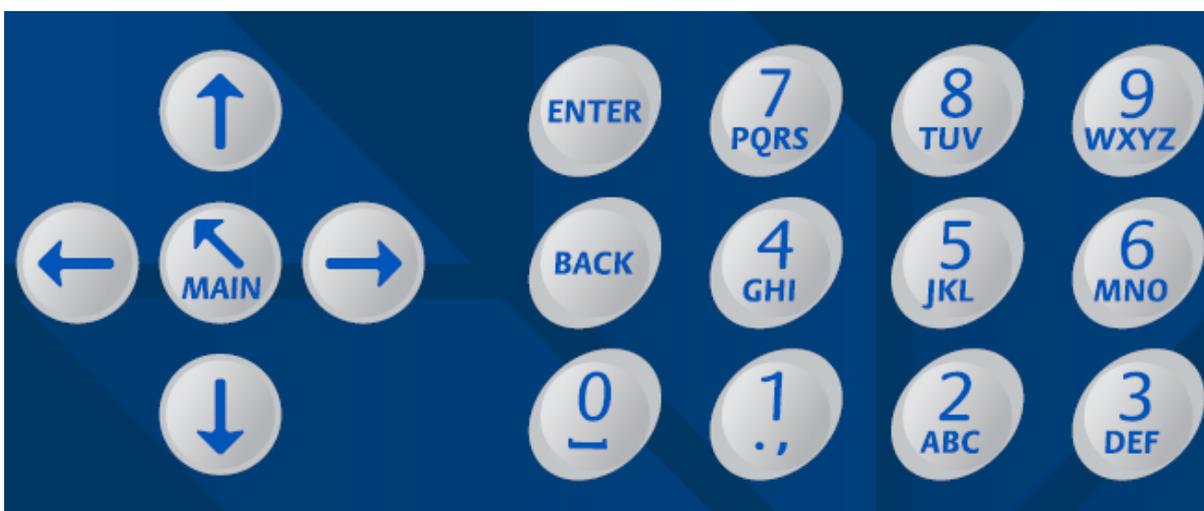
Figure 5-3 Front-panel Keypad

5.6 Rear Panel

The rear panel, shown in **Figure 5-4**, provides a full set of terrestrial and satellite data interfaces. Connector pinouts are defined in Chapter 11.

Figure 5-4 Modem 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 (1A @100V, 0.5A @ 240V, 47 to 63Hz). The IEC connector incorporates two fuses,

independently fusing both live and neutral lines. Access to the fuses is provided by a slide-out tray. Both fuses are standard 20mm type, rated T3.15A, of the slow-blow (time-delay) type.

- **Chassis Ground Stud**

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

- **Tx IF Output**

This is a 50Ω/75Ω BNC female connector. The output power level can be varied from 0dBm to -25dBm.

- **Tx L-band Output**

This is a 50Ω N-type female connector (although 75Ω cables can also be used without any problem). The output power level can be varied from 0dBm to –30dBm.

- **Alarms and AGC Connector**

This is a 15-pin D-type male 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.

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.
- A backward alarm is being received from either the satellite or terrestrial ports.

- **Async ESC Connector**

This is a 15-pin D-type female connector. It provides an RS232/RS422/RS485 asynchronous port for either a high-rate Async Engineering Service Channel (ESC) facility (for IBS or Closed Network plus ESC services) or the IBS 'low-rate Intelsat oversampled ESC facility' (which is configured as the Aux channel on the modem).

When the IDR option is fitted, separate ports for the ESC and Aux channels on the IDR card replace the ESC and Aux functions on the Async ESC connector, which

are disabled. The Async ESC connector also provides an RS422-compatible Station Clock input.

- **On-line LED**

  This LED mirrors the front-panel Tx Carrier LED allowing the operator, from the rear of the modem, to ascertain the carrier status and to identify which modem in a 1:1 redundant pair is offline.

- **Optional Terrestrial Interface Positions**

  There are four terrestrial interface positions that can be fitted with a variety of interface cards including EIA-530, G.703, Quad E1, Quad ASI, LVDS, HSSI and STM-1/OC-3/Optical Ethernet.

  The G.703 interface card supports T1, E1, T2, E2, T3 and E3 data rates. Balanced operation is provided on two RJ45 connectors while unbalanced operation is via two BNC connectors. For balanced operation, T1 line impedance is 100Ω, E1 line impedance is 120Ω and T2 line impedance is 110Ω. Unbalanced E1, T2, E3 and T3 line impedance is 75Ω. Line impedance is software selectable.

- **ESC and Aux Connector (IDR Option Card)**

  When fitted, the IDR option card provides access to:

  - Four backward-alarm 'form-C' relay outputs and four backward-alarm inputs, together with an Rx summary-alarm signal.
  - Two audio ESC ports (with 4-wire 600Ω impedance and input range +7dBm to -16dBm) for use in IDR operation. These ports may also be used in IBS services to generate a 64kbps IBS carrier comprised of two 32kbps ADPCM audio channels or a 128kbps IBS carrier comprised of 64kbps data (from the main data interface of the modem) plus two 32kbps ADPCM audio channels.
  - An RS232/RS422/RS485 port for synchronous and asynchronous ESC traffic. This port replaces the shared ESC/Aux function on the rear-panel Async ESC connector. It provides an 8kbps synchronous IDR ESC channel. If the Async ESC feature is available then this port provides an asynchronous 8kbps channel and a high-rate asynchronous ESC in IBS and Closed Network + ESC services.
  - An RS232/RS422 port for synchronous and asynchronous Aux traffic. This port replaces the shared ESC/Aux function on the rear-panel Async ESC connector. The port provides a 32kbps or 64kbps IDR overhead channel in place of one or both of the IDR 32kbps ADPCM audio ESC channels. In IBS, this port may be configured to provide either the IBS 'low-rate Intelsat oversampled ESC facility' or a higher-rate synchronous channel within the IBS overhead.

- **Rx IF Input**

  This is a 50Ω/75Ω BNC female connector. The carrier signal level at the input of the modem must be in the following range:

  Minimum signal level: -115 +10 log (symbol rate) dBm

Maximum signal level: -80 + 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: -94 + 10 log (symbol rate) dBm

The maximum composite power level is +10dBm.

- **Rx L-band Input**

This is a 50Ω N-type female connector (although 75Ω cables can also be used without any problem). The carrier signal level at the input of the modem must be in the following range:

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

Maximum signal level: -80 + 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.

- **Fans**

There are two side-mounted high-performance fans that draw air in through ventilation holes in the sides of the unit and expel the air outwards. The side vents must not be blocked.

- **1:1 Redundancy Connector**

The modem has a built-in 1:1 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, a 'Y' cable for splitting the traffic path and passive splitters and combiners for the IF ports. An overview of 1:1 operation is provided in Section 7.3.

- **Remote M&C Connector**

This is a 9-pin D-type female connector. The modem supports the Paradise Universal Protocol (PUP) as specified in the document '*Remote M&C Specification for Q-Flex™ Satellite Modem*'. RS232 (for direct-to-PC applications) and RS485 (for multidrop applications) are supported. The Remote M&C interface can be connected to the remote modem's Async ESC interface, allowing remote modem control over satellite.

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

Two Gigabit Ethernet RJ45 connectors are provided for modem Monitor and Control (M&C) and satellite traffic respectively. Ethernet speed, duplex and cable termination (crossover versus straight-through) are auto-negotiated. Line speed and duplex can also be set to fixed values. The two Ethernet ports can be bridged together under software control.

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. When 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 7.8.2.

- **Station Clock**

This is a 75Ω BNC female connector that accepts a 1MHz to 10MHz signal, either a square wave of >1V peak-to-peak or a sine wave at a power level of 0dBm or greater. Alternatively, the station clock signal can be input as an RS422 signal on the Async ESC connector.

The station clock acts as a clock for either the modem receive circuit (or, if the input is at exactly 10MHz, for both the receive and transmit circuits). It is therefore possible to maintain clock synchronization between several modems by feeding a common master clock signal into all of them.

Chapter 6   User Interfaces

6.1 User Control

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

For remote web browsing, there are two fixed user names, 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 user names.

There is no restriction on the number of users (as either *admin* or *user*) that can be logged in at the same time. Remote *admin* users who log in while the modem is under local front-panel control will be restricted to view-only permissions.

6.1.1   Local Mode

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   Takeaway Mode

In *Takeaway 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 *Takeaway mode* to *Local mode* then all remote *admin* users will be automatically logged out.

While *Takeaway mode* is very convenient, it is essential for there to be clear 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.

> ⚠️ ***Factory Menus***
>
> *Over time, legacy features may be deprecated and may be moved from the regular menus to a set of factory menus. Other features that have been developed for a very specific but strictly limited purpose may also reside on the factory menus.*
>
> *The factory menus can be accessed via the front panel by entering '99' while on the MAIN menu.*
>
> *They can be accessed from a web browser by adding '/factory' to the end of the modem URL (e.g. http://10.0.70.1 becomes http://10.0.70.1/factory). This will add an extra tab named 'Factory' under the top-level Edit menu (the web page may have to be refreshed for this to appear).*
>
> *The factory menus are deliberately not documented in this user manual. Please contact Technical Support for further information.*

6.2.1   Login Screen

To connect to the modem from a web browser, ensure an Ethernet cable is connected into the Remote M&C RJ45 socket on the rear of the modem. From the modem front panel enter (under *Edit->Unit->M&C->IP Address*) an IP address and subnet mask that are compatible with your network. Then enter the modem's IP address into the web browser address bar.

The browser will then request (as shown in **Figure 6-1**) a user name and password. The default *admin* and view-only *user* passwords are both set to *paradise*. It is recommended that passwords are changed from their default values. When entered, the login details are sent in an encrypted form back to the modem.
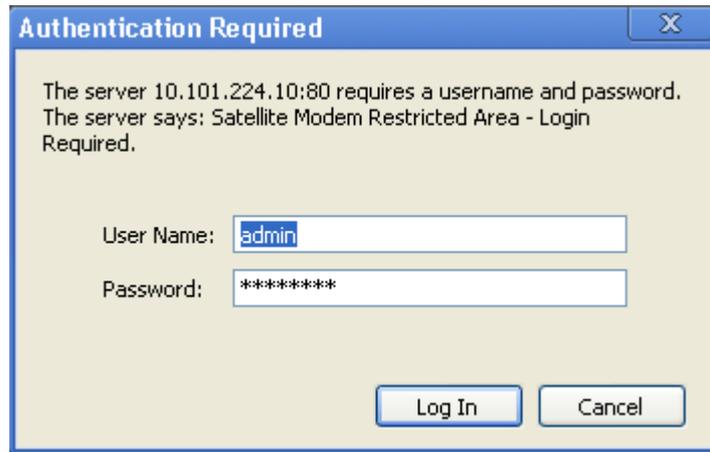
Figure 6-1 Web User Interface Login Screen

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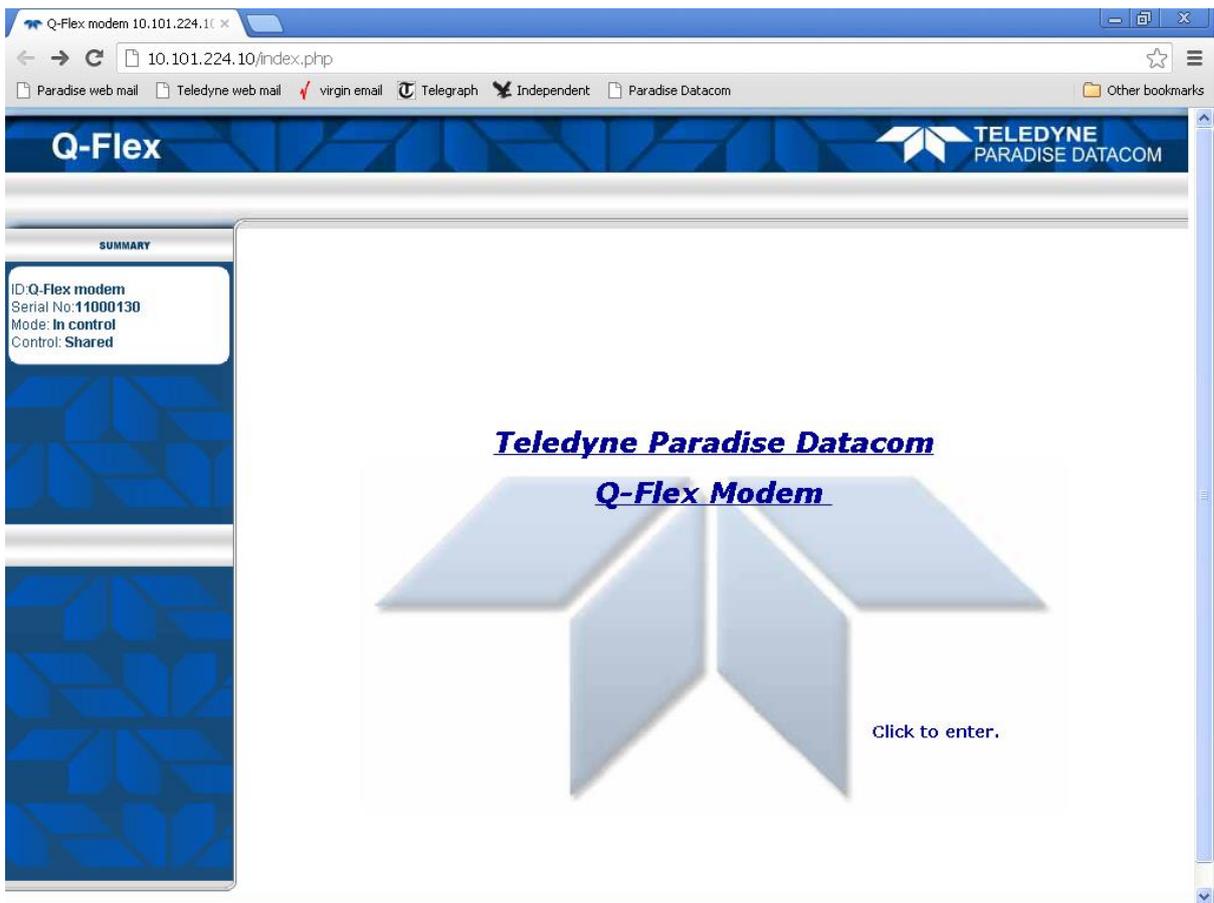
Figure 6-2 Web Server Welcome Screen

This screen will include the text 'The web user interface is in 'View-only' mode' when the modem is in *Local* control mode, in which modem control is restricted to front-panel operation only. The Status screen shown in **Figure 6-3** will then be presented.

6.2.2 Status Screen

The Status screen is shown in **Figure 6-3**.

Note that 1:N backup modems will show additional status information as defined in the document '*Installation and Operating Handbook for Quantum, Evolution and Q Series Satellite Redundancy Switches',* which is available for download from http://www.paradisedata.com.

Figure 6-3 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 tabs below the buttongs give access to individual menus. Tabs are nested and several levels of tab 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) shown 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 significantly different to those shown in this handbook.***

Figure 6-4 Modem Summary Status

Summary status information for the modem is shown at the top left-hand side of the screen as shown in **Figure 6-4**. This presents the following:

- 'ID': The user-entered modem-identification text string.
- '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.

The *Status* screen contains the current modem status split over several screens as described in the following sections.

6.2.2.1 Status Setup

The *Setup* section of the *Status* screen is continually updated with the following information:

- *Transmit and receive carrier frequencies.*
- *Transmit and receive terrestrial data rates.*
- *Transmit and receive symbol rates.*

In addition, the following are shown:

- *Transmit carrier bandwidth at the -3dB point.*
- *Transmit carrier bandwidth at the -30dB point.*

These 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.

6.2.2.1.1 Status Traffic

The *Traffic* section of the *Status* 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.
- *Transmit carrier status*. This displays one of the following:

  - '*Normal*': the carrier is on.
  - '*Mute-Ext*': the carrier is muted due to an alarm detected by the modem hardware.
  - '*Mute-Ter*': the carrier is muted due to either the terrestrial Tx RTS pin being active (this is an input signal that can be used to mute the carrier under external control as required) or some other problem being experienced with the terrestrial interface.
  - '*Mute-1:1*': the carrier is muted due to being the Standby modem in a 1:1 redundancy system.
  - '*Mute-Brk*': the carrier is muted following a power outage.
  - '*Mute-Flt*': the carrier is muted due to an alarm detected by the modem software.
  - '*Mute-Cfg*': the carrier is muted due to the modem being in the process of reconfiguring.
  - '*Mute-Off*': the carrier has been muted by the user.
- *IP Tx buffer fill status*. This is displayed when the IP terrestrial interface is selected and shows, as a percentage, how full the modem's transmit buffer towards satellite is.

6.2.2.2 Status Demodulator

The *Traffic* section of the *Status* screen is continually updated with the following information:

- *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 composite power level* (i.e. all of the power in the receive channel, consisting of both wanted and unwanted 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.
- *Receive Doppler buffer usage.* This indicates how full the receive Doppler buffer is. This is displayed only when a receive Doppler buffer is being used to compensate for movements in the satellite (i.e. when the Rx clock source is set to something other than *Satellite).*
- *Number of Doppler buffer overflows and underflows.* These represent the number of times the receive buffer has slipped as a result of overflows and underflows. These counts are reset to zero when the demodulator goes out of lock. They can also be cleared using the front-panel menus.
- *Receive DVB-S2 baseband frames and errors.* These indicate the number of DVB-S2/S2X baseband frames and baseband frame errors, respectively, that have been received since the Rx service was started and give an indication of the quality of the service. The *Reset baseband counts* button can be used to set these counts back to zero.

6.2.2.3   Status Paired Carrier+

The Paired Carrier+ section of the *Status* screen is displayed and continually updated with the following information while Paired Carrier+ is enabled:

- *Paired Carrier+ status.* This is shown as *Locked* when Paired Carrier+ has locked to one of the two overlapping carriers and is shown as *Unlocked* when Paired Carrier+ is attempting to acquire the carrier (refer to Section 6.2.3 for potential causes).
- *Paired Carrier+ frequency offset.* This is the measured offset between the expected centre frequency for the wanted carrier and the actual centre frequency. An unexpectedly large offset may indicate a false lock, where Paired Carrier+ is locked to something other than the wanted carrier.
- *Paired Carrier+ satellite delay.* This is the measured round-trip delay to the satellite. Once this value has been established then the carrier acquisition time can be optimised by setting the Paired Carrier+ minimum and maximum satellite delays accordingly. It is recommended that these are set to the measured delay -/+0.5ms respectively (via the *Edit->Paired Carrier* menu).
- *Paired Carrier+ near/far power ratio.* This indicates the power spectral density ratio of the two overlapped carriers. It may be useful during deployment and whenever degraded performance is being experienced to check that the power ratio is as expected in relation to the level of power asymmetry. The power ratio should be in the range -10dB to 10dB for normal operation.

6.2.2.4   Status ACM

The *Adaptive Coding and Modulation* (*ACM)* section of the *Status* screen is displayed and continually updated with the following while ACM is active:

- *Remote modem Es/No* (energy per symbol to spectral noise density ratio).

- *Transmit data rate*. This is the instantaneous transmit data rate, which varies with *modcod* (modcod is the term used to describe the combination of modulation and FEC rate).
- *Transmit modcod*. This is the current transmit modulation and FEC rate, which vary with remote Es/No.
- *Receive data rate*. This is the instantaneous receive data rate, which varies with modcod.
- *Receive modcod*. This is the current receive modulation and FEC rate, which the remote modem varies in accordance with the Es/No being received by the local modem.

ACM operation is described in Section 7.8.13.

6.2.2.5 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.
- *Link*. This is the status of the Engineering Service Channel (ESC) link, which in non-DVB-S2 modes is used to pass AUPC control messages to the remote modem and to read back the remote Eb/No level. The ESC channel is not used when AUPC is used with DVB-S2. The status is shown as *Failed* if the link is not working correctly otherwise it will be shown as *OK*.

6.2.2.6 Status BUC/LNB

Under the *Status BUC/LNB* tab, Block Up Converter (BUC) status is continually updated with the following information when a BUC is being controlled from the modem:

- *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*. When a BUC PSU is fitted then this shows the BUC current level in Amperes.
- *LNB voltage*. When an LNB is fitted then this shows the LNB voltage in Volts.
- *LNB current*. When an LNB is fitted then this shows the LNB current in milli-Amperes.

All of the BUC status, other than BUC current, requires a communications link to exist between the modem and the BUC. BUC and LNB under and over-current alarms can be controlled via the *Edit->Unit->Alarms* screen. (Note that only **Q-Flex™** modems produced from the second half of 2014 onwards support the LNB current monitor function.)

6.2.3 Edit Screen

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

- *Tx-Rx.* These menus allow setup of the modem transmit and receive paths.
- *Unit.* These menus contain all of the general modem configuration settings including the terrestrial interface, monitor and control, alarms, station clock and Software Activated Features (SAF) settings. They also include a software upgrade factility.
- *IP.* This menu allows setup of the IP traffic interface.
- **Paired Carrier™.** This menu allows the setup of the carrier overlap feature.
- *Memories.* These menus support the storing, recall, deletion, upload and download of modem configurations.
- *Redundancy.* These menus are used to control modem 1:1 and 1:N redundancy.

6.2.4 Edit->Tx-Rx->Service Screen

The *Edit->Tx-Rx->Service* screen is shown in **Figure 6-5**.

Figure 6-5 Edit->Tx-Rx->Service Screen

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.

IP mode   Routing mode ▼

Example of Modem Actioning a User-Requested Change

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

6.2.4.1   Terrestrial Interface

Table 6-1 lists the different terrestrial interface options that are available. With the exception of IP, which is provided as standard, they require the relevant interface card option to be fitted. Up to four different interface cards can be fitted in addition to the IP interface provided as standard.

IP	This enables the Ethernet traffic interface.
G.703	This enables the G.703 traffic interface.
Quad E1	This enables the Quad E1 traffic interface.
STM-1/OC-3	This enables the STM-1/OC-3 traffic interface and requires an STM-1/OC-3/Optical Ethernet interface card to be fitted. The correct SFP transceiver module must be fitted to the interface card SFP cage.
Optical Ethernet	This enables the Optical Ethernet traffic interface and requires an STM-1/OC-3/Optical Ethernet interface card to be fitted. The correct SFP transceiver module must be fitted to the interface card SFP cage.
RS422	This enables the RS422 traffic interface and requires an EIA-530 interface card to be fitted.
RS232	This enables the RS232 traffic interface and requires an EIA-530 interface card to be fitted.
V.35	This enables the V.35 traffic interface and requires an EIA-530 interface card to be fitted.
LVDS	This enables the LVDS traffic interface.
HSSI	This enables the HSSI traffic interface.

Table 6-1 Terrestrial Interface

6.2.4.2 Rx Values Track Tx

This is an On/Off control that allows the receive path to be automatically configured to be the same as the transmit path, thereby simplifying set up. There are a number of exceptions including carrier frequency, spectral inversion, timeslots and clock settings.

6.2.4.3 Tx/Rx Service

Off	This switches the modem's Tx service off.
Closed network	Unlike open network services, *Closed network* in general does not add any satellite framing overhead. However, some framing overhead will be added for packetized data such as IP, in order to allow the demodulator to synchronize with the transmitted packets.
Closed network plus ESC	This provides a framed satellite service that incorporates an

	Engineering Service Channel (ESC). The ESC provides a secondary communications channel, often used for monitor and control of remote equipment. The variable-rate ESC channel can provide up to 70% of the main channel rate, subject to a maximum size of 115kbps. It also provides a backward alarm facility that notifies upstream equipment of faults detected by downstream equipment. *Closed network plus ESC* allows individual timeslots to be processed when using the G.703 interface.
IBS	Intelsat Business Service (IBS) is an open network standard where 1/15 framing overhead is added to the data. This mode is compatible with other open network equipment.
IDR	Intermediate Data Rate (IDR) is an open network standard that adds 96kbps of framing overhead to the data. This mode is compatible with other open network equipment. It requires an IDR option card to be fitted to the modem.
DVB-S2	DVB-S2 services can be used with both packetized and continuous data streams. DVB-S2 requires a hardware option card to be fitted to the modem. For continuous data streams, such as G.703, *Closed network* or *Closed network plus ESC* should be selected together with *SmartLink* as the FEC type. *SmartLink* provides a DVB-S2 service along with all of the necessary support for continuous data streams. For packetized data, such as IP, it is normally sufficient just to select the DVB-S2 service itself. Alternatively, should additional services such as an ESC channel be required then the appropriate service, such as *Closed network plus ESC,* should be selected together with *SmartLink* as the FEC type. DVB-S2 configuration options such as FEC frame size and pilots are available under *Edit->Tx-Rx->Advanced*.
DVB-S2X	The DVB-S2X service is an extension of the DVB-S2 service. As well as supporting additional choices for modulation and FEC rate, it supports additional roll-off factors of 5%, 10% and 15%. DVB-S2X configuration options such as FEC frame size and pilots are available under *Edit->Tx-Rx->Advanced*.

Table 6-2 Tx/Rx Service

6.2.4.4 Tx/Rx Rate Control

Data rate	This allows the user to enter a data rate, from which a symbol rate is calculated.
Symbol rate	Tthis allows the user to enter a symbol rate, from which a data rate is calculated.

Table 6-3 Tx/Rx Rate Control

6.2.4.5 Tx/Rx Data Rate

Range:	0.0024Mbps to 200.0Mbps; step size: 0.000001Mbps
Description:	The terrestrial data rate is the maximum number of data bits that the modem will process in relation to the selected terrestrial 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. 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. When a baseband mode other than *Continuous* is used then the terrestrial data rate will be automatically fixed in accordance with the services that are being used (such as the number of timeslots used for a G.703 service). The minimum and maximum data rate limits are determined by a number of factors such as the terrestrial interface type, type of service, FEC type and FEC rate. 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.

Table 6-4 Tx/Rx Data Rate

6.2.4.6 Tx/Rx Symbol Rate

Range:	0.0024Msps to 50.0Msps; step size: 0.000001Msps
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. 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 6-5 Tx/Rx Symbol Rate

6.2.4.7 Tx Clock Source

Tx Clock In	The external clock supplied on the interface *Clock In* line will be used. Should this clock fail then the modem will switch to an internal backup clock.
Internal	The Tx clock is generated from an internal frequency reference. This is also output on the *Int Tx Clock Out* line for use by external equipment.
Receive reference	The Tx clock is generated from the Rx clock. This is only of any practical use when the Rx clock is set to *Satellite* or *Station*. This setting should always be used when using Paired Carrier+ with IP traffic as explained in the information point below.
Station	The Tx clock is generated from the station clock input.

Table 6-6 Tx Clock Source

When using Paired Carrier+ with IP traffic, it is highly advisable to set the Tx clock source to 'Receive reference' at one end of the link in order to fix the relative clocking for the overlapped carriers, thereby preventing any similar patterns in the respective satellite frames (particularly frame headers) from interfering with each other. Frame header clashes may show up as periodic Paired Carrier+ outages potentially many hours apart.

6.2.4.8 Rx Clock Source

Satellite	This is the clock from the satellite. This is converted to the rate required at the terrestrial port.
Tx Clock In	This causes the Tx clock to be used to clock Rx data to the terrestrial port. This is a plesiochronous mode and requires the receive buffer to be set to a value sufficient to accommodate both the difference in the clocks at each end of the link and any Doppler shift, while also providing the required interval between buffer slips.

Internal	This uses an internal reference clock to be used to clock data to the terrestrial port. This requires the receive buffer to be set as per the *Tx Clock In* option.
Station	The Rx clock is generated from the station clock input. If the station clock frequency is the same as the Rx data rate then the station clock is used directly. If the station clock is a different frequency to the Rx data rate then an internal conversion to the correct frequency is made. This requires the receive buffer to be set as per the *Tx Clock In* option.

Table 6-7 Rx Clock Source

6.2.4.9 Tx/Rx FEC Type

FastLink	This enables Paradise's *FastLink* low-latency Low-Density Parity-Check (LDPC) FEC. *FastLink* gives BER performance approaching that of conventional LDPC but with latency nearer to that of TPC. In addition, *FastLink* supports modes (available on the *Edit->Tx-Rx->Service->Advanced* menu) that optimize either BER performance or latency even further, giving the flexibility to match performance more closely to the constraints of the satellite application.
SmartLink	This selects *SmartLink,* which extends DVB-S2 from working with only packetized data such as IP to working with any terrestrial interface. Using *SmartLink* in Closed network provides a normal DVB-S2 service (with no additional overhead). However, *SmartLink* can also support the use of traditional service features not normally available with DVB-S2, such as Drop and Insert, ESC channel, remote M&C control, AUPC, IDR audio channels, etc. *SmartLink* is described in Section 7.9.
TPC	This selects the Turbo Product Code (TPC) FEC.
Viterbi	This selects the Viterbi FEC.
TCM	This selects the Trellis Coded Modulation (TCM) FEC.
Sequential	This selects the Sequential FEC.

Table 6-8 Tx/Rx FEC Type

6.2.4.10 Tx/Rx Modulation

The modulations that are available depend on the FEC type selected. The supported combinations are listed in **Table 6-9**.

6.2.4.11 Tx/Rx FEC Code Rate

The FEC rates that are available depend on the FEC type and modulation that are selected. The supported combinations are listed in **Table 6-9**.

FastLink	BPSK: 0.499 QPSK (and OQPSK): 0.532, 0.639, 0.710, 0.798 8PSK: 0.639, 0.710, 0.778 8QAM: 0.639, 0.710, 0.778 16APSK: 0.726, 0.778, 0.828, 0.851 16QAM: 0.726, 0.778, 0.828, 0.851 32APSK: 0.778, 0.828, 0.886, 0.938 64QAM: 0.828, 0.886, 0.938, 0.960
DVB-S2 *(and SmartLink)*	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 (Note that DVB-S2 32APSK is available when DVB-S2 is purchased as part of DVB-S2X but is not available when the low-cost DVB-S2 option is purchased.)
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
TPC	BPSK: 5/16, 21/44, 3/4, 7/8 QPSK (and OQPSK): 5/16, 21/44, 3/4, 7/8, 0.93 8PSK: 3/4, 7/8, 0.93 16QAM: 3/4, 7/8, 0.93
Viterbi	BPSK: 1/2, 3/4, 7/8 QPSK (and OQPSK): 1/2, 3/4, 7/8

TCM	8PSK: 2/3
Sequential	BPSK: 1/2, 3/4, 7/8 QPSK (and OQPSK): 1/2, 3/4, 7/8

Table 6-9 Tx/Rx Modulation and FEC Code Rates

6.2.4.12 Tx/Rx Frequency Band

The modem supports independent selection of IF and L-band operation in transmit and receive.

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 2150MHz (and optionally to 2450MHz on some Q-Flex models).

Table 6-10 Tx/Rx Frequency Band

6.2.4.13 Tx/Rx Carrier Frequency

There are various frequency control options, depending on whether IF or L-band has been selected and whether a BUC or LNB is fitted that is being controlled via the modem. The frequency control options are presented in **Tables 6-11** through **6-14**.

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

Table 6-11 Tx/Rx Carrier Frequency (IF)

Range:	950.0MHz to 2150.0MHz (note: the upper limit is 2450MHz on some Q-Flex models); step size: 0.0001MHz or 0.000001 (i.e. 100Hz or 1Hz)
Description:	This is the L-band frequency used in transmitting to, or receiving from, satellite. If the *BUC LO frequency* has been set on the *Edit->Tx-Rx->BUC/LNB* 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 6-12 Tx/Rx 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 6-13 BUC Carrier Frequency

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->Tx-Rx->BUC/LNB* menu then the L-band receive frequency will no longer be available and will be automatically controlled by the modem to achieve the requested LNB receive frequency.

Table 6-14 LNB Carrier Frequency

6.2.4.14 Tx/Rx 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 6-15**.

Range:	5%, 10%, 15%, 20%, 25%, 35%
Description:	All spectral roll-off factors are available for all FECs including DVB-

	S2 and DVB-S2X (with the exception of the low-cost version of DVB-S2, which supports roll-off factors down to and including 15% roll-off). A comparison of the different spectral roll-offs, including their effect on carrier power, is provided in the document '*Saving Satellite Bandwidth by Optimising Spectal Roll-off*'. This is available from the White Papers section of the Paradise web site at http://www.paradisedata.com.

Table 6-15 Tx/Rx Spectral Roll-off

6.2.4.15 Tx/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.

Paradise recommends keeping the signals in the space segment non-inverted, particularly when Paired Carrier+ is being used. If the ground-segment uplink equipment contains a spectral inversion then transmit spectral inversion should be enabled in the modem to correct for it. Similarly, if the ground-segment downlink equipment contains a spectral inversion (e.g. due to an inverting LNB) then receive spectral inversion should be enabled in the modem to correct for it.

6.2.4.16 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 6-16 IF Output Power

Range:	0.0dBm to -40.0dBm; step size: 0.1dBm
Description:	This is the transmitted output power when using L-band.

Table 6-17 L-band Output Power

6.2.4.17 Modem/BUC Carrier

These allow the modem and BUC carriers to be switched on/off independently of each other. BUC carrier control requires a control channel (i.e. FSK or RS485) to exist between the modem and the BUC.

6.2.5 Edit->Tx-Rx->Service->Advanced Screen

The *Edit->Tx-Rx->Service->Advanced* screen is shown in **Figure 6-6**. (For additional options that appear when G.703 and Quad E1 are being used, please refer to Section 13.5 and Section 13.6 respectively.)

Figure 6-6 Edit->Tx-Rx->Service->Advanced Screen

6.2.5.1 FastLink™ Optimisation Mode

The *FastLink optimisation mode* will be shown if **FastLink™** has been selected.

Balanced	Provides performance that is a good balance between low latency and good BER performance. It is the best compromise between trying to achieve the low latency of TPC and the BER performance of conventional LDPC.
Low latency	Provides a lower level of latency that attempts to match or beat that of TPC. This is at the expense of a small increase (typically around 0.3dB compared to *Balanced* mode) in Eb/No required to achieve a specific BER level.
Low BER	Provides better BER performance (typically reducing the Eb/No required to achieve a particular BER level by around 0.3dB compared to *Balanced* mode) at the expense of higher latency. Latency halves as data rate doubles so this mode is suitable for applications that are not latency sensitive and for higher data rate applications (nominally 2Mbps and above).

Table 6-18 FastLink™ Optimisation Mode

This sets the **FastLink™** optimisation mode. FEC design involves a trade-off between achieving low latency and good BER performance and the optimisation mode allows performance to be slanted towards one or the other of these, or set to be a balance between both. This flexibility allows FastLink to be used in place of both TPC and conventional LDPC.

6.2.5.2 DVB-S2 Tx/Rx Pilot Tones

Pilots are an On/Off control that controls whether 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%. Pilots are recommended for FEC rates below rate ½ and for situations where the receive signal may be degraded.

6.2.5.3 DVB-S2/S2X Tx/Rx 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 6-19 DVB-S2/S2X Tx/Rx Frame Size

6.2.5.4 Sweep Mode

Normal	In this mode the sweep width is controlled automatically by the modem. The default sweep width used by the modem is +/-20kHz.
Other	This mode allows the user to set the sweep width in order to compensate for carrier frequency uncertainty introduced in either the ground equipment or in the space segment (due to, for example, frequency conversion errors). At very low data rates, reducing the sweep width may speed up carrier acquisition.

Table 6-20 Sweep Mode

6.2.5.5 Sweep Width

Range (+/-):	1kHz to 255kHz; step size: 1kHz
Description:	Controls the Rx signal sweep width when the *Sweep mode* is set to *Other*. This is a +/- setting, i.e. the total width is twice the value that is entered. The default sweep width used by the modem is +/-20kHz.

Table 6-21 Sweep Width

6.2.5.6 Acknowledge Power Break

If the *Modem carrier* setting on the *Edit->Tx-Rx->Service* menu is set to '*On (mute if power break)'* the any power outage must be explicitly acknowledged using this control thereby confirming that it is okay to restart transmission following the outage.

6.2.5.7 Carrier Protection

In extreme high noise, this control provides adjacent carrier immunity from sudden large power level fluctuations. It has no effect except when using DVB-S2/S2X. Most users will not see any benefit from this feature since extreme high noise situations are rare.

6.2.5.8 Reed-Solomon FEC Options

When using Viterbi and Trellis Coded Modulation (TCM), Reed-Solomon options will become available on the *Edit->Tx-Rx->Service->Advanced* menu. These allow Reed-Solomon to be switched on/off in transmit and receive. Reed-Solomon is an 'outer' codec that can be used to correct errors remaining from the Viterbi and TCM inner FECs.

6.2.1 Edit->Tx-Rx->Advanced Timeslot Screens

Timeslot configuration of G.703 and Quad E1 interfaces is described in Chapter 13.

6.2.2 Edit->Tx-Rx->Framing Screen

Framing is described in Chapter 13.

6.2.3 Edit->Tx-Rx->AUPC Screen

The *Edit->Unit->AUPC* screen is shown in **Figure 6-7**.

Figure 6-7 Edit->Tx-Rx->AUPC Screen

Automatic Uplink Power Control (AUPC) is described in Section 7.2. It provides a method of overcoming rain fade in order to maintain a constant carrier-to-noise level. It does this by attempting to maintain the remote Eb/No at a specified target level by varying the local modem transmit power level.

6.2.3.1 AUPC Mode

Off	The AUPC function is switched off.
Monitor remote Eb/No	In this mode, the modem will monitor the Eb/No of the remote modem via the ESC, without making any changes to the Tx power level.
Maintain remote Eb/No	In this mode, the modem will attempt to maintain the remote Eb/No at the specified target level. It requires a bidirectional ESC channel to be set up.

Table 6-22 AUPC Mode

Typically, the local controlling modem is placed in *Maintain* mode and the remote modem is placed in *Monitor* mode (unless it is also controlling another modem via AUPC in which case it will also be placed in *Maintain* mode).

6.2.3.2 Target Remote Eb/No

Range:	0.1dB to 14.9dB; step size: 0.1dB
Description:	This is the remote Eb/No that AUPC tries to maintain by adjusting the Tx power level.

Table 6-23 Target Remote Eb/No

6.2.3.3 Maximum AUPC Power Offset

Range:	0dBm to 25.0dBm; step size: 0.1dBm
Description:	This is the maximum increase in Tx power level that AUPC is allowed to make in order to maintain remote Eb/No.

Table 6-24 Maximum AUPC Power Offset

6.2.3.4 Maximum Negative AUPC Power Offset

Range:	0dBm to 25.0dBm; step size: 0.1dBm
Description:	This is the maximum decrease in Tx power level that AUPC is allowed to make in order to maintain remote Eb/No.

Table 6-25 Maximum Negative AUPC Power Offset

6.2.3.5 AUPC Method

Normal	This should be selected when Q-Series, Quantum or Evolution modems are being used at either end of the satellite link.
Self	In this mode, the modem will adjust power output in an attempt to maintain the Eb/No at its target level using the Eb/No from its own received carrier rather than the Eb/No value being passed back from any remote modem.
P300	This should be selected when interoperating with a P300-series modem.

Table 6-26 AUPC Method

6.2.3.6 Carrier Loss Action

Set to Nominal	The AUPC delta power is set to zero, causing the carrier to return to its nominal power level.
Freeze at current value	The carrier power is frozen at its current value.
Set to max	The AUPC delta power is set to the maximum power limit as defined by *Maximum AUPC power offset.*

Table 6-27 Carrier Loss Action

6.2.3.7 Local Demod Unlocked Action

Off	When set to *Off*, then the *Local demod unlocked action* has no effect and only the *Carrier loss action* is used. The distinction between the two carrier loss actions is as follows: The *Carrier loss action* covers the situation where the distant modem's demodulator has unlocked, resulting in no Es/No information being available from the distant modem. In this situation, you may, for example, want to increase the AUPC uplink level from the local modem to the maximum. The *Local demod unlocked action* covers the situation where the local demodulator has unlocked, also resulting in no Es/No information being available from the distant modem. In this situation, because there is no carrier being received from the distant modem, you may, for example, want to set the AUPC uplink level from the local modem to its nominal level since there is no indication in this scenario of a problem with the distant modem receiving the local modem's carrier.
Set to Nominal	The AUPC delta power is set to zero, causing the carrier to return to its nominal power level.
Freeze at current value	The carrier power is frozen at its current value.
Set to max	The AUPC delta power is set to the maximum power limit as defined by *Maximum AUPC power offset.*

Table 6-28 Local Demod Unlocked Action

6.2.4 Edit->Tx-Rx->BUC/LNB Screen

The *Edit->Unit->BUC/LNB* screen is shown in **Figure 6-8**.
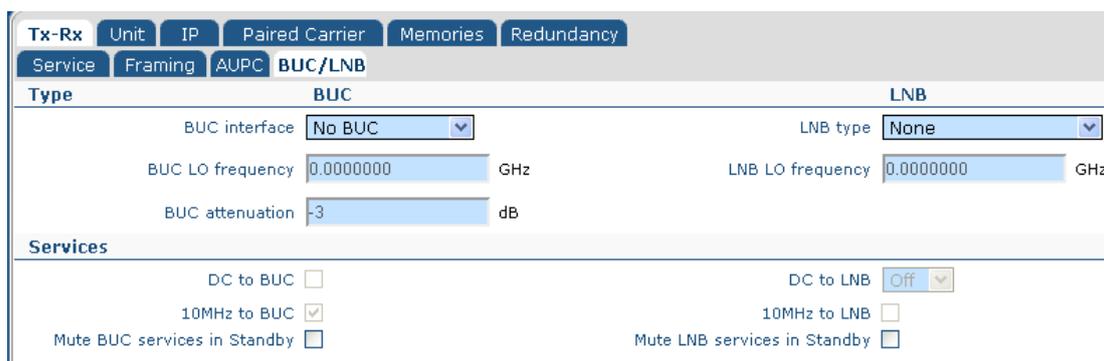
Figure 6-8 Edit->Tx-Rx->BUC/LNB Screen

6.2.4.1 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 fitted.

Table 6-29 BUC Interface

6.2.4.2 BUC LO Frequency

Range:	-99.999GHz to 99.999GHz; step size: 0.0000001GHz
Description:	This is the local oscillator frequency of the BUC.

Table 6-30 BUC LO Frequency

6.2.4.3 BUC Attenuation

Range:	0dB to -15.0dB; step size: 1dB
Description:	This varies the front-end attenuation applied by the 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.

Table 6-31 BUC Attenuation

6.2.4.4 DC to BUC

> **It is strongly recommended that all 10MHz and DC services are switched off to the BUC and LNB before connecting or disconnecting the modem L-band RF cables in order to avoid the potential for damage.**

This is an On/Off control used to enable and disable the DC power supply from the modem to the BUC.

6.2.4.5 10MHz to BUC

> **It is strongly recommended that all 10MHz and DC services are switched off to the BUC and LNB before connecting or disconnecting the modem L-band RF cables in order to avoid the potential for damage.**

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

6.2.4.6 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.

6.2.4.7 LNB Type

None	This indicates that no LNB is fitted.
Other	This indicates that an LNB is fitted but is not one of the Paradise LNBs listed below.
C 3.635 – 4.200 GHz	This presets the LNB LO frequency to 5150MHz.
Ku 10.95 – 11.45 GHz	This presets the LNB LO frequency to 10000MHz
Ku 11.2 – 11.7 GHz	This presets the LNB LO frequency to 10250MHz
Ku 11.7 – 12.2 GHz	This presets the LNB LO frequency to 10750MHz
Ku 12.25 – 12.75 GHz	This presets the LNB LO frequency to 11300MHz

Table 6-32 LNB Type

6.2.4.8 LNB LO Frequency

Range:	-99.999GHz to 99.999GHz; step size: 0.0000001GHz
Description:	This is the local oscillator frequency of the LNB.

Table 6-33 LNB LO Frequency

6.2.4.9 DC to LNB

> ⚠️ ***It is strongly recommended that all 10MHz and DC services are switched off to the BUC and LNB before connecting or disconnecting the modem L-band RF cables in order to avoid the potential for damage.***

This is an On/Off control used to enable and disable the DC power supply from the modem to the LNB.

6.2.4.10 10MHz to LNB

> ⚠️ ***It is strongly recommended that all 10MHz and DC services are switched off to the BUC and LNB before connecting or disconnecting the modem L-band RF cables in order to avoid the potential for damage.***

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

6.2.4.11 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.

6.2.5 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.

- *Station Clock.* This controls the station clock, which replaces the internal 10MHz clock reference, allowing a number of modems to share a common clock source.
- *SAF.* This allows the entry of Software Activated Feature (SAF) codes that enable modem feature activation 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.

6.2.6 Edit->Unit->M&C Screen

The *Edit->Unit->M&C* screen is shown in **Figure 6-9**.

Figure 6-9 Edit->Unit->M&C Screen

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

6.2.6.1 Modem Control and Passwords

Table 6-34 shows the *Modem control* options, for user control of the modem.

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 6-34 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.

6.2.6.2 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 6-35 RADIUS Server IP Address and Fallback Address

6.2.6.3 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.

6.2.6.4 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 6-36 RADIUS Authentication Validity

6.2.6.5 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 6-37 RADIUS Server Timeout

6.2.6.6 Remote M&C Interface

Table 6-38 shows the *Remote M&C interface* options, with respect to the serial M&C interface of the modem. **Tables 6-40** and **6-41** describe the options for assigning an RS485 address to the serial M&C interface and setting its baud rate, respectively.

RS232	This sets the serial M&C interface to RS232. This allows the modem to be controlled using Paradise Universal Protocol (PUP) commands as specified in the document '*Remote M&C Specification for Q-Series modems*'. If the serial M&C interface is internally or externally looped to the modem's ESC interface then the commands can be forwarded to the far end of the link in order to control either the remote modem or other equipment.
RS485	This sets the serial M&C interface to RS485. This allows the modem to be controlled using Paradise Universal Protocol (PUP) commands as specified in the document '*Remote M&C Specification for Q-Series modems*'. If the serial M&C interface is internally or externally looped to the modem's ESC interface then the commands can be forwarded to the far end of the link in order to control either the remote modem or other equipment.
IP - Local	This option is only available when the *ESC interface type* is set to *IP*. This mode takes the serial M&C data, converts it to an IP format and forwards it to the remote modem via the ESC channel, where it is converted back to serial data again and output via the remote modem's M&C serial interface. This can be used to control remote equipment. By converting the serial data to IP, it allows the ESC channel to be shared with other IP traffic.
IP – Remote	This mode is used at the remote end of the link. It allows serial M&C data, transferred in IP format over the ESC channel, to be output via the serial M&C interface of the remote modem. (See **Figure 6-10** for details of the TCP port usage in relation to these commands.) This allows serial control of remote equipment while allowing the ESC channel to operate in an IP mode where it is shared with other IP traffic.

IP – Forward to Remote	This option is only available when the *ESC interface type* is set to *IP*. Commands sent to the local modem's IP address are forwarded to the remote modem where the commands are converted to serial M&C commands for control of remote equipment. (See **Figure 6-10** for details of the TCPs port usage in relation to these commands.)

Table 6-38 Modem Control
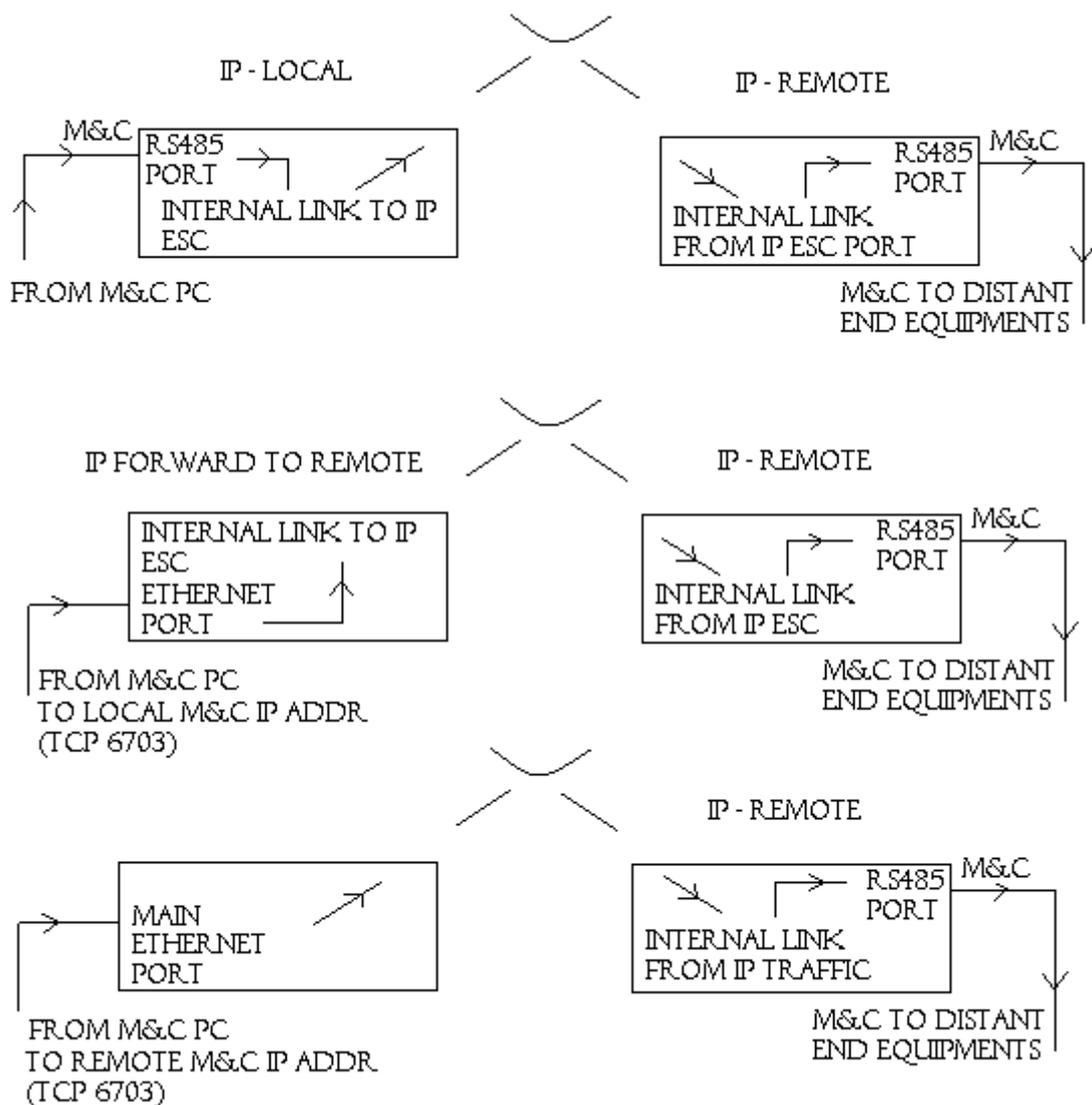
Figure 6-10 Serial M&C Interface: IP ESC Extension Modes

Table 6-33 defines the serial M&C RS485 interface pinout when *IP-Remote* is selected (refer to Chapter 11 for full connector pinouts).

Pin	Signal Name	Direction	RS485: IP – Remote Mode
	Shield/Gnd		Shield/Gnd
3	Master-B	+ to modem	TX-B
4	Slave-B	+ from modem	RX-B
5	Shield/Gnd		
6	Slave-A	- from modem	RX-A
9	Master-A	- to modem	TX-A

Table 6-39 Serial M&C Interface RS485 Pinout (IP Remote Mode)

Range:	1 to 255; step size: 1
Description:	This is the RS485 address that is assigned to the modem's serial M&C interface.

Table 6-40 Serial M&C Interface RS485 Address

Range:	110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200
Description:	This sets the baud rate associated with the modem's serial M&C interface.

Table 6-41 Serial M&C Interface Baud Rate

6.2.6.7 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.

6.2.6.8 Submit Mode

Submit mode is used when reconfiguring modems (particularly 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 6-11**.
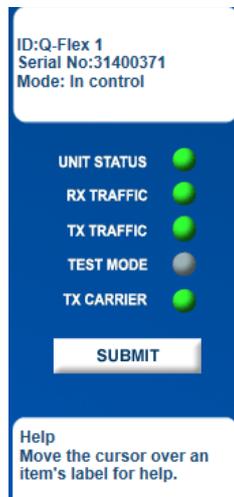
Figure 6-11 Modem Status Summary Screen with Submit Mode Button

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 of 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 M&C application (which can be downloaded freely from the Paradise 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.

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

The *Edit->Unit->M&C->SNMP* screen is shown in **Figure 6-12**.

Figure 6-12 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.

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

The *Edit->Unit->M&C->Email* screen is shown in **Figure 6-13**.

Figure 6-13 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 Simple Mail Transfer Protocol (SMTP) mail server is available. 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 Rx Eb/No values
- Up to a month's worth of logged AUPC remote Eb/No values
- Up to a month's worth of logged Rx power level values
- Up to a month's worth of logged user BER values
- Up to a month's worth of logged AUPC Tx power level values
- Up to a month's worth of logged modem temperature values
- The contents of the modem's event log (i.e. all noteable 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
- Instantaneous PRBS BER test results

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 *Reply to* 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 spreadsheed 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 6-14**.

Q-Flex™ Satellite Modem Installation and Operating Handbook
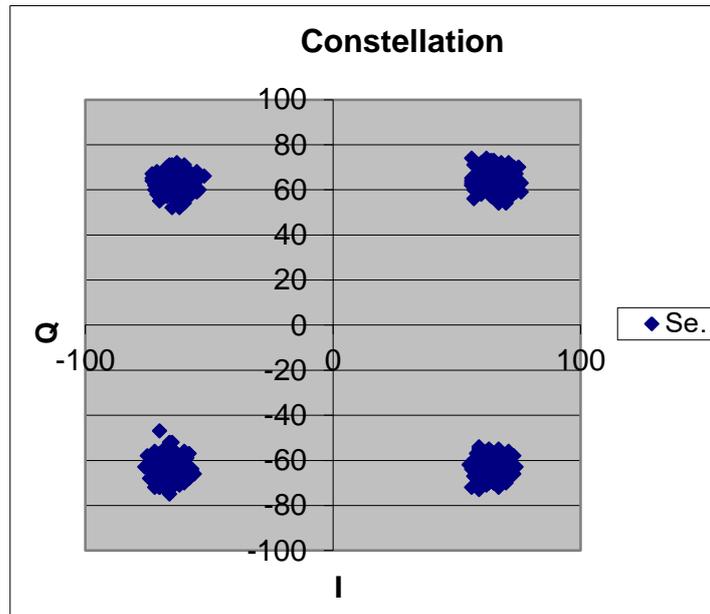
Constellation

Figure 6-14 Example Constellation Graph (Microsoft Excel)

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

The *Edit->Unit->M&C->HTTPS* screen is shown in **Figure 6-15**.
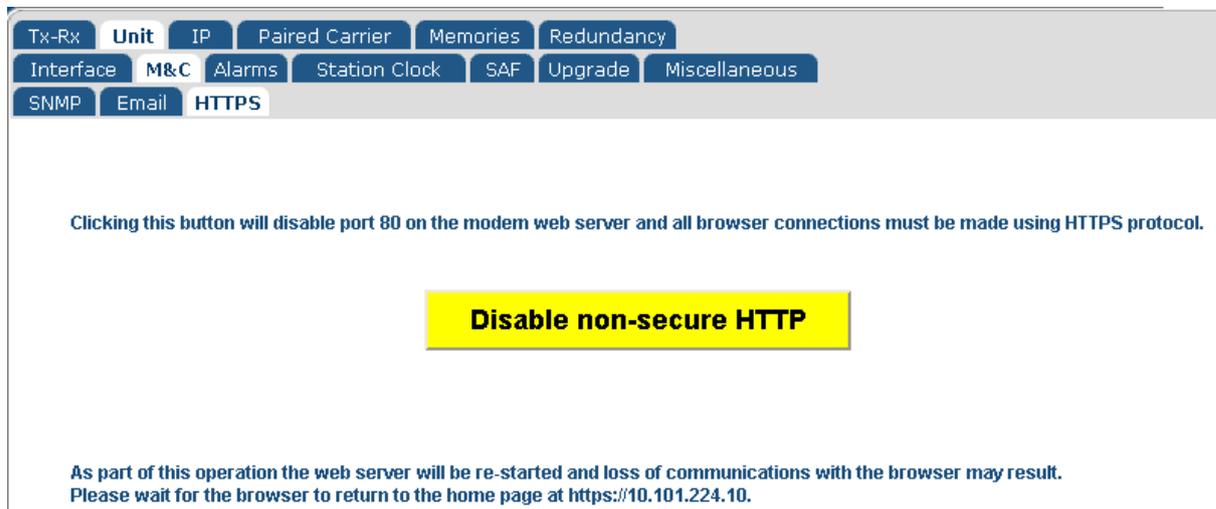
Figure 6-15 Edit->Unit->M&C->HTTPS Screen

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.

6.2.10 Edit->Unit->Alarms Screen

The *Edit->Unit->Alarms* screen is shown in **Figure 6-16**.

Figure 6-16 Edit->Unit->Alarms Screen

6.2.10.1 LinkGuard™ Interference

LinkGuard™ is a Paradise patented technology (US patent 8351495) for detecting in-band interference underneath satellite carriers while remaining on traffic.

An automated alarm can be generated whenever the power spectral density of the interference goes above a user-set threshold, thereby automatically alerting the operator whenever meangingful levels of interference are detected. This threshold check is enabled and disabled via the *LinkGuard interference over-threshold check* control. The threshold level setting itself is described in **Table 6-42**.

Range:	0dB to 9.9dB; step size: 0.1dB
Description:	Sets a power spectral density threshold used to monitor for any signal under the received carrier. If the detected level of interference exceeds the threshold then an Rx traffic warning alarm is raised. See Section 7.6 for more information on **LinkGuard™**.

Table 6-42 LinkGuard™ Interferer Threshold

6.2.10.2 Tx/Rx AIS Alarm Action

These control the action taken with respect to Alarm Indication Signal (AIS) detection, commonly used in G.703 circuits. It is a sequence of 'all ones' that replaces the normal

data stream when a failure is detected, in order to alert downstream equipment of the failure.

AIS can be ignored or set to raise an alarm, regenerate AIS and send a backward alarm where possible as described in **Table 6-43**.

Ignore	Ignore any AIS indication.
Prompt	When AIS is detected, raise an alarm, regenerate the AIS indication and send a backward alarm to the upstream equipment.

Table 6-43 Tx/Rx AIS Alarm Action

6.2.10.3 Local/Remote Eb/No Alarm Threshold

Range:	0dB to 99.0dB; step size: 0.1dB
Description:	These set the Eb/No thresholds below which a deferred alarm will be generated for the local (i.e. received carrier) and remote (i.e. transmitted carrier) Eb/No values respectively.

Table 6-44 Local/Remote Eb/No Alarm Threshold

6.2.10.4 Buffer Slip Alarm Threshold

Range:	0 hours to 9999 hours; step size: 1 hour
Description:	Sets the threshold period for consecutive buffer slips above which a deferred alarm is generated. A setting of 0 (zero) disables this alarm.

Table 6-45 Buffer Slip Alarm Threshold

6.2.10.5 BUC DC Current Alarm

Even when there is no communications path between the BUC and modem, it is still possible for the modem to monitor the BUC for under/over current and over temperature conditions that cause the BUC to shut down. **Table 6-46** 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
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 6-46 BUC DC Current Minimum/Maximum

6.2.10.6 LNB DC Current Alarm

From the second half of 2014 onwards, hardware support has been added to the modem to monitor the LNB current. **Table 6-47** 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 6-47 LNB DC Current Minimum/Maximum

6.2.10.7 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.

6.2.11 Edit->Unit->Station Clock Screen

The *Edit->Unit->Station Clock* screen is shown in **Figure 6-17**.

Figure 6-17 Edit->Unit->Station Clock Screen

The station clock input is a way of providing a common clock to a number of modems in order to synchronize all satellite traffic to a master clock.

The modem's terrestrial interface clocking function (both transmit and receive) is slaved to the station clock input when it is active. The station clock can be provided at any of a range of frequencies and does not need to be fixed at the precise data rate for the link.

In addition, the modem's internal high-stability oscillator can be slaved to the station clock thereby ensuring its use in carrier and BUC/LNB control. Note that even when being used in the IF frequency bands, the high-stability oscillator (normally regarded as an L-band feature) can still be slaved to the station clock. The station clock frequency must be at one of a small number of fixed frequencies when used to slave the high-stability oscillator.

The options also allow the 10MHz reference to be output through the 75Ω BNC station clock connector.

6.2.11.1 Station Clock Source

None	No station clock source has been selected.
BNC	The station clock input is provided via the rear-panel Station Clock BNC.
RS422	The station clock input is provided via the RS422 differential station clock pins on the rear-panel Async ESC connector.

Table 6-48 Station Clock Source

When providing an external 10MHz clock to the modem, it must meet the following single sideband phase noise measurements at various offset frequencies:

- 10 Hz: -125 dBc/Hz
- 100 Hz: -145 dBc/Hz
- 1kHz: -150 dBc/Hz
- 10 kHz: -155 dBc/Hz
- 100 kHz: -155 dBc/Hz

6.2.11.2 Station Clock Frequency

The actual station clock input frequency value must be input to the modem. Valid frequency values will vary depending on whether the station clock is being used for terrestrial clocking only or whether it is additionally used for carrier and/or BUC/LNB control. The appropriate frequency input range will be automatically displayed.

Range:	1000kHz to 10000kHz; step size: 1kHz
Description:	This must reflect the actual frequency of the station clock input as the modem does not automatically measure the frequency. It is used by the modem in programming the terrestrial interface clocking logic.

Table 6-49 Station Clock Frequency (when not locking the high-stabiliy oscillator)

Options:	10MHz, 5MHz, 2MHz, 1MHz
Description:	This must reflect the actual frequency of the station clock input as the modem does not automatically measure the frequency. It is used by the modem in programming the terrestrial interface clocking logic.

Table 6-50 Station Clock Frequency (when locking the high-stabiliy oscillator)

6.2.11.3 Locking the High-Stability Oscillator to the Station Clock

This is an On/Off control that determines whether the modem's internal high-stability oscillator is slaved to the station clock input. The high-stability oscillator is used in carrier and BUC/LNB control. It therefore provides a way of extending system clock synchronization to ancilliary equipment beyond the satellite modems.

6.2.12 Edit->Unit->SAF Screen

The *Edit->Unit->SAF* screen is shown in **Figure 6-18**. The concept of Software Activated Features (SAF) is explained in .
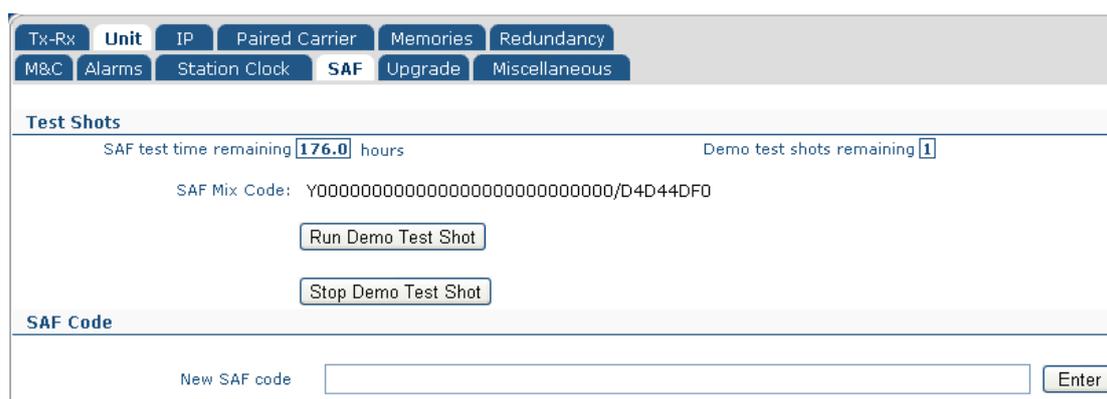
Figure 6-18 Edit->Unit->SAF Screen

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 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 of 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 SAF features.

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 Paradise 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.

6.2.13 Edit->Unit->Upgrade Screen

The *Edit->Unit->Upgrade* screen is shown in **Figure 6-19**. 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.
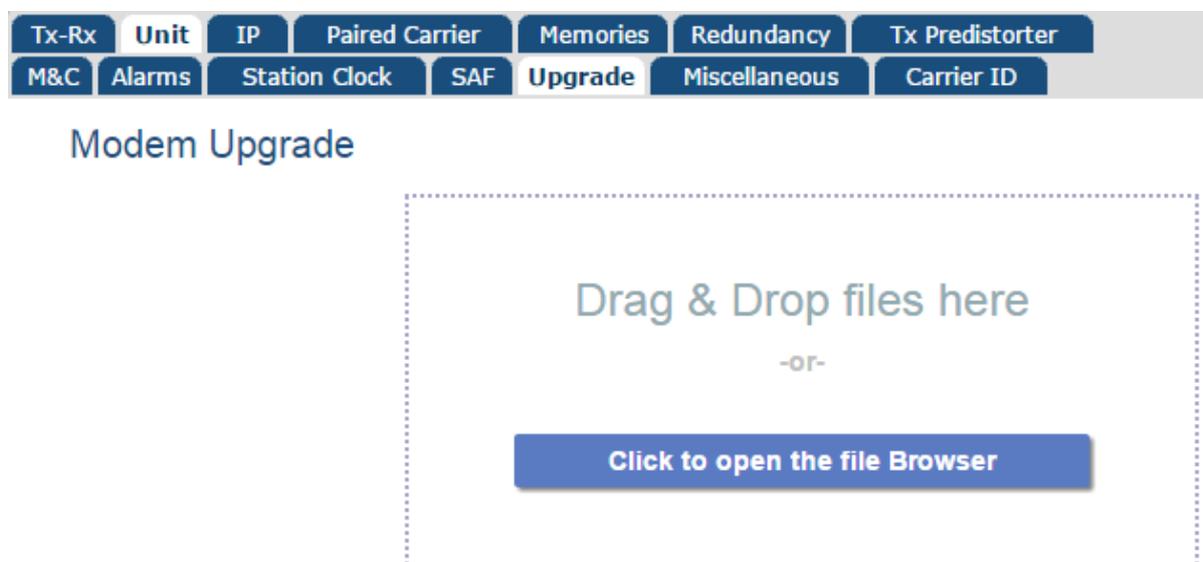
Figure 6-19 Edit->Unit->Upgrade Screen

The latest software can be found under Downloads on the Paradise company web site at http://www.paradisedata.com. The software should be downloaded from the web site to a temporary location that can be accessed by the browser and modem.

The modem should be placed into bridge mode with all advanced IP features (such as TCP acceleration, ACM, routing, etc.) switched off.

It is necessary only to browse to the location of the upgrade file and open the file before starting the upgrade. During the upgrade process the modem will drop any service that it is providing.

Feedback on the progress of the upgrade, which typically takes around two minutes, is provided on the screen on shown in **Figure 6-20**. The modem will restart automatically when the upgrade is complete and will resume operation using the same configuration as prior to the upgrade.
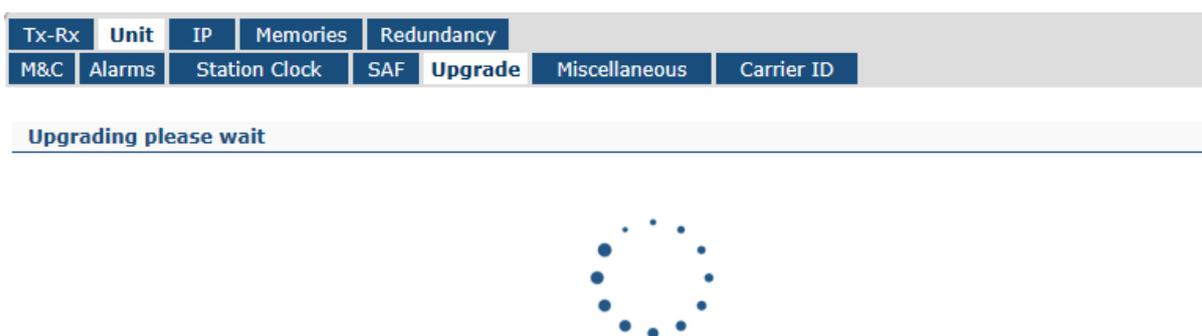
Figure 6-20 Edit->Unit->Upgrade Screen Progress Indication

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.

In the event that an upgrade is unsuccessful then the modem will revert to a backup version of software. This will normally be the same version as the software that 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 (this is a hidden menu option). This boots the modem from a backup copy of the software stored when the modem was manufactured. Once the modem has been recovered then the standard upgrade process can be repeated.

<u>Upgrade from USB memory stick</u>

- Create a new folder on the USB memory stick and name it `upgrade`.
- Unzip the contents of the software upgrade zip file 'Q-Flex-x.x.xx.zip' to this folder.
- Three files with the following names should now be present in the upgrade folder as shown in **Figure 6-21**.

cf.img.gz	WinZip File	11/07/2013 07:48	50,677,...	0%	50,684,512
uImage	File	08/07/2013 15:16	1,204,504	0%	1,204,115
fpga.bin.gz	WinZip File	01/07/2013 12:01	442,293	0%	441,624

Figure 6-21 USB Memory Stick Upgrade Files in Upgrade Folder

- Plug the memory stick into a USB port on the modem.
- On the front panel keypad select **2:Edit**, **4:Unit**, **5: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.

Recovery from a failed upgrade

There are three methods of recovering from a failed upgrade.

Recovery to factory-installed backup software version

To revert to the default backup version of software installed in the modem during the production process, hold down the **MAIN** key at power-up, then when the menu appears press **5** (this is a hidden menu option).

This boots the modem from a backup copy of the software stored when the modem was manufactured. During the boot process the contents of the front-panel display will be incorrect and should be ignored. Once the modem has been recovered then the standard upgrade process can be repeated.

Recovery via the Rescue menu option

It is possible to boot the modem to a basic web server that allows the software upgrade process to be repeated. The basic web server will display a web page that allows you to navigate to the software upgrade file and when this is selected then the software will be upgraded as normal and the modem will reboot automatically at the end of the process.

To initiate the rescue process, hold down the **MAIN** key at power-up, then when the menu appears press **2:Rescue**. The basic web server uses an IP address of 10.0.70.1/16 and uses the IP traffic port on the modem (not the M&C Ethernet port).

Recovery via USB memory stick

- Unzip the contents of the software upgrade zip file 'Q-Flex-x.x.xx.zip' to the root folder for the memory stick (e.g. 'D:\').

- Copy the `recimage` file to the memory stick's root folder: (Contact Paradise Technical Support for the recovery image file)
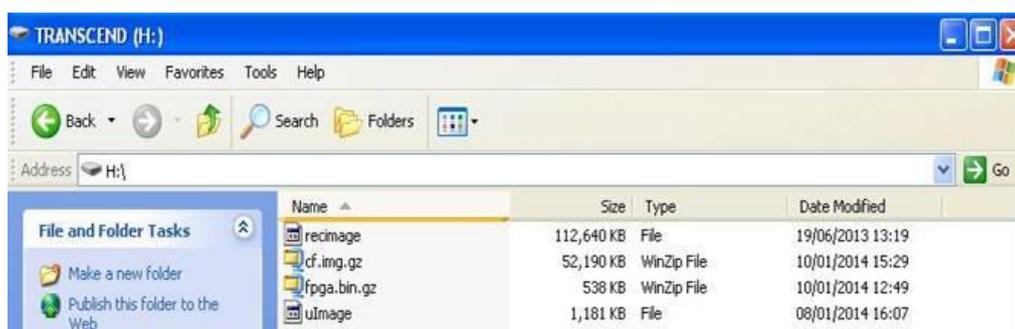
Figure 6-22 USB Memory Stick Root Folder

- There should now be 4 files in the memory stick's root folder as shown in **Figure 6-22**.
- Power up the modem and keep the **MAIN** key pressed down for a few seconds until a menu appears.
- Select **3:USB** from the menu.
- The modem will recover and complete the upgrade process from the memory stick within a few minutes. During the boot process the contents of the front-panel display will be incorrect and should be ignored.

6.2.14 Edit->Unit->Miscellaneous->Time Screen

The *Edit->Unit->Miscellaneous->Time* screen is shown in **Figure 6-23**. 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 modem will display a dialog box to confirm that the date and time have been changed (however, this will be displayed very briefly and may not be seen in every case).

Figure 6-23 Edit->Unit->Miscellaneous->Time Screen

6.2.1 Edit->Unit->Miscellaneous->Reset Screen

The *Edit->Unit->Miscellaneous->Reset* screen is shown in **Figure 6-24**. This allows the modem to be reset, following confirmation.
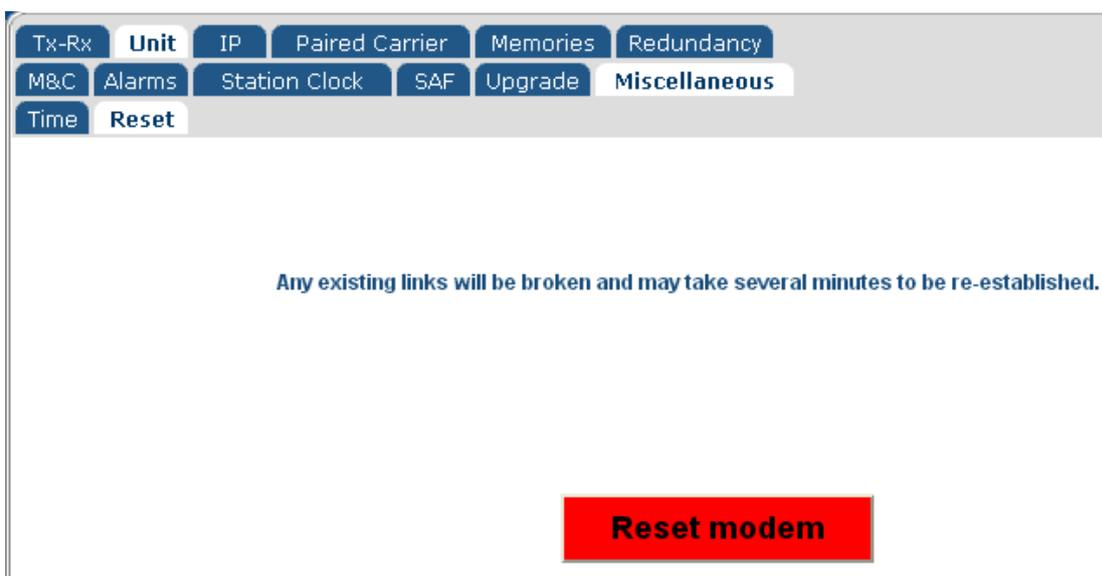
Figure 6-24 Edit->Unit->Miscellaneous->Reset Screen

6.2.1 Edit->Unit->Miscellaneous->NTP Screen

The *Edit->Unit->Miscellaneous->NTP* screen is shown in **Figure 6-25**. 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)).

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.
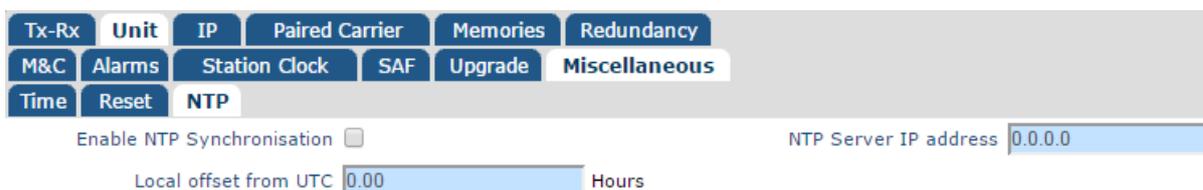
Figure 6-25 Edit->Unit->Miscellaneous->NTP Screen

6.2.1 Edit->Unit->Carrier ID Screen

The *Edit->Unit->Carrier ID* screen is shown in **Figure 6-26**. This allows a low-power spread spectrum signal containing user identification information to be superimposed on the Tx carrier. When used with a suitable decoder, the information can be used to identify the source of satellite carriers that are interfering with other satellite services.

Figure 6-26 Edit->Unit->Carrier ID Screen

6.2.1.1 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.

6.2.1.2 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.

6.2.1.3 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.

6.2.1.4 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.

6.2.2 Edit->IP Screen

The *Edit->IP* screen (shown in **Figure 6-27**) allows the following to be set up:

- Basic and advanced IP modes and features, such as bridging, routing, acceleration and compression.
- The modem's terrestrial and satellite traffic IP addresses.
- Miscellaneous IP features used for specialized modes of operation.
- Further tabs are available that allow the setup of advanced features (VCM multistreaming and MPEG2 transport streams), traffic shaping (QoS) and static routes.

Ethernet speed/duplex settings are available on the *Edit->Unit->Interface* screen.

Figure 6-27 Edit->IP Screen

6.2.2.1 IP Mode

Table 6-51 shows the *IP mode* options. The operation of the M&C and IP Traffic Ethernet ports is summarized in **Table 6-52**.

Bridge mode	In this mode the modem acts as an Ethernet bridge, preserving the original Ethernet frames (including additional fields such as VLAN and MPLS headers) over satellite.
Routing	In this mode IP packets are forwarded based on the contents of the

mode	modem's routing table, which can be configured manually with static routes or controlled dynamically by enabling dynamic routing. Dynamic routing populates the routing table based on information forwarded by other routers in the network. The modem operates as a two-port router in this mode (with separate terrestrial and satellite IP addresses).
Trunking mode	Trunking mode implements a Layer 2 bridge in hardware. This results in a much higher packet handling capability (up to 500,000 packets per second as opposed to a maximum of 150,000 packets per second when in other modes). Because the processor is bypassed in this mode, jitter is also minimised and typically registers as zero when measured with Ethernet test equipment. ACM (and AUPC) can be used in Trunking mode but other IP features such as TCP acceleration cannot be used because they require the packets to be passed through the processor.

Table 6-51 IP Mode

Control of Remote Modem in Bridge Mode

When the M&C and IP traffic ports are on the same subnet then the ports can be bridged together (sharing a single address) and all M&C requests will then automatically find their way to the remote modem.

When the M&C and IP traffic ports are on separate subnets then the following technique can be used. IP should be selected as the mode for the ESC channel along with IP as the interface for the main channel. If you then bridge the M&C to the traffic port, the main channel runs as a separate bridge connected to the IP traffic port but, at the same time, the ESC channel runs as a separate bridge between the M&C ports of the two modems. The traffic for each is completely separated. Separate subnets can be used for M&C and IP traffic ports, since they retain individual addresses in the specific case where both the ESC and main channel are both set to IP mode.

If the M&C port were to be removed from the bridge then the IP traffic port is still bridged over the main channel but the M&C traffic will now pass no further than the local modem (unless addressed to specific TCP ports, which can cause packets to be forwarded over the ESC). This explicit control over what passes through the ESC channel avoids bandwidth being potentially wasted on broadcast M&C traffic.

The ESC channel is not available in DVB-S2 and DVB-S2X modes. For this reason support for an M&C VLAN has been added that causes all M&C traffic (on its own separate subnet) to pass over satellite in its own VLAN, allowing easy M&C connectivity even when using DVB-S2/S2X. Please see Section 6.2.2.18 for further details.

Modem Settings			Ethernet Operation	
Bridging/Routing Mode	**M&C and IP Traffic Ethernet Ports**	**TCP Acceleration**	**Operation of M&C Ethernet Port**	**Operation of IP Traffic Ethernet Port**
Bridging	Bridged	Off	M&C address shared with IP Traffic port; M&C traffic will be bridged over satellite as required	IP Traffic address not used; port is addressed via M&C address; traffic will be bridged over satellite as requried
Bridging	Bridged	On	This combination of modem settings is illegal (M&C port will be automatically removed from bridge)	
Bridging	Not bridged	Off	M&C port has dedicated address; M&C traffic will not be bridged over satellite	IP Traffic port has dedicated address; traffic will be bridged over satellite as required
Bridging	Not bridged	On	M&C port has dedicated address; M&C traffic will not be bridged over satellite; modem gateway is applied to M&C subnet	IP Traffic address not used; IP Traffic port dedicated to satellite traffic only, which will be accelerated and bridged over satellite as required
Routing	Bridged	Off	This combination of modem settings is illegal (M&C port will be automatically removed from bridge)	
Routing	Bridged	On	This combination of modem settings is illegal (M&C port will be automatically removed from bridge)	
Routing	Not bridged	Off	M&C port has dedicated address, which must be on a different subnet to IP Traffic port; M&C traffic will be routed over satellite as required	IP Traffic port has dedicated address; traffic will be routed over satellite as required
			Modem gateway applied to either port as specified by subnet	
Routing	Not bridged	On	M&C port has dedicated address, which must be on a different subnet to IP Traffic port; M&C traffic will be routed and accelerated over satellite as required	IP Traffic port has dedicated address; traffic will be routed and accelerated over satellite as required
			Modem gateway applied to either port as specified by subnet	

Table 6-52 Ethernet Port Operation

6.2.2.2 Bridge M&C

This is an On/Off control that determines whether the two RJ45 Ethernet ports on the modem are bridged together or whether they have separate IP addresses allocated to them.

When the Remote M&C Ethernet port is out of the bridge then satellite IP traffic and M&C traffic are processed separately and therefore the two modem Ethernet connectors are no longer interchangeable. Care should be taken in selecting this mode for a remote modem since if the cables have been incorrectly fitted then it could result in M&C communications with the remote modem being lost.

When the Remote M&C Ethernet port is bridged to the satellite IP Traffic port then the two modem Ethernet ports act as a two-port Ethernet switch.

6.2.2.3 TCP Accleration

This is an On/Off control that controls 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*

  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. The M&C Ethernet port cannot be bridged to the IP Traffic port when using bridged TCP acceleration. 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.

6.2.2.4   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. **Note that the *Satellite buffer size* also plays an important role in preventing oscillations in throughput when TCP acceleration is on – it is recommended that this should normally be set to 8.**

Table 6-53   Round-trip Satellite Delay

6.2.2.5   Header Compression

This is an On/Off control that controls header compression.

IP, UDP and RTP header compression is supported in accordance with the Robust Header Compression (ROHC) standard RFC 3095 (profiles 2 and 3). ROHC typically reduces the 40 bytes of IP, UDP and RTP header, which is typically used with Voice over IP data, down to between 1 and 3 bytes. Ethernet header compression is also supported in addition and this reduces 14 bytes of Ethernet frame down to typically 1 byte. Overall savings from compression from both types of compression (e.g. for a G.729 voice stream) can be as high as 60%.

When header compression is on, Ethernet, UDP, TCP, RTP and IP packet headers are compressed in order to save satellite bandwidth. The relative bandwidth saving is greater for smaller packets.

The compressed packets will be either bridged or routed as determined by the *IP mode* setting.

Selective compression of packets can be controlled via the *Edit->IP->Header Compression* screen, which allows routes to be added.

6.2.2.6   Payload Compression

This is an On/Off control that controls header compression.

When payload compression is on, the payload of IP packets are compressed in order to save satellite bandwidth.

The compressed packets will be either bridged or routed as determined by the *IP mode* setting.

6.2.2.7   ACM Mode

Table 6-54 lists the modes available with respect to Adaptive Coding and Modulation (ACM). ACM converts any unused link margin into additional IP throughput.

Off	When using DVB-S2, this switches ACM off in both transmit and receive.
On	This switches ACM on in both transmit and receive.
	When ACM is on, the choice of modulation and FEC rate (modcod) in the transmit path is dynamically matched to the reported Es/No from the remote modem. Symbol rate and carrier power are unchanged but data rate will vary with the choice of modcod.
	The modem will automatically insert regular Es/No information into the return carrier (with no material effect on bandwidth). This is used to control the carrier modcod selection of the other modem, should it have ACM enabled.
Monitor	This switches ACM on in receive only. This causes the modem to automatically insert regular Es/No information into the return carrier, which is used by the distant modem to determine the choice of transmit modcod.
	A secondary function that is switched on is as a test mode that simulates ACM being on but does not actually change modcod. Instead, it records what modcods *would* have been selected if ACM was actually on, including recording the time, remote Es/No and the data rate. This allows ACM to be tested in a non-intrusive way on a live link and also allows any projected bandwidth savings to be confirmed prior to going live.
	The record of ACM modcod changes can be viewed graphically on the ACM graph (under *View->Graphs->IP->ACM*) or as text in the system log (under *View->Log*).

Table 6-54 ACM Mode

6.2.2.8 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. 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 6-55 ACM Rain Fade Margin

6.2.2.9 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. When the M&C and traffic Ethernet ports are bridged together then this address is used for both M&C purposes and satellite traffic. 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) table on the device is 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 6-56 M&C IP Address, Subnet Mask & Modem IP Gateway

6.2.2.10 Traffic/Satelite IP Addresses and Subnet Masks

Traffic IP address	This sets the IP address for the modem's IP Traffic port. (DHCP is not supported for this address and therefore an address must be manually entered.) When IPv6 support is selected on the menus then additional address entry options are provided.
Traffic IP subnet mask	This sets the subnet mask for the modem's IP Traffic port.
Satellite IP address	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.
Satellite IP subnet mask	This sets the subnet mask for the modem's satellite IP port.

Table 6-57 Traffic/Satellite IP Address & Subnet Mask

6.2.2.11 IP Encapsulation Type

MPE	This selects Multi-Protocol Encapsulation (MPE) as the protocol for encapsulating IP packets and Ethernet frames for transmission over satellite when using DVB-S2/S2X. This protocol is widely supported and is therefore useful for interoperability. It adds an overhead of around 10%.
ULE	This selects Unidirectional Lightweight Encapsulation (ULE) as the protocol for encapsulating IP packets and Ethernet frames for transmission over satellite when using DVB-S2/S2X. It adds an overhead of around 5% to 7%.
PXE	This selects proprietary Paradise XStream Encapsulation (PXE) as the protocol for encapsulating IP packets and Ethernet frames for transmission over satellite when using DVB-S2. It adds an overhead of around 2%.
GSE	This selects Generic Stream Encapsulation (GSE) as defined in the DVB-S2X standard. On the transmit side, the modem implements the GSE High Efficiency Mode (HEM) since this gives the most efficient packing and padding, thereby maximizing bandwidth utilization and efficiency. On the receive side, the modem implements both HEM and the GSE Lite mode. GSE adds an overhead of around 2%.

Table 6-58 (DVB-S2/S2X) IP Encapsulation Type

6.2.2.12 Encapsulation PID

Range:	0 to 8190; step size: 1
Description:	When encapsulating Ethernet frames or IP packets into MPEG2 packets as part of a DVB-S2 IP service, this specifies the Packet ID (PID) value to be entered into the MPEG2 packets that are being created. Note that the value is in decimal, not hexadecimal. The PID can then be used for filtering MPEG2 packets on the receive side. The encapsulation PID must be left at its default value of 970 if DVB-S2 AUPC or DVB-S2 ACM is being used.

Table 6-59 Encapsulation PID

6.2.2.13 MPE MAC Address

Format example:	00:11:29:00:F0:23
Description:	For DVB-S2 IP services, this is used for filtering of Multi-Protocol Encapsulation (MPE) packets on the receive side. The receiver will filter against whatever MAC address has been provided, which can therefore be a virtual MAC address rather than the receiver's address. (There is currently no equivalent modulator support to allow a specific MAC address to be added to MPE packets. A Paradise modulator will always set the MPE MAC address to all zeros in routing mode and to the destination MAC address of the incoming Ethernet frame when in bridging mode.)

Table 6-60 MPE MAC Address

6.2.2.14 Weighted QoS

This is an On/Off control that controls IEEE 802.1p packet prioritization. It is mutually exclusive with the traffic shaping feature and when traffic shaping is enabled then strict/fair queuing will be automatically switched off.

This allows for eight classes of data to be specified as part of a three-bit field within the Layer 2 IEEE 802.1q VLAN header. The packets must already be tagged at the point of entry to the modem. Priority 7 is typically used for network-critical traffic such as dynamic routing protocol packets; priorities 5 and 6 for video and voice, etc. The modem uses the priority tag to decide how to process each packet. The options are:

- **Strict-priority queuing**: packets are queued for transmission based solely on their priority with the highest always being sent first. Strict-priority queuing is active whenever *Weighted QoS* is set to Off.
- **Fair-weighting queuing**: higher-priority packets are transmitted first but lower-priority packets are given a percentage of the bandwidth. Fair-weighting queuing is active whenever *Weighted QoS* is set to On.

The implementation of IEEE 802.1p packet prioritization is as follows:

- The eight QoS priority levels are mapped to three TCP/IP queues in the modem.
- Packets with highest QoS priority (level 7) are sent to high priority TCP/IP queue.
- Delay-sensitive packets (QoS levels 6 and 5) are sent to the medium priority queue.
- The remainder (QoS levels 4 to 0) are sent to the low priority TCP/IP queue.
- For strict-priority queuing, all packets in the high-priority queue are processed before any in the medium-priority queue, which in turn are processed before any in the low-priority queue.

For fair-weighting queuing, for every four packets sent from the high-priority queue, two are sent from medium-priority queue and one from the low-priority queue.

6.2.2.15 M&C and IP Traffic Ethernet Speed/Duplex

Table 6-61 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 both.

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 6-61 Ethernet Speed/Duplex

6.2.2.16 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 6-62 IPv4/IPv6 Mode

6.2.2.17 Ethernet MTU

Range:	2,000 bytes to 10,000 bytes; step size: 1 byte
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 6-63 Ethernet MTU

6.2.2.18 M&C VLAN

This is an On/Off control that controls whether M&C traffic destined for the remote modem is transmitted in a special VLAN. When the control is checked, all M&C traffic for the remote modem is sent over satellite using VLAN 0. The M&C packets will be received and processed by the remote modem when the equivalent control is enabled on the remote modem.

This technique for remote control means that the M&C port does not need to be bridged to the traffic port(s) thereby facilitating the use of separate M&C and traffic networks that use different subnets.

6.2.3   Edit->IP->Advanced Screen

The *Edit->IP-Advanced* screen (shown in **Figure 6-28**) allows the following to be set up:

- IP buffers used in the process of receiving terrestrial IP packets and transmitting them over satellite. The buffers influence the quality of service with respect to overall packet delay and whether packets are dropped or buffered during periods of congestion.
- DHCP and NAT control, which allow local network devices to be allocated IP addresses from the modem and for those addresses to be hidden behind a single IP address when viewed from the far end of the satellite link.
- Miscellaneous settings used in specific modes of operation, including operation of the 4-port Ethernet switch, internal VLAN tagging inside the modem and point-to-multipoint operation.
- MPEG2 transport stream processing, when using the ASI interface, or IP over DVB (where several MPEG2 transport stream packets are included inside one IP packet).
- Multiple streams, when using DVB-S2 Variable Coding and Modulation (VCM). Two streams are supported (two ASI streams, or one ASI stream plus IP).

Figure 6-28 Edit->IP->Advanced Screen

6.2.3.1   Terrestrial Buffer Size

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 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.

6.2.3.2   Satellite Buffer Size

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 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.**

6.2.3.3   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.

Most buffer management in TCP/IP devices is 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 is 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.

DHCP and NAT

The modem supports the automatic allocation of IP addresses to network devices using DHCP, combined with the ability to hide all of these addresses behind an optional NAT firewall. With DHCP and NAT enabled, this gives the ability for all of the near-side network devices to appear as a single IP address when viewed from the far end of the satellite link.

This is supplemented by the use of a caching DNS proxy server in the modem that can reduce the number of satellite round trips associated with connecting to the actual DNS server.

When DHCP is active, the modem's M&C port has a separate IP address to the modem's IP traffic address. The modem IP traffic address effectively doubles up as the DHCP server address and proxy DNS server address in this situation.

6.2.3.4 Ethernet DHCP Server

This is an On/Off control that enables a DHCP server within the modem. This can be used to serve a configurable range of IP addresses to local network devices, as required.

6.2.3.5 Enable NAT

This is an On/Off control that enables a NAT firewall within the modem. The DHCP server must be enabled before it can be used. The NAT sits between the terrestrial IP traffic port(s) and the satellite port on the modem and converts all local IP addresses as defined by the DHCP server address range to (and from) a single IP address (as defined by the *Traffic IP address*) when viewed from the far end of the satellite link.

The use of NAT is optional but it can only be used when DHCP is also enabled.

6.2.3.6 DHCP Server Start/End Addresses and Traffic IP Address

The DHCP server start and end addresses allow a range of IP addresses to be defined that are managed by the modem. It will allocate these to local network devices when they make DHCP IP address allocation requests to the DHCP server on the modem.

DHCP requests will also result in the *Traffic IP address* being returned as the location of a DNS server. This is actually the address of a proxy DNS server on the modem, as well as being the address of the DHCP server.

6.2.3.7 DNS IP Address

This is the address of an actual DNS server that the modem can use to satisfy any DNS requests that it receives. The modem supports a proxy DNS server (defined by the *Traffic IP address*) and, when DHCP and NAT are enabled, will cache DNS results in order to reduce the number of satellite round trips that are required. The DNS server IP address is normally included as part of the network connection details on Windows PCs.

6.2.3.8 Ethernet Address Learning

By default, Ethernet (or MAC) address learning is not enabled on the modem. This helps to protect against the possibility of traffic storms caused by inadvertent loops in the network.

However, when the 4-port Ethernet expansion switch is fitted to the modem then it is strongly recommended that Ethernet address learning is enabled. If address learning is disabled when the 4-port switch is fitted then traffic sent to one port will also be flooded onto all other ports since the modem will be unaware of which devices are connected to which switch port. While a small amount of flooding is acceptable as a means of automatically detecting and adapting to changes in the network, it is undesirable to do it all the time. This problem does not arise when only a single IP traffic port is available on the modem.

6.2.3.9 Null Packet Insertion

Off	When using the ASI or IP terrestrial interfaces with MPEG2 transport stream packets, any MPEG2 null packets within the incoming terrestrial data stream will be left untouched (and will therefore be transmitted over satellite) when null packet insertion is set to *Off.*
On	When null packet insertion is set to *On*, any MPEG2 null packets within the data stream will be stripped out and discarded. Since null packets contain no useful data then discarding them can save bandwidth.
Strip & Insert	The strip and insert option strips all MPEG2 null packets from the incoming terrestrial data stream. It also inserts MPEG2 null packets into the stream of packets transmitted to satellite in such a way as to match exactly the required transmit symbol rate in the event that there are less packets than required to fill the satellite pipe.

Table 6-64 Null Packet Insertion

6.2.3.10 PCR Restamping

PCR restamping is an On/Off control that controls whether MPEG2 Program Clock Reference (PCR) timestamps in received MPEG2 transport stream packets (via the ASI or IP interfaces) are adjusted for any delay introduced by the modem. By adjusting the timestamps as required, potential jitter in the play out of the packets at the receiver/decoder can be eliminated.

6.2.3.11 MPEG Over IP Type

UDP/TS	This indicates that the MPEG2 transport stream packets are encapsulated into into IP packets using the UDP protocol.
UDP/RTP/TS	This indicates that the MPEG2 transport stream packets are encapsulated into into IP packets using the UDP and RTP protocols.

Table 6-65 MPEG Over IP Type

When sending MPEG2 packets encapsulated inside IP packets, the modem can reduce the satellite transmission overhead by removing the IP headers and sending only the MPEG2 packets. On the receive side, the MPEG2 packets are encapsulated back into IP packets, using IP address and port number information entered by the user. When decapsulating and encapsulating MPEG2 packets, the modem needs to know whether the IP packets contain just UDP headers, or UDP and RTP headers.

6.2.3.12 TS Data Rate and Nominal De-jitter Buffer Delay

These settings control a de-jitter buffer that can be used to remove IP network jitter that may be present in MPEG-over-IP transport streams. De-jittering of multiple concurrent transport streams is supported, regardless of whether the streams have been generated using independent clocks or not (i.e. whether or not the various stream PCR reference clocks are asynchronous with respect to each other).

The *TS data rate* is the MPEG-over-IP transport stream bit rate being input to the modem. A value must be entered in order to use the de-jitter buffer. Note that the normal *Tx data rate* defines the transmit data rate **after** any transport stream rate adaption by the modem.

Setting the de-jitter buffer delay to 0 sets the buffer depth to give maximum resilience to IP network jitter.

Setting the de-jitter buffer larger than necessary will increase packet latency (the buffer can accommodate a maximum of over 1000 MPEG packets). Consequently, if the peak-to-peak IP network jitter is known, latency can be minimised by setting the de-jitter buffer depth to a little over half of the peak-to-peak jitter value. For example, if the TS data rate is 6Mbps (which is 750k bytes per second), the de-jitter buffer latency for a half-full quiescent level will be K * 750e3 = 136.533ms (where K is the de-jitter buffer size, which is (200*1024)/2), enabling the buffer to cope with IP network peak-to-peak jitter in the order of 136.533ms x 2 = 270ms peak-to-peak. The maximum peak-to-peak IP network jitter the de-jitter buffer can cope with falls as TS data rate increases.

The current implementation assumes that the transport stream rate is Constant Bit Rate (CBR). There are two potential ways of configuring the modem when using CBR operation:

1. Prevent any TS rate adaptation by setting the *Tx clock source* to *External*, *Null packet insertion* to *Off* and *PCR restamping* to *Off*, which effectively sets the modulator data rate (*Tx data rate*) to the *TS data rate*. This will minimise the required bandwidth.
2. Perform TS rate adaptation by setting the *Tx clock source* to *Internal*, *Null packet insertion* to *On* and *PCR restamping* to *On.* In this mode the de-jitter buffer is active and will output a transport stream at the *TS data rate*. Following null packet insertion and PCR restamping, the de-jittered stream will be transmitted at the *Tx data rate*.

6.2.3.13 Destination Address and Destination Port

Destination address	When using MPEG2 over IP, the IP packet wrapper is discarded in order to save satellite bandwidth. The user-entered destination address is therefore used on the receive side in order to recreate a copy of the original IP packet.

Destination port	The destination UDP port number is used in a similar way to to the destination address above, when creating a copy of the original IP packet in order to wrapper received MPEG2 packets.

Table 6-66 Destination Address & Destination Port

6.2.3.14 Local Multicast Address and Local Port

Local multicast address	When using MPEG2 over IP, the modem can listen on a local multicast address in order to detect packets to be sent over satellite.
Local port	The local port number is used in conjunction with the local multicast address above in order to fully define the address and port number the modem should listen on for incoming multicast packets.

Table 6-67 Local Multicast Address and Local Port

6.2.3.15 Stream Tx/Rx Terrestrial Interface

Off	When the terrestrial interface is off then then the particular stream is not used.
ASI-1, ASI-2, ASI-3	This takes the stream input from, or directs the stream output to, the specified port on the ASI card.
IP	This takes the stream input from, or directs the stream output to, the IP traffic interface

Table 6-68 Stream Tx/Rx Terrestrial Interface

6.2.3.16 Stream Tx/Rx Identifier

Range:	0 to 25; step size: 1
Description:	In the context of DVB-S2 Variable Coding and Modulation (VCM) used to support multiple streams, the stream identifier corresponds to the DVB-S2 Input Stream Identifier (ISI) used to differentiate each unique stream in order to be able to correlate transmitted and received streams.

Table 6-69 Stream Tx/Rx Identifier

6.2.3.17 Stream Tx Data Rate

Range:	0.2Mbps to 200.0Mbps; step size: 0.000001Mbps
Description:	The stream data rate is the maximum number of data bits that the modem will process in relation to the selected terrestrial interface.

Table 6-70 Stream Tx Data Rate

6.2.3.18 Stream Tx Modulation

Each stream can use any of the supported DVB-S2/S2X modulations listed in **Table 6-71**. (In receive, the modulation type is detected automatically.)

DVB-S2	QPSK: 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 8PSK: 3/5, 2/3, 3/4, 5/6, 8/9, 9/10 16APSK: 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 32APSK: 3/4, 4/5, 5/6, 8/9, 9/10
DVB-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 6-71 Tx Modulation and FEC Code Rates

6.2.3.19 Stream Tx FEC Code Rate

Each stream can use any of the supported DVB-S2/S2X FEC code rates listed in **Table 6-71**. (In receive, the FEC code rate is detected automatically.)

6.2.3.20 Stream 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%.

6.2.3.21 Stream 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 6-72 Stream Tx Frame Size

6.2.3.22 Tx/Rx Symbol Rate

The calculated transmit and receive symbol rates, aggregated for all streams, are displayed in order to allow the user to verify that the streams have been set up correctly.

6.2.3.23 Point-to-multipoint Operation

By default it is assumed that the modem is being used in a point-to-point mode. It is also possible to use the modem as a remote modem in a point-to-multipoint system involving the **Q-MultiFlex™**. The operation of the modem with respect to packet processing is different in each case and therefore it is necessary to explicitly set the required mode.

Point-to-multipoint multistreaming is where the Q-Flex receives a shared outbound consisting of multiple modcods (where each stream in the outbound is using a different modcod from the other streams). For example, one remote may receive 8PSK ¾ while another receives QPSK 9/10 and another receives 16APSK 8/9, all as part of the same shared outbound carrier from the hub. (The shared outbound is partitioned using traffic shaping in the Q-MultiFlex, which allows a number of streams to be created, each associated with a particular modcod.) To demodulate just one of the streams (modcods) in the outbound, the *Point-to-multipoint-multistream* setting is used – see below. The Q-Flex needs to be set to receive the entire outbound carrier (in terms of receive symbol rate) but the normal receive modcod selection should be for just the modcod of the stream that is to be demodulated. In addition, alongside the point-to-multipoint option on the *Edit->IP->Advanced* menu, there is a *Stream identifier* setting, which should be set to the required stream number (as entered via the traffic shaping feature of the Q-MultiFlex that is generating the shared outbound carrier).

Point-to-multipoint operation [Point to multipoint multistrea ∨]   Stream identifier [4]

**Point-to-multipoint Multistreaming (VCM) Operation
showing selection of one stream (modcod) from hub shared outbound**

Point-to-point	The modem is being used in a point-to-point mode involving communication to or from a single other modem.
Point-to-multipoint	The modem is being used as a remote modem in a point-to-multipoint system involving communication to or from a **Q-MultiFlex™** system.
Point-to-multipoint-multistream	The modem is being used as a remote modem in a point-to-multipoint system involving communication to or from a **Q-MultiFlex™** system where the shared outbound consists of multiple modcods (i.e. DVB-S2/S2X VCM mode).

Table 6-73 Point-to-multipoint Operation

6.2.3.24 VLAN Filtering

VLAN filtering is used in point-to-multipoint mode only, in order to ensure that just the relevant packets are processed at each remote site, with all non-relevant packets being discarded. The hub modem will automatically add the appropriate VLAN tags to the packets to to be transmitted to the remote modems. Filtering out irrelevant packets at the remote sites stops them circulating in the wider network and potentially causing packet storms.

When VLAN filtering is disabled, VLAN tags are not generated or removed by the modem. This means that no filtering of traffic based on VLAN ID takes place. Since each remote modem receives the same broadcast traffic, a device such as a router must be present to filter out any traffic that is intended only for the other remote modems.

When VLAN filtering is enabled, each remote modem can be assigned a VLAN ID which is used by the hub to tag each packet destined for any device attached to a network off that particular remote modem. The tags are added at the hub (either by the **Q-MultiFlex™** or a suitably configured Ethernet switch) and removed by the remote modem. The remote modem uses the tag to filter out unwanted data that has been broadcast indiscriminately to all remote modems.

A value must be set for the VLAN IDs of the remote modems. The VLAN ID should be used to uniquely identify each remote modem. It is used to filter the wanted from the unwanted IP packets in point-to-multipoint systems. The VLAN tags are removed by the remote modems prior to onward transmission.

When VLAN filtering is enabled, the remote modem will also automatically receive M&C traffic from the hub **Q-MultiFlex™** on a special VLAN (VLAN 0), when the M&C VLAN setting has been enabled on the **Q-MultiFlex™**. This provides a convenient way of

establishing remote control of the modem from the hub while also allowing the M&C and IP traffic to be on separate networks.

6.2.3.25 Download Root Authority Security Certificate

When using Internet Explorer, it is possible to minimize security alerts related to the download of Java applets used for graphing purposes. This is done be installing a security certificate from the modem onto the browser device using the hyperlink provided at the bottom of the *Edit->IP->Advanced* screen. The procedure is described in Section 6.2.10 (View Screen) under the title 'Minimizing Security Warnings When Viewing Graphs'.

6.2.4   Edit->IP->QoS Screen

Traffic shaping is described in Section 7.8.9.

6.2.5   Edit->IP->Static Routes Screen

The *Edit->IP->Static Routes* screen, shown in **Figure 6-29,** allows up to 16 static routes to be added. (If required, more can be added via command line entry; please contact Customer Support for details.)

Figure 6-29 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.

6.2.6 Edit->IP->Header Compression Routes Screen

The *Edit->IP->Header Compression Routes* screen, shown in **Figure 6-30,** allows up to 16 static routes to be added. (If required, more can be added via command line entry; please contact Customer Support for details.) These determine which packets header compression is applied to. Compression is both transparent and lossless.

	Destination	Subnet mask		
Route 0	192.168.3.0	255.255.255.0	Add	Del
Route 1	192.168.4.0	255.255.255.0	Add	Del
Route 2			Add	Del
Route 3			Add	Del
Route 4			Add	Del
Route 5			Add	Del
Route 6			Add	Del
Route 7			Add	Del
Route 8			Add	Del
Route 9			Add	Del
Route 10			Add	Del
Route 11			Add	Del
Route 12			Add	Del
Route 13			Add	Del
Route 14			Add	Del
Route 15			Add	Del

Tx-Rx | Unit | IP | Paired Carrier | Memories | Redundancy
Advanced | QoS | Static Routes IPv4 | **Header Compression IPv4**

Show Routes   Click to apply routes

Figure 6-30 Edit->IP->Header Compression Routes Screen

Each route consists of a destination IP address and subnet mask. The *Add* and *Del* buttons enable and disable each route, respectively. Note that routes can be applied even when in bridging mode.

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

The *Show Routes* button can be used to confirm the active header compression routes.

6.2.7   Edit->Paired Carrier Screen

The *Edit->Paired Carrier* screen (shown in **Figure 6-31**) is used to set up the Paired Carrier+ function, which allows two carriers to be overlapped in the same space segment.

Figure 6-31   Edit->Paired Carrier Screen

6.2.7.1   Paired Carrier+ Enable

This is an On/Off control that enables and disables Paired Carrier+ operation.

Deployment recommendations for first-time use of Paired Carrier+ are provided in the information box on the next page.

When switched on, the modem expects the received signal to consist of two overlapped carriers utilizing the same space segment. When active, a copy of the modem's transmitted signal will be stored in memory and the Paired Carrier+ signal processing algorithm will attempt to match this with the composite return signal, in order to subtract the unwanted near signal leaving just the far carrier.

Prior to enabling Paired Carrier+ it is necessary to set up the delay to satellite as in the following menu options.

Note that there are no other control settings that are specific to Paired Carrier+ operation – other settings used by the Paired Carrier+ algorithm such as centre frequency and sweep width form part of the normal setup of the modem even for non-overlapped carriers and work in the same way. The cancellation bandwidth itself is automatically deduced by the modem from the larger of the transmit and receive symbol rates and roll-off factors (i.e. occupied bandwidth).

Table 6-73 indicates the circumstances under which modem signal inversions are required in relation to Paired Carrier+ operation.

Paired Carrier Working?	BUC	LNB	Tx Modem Inversion	Rx Modem Inversion
Yes	Non-Inverting	Non-Inverting	No	No
Yes	Non-Inverting	Inverting	No	Yes
Yes	Inverting	Inverting	No	No
No	Inverting	Non-Inverting	N/A	N/A

Table 6-74 Paired Carrier+ Spectral Inversion Control

PLEASE READ THE FOLLOWING INFORMATION FOR FIRST-TIME SETUP OF A PAIRED CARRIER™ LINK.

In relation to Paired Carrier+, generally there are no restrictions on how the overlapped carriers are brought up and the satellite link is established. However, the following guidelines may be useful in proving correct **Paired** Carrier**+** operation as part of the overall initial link deployment process. Once correct operation is established then Paired Carrier+ can be switched on and off or reconfigured just like any other modem feature.

You must get each link working correctly as a normal link prior to switching Paired Carrier+ on! You must ensure that there is no spectral inversion in the RF chain – if there is then this must be corrected by re-inverting it for Paired Carrier+ operation to work – see the above table.

1. Ensure Paired Carrier+ is switched off (via the *Paired Carrier enable* setting on the *Edit->Paired Carrier* menu).
2. Before starting, it is strongly recommended to prepare for a BER data transparency test, using data test sets connected to each modem, or using the modem internal PRBS BER test feature, which can be temporarily enabled if necessary.
3. Configure both modems for identical services, including the same Tx and Rx frequencies.

Different PRBS test patterns must be used in each direction (e.g. for Modem 1 Tx to Modem 2 Rx use 2^15-1 and for Modem 2 Tx to Modem 1 Rx use 2^23-1). This ensures that the two signals are sufficiently different from each other to allow Paired Carrier+ to work.

4. Check the Tx power level setting is correct and bring up the first carrier (using the selected common transmission frequency) and
   • Check the receive signal level, Eb/No, spectrum and constellation are as expected.
   • Check the received signal is data transparent.
5. Switch the first carrier off.
6. Check the Tx power level setting is correct and bring up the second carrier (using the selected common transmission frequency) and
   • Check the receive signal level, Eb/No, spectrum and constellation are as expected.
   • Check the received signal is data transparent.

7. Switch the second carrier off.

To avoid non-linear distortion, ensure adequate HPA back-off when using multiple carriers through a single amplifier, particularly with higher order modulations when testing at a single site.

8. At each modem, set either location information or, alternatively, the round trip delay to satellite (via the *Round-trip delay* setting on the *Edit->Paired Carrier* menu). If location information is entered for the modem position then the satellite delay will be calculated automatically. To minimise acquisition time when using a round trip delay, the delay should be specified to within ±1ms of the nominal value that you have calculated.
9. Enable the Tx carrier in the first modem. Both demodulators should lock (Rx traffic LED should go green).
10. Enable the Tx carrier in the second modem. Both demodulators should go out of lock (Rx traffic LED should go out). Please note: the combined carrier power will increase by 3dB when the second carrier is enabled.
11. Enable Paired Carrier+ in the first modem (via the *Paired Carrier enable* setting on the *Edit->Paired Carrier* menu). Its demodulator should lock (Rx traffic LED should go green).
12. Enable Paired Carrier+ in the second modem (via the *Paired Carrier enable* setting on the *Edit->Paired Carrier* menu). Its demodulator should also lock (Rx traffic LED should go green).
13. Enable the BER test and check for data transparency in both directions. Inject errors via the BER testers in both directions and ensure they are received correctly.
14. If the modems do not lock or are not data transparent then
    - Ensure there is no spectral inversion in the RF chain. If there is, then this must be corrected by re-inverting it for Paired Carrier+ operation to work.
    - Check the modem/satellite location information or round trip time that has been set in each modem. The range entered for the round trip time must cover the actual distance to the satellite. Try widening out the round trip delay to ensure that it definitely covers the actual time delay to satellite. Try switching from location to round trip delay or vice versa.
    - Switch Paired Carrier+ off and on again in each modem (to counter the possibility of a false lock).
    - If this does not work then switch the carrier off and on again in each modem.
    - Check the receive signal level and Eb/No are correct.
    - Check the spectrum and constellation for signs of signal degradation such as noise or interference.
    - Otherwise check the general modem settings for correct configuration and overlap of the two carriers (note that there are restrictions on the supported level of power asymmetry and symbol rate asymmetry).
15. If the modems take a long time to lock then
    - Narrow the difference between the minimum and maximum round trip delay times (if these are being used) to minimise the

uncertainty in the range to the satellite (via the *Round-trip delay* setting on the *Edit->Paired Carrier* menu). This has a significant effect on acquisition time. If using a round trip delay then try switching to using location information.

- Reduce the sweep width (via the *Sweep width* setting on the *Edit->Tx-Rx->Advanced* menu) as this may significantly speed up the acquisition process.

- Check for signs of signal degradation such as poor Eb/No values or poor spectrum and constellation.

16. If 1:1 or 1:N redundancy is being used, Paradise recommends setting the modems to switch on Unit Faults only (i.e. setting the Tx and Rx fail switchovers off via the *Edit->Redundancy* menu option). This is because when a modem is in standby, no transmit carrier is generated, therefore there is nothing for Paired Carrier+ to cancel and the standby demodulator will not lock because it cannot separate the two interfering carriers (from the online modem and the remote modem). In this case, a switchover from the online modem can never occur since the standby modem is, from a logical point of view, faulty and a switchover will not occur to a standby modem deemed faulty. Please refer to application note AN_027A (1:1 quick start guide) for further details.

17. When using *Paired Carrier* with IP as the terrestrial interface type, Paradise recommends setting the master hub transmit timing to *Internal*, the hub and remote receive clocking to *Satellite* and the remote transmit clocking to *Rx reference*. This ensures only one master clock is providing timing for both modems and can prevent data pattern clashes (between the two overlapping carriers caused by similarities in the satellite framing) that otherwise can degrade Paired Carrier+ performance.

6.2.7.2 Round-trip Delay

The modem needs to know the delay to the satellite in order for Paired Carrier+ to work. Several methods of calculating the round-trip delay are supported, as listed in **Table 6-75**.

Set location	In this mode the modem automatically calculates the satellite round trip delay using coordinates that you enter for the modem and satellite positions.
Set delay	This mode uses user-entered minimum and maximum satellite round-trip delay times and searches for the satellite 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->Paired Carrier* 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/Longtitude (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 6-75 Round-trip Delay

6.2.7.3 Satellite Longitude

Range:	-180 Degrees to +180 Degrees ; step size: 0.01 Degrees
Description:	The longitudinal position of the satellite. If using the modem front panel then the *Up* and *Down* arrow keys are used for setting '+' and '-', respectively.

Table 6-76 Satellite Longitude

6.2.7.4 Earth Station Longitude

Range:	-180 Degrees to +180 Degrees ; step size: 0.01 Degrees
Description:	The longitudinal position corresponding to the modem location. If using the modem front panel then the *Up* and *Down* arrow keys are used for setting '+' and '-', respectively.

Table 6-77 Earth Station Longitude

6.2.7.5 Earth Station Latitude

Range:	-90 Degrees to +90 Degrees ; step size: 0.01 Degrees
Description:	The latitudinal position corresponding to the modem location. If using the modem front panel then the *Up* and *Down* arrow keys are used for setting '+' and '-', respectively.

Table 6-78 Earth Station Latitude

6.2.7.6 Calculated Satellite Delay

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, with any significant difference in these two values potentially indicating a false lock.

6.2.7.7   Minimum Round-trip Delay

Range:	0.01ms to 400ms ; step size: 0.01ms
Description:	The minimum satellite round-trip delay. To minimize the Paired Carrier+ acquisition time, set this to the actual measured satellite delay value (shown on the *Status->PCMA* screen) **minus 0.5ms**.

Table 6-79 Minimum Round-trip Delay

6.2.7.8   Maximum Round-trip Delay

Range:	0.01ms to 400ms ; step size: 0.01ms
Description:	The maximum satellite round-trip delay. To minimize the Paired Carrier+ acquisition time, set this to the actual measured satellite delay value (shown on the *Status->PCMA* screen) **plus 0.5ms**.

Table 6-80 Maximum Round-trip Delay

6.2.8   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 equivalent to allow configurations to be shared between different modems.

The following operations can be performed on configuration memories:

- *Store.* This allows the current M&C configuration to be stored to a named configuration memory for later use. Up to 20 configuration memories can be created (more may be stored if memory allows). The memories are non-volatile and will persist between successive power-ups of the modem. 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.
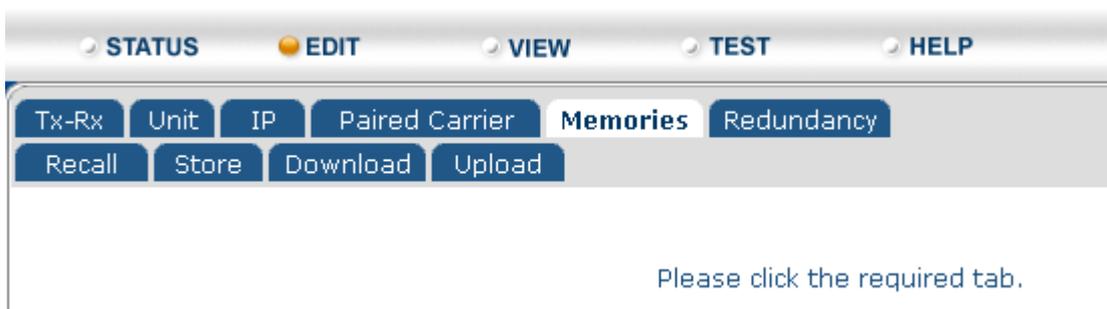
Figure 6-32 Edit->Memories Screen

6.2.8.1   Edit->Memories->Recall Screen

The *Edit->Memories->Recall* screen (shown in **Figure 6-33**) 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.
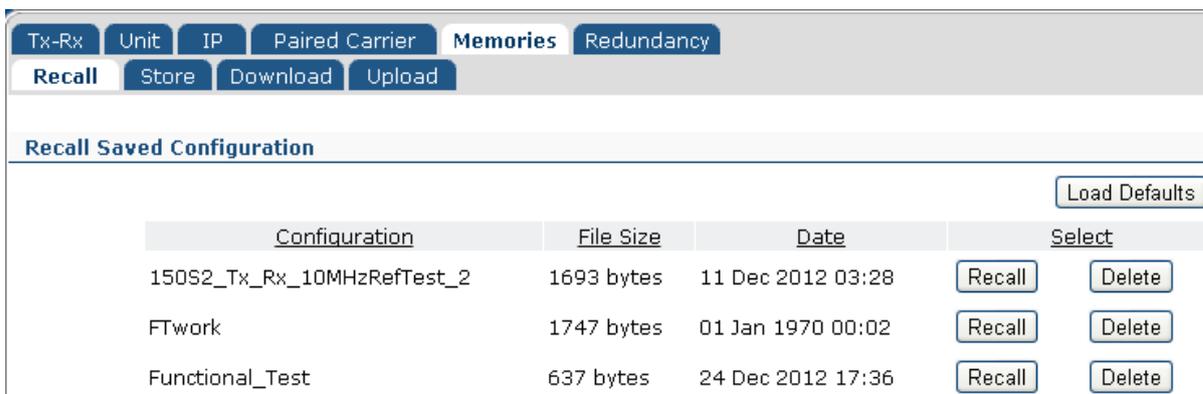
Figure 6-33 Edit->Memories->Recall Screen

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

The *Edit->Memories->Recall->Advanced* screen (shown in **Figure 6-34**) supports a method for recovering a remote modem from a failure during a change to the modem's configuration. In essence, this 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.
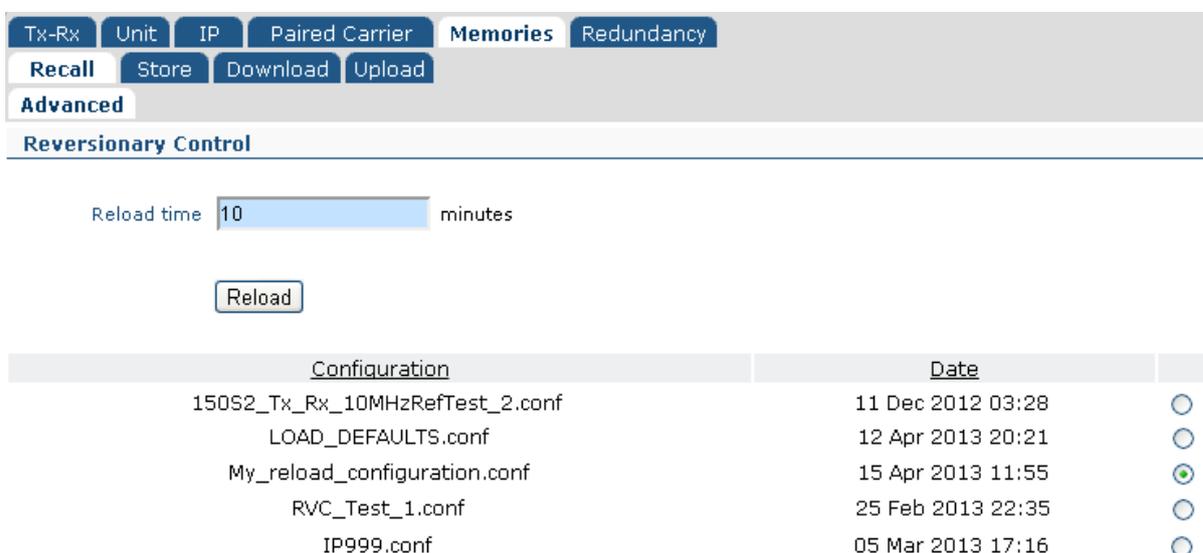
Figure 6-34 Edit->Memories->Advanced Reversionary Control Screen

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 6-35**, 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 6-34**.

Figure 6-35 Edit->Memories->Advanced Reversionary Control Screen (Active state)

6.2.8.3 Edit->Memories->Store Screen

The *Edit->Memories->Store* screen (shown in **Figure 6-36**) allows the current modem configuration to be stored to a configuration memoriy under a given name. It also displays all of the configurations that are already stored on the modem. The *Delete* button can be used to delete a specific configuration memory.
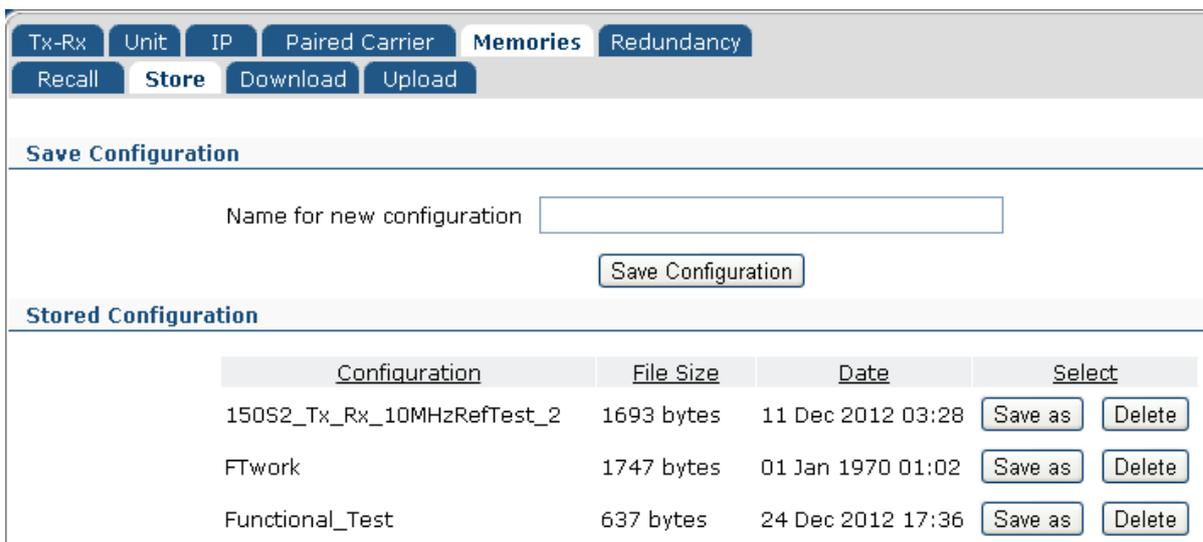
Figure 6-36 Edit->Memories->Store Screen

6.2.8.4 Edit->Memories->Download Screen

The *Edit->Memories->Download* screen (shown in **Figure 6-37**) 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).
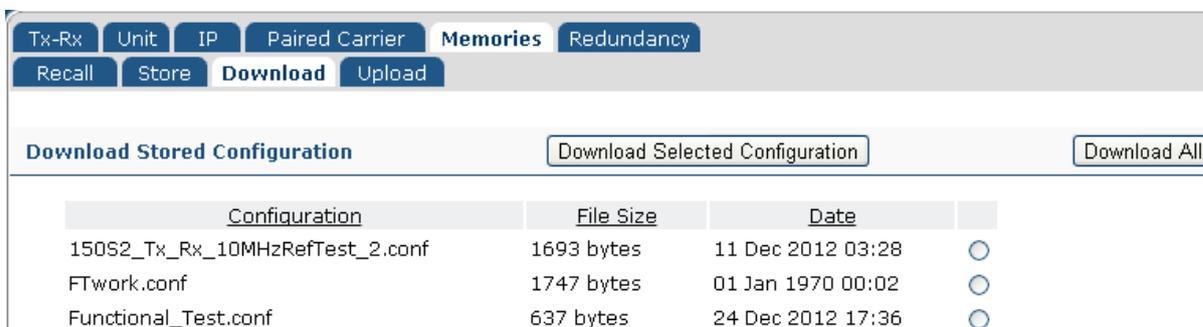
Figure 6-37 Edit->Memories->Download Screen

6.2.8.5 Edit->Memories->Upload Screen

The *Edit->Memories->Upload* screen (shown in **Figure 6-38**) allows the user to browse to a location on their browser device where they have a configuration memory 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.
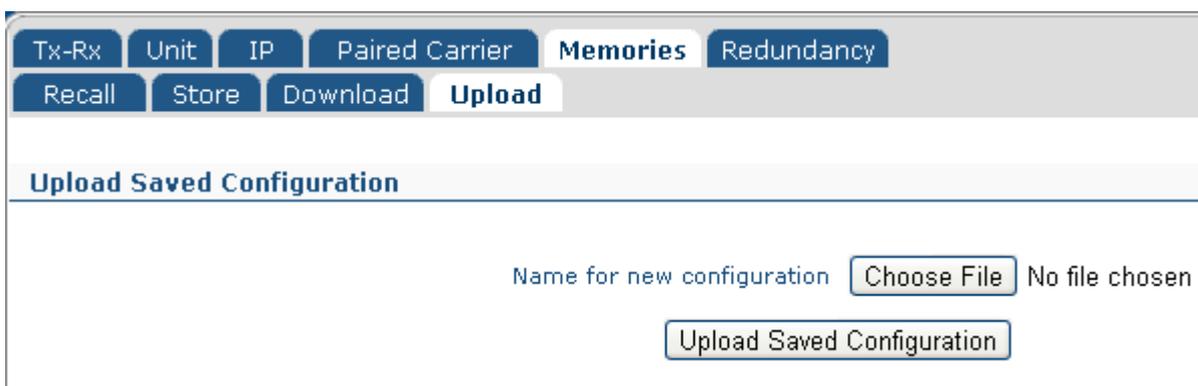
Figure 6-38 Edit->Memories->Upload Screen

6.2.9   Edit->Redundancy Screen

The *Edit->Redundancy->1-for-1* screen (shown in **Figure 6-39**) controls the operation of the modem when in a 1:1 redundancy configuration.

The *Edit->Redundancy->1-for-N* screen and 1:N redundancy in general is documented separately in '*Installation and Operating Handbook for Quantum, Evolution and Q Series Satellite Redundancy Switches',* which is available for download from http://www.paradisedata.com.
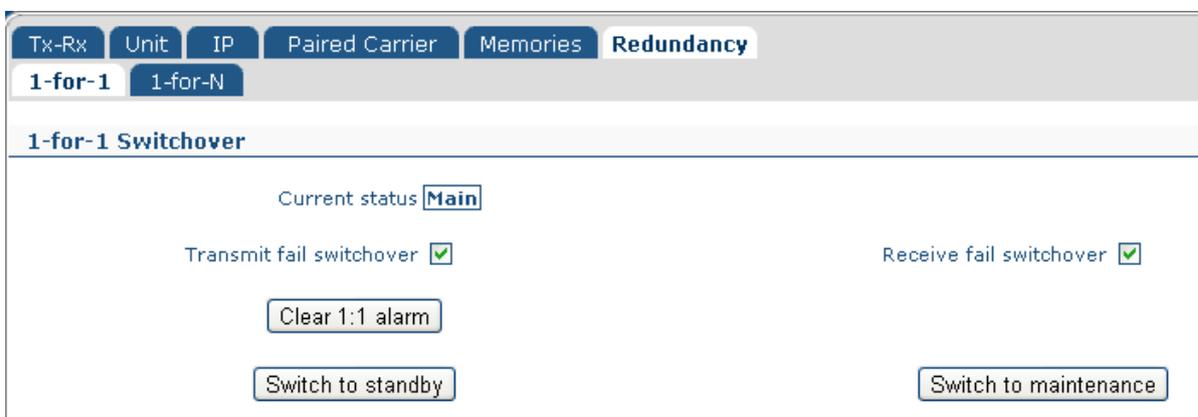
Figure 6-39 Edit->Redundancy->1-for-1 Screen

The *Current 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. Ticking 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.

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.

6.2.1   ClearLinQ™ Tx Adaptive Predistorter Screens

ClearLinQ™ is a Tx adaptive predistorter that corrects for non-linear (and to a lesser extent linear) distortion in the RF chain. It is applicable to all FECs and modulations including DVB-S2X, FastLink™ and TPC (with the exception of the *low-cost* DVB-S2 option).

The predistorter compensates for non-linear AM-AM, AM-PM and memory effects associated with an up-link HPA or satellite transponder (or both). The compensation characteristic is acquired via a closed loop with the local receive demodulator. Transmit charactersitsics are tuned adaptively in order to minimise the receive constellation error (Error Vector Magnitude (EVM)). This avoids the need to input into the modem the AM-AM or AM-PM characteristics associated with the non-linearity but does mean that the modem must go through a one-time 'learning' process with respect to the particular operational conditions. If the RF operating conditions change in any significant way (including any change to the modulation type, Tx power level, etc.) the learning process must be repeated. Once learning is completed then it is necessary only to switch predistortion on. 1dB to 2dB of compensation for distortion is achievable.

The predistorter can only compensate for distortions in the signal that it is responsible for generating. For this reason, this feature can only be used if the HPA is being used to generate a single carrier. The transponder itself can be multi-carrier if the compensation is aimed at removing just the effects of the HPA. Additional compensation for distortion in the transponder is recommended only for single-carrier-per-transponder usage. The learning process should therefore involve either a short loop around the HPA or a long loop around the transponder to reflect which of these two types of compensation is required.

Figure 6-40 shows the *Control* screen for predistortion. This initially has just an *Enable* button. This is used to control whether Tx adaptive predistortion is active in the modem or not.

When enabled, the *Adapt* button becomes visible. With Tx looped to Rx through the HPA (and potentially the transponder as well), the *Adapt* button should be pressed in order to go through the one-time learning process that determines the required compensation characteristics.

Figure 6-40 Edit->Tx Predistorter Screen

During the learning process a screen similar to **Figure 6-41** will be displayed.

Figure 6-41 Edit->Tx Predistorter Screen (during the learning process)

On completion of the learning process, which may take a couple of minutes, a screen similar to **Figure 6-42** will be displayed.
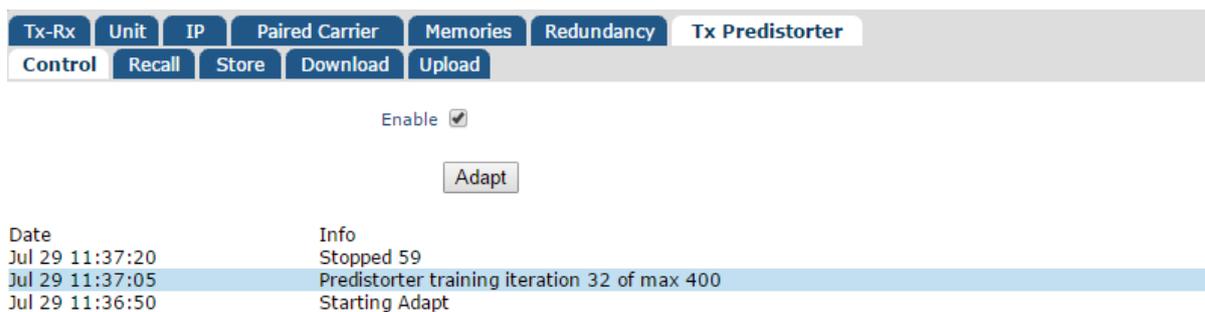
Figure 6-42 Edit->Tx Predistorter Screen (on completion of the learning process)

When the learning process indicates that it has stopped (indicated by 'Stopped' followed by an arbitrary number representing the number of iterations required to converge to the final compensation data) then the *Store* screen shown in **Figure 6-43** should be selected in order to store the predistortion compensation data to a file in the modem for subsequent use (without this step the data will be lost when the modem is next powered down).
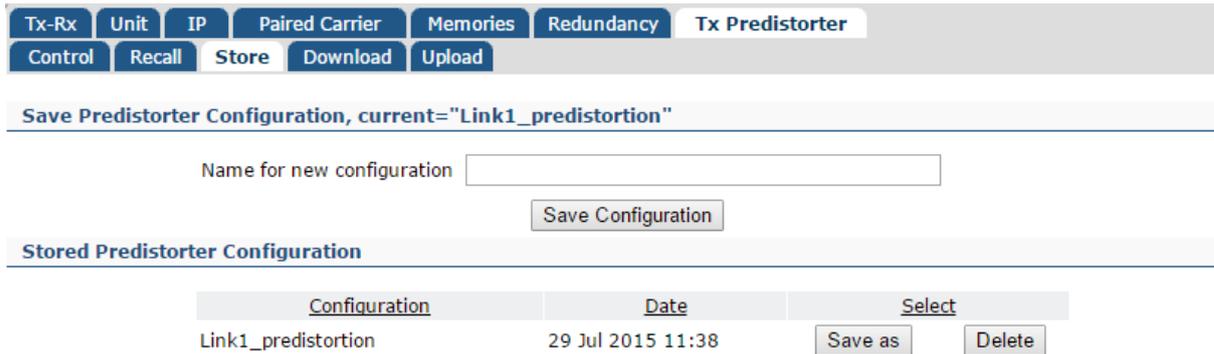
Figure 6-43 Edit->Tx Predistorter Store Screen

The learning process can be repeated as many times as necessary for distinct modem and HPA operating conditions (e.g. for different modulations and HPA power levels) and the results stored to individual files. Having sets of predefined compensation data allows planned changes to link operation to be carried out with the minimum of interruption.

The *Recall* screen shown in **Figure 6-44** should be used to recall the relevant predistortion compensation data when the modem or HPA operating parameters are subsequently changed.

Figure 6-44 Edit->Tx Predistorter Recall Screen

Download and *Upload* screens (not shown) allow the predistortion compensation data to be stored on a network device and then loaded into another modem (for example, a replacement modem) when required.

6.2.2   View Screen

The *View* screen (shown in **Figure 6-45**) allows the following to be viewed:

- *Graphs*. These include spectrum, constellation, throughput and time-based performance graphs. None of these interfere with the service being provided by the modem. (Note that from software version V3.0.90, the Java Runtime Environment is no longer needed in order to view graphs.)
- *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 noteable 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.

Graphs	Alarms	Log	Setup	Unit	SAF
Spectrum	Constellation		IP	Others	

Please click the required graph tab.

Figure 6-45 View Screen

Viewing Graphs

From software version V3.0.90 onwards, the modem web graphs no longer require the Java Runtime Environment (JRE) to be installed on the browser device. The replacement form of web graphs does not require any special software to be downloaded to the browser device. If Java is causing web browser security violations then is is recommended that the modem software is upgraded to a non-Java version. Alternatively, please contact Paradise Technical Support for details of Java workarounds that allow Java to continue to be used.

6.2.2.1 Rx Spectrum Monitor

The Rx Spectrum Monitor shown in **Figure 6-46** is a powerful real-time spectrum analyser within the modem that is used to view the received signal spectrum.

The spectrum monitor can also be used in a satellite beacon receiver mode as described in Section 7-12.
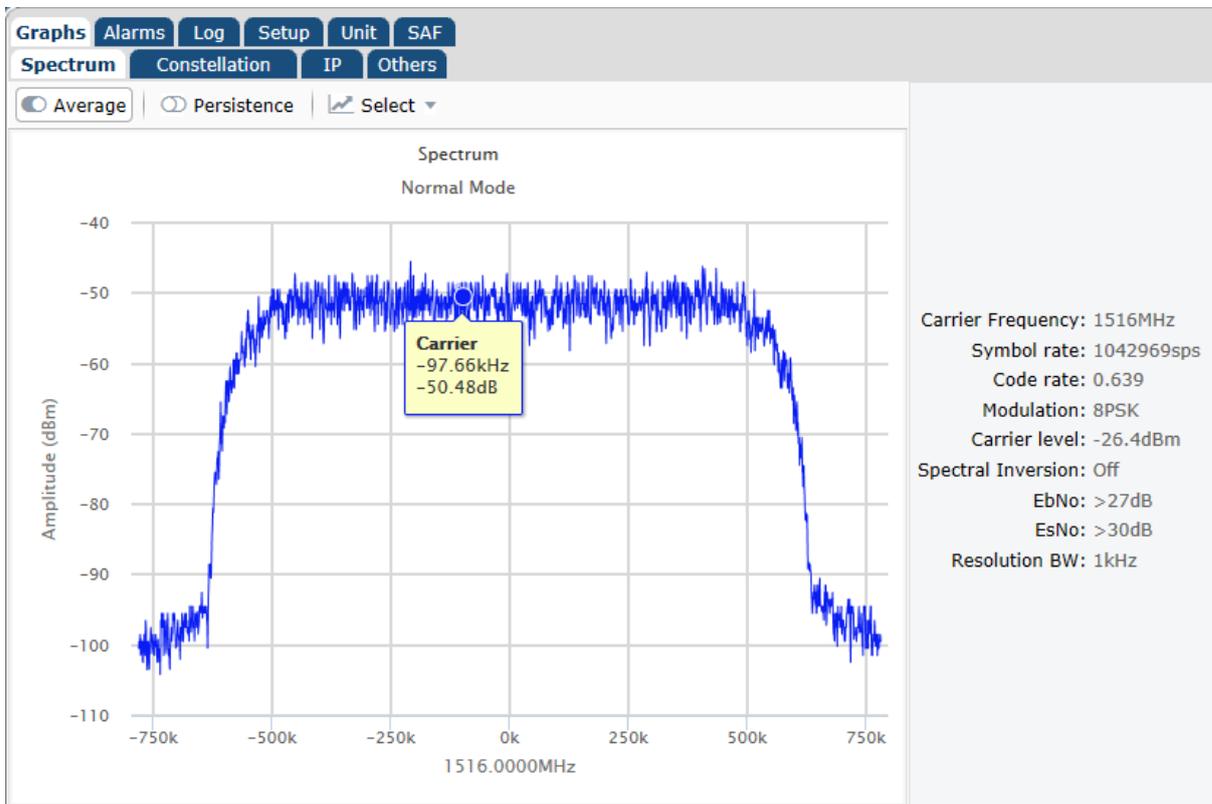
Figure 6-46 Rx Spectrum Monitor

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

The *Span* can be set to *Normal*, which limits the frequency span to that of the carrier, or *Super Wide*, which displays a frequency span of +/-25MHz centred on the carrier's centre frequency. *Super Wide* is useful for checking for adjacent interfering carriers.

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 acts as an on/off toggle.

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

LinkGuard™ is patented technology that monitors underneath the received carrier for any interference, while on traffic. It is viewed using the Rx Spectrum Monitor screen shown in **Figure 6-47** (using the Select button to select it). **LinkGuard™** is explained in Section 7.6.
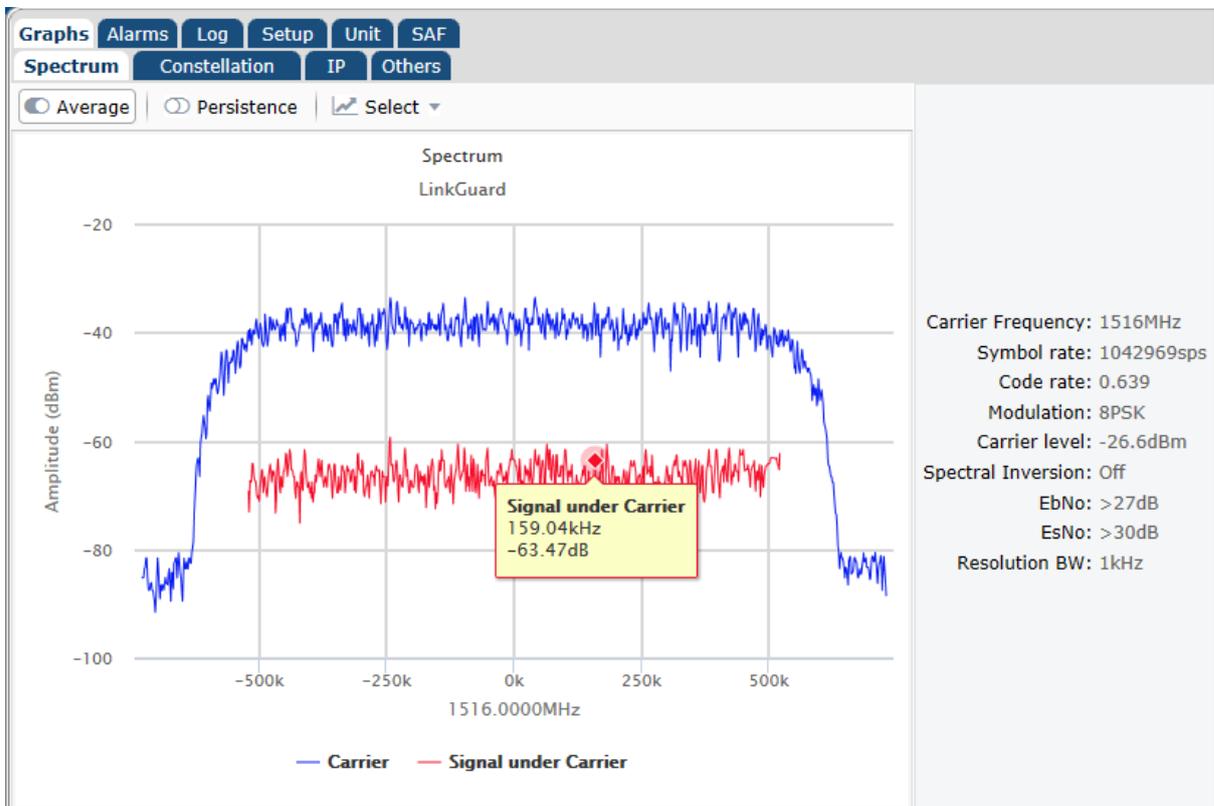
Figure 6-47 LinkGuard™ Signal-Under-Carrier Spectrum Monitor

6.2.2.2 Rx Constellaton Monitor

The Rx Constellation Monitor feature shown in **Figure 6-48** allows the modem to be used as a spectrum analyser to view the received signal spectrum.
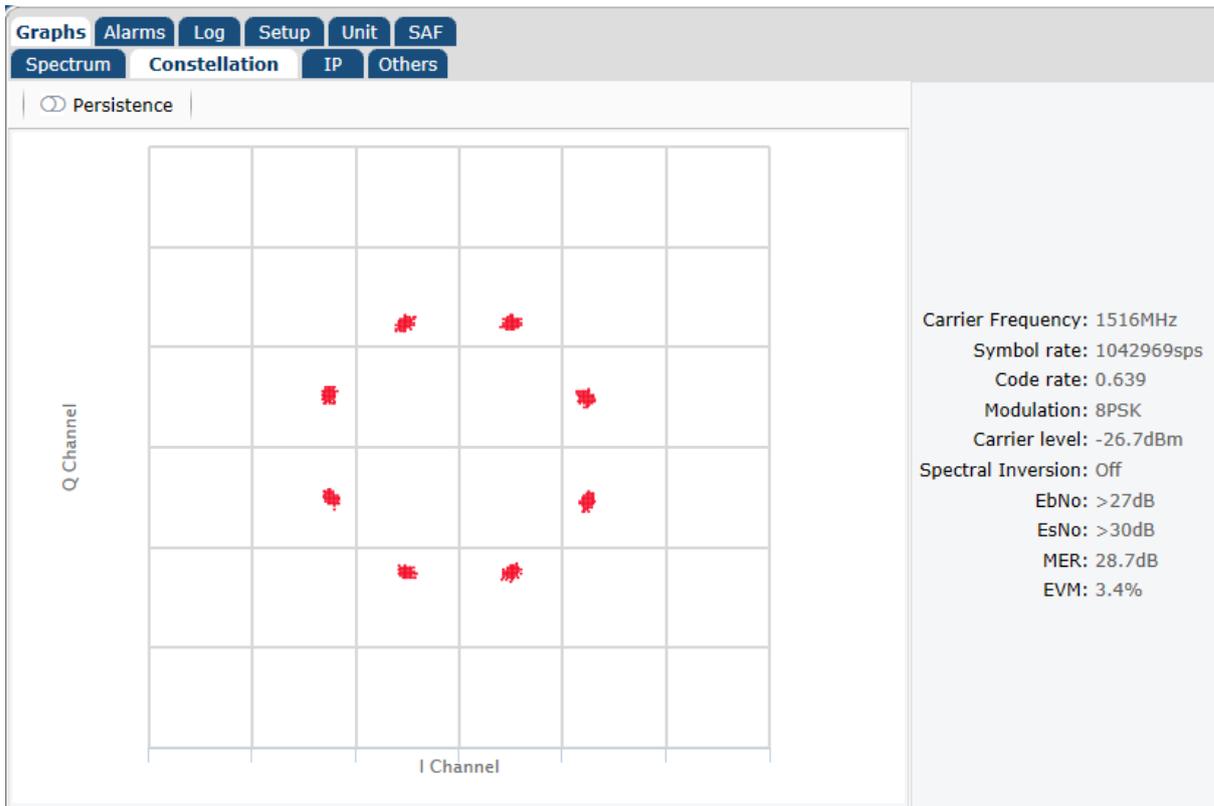
Figure 6-48 Rx Constellation Monitor

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 panel.

⚠️   ***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.

Modulation error = Transmitted symbol – Target symbol
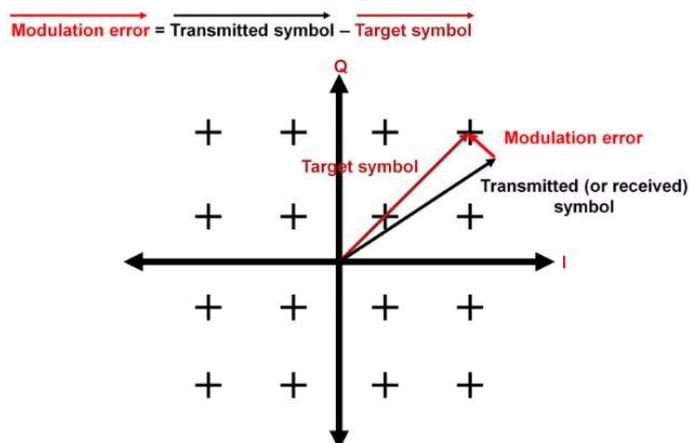
They are defined as follows:

- *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:

Spectral inversion : Off
Carrier frequency : 1129.9149MHz
Carrier level : -59.3dBm
Symbol rate : 2.1Msps
Modulation : 8QAM
Code rate : 0.778
Es/No : 22.3dB
MER : 26.3dB
EVM : 3.4%
Eb/No : 18.6dB

21 April 2015
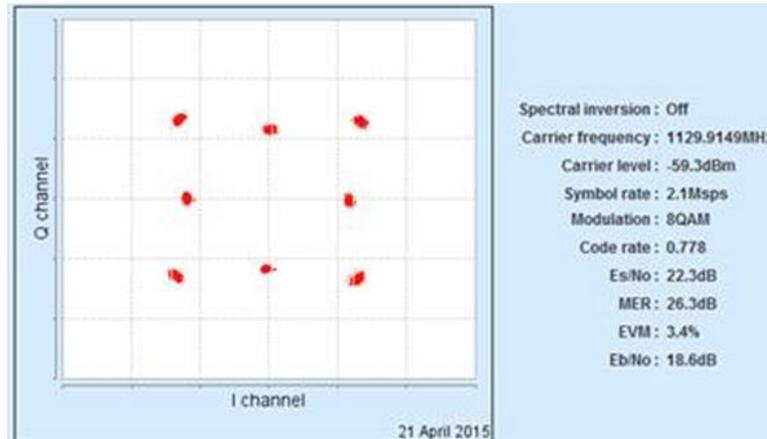
where MER=26.3dB and EVM=3.4%.

The following is an example of a poor signal:

Spectral inversion : Off
Carrier frequency : 1129.9149MHz
Carrier level : -59.8dBm
Symbol rate : 2.1Msps
Modulation : 8QAM
Code rate : 0.778
Es/No : 22.3dB
MER : 23.0dB
EVM : 7.0%
Eb/No : 18.6dB

21 April 2015
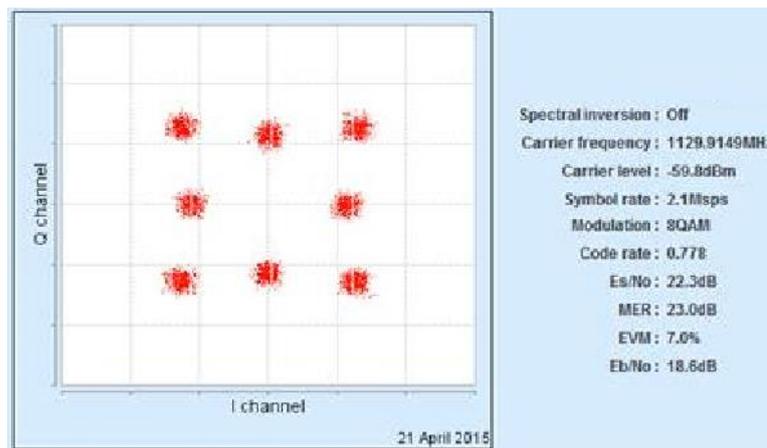
where MER=23.0dB and EVM=7.0%.

6.2.2.3 IP Graphs

Figure 6-49 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 day and 30 day time periods.

It is also possible to view the throughput associated with each individual traffic stream as classified by the traffic shaping feature.
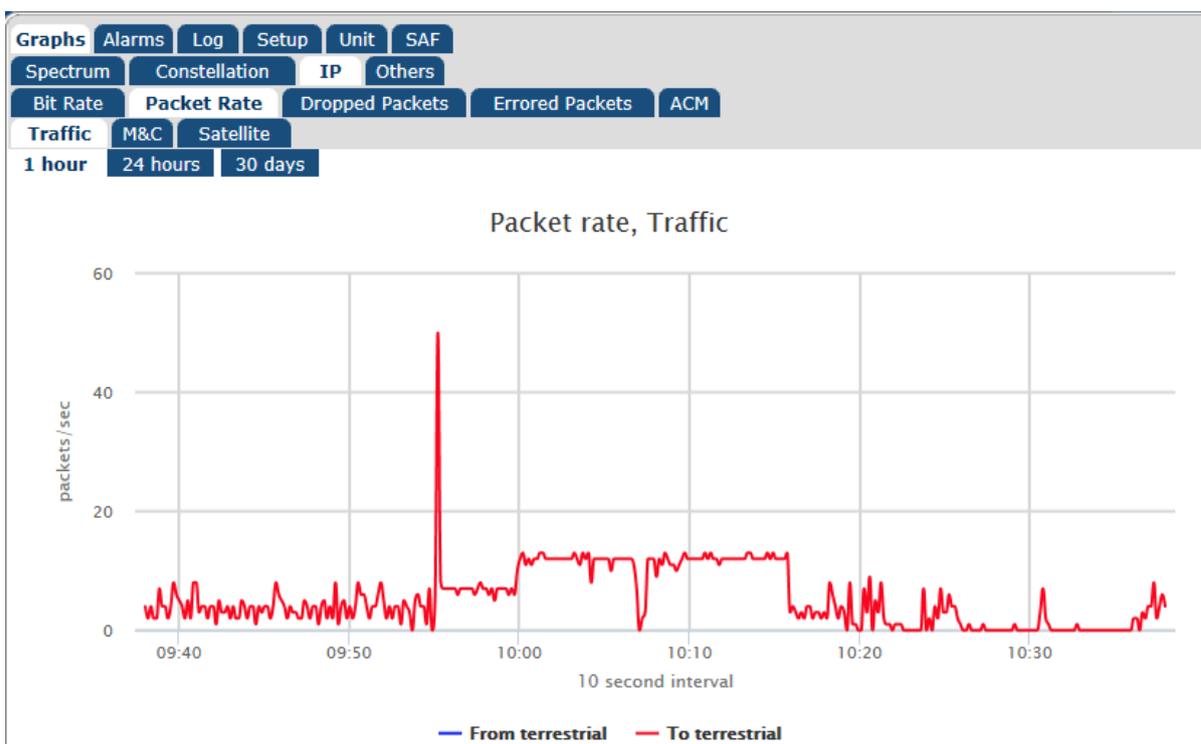
Figure 6-49 IP Throughput Graph

QoS (traffic shaping) graphs are described in Section 7.8.9.

An example ACM graph is shown in **Figure 6-50**. 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.

An example of the ACM graph viewed over a shorter time period is shown in **Figure 6-51**.

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 (see Section 6.2.2.7).
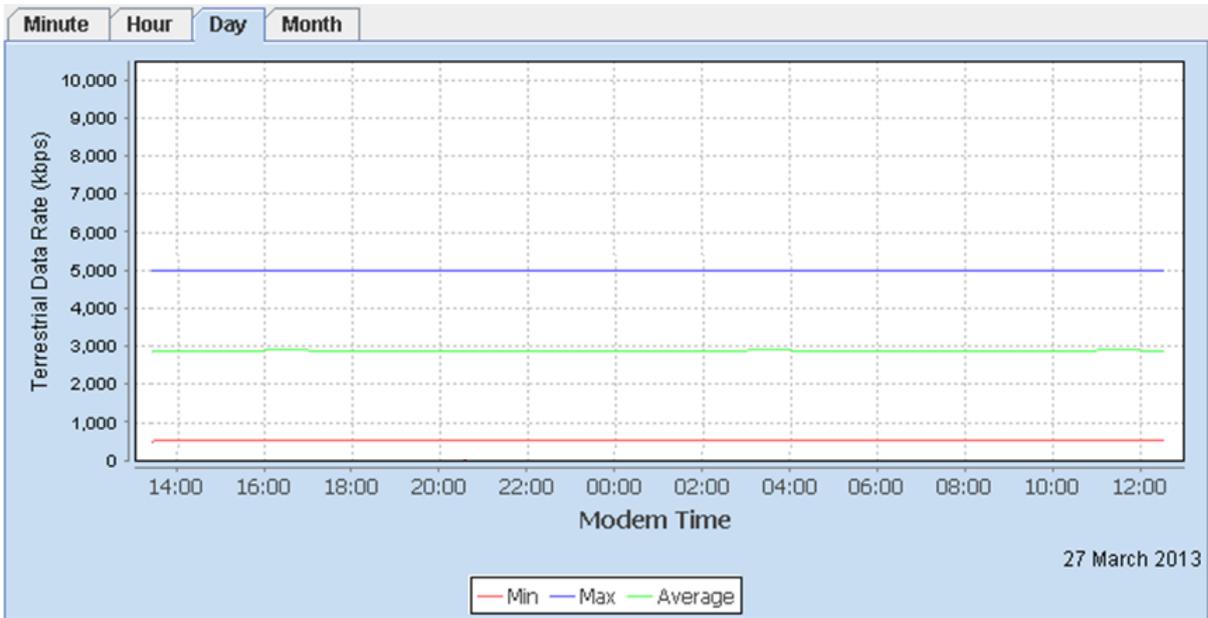
Figure 6-50 ACM Terrestrial Data Rate Graph
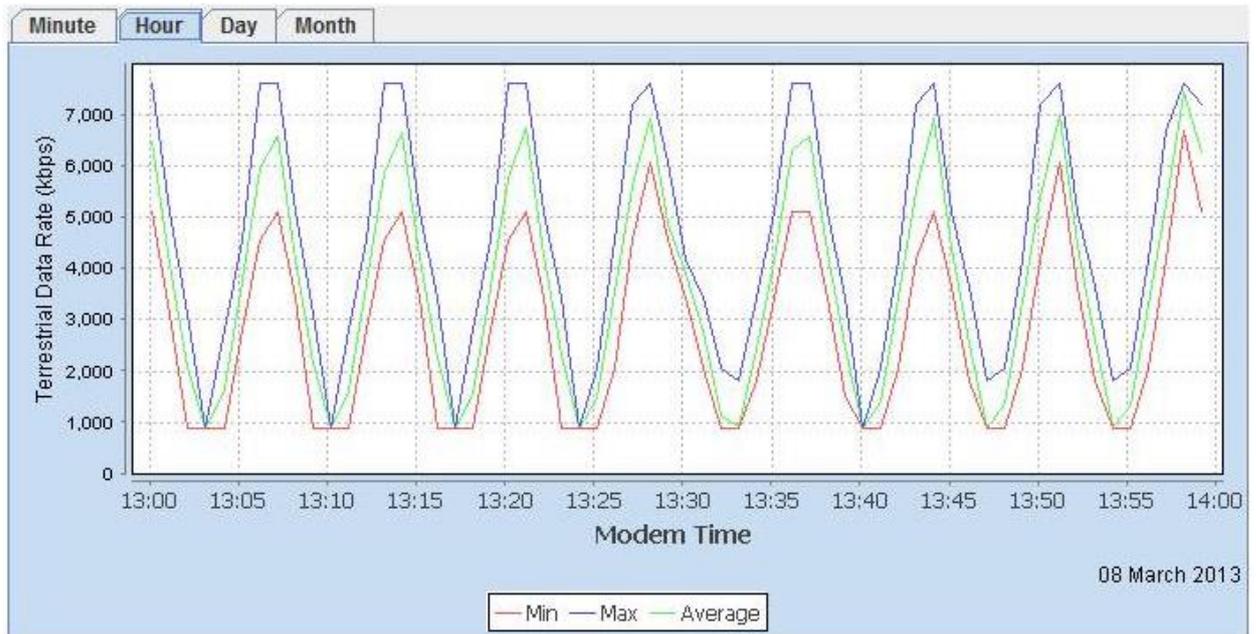
Figure 6-51 ACM Terrestrial Data Rate Graph (Short time period)

6.2.2.4   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.
- The modem received power level.
- Receive frequency offset from centre frequency.
- **LinkGuard™** interference power spectral density.
- The Eb/No of the distant modem being controlled via AUPC.
- The transmit power level while under AUPC control.
- CPU usage.
- ACM data rate.

An example graph is shown in **Figure 6-52**.
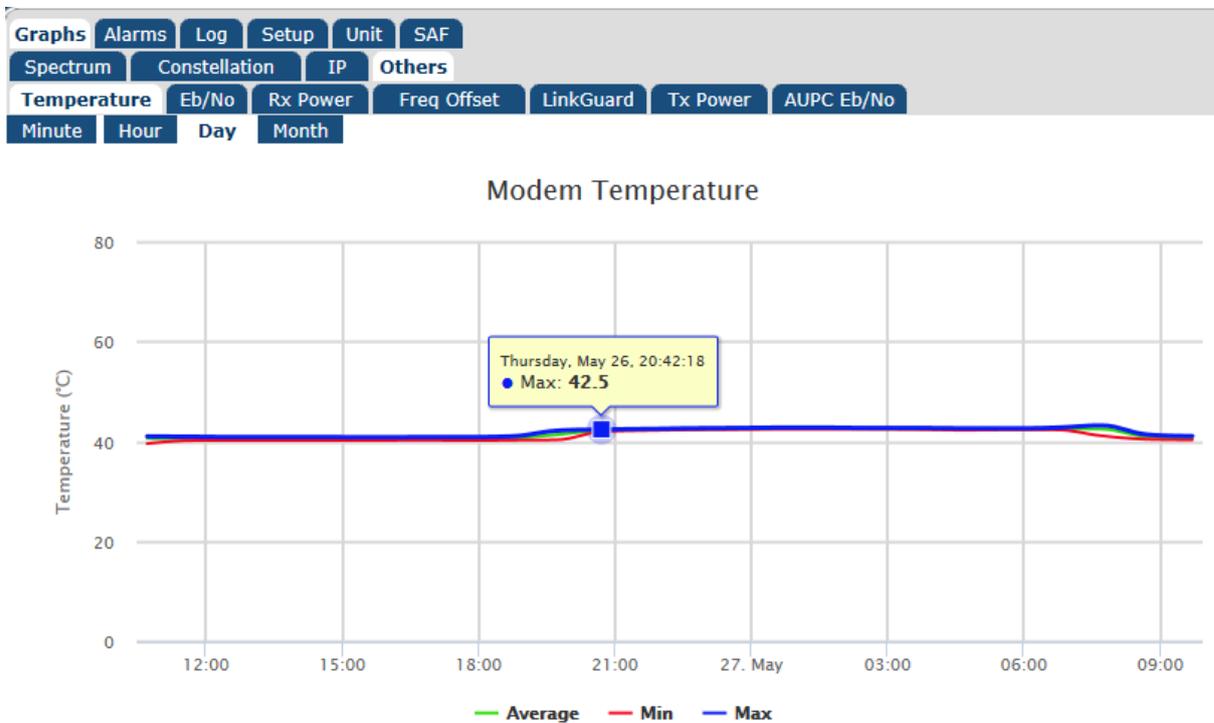
Figure 6-52 Temperature Graph

6.2.2.5 Alarms

System alarms can be viewed using the *View->Alarms* screen shown in **Figure 6-53**. 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 of the alarms after which the web page will automatically update and show details of any alarms that are still active.
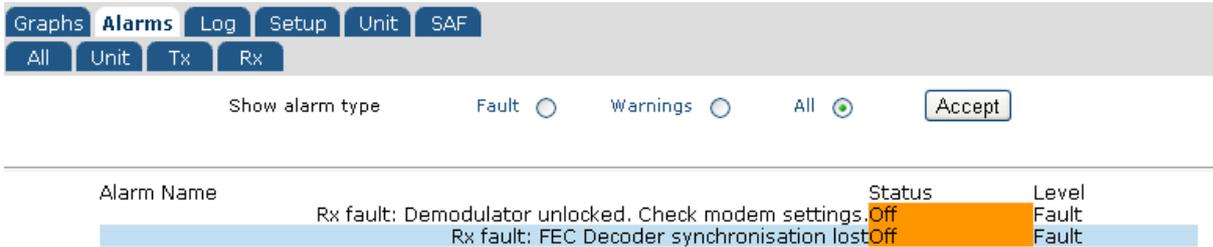
Figure 6-53 System Alarms Screen

6.2.2.6 System Log

The system log can be viewed using the *View->Log* screen shown in **Figure 6-54**. The *Clearc* 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.
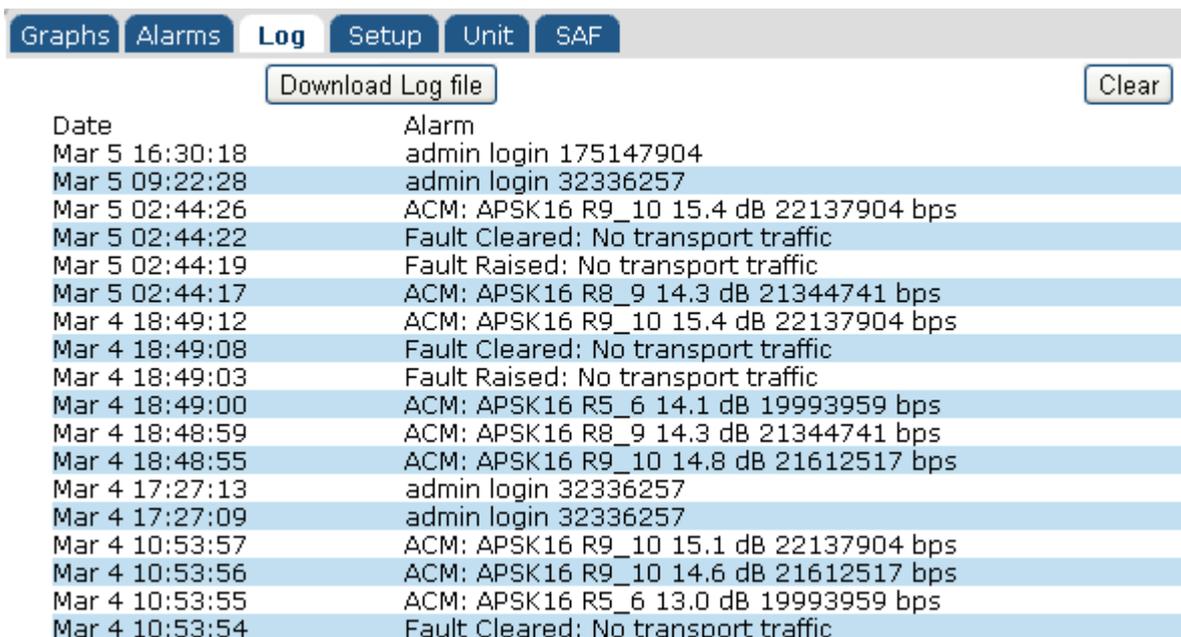
Figure 6-54 System Log Screen

6.2.2.7 View->Setup Screen

The *View->Setup* screen shown in **Figure 6-55** displays the current values of the most important configuration settings.
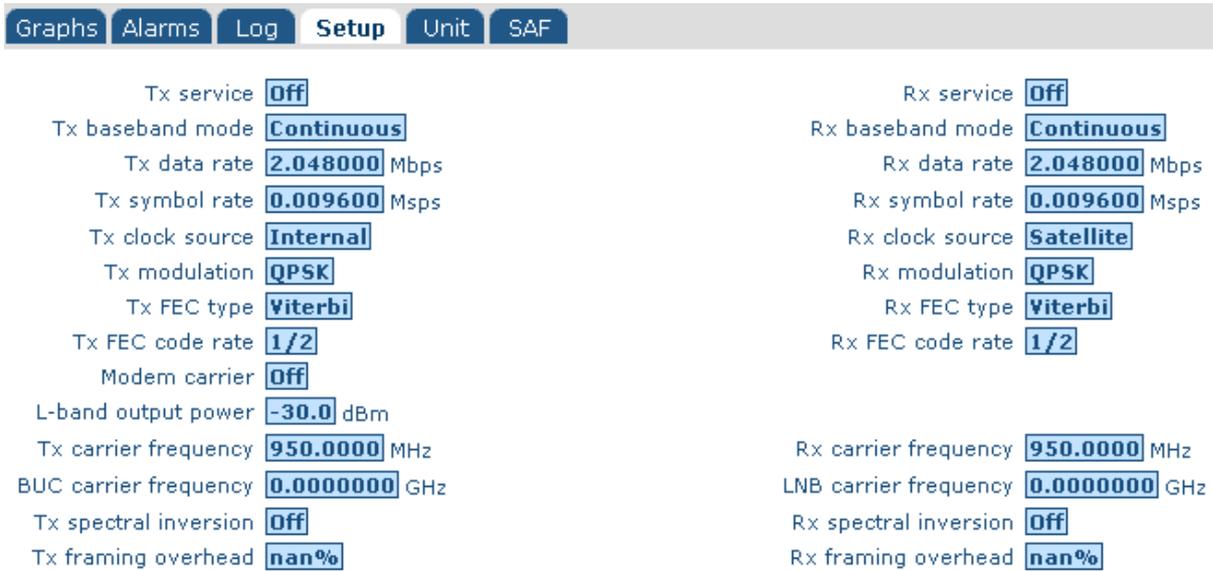
Figure 6-55 View->Setup Screen

6.2.2.8 View->Unit Screen

The *View->Unit* screen shown in **Figure 6-56** displays 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).
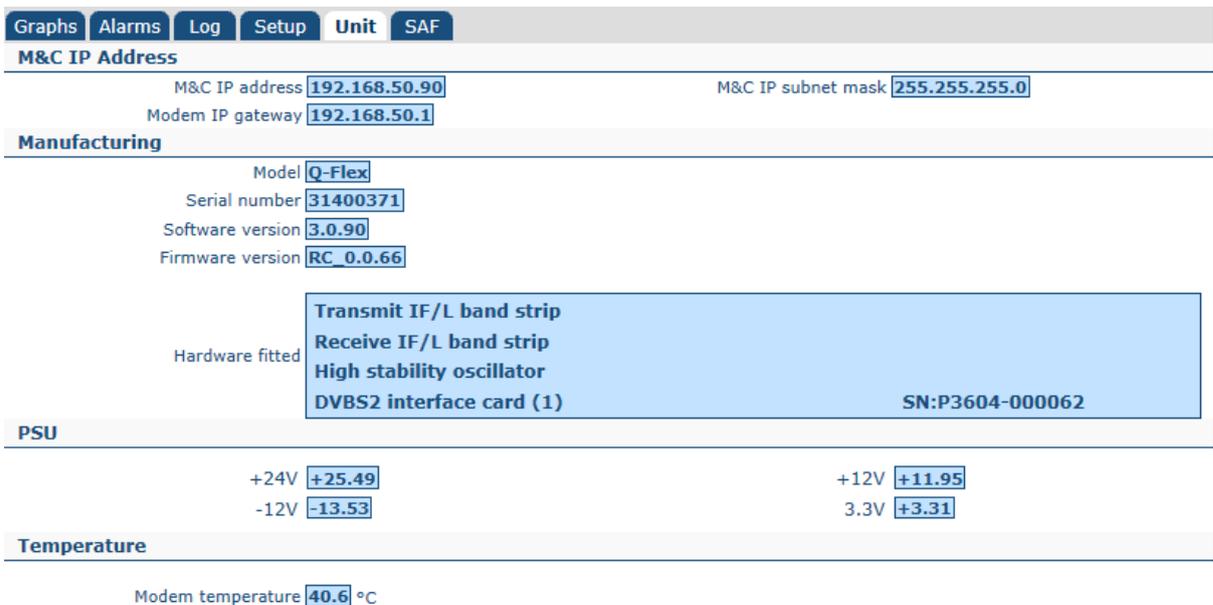
Figure 6-56 View->Unit Screen

6.2.2.9 View->SAF Screen

The *View->SAF* screen shown in **Figure 6-57** 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. The SAF concept is explained in Section 7.4.
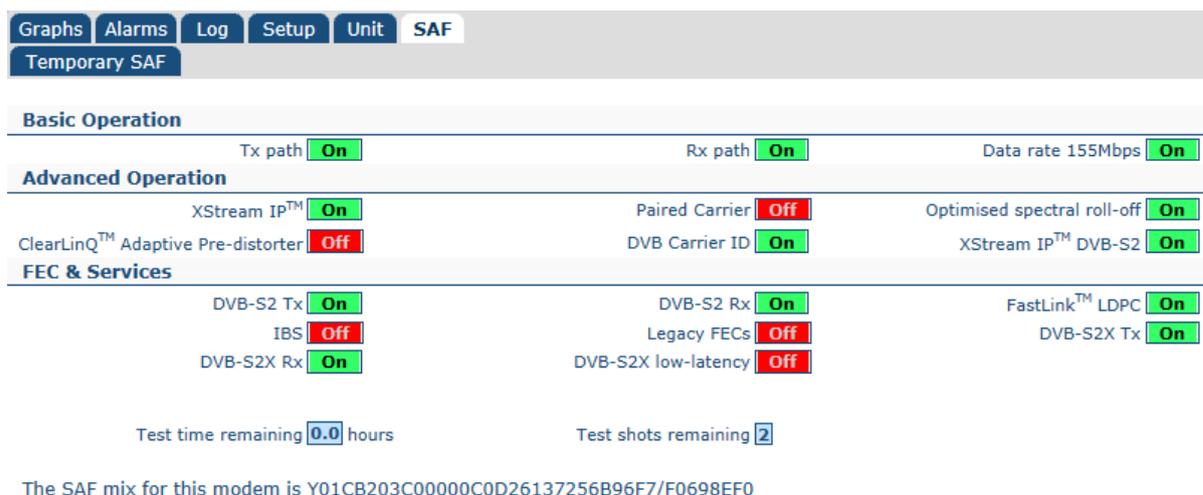
Figure 6-57 View->SAF Screen

6.2.3 Test Screen

The following test functions are supported as shown on **Figure 6-58**:

- *Loopback.* This allows selection of internal loopback between the transmit and receive paths, at different points in the processing chain. This provides a convenient way of checking modem operation in isolation from other equipment. Local loopback refers to returning local signals traveling within the modem in the direction of the satellite, back towards the terrestrial interface. Remote loopback refers to returning remote signals traveling in the direction of the terrestrial interface, back towards the satellite interface.
- *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 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 traffic only. It should always be set to 0 when using IP over satellite. Note that 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).
- *BER test.* This feature provides the ability to inject a test pattern into the modem, through the main traffic channel or via an overhead channel and to monitor the results, using the modem's internal Pseudo-Random-Bit-Sequence (PRBS) Bit Error Rate (BER) Tester.
- *IP packet generator/analyser.* These provide the ability to generate TCP and UDP packets and to measure the throughput, delay and jitter. These allow modem-to-modem

IP communications to be tested (during deployment for example) without the need for any other test equipment.

- *Antenna control.* The modem supports interoperation with antenna control units (ACU) (via a choice of serial or IP protocol). Antenna control is documented in Section 7-11.
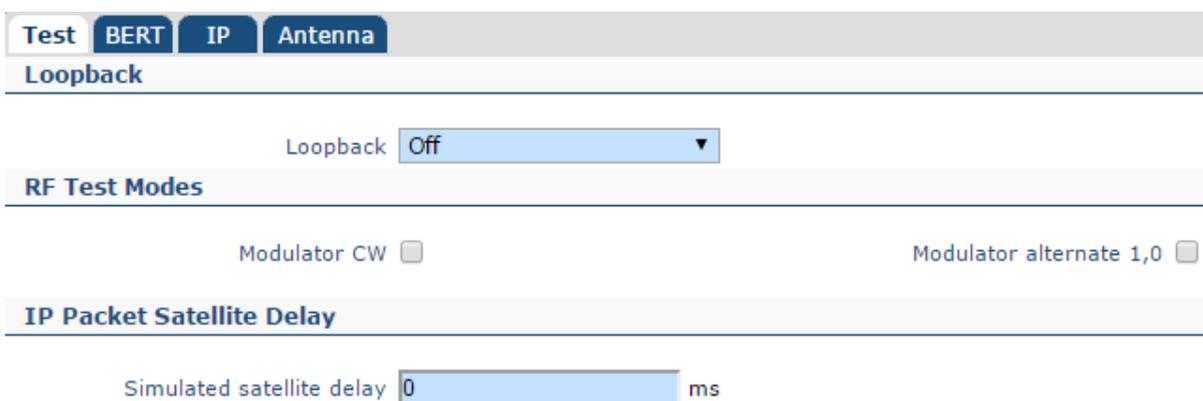
Figure 6-58 Test Screen

The *Loopback* setting allows a number of loopbacks to be selected to aid fault diagnosis and resolution of system level problems.

- *IF (local)* is used to loopback transmit to receive internally within the modem.
- *Interface (local and remote)* is used to loopback receive to transmit and is normally set on one of the pair of modems (usually the remote modem).
- The other modes are more specialized and cause a loopback at various points within the Tx/Rx processing chains.

Note that the loopback of IP has been disabled. This would cause the modem to retransmit on its terrestrial port packets that it has received and this can confuse intelligent switches, which conclude that the original sending device has moved and is now on a different port, which can cause traffic storms.

With respect to the *RF Test Modes*, selecting Tx CW causes a pure carrier to be transmitted rather than the normal modulated carrier. This is useful for evaluating phase noise and spurious but should not be used over a live satellite link without the operator's permission. Selecting *Modulator alternate 1,0* causes an alternating 1,0,1,0 …… pattern to be fed to the modulator at the symbol rate. This causes two discrete frequencies to be generated, spaced at the symbol rate about the (suppressed) carrier. This is useful for evaluating the carrier suppression of the modulator but should not be used over a live satellite link.

6.2.4   BER Test

The internal PRBS BER Tester shown in **Figure 6-59** allows pseudo-random bit patterns to be injected into the main traffic or overhead channel and the BER results to be monitored.   Use of the ESC and AUX channels allows continuous real traffic BER performance monitoring whilse the modem carries traffic.

A facility exists to inject errors into the generated PRBS stream and see these reflected within the error count.

Figure 6-59 BER Test Generator/Analyser Screen

Data Invert allows an inverted data bit stream to be transmitted (or received if selected on the analyser).

The *Inject Error* button can be used to inject a single error into the bit pattern, which should increment the number of bit errors by one.

The *Cyclic Error* forces a single error to be injected periodically. The frequency can be selected from a drop down box (in bits) which appears once the cyclic error is selected.

The *Elapsed Time* indicates the time since the test was started or restarted.

The *Errors* field indicates the total number of error bits detected since the test started.

The *Average BER* field indicates the number of bit errors in relation to the number of bits received.

Latency is shown in terms of both bits and time. The latency is only valid when the Tx signal of the modem is fed back to the Rx input. A long test pattern must be selected in order to make sure that the pattern is unique for longer than the actual latency period, otherwise the latency will be under-reported.

The *Sync OK LED* shows the instantaneous test pattern synchronisation status. When the Rx path is synchronised to the incoming Tx test pattern then the LED will be green and it will be red when synchronisation is lost.

The analyser *Sync Lost Threshold* can be customised or left as *Auto*. The *Counter Action on Sync Loss* can be set to *Reset, Continue* or *Freeze* allowing further customization of the display.

The *Restart* button can be used to start or restart the BER test including clearing all of the error counts.

6.2.5   IP Test Features

TCP and UDP packet generator/analyser tools are available in the modem. These allow the satellite link to be tested without requiring any additional test equipment.

Figure 6-60 shows an example of a modem set up to generate TCP, where the M&C address of the receiving modem is entered.
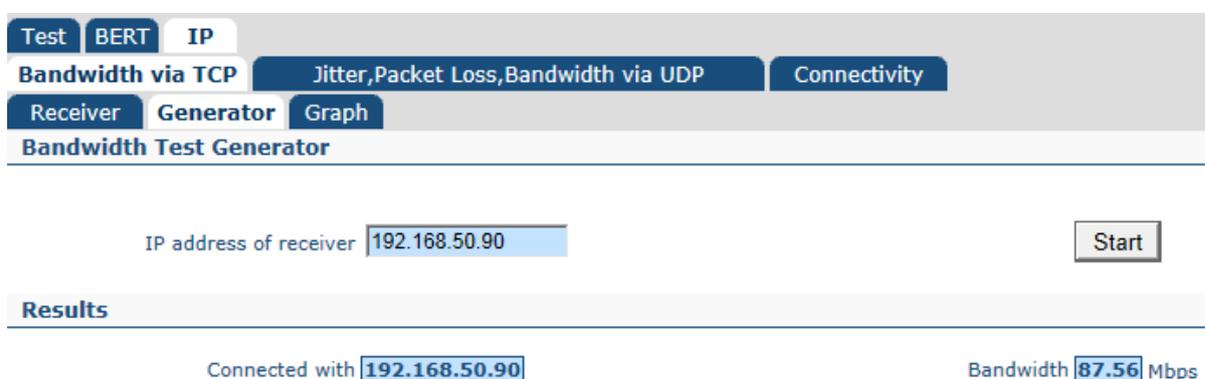
Figure 6-60 IP TCP Packet Generator Screen

Figure 6-61 shows the set up of the receiving modem for the above and **Figure 6-62** shows the bandwidth throughput results for this particular TCP test.
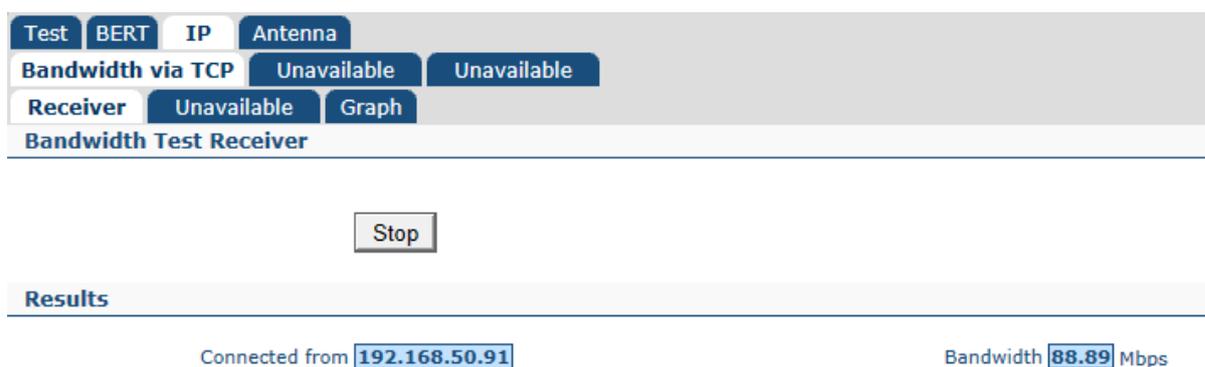
Figure 6-61 IP TCP Packet Receiver Screen
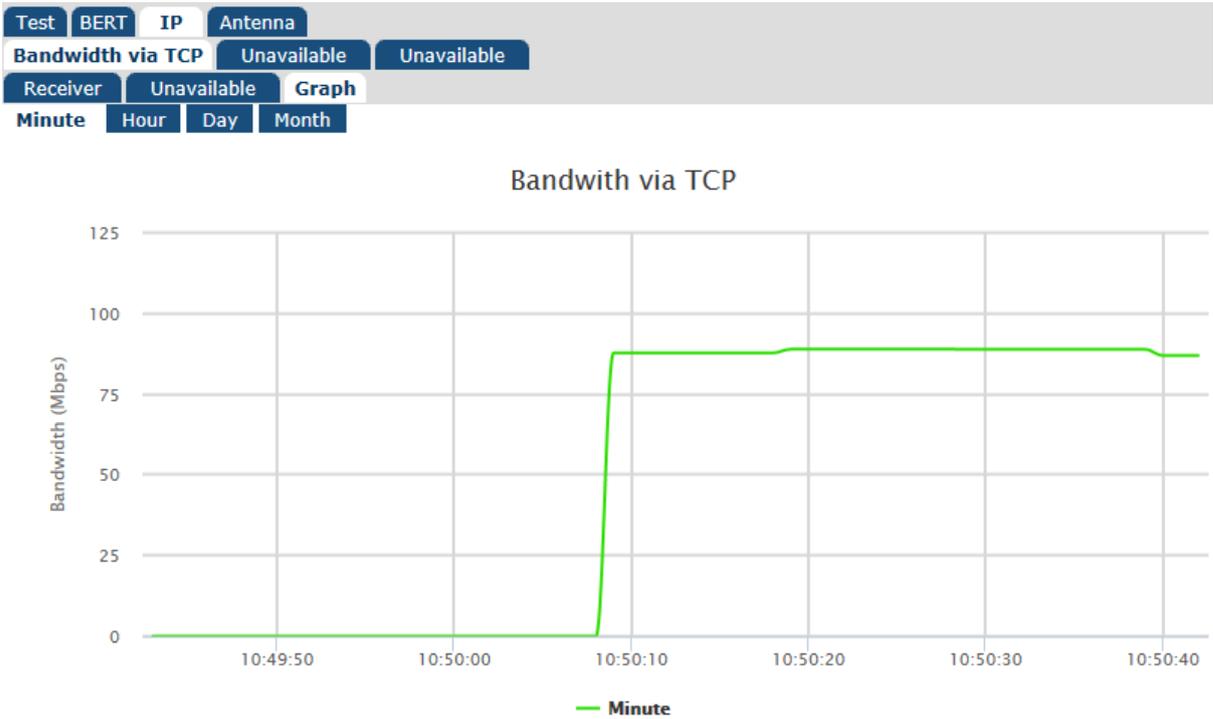
Figure 6-62 IP TCP Test Throughput Screen

Figure 6-63 shows a ping facility built into the modem, which can be used to test connectivity from the modem to other network devices and locations.
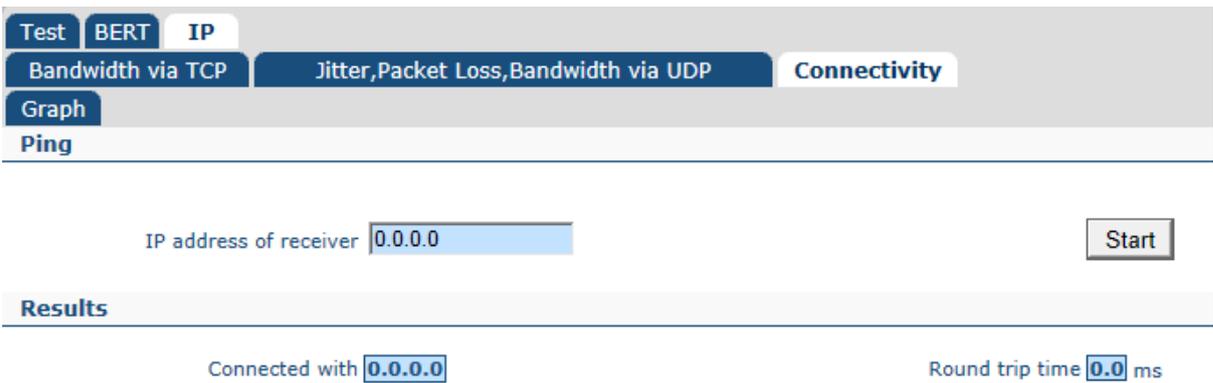
Figure 6-63 IP Connectivity Test Screen

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.

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.

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 *Up* arrow key is also used to enter a hyphen when a range of values is required (such as for timeslots).

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 *Down* arrow key is also used to enter a comma when entering a number of values together (such as when entering a list of timeslots).

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 entrying 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.

Buffer Overflow / Underflow clear

The buffer Overflow and Underflow slip counters can be cleared by pressing the 0 key when on the front-panel *Status->Demodulator* screen.

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.

```
Station clock source: [None]
     1:None       2:BNC
     3:RS422
```
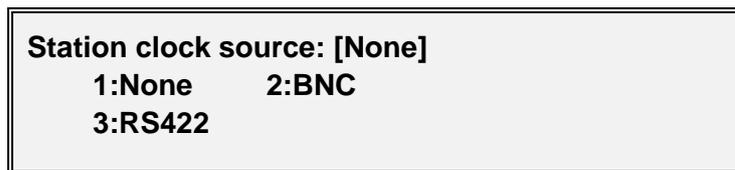
Screen Type 1: Menu Selection from Pre-defined List

```
IF carrier freq:50 to 90, 100 to 180MHz
   [070.0000] Step 100Hz
New:  070.0000
```
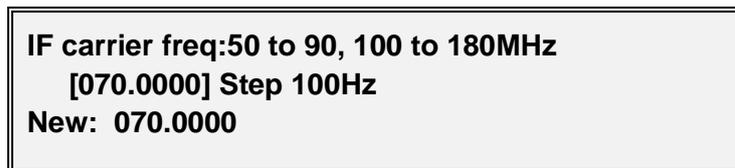
Screen Type 2: Entry of New Value

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 issue a SAF key to unlock the feature.*
- *The feature is available but its use is precluded by the current operational modem settings.*

6.4 Front Panel Menu Structure

The menu hierarchy for the front panel is described in the following sections.

6.4.1 Main Menu

```
          [London-New York]
     1:Status          2:Edit
     3:View            4:Test
```

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 all modem configurable properties.

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

Test   Controls the selection of test modes.

A user-set Modem Identifier is shown on the top line of the screen and is typically used to specify the physical location of the modem or identify the modem satellite link. This can be set via the *Edit->Unit->M&C->Identity* menu.

6.4.2   Status Menu

SETUP
Tx carrier frequency
Rx carrier frequency
Tx data rate
Rx data rate
Tx symbol rate
Rx symbol rate

TRAFFIC
((Tx path okay since OR last
Tx fault message)
(Rx path okay since OR last
Rx fault message)
Tx carrier status

DEMODULATOR
Eb/No
Es/No
Rx power level
Rx frequency offset

Doppler buffer usage
Overflows
Underflows

PCMA
Paired Carrier lock status
Paired Carrier frequency offset
Paired Carrier satellite delay

ACM
Remote Es/No
ACM Tx modcod
ACM Tx data rate
ACM Tx on/off status
ACM Rx modcod
ACM Rx data rate
ACM Rx on/off status

BUC
Output on/off status
Temperature
Class
Current level

AUPC
Remote Eb/No
Power offset
Link status

1-FOR-N
Switch status

MISC
Eb/No
Es/No
Rx power level

STATUS
Setup
Traffic
Demodulator
PCMA
ACM
BUC
AUPC
1-for-N
Misc

Figure 6-64 Front-panel Status Menus

6.4.3 Edit Menu

```
                            ALL
                            (All common Edit controls)

                            TX - SEE SEPARATE MENU TREE

                            RX - SEE SEPARATE MENU TREE

                            UNIT - SEE SEPARATE MENU TREE

                                    Mode
                                      IP mode
                                      Bridge M&C port
                                      TCP acceleration
                                      Satellite round-trip delay
                                      Header compression
                                      Payload compression
                                      ACM mode
                                      Encryption
                                      Encryption seed
EDIT                                                                                       1-for-1
All                                 Addresses                                               Switchover
Tx                          IP        Remote control port IP address                         Switch to standby
Rx                                    Remote control port IP subnet                          Switch to maintenance
Unit                                  Modem gateway                                          Switch to service
IP                                    IP traffic port IP address                           Operation
PCMA                                  IP traffic port IP subnet                              Receive fail switchover
Memories                              Satellite traffic port IP address                     Transmit fail switchover
Redundancy                            Satellite port IP subnet                              1-for-1 mode
                                                                                          1-for-N
                                    Misc                                                    Redundancy switch RS485 address
                                      DVB-S2 IP encapsulation type                          Switch to standby
                                      MPE air MAC address                                   Learn modem configurations
                                      DVB-S2 PID filter                                     Maintenance
                                      Weighted QoS                                            Switch modem to maintenance
                                      IP\V4/IP\V6 address selection                           Switch modem to in-service
                                                                                             Switchover off/on
                            PCMA        Paired Carrier on/off                                 Switch status
                                        Method selection for round-trip delay calculation    Modem priority setting
                                        Modem latitude/longitude                              Switch 'learn' polling rate
                                        Satellite longitude
                                        Minimum/maximum round-trip delays

                            MEMORIES   Store
                                       Recall
                                       Erase

                            REDUNDANCY
```

Figure 6-65 Front-panel Edit Menus

6.4.3.1 Edit->Tx Menu

Figure 6-66 Front-panel Edit->Tx Menus

6.4.3.2   Edit->Rx Menu

Figure 6-67 Front-panel Edit->Rx Menus

6.4.3.3   Edit->Unit Menu

```
                        ─── INTERFACE
                            Terrestrial
                              Terrestrial interface type
                              IP speed/duplex
                              G703 rate
                              G703 line format
                              G703 line encoding
                              G703 line length
                            Quad E1
                               Quad E1 timeslot set up (per port)

                        ─── M&C
                            Control
                               Modem control
                            Passwords
                              Remote admin password
                              Remote view-only user password
                            Interface
                              Remote serial interface mode
                              Remote serial interface baud rate
                              Remote serial interface RS485 address
                            Identity
   UNIT                        Modem identity
   Interface                 SNMP
   M&C                        SNMP on/off
   Alarms
   Clock        ───────  ─── ALARMS
   SAF                      Link Guard interferer monitor
   Upgrade                  Link Guard interferer threshold
   Misc                     Tx AIS alarm action
                            Rx AIS alarm action
                            Eb/No threshold
                            Deferred distant Eb/No
                            Buffer slip threshold
                            DC current minimum
                            DC current maximum
                            DC alarm action

                        ─── CLOCK
                            Station clock source
                            Station clock use
                            Station clock frequency

                        ─── SAF
                            New SAF code entry
                            End current test shot

                        ─── UPGRADE
                            Upgrade modem software via USB

                        ─── MISC
                            Set modem time/date
                            10MHz reference adjustment
```

Figure 6-68   Front-panel Edit->Unit Menus

6.4.4 View Menu

Figure 6-69 Front-panel View Menus

6.4.5 Test Menu

Figure 6-70 Front-panel Test Menus

Chapter 7   Modem Concepts

7.1 System Clocking

There are two terms commonly used when referring to the receive buffering, namely *Doppler* and *Plesiochronous.*

Doppler: Receive Doppler buffering is required because the incoming data from the satellite is subject to Doppler shift, which occurs in an approximately 24-hour cycle. The Doppler shift is due to the satellite movement relative to the earth and is directly proportional to its station keeping accuracy. Towards the end of a satellite's life when its station keeping is degraded to save fuel, the Doppler shift on incoming signals increases and buffers may have to be increased in size. The receive buffer acts as an elastic store or First-In-First-Out (FIFO) memory gradually emptying and filling to absorb differences over the 24-hour period.

A design aim should be to have all clock signals within the system originating from one master source in order to ensure that the buffer does not underflow or overflow during the 24-hour cycle

Plesiochronous: This is where there is more than one clock in the system and a buffer is required to absorb the difference between the clocks. Data is typically placed into the buffer with one clock and removed with another, causing continuous filling or emptying of the buffer and resulting in buffer slips on a regular basis. The period between buffer slips will be constant, and proportional to the difference between the two clocks. Each buffer slip will result in a temporary loss of data and therefore this clocking scheme is not ideal.

The buffer itself is independent of the clocking scheme and will support all methods of system clocking. With typical earth station clock accuracies, buffers should never need to be larger than 16ms.

7.1.1 Transmit Clocking

There are three transmit clocking modes that are used in the modem.

7.1.1.1 Internal Clock

When *Internal* is selected, the modem, which is always configured to be a Data Communications Equipment (DCE), supplies the clock. This is provided by the modem to the Data Terminal Equipment (DTE) via the External Transmit Clock (ETC) signal line for using in clocking the data through to the modem. It is important that the terrestrial data coming into the modem uses the ETC clock looped back through the DTE equipment.
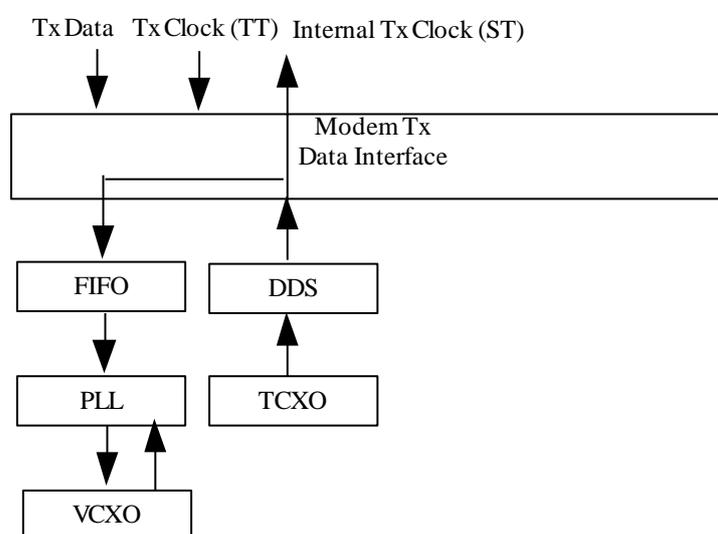
Figure 7-1 Internal Tx Clock Mode

7.1.1.2 Tx Clock In

When *Tx Clock In* is selected, the DTE equipment is responsible for providing the clock. The modem provides a signal on Send Timing (ST) in this mode and requires a clock signal to be provided on Terminal Timing (TT). The ST signal is provided in order to allow the DTE to be operated with a modem supplied clock, in a similar way to when *Internal Clock* is selected but the TT and Send Data (SD) phase-relationship will be correctly aligned. If the external clock is missing for any reason then the modem will substitute an internal clock. Note that the G.703 interface should always use external clocking.

Tx Data   Tx Clock (TT)   Internal Tx Clock (ST)

Modem Tx
Data Interface

FIFO   DDS

PLL   TCXO

VCXO
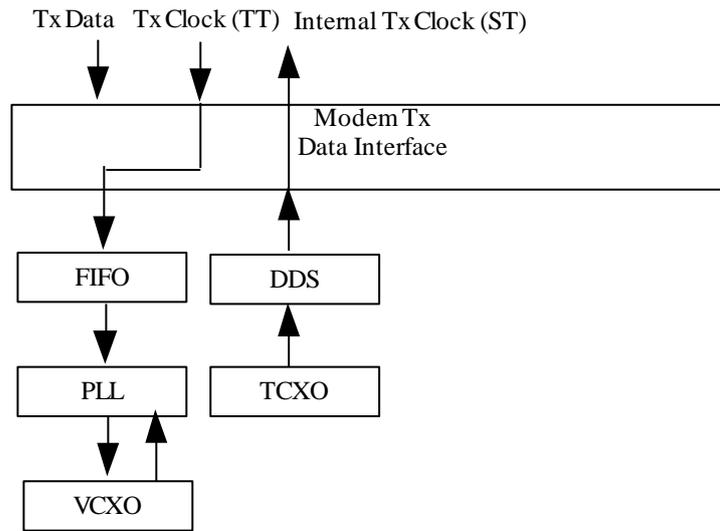
Figure 7-2 External Tx Clock Mode

7.1.1.3   Receive Reference

When *Receive Reference* is selected, it allows the modem to provide an ST clock to the DTE that is locked to the receive satellite signal. The timing is actually phase locked to the Rx data rate but at the frequency of the Tx data rate. This is to allow asymmetric operation. The DTE then synchronises the data going into the modem (SD) to this clock. If the external clock is missing for any reason then the modem will substitute an internal clock.

Tx Data   Tx Clock (TT)   Internal Tx Clock (ST)

Modem Tx
Data Interface

FIFO   DDS

PLL   VCXO

VCXO   PLL

Rx Clk
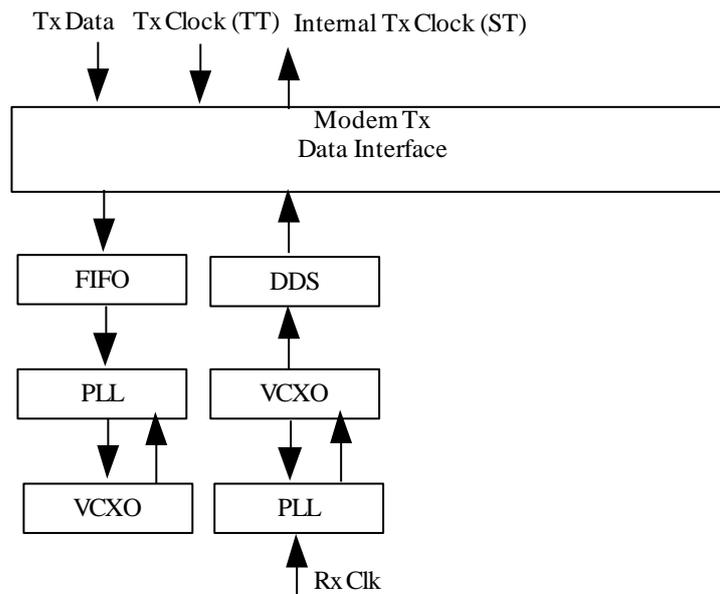
Figure 7-3 Receive Reference Tx Clock Mode

7.1.2 Receive Clocking

There are four receive clocking modes that are used in the modem.

7.1.2.1 Satellite

When *Satellite* is selected, the modem disables the Rx Doppler buffer and derives a clock from the incoming satellite signal. This means that the signal will be subject to Doppler/plesiochronous offsets.
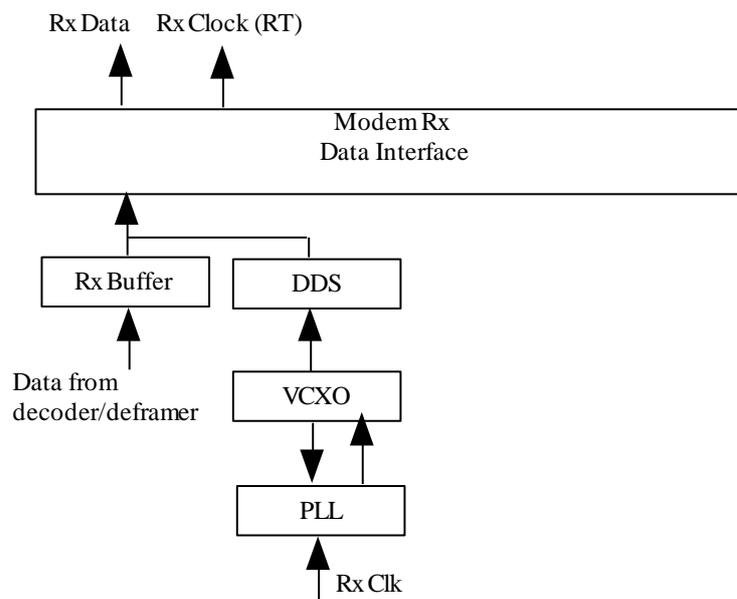
Figure 7-4 Satellite Rx Clock Mode

7.1.2.2 Tx Clock In

When *Tx Clock In* is selected, the Rx clock and data are phase locked to the Tx data rate frequency but at the Rx data rate. The clock and data appear on Receive Timing (RT) and Receive Data (RD) respectively. The Rx Doppler buffer is enabled and the output clock for the buffer is derived from either ST or TT.
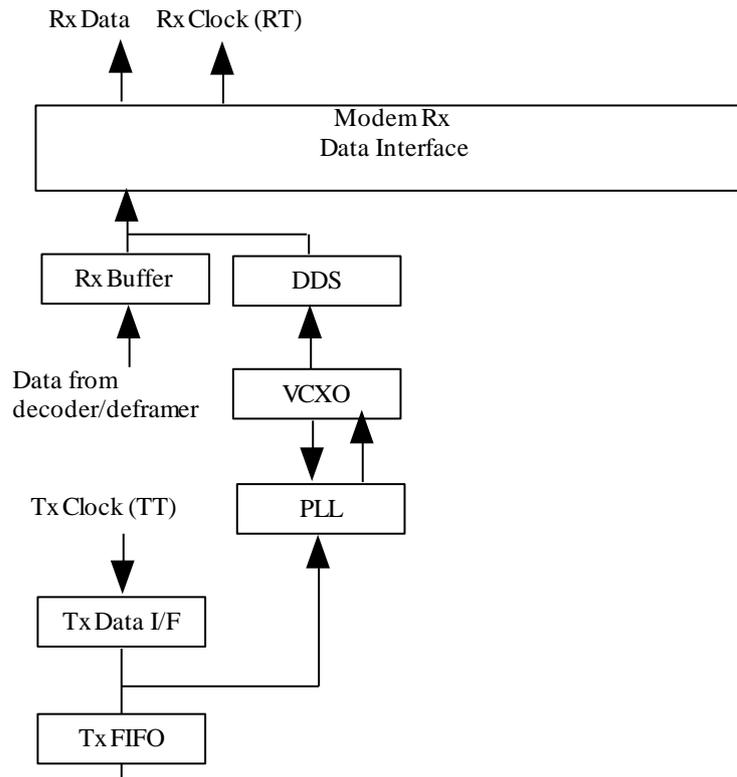
Figure 7-5 Tx Clock In Rx Clock Mode

7.1.2.3 Station Clock

When *Station* is selected, the modem's Rx timing is phase-locked to the station clock input but is run at the Rx data rate frequency. The Rx Doppler buffer is enabled. The clock and data appear on RT (Receive Timing) and RD (Receive Data) respectively. The station clock input can be configured to provide a clock just for Rx path processing or it can be used to replace the modem's internal 10MHz clock (used for all internal processing). The station clock frequency need not equal the modem's internal 10MHz clock frequency when it is being used to provide just Rx path clocking: it can be set anywhere between 1kHz and 10MHz.
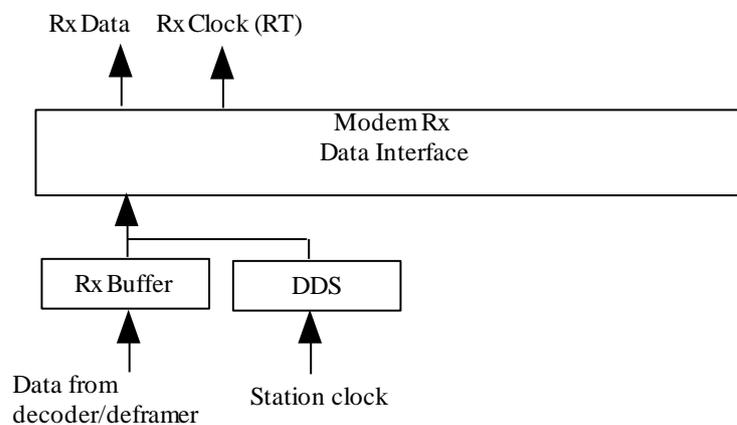
Figure 7-6 Station Clock Rx Clock Mode

7.1.2.4 Internal Clock

When *Internal* is selected, the modem's Rx timing is phase locked to the modem's internal clock but is run at the Rx data rate frequency. The Rx Doppler buffer is enabled. The clock and data appear on Receive Timing (RT) and Receive Data (RD) respectively.
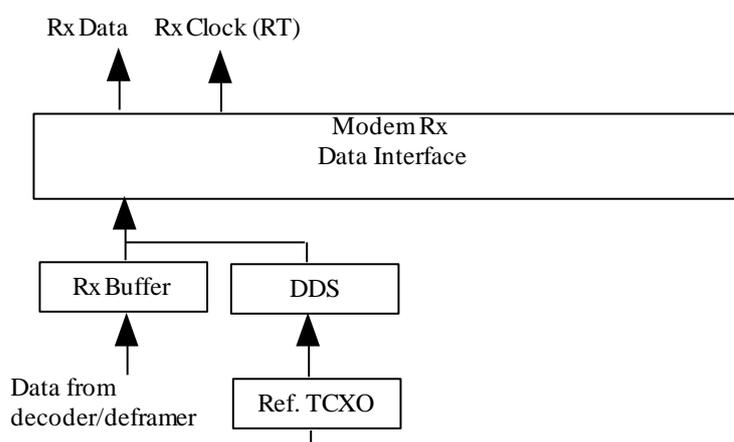
Figure 7-7 Internal Rx Clock Mode

7.1.3 Guidelines for Clocking Configuration

The following needs to be ascertained:

- Incoming Rx carrier:
  - Is your Tx clock looped back at the remote end?
  - If not, what is the accuracy of the clock transmitted by the remote end?
- Outgoing Tx carrier:
  - Is the incoming Rx clock being looped (Tx clock = Rx, or clock looped by the equipment or via cables)?
  - If not, what is the accuracy of the Tx clock?

The various Tx and Rx clocking modes of the modem are described in the following sections.

7.1.3.1 Clock Loop at One End

The end *with the clock loop* requires the buffer to be disabled (i.e. the Rx clock to be set to *Satellite*). If there is either a cabled clock loop or the equipment loops the Rx clock back to the modem Tx input then set Tx clock = *Tx Clk In*. If there is no physical clock loop set the Tx clock = *Rx*.

The end *without the loop* requires the buffer to be activated (i.e. the Rx clock to be set to something other than *Satellite*). The buffer size should be set to twice the Doppler shift. This in turn depends on the the accuracy with which the satellite orbit is maintained. As a

rule of thumb, 2ms end-to-end buffering should be sufficient for one satellite hop and 4ms for a round trip where twice the Doppler shift is required.

Set the Tx and Rx clocks as follows:

When the clock is provided via the terrestrial interface

Set *Tx clock* to *Tx clk in* and *Rx clock* to *Tx clk in.*

Modem internal clock

This sets *Rx clock* to *Internal* and feeds the clock to the terrestrial equipment. If the Rx output clock is internally or externally looped then set *Tx clock* to *Tx Clk In*. If the Rx output clock is not returned to the modem Tx input then set *Tx clock* to *Rx Clk*.

Station clock

When *Rx clock* is set to *Station* then set the *Tx clock* as for modem internal clock above.

Satellite

This is an invalid Rx clock setting. With a clock loop at the remotet end the Rx satellite clock is a copy of the Tx clock and cannot be looped again.

7.1.3.2   No Clock Loop

If there is no clock loop then both ends need the buffer to be enabled in order to cope with Doppler and the plesiochronous effect (i.e. the difference between the clocks at each end).

Apply the following rule to both ends:

- If a clock is being provided via the terrestrial interface and a station clock is available then set *Rx clock* to *Station*. If there is no station clock then set *Rx clock* to *Tx Clk In* (as the Tx clock comes from the network this will be derived from the network master clock). Set *Tx clock* to *Tx Clk In*.

7.1.3.3   Determining Buffer Size

The following calculation can be used to determine the buffer size required. The required plesiochronous buffer size (middle-to-end) in seconds is:

$$\text{Buffer size (Bs)} = Ms \times 24 \times 60 \times 60 \times (Lc + Rc)$$

Where:

- Lc is the local clock accuracy (e.g. $\Box 1 \times 10^{-9}$),
- Rc is the remote clock accuracy (e.g. $\Box 1 \times 10^{-11}$)
- Ms is the minimum-slip period in days (e.g. 40 days)

For end-to-end buffering, with a Doppler allowance of 2ms:

$$Bs = 0.002 + 172800 \times Ms \times (Lc + Rc) \text{ seconds.}$$

Using the bracketed example figures above gives a result of 0.00898 seconds, requiring a buffer size of 9ms to absorb the plesiochronous effects. To this must be added any Doppler requirement (e.g. 2ms for each satellite hop).

7.1.3.4   G.703 Clock Extension

The modem can provide a highly stable GPS-derived clock from a hub modem to a remote modem, thereby saving the cost of installing GPS devices at both ends of the link.

The implementation involves the use of the G.703 interface card in the modem but the resulting high-stability clock can be used in conjunction with any modem terrestrial interface (such as IP).

The method involves extending a G.703 T1 or E1 timing reference to the remote end of a satellite link, regardless of actual data rate required for the link.

This is achieved via a G.703 clock extension feature that propagates a high-stability reference from the *hub* to the *remote*. It requires a high-stability E1/T1 reference signal (ideally from a GPS receiver) to be fed to the hub modem (via the G.703 balanced or unbalanced connectors).

The remote modem will then generate a T1/E1 output signal synchronized to the local modem's GPS signal. This signal can then be used for synchronizing the remote site equipment.

To set the G.703 clock extension in Tx, set the Tx clock source to *Internal* at which point the option to forward the G.703 clock as a clock reference over satellite will be presented.

To use the G.703 clock extension in Rx, set the Rx clock source to *Satellite* at which point the option to generate a G.703 clock from the satellite clock will be presented. This will result in the modem generating an Alt1/0 timing reference signal at either T1 or E1 through the G.703 interface card.

7.2   Automatic Uplink Power Control

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

7.2.1   Introduction

Automatic Uplink Power Control (AUPC) provides a mechanism to counteract changes in atmospheric conditions, such as rain, 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 messages through the asynchronous ESC channel (which is carried over the satellite multiplexed with the main data channel). When using DVB-S2, which does not have an inherent ESC channel, Eb/No information is injected, at a low rate with extremely low overhead, into the return channel.

An asynchronous ESC channel is available in Closed Network Plus ESC, IBS and IDR modes. AUPC can share the ESC channel with other traffic, such as remote M&C commands.

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.

7.2.2   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.

7.3   1:1 Redundancy Operation

7.3.1   Overview

Two modems can operate as a 1:1 redundant pair using a single interconnecting lead, two power splitters/combiners and cable forms to parallel up the terrestrial interfaces of both units. Both modems operate normally with respect to incoming data and IF signals, but only one modem enables its satellite and terrestrial outputs at any point in time.

Figure 7-8 illustrates how a 1:1 redundant pair is configured.
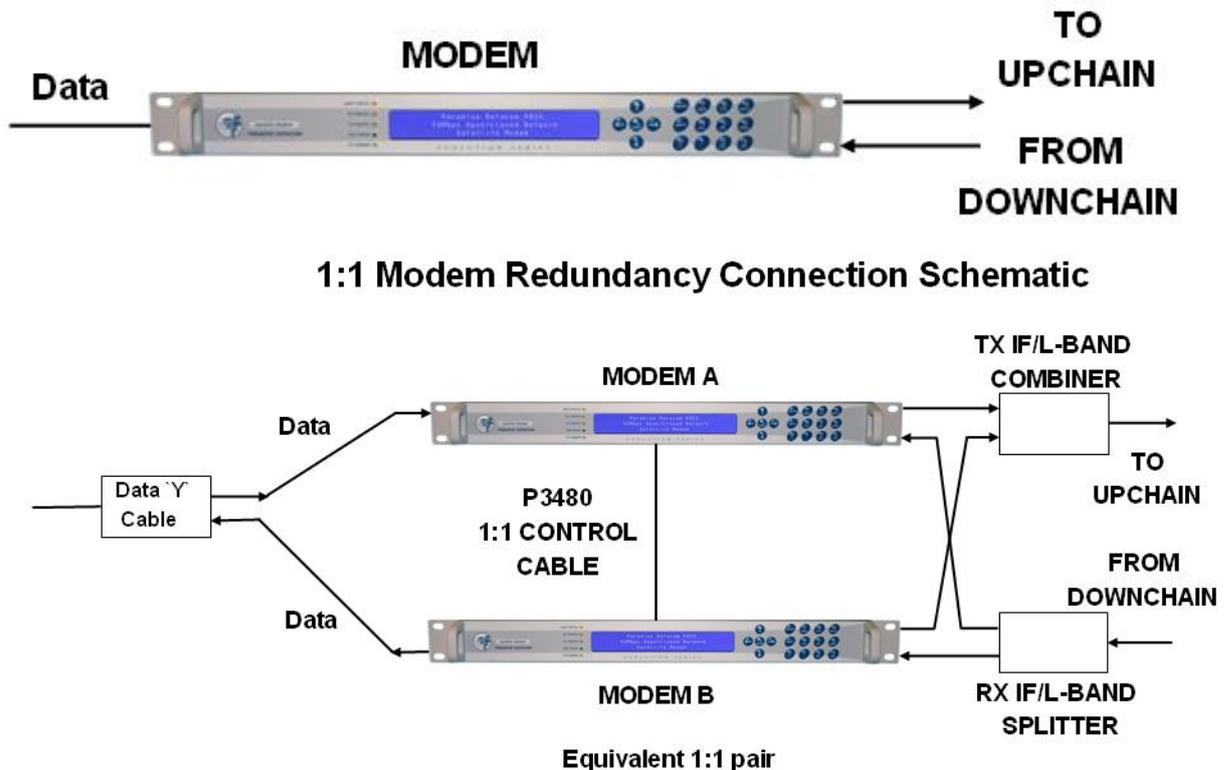
Figure 7-8 Modem 1:1 Redundancy System

It is possible to replace the offline modem in a 1:1 pair without interrupting traffic.

7.3.2   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 monitors its own status and the status of the online modem continually 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.

7.3.3   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. See Section 7.3.4 for details of how to configure IP addresses in modem redundancy configurations.
2. Connect a suitable cable between the 9-way 1:1 connectors on the two modems.
3. Connect the terrestrial data interfaces for the two modems in parallel.
4. nd configure the two units alike. Suitable adapter cables are available from Teledyne Paradise Datacom.
5. 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 using RJ45 crossover cables.
6. Connect the two transmit IF ports to the input ports of a suitable splitter/combiner of the correct impedance (50Ω or 75Ω) 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.
7. Connect the two receive IF ports to the two output ports of a suitable powersplitter/combiner of the correct impedance (50Ω or 75Ω) 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.
8. Check correct operation by performing a manual switch between the units (via the *Unit-Advanced-Operation* menu). The pair will not switch over unless the Standby unit is fully operational. (Note that the pair can be tested in loopback mode but this requires the IF signals to be split and combined and looped back to the other unit. Looping the output of one unit back to its self will not work, since the Standby unit output is muted and it will therefore not detect any carrier.)

7.3.4   IP Addressing and Operation in Redundancy Configurations

7.3.4.1   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, the IP traffic addresses also need to be different for each modem. In bridging modes the IP traffic address is not used but it is required for routing mode.
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 on line.

If dynamic routing is being used when a switchover occurs then the route through the newly online modem will be learned automatically.

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.

7.3.4.2   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 control the Standby modem at all times.

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

7.4   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 of 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 Demonstration Mode. 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. 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 user interfaces and on 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.

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

7.5   Software Upgrading

It is possible to update the software and firmware within the modem via the Remote M&C Ethernet connection web user interface (upgrades via the serial M&C port are not supported). The software upgrade process is described in Section 6.2.13.

7.6 LinkGuard™ Interference Detection and Carrier Relocation

LinkGuard™ is a Paradise patented technology for detecting in-band interference underneath satellite carriers while remaining on traffic. A visual indication of any unwanted interference is provided through a signal-under-carrier spectrum web graph showing the wanted carrier along with any unwanted interference. The graph includes a 'persistence' mode to show even intermittent interference.

In addition, **LinkGuard™** now supports the ability to optionally automatically relocate a carrier to a new user-selected frequency when significant levels of interference are experienced. The user can set an interference threshold and an associated time period. When interference is experienced above the threshold for the defined time period then the carrier frequency will be changed at both ends of the link using Paradise's Reversionary Control feature (which allows the distant modem's configuration to be changed automatically).

Figure 7-9 shows a 32APSK carrier (in blue) initially with no interference (shown in red) and then with interference caused by another modulated carrier. Note that the interference is sufficient to reduce the Es/No of the carrier by around 4dB but is not obvious by looking only at the received carrier spectrum. The modem I/Q constellation graph is also shown.
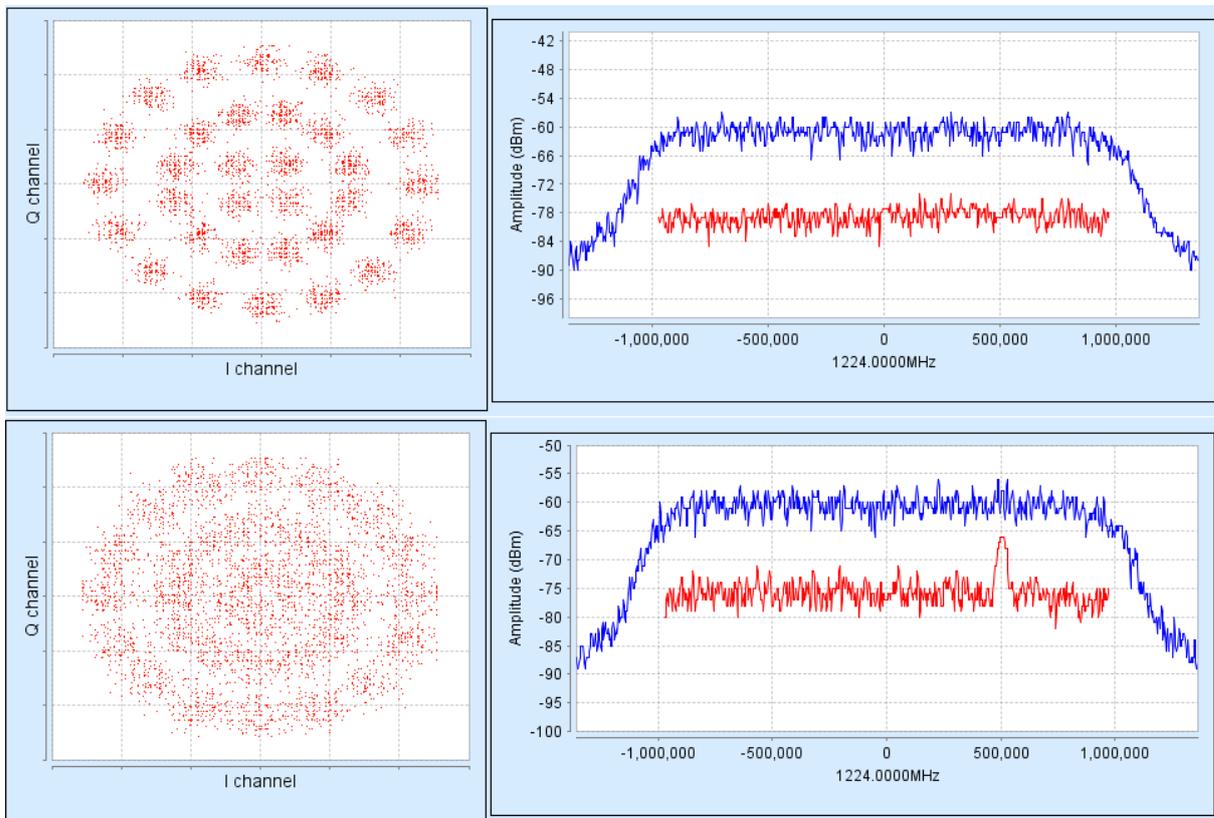
Figure 7-9 Example LinkGuard™ Web Screenshots without/with Interference

LinkGuard™ provides a menu option for setting a power spectral density threshold, above which the modem will automatically alarm to indicate that a significant source of interference has been detected. The **LinkGuard™** Rx traffic warning alarm is displayed locally on the modem and can be accessed remotely via the modem's web server, SNMP traps and physical contact relays. Automated 24x7 interference detection is therefore provided without the need for an operator to be present.

LinkGuard™ detects various forms of interference including tonal interferers (such as CW), radars, Wi-MAX, jammers and other modulated carriers including adjacent interfering carriers. If there is more than one source of interference then it will detect and display all of them.

When *Paired Carrier* is being used (where two carriers are deliberately superimposed on top of each other) then **LinkGuard™** is capable of detecting and displaying any interference under both of the carriers.

For existing links, even ones that do not use Paradise modems, a **LinkGuard™**-capable modem can be set up to receive the same Rx signal in order to simply monitor the link for interference (so long as it can lock to the carrier). This is a useful and convenient way of quickly confirming suspected cases of interference while keeping the service running.

Note that even when the level of interference is severe enough to prevent the demodulator from locking, the spectrum graph will continue to show the interference along with the wanted signal (although it will not be able to differentiate between them at this point and will show a single composite spectrum).

LinkGuard™ does not necessarily replace other interference detection equipment but it does provide a useful new first line of defense. It works with all carriers including DVB-S2/S2X.

7.7 FastLink Low-latency LDPC

FEC design is a trade-off between good BER performance and low latency. TPC has low latency but BER performance can be 1dB or more worse than conventional LDPC. (For example, TPC 8QAM ¾ at 5e-8 BER has an Eb/No of 6.4dB compared to LDPC at 5.5dB.) Conventional LDPC latency can be many times that of TPC. (For example, LDPC 16QAM ¾ at 64kbps has a latency of 395ms compared to TPC latency of 47ms, which is a factor of over eight different.)

With satellite delay in addition, LDPC can exhibit over ½ second one-way delay for very low data rates. Low-latency LDPC FECs are becoming available that provide comparable BER performance to LDPC with latency nearer to TPC. FastLink low-latency LDPC from Paradise does precisely this. FastLink also offers an extensive range of modulations ranging from BPSK to 64QAM (including both 8PSK and 8QAM, 16APSK and 16QAM and 32APSK).

One of the key advantages of FastLink is its flexibility. As mentioned, FECs offer a trade-off between BER performance and latency. While the default settings for FastLink achieve this balance, two other modes are also available. The first mode optimises performance for particularly low latency, at the cost of a slight increase in Eb/No required to achieve a specific BER. The second mode optimises BER performance and is suitable when latency is not an issue (e.g. when higher data rates are being used). This flexibility

means that FastLink LDPC has now superseded Paradise's conventional LDPC offering. This flexibility also means that FastLink can be used in a wide range of demanding applications, allowing a single FEC to potentially replace the use of multiple existing FECs.

If one FEC is to be used in place of all others then Paradise believes you should choose one with flexible configuration as opposed to a fixed set of modulation and code rates that are inevitably a compromise.

FastLink is available on all Paradise SCPC modems at all data rates up to 100Mbps. FastLink LDPC is compatible with *Paired Carrier*. FastLink does not interoperate with any other LDPC.

FastLink BER performance is defined on our modem datasheets.

7.8   IP Functionality

7.8.1   Base Modem IP

As shown in **Figure 7-10**, the modem has one RJ45 auto-sensing Gigabit Ethernet port for M&C and one for sending and receiving satellite IP traffic. (A 4-port Gigabit Ethernet switch is available as an option.)
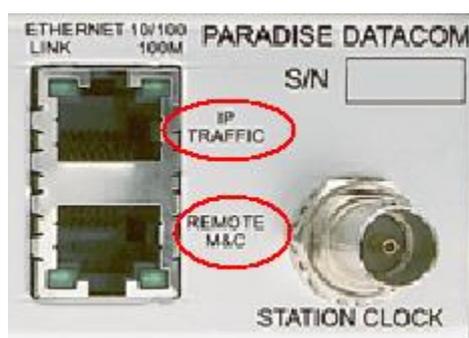
Figure 7-10   Modem Ethernet Ports

Both of the Ethernet connections by default form part of an Ethernet bridge and share an IP address. Essentially, the bridge makes the modem disappear from the network in relation to passing IP traffic over a satellite. Consequently, for simple point-to-point communications, little or no user set up is required to pass IP traffic over satellite. If both Ethernet ports are configured to be part of the bridge then a single Ethernet connection to the modem can be used for both IP traffic and modem M&C control (using either of the two RJ45 connectors). If the M&C port is configured to be outside the bridge then one Ethernet port is dedicated to IP traffic and the other to M&C control (as labeled on the connectors).

To communicate with the modem itself 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 Porotocol (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. Dynamic routing is also supported.

The use of a default gateway IP address is supported. When a gateway is specified then it 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.

The M&C port can be taken out of the bridge (via the '*Bridge M&C port*' menu option) in which case each port has its own IP address.

7.8.2 IP Addressing

The Ethernet ports on the 4-port Gigabit Ethernet switch are always bridged together. This is true regardless of what bridging or routing mode is selected. In bridging mode, IP addresses are not used so there is no restriction on what subnets are connected to the switch traffic ports. In routing mode, since the Ethernet switch card has a single address covering all ports, only one direct subnet can be connected to the ports.

When the M&C port is not bridged to the traffic port(s) then it has its own IP address. In this case the IP traffic port and M&C port *must* be on different subnets because otherwise the modem does not know which port to respond out of.

7.8.2.1 Gateways

There is a single gateway address for the modem. This can be applied to any subnet. If further gateways are required then these can be applied as static routes.

7.8.3 Throughput Performance

Actual throughput performance depends on a number of factors including one way/two way 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. (In Trunking mode this increases to 500,000 packets to second.) 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 to at least 100Mbps.

Header compression works to 60,000 packets per second one way, 45,000 two way.

7.8.4 Jumbo Ethernet Frame Support

The modem supports Ethernet frames up to 10k bytes in length. For optical Ethernet, this is increased to 16k bytes.

7.8.5 M&C VLAN

Traditionally, the Engineering Service Channel (ESC) was used as a separate channel to the main data channel. The ESC was used for control of remote equipment (modem, BUC, etc.).

Modern satellite services such as DVB-S2 and DVB-S2X do not incorporate an ESC channel. Paradise has chosen to create an alternative, which is a special VLAN that is used just for M&C traffic. VLAN 0 is used for this purpose and should not interfere with user VLAN traffic. Simply by turning on the M&C VLAN option in both modems in a point-to-point link, the modem will ensure that M&C traffic is kept separate from user traffic and it will

automatically be forwarded to the far modem. The M&C VLAN is filtered (pulled off) by each modem and the commands processed. This is true also in a point-to-multipoint mode, where the M&C messages for all the remote modems share the M&C VLAN, with each modem acting on just the M&C messages addressed to that 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 more 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.

7.8.6   IP Over ESC

The Engineering Service Channel (ESC) is a low rate independent data channel from the main data channel that exists within some framed satellite services such as IBS and Closed Network plus ESC. It was originally intended for inter-earth station communications and is often used for M&C control of remote equipment.

The ESC is implemented as an internal serial interface run at baud rates up to a maximum of 115kbps. The '*ESC interface type*' needs to be set to '*IP*' to put the ESC into IP mode. Because the ESC is a serial interface, IP will not run directly on top of it – the modem encapsulates IP packets within PPP, much the same as a dial-up modem connecting to the internet. When used for IP, the ESC channel runs in bridge mode, with the M&C port being bridged to the ESC channel.

Since the ESC channel acts as a bridge, some bandwidth may be consumed by broadcast traffic finding its way onto it and it is best to minimize this if possible.

The modem allocates private IP addresses to the two ends of the ESC link – no user address set up is required.

The ESC channel in IP mode has some sophisticated M&C modes as described in the following list (in all cases, IP packets destined for the remote network continue to be bridged over the ESC):

- Paradise Univeral Protocol (PUP) commands can be sent to the modem with an '*esc*' prefix to force them to be sent over the ESC to the far modem e.g. '*esc get RxRemoteEbNo*'.
- If you don't want packets to be indiscriminately forwarded over the ESC then you can take the M&C port out of the bridge, meaning that packets on the M&C port will not *normally* then go any further than the local modem. You can then force chosen packets to be forwarded over the ESC if you want. Forwarding is controlled by the '*Remote M&C interface*' setting. Setting this to '*IP – Forward to remote*' causes the modem to process TCP packets sent to ports 6703 and 6704 in a special way.
  - o Packets sent to port 6703 are forwarded over the ESC to port 6703 on the remote modem. At the remote modem (with the remote M&C interface mode set to '*IP – Remote (Rem M&C)*'), the payloads of packets received over the ESC on port 6703 are forwarded out of the serial RS485 M&C interface (i.e. converted from IP to serial commands).
  - o Packets sent to port 6704 are forwarded over the ESC to port 6701 on the remote modem. At the remote modem, packets received over the ESC on port 6701 are treated as local M&C commands for the modem and go no further.

- You can send M&C packets to port 6701 on the local modem at any time when using the ESC channel in IP mode, without having to set the '*Remote M&C interface*'. If you just want to bridge IP packets then you can ignore the remote M&C interface setting.

To summarise the ESC bridging options:

- IP can be used over the ESC and the main data channel at the same time.
- With the M&C port in the bridge and IP selected for both the ESC and main data channel, the M&C port is now bridged to the ESC channel *not the IP traffic port.* The IP traffic port is still bridged, but only to the satellite port (when the ESC is not being used, bridging the M&C port bridges it to the IP traffic port and the satellite port)

Note that the ESC channel is used to support the AUPC feature but this does not prevent it being used for other purposes at the same time (the AUPC messages are just multiplexed in with the other data).

7.8.7 IP Interoperability

Over satellite, the modem uses HDLC to encapsulate the Ethernet frames or IP packets (unless DVB-S2 is being used, in which case another form of encapsulation is used such as MPE or ULE). If Cisco HDLC is selected on the modem then the received IP stream can be forwarded out of a serial interface to a serial router that supports Cisco HDLC, which can convert it back to IP.

In general different modem manufacturer's IP, even when using HDLC, is not interoperable as there is no standard defined in this area. If instead DVB-S2 is used, then generally IP is interoperable between different manufacturer's modems, so long as incompatible IP features are not being used such as compression or acceleration.

7.8.8 IP Connectivity Modes

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

7.8.9 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 whatever the available traffic bandwidth is over satellite. Acceleration can be used in point-to-point and 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 significant 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 then 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.

7.8.10 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.

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->Unit->Advanced->QoS*.

7.8.10.1 Guaranteed Bandwidth

The allocation of bandwidth to a classified data stream is controlled via the *Edit->Unit->Advanced->QoS* tab of the web user interface.

The **Commited Information Rate (CIR)** is the guaranteed bandwidth, in bits per second (bps) (or as a percentage) 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 that the transmission data rate of the modem.

7.8.10.2 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 is not wasted and it can be allocated in a controlled manner between potentially competing streams.

This setting is called the **Burst Information Rate (BIR)** specified in bits per second (bps) (or as a percentage). It defines the maximum amount of bandwidth, beyond the guaranteed bandwidth, that a stream should be allocated, should spare bandwidth become available. Each BIR must be less than or equal to the transmission data rate of the modem.

7.8.10.3 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.

7.8.10.4 Stream Classification

How does the modem know which packets belong to which streams? Streams can be classified using one of 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 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 3-bit EXP field in an MPLS header.
- The VLAN ID in an IEEE 802.1Q VLAN tag.
- The PID value in an MPEG2 transport stream packet.

The key classifiers are described in the following sections. These can be selected using the *Quality of service scheme* dropdown control on the web user interface. 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 it equal to the transmit data rate of the modem.

7.8.10.4.1 IP Address

It is possible to classify a data stream 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.

Each address has an associated subnet mask that delimits the particular host subnet from the overall network.

If matching on a port is also selected then the packet will only be classified as part of the data stream if both the address and the port number match.

Up to 16 streams are supported, each of which has its own CIR, BIR and priority level settings.

The example in **Figure 7-11** shows a traffic shaping scheme based on matching on source address and source port number. Note the *Enable shaping* checkbox, which controls whether traffic shaping is enabled or not. The *Input mode* can be set the entry method to bits per second, or percentage input. Using percentages may be useful when using ACM, where the bandwidth varies dynamically. In addition, input can be specified as percentages but using a fixed CIR in bits per second, allowing absolute guaranteed bandwidths to be allocated with excess bandwidth being distributed using percentages.

Quality of service scheme | IP Address ▼   Enable traffic shaping ☑

Quality of service IP address class | Both source and destination + port ▼   Input mode | Percentage (%) ▼

QoS Class	CIR (%)	BIR (%)	Priority	Src Address	Src Mask	Src Port	Src Port End	
0	500000	900000	0 ▼	10.1.70.5	255.255.255.255	21	0	Submit
1	400000	800000	1 ▼	10.1.70.2	255.255.255.255	22	0	Submit
2	50000	1000000	2 ▼	10.3.80.0	255.255.255.255	23	0	Submit
3	50000	1000000	3 ▼	10.3.0.0	255.255.255.255	24	0	Submit
4	0	0	0 ▼	0.0.0.0	255.255.255.255	0	0	Submit
5	0	0	0 ▼	0.0.0.0	255.255.255.255	0	0	Submit
6	0	0	0 ▼	0.0.0.0	255.255.255.255	0	0	Submit
7	0	0	0 ▼	0.0.0.0	255.255.255.255	0	0	Submit

QoS Class				Dest Address	Dest Mask	Dest Port	Dest Port End	
0				0.0.0.0	255.255.255.255	0	0	Submit
1				0.0.0.0	255.255.255.255	0	0	Submit
2				0.0.0.0	255.255.255.255	0	0	Submit
3				0.0.0.0	255.255.255.255	0	0	Submit
4				0.0.0.0	255.255.255.255	0	0	Submit
5				0.0.0.0	255.255.255.255	0	0	Submit
6				0.0.0.0	255.255.255.255	0	0	Submit
7				0.0.0.0	255.255.255.255	0	0	Submit
Def	0	1000000						Submit
Total	1000000							

Figure 7-11 Traffic Shaping Configuration Screen using IP Addresses

As can be seen, QoS Class 0 is guaranteed a bandwidth of 500,000bps. It may be allocated up to 900,000bps, depending on what is allocated to other QoS classes. If no other data is being received then Class 0 will be allocated up to 900,000bps, if needed.

Assume at this point (when Class 0 ideally wants 900,000bps) that the Class 1 data stream is flowing at 350,000bps. Since 350,000bps is less than the CIR of Class 1 then it will get all the bandwidth it needs. Class 0 will get its guaranteed 500,000 bps, but will be allocated only an additional 150,000bps (bringing its total to 650,000bps) because this is all of the spare bandwidth, and is less than the Class 0 BIR value.

In another example, assume Class 2 is being received at 400,000bps and Class 1 at 950,000bps. In this situation the Class 1 data stream will be allocated 800,000bps, its maximum, while Class 2 will be allocated only 200,000bps. The spare bandwidth is allocated to Class 1 first because it has a higher priority. When the BIR of Class 1 is reached, the remaining spare bandwidth will be allocated to Class 2.

7.8.10.4.2 Diffserv DSCP Class

It is possible to classify data streams based on the Differentiated Services Code Point (DSCP) value in the IP packet header. The DSCP class bits are the top three bits of the DS field in an IP header (the other three bits of the field indicate drop precedence, which can be mimicked using the Priority setting for the stream in the modem). 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 modem maps the eight possible DSCP classes directly to eight equivalent internal modem classes (each of which can be allocated its own CIR, BIR, etc.). DSCP Class 0 maps to internal modem QoS Class 0, etc., down to DSCP Class 7 which maps to QoS Class 7. Class 7 has the highest priority.

An example traffic shaping scheme based on DSCP classification is shown in **Figure 7-12**.

Quality of service scheme	Diffserv DSCP		Enable shaping ☑
Quality of service IP address class	Source address + port		Input Mode	Bits / sec (bps)

QoS Class	CIR (bps)	BIR (bps)	Priority	
0	200000	800000	0	Submit
1	200000	900000	1	Submit
2	100000	1000000	2	Submit
3	100000	1000000	3	Submit
4	100000	1000000	4	Submit
5	100000	1000000	5	Submit
6	100000	1000000	6	Submit
7	100000	1000000	7	Submit
Def	0	0		
Total	1000000			
Tx data rate	1000000			

Figure 7-12 Traffic Shaping Configuration Screen using DSCP

7.8.10.4.3 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.

[*Note that the modem includes support for IEEE 802.1p (priority tagging) as an alternative QoS scheme to traffic shaping in its own right. In this case the packets must already be tagged at the point of entry to the modem. It is a layer 2 feature that uses 8 classes of data*

(3-bit field) to prioritise packets. The modem uses the tags to decide which packet to transmit over satellite first when it has more than one packet to send.

Two modes are supported, namely Strict Priority Queuing and Fair Weighting Queuing:

- *Strict priority queuing: packets are queued for transmission based solely on their priority – highest will always be sent first.*
- *Fair-weighting queuing: higher priority transmitted first but lower priority packets are given a percentage of the bandwidth to stop total starvation.*

The 8 QoS priority levels are mapped to three TCP/IP queues. Packets with highest QoS priority (level 7) are sent to high priority TCP/IP queue. Delay-sensitive packets (QoS levels 6 and 5) are sent to the medium priority queue. The remainder (QoS levels 4 to 0) are sent to the low priority TCP/IP queue. For Strict priority queuing, all packets in high priority queue are processed before any in medium priority queue which in turn are processed before any in the low priority queue. For Fair-weighting queuing, for every 4 packets sent from high priority queue, 2 are sent from medium queue and 1 from low priority queue.]

The example shown in **Figure 7-13** is a traffic shaping scheme based on priority tagging.

Figure 7-13 Traffic Shaping Configuration Screen using IEEE 802.1p Priority Tags

7.8.10.4.4 Other QoS Classification Methods

Stream classification may be based on VLAN ID. VLAN tags can be added externally or by the modem.

Stream classification may also be based on MPLS QoS, specifically the 3-bit EXP field in the MPLS header. This is often used to support Diffserv in MPLS networks. The MPLS EXP field has eight possible values, mapping directly to equivalent internal modem classes (0 to 7) each of which can be shaped using its own CIR, BIR, etc. 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.

7.8.10.5 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.

7.8.11 Static and Dynamic Routing

The modem can be operated as a two-port static router, one port being the terrestrial interface and the other port being the satellite interface. Static routing is useful for small networks that do not require dynamic routing – it can be activated by selecting routing mode but not enabling any dynamic routing protocols (static routing is provided as a free feature).

Each route comprises a *Destination IP Address, Subnet Mask* and a *Gateway Address.* If the destination address of a packet fails to match any entries in the routing table, and the packet has a destination address outside of the local network, the packet will be sent to the default gateway, if specified, otherwise the packet will be discarded. (Static routes can also be entered, and the whole routing table displayed, via the telnet interface to Zebra within the Quagga Router when in Routing Mode The Zebra interface is not dissimilar to Cisco's command line interface and is described in the Quagga user manual available from http://www.quagga.net/docs/quagga.pdf.)

Dynamic routing in the modem offers support for RIP V1 and V2, OSPF V2 and V3 and BGP V4. Note that the 64 static routes have precedence over dynamic routes.

When dynamic routing is on, traffic will be automatically routed across satellite correctly by automatic exchange of routing information with other routers. The routing information exchange uses satellite bandwidth and is therefore an overhead. The amount of bandwidth required depends on the size of the routing tables that are exchanged and the frequency with which they are exchanged.

Dynamic routing is supported via the Quagga software package. Itan only be used on point-to-point links. It is possible to enable routing, TCP acceleration and traffic shaping together at the same time (but routing is incompatible with the header compression feature).

Configuration of dynamic routing protocols can be complex and for this reason the modem provides only a default configuration for the RIP and OSPF protocols that can be enabled from the user interfaces. These will be all that is required in many cases. Further configuration of all routing protocols is available for expert users, via a telnet interface to the Quagga software (the Quagga user manual available from http://www.quagga.net/docs/quagga.pdf). You can telnet into a different command line interpreter for setting up each routing protocol and one that can be used for basic-level setup of all routing protocols. These provide 'Cisco IOS-like' commands that will be familiar to users of Cisco equipment.

When using telnet to login to the Quagga (the default password is 'paradise') various port numbers are used to access the routing protocol to be configured, as follows:

- RIP: port 2602
- OSPF: port 2604
- BGP: port 2605
- Zebra: port 2601

7.8.12 Header Compression

The modem supports RObust Header Compression (ROHC) of:

- IP + UDP headers
- IP + UDP + RTP headers
- IP + TCP headers
- All Ethernet headers

The 40 bytes of IP, UDP and RTP headers are typically compressed to between one to three bytes.

Ethernet header compression is also supported. The 14 bytes of Ethernet frame (the Ethernet CRC is not sent over satellite even when compression is off) are typically reduced to one byte.

Before Header Compression

IP (20 bytes)	UDP (8 bytes)	RTP (12 bytes)	Payload Variable size depending on codec

Header
40 bytes

After Header Compression

Header (1 to 3 bytes)	Payload Variable size depending on codec
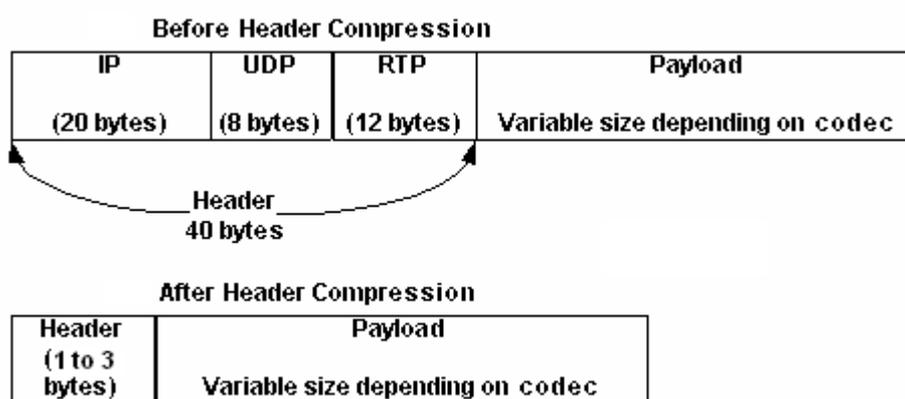
Example: G.729 packet with 20ms (20 bytes) of payload:
- Original size = 40 byte header (IP+UDP+RTP) + 14 bytes Ethernet + 20 bytes payload + 5 bytes HDLC
= 79 bytes
- Following compression = 1 byte header (IP+UDP+RTP) + 1 byte Ethernet + 20 bytes payload + 5 bytes HDLC
= 27 bytes (best case)

This represents more than a 60% bandwidth reduction.

There is support for 'per route' configuration control, where you can specify up to 32 source or destination IP addresses – only packets with one of these addresses get directed through the compressor.

Header compression runs up to 60000 packets per second one-way, 45000 packets per second two-way.

7.8.13 VLAN Operation

A VLAN allows virtual networks to be created as opposed to being limited to purely physical segments. Benefits include creating a restricted broadcast domain so not everyone sees all traffic, plus added security.

Transparent VLAN operation is supported in bridging mode.

7.8.14 Adaptive Coding and Modulation (ACM)

Adaptive Coding and Modulation (ACM) uses feedback from the receiver to the transmitter to respond to changes in channel conditions to optimise throughput, by providing only the level of error protection that is required.

ACM can be used in both directions at the same time, maximising throughput for outbound and return. Deployed links have reported throughput gains of up to 100%.

ACM works in conjunction with DVB-S2/S2X (although the return channel does not have to be DVB-S2/S2X unless ACM operation is required for both outbound and inbound carriers).

By varying the error correction strength to match atmospheric conditions, link margin is converted into useful bandwidth. Modulation and FEC rate (modcod) is dynamically matched to the current Es/No returned from the remote modem. Symbol rate is kept constant, changing the terrestrial data rate up or down with Es/No. ACM operation automatically accounts for all other link impairments including antenna alignment error, inclined orbit, phase noise and other degradations.

ACM can be used on point-to-point IP links. ACM must be on in Tx on the transmitting modem and Rx in the receiving modem. It must be on in both Tx and Rx in both modems if ACM is to be actively used for both outbound and inbound carriers. It requires a satellite return channel (either DVB-S2 or SCPC). The return channel can be used for user data as well and no special set up is required – the modem will automatically ensure Es/No information is returned to the transmitting modem with no material impact on bandwidth.

In terms of configuration, the link is set up as normal, using a nominal data rate, modulation and FEC rate that gives the required symbol rate. The *only* other step is switching ACM on!

The modcod selected by the user on the forward path represents the maximum modcod to be used when ACM is active. This allows higher order modcods that cause non-linear distortion in the RF chain to be avoided. ACM will use all modcods up to and including the modcod set by the user. It is easier to set up an ACM link as normal rather than being forced to adapt to an alternative such as setting a fixed symbol rate. Uniquely for any ACM implementation, other than switching ACM on, no other ACM-specific controls are necessary.

Paradise ACM works at true QEF points. All DVB-S2 modcods from QPSK ¼ to 16APSK 9/10 are available and both short block and normal block sizes are supported. Each modcod operates over a defined range in relation to carrier-to-noise level, providing true quasi-error-free operation. Rapid fading is countered by using predictive tracking to estimate what the remote Es/No will do before it happens, which prevents link loss even in sudden deep fades. Should the link be lost then the minimum modcod is automatically selected in order to re-establish the link. The transmitter can switch between any two modcods – it does not have to go through them in sequence. Since ACM can work all the way down to a negative Es/No, i.e. below what the link was designed for, it effectively gives 100% link availability (albeit at a reduced data rate).

Note that with DVB-S2 ACM, pilots are automatically switched on at operating points where their use achieves the maximum throughput for a particular Es/No. For example, for an available Es/No of 6.5dB, it is better to use short-block 8PSK 3/5 with pilots on (spectral efficiency 1.69bits/s/Hz) than to use the most suitable short-block modcod with

pilots off, i.e. QPSK 5/6 (spectral efficiency 1.6bits/s/Hz). Pilots are sometimes viewed as causing an undesirable increase in overhead but it should be remembered that they also reduce the Es/No at which the modem can lock – this trade-off means that optimal throughput is sometimes achieved only with the active use of pilots.

Note that ACM can be used with AUPC at the same time (providing automatic uplink power control helps maintain the remote Eb/No at the target level).

Modcod changes are totally transparent at the receiver - it does not involve the demodulator having to reacquire the signal. Modcod changes can be made instantly whenever required, maximising throughput at all times.

Because the symbol rate is kept constant, any change in modcod will change the terrestrial data rate. An increase in data rate does not need to be explicitly signalled to the terrestrial network. A decrease does, because it could result in a buffer overflow in the transmit modem if it receives more data than it can transmit. Upstream buffer control is achieved by sending Ethernet Pause frames that define a period of time for which transmission should be suspended. In principle, Pause frames are supported only for full-duplex links and support for them in vendor equipment is optional, therefore the modem auto-negotiates this capability with the attached equipment.

Paradise ACM is intrinsically tied to an IP traffic shaper and TCP accelerator, allowing data grooming to match data priority to the available bandwidth. Without this, there would be no effective data management of a dynamically varying channel, which would become a free-for-all where you would not be sure which packets will be passed over satellite and which will be dropped. Note that an external traffic shaper cannot be aware of the instantaneous data rate in the modem and is therefore restricted to shaping for the nominal data rate of the link (i.e. for a fixed modcod). (The Ethernet Pause frame does not help in any way with external traffic shaping – its purpose is purely to minimize any packet loss at the point in time when a modcod change occurs. It is therefore strongly recommended to use the modem's internal traffic shaping feature in conjunction with ACM.)

Note that ACM works to the full symbol rate of the modem.

ACM menu on/off options are accessible once DVB-S2 is selected as the Tx or Rx service (see the *Edit->Tx-Rx->Service* screen). ACM status can be viewed from the *Status* screen).

ACM is built into the modem and does not require the use of a separate controller box.

ACM is compatible with the use of Paradise's *Paired Carrier*, allowing both carriers to use the same space segment, further reducing bandwidth requirements.

7.9 DVB-S2X, DVB-S2 and SmartLink

The **Q-Flex™** modem supports SCPC, DVB-S2/S2X and combined SCPC/DVB-S2 operation.

The DVB-S2 standard was approved by ETSI (European Telecommunications Standards Institute) in November of 2006 and was extended in March of 2014 by the DVB-S2X standard. Each in turn has provided greater spectral efficiency and improved link stability, using high-order modulation schemes and more powerful FEC coding.

DVB-S2/S2X is suitable for the transmission of all types of traffic, not just video. DVB-S2 allows for *both* continuous data streams (such as those provided by G.703 and EIA530 interfaces) and packetised data (such as IP and MPEG video). The space segment savings of DVB-S2/S2X can therefore be obtained equally on a wide range of satellite links ranging from traditional low-rate SCPC links to high rate broadcast video and IP.

The **Q-Flex™** allows:

- DVB-S2/S2X outbound with an SCPC return or an SCPC outbound with a DVB-S2/S2X return.
- DVB-S2/S2X outbound and return.
- SCPC outbound and return.
- *SmartLink* mode where SCPC features are combined with DVB-S2 space segment savings. All traditional SCPC features such as IBS, Drop and Insert, ESC, AUPC, etc. are supported. The operation of the *SmartLink* FEC in terms of BER performance is identical to DVB-S2. (Note that *SmartLink* has not yet been extended to work in DVB-S2X mode.)

DVB-S2 does not directly support any of these SCPC features and therefore *SmartLink* was developed to allow existing SCPC services to benefit immediately by switching to the newer highly-efficient DVB-S2 technology without compromising the services being provided.

SCPC, DVB-S2 and *SmartLink* processing paths through the modem are shown in the diagram overleaf. The top path (Interface-Framer-Outer FEC-Inner FEC-Modulator/Demodulator) shows the path used in SCPC processing and the functionality that is associated with each of these blocks. The lower path (Interface-SCPC Framer-DVB-S2 Framer-Outer FEC-Inner FEC-Modulator/Demodulator) shows the path used in DVB-S2 and *SmartLink* processing. Note that 'pure' DVB-S2 bypasses the SCPC framer and uses the DVB-S2 framer only. *SmartLink* takes the output of the SCPC framer (which includes the output from Drop and Insert, the ESC channel, etc.) and overlays this with DVB-S2 framing. Even although this can involve two lots of framing (depending on whether SCPC Closed Network mode is selected) the increased overhead is more than offset by the savings of switching to DVB-S2 space segment.

Figure 7-14 shows which features can be mixed in *SmartLink* mode and which cannot – for example, 16QAM appears on the SCPC processing path only and is therefore not available when *SmartLink* is operational.
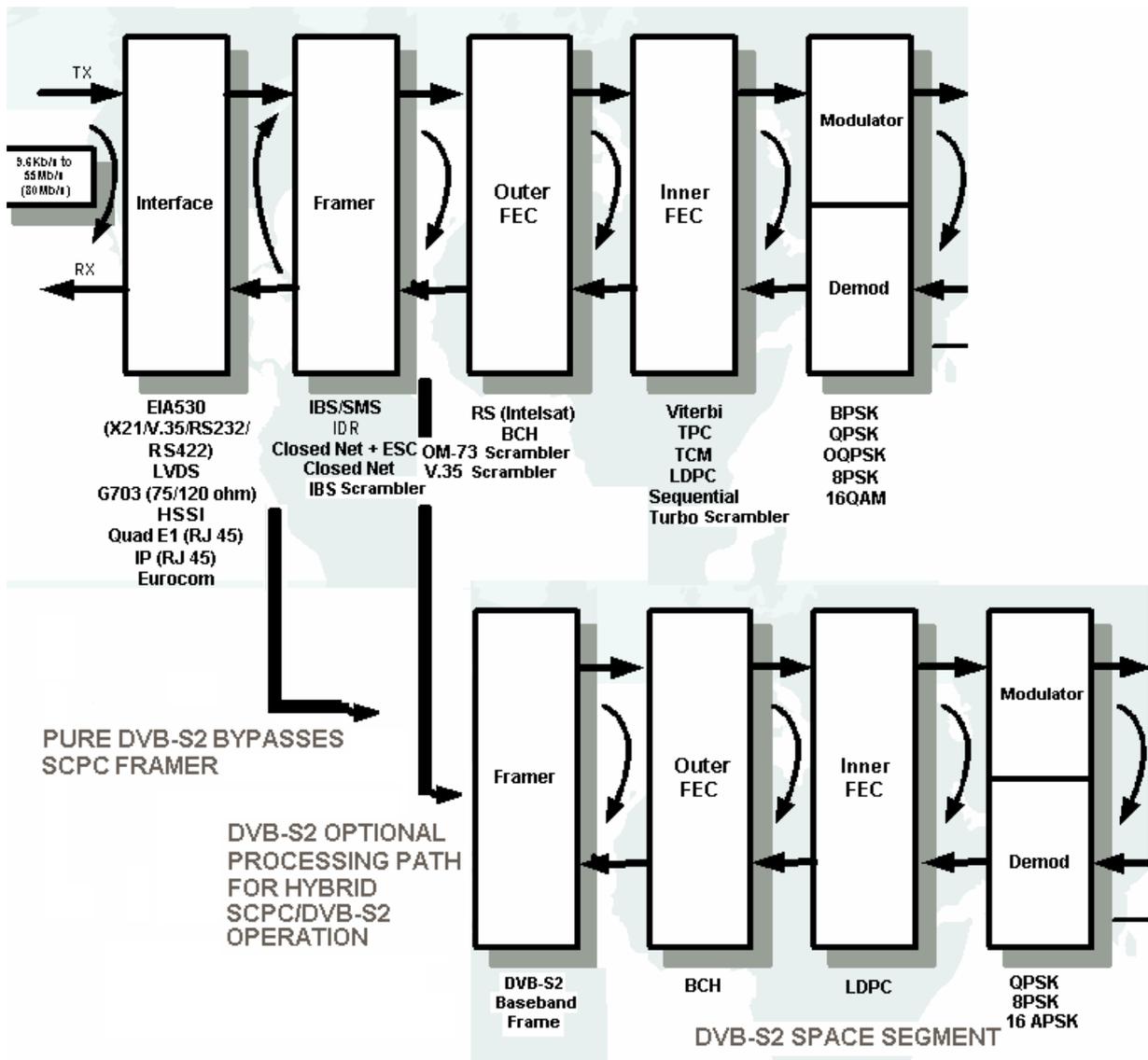
Figure 7-14 Processing Paths through Modem
(Top path is SCPC; lower path is DVB-S2/*SmartLink*)

If DVB-S2 is required but no SCPC features are required then as well as selecting *SmartLink,* the Tx or Rx service should be set to *Closed network* as this does not add any extra framing to that provided by DVB-S2.

DVB-S2/S2X is provided as a Tx/Rx service option whereas *SmartLink* is provided as an SCPC FEC option once an SCPC service has been selected.

> ⚠ *If a DVB-S2-only service is required for an interface other than IP then the Closed Network service should be selected, along with the* **SmartLink** *FEC option. This will provide a DVB-S2 service with no additional SCPC framing overhead. DVB-S2 with IP is supported directly from the Tx and Rx service menu options.*

Once DVB-S2/S2X or *SmartLink* has been enabled, various other configuration menu options become available, including choice of modulation and FEC rate, as well as DVB-S2/S2X FEC frame size choice and DVB-S2/S2X pilots. DVB-S2/S2X pilots introduce a regular burst of unmodulated carrier that helps the demodulator lock onto the signal in poor signal-to-noise conditions at a cost of increased overheads of around 2.4%.

7.10 Paired Carrier™

Paired Carrier+ can be used to reduce satellite bandwidth requirements by up to 50% by overlapping transmit and receive carriers in the same space segment. It uses ViaSat's patented PCMA technology. Paired Carrier+ is now mature fourth-generation giving performance second to none. Adaptive self-interference cancellation is used to subtract the unit's transmitted signal from the composiste received signal, leaving just the desired signal. This is depicted in **Figure 7-15**.
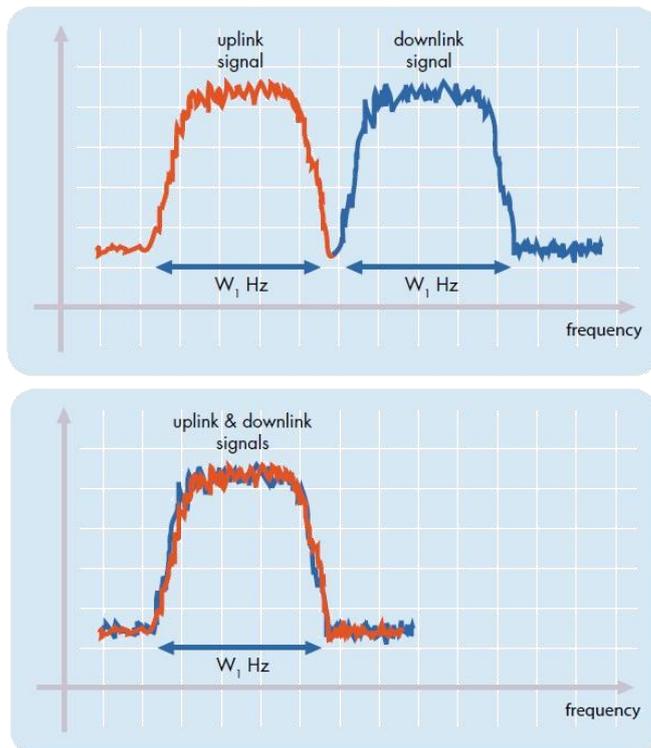
Typical satellite transmission with separate frequency slots for the uplink and downlink.

Using Paired Carrier+ with uplink and downlink carriers overlaid, 50% can be saved on the cost of space segment.

Figure 7-15 Frequency Re-use by Overlaying Carriers

The Paired Carrier+ processing in the modem to cancel the unwanted signal in the composite received signal to be left with only the desired signal is shown in the diagram overleaf. The signal cancellation algorithm estimates and compensates for gain, frequency, phase and delay in matching the unwanted component of the composite Rx signal with a delay buffered version of its own transmission.
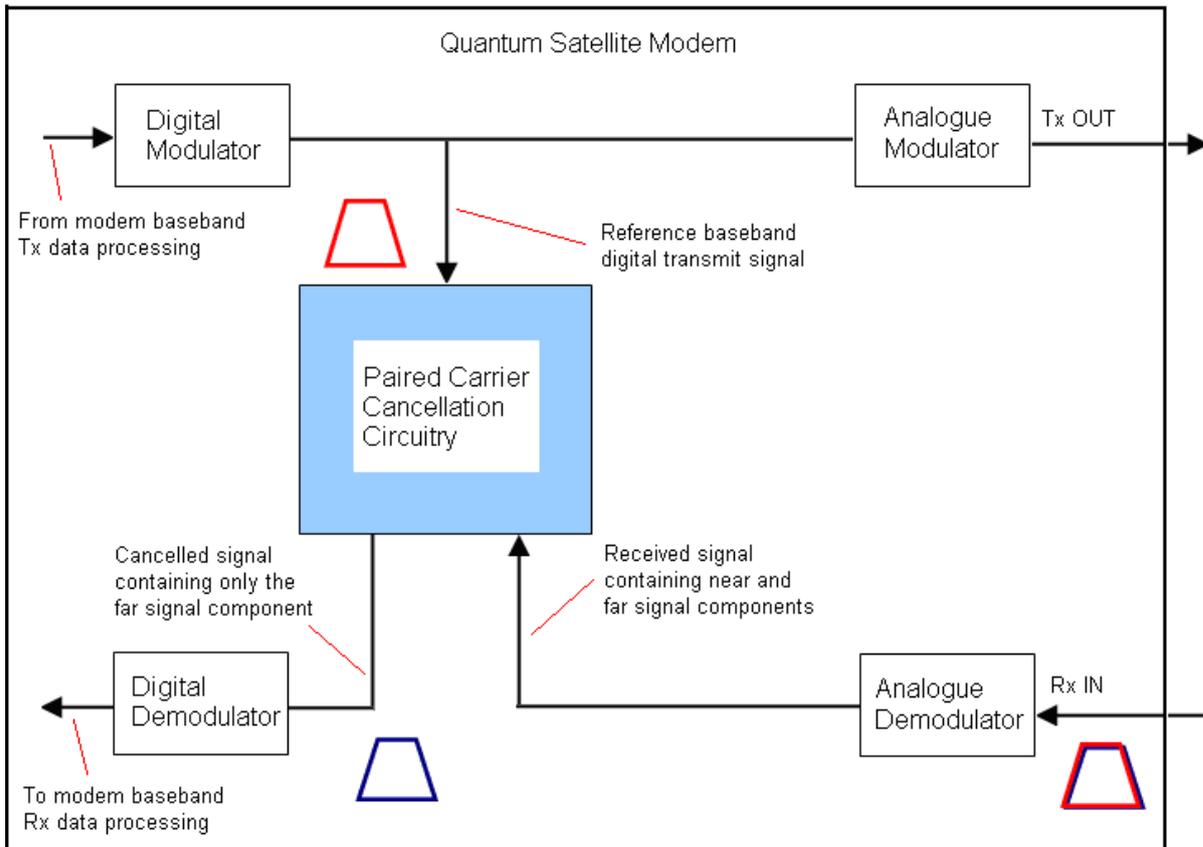
Figure 7-16 Q-Flex™ Modem Paired Carrier Processing

Paired Carrier+ can be added to existing systems as well as being incorporated into the design of new systems. The signal cancellation techniques used guarantees at least 25dB (typically 30dB) cancellation of the unwanted signal meaning that the uplink and downlink signals can share the same space segment. By doubling satellite throughput in terms of spectral efficiency Paired Carrier+ can be used to cut operational expenses and/or free up satellite bandwidth for new applications and services. The savings can be used to reduce bandwidth or increase throughput or convert to a higher coding gain to decrease power.

Both symmetric and asymmetric point-to-point links are supported. Symmetric links typically have similar antenna sizes and use similar power levels at each end of the link whereas asymmetric links wil typically use a larger antenna at one end of the link and a smaller antenna at the other end, with dissimilar power levels. In the asymmetric case, the system can be designed to require signal cancellation at only one end of the link, with the unwanted signal at the other end being reduced to a level comparable with system noise.

Paired Carrier+ is designed for use in point-to-point links.

Paired Carrier+ helps in the case of bandwidth-limited links. However, if a link is instead power limited then its design can be changed to turn it into a bandwidth-limited link and then Paired Carrier+ can be used to improve the bandwidth utilisation.

Paired Carrier+ is waveform agnostic and will work with all modulation and FEC schemes. It is used in addition to, not instead of, other bandwidth saving techniques.

Paired Carrier+ and DVB-S2/S2X represent two of the most bandwidth-efficient technologies available today and can be used together in the **Q-Flex™** modem.

Some frequently asked questions about Paired Carrier+ operation along with answers are provided below.

Q. Does Paired Carrier+ require a particular modulation or FEC configuration?

A. No, Paired Carrier+ imposes no special parameter limitations on the carriers involved. However, sometimes it is advantageous to use the bandwidth savings to switch to a more robust modulation and coding scheme - but this is application dependent.

Q. Can Paired Carrier+ handle multiple transmit and receive carriers?

A. No, the separate Paradise PCMA-70 Satellite Bandwidth Extender should be used if you require to cancel multiple carriers appearing within the cancellation bandwidth.

Q. Can Paired Carrier+ handle asymmetric carriers, that is, carriers with different data rates and/or different symbol rates on transmit and receive?

A. Yes, the Paired Carrier+ can handle asymmetric carriers.

Q. My transmit and receive carrier levels off satellite are different, can I still use the Paired Carrier+ satellite signal canceller?

A. Yes, however, the wanted and unwanted signal levels (power spectral density) should normally be within 10dB of each other. Symbol rate asymmetry of up to 12:1 is supported. It is sometimes possible to relax these conditions subject to the constraints of an overall detailed link budget analysis. Power asymmetry must be kept between +10 to -10dB using the equation

Power ratio (dB) = Near PSD – Far PSD + 10log(Near symbol rate/Far symbol rate)

Q. Does the modem redundancy configuration affect Paired Carrier+ operation?

A. No, Paired Carrier+ works equally as well in 1:1 and 1:N modem redundancy systems. The standby modem will have to go through the normal acquisition process when it comes on traffic. While it is in standby, it is not possible for the demodulator to lock (it cannot cancel the unwanted carrier since in principle it can only cancel its own transmission). Paradise has therefore muted various spurious alarms that would otherwise be reported for the standby modem in this situation.

Q. Can I remotely control the Paired Carrier+ function?

A. Yes, Paired Carrier+ can be controlled remotely in the same way as any other modem function via RS232, RS485, web browser or SNMP.

Q. Can I add Paired Carrier+ into an existing network?

A. Yes, bandwidth savings can be made with existing networks, but a link budget analysis must be made to assess the suitability and benefits.

Q. Surely there is some disadvantage in using Paired Carrier+?

A. Paired Carrier+ has a minimal impact on Eb/No for a desired BER but typically between 0.15dB and 0.5dB extra carrier power is required to be transmitted on satellite to overcome the imperfections in the signal cancellation process. Also, of course, power is needed for the second carrier.

Q. What prerequisites exist for using Paired Carrier+?

A. It requires a full-duplex link where you must be able to receive your own uplink signal off satellite. It works only with 'bent-pipe' transponders where there is no demodulation/remodulation or cross-strapping between transponders. The transponder must do no more than filter, frequency convert and amplify the signal.

Q. Is it difficult and time consuming to install and set up Paired Carrier+?

A. No. The operator sets the satellite delay or alternatively the modem and satellite positions to allow the satellite signal to be acquired. A few other parameters specific to Paired Carrier+ need to be set up. Set up takes less than five minutes in total.

Q. Is Paired Carrier+ available as a field upgrade?

A. Yes. All **Q-Flex™** modems can be field upgraded to support Paired Carrier+ operation to the desired cancellation bandwidth.

Q. Is Paired Carrier+ affected by spectral inversions?

A. Yes. Paired Carrier+ will operate correctly if the following simple spectral inversion rules are observed:

     a. Try to keep the signals in the space segment non-inverted. This keeps everything conceptually straightforward. If the ground-segment **uplink** equipment contains a spectral inversion then you should put a **Tx** spectral inversion in the modem to correct for it. This ensures that the signals in the space segment are spectrally non-inverted.

     b. If the ground segment **downlink** equipment contains a spectral inversion (e.g., due to an inverting LNB) then you should put an **Rx** spectral inversion in the modem to correct for it.

7.11 Antenna Control

Two methods of antenna control are provided by the modem:

- A scalable (0 to 10V) AGC output is available via the Alarms & AGC serial connector (the pinout for which is defined in Chapter 10). The AGC output can be set to represent the demodulator AGC level, the Rx composite power level, the Rx wanted signal level or the receive Eb/No level (the last two of which are only available when the demodulator is locked). Other signals on this connector can be used to infer the demodulator lock status and to mute the modem Tx carrier.
- The OpenAMIP protocol is supported.

Both of these options are described in more detail below.

Antenna Serial Control

Serial antenna control is supported under *Test->Antenna* (**Figure 7-17**).
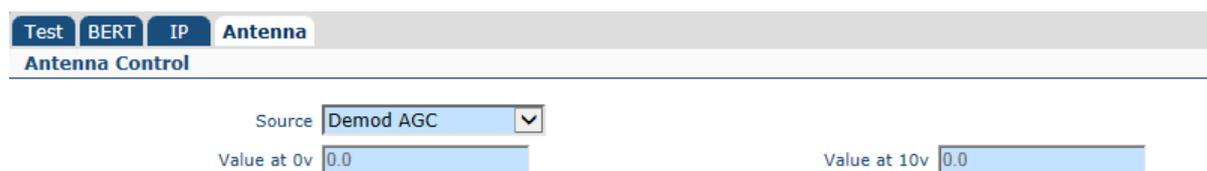
Figure 7-17 Antenna Serial Control AGC Output

The AGC output on the Alarms & AGC connector can be set to be driven by various signals (demodulator AGC, Rx composite power, Rx wanted signal level and Rx Eb/No) as shown in **Figure 7-18**.
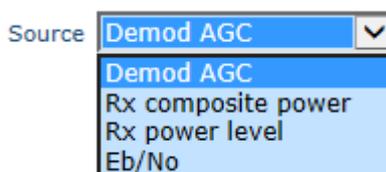
Figure 7-18 Antenna Serial Control Output Source Signal Selection

The AGC output range is 0 to 10V. A scaling factor can be applied to the output. This controls the slope of the output in order to give the desired range of output values for supplying to the antenna controller. For example, if the AGC output is set to represent Eb/No, then a user may decide to set 0V to represent 0dB and 10V to represent 6dB Eb/No (by entering 0 and 6 respectively to represent the 0 and 10V levels). In this case, any Eb/No value over 6dB would be represented by a 10V output also.

In addition to the AGC output on pin 8, there is a Tx Mute control and the Rx Lock status can be obtained on the Alarms & AGC connector as follows:

- Pin 3 provides an indication for Rx traffic faults, the highest priority fault of which is a demodulator unlock (so the alarm output approximately amounts to a demodulator lock/unlock status). Since this is a relay output, the relay common on pin 2 needs to connected to GND (pin 15). A pull-up resistor (if there isn't one already in the ACU) needs to be attached to pin 3 as it is normally open (representing the non-fail state).
- Pin 7 is a Tx Mute input from the ACU. It will inhibit transmission when active.
- GPS is supported by the modem in general but not for beam switching therefore a GPS input is not required in relation to antenna control.

Antenna IP Control

The OpenAMIP protocol is supported for use with antenna control units. This feature is supported in the Antenna IP Control section of the *Test->Antenna* menu (**Figure 7-19**).

Figure 7-19 Antenna IP Control

Tx Mute control and Rx Lock status are provided via the AMIP protocol. The AMIP control needs to be enabled and the antenna controller IP address and TCP port number need to be entered. Thereafter, all AMIP control is automatic.

7.12 Beacon Receiver

The Q-Lite modem supports a beacon receiver mode of operation as standard.

The beacon receiver support in the modem can help with automatic antenna pointing when attempting to lock onto a satellite. This modem feature negates the need for a separate beacon receiver.

The beacon receiver detection capability (**Figure 7-20**) has been added to the existing built-in web spectrum monitor tool and allows a satellite beacon transmission to be detected down to very low signal levels.
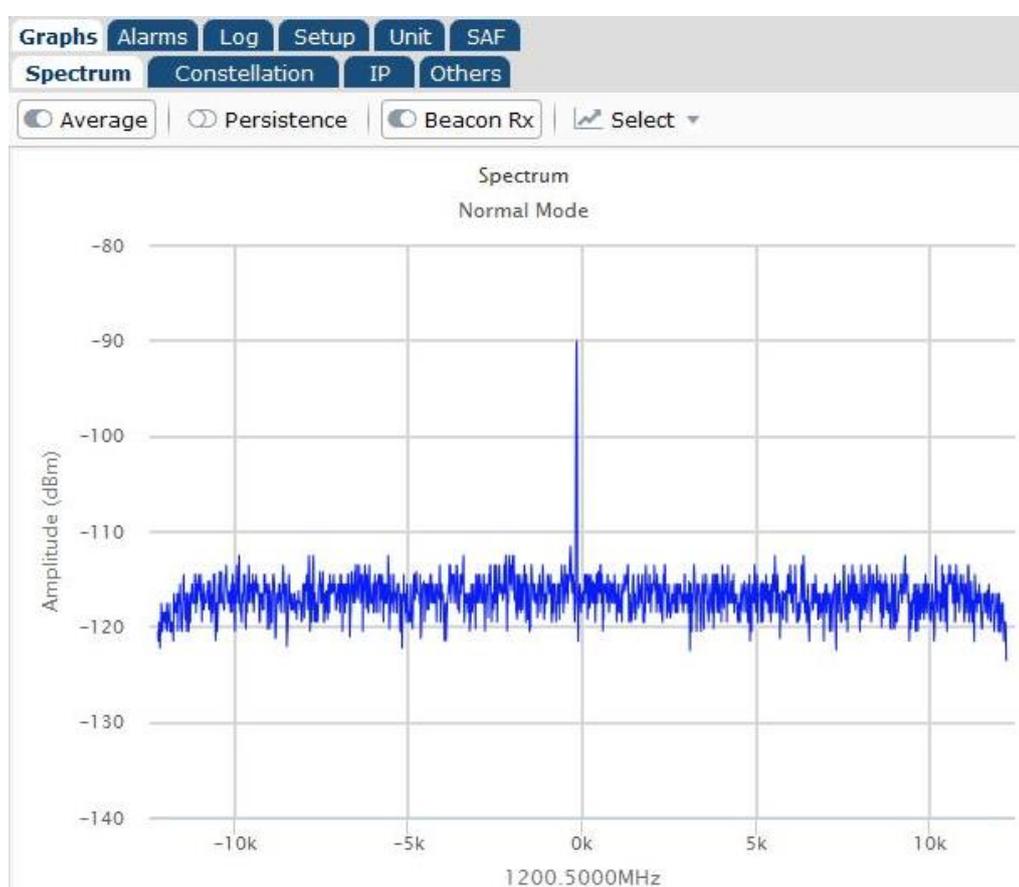
Figure 7-20 Spectrum Monitor in Beacon Receiver Mode

Figure 7-20 shows the beacon frequency to be 1200.5MHz and a received power level of -92dBm. The noise floor is at -134dBm/Hz and the total power across the band is -45.2 dBm. In this particular case, there were also adjacent carriers as follows: Interferer 1 at 1198.6328MHz (approximately 2MHz wide) at a signal level of -40.5dBm; Interferer 2 at 1202.3672MHz (also approximately 2MHz wide) at a signal level of -40.6 dBm.

When the beacon receiver mode is is selected, the demodulator is reprogrammed and can lock onto a CW signal being transmitted by a satellite beacon. This will be shown on the spectrum plot and the Rx signal level will be reported. The composite Rx power level (from all the transponders on the satellite) is also available and can be used in

conjunction with the received beacon signal level at an early point in the detection process to confirm the antenna is pointed in the correct direction.

Once the signal has been peaked it is possible to determine the beacon carrier-to-noise measurement by analysing the spectrum graph data and looking for maximum and minimum signal levels.

This feature is useful when deploying a satellite terminal, allowing the user to correctly identify the satellite that antenna is pointed towards.

While active, the beacon detection interferes with the normal demodulation process of the modem but since beacon detection is normally a deployment activity prior to establishing a working service, this restriction should not be an issue.

7.13 Point-to-multipoint Interoperation with Q-MultiFlex

The Q-Lite can receive a shared outbound from a Q-MultiFlex unit and generate an inbound carrier that is received by one of the sixteen demodulators in the Q-MultiFlex.

This section explains the different modes that can be used. Bridging, VLAN tagging and routing are all supported. Remote M&C traffic can be passed in its own special VLAN (which creates convenient separation from user traffic) regardless of whether VLANs are or aren't being used more generally. Traffic and M&C ports can be on separate subnets if required.

When using DVB-S2/S2X, the shared outbound carrier from the Q-MultiFlex can be composed of a single modcod (i.e. modulation and FEC rate) or of a unique modcod for each remote modem (up to 16 modcods are supported). (This form of multistreaming is sometimes referred to as VCM.) There is no limit to the number of remote modems that can share a single outbound since multiple Q-MultiFlex units can be cascaded together to share the same outbound. The Q-Lite is capable of filtering on a single stream (modcod) in the shared outbound. The modcod will be chosen depending on the signal strength received at the remote modem. For example, one site may be able to receive only QPSK 9/10 while another may be able to receive 8PSK ¾ and another 16APSK 8/9. The spectral efficiencies of each of these vary considerably and therefore throughput can be maximised for each remote site at the same time.

In addition, point-to-multipoint DVB-S2/S2X ACM is supported. In this scenario, each remote modem reports back its current Es/No and the Q-MultiFlex will change each of the modcods independently in the shared outbound in order to maximise the throughput for the current conditions being experienced at each remote.

In all cases when interoperating with a Q-MultiFlex, the Q-Lite must have the point-to-multipoint setting set to *Point-to-multipoint* or *Point-to-multipoint-multistreaming* as described in Section 6.3.2.8, which also describes how the Q-Lite can filter on a single stream (modcod) from the shared outbound. VLAN tags can be attached/removed internally by the Q-MultiFlex and Q-Lite or can be handled outside of the modems (by Ethernet switches for example). A VLAN can optionally be associated with each modcod in the shared outbound. Filtering at the Q-Lite in this case is by *Stream Identifier* and by the VLAN ID. VLAN filtering can also be used in the case where the shared outbound consists of only a single modcod. In all cases, traffic shaping can be used to allocate bandwidth to VLANs and/or modcod streams.

When point-to-multipoint ACM is being used on the Q-Lite, the setup is the same as for *Point-to-multipoint-multistreaming* mentioned above with the addition that the ACM feature is switched on in the Q-Lite (specifically being set to *Monitor* mode). It is important that the 'nominal' modcod set for the Q-Lite represents the highest modcod that ACM should use when selecting a modcod for the remote modem as part of the shared outbound carrier. For example, the RF constraints of one remote site may mean that the highest modcod that can be used is 8PSK ¾ whereas another site may be able to use 16APSK 9/10. In all cases, the symbol rate for the received carrier should be set to the overall symbol rate of the shared outbound, which does not vary regardless of the set of modcods being generated by the Q-MultiFlex.

Chapter 8   Remote Control Protocol

The modem supports the following remote control interfaces:

- A built-in remote web user interface that provides 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 port 80).
- 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'*) 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 Series Satellite Modems*'.

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 l F T x l 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 l F T x l 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 9   Data Interfaces

The modem provides Ethernet IP interfaces as standard plus options for LVDS, EIA530 (RS422, V.35, and RS232), IDR, HSSI, G.703 (balanced and unbalanced), Quad E1, IP traffic and Eurocom D1 interfaces. There are four data interface positions on the modem.

The P3722 G.703 option card supports E1/T1/E2/T2/E3/T3 data rates. Both balanced RJ45 and and unbalanced BNC connectors are available.

The P3721 IDR option must be fitted in an upper interface position.

1:1 Redundancy Operation

The G.703 interface needs to be specifically configured for 1:1 operation. The 1:1 G.703 mode controls what happens when power is removed. If the power is lost in *Normal* mode then the G.703 input and output are joined in order to ensure that if the G.703 signal is looped through multiple equipment then the other traffic is not affected by a break in the G.703 line. If the power is lost in *1:1* mode then the G.703 output goes high impedance, allowing the online modem in the 1:1 pair to carry the traffic.

'Y' cables are normally used with the terrestrial interfaces. The IP interface requires separate but parallel connections to the network.

IP 1:1 Modem Redundancy Connection Schematic
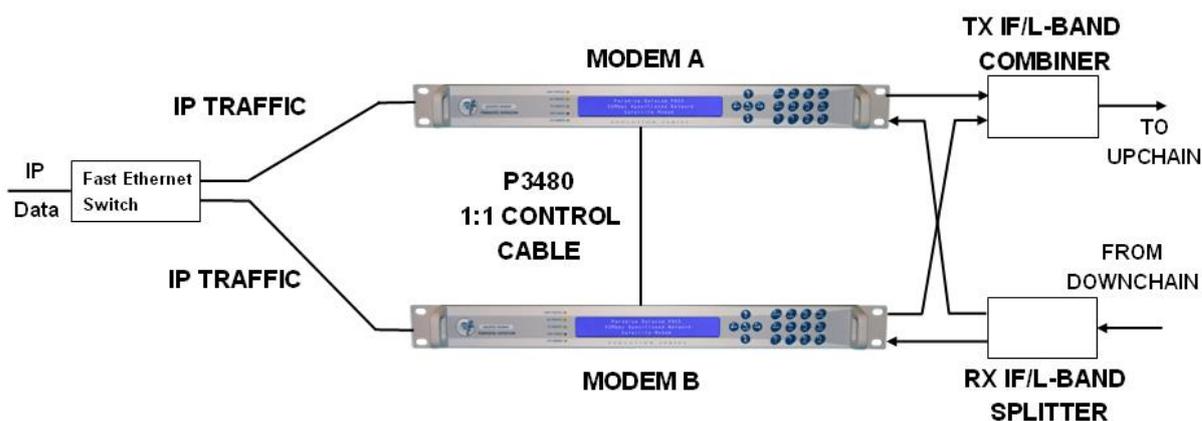
Handshake Lines

Many interfaces provide optional control lines (such as RTS/CTS etc). It is generally better to use these if they are available.

Q3001 LVDS Interface

The LVDS interface is used as follows.

Min Req	Signal Description	LVDS Name	Circuit Number	25 pin		Electrical Levels
				A	B	
DATA CIRCUIT TOWARDS MODEM (TX)						
✓	**Clock In**	TT	113	24	11	LVDS
✓	**Data In**	SD	103	2	14	LVDS
	Sig' Valid In	RS	105	4	19	LVDS
	Sig Accpt'd Out	CS	106	5	13	LVDS
	Int' Tx Clock Out	ST	114	15	12	LVDS
DATA CIRCUIT FROM MODEM (RX)						
✓	**Clock Out**	RT	115	17	9	LVDS
✓	**Data Out**	RD	104	3	16	LVDS
	Sig' Valid Out	RR	109	8	10	LVDS
COMMON LINES						
✓	**Signal Ground**	SG	102	7		Ground
✓	**Shield/Protective ground**	PG	101	1		Screen
	Device (DTE) Ready In	TR	108	20	23	LVDS
	Device (DCE) Ready Out	DM	107	6	22	LVDS
	Local Loop In	LL	141	18		LVDS
	Remote Loop In	RL	140	21		LVDS

The modem can operate at high data rates using the LVDS interface, but the maximum useable data rate is limited by connecting cable length. The maximum data rate is 10Mbps over a 10m cable (over good quality twisted pair screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (.e. 5Mbps to 20m, 2.5Mbps to 40m etc). Similarly, the maximum data rate increases as the connecting cable length is reduced (i.e. 20Mbps to 5m, 40Mbps to 2.5m).

The input clock/data phase is selected automatically, reporting a `Data Marginal` warning whenever it has to switch phase. If the modem reports Data Marginal frequently then this is not a modem fault but an indication that you have a clocking problem external to the modem (ie changing clock/data phase, a problem which would otherwise have caused untraceable data errors). With the Tx Clocking Set to *Tx Clock In* the `Data In` signal is checked against the `Clock In` signal. With the Tx Clocking Set to *Internal* or *Rx* the `Data In` signal is checked against the `Int` Tx Clk Out` signal.

By selecting *Advanced* it is possible to configure the modem to raise an alarm if either the `Sig` Valid In` line (RS) or `Device (DTE) Ready In` line (TR) switch to the inactive state. It is also possible to configure the Tx carrier to be switched on and off by the `Sig` Valid In` line (RS) by selecting *Edit->Tx->Carrier* and selecting *RTS enabled*.

Q3705 HSSI Interface

The HSSI interface is used as follows.

Min Req	Signal Description	HSSI Name	50 pin		Electrical Levels
			+	-	
DATA CIRCUIT TOWARDS MODEM (TX)					
✓	**Clock In**	TT	9	34	ECL
✓	**Data In**	SD	11	36	ECL
✓	**Signal Ground**	SG	7	32	Ground
✓	DTE Available	TA	8	33	ECL
	Int' Tx Clock Out	ST	6	31	ECL
DATA CIRCUIT FROM MODEM (RX)					
✓	**Clock Out**	RT	2	27	ECL
✓	**Data Out**	RD	4	29	ECL
✓	**Signal Ground**	SG	1	26	Ground
✓	DCE Available	CA	3	28	ECL
COMMON LINES					
✓	**Signal Ground**	SG	13	38	Ground
✓	**Signal Ground**	SG	19	44	Ground
	Loopback Circuit A	LA	10	35	ECL
	Loopback Circuit B	LB	12	37	ECL
	Loopback Circuit C	LC	5	30	ECL

The modem can operate at high data rates using the HSSI interface, but the maximum useable data rate is limited by the connecting cable length. The maximum data rate is 10Mbps over a 10m cable (over good quality twisted pair screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (e.g. 5Mbps to 20m, 2.5Mbps to 40m, etc). Similarly, the maximum data rate increases as the connecting cable length is reduced (i.e. 20Mbps to 5m, 40Mbps to 2.5m).

The input clock/data phase is selected automatically, reporting a *Data Marginal* warning whenever it has to switch phase. If the modem reports *Data Marginal* frequently then this is not a modem fault but an indication that there is a clocking problem external to the modem (i.e. changing clock/data phase, a problem which would otherwise have caused untraceable data errors). With the Tx Clocking Set to *Tx Clock In* the *Data In* signal is checked against the *Clock In* signal. With the Tx Clocking Set to *Internal* or *Rx* the *Data In* signal is checked against the *Int` Tx Clk Out* signal.

All signals are balanced, differentially driven and received at standard ECL levels. The loopbacks LA and LB provided are direct supersets of the EIA signals LL (Local Loopback) and RL (Remote Loopback) Loopback LC is an optional request signal from DCE to DTE, to request that the DTE provides a loopback path to the DCE.

By selecting *Advanced* it is possible to configure the modem to raise an alarm if either the *Sig` Valid In* line (RS) or *Device (DTE) Ready In* line (TR) switch to the inactive state. It is also possible to configure the Tx carrier to be switched on and off by the *Sig= Valid In* line (RS) by selecting *Edit->Tx->Carrier* and selecting *RTS enabled*.

Please note: Although the HSSI cable uses the same connector as the SCSI-2 specification, the cable impedances of HSSI and SCSI-2 cables are different. SCSI-2 cables can be as low as 70Ω, whereas HSSI cables are specified at 110 Ohms. As a result, cables made to SCSI-2 specifications may not work correctly with HSSI. Incompatibilities will be more apparent with longer cable lengths.

EIA-530 Interface in RS422 Mode

The EIA-530 interface is used in RS422 mode as follows.

Min Req	Signal Description	RS422 Name	Circuit Number	25 pin		Electrical Levels
				A	B	
DATA CIRCUIT TOWARDS MODEM (TX)						
✓	**Clock In**	TT	113	24	11	RS422
✓	**Data In**	SD	103	2	14	RS422
	Sig' Valid In	RS	105	4	19	RS422
	Sig Accpt'd Out	CS	106	5	13	RS422
	Int' Tx Clock Out	ST	114	15	12	RS422
DATA CIRCUIT FROM MODEM (RX)						
✓	**Clock Out**	RT	115	17	9	RS422
✓	**Data Out**	RD	104	3	16	RS422
	Sig' Valid Out	RR	109	8	10	RS422
COMMON LINES						
✓	**Signal Ground**	SG	102	7		Ground
✓	**Shield/Protective ground**	PG	101	1		Screen
	Device (DTE) Ready In	TR	108	20	23	RS422
	Device (DCE) Ready Out	DM	107	6	22	RS422
	Local Loop In	LL	141	18		RS232
	Remote Loop In	RL	140	21		RS232

The maximum data rate is 10Mbps (over good quality twisted pair screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (ie 5Mbps to 20m, 2.5Mbps to 40m etc).

The input clock/data phase is selected automatically, reporting a `Data Marginal` warning whenever it has to switch phase. If the modem reports Data Marginal frequently then this is not a modem fault but an indication that you have a clocking problem external to the modem (i.e. changing clock/data phase, a problem which would otherwise cause untraceable data errors). With the Tx Clocking Set to *Tx Clock In* the `Data In` signal is checked against the `Clock In` signal. With the Tx Clocking Set to *Internal* or *Rx* the `Data In` signal is checked against the `Int= Tx Clk Out` signal.

By selecting *Advanced* it is possible to configure the modem to raise an alarm if either the `Sig= Valid In` line (RS) or `Device (DTE) Ready In` line (TR) switch to the inactive state. It is also possible to configure the Tx carrier to be switched on and off by the `Sig= Valid In` line (RS) by selecting *Change*, *Tx*, *Modulator*, *Carrier*, *RTS-Controlled*.

EIA-530 Interface in V.35 Mode

The EIA-530 interface is used inV.35 mode as follows.

Min Req	Signal Description	V.35 Name	Circuit Number	25 pin		Electrical Levels	Old Style Winchester
				A	B		
	DATA CIRCUIT TOWARDS MODEM (TX)						
✓	**Clock In**	SCTE	113	24	11	V.35	U & W
✓	**Data In**	SD	103	2	14	V.35	P & S
	Sig' Valid In	RTS	105	4		RS232	C
	Sig Accpt'd Out	CTS	106	5		RS232	D
	Int' Tx Clock Out	SCT	114	15	12	V.35	Y & aa
	DATA CIRCUIT FROM MODEM (RX)						
✓	**Clock Out**	SCR	115	17	9	V.35	V & X
✓	**Data Out**	RD	104	3	16	V.35	R & T
	Sig' Valid Out	RLSD	109	8		RS232	F
	COMMON LINES						
✓	**Signal Ground**	SG	102	7		Ground	B
✓	**Shield/Protective ground**	FG	101	1		Screen	A
	Device (DTE) Ready In	DTR	108	20		RS232	H
	Device (DCE) Ready Out	DSR	107	6		RS232	E
	Local Loop In	LL	141	18		RS232	-
	Remote Loop In	RL	140	21		RS232	-

The maximum data rate is 10Mbps (over good quality twisted pair screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (ie 5Mbps to 20m, 2.5Mbps to 40m etc.).

The input clock/data phase is selected automatically, reporting a `Data Marginal` warning whenever it has to switch phase. If the modem reports Data Marginal frequently then this is not a modem fault but an indication that you have a clocking problem external to the modem (ie changing clock/data phase, a problem which would otherwise have caused untraceable data errors). With the Tx Clocking Set to *Tx Clock In* the `Data In` signal is checked against the `Clock In` signal. With the Tx Clocking Set to *Internal* or *Rx* the `Data In` signal is checked against the `Int= Tx Clk Out` signal.

If you require the older 34-pin `Winchester` connector then an adaptor lead is required - please contact the factory for details.

By selecting *Advanced* it is possible to configure the modem to raise an alarm if either the `Sig= Valid In` line (RTS) or `Device (DTE) Ready In` line (DTR) switch to the inactive state. It is also possible to configure the Tx carrier to be switched on and off by the `Sig= Valid In` line (RTS) by selecting *Edit->Tx->Carrier* and selecting *RTS enabled*.

EIA-530 Interface in RS232 Mode

The EIA-530 interface is used in RS2322 mode as follows. The interface type can be selected as *Synchronous* or *Asynchronous*
.

Min Req	Signal Description	RS232 Name	Circuit Number	25 pin A	B	Electrical Levels
DATA CIRCUIT TOWARDS MODEM (TX)						
✓	**Clock In**	DA	113	24		RS232
✓	**Data In**	BA	103	2		RS232
	Sig' Valid In	CA	105	4		RS232
	Sig Accpt'd Out	CB	106	5		RS232
	Int' Tx Clock Out	DB	114	15		RS232
DATA CIRCUIT FROM MODEM (RX)						
✓	**Clock Out**	DD	115	17		RS232
✓	**Data Out**	BB	104	3		RS232
	Sig' Valid Out	CF	109	8		RS232
COMMON LINES						
✓	**Signal Ground**	AB	102	7		Ground
✓	**Shield/Protective ground**	SHIELD	101	1		Screen
	Device (DTE) Ready In	CD	108	20		RS232
	Device (DCE) Ready Out	CC	107	6		RS232
	Local Loop In	LL	141	18		RS232
	Remote Loop In	RL	140	21		RS232

The maximum synchronous data rate is 100kbps (over good quality screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (ie 50kbps to 20m, 25kbps to 40m etc). Note that this is a synchronous RS232 interface - if you need an asynchronous interface then please contact the factory.

For the Synchronous RS232 interface theinput clock/data phase is selected automatically, reporting a `Data Marginal` warning whenever it has to switch phase. If the modem reports

Data Marginal frequently then this is not a modem fault but an indication that you have a clocking problem external to the modem (ie changing clock/data phase, a problem which would otherwise have caused untraceable data errors). With the Tx Clocking Set to *Tx Clock In* the `Data In` signal is checked against the `Clock In` signal. With the Tx Clocking Set to *Internal* or *Rx* the `Data In` signal is checked against the `Int= Tx Clk Out` signal. By selecting *Advanced* it is possible to configure the modem to raise an alarm if either the `Sig= Valid In` line (CA) or `Device (DTE) Ready In` line (CD) switch to the inactive state. It is also possible to configure the Tx carrier to be switched on and off by the `Sig= Valid In` line (CA) by selecting *Change*, *Tx*, *Modulator*, *Carrier*, *RTS-Controlled*.

For Asynchronous RS232 interface the Tx / Rx AIS detectors and the data marginal detectors are automatically disabled to prevent any unwanted alarms. The internal Tx clock output is also automatically used to provide a reference clock to the incoming Async data. For best operation, Paradise recommends using the Async RS232 interface at least 10 times oversampled. For example, an Async baud rate of 56.7kbaud requires a Modem bit rate of 512kbit.

EIA-530 Interface in X.21 Mode

The EIA530 interface can provide both X.21 DCE and X.21 DTE operation. For X.21 operation the interface must be set to RS422 mode, and the Tx & Rx Clocking modes must be set correctly. With the use of the appropriate adaptor lead (to convert to the X.21 standard 15 pin D connector), a full X.21 DCE or DTE interface is available.

X.21 DCE Operation

This has only a clock *from* the modem to the terrestrial equipment. Configure a cable with a 15 pin `D` female at one end (X.21 DCE) and a 25 pin `D` male at the other end as follows:

Min Req	X.21 DCE (15 pin D female)			Signal Description	RS422 Name	Circuit Number	25 pin		Electrical Levels
	Name	A	B				A	B	
DATA CIRCUIT TOWARDS MODEM (TX)									
✓	T	2	9	**Data In**	SD	103	2	14	RS422
	C	3	10	Sig' Valid In	RS	105	4	19	RS422
DATA CIRCUIT FROM MODEM (RX)									
✓	S	6	13	**Clock Out**	RT	115	17	9	RS422
✓	R	4	11	**Data Out**	RD	104	3	16	RS422
	I	5	12	Sig' Valid Out	RR	109	8	10	RS422
COMMON LINES									
✓	Sig gnd	8		**Signal Ground**	SG	102	7		Ground
✓	Prot gnd	1		**Shield/ Prot' ground**	PG	101	1		Screen

Clocking

For the interface to function as X.21, the clocking must be set as follows. The *Rx Clock Menu* is used to set the source of the single clock from the modem as *Satellite*, *Internal*, or *Station Clock*. *Tx Clk In* does not exist in X.21 and cannot be used. The Tx clock should be set to *Rx* as the Tx data is clocked by the same clock as the Rx data.

The maximum data rate is 10Mbps (over good quality twisted pair screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (ie 5Mbps to 20m, 2.5Mbps to 40m etc).

The input clock/data phase is selected automatically, reporting a `Data Marginal` warning whenever it has to switch phase. If the modem reports Data Marginal frequently then this is not a modem fault but an indication that you have a clocking problem external to the modem (ie changing clock/data phase, a problem which would otherwise have caused untraceable data errors). Check the phase of the *Data In* with respect to the *Clock Out* line.

It is possible to configure the Tx carrier to be switched on and off by the `Sig= Valid In` line by selecting Edit->*Tx*->*Carrier* and selecting *RTS enabled*.

X.21 DTE Operation

This has only a clock *to* the modem from the terrestrial equipment. Configure a cable with a 15 pin `D` male at one end (X.21 DTE) and a 25 pin `D` male at the other end as follows:

Min Req	X.21 DTE (15 pin D male)			Signal Description	RS422 Name	Circuit Number	25 pin		Electrical Levels
	Name	A	B				A	B	
DATA CIRCUIT TOWARDS MODEM (TX)									
Y	S	6	13	**Clock In**	TT	113	24	11	RS422
Y	R	4	11	**Data In**	SD	103	2	14	RS422
	I	5	12	Sig' Valid In	RS	105	4	19	RS422
DATA CIRCUIT FROM MODEM (RX)									
Y	T	2	9	**Data Out**	RD	104	3	16	RS422
	C	3	10	Sig' Valid Out	RR	109	8	10	RS422
COMMON LINES									
Y	Sig gnd	8		**Signal Ground**	SG	102	7		Ground
Y	Prot gnd	1		**Shield / Prot' ground**	PG	101	1		Screen

Clocking

For the interface to function as X.21, the clocking must be set as follows. The *Tx Clocks* menu should be used to take the single clock from the terrestrial by selecting *Tx Clock In.* The *Rx Clocks* menu should also be set to return Rx data in time with the single Tx Clock by also selecting *Tx Clock In.* No other combinations will work.

The maximum data rate is 10Mbps (over good quality twisted pair screened cable), but this rate is reduced as the connecting cables extend beyond 10m. As an estimate, assume the maximum rate halves as the distance doubles (ie 5Mbps to 20m, 2.5Mbps to 40m etc).

The input clock/data phase is selected automatically, reporting a `Data Marginal` warning whenever it has to switch phase. If the modem reports Data Marginal frequently then this is not a modem fault but an indication that you have a clocking problem external to the modem (ie changing clock/data phase, a problem which would otherwise have caused untraceable data errors). Check the phase of the *Data In* with respect to the Clock In line.

It is possible to configure the Tx carrier to be switched on and off by the `Sig= Valid In` line by selecting *Edit->Tx->Carrier* and selecting *RTS enabled.*

P3722 G.703 Interface

The G703 interface supports the following settings.

Rate	Bit rate	Line code	Impedance	Interface Card Connector
T1	1544kbps	AMI	100 Ohm	RJ45
T1	1544kbps	B8ZS	100 Ohm	RJ45
E1	2048kbps	HDB3	120 Ohm	RJ45
E1	2048kbps	HDB3	75 Ohm	BNC
T2	6312kbps	B6ZS	110 Ohm	RJ45
T2	6312kbps	B8ZS	75 Ohm	BNC
E2	8448kbps	HDB3	75 Ohm	BNC
E3	34.368Mbps	HDB3	75 Ohm	BNC
T3	44.736Mbps	B3ZS	75 Ohm	BNC

Unbalanced 75Ω operation is via BNC connectors and balanced 100/110/120Ω operation is via RJ45 connectors.

For T1 operation, AMI and B8ZS line code settings are available. For E1 operation, AMI and HDB3 line code settings are available. The modem will display a `Data Marginal` warning whenever a line code violation is detected. For T1 operation, a choice of line lengths is available that cause the modem to compensate the T1 signal for any line loss associated with the cable.

IP Interface

The IP is a standard interface supplied with the modem.

The modem supports two RJ45 Ethernet port for IP traffic and remote control respectively.

The Ethernet supports 10/100/1000Mbps data rates and uses CAT 5 Ethernet cable. Both straight and crossover cables are supported.

Quad E1 Interface

The P3706 Quad E1 interface card provides four RJ45 connectors supporting balanced E1 G.703 (full or partial E1s). Unbalanced G.703 is supported using an external adaptor.

Min Req	Signal Description	RJ45 A	RJ45 B	Electrical Levels
DATA CIRCUIT TOWARDS MODEM (TX)				
✓	**Data In**	1	2	G.703
DATA CIRCUIT FROM MODEM (RX)				
✓	**Data Out**	4	5	G.703

Line code is fixed as HDB3 for all ports. The master clock source for all ports is the lowest active port number that is configured and connected. For example, if port one is being used then this provides the clock source for all other ports, which are slaved to this clock. The slaved ports require a bearer to be generated from the modem. Alternatively, timing may be distributed to the terrestrial equipment/modem from a single master clock source.

Example RJ45 connectors are shown in the following figure:
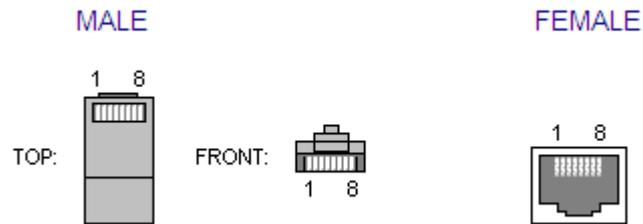
Chapter 10   Connector Pinouts

Remote M&C (RS485/RS232) Connector
The selection of RS232 or RS485 must be made via the front panel. The communications protocol is defined in the document *'Remote M&C Specification for **Q-Flex™** Satellite Modem'*.

Connector type: 9-pin `D' female.

Pin	Signal name	Direction	Name-RS485		Name-RS232
				Paradise	
1	Shield/Gnd *			Shield/Gnd	Shield/Gnd
2				-	-
3	Master-B	+ to modem		RX-B	-
4	Slave-B	+ from modem		TX-B	-
5	Shield/Gnd *			Shield/Gnd	Shield/Gnd
6	Slave-A	- from modem		TX-A	Tx. data
7				-	-
8				-	-
9	Master-A	- to modem		RX-A	Rx. data

* Pins 1 and 5 are both grounded on the modem (ie Shield and Ground are interchangeable).

1:N (1:1) Interface

Connector type: 9-pin `D' male.

1:n CONNECTOR	
1	Ground
2	Line In
3	Line Out
4	Serial In (A) (RS232/485)
5	Serial In (B) (RS232/485)
6	Fail In
7	Fail Out
8	Serial Out (A) (RS485)
9	Serial Out (B) (RS485)

Serial In/Out

This is an uncommitted and currently unused RS232 or RS485 serial port.

Line In/Out & Fail In/Out

The 1:1 redundancy cable is wired as follows:

Modem 1	Modem 2	Signal Name
Pin 1	Pin 1	Circuit ground (screen)
Pin 2	Pin 3	On-Line signal 2-1
Pin 3	Pin 2	On-Line signal 1-2
Pin 6	Pin 7	Fail signal 2-1
Pin 7	Pin 6	Fail signal 1-2

The cable must be of the shielded variety and should be kept as short as practical.

A standard 1:1 lead (part number P1391) is available from Teledyne Paradise Datacom. The lead is 10cm long and is designed for use when two modems are mounted vertically adjacent to each other in the rack.

Alarms and AGC Connector

Connector type: 15-pin `D' male

ALARMS CONNECTOR	
2, 12	Fault Relay - Common
4	Prompt Unit fault - N/O
11	Prompt Unit fault - N/C
3	Prompt Rx Traffic fault (prompt) - N/O
10	Prompt Rx Traffic fault (prompt) - N/C
5	Prompt Tx Traffic fault (prompt) - N/O
13	Prompt Tx Traffic fault (prompt) - N/C
1	Deferred alarm - N/O
9	Deferred alarm - N/C
6	Uncommitted analog output from processor – not currently used
7	Transmit inhibit
8	Buffered direct AGC voltage. This may be used as an antenna-pointing signal when the demod is unlocked. It responds to composite power in approximately a 2MHz bandwidth around the nominal Rx carrier frequency.
14	Not connected
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 (ie non-energised) alarm state.

Async ESC Connector

This connector comprises:

- An RS232/RS422/RS485 async port for use on either the ESC or Aux channels.
- An RS232 serial port (currently unused).
- An RS422 Station Clock input.

ASYNC ESC CONNECTOR		
RS232	**RS422/ RS485**	**Async port for ESC or Aux channel**
2	2 (a)	Async ESC/Aux Input (to satellite)
-	9 (b)	Async ESC/Aux Input (to satellite)
3	3 (a)	Async ESC/Aux Output (from satellite)
-	10 (b)	Async ESC/Aux Output (from satellite)
1	1	Ground
RS232		**Serial port (currently unused)**
12		Serial Input (RS232 port)
5		Serial Output (RS232 port)
13		Ground
RS422		**Differential Station Clock Input**
4		Station Clock (a)
11		Station Clock (b)
13		Ground

Differential Station Clock

This provides a RS422 compatible station clock in addition to the unbalanced 75Ω station clock BNC connector.

Async Port for ESC or Aux Channels

The modem has two fully independent data channels that may be carried over the satellite within any overhead that is added. These are referred to as the ESC and Aux channels. The shared interface on this connector allows the use of only one of these channels at a time, and then only in an Async mode (there is no clock signal on this port). If both ESC and Aux channels are to be used together or either channel used in a synchronous mode, then the IDR option must be fitted which provides separate ESC & Aux ports both with clock, data, and octet lines. When the IDR option is fitted the shared ESC/Aux port on the Async ESC connector is DISABLED.

When configured for different services the ESC and Aux channels provide as follows:

- In **Closed Net Plus ESC** mode the ESC channel provides the variable rate async ESC facility, the Aux channel is not used.
- In **IBS/SMS** modes the ESC channel provides the High Rate Async ESC facility (2400 Baud at 64kbps) and the Aux channel either the Intelsat low rate ESC facility (50 Baud at 64kbps) or a variable rate synchronous Aux circuit. However to use the Aux channel in a synchronous mode the IDR option must be fitted. Without the IDR option that has separate ports for ESC & Aux channels, both ESC and Aux channels (ie high rate async ESC & Intelsat low rate ESC) cannot be used simultaneously.
- In **IDR** Mode this port is not used, as when the IDR option is fitted separate ESC and Aux ports on the IDR card replace this shared ESC/Aux port. Refer to the definitions of the ESC & Aux ports on the 50 way IDR ESC/Aux/Backward Alarm connector on the following few pages.

Standard Lead

A constellation monitor/serial lead (part number M1479) is available from Teledyne Paradise Datacom. This lead provides the required connections to a 25-pin D-type for a PC connection (note that this is currently unused by the modem) and three BNCs for connecting to an oscilloscope for the constellation monitor.

ESC/Aux and Backward Alarms Connector

This connector is fitted as part of the IDR option. Note that when this option is fitted, the ESC and Aux ports on this connector replace the shared ESC/Aux port on the Async ESC connector.

Connector type: 50-pin D-type female

ESC Port

Pin Number	Sync	Async	RS485/RS422 Usage	RS232 Usage
30	U		Tx ESC Clock out A	Tx ESC Clock out
31	U		Tx ESC Clock out B	n/c
13	U	U	Tx ESC Data in A	Tx ESC Data in
14	U	U	Tx ESC Data in B	n/c
32	U		Rx ESC Clock out A	Rx ESC Clock out
33	U		Rx ESC Clock out B	n/c
15	U	U	Rx ESC Data out A	Rx ESC Data out
16	U	U	Rx ESC Data out B	n/c
46	(U)		Tx ESC Octet out A	Tx ESC Octet out
47	(U)		Tx ESC Octet out B	n/c
48	(U)		Rx ESC Octet out A	Rx ESC Octet out
49	(U)		Rx ESC Octet out B	n/c
17	U	U	Ground	Ground

(U) indicates lines are optional.

In Closed Net Plus ESC mode the variable rate async ESC is available on this port.

In IBS modes high rate *async* ESC is available on this port.

In IDR modes this port provides access to the 8kbps IDR ESC channel. This can either by synchronous at 8kbps or (if the Async ESC feature is available) asynchronous at up to 4800 or 9600 Baud.

Aux Port

Pin Number	Sync	Async	RS422 Usage	RS232 Usage
26	U		Tx Aux Clock out A	Tx Aux Clock out
27	U		Tx Aux Clock out B	n/c
9	U	U	Tx Aux Data in A	Tx Aux Data in
10	U	U	Tx Aux Data in B	n/c
28	U		Rx Aux Clock out A	Rx Aux Clock out
29	U		Rx Aux Clock out B	n/c
11	U	U	Rx Aux Data out A	Rx Aux Data out
12	U	U	Rx Aux Data out B	n/c
42	(U)		Tx Aux Octet out A	Tx Aux Octet out
43	(U)		Tx Aux Octet out B	n/c
44	(U)		Rx Aux Octet out A	Rx Aux Octet out
45	(U)		Rx Aux Octet out B	n/c
50	U	U	Ground	Ground

(U) indicates lines are optional.

In Closed Net plus ESC mode the aux port is not used.

In IBS modes the Aux port can be set to both `Intelsat` (using TS32 bit 1) and `Sync` modes (selectable to use any of TS16, TS32 bits 1 and 5-8, and TS48). In both modes a clock is provided and the port can be used synchronously (with the clock), or asynchronously (allowing the async data to be oversampled by the higher rate clock). In this oversampled mode (as specified by Intelsat), the Baud rate is limited to approximately 25-33% of the synchronous clock rate.

In IDR modes the Aux port provides either 32 or 64kbps data access in place of either one or both of the 32kbps ADPCM audio channels. Typically this would be used synchronously, but if required it could be used asynchronously and oversampled giving maximum baud rates of approx 9600 Baud (in place of one audio channel) or 19200 Baud (in place of both Audio channels).

Audio Ports

Pin Number	Description
38	Tx Audio Channel 1 in A
39	Tx Audio Channel 1 in B
40	Tx Audio Channel 2 in A
41	Tx Audio Channel 2 in B
34	Rx Audio Channel 1 out A
35	Rx Audio Channel 1 out B
36	Rx Audio Channel 2 out A
37	Rx Audio Channel 2 out B
50	Ground

All ports are 600Ω, with levels +7dBm to -16dBm set independently from the front panel. Audio is encoded as 32kbps ADPCM (or 16kbps ADPCM in some custom modes)

The Audio ports may be used in two applications:

In IBS modes, if set to emulate a P1348/P1448 Audio/Data mux card, the ESC ports provide the equivalent of the two audio ports on the P1348/P1448 (ie can transmit 64kbps=2 audio channels, or 128kbps=2 audio channels plus 64 kbps data from main data port).

In IDR modes these are used to access the IDR Audio ESC channels. One or both Audio ESCs may be dropped in favour of 32 or 64kbps access to the channel by the Aux port.

Backward Alarms

Pin Number	Description
1	BA 1-4 Common
2	BA1 N/O
18	BA1 N/C
3	BA2 N/O
19	BA2 N/C
4	BA3 N/O
20	BA3 N/C
5	BA4 N/O
21	BA4 N/C
22	BA1 Input
23	BA2 Input
24	BA3 Input
25	BA4 Input
7	Rx Summary fault output (link to BA in)
6	Ground

N/O indicates normal open in the normal, non-alarm state & N/C normally closed in the non-alarm state. Unlike the modem fault relays, the backward alarms are not normally energised, and fall back to the `Normal` state when modem power is removed. The modem deferred alarm acts as a summary backward alarm and activates when any backward alarm is received (this does fall back to the `Fail` state when power is removed).

Backward alarm inputs float to the `Good` state (high =+5V) and indicate `Fail` when connected to 0V. The Rx summary fault is an open collector output, 0V = Fail, open collector=OK. From the front panel the backward alarm inputs (BA x)can be set as follows (E=Ext, A=Auto-Rx fail, O=OK):

	Menu Opt	BA 1	BA 2	BA 3	BA 4
Mode 1	EEEE	Ext patch	Ext patch	Ext patch	Ext patch
Mode 2	AEEE	Rx Fail	Ext patch	Ext patch	Ext patch
Mode 3	AOOO	Rx Fail	Good	Good	Good
Mode 4	AAAA	Rx Fail	Rx Fail	Rx Fail	Rx Fail

If external patching is required, connect the Rx summary fault to the required BA input and any other modem fail outputs to the appropriate other BA inputs. Leave unused inputs floating.

In IDR modes these are used for the four standard IDR backward alarms.

In IBS modes, BA 1 indicates the normal single IBS backward alarm status (mirrored by the unit deferred alarm). For multidestinational IBS carriers it is possible to operate the modem in IBS mode but use four separate backward alarms as per IDR.

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: To Terrestrial

TA: AIS in selected timeslot if the Insert MUX is active or AIS over all data if not in Insert mode. If Insert mode is active and the user control thin route spoofing is on, then AIS is forced over the whole PCM bearer, not just the selected timeslots to spoof full bearer connectivity when passed over a Thin Route satellite circuit.
TB: Frame Backward alarm.
TC: AIS forced in the G.732 CAS 'abcd' signalling nibble.
TD: Force a fixed value in the G.732 CAS 'abcd' signalling nibble.
TE: Multiframe Backward alarm in IBS/SMS TS16/TS48 over satellite.

Actions: To Satellite

SA: AIS framed and scrambled and subject to RS coding if active.
SB: Frame Backward alarm.
SC: AIS in CAS signalling carried in IBS/SMS TS16/TS48 over satellite.

Actions: Other

CM: Carrier mute.
TF: Tx flow control CTS (Clear To Send) line is switched off.
RF: Rx flow control RR (Receive Ready) line is switched off.

11.1 Transmit Faults

Fault Text	Notes	Relays	To Ter	To Sat	Other
Tx fault: External Tx clock selected, but no clock from interface.	The modem is set to use an external clock but no clock is being provided. The clock generation will use the internal clock as a backup to maintain the carrier and signal integrity. Check the data connector is attached and check for activity on the clock input lines.	T	TB	SA,SC	
Tx fault: Data Ready Input active.	The DRI line has been de-asserted by the data source feeding the modem, indicating a unit fault with data source.	T			
Tx fault: Signal Valid Input active.	The SVI line has been de-asserted by the data source feeding the modem, indicating it wished to disable transmission. If the carrier is set to RTS Enabled the carrier will be muted.	T			
Tx fault: Data input is all ones (AIS), indicating upstream equipment fault.	The data supplied to the modem is all ones (AIS). This is normally used to indicate an upstream equipment fault. It is not a modem fault. This alarm can be switched off if required using the *Edit->Unit->Advanced->Alarms->Actions* menu.	T	TB	SA,SC,	
Tx fault: Frame sync lost on Tx input. Check bearer type and AIS.	The modem detects frame synchronisation when the Drop MUX is active (or 2048k IBS G.732 mode is enabled). Check the bearer type is specified correctly. This fault normally occurs only when there are significant errors on the terrestrial link or when the signal is supplied with AIS and the modem is set to ignore AIS. Check that the AIS detector is not disabled. There is an option to make the modem re-seek frame synchronisation when CRC synchronisation is lost - check the modem is not set to expect a CRC and is forcing frame re-acquisition when CRC is lost but there is no CRC on the PCM signal.	T	TB	SA,SC	
Tx fault: Dropped data is all ones (AIS), indicating upstream equipment fault.	The specific timeslots dropped by the Drop MUX contain all ones (AIS). This is different to the 'Tx Fault: Data input is all ones (AIS)' message described above which refers to the whole PCM bearer being AIS. In this case, it is only the specific dropped timeslots that contain AIS. This is normally used to indicate an upstream equipment fault - it is not a modem fault.	T	TB	SA	
Tx fault: CRC sync loss on Tx input.	The modem only seeks Cyclic Redundancy Code (CRC) sync when the Tx baseband is set to use the Drop mux in G.732 mode (or 2048k IBS G.732 0% overhead mode) and when set by the user to process CRC's. If CRC sync is permanently lost, check if a CRC is present on the PCM signal.	T			
Tx fault: Input BER > 1E-3.	The Bit Error Rate at the Tx input (measured on the PCM Frame Alignment Words) is worse than 1×10^{-3}. This can only be due to a very poor error rate on the PCM input signal.	T	TB	SA	
Tx fault: TS16 MF sync lost on Tx input	The modem only seeks TS16 Multiframe sync when the Tx baseband is set to use the Drop mux in a G.732 mode and CAS signalling has been selected (or 2048k IBS G.732 0% overhead mode with CAS is enabled). Check that a CAS multiframe is present on the PCM signal applied to the modem	T	TB/TE	SC	
Tx fault: Frame sync lost on Tx input. Check bearer type and AIS.	Frame sync has been lost on the terrestrial input. Only displayed when using the drop mux. Check the bearer type has been correctly configured. If the AIS detectors are disabled check equipment generating bearer is not generating AIS.	T			
Tx fault: Frame sync lost on ports (1 to 4).	Frame sync has been lost on one or more of the Quad E1 card terrestrial inputs.	T			

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: Data input all ones on ports (1 to 4).	Quad E1 fault indicating AIS (all 1s, i.e no data) is being received on the specified Quad E1 card terrestrial ports.				
Tx fault: Drop mux fault on ports (1 to 4).	Quad E1 card data input fault when trying to drop specified timeslots from specified E1 ports onto transmitted carrier.				
Tx fault: FastLink: Aligned frame FIFO overflow.	FastLink error whereby FEC is unable to process the data to be transmitted due to an internal buffer overflow.				
Tx fault: FastLink: Uncoded FIFO overflow.	FastLink error whereby FEC is unable to process the data to be transmitted due to an internal buffer overflow.				
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: Maximum multiframe period too small.	Framer failed to find a frame length to support TS ID maintenance. Try reducing ESC baud rate or increasing maximum multiframe period.				
Tx warning: Frame backward alarm detected at Tx input, indicating Rx output or downstream Rx equipment fault.	A frame backward alarm has been detected at the Tx 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 status and that the Rx data output from the modem is connected to the downstream equipment.	D		SB	
Tx warning: TS16 MF backward alarm detected at Tx input, indicating equipment downstream of Rx has failed to find MF sync.	A multiframe backward alarm has been detected at the Tx input indicating that equipment downstream of the receive path has failed to find multiframe sync and is returning an alarm. On the Rx path, if the Insert Mux bearer is set to Originate, then check the Rx path is also using CAS, otherwise it will generate a bearer without a TS16 Multiframe.	D		SB/SD	
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 it's 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: Tx exceeds 4.5Mbps limit in TPC 5/16.	Configuration error, data rate for FEC scheme exceeded.				
Tx warning: Tx exceeds 6.5Mbps limit in TPC 21/44 or 2/3.	Configuration error, data rate for FEC scheme exceeded.				
Tx warning: Tx exceeds 7.7Mbps limit in TPC 1/2.	Configuration error, data rate for FEC scheme exceeded.				
Tx warning: Tx exceeds 12Mbps limit in TPC 7/8.	Configuration error, data rate for FEC scheme exceeded.				
Tx warning: Tx exceeds 33Mbps limit in TCM 2/3.	Configuration error, data rate for FEC scheme exceeded.				
Tx warning: Tx data rate outside interface range.	Configuration error, data rate for terrestrial interface exceeded.				
Tx warning: G703 carrier lost.	Modem is set to use the G703 terrestrial interface but no G703 signal has been detected, check configuration of G703 interface.				CM
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: Line Code Violation detected.	Line code violations have been detected on the G703 interface, check configuration of G703 interface.	D			
Tx warning: Tx symbol rate outside range.	The modems current configuration exceeds the permissible symbol rate, check the configuration.				CM
Tx warning: Data clock inverted, data changing state on wrong edge.	The phase of the input clock and data is checked to ensure the data is stable when it is actually latched into the modem. This message means that the data is changing at this critical time, and it will cause data errors. Check the A & B clock lines are not reversed.	D			

11.3 Receive Faults

Fault Text	Notes	Relays	To Ter	To Sat	Other
Rx fault: RS de-interleaver unable to sync to decoded data. Check RS settings.	The demodulator can lock to the carrier and the inner FEC decoder to the demodulated data. However, the Reed-Solomon de-interleaver cannot synchronise with the decoded data. Check the RS de-interleaving depth and the values of `n` and `k`.	R	TA,TC	SB	RF
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: Cannot find frame sync on Rx data - check Rx Service settings.	The modem cannot find the IBS or IDR frame sync on the receive data. Check the Rx Service settings.	R	TA,TC	SB	RF
Rx fault: Cannot find IBS TS32 multiframe sync on Rx data.	The modem cannot find the IBS TS32 multiframe sync on the receive data although it has found frame sync.	R	TA,TC	SB	RF
Rx fault: No insert bearer, generating.	Modem is set to loop bearer but no bearer was detected at Tx input. The bearer is currently being generated by the insert mux.	R			
Rx fault: CAS multiframe sync lost.	The modem cannot find the IBS CAS multiframe sync on the receive data although it has found frame sync and TS32 multiframe sync. CAS Multiframe sync is used to convey either 1) Channel Associated Signalling (CAS) in G.732 Drop/Insert modes using CAS; 2) To maintain the identity of a group of timeslots in some cases; 3) To maintain Robbed Bit Signalling (RBS) in T1-D4 or T1-ESC Drop/Insert modes. Check as follows for each use: 1) The Tx modem is set to operate in CAS mode if CAS signalling is to be conveyed within the IBS/SMS overhead; 2) If the Tx modem cannot use a CAS Multiframe to maintain the TS identity for the `Odd values of N` then to prevent this modem seeking a CAS multiframe for one of these values, set timeslot identity to 'Do not maintain'; 3) If the Tx modem cannot use a CAS Multiframe to maintain RBS over satellite, switch RBS off.	R	TA,TC	SB	RF
Rx fault: Final BER > 1E-3.	Final BER has exceed 1x10-3	R	TA,TC	SB	
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: Insert data is all ones (AIS), indicating upstream equipment fault.	The final customer data after demodulation, error correction, deframing and descrambling is all ones. This is normally used to indicate an upstream equipment fault (such as a lack of input clock at the Tx end), it is not a modem fault.	R	TA	SB	
Rx fault: Data input is all ones (AIS), indicating upstream equipment fault.	The modem is set to loop bearer, but that bearer is indicating AIS.	R			
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: Insert mux fault on ports (1 to 4).	Quad E1 card fault.				
Rx fault: Rx SM sync loss.	Quad E1 sync loss fault.				
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.				

Fault Text	Notes	Relays	To Ter	To Sat	Other
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 isunmuted 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 valide baseband frame, indicating the the data has become corrupted (poor signal, interference, etc).				
Rx fault: RS de-interleaver unable to sync to decoded data. Check RS settings.					

11.4 Receive Warnings

Fault Text	Notes	Relays	To Ter	To Sat	Other
Rx warning: Doppler buffer max limited Rx data rate above 42Mbps.	Buffer size should not exceed 80ms when data rate exceeds 42Mbps				
Rx warning: The minimum period between buffer slips is less than the user threshold set for the deferred alarm.	Buffer slips are occurring too frequently, this could indicate that the clock accuracy is less than expected.	D			
Rx warning: Rx exceeds 4.5Mbps limit in TPC 5/16.	Configuration error, data rate for FEC scheme exceeded.				
Rx warning: Rx exceeds 6.5Mbps limit in TPC 21/44 or 2/3.	Configuration error, data rate for FEC scheme exceeded.				
Rx warning: Rx exceeds 7.7Mbps limit in TPC 1/2.	Configuration error, data rate for FEC scheme exceeded.				
Rx warning: Rx exceeds 12Mbps limit in TPC 7/8.	Configuration error, data rate for FEC scheme exceeded.				
Rx warning: Rx exceeds 33Mbps limit in TCM 2/3.	Configuration error, data rate for FEC scheme exceeded.				
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: Maximum multiframe period too small.	Deframer failed to find a frame length to support TS ID maintenance. Try reducing ESC baud rate or increasing maximum multiframe period.				

Fault Text	Notes	Relays	To Ter	To Sat	Other
Rx warning: Backward alarm from satellite detected at Rx input, indicating Tx or downstream of Tx equipment fault.	A backward alarm has been detected at the Rx input. This indicates that equipment downstream of the transmit path (i.e. from the modem Tx output) has failed and is returning an alarm. This may be due to a downstream receive path equipment failure, the modem Tx failing or a satellite failure. Check the modem Tx path status. Check the Tx IF output from the modem is connected to the upconverter equipment and onwards. Monitor the Tx carrier (or distant Rx if possible) with a spectrum analyser.	D	TB		
Rx warning: CAS multiframe backward alarm from satellite, indicating equipment downstream of Tx has failed to find CAS MF sync.	A multiframe backward alarm has been detected at the Rx input indicating that equipment downstream of the transmit path has failed to synchronise to the CAS multiframe and is returning an alarm. This could be caused by any equipment from the Tx modulator onwards but is unlikely to be other than the Tx mod, the Rx demod, or further down the Rx path.	D	TE		
Rx warning: Backward alarm 1 (or 2 or 3 or 4) from satellite, indicating equipment downstream of Tx has failed.	This indicates which of the four backward alarms are active at the Rx input. This indicates that equipment downstream of the transmit path (ie the distant end Rx path or further downstream) has failed and is returning an alarm. In Multidestinational circuits this may not correspond to the Tx path of this modem. The fault may be due to any receive downstream equipment, but could be due to the relevant modem Tx output failing. Check the relevant modem Tx path indicates OK. Check the Tx IF output from the modem is connected to the upconverter equipment and onwards and monitor the Tx carrier (or distant Rx if possible) with a spectrum analyser.	D			
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: The final BER is worse than the user threshold set for the deferred alarm.	This indicates that the received signal has degraded resulting in a potentially unacceptable number of errors.	D			
Rx warning: Rx FIFO underflow on ports (1 to 4).	Quad E1 card Rx problem.				
Rx warning: Rx FIFO overflow on ports (1 to 4).	Quad E1 card Rx problem.				
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.				
Rx warning: LinkGuard interfererence over threshold.	A source of interference has been detected underneath the receive carrier that exceeds the alarm threshold set by the user. This may be degrading the received signal and should be investigated and reported to the satellite operator.				
Rx warning: Rx failed LDPC/BCH decoding.	The receiver was unable to decode the demodulated LDPC carrier successfully. This indicates either that the satellite data has become corrupted or that there is a configuration incompatibility between the encoder and decoder.				

11.5 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 deg C and becomes a fault at 70 deg C	U,D	TA,TC		TF,RF, CM

11.6 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: Quad E1 ports have active alarms (1 to 4).	Indicates that the Quad E1 card ports have unspecified alarms. Consult factory.				
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.				

11.7 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, entitled, 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 Common Main Specifications

Parameter	Modem
Modulation	BPSK, QPSK, OQPSK, 8PSK, 8APSK, 8QAM, 16APSK, 16QAM, 32APSK, 64APSK, 64QAM
IF Frequency Range	50 to 90MHz and 100 to180MHz
L-band Frequency Range	950 to 2150 MHz
Frequency Resolution	IF: 100Hz; L-band: Selectable 100Hz or 1Hz
Traffic Interface - Electrical	Gigabit Ethernet on RJ45 with link and traffic indicators
Traffic Interface - Options	RS422 including X.21 DCE and DTE emulation, V.35 and RS232 on EIA530 connector 25 pin female D-type; EIA-530 maximum 10Mbps; RS232 max 100kbps G.703 balanced on RJ45; unbalanced on BNC female 75Ω STM-1/OC-3/Optical Ethernet on small-form-factor pluggable module LVDS 25 pin female D-type HSSI 50 pin SCSI-2 type connector Quad E1 (four balanced G.703 on RJ45 connectors)
User Traffic Data Rate	2.4kbps to 2Mbps Extends base operation to 5Mbps Extends 5Mbps to 10Mbps Extends 10Mbps to 25Mbps Extends 25Mbps to 60Mbps Extends 60Mbps to 100Mbps Extends 100Mbps to 200Mbps Extensions are cumulative
User Traffic Data Rate Resolution	1bps
<u>Note</u> The combination of FEC rate, modulation scheme and satellite overhead limits the traffic data rate range in all modes.	
User Data Rate Range: Closed Network	2.4kbps (2.4ksps) to 100Mbps (40Msps)
User Data Rate Range: Closed Network Plus ESC	As Closed Network except limits inclusive of overhead of approximately 1.4 times the ESC baud rate. Supports ESC rate from 110bps to 115kbps
DVB-S2/S2X	50kbps (100ksps) to 200Mbps (50Msps)
User Data Rate Range: IBS	2.4kbps to 10Mbps (6.7% satellite overhead added)
User Data Rate Range: IDR	2.4kbps to 10Mbps (96k overhead added); resolution of 8k (limitation of frame structure)
Audio Channels Option	Used with IBS and IDR to provide 2 x 32kbps audio ADPCM coded channels within a 64kbps IBS carrier and 2 x 32kbps audio ADPCM coded channels plus 64kbps data within a 128kbps IBS carrier

Inner Forward Error Correction	**DVB-S2**:
	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
	
	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
	
	DVB-S2X Short Frame:
	QPSK: 11/45, 4/15, 14/45, 7/15, 8/15, 32/45
	8PSK: 7/15, 8/15, 26/45, 32/45
	16APSK: 7/15, 8/15, 26/45, 3/5, 32/45
	32APSK: 2/3, 32/45
	
	FastLink™ Low-Latency LDPC option:
	  BPSK 0.499
	  (O)QPSK 0.532, 0.639, 0.710, 0.798
	  8PSK/8QAM: 0.639, 0.710, 0.778
	  16APSK/16QAM: 0.726, 0.778, 0.828, 0.851
	  32APSK: 0.778, 0.828, 0.886, 0.938
	  64QAM: 0.828, 0.886, 0.938, 0.960
	
	TPC:
	  BPSK 5/16, 21/44, 2/3, 3/4,
	    Rate 7/8 (de facto)
	  (O)QPSK: 5/16, 21/44, 2/3, 3/4,
	    7/8 (de facto), 0.93 (Paradise)
	  8PSK: 3/4 de facto, 7/8 (de facto),
	    0.93 (Paradise)
	  16QAM: 3/4 (de facto), 7/8 (de facto),
	    0.93 (Paradise)
	Viterbi: BPSK/(O)QPSK 1/2, 3/4, 7/8
	TCM: 8PSK 2/3
	Sequential: BPSK/(O)QPSK 1/2, 3/4,7/8

Outer Forward Error Correction	Concatenated Intelsat Reed-Solomon outer codec to IESS308/310 to 10 Mbps, available with Viterbi, TCM and Sequential
Scrambling (IBS)	Synchronised to framing per IESS-309 up to 10 Mbps
Scrambling (IDR, Closed Network)	With RS coding: synchronised to RS overhead. Without RS coding and non-TPC FEC: V.35 self-synchronising No RS coding with TPC FEC: 2^{12}-1 up to 10 Mbps
Scrambling (Closed Network Plus ESC)	32kbps or above: synchronised to ESC overhead. Less than 32kbps: as per closed network. V.35 scrambler up to 100Mbps
IF Connector Type	BNC female

L-band Connector Type	N-type female
IF Impedance	50Ω & 75Ω
L-band Impedance	50Ω
IF Return Loss	>18dB
L-band Return Loss	>15dB
Internal Frequency Reference - Ageing	<1ppm/yr
External Reference	Clocking only: 1 to 10MHz in 1kHz steps. Clocking and RF frequency: 10MHz, 2dBm±1dB

12.2 Tx Modulator Specifications

Parameter	Modem
IF Output Power Level	0 to –25dBm continuously variable in 0.1dB steps
L-band Output Power Level	0 to –40dBm continuously variable in 0.1dB steps
Output Level Accuracy and Stability	Accuracy: ±0.375dB; Stability: ±1dB, 0ºC to 50ºC
Transmit Filtering	Spectral roll-off factors of 5%, 10%, 15%, 20%, 25% and 35%. See the document 'Saving Satellite Bandwidth by Optimising Spectral Roll-off' (document number AN_035) from the White Papers section of http://www.paradisedata.com) for more details, including occupied bandwith calculations
Occupied Bandwidth	See referenced document AN_035 above
Recommended Channel Spacing	See referenced document AN_035 above
Phase Accuracy	±2º maximum
Amplitude Accuracy	±0.2dB maximum
Carrier Suppression	-30dBc minimum
Output Phase Noise	As IESS-308, IESS-316 and DVB-S2/S2X standards, nominally 3dB better
IF Output Frequency Stability	±0.05 ppm per year
L-band Output Frequency Stability	±0.05 ppm per year
IF Harmonics	Better than –60dBc/ 4kHz in band
L-band Harmonics	Better than –60dBc/ 4kHz in band
IF Spurious	Better than –60dBc/ 4kHz in band
L-band Spurious	Better than –60dBc/ 4kHz in band
Transmit On/Off Ratio	-65dB minimum
External Transmit Inhibit	By external contact closure or by TTL signal applied to rear panel Alarms & AGC connector

12.3 Rx Demodulator Specifications

Parameter	Modem
IF Input Range	Minimum: -115+10 log (symbol rate) Maximum: -80 + 10 log (symbol rate)
L-band Input Range	Minimum: -130 + 10 log (symbol rate) Maximum: -80 + 10 log (symbol rate)
Maximum Composite signal	+10dBm
Wanted-to-composite Level	IF: -94 + 10 log (symbol rate) L-band: -102 + 10 log (symbol rate)
Frequency Acquisition Range	Selectable from ±1kHz to ±255kHz (1kHz steps)
Acquisition Threshold	<5dB Es/No QPSK
Acquisition Time	At 9.6kbps, less than 1s at 6dB Es/No. QPSK At 10 Mbps, less than 100ms at 6dB Es/No. QPSK
Clock Tracking Range	±100ppm minimum
Receive Filtering	Spectral roll-off factors of 5%, 10%, 15%, 20%, 25% and 35%. See the document 'Saving Satellite Bandwidth by Optimising Spectral Roll-off' (document number AN_035) from the White Papers section of http://www.paradisedata.com) for more details, including occupied bandwith calculations.
Performance Monitoring	Measured Eb/No (range 0-15dB, ±0.2dB). Measured Frequency Offset (100Hz resolution). Wanted signal level strength indicator centred on the middle of the Rx input range.
AGC Output	Buffered direct AGC output for antenna tracking, etc.

12.4 Clocking and Buffering Specifications

Parameter	Modem	
Clock Integrity	Frequency Locked Loops give phase-hit immune operation even with poor clock sources such as routers etc.	
Tx Clocking	Internal	±0.5ppb per day
	External	Tracking range ±100ppm/min
	Rx Clock	Slaves Tx timing from Rx clock. (Includes full asymmetric operation)
Rx Clocking	Buffer Disable	Clock from Satellite
	Tx Input clock	Plesiochronous. (Includes full asymmetric operation)
	Internal	±0.5ppb per day
	External timing clock (DTE interface only)	
	Station Reference (see below)	
Station Reference Inputs	75Ω BNC female Station Clock Connector. 1MHz to 10MHz in 1kHz steps (accepts sinusoidal >0dBm or square-wave e.g., G.703 para 10	
	120Ω RS422 compatible input, 1MHz to 10MHz in 1kHz steps via Async ESC connector	
	NB: When set to 10MHZ, the station reference may replace internal reference to all internal circuitry and reference outputs on the IF ports. The unit automatically switches back to internal reference if the station reference fails.	
Buffer Size	Selectable in 1ms increments from 0ms to 99ms at data rates up to 42Mbps and from 0ms to 80ms at data rates from 42Mbps up to 55Mbps. Automatically adjusted to slip an integer number of terrestrial multi-frame lengths for framed rates Buffer storage: Maximum buffer size – 256kbytes	

12.5 Framing and Deframing Specifications

Parameter	Modem
Closed Network Format	Unframed, no overhead.
IBS/SMS Option Format	Intelsat IBS to IESS-309 and IESS-310 up to 10 Mbps, and Eutelsat SMS to EESS501.
IDR Option Format	Intelsat IDR to IESS-308 and IESS-310 up to 10 Mbps.
Closed Network plus ESC Format	Provides variable rate asynchronous ESC, optional synchronous scrambler above 32kbps to replace error multiplying V.35 scrambler, optional backward alarm facility and optional timeslot ID maintenance when used with Drop/Insert, all in minimum possible overhead down to <0.5%

12.6 Intelsat Reed-Solomon Codec and Custom Option Specifications

Parameter	Modem
Format	Concatenated Reed-Solomon outer codec to IESS-308/310

Code Rate	Default n, k, t = (126, 112, 7) depth 4.
	Automatically switches to:
	    (225, 205, 10) depth 4 for 1544kbps IDR mode or
	    (219, 201, 9) depth 4 for 2048kbps IDR mode and
	    TCM<=1544kbps or
	    (219, 201, 9) depth 8 for TCM >1544kbps.

Processing Delay	Combined encoder and decoder: 8 x (2n-k+60) Combined Interleaver/De-Interleaver: 8 x n x Depth (Calculate delay time using data rate including RS overhead).
Custom Option	When fitted allows arbitrary selection of n and k to provide fully variable code rate. 60<=n<=255 (n-20)<=k<=(n-2) in steps of 2. Interleaving depth of 4 or 8. The custom option allows use of shorter code words to reduce interleaver/de-interleaver delay on low data rate circuits. Up to 10Mbps.

12.7 Drop and Insert Option Specifications

Parameter	Modem
Bearer Types	T1-D4, T1-ESF and E1-G.732
Timeslot Selection	Independent selection of arbitrary timeslots for both drop and insert.
Bearer Generation	The terrestrial bearer may be looped through the Drop Mux then Insert Mux, or terminated after the Drop Mux and a new blank bearer generated by the insert Mux. The bearer generated within the Insert Mux provides full multiframe and CRC support and may be generated from the Tx clock, station reference, satellite clock or Internal reference.
Bearer Backup	In the event that the Insert Mux bearer clock is lost, or AIS is supplied, then the Insert Mux will switch temporarily to bearer generation mode in order to preserve the receive traffic. The backup bearer may be generated from the station reference, satellite clock or internal reference.
Terrestrial CRC	Fully supported, with front panel display of terrestrial error rate based on CRC (T1-ESF and G.732) or Frame Alignment Word errors (all bearer types).
Timeslot ID Maintenance	The IBS/SMS or Closed Net Plus ESC overhead maintains the identity of individual Drop/Insert timeslots for N=1,2,3,4,5,6,8,10,12,15,16,20,24 and 30.

12.8 Extended Drop and Insert Option Specifications

Parameter	Modem
Timeslot Re-Ordering	Selected timeslots may be independently re-ordered on both Tx and Rx paths.
Multi-Destinational Working	All or only a subset of the received data may be inserted into the terrestrial bearer on the receive path for multi-Destinational working.
Timeslot ID Maintenance	The IBS/SMS or Closed Net Plus ESC is extended to maintain the identity of individual timeslots for all values of N from 1 to 31.
Signalling	Both Channel Associated Signalling (CAS) and Robbed Bit Signalling (RBS) are fully supported. For G.732 Drop/Insert, CAS signalling is extracted from terrestrial TS16 and carried over the satellite in IBS/SMS TS16 before re-inserting into the distant terrestrial TS16. For RBS, the IBS or Closed Net Plus ESC overheads maintain the identity of the in-band signalling and it is re-inserted into the terrestrial multi-frame in the correct positions to maintain the RBS.

12.9 Advanced ESC and Advanced Aux Option Specifications

Parameter	Modem	
ESC/Aux Port	A single port provides the interface for optional high rate async ESC (IBS/SMS option or Closed Net Plus ESC) or the Intelsat low rate async IBS ESC channel.	
Electrical Interface	RS232, RS422 or RS485 external interfaces or internal link to remote M&C port (software selected). Other devices externally wired in parallel with M&C port can also be accessed remotely.	
Async ESC Option	Closed Net Plus ESC	Overhead scales to provide any user specified async ESC baud rate whatever the satellite data rate. ESC limit is approximately 70% of main channel rate, overhead varies from <0.5% to >70%.
	IBS option	High rate async data using from $1/32^{nd}$ to $22/32^{nd}$ of the IBS overhead, providing async baud rates from 0.2% to 5.1% of the terrestrial rate (e.g., up to >2400 baud at 64kbps). Includes modes compatible with the P300 and P400 Series, P230 & P1300/P1361 (using $20/32^{nd}$ of the overhead).
IBS Aux Data Channel	With IBS option and Advanced Aux option: Intelsat low rate async ESC definition carried in bit 1 of TS32 providing a synchronous channel at $1/480^{th}$ of the data rate, allowing up to one quarter of this rate for over-sampled async data. Compliant with Intelsat IESS-403 low rate ESC definition.	

12.10   IDR Option Specifications

Parameter	Modem	
IDR ESC Audio	Two 32kbps ADPCM channels	
Interface	4-wire 600Ω, +7dBm to –16dBm (programmable in 0.1dB steps).	

Backward Alarms	Outputs: Four "form c" relays.
	Inputs: Four protected inputs, short to 0V to send alarm with matching summary Rx fail output. Alarm inputs software configurable for:
	   a) All external patch,
	   b) 1=Rx fail and 2-4=external patch,
	   c) 1=Rx fail and 2-4=OK,
	   d) 1-4=Rx fail	

ESC/Aux Ports	When the IDR option is fitted, independent ESC & Aux ports on the IDR option replace the single shared ESC/Aux port on the base unit.	
ESC Port	RS232, RS422 or RS485 external interfaces or internal link to remote M&C port (software selected). No external cabling required between the ESC and M&C ports for M&C via ESC channel within overhead. Other devices externally wired in parallel with M&C port can also be accessed remotely. Provides clock, data and sync (octet timing) lines.	
	IDR	Synchronous access to 8kbps IDR ESC. With the Async ESC option, async ESC access to the 8kbps IDR ESC is provided giving up to a 9600 baud async channel
	Others	IBS and Closed Net Plus ESC facilities as before installation of IDR option, but now on ESC port on IDR card not shared ESC/Aux port of base unit.
Aux Port	RS232 or RS422 (user selectable). Provides clock and data lines	
	IDR	Provides 32 or 64kbps access in place of one or both audio ESC channels.
	IBS	Intelsat low rate ESC mode as previously but now via Aux port on IDR card not shared ESC/Aux port of base unit. IDR option also adds sync IBS mode, configurable to use between $1/32^{nd}$ and $21/32^{nd}$ of the IBS overhead providing a full sync Aux port at between 0.2% and 4.3% of the main data rate. Aux port provides satellite timing information for P1500 slave Frequency Standard when not configured for Aux data access.

12.11 BERT Option Specifications

Parameter	Modem
BER Channel	The BERT may operate through main traffic, ESC data or Aux data channels. Use of ESC & Aux data channels allows continuous real traffic BER performance monitoring while the modem carries traffic
Test Patterns	2^{11}-1, 2^{15}-1, 2^{20}-1 and others, compatible with common standalone BER testers
Results	Display of error count and average BER
Autolog	Automatic logging of average BER and other parameters at regular intervals

12.12 AUPC Specifications

Parameter	Modem
Modes of Operation	Monitor of remote Eb/No and BER only, full remote Eb/No maintenance. Unidirectional or Bi-directional operation.
Communication Link	Utilises asynchronous ESC channel on IBS/SMS, IDR and Closed Network plus ESC carriers (ESC from 300 baud, i.e., overheads down to less than 1%).
User Parameters	Target Eb/No, positive power offset, negative power offset.

12.13 Traffic Log Specifications

Parameter	Modem
Capacity	Over 6000 entries
Entry Format	Fault message with time and date stamp. Separate entry when fault clears/changes.

12.14   Common Specifications

Parameter	Modem
Loop-backs	Interface Loop (Local and Remote) Internal IF loopback (local, automatically matching Rx IF frequency to Tx)
Test Modes	Transmit CW (Pure Carrier) Transmit Alternate 1-0 Pattern

Alarm Relays	4 Independent Change-Over Contacts:
	     Unit Fault,
	     Rx Traffic Fault
	     Tx Traffic Fault,
	     Deferred Alarm (backward alarm, BER or Eb/No below user set threshold)

Embedded Software	Revised embedded software may be downloaded into non-volatile memory via Ethernet port (or USB) with modem remaining in equipment rack.
Configuration Memories	>100 configurations can be stored and recalled from the front panel or remote M&C. Memories can be labeled with text string to aid identification.
User Interface	Clear and intuitive operator interface with plain English dialogue (other languages supported). Graphic display, backlit, high contrast, wide angle LCD. 17 key tactile full keyboard.
Remote Monitor and Control	For multi-drop applications, RS485 interface. For direct to PC applications, RS232 interface (front panel selectable). M&C port may be directly internally linked to ESC port for "over-the-satellite" M&C without cabling. Ethernet (10/100/1000 BaseT) via RJ45, embedded Web server, SNMP agent V1, V2c, V3.
Redundancy Features	1:1 redundancy controller built in. "Y" cables passively split data maintaining impedances. IF inputs/outputs are passively split/combined outside the units. Off-line unit tri-states data outputs and mutes Tx carrier. 1:N (up to 16) supported for many interface types.
Monitor	0 to 10V analogue output (Signal level, Eb/No, or Rx offset frequency) on Alarms & AGC connector
Mechanical	1U chassis, 410mm deep, excluding front panel handles and rear panel connectors and fans.
Weight	3.5 Kg
Power Supply	90 to 264VAC, 1A @100V, 0.5A @ 240V, 47 to 63Hz Fused IEC connector (live and neutral fused); 24V and 48V DC options
Safety	EN60950-1
EMC	EN55022 Class B (Emissions) EN55082 Part 1 (Immunity)
Environmental	Operating Temperature Range 0 to 50ºC
Mains data	AC Mains inrush surge current at power up = 25A @ 250V Modem uses 3.15A slow blow fuses in all cases. Maximum power consumption fully loaded is approx

	105W. Earth leakage current is approx 2mA @250V

12.15   Internet Traffic

Parameter	Modem
Standard (unaccelerated)	Throughput depends on traffic format – formats such as UDP that do not require acknowledgements run at up to the maximum data rate of the modem – unaccelerated TCP (which requires acknowledgements) will typically run at up to 128kbps per connection, 80 Connections/Sec

12.16   BUC / LNB facilities

Parameter	Modem
BUC Power Supply Options	Mains input, +48V DC 2A output (100W) to BUC via Tx IFL Mains input, +24V DC 4A output (100W) to BUC via Tx IFL Mains input, +48V DC 3.5A output (200W) to BUC via Tx IFL Mains input, +24V DC 6A output (200W) to BUC viaTx IFL +48V DC input, +48V DC 3.5A output (180W) to BUC via Tx IFL +48V DC input, +24V DC 6A output (180W) to BUC viaTx IFL
FSK Control Option	Requires a BUC Power Supply to be fitted. Allows monitor & control of a compatible BUC from the Modem, via the IFL
BUC 10MHz Reference	Via IFL cable; 10MHz ± 0.01 ppm; 3dBm ± 3dB
LNB 10MHz Reference	Via IFL cable; 10MHz ± 0.01 ppm; 3dBm ± 3dB
LNB Voltage	Selectable 13V, 15V, 18V, 20V or 24V DC to LNB via IFL cable; maximum 0.5A

12.17   FEC BER/PER Performance

BER curves are no longer provided by Paradise. Instead, performance based at specific points is given. This reflects the fact that modern FECs have extremely steep curves and it is extremely difficult, if not impossible, to actually operate at a specific point on the curve. 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. If you have concerns on this issue then please contact our technical support team.

Note that where PER is stated the equivalent BER figure can be calculated by using the fact that a packet is defined as 188 bytes x 8 bits.

12.17.1 DVB-S2/S2X

DVB-S2 Performance QEF (PER 10e-7) Normal frames, Pilots off		
	Spectral Efficiency	Eb/No (dB) & Es/No (dB)
QPSK 1/4	0.490243	1.1 (-2.0)
QPSK 1/3	0.656448	0.7 (-1.1)
QPSK 2/5	0.789412	0.7 (-0.3)
QPSK 1/2	0.988858	1.1 (1.1)
QPSK 3/5	1.188304	1.7 (2.4)
QPSK 2/3	1.322253	2.0 (3.2)
QPSK 3/4	1.487473	2.4 (4.1)
QPSK 4/5	1.587196	2.6 (4.6)
QPSK 5/6	1.654663	3.0 (5.2)
QPSK 8/9	1.766451	3.7 (6.2)
QPSK 9/10	1.788612	3.9 (6.4)
8PSK 3/5	1.779991	3.5 (6.0)
8PSK 2/3	1.980636	4.0 (7.0)
8PSK 3/4	2.228124	4.6 (8.1)
8PSK 5/6	2.478562	5.6 (9.5)
8PSK 8/9	2.646012	6.6 (10.8)
8PSK 9/10	2.679207	6.9 (11.2)
16APSK 2/3	2.637201	5.2 (9.4)
16APSK 3/4	2.966728	5.8 (10.5)
16APSK 4/5	3.165623	6.2 (11.2)
16APSK 5/6	3.300184	6.6 (11.8)
16APSK 8/9	3.523143	7.5 (13.0)
16APSK 9/10	3.567342	7.8 (13.3)
32APSK 3/4	3.703295	7.3 (13.0)
32APSK 4/5	3.951571	7.8 (13.8)
32APSK 5/6	4.119540	8.4 (14.5)
32APSK 8/9	4.397854	9.4 (15.8)
32APSK 9/10	4.453027	9.6 (16.1)

Figure 12-1 PER for DVB-S2 Normal Frames

DVB-S2 Performance QEF (PER 10e-7) Short frames, Pilots off		
	Spectral Efficiency	Eb/No (dB) & Es/No (dB)
QPSK 1/4	0.365324	2.2 (-2.2)
QPSK 1/3	0.629060	1.3 (-0.7)
QPSK 2/5	0.760928	1.1 (-0.1)
QPSK 1/2	0.848840	1.6 (0.9)
QPSK 3/5	1.156532	2.1 (2.7)
QPSK 2/3	1.288400	2.3 (3.4)
QPSK 3/4	1.420269	2.9 (4.4)
QPSK 4/5	1.508181	3.1 (4.9)
QPSK 5/6	1.596093	3.5 (5.5)
QPSK 8/9	1.727961	4.0 (6.4)
8PSK 3/5	1.725319	4.0 (6.4)
8PSK 2/3	1.922040	4.5 (7.3)
8PSK 3/4	2.118761	5.1 (8.4)
8PSK 5/6	2.381056	6.0 (9.8)
8PSK 8/9	2.577777	7.0 (11.1)
16APSK 2/3	2.548792	5.6 (9.7)
16APSK 3/4	2.809662	6.2 (10.7)
16APSK 4/5	2.983575	6.7 (11.4)
16APSK 5/6	3.157488	7.1 (12.1)
16APSK 8/9	3.418357	8.1 (13.4)
32APSK 3/4	3.493093	8.1 (13.5)
32APSK 4/5	3.709309	8.7 (14.4)
32APSK 5/6	3.925526	9.0 (14.9)
32APSK 8/9	4.249850	10.2 (16.5)

Figure 12-2 PER for DVB-S2 Short Frames

DVB-S2X Performance QEF (PER 10e-7) Normal frames, Pilots off	Spectral Efficiency	Eb/No (dB) & Es/No (dB)
QPSK 13/45	0.567805	0.5 (-2.0)
QPSK 9/20	0.889135	0.9 (0.4)
QPSK 11/20	1.088581	1.1 (1.5)
8APSK-L 5/9	1.647211	3.1 (5.3)
8APSK-L 26/45	1.713601	3.2 (5.5)
8PSK 23/36	1.896173	3.6 (6.4)
8PSK 25/36	2.062148	4.1 (7.2)
8PSK 13/18	2.145136	4.3 (7.6)
16APSK-L 1/2	1.972253	3.4 (6.3)
16APSK-L 8/15	2.104850	3.5 (6.7)
16APSK-L 5/9	2.193247	3.6 (7.0)
16APSK-L 3/5	2.370043	3.9 (7.6)
16APSK-L 2/3	2.635236	4.4 (8.6)
16APSK 26/45	2.281645	4.2 (7.8)
16APSK 3/5	2.370043	4.4 (8.1)
16APSK 28/45	2.458441	4.2 (8.1)
16APSK 23/36	2.524739	4.6 (8.6)
16APSK 25/36	2.745734	5.2 (9.6)
16APSK 13/18	2.856231	5.4 (10.0)
16APSK 7/9	3.077225	6.0 (10.9)
16APSK 77/90	3.386618	7.0 (12.3)
32APSK-L 2/3	3.289502	6.5 (11.7)
32APSK 32/45	3.510192	6.5 (12.0)
32APSK 11/15	3.620536	6.7 (12.3)
32APSK 7/9	3.841226	7.5 (13.3)
64APSK-L 32/45	4.206428	8.4 (14.6)
64APSK 11/15	4.338659	8.9 (15.3)
64APSK 7/9	4.603122	9.3 (15.9)
64APSK 4/5	4.735354	9.5 (16.3)
64APSK 5/6	4.933701	10.3 (17.2)

Figure 12-3 PER for DVB-S2X Normal Frames

DVB-S2X Performance QEF (PER 10e-7) Short frames, Pilots off		
	Spectral Efficiency	Eb/No (dB) & Es/No (dB)
QPSK 11/45	0.453236	1.4 (-2.0)
QPSK 4/15	0.497192	1.3 (-1.7)
QPSK 14/45	0.585104	1.1 (-1.2)
QPSK 7/15	0.892796	1.4 (0.9)
QPSK 8/15	1.024664	1.7 (1.8)
QPSK 32/45	1.376313	2.6 (4.0)
8PSK 7/15	1.331876	3.1 (4.3)
8PSK 8/15	1.528597	3.4 (5.2)
8PSK 26/45	1.659745	3.8 (6.0)
8PSK 32/45	2.053188	4.8 (7.9)
16APSK 7/15	1.766184	4.0 (6.5)
16APSK 8/15	2.027053	4.4 (7.5)
16APSK 26/45	2.200966	4.8 (8.2)
16APSK 3/5	2.287923	5.0 (8.6)
16APSK 32/45	2.722705	5.8 (10.2)
32APSK 2/3	3.168769	6.8 (11.8)
32APSK 32/45	3.384985	7.3 (12.6)

Figure 12-4 PER for DVB-S2X Short Frames

12.17.2   FastLink

FastLink™ Performance at BER 5E-8
(Note: * denotes BER of 5E-12)

	FEC Rate	Low BER Eb/No & Es/No	Balanced Eb/No & Es/No	Low Latency Eb/No & Es/No
BPSK	0.499	2.1 (-0.9)	2.9 (-0.1)	3.4 (0.4)
(O)QPSK	0.532	2.1 (2.4)	2.6 (2.9)	2.9 (3.2)
(O)QPSK	0.639	2.4 (3.5)	2.8 (3.8)	3.2 (4.3)
(O)QPSK	0.710	2.7 (4.2)	3.2 (4.7)	3.7 (5.2)
(O)QPSK	0.798	3.1 (5.1)	3.9 (6.0)	4.2 (6.2)
8PSK	0.639	5.4* (8.2)	5.9* (8.7)	6.3* (9.1)
8PSK	0.710	5.6* (8.9)	5.5 (8.8)	5.8 (9.1)
8PSK	0.778	5.6 (9.3)	6.1 (9.7)	6.4 (10.1)
8QAM	0.639	4.4 (7.2)	4.8 (7.6)	5.0 (7.8)
8QAM	0.710	5.0 (8.3)	5.3 (8.6)	5.5 (8.8)
8QAM	0.778	5.5 (9.2)	5.9 (9.6)	6.1 (9.8)
16APSK	0.726	7.6* (12.2)	7.5* (12.1)	7.5 (12.1)
16APSK	0.778	7.8* (12.7)	7.1 (12.0)	7.5 (12.4)
16APSK	0.828	7.4 (12.6)	8.1 (13.3)	8.4 (13.6)
16APSK	0.851	7.9 (13.2)	8.3 (13.6)	8.8 (14.1)
16QAM	0.726	7.2* (11.8)	6.6 (11.2)	6.8 (11.4)
16QAM	0.778	6.7 (11.6)	7.1 (12.0)	7.4 (12.3)
16QAM	0.828	7.2 (12.4)	7.7 (12.9)	8.0 (13.2)
16QAM	0.851	7.5 (12.8)	8.0 (13.3)	8.4 (13.7)
32APSK	0.778	9.8* (15.7)	9.6 (15.5)	10.0 (15.9)
32APSK	0.828	9.8 (16.0)	10.6 (16.8)	10.9 (17.1)
32APSK	0.886	10.8 (17.3)	11.4 (17.9)	11.9 (18.4)
32APSK	0.938	12.6 (19.3)	13.2 (19.9)	13.9 (20.6)

Figure 12-5 BER for FastLink

12.17.3   TPC

TPC Performance
Eb/No (dB) at BER 5E-8

	Rate 1/2	Rate 3/4	Rate 7/8	Rate 0.93	
BPSK, (O)QPSK	3.0	4.2	4.2	6.5	
8PSK		6.3	6.8	9.6	
8QAM		6.7	6.8	10.1	
16QAM		7.6	7.9	10.4	

Figure 12-6 BER for TPC

12.17.4 DVB-S/DSNG

DVB-S/DSNG Performance
Eb/No (dB) at QEF

	Rate 1/2	Rate 2/3	Rate 3/4	Rate 5/6	Rate 7/8	Rate 8/9
QPSK	3.9	4.6	4.0	4.6	5.3	
8PSK		6.9		8.9		9.4
16QAM			9.0		10.7	

Figure 12-7 BER for DVB-S/DSNG

12.18 FEC Minimum/Maximum Data Rates

FEC/Modulation	FEC Rate	Min Data Rate kbps	Max Data Rate Mbps
Normal Frames			
DVB-S2X QPSK	13/45	56.79	25.55
DVB-S2X QPSK	9/20	88.92	40.02
DVB-S2X QPSK	11/20	108.86	48.98
DVB-S2X 8APSK-L	5/9	164.73	74.12
DVB-S2X 8APSK-L	26/45	171.36	77.11
DVB-S2X 8PSK	23/36	189.62	85.32
DVB-S2X 8PSK	25/36	206.22	92.79
DVB-S2X 8PSK	13/18	214.51	96.53
DVB-S2X 16APSK-L	1/2	197.23	88.75
DVB-S2X 16APSK-L	8/15	210.49	94.71
DVB-S2X 16APSK-L	5/9	219.33	98.69
DVB-S2X 16APSK-L	3/5	237.00	106.65
DVB-S2X 16APSK-L	2/3	263.72	118.67
DVB-S2X 16APSK	26/45	228.17	102.67
DVB-S2X 16APSK	3/5	237.00	106.65
DVB-S2X 16APSK	28/45	245.85	110.62
DVB-S2X 16APSK	23/36	252.48	113.61
DVB-S2X 16APSK	25/36	274.58	123.55
DVB-S2X 16APSK	13/18	285.63	128.53
DVB-S2X 16APSK	7/9	307.73	138.47
DVB-S2X 16APSK	77/90	338.67	152.39
DVB-S2X 32APSK-L	2/3	263.53	118.58
DVB-S2X 32APSK	32/45	351.02	157.95
DVB-S2X 32APSK	11/15	362.06	162.92
DVB-S2X 32APSK	7/9	384.13	172.85
DVB-S2X 64APSK-L	32/45	420.65	166.15
DVB-S2X 64APSK	11/15	433.87	171.37
DVB-S2X 64APSK	7/9	460.32	181.82
DVB-S2X 64APSK	4/5	473.54	187.04
DVB-S2X 64APSK	5/6	493.67	194.99
Short Frames			
DVB-S2X QPSK	11/45	50.00	20.39
DVB-S2X QPSK	4/15	50.00	22.37
DVB-S2X QPSK	14/45	58.52	26.32
DVB-S2X QPSK	7/15	89.29	40.17
DVB-S2X QPSK	8/15	102.47	46.10
DVB-S2X QPSK	32/45	137.64	61.93
DVB-S2X 8PSK	7/15	133.19	59.93
DVB-S2X 8PSK	8/15	152.86	68.78
DVB-S2X 8PSK	26/45	165.98	74.68
DVB-S2X 8PSK	32/45	205.32	92.39
DVB-S2X 16APSK	7/15	176.62	79.47
DVB-S2X 16APSK	8/15	202.71	91.21
DVB-S2X 16APSK	26/45	220.10	99.04
DVB-S2X 16APSK	3/5	228.80	102.95
DVB-S2X 16APSK	32/45	272.28	122.52
DVB-S2X 32APSK	2/3	316.88	142.59
DVB-S2X 32APSK	32/45	338.50	152.32

FEC/Modulation	FEC Rate	Min Data Rate kbps	Max Data Rate Mbps
DVB-S2 QPSK	1/4	50	16.43
DVB-S2 QPSK	1/3	65.7	28.30
DVB-S2 QPSK	2/5	79	34.24
DVB-S2 QPSK	1/2	98.9	38.19
DVB-S2 QPSK	3/5	118.9	52.04
DVB-S2 QPSK	2/3	132.3	57.97
DVB-S2 QPSK	3/4	148.8	63.91
DVB-S2 QPSK	4/5	158.8	67.86
DVB-S2 QPSK	5/6	165.5	71.82
DVB-S2 QPSK	8/9	176.7	77.75
DVB-S2 QPSK	9/10	178.9	80.48
DVB-S2 8PSK	3/5	178	80.09
DVB-S2 8PSK	2/3	198.1	89.12
DVB-S2 8PSK	3/4	222.9	100.26
DVB-S2 8PSK	5/6	247.9	111.53
DVB-S2 8PSK	8/9	264.7	119.07
DVB-S2 8PSK	9/10	268	120.56
DVB-S2 16APSK	2/3	263.8	118.67
DVB-S2 16APSK	3/4	296.7	133.50
DVB-S2 16APSK	4/5	316.6	142.45
DVB-S2 16APSK	5/6	330.1	148.50
DVB-S2 16APSK	8/9	352.4	158.54
DVB-S2 16APSK	9/10	356.8	160.53

FEC/Modulation	FEC Rate	Min Data Rate kbps	Max Data Rate Mbps
FastLink BPSK	0.499	9.00	19.98
FastLink (O)QPSK	0.532	19.18	42.62
FastLink (O)QPSK	0.639	23.02	51.13
FastLink (O)QPSK	0.710	25.56	56.80
FastLink (O)QPSK	0.798	28.76	63.90
FastLink 8PSK	0.639	26.85	76.70
FastLink 8PSK	0.710	29.82	85.20
FastLink 8PSK	0.778	32.71	93.44
FastLink 8QAM	0.639	18.00	40.00
FastLink 8QAM	0.710	38.35	85.20
FastLink 8QAM	0.778	42.06	93.44
FastLink 16APSK	0.726	52.29	100.00
FastLink 16APSK	0.778	56.07	100.00
FastLink 16APSK	0.828	59.69	100.00
FastLink 16APSK	0.851	61.34	100.00
FastLink 16QAM	0.726	52.29	100.00
FastLink 16QAM	0.778	56.07	100.00
FastLink 16QAM	0.828	59.69	100.00
FastLink 16QAM	0.851	61.34	100.00
FastLink 32APSK	0.778	58.41	100.00
FastLink 32APSK	0.828	62.18	100.00
FastLink 32APSK	0.886	66.50	100.00
FastLink 32APSK	0.938	70.38	100.00
FastLink 64QAM	0.828	1492.17	100.00
FastLink 64QAM	0.886	1595.85	100.00
FastLink 64QAM	0.938	1689.08	100.00
FastLink 64QAM	0.960	1729.49	100.00

Modulation/FEC	FEC Rate	Min Data Rate kbps	Max Data Rate Mbps
BPSK VIT / SEQ	1/2	4.8	15 / 2
BPSK VIT / SEQ	3/4	7.2	22.5 / 2
BPSK VIT / SEQ	7/8	8.4	26.2 / 2
BPSK VIT RS	1/2	4.3	13.33
BPSK VIT RS	3/4	6.4	20
BPSK VIT RS	7/8	7.5	23.33
O/QPSK VIT / SEQ	1/2	9.6	30 / 2
O/QPSK VIT / SEQ	3/4	14.4	45 / 2
O/QPSK VIT / SEQ	7/8	16.8	52.5 / 2
O/QPSK VIT RS	1/2	8.6	26.67
O/QPSK VIT RS	3/4	12.8	40
O/QPSK VIT RS	7/8	15	46.67
O/QPSK TPC	1/2	2.4	12
O/QPSK TPC	3/4	14.4	60
O/QPSK TPC	7/8	16.8	60
O/QPSK TPC	0.93	17.9	60
8PSK TCM	2/3	19.2	60
8PSK TCM RS	2/3	17.7	60
8PSK TPC	3/4	21.6	60
8PSK TPC	7/8	25.2	60
8PSK TPC	0.93	26.8	60
16QAM TPC	3/4	28.8	60
16QAM TPC	7/8	33.6	60
16QAM TPC	0.93	35.8	60

Chapter 13   Advanced Framing

This chapter describes the advanced framing options available on the modem.

13.1 Edit->Tx-Rx->Framing Screen

The *Edit->Tx-Rx->Framing* screen, shown in **Figure 13-1**, allows configuration of framing, timeslots and overhead.

Figure 13-1 Edit->Tx-Rx->Framing Screen

The menu contains the following options:

- *Baseband mode*. *Continuous* selects normal continuous data interface operation. *Drop MUX* processes a T1 or E1 bearer, with Tx data being dropped from specific timeslots of the bearer (on the Rx side, data can be inserted back into the same timeslots or into different timeslots). *Audio/data* requires an IDR interface card to be fitted, plus IBS satellite framing, which provides a P1348 emulation mode. It uses the audio ports normally used for the IDR audio ESC circuit, as the main traffic data. A 64kbps carrier can be generated, comprising two 32kbps ADPCM audio channels, or a 128kbps carrier can be generated, comprising 64kbps data (from the modem main data interface) plus two 32kbps ADPCM audio channels. These modes emulate the popular P1348/P1448 voice/data MUX card.
- *2048k mode*. This option is used to indicate whether a continuous 2048kbps traffic stream is formatted as G.732 or not.
- *G.732 CAS signalling.* This specifies whether Channel Associated Signalling (CAS) information in Timeslot 16 CAS is processed and routed through the satellite. When CAS is selected, the CAS will be conveyed from end-to-end of the link using the IBS overhead. No CAS indicates that a terrestrial CAS multiframe and 'abcd' signalling nibbles for each timeslot are not present and consequently, Timeslot 16 may be dropped/inserted in a similar manner to other timeslots.
- *Drop/insert bearer format.* This specifies the framing format for Drop/Insert MUX operation. The supported formats are: G.732, T1-D4 and T1-ESF.
- *Generate bearer*. This specifies whether the modem should generate a bearer for G.703 traffic or whether a bearer is already being looped through the modem and the modem should multiplex its data onto this.

13.2 Edit->Tx-Rx>Framing->Overhead Closed Screen

The *Edit->Tx-Rx->Framing->Overhead Closed* screen, shown in **Figure 13-2** controls the overhead in Closed Network Plus ESC mode, allowing the high-rate asynchronous ESC channel to be set up.

Figure 13-2 Edit->Tx-Rx->Framing->Overhead Closed Screen

This contains the following options:

- *ESC interface baud rate.* This can be set in the range 110 baud to 115,200 baud.
- *ESC interface character length.* This can be set to 7 or 8 bits.
- *ESC interface parity polarity.* This can be set to *None*, *Even* or *Odd*.
- *Enable backward alarm.* This controls whether a backward alarm facility is supported as part of the ESC channel.
- *ESC interface type.* This specifies which of the modem's physical interfaces is to be connected through to the satellite ESC channel as described below.

Note that the rear-panel Async ESC connector provides either a high-rate asynchronous ESC interface for IBS and Closed Network Plus ESC overhead channel data, or it provides the Aux function. When an IDR interface card is fitted then the rear-panel shared Async ESC port is disabled and the IDR card provides separate ESC and Aux ports.

In the case of RS232, RS422 and RS485, the relevant physical interface on the Async ESC port is directly connected through to the ESC channel and the data is therefore passed transparently, i.e. whatever is passed through is what comes out on the equivalent interface on the remote modem, without being interpreted in any way by either modem. For example, messages could be passed to control any manufacturer's piece of equipment that is listening on an RS485 multidrop bus at the remote modem.

An IP mode allows IP packets to be sent over the satellite ESC channel. The ESC channel forms part of an Ethernet bridge and the modem therefore learns which IP packets should be sent over the ESC channel. The IP packets need not be destined for the remote modem as they will be passed onto the remote Ethernet network if they are addressed to a device on that network. The IP packets will be interleaved with AUPC messages when AUPC is switched on. RS485 M&C messages can be sent over the satellite ESC channel at the same time as IP packets, provided that the M&C messages are prefixed with *ESC* as described in the document '*Remote M&C Specification for Q-Flex™ Satellite Modem*'.

For IP, the modem will allocate internal IP addresses to each end of the ESC channel and these will only be visible internally within the modem.

The *RS485-Local* and *RS485-Remote* modes are referred to as *Link-Local* and *Link-Remote*, respectively. These modes create internal links between the ESC port of the modem and the Remote M&C port in order to facilitate passing M&C messages over satellite to control a remote modem without the need for external loopback cables between the Async ESC and Remote M&C ports. Both point-to-point and point-to-multipoint RS485 over the ESC channel are supported. The following drawing shows the internal connections that are made.
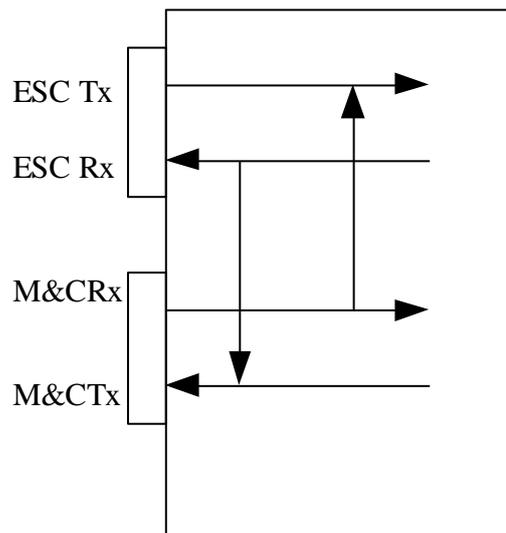
Link-Local
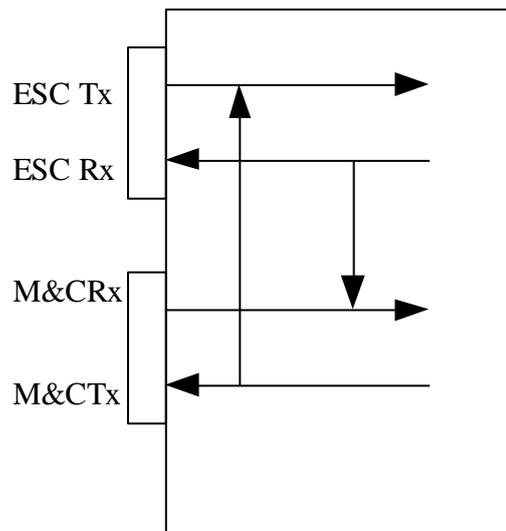
Link-Remote

With both of these options, the physical ESC port is disabled due to being internally linked to the M&C port. The mode must be set according to whether the modem is at the local or remote end of the link.

The effect of *Link-Local* is to transmit whatever is received over the satellite ESC channel out onto the local modem's M&C bus, while at the same time, transmitting all incoming M&C messages out over the satellite ESC channel.

The effect of *Link-Remote* is to loop back whatever is received over the modem's satellite ESC channel to the modem's M&C port and to transmit over the satellite ESC channel whatever is transmitted by the modem out of its M&C port.

IP to Serial supports the transmission of IP-wrapped RS485 messages through the ESC channel, which are then transmitted as serial messages on the remote RS485 bus.

13.3 Edit->Tx-Rx>Framing->Overhead IBS Screen

The *Edit->Tx-Rx->Framing->Overhead IBS* screen, shown in **Figure 13-3** controls the overhead in IBS mode, allowing both the low and high-rate ESC channels to be set up.

Figure 13-3 Edit->Tx-Rx->Framing->Overhead IBS Screen

This contains the following options:

- *High-rate ESC data mode.* Controls whether the IBS high-rate asynchronous ESC channel is enabled.
- *High-rate ESC overhead usage.* This allows backward compatibility with the Paradise P230 unit but should otherwise be set to *Maximum overhead*.
- *ESC interface baud rate.* IBS uses a fixed frame format and therefore the amount of overhead is limited. The maximum ESC baud rate that may be selected is displayed.
- *ESC interface character length.* This can be set to 7 or 8 bits.
- *ESC interface parity polarity.* This can be set to *None*, *Even* or *Odd*.

- *IBS Aux mode.* This controls the operating mode of the Aux channel, controlling the allocation of overhead between the Aux and ESC interfaces. The Aux channel can be set to *Off*, *Intelsat over-sampled* or *Synchronous.*
- *Enable backward alarm.* This controls whether a backward alarm facility is supported as part of the ESC channel.
- *ESC interface type.* This specifies which of the modem's physical interfaces is to be connected through to the satellite ESC channel. This is described under the *Edit->Tx-Rx>Framing->Overhead Closed* screen description.
- *Aux interface type.* This specifies the Aux electrical interface. The relevant physical interface (on the shared Async ESC/Aux port on the base modem or the separate Aux port on the IDR card) is directly connected through to the ESC channel. This interface on the modem provides the IBS low-rate Intelsat oversampled ESC facility. The ESC and Aux functions are mutually exclusive unless an IDR card is fitted. If an IDR card is fitted then the Aux port can provide 32kbps or 64kbps access to the IDR overhead in place of one or both of the IDR 32kbps ADPCM audio ESC channels, or it can provide either the IBS low-rate Intelsat oversampled ESC facility or a higher rate synchronous channel within the IBS overhead.

13.4 Edit->Tx-Rx>Framing->Overhead IDR Screen

The *Edit->Tx-Rx->Framing->Overhead IDR* screen, shown in **Figure 13-4** controls the overhead in IDR mode, allowing the IDR 8kbps ESC channel and audio channels to be set up and the routing of multiple backward alarms. It also allows Aux data to be allocated in place of one or both of the IDR audio channels if these are not used or it can be used to reduce the standard 96kbps overhead to 64kbps or 32kbps.

Figure 13-4 Edit->Tx-Rx->Framing->Overhead IDR Screen

This contains the following options:

- *IDR 8k ESC mode*. This controls the operating mode of the low-rate IDR ESC channel, which can be set to *Off*, *Synchronous* or *Asynchronous*.
- *ESC interface baud rate*. IBS uses a fixed frame format and therefore the amount of overhead is limited. The maximum ESC baud rate that may be selected is displayed.
- *ESC interface character length.* This can be set to 7 or 8 bits.
- *ESC interface parity polarity.* This can be set to *None, Even* or *Odd*.
- *IDR ESC audio data encoding.* This controls audio data format for the ESC overhead in IDR mode. The overhead can be set to 32, 64 or 96kbps. 64kbps of this can be not transmitted, allocated to voice or allocated to Aux data via the Aux controls. When set to *Off*, V1 and V2 are omitted and consequently only 32kbps overhead is transmitted (or the 64kbps of V1 and V2 overhead can be reallocated to Aux data via the *IDR Aux mode* setting). The 32kbps overhead includes FAS, backward alarms and an 8kbps synchronous ESC channel. When set to *2x16k in V1,* two 16kbps ADPCM channels are provided in V1 (with V2 either being omitted or being replaced with Aux data as determined by the *IDR Aux mode* setting). When set to *1x32k in V1,* 32kbps is provided in V1 (with V2 either being omitted or being replaced with Aux data as determined by the *IDR Aux mode* setting). When set to *2x32k in V1,V2*, the normal full 96kbps of IDR overhead is used, including two audio ESC channels encoded as 32kbps ADPCM, as well as the standard 32kbps for FAS, backward alarms and an 8kbps synchronous ESC channel .
- *IDR Aux data*. This controls the Aux channel in IDR mode. It allocates Aux data in place of one or both of the IDR voice channels if these are not used or can be used to reduce the 96kbps overhead to 64kbps or 32kbps. When set to *Off*, no Aux data is placed in the overhead. When set to *32K,* 32kbps of Aux data replaces the data in IDR audio ESC channel V2 (this requires the *IDR audio mode* setting to be *2x16k in V1* or *1x32k in V1*). When set to *64K*, 64kbps of Aux data replaces the data in IDR audio ESC channels V1 and V2 (this requires the *IDR audio mode* to be set to *Off*).
- *ESC level ch1, ch2*. These can be set in the range 0 to 38dB. They set the input/output levels for the IDR audio ESC channels. The two channels can be configured independently.
- *Backward alarm mode*. This controls routing of multiple backward alarms in IDR mode. When internally linked from Rx-Fail to BA1 or BA1-4, these alarms respond similarly to the normal single backward alarm. The options are to set
    - *Backward alarm 1-4 external*
    - *Backward alarm 1 internal, backward alarm 2-4 external*
    - *Backward alarm 1 internal, backward alarm 2-4 forced okay*
    - *Backward alarm 1-4 internal.*
- *ESC interface type.* This specifies which of the modem's physical interfaces is to be connected through to the satellite ESC channel. This is described under the *Edit->Tx-Rx>Framing->Overhead Closed* screen description.
- *Aux interface type.* This specifies the Aux electrical interface. The relevant physical interface (on the shared Async ESC/Aux port on the base modem or the separate Aux port on the IDR card) is directly connected through to the ESC channel. This interface on the modem provides the IBS low-rate Intelsat oversampled ESC facility. The ESC and Aux functions are mutually exclusive unless an IDR card is fitted. If an IDR card is fitted then the Aux port can provide 32kbps or 64kbps access to the IDR overhead in place of one or both of the IDR 32kbps ADPCM audio ESC channels, or it can provide either the IBS low-rate Intelsat oversampled ESC facility or a higher rate synchronous channel within the IBS overhead.

13.5 G.703 Menus and Operation

The *Edit->Tx-Rx->Advanced* screen will include the options shown in **Figure 13-5** when G.703 is selected as the terrestrial interface type.


Figure 13-5 Edit->Tx-Rx->Advanced Screen for G.703

This contains the following options:

- *G.703 data rate*. This can be set to *E1*, *T1*, *E2*, *T2*, *E3* or *T3*.
- *G.703 line format*. This can be set to *Balanced* or *Unbalanced*.
- *G.703 line encoding*. This can be set to *AMI*, *B3ZS*, *B6ZS* or *HDB3*. These are schemes that limit the number of contiguous zeros that can be sent in order to aid clock recovery and prevent data errors.
- *G.703 line length*. This can be set to *133m*, *266m*, *399m*, *533m* or *655m*. This allows signal compensation for differing lengths of standard `ABAM` cable. If in doubt then *133m* should be selected (no compensation). This is only relevant for T1 and T2.

The *Edit->Tx-Rx->Framing* screen will show options as displayed in **Figure 13-6** when G.703 is selected as the terrestrial interface type.

Figure 13-6 Edit->Tx-Rx->Framing Screen

This contains the following options:

- *Tx baseband mode*. This can be set to *Continuous*, where the G.703 traffic is treated as full E1 (or T1/E2/T2/E3/T3) with no options to process individual timeslots with respect to the PCM bearer. It can also be set to *Drop MUX*, which

for E1 (and T1) allows dropping of individual timeslots from the incoming terrestrial signal onto the satellite carrier (timeslot control tabs will be displayed in this mode).

- *Rx baseband mode* allows similar options to *Tx baseband mode* including the ability to insert individual received timeslots into the terrestrial carrier.
- *Tx/Rx 2048k format*. This supports options of *Unformatted* or *G.732*. The menu option is enabled when the *Tx/Rx service* is *IBS* or *IDR* and the *Tx data rate* is 2.048Mbps.
- *Tx/Rx G.732 CAS signalling.* This menu option is enabled for continuous G.732 signals. The options are *CAS* and *No CAS.* For G.732 bearer operation it indicates whether Channel Associated Signalling information is present in Timeslot 16. When *CAS* is selected, the CAS will be conveyed end-to-end using the IBS overhead. *No CAS* indicates that a terrestrial CAS multiframe and 'abcd' signalling nibbles for each timeslot are not present. In this case Timeslot 16 may be dropped/inserted in a similar manner to other timeslots.
- *Drop/insert bearer format*. Options of *G.732*, *T1-D4* and *T1-ESF* are supported.
- *Generate bearer*. This supports options of *Loop (auto-originate)* and *Originate*.

This controls the origination of a terrestrial bearer from the Insert MUX. *Loop (auto-originate)* loops the existing external bearer through the modem (thereby retaining the original bearer timing when inserting timeslots from satellite). It will also auto-originate a bearer should the bearer fail. *Originate* causes the modem to generate a new bearer. Typical usage is shown in **Figure 13-7**, which shows a master/slave clocking system where the bearer clock is propogated over satellite and looped at one end of the link.

Other clocking systems are also valid, such as having independent clocks at each end of the link (although this will require a buffer to be set in the modem and may result in periodic data loss).
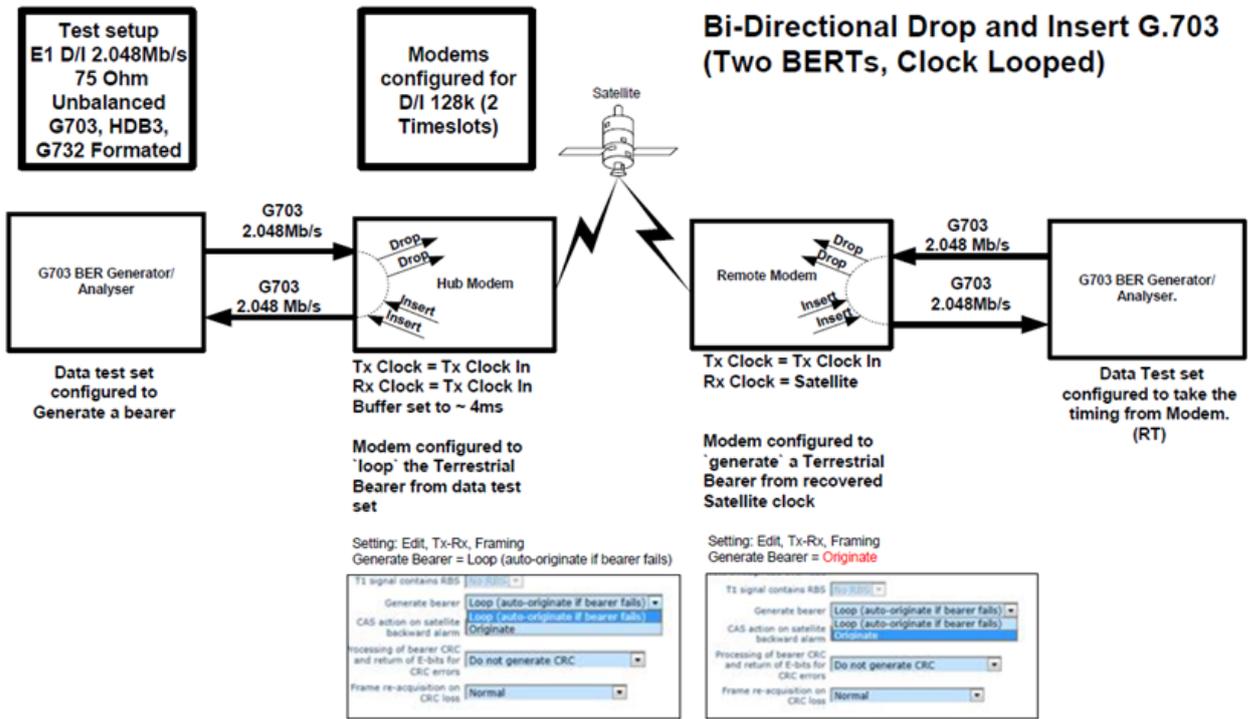
Figure 13-7 G.703 Master/Slave Clocking (single clock looped at remote modem)

The *Edit->Tx-Rx->Framing->Tx Timeslots* screen is shown in **Figure 13-8.**

Figure 13-8 G.703 Edit->Tx-Rx->Framing->Tx Timeslots Screen

This contains the following options:

- *Number of timeslots to satellite*. This controls the number of timeslots dropped off the terrestrial bearer and sent over the satellite.
- *Timeslots.* The edit capabilities allow any timeslot from 0 to 31 to be sent in any timeslot position. (Alternatively, when entering timeslot numbers from the front panel keypad, the following editing rules should be observed. Timeslots can be entered as individual numbers separated by commas or as an inclusive range denoted by the first and last timeslot numbers in the range with a hyphen between them. For example, '0,18-31,17,16-1' swops timeslots groups 18 to 31 with 1 to 16 and additionally reverses timeslots 1 to 16. The *Down* arrow key is used to enter a comma and the *Up* arrow key enters a hyphen. The 0 key pressed together at the same time as the *Right* arrow key deletes the character at the cursor.)
- *Maintain timeslot ID over satellite*. This controls whether timeslot identity is maintained over satellite. When *Off*, timeslot identity is not maintained. When *On*, the modem will activate a satellite CAS multiframe in order to provide timeslot identity maintenance.
- *Dropped timeslots*. This controls whether dropped timeslots are replaced with Idle code. *Leave on bearer* causes the Tx data to remains on the terrestrial bearer where it will be accessible to downstream equipment (unless Rx data from satellite is

inserted over it). *Replace with Idle code* causes the Tx data on the bearer to be replaced as follows (MSB to LSB): G.732 timeslots are replaced with 01010101; G.732 CAS in TS16 is replaced with 0101 if CAS signalling is active; T1-D4 and T1-ESF timeslots are replaced with 10000000.

The *Edit->Tx-Rx->Framing->Rx Timeslots* screen is shown in **Figure 13-9.**
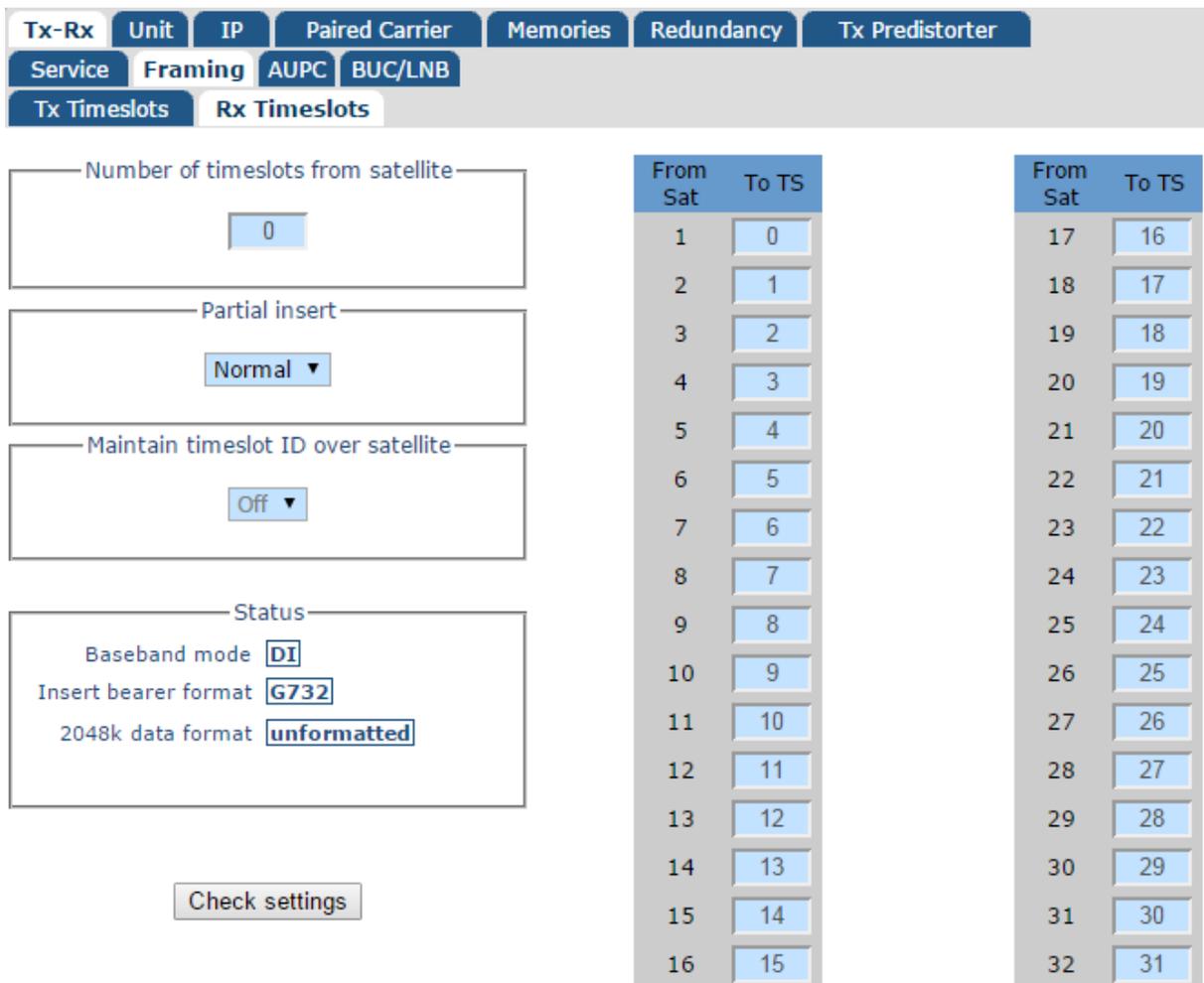

Figure 13-9 G.703 Edit->Tx-Rx->Framing->Rx Timeslots Screen

This contains similar options to the *Tx Timeslots* screen, with the following exception:

- *Partial insert*. When active, this controls which timeslots from the satellite are inserted into the terrestrial bearer. The options are *Partial* and *Normal.* These control whether part or all of the received data is inserted into the terrestrial bearer.

13.6 Quad E1 and MultiMux Menus and Operation

The *Edit->Tx-Rx->Advanced* screen will show options as displayed in **Figure 13-10** when Quad E1 is selected as the terrestrial interface type.
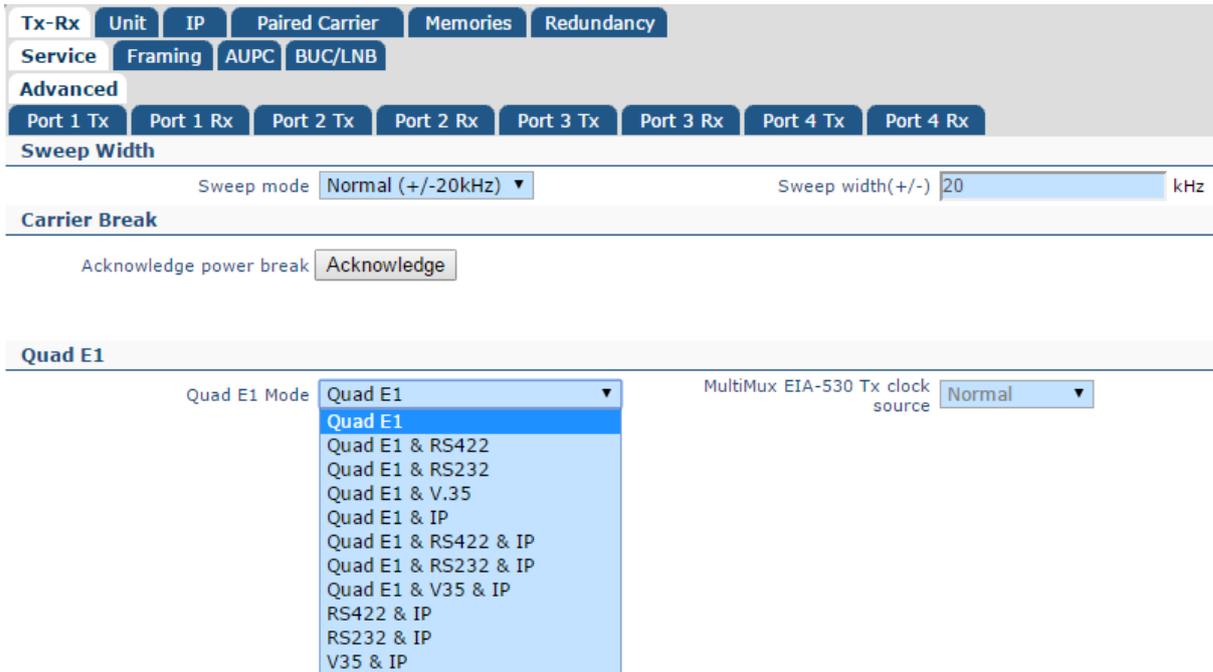
Figure 13-10 Edit->Tx-Rx->Service->Advanced Screen with Quad E1 options

This contains the following Quad E1 options:

- *Quad E1 mode*. A number of modes are supported as shown in **Figure 13-10**. The Quad E1 interface can be operated purely as four E1 ports (when *Quad E1 mode* is set to *Quad E1*) or using a mixture of interfaces that are multiplexed onto a single carrier (referred to as MultiMux). MultiMux is documented later in this section.
- *MultiMux EIA-530 Tx clock source*. This forms part of MultiMux operation and is documented later in this section.

The *Edit->Tx-Rx->Advanced->Port Tx* screen for Quad E1 Tx timeslots is shown in **Figure 13-11.**

Figure 13-11 Quad E1 Edit->Tx-Rx->Service->Advanced->Tx Timeslots Screen

This contains the following options:

- *Mode.* This selects the operating mode for the particular terrestrial port on the Quad E1 card. The options represent interfaces between different components within a GSM system. The selection is used to default timeslot settings for the particular port, in accordance with the type of interface. When set to *Off, t*he specified port on the Quad E1 card is not being used and is therefore disabled. When set to *E*, the specified port on the Quad E1 card is being used between a PSTN (Packet Switched Telephone Network) and MSC (Mobile Switching Centre). When set to *A*, the specified port on the Quad E1 card is being used between a BSC (Base Station Controller) and MSC (Mobile Switching Centre). When set to *Abis*, the specified port on the Quad E1 card is being used between a BSC (Base Station Controller) and BTS (Base Transceiver Station). When set to *Ater*, the specified port on the Quad E1 card is being used between a TRAU (Transcoding and Rate Adaption Unit) and BTS (Base Transceiver Station). When set to *Drop-Insert*, timeslots on the specified port can be configured manually. Selecting *Unframed* indicates that full E1 rather than fractional E1 is being used and therefore individual timeslot processing is disabled. For unframed E1, the E1 signal is passed transparently over the satellite link and the modem will not synchronise to the incoming E1 frame (2M or CRC4), nor will E1 frame alarms be generated.
- *Interface loopback.* This invokes a loopback between Rx and Tx allowing the data transmitted via one modem to be returned via the receiving modem.
- *Tx data rate.* This status indicates the modem transmit data rate and will change with the number of timeslots that are selected.
- *2048k data format.* This status reflects the *Tx 2048k data format* selection on the *Edit->Tx-Rx->Framing* menu.
- *Dropped timeslots.* This controls whether dropped timeslots are replaced with Idle code. *Leave on bearer* causes the Tx data to remains on the terrestrial bearer where it will be accessible to downstream equipment (unless Rx data from satellite is

inserted over it). *Replace with Idle code* causes the Tx data on the bearer to be replaced with data pattern '55'.

- *Tx bearer CRC.* The *Tx bearer CRC* options are *Ignore CRC* and *Check CRC*, which respectively cause the CRC in the incoming CRC4 multiframe to be ignored or processed. Please refer to the *CRC Processing* information panel for a full description of CRC processing options.
- *Baseband mode.* This reflects the *Tx baseband mode* selection on the *Edit->Tx-Rx->Framing* menu.
- *Timeslots to satellite.* This status reflects the number of timeslots dropped off the terrestrial bearer and sent over the satellite.
- *Timeslots.* The edit capabilities allow any timeslot from 0 to 31 to be sent over satellite.

CRC Processing

The first bit of TS0 is the international bit (usually set to 1) but can also be used to pass a CRC (which as well as detecting errors can also aid frame synchronisation). When used for a CRC, the first bit of TS0 follows a 16-frame pattern:

(Even)	C1	C2	C3	C4	C1	C2	C3	C4
(Odd)	0	0	1	0	1	1	E	E

When processing incoming terrestrial timeslots for transmission over satellite, the dropped timeslots can be left on the bearer coming into the modem (loop mode), or they can be replaced with idle code (data pattern '55'), assuming that the bearer is being looped through the modem and onto other equipment. A Tx CRC alarm will be raised when Tx CRC processing is enabled and the modem detects CRC errors with respect to the incoming signal.

TS0 processing on the Rx side is as follows:

- *The TS0 received over satellite can be inserted onto the terrestrial bearer.*
- *The terrestrial bearer, including TS0, can be looped from Tx to Rx in the modem so that it is available to other equipment.*
- *A new bearer can be generated by the modem where TS0 is blank. This includes the 8 CRC bits of the CRC4 multiframe when CRC generation is enabled. When CRC processing is disabled then then the first bit of TS0 is set to 1 (the idle pattern).*
- *The modem does not allow Rx CRC processing to be enabled when TS0 is being carried over satellite.*

There is an Rx option to control the generation of a CRC for the terrestrial frame and processing of E-bits. The options are:
- *Do not generate CRC (where no CRC4 multiframe is generated).*
- *Generate CRC but not E-bits (where the CRC4 multiframe is regenerated but not the error bits).*
- *Generate CRC and return E-bits (where the CRC4 multiframe is*

regenerated including the error bits).

If CRCs are being used then the CRC4 checksum needs to be regenerated by the receiving modem when only a subset of the timeslots are transferred over satellite, since if instead the original checksum is output then it will be incorrect.

When CRC generation is enabled:

- *The receive path CRC logic monitors the TS0 frame for the CRC4 multiframe. If detected, the eight CRC bits are overwritten with the new CRC bits. If the CRC multi-frame is not detected then the first bit of TS0 is unaltered.*
- *When TS0 is included in the drop and insert timeslots, or loop mode is selected, the incoming E1 signal source must be set for 16-frame multiframe (CRC4) operation. An incoming 2-frame multiframe will not result in an outgoing 16-frame multiframe in these modes.*
- *When TS0 is not included in the drop and insert timeslots, a blank TS0 is generated by the modem and the blank CRC bits are overwritten with new CRC bits generated by the modem. When CRC generation is disabled then these bits will be set to 1.*

The *Edit->Tx-Rx->Advanced->Port Rx* screen for Quad E1 Rx timeslots is shown in **Figure 13-12.**
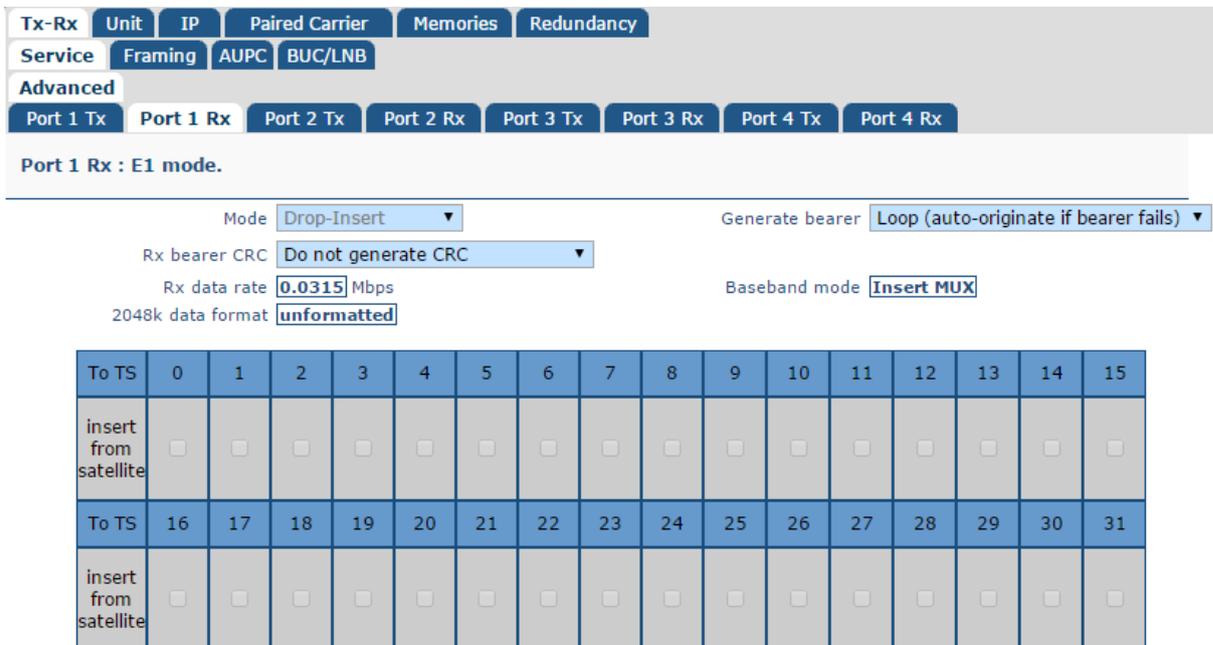
Figure 13-12 Quad E1 Edit->Tx-Rx->Service->Advanced->Rx Timeslots Screen

This contains similar options to the *Tx Timeslots* screen, with the following exceptions:

- *Rx bearer CRC.* This controls the generation of a CRC and E-bits with respect to the terrestrial bearer. Please refer to the *CRC Processing* information panel for more details.
- *Generate bearer.* This supports options of *Loop (auto-originate if bearer fails)* and *Originate.* This controls the origination of a terrestrial bearer from the Insert MUX. *Loop (auto-originate if bearer fails)* loops the existing external bearer through the modem (thereby retaining the original bearer timing when inserting timeslots from satellite). It will also auto-originate a bearer should the bearer fail. *Originate* causes the modem to generate a new bearer. Typical usage is shown in **Figure 13-7**, which shows a master/slave clocking system where the bearer clock is propogated over satellite and looped at one end of the link.

MultiMux Operation

The Quad E1 option card (part number P3706) supports four G.703 HDB3-encoded balanced RJ45 interfaces. It also provides MultiMux, a feature that allows G.703, EIA-530 and IP traffic to be multiplexed together onto a single carrier.

The maximum data rates of the different types of interface when used with MultiMux are as follows:

- E1: 2.048Mbps per E1 port.
- EIA-530: 10Mbps per EIA-530 port.
- IP: 32.768Mbps.

Possible traffic combinations include (but are not limited to):

- Four E1s, each with individual timeslot selection. When using *Closed network* or *Closed network plus ESC*, a maximum of 64 timeslots can be used with respect to E1 operation. Above this number of timeslots IBS framing must be used.
- Two E1s, 2Mbps IP and 2Mbps EIA-530 data (or up to three E1s when one or other of IP or EIA-530 is not used).
- 32Mbps IP with three E1s.
- 32Mbps IP with 10Mbps EIA-530 and two E1s.
- Two E1s and two 10Mbps EIA-530 interfaces.

Data rates are specified as multiples of a variable step size. The step size depends on the highest data rate being used for any interface, as follows:

- Port rate <= 2.048Mbps: step size = 64kbps. For fractional E1 operation (i.e. timeslot drop and insert), the step size must be 64kbps; above this step size only the full E1 data rate can be used.
- Port rate > 2.048Mbps and <= 4.096Mbps: step size = 128kbps.
- Port rate > 4.096Mbps and <= 8.192Mbps: step size = 256kbps.
- Port rate > 8.192Mbps and <= 16.384Mbps: step size = 512kbps.
- Port rate > 16.384Mbps and <= 32.768Mbps: step size = 1024kbps.

Note that IBS framing cannot be used with step sizes above 64kbps (*Closed network* or *Closed network plus ESC* must be selected instead). *Closed network* will result in the lowest level of satellite framing overhead (less than 0.5%), followed by *Closed network plus ESC* (variable overhead as required); IBS has the highest overhead (fixed at 6.7%).

For example, if the IP data rate is 32.768Mbps then the EIA-530 data rate would have to be chosen as a multiple of 1024kbps, while the E1 data rate, if used, must be 2.048Mbps (since fractional E1 is not supported when any data rates exceeds 2.048Mbps).

The steps to determine the data rates to enter into the modem for IP and EIA-530 are as follows:

- Use the higher of the desired data rates to determine the step size using the rules above.
- Divide each desired data rate by the step size and round the result up to the next whole number. Multiply these numbers by the step size. These are the numbers that should be entered.

This method calculates the next highest valid data rate rather than the closest valid data rate (which may be lower than the required data rate).

For example, assume the desired data rates are 4.324Mbps for IP and 2.65Mbps for EIA-530. This means a step size of 256kbps must be used. The calculations are as follows:

- IP: 4324kbps / 256kbps = 16.89 -> 17 -> 17 x 256 = 4.352Mbps
- EIA-530: 265kbps / 256kbps = 1.03 -> 2 -> 2 x 256 = 0.512Mbps

Quad E1 MultiMux Configuration

When Quad E1 is fitted, the *Edit->Tx-Rx->Service->Advanced* screen will show Quad E1 configuration tabs for each port as shown in **Figure 13-13.**
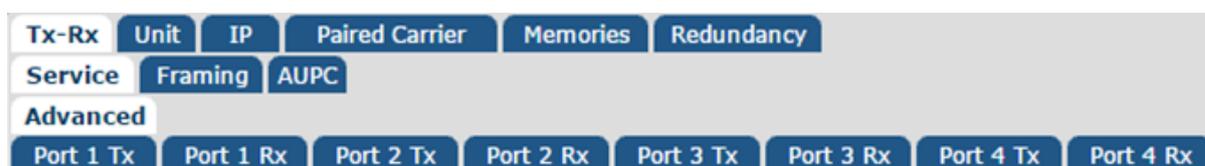
Figure 13-13 Edit->Tx-Rx->Service->Advanced Screen Quad E1 Configuration Tabs

As well as allowing the configuration of each E1 port, these allow the configuration of MultiMux. Ports 1 and 2 are dedicated to E1, while Port 3 can be used for E1 or EIA-530; Port 4 can be used for E1, IP or a second EIA-530.

On the *Edit->Tx-Rx->Service->Advanced* screen, the *Port 3* and *Port 4* tabs screens will show options for the selection of data rates for EIA-530 (Port 3) and IP (port 4) as shown in **Figure 13-14**.
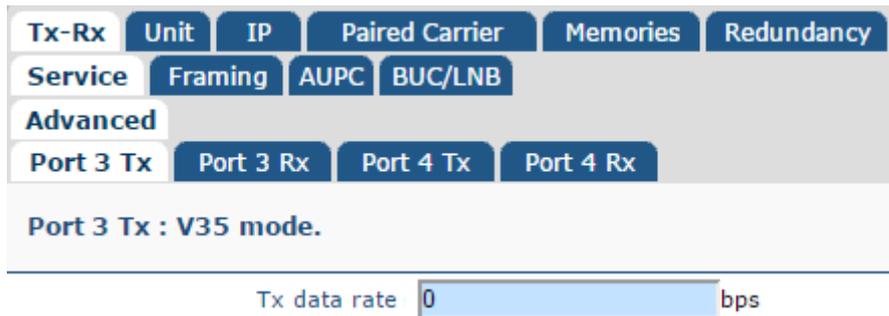
Figure 13-14 Edit->Tx-Rx->Service->Advanced MultiMux Data Rate Screen

MultiMux Clocking

Transmit clocking is described in Section 6.2.4.7 and its configuration will depend on the overall system clocking scheme and the modem's location with respect to the master clock source.

Figure 13-15 shows an example of MultiMux clock configuration for a hub and remote site.
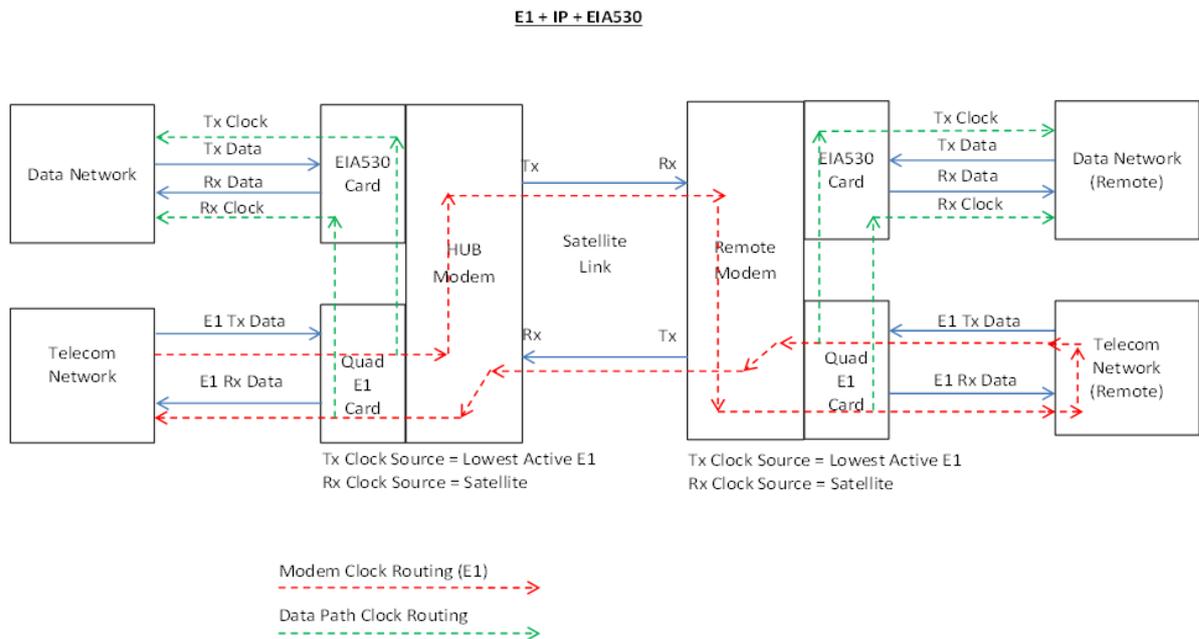

Figure 13-15 MultiMux Clocking Example

In this example, EIA-530 maintains clock synchronisation with the E1 transmit data. The modem uses the timing from the terrestrial equipment connected to Port 1 to time all other ports. The following clock settings are used:

[**Hub Site**]
TX Clock source = Lowest Active E1 port
RX Clock source = Satellite

[**Remote Site**]
TX Clock source = Lowest Active E1 port

RX Clock source = Satellite

The EIA-530 interface also supports the X.21 interface as shown in **Figure 13-16**.
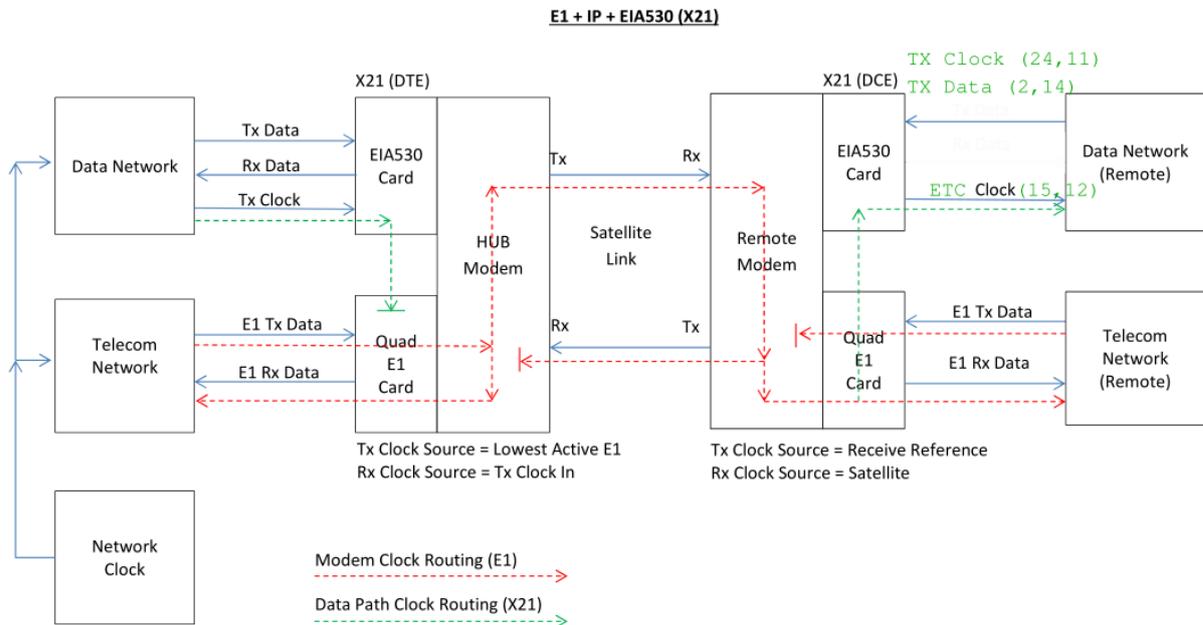

Figure 13-16 MultiMux X.21 Clocking Example

The hub and data network needs to be externally synchronised with the E1 telecoms network as shown. The following clock settings are used:

[**Hub Site**]
TX Clock source = Lowest Active E1 port
RX Clock source = Tx Clock In

[**Remote Site**]
TX Clock source = Receive reference
RX Clock source = Satellite (no buffer used here)

In addition, the buffer in the modem must be set to accommodate Doppler shift on both the outgoing and incoming paths (using the *Edit->Tx-Rx->Service->Advanced* menus). If the buffer is too small then it will result in cyclical buffer underflows or overflows, which may lead to errors (4ms is normal okay for most satellites with good station keeping).

MultiMux EIA-530 Tx Clock Source
The *MultiMux EIA-530 Tx clock source* is shown in **Figure 13-10** (the *Edit->Tx-Rx->Service->Advanced* screen).

When the EIA-530 interface is selected as part of MultiMux then an additional clock source selection menu for EIA-530 becomes available. This supplements the normal transmit clock menu option. The *MultiMux EIA-530 Tx clock source* options are shown in **Table 13-1**.

Normal	This is the default setting and has the same functionality as the *Tx Clock Out* option.
Tx Clock Out	This forces the *Int Tx Clock Out* signal (pins 15 and 12) to be used internally to time data to the modem in the transmit direction towards satellite; this is therefore synchronized to the Tx clock source.
Tx Clock In	This uses the *Int Tx Clock Out* pins (synchronised to the Tx clock source) to supply a network clock to time external equipment. The external terrestrial equipment should be configured to use this clock to time data towards the transmit path of the modem (on pins 24 and 11). This allows the modem to compensate for any clock skew caused by extended cable runs to the data network equipment.

Table 13-1 MultiMux EIA-530 Tx Clock Source

Figure 13-17 shows an example where the *EIA-530 Tx clock source* is set to *Tx Clock Out*, where the modem's internal *Tx Clock Out* is used internally to time data towards the satellite in the transmit direction from the data network.
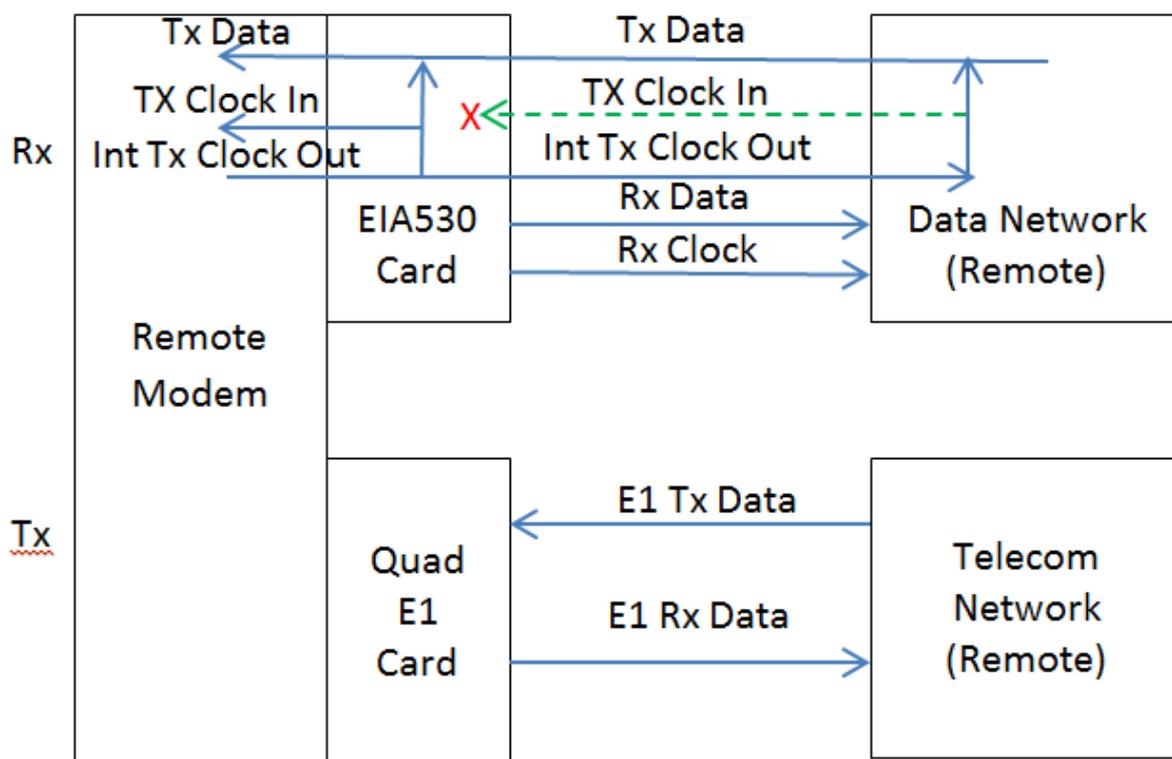

Figure 13-17 MultiMux Example with EIA-530 Tx Clock Source set to Tx Clock Out

Figure 13-18 shows an example where the *EIA-530 Tx clock source* is set to *Tx Clock In*, where the modem's *Int Tx Clock Out* is used to time data within the terrestrial equipment in the transmit direction towards the modem.
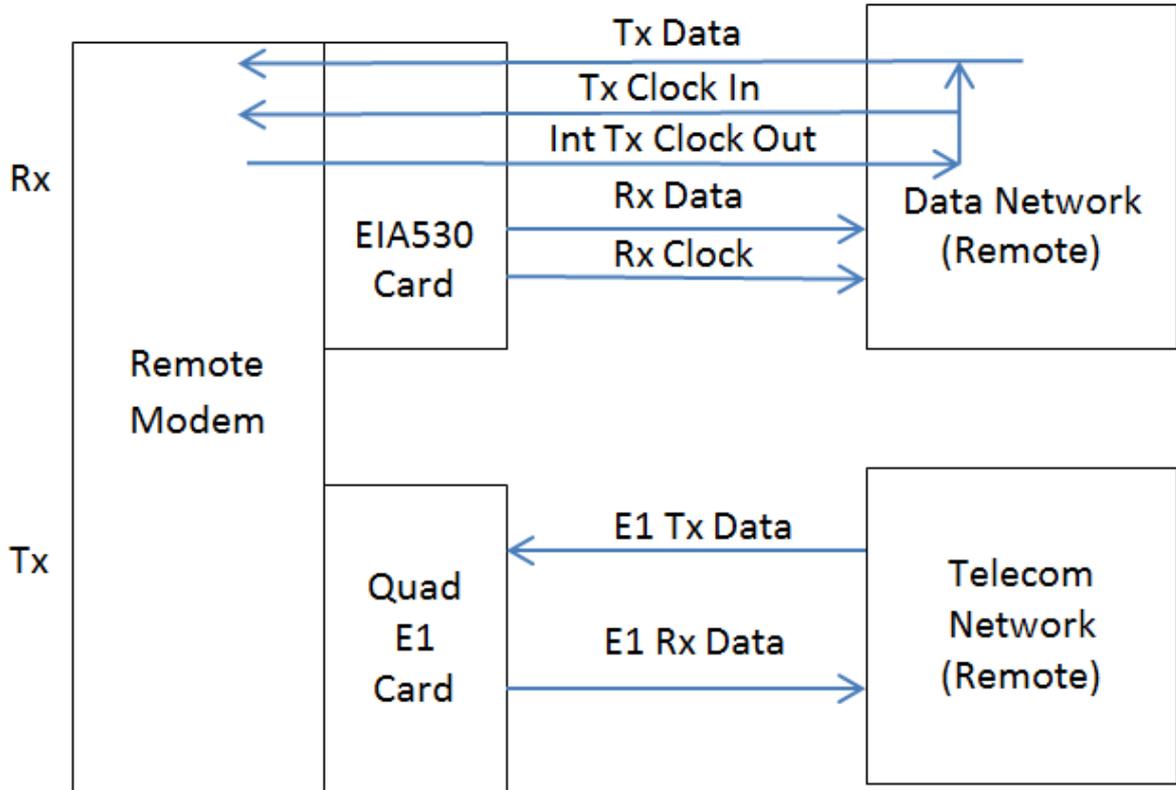
Figure 13-18 MultiMux Example with EIA-530 Tx Clock Source set to Tx Clock In

Chapter 14   QubeFlex™

The **QubeFlex™** ground-segment modem has been designed for the low-earth orbit CubeSat and smallsat markets. It provides CCSDS and Intelsat-compliant Viterbi/Reed-Solomon operation. Compatible onboard transmitter/transceivers for the satellite are provided by our partners (please contact us for details).

The **QubeFlex™** offers the same front-panel and web user interfaces as the **Q-Flex™** but with relatively minor modifications to the standard menus as described in this section.

QubeFlex™ Software Upgrades

*When performing a software upgrade to a **QubeFlex™**, only files with the filename format '**QubeFlex-x.x.x.zip**' should be used. Loading other files, including standard Q-Flex software, will corrupt the modem and will necessitate going through the standard recovery process. The software upgrade process is described in Section 6.2.13.*

14.1 Edit->Tx-Rx->Service Screen for QubeFlex™

The **QubeFlex™** *Edit->Tx-Rx->Service* screen is shown in **Figure 14-1**. (This replaces the standard **Q-Flex™** *Edit->Tx-Rx->Service* screen.)
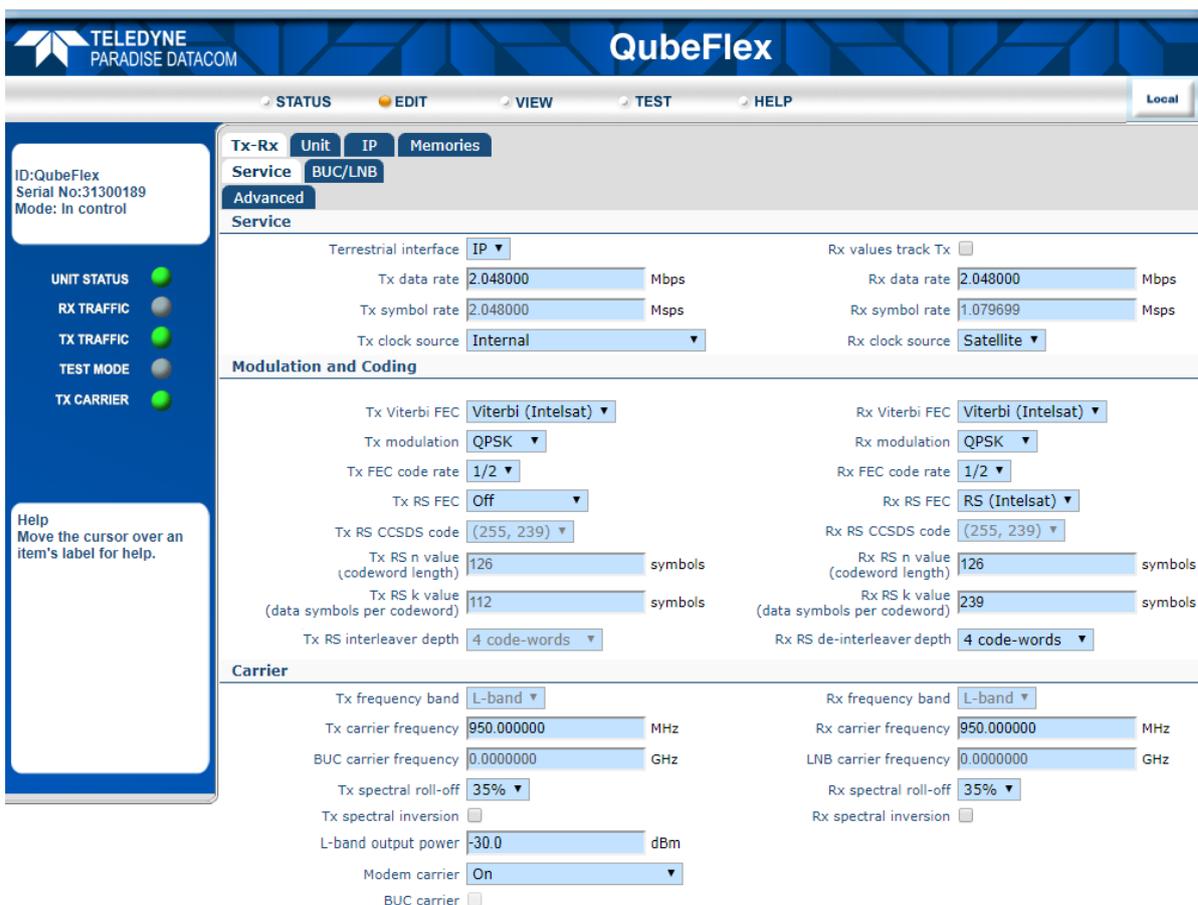
Figure 14-1 Edit->Tx-Rx->Service Screen

14.1.1 Terrestrial Interface

Table 6-1 lists the different terrestrial interface options that are available. With the exception of IP, which is provided as standard, they require an interface card to be fitted. Up to four different interface cards can be fitted in addition to the IP interface provided as standard.

IP	This enables the Ethernet traffic interface. The maximum data rate is 60Mbps (subject to prevailaing data rate limits).
RS422	This enables the RS422 traffic interface and requires an EIA-530 interface card to be fitted. The maximum data rate is 10Mbps (subject to prevailaing data rate limits).
RS232	This enables the RS232 traffic interface and requires an EIA-530 interface card to be fitted. The maximum data rate is 100kbps.
V.35	This enables the V.35 traffic interface and requires an EIA-530 interface card to be fitted. The maximum data rate is 10Mbps (subject to prevailaing data rate limits).

Table 14-1 Terrestrial Interface

14.1.2 Rx Values Track Tx

This is an On/Off control that allows the receive path to be automatically configured to be the same as the transmit path, thereby simplifying set up. There are a number of exceptions including carrier frequency, spectral inversion, timeslots and clock settings.

14.1.3 Tx/Rx Data Rate

Range:	0.0024Mbps to 60.0Mbps; step size: 0.000001Mbps
Description:	The terrestrial data rate is the maximum number of data bits that the modem will process in relation to the selected terrestrial 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 for transmission to satellite, the terrestrial data rate must allow for all overhead due to IP headers and Ethernet frames. When being used as a demodulator receiving a serial bit stream that is being converted to IP output, the data rate needs to be configured to match that of the serial data stream. The minimum and maximum data rate limits are determined by a number of factors such as the terrestrial interface type, type of service, FEC type and FEC rate. 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.

Table 14-2 Tx/Rx Data Rate

14.1.4 Tx/Rx Symbol Rate

Range:	0.0024Msps to 50.0Msps; step size: 0.000001Msps
Description:	The symbol rate is determined by settings such as the terrestrial data rate, modulation and FEC rate and cannot be set directly by the user.

Table 14-3 Tx/Rx Symbol Rate

14.1.5 Tx Clock Source

Tx Clock In	The external clock supplied on the interface *Clock In* line will be used. Should this clock fail then the modem will switch to an internal backup clock.
Internal	The Tx clock is generated from an internal frequency reference. This is also output on the *Int Tx Clock Out* line for use by external equipment.
Receive reference	The Tx clock is generated from the Rx clock. This is only of any practical use when the Rx clock is set to *Satellite*.
Station	N/A

Table 14-4 Tx Clock Source

14.1.6 Rx Clock Source

Satellite	This is the clock from the satellite. This is converted to the rate required at the terrestrial port.
Tx Clock In	This causes the Tx clock to be used to clock Rx data to the terrestrial port. This is a plesiochronous mode and requires the receive buffer to be set to a value sufficient to accommodate both the difference in the clocks at each end of the link and any Doppler shift, while also providing the required interval between buffer slips.
Internal	This uses an internal reference clock to be used to clock data to the terrestrial port. This requires the receive buffer to be set as per the *Tx Clock In* option.
Station	N/A

Table 14-5 Rx Clock Source

14.1.7 Tx/Rx Viterbi FEC

Off	This turns the Viterbi FEC off.
Viterbi (CCSDS)	This selects a CCSDS-compatible version of the Viterbi FEC.
Viterbi (Intelsat)	This selects an Intelsat-compatible version of the Viterbi FEC.

Table 14-6 Tx/Rx Viterbi FEC

14.1.8 Tx/Rx Modulation

The modulations that are available depend on the FEC type selected. The supported combinations are listed in **Table 14-7**.

14.1.9 Tx/Rx FEC Code Rate

The FEC rates that are available depend on the FEC type and modulation that are selected. The supported combinations are listed in **Table 14-7**.

Viterbi (CCSDS)	BPSK: 1/2, 2/3, 3/4, 5/6, 7/8 QPSK and OQPSK: 1/2, 2/3, 3/4, 5/6, 7/8
Viterbi (Intelsat)	BPSK: 1/2, 3/4, 7/8 QPSK and OQPSK: 1/2, 3/4, 7/8

Table 14-7 Tx/Rx Modulation and FEC Code Rates

14.1.10   Tx/Rx RS FEC

Off	This turns the Reed-Solomon FEC off.
RS (CCSDS)	This selects a CCSDS-compatible version of the Reed-Solomon FEC.
RS (Intelsat)	This selects an Intelsat-compatible version of the Reed-Solomon FEC.

Table 14-8 Tx/Rx RS FEC

Reed-Solomon Coding

The Reed-Solomon FEC can be used to correct errors remaining from the Viterbi FEC. The code is specified by three values, namely, n, k, and t. These have a fixed relationship of n - k = 2t, making t half the difference between n and k. An example code is specified as (n, k, t) = (126, 112, 7).

Reed-Solomon error correction works on codewords (blocks) of bytes, where n is the length of the block of which there are k bytes of original data and 2t bytes of error correction information. The Reed-Solomon codec can correct any bytes in error up to a value of t bytes. In the above example with t=7, up to seven bytes within 126 may be corrected no matter how many individual bits per byte are in error. Once the error correction threshold is passed then the codec considers it uncorrectable and passes the entire block uncorrected.

Interleaving depth controls the number of Reed-Solomon codewords that

are interleaved. Interleaving mixes up the blocks such that a burst of channel errors is distributed over a number of codewords, rather than affecting a lot of bytes from a single block, thus improving the resilience to error bursts.

14.1.11   Tx/Rx RS CCSDS Code

(255, 223)	This selects the Reed-Solomon (255, 223) CCSDS code. This is the default.
(255, 239)	This selects the Reed-Solomon (255, 239) CCSDS code.

Table 14-9 Tx/Rx RS CCSDS Code

14.1.12   Tx/Rx RS n Value

Range:	60 symbols to 255 symbols; step size: 1 symbol; default: 126 symbols
Description:	This sets the Reed-Solomon codeword length, i.e. k data symbols + (n - k) parity symbols, where (n - k)/2 symbol errors per codeword can be corrected. This parameter is only configurable when Intelsat Reed-Solomon is being used.

Table 14-10 Tx/Rx RS n Value

14.1.13   Tx/Rx RS k Value

Range:	40 symbols to 253 symbols; step size: 2 symbols; default: 112 symbols
Description:	This sets the number of data symbols per Reed-Solomon codeword. The selectable range at any point is (n - 2) to (n - 20) in steps of 2. This parameter is only configurable when Intelsat Reed-Solomon is being used.

Table 14-11 Tx/Rx RS k Value

14.1.14   Tx/Rx RS Interleaver Depth

1 code-word	This sets the Reed-Solomon interleaver depth to 1 (valid for CCSDS only).
2 code-words	This sets the Reed-Solomon interleaver depth to 2 (valid for CCSDS only).
3 code-words	This sets the Reed-Solomon interleaver depth to 3 (valid for CCSDS only).
4 code-words	This sets the Reed-Solomon interleaver depth to 4 (valid for CCSDS and Intelsat). This is the default value.
5 code-words	This sets the Reed-Solomon interleaver depth to 5 (valid for CCSDS only).
8 code-words	This sets the Reed-Solomon interleaver depth to 8 (valid for CCSDS and Intelsat).

Table 14-12 Tx/Rx RS Interleaver Depth

14.1.15   Tx/Rx Frequency Band

The modem supports independent selection of IF and L-band operation in transmit and receive.

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 14-13 Tx/Rx Frequency Band

14.1.16   Tx/Rx Carrier Frequency

There are various frequency control options, depending on whether IF or L-band has been selected and whether a BUC or LNB is fitted that is being controlled via the modem. The frequency control options are presented in **Tables 14-14** through **14-17**.

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

Table 14-14 Tx/Rx Carrier Frequency (IF)

Range:	950.0MHz to 2450.0MHz; step size: 0.0001MHz or 0.000001 (i.e. 100Hz or 1Hz)
Description:	This is the L-band frequency used in transmitting to, or receiving from, satellite. If the *BUC LO frequency* has been set on the *Edit->Tx-Rx->BUC/LNB* 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 14-15 Tx/Rx 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 14-16 BUC Carrier Frequency

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->Tx-Rx->BUC/LNB* menu then the L-band receive frequency will no longer be available and will be automatically controlled by the modem to achieve the requested LNB receive frequency.

Table 14-17 LNB Carrier Frequency

14.1.17   Tx/Rx Spectral Roll-off

The spectral roll-off determines the slope of the carrier at its edges. The standard supported roll-off factors are listed in **Table 14-18**.

Range:	5%, 10%, 15%, 20%, 25%, 35%
Description:	All spectral roll-off factors are available for all FECs.

Table 14-18 Tx/Rx Spectral Roll-off

14.1.18   Tx/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.

14.1.19   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 14-19 IF Output Power

Range:	0.0dBm to -40.0dBm; step size: 0.1dBm
Description:	This is the transmitted output power when using L-band.

Table 14-20 L-band Output Power

14.1.20   Modem/BUC Carrier

These allow the modem and BUC carriers to be switched on/off independently of each other. BUC carrier control requires a control channel (i.e. FSK or RS485) to exist between the modem and the BUC.

14.2 Edit->Tx-Rx->Service->Advanced Screen for QubeFlex™

The **QubeFlex™** *Edit->Tx-Rx->Service->Advanced* screen is shown in **Figure 14-2**. (This replaces the standard **Q-Flex™** *Edit->Tx-Rx->Service->Advanced* screen.)

Figure 14-2 Edit->Tx-Rx->Service->Advanced Screen

14.2.1 Sweep Mode

Normal	In this mode the sweep width is controlled automatically by the modem. The default sweep width used by the modem is +/-20kHz.
Other	This mode allows the user to set the sweep width in order to compensate for carrier frequency uncertainty introduced in either the ground equipment or in the space segment (due to, for example, frequency conversion errors). At very low data rates, reducing the sweep width may speed up carrier acquisition.

Table 14-21 Sweep Mode

14.2.2 Sweep Width

Range (+/-):	1kHz to 255kHz (standard); step size: 1kHz
Description:	Controls the Rx signal sweep width when the *Sweep mode* is set to *Other*. This is a +/- setting, i.e. the total width is twice the value that is entered. The default sweep width used by the modem is +/-20kHz.

Table 14-22 Sweep Width

14.2.3 Carrier Protection

In extreme high noise, this control provides adjacent carrier immunity from sudden large power level fluctuations. It has no effect except when using DVB-S2/S2X. Most users will not see any benefit from this feature since extreme high noise situations are rare.

14.2.4 Transfer Frame Length

Range:	1 byte to 4095 bytes; step size: 1 byte; default: 223 bytes
Description:	For CCSDS Viterbi (and CCSDS uncoded operation), the maximum frame length is 2048. For CCSDS Reed-Solomon, valid transfer frame lengths are a function of the codeblock length, error correcting capability and interleaver depth. The transfer frame length does not include the CCSDS ASM marker. When converting to IP, each IP packet contains a complete CCSDS transfer frame (without ASM marker). For Intelsat operation involving conversion to IP output at the demodulator, the user data will be arbitrarily segmented into IP packets where the payload size is set to equal the transfer frame length.

Table 14-23 Transfer Frame Length

14.3 Edit->IP Screen for QubeFlex™

The **QubeFlex™** *Edit->IP* screen is shown in **Figure 14-3**. (This replaces the standard **Q-Flex™** *Edit->IP* screen.) Only the QubeFlex™ section of this menu is described here.

Figure 14-3 Edit->IP Screen

14.3.1 Timestamp Packets

Timestamping is an On/Off control that controls whether IP packets output by the demodulator are given a timestamp to indicate the point in time, using the Coordinated Universal Time (UTC) standard, at which they were demodulated. The format of the timestamps is provided in a QubeFlex™ application note that is available from Technical Support.

14.3.2 Add Metadata to Packets

'Add metadata to packets' is an On/Off control that controls whether additional demodulator performance information is added to IP packets output by the demodulator. The contents and format of the metadata is provided in a QubeFlex™ application note that is available from Technical Support.

14.3.3 Serial Conversion to IP

'Serial conversion to IP' is an On/Off control that controls whether the stream of demodulated data is output as IP packets rather than being output via a serial interface.

Default operation for conversion to IP of CCSDS data is that each CCSDS user transfer frame will be placed in its own IP packet (with or without additional timestamp and metadata). For Intelsat operation, the user data is arbitrarily segmented such that the payload size equals the transfer frame length set by the user. IP packets are sent to the destination address and port number provided by the user.

14.3.4 Destination Address and Destination Port

Destination address	When converting the user data stream to IP, it is necessary to know what destination address to forward the IP packets to. This can be any unicast or multicast address and is typically the address of a computer that is running a packet capture software application for storage and further processing of the data.
Destination port	The destination UDP port number is used in conjunction with the destination address above in order to identify the specific application on the destination computer that will process the packets output from the demodulator.

Table 6-66 Destination Address & Destination Port

Chapter 15   Glossary

ACM	Adaptive Coding and Modulation
ADPCM	Adaptive Differential Pulse Code Modulation
AGC	Automatic Gain Control
ARP	Address Resolution Protocol
AUPC	Automatic Up-link Power Control
BER	Bit Error Rate
BERT	Bit Error Rate Tester
BIR	Burst Information Rate
BUC	Block Up Converter
CAS	Channel Associated Signalling
CIR	Committed Information Rate
CRC	Cyclic Redundancy Check
CW	Continuous Wave
ESC	Engineering Services Channel
FEC	Forward Error Correction
LCD	Liquid Crystal Display
LDPC	Low Density Parity Code Check
LVDS	Low Voltage Differential Signal
IBS	Intelsat Business Service
IESS	Intelsat Earth Station Standard
IDR	Intermediate Data Rate
M&C	Monitor and Control
MIB	(SNMP) Management Information Base
Mux	Multiplexer
PUP	Paradise Universal Protocol
PLL	Phase Locked Loop
PPP	Point-to-Point Protocol
PRBS	Pseudo-Random Bit Sequence
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
RS	Reed-Solomon
Rx	Receive or Receiver
SAF	Software Activated Feature
SNMP	Simple Network Management System
TCM	Trellis Coded Modulation
TPC	Turbo Product Coding
Tx	Transmit or Transmitter

Chapter 16   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 in Europe and North America are as follows:

Teledyne Paradise Datacom Ltd.
2&3 The Matchyns, Rivenhall End,
Witham, Essex, CM8 3HA, England.
Tel: +44(0)1376 515636
Fax: +44(0)1376 533764

Teledyne Paradise Datacom LLC
328 Innovation Blvd.
State College, PA 16803, U.S.A.
Tel: +1 814 238 3450
Fax: +1 814 238 3829

Worldwide support via email is available by filling in the Technical Support Contact Form on the Support web page at http://www.paradisedata.com, which will forward your support issues to your local Teledyne Paradise Datacom Technical Support team for your geographic area.

Repair/Return Procedure

Please refer to the equipment warranty statement for full details of returning equipment for repair or upgrade. In summary:

1. Ensure the equipment really does have a fault.

2. Write an *explicit fault report*, including what appears to be wrong, the circumstances under which it occurs and what other equipment is involved.

3. Provide an official Purchase Order to cover the cost of any repairs or sign disclaimer on the Fault Report page.

4. Outside of the UK, contact either the UK or US Teledyne Paradise Datacom offices for a Return Material Authorisation (RMA) number and information on import/export procedures. The RMA number must be quoted on all documentation and on the outside of the packaging.

   Within the UK, contact Paradise UK for an RMA number.

5. Generate the required import paperwork explicitly following the import/export procedures stated when the RMA number was given.

6. Outside of the UK, fax the paperwork to us directly and return the goods to Teledyne Paradise Datacom. Within the UK, fax the paperwork and return the goods to the Teledyne Paradise Datacom UK facility.