DATUM SYSTEMS

M500 VSAT/SCPC Satellite Modem

PSM-500/PSM-500L/500LT

Installation and Operation Manual

Revision 0.91

Table of Contents

Appendices

Note: All appendices may not be present in manual. Some Appendixes may be shipped with the option.

Safety Notice

This equipment has been designed in accordance with UL and CSA standards for Safety of Information Technology Equipment.

The PSM-500 Modem contains potentially lethal voltages inside the case. Extreme caution should be exercised when the cover is removed by following the precautions listed below

Never operate the equipment with the cover removed. Never remove the cover with power applied. As a safety measure the power cord should be disconnected from the unit when preparing to remove the cover.

This modem is designed for indoor use. Do not operate this equipment in a wet environment or outdoors.

Do not operate the modem in an unsafe environment near explosive or flammable gases or liquids

Insure good grounding practices. The grounding lug on the rear of the modem should be connected to a good earth ground with low impedance cable in rack installations.

The modem is supplied with an IEC filtered power inlet module designed to accept a 3-wire mains connection consisting of an earth ground, neutral and line conductors. The mating power cord should have a line cord and plug suitable for the country of operation.

EMC Notice

$C\epsilon$

This equipment has been designed in accordance with FCC and CE standards.

> FCC: Part 15, Subpart B, Class A
> CE Emissions: EN 55022 Class A, EN 61000-3-2 Class A, EN 61000-3-3
> CE Immunity: EN 55024
> ICES-003, Class A

To maintain compliance with these standards the following the precautions must be observed.

The equipment must be operated with the cover and all cover screws in place.

Do not remove the rear panel option plate without replacing it with one designed for a specific option assembly.

All rear connections are designed to have integral shielding on the cable and connector assembly. "D" type signal connectors must have grounding fingers on the connector shell.

About This Manual

This manual is composed of several separable documents. They include the main body of the manual and several "Appendices". The main body itself is separated into several "Chapters" and "Sections". A "Section is considered a sub-section of a Chapter, such as Section 4.1.2 is a numbered section within Chapter 4. Page numbers include the Chapter, as in page 3-14.

This manual is available in a printed form and as an electronic "Portable Document Format" or .PDF file. The electronic format is produced as a universal Adobe Acrobat readable file, and can be requested directly from Datum Systems, Inc., or via download from the web at www.datumsystems.com. The electronic format on the web is always the latest revision.

Revision History

Revision 0.8	3/17/2006	Initial Public Release. ** Preliminary ** Requires minimum Modem Software Revision 0.12.
Revision 0.83	12/4/2006	Still. ** Preliminary ** Includes additional FEC modes. Requires minimum Modem Software Revision 0.21.
Revision 0.85	12/14/2006	Includes additional FEC modes and corrections. Requires minimum Modem Software Revision 0.26.
Revision 0.86	8/12/2007	Includes additional FEC modes, corrections and new menu features for Unit Configuration, RTS Monitor and Transmit Mute. Requires minimum Modem Software Revision 0.52.
Revision 0.87	1/10/2008	Includes added Advanced TPC modes and corrections. Requires minimum Modem Software Revision 0.63.
Revision 0.88	4/10/2008	Includes added 8QAM modulation, HSSI references, revised M500 Update procedures and corrections. Requires minimum Modem Software Revision 0.72.
Revision 0.90	10/20/2010	Removes references to PSM-500H modem which is not available in the PSM-500 Series.
Revision 0.91	7/15/2011	Update data rate limits and add more LDPC information. Added AUPC setup example.

Pen and Ink Changes Made to this Manual

_____

_____

_____

_____

_____

_____

Chapter 1 - PSM-500 Modem Description

1.0 Introduction

The Datum Systems' PSM-500 Series are multi modulation mode VSAT/SCPC Satellite Modems. They are capable of BPSK, QPSK, OQPSK, 8PSK, 8QAM and 16QAM modulation modes on transmit and receive independently Their main use is as part of the transmitting and receiving ground equipment in a satellite communications system. The PSM-500 series uses the latest Digital Signal Processing (DSP) technology and proprietary techniques to provide unsurpassed performance at a low cost.

The PSM-500 series is available in 4 IF versions with 3 upgradeable "feature sets" in each. The matrix below shows the current IF versions available or planned, and the matrix in Section 1.1.2 on the next page shows the feature sets available. Note that the terms PSM-500S and N are not normally used except to differentiate between different IF versions.

PSM-500 Series IF Interface Versions.

Interface Versions	PSM-500S	PSM-500N	PSM-500L	PSM-500LT
IF Transmit	50 ~ 90 MHz	100 ~ 180 MHz	950 ~ 1750 MHz	950 ~ 1750 MHz
IF Receive	50 ~ 90 MHz	100 ~ 180 MHz	950 ~ 1900 MHz	950 ~ 1900 MHz

The PSM-500 with a standard 70 (or 140) MHz IF is the first member of Datum Systems' M500 Class Modem products, representing a major extension to our fifth generation of innovative design concepts proven and refined over ten years of production. The PSM-500L is the second, utilizing L-Band frequencies for both the Transmit and Receive IF, it creates the ability to build extremely simple and low cost high performance VSATs All M500 class products encompass significant performance improvement over previous modems at reduced cost. The PSM-500LT is the third, providing an integrated BUC power supply.

The modem is designed for service in varied types of satellite systems. Either SCPC systems where two modems are set for continuous operation with each other, or shared resource systems where modem carriers are not continuous in nature, such as DAMA networks, where outgoing signals from the modem can be operated in an extremely fast acquisition mode.

The modem is designed to be easily integrated into either a master or remote station via rack mounting. A highly integrated design allows the PSM-500 to be built into a one rack unit (1 RU, 1.75") high mounting case, using minimal power for dense applications. The modem is an integral part of a satellite earth station's equipment operating between the Data Terminal Equipment and the station Up and Downconverter equipment.

1.0.1 How to Use This Manual

This manual provides Installation, Operating and Maintenance procedures for the PSM-500 Satellite Modem and available options at the time of printing.

This manual is an integral part of the modem and is used to explain the installation and operating procedures for the PSM-500 and present its capabilities and specifications. The manual is divided into 4 Chapters with Appendices. The 4 Chapters are the Modem Description, Installation, Operation and Maintenance. The Appendices include the Specifications, Remote Control Protocol and gives further information on Options, Cabling and information related to placing the Modem in service.

The divisions of the manual are intended for use by personnel to answer questions in general areas. Planners and potential purchasers may read the Introduction and Specifications to determine the suitability of the modem to its intended use; Installers should read the Installation Chapter and the

Cabling Specification Appendix; Operating Personnel would use the Operations Chapter to become familiar with the Modem; while System Programmers would use the Remote Control Protocol to determine control requirements.

The PSM-500, 500L and 500LT modems are fully interchangeable with the single exception of the IF input frequency range. In addition all options available for the PSM-500 are usable with the L or LT version. The term PSM-500 is used throughout this manual where references apply to either the PSM-500, 500L or 500LT modems. Where a subject is specific to one modem the "L" or "LT" suffix is used or the specific differences in operation between the three modem versions are detailed.

1.0.2 Quick Start for Experienced Modem Users

If you are experienced with modems, but not this particular one, you may want to skip some of the introductory material and learn how to operate the front panel to set up the modem immediately. Go directly to Section 3.1 – "Operating Procedures" and get a feel for how the front panel operates. Then scan Tables 3-1 through 3-4 listing the parameters that can be changed, and set up the modem for your application. We strongly recommend that you go back to learn more, as these modems have extensive capabilities and features that are unique. A list of abbreviations is located at the end of the "Frequently Asked Questions" (FAQ) in Chapter 4.

1.0.3 What's New – This Modem and This Manual

If you are familiar with Datum Systems modems, especially the PSM-4900, then you should feel comfortable with both this modem's operation and this manual. There are some significant differences you should review in the list below.

New in This Modem:

- The PSM-500 series is the first to include 8PSK, 8QAM and 16QAM modulation modes, requiring new procedures and remote control interaction.

- The PSM-500 now includes remote control and firmware update via USB interface on the rear panel. This was especially necessary since the 10 fold increase in firmware requires a faster method to load new firmware configurations.

- Each PSM-500 IF version is capable of 3 standard value software upgradeable "Feature Sets", as described in section 1.1.2. Many features of the modem are field upgradeable without adding new hardware. Subsets of these Feature Sets are available.

- There are two option slots on the main PCB used for FEC/processing options. One is always used for the standard FEC set as a minimum. They are wired in parallel like the PCI slots on a computer, but use an SO-DIMM form factor. Please don't plug memory in!

- The IBS multiplexer with AUPC is now standard and built into the main board FPGA logic.

- The Reed-Solomon concatenated FEC is now standard and built into the standard FEC card.

New in This Manual:

- A new "How-To" Appendix is added in Appendix H. It gives quick instructions on setting up common features and capabilities.

1.1 Modem Capabilities

1.1.1 Modem IF Variations

The PSM-500 series is currently offered with 3 main Intermediate Frequency (IF) variations designed to meet the needs of various station types. The standard PSM-500 modem has a 70 MHz (or optional 140 MHz) transmit and receive IF which is typical for use in large stations with indoor or outdoor up and down converters. The PSM-500L and PSM-500LT units feature an L-Band transmit and receive making it ideal for low cost Vsat remote earth stations.

1.1.2   Modem Feature Set Variations

Feature sets are specific capabilities that suit a modem for a particular purpose. The PSM-500 series is the first modem Datum Systems has offered with variable feature sets. The advantage is that a customer does not have to pay for features he does not use, but later features can be upgraded in the field electronically by adding new firmware Intellectual property to the modem. The user has the best of both worlds. Feature sets are purposely kept to a minimum to make their control easy and therefore reduce the cost. There are currently only 3 main feature sets offered for the PSM-500 series, and they apply to any of the IF variations.

For comparison, the features available in the PSM-4900 modem are also shown. More detail on maximum and minimum data rates are shown in Appendix A.

PSM-500 Series Feature and Option Matrix.

Feature	Original M5	PSM-500S/N/L/LT Series		
	PSM-4900	M505	M511	M523
Modulation				
BPSK	✔	✔	✔	✔
QPSK	✔	✔	✔	✔
OQPSK	N/A	✔	✔	✔
8PSK/QAM	N/A	Upgrade	✔	✔
16QAM/APSK	N/A	Upgrade	Upgrade	✔
Max Data Rate	M523 rates slightly higher at higher FEC rates. See Notes below.			
BPSK	2.46 Mbps	2.5 Mbps	5 Mbps	7.38 Mbps
QPSK/OQPSK	4.92 Mbps	5 Mbps	10 Mbps	14.76/28 Mbps
8PSK/QAM/TCM	N/A	N/A	10 Mbps	29.52 Mbps
16QAM/APSK	N/A	N/A	N/A	29.52 Mbps
FEC Modes				
Disabled	N/A	✔	✔	✔
Viterbi	☐	✔	✔	✔
Reed-Solomon	Option	✔	✔	✔
TPC – 4K (2)	Option	Option	Option	Option
TPC – 16K	N/A	Option	Option	Option
LDPC-16k (2k)	N/A	Option	Option	Option
IBS Mux/AUPC	Option	✔	✔	✔
SnIP Ethernet Int.	Option	Option	Option	Option

There are multiple items lists as "Options". Options are specifically hardware items that are installed in the modem, while a "feature" is a software installation listed as an "upgrade". To upgrade the modem from one feature set to another refer to the instructions in Section 4.4.

Maximum data rates are dependent on many factors besides the basic capabilities of the interface, including cabling, interface type, features and options installed. The TPC4K hardware codec is limited to 5Mbps.

1.1.3 Applications

Following are just a few representative forms of satellite communications links and networks in which the PSM-500 modem series may be used.

1.1.3.1 SCPC Point-to-Point Links

The most straightforward application for a satellite modem is to serve as the Data Communications Equipment (DCE) for a point-to-point data link. When used in this mode, two modems located at two different sites are tuned to complementary transmit and receive frequencies. Each direction of the communications link may have the same or entirely different transmission parameters. In this application it is typical that the link is established and maintained on a continuous basis, although a special "on demand" case is described later.

In SCPC point-to-point links the power required from the satellite or the size of the receive antenna is dependent upon the modem receive performance. The PSM-500 modem uses the most rigorous methods to maintain performance as close to the theoretical "waterfall" curves as possible. In most cases the modem will perform at 0.1 to 0.2 dB from the curve (although we say "typically" 0.3 dB). This consistent performance, plus advanced technology such as TPC results in the absolute minimum power requirements, which equates to the minimum operating.

Ku Band satellite systems are subject to changing performance due to rain at one or more sites. The PSM-500 contains built in software to perform Automatic Uplink Power Control (AUPC). If the modems at each link end are provided with an external asynchronous channel of 300 bps they can be set to automatically maintain a constant Eb/No within programmable limits. This can result in significantly lower satellite power requirements in a large system in addition to maintaining proper performance in any system. The optional Multiplexer/interface card can provide this low rate channel in addition to an Earth Station to Earth Station overhead service channel.

1.1.3.2 SCPC Point to Multi–Point Links in a Broadcast Application

A broadcast application might involve the necessity of sending continuous or intermittent data from one source and "broadcasting" the information to many remote locations. For instance, constant pricing information and updates may be sent by a central location to many store locations. There may be minor return information from the remotes acknowledging receipt.

Another broadcast application could be transmitting background music from a central location to many store sites. In this case there would be no return path.
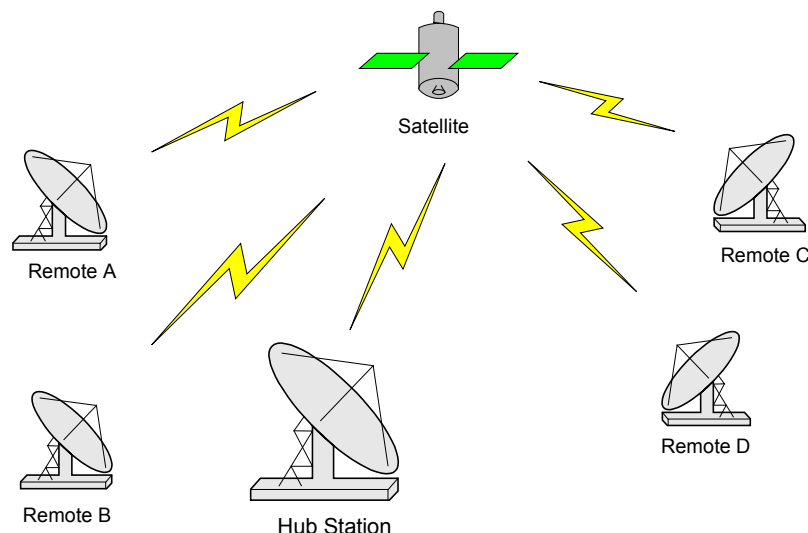
Figure 1-1   Simple Star Network

The topology of the network in both of these broadcast examples would typically be called a "Star" network. As shown in

Figure 1-1, the shape of the configuration is drawn with the central "Hub" as the center of the star and the remotes as points of the star. In both cases the transmit frequency and other parameters may be shared by the receive of all the remotes.

The PSM-500L and LT are ideally suited for use at remote or small stations. Since the receive down-converter requirement is significantly reduced in this version, requiring only that a data grade LNB (Low Noise Block down-converter) be connected to the modem. The L-Band version modems can even supply power and reference to the LNB if needed. In addition the PSM-500L and PSM-500LT modems are designed for use with a Block Up Converter or "BUC" and can supply power and reference signals on the transmit cable. Most BUCs today are designed to receive these signals on the cable.

In Broadcast type systems where the remotes only require a receiver, the L or LT is very low cost and the transmit modulator section can be simply turned off.

A "Star" network configuration is also commonly used with multiple point-to-point links where the hub is common to every link. An example might be where each remote represents a house or building with voice or data traffic all destined for a common switch located near the hub. Each link is then usually dedicated to that customer and the link resources are wasted when no traffic is carried. That loss is partially offset by being able to use smaller antennas and power at each of the remotes, concentrating costs at the hub.

1.1.3.3 DAMA (Demand Assigned Multiple Access)

Suppose that we wanted to simulate a telephone network with a virtual switch between modems carrying digitized voice information. We might use a central computer to assign a pair of frequencies for any conversation and send this connection information to the proper sites to set up the connection. Many systems of this type use "Star" network topology, but this has the disadvantage that for a person at Remote A to talk to someone at Remote D the traffic must go through the hub. The resulting delay through 2 satellite hops is just at the limit of what is tolerable for voice traffic.

In this application a new network configuration is usable. That is a "Mesh" network where any of the voice modems at any site can be programmed to link with any other modem directly at any other site. The resulting link diagram looks like a mesh of interconnects. Now there must be sufficient antenna size and power at each remote to link to every other remote. The station costs can go up significantly, and are multiplied by the number of stations.

Since the frequencies can be assigned on demand, the network is then called "Demand Assigned, Multiple Access", or DAMA. One important characteristic of a DAMA system used for voice information is the lock-up time of the modem. At the low data rates used to digitize voice today (4.4 to 32 kbps) the modem receive acquisition method of sweeping results in lock-up times of tens of seconds to minutes. The PSM-500 modem is uniquely designed to significantly reduce this time:

The fast acquisition digital signal processor used in the PSM-500 looks at the receive signals within its acquisition range much like a person might view the same region using a spectrum analyzer. It then "homes in" and locks to the most probable carrier. This acquisition mode can reduce the receive acquisition time to approximately $1/3^{rd}$ of a second at 9.6 kbps in QPSK mode over +/- 30 kHz, and less in BPSK mode.

1.1.3.4 TDMA (Time Division Multiple Access) Remote Site Application

In a TDMA network the central Hub continually transmits a stream of outbound data containing information for multiple remote sites, while the remotes transmit back to the Hub on a timed basis. Each of these remotes is said to "burst" its information back on a specific frequency. This may be the same inbound frequency for all sites. Each of the remotes is responsible for accessing its own information from the outbound data stream by reading the address assigned to specific parts of the data.

The TDMA network usually looks like the Star network described above. The outbound (from the Hub) data rate may be quite high to accommodate many remotes with low latency, while the inbound data rate may be low to allow use of a small antenna and power amplifier at the many remote sites.

The PSM-500L is specifically designed to be usable as the remote site modem of a TDMA network when coupled with a proper "Burst" demodulator at the hub site. ***Note: As of the time of this manual the "TDMA burst" mode is a special factory request option and not installed in standard modems.***

Another variation could use both the DAMA (star or mesh configuration) with a concurrent TDMA system as the monitor/control network for the DAMA. Again the PSM-500 modem is ideally suited for both modem applications at both low and high speeds.

1.2   Modem Functional Assemblies

The PSM-500 VSAT/SCPC Modem consists of seven main functional elements arranged on three electronic printed circuit assemblies, as shown in Figure 1-2.

The Main Modem Circuit Assembly consists of the following major assemblies:

1.   The Modem digital PSK/QAM modulator with carrier generation in the 50 to 90 MHz range for standard modem, or 950 to 1750 MHz in the L-Band versions.

2.   The Modem digital PSK/QAM demodulator accepting signals in the 50 to 90 MHz range for the standard modem and 950 to 1900 MHz in the L-Band versions.

3.   The Modem microprocessor monitor/control subsystem.

4.   The Modem Digital Signal Processor Acquisition subsystem.

5.   The Programmable Data Interface. Seven standard data interfaces are built onto the main modem assembly. The unit can also accept special interfaces via an optional interface card.

The other two printed circuit assemblies are the Front Panel Control Assembly, and the Power Supply Assembly.

In addition the main PWB can accept two plug-in sub-assemblies for Forward Error Correction (FEC). The first subassembly normally contains either the standard Viterbi and Reed-Solomon FEC set or a combination card containing Viterbi/TCM, Reed-Solomon and either a 4k block size Turbo Product Codes (TPC) or a 16k block size TPC. The TPC could also be installed alone on a card placed in the second plug in location. The second location could also be one of a number of FECs that are be available for the M500, such *as FlexLDPC*.

The IBS Multiplexer circuitry that was on another daughter card in previous modems is now part on the main board's FPGAs.

Note in the functional block diagram below that, with the exception of the receive FIFO buffer, there are complementary signal processing blocks in the transmit and receive paths. Note also that there are no typical superhetrodyne mixing and filtering blocks. That is because there are none used in the direct modulation and demodulation scheme used in the PSM-500, sometimes referred to as Zero IF.

The following sections described more detail on the design of the modulator and demodulator.
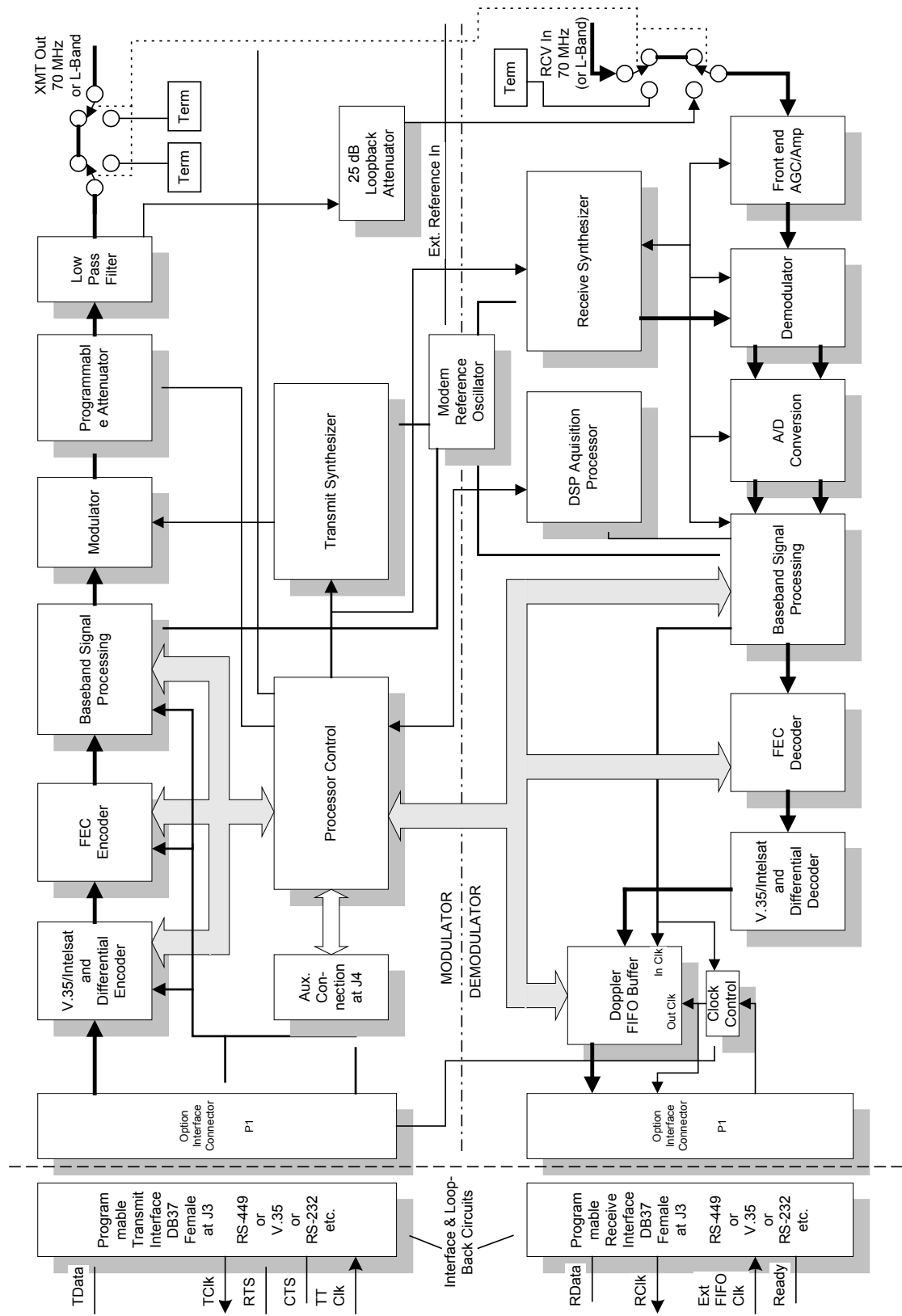
Figure – M500 Modem Block Diagram

Figure 1-2   Modem Block Diagram

1.2.1 Modulator

The PSK/QAM modulator in the modem employs a unique digital modulation scheme requiring no heterodyne operations (mixing and filtering to an IF) to arrive at the transmit RF frequency. The desired carrier frequency is synthesized and directly modulated with the baseband signal. The baseband signal is itself digitally derived and generated using a digital to analog (D/A) converter. The digital signal processing of the transmit signal includes the equivalent of a 144 tap FIR filter function.

As previously shown in Figure 1-2, synchronous transmit data and clock signals are accepted by the modulator, then processed by the V.35/Intelsat scrambler and differential encoder. The modulator can be set by the processor to operate at a number of data rates between 1.2 kbps (BPSK, rate 1/2) and 20 Mbps (8PSK +, M520 feature set). Refer to the specification in Appendix A for exact rate capabilities. The data is then encoded for Forward Error Correction (FEC) at rate 1/2, 3/4, 5/6 or 7/8 resulting in an encoded signal at between 2.4 and 14,760 ksps (kilo symbols per second). The Viterbi convolutional encoder can be programmed for rate 1/2, 3/4, 5/6 or 7/8 and is set for a constraint factor (K) of 7 for use by a (receiving end) Viterbi convolutional decoder with the same rate and K factor. A Reed-Solomon FEC is available for concatenated operation with the Viterbi Codec and two types of "Turbo Codes" Codecs are also available to replace the Viterbi Codec. A special case is 8PSK, which only operates in a Trellis Code Modulation (TCM) mode at rate 2/3, unless a non-Viterbi FEC is added such as TPC or *FlexLDPC*.

The FEC is followed by an optional differential encoder. The differential encoder output is then sent to the transmit baseband signal processor whose main function is to convert the data stream into analog baseband I and Q channels for modulating the carrier. The actual conversion process is accomplished in a lookup table, latch and D/A converter. The lookup table represents a digitally preprocessed function required to produce the proper RF signal output when mixed with the desired carrier frequency. A low-pass filter is applied to the D/A output to reduce the level of sampling components.

Transmit Local Oscillator generation is accomplished in two parts. A PLL step synthesizer is used to generate a basic LO in the 52 to 92 (or 104 to 184 or 952 to 1752) MHz range with 500 kHz step size. A Direct Digital Synthesizer (DDS), consisting of an NCO and D/A conversion, is used to generate an approximate 2 MHz signal with fine step size of approximately 1 Hz and a range of ±1.25 MHz. When the DDS is subtracted from the step synthesizer output in a second PLL, the available LO can be tuned in 1 Hz steps over the full range of 50 to 90 MHz (100 to 180 MHz if built for that version).

The processed baseband signal is then mixed with the transmit synthesizer's LO carrier signal to generate an output modulated carrier in the 50 to 90 MHz range (or 950 to 1750 MHz in the L-Band modem). A classic IQ modulator with two mixers is used and the LO is fed into the second mixer shifted 90 degrees from the first. The modulated baseband signal can take two forms at this point depending on whether BPSK or QPSK modulation is used. In BPSK mode, the baseband signal fed to the two mixers is identical. In QPSK mode, the two signals represent the baseband I and Q channels of the baseband.

The resultant RF signal is then low pass filtered and amplified to produce a signal at approximately over 5 dBm into 75Ω. An output attenuator controlled by the onboard processor is used to set the modulator output level over a range of +5 to –35 dBm. The actual attenuator is a set of pin diodes whose voltage is derived from the processor via a 12-bit D/A converter. The processor also holds a calibration table of DAC input vs. RF output level/frequency in non-volatile memory.

No physical adjustments are present in the modulator. All necessary adjustments are electronically performed during calibration and are intended to last the life of the unit without requiring resetting.

The modulator is capable of operating in two different modes: Continuous mode for SCPC use and "Burst" mode for use at a VSAT location. When set to VSAT operating mode, the transmit signal is turned off and on according to the status of the data interface control lines and framing information in the data stream as described in the "Operation" Chapter of this document. The burst mode allows multiple station modulators to link up consecutively with a single master station "burst demodulator".

Note: As of the time of this manual the burst mode is a special factory request option and not installed in standard modems.

The Modulator IF output can be routed to the Demodulator input using a built-in "IF Loop-back" function. The loop-back path provides a 25 dB attenuator to avoid overloading the receive input.

1.2.2 Demodulator

The Modem Demodulator uses direct conversion techniques for recovery of data from an incoming carrier, and therefore like the modulator does not use heterodyning, and has no internal IF signal or processing. Referring to Figure 1-2, the input RF signal is first input to the receive AGC amplifier. The AGC amplifier has a range of greater than 40 dB at any data rate, allowing inputs over that range while still meeting performance criteria. The range is controlled in several steps depending on the data rate extending over the range of –20 dBm at high data rates to –84 dBm at low data rates. The proper AGC gain is digitally determined as that which produces an optimal output from the A/D converters and is thus derived after the A/D converters.

The RF input is then demodulated using a "Costas Loop", phase locked loop demodulator where the signal is split using a 90 degree hybrid into I and Q channels. In BPSK mode, the I channel carries the data information and the Q channel represents the noise and carrier phase information in the Costas loop. For QPSK operation, the I and Q channels each carry data information. The I and Q channel "eye" signals are not available as in many other modems because the signal/data representation at this point is still strictly digital for direct signal processing.

A receive synthesizer generates the demodulator local oscillator which is at the desired receive carrier frequency. The synthesizer is tunable over the range of 50 to 90 MHz (or 950 to 1900 MHz in the L-Band modems) and has two tuning components; the LO step synthesizer used to tune in steps of 500 kHz, and a Direct Digital Synthesizer (DDS) component used to acquire and track the received carrier. The DDS control has two tuning sources; (1) the digital Costas demodulation loop phase detector used to track an already "locked" signal and (2) the processor control used to set the carrier frequency and acquire new signals. The processor controls the acquisition search over a programmable range from ±100 Hz to ±1.25 MHz.

The I and Q channel baseband outputs of the Costas Loop demodulator are converted to digital data streams by parallel 12 bit D/A converters. The digital information is then filtered via a Datum Systems' proprietary programmable digital filter. The filtered sample output is sent to the input of the Forward Error Correction (FEC) process (either Viterbi convolutional, concatenated Reed-Solomon, 8PSK TCM rate 2/3, Turbo Codes or LDPC decoder) circuit. Multiple bits of the filtered A/D converter are used for "soft decision" decoding in the FEC, providing an improvement in performance over hard decision decoding.

The A/D output is also available to a special Digital Signal Processor (DSP), which is used to examine the incoming signals for known energy patterns and acquire carriers significantly faster than conventional sweep acquisition. This DSP controlled acquisition is especially useful at low data rates and can improve over a typical sweep by more than 2 orders of magnitude.

The receive signal processing shown in Figure 1-2 serves the following multiple functions:

1. Generates the soft decision symbol information for input to the FEC.

2. Recovers the bit rate clock from the incoming signal.

3. Measures the Es/No of the received signal.

4. Generates the receive AGC signal to set the input stage gain.

The FEC decoders are contained on one or two adaptor cards plugged into the main board (all except the TPC are contained with the adaptors FPGA), which is under control of the onboard processor.

A differential decoder and INTELSAT / V.35 descrambler for the received data signal can be individually enabled or disabled by the processor based on the current FEC and other settings. It is no longer under control of the front panel or command interface. This configuration is held in the

nonvolatile EEPROM and does not have to be reconfigured on power-up. The resulting received data and clock signals are sent to the interface assembly. Receive interface clocking can take several forms as explained below.

1.2.3 Modem Bit Rate Timing

The Modulator and the Demodulator each have 4 possible sources for their bit rate timing.

The Modulator always outputs the Send Timing signal, but the source of this timing may be either:

1. An Internally generated bit rate NCO locked to the Internal Reference,

2. The Demodulator Receive Clock,

3. An External input at the data rate or

4. An external input on the Interface Terminal Timing input.

The modem's internal reference is a 2.0 parts per million clock oscillator, which is sufficiently accurate for most applications. If system timing requirements dictate a better reference, the internal oscillator may be phase locked to an external reference applied at the rear panel.

The Demodulator always outputs the Receive Timing signal. The receive demodulator clock derived from the receive signal is synchronous with the Receive Data and is the normal source of the receive timing. If the system requires a different clock (which still must be the same average rate as the demodulator's receive clock) then provisions are made to buffer the data in a programmable FIFO. The demodulator receive clock is always used to clock the data into the FIFO. The clock output can be either:

1. The Demodulator Receive Clock,

2. The Modulator Clock

3. An internally generated bit rate NCO locked to the Internal Reference, or

4. An External FIFO Clock applied on the interface connector.

If the demodulator receive clock is selected then the FIFO itself is physically bypassed by switching circuitry.

The internally generated bit rate NCO locked to the Internal Reference oscillator is settable to 40 bit accuracy. That is 1 part in 10 to the 12 or 1 part per trillion.

The PSM-500 series includes two changes to previous modems to insure proper operation. First, the modem detects if no data is present on the input by a lack of transitions for approximately 5 seconds and will produce a programmable alarm after that time. Second, due to the higher data rates the PSM-500 input circuitry automatically fine tunes the clocks to attempt to place the data period at the optimal point with respect to the clocks. This also helps tremendously when using the TT clock to create the transmit timing.

A block diagram simplified representation of the Transmit and Receive clock sources are shown in Figure 1-3.

Transmit Clock Sources

Receive Clock Sources
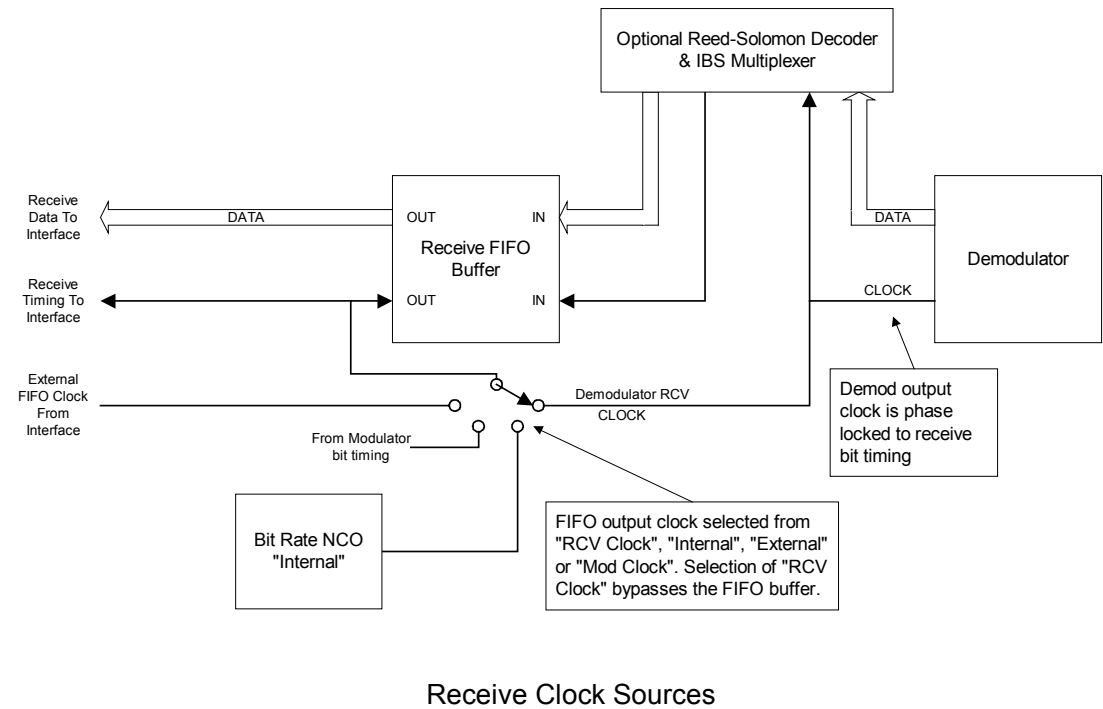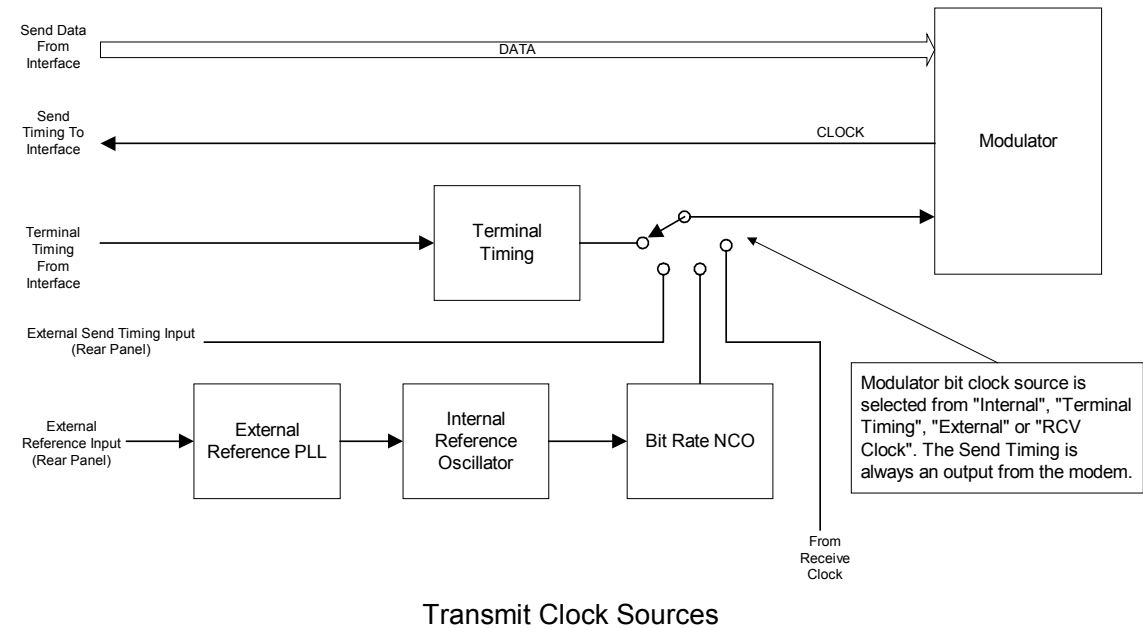
Figure 1-3 Clock Source Options

These Clock sources may be used in various ways in a system implementation to provide correct timing at a destination. Each of the clock sources can be set either from the front panel or from an external monitor and control system.

1.2.4 Control Processor

A single microprocessor manages all monitor, control and communications functions on the modem board. The processor continuously monitors all onboard status signals.

The modem control processor uses external address and data buses to connect to external Flash PROM containing the instruction code. The processor uses both internal and external RAM for all operations and maintains configuration and permanent parameters in parallel EEPROM. The processor also connects to the FEC, the custom ASICs, the DSP processor, the front panel, and various onboard peripheral functions via the address and data bus.

The control processor also maintains a serial peripheral interface to connect to several onboard peripherals. These include external D/A converters holding calibration and current analog settings, identification EEPROMs on option and interface cards and step synthesizers.

The control processor also contains an internal 12-Channel 10-bit A/D converter for gathering analog information from various onboard monitored points including the phase locked loop tuning voltages.

Digital I/O used to monitor and control the modem is handled mainly through the DSP circuits and their interface to the processor. Such parameters as the current Eb/No and receive offset frequency information are read by the processor from the DSPs while most configuration information is written to the DSPs.

The control processor uses a full-duplex Universal Asynchronous Receiver/Transmitter (UART) for communications with either the RS–232 / RS–485 remote command port or with a separate VT100 type "console" terminal device connected to the modem. In addition a USB control interface is provided.

The control processor has provisions for communicating with another PSM-500 modem for implementation of Automatic Uplink Power Control (AUPC). The channel for this communications is normally provided by equipping the unit with the optional IBS multiplexer interface card.

1.2.5 Acquisition Processor

The acquisition processor, a Texas Instruments 320C5xxx Digital Signal Processor, manages the receive signal acquisition and lock functions to achieve fast acquisition performance at low data rates. This DSP is controlled by the control processor via a communications protocol managed through a special bi-directional parallel interface to the main processor.

The signal acquisition DSP accepts sampled data from the receive chain A/D Converters and mathematically determines the location of the incoming carrier. This is accomplished in a multi–step process which continues to narrow down the exact frequency until it is known within the lock range of the PLL demodulator. At data rates below 16 kbps this process is more than an order of magnitude faster than a standard sweep method. Typical signal acquisition times at 16 kbps QPSK are 0.2 seconds using the acquisition processor vs. over 20 seconds using a standard sweep.

1.2.6 Standard Data Interface

The standard Interface in the PSM-500 is built onto the main PWB and contains the drivers and receivers for one of five possible data interface standards (seven including minor variations of each). All interface standards are selected under program control via the front panel or remote control. Five of these standards are common interfaces used in the communications industry:

- RS-449, terminated and un-terminated
- V.35,
- V.36
- Synchronous RS-232 (Limited to 128 kbps by drivers and receivers.)
- EIA-530 and EIA-530A
- Asynchronous RS-232 (Limited to 115 kbps by various protocols).

The un-terminated versions of these standard interfaces and are used to implement one for one (1:1) redundancy between two PSM-500 units.

A single 37 pin "D" type female connector is available on the rear panel at J3 providing the terrestrial data interface. The interface standard is electronically selectable via front panel or remote control.

Optional interfaces are provided by a separate option interface card which is mounted inside the modem chassis. The provision of an optional interface "adds" to the available interfaces which can be selected under program control. An interface field kit of parts to add an option interface is available from the manufacturer for installation by qualified technical field service personnel. When an optional interface is installed the main processor automatically queries and installs the necessary software controls for accessing the interface.

1.2.6.1 Data Interface Loop-Back Function

The standard and most optional interfaces also provide the data loop-back function. Ethernet interfaces do not have this function. The data loop-back can be controlled from the front panel or via remote control command. The data towards both the terrestrial and satellite sides can be looped back individually by enabling this function via the front panel or remote control

> ⇒ *Caution*: **Enabling the "Data Loop-Back" functions will result in loss of traffic. It should not be used in operating links without prior arrangements.**

The data loop-back allows testing of the signal path connection up to the loop-back and back to the source. Since both terrestrial and satellite sides of the signal path can be looped, the connection from a local DTE can be checked on the terrestrial side while the connection from the far end DTE over the satellite and through the modem can be checked on the satellite side.

More information on use of the loop-back modes is given in Section 4.1 *Common Test Procedures*.

1.2.6.2 Data Interface BERT Function

The standard interfaces also include a programmable Bit Error Rate Test (BERT) set. It is located between the modem's satellite and terrestrial data loop-back functions. Ethernet interfaces do not have this function. The BERT can be controlled from the front panel or via remote control command and provides extensive test result data.

> ⇒ *Caution*: **Enabling the "BERT" function will result in loss of traffic. It should not be used in operating links without prior arrangements.**

New in this modem is the ability to set the BERT set to point toward the "Line" side external cabling, acting as a DCE device. More on use of the BERT functions and modes is given in Section 4.1.2 *"Using the Built-in BERT"*.

1.2.6.3 Data Interface 1:1 Redundancy Function

The standard interfaces are also capable of operating in a special 1:1 redundancy mode. In this mode the data interfaces are tied directly in parallel using a special "Y" cable. Software control built into the modem can then be set to indicate that the two connected modems are operating in a redundant mode. The two modems communicate with each other to determine the alarm status of each and force the "off-line" unit's data interface into an un-terminated condition. This allows both interfaces to receive incoming data and clock signals, which are necessary to ascertain correct functioning. At the same time the transmit and receive IF ports are also connected together through the stations (or separately supplied) transmit and receive IF combiner/splitter assemblies.

The alarms that are used to determine switching criteria are programmable, and the first modem set up for this mode automatically loads its configuration information to the second or "back-up" unit. These features create a very low cost redundancy system that is both flexible and easily set up.

More information on the set-up and use of the 1:1 redundancy functions and modes is given in Sections 2.3.5 *"1:1 Redundancy Connection"* and 3.10 *"Built-in 1:1 Redundancy Mode Operation"*.

1.2.7 Standard Framing and IBS Multiplexer

The framing/multiplexer is capable of multiplexing a relatively low speed overhead channel onto the terrestrial data stream resulting in a slightly higher combined or "aggregate" data rate through the modem. The overhead channel is recovered at the far end. This added channel is termed variously an overhead channel, ESC, service channel, "asynch" channel or, in IESS terminology, an ES to ES data channel. A simplified block diagram of the data multiplexer is shown in Appendix RS.

The basic frame structure used by the multiplexer is that specified in the IESS-309 standard, Page 60, Figure 10, resulting in a 16/15 aggregate to through data ratio. This means that when the multiplexer is enabled the modem aggregate operating data rate is computed as the terrestrial connection (through) data rate multiplied by 16/15. The user sets only the desired through data rate while the modem computes the aggregate rate required. The multiplexer is also capable of expanded operating modes which include custom setting of the ratio of data to framing bytes.

The Multiplexer provides the following modes of operation. They are described more fully in The IBS Multiplexer/Reed-Solomon Appendix RS.

Mode	Standard/ Compatibility	Overhead Ratio	Notes
Disabled	N/A	1/1	
Standard	IESS-309	16/15	Fixed synchronous ESC, No AUPC, No MCC
Enhanced	Modified IESS-309	16/15	M4 compatible ESC and AUPC (limited MCC).
Custom	Modified IESS-309	Variable	Full ESC and MCC including AUPC, Remote Modem Control, 2 one=bit control channels. Also variable data load per frame.

The ESC Data Channel can be set under software-control to either RS-232 or RS-485 mode. The pin assignments for both modes are shown in Section 2.3 and Appendix RS. These pin assignments appear on the rear panel "AUX" (Auxiliary) connector J4 only when the Multiplexer function is enabled. The RS-485 Transmit Data Drivers can set to "RS-485" or "RS-485 ON" when in "Enhanced" mode. The "ON" setting forces the driver continuously on while the "RS-485" setting controls the output into tri-state when the modem is not transmitting data, allowing multiple modem outputs to be connected together. In the standard IBS mode only the "RS-485 ON" mode is available.

In Enhanced or Custom mode a 2 wire receive operating mode can be selected for the receive data into the ESC channel. In this mode the receive input is muted while the transmit data output is active. In 4 wire mode the receive is always enabled. In the standard IBS mode only the 4 wire mode is available. Note that the transmit and receive pairs are physically separate wires and must be connected together if true RS-485 2 wire connectivity is desired.

The processor on the main board performs software/hardware assignment of bits to specific purposes in the Custom mode and buffers the ESC Data Channel to standard asynchronous data rates.

The user does not have to compute data framing variables to use the Custom Multiplexer Mode. When placed in this mode the entry parameters are the ESC and MCC channel rates selected from standard asynchronous data rates (300 to 38,400 bps). The modem then computes the proper relationship between the framing and terrestrial data rates to achieve the proper operation. The modem also displays the terrestrial data to aggregate ratio.

1.2.7.1   Modem Control Channel (MCC)

The MCC is available in both the Enhanced and Custom Multiplexer modes. In the Enhanced mode the MCC provides for an AUPC channel. In the Custom mode the MCC provides for the AUPC plus the Remote Modem Control (RMC) Channel and the Auxiliary control bits (RFC).

1.2.7.1.1   AUPC Control Channel (AUPC)

When the modem is placed into either the "Enhanced" or "Custom" modes the AUPC control channel becomes available. The AUPC operation itself is under control of the modem while the AUPC facility in the MCC provides the channel for the information. This channel provides a minimum 300 baud control channel in each direction to allow the modems at two ends of a link to interactively maintain the receive Eb/No by controlling the power output at the transmit site.

Refer also to the AUPC operation description of the main manual in Section 3.8 titled "*Automatic Uplink Power Control (AUPC)" Operation.*

1.2.7.1.2   Remote Modem Control Channel (RMC)

When the modem is placed in the "Custom" mode the Remote Modem Control Channel becomes available. This channel allows the control of a far end modem from the near end site. This control is not however allowed from the near end front panel, but only via the remote control interface port. The command protocol for remote unit control is explained in Appendix B*, "Remote Control Protocol".*

Note that the Automatic Configuration Recovery or ACR is partially designed as a safety feature to be used with the remote programming of modems. It can help prevent "losing" the modem at an unattended site. Refer to the ACR section of the main manual in 3.14 "*Automatic Configuration Recovery".*

1.2.7.1.3   Auxiliary Bit Control Channels (RFC)

When the Multiplexer is placed into the "Custom" mode the auxiliary bit control RFC channels becomes available. These consist of two single line or "one-bit" control channels that can be used to send control information independently in both directions over the link. The input signals on these channels can be either a contact closure or a logic type signals while the output is a form C relay contract set whose state depends on the state of the input signal. The low input logic level is 0 to 0.4 VDC, while the logic high level can be from 2.4 to approximately 20 VDC. The input is current limited to accept this wide voltage range without damage. Higher voltages may damage the inputs however and caution should be exercised. Pin connections for these one bit channels are shown in the RS Appendix.

1.2.8 Standard and Optional Modem FEC Cards

All of the M500 class modems have two card slots on the main PCB for two FEC function boards. One board is normally installed containing the standard Forward Error Correction set including Viterbi (with Trellis Code Modulation mode when in 8PSK mode only) and Reed-Solomon concatenated codecs. The same standard card has several variations which includes either a 4k or 16k block size TPC or both on the same board if ordered that way initially. The second slot can be used for optional FECs as desired, for example the *FlexLDPC* FEC featuring exceptional performance at very low Eb/No.

These two FEC slots are wired in parallel and the control processor on the main board searches for a requested FEC on the first card containing that capability. The same FEC functions can exist on both cards, but only the first card will be used in that case.

FEC technology is in many ways a matter of tradeoffs. In most cases the tradeoff is between bandwidth and performance, which also relates to power and performance. FECs are normally specified by "Rate", which is the ratio of data information bits to transmitted bits, and coding gain, which is the Eb/No reduction able to achieve a specified BER as compared to an unencoded signal. The extra bits required for a given rate are redundancy processing bits needed to perform forward

error correction. For example, the common rate ½ means that for every data bit two bits are transmitted, and in rate 5/6, 6 bits are transmitted for every 5 data bits. Better performance is commonly considered higher coding gain at a given rate. There are always other factors to consider, such as the latency (processing time) required, time to recover from a synch loss, signal acquisition time, etc, etc.

FECs technology is often specifically adapted to a particular use. For example, it is common to use special forms of Reed-Solomon, TPC and LDPC for video signals. These type signals and FECs typically have a fairly high performance floor that are of little consequence for a wideband video signal, but would be entirely unacceptable for most data information especially at low data rates.

Viterbi has been the standard high performance FEC used in satellite communications for approximately 10 years. It has only been in the past few years that new technologies have emerged which provide more coding gain with reasonable implementations. The standard PSM-500 FEC card includes the circuitry for a Viterbi, TCM and Reed-Solomon Codec providing the PSM-500 with basic functional capability for all standard operating parameters including 8PSK TCM and 16QAM. The following are general descriptions of the characteristics of each of these functions.

The table below shows the currently available modes depending on modulation.

Note in Table A that the front panel selection number for each of the options is listed as the "Sel #". For example The Modulation modes show the selection numbers 0 through 6, and the FEC Type, Option and Code Rate selection numbers are listed in the column to the right of each item. These numbers can be referred to for front panel operation but are even more applicable to the SnIP Telnet command line program named "**m500ctl**". This program has specific commands that allow entering either just the 3 digit FEC options or the full **M**odulation, FEC **T**ype, **O**ption, **C**ode rate and **R**eed-Solomon mode (MTOCR) in a single entry. Refer to the SnIP documentation for more information.

PSM-500 Series FEC Option Table Rev 1.9   Modem Firmware V 0.77+

FEC Type	Sel #	FEC Type Option	Sel #	Code Rates Available	Sel #	R-S Option	BPSK 0	QPSK 1	OQPSK 2	8PSK 3	8QAM 4	16QAM 6
None	0	N/A	0	N/A	0		●	●	●			
Viterbi	1	Normal	0	1/2	0	●	●	●	●			●
				3/4	1	●	●	●	●			●
				5/6	2	●	●	●	●			●
				7/8	3	●	●	●	●			●
		Swap C0/C1	1	1/2	0	●	●	●	●			●
				3/4	1	●	●	●	●			●
				5/6	2	●	●	●	●			●
				7/8	3	●	●	●	●			●
		CT	2	3/4	1	●◆						●
				7/8	2	●◆						●
TCM	2		0	2/3	0	●				●		
TPC	4	Advanced	0	0.453-16k	0		●	●	●		●	●
				1/2-16k	1		●	●	●		●	●
				1/2-4k	2		●	●	●		●	●
				3/4-16k	3		●	●	●	●	●	●
				3/4-4k	4		●	●	●	●	●	●
				7/8-16k	5		●	●	●	●	●	●
				7/8-4k	6		●	●	●	●	●	●
				0.922-16k	7		●	●	●	●	●	●
				0.950-4k	8		●	●	●	●	●	●
		M5 Full	1	1/2	0		●	●				
		*TPC4k Only		3/4	1		●	●				
				7/8	2		●	●				
		M5 Short	2									
				3/4	1		●	●				
		*TPC4k Only		7/8	2		●	●				
		M5 Legacy	3									
				3/4	1		●	●				
				7/8	2		●	●				
		CT	4	5/16	0		●					
				21/44	1		●	●	●			
				3/4	2		●	●	●	●	●	●
		*TPC16k only		7/8	3		●	●	●	●	●	●
				0.95	4		●	●	●	●	●	●
LDPC	5	Any	0	1/2	0		●	●	●	●	●	●
		Block Size		2/3	1		●	●	●	●	●	●
		256~16k		3/4	2		●	●	●	●	●	●
		Option 0~6		14/17	3		●	●	●	●	●	●
				7/8	4		●	●	●	●	●	●
				10/11	5		●	●	●	●	●	●
				16/17	6		●	●	●	●	●	●
				7/8								

1. The TPC M5 Full, Short and Legacy modes are intended for PSM-4900 Compatibility only

2. * TPC 4k/16k restrictions apply to that line and Code Rate only

3. TPC4k Max data rate limits see below

4. TPC16k operates up to 20 Mbps depending on Feature Set and modulation

5. The Viterbi, Rate 3/4 & 7/8, 16QAM CT modes are only for Comtech modem compatibility as they only operate in this mode with R-S at 220, 200, depth of 4. R-S is auto-enabled

6. TPC Advanced modes are Datum Systems proprietary implementations that require the TPC16k option only for the colored lines. They offer superior performance to CT modes

1.2.8.0 Special Codec CT Modes

The wide range of FECs available today and the possibility of many different operating modes and parameters for each can make compatibility with other brands of modems extremely difficult. To aid in FEC compatibility with other brands of modems, the PSM-500 series offers special "CT" modes, standing for "Competing Technology". These modes use the same parameter settings as popular modems by other manufacturers.

Take note of the special CT modes available for Viterbi, Reed-Solomon and TPC modes below.

1.2.8.1 Viterbi, Trellis Code Modulation Codec

Viterbi has been the standard high performance FEC used in satellite communications for approximately 10 years. It has only been in the past few years that new technologies have emerged which provide more coding gain with reasonable implementations. Viterbi still maintains the advantage of fairly high coding gain with very low latency. So, for voice circuits or DAMA links requiring fast acquisition times Viterbi may be the FEC of choice.

Viterbi is part of a class of FECs considered "convolutional", basically meaning folded as in the redundancy bits are folded into the data bit stream. The important issue here is that it is not block oriented and not framed. It is therefore the responsibility of the FEC decoder to determine which are the proper data bits.

Trellis Code Modulation or "TCM" is a standard part of the M500 used with 8PSK at rate 2/3.

The Viterbi CT option mode follows that of competitive modems for 16QAM operation at rates ¾ and 7/8. The CT mode at this setting defaults to selecting Reed-Solomon CT mode at n, k and depth values of 220, 200, depth of 4 and inverts the data. This is a closed circuit mode that does not meet normal IESS standards, but is necessary in order to link to those modems.

1.2.8.2 Reed-Solomon Codec Capability

Reed-Solomon Codec places a second Forward Error Correction (FEC) process outside of and in series with the existing Viterbi FEC. The two FECs are thus considered "Concatenated". In addition, the data between the two FECs is "interleaved" which effectively reduces the possibility of multiple consecutive errored block symbols, thus improving the Reed-Solomon Codec performance.

The performance improvement achieved by this combination is significant. For example, the BER vs. Eb/No performance of concatenated Viterbi rate 3/4 coding with R-S is better than Viterbi rate 1/2 alone and it uses less bandwidth than the Viterbi rate 1/2 alone.

Reed-Solomon is a block oriented code, meaning that data is framed into fixed size blocks and processed in a specific way. A full block must be received before processing can begin, thus adding to the latency. The PSM-500 type R-S Codec is capable of operating in multiple standard and custom modes as shown in the table below.

Reed-Solomon uses framing which allows the use of a synchronous scrambler resulting in slightly improved performance relative to the self-Synchronized scrambler normally used.

A simplified block diagram of the Reed-Solomon Codec is shown in the Figure below.
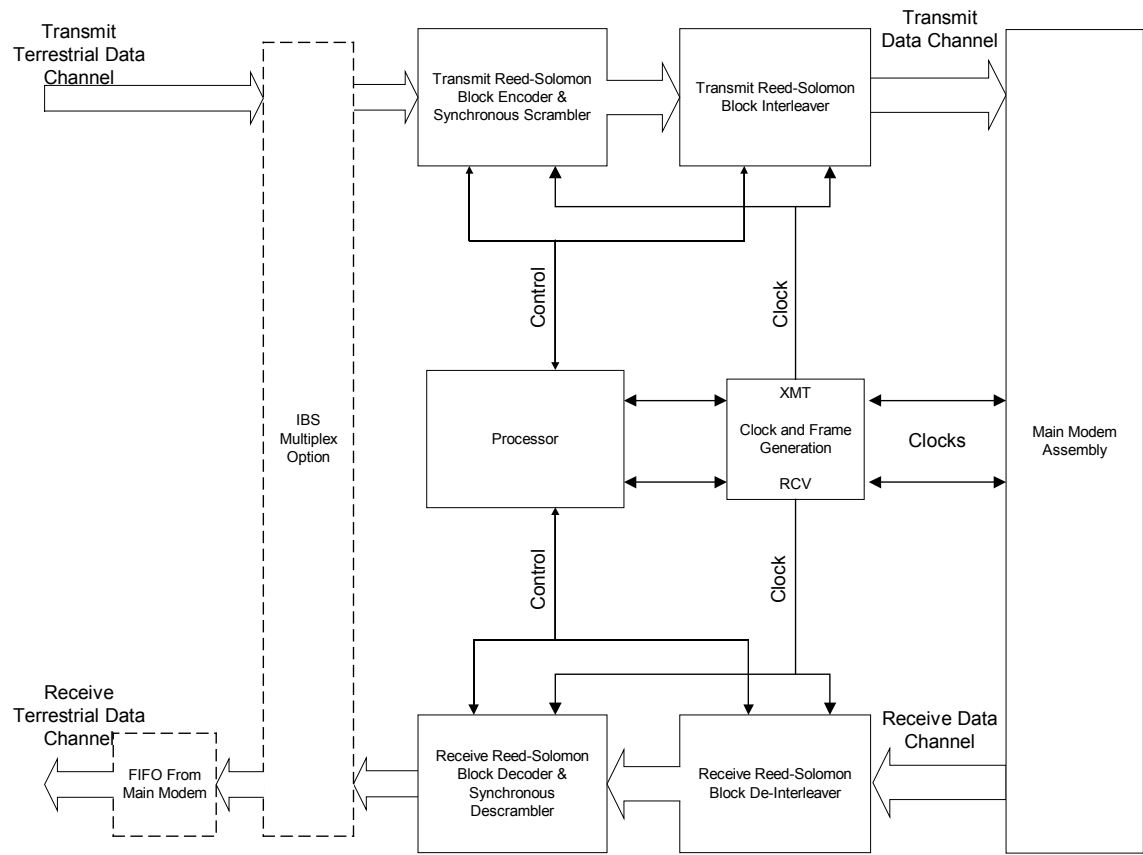
Reed-Solomon Codec Simplified Block Diagram

The Reed-Solomon modes shown available below can be selected from the front panel or remote control. The CT220,200 mode is a special compatibility mode and is automatically set by certain CT FEC modes, for example when Viterbi, Rate ¾ is selected when in 16QAM mode. It can be over-ridden by choice from the Reed-Solomon parameter.

Mode	Compatibility	Terrestrial Data Rate	Overhead Ratio	n, k and depth Values
Disabled	N/A		1/1	
IESS-308	IESS-308	1.2 kbps to <1.544 Mbps	9/8	126, 112, 4 (M4 modem compatible)
	IESS-308	1.544 Mbps to <2.048 Mbps	45/41	225, 205, 4
	IESS-308	>2.048 Mbps	73/67	219, 201, 4
IESS-309	IESS-309	All	73/67	219, 201, 4
CT220,200	Comtech	All	11/10	220, 200, 4
Custom	Modified IESS-309	All	Variable	Allows setting the "n", "k" and "depth" values for special requirements. Can also be set for M4 compatibility to max M4 data rate.

The IESS 308 mode automatically adjusts the n and k factors dependent on the data rate. The "Overhead" ratio is the ratio of the data rate at the R-S encoder output to the data rate at the input. It is defined as n/k. The modem automatically adjusts to accommodate the new rate.

The Reed-Solomon Codec function can be turned on and off under software control, and is independent of the IBS ESC Data Channel enabling.

1.2.8.3 Turbo Product Codes FEC Capability

The addition of the Turbo Product Codes (TPC) option allows replacement of the standard Viterbi FEC selectively for the transmit and receive paths independently. The performance improvement achieved by the TPC is significant. For example, the BER vs. Eb/No performance of TPC Rate ¾ is approximately equal to Rate ½ Viterbi and uses over 40% less bandwidth. TPC also provides better bandwidth/power utilization than either Reed-Solomon concatenated on Viterbi or 8PSK/TCM with Reed-Solomon.

The PSM-500 series offers extensive TPC capabilities including both first generation 4k block TPC with both PSM-4900 compatibility (M5) and Competitive Technology (CT) operating modes plus a newer second generation 16k block TPC. This second TPC offers superior performance at the expense of more delay due to larger processing blocks.

The Datum Systems' proprietary TPC "Advanced" mode has been optimized to provide the highest performance available in any TPC on the market. These modes not only outperform other manufacturer's TPC, but also LDPC in many cases.

The Turbo Product Codes FEC is more fully explained in Appendix TPC.

1.2.8.4 FlexLDPC FEC Capability

The addition of the *FlexLDPC* FEC option allows replacement of the standard Viterbi FEC selectively for the transmit and receive paths. The performance improvement achieved by *FlexLDPC* is the highest and most flexible of any specialized FEC technology to date, outperforming TPC in across all modes. *FlexLDPC* at rate ½ are capable of operating at a sustained Eb/No of only 1.5 dB with an error rate less than 10^{-9}

.

1.2.9   Optional Interface Capability

The M500 modems are also capable of accepting optional interface cards to replace the standard synchronous serial interfaces. The first of these cards is the Ethernet interface embodied in the Datum Systems' Satellite Network Interface Processor, or "SnIP". The SnIP is more fully explained in Appendix SNIP.

A second specialized interface card available is a High Speed Serial Interface or HSSI that is commonly used for connection to some routers. The HSSI interface is more fully explained in Appendix HSSI.

For users that require the option to select either SnIP or HSSI interfaces in addition to the standard synchronous serial interfaces, both cards can be installed in a "stacked configuration.

Installed option interfaces are automatically recognized by the modem, making them a selectable option on the front panel or remote control protocols.

1.2.10   Modem Circuit Implementation

Much of the functionality in this modem has been achieved by incorporation of extensive circuitry into Digital Signal Processing parts and Field Programmable Gate Arrays (FPGA). Depending on features and options installed there are between 1.2 and over 2 Million gates of logic encapsulated in the FPGAs, a 10 fold increase over the last generation modem. The logic can be augmented and changed as requirements change. The modems unique direct modulation and demodulation scheme also completely eliminates all IF mixing and filtering circuitry.

Chapter 2 - Installation

2.0   Installation Requirements

The PSM-500 VSAT/SCPC Modem is designed for installation in any standard 19-inch equipment cabinet or rack, and requires 1 RU mounting space (1.75 inches) vertically and 12 inches of depth. Including cabling, a minimum of 15-inches of rack depth is required. The rear panel of the PSM-500 is designed to have power enter from the left and IF cabling enter from the right when viewed from the rear. Data and control cabling can enter from either side although they are closer to the left. The unit may be placed on a table or suitable surface as required.

> ⟹ **CAUTION**: *There are no user-serviceable parts or configuration settings located inside the PSM-500 modem case. There is a shock hazard internally at the power supply module. DO NOT open the modem case unless power is removed for option installation.*

> ⟹ **CAUTION**: *Before initially applying power to the modem, it is a good idea to disconnect the transmit output from the operating satellite ground station equipment. This is especially true if the current modem configuration settings are unknown, where incorrect setting could disrupt existing communications traffic.*

2.1   Unpacking

The PSM-500 Modem was carefully packed to avoid damage and should arrive complete with the following items for proper installation:

1. PSM-500 Modem Unit. L-Band Units may include an external BUC power supply.

2. Power Cord, 6 foot with applicable AC connector.

3. Installation and Operation Manual plus other information on CD.

2.1.1   Removal and Assembly

If using a knife or cutting blade to open the carton, exercise caution to ensure that the blade does not extend into the carton, but only cuts the tape holding the carton closed. Carefully unpack the unit and ensure that all of the above items are in the carton. If the Prime AC power available at the installation site requires a different power cord/AC connector, then arrangements to receive the proper device will be necessary before proceeding with the installation.

The PSM-500 Modem unit is shipped fully assembled and does not require removal of the covers for any purpose in normal installation. All normal hardware configuration, including setting the data interface type and IF impedance is under software control. The type of Feature Sets, FEC Options and Interface Options installed can be read from the LCD display on the front panel under **<Unit: Status – >** column by scrolling down after initial application of power.

Should the power cable AC connector be of the wrong type for the installation, either the cable or the power connector end should be replaced. The power supply itself is designed for world-wide application using from 90 to 264 VAC (100 to 240 VAC +/- 10%).

2.2   Mounting Considerations

When mounted in an equipment rack, adequate ventilation must be provided. The ambient temperature in the rack should preferably be between 10 and 35° C, and held constant for best equipment operation. The air available to the rack should be clean and relatively dry. The modem units may be stacked one on top of the other to a maximum of 10 consecutive units before

providing a 1 RU space for airflow. Modem units should not be placed immediately above a high heat or EMF generator to ensure the output signal integrity and proper receive operation.

Do not mount the PSM-500 in an unprotected outdoor location where there is direct contact with rain, snow, wind or sun. The modem is designed for indoor applications only.

The only tools required for rack mounting the PSM-500 is a set of four rack mounting screws and an appropriate screwdriver. Rack mount brackets are an integral part of the front panel plate of the unit and are not removable.

The following interface connections should be available at the mounting location as a minimum:

1. Prime AC power.

2. A 75Ω Transmit IF cable with BNC male connector. (50Ω optional) or a 50Ω Transmit IF cable with type N male connector for the L-Band version.

3. A 75Ω Receive IF cable with BNC male connector. (50Ω optional)
   or a 75Ω Receive IF cable with type F male connector for the L-Band versions.

4. A Terrestrial data interface cable to mate with the modem or installed option; either a 37-pin male "D" sub connector for all standard or appropriate connector for an optional interface (such as G.703 or Ethernet 10 Base T).

Other optional connections are shown below.

2.3 Modem Connections

All modem connections are made to labeled connectors located on the rear of the unit: The connector definitions below are those on the modem unit. Any connection interfacing to the modem must be the appropriate mating connector. Cabling and Connections are detailed in Appendix C, "*Cabling Specifications*". Refer to Figure 2-1 to locate the following connectors:

Prime AC power to the far left IEC male input at J1:
> 90 to 260 VAC, 47 – 63 Hz.
> Maximum unit power consumption is 50 Watts (Typical < 30 Watts).
> Integral switch provided as part of power entry connector.

Chassis ground connection at #8 stud location J2.

Data Interface Connection at Data Connector J3:
> Standard RS–449 Connector (37-pin female "D" sub connector).
> DB25 adaptor cable supplied with modem for V.35, EIA 530, RS-232.

Alarm Connection at 9-pin male "D" connector J5.

RS–485 Control Port connection at 9-pin female "D" sub connector J6:
> Shield ground on pin 15
> Transmit A on pin 6 (output from modem)
> Transmit B on pin 1. (output from modem)
> Receive A on pin 9 (input to modem)
> Receive B on pin 8. (input to modem)

OR

RS–232 Control port connection at 9-pin female "D" sub connector J6:
> Transmit on pin 3 (input to modem)
> Receive on pin 2 (output from modem)
> Common on pin 5.

The Modulator 70 MHz IF Output at female BNC J7
  50 – 90 MHz
  Programmable +5 to –35 dBm output at 75Ω
  Programmable +3 to –35 dBm output at 50Ω.

The L-Band Modulator (PSM-500L) L-Band IF Output at female Type N J7
  950 – 1750 MHz
  Programmable +3 to –35 dBm output at 50Ω.
  BUC Power Source (normally 24VDC @ <4A) to be output on this connector. Various supplies are available and all are connected to the 5 pin DIN connector at J10.
  Programmable 10 MHz Reference signal to be output on this connector.

> $\Rightarrow$ **CAUTION!: Extreme Care should be exercised when connecting test equipment in the transmit line either directly to the modem output or within the line to the BUC. The voltage present to power the BUC can cause <u>severe</u> damage to the input of test equipment like spectrum analyzers. A DC Block device is highly recommended for test equipment connection.**

> $\Rightarrow$ **CAUTION!: Extreme Care should be exercised when handling the transmit cable as it is possible to have hazardous voltages on the transmit line. When higher voltages are used to supply BUCs that require 48VDC the transmit line can <u>seriously</u> injure personnel.**

> **To avoid injury or equipment damage unplug the L-Band modem and BUC power supply whenever the transmit cable is disconnected!**

The L-Band Modulator (PSM-500L) Block Up Converter Power Supply at J10
  12 to 56 Volts DC, up to 6 Amp capability.
  Programmable enable and disable onto the transmit cable at J7
  The BUC Power Status LED next to J7 shows the status as follows
    Red – *No voltage sensed on DIN input connector or power is input and the enabled but the cable to the BUC is shorted.*
    Green – *Power sensed and enabled (connected) to transmit cable*
    Off – *Power sensed but disabled (disconnected) from transmit cable.*

The Demodulator 70 MHz IF Input at female BNC J9, 50 – 90 MHz
  –20 to –60 dBm input at 75 or 50Ω. (to –84 dBm at lower bit rates)

The L-Band Demodulator (/L) L-Band IF Input at female Type F J9
  950 – 1900 MHz
  –20 to –60 dBm input at 75Ω. (to –100 dBm at lower bit rates)
  Programmable 0, 13VDC or 18VDC @ <500mA to be output on this connector
  Programmable 10 MHz Reference signal to be output on this connector.

> $\Rightarrow$ **CAUTION: Extreme Care should be exercised when connecting test equipment in the receive line to the LNB. The voltage present to power the LNB can cause severe damage to the input of test equipment like spectrum analyzers. A DC Block device is highly recommended for test equipment connection.**

The Modem External Reference Input at female BNC J8
  1, 5, 9 or 10 MHz input
  +10 to –15 dBm input level at 50Ω (normally a sine wave).

The ESC channel connection at 37-pin male "D" sub connector J4 (AUX). (When the optional IBS multiplexer is enabled). See Appendix C, "*Cabling Specifications*" for the pins used for each of the following interfaces available on the "AUX" connector.

RS-232 Standard Mode Connection (synchronous)
    RS-232 Transmit on pin 4 (input to modem, sampled on rising clock edge)
    RS-232 Transmit Clock on pin 13 (output from modem)
    RS-232 Receive on pin 6 (output from modem, changes on falling clock edge)
    RS-232 Receive Clock on pin 7 (output from modem)
RS-232 Enhanced/Custom Mode Connection:
    RS-232 Transmit on pin 4 (input to modem)
    RS-232 Receive on pin 6 (output from modem)
    RS-232 CTS on pin 7 (output from modem)
    RS-232 RTS on pin 9 (input to modem)
    RS-232 DSR on pin 11 (output from modem)
    RS-232 DTR on pin 12 (input to modem)
    RS-232 DCD on pin 13 (output from modem)
RS-485 Connection:
    RS-485 Receive A on pin 11 (output from modem)
    RS-485 Receive B on pin 6. (output from modem)
    RS-485 Transmit A on pin 12 (input to modem)
    RS-485 Transmit B on pin 4. (input to modem)
User Remote Facility Control channel A
    Pin 33 - RFC channel A Input (TTL, Internal 1mA Pull-Up)
    Pin 34 - RFC channel A Form-C Common
    Pin 35 - RFC channel A Form-C N.C.
    Pin 16 - RFC channel A Form-C N.O.
User Remote Facility Control channel B
    Pin 15 - RFC channel B Input (TTL, Internal 1mA Pull-Up)
    Pin 17 - RFC channel B Form-C Common
    Pin 18 - RFC channel B Form-C N.C.
    Pin 36 - RFC channel B Form-C N.O.
Grounds
    Pins 14, 19, 20, 32, 37
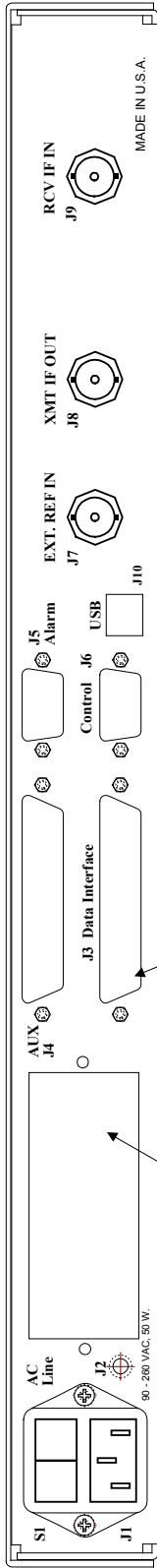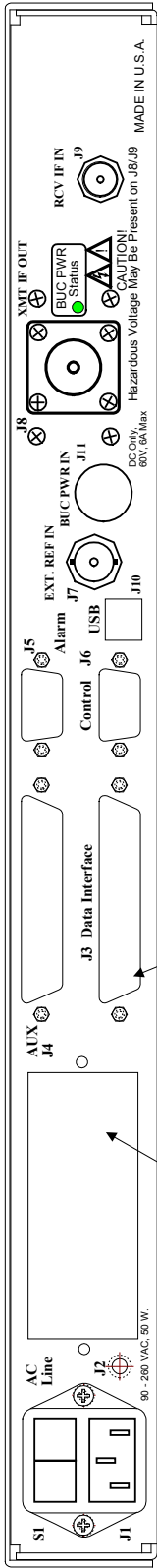
Figure 2-1 Modem Rear Panel

2.3.1 Data Interface Pin Connections

The unit is supplied with an electronically programmable data interface assembly. Table 2-1 shows the pin assignments for the possible standard interfaces. Additional information aiding the creation of "adaptor" cables from the unit's 37-pin female "D" sub connector to other types of interface connections such as V.35 "Winchester" type connector standard pin-outs or RS-232 type DB25 connector is presented in Appendix C *"Cabling Specifications"*.

Table 2–1 Data Interface Connector J3 Pin Assignment by Signal					
Modem Pin #	RS–449 Signal Name	V.35, V.36 Signal Name	RS-232 Signal Name *(5)	Eia-530 Signal Name	Direction
1	Shield (GND)	Shield (GND)	Shield (GND)	SHD (GND)	GND (4)
4	Transmit Data (A) –	SD A (SD-)	SD	TD A	Input
22	Transmit Data (B) +	SD B (SD+)		TD B	Input
5	Transmit Clock (A) –	SCT A (ST-)	ST	TTSETC A	Output
23	Transmit Clock (B) +	SCT B (ST+)		TSETC B	Output
6	Receive Data (A) –	RD A (RD-)	RD	RD A	Output
24	Receive Data (B) +	RD B (RD+)		RD B	Output
8	Receive Clock (A) –	SCR A (RT-)	RT	RSETC A	Output
26	Receive Clock (B) +	SCR B (RT+)		RSETC B	Output
7	RTS (A) –	RTS	RTS	RTS A	Input
25	RTS (B) +			RTS B	Input
9	CTS (A) –	CTS	CTS	CTS A	Output
27	CTS (B) +			CTS B	Output
11	Data Mode (A) –	DSR	DCR	DCR A	Output
29	Data Mode (B) +			DCR B	Output
12	TR (A) –	DTR	DTR	DTR A	Input
30	TR (B) +			DTR B	Input
13	Receive Ready (A) –	RLSD	RLSD	RLSD A	Output
31	Receive Ready (B) +			RLSD B	Output
17	Terminal Timing (A) –	SCTE A (TT-)	TSETT	TSETT A	Input
35	Terminal Timing (B) +	SCTE B (TT+)		TSETT B	Input
3	External data Clock (transmit data clock or receive FIFO Buffer output Clock (A) – *(3)	Ext Data/FIFO Clock A (-)*(3)	Ext Data/FIFO Clock A (-)*(3)	Ext Data/FIFO Clock A (-)*(3)	Input
21	External data Clock (transmit data clock or receive FIFO Buffer output Clock (B) + *(3)	Ext Data/FIFO Clock B (+)*(3)	Ext Data/FIFO Clock B (+)*(3)	Ext Data/FIFO Clock B (+)*(3)	Input
19	Signal GND	SIG GND	GND	SGND	GND
20	Common	Chassis			GND
10	Mod Fault Alarm *(2)	Mod Fault Alarm *(2)	Mod Fault Alarm *(2)	Mod Fault Alarm *(2)	OC TTL output

Modem Pin #	RS–449 Signal Name	V.35, V.36 Signal Name	RS-232 Signal Name *(5)	Eia-530 Signal Name	Direction
Table 2–1 Data Interface Connector J3 Pin Assignment by Signal					
28	Demod Fault Alarm *(2)	Demod Fault Alarm *(2)	Demod Fault Alarm *(2)	Demod Fault Alarm *(2)	OC TTL output
32	Aux RS-232 Receive *(1)	Aux RS-232 Receive *(1)	Aux RS-232 Receive *(1)	Aux RS-232 Receive *(1)	Input
34	Aux RS-232 Transmit *(1)	Aux RS-232 Transmit *(1)	Aux RS-232 Transmit *(1)	Aux RS-232 Transmit *(1)	Output
37	Send Common				GND

Notes on Data Interface Connections:

1. If Automatic Uplink Power Control is provided by an external multiplexer the control channel may use the Aux RS-232 signal lines. These lines are however dedicated when the 1:1 redundancy mode is enabled for inter-modem communications.

2. The modulator and demodulator fault alarms are Open Collector TTL outputs used to interface to redundancy control equipment.

3. The External Data/FIFO clock pins are an input to the modem. An input at the receive data rate can be used to clock data out of the demodulator FIFO buffer. An input at the transmit data rate can be used to provide a transmit send timing clock which the modem will phase locked to (if within acceptable range). The send timing signal is still an output from the modem, but in this case will be at the input signal rate. Both functions can be used simultaneously if the transmit and receive data rates are the same.

4. The Shield is normally connected to the cables shield at one end of the cable only. Connecting at the DCE end only prevents ground loop currents being carried on the shield.

5. The synchronous RS-232 connection is limited to 128 kbps.

2.3.1.1 Connecting the Data Interface to Other Equipment

The PSM-500 physical connector is that of an RS-449 interface. The electrical interface however can be changed under front panel or remote program control to include the types of interfaces shown above. Connecting the Data Interface to other types of equipment involves building cables between the PSM-500 and that other equipment's physical interface. Refer to Appendix C, *"Cabling Specifications"* for more information on building and connecting these cables.

2.3.2 Remote Control Connection

The modem has a command interface serial control port which can be configured for either of two electrical interface modes of operation. Both are located on the rear panel 9-pin female "D" sub connector J6. Connection to either the RS–232 or RS–485 is selected by connecting to the proper set of pins as shown in table 2-4, and setting the remote mode as applicable via the front panel control. If the user desires a 2 wire RS-485 bus then the transmit and receive 485 lines should be externally connected together (1 to 8 and 6 to 9).

The USB type B connection is also available for use as a remote control connection, although its primary purpose is loading new firmware. Computers that do not have an available RS-232 port could use of this port for control, but it requires that a special USB device driver be loaded into the computer to access the modem via this port. This driver makes the control port appear similar to a serial port. The latest driver is available on our web site.

Table 2–2. Remote Control Connector J6 Pin Assignment			
P2 Pin #	**Signal Name**	**Use**	**Direction**
1	Transmit B	RS–485 Transmit Data (B) +	Output
2	Transmit	RS–232 Transmit Signal	Output
3	Receive	RS–232 Receive Signal	Input
4		Not Used	
5	Common	RS-232 Signal Common	I/O
6	Transmit A	RS-485 Transmit Data (A) -	Output
7		Not Used	
8	Receive B	RS-485 Receive Data (B) +	Input
9	Receive A	RS-485 Receive Data (A) -	Input

Refer to Appendix C, "Cabling Specifications" for information on making a remote control cable.

2.3.3 Alarm Connection

The modem has two form-C dry contact alarm relays on board and an alarm connector located on the rear panel, the 9-pin male "D" sub connector J5.

The two relays are designated "A" and "B" and the particular alarms that are summarized on each relay are programmable from the front panel of the unit or via remote control. Connection to the A and B relays is via the proper set of pins as shown in Table 2-5 below and programming the applicable alarm entries via the front panel control or remote control. Non-Alarm is defined as the powered state of the relay resulting in an alarm when power is lost.

The analog monitor output is programmable from the front panel to select either receive Eb/No, receive AGC voltage or transmit output power.

Table 2–3. Alarm Connector J5 Pin Assignment	
J5 Pin #	**Connection**
1	Relay A - NO on Alarm
2	Relay A - Common
3	Relay A - NC on Alarm
4	No Connection
5	Analog Monitor Output (1kOhm)
6	GND for analog monitor
7	Relay B - NO on Alarm
8	Relay B - Common
9	Relay B - NC on Alarm

Note:

By convention "NO" means Normally Open, and "NC" means Normally Closed.

Both conditions are the non-powered, Alarm State.
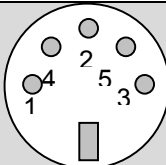
2.3.4 Auxiliary (AUX) Connection

The modem has an auxiliary connector located on the rear panel, the 37-pin male "D" sub connector J4. The pin-out of this connector is determined by option board(s) installed in the modem; for example a multiplexer option would present overhead channel and analog channel inputs at this connector. The pin definitions are defined in the addendum related to installed options, for example when the IBS Multiplexer/Reed-Solomon option card is installed the I/O on connector J4 is defined in Appendix RS.

2.3.5 L-Band BUC Power Connection/PSM-500L

The PSM-500L modem has a 5 pin circular DIN connector at the rear panel J11. This connector is used to connect an auxiliary DC supply to power Block Up Converters that accept DC power via the transmit line. This connector applies the input voltage to the transmit cable via a relay internal to the modem and a "Bias-T" circuit. The relay is under processor control and can be enabled or disabled using the front panel or remote control. The processor also reads the voltage and current applied to the BUC and can create alarms in addition to reading voltage and current at the front panel. The power connector pin-out and rear panel LED (labeled "BUC Power Status") meanings are shown below.

Table 2–4. BUC Power Connector J11 Pin Assignment	
J11 Pin #	**Connection**
1	Ground
2	Ground
3	V+
4	Ground
5	V+

⇒ *Caution: The BUC power input is DC Only, 60 VDC maximum, 6 Amps maximum. The power input is only intended for positive voltages with respect to ground.*

Rear Panel BUC Status Indicator

Red – No voltage sensed on DIN input connector or power is input and enabled but the cable to the BUC is shorted.

Green – Power sensed and enabled (connected) to transmit cable.

Off – Power sensed but disabled (disconnected) from transmit cable.

2.3.6 Redundancy Connection

The modem is capable of operating in a limited 1:1 redundancy protection mode without the use of a separate redundancy switch. It does require specific minimal facilities at the transmit and receive IF signal connections and at the terrestrial data connection. These are a combiner at the transmit IF, a splitter at the receive IF and a "Y" cable at the terrestrial data connection. With this connection scheme the switching is only performed on the outputs from the modem. The modem IF and data inputs are always available at the modem allowing internal circuitry to determine if one modem is correctly accepting and "locking" to the input signals while the other is unable to if in a failed state.

The two modems communicate with each other over the data "Y" cable. In this cable all connections are 1 to 1 except the auxiliary RS-232 transmit and receive lines. These two lines are swapped between the two modems allowing them to talk over an auxiliary serial link. Specifics of this cable wiring are shown in Appendix C, "*Cabling Specifications*". Operation of the data interface connected in parallel depends upon the programmable interface drivers to be tri-stated and the receivers to be set in an un-terminated mode. This is accomplished under control of the modem's internal software.

Note: The two modems should be at the same firmware revision for proper redundant operation.

The two modems operate in a "non-priority" redundancy mode, that is, no modem is specified as "primary", or having preference when both modems are operational. The first modem turned on assumes a non-redundancy mode until the second connected unit is powered up. The on-line unit can be set to send its configuration information to a second unit via the front panel. The modems will remain in this state, constantly sending status information back and forth until one unit indicates a failure. If that modem is currently on line, it is switched off-line and the alternate unit is switch on.

The modem is also capable of operating in 1:N and M:N redundancy switching schemes. The necessary connections to monitor and control switching are available on the data connector itself in the form of the modulator and demodulator fault outputs and the auxiliary RS-232 control port. The alarm outputs are also available. The other facility provided to aid in these redundancy schemes is the ability to save and recall configuration information. Thus a back-up modem can obtain and save the configurations from 8 other modems and switch immediately to the necessary parameters to replace any of those units by simply recalling that unit's stored configuration. In addition, the programmable interface and common physical data connector allows different interface protocols between the primary modems.

A diagram of the connections required for installing 1:1 redundancy is shown in the figure below.
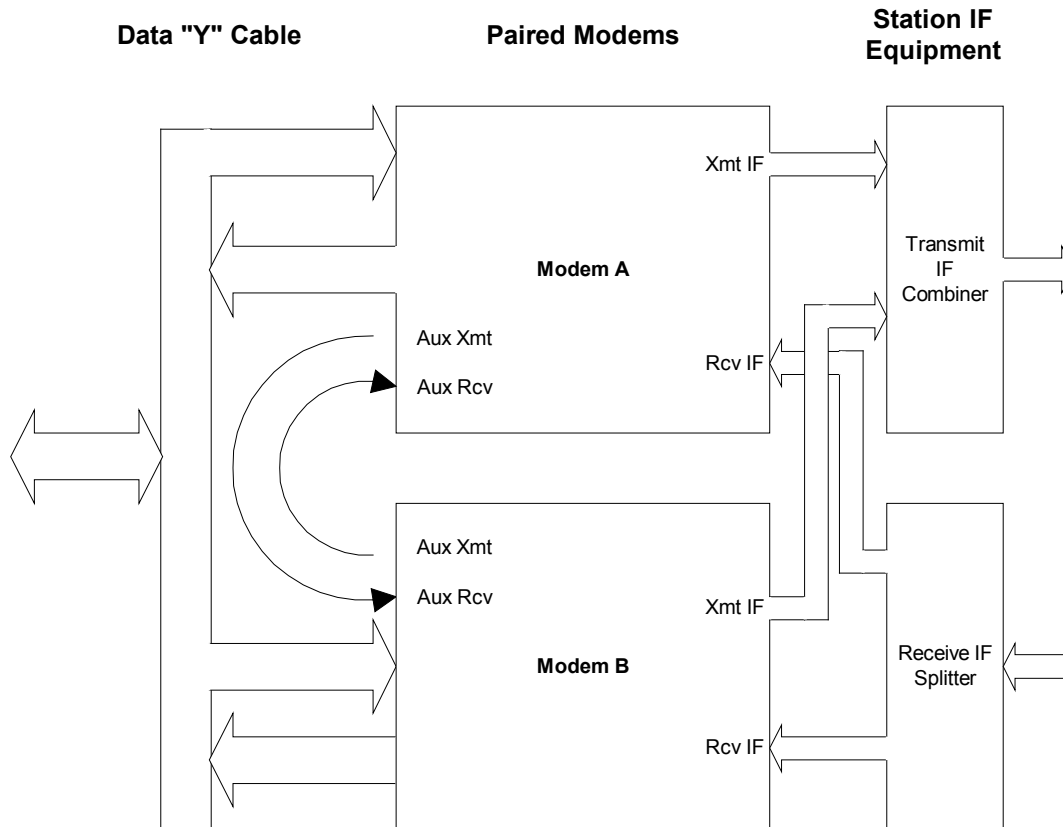
Figure 2-2 - Modem Connections for 1:1 Redundancy

It is important in L-Band systems to use special splitters and combiners that have the ability to pass DC used to power the BUC and LNB with sufficient current capacity. One type of these is termed "Wilkinson" combiners. For the lower power receive LNB connection there are low cost DC pass combiners that may be suitable. Visit our web site for recommendations.

2.3.6.1 Set-Up Procedure for 1:1 Redundancy

If redundancy mode is to be set up between a pair of modems then the following procedure is followed during installation, other wise this section can be skipped. In overview the procedure is:

1. Physically install both units to be paired and connect the IF transmit and receive coaxial cables and data cables to both units. The special data "Y" cable is connected between the redundant pair. For convenience we will arbitrarily call one modem "Primary" and the other "Secondary".

2. Power-up and configure the primary modem completely for the intended operating parameters, including setting the **<Unit: Redundancy – Mode>** parameter to "1:1". This initial unit should not be in alarm. The second unit should still be turned off.

3. Turn the power on the secondary unit on.

4. Go to the primary unit menu item **<Unit: Redundancy – Config>** and press the "Edit" key. The on-line unit will ask permission to transfer configuration to the second unit with the prompt "Config Backup?" Confirm by pressing "Enter". The primary unit should say "Sending Config" for approximately 1 second. If the transfer of any packet results in an error, a "Send Fail" message will be displayed, but transfer will continue.

5. Verify that the units are functioning correctly in redundancy mode. Go to the **<Unit: Status – Redundancy>** item in both units. The on-line unit will say "On-Line, Bckup OK" while the off-line unit will say "Standby, OK".

Physical installation of the two units is best accomplished with one unit directly above the other in the rack. This allows the status of the two modems to be seen together and avoids confusion.

Care should be taken that both units are not turned on in a non-redundant configuration with the "Y" data cable installed. This will result in the two unit's data output drivers possibly conflicting and causing damage.

During configuration of the primary unit several new parameters will become available after the mode is set to 1:1. In addition to the **<Unit: Redundcy - Config>** parameter of step 4 above there will also be parameters that allow the alarms and timing to be configured for the application. The default values for these parameters are probably good in most installations, but they may require specific configuration, especially if the unit had been configured for another unique application. These new parameters are:

- **<Unit: Redundncy – Sw Rqst>** This parameter allows you to determine which alarm indications result in a switch request. The possible selections are "On Any Alarm", "On Alarm A", "On Alarm B", or "On Alarm A & B". Since the specific alarms which comprise Alarm A and Alarm B are programmable themselves, then a switch request is highly programmable itself. For most applications though the default "On Any Alarm" is a preferred selection.

- **<Unit: Redundncy – Sw Hold>** This parameter determines how long an alarm must exist on the on-line unit and not the off-line unit before switching will occur. Allowable values are 0.0 to 600.0 seconds. The value could be set to zero, but this is not advised. A nominal value of 0.5 seconds insures that intermittent cases do not cause undue switching. A built in factor of 10 seconds is provided once a switch has occurred before a switch back to the original unit is allowed (except in the case of a manual switch request or loss of power in the on-line unit which requires 2 seconds).

Teardown or un-pairing of two redundant units is accomplished by turning both units off before removing the "Y" cable. Then power on and set the **<Unit: Redundancy – Mode>** to "Disabled".

A unique case can arise when both units are off-line and powered up at the same time. They will probably go out of alarm at virtually the same time. In such tie cases, which unit will be placed on line is determined by the unit serial numbers, where the highest serial number wins the tie.

2.4   Modem Checkout

The following descriptions assume that the modem is installed in a suitable location with prime AC power and supporting equipment available.

2.4.1   Initial Power-Up

> ⟹ **CAUTION:** *Before initial power-up of the modem, it is a good idea to disconnect the transmit output from the operating satellite ground station equipment. This is especially true if the current modem configuration settings are unknown, where incorrect setting could disrupt existing communications traffic. New modems from the factory are normally shipped in a default configuration which includes setting the transmit carrier off.*

Turn the unit "ON" by placing the rear panel switch (above the power entry connector) to the "ON" position. At every power-up, the modem processor tests itself and several of its components before beginning its main monitor/control program. These power-up diagnostics take approximately 1 second and show no results if successful. If a failure is detected, the indications vary by the type of fault detected. A serious failure will result in the front panel Alarm LEDs flashing at a rate of approximately 4 times a second, and the unit beeper sounding.

Most potential failures will result in the modem giving a verbal indication of the problem on the front panel LCD display. Status indications are shown highest priority first.

The initial field checkout of the modem can be accomplished from the front panel or in the Terminal Mode. The Terminal Mode has the advantage of providing full screen access to all of the modem's parameters, but requires a separate VT100 terminal or computer running a terminal program in VT100 or ANSI mode. The modem unit is placed into terminal mode by setting two options via the front panel. First set the **<Unit: Remote – Protocol>** parameter to "VT100" (option 0), then set the **<Unit: Remote – Port>** parameter to "RS–232" (option 0). The **<Unit: Remote – Bit Rate>** and Format also require setting to match the terminal settings. The **<Unit: Remote – Address>** serves no function in the Terminal mode. See below for a quick introduction on the use of the front panel and steps for entering parameters.

2.5   Modem Control from the Front Panel

The front panel can be used to completely control the modem setup and operating parameters. Front panel control of the modem is more thoroughly discussed in the Operations Section, *3.1.3 "Guide to Front Panel Monitor and Control",* but a quick introduction to the front panel operations is given here to allow initial setup. The Navigation figure in Section 3.1.3 is especially useful.

The modem parameters are arranged in four matrices, one each for "Unit", "Mod", "Demod" and "Int'f", representing Unit, Modulator, Demodulator and Interface. Each matrix is 4 to 10 columns wide and up to 20 rows long as shown in the parameter matrix tables. The particular functional matrix is selected by pressing one of the four buttons to the immediate right of the LCD display. In response the modem will highlight the particular button text selected. Within each matrix the columns designation is shown in the upper left hand corner of the LCD Display and is selected using the left and right arrow keys. Columns common to all matrices are "Status", "Alarm" and "Test", while others vary by the parameters required. The particular parameter within a column is shown in the upper right hand of the LCD display and is selected using the up and down arrow keys. The LCD display allows viewing only one of the many parameters at one time, while the four arrow keys (↑), (↓), (→), (←), allow scrolling through the rows and columns of the parameter matrix. The complete matrix is shown as Tables 3-1 through 3-4 in Chapter 3, "Operation" of this manual.

In this manual operation of the keypad to access a certain parameter is shown in the format **<Function: Column – Row>**. For example, to get to the Modulator IF Level the method is to press the "Mod" key then use the left and right arrow keys to access the "IF" column and the up

and down arrow keys to arrive at the "Level" parameter. This is shown by convention in this manual as **<Mod: IF – Level>**

2.5.1 Parameter Setup

Each individual item that may be read or set is referred to as a "parameter". Parameters are arranged in a matrix of rows and columns. To set any parameter:

1. Select the functional matrix by choosing one of the four function keys; Unit, Mod, Dem and Int'f.

2. Select the parameter to be set using the four arrow keys to the right of the LCD display. The Left and right arrow keys control the column of the matrix and is shown in the upper left position of the LCD display. The up and down arrow keys control the row of the matrix and is shown in the upper right of the LCD display. Then

3. Press the "Edit" key to indicate that a new entry is desired (If the "Quick" keyboard entry is enabled this step may be skipped), next

4. Set the parameter via the numeric keypad, and

5. Finalize the data entry using the "Enter" key.

The current input can be canceled by pressing the "Clear" key at any time before pressing "Enter".

When the entry involves selection of one of several choices; this is accomplished by either:

1. Use the up and down arrow keys to scroll though the available options, pressing "Enter" when the desired option is displayed. When scrolling though the available options the current setting is denoted by an arrow in the left column position, or

2. Pressing an option number selection (0 to max. where max. may be 1 to 8), then pressing the "Enter" key. This method is faster when the option scheme becomes more familiar. For instance, all options that can be enabled or disabled use "1" to enable and "0" to disable. Note that the "yes" and "no" below the 1 and 0 key aid this convention.

Following a valid input, the modem will place the new setting into the nonvolatile EEPROM making it available immediately and also automatically the next time the unit is powered on.

2.6 Modem Terminal Mode Control

The modem can be interactively monitored and controlled in the VT100 Terminal mode, with a full screen presentation of current settings and status. Programming is accomplished by selecting the item to be modified and pressing the terminal key of the option letter "A" through "Z". For example, to change the transmit data rate, press the terminal's "A" key (upper case is not necessary for letters). The modem will respond by presenting the options available and requesting input. Two types of input may be requested. If the input is multiple choice, the desired choice is selected by pressing the indicated number key. This input type does not require pressing the "Enter" or carriage return key. The other possible input type requires a numerical input (such as entering a frequency or data rate). This type of input is followed by pressing the "Enter" or carriage return key. An input can be aborted at any time by pressing the "TAB" key. Invalid input keys are signaled by a beep or bell signal from the terminal. Note that the "ESC" key is <u>not</u> used to escape or cancel an input because the common ANSI and VT100 terminal control sequences use the escape character to flag start of sequence.

Following a valid input, the modem will place the new setting into the nonvolatile EEPROM making it available not only immediately but also automatically the next time the unit is powered up.

2.7 Self-Test Mode

> $\Rightarrow$ **CAUTION**: The Self-Test Mode will disconnect the transmit and receive IF from the ground station equipment and will therefore disrupt any traffic currently through the PSM-500 under test. This Test Mode should not be used on a live traffic unit.

The PSM-500 provides a built–in self-test mode which uses the IF Loop-back and a predefined sequence of actions to test the basic modem operation. This test mode can be used to verify correct functioning of the modem before placing it into service. The modem is placed into self-test mode by using the front panel controls to initiate the test mode sequence.

The Self-Test Mode does not use or change the current configuration parameters, and returns to these parameters after the test is completed.

To access the Self-Test Mode from the front panel, select "Unit" and use the right arrow key to scroll to the "Test" column of the configuration matrix and then scroll down until "Test   Modem" is displayed. Then press "Edit", the "3" key then "Enter" to start the test. The modem self-test only requires approximately one minute. This tests both the lamp and unit functioning. Just the lamp test is performed by selecting "1" above or the Loop tests by selecting "2" above.

If any portion of the self-test fails, the modem will halt on the failed test and enter a loop with 4 short "beeps" then pause for several seconds and repeat the 4 short beeps.

The Self-Test Mode state is not stored in EEPROM, therefore if the unit is powered off during Self-Test Mode it will be configured for Self-Test Mode disabled when powered up again

2.8 IF Loop-back Test Mode

> $\Rightarrow$ **CAUTION**: The IF Loop-back Mode will disconnect the receive IF from the ground station equipment and will therefore disrupt any traffic currently through the PSM-500 under test. The transmit output is still active if it was enabled before initiating an IF Loop-back. This Test Mode should not be used on a live traffic unit.

The PSM-500 provides a built–in IF loop-back mode which couples the transmit output to the receive input via physical relays at the modem IF and an internal attenuator to achieve proper input levels. This mode can be used to test modem operation with data, for instance using a BER test set, before going up on the satellite.

The IF Loop-back Test Mode uses the current modulator carrier frequency (plus offset setting) only and sets the demodulator to the same carrier frequency setting when in loop-back. The user is responsible for all other compatible settings in order for the modulator and demodulator to operate properly. When the IF Loop-back Test Mode is disabled, the demodulator carrier frequency is returned to that stored in EEPROM (present before Loop-back was initiated).

To access the IF Loop-back Mode using the front panel, select the "Demod" and use the arrow keys to scroll to the "Test" column of the configuration matrix and then scroll down until "IF Loopbck" is displayed. Then press "Edit", the "1" key for enable and then "Enter" to enable the IF Loop-back. When finished using this mode, return to the "Test - IF Loop" position and press the "0" option key to disable.

2.8.1 Built-in BERT

When in IF Loop-back mode a Bit Error Rate Test (BERT) can also be performed using the modem's built in BER test capabilities. The transmit and receive BERTs are independent and are enabled in the **<Int'f: Test – Mod BER>** and **<Int'f: Test – Dem BER>** parameters. Note this convention for accessing a parameter. It means press the "Int'f" key (if not already set) and scroll left or right to the Test column and then up or down until the LCD displays "Test – Mod BER" on the upper line. The BER test is enabled by pressing "Edit" and then pressing either "1" for a

"2047" pattern or "2" for a "2^23-1" pattern. The "0" key will disable the BER test mode. BERT test readings are displayed in the **<Int'f: Status - BER>** parameter and the 6 items below it.

Since there is no noise added in the IF Loop-back mode the BER results should show no errors. This test is more useful once the modem is configured and a Loop-back over the satellite is performed by setting the receive frequency to that output by the modulator.

The IF Loop-back state and the BERT state are both stored in EEPROM, therefore if the unit is powered off during IF loop-back and/or BERT test it will return to this state when powered up again.

More information on the BERT functions is given in Section 4.1.2 *"Using the Built-in BERT"*.

2.9   Modem Configuration

Configuring the PSM-500 Modem operating parameters is essential before placing the unit into service. The PSM-500 Modem operating parameters may be set up using the front panel, the USB or the terminal command mode. The binary remote control input may also be used if the remote interface parameters are already known and set.

2.9.0   Configuring the Modem for Operation

The following description assumes that the modem setup is to be done manually at a depot location or in the field via the front panel. Alternately, the modem could be automatically set up using a controller and the command interface. No software is provided for such an external control application and therefore this task is the responsibility of the using organization.

2.9.1   Setting Essential Parameters

The setting of several basic parameters is essential to achieve proper operation and carrier lock with the modem. Improper setting of any of these parameters will probably result in failure to communicate with the far end of the link. These basic parameters are listed here to serve as a minimum checklist for installation.

Modulator and Demodulator

1. Carrier Frequency (Note special procedures below available for L-Band interfaces.)
2. Modulation Mode (BPSK or QPSK)
3. Bit Rate
4. FEC Code Rate
5. Scrambler (Normally Enabled in IESS 308/309 mode – See "*Using The Proper Scramble*" below)
6. Clock sources set per system requirements.
7. Reed-Solomon Codec settings if enabled
8. IBS Multiplexer settings if enabled
9. External reference set properly
10. Modulator and Demodulator functions enabled

Modulator

1. Output Level
2. Carrier Enable
3. The L-Band modem can also supply power and reference to a BUC.

Demodulator

1. Carrier Acquisition Mode and Acquisition Range

2. The L-Band modems with L-Band Receive can be set to supply power at either 13 or
    18 VDC and/or a 10 MHz reference signal on the receive input connector for coupling
    to the LNB via the receive cable.

2.9.1.1 IBS Multiplexer and Reed-Solomon Selection

The PSM-500 Modem contains on-board circuitry implementing either an IBS Multiplexer or a
Reed-Solomon concatenated FEC capability independently.

The IBS Multiplexer and Reed-Solomon functions are independent and each can be enabled and
disabled as required. The Modulator (Transmit) and Demodulator (Receive) functions of each
option are also independent and can be enabled and disabled as required.

For additional information on the configuration of the IBS Multiplexer/Reed-Solomon capabilities
refer to Appendix RS.

2.9.1.2 Using the Proper Scrambler

The PSM-500 modems now have had an "Auto" mode used to automatically select the preferred
scrambler setting in any FEC or other dependent mode. This replaces the previous "IESS 308" or
"IESS-309" auto modes used in the PSM-4900. There is no IESS Standard covering the Turbo
Product Codes FEC. The Auto mode is highly recommended. Following is the setting chosen by
the modem when in Auto Scrambler mode:

- When TPC is either not installed or not enabled the preferred scrambler and descrambler
  is automatically selected to "IESS 308" or "IESS 309". See below for the difference.
- When TPC is enabled but the IBS multiplexer option is not installed or not enabled "Auto"
  uses the new Scrambler and Descrambler option #7 "TPC Sync" this uses a synchronous
  scrambler specific to the TPC Codec.
- When both TPC and IBS multiplexer are installed and enabled Auto uses the "IESS 308"
  option.

Remember that the scrambler and descrambler may be set independently in each link direction.

IESS-308 Scrambler Mode Operation

- With no mux or RS then the self-synchronizing Intelsat scrambler is enabled.
- With just the IBS mux enabled then the IBS synchronous scrambler is used
- With just the R-S enabled then the R-S synchronous scrambler is used
- With both IBS Mux and R-S enabled then the IBS synchronous scrambler is used.

IESS-309 Scrambler Mode Operation

The operation is the same as the IESS-308 option with the exception that

- With just R-S enabled then the self-synchronizing Intelsat scrambler is used.

Fixed Scrambler Mode Operation

The V.35 and Intelsat scrambler modes use the V.35 and Intelsat self-synchronizing scramblers
respectively in all modes.

Alternate Scrambler Mode Operation

The alternate V.35 and alternate Intelsat scrambler mode performs a data inversion required by
some "Comstream" modems.

2.9.1.3 Using The L-Band PSM-500L Transmit RF Frequency Feature

The PSM-500L can cover the entire satellite's receive range from it's transmit output. This output
can be tuned to any frequency on 1 Hz increments in the 950 to 1750 MHz range. The coverage
can be "projected" to the actual satellite RF frequency being transmitted at the BUC output. To

enable this feature simply supply the **<Mod: BUC – LO Frequency>** parameter with a value other than "0". When the value set here is equal to the BUC's LO frequency then the modem can automatically compute the RF frequency at the BUC output.

The PSM-500L modem will also determine if the LO is high or low side and sets the spectrum so that it is always "Normal", i.e. not inverted. You do not have to change the IF spectrum setting from "Normal" to achieve this.

> *Note: After entering a new BUC LO frequency the modem requires a new Transmit IF frequency input to recalculate the proper output frequency setting.*

To return to using the L-Band IF frequency setting, simply enter a value of "0" into the BUC LO parameter. A common BUC LO frequency for the C-Band 5.925 to 6.425 GHz Range is 4900 MHz (low side LO), while a low side LO for the Ku Band 14.0 to 14.5 GHz range is 13150 MHz.

2.9.1.4   Using The L-Band & L Receive RF Frequency Feature

The L or LT models can cover the entire satellite's transmit range on it's receive input. This input can be tuned to any frequency on 1 Hz increments in the 950 to 1900 MHz range. The coverage can be "projected" to the actual satellite RF frequency being received at the LNB input. To enable this feature simply supply the **<Dem: LNB – LO Frequency>** parameter with a value other than "0". When the value set here is equal to the LNB's LO frequency then the modem can automatically compute the RF frequency at the LNB input.

The L/LT modems will also determine if the LO is high or low side and sets the spectrum so that it is always "Normal", i.e. not inverted. You do not have to change the IF spectrum setting from "Normal" to achieve this.

> *Note: After entering a new LNB LO frequency the modem requires a new Receive IF frequency input to recalculate the proper input frequency setting.*

To return to using the L-Band IF frequency setting, simply enter a value of "0" into the LNB LO parameter. A common LO frequency for the C-Band 3.7 to 4.2 GHz Range is 5150 MHz (high side LO), while a common LO for the Ku Band 11.7 to 12.2 GHz range is 10750 MHz (low side LO).

2.9.2   Carrier Acquisition Parameters

The PSM-500 Modem has two main modes and several programmable receive carrier acquisition parameters available. These parameters control the initial acquisition of a carrier and reacquisition of a carrier when it has been removed and reapplied.

There are two main acquisition methods used by the PSM-500. The normal mode for fastest possible acquisition (especially at low data rates) is the "Fast" mode which utilizes an onboard digital signal processor (DSP) to mathematically determine the location of the carrier and lock as fast as possible. This mode initially goes for the largest carrier power within the acquisition range. A new acquisition attempt will always repeat the same process and go to the same carrier. The "fast" acquisition mode is optimized for the fastest possible acquisition speed, and is set as the default acquisition mode for the modem.

A second mode called "Search" also uses the DSP but performs a piece-wise sweep of the programmable acquisition range to locate the carrier and lock to it. If the modem cannot lock to the first carrier it detects it will attempt to find another carrier in the next step of frequency. The sweep always starts at the low end of the acquisition range and moves upward, wrapping around to the low end when the top is reached. The Search mode is optimized for crowded spectrum applications where nearby high power carriers may interfere with the standard "Fast" acquisition mode. To our knowledge no one has ever had a problem using the standard Fast mode over several years with many thousands of units, but the "Search" mode is still supplied just in case.

The hybrid "Auto Narrow" and "Auto Track" modes available in previous generations of this modem are no longer available as separate entries. The "Auto Narrow" function of initially searching in a smaller acquisition range is incorporated into the latest version of the "Search" mode. Setting the "Search" mode also enables a new menu item for "Sweep Time". To be enabled the **<Dem: IF – Sweep Time>** is set to a value other than 0 Seconds. Then, when a carrier lock is lost, the modem will search in a reduced acquisition range (equal to the symbol rate in Hertz) for the specified Sweep Time.

The "Search" acquisition mode also allows a modified version of the previous "Auto Track" function. When in this mode the modem can be commanded to an offset from the set receive IF frequency and the modem will begin its narrow search about that offset for the specified Sweep Time. In this mode the Demod Offset may be set by any command method and the demodulator will search at that point in the narrow DSP mode. (Note that in the standard fast acquisition mode the Demod Offset is read only) This mode is intended for possible DAMA use where the offset can be maintained to insure the fastest lock time.

The acquisition mode is set by setting the **<Demod: IF - Sweep Mode>** option parameter to either "Fast" (0), or "Search" (1). The "Fast" mode is the standard setting.

2.9.2.1   Initial Acquisition

For initial acquisition, a single setting allows programming the acquisition sweep range that the modem will search to find an available carrier. This parameter can be set from $\pm$ 100 Hz $\pm$ 1.25 MHz, where $\pm$ 30 kHz is common for standard demodulators. If all of the system offsets are known and stable for a given installation, the initial acquisition range can be set to a low value which will slightly reduce acquisition time, especially at low data rates. Conversely if a very "loose" downconverter is in use such as a block down converter, for example, the initial acquisition range can be set very wide to allow locking to a carrier well outside the range of standard modems. Several cautions are in order here. If the acquisition range is set too small and the system offsets drift, then a carrier may be locked out of acquisition or lost during operation. If the acquisition range is set too wide and other compatible carriers are within the acquisition range, then the wrong carrier may be locked.

If a Demodulator Offset frequency parameter is entered in "Search" mode, the Demodulator carrier frequency setting plus the offset setting is used as the start point for attempting to acquire a signal. If a sweep time has been set in the "Search" mode the modem uses the last carrier lock offset as the initial setting.

If the demodulator lock to a signal is forcibly aborted in "Search" mode, the Demodulator will attempt to acquire another signal immediately higher in frequency than the aborted signal. This pseudo-sweep always progresses more positive in frequency until it reaches the upper limit of the set acquisition range, where it will start searching again beginning at the lower limit of the set acquisition range. This allows a user to "search" through all of the available carriers within the acquisition range by viewing the **<Dem: Lock – Status>** and pressing the "Edit" or "Enter" key. At this keypress the modem will prompt with "Enter to unlock". Pressing "Enter" will cause the modem to unlock and find the next higher frequency carrier within the acquisition range.

2.9.2.2   Carrier Re-acquisition

For the "Search" acquisition modes the PSM-500 attempts to find a carrier in a reduced or "narrow" search range for a specified period of time before reverting to the standard search range. The reduced sweep range is equal to the symbol rate in Hertz. Once the "Search" acquisition mode is set, the "Sweep Time" Demod parameter setting controls the acquisition search time in the reduced range.

NOTE: The Narrow sweep range is relative to the receive frequency offset that is commanded via the remote control or front panel, or the last lock offset.

2.9.3   Sample Configuration Setting

The following procedures are used to set each of the modem's parameters using the front panel.

Assuming the modem is to be used in the SCPC mode for a point-to-point link with another PSM-500, the following sample configuration is representative of the required procedures:

For easier entry we can first set the entry mode to "Quick". Go to **<Unit: Keybrd – Entry>** and set the "Quick" mode. This is the default setting.

The desired transmit operating mode is 81.275 MHz, QPSK, 56 kbps, Rate 1/2 FEC, and receive at 81.550 MHz, BPSK, 128 kbps, Rate 1/2 FEC. This example uses different transmit and receive parameters to illustrate several points. The other end of the link would naturally have the opposite transmit and receive parameter settings.

The transmit parameters will be set first. With the unit powered on, press the "Mod" function button. Next, press the left or right arrow keys until the "IF" identifier is in the upper left line of the LCD display indicating that we are in the Modulator IF column of the parameter matrix. Now scroll down (or up) until the upper right of the LCD display indicates "Frequency". The value displayed in the lower line is the current setting for the transmit frequency. A new frequency can now be directly entered by using the numeric keypad. First indicate that a new entry is desired by pressing the "Edit" key, which will display the current setting with the cursor set on the first available digit. Enter a frequency in MHz not including the decimal point, entering all digits required to specify the shown frequency, then press the "Enter" key to apply this new parameter value. In this first setting we did not use the quick entry mode, but the following will use that mode. Note that when not using quick entry the frequency edit function skipped over the decimal point. Late you might try returning to the frequency setting and enter the frequency directly using quick entry and the decimal point.

Next scroll down to the "Modulation" entry and press the "1" key to request QPSK, then press the "Enter" key to apply this new parameter value. Scroll right to the "Data" column and down to the "Bit Rate" parameter and press "56" and "Enter". *(Without Quick entry we would have to press "Edit", "0", "0", "5", "6" and "Enter". Note that if digits other than "0" had been set in positions after the last "6" of the valid entry, then they must be overwritten with "0"s.)* Last, scroll down to the "Code Rate" parameter and press "Edit", "0" and "Enter".

To set the receive parameters, press the "Demod" button and the right arrow key until the "IF" identifier is in the upper left line of the LCD display indicating that we are in the Demodulator IF column of the parameter matrix. Now scroll down (or up) until the upper right of the LCD display indicates "Frequency", and press the "Edit" key. Then edit the displayed frequency to 81.55 MHz and press "Enter". Note that if digits other than "0" had been set in positions after the last "5" of the valid entry, then they must be overwritten with "0"s. Scroll down to the "Modulation" entry and press the "Edit", the "0" key to request BPSK and press the "Enter". Scroll right to the "Data" column and down to the "Bit Rate" parameter and press "Edit", "0", "1", "2", "8" and "Enter". Last scroll down to the "Code Rate" parameter and press "Edit", "0" and "Enter". Next scroll left and down in the IF list to the "Sweep Range" parameter and set the value to 30 kHz.

This configuration example has illustrated how to "navigate" through the available parameter matrix and has shown two modes of entry for numerical and list selected values. If the Unit keyboard Entry had been set to "Quick" then all of the parameters shown above could have been set directly without pressing the "Edit" key first. This mode also does not require that existing characters be overwritten when entering new data.

Using the front panel or terminal command mode, set all modem parameters as necessary for the type of service intended. This should prepare the unit for operation. If the modem is to be controlled by an external command controller, set the modem address properly as described in the next section. The modem should now be ready for service in an operating satellite system.

Once all parameters have been set and verified, the transmit output can be connected to the ground station equipment for transmission to the satellite. Verify that the alarms are extinguished and that the demodulator has locked.

2.9.4 Setting Additional Parameters

As stated before, the basic parameter settings are essential to achieve modem operation and carrier lock. There are many other parameters, which must be set on the PSM-500 to configure the unit to operate within your own system. These include setting those parameters which fall into three major categories; Data Interface compatibility; Automatic Correction for link properties; and Alarm configuration.

2.9.4.1 Data Interface Compatibility

Mod and Demod Data Sense

Mod and Demod Clock Source

Mod and Demod Clock Phase (Default Mod Clock is now "Auto").

Modulator RTS Enable

2.9.4.2 Automatic Correction

Automatic Uplink Power Control (if equipped)

Demod FIFO Operation

2.9.4.3 Alarm configuration

The PSM-500 Alarm system represents a sophisticated method of controlling visual, relay and logical alarm outputs which can be used for multiple purposes including redundancy. A basic representation of the alarm system functioning is shown in the figure below.

Individual Alarms   **Processing Matrix**   **Outputs**
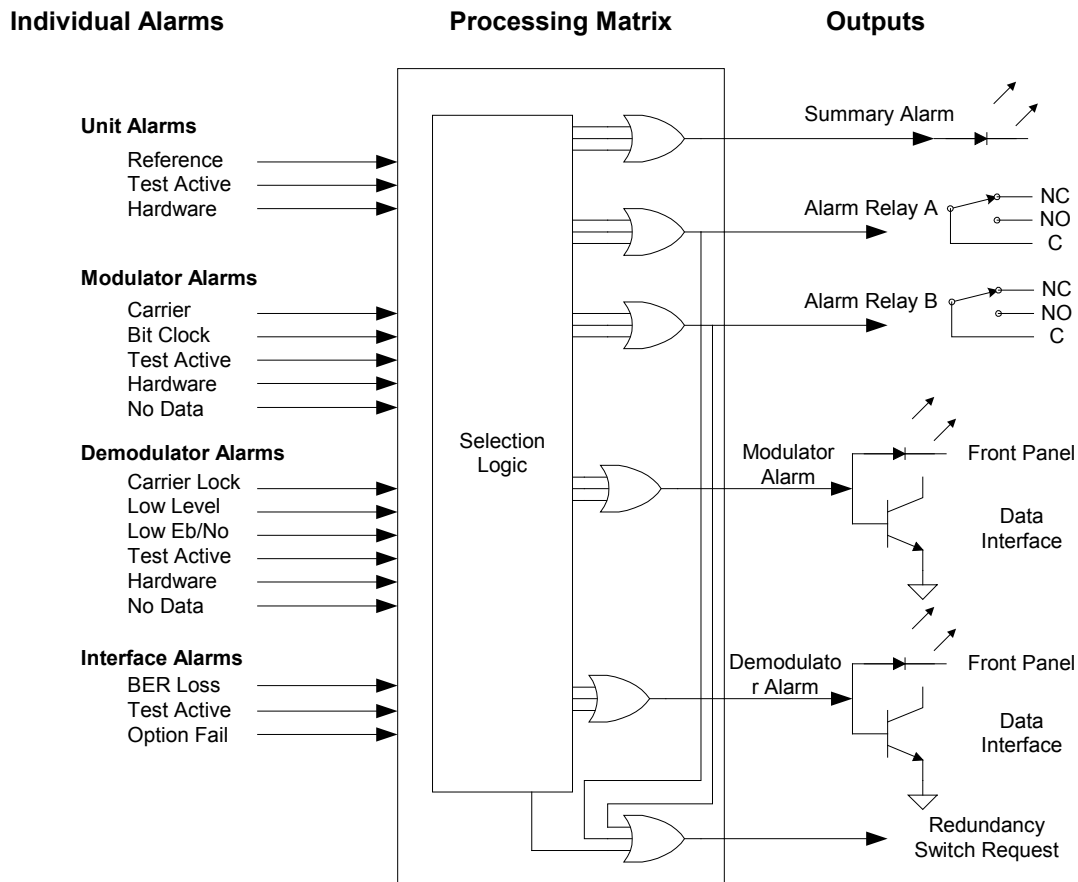
Figure 2-3 - Alarm Processing

There are also other possible alarm inputs depending on the modem options and configuration. Each of the individual alarm inputs has a configuration selection parameter under the "Alarm" column of its matrix. The general options available are to set the alarm to either be ignored or to form one of the "OR" inputs to the A or B alarm relay or both. The default set-up for these alarms is to have all the modulator related alarms assigned to Alarm A and all demodulator alarms assigned to Alarm B. The two alarm relays could be changed to represent "Major" and "Minor" alarms.

The open collector outputs for the modulator and demodulator alarms are available on the data interface connector and are used by some types of redundancy switches for determining alarm status. The modem's built-in redundancy switch logic uses either all alarms or combinations of the A and B alarms to activate a switch request.

A description of each of these settings is contained in Operations, Section 3.2 and Tables 3-5 through 3-8 later in this manual. A brief description of alarm configuration is also given here. Possible alarm sources include the following items:

1. Unit Reference missing.
2. Unit Test Active.
3. Unit Hardware Fault.
4. Transmit Carrier Off.
5. Modulator Bit Rate Lock.

6. Modulator AUPC Alarm.

7. Modulator Test Active.

8. Modulator Hardware Fault.

9. Demodulator Signal Lock.

10. Receive Input Level below AGC range.

11. Receive Low E_b/N_o below threshold.

12. Demod Test Active.

13. Demodulator Hardware Fault.

14. Interface Test mode Active.

15. Interface BER Test Sync Loss.

16. Backward Alarm from IBS multiplexer (if equipped).

The inputs are read by the processor and eight outputs are produced including two alarm relays, one Modulator , one Demodulator and one Summary alarm LED on the front panel, and a modulator and demodulator redundancy open collector alarms on the interface card, plus the redundancy switch request. The summary Alarm LED is the OR function of either of the alarm relays. The front panel or remote control can be used to select which of the possible alarm sources are assigned to each of the relays or can individually ignore any of the sources. Some modems only present alarms based upon a hardware fault in either the modulator or demodulator. The PSM-500 allows the user to select such items as a low input level or E_b/N_o to activate an alarm. By providing two relays and the configuration options, several alternative alarm scenarios can be used. The A and B alarm relays could represent a minor and major alarm, or they could be separated into modulator and demodulator functions, or one could be a summary alarm while the other is a dry contact input to a redundancy control unit.

2.9.5   Using the Internal or an External Reference

The PSM-500 contains an internal Temperature Compensated Crystal Oscillator (TCXO) reference which determines the basic accuracy of all modem frequency and rate settings. This internal reference is a nominal 2.0 ppm stability over normal operating temperature, and exhibits aging less than 1 ppm per year. This is accurate for most applications, and for example, produces a worst case transmit center output frequency accuracy of $2.0 \times 10^{-6} \times 70$ MHz $\times 10^6$ or ± 140 Hz (176 Hz at 88 MHz). If this accuracy is not sufficient, or the network operating mode dictates, an external reference can be used.

The L-Band modem, PSM-500L, uses an Oven Controlled Crystal Oscillator (OCXO) and the standard unit has a 1×10^{-7} stability and 2 to 3×10^{-7} aging rate per year. The increased stability is necessary because the oscillator can be used as the reference for a BUC.

The external reference frequency is applied at the rear panel BNC connector, J7, at a frequency of 1, 5, 9 or 10 MHz. Use of the external reference and the reference frequency are selected at the front panel from the **<Unit: Ref – Source>**, setting to external which then enables the entry for **<Unit: Ref – Frequency>**.

The external reference input does not perform any clean-up of an input other than band-pass filtering with a pass-band from approximately 1 to 12 MHz. The reference input should therefore been a low noise source.

2.9.5.1   Reference Calibration

During factory testing and calibration the modem unit is compared to a known in-house reference and calibrated. A default value is permanently stored representing this factory calibration. The unit may be offset from this factory value by using the manual tuning or automatic recalibration.

Manual tuning of the modem's reference is accomplished using the **<Unit: Ref – Fine Tune>** parameter and entering a value from –127 to +127

Automatic calibration of the modem's internal reference is accomplished by inserting a known high accuracy reference at the rear panel "External Reference" input and enabling the **<Unit: Test – Cal Ref>** item. The calibration should take several seconds and will indicate a successful completion. If the calibration fails then the external reference was out of range in either level or frequency.

The factory calibration may be restored by setting the **<Unit: Ref – Fine Tune>** value to "0".

2.9.6 Setting the Modem Station ID Name

Each PSM-500 contains two unique identification entries available at the front panel or remotely. They are the unit serial number and the Unit Name or "Unit ID". The serial number is set at the factory and cannot be changed, but the Unit ID can be set and changed whenever necessary. This field allows identification of the modem with up to 16 characters.

The Unit ID can be set easily from the VT100 terminal mode, and with slightly more effort from the unit front panel. To set the Unit ID, use the front panel arrow keys to scroll to the **<Unit: Status – Unit ID>** parameter and pressing "Edit" to begin entry. Each character position is selected using the right and left arrow keys, and the character at that position is set using the up and down arrow keys. When the proper entry is achieved press the "Enter" key to finalize the input. The first character is the "Space" followed by the characters below.

ASCII Characters Available for Unit Station ID												
Char		Char		Char		Char		Char		Char		Char
!		/		.		M		]		l		{
"		0		?		N		^		m		|
#		1		@		O		_		n		}
$		2		A		P		'		o		→
%		3		B		Q		a		p		÷
&		4		C		R		b		q		&
'		5		D		S		c		r		
(		6		E		T		d		s		
)		7		F		U		e		t		
*		8		G		V		f		u		
+		9		H		W		g		v		
,		:		I		X		h		w		
-		;		J		Y		I		x		
.		<		K		Z		j		y		
		=		L		[		k		z		

When entering this parameter via a terminal connected to the remote port the Unit ID Name is entered directly as text from the terminal keyboard. The Unit ID can also be entered via remote control at the rear panel DB9 or USB control ports.

After any entry mode the processor will center the input characters on the lower line of the LCD display

2.9.7 Setting the Modem Address for Command Mode Operation

If Command Mode Binary Packet Operation is desired the modem packet "address" must be set via the front panel before the modem will recognize packets. To set the address use the arrow keys to go to the **<Unit: Remote – Address>** parameter and press "Edit", then use the numeric keypad to enter the address from 0 to 255. Then press the "Enter" key to enable the change.

The address 255 is "global" and all units will respond to a message packet with this address regardless of its setting, but no unit will return a response message. It is suggested that you do not use addresses 1 or 255 (1 is the factory setting, and any new unit added to a system will have address 1).

The address "0" is also unique. This address causes the modem to accept commands and send responses without the address fields normally required in the command packets.

2.10 Interface Type Configuration

The PSM-500 Modem contains on-board circuitry to implement several different interface types:

0	Disabled
1	RS-232 (Synchronous only, limited to 128 kbps by drivers and receivers)
2	RS-449
3	RS-449/Unterminated (used in redundancy)
4	V.35
5	V.36
6	EIA-530
7	EIA-530A
8	SnIP (Option)
9	HSSI (Option)

A single 37 pin female "D" type connector on the rear panel at J3 is used for all interface types. The connector pin-out is shown in Chapter 2, Installation. Adaptor cables are available for other physical connector types. The two we make are the DB25 (P/N DSF00-080) and Winchester M34 style V.35 (P/N DSF00-083). See Appendix C for more cabling information.

The modem is also capable of accepting one of several existing and to be implemented additional option interfaces. These include a 10 Base T Ethernet interface, a High Speed Serial Interface (HSSI), a G.703 interface and others. The main processor automatically determines the presence and type of interface and options by querying the interface card. Adding an optional interface card or changing an already installed interface should only be attempted by experienced personnel familiar with electronic communications equipment. Either of these operations requires removing the modem from service, and removal and replacement of the modem top cover to gain access to the interface PCB assembly.

2.10.1 Adding or Changing the Optional Interface Type

An optional interface card may be installed or exchanged in a modem unit by removing the modem's top cover. First the interface option card rear panel plate is released from the chassis by removing the two screws on either side of this plate at the rear panel. The interface card to be removed is disconnected from the main board by releasing the one or two ribbon cables from the IDC connectors at P5 and P7 (or P5 only if so configured). These designations are those on the main modem PWB. The three #6 screws and lock washers are then removed if in an existing board and saved for placing the new interface card into the chassis. Once the new interface card is installed on the standoffs the two rear panel screws are installed first, then the three #6 screws are used to mount the board to the chassis (some boards have 4 mounting screws). Finally the required ribbon cables are (re-)attached to the new card and the main PWB at P5 (and also P7 if used). Finally the unit top cover is replaced using the 8 screws removed above.

When the unit is powered-up again the main modem processor will automatically query the new interface card and determine the type and options installed.

Most option interface cards completely co-exist with the on-board interface types, allowing the optional interface to represent one or more added interface types available. Only one interface type is however allowed to be enabled at one time.

Rear Connector Plate

External Connector Area

To P5

Figure 2-4   Typical Interface Card Layout

The SnIP Ethernet interface and the HSSI interface may be installed alone or together. In the latter case the two interfaces are "stacked" and a special ribbon cable is available for this configuration to connect to the internal modem interface. More information on this installation is provided with the HSSI interface option.

Once installed the main data interface for the SnIP option is its standard RJ-45 10/100 base T Ethernet interface connector located on the rear panel.

Once installed the main data interface for the HSSI option is its standard High Density SCSI-2 type connector located on the rear panel. This connection is designed to interface directly with a Cisco or compatible HSSI router interface module via a commercially available HSSI cable. See Appendix C for more cable information.

2.10.2   Optional Interface Configuration

Installed interface cards are automatically recognized by the modem and an entry is added to the Interface Option selection menu. Selection of the option interface then becomes identical to selection of any of the standard interfaces. Both the SnIP and HSSI automatically use the modem's transmit and receive data rate parameter as their clock signal just like the standard interfaces.

2.11   Option FEC Card Installation

The PSM-500 Modem contains on-board circuitry and two "slot" connectors for adding several available and planned FEC option "daughter" boards. These plug into either the A or B slots on the main modem assembly. Installation of these cards is not difficult, but requires removal of the modem from service and removal of the unit's cover, and should be accomplished only by a qualified technician. The modem automatically recognizes the presence of the option card and

provides additional front panel and remote control parameter settings allowing control of the option.

The modem's two FEC slots are identical, and if similar functions exist on two cards the modem will select a requested FEC option from the first slot which has that capability

In some cases when options are first introduced a software update to the modems internal program is necessary to allow use of the option. Refer to Section 4.3 "*Updating Modem Software*". The Datum Systems' M500 Update program will also recognize and install software for FEC cards present in the modem.

The physical arrangement of the two FEC slots is shown in Figure 2-x below. The same PWB is used for the standard Viterbi, Trellis Code Modulation and Reed-Solomon FECs with the manufacturing option to add either the TPC4k or TPC16k chips when ordered. If these options are ordered later a new board is supplied that has all of the necessary FEC capabilities and the original standard FEC may be removed. *FlexLDPC* has a unique PWB, but comes standard with Viterbi, Trellis Code Modulation and Reed-Solomon FECs, and is configurable to add either the TPC4k or TPC16k chips when ordered.

2.11.1 Turbo Product Codes Option Installation

The PSM-500 Modem contains on-board circuitry and connectors for adding a Turbo Product Codes Option Card. This card can co-exist with the IBS Multiplexer (and the Reed-Solomon function also, but both cannot be used simultaneously).

Turbo Product Codes or TPC is available in multiple mechanical forms and also versions depending on the link requirements. The three versions are a TPC4K which uses the same TPC chip as in the PSM-4900 series of modems, and a TPC16K which uses a newer 16K block size to improve performance, and a TPC-20K board with both the TPC4k and TPC16k chips installed. Because of the larger processed block size, the TPC16K device has much higher delay or latency than the 4K block device. It is also more expensive.

The modem can be ordered with any of these TPC options from the factory, and will then normally be supplied as added components on the standard FEC card already containing the Viterbi, TCM and Reed-Solomon FECs. Only one of these four versions can be installed on the standard FEC card, and the type cannot be changed.

The other possibility is to add a card which has one of these two TPC chips into the Slot B of a modem which already has Slot A occupied by the standard FEC card. Installation of these cards is into a common SO-DIMM, 144 pin socket, and should be installed only by a qualified technician.

The modem automatically recognizes the presence of the option card(s) and capabilities and provides additional front panel and remote control parameter settings to control the option.

The Turbo Product Codes option, when enabled, replaces the convolutional encoder/Viterbi decoder functions. The Modulator (Transmit) and Demodulator (Receive) functions of each option are also independent and can be enabled and disabled as required.

Top and side views of the FEC cards are shown in Figure 2-5 below. For additional information on the installation and configuration of the Turbo Product Codes option refer to Appendix TPC.

J3 and J4 Connectors   Rear Panel

Interface Option
Connector

Top View

M500 Series Main PCB

Latches   **FEC Card**

DRA05-002

FEC Slot B

FEC Slot A

Flash

TPC4k

FPGA

TPC16k

**Side View
Showing Insertion**

Slot B must be empty
to install in Slot A

Main PCB
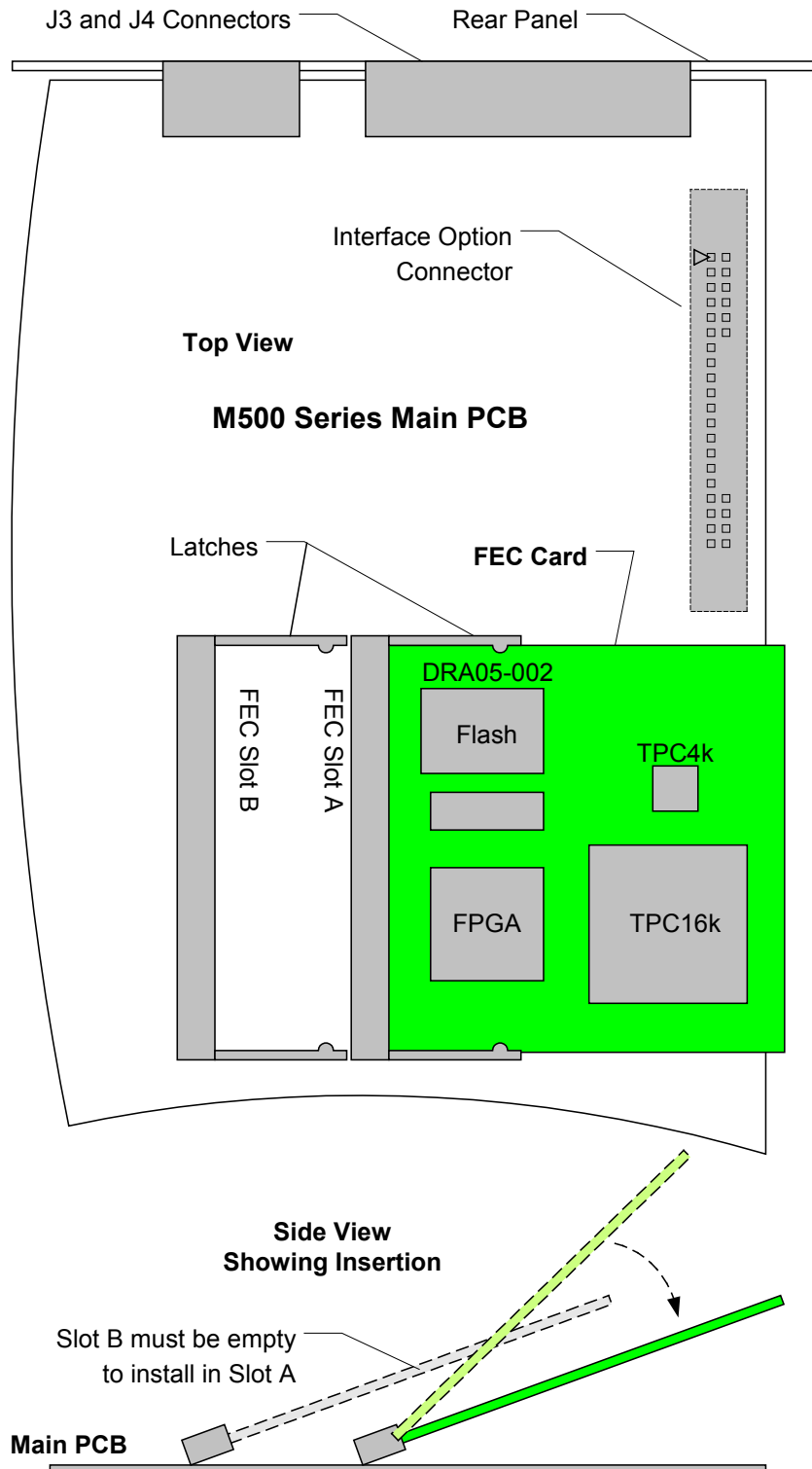
Figure 2-5   FEC Option Card Installation

Chapter 3 - Operation

3.1 Operating Procedures

Operation of the PSM-500 Modem consists of controlling the unit's operating parameters and monitoring status and responses via one of the control interfaces. There are three possible control methods for the modem:

1. Front Panel Keypad Control. (Section 3.1.1)

2. Terminal Mode Control via rear panel 232/485 or USB control ports. (Section 3.3)

3. Command Interface Binary Control via rear panel 232/485 or USB control ports. (Section 3.4)

Any of these methods may be used separately or together to monitor and control the modem unit. Each of these three interfaces and their respective methods are discussed separately below in the sections noted above.

Additional operating procedures are also presented later in this section on using some of the unique features of the PSM-500 that would not normally be set-up during installation. These include such items as the FIFO buffer, built-in BERT, storing and recalling configuration information, AUPC, the analog monitor output, redundancy and automatic recovery.

3.1.1 Front Panel Control

The front panel of the PSM-500 allows complete control and monitor of all modem parameters and functions via a keypad, LCD display and status LEDs.

3.1.2 Front Panel Layout and Features

The front panel layout shown in Figure 3–1, identifies the location and labeling of items on the front panel. The front panel is divided into three functional areas: the LCD display, the Keypad and the LED Indicators, each described below.

3.1.2.1 Front Panel LCD Display

The front panel display is a 2 line by 16 character LCD display. It is augmented by the four LED highlighted legends to the display's right. The display and legends are lighted and the brightness can be set to increase when the front panel is currently in use, automatically dimming with inactivity. The display has four distinct areas showing current information. The four legends indicate the Modem's functional area that is currently being monitored or controlled, including "Unit", "Mod", "Demod" and "Interface". The upper left of the LCD shows the current area of use, such as "Status", "IF", "Data", "Alarm" or "Test" (for the Mod and Demod). The upper right shows the current parameter being monitored, such as "Frequency", "Offset" or "Bit Rate". The lower line shows the current value of that parameter. The LCD display is a single entry window into the large matrix of parameters which can be monitored and set from the front panel. It is convenient to imagine the matrix as 3 dimensional spreadsheet just like a multi-sheet Excel workbook, with the different "sheets" selected by the buttons for Unit, Mod, Demod and Interface, while navigation on a given sheet is accomplished using the up, down, left and right arrow keys.

The backlight brightness can be set for two states: Active and Idle. The active state is entered whenever a key on the front panel is pressed, while the idle state occurs after approximately 60 seconds of inactivity. Each state may be set to "Off", 1/3 brightness, 2/3 brightness and full brightness. The default setting is full in the active state and 1/3 in the idle state. To change the settings for either state go to the "Modem LCD Active" or "Modem LCD Idle" brightness parameter and adjust to the desired values.

3.1.2.2 Front Panel Keypad

The front panel keypad consists of three areas:

First, is a 10-key numeric entry with 5 additional keys. Two keys provide for a "+/-" (change sign) and "." (decimal point) function, while three more on the far right provide "Edit", "Clear" and "Enter". The "Enter" key on the lower right is normally blue while the rest of the numeric keypad keys are gray. This allows easy identification of the Enter key.

The second area is a set of "Arrow" or "Cursor" keys used to navigate the parameter currently being monitored or controlled. During entry, the cursor keys allow moving a cursor to individual digits of a numerical entry or scrolling through the available options of a selection entry. The arrow keys are also in blue.

The third area is the four selection keys previously discussed with the LCD display. They allow selecting which functional area or "sheet" of the display matrix is currently in use. The four functional buttons represent the Unit, Modulator, Demodulator and Interface.
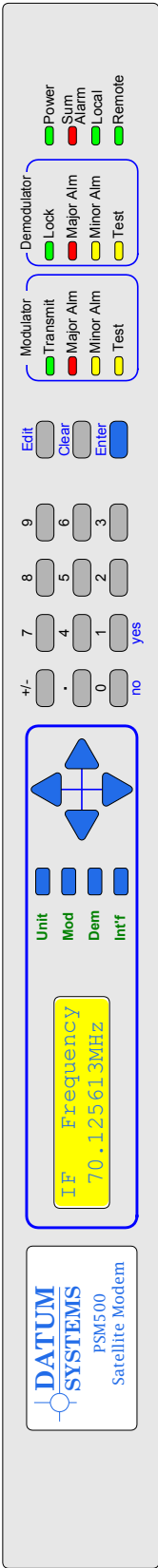
Figure 3-1 PSM-500 Front Panel Controls and Indicators

3.1.2.3 Front Panel LED Indicators

There are 12 LEDs on the modem front panel to indicate current status of the modem's operation. They are separated into three columns representing (from left to right) the Modulator status, the Demodulator status and the Modem (Unit) status. The LED colors maintain a consistent meaning. Green signifies that the indication is appropriate for normal operation, Yellow means that there is a condition not proper for normal operation. Red indicates a fault condition which will result in lost communications

When one of the Alarm lamps below is illuminated, the highest priority alarm condition is displayed in the LCD window.

Modem LED Indicators

1. Power: Green – Indicates the modem unit is currently under power.

2. Alarm: Red – if summary fault condition exists from either Alarm A or Alarm B.

3. Local: Green – Indicates that the unit is set to respond to the front panel.

4. Remote: Green – Indicates that the unit is set to respond to the remote control input.

Modulator LED Indicators

1. Transmit: Green – Indicates that the transmit output is currently active. Green Flashing when an IF Looback test is active and the carrier is configured to the "disabled" state.

2. Major Alarm: Red – Indicates that the transmit direction has failed, losing traffic.

3. Minor Alarm: Yellow – Indicates a transmit warning condition exists.

4. Test Mode: Yellow Flashing – Indicates the modulator is involved in a current test mode activity.

Demodulator LED Indicators

1. Lock: Green – Indicates receiver lock to an incoming CXR and data including FEC sync.

2. Major Alarm: Red – Indicates that the receive direction has failed, losing traffic.

3. Minor Alarm: Yellow – Indicates a receive warning condition exists, either an incoming carrier with a low input level or a low E_b/N_o (programmable threshold), or a backward alarm received from the far end.

4. Test Mode: Yellow Flashing – Indicates the receiver is involved in a current test mode activity.

3.1.3   Guide to Front Panel Monitor and Control

The front panel can be used to perform complete monitor and control of the modem setup and operating parameters. The operation of the front panel should be intuitive after very little use to familiarize the user with basic concepts and operations. Parameter entry operations have two methods of accomplishing the same goal and the method used is up to the user although in most cases one method will have potential advantages.

3.1.3.1   Navigating Modem Parameters

Consider that there are over 180 programmable or monitored parameters on the PSM-500 and that the LCD display can only show one parameter at a time. To simplify locating any desired parameter, they are organized into a 3 dimensional table or matrix form with 4 layers or "sheets", each one having 4 to 10 columns and up to 32 rows. This matrix is shown in Tables 3-1 through 3-4. Each matrix sheet represents a major functional area of modem operation (i.e. Unit, Modulator, Demodulator and Interface) while the columns represent groupings within those functional areas and the rows represent individual parameters associated with that function. The columns include such divisions as Status, Alarm and Test areas. The LCD display allows viewing only one of the many parameters at one time. At any time the LCD display shows the monitored parameter value on the lower line of the two-line display. The upper left line of the display shows the column name (such as Status, IF, Data, Alarm and Test) while the upper right shows the parameter (row) name.
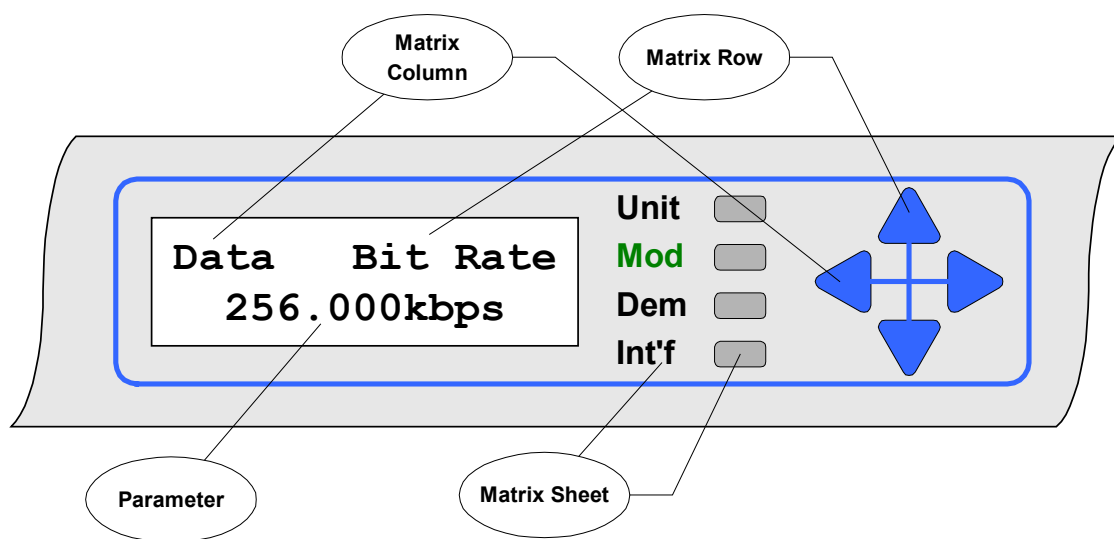
Front Panel Parameter Matrix Navigation

The four arrow keys located to the right of the LCD display are used to scroll through the rows and columns of each parameter matrix layer or sheet. The left and right arrow keys scroll through the columns and the up and down arrow keys scroll through the available parameters in each column. Both the columns and rows "wrap around" such that scrolling past the last item in a row starts with the first item in the same row again, and the same for columns.

In this manual operation of the keypad to access a certain parameter is shown in the format **<Function: Column – Row>**. For example, to get to the Modulator IF Level the method is to press the "Mod" key then use the left and right arrow keys to access the "IF" column and the up and down arrow keys to arrive at the "Level" parameter. This is shown by convention in this

manual as **<Mod: IF – Level>**. We may also show selection of a specific value for the parameter using the notation **<Function: Column – Row> = value(#)**. The value is descriptive and the # in parenthesis is the selection number key to press for optional parameters, if applicable, in the direct entry mode explained below.

It is convenient to imagine the matrix as 3 dimensional spreadsheet just like a multi-sheet Excel workbook, with the different "sheets" selected by the buttons for Unit, Mod, Demod and Interface, while navigation on a given sheet is accomplished using the up, down, left and right arrow keys.

Until you become familiar with the location of parameters using the front panel, it is convenient to use the Matrix Tables 3-1 through 3-4 as a quick reference.

3.1.3.2   Monitoring Modem Parameters

Any available modem parameter is monitored by simply using the function and arrow keys to display the desired parameter in the LCD display. The item displayed will remain until changed or power is removed from the modem unit. The display is "Live", therefore when a currently displayed parameter changes the display will change without operator intervention. When multiple parameters could be displayed (such as when multiple test modes are currently running or multiple alarms are present) only the highest priority item is displayed. When that item is no longer valid the next highest priority is displayed. The priority of items is fixed within the modem software.

3.1.3.3   Changing Modem Parameters

To set any parameter, the 4 functional area keys and the 4 arrow keys to the right of the LCD display are first used to select the parameter to be set, then one of several "entry" modes is used to change the parameter. In any entry mode pressing the "Edit" key to indicate a new entry, then editing the parameter via the arrow keys and the numeric keypad and finalizing the data entry using the "Enter" key will work. The "Quick" entry mode allows direct entry of a new value without first pressing the "Edit" key. All entry items take one of two forms:

1. Numeric entry such as frequency or bit rate; and

2. Selection from a list such as selecting FEC rates 1/2, 3/4 or 7/8.

Numeric entries may be entered by performing one of the following:

- When a numeric parameter is displayed, it can be changed by pressing the "Edit" key, then using the left and right arrow keys to select the first digit to be changed and entering a new digit. Successive digit entries go to successive characters on the display, skipping over the decimal point which is in a fixed location. Leading zeros must be used to enter smaller numbers than are currently displayed, and trailing zeroes are used to eliminate trailing digits not required. The entry is finalized by pressing the "Enter" key.

- An alternate edit mode is accomplished by first pressing the "Edit" key, then using the left and right arrow keys to select the first digit to be changed. The digit is "scrolled" using the up and down arrow key. Additional digits are pointed to using the left and right arrows and also scrolled. Finish the edit by pressing the enter key. Overflow when scrolling up through 9 will increment the next higher digit while underflow will decrement the next higher digit.

- Direct entry can be accomplished if the **<Unit: Keyboard – Entry Mode>** is set to "Quick". In this mode the current parameter can be changed by simply entering new information, which completely overwrites the existing parameter. For example when viewing the Modulator Data Bit Rate of 256.000kbps entering the digits 47.243 (including the decimal point) and pressing "Enter" will change to that new data rate. Note that a leading "0" did not have to be entered to overwrite the "2" of the existing parameter.

The current input can be canceled by pressing the "Clear" key at any time before pressing "Enter". Failure to press a key for approximately 60 seconds results in automatic canceling of the current entry and return of the display to the current setting.

Selection entries may be accomplished by one of the following:

- When a selection entry parameter is displayed, simply press the "Edit" key followed by a digit key 0, 1, 2, 3 or 4. In this scheme "0" represents disabled, OFF, NO or the first possible choice. "1" represents enabled, ON, YES or the second possible choice. "2", "3" and "4" represents the third, fourth and fifth possible choices. Then press the "Enter" key to finalize the entry.

- Alternately, when a selection parameter is displayed it can be changed by pressing the "Edit" key, then using the up and down arrow keys to scroll through the possible choices. When the desired option is displayed, pressing the "Enter" key selects the displayed choice and finalizes the entry. When scrolling though the available options, an arrow in the left column position denotes the current setting.

- Direct entry can be accomplished if the **<Unit: Keyboard – Entry Mode>** is set to "Quick". In this mode the current parameter can be changed by simply entering digit key 0, 1, 2, 3 or 4   and pressing "Enter" to finalize the entry. Optional selections can be viewed by successively pressing several keys to determine their value, then pressing "Enter".

Following a valid input, the modem will place the new setting into the nonvolatile EEPROM making it available not only immediately, but also automatically the next time the unit is powered on.

3.1.3.4 Automatic Modem Parameter Sequences

Certain parameters are dependent on other parameter settings. New in the PSM-500 is automatic presentation of those parameters that must be set to properly achieve the first setting entered. An example of this is when entering an "IF Modulation" mode change, the modem will accept that but next request entry of the "Data FEC" type, then the "Data Code Rate" finally returning to the original IF Modulation screen. If only the Data FEC type were initially changed then only the following item in the sequence would be requested. This insures that all of the necessary parameters are entered to enable any mode dependent on other settings. Normal settings are typically displayed during this sequence and it may be possible to simply press the "Enter" key at each succeeding request.

3.1.3.5 Finding Modem Parameter Limits

During parameter setting you may not know what the maximum or minimum value is that may be entered. The modem can help in some cases by taking the parameter to its maximum or minimum value when you enter a value greater or less than possible. For example, when all other parameters have been set, if you wish to go to the maximum transmit data rate possible in an M505 modem simply enter a value like 10000 (for 10,000 kbps). The modem should beep, say "Set at max" and enter a value of 5000 (for 5 Mbps).

3.2 Front Panel Monitor and Control Parameters

The following tables 3-1 through 3-4 list the parameter matrices available from the front panel. Parameters that appear shaded are only accessible when the modem is configured to use those parameters. For example, those parameters pertaining the to AUPC are only available when the AUPC is enabled, and those pertaining to the Reed-Solomon Codec will appear only if the Reed-Solomon Codec is installed and enabled. This list does not include optional parameters for some interface options such as Ethernet or G.703 E1 interfaces.

The top gray row represents column headers, which are shown on the LCD display in the upper left. Items below the header are row parameter names shown in the upper right of the LCD. Columns are navigated using the left and right arrow keys while rows are navigated using the up and down arrow keys.

The tables below are organized with general "Rules of Thumb" which aid navigation.

1. The "Status" columns are generally read only, providing status on specific areas of modem operation.

2. The Modulator and Demodulator matrixes use common column designations. A current parameter in one area can be immediately accessed in the other by pressing the appropriate "Mod" or "Dem" button. For example when viewing the Mod Bit Rate, the Demod Bit Rate is accessed by simply pressing the "Dem" button.

3. The "Alarm" columns existing in all four matrixes and represents the disposition of alarm information from that source. Therefore the **<Dem: Alarm – CXR Lock>** sets the disposition of the Demodulator Carrier Lock Alarm as either None, to Alarm Relay A, to Alarm Relay B, or to Alarm Relay A & B.

4. The "Test" columns existing in all four matrixes and represents the control and display of test information for that area. The top entries in the Test column contain tests which can be enabled or disabled if available. The lower rows represent measurements of parameters and are read only. Active tests enabled in these columns generate flashing "Test" LED lamps in appropriate areas.

Table 3-1
PSM-500 Front Panel Parameter Matrix – Unit Sheet

Status	Redundcy	Config	Keybrd	Remote	USB	Ref	Monitor	Alarm	Test
Modem	Mode	Modem	Mode	Mode	Mode	Source	Mode	Reference	Modem
Reference	SW Rqst	Recall	Entry	Protocol	Activity	Frequency	Full	OCXO Oven	Cal Ref
Redundcy	SW Hold	Store	LCD Actve	Address		Fine Tune		Tst Active	Update ROM
Unit ID	Backup	Restore 1	LCD Idle	Rate		Zero		Hardware	
Model		Restore 2	LCD Cntst	Format				Ref AFC	
Feature		Restore 3	Activity	Port				Beep	
Serial #		Restore 4		Activity				SysClk AFC	
Version		Restore 5						+3.3V	
FEC A		Restore 6						+5.0V	
FEC A Ver		Restore 7						+12.0V	
FEC B		Restore 8						-12.0V	
FEC B Ver		Power-Up						+21.0V	
Mod Opt								Boot Code	
Int'f Opt									

Notes:

Parameters shown in gray are only available when the entry immediately above is enabled or set to a mode that requires those entries. The gray Redundancy parameters are only shown when connected to another unit in redundancy mode.

Other columns may be added by options added to the modem or software.

Word spelling is purposely truncated to fit in available LCD display window.

Status	IF	Data	Mux	BUC	Alarm	Test
Table 3-2 **PSM-500 Front Panel Parameter Matrix – Modulator Sheet**						
Status	IF	Data	Mux	BUC	Alarm	Test
CXR	Frequency	Bit Rate	Mode	Power	CXR	Modulation
Data	Offset	Fec	ESC Overhead	Voltage Out	Data	Symbol Rate
Clock	Level	FEC Options	MCC Overhead	Voltage Min	Clock	Clock Error
Test	Output	Code Rate	OverHd Ratio	Current Out	AUPC	CXR ALC
	Modulation	RS Mode	ESC Port	Current Max	Tst Active	LO AFC
	Spectrum	RS (n)	ESC Rate	Current Min	Hardware	Step AFC
	Filter Mask	RS (k)	ESC Frmt	10 MHz Ref	BUC Power	
	Mode	RS Depth	ESC CTS	LO Frequency		
	Preamble	Dif Encoder				
	AUPC	Scrambler				
	AUPC Eb/No	Clk Source				
	AUPC Max Lvl					
	AUPC Min Lvl					
	Mute					
	Impedance					

BUC parameters are only available on PSM-500L.
AUPC settings are only visible if the AUPC is enabled.
Dif Encoder disabled and not visible with Turbo Product Codes Option installed and enabled.

Status	IF	Data	Mux	LNB	Alarm	Test
Table 3-3 **PSM-500 Front Panel Parameter Matrix – Demodulator Sheet**						
Status	IF	Data	Mux	LNB	Alarm	Test
CXR	Frequency	Bit Rate	Mode	Power	CXR Lock	IF Loopbck
Eb/No	Sweep Range	Fec	ESC Overhead	Current Out	Data	Symbol Rate
Offset	Sweep Mode	FEC Options	MCC Overhead	Current Max	Low Eb/No	Clock Error
Level	Sweep Time	Code Rate	OverHd Ratio	Current Min	Low Level	AGC
Est.BER	Modulation	RS Mode	ESC Port	10 MHz Ref	Tst Active	LO AFC
SER	Spectrum	RS (n)	ESC Rate	LO Frequency	Hardware	Step AFC
Buffer	Filter Mask	RS (k)	ESC Frmt		Backward	IDcOff
Test	Eb/No Alm	RS Depth	ESC DTR		LNB Power	QDcOff
	Low Level Alm	Dif Decoder	ESC DSR			
	Impedance	Descrambler				
		Clk Source				
		Buffr Delay				
		Buffer Size				
		FEC Hold				

LNB column is only available on Land LT models.

Sweep Time is only visible if Sweep Mode is set to "Search".

Buffer Parameters are only visible if the Data Clock Source is not set to "Demod", enabling the buffer.

Dif Decoder is disabled and not visible with Turbo Product Codes Option installed and enabled.

Table 3-4 PSM-500 Front Panel Parameter Matrix – Interface Sheet				
Status	**I/O**	**SnIP or SDMS**	**Alarm**	**Test**
I/O	Mode	IP Addr	Tst Active	Ter Loopbck
RTS	Format	Netwrk Mask	BER Loss	Sat Loopbck
CTS	RTS	MAC Addr	SnIP or SDMS	BER I/O
DCD	CTS	Options		Mod BER
DTR	DCD	Version		Demod BER
DSR	DTR	Serial#		
Test	DSR			
Test BER	Xmt Data			
Sync Loss	Xmt Clock			
Errors	Rcv Data			
Bits	Rcv Clock			
EFS	RTS Monitor			
Erred Sec				
Total Sec				

Note: The seven shaded BERT Status column items are only visible when the Demod BER is enabled in the Test column.

The center column is used for interface option expansion, and is only displayed with an option installed. The entries shown are only representative of one type of option interface.

The RTS Monitor function is only available in firmware versions 0.47 and after.

Tables 3-5 through 3-8 describe the parameters available from the front panel and entry in more detail. The grayed separators delineate column divisions in the area matrix. The "»"symbol indicates that this parameter is not available unless a preceding parameter is enabled or set to require those parameters, or optional hardware is installed that uses that particular parameter. Parameters can also be added as new options are installed.

Table 3-5. Modem (Unit) Parameter Detail

Unit Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Status    Modem Locked & Sending`	Read Only	Read Only	Mod & Demod Status
`Status  Reference Internal, OK`	Read Only	Not changeable	Reference source and status
`Status   Redundcy 1:1 On Line`	Read Only	Used to force a transfer away from this unit.	Redundancy Status
`Status    Unit ID Rmt Santa Cruz`	Alpha – Numeric	Entered as ASCII for up to 16 characters	Station Name for user
`Status     Model PSM-500`	Read Only	Read from software	Modem Model #,
`Status    Feature M523-8PSK-16QAM`	Numeric	16 digit Feature Set upgrade code inserted here.	Used to display features and upgrade feature set.
`Status   Serial# 12923`	Read Only	Not changeable	Modem Serial Number
`Status    Version 0.10`	Read Only	Read from software	Version of software installed
`Status     FEC A Viterbi/TCM/RS`	Read Only	Read from Installed Option	Available FEC options in Slot A.
`Status  FEC A Ver 01-004`	Read Only	Read from Installed Option	FEC Type Number and Firmware Revision
`Status     FEC B TPC4K`	Read Only	Read from Installed Option	Available FEC options in Slot B.
`Status  FEC B Ver 03-004`	Read Only	Read from Installed Option	FEC Type Number and Firmware Revision
`Status   Mod Opt Burst`	Read Only	Read from Installed Option	Type of Installed Option
`Status  Int'f Opt SDMS-Lite`	Read Only	Read from Installed Option	Type of Installed Option
`Redundcy    Mode Internal 1:1`	Selection	0 = Disable, 1 = Internal 1:1, 2 = External	Select Redundancy mode. Internal requires "Y" cable.
`Redundcy Sw Rqst on Alarm A & B`	Selection	0 = On any Alarm 1= On Alarm A 2 = On Alarm B 3 = On Alarm A & B	What will request a switch to backup modem.

Unit Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Redundcy Sw Hold .5 Sec`	Numeric	0.0 to 600.0 seconds in 0.1 second increments.	Sets the minimum time that a redundancy alarm must last before switching occurs.
`Redundcy Backup Idle`	Selection	Backup Status or Press "0" or "Edit" then "Enter" to transfer current configuration to backup.	View status of or configure backup. Only available when on-line.
`Config Modem Mod & Demod`	Selection	0 = Disable, 1 = Demod Only, 2 = Mod Only, 3 = Mod & Demod	Used to disable the Mod or Demod and also the lamps and indications when not used.
`Config Recall Factory, 1 to 8`	Selection/ Numeric	0 to 8, 0 = Factory	Location to recover current configuration from.
`Config Store Factory, 1 to 8`	Selection/ Numeric	1 to 8, Factory configuration not alterable	Location to store current configuration to.
`Config Restore 1 After 1 Sec`	Selection/ Numeric	Disabled (0), 1 to 14,400 seconds	Time after loss of rcv carrier to restore this configuration.
`...Restore 2-7`			
`Config Restore 8 Disabled`	Selection/ Numeric	Disabled (0), 1 to 14,400 seconds	Time after loss of rcv carrier to restore this configuration.
`Config Power-Up Last`	Selection/ Numeric	Last (0), Recall 1 to 8	Behavior on power-up. Either the last settings or try to lock using one of the stored configurations.
`Keybrd Mode Full Access`	Selection	0 = Disable, 1 = Read Only, 2 = Full Access	Keyboard access control.
`Keybrd Entry Quick`	Selection	0 = Quick, 1 = Edit Only 2 = Confirm	Keyboard Entry method. Quick is the normal default mode.
`Keybrd LCD Active Backlight Full`	Selection	0 = off, 1 = 1/3, 2 = 2/3, 3 = Full	Active level of LCD backlight
`Keybrd LCD Idle Backlight 1/3`	Selection	0 = off, 1 = 1/3, 2 = 2/3, 3 = Full	Idle level of LCD backlight
`Keybrd LCD Cntst 10`	Numeric	0 to 20	LCD Contrast setting
`Keybrd Activity Beep`	Selection	0 = None, 1 = Beep, 2 = Blink, 3 = Beep & Blink	Audible "click" and/or "Local" LED Blink on front panel key press.
`Remote Mode Full Access`	Selection	0 = Disable, 1 = Read Only, 2 = Full Access.	Remote control access mode allowed

Unit Parameter Detail			
Representation	**Type**	**Entry**	**Description**
Remote Protocol Binary Packet	Selection	0 = VT100, 1 = Quiet VT100, 2 = Binary Packet,	Remote control mode type
Remote Address 1	Numeric	0 to 255 0 = address disabled 255 = global	Address used to access this unit via remote control and USB packets.
Remote Rate 19200bps	Selection	0 to 7 selects 300 to 38,400 bits per second.	Remote port bit rate
Remote Format N,8,1	Selection	0 = N,8,1 1 = E,8,1 2 = O,8,1 3 = M,8,1 4 = S,8,1	Remote control data/stop bits and parity. Always 8 data bits and 1 stop bit. N= No Parity, E = Even, M = Mark, S = Space.
Remote Port RS-485	Selection	0 = RS–232, 1 = RS–485	Remote control port used
Remote Activity RS-485	Selection	0 =None, 1 =Beep, 2 =Blink, 3 =Beep & Blink	Audible "click" on/or and "Remote" LED Blink on Remote port activity.
USB Mode Full Access	Selection	0 = Disable, 1 = Read Only, 2 = Full Access.	Remote control access mode allowed from front panel port.
USB Activity Blink	Selection	0 = None, 1 = Beep, 2 = Blink, 3 = Beep & Blink	Audible "click" on/or and "Remote" LED Blink on Infrared port activity.
Ref Source Internal	Selection	0 = Internal, 1 = External	Rear panel external reference.
Ref Frequency 10.000MHz	Selection	0 =1.0, 1 =5.0, 2 =9.0, 3 =10.0 MHz	Reference frequency at rear panel. Only available if set to external reference.
Ref Fine Tune 0	Numeric	+127 to -127	Internal reference fine adjustment. Only in Internal
Monitor Mode AGC Level	Selection	0 =AGC Level, 1 =Eb/No, 2 =Mod CXR Level	Selects source of analog output on rear panel alarm connector pins 5 and 6
Monitor Full +5.0V	Numeric	+10.0 to –10.0	Full scale setting for maximum output
Monitor Zero 0.0V	Numeric	+10.0 to –10.0	Minimum scale setting for minimum output.

Unit Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Alarm    Reference` `   To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A&B, 4 = Mute CXR, 5 = Mute & Alarm A, 6 = Mute & Alarm B, 7 = Mute & Alarm A & B	Selects destination and action taken for reference oscillator alarm types.
`Alarm   OCXO Oven` `Mute & Alarm A`	Selection	0=None, 1=A, 2=B, 3=A&B, 4 = Mute CXR, 5 = Mute & Alarm A, 6 = Mute & Alarm B, 7 = Mute & Alarm A & B	Selects destination of alarm
`Alarm  Tst Active` `   To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm    Hardware` `   To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm       Beep` ` On Alarm A & B`	Selection	0=None, 1=On Alarm A, 2=On Alarm B, 3=On Alarm A & B	Selects if alarm causes a unit audible "beep".
`Test       Modem` `     Disabled`	Selection	0 = Disabled, 1 = Lamp Test, 2 = Self Test 3 = Lamp & Self Test	Carrier output mode for test purposes.
`Test    Cal Ref` `     Disabled`	Selection	0 = Disabled, 1 = Enabled	Calibrates the internal reference to an external input.
`Test  Update ROM` `     Disabled`	Numeric	Normally Disabled, Enter unit serial number and "Enter" key to start.	Entering the serial number and pressing "Enter" starts the update process.
`Test     Ref AFC` `       +1.1V`	Read Only	N/A	Internal Loop Voltage
`Test  SysClk AFC` `       +9.1V`	Read Only	N/A	Internal Loop Voltage
`Test      +3.3V` `       +3.3V`	Read Only	N/A	Internal Supply Voltage
`Test      +5.0V` `       +5.0V`	Read Only	N/A	Internal Supply Voltage
`Test     +12.0V` `      +12.1V`	Read Only	N/A	Internal Supply Voltage
`Test     +21.0V` `      +20.8`	Read Only	N/A	Internal Supply Voltage
`Test     -12.0V` `      -12.1V`	Read Only	N/A	Internal Supply Voltage
`Test   Boot Code` ` 0000:0000:0000`	Read Only	N/A	Factory Diagnostic Use

Table 3-6. Modulator Parameter Detail

Modulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Status      CXR` `  Sending, OK`	Read Only	Read Only	Modulator Carrier Status
`Status      Data` `   NO DATA`	Read Only	Read Only	Modulator Input Data Status
`Status     Clock` `  Internal, OK`	Read Only	Read Only	Modulator Bit Rate Clock Status
`Status      Test` `    Normal`	Read Only	Read Only	Modulator Test Status
`IF      Frequency` `70.000000MHz`	Numeric	50.000 000 to 90.000 000 MHz	Carrier center frequency
`IF        Offset` `  -8.031kHz`	Numeric	−1,250.000 to +1,250.000 kHz	Carrier offset frequency
`IF         Level` `  -20.4dBm`	Numeric	+5.0 to −35.0 dBm +3.0 max at 50Ω	Transmit output power level
`IF        Output` `  Enabled`	Selection	0 = Disable, 1 = Enable	Carrier output enable
`IF     Modulation` `    QPSK`	Selection	0 = BPSK, 1 = QPSK, 2 = OQPSK, 3 = 8PSK, 6 = 16QAM	Modulation Mode. Some values left available for new options.
`IF      Spectrum` `    Normal`	Selection	0 = Normal, 1 = Inverted	Modulation Spectrum control
`IF    Filter Mask` `    Normal`	Selection	0 = IESS, 1 = Legacy	Modulation Spectrum Filter Control. Legacy for PSM-4900 compatibility.
`»IF         Mode` `  Continuous`	Selection	0 = Continuous, 1 = Burst	Only available with burst option installed.
`»IF     Preamble` `  64 Symbols`	Selection	0 = 32, 1 = 64 Symbols	Selects preamble length when burst option installed.
`IF         AUPC` `   Disabled`	Selection	0 = Disable, 1 = Enable	Automatic Uplink Power Control
`»IF     AUPC Eb/No` `  6.5dB`	Numeric	3.0 to 20.0 dB	AUPC remote receive Eb/No level set point.
`»IF   AUPC Max Lvl` `  -10.0 dB`	Numeric	+5.0 dBm to Minimum level	Max. Transmit level under AUPC control
`»IF   AUPC Min Lvl` `  -20.0 dB`	Numeric	Maximum level to −35 dBm	Min. Transmit Level under AUPC control
`IF          Mute` `    Manual`	Selection	0 = Automatic, 1 = Confirm, 2 = Manual 3 = Manual & Pwr Loss	Manual requires manual Carrier enable after Mod output change. Option 3 forces Cxr off after power fail.
`IF      Impedance` `   75 Ohm`	Selection	0 = 50Ω, 1 = 75Ω	Transmit IF impedance.

Modulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Data     Bit Rate` `    2.100000Mbps`	Numeric	1.200 to 20,000.000 kbps in 1 bps resolution. Entered in kbps to 1bps increments.	Modulator Bit Rate – The max and min are determined by settings and options.
`Data          FEC` `       Viterbi`	Selection	0 – None 1 = Viterbi, 2 = TCM (8PSK only) 3 = TPC Short 4 = TPC (Legacy) 5 = TPC (CT)	TPC Encoder - Only available if installed. Reed-Solomon is enabled below. Legacy in Rate ¾, 7/8 only. CT compatibility Rate ¾ only.
`Data  FEC Option` `     Normal`	Selection	0 = Normal, 1 = Swap C0/C1,	FEC Optional Modes. May change depending on FEC options installed.
`Data     Code Rate` `     Rate 1/2`	Selection	0 = ½, 1 = ¾, 2 = 5/6 3 = 7/8. 0 = 2/3 in 8PSK TCM	FEC Code Rate. The options may change depending on FEC installed and selected
`RS          Mode` `      IESS-308`	Selection	0 = Disabled, 1 = IESS-308 2 = IESS-309 4 = IESS Custom	Reed-Solomon column and options only available if not disabled. Entry is not shown when TPC enabled.
`»RS FEC       (n)` `       126`	Numeric	In Custom Mode only: Available n values Read only in other modes	Block size n = 22 to 255
`»RS FEC       (k)` `       112`	Numeric	In Custom Mode only: Available k values Read only in other modes	k = 20 to 253, k must be 2 to 20 less than n
`»RS FEC     depth` `       4`	Selection	In Custom Mode only: 0 = 4, 1 = 8, 2 = 16 Read only in other modes	Interleave depth factor
`Data  Dif Encoder` `     Enabled`	Not Shown	0 = Disable, 1 = Enable	Differential Encoder Not shown or settable except in special modes.
`Data     Scrambler` `       Auto`	Selection	0 = Disable, 1 = Auto 2 = V.35, 3 = Intelsat, , 4 = Alt V.35, 5 = Alt. Intelsat 6 = EFD 7 = TPC Sync	Scrambler types. Types are added if optional hardware is installed. The Auto mode uses IESS 308 & 309 standards to automatically switch to use synchronous scramblers part of R-S and TPC.
`Data   Clk Source` `     Internal`	Selection	0 = Internal, 1 = TT Clock, 2 = External, 3 = RCV Clock	Transmit Data Clock Source. Type 1, 2 or 3 will fall-back to Internal if clock is not present in these modes.

Modulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Mux        Mode` `   IBS Custom`	Selection	0 = Disabled, 1 = IBS Standard, 2 = IBS Enhanced 3 = IBS Custom	Enables Multiplexer to specified mode. Enable makes other menu selection below visible.
`»Mux ESC Overhead` `   9600 bps`	Selection	0 = Disable 1 to 7 selects standard rates 300 bps – 38.4 kbps	Only in Custom Mode. Selects framing resources committed to ESC Comm.
`»Mux MCC Overhead` `   1200 bps`	Selection	0 = Disable 1 to 7 selects standard rates 300 bps – 38.4 kbps	Only in Custom Mode. Selects framing resources committed to MCC Comm.
`»Mux      Ratio` `    15:16`	Read Only		Shows current data to aggregate ratio for mux.
`»Mux   ESC Port` ` RS-485, 4 Wire`	Selection	0 = RS-232, 1 = RS-485 2 wire, 2 = RS-485 4 wire, 3 = RS-485 Drvr On	Physical ESC port type. . (coupled to receive)
`»Mux   ESC Rate` `   9600 bps`	Selection	0 to 7 selects standard rates 300 bps – 38.4 kbps	Physical ESC port rate at rear panel. (coupled to receive)
`»Mux   ESC Frmt` `    N,8,1`	Selection	0 = N/7/1, 1 = P/7/1, 2 = N/8/1, 3 = P/8/1	Physical ESC port format at rear panel. (coupled to receive)
`BUC        Power` `    Enabled`	Selection	0 = Disabled 1 = Enabled	Selects Power and Voltage to a BUC in the 500L
`BUC   Voltage Out` `    +23.8V`	Numeric	Read Only	Displays Voltage output on Transmit Cable.
`BUC   Voltage Min` `    +20.0V`	Numeric	0 to 60.0 V	Sets the minimum BUC voltage before an alarm.
`BUC   Current Out` `    2.37A`	Numeric	Read Only	Displays Current draw of BUC
`BUC   Current Max` `    5.00A`	Numeric	0 to 6.00 A	Sets the maximum BUC current before an alarm.
`BUC   Current Min` `    1.25A`	Numeric	0 to 4.00 A	Sets the minimum BUC current before an alarm.
`BUC   10 MHz Ref` `    Enabled`	Selection	0 = Disabled 1 = Enable	Selects if modem's current 10 MHz reference to be supplied to a BUC in PSM-500L
`BUC  LO Frequency` ` 7375.000000MHz`	Numeric	0 to 49999.999996 MHz	Selects BUC LO frequency in PSM-500L. If set non-zero then IF frequency setting is at RF frequency.

Modulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Alarm     Carrier` `  To Alarm A`	Selection	0 = Mute CXR, 1 = Mute & Alarm A, 2 = Mute & Alarm B, 3 = Mute & Alarm A & B	Selects destination of alarm
`Alarm       Data` `  To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm      Clock` `  To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B, 4=Send All ones. 5 = All ones & A 6 = All ones & B 7 = All ones & A & B 8 = Mute Mod Cxr 9 = Mute & A	Selects destination of alarm
`Alarm       AUPC` `  To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm  Tst Active` `  To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm    Hardware` `  To Alarm A & B`	Selection	0 = Mute CXR, 1 = Mute & Alarm A, 2 = Mute & Alarm B, 3 = Mute & Alarm A & B	Selects destination of alarm
`Alarm   BUC Power` `  Mute & Alarm A`	Selection	0=None, 1=A, 2=B, 3=A&B, 4 = Mute CXR, 5 = Mute & Alarm A, 6 = Mute & Alarm B, 7 = Mute & Alarm A & B	Selects destination of alarm
`Test    Modulation` `     Normal`	Selection	0 = Normal, 1 = Pure Carrier, 2 = Alt 1/0 3 = Sideband	Carrier output mode for test purposes.
`Test Symbol Rate` `   256.000ksps`	Read Only	N/A	Computed Transmit Symbol Rate
`Test Clock Error` `      251`	Read Only	N/A	Bit Rate Clock error
`Test    CXR ALC` `       +3.0V`	Read Only	N/A	Internal Loop Voltage
`Test     LO AFC` `       +9.1V`	Read Only	N/A	Internal Loop Voltage
`Test    Step AFC` `       +9.5V`	Read Only	N/A	Internal Loop Voltage

Table 3-7. Demodulator Parameter Detail

Demodulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Status    Carrier` `Locked, OK`	Read Only	N/A	Demodulator receive Carrier Status
`Status      Eb/No` `4.7dB`	Read Only	Measured by internal circuitry.	Measured Eb/No
`Status     Offset` `-8.031kHz`	Numeric	Within +/– Narrow Acquisition Range	Receive carrier offset frequency. An entry will reset to 0 after search time has elapsed.
`Status      Level` `-52.4dBm`	Read Only	N/A	Receive carrier level
`Status   Est. BER` `2x10^-7`	Read Only Resettable	Press "0" or "Edit" and "Enter" to restart.	Estimated Bit Error Rate
`Status        SER` `3.37x10^-2`	Read Only Resettable	Press "0" or "Edit" and "Enter" to restart.	Measured Symbol Error Rate
`Status     Buffer` `100%`	Read Only Resettable	0 = Reset Slip (Flag) 1 = Re-center	FIFO Buffer status in percent fill. Only visible when Demod Data clock source is not set to "RCV Clock". The "slip" flag tells when the FIFO automatically re-centered.
`Status       Test` `Normal`	Read Only	N/A	Demodulator Test Status
`IF      Frequency` `70.000000MHz`	Numeric	50.000 000 to 90.000 000 MHz 950 000 000 to 1900 000 000 MHz for L-Band unit	Carrier center frequency. L-Band frequency shown if LNB LO is set to 0, else is set to RF frequency.
`IF     Sweep Range` `+/-30.000kHz`	Numeric	+/–0.1 to +1,250.000 kHz	Carrier Acquisition Range in kHz.
`IF      Sweep Mode` `Fast`	Selection	0 = Fast, 1 = Search	Fast Acquisition mode is standard method
`»IF     Sweep Time` `10.0 Sec`	Numeric	0.0 to 600.0 Seconds. 0 Disables Narrow Sweep	Narrow Sweep time applicable to Search sweep mode only.
`IF      Modulation` `QPSK`	Selection	0 = BPSK, 1 = QPSK, 2 = OQPSK, 3 = 8PSK, 6 = 16QAM	Modulation Mode. Some values left available for new options.
`IF        Spectrum` `Normal`	Selection	0 = Normal, 1 = Inverted	Modulation Spectrum control
`IF      Filter Mask` `Normal`	Selection	0 = IESS, 1 = Legacy	Modulation Spectrum Filter Control. Legacy for PSM-4900 compatibility.

Demodulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`IF      Eb/No Alm     2.0dB`	Numeric	1.0 to 20.0 dBm in 0.1 dB increments	A receive Eb/No level at or below this level will produce an alarm.
`IF   Low Level Alm     -65.5dBm`	Numeric	-26 to –85 dBm in 0.1 dB increments. Dependent on Bit Rate.	A receive carrier level at or below this level will produce an alarm.
`IF        Impedance     50 Ohm`	Selection	0 = 50Ω, 1 = 75Ω	Receive IF impedance.
`Data     Bit Rate     2.100000Mbps`	Numeric	1.200 to 20,000.000 kbps in 1 bps resolution. Entered in kbps to 1bps increments.	Modulator Bit Rate – The max and min are determined by settings and options.
`Data        FEC     Viterbi`	Selection	0 = Viterbi, 1 = TPC Full 2 = TPC Short 3 = TPC (Legacy) 4 = TPC (CT)	TPC Decoder - Only available if installed. Reed-Solomon is enabled in R-S column. Legacy in Rate ¾, 7/8 only. CT compatibility Rate ¾ only.
`Data  FEC Option     Normal`	Selection	0 = Normal, 1 = Swap C0/C1, 2 = Invert C1, 3 = Swap and Invert C1	FEC Optional Modes. May change depending on FEC options installed.
`Data     Code Rate     Rate 1/2`	Selection	0 = ½, 1 = ¾, 2 = 5/6 3 = 7/8. 0 = 2/3 in 8PSK TCM	FEC Code Rate. The options may change depending on FEC installed and selected
`R-S        Mode     IESS-308`	Selection	0 = Disabled, 1 = IESS-308 2 = IESS-309 5 = IESS Custom	Reed-Solomon column and options only available if not disabled. Entry is not shown when TPC enabled.
`»RS FEC        (n)     126`	Numeric	In Custom Mode only: Available n values Read only in other modes	Block size n = 22 to 255
`»RS FEC        (k)     112`	Numeric	In Custom Mode only: Available k values Read only in other modes	k = 20 to 253, k must be 2 to 20 less than n
`»RS FEC     depth     4`	Selection	In Custom Mode only: 0 = 4, 1 = 8, 2 = 16 Read only in other modes	Interleave depth factor
`Data  Dif Decoder     Enabled`	Not Shown	0 = Disable, 1 = Enable	Differential Encoder Not shown or settable except in special modes.

Demodulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`Data    Descrambler Auto`	Selection	0 = Disable, 1 = Auto 2 = V.35, 3 = Intelsat, , 4 = Alt V.35, 5 = Alt. Intelsat 6 = EFD 7 = TPC Sync	Scrambler types. Types are added if optional hardware is installed. The Auto mode uses IESS 308 & 309 standards to automatically switch to use synchronous scramblers part of R-S and TPC.
`Data    Clk Source RCV Clock`	Selection	0 = RCV Clock 1 = Internal, 2 = External, 3 = Mod Clock	Receive Data Clock Source. Selecting "0" disables FIFO buffer, any other setting enables it.
`»Data Buffr Delay 2.00000ms`	Numeric	0 to maximum calculated by data rate.	Receive FIFO buffer delay in milli-Seconds.
`»Data Buffer Size 512 Bits`	Numeric	0 to 131,070 bits in 1 bit increments.	Receive FIFO buffer delay in bits. Buffer has this many bits filled and empty when centered.
`Data    FEC Hold 1`	Numeric	0 to 255 Normally set to 1	Number of FEC lock "cycles" the FEC will accomplish before declaring loss of lock.
`Mux        Mode IBS Custom`	Selection	0 = Disabled, 1 = IBS Standard, 2 = IBS Enhanced 3 = IBS Custom	Enables Multiplexer to specified mode. Enable makes other menu selection below visible.
`»Mux ESC Overhead 9600 bps`	Selection	0 = Disable 1 to 7 selects standard rates 300 bps – 38.4 kbps	Only in Custom Mode. Selects framing resources committed to ESC Comm.
`»Mux MCC Overhead 1200 bps`	Selection	0 = Disable 1 to 7 selects standard rates 300 bps – 38.4 kbps	Only in Custom Mode. Selects framing resources committed to MCC Comm.
`»Mux      Ratio 15:16`	Read Only		Shows current data to aggregate ratio for mux.
`»Mux    ESC Port RS-485, 4 Wire`	Selection	0 = RS-232, 1 = RS-485 2 wire, 2 = RS-485 4 wire, 3 = RS-485 Drvr On	Physical ESC port type. (coupled to transmit)
`»Mux    ESC Rate 9600 bps`	Selection	0 to 7 selects standard rates 300 bps – 38.4 kbps	Physical ESC port rate at rear panel. (coupled to transmit)
`»Mux    ESC Frmt N,8,1`	Selection	0 = N/7/1, 1 = P/7/1, 2 = N/8/1, 3 = P/8/1	Physical ESC port format at rear panel. (coupled to transmit)

Demodulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
`LNB      Power` `      +18V`	Selection	0 = Disabled 1 = +13VDC 2 = +18VDC	Selects Power and Voltage to an LNB in the 500L or LT
`LNB    Current Out` `     221mA`	Numeric	Read Only	Displays Current draw of LNB
`LNB    Current Max` `     300mA`	Numeric	0 to 500 mA	Sets the maximum LNB current before an alarm.
`LNB    Current Min` `    150mA A`	Numeric	0 to 500 mA	Sets the minimum LNB current before an alarm.
`LNB    10 MHz Ref` `     Disabled`	Selection	0 = Disabled 1 = Enable	Selects if modem's current 10 MHz reference to be supplied to an LNB in or L
`LNB  LO Frequency` `  5150.000000MHz`	Numeric	0 to 49999.999996 MHz	Selects LNB LO frequency in or L. If set non-zero then IF frequency setting is at RF frequency.
`Alarm    CXR Lock` `    To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A&B, 4 = Mute Mod CXR, 5 = Mute & Alarm A, 6 = Mute & Alarm B, 7 = Mute & Alarm A & B	Selects destination of alarm
`Alarm       Data` `    To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm   Low Eb/No` `    To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm   Low Level` `    To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm   Tst Active` `    To Alarm A`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`Alarm    Hardware` `   To Alarm A & B`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
`»Alarm  Backward` `  To Alarm A & B`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm – Only available with mux.
`»Alarm  LNB Power` `  To Alarm A & B`	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm – Only shown in /L.
`Test  IF Loopbck` `     Disabled`	Selection	0 = Disable, 1 = Enable	IF Loop-back control.
`Test Symbol Rate` `   256.000ksps`	Read Only	N/A	Receive Symbol Rate
`Test Clock Error` `     251`	Read Only	N/A	Bit Rate Clock error
`Test       AGC` `      -1.9V`	Read Only	N/A	Internal Loop Voltage

Demodulator Parameter Detail			
Representation	**Type**	**Entry**	**Description**
Test LO AFC +8.8V	Read Only	N/A	Internal Loop Voltage
Test Step AFC +9.4V	Read Only	N/A	Internal Loop Voltage
Test IDcOff -0.1V	Read Only	N/A	Internal Loop Voltage. I channel DC offset
Test QDcOff -0.1V	Read Only	N/A	Internal Loop Voltage. Q channel DC offset

Table 3-8. Interface Parameter Detail

Interface Parameter Detail			
Representation	**Type**	**Entry**	**Description**
Status I/O Online	Read Only	N/A	Interface Status **
Status RTS Off	Read Only	N/A	Interface RTS line status
Status CTS On	Read Only	N/A	Interface CTS line status
Status DCD On	Read Only	N/A	Interface DCD line status
Status DTR Off	Read Only	N/A	Interface DTR line status
Status DSR Off	Read Only	N/A	Interface DSR line status
Status Test Mod BER	Read Only	N/A	Interface Test status
Status BER 0.0 E-7	Read Only	N/A	Interface Test status
Status Sync Loss 3	Read Only	N/A	Interface Test status
Status Errors 7	Read Only	N/A	Interface Test status
Status Bits 1.45 E7	Read Only	N/A	Interface Test status
Status EFS 99.95%	Read Only	N/A	Interface Test status
Status Erred Sec 1	Read Only	N/A	Interface Test status
Status Total Sec 2135	Read Only	N/A	Interface Test status
I/O Mode RS-449	Selection	0 = Disable 1 = RS-232 2 = RS-449 3 = RS-449/Unterm 4 = V.35 5 = V.36 6 = EIA-530 7 = EIA-530A 8 = SnIP (Option) 9 = HSSI (Option)	Interface electrical mode. Some option interfaces may replace the SnIP or HSSI interface. Other options may include G.703 (when released)
I/O RTS Ignore	Selection	0 = Normal 1 = Control CXR 2 = Ignore	Interface RTS line control
I/O CTS Normal	Selection	0 = Normal, 1 = Force Active	Interface CTS line control
I/O DCD Normal	Selection	0 = Normal, 1 = Force Active	Interface DCD line control
I/O DTR Normal	Selection	0 = Normal, 1 = Ignore	Interface DTR line control

Interface Parameter Detail			
Representation	**Type**	**Entry**	**Description**
I/O DSR Normal	Selection	0 = Normal, 1 = Force Active	Interface DSR line control
I/O Xmt Data Normal	Selection	0 = Normal, 1 = Inverted	Transmit Data Inversion
I/O Xmt Clock Normal	Selection	0 = Normal, 1 = Inverted, 2 = Auto	Transmit Clock Phase. Auto is now default standard.
I/O Rcv Data Normal	Selection	0 = Normal, 1 = Inverted	Receive Data Inversion
I/O Rcv Clock Normal	Selection	0 = Normal, 1 = Inverted	Receive Clock Phase
I/O RTS Monitor Normal	Selection	0 = Disabled, 1 = to Alarm A, 2 = to Alarm B	Allows using Alarm relay contacts to show RTS Status, overriding other alarms.
SnIP IP Addr 192.168.100.1	Numeric		IP Address for Ethernet Interface.
SnIP Netwrk Mask 255.255.255.0	Numeric		IP Mask Address for Ethernet Interface.
SnIP MAC Addr 0080A800256C	Read Only	Read Only	Allows read of fixed Interface MAC Address..
SnIP Options 00007f	Read Only	Read Only	Displays SnIP Options enabled
SnIP Version 021771-001-50	Read Only	Read Only	Displays SnIP Software Version Number
SnIP Serial# 1200047	Read Only	Read Only	Displays SnIP Serial Number
Alarm Tst Active to Alarm A	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
Alarm BER Loss to Alarm B	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
Alarm SnIP to Alarm B	Selection	0=None, 1=A, 2=B, 3=A & B	Selects destination of alarm
Test Ter Loopbck Disabled	Selection	0 = Disable, 1 = Enable	Interface terrestrial loop-back xmt input to receive output.
Test Sat Loopbck Disabled	Selection	0 = Disable, 1 = Enable	Interface satellite loop-back receive output to xmt input.
Test BER I/O Satellite	Selection	0 = Satellite, 1 = Terrestrial	BERT Transmit output and Receive input direction..
Test Mod BER Disabled	Selection	0 = Disable, 1 = 2047, 2 = 2^23-1 3 = Insert 1 Error (if enabled)	BERT enable to modem transmit input.
Test Demod BER Disabled	Selection	0 = Disable, 1 = 2047, 2 = 2^23-1	BERT enable from modem receive output.

** Interface Status when the SnIP option is installed and enabled can be:

- "SnIP FAILURE", Meaning no communications from SnIP card to modem processor.
- "SnIP HARD RESET", Meaning that the SnIP is in process of resetting its parameters.
- "SnIP LIMIT ALARM", Meaning that the SnIP is not able to process data.

The front panel controls for the SDMS are normally only used for basic initial setup. When more sophisticated software is loaded into the SDMS control is usually via the Ethernet connection.

3.3   Terminal Mode Control

The PSM-500 Terminal Mode Control allows the use of an external terminal or computer to monitor and control the modem from a full screen interactive presentation operated by the modem itself. No external software is required other than VT100 terminal emulation software (e.g. "Procomm" or "HyperTerminal") for a computer when used as a terminal. The control port is normally used as an RS–232 connection to the terminal device. The RS–232 operating parameters can be set using the modem front panel and stored in EEPROM for future use.

The USB connection at J10 cannot be used for Terminal Mode Control. To connect to the modem from a computer's USB port, use a USB to serial adaptor connected to the DB9 at J6.

3.3.1   Modem Setup for Terminal Mode

Terminal mode communications and protocol is set from the front panel control by setting the **<Unit: Remote – Protocol>** parameter to "VT100" (Option 0), and then setting the **<Unit: Remote – Port>**, **<Unit: Remote – Rate>** and **<Unit: Remote – Format>** parameters as desired. Then a "VT100" protocol terminal is connected to connector J6. All operating software for the terminal mode is contained within the PSM-500 modem internal control software.

A "break" signal on the communications line, pressing "Control R" on the terminal or power on of the modem will initiate full screen terminal mode printing and redraw the full screen. The terminal mode displays the present status of all user parameters controlled and read by the processor, and offers a menu allowing change to any controlled parameter.

A single terminal mode screen displays one full column of information from any one of the four matrixes, being Unit, Modulator, Demodulator and Interface. The number of terminal mode display screens possible is equal to the total number of columns in the four matrixes (24 at current count). Any possible screen can be accessed by 2 key presses from any other screen.

The 2 key presses are:

1. A first digit representing the functional area:
   a) 0 = Unit
   b) 1 = Modulator
   c) 2 = Demodulator
   d) 3 = Test

2. A second digit representing the column number. (0 to 9 for the Unit, 0 to 5 for Modulator and Demodulator or 0 to 4 for the Interface).

The resulting screen display shows all items present in that column of the matrix.

For example the basic Unit Status screen shown below lists the status items from the Unit Status column of the Unit Matrix. Notice that at the bottom of the screen is a prompt inviting you to select from one of the 4 items as the first step to change to another screen.

```
                        PSM-500 VT100 Terminal Control

                             Unit Status
                             Modem Demod Tst Active
                             Reference Internal, Ok
                        C)   Redundcy Internal 1:1
                        D)   Unit ID
                             Model PSM-500
                             Serial# 13490
                             Version 0.10








 Section ? 0)Unit, 1)Mod, 2)Demod, 3)Intf

         Strike Number/Letter of Option to Select, TAB Key Aborts Selection.
```

Figure 3-2a. Terminal Mode – Example of Unit Status Screen

Assuming that we wanted to view another of the Unit column screens. If we first press the "0" key to indicate that we want to change to a "Unit" screen the following lower screen prompt will be displayed:

```
                        PSM-500 VT100 Terminal Control

                             Unit Status
                             Modem Demod Tst Active
                             Reference Internal, Ok
                        C)   Redundcy Internal 1:1
                        D)   Unit ID
                             Model PSM-500
                             Serial# 13490
                             Version 0.10








 Unit ? 0)Status, 1)Config, 2)Keybrd, 3)Remote, 4)USB, 5)Ref, 6)Redundcy,
        7)Monitor, 8)Alarm, 9)Test
         Strike Number/Letter of Option to Select, TAB Key Aborts Selection.
```

Figure 3-2b. Terminal Mode – Example of Unit Status Screen Selection

Notice now that we can select from the Status, Configuration, Keyboard, etc. columns of the Unit Matrix. Selecting for example the "Test" item (selection 9), would display the following new screen.

```
                        PSM-500 VT100 Terminal Control

                                 Unit Test
                        A) Modem BER Test
                        B) Cal Ref Disabled
                           Ref AFC +1.1V
                           SysClk AFC +9.3V
                           +3.3V Power +3.3V
                           +5.0V Power +5.0V
                           +12.0V Power +12.0V
                           +21.0V Power +20.8V
                           -12.0V Power -12.2V
                        J) Boot Code 0000:0000:0000







 Mod ? 0)Status, 1)IF, 2)Data, 3)Alarm, 4)Test

        Strike Number/Letter of Option to Select, TAB Key Aborts Selection.
```

Figure 3-3.   Terminal Mode – Example of Unit Test Screen

Notice that some items have a preceding letter with parentheses. These items are programmable via the communications interface. Items without a preceding letter in parentheses are "Read Only" items.

Any available "screen" can be displayed with only two keystrokes. These are similar to designating the functional area and column of a matrix as when using the front panel.

3.3.2 Programming Modem Operational Values From the Terminal Screens

The modem can be interactively monitored and controlled in the Terminal mode, with a full screen presentation of current settings and status. Programming is accomplished by selecting first the desired screen, then the item to be modified and pressing the terminal key of the option letter "A" through "Z". For example, to change the modulator's carrier frequency you must first go to the modulator screen if not already there (Press "1, 1") and press the terminal's "A" key (lower case is fine!). The modem screen will respond by presenting the options, or input range, available and waiting for input. The operator input is followed by pressing the "Enter" or carriage return key. An input can be aborted at any time before completing by pressing the "TAB" key, restoring the previous setting. Invalid input keys are signaled by a beep or bell signal from the terminal.

Following a valid input, the modem will place the new setting into the nonvolatile EEPROM making it available not only immediately but also automatically the next time the unit is powered up.

3.4   Remote Command Interface Control

The PSM-500 Command Mode allows the use of an external controller or computer to monitor and control the modem via a packet-based message protocol. This mode normally uses the RS–485 connections allowing multiple modems (and other devices) to share the command link under control of a single or multiple entities. An RS–232 connection is also usable for this application, but lacks the RS-485's ability to work on a "party line" and is therefore limited to a single controller and single modem, for example a computer to a modem. The packets use a unique address for each controlled device, which is set using the modem's front panel. The message packets themselves use a binary format for efficiency. The complete protocol is shown in Appendix B.

The protocol consists of messages from the controller to the modem and response messages from the modem back to the controller. The modem never initiates communications without having first received a correctly addressed and formed message requiring a response.

Message packets to the modem can take two forms;

1.   Messages requesting information in a response message or "Read";

2.   Messages commanding a change in operating parameters or "Write".

Any write information is automatically saved to non-volatile memory and is still present on the next power-up.

The packet of both incoming and outgoing messages take the same generic form. First are pad and opening flag, then the destination and source addresses, followed by the command code (and read or write mode), then necessary data. The message packet is closed with a closing flag and check word to verify the packet integrity. The use of a source address allows multiple controllers on a single control link.

3.4.1   System Unit Programming/Communications

The communications protocol is unique. This mode is termed "command mode" communications in the following discussion and is normally accomplished via an RS–485 4-wire connection to the modem at "Control" connector J6. Note that the transmit and receive pair of this interface are separated to form a 4-wire basis. If a 2-wire connection is desired, the transmit A and B leads may be connected to the Receive A and B leads respectively in the connector applied to J6.

This command mode communications protocol involves the sending of a standard message packet from a controller requesting information or commanding a change. The PSM-500 modem responds with a message packet containing the information or confirmation of change. The Modem never initiates communications at any time except in response to a command or query message from the station controlling devices.

The new features and capabilities of the PSM-500 modem over previous versions required modification of the protocol such that older control programs would not work directly. The PSM-500 however emulates the protocol used in the PSM-4900 and other M5 series modems within the capabilities of those previous modems. Therefore, the PSM-500 may be placed into a system with existing PSM-4900s and the control mechanisms do not have to be changed until newer feature control is desired. This emulation capability also allows an SDMS type Ethernet interface card designed for an M5 modem to be placed into an M500 series modem and still work. See Appendix B for more information.

3.5   Modem Checkout

The following descriptions assume that the full system is in operation and that software is running properly on the central processor.

3.5.1 Power-Up

On initial and every subsequent power-up, the modem microprocessor will test itself and several of its components before beginning its main monitor/control program. These power-up diagnostics show no results if successful. If a serious power on failure is detected, the ALARM LED is flashed at an approximate 4 Hz rate. Other failure modes are displayed on the front panel LCD.

New modems from the factory have default values placed into the EEPROM for operating parameters. If a Monitor/Control System does not configure the modem automatically via the serial command channel, the modem can be easily configured from the front panel or can be connected to a VT100 protocol terminal to set the modem's operating parameters. To restore the default parameters the modem can be powered on while depressing the "Clear" key.

The most common default parameters placed into the EEPROM are as follows: A modem can be returned to the factory default settings by using the front panel command **<Unit: Config - Recall>**, then editing (or quick edit) and choosing the "Factory" or "0" selection option.

Modulator:

    Carrier Frequency = 70.00 MHz
    Data Rate = 256 kbps
    Modulation = QPSK
    Code Rate = Rate 1/2
    Differential Encoder = Enabled
    Scrambler = Auto
    Clock phase = Normal
    Data = Normal
    Clock Source = Internal
    RTS = Ignore
    Carrier = Off.
    All Mod Alarms to Relay A

Demodulator:

    Carrier Frequency = 70.00 MHz
    Data Rate = 256 kbps
    Modulation = QPSK
    Code Rate = Rate 1/2
    Differential Decoder = Enabled
    Descrambler = Auto
    Clock phase = Normal
    Data = Normal
    Clock Source = Receive
    Sweep mode = Fast
    Acquisition Range = +/- 30 kHz
    All Demod Alarms to Relay B

Modem Unit:

    Modem Reference: Internal, 10 MHz
    Remote Port Address = 1
    Remote Port = RS-232
    Remote Mode = Binary Packet
    Remote Rate = 9.6 kbps
    Remote Data Format = 8 data bits, 1 stop, no parity

Interface:

    Mode = RS-449
    All Tests Off
    Data and Clocks in normal mode (not inverted). The XMT Clock now uses a default "Auto" mode that detects the proper phasing and applies it.

In a properly operating system, with an incoming carrier available for the demodulator, the modem's Alarm (red) and Warning (yellow) LEDs should all go out. Without an acceptable incoming carrier the Demod "Major Alarm" and "Summary Alarm" will illuminate. When the incoming carrier is acquired, the green "Signal Lock" LED should illuminate. The "Transmit On" LED will also illuminate if the transmit output is enabled.

3.6 L-Band Feature Operation

Note: The following special L-Band features refer to the transmit and receive for the PSM-500L and the PSM-500LT .

3.6.1 L-Band BUC Control

The PSM-500L offers 3 specific features related to the control and use of an outdoor Block Up Converter or BUC: Frequency control, power control and reference control.

Transmit Frequency Control – When the BUC Local Oscillator or LO frequency is entered into the **<Mod: BUC – LO Frequency>** parameter the **<Mod: IF – Frequency>** parameter entry allows (and requires) entry of transmit frequency at the actual satellite uplink RF frequency. To return to using L-Band IF frequencies set the BUC – LO Frequency parameter to "0".

BUC Power Control – When a power supply is plugged into the rear panel DIN connector, J10, the PSM-500L uses and internal power relay to control application of power to the BUC's transmit input cable under front panel or remote control. The modem can also read the voltage and current being applied to the transmit cable. The PSM-500LT has an integrated BUC power supply.

BUC Reference Control – The PSM-500L/LT contains a high stability 10 MHz OCXO reference oscillator designed to provide a suitable reference signal to most BUCs. See the specifications in Appendix A for the exact reference stability, aging, phase noise and level specifications. The application of the reference to the transmit cable is under front panel or remote control, as required by the BUC. Some BUCs use the 10 MHz signal to control application of power to the final PA, removing it and going to a low power state when the 10 MHz is absent.

3.6.2 L-Band LNB Control

The PSM-500L and H offer 3 specific features related to the control and use of an outdoor Low Noise Block Down Converter or LNB: Frequency control, power control and reference control.

Receive Frequency Control – When the LNB Local Oscillator or LO frequency is entered into the **<Dem: LNB – LO Frequency>** parameter the **<Dem: IF – Frequency>** parameter entry allows (and requires) entry of receive frequency at the actual satellite downlink RF frequency. To return to using L-Band IF frequencies set the LNB – LO Frequency parameter to "0".

LNB Power Control – The PSM-500L and PSM-500LT contain an internal LNB power supply and internal power relay to control application of power to the LNB's receive output cable under front panel or remote control. The voltage applied can be chosen for either 18VDC or 13 VDC. The modem can also read the voltage and current being applied to the receive cable.

LNB Reference Control – The PSM-500L and PSM-500LT contain an internal 10 MHz reference oscillator designed to provide a suitable signal to those LNBs requiring an external reference. See the specifications in Appendix A for the exact reference stability, aging, phase noise and level specifications. The application of the reference to the receive cable is under front panel or remote control, as required by the LNB.

3.7 Data Interface Clock Options

The modem clocking and options for either VSAT or SCPC operation is discussed below:

3.7.1 VSAT Mode

A typical method of synchronization in a VSAT system is as follows. The master station reference is used to synchronize the master station transmit data clock. The VSAT terminal receive data clock maintains this synchronization. The VSAT terminal DTE equipment may use the receive data clock to synchronize itself and generate the transmit data clock for input to the VSAT modulator either directly via setting the Modulator clock source to "Receive Clock" or indirectly via the Terminal Timing input. Alternately it may use an accurate clock to generate the transmit data clock and input it via the Terminal Timing input.

3.7.2 SCPC Mode

Independent – Each station of two linked SCPC modems is considered independent. The transmit data clock is either an input to or output from each station modulator. The other station receive data clock maintains this synchronization. The clocking in each direction is independent and follows the same transmit to receive synchronization.

Master/Slave – One station of two linked SCPC modems is considered the master and the other station is considered the slave. The master transmit data clock is either an input to or output from the master station modulator. The slave station receive data clock maintains this synchronization. The receive data clock is used to generate a contra–directional transmit data clock (from modulator to DTE) of the same frequency, but not necessarily phase, as the receive data clock.

3.7.3 Transmit Interface Clock Auto Mode

The PSM-500 Modem uses a transmit clock option called "Auto", which is now the default setting. The new clock mode appears in the "Interface I/O" menu column under "Xmt Clock" and is not settable. The modem measures the phase relationship between the transmit clock and data and automatically sets the clock phase correctly. This gives improved performance on slightly longer data cables when operating at bit rates above approximately 1.5 Mbps.

3.8 Automatic Uplink Power Control (AUPC) Operation

The PSM-500 modem has built-in logic for Automatic Uplink Power Control (AUPC). AUPC attempts to maintain a constant E_b/N_o at the receive end of an SCPC link by adjusting the transmit power at the transmit end of the link. This is especially useful when operating over a satellite at Ku-Band frequencies in locations with high rainfall periods.

The AUPC function requires a data channel at 300 to 1200 baud in order to operate. This data channel can either be external to the modem (that is provided by an external multiplexer or telephone line modem) or provided by the internal IBS multiplexer when enabled.

Note: The "Enhanced" or "Custom" Multiplexer mode MUST be selected to provide a channel for AUPC operation from the IBS multiplexer option.

The internal data multiplexer in "Enhanced" mode provides a 300 baud service channel between the two sites of a link permitting the modem processors to send messages and get responses over this channel. AUPC can be set to operate on either or both directions of a link but always requires a bi–directional channel. The AUPC functions and their descriptions are shown in the table below:

Function	Description
AUPC ENABLE/DISABLE	Enables/Disables the AUPC to function locally.
MOD AUPC E_b/N_o	Desired E_b/N_o of remote modem.
MOD AUPC MIN LVL	Sets minimum output power to be used.
MOD AUPC MAX LVL	Sets maximum output power to be used.

The basic AUPC operation is described as follows: Assume that the two modems, one at each end of the link, are set up for AUPC operation. Only one direction is discussed, controlling the Eb/No at Site B, but the same functions could be occurring in both directions simultaneously. This is shown in the Figure 3-4 below. Modem "A" is transmitting to modem "B" under normal conditions and modem "B" has a receive Eb/No of 7.5 dB. Modem "A" has been set to an AUPC

Eb/No on the front panel of 7.5 dB, and is currently outputting –15 dBm. Next it begins raining at location "B", and the Eb/No drops to –7.0 then –6.8 dB. Modem "B" is constantly sending update messages to "A" and reports the current Eb/No. When "A" sees the drop in Eb/No, it slowly begins to raise the output power, and raises it again when it sees further drops. As the rain increases in intensity, and the Eb/No decreases again, "A" continues to increase its power level to compensate, and when the rain diminishes and quits, it also lowers its power level to compensate. The operation is therefore a feedback control loop with the added complication of a significant time delay.
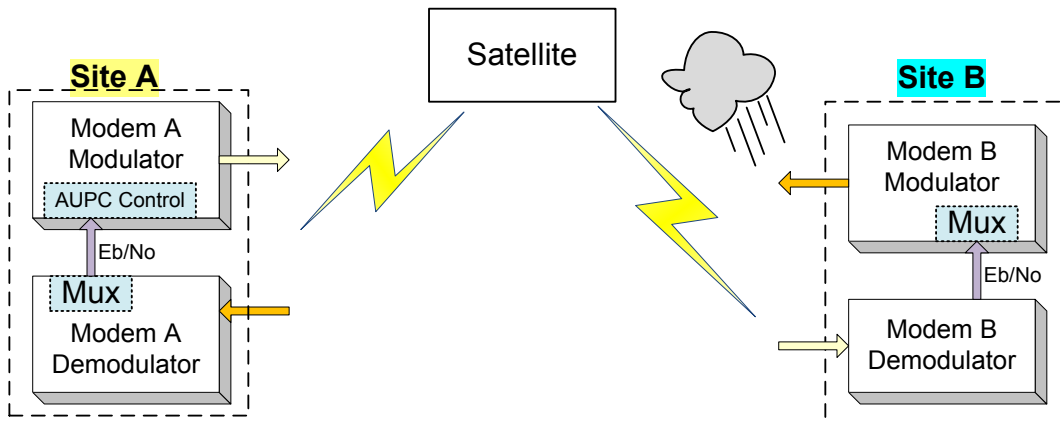
Figure 3-4 AUPC

There must be safeguards built into the AUPC system. First, the Modulator has two additional parameters which allow control of the maximum and minimum power output level. The other controls are built into the operating control software to limit response times and detect adverse operating conditions.

3.8.1 AUPC Setup Guide

The normal method for setting up AUPC over a point to point link is to use the PSM-500's built in multiplexer to provide the necessary communications channel. Since AUPC can be enabled in a single direction the multiplexer must be enabled in only the direction necessary to return Eb/No information to the controlled transmit modem. The best way to illustrate this is with an expansion of the example shown above for sites A and B. Here are the steps assuming that we start with a working link between A and B without any multiplexers or AUPC enabled. We will also assume that the desired receive Eb/No that we wish to maintain at site B is 7.0 dB.:

Site B AUPC Setup

1. Set the B Modulator Multiplexer to Custom mode. Note this kills the link from B to A until the A Demod is set with the same Multiplexer settings.
2. If not using the ESC channel for some other reason then set the ESC Overhead to "Disabled".
3. Set the MCC Overhead Rate to 1200 bps. This carries the AUPC information and 300 baud is the absolute minimum required. But in most cases you should start at this higher rate. You can always go back and try lower values. The speed here determines the time it takes to send the information.

Site A AUPC Setup

4. Set the A Demodulator Multiplexer to Custom mode (or match the B setup above).
5. If not using the ESC channel for some other reason then set the ESC Overhead to "Disabled".
6. Set the MCC Overhead Rate to match that set for Site A above e.g. 1200 bps.

[The link should now be working again from B to A.]
7. Set the Modulator IF AUPC to "Enabled.
8. Set the Modulator IF AUPC Eb/No to that desired, e.g. 7.0 dB.
9. Set the Modulator IF AUPC Maximum Level to that desired allowing at least several dB above the nominal operating point for margin, e.g. -10.0 dBm.
10. Set the Modulator IF AUPC Minimum Level to that desired, e.g. -32.0 dBm.

The link should now be operating and using AUPC to set the A transmit level keeping the B receive Eb/No constant. Alarms will be generated if the transmit level reaches either the max or min level attempting to maintain the receive E/b/No.

The exact settings required can be further adjusted to account for the type of fading expected. For example if in a tropical environment with sudden heavy showers you may want to allow more power margin and possibly speeding up the response time by using a higher speed MCC channel.

To set the other direction to use AUPC, simply repeat the above instructions reversing the A and B site.

3.9 Demodulator Receive Data FIFO Operation

The PSM-500 modem has a built-in First In First Out (FIFO) buffer on the receive data channel that may be enabled to compensate for cyclical variations in the receive data rate or different systems clocks at the two link ends. A receive buffer of this type is sometimes referred to as a Plesiochronous buffer when the intent is to absorb different clocks on the transmit and receive end. This type of clock difference is usually uni-directional and cumulative. Cyclical variations are most often caused by the daily movement of the satellite in its position resulting in a varying distance from earth station locations. This movement would cause the receive data rate to increase during a portion of the day and decrease during other periods. This type of variation is termed Doppler variation and the buffer to absorb the variation is a Doppler Buffer. If the daily or weekly average rate is the same then this temporal variation can be absorbed by the receive FIFO without ever losing data (assuming the FIFO is large enough). Other data rate variations between the transmitting and receiving stations which are not periodic (that is average to zero) can still be buffered by the FIFO, but will eventually result in lost data.

Operation of the FIFO requires two clock sources: one that clocks the data into the FIFO, which is always the clock recovered from the received signal; and one that clocks the data out of the FIFO. The "out" clock can come from one of four sources:

1. *Receive Clock* – (Option 0) Meaning that the input and output clocks are the same, disabling the FIFO.

2. *Internal Clock* – (Option 1) Uses a dedicated modem internal NCO generated data rate clock as the output clock. Use of this clock does not require that the modulator and demodulator data rate be identical.

3. ***External FIFO Clock*** – (Option 2) This option allows a station-derived standard clock rate to be used to clock data out of the FIFO. The externally supplied clock must be equal to the average receive data rate.

4. ***Modulator Clock*** – (Option 3) Uses the modulator data rate clock as the output clock and obviously requires that the modulator and demodulator data rate be identical.

The Receive FIFO operation can be set from the front panel or remote control, and consists of selecting the output clock source, and either the delay time desired in milliseconds or the number of bits of delay. The processor computes the other value based on the one entered and the current data rate. The modem processor also keeps track of and can display the current FIFO fill percentage status. The FIFO sets the delay or number of bits selected upon activation and this center value represents 100% FIFO fill. At any time the FIFO may contain from 0% to 200% of the set value. The percentage fill can also represent the percentage of delay with respect to the setting. For example if the buffer was set to 2 mS of delay and the fill is 150% this represents 3 mS of delay.

When the data rate is changed the modem maintains delay time constant, automatically changing the number of bits stored in the buffer to compensate.

> ***NOTE:*** *When the number of bits of delay are very small, one bit may represent a large percentage change (e.g. if the delay is only 4 bits, each bit represents 25%). The delay may be set from 4 bits to 131,070 bits at any data rate, resulting in a delay ranging from 0.00081mS (4 bits at 4.92 Mbps) to over 42,000 mS (131,070 bits at 2400 bps).*

An overrun occurs when a bit is clocked into the FIFO causing the fill to reach a full 200% of the selected value. This causes flushing the upper half of the FIFO, restoring the fill to 100%, re-centering the FIFO. The data flushed is lost and cannot be recovered.

An under-run occurs when the last bit is clocked out of the FIFO, emptying it. This also causes re-centering of the FIFO by resetting the buffer pointers to the mid or 100% level, resending all the data in the buffer. Both conditions result in a potential serious disruption of traffic.

When an under or over-run occurs an internal modem flag is set indicating that a re-center has occurred. The front panel display shows "Slip" and FIFO fill data percentages read from the remote port are negative numbers. This latched flag may be reset at the front panel or by writing to the remote port FIFO parameter.

The FIFO may also be re-centered at any time on command from either the front panel or via the remote control. At the front panel the command is **<Dem: Status - Buffer>** and pressing the "1" key, then "Enter" to confirm. Pressing the "0" key on this parameter will clear the "Slip Status".

In "framed" communications the severity of the disruption can be minimized by setting the buffer size in bits to multiples of the frame size. For example if the total frame size is 512 bits and the buffer is set to a size of 1024 bits an under or over-run would result in the frame flags remaining in the same location in the data stream. Note that frames will still be errored by the under or over-run, but synchronization may not be lost. If a superframe structure is used it is likely that synchronization will still be lost.

3.10   *Built-in 1:1 Redundancy Mode Operation*

The PSM-500 modem has a built-in 1:1 redundancy mode that allows two modems to be connected together sharing connections, but with only one unit "on-line". The built-in software provides automatic back-up protection should the on-line unit indicate a failure by switching to a functioning off-line unit.

A diagram of the connections is shown in Section 2.3.6.

This is a very low cost method of achieving redundancy and because of the design has both advantages and disadvantages:

- Advantage – The second or current back-up unit can be sent its full configuration from the on-line unit, making set-up extremely easy.

- Advantage – Since the units are fully programmable concerning alarm content that determines the switching criteria, this method is more flexible than most redundancy schemes.

- Advantage – The single point failure of the switch in a classic 1:1 redundancy scheme is eliminated. Since these switches are often mechanical relays they actually have a poor failure rate, reliability (with respect to a classic scheme) is not seriously compromised.

- Disadvantage – There is no separate physical switch which provides a positive lock-out of a seriously failed unit that may not be able to turn its output signals off.

- Disadvantage – There is no single point control allowing forced switching away from one unit. Forced switching is accomplished only "from" the currently on-line unit.

- Disadvantage – There is no mode forcing a priority unit. In a priority system one unit is considered primary and the other secondary. If both units show good status the primary is always on-line. But, the priority scheme would also create more switching and is not normally used anyway.

Of course the major advantage to the built-in redundancy capability is its extreme low cost.

3.10.1 Setting Up 1:1 Redundancy Mode

Redundancy mode between a pair of modems is normally accomplished during installation. The procedure outlined here provides that information again, but also additional information on options and parameters used to determine operating modes. In overview the procedure is to:

Note: The two modems MUST be the same model number and type, and should be at the same firmware revision for proper redundant operation.

1. Configure the first modem completely for the intended operating parameters, including setting the redundancy parameter to "1:1". This initial unit should not be in alarm.

2. Physically install the second unit to be paired, but with its power off.

3. Connect the IF and data cables to both units. The special data "Y" cable is connected between the redundant pair.

4. Turn the secondary unit on.

5. Go to the menu in the **<Unit: Redundancy – Config>** and press the "Edit" key. The on-line unit will ask permission to transfer configuration to the second unit. Confirm by pressing "Enter". The primary unit should say "Sending Config" for approximately 1 second. If any packet transferred results in an error message a "Send Fail" message will be displayed, but the remainder of the transfer will continue.

6. Verify that the units are functioning correctly in redundancy mode. Go to the **<Unit: Status – Redundancy>** item in both units. The on-line unit will say "On-Line, Bckup OK" while the off-line unit will say "Standby, OK".

Tear-down or un-pairing of two units is accomplished by turning both units off before removing the "Y" cable. Then turn the units back on and set the redundancy to "Disabled"

Two parameters are added to the unit redundancy menu when redundancy is enabled:

- **<Unit: Redundncy – Sw Rqst>** This parameter allows you to determine which alarm indications result in a switch request. The possible selections are "On Any Alarm", "On Alarm A", "On Alarm B", or "On Alarm A & B". Since the specific alarms which comprise Alarm A and Alarm B are programmable themselves, then a switch request is highly

programmable itself. For most applications though the default "On Any Alarm" is a preferred selection.

- **<Unit: Redundncy – Sw Hold>** This parameter determines how long an alarm must exist on the on-line unit and not the off-line unit before switching will occur. Allowable values are 0.0 to 600.0 seconds. The value could be set to zero, but this is not advised. A nominal value of 0.5 seconds insures that intermittent cases do not cause undue switching. A built in factor of 10 seconds is provided once a switch has occurred before a switch back to the original unit is allowed (except in the case of a manual switch request or loss of power in the on-line unit which requires 2 seconds).

The possible case can arise when both units go out of alarm at virtually the same time. This might occur if both units are powered on simultaneously or the receive carrier appears after being off or a necessary clock signal is applied to both units. In such tie cases, which unit will be placed on line is determined by the unit serial numbers, where the highest serial number wins the tie.

3.10.2   Operating 1:1 Redundancy Mode

Operation of a redundant pair of modems consists mainly of determining the status of units and forcing transfer of operation from one unit to the other.

A quick status to determine which modem is currently on "On-Line" and the failure state of the paired modems is done by viewing the LED indicators on the front panels. In a fully operating set-up there will be no alarms on either unit, but one modem will have the green Modulator Transmit LED illuminated and the other will have the transmit LED extinguished. The other LED indicators still show the relevant condition of the Modulator, Demodulator and Unit.

A more thorough status condition is viewed by setting both modems to the **<Unit: Status – Redundcy>** parameter. The unit currently On-Line will present its status on the lower line of the LCD display as "Online – xxxxx" where xxxxx could be one of several messages:

- Bckup OK – This modem thinks that everything is fine.

- BCKUP ALM – The backup modem is in an alarm state.

- NO BCKUP – No backup modem was found via the aux communications channel.

- The unit currently Off-Line will present its status on the lower line of the LCD display as "Standby OK" or "OFFLINE – ALARM".

3.10.2.1   Forcing a Transfer Switch in 1:1 Redundancy Mode

The 1:1 "transfer" process of forcing the two paired modems to swap their on-line/off-line status is a one step process. The procedure however can only be accomplished on the unit that is currently "On-Line".

- On the currently "On-Line" unit go to the**<Unit: Status – Redundcy>** parameter and press the "Edit" key.

- The LCD display will present the message "Enter to Xsfer?". Pressing the "enter key will cause the unit to go off-line and the currently "Off-Line" backup unit to go "On-Line".

If there is no backup unit or the backup unit is itself in alarm then the transfer will not be completed and an error message is displayed.

3.10.3 Removal and Replacement of Units in Redundancy Mode

It may be necessary to remove a unit of a redundant pair and replace that unit with another. The following method performs that function with the minimum disruption to the traffic status. In overview the procedure is to:

1. Force a switch away from the unit to be removed (if it is currently on-line),

2. Disconnection of cables from the now off-line unit, and

3. Physical removal of the unit.

Replacement is the reverse of this procedure.

3.11 Bit Error Rate Test (BERT) Set Operation

The PSM-500 modem has a built-in BERT that can be individually enabled in the transmit and receive direction. It is capable of operating with two standard patterns; "2047" and "2^23 –1" and maintains even complex BER test results. BER test results include BER, Sync Loss, Errored Bits, Total Bits, Error Free Seconds, Erred Seconds and Total Seconds. Tests can be re-started at will and run via the remote control and from the front panel.

> $\Rightarrow$ **CAUTION**: *Enabling the BER Test set will result in disruption of any traffic currently through the PSM-500 in the direction that is enabled. BER Tests should not be performed on a live traffic unit.*

The PSM-500 BER Test set can be "pointed" in two possible directions. The normal mode as available in the PSM-4900 involves the BER transmitting in the direction of the satellite and receiving from the satellite direction. An alternate mode allows the BER set to transmit and receive toward the terrestrial data interface or "line" side. The direction is controlled via the Interface **<Intf: Test – BER I/O>** parameter and can be selected for either "Satellite" or "Terrestrial". The Satellite direction looks to the modem as if a DTE is sending and receiving data. The Terrestrial direction appears to the line as if a DCE device is sending and receiving data.

The use of the BERT is more fully described in the Maintenance Section 4.1.2.

3.12 Analog Monitor Output Operation

The PSM-500 modem has a built-in function to output an analog voltage representing the current value of one of three internal parameters. These are the receive Automatic Gain Control (AGC) level, the receive Eb/No and the transmit output power level. Each of these is a digital value accessible to the main processor, which can output the selected value continuously to the rear panel Alarm connector via a 16 bit digital to analog converter.

Processor access and control of these signals allows a highly flexible output format tailored to the user's requirements. In addition to selecting the parameter value to output the processor allows control of the "full scale" and "zero scale" output voltage over a range of –10.0 Volts to +10.0 Volts. These two settings can control the output slope (gain and direction) and offset.

To illustrate consider the example of outputting the receive AGC (representative of received signal level) to automatic antenna positioning equipment. The PSM-500 has a carrier input range of approximately –20 to –60 dBm. The AGC over this range is a voltage varying from approximately –5 Volts at the maximum input and +5 Volts at the minimum input. Note that these voltages can vary with data rate and other factors. The slope of this response is negative relative to the receive signal level. Next assume that the positioning equipment wants a positive slope between 0 and +10 Volts, where +10 Volts represents the maximum received signal level. In this case we would set the **<Unit: Monitor - Full>** to 0.0 Volts and the **<Unit: Monitor - Zero>** to +10.0 Volts. These settings have the effect of inverting the slope of the AGC signal and applying an offset of +5 Volts to the output.

The analog output presented at the rear panel Alarm connector J5 has a 1kΩ output impedance, protecting the driver circuitry from shorts.

3.13   Storing and Recalling Configuration

The PSM-500 modem has a built-in function allowing the operator to store the current complete configuration in one of 8 numbered locations.

Any stored configuration can then be recalled, including one permanent configuration called "Factory" which is a set of default configurations.

3.14   Automatic Configuration Recovery - ACR

The PSM-500 modem has an additional feature related to the ability to store and recall configurations. Any or all of the 8 configurations can be set to be automatically recalled in the event of receive carrier loss for more than a specified number of seconds. This automatic recall is termed "Restore" on the control options. Each configuration has an associated time parameter that is normally set to a 0 (zero) value. When any other value up to 14,400 seconds is placed in this parameter then that configuration is recalled if the current configuration results in a loss of carrier for more than the specified number of seconds.

The automatic configuration recovery feature, or ACR is also commonly used with the ability to turn the carrier off after loss of receive carrier.

A feature added in version 0.52 of the modem firmware allows the power up behavior of the modem to be selected as either "Last" or recalling one of the 8 stored configurations. Last is the normal previous mode where the modem powers up using the last settings. Recall 1..8 will recall any stored configuration on power up. The default stored in each configuration is the factory settings.

⟹ *Note: The ACR is not available when the modem is operating in a redundancy mode.*

Several examples more clearly illustrate the use and operation of the automatic configuration recovery (ACR).

Consider a demand access type system where modems not currently in use are intended to be placed at a "home" location. This would consist of mainly a receive IF frequency and data rate where the modem could receive assignment information. By storing the necessary parameters for the home location in configuration #1, and setting the configuration #1 time to 10 seconds, the modem will return to home whenever no carrier is received for 10 seconds. Then upon receiving an assignment, going to the new assigned set-up, and passing data traffic the link "tear-down" only requires removing the inbound carrier. 10 seconds later the modem will return to the home location awaiting another assignment.

Consider a simpler system that uses the multiplexer option to remotely program a far end modem. This ability is only available via remote control, not the front panel. If a remote unattended modem is erroneously commanded to a location and does not find the carrier then it may be impossible to "re-acquire" that modem, necessitating a technician to visit that site. By first storing the current configuration in one available location, and then setting the time to perhaps 30 seconds (all over the link itself) for that configuration then the remote modem can safely be sent a command to change frequency (for example) knowing that if the modem does not lock up to a receive carrier in 30 seconds it will return to the current configuration.

Multiple configurations can have time settings associated with them. The result is that each configuration will be tried in turn until a carrier is found and locked. Upon losing the receive carrier again the modem will restart the configuration sequence beginning with the lowest numbered configuration having an associated non-zero time. The sequence is repeating with the highest configuration with a non-zero time "wrapping" around to the lowest.

Caution – What is not immediately obvious is that the time set is the time of the "current" configuration with no carrier before switching to that configuration. Thus if configuration #1 is set to 12 seconds and #4 is set to 2 seconds (all others being set to zero) then when on #4 for 12 seconds with no receive carrier the modem will change to #1, and when on #1 for 2 seconds with no receive carrier then the modem changes to configuration #4.

Note that all of the above examples would be "safer" if the **<Dem: Alarm – CXR Lock>** is set to "Mute and   ". With this setting the transmit carrier is turned off when no receive carrier is present, even if commanded on.

3.15   Special Control Mechanisms

The PSM-500 modem includes several special controls that were built in for specific customer systems, but may be of use by other user. This are listed here since they are not considered normal options and could be easily overlooked.

3.15.1   Power-Up Behavior

The PSM-500 modem has the capability to always revert to the transmit carrier disabled on power-up. This might be useful for example in mobile environments where the antenna may not be deployed or aligned on each power-up cycle. Setting this option in the **<Modulator: IF Mute>** parameter allows such operation.

In other cases the user may require that the modem always revert to a specific configuration on power-up. The normal behavior is for the modem to power-up with the last settings still in effect. One of the options in the Unit Configuration column is "Power-Up" control (**<Unit: Config – Pwr-Up>**). The default setting is to "Last" which performs as the normal described above. A user can select any of the 8 stored configurations to be recalled on each power-up cycle. This could be useful in a mobile environment or a DAMA system where a "home" channel is desired on each power-up. In a large system units can be pre-set to a specific configuration for use in initially bringing up a site and then easily changed to another configuration for normal operation.

3.15.2   Monitors and Outputs

The PSM-500 has always had the ability to send one of 3 measured parameters to an analog monitor output on the rear panel Alarm connector at pin 5 of J5. A newer monitor output added in Version 0.47 of the modem code allows putting the Data Interface RTS status onto either the A or B Alarm relay output, also on the rear panel J5 connection. Since these relays are form C, either logic direction can be chosen for the output to use in controlling other equipment. Control of this feature is in the **<Intf: I/O – RTS Monitor>** parameter. *Caution – Setting this to either Alarm A or B relay will override an other settings going to that alarm relay.* It is the responsibility of the user to set alarms properly when using this unique feature. This relay control is also not de-bounced with a time delay, therefore a fast changing or chattering RTS signal will cause the relay to chatter. This feature is independent of the **<Intf: I/O – RTS>** parameter which can be used to control the Carrier enable via the RTS status.

3.16   Burst Mode Operation

Note: As of the time of this manual the burst mode is a special factory request option and not installed in standard modems. The following description is typical of burst operations.

The modulator burst mode is controlled by the interface RTS/CTS and data flag signals. The sequence of events for the burst mode is as follows:

1. The RTS from the DTE device is normally active. The idle character from the DTE is a continuous Mark condition. The modulator output carrier is off in this idle state.

2. The modulator responds to the DTE device when ready to transmit by activating the CTS signal.

3. Any time after the CTS is received by the DTE, the DTE starts transmitting flags and/or data. The first non–SDLC/HDLC flag character received by the modulator is the start of transmission signal, causing the modem to generate a preamble and initiate the "Carrier ON" command. Transmission continues with data bytes placed after the preamble.

4. The next SDLC/HDLC flag received by the modulator is the end of transmission signal.

5. When the closing flag is detected by the modulator, it drops the CTS indicating that a new data message cannot be started. When the last data bit is sent, the modulator will reassert the CTS signal, and turn the carrier OFF.

Chapter 4 - Maintenance

4.0 Periodic Maintenance

The PSM-500 requires no mandatory periodic field maintenance procedures. The unit contains no adjustments and most calibration is digital and held in EEPROM. Should a unit be suspected of a defect in field operations after all interface signals are verified the proper procedure is to replace the unit with another known working modem. If this does not cure the problem, other equipment in the link, wiring or power should be suspect.

There are no batteries or parts requiring periodic service contained within the case. The only moving part is the internal fan, which is designed for a service life in excess of 200,000 hours.

There is no external fuse on the PSM-500 Modem. The fuse is located on the power supply assembly inside the case, and replacement is not intended in the field.

4.0.1 Internal Reference Calibration

If desired, or if it is suspected that the modem's internal reference requires calibration, this can be performed on a unit "on-location". A recommended interval for the reference calibration would be after the first 6 months to a year in service and on a yearly basis thereafter. The external reference should be of known accuracy before attempting calibration. The calibration of the modem's internal reference from an externally applied reference is an automatic procedure enabled from the unit's front panel. Go to **<Unit: Test – Cal Ref>** to enable the calibration procedure.

> ⇒ *Caution: The Reference Calibration procedure may result in lost traffic during performance of the calibration! The calibration should not be performed in operating links without prior arrangements.*

Before beginning an internal reference calibration an external reference must be applied and the **<Unit: Ref – Source>** must be set to "External".

4.1 Common Test Procedures

When a modem, link or system is first installed and placed in service it is common to run several tests to verify proper performance of each of the equipment items in the link. The PSM-500 is designed to aid in this process by providing built in test modes geared to verifying performance, and isolating potential problems. These aids consist of the modem self test procedure, the multiple "Loop-Back" modes available and the built-in BERT. These facilities are also useful when troubleshooting system or link problems which involve the modem.

> ⇒ *Caution: All of the modem operating procedures described below will result in loss of traffic. They should not be used in operating links without prior arrangements.*

The modem self test can be used to check out a modem within a system or stand alone on a bench. It requires nothing more than power. The procedure is described in more detail in Section 4.2.3 below.

4.1.1 Loop-Back Testing

The Loop-Back modes are typically used in a wired link with DTE equipment that can transmit and verify receipt or preferably a Bit Error Rate Test Set (BERT). The basic procedure used is to

transmit a data signal at one end of the link and sequentially set each of the loop-back options. Proper reception of the loop-back data verifies all components between the source and the loop.

The simplified diagram below shows the location of the PSM-500's built in loop-back functions within the link from one end of a link to the other. The advantage to having these functions built-in is that they are electronically programmable without having to disconnect existing cabling to connect equipment that must be available for testing.
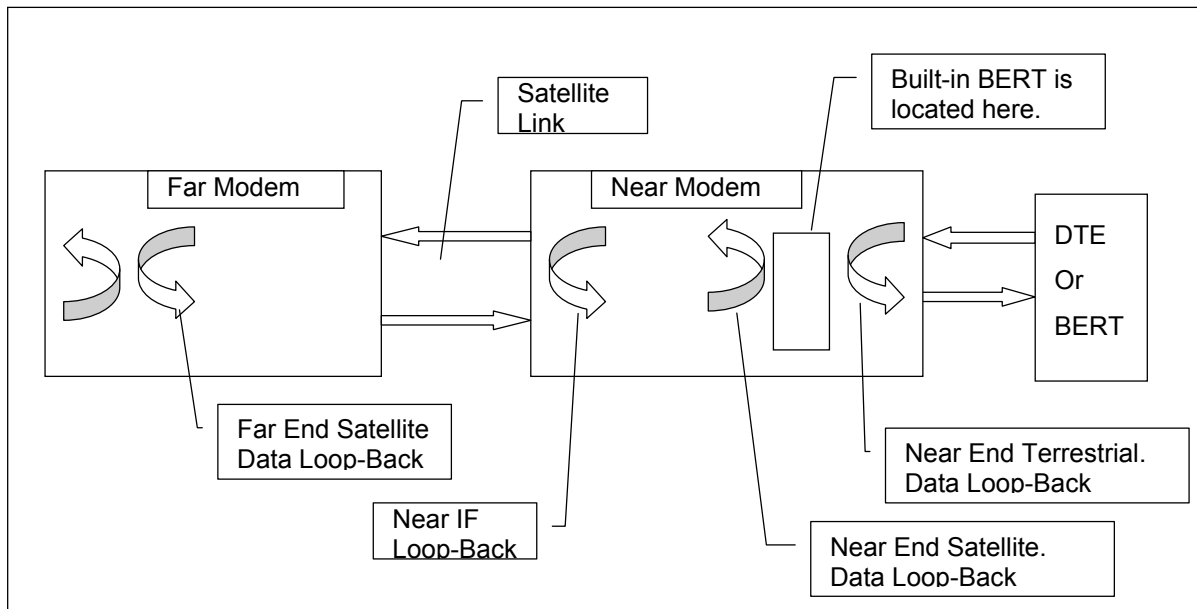
Each of these loop-back modes are individually programmable at the modem front panel or remote control interface. More detail on each of the typical loop back uses is given below.

- **Near End Terrestrial Data Loop-Back**: This will be the closest loop-back to the DTE or BERT. If data is returned and received properly it indicates that the DTE wiring and connection to the modem are correct. Note from the position of the built-in BERT in the diagram above that this test requires an external source of data. The PSM-500 can individually set the data path terrestrial side loop-back and the data path satellite side loop-back in **<Int'f: Test - Ter Loopbck>** and **<Int'f: Test - Sat Loopbck>** respectively.

- **Near End IF Loop-Back**: This second loop-back will verify the modem transmit data signal processing, modulation, demodulation, receive signal processing, and connection to the receive interface. The PSM-500 sets the IF loop-back in **<Dem: Test - IF Loopbck>**. Note in this test that the near end satellite loop-back function should not be enabled whether using the internal or an external BERT.

- **Far End Satellite Data Loop-Back**: This will test most of the satellite link as well as the functions checked in test 2 above. The signal is sent over the satellite (or test setup) and is looped back at the satellite side of the data interface on the far end. This tests both modems, the satellite link and originating end wiring. The PSM-500 sets the satellite side loop-back in **<Int'f: Test - Sat Loopbck>**. Note in this test that the near end satellite and IF loop-back functions should not be enabled whether using the internal or an external BERT. Setting this mode slaves the modulator timing to the demod timing and the FIFO buffer remains engaged if enabled.

In this type of testing an external BERT is typically set to provide a terminal timing output, while the connected modem is set to use the terminal timing signal as the transmit bit rate clock source. This modem can alternatively be set to use its internal clock for the transmit clock timing

and provide that signal to the BERT for synchronization. More information on using the PSM-500's internal BERT is given below.

4.1.2 Using the Built-in BERT

The PSM-500 contains a complete transmit and receive Bit Error Rate Test (BERT) set. Each direction is independent and can be used for either loop-back testing or uni-directional testing with another PSM-500 on the other end of the link. Since the test sequences used are industry standard it should also be possible to use the built in BERT with an external BERT and any brand of modem at the other link end, although this has not been extensively tested.

The Modulator (Transmit) BERT is enabled at **<Int'f: Test – Mod BER>**, and the Demodulator (Receive) BERT is enabled at **< Int'f: Test – Dem BER >**. With either transmit or receive being enabled by choosing either the 2047 or 2^23-1 test pattern options. Both should be the same to operate properly.

When the Demodulator receive BER Test is enabled the test results are available in the **<Int'f: Status - Test>** parameter item and the 7 items below it in the Interface Status column. These 7 items are:

1. Test BER – The ratio of errored bits to un-errored bits since the test began or was last reset. Expressed in bits per bit as x.yyy E-power where the mantissa (x.yyy) is always between 0 and 10 and power is the power of 10. For example 1.200 E-6 is 1.2 errored bits in 10^6 bits, or 1.2 errors per million bits. No errors are expressed as 0.000E-power. Since Errored bits do not accumulate during a sync loss, it is possible to lose sync for several seconds and not have the BER affected.

2. Sync Loss – The total number of sync losses that have occurred since the test began or was last reset.

3. Errors – The total number of bit errors that have occurred since the test began or was last reset. Errored bits do not accumulate during a sync loss.

4. Bits – The total number of bits that have been received since the test began or was last reset.

5. EFS – Error Free Seconds. The percentage of the total number of seconds with no errors occurring during that particular second. Compiled since the test began or was last reset. No errors are shown as "100.00%". Errored seconds accumulate during a sync loss.

6. Erred Sec – The total number of seconds with errors occurring during that particular second, since the test began or was last reset. Errored seconds accumulate during a synch loss

7. Total Sec – The total number of seconds since the test began or was last reset.

The test is reset or started over by viewing any of the 7 status items listed above and pressing the "Edit" or "0" key, then responding to the prompt "Enter to Restart" by pressing "Enter". A restart on any items resets all items and values.

A single error may be inserted when the BER test is active to verify proper operation by using the **<Int'f: Test – Mod BER>** parameter and pressing "3" and "Enter". This could be useful since it is sometimes difficult to see errors with the Turbo Product Codes FEC.

In the loop-back diagram shown above the BER test sets are physically between the satellite and terrestrial loop-back functions. Thus data traversing through either of these loop-backs does not involve the BER test sets, even if enabled. If the built-in BERT is being used the local "satellite loop-back" function should not be enabled.

The transmit output from the built-in BERT always faces toward the modem's transmit or satellite side, while the receive comes from the modem's receive side. It is not designed to transmit and receive signals from the terrestrial side of the data connection.

All of these settings and test results are also available via the remote control interface, allowing for automated and periodic testing of units not in service.

4.2 Troubleshooting

The following is a list of possible problems that could be caused by failures of the modem or improper setup and configuration for the type of service. The list is arranged by possible symptoms exhibited by the modem. When simple solutions yield not results then test equipment may be necessary to help isolate the trouble. A spectrum analyzer is invaluable. So is a Bit Error Rate Test set (BERT). The PSM-500 has a built in BERT function.

In most cases the first attempt at isolating a problem suspected of being within the modem is to place the modem in the Self-Test Mode. Since this the vast majority of internal circuitry then a pass on this test means that the user should probably concentrate on parameter settings and external equipment and connections.

One obvious and time-honored method of isolating problems is to substitute suspect equipment with known good equipment. Assuming that the configuration setting of the equipment is not the source of the problem, this method will quickly eliminate items from the potential source list. The two drawbacks to this method are the availability of extra equipment and the possibility of interaction between two or more equipment items.

Symptom: The Modem will not acquire the incoming carrier:

Possible Cause: Improper receive input to modem.

Action: Check that the receive cabling is correct.

Possible Cause: Receive carrier level too low.

*Action***:** Check that the receive cabling is correct, that the downconverter is properly set and that the LNA is turned on. If a spectrum analyzer is available, locate and measure the receive level, which should not be below –60 dBm absolute. At lower data rates the input level may be as low as –84 dBm.

Possible Cause: Receive carrier frequency outside of acquisition range.

*Action***:** Check the receive acquisition range is adequate for the possible system offsets. Setting the value to 30 kHz is a standard value encompassing all normal offsets. After acquisition, the actual receive frequency can be read from the front panel.

Possible Cause: Transmit carrier incompatible.

Action: Check the receive parameter settings and ensure that they match those on the modulator.

Possible Cause: Modem is in test mode.

Action: Check the modem front panel for yellow warning LEDs indicating a test mode is enabled. Self Test or IF Loop-back disconnects the Demodulator from the IF receive input connector.

Possible Cause: Interference on the satellite.

Action: The interference can take many forms. The most common are an adjacent large carrier, antenna feed polarization off resulting in carrier interference in opposite

polarization, intermodulation products. Most of these cases can more easily be determined with a spectrum analyzer. If possible move to another operating frequency to see if that resolves the problem.

Symptom: The Modem acquires a carrier but loses lock intermittently.

Possible Cause: Receive acquisition range set too narrow. When the carrier drifts outside of the acquisition range the demodulator looses lock until the carrier returns inside the acquisition range.

Action: Check the actual receive carrier frequency and the receive offset at the front panel and set the acquisition range appropriately.

Possible Cause: Receive level varying out of AGC range.

*Action***:** Check the actual receive input level at the front panel. Change the carrier input level to within the correct range. In Ku–Band systems, rain fade can cause significant receive level variance.

Possible Cause: Transmit or Receive Converter equipment noisy.

Action: The dependence up good phase noise in converter equipment is especially noticeable at low data rates and when using QPSK modulation. Very low frequency phase noise on the converter oscillators is very difficult to see or measure, but is detrimental to proper low data rate performance. Substitution of another modem will verify the correct modem functioning.

Symptom: The Modem output data is corrupted.

Possible Cause: Receive data or clock inverted.

Action: Check the current state of the Demod Clock and Data Phase. Try inverting the phase.

Possible Cause: Receive Carrier signal Eb/No is too low resulting in poor BER performance.

Action: Ensure that the transmit end is properly set and that the receive subsystems are all operating correctly. In a small station ensure that the antenna is "peaked" on the satellite. In a Ku-Band station, intense rain can cause poor receive performance.

Possible Cause: Transmit and Receive scrambler or differential encoder options do not match or not enabled. Note – The differential encoder in the PSM-500 is under processor control only, but this cause could apply to a mixed system linked to another modem.

Action: Check the current state of the Scrambler and differential encoder. In all operating systems the differential encoder/decoder and one of the available scramblers must be enabled.

Symptom: The Modem receive FIFO buffer indicates "Slip".

Possible Cause: The FIFO automatically re-centers when an overrun or under-run condition occurs.

Action: Check that the proper clocking options are used and the FIFO buffer is set large enough to handle the expected satellite Doppler shift over a 24 hour period. No amount of buffering will correct for different clocks on the input and output of the FIFO.

Symptom: Receive DTE equipment indicates "clock slip" or "sync lost".

Possible Cause: The FIFO automatically re-centers when an overrun or under-run condition occurs.

*Action***:** Check that the proper clocking options are used and the FIFO buffer is set large enough to handle the expected satellite Doppler shift over a 24 hour period. No amount of buffering will correct for different clocks on the input and output of the FIFO.

Possible Cause: Receive signal or clock inverted.

Action: Check the current state of the Demod Clock Phase. Try inverting the phase.

4.2.1 Onboard Diagnostic Indicators

There are 8 LEDs on the main PWB which provide diagnostic information about the status of various functions:

1. **DS1** - *MBIT FAULT-* (Red) – Indicates that the transmit bit timing is not synchronized. The most common reason for this fault should be that the modem is set for external Transmit Timing input and either none is present or the applied signal is off frequency.

2. **DS2** - MOD ENABLE-   (Green) – Indicates that the modulator hardware has enabled the transmit carrier.

3. **DS3** - Modulator FPGA program fault-   (Red) – Indicates that the modulator FPGA failed to program correctly.

4. **DS4** - *MSTP FAULT-* (Red) – Indicates that the transmit step synthesizer is unlocked. Normally this would result only from an onboard fault.

5. **DS5** - *REF FAULT-*   (Red) – Indicates that the onboard TCXO reference oscillator is not phase locked when set to an external reference input.

6. **DS6** - System Clock Alarm-(Red) – Indicates that the 80 MHz clock hardware has failed.

7. **DS7** - *DEM LOCK-*   (Green) – Indicates that the demod hardware has locked to an incoming carrier.

8. **DS8** - *DSTP FAULT-* (Red) – Indicates that the receive step synthesizer is unlocked. Normally this would result only from an onboard fault.

9. **DS9** - Demodulator FPGA program fault-   (Red) – Indicates that the demodulator FPGA failed to program correctly.

10. **DS10** - I channel FPGA program fault-   (Red) – Indicates that the I channel filter failed to program correctly.

11. **DS11** - Q channel FPGA program fault-   (Red) – Indicates that the Q channel filter failed to program correctly.

12. **DS12** - *MLO FAULT-* (Red) – Indicates that the transmit Local Oscillator synthesizer is unlocked. Normally this would result only from an onboard fault.

13. **DS13** - *DLO FAULT-* (Red) – Indicates that the receive Local Oscillator synthesizer is unlocked. Normally this would result only from an onboard fault.

14. **DS14** - Front Panel FPGA program fault-   (Red) – Indicates that the front panel FPGA failed to program correctly.

4.2.2 Onboard Processor Power-On Sequence and Diagnostics

The processor goes through the following sequence every time the modem is powered up.

1. Sets up the stack pointer and initializes the register bank;

2. Disables all interrupts;

3. All internal RAM and all external RAM is tested by writing to it and reading from it. If any value does not work correctly, the initialization is halted and an endless loop is entered putting out a square wave on ALARM LED;

4. The front panel is checked for presence.

5. Checks the Flash memory contents and calculates its checksum value. If the checksum does not correspond to that in the ROM, the initialization is halted and an endless loop is entered putting out a square wave on the ALARM LED;

6. The EEPROM is tested for specific flag bytes in its contents. If the flags are incorrect, the EEPROM is assumed to be corrupted and is re-initialized with the factory defaults, removing the current. A message is displayed on the front panel LCD.

7. Initializes all variables and internal components;

8. The standard or optional interfaces are interrogated for type and installed options.

9. Initializes the serial UARTs, A/D converter and internal timers, enabling these interrupts in the process;

10. Begins operating its main loop program which responds to control inputs, monitors and displays terminal and LED status, controls the modulator output, FEC, operating modes, etc.

4.2.3 Built-in Lamp Test

4.2.3.1 Lamp Test

The Front Panel LEDs and LCD display backlight are tested. This is meant to be viewed by an operator. During the 4 seconds of this test both alarm relays are forced off.

Eb/No, input level and offset frequency are all within limits. The internal BERT is used to verify no errors or loss of sync.

4.3 Updating Modem Software

The PSM-500 modem software and firmware are held in flash memory and can be field upgraded by several methods. The most common is to download newer software revisions via the Internet and install from a Window's type USB capable PC using the modem's USB control port. If a USB capable computer is not available software and firmware can be updated via the serial control port, but this method is not recommended because of the large amount of firmware and the slow serial connection.

We do occasionally add new features or correct operating procedures within the modem software that might lead to problems. When the operating software changes the Revision number is updated. Some changes may involve modification of the information or structure in the non-volatile EEPROM storage.

The latest versions of firmware, instructions and PC compatible update programs are available on the www.datumsystems.com web site, and should be checked for the latest instructions before attempting the procedures below

The complete software update "package" consists of two or three ZIP compressed files – One holding the Update program with a Window's Installer and the other two holding the firmware images that the Update program writes to the modem. There are separate firmware files for the main unit and the FEC card The following are typical of the file types and ZIP contents, but they may change as to provide easier operation – check the web site for the latest:

A. - M500UpdateFullVxxx.zip where xxx is the current version number of the M500Update program. Besides the Loader program itself this zip file also contains the full set of Visual Basic DLL and OCX associated files. The USB drivers needed for installation on a computer are typically separately packaged.

Once installed the latest version of the program itself without the other drivers and DLL files is available as **M500UpdateVxxx.zip** (note the "Full" is not in this version's name).

- M500Flash.EXE   PC based program to load software to the modem.

- Various DLL, OCX Visual Basic runtime routines necessary to run the M500Flash.exe program.

B. M500ModemUSBDriver.zip This program is only needed once on any computer to provide the USB driver.

- USB drivers for the FTDI USB interface – currently named FTD2XX.lib, sys, dll, ini, etc.

- Windows installer used to install the driver program and its associated files.

C. M500Ux.xx.yyy.zip where x.xx is the current version number and yyy is the applicable unit type as explained below.

- M500Ux.xx.yyy.fbf   Binary image of the modem's main Unit software/firmware. M500U is for the Unit where currently exists yyy values of:

    o   000 for a 70 MHz modem

    o   001 for a 140 MHz Modem

    o   040 for the L-Band Modems

D. M500Fx.xx.yyy.zip where x.xx is the current version number and yyy is the applicable FEC card type as explained below.

- M500Fx.xx.yyy.fbf   Binary image of the FEC cards firmware. M500F is for the FEC where currently exist yyy card types of

    o   001 for the standard FEC card containing Viterbi, Trellis Code Modulation (TCM) and Reed-Solomon

    o   002 for the enhanced standard FEC card containing Viterbi, Trellis Code Modulation (TCM) and Reed-Solomon, plus the TPC4K type Turbo chip.

    o   003 for the enhanced standard FEC card containing Viterbi, Trellis Code Modulation (TCM) and Reed-Solomon, plus the TPC16K type Turbo chip.

    o   004 Not defined yet.

In addition the user must supply a "PC" type computer running Windows and a USB A to B type cable to connect the PC to the modem. The USB type A connection goes to the computer and the type B connection to J10 on the rear of the modem. This is a normal serial cable available from many common sources and also used with many computer peripherals such as printers. Do not connect this USB cable until the software drivers are installed.

> *Although not recommended, if using a serial RS-232 connection to perform modem updates, the serial cable has a male DB9 connector on the modem end and normally a female DB9 connector on the computer end. Older computers may require a DB25 to DB9 adaptor on the computer end. The 9 pin cable is wired 1:1 with no crossovers (as in*

> *"null modem" type cables). This is a standard serial extension cable available at computer outlets.*

Any software upgrade requires a "Control Program" hosted on the computer which transmits or "Loads" the new software to the modem. The Control Program is available with the newer software revision. Currently the name of the control program is "M500 Update.exe". This Loader is an IBM PC Visual Basic based program that can be run under Windows 98, 2000 and XP. We now have a newer self contained M500 Update program capable of running under Windows Vista available on the web site. This version can also check a special web site on demand for newer firmware for the connected modem, making the process as painless as possible.

The Installation program must be run first to install the update program in the PC used for updating modem firmware. The M500Update program is specifically designed to stand alone if it is located in a directory with its VB DLL and OCX files plus the flash binary format files for the modem. It does not change the registry or appear in the "Start Programs" menu. The advantage of this is that it can even be run from the CD that comes with the modem (although that probably does not have newer flash files), or from a central networked computer location.

4.3.1 Update Software Installation –

There are two M500 software/firmware update programs available. The main one is the recommended M500 Update program that is very easy to use. The alternate is the M500FlashLoader program that may be required in special cases only. Both are briefly described below. More complete installation and usage information is available on the web and with the programs.

4.3.1.1 M500 Update Program

The M500Update program is designed to be very simple to install and use. It looks at the modem and the .fbf files in its own directory and determines if an update is available. You only need to push one button and the program will load the main unit and any FEC files needed by the modem. The program is normally installed in a folder/directory of your choosing, for example one named C:\My Documents\M500Tools. It is described above and on the "download" page of our web site.

Beginning with version 2.0 the M500Update program was renamed to M500 Up_date for programming reasons. These versions are needed to operate in Windows Vista operating systems. Newer versions of this update program are even easier to use. As of this writing version 2.10 is available. In this release a computer with web access can determine the Unit and FEC versions in the USB connected modem and then check the web for availability of later firmware. On command it can download the new firmware, unpack it and install it into the modem. It can even check for newer versions of the Update program itself. To use the latest implementation the user only needs the M500 Up_date.exe program and the USB driver to get new firmware and update modems.

4.3.1.2 M500 Flash Loader Program

This is an older, but more flexible program that operates in a slightly different manner than the normal M500 Update program: It is not recommended unless specifically required.

The M500 Flash Loader program can be "installed" and will appear in the Start Programs menu.

The Flash Binary Format files do not have to be in the same directory as the program.

It does not analyze the modem to determine if an update is needed based on those .fbf files.

It allows installing down rev software if required.

The installation program handles this location by default. The recommended method for installing the Update Software program is as follows:

1. Download the Full version of the update program which includes the program, associated files and USB drivers. Also download the latest firmware for your modem from the web site.

2. Unzip or extract the program files into the directory where you saved the download in step one. An alternative is to leave the downloaded program files compressed - either WinZip or Windows XP compressed folders will allow you to run the install program directly from within the compressed file.

3. Run the "Install.exe" file by double clicking on it. This will create the C:\Program Files\M500 FLASH Loader directory and place the program and associated files there. The USB drivers will be in a sub-directory named. C:\Program Files\M500 FLASH Loader\UsbDriver.

4. Unzip or extract the binary files into a suitable folder. You could use the C:\Program Files\M500 FLASH Loader directory, or chose one within My Documents such as "M500 Binaries".

5. Connect the computer to the modem via a USB cable. If the modem is turned off then turn it on. The computer will recognize and advise you that new hardware has been found and run the new hardware wizard.

6. If the wizard asks if you would like to connect to the Internet to search for drivers, select "No, not this time" and click "Next".

7. When asked if you want to "Install Automatically" or "Locate the drivers myself" or "Have Disk", select the self locate or have disk option and navigate to the C:\Program Files\M500 FLASH Loader\UsbDriver folder and there select the **ftd2xx.inf** file. Then let windows do the rest. If notified that the driver is not certified select "Continue Anyway". The supplied drivers are from a reputable source that manufactures the USB interface chip.

The modem has a complementary program which talks to the loader and controls re-writing of the flash memory. No actions to the modem are normally necessary before beginning update with the exception of removing it from service, and the M500 Flash Update program can take care of all tasks directly including finding the modem, determining if it has newer software/firmware versions available and preventing loading of incorrect firmware to the modem The modem is specifically designed to not accept firmware that is not made for it. For example the standard 70 MHz modem would reject firmware for a 140 MHz or L-Band Modem.

It is a good idea to see if a later version of the update program or the update instructions are available on the web. Those could be newer than the basic information given here.

4.3.2 Performing the Software/Firmware Update –

Once the PC program which does the actual update and communications with the modem is installed the process for accomplishing the actual update using the original "M500 Flash Loader" is as shown below.

> ⇒ **Note**: *For virtually all users the recommended program is the newer "M500 Up_date.exe" program available on our web site at* www.datumsystems.com. *This newer program in version 2.06 and later is significantly easier to use, works with any version of Windows including Vista, and can check a special web site for available modem and program updates on user command. This relieves the user from having to know about numbering schemes, modem types, etc. Use instructions are also on the web site.*

The M500 Flash Update program gives feedback to the user during the update process. If you suspect that something is not going correctly with the update process then wait until the current process is completed and contact Datum Systems via email with details of what is observed. We have tried very hard to make the program as robust as possible.

There are two types of software/firmware files that may be uploaded to the modem. One is for the main modem itself and its binary file name begins with "M500U". The other is update firmware for the particular FEC card that may be installed and its binary file name begins with "M500F". The update program is intended to determine which one of these may be required and which one should be loaded first.

All user settings and calibration data are maintained when newer software revisions are installed.

> ⟹ **CAUTION**: *The process of updating software will result in disruption of any traffic currently through the PSM-500. Upgrade should not be performed on a live traffic unit.*

> ⟹ **CAUTION**: *The process of updating software must not be interrupted once started. In the rare occasions when a new bootloader is installed in flash, failure to complete this portion of the loading process may result in complete loss of the modem programming. In this eventuality the modem must be returned to Datum Systems for software initialization and calibration..*

Complete update of the modem normally requires approximately 4 to 6 minutes. The process cannot be accomplished on multiple modems simultaneously.

Before performing an update check the web site first to determine if there is a later firmware revision and if there is any advantage to performing the update. The firmware revision on the web is compared to that in the modem.

To determine the modem's current Unit firmware revision go to the front panel and navigate to the **<Unit: Status - Version>** parameter. It will display a number including two decimal points, for example 0.09.000 where the 0.09 represents the firmware revision "0.09" of modem type "000". In this case the 000 type is a 70 MHz modem. Then if on the web site there is found for example a firmware updated version number 0.12.000 that indicates that the latest revision available for the 70 MHz M500 modem is 0.12. The file can be downloaded, unzipped and placed in the C:\Program Files\M500 FLASH Loader directory where the program can find it. It may alternately be placed in another directory or folder and you will have to browse to locate the binary file.

And finally the procedure:

1. Insure that the modem is connected to the PC via a USB type A to B cable, and the modem is powered on. The USB drivers for the modem should have already been installed.

2. Start the update program via "**Start – Programs – M500 FLASH Loader"** menu, and the M500 Flash Loader program should start and recognize the attached modem. In a few seconds the modem's serial number and other information will be shown in the left panel displaying a window similar to that below.
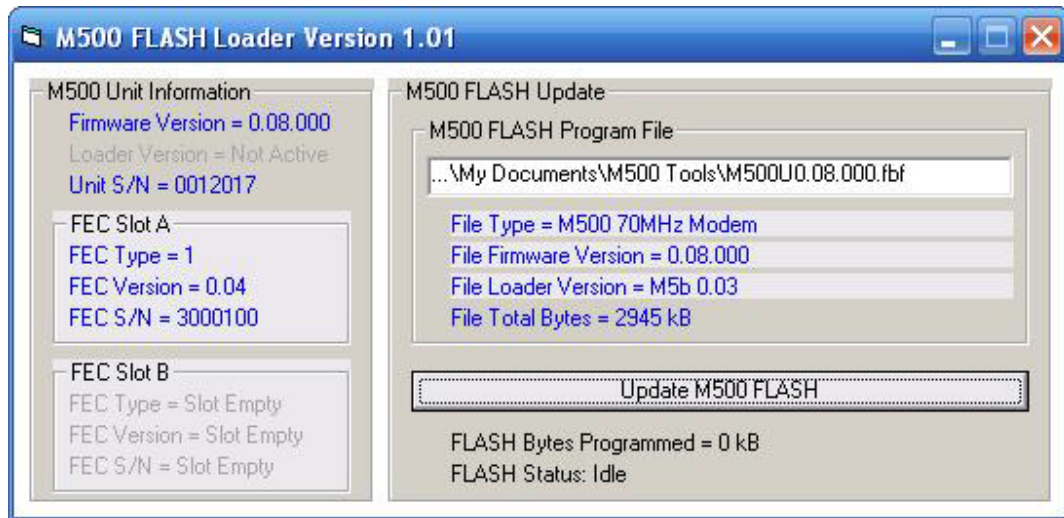
3. Click on the entry box below "M500 FLASH Program File" in the right pane. This will bring up a file open dialog box. Browse to the location of the flash binary format (.fbf) files downloaded with the newer firmware version, and select the M500F or M500U file desired.

4. The program window should now show that file selected, and if it is the same as the current file loaded into the modem it will display as below:
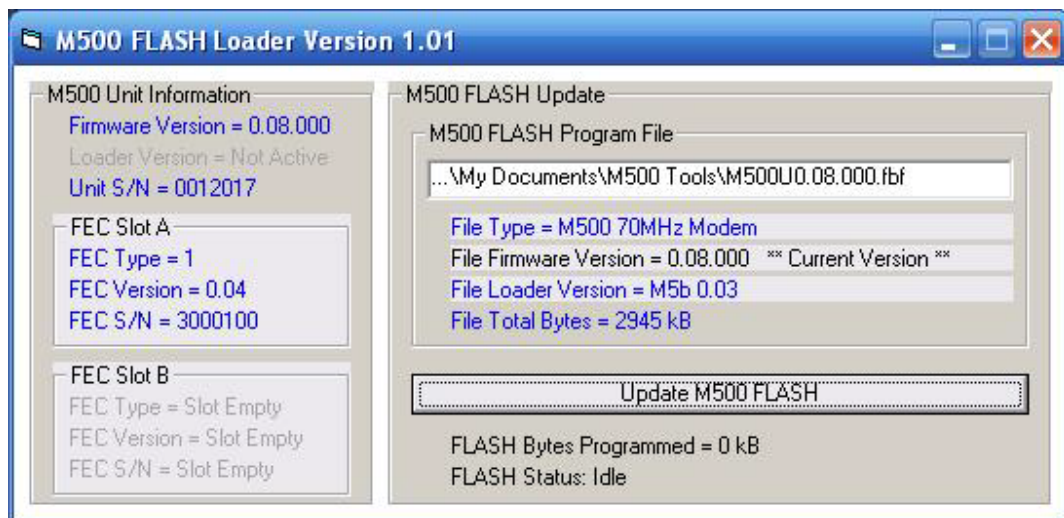
Not the "** Current Version **" after the File Firmware Version = 0.08.000 indicating the selected file is the same as that loaded.

5. If the binary file versions available in this directory are newer than those in the modem, then select the "Update M500 FLASH" button and the update process will begin.

6. When completed the modem will reset itself and the revised information will be displayed in the left pane. If you need to also load an FEC firmware binary file, then repeat the process by selecting that file and updating again. When finished simply end the M500 FLASH Update program and disconnect the modem from the computers USB port.

NOTE: The IF version of the 70 MHz, 140 MHz and L-Band modem is determined by hardware only, and has nothing to do with the software. The modem will refuse to accept attempts to load the wrong software intended for another version.

4.4   Upgrading the Modem Feature Set

Each of the modems in the PSM-500 series is available currently with 3 different "Feature Sets", M505, M511 and M523, representing basic capabilities that suit it to certain tasks. They are currently given a feature set code representing the elements of those features. Refer to Section 1.1.2. which shows the capabilities of each standard feature set.

Upgrading from one feature set to another is accomplished in the following manner.

Contact your local reseller or Datum Systems directly requesting an upgrade and noting the Unit Serial Number, current version and the version to which you would like to upgrade to. There are only 3 upgrades possible at this writing, from the M505 to the M511, from the M511 to the M523 and from the M505 to the M523.

Upon purchasing an upgrade you will be provided with a special 16 digit code which is used to enable the upgraded features. The code is unique to this unit's serial number and will not work in any other modem.

To insert the code go to the **<Unit: Status - Feature>** parameter using the front panel keypad. Then enter the 16 digits of the given code directly using the digits on the keypad, then press the "Enter" key. If correctly entered the modem will now display the new feature set and list the available modulation modes above the standard set in the M505. For example when the M523 feature set is enabled the **<Unit: Status - Feature>** parameter will display "M523-8PSK-16QAM".

Feature sets can only be upgraded. There is no code to downgrade a feature set to a lower one.

4.4.1   Future Software Options –

In the future we may have additional options which can be enabled via an "unlock code". For example, newer FEC options based on Intellectual Property (IP) which we must license and charge for, may fit into this category. The procedure for these options will be similar to that described above and explained in the transmittal that accompanies the unlock code.

4.5   Frequently Asked Questions - FAQ

OR   How Do I?,
Why Doesn't It?,
and Where Is?

This Section is intended to form a smart index pointing to proper sections of the manual with information on performing common actions or answering common questions. The presentation here is divided into 5 common areas – Link Setup, Front Panel, Remote Control, Data Interface and Manual.

A. Link Set Up and Installation.

A.1   Compatibility with other Modems.

How do I make the PSM-500 talk to a xxxx brand modem on the other end of a link?

The PSM-500 has several new programmable features which should make this easier than ever. First, where possible if both modems adhere to Intelsat IESS standards then those defined parameters should be set the same. Still all modem manufacturers have their own conventions for setting parameters with no specified standard, so for example some modems may have a different modulation sense for data bits than others. This would make no difference between two modems of the same type, but would invert data between modems of different types on each end of a link. Most items of this type are programmable in the PSM-500 modem.

The PSM-500 also has a significant number of FEC compatibility modes for aid in achieving compatibility with some competitive modems, especially in Turbo FEC modes. These modes are denoted by the FEC Option type "CT" on the front panel selection.

Is Datum Systems' Turbo Product Codes compatible with that made by other modem manufacturers?

The PSM-500 also has a significant number of FEC compatibility modes for aid in achieving compatibility with some competitive modems, especially in Turbo FEC modes. These modes are denoted by the FEC Option "CT" on the front panel selection. These modes are typified by the modes used in the CDM5xx and CDM6xx series of competitive modems.

There are several modes that are probably **not** compatible for several reasons. First is that there is no standard for implementation of TPC. Second, Datum Systems spent a lot of time and development in implementing a full set of TPC parameters (i.e. Rates 1/2, 3/4 and 7/8), and insuring the absolute best performance with no compromises. We have seen no other TPC implementation that even comes close to ours. Third, because we have many customers that use our modems in systems requiring low latency we implemented an alternate "Short Block" mode that reduces the typical TPC delay by approximately 1/3. The techniques used in this TPC achieve the best performance of any modem currently produced. Our latest TPC "Advanced" modes are also proprietary to Datum Systems, simply because we know of no one else using the specific parameters.

Is the PSM-500 Remote Control Protocol Compatible with the PSM-4900?

The PSM-500 has significant new capabilities and features that cannot fit into the structure of the PSM-4900 protocol. However, the PSM-500 will respond to properly formatted PSM-4900 binary control packets within the capabilities of the PSM-4900. This allows mixed systems of 4900 and 500 series modems without initially changing control software. The compatibility does not currently extend to operation over the link on the MCC channel.

My PSM-500 and PSM-2100 do not agree on the Eb/No parameter with Reed-Solomon Codec installed?

The PSM-2100 was designed before Intelsat IESS 309 added the section defining how the Eb/No was measured with Reed-Solomon concatenated coding, and uses a different method. The method is encapsulated in ASIC and not changeable. Unfortunately the IESS lists two possible methods of computing the Eb/No with Reed-Solomon. The PSM-500, being of more recent design, adheres to both IESS definitions by allowing the reference point to be varied. The two therefore may read differently, but actually achieve the same performance. Refer to Appendix RS for more information on setting the calculation parameter.

Does the PSM-500 have AUPC and AUFC and are they compatible with the PSM-2100?

The PSM-500 does not have AUFC, but retains the AUPC from the PSM-2100 type modems. Like the PSM-2100 the built in AUPC (Automatic Uplink Power Control) can be enabled only if the multiplexer option is installed or if an external communications channel is provided.

The PSM-500 AUPC is compatible with that in the 2100 when the PSM-500 modem IBS Multiplexer is placed in the "Enhanced" mode. It is not compatible in the "Custom" mode.

How do I set up the IBS Multiplexer and AUPC Option in the PSM-500 to be compatible with the PSM-2100 Modem?

The PSM-500 Modem is capable of varying the parameters for the IBS Multiplexer beyond the capabilities of the PSM-2100. To maintain compatibility with the PSM-2100 specific similarly named options are available in the PSM-500. These modes are the "Standard" and "Enhanced" multiplexer operating modes. The 500's "Custom" mode is not compatible with the PSM-2100.

For the AUPC to function and to be compatible with a PSM-2100 it must be set in the "Enhanced" mode.

How do I set up the Reed-Solomon Option in the PSM-500 to be compatible with the PSM-2100 Modem?

The PSM-500 Modem is capable of varying the parameters for the Reed-Solomon Codec beyond the capabilities of the PSM-2100. To maintain compatibility with the PSM-2100 specific similarly named options are available in the PSM-500. When enabled the RS FEC Mode should be set to "IESS-308". This will automatically set the "n", "k" and "Depth" options to 126, 112 and 4 respectively. The 500's "IESS-309" and "Custom" modes are not compatible with the PSM-2100.

A.2   Operating and Performance Questions.

There are so many options and parameter settings! Where do I start?

The PSM-500 is highly programmable. This can make the set-up daunting at first. If you are unfamiliar with the common terms and modes used in satellite communications you should first refer to Chapter 2 of this manual "*Installation and Setup*". As a starting point the modem can also be taken to a default basic set of operating parameters by using the front panel **<Unit: Configuration - Recall>** parameter and select option "0" or "Factory". From that point you make necessary changes to set the desired configuration. Once all parameters are set as required the configuration can be saved using the **<Unit: Configuration - Store>** control. From there you can always go back to this configuration by recalling it.

Why doesn't my PSM-500 talk to another PSM-500 over the satellite? I have set all the parameters the same.

Any satellite modem has a significant number of parameters, which are settable in order to achieve the maximum performance at the least cost. Because there are so many parameters it is possible to have one unit with a slightly different parameter set than that at the other end of the

link. If after insuring that all parameters are set the same and that the acquisition range is correct and that there are no interfering carriers; one other method is to take both modems back to the factory default condition and rebuild the configuration from "scratch". Use the front panel **<Unit: Configuration - Recall>** and select option "0" or "Factory". You may want to save your current configuration before resetting to the default.

What is the delay from end to end using the PSM-500?

The satellite link itself represents a fixed and very slightly variable delay due to the distance of the satellite from the two stations linked. This delay is approximately 250 milli-seconds. In addition Appendix A lists the specified fixed and rate dependent delays incurred in the modem's transmit and receive processing, including those in the IBS Multiplexer and Reed-Solomon if equipped and enabled.

Can I use the PSM-500 to help align the station antenna?
Is an AGC output provided to feed to automatic antenna positioning equipment?

Yes - The PSM-500 has a single analog output that is produced by the main processor and converted to analog by a D/A converter. The parameter selected for this output can be either the AGC, Eb/No or Mod CXR Level selected in the **<Unit: Monitor - Mode>**. The slope and polarity are selected using the "Zero" and "Full" parameters below this. The signal is available at the rear panel on the J5 Alarm Connector, pin 5 with the Ground return on pin 6. See Installation Section 2.3.3, "*Alarm Connection*", and Operations Section 3.11 for more information on connection and use of the monitor function.

The AGC has been the classic parameter used for this type of function, but the PSM-500 provides an output that may be better in most situations. That is the Eb/No, which is a function without the slope changes and negative signal sense of the AGC signal.

Where is the "Eye Pattern" test points for the I and Q channel receive signals?

The PSM-500 does not have an analog test point to view the eye pattern. All information at this point in the receive chain is digital and measured by the modem processor. The result of this measurement is presented as the Eb/No. If it is absolutely essential to view the eye pattern as analog test information, contact the factory for availability of a special test fixture for conversion.

What happened to the Burst Modulator mode in the PSM-500?

The PSM-500 has the basic circuitry necessary to implement burst modulation. The burst demodulation scheme compatible with the modulation used in the PSM-2100 is no longer manufactured, and there is no clear standard for implementing this capability. Modifying the PSM-500 to work with a specific burst demodulator scheme is an option which requires contacting the factory for availability.

How do I use the modulator and demodulator functions to invert the spectrum?

These options were added into the PSM-500 to aid in building specialized systems which may invert the spectrum sense of the received carrier. The main cause of this would be an up or down converter which performs a spectrum inversion.

How do I use the modulator and demodulator functions to vary the FEC C0 and C1 values?

These options were added into the PSM-500 to help achieve compatibility with other brands of modems at the other end of a link. These parameter settings also allow changing the modulation of adjacent carriers on the satellite so that a demodulator will not lock to them. This has value if the carriers are placed closer than the required receive acquisition range. Using this scheme requires the use of the demodulator search mode.

Intelsat in the latest IESS 308/309 has changed the definition of the C0 and C1 values. This option allows compatibility with any definition.

How do I determine the transmitted "Symbol Rate" of the modem?

This particular parameter used to be a lot simpler to define. With the introduction of Turbo Product Codes coupled with all the other modem modes and options like programmable IBS multiplexer data load it is now extremely hard to define. The modem knows though, and it is available at the front panel parameter showing the current transmit/receive symbol rate. It is in the **<Mod: Test – Symbol Rate>** and the **<Dem: Test – Symbol Rate>** parameters.

A.3   Why does It do that?

The modem is operating fine and then suddenly will not lock!

You probably have the differential encoder/decoder turned off. It is only provided as a control for very special cases and should normally be set to "Enabled".

The modem changed its operating parameters without me doing anything!

The ACR or Automatic Configuration Recovery feature is possibly enabled by setting one of the **<Unit: Config – Recall X>** parameters set to a non-zero value. This will change the modem configuration if the receive carrier is lost longer than the number of seconds entered.

The **<Unit: Config – Power-Up>** parameter may be set to change to a specified configuration on power-up. The normal setting for this is "Last" (0).

B. Front Panel Control

What happened to the "Differential Encoder/Decoder parameter?

In normal operation there is no need to disable the Differential encoder or decoder. We only found that occasionally someone disabled it and then had problems locking up to carriers, so this capability was initially removed from front panel control. All of the latest firmware however now allows this control, so you may need to update your firmware.

How do I enter a number with a minus sign?

At any time during the "Edit" process the "+/-" key will change the sign of the current entry (if the change is possible). In the quick edit mode this can be the first key pressed, so for instance, if the current setting for modulator transmit output level is –10 dBm then pressing "+/-, 12" will enter a value of –12 dBm. You could also press "1+/-2" or "12+/-" with the same result.

Why doesn't the PSM-500 front panel act like the PSM-2100 or PSM-4900? [and] How do I make it act like the PSM-2100?

The PSM-500 has many more features and programmable options than the PSM-2100 modems. A close match is achieved by disabling the "quick" entry mode and remembering to press the "Edit" key first instead of the "Enter" key. Once you become accustomed to the "Quick" entry mode and using the change sign (+/-) and decimal point keys you will find it more convenient than any entry on the PSM-2100.

Why does the transmit carrier turn off whenever I make a change?

First the transmit carrier can be set to a mode which will turn the carrier off if any change is made that would result in a possible interference with other carriers on the satellite. This mode can be set to one of three states: Automatic, Confirm or Manual. Automatic will turn the carrier off during the parameter change and return the carrier on (if currently enabled) after the change is completed, Confirm will ask if the carrier should be left on (requiring a "yes" or "no" answer), while

Manual will always turn the carrier off after a change. This option is set in **<Mod: IF – Mute>**. More directly the setting described is probably set to "Manual" mute mode.

Why can't I find or see a certain option parameter that is shown in the tables?

Many parameters are only available when another option has been enabled which requires that parameter. For example, the **<Demod: IF – Sweep Time>** parameter is only visible if the **<Demod: IF – Sweep Mode>** is set to "Search". These options are shown in the tables as gray to indicate this status.

Can I control the far end modem from the front panel of a local modem?

The PSM-500 has the ability to control the far end modem (when linked and locked) from a local modem, but only using the remote control port. This ability requires enabling the Multiplexer option. Control from the front panel is prone to possible mistakes that would lead to accidentally setting the remote modem in a state that could not be recovered without going to the remote site.

The far right "Remote" LED is blinking. What does it mean?

The Unit Remote Activity parameters allow setting this lamp to blink when activity is detected on the USB or serial remote control ports. The same is possible for the "Local" LED using the Unit Keyboard Activity control.

I seem to have no modulator or demodulator functions available?

There are two reasons that could explain this. First, there are some units sold with only one function installed for special purposes. These units would have a model number indicating this such as PST for a Modulator transmit only or PSD indicating a Demodulator receive only.

The other reason could be that the Modulator or Demodulator is disabled. To check and enable if desired, go to the **<Unit: Config – Modem>**.parameter which shows what is enabled and allows changing.

What do the abbreviations on the front panel and in the manual mean?

See the abbreviations in FAQ Section E below.

C. Remote Control

Where is the ASCII Control packet structure in the PSM-500?

The PSM-500 and the PSM-4900 modems do not have an ASCII control packet protocol, only the binary packet protocol. The SnIP however does have a fairly complete command line driven control method via the "m500ctl" program. In addition the SnIP can potentially control multiple modems connected via its external RS-485 control port.

Can I use the USB connector at J10 to remotely control the PSM-500?

The USB connector is mainly intended for firmware updates requiring a faster speed than the RS-232/449 connection can supply. It is possible to control the modem in binary packet mode via the USB connection. However, this connection does not use or accept addresses in the packet structure, so it will likely require re-writing your packet routines.

You cannot currently use the USB connection for "Terminal Mode" control.

Is there a "compatibility" mode for the remote control binary packet protocol that looks like that in the PSM-4900?

Yes. The new PSM-500 design dictated a new structure to implement the significantly greater number of commands available in the PSM-500. Many items such as the interface structure, data rates and available options are so different that creating a compatible command set was

impossible. However the PSM-500 actually contains both its own and a copy of the PSM-4900 protocol, allowing the PSM-500 to accept and respond to PSM-4900 packets within the limitations of the PSM-4900 capabilities. This allows mixed systems of 4900 and 500 series modems without initially changing control software. The compatibility does not currently extend to operation over the link on the MCC channel.

Is there a "compatibility" mode for the remote control binary packet protocol that looks like that in the PSM-2100?

No. The new commands dictated a new structure to implement the significantly greater number of commands available in the PSM-500. Many items such as the interface structure, data rates and available options are so different that creating a compatible command set was impossible. The packet structure itself is virtually identical though and in most cases the new command set can be accommodated by a "driver" tailored to the PSM-500.

D. Data Interface

How do I make a cable to connect to my V.35 (or EIA-530) device?

See the "Installation" Chapter 2 and Appendix C on "Cabling Specifications" which shows how to make cables to interface between the modem's DB37 connector and other types of common connectors used.

Where do I get a "Y" cable to implement 1:1 redundancy?

These may be purchased from Datum Systems or it is possible to build your own. The connections are discussed in Chapter 2 "Installation" and shown in Appendix C, "*Cabling Specifications*".

Why do I keep getting "sync losses" on my link? Or why does a BERT test show "sync losses"?

This is usually a sign that some section of the link has a clock or data inversion. See Chapter 4 of the manual for "Loop" testing to try to determine where the problem is and correct either the wiring or change the modem data or clock sense.

Why does the modem occasionally fail to operate with my DTE equipment, and to correct it I have to invert the data or clock?

The only cause in an otherwise functioning modem for this symptom is that the differential encoder/decoder is turned off. Modems use the differential encoding to determine the proper relationship between the clock and data. If the encoder is turned off the modem has a possibility of locking to a signal with the wrong phase. For all normal operation of the modem the Modulator differential encoder and the Demodulator differential decoder must be "Enabled".

The Turbo Product Codes (TPC) option does not use the differential encoder, and when it is enabled the differential encoder and/or decoder is turned off and the option is removed from the parameter matrix. Other modes also automatically control the differential encoder and decoder in the PSM-500, but a linked modem may have the ability to turn it on or off.

How do I use the built-in Bit Error Rate Test (BERT) set?

See Maintenance Section 4.1.2 for information on using the built-in BERT. The PSM-500 BERT now has the ability to be switched to look at the data line side.

Can I use the built-in Bit Error Rate Test (BERT) set to test the line or DTE side equipment?

Yes with reservations. The BERT is designed to normally transmit and receive to the modem side. New in the PSM-500 is the ability to electrically switch the direction that the BERT "looks"

toward the line side. However, because of the hard wiring of the interface the pinout is fixed as a DCE device. See Maintenance Section 4.1.2 for information on using the built-in BERT.

Why doesn't my 1:1 redundant switch on certain alarms?

The 1:1 redundancy logic is programmable on two levels. First is the **<Unit: Redundcy – SW Rqst>** parameter which selects whether a switch is requested on all alarms, alarm A and/or alarm B. If it is set to any options but "On All Alarms" then the particular alarms that are summed into the A and B alarms are themselves programmable, creating the second level. See the discussion in section for more information.

E. Manual

What do the abbreviations on the front panel and in the manual mean?

A good example is the display and manual representation "Redundcy   SW Rqst". Unfortunately the display does not hold enough characters to display the full text of "Redundancy Switch Request". Following is a list of abbreviations used.

Abbreviation	Full Text
1:1, 1:N, M:N	One for One, One for N and M for N. All redundancy switch types.
ACR	Automatic Configuration Recovery
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
ALC	Automatic Level Control
Alm	Alarm
Alt	Alternate
AUPC	Automatic Uplink Power Control
AUFC	Automatic Uplink Frequency Control
BER, BERT	Bit Error Rate, Bit Error Rate Test
BUC	Block Up-Converter
Cal	Calibrate
Clk	Clock
Config	Configuration
Cntst	Contrast
CXR	Carrier
Dem	Demodulator
Dif	Differential
ESC	Engineering Service Channel
Erred	Errored
FEC	Forward Error Correction
Freq, Frq	Frequency
Frmt	Format
HSSI	High Speed Serial Interface (used with routers)
IDcOff, QDcOff	I and Q channel DC Offset
I/O	Input/Output
Int'f	Interface

Abbreviation	Full Text
Keybrd	Keyboard
LCD	Liquid Crystal Display
LDPC & FLDPC	(Flexible) Low Density Parity Check FEC
LNB	Low Noise Block downconverter
LO	Local Oscillator
Loopbck	Loop-back
Lvl	Level
Max	Maximum
MCC	Modem Control Channel
Min	Minimum
Mod	Modulator
Mux	Multiplexer
Opt	Option
OverHd	Overhead
RCV, Rcv	Receive, into the Demodulator
Redundcy	Redundancy
Ref	Reference
Rqst	Request
RS, R-S	Reed-Solomon – Type of FEC
Sat	Satellite
SCPC	Single Channel Per Carrier
SER	Symbol Error Rate
SnIP	Satellite network Interface Processor, our name for an Ethernet Interface running Linux.
SW, Sw	Switch
Sync	Synchronous or Synchronization
SysClk	System Clock
Ter, Terr	Terrestrial – Line side of modem
TPC	Turbo Product Codes – Type of FEC
Tst	Test
USB	Universal Serial Bus
VSAT	Very Small Aperture Terminal
XMT, Xmt	Transmit, from the Modulator