DATUM SYSTEMS

Datum Systems

PSM-2100 & PSM-512

VSAT/SCPC 70 MHz Modem

Installation and Operation Manual

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Section One - PSM-2100 & PSM-512 Modem Description

1.0 Introduction

This manual applies to both the PSM-2100 and PSM-512 Satellite Modems. The PSM-512 is identical in all respects to the PSM-2100 except that the upper data rate is limited to 525 kbps for both transmit and receive operation. The modem is referred to as the “modem” or PSM-2100 in the remainder of this document.

The Datum Systems’ PSM-2100 VSAT/SCPC Satellite Modem is a microprocessor-controlled Binary Phase Shift Keyed (BPSK) or Quadrature Phase Shift Keyed (QPSK) Modulator and Demodulator for use as part of the transmitting and receiving ground equipment in a satellite communications system. The modem is designed for service in two different types of satellite systems. Either TDMA systems where incoming signals to the modem are continuous in nature and the outgoing signals from the modem can be operated in a “burst” mode, or an SCPC system where two modems are set for continuous operation with each other.

The modem is designed to be easily integrated into either a master or remote station via rack mounting. Modern design allows the PSM-2100 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.

1.1 Modem Capabilities

1.1.1 Applications

Following are just a few representative forms of satellite communications links and networks in which the PSM-2100 modem may be used.

1.1.1.1 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-2100 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 results in the absolute minimum power requirements, which equates to the minimum operating costs and maximum margins.

Ku Band satellite systems are subject to changing performance due to rain at one or more sites. The PSM-2100 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.

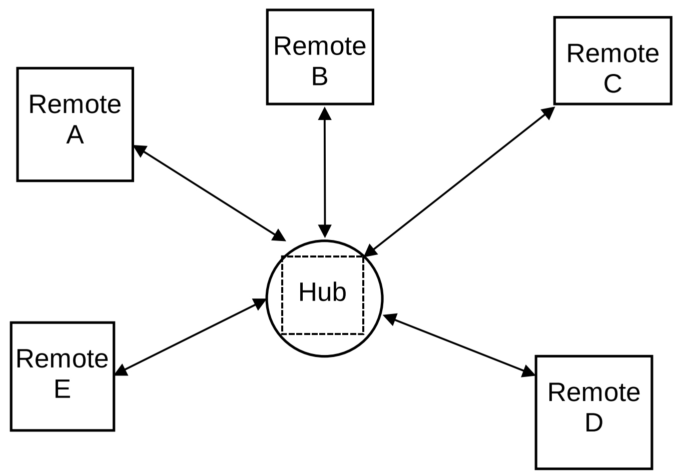
1.1.1.2 SCPC Point to Multi–Point Links in a Broadcast Application

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.

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 are shared by the receive of all the remotes.

Figure 1-1. Star Network Configuration



1.1.1.3 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. 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. The resulting link diagram looks like a mesh of interconnects.

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-2100 modem has two methods to significantly reduce this time:

1. First, the receive acquisition range can be programmed to a small range close to where the signal should be. If a database of known offsets in the system is kept and used to direct the receive frequency, and the search range is set to less than +/-1 kHz, the lock up time can be made less than 10 seconds.

2. Second, and much more valuable, is the fast acquisition digital processor used in the PSM-2100. This DSP 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 second at 9.6 kbps in QPSK mode over +/- 30 kHz, and much less in BPSK mode.

1.1.1.4 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-2100 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.

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-2100 modem is ideally suited for both modem applications at both low and high speeds.

1.2 Modem Functional Assemblies

The PSM-2100 VSAT/SCPC Modem consists of seven main functional elements arranged on four 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 modulator with carrier generation in the 50 to 90 MHz range.
2. The Modem digital PSK demodulator accepting signals in the 50 to 90 MHz range.
3. The Modem microprocessor monitor/control subsystem.
4. The Modem Digital Signal Processor Acquisition subsystem.
5. The Data Interface Assembly. An optional Data Interface also contains the IBS Multiplexer / Reed-Solomon concatenated codec functions.
6. Front Panel Control Assembly.
7. Power Supply Assembly.

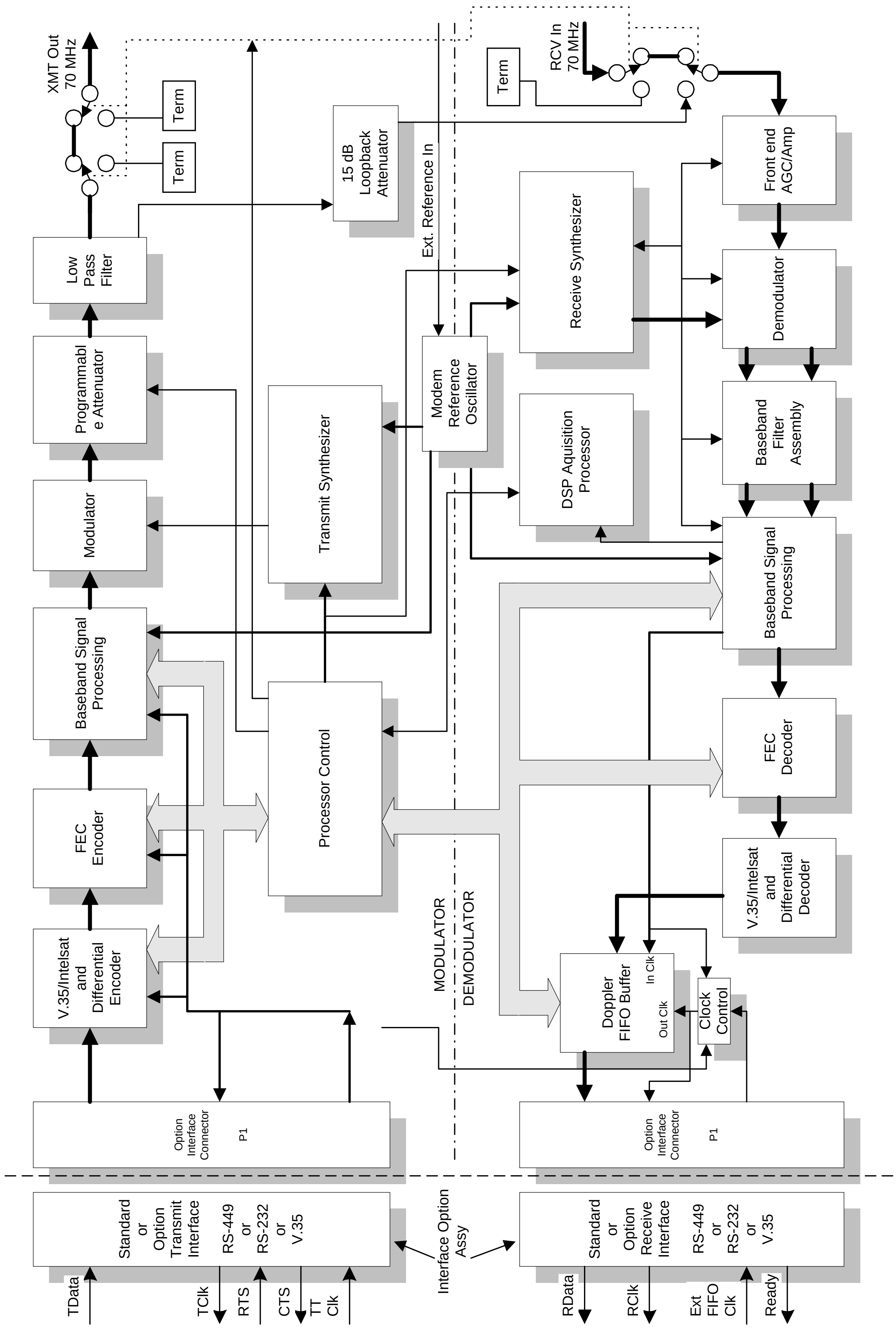


Figure 1-2 - PSM-2100 Modem Block Diagram

Figure 1-2 Modem Block Diagram

1.2.1 Modulator

The PSK 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 RS–449 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 3.6 kbps (BPSK, rate 1/2) and 2,100 kbps (QPSK, rates 3/4 or 7/8). Refer to the specification in Appendix A for exact rate capabilities. The data is then convolutionally encoded for Forward Error Correction (FEC) at rate 1/2, 3/4 or 7/8 resulting in an encoded signal at between 3.4 and 516.7 Ksps (kilo symbols per second). The convolutional encoder can be programmed for rate 1/2, 3/4 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.

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 48 to 88 MHz range with 200 kHz step size. A Direct Digital Synthesizer (DDS), consisting of an NCO and A/D 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 added to 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.

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. Two mixers are 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 0 dBm into 75 Ohms. An output attenuator controlled by the onboard processor is used to set the modulator output level over a range of –5 to –25 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 EEPROM.

The two physical adjustments in the modulator are the I and Q channel phase and amplitude balance settings performed in factory calibration. These two adjustments are intended to last the life of the unit without requiring resetting.

The transmit synthesizer operates in 1 Hz steps from 50 to 90 MHz and the frequency can be programmed by input to the processor from the front panel or the command interface. Modulator and Demodulator frequency settings are normally stored in EEPROM for return to the last set frequency on powerup.

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” section of this document. The burst mode allows multiple station modulators to link up consecutively with a single master station “burst demodulator”.

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, allowing inputs over that range while still meeting performance criteria over the range of –20 to –60 dBm. 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 can be viewed at “DEM I” and “DEM Q” test points respectively on the main PWB.

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 and has two tuning components; the LO step synthesizer used to tune in steps of 200 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 ±200 Hz to ±1.25 MHz.

The I and Q channel baseband outputs of the Costas Loop demodulator are filtered via the variable receive filter and then digitized using two 6-bit flash A/D converter. The A/D output is sent to the input of the Viterbi FEC convolutional decoder circuit. 3 bits of the A/D converter are used for “soft decision” decoding in the FEC for 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 sweep by more than 2 orders of magnitude.

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

1. 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 decoder uses a single IC Viterbi decoder 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 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 powerup. The resulting received data and clock signals are sent to the interface assembly.

1.2.3 Modem Bit Rate Timing

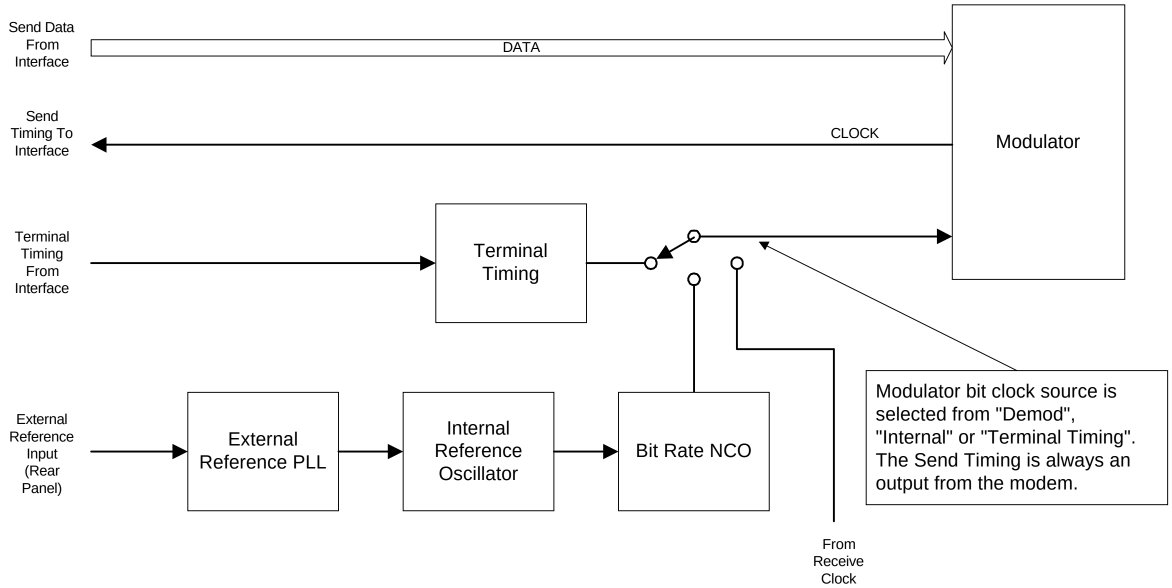
The Modulator and Demodulator each have 3 possible sources for their bit rate timing.

The Modulator always outputs the Send Timing signal, but the source of this timing may be either the Internal Reference, The Demodulator Receive Clock or an external input on the Interface Terminal

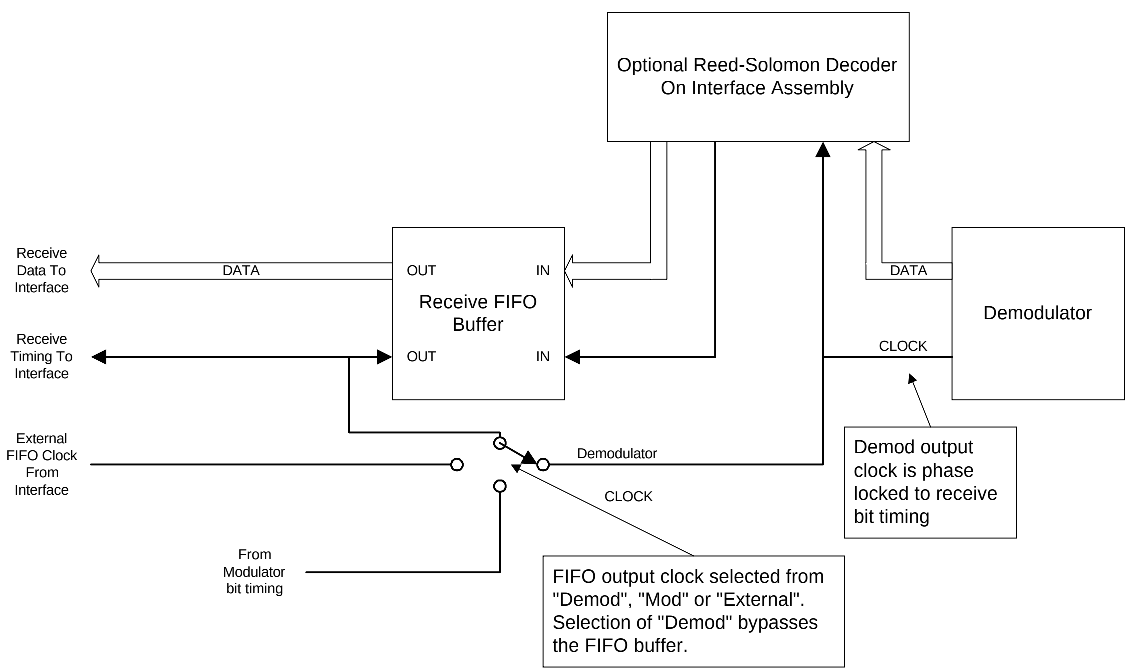
Timing input. The modem's internal reference is a 2.5 parts per million clock oscillator which is sufficiently accurate for most applications. If system timing requirements dictate a better reference, the internal oscillator may be phase locked to an external reference applied at the rear panel.

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 systems 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 the Demodulator Receive Clock, the Modulator Clock or 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.

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 is an 8051 type microcomputer operating at a clock frequency of 11.0592 MHz. This frequency results in execution of most operations in approximately 1 to 2 micro–seconds. This CPU clock is divided to derive the control communications baud rates. The processor uses external address and data buses to connect to external EPROM containing the instruction code. The processor uses both internal and external RAM for all operations. 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 onboard peripherals which do not require fast access. These include external EEPROM for storing nonvolatile configuration information, including all parameters necessary for a unit to return to the last operating state on power-up, and the interface card and step synthesizers.

The control processor also contains an internal 8-Channel 8-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 ASIC DSP circuits and their interface to the processor. Such parameters as the current Es/No and receive offset frequency information are read by the processor from the ASIC DSPs while most configuration information is written to the ASIC DSPs.

The control processor uses its internal 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. The UART can be operated from 150 bps to 19.2 bps under control of the front panel or remote control itself.

The control processor has provisions for communicating with another PSM-2100 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 320C50 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 “mailbox”.

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 0.5 seconds using the acquisition processor vs. over 20 seconds using a standard sweep.

1.2.6 Standard Data Interface Card

The standard Interface Card contains the drivers and receivers for one of three possible data interface standards. IC Sockets are provided to populate the board as either RS-449, V.35 or synchronous RS-232. Only one of the driver/receiver sets may be populated at one time. A separate connector is also provided for each of these interface standards. This connector is used to connect to a chassis mounted external data interface connector of the type required for each standard. The RS-449 uses a 37 pin “D” type connector while the V.35 and RS-232 use a 25 pin “D” type connector.

The modem is normally factory configured for the desired interface type. The interface type may be field retrofitted to change the interface type. A kit of parts to change the interface is available from the manufacturer for use by a qualified technical field service personnel. The kit consists of the proper interface driver/receiver integrated circuits plus the cable and connector to go to the rear panel and the mounting hardware.

1.2.6.1 Data Interface Card Loop-Back Function

The standard and optional interface cards also provide the data loop-back 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 are looped back when this option is enabled.

⇒ ***Caution: Enabling the “Data Loop-Back” function 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 are 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.

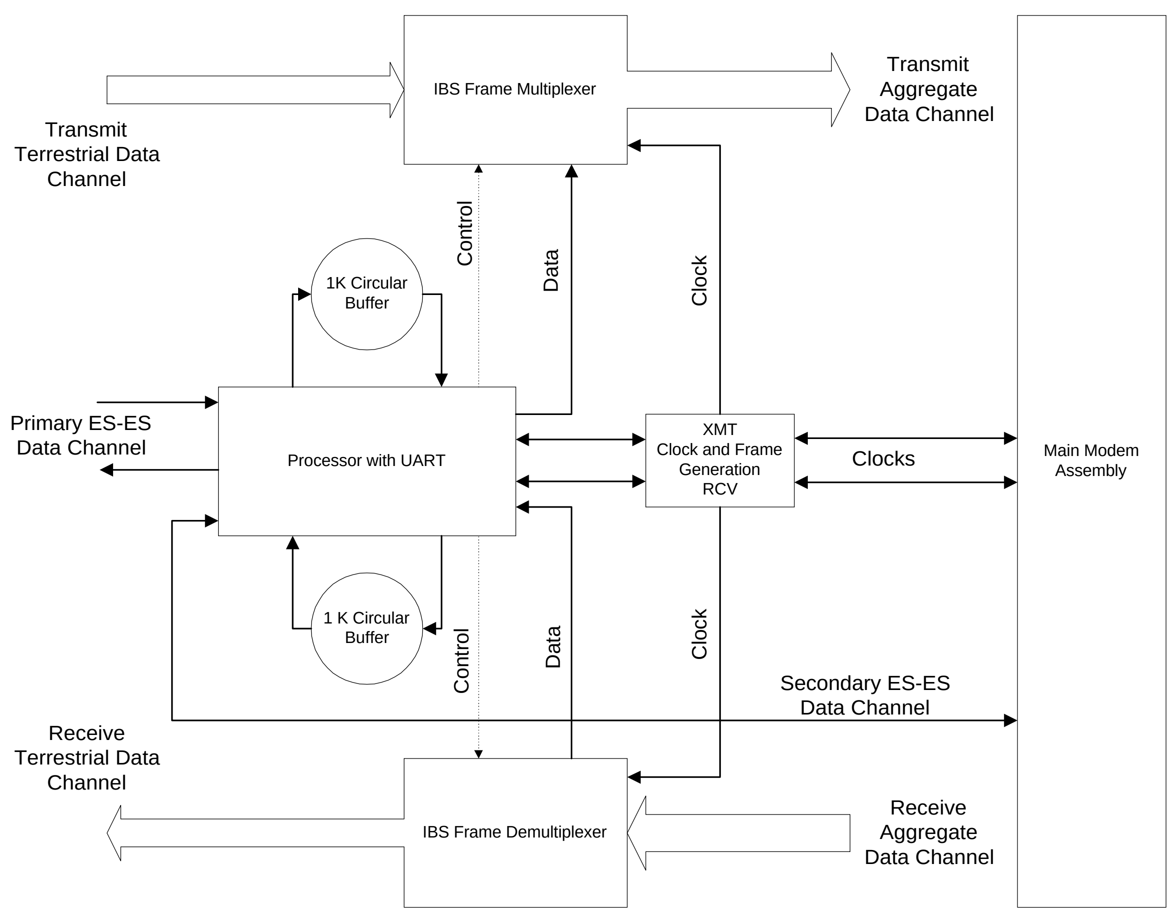
More information on use of the loop-back modes is given in Section 4.1 Common Test Procedures.

1.2.7 Optional Framing/Multiplexer/Reed-Solomon Codec Interface Card

The installation of the optional Interface Card provides the PSM-2100 with a greater level of functional capability. It is provided in two possible configurations; 1) Framing and IBS Multiplexer, and 2) Framing and IBS Multiplexer with Reed-Solomon Codec. The Reed-Solomon codec may be added later to a multiplex-only card. The following are general descriptions of the characteristics of each of these cards. A common clock generator circuit is used to support both the multiplexer and Reed-Solomon codec.

1.2.7.1 Framing/Multiplexer Capability

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, 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 Figure 1-4 below.



IBS Multiplexer Simplified Block Diagram

Figure 1-4 Optional Multiplexer Block Diagram

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. Most of the IESS Framing Structure diagram is shown here in Figure 1-5 below.

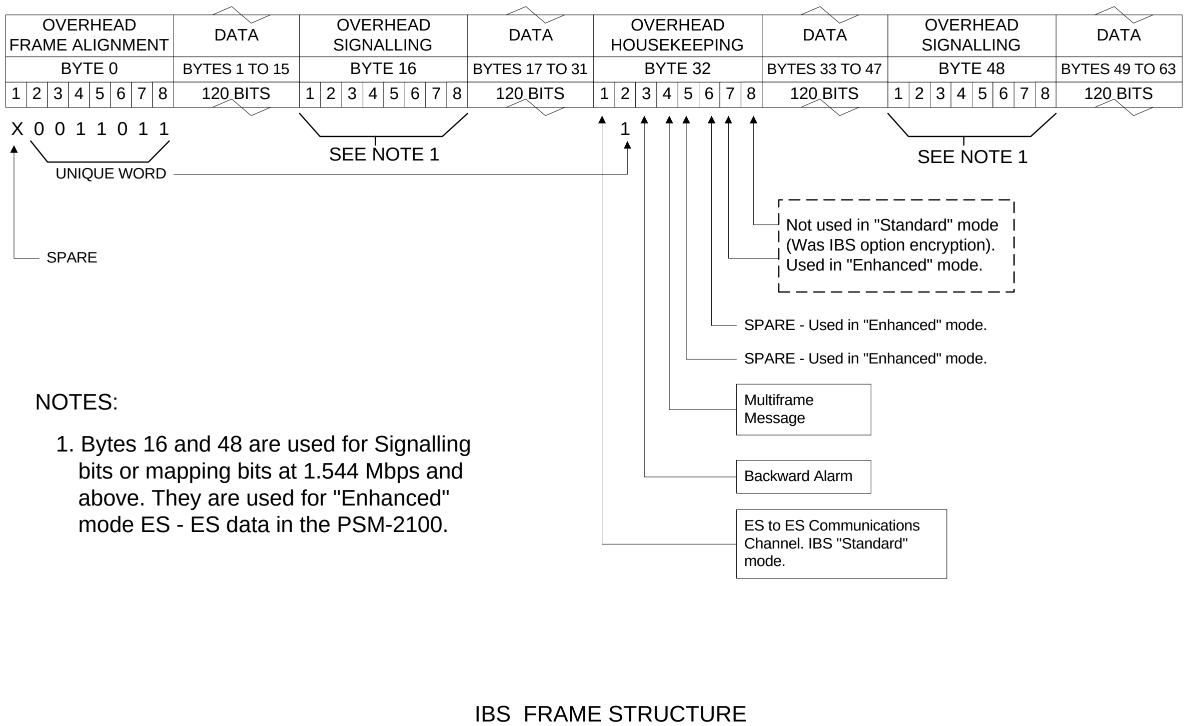


Figure 1-5 IBS Frame Structure

Overhead signaling bytes 16 and 48 are not implemented as signaling or mapping bits as the unit does not operate at a 1544 or 2048 kbps data rate. Two software controlled modes are designed into the card to best utilize the available bits; “Standard IBS” and “Enhanced”. The characteristics of the channel interface is also determined by the standard or enhanced mode.

The ES to ES 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 Table 1-2. 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 mode a 2 wire receive operating mode can be selected for the receive data into the ES-ES 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.

Table 1-2. RS-232/RS-485 Pin Functions

DB9 Pin	Function
1	RS-485 Transmit Data B (+)
2	RS232 Transmit Data
3	RS232 Receive Data
4	
5	GND
6	RS-485 Transmit Data (A) -
7	
8	RS-485 Receive Data B (+)
9	RS-485 Receive Data A (-)

1.2.7.1.1 Standard IBS Mode

In the first or "Normal" mode, all bit assignments are per the IBS standard. The bits of Overhead Housekeeping byte 32 are implemented as shown below:

Bit 1 - *ES to ES Data Channel* — This bit is routed directly to the ES to ES Data Channel. Its data rate is 1/512th of the aggregate rate (or 1/480th of the through terrestrial data rate), and is normally used to super-sample an asynchronous data channel.

Bit 2 - — Part of the Frame Alignment word.

Bit 3 - *Backward Alarm* — Transmit and Receive with main processor to activate main alarm/LED

Bit 4 - *Multiframe Message* — As per IBS

Bits 5 and 6 - *Spare* — Not currently Utilized

Bits 7 and 8 - *Encryption Utilization* — Not currently Utilized

The ratio of the through terrestrial data channel rate to the aggregate rate is 15/16.

The standard transmit and receive channels of the ES to ES data channel in standard IBS mode are raw channels operating at the specific bit rate as controlled by the data channel rate, without buffering. Also no clocks are provided with this channel. Since it would be rare that the data rate provided was exactly that required for a standard rate device, the only method of communicating using this channel is to allow it to super-sample the user data. The ES to ES data channel rate should normally then be a minimum of 3 times the desired asynchronous rate to work properly, while 4 times the desired rate would have fewer errors.

1.2.7.1.2 Enhanced Multiplexer Mode

Since many of the frame bits in the standard IBS mode are not used, an "Enhanced" multiplexer mode has been implemented that can be engaged under software control. Since this mode changes the use of many of the framed non-data bits, this mode is only usable when the PSM-2100 is at both ends of a link. In this mode, the overhead signaling bytes 16 and 48 can be used to implement a significantly higher speed ES to ES Data Channel under software control. When implemented, this rate is 16 times that of the normal IBS standard, or 1/30th of the terrestrial data rate (1/32nd of the aggregate rate). In addition, spare bit 1 of Byte 1 and bits 1, 5, 6, 7 and 8 of Byte 32 are typically used to implement a secondary ES-ES modem channel dedicated to communications between the two modems-on a link for Status and Automatic Uplink Power Control (AUPC) applications.

> ***NOTE: The Enhanced IBS mode MUST be selected for true Asynchronous channel operation to be available.***

The microprocessor on the interface board performs software/hardware assignment of bits to specific purposes in the enhanced mode and buffers the ES to ES Data Channel to standard asynchronous data rates. The secondary ES-ES modem channel should normally be at 300 bps minimum in order to maintain a sufficient loop response time when using Automatic Uplink Power control. Therefore, if the aggregate rate results in a secondary ES-ES modem channel rate less than 300 bps minimum (approximately 25 kbps) then the Overhead Signaling bytes are commandeered for this purpose. The primary ES-ES channel then uses the six spare and unused bits which is still six times the rate of standard IBS. Note that this occurs in the enhanced mode whether the AUPC is enabled or not.

The processor-controlled primary and secondary ES-ES channels each contain both transmit and receive data buffers which are 1024 bytes in length. These act as long FIFOs on the data in each direction. No data is lost if the actual ES-ES data channel and the buffered user data rates are different unless the sustained user data rate causes the buffer to overflow. Buffer overflow results in purging the entire buffer contents. Gaps between characters or messages do not use the buffer and thus can be used to prevent overflow. If the user data rate is less than the data channel rate, then there are simply gaps between characters, which is normal in asynchronous communications. The transmit and receive data rates at either end do not have to be the same, so one end of the link could, for example, have 19.2 kbps transmit and 4.8 kbps receive while the other end may have 9.6 kbps receive and 1.2 kbps transmit. Needs diagram.

1.2.7.2 Reed-Solomon Codec Capability

The addition of a 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.

A simplified block diagram of the Reed-Solomon Codec is shown in Figure 1-7 below.

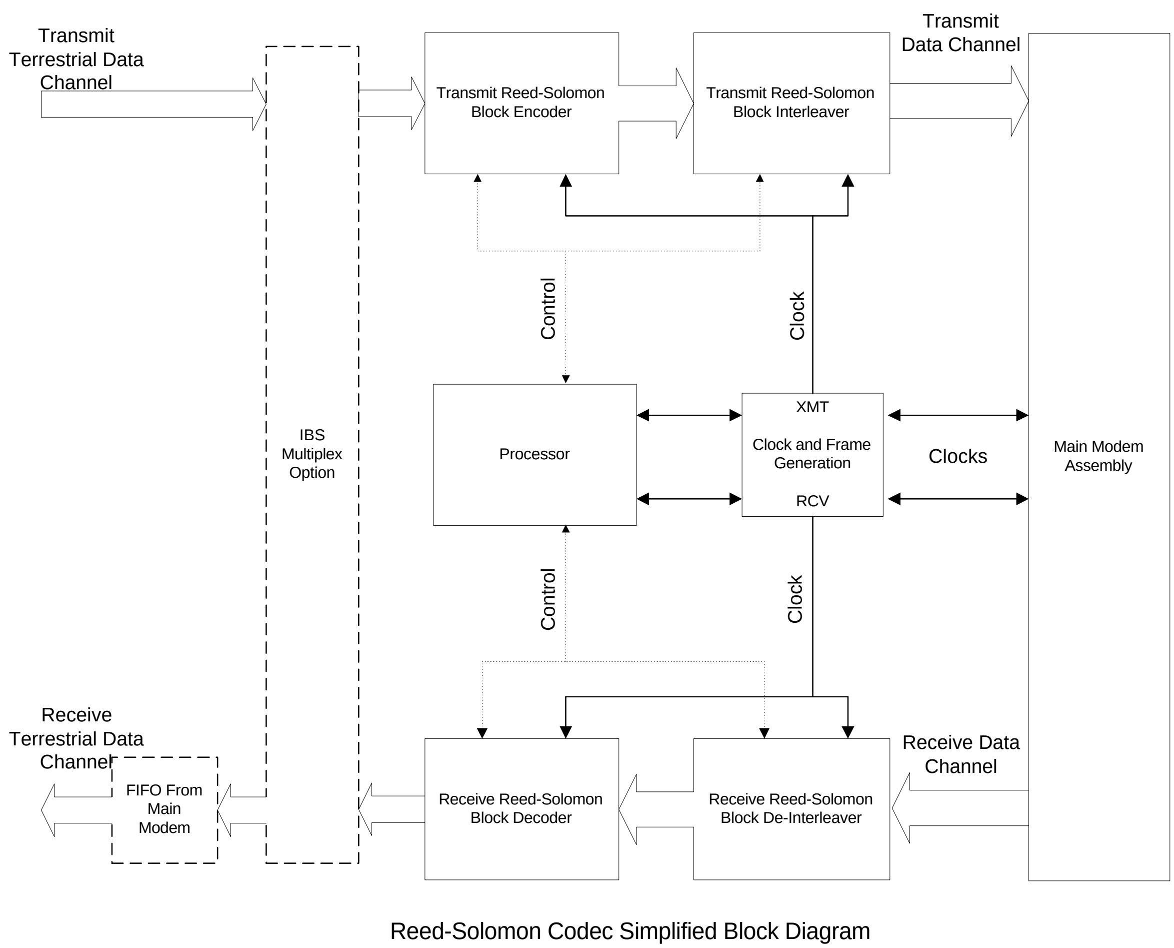


Figure 1-7 Reed-Solomon Block Diagram

The clock generation for the RS Codec is accomplished in the same Framing/Multiplexer circuits used for the ES to ES Data Channel. The R-S codec uses a single block format of 126,112,7. The ratio of encoded to unencoded transmission is 9/8.

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

1.2.8 Circuit Implementation

Much of the functionality and size reduction in this modem has been achieved by incorporation of extensive circuitry into Application Specific IC Gate Arrays for Digital Signal Processing (ASIC DSP) and Field Programmable Gate Arrays (FPGA).

There are four onboard ASIC DSPs used on the modem assembly as a direct adjunct to the control processor. Two of the ASIC DSPs perform the modulator functions and two perform the demodulator functions. The FEC can be considered as a fifth ASIC DSP. The signal acquisition DSP is a sixth such device and its hardware logic is contained within another FPGA.

Several modern modems accomplish direct modulation and demodulation. What makes the PSM-2100 modem unique is that the direct demodulation is not done using the common techniques and available ICs which perform “digital downconversion”. That technique has several problems resulting in performance compromises. That in turn causes the modem to have difficulty operating at less than 0.5 to 1.0 dB from the theoretical waterfall curves. The rigorous methods used in the PSM-2100 allow direct demodulation at the IF frequency with excellent dynamic range and overload performance without pre-filtering. This results in performance that is typically only 0.1 to 0.2 dB from the theoretical waterfall curves.

DC Power for the modem is provided at internal connector P7 and consists of +5 Vdc, +12 Vdc and –12 Vdc. A power supervisor IC monitors the +5 Vdc onboard and will reset the computer if the voltage drops below approximately 4.65 volts. Total power consumption for the modem assembly is typically 40 Watts.

Section Two - Installation

2.0 Installation Requirements

The PSM-2100 VSAT/SCPC Modem is designed to be installed within any standard 19-inch equipment cabinet or rack, and requires 1 RU mounting space (1.75 inches) vertically and 17 inches of depth. Including cabling, a minimum of 20-inches of rack depth is required. The rear panel of the PSM-2100 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 can be simply placed on a table or suitable surface as required.

> ⇒ ***CAUTION:*** *There are no user-serviceable parts or configuration settings located inside the PSM-2100 modem case. There is a shock hazard internally at the power supply module. DO NOT open the modem case.*

> ⇒ ***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-2100 Modem was carefully packed to avoid damage and should arrive complete with the following items for proper installation:

1. PSM-2100 or PSM-512 Modem Unit.
2. Power Cord, 6 foot with applicable AC connector.
3. Installation and Operation Manual.

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-2100 Modem unit is shipped fully-assembled and does not require removal of the covers for any purpose in installation. The only hardware configuration not under software control is the selection of data interface type for either RS–449, RS-232 or V.35 and is not intended to be accomplished in the field. The type of interface installed can be read from the LCD display on the front panel under “Modem Interface” and also “Modem Inf Option” showing either “None” for the standard interface or “IBS Mux” or “IBS Mux and RS FEC”. 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 260 Vac.

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 air flow. 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-2100 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-2100 is a set of four rack mounting screws and an appropriate screwdriver. Rack mount brackets are an integral part of the cast front bezel 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 75-Ohm Transmit IF cable with BNC male connector.
3. A 75-Ohm Receive IF cable with BNC male connector.
4. An Terrestrial data interface cable to mate with the installed option; either a 37-pin male “D” sub connector for RS-449 or a 25 pin male “D” sub connector for V.35 or RS-232..

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. 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.
Integral switch provided as part of power entry connector.

Chassis ground connection at #8 stud location J2.

Data Interface Connection at Option Connector J3:
Standard RS–449 Connector (37-pin female “D” sub connector)
Optional V.35 Connector (25- pin female “D” sub connector).
Optional RS-232 Connector (25- pin female “D” sub connector).

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 14
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)

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 –25 dBm output at 75 Ohms.

The Demodulator 70 MHz IF Input at female BNC J9
50 – 90 MHz
–20 to –60 dBm input at 75 Ohms.

The Modem External Reference Input at female BNC J8
2.5, 5, 9 or 10 MHz input
+10 to –15 dBm input level at 50 Ohms (normally a sine wave).

The ES to ES channel connection at 9-pin female “D” sub connector J4. (When the optional IBS multiplexer is installed)
RS-485 Shield ground on pin 14
RS-485 Transmit A on pin 6 (output from modem)
RS-485 Transmit B on pin 1. (output from modem)
RS-485 Receive A on pin 9 (input to modem)
RS-485 Receive B on pin 8. (input to modem)
RS-232 Transmit on pin 3 (input to modem)
RS-232 Receive on pin 2 (output from modem)
RS-232 Common on pin 5.

2.3.1 Data Interface Pin Connections

The unit may be supplied with either an RS–449, RS-232 or V.35 data interface assembly. Table 2-1 shows the pin assignments for these two interfaces. Table 2-2 shows the pin assignments for the 25-pin female “D” sub connector.

Table 2–1. RS-449 Data Interface Connector J3 Pin Assignment

RS–449 Pin	Signal Name	Direction
1	Shield	Open
3	External FIFO Buffer output Clock (A) –	Input
4	Transmit Data (A) –	Input
5	Transmit Clock (A) –	Output
6	Receive Data (A) –	Output
7	RTS (A) –	Input
8	Receive Clock (A) –	Output
9	CTS (A) –	Output
11	Data Mode (A) –	Output
12	DTR (A) –	Input
13	Receive Ready (A) –	Output
14	Mod Fault Alarm	OC TTL output

Table 2–1. RS-449 Data Interface Connector J3 Pin Assignment

RS–449 Pin	Signal Name	Direction
17	Terminal Timing (A) –	Input
19	Signal GND	GND
20	Common	GND
21	External FIFO Buffer output Clock (B) +	Input
22	Transmit Data (B) +	Input
23	Transmit Clock (B) +	Output
24	Receive Data (B) +	Output
25	RTS (B) +	Input
26	Receive Clock (B) +	Output
27	CTS (B) +	Output
29	Data Mode (B) +	Output
30	DTR (B) +	Input
31	Receive Ready (B) +	Output
33	Demod Fault Alarm	OC TTL output
35	Terminal Timing (B) +	Input

Table 2-2. V.35 Data Interface 25-Pin 'D-Sub" Female Connector Pin Assignment

Pin No.	Assignment	Direction
1	Chassis	GND
7	SIG GND	GND
15	SCT A (ST-)	Output
12	SCT B (ST+)	Output
2	SD A (SD-)	Input
14	SD B (SD+)	Input
24	SCTE A (TT-)	Input
11	SCTE B (TT+)	Input
17	SCR A (RT-)	Output
9	SCR B (RT+)	Output
3	RD A (RD-)	Output

Table 2-2. V.35 Data Interface 25-Pin 'D-Sub" Female Connector Pin Assignment		
Pin No.	**Assignment**	**Direction**
16	RD B (RD+)	Output
4	RTS	Input
5	CTS	Output
6	DSR	Output
8	CD	Output
20	DTR	Input
25	Mod Fault Alarm	OC TTL output
23	Demod Fault Alarm	OC TTL output
21	Ext FIFO Clock B (+)	Input
19	Ext FIFO Clock A (-)	Input

Table 2-3. RS232 Data Interface 25-Pin 'D-Sub" Female Connector Pin Assignment		
Signal Function	**Name**	**Pin #**
Ground	GND	1,7
Send Data	SD	2
Receive Data	RD	3
Request To Send	RTS	4
Clear To Send	CTS	5
Data Set Ready	DSR	6
Data Carrier Detect	DCD	8
Data Terminal Ready	DTR	20
Demod Fault	DF	23
Send Timing	ST	15
Receive Timing	RT	17
Ext. FIFO Clock	XFC	19
Terminal Timing	TT	24
Mod Fault	MF	25
No Connection	NC	9, 10, 11, 12, 13, 14, 16, 18, 21, 22

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).

Table 2–4.
Remote Control Connector J6 Pin Assignment

P2 Pin Number	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

2.3.3 Alarm Connection

The modem has two form-C dry contact alarm relays onboard and an alarm connector located on the rear panel, the 9-pin male “D” sub connector J3.

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.

Table 2–5.
Alarm Connector J5 Pin Assignment

J1 Pin Number	Connection
1	Relay A NO on Alarm
2	Relay A Common
3	Relay A NC on Alarm

Table 2–5. Alarm Connector J5 Pin Assignment	
J1 Pin Number	**Connection**
4	
5	
6	
7	Relay B NO on Alarm
8	Relay B Common
9	Relay B NC on Alarm

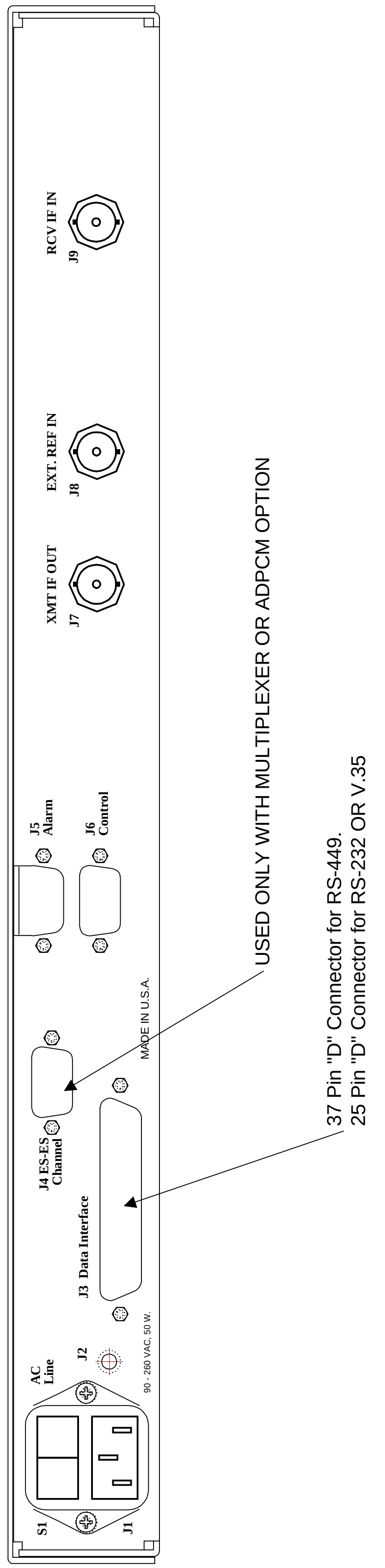


Figure 2-1 Modem Rear Panel

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 initial and every subsequent power-up, the modem processor 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 failure is detected, the Alarm LED is flashed at a rate which indicates which component tested faulty:

1. A 5-Hertz rate of the ALARM LED indicates that ROM Checksum test failed. The LCD display will show "Modem Failure! ROM Corrupt"
2. A 1-Hertz rate indicates that the internal or external RAM test failed.
3. A 1-Hertz rate indicates that the EEPROM test failed. The LCD display will show "Modem Failure! EEPROM Corrupt"

The initial field checkout of the modem can either 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 "Modem – Remote" parameter to "Terminal" (option 3), then set the "Modem – Remote Port" parameter to "RS–232" (option 0). The "Modem – Bit Rate, Format and Parity" also require setting to match the terminal settings. The Modem 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, but a quick introduction to the front panel operations is given here to allow initial setup.

The modem parameters are arranged in a large matrix that is 4 columns wide and up to 36 rows long as shown in the parameter matrix tables. The four columns are Mod (Modulator), Demod (Demodulator), Modem (Unit) and Test. 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 matrix is shown as Table 3-1 in Section 3, "Operation" of this manual.

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 parameter to be set using the four arrow keys to the right of the LCD display, then
2. Press the "Enter" key to indicate that a new entry is desired, next

3. Set the parameter via the numeric keypad, and
4. Finalizing 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.

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 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 number “1” through “9” and letters “A” through “Z”. For example, to change the transmit data rate, press the terminal's “2” 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 not 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

> ⇒***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-2100 under test. This Test Mode should not be used on a live traffic unit.*

The PSM-2100 provides a built–in self-test mode which uses the IF Loopback 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 the modem into satellite service. The modem is placed into self-test mode by using the front panel controls to set the modem into 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, use the arrow keys to scroll to the “Test” column of the configuration matrix and then scroll down until “Test Modem Test” is displayed. Then press “Enter”, the “1” key then “Enter” to start the test. The modem self-test only requires approximately one minute.

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.

2.8 IF Loopback Test Mode

> ⇒ ***CAUTION:*** *The IF Loopback Mode will disconnect the receive IF from the ground station equipment and will therefore disrupt any traffic currently through the PSM-2100 under test. The transmit output is still active if it was enabled before initiating an IF Loopback. This Test Mode should not be used on a live traffic unit.*

The PSM-2100 provides a built–in IF loopback 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 Loopback Test Mode uses the current modulator carrier frequency (plus offset setting) only and sets the demodulator to the same carrier frequency setting when in loopback. The user is responsible for all other compatible settings in order for the modulator and demodulator to operate properly. When the IF Loopback Test Mode is disabled, the demodulator carrier frequency is returned to that stored in EEPROM (present before Loopback was initiated).

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

The IF Loopback state is not stored in EEPROM

2.9 Modem Configuration

Configuring the PSM-2100 Modem operating parameters is essential before placing the unit into service. The PSM-2100 Modem operating parameters may be set up using the front panel or the terminal command mode.

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 and Offset
2. Modulation Mode (BPSK or QPSK)
3. Bit Rate
4. FEC Code Rate
5. Differential Encoder (Normally Enabled)
6. Scrambler (Normally Enabled in V.35 or Intelsat mode)
7. Clock sources.
8. Reed-Solomon Codec settings if installed

9. IBS Multiplexer settings if installed
10. AUFC turned Off.
11. External reference set properly
12. Modulator and Demodulator functions enabled

Modulator

1. Output Level
2. Carrier Enable

Demodulator

1. Carrier Acquisition Mode and Acquisition Range

2.9.2 Carrier Acquisition Parameters

The PSM-2100 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-2100. 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

A second mode called “Standard” 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 standard mode is optimized for crowded spectrum applications where nearby high power carriers may interfere with the “fast” acquisition.

A hybrid mode is also available for special applications called “Auto Narrow”. In this mode, initial acquisition is by the previously described “Standard” mode and reacquisition of a lost carrier is by DSP fast acquisition mode, over a reduced range of approximately 1/4th of the symbol rate in Hertz; i.e., if the symbol rate is 16 Ksps then the narrow range is approximately ±4 kHz. The original carrier lock must have lasted longer than the “lock qualification Time”, and the narrow mode with attempt to re-acquire the carrier for the “narrow sweep” time setting. If a carrier is not acquired during the narrow sweep time then the full acquisition range is used to attempt to lock to a suitable carrier.

A fourth mode available is called “Auto Track”. In this mode the receive offset is saved from a current lock longer than the “lock qualification time”. Then if the carrier frequency is changed the offset is retained and the “narrow” DSP fast acquisition is used for the “narrow” time setting. 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. In the 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 Swp Mode” option parameter to either “Fast” (3), Auto Track (2), Auto Narrow (1) or Standard (0).

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 ± 200 Hz ± 1.25 MHz, where ± 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 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 either Standard, Auto Narrow or Auto Track modes, the Demodulator carrier frequency setting plus the offset setting is used as the start point for attempting to acquire a signal. The Auto Narrow mode uses the last carrier lock offset as the initial setting while the other two modes require an entry of offset frequency.

If the demodulator lock to a signal is forcibly aborted in either Standard, Auto Narrow or Auto Track modes, 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.

2.9.2.2 Carrier Reacquisition

For the “Auto Narrow” and “Auto Track” acquisition modes the PSM-2100 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. Once the search mode is set to either “Auto” mode, the following Demod parameter settings control the acquisition in the reduced range.

1. Qual Time (Lock Qualify Time)
   The time a carrier must be initially locked before “narrow” reacquisition is used upon loss of the carrier

2. Nrw Time (Narrow Sweep Time)
   The time that the PSM-2100 will search to re– acquire the lost carrier before reverting to the standard or “Wide” search range.

3. Nrw Swp (Narrow Sweep Range)
   The Narrow Sweep Range is automatically set by the processor to approximately 1/4th of the symbol rate in Hertz.

NOTE: The Narrow sweep range is relative to the receive frequency offset that the carrier was last locked at or the offset that is commanded via the remote control or front panel.

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

2.9.3 Sample Configuration Setting

Assuming the modem is to be used in the SCPC mode for a point-to-point link with another PSM-2100, the following is applicable:

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 left or right arrow keys until the “Mod” identifier is in the upper left line of the LCD display indicating that we are in the modulator column of the parameter matrix. Now scroll down (or up) until the upper right of the LCD display indicates “CXR Freq.”. 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 “Enter” key, which will display the current setting with the cursor set on the first available digit. Enter a frequency in MHz excluding the decimal point (the cursor will skip over the decimal point position), entering all digits required to edit the shown frequency, then press the “Enter” key to apply this new parameter value. Next scroll down to the “Modulation” entry and press “Enter”, the “1” key to request QPSK and press the “Enter” key to apply this new parameter value. Scroll down to the “Bit Rate” parameter and press “Enter”, “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 “Enter”, “0” and “Enter”.

To set the receive parameters, press the right arrow keys until the “Demod” identifier is in the upper left line of the LCD display indicating that we are in the demodulator column of the parameter matrix. Now scroll down (or up) until the upper right of the LCD display indicates “CXR Freq.”, and press the “Enter” 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 “Enter”, the “0” key to request BPSK and press the “Enter”. Scroll down to the “Bit Rate” parameter and press “Enter”, “0”, “1”, “2”, “8” and “Enter”. Last scroll down to the “Code Rate” parameter and press “Enter”, “0” and “Enter”. Next scroll down in the Demod list to the “Sweep” 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

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-2100 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.

Data Interface Compatibility

1. Mod and Demod Data Sense
2. Mod and Demod Clock Source
3. Mod and Demod Clock Phase
4. Modulator RTS Enable

Automatic Correction

1. Automatic Uplink Power Control

2. Automatic Uplink Frequency Control
3. Demod FIFO Operation

Alarm configuration

Assignment of Modulator Related Alarms-

Carrier, Bit Lock, AUPC, Test Active and Hardware Fault

Assignment of Demodulator Related Alarms-

Signal Lock, Input Level, Low E_b/N_o, Test Active, Backward and Hardware Fault

A description of each of these settings is contained in Operations, Section 3 of this manual. A brief description of alarm configuration is also given here. Possible alarm sources include the following items:

1. Transmit Carrier Off
2. Modulator Bit Rate Lock
3. Modulator AUPC Alarm
4. Modulator Interface Alarm
5. Modulator Hardware Fault
6. Demodulator Signal Lock
7. Demod Interface Lock
8. Receive Input Level below AGC range
9. Receive Low E_b/N_o below threshold
10. Demodulator Hardware Fault
11. Test mode currently active
12. Backward Alarm from IBS multiplexer

The inputs are read by the processor and seven outputs are produced including two alarm relays, one Modulator , one Demodulator, one Summary alarm LED on the front panel and a modulator and demodulator redundancy open collector alarms on the interface card. 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-2100 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 an External Reference

The PSM-2100 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 2.5 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 transmit center output frequency accuracy of 2.5 X 10^{-6} X 70 MHz X 10^{6} or $\pm$175 Hz (220 Hz at 88 MHz). If this accuracy is not sufficient, or the network operating mode dictates, an external reference can be used. The external reference frequency is applied at the rear panel BNC connector, J7, at a frequency of 2.5, 5, 9 or 10 MHz. Use of the external reference and the reference frequency are selected at the front panel from the “Modem Reference” and “Modem Ref. Freq.” entries.

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

2.9.6 Setting the Modem Station ID Name

Each PSM-2100 contains two unique identification entries available at the front panel or remotely. They are the unit serial number and the “Station ID”. The serial number is set at the factory and cannot be changed, but the Station ID can be set and changed whenever necessary. This field allows identification of the modem in whatever form the user desires up to 16 characters. To set the Station ID, use the front panel arrow keys to scroll to the “Modem” – “Station ID” parameter and pressing “Enter” begin entry. Each character is entered by pressing the two keys of its ASCII code minus 32. For example to name a modem “X11” the entry would be “Enter”, “56”, “17”, “17”. Then press the “Enter” key to enable the change. When entering this parameter via a terminal connected to the remote port the Station ID Name is entered directly as text.

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 “Modem” – “Address” parameter and press “Enter”, 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).

2.10 Interface Card Configuration

The PSM-2100 Modem contains a separate interface card assembly that has been pre-configured in the factory to the requested interface type. This card may also contain the IBS and Reed-Solomon options if ordered.

The modem main processor automatically determines the type of interface and options by querying the interface card. Changing the interface card itself or changing an interface card’s terrestrial data interface type 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 Changing the Terrestrial Interface Type

Any of the three basic interface card types (Standard, IBS/Reed-Solomon, or ADPCM) may be configured for either RS-449, V.35 or synchronous RS-232 interface protocols. The procedure is identical for all three cards, and although the standard interface card diagram is shown below, the optional components to be changed are the same and in the same location on all cards.

The Interface can be configured for 1 of 3 standard types: RS-449, V.35 or synchronous RS-232. Configuring the interface consists of inserting the correct driver/receiver ICs into sockets on the board and installing the correct cable/connector between the interface board and the rear panel.

IC	RS-449	RS-232	V.35
U1	26LS32	Not Installed	Not Installed
U2	26LS31	Not Installed	Not Installed
U3	26LS31	Not Installed	Not Installed
U4	26LS32	Not Installed	Not Installed
U5	Not Installed	Not Installed	LTC1345
U6	Not Installed	MAX231EPD	MAX231EPD
U7	Not Installed	MAX231EPD	Not Installed
U8	Not Installed	MAX231EPD	Not Installed
Interface Cable	DB37 to P1	DB25 female to P3	DB25 female to P2

All of the affected integrated circuits are placed in sockets on the interface card as shown in the Figure 2-2 below. Note that certain ICs from un-implemented standards must be removed. Only one standard may be implemented on these boards at one time.

Two types of cables are available to connect between the interface card and the rear panel. The RS-449 cable is a DB37 connector with attached ribbon cable and IDC 40 pin connector for placement in P1 on the interface card. The DB37 connector is mounted to the inside of the rear panel using two jack screws. The V.35 or RS-232 cable is a DB25 connector attached to a ribbon cable and IDC 26 pin connector for placement in P2 (V.35) or P3 (RS-232). The DB25 connector is factory mounted to an aluminum adapter plate using two jack screws. The adapter plate is then attached to the inside of the rear panel using two #4 pan head screws.

An option kit is available from the factory consisting of the necessary ICs and cable to install or change to any of the available options.

2.10.2 Changing the Optional Interface Card

Any of the three basic interface card types (Standard, IBS/Reed-Solomon, or ADPCM) may be exchanged in a modem unit by removing the modem's top cover. The interface card to be removed is disconnected from the main board and the rear panel by releasing the three ribbon cables from the IDC connectors at P5, P4 and P1 (or P2 or P3 if using those connectors). The four #6 screws and lock washers are then removed and saved for placing the new interface card into the chassis. Once the new interface card is installed the three ribbon cables are re-attached to the new card. If the interface type is to be changed refer to the preceding section. The main modem processor will automatically query the new interface card and determine the type and options installed.

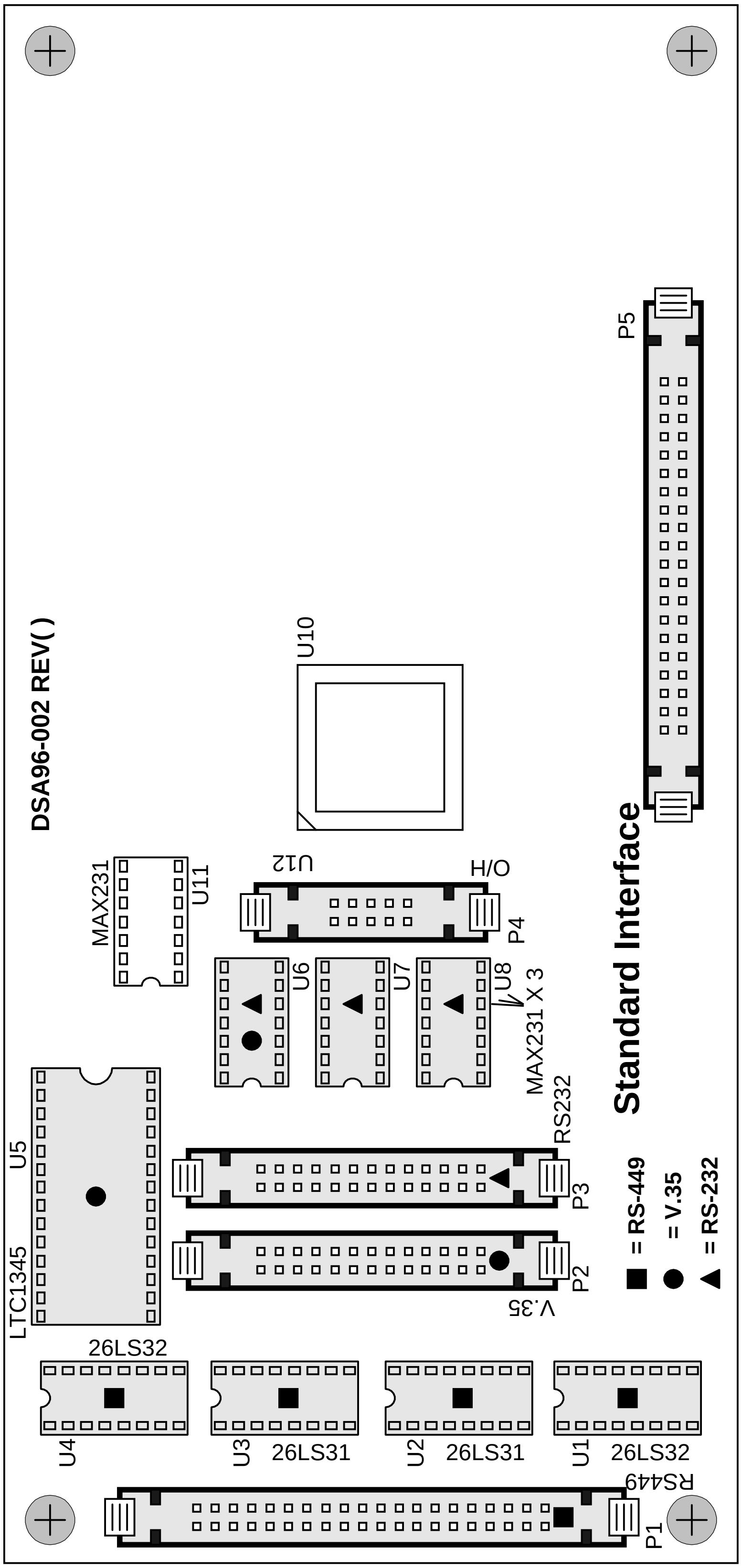


Figure 2-2 Interface Card Configuration Options

Section Three - Operation

3.1 Operating Procedures

Operation of the PSM-2100 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 options for the modem:

1. Front Panel Control.
2. Terminal Mode Control.
3. Command Interface Control.

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.

3.1.1 Front Panel Control

The front panel of the PSM-2100 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. The display is lighted and the brightness can be set to increase when the front panel is currently in use, automatically dimming with inactivity. The display has three distinct areas showing current information. The upper left shows the current area of use, either Mod, Demod, Modem or Test. The upper right shows the current parameter being monitored, such as "CXR Freq" (Carrier Frequency) 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.

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 two areas: a 10-key numeric entry with 2 added keys for an "Enter" and "Clear" function. 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.

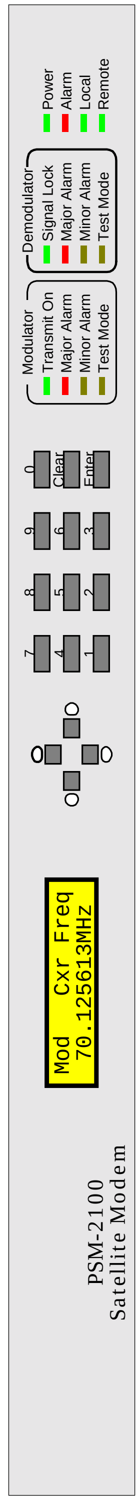


Figure 3-1. PSM-2100 Front Panel Controls and Indicators

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 On: Green – Indicates that the transmit output is currently active. Green Flashing when Modulator Test mode is active - 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. Signal 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 100 programmable or monitored parameters on the PSM-2100 and that the LCD display can only show one parameter at a time. To simplify locating any desired parameter, they are organized into a large table or matrix form with 4 columns and up to 36 rows. This matrix is shown in Table 3-1. Each matrix column represents a major functional area of modem operation and the rows represent individual parameters associated with that functional area. The four columns are Mod (Modulator), Demod (Demodulator), Modem (Unit) and Test. 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 (Mod, Demod, Modem or Test) while the upper right shows the parameter (row) name.

The four arrow keys located to the right of the LCD display are used to scroll through the rows and columns of the parameter matrix. The left and right arrow keys scroll through the four 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.

3.1.3.2 Monitoring Modem Parameters

Any available modem parameter is monitored by simply using the 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.

3.1.3.3 Changing Modem Parameters

To set any parameter, the 4 arrow keys to the right of the LCD display are used to select the parameter to be set, then pressing the "Enter" key to indicate a new entry, then setting the parameter via the numeric keypad and finalizing the data entry using the "Enter" 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 the following:

- When a numeric parameter is displayed, it can be changed by pressing the "Enter" 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.

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:

1. When a selection entry parameter is displayed, simply press the “Enter” key followed by a digit key 0, 1, 2, 3 or 4. In this scheme “0” represents disabled, OFF or the first possible choice. “1” represents enabled, ON 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.
2. Alternately, when a selection parameter is displayed it can be changed by pressing the “Enter” 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, the current setting is denoted by an arrow in the left column position.

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.

3.2 Front Panel Monitor and Control Parameters

The following table lists the parameter matrix 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 Audio ADPCM or G.703 E1 interfaces.

Table 3-1
PSM-2100 Front Panel Parameter Matrix

Modulator	**Demodulator**	**Modem**	**Test**
Mod Status Sending, Ok	Demod Status Locked, Ok	Modem Status Locked & Sending	Test Status Normal
Mod CXR Freq 70.000000MHz	Demod CXR Freq 70.000000MHz	Modem Config Local & Remote	Test IF Loop Disabled
Mod Offset Freq 0.000kHz	Demod Offset Frq 2.566kHz	Modem Mode Mod & Demod	Test Data Loop Disabled
Mod Output Lvl -20.4dBm	Demod Input Lvl -45dBm	Modem Reference Internal	Test Mod Output Normal
Mod CXR Output Enabled	Demod Eb/No 4.7dB	Modem Ref Freq 10.000MHz	Test DSTP AFC 3.2V
Mod Bit Rate 2.100000Mbps	Demod Bit Rate 2.100000Mbps	Modem Remote ASCII Packet	Test DLO AFC 3.2V
Mod Modulation QPSK	Demod Modulation QPSK	Modem Rmote Port RS-485 *	Test AGC 3.2V

Table 3-1
PSM-2100 Front Panel Parameter Matrix

Modulator	Demodulator	Modem	Test
Mod Code Rate Rate 1/2	Demod Code Rate Rate 1/2	Modem Address 3 *	Test IDC Offset 3.2V
Mod RS FEC Enabled	Demod RS FEC Enabled	Modem Bit Rate 9.6kbps *	Test QDC Offset 3.2V
Mod Diff Encoder Enabled	Demod Diff Decod Enabled	Modem Format 8 Data, 1 Stop*	Test MSTP AFC 3.2V
Mod Scrambler Intelsat	Demod Scrambler Intelsat	Modem Parity None *	Test MLO AFC 3.2V
Mod Mux IBS Enhanced	Demod Demux IBS Enhanced	Modem Xon/off Option N/A *	Test Ref AFC 3.2V
Mod ES>ES Port RS-485, 4 Wire*	Demod ES>ES Port RS-232 *	Modem Key Click Enabled	Test Modem Test Disabled
Mod ES>ES Rate 9600bps *	Demod ES>ES Rate 9600bps *	Modem LCD Active Backlight Full	
Mod ES>ES Frmt N,8,1 *	Demod ES>ES Frmt N,8,1 *	Modem LCD Idle Backlight 1/3	
Mod Data Normal	Demod Data Normal	Modem Station ID Rmt Santa Cruz	
Mod Clk Phase Normal	Demod Clk Phase Normal	Modem Model PSM-2100	
Mod Clk Source Internal	Demod Clk Source Ext FIFO Clk	Modem Softwr Ver 2.02	
Mod AUPC Disabled	Demod FIFO Stat 120% *	Modem Serial # 1123	
Mod AUPC Eb/No 6.5dB *	Demod FIFO Delay 2.0000ms *	Modem Interface RS-449	
Mod AUPC Max Lvl -10.0dBm *	Demod FIFO Size 131070 Bits *	Modem Inf Option IBS Mux & RS FEC	
Mod AUPC Min Lvl -20.0dBm *	Demod Swp Mode Auto Narrow	Modem Inf Max 2.100000Mbps	
Mod AUFC Enabled	Demod Sweep +/-1.2500MHz	Modem Inf Min 3.600kbps	

Table 3-1
PSM-2100 Front Panel Parameter Matrix

Modulator	Demodulator	Modem	Test
Mod AUFC Limit +/-10.000kHz *	Demod Nrw Time 30 Sec *		
Mod RF Cnv Up/Dn 1.166666667 *	Demod Qual Time 5 Sec		
Mod Spectrum Normal *	Demod SER 3.37x10^-2		
Mod SAT Err Frq 2.387kHz *	Demod Est. BER 2x10^-7		
Mod Mode Continuous	Demod Low Eb/No 4.0dB		
Mod Preamble 64 Symbols *			
Mod RTS Input Ignore			
Mod CXR Mute Manual	Demod Back Alm to Alarm B		
Mod CXR Alm to Alarm A	Demod Lock Alm to Alarm B		
Mod AUPC Alm to Alarm A	Demod Input Alm Ignore		
Mod Bit Alm to Alarm A	Demod Eb/No Alm to Alarm B		
Mod Tst Active to Alarm A	Demod Tst Active to Alarm B		
Mod Hardwr Flt to Alarm A & B	Demod Hardwr Flt to Alarm A & B		

Tables 3-2 through 3-5 describe the parameters available from the front panel and entry in more detail:

Table 3-2. Modulator Parameters

Representation	Type	Entry	Description
`Mod Status Sending, OK`	Read Only	Read Only	Modulator Status
`Mod CXR Freq. 70.000000MHz`	Numeric	50.000 000 to 90.000 000 MHz	Carrier center frequency
`Mod Offset Freq. –8.031kHz`	Numeric	–1,250.000 to +1,250.000 kHz	Carrier offset frequency
`Mod Output Lvl –20.4dBm`	Numeric	–5.0 to –25.0 dBm	Transmit output power level
`Mod CXR Output Enabled`	Selection	0 = mute, 1 = enable	Carrier output enable
`Mod Bit Rate 2.100000Mbps`	Numeric	3.600 to 2,100.000 kbps in 1 bps resolution. Maximum 525.000 for PSM-512.	Modulator Bit Rate
`Mod Modulation QPSK`	Selection	0 = BPSK, 1 = QPSK	Modulation Mode
`Mod Code Rate Rate 1/2`	Selection	0 = ½, 1 = ¾, 2 = 7/8	FEC Code Rate
`Mod RS FEC Enabled`	Selection	0 = disable, 1 = enable	Reed-Solomon Encoder (Only available if installed.)
`Mod Diff Encoder Enabled`	Selection	0 = disable, 1 = enable	Differential Encoder
`Mod Scrambler Disabled`	Selection	0 = disable, 1 = Intelsat, 2 = V.35, 3 = IBS, 4 = RS IBS	Scrambler types. Types 3 and 4 are only available if hardware is installed
`Mod Mux IBS Enhanced`	Selection	0 = Disabled, 1 = IBS Standard, 2 = Enhanced	Multiplexer options only available if installed
`Mod ES>ES Port RS-485, 4 Wire`	Selection	0 = RS-232, 1 = RS-485 2 wire, 2 = RS-485 4 wire	
`Mod ES>ES Rate 9600 bps`	Selection	0 to 7 selects standard rates 150 bps - 19.2 kbps	
`Mod ES>ES Frmt N, 8, 1`	Selection	0 = N/7/2, 1 = P/7/1, 2 = P/7/2, 3 = N/8/1, 4 = N/8/2, 5 = P/8/1	
`Mod Data Normal`	Selection	0 = normal, 1 = inverted	Transmit Data Inversion
`Mod Clk Phase Normal`	Selection	0 = normal, 1 = inverted	Mod Clock Phase
`Mod Clk Source Internal`	Selection	0 = Internal, 1 = TT Clk, 2 = Receive Clk	Modulator Bit Rate clock source.
`Mod AUPC Disabled`	Selection	0 = disable, 1 = enable	Automatic Uplink Power Control

Representation	Type	Entry	Description
Mod AUPC Eb/No 6.5dB	Numeric	3.0 to 20.0 dB	AUPC Level
Mod AUPC Max Lvl –10.0 dB	Numeric	–5.0 dBm to Minimum level	Max. level under AUPC control
Mod AUPC Min Lvl –20.0 dB	Numeric	Maximum level to –25 dBm	Min. Level under AUPC control
Mod AUFC Disabled	Selection	0 = disable, 1 = enable	Auto Uplink Frequency Control
Mod AUFC Limit +/–10.000kHz	Numeric	0.100 to 1,250.000 kHz	Limit of AUFC action
Mod RF Cnv Up/Dn 1.166666667	Numeric	0.5 to 2.0, up to 9 decimal places	AUFC Converter Ratio
Mod Spectrum Normal	Selection	0 = normal, 1 = inverted	AUFC spectrum sense
Mod Sat Err Frq 14.387 kHz	Numeric	–1,250.000 to +1,250.000 kHz	AUFC Satellite Error Frequency
Mod Mode Continuous	Selection	0 = continuous, 1 = burst	Transmit Mode
Mod Preamble 64 Symbols	Selection	0 = 32, 1 = 48, 2 = 64 symbols	Burst Preamble Length
Mod RTS Input Ignore	Selection	0 = ignore, 1 = control Carrier	Interface RTS action
Mod CXR Mute Manual	Selection	0=Manual, 1=Automatic	Manual requires manual Carrier enable after Mod output change.
Mod CXR Alm To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Mod AUPC Alm To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Mod Bit Alm To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Mod Tst Active To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Mod Hardwr Flt To Alarm A & B	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm

Table 3-3. Demodulator Parameters

Representation	Type	Entry	Description
Demod Status Locked, OK	Read Only		Modulator Status
Demod CXR Freq. 70.000000MHz	Numeric	50.000 000 to 90.000 000 MHz	Carrier center frequency
Demod Offset Frq 12.566kHz	Read Only	Measured by internal circuit	Offset from set CXR frequency
Demod Input Lvl –45dBm	Read Only	–20.0 to –60 dBm	Approx. Rcv input power level
Demod Eb/No 4.7dB	Read Only	Measured by internal circuit	
Demod Bit Rate 2.100000Mbps	Numeric	3.600 to 2,100.000 kbps in 1 bps resolution. Maximum 525.000 for PSM-512.	Demod Bit Rate
Demod Modulation QPSK	Selection	0 = BPSK, 1 = QPSK	Modulation Mode
Demod Code Rate Rate 1/2	Selection	0 = 1/2, 1 = ¾, 2 = 7/8	FEC Code Rate
Demod RS FEC Enabled	Selection	0 = disable, 1 = enable	Reed-Solomon Decoder (Only available if installed.)
Demod Diff Decod Enabled	Selection	0 = disable, 1 = enable	Differential Decoder
Demod Scrambler Disabled	Selection	0 = disable, 1 = Intelsat, 2 = V.35, 3 = IBS, 4 = RS IBS	Descrambler types. Types 3 and 4 are only available if hardware is installed
Demod Demux IBS Enhanced	Selection	0 = Disabled, 1 = IBS Standard, 2 = Enhanced	Multiplexer options only available if installed
Demod ES>ES Port RS-485, 4 Wire	Selection	0 = RS-232, 1 = RS-485, 2 = RS-485 On	Option 1 only drives output when sending data. 2 is on continuously.
Demod ES>ES Rate 9600 bps	Selection	0 to 7 selects standard rates 150 bps - 19.2 kbps	
Demod ES>ES Frmt N, 8, 1	Selection	0 = N/7/2, 1 = P/7/1, 2 = P/7/2, 3 = N/8/1, 4 = N/8/2, 5 = P/8/1	
Demod Data Normal	Selection	0 = Normal, 1 = inverted	Data Sense
Demod Clk Phase Normal	Selection	0 = Normal, 1 = inverted	Demod output clock phase
Demod Clk Source Ext FIFO Clk	Selection	0 = Receive Clk, 1 = external FIFO Clk, 2 = Mod Clk	FIFO output clock source. Selecting Receive Clk bypasses the FIFO.
Demod FIFO Stat 120%	Selection	0 = Clear, 1 = Re–Center	0 – 200%, 100% = reset level.
Demod FIFO Delay 2.000ms	Numeric	0.0025 to 54,612.5000	Delay time is constant when

Representation	Type	Entry	Description
		msec.	changing data rate.
Demod FIFO Size 131070 Bits	Numeric	4 to 131,070 bits	Bits of FIFO delay. Automatically adjusted when data rate is changed.
Demod Swp Mode Auto Narrow	Selection	0= Standard, 1= Auto Narrow, 2 = Auto Track, 3 = Fast	Sweep mode, All use DSP acquisition processor. Fast is optimized for speed.
Demod Sweep ±1.2500MHz	Numeric	0.2 kHz to 1,250 kHz	Acquisition range
Demod Nrw Time 30 Sec	Numeric	10 Sec. to 65,535 Sec.	Narrow sweep time
Demod Qual Time 5 Sec	Numeric	5 Sec. to 65,535 Sec.	Lock qualify time for narrow sweep.
Demod SER 3.37x10^–2	Read Only	Measured by FEC. Press "Enter" twice to restart.	Measured Symbol Error Rate
Demod Est. BER 2x10^–7	Read Only	Press "Enter" twice to restart.	Estimated Bit Error Rate
Demod Low Eb/No 4.0dB	Numeric	0.0 to 25.5 dB	Low Eb/No threshold alarm
Demod Back Alm To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Demod Lock Alm To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Demod Input Alm Ignore	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Demod Eb/No Alm To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Demod Tst Active To Alarm A	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm
Demod Hardwr Flt To Alarm A & B	Selection	0=Ignore, 1=A, 2=B, 3=A&B	Selects destination of alarm

Table 3-4. Modem (Unit) Parameters

Representation	Type	Entry	Description
`Modem Status` `Locked & Sending`	Read Only	Read Only	Mod & Demod Status
`Modem Config` `Local & Remote`	Selection	0 = Disable, 1 = Local Only, 2 = Remote Only, 3 = Local & Remote	Determines access to modify Modem Parameters
`Modem Mode` `Mod & Demod`	Selection	0 = Disable, 1 = Demod only, 2 = Mod only, 3 = Mod & Demod	Allows disable of major functions
`Modem Reference` `Internal`	Selection	0 = Internal, 1 = External	Rear panel external reference.
`Modem Ref Freq.` `10.000MHz`	Numeric	0 =2.5, 1 =5.0, 2 =9.0, 3 =10.0 MHz	Reference frequency at rear panel.
`Modem Remote` `ASCII Packet`	Selection	0 = Disable, 1 = Binary Packet, 2 = ASCII Packet, 3 = Terminal	Remote control mode type
`Modem Remote Port` `RS–485`	Selection	0 = RS–232, 1 = RS–485	Remote control port used
`Modem Address` `3`	Numeric	0 to 255, 255 = Global	Remote port address
`Modem Bit Rate` `9.6kbps`	Numeric	0 to 7 selects standard rates 150 bps - 19.2 kbps	Remote control bit rate
`Modem Format` `8 Data, 1 Stop`	Selection	7 or 8 data bits, 1 stop bit for all modes except 2 at 7 bit, no parity.	Remote control data/stop bits.
`Modem Parity` `None`	Selection	0 = Space, 1 = Mark, 2 = Odd, 3 = Even, 4 = None	Remote control Parity
`Modem Xon/Xoff` `Option N/A`	Selection	0 = disable, 1 = enable	Remote control Xon/Xoff. Only available in terminal mode.
`Modem Key Click` `Enabled`	Selection	0 = disable, 1 = enable	Audible “click” on key press
`Modem LCD Active` `Backlight Full`	Selection	0 = off, 1 = 1/3, 2 = 2/3, 3 = full	Active level of LCD backlight
`Modem LCD Idle` `Backlight 1/3`	Selection	0 = off, 1 = 1/3, 2 = 2/3, 3 = full	Idle level of LCD backlight
`Modem Station ID` `Rmt Santa Cruz`	Alpha – Numeric	Entered as ASCII numbers for up to 16 characters	Station Name for user
`Modem Model` `PSM-2100`	Read Only	Read from software	Modem Model #,

Representation	Type	Entry	Description
Modem Softwr Ver 2.02	Read Only	Read from software	Version of software installed
Modem Serial # 1123	Read Only	Not changeable	Modem Serial Number
Modem Interface RS–449	Read Only	Read from Interface card	Interface option card type
Modem Inf Option None	Read Only	Read from Interface card	Options on the interface card
Modem Inf Max. 2.100000Mbps	Read Only	Read from Interface card	Data interface maximum bit rate
Modem Inf Min. 3.600kbps	Read Only	Read from Interface card	Data interface minimum bit rate

Table 3-5. Test Parameters

Representation	Type	Entry	Description
Test Status Sending, OK	Read Only	Read Only	Modem Test Status
Test IF Loop Disabled	Selection	0 = disable, 1 = enable	IF loopback transmit to receive.Transmit output controlled by enable, receive is terminated.
Test Data Loop Disabled	Selection	0 = disable, 1 = enable	Data loopback toward satellite and terrestrial.
Test Mod Output Normal	Selection	0 = Normal, 1 = Pure Carrier, 2 = Sideband	Carrier output mode for test purposes.
Test Dstp AFC 3.2V	Read Only	AFC loop voltage	Demod Step Synthesizer PLL
Test DLO AFC 3.2V	Read Only	AFC loop voltage	Demod Local Oscillator PLL
Test AGC 3.2V	Read Only	AGC internal voltage	Representative of input level
Test IDC Offset 3.2V	Read Only	Receive I channel offset voltage	
Test QDC Offset 3.2V	Read Only	Receive Q channel offset voltage	
Test Mstp AFC 3.2V	Read Only	AFC loop voltages	Mod Step Synthesizer PLL
Test MLO AFC 3.2V	Read Only	AFC loop voltages	Mod Local Oscillator PLL
Test Ref AFC 3.2V	Read Only	AFC loop voltages	Input reference PLL
Test Modem Test Disabled	Selection	0 = disable, 1 = enable	Modem Self Test

3.3 Terminal Mode Control

The PSM-2100 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”) 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.

3.3.1 Modem Setup for Terminal Mode

Terminal mode communications and protocol is set from the front panel control by setting the "Modem Remote" parameter to "Terminal" (Option 3), and then setting the "Modem Port", "Modem Bit Rate", "Modem Format" and "Modem Parity" parameters as desired. Then a "VT100" protocol terminal is connected to connector P2. All operating software for the terminal mode is contained within the PSM-2100 modem internal control software.

```
          PSM-2100 Satellite Modem, VT100 Remote Terminal Mode

(1) Mod Status Sending, Ok               (G) Mod Clock Source Internal
(2) Mod CXR Frequency 70.000000MHz      (H) Mod Clock Phase +Edge Valid
(3) Mod Offset Freq. 0.000kHz           (I) Mod Mode Continuous
(4) Mod Output Level –10.0dBm           (J) Mod Preamble Option N/A
(5) Mod CXR Output Enabled              (K) Mod AUFC Disabled
(6) Mod AUPC Disabled                   (L) Mod AUFC Limit Option N/A
(7) Mod AUPC Eb/No Option N/A           (M) Mod RF Cnv Up/Dwn Option N/A
(8) Mod AUPC Max. Level Option N/A      (N) Mod Spectrum Option N/A
(9) Mod AUPC Min. Level Option N/A      (O) Mod SAT Error Frq Option N/A
(A) Mod Modulation QPSK                 (P) Mod RTS Input Ignore
(B) Mod Bit Rate 256.000kbps            (Q) Mod CXR Mute Manual
(C) Mod Code Rate Rate 1/2              (R) Mod CXR Alarm to Alarm A
(D) Mod Diff Encoder Enabled            (S) Mod AUPC Alarm Option N/A
(E) Mod Scrambler Enabled               (T) Mod Bit Alarm to Alarm A
(F) Mod Data Non–Inverted               (U) Mod Hardwr Fault to Alarm A

                  (0) Select Active Screen [Modulator]

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

Figure 3-2. Terminal Mode – Example Modulator Screen

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.

The Terminal Mode uses four "Screens", each of which have the basic contents of the four modem control areas as set in the front panel matrix columns. That is one screen that is used for setting the parameters of the Modulator, Demodulator, Modem Unit and Test Areas. A representation of the terminal screen is shown in Figures 3-2 through 3-5. These screens may differ from the exact screens displayed due to changes in software and the presence of options in the modem hardware. For instance, the presence of a Reed-Solomon Codec will result in added options available on the screens.

NOTE: Near the bottom of each of these screens is a line which shows the current area of display and gives a number key to press to change the area.

```
(0) Select Active Screen [Modulator]
```

Pressing the "0" key allows the option of changing from one screen to the next. Press the key indicated for the desired screen to change.

```
          PSM-2100 Satellite Modem, VT100 Remote Terminal Mode

(1) Demod Status Locked, Ok              (G) Demod Clock Source Demod Clk
(2) Demod CXR Frequency 70.000000MHz     (H) Demod Clock Phase +Edge Valid
(3) Demod Offset Freq. 0.000kHz          (I) Demod FIFO Status Option N/A
    Demod Input Level –55dBm             (J) Demod FIFO Delay Option N/A
    Demod Eb/No 14.0dB                   (K) Demod FIFO Size Option N/A
(6) Demod Sweep Mode Wide Only           (L) Demod Symbol Error Rate 0.00x10^–5
(7) Demod Sweep ±30.0kHz                 (M) Demod Estimated BER <x10^–10
(8) Demod Narrow Time Option N/A         (N) Demod Low Eb/No Threshold 5.0dB
(9) Demod Lock Qualify Time 5 Sec        (O) Demod Lock Alarm to Alarm B
(A) Demod Modulation QPSK                (P) Demod Input Alarm to Alarm B
(B) Demod Bit Rate 256.000kbps           (Q) Demod Eb/No Alarm to Alarm B
(C) Demod Code Rate Rate 1/2             (R) Demod Hardwr Fault to Alarm B
(D) Demod Diff Decoder Enabled
(E) Demod Descrambler Enabled
(F) Demod Data Non–Inverted

                  (0) Select Active Screen [Demodulator]

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

Figure 3-3. Terminal Mode – Example of Demodulator Screen

Items that are programmable via the communications interface have a preceding number or letter in parentheses which is used to select that option.

```
          PSM-2100 Satellite Modem, VT100 Remote Terminal Mode

(1) Status Normal
(2) IF Loop–Back Disabled
(3) Data Loop–Back Disabled
(4) Mod Output Normal
    Demod STP AFC 5.0V
    Demod LO AFC 5.2V
    Demod AGC 6.9V
    Demod IDC Offset –2.8V
    Demod QDC Offset –2.6V
    Mod STP AFC 4.9V
    Mod LO AFC 5.4V
    Reference AFC 1.7V
(D) Modem Self Test Disabled

                      0) Select Active Screen [Test]

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

Figure 3-4. Terminal Mode – Example of Modem Test Screen

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 number "1" through "9" and "A" through "Z" (if an option above "Z" is required the left bracket is used "[". For example, to change the modulator's carrier frequency you must first go to the modulator screen if not already there (Press "0 0") and press the terminal's "2" key. 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 competing 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-2100 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 usable only with a single controller and modem. The packets use a unique address for each controlled device, which is set using the modem's front panel. The message packets themselves can take two forms, either binary or ASCII. The complete protocol is shown in Appendix B.

```
      PSM-2100 Satellite Modem, VT100 Remote Terminal Mode

 Status Locked & Sending               (G) Station ID Station Name
(2) Config Access Local & Remote           Model PSM-2100
(3) Mode Mod & Demod                       Software Version C
(4) Reference Internal                     FEC Type Q1650
(5) Ref Freq. 10.000MHz                     Serial Number 0
(6) Remote VT100 Terminal                  Interface RS–449
(7) Remote Port RS–232                     Interface Option None
(8) Remote Address 1                       Interface Max. 2.100000Mbps
(9) Remote Bit Rate 9.6kbps                Interface Min. 3.600kbps
(A) Remote Format 8 Data, 1 Stop           Interface Ratio 1.000000000
(B) Remote Parity None                     Interface Offset 0.000kbps
(C) Remote X on/off Disabled           (R) Redundancy Disabled
(D) Key Click Enabled                  (S) Redundancy Alarm Option N/A
(E) LCD Active Backlight Full          (T) Test Active to Alarm A & B
(F) LCD Idle Backlight 1/3

        (0) Select Active Screen [Modem]

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

Figure 3-5. Terminal Mode – Example of Modem Unit Screen

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 message requiring a response.

Message packets to the modem can take three forms;

1. Messages requesting information in a response message or “Read”;
2. Messages commanding a change in operating parameters or “Write”;
3. Command messages as in 2, with a save to EEPROM.

Any write information without a save to EEPROM is lost on removal of power from the unit.

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 (for binary packets) 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 J4. 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 J4.

This command mode communications protocol involves the sending of a standard message packet from a controller requesting information or commanding a change. The PSM-2100 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.

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 failure is detected, the ALARM LED is flashed at a rate which indicates what component tested faulty:

1. A 5-Hertz rate of the ALARM LED indicates that ROM Checksum test failed. The LCD display will show “Modem Failure! ROM Corrupt”
2. A 1-Hertz rate indicates that the internal or external RAM test failed.
3. A 1-Hertz rate indicates that the EEPROM test failed. The LCD display will show “Modem Failure! EEPROM Corrupt”

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:

Modulator:

Carrier Frequency = 70.00 MHz
Data Rate = 256 kbps
Modulation = QPSK
Code Rate = Rate 1/2
Differential Encoder = Enabled
Scrambler = Intelsat
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 = Intelsat
Clock phase = Normal
Data = Normal
Clock Source = Receive
Sweep mode = Fast
All Demod Alarms to Relay B

Modem Unit:

Modem Mode = Mod and Demod
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

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 Burst Mode Operation

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 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 flag received by the modulator is the end of transmission signal. The modem maintains a 56-bit buffer which allows placement of the closing flag exactly 56 bits prior to the final data bit. This protocol is specific to the “Comstream“ CP–101 hub station burst demodulator and is very efficient.
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.

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.

3.8 Automatic Uplink Power Control (AUPC) Operation

The PSM-2100 modem has built-in provisions for Automatic Uplink Power Control (AUPC). AUPC attempts to maintain a constant E_b/N_o at the receive end of an SCPC 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 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 option when supplied.

Note: The Enhanced 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 to AUPC operation. Only one direction is discussed, but the same functions could be occurring in both directions simultaneously. 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.

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.

3.9 Automatic Uplink Frequency Control (AUFC) Operation

The PSM-2100 modem has built-in provisions for Automatic Uplink Frequency Control (AUFC). This function operates independently within the modem and does not require a data link to communicate with the far end modem processor. AUFC attempts to maintain a constant receive carrier frequency at the far receive end of an SCPC or VSAT link using an algorithm which adjusts the transmit frequency based on the receive offset. This function can be very useful in systems which use the PSM-2100 as the remote terminal of a TDMA system where the hub station is using a burst demodulator. This function is based upon a common reference used by both the up- and downconverter at each end of the link.

If the receive carrier offset changes in a modem set for AUFC operation, the transmit synthesizer in the same modem is adjusted to compensate for that amount of change adjusted by several “factors”. These factors include:

- The Converter RF transmit to receive ratio (at 6 and 4 GHz for C–band for instance this is approximately 1.5)
- The spectrum “sense” or direction of change required (i.e. if the receive offset goes more negative does the transmit offset move positive or negative?), and
- An absolute limit on how far the transmit is allowed to change. An additional parameter entry can set the known satellite error frequency.

The basic operation is illustrated further by an example: Assume that we have a Star system with a hub station and remote stations. A remote station modem is set for AUFC operation. Only one direction is discussed and operation is intended for only one direction of a link. If both directions were set to use AUFC then the system may become unstable. Modem “A”, at a hub station, is transmitting to modem “B” under normal conditions and modem “B” in this case is set to AUFC operation. If the up and down converters in both stations were perfect and the satellite error frequency and Up to Down converter ratio is entered at “B” then “B” will not offset its transmit frequency to adjust for this known satellite offset, and station “A” modem will receive “B”s carrier offset by this amount. If the converter in either station starts to drift slightly in frequency then “B”s receive offset now changes and the “B” modem will adjust its transmit offset to compensate, maintaining the constant, but offset, receive frequency at the “A” station. Assuming that the A hub station has very stable converters then lower cost converters at remote stations can be readily compensated for by this method.

3.10 Demodulator Receive Data FIFO Operation

The PSM-2100 modem has a built-in First In First Out (FIFO) on the receive data channel that may be enabled to compensate for cyclical variations in the receive data rate. This is 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. 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 (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 three sources:

1. ***Receive Clock*** – Meaning that the input and output clocks are the same, disabling the FIFO.
2. ***Modulator Clock*** – Uses the modulator data rate clock as the output clock and obviously requires that the modulator and demodulator data rate be identical.
3. ***External FIFO Clock*** – This option allows a station-derived standard clock rate to be used to clock data out of the FIFO.

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.

> ***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 0.0025mS (4 bits at 2.1 Mbps) to 27,306 mS (131,070 bits at 4800 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 refilling to 100% before any data is allowed to be clocked out. Both conditions result in a potential serious loss of data.

When an under or over-run occurs a internal modem flag is set indicating that a re-center has occurred. The front panel display shows “Re-Centered” 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.

Section Four - Maintenance

4.0 Periodic Maintenance

The PSM-2100 requires no periodic field maintenance procedures. The unit contains very few 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, 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-2100 Modem. The fuse is located on the power supply assembly inside the case, and replacement is not intended in the field.

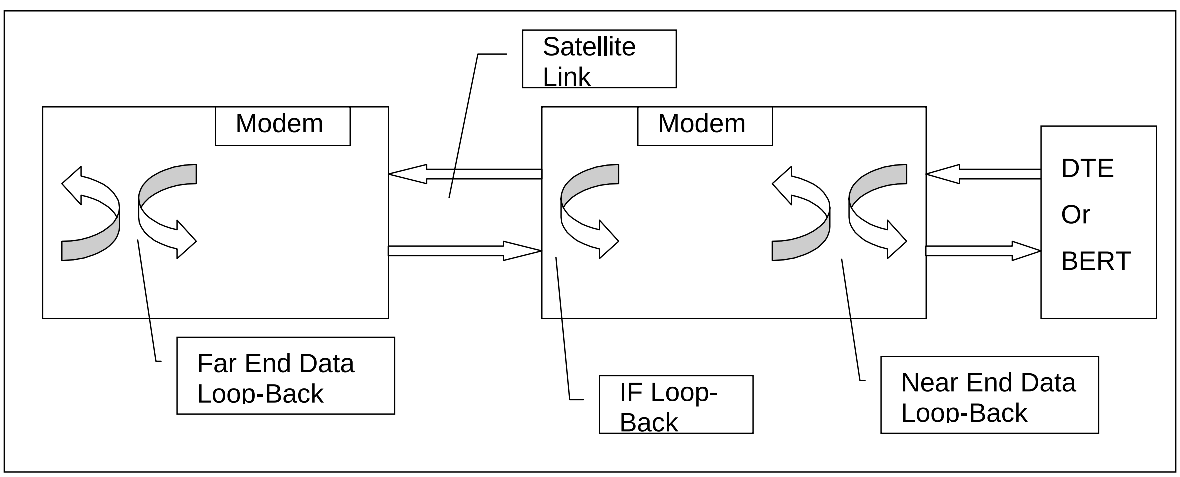
4.1 Common Test Procedures

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-2100 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 and the multiple “Loop-Back” modes available.

⇒ ***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.

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.



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 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.
- **Near End IF Loop-Back**: This second loop-back will verify the DTE wiring (as in 1 above) plus the modem transmit signal processing, modulation, demodulation, receive signal processing, and connection to the receive wiring.
- **Far End Data Loop-Back**: This will test most of the satellite link as well as the functions checked in 1 and 2 above. The signal is sent over the satellite (or test setup) and is looped back at the data interface on the far end. This tests both modems, the satellite link and originating end wiring.

In this type of testing the 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.

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.

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.

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 Loopback disconnects the Demodulator from the IF receive input connector.

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

Possible Cause: Receive acquisition range set too narrow.

Action: Check the actual receive carrier frequency 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.

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.

Action*:* Check the current state of the Scrambler and differential encoder.

Symptom: The Modem receive FIFO buffer indicates “recentered”.

Possible Cause: The FIFO automatically recenters when an overrun or underrun 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 recenters when an overrun or underrun 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 Test Points

The following Table is provided for depot level maintenance only. Since the PSM-2100 unit is not field-repairable, it can only be used to indicate the possible cause of a failure. A listing of signals to be observed at each of the test points on the modem board follows:

Table 4-1. PSM-2100 Test Points

Test Point	Name	Test Equipment	Description
TP45	+5V	DVM	+5 Vdc as input to PWB. Allowable range: +4.75 to +5.25 Vdc
TP22	+5Vb	DVM	Reference Synthesizer +5Vdc regulated from +12V source. Allowable range: +4.75 to +5.25 Vdc
TP23	+5Vc	DVM	Mod and Demod Carrier synthesizer +5Vdc regulated from +12V source. Allowable range: +4.75 to +5.25 Vdc
TP5	MSTEP+5V	DVM	Mod Step Synthesizer +5Vdc regulated from +12V source. Allowable range: +4.75 to +5.25 Vdc
TP3	DSTEP+5V	DVM	Demod Step Synthesizer +5Vdc regulated from +12V source. Allowable range: +4.75 to +5.25 Vdc
TP46	–12V	DVM	–12 Vdc on board Allowable range: –12.6 to –11.4 Vdc
TP48	+12V	DVM	+12 Vdc on board Allowable range: +11.4 to +12.6 Vdc
TP9	+21V	DVM	+21 Vdc voltage doubler output . Nominal +21 Vdc
TP10	-2V	DVM	-2 Vdc. For synthesizers Nominal -2 Vdc
TP31	+8Vdc	DVM	+8 Vdc for variable receive filter Allowable range: ± 5% plus tolerance.
TP36	-8Vdc	DVM	-8 Vdc for variable receive filter Allowable range: ± 5% plus tolerance.
TP37	DEM I	Oscilloscope	Eye pattern view of the receive I channel. Represents the received signal in both BPSK or QPSK mode.
TP32	DEM Q	Oscilloscope	Eye pattern view of the receive Q channel. In BPSK this represents received noise while in QPSK mode it represents received signal
TP27	DSCLK	Oscilloscope	Receive symbol rate clock.
TP42	MOD I	Oscilloscope	Eye pattern view of the modulator I channel. Represents the received signal in both BPSK or QPSK mode.
TP43	MOD Q	Oscilloscope	Eye pattern view of the modulator Q channel. In

Test Point	Name	Test Equipment	Description
			BPSK this represents received noise while in QPSK mode it represents received signal
TP24	RESET	Oscilloscope	The processor reset input active negative. A reset is initiated by the voltage supervisor.
TP21	REF AFC	Oscilloscope	52 MHz master clock PLL tuning voltage. Proper range: +1 to +9 Vdc
TP4	MSTP AFC	Oscilloscope	Transmit Step Synthesizer PLL AFC tuning voltage Proper range: +1 to +16 Vdc
TP14	MLO AFC	DVM	Transmit LO carrier PLL AFC tuning voltage. Proper range: +1 to +16 Vdc
TP2	DSTP AFC	Oscilloscope	Demod Step Synthesizer PLL AFC tuning voltage Proper range: +1 to +16 Vdc
TP18	DLO AFC	DVM	Demod LO carrier PLL AFC tuning voltage. Proper range: +1 to +16 Vdc
TP28	AGC	DVM	DC voltage representing the received signal level of the carrier for the currently locked carrier. More negative means greater signal level. Proper range: +10 to –10 Vdc
TP30	IDC	DVM	I channel DC offset level used to balance the mixer DC. Proper range: +10 to –10 Vdc
TP29	QDC	DVM	Q channel DC offset level used to balance the mixer DC. Proper range: +10 to –10 Vdc
TP40	A/D REF	DVM	Reference for the Demodulator A/D converters. Nominal +4.0 Vdc
TP49	D/A REF	DVM	Reference for the Modulator D/A converters. Nominal +5.0 Vdc
TP52	GND	————	
TP53	GND	————	

4.2.2 Onboard Diagnostic Indicators

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

1. **DS2** - *MSTP FAULT*- (Red) – Indicates that the transmit step synthesizer is unlocked. Normally this would result only from an onboard fault.
2. **DS1** - *MLO FAULT*- (Red) – Indicates that the transmit Local Oscillator synthesizer is unlocked. Normally this would result only from an onboard fault.
3. **DS4** - *DSTP FAULT*- (Red) – Indicates that the receive step synthesizer is unlocked. Normally this would result only from an onboard fault.
4. **DS5** - *DLO FAULT*- (Red) – Indicates that the receive Local Oscillator synthesizer is unlocked. Normally this would result only from an onboard fault.

5. **DS6** - *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.
6. **DS3** - *REF FAULT-* (Red) – Indicates that the onboard reference oscillator is not phase locked. There are two selectable sources that this oscillator can lock to: Either the internal TCXO or the external reference input.
7. **DS7** - *DEM LOCK-* (Green) – Indicates that the demod hardware has locked to an incoming carrier.
8. **DS8** - MOD ENABLE- (Green) – Indicates that the modulator hardware has enabled the transmit carrier.

4.2.3 Onboard Processor Power-On Sequence and Diagnostics

The processor goes through the following sequence every time the modem is powered up. Refer to a software listing for more detail of each process.

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 EPROM 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 an endless alarm loop is initiated, and display a message 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.

4.2.4 Built-in Self-Test Sequence

The built-in self-test goes through a specific sequence outlined here for reference only. The purpose of this test is to verify the integrity of internal modem operations as fully as possible while requiring no or minimal external test equipment or fixtures. Since there is no external testing done, the functioning of the modem data interface, external reference input and physical IF input and output are not tested. Alarm relay connections to external equipment can however be exercised during the test sequence.

⇒ ***CAUTION:*** *The Self-Test Mode will disconnect the receive IF from the ground station equipment and will therefore disrupt any traffic currently through the PSM-2100 under test. This Test Mode should not be used on a live traffic unit.*

A self test in progress may be cleared by pressing "Clear" on the front panel.

4.2.4.1 Lamp Test

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

4.2.4.2 Alarm Relay Test

Alarm relay A is turned on for 1 second, then Alarm B is turned on for 1 second. This is intended for checking externally connected equipment.

4.2.4.3 Alarm Test in 2 passes

In pass one, all parameters are set to force a failure and any non–alarm conditions results in a failure of the test. In pass two, all parameters are set to remove alarms, and any alarm remaining results in failure of the test.

4.2.4.4 AFC Limit Test in 2 steps

In step one, the modulator and demodulator are set to 52 MHz with offset to 51.75 MHz and the synthesizer loop voltages are tested for proper range. All processor read voltages are monitored for proper range. In step two, the modulator and demodulator are set to 88 MHz with the offset to 89.25 MHz and the loop and other monitored voltages are measured again for proper range.

4.2.4.5 Loop Test 1

The modulator and demodulator are set to 2.1 Mbps (525 kbps in the PSM-512), QPSK, Rate ¾ and an IF Loop is initiated. The processor checks to see if the receive Eb/No is above a limit of 24.0 dB.

4.2.4.6 Loop Test 2

The modulator and demodulator are set to 4.8 kbps, QPSK, Rate 1/2 and an IF Loop is initiated. The processor checks to see if the receive Eb/No is above a limit of 24.0 dB.

4.3 Updating Modem Software

The current modem software has several years of in service use, and has eliminated any current known errors. We do occasionally add new features or correct operating procedures within the modem software that lead to problems. When the operating software changes the Revision number is updated. Some changes involve changes to the information or structure in the non-volatile EEPROM storage. If you have modems with different software revisions it is important that you do not attempt to "upgrade the modem by placing the later revision EPROM into the older modem. This may result in corrupting the EEPROM mapping of power level vs. frequency calibration data, which is almost always irretrievable in the field, and requires returning the unit to the factory for re-calibration.