DATUM SYSTEMS

PSM-2100L Satellite Modem
L-Band IF Addendum

1.0 Introduction

Small receive only satellite stations have used L-Band as an outdoor to indoor equipment IF link for several years. The advent of full transmit and receive modems utilizing L-Band interface frequencies promises to usher in a new era in small terminal design and construction. The promise of this new equipment configuration is reduced complexity and cost.

The PSM-2100L modem brings all the advantages of Datum System's direct modulation and demodulation design, superior performance and high digital integration for low cost assembly to the VSAT station. Because this new modem costs little more than a standard 70 MHz IF modem and significantly reduces the complexity and cost of the up and down conversion equipment, it promises to provide a new high in performance per dollar.

A significant aspect of small station design using an L-Band interface modem is that all of the complexity and "smarts" are contained within the modem itself. The Block UpConverter or "BUC" and the Low Noise Block DownConverter or "LNB" now each contain a single fixed local oscillator, not required to tune for operation over the entire satellite band covering all transponders. The PSM-2100L tunes over an extended range of 950 to 1650 MHz in 1 Hz increments allowing it to access 700 MHz of RF spectrum.

Aside from the many advantages, using L-Band as an inter-facility link frequency results in the need to carefully consider the components, frequencies and construction techniques used to insure proper operation. Part of the purpose of this addendum is to spell out those areas where special care must be used to achieve a reliable station operation.

For the purposes of the remainder of this document the names, acronyms and meanings used which may be new for this type modem are:

- "***Modem***" - Refers to the PSM-2100L modem capable of both transmit and receive operation.
- "***IF***". The modems Intermediate Frequency used to connect to the Up and DownConversion equipment.
- "***BUC***" – Block Up Converter, Often with an integrated power amplifier for installation directly to the feed at the antenna.
- "***LNB***" – Low Noise Block Down Converter. Includes a low noise RF front end and single down conversion stage to L-Band frequencies. In a VSAT, especially at low data rates, this is a significantly better device than the typical free running LNB used for video broadcast reception. A "data grade" LNB must have very low phase noise and a phase locked LO for proper performance.
- "***Bias T Mux***". This is a device that multiplexes power, IF signals and often a reference frequency onto a single cable going up to the BUC or LNB.
- "***Terrestrial***" side. The Line or data side of the modem.
- "***VSAT***" – Vary Small Aperture Station, referring to a station with a small antenna, typically 1 to 4.5 meters in diameter.
- "***LO***" – Local Oscillator frequency used for up or down conversion of RF frequenies.

2.0 Differences Between 70 MHz and L-Band Modems

Since the PSM-2100L modem is closely based on the design of the PSM-2100 70 MHz modem the vast majority of the operation of these modems is identical. We briefly list the differences between these modems here and further amplify operating differences in the following sections.

- IF Frequency range changed to 950 to 1650 MHz, Transmit and Receive.
- Transmit Output Level expanded to +5 to –35 dBm to accommodate a wide range of losses between the modulator and BUC.
- Receive Input Level AGC range is greatly expanded covering demodulator input levels of –20 dBm to –102 dBm, dependant on data rate.
- New and Modified Commands available.

2.1 IF Frequency Range

Typical 70 MHz modems are designed to operate over a 36 (or 40) MHz range representing the bandwidth of a single transponder on a C-Band (6 GHz uplink/4 GHz downlink) satellite. This results in the classic 70 MHz IF range of 52 to 88 MHz.

Since it is expected that no tuning is available in the BUC or LNB, then an L-Band modem must tune over at least the 500 MHz of a typical satellite's full transponder range. For C-Band this would be the RF ranges of 5.925 to 6.425 GHz transmit and 3.7 to 4.2 GHz receive. Translated to an L-Band IF this would represent the typical frequency range of 950 to 1450 MHz. Not all satellites use the exact same bands of RF frequencies for transmit and receive, therefore the PSM-2100L is designed to tune over a 700 MHz range to accommodate as many satellite range/converter LO schemes as possible. One scheme seems to be fairly common using a BUC transmit LO of 4.900 GHz, while the LNB uses an LO of 5.150 GHz

The PSM-2100L provides two methods of specifying transmit and receive frequencies. Added transmit and receive parameter inputs are provided for the transmit BUC and receive LNB Local Oscillator (LO) frequencies. On the front panel display they are referred to as “MOD Cnvrter LO”, and “DEMOD Cnvrter LO”.

1. If a zero frequency is supplied here then the user inputs L-Band IF frequencies (950 to 1650 MHz) for the transmit or receive carrier frequency assignment.

2. If a transmit or receive LO frequency is supplied, for example the 4.90 GHz transmit LO and 5.15 GHz receive LO, then the modem accepts RF frequency inputs and computes the actual required L-Band IF transmit and receive frequency. The modem also determines if the LO is a high side or low side LO, and if a spectrum inversion results, and then corrects for spectrum inversions within the modem parameters.
   The modem's automatic use of input LO frequencies is independent in the transmit and receive channels.

As you might imagine it would be difficult to compute the proper L-Band IF frequencies to use every time a new transmit or receive frequency is desired. The second method is highly preferable since the LO frequencies are only entered once and the modem stores them in non-volatile memory.

> ***Note:*** *If this second method is used it is important to set the “Spectrum” parameter for transmit and receive to “Normal” Then the modem will set the spectrum sense correctly for the chosen LO frequency.*

EXAMPLE:

Using the above LOs as an example, suppose that we wanted to operate on transponder 1 of a C- Band satellite at RF transmit frequency of 5932.1 MHz and a receive frequency of 3705 MHz (representing a 5930.0 MHz transmit from the other station at a satellite LO of 2225 MHz). The given transmit LO is used in an additive scheme where the RF frequency = IF + 4900 MHz. The L-Band IF is then 5932.1 – 4900 or 1032.1 MHz. The receive must use a subtractive scheme where the IF = 5.15 – RF frequency. This will result in a spectrum inversion on the receive side only. The receive L-Band IF frequency is 5150 – 3705 or 1445 MHz.

By having previously entered the BUC and LNB LO frequencies we only had to enter the RF frequencies. These are the same frequencies that we would see on a spectrum analyzer looking directly at the station transmit and receive RF.

Notice that these common LO examples resulted in L-Band IF frequencies at opposite ends of the L-Band range for carriers that were almost next to each other on the satellite.

2.1.1 Some Other Block Converter Schemes

In a single conversion UpConverter from L-Band there is also the possibility of using a “high side” LO for both C and L-Band transmit frequencies. For a C-Band BUC using a High side LO going from 950 – 1450 MHz to 5925 – 6425 MHZ the LO frequency would be 7375 MHz (950 + 6425 MHz). There would be an inversion in the transmit output spectrum. Notice also that the highest transmit output frequence results from using the lowest L-Band modem transmit frequency.

The same schemes are possible at Ku-Band frequencies, where either a high or low side LO may be used. The following table summarizes the straightforward low and high side LO frequencies for Block Up and Down Converters.

Band	Up/Down	Freq Range (MHz)	LO	LO Freq. (MHz)	Spectrum Inversion	Notes
C	Up	5925-6425	Low	4900	No	Common
C	Up	5925-6425	High	7375	Yes	
C	Up	5850-6350	High	7300	Yes	Brazilian
C	Down	3700-4200	High	5150	Yes	Common
C	Down	3700-4200	Low	2750	Yes	Not used
Ku	Up	14,000-14,500	High	15,450	Yes	
Ku	Up	14,000-14,500	Low	13,050	No	
Ku	Down	11,700-12,200	Low	10,750	No	Common
Ku	Down	11,700-12,200	High	13,150	Yes	?

Of course there are many possible frequency ranges used for satellite stations in different parts of the world and we make no attempt to show them all here. This table is simply to list some of the possibilities. The PSM-2100L tunes over more than the typical 500 MHz (700 MHz), so it is also possible to use an LO frequency that allows a single modem and Converter to cover multiple frequency ranges. For example, a 4800 MHz C-Band Low side LO would translate the 950 to 1650 MHz range (available in the PSM-2100) to 5750 to 6450 MHz.

2.2 Transmit Output Power Levels

The PSM-2100L has increased the range of power levels available from the transmit output. This is to accommodate direct connection (through a bias T mux) to a standard BUC including significant cable loss without the need for inline amplifiers or attenuators. The PSM-2100L can output from –35 dBm to +5 dBm in 0.1 dB steps. This 40 dB range can accommodate a wide range of cable length and BUC gain. Assuming for example that with a BUC gain of 50 dB, and a 4 Watt maximum output (+36 dBm) the required BUC input to achieve full output power would be –14 dBm. The modem then could drive up to a maximum of 19 dB of cable/connection losses. This could be a maximum of 100 to 400 feet or more depending on the size and type of cable used. More about cable selection is provided in Section 3 below on designing and setting up an L-Band station.

2.3 Receive Input Power Levels

The PSM-2100L has increased the range of power levels acceptable to the receive input. This is to accommodate direct connection (through a bias T mux) of a standard data grade LNB including significant cable loss without the need for inline amplifiers or attenuators. The PSM-2100L can accept a window of approximately 60 dB at any given data rate. The input level range changes with data rate. When considering the full data rate range of 3.6 kbps (BPSK, rate ½) to 2.1 Mbps (QPSK, rate ¾ or 7/8) this results in a total range of approximately from –20 dBm to -102 dBm. The modem automatically adjusts the range for the data rate used and the user is warned if the level is marginal. Of course, if the level is below the AGC capability then the modem will not acquire signal lock. This 60 dB range at any particular data rate can accommodate a wide range of cable length and LNB gains. The LNB gain minus the cable loss should always fall within the range of 35 dB to 70 dB of overall gain. As long as this gain is achieved, the demodulator will function properly at all data rates from 3.6 kpbs to 2.1 Mbps requiring no further system level engineering. For example a typical data grade LNB has a gain of approximately 60 dB. This would allow for up to 25 dB of cable loss at any data rate. Like the transmit this allows a maximum cable length of approximately 100 to 400 feet depending on the size and type of cable used. The LNB gain and cable loss variations due to temperature changes are unimportant on the receive side as long as the overall gain range above is met at all times.

The standard Datum Systems supplied Receive Bias T Mux provides impedance conversion from a 75 Ohm LNB and cable to the 50 Ohms used by the demodulator. An additional cable loss of 6 dB should be added to the input level range calculation. More about cable selection is provided in Section 3 below on designing and setting up an L-Band station.

The user does not have to specify the input power level. The modem AGC locks to the signal and reports the receive signal level as a front panel parameter under “DEMOD INPUT LEVEL”

2.4 New/Modified Commands

New Commands relative to the 70 MHz modem are all directly related to L-Band operation. Each is represented by a new “parameter entry” in the front panel matrix, and a new binary and ASCII command code in the command protocols. Changed commands have modified entry parameters from the 70 MHz modem commands.

2.4.1 New Commands

“**MOD Cnvrter LO**” - Transmit Converter LO Frequency – Input to a non-zero value allows direct RF frequency entry (see Section 2.1)

“**MOD Spectrum**” - Transmit Spectrum Sense – May be set Normal or Inverted to correct for a converter mixing scheme that results in a spectrum inversion. *Note: Set to “Normal” when entering a “MOD Cnvrter LO” not equal to zero. (see Section 2.1)*

“**DEMOD Cnvrter - LO**” Receive Converter LO Frequency – Input to a non-zero value allows direct RF frequency entry (see Section 2.1)

“**DEMOD Spectrum**” - Receive Spectrum Sense – May be set Normal or Inverted to correct for a converter mixing scheme that results in a spectrum inversion. *Note: Set to “Normal” when entering a “DEMOD Cnvrter LO” not equal to zero. (see Section 2.1)*

2.4.2 Modified Commands

Modulator Carrier Frequency
- Was: 50 to 90 MHz, 4 bytes in binary command
- Is: 950 to 1650 MHz, 5 bytes in binary command
  OR 700 MHz of RF frequency range when the LO input not = 0.

Modulator Carrier Offset Range
- Was: 0 Hz to +/- 1.25 MHz
- Is: 0 Hz to +/- 750 kHz

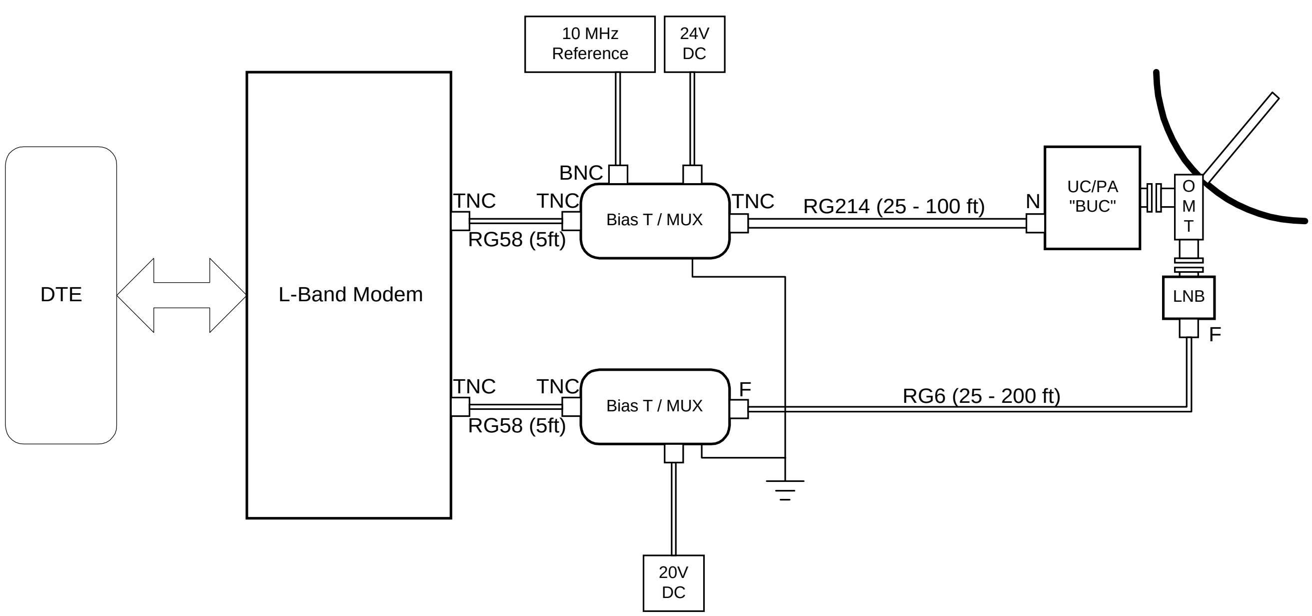
Modulator Output Level
- Was: -5 to –25 dBm
- Is: +5 to –35 dBm

Demodulator Carrier Frequency
- Was: 50 to 90 MHz, 4 bytes in binary command
- Is: 950 to 1650 MHz, 5 bytes in binary command
  OR 700 MHz of RF frequency range when the LO input not = 0.

Demodulator Acquisition Range
- Was: +/- 200 Hz to +/- 1.25 MHz
- Is: +/- 200 Hz to +/- 750 kHz

3.0 Designing and Setting up an L-Band Station

The equipment complement at any station site almost always consists of transmit and receive equipment including Modem(s), UpConverter and Downconverter, Power Amplifier and Low Noise Receivers as well as the antenna itself. In an L-Band IF station the locations and complexity of these items is changed. The basic station diagram below shows the typical equipment complement for an L-Band based VSAT. The station can be expanded by adding combiners and splitters in the IF to feed more modems.



Typical VSAT Configuration
L-Band Version

MAB 10/19/98

This is not intended as a definitive guide to design of L-Band stations. Rather it is a list of considerations and recommendations when putting together the equipment complement for a station. The equipment market is just starting for this application and there is much to be worked out concerning interoperability between components. Note also that the BUC and LNB usually require power and reference signals. The voltages show on the diagram above are dependant on the particular equipment used. Some BUCs require approximately 15 volts while others may use approximately 36 or 48 volts. Some BUCs also use a reference frequency in the L-Band range instead of the more common 10 MHz.

3.1 Block UpConverter/ Power Amplifier Selection

A prospective BUC must meet certain minimum requirements:

- Minimum gain should be based on the required output power levels and cable losses.
- Maximum phase noise levels need to be determined based on the data rates being used.
- Frequency stability: Determined by externally applied 10 MHz reference oscillator. Typically requires at least 1 part in 10^7 or better for C-Band operation. This represents a possible 600 Hz error at 6 GHz transmit frequency.
- Input Connector: 50 Ohm, Type N or TNC
- Power Output: 1 to 20 Watts depending on satellite, location, antenna size, etc.

If the cable length between the power insertion point and the BUC is very long then a higher voltage may be desirable due to losses in the cables.

3.2 LNB Selection

It is doubtful that one could use a TVRO video class LNB and make it work in a data application. This is mainly because these LNBs were designed with a very wideband video carrier in mind, and the phase noise performance is far from that necessary for a lower data rate PSK carrier. Today, data grade LNBs are still fairly inexpensive, but a prospective LNB must meet certain minimum requirements:

- Gain of approximately 45 to 70 dB
- Maximum phase noise levels need to be determined based on the data rates being used.
- Frequency stability: +/- 5 to +/- 25 kHz preferred, +/- 500 kHz acceptable if phase noise good.

> ***Caution: If the receive frequency stability exceeds the channel spacing then there is the possibility of locking to adjacent similar carriers!***

- Input Connector: 50 Ohm, Type N or TNC preferred. Options may be limited to 75 Ohm and/or type “F” connector. If type F is used insure that it is weather sealed.

3.3 Outdoor Equipment Power Provision

Block UpConverter Power. Current BUCs may require anywhere from approximately 12 VDC to – 48 VDC depending on the manufacturer. Approximately 50 Watts is not uncommon. The power is typically applied via the transmit cable, and removed by the BUC for internal use. The PSM-2100 can be supplied with a power supply and transmit Bias T/Mux to apply the power to the transmit line. See figure x for an example of this configuration

LNB Power. Most current data grade LNBs require approximately 15 to 24 VDC at 200 to 300 milli-Amps. The power is typically applied via the receive cable, and removed by the LNB for internal use. The PSM-2100 can be supplied with a power supply and receive Bias T/Mux to apply the power to the receive line.

3.4 Station Reference

Most current BUCs require an external 10 MHz reference supplied on the cable which they demultiplex and use to phase lock the Upconverter Local Oscillator. The two characteristics required here are very good stability (probably an OCXO) and low phase noise. The BUC manufacturer should specify the requirements, but it is not difficult to figure out some minimum capabilities. First, to achieve an Intelsat specified transmit signal uncertainty of 50 Hz per kbps. A C-Band reference for a 32 kbps carrier would require approximately 2 parts in 10^7 stability minimum. This is +/- 1200 Hz at 6 GHz transmit frequency. A Ku-Band BUC would require 1 part in 10^7 stability for a 32 kbps data rate.

The typical BUC level requirement for the reference input might by +3 to –3 or –5 dBm from a sine wave oscillator. Since the typical OCXO type oscillator will usually have an approximate +7 dBm output this should not be a problem unless the signal is split many ways.

The reference oscillator phase noise is multiplied when phase locking the BUC Local Oscillator. Thus the phase noise on the oscillator must be extremely low and probably cannot be viewed directly on a spectrum analyzer. Its effect however will be visible on the BUC output with a known clean carrier input.

3.5 Station Gain Budgets

Below is a block and level diagram of a typical station showing the levels of all relevant signals at each point in the transmit and receive chain.

3.6 Cable Selection

Knowing what approximate levels are required at each point in the station block diagram permits specification of required cable size and type. Several other factors enter here:

1. The transmit cable must also carry a heavy current on the order of 1 to 5 Amps to power the BUC/PA combination. The DC resistance and cable voltage drop must allow this gear to receive their minimum voltage plus enough margin for variation with time and temperature.
2. At L-Band frequencies the loss variation with temperature can be extreme. For example a 200 foot length of RG214 cable (double shielded, ½ in class) has approximately 20 dB of loss and a variation vs. Temperature of 0.2% (of dB) per degree Centigrade. If operating in an exposed environment (like a desert) where the temperature may vary approximately 20 deg. C from day to night that could represent a variation of almost 1 dB over a 12 hour period. In a 20 dB loss cable the attenuation change is then approximately .04 dB per deg. C, or 0.8 dB over the full 20 deg. C change. First, this probably says that the cables must be either buried in conduit or shielded from the sun if run on a cable rack to minimize variations.
3. The transmit and receive cables must be separated and definitely not tied directly together with “tie-wraps”, especially on longer runs. This is because of the tremendous difference between the transmit and receive levels possible. This is made worse on long cable runs because the modem end will have higher transmit levels and the receive will have lower levels than on a short run. The better cables in this regard have double shielding (two braids or a braid/foil combination) and a shielding efficiency of 100 dB or better. A good note here is that with the typical LO frequencies as shown in the example above, the transmit and receive L-Band frequencies are widely separated. If the signals were within the LNB stability/drift frequency limits there might be a tendency for the receive to attempt locking to its own transmit signal.
4. Considering the L-Band IF range is 700 MHz spanning close to an octave, the variation in loss between the high and low ends of the IF range may be significant.

A nominal design point may be to allow for 10 to 15 dB of total cable losses and select cable that will reliably achieve this. A more accurate “rule of thumb” would be to design for a total gain from the modem to the antenna in transmit, or antenna to modem in receive of 35 dB. For example if the receive LNB has a gain of 60 dB and the Bias-T/Mux has 6 dB of conversion loss then the cable can have a maximum loss of 19 dB (60 – 35 – 6 dB). In formula form this is:

Loss(cable max) = Gain(LNB) – 35 – Loss(misc)   in dB

Or for the transmit side the formula would be:

Loss(cable max) = Gain(PA) – 35   in dB

Notice that we are assuming no miscellaneous losses in the transmit side, but there may be other losses such as a splitter or output sample port used.

Trying to buy too cheap a cable will only result in problems that are more expensive to fix than using the proper cable to begin with. Remember that the L-Band design allows for moderately inexpensive cable in exchange, especially as compared to the typical requirement for either expensive outdoor converters or very expensive heliax / waveguide with indoor converters.

The PSM-2100L provides a 50 Ohm impedance on its cable connections. Most BUCs are 50 Ohm, but many LNBs provide a 75 Ohm impedance and use Type "F" connectors. We can supply a receive "Bias T" that includes an integrated 75 to 50 Ohm converter (minimum loss pad). When the 75 to 50 Ohm converter is included the receive input connector (from LNB) can also be a type "F".

Several cable types are shown below with typical maximum recommended frequency, size, losses per 100 feet at 1.2 GHz, shielding efficiency, and relative approximate costs per foot. Recommended cables are shown with asterisks. Since maximum loss is preferred to be 20 dB or less, then generally the cable size is chosen to keep the cable loss well below that point. 10 to 15 dB is probably a better design guide considering that other connection losses are inevitable. DC resistance for the transmit cable should also be considered with respect to BUC current draw/voltage drop. Also consider that in areas where temperature change is high a lower loss cable should be chosen to minimize absolute transmit power variation.

Typical Coaxial Cable Characteristics					
Cable Type	**Max. Freq. (MHz)**	**O.D. (in.)**	**Loss/100 feet (dB) @ 1.2 GHz**	**Shielding Efficiency (dB)**	**Cost/ft. (USD)**
RG58 (50)	1,000	.19	21	70	$0.39
RG59 (75)	1,000	.25	18	70	0.39
Times LMR-240 (50)	5,000	.24	9.2	>90	0.47
Times LMR-300 (50)	5,000	.30	6.8	>90	0.53
Times LMR-400 (50)	5,000	.405	4.8	>90	0.64
Belden 9913 (50)	5,000	.405	5.2	>90	0.60
Times LMR-600 (50)	5,000	.59	3.1	>90	1.30
RG214 (50)	5,000	.405	10.1	>90	1.70
3/8"LDF (50)	5,000	.44	4.1	>90	1.89
1/2"Superflex (50)	5,000	.52	4.2	>90	1.89

Note that the common RG214 type cable is not only more expensive, but also higher loss than several other available cable types. The maximum length that RG214 would be used assuming the approx 15 dB loss criteria would be 150 ft or 50 meters. Times LMR-400 cable would be usable over 300 ft. At less cost.

4.0 Interoperability Between 70 MHz and L-Band Modems

Not only is the design and operation of the PSM-2100L modem closely based on that of the PSM-2100 70 MHz modem, but the units are fully interoperable. Thus a typical system configuration with one or more “Hub” stations utilizing 70 MHz as the IF and many remotes utilizing both 70 MHz and L-Band equipments works well without consideration to the particular equipment at any site. New sites in an existing system may be added using either L-Band or 70 MHz as the IF link frequency.

5.0 Specifications

The specifications for the PSM-2100L are included at the end of this document

6.0 Command and Control Protocol

The command and control protocol for the PSM-2100L is virtually identical to that for the PSM-2100 70MHz IF unit. The “New/Modified Commands” shown in Section 2.4 are also reflected in the command structure of the PSM-2100L via remote control. The control table additions and changes are shown below. Note that one major difference is that transmit and receive frequencies now must use a 5 byte data field as opposed to the 4 bytes used with the 70 MHz unit when operating in binary control protocol mode.

> ***WARNING: It may be difficult in many programming languages to generate a 5 byte number representation for binary programming of the modem.***

Like the front panel controls, the remote control procedures for specifying transmit and receive IF frequencies are dependant upon wether an upconverter and/or downconverter LO frequency has be supplied. If a non-zero frequency has been input from any source then the transmit and receive frequency becomes the RF operating frequency as described in section 2.1, “IF Frequency Range”. This property is independent for the transmit and receive paths.

Note that the few changes relative to the standard 70 MHz unit makes it easy to use a single monitor and control systems to talk to both modem types.

Note also that the Mod and Demod “Spectrum” command is new on both the 70 MHz and L-Band Modems. This was added to the 70 MHz PSM-2100 in Software Revision 2.00 The AUFC sub-command for Spectrum Sense is now named “Slope” for both modems.

The following table lists the remote control packet commands that are new or modified in the PSM-2100L (L-Band Modem) by binary command number. This table is only for PSM-2100L Units with software revisions "1.00" and above. The software version can be viewed at the unit front panel.

Table B-1
PSM-2100"L" Remote Control Packet Command Additions/Modifications for Software Rev "1.00"

Modem Function	Binary Cmd	ASCII Cmd	Write Value	Read Value
Mod CXR Frequency (MODIFIED, now uses 5 bytes in binary)*	**01h**	**MCF**	950.000000MHz to 1650.000000MHz Only if "Mod Cnvrter LO" = 0	950.000000MHz to 1650.000000MHz Only if "Mod Cnvrter LO" = 0
Mod CXR Frequency (NEW MODE, now uses 5 bytes in binary)*	**01h**	**MCF**	950.000000MHz to 1650.000000MHz Plus or Minus "Mod Cnvrter LO" if not = 0	950.000000MHz to 1650.000000MHz Plus or Minus "Mod Cnvrter LO" if not = 0
Mod CXR Offset Frequency (MODIFIED Range)	**02h**	**MOF**	-750.000kHz to +750.000kHz	-750.000kHz to +750.000kHz
Mod Output Level (MODIFIED)	**03h**	**MOL**	+5.0dBm to -35.0dBm	+5.0dBm to -35.0dBm
Mod Spectrum (NEW)**	**29h**	**MSP**	0 = Normal, 1 = Inverted	0 = Normal, 1 = Inverted
Mod Cnvrter LO (NEW)	**2Ah**	**MLO**	Either 0, OR BUC LO frequency (e.g. 4900.000000MHz)	Either 0, OR BUC LO frequency (e.g. 4900.000000MHz)
Demod CXR Frequency (MODIFIED, now 5 bytes in binary)*	**41h**	**DCF**	950.000000MHz to 1650.000000MHz Only if "Demod Cnvrter LO" = 0	950.000000MHz to 1650.000000MHz Only if "Demod Cnvrter LO" = 0
Demod CXR Frequency (NEW MODE, 5 bytes in binary)*	**41h**	**DCF**	950.000000MHz to 1650.000000MHz Plus or Minus "Demod Cnvrter LO" if not = 0	950.000000MHz to 1650.000000MHz Plus or Minus "Demod Cnvrter LO" if not = 0
Demod CXR Offset Frequency (MODIFIED Range)	**42h**	**DOF**	-Wide Sweep to +Wide Sweep (Max. +/- 750 kHz)	-Wide Sweep to +Wide Sweep (Max. +/- 750 kHz)
Demod Input Level (MODIFIED)	**43h**	**DIL**	Read Only	-20 to -105 dBm in 1 dB increments
Demod Wide Sweep Freq. (MODIFIED Range)	**56h**	**DWS**	0.2kHz to 750.0kHz	0.2kHz to 750.0kHz
Demod Spectrum (NEW)**	**69h**	**DSP**	0 = Normal, 1 = Inverted	0 = Normal, 1 = Inverted
Demod Cnvrter LO (NEW)	**6Ah**	**DLO**	Either 0, OR LNB LO frequency (e.g. 5150.000000MHz)	Either 0, OR LNB LO frequency (e.g. 5150.000000MHz)

* See Section 2.1 for more detail on frequency settings
** The Mod and Demod "Spectrum" parameters should be set to "Normal" when Converter LO frequencies not zero are entered.