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SLM-3650

Satellite Modem
2.4 kbps to 5.0 Mbps
Installation and Operation Manual

Part Number MN/SLM3650.IOM **Revision 3**

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SLM-3650

Satellite Modem
2.4 kbps to 5.0 Mbps
Installation and Operation Manual

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Part Number MN/SLM3650.IOM Field
Revision 3
October 19, 2004

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About this Manual

This manual provides installation and operation information for the Comtech EF Data SLM-3650 satellite modem. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the SLM-3650.

Related Documents

The following documents are referenced in this manual:

- *Comtech EF Data UB-300 Universal Breakout Panel Installation and Operation Manual*
- *Comtech EF Data UB-54 Universal Breakout Panel Installation and Operation Manual*
- *Comtech EF Data SDR-54A Satellite Demodulator Installation and Operation Manual*
- *Comtech EF Data Space Link Remote System User's Guide*
- *INTELSAT Earth Station Standards 308, 309, and 310, and 314.*
- *International Telephone and Telegraph Consultative Committee V.35 and G.721*
- *Comtech EF Data UB-530 Universal Breakout Panle Installation and Operation Manual*

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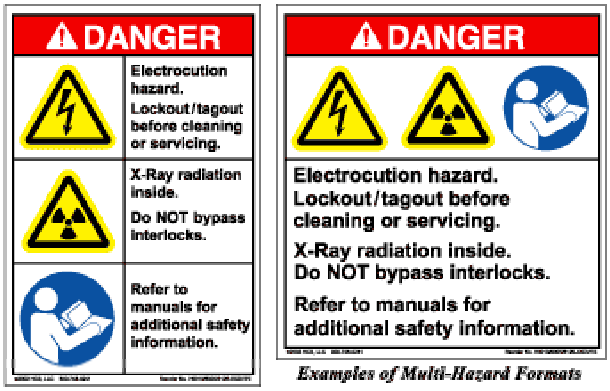
Conventions and References

Cautions and Warnings

CAUTION indicates a hazardous situation that, if not avoided, may result in minor or moderate injury. CAUTION may also be used to indicate other unsafe practices or risks of property damage.

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

IMPORTANT indicates a statement that is associated with the task being performed.



Examples of Multi-Hazard Formats

Examples of Multi-Hazard Formats

Metric Conversion

Metric conversion information is located on the inside back cover of this manual. This information is provided to assist the operator in cross-referencing non-metric to metric conversions.

Recommended Standard Designations

Recommended Standard (RS) Designations are equivalent to the Electronic Industries Association (EIA) designations. Either reference designation is acceptable.

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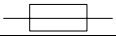
European EMC Directive

In order to meet the European Electro-Magnetic Compatibility (EMC) Directive (EN55022, EN50082-1), properly shielded cables for DATA I/O are required. More specifically, these cables must be shielded from end-to-end, ensuring a continuous ground shield.

The following information is applicable for the European Low Voltage Directive (EN60950):

<HAR>	Type of power cord required for use in the European Community.
	CAUTION: Double-pole/Neutral Fusing ACHTUNG: Zweipolige bzw. Neutralleiter-Sicherung

International Symbols:

	Alternating Current.
	Fuse.
	Safety Ground.
	Chassis Ground.

Note: For additional symbols, refer to “Cautions and Warnings” listed earlier in this preface.

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If you have any questions regarding your equipment or the information in this manual, please contact the Comtech EF Data Customer Support Department:
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Chapter 1. INTRODUCTION

This chapter provides an overview of the SLM-3650 Modem, referred to in this manual as “the modem” (Figure 1-1).



Figure 1-1. SLM-3650

1.1 Overview

The SLM-3650 is a high performance, full-duplex, digital-vector, modulator/demodulator that meets the open network requirements of the INTELSAT Earth Station Standards (IESS) -308, -309, -310, and –315 (Turbo only) emulation specifications for the following:

- **I**ntermediate **D**ata **R**ate (IDR)
- **I**NTELSAT **B**usiness **S**ervices (IBS)

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- **S**atellite **M**ultiservice **S**ystem (SMS)

Additionally, the modem can be used for many closed network satellite communications systems.

The modem provides:

- High performance with narrow occupied bandwidth
- Automatic signal acquisition
- High flexibility
- Extensive online monitoring circuits

1.1.1 Standard Features

The modem contains the following standard features:

- **F**ully **A**ccessible **S**ystem **T**opology (FAST) (refer to Appendix A)
- Differential Encoder/Decoder
- Built-in Scramblers/Descramblers
- TX and RX Frequency Synthesizers
- Multi-rate FEC convolutional Viterbi and Sequential Decoder
- Built-in self test (refer to Chapter 5)
- **As**ymmetrical **L**oop **T**iming (ASLT)
- IDR **E**ngineering **S**ervice **C**ircuit (ESC) channel option of 64k data or two audio channels
- **S**pace **L**ink **R**emote **C**ontrol (SLRC) (refer to Chapter 3)
- Selectable near or far end, baseband or interface loopback with any overhead option enabled

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1.1.2 Modes of Operation

The following main modes of operation are supported:

ASYNC Overhead Interface with AUPC	SDM-100 Emulation
Custom	SDM-650 Emulation
Drop & Insert (D&I)	SDM-6000 Emulation
EFD Closed Network	SDM-300 Emulation
IDR	SDM-308 Emulation
IBS	SDM-309 Emulation
CDM Modem	

The ASYNC/AUPC option allows for an additional overhead channel to be multiplexed and demultiplexed from the data carrier.

The Custom mode of operation enables the programming of the modem for emulating most proprietary modems.

Two mechanisms are provided for uplink power control within a closed network. One method, which requires the optional ASYNC/AUPC interface card, is used for control between two links to sustain sufficient transmit power to maintain a programmed E_b/N_0 at both ends.

The second method is used for self-monitoring the carrier from the same uplink with the local demodulator, requires no additional hardware, and is software-selectable. This method is appropriate for applications such as paging networks, where the uplink is transmitting to receive-only devices. The self-monitoring AUPC function is not available when the ASYNC/AUPC interface option is installed.

The modem interfaces between the channel unit or **mu**ltiple**x**er (MUX) and **I**ntermediate **F**requency (IF) converter equipment operating in a 50 to 180 MHz band. An internal channel unit, conforming to IESS-308, -309, -310, and –315 (Turbo only) emulation specifications, provides overhead designated for an ESC.

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The modem is used in **S**ingle **C**hannel **P**er **C**arrier (SCPC) applications with the following specifications:

- Modulator type: QPSK, BPSK, 8-PSK, OQPSK, and TPC
- Forward Error Correction: 1/2, 21/44, 5/16, 3/4, 7/8, 1/1, or 2/3
- Symbol rate of 4.8 ks/s to 2.5 Ms/s

Note: The modem can be configured to add overhead/framing to the data. Available modulation types include:

- **B**i-**P**hase **S**hift **K**eying (BPSK)
- **Q**uadrature **P**hase **S**hift **K**eying (QPSK)
- **O**ffset **Q**uadrature **P**hase **S**hift **K**eying (OQPSK)
- 8-PSK

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1.1.3 Modem Construction

The modem contains:

Built-in scramblers/descramblers	TX and RX frequency synthesizers
Differential encoder/decoder	Multi-rate FEC convolutional Viterbi and Sequential Decoder

The modem is a complete, self-contained unit in standard, **o**ne-**r**ack **u**nit (1 RU), 19-inch (48 cm), rack-mountable enclosure weighing approximately 11 lbs (5 kg). The unit is constructed using modular design (Figure 1-2), and consists of from two to five **P**rinted **C**ircuit **B**oards (PCBs), depending on the configuration. The modem consists of two major replaceable assemblies as follows:

- Rear panel, main PCB, and power supply
- Upper and lower enclosures (chassis) and the front panel

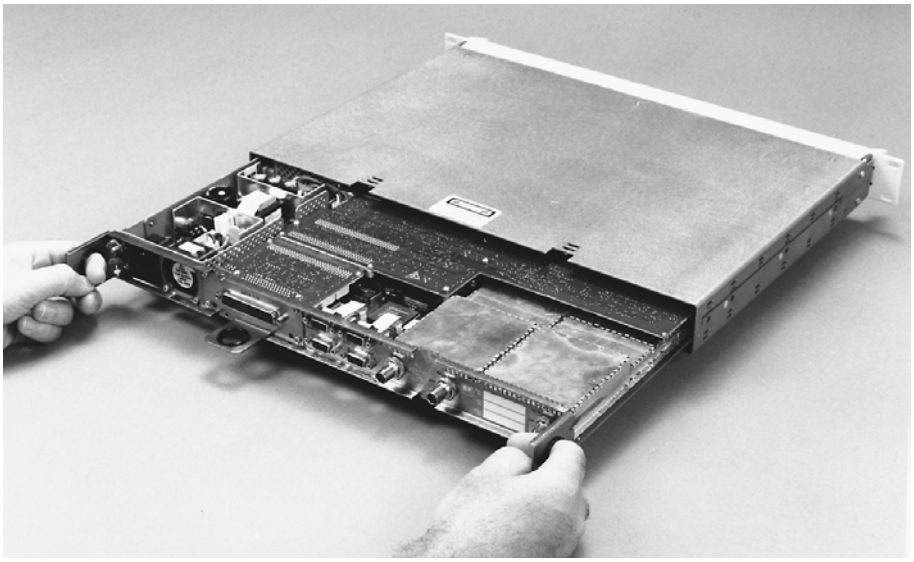


Figure 1-2. Modular Design

The front panel of the modem contains all **M**onitor and **C**ontrol (M&C) function indicators used for operating the modem. The modem can be operated remotely via the M&C connection on the rear panel. Refer to Chapter 2 for connector information and Appendix B for remote control operation information.

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1.2 Options

Refer to Table 1-1 for options.

Table 1-1. Options

Option	Requirements
50Ω IF Impedance	-20 dB return loss 50 to 180 MHz
-20 to +5 dBm IF output	Output 2nd Harmonics: < 45 dBc at data rates < 64 kbps < 50 dBc at data rates ≥ 64 kbps
Sequential , Viterbi, Reed-Solomon, or Turbo Product Codec	Modem can be supplied with any combination of: ▪ Viterbi ▪ Sequential ▪ Reed-Solomon ▪ Turbo (**Note:** For Turbo, Revision C (or later) main board is required. For Reed-Solomon, Concatenates with Viterbi or Sequential ONLY.)
8-PSK, 2/3 rate, IESS-310	Requires Viterbi and Reed-Solomon Codec
8-PSK, 2/3 rate, EFD Mode	Requires Viterbi Codec
Turbo Codec	Requires Turbo Codec
Asynchronous Overhead	Includes automatic uplink power control (AUPC)
IBS and IDR Overhead	
Drop & Insert Overhead	
EIA-422/449 Interface	
EIA-530 Interface	
EIA-232 Interface	
V.35 Interface	
48 VDC Input Power	
Single Data/Code Rate	
≤ 512 kbps maximum data rate	
≤ 5.0 Mbps maximum data rate	
High Stability Reference.	Internal stability = ± 0.2 PPM, with the ability to drive out the external reference connector
High Stability	Internal Clock Stability ±2 X 10^{-7}
Asymmetrical Loop Timing (ASLT)	
TX Only RX Only	
Duplex Reed-Solomon	
Mux	Available in: 4-Channel 8-Channel
Flex Mux	

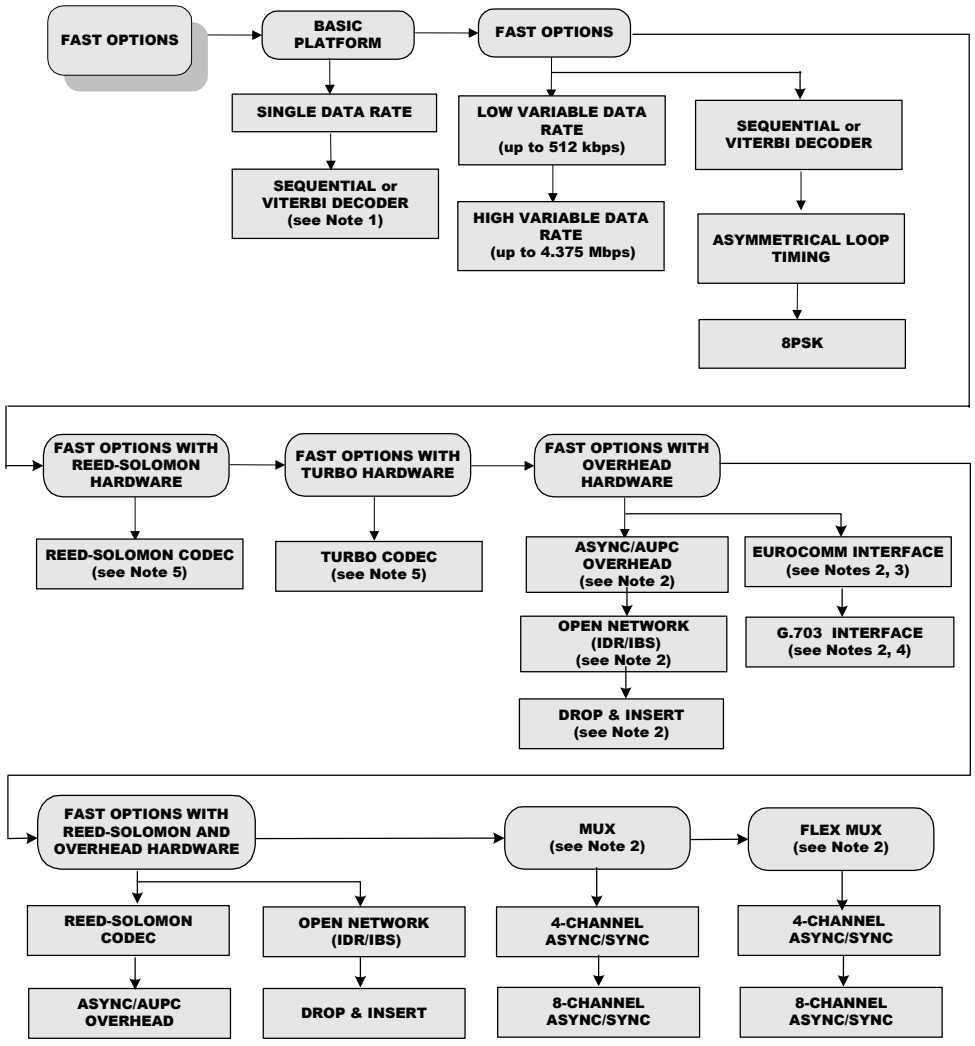
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1.2.1 FAST Options

The modem has a variety of hardware options available as shown in Table 1-2. Hardware options are available through conventional means as well as through Comtech EF Data's FAST system. For detailed descriptions of the FAST feature and all options, refer to Appendix A.

Note: Comtech EF Data has included a DEMO Mode in the Utility Menu. This feature will allow the operator to experience any of the FAST options. This feature has a 60-minute time limit, after which, the unit will return to its previous configuration.

Table 1-2. FAST Options



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Notes:

1. The basic modem is shipped with either Sequential or Viterbi decoder.
2. The overhead interface card and a compatible relay adapter card (connector personality card) are required for this option. Refer to Chapter 1 for the applicable part numbers.
3. Requires Eurocom Interface module.
4. Requires G.703 Interface module and **O**verhead **I**nterface (OH) card.
5. Either Simplex Reed-Solomon or Turbo Codec is installed, but not both.
6. Duplex Reed-Solomon and Turbo can be installed together; however, only one can be used at a time.

1.2.2 Factory-Installed Options

Consult a Comtech EF Data Customer Support representative for modem options. The following options are installed at the factory:

- Output Impedance: 75Ω (50Ω Optional)
- High Stability Reference Oscillator
- High-power version (+5 to -20 dBm)

1.2.3 Factory- or User-Installed Options

Consult a Comtech EF Data Customer Support representative for modem options. The following options can be factory- or user-installed:

- INTELSAT/Closed Network TX or RX Reed-Solomon
- Overhead (G.703/IBS/IDR/ASYNC/AUPC/D&I)
- MUX:
  - 4-Channel (SYNC)
  - 8-Channel (SYNC)
  - 4-Channel (ASYNC)
  - 8-Channel (ASYNC)
  - 4-Channel (ASYNC/SYNC)
  - 8-Channel (ASYNC/SYNC)
- Flex MUX

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1.2.4 Breakout Panels

The UB-530 universal breakout panel (BOP) is an option for breaking out the V.35, G.703, EIA-232, or EIA-422 signals as well as the overhead ESC and Alarm signals.

When the modem is equipped with a 50-pin data I/O connector, the use of the BOP is required to interface with the customer data connector to the modem.

The UB-54 **b**reak**o**ut **p**anel (BOP) is an option for MUX only.

Refer to Figure 1-3 for a system block diagram.

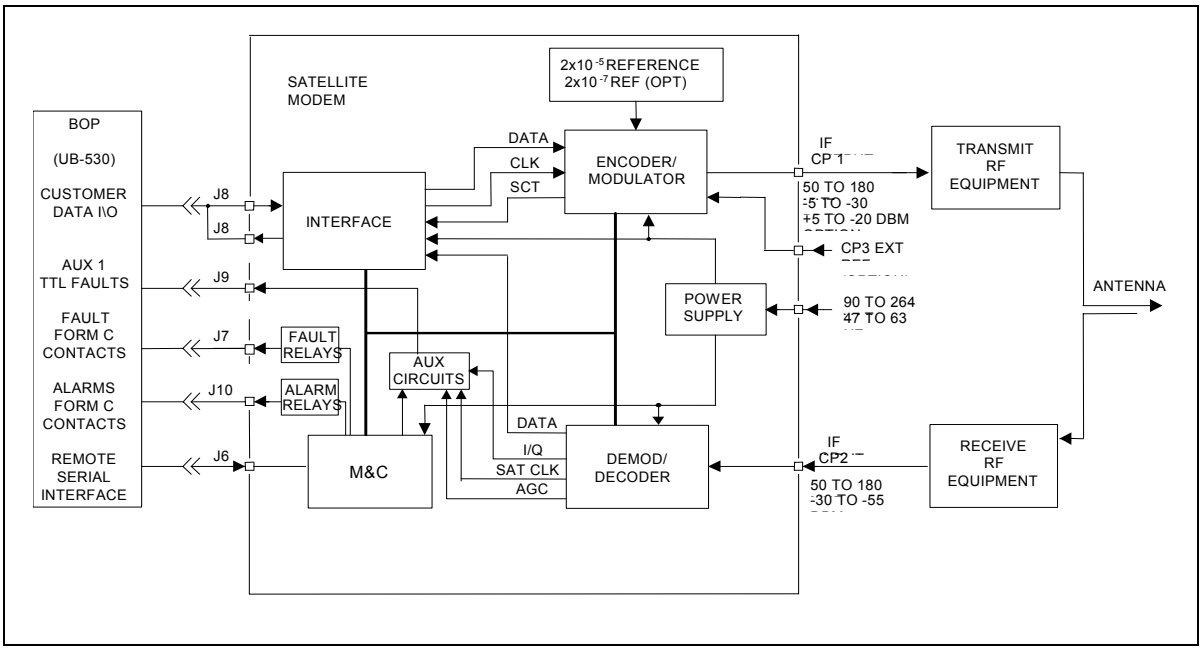


Figure 1-3. Block Diagram

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1.2.4.1 UB-300 Universal Breakout Panel

The UB-300 universal breakout panel can function as an IDR, D&I, or ASYNC/AUPC data breakout panel in one small rack-mountable unit.

Note: The 25-pin connector at J3 on the UB-300 is not an EIA-530 pinout.

For more information, refer to the Comtech EF Data UB-300 Universal Breakout Panel Installation and Operation Manual.

1.2.4.2 UB-530 Breakout Panel

Alternate part for UB-300.

The UB-530 functions the same as UB-300, except the UB-530 has an EIA-530 – 25-pin Data I/O connector at J3.

For more information, refer to the Comtech EF Data UB-530 Breakout Panel Installation and Operation Manual.

1.2.4.3 UB-54 Breakout Panel

The UB-54 breakout panel functions with the MUX option as a rack-mountable unit.

For more information, refer to the Comtech EF Data UB-54 Breakout Panel Installation and Operation Manual.

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1.3 Modem Assemblies

Table 1-3. Comtech EF Data Part Numbers for Various Modules

Part Number	Nomenclature	Comments
PL/6096	Top Assy	SLM-3650
PL/5303-41	Panel Assy, Front	SLM-3650 KT/6095 KT/6596
PL/5305-2	Overhead Interface Assy, PCB	Interface Board for G.703, IDR, IBS, AUPC, D&I Without Antenna
PL/5305-3	Overhead Interface Assy, PCB	Interface Board for G.703, IDR, IBS, AUPC, D&I With Antenna
PL/5676-1	Connector, EIA-530	50-Pin
PL/5727-1	I/O Port Assy, Data	25-Pin
PL/5509-2	IDR/IBS/D&I Relay Adapter Assy, PCB	50-pin Overhead
PL/6031-1	RS422 Adapter Assy, PCB	37-Pin
PL/6032-1	V.35 Adapter Assy, PCB	34-Pin
PL/6167-1	Non-Overhead Assy, PCB	50-pin
PL/6244-3	Base Modem Assy	50Ω, TNC, H/S 10^{-7} , -5 dB Power Out
PL/6244-4	Base Modem Assy	50Ω, TNC, H/S 10^{-7} , +5 dB Power Out
PL/6244-5	Base Modem Assy	50Ω, BNC, H/S 10^{-7}, +5 dB Power Out
PL/6244-6	Base Modem Assy	50Ω, TNC, H/S 10^{-7}, -5 dB Power Out with Antenna
PL/6244-7	Base Modem Assy	50Ω, TNC, H/S 10^{-7}, +5 dB Power Out with Antenna
PL/6284	TX Reed-Solomon Assy, PCB	
PL/6285	RX Reed-Solomon Assy, PCB	Without Antenna
PL/6285-1	RX Reed-Solomon Assy, PCB	With Antenna
PL/6451	Flex MUX Personality Card Assy, PCB	
PL/7175-1	Cover Assy, Chassis	EMI Modified
PL/7675-1	Signal Extender Card Assy, PCB	SLM-3650
PL/7677-1	NRZ, EIA-530, RS-422 Interface Card Assy, PCB	
PL/7838-1	Interface Adapter Assy, PCB	Intelsat Board for G.703, IDR, IBS, AUPC, D&I Without Antenna (see Note 1)
PL/9394-1	Turbo Codec Assy, PCB	
PL/9658-1	Duplex Reed-Solomon	Can be installed with Turbo.
PL/9672-1	Turbo Codec Upgrade Kit	Requires Main Board, PL/6093-X Rev. C See Chapter 2, Turbo Upgrade.

Notes:

1. G.703 is included with IDR, IBS, and D&I software.
2. IDR, IBS, and/or D&I only can be selected if Viterbi decoder is active.
3. IDR and IBS software cannot be selected with 2.4 to 512 kbps data rate.
4. Viterbi decoder must be selected when 8-PSK modulation is active.
5. Customer-selected Viterbi or Sequential.
6. Cutomer-selected Reed-Solomon or Turbo.
7. Antenna Handover requires Duplex and Reed-Solomon boards.

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1.4 Specifications

1.4.1 Modem Specifications

Table 1-4 lists the operating of the modem.

Table 1-4. SLM-3650 Satellite Modem Specifications

General Specifications	
Operating Frequency Range	50 to 180 MHz Synthesized in 1 Hz steps
Modulation Types	8-PSK QPSK OQPSK BPSK (Front panel selection)
Operating Channel Spacing	Less than 0.5 dB degradation operating with two adjacent like channels (each 10 dB higher at 1.3 times the symbol rate) A single adjacent carrier spaced 1.4 times the symbol rate, up to +20 dBm
Baseband Interface	EIA-422/449 V.35 EIA-232 G.703-1544 G.703-2048 (Field-selectable)
Elastic Buffer	32 to 262144 bits, selectable from front panel in bits or ms
Digital Data Rate	2.4 kbps to 5.0 Mbps in 1 bit/s steps (front panel selection)
Scrambling/Descrambling Types	IESS 309 (Synchronous 2^{15}) International Telephone and Telegraph Consultative Committee (CCITT) V.35 Comtech EF Data/Comstream compatible Fairchild compatible OM-73
Forward Error Correction	Viterbi K=7: Rate 1/2, 3/4, 7/8, 2/3 Reed-Solomon: Rate 225/205, 126/112, 219/201 Sequential: Rate 1/2, 3/4, 7/8 IBS: 219/204 Turbo: Rate 5/16, 21/44, 3/4, 1/2 FEC “OFF” Uncoded (Code rates selectable from front panel)
M&C	Front panel display (16 character by 2 rows), backlit
Filter Mask Types	INTELSAT/EUTELSAT Closed net (Comtech EF Data) Closed net (Fairchild compatible), SDM-51 compatible

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Table 1-4. SLM-3650 Satellite Modem Specifications (Continued)

General Specifications (Continued)	
Loopback Modes	Baseband (near end and far end) Interface (near end and far end) D&I baseband (insert data into drop data out) IF Loopback (near end) RF Loopback (far end)
ESC	IDR IBS None, field-selectable
Diagnostic Features	IF Loopback RF Loopback Baseband Loopback Interface Loopback Fault monitoring (includes current and stored faults) BER monitoring Input IF power monitoring Buffer fill status monitoring Remote control via serial port
Power	Prime power 90 to 264 VAC, 47 to 63 Hz, 40W maximum, fused at 2A 38 to 64 VDC
Physical: Size Weight	 1.75" H x 19.0" W x 15.7" D (1 RU) (4.4 H x 48 W x 40 D cm) ≤ 11 lbs (≤ 5 kg)
Shipping (including container): Size Weight	 9" H x 21" W x 20" D (23 H x 53 W x 51 D cm) 17 lbs (8 kg) (approximate)
Environmental: Temperature Humidity	 0° to 50°C (32° to 122°F) 0 to 95% non-condensing
Additional Modulator Specifications	
Output Power	-5 to -30 dBm, adjustable in 0.1 dB steps +5 to -20 dBm high-power output (optional)
Output Spurious	-55 dBc in-band (0 to 500 MHz)
Output Impedance	50Ω (75Ω optional)
Output Return Loss	20 dB
Data Clock Source	Internal, ± 1 x 10^{-5} stability Internal high stability, ± 2 x 10^{-7} (optional)
Output Frequency Stability	± 10 PPM
Additional Demodulator Specifications	
Input Power (Desired Carrier) (Adjacent Carriers) (Maximum Total)	-30 to -55 dBm +30 dBc total power within 10 MHz from desired carrier +40 dBc power outside of 10 MHz from desired carrier -5 dBm
Input Impedance	50Ω (75Ω optional)
Input Return Loss	20 dB
Carrier Acquisition Range	± 35 kHz maximum
Clock Acquisition Range	± 100 PPM

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Table 1-4. SLM-3650 Satellite Modem Specifications (Continued)

Remote Control Specifications	
Serial Interface	EIA-232 or EIA-485 (2- or 4-wire)
Baud Rate	150 to 19200 Mbps
Signals Controlled	Transmit Frequency Receive Frequency Transmit Power Transmitter On/Off Data Rate Select RF Loopback IF Loopback Baseband Loopback Interface Loopback Transmit and Receive Filter Mask Self Test Scrambler Type Scrambler On/Off Descrambler Type Descrambler On/Off Buffer Clock TX/RX/INT/INS (D&I only) Transmit Clock Internal/External Receive Clock Normal/Invert Differential Encoding and Decoding Code and Decode Rate Transmit and Receive Overhead Type Acquisition Sweep Parameters Buffer Size IDR Backward Alarm Control On/Off Reed-Solomon On/Off Mod and Demod Spectrum Norm/Invert Rev Emulation Current/Functional Local Modem AUPC On/Off Remote AUPC Enable On/Off
Signals Monitored	Raw Error Rate Corrected BER Receive E_b/N_0 Receive Signal Level Receive Carrier Detect Power Supply Voltages Fault Status Stored Fault Status
Configuration Retention	Will maintain current configuration for at least one year without power
Addressing	Programmable to 1 of 255 possibilities; address 0 is reserved for global addressing

Note: Local control of all remote functions is included by push-button entry.

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1.5 BER Performance Specifications

Table 1-5 through Table 1-9 lists the Bit Energy-to-Noise Ratio (E_b/N_0) required to achieve 10^{-3} to 10^{-10} BER.

1.5.1 Viterbi Decoder BER

Table 1-5 lists the Viterbi specifications for the E_b/N_0 required to achieve 10^{-3} to 10^{-8} BER for different coding configurations. All values are for operating in QPSK mode. Without coding, the modem provides QPSK operation within 0.8 dB of theoretical for BER in the range 10^{-1} to 10^{-6}. Performance measurements were recorded with transmit and receive IF connected back-to-back through an additive white Gaussian noise channel. Refer to Figure 1-4 for the Viterbi BER curves.

Table 1-5. Viterbi Decoder BER Data

	Specification			Typical		
	IBS	IDR	IDR	IBS	IDR	IDR
BER	1/2 Rate	3/4 Rate	7/8 Rate	1/2 Rate	3/4 rate	7/8 Rate
10^{-3}	4.2 dB	5.3 dB	6.3 dB	3.9 dB	4.6 dB	5.8 dB
10^{-4}	4.7 dB	6.1 dB	7.2 dB	4.1 dB	5.4 dB	6.5 dB
10^{-5}	5.4 dB	6.8 dB	8.0 dB	4.6 dB	6.0 dB	7.2 dB
10^{-6}	6.1 dB	7.6 dB	8.7 dB	5.3 dB	6.8 dB	7.9 dB
10^{-7}	6.7 dB	8.3 dB	9.4 dB	5.9 dB	7.5 dB	8.6 dB
10^{-8}	7.2 dB	8.8 dB	10.3 dB	6.4 dB	8.0 dB	9.4 dB

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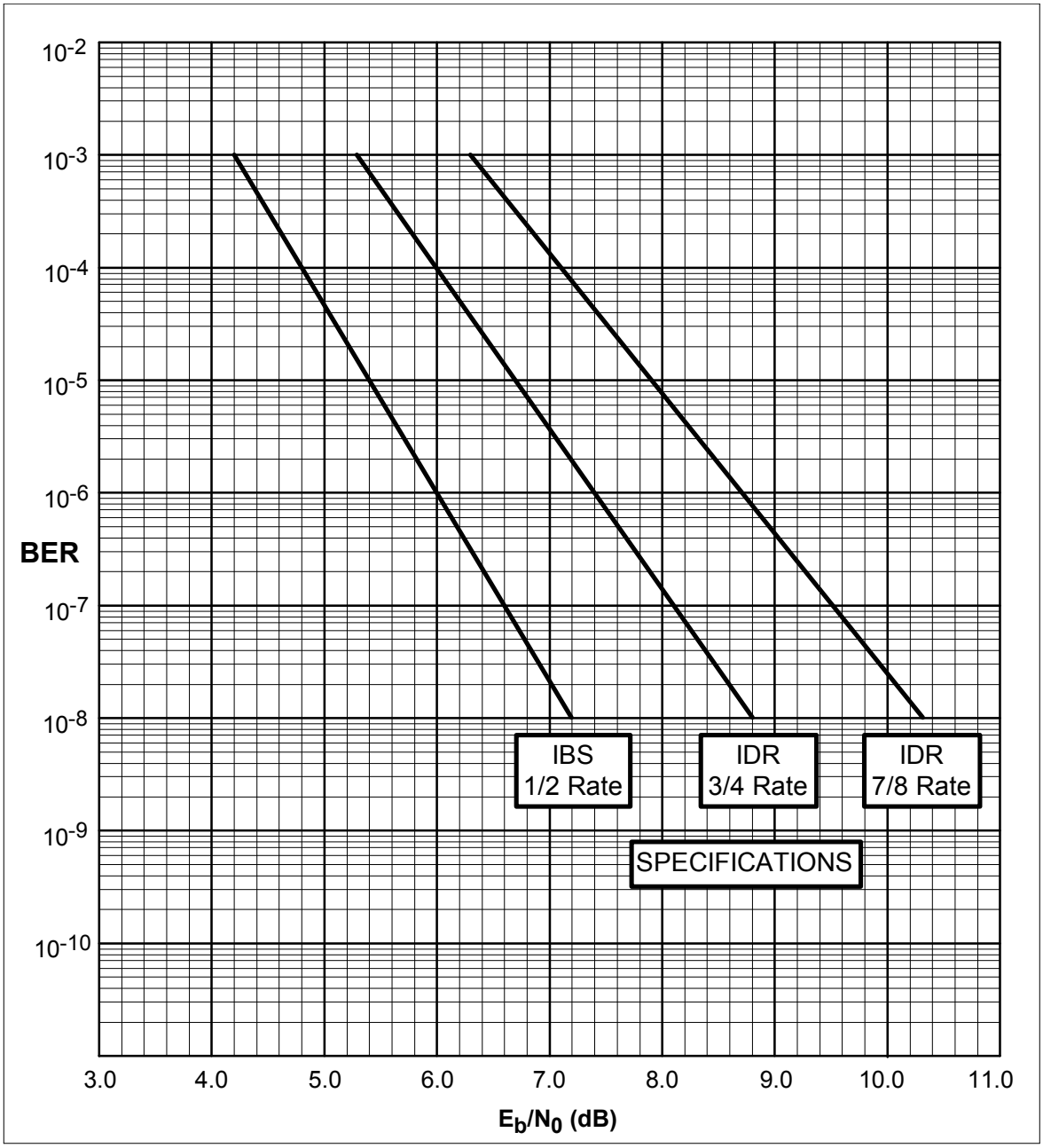


Figure 1-4. Viterbi BER Performance Curves

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1.5.2 INTELSAT Viterbi with Reed-Solomon Codec BER

Table 1-6 lists the INTELSAT Viterbi with Reed-Solomon specifications for the E_b/N_0 required to achieve 10^{-5} to 10^{-10} BER for different configurations. Refer to Figure 1-5 for the INTELSAT Viterbi with Reed-Solomon BER curves.

Table 1-6. INTELSAT Viterbi with Reed-Solomon BER Data

	Specification			Typical	
	IBS	IDR		IBS	IDR
BER	1/2 Rate	3/4 Rate	BER	1/2 Rate	3/4 Rate
10^{-6}	4.1 dB	5.6 dB	10-5	3.2 dB	4.0 dB
10^{-7}	4.2 dB	5.8 dB	10-6	3.5 dB	4.2 dB
10^{-8}	4.4 dB	6.0 dB	10-7	3.6 dB	4.4 dB
10^{-10}	5.0 dB	6.3 dB	10-8	3.8 dB	4.6 dB

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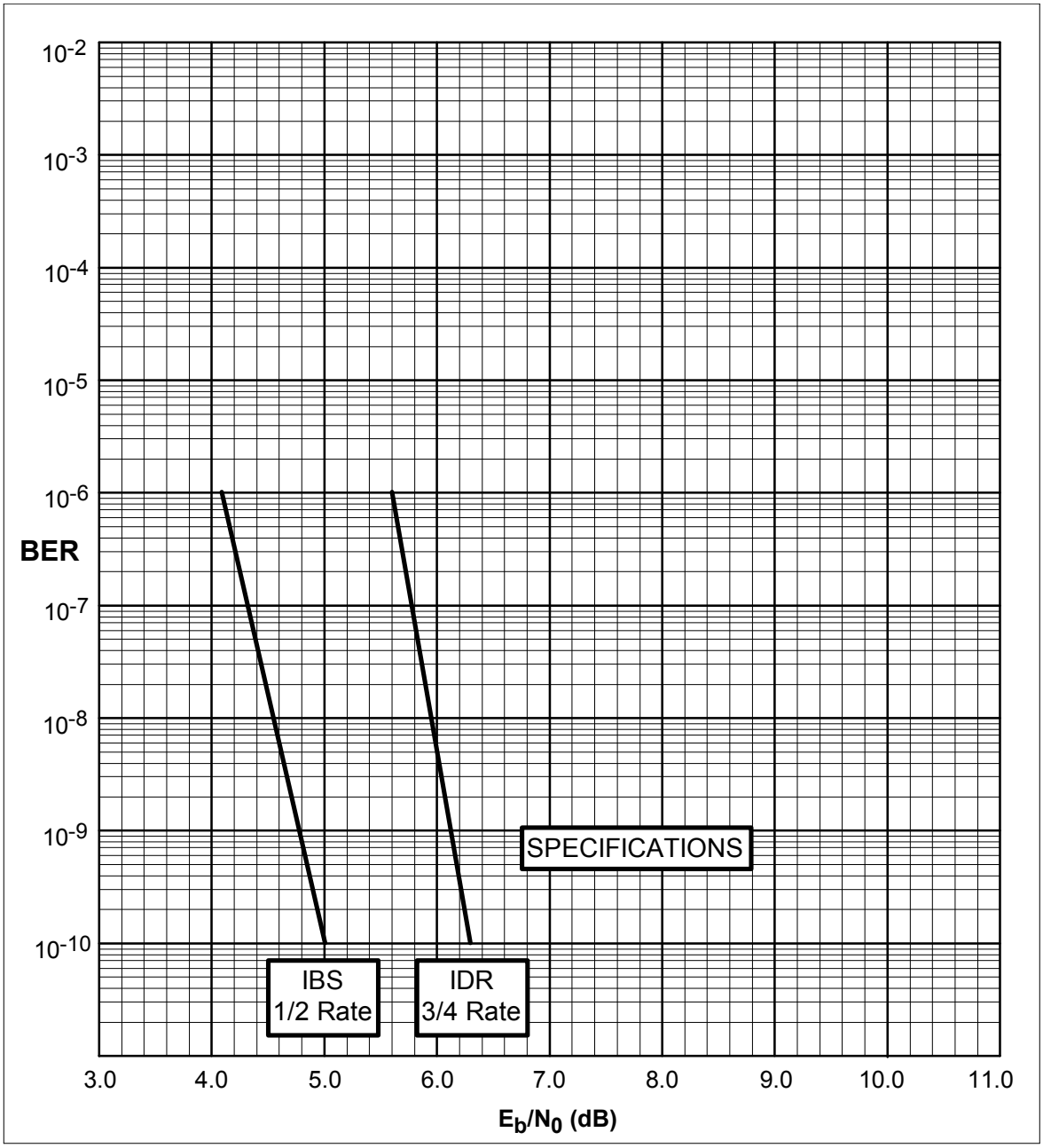


Figure 1-5. INTELSAT Viterbi with Reed-Solomon BER Performance Curves

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1.5.3 Viterbi/Sequential Closed Network Connection BER (with Reed-Solomon)

Table 1-7 lists the Viterbi/Sequential decoder with Reed-Solomon specifications for the E_b/N_0 required to achieve 10^{-6} to 10^{-10} BER for different configurations. Refer to Figure 1-6. Viterbi/Sequential Closed Network Connection (with Reed-Solomon) BER Performance Curves.

Table 1-7. Viterbi/Sequential Decoder with RS

Eb/N0 (dB) Specification			
BER	**1/2 Rate**	**3/4 Rate**	**7/8 Rate**
10-6	4.1	5.6	6.7
10-7	4.2	5.8	6.9
10-8	4.4	6.0	7.1
10-10	5.0	6.3	7.5

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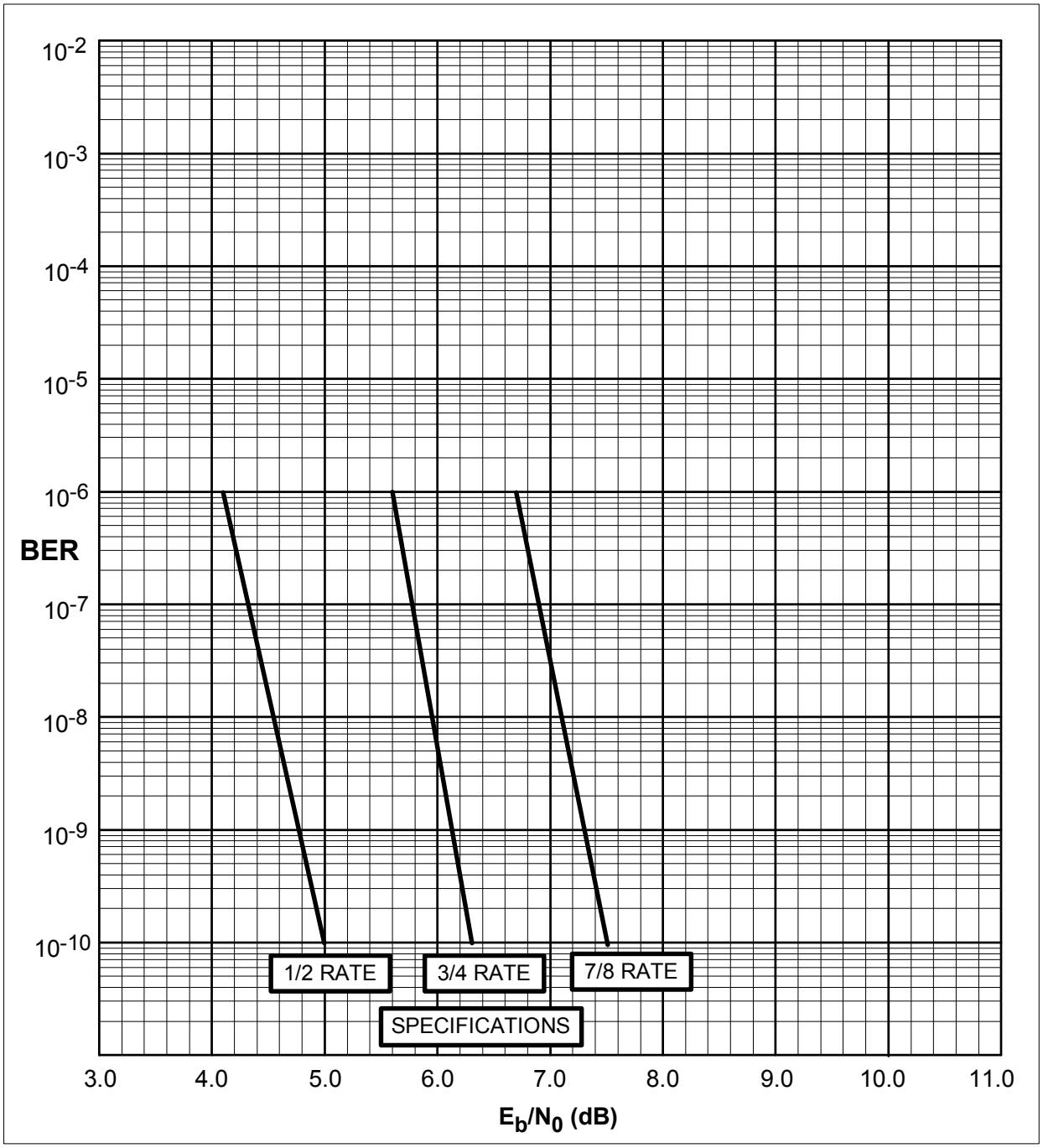


Figure 1-6. Viterbi/Sequential Closed Network Connection (with Reed-Solomon) BER Performance Curves

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1.5.4 Sequential Decoder BER (56 kbps)

Table 1-8 lists the sequential specifications for the E_b/N_0 required to achieve 10^{-3} to 10^{-8} BER at 56 kbps. All values are for operating in BPSK and QPSK modes. Refer to Figure 1-7 for the sequential BER curves.

Table 1-8. Sequential BER Data (56 kbps)

	Specification			Typical		
BER	1/2 Rate	3/4 Rate	7/8 Rate	1/2 Rate	3/4 Rate	7/8 Rate
10-3		4.6 dB	5.5 dB		4.1 dB	5.0 dB
10-4	4.1 dB	5.1 dB	6.1 dB	3.6 dB	4.6 dB	5.6 dB
10-5	4.5 dB	5.5 dB	6.6 dB	4.0 dB	5.0 dB	6.1 dB
10-6	5.0 dB	5.9 dB	7.3 dB	4.5 dB	5.4 dB	6.8 dB
10-7	5.4 dB	6.4 dB	7.8 dB	4.9 dB	5.9 dB	7.4 dB
10-8	5.8 dB	6.8 dB	8.4 dB	5.3 dB	6.3 dB	7.9 dB

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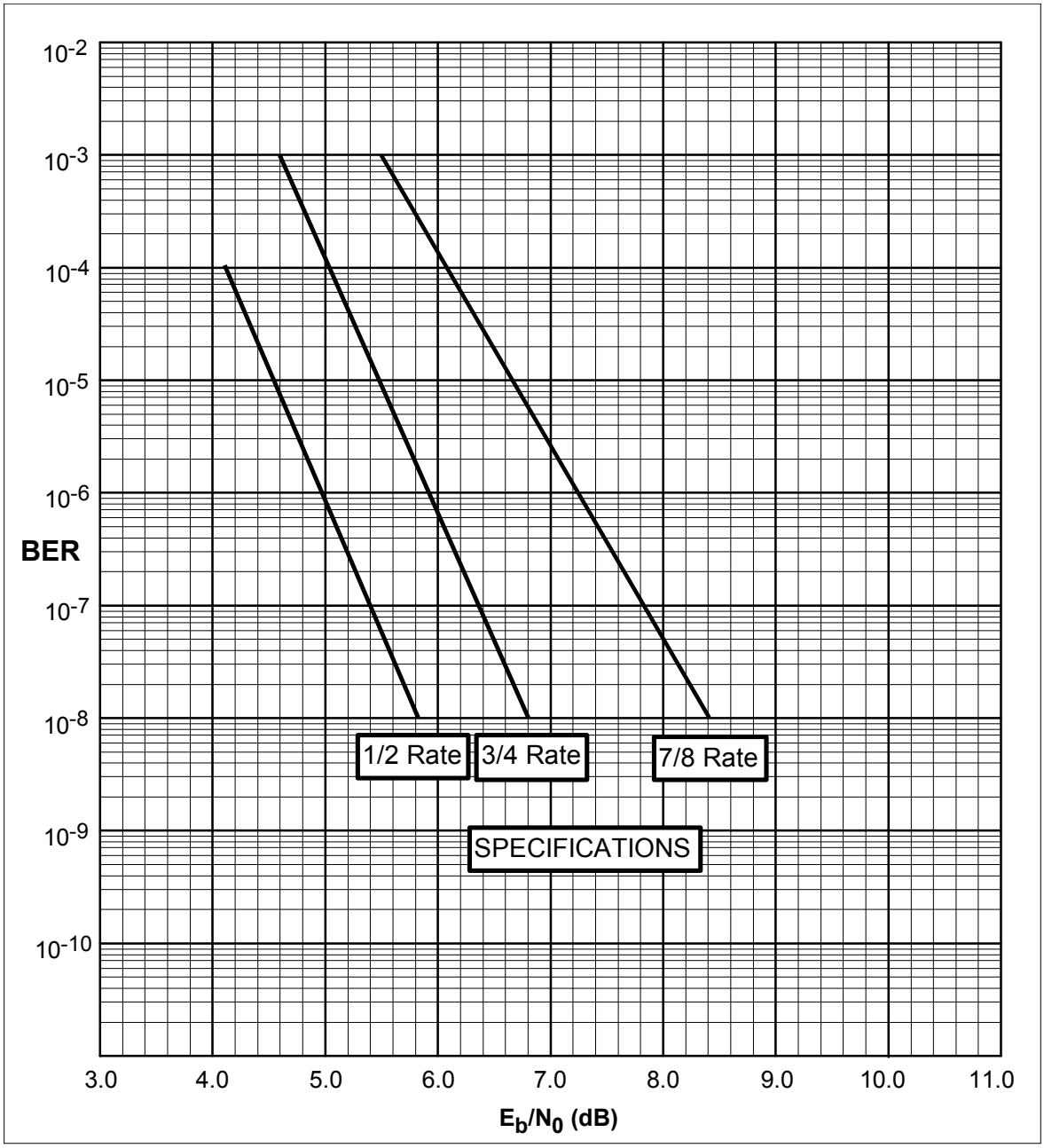


Figure 1-7. Sequential BER Specification Curves (56 kbps)

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1.5.5 Sequential Decoder BER (1544 kbps)

Table 1-9 lists the sequential specifications for the E_b/N_0 required to achieve 10^{-3} to 10^{-8} BER at 1544 kbps. All values are for operating in BPSK and QPSK modes. Refer to Figure 1-8 for the Sequential BER curves.

Table 1-9. Sequential Decoder BER Data (1544 kbps)

	Specification			Typical		
BER	1/2 Rate	3/4 Rate	7/8 Rate	1/2 Rate	3/4 Rate	7/8 Rate
10-3	4.8 dB	5.2 dB	6.0 dB	4.3 dB	4.7 dB	5.5 dB
10-4	5.2 dB	5.7 dB	6.4 dB	4.7 dB	5.2 dB	5.9 dB
10-5	5.6 dB	6.1 dB	6.9 dB	5.1 dB	5.6 dB	6.4 dB
10-6	5.9 dB	6.5 dB	7.4 dB	5.4 dB	6.1 dB	6.9 dB
10-7	6.3 dB	7.0 dB	7.9 dB	5.8 dB	6.5 dB	7.4 dB
10-8	6.7 dB	7.4 dB	8.4 dB	6.2 dB	6.9 dB	7.9 dB

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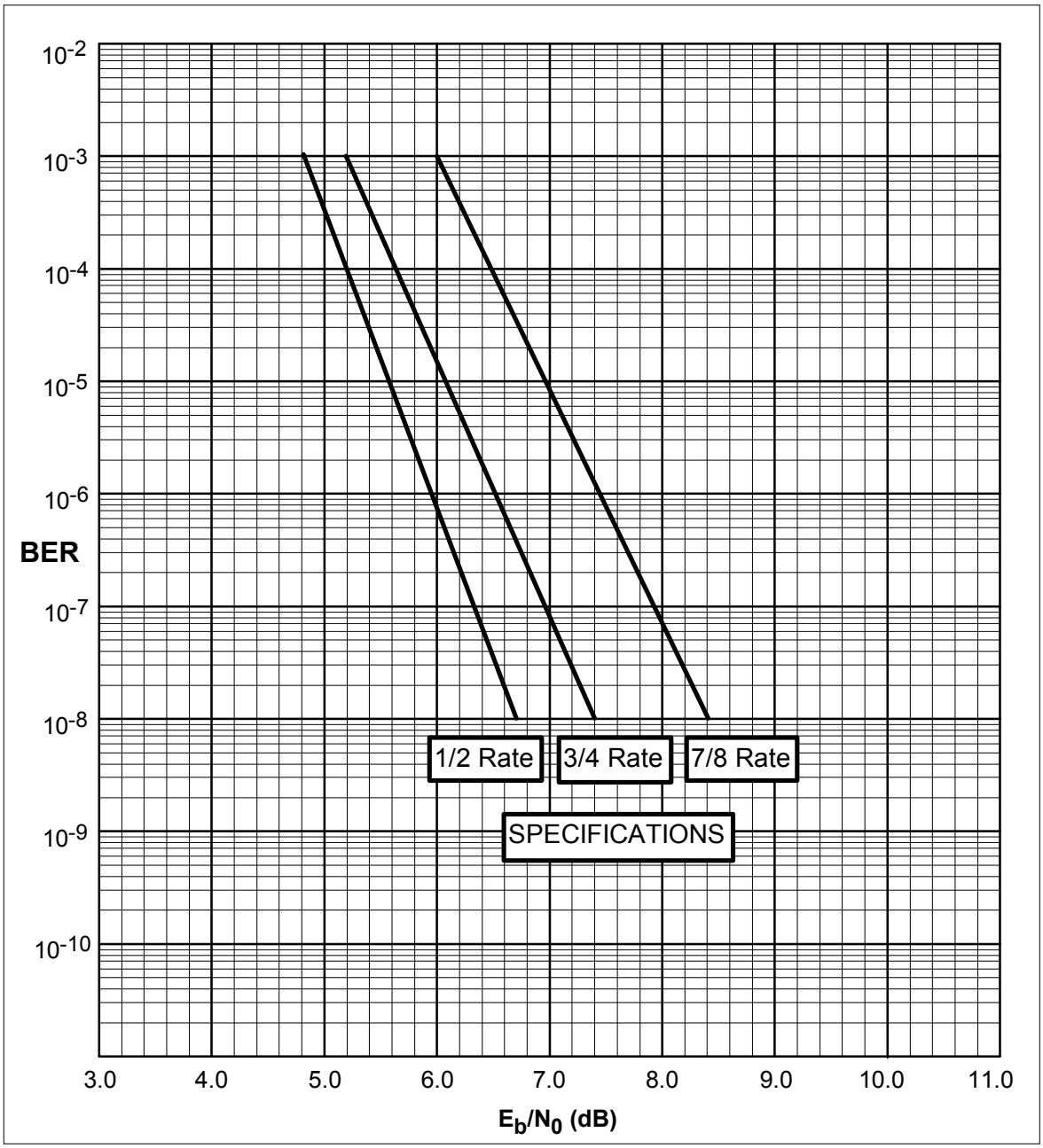


Figure 1-8. Sequential Decoder BER Specification Curves (1544 kbps)

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1.5.6 Trellis 8-PSK BER

Table 1-10 list the 8-PSK specification for performance with noise and with/without Reed-Solomon. All values are for operating in 8-PSK mode. Refer to Figure 1-9 for the 8-PSK curves.

Table 1-10. 8-PSK Specification

	2/3 8-PSK with R-S		2/3 8-PSK without R-S	
BER	Spec	Typical	Spec	Typical
10^{-4}	6.1	5.6	7.3	6.4
10^{-5}	6.3	5.8	8.2	7.2
10^{-6}	6.5	6.1	9.0	8.0
10^{-7}	6.7	6.35	9.8	8.8
10^{-8}	6.9	6.6	10.4	9.6

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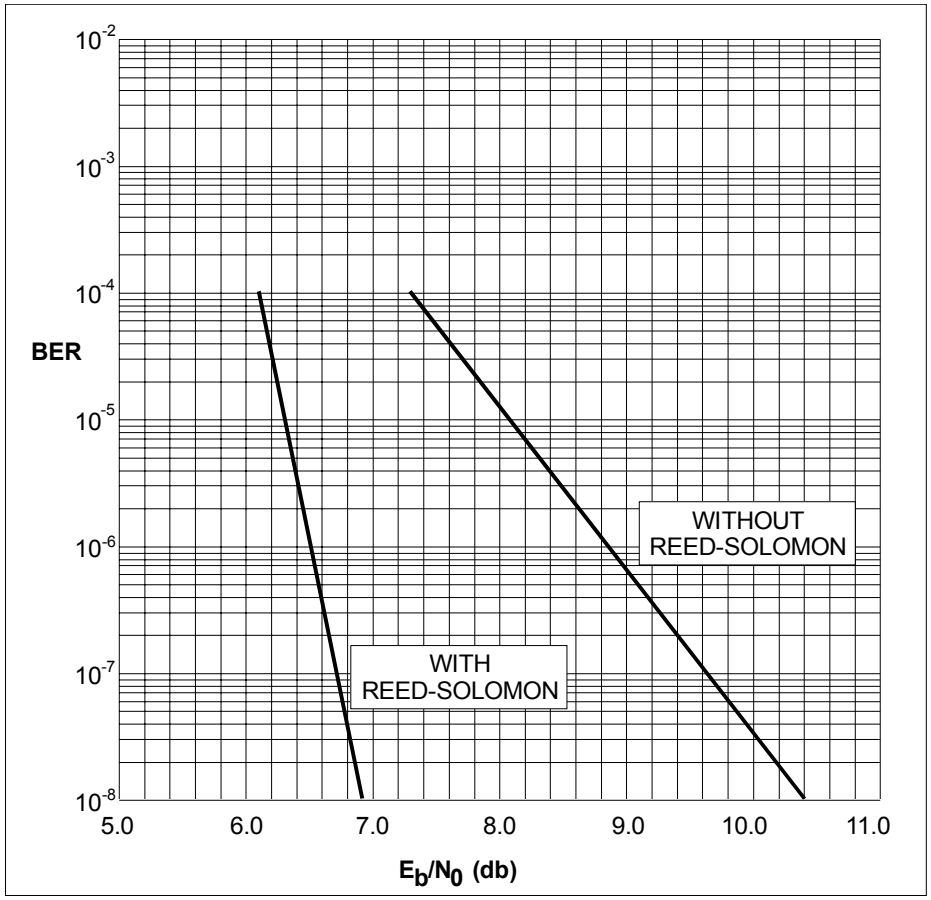


Figure 1-9. 8-PSK BER Specification Curves

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1.5.7 Performance with Noise Turbo Product Codec (Optional)

Table 1-11 lists the Turbo Codec specification for performance. All values are for operating in 8-PSK mode. Refer to Figure 1-10 for Turbo Product Codec Values.

Table 1-11. Turbo Product Codec

	{O}QPSK		BPSK		8-PSK
BER	1/2 Rate	3/4 Rate	21/44 Rate	5/16 Rate	3/4 Rate
10^{-6}	3.0	3.9	2.8	*see Note*	7.0
10^{-7}	3.2	4.1	3.1	*see Note*	7.3
10^{-8}	3.5	4.3	3.3	*see Note*	7.6
10^{-9}	3.8	4.8	3.7	4.0	8.0

Note: 5/16 BPSK is included for compatibility with other equipment but implementation limitations prohibit optimum performance at low Eb/No. Performance is virtually error free above 4 dB Eb/No. Performance below 4dB Eb/No is not guaranteed. Rate 1/2 (21/44) has implementation limits. It will not reliably work below 3 dB Eb/No.

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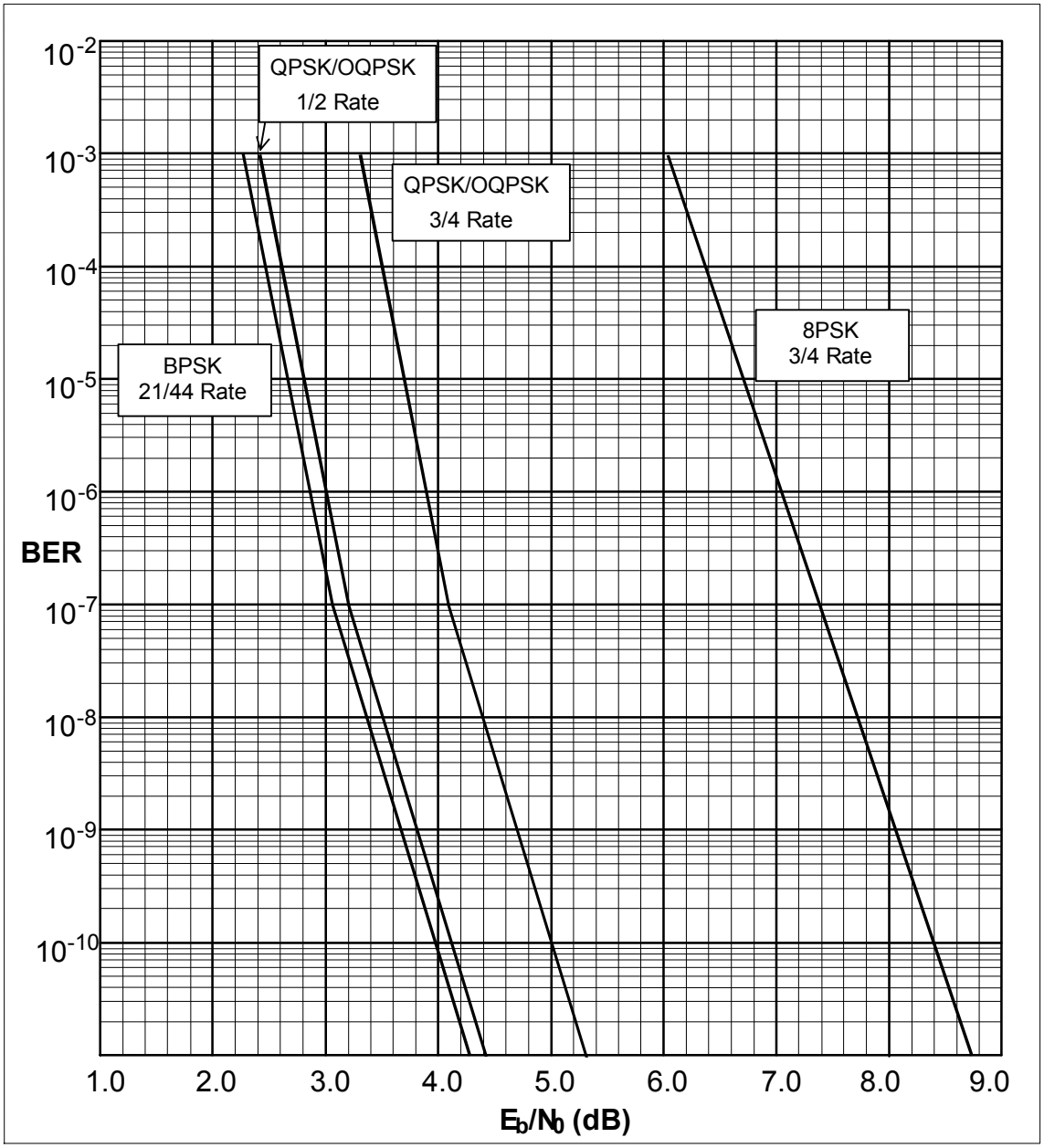


Figure 1-10. Turbo Product Codec

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1.5.8 Performance with Uncoded, BPSK, QPSK, and OQPSK

Table 1-12 lists the Turbo Codec specification for performance. All values are for operating in uncoded mode. Refer to Figure 1-11 for uncoded values.

Table 1-12. Uncoded Values

	Uncoded
BER	1:1 Rate
10^{-3}	8.0
10^{-4}	9.6
10^{-5}	10.8
10^{-6}	11.6
10^{-7}	12.4

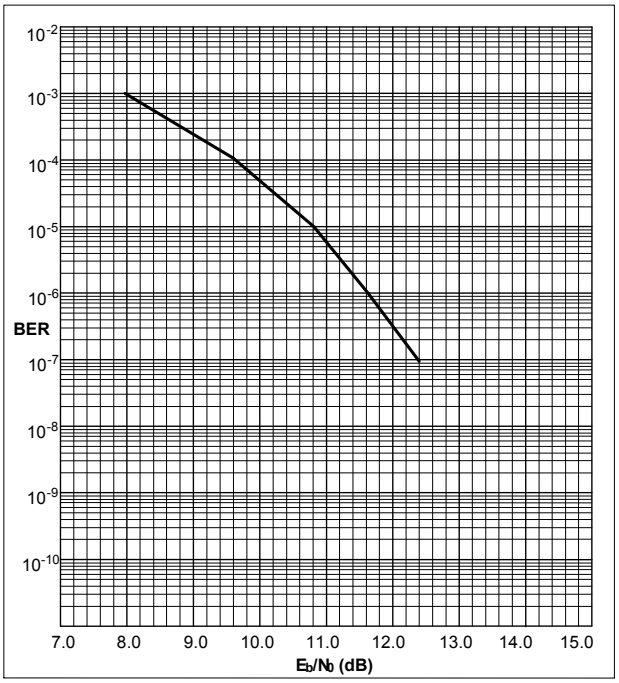


Figure 1-11. Uncoded Curves

1.6 Typical Spectral Occupancy

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Figure 1-12 shows a typical spectral occupancy curve using the Comtech EF Data filter mask.

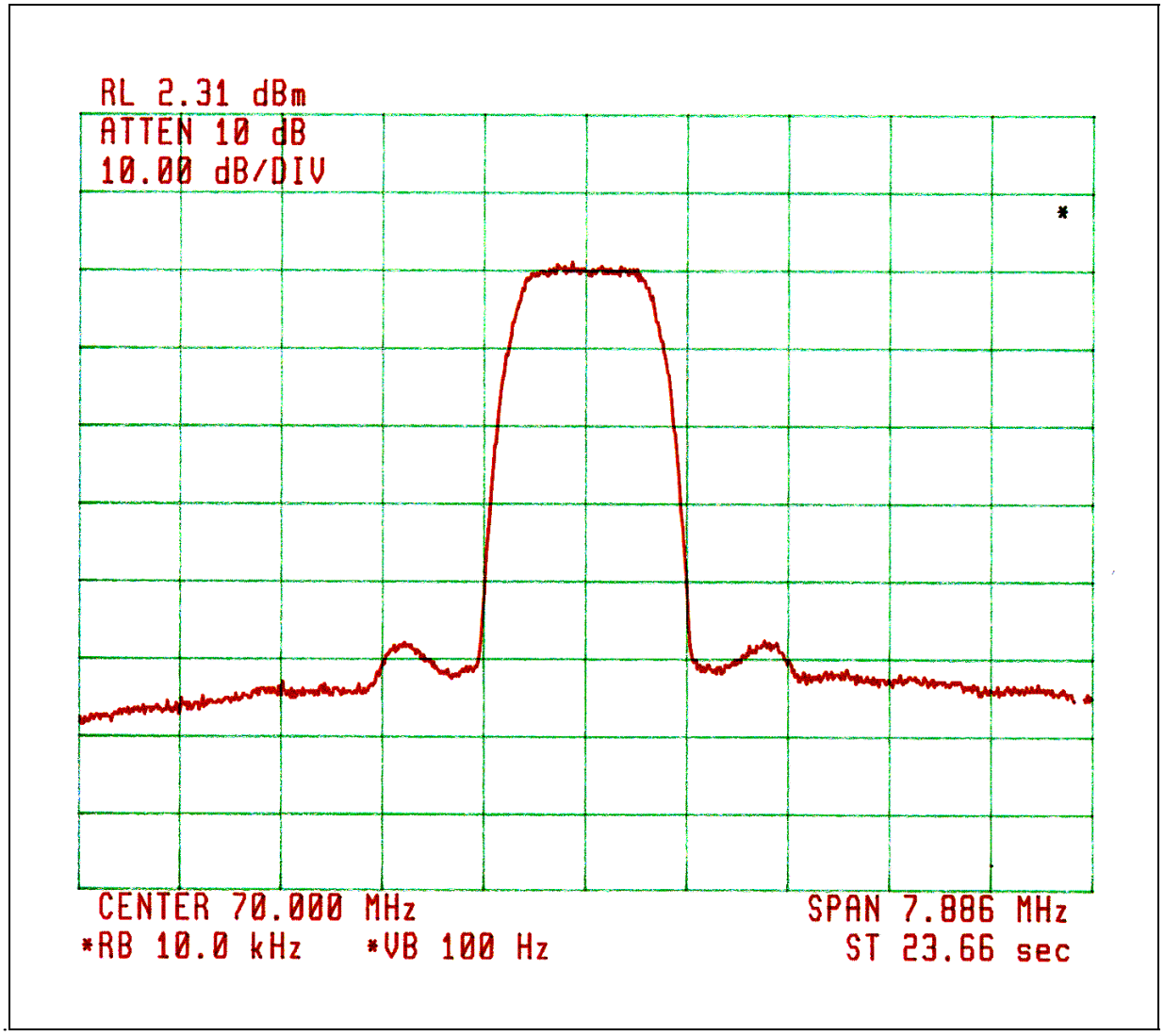


Figure 1-12. Typical Spectral Occupancy

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1.7 Dimensional Envelope

Note: Dimensions are listed in inches and centimeters are noted in parentheses.

Refer to Figure 1-13.

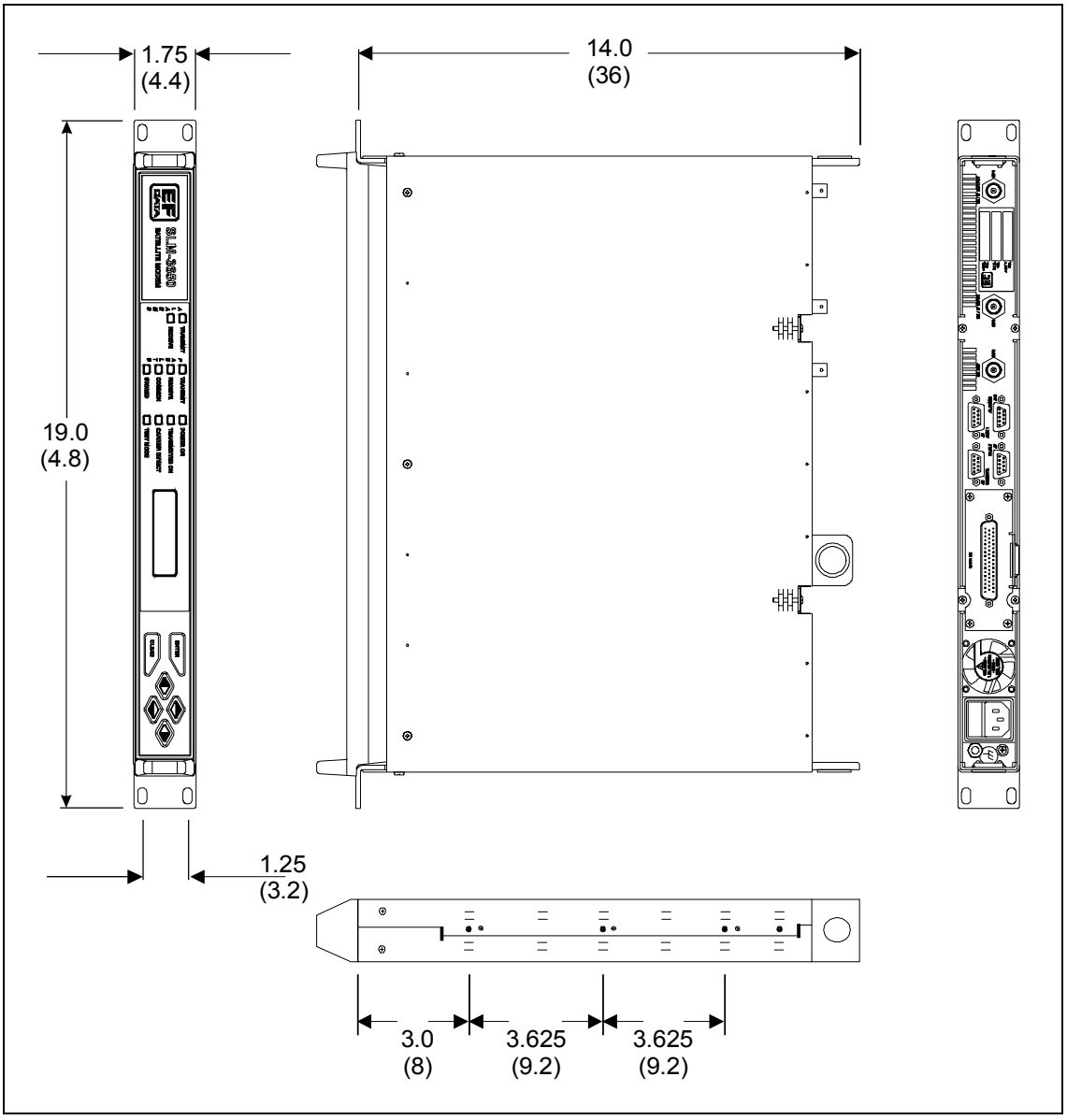


Figure 1-13. SLM-3650 Dimensional Drawing

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Chapter 2. INSTALLATION

This chapter provides unpacking and installation instructions, and a description of external connections and backward alarm information.



The equipment contains parts and assemblies sensitive to damage by Electrostatic Discharge (ESD). Use ESD precautionary procedures when touching, removing, or inserting PCBs.

2.1 Unpacking

The modem and manual are packaged in pre-formed, reusable, cardboard cartons containing foam spacing for maximum shipping protection.



Do not use any cutting tool that will extend more than 1 inch into the container. This can cause damage to the modem.

Unpack the modem as follows:

1. Cut the tape at the top of the carton indicated by OPEN THIS END.
2. Remove the cardboard/foam space covering the modem.
3. Remove the modem, manual, and power cord from the carton.
4. Save the packing material for storage or reshipment purposes.
5. Inspect the equipment for any possible damage incurred during shipment.
6. Check the equipment against the packing list to ensure the shipment is correct.
7. Refer to Installation, Section 2.2.

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2.2 Installation

The modem arrives fully assembled from the factory. After unpacking the modem, install the modem as follows:

1. If required, install the mounting bracket in equipment rack (Figure 2-1). Install and tighten the bracket bolts.

2. Loosen the screw with flat washer located on the left side of modem chassis. Mount the modem chassis into the equipment rack and slide the screw with flat washer through the slot of the mounting bracket. Tighten the screw sufficiently to allow the modem chassis to slide in the bracket.

3. Connect the cables to the proper locations on the rear panel. Refer to Section 2.3 for connector pinouts, placement, and function.

4. Connect the primary power cable to the power source. Before turning on the power switch, become familiar with the front panel operation in Chapter 3.

5. If problems exist with the installation, refer to Chapter 5 for troubleshooting information.

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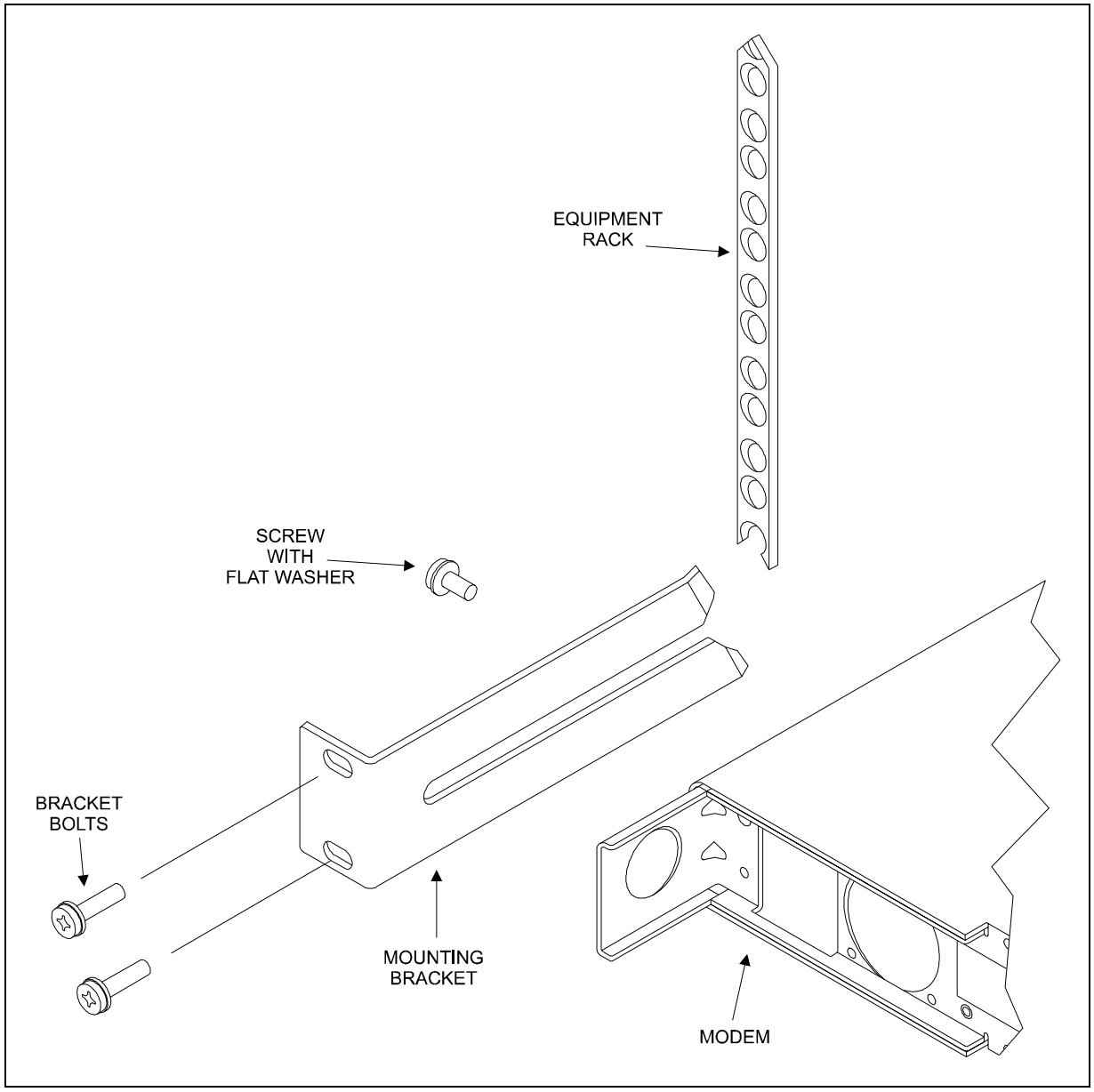


Figure 2-1. Installation of the Mounting Bracket

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2.3 External Modem Connections

When a breakout panel, such as the UB-300, is not required, the rear panel connectors provide all necessary external connections between the modem and other equipment. Table 2-1 lists these connectors, and Figure 2-2 through Figure 2-6 show their locations.

Notes:

1. Refer to the Comtech EF Data *UB-300 Universal Breakout Panel Installation and Operation Manual* for connecting the UB-300 breakout panel.
2. Refer to the Comtech EF Data *UB-54 Breakout Panel Installation and Operation Manual* for connecting the UB-54 breakout panel in a MUX option configuration.

Table 2-1. Modem Rear Panel Connectors

Name	Ref Des	Connector Type	Function
REMOTE	J6	9-pin D	Remote Interface
FAULT	J7	9-pin D	FORM C Fault Relay Contacts
DATA I/O	J8	25-pin D 34-pin 37-pin D 50-pin D 50-pin D 100-pin D 15-pin D & BNC	Data Input/Output (standard modem) V.35 EIA-422 Data Input/Output (modem with D&I/ASYNC/AUPC/IDR/IBS option) Without Overhead Card MUX option only (Refer to Appendix A.) G.703 T1, E1/ASYNC Interface Adapter
AUX 1	J9	9-pin D	(TTL) Faults Satellite Clock Demod I/Q Automatic Gain Control (AGC) Out
ALARMS	J10	9-pin D	FORM C Alarm Relay Contacts
TX/IF OUTPUT	CP1	TNC	RF Output
RX/IF INPUT	CP2	TNC	RF Input
EXTERNAL REF	CP3	TNC	Input
AC INPUT	NONE	IEC	Modem Power
GROUND	NONE	10-32 Stud	Grounding

Note: The European EMC Directive (EN55022, EN50082-1) requires using properly shielded cables for DATA I/O. These cables must be double-shielded from end-to-end, ensuring a continuous ground shield.

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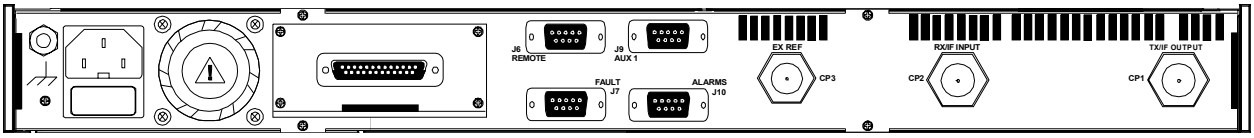


Figure 2-2. Basic Modem, 25-Pin D Connector

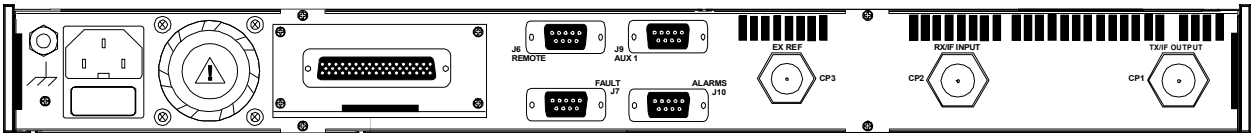


Figure 2-3. Overhead Option, 50-Pin D Connector

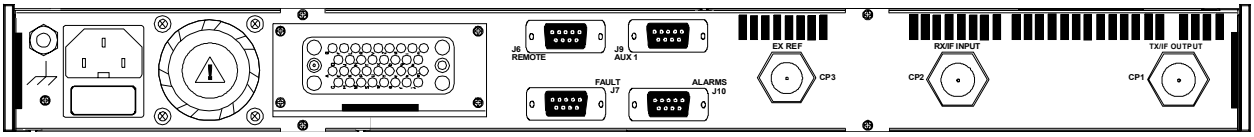


Figure 2-4. (V.35) 34-Pin Winchester Connector

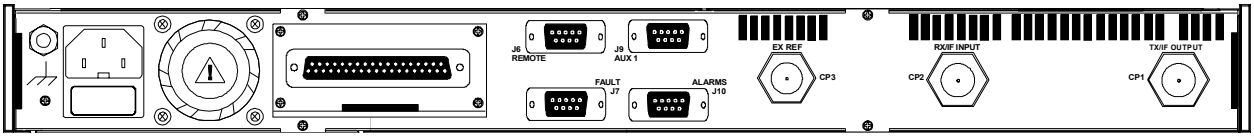


Figure 2-5. EIA-422/449, 37-Pin D Connector

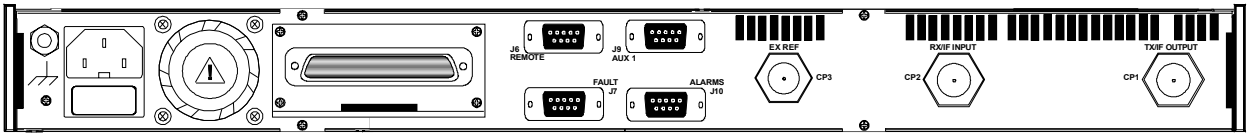


Figure 2-6. 8-Channel, 100-Pin MUX Connector

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2.3.1 Remote Connector and Pinouts (J6)

The remote connector is a 9-pin female D connector (J6) located on the rear panel of the modem. Screw locks are provided for mechanical security of the mating connector.

The remote connector interfaces the M&C functions to a remote location. The remote location can be an M&C computer located away from the modem, but attached via cable to the remote connector. This is a DCE interface that is user selectable for either EIA-485 or EIA-232. Refer to Appendix B for a description of the remote interface.

Refer to Table 2-2 for pinout information.

Table 2-2. Remote Connector and Pinouts (J6)

EIA-485			EIA-232	
4-Wire Mode		2-Wire Mode		
Pin #	Name	Name	Pin #	Name
1	GND	GND	1	
2			2	RD (RX)
3			3	TD (TX)
4	+TX	+RX/TX	4	
5	-TX	-RX/TX	5	GND
6			6	DSR
7			7	RTS
8	+RX	+RX/TX*	8	CTS
9	-RX	-RX/TX*	9	

*For 2-Wire Operation:

- Only 2 wires are required.
- Tie pins 4 and 8 together (both +)
- Tie pins 5 and 9 together (both -)

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2.3.2 Fault Connector and Pinouts (J7)

The fault connector provides Form C contact closures for fault reporting. The three Form C summary fault contacts are Modulator, Demodulator, and Common Equipment.

The fault interface connection is a 9-pin female D connector (J7) located on the rear panel of the modem. Screw locks are provided for mechanical security on the mating connector. Refer to Table 2-3 for pinout information.

Table 2-3. Fault Connector and Pinouts (J7)

Pin #	Signal Function	Name
1	Common equipment is not faulted	NO
2		COM
3	Common equipment is faulted	NC
4	Modulator is not faulted	NO
5		COM
6	Modulator is faulted	NC
7	Demodulator is not faulted	NO
8		COM
9	Demodulator is faulted	NC

Note: A connection between the common (COM) and normally open (NO) contacts indicates no fault.

Refer to Chapter 5 for a discussion of monitored faults. To obtain a system summary fault, connect all the Form C contacts in parallel.

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2.3.3 Data I/O Interface Connector (J8)

The Data I/O interface connector conducts data input and output signals to and from the modem and connects to the customer's terrestrial equipment, breakout panel, or protection switch. The modem is currently available with a choice of four Data I/O connectors, as follows:

- 25-pin D connector is the standard connector shipped with a base platform modem.
- 50-pin D connector is the standard connector when the modem is ordered with the optional overhead PCB, or if the overhead PCB has been installed in the field.
- 50-pin D that can be ordered with the basic modem, but it does not include the Overhead Card. This is used with breakout panels and switches.
- 37-pin D is an alternate connector available upon special request for the base platform modem.
- 34-pin Winchester is an alternate connector available upon special request for the base platform modem.
- G.703 T1, E1/ASYNC Interface Adapter is an alternate connector available upon special request for converting unbalanced signals to balanced signals.
- 50-pin D connector is used when the optional Flex MUX overhead board is installed.
- 100-pin D connector is used when the optional 8-channel MUX board is installed.

The Data I/O pinout is different for each of the interface configurations. For pinout information, refer to the appropriate table as follows:

Standard 25-pin D connector	Table 2-4
Optional 50-pin D connector	Table 2-5
Optional 37-pin D connector	Table 2-6
Optional 34-pin Winchester connector	Table 2-7
Optional 15-pin D connector	Table 2-9

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Table 2-4. 25-Pin D Connector Pinouts

25-Pin D Connector			
Pin #	**EIA-422**	**EIA-232**	**V.35**
1	SHLD	SHLD	SHLD
2	SD-A	TXD	SD-A
3	RD-A	RXD	RD-A
4	EIA-A	RTS	RTS
5	CS-A	CTS	CTS
6	DM-A	DSR	DSR
7	SIGGND	SIGGND	SIGGND
8	RR-A	DCD	RLSD
9	RT-B		SCR-B
10	RR-B		
11	TT-B		SCTE-B
12	ST-B		SCT-B
13	CS-B		
14	SD-B		SD-B
15	ST-A	ST	SCT-A
16	RD-B		RD-B
17	RT-A	RXC	SCR-A
18	LL	LL	LL
19	EIA-B		
20*	MC-A	MC	MC-A
21	DF	DF	DF
22	DM-B		
23*	MC-B		MC-B
24	TT-A	TXC	SCTE-A
25	MF	MF	MF

***Note:** Use the MASTER clock for EXTERNAL clock input. This clock input should equal the data rate unless the Asymmetrical Loop Timing Option (ASLT) is available. The ASLT option allows selection of different clock rates that vary from the digital data rate. Refer to the Utility/Modem Type/Modem Options menu for the ASLT option information.

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Table 2-5. 50-Pin Connector Pinouts

50-Pin D Connector				
Pin #	**IDR**	**IBS**	**Async**	**D&I**
1	GND	GND	GND	GND
2	GND	GND	GND	GND
3	AGC Out	AGC Out	AGC Out	AGC Out
4	EIA-422 TXOctA In		ESC TXDB In (485 only)	
5	EIA-422 TXOctB In	ESC TXDA In (232 only)	ESC TXDA In (485 & 232)	ESC TXD In (232 only)
6	EIA-422 RXOctA Out		ESC RXDB Out (485 only)	
7	EIA-422 RXOctB Out	ESC RXDA Out (232 only)	ESC RXDA Out (485 & 232)	ESC RXD Out (EIA-232)
8	BWO1_C	EIA-422 RX Oct A		
9	BWO2_C	EIA-422 RX Oct B		
10	BWO3_C	PRIMARY_C		PRIMARY_C
11	BWO4_C	SECONDARY_C		SECONDARY_C
12	BWAI 1	V.35/EIA-422 SCTE/TT A	V.35/EIA-422 SCTE/TT A	
13	BWAI 2	V.35/EIA-422 SCTE/TT B	V.35/EIA-422 SCTE/TT B	
14	BWAI 3	EIA-422 TX Oct A		
15	BWAI 4	EIA-422 TX Oct B		
16	Demod Fault C			
17	Def Maint Alrm			
18	G.703 SDB In	G.703 SDB In	G.703 SDB In	G.703 SDB In
19	EIA-422 ExtClkB In	V.35/EIA-422 EXCB In	V.35/EIA-422 EXCB In	EIA-422 EXCB In
20	G.703 RDB Out	G.703 RDB Out	G.703 RDB Out	G.703 RDB Out
21	EIA-422 8k TClkA Out	V.35/EIA-422 ST-A Out	V.35/EIA-422 ST-A Out	
22	EIA-422 8k TClkB Out	V.35/EIA-422 ST-B Out	V.35/EIA-422 ST-B Out	
23	EIA-422 8k RClkA Out	V.35/EIA-422 RT-A Out	V.35/EIA-422 RT-A Out	G.703 IDI-B In
24	EIA-422 8k RClkB Out	V.35/EIA-422 RT-B Out	V.35/EIA-422 RT-B Out	
25	BWO1_NC	ESC TCLK Out (EIA-232)		
26	BWO2_NC	ESC RCLK Out (EIA-232)		
27	BWO3_NC	PRIMARY_NC		PRIMARY_NC
28	BWO4_NC	SECONDARY_NC		SECONDARY_NC
29	Aud1-B In (or 64SDB)	V.35/EIA-422 RTS-B	V.35/EIA-422 RTS-B	
30	Aud1-B Out (or 64RTB)	V.35 RLSD/EIA-422 RR-B	V.35 RLSD/EIA-422 RR-B	
31	Aud2-B In (or 64STB)	V.35/EIA-422 CTS-B	V.35/EIA-422 CTS-B	
32	Aud2-B Out (or 64RDB)	V.35 DSR/EIA-422 DM-B	V.35 DSR/EIA-422 DM-B	
33	DEMOD Fault	DEMOD Fault	DEMOD Fault	DEMOD Fault
34	G.703 SDA In	G.703 SDA In	G.703 SDA In	G.703 SDA In
35	EIA-422 ExtClkA In	V.35/EIA-422 EXCA In	V.35/EIA-422 EXCA In	EIA-422 EXCA In
36	G.703 RDA Out	G.703 RDA Out	G.703 RDA Out	G.703 RDA Out
37	EIA-422 8k TXDA In	V.35/EIA-422 SD-A In	V.35/EIA-422 SD-A In	G.703 DDO-A Out
38	EIA-422 8k TXDB In	V.35/EIA-422 SD-B In	V.35/EIA-422 SD-B In	G.703 DDO-B Out
39	EIA-422 8k RXDA Out	V.35/EIA-422 RD-A Out	V.35/EIA-422 RD-A Out	G.703 IDI-A In
40	EIA-422 8k RXDB Out	V.35/EIA-422 RD-B Out	V.35/EIA-422 RD-B Out	G.703 IDI-B In
41	BWO1_NO	ESC DSR (EIA-232)		
42	BWO2_NO			
43	BWO3_NO	PRIMARY_NO		PRIMARY_NO
44	BWO4_NO	SECONDARY_NO		SECONDARY_NO
45	Aud1-A In (or 64SDA)	V.35/EIA-422 RTS-A	V.35/EIA-422 RTS-A	
46	Aud1-A Out (or 64RTA)	V.35 RLSD/EIA-422 RR-A	V.35 RLSD/EIA-422 RR-A	
47	Aud2-A In (or 64STA)	V.35/EIA-422 CTS-A	V.35/EIA-422 CTS-A	
48	Aud2-A Out (or 64RDA)	V.35 DSR/EIA-422 DM-A	V.35 DSR/EIA-422 DM-A	ESC DSR (EIA-232)
49	MOD Fault	MOD Fault	MOD Fault	MOD Fault
50	Demod Fault NO			

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Notes:

1. IDR configuration connector pinouts:
   a. Backward alarm relay contacts are named for normal no fault conditions (BWOx-C connected to BWOx-NC if no fault).
   b. Backward alarm inputs should be grounded or pulled logic low to clear the alarm.
   c. Signals MF, DF, and DMA are open-collector, high-impedance (if faulted). MF and DF are used by a backup protection switch if the modem is used in a redundant system.
   d. Relay contacts DF-C and DF-NO are named for faulted condition (DF-C connected to DF-NO, unless demodulator [Demod] fault).
2. D&I/ASYNC interface connector pinouts:
   a. With regard to alarm relay contacts, COMM is connected to NO when there is no fault. COMM is connected to NC in a faulted condition.
   b. Signals MF, DF, and DMA are open-collector, high-impedance (if faulted). MF and DF are used by a backup protection switch if the modem is used in a redundant system.
3. The 50-pin connector requires a breakout panel for the external connections between the modem and terrestrial equipment.

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Table 2-6. Optional 37-Pin Connector Pinouts

DB37	EIA-422	DB25	V.35/Winchester
1, 19	SIGGND	1, 7	A, B
3	MF	25	MM (m)
4	SD-A	2	P
5	ST-A	15	Y
6	RD-A	3	R
7	RTS-A	4	C
8	RT-A	17	V
9	CTS-A	5	D
11	DM-A	6	E
13	RR-A	8	F
16	MC-A	20	CC (c)
17	TT-A	24	U
20, 37	SHLD	1, 7	A, B
21	DF	21	NN (n)
22	SD-B	14	S
23	ST-B	12	AA (a)
24	RD-B	16	T
25	RTS-B	19	(N/A)
26	RT-B	9	X
27	CTS-B	13	(N/A)
29	DM-B	22	(N/A)
31	RR-B	10	(N/A)
34	MC-B	23	DD (d)

There are jumpers on the PL/6031 EIA-422 interface. Place the jumpers on the center pin and the pin towards the Master Clock (MC) to allow an external clock input on pins 16 and 34.

If desired, place the jumpers on the TR side to allow an external clock input on pins 12 and 30.

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Table 2-7. 34-Pin Winchester Connector Pinouts (V.35)

Pin #	Name
A	Ground
B	Ground
C	Request to Send (RTS)
D	Clear to Send (CTS)
E	Data Set Ready (DSR)
F	Receive Line Signal Detect (RLSD)
P	Send Data A (SD A)
R	Receive Data A (RD A)
S	Send Data B (SD B)
T	Receive Data B (RD B)
U	Serial Clock Transmit External A (SCTE A)
V	Serial Clock Receive A (SCR A)
W	Serial Clock Transmit External B (SCTE B)
X	Serial Clock Receive B (SCR B)
Y	Serial Clock Transmit A (SCT A)
a (AA)	Serial Clock Transmit B (SCT B)
c (CC)	External Reference Clock A (EXC A)
d (DD)	External Reference Clock B (EXC B)
m (MM)	Modulator Fault (MF)
n (NN)	Demodulator Fault (DF)

Note: Pins H, J, K, L, M, N, Z, b (BB), e (EE), f (FF), h (HH), j (JJ), k (KK), l (LL) have no connection.

The SLM-3650 is available with a Winchester V.35 as the data I/O connector (PL/6032). There is a jumper on the unit that either opens or closes the CC line. The interface is shipped with jumpers in positions 2 and 3, because:

1. Comtech EF Data has determined that several locations use Fireberd™ test equipment and a conflict will occur if CC is connected between the modem and the Fireberd™.

2. Placing the jumper in positions 2 and 3 opens up the CC line, because the TTC/Fireberd™ test equipment interfaces use the line for DTE/DCE control.

3. Grounding pin CC at the Fireberd™ interface will change the Fireberd ™ to a DCE device.

4. Comtech EF Data uses the CC and DD for the input master clock (same as the external clock input to the modem). To input an external clock, change the jumper to positions 1 and 2 (the pin closest to the Winchester connector).

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2.3.3.1 Data I/O Interface Connector (J8) Removal/Installation

Note: The following procedures outline the removal and installation of the Data I/O connector (J8). These procedures are written with the assumption that the same configured connector will be reinstalled. However, the operator does have an option to install a different configured connector. Refer to Table 2-8 for a matrix explaining connector options.

Table 2-8. Connector (J8) Matrix

Modem Configuration	EIA-232	EIA-422/EIA449	V.35	G.703 Overhead
25-pin Connector	X	X	X	
34-pin Connector			X	
37-pin Connector		X		
50-pin Connector	X	X	X	X
50-pin Connector (Optional)	X	X	X	
15-pin BNC				X

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2.3.3.1.1 Data I/O Connector (J8) Removal

1. (For Ribbon-Configured Connector PL/6031.) Remove Data I/O connector (J8) (Figure 2-7) as follows:

   a. Remove four screws securing the rear panel to the chassis.
   b. Pull out rear panel to gain access to disconnect connector (J8).
   c. Disconnect connector (J8) from the PCB.
   d. Remove the four screws securing connector (J8) to the rear panel.
   e. Remove the connector (J8).

2. (For Part No. PL/5509-1.) Remove 50-pin Data I/O connector (J8) as follows:

   a. Remove the four screws securing the connector (J8) to the rear panel.
   b. Establish a grip on connector (J8) and pull backwards until separation of the connectors is obtained.
   c. Remove connector (J8).

2.3.3.1.2 Data I/O Connector (J8) Installation

1. (For Ribbon-Configured Connector PL/6031.) Install Data I/O connector (J8) (Figure 2-7) as follows:

   a. Position connector (J8) in rear panel.

   Use care when connecting the data I/O connector (J8) to the PCB. Damage to the connector pins may render the data I/O connector (J8) unserviceable. Misalignment can be the result.

   b. Connect connector (J8) to the PCB.
   c. Secure connector (J8) to the rear panel with four screws.
   d. Position the rear panel to mate with the chassis and secure with four screws.

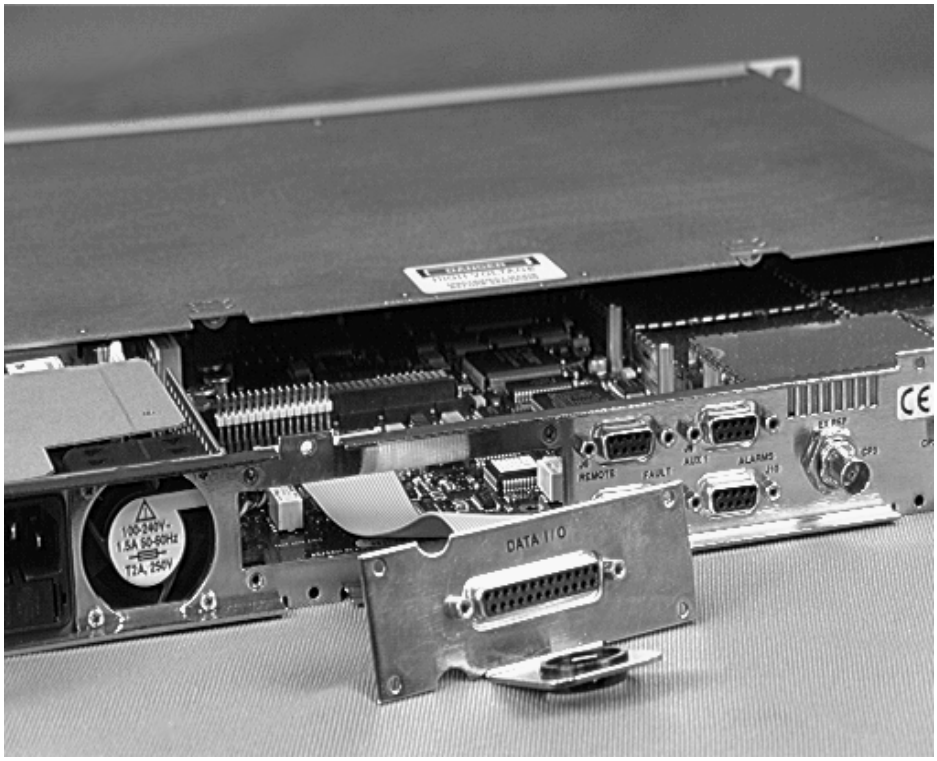
2. (For Part No. PL/5509-1.) Install 50-pin Data I/O connector (J8) as follows:

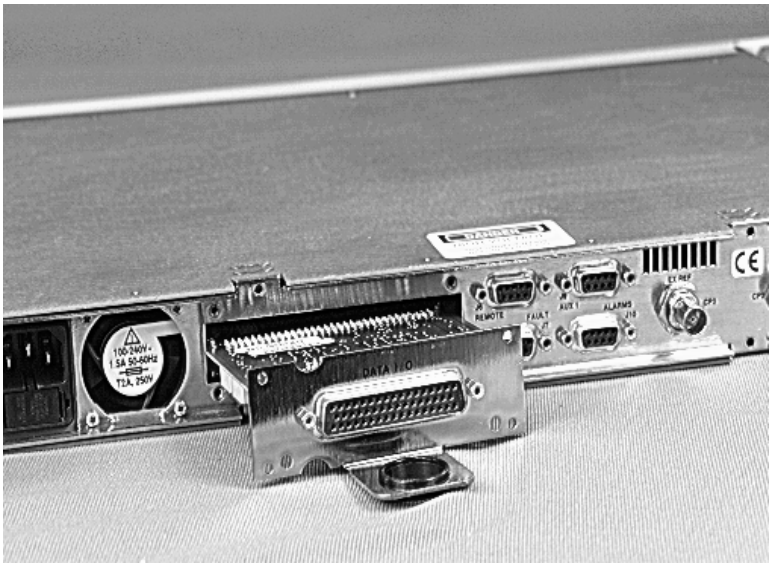
   Use care when connecting the Data I/O connector (J8) to the PCB. Damage to the connector pins may render the data I/O connector (J8) unserviceable. Misalignment can be the result.

   a. Connect connector (J8) to the PCB.
   b. Secure connector (J8) using four screws.

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For Ribbon-Configured Connector



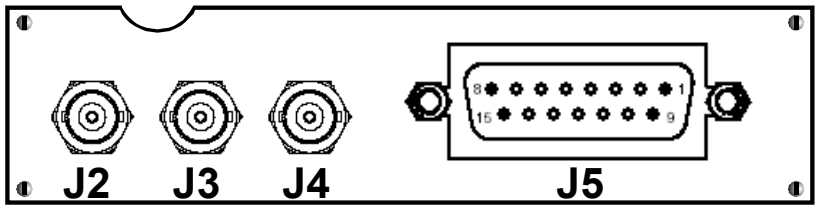
For 50-Pin Connector with Overhead Interface Board

Figure 2-7. Data I/O Connector (J8) Removal/Installation

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2.3.3.2 G.703 T1 E1/ASYNC Interface Adapter

The G.703 T1, E1/ASYNC Interface Adapter has three BNC connectors and a 15-pin sub-miniature D connector.



BNC Connectors

- BNC connector SD and RD support G.703 unbalanced 75Ω TX and RX data interfaces.
- BNC connector MC supports the 75Ω unbalanced Master Clock interface.

15-Pin Connector

The 15-pin D connector supports:

- G.703 balanced TX and RX data.
- Balanced Master Clock.
- Open collector Mod and Demod fault.
- Asynchronous overhead data interfaces.

Pinouts for the 15-pin D connector are as follows:

Table 2-9. G.703 T1/E1/ASYNC Interface Adapter

Pin #	Signal
1	SD-
2	GND
3	RD-
4	GND
5	ETXB
6	ERXB
7	MC-
8	MC+
9	SD+
10	N.C.
11	RD+
12	ETXA
13	ERXA
14	MODFLT
15	DMSFLT

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2.3.4 Auxiliary 1 Connector and Pinouts (J9)

The auxiliary 1 (AUX 1) connector provides:

- MOD and DEMOD (TTL) faults
- Satellite clock
- Satellite I&Q
- Automatic Gain Control (AGC) output voltage

The faults are open collector levels that indicate a modulator or demodulator failure. A logic "1" indicates the faulted condition.

AGC_OUT is a programmable voltage, 0 to 10V, for a receive signal level between -25 and -60 dBm.

AUX 1 connection is a 9-pin female D connector (J9) located on the rear panel of the modem. Screw locks are provided for mechanical security on the mating connector. Refer to Table 2-10 for pinout information

Table 2-10. AUX 1 Connector and Pinouts (J9)

Pin #	Signal Function	Name
1	Satellite Clock-	SAT_CLK-
2	N/A	
3	Satellite Clock+	SAT_CLK+
4	Modulator fault-	MDTTLFLT
5	Ground-	GND
6	RX Q Channel Eye	RX_Q
7	Demodulator fault-	DMTTLFLT
8	RX 1 Channel Eye	RX_I
9	AGC Out	AGC_OUT

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2.3.5 Alarms Connector and Pinouts (J10)

The alarms connector provides Form C contact closures for alarm reporting. The two Form C summary fault contacts are Modulator and Demodulator.

The alarms connection is a 9-pin female D connector (J10) located on the rear panel of the modem. Screw locks are provided for mechanical security on the mating connector. Refer to Table 2-11 for pinout information.

Table 2-11. Alarms Connector and Pinouts (J10)

Pin #	Signal Function	Name
1	Alarm 1 is faulted	NO
2		COM
3	Alarm 1 is not faulted	NC
4	Alarm 2 is faulted	NO
5		COM
6	Alarm 2 is not faulted	NC
7	Alarm 3 is faulted	NO
8		COM
9	Alarm 3 is not faulted	NC

- Alarm 1 = Not used
- Alarm 2 = TX
- Alarm 3 = RX

Refer to Chapter 5 for a discussion of monitored alarms. To obtain a system summary alarm, connect all the Form C contacts in parallel.

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2.3.6 RF Output Connector (CP1)

CP1 is a TNC connector for the TX-IF signal. The output impedance is 50Ω (75Ω optional), and the output power level is -5 to -30 dBm, with +5 to -20 dBm optional. In normal operation, the output will be a modulated result of the Data I/O connector between 50 and 180 MHz, in 1 Hz steps.

2.3.7 RF Input Connector (CP2)

CP2 is a TNC connector for the RX-IF signal. The input impedance is 50Ω (75Ω optional). For normal operation, the desired carrier signal level should be between -30 and -55 dBm. Signals between 50 and 180 MHz are selected and demodulated to produce clock and data at the Data I/O connector.

2.3.8 External Reference (CP3)

CP3 is a TNC connector for an external reference. The input impedance is 50Ω. For normal operation, the reference signal is ≥ 0 dBm.

2.3.9 AC Power Connector

A standard, detachable, non-locking, 3-prong power cord (IEC plug) supplies the Alternating Current (AC) power to the modem. Normal input voltage is 90 to 264 VAC, 47 to 63 Hz. The modem automatically switches among ranges. Maximum power consumption is less than 40W.

2.3.10 Ground Connector (GND)

A #10-32 stud on the rear panel of the modem is used for connecting a common chassis ground among all equipment.

Note: The AC power connector provides the safety ground.

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2.4 Turbo Product Code FEC

The SLM-3650 modem supports the optional Turbo Product Code Forward Error Correction (FEC) feature. A Turbo Product Codec can be installed at the factory or added as a field-installed upgrade to modems currently deployed. Seven new Turbo code rates/modulations are supported:

- BPSK 5/16
- BPSK 21/44
- QPSK 3/4
- OQPSK 3/4 (requires OQPSK optioned modem)
- 8PSK 3/4 (requires 8PSK optioned modem)
- QPSK 1/2
- OQPSK 1/2 (requires OQPSK optioned modem)

These Turbo code rates and modulations are also compatible with the equivalent functions in the similar modems. Interoperability between these modems and the SLM-3650 is guaranteed.

Benefits of Turbo Product Code FEC include:

Enhanced BER Performance	QPSK 3/4 rate Turbo provides nearly a 2 dB improvement over Viterbi 3/4 rate concatenated Reed-Solomon.
Reduced Delay	Significantly less processing delay (latency) than concatenated Reed-Solomon modes.
Soft Knee Characteristic	Traditional concatenated Reed-Solomon schemes exhibit a pronounced threshold effect where a small reduction in Eb/No results in a total loss of data. Turbo does not suffer from this problem; the decoder stays locked down to the point of unusable error rate.
Bandwidth Efficiency	No additional bandwidth expansion requirement (such as that associated with Reed-Solomon coding), resulting in bandwidth savings of 9% to 13%.

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2.4.1 BER Performance

Eb/N0 (dB) Specification					
BER	QPSK/OQPSK		BPSK		8PSK
	1/2 Rate	3/4 Rate	21/44 Rate	5/16 Rate	3/4 Rate
10-6	3.0	3.9	2.9	See Note	7.0
10-7	3.2	4.1	3.1	See Note	7.3
10-8	3.5	4.4	3.4	See Note	7.6
10-9	3.8	4.7	3.7	4.0	8.0

Note: BPSK 5/16 rate Turbo is included for compatibility with other Comtech EF Data equipment. However, implementation limitations prohibit optimum performance at Eb/No values below 4.0 dB. Performance is virtually error free above 4.0 dB Eb/No, and operation below this level is not recommended.

2.4.2 Data Rate

Modulation Type	Encoding Type	Data Rate Range	
BPSK	5/16 Rate Turbo	2.4 Kbps	781.25 Kbps
BPSK	21/44 Rate Turbo	2.4 Kbps	1193.0 Kbps
QPSK/OQPSK	1/2 Rate Turbo	4.8 Kbps	2386.0 Kbps
QPSK/OQPSK	3/4 Rate Turbo	7.2 Kbps	3750.0 Kbps
8PSK	3/4 Rate Turbo	64.0 Kbps	5000.0 Kbps

Note: {O}QPSK 1/2 Rate Turbo requires additional frame overhead. When computing symbol rates for {O}QPSK 1/2 Rate, use an additional factor of 22/21 (e.g.: SR = [DR ∗ 2/1 ∗ 22/21] / 2).

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2.4.3 Remote Control & Menu Structure Changes

Changes to the remote control and menu structure are minimal. The following list summarizes the changes required for the Turbo Codec option:

Encoder/Decoder Select	Turbo added as selection with Viterbi and Sequential; Turbo can only be selected for a Modem Type of "Custom" or "EF Data."
Data Rate	Selection and assignments for Turbo rates available when Turbo is enabled.

2.4.4 Upgrading To Turbo

Upgrading requires installation of the Turbo Codec module, installation of new M&C firmware, and installation of new Bulk firmware.

An upgrade kit includes the following items:

Upgrade Kit Part Number KT/9672-1:

1. PL/9394-1 (Turbo Codec Module)
2. FW/6535-1V or later version (M&C firmware)
3. FW/6094W or later version (Bulk firmware)
4. Installation instructions

The units must have a Revision C (or later) main board for the Turbo upgrade. Refer to the following ways to determine the revision status:

1. Provide the SN of the modem to Comtech EF Data for verification of the revision status.
2. If the first two digits of the modem SN start with 99, 00 or 01, corresponding to the year of manufacture, then the modem main board is Revision C.
3. If the SN starts with 98 then it is either Revision B or C and it is necessary to check with the factory. SNs beginning 97 or earlier are not eligible for upgrade.

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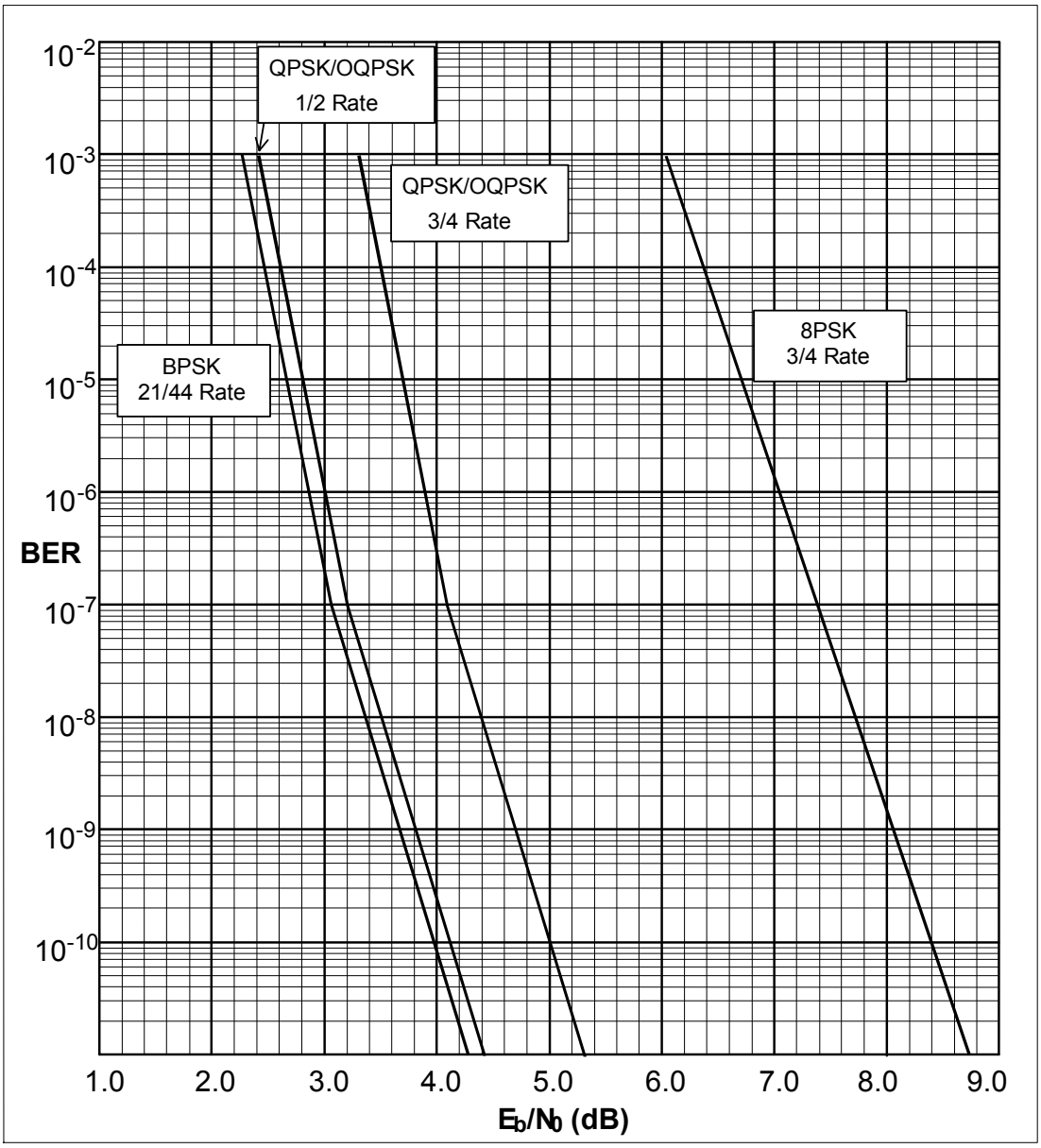


Figure 2-8. Turbo Codec BER Performance

CAUTION

Observe all normal precautions for handling electrostatic-sensitive devices.

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2.4.4.1 Install Turbo Board and Firmware

1. Disconnect the AC power to the unit.

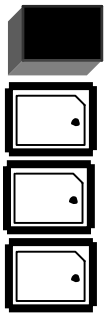
2. Remove two side screws near front of the modem. Slide top cover back and lift off.

3. Card 1 Removal, refer to **Figure 2-9** unit has top board (Card 1 – Overhead board), remove the four rear panel screws around the 50-Pin I/O switch module. Unplug the I/O module, then remove the seven mounting screws holding the Overhead board and carefully lift it off.

4. Turbo installation, refer to **Figure 2-10**. Align the Turbo board with either of the SIMM sockets while holding it nearly vertical with components toward Rear Panel. Seat the connector into socket and tilt board toward the Front Panel until the spring clips lock the board into place.

5. Firmware installation, refer to **Figure 2-11**. If replacement Firmware IC's were sent with the Turbo Board, remove existing Firmware, U86 and U74 with PLCC type IC puller. If puller is not available, use ice pick type tool to carefully pry upward at opposite corners of IC.

   Install the replacement Firmware, noting that the Dot mark should be oriented toward the beveled corner of the socket before pushing the IC into the socket. U86 is located next to the lithium battery NV-RAM (Large Black or Yellow IC, U95). U74 is located in the center socket position.



6. If step #3 is required, re-install the Overhead board with its seven mounting screws then re-plug the I/O Module into the Rear Panel location and install its four mounting screws.

7. Replace the Top Cover so forward edge mates under Front Panel lip. While holding in place, re-install the two side screws.

8. Turn on the AC power to the modem. Modem will re-initialize.

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2.4.4.2 Turbo Set-up:

1. Press the [←] [→] arrow key until the screen reads: “Function Select Utility” then press the Enter key.

2. Press the [→] arrow key until the screen reads: “Utility Modem Type” then press the Enter key.

3. Press the [↑] or [↓] arrow key until the screen reads: “Modem Type Custom” or “Modem Type EFD” then press the Enter key. Press Clear.

4. Press the [→] arrow key until the screen reads: “Utility Modulator” then press the Enter key.

5. Press the [→] arrow key until the screen reads: “Encoder Type” then press the Enter key, then [↑] key to get “Turbo,” press Enter.

6. Press Clear, then press the [→] arrow key until the screen reads: “Utility Demodulator” then press the Enter key.

7. Press the [→] arrow key until the screen reads: “Decoder Type” then press the Enter key, then [↑] key to get “Turbo,” press Enter.

Notes:

1. In this configuration, the Modem will allow only valid Data Rates and Formats for Turbo.
2. Open-network modem types cannot be selected.

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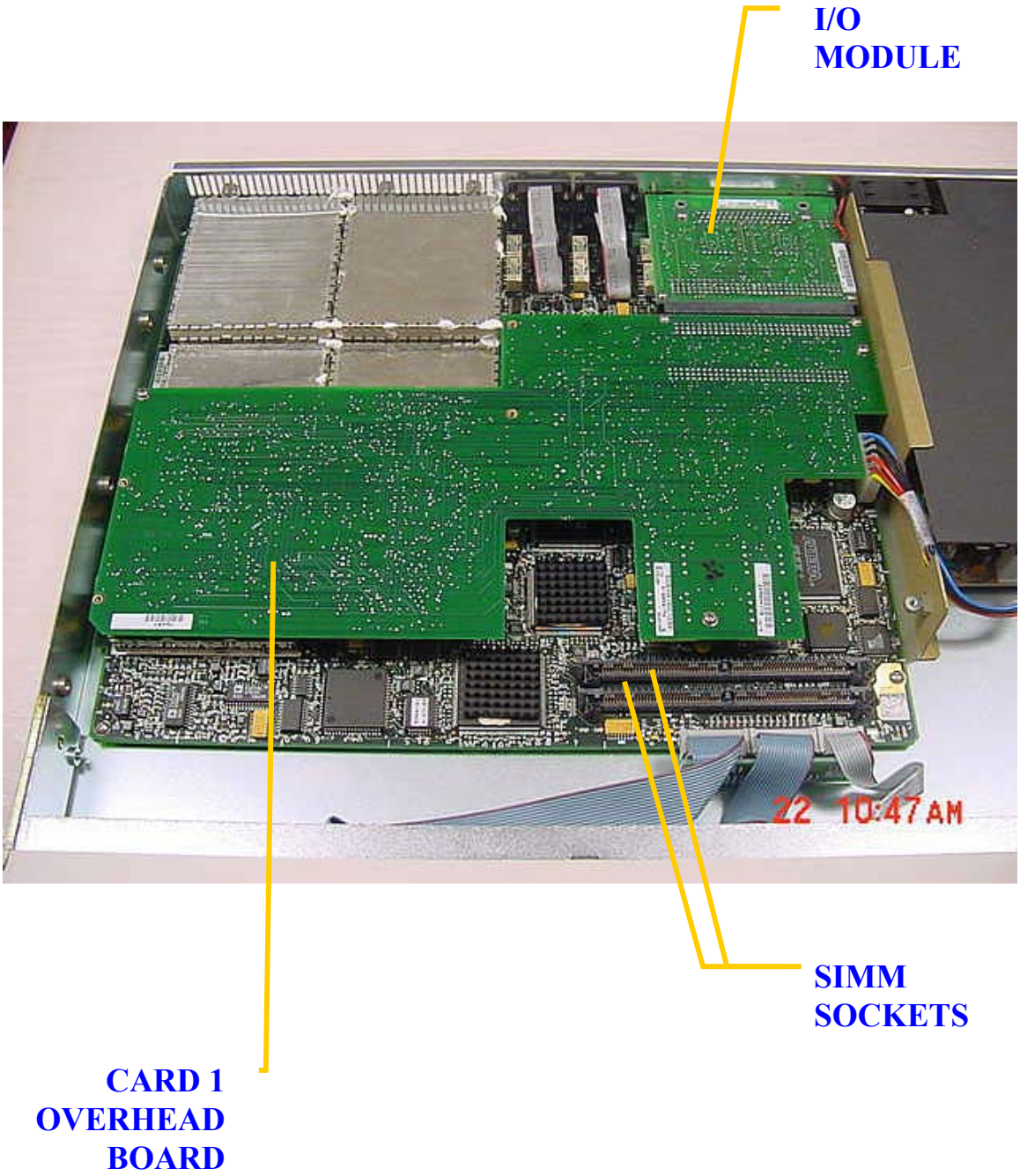


Figure 2-9. Card Removal

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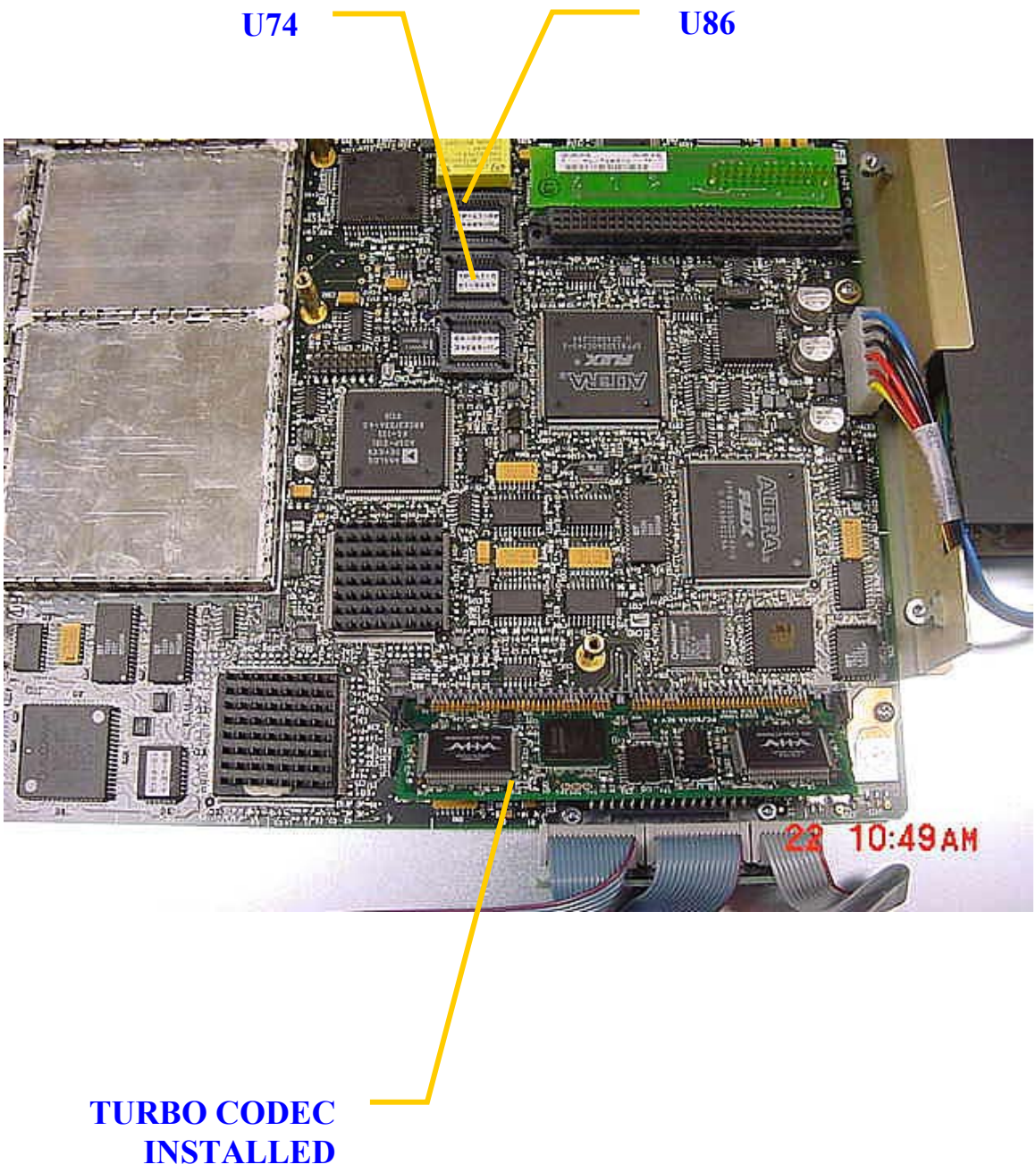


Figure 2-10. Turbo Codec Card Installation

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2.5 Duplex Reed-Solomon

The SLM-3650 modems support the optional Duplex Reed-Solomon Codec Forward Error Correction (FEC) feature. A Duplex Reed-Solomon Codec can be installed at the factory or added as a field-installed upgrade to modems currently deployed.

2.5.1 Upgrading To Duplex Reed-Solomon

Upgrading requires installation of the Duplex Reed-Solomon module (Simplex Reed-Solomon modules must be removed if installed, Turbo and Duplex Reed-Solomon can be populated at the same time), installation of new M&C firmware, and installation of new Bulk firmware, and installation of new Turbo firmware are required.

An upgrade kit includes the following items:

Upgrade Kit Part Number KT/9658-1:

1. PL/9658-1 (Duplex Reed-Solomon Module)
2. FW/6535-1AA or later version (M&C firmware)
3. FW/6094W or later version (Bulk firmware)
4. Installation instructions
5. FW/9600C or later version (Turbo Firmware – if Turbo is installed)

The modems must have a Revision C (or later) main board for the Duplex Reed-Solomon upgrade. There are two ways to determine the revision status:

Step	Procedure
1	Provide the SN of the modem to Comtech EF Data for verification of the revision status.
2	If the first two digits off the modem SN start with 99, 00 or 01, corresponding to the year of manufacture, then the modem main board is revision C. If the SN starts with 98 then it is either revision B or C and it is necessary to check with the factory. SNs beginning 97 or earlier are not eligible for upgrade.

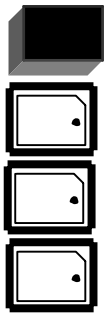


Observe all normal precautions for handling electrostatic-sensitive devices.

2.5.2 Install Duplex Reed-Solomon Board and Firmware

Step	Procedure

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1	Disconnect the AC power to the unit.
2	Remove the (2) side screws near the front of the modem. Slide top cover back and lift off.
*3	Card 1 Removal, refer to Figure 2. If unit has top board (Card 1 – Overhead board), remove the (4) rear panel screws around the 50-Pin I/O switch module. Unplug the I/O module, then Remove the (7) mounting screws holding the Overhead board and carefully lift it off.
4	Simplex Reed-Solomon removal, refer to Figure 2. Remove all Simplex Reed-Solomon Boards if installed, from the SIMM sockets by pushing the spring clips outward while rocking the board vertically, then lift out.
**5	Duplex Reed-Solomon installation, refer to Figure 3. Align the Duplex Reed-Solomon board with either of the SIMM sockets while holding it nearly vertical with components toward Rear Panel. Seat the connector into the socket and tilt the board toward the Front Panel until the spring clips lock the board into place.
6	Firmware installation, refer to Figure 3. *If replacement Firmware IC's where sent with the Duplex Reed- Solomon Board*, Remove existing Firmware, U86 and U74 with PLCC type IC puller. If puller not available, use ice pick type tool to alternately, carefully pry upward at opposite corners of IC. 
7	Install the replacement Firmware, noting that the Dot mark should be oriented toward the beveled corner of the socket before pushing the IC into the socket. U86 is located next to the lithium battery NV-RAM (Large Black or Yellow IC, U95). U74 is located in the center socket position.
*8	If step #3 was required, re-install the Overhead board with its (7) mounting screws then re-plug the I/O Module into the Rear Panel location and install its (4) mounting screws.
9	Replace the Top Cover so forward edge mates under Front Panel lip. While holding in place, re-install the (2) side screws.
10	Turn on the AC power to the modem. Modem will re-initialize.

* Dependent steps – Other procedures shall be accomplished prior to performing steps indicated by an *.
** For PL/9394-1 Rev. A Turbo Codec Board (Has a socket that the firmware is installed into). This assembly shall be installed in card slot #2 (see Figure 2-11) and Duplex Reed-Solomon in card slot #3. All other revisions of PL/9394-1 Turbo Codec Board can be installed in either slot.

2.5.3 Duplex Reed-Solomon Set-up:

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No special setup is required the Reed-Solomon option is avalible as normal under **Configuration: Modulator/Demodulator** menu.

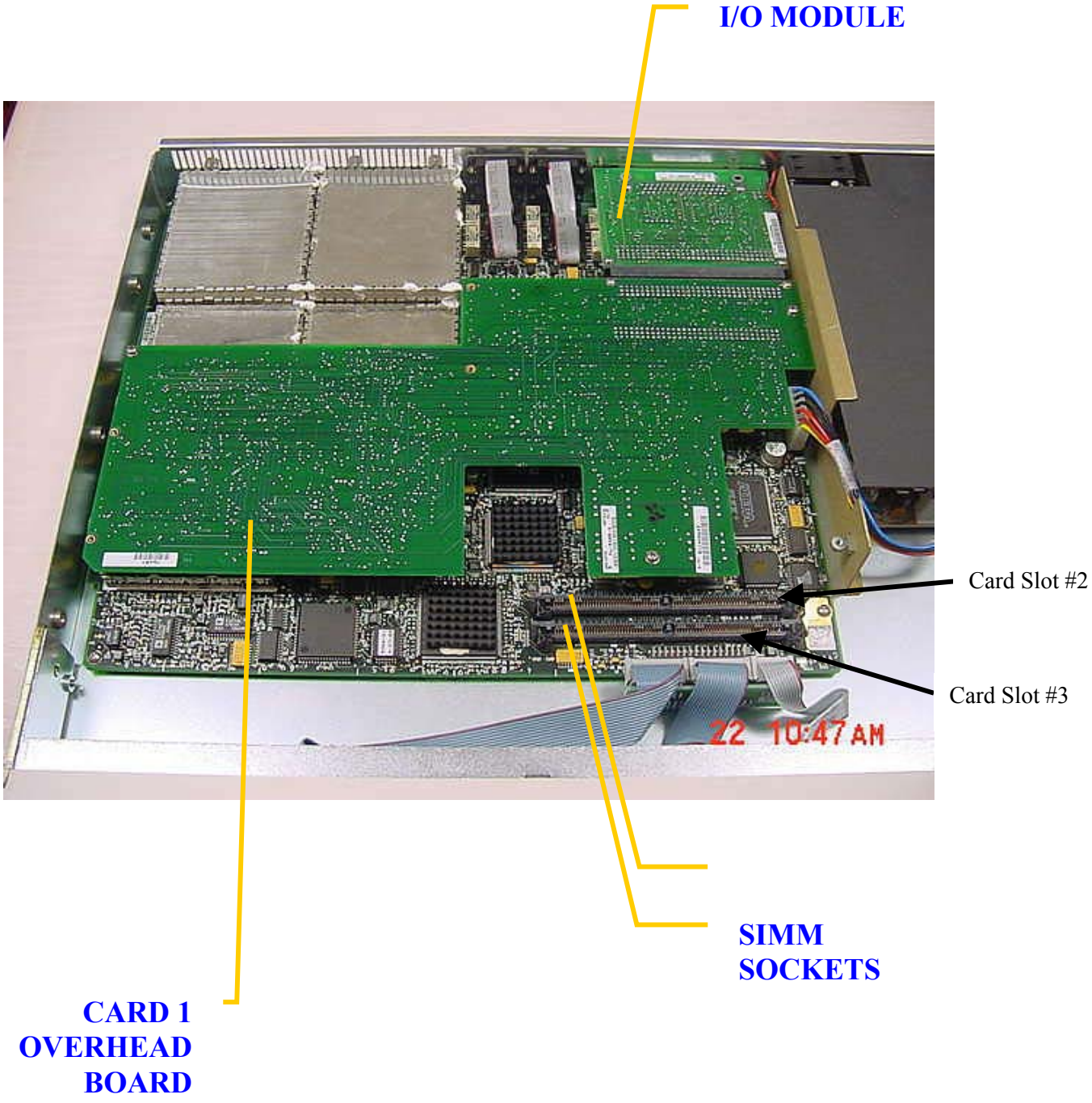


Figure 2-11. Duplex Reed-Solomon Setup

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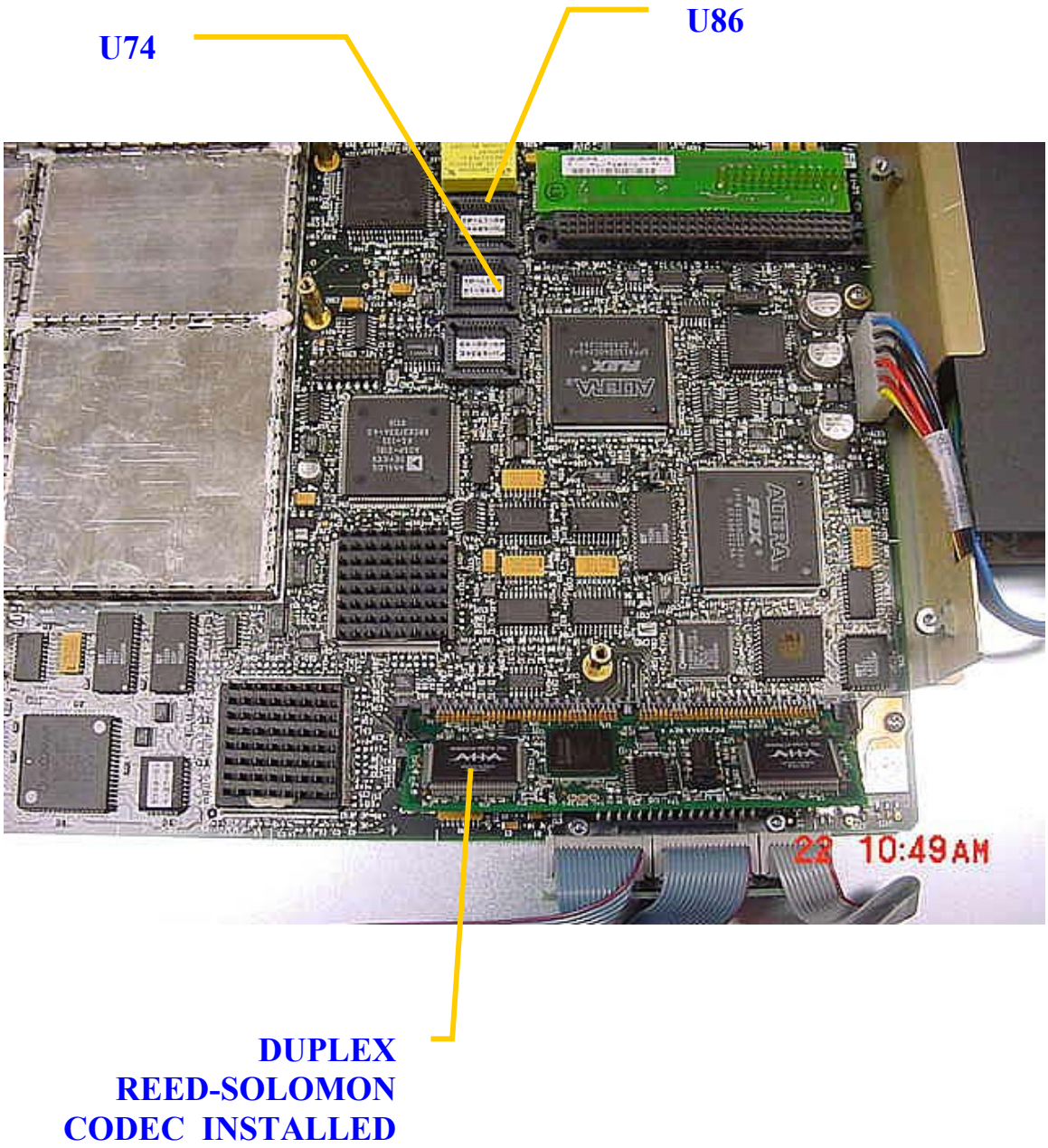


Figure 2-12. Installation of Duplex Reed-Solomon

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Chapter 3. OPERATION

This chapter describes the front panel operation of the modem, including the menus and their explanations, software configuration, clocking information, and buffering.

For information about remote control operation, refer to Appendix B.

3.1 Front Panel

The modem front panel (Figure 3-1) enables control of modem configuration parameters and displays the modem status.

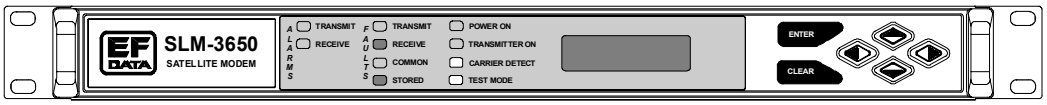


Figure 3-1. Front Panel View

The front panel features include:

- 32-character, 2-line LCD display
- 6-button keypad for local control
- 10 LEDs to provide overall status at a glance

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All functions are accessible at the front panel by entering one of six pre-defined Function Select categories or levels:

- Configuration
- Monitor
- Faults/Alarms
- Stored Faults/Alarms
- Remote AUPC (ASYNC mode only)
- Utility

3.1.1 LED Indicators

The 10 LEDs on the front panel indicate:

- General modem summary faults
- Status
- Alarms

The indicators are defined in Table 3-1 as follows:

Table 3-1. LED Indicators

Name	LED	Meaning
Faults		
Transmit	Red	A fault condition exists in the transmit chain.
Receive	Red	A fault condition exists in the receive chain.
Common	Red	A common equipment fault condition exists.
Stored	Yellow	A fault has been logged and stored. The fault may or may not be active.
Status		
Power On	Green	Power is applied to the modem.
Transmitter On	Green	Transmitter is currently on. This indicator reflects the actual condition of the transmitter, as opposed to the programmed condition.
Carrier Detect	Green	Decoder is locked.
Test Mode	Yellow	Flashes when the modem is in a test configuration.
Alarms		
Transmit	Yellow	A transmit function is in an alarm condition.
Receive	Yellow	A receive function is in an alarm condition.

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3.1.2 Front Panel Keypad

The front panel keypad permits local operation of the modem. The keypad consists of six keys (Figure 3-2).

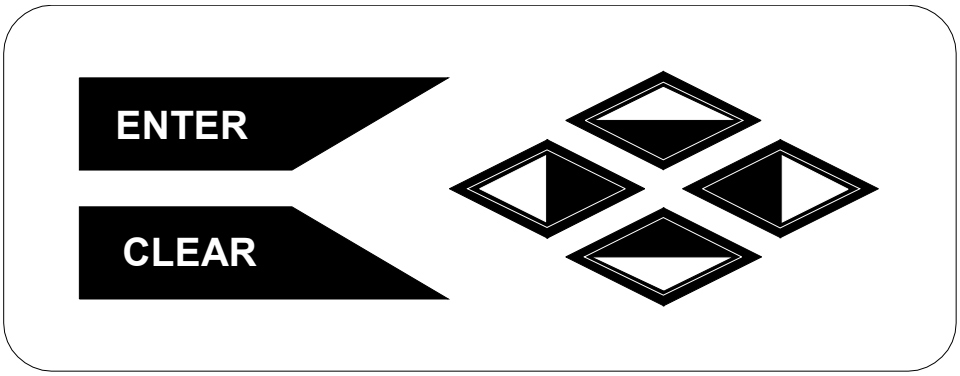


Figure 3-2. Keypad

Each key provides one or more logical functions. These functions are defined in the following table.

ENTER	This key is used to select a displayed function or to execute a modem configuration change.
CLEAR	This key is used to back out of a selection or to cancel a configuration change which has not been executed using [ENTER]. Pressing [CLEAR] generally returns the display to the previous selection.
Left and Right Diamond Keys (◄ ►)	These keys are used to move to the next selection or to move the cursor for certain functions. **Note:** Throughout this chapter, [←] and [→] are used to indicate left and right diamond keys.
Top and Bottom Diamond Keys (▲ ▼)	These keys are used primarily to change configuration data (numbers). At times, they are also used to move from one section to another. **Note:** Throughout this chapter, [↑] and [↓] are used to indicate top and bottom diamond keys.

The modem responds by beeping whenever a key is pressed:

- A single beep indicates a valid entry and the appropriate action was taken.
- A double beep indicates an invalid entry or a parameter is not available for operation.

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3.2 Revision Emulation Operation

To program an emulation mode from Version 1.1.1 through the current version, use the revision emulation feature in the Figure 3-21, Utility Modem Type menu. Refer to Table 3-2

Table 3-2. SLM-3650 Revision Emulation

Software Version	Firmware	Rev	Description of Change
1.1.1	FW/6535-1	-	Original Issue.
2.1.1	FW/6535-1	A	Updated menus to reflect current application.
3.1.1	FW/6535-1	B	Added reflash capability.
4.1.1	FW/6535-1	C	To allow the flex mux to operate in a T1/E1 mode.
4.1.2	FW/6535-1	D	Loop timing and clocking in D&I mode.
5.1.1	FW/6535-1	E	Added FAST Option OQPSK 1/2, 3/4, and 7/8.
5.1.2	FW/6535-1	F	Modem external reference.
6.1.9	FW/6535-1	U	Added Turbo.
6.1.11	FW/6535-1	W	Updated menus to reflect current application.
7.1.13	FW6535-1	AP	Updated menus to reflect current application.
7.1.16	FW/6535-1	AU	Added duplex reed-solomon.

3.3 Data Rates

Code Rate	Data Rate Range
Non-Turbo Requirements	
BPSK 1/2	2.4 to 1250 kbps
{O}QPSK 1/2	4.8 to 2500 kbps
{O}QPSK 3/4	7.2 to 3750 kbps
{O}QPSK 7/8	8.4 to 4375 kbps
8-PSK 2/3	64 to 5000 kbps
BPSK 1/1	4.8 to 2500 kbps
{O}QPSK 1/1	9.6 to 5000 kbps
Turbo Requirements	
BPSK 21/44	2.4 to 1193.181 kbps
BPSK 5/16	2.4 to 781.25 kbps
{O}QPSK 1/2	4.8 to 2386.363 kbps
{O}QPSK 3/4	7.2 to 3750 kbps
8-PSK 3/4	64 to 5000 kbps

Notes:

1. Max Symbol Rate = 2500 ksps.
2. Max Data Rate for Low var. Rate = 512 kbps.
3. OQPSK Option only = OQPSK 1/2, 3/4, or 7/8.
4. When the TX rate has been programmed, the transmitter is automatically turned off to prevent swamping of other channels. To turn the transmitter on, use the TX-IF Output function.

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5. Code Rate 3/4 not compatible with a combination of a CSC Closed Modulator Type and Sequential Encoder.

3.4 Menu System

To access and execute all functions, refer to Figure 3-4 through Figure 3-22. Use the Main menu in Figure 3-3 as a quick reference for accessing the modem functions.

Note: Refer to Appendix A for the default settings for IDR, IBS, D&I, and ASYNC modes.

When the modem power is applied, the base level of the menu system displays the sign-on message:

- Line 1 of the sign-on message is the modem model number and type.
- Line 2 is the version number of the firmware.

The main level of the menu system is Function Select. To access this level from the sign-on message, press the [←] or [→] keys. From the Function Select menu, select one of the functional categories:

- Configuration
- Monitor
- Faults/Alarms
- Stored Faults/Alarms
- Remote AUPC (ASYNC mode only)
- Utility

Press [←] or [→] to move from one selection to another. When line 2 displays the desired function, select that level by pressing [ENTER]. After entering the appropriate functional level, press [←] or [→] to move to the desired function.

To view or change the modem's configuration, enter the Configuration level from the Function Select menu. Once in the Configuration menu, press [←] or [→] to scroll through the Configuration menu selection:

- Modulator
- Demodulator
- Interface
- Local AUPC (ASYNC Mode or Local Modem AUPC only)
- MUX (Optional)
- Flex MUX (Optional)
- Save
- Recall

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Press [ENTER] to select the desired Configuration menu option. To view the options for the selected configuration parameters, press [←] or [→]. To change a configuration parameter, press [ENTER] to begin the change process.
Press [↑] or [↓] to change the parameters. After the display represents the correct parameters, press [ENTER] to execute the change. This action initiates the necessary programming by the modem.

To undo a parameter change prior to execution, press [CLEAR].

Notes:

1. Menus or commands that are specific to certain modem configurations are only accessible after selecting the appropriate modem configuration. This prevents incompatible parameters from accidentally being selected.
2. All of the windows are accessible in the Custom mode. Take caution not to select incompatible parameters, as the modem does not shut out incompatible command choices in the Custom mode.

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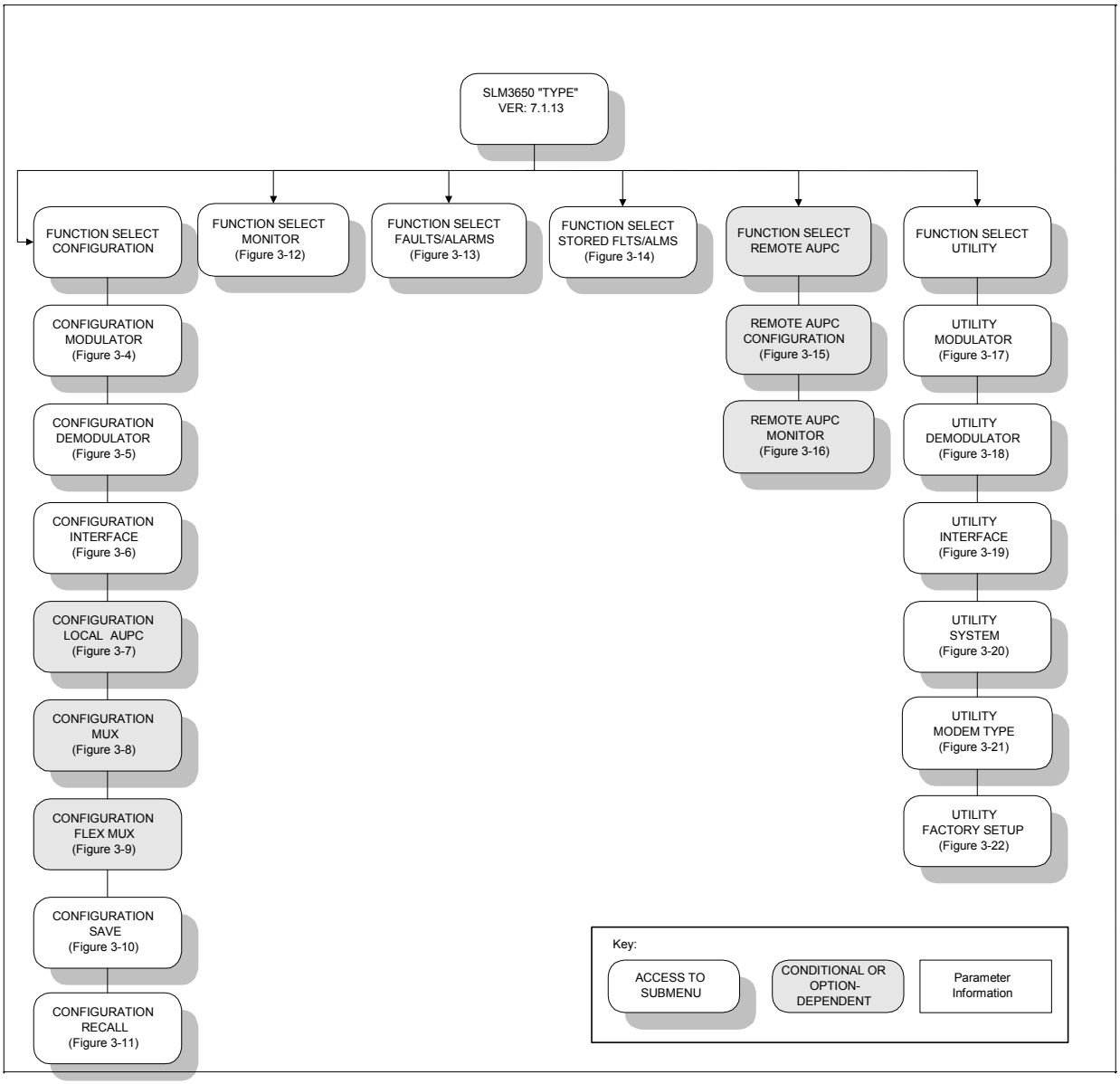


Figure 3-3. Main Menu

Note: Refer to Appendix A for the default settings of IDR, IBS, D&I, Custom, ASYNC, and System modem types.

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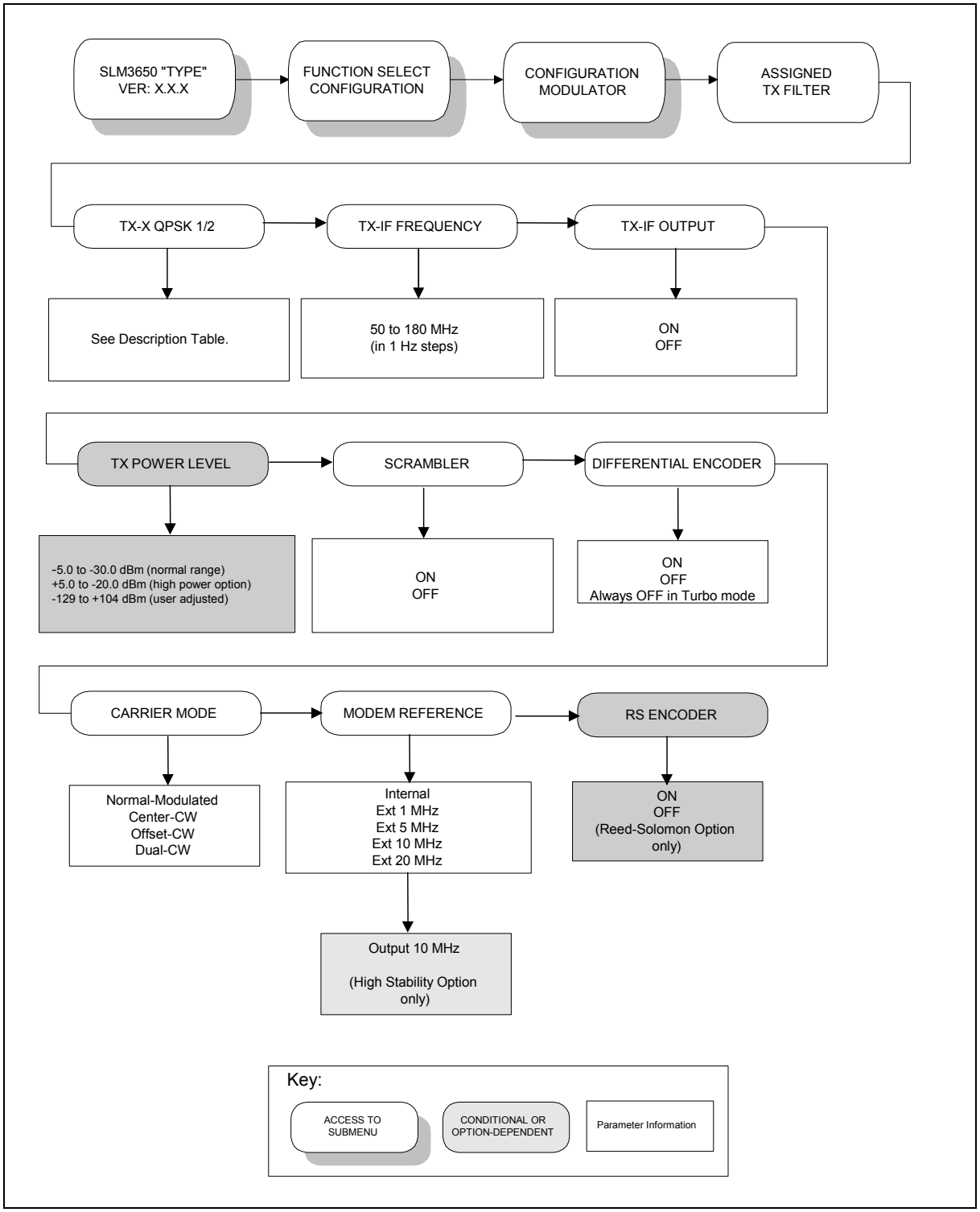


Figure 3-4. Configuration Modulator Menu

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3.4.1 Function Select: Configuration: Modulator

Refer to Figure 3-4.

TX-X CODE_RATE	Upon entry, the current transmitter rate is displayed with the flashing cursor on the first character of the code rate on Line 1. Line 2 displays the data rate. Press [←] or [→] to make the selection. To select the currently defined variable data rate, select TX-V, and press [ENTER] twice. To change the rate using the variable rate selection, press [ENTER] when TX-V is displayed. A flashing cursor is displayed on the first character of the coding type on Line 1. Press [←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change. Refer to 3.3 for Code/Data Rates. Refer to Table 4-1 for code/data rate default settings
TX-IF FREQUENCY	Programs the modulator transmit frequency between 50 and 180 MHz, in 1 Hz steps. Upon entry, the current transmitter frequency is displayed with the flashing cursor on the first character. Press [←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change. Note: When the transmitter frequency is changed, the transmitter is automatically turned off to prevent the possible swamping of other channels. To turn the transmitter on, use the TX-IF Output function.
TX-IF OUTPUT	Programs the modulator output ON or OFF. Upon entry, the current status of the output is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
TX POWER LEVEL	**Conditional:** An offset can be added through the Function Select: Utility menu to remove losses or gains in the system. Programs the modulator output power level within: ➢ -5 to -30 dBm, normal range ➢ +5 to -20 dBm, high power option ➢ -129 to +104 dBm, user offset adjust Upon entry, the current transmitter power level is displayed with the flashing cursor on the first character. Press [↑] or [↓] to increase or decrease the output power level in 0.1 dBm steps. Press [ENTER] to execute the change. Note: The front panel display may be changed in the power offset utility. Using that function does not change the actual output power level. The high power oscillator option is +5 to -20 dB. The window displays AUPC_PWR when the AUPC is turned on in the AUPC Configuration menu. For more information, refer to Section 3.1.3.10.

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SCRAMBLER	Programs the scrambler ON or OFF. Upon entry, the current status of the scrambler is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
DIFF. ENCODER	Programs the differential encoder ON or OFF. Upon entry, the current status of the differential encoder is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
CARRIER MODE (Test Mode Configuration)	Programs the modem for continuous wave mode. Four modes of operation are available: **NORMAL-MODULATED:** The Carrier mode is normally in the OFF position. **CENTER-CW:** Generates a carrier at the current modulator frequency. This can be used to measure the output frequency. **DUAL-CW:** Generates a dual side-band suppressed carrier signal. Side-bands are at one-half of the symbol rate from the carrier. This is used to check the channel balance and carrier null. **OFFSET-CW:** Generates a single, upper, side-band-suppressed carrier signal. The upper side-band is at one-quarter of the symbol rate from the carrier. When inverted spectrum is selected, this generates a single, lower, side-band-suppressed carrier. Upon entry, the Center mode is displayed. To activate this test mode, press [ENTER]. Press [↑] or [↓] to select the desired mode. To return to the Configuration menu, press [CLEAR]. Note: When [CLEAR] is pressed, the modem is configured to the state before CW mode was invoked. The transmitter is automatically turned OFF to prevent the possible swamping of other channels. To turn the transmitter ON, use the IF Output function.
MODEM REFERENCE	Use only Internal or EXT10 MHz with a Block Up Converter (BUC) or Outdoor Unit (ODU). Program the following references to the modulator: ➢ INTERNAL. ➢ 1, 5, 10, and 20 MHz external references (CP3) ➢ 10 MHz Out (High Stability Option only) Note: If any EXT REF is selected for the modem reference and there is no input to CP3, the modem will detect an alarm and switch to the INT CLK. Upon entry, the Internal mode is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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RS ENCODER	**Conditional:** Programming the Reed-Solomon Encoder automatically turns OFF the RF transmitter (because of symbol rate changes). If none of the proper overhead types and data rates apply, the Reed-Solomon Encoder program in the ON state will be rejected (double beep). Programs the Reed-Solomon encoder ON or OFF. Upon entry, the current status of the Reed-Solomon encoder is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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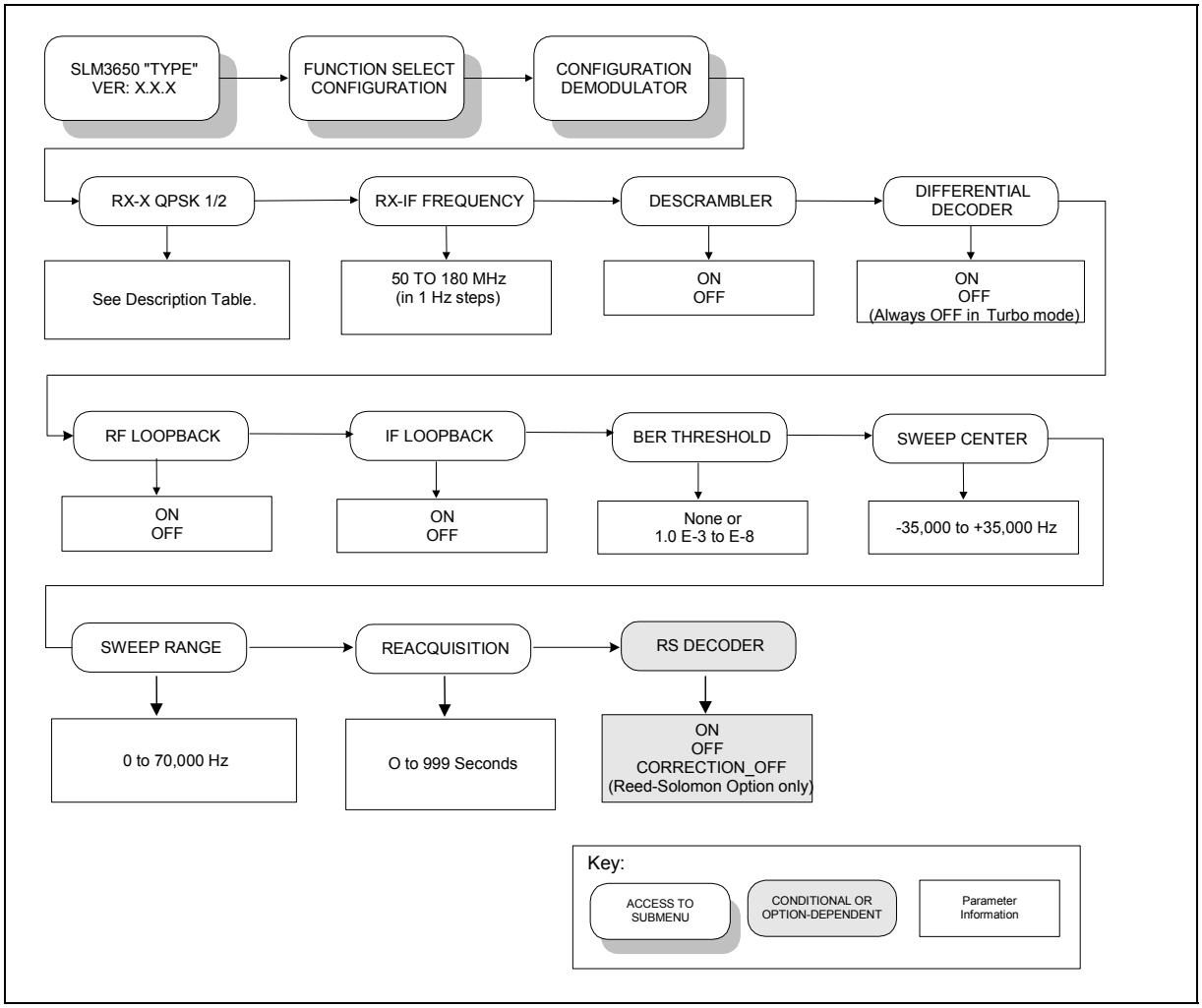


Figure 3-5. Configuration Demodulator Menu

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3.4.2 Function Select: Configuration: Demodulator

Refer to Figure 3-5.

RX-X CODE_RATE/TYPE	Upon entry, the current RX rate is displayed with the flashing cursor on the first character of the code rate on Line 1. Line 2 displays the data rate. Press [←] or [→] to make the selection. To select the currently defined variable data rate, select RX-V, and press [ENTER] twice. To change the rate using the variable rate selection, press [ENTER] when RX-V is displayed. A flashing cursor is displayed on the first character of the coding type on Line 1. Press [←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change. Refer to 3.3 for Code/Data Rates. Refer to Table 4-1 for RX Code/Data Rate Default settings.
RX-IF FREQUENCY	Programs the demodulator receive frequency between 50 and 180 MHz, in 1 Hz steps. Upon entry, the current receive frequency is displayed with the flashing cursor on the first character. Press [←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
DESCRAMBLER	Programs the descrambler ON or OFF. Upon entry, the current status of the descrambler is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
DIFF. DECODER	Programs the differential decoder ON or OFF. Upon entry, the current status of the differential decoder is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. Note: Always OFF in Turbo mode.
RF LOOPBACK (Test Mode Configuration)	Programs the modem for RF loopback operation. When RF loopback is turned ON, the demodulator is programmed to the same frequency as the modulator. When RF loopback is turned OFF, the demodulator is tuned to the previous frequency. Refer to Figure 3-23 for a block diagram of RF loopback operation. Note: RF loopback nullifies IF loopback. Upon entry, the current status of the RF loopback is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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IF LOOPBACK (Test Mode Configuration)	Programs the modem for IF loopback operation. When IF loopback is turned ON, the demodulator input is connected to the modulator output through an internal attenuator. The demodulator is programmed to the same frequency as the modulator. An attenuator within the modem connects the IF Out to the IF In. When IF loopback is turned OFF, the demodulator is tuned to the previous frequency and is reconnected to the IF input. Refer to Figure 3-24 for a block diagram of IF loopback operation. Note: IF loopback nullifies RF loopback. Upon entry, the current status of IF loopback is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
BER THRESHOLD	Sets the BER threshold. If the BER threshold set is exceeded, a receive fault will be indicated by the modem status indicators. BER threshold may be set from 1.0 E-3 to 1.0 E-8, or may be disabled by specifying NONE. Upon entry, the current setting of the BER threshold is displayed. Press [↑] or [↓] to select the desired setting. Press [ENTER] to execute the change.
SWEEP CENTER	Programs the sweep center frequency for the directed sweep function. When in directed sweep, the value from the sweep monitor screen (when the modem was last locked) should be entered for the sweep center frequency. The sweep center frequency can be set in the range from: -35000 to +35000 Hz. Upon entry, the current programmed setting is displayed with a flashing cursor on the first character. Press [←] or [→] to move the flashing cursor. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
SWEEP RANGE	Programs the overall travel of the sweep width range during acquisition in the directed sweep mode. The sweep width may be set from 0 to 70000 Hz. When set at 70000 Hz, the modem is in the normal acquisition mode. The smaller the range, the faster the modem will lock, provided the receive carrier center frequency is within the RX IF frequency sweep range. Upon entry, the current programmed setting is displayed. Press [←] or [→] to move the flashing cursor. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
REACQUISITION	Programs the sweep reacquisition mode time duration. This is the time that the modem will remain in a narrow sweep after loss of acquisition. After this timer runs out, the modem will return to the normal acquisition sweep. The reacquisition time is 0 to 999 seconds. Upon entry, the current programmed setting is displayed with a flashing cursor on the first character. Press [←] or [→] to move the flashing cursor. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Select the number of seconds desired for the reacquisition mode. Press [ENTER] to execute the change.

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RS DECODER	**Conditional:** If none of the proper overhead types or data rates apply, the Reed-Solomon decoder in the ON state will be rejected (double beep). With the Reed-Solomon decoder turned ON (not OFF or Correction OFF), the corrected BER will be reported from the outer decoder (Reed-Solomon decoder). Programs the Reed-Solomon decoder ON, Correction OFF, or OFF. Upon entry, the current status of the Reed-Solomon decoder is displayed. Use [↑] or [↓] to select one of the following modes: **ON:** Enables the Reed-Solomon decoder to provide data error corrections. **CORRECTION_OFF:** Turns off the Reed-Solomon decoder data error correction circuitry. Data flow is then routed through normal data paths without error corrections. **OFF:** The RS decoder is normally disabled (OFF position). To execute any of the Reed-Solomon decoder modes, enter the desired Reed-Solomon decoder and select the desired mode. Press [ENTER] to execute the change.

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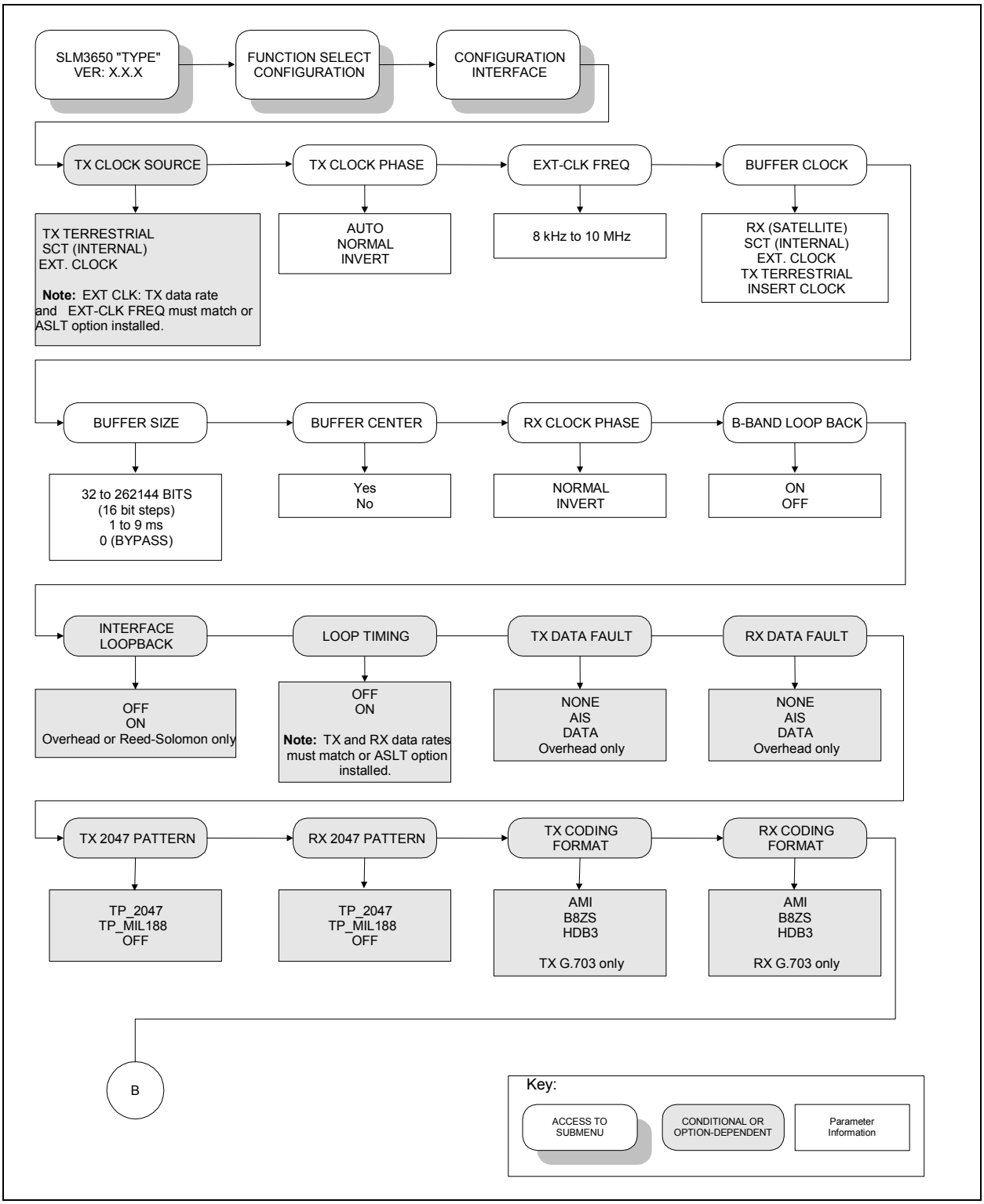


Figure 3-6. Configuration Interface Menu

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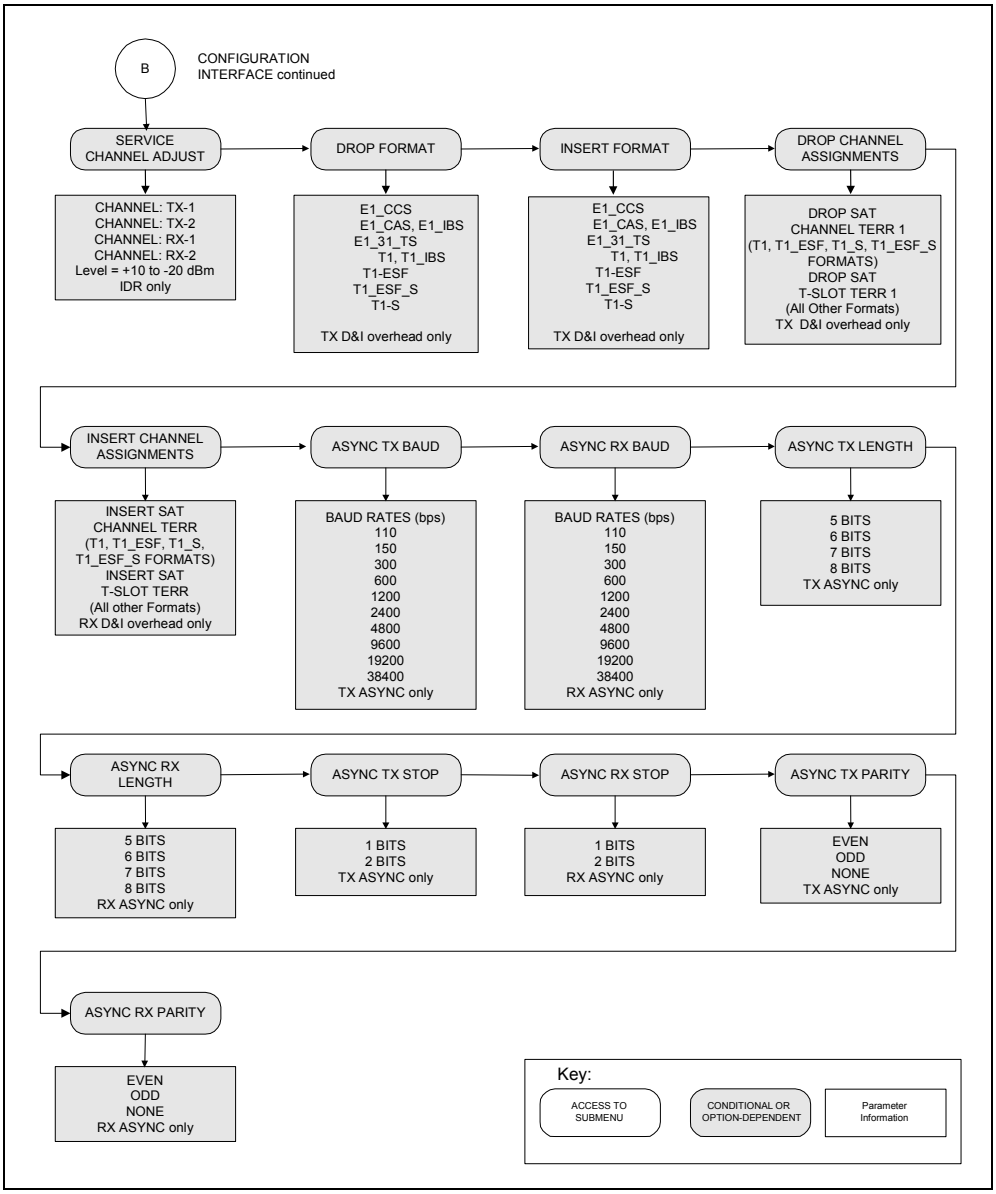


Figure 3-6. Configuration Interface Menu (Continued)

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3.4.3 Function Select: Configuration: Interface

Refer to Figure 3-6.

TX CLOCK SOURCE	Programs the clock source for the modem transmitter clock to the following configurations: **TX TERRESTRIAL**: Sets the TX clock to recover timing from the incoming clock/data. **SCT (INTERNAL):** Sets the TX clock to operate from the modem internal clock (this is also the fallback clock). Note: When loop timing is enabled, SCT (LOOP) is displayed instead of SCT (INTERNAL). **EXT. CLOCK/DATA CLOCK:** Sets the TX clock to operate from the external reference clock. Ext Clock: TX Data Rate and Ext. Clock frequency shall match or ASLT option. The correct frequency must be programmed into EXT-CLK FREQ. Upon entry, the current transmit clock setting is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
TX CLOCK PHASE	Programs the TX clock phase to AUTO, NORMAL, or INVERT. Upon entry, the current setting of the TX clock phase is displayed. Press [↑] or [↓] to make the selection. When AUTO is selected, the modem will automatically select NORMAL or INVERT to properly phase the TX clock with the TX data. Press [ENTER] to execute the change.
EXT-CLK FREQ	Programs the external reference clock input frequency between 8.0 kHz and 10.0 MHz. Notes: ➢ The clock rate must be equal to the data rate unless the asymmetrical loop timing option is present. ➢ When an ODU or BUC is operated with an EXT REF, 10MHz is required. This clock frequency can be any multiple of 600 Hz from 2.4 to 64 kHz, and can be any multiple of 8 kHz from 64 kHz to 4.376 MHz. This can be used for the Doppler/plesiochronous buffer reference. It can be a reference to SCT. Use the master clock input on J8 for the external master reference. The EXT REF on CP3 only allows for 1, 5, 10, and 20 MHz EXT REF input. Upon entry, the current setting for the external reference is displayed. Press [←] or [→] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.

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BUFFER CLOCK	Programs the interface buffer output clock to one of the following modes: **RX (SATELLITE):** Sets the output buffer clock to the satellite clock. **SCT (INTERNAL):** Sets the buffer clock to operate from the modem internal clock. This is also the fallback clock. **EXT. CLOCK:** Sets this clock source to the external clock. **TX TERRESTRIAL:** Sets the buffer output clock to recover timing from the incoming TX data clock. **INSERT CLOCK:** Selects the recovered clock from the insert send data input received from the terrestrial equipment. **Note:** INSERT CLOCK selection is only available when D&I overhead is enabled as the RX Overhead type or when Modem Type is D&I. Upon entry, the current setting of the plesiochronous buffer clock is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
BUFFER SIZE	Sets the size of the buffer in either Bits or Milliseconds. Upon entry, the current buffer length is displayed. Press [↑] or [↓] to select the desired buffer size. The buffer size is displayed in seconds or bits. Enter the ***Function Select: Utility Interface*** menu to change the buffer units to seconds or bits. ➢ If selecting seconds, choose from 1 to 99 ms, in increments of 1 ms or 0 (Bypass). ➢ If selecting bits, choose from 32 to 262144 bits, in increments of 16 bits. Press [ENTER] to execute the change. When D&I is selected for modem type, the buffer units are automatically set to ms. The user may select as follows: nn = 7.5, 15, or 30 ms for E1CAS format. nn = 6, 12, 24, or 30 ms for T1IBS/T1S/T1ESFS format. nn = 1, 2, 4, 8, 16, or 32 ms for all other D&I formats. **Note:** To have the modem calculate the plesiochronous shift, set the buffer units to ms. When a specific buffer depth is desired, set the buffer units to bits.
BUFFER CENTER	This configuration function is used to center the buffer. Choosing YES centers the buffer. Press [ENTER] twice to center the buffer.
RX CLOCK PHASE	Programs the RX clock phase to Normal or Inverted. Upon entry, the current status of the RX Clock is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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B-BAND LOOP BACK (Test Mode Configuration)	Programs the modem for baseband loopback operation. When baseband loopback is turned ON, the data and timing signals are switched from the demodulator to the modulator on the modem side of the interface. The DTE baseband signals are also looped back from the transmitter data and clock to receiver data and clock on the customer side of the interface. This is a bi-directional loopback of the baseband data. Refer to **Figure 3-25** for a block diagram of baseband loopback operation. Upon entry, the current status is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
INTERFACE LOOPBACK (Test Mode Configuration)	Programs the modem for Interface Loopback operation. When INTERFACE LOOPBACK is turned ON, data is looped back at the modem side of the interface. This is a bi-directional loop back of the data after the base band data has had the overhead added. Refer to **Figure 3-26** for the interface loopback block diagram. Upon entry, the current status is displayed. [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the overhead interface PCB or Reed-Solomon PCB is installed.
LOOP TIMING	Programs the transmit clocking to the RX satellite clock. **Note:** TX and RX data rates must be equal unless the asymmetrical loop timing option is enabled. Upon entry, the current status is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
TX DATA FAULT	Transmit data fault. Press [↑] or [↓] to select one of the following modes: **NONE:** The transmit interface fault Data/AIS is not activated. **ALARM INDICATION SIGNAL (AIS):** Sets transmit interface fault Data/AIS to monitor a fault condition of all 1s from customer data input to the modem. **DATA:** Sets transmit interface fault Data/AIS to monitor a fault condition of all 1s or 0s. This is referred to as a data-stable condition, which means that the data is not transitioning. Upon entry, the current TX data fault that is being monitored is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the overhead interface PCB is installed.

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RX DATA FAULT	Receive data fault. Selects a receive interface fault monitor of NONE, AIS, or DATA. The data monitored for RX data is coming from the satellite. Refer to TX DATA FAULT for a description of function choices. Upon entry, the current, monitored RX DATA FAULT is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the overhead interface PCB is installed.
TX 2047 PATTERN (Test Mode Configuration)	Programs the transmitter to ON or OFF to insert a 2047 pattern instead of the normal transmit data. Upon entry, the current status is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the overhead interface PCB is installed.
RX 2047 PATTERN (Test Mode Configuration)	Programs the modem to receive a 2047 pattern as the normal receive data, and allows the BER monitor to work on that 2047 pattern. Upon entry, the current status is displayed. Press [↑] or [↓] to select on or off. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the overhead interface PCB is installed.
TX CODING FORMAT	Programs the transmitter for AMI, B8ZS, or HDB3 coding of the baseband data. Upon entry, the current coding format is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the TX G.703 interface is programmed. This requires that the optional Overhead Card is installed.
RX CODING FORMAT	Programs the receiver for AMI, B8ZS, or HDB3 coding. Upon entry, the current coding format is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the RX G.703 interface is programmed. This requires that the optional Overhead Card is installed.

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SERVICE CHANNEL ADJUST	This configuration function is used to set service channel audio levels at TX-1, TX-2, RX-1, or RX-2. Upon entry, press [←] or [→] to select the desired service channel. To adjust the service channel level (+10.0 to -20.0 dBm), press [ENTER]. Press [↑] or [↓] to adjust the service channel. Press [ENTER] to execute the change. **Conditional:** This menu is only available when IDR has been selected for modem type in the Utility menu and the Overhead Card is installed.
DROP FORMAT	This configuration is used to select the desired drop data channel signaling. The choices are: E1_CCS (E1 Common Channel Signaling) E1-CAS (E1 Channel Associated Signaling) E1_31_TS (E1 No Multiframe Sync Alignment) T1 (T1 Data) T1_ESF (T1 Extended Super Frame) T1_ESF_S (Special Signaling) T1_S (Special Signaling) Upon entry, the current drop data channel signal is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the optional D&I has been selected for Modem Type in the ***Function Select: Utility*** menu and the Overhead card is installed.
INSERT FORMAT	Selects the desired insert data channel signaling. The choices are: E1_CCS (E1 Common Channel Signaling) E1-CAS (E1 Channel Associated Signaling) E1_31_TS (E1 No Multiframe Sync Alignment) T1 (T1 Data) T1_ESF (T1 Extended Super Frame) T1_ESF_S (Special Signaling) T1_S (Special Signaling) Upon entry, the current insert data channel signal is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the optional D&I has been selected for Modem Type in the ***Function Select: Utility*** menu and the Overhead card is installed.

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DROP CHANNEL ASSIGNMENTS	Programs the drop channels into the following desired time slot: • DROP SAT CHANNEL TERR (For T1, T1_ESF, T1_S, T1_ESF_S) • DROP SAT T-SLOT TERR (For all other formats) Upon entry, drop channel 1 and the current time slot are displayed. Press [↑] or [↓] to select the drop channel to be programmed. Press [ENTER] to begin programming. Press [↑] or [↓] to select the time slot for each available drop channel by incrementing or decrementing the digit at the flashing cursor. Press [ENTER] to execute the change. **Conditional:** This menu is only available when the optional D&I has been selected for Modem Type in the ***Function Select: Utility*** menu and the Overhead card is installed.
INSERT CHANNEL ASSIGNMENTS	Programs the satellite channels into the following desired terrestrial frame slot: • INSERT SAT CHANNEL TERR (For T1, T1_ESF, T1_S, T1_ESF_S) • INSERT SAT T-SLOT TERR (For all other formats) Upon entry, satellite channel 1 and the current terrestrial frame slot are displayed. Press [↑] or [↓] to select the satellite channel to be programmed. Press [ENTER] to choose the satellite channel to be programmed. Press [↑] or [↓] to select the terrestrial frame slot for each available satellite channel by incrementing or decrementing the digit at the flashing cursor. If a time slot is unused, select NI (Not Inserted). Press [ENTER] to execute the change. **Conditional:** This menu is only available when the optional D&I has been selected for Modem Type in the ***Function Select: Utility*** menu and the Overhead card is installed.
ASYNC TX BAUD	Programs the ASYNC overhead transmit baud rate for 110 to 38400 bit/s. Upon entry, the current status of the ASYNC TX baud rate is displayed. Press [↑] or [↓] to select one of the following baud rates (bit/s): 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.

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ASYNC RX BAUD	Programs the ASYNC overhead receive baud rate for 110 to 38400 bit/s. Upon entry, the current status of the ASYNC RX baud rate is displayed. Press [↑] or [↓] key to select one baud rate. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.
ASYNC TX LENGTH	Programs the ASYNC overhead transmit word length for 5, 6, 7, or 8 bits. Upon entry, the current status of the ASYNC TX word length is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.
ASYNC RX LENGTH	Programs the ASYNC overhead receive word length for 5, 6, 7, or 8 bits. Upon entry, the current status of the ASYNC RX word length is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.
ASYNC TX STOP	Programs the ASYNC overhead transmit stop bits for 1 or 2. Upon entry, the current status of the ASYNC TX stop bits is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.
ASYNC RX STOP	Programs the ASYNC overhead receive stop bits for 1 or 2. Upon entry, the current status of the ASYNC RX stop bits make the selection. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.

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ASYNC TX PARITY	Programs the ASYNC overhead transmit parity for Even, Odd, or None. Upon entry, the current status of the ASYNC TX parity is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.
ASYNC RX PARITY	Programs the ASYNC overhead receive parity for Even, Odd, or None. Upon entry, the current status of the ASYNC RX parity is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** The menu is only available when the ***Function Select: Utility: Modem Type*** = ASYNC and requires that the Overhead Card is installed.

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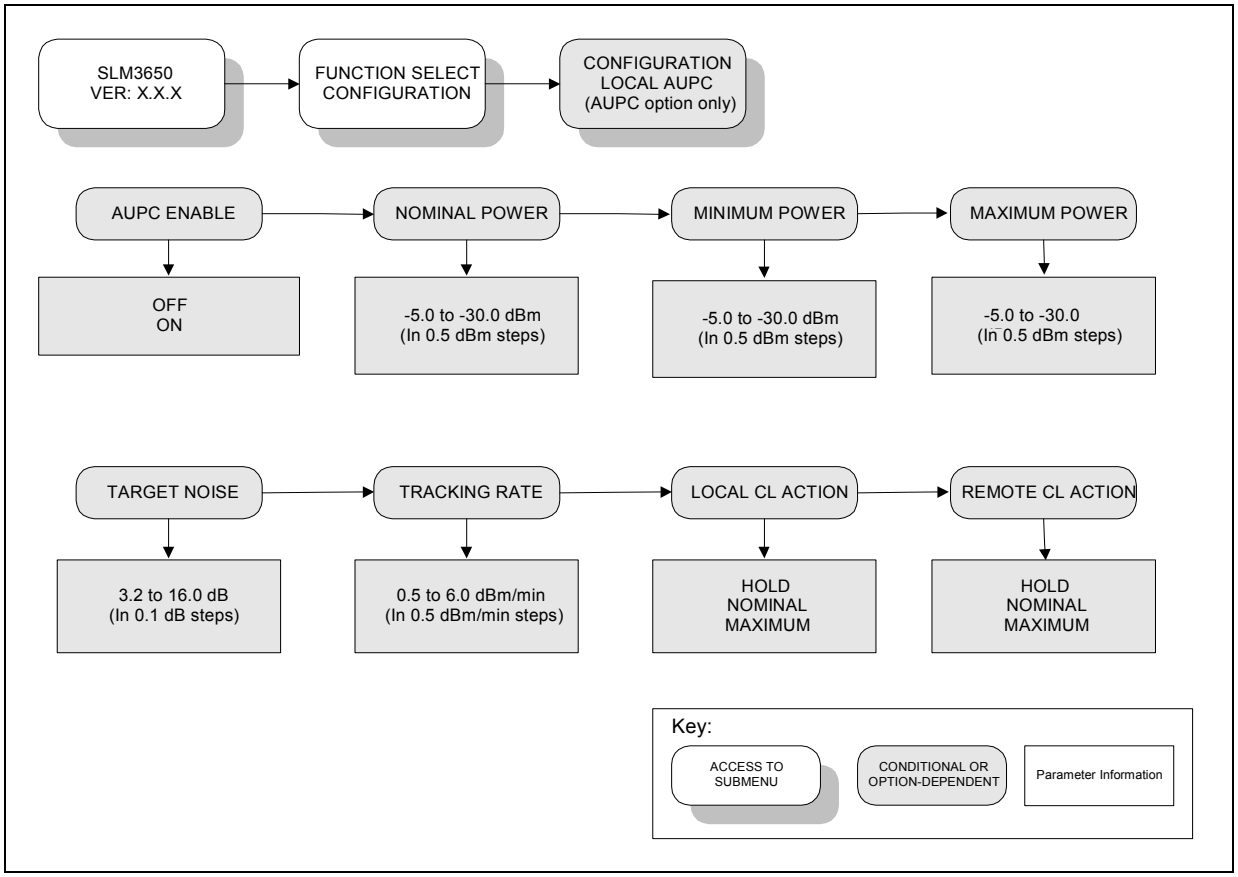


Figure 3-7. Configuration Local AUPC Menu

Note: Used for ASYNC/AUPC option and for self-monitoring local AUPC control.

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3.4.4 Function Select: Configuration: Local AUPC

Conditional: This menu is displayed when the Local Modem AUPC = ON located under the ***Function Select: Utility: Modem Type*** menu. Refer to Figure 3-7.

AUPC ENABLE	Programs the AUPC ON or OFF. Upon entry, the current status is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
NOMINAL POWER	Programs the nominal power value of the AUPC. The nominal power value can range from -5 to -30 dBm, in 0.5 dBm steps. Upon entry, the current nominal power value is displayed. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
MINIMUM POWER	Programs the minimum power level of the AUPC. The minimum power level can range from -5 to -30 dBm, in 0.5 dBm steps. Upon entry, the current minimum power level is displayed. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
MAXIMUM POWER	Programs the maximum power level of the AUPC. The maximum power level can range from -5 to -30 dBm, in 0.5 dBm steps. Upon entry, the current maximum power level is displayed. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
TARGET NOISE	Programs the Eb/N0 target set point. The Eb/N0 target set point ranges from 3.2 to 16.0 dB, in 0.1 dB steps. Upon entry, the current Eb/N0 target set point is displayed. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
TRACKING RATE	Programs the maximum tracking rate of the AUPC. Maximum tracking rate can range from 0.5 to 6.0 dBm/minute, in 0.5 dBm/minute steps. Upon entry, the current maximum tracking rate is displayed. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change.
LOCAL CL ACTION	Programs the local carrier loss for HOLD, NOMINAL, or MAXIMUM. Upon entry, the current status of the local carrier loss is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
REMOTE CL ACTION	Programs the remote carrier loss for HOLD, NOMINAL, or MAXIMUM. Upon entry, the current status of the remote carrier loss is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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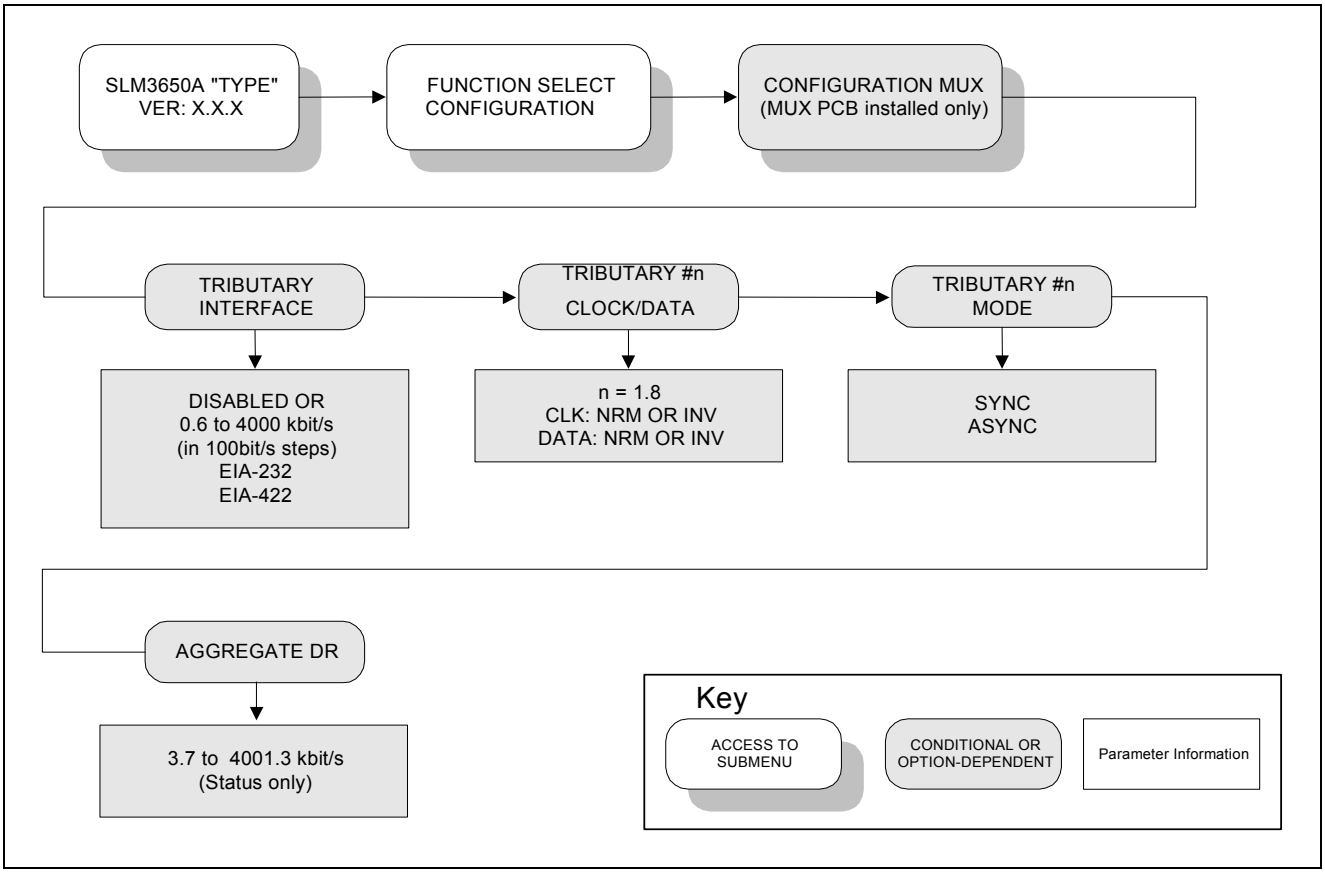


Figure 3-8. Configuration MUX

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3.4.5 Function Select: Configuration: MUX

Optional/ Conditional: The multiplexer (MUX) system provides for 1 to 8 tributary channels to be multiplexed onto a single aggregate carrier. Independent tributary data rates from 600 bps to 4000 kbps in 100 bps increments are supported. This option is used primarily with the SDR-54 receiver.

This menu is available only if the optional MUX card (slot #1) is installed.

Refer to Figure 3-8.

TRIBUTARY INTERFACE	Programs the Tributary Interface (EIA-232 or EIA-422 to either Disabled or 0.6 to 4000 kbps in 100 bit/s steps) On entry the current status is displayed. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TRIBUTARY CLOCK/DATA	Select the tributary 1-8 and program the clock phase to: ➢ Normal ➢ Invert On entry the current status is displayed. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TRIBUTARY MODE	Select the tributary 1-8 and program for: ➢ SYNC ➢ ASYNC ASYNC Format: 7E1, 7O1, 7N2, 7E2, 7O2, 8N1, or 8N2 Note: Select the mode. If ASYNC is selected, select the ASYNC format as well. On entry the current status is displayed. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
AGGREGATE DR	3.7 to 4001.3 kbps > 4001.3 or < 3.7 kbps, status only The aggregate data rate is the sum of all tributary data rates plus the multiplex overhead (1.3 kbps).

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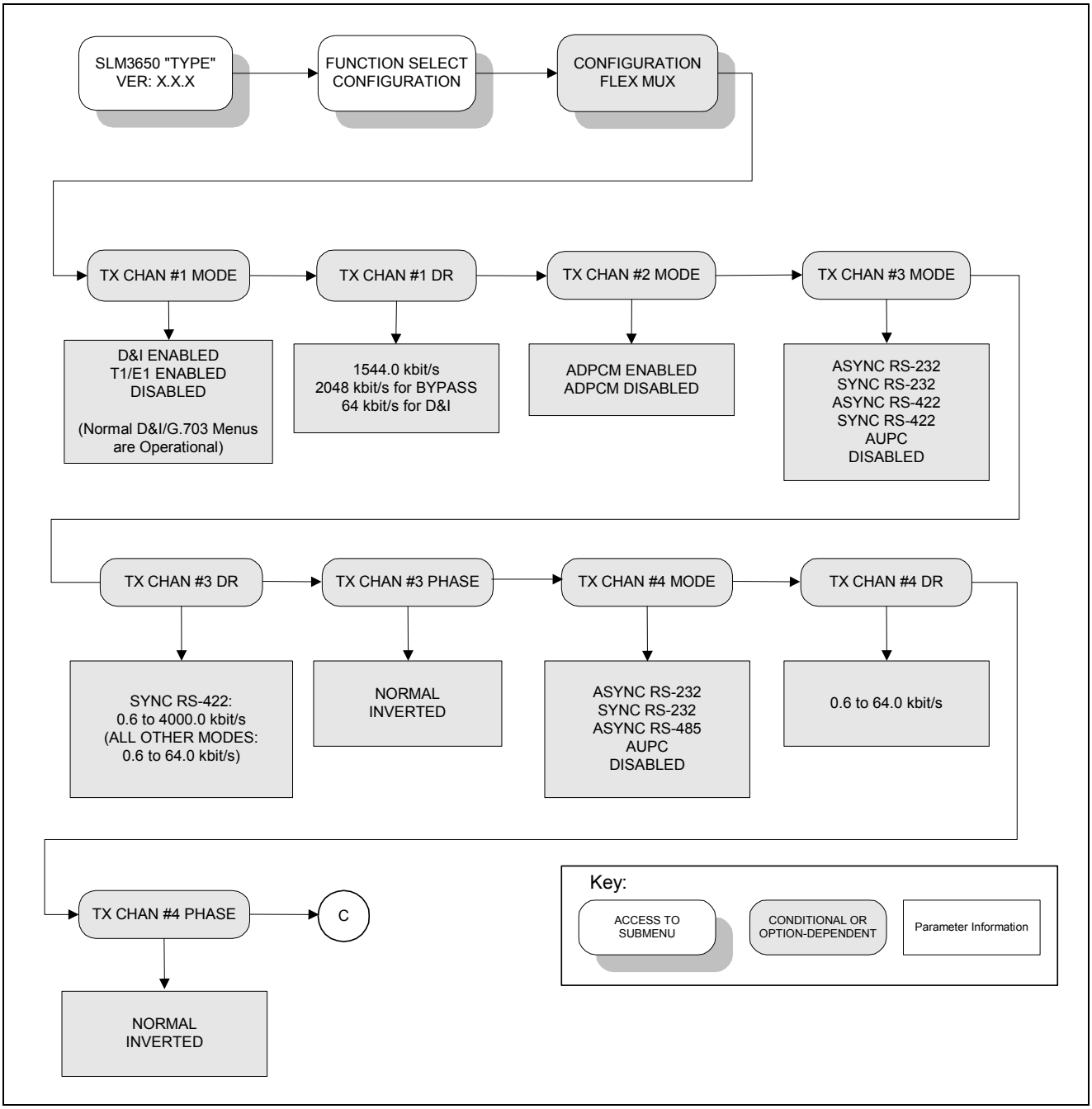


Figure 3-9. Configuration Flex Mux

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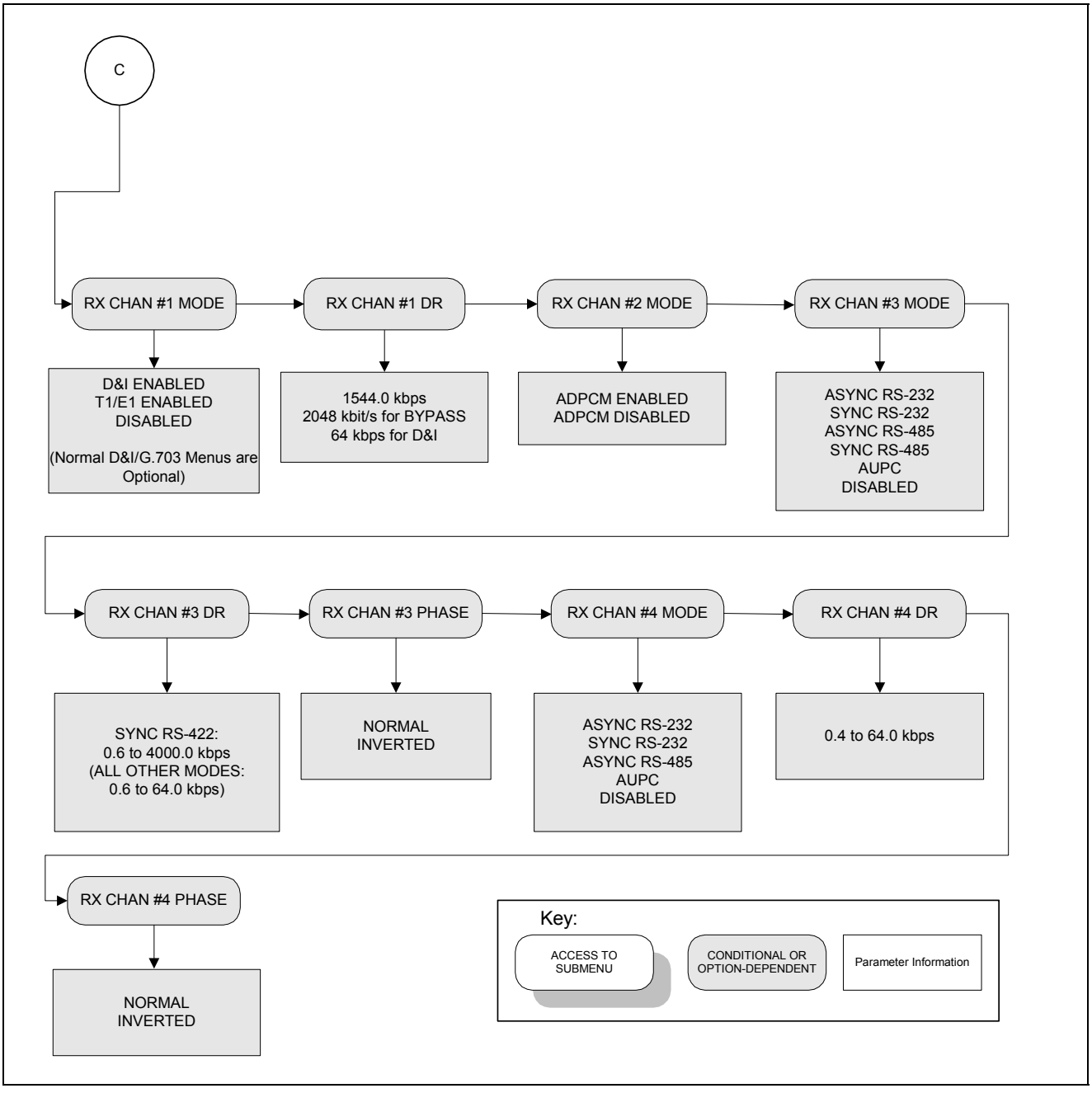


Figure 3-9. Configuration Flex Mux (Continued)

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3.4.6 Function Select: Configuration: Flex Mux

Optional/Conditional: This menu is available only if the optional FLEX MUX card is installed, and Modem Type = CUSTOM with Overhead Type = FLEX MUX.

Flex Mux is offered as a factory or field installed interface. Simultaneous operation of a main data channel and three overhead channels are supported. The main data channel is a G.703 type electrical interface at E1 (2048 kbps) or T1 (1544 kbps) terrestrial data rate and supports both pass through and D&I modes of operation. AUPC, ASYNC data and voice channels are supported in the three overhead channels.

Channel (Main Data) # 1: G.703, E1 or T1
Channel (Overhead) # 2: ADPCM (Audio)
Channel (Overhead) # 3: EIA-232, EIA-422 or AUPC
Channel (Overhead) # 4: EIA-232, EIA-485 or AUPC

Refer to Figure 3-9.

TX CHAN # 1 MODE	Programs the TX Channel # 1 MODE. ➢ D&I Enabled ➢ T1/E1 Enabled ➢ Disabled Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TX CHAN # 1 DR	Programs the TX Channel # 1 DR. TX Channel 1 Data Rates: 1544 kbps or 2048 kbps for bypass N * 64.0 kbps for D&I Note: Not displayed if Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TX CHAN # 2 MODE	Programs the TX Channel # 2 MODE. ➢ ADPCM Enabled ➢ ADPCM Disabled Note: Allows ADPCM 32 kbps operation. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.

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TX CHAN # 3 MODE	Programs the TX Channel # 3 MODE. ➢ ASYNC RS232 ➢ SYNC RS232 ➢ ASYNC RS422 ➢ SYNC RS422 ➢ AUPC ➢ Disabled Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TX CHAN # 3 DR	Programs the TX Channel # 3 DR. ➢ SYNC RS422: 0.6 to 4000.0 kbps ➢ All other modes: 0.6 to 64 kbps Note: Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TX CHAN # 3 PHASE	Programs the TX # 3 PHASE. NRM or INV Note: Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TX CHAN # 4 MODE	Programs the TX Channel #4 MODE. ➢ ASYNC RS232 ➢ SYNC RS232 ➢ ASYNC RS485 ➢ AUPC ➢ Disabled Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.

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TX CHAN # 4 DR	Programs the TX Channel # 4 DR. 0.6 to 64 kbps **Note:** Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
TX CHAN # 4 PHASE	Programs the TX # 4 PHASE. NRM or INV **Note:** Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 1 MODE	Programs the RX Channel # 1 MODE. D&I Enabled T1/E1 Enabled Disabled Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 1 DR	Programs the RX Channel # 1 DR. TX Channel 1 Data Rates: 1544 kbps or 2048 kbps for bypass N * 64.0 kbps for D&I **Note:** Not displayed if Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 2 MODE	Programs the RX Channel # 2 MODE. ➢ ADPCM Enabled ➢ ADPCM Disabled **Note:** Allows ADPCM 32 kbps operational. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.

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RX CHAN # 3 MODE	Programs the RX Channel # 3 MODE. ➢ ASYNC RS232 ➢ SYNC RS232 ➢ ASYNC RS422 ➢ SYNC RS422 ➢ AUPC ➢ Disabled Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 3 DR	Programs the RX Channel # 3 DR ➢ SYNC RS422: 0.6 to 4000.0 kbps ➢ All other modes: 0.6 to 64 kbps **Note:** Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 3 PHASE	Programs the RX # 3 PHASE. NRM or INV **Note:** Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 4 MODE	Programs the RX Channel # 4 MODE. ➢ ASYNC RS232 ➢ SYNC RS232 ➢ ASYNC RS485 ➢ AUPC ➢ Disabled Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.
RX CHAN # 4 DR	Programs the RX Channel # 4 DR. 0.6 to 64 kbps **Note:** Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.

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RX CHAN # 4 PHASE	Programs the RX # 4 PHASE. NRM or INV Note: Not displayed if AUPC or Disabled is selected. Press[←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the selected kbps. Press [ENTER] to execute the change.

Notes:

1. The modulator and demodulator data rates are status only. Only the code rate can be changed. The data rate displayed includes data rates of all channels plus 1.3 kbps (if applicable) fixed overhead.
2. When calculating the symbol rate based on the programmed code rate, D&I overhead (16/15 if enabled) and Reed-Solomon overhead (126/112 or 219/201 if enabled) must be included.
3. Channels 3 and 4 data rates are in steps of 100 bps.
4. AUPC can only be enabled on one tributary (#3 or #4).
5. AUPC channel operates at 600 bps.
6. ASYNC communications fixed at 10 bits per word.
7. Frame BER not operational.

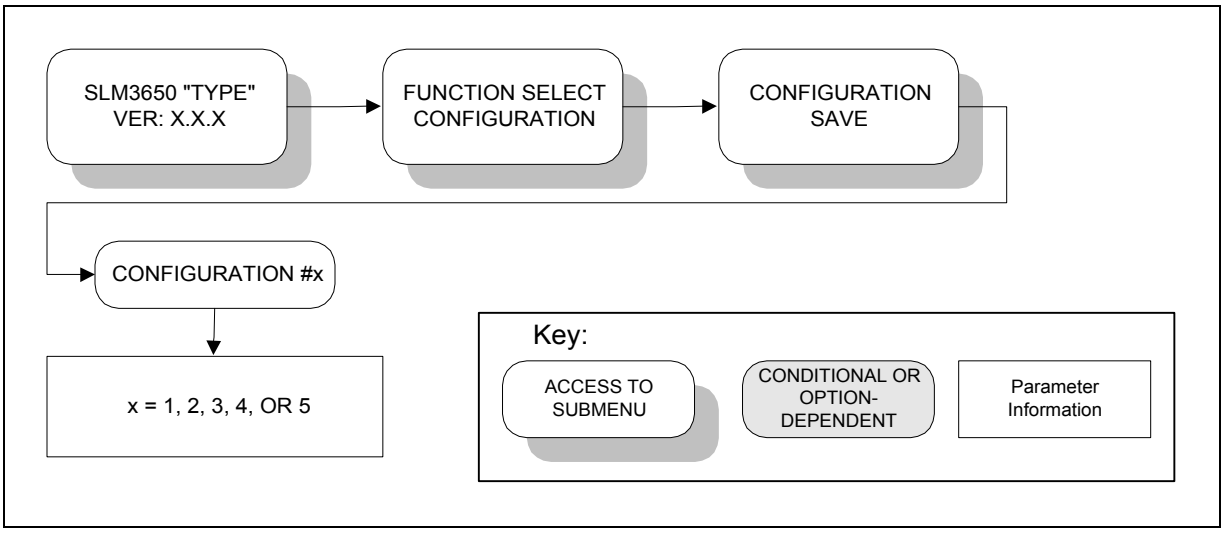


Figure 3-10. Configuration Save Menu

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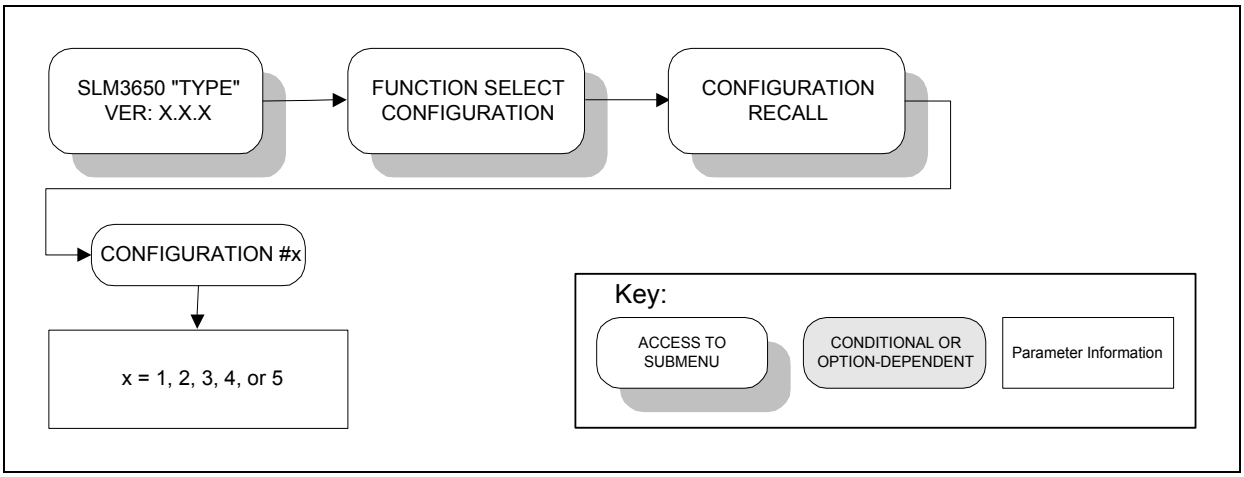


Figure 3-11. Configuration Recall Menu

3.4.7 Function Select: Configuration: Save

Refer to Figure 3-10.

The Configuration Save menu allows programming of configuration parameters into memory on the M&C. There are five memory locations that may be used to store specific configuration setups that are frequently used.

After changing the configuration parameters to the desired settings, enter the Configuration Save menu and select memory location 1 through 5. Press [ENTER] to execute the save.

3.4.8 Function Select: Configuration: Recall

Refer to Figure 3-11.

The Configuration Recall menu allows the user to recall a previously saved configuration setup. Upon entry, select memory location 1 through 5 by pressing [↑] or [↓]. Press [ENTER] to execute the recall.

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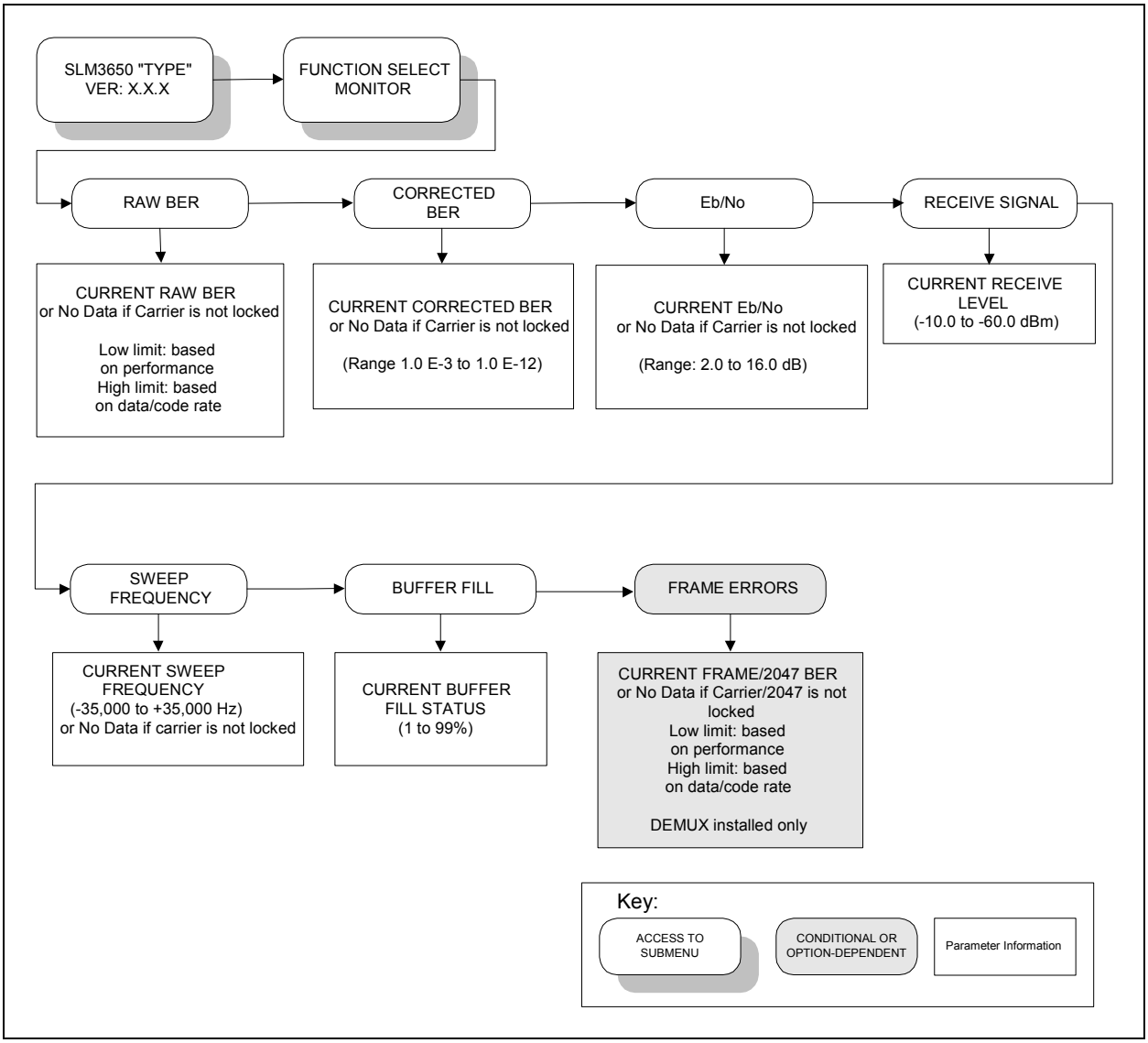


Figure 3-12. Monitor Menu

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3.4.9 Function Select: Monitor

Refer to Figure 3-12.

When the Monitor level is entered, press [←] or [→] to select the desired monitor function. Each monitor function is displayed in real time as long as it is selected.

RAW BER	Displays the current BER or "No Data" (if carrier is not locked). Range: < m.m E-e to > m.m E-e. **Note:** Low limit is based on performance. High limit is based on data/code rate.
CORRECTED BER	Displays the current corrected BER or "No Data" (if carrier is not locked). Range: 1.0 E-3 to 1.0 E-12. **Note:** Low limit is based on performance. High limit is 1.0 E-12.
E_b/N_0	Displays the current E_b/N_0 or "No Data" (if carrier is not locked). Range: 2.0 to 16.0 dB. **Note:** Low limit is based on the data rate. High limit is 16.0 dB.
RECEIVE SIGNAL	Displays the current receive signal level. Range: -10.0 to -60.0 dBm.
SWEEP FREQUENCY	Displays the current offset frequency or "No Data" (if carrier is not locked). Range: -35,000 to +35,000 Hz.
BUFFER FILL	Displays the current plesiochronous buffer fill status percent. Range: 1 to 99%.
FRAME ERRORS	Displays the current framing pattern bit error rate or "No Data" (if carrier is not locked). Monitors the currently selected READ_ERROR function. Range: < mm.m E-e to > mm.m E-e. **Note:** Low limit is based on performance. High limit is based on the data/code rate. This menu is only available when DEMUX is installed.

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3.4.10 Function Select: Faults/Alarms

Refer to Figure 3-13.

The Faults/Alarms menu is accessible from the Function Select menu. The Faults/Alarms are similar to monitor functions, as they display the current fault status of the group being displayed.

Press [←] or [→] to move between the following Faults/Alarms groups:

- Modulator
- Demodulator
- Transmit Interface
- Receive Interface
- Common Equipment
- Backward Alarms (IDR option only)

Line 2 of the display shows the current Faults/Alarms status in real time. For each parameter monitored, fault status is displayed as one of the following:

- "–" indicates that no fault or alarm exists.
- "+" indicates that a fault exists, and will cause switching in a redundant system.
- Reversed contrast "+" indicates an active alarm.

Unlike faults, alarms do not cause switching to occur. To display labels for individual faults or alarms, press [ENTER].

Press [←] or [→] to move the flashing cursor to make the selection. The label for that Fault/Alarm is then displayed on Line 1 of the display. Press [CLEAR] to exit this level of operation and return to the previous level.

The following sections outline the faults and alarms monitored and displayed in each group.

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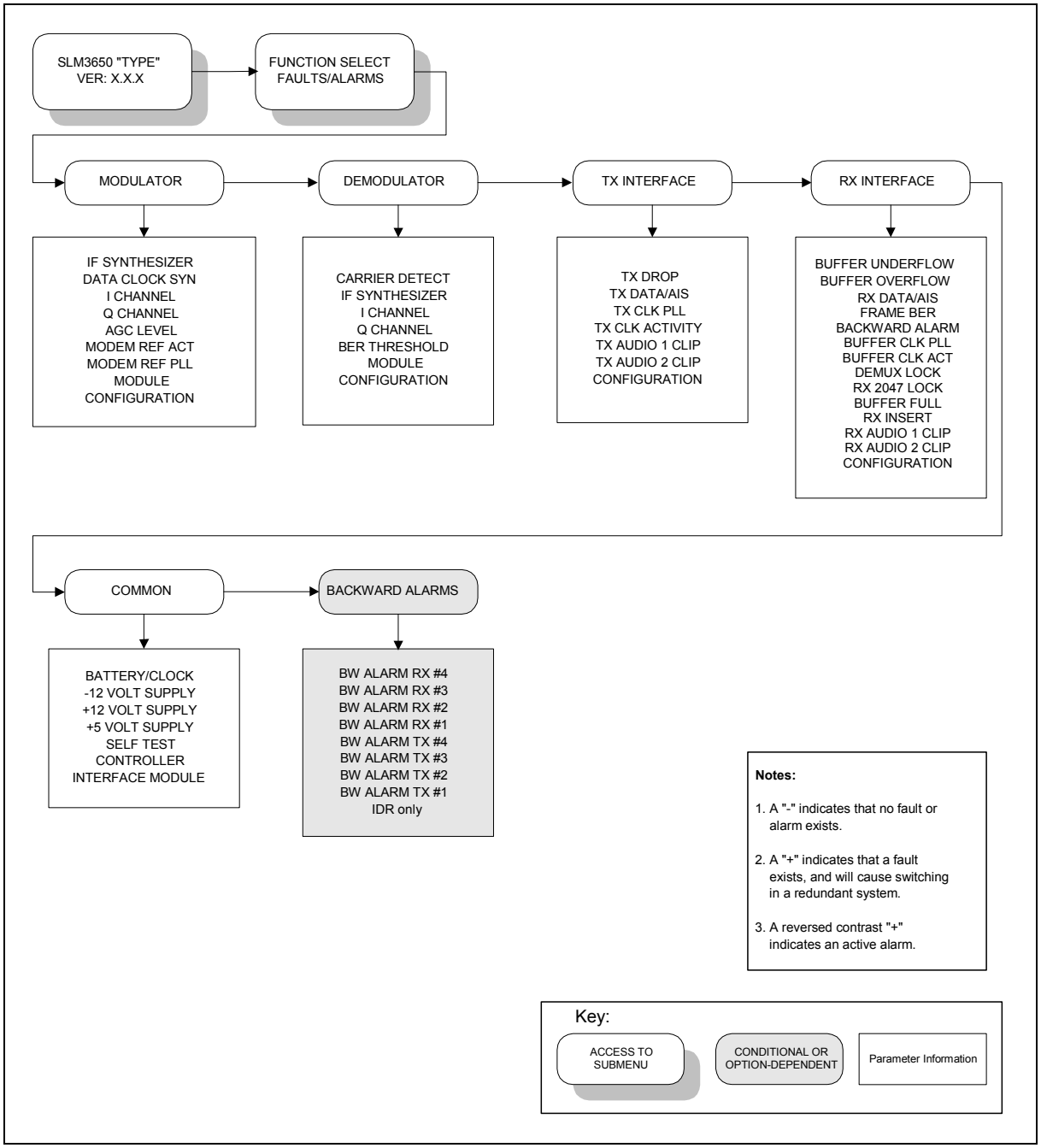


Figure 3-13. Faults/Alarms Menu

Note: Refer to Section 5.2 for additional fault isolation information.

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3.4.10.1 Function Select: Modulator: Faults

IF SYNTHESIZER	Modulator IF synthesizer fault.
DATA CLOCK SYN	Transmit clock synthesizer fault. Indicates the internal Voltage Controlled Oscillator (VCO) has not locked to the incoming data clock.
I CHANNEL	I channel data activity fault.
Q CHANNEL	Q channel data activity fault.
AGC LEVEL	TX IF AGC level fault.
MODEM REF ACT	MODEM REF activity alarm.
MODEM REF PLL	MODEM REF PLL not locked.
MODULE	Modulator module fault.
CONFIGURATION	Modulator configuration fault.

3.4.10.2 Function Select: Demodulator: Faults

CARRIER DETECT	Carrier detect fault. Indicates the decoder is not locked.
IF SYNTHESIZER	Demodulator IF synthesizer fault. Indicates the IF synthesizer is not locked.
I CHANNEL	I channel activity fault. Indicates a loss of activity in the I channel of the quadrature demodulator.
Q CHANNEL	Q channel activity fault. Indicates a loss of activity in the Q channel of the quadrature demodulator.
BER THRESHOLD	Secondary alarm result of the BER threshold set in the DEMOD Configuration menu.
MODULE	Demodulator/decoder module fault.
CONFIGURATION	Demodulator/decoder configuration fault.

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3.4.10.3 Function Select: Transmit Interface: Faults

TX DROP	Drop interface hardware fault. Typically indicates that the drop interface PLL is not locked (D&I only).
TX DATA/AIS	Data or AIS. When data fault is selected in the Interface Configuration menu, the fault indicates a data stable condition. This indicates the data is all 1s or 0s (i.e., data is not transitioning). When AIS is selected, the alarm indicates the data is all 1s from customer data input to the modem. When None is selected in the Interface Configuration menu, the TX Data/AIS Fault/Alarm is not activated. **Note:** AIS is an alarm, not a switching fault.
TX CLK PLL	Transmitter phase-locked loop fault. Indicates the transmitter Phase-Locked Loop (PLL) is not locked.
TX CLK ACTIVITY	Activity detector alarm of the selected interface transmit clock. The interface will fall back to the internal clock when this alarm is active.
TX AUDIO 1 CLIP	IDR TX audio for channel 1 is clipped.
TX AUDIO 2 CLIP	IDR TX audio for channel 2 is clipped.
CONFIGURATION	TX interface configuration fault. Indicates the TX interface cannot execute a programmed configuration parameter.

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3.4.10.4 Function Select: Receive Interface: Faults

BUFFER UNDERFLOW	Buffer underflow alarm. Indicates that a buffer underflow has occurred.
BUFFER OVERFLOW	Buffer overflow alarm. Indicates that a buffer overflow has occurred.
RX DATA/AIS	Data or AIS. When data fault is selected in the ***Function Select: Configuration Interface*** menu (Figure 3-6), the fault indicates a data stable condition. This indicates the data coming from the satellite is all 1s or 0s (i.e., data is not transitioning). When AIS is selected, the Alarm indicates the data is all 1s from the satellite. When None is selected in the Configuration Interface menu, the RX Data/AIS Fault/Alarm is not activated. **Note:** AIS is an alarm, not a switching fault.
FRAME BER	Frame BER fault. Indicates that the frame BER exceeds 1^{-3}.
BACKWARD ALARM	Backward alarms.
BUFFER CLK PLL	Buffer clock phase-locked loop fault. Indicates the buffer clock PLL is not locked.
BUFFER CLK ACT	Activity detector alarm of the selected interface receive clock. The interface will fall back to the satellite clock when this fault is active.
DEMUX LOCK	DEMUX lock fault. Indicates that the DEMUX is not locked.
RX 2047 LOCK	RX 2047 lock alarm. Indicates the RX 2047 data pattern is not locked. **Note:** This alarm is only active if RX 2047 is ON.
BUFFER FULL	Buffer full alarm. Indicates the buffer is less than 10% or greater than 90% full.
RX INSERT	Insert interface hardware fault. Typically indicates the insert interface PLL is not locked. This fault is only available when D&I is selected for modem type.
RX AUDIO 1 CLIP	IDR RX audio for channel 1 is clipped.
RX AUDIO 2 CLIP	IDR RX audio for channel 2 is clipped.
CONFIGURATION	Configuration alarm

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3.4.10.5 Function Select: Common Equipment: Faults

BATTERY/CLOCK	Battery or clock fault.
-12V SUPPLY	-12V power supply fault.
+12V SUPPLY	+12V power supply fault.
+5V SUPPLY	+5V power supply fault.
SELF TEST	Built in self test fault.
CONTROLLER	Controller fault. Typically indicates the controller has gone through a power on/off cycle.
INTERFACE MODULE	Interface module fault. Typically indicates that the interface module is missing or will not program.

3.4.10.6 Function Select: Backward Alarms

BW Alarm RX #4	Receive backward alarm #4 indicator.
BW Alarm RX #3	Receive backward alarm #3 indicator.
BW Alarm RX #2	Receive backward alarm #2 indicator.
BW Alarm RX #1	Receive backward alarm #1 indicator.
BW Alarm TX #4	Transmit backward alarm #4 indicator.
BW Alarm TX #3	Transmit backward alarm #3 indicator.
BW Alarm TX #2	Transmit backward alarm #2 indicator.
BW Alarm TX #1	Transmit backward alarm #1 indicator.

Conditional: Only available with IDR selected.

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3.4.11 Function Select: Stored Faults/Alarms

Refer to Figure 3-14.

The modem stores the first 10 (Flt0 through Flt9) occurrences of fault status changes in each of the following major fault categories:

- Modulator
- Demodulator
- TX Interface
- RX Interface
- Common Equipment
- Backward Alarms (IDR option only)

Each fault status change is stored with the time and date of the occurrence of the fault. Stored faults may be viewed by entering the stored faults level from the Select menu. Refer to Faults and Alarms menus for fault explanations. UNAVAL SECONDS fault information appears in Section 3.4.11.1.

Stored faults are not maintained through controller power-on reset cycle. However, the last known time is maintained in non-volatile Random Access Memory (RAM). On power-up, a common equipment fault is logged (Flt0) with that last known time and date. Also on power-up, an additional common equipment fault is logged (Flt1) to indicate the power-up time and date. The power-down and power-up times are logged as common equipment fault 0 and common equipment fault 1, respectively. On entering the stored faults level, press [←] or [→] to move between the fault groups and the "Clear Stored Faults?" selections. The time and date of the first stored fault status (Flt0) for the selected group will be displayed alternately on Line 2 of the display. Press [↑] or [↓] to cycle through the selected group's stored fault status (Flt0 through Flt9). To display the fault status associated with the displayed time and date, press [ENTER]. To identify the fault, press [←] or [→] to move the flashing cursor. To clear the currently logged stored faults, press [ENTER] when the "Clear Stored Faults/Yes?" selection is displayed.

Note: Faults are stored in time sequence, with the oldest fault status change stored in Flt0, and the most recent in Flt9. Only the first 10 fault status changes are stored. All stored faults which have not been used indicate "No Fault" on the display.

3.4.11.1 Function Select: Stored Faults/Alarms: Unavailable Seconds Fault

UNAVAL SECONDS x	A fault is indicated if the Reed-Solomon Codec could not correct bit errors in one block of serialized data in any given second. **Note:** This is available only with the Reed-Solomon option.

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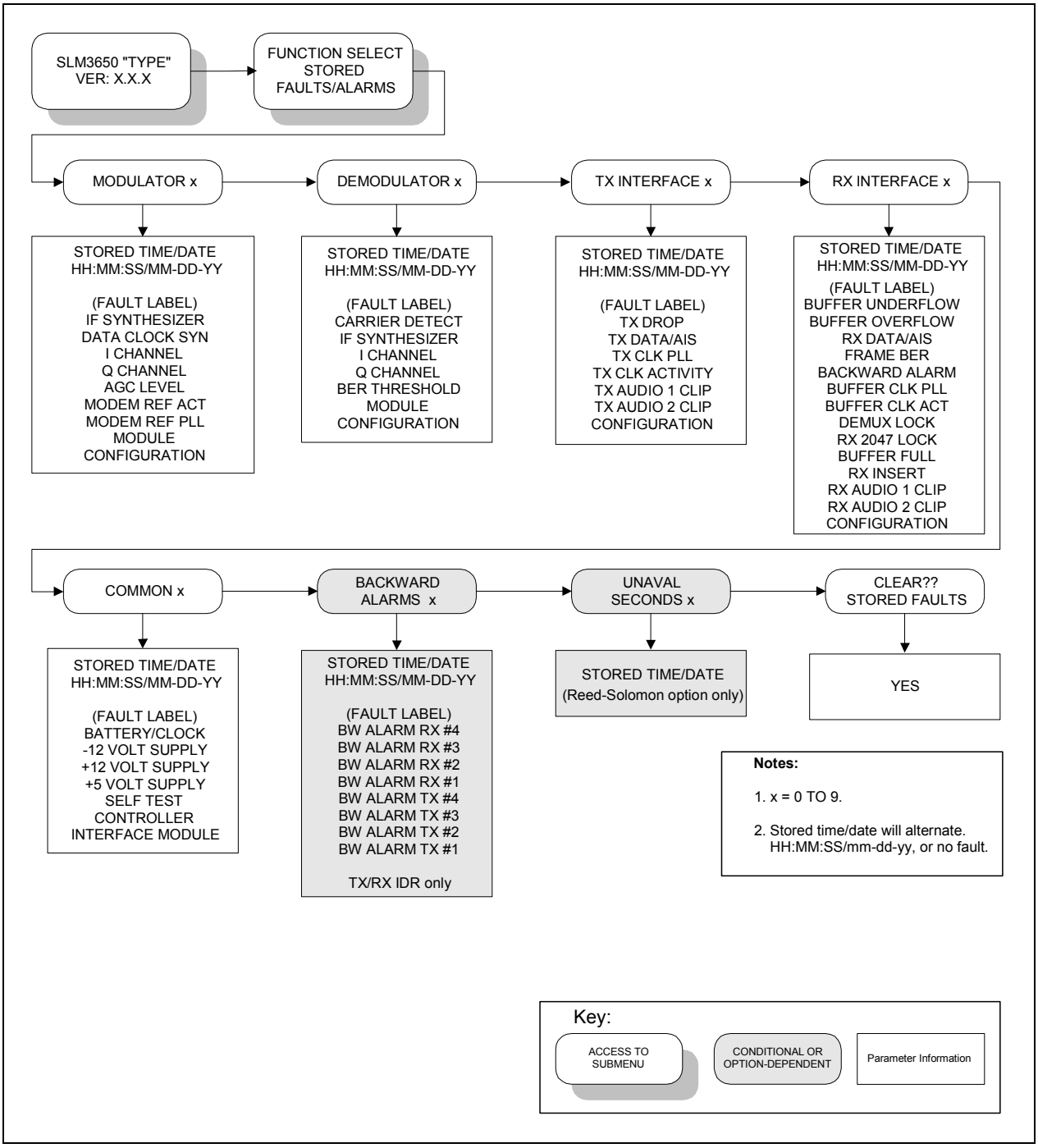


Figure 3-14. Stored Faults/Alarms Menu

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3.4.12 Function Select: Remote AUPC

To view or change the Remote AUPC functions, enter the Remote AUPC menu from the Function Select menu on the front panel. After entering the Remote AUPC menu, press [←] or [→] to select the Configuration or Monitor menu. Enter the selected menu by pressing [ENTER]. Press [←] or [→] to view the selected configuration parameters.

Note: This is only available with the ASYNC/AUPC overhead option.

3.4.13 Function Select: Remote AUPC: Remote AUPC Configuration

Refer to Figure 3-15.

AUPC ENABLE	Programs the AUPC feature ON or OFF. Upon entry, the current status of the remote AUPC is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Note:** This program is for control or last known status.
B-BAND LOOPBACK	Programs the remote baseband loopback ON or OFF. Upon entry, the current status of the remote baseband loopback is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Note:** This program is for control or last known status.
TX 2047 PATTERN	Programs the remote TX 2047 pattern ON or OFF. Upon entry, the current status of the remote TX 2047 is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Note:** This program is for control or last known status.

3.4.13.1 Function Select: Remote AUPC: Remote AUPC Monitor

Refer to Figure 3-16.

2047 ERRORS	Receive 2047 BER. This is a monitor point that displays the current RX 2047 BER. If no data is available, “No Data” is displayed.

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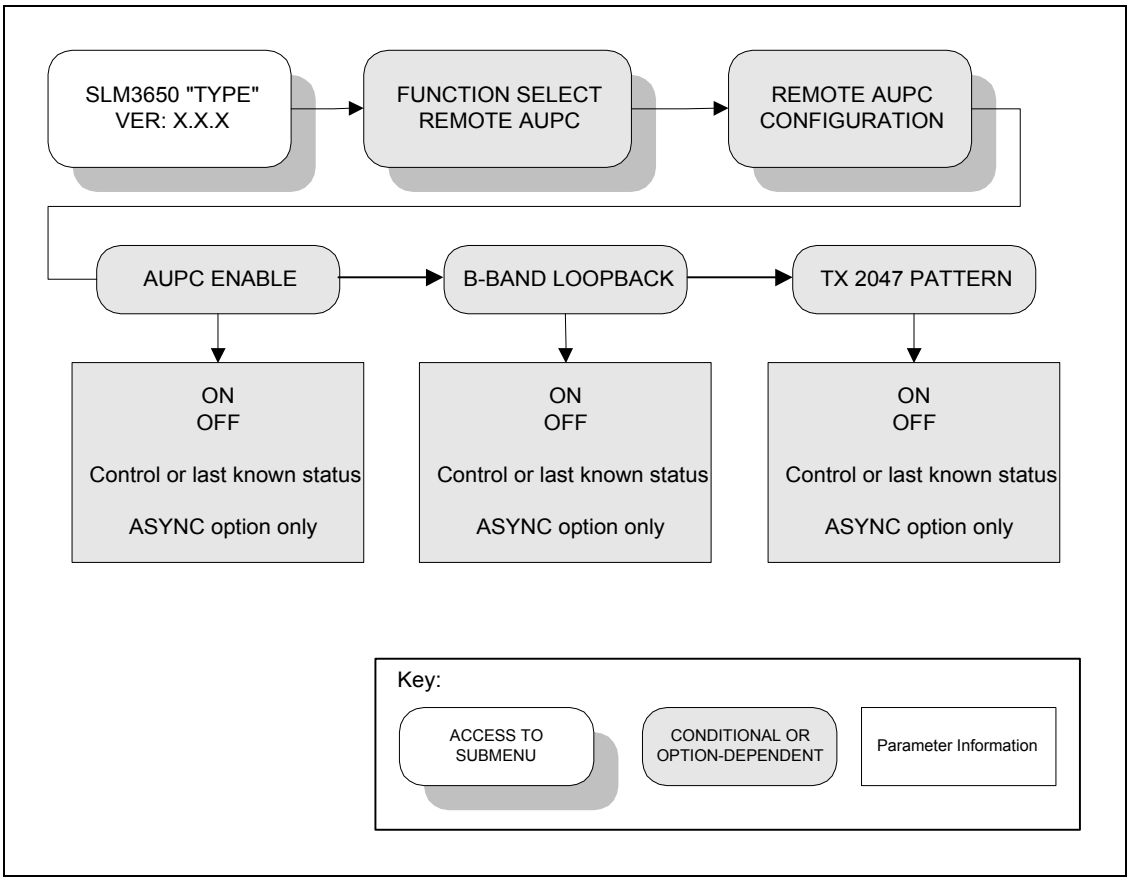


Figure 3-15. Remote AUPC Configuration Menu

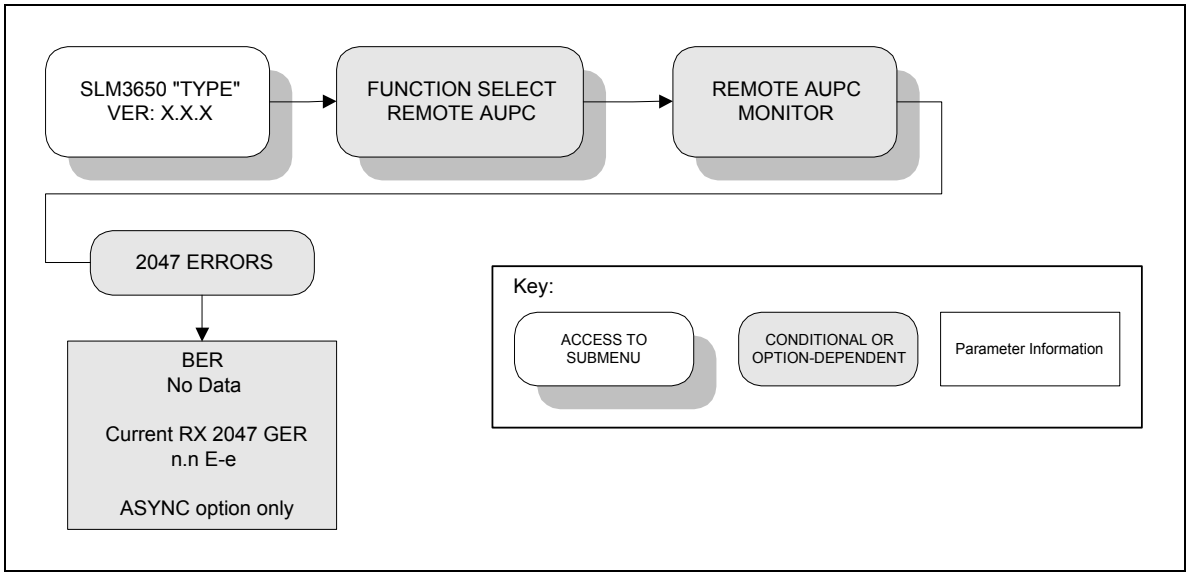


Figure 3-16. Remote AUPC Monitor Menu

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3.4.14 Function Select: Utility

The Function Select Utility menu is divided into the following categories:

- Modulator
- Demodulator
- Interface
- System
- Modem Type
- Factory Setup

Refer to Figure 3-17 through Figure 3-22 for different menu categories. The menu information includes:

- Filter Types
- Terrestrial Interface Types
- Mod/Demod Types
- Time/Date
- Encoder/Decoder Types
- Modem Types
- Current Firmware
- Test Mode Status
- Overhead Type
- Revision Emulation
- Lamp Test

Provisions also are made for assigning data and code rates to the modulator and demodulator.

After entering the ***Function Select: Utility*** menu, press [←] or [→] to select the desired sub-menu, and press [ENTER].

Notes:

1. The ***Function Select: Utility: Factory Setup*** menu is for Comtech EF Data service personnel only. Entering this menu without authorization may cause the modem to operate incorrectly.
2. Changes in the ***Function Select: Utility*** menu may cause changes in other front panel menus.

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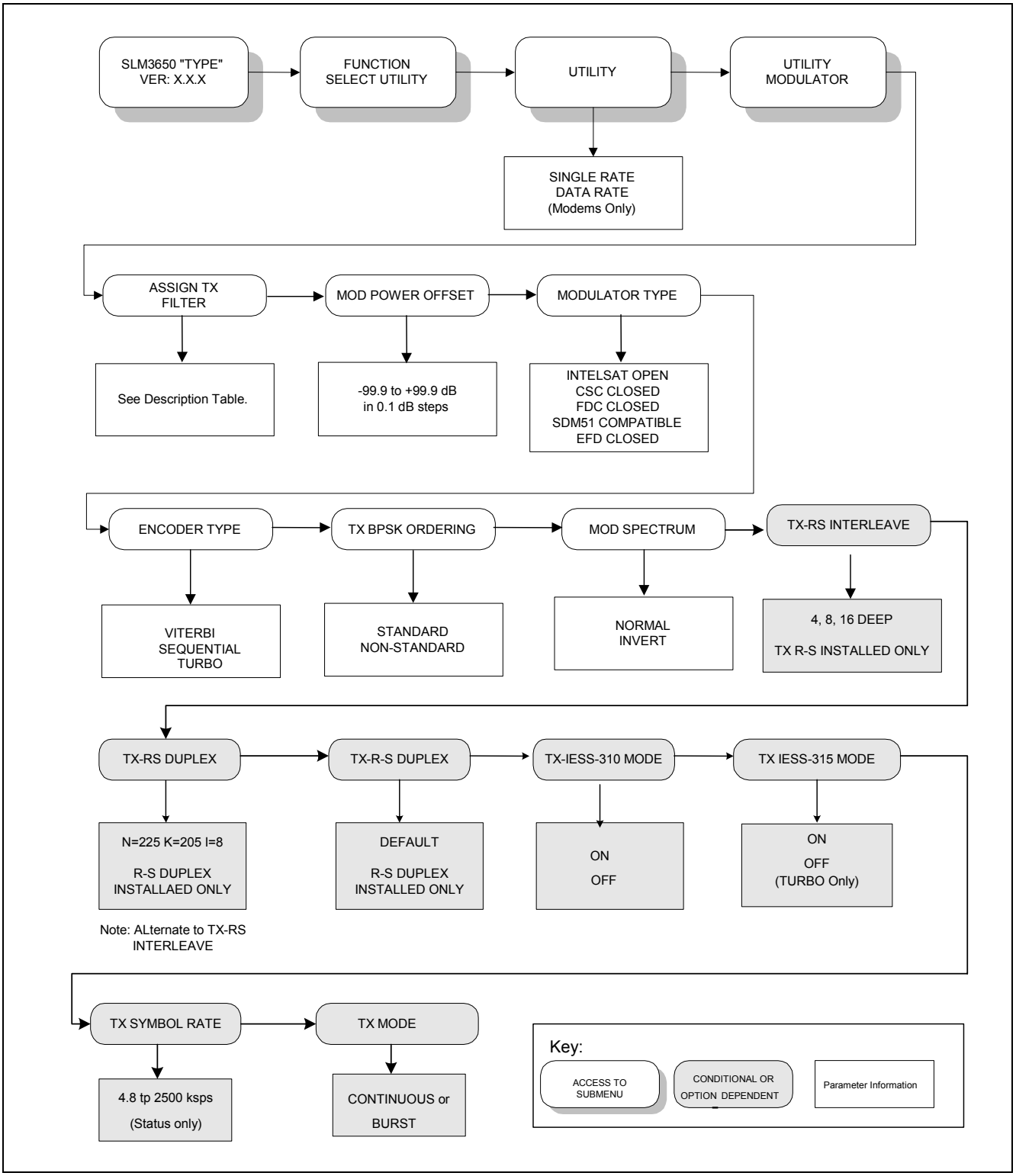


Figure 3-17. Utility Modulator Menu

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3.4.14.1 Function Select: Utility: Modulator

Refer to Figure 3-17.

UTILITY	Displays either Single Code/Data Rate modem only. • If CR/DR is blank, user is permitted to enter CR:_____ code and data rate one time. • If CR/DR is displayed, DR:_____kb, then fixed code/data rate is shown. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
ASSIGN TRANSMIT FILTERS	Upon entry, the current transmitter rate is displayed with the flashing cursor on the first character of the code rate on Line 1. Line 2 displays the data rate. Press [←] or [→] to make the selection. To select the currently defined variable data rate, select TX-V, and press [ENTER] twice. To change the rate using the variable rate selection, press [ENTER] when TX-V is displayed. A flashing cursor is displayed on the first character of the coding type on Line 1. Press [←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change. Refer to 3.3 Data Rates Refer to Table 4-1 for code/data rates Default settings
MOD POWER OFFSET	Modulator power offset adjust. Offsets the modulator output power readout in the Configuration menu. This feature does not actually change the modulator power level, but displays an offset value in the monitor. The modulator power offset range is -99.9 to +99.9 dB, in 0.1 dB steps. **Note:** Anything except 0.0 dB will cause ADJ to be displayed for the TX power level.
MODULATOR TYPE	TX filter type select. Select INTELSAT OPEN, EFD CLOSED, CSC CLOSED, FDC CLOSED, or SDM-51 COMPATIBLE network filtering. **Notes:** 1. Selectable only when EFD, ASYNC, AUPC, or CUSTOM is selected for the modem type in the ***Utility: Modem Type*** menu. 2. CSC CLOSED Modulator Type is not compatible with a 3/4 Code Rate and Sequential Encoder type combination.
ENCODER TYPE	Encoder type selection. Select Viterbi, Sequential, or Turbo encoder type. **Notes:** 1. Selectable only when EFD, ASYNC, AUPC, or CUSTOM is selected for the modem type in the ***Utility: Modem Type*** menu. 2. CSC CLOSED Modulator Type is not compatible with a 3/4 Code Rate and Sequential Encoder type combination.
TX BPSK ORDERING	TX BPSK bit ordering selection. Select STANDARD or NON-STANDARD. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
MOD SPECTRUM	Programmable vector rotation allows the operator to select NORMAL or INVERT for spectrum reversal of the I and Q baseband channels. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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TX-RS INTERLEAVE	Selection of 4, 8, or 16 deep. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
TX IESS-310 MODE	Selection of 8-PSK 2/3 with Reed-Solomon. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** Only available when 8-PSK option and RS option are installed and selected.
TX IESS-315 MODE	Selection with TURBO. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** Only available when TURBO installed and selected.
TX SYMBOL RATE	Programmable with 4.800 to 2500 kbps. Status Only. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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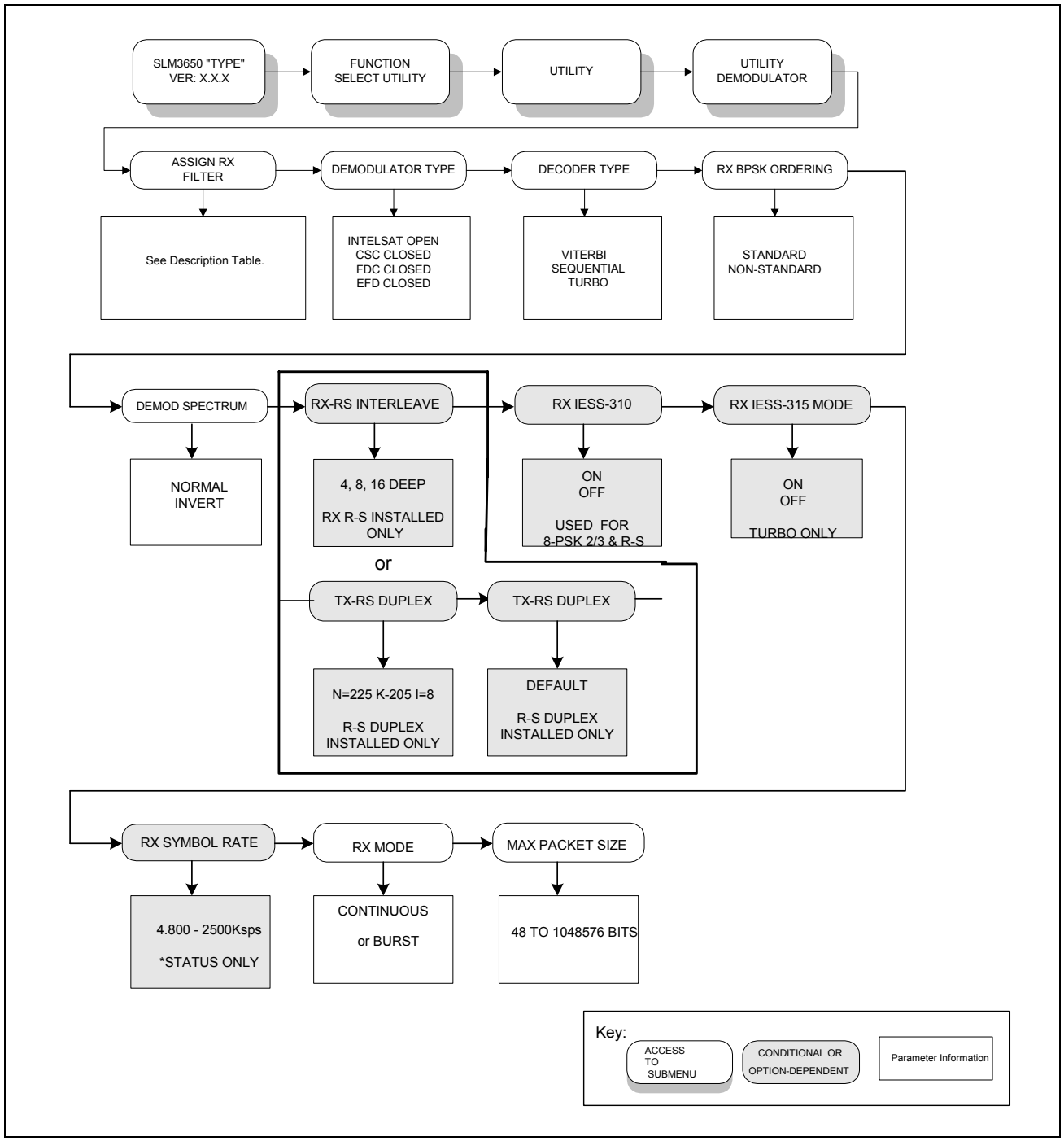


Figure 3-18. Utility Demodulator Menu

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3.4.14.2 Function Select: Utility: Demodulator

Refer to Figure 3-18.

ASSIGN RECEIVE FILTERS	Upon entry, the current receive rate is displayed with the flashing cursor on the first character of the code rate on Line 1. Line 2 displays the data rate. Press [←] or [→] to make the selection. To select the currently defined variable data rate, select RX-V, and press [ENTER] twice. To change the rate using the variable rate selection, press [ENTER] when RX-V is displayed. A flashing cursor is displayed on the first character of the coding type on line 1. Press [←] or [→] to move the flashing cursor, and [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change. Refer to 3.3 for Code/Data Rates. Refer to Table 4-1 for data rate default settings.
DEMODULATOR TYPE	**Conditional:** RX FILTER TYPE is selectable only when Custom is selected for modem type in the ***Function Select: Utility: Modem Type*** menu. Receive filter type select. Select Type INTELSAT OPEN, EFD CLOSED, CSC CLOSED, or FDC CLOSED network receive filtering. Note: CSC Closed Demodulator type is not compatible with a 3/4 Code Rate and Sequential Decoder type.
DECODER TYPE	**Conditional:** Changes only when Modem Type (under ***Function Select: Utility: Modem Type***) is either EFD, Custom, AUPC or ASYNC mode. Decoder type selection. Select Viterbi, Sequential, or Turbo decoder type. The modem must have the proper hardware enabled. Note: A Sequential Decoder type and a 3/4 Code Rate combination is not compatible with a CSC Closed Demodulator type.
RX BPSK ORDERING	Receive BPSK bit ordering selection. Select STANDARD or NON-STANDARD.
DEMOD SPECTRUM	Programmable vector rotation. Select NORMAL or INVERT for spectrum reversal of the I and Q baseband channels.
RX-RS INTERLEAVE	Selection of 4, 8, or 16 deep. **Conditional:** This menu is active only when Reed-Solomon is installed and RS Option is ON (under ***Function Select: Configuration: Demodulator***).
TX R-S DUPLEX	N=225, K=205, I=8 **Conditional:** R-S Duplex must be installed.
TX R-S DUPLEX	Default **Conditional:** R-S Duplex must be installed.
RX IESS-310 MODE	Selection of 8-PSK 2/3 with Reed-Solomon. **Conditional:** Only available when the 8-PSK option is selected and Reed-Solomon option is installed and selected.

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RX IESS-315 MODE	Selection with TURBO. **Conditional:** Only available when TURBO installed and selected.
RX SYMBOL RATE	Programmable with 4.800 to 2500 kbps. Status Only. Upon entry, the current status of the utility menu is displayed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
RX MODE	Select: Continuous or Burst.
RX MAX PACKET SIZE	Maximum packet size range: 48 to 1048576 bits.

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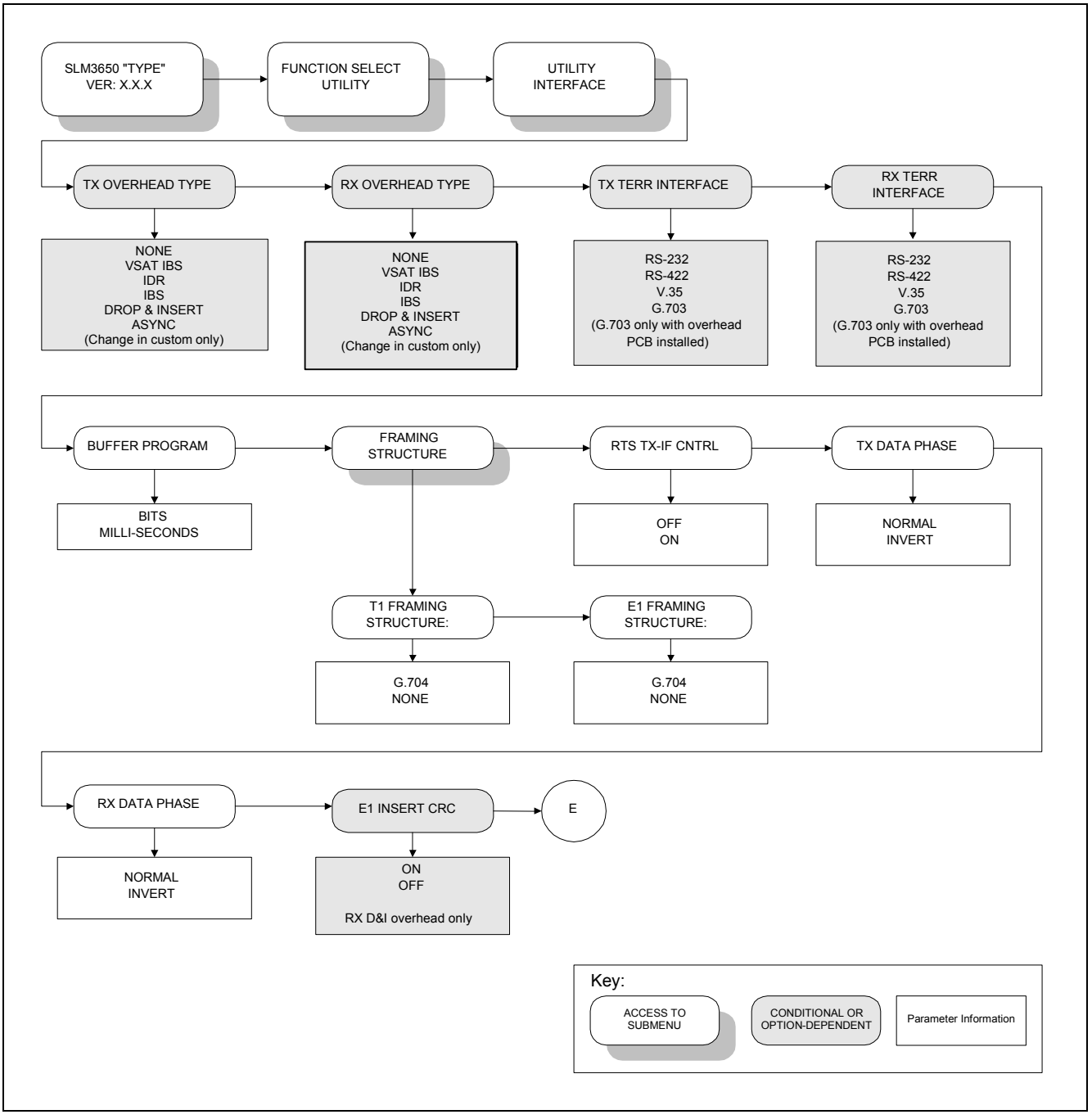


Figure 3-19. Utility Interface Menu

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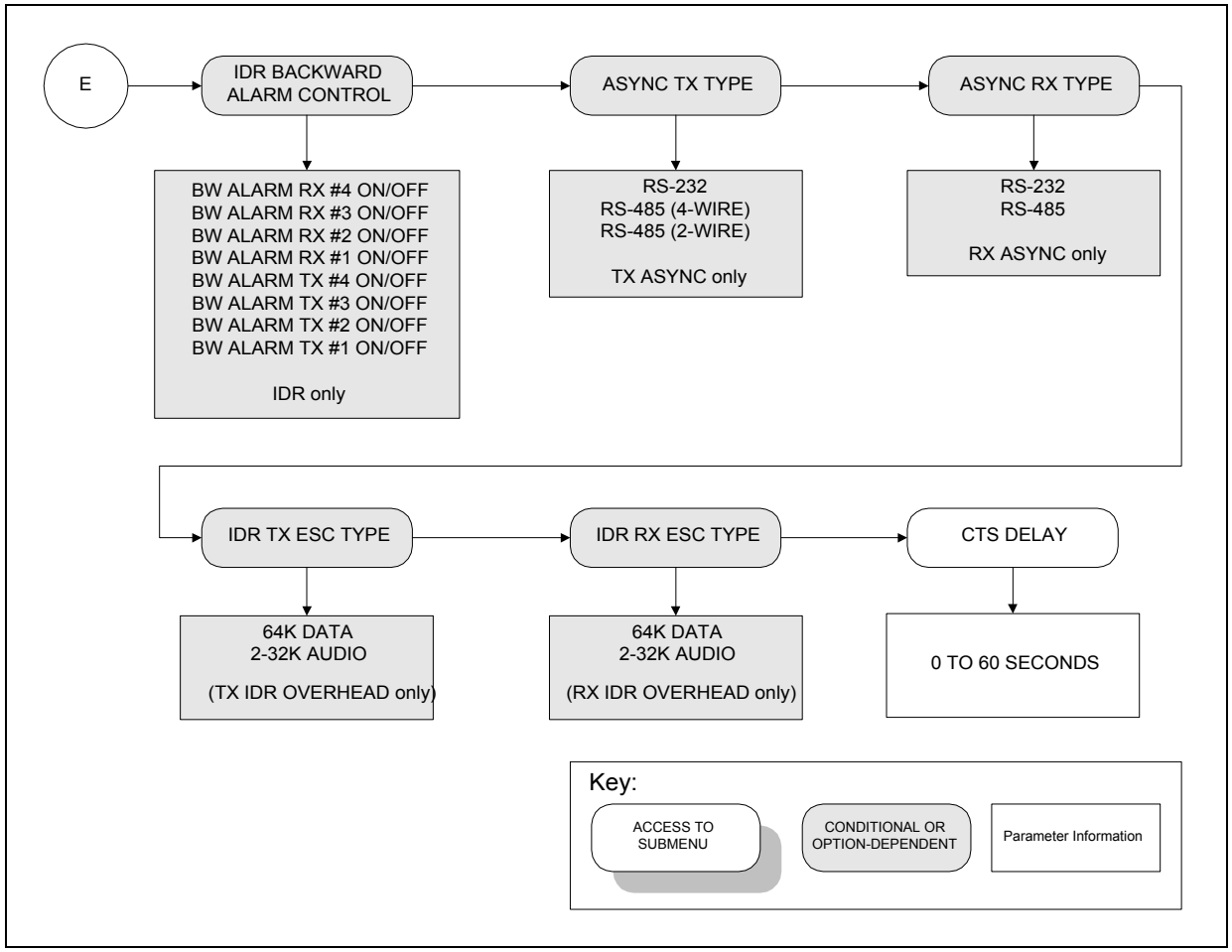


Figure 3-19. Utility Interface Menu (Continued)

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3.4.14.3 Function Select: Utility: Interface

Refer to Figure 3-19.

TX OVERHEAD TYPE	Select NONE, VSAT-IBS, IDR, IBS, DROP & INSERT, AUPC or ASYNC for TX overhead type. Note: Overhead types are selectable only when Custom is selected for modem type in the ***Utility: Modem Type*** menu.
RX OVERHEAD TYPE	Select NONE, VSAT-IBS, IDR, IBS, DROP & INSERT, AUPC or ASYNC for RX overhead type. Note: Overhead types are selectable only when Custom is selected for modem type in the ***Utility: Modem Type*** menu.
TX TERR INTERFACE	Displays the TX interface type EIA-232, EIA-422, V.35, or G.703. **Conditional:** G.703 is available only when the overhead interface PCB is installed.
RX TERR INTERFACE	Displays the RX interface type EIA-232, EIA-422, V.35, or G.703. **Conditional:** G.703 is available only when the overhead interface PCB is installed.
BUFFER PROGRAM	Buffer unit program function. Select MILLI-SECONDS or BITS. Note: To have the modem calculate the plesiochronous shift, set the buffer units to MILLI-SECONDS. For a specific buffer depth, set the buffer units to BITS.
FRAMING STRUCTURE	Displays the currently selected framing type and structure of the data. This function is used with the buffer program in ms for plesiochronous buffer slips. Upon entry, the framing type (T1 or E1) is displayed on Line 1. The framing structure of each type (NONE or G.704) is displayed on Line 2. Press [←] or [→] and [↑] or [↓] to select framing structure and type. Press [ENTER] to execute the change .
RTS TX-IF CNTRL	Programs the modem to allow a Request To Send (RTS) signal to enable the output when data is ready for transmission.
TX DATA PHASE	TX data phase relationship. Use this option to select NORMAL or INVERT for the TX data relationship to the selected TX clock. Upon entry, press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
RX DATA PHASE	RX data phase relationship. Use this option to select NORMAL or INVERT for the RX data relationship to the selected RX clock. Upon entry, press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.

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E1 INSERT CRC	E1 INSERT CRC enable function. Use this option to turn ON or OFF the CRC-4 on the insert side of the E1. The default for this function is ON. If the equipment cannot use the CRC-4 signal, disable the signal by selecting OFF. **Conditional:** This selection is available only when D&I is enabled.
IDR BACKWARD ALARM CONTROL	Controls IDR monitor and alarm functions when not using a communications link. Use this option to select ON or OFF for the RX and TX alarms. Press [↑] or [↓] to select the backward alarm RX or TX numbers 1 through 4. Press [ENTER] to execute the change. **Conditional:** This selection is available only when IDR is enabled.
ASYNC TX TYPE	Select EIA-232, EIA-485 (4-WIRE), or EIA-485 (2-WIRE) for ASYNC overhead type. **Conditional:** Available only with ASYNC overhead option.
ASYNC RX TYPE	Select EIA-232 or EIA-485 (4-WIRE), or EIA-485 (2-WIRE) for ASYNC overhead type. **Conditional:** Available only with ASYNC overhead option.
IDR TX ESC TYPE	Select 2-32K Audio or 64K Data for the IDR TX ESC type. **Conditional:** Available only with TX IDR overhead option.
IDR RX ESC TYPE	Select 2-32K Audio or 64K Data for the IDR RX ESC type. **Conditional:** Available only with RX IDR overhead option.
CTS DELAY	Sets the delay in seconds (0 to 60) for the Clear To Send (CTS) signal.

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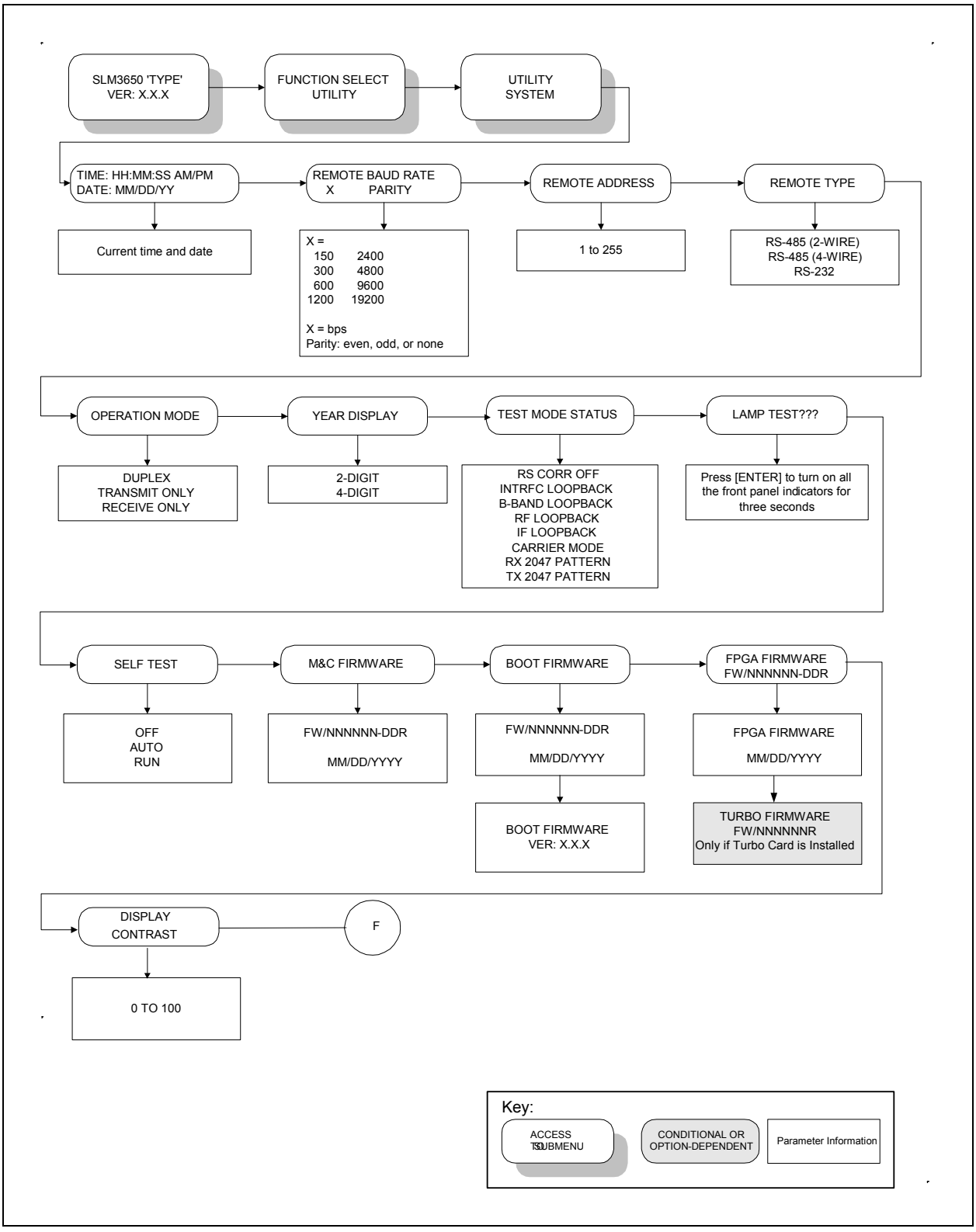


Figure 3-20. Utility System Menu

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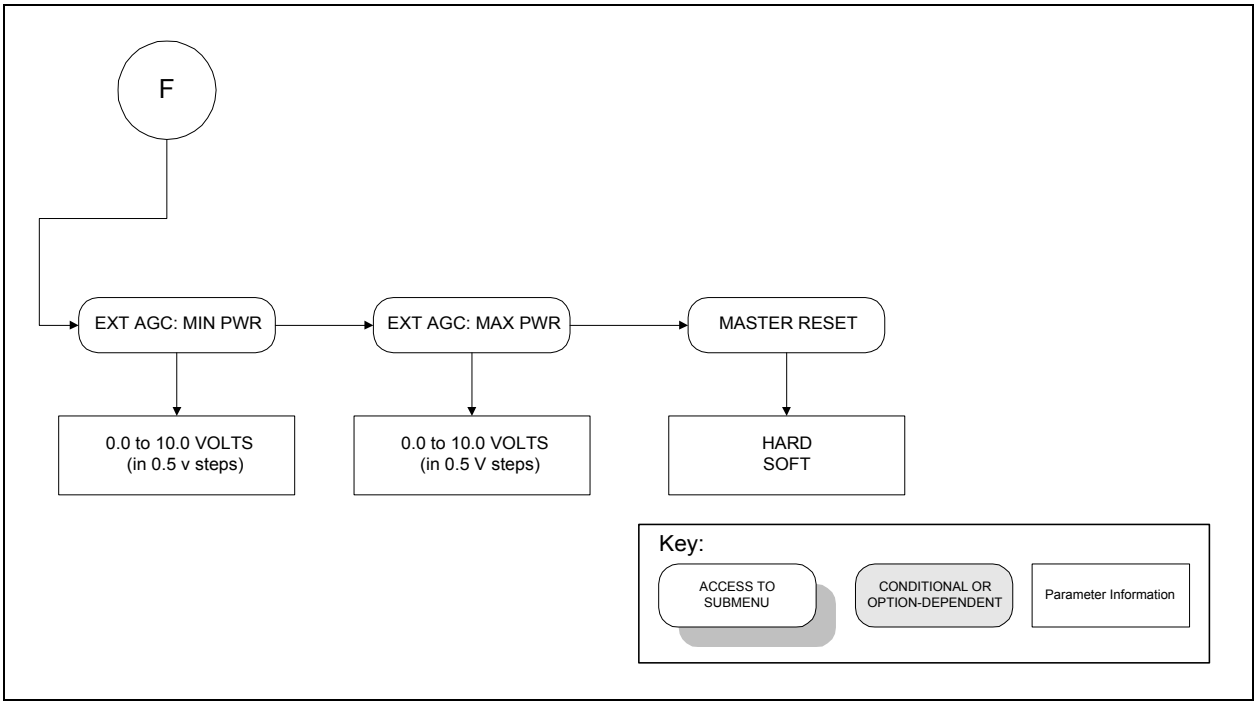


Figure 3-20. Utility System Menu (Continued)

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3.4.14.4 Function Select: Utility: System

Refer to Figure 3-20.

TIME: HH:MM:SS AM/PM DATE: MM/DD/YYYY	Time of day and date display/set function. The current time and date in the modem's memory are displayed when selected. To change the modem time and/or date, press [ENTER]. Press [←] or [→] to position the cursor over the parameter to be changed. Press [↑] or [↓] to change the parameter. Once the parameters are displayed as desired, press [ENTER] to set the time and date.
REMOTE BAUD RATE X PARITY	The parity and baud rate settings of the modem are displayed. To change the modem baud rate and/or parity, press [ENTER]. Press [←] or [→] to position the cursor over the parameter to be changed. Press [↑] or [↓] to change the parameter. Once the parameters are displayed as desired, press [ENTER] to set the baud rate and parity. The parity can be set to EVEN, ODD, or NONE. The baud rate can be set from 110 to 19200 bit/s.
REMOTE ADDRESS	The current modem address is displayed (1 to 255). To change the remote address, press [ENTER]. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
REMOTE TYPE	Select EIA-485 (2-Wire), EIA-485 (4-Wire), or EIA-232.
OPERATION MODE	Programs the modem for DUPLEX, TRANSMIT ONLY, or RECEIVE ONLY operation. Upon entry, the operational status may be changed. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change. **Conditional:** When TX ONLY or RX ONLY are selected, the appropriate faults are masked from the Faults and Stored Faults menus.
YEAR DISPLAY	Displays the year in either 2-digits or 4-digits. To change the remote address, press [ENTER]. Press [↑] or [↓] to make the selection. Press [ENTER] to execute the change.
TEST MODE STATUS	Test mode status indicator. The following modem test points are listed and display a "+" when a test mode is active: ➢ RS CORR OFF ➢ INTRFC LOOPBACK ➢ B-BAND LOOPBACK ➢ RF LOOPBACK ➢ IF LOOPBACK ➢ CARRIER MODE ➢ RX 2047 Pattern ➢ TX 2047 Pattern To view the test modes, press [ENTER]. Press [↑] or [↓] to make the selection.
LAMP TEST ??	Lamp test function. Press [ENTER] to turn the front panel indicators on for three seconds.

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SELF TEST	Select OFF, AUTO, or RUN. After completion of the test, SELF TEST ("PASSED" or "FAILED") is displayed. ➢ OFF bypasses built-in self test. ➢ AUTO initiates built-in self test when turning on modem. ➢ RUN initializes self test.
M&C FIRMWARE	Displays the M&C module firmware version. Press [ENTER] to display the month, day, and year.
BOOT FIRMWARE	Displays the BOOT module firmware version. Press [ENTER] to display the month, day, and year. Press [ENTER] again, to display version number.
FPGA FIRMWARE	Displays the FPGA module firmware version. Press [ENTER] to display the month, day, and year.
TURBO FIRMWARE	Displays the Turbo module firmware version. Press [ENTER] to display the month, day, and year. **Conditional:** Only if Turbo card is installed.
DISPLAY CONTRAST	Sets the contrast setting of the Front Panel menu. Press [ENTER] to begin. Press [↑] or [↓] to increment or decrement the number at the flashing cursor, from 0 to 100. Press [ENTER] to execute the change.
EXT AGC: MIN PWR	Sets the AGC voltage for a RX signal level of -25.0 dBm. The voltage range is 0.0 to 10.0V, in 0.5V steps. Upon entry, the current external AGC voltage level is displayed. Press [↑] or [↓] to increment or decrement the AGC voltage level in 0.5V steps. Press [ENTER] to execute the change. **Note:** For any receive signal level between -25.0 and -60.0 dBm, the software will interpolate the required AGC voltage.
EXT AGC: MAX PWR	Sets the AGC voltage for a RX signal level of -60.0 dBm. The voltage range is 0.0 to 10.0V, in 0.5V steps. Upon entry, the current external AGC voltage level is displayed. Press [↑] or [↓] to increment or decrement the AGC voltage level in 0.5V steps. Press [ENTER] to execute the change. **Note:** For any receive signal level between -25.0 and -60.0 dBm, the software will interpolate the required AGC voltage.

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MASTER RESET	Master reset function.  ***Initiating a hard reset will reset the modem and place the default configuration settings in ROM. Initiating a soft reset will reset the modem hardware, but saves the current configuration settings.*** Select [ENTER] once to access HARD or SOFT. Press [←] or [→] to make the selection. Press [ENTER]. Press [→] five times to move the cursor to YES. Select YES and press [ENTER] again. **Note:** The following parameters do not revert to default settings after a hard reset: ➢ Address ➢ Parity ➢ Baud Rate ➢ Remote Type ➢ Ext AGC: Min Pwr ➢ Ext AGC: Max Pwr ➢ Display Contrast

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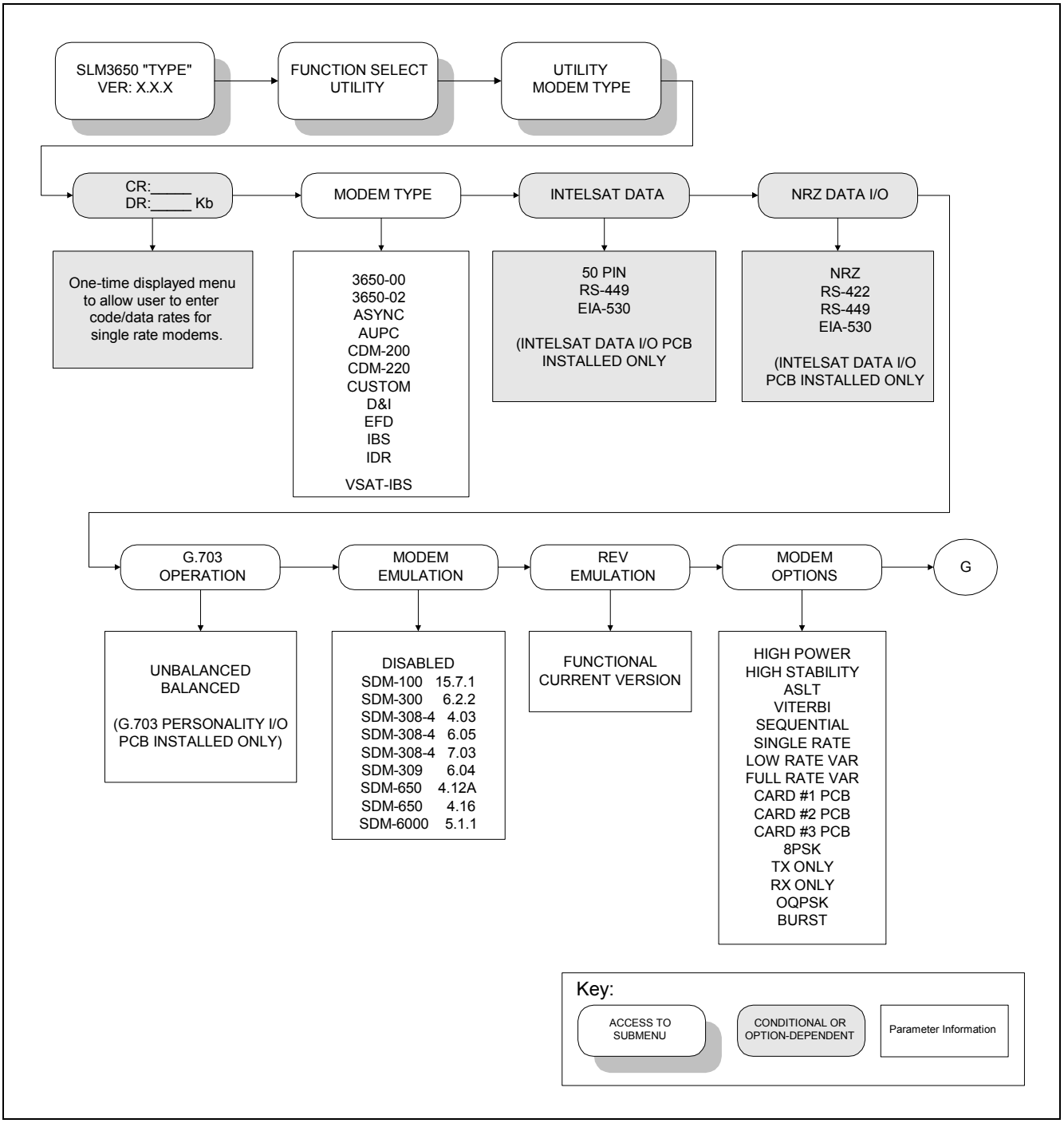


Figure 3-21. Utility Modem Type Menu

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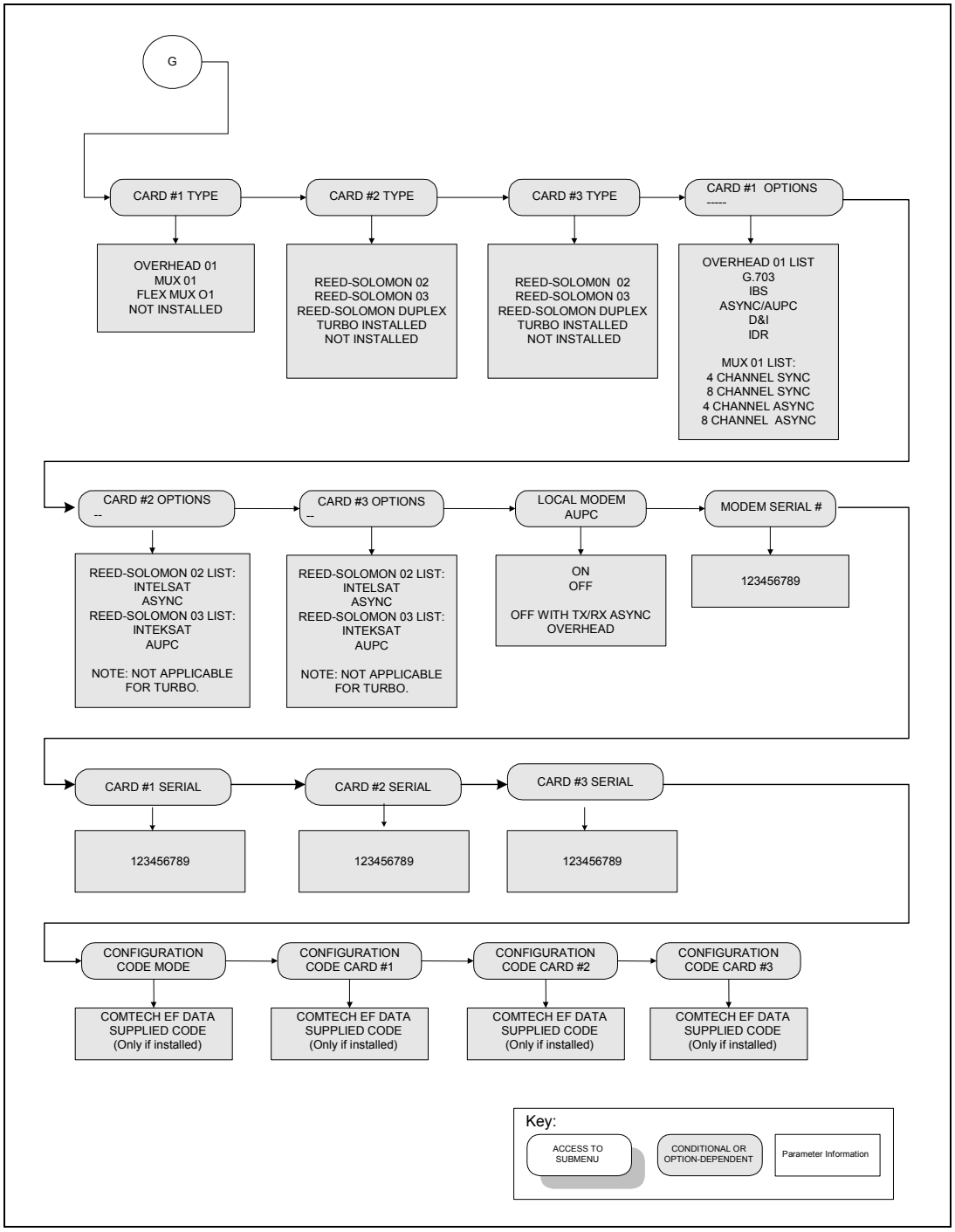


Figure 3-21. Utility Modem Type Menu (Continued)

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3.4.14.5 Function Select: Utility: Modem Type

Refer to Figure 3-21.

UTILITY	CR:_____ is a one time displayed menu to permitted the user to enter DR:_____ kb code/data rate for single rate modems.
MODEM TYPE	Selects the following types of modem operation: CUSTOM Selections are made from the Front Panel menu D&I D&I ASYNC ASYNC Overhead Option IDR SDM-308 IBS SDM-309 EFD Closed Network Operation 3650-00 3650-02 AUPC CDM Comtech EF Data Compatible When the modem is changed from one type of operation to another, the modem will be reset to the default configurations of the new modem type. The RF-IF Output must be turned on to get the modem to lock. If the existing modem type is the same as the type entered, the modem will not change any parameters. If the modem type is changed to Custom, no parameters will be changed. If the modem will not allow the modem type selection, that type of operation may not be an available option. Select MODEM OPTIONS and OVERHEAD OPTIONS to see which modem operations are allowed. CAUTION ***Use caution when modifying the Custom Type. This type accepts all changes to the modem, including incompatible parameter changes. Only experienced modem operators who are familiar with all of the controls should use Custom type.*** **Note:** Refer to Section 3.5.1 for additional modem type information.
INTELSAT DATA	**Conditional:** Intelsat Data I/O PCB installed only. 50-pin, RS-422-449, or EIA-530
NRZ DATA I/O	**Conditional:** NRZ Data I/O installed only. NRZ, RS-422-449, or EIA-530
G.703 OPERATION	**Conditional:** G.703 Personality I/O PCB must be installed. Unbalanced or Balanced

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MODEM EMULATION	Selects the following types of modem emulation: ➢ SDM-100 15.7.1 ➢ SDM-300 6.2.2 ➢ SDM-308-4 4.03 ➢ SDM-308-4 6.05 ➢ SDM-308-4 7.03 ➢ SDM-308-5 6.08 ➢ SDM-309 6.04 ➢ SDM-650 4.12A ➢ SDM-650 4.16 ➢ SDM-6000 5.1.1
REV EMULATION	Programs an emulation mode of a previous functional revision. This allows the user to select the CURRENT VERSION or FUNCTIONAL X. Note: The number displayed in the CURRENT VERSION position increases with each software version change. Upon entry, the CURRENT VERSION is displayed. Press [↑] or [↓] to select the FUNCTIONAL version. Press [ENTER] to execute the change. Notes: 1. Programming a current version (default) allows all features and options (if installed) to operate normally. 2. Programming a FUNCTIONAL version (X) eliminates any changes that affect the later version. Only functional changes are affected by the revision emulation feature. 3. A correction change (e.g., VER 3.1.2) remains fixed in accordance with the latest version. Since the revision emulation default is the current version, program the functional version at the start of each operation. 4. The revision emulation feature does not affect some interface changes for the direct operation of the modem (Configuration save/recall, test mode screen in the Utility/System, all factory setup modes, etc.).

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<table>
<tr><td>MODEM OPTIONS</td><td>(Status Only.)

Displays the installed modem options.

<u>Legend</u>
High Power (0 or +)
High Stability (0 or +)
ASLT (- or +)
Viterbi (- or +)
Sequential (- or +)
Single Rate (- or +)
Low Rate Var (- or +)
Full Rate Var (- or +)
Card #1 PCB (x or +)
Card #2 PCB (x or +)
Card #3 PCB (x or +)
8-PSK (- or +)
TX Only (0 or +)
RX Only (0 or +)
OQPSK (- or +)
0 = Not Installed, Factory Upgradable
- = Not Installed, FAST Upgradable
+ = Installed
x = Not Installed, Field Upgradable

If the option is installed, a “+” symbol is displayed. To view the available options press [ENTER]. Observe for the flashing cursor. Press the [←] [→] arrows to move from one symbol to the next. The first line will display the option. The second line will display the status:

A “+” symbol indicates the option is installed.
A “-” symbol indicates the option is FAST accessible.
A “0” symbol indicates the option is a factory upgrade.
An “x” symbol indicates the option is field insertable.</td></tr>
<tr><td>CARD #1 TYPE</td><td>(Status Only.)
Overhead 01
MUX 01
FLEX MUX 01
Not Installed

Displays installed overhead card.</td></tr>
<tr><td>CARD #2 TYPE</td><td>(Status Only.)
Reed-Solomon 02
Reed-Solomon 03
Turbo Installed
Not Installed
Duplex Reed-Solomon

Displays installed Reed-Solomon card.</td></tr>
<tr><td>CARD #3 TYPE</td><td>(Status Only.)
Reed-Solomon 02
Reed-Solomon 03
Turbo Installed
Not Installed
Duplex Reed-Solomon
Displays installed Reed-Solomon card.</td></tr>
</table>

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CARD #1 OPTIONS	(Status Only.) Overhead 01 List: G.703 (- or +) IBS (- or +) ASYNC/AUPC (- or +) D&I (- or +) IDR (- or +) MUX 01 List: 4 Channel SYNC (- or +) 8 Channel SYNC (- or +) 4 Channel ASYNC (- or +) 8 Channel ASYNC (- or +) Displays installed overhead options.
CARD #2 OPTIONS	(Status Only.) Reed-Solomon 02 List: Intelsat (- or +) AUPC (- or +) Reed-Solomon 03 List: Intelsat (- or +) AUPC (- or +) Duplex Reed-Solomon: Intelsat (- or +) AUPC (- or +) Note: Not applicable for Turbo mode. Displays installed Reed-Solomon options.
CARD #3 OPTIONS	(Status Only.) Reed-Solomon 02 List: Intelsat (- or +) AUPC (- or +) Reed-Solomon 03 List: Intelsat (- or +) AUPC (- or +) Duplex Reed-Solomon: Intelsat (- or +) AUPC (- or +) Note: Not applicable for Turbo mode. Displays installed Reed-Solomon options.

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LOCAL MODEM AUPC	Configures the modem for the self-monitoring Local Modem AUPC mode and for local TX power control (self-monitoring) due to severe rain fade. **Notes:** 1. The self-monitoring Local Modem AUPC mode is not used when the ASYNC/AUPC interface option is installed. 2. OFF with TX or RX ASYNC overhead. Refer to Appendix A for more information.
MODEM SERIAL #	(Status Only). Displays the modem serial number.
CARD #1 SERIAL #	(Status Only.) Displays the first daughter card serial number.
CARD #2 SERIAL #	(Status Only.) **Note:** Not applicable for Turbo mode. Displays the second daughter card serial number.
CARD #3 SERIAL #	(Status Only.) **Notes:** 1. Not applicable for Turbo mode. 2. Displays the third daughter card serial number.
CONFIGURATION CODE - MODE	Comtech EF Data-supplied code. On entry, the current configuration code is displayed with the flashing cursor on the first character. Press [←] or [→] to move the flashing cursor. Press [↑] or [↓] to increment or decrement the digit at the flashing cursor. Press [ENTER] to execute the change. Entering this code enables the corresponding modem option. To purchase an option, contact a Comtech EF Data sales representative for more information.
CONFIGURATION CODE – CARD #1	Provides the means to enter modem-specific code necessary to access certain options. Refer to Appendix A for more information. **Note:** Displays only when daughter card is installed.
CONFIGURATION CODE – CARD #2	Provides the means to enter modem-specific code necessary to access certain options. Refer to Appendix A for more information. Notes: 1. Not applicable for Turbo mode. 2. Displays only when second daughter card is installed.
CONFIGURATION CODE – CARD #3	Provides the means to enter modem-specific code necessary to access certain options. Refer to Appendix A for more information. Notes: 1. Not applicable for Turbo mode. 2. Displays only when third daughter card is installed.

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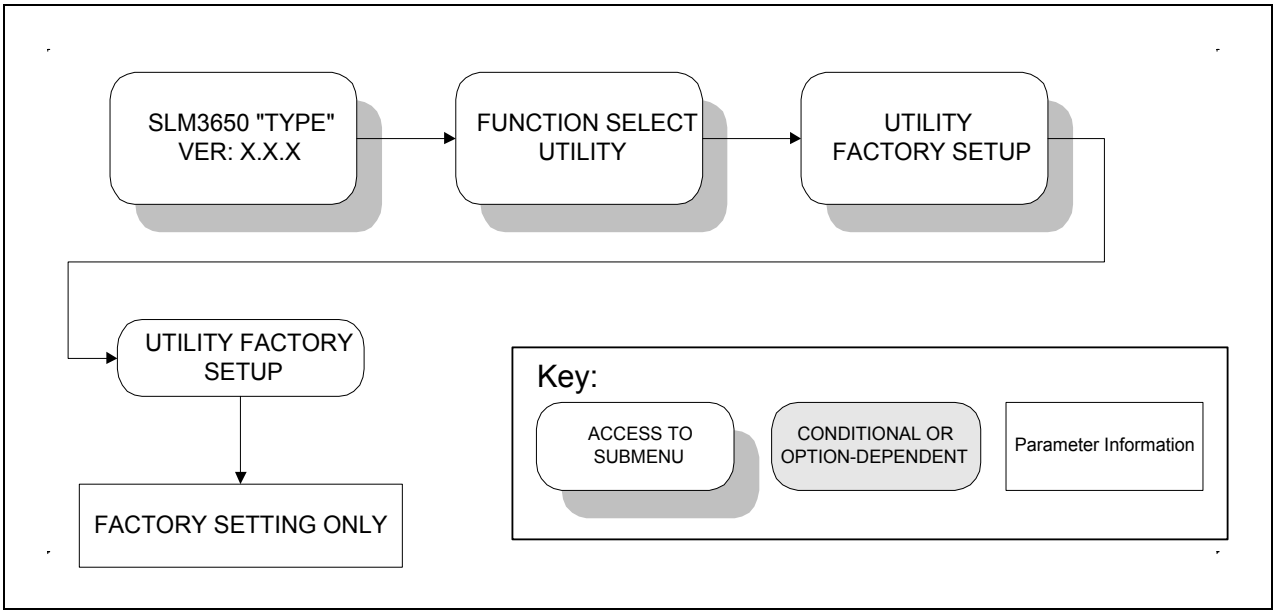


Figure 3-22. Utility Factory Setup Menu

3.4.14.6 Function Select: Utility: Factory Setup

Refer to Figure 3-22.

CAUTION

This command is used for factory configuration only. Factory setup should not be changed by unauthorized persons; doing so can cause modem failure.

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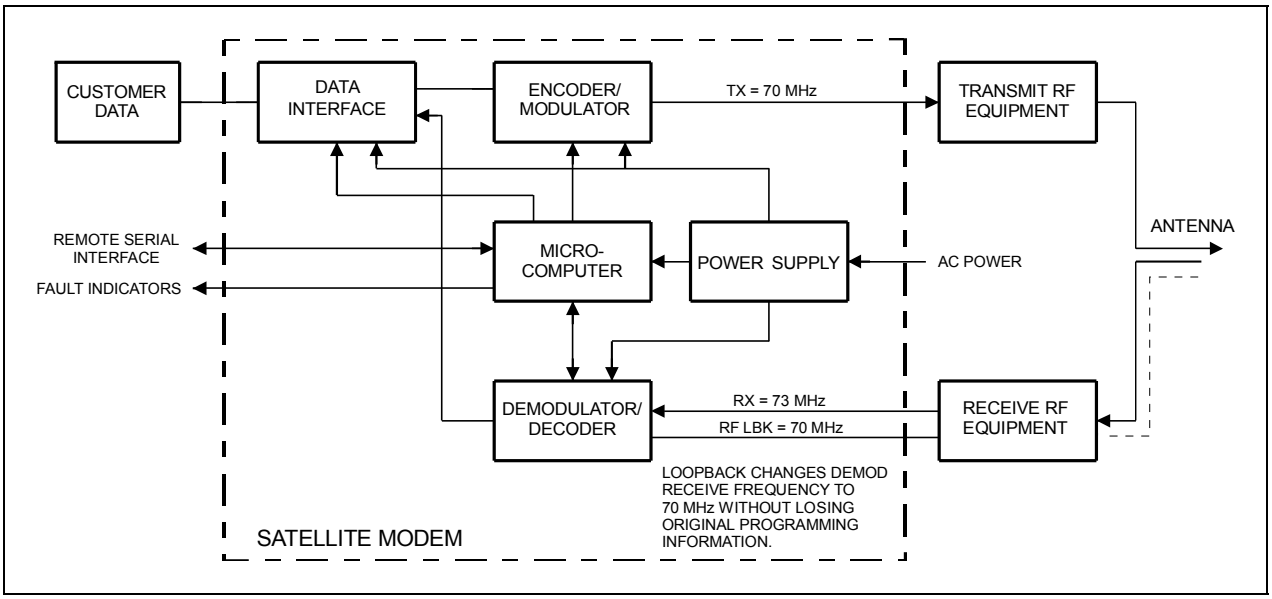


Figure 3-23. RF Loopback

Note: When RF loopback is turned ON, the demodulator receive frequency is programmed to be the same frequency as the modulator transmit frequency. This test mode will verify the satellite link without changing the programmed frequency of the demodulator. When RF loopback is turned OFF, the demodulator is programmed back to the previous frequency.

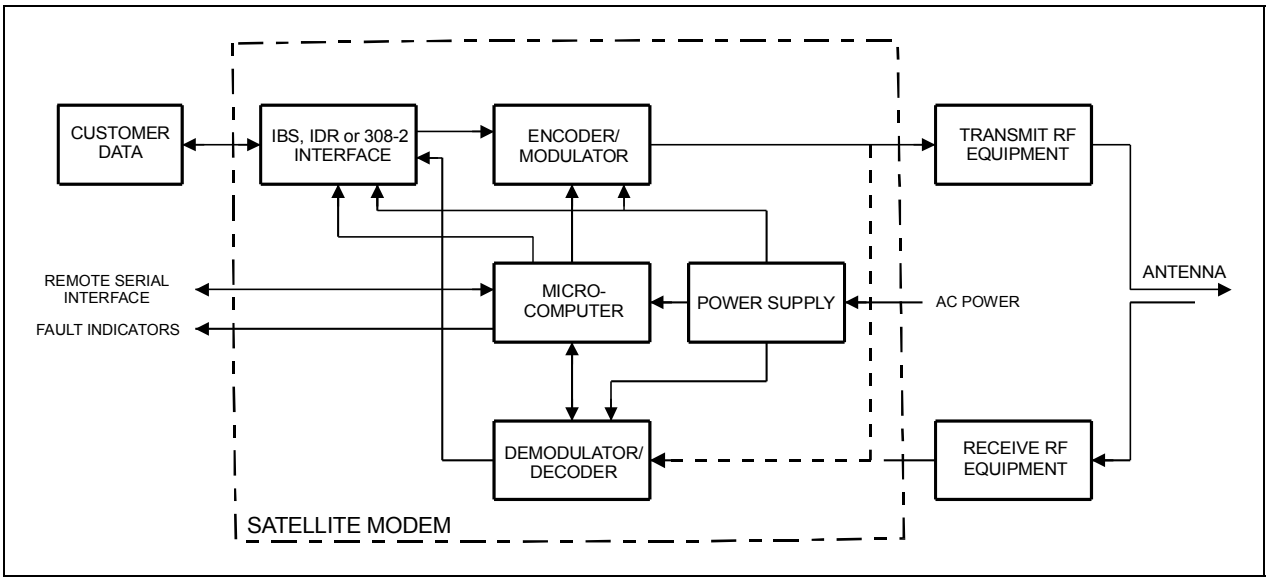


Figure 3-24. IF Loopback

Note: When IF loopback is turned ON, the demodulator is looped back to the modulator inside the modem and the demodulator is programmed to the same frequency as the modulator. This test mode will verify the operation of the modem. When IF loopback is turned OFF, the demodulator is programmed back to the previous frequency and is reconnected to the IF input.

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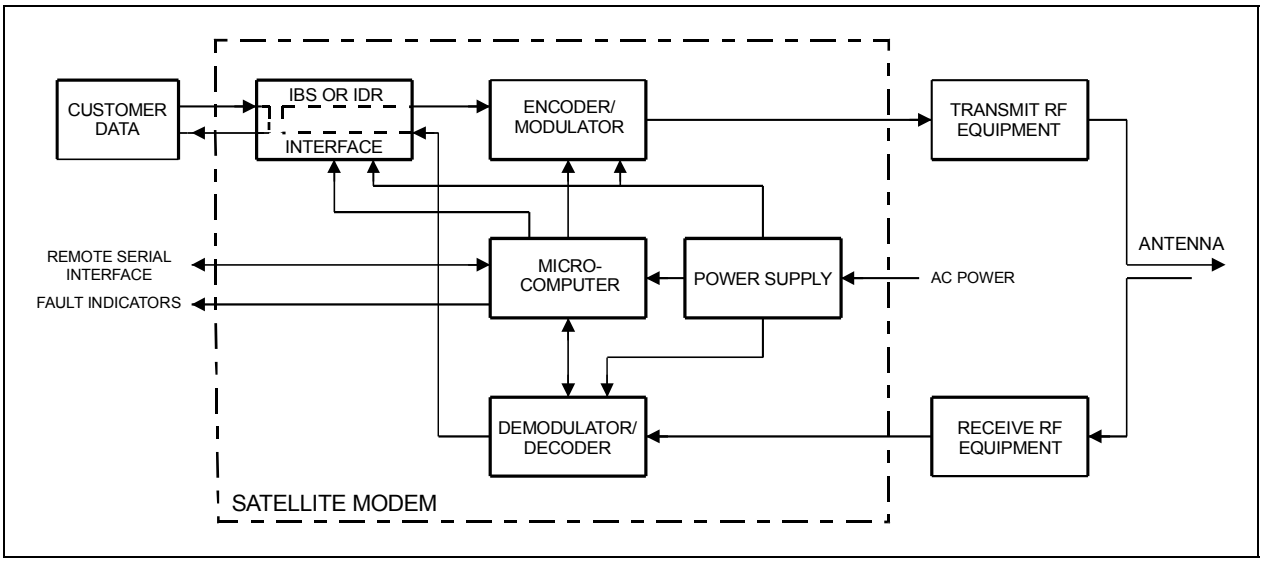


Figure 3-25. Baseband Loopback

Note: When baseband loopback is turned ON, data is looped back on the customer side of the interface. This is a bi-directional loopback of the baseband data. This test mode will verify the customer equipment and cabling between the modem and the customer equipment. The baseband loopback is not bi-directional in D&I.

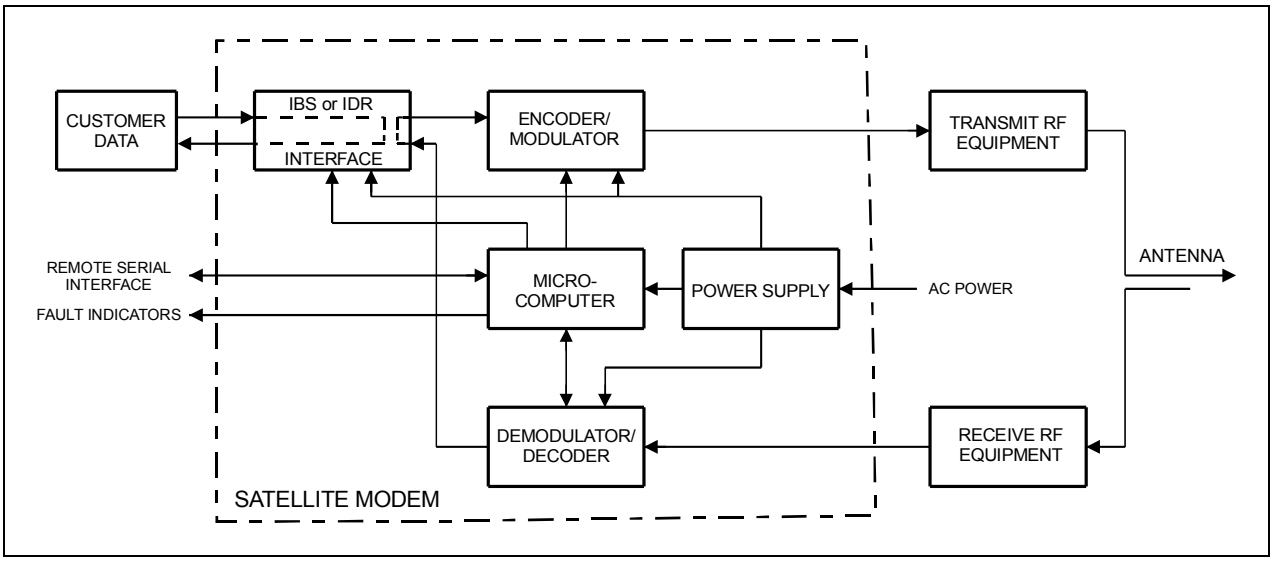


Figure 3-26. Interface Loopback

Note: When interface loopback is turned ON, data is looped back on the modem side of the interface. This is a bi-directional loopback of the data after the baseband data had the 16/15 overhead added. This test mode will verify the internal channel unit interface operation.

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3.5 Software Configuration

3.5.1 Modem Types

Refer to Figure 3-21.

Refer to Table 3-3 for configuring the modem to the following types of operation. Each type allows the user to operate the modem under the requirements of the configuration specifications listed below.

Table 3-3. Modem Types

Configuration	Specification
IDR (Intermediate Data Rate)	IESS-308
IBS (INTELSAT Business Service)	IESS-309
D&I (Drop & Insert)	IESS-308-5
ASYNC	Asynchronous Overhead
EFD	Comtech EF Data Closed Network
CUSTOM	Access all modes
AUPC	Automatic Uplink Power Control
VSAT-IBS	Intelsat compliant No Overhead
3650-00	No Overhead OM-73
3650-02	ASYNC Overhead OM-73
Emulation Types	**Specification**
SDM-100	Emulates SDM-100 Ver: 15.7.1
SDM-300	Emulates SDM-300 Ver: 6.2.2
SDM-308-4	Emulates SDM-308-4 Ver: 4.03, 6.05, or 7.03
SDM-308-5	Emulates SDM-308-5 Ver: 6.08
SDM-309	Emulates SDM-309 Ver: 6.04
SDM-650	Emulates SDM-650 Ver: 4.12A or 4.16
SDM-6000	Emulates the SDM-6000 Ver: 5.1.1
Revision Emulation	Emulates earlier released software remote protocol

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3.5.1.1 IDR Operation

To operate the modem in the IDR configuration, the following cards must be installed in the modem:

- Overhead G.703/IDR/IBS/ASYNC/AUPC/D&I card (PL/5305-1)
- 50-pin D relay adapter card (PL/5509)

The IDR option is a FAST feature that must be enabled using the front panel and the Utility Modem Type menu. Table 3-4 lists the parameters that are accessible once the IDR modem type is enabled.

Table 3-4. IDR Parameter Settings

Parameter	Front Panel Setting	Reference Menu
Modem Type	IDR	Utility Modem Type
TX Data/Code Rate	TX-V, QPSK 3/4	Configuration Modulator
TX IF Output	ON	Configuration Demodulator
RX Data/Code Rate	RX-V, QPSK 3/4	Configuration Demodulator
TX Clock Source	TX Terrestrial, Internal, Ext. Reference	Configuration Interface
Buffer Clock Source	Satellite, TX Terrestrial, Internal, Ext. Reference	Configuration Interface
TX Coding Format	AMI, B8ZS, HDB3, or B6ZS	Configuration Interface
RX Coding Format	AMI, B8ZS, HDB3, or B6ZS	Configuration Interface
Backward Alarm Control	TX-1, TX-2, TX-3, TX-4 RX-1, RX-2, RX-3, RX-4 ON or OFF	Utility Interface
Service Channel Adjust	TX-1, TX-2, RX-1, RX-2 levels	Configuration Interface

The IDR modem type is an open network application, primarily used for voice circuits. IDR has a fixed overhead structure. Refer to Section A.1.6 for more information on IDR theory of operation.

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3.5.1.2 IBS Operation

To operate the modem in the IBS configuration, the following cards must be installed in the modem:

- Overhead G.703/IDR/IBS/ASYNC/AUPC/D&I card (PL/5305-1)
- 50-pin D relay adapter card (PL/5509)

The IBS option is a FAST feature that must be enabled using the front panel and the Utility Modem Type menu. Table 3-5 lists the parameters that are accessible once the IBS modem type is enabled.

Table 3-5. IBS Parameter Settings

Parameter	Front Panel Setting	Reference Menu
Modem Type	IBS	Utility Modem Type
TX Data/Code Rate	TX-V, QPSK 1/2	Configuration Modulator
TX IF Output	ON	Configuration Demodulator
RX Data/Code Rate	RX-V, QPSK 1/2	Configuration Demodulator
TX Clock Source	TX Terrestrial, Internal, Ext. Reference	Configuration Interface
Buffer Clock Source	Satellite, TX Terrestrial, Internal, Ext. Reference	Configuration Interface
TX Coding Format	AMI, B8ZS, or HDB3	Configuration Interface
RX Coding Format	AMI, B8ZS, or HDB3	Configuration Interface

The IBS modem type is an open network application, primarily used for data circuits. IBS has a variable overhead structure that is dependent on the transmitted data rate. Refer to Section A.1.7 for more information on IBS theory of operation.

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3.5.1.3 D&I Operation

To operate the modem in the Drop & Insert configuration, the following cards must be installed in the modem:

- Overhead G.703/IDR/IBS/ASYNC/AUPC/D&I card (PL/5305-1)
- 50-pin D relay adapter card (PL/5509)

The D&I option is a FAST feature that must be enabled using the front panel and the Utility Modem Type menu. Table 3-6 lists the parameters that are accessible once the D&I modem type is enabled.

Table 3-6. D&I Parameter Settings

Parameter	Front Panel Settings	Reference Manual
Modem Type	D&I	Utility - Modem Type
TX Data/Code Rate	TX-V, QPSK 1/2 (NX64)	
TX IF Output	ON	Configuration - Demodulator
RX Data/Code Rate	RX-V, QPSK 1/2 (NX64) Table 3-5	Configuration - Demodulator
TX Clock Source	TX Terrestrial	Configuration - Interface
Buffer Clock Source	Insert Clock	Configuration - Interface
TX Coding Format	HDB3	Configuration - Interface
RX Coding Format	HDB3	Configuration - Interface
Drop Format	E1CCS/E1CAS (E1)	Configuration - Interface
Insert Format	E1CCS/E1CAS (E1)	Configuration - Interface

In D&I operation, the transmit data rate is a fractional portion of the trunk T1 or E1 terrestrial input. The N stands for the number of 64 kbps time slots available for transmission. Table 3-7 shows the allowable TX data rates for D&I with the corresponding number of time slots available for each data rate. Refer to Chapter 4 for the interface specifications on the satellite data rates supported for E1 and T1 operation. Refer to Appendix A, A.1.3, for D&I theory of operation.

Table 3-7. N x 64 Chart

Time Slots	TX Data Rate	Time Slots	TX Data Rate
1	64 kbps	10	640 kbps
2	128 kbps	12	768 kbps
3	192 kbps	15	960 kbps
4	256 kbps	16	1024 kbps
5	320 kbps	20	1280 kbps
6	384 kbps	24	1536 kbps
8	512 kbps	30	1920 kbps

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3.5.1.4 ASYNC/AUPC Operation

To operate in the Asynchronous/AUPC configuration, the following cards must be installed in the modem:

- Overhead G.703/IDR/IBS/ASYNC/AUPC/D&I card (PL/5305-1)
- 50-pin D relay adapter card (PL/5509)

The ASYNC/AUPC option is a FAST feature that must be enabled using the front panel and the Utility Modem Type menu. Table 3-8 lists the parameters that are accessible once the ASYNC/AUPC modem type is enabled.

Table 3-8. Asynchronous Parameter Settings

Parameter	Front Panel Setting	Reference Menu
Modem Type	ASYNC	Utility Modem Type
TX Data/Code Rate	TX-V, BPSK 1/2 or QPSK 1/2, 3/4, or 7/8	Configuration Monitor
TX IF Output	ON	Configuration Demodulator
RX Data/Code Rate	RX-V, BPSK 1/2 or QPSK 1/2, 3/4, or 7/8	Configuration Demodulator
Encoder Type	Viterbi/Sequential	Utility Modulator
Decoder Type	Viterbi/Sequential	Utility Demodulator
ASYNC TX Baud	110 to 38400 bit/s	Configuration Interface
ASYNC RX Baud	110 to 38400 bit/s	Configuration Interface
ASYNC TX Length	5 to 8 bits	Configuration Interface
ASYNC RX Length	5 to 8 bits	Configuration Interface
ASYNC TX Stop	1 or 2 bits	Configuration Interface
ASYNC TX Parity	Even or Odd	Configuration Interface
ASYNC RX Parity	Even or Odd	Configuration Interface
Local AUPC	ON or OFF	Configuration Local AUPC
Nominal Power	-5 to -30 dBm	Configuration Local AUPC
Minimum Power	-5 to -30 dBm	Configuration Local AUPC
Maximum Power	-5 to -30 dBm	Configuration Local AUPC
Tracking Rate	0.5 to 6.0 dBm/min.	Configuration Local AUPC
Remote AUPC	ON or OFF	Function Remote AUPC
AUPC Enable	ON or OFF	Function Remote AUPC
Baseband Loopback	ON or OFF	Function Remote AUPC

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Asynchronous Overhead with AUPC is a closed network application that gives the user the ability to communicate from the hub site to the remote site through the added overhead. The user can use the AUPC feature that remotely controls the remote modem's power level, according to parameters programmed by the user. The user can also remotely monitor and control the remote modem by sending remote commands over the link via the overhead. This can be done by a local terminal or Monitor and Control system. Refer to Section A.1.4 for more information on the Asynchronous interface with AUPC.

3.5.1.5 EFD Closed Network Operation

The modem does not require any additional hardware installed to operate in EFD Closed Network configuration. The basic modem configuration, which includes the 25-pin D Data I/O connector, supports V.35, EIA-422, and EIA-232 data with no overhead. The Comtech EF Data closed network configuration allows the SLM-3650 to be compatible with any Comtech EF Data closed network application.

The modem can be compatible with other closed network applications by selecting different modulator and demodulator types. Fairchild and Comstream compatible closed network systems can be supported with the modem. When selecting these modulator and demodulator types, the modem becomes compatible with Fairchild or Comstream closed network modems that may be at the distant end of the link.

The modem can also support SDM-51 receive-only Space Link Remote Controlled (SLRC) modems. These receive-only modems are used in closed network applications where a small amount of overhead is used for monitor and control functions by the transmitting modem. The modem would become a transmit-only modem when the SDM-51 compatible modulator type was selected.

To operate the modem in the SDM-51 compatible configuration, the modem does not require any additional hardware installed. The 25-pin D Data I/O connector supports either EIA-422 or EIA-232 data that is used in the SDM-51, SDM-52, or SDR-54 receive-only modems. Refer to Table 3-9 for EFD Closed Network parameter settings.

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Table 3-9. EFD Closed Network Parameter Settings

Parameter	Front Panel Setting	Reference Menu
Modem Type	EFD	Utility: Modem Type
TX Data/Code Rate	TX-V, QPSK 1/2	Configuration : Modulator
TX IF Output	ON	Configuration: Modulator
RX Data/Code Rate	RX-V, QPSK 1/2	Configuration: Demodulator
TX Clock Source	TX Terrestrial	Configuration: Interface
Buffer Clock Source	Satellite Clock	Configuration: Interface
Modulator Type	EFD Closed (All modulator types are accessible)	Utility: Modulator
Encoder Type	Viterbi, Sequential or Turbo	Utility: Modulator
Demodulator Type	EFD Closed (All modulator types are accessible)	Utility: Demodulator
Decoder Type	Viterbi, Sequential or Turbo	Utility: Demodulator
TX Overhead Type	None	Utility: Interface
RX Overhead Type	None	Utility: Interface
Interface Type	EIA-422, EIA-232, V.35, G.703 *(see note)*	Utility: Interface
Buffer Program	Bits or Milliseconds	Utility: Interface
RTS TX IF Cntrl	OFF or ON	Utility: Interface
CTS Delay	0 Seconds	Utility: Interface

Note: To use G.703, the modem must have the required G.703 Overhead board installed.

3.5.1.6 Custom Operation

Note: If the modem serves as the backup unit for a rack of modems having different hardware and FAST options, then the backup modem shall have all of the features and hardware found in the other modems.

Operating in Custom mode allows access to all front panel menus, including the Utility menus. The Custom operation mode is mainly used when the modem must function with no overhead in an open network application. For example, to use the modem in the IDR mode of operation with overhead (308-2), the following steps are taken:

1. Select the IDR modem type, so that the modem loads the IDR default parameter.
2. Select the Custom modem type, which allows Access to the modulator and demodulator overhead type.
3. Select NONE for the overhead types.

A protection switch can make use of the Custom operation mode when the modem is configured as a backup modem. Because the backup modem is operating in Custom Mode, the switch can program all the backup modems parameters. Thus, the one backup modem can be made compatible with all of the various application types found in the rack.

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3.5.1.7 SDM-100 Emulation Operation

The SDM-100 Emulation feature of the modem provides remote protocol compatibility with existing SDM-100 modems, which makes several applications possible:

- Add an SLM-3650 to a rack of SDM-100s with a protection switch.
- Replace an SDM-100 requiring service with SLM-3650.
- Use SLM-3650 as the backup modem for a rack containing a mix of SDM-100 and SLM-3650 modems.

SDM-100 Emulation is typically a closed network application, with no added overhead. The modem does not require any additional hardware to operate in SDM-100 Emulation. The basic modem configuration, which includes the 25-pin D Data I/O connector, supports V.35, EIA-422, and EIA-232-C data.

Refer to Table 3-10 for SDM-100 emulation parameter settings.

Table 3-10. SDM-100 Emulation Parameter Settings

Parameter	Front Panel Settings	Reference Menu
Modem Emulation	SDM-100	Utility: Modem Type
TX Data/Code Rate	TX-V, QPSK 1/2	Configuration; Modulator
TX IF Output	ON	Configuration: Modulator
RX Data/Code Rate	RX-V, QPSK 1/2	Configuration: Demodulator
TX Clock Source	TX Terrestrial	Configuration: Interface
Buffer Clock Source	Satellite Clock	Configuration: Interface
Modulator Type	INTELSAT Open, CSC Closed, FDC Closed, EFD Closed	Utility: Modulator
Encoder Type	Viterbi or Sequential	Utility: Modulator
Demodulator Type	INTELSAT Open, CSC Closed, FDC Closed, EFD Closed	Utility: Demodulator
Decoder Type	Viterbi or Sequential	Utility: Demodulator
TX Overhead Type	None	Utility: Interface
RX Overhead Type	None	Utility: Interface
Interface Type	EIA-422, EIA-232, V.35	Utility: Interface
Buffer Program	Bits or Milliseconds	Utility: Interface
RTS TX IF Cntrl	OFF or ON	Utility: Interface

Note: Refer to Appendix A, A.1.4, for more information on the asynchronous interface with AUPC.

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3.5.1.8 SDM-6000 Emulation Operation

The SDM-6000 Emulation allows the SLM-3650 to be compatible with the SDM-6000 remote protocol. This modem type is used for mixing SLM-3650 modems with SDM-6000 modems that are in service, allowing the user to:

- Add a SLM-3650 to a rack of SDM-6000s with a protection switch.
- Replace an SDM-6000 requiring service with SLM-3650.
- Use SLM-3650 as the backup modem for a rack containing a mix of SLM-3650 and SDM-6000 modems.

The SDM-6000 Emulation can be an open or closed network application. If SDM-6000 application requires the use of IDR, IBS, D&I, or ASYNC overhead, then the Overhead PCB must be installed in the SLM-3650, and the applicable FAST option shall be enabled using the front panel.

Refer to Table 3-11 for SDM-6000 emulation parameter setting.

Table 3-11. SDM-6000 Emulation Parameter Settings

Parameter	Front Panel Setting	Reference Menu
Modem Emulation	SDM-6000	Utility: Modem Type
TX Data/Code Rate	TX-V, QPSK 1/2	Configuration: Modulator
TX IF Output	ON	Configuration: Modulator
RX Data/Code Rate	RX-V, QPSK 1/2	Configuration: Demodulator
TX Clock Source	TX Terrestrial	Configuration: Interface
Buffer Clock Source	Satellite Clock	Configuration: Interface
Modulator Type	INTELSAT Open, CSC Closed, FDC Closed, EFD Closed, SDM-51 Compatible	Utility: Modulator
Encoder Type	Viterbi or Sequential	Utility: Modulator
Demodulator Type	INTELSAT Open, CSC Closed, FDC Closed, EFD Closed	Utility: Demodulator
Decoder Type	Viterbi or Sequential	Utility: Demodulator
TX Overhead Type	None	Utility: Interface
RX Overhead Type	None	Utility: Interface
Interface Type	EIA-422, EIA-232, V.35, G.703	Utility: Interface
Buffer Program	Bits or Milli-Seconds	Utility: Interface
RST TX IF Cntrl	OFF or ON	Utility: Interface

Note: The SDM-6000 software version compatibility is displayed on the second line of the Figure 3-21, ***Utility:Modem Type:Modem Emulation*** menu.

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3.6 Clocking Options

Clocking of the data from the terrestrial equipment to the satellite (and vice versa) will depend on the application. This section describes the most common options and recommended configurations.

3.6.1 EIA-232, EIA-422, or V.35 Master/Master

Refer to Figure 3-27 for:

- Clocking block diagram
- Transmit clock options
- Buffer clock options
- V.35 timing signals
- EIA-422 timing signals

3.6.2 EIA-232, EIA-422, or V.35 Master/Slave

Refer to Figure 3-28 for:

- Clocking block diagram
- Transmit clock options
- Buffer clock options
- V.35 timing signals
- EIA-422 timing signals

The use of loop timing in the modem is an option for both EIA-422 and V.35 operation.

SCT (LOOP): SCT (INTERNAL) clock no longer applies when the modem has loop timing on. The TX clock source is now recovered from the RX satellite data. This recovered clock is put out on the ST line and is used to clock the terrestrial equipment. The transmit terrestrial clock is now essentially the same as the RX satellite clock, except that it has been buffered by the terrestrial equipment. Select TX TERRESTRIAL for the TX clock source when in loop timing, if the user equipment is being slaved off of the modem. The SCT (LOOP) indication serves as a reminder that the SCT internal clock is now the recovered clock, not the internal oscillator. Select SCT (LOOP) when the terrestrial equipment does not provide a transmit terrestrial clock.

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3.6.3 IDR/IBS G.703 Master/Master

Use this application when both earth stations have high stability clocks and the received data is to be clocked to the local network. Refer to Figure 3-29 for:

- Clocking block diagram
- Transmit clock options
- Buffer clock options

The disadvantage of the master/master application is that the receive data will slip, as the clocks will not be synchronized. If the buffer is properly set up, the slips will be an exact frame length, causing minimum loss of data. By using very high stability clocks, the expected time between slips can be several days.

Loss of the buffer clock will mean the buffer will not be emptied and data will not be available. The buffer clock will normally revert to the low stability internal reference automatically.

3.6.4 IDR/IBS G.703 Master/Slave

Use this application when the far end earth station does not have local access to a high stability reference clock, or when it is not required to synchronize with a local clock. Refer to Figure 3-30 for:

- Clocking block diagram
- Transmit clock options
- Buffer clock options for using external loop timing

Modem loop timing does not apply for G.703 operation. The terrestrial equipment must select loop timing to recover the clock off the receive data and use that recovered clock for the transmit data.

The disadvantage of the master/slave application is that the signal received at the slave station is subject to Doppler shift. The length of the buffer at the master end will need to be twice the length that is normally required, compensating for the Doppler shift on the outward and return paths.

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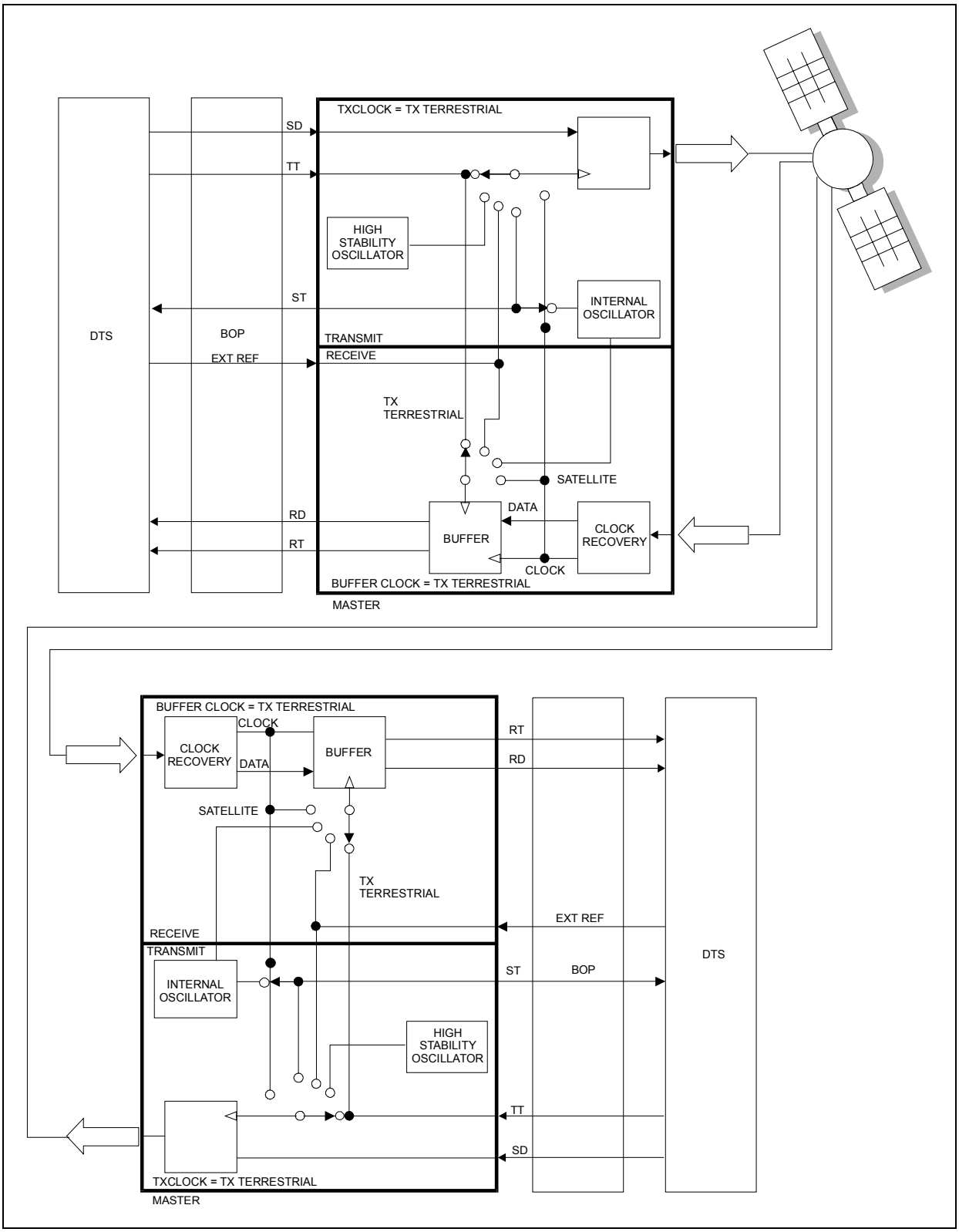


Figure 3-27. EIA-422, EIA-232, or V.35 Master/Master Clocking Diagram

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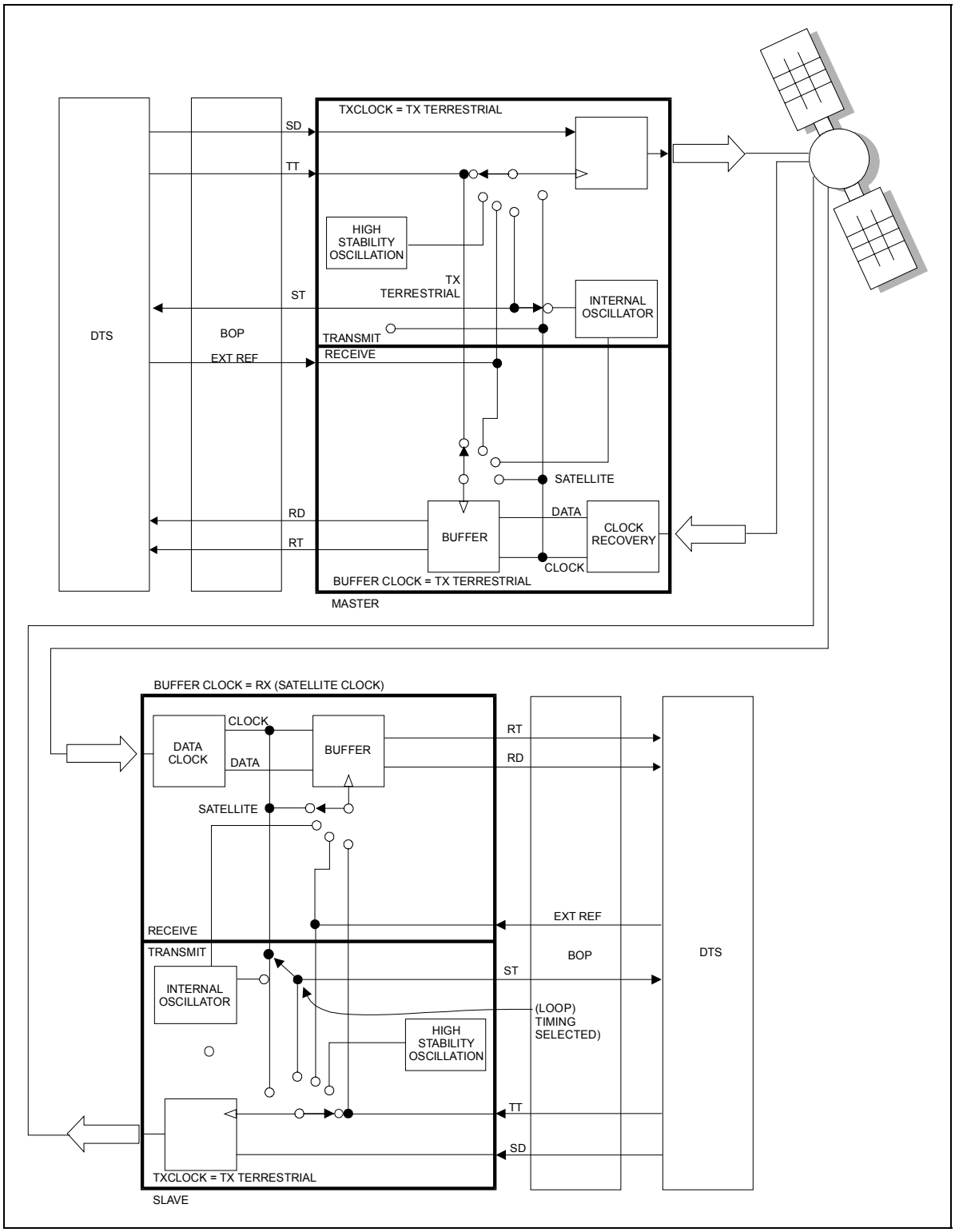


Figure 3-28. EIA-422, EIA-232, or V.35 Master/Slave Clocking Diagram

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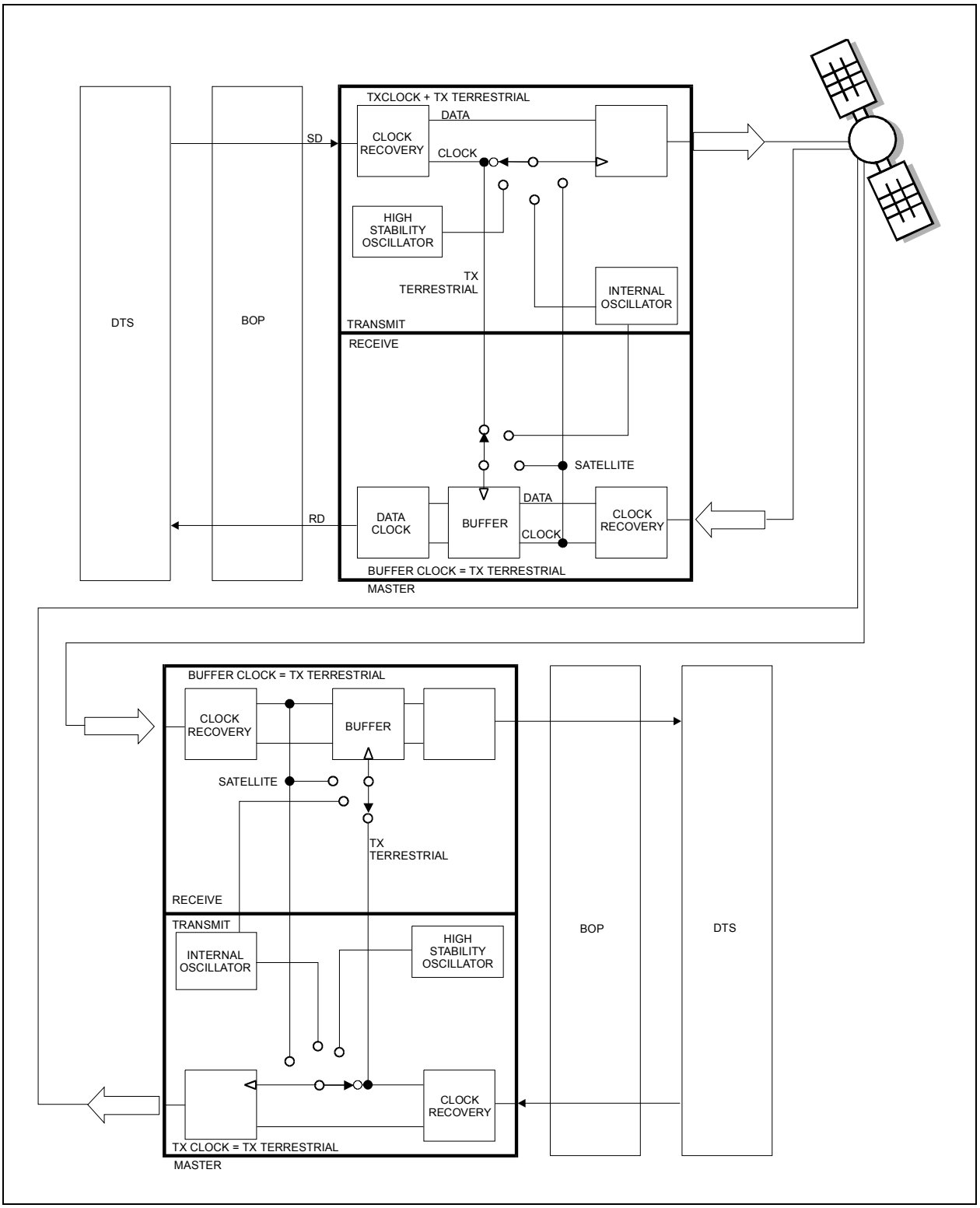


Figure 3-29. IDR/IBS G.703 Master/Master Clocking Diagram

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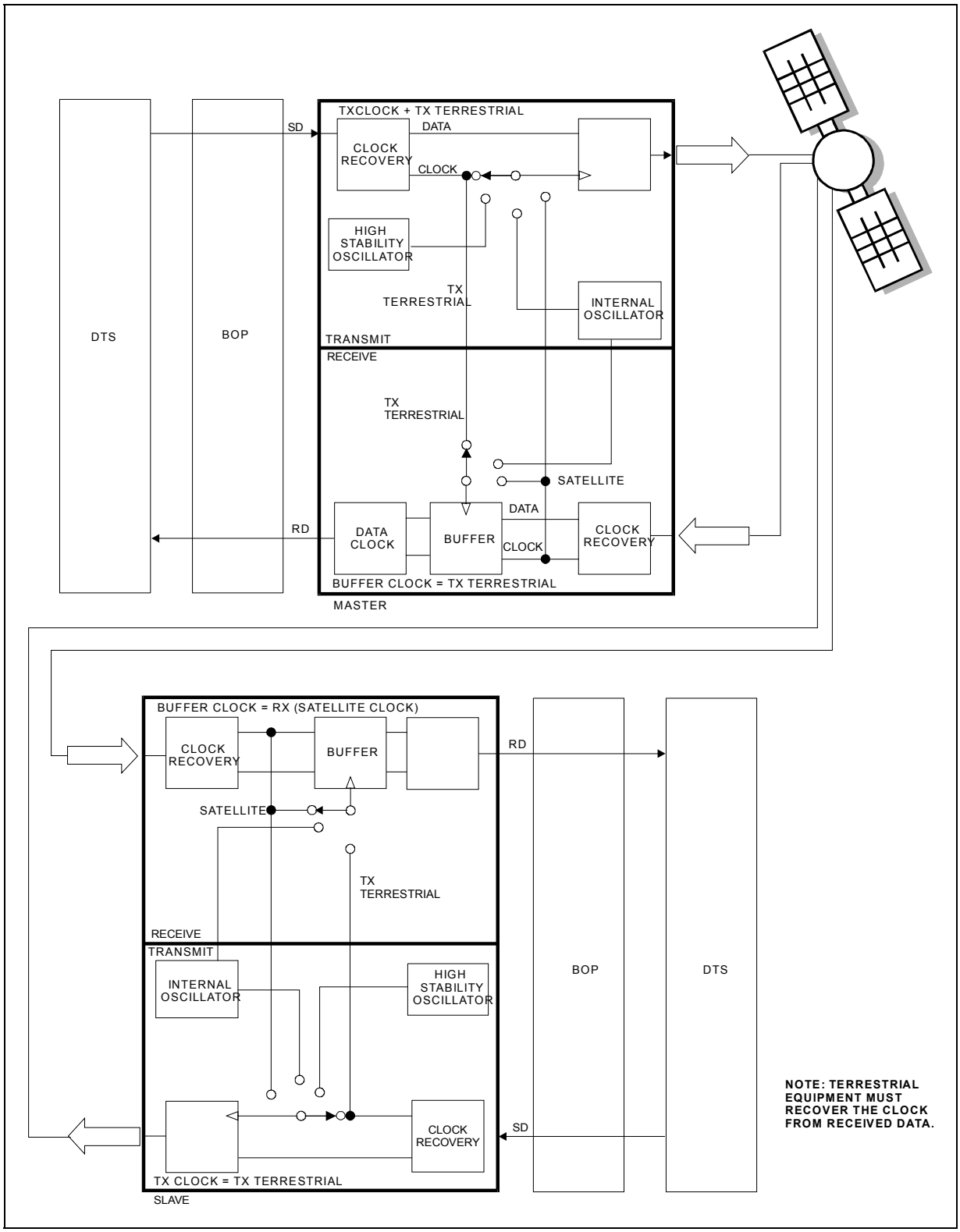


Figure 3-30. IDR/IBS G.703 Master/Slave Clocking Diagram

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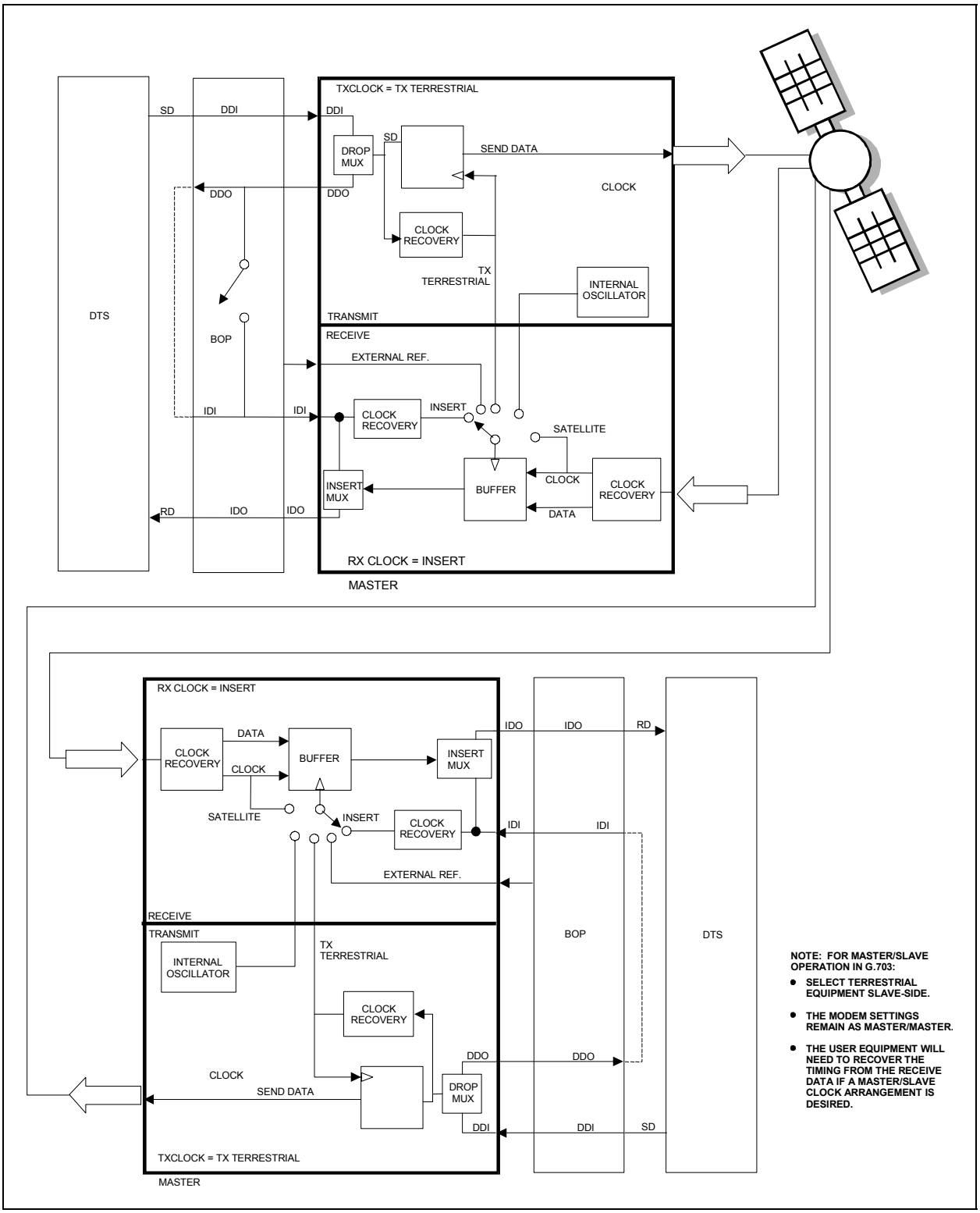


Figure 3-31. D&I G.703 Master/Master Clocking Diagram

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3.6.5 D&I G.703 Master/Master

In the D&I configuration, the most typical clocking option is the master/master application. Refer to Figure 3-31 for:

- Clocking block diagram
- Transmit clock options
- Buffer clock options

3.7 Buffering

The purpose of a receive buffer is to provide:

- Plesiochronous buffering of two dissimilar clock frequencies (normally the far end transmit clock vs. the local network clock). The clocks may be very close in frequency to each other and will normally slip at a constant rate. Figure 3-32 shows plesiochronous operation for dissimilar clocks. If incoming traffic is too fast, an occasional bit will be lost. If incoming traffic is too slow, an occasional bit will be repeated.

- Doppler buffer of the signal of the satellite. The Doppler shift results from the "figure 8 Station-keeping movement" (Figure 3-33) performed by the satellite in space over a period of one day. Doppler shift should not result in a clock slip, as the buffer will constantly fill and empty.

If the two earth stations are configured as master/slave, then the buffer need only be configured for Doppler operation. The buffer will then have sufficient capacity for the Doppler shift on the outward and return paths.

A buffer set up for Doppler operation only will typically require less depth than one intended for both Doppler and plesiochronous operation.

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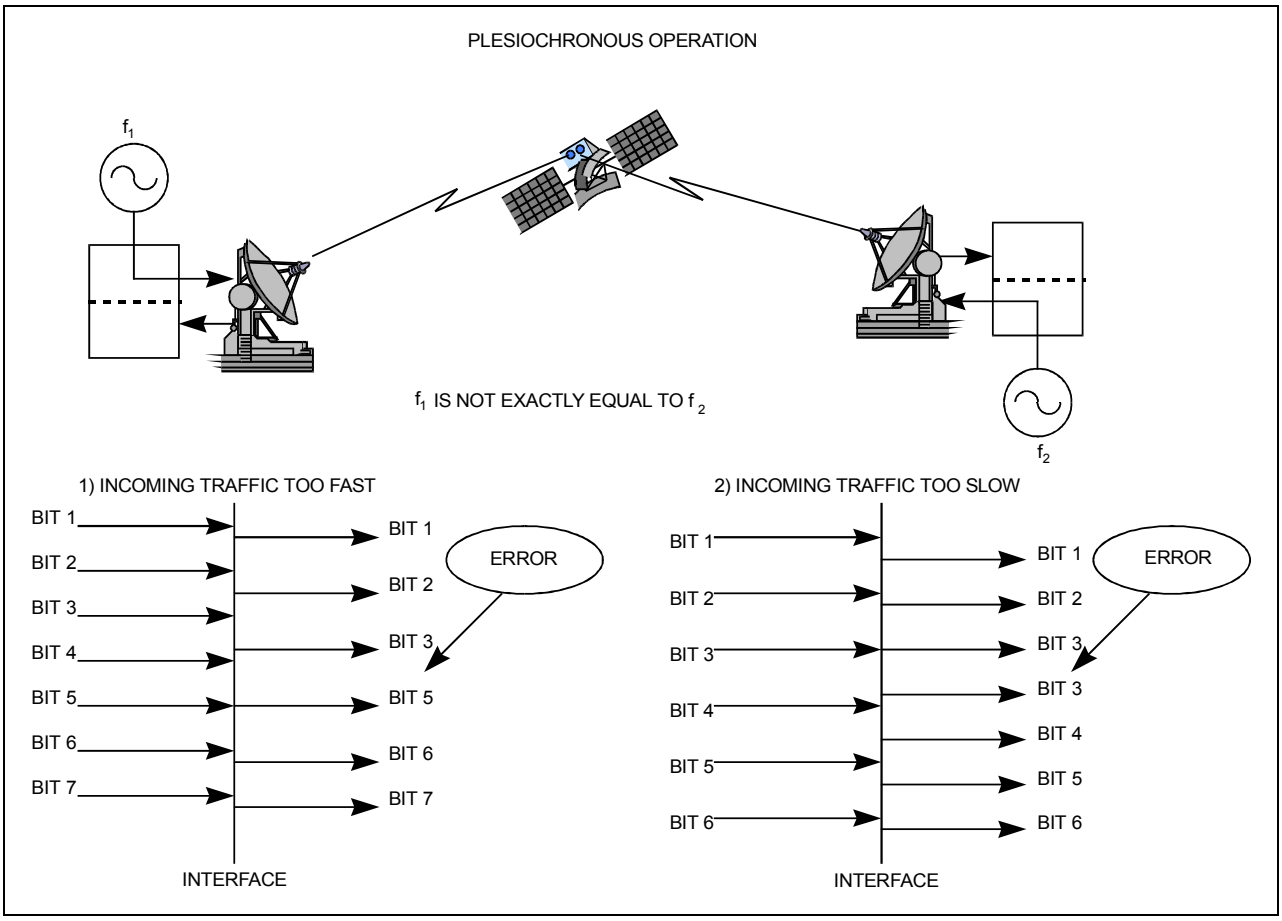


Figure 3-32. Clock Slip

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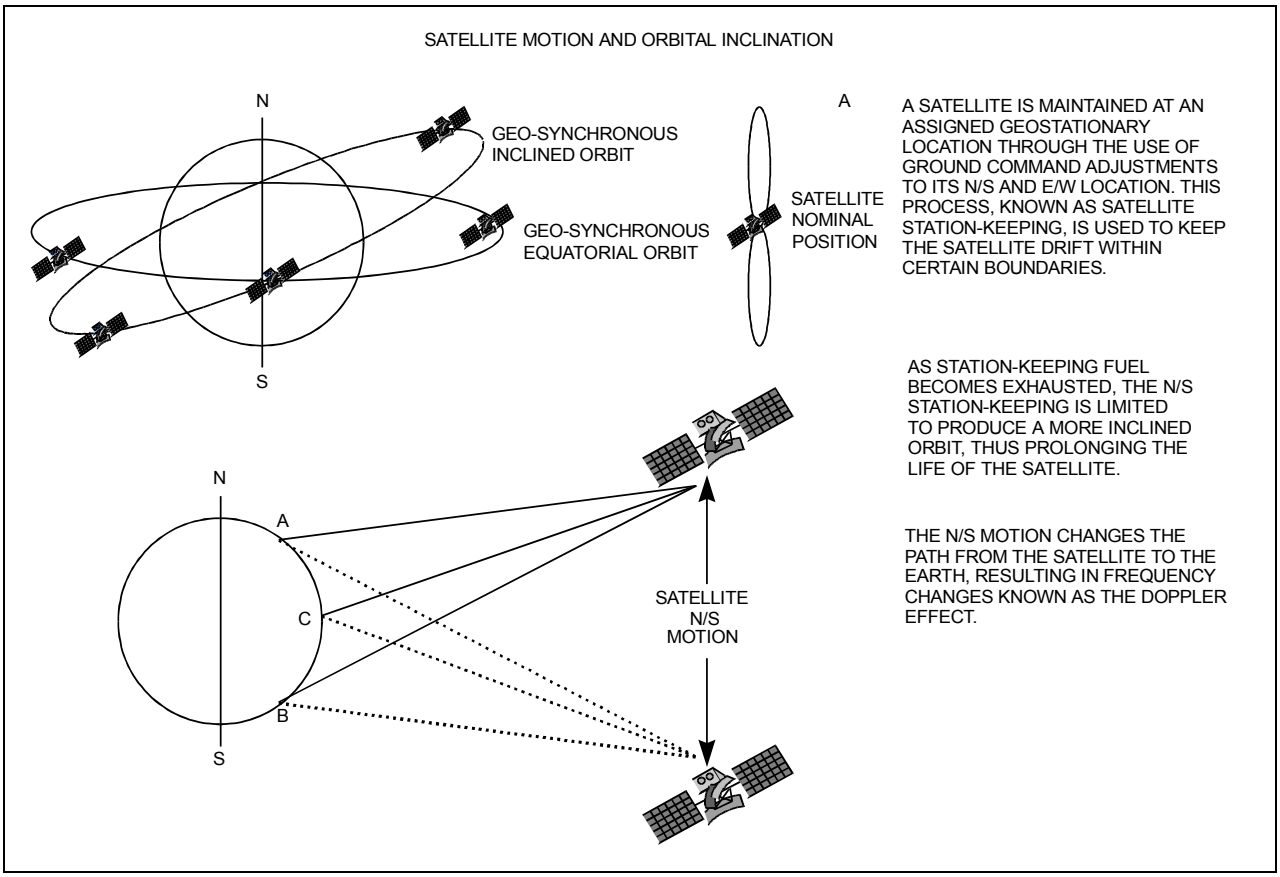


Figure 3-33. Doppler Shift

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3.7.1 Buffer Size

The depth of the receive buffer will depend on four parameters:

- Doppler shift caused by satellite
- Stability of each clock (plesiochronous/Doppler operation)
- Frame/Multiframe length of multiplexed data format
- Allowable time between clock slips

3.7.1.1 Doppler

A geostationary satellite should be positioned directly over the equator and orbit with a duration of 24 hours. In practice, the exact inclination of the satellite (relative to the equator) is influenced by the earth, moon, and sun's gravity, as well as solar wind. Station keeping motors are required to maintain the orbital position.

When viewed from the earth, the satellite appears to prescribe and ellipse in space, degrading to a "figure 8" as the angle of inclination increases.

The orbit of the satellite can result in a peak-to-peak altitude variation of ± 2% (85 km), while the station keeping of a newly launched satellite will typically be ± 0.1° (150 km). The total effect will be 172 km relative to the nominal 42,164 km radius.

Depending upon the location of the earth station relative to the satellite, the variation in propagation delay will typically be 1.15 ms (up to satellite and back down), therefore a buffer depth of 2 ms is sufficient to cope with most commercial satellites.

Since station keeping involves using fuel in the motors, the "lifetime" of the satellite can be extended by allowing the satellite to drift into a wider "figure 8" and using the motor less often.

The older satellites will be found in a more inclined orbit with the station keeping varying in latitude by as much as ± 4°. The total effect of the inclined orbit may result in a typical variation in path delay of 35 ms.

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3.7.1.2 Plesiochronous

The stability of station reference clocks is normally 1 x 10^{-12} (derived from a cesium standard). While the stability is exceptionally high, the two clocks are not in synchronization with each other and will eventually pass by each other.

The clock used for the transmit signal is passed over the satellite, but will not be used at the receive earth station where a national network derives its time locally. A buffer will fill up with data using the clock from the satellite and will empty using the local clock. The object of the buffer is to ensure that the buffer overflows or underflows at regular, determinable intervals (typically every 40 days).

The buffer depth required (from center to end) will be:

Minimum slip period (seconds) ∗ [stability of far end (transmit) clock + stability of local clock]

For example:

Far end (transmit) clock stability	1 x 10^{-9}
Local (buffer) clock	1 x 10^{-11}
Minimum clock slip	40 days

Buffer Depth = (40 x 24 x 60 x 60) x (1 x 10^{-9} + 1 x 10^{-11}) = 3.49 ms

Because the buffer will either fill or empty (depending on the frequency relationship of the two clocks), the total buffer depth will be 2 x 3.49 ms = 6.98 ms.

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3.7.1.3 Frame/Multiframe Length

The depth of the receive buffer required has been discussed in Section 3.7.1, and is applicable to all unframed data.

When the data is framed (such as 2048 kbps G732, or 1544 kbps G733), it is desirable to provide slips in predefined locations. The advantage of organized slip locations (in relation to the frame) is that multiplexing equipment does not lose sync and outages on any channel are kept to a minimum.

A 2048 kbps frame structure commonly used is G732. This has a frame length of 256 bits with 16 frames per multiframe (4096 bits total, or 2 ms).

3.7.1.3.1 Multiples of the Frame Length

If this setting is set to NONE, the user can choose any buffer depth.

3.7.1.4 Total Buffer Length

T1 and E1 framing structure under G.704 is available. When this is selected the buffer length is restricted to the size of the buffer as determined by Sections 3.7.1.1 through 3.7.1.3. Using the examples from the three previous sections, the total buffer depth (end to end) will be:

Doppler + Plesiochronous (rounded up to the nearest multiframe)
1.15 ms + 6.98 ms = 8.13 ms

If the frame length is 2 ms, then the nearest multiframe will be 10 ms, or 20,480 bits.

3.7.2 Converting Between Bits and Seconds

3.7.2.1 Bits to Seconds

1/Data Rate x Bits = Seconds.

3.7.2.2 Seconds to Bits

Data Rate x Seconds = Bits.

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Chapter 4. THEORY OF OPERATION

This chapter contains the theory of operation information for the Monitor and Control (M&C) section, modulator, demodulator, decoder, overhead interface, backward alarm information.

4.1 Monitor and Control (M&C)

The M&C monitors the modem and provides configuration updates to other modems within the modem when necessary.

The modem configuration parameters are maintained in battery-backed RAM, which provides total recovery after power-down situation.

The M&C functions include extensive fault and status reporting.

All modem functions are accessible through a local front panel interface and a remote communications interface.

A block diagram of the M&C is shown in Figure 4-1.

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4.1.1 Theory of Operation

The M&C card is composed of the following subsections:

- Microcontroller with Universal Asynchronous Receiver/Transmitter (UART)
- Digital-to-Analog Converter (DAC)
- Read Only Memory (ROM)
- Analog-to-Digital Converter (ADC)
- Read Access Memory (RAM)
- Universal ASYNC
- User Interface
- Fault and Alarm Relays

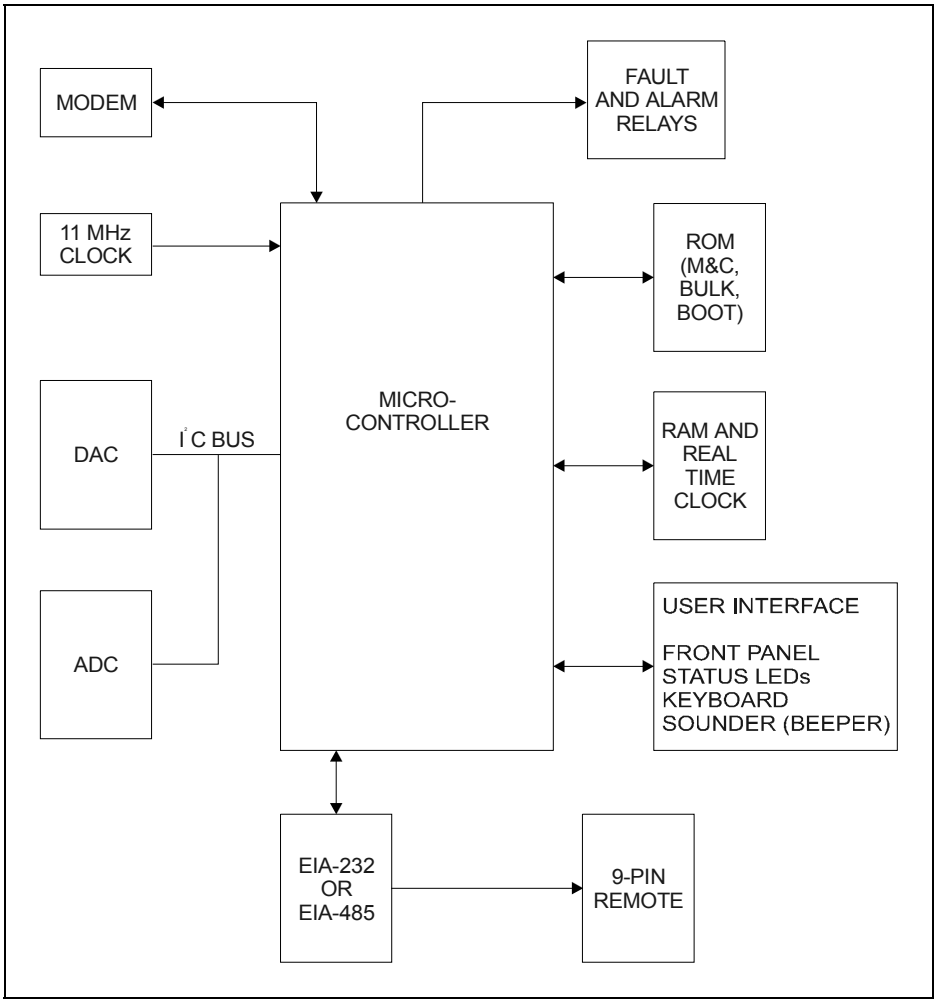


Figure 4-1. M&C Block Diagram

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The heart of the M&C card is the Dallas 80C310 microcontroller operating at 11 MHz. This microcontroller contains 256 kbytes of internal RAM. The ROM at U8 is 29F040 (512 kbytes).

ROM access times must be equal to or greater than 150 ns. The RAM can be 8 kbytes or 32 kbytes in size. This RAM chip is internally battery-backed and contains a real time clock used by the M&C.

The non-volatile RAM on the M&C module allows the module to retain configuration information without prime power for 1 year (approximately). If the modem is powered down, the following sequence is carried out by the M&C microcontroller.

1. When power is applied to the M&C, the microcontroller checks the non-volatile memory to see if valid data has been retained. If valid data has been retained, the modem is reconfigured to the parameters maintained by the RAM.

2. If the non-volatile memory fails the valid data test, a default configuration from ROM is loaded into the system.

The UART supports serial ASYNC communications channels (remote port) with a maximum data rate of 19200 bps. The UART is a built-in peripheral of the microcontroller. The communications type can be EIA-232, EIA-485 (2-wire), EIA-485 (4-wire), software selectable.

The DAC supplies a voltage that controls the contrast of the display. The ADC monitors all the voltages from the power supply. The DAC and ADC are mapped to the microcontroller with an Integrated Circuit (IC) bus.

The user interface includes the following parts:

- Front panel
- Status LEDs
- Keyboard
- Sounder (beeper)

All functions are memory-mapped to the microcontroller.

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4.1.2 Remote Baud Rate

The remote communications baud rate and parity are programmed by the front panel control in the Utility System menu (refer to Chapter 3). The programmed baud rate and parity are maintained indefinitely in RAM on the M&C module. The parity bits can be set to EVEN or ODD. The available baud rate are listed below:

- 150
- 300
- 600
- 1200
- 2400
- 4800
- 9600
- 19200

4.1.3 Remote Address

To communicate with the established remote communications protocol, configure each modem for one address between 1 and 255. Each modem on a common remote communications link (EIA-485) must have a distinct address. Use the front panel control in the ***Function Select: Utility: System*** menu (Chapter 3) to program the address.

An EIA-485/EIA-232 communications link remotely controls and monitors all modem functions. Use the 2- or 4-wire, half-duplex EIA-485 interface to connect between two or more modems and switches on a common communications link. Use the EIA-232 interface to communicate with a single modem.

Note: Address 0 is reserved as a global address which simultaneously addresses all devices on a given communications link.

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4.1.4 SLM-3650 Custom Modem Defaults

Refer to Table 4-1 for custom modem defaults.

Note: The following parameters do not revert to default settings after a hard reset:

- Address/Parity/Baud Rate
- Remote Type
- EXT AGC MIN Power
- EXT AGC Max Power
- Display Contrast

Table 4-1. Custom Modem Defaults

Configuration:			
Modulator		**Demodulator**	
Data Rate	A	Date Rate	A
TX Rate A	64 kbps, QPSK 1/2	RX Rate A	64 kbps, QPSK 1/2
TX Rate B	128 kbps, QPSK 1/2	RX Rate B	128 kbps, QPSK 1/2
TX Rate C	256 kbps, QPSK 1/2	RX Rate C	256 kbps, QPSK 1/2
TX Rate D	512 kbps, QPSK 1/2	RX Rate D	512 kbps, QPSK 1/2
TX Rate V	38.4 kbps, QPSK 1/2	RX Rate V	38.4 kbps, QPSK 1/2
TX-IF Frequency	70 MHz	RX-IF Frequency	70 MHz
TX-IF Output	OFF	Descrambler	ON
TX Power Level	-10 dBm	Diff. Decoder	ON
Scrambler	ON	RF Loop Back	OFF
Diff. Encoder	ON	IF Loop Back	OFF
Carrier Mode	Normal-Modulated	BER Threshold	NONE
Modem Reference	Internal	Sweep Center	0 Hz
RS Encoder	OFF	Sweep Range	60000 Hz
		Reacquisition	0 seconds
		RS Decoder	OFF
Configuration: Interface			
TX Clock Source	TX Terrestrial	Service Channel Adj	-5 dBm
TX Clock Phase	AUTO	Drop Format	T1
EXT-CLK Freq	1544 kHz	Insert Format	T1
Buffer Clock	RX (Satellite)	Drop SAT	Channel Terr, other T-Slot Terr
Buffer Size	384 bits or 6 ms	Insert SAT	Channel Terr, other T-Slot Terr
RX Clock Phase	Normal	ASYNC TX Baud	110 kbps
B-Band Loop Back	OFF	ASYNC RX Baud	110 kbps
INTRFC Loop Back	OFF	ASYNC TX Length	7 bits
Loop Timing	OFF	ASYNC RX Length	7 bits
TX Data Fault	None	ASYNC TX Stop	2 bits
RX Data Fault	None	ASYNC RX Stop	2 bits
TX 2047 Pattern	OFF	ASYNC TX Parity	Even
RX 2047 Pattern	OFF	ASYNC RX Parity	Even
TX Coding Format	AMI		
RX Coding Format	AMI		
Function Select: Local AUPC			
AUPC Enabled	OFF	Target Eb/No	6.0 dB
Nominal Power	–10.0 dBm	Tracking Rate	0.5 dB/min
Minimum Power	-30.0 dBm	Local CL Action	Hold
Maximum Power	-5.0 dBm	Remote CL Action	Hold

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Configuration MUX			
Tributary #N	2048.0 kbps RS422 CLK:NRM DATA:NRM MD: SYNC AF:7E2	Aggregate DR	2305.3 kbps
Flex MUX			
TX Chan #1 Mode	D&I Enabled	RX Chan #1 Mode	D&I Enabled
TX Chan #1 DR	64.0 kbps	RX Chan #1 DR	64.0 kbps
TX Chan # 2 Mode	ADPCM Disabled	RX Chan # 2 Mode	ADPCM Disabled
TX Chan #3 Mode	SYNC RS422	RX Chan #3 Mode	SYNC RS422
TX Chan #3 DR	64.0 kbps	RX Chan #3 DR	64.0 kbps
TX Chan #3 Phase	CLK:NRM DATA:NRM	RX Chan #3 Phase	CLK:NRM DATA:NRM
TX Chan #4 Mode	ASYNC RS485	RX Chan #4 Mode	ASYNC RS485
TX Chan #4 DR	9.6 kbps	RX Chan #4 DR	9.6 kbps
TX Chan #4 Phase	CLK:NRM DATA:NRM	RX Chan #4 Phase	CLK:NRM DATA:NRM
Function Select: Monitor			
Raw BER	2.4 E-3	Sweep Frequency	0 Hz
Corrected BER	4.0 E-3	Buffer Fill	50%
Eb/No	16.0 dB	Frame Errors	n.n E-e
Receive Signal	-45.0 dBm		
Function Select: Remote AUPC			
AUPC Enable	OFF	TX 2047 Pattern	OFF
B-Band Loop Back	OFF	2047 Errors	n.n E-e
Function Select: Utility			
Modulator		**Demodulator**	
Data Rate	A	Date Rate	A
TX Rate A	64 kbps, QPSK 1/2	RX Rate A	64 kbps, QPSK 1/2
TX Rate B	128 kbps, QPSK 1/2	RX Rate B	128 kbps, QPSK 1/2
TX Rate C	256 kbps, QPSK 1/2	RX Rate C	256 kbps, QPSK 1/2
TX Rate D	512 kbps, QPSK 1/2	RX Rate D	512 kbps, QPSK 1/2
TX Rate V	38.4 kbps, QPSK 1/2	RX Rate V	38.4 kbps, QPSK 1/2
MOD Power Offset	+0.0 dB	Demodulator Type	INTELSAT Open
Modulator Type	INTELSAT Open	Decoder Type	Viterbi
Encoder Type	Viterbi	RX BPSK Ordering	Standard
TX BPSK Ordering	Standard	Demod Spectrum	Normal
MOD Spectrum	Normal	RX-RS Interleave	8 Deep
TX-RS Interleave	8 Deep	RX-RS (Alternate)	N=225, K=205, I=8
TX-RS Duplex (Alternate)	N=225, K=205, I=8	RX-RS Duplex	Default
TX-RS Duplex	Default	RX IESS-310 Mode	OFF
TX IESS-310 Mode	OFF	RX-IESS-315 Mode	OFF
TX-IESS-315 Mode	OFF	RX Symbol Rate	64 ksps
TX Symbol Rate	64.0 ksps	RX Mode	Continuous
TX Mode	Continuous	Max Packet Size	2048
Utility: Interface			
TX Overhead Type	None	E1 Insert CRC	ON
RX Overhead Type	None	IDR Backward Alarm	ON
TX TERR Interface	RS-422	ASYNC TX Type	RS-232
RX TERR Interface	RS-422	ASYNC RX Type	RS-232
Buffer Program	Bits	IDR TX ESC Type	2-32K Audio
Framing Structure (T1 & E1)	G.704	IDR RX ESC Type	2-32K Audio
RTS TX-IF CNTRL	OFF	CTS Delay	0 seconds
TX Data Phase	Normal		
RX Data Phase	Normal		

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Utility:Utility System			
Time Date	12:00:00 AM 7/04/76	M&C Firmware	FW/NNNNNN-DDR MM/DD/YYYY
Remote Baud Rate	9600 bps	Boot Firmware	FW/NNNNNN-DDR MM/DD/YYYY VER: x.x.x
Remote Address	1	FPGA Firmware	FW/NNNNNN-DDR MM/DD/YYYY
Remote Type	RS-485 (2-wire)	Turbo Firmware	FW/NNNNNNR
Operation Mode	Duplex	Display Contrast	64
Year Display	2-digit	EXT AGC MIN PWR	0.0 Volts
Self Test	OFF	EXT AGC MAX PWR	10.0 Volts
Utility: Modem Type			
Modem Type	Custom	Rev. Emulation	Current Version
Intelsat Data	50-Pin	Card #1 Type	Overhead 01
NRZ Data I/O	RS-422	Card #2 Type	Reed-Solomon 02
G.703 Operation	Unbalanced	Card #3 Type	Reed-Solomon 03
Modem Emulation	Disabled	Local Modem AUPC	OFF

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4.2 Modulator

The modulator provides PSK modulated carriers within the 50 to 180 MHz range. The types of modulation that encode the transmitted baseband data from the interface PCB are:

- BPSK
- QPSK
- OQPSK
- 8PSK

Refer to 4.2.3 for a description of each modulation type.

A block diagram of the modulator is shown in Figure 4-2.

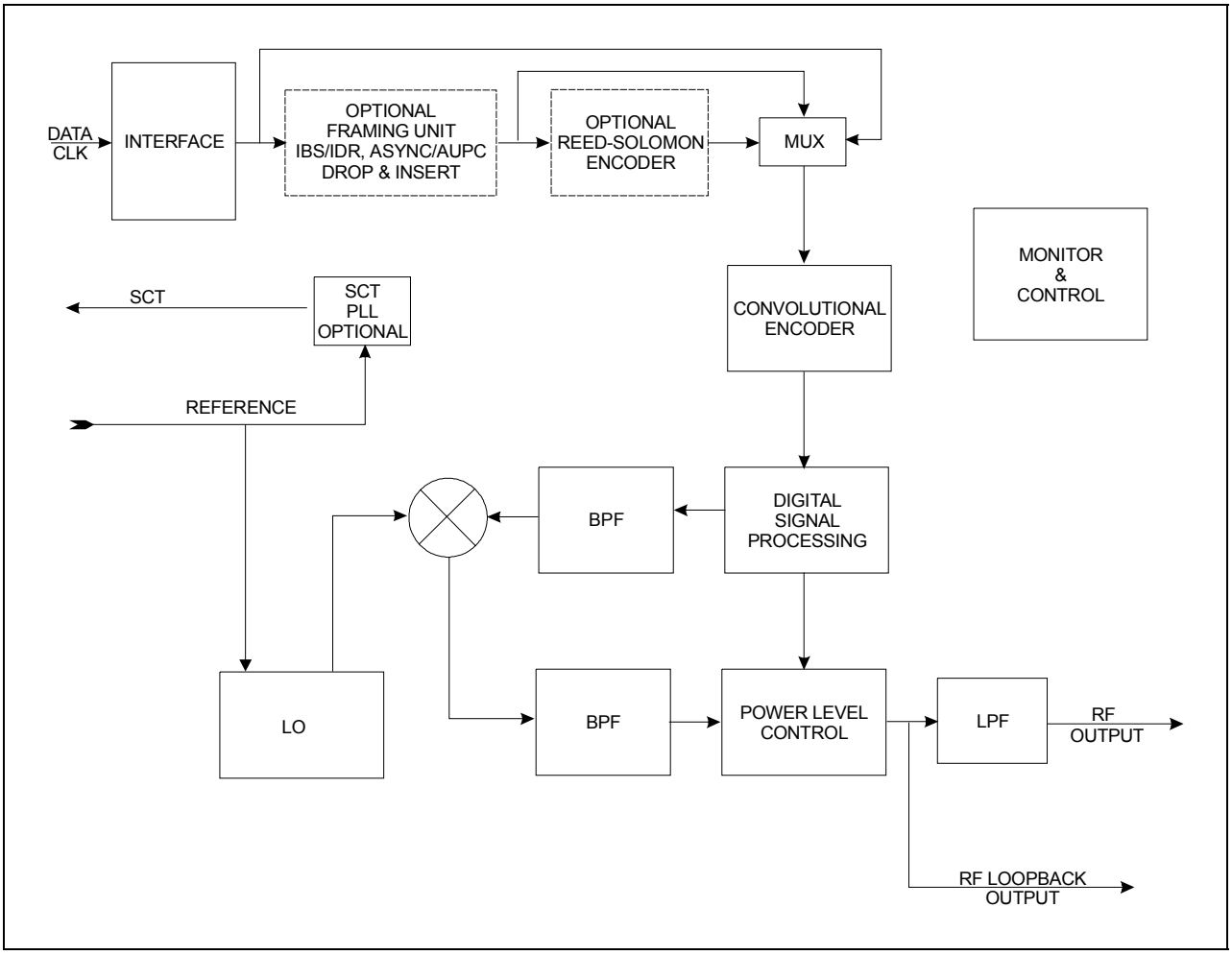


Figure 4-2. Modulator Block Diagram

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4.2.1 Modulator Specifications

Refer to Table 4-2 for modulator specifications.

Table 4-2. Modulator Specifications

Parameter	Specification	
Modulation Types	BPSK, QPSK, OQPSK, 8-PSK	
Data Rate Range	2.4 kbps to 1.25 Mbps	1/2 Rate BPSK
	4.8 kbps to 2.5 Mbps	1/2 Rate {O}QPSK
	7.2 kbps to 3.75 Mbps	3/4 Rate {O}QPSK
	8.4 kbps to 4.375 Mbps	7/8 Rate {O}QPSK
	64 kbps to 5.0 Mbps	2/3 Rate 8PSK
	4.8 kbps to 2.5Mbps	1/1 Rate BPSK
	9.6 kbps to 5.0 Mbps	1/1 Rate {O}QPSK
	2.4 kbps to 1193.181 kbps	21/44 Rate BPSK
	2.4 kbps to 781.25 kbps	5/16 Rate BPSK
	4.8 kbps to 2386.363 kbps	1/2 Rate {O}QPSK
	64 kbps to 5.0 Mbps	3/4 Rate 8PSK
Symbol Rate Range	4.8 ks/s to 2.5 Ms/s	
Test Modes	Carrier Null and Quadrature (Dual and Offset)	
Frequency Range	50 to 180 MHz	
Frequency Select Method	Synthesized	
Frequency Step Size	1 Hz	
Frequency Stability (RF)	Internal Reference: ± 10 PPM oscillator Optional high stability oscillator (2 x 10^{-7}), with ability to drive out the EXT REF. Connector External Reference: Will lock to external 1, 5, 10, or 20 MHz reference	
Frequency Stability (SCT)	Internal Reference: ± 10 PPM oscillator Optional high stability oscillator (2 x 10^{-7}) External Reference: Will lock to external 1, 5, 10, or 20 MHz reference	

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Table 4-2. Modulator Specifications (Continued)

Parameter	Specification
Phase Error	2.5° maximum
Filtering Type	Nyquist, pre-equalized
Spectral Occupancy	Spectral density is -30 dB at ± 0.75 symbol rate
Spurious and Harmonics	-55 dBc, 0 to 500 MHz
Output Power Level Range	-5 to -30 dBm, ± 0.5 dB (+5 to -20 dBm high-power option)
Output Stability	± 0.5 dB
Output Power Adjustment	0.1 dB step size
Output Impedance	50Ω (75Ω optional)
Output Return Loss	20 dB minimum
Scrambler Type	V.35
Differential Encoding	2-phase or none
FEC Convolution Encoding/ Viterbi or Sequential Encoding	Rate 1/2, 3/4, 7/8, 2/3 (Viterbi/TCM) Rate 1/2, 3/4, 7/8 (Sequential) Reed-Solomon: Rate 225/205, 126/112, 219/201 IBS: 219/204 FEC 'OFF' Uncoded
Filter Masks	Open Net (Intelsat or Eutelsat), EFD Closed, Comstream Closed, FDC Closed, and SDM-51 Compatible
I/O Connector	TNC 50Ω (TX IF)
Reported Faults	AGC Level IF Synthesizer I Channel Filter Activity Q Channel Filter Activity Modem Reference Activity Data Clock Syn Module Modem Reference PLL

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4.2.2 Theory of Operation

The modulator is composed of eight basic subsections. These subsections are divided into the baseband processing section and the RF section of the modulator. The modulator controls all programmable functions on this module. Fault information from the modulator is sent to the M&C. Refer to Chapter 5 for a list of reported faults.

The major modulator subsections are:

- Scrambler/Differential Encoder
- Convolutional Encoder
- Programmable Vector Rotation
- I/Q Nyquist Filters
- Modulator
- RF Synthesizer
- Output Amplifier
- Output Level Control

If the modem is so equipped, the data is first processed by the optional overhead or Reed-Solomon PCB. The data is then sent to the scrambler for energy dispersal, and then to the differential encoder. The differential encoder is a 2-bit encoder which allows for resolution of two of the four ambiguity states of the QPSK demodulator.

The data is sent to the convolutional encoder for encoding the baseband data. The code rates 1/2, 3/4, 7/8, and 2/3 are based on the symbol rate range of 2.4 kbps to 2.5 Mbps. For Viterbi codes, the convolutional encoder encodes the data at 1/2 rate. If the selected code rate is 3/4, then 2 of every 6 symbols are punctured. For 3 bits in, there are 4 symbols out.

For Sequential codes, the convolutional encoder generates the parity bits from the input data stream, which allows for error correction at the far end of the link. The rate of the encoder may be 1/2, 3/4, 7/8, and 2/3. For example, the 7/8 rate puts out 8 symbols for every 7 bits in. In QPSK mode, the data is split into two separate data streams to drive the I and Q channels of the modulator. Refer to Section 4.2.3 for the theory of modulation types.

After the convolutional encoder, the data is sent to a programmable vector rotation circuit. This feature provides the user with data communications compatibility for spectrum reversal of the I and Q channels before and after satellite transmission.

The I and Q channel data then pass through a set of variable rate digital Nyquist filters.

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The two identical digital Nyquist filters are followed by Direct Digital Modulation. Symbol rates up to 2.5 Mbps can be achieved automatically.

The modulated carrier is applied to the RF section for conversion to the correct output frequency. The spectral shape will be identical to that of the input data streams, but double-sided about the carrier frequency.

The RF synthesizer provides the proper frequencies to convert the modulator IF to the desired output frequency in the 50 to 180 MHz range. The synthesizer has a single loop, and incorporates a Direct Digital Synthesis (DDS) chip to accommodate 1 Hz steps over a range of 130 MHz. The RF section has a frequency stability of $\pm$ 1 x 10^{-5}. An optional 2 x 10^{-7} Temperature Compensated Crystal Oscillator (TCXO) can be installed.

The signal is sent to the output amplifier. The amplifier takes the low level signal from the modulator section and amplifies the signal to the proper level for output from the module. The amplifier circuitry provides programmable control of the output level over a range of -5 to -30 dB, in 0.1 dB steps. The amplifier has power leveling of $\pm$ 0.5 dB to maintain the stability of the output level over time and temperature. The +5 dB output option is capable of outputting +5 to -20 dBm.

4.2.3 Theory of Modulation Types

The modulation types for the modem include BPSK, QPSK, or 8PSK.

The PSK data transmission encoding method uses the phase modulation technique. This method varies the phase angle of the carrier wave to represent a different bit value for the receiver. The higher levels of modulation are required for an operating range that has a limited bandwidth.

The order of modulation is represented by mPSK, where “m” relates to the number of discrete phase angles. Refer to the following list for a brief description of the modulation types.

- BPSK: 2 discrete phase angles represent the 2 possible states of a symbol.
- QPSK: 4 discrete phase angles represent the 4 possible states of a symbol.
- 8PSK: 8 discrete phase angles represent the 8 possible states of a symbol.

Note: The code rate determines the number of symbols per bit.

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4.2.3.1 BPSK Encoding

The modulator converts transmitted baseband data into a modulated BPSK carrier at 2.4 kbps to 1.25 Mbps (1/2 rate). Using vector analysis of the constellation pattern, BPSK represents one symbol with the carrier phase either at 0° or 180°. The 1/2 rate encoding at the convolutional encoder provides two symbols output for every bit input.

Code Rate	Symbols/Bit	Bits/Hz
1/2	2	0.5

4.2.3.2 QPSK Encoding

The modulator converts transmitted baseband data into a modulated QPSK carrier at the following parameters:

- 4.8 kbps to 2.5 Mbps (1/2 rate)
- 7.2 kbps to 3.75 Mbps (3/4 rate)
- 8.4 kbps to 4.375 Mbps (7/8 rate)

Using vector analysis of the constellation pattern, QPSK represents a symbol with the carrier phase angle at 45°, 135°, 225°, or 315°. The 1/2, 3/4, and 7/8 rates encoded at the convolutional encoder provide the desired input/output bit rates.

Code Rate	Symbols/Bit	Bits/Hz
1/2	2	1
3/4	1.5	1.33
7/8	1.143	1.75

4.2.3.3 8-PSK Encoding

The modulator converts transmitted baseband data into modulated 8-PSK carrier at the following parameters:

- 64 kbps to 5.0 Mbps (2/3 rate)

Using vector analysis of the constellation pattern, 8-PSK represents a symbol with carrier phase angles at 22.5°, 67.5°, 112.5°, 157.5°, 202.5°, 247.5°, 292.5°, and 337.5°. The 2/3 rate encoding provides the desired input/output bit rates.

Code Rate	Symbol/Bit	Bit/s Hz
2/3	1.5	2

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4.3 Demodulator

A block diagram of the demodulator is shown in Figure 4-3.

The demodulator converts PSK modulated carriers within the 50 to 180 MHz range to a demodulated baseband data stream. The converted modulation types are BPSK, QPSK, and 8PSK (refer to Section 4.2.3 for a description of modulation types). The demodulator then performs FEC on the data stream using Viterbi or Sequential decoding algorithms.

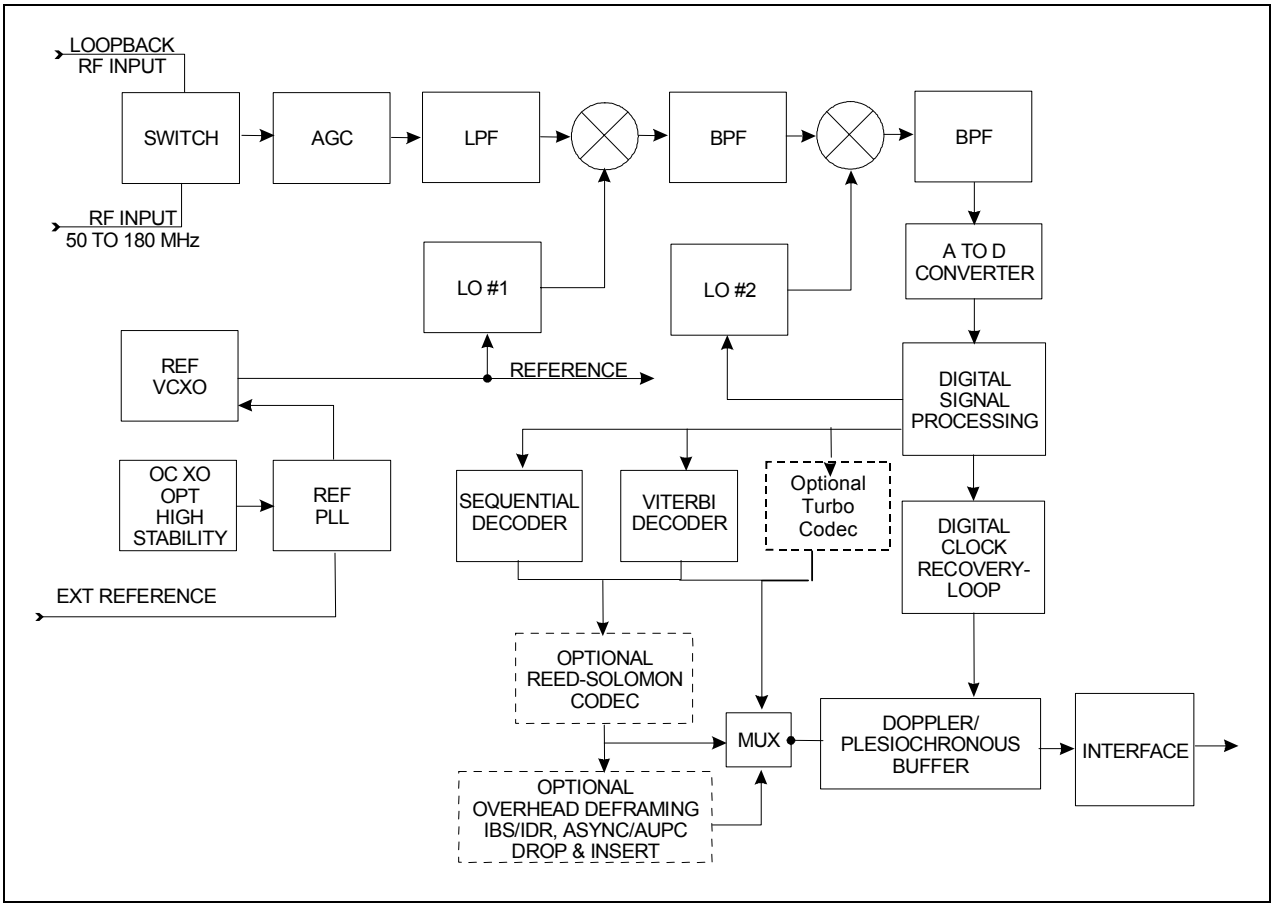


Figure 4-3. Demodulator Block Diagram

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4.3.1 Demodulator Specifications

Refer to Table 4-3 for demodulator specifications.

Table 4-3. Demodulator Specifications

Parameter	Specification
Modulation Types	BPSK, QPSK,OQPSK, 8PSK
Data Rate Range	2.4 kbps to 1.25 Mbps 1/2 Rate BPSK 4.8 kbps to 2.5 Mbps 1/2 Rate {O}QPSK 7.2 kbps to 3.75 Mbps 3/4 Rate {O}QPSK 8.4 kbps to 4.375 Mbps 7/8 Rate {O}QPSK 64 kbps to 5.0 Mbps 2/3 Rate 8PSK 4.8 kbps to 2.5 Mbps 1/1 Rate BPSK 9.6 kbps to 5.0 Mbps 1/1 Rate {O}QPSK 2.4 kbps to 1193.181 kbps 21/44 Rate BPSK 2.4 kbps to 781.25 kbps 5/16 Rate BPSK 4.8 kbps to 2386.363 kbps 1/2 Rate {O}QPSK 64 kbps to 5.0 Mbps 3/4 Rate 8PSK
Symbol Rate Range	4.8 ks/s to 2.5 Ms/s
IF Frequency	50 to 180 MHz, in 1 Hz steps
Input Level	-30 to -55 dBm
Decoding Type	Rate 1/2, 3/4, 7/8, 2/3 (Viterbi/TCM) Rate 1/2, 3/4, 7/8 (Sequential) Rate 225/205, 126/112, 219/201 (Reed-Solomon) IBS: 219/204 Turbo: Rate 5/16, 21/44, 1/2, 3/4 FEC 'OFF' Uncoded
Filter Masks	Open net (INTELSAT or EUTELSAT) EFD Closed net, Comstream Closed, FDC Closed
Descrambler Type	V.35
Reported Faults	Carrier Detect IF Synthesizer BER Threshold RX Clock Syn Module I Channel Q Channel

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4.3.2 Theory of Operation

The demodulator functions as an advanced, digital, coherent-phase-lock receiver and decoder. Demodulator faults are also reported to the front panel. The demodulator consists of the following basic subsections.

- Digital Costas Loop
- RF Section
- Automatic Gain Control
- Analog-to-Digital (A/D) Converter
- Soft Decision Mapping
- Programmable Vector Rotation
- Digital Nyquist Filters
- FEC Decoder
- Digital Clock Recovery Loop
- Decoder

The modulated IF signal at 50 to 180 MHz enters the RF module for conversion to an IF frequency. The IF is then sampled by an A to D converter and digitally demodulated. The I and Q data is then sent to the digital Nyquist filters, resulting in a filtered, digital representation of the received signal. The digital data is then sent to four separate circuits:

- Automatic Gain Control
- Carrier Recovery (Costas) Loop
- Clock Recovery Loop
- Soft Decision Mapping

The AGC provides a gain feedback signal to the RF section. This closed loop control ensures that the digital representation of the I and Q channels is optimized for the Costas and Clock loops, as well as the soft-decision mapping circuitry.

When the active decoder determines that the modem is locked, the M&C stops the sweep and begins the de-stress process. This involves fine tuning the DDS based on the phase error in the Costas loop. The de-stress process continues as long as the modem is locked. If the carrier is interrupted, the M&C resumes the sweep process.

The digital Costas loop, in conjunction with a Direct Digital Synthesizer (DDS), performs the carrier recovery function. The Costas loop consists of a Costas phase detector, loop filter, and DDS, all implemented digitally. The DDS performs the function of a Voltage-Controlled Oscillator (VCO) in an analog implementation, but can be easily programmed to the desired center frequency via the M&C. The output of the DDS is sent to the RF module and provides the reference to which the local oscillator is locked. The M&C sweeps the local oscillator (via DDS programming) through the user-specified sweep range.

The digital clock loop, in conjunction with another DDS, performs the clock recovery function. The clock loop consists of a phase detector, loop filter, and DDS, all

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implemented digitally. The DDS performs the function of a VCO in an analog implementation. The recovered data and symbol clocks are then used throughout the demodulator.

The soft decision mapper converts the digital I and Q data to 3-bit soft decision values. These values are then fed to the programmable vector rotation circuit, providing compatibility with spectrum reversal of the I and Q channels.

The output of the vector rotation circuit is then sent to the Viterbi decoder and optional Sequential decoder. The output is then sent to the optional Reed-Solomon or Overhead PCB.

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4.4 Decoder

The SLM-3650 can be configured in any of the following configurations:

- Basic SLM-3650 (Sequential or Viterbi Decoder)
- FAST options (Sequential or Viterbi Decoder)
- FAST options with Reed-Solomon hardware (Sequential or Viterbi Decoder)
- FAST options with Turbo Codec hardware
- FAST options with Overhead hardware (Sequential or Viterbi Decoder)
- FAST options with Reed-Solomon and Overhead hardware (Sequential or Viterbi Decoder)

Refer to Appendix A for additional information.

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4.5 Interface

The terrestrial interface functions include:

- MUX various types of ESC into the data
- Buffering the receive data
- DEMUX various types of ESC from the data
- Monitoring and displaying the interface status without interruption of service

The interface block diagram is shown in Figure 4-4.

The terrestrial interfaces for the modem are defined by data communication standards MIL-STD-188/EIA-449, EIA-232, or V.35. The interface receivers and drivers for these standards, as well as the handshake signals for MIL-STD-188 and V.35, are selectable through the front panel selection.

Overhead can be added to the terrestrial data for IBS and IDR modes of operation. The format of the overhead data is dependent on the mode of operation and requires one of the following options used with the interface PCB:

- D&I MUX
- ASYNC/AUPC

Refer to Appendix A for additional information concerning these options.

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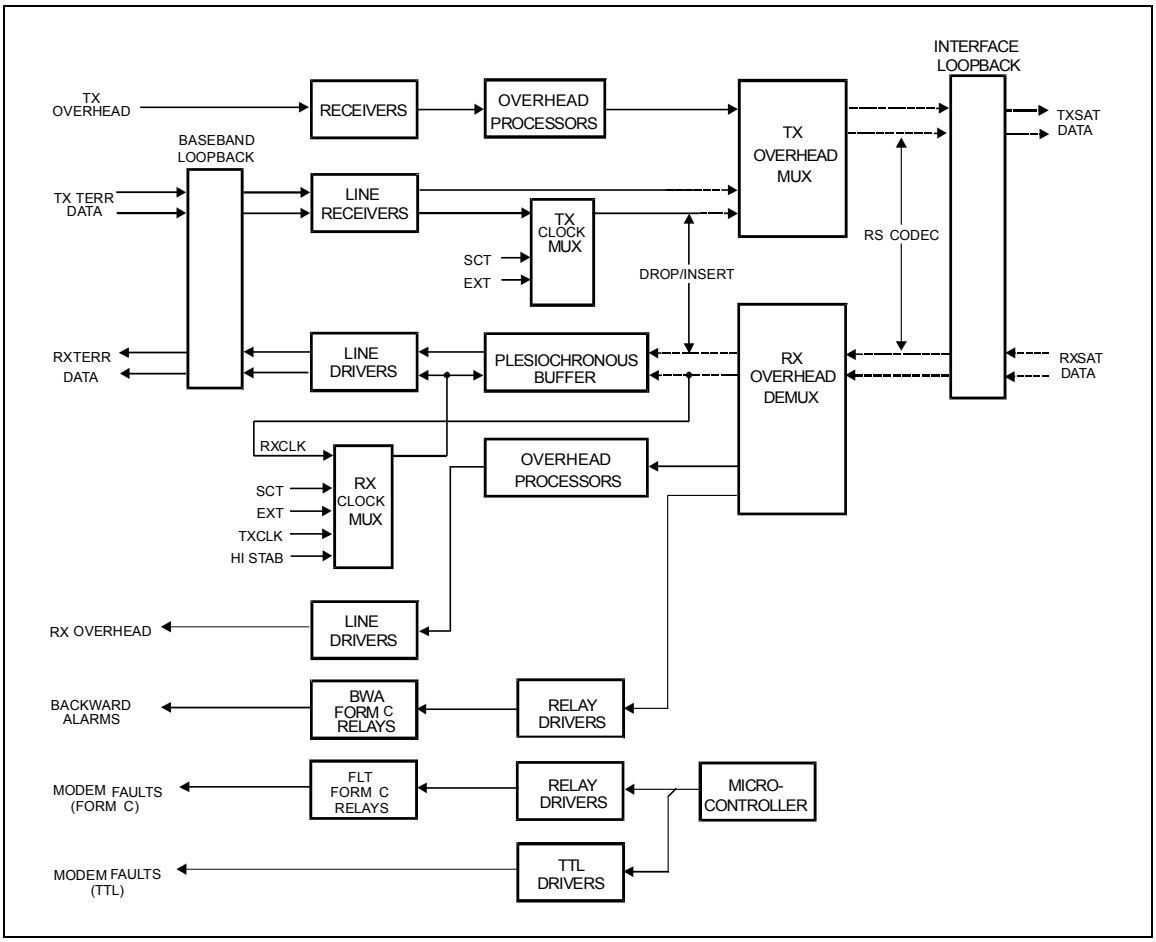


Figure 4-4. Interface Block Diagram

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4.5.1 Interface Specifications

Note: Refer to Appendix A for information on the following:

- G.703
- IDR
- IBS
- Drop and Insert (D&I)
- Asynchronous

4.5.1.1 Digital Interfaces

Refer to Table 4-4 for digital interfaces.

Table 4-4. Digital Interfaces

Main Channel		
Physical Interfaces	EIA-449/EIA-422 V.35 G.703 T1 and E1 (1544 and 2048 kbps) EIA-232 ≤ 120 kbps	
Data Rates	2.4 kbps to 4.375 Mbps, in 1 Hz steps	
External Clock Frequency Range	2.4 kHz to 4.376 MHz	
External Clock Amplitude	Common Mode 0 to 2.5 VDC	
External Clock Impedance	100kΩ	
External Clock Input Type	Square wave Duty cycle 50% ±10%	
TX Clock Reference	Normal (derived from SD for G.703 interface, SCTE, TT) Internal (10^{-5} accuracy), Optional (2×10^{-7} high stability) External	
Plesiochronous Buffer	Included in receive path	
Buffer Clock Reference	TX satellite, EXT CLK, RX, SAT, Internal, Insert CLK D&I only	
Buffer Depth	Monitor accurate to 1% displayed on front panel	
Buffer Centering	Automatic (start of service, overflow, or underflow) and Manual	
Overflows/Underflows	Logged as stored fault loopback	
Loopback	Baseband loopback Interface loopback	
Reported Faults		
TX Faults	RX Faults	Buffer Clock Act
TX Drop	Buffer Underflow	DEMUX Lock
TX Data/AIS	Buffer Overflow	RX 2047 Lock
TX Clock PLL	RX Data/AIS	Buffer Full
TX Clock Activity	Frame BER	RX Insert
Programming	Backward Alarm	Programming
Configuration	Buffer Clock PLL	

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4.5.1.2 EIA-422/EIA-449 Specifications

Refer to Table 4-5 for EIA-422/EIA-449 specifications.

Table 4-5. EIA-422/EIA-449 Specifications

Parameter	Specification
Circuit Supported	SD, ST, TT, RD, RT, DM, RR, RS, CS, MC
Amplitude (RD, RT, ST, DM, RR)	± 2V differential into 100Ω
Impedance (RD, RT, ST, DM, RR)	Less than 100Ω, differential
Impedance (SD, TT, MC)	4kΩ True when B positive with respect to A False when A positive with respect to B
Phasing (RD, RT)	False-to-true transition of RT nominally in center of RD data bit
Symmetry (ST, TT, RT)	50% ± 5%

4.5.1.3 V.35 Specifications

Refer to Table 4-6 for V.35 specifications.

Table 4-6. V.35 Specifications

Parameter	Specification
Circuit Supported	SD, SCT, SCTE, RD, SCR, DSR, RLSD, RTS, CTS, MC
Amplitude (RD, SCR, SCT, SD, SCTE)	± 55V-pk ± 20% differential, into 100Ω
Amplitude (CTS, DSR, RLSD)	±10 ± 5V into ± 5000 ± 2000Ω
Impedance (RD, SCR, SCT)	100, ± 255 > 20Ω, differential
Impedance (SD, SCTE)	100, ± 10Ω, differential
Impedance (RTS)	5000, ± 2000Ω, < 2500 pF
DC Offset (RD, SCR, SCT)	± 0.6V maximum, 1000Ω termination to ground
Polarity (SD, SCT, SCTE, RD, SCR)	True when B positive with respect to A False when A positive with respect to B
Polarity (RTS, CTS, DSR, RLSD)	True when < -3V with respect to ground False when > +3V with respect to ground
Phasing (SCTE, SCR)	False-to-True transition nominally in center of data bit
Symmetry (SCT, SCTE, SCR)	50%, ± 5%

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4.5.1.4 EIA-232 Specifications

Refer to Table 4-7 for EIA-232 specifications.

Table 4-7. EIA-232 Specifications

EIA-232 Specification	
Circuit Supported	TXD, TXC, RXD, RXC, DSR, DCD, CTS, LL, RTS, MC
Driver Amplitude (RXD, RXC, ST, CTS, DM, DSR)	True: 10V, ± 5V False: -10V, ± 5V
Receiver Amplitude (TXD, TXC, RTS, LL, MC)	True: Minimum +1V False: Maximum -1V
Impedance	5000, ± 2000Ω < 2500 pF
Signals	**Description**
TXC	Send Data
RXC	Receive Data
RTS	Request to Send
CTS	Clear to Send
DM	Data Mode
DSR	Receiver Ready
MC	Master Clock
LL	Local Loopback
ST	Send Timing
RXC	Receive Timing
TXC	Terminal Timing
MF	Mod Fault (ttl)
DF	Demod Fault (ttl)

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4.5.2 Plesiochronous/Doppler/Buffer

Data from the DEMUX section is fed into a buffer. This buffer size is user-selectable in bit increments that correspond to the length of an IESS-308 satellite superframe. The increments range from 1 to 32 ms. Refer to the interface specifications, 4.5.1, for a list of valid entries for each of the selected formats. The buffer automatically centers on resumption of service, either from the front panel or remotely. The startup buffer will overfill when centering to match the satellite frame to the terrestrial frame with a maximum slide of 0.5 ms.

The fill status is available as a monitor and is accurate to 1%. Overflows or underflows are stored in the stored fault section of the M&C status registers, along with the date and time of the incident (which are provided by the modem internal clock). These are stored in battery-backed RAM.

A normal selection is to have the data clocked out of the buffer by an external clock. This procedure removes the Doppler from the receive satellite data.

The operator may select from four other clock sources as a backup:

- Insert clock (D&I mode only)
- RX satellite
- Internal clock source
- TX terrestrial

Problems occurring on any of the selected clocks will cause the modem to substitute the satellite clock and a fault will be signaled.

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4.5.3 Closed Network

Typically, the closed network operation does not add overhead to the terrestrial data. The closed network operation is not dictated by a specification. The terrestrial data and clock are passed through the baseband loopback relay and are translated from the selected baseband format to TTL. The data is re-synchronized by the clock and the data stream is then output to the modulator through the interface loopback device.

The receive data from the demodulator/decoder is input to the buffer. User data from the DEMUX section may be optionally input to the buffer.

The front panel interface provides four clock selections clocking the data out of the buffer:

- Internal Clock (SCT)
- RX Recovered Clock (RXCLK)
- External Clock (EXT)
- TX Clock Dejittered (TXCLK)

If either RXCLK, SCT, or EXT is selected and then fails, the interface will automatically switch to RX Sat CLK as the source. The receive data and selected clock are translated to the levels of the selected baseband interface and output through the baseband loopback relay.

4.5.4 Open Network

The modem is a high-performance, full-duplex, digital-vector modulator/demodulator. The modem meets the open network requirements of the INTELSAT IESS-308 and -309 specifications for IDR, IBS, and EUTELSAT SMS.

Refer to Appendix A for IBS and IDR information.

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4.6 Backward Alarm Theory and Connections

Four sets of transmit and receive backward alarms are available to implement the structure defined in IESS-308. Backward alarms are sent to the distant side of an IDR link to signal that trouble has occurred at the receive side (which may have resulted from an improper transmission). INTELSAT specifies that any major failure of the downlink chain will generate a backward alarm.

Implementation is straightforward in a simple, single-destination link. The modem has a demodulator fault relay which de-energizes in the event of a receive fault. For this relay to be connected to the appropriate backward alarm input, the Fault menu for this signal includes the appropriate overhead framing faults.

This signal also includes faults in the downlink chain, since major problems with the antenna, Low Noise Amplifier (LNA), down converter, and other components will cause an interruption in service and fault the modem.

The outputs of the demodulator fault relay are available as follows:

- Pins DF-C and DF-NO on the 50-pin D IDR interface connector (J8)
- 9-pin D modem fault connector (J7)

The relay contacts are named for the faulted state. If a receive fault does not occur, DF-C is connected to DF-NO. The preferred method of using a backward alarm in a single-destination system is to connect the signals at the IDR data interface (at the modem in a non-redundant system, or at the protection switch, if used).

Signal	Pin #
GND	DB50-2
BWI1	DB50-12
BWI2	DB50-13
BWI3	DB50-14
BWI4	DB50-15
DF-C	DB50-16
DF-NO	DB50-50

This method signals faults on all four alarm channels, and is compatible with a redundancy system. The method assumes that the same modem handles traffic in both directions in each single-destination link.

To handle more complicated systems, connect the appropriate outputs of the Demod fault relay to the appropriate backward alarm inputs. In a multi-destination system, connect the relay to the particular backward alarm assigned to that link. Refer to IESS-308 for further clarification.

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A backward alarm being received on a particular link is detected by one of the two following methods:

- The backward alarm output drives a FORM C relay with all three contacts available on the data connector.
- The status of all transmit and receive backward alarms may be read through the EIA-232 or EIA-485 remote interface connector that is integrating a modem or switch into a computer network.

Refer to Appendix B for the remote interface specification.

In addition to the four backward alarms for IDR and two backward alarms (primary and secondary) for IBS, all modes support the following faults:

- MOD (modulator equipment)
- DEM (demodulator equipment)
- CEQ (common equipment)

Each fault is indicated by a FORM C relay contact and an open collector output.

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Chapter 5. MAINTENANCE

This chapter provides the following information:

- System checkout
- Fault isolation
- Module replacement and identification

5.1 System Checkout



This equipment contains parts and assemblies sensitive to damage by ESD. Use ESD precautionary procedures when touching, removing, or inserting PCBs.

The modem comes equipped with an internal self-test feature. This feature is designed to provide the operator with maximum confidence that the modem is fully operational without installing external equipment.

A 2047 pattern is generated by the modem and routed through all sections. This is accomplished by placing the modem in IF and baseband loopbacks. Pseudo Gaussian noise is introduced to the modulated IF section allowing the modem to check its indicated E_b/N_0 against the known E_b/N_0 of the demodulated input. Observe the following:

- If this measurement falls outside of a specified window, the modem declares a failed test.
- If an overhead card and/or Reed-Solomon card are installed, the signal is routed through the card, verifying their operation.
- Faults, if any, are stored in the Stored Fault menu.

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5.1.1 Interface Checkout

Use the following procedure and the test setup in Figure 5-1 to inspect the interface.

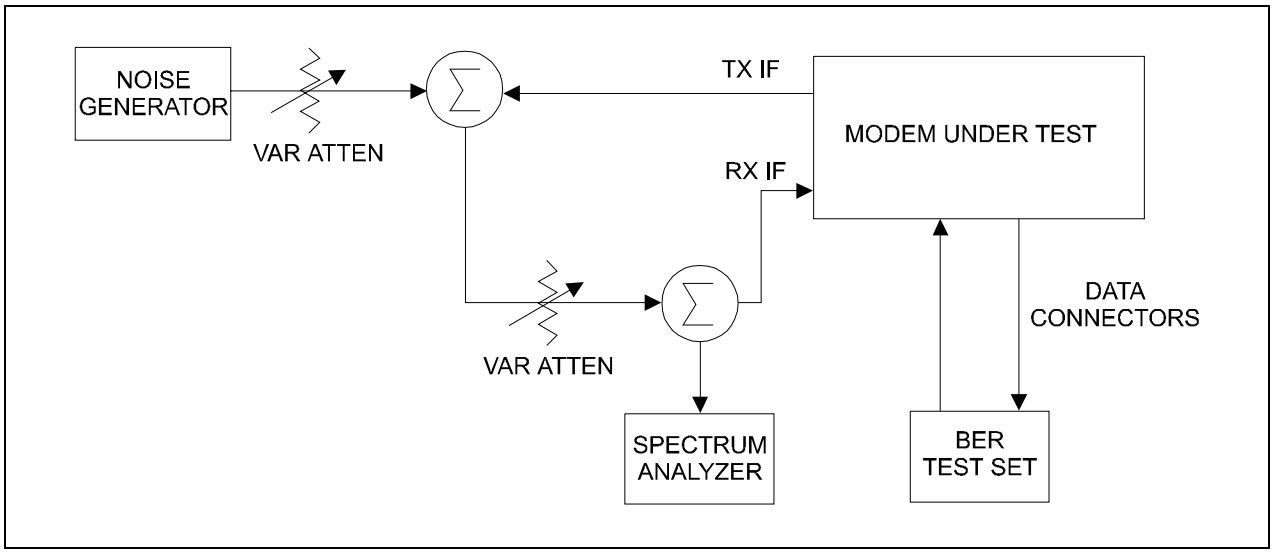


Figure 5-1. Fault Isolation Test Setup

1. Connect a BER test set to the appropriate modem data connector as shown in Figure 5-2. Refer to Chapter 2 for external modem connections.

2. Set up the modem for baseband loopback operation by using the Configuration Interface front panel menu (Chapter 3). The modem will run error free. Refer to Chapter 3 for a block diagram of the baseband loopback operation.

3. Change the modem from baseband loopback to interface loopback operation by using the Configuration Interface front panel menu (Chapter 3). The modem will run error free. Refer to Chapter 3 for a block diagram of the interface loopback operation.

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5.1.2 Modulator Checkout

Use the following procedure to check out the modulator:

1. Set up the equipment as shown in Figure 5-1. Refer to Chapter 4 for modulator specifications.

2. Set up the modem for operation by using the Configuration Modulator and Demodulator front panel menus.

3. Clear all TX faults by correct use of data and clock selection (Chapter 4).

4. Measure the E_b/N_0 with a receiver that is known to be properly operating. Refer to Table 5-1 and Figure 5-2 to check for proper E_b/N_0 level. The (S+N)/N is measured by taking the average level of the noise and the average level of the modem spectrum top. Use this measurement for the first column on Table 5-1. Read across the page to find the S/N and E_b/N_0 for the specific code rate.

   Once the demodulator has locked to the incoming signal, the Monitor menu will display signal level, raw BER, corrected BER, and E_b/N_0. Refer to Chapter 1 for examples of BER performance curves.

5. Connect a spectrum analyzer to the modem as shown in Figure 5-2. Ensure the IF output meets the appropriate mask and spurious specifications. Measure the power output at different levels and frequencies.

   A typical output spectrum is shown in Figure 5-3.

6. To check the frequency and phase modulation accuracy:

   a. Set the modem to the continuous wave Normal mode by using the Carrier Mode front panel menu (Chapter 3). This sets the Carrier mode in the off condition. A pure carrier should now be present at the IF output. This should only be used for frequency measurements. In this mode, spurious and power measurements will be inaccurate.

   b. Set the modem to the continuous wave Offset mode by using the Carrier Mode front panel menu (Chapter 3). This generates a single, upper side-band-suppressed carrier signal. Ensure the carrier and side-band suppression is < -35 dBc.

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Table 5-1. Conversion to S/N and E_b/N_0 Chart

(dB)	Code	Rate 1/2	Code	Rate 3/4	Code	Rate 7/8
(S+N)/N	S/N	E_b/N_0	S/N	E_b/N_0	S/N	E_b/N_0
4.0	1.8	1.8	1.8	0.0	1.8	-0.6
4.5	2.6	2.6	2.6	0.8	2.6	0.2
5.0	3.3	3.3	3.3	1.6	3.3	0.9
5.5	4.1	4.1	4.1	2.3	4.1	1.6
6.0	4.7	4.7	4.7	3.0	4.7	2.3
6.5	5.4	5.4	5.4	3.6	5.4	3.0
7.0	6.0	6.0	6.0	4.3	6.0	3.6
7.5	6.6	6.6	6.6	4.9	6.6	4.2
8.0	7.3	7.3	7.3	5.5	7.3	4.8
8.5	7.8	7.8	7.8	6.1	7.8	5.4
9.0	8.4	8.4	8.4	6.7	8.4	6.0
9.5	9.0	9.0	9.0	7.2	9.0	6.6
10.0	9.5	9.5	9.5	7.8	9.5	7.1
10.5	10.1	10.1	10.1	8.3	10.1	7.7
11.0	10.6	10.6	10.6	8.9	10.6	8.2
11.5	11.2	11.2	11.2	9.4	11.2	8.8
12.0	11.7	11.7	11.7	10.0	11.7	9.3
12.5	12.2	12.2	12.2	10.5	12.2	9.8
13.0	12.8	12.8	12.8	11.0	12.8	10.3
13.5	13.3	13.3	13.3	11.5	13.3	10.9
14.0	13.8	13.8	13.8	12.1	13.8	11.4
14.5	14.3	14.3	14.3	12.6	14.3	11.9
15.0	14.9	14.9	14.9	13.1	14.9	12.4
15.5	15.4	15.4	15.4	13.6	15.4	12.9
16.0	15.9	15.9	15.9	14.1	15.9	13.5
16.5	16.4	16.4	16.4	14.6	16.4	14.0
17.0	16.9	16.9	16.9	15.2	16.9	14.5
17.5	17.4	17.4	17.4	15.7	17.4	15.0
18.0	17.9	17.9	17.9	16.2	17.9	15.5
18.5	18.4	18.4	18.4	16.7	18.4	16.0
19.0	18.9	18.9	18.9	17.2	18.9	16.5
19.5	19.5	19.5	19.5	17.7	19.5	17.0
20.0	20.0	20.0	20.0	18.2	20.0	17.5

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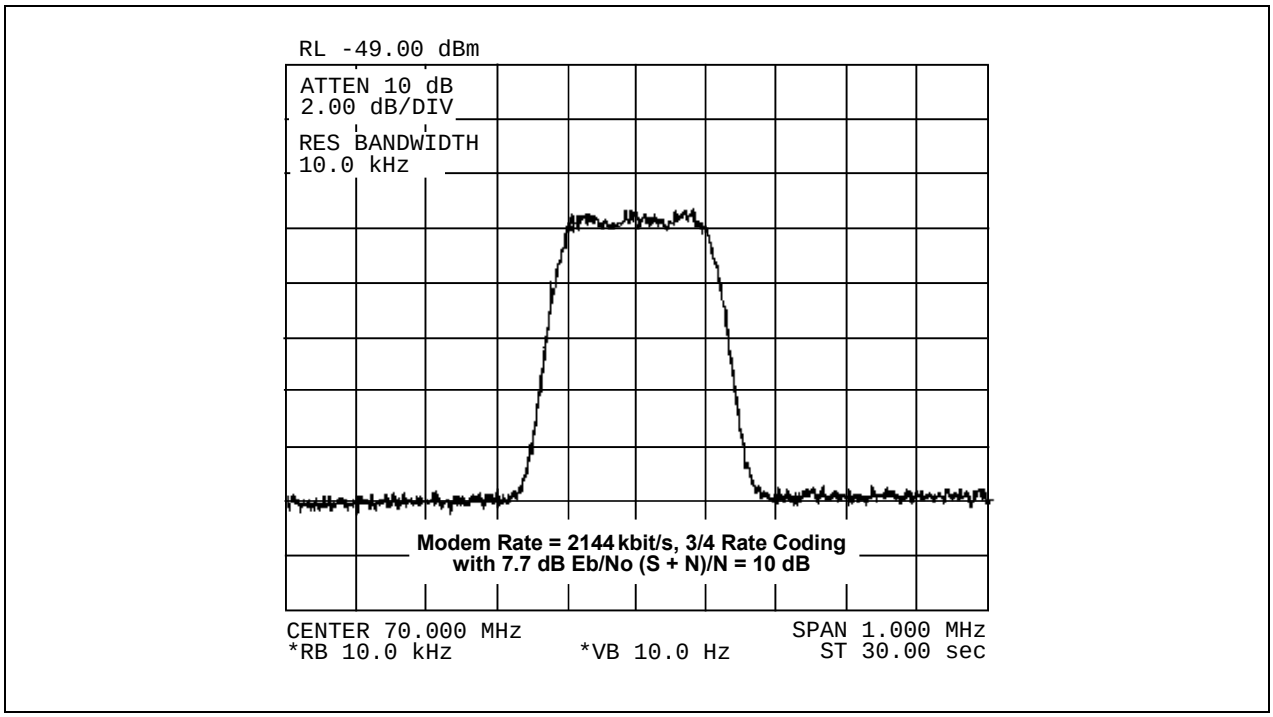


Figure 5-2. Typical Output Spectrum (with Noise)

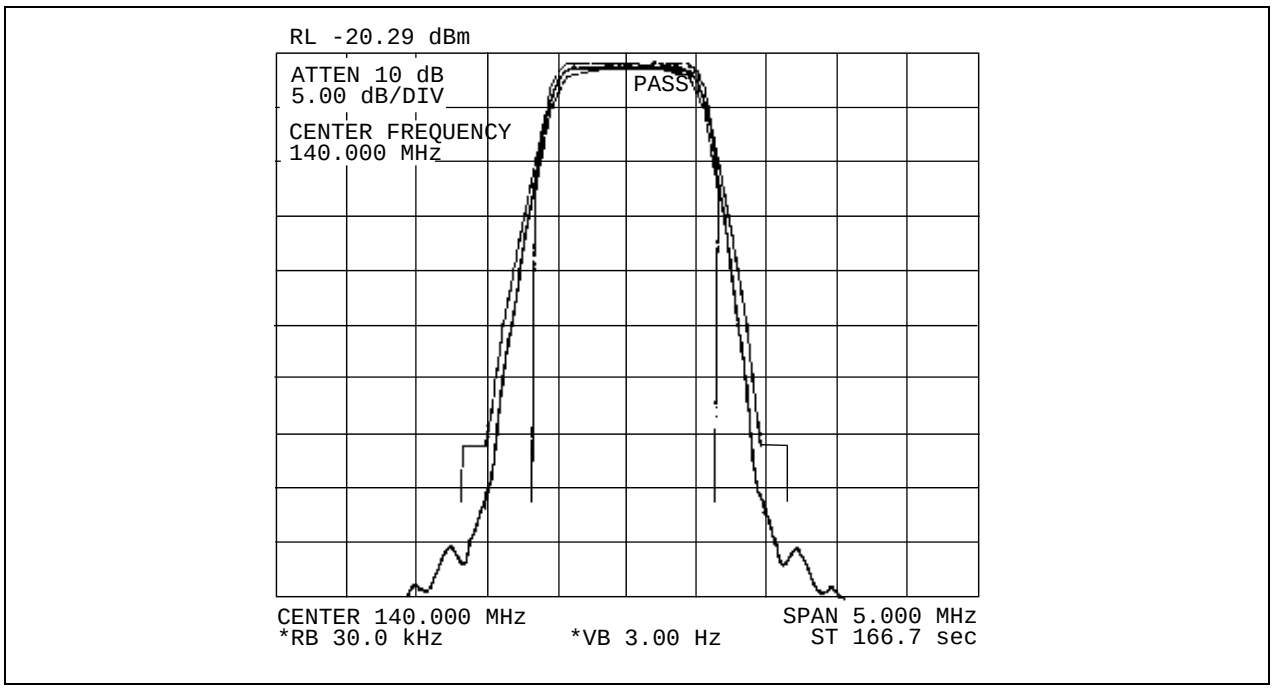


Figure 5-3. Typical Output Spectrum (without Noise)

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5.1.3 Demodulator Checkout

Use the following procedure to test the demodulator.

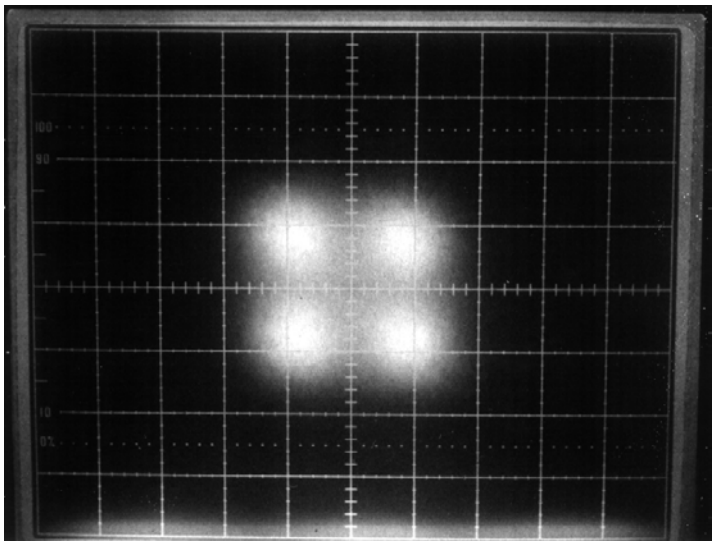
1. Set up the equipment as shown in Figure 5-1. Refer to Chapter 4 for the demodulator specifications.

2. Set up the modem with an external IF loop and level. Use a properly operating modulator, and ensure that power levels, data rates, code rates, etc., are compatible.

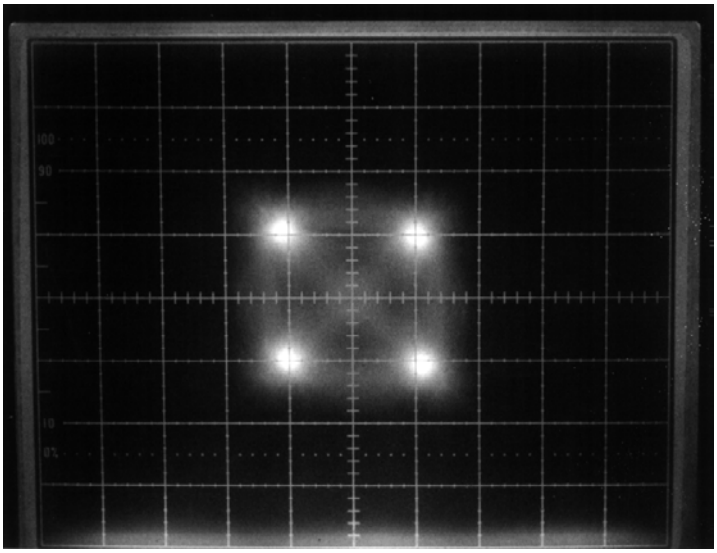
3. Allow the modem to lock up. Depending on the data rate and overhead type, lock up may take several seconds. When the green carrier detect LED is on and the DEMUX lock fault has been cleared (where applicable), the modem will run at the specified error rate. Run the TX power level (input amplitude) over the full range, and offset the TX frequency from the RX frequency by 35 kHz. Ensure the modem still runs within the specified error rate.

4. Set up the modem to check the constellation patterns with an oscilloscope that is set in the X-Y mode. Typical constellation patterns with noise and without noise are shown in Figure 5-4. These test points are available on the auxiliary connector (J9, pins 6 and 8). It is not necessary to open the modem to look at these test points.

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WITH NOISE



WITHOUT NOISE

Figure 5-4. Typical Eye Constellations

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5.2 Fault Isolation

The modem's design allows a technician to repair a faulty modem on location.



This equipment contains parts and assemblies sensitive to damage by ESD. Use ESD precautionary procedures when touching, removing, or inserting PCBs.

The fault isolation procedure lists the following categories of faults or alarms.

- Modulator
- Demodulator
- Transmit Interface
- Receive Interface
- Common Equipment
- Backward Alarms

  Note: Each fault or alarm category includes possible problems and the appropriate action required to repair the modem.

If any of the troubleshooting procedures mentioned earlier in this chapter do not isolate the problem, and Comtech EF Data Customer Support assistance is necessary, have the following information available for the representative:

- Modem configuration. Modem configuration includes the modulator, demodulator, interface, or local AUPC sections.

- Faults (active or stored).

5.2.1 System Faults/Alarms

System faults are reported in the "Faults/Alarms" menu, and stored faults are reported in the "Stored Flts/Alms" menu. Refer to Chapter 3 for more information. To determine the appropriate action for repairing the modem, refer to Table 5-2 and the list of possible problems.

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Table 5-2. SLM-3650 Fault Tree

	TX IF OUTPUT OFF	TX FAULT LED	TX FAULT RELAY (1)	RX FAULT LED	RX FAULT RELAY (2)	COM EQ FAULT LED	COM EQ FAULT RELAY (3)	TX ALARM LED	TX ALARM RELAY #2 (4)	RX ALARM LED	RX ALARM RELAY #3 (5)	SPARE RELAY ALARM #1	PRIMARY ALARM RELAY (6) ** ***	SECONDARY ALARM RELAY (7) ** ***	IBS BACKWARD ALARM ** ***	DEFERRED MAIN ALARM (8) *	TX AIS * ** ***	RX AIS * ** ***	D&I INTERR BWA ***
MODULATOR FAULTS																			
IF SYNTHESIZER	X	X	X										X				X		X
DATA CLOCK SYN	X	X	X										X				X		X
I CHANNEL	X	X	X										X				X		X
Q CHANNEL	X	X	X										X				X		X
AGC	X	X	X										X				X		X
MODEM REF ACT								X	X					X					
MODEM REF PLL	X	X	X										X				X		X
MODULE	X	X	X										X				X		X
CONFIGURATION	X	X	X																
DEMODULATOR FAULTS																			
CARRIER DETECT				X	X								X		X			X	
IF SYNTHESIZER				X	X								X		X			X	
I CHANNEL				X	X								X		X			X	
Q CHANNEL				X	X								X		X			X	
BER THRESHOLD										X	X			X		X			
MODULE				X	X								X		X			X	
CONFIGURATION				X	X														

Legend		
Note	**Fault/Alarm Relay**	**Test Points Connector/Pins**
1	TX FAULT	Pin 4 (NO), 5 (COM), 6 (NC) ****
2	RX FAULT	Pin 7 (NO), 8 (COM), 9 (NC) ****
3	COM EQ FAULT	Pin 1 (NO), 2 (COM), 3 (NC) ****
4	TX ALARM #2	Pin 4 (NO), 5 (COM), 6 (NC) ****
5	RX ALARM #3	Pin 7 (NO), 8 (COM), 9 (NC) ****
6	PRIMARY ALARM	Pin 43 (NO), 10 (COM), 27 (NC) ****
7	SECONDARY ALARM	Pin 44 (NO), 11 (COM), 28 (NC) ****
8	DEF MAINT ALARM	Pin 17 *****
*	IDR only.	
**	IBS only.	
***	D&I only.	
****	A connection between the common and N.O. contacts indicate no fault/alarm.	
*****	Signal is open collector high impedance if faulted.	

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Table 5-2. SLM-3650 Fault Tree (Continued)

	TX IF OUTPUT OFF	TX FAULT LED	TX FAULT RELAY (1)	RX FAULT LED	RX FAULT RELAY (2)	COM EQ FAULT LED	COM EQ FAULT RELAY (3)	TX ALARM LED	TX ALARM RELAY #2 (4)	RX ALARM LED	RX ALARM RELAY #3 (5)	SPARE RELAY ALARM #1	PRIMARY ALARM RELAY (6) ** ***	SECONDARY ALARM RELAY (7) ** ***	IBS BACKWARD ALARM ** ***	DEFERRED MAIN ALARM (8) *	TX AIS * ** ***	RX AIS * ** ***	D&I INTERR BWA ***
TX INTERFACE FAULTS																			
TX DROP		X	X										X				X		X
TX DATA/AIS								X	X					X		X			
TX CLK PLL	X	X	X										X				X		
TX CLK ACTIVITY								X	X				X				X		X
TX AUDIO 1 CLIP								X	X										
TX AUDIO 2 CLIP								X	X										
CONFIGURATION	X	X	X																
RX INTERFACE FAULTS																			
BUFFER UNDERFLOW										X	X								
BUFFER OVERFLOW										X	X								
RX DATA/AIS										X	X			X		X			
FRAME BER				X	X								X		X			X	
BACKWARD ALARM										X	X			X					X
BUFFER CLK PLL				X	X								X					X	
BUFFER CLK ACT										X	X		X						
DEMUX LOCK				X	X								X		X			X	
RX 2047 LOCK										X	X								
BUFFER FULL										X	X								
RX INSERT				X	X								X					X	
RX AUDIO 1 CLIP										X	X								
RX AUDIO 2 CLIP										X	X								
CONFIGURATION				X	X														

Legend		
Test Note	**Fault/Alarm Relay**	**Test Points Connector/Pins**
1	TX FAULT	Pin 4 (NO), 5 (COM), 6 (NC) ****
2	RX FAULT	Pin 7 (NO), 8 (COM), 9 (NC) ****
3	COM EQ FAULT	Pin 1 (NO), 2 (COM), 3 (NC) ****
4	TX ALARM #2	Pin 4 (NO), 5 (COM), 6 (NC) ****
5	RX ALARM #3	Pin 7 (NO), 8 (COM), 9 (NC) ****
6	PRIMARY ALARM	Pin 43 (NO), 10 (COM), 27 (NC) ****
7	SECONDARY ALARM	Pin 44 (NO), 11 (COM), 28 (NC) ****
8	DEF MAINT ALARM	Pin 17 *****

* IDR only.
** IBS only.
*** D&I only.
**** A connection between the common and N.O. contacts indicate no fault/alarm.
***** Signal is open collector high impedance if faulted.

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Table 5-2. SLM-3650 Fault Tree (Continued)

COMMON EQUIP FAULTS	TX IF OUTPUT OFF	TX FAULT LED	TX FAULT RELAY (1)	RX FAULT LED	RX FAULT RELAY (2)	COM EQ FAULT LED	COM EQ FAULT RELAY (3)	TX ALARM LED	TX ALARM RELAY #2 (4)	RX ALARM LED	RX ALARM RELAY #3 (5)	SPARE RELAY ALARM #1	PRIMARY ALARM RELAY (6) ** ***	SECONDARY ALARM RELAY (7) ** ***	IBS BACKWARD ALARM ** ***	DEFERRED MAIN ALARM (8) *	TX AIS * ** ***	RX AIS * ** ***	D&I INTERR BWA ***
BATTERY/CLOCK						X								X		X			
-12V POWER SUPPLY						X	X						X						
+12V POWER SUPPLY						X	X						X						
+5V SUPPLY						X	X						X						
SELF TEST						X													
CONTROLLER						X	X						X				X	X	
INTERFACE MODULE						X	X						X				X	X	
BACKWARD ALARMS (IDR OVERHEAD ONLY)																			
BW ALARM RX #4										X	X					X			
BW ALARM RX #3										X	X					X			
BW ALARM RX #2										X	X					X			
BW ALARM RX #1										X	X					X			
BW ALARM TX #4								X	X										
BW ALARM TX #3								X	X										
BW ALARM TX #2								X	X										
BW ALARM TX #1								X	X										

Legend		
Test Note	**Fault/Alarm Relay**	**Test Points Connector/Pins**
1	TX FAULT	Pin 4 (NO), 5 (COM), 6 (NC) ****
2	RX FAULT	Pin 7 (NO), 8 (COM), 9 (NC) ****
3	COM EQ FAULT	Pin 1 (NO), 2 (COM), 3 (NC) ****
4	TX ALARM #2	Pin 4 (NO), 5 (COM), 6 (NC) ****
5	RX ALARM #3	Pin 7 (NO), 8 (COM), 9 (NC) ****
6	PRIMARY ALARM	Pin 43 (NO), 10 (COM), 27 (NC) ****
7	SECONDARY ALARM	Pin 44 (NO), 11 (COM), 28 (NC) ****
8	DEF MAINT ALARM	Pin 17 *****

* IDR only.
** IBS only.
*** D&I only.
**** A connection between the common and N.O. contacts indicate no fault/alarm.
***** Signal is open collector high impedance if faulted.

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5.2.2 Faults/Alarms Display

General fault, status, and alarm information are indicated by 10 LEDs located on the modem's front panel.

A fault (red LED) indicates a fault that currently exists in the modem.

When a fault occurs, it is stored in the stored fault memory, and indicated by the single yellow LED.

The LED is turned off when the fault clears. If the fault clears, the occurrence is also stored.

A total of 10 occurrences of any fault can be stored. Each fault or stored fault indicated by a front panel LED could be one of many faults. To determine which fault has occurred, use the Fault or Stored Fault front panel menu. Refer to Chapter 3 for information on the Fault or Stored Fault front panel menu.

Alarms are considered minor faults which will not switch the modem offline in a redundant system. Alarms are shown in the Fault or Stored Fault front panel menu by a reversed contrast (white on black) character that appears at the display panel.

5.2.3 Faults/Alarms Analysis

This section describes the possible problems and actions to take for the following faults:

- Modulator
- Demodulator
- Transmit interface
- Receive interface
- Common equipment
- Backward alarm

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5.2.3.1 Modulator Faults

Fault/Alarm	Possible Problem and Action
IF SYNTHESIZER	Modulator IF synthesizer fault. This is considered a major alarm, and will turn off the modulator output. Return the modem for repair.
DATA CLOCK SYN	Transmit data clock synthesizer fault. This fault indicates that the internal clock VCO has not locked to the incoming data clock, or the internal clock synthesizer has not locked to the internal reference. This is considered a major alarm, and will turn off the modulator output. Ensure the proper data rate has been set up and selected, and the incoming data rate matches the modem selections. In the IDR type configuration, the data rate must reflect any overhead bits that are added. In the IBS type, the internal reference is changed to account for the IBS overhead of 16/15. A standard IDR type configuration operating at Rev. 2 would be programmed to the input data rate. An IDR type operating at Rev. 3 would be programmed to reflect the 96 kbps of overhead. A 1544 kbps Rev. 3 IDR is programmed to 1640 kbps. An IBS type would be programmed for the input data rate to the channel unit. The modem accounts for the overhead because of the change in internal reference. Use interface loopback for isolating the problem. Verify the frequency of the input data clock to be within the lock range of 100 PPM.
I CHANNEL	Activity alarm for the I channel digital filter. This alarm is considered a major alarm, and will turn off the modulator IF output. An alarm in this position indicates either a fault in the scrambler, or if the scrambler is disabled, the alarm indicates a loss of incoming data. If the fault is active with the scrambler turned off, check for input data at the DATA I/O connector.
Q CHANNEL	Activity alarm for the Q channel digital filter. Use the I channel procedure.
AGC LEVEL	Output power AGC level fault. Indicates the level at the modulator output is not the programmed level.
INTERNAL SCT SYN	Internal TX data clock synthesizer fault. The SCT has failed to lock to the internal reference.
EXT REF ACT	External reference activity fault. Indicates clock reference not detected.
MODULE	Modulator module fault. Typically indicates that the modulator module is missing or will not program.

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5.2.3.2 Demodulator Faults

Fault/Alarm	Possible Problem and Action
CARRIER DETECT	Carrier detect fault. Indicates the decoder is not locked. This is the most common fault displayed in the modem. Any problem from the input data on the modulator end of the circuit to the output of the decoder can cause this alarm. First, ensure the demodulator has an RF input at the proper frequency and power level. Ensure the demodulator data rate is properly programmed. Refer to the fault isolation procedure for Data Clock Syn in the modulator section. Verify the frequency of the data transmitted from the modulator is within 100 PPM.
IF SYNTHESIZER	Demodulator IF synthesizer fault. Indicates the demodulator IF synthesizer is faulted. This fault is a hardware failure. Contact the Comtech EF Data Customer Support Department.
I CHANNEL	Indicates a loss of activity in the I channel of the quadrature demodulator. Typically indicates a problem in the modulator side of the circuit. Check for proper RF input to the demodulator. If the input to the demodulator is correct, then the problem is in the baseband processing.
Q CHANNEL	Indicates a loss of activity in the Q channel of the quadrature demodulator. Follow the same procedure for the I channel fault.
BER THRESHOLD	Indicates the preset BER threshold has been exceeded. Setting of this alarm is done in the Utility menu. This is an alarm based on the corrected BER reading on the front panel.
MODULE	Demodulator module fault. Typically indicates that the demodulator module is missing or will not program. Contact the Comtech EF Data Customer Support Department.

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5.2.3.3 Transmit Interface Faults

Fault/Alarm	Possible Problem and Action
TX DROP	Drop interface hardware fault (D&I only). The typical cause of this fault is the drop phase-locked loop is not locked, or some other drop interface hardware has malfunctioned. Contact the Comtech EF Data Customer Support Department.
TX DATA/AIS	Data or incoming AIS. When the AIS is selected in the Interface Utility menu for TX data fault, the transmit interface fault TX data/AIS is monitoring a fault condition of all 1s from customer data input to the modem. When data is selected in the Interface Utility menu for TX data fault, the TX interface fault TX data/AIS is monitoring a fault condition of all 1s or 0s. This is referred to as a data-stable condition (data is not transitioning). This fault indicates there is trouble in the chain sending data to the modem. The modem passes this signal transparently, and takes no other action. This indication is a monitor function only, and aids in isolating the trouble source in a system.
TX CLOCK PLL	Transmitter phase-locked loop fault. Indicates the transmitter PLL is not locked to the reference of the interface transmit clock recovery oscillator. Contact the Comtech EF Data Customer Support Department.
TX CLOCK ACT	Activity detector alarm of the selected interface transmit clock. Indicates the selected TX clock is not being detected. Check the signal of the selected TX clock source to verify the signal is present. The interface will fall back to the internal clock when this alarm is active.

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5.2.3.4 Receive Interface Faults

Fault/Alarm	Possible Problem and Action
BUFFER UNDERFLOW	Buffer underflow alarm. Indicates the plesiochronous buffer has underflowed. Buffer underflow is normally a momentary fault (there are clock problems if this alarm is continuously present). This alarm is included in this section to be consistent with the fault reporting system and to be correctly registered in the stored fault memory. The time and date of the first 10 receive buffer underflow faults are stored in battery-backed memory as an aid to troubleshooting. The interval between stored overflow/underflow events can be used to determine relative clock accuracies.
BUFFER OVERFLOW	Buffer overflow alarm. Indicates the plesiochronous buffer has overflowed. The problems and actions in the buffer underflow section apply to this alarm.
RX DATA/AIS	Data or incoming AIS. The data monitored for RX data is coming from the satellite. When the AIS is selected for RX data fault in the Interface Utility menu, the RX data/AIS is monitoring an alarm condition of all 1s from the satellite. When data is selected for RX data fault in the Interface Utility menu, the RX data/AIS is monitoring a fault condition of all 1s or 0s. This is referred to as a data-stable condition (data is not transitioning). The fault indicates trouble in receiving data from the satellite. The modem passes this signal transparently, and can close a FORM C contact. The indication is a monitor function only to help isolate the source of trouble in a system.
FRAME BER	The receive decoded error rate has exceeded 10^{-3} over a 60-second period measured on the framing bits. This is defined as a major (prompt) receive alarm by INTELSAT specifications IESS-308. In a redundant system, a switch-over will be attempted. Since some data must be correctly received to indicate this fault, receive AIS will not be substituted. This fault is to be sent as a backward alarm to the distant end. This must be wired externally, as faults other than from the modem may need to enter the fault tree.
BACKWARD ALARM	Backward alarm. Modem is receiving a backward alarm, indicating trouble at the distant end. The alarm may be a result of improper transmission at the near end of the link. This particular alarm is reported and recorded, but the modem takes no other action. In most cases, the fault is due to some receive problem with the modem, so a real fault will probably be occurring if backward alarm faults are being recorded.

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Fault/Alarm	Possible Problem and Action
BUFFER CLK PLL	Buffer clock phase-locked loop fault. The buffer synthesizer is the wrong frequency or will not lock. Ensure the selected buffer clock source is at the proper frequency and level. If the fault continues, contact the Comtech EF Data Customer Support Department.
BUFFER CLK ACT	Activity detector alarm of the selected interface receive clock. The interface will fall back to the satellite clock when this fault is active.
DEMUX_LOCK	Demultiplexer synchronization lock fault. This fault means that the demultiplexer is unable to maintain valid frame and multiframe alignment. The usual cause is invalid or absent receive data. This is a major (prompt) alarm. The alarm will cause insertion of receive AIS (all 1s) and the switch-over will be attempted. This fault is to be sent as a backward alarm to the distant end. This fault will occur when no carrier is present, but will probably never occur with a correct signal.
RX 2047 LOCK	RX 2047 lock alarm. Indicates the RX 2047 data test pattern is not being received by the decoder. The alarm probably indicates the transmitter is not set correctly.
BUFFER FULL	Buffer full alarm. Indicates the buffer is < 10% or > 90% full.
RX INSERT	Insert interface hardware fault (D&I only). The typical cause of this fault is the insert phase-locked loop is not locked, or some other insert interface hardware has malfunctioned. Contact the Comtech EF Data Customer Support Department.

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5.2.3.5 Common Equipment Faults

Fault/Alarm	Possible Problem and Action
BATTERY/CLOCK	M&C battery voltage or clock fault. Indicates a low voltage in the memory battery. Typically, this fault will be active when a modem has been hard reset or the firmware has been changed. When a hard reset has been executed or the firmware has been changed, this fault will typically be active when the modem is first turned on.
-12 VOLT SUPPLY	-12V power supply fault. Indicates a high or low voltage condition. Level is ± 5%. Check for a short on the -12V line from the power supply or on any of the plug-in boards.
+12 VOLT SUPPLY	+12 VDC power supply fault. Use the same procedure as with -12V fault.
+5 VOLT SUPPLY	+5V power supply fault. Use the same procedure as with a -12V fault. The +5V supply requires a minimum load of 1A.
CONTROLLER	Controller fault. Indicates a loss of power in the M&C card. Typically indicates the controller has gone through a power on/off cycle.
INTERFACE	Interface module fault. Indicates a problem in programming the interface card.

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5.2.3.6 Backward Alarms Faults

Fault/Alarm	Possible Problem and Action
BW ALARM RX4	Receive backward alarm #4. The distant end of the link is sending backward alarm #4. This indicates trouble at the distant end, which may be a result of improper transmission at the near end of the link. The modem will signal this event by setting the deferred maintenance alarm (open collector). This alarm is a monitor function. The modem reports and records the event, but takes no other action. Refer to Chapter 2 for the backward alarm theory of operation. If the user does not wish to monitor the backward alarm faults, the backward alarm inputs must be grounded at the breakout panel. Refer to Chapter 2 for breakout panel pinouts.
BW ALARM RX3	Receive backward alarm #3. Refer to BW Alarm RX4 for details.
BW ALARM RX2	Receive backward alarm #2. Refer to BW Alarm RX4 for details.
BW ALARM RX1	Receive backward alarm #1. Refer to BW Alarm RX4 for details.
BW ALARM TX4	Transmit backward alarm #4. The modem is being instructed to send backward alarm #4 to the distant end of the link. This alarm is controlled by wiring the backward alarm inputs of the modem to the demod fault relay and/or other fault outputs in the receive system (see IESS-308 for clarification). The simplest implementation for single destination service is to wire the demod fault relay between ground and the four backward alarm inputs (see Chapter 3 for clarification). This sends all four backward alarms in the event of any major (prompt) receive fault. This particular alarm is transmitted, reported, and recorded, but the modem takes no other action. In most cases, this will be sent due to some receive problem with the modem, so a real fault will probably be occurring if backward alarms are being sent. The transmit backward alarms are a symptom of trouble, not a cause.
BW ALARM TX3	Transmit backward alarm #3. Refer to BW Alarm TX4 for details.
BW ALARM TX2	Transmit backward alarm #2. Refer to BW Alarm TX4 for details.
BW ALARM TX1	Transmit backward alarm #1. Refer to BW Alarm TX4 for details.

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Appendix A . OPTIONS

This appendix describes the options available for the SLM-3650. Available options are:

- **F**ully **A**ccessible **S**ystem **T**opology (FAST) Options
- Conventional Options
- Software and Hardware Upgrades
- 8-Channel Multiplexer Option
- Flex Mux
- Turbo

The following table is provided to assist the operator through Appendix A:

A.1 FAST Accessible Options	A.2 Conventional Options	A.3 Full Duplex Reed-Solomon	A.4 Software and Hardware Upgrades	A.5 Turbo Product Codec
A.1.1 FAST Theory of Operation	A.2.1 Reed-Solomon Codec	A.3.1 Interface	A.4.1 Overhead Interface	A.5.1 Turbo Product Codec as FEC
A.1.2 Implementation	A.2.2 Reed-Solomon Encoder	A.3.2 Reed-Solomon Features	A.4.2 Installation	A.5.2 End-to-End Processing Delay
A.1.3 Drop & Insert	A.2.3 Reed-Solomon Decoder	A.3.3 Encoder	A.4.3 Hardware Upgrades	A.5.3 Comparison of TPC Modes
A.1.4 Asynchronous Interface/AUPC	A.2.4 Unpacking	A.3.4 Interleaver	A.4.4 8-Channel Multiplexer Option	
A.1.5 Decoder	A.2.5 Installation	A.3.5 Decoder	A.4.5 Flex Mux	
A.1.6 IDR				
A.1.7 IBS				
A.1.8 Asymmetrical Loop Timing				
A.1.9 G.703				
A.1.10 Variable Data Rates				

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A.1 FAST Accessible Options

Comtech EF Data's FAST system allows immediate implementation of different options through the user interface keypad. Some FAST options are available through the basic platform unit, while others require that the unit be equipped with optional hardware or that the hardware be installed in the field. Refer to Table A-1 for a listing of possible configurations.

The options available through the FAST architecture include:

- Drop and Insert (D&I)
- ASYNC/AUPC
- Decoder
- IDR
- IBS
- Asymmetrical loop timing
- G.703 operation
- Variable data rates

Other options are available through conventional changes such as installing daughter card PCBs. Refer to Section A.2, Conventional Options, for additional information.

Table A-1. FAST Options and Required Configurations

Hardware	Single Data Rate	Low Variable Data Rate (up to 512 kbps)	High Variable Data Rate (up to 4.375 Mbps)	Sequential Decoder	Viterbi Decoder	Asymmetrical Loop Timing	8PSK	Reed–Solomon Codec	Turbo Codec	ASYNC/AUPC Overhead	Open Network (IDR/IBS)	Drop & Insert	Eurocomm Interface	G.703 Interface	4-Channel ASYNC SYNC	8-Channel ASYNC SYNC
Basic Platform	●			● 1	● 1											
FAST Options		●	●	●	●	●	●									
FAST Options with Reed-Solomon Hardware								● 5								
FAST Options with Turbo Hardware									● 5							
FAST Options with Overhead Hardware										● 2	● 2	● 2	● 2, 3	● 2, 4		
FAST Options with Reed-Solomon And Overhead Hardware								●		●	●	●				
Mux															● 2	● 2
Flex Mux												● 2		● 2		

Notes:

1. The basic modem is shipped with either Sequential or Viterbi decoder.
2. The overhead interface card and a compatible relay adapter card (connector personality card) are required for this option. Refer to Chapter 1 for the applicable part numbers.
3. Requires Eurocom Interface module.
4. Requires G.703 Interface module and OH card.
5. Select either Reed-Solomon or Turbo.

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A.1.1 FAST System Theory

FAST is an enhancement feature available only in Comtech EF Data products, enabling on-location upgrade of the operating feature set—in the rack—without removing a modem from the setup. When service requirements change, the operator can upgrade the topology of the modem to meet those requirements within minutes after confirmation by Comtech EF Data. This accelerated upgrade can be accomplished only because of FAST's extensive use of programmable devices incorporating Comtech EF Data-proprietary signal processing techniques. These techniques allow the use of a unique access code to enable configuration of the available hardware. The access code can be purchased at any time from Comtech EF Data. Once obtained, the access code is loaded into the unit through the front panel keyboard or the rear remote port.

With the exclusive FAST technology, operators have maximum flexibility for enabling functions as they are required. FAST allows an operator to order a modem precisely tailored for the initial application, reducing risk and cost overruns during the application integration process.

A.1.2 Implementation

FAST is factory-implemented in the modem at the time of order. Hardware options for basic modems can be ordered and installed either at the factory or in the field. The operator can select options that can be activated easily in the field, depending on the current hardware configuration of the modem.

A.1.2.1 Obtain Modem Serial Number

Step	Procedure
1	Press [CLEAR] to return to the Main menu.
2	Use [←] and [→] to select Function Select menu.
3	Press [ENTER].
4	Use [←] and [→] to select Utility Modem Type menu.
5	Press [ENTER].
6	Use [←] and [→] to select Modem Serial # menu.
7	Record serial number:

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A.1.2.2 Select Features:

Step	Procedure
1	Use [←] and [→] to select Modem Options menu.
2	Press [ENTER].
3	Scroll through the Modem Options and check off all features that display a "+" sign as follows: HIGH POWER [ ] HIGH STABILITY [ ] ASLT [ ] VITERBI [ ] SEQUENTIAL [ ] SINGLE RATE [ ] LOW RATE VARIABLE [ ] FULL RATE VARIABLE [ ] CARD #1 PCB [ ] CARD #2 PCB [ ] CARD #3 PCB [ ] 8-PSK [ ] TX Only [ ] RX Only [ ] OQPSK [ ] BURST [ ] **Notes:** If the menu displays a "0", the unit will need to be returned to the manufacturer for the desired hardware upgrade. If the unit displays an "X," the unit can be upgraded in the field. If the unit displays a "+", the feature is installed. If the unit displays a "-," the feature is FAST accessible.
	Press [CLEAR].
5	Use [←] and [→] to select CARD #1 (Overhead Card) menu.
6	Record Card #1 serial number, if displayed:
7	Use [←] and [→] select CARD #2 (Reed-Solomon Card) menu.
8	Record Card #2 serial number, if displayed:
9	Press [CLEAR].
10	Contact a Comtech EF Data sales representative to order features.
11	Comtech EF Data Customer Support personnel will verify the order and provide an invoice and instructions.

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A.1.2.3 Entering Access Codes from the Front Panel

Step	Procedure
1	Press CLEAR to return to Main menu.
2	Use the [←] [→] keys to go to the Function Select: Utility menu.
3	Press <ENTER>.
4	Go to Utility: Modem Type menu.
5	Press <ENTER>.
6	Go to Configuration Code-Modem menu.
7	Press <ENTER>.
8	Menu should display as follows: **1) AAAAAAAAAA** **2) AAAAAAAAAA**
9	To enter the code, press <ENTER> and use the [↑] [↓] keys to select an alpha numeric character. Use [→] to move to the next character or to move to the next line. Repeat this procedure until all 20 characters of the code have been entered.
10	After completing entry of the 20-character code, press <ENTER>. The unit should display Modem Initialization and will reboot to the factory default settings with the new option available.
11	If a wrong or invalid code is entered, the unit will display Wrong Code Entered! and no changes will occur. Retry the code, verify that the code is correct, or request assistance from Comtech EF Data Customer Support.

A.1.2.4 Entering Access Codes from the Remote Control Port

Step	Procedure
1	Establish remote communication with the unit. Display will show REMOTE MODE (if applicable).
2	Enter the following commands as needed to enable the option related to each board:
3	The modem should re-initialize and boot up to the factory default settings. Note: If the unit is an SDR-54/54A, the power should be cycled to re-initialize the unit and enable the option(s).

Main Board:	*<x/CCMD_code*	*x = address* *code = 20 digit configuration code*
Overhead board:	*<x/CCOD_code*	
Mux/Demux Board:	*<x/CCMX_code*	
TX-Reed-Solomon:	*<x/CCTR_code*	
RX-Reed-Solomon:	*<x/CCRR_code*	

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A.1.2.5 Verify Upgrade

Step	Procedure
1	Press [CLEAR] to return to the Main menu.
2	Use [←] and [→] to select Function Select: Utility menu.
3	Press [ENTER].
4	Use [←] and [→] to select Utility: Modem Type menu.
5	Press [ENTER].
6	Use [←] and [→] to select Modem: Options menu.
7	Press [ENTER].
8	Use [←] and [→] to scroll through features. Visually check selected features for a "+" sign. If a "+" sign is evident, the upgrade is completed.
9	If upgrade is incorrect, the menu display will exhibit "WRONG CODE ENTERED." Repeat procedures. Contact Comtech EF Data Customer Support personnel for further instructions, if the error message remains.

A.1.2.6 Variable Data Rates

The basic platform modem comes with single data rate capabilities. At the time of purchase, the customer can add optional variable data rate capabilities.

If variable rate requirements arise after the purchase of a basic platform modem, these capabilities can be added in the field using FAST technology. The variable rate options include one of the following:

Rates up to 512 kbps
Rates up to 4.375 Mbps

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A.1.3 D&I

Note: If required, refer to Section A.3 for installation of the overhead interface PCB.

The D&I MUX works in conjunction with the interface card to enable the modem to transmit or receive fractional parts of a T1 data stream.

- Refer to Figure A-1 for a block diagram of the D&I with asynchronous overhead.
- Refer to Figure A-2 for a block diagram of the D&I overhead data flow.

The D&I option provides fully compliant baseband processing in accordance with INTELSAT IESS-308 Rev. 6 for the terrestrial information rate of 2048 kbps (E1). N x 64 kbps data rates are allowed over the satellite link (see the specifications for N = X). The interface also supports IESS-308 Rev. 6 transmission and reception parameters with a G.703 1544 kbps (T1) terrestrial interface. The interface module provides interface to transmission level framing compliant to IESS-309 data type 2. Control parameters including T1 or E1 may be set by the customer in the Configuration Interface menu either from the front panel or remotely through the EIA-232 interface.

Selection of the transmit and receive data rates may be made in 64 kbps increments and may be independent of each other. The actual satellite rates are 16/15 of the transmit or receive data rate to include overhead per IESS-308 Rev. 6 (this is transparent to the user).

Select the actual terrestrial time slots to be transmitted or received under the Configuration Interface menu. The user can select (either from the front panel or through the EIA-232 interface) any time slots from 1 to 31 for E1, or channels from 1 to 24 for T1. The E1 access to time slot 0 is not allowed.

Time slots may be selected in arbitrary order. Some time slots contain framing information instead of data. This allows for greater flexibility in the selection process. The configuration menu allows time slots to be selected for transmission or reception up to the maximum permitted limits by the particular transmit or receive data rate.

The satellite overhead includes an ESC. Use of this channel is not specified by IESS-308 and IESS-309. Comtech EF Data uses the ESC to implement a sampled EIA-232 data link, which works at data rates up to 1/2000 of the satellite rate.

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A.1.3.1 D&I Specifications

Refer to Table A-2 for D&I specifications.

Table A-2. D&I Specifications

Parameter	Specification
Primary Data Circuits Supported	T1 DSD, DRD, ISD, IRD E1 DSD, DRD, ISD, IRD
Primary Data Rates Supported	1544 kbps per G.703 2048 kbps per G.703
Satellite Data Rates Supported	N x 64 kbps N = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, or 24 (T1) N = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, or 30 (E1)
Terrestrial Framing Supported	G.732/G.733, G.704
Satellite Overhead Rate	1/15 of data rate per IESS-308 Rev. 6 and IESS-309 Rev. 3
Drop Time Slot Selection (Time Slot 0 not Allowed)	1 to 24 (T1) 1 to 31 (E1) Arbitrary order
Insert Time Slot Selection (Time Slot 0 not Allowed)	1 to 24 (T1) 1 to 31 (E1) Arbitrary order
Interface Type	Transformer coupled symmetrical pair
Terrestrial Input Data Rate	T1 1544 kbps ± 100 bit/s E1 2048 kbps ± 130 bit/s
Pulse Width	T1 324 ± 50 ns E1 244 ± 25 ns
SD Amplitude	T1 3.0 +0.3/-1.5 V-pk into 100Ω E1 3.0 +0.3/-1.5 V-pk into 120Ω
RD Amplitude	T1 3.0 ± 0.3 V-pk into 100Ω E1 3.0 ± 0.3 V-pk into 120Ω
Pulse Mask	T1 G.703.2 E1 G.703.6
Line Code	Selectable AMI, B8ZS, HDB3
Jitter Attenuation	T1, per AT&T 43802 T1, per CCITT G.824 E1, per CCITT G.823
Transmit Clock Reference	Normal (derived from drop SD) Internal (10-5 accuracy) External (EIA-422 input)
Plesiochronous Buffer	Included in receive path
Buffer Clock Reference	Derived from insert input External (EIA-422) Internal

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Table A-2. D&I Specifications (Continued)

Parameter	Specification
Buffer Depth	
T1, T1_ESF, E1_CCS, E1_IBS, E1_31_TS	1, 2, 4, 8, 16, or 32 ms
E1_CAS	7.5, 15, or 30 ms
T1_IBS	6, 12, 18, 24, or 30 ms
Depth Status	Monitored accurate to 1%
Buffer Centering	Automatic (start of service), manual
Overflows/Underflows	Logged as stored fault
Engineering Service Channel	
ESC Data Interface Type	EIA-232
ESC Data Rate (Maximum Asynchronous)	1/2000 of satellite data rate, maximum (over sampled)
ESC Data Circuits Supported	SD, RD, DSR
Faults and Alarms	
Backward Alarms Supported	1 (looped per IESS-309)
Backward Alarm Output	Sums into secondary alarm
Modulator Fault	Open collector, 15V maximum, 20 mA maximum, used by protection switch, if in system
Demodulator Fault	Open collector, 15V maximum, 20 mA maximum, used by protection switch, if in system

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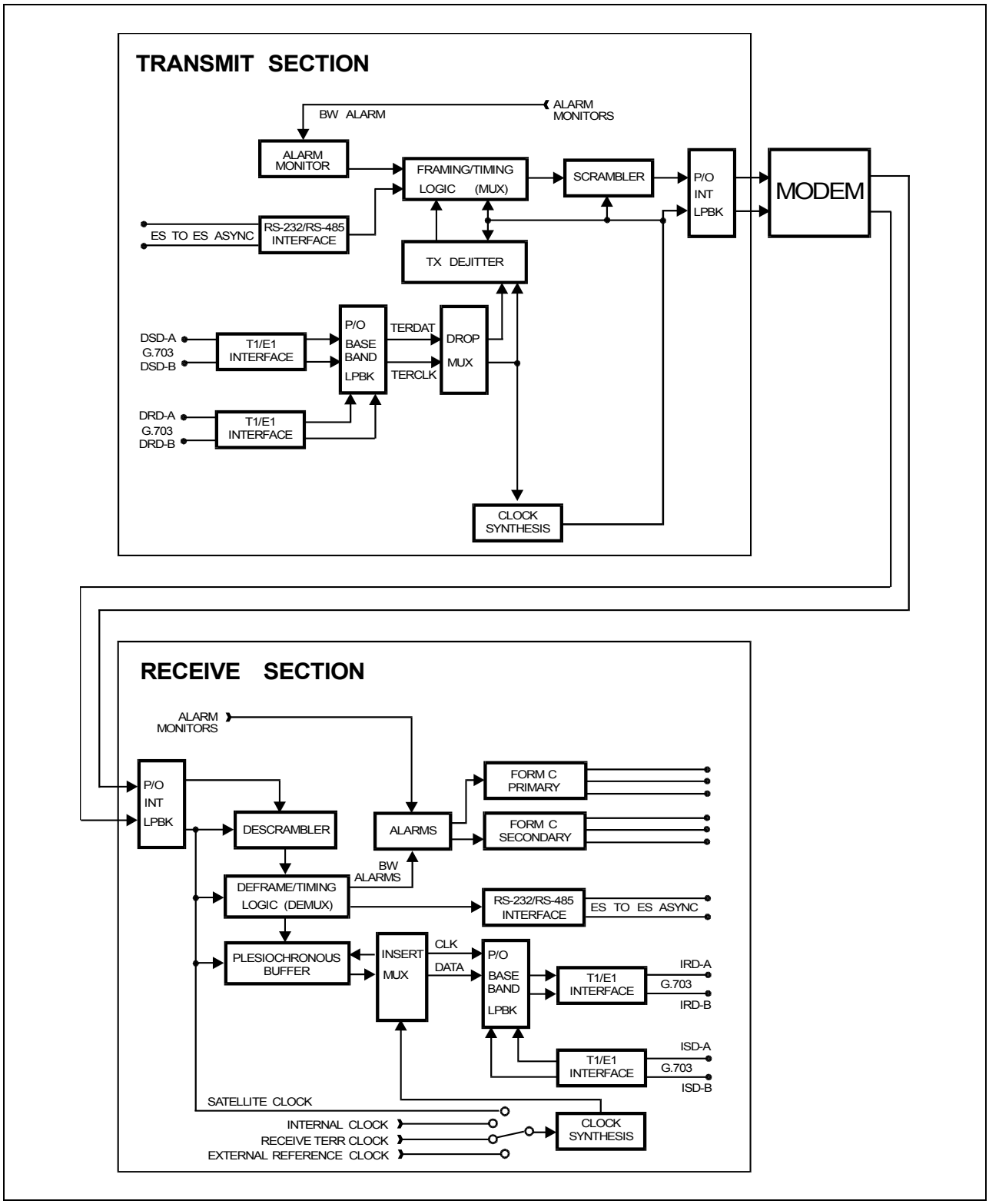


Figure A-1. D&I with Asynchronous Overhead Block Diagram

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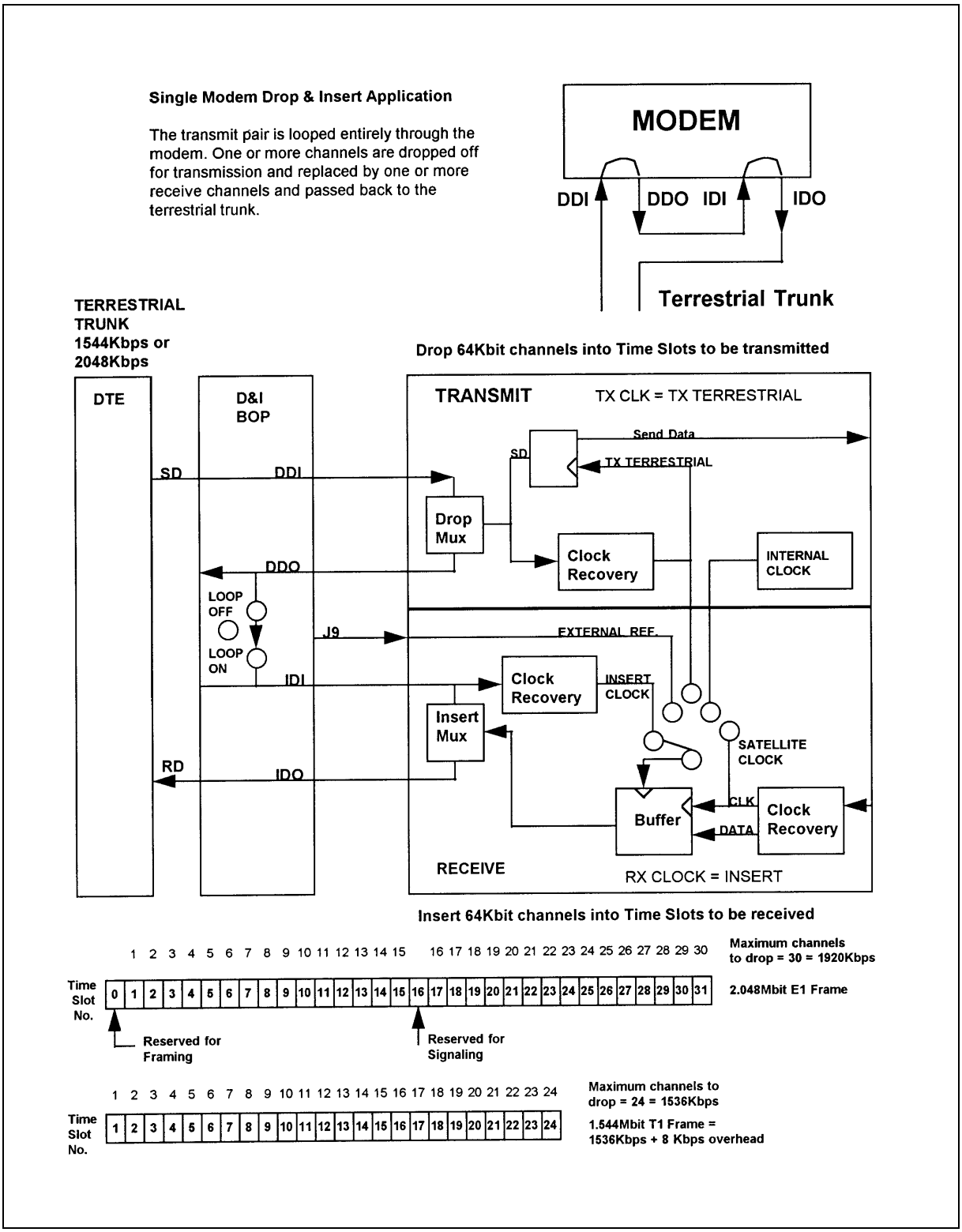


Figure A-2. D&I with Asynchronous Overhead Data Flow

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A.1.3.2 Theory of Operation

The main features of the D&I option are as follows:

- Data interface
- Transmit MUX
- Receive DEMUX
- ESC
- Backward alarm

A.1.3.2.1 Data Interference

Data interface contains transformer-balanced data interfaces that support CCITT G.703 parameters and dejitter. This is compatible with AT&T Digital Speech Interpolation (DSI) service. Data inputs and outputs named are listed below:

Data Inputs	Drop send data input A and B (DSD-A and DSD-B) Insert send data input A and B (ISD-A and ISD-B)
Data Outputs	Drop receive data output A and B (DRD-A and DRD-B) Insert receive data output A and B (IRD-A and IRD-B)

The system is frequently used with the drop receive data output signal (DRD-A, -B) looped to feed the insert send data input signal (ISD-A, -B). This is accomplished at the far end of any redundancy switching in order to allow transmit and receive chains to be switched independently. The zero substitution codes (Alternate Mark Inversion [AMI], B8ZS, and HDB3) are user-selectable during configuration.

A data loopback function on the insert data is available in this section. This enables the user to determine that the T1 or E1 data parameters correctly match those of this interface. The drop data is always hard-wired into loopback.

A.1.3.2.2 Transmitted MUX

The data stream is transmit MUX with a 1/15 overhead channel and the resultant information rates are interfaced to the Mod/Demod/Coder sections of the modem. A phase-locked loop generates the output clock (with overhead), using the input clock as a reference. The input clock is normally the recovered clock from the data interface. If a valid input signal is not present, the interface falls back to a 10^{-5} accuracy reference clock generated in the modem, and will transmit a valid IESS-308 framing pattern. If this occurs, the link will remain open at the far end and a fault will be signaled.

The transmit data will be replaced with an all 1s pattern (AIS) in the event of certain failures, in accordance with IESS-308.

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As a test mode, the transmit data can be replaced with a 2047 pattern. This selection overrides the AIS. Only user data bits are replaced with the pattern, while the Engineering Service Channel (ESC) (including framing and alarms) will operate normally.

The composite MUX data stream is normally fed to the modem for further processing (scrambling and K=7 Viterbi encoding). The composite data stream may be looped back at this point as a test function, called interface loopback, when the transmit data rate matches the receive data rate. This allows the operator to test the entire interface as the ESC is looped to itself through the DEMUX. The plesiochronous buffer may also be checked, since user data passes through this circuit.

A.1.3.2.3 Receive DEMUX

The receive data with overhead is processed in the DEMUX. This circuit checks and synchronizes to the frame pattern and separates the user data from the Engineering Service Channel (ESC). If the DEMUX is receiving a correct and synchronized signal, it will signal the modem that the MUX system is locked (MUXlock) and passing data. This is indicated by interrogating the modem, a green LED on the interface and sending the signal into the receive fault tree in accordance with IESS-308. Under certain fault conditions defined by IESS-308, the receive user data will be replaced by a pattern with all 1s, and a fault will be signaled.

A.1.3.2.4 Plesiochronous Buffer

Data from the DEMUX section is fed into a plesiochronous buffer. This buffer size is user-selectable in bit increments that correspond to the length of an IESS-308 satellite superframe. The increments range from 1 to 32 ms. Refer to the interface specifications for a list of valid entries for each of the selected formats. The buffer automatically centers on resumption of service, either from the front panel or remotely. The startup buffer will overfill when centering to match the satellite frame to the terrestrial frame with a maximum slide of 0.5 ms. In general, manual centering will not be plesiochronous.

The fill status is available as a monitor and is accurate to 1%. Overflows or underflows are stored in the stored fault section of the M&C status registers, along with the date and time of the incident (which are provided by the modem internal clock). These are stored in battery-backed RAM.

A normal selection is to have the data clocked out of the buffer by an external clock. This procedure removes the Doppler from the receive satellite data.

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The operator may select from four other clock sources as a backup:

- Insert clock (D&I mode only)
- RX satellite
- Internal clock source
- TX terrestrial

Problems occurring on any of the selected clocks will cause the modem to substitute the satellite clock and a fault will be signaled.

A.1.3.2.5 Engineering Service Channel (ESC)

The ESC uses certain bits of the satellite overhead to implement an EIA-232 data channel. The two types of available data channels are asynchronous and synchronous.

The asynchronous channel works by over-sampling input and output EIA-232 data, so that a clock signal is not required. Data rates up to 1/2000 of the satellite rate may be used. Synchronous data channels are also allowed at a rate of 1/512 of the data rate of the modem. The synchronous channel requires use of the TX clock provided by the modem for operation.

A.1.3.2.6 Backward Alarm

A backward alarm signal is included in the D&I overhead. The signal is sent to the distant side of a satellite link to indicate trouble with the receive side, which may be a result of improper transmission. The M&C computer monitors the receive side of the link. In the event of trouble, the M&C sends an alarm over the transmit side to the distant end. This alarm signal indirectly includes faults in the downlink chain, since major problems with the antenna, Low Noise Amplifier (LNA), or down converter, etc., will cause an interruption in service and fault the modem. Reception of a backward alarm is indicated as one of the events that causes a secondary alarm. The modem may be interrogated from the front panel or by using the EIA-485 or EIA-232 interface to identify the cause of the alarm.

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A.1.3.3 D&I Framing Formats

The D&I framing formats used in the modem can be divided into T1 and E1 categories, as follows:

T1_ESF	T1 Extended Super Frame
T1	T1 D4 Framing
T1_ESF_S	T1 Extended Super Frame Special
T1_S	T1 D4 Framing Special
T1_IBS	T1 IBS Non Fractional, Full 1.544M
E1_CCS	E1 Common Channel Signaling
E1_CAS	E1 Channel Associated Signaling
E1_IBS	E1 IBS Non Fractional, Full 2M
E1_31_TS	E1 31 Time Slots

Each format is further explained in Figure A-3 and Figure A-4.

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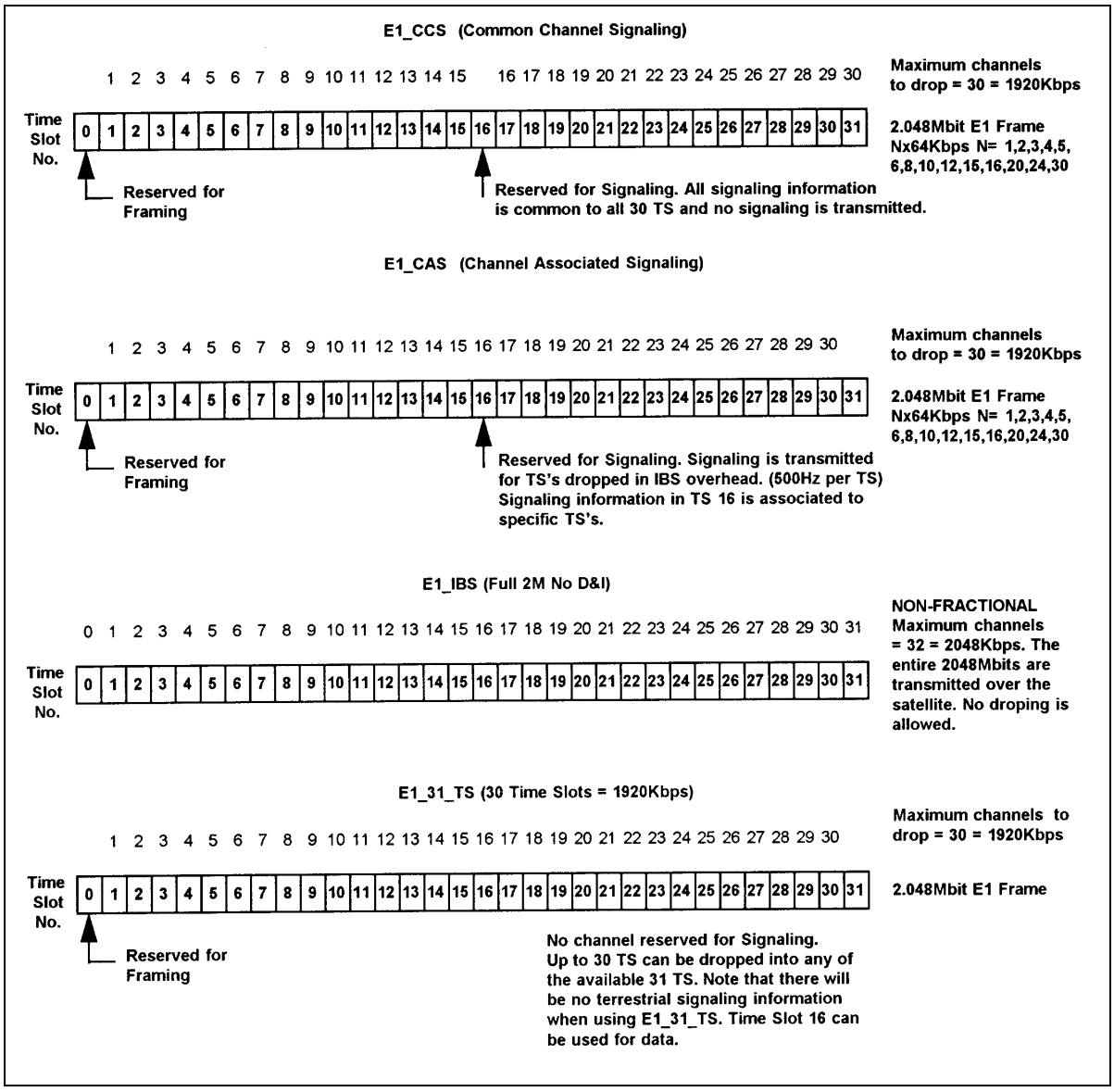


Figure A-3. E1 Framing Formats

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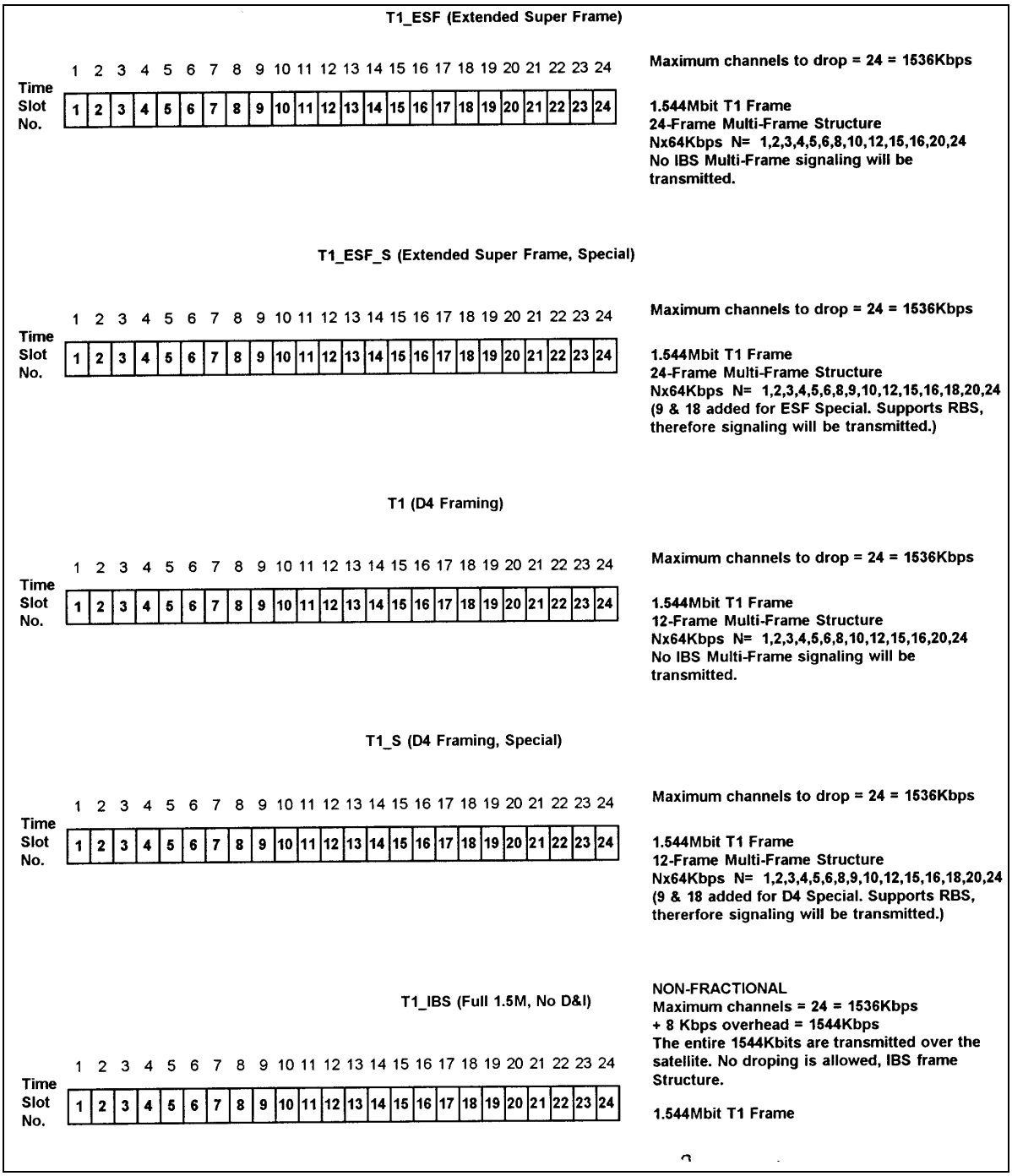


Figure A-4. T1 Framing Formats

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A.1.3.4 D&I Modem Defaults

Refer to Table A-3 for D&I Modem Faults.

Table A-3. D&I Modem Faults

Modulator		**Demodulator**	
Data Rate	A	Data Rate	A
TX Rate A	64 kbps, QPSK 1/2	RX Rate A	64 kbps, QPSK 1/2
TX Rate B	256 kbps, QPSK 1/2	RX Rate B	256 kbps, QPSK 1/2
TX Rate C	768 kbps, QPSK 1/2	RX Rate C	768 kbps, QPSK 1/2
TX Rate D	2048 kbps, QPSK 1/2	RX Rate D	2048 kbps, QPSK 1/2
TX Rate V	128 kbps, QPSK 1/2	RX Rate V	128 kbps, QPSK 1/2
IF Frequency	70 MHz	IF Frequency	70 MHz
IF Output	OFF	Decoder Type	Viterbi
Mod Power Offset	0 dB	Differential Decoder	ON
Power Output	-10 dBm	Demodulator Type	Open Net
Differential Encoder	ON	IF Loopback	OFF
Modulator Type	INTELSAT Open Net	RF Loopback	OFF
Encoder Type	Viterbi	Sweep Center Freq.	0 Hz
CW Mode	Normal (OFF)	Sweep Range	60000 Hz
Mod Power Fixed	0 dB	Sweep Reacquisition	0 seconds
Mod Spectrum	Normal	BER Threshold	NONE
		Demod Spectrum	Normal
Interface			
TX Clock Source	TX Terrestrial	Buffer Size	1 mS
Buffer Clock Source	Insert	Frame Structure T1 Data	G.704
TX Clock Phase	Auto	Frame Structure E1 Data	G.704
RX Clock Phase	Normal	Frame Structure T2 Data	G.743
External Reference Freq.	1544 kHz	Frame Structure E2 Data	G.742
Baseband Loopback	OFF	Loop Timing	OFF
Interface Loopback	OFF	TX Overhead Type	D&I
TX Coding Format	AMI	RX Overhead Type	D&I
RX Coding Format	AMI	TX Terr Interface	G.703
TX 2047	OFF	RX Terr Interface	G.703
RX 2047	OFF	IBS Descrambler	ON
IBS Scrambler	ON	Insert Data Format	T
Drop Data Format	T1	TX Data Phase	Normal
TX Data/AIS Fault	NONE	RX Data Phase	Normal
RX Data/AIS Fault	NONE		
Buffer Programming	mS		

Note: When selecting E1_CAS or E1_CCS D&I data format, the defaults in the D&I data channels are offset by 1 from 16 and up. When programming from E1_CAS or E1_CCS to any other format, the D&I channels are defaulted to straight through.

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A.1.4 Asynchronous Interface/AUPC

Note: If required, refer to Section A.3 for installation of the overhead interface PCB.

The asynchronous (ASYNC) interface option provides the interface for terrestrial data and a single ASYNC overhead channel. Typically used for earth-station-to-earth-station communication, the overhead channel is MUXed onto the data and transmitted at an overhead rate of 16/15 of the main channel. The AUPC feature works with the ASYNC option to allow remote communication between a local modem and a remote modem.

Refer to Figure A-5 for a modem block diagram with the ASYNC/AUPC interface option.

G.703, EIA-422, or V.35 interfaces are available for terrestrial data input and output. These interfaces can be selected via the front panel.

EIA-485 or EIA-232 interfaces are available for ASYNC channel input and output. These interfaces can also be selected from the front panel. Fixed 1/15 overhead is added to the data when an ASYNC channel is being used. With the ASYNC channel enabled, the terrestrial data rate can be from 8 to 2048 kbps. The ASYNC channel I/O protocol can be as follows:

Baud	110 to 38400
Data Bits	5 to 8
Parity	odd, even, or none
Stop Bits	1 or 2

Note: Certain combinations of baud rate, data rate, parity, and stop bits will limit the maximum baud rate allowed for continuous throughput based on terrestrial data rate.

ASYNC overhead is a 1/15 rate overhead channel composed of the following:

- Framing information
- EIA-232 or EIA-485 data
- Valid data flags
- AUPC information (if installed)
- Parity bits

The rate of asynchronous data transfers may be selected by the operator, with the maximum rate available limited to 1.875% of the synchronous data rate.

Note: The asynchronous overhead structure is a Comtech EF Data standard, and is not compatible with IBS or IDR overhead formats.

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The ASYNC interface PCB also provides its own Doppler buffer, which has a maximum depth of 32 ms at the highest terrestrial data rate. Buffer fill status can be checked in the Monitor menu on the front panel of the modem. Depth selection and centering of the buffer are provided in the Configuration Interface menu.

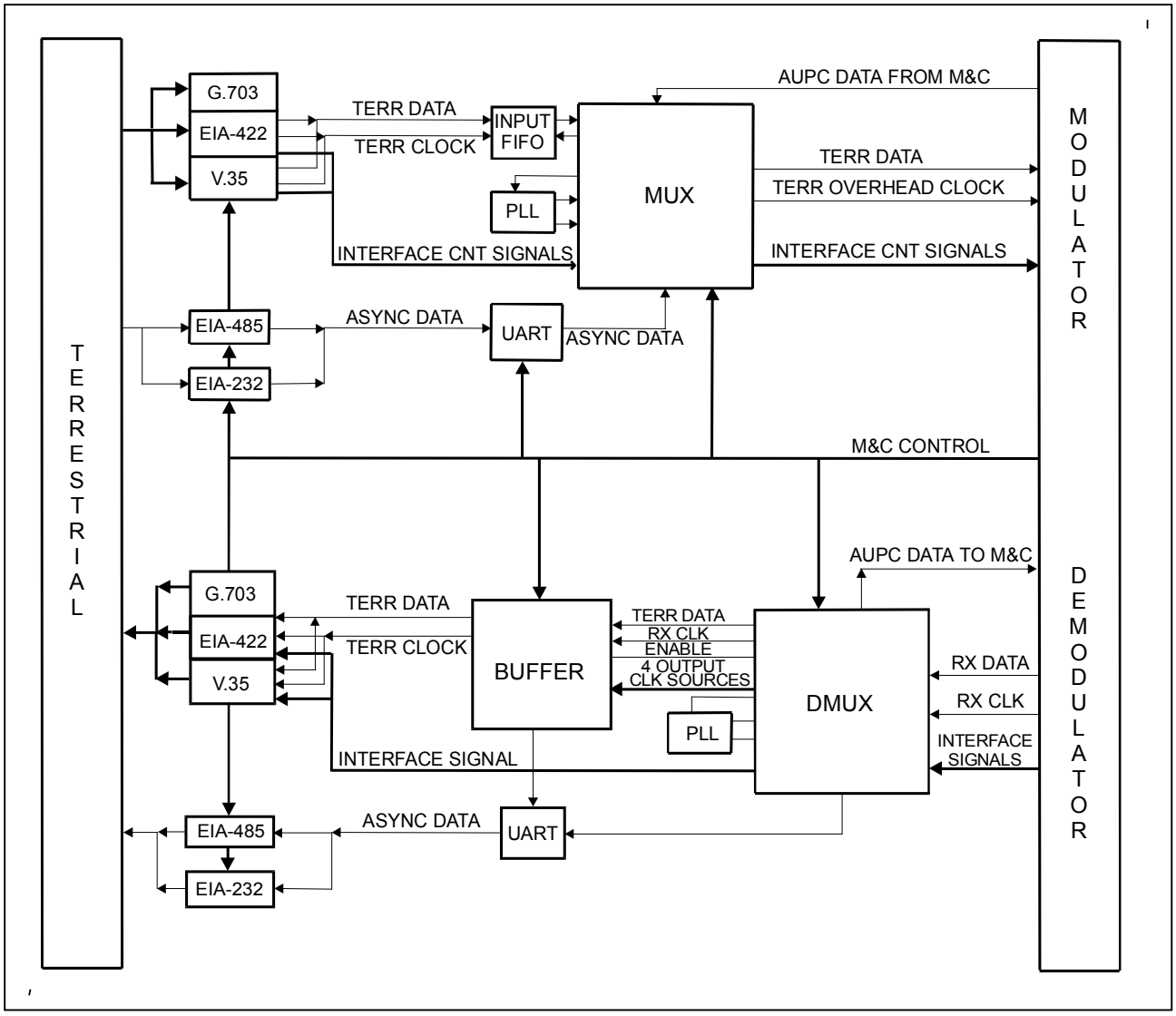


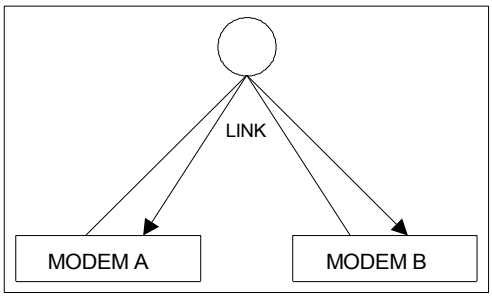
Figure A-5. ASYNC/AUPC Block Diagram

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A.1.4.1 Local AUPC

The AUPC function allows each of two modems in a closed link to control the output of the other modem. Both modems must have the AUPC options enabled. These options are:

AUPC ENABLE	Enables the AUPC to function locally.
NOMINAL POWER	Output power level. Can be used for problem conditions, if chosen.
MINIMUM POWER	Sets minimum output power to be used.
MAXIMUM POWER	Sets maximum output power to be used.
TARGET NOISE	Desired E_b/N_0 of the local modem.
TRACKING RATE	Sets speed at which modems will adjust to output power.
LOCAL CL ACTION	Defines action that local modem will take if it loses carrier (Maximum, Minimum, or Hold).
REMOTE CL ACTION	Defines action that local modem will take if remote modem reports carrier loss (Maximum, Minimum, or Hold).



With AUPC enabled on both modems (A and B), if modem A loses carrier:

1. Modem A sets its output power (MAXIMUM, MINIMUM, OR HOLD) as specified by LOCAL CL ACTION.

2. Modem A then sends a “lost carrier” command to modem B.

3. Modem B sets its output power (MAXIMUM, MINIMUM, OR HOLD) as specified by REMOTE CL ACTION.

4. Once modem A has reacquired the carrier, it sends commands to modem B to achieve the desired E_b/N_0. During this time, modem B sends commands to modem A to increase or decrease power to maintain modem B’s target E_b/N_0.

Notes:
1. Local carrier loss always takes priority over remote carrier loss.
2. The RX AUPC link is dead when the carrier is lost.

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A.1.4.1.1 Self-Monitoring Local Modem AUPC Control

Note: This feature is available with or without the overhead PCB installed. Self-monitoring AUPC is not used when the ASYNC/AUPC option is installed, because the ASYNC/AUPC feature uses the overhead channel to control the modem's output power.

The operator can allow the modulator to control its own TX power when the earth station is in the same satellite footprint. The operator should tune the demodulator to receive its own signal, similar to a satellite loop.

Note: This option can be used for half-duplex operation and for one signal transmitting to many sites. For full-duplex operation, use a separate demodulator.

This option is located in the ***Function Select: Utility: Modem Type: Local Modem AUPC*** menu. Proceed as follows:

1. Locate and enable the option.
2. Set all configuration parameters.

Notes:

1. Comtech EF Data does not recommend increasing the power to the satellite without consulting with the satellite controller.
2. Be careful not to set carrier output to the high-side when there is a loss of carrier due to severe weather.
3. Do not use the distant end RX signal to compensate for local rain fade unless allowances are made for a narrow window for TX level changes.
4. Changes in local weather will attribute to cause level unbalancing in the TX signal. The TX signal is attenuated due to heavy, dense, or cloud conditions.

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A.1.4.2 Remote AUPC

This feature allows the user to monitor and control a remote modem location using the front panel or serial port of the local modem. The operator can set or reset the following commands:

- Baseband loopback
- TX 2047 pattern
- AUPC enable

The user can remotely monitor the receive 2047 BER. Refer to Appendix B for a description of remote operation.

A.1.4.3 Theory of Operation

A.1.4.3.1 Terrestrial Data Interfaces

Two I/O interfaces are provided for the terrestrial data source: EIA-422 and V.35. The operator must select the terrestrial interface type from the front panel under the ***Function Select: Utility: Interface*** menu. Once selected, I/O data is routed to and from the appropriate drivers and receivers.

A.1.4.3.2 ASYNC Data Interfaces

The EIA-485 and EIA-232 I/O interfaces are provided for the ASYNC data source. The operator must select the ASYNC data interface type from the front panel under the ***Function Select: Utility: Interface*** menu. Once selected, the I/O data is routed to and from the appropriate drivers and receivers.

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A.1.4.3.3 MUX Operation

The MUX receives terrestrial and ASYNC data from the selected receivers. The terrestrial data flows into a small First In/First Out (FIFO) buffer. The FIFO buffer aids in the rate exchange between the terrestrial data rate and the overhead rate. The data can be clocked into the MUX by the terrestrial clock or an internal clock.

ASYNC data is received by the RX section of a Universal Asynchronous Receiver/ Transmitter (UART) programmed by the M&C for the correct data protocol. The incoming ASYNC data is sampled with a 16x clock in the middle of the bit time.

AUPC data is received from a serial M&C interface. The overhead clock is generated from the terrestrial data clock by a phase-locked loop. Inside the multiplexer, overhead bits (1/16) are added to create a sub-frame, frame, and multi-frame structure. The AUPC data from the M&C interface and the ASYNC data are inserted into the framing structure. The framed data is output to the modulator card on the modem at the overhead rate.

A.1.4.3.4 DEMUX Operation

The DEMUX section functions in a “reverse” manner to the MUX side. Data, including overhead, is received from the Demod card in the modem at the overhead rate.

The DEMUX locates the framing in the overhead and locks to the frame sync pattern generated by the multiplexer on the transmitting end. Once locked to the framing, the terrestrial data is clocked into the Doppler buffer with the overhead clock and an enable line.

The ASYNC channel data is stripped out of the frame structure, and is buffered in the TX portion of a UART. The UART then transmits the data with the selected protocol to the appropriate drivers to the end user. The AUPC data is also stripped from the frame structure and is sent to the M&C via a serial interface.

A.1.4.3.5 Buffer Operation

The buffer has two serial interfaces to the M&C interface. The first serial interface is used to download the desired buffer size. The second serial interface is used to provide the M&C with the information necessary to calculate the fill status of the buffer. Three discrete lines are provided:

- One line to center the buffer on command.
- Two lines to indicate either an overflow or underflow condition.

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The Doppler buffer receives data clocked by the overhead clock from the Demod and an enable line from the DEMUX. The data is stored in RAM. Four options are allowed to clock the data out of the buffer:

- TX
- RX
- Internal
- External

Based on this selection, terrestrial data is clocked out of the buffer to the selected drivers and on to the end user.

A.1.4.3.6 Loop Timing Operation

A loop timing option is provided. When loop timing is selected, the Doppler buffer output clock is forced to the RX clock by the M&C. An M&C-controlled MUX switches the Send Timing (ST) pin to output the RX clock. The RX clock is sent out the ST pin to the appropriate interface drivers and on to the user. The operator is left with the option of clocking terrestrial data into the MUX on the transmit side with either the external clock source Terminal Timing (TT) or the internal clock source. The internal clock source is the same as the ST pin.

A.1.4.3.7 Baseband Loopback Operation

A baseband loopback option is provided. When selected, the input terrestrial data and clock from the operator are looped back to the user as the output terrestrial data and clock.

The terrestrial data and clock output from the DEMUX are also looped to the terrestrial data and clock input at the MUX.

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A.1.4.3.8 Non-ASYNC Operation

The ASYNC interface has pass-through capability. If ASYNC is turned off in the ***Configuration: Interface*** menu, then a standard G.703, EIA-422, or V.35 interface is selected. The modem will operate as a standard G.703, EIA-422, or V.35 interface with no overhead. Instead of changing jumpers on the interface PCB to change polarities for various signals, polarity inversion is available in the ***Utility: Interface*** menu for the following signals:

- Send Data (SD)
- Terminal Timing (TT)
- Request to Send (RS)
- Receive Data (RD)
- Receive Timing (RT)
- Receiver Ready (RR)
- Data Mode (DM)
- Monitor and Control (MC)
- Send Timing (ST)

A.1.4.3.9 ASYNC Channel EIA-485 2- and 4-Wire Operation

The ASYNC interface is compatible with either a 2- or 4-wire interface for the EIA-485 channel. The 2- or 4-wire operation is selected via the front panel.

- In the 2-wire mode, the EIA-485 receivers are disabled whenever the data is to be transmitted down the 2-wire interface.

- In the 4-wire mode, the receiver is always on.

The receive modem controls the transmit and receive data in two wire operation. EIA-485 (2 wire) must be turned on in the ***Function Select: Utility: Interface*** menu.

The output driver will be turned on when the receive demux on the overhead card detects ASYNC data. The input driver will be turned off at the same time. This prevents the receive data from transmitting back to the originating modem.

For EIA-485 two wire, loop the highs (TX+, RX+) and then loop the lows (TX-, RX-) at the connector for two wire operation. These loops are not accomplished inside the modem.

EIA-485 four wire circuits will become 2 wire when attached to any device that is EIA-485 two wire.

For example: The modem Async overhead at a site that has an RF terminal, must be set to TX EIA-485 (two wire) because the RF terminal is only EIA-485 two wire.

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A.1.4.3.10 Valid ASYNC Baud Rates

The ASYNC baud rates are limited by the terrestrial data rates. The following table shows the relationships between data and baud rates.

If DR ≤ 15.999K	Maximum baud rate is 150
If DR ≤ 31.999K	Maximum baud rate is 300
If DR ≤ 63.999K	Maximum baud rate is 600
If DR ≤ 127.999K	Maximum baud rate is 1200
If DR ≤ 255.999K	Maximum baud rate is 2400
If DR ≤ 511.999K	Maximum baud rate is 4800
If DR ≤ 1023.999K	Maximum baud rate is 9600
If DR ≤ 2047.999K	Maximum baud rate is 19200
If DR ≤ 2048.999K	Maximum baud rate is 38400

The following table lists examples.

If DR = 8.000K	Baud rate can be 150 or lower
If DR = 16.000K	Baud rate can be 300 or lower
If DR = 32.000K	Baud rate can be 600 or lower
If DR = 64.000K	Baud rate can be 1200 or lower
If DR = 128.000K	Baud rate can be 2400 or lower
If DR = 256.000K	Baud rate can be 4800 or lower
If DR = 512.000K	Baud rate can be 9600 or lower
If DR = 1024.000K	Baud rate can be 19200 or lower
If DR = 2048.000K	Baud rate can be 38400 or lower

A.1.4.4 Front Panel Operation

For information on the additional front panel operations that are specific to the ASYNC interface, refer to Chapter 3. The following menus are affected:

- Configuration Interface
- Configuration Local AUPC
- Utility Interface
- Remote AUPC Configuration
- Remote AUPC Monitor

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A.1.4.5 ASYNC Remote Operation

Remote modems can be controlled over the ASYNC channel from the local (or "hub") modem. Refer to Table A-4 for a list of combinations:

Table A-4. ASYNC Remote Operation

Configuration #	Local Modem	To Remote Modem	Table #
1	EIA-232	EIA-232	Table A-5
2	EIA-232	EIA-485 (4-wire)	Table A-6
3	EIA-232	EIA-485 (2-wire)	Table A-7
4	EIA-485 (4-wire)	EIA-232	Table A-8
5	EIA-485 (4-wire)	EIA-485 (4-wire)	Table A-9
6	EIA-485 (4-wire)	EIA-485 (2-wire)	Table A-10
7	EIA-485 (2-wire)	EIA-232	Table A-11
8	EIA-485 (2-wire)	EIA-485 (4-wire)	Table A-12

For each of the above combinations, front panel control settings and pinouts for local and remote cables are listed in the following sections:

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Before remote ASYNC communications can be implemented, the following must occur:

- At both the local and remote modems, front panel configuration parameters must be set for each type of configuration.
- Industry-standard cables must be used at both modems.

To implement remote ASYNC operation, use the configuration information found in the applicable section and perform the following steps:

1. Set the jumpers on the remote modem M&C/Display PCB according to the information found in the applicable configuration section.
2. Set the local modem front panel controls according to the information found in the applicable configuration section.
3. Connect the local modem 25-pin ASYNC connection (via breakout panel or Y cable) to the terminal using the pinout information found in the applicable configuration section. Refer to Figure A-5 and Figure A-6.
4. Set the remote modem front panel controls according to the information found in the applicable configuration section.
5. Connect the remote modem 25-pin ASYNC connection (via breakout panel or Y cable) to the 9-pin J6 port at the rear of the modem using the pinout information found in the applicable configuration section. Refer to Figure A-6 and Figure A-7.

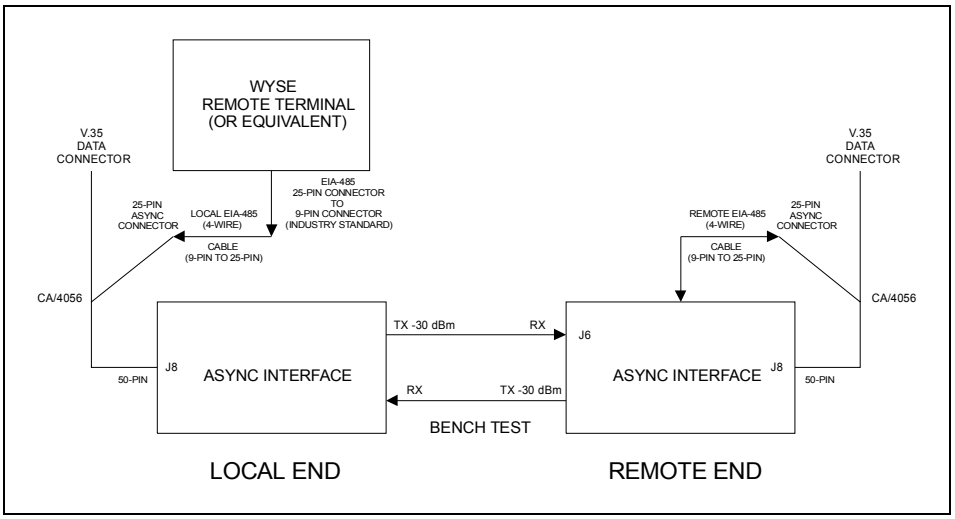


Figure A-6. Remote ASYNC Connection Diagram for Y Cable

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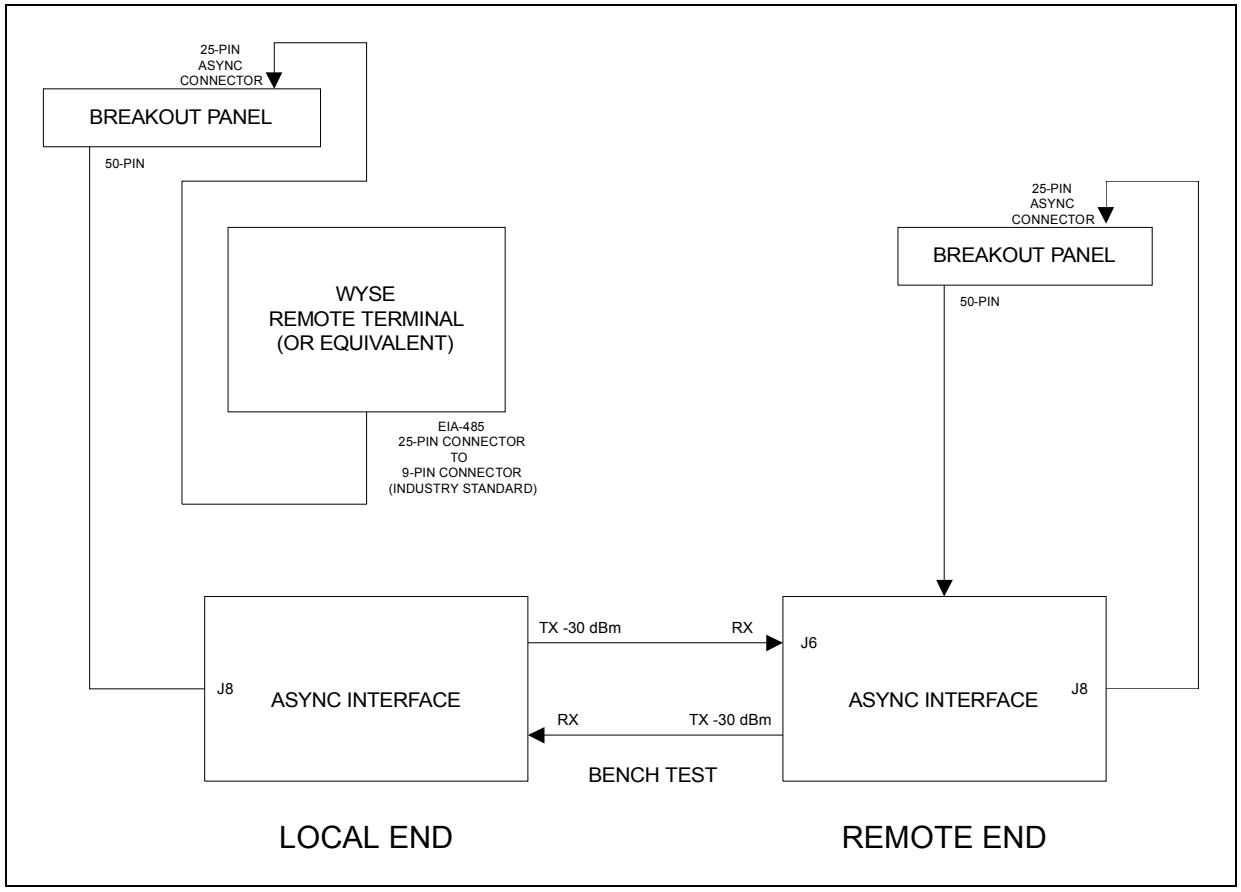


Figure A-7. Remote ASYNC Connection Diagram for Breakout Panel

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A.1.4.5.1 Configuration #1 (Local EIA-232 to Remote EIA-232)

Table A-5. Local EIA-232 to Remote EIA-232

#1. Local End Modem Settings for EIA-232	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-232
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#1. Remote End Modem Settings for EIA-232	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-232
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-232 remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#1. Local End EIA-232			
9-Pin Female Connector		**25-Pin Male Connector**	
RX	2	3	TX
TX	3	2	RX
GND	5	7	GND

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#1. Remote End EIA-232			
9-Pin Male Connector		**25-Pin Male Connector**	
RX	2	2	RX
TX	3	3	TX
GND	5	7	GND

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A.1.4.5.2 Configuration #2 (Local EIA-232 to Remote EIA-485 [4-Wire])

Table A-6. Local EIA-232 to Remote EIA-485 (4-Wire)

#2. Local End Modem Settings for EIA-232 (4-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-232
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#2. Remote End Modem Settings for EIA-485 (4-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (4-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-232 (4-wire) remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#2. Local End EIA-232			
9-Pin Female Connector		**25-Pin Male Connector**	
RX	2	3	TX
TX	3	2	RX
GND	5	7	GND

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#2. Remote End EIA-485 (4-Wire) Twisted Pair			
9-Pin Male Connector		**25-Pin Male Connector**	
TX+	4	16	RX+
TX-	5	3	RX-
RX+	8	14	TX+
RX-	9	2	TX-

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A.1.4.5.3 Configuration #3 (Local EIA-232 to Remote EIA-485 [2-Wire])

Table A-7. Local EIA-232 to Remote EIA-485 (2-Wire)

#3. Local End Modem Settings for EIA-232	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-232
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#3. Remote End Modem Settings for EIA-485 (2-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (2-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-232 remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#3. Local End EIA-232			
9-Pin Female Connector		**25-Pin Male Connector**	
RX	2	3	TX
TX	3	2	RX
GND	5	7	GND

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#3. Remote End EIA-485 (2-Wire)			
9-Pin Male Connector		**25-Pin Male Connector**	
TX/RX+	4	14, 16	TX+, RX+
TX/RX-	5	2, 3	TX-, RX-

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A.1.4.5.4 Configuration #4 (Local EIA-485 [4-Wire] to Remote EIA-232)

Table A-8. Local EIA-485 (4-Wire) to Remote EIA-232

#4. Local End Modem Settings for EIA-485 (4-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (4-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	110 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#4. Remote End Modem Settings for EIA-232	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-232
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-485 (4-wire) remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#4. Local End EIA-485 (4-Wire) Twisted Pair			
9-Pin Female Connector		**25-Pin Male Connector**	
TX+	4	14	TX+
TX-	5	2	TX-
RX+	8	16	RX+
RX-	9	3	RX-

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#4. Remote End EIA-232			
9-Pin Male Connector		**25-Pin Male Connector**	
RX	2	2	RX
TX	3	3	TX
GND	5	7	GND

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A.1.4.5.5 Configuration #5 (Local EIA-485 [4-Wire] to Remote EIA-485 [4-Wire])

Table A-9. Local EIA-485 (4-Wire) to Remote EIA-485 (4-Wire)

#5. Local End Modem Settings for EIA-485 (4-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (4-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#5. Remote End Modem Settings for EIA-485 (4-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (4-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-485 (4-wire) remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#5. Local End EIA-485 (4-Wire) Twisted Pair			
9-Pin Female Connector		**25-Pin Male Connector**	
TX+	4	14	TX+
TX-	5	2	TX-
RX+	8	16	RX+
RX-	9	3	RX-

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#5. Remote End EIA-485 (4-Wire)Twisted Pair			
9-Pin Male Connector		**25-Pin Male Connector**	
TX+	4	16	RX+
TX-	5	3	RX-
RX+	8	14	TX+
RX-	9	2	TX-

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A.1.4.5.6 Configuration #6 (Local EIA-485 [4-Wire] to Remote EIA-485 [2-Wire])

Table A-10. Local EIA-485 (4-Wire) to Remote EIA-485 (2-Wire)

#6. Local End Modem Settings for EIA-485 (4-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (4-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#6. Remote End Modem Settings for EIA-485 (2-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (2-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 *(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-485 (4-wire) remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#6. Local End EIA-485 (4-Wire) Twisted Pair			
9-Pin Female Connector		**25-Pin Male Connector**	
TX+	4	14	TX+
TX-	5	2	TX-
RX+	8	16	RX+
RX-	9	3	RX-

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#6. Remote End EIA-485 (2-Wire)			
9-Pin Male Connector		**25-Pin Male Connector**	
TX/RX+	4	14, 16	TX+, RX+
TX/RX-	5	2, 3	TX-, RX-

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A.1.4.5.7 Configuration #7 (Local EIA-485 [2-Wire] to Remote EIA-232)

Table A-11. Local EIA-485 (2-Wire) to Remote EIA-232

#7. Local End Modem Settings for EIA-485 (2-Wire)	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-485 (2-wire)
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 (*See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
#7. Remote End Modem Settings for EIA-232	
Utility: Interface Menu	
ASYNC TX and RX Type	EIA-232
Configuration: Interface Menu	
ASYNC TX and RX Baud Rate	150 to 38400 (*See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits
ASYNC TX and RX Parity	Even
ASYNC TX Stop	2 bits
Utility: System Menu	
Remote Baud Rate	Equal to ASYNC TX and RX baud rate
Parity	Even
Address	1 to 255

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The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-485 (2-wire) remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#7. Local End EIA-485 (2-Wire)			
9-Pin Female Connector		25-Pin Male Connector	
TX/RX+	4	14, 16	TX+/RX+
TX/RX-	5	2, 3	TX-/RX-

In addition, the following table lists the pinout for the WYSE terminal cable using an EIA-232 to EIA-485 converter.

#7. Local End WYSE Cable With Converter			
25-Pin Male Connector		9-Pin Male Connector	
TX-/RX-	2, 5	5	TX/RX-
TX+/RX+	14, 17	4	TX/RX+
(See Note)	18, 21		

Note: Disables RD during TD.

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#7. Remote End EIA-232			
9-Pin Male Connector		25-Pin Male Connector	
RX	2	2	RX
TX	3	3	TX
GND	5	7	GND

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A.1.4.5.8 Configuration #8 (Local EIA-485 [2-Wire] to Remote EIA-485 [4-Wire])

Table A-12. Local EIA-485 (2-Wire) to Remote EIA-485 (4-Wire)

#8. Local End Modem Settings for EIA-485 (2-Wire)		
Utility: Interface MENU		
ASYNC TX and RX Type	EIA-485 (2-wire)	
Configuration: Interface Menu		
ASYNC TX and RX Baud Rate	150 to 38400	*(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits	
ASYNC TX and RX Parity	Even	
ASYNC TX Stop	2 bits	
#8. Remote End Modem Settings for EIA-485 (4-Wire)		
Utility: Interface Menu		
ASYNC TX and RX Type	EIA-485 (4-wire)	
Configuration: Interface Menu		
ASYNC TX and RX Baud Rate	150 to 38400	*(See A.1.4.3.10)*
ASYNC TX and RX Length	7 bits	
ASYNC TX and RX Parity	Even	
ASYNC TX Stop	2 bits	
Utility: System Menu		
Remote Baud Rate	Equal to ASYNC TX and RX baud rate	
Parity	Even	
Address	1 to 255	

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The local end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the EIA-485 (2-wire) remote terminal (WYSE or laptop computer). The pinout of the local cable is listed in the following table.

#8. Local End EIA-485 (2-Wire)			
9-Pin Female Connector		25-Pin Male Connector	
TX/RX+	4	14, 16	TX+/RX+
TX/RX+	5	2, 3	TX-/RX-

In addition, the following table lists the pinout for the WYSE terminal cable using an EIA-232 to EIA-485 converter.

#8. Local End WYSE Cable With Converter			
25-Pin Male Connector		9-Pin Male Connector	
TX-/RX-	2, 5	5	TX/RX-
TX+/RX+	14, 17	4	TX/RX+
(See Note)	18, 21		

Note: Disables RD during TD.

The remote end cable connects the 25-pin female ASYNC connector (on either the breakout panel or the Y cable) to the 9-pin female connector, J6, at the rear of the modem. The pinout of the remote cable is listed in the following table.

#8. Remote End EIA-485 (4-Wire) Twisted Pair			
9-Pin Male Connector		25-Pin Male Connector	
TX+	4	16	RX+
TX-	5	3	RX-
RX+	8	14	TX+
RX-	9	2	TX-

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A.1.4.6 ASYNC/AUPC Modem Defaults

Refer to Table A-13 for ASYNC/AUPC modem defaults.

Table A-13. ASYNC/AUPC Modem Defaults

Modulator		Demodulator	
Data Rate	A	Data Rate	A
TX Rate A	64 kbps, QPSK 1/2	RX Rate A	64 kbps, QPSK 1/2
TX Rate B	256 kbps, QPSK 1/2	RX Rate B	256 kbps, QPSK 1/2
TX Rate C	768 kbps, QPSK 1/2	RX Rate C	768 kbps, QPSK 1/2
TX Rate D	2048 kbps, QPSK 1/2	RX Rate D	2048 kbps, QPSK 1/2
TX Rate V	128 kbps, QPSK 1/2	RX Rate V	128 kbps, QPSK 1/2
IF Frequency	70 MHz	IF Frequency	70 MHz
IF Output	OFF	Descrambler	ON
TX Power Level	+0 dBm	Differential Decoder	ON
Scrambler	ON	RF Loopback	OFF
Differential Encoder	ON	IF Loopback	OFF
CW Mode	Normal (OFF)	BER Threshold	NONE
RS Encoder	OFF	Sweep Center Freq.	0 Hz
Modulator Type	EFD Closed	Sweep Range	60000 Hz
Encoder Type	Viterbi	Sweep Reacquisition	0 seconds
Mod Spectrum	Normal	RS Decoder	OFF
Mod Power Fixed	0 dB	Demodulator Type	EFD Closed
		Decoder Type	Viterbi
		Demod Spectrum	Normal
Interface			
TX Clock Source	TX Terrestrial	Frame Structure E1 Data	G.704
Buffer Clock Source	RX Satellite	Frame Structure T2 Data	G.743
TX Clock Phase	Auto	Frame Structure E2 Data	G.742
RX Clock Phase	Normal	TX Terr Interface	G.703
EXT-REF Frequency	1544.000 kHz	RX Terr Interface	G.703
Baseband Loopback	OFF	TX Data Phase	Normal
Interface Loopback	OFF	RX Data Phase	Normal
Loop Timing	OFF	Async TX Baud	110 bps
TX Data/AIS Fault	NONE	Async RX Baud	110 bps
RX Data/AIS Fault	NONE	Async TX Length	7 Bits
TX 2047 Pattern	OFF	Async RX Length	7 Bits
RX 2047 Pattern	OFF	Async TX Stop	2 Bits
TX Coding Format	AMI	Async RX Stop	2 Bits
RX Coding Format	AMI	Async TX Parity	EVEN
Buffer Programming	Bits	Async RX Parity	EVEN
Buffer Size	384	TX Overhead Type	Async
Frame Structure T1 Data	G.704	RX Overhead Type	Async
Local AUPC			
AUPC ENABLE	OFF	Target Noise	6.0 dB
Nominal Power	+0.0 dBm	Tracking Rate	0.5 dB/MIN
Minimum Power	-20.0 dBm	Local CL Action	Hold
Maximum Power	+5 dBm	Remote CL Action	Hold

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A.1.5 Decoder

A.1.5.1 Sequential Decoder

The sequential decoder is used in closed network applications, typically in Frequency Division Multiple Access (FDMA) satellite communications systems. The sequential decoder is a FAST option.

Refer to Figure A-8 for a block diagram of the sequential decoder.

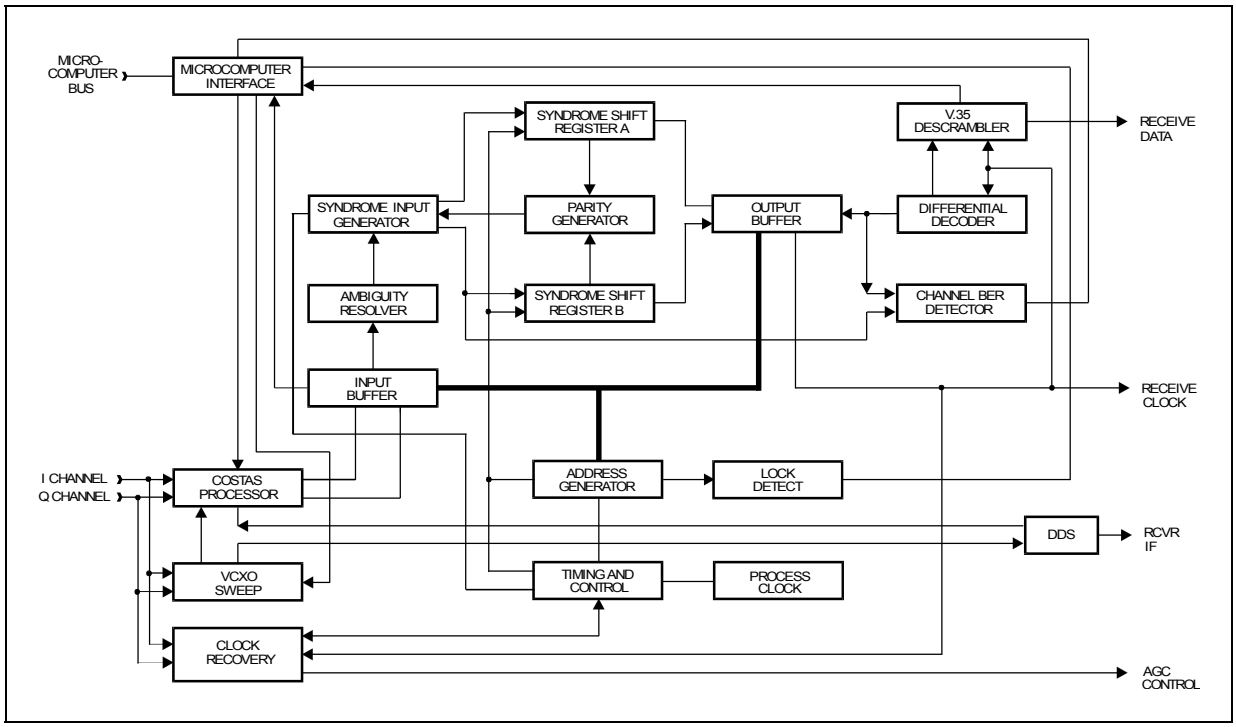


Figure A-8. Sequential Decoder Block Diagram

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A.1.5.1.1 Theory of Operation

The sequential decoder also works in conjunction with the convolutional encoder at the transmitting modem to correct bit errors in the received data stream from the demodulator.

The sequential decoder processes 2-bit quantized I&Q channel data symbols from the demodulator. This data is assumed to be a representation of the data transmitted, corrupted by additive white Gaussian noise. The decoder's task is to determine which bits have been corrupted by the transmission channel, and correct as many as possible. This is accomplished by the use of parity bits added by the encoder to the data stream prior to transmission.

The possible sequences of bits, including parity output by the encoder, are listed on a code tree. The decoder uses the parity bits and knowledge of the code tree to determine the most likely correct sequence of data bits for a given received sequence.

The search proceeds from a node in the code tree by choosing the branch with the highest metric value (highest probability of a match between the received data and a possible code sequence). The branch metrics are added to form the cumulative metric. As long as the cumulative metric increases at each node, the decoder assumes it is on the correct path, and continues forward. If the decoder makes a wrong decision, the cumulative metric will decrease rapidly as the error propagates through the taps of the parity generator. In this case, the decoder tries to back up through the data to the last node where the metric was increasing, then take the other branch.

In an environment with severe errors, the decoder will continue to search backwards for a path with an increasing metric until it either finds one, runs out of buffered data, or runs out of time and must deliver the next bit to the output.

The decoder processes data at a fixed rate, which is much higher than the symbol rate of the input data. This allows it to evaluate numerous paths in its search for the most likely one during each symbol time.

Data enters the input RAM of the decoder from the demod processor in 2-bit soft decision form for both I&Q channels, as shown in the block diagram (Figure 4-3). The input RAM buffers the data to provide history for the backward searches. Data from the RAM passes through the Ambiguity Corrector, which compensates for the potential 90° phase ambiguity of the demodulator.

The syndrome input generator converts the 2-bit soft decision data into a single bit per channel, and simultaneously corrects some isolated bit errors. The data is then shifted through the syndrome shift registers, which allows the parity generator to detect bit errors. The resulting error signal provides the feedback to the timing and control circuitry to allow it to direct the data along the path of the highest cumulative metric.

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The corrected data is buffered through the output RAM and re-timing circuit, which provides a data stream to the differential decoder and descrambler at the constant rate of the data clock. The data and the clock are then output from the card.

The sequential decoder also provides a lock detect signal to the M&C when the error rate has dropped below a threshold level. The M&C monitors these signals and takes appropriate action.

The raw BER count is made by comparing the input and output decoder data. Because the output data contains many fewer errors than the input, differences in the two can be counted to yield the raw BER. The raw BER is sent to the M&C for further processing.

A.1.5.2 Viterbi Decoder

The Viterbi decoder operates in conjunction with the convolutional encoder at the transmit modem. The decoder uses a decoding algorithm to provide FEC on the received data stream for errors occurring in the transmission channel.

A block diagram of the Viterbi decoder is shown in Figure A-9.

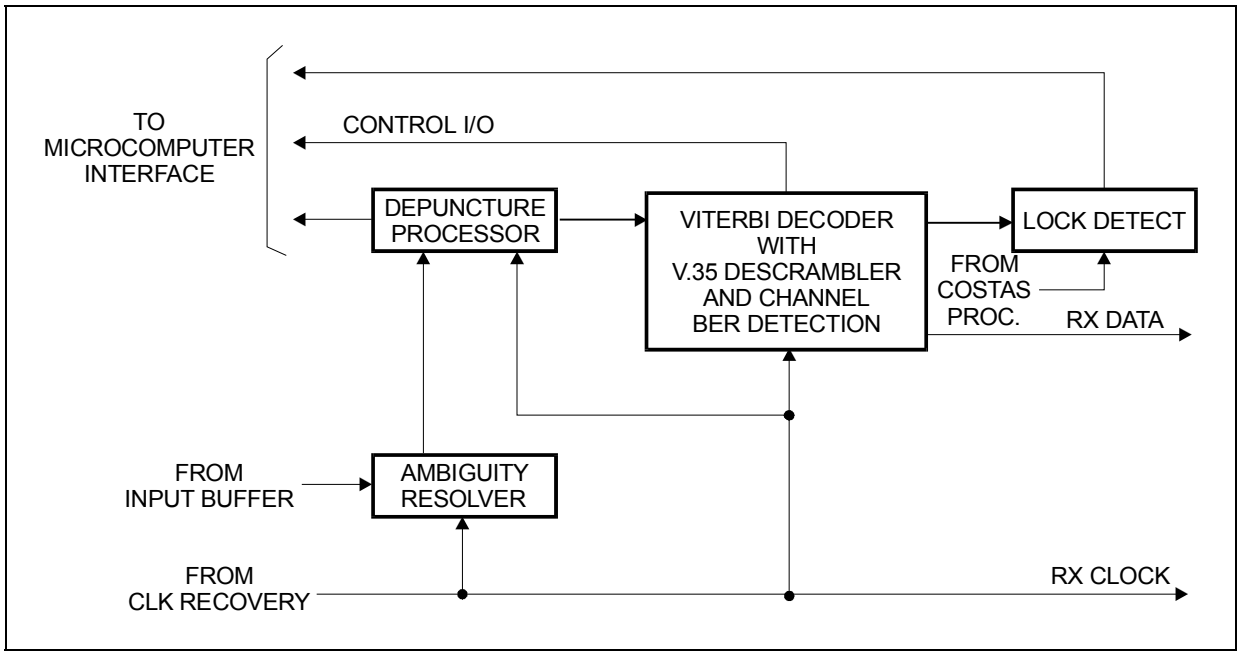


Figure A-9. Viterbi Decoder Block Diagram

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A.1.5.2.1 Specifications

Refer to Table A-14 for Viterbi specification.

Table A-14. Viterbi Specification

Parameter	Specification
BER	See Chapter 1
Maximum Data Rate	2.048 Mbps (rate 1/2) 2.048 Mbps (rate 3/4) 2.048 Mbps (rate 7/8)
Synchronization Time	8000 bits (maximum)
Output Fault Indicators	Activity detection of I and Q data sign bits
Raw BER Detection	From 0 to 255 bits out of 1024 samples
Differential Decoding	2-phase or none
Constant Length	7

A.1.5.2.2 Theory of Operation

The Viterbi decoder processes 3-bit quantized R0 and R1 parallel code bits or symbols from the demodulator. The quantization is 3-bit soft-decision in sign/magnitude format. This data is a representation of the data transmitted, corrupted by additive white Gaussian noise. The task of the decoder is to determine which symbols have been corrupted by the transmission channel and correct as many errors as possible. The code symbols produced by the encoder provide the data for this task.

The seven functions used in processing the data stream are:

- Phase compensation with an ambiguity resolver
- De-puncturing
- Computing branch metric values
- Add-Select-Compare (ASC) computer processing
- Memory storage
- Descrambling
- Differential decoding

The data is first sent through an ambiguity resolver for compensating the potential 90° phase ambiguity inherent in a QPSK demodulator. The data is then de-punctured if the decoder is operating in the 3/4 or 7/8 rates. The de-puncture pattern is the same as the puncture pattern used in the encoder.

A set of branch metric values is then computed for each of the received symbol pairs. This is related to the probability that the received symbol pair was actually transmitted as one of the four possible symbol pairs.

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The branch metrics are then processed by the ASC computer. The ASC computer makes decisions about the most probable transmitted symbol stream with the state metrics computed for the previous 64 decoder inputs.

The results of the ASC computer are stored in the path memory (80 states in depth). The path with the maximum metric is designated as the survivor path, and its data is used for output. The difference between the minimum and the maximum path metrics is used as the means of determining synchronization of the decoder.

The output data is then descrambled and differentially decoded. Both of these processes are optional, and may be selected by the user locally or remotely. The data from the differential decoder is sent to the interface PCB for formatting and output. The synchronization signal is used for lock-detect and sent to the M&C.

The raw BER count is generated from the minimum and maximum metrics and sent to the M&C for further processing. Refer to Chapter 1 for Viterbi decoder BER specifications.

A.1.5.3 Reed-Solomon Decoder

Refer to Section A.2, Conventional Options, for Reed-Solomon information.

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A.1.6 IDR

IDR operation adds 96 kbps overhead to the terrestrial data. The terrestrial data rates supported are:

- 1.544 Mbps (T1) + 96k = 1640 Mbps on the data rate menu
- 2.048 Mbps (E1) + 96k = 2144 Mbps on the data rate menu

The terrestrial data is passed through the baseband loopback relay and is translated from the G.703 format to TTL with a recovered clock.

Overhead data can include two ADPCM audio channels or one 64 kbps data channel, four backward alarms, and an EIA-422 format 8 kbps synchronous data channel multiplexed with the dejittered terrestrial data. If the 64 kbps option is selected, the data path is through the normal ADPCM audio path. The audio or 64 kbps option is selected from the ***Utility: Interface*** menu (Chapter 3), using the IDR TX ESC TYPE and IDR RX ESC TYPE commands.

The interface for the audio is a 600Ω transformer-balanced input. The ADPCM audio channels are encoded according to CCITT G.721.

The backward alarms are level-translated to TTL by threshold comparators set to 2.5V. A 1K pull-up resistor to +5V is connected to each alarm input.

The multiplexed data stream is output to the modulator through the interface loopback device. The receive data from the demodulator is input through the same interface loopback device. The receive data is demultiplexed to produce:

- Receive terrestrial data
- 2 ADPCM audio channels or one 64 kbps data channel
- 4 backward alarms
- 8 kbps synchronous data channel
- 1 octet path

The 8 kbps synchronous data channel is formatted for EIA-422. The terrestrial data output from the DEMUX is input to a plesiochronous buffer. The front panel interface provides four clock selections clocking the data out of the buffer:

- Internal Clock (SCT)
- RX Recovered Clock (RXCLK)
- External Reference Clock (EXT)
- TX Clock (TXCLK)

If either RXCLK or EXT is selected and then fails, the interface automatically switches to SCT recovered clock as the source.

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The AIS is detected in the receive data and reported to the M&C. The M&C control inserts AIS into the TX data path.

The receive data and selected clock are translated to conform to the G.703 interface, and output through the baseband loopback relay.

Four sets of transmit and receive backward alarms are available to implement the structure defined in IESS-308. Backward alarms are sent to the distant side of an IDR link to signal that trouble has occurred at the receive side (which may have resulted from an improper transmission).

The octet path is used for transferring a clock pulse to the distant end terrestrial equipment. In IDR applications, this is the ESC EIA-422 data rate divided by 8 (for example, 8 kbps ÷ 8 = 1 kbps). If the octet path is used, then the clock pulse must be 1 kbps; otherwise, it can be ignored.

Implementation is straightforward in a simple, single destination link. INTELSAT specifies that any major failure of the downlink chain is to generate a backward alarm. The modem has a demodulator fault relay which de-energizes in the event of a receive fault.

The fault tree for this signal includes the appropriate overhead framing faults in order for this relay to be connected to the appropriate backward alarm input. This signal also includes faults in the downlink chain, since major problems with the antenna, Low Noise Amplifier (LNA), down converter, and other components will cause an interruption in service and fault the modem. Refer to Chapter 2 for connection information.

The desired faults must be hardwired into either the UB-300 breakout panel or the SMS-7000 data switch module in order to take advantage of the backward alarm capabilities. Otherwise, the user can turn them OFF under the Utility/Interface/IDR Backward Alarm control or ground them out at the connector.

Refer to Figure A-10 for a block diagram of the IDR interface.

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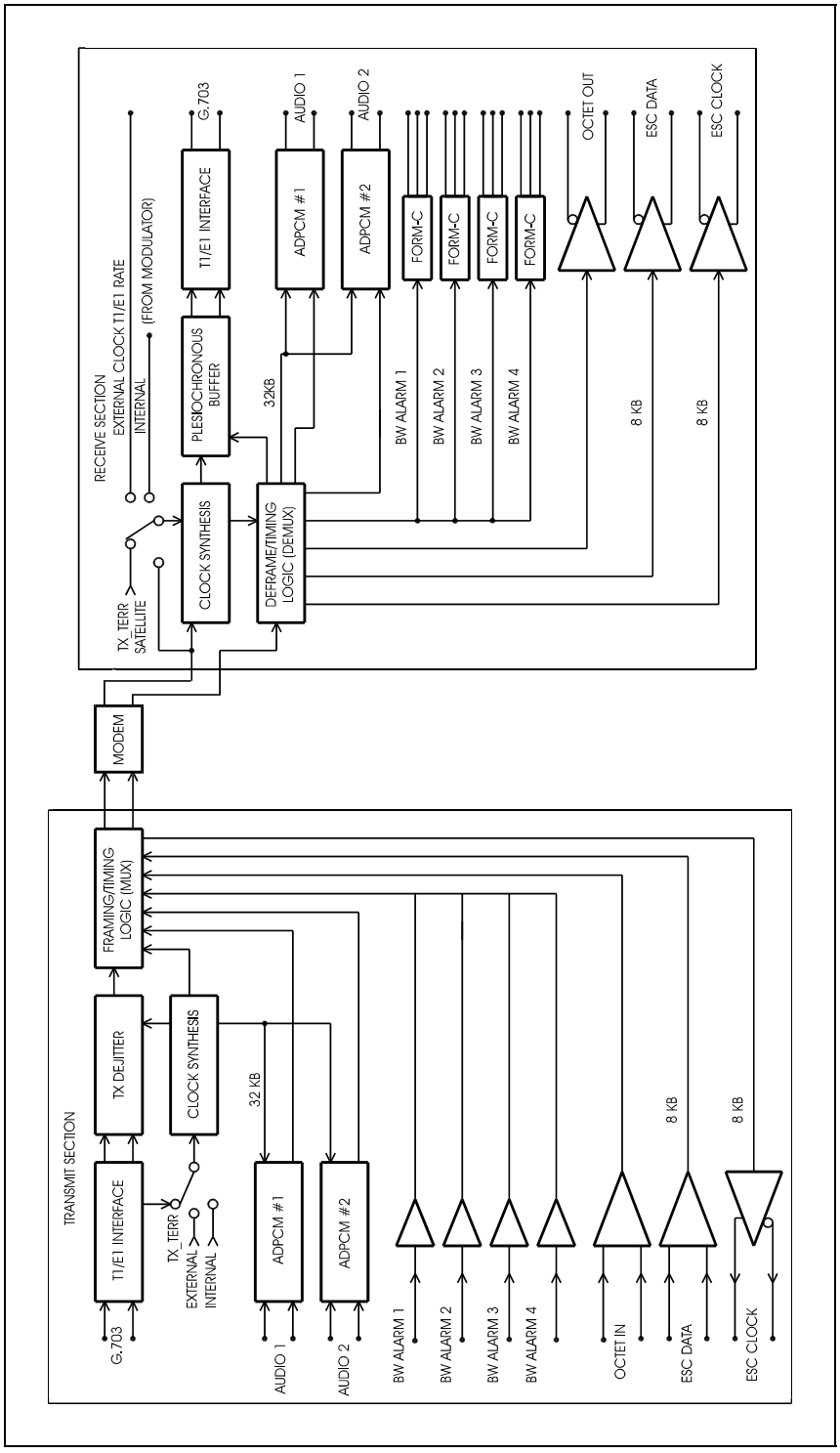


Figure A-10. IDR Interface Block Diagram

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A.1.6.1 IDR Specifications

Refer to Table A-15 for IDR specification.

Table A-15. IDR Specification

Primary Data Rates Supported	
G.703	1544 kbps 2048 kbps
Engineering Service Channel	
ESC Audio	2 channels at 32 kbps duplex ADPCM channel
ESC Data (Optional)	64 kbps duplex data (in place of audio channels)
Audio Encoding	CCITT G.721
Audio Interface Type	600Ω transformer balanced 4-wire
Audio Input Level	-20 to +10 dBm for 0 dBm, 1 dB steps
Audio Output Level	-20 to +10 dBm for 0 dBm, 1 dB steps
Filtering	Internal 300 to 3400 Hz, input and output
ESC Data Interface Type	EIA-422
ESC Data Rate	8 kbps
ESC Data Circuits Supported	SD, ST, RD, RT, Octet in, Octet out
Data Signal Phasing	Per EIA-449, data changes on the rising clock transition, is sampled on the falling clock edge
Octet Clock Pulse	Octet high with every 8th bit, aligns with frame bit d8
Faults and Alarms	
Backward Alarms Supported	4 input, 4 output
Backward Alarm Inputs	1 kΩ pull up to +5V, set below 2V to clear
Backward Alarm Outputs	Form C Relay, NO, NC, C
Demodulator Fault Relay	NO, C contacts available for backward alarm inputs
Deferred Maintenance Alarm	Open collector, high impedance IF fault, 15V maximum, 20 mA maximum

Note: A 64 kbps data channel may be substituted for the two audio channels.

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A.1.6.2 IDR Modem Defaults

Refer to Table A-16 for IDR modem defaults.

Table A-16. IDR Modem Defaults

Modulator		Demodulator	
Data Rate	A	Data Rate	A
TX Rate A	1640 kbps, QPSK 3/4	RX Rate A	1640 kbps, QPSK 3/4
TX Rate B	2144 kbps, QPSK 3/4	RX Rate B	2144 kbps, QPSK 3/4
TX Rate C	6408 kbps, QPSK 3/4	RX Rate C	6408 kbps, QPSK 3/4
TX Rate D	8544 kbps, QPSK 3/4	RX Rate D	8544 kbps, QPSK 3/4
TX Rate V	1640 kbps, QPSK 3/4	RX Rate V	1640 kbps, QPSK 3/4
IF Frequency	70 MHz	IF Frequency	70 MHz
IF Output	OFF	Demodulator Type	Open Net
Mod Power Offset	0 dB	V.35 Scrambler	ON
Power Output	-10 dBm	Differential Decoder	ON
Scrambler	ON	Decoder Type	Viterbi
Differential Encoder	ON	IF Loopback	OFF
Modulator Type	INTELSAT Open Net	RF Loopback	OFF
Encoder Type	Viterbi	Sweep Center Freq.	0 Hz
CW Mode	Normal (OFF)	Sweep Range	60000 Hz
Mod Power Fixed	0 dB	Sweep Reacquisition	0 seconds
Mod Spectrum	Normal	BER Threshold	NONE
		Demod Spectrum	Normal
Interface			
TX Clock Source	TX Terrestrial	Buffer Size	384
Buffer Clock Source	Receive Satellite	IBS Scrambler	ON
TX Clock Phase	Auto	IBS Descrambler	ON
RX Clock Phase	Normal	Frame Structure T1 Data	G.704
External Reference Freq.	1544 kHz	Frame Structure E1 Data	G.704
Baseband Loopback	OFF	Frame Structure T2 Data	G.743
Interface Loopback	OFF	Frame Structure E2 Data	G.742
TX Coding Format	AMI	Loop Timing	OFF
RX Coding Format	AMI	TX Overhead Type	IDR
TX 2047	OFF	RX Overhead Type	IDR
RX 2047	OFF	TX Terr Interface	G.703
TX Data/AIS Fault	NONE	RX Terr Interface	G.703
RX Data/AIS Fault	NONE	TX Data Phase	Normal
Buffer Programming	Bits	RX Data Phase	Normal

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A.1.7 IBS

IBS operation adds a proportional overhead (1/15) to the terrestrial data. The terrestrial data and clock are passed through the baseband loopback relay and are translated from the selected baseband format to Transistor-Transistor Logic (TTL). The data is scrambled synchronously with the multiframe sync in the multiplexer. The scrambler is enabled using the front panel.

External input and output for an ESC in EIA-232 format is provided on the interface. The ESC runs asynchronously at approximately 1/2000 of the terrestrial data rate. If the ESC clock is used, the channel runs at 1/512 of the terrestrial data rate. The overhead containing framing, the ESC channel, and faults from the modem are multiplexed with dejittered terrestrial data. The multiplexed data stream is output to the modulator through the interface loopback device.

The receive data from the demodulator is input through the same interface loopback device. The receive data is demultiplexed and synchronously descrambled by the demultiplexer. The backward alarm is reported to the M&C and output by Form C relay contact. The ESC is output by an EIA-232 driver. The terrestrial data output from the demultiplexer is input to a plesiochronous buffer.

The front panel interface provides four clock selections clocking the data out of the buffer:

- Internal Clock (SCT)
- RX Recovered Clock (RXCLK)
- External Reference Clock (EXT)
- High Stability Clock (HI STAB)
- TX Clock Dejittered (TXCLK)

If either RXCLK or EXT is selected and then fails, the interface automatically switches to SCT as the source.

AIS is detected in the receive data and reported to the M&C.

The receive data and selected clock are translated to the levels of the selected baseband interface and output through the baseband loopback relay.

The octet path is used for transferring a clock pulse to the distant end terrestrial equipment. The clock pulse rate is the IBS data rate ÷ 8.

Refer to Figure A-11 for a block diagram of the IBS interface.

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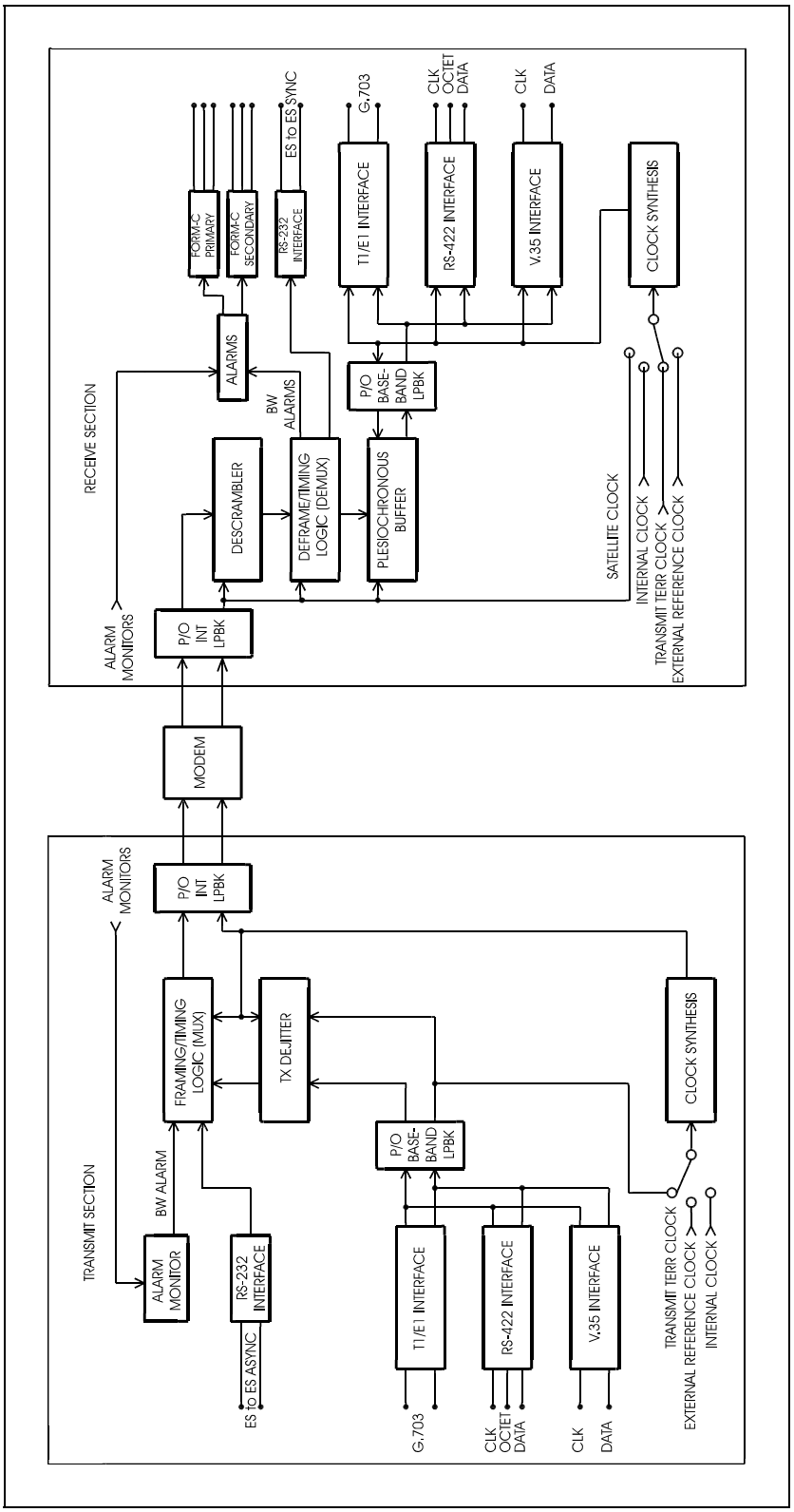


Figure A-11. IBS Interface Block Diagram

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A.1.7.1 IBS Specifications

Refer to Table A-17 for IBS specification.

Table A-17. IBS Specification

Parameter	Specification
Composite Data Rates Supported	N x 64 kbps from 64 kbps to 2048 kbps, with 1/15 overhead
Primary Data Circuits Supported	G.703 1.544 Mbps SD, RD G.703 2.048 Mbps SD, RD EIA-422/449, V.35
Engineering Service Channel	
Earth Station-to-Earth Station Channel	EIA-232 TD, RD, DSR, RTS Asynchronously sampled at 1/2000 of the primary channel data rate. Data rate is 1/512 of primary data if an EIA-232 clock is provided.
Octet Clock Pulse	Data rate ÷ 8 Octet high with every 8th bit
EIA-232 Specification	
Circuit Supported	RD, TD, DSR, RTS, CTS
Amplitude (RD, RTS)	True: 14V ± 11V False: -14V ± 11V
Amplitude (TD, DSR, CTS)	True: 11V ± 2V False: -11V ± 2V
Impedance	5000 ± 2000Ω < 2500 pF
Baud Rate	Max: 1/2000 times the data rate
Faults	
Modulator Fault	Open collector output, 15V maximum, 20 mA maximum current sink Fault is open circuit
Demodulator Fault	Open collector output, 15V maximum, 20 mA maximum current sink Fault is open circuit
Backward Alarms	Primary and secondary alarms
Backward Alarm Output	Form C contacts available

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A.1.7.2 IBS Modem Defaults

Refer to Table A-18 for IBS modem defaults.

Table A-18. IBS Modem Defaults

Modulator		Demodulator	
Data Rate	A	Data Rate	A
TX Rate A	64 kbps, QPSK 1/2	RX Rate A	64 kbps, QPSK 1/2
TX Rate B	256 kbps, QPSK 1/2	RX Rate B	256 kbps, QPSK 1/2
TX Rate C	768 kbps, QPSK 1/2	RX Rate C	768 kbps, QPSK 1/2
TX Rate D	2048 kbps, QPSK 1/2	RX Rate D	2048 kbps, QPSK 1/2
TX Rate V	128 kbps, QPSK 1/2	RX Rate V	128 kbps, QPSK 1/2
IF Frequency	70 MHz	IF Frequency	70 MHz
IF Output	OFF	Decoder Type	Viterbi
Mod Power Offset	0 dB	Differential Decoder	ON
Power Output	-10 dBm	Demodulator Type	Open Net
Differential Encoder	ON	IF Loopback	OFF
Modulator Type	INTELSAT Open Net	RF Loopback	OFF
Encoder Type	Viterbi	Sweep Center Freq.	0 Hz
CW Mode	Normal (OFF)	Sweep Range	60000 Hz
Mod Power Fixed	0 dB	Sweep Reacquisition	0 seconds
Mod Spectrum	Normal	BER Threshold	NONE
		Demod Spectrum	Normal
Interface			
TX Clock Source	TX Terrestrial	Buffer Size	384
Buffer Clock Source	Receive Satellite	IBS Scrambler	ON
TX Clock Phase	Auto	IBS Descrambler	ON
RX Clock Phase	Normal	Frame Structure T1 Data	G.704
External Reference Freq.	1544 kHz	Frame Structure E1 Data	G.704
Baseband Loopback	OFF	Frame Structure T2 Data	G.743
Interface Loopback	OFF	Frame Structure E2 Data	G.742
TX Coding Format	AMI	Loop Timing	OFF
RX Coding Format	AMI	TX Overhead Type	IBS
TX 2047	OFF	RX Overhead Type	IBS
RX 2047	OFF	TX Terr Interface	G.703
TX Data/AIS Fault	NONE	RX Terr Interface	G.703
RX Data/AIS Fault	NONE	TX Data Phase	Normal
Buffer Programming	Bits	RX Data Phase	Normal

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A.1.8 Asymmetrical Loop Timing

Asymmetrical Loop Timing is the same timing method that is designed into the SDM-650B TROJAN interfaces. Refer to Figure A-12 and Figure A-14 for TX and RX Asymmetrical Loop Timing block diagram. There are two advantages for using Asymmetrical Loop Timing:

- Versatility: The user can select different transmit and receive data rates, yet still clock the send data with the receive satellite clock.

- Fits easily into on site clocking schemes: The user may clock the send data with a clock that is not necessarily operating at the same rate as the data rate.

The send timing may only be referenced from an external clock source that is equal to the data rate in the basic modem.

The asymmetrical clock loop reference must be one of the following:

- Transmit terrestrial clock
- External clock input
- Receive clock input

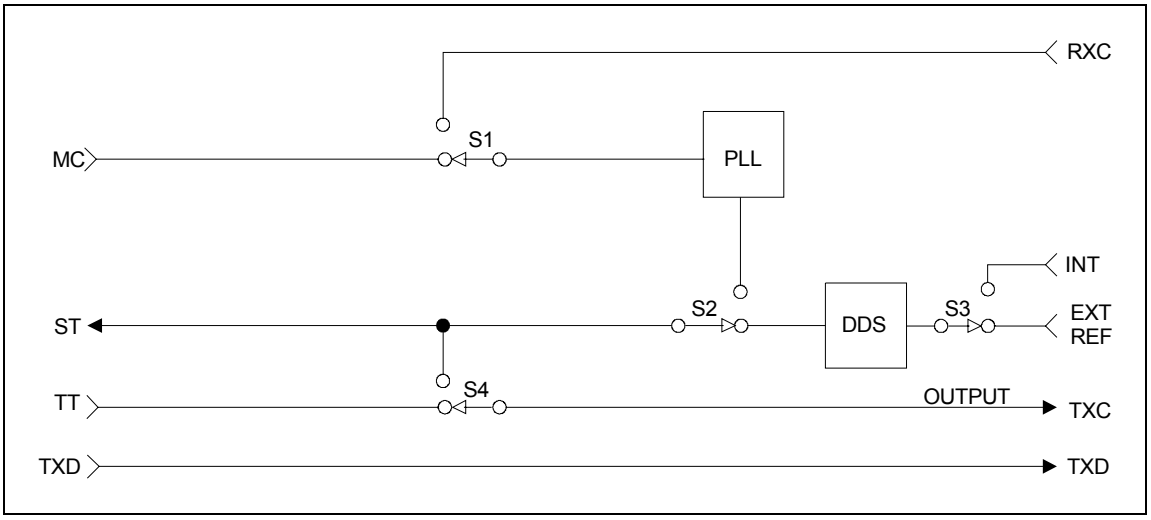
Notes:

1. The clock inputs are as follows:
   a. ≥ 64 kHz shall be divisible by 8 kHz.
   b. ≥ 32 kHz but < 64 kHz shall be divisible by 600 Hz or 8 kHz.
   c. < 32 kHz shall be divisible by 600 Hz.

2. The transmit clock source can be the same at the RX digital data rate or EXT CLOCK if they are ± 100 PPM. This is provided on the basic unit, with or without the asymmetrical loop timing option.

The transmit data is normally clocked into the modem with the Terminal Timing (TT) clock in typical EIA-422 operation. The received data is clocked out with the Receive Timing (RT) clock. The asymmetrical loop timing option allows the transmit and receive data to be clocked with the same, or a multiple of the same clock. The added benefit is that the transmit and receive data rates do not have to be the same.

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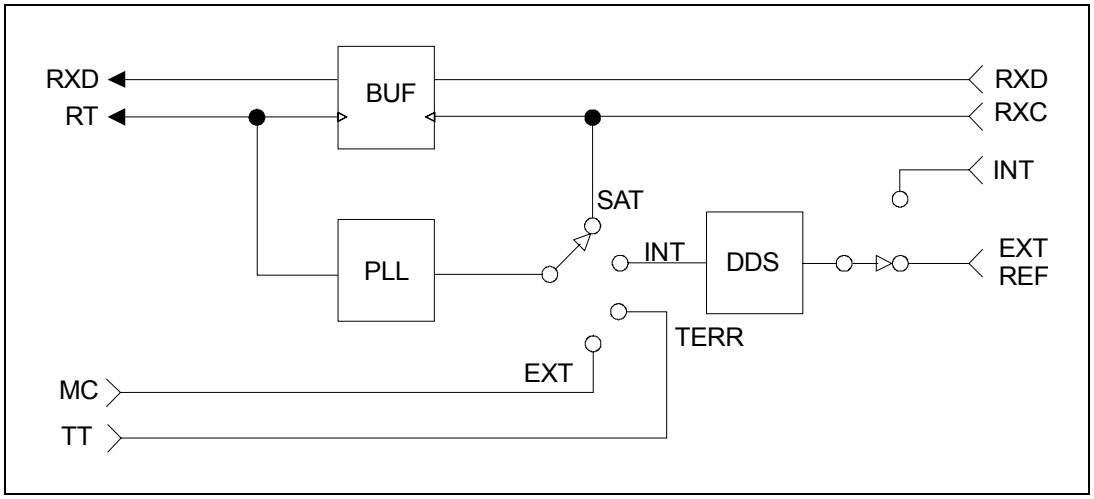
Clock Selection	S1 set to:	S2 set to:	S3 set to:	S4 set to:
TX TERR (TT)		DDS	INT	TT
INT (SCT)		DDS	INT	ST
SCT (INT)		DDS	EXT REF (See Note 2)	ST
SCT (LOOP)		DDS	EXT REF (See Note 2)	ST
INT (LOOP) (See Note 1)	RXC	PLL		ST
EXT CLOCK	MC	PLL		ST

Notes:

1. When CONFIGURATION INTERFACE → LOOP TIMING is set to ON, SCT(INT) will change to read: SCT(LOOP).
2. When CONFIGURATION MOD → MOD REF is set to EXT MOD, S3 will switch to the EXT REF position.

Figure A-12. Transmit Section of the Asymmetrical Loop Timing Block Diagram

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Note: PLL will be bypassed when the RX data rate is set to the TX data rate. This will disable the Asymmetrical Mode.

Figure A-13. Receive Section of the Asymmetrical Loop Timing Block Diagram

Example:

Master/Slave Clocking Setup:

1. Master site has a 10 MHz clock that is needed as the clock source.
2. Unequal data rates: 4.096 Mbps and 2.152 Mbps (numbers divisible by 8).

Master Site Option No. 1:

1. Set Configuration/Modulator/Modem Reference to EXT 10 MHz.
2. Set Configuration/Interface/TX Clock Source to SCT (Internal).

   Note: The SCT clock is slaved off of the 10 MHz input. The 10 MHz reference should be placed into CP3 of the modem.
3. Set Configuration/Interface/Buffer Clock to SCT (Internal).

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Master Site Option No. 2:

1. Set Configuration/Modulator/Modem Reference to INTERNAL.

2. Set Configuration/Interface/EXT-CLK Frequency to 10 MHz to INTERNAL.

3. Set Configuration/Interface/TX Clock Source and Buffer Clock to EXT Clock.

Note: Input the 10 MHz clock at either the EXC (CP5) clock, unbalanced input of the SMS-7000 data switch module, or balanced pins 7 and 8 of the switch module, V3. This external clock input will go into the modem on pins 35 and 19 of the 50-pin connector, located at the rear of the modem.

Slave Site:

1. Set Configuration/Interface/Loop Timing to ON.

2. Set Configuration/Interface /TX Clock Source to SCT (LOOP)
   or TX Terrestrial, only if the user equipment can provide the proper slaved clock to the modem.

Note: SCT Internal changes to loop when Loop Timing is set to ON.

3. Set Configuration/Interface/Buffer Clock to RX (Satellite) “Buffer Bypass”.

A.1.9 G.703

Note: If required, refer to Section A.3 for installation of the interface PCB.

G.703 data is either in AMI, B8ZS (8 zero) suppression, or HDB3 (3 zero) suppression formats. There is not a coexisting clock that is on a separate line for G.703 data. The clock is derived from the data stream within the modem and in the user equipment.

Loop timing, if desired, must occur in the customer equipment for the link to operate in Master/Slave. The modem cannot do loop timing in G.703 operation because the modem does not emit an ST signal for the Transmit Clock Source.

The modem can be placed in loop timing under EIA-422 or V.35 operation. Therefore, a master/slave relationship easily occurs. This causes the receive clock to be placed on the ST line to the terrestrial equipment. The customer equipment can then clock the transmit data to the modem using the ST line that has been derived from the RX recovered clock.

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A.1.9.1 G.703 Specifications

Refer to Table A-19 G.703 specifications.

Table A-19. G.703 Specifications

Parameter	Specification
Primary Data Circuits Supported	T1 SD, RD E1 SD, RD
Interface Type	Transformer coupled symmetrical pair
Data Rates	T1 1544 kbps ± 100 bit/s E1 2048 kbps ± 130 bit/s
Pulse Width	T1 324 ± 50 Ns E1 244 ± 25 Ns
SD Amplitude	T1 3V +0.3/-1.5V-pk into 100Ω E1 3V +0.3/-1.5V-pk into 120Ω
RD Amplitude	T1 3V +0.3/-1.5V-pk into 100Ω E1 3V +0.3/-1.5V-pk into 120Ω
Pulse Mask	T1 G.703.2 E1 G.703.6
Jitter Attenuation	T1 G.824 E1 G.823
Line Code	AMI, B8ZS, B6ZS, HDB3

A.1.10 Variable Data Rates

The basic platform modem comes with single data rate capabilities. At the time of purchase, the customer may add optional variable data rate capabilities. If variable rate requirements arise after the purchase of a basic platform modem, these capabilities can be added in the field using FAST technology. The variable rate options include one of the following:

- Rates up to 512 kbps
- Rates up to 4.375 Mbps

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A.2 Conventional Options

A.2.1 Reed-Solomon Codec

Note: Pre-Duplex Reed-Solomon.

The modem must have the Reed-Solomon PCB installed to access this feature. The Reed-Solomon Codec PCB is a 4.75” x 6.00” (12.07 x 15.24 cm) daughter card that is located on the main PCB (Figure A-14).

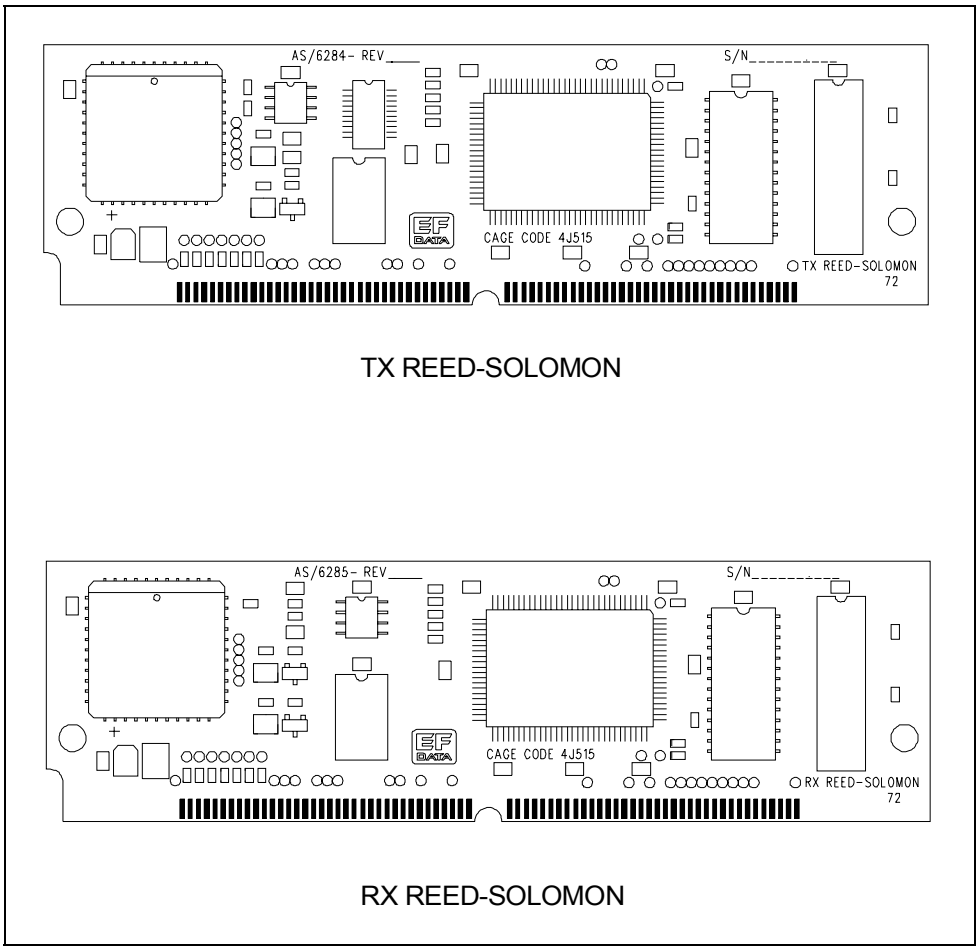


Figure A-14. Reed-Solomon PCB

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The Reed-Solomon Codec works in conjunction with the Viterbi decoder and includes additional framing, interleaving, and Codec processing to provide concatenated FEC and convolutional encoding and decoding.

Refer to Figure A-15 for a block diagram of the Reed-Solomon Codec.

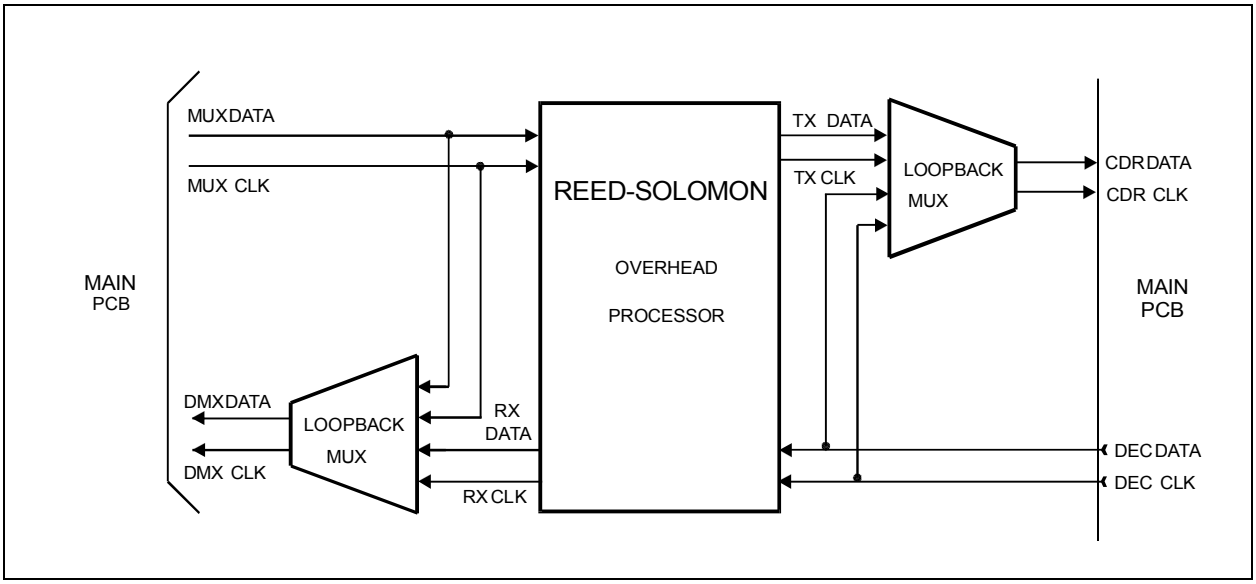


Figure A-15. Reed-Solomon Codec Block Diagram

A.2.1.1 Specifications

Refer to Table A-20 (below) for overhead types and data rates supported by the Reed-Solomon Codec option. Refer to Chapter 1 for BER specifications.

Table A-20. Specifications

Overhead Type	Data Rate
IDR (T1)	1640 kbps
IDR (E1)	2144 kbps
D&I	64 to 1920 kbps
IBS	64 to 2048 kbps
ASYNC	2.4 to 2048 kbps
No Overhead	2.4 to 4.555 kbps
AUPC	2.4 to 2048 kbps

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A.2.1.2 Theory of Operation

The Reed-Solomon Codec works in conjunction with the interface card to provide concatenated convolutional encoding and decoding.

The two main sections of the Codec are:

- Reed-Solomon encoder (Section A.2.1.3)
- Reed-Solomon decoder (Section A.2.1.4)

A.2.2 Reed-Solomon Encoder

A block diagram of the Reed-Solomon encoder section is shown in Figure A-16.

The Reed-Solomon encoder section includes the following circuits:

- Synchronous Scrambler
- Reed-Solomon Codec (encoder section)
- Serial/Parallel Converter
- RAM Interleaver
- Parallel/Serial Converter

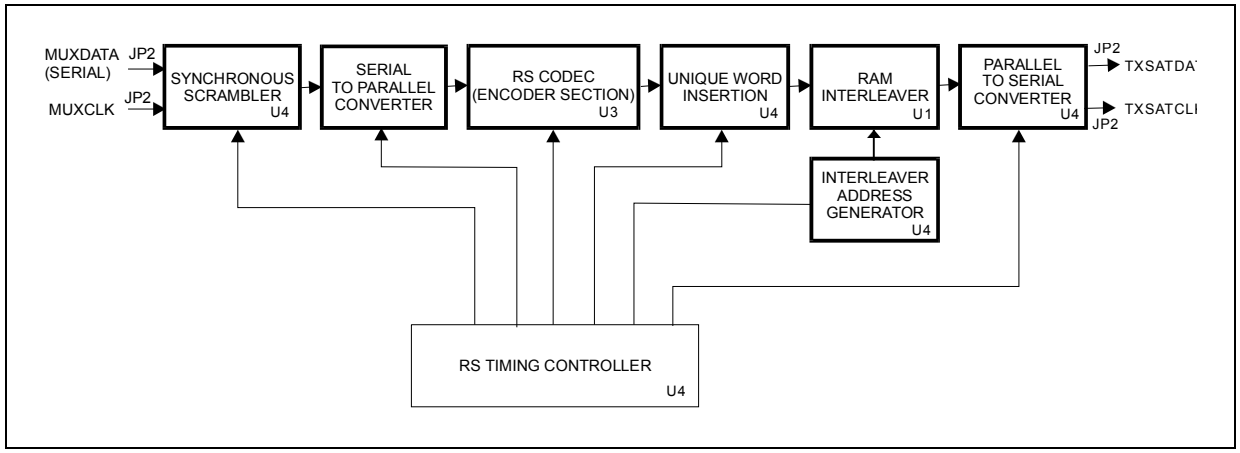


Figure A-16. Reed-Solomon Encoder Section Block Diagram

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The data and clock signals (MUXDATA and MUXCLK) come from the multiplexer on the main PCB, and are sent to the Reed-Solomon encoder section. Since the data input to the Reed-Solomon encoder is serial, the data passes through a self-synchronizing serial scrambler, in accordance with INTELSAT-308 Rev. 6B specification.

The host software allows the scrambler to be turned on or off at the front panel as required by the user. If the scrambler is disabled, the data passes through the scrambler unaltered.

The data then passes through a serial/parallel converter, and on to a FIFO. The serial/parallel converter changes the data to an 8-bit word. A synchronous FIFO buffers the incoming data, because the rate is different than the encoded data rate. Once buffered by the FIFO, the data passes to the Reed-Solomon Codec.

Refer to Figure A-16 for the Reed-Solomon code page format. The Reed-Solomon outer Codec reads the data in blocks of k bytes, and calculates and appends check bytes to the end data block. The letter n represents the total number of bytes in a given block of data out of the Codec. The letter k represents the number of data bytes in a given block.

The term, ***n - k = 2t***, is the total number of check bytes appended to the end of the data. This is referred to as the "Reed-Solomon overhead." The terms ***k, n***, and ***t*** will vary, depending on the Reed-Solomon coding used. The output data is passed to a block interleaver.

Since errors from the Viterbi decoder usually occur in bursts, a block interleaver with a depth of four is used in accordance with the INTELSAT-308 Rev. 6B specification. The interleaver has the effect of spreading out the errors across blocks of data instead of concentrating the errors in a single block of data. Since there are fewer errors in any given block, there is a greater chance that the Reed-Solomon decoder can correct the errors on the receiving end of the satellite link. To allow the decoder to synchronize to the data, four unique words are inserted in the last two bytes of the last two pages at the end of each page of data (refer to Figure A-17).

Once the data passes through the interleaver, it is fed through a parallel/serial converter and sent back to the interface PCB. After further processing by the interface PCB, the data is sent to the modulator PCB.

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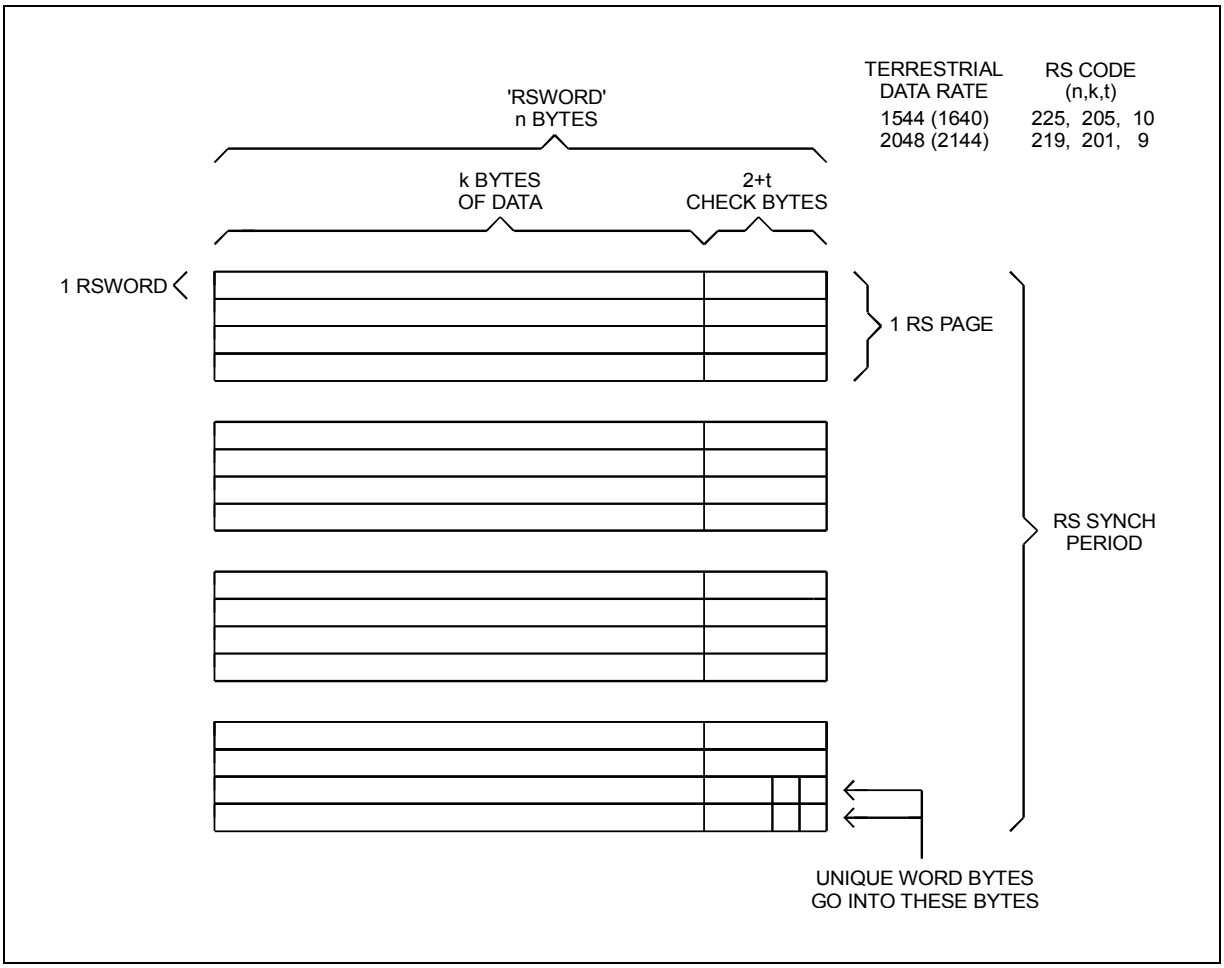


Figure A-17. Reed-Solomon Code Page Format

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A.2.3 Reed-Solomon Decoder

Refer to Figure A-18 for a block diagram of the Reed-Solomon decoder section.

The Reed-Solomon decoder section includes the following circuits:

- Serial/Parallel Converter
- RAM Deinterleaver
- Parallel/Serial Converter
- Reed-Solomon Codec (decoder section)
- Synchronous Descrambler

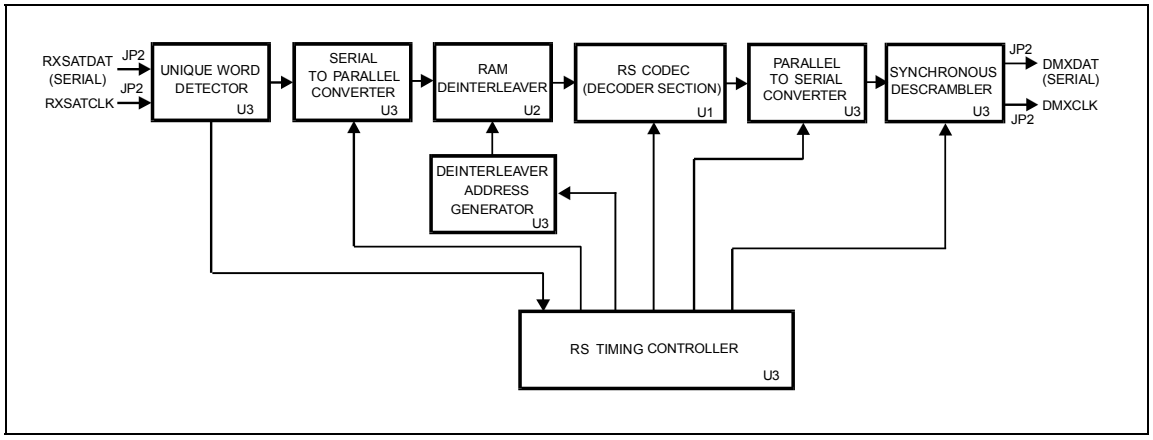


Figure A-18. Reed-Solomon Decoder Section Block Diagram

The data and clock signals come from the demultiplexer on the interface PCB, and are sent to the Reed-Solomon decoder section.

The data is sent through a serial/parallel converter. Because it was block interleaved by the encoder, the data must pass through a de-interleaver with the same depth as the interleaver used on the encoder. The de-interleaver is synchronized by the detection of the unique words, which are placed at the end of each page by the interleaver on the encoder.

Once the de-interleaver is synchronized to the incoming data, the data is reassembled into its original sequence, in accordance with the INTELSAT-308 Rev. 6B specification. The data is then sent to the Reed-Solomon outer decoder.

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Refer to Figure A-17 for the Reed-Solomon code page format. The outer Codec reads the data in blocks of ***n*** bytes and recalculates the check bytes that were appended by the encoder. If the recalculated data bytes do not match the check bytes received, the Codec makes the necessary corrections to the data within the data block. The letter ***n*** represents the total number of bytes in a given block of data out of the Codec. The letter ***k*** represents the number of data bytes in a given block.

The term ***n - k = 2t*** is the total number of check bytes appended to the end of the data. The terms ***k, n,*** and ***t*** will vary depending on the Reed-Solomon coding used. The Codec then sends the corrected data to a FIFO.

Because the check bytes are not part of the real data, a synchronous FIFO is used to buffer the data and strip the check bytes out of the blocks of data. The data then passes through a parallel converter to be serialized.

The data is sent through a self-synchronizing serial descrambler in accordance with the INTELSAT-308 Rev. 6B specification. The descrambler converts the data back into the original data that the user intended to send. The synchronous descrambler is synchronized by the detection of the unique word at the end of each Reed-Solomon page. The data is then sent to the interface PCB for further processing.

A.2.3.1 Reed-Solomon Specifications (Optional)

Refer to Table A-21 for Reed-Solomon optional specifications.

Table A-21. Reed-Solomon Specifications Optional

Overhead Type	Data Rate
IDR (T1)	1640 kbps
IDR (E1)	2144 kbps
D&I	64 to 1920 kbps
IBS	64 to 2048 kbps
ASYNC	2.4 to 2048 kbps
No Overhead	2.4 to 4.555 kbps
AUPC	2.4 to 2048 kbps

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A.2.4 Unpacking



This equipment contains parts and assemblies sensitive to damage by ESD. Use ESD precautionary procedures when touching, removing, or inserting PCBs.

1. Remove the Reed-Solomon PCB and mounting hardware from the cardboard caddypack and anti-static material.

2. Check the packing list to ensure the shipment is complete.

3. Inspect the Reed-Solomon PCB for any shipping damage.

A.2.5 Installation

The following tool is required to install the overhead interface PCB:

Description	Application
Phillips ™ Screwdriver	To remove and replace cross-point screws.

Use the following information to install the Reed-Solomon Codec PCB as a daughter card on the main PCB.

Refer Figure A-19 for installation location of the Reed-Solomon daughter card.



Turn the power off before installation. High current VDC is present. Failure to do so could result in damage to modem components.

1. Turn off the modem and unplug the power supply.

2. Remove the rear panel retaining screws. Using the finger pulls, slide the main modem assembly out from the rear of the modem chassis.

3. Install the Reed-Solomon PCB to the main PCB by mating the male simm connectors with the female simm connectors in the position shown in Figure A-19.

4. After completing the above installation procedure, turn on the modem. If the Reed-Solomon PCB was installed properly, the Utility Modem Type menu will display “Card #2 Type Reed-Solomon 02 ” and “Card #3 Type Reed-Solomon 03” (if both boards were installed). Refer to Chapter 3 for more information.

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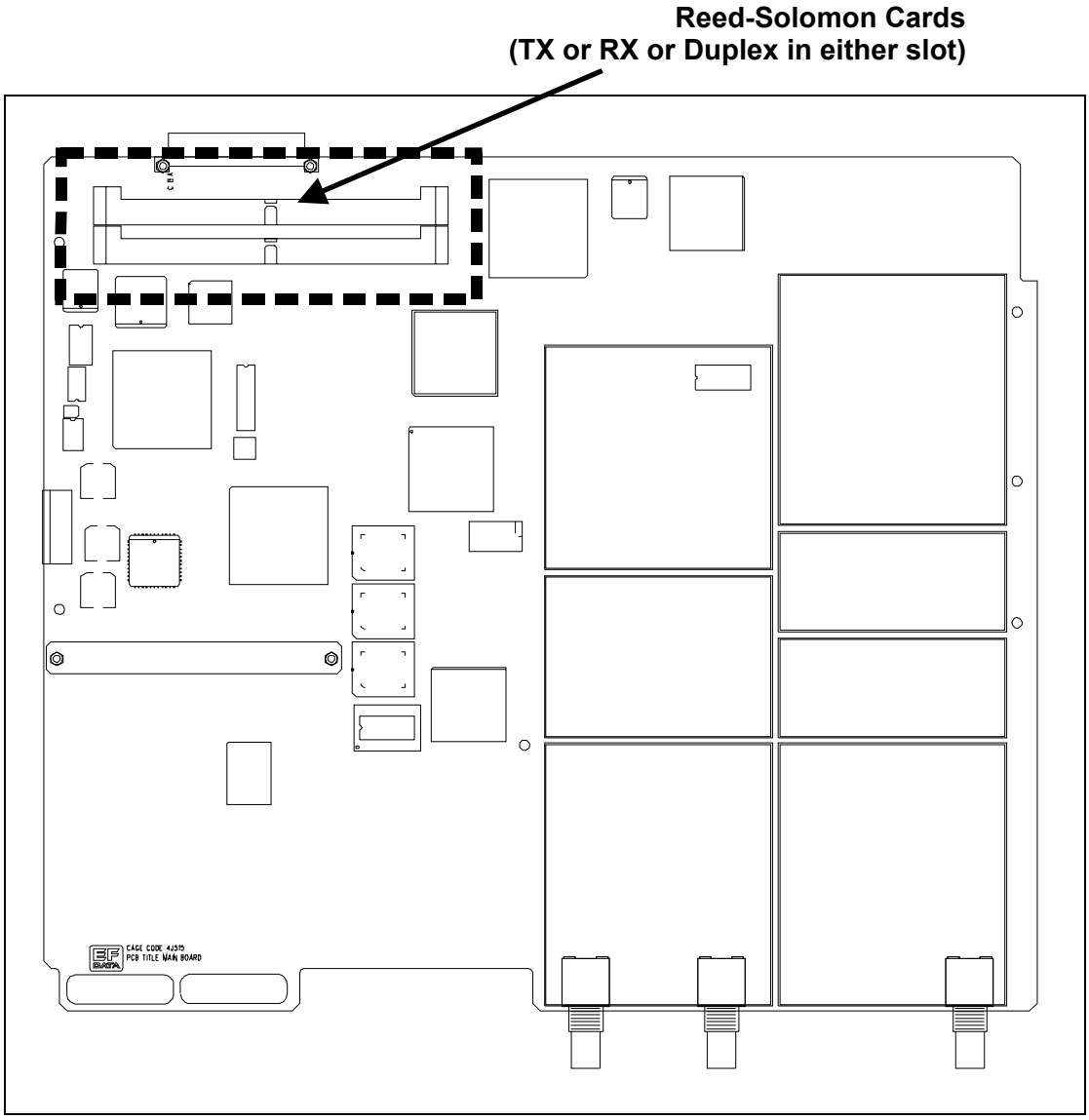


Figure A-19. Reed-Solomon Codec Installation

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A.3 Full Duplex Reed-Solomon Card

The Reed-Solomon Duplex board is a 1.2"x 4.2" daughter card for 300 series modems that can do either Reed-Solomon Encoding or Reed-Solomon Decoding by means of the Reed-Solomon Interface on the Spartan 2 FPGA. See below for a block diagram of the Reed-Solomon Duplex card.

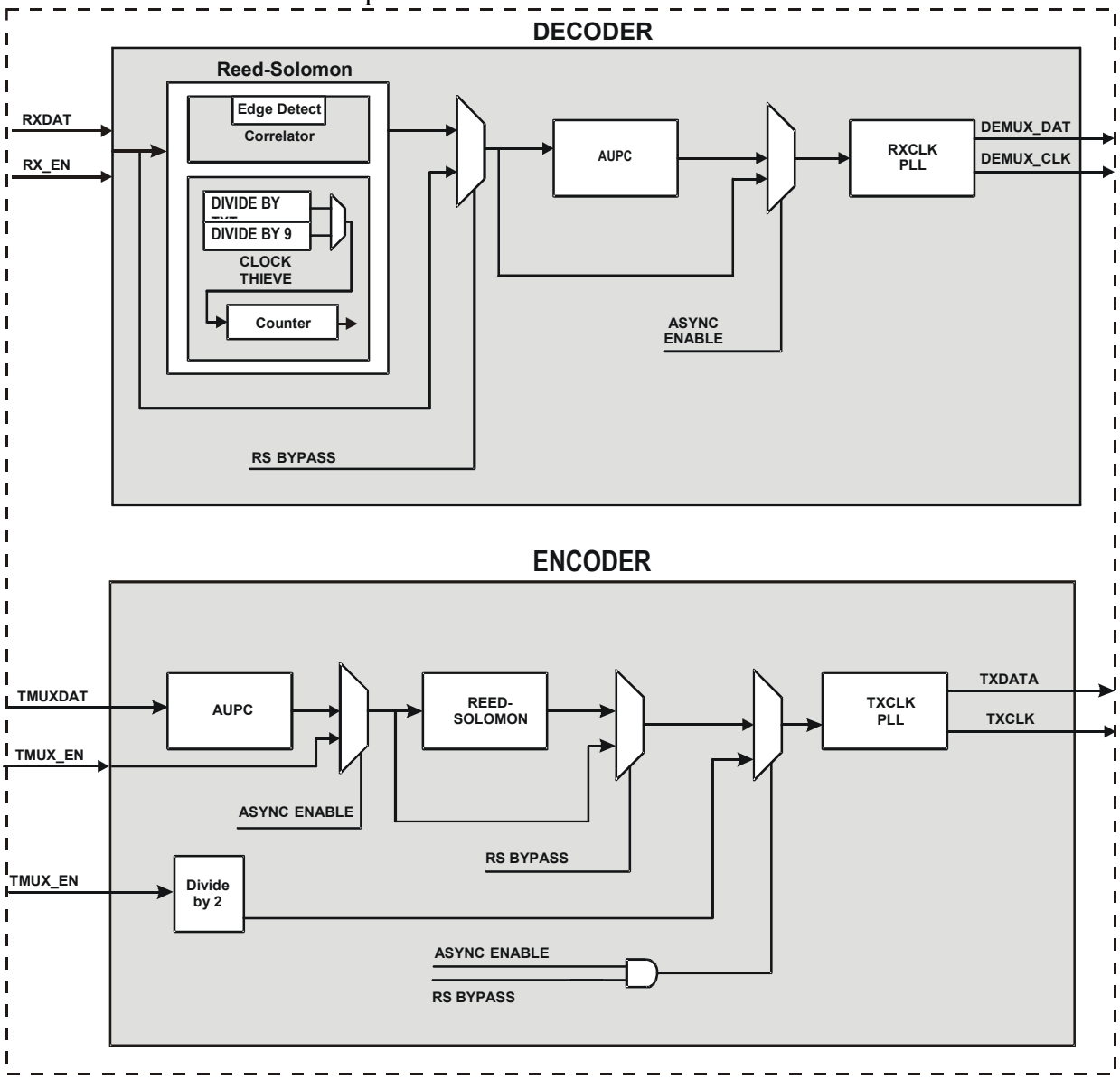


Figure A-20. Reed-Solomon Interface on the Spartan 2 FPGA

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Design guidelines are per IESS-308/309/310.

The Duplex Reed-Solomon Card assembly contains the following IC's:

- 1- Spartan 2 FPGA
- 1- AHA 4011 encoder
- 1- AHA 4011 decoder
- 2- 71256 RAM's
- 1- 74FCT2574 Latch

The Reed-Solomon Interface on the Spartan 2 features:

- Reed-Solomon Encoder
- Reed-Solomon Decoder
- Variable Interleaver depth
- Synchronous descrambler
- Self synchronizing descrambler
- Variable Deinterleaver depth
- Correction On/Off capability
- Monitor and Control

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A.3.1 Reed-Solomon Features

The design implements RS encoding and decoding by utilizing the Advanced Hardware AHA4011B chip set. See Table A-22 for R-S codes.

Table A-22. R-S Codes

Service	Data Rate kbps	RS Code (n, k, t)
IDR with IBS Overhead	64	126,112,7
D&I	128	126,112,7
	256	126,112,7
	384	126,112,7
	512	126,112,7
	768	126,112,7
	1024	126,112,7
	1536	126.112,7
IDR with 96 kbit/s Overhead	1544	225,205,10
	2048	219,201,9
No Overhead - ASYNC	64 to 2048 kbps	225,205,10
IDR with 96 kbit/s Overhead	1544	225,205,10
	2048	219,201,9
IDR T2 & E2		194,178,8
IDR T1		225,205,10
IDR 310 Mode		219,201,9
CDM 200/180-4-V		220,180,10
CDM 220/200-4-V		220,200,10
CDM 200/180-4-S		220,180,10
CDM 220/200-4-S		220,200,10
EFD Closed		225,205,10

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A.3.2 Encoder

The encoder inserts the unique word into the data stream for synchronization of the descrambler and the deinterleaver on the decode side. The unique word consists of four hex bytes Ox5AOFBE66, Ox5A being the first bit in time. The unique word is inserted into the last two bytes of the last two blocks of the last page of the interleave frame.

The RS rate exchange is performed by the RS Xilinx using the 25 MHz system clock. The muxclk is converted to 40nS wide pulses at the TX terrestrial data rate. This generated clock is used by the Xilinx circuitry for data processing at the none RS overhead rate. The RS overhead clock is generated by inserting more 40nS pulses into the none overhead clock pulse stream. The required insertions are determined by the RS n, k, t values programmed into the Xilinx.

The RS overhead pulse insertions are always 80nS after a detected none RS overhead pulse. Keeping in mind that an Overhead card may also be inserting pulses prior to the RS card insertions, a method of monitoring the insertion rate is necessary to keep from disturbing the MOD encoder operation. The MOD can handle only one insertion per symbol clk/4. An up/down counter is used to keep track of proposed insertion points (either overhead or Reed-Solomon). Everytime a proposed insertion point is detected the up/down counter is bumped up. When the up/down counter is at a none-zero point a real insertion takes place every 5 terrestrial data clocks. Insertions continue at a rate of every 5 terrestrial clocks until the up/down counter is zeroed, at that point no more insertions take place until the counter is bumped again.

On the encode side, dummy Reed-Solomon check bytes are clocked into the Reed-Solomon codec as place holders for the real check bytes. While the dummy check bytes are inserted, the erase line on the Reed-Solomon codec is asserted. Asserting the erase line at this time increases the correction capability of the Reed-Solomon codec on the decode side, because the position information of the erasures is known. Correcting erasures takes half as much correction capability as correcting errors. See Figure A-21 for a block diagram of the R-S Encoder.

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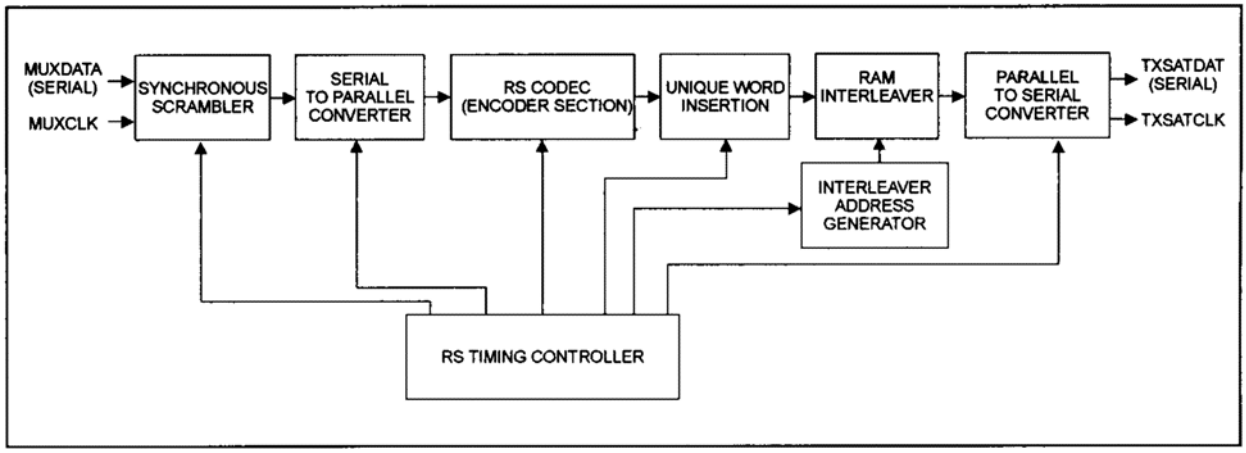


Figure A-21. Reed-Solomon Encoder Section Block Diagram

A.3.3 Interleaver

The interleaver is implemented by writing scrambled and RS encoded data (with check bytes) into a static ram in a row format, and reading data out in a column format.

The interleaver depth can be programmed for 4, 8, or 16.

When a depth of 4 is programmed, the interleaver consists of four pages with each page consisting of 4 Reed-Solomon code word blocks. A total of 16 Reed-Solomon code word blocks make up the interleave frame. The unique words are inserted during the interleaving process and placed in the last two bytes of the last two Reed-Solomon code word blocks of the last page of the interleave frame.

When a depth of 8 is programmed, the interleaver consists of two pages with each page consisting of 8 Reed-Solomon code word blocks. Again, a total of 16 Reed-Solomon code word blocks make up the interleave frame. The unique words are inserted during the interleaving process and placed in the last two bytes of the last two Reed-Solomon code word blocks of the last page of the interleave frame.

The unique word is used by the decoder to detect the frame boundary for synchronization of the descrambler and the deinterleaver. The deinterleaver operates in much the same manner as the interleaver, except it writes data in column format and reads in row format. See Figure A-22. for the RS code word format prior to interleaving.

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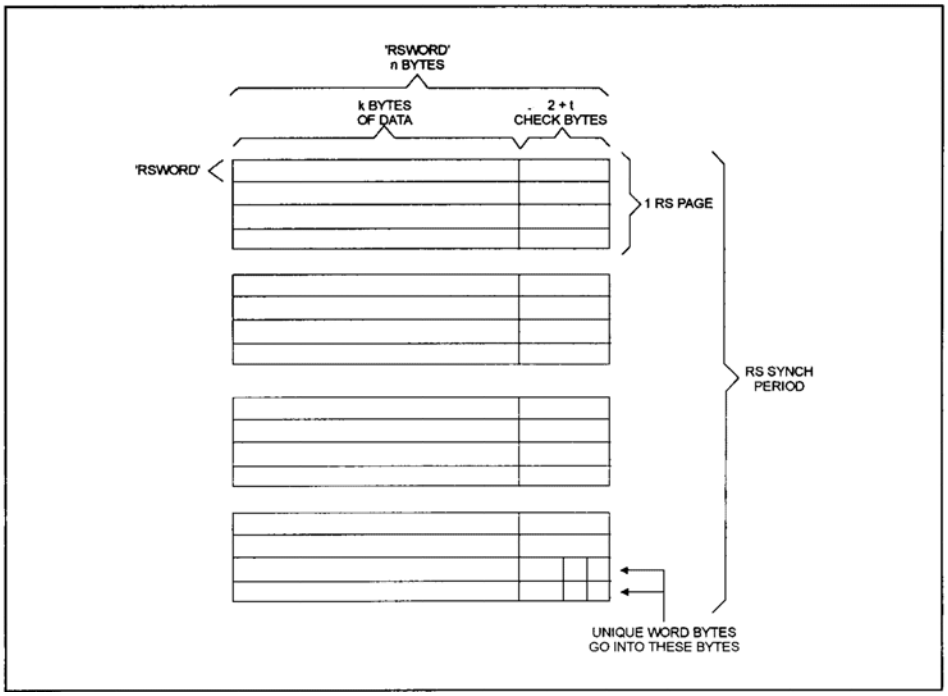


Figure A-22. RS Codeword Format

A.3.4 Decoder

A.3.4.1 Correlator

On the receive side (decoder), the correlator searches for the unique words of the RS frame. The correlator starts in hunt mode searching for the first two bytes of the unique word. Upon detection of the first two bytes of the unique word, the correlator searches for the next two bytes of the unique word. When all four bytes of the unique word are found, an up/down counter is incremented. The correlator acknowledges a locked condition when the up/down counter reaches a maximum count of 16.
Once the counter starts counting up, a missing byte of the unique word causes the counter to count down. The counter must count down to zero before again entering hunt mode, offering some compliance for noise in the system.

After a locked condition is reached, the correlator uses the known frame sync position to synchronize the counters that generate the de-interleaver addresses, W/R selects, and the descrambler synchronization. The correlator converts the input data stream to an 8-bit parallel byte format for processing by the deinterleaver and RS decoder.
The RS rate exchange is performed by the RS Xilinx using the system 25 MHz clock. The receive clock is converted to a series of 40nS pulses at the receive data rate. To generate the demux (Non-RS overhead rate) pulses are removed from the receive clock using the RS n, k, t values programmed into the Xilinx.

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A.3.4.2 Error Detection

The decoder provides a means to check for uncorrectable RS blocks. The decode Xilinx monitors the CRTN line out of the RS decoder. CRTN is valid during the first byte of each RS block. CRTN is programmed such that a low indicates that the last RS block of data was correctable. If CRTN is high during the first byte, then the last RS block of data exceeded the correction capability of the RS decoder. If the block is uncorrectable, the data is passed through the decoder as received, meaning no correction was performed on that block of data. The decode Xilinx monitors the CRTN line and latches a status line on any high state. Approximately once every second the M&C reads the status line and reports any UAS (unavailable seconds) as a stored fault on the modem front panel. The status line is cleared every time the M&C reads the status. See Figure A-23 for a block diagram of the RS Decoder.

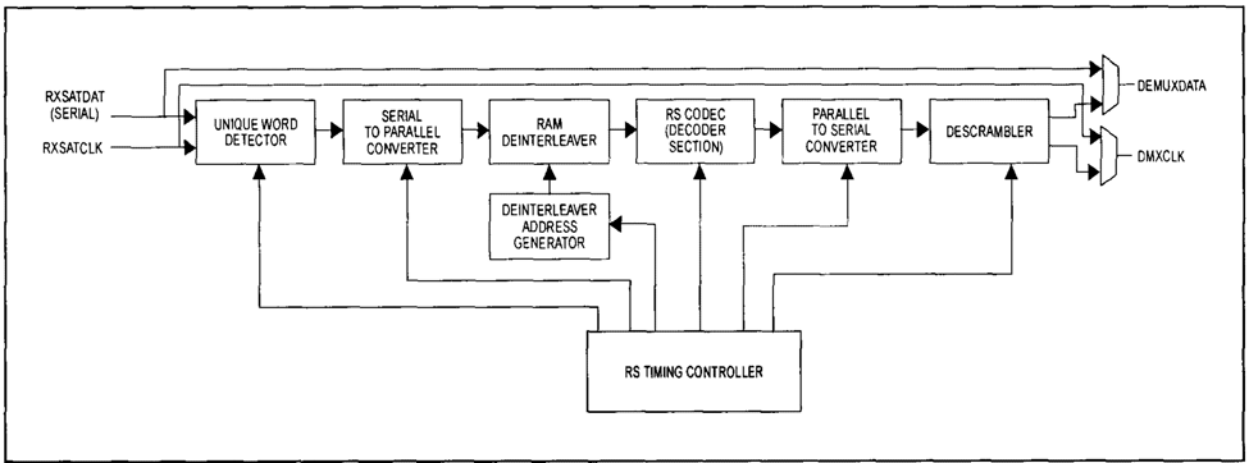


Figure A-23. Reed-Solomon Decoder Section Block Diagram

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A.3.4.3 Deinterleaver

The unique words inserted by the encoder are used by the decoder to detect the frame boundary for synchronization of the descrambler and the de-interleaver. The de-interleaver operates in much the same manner as the interleaver, except it writes scrambled and RS encoded data (with check-bytes) into a static ram in column format and reads in row format. The result is data in the original RS code word format. See Figure A-24 for the RS code word format after de-interleaving.

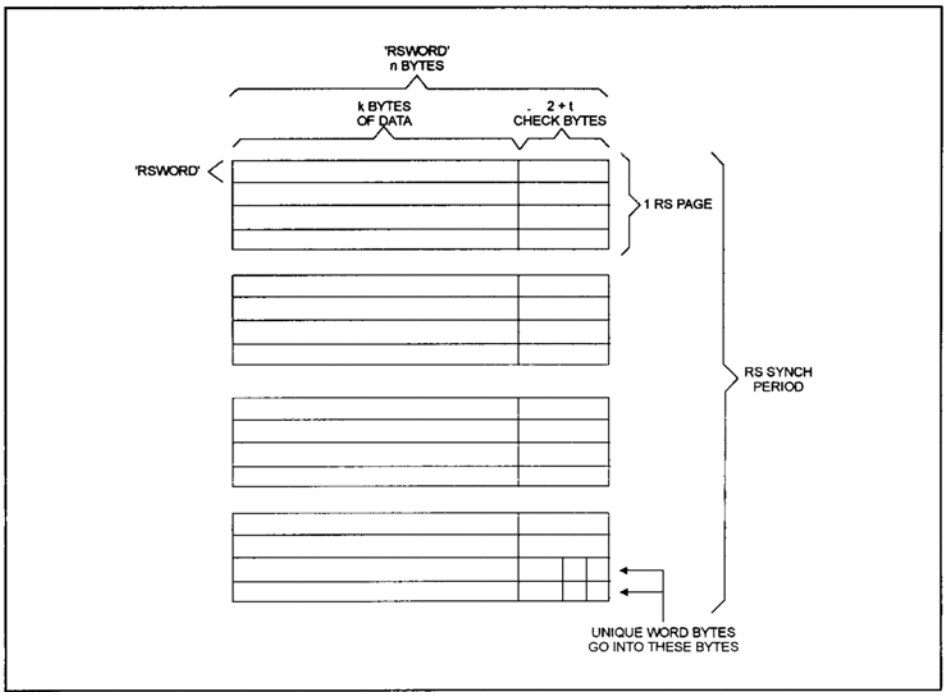


Figure A-24. R-S Codeword Format

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A.3.4.4 Performance

See Figure A-25 and Table A-23 for operational performance.

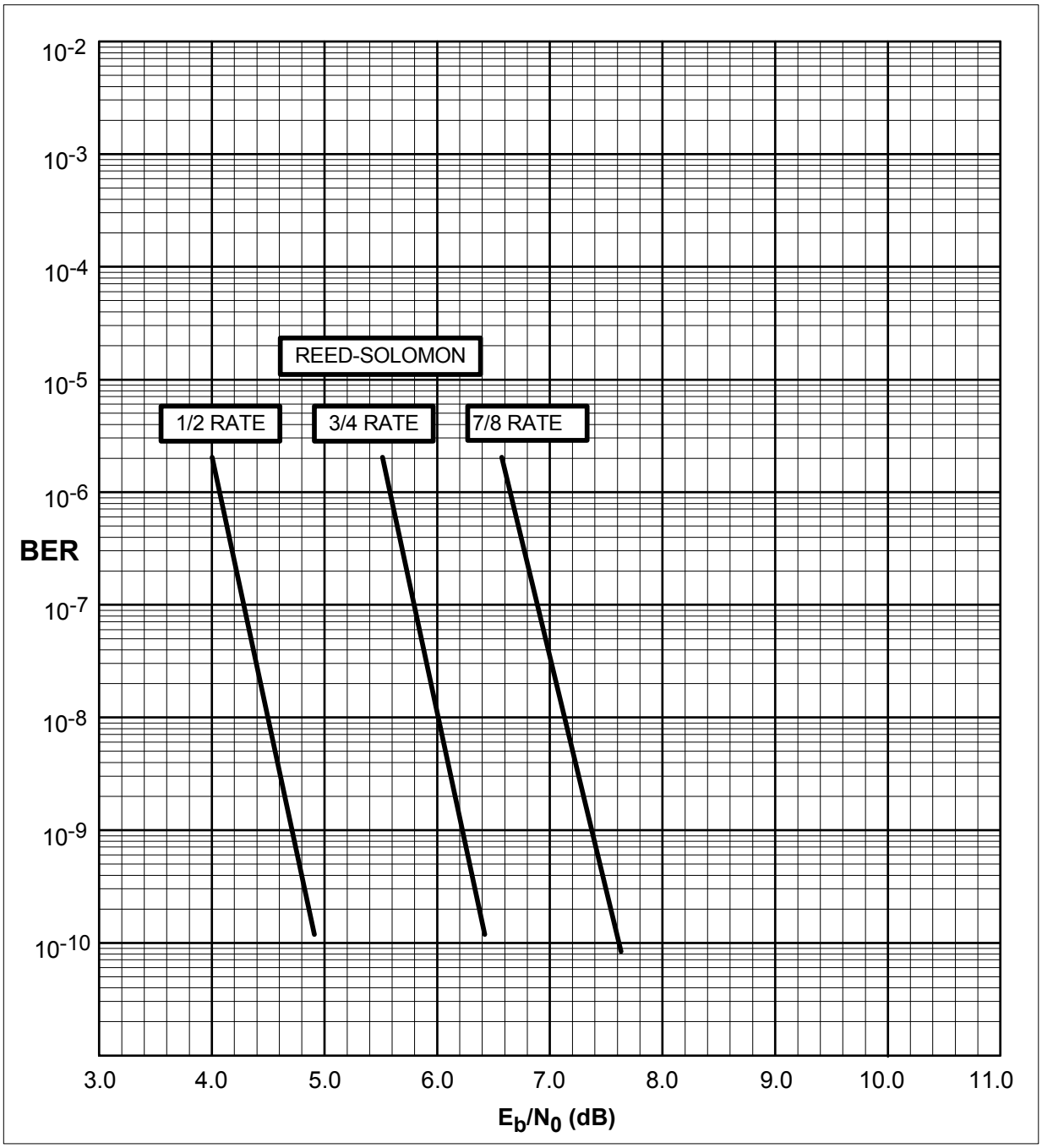


Figure A-25. Performance with Noise, Viterbi Decoder and Reed-Solomon (Optional)

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Table A-23. Performance with Noise, Viterbi Decoder and Reed-Solomon (Optional)

E_b/N_0 (dB) Specification			
BER	1/2 Rate	3/4 Rate	7/8 Rate
10^{-6}	4.1	5.6	6.7
10^{-7}	4.2	5.8	6.9
10^{-8}	4.4	6.0	7.1
10^{-10}	5.0	6.3	7.5

A.3.4.5 Digital Data Rates

The digital data rate is selectable in 1 Hz steps. The modem automatically calculates and sets the symbol rate. Data rates entered that exceed the data rate or symbol rate specification are rejected at entry.

The symbol rate range is 4.8 kHz to 2.5 MHz.

Modulation Type	Encoding Type	Data Rate Range	
BPSK 1/2	Viterbi	2.4 kbps	1.25 Mbps
QSPK 1/2	Viterbi	4.8 kbps	2.5 Mbps
QPSK 3/4	Viterbi	7.2 kbps	3.75 Mbps
QPSK 7/8	Viterbi	8.4 kbps	4.375 Mbps
BPSK 1/2	Sequential	2.4 kbps	1.25 Mbps
QSPK 1/2	Sequential	4.8 kbps	2.5 Mbps
QPSK 3/4	Sequential	7.2 kbps	3.75 Mbps
QPSK 7/8	Sequential	8.4 kbps	4.375 Mbps
BPSK 1/2	Viterbi & Reed-Solomon	2.4 kbps	1.138 Mbps
QSPK 1/2	Viterbi & Reed-Solomon	4.8 kbps	2.277 Mbps
QPSK 3/4	Viterbi & Reed-Solomon	7.2 kbps	3.416 Mbps
QPSK 7/8	Viterbi & Reed-Solomon	8.4 kbps	3.986 Mbps
BPSK 1/2	Sequential & Reed-Solomon	2.4 kbps	1.138 Mbps
QSPK 1/2	Sequential & Reed-Solomon	4.8 kbps	2.277 Mbps
QPSK 3/4	Sequential & Reed-Solomon	7.2 kbps	3.416 Mbps
QPSK 7/8	Sequential & Reed-Solomon	8.4 kbps	3.986 Mbps
QSPK 1/2	IBS or D&I or ASYNC	64 kbps	2048 Mbps
QSPK 1/2	IBS or D&I & Reed-Solomon	64 kbps	2048 Mbps
QSPK 1/2	ASYNC & Reed-Solomon	2.4 kbps	2048 Mbps
QPSK 3/4	IDR, T1	1640 kbps	
QPSK 3/4	IDR, T1 & Reed-Solomon	1800 kbps	
QPSK 3/4	IDR, E1	2144 kbps	
QPSK 3/4	IDR, E1 & Reed-Solomon	2335 kbps	

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A.4 Software and Hardware Installation/Upgrades

A.4.1 Overhead Interface PCB Installation

The overhead interface PCB may be installed at the factory or in the field. The overhead interface PCB is required to access certain options and functionality of the modem. Observe the following:

- If the overhead interface PCB is installed at the factory, then the 50-pin interface relay card will be pre-installed.
- If the overhead interface PCB is installed in the field, then one of four connector/card combinations will have been shipped with the overhead interface PCB.
- Refer to Chapter 2 for connector information.

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A.4.2 Installation

CAUTION

This equipment contains parts and assemblies sensitive to damage by ESD. Use ESD precautionary procedures when touching, removing, or inserting PCBs.

The following tool is required to install the overhead interface PCB:

Description	Application
Phillips ™ Screwdriver	To remove and replace cross-point screws.

Use the following information to install the overhead interface PCB as a daughter card on the main PCB. Refer to Figure A-26 for the installation location of the overhead interface daughter card.

CAUTION

Turn the power off before installation. High current VDC is present. Failure to do so could result in damage to the modem components.

1. Turn off the modem and unplug the power supply.

2. Remove the rear panel retaining screws. Using the finger pulls, slide the main modem assembly out from the rear of the modem chassis.

3. Install the overhead interface PCB, face down, onto the main PCB by mating the male header connectors with the female header connectors.

4. Align the overhead interface PCB standoffs with the main PCB mounting holes. Install the four mounting screws and washers.

   CAUTION

   The mounting hardware must be installed to provide proper grounding between the overhead interface PCB and the main PCB.

5. After completing the installation procedure, turn on the modem. Select the desired modem option to use the overhead card.

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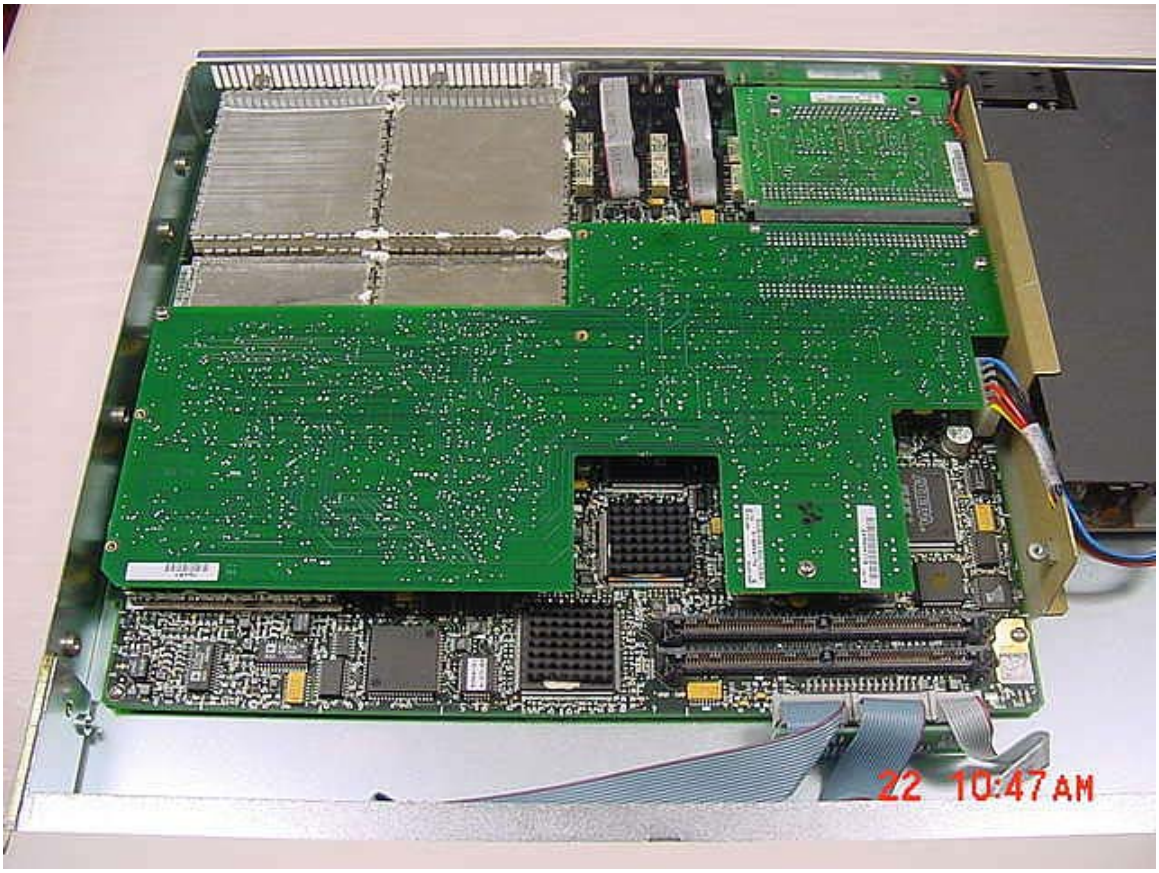


Figure A-26. Overhead Interface PCB Installtion

A.4.3 Hardware Upgrades

A.4.3.1 Main PCB

The main PCB has two field-changeable firmware chips. If necessary, these chips can be removed and new chips added to allow for additional options, enhancements, or repairs. Currently, there are no foreseeable requirements for this task. See Figure A-27 for the locations of the field-changeable chips.

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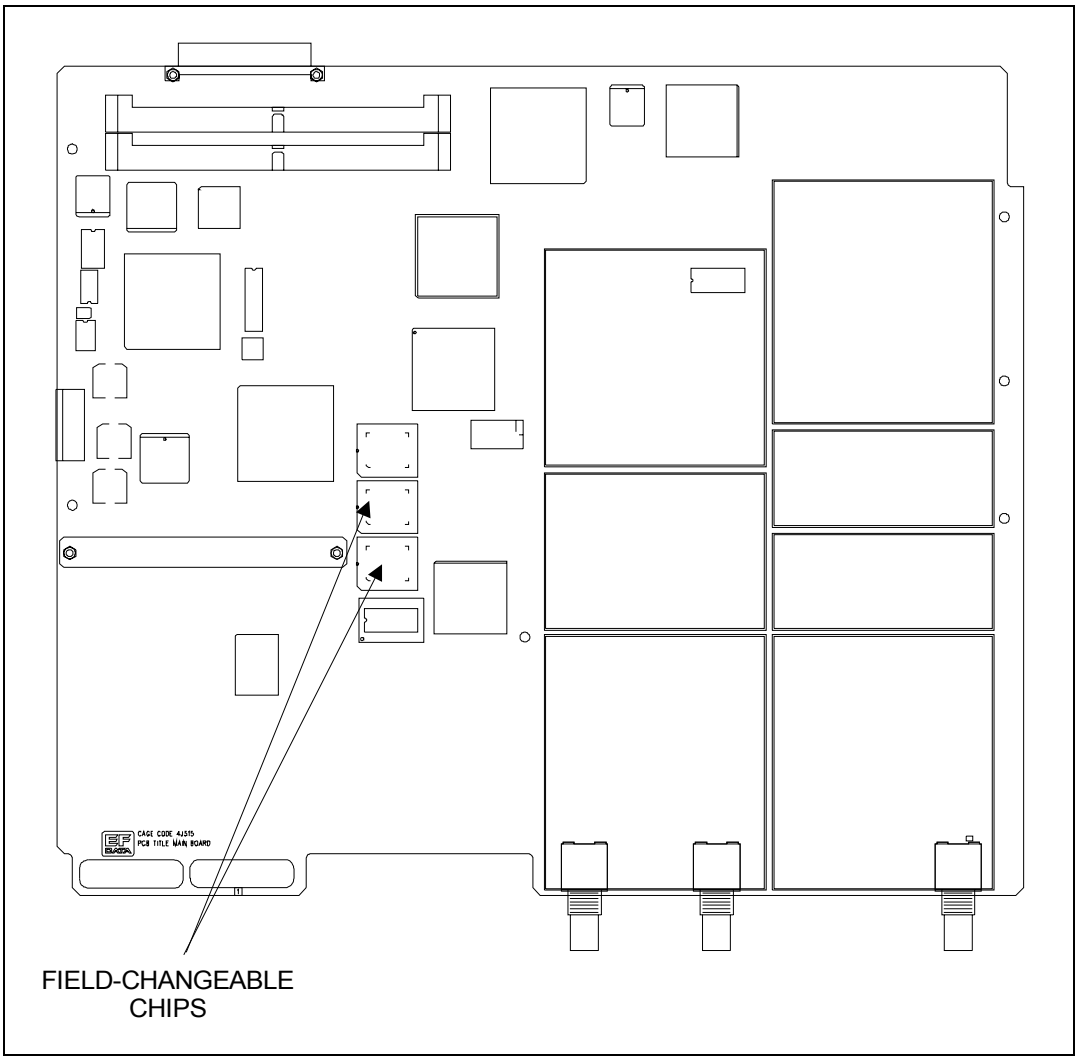


Figure A-27. Main Board Field-Changeable Chips

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A.4.3.2 Overhead Interface PCB

The overhead interface PCB has four field-changeable firmware chips. If necessary, these chips can be removed and new chips added to allow for additional options, enhancements, or repairs. Currently, there are no foreseeable requirements for this task. See Figure A-28 for the locations of the field-changeable chips.

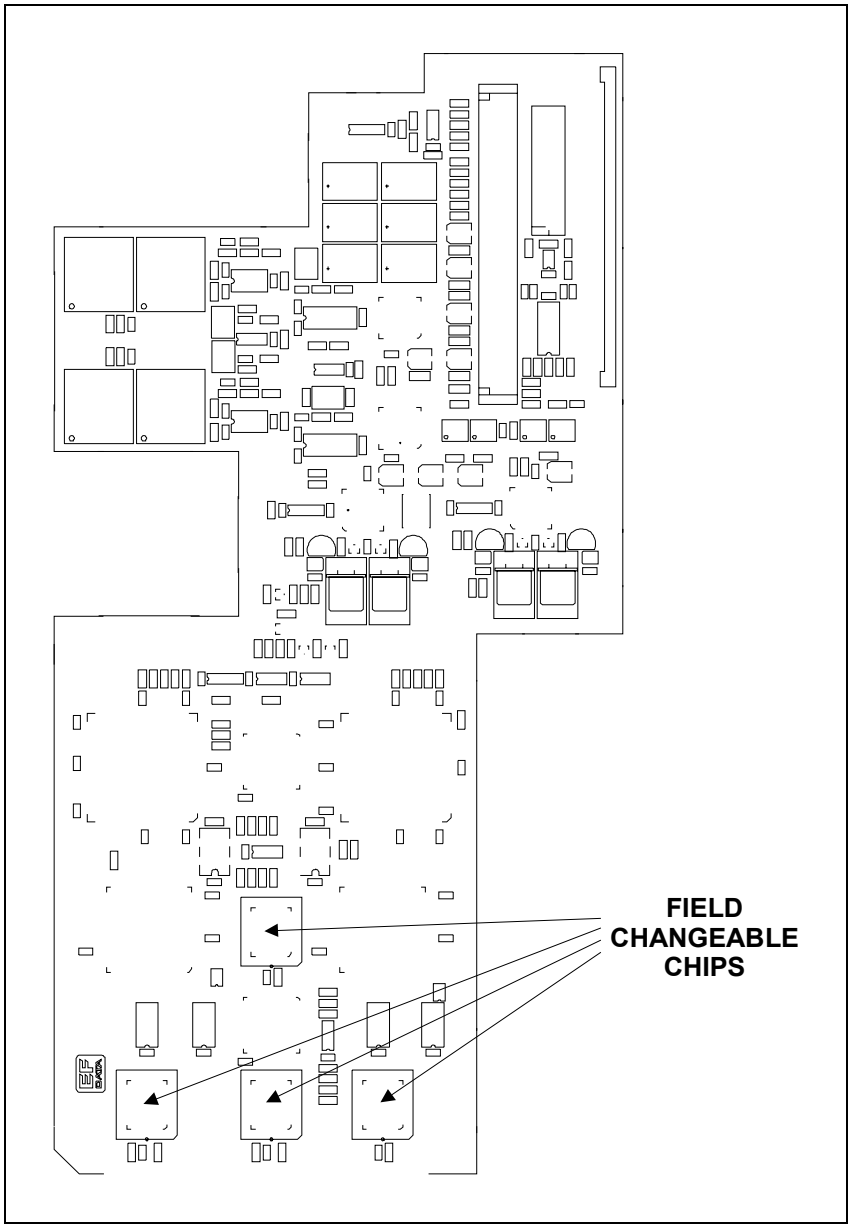


Figure A-28. Overhead Board Field-Changeable Chips

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A.4.4 8-Channel Multiplexer Option

The multiplexer (MUX) system (Figure A-29) provides for 1 to 8 tributary channels to be multiplexed onto a single aggregate carrier. Independent tributary data rates from 600 bit/s to 4000 kbps in 100 bit/s increments are supported. This option is used primarily with the SDR-54 receiver.

The 8-Channel Mux PCB can be installed in the factory or in the field. This MUX PCB is used in conjunction with a compatible I/O card to provide a 100-pin subminiature D style connector located on the rear panel of the SDM-300A modem. All tributary and aggregate data is available at this 100-pin connector. An optional breakout panel (UB-54) can be used to provide eight separate 15-pin D connectors for individual tributary circuits and one 15-pin D connector for auxiliary circuits.

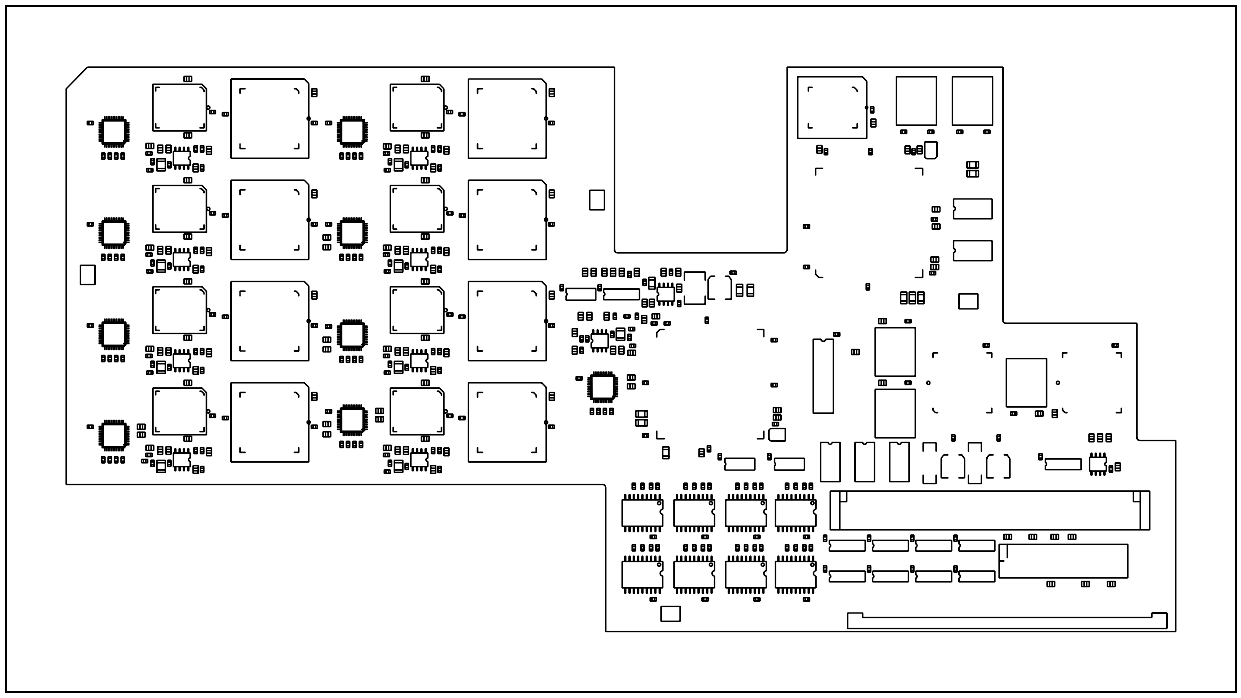


Figure A-29. 8-Channel Multiplexer PCB

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A.4.4.1 Installation

The following tool is required to install the 8-Channel Mux PCB:

Description	Application
Phillips ™ Screwdriver	To remove and replace cross-point screws.

Install the 8-Channel Mux PCB as a daughter card on the main PCB as follows:



The equipment contains parts and assemblies sensitive to damage by Electrostatic Discharge (ESD). Use ESD precautionary procedures when touching, removing, or inserting PCBs.

1. Turn power off and unplug the power supply.
2. Remove the rear panel retaining screws. Using the finger pulls, slide the main modem assembly out from the rear of the modem chassis.
3. Install the 8-Channel Mux PCB to the main PCB by mating the male header connectors with the female header connectors.
4. Align the 8-Channel Mux PCB standoffs with the main PCB mounting holes and install the mounting screws and washers.
5. After completing the installation procedure, turn power on. If the 8-Channel Mux was installed properly, the Configuration MUX menu will be available.

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A.4.4.2 Specifications Summary

Refer to Table A-24 and Table A-25 for specification summary and MUX data for connector (J10).

Table A-24. Specification Summary

System Specification	
Number of Channels (Tributaries)	1 to 8, the data rate for each channel is independently configurable.
Tributary Type	Synchronous (clock/data) or Asynchronous (data only).
Tributary Data Interface	EIA-422 or EIA-232-C, selectable per tributary.
Tributary Data Rate	**Note:** EIA-232-C maximum data rate is 64.0 kbps.
Synchronous	600 bit/s to 4000 kbps in 100 bit/s increments.
Asynchronous	600 baud to 64k K-baud in 100 bit/s increments.
MUX Overhead	1.3 kbps, fixed.
MUX Technique	Data Interleaved Time Division.
Aggregate Data Rate	4001.3 kbps maximum, the aggregate data rate is the sum of all tributary data rates plus the multiplex overhead.
MUX System Specification	
Tributary Data Interface (Synchronous Mode)	The MUX supports a synchronous data interface for each tributary. The tributary data interfaces use DCE conventions with data (send data) sourced by external equipment and clock (send timing) sourced by the MUX.
Tributary Clock Output (Synchronous Mode)	50% duty cycle ± 10%, clock (send timing) is phase locked to the aggregate clock supplied by the modem. Clock stability is based on the reference source. The clock accuracy will nominally be 10E-5 when using the modem SCT clock. Higher stability can be obtained by using the modem External Reference input.
Tributary Data Interface (Asynchronous Mode)	The MUX supports an asynchronous data interface for each tributary. The tributary data interfaces use DCE conventions with data (send data) sourced by external equipment. The MUX samples the input data and passes it across the communications channel. All data formatting and framing is preserved, including start/stop bits and parity. **Note:** CTS (clear to send) flow control is employed to prevent loss of data caused by clock differences between the asynchronous source and the synchronous satellite channel.
Receive Channel Pass Through	The MUX provides an output path for the received clock/data from the SDM-300A modem.
Interface Connector	96-pin female DIN connector (includes all tributary interfaces).
Interface I/O Card (PC/6029)	96-pin male DIN to 100-pin subminiature D conversion PC card.
Breakout Panel (UB-54)	Optional 1 RU breakout panel converts 100-pin D interface to eight 15-pin D separate tributary interfaces and one 15-pin D connector for auxiliary circuits.

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Table A-25. MUX Data 100-Pin Connector (J10)

MUX Data 100 Pin Rear Panel Connector (J10)					
Pin #	**Circuit**	**Description**	**Pin #**	**Circuit**	**Description**
1	-	N/A	51	GND	GROUND
2	-	N/A	52	TC232_5	EIA-232, TX CLK, TRIB5
3	-	N/A	53	TD232_5	EIA-232, TX DAT, TRIB5
4	-	N/A	54	CTS232_5	EIA-232, CTS, TRIB5
5	GND	GROUND	55	TD422B_5	EIA-422, TX DATB (+), TRIB5
6	GND	GROUND	56	TD422A_5	EIA-422, TX DATA (-), TRIB5
7	DF	DEMOD FAULT	57	TC422B_5	EIA-422, TX CLKB (+), TRIB5
8	MF	MOD FAULT	58	TC422A_5	EIA-422, TX CLKA (-), TRIB5
9	GND	GROUND	59	CTS422B5	EIA-422, CTSB (+), TRIB5
10	RT+B	RECEIVE TIMING B (+)	60	CTS422A5	EIA-422, CTSA (-), TRIB5
11	RT-A	RECEIVE TIMING A (-)	61	GND	GROUND
12	GND	GROUND	62	TC232_4	EIA-232, TX CLK, TRIB4
13	RD+B	RECEIVE DATA B (+)	63	TD232_4	EIA-232, TX DAT, TRIB4
14	RD-A	RECEIVE DATA A (-)	64	CTS232_4	EIA-232, CTS, TRIB4
15	GND	GROUND	65	TD422B_4	EIA-422, TX DATB (+), TRIB4
16	RR+B	RECEIVER READY B (+)	66	TD422A_4	EIA-422, TX DATA (-), TRIB4
17	RR-A	RECEIVER READY A (-)	67	TC422B_4	EIA-422, TX CLKB (+), TRIB4
18	GND	GROUND	68	TC422A_4	EIA-422, TX CLKA (-), TRIB4
19	MCB	MASTER CLOCK B	69	CTS422B4	EIA-422, CTSB (+), TRIB4
20	MCA	MASTER CLOCK A	70	CTS422A4	EIA-422, CTSA (-), TRIB4
21	GND	GROUND	71	GND	GROUND
22	TC232_8	EIA-232, TX CLK, TRIB8	72	TC232_3	EIA-232, TX CLK, TRIB3
23	TD232_8	EIA-232, TX DAT, TRIB8	73	TD232_3	EIA-232, TX DAT, TRIB3
24	CTS232_8	EIA-232, CTS, TRIB8	74	CTS232_3	EIA-232, CTS, TRIB3
25	TD422B_8	EIA-422, TX DATB (+), TRIB8	75	TD422B_3	EIA-422, TX DATB (+), TRIB3
26	TD422A_8	EIA-422, TX DATA (-), TRIB8	76	TD422A_3	EIA-422, TX DATA (-), TRIB3
27	TC422B_8	EIA-422, TX CLKB (+), TRIB8	77	TC422B_3	EIA-422, TX CLKB (+), TRIB3
28	TC422A_8	EIA-422, TX CLKA (-), TRIB8	78	TC422A_3	EIA-422, TX CLKA (-), TRIB3
29	CTS422B8	EIA-422, CTSB (+), TRIB8	79	CTS422B3	EIA-422, CTSB (+), TRIB3
30	CTS422A8	EIA-422, CTSA (-), TRIB8	80	CTS422A3	EIA-422, CTSA (-), TRIB3
31	GND	GROUND	81	GND	GROUND
32	TC232_7	EIA-232, TX CLK, TRIB7	82	TC232_2	EIA-232, TX CLK, TRIB2
33	TD232_7	EIA-232, TX DAT, TRIB7	83	TD232_2	EIA-232, TX DAT, TRIB2
34	CTS232_7	EIA-232, CTS, TRIB7	84	CTS232_2	EIA-232, CTS, TRIB2
35	TD422B_7	EIA-422, TX DATB (+), TRIB7	85	TD422B_2	EIA-422, TX DATB (+), TRIB2
36	TD422A_7	EIA-422, TX DATA (-), TRIB7	86	TD422A_2	EIA-422, TX DATA (-), TRIB2
37	TC422B_7	EIA-422, TX CLKB (+), TRIB7	87	TC422B_2	EIA-422, TX CLKB (+), TRIB2
38	TC422A_7	EIA-422, TX CLKA (-) TRIB7	88	TC422A_2	EIA-422, TX CLKA (-), TRIB2
39	CTS422B7	EIA-422, CTSB (+), TRIB7	89	CTS422B2	EIA-422, CTSB (+), TRIB2
40	CTS422A7	EIA-422, CTSA (-), TRIB7	90	CTS422A2	EIA-422, CTSA (-), TRIB2
41	GND	GROUND	91	GND	GROUND
42	TC232_6	EIA-232, TX CLK, TRIB6	92	TC232_1	EIA-232, TX CLK, TRIB1
43	TD232_6	EIA-232, TX DAT, TRIB6	93	TD232_1	EIA-232, TX DAT, TRIB1
44	CTS232_6	EIA-232, CTS, TRIB6	94	CTS232_1	EIA-232, CTS, TRIB1
45	TD422B_6	EIA-422, TX DATB (+), TRIB6	95	TD422B_1	EIA-422, TX DATB (+), TRIB1
46	TD422A_6	EIA-422, TX DATA (-), TRIB6	96	TD422A_1	EIA-422, TX DATA (-), TRIB1
47	TC422B_6	EIA-422, TX CLKB (+), TRIB6	97	TC422B_1	EIA-422, TX CLKB (+), TRIB1
48	TC422A_6	EIA-422, TX CLKA (-), TRIB6	98	TC422A_1	EIA-422, TX CLKA (-), TRIB1
49	CTS422B6	EIA-422, CTSB (+), TRIB6	99	CTS422B1	EIA-422, CTSB (+), TRIB1
50	CTS422A6	EIA-422, CTSA (-), TRIB6	100	CTS422A1	EIA-422, CTSA (-), TRIB1

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A.4.5 Flex Mux

Flex Mux (Figure A-30) PCB is offered as a factory or field installable interface. Simultaneous operation of a main data channel and three overhead channels are supported. The main data channel is a G.703 type electrical interface at E1 (2048 kbps) or T1 (1544 kbps) terrestrial data rate and supports both pass through and D&I modes of operation. AUPC, ASYNC data and voice channels are supported in the three overhead channels.

Flex Mux is designed to plug into the base board of the modem at two internal interfaces, and provide a single 50-pin “D” sub-connector at the rear of the modem to replace the non-overhead 25-pin connector. The particular overhead configuration of the PCB is determined by software control via the front panel.

Connection to the main PCB of the modem is accomplished through a 96-pin DIN connector and a 30-pin HEADER. The 96-pin connector provides most of the required signals and power.

Refer to the following tables for system specification:

- Table A-26 System Specifications
- Table A-27 Multiplexer Specifications
- Table A-28 Demultiplexer Specifications

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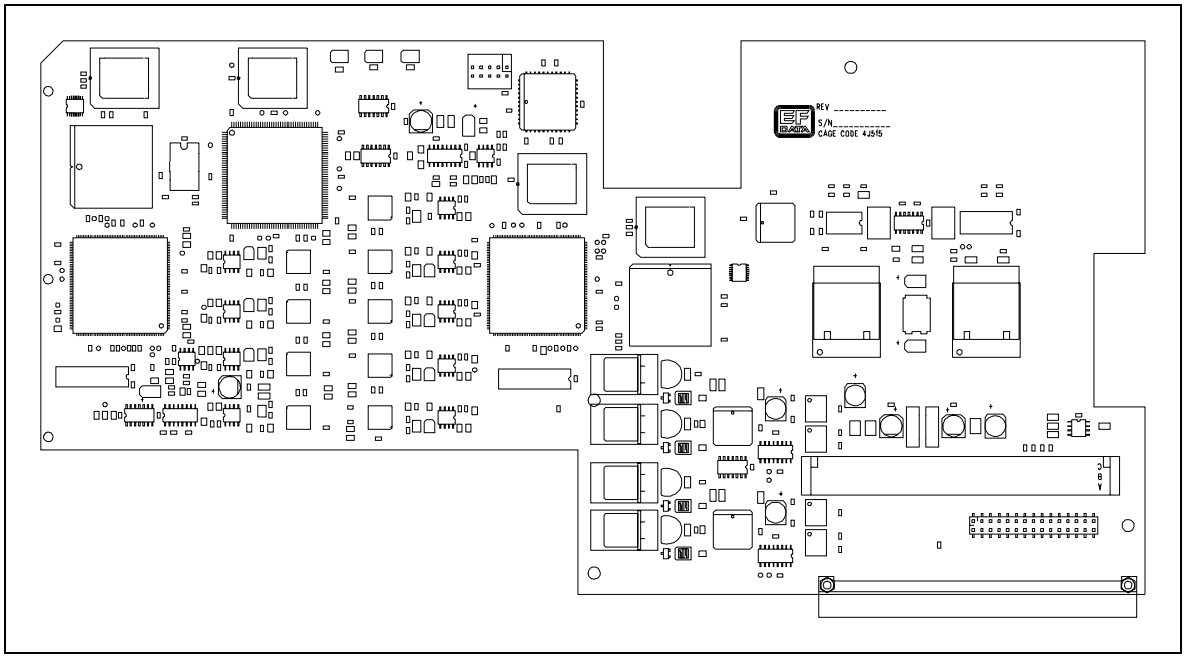


Figure A-30. Flex Mux

Table A-26. System Specifications

System Specifications	
Number of Channels	1 to 4, Each Channel is independently configurable.
User Channel #1 Drop and Insert	G.703 E1 with Nx64 kbps channels. G.703T1 with Nx64 kbps channels.
User Channel #1 Pass Through Mode	G.703 E1 (2048 kbps). G.703 T1 (1544 kbps).
User Channel #2 ADPCM Audio Channel	32 kbps audio channel 600Ω , balanced 4-wire.
User Channel #3 AUPC Channel	AUPC is included to provide remote output power adjustment capability.
User Channel #3 Auxiliary Data Channel	EIA-422 SYNC 0.6 to 4000 kbps. EIA-232 ASYNC 0.6 to 64 kbps with CTS flow control. (100 kbps steps.)
User Channel #4 AUPC Channel	AUPC is included to provide remote output power adjustment capability.
User Channel #4 Auxiliary Data Channel #2	EIA-422 SYNC 0.6 to 4000 kbps. EIA-232 ASYNC 0.6 to 64 kbps with CTS flow control. (100 kbps steps.)
Aggregate Data Rate	4.8 to 4001.3 kbps, the aggregate data rate is the sum of all tributary data rates plus the multiplex overhead.

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Table A-27. Multiplexer Specifications

Multiplexer Specific Specifications	
Tributary Data Interface (Synchronous Mode)	The multiplexer supports data from each tributary. The tributary interfaces use DCE conventions with data (send data) sourced by external equipment and clock (send timing) sourced by the multiplexer.
Tributary Clock Output (Synchronous mode)	50% duty cycle ± 10%, clock (send timing) is phase locked to aggregate clock supplied by the modem or an external reference supplied by the user equipment. Clock stability is based on the reference equipment.
Tributary Data Interface (Asynchronous mode)	The multiplexer supports asynchronous data interface for each tributary data interface and uses (DCE) conventions with data (send data) sourced by external equipment. The multiplexer samples data and passes it across the communications channel. L data formatting and framing is preserved. Note: CTS (Clear-to-Send) flow control is employed to prevent loss of data caused by clock differences between the asynchronous source and the asynchronous satellite channel.

Table A-28. Demultiplexer Specific Specifications

Demultiplexer Specific Specifications	
Tributary Data Interface (Synchronous mode)	The demultiplexer supports synchronous data for each tributary. The tributary interfaces use DCE conventions with data (send data) sourced by external equipment and clock (send timing) sourced by the multiplexer.
Tributary Data Interface (Asynchronous mode)	The demultiplexer supports asynchronous data interface for each tributary. The tributary data interface used (DCE) conventions with data (receive data) sourced by demultiplexer. Asynchronous mode at the demultiplexer is really no different from synchronous mode, because the multiplex equipment does async to sync conversion prior to transmission over the satellite channel. The asynchronous data is passed in virtual transparent mode and retains as the transmitting equipment. The synchronous tributary clock remains active in this mode but is not used.
Tributary Clock Output	50% duty clock ± 10%, clock (receive timing) is phase locked to aggregate clock recovered by the modem.
Clock Jitter	± 5% of 1/data rate, maximum (Eb/N0 > 7 dB).
Data Delay Variation	< 5% of 1/data rate, maximum unit to unit, average arrival time, including the demodulator.
Lock Time	< 1.0 second.

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A.4.5.1 Installation

The following tool is required to install the Flex Mux PCB:

Description	Application
Phillips ™ Screwdriver	To remove and replace cross-point screws.

Install the Flex Mux PCB as a daughter card on the main PCB as follows:



The equipment contains parts and assemblies sensitive to damage by Electrostatic Discharge (ESD). Use ESD precautionary procedures when touching, removing, or inserting PCBs.

1. Turn power off and unplug the power supply.
2. Remove the rear panel retaining screws. Using the finger pulls, slide the main modem assembly out from the rear of the modem chassis.
3. Install the Flex Mux PCB to the main PCB by mating the male header connectors with the female header connectors.
4. Align the Flex Mux PCB standoffs with the main PCB mounting holes and install the mounting screws and washers.
5. After completing the installation procedure, turn power on. If the Flex Mux was installed properly, the Configuration MUX menu will be available.

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A.4.5.2 Pin Assignment

Refer to Table A-29 for 50-pin connector pin assignments.

Table A-29. 50-Pin Connector Pin Assignments

Pin #	Signal Name	Description	Pin #	Signal Name	Description
1, 2	GND		11	RT2-A Channel #3	Receive Timing - Auxiliary 2
34	DDI-A Channel #1	Drop Data Input - Main Channel G.703	44	RT2-B Channel #3	Receive Timing + Auxiliary 2
18	DDI-B Channel #1	Drop Data Input + Main Channel G.703	43	ST2-A Channel #3	Send Timing - Auxiliary 2
36	IDO-A Channel #1	Insert Data Output - Main Channel G.703	27	ST2-B Channel #3	Send Timing + Auxiliary 2
20	IDO-B Channel #1	Insert Data Output + Main Channel G.703	28	CTS2-A Channel #3	Clear-To-Send - Auxiliary 2
37	DDO-A Channel #1	Drop Data Output - G.703 Main.	15	CTS2-B Channel #3	Clear-To-Send + Auxiliary 2
38	DDO-B Channel #1	Drop Data Output + G.703 Main.	5	TXD-A Channel #4	ESC Send Data -
39	IDI-A Channel #1	Insert Data Input - G.703 Main.	4	TXD-B Channel #4	ESC Send Data +
40	IDI-B Channel #1	Insert Data Input + G.703 Main.	7	RXD-A Channel #4	ESC Receive Data -
35	EXC_A Channel #1	External Clock Input - Main Channel	6	RXD-B Channel #4	ESC Receive Data +
19	EXC_B Channel #1	External Clock Input + Main Channel	26	RXCLK Channel #4	ESC Receive Clock
45	AII-A Channel #2	Audio In -	25	TXCLK Channel #4	ESC Send Clock
29	AII-B Channel #2	Audio In +	41	ESCDSR Channel #4	ESC Data Set Ready
46	AIO-A Channel #2	Audio Out -	17	DMA	
30	AIO-B Channel #2	Audio Out +	50	DF-NO	
8	SD2-A Channel #3	Send Data - Auxiliary 2	16	DF-COM	
9	SD2-B Channel #3	Send Data + Auxiliary 2	49	MOD-FLT	Modulator Fault
42	RD2-A Channel #3	Receive Data - Auxiliary 2	33	DMD-FLT	Demodulator Fault
10	RD2-B Channel #3	Receive Data + Auxiliary 2	3	AGC_OUT	Analog Voltage

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A.5 Turbo Product Codec (Hardware Option)

A.5.1 Introduction



Turbo coding is an FEC technique, which delivers significant performance improvements compared to the more traditional techniques.

Two general classes of Turbo Codes have been developed, Turbo Convolutional Codes (TCC), and Turbo Product Codes (TPC, a block coding technique). Comtech EF Data has chosen to implement an FEC Codec based on TPC. A Turbo Product Code is a 2 or 3 dimensional array of block codes. Encoding is relatively straightforward, but decoding is a very complex process requiring multiple iterations of processing for maximum performance to be achieved.

Unlike the popular method of concatenating a Reed-Solomon Codec with a primary FEC Codec, Turbo Product Coding is an entirely stand-alone method. It does not require the complex interleaving/de-interleaving of the RS approach, and consequently, decoding delays are significantly reduced. Furthermore, the traditional concatenated RS schemes exhibit a very pronounced threshold effect – a small reduction in Eb/No can result in total loss of Demod and decoder synchronization. TPC does not suffer from this problem – the Demod and decoder remain synchronized down to the point where the output error rate becomes unusable. This is considered to be a particularly advantageous characteristic in a fading environment. Typically, in QPSK, 8PSK mode the Demod and decoder can remain synchronized ***2 – 3 dB below*** the Viterbi/Reed-Solomon or TCM cases.

With this revision of the SLM-3650, Comtech EF Data now provides the best Forward Error Correction technology currently available, offering a very broad range of TPC code rates, combined with the entire range of modulation types.

A.5.2 End-to-End Processing Delay

In many cases, FEC methods that provide increased coding gain do so at the expense of increased processing delay. However, with TPC, this increase in delay is very modest. Table A-28 shows the processing delays for the major FEC types, including the three TPC modes:

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Table A-30.Turbo Product Coding Processing Delay Comparison

FEC Mode (64 kbps data rate)	End-to-end delay, ms
Viterbi, Rate 1/2	12
Sequential, Rate 1/2	74
Viterbi Rate 1/2 + Reed-Solomon	266
Sequential Rate 1/2 + Reed-Solomon	522
Turbo Product Coding, Rate 3/4, {O}QPSK	79
Turbo Product Coding, Rate 21/44, BPSK	64
Turbo Product Coding, Rate 5/16, BPSK	48

Note: In all cases, the delay is inversely proportional to data rate, so for 128 kbps, the delay values would be half of those shown above.

It can be clearly seen that the concatenated Reed-Solomon cases increase the delay very significantly (due mainly to interleaving/de-interleaving), while the TPC cases yield delays which are less than or equal to Sequential decoding.

A.5.3 Comparison of all TPC Modes

Mode	Eb/No at BER = 10^{-6}	Eb/No at BER = 10^{-8}	Spectral Efficiency	Symbol Rate	Occupied * Bandwidth for 1 Mbps Carrier
QPSK Rate 1/2 Viterbi (see Note 1)	3.8 dB	7.2 dB	1.00 bits/Hz	1.0 x bit rate	1190 kHz
BPSK Rate 21/44 Turbo	2.8 dB	3.3 dB	0.48 bits/Hz	2.1 x bit rate	2493 kHz
BPSK Rate 5/16 Turbo	< 4.0	< 4.0 dB	0.31 bits/Hz	3.2 x bit rate	3808 kHz
{O}QPSK Rate 1/2 Turbo	3.0 dB	3.5 dB	1.00 bits/Hz	1.0 x bit rate	1190 kHz
{O}QPSK Rate 3/4 Turbo	3.9 dB	4.3 dB	1.50 bits/Hz	0.67 x bit rate	793 kHz
8-PSK Rate 2/3 TCM and R-S (IESS-310) (see Note 2)	6.1 dB	6.6 dB	1.82 bits/Hz	0.56 x bit rate	666 kHz
8-PSK Rate 3/4 Turbo	7.0 dB	8.0 dB	2.25 bits/Hz	0.44 x bit rate	529 kHz

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Notes:

1. The occupied bandwidth is defined at the width of the transmitted spectrum taken at the –10 dB points on the plot of power spectral density. This equates to 1.19 x symbol rate for the SLM-3650 TX filtering.
2. Included for comparison purposes.

Observe that the 8=PSK Rate 3/4 Turbo performance closely approaches that of the Rate 2/3 TCM/Reed-Solomon case – the BER performance is within approximately 0.4 dB. However, it should be noted that the Rate 3/4 Turbo mode is ***20% more bandwidth efficient*** than the TCM case. The additional advantages of Turbo (lower delay, performance during fades, etc.) also should be considered.

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A.6 Uncoded Operation (No FEC)

There are occasions where a user may desire to operate a satellite link with *No FEC* of any kind. For this reason, the SLM-3650 offers this uncoded mode for three modulation types - BPSK, QPSK and OQPSK. However, the user should be aware of some of the implications of using this approach.

PSK demodulators have two inherent undesirable features. The first of these is known as 'phase ambiguity', and is due to the fact the demodulator does not have any absolute phase reference, and in the process of carrier recovery, the demodulator can lock up in any of K phase states, where K = 2 for BPSK, K = 4 for {O}QPSK. Without the ability to resolve these ambiguous states there would be a 1-in-2 chance that the data at the output of the demodulator would be wrong, in the case of BPSK. For {O}QPSK, the probability would be 3 in 4.

The problem is solved in the case of BPSK by differentially encoding the data prior to transmission, and then performing the inverse decoding process. This is a very simple process, but has the disadvantage that it doubles the receive BER. For every bit error the demodulator produces, the differential decoder produces two.

The problem for QPSK is more complex, as there are 4 possible lock states, leading to 4 ambiguities. When FEC is employed, the lock state of the FEC decoder can be used to resolve two of the four ambiguities, and the remaining two can be resolved using serial differential encoding/decoding. However, when *No FEC* is being used, an entirely different scheme must be used. Therefore, in QPSK, a parallel differential encoding/decoding technique is used, but has the disadvantage that it again doubles the receive BER.

OQPSK is a different situation again, where the ambiguities result not only from not having an absolute phase reference, but also not knowing which of the two parallel paths in the demod, I or Q, contains the half-symbol delay. Another type of differential encoding is used, but yet again the error rate is doubled, compared to ideal.

NOTE: Whenever uncoded operation is selected, the modem automatically uses the differential encoder/decoder appropriate for the modulation type. It cannot be disabled.

The second problem inherent in PSK demodulators is that of 'data false locking'.
In order to accomplish the task of carrier recovery, the demodulator must use a non-linear process. A second-order non-linearity is used for BPSK, and a fourth-order non-linearity is used for QPSK. When data at a certain symbol rate is used to modulate the carrier, the demodulator can lock at incorrect frequencies, spaced at intervals of one-quarter of the symbol rate away from the carrier. Fortunately, when FEC decoding is used, the decoder synchronization state can be used to verify the correct lock point has been achieved, and to reject the false locks.

However, if uncoded operation is used, there is no way to recognize a data false lock. The demodulator will indicate that it is correctly locked, but the data out will not be correct.

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Comtech EF Data strongly cautions users when using uncoded operation. If the acquisition sweep width exceeds one quarter of the symbol rate, there is a very high probability that the demodulator will false lock.

As an example, if 64 kbps QPSK uncoded is used, then the symbol rate will be half of this rate, or 32 ksymbols/second. One quarter of this equals 8 kHz. Therefore, the absolute maximum acquisition sweep range, which should be considered, is ± 8 kHz. If there is any frequency uncertainty on the incoming carrier, this should be subtracted from the sweep width. The problem becomes progressively better with increasing symbol rate.



Comtech EF Data is not responsible for incorrect operation if the user does not adhere to these guidelines when using uncoded operation.

.

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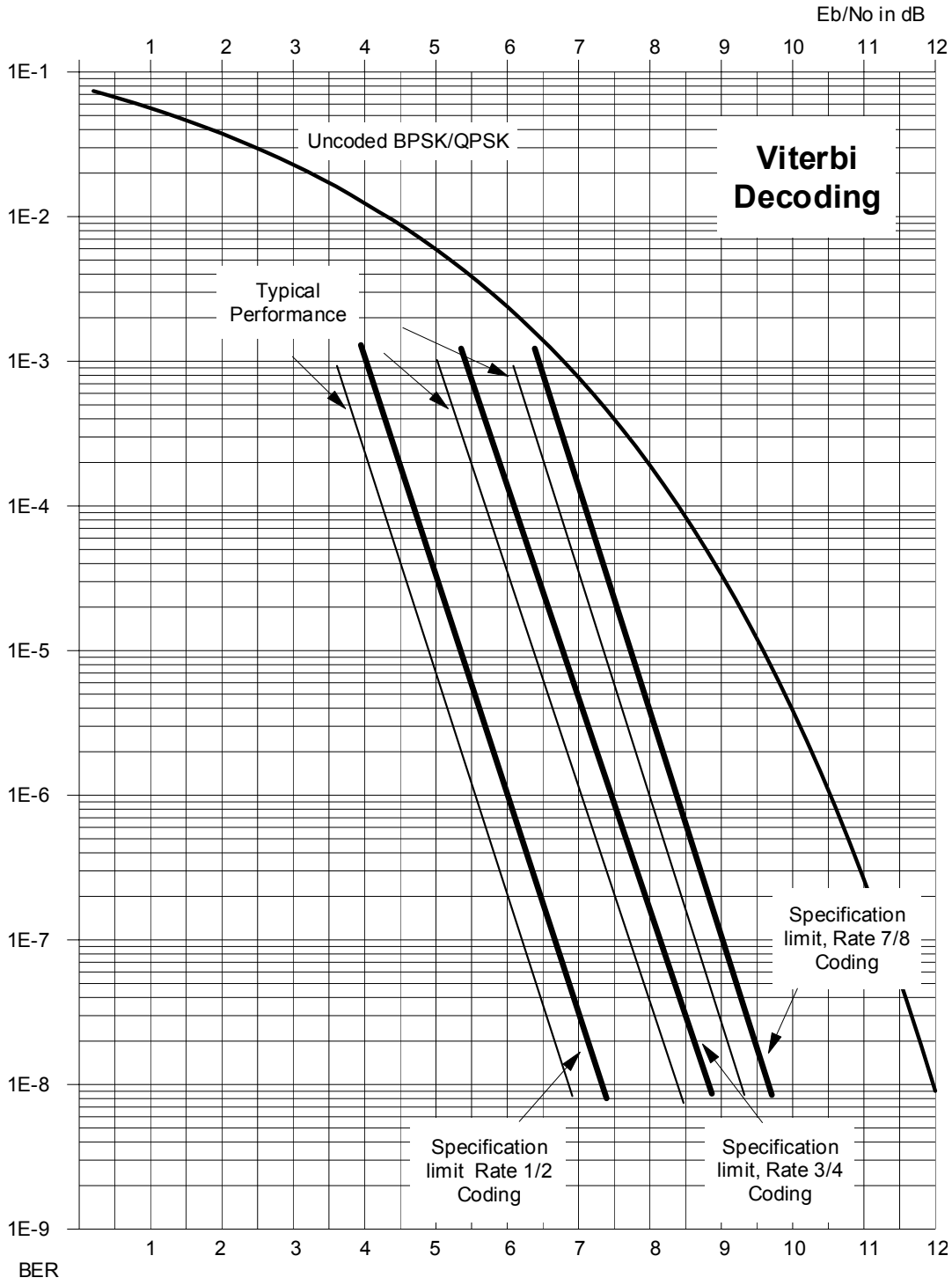


Figure A-31. Viterbi Decoding

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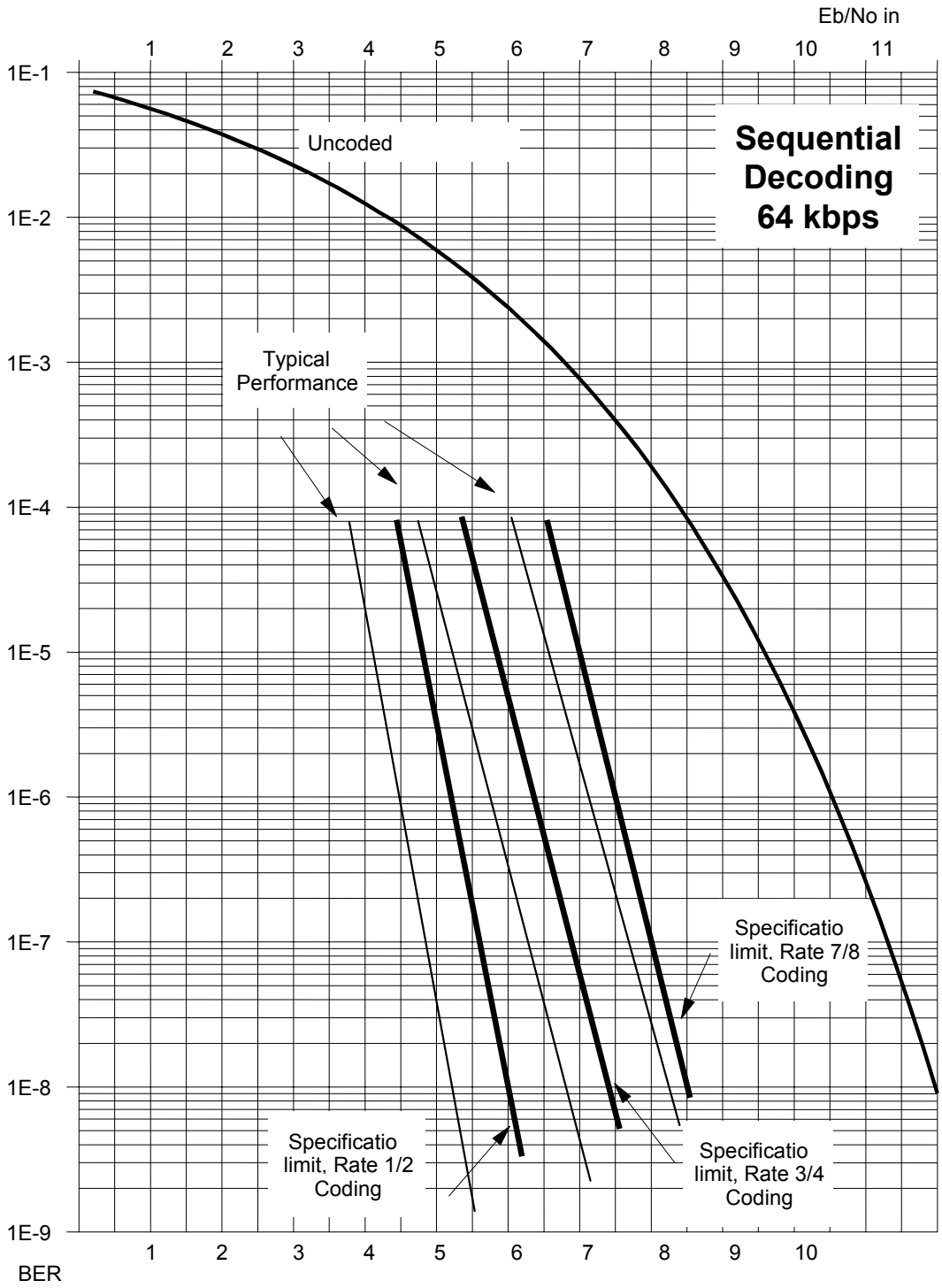


Figure A-32. Sequential Decoding 64 kbps

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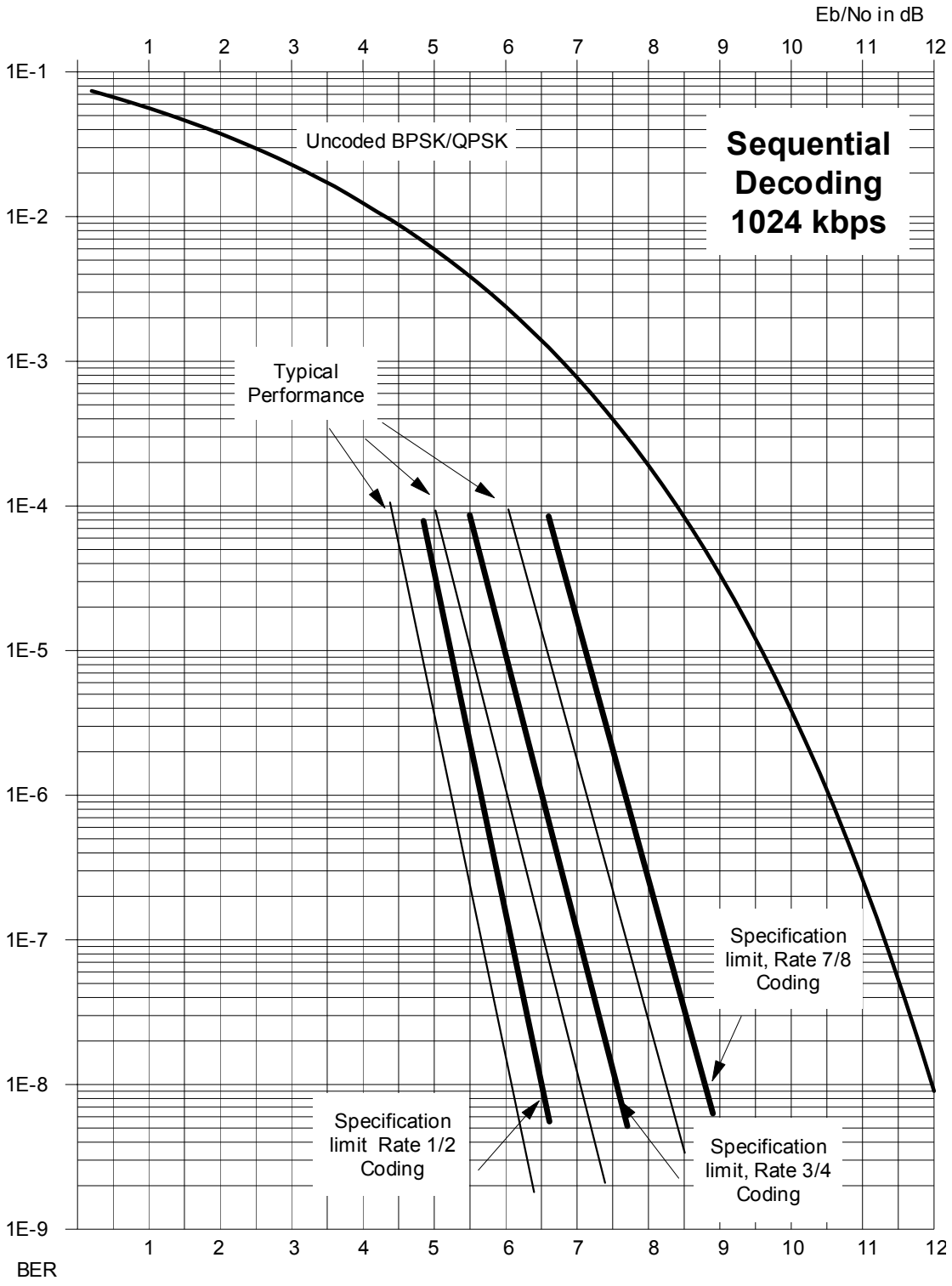


Figure A-33. Sequential Decoding 1024 kbps

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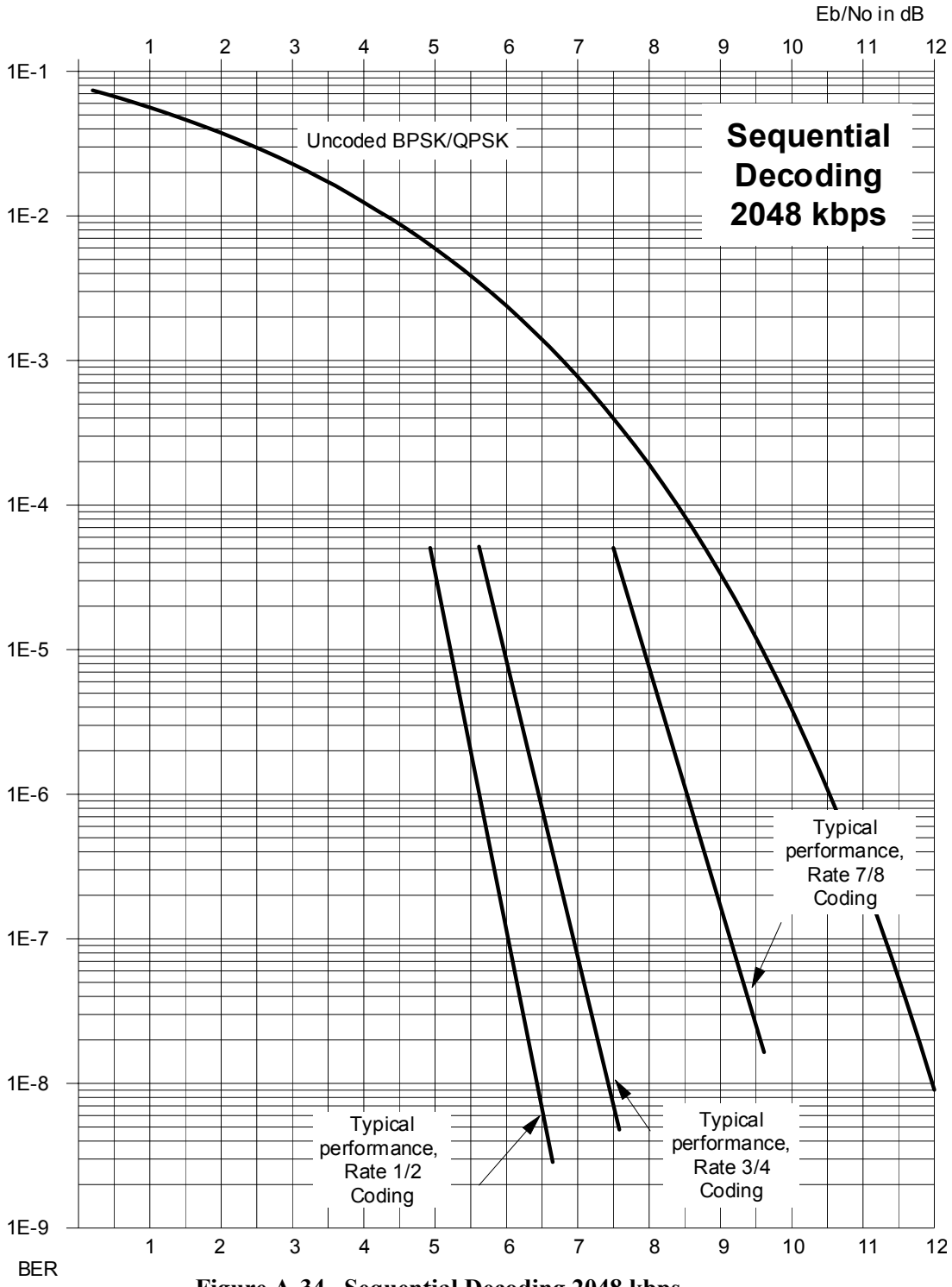


Figure A-34. Sequential Decoding 2048 kbps

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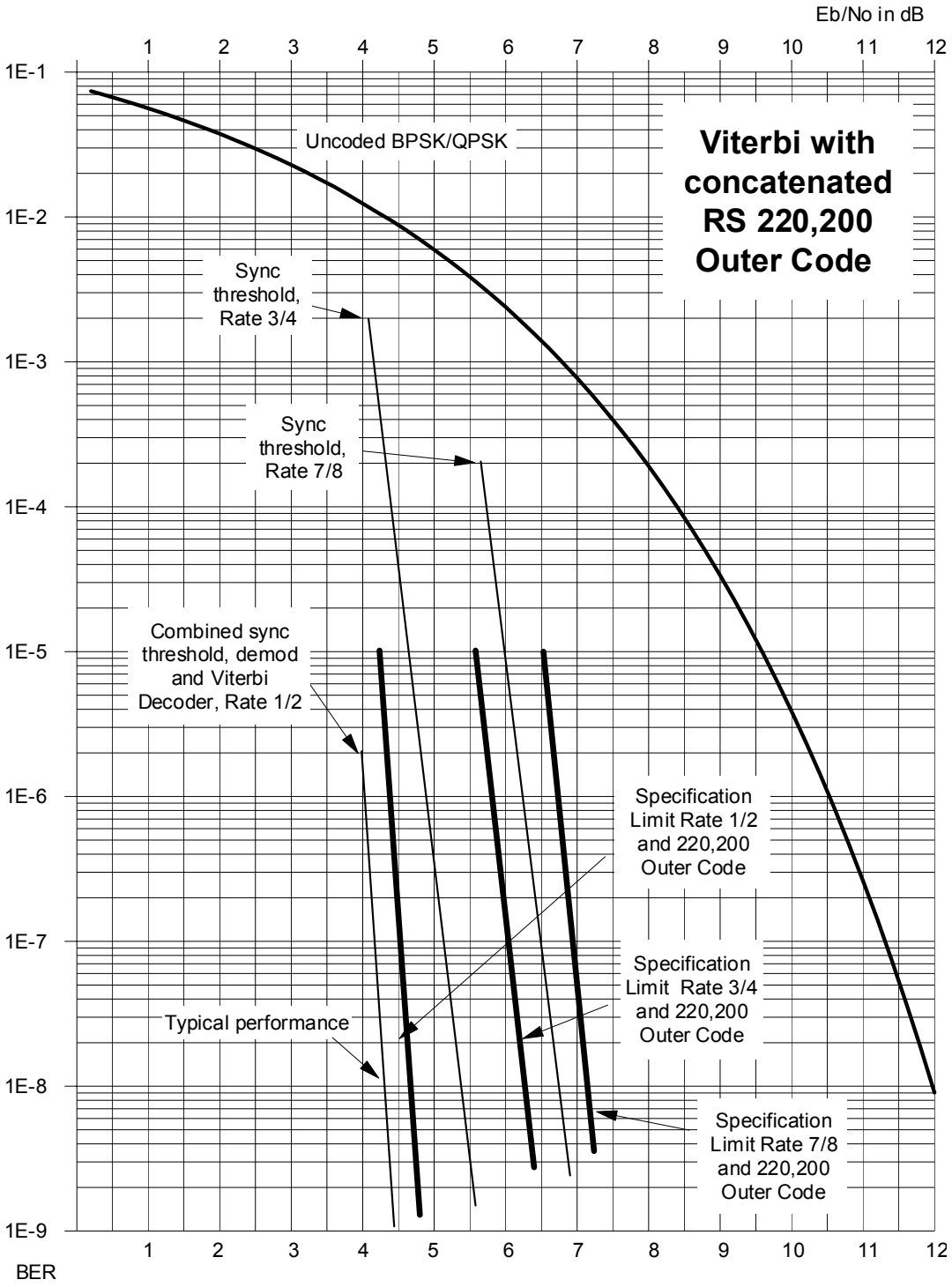


Figure A-35. Viterbi with concatenated RS Outer Code

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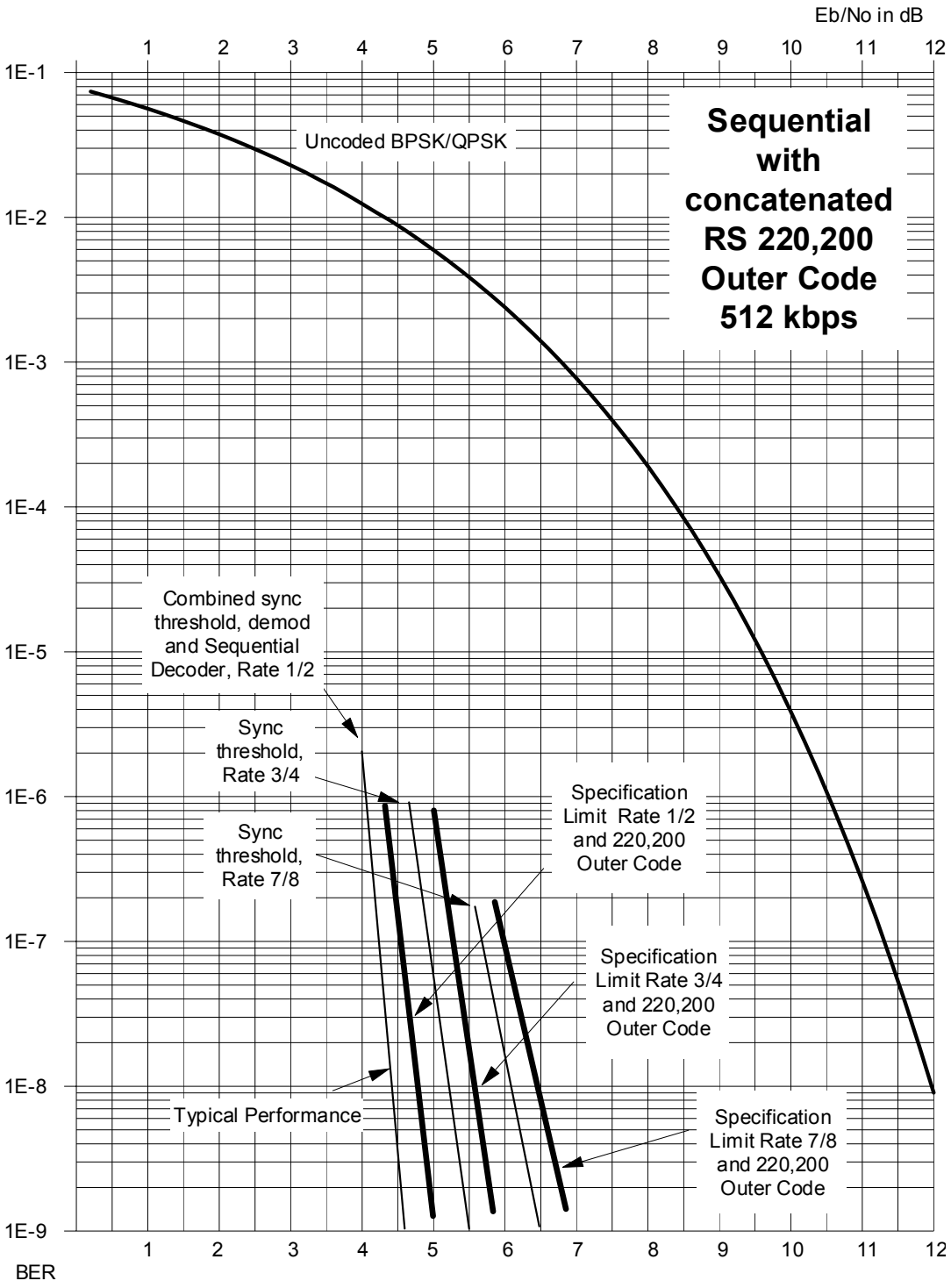


Figure A-36. Sequential with concatenated RS Outer Code

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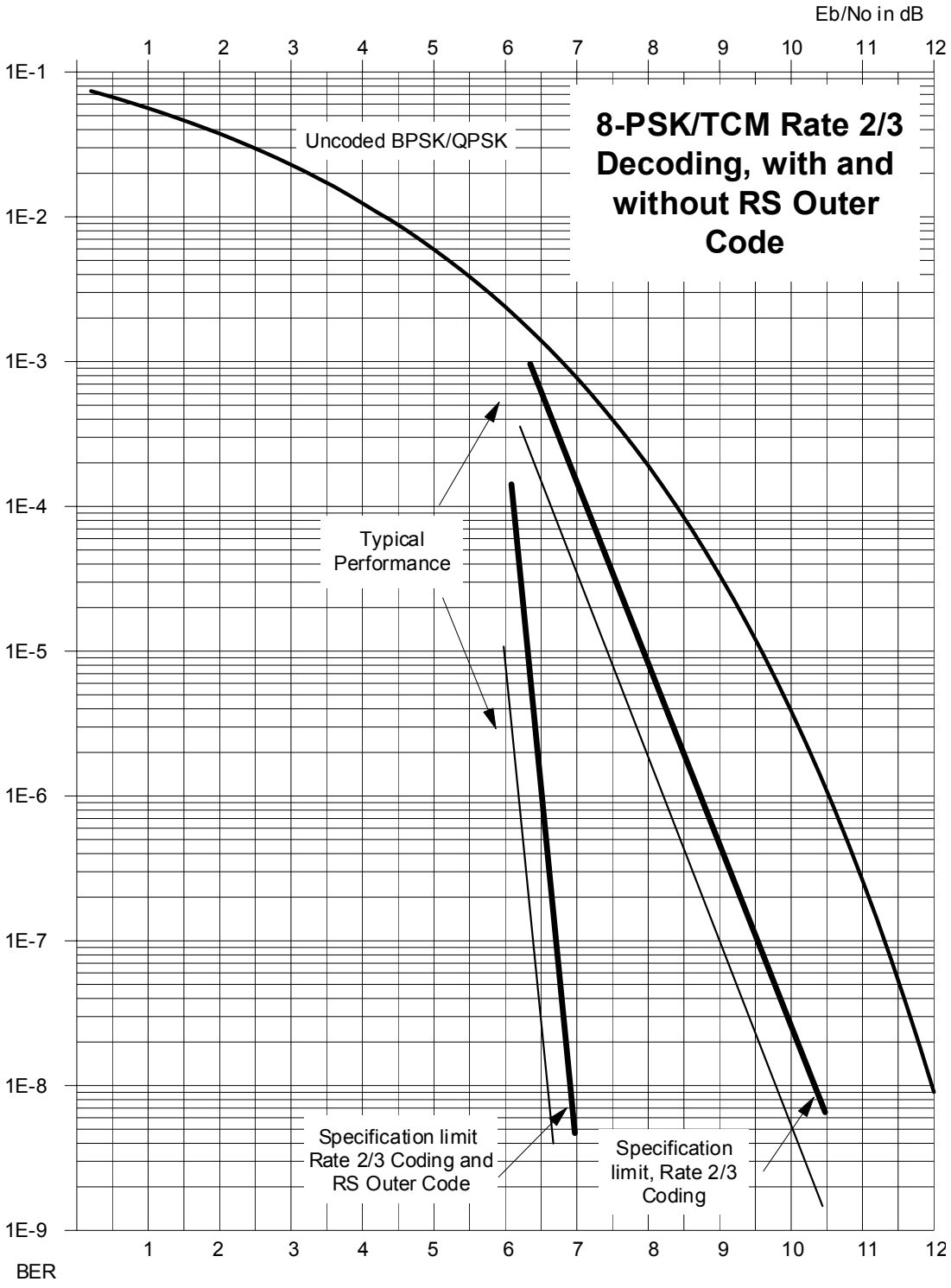


Figure A-37. 8PSK/TCM Rate 2/3 with and without concatenated RS Outer Code

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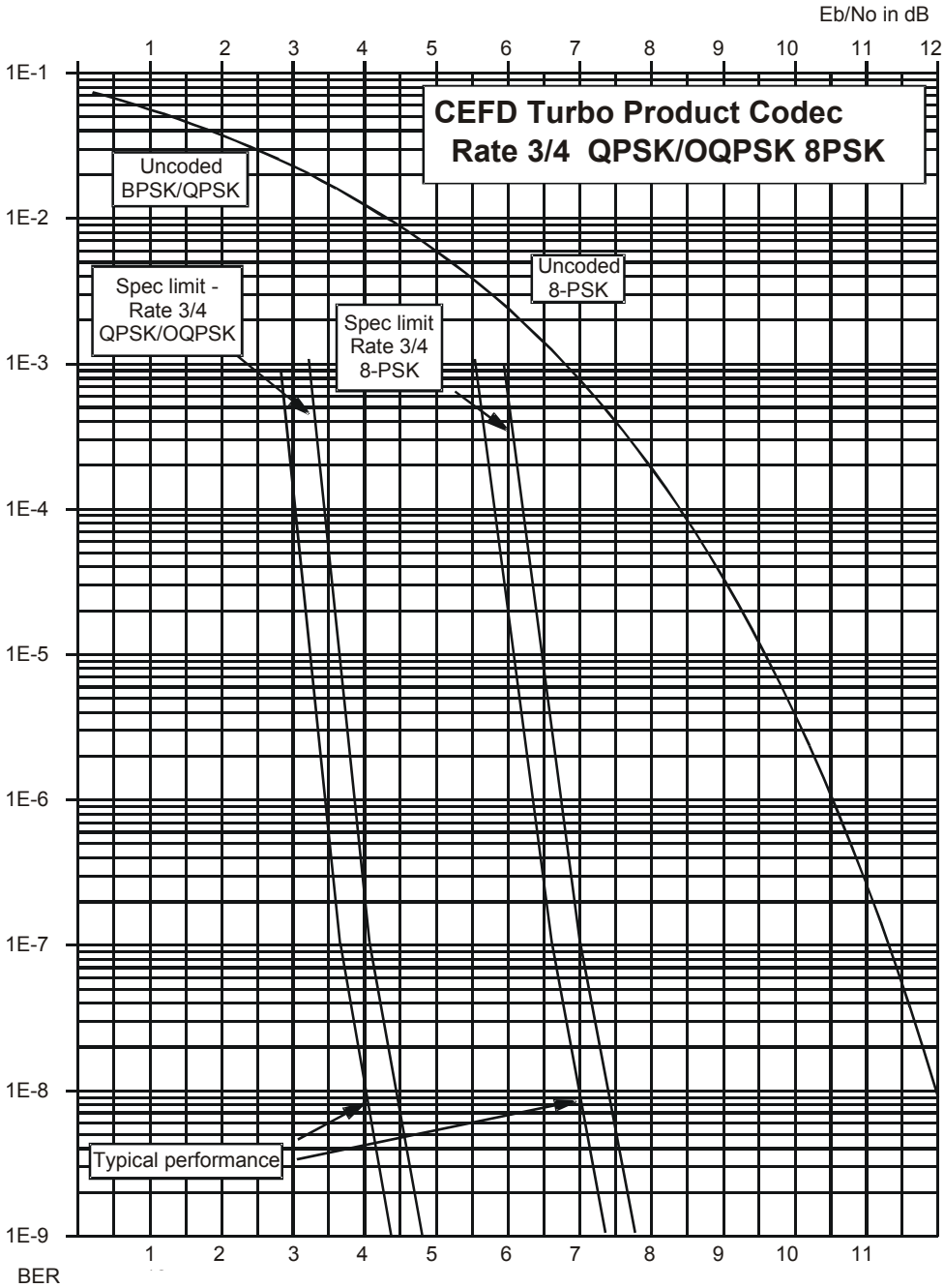


Figure A-38. Comtech EF Data Turbo Product Codec Rate 3/4 QPSK/OQPSK, and 8PSK

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Glossary

The following is a list of acronyms and abbreviations that may be found in this manual.

Acronym	Definition
Ω	Ohms
8-PSK	8-Phase Shift Keying
A	Ampere
AC	Alternating Current
ADJ	Adjust
AGC	Automatic Gain Control
AIS	Alarm Indication Signal
AM	Amplitude Modulation
ASCII	American Standard Code for Information Interchange
ASYNC	Asynchronous
AUPC	Automatic Uplink Power Control
BB	Baseband
bps	bits per second
BPSK	Binary Phase Shift Keying
C	Celsius
CLK	Clock
COM	Common
CS	Clear to Send
CTS	Clear to Send
CW	Continuous Wave
dB	Decibels
dBc	Decibels referred to carrier
dBm	Decibels referred to 1.0 milliwatt
DC	Direct Current
DCE	Data Circuit Terminating Equipment
Demod	Demodulator
DM	Data Mode
DSR	Data Signal Rate

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EIA	Electronic Industries Association
EMC	Electro-Magnetic Compatibility
ESC	Engineering Service Circuit or Engineering Service Channel
ESD	Electrostatic Discharge
EXT REF CLK	External Reference Clock
FAST	Fully Accessible System Topology
FIFO	First in/First Out
FW	Firmware
GND	Ground
Hz	Hertz (cycle per second)
I/O	Input/Output
IF	Intermediate Frequency
INV	Invert
kbps	Kilobits per second
kHz	Kilohertz (10^3 Hertz)
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
lf	Line Feed
m	mille (10^{-3})
M&C	Monitor and Control
Max	Maximum
Mbps	Megabits per second
MC	Monitor and Control
MFS	Multiframe Sync
MHz	Megahertz (10^6 Hertz)
Mod	Modulator
MOP	Modulated Output Power
MSB	Most Significant Bit
MUX	Multiplexer
n	nano (10^{-9})
N/A	Not Applicable
NC	No Connection or Normally Closed
NO	Normally Open
NRM	Normal
OQPSK	Offset Quadrature Phase Shift Keying
p	pico (10^{-12})
PCB	Printed Circuit Board
PLL	Phase-Locked Loop
PPM	Parts Per Million
PSK	Phase Shift Keying
QPSK	Quadrature Phase Shift Keying
RAM	Random Access Memory
RD	Receive Data
RF	Radio Frequency
RR	Receiver Ready
RS	Ready to Send
RT	Receive Timing
RTS	Request to Send
RX	Receive (Receiver)
RXD	Receive Data
s	Second
SCT	Serial Clock Transmit
SD	Send Data
ST	Send Timing

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SYNC	Synchronize
TT	Terminal Timing
TTL	Transistor-Transistor Logic
TX	Transmit (Transmitter)
TXCLK	Transmit Clock
TXD	Transmit Data
UB	Universal Brreakout box
US	United States
V	Volts
VAC	Volts, Alternating Current
VCO	Voltage-Controlled Oscillator
VDC	Volts, Direct Current
VIT	Viterbi
W	Watt

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METRIC CONVERSIONS

Units of Length

Unit	Centimeter	Inch	Foot	Yard	Mile	Meter	Kilometer	Millimeter
1 centimeter	—	0.3937	0.03281	0.01094	6.214×10^{-6}	0.01	—	—
1 inch	2.540	—	0.08333	0.2778	1.578×10^{-5}	0.254	—	25.4
1 foot	30.480	12.0	—	0.3333	1.893×10^{-4}	0.3048	—	—
1 yard	91.44	36.0	3.0	—	5.679×10^{-4}	0.9144	—	—
1 meter	100.0	39.37	3.281	1.094	6.214×10^{-4}	—	—	—
1 mile	1.609×10^{5}	6.336×10^{4}	5.280×10^{3}	1.760×10^{3}	—	1.609×10^{3}	1.609	—
1 mm	—	0.03937	—	—	—	—	—	—
1 kilometer	—	—	—	—	0.621	—	—	—

Temperature Conversions

Unit	° Fahrenheit	° Centigrade
32° Fahrenheit	—	0 (water freezes)
212° Fahrenheit	—	100 (water boils)
-459.6° Fahrenheit	—	273.1 (absolute 0)

Formulas
C = (F - 32) * 0.555
F = (C * 1.8) + 32

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoir.	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoir.	28.35	—	0.9115	0.0625	0.07595	0.02835
1 oz. troy	31.10	1.097	—	0.06857	0.08333	0.03110
1 lb. avoir.	453.6	16.0	14.58	—	1.215	0.4536
1 lb. Troy	373.2	13.17	12.0	0.8229	—	0.3732
1 kilogram	1.0×10^{3}	35.27	32.15	2.205	2.679	—

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