SDM-9000

Satellite Modem
Installation and Operation Manual

Part Number MN/SDM9000.IOM Revision 4

Errata A

Comtech EFData Documentation Update

Subject: Added 8PSK and 16QAM information

Date: June 6, 2000
Document: SDM-9000 Satellite Modem Installation and Operation Manual Part Number MN/SDM9000.IOM Rev. 4 dated May 5, 1997
Part Number: MN/SDM9000.EA4
Collating Instructions: Attach this page to page 1-16

Comments:

The following changes provide updated information for Section 1.4.3, Table 1-4, Figures 1-6 and 1-7. This information will be incorporated into the next revision.

Change Specifics:

1.4.3 8PSK and 16QAM (Viterbi Decoder and Reed-Solomon Codec)

The 8PSK and 16QAM specifications for the E_b/N_0 required to achieve 10^{-6} to 10^{-9} BER with the Viterbi decoder and Reed-Solomon Codec are shown in Table 1-4. Refer to Figures 1-6 (8PSK) and 1-7 (16QAM) for the BER curves with the Reed-Solomon option.

Table 1-4. 8PSK and 16QAM BER Data

Specification								
	Without IDR				With IDR			
	8PSK	8PSK	16QAM	16QAM	8PSK	8PSK	16QAM	16QAM
BER	2/3 Rate	5/6 Rate	3/4 Rate	7/8 Rate	2/3 Rate	5/6 Rate	¾ Rate	7/8 Rate
10^{-6}	6.1 dB	8.2 dB	8.3 dB	9.8 dB	6.5 dB	8.6 dB	8.7 dB	10.2 dB
10^{-7}	6.4 dB	8.5 dB	8.5 dB	10.0 dB	6.9 dB	8.9 dB	8.9 dB	10.4 dB
10^{-8}	6.6 dB	8.9 dB	8.7 dB	10.3 dB	7.1 dB	9.3 dB	9.1 dB	10.7 dB
10^{-9}	6.9 dB	9.3 dB	8.9 dB	10.5 dB	7.4 dB	9.7 dB	9.4 dB	10.9 dB
	Typical				Typical			
	8PSK	8PSK	16QAM	16QAM	8PSK	8PSK	16QAM	16QAM
BER	2/3 Rate	5/6 Rate	3/4 Rate	7/8 Rate	2/3 Rate	5/6 Rate	3/4 Rate	7/8 Rate
10^{-6}	5.6 dB	7.7 dB	7.8 dB	9.4 dB	5.9 dB	8.1 dB	8.2 dB	9.8 dB
10^{-7}	5.8 dB	7.9 dB	8.1 dB	9.7 dB	6.2 dB	8.3 dB	8.5 dB	10.1 dB
10^{-8}	6.1 dB	8.4 dB	8.3 dB	9.9 dB	6.5 dB	8.9 dB	8.7 dB	10.3 dB
10^{-9}	6.3 dB	8.7 dB	8.6 dB	10.2 dB	6.7 dB	9.1 dB	9.0 dB	10.6 dB

Note: Reed-Solomon parameters differ from open network and closed network. Open network meets IESS-308 QPSK operation, using a 4-deep interleaver. Closed networks run different Reed-Solomon parameters. A longer code word and an 8-deep interleaver is used, resulting in better performance.

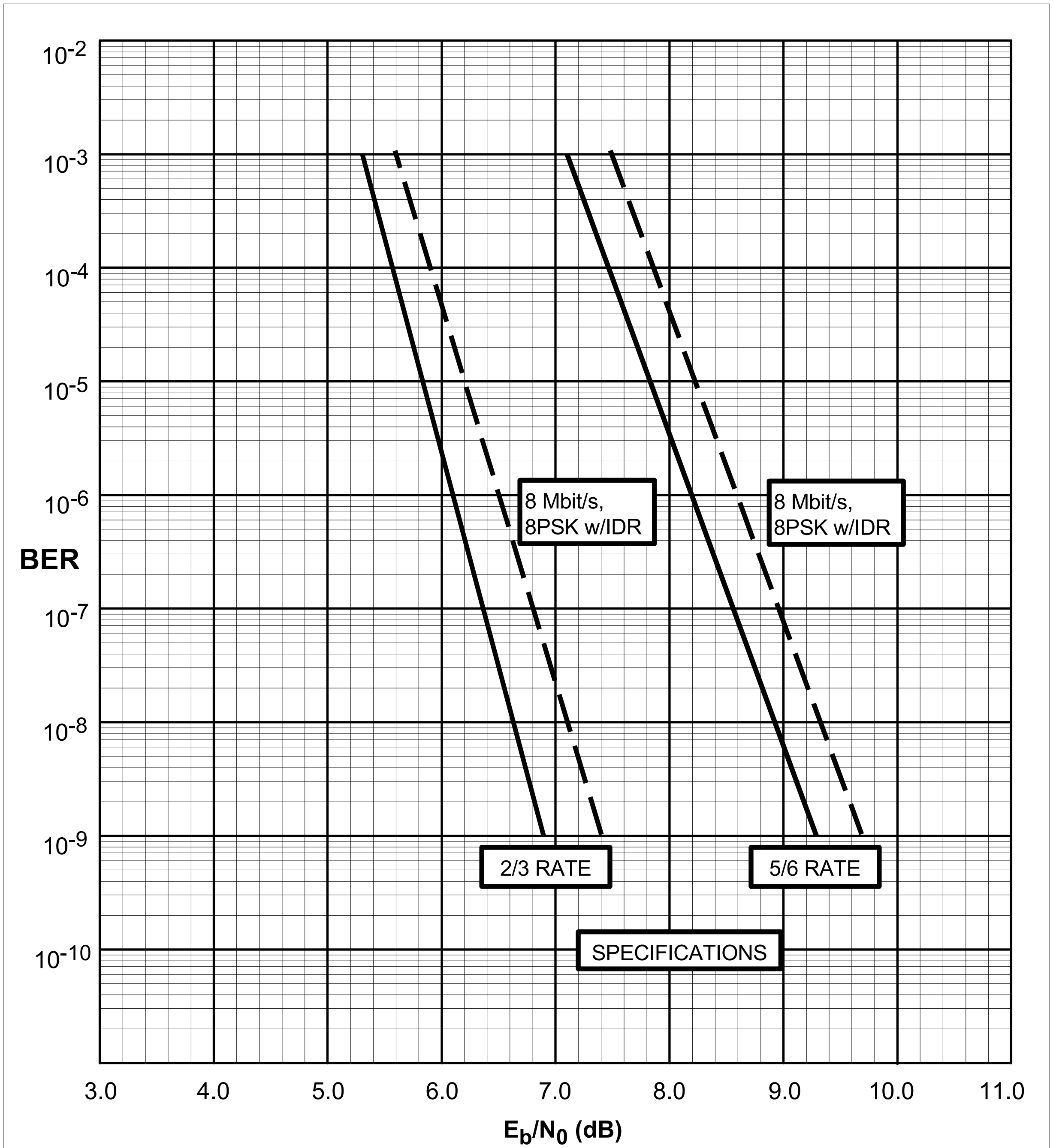

Figure 1-6. 8PSK BER Performance Curves (with Reed-Solomon)

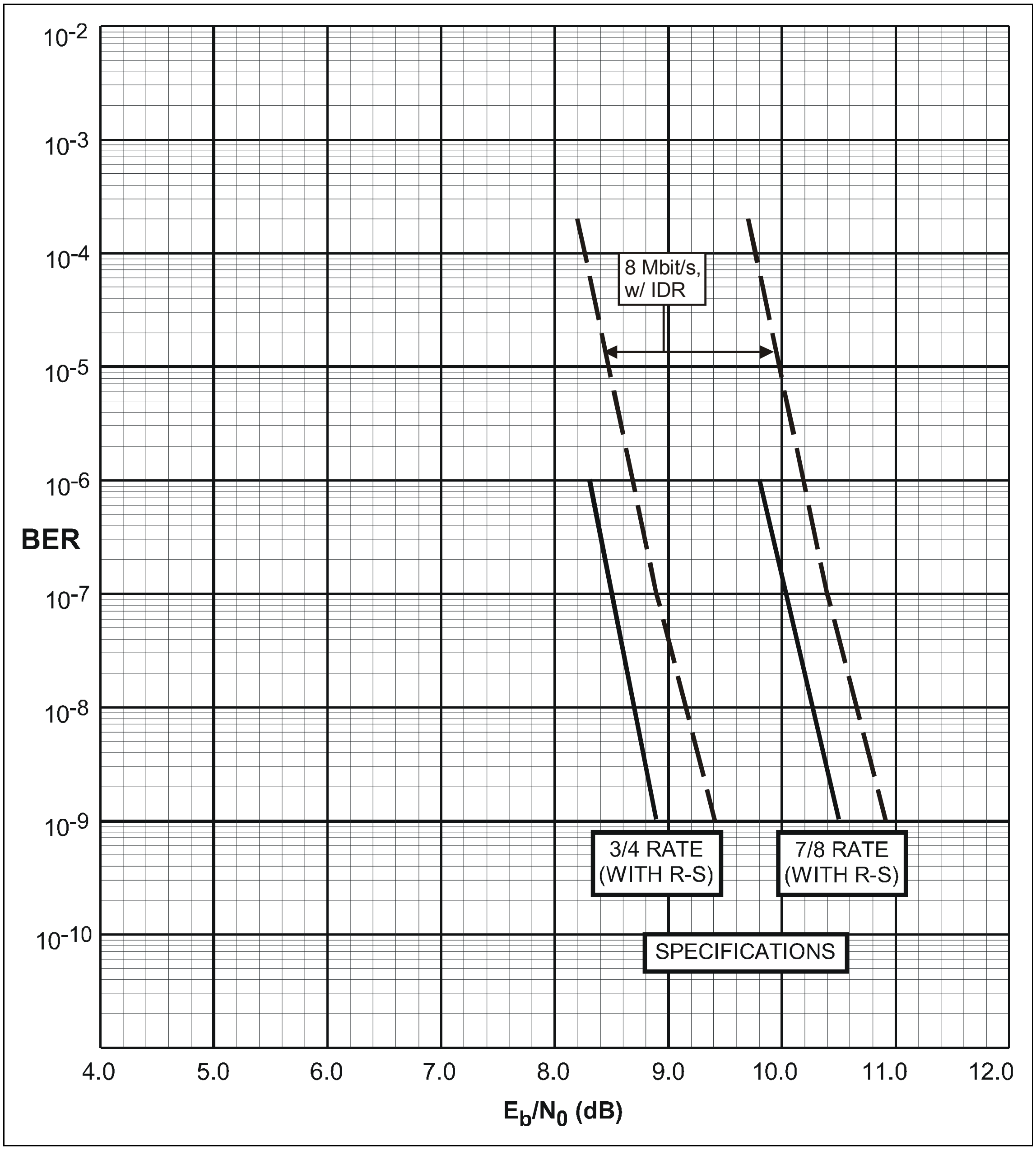

Figure 1-7. 16QAM BER Performance Curves (with Reed-Solomon)

Errata B

Comtech EFData Documentation Update

Subject:	Changes to Note in Section 2.4.10, Alarms
Date:	January 19, 2001
Document:	SDM-9000 Satellite Data Modem Installation and Operation Manual, Rev. 4, dated May 5, 1997
Part Number:	MN/SDM9000.EB4
Collating Instructions:	Attach this page to page 2-15

Comments:

The following changes provide updated information for page 2-15. This information will be incorporated into the next revision.

Change Specifics:

2.4.10 Alarms (J10)

The alarms connector is used to provide three Form C contact closures for alarm reporting, as follows:

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

The two Form C summary fault contacts currently used are:

- Transmit alarm (Alarm 2)
- Receive alarm (Alarm 3)

Refer to Chapter 4 for a discussion of alarms monitored. To obtain a system summary alarm, connect all the Form C contacts in parallel.

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

Pin #	Signal Function	Name
1		NO
2	Alarm 1	COM
3		NC
4		NO
5	Alarm 2	COM
6		NC
7		NO
8	Alarm 3	COM
9		NC

Note: A connection between the common (COM) and normally closed (NC) contacts indicates no alarm.

Errata C

Comtech EFData Documentation Update

Subject: Changes to Table 3-2 (Modulator PCB Jumper Settings)

Date: January 23, 2002
Document: SDM-9000 Satellite Modem Installation and Operation Manual, Rev. 4, dated May 5, 1997
Part Number: MN/SDM9000.EC4
Collating Instructions: Attach this page to page 3-3

Comments:

The following changes provide updated information for Table 3-2. This information will be incorporated into the next revision.

Change Specifics:

3.2 Modulator

The modulator PCB (AS/3969) is located in the top slot of the modem chassis. The jumper settings are listed in Table 3-2. Figure 3-2 shows the modulator card and the jumper locations.

Table 3-2. Modulator PCB Jumper Settings

Jumper	Position	Function
J7	1 to 2 2 to 3	Output forced ON, test mode Normal, processor control
J9 (EEPROM size select)	1 to 2 2 to 3	27C512 (64K EEPROM) 27C256 (32K EEPROM)

Note: The modulator PCB jumpers in Table 3-2 are factory set.

SDM-9000

Satellite Modem
Installation and Operation Manual

Comtech EFData is an ISO 9001
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Part Number MN/SDM9000.IOM
Revision 4
May 5, 1997

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5. Ship the product back to Comtech EFData. (Shipping charges should be prepaid.)

For more information regarding the warranty policies, see Warranty Policy, p. xiv.

Table of Contents

Figures

Tables

Overview of Changes to Previous Edition

Changes made to Rev. 3 include:

- Added metric conversion paragraph to Preface.
- Incorporated comment column to table on Page 1-3.
- Revised table reflecting SDM-9000 part numbers.
- Relocated reference to Figure 1-8 to Page 1-21.
- Rearranged Chapter 2 paragraphing as follows:
- Changed 2.5 to 2.2
- Changed 2.2 to 2.3
- Changed 2.4 to 2.5
- Added second step to Note on Page 2-3.
- Rearranged Table 2-1 to reflect a alpha/numeric sequence.
- Rearranged paragraphing to agree with Table 2-1.
- Deleted the notes following 2.4.8.1, 2.4.8.1.1, 2.4.8.2, and 2.4.8.3.
- Chapter 2.4.8 note references are to the notes listed in 2.4.8.
- Incorporated tool reference in 3.5.2.3.1, step (1)
- Incorporated tool reference in 3.5.2.3.2, step (1).
- Revised section 3.6.1 to reflect history of software versions.
- Revised table in 4.2.1.1 to agree with Figure 4-3.
- Revised Figure 4-4 to reflect to reflect Test Mode Configuration conditions.
- Revised table 4.2.1.2 to agree with Figure 4-4.
- Revised table 4.2.1.3 to agree with Figure 4-5.
- Deleted 4.2.4.1.
- Added Reed Solomon to table specified in 5.5.1.
- Added section A.3 ESC 64 kbit/s Data Option to Appendix A.
- Added metric conversion table to inside of back cover.

About this Manual

This manual provides installation and operation information for the EFData SDM-9000 satellite modem. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the SDM-9000.

Related Documents

The following documents are referenced in this manual:

- Department of Defense (DOD) MIL-STD-188-114A, "*Electrical Characteristics of Digital Interface Circuits*"
- *Comtech EFData Specification SP/3965*
- *INTELSAT Earth Station Standards (IESS) 308/309*
- *Sonnet Specifications STS-1*
- *International Telephone and Telegraph Consultative Committee (CCITT) V.35*
- *European Broadcasting Union (EBU) DVB SB 5 (94) 5*
- *EBU ETS 300 421*
- *ISO/IEC 13818*
- *Comtech EFData B141-1 Breakout Panel Installation and Operation Manual*

Conventions and References

Cautions and Warnings

CAUTION

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

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

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 English to Metric conversions.

Recommended Standard Designations

Recommended Standard (RS) Designations have been superseded by the new designation of the Electronic Industries Association (EIA). References to the old designations are shown only when depicting actual text displayed on the screen of the unit (RS-232, RS-485, etc.). All other references in the manual will be shown with the EIA designations (EIA-232, EIA-485, etc.) only.

Military Standards

References to “MIL-STD-188” apply to the 114A series (i.e., MIL-STD-188-114A), which provides electrical and functional characteristics of the unbalanced and balanced voltage digital interface circuits applicable to both long haul and tactical communications. Specifically, these references apply to the MIL-STD-188-114A electrical characteristics for a balanced voltage digital interface circuit, Type 1 generator, for the full range of data rates. For more information, refer to the Department of Defense (DOD) MIL-STD-188-114A, “*Electrical Characteristics of Digital Interface Circuits*.”

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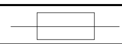
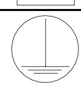
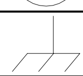
European EMC Directive

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 double-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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The foregoing warranty shall not apply to defects resulting from improper installation or maintenance, abuse, unauthorized modification, or operation outside of environmental specifications for the product, or, for damages that occur due to improper repackaging of equipment for return to Comtech EFData.

No other warranty is expressed or implied. Comtech EFData specifically disclaims the implied warranties of merchantability and fitness for particular purpose.

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Disclaimer

Comtech EFData has reviewed this manual thoroughly in order that it will be an easy-to-use guide to your equipment. All statements, technical information, and recommendations in this manual and in any guides or related documents are believed reliable, but the accuracy and completeness thereof are not guaranteed or warranted, and they are not intended to be, nor should they be understood to be, representations or warranties concerning the products described. Further, Comtech EFData reserves the right to make changes in the specifications of the products described in this manual at any time without notice and without obligation to notify any person of such changes.

If you have any questions regarding your equipment or the information in this manual, please contact the Comtech EFData Customer Support Department.

Chapter 1. INTRODUCTION

This chapter describes the options and provides an overview, description, and specifications for the SDM-9000 satellite modem, referred to in this manual as “the modem” (Figure 1-1).

Figure 1-1. SDM-9000

1.1 Overview

The modem is a high performance, full-duplex, digital-vector modulator/demodulator that meets the open network requirements of the IESS-308 specifications for Intermediate Data Rate (IDR). The modem can also be used for any closed network and satellite communication system applications. Refer to Section 1.1.3 for additional applications data.

Module types that are compatible with each application are as follows:

Configuration	Interface Type	FEC Option	Options
70/140 MHz Duplex (AC)	MIL188/144 with Buffer	QPSK	50Ω
70/140 MHz TX (AC)	MIL188/144 with ESC	8PSSK/16QAM	H/S 10^{-7}
70/140 MHz RX (AC)	MIL188/144 with Buffer /RS		Digital Video Broadcast (DVB)
70/140 MHz Duplex (DC)	MIL188/144 with ESC/RS		H/S 10^{-7} with DVB
70/140 MHz TX (DC)	ECL with Buffer		
70/140 MHz RX (DC)	ECL with ESC		
	ECL with Buffer/RS		
	PECL with Buffer		
	PECL with ESC		
	PECL with Buffer/RS		
	PECL with ESC/RS		
	G.703 with Buffer		
	G.703 with ESC		
	G.703 Buffer/RS		
	G.703 with ESC/RS		
	G.703 with ESC/64 kbit/s		
	G.703 with ESC/64 kbit/s /RS		

Notes:
1. 75Ω, QPSK, and +5 dBm output are standard with the SDM-9000.
2. The standard Reed-Solomon is in accordance with IESS-308 (IDR).

The modem operates with IF converter equipment operating within a 50 to 180 MHz band. An internal channel unit, conforming to the IESS-308 specification, provides overhead designated for Engineering Service Circuits (ESC).

The modem contains:

- Built-in scramblers/descramblers
- Differential encoder/decoder
- Transmit and receive frequency synthesizers
- Multi–rate Forward Error Correction (FEC) convolutional encoder and Viterbi decoder

The modem provides high performance with:

- Narrow occupied bandwidth
- Automatic signal acquisition
- High flexibility
- Extensive online monitoring circuits

The modem interfaces between Single Channel Per Carrier (SCPC) fixed-rate terminal equipment that operates within the following specifications:

- Data rate of 6.0 to 51.84 Mbit/s
- Symbol rate of 1.7 to 37.5 Ms/s
- Configured to add overhead and framing to the data

The 51.84 Mbit/s data rate is defined by STS-1 (Sonnet specifications).

1.1.1 Nyquist Filter Printed Circuit Boards

The modem features include a Nyquist filter Printed Circuit Board (PCB) for enabling the user to change data rates at the modulator or demodulator. The modem supports up to four channels at the following data rate and modulation type combinations:

Data Rates	6.0 to 51.84 Mbit/s	Comments
Modulation Types	QPSK 1/2 Rate	
	QPSK 3/4 Rate	
	QPSK 7/8 Rate	
	8PSK 2/3 Rate	Optional
	8PSK 5/6 Rate	Optional
	16QAM 3/4 Rate	Optional
	16QAM 7/8 Rate	Optional

Data rate information is automatically recovered from the filter module upon system power-up or initialization. The installed interface, modulator, and demodulator must be compatible with the installed filters for proper modem operation. The filters can be installed in the factory or field.

Refer to Chapter 3 for information about modem configuration.

1.1.2 Description

The modem is a complete, self-contained unit in a standard 2 unit (2U) 19" rack-mountable enclosure weighing approximately 19 lbs. The unit is of modular construction consisting of five PCB assemblies:

- Modulator
- Demodulator
- Interface
- Display/Monitor & Control (M&C) (front panel)
- Backplane (rear panel)

The backplane PCB is mounted on the chassis assembly and contains receptacles for three plug-in PCBs:

- Modulator
- Demodulator
- Interface

Test points are located on the front edges of the three PCBs. Figure 1-2 shows the front view of the modem (without the front panel).

All M&C functions and indicators for operation of the modem are located on the display/M&C. The chassis also contains a fan (on the rear panel) and a power supply. Refer to Figure 1-3 for a system block diagram.

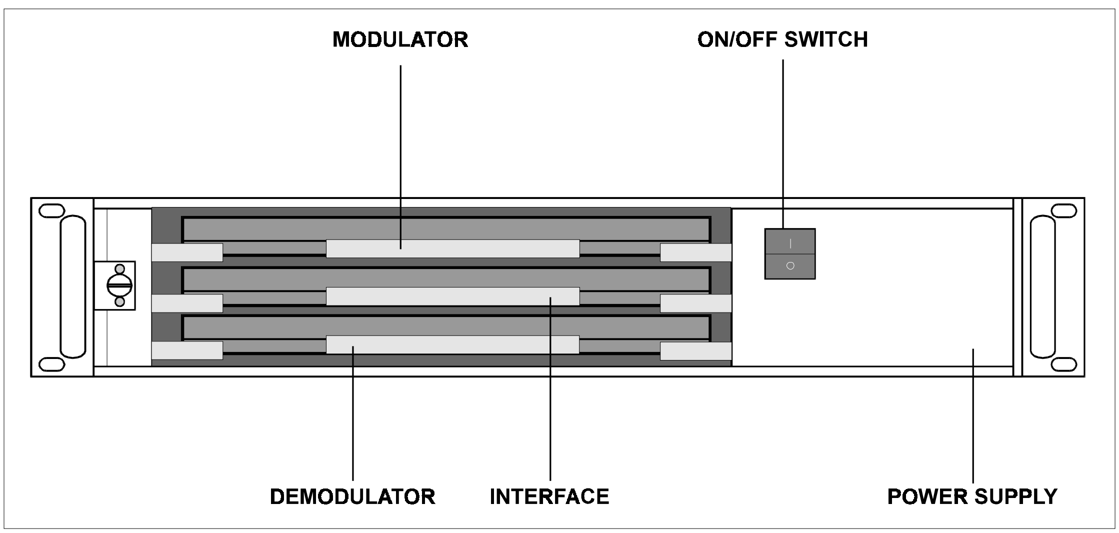

Figure 1-2. Modular Construction

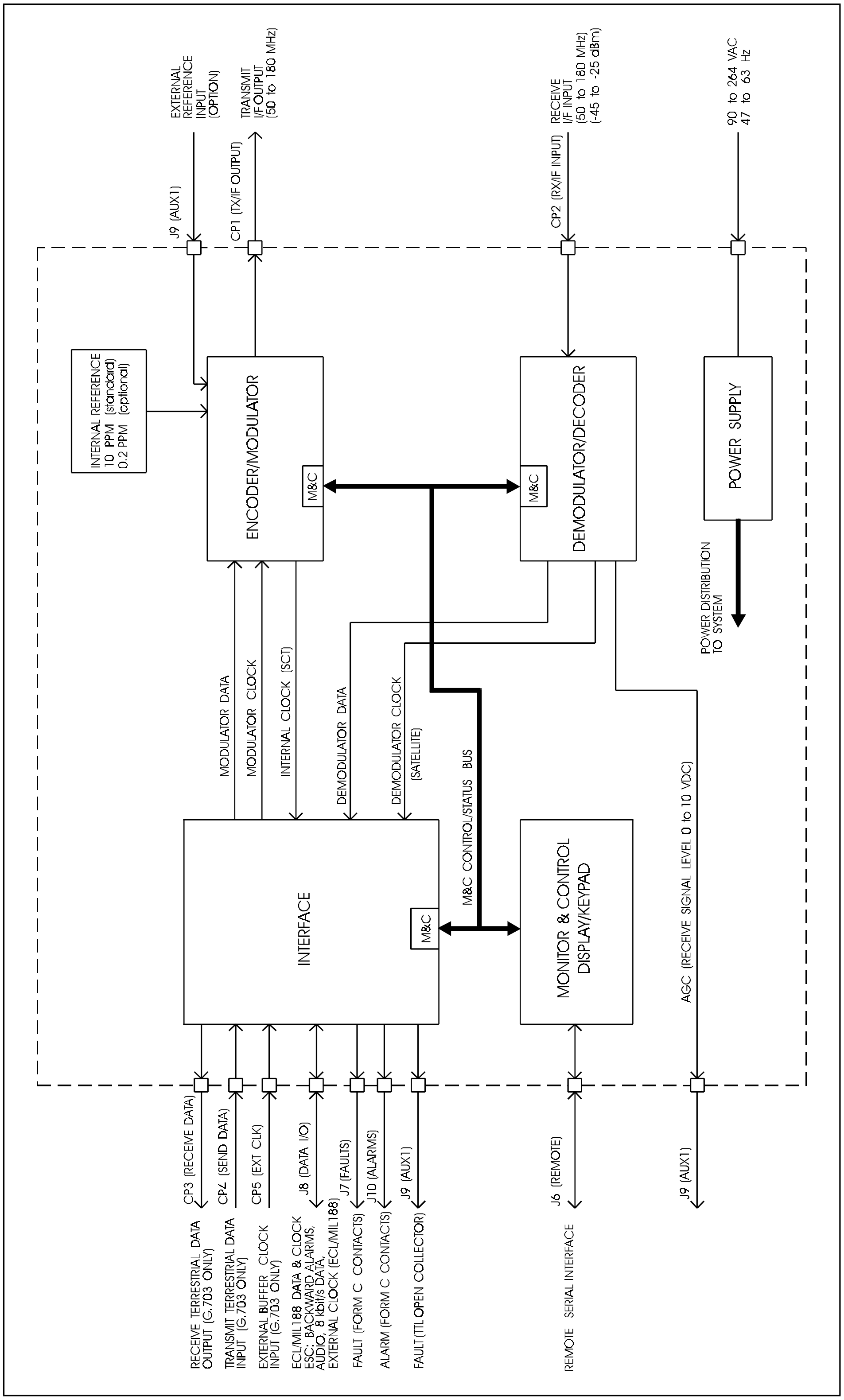

Figure 1-3. SDM-9000 Block Diagram

1.1.3 Options

1.1.3.1 Reed-Solomon Codec

The Reed-Solomon Codec works in conjunction with the Viterbi decoder, and includes additional framing, interleaving, and Codec.

This option can be factory or user installed. Refer to the following table for modem compatibility requirements.

Interface PCB	Type 2 or 3 (or greater) AS/3971-2 AS/3971-3
Display/M&C PCB	AS/2305 Rev. C4 (or greater)
Modulator PCB	AS/3969
Demodulator PCB	AS/3970
Reed-Solomon Codec PCB	AS/4080
Reed-Solomon Daughter Board (DVB Standard)	AS/4524

Refer to Appendix A for more information.

1.1.3.2 8PSK/16QAM

The 8PSK modulation type is a PSK encoding method for providing a modulated carrier at 6.0 to 51.84 Mbit/s by pragmatic trellis encoding at 2/3 and 5/6 code rates. This option is installed at the factory.

The 16QAM is an encoding method for providing a modulated carrier at 6.0 to 51.84 Mbit/s in 3/4 and 7/8 rates.

Interface PCB	Type 2 and 3 (or greater) AS/3971-2 AS/3971-3
Display/M&C PCB	AS/2305 Rev. C4 (or greater)
Modulator PCB	AS/3969-1, -2, -5, and -6
Demodulator PCB	AS/3970-1 and -2
Reed-Solomon Codec PCB	AS/4080

Note: The Reed-Solomon option is required for 8PSK/16QAM operation.

1.1.3.3 Direct Broadcast Satellite

As implemented in the SDM-9000, Direct Broadcast Satellite (DBS) mode supports data rates up to 44.736 Mbit/s using a single FEC channel. Single channel implementation differs significantly from the International Telecommunications Satellite Organisation (INTELSAT) specifications (for carriers greater than 10 Mbit/s) for communicating the data across three channels.

Refer to Appendix A for more information.

1.2 Modem Assemblies

The following table reflects the possible configurations available for the SDM-9000:

Configuration	Type		Chassis P/N	Mod	Demod.	Interface Type
70/140 MHz	Duplex	AC	3966-1	X		QPSK
70/140 MHz	TX	AC	3966-1	X		
70/140 MHz	RX	AC	3966-1		X	8PSK/ 16QAM
70/140 MHz	Duplex	DC	3966-2			
70/140 MHz	TX	DC	3966-2			
70/140 MHz	RX	DC	3966-2			

The current main assemblies, options, and alternates for the modem are listed in the table below:

Part Number	Description	Comments
AS/3965	Assy, Top SDM-9000	
PL/3966-1	Assy, Chassis, AC	CE Mark
PL/3966-2	Assy, Chassis, DC	
PL/3978	Motherboard	
PL/2305	Display/Monitor & Control	No FW/ included
PL/4124-1	Filter, Nyquist TX	
PL/4124-2	Filter, Nyquist RX	
PL/4109	Supply, Power AC	Alternate
PL/4110	Supply, Power AC	Preferred

The following table outlines the options available for a specific SDM-9000 configuration:

Output	Oscillator	Data Format	Mod P/N	RF Mod P/N	Demod P/N	RF Demod P/N
50Ω	Standard	QPSK 8PSK 16QAM	3969-1	3995-33	3970-1	4401-31
75Ω	Standard	QPSK 8PSK 16QAM	3969-2	3995-34	3970-2	4401-32
50Ω	Standard	QPSK	3969-3	3995-33	3970-3	4401-31
75Ω	Standard	QPSK	3969-4	3995-34	3970-4	4401-32
50Ω	HI Stability	QPSK 8PSK 16QAM	3969-5	3995-37	3970-1	4401-31
75Ω	HI Stability	QPSK 8PSK 16QAM	3969-6	3995-38	3970-2	4401-32
50Ω	HI Stability	QPSK	3969-7	3995-37	3970-3	4401-31
75Ω	HI Stability	QPSK	3969-8	3995-38	3970-4	4401-32

The following table reflects the relationship of the interface card (MIL-STD-188) with Reed-Solomon:

Condition	Interface Card (MIL-STD-188) P/N	Reed-Solomon (IDR STD) P/N	Reed Solomon (DVB STD) P/N
Base	4477-13		
Buffer	4477-23		
Buffer with ESC	4477-33		
Buffer with Reed Solomon	4477-23	4080	4524
ESC with Reed-Solomon	4477-33	4080	4524

The following table reflects the relationship of the interface card (ECL) with Reed-Solomon:

Condition	ECL P/N	Reed Solomon (IDR STD) P/N	Reed Solomon (DVB STD) P/N
Base	4477-11		
Buffer	4477-21		
ESC	4477-31		
Buffer with Reed Solomon	4477-21	4080	4524
ESC with Reed-Solomon	4477-31	4080	4524

The following table reflects the relationship of the interface card (G.703) with Reed-Solomon:

Condition	G.703 P/N	Reed Solomon (IDR STD) P/N	Reed Solomon (DVB STD) P/N
Base	3971-1		
Buffer	3971-2		
ESC	3971-3		
Buffer with Reed Solomon	3971-2	4080	4524
ESC with Reed-Solomon	3971-3	4080	4524
Without Buffer	5618-1		
Buffer, 8 Mbit/s	5618-2	4080	4524
ESC, 64kbit/s, 8 Mbit/s	5618-3	4080	4524

1.3 Modem Specifications

Table 1-1 lists the operating specifications of the modem.

Table 1-1. SDM-9000 Specifications

General Specifications	
Operating Frequency Range	50 to 180 MHz, synthesized in 2.5 kHz steps
Modulation Types	• QPSK at 1/2, 3/4, and 7/8 rates • 8PSK trellis at 2/3 and 5/6 rates (optional) • 16QAM at 3/4 and 7/8 rates (optional)
Operating Channel Spacing	Less than 0.5 dB degradation operating with 2 adjacent like channels, each 10 dB higher at 1.3 times the symbol rate
BER	See Tables 1-2 through 1-4
Baseband Interface: MIL-STD-188 ECL G.703	 6 to 13 Mbit/s 6 to 51.84 Mbit/s 8.448 Mbit/s 32.064 Mbit/s 34.368 Mbit/s 44.736 Mbit/s 51.840 Mbit/s
Elastic Buffer	2 to 32 ms, selectable from front panel
Digital Data Rate	6.0 to 51.84 Mbit/s, in 1 bit steps
Scrambling/Descrambling Types	• V.35 (per CCITT V.35) • IDR (per IESS-308) • EFD (SDM-450 compatible)
Forward Error Correction: Viterbi K=7 Reed-Solomon Pragmatic Trellis	Rates: 1/2, 3/4, 7/8 Optional 2/3 and 5/6
M&C	Front panel display (16 character by 2 rows)
Filter Mask Types	INTELSAT
ESC	IDR or None, field selectable
Loopback Modes	• Baseband (near end) • Interface (near end and far end) • IF/RF
Diagnostic Features	• IF/RF loopbacks • Baseband/Interface loopbacks • Fault monitoring (includes current/stored faults) • BER monitoring • Input IF power monitoring • Buffer fill status monitoring • Remote control via serial port
Prime Power	90 to 264 VAC, 47 to 63 Hz, 200W maximum, fused at 2A 38 to 64 VDC
Physical	
Size Weight	3.5” H x 19.0” W x 20.0” D (2 RU) (see Figure 2-1) 19 lbs. (approximate)

Environmental	
Temperature Range Humidity	0 to 50°C 0 to 95%, noncondensing
Additional Modulator Specifications	
Output Power	-20 to +5 dBm, adjustable in 0.1 dB steps Accuracy ± 0.5 dB
Output Spurious and Harmonics	-55 dBc
Output Impedance	75Ω (50Ω optional)
Output Return Loss	> 18 dB
Output Frequency Stability	± 10 PPM (± 0.2 PPM with high stability option)
Internal Data Clock Stability	± 10 PPM internal oscillator ± 0.2 PPM with high stability option
Additional Demodulator Specifications	
Input Power (Desired Carrier)	-45 to -25 dBm
Input Impedance	75Ω (50Ω optional)
Input Return Loss	> 18 dB
Carrier Acquisition Range	± 60 kHz maximum
Clock Acquisition Range	± 100 PPM
Remote Control Specifications	
Serial Interface	RS-232-C or RS-485
Baud Rate	110 to 19200 bit/s
Functions Controlled	• Transmit/Receive frequency • Transmit power • Transmitter on/off • Data rate/modulation • RF/IF loopback • Baseband/Interface loopbacks • Scrambler/Descrambler types • Scrambler/Descrambler on/off • Buffer clock TX/RX/INT/EXT • Receive clock normal/invert • Differential encoding and decoding • Transmit and receive overhead type • IDR backward alarm control on/off • Reed-Solomon on/off • Mod and demod spectrum norm/invert • Sweep width range • Rev emulation current/functional
Signals Monitored	• Raw error rate • Corrected BER • Receive E_b/N_0 • Receive signal level • Receive carrier detect • Power supply voltages • Fault status • Current sweep value • 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 reserved for global addressing

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

1.4 BER Performance Specifications

The bit energy-to-noise ratios (E_b/N_0) required to achieve 10^{-3} to 10^{-10} Bit Error Rates (BERs) are listed in Tables 1-2 through 1-4. The BER performance curves are shown in the following figures:

Figure	Modulation
1-4	QPSK
1-5	QPSK (with Reed-Solomon)
1-6	8PSK (with Reed-Solomon)
1-7	16QAM (with Reed-Solomon)

1.4.1 Viterbi Decoder BER (QPSK)

The Viterbi specifications for the E_b/N_0 required to achieve 10^{-3} to 10^{-8} BER for different coding configurations are shown in Table 1-2. All values are for operation in QPSK mode.

Performance measurements are 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 1-2. Viterbi Decoder BER Data

Specification			
BER	**1/2 Rate**	**3/4 Rate**	**7/8 Rate**
10^{-3}	4.2 dB	5.2 dB	6.4 dB
10^{-4}	4.8 dB	6.0 dB	7.2 dB
10^{-5}	5.4 dB	6.7 dB	7.9 dB
10^{-6}	6.0 dB	7.5 dB	8.6 dB
10^{-7}	6.6 dB	8.2 dB	9.2 dB
10^{-8}	7.2 dB	8.8 dB	9.9 dB
Typical			
BER	**1/2 Rate**	**3/4 Rate**	**7/8 Rate**
10^{-3}	3.8 dB	4.8 dB	6.0 dB
10^{-4}	4.2 dB	5.5 dB	6.6 dB
10^{-5}	4.9 dB	6.1 dB	7.3 dB
10^{-6}	5.5 dB	6.7 dB	8.0 dB
10^{-7}	6.1 dB	7.6 dB	8.6 dB
10^{-8}	6.7 dB	8.2 dB	9.3 dB

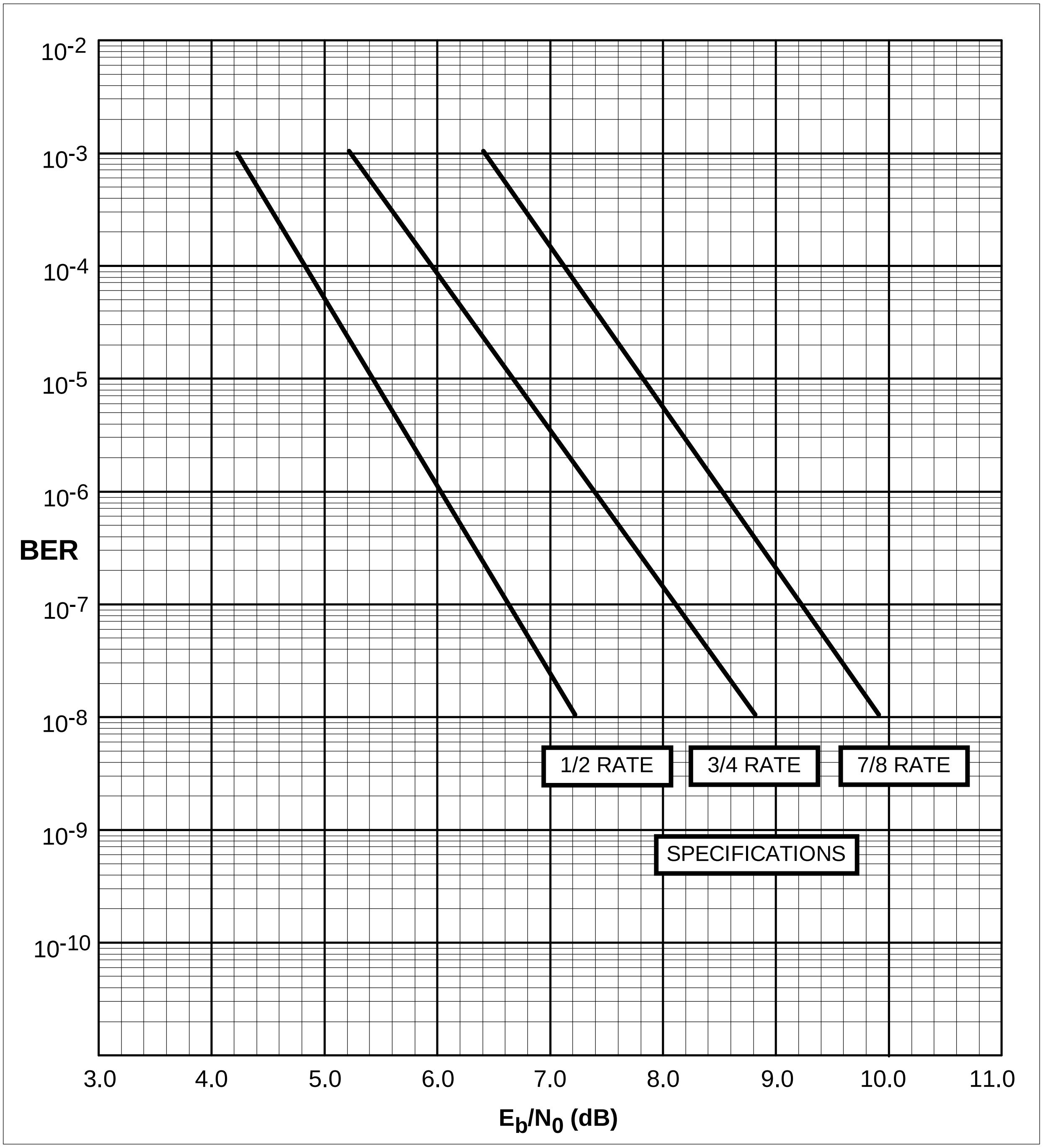

Figure 1-4. Viterbi BER Performance Curves (QPSK)

1.4.2 Reed-Solomon Codec BER (QPSK)

The Reed-Solomon specifications for the E_b/N_0 required to achieve 10^{-6} to 10^{-10} BER for different configurations are shown in Table 1-3. All values are for QPSK mode operation. Refer to Figure 1-5 for the Reed-Solomon BER curves.

Table 1-3. Reed-Solomon BER Data

Specification			
BER	**1/2 Rate**	**3/4 Rate**	**7/8 Rate**
10^{-6}	4.1 dB	5.6 dB	6.7 dB
10^{-7}	4.2 dB	5.8 dB	6.9 dB
10^{-8}	4.4 dB	6.0 dB	7.1 dB
10^{-10}	4.7 dB	6.4 dB	7.5 dB
Typical			
BER	**1/2 Rate**	**3/4 Rate**	**7/8 Rate**
10^{-6}	3.5 dB	5.0 dB	6.1 dB
10^{-7}	3.6 dB	5.2 dB	6.3 dB
10^{-8}	3.8 dB	5.4 dB	6.5 dB
10^{-10}	4.1 dB	5.8 dB	6.9 dB

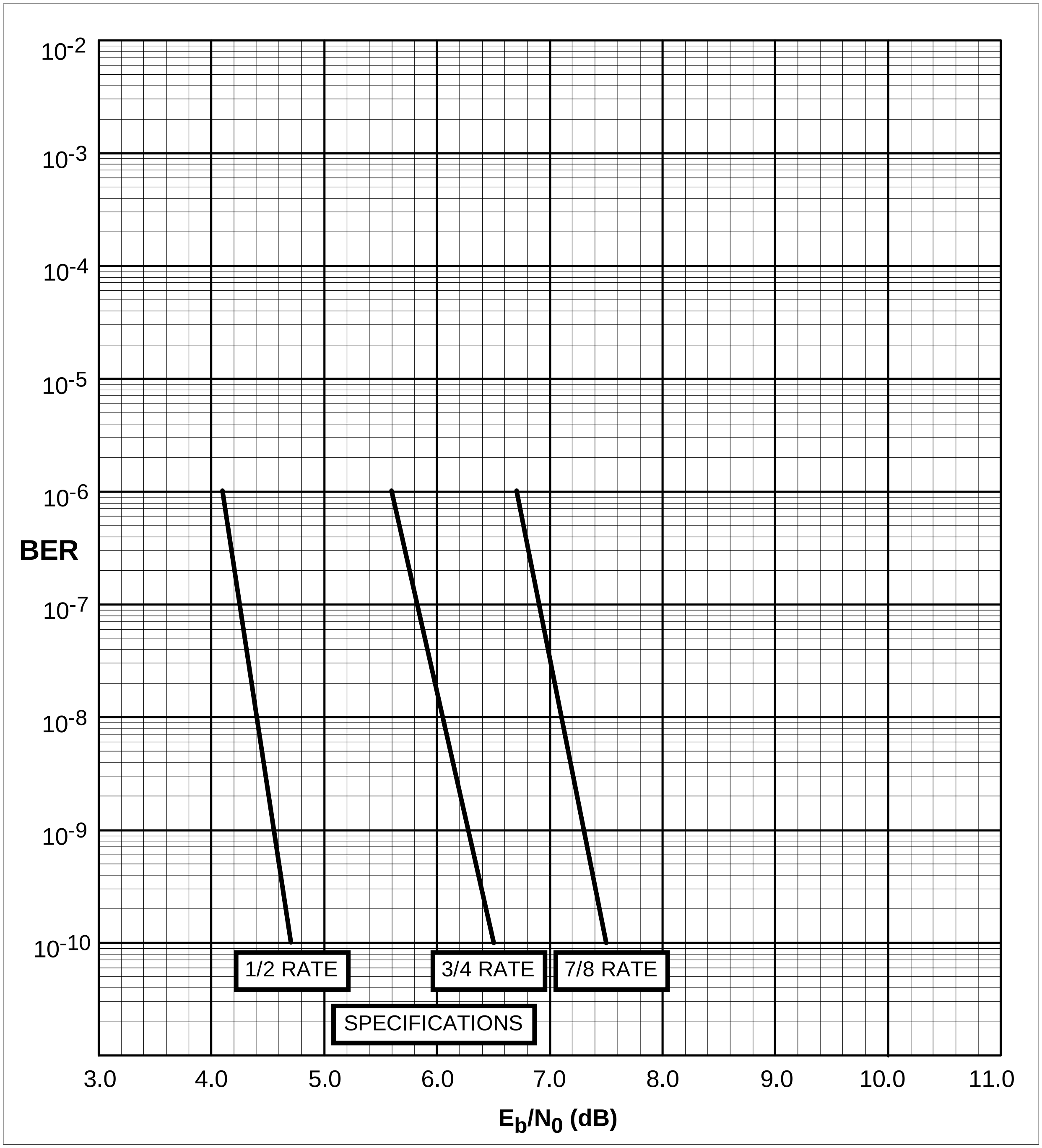

Figure 1-5. Reed-Solomon BER Performance Curves (QPSK)

1.4.3 8PSK and 16QAM (Viterbi Decoder and Reed-Solomon Codec)

The 8PSK and 16QAM specifications for the E_b/N_0 required to achieve 10^{-6} to 10^{-9} BER with the Viterbi decoder and Reed-Solomon Codec are shown in Table 1-4. Refer to Figures 1-6 (8PSK) and 1-7 (16QAM) for the BER curves with the Reed-Solomon option.

Table 1-4. 8PSK and 16QAM BER Data

Specification				
	8PSK	8PSK	16QAM	16QAM
BER	2/3 Rate	5/6 Rate	3/4 Rate	7/8 Rate
10^{-6}	6.1 dB	8.2 dB	8.3 dB	9.8 dB
10^{-7}	6.4 dB	8.5 dB	8.5 dB	10.0 dB
10^{-8}	6.6 dB	8.9 dB	8.7 dB	10.3 dB
10^{-9}	6.9 dB	9.3 dB	8.9 dB	10.5 dB
Typical				
	8PSK	8PSK	16QAM	16QAM
BER	2/3 Rate	5/6 Rate	3/4 Rate	7/8 Rate
10^{-6}	5.6 dB	7.7 dB	7.8 dB	9.4 dB
10^{-7}	5.8 dB	7.9 dB	8.1 dB	9.7 dB
10^{-8}	6.1 dB	8.4 dB	8.3 dB	9.9 dB
10^{-9}	6.3 dB	8.7 dB	8.6 dB	10.2 dB

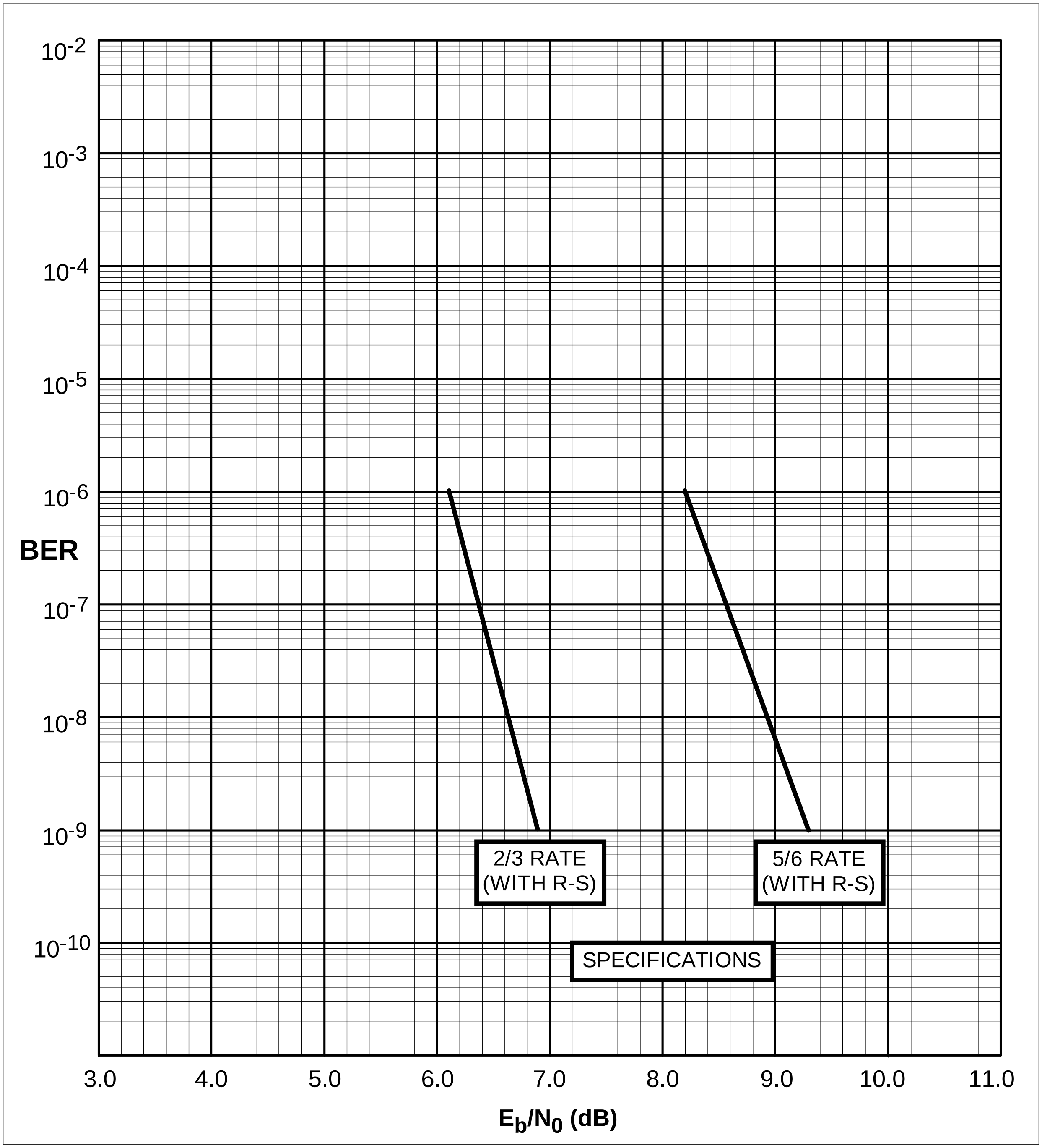

Figure 1-6. 8PSK BER Performance Curves (with Reed-Solomon)

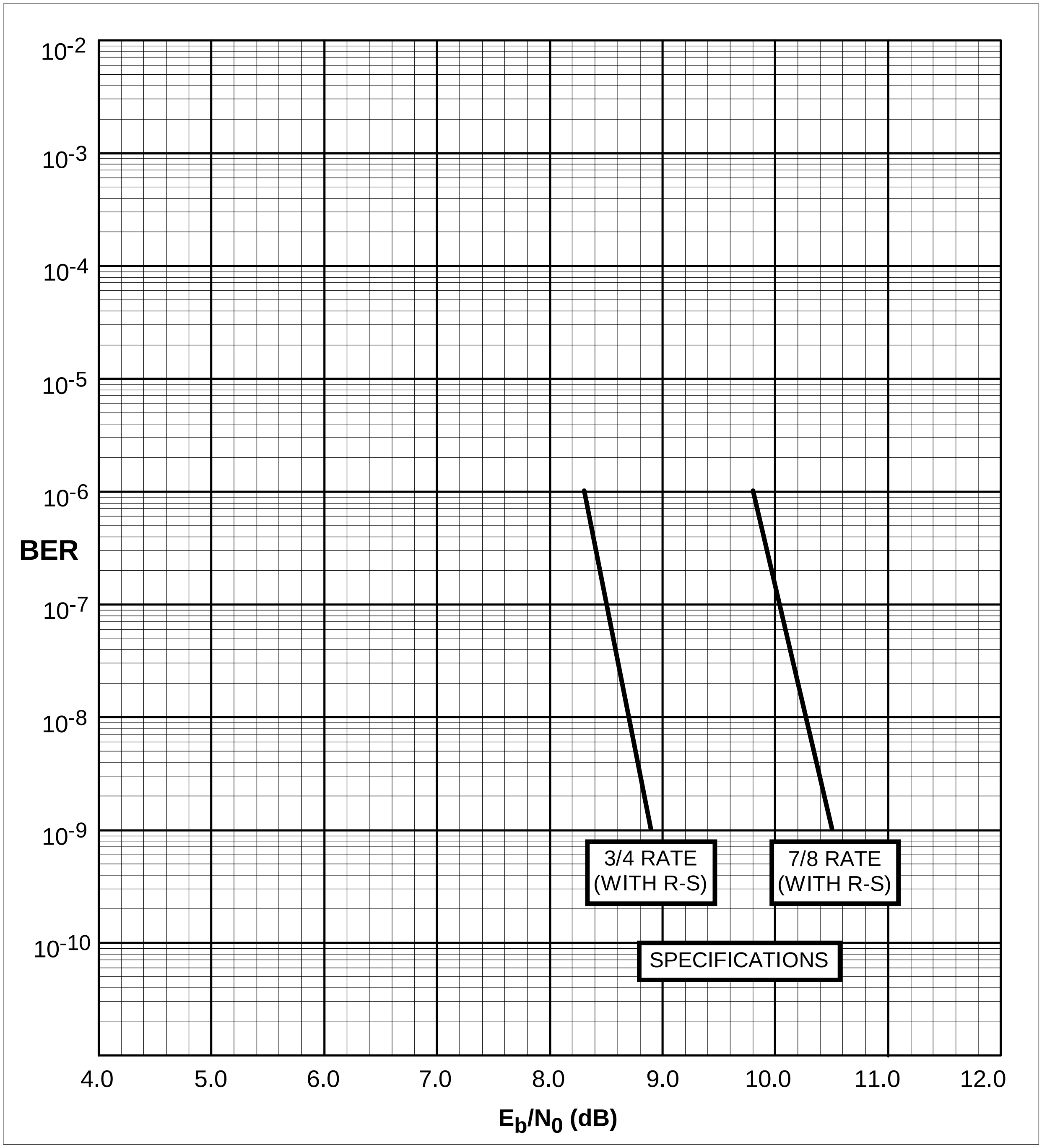

Figure 1-7. 16QAM BER Performance Curves (with Reed-Solomon)

A typical spectral occupancy curve is shown in Figure 1-8.

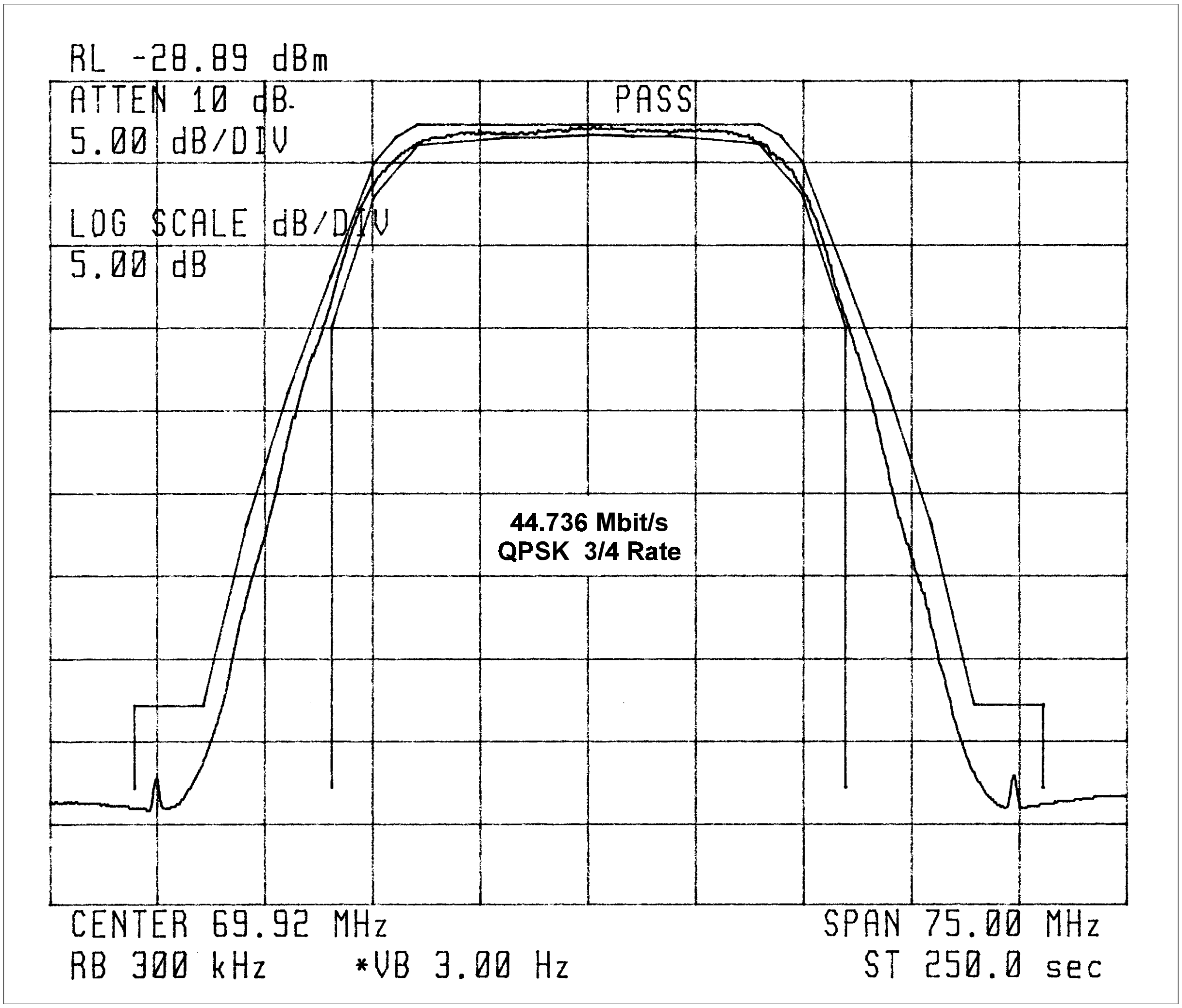

Figure 1-8. SDM-9000 Typical Spectral Occupancy

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Chapter 2. INSTALLATION

This chapter includes instructions for unpacking and installing the modem, a description of the external connections, and backward alarm information.

This 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 preformed, reusable cardboard cartons containing foam spacing for maximum shipping protection. The circuit cards are packed in separate cardboard caddypacks (also packaged within the cardboard carton).

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

To remove the modem:

1. Cut the tape at the top of the carton (indicated by OPEN THIS END).
2. Remove the cardboard/foam spacer covering the modem and caddypacks.
3. Remove the modem, caddypacks, manual, and power cord from 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 complete.
7. Refer to Section 2.2 for further system installation instructions.

2.2 System Options

The standard SDM-9000 with all PCB assemblies installed (Chapter 1) is a full-duplex QPSK satellite modem. The system can also be configured for TX-only or RX-only operation.

1. For a TX-only system, the demodulator PCB (AS/3970) should be removed.
   - Enter the System Utility menu on the front panel and select Operation mode.
   - Enter the menu and select TX-only. This will mask the RX faults and stored faults in the Faults menu.
2. For RX-only system, the modulator PCB (AS/3969) should be removed.
   - Enter the System Utility menu on the front panel and select Operation mode.
   - Enter the menu and select RX-only. This will mask the TX faults and stored faults in the Faults menu.

2.3 System Installation

Install the modem as follows:

1. Mount the modem chassis in the assigned position of the equipment rack. It is recommended that the modem be supported by a rack-mounted shelf, or the two rear rack-mount brackets supplied with the unit.

   Note: For a custom rack installation, refer to the chassis dimensional drawing in Figure 2-1.

2. Connect the cables to the proper locations on the rear panel. Refer to Section 2.4 for connector pinouts, placement, and functions.

3. Open the front panel and install the three main PCB assemblies (Figure 1-2) as follows:

   a. Install the modulator PCB (AS/3969) in the top slot.

   b. Install the interface PCB (AS/3971, AS/4477, or AS/5618) in the middle slot.

   c. Install the demodulator PCB (AS/3970) in the bottom slot.

   Note: The cards are keyed, and will only fit in the proper chassis slot. Verify the PCBs are properly seated.

4. Before turning on the power switch, verify all interface jumper settings are in their proper positions (Chapter 3), and become familiar with front panel operation (Chapter 4).

5. Turn on the power switch (located inside the front panel).

6. Check for the proper TX output signal level and spectrum.

7. Check for the proper RX input signal level and spectrum.

8. If there is any installation problem, refer to Chapter 6 for troubleshooting assistance.

Note: All dimensions are listed in inches.

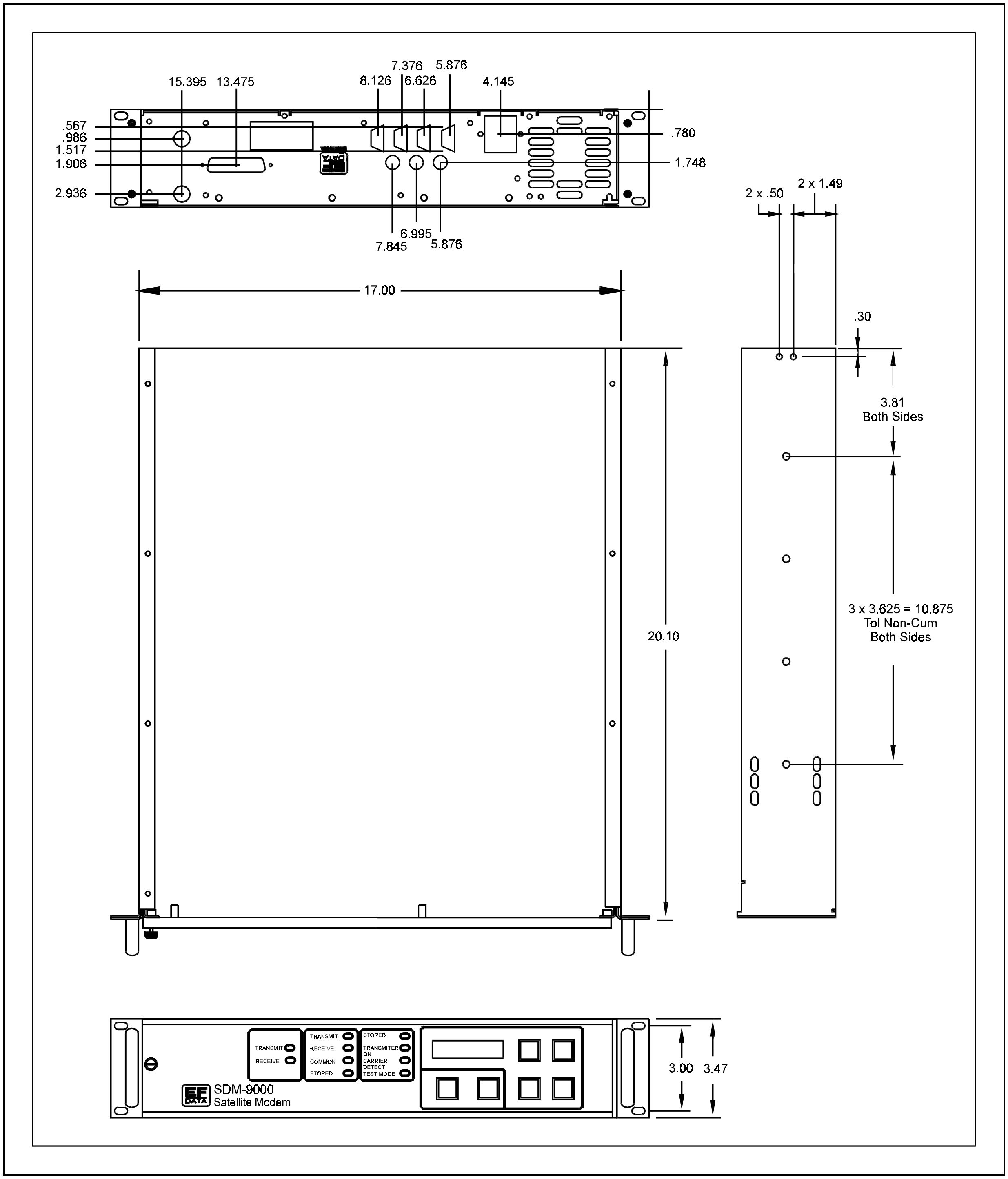


Figure 2-1. SDM-9000 Dimensional Drawing

2.4 External Connectors

When a breakout panel is not required, the external modem connections between the modem and other equipment are made through several rear panel connectors. These connectors are shown in Figure 2-2, and their locations are listed in Table 2-1. The connectors are described in the following paragraphs.

When a B141-1 breakout panel is required, refer to the *B141-1 Breakout Panel Installation and Operation Manual* for connector information.

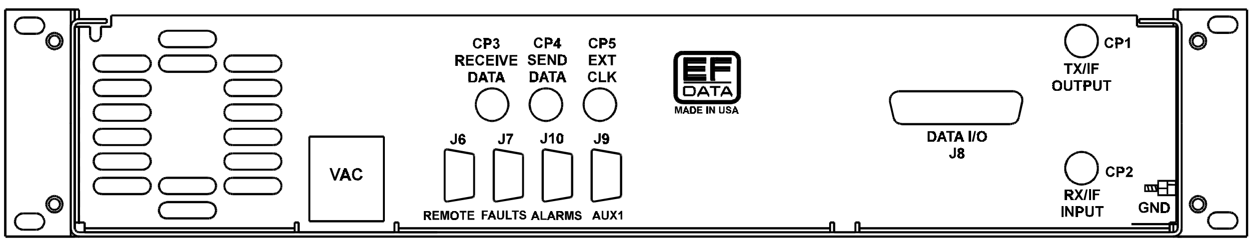


Figure 2-2. SDM-9000 Rear Panel View

Note: In order to meet the European EMC Directive (EN55022, EN50082-1), properly shielded cables for DATA I/O are required. These cables must be double-shielded from end to end, ensuring a continuous ground shield.

Table 2-1. Modem Rear Panel Connectors

Name	Ref. Desig.	Connector Type	Function
TX/IF OUTPUT	CP1	BNC	RF output
RX/IF INPUT	CP2	BNC	RF input
RECEIVE DATA	CP3	BNC	RX terrestrial data input
SEND DATA	CP4	BNC	TX terrestrial data input
EXT CLK	CP5	BNC	External clock input
REMOTE	J6	9-pin D	Remote interface
FAULTS	J7	9-pin D	Form C fault relay contacts
DATA I/O	J8	50-pin D	Data I/O (ESC)
AUX1	J9	9-pin D	TTL faults External reference AGC output
ALARMS	J10	9-pin D	Form C alarm relay contacts

2.4.1 TX/IF Output (CP1)

The TX/IF output connection is a BNC connector used for the transmit IF signal. The output impedance is 75Ω (50Ω optional). The output power level is +5 to -20 dBm.
In normal operation, the output is a modulated carrier with center frequency between 50 and 180 MHz.

2.4.2 RX/IF Input (CP2)

The RX/IF input connection is a BNC connector used for the receive IF signal. The input impedance is 75Ω (50Ω optional). For normal operation, the desired carrier signal level should be between -25 and -45 dBm.
The signal frequency of the receive RX/IF input is between 50 and 180 MHz.

2.4.3 Receive Data (CP3)

The Receive Data connection is a BNC connector used for the terrestrial data output (G.703 interface only). The output impedance is 75Ω.

2.4.4 Send Data (CP4)

The Send Data connection is a BNC connector used for the terrestrial data input (G.703 interface only). The input impedance is 75Ω.

2.4.5 External Clock (CP5)

The External Clock connection is a BNC connector used for the external buffer clock input (Ext Clk). The input impedance is 75Ω. This input is used for the G.703 interface only. The external clock input for ECL/MIL-STD-188 interfaces is provided on the J8 connector.

2.4.6 Remote (J6)

The remote connector is used to interface the M&C functions to a remote location. This is a Data Circuit Terminating Equipment (DCE) interface that can be either RS-232-C or RS-485. Refer to Appendix B for remote control operation information.

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

RS-485			RS-232-C	
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	

2.4.7 Fault (J7)

The fault connector is used to provide Form C contact closures for fault reporting. The three Form C summary fault contacts are:

- Transmit faults
- Receive faults
- Common equipment faults

Refer to Chapter 4 for a discussion of faults monitored. To obtain a system summary fault, connect all the Form C contacts in parallel

The fault interface connection is a 9-pin female D connector located on the rear panel of the modem. Screw locks are provided for mechanical security on the mating connector.

Signal Function	Name	Pin #
Common equipment is OK	NO	1
Common	COM	2
Common equipment is faulted	NC	3
Transmit is OK	NO	4
Common	COM	5
Transmit is faulted	NC	6
Receive is OK	NO	7
Common	COM	8
Receive is faulted	NC	9

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

2.4.8 DATA I/O (ESC) Interface (J8)

The DATA I/O (ESC) connection is a 50-pin female D connector located on the rear panel of the modem. Screw locks are provided for mechanical security of the mating connector.

The J8 connector is used to interface data input/output and ESC signals to and from the modem. The configuration of J8 depends on the following interface types:

- G.703
- ECL
- PECL
- MIL-STD-188

The DATA I/O pinout will be different for each of the interface configurations. The interface pinouts are listed in the following sections. Refer to the following Notes for additional data applying to each condition.

Notes:

1. Backward alarm relay contacts named for normal no-fault condition (BWOx–C connected to BWOx–NC if no fault).
2. Backward alarm inputs must be grounded or pulled logic low to clear alarm.
3. Signals MF, DF, and DMA are open-collector high-impedance, if faulted. MF and DF are used by M:N protection switch, if used in redundant system.
4. Relay contacts DF–C and DF–NO named for faulted condition (DF–C connected to DF–NO unless Demod fault).

2.4.8.1 G.703 (IDR) Interface (J8) (Audio Mode)

Signal Function	Name	Pin #
Ground	GND	1, 2
8 kbit/s TX data input (RS-422)	TXD–A TXD–B	37 38
8 kHz TX clock output (RS-422)	TXC–A TXC–B	21 22
1 kHz TX octet input (RS-422)	TXO–A TXO–B	4 5
8 kbit/s RX data output (RS-422)	RXD–A RXD–B	39 40
8 kHz RX clock output (RS-422)	RXC–A RXC–B	23 24
1 kHz RX octet output (RS-422)	RXO–A RXO–B	6 7
ADPCM 1 audio input	A1I–A A1I–B	45 29
ADPCM 1 audio output	A1O–A A1O–B	46 30
ADPCM 2 audio input	A2I–A A2I–B	47 31
ADPCM 2 audio output	A2O–A A2O–B	48 32
Backward alarm 1 output	BWO1–C BWO1–NC BWO1–NO	8 *(Note 1)* 25 41
Backward alarm 2 output	BWO2–C BWO2–NC BWO2–NO	9 *(Note 1)* 26 42
Backward alarm 3 output	BWO3–C BWO3–NC BWO3–NO	10 *(Note 1)* 27 43
Backward alarm 4 output	BWO4–C BWO4–NC BWO4–NO	11 *(Note 1)* 28 44
Backward alarm 1 input	BWI1	12 *(Note 2)*
Backward alarm 2 input	BWI2	13 *(Note 2)*
Backward alarm 3 input	BWI3	14 *(Note 2)*
Backward alarm 4 input	BWI4	15 *(Note 2)*
Modulator fault (TTL)	MF	49 *(Note 3)*
Demodulator fault (TTL)	DF	33 *(Note 3)*
Deferred maintenance alarm	DMA	17 *(Note 3)*
Demodulator fault relay	DF–C DF–NO	16 *(Note 4)* 50
AGC output (receive input, if level)	AGC–OUT	3

2.4.8.2 G.703 (IDR) Interface (J8) (64 kbit/s Mode)

Signal Function	Name	Pin #
Ground	GND	1, 2
8 kbit/s TX data input (RS-422)	TXD–A TXD–B	37 38
8 kHz TX clock output (RS-422)	TXC–A TXC–B	21 22
1 kHz TX octet input (RS-422)	TXO–A TXO–B	4 5
8 kbit/s RX data output (RS-422)	RXD–A RXD–B	39 40
8 kHz RX clock output (RS-422)	RXC–A RXC–B	23 24
1 kHz RX octet output (RS-422)	RXO–A RXO–B	6 7
64 kbit/s send data input (RS-422)	E-SD-A E-SD-B	45 29
64 kHz receive timing out (RS-422)	E-RT-A E-RT-B	46 30
64 kHz send timing out (RS-422)	E-ST-A E-ST-B	47 31
64 kbit/s receive data out (RS-422)	E-RD-A E-RD-B	48 32
Backward alarm 1 output	BWO1–C BWO1–NC BWO1–NO	8 *(Note 1)* 25 41
Backward alarm 2 output	BWO2–C BWO2–NC BWO2–NO	9 *(Note 1)* 26 42
Backward alarm 3 output	BWO3–C BWO3–NC BWO3–NO	10 *(Note 1)* 27 43
Backward alarm 4 output	BWO4–C BWO4–NC BWO4–NO	11 *(Note 1)* 28 44
Backward alarm 1 input	BWI1	12 *(Note 2)*
Backward alarm 2 input	BWI2	13 *(Note 2)*
Backward alarm 3 input	BWI3	14 *(Note 2)*
Backward alarm 4 input	BWI4	15 *(Note 2)*
Modulator fault (TTL)	MF	49 *(Note 3)*
Demodulator fault (TTL)	DF	33 *(Note 3)*
Deferred maintenance alarm	DMA	17 *(Note 3)*
Demodulator fault relay	DF–C DF–NO	16 *(Note 4)* 50
AGC output (receive input, if level)	AGC–OUT	3

2.4.8.3 ECL Interface (J8)

Signal Function	Name	Pin #
Ground	GND	1, 2
Send data input	TXD–A (ECL-) TXD–B (ECL+)	37 38
Terrestrial timing input (TT)	TXO–A (ECL-) TXO–B (ECL+)	4 5
SYNC TX frame input (TX SYNC)	SD–A (ECL-) SD–B (ECL+)	34 18
Send timing output (ST)	TXC–A (ECL-) TXC–B (ECL+)	21 22
Receive data output (RD)	RXD–A (ECL-) RXD–B (ECL+)	39 40
Receive timing output (RT)	RXC–A (ECL-) RXC–B (ECL+)	23 24
SYNC RX frame output (RX SYNC)	RD–A (ECL-) RD–B (ECL+)	36 20
External clock input (EXC)	EXC- (ECL-) EXC+ (ECL+)	35 19
ADPCM 1 audio input	A1I–A A1I–B	45 29
ADPCM 1 audio output	A1O–A A1O–B	46 30
ADPCM 2 audio input	A2I–A A2I–B	47 31
ADPCM 2 audio output	A2O–A A2O–B	48 32
Backward alarm 1 output	BWO1–C BWO1–NC BWO1–NO	8 *(Note 1)* 25 41
Backward alarm 2 output	BWO2–C BWO2–NC BWO2–NO	9 *(Note 1)* 26 42
Backward alarm 3 output	BWO3–C BWO3–NC BWO3–NO	10 *(Note 1)* 27 43
Backward alarm 4 output	BWO4–C BWO4–NC BWO4–NO	11 *(Note 1)* 28 44
Backward alarm 1 input	BWI1	12 *(Note 2)*
Backward alarm 2 input	BWI2	13 *(Note 2)*
Backward alarm 3 input	BWI3	14 *(Note 2)*
Backward alarm 4 input	BWI4	15 *(Note 2)*
Modulator fault (TTL)	MF	49 *(Note 3)*
Demodulator fault (TTL)	DF	33 *(Note 3)*
Deferred maintenance Alarm	DMA	17 *(Note 3)*
Demodulator fault relay	DF–C DF–NO	16 *(Note 4)* 50
AGC output (receive input, if level)	AGC–OUT	3

2.4.8.4 MIL-STD-188 Interface (J8)

Signal Function	Name	Pin #
Ground	GND	1, 2
Send data input	TXD–A TXD–B	37 38
Terrestrial timing input (TT)	TXO–A TXO–B	4 5
Request to send input (RTS)	SD–A SD–B	34 18
Send timing output (ST)	TXC–A TXC–B	21 22
Receive data output (RD)	RXD–A RXD–B	39 40
Receive timing output (RT)	RXC–A RXC–B	23 24
Data mode output (DM/DSR)	RD–A RD–B	36 20
External clock input (EXC)	EXC- EXC+	35 19
Receiver ready output (RR/RLSD)	RXO–A RXO–B	6 7
ADPCM 1 audio input	A1I–A A1I–B	45 29
ADPCM 1 audio output	A1O–A A1O–B	46 30
ADPCM 2 audio input	A2I–A A2I–B	47 31
ADPCM 2 audio output	A2O–A A2O–B	48 32
Backward alarm 1 output	BWO1–C BWO1–NC BWO1–NO	8 *(Note 1)* 25 41
Backward alarm 2 output	BWO2–C BWO2–NC BWO2–NO	9 *(Note 1)* 26 42
Backward alarm 3 output	BWO3–C BWO3–NC BWO3–NO	10 *(Note 1)* 27 43
Backward alarm 4 output	BWO4–C BWO4–NC BWO4–NO	11 *(Note 1)* 28 44
Backward alarm 1 input	BWI1	12 *(Note 2)*
Backward alarm 2 input	BWI2	13 *(Note 2)*
Backward alarm 3 input	BWI3	14 *(Note 2)*
Backward alarm 4 input	BWI4	15 *(Note 2)*
Modulator fault (TTL)	MF	49 *(Note 3)*
Demodulator fault (TTL)	DF	33 *(Note 3)*
Deferred maintenance alarm	DMA	17 *(Note 3)*
Demodulator fault relay	DF–C DF–NO	16 *(Note 4)* 50
AGC output (receive input, if level)	AGC–OUT	3

2.4.9 AUX 1 (J9)

The Auxiliary 1 (AUX 1) connector provides:

- TTL faults
- External high stability reference
- AGC output voltage

The faults are open collector levels to indicate a modulator or demodulator failure. A logic 1 indicates the faulted condition. The signals are primarily used in operating a protection switch.

The external high stability reference clock input is 5, 10, or 20 MHz.
AGC-OUT is the voltage for a receive signal level between -25 and -50 dBm.

The AUX 1 connection is a 9-pin female D connector located on the rear panel of the modem. Screw locks are provided for mechanical security on the mating connector.

Signal Function	Name	Pin #
Ground	GND	5, 6, 8
External reference	EXT–REF	2
Transmit fault	MDTTLFLT	4
Receive fault	DMTTLFLT	7
AGC output (Receive input, IF level)	AGC–OUT	1

2.4.10 Alarms (J10)

The alarms connector is used to provide three Form C contact closures for alarm reporting, as follows:

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

The two Form C summary fault contacts currently used are:
- Transmit alarm (Alarm 2)
- Receive alarm (Alarm 3)

Refer to Chapter 4 for a discussion of alarms monitored. To obtain a system summary alarm, connect all the Form C contacts in parallel.

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

Signal Function	Name	Pin #
Alarm 1 is OK	NO	1
Common	COM	2
Alarm 1 is faulted	NC	3
Alarm 2 is OK	NO	4
Common	COM	5
Alarm 2 is faulted	NC	6
Alarm 3 is OK	NO	7
Common	COM	8
Alarm 3 is faulted	NC	9

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

2.4.11 AC Power

The AC power is supplied to the modem by a standard detachable, non-locking, 3-prong power cord (IEC plug). Normal input voltage is 90 to 264 VAC, 47 to 63 Hz. The power supply will automatically switch between ranges. Maximum power consumption is less than 200W.

2.4.12 DC Power

The DC power is supplied to the modem by a standard detachable, non-locking, 3-prong power cord (IEC plug). Normal input voltage is 38 to 64 VDC.

2.4.13 Ground (GND)

A #10-32 stud on the rear panel of the modem is used for connecting a common chassis ground between all equipment.
Note: The safety ground is provided through the AC power connector.

Chapter 3. CONFIGURATION

This chapter describes the hardware and software configuration of the modem.

Note: All jumper settings are described in their appropriate tables.

3.1 Display/M&C

The Display/M&C PCB (AS/2305) is located on the front panel of the modem. Figure 3-1 shows the Display/M&C card and the jumper locations. The jumper settings are listed in Table 3-1.

All modem functions can be remotely controlled and monitored via an RS-485/ RS-232-C communications link. The 2- or 4-wire, half-duplex RS-485 interface makes it possible to operate 1 to 255 modems on a common communications link. The RS-232-C interface is used to communicate with a single modem.

The M&C module must be hardware configured to one of the two interfaces as listed in Table 3-1.

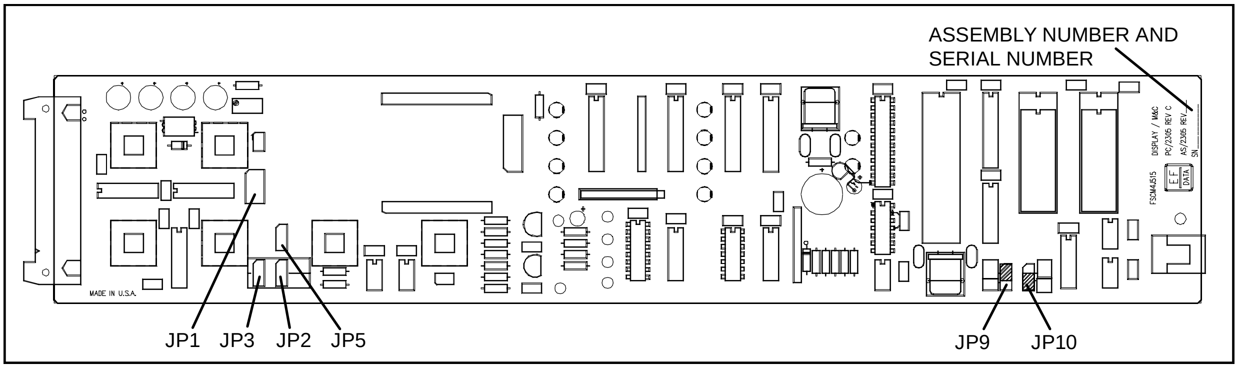


Figure 3-1. Display/M&C PCB

Table 3-1. Display/M&C PCB Jumper Settings

Jumper	Position	Function
JP1	1 to 2 3 to 4 5 to 6 7 to 8	RS-485 Remote RS-485 Remote RS-232-C Remote RS-232-C Remote
JP2 (*See Note*)	1 to 2 2 to 3	4-Wire 2-Wire
JP3 (*See Note*)	1 to 2 2 to 3	4-Wire 2-Wire
JP5	1 to 2 2 to 3	RS-485 Remote RS-232-C Remote
JP9 and JP10	32K 64K 128K 256K 256K	27C256 EEPROM at U17 27C512 EEPROM at U17 27C010 EEPROM at U17 27C020 EEPROM at U17 27C040 EEPROM at U17

Note: Pins JP2 and JP3 must be in the 4-wire position for RS-232-C.

RS-485 Configuration	Install two jumpers (shunts) at the RS-485 positions of JP1, and install one jumper at the RS-485 position of JP5. For 2- or 4-wire operation, position jumpers at JP2 and JP3 to the designated positions.
RS-232-C Configuration	Install two jumpers (shunts) at the RS-232-C positions of JP1, and install one jumper at the RS-232-C position of JP5. Install jumpers at JP2 and JP3 for 4-wire operation.

3.2 Modulator

The modulator PCB (AS/3969) is located in the top slot of the modem chassis. The jumper settings are listed in Table 3-2. Figure 3-2 shows the modulator card and the jumper locations.

Table 3-2. Modulator PCB Jumper Settings

Jumper	Position	Function
J7	1 to 2 2 to 3	Normal, processor control Output forced ON, test mode
J9 (EEPROM size select)	1 to 2 2 to 3	27C512 (64K EEPROM) 27C256 (32K EEPROM)

Note: The modulator PCB jumpers in Table 3-2 are factory set.

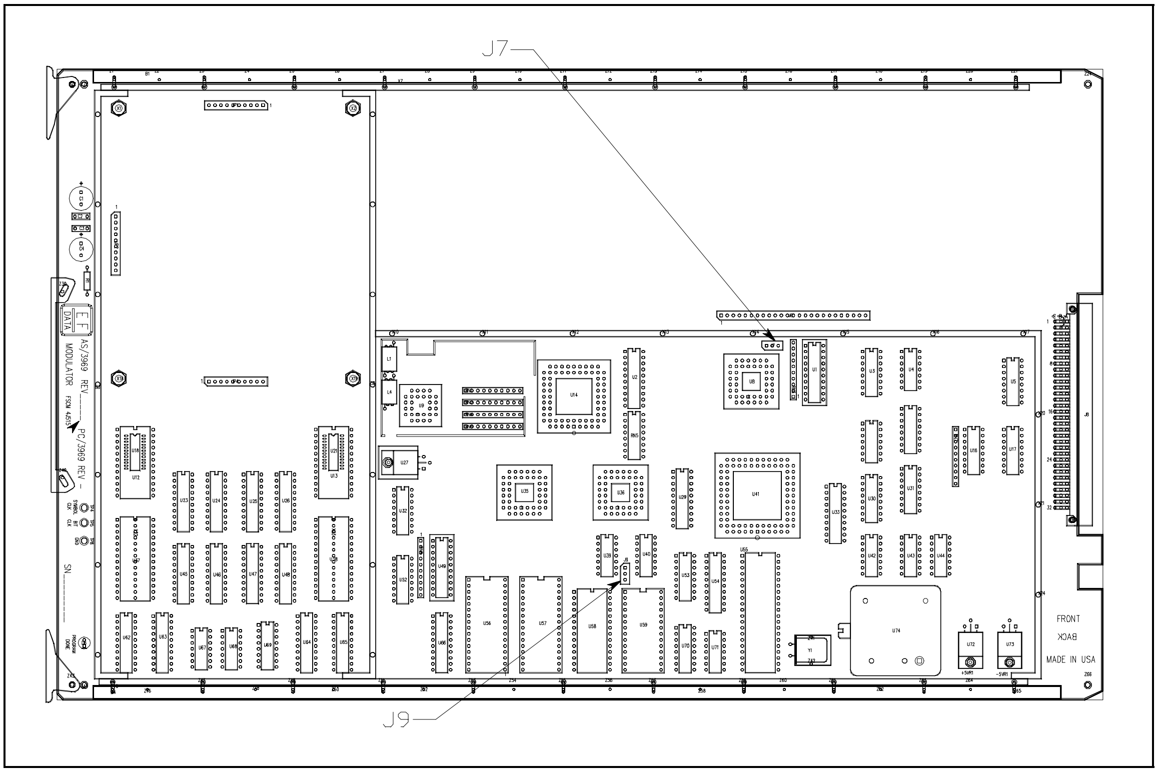


Figure 3-2. Modulator PCB (AS/3969)

3.3 Demodulator

The demodulator PCB (AS/3970) is located in the bottom slot of the modem chassis. The jumper settings are listed in Table 3-3. Figure 3-3 shows the demodulator card and the location of jumper JP5.

Table 3-3. Demodulator PCB Jumper Settings

Jumper	Position	Function
JP5 (EEPROM size select)	1 to 2 2 to 3	27C256 (32K EEPROM) 27C512 (64K EEPROM)

Note: The demodulator PCB jumpers in Table 3-3 are factory set.

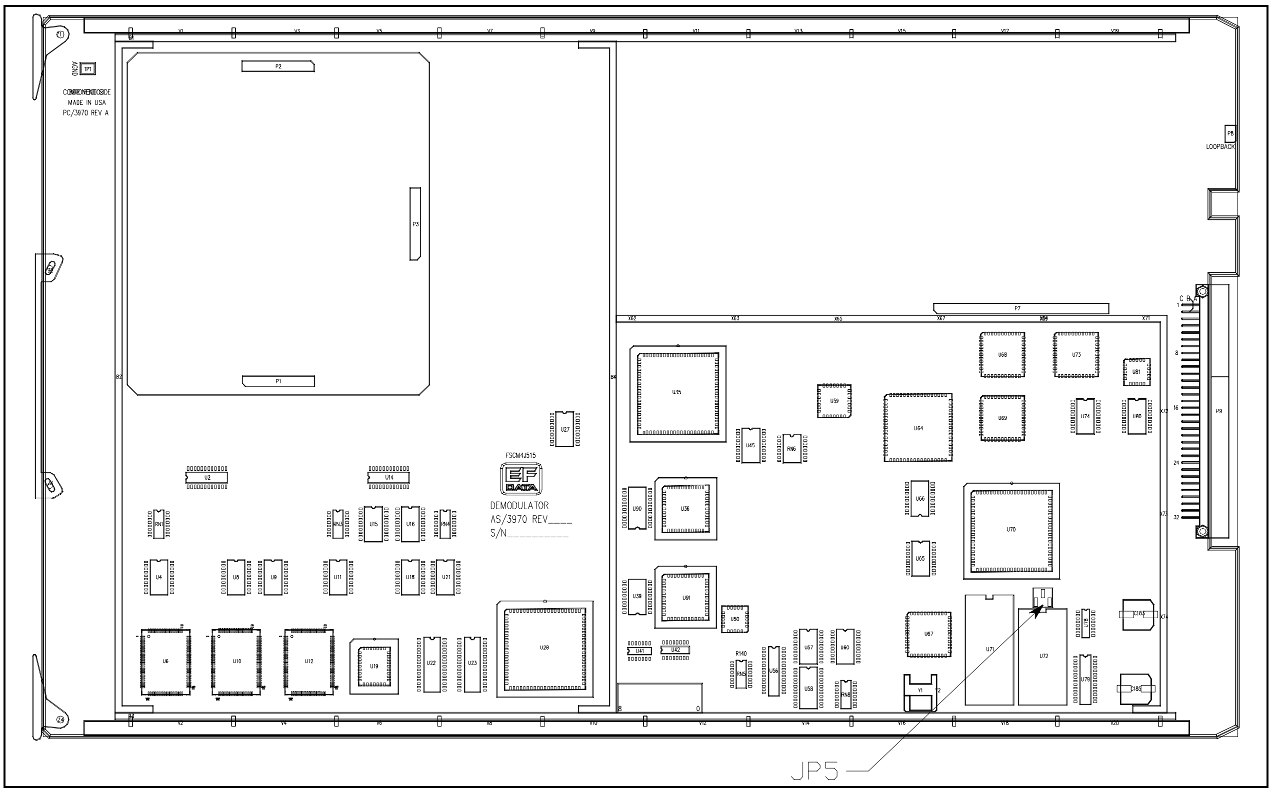


Figure 3-3. Demodulator PCB (AS/3970)

3.4 Interface

The interface PCB (AS/3971, AS/4477, or AS/5618) is located in the middle slot of the modem chassis. The three interface configurations are:

AS/3971	G.703
AS/4477	ECL/MIL-STD-188-144
AS/5618-3	G.703 with 64 kbit/s ESC

Note: The AS/5618-3 G.703 interface assembly supports one 64 kbit/s data channel or two 32 kbit/s audio channels (per IESS-308, Rev. 8A). The modem can provide independent transmit (TX) and receive (RX) of audio or digital 64 kbit/s data. This allows four possible applications:

- TX and RX: one 64 kbit/s data channel
- TX and RX: two 32 kbit/s audio channels
- TX: one 64 kbit/s data channel while RX: two 32 kbit/s audio channels
- TX: two 32 kbit/s audio channels while RX: one 64 kbit/s data channel

The jumper settings are listed in Table 3-4. Figure 3-4 (AS/3971) and Figure 3-5 (AS/4477) show the interface cards and the locations of jumper JP1.

See Table 3-4 for the appropriate jumper settings for a particular application.

Table 3-4. Interface Configuration Jumper Settings

AS/3971 Interface Only			
Jumper		Position	Function
JP1 (EEPROM size select)		1 to 2 2 to 3	27C256 (32K EEPROM) 27C512 (64K EEPROM)
AS/5618-3 G.703 Interface Only			
Channel	**Jumper**	**Position**	**Function**
TX	JP7 (Jumper block)	1 to 2 2 to 3	64 kbit/s Audio
RX	JP6 (Jumper block)	1 to 2 2 to 3	64 kbit/s Audio

Note: See options, Appendix A for additional timing information.

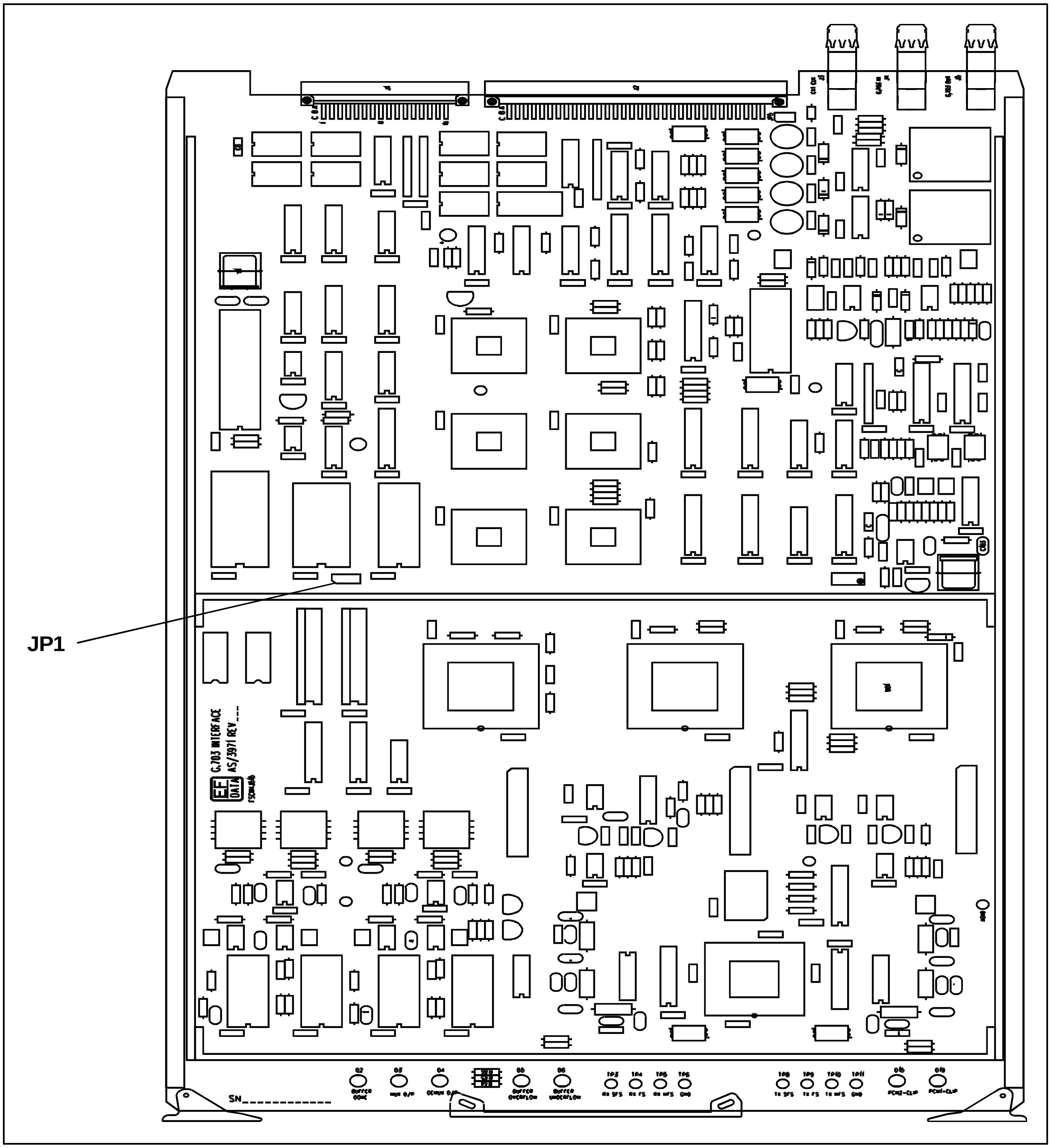


Figure 3-4. Interface PCB (AS/3971)

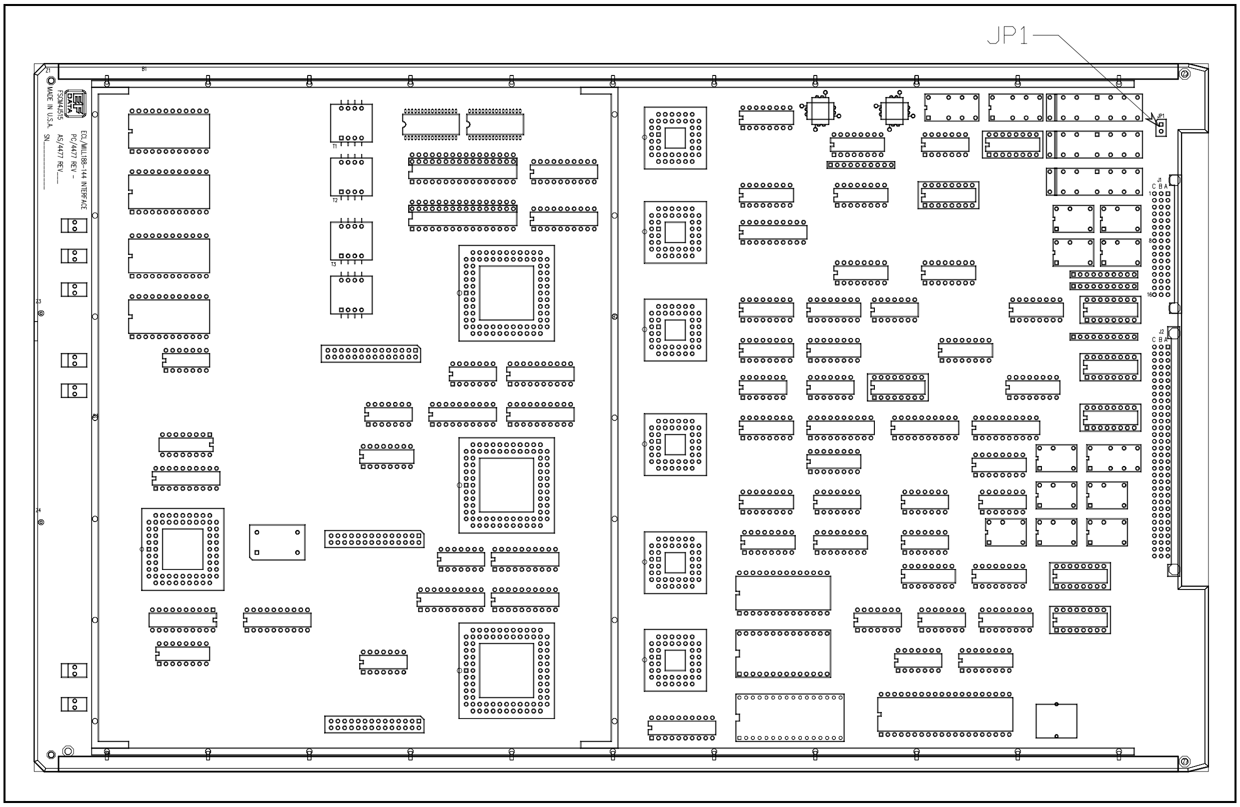


Figure 3-5. Interface PCB (AS/4477)

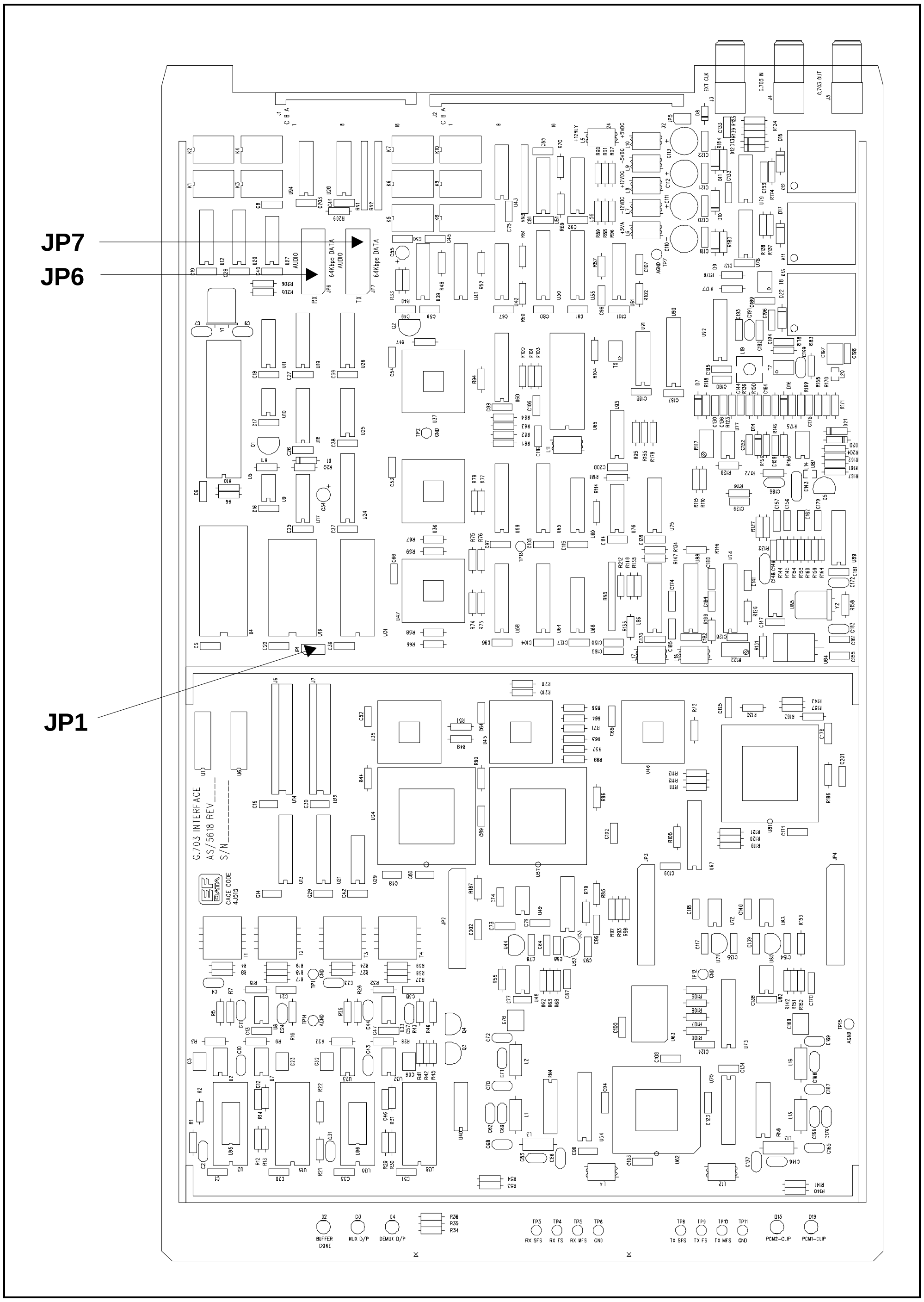


Figure 3-6. Interface PCB (AS/5618)

3.5 Nyquist Filter Configuration

The Nyquist filter (AS/4124) is a 4.5” x 5.0” daughter card that is located on the modulator and demodulator PCBs. The filters are capable of supporting four data/code rate and modulation type combinations per card. There is one TX card and one RX card:

Type	Part Number	Used with
TX PCB	AS/4124-1	Baseband Modulator PCB (AS/3969)
RX PCB	AS/4124-2	Baseband Demodulator PCB (AS/3970)

The filters include a factory programmable device that contains:

- Data Rates
- Coding Rates
- Symbol Rates
- Options

This information is programmed into the filter PCB at calibration time. A label indicates the symbol rates of the populated filters. For example, a Nyquist filter may be required with four symbol rates as follows:

- 21.376 MHz
- 22.912 MHz
- 29.824 MHz
- 34.560 MHz

Configuration information is recovered from the filter PCBs during system power-up and initialization. The filter configuration information is available to the user. Refer to Chapter 4 for the Configuration Modulator, Configuration Demodulator, and Utility menus.

3.5.1 Compatibility

For proper modem operation, the installed interface, modulator, and demodulator must be compatible with the installed filters. Refer to the following table for baseband interface data rates.

Interface Type	Data Rates
G.703	8.448 Mbit/s 32.064 Mbit/s 34.368 Mbit/s 44.736 Mbit/s 51.840 Mbit/s
ECL/PECL	6.0 to 52.0 Mbit/s, in 1 bit/s steps
MIL-STD-188	6.0 to 13.0 Mbit/s, in 1 bit/s steps

3.5.2 Installation

Installation instructions for the field-installed Nyquist filters (AS/4124) include:

- Unpacking/initial inspection
- Tools required
- Installation procedure

3.5.2.1 Unpacking Instructions

CAUTION

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

1. Remove the Nyquist filter PCB and mounting hardware from the cardboard caddypack and anti-static material.

2. Check packing list to ensure the shipment is complete.

3. Inspect the Nyquist filter PCB for any shipping damage. Ensure all ICs are seated properly.

3.5.2.2 Tools Required

The following tool is required to accomplish the task of this section:

Tool	Description
Driver, Nut	1/4-inch

3.5.2.3 Installation Procedure

Note: The Nyquist filter PCB is field-replaceable to enable the user to install optional data rates.

1. Install the Nyquist filter PCB as a daughter card on the modulator or demodulator PCB as follows:

Type	Part Number	Used with
TX PCB	AS/4124-1	Baseband Modulator PCB (AS/3969)
RX PCB	AS/4124-2	Baseband Demodulator PCB (AS/3970)

   a. Ensure that each filter has three 10-pin connectors for I/O and power.

   b. Mount the card on the four standoffs with a 1/4” hex nut on each standoff to secure the PCB. Tighten each nut using the 1/4” nut driver.

2. Refer to Figure 3-7 for connector locations.

3.5.2.3.1 Nyquist Filter Removal

1. Remove the TX filter (AS/4124-1) or RX filter (AS/4124-2) as follows:

   a. Open the modem front door and turn off the power.

   b. Remove the modulator or demodulator PCB from the modem and place on a static-free work area.

   c. Remove the four 1/4” hex nuts that secure the filter card (AS/4124-X) using the 1/4” nut driver.

   Note: Do not remove the screws and standoffs from the modulator or demodulator. Remove the four hex nuts only.

2. Carefully unplug the filter card from the modulator or demodulator connectors.

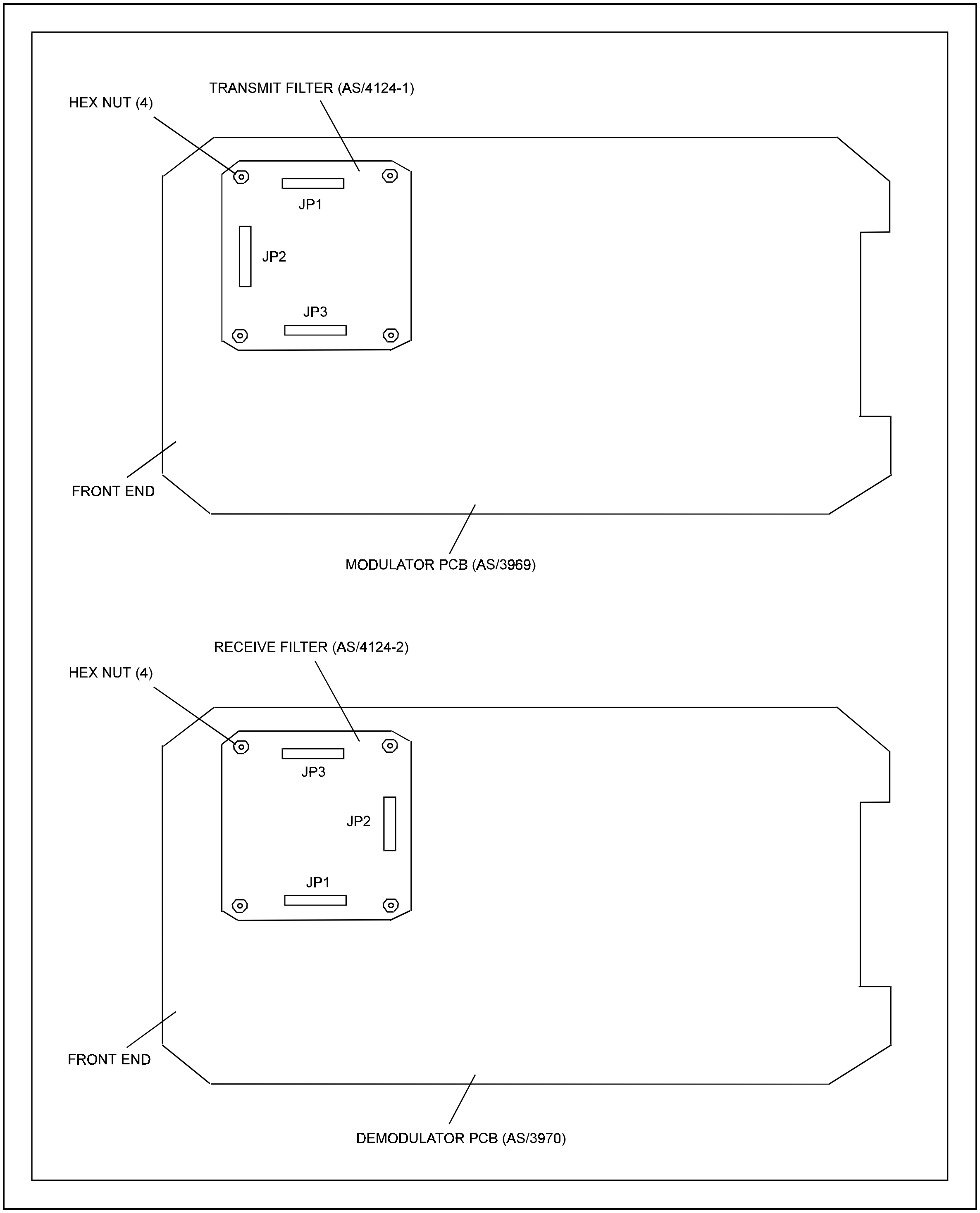


Figure 3-7. Nyquist Filter Installation

3.5.2.3.2 Nyquist Filter Replacement

1. Replace the TX filter (AS/4124-1) or RX filter (AS/4124-2) as follows:

   a. Remove the TX/RX filter card (AS/4124) in accordance with Section 3.5.2.3.1.

   b. Carefully install the TX/RX filter card on the three 10-pin connectors.

   Note: The TX/RX filter cards are keyed for easy installation.

TX Filter Connectors		RX Filter Connectors	
Filter	Modulator	Filter	Demodulator
JP1	JP1	JP1	P1
JP2	JP2	JP2	P3
JP3	JP4	JP3	P2

CAUTION

Ensure the connector pins are not bent during installation.

   c. Install the four 1/4” hex nuts to the standoffs, and tighten using the 1/4” nut driver.

2. Install the modulator or demodulator in the modem.

3.6 Software Configuration

This section consists of the following software information:

- Revision emulation feature
- Programming the remote baud rates/addresses
- Modem defaults

3.6.1 Revision Emulation

The modem includes a revision emulation feature that allows the user to program an emulation mode of a previous functional revision. This feature is accessed through the Utility Modem Type menu (refer to Chapter 4). The user can emulate Version 1.1.1 through the current version by selecting a functional number at the Rev. Emulation menu (refer to Table 3-5).

Table 3-5. SDM-9000 Revision Emulation

Functional #	Software Version	Firmware #	Description of Change
1	1.1.1	4100-1-	Original version
2	2.1.1	4100-1A	Software changes
3	3.1.1	4100-1B	Software changes
3	3.1.2	4100-1C	Correctional Setting
4	4.1.1	4100-1D	Software changes
5	5.1.1	4100-1E	Software changes
6	6.1.1	4100-1F	Software changes

Notes:

1. Programming a functional number (1 through X) eliminates all changes (disables new features/options) for the later version numbers. For example, functional number 3 may eliminate some features/options for Version 4.1.1 or greater.
2. Programming Current Version (default) allows all features and options to operate (if installed).
3. The user must manually program the functional version on a cold-start (default is Current Version).
4. Revision emulation will not affect some user interface changes that do not affect direct operation of the modem. For example: Configuration Save/Recall; cosmetic changes; Test Mode screen in the Utility System menu; all Factory Setup modes, and so forth.

3.6.2 Remote Interface Specification

Refer to Appendix B for remote control operation information.

3.6.2.1 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 4). The programmed baud rate and parity are maintained indefinitely by use of the EEPROM on the M&C module. The parity bits can be set to EVEN, ODD, or NONE (with 8 data bits). The available baud rates (bit/s) are listed below:

- 110
- 150
- 300
- 600
- 1200
- 2400
- 4800
- 9600
- 19200

3.6.2.2 Remote Address

To communicate with the established remote communications protocol, each modem must be configured for one address between 1 and 255. Address 0 is reserved as a global address that simultaneously addresses all devices on a given communications link. Each modem on a common remote communications link (RS-485) must have a distinct address.

The addresses are programmed by front panel control in the Utility System menu and maintained in EEPROM.

3.6.3 Modem Defaults

With certain exceptions, the M&C default settings are loaded into the modem after a hard reset (refer to Chapter 4). The defaults are listed in Table 3-6.

In the case of the exceptions, the settings last saved are retained. Exceptions include the following:

- Address
- Parity
- Baud Rate
- Ext AGC: Minimum Pwr
- Ext AGC: Maximum Pwr
- Display Contrast

Table 3-6. Modem Defaults

Modulator Defaults			Demodulator Defaults		
Data Rate	*(See Note)*	TX Rate A	Data Rate	*(See Note)*	RX Rate A
IF Frequency		70 MHz	IF Frequency		70 MHz
IF Output		OFF	Differential Decoder		ON
Mod Power Offset		0 dB	IF Loopback		OFF
TX Power Level		0.0 dBm	RF Loopback		OFF
Differential Encoder		ON	BER Threshold		NONE
Carrier Mode		Normal (OFF)	Demod Spectrum		Normal
Mod Spectrum		Normal			
Interface Defaults					
Buffer Clock Source		RX Satellite	Descrambler		ON
TX Clock Phase		Normal	Buffer Size		12 ms
RX Clock Phase		Normal	Service Channel TX1		-5 dBm
Ext-Ref Freq.		5000.000 kHz	Service Channel TX2		-5 dBm
B-Band Loopback		OFF	Service Channel RX1		-5 dBm
Intrfc Loopback		OFF	Service Channel RX2		-5 dBm
TX Coding Format		AMI	Loop Timing		OFF
RX Coding Format		AMI	TX Overhead Type		NONE
TX 2047 Pattern		OFF	RX Overhead Type		NONE
RX 2047 Pattern		OFF	TX Data Phase		Normal
TX Data Fault		NONE	RX Data Phase		Normal
RX Data Fault		NONE	IDR B/W Alarm Control		ON
Descrambler Type		IDR	Scrambler		ON
Scrambler Type		IDR	Scrambler Defaults		ON
System Defaults					
Operation Mode		Duplex	Remote Address	*(See Note)*	1
Baud Rate	*(See Note)*	9600	Time		12:00 AM
Parity	*(See Note)*	EVEN	Date		11/21/94
Ext AGC: Min Pwr	*(See Note)*	10.0V	Ext AGC: Max Pwr		0.0V

Note: All code rate/data rate information is read from the modulator/demodulator filter boards on power-up. If a board is missing or the filters were not installed per order, “N/A” (Not Applicable) will be displayed on the front panel.

Chapter 4. OPERATION

This chapter includes operational information for the front panel and the menu system.

4.1 Front Panel

The modem front panel (Figure 4-1) enables the user to control modem configuration parameters and display the modem status.

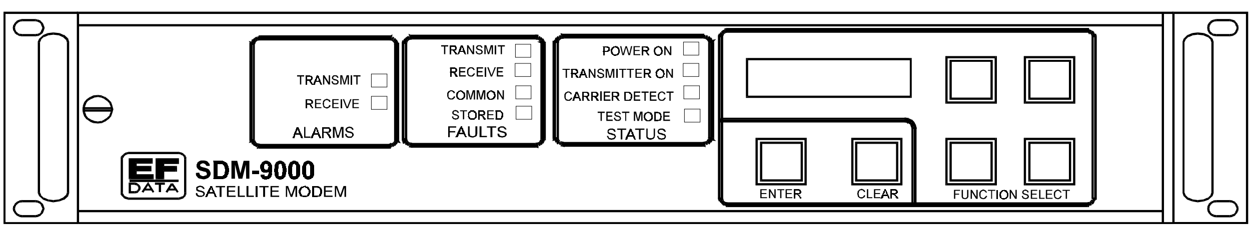


Figure 4-1. SDM-9000 Front Panel View

The major front panel features are:

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

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

- Configuration
- Monitor
- Faults/Alarms
- Stored Faults/Alarms
- Utility

4.1.1 LED Indicators

General modem summary fault information, status, and alarms are indicated by the 10 LEDs on the front panel. The LEDs, when lit, indicate the following information:

LED	Color	Description
Faults		
TX	Red	A fault condition exists in the TX chain.
RX	Red	A fault condition exists in the RX chain.
Common	Red	A common equipment fault condition exists.
Stored	Yellow	A fault has been logged and stored. The fault may be active.
Status		
Power ON	Green	Power is applied to the modem.
TX ON	Green	TX is currently on. This indicator reflects the actual condition of the TX, as opposed to the programmed condition.
Carrier Detect	Green	Decoder is locked.
Test Mode	Yellow	Flashes when the modem is in a test configuration. The test mode status can be identified in the Utility System menu in Figure 4-14.
Alarms		
TX	Yellow	A TX function is in an alarm condition.
RX	Yellow	AN RX function is in an alarm condition.

4.1.2 Front Panel Controls

The modem is locally operated by using the front panel keypad (Figure 4-1). The keypad consists of six keys. Each key provides one or more logical functions:

Key	Function
[ENTER]	[ENTER] is used to select a displayed function or to execute a modem configuration change.
[CLEAR]	[CLEAR] 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.
[←] and [→]	These keys are used to move to the next selection or to move the cursor for certain functions.
[↑] and [↓]	These keys are used primarily to change configuration data (numbers), but are also used at times to move from one section to another.

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.

The modem front panel control uses a tree-structured menu system (Figures 4-2 through 4-16) to access and execute all functions. The base level of this structure is the sign-on message that is displayed on the front panel when the modem power is turned on:

- Line 1 of the sign-on message is the modem model number (SDM-9000).
- Line 2 is the version number of the firmware implemented in the modem.

The main level of the menu system is Function Select. This may be accessed from the base level by pressing any of the arrow keys. From the Function Select menu, the user may select any one of five functional categories:

Note: The user should proceed to the Utility menu and establish the identity of the modem before proceeding with the Configuration menu.

- Configuration
- Monitor
- Faults/Alarms
- Stored Faults/Alarms
- Utility

Press [←] or [→] to move from one selection to another. When the desired function is displayed on line 2, select that level by pressing [ENTER]. After entering the appropriate functional level, move to the desired function by pressing [←] or [→]. Refer to the following section for information on individual functional categories and their functions.

4.2 Menu System

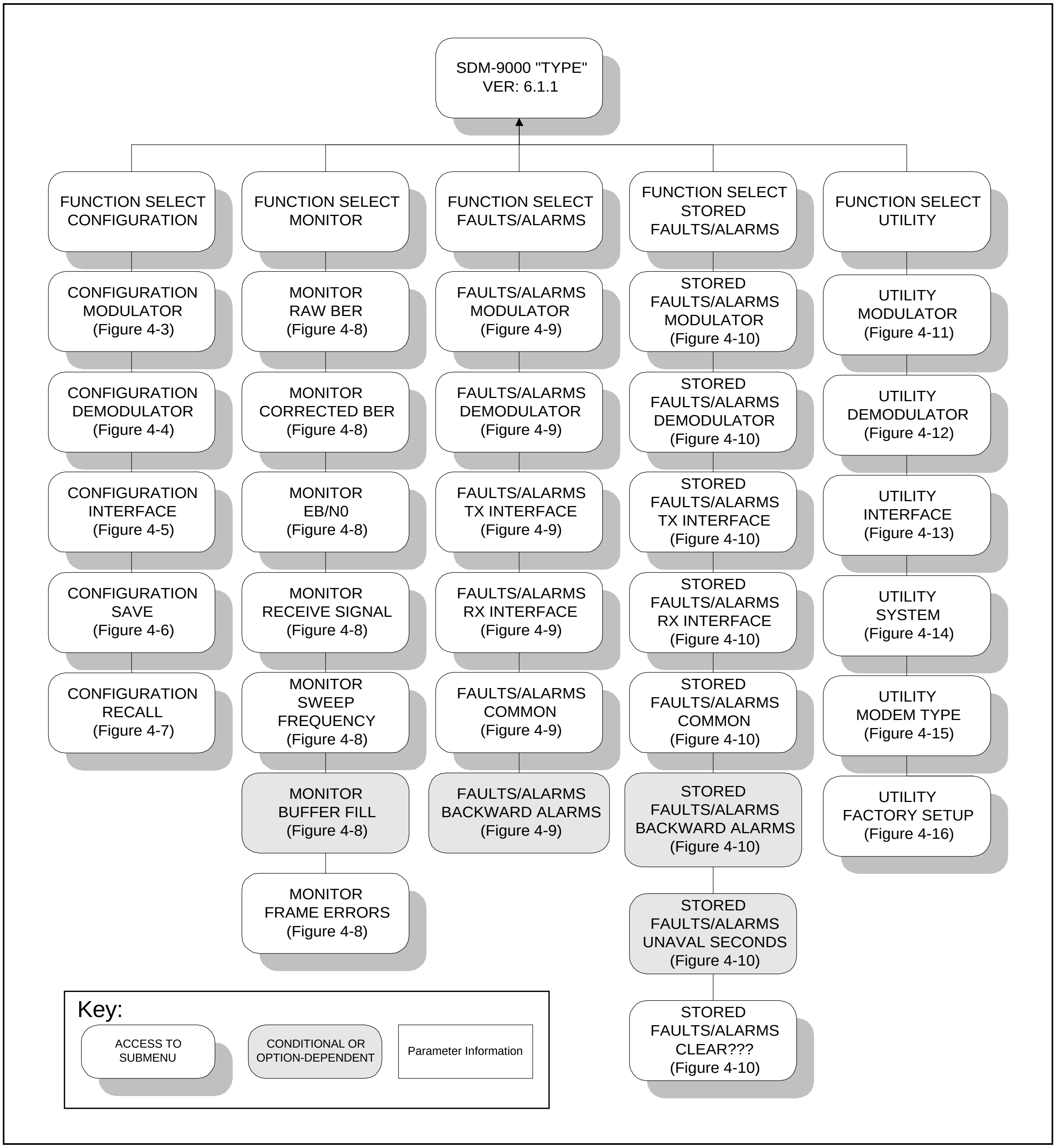


Figure 4-2. Main Menu

4.2.1 Configuration

Refer to the menu trees (Figures 4-3 through 4-7) for configuration changes. Modem configuration may be viewed or changed by entering the Configuration level from the Function Select menu on the front panel. Once in the Configuration menu, press [←] or [→] to select one of the following configurations:

- Modulator
- Demodulator
- Interface
- Save
- Recall

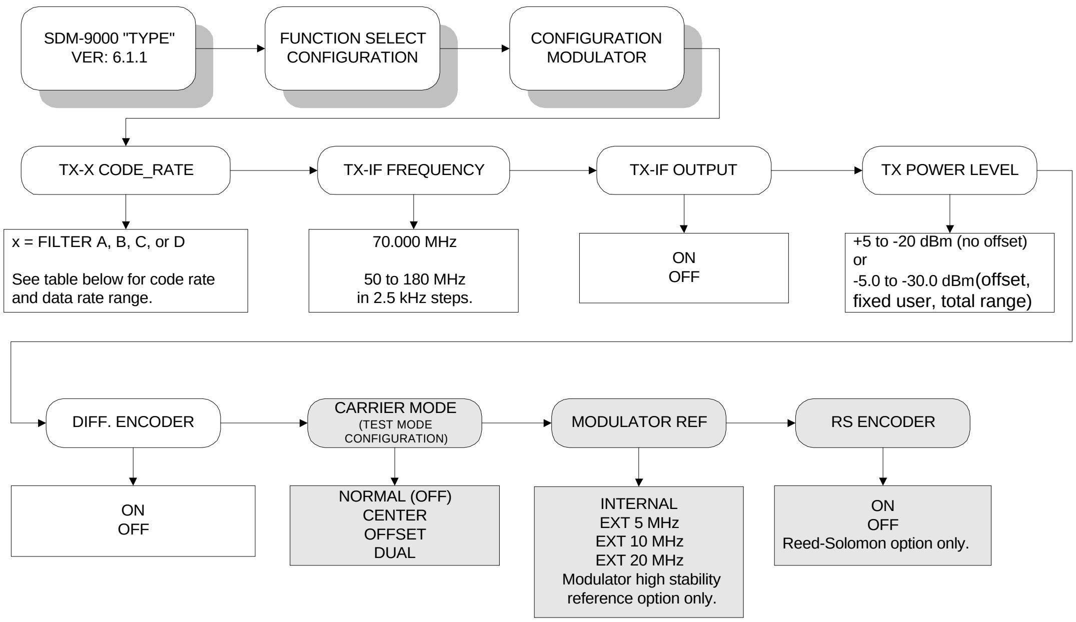
Enter the selected configuration menu by pressing [ENTER]. Press [←] or [→] to view the selected configuration parameters. If a configuration parameter change is required, press [ENTER] to begin the change process.

Press the arrow keys to change the parameters. After the display represents the correct parameters, execute the change by pressing [ENTER]. This action initiates the necessary programming by the modem.

To cancel a parameter prior to executing the change, simply press [CLEAR].

Notes:

1. Hardware configuration may change the front panel menu selection (all front panel configuration windows are listed in the following paragraphs).
2. If a particular window is specific to a certain modem configuration, the user will not be able to enter that window unless that configuration is selected. This eliminates incompatible parameters from accidentally being set in the different modes of operation.



Code Rate	G.703 (Mbit/s)	ECL/PECL (Mbit/s)	MIL-STD-188 (Mbit/s)
QPSK 1/2	8.448, 32.064, 34.368	6.000 to 37.000	All code rates:
QPSK 3/4 QPSK 7/8 8PSK 2/3 8PSK 5/6 16QAM 3/4 16QAM 7/8	All other code rates: 32.064, 34.368 44.736, 51.840	All other code rates: 6.000 to 51.840	6.000 to 13.000

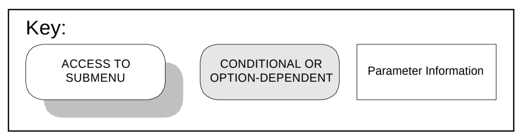


Figure 4-3. Configuration Modulator Menu

4.2.1.1 Configuration Modulator

TX-X CODE_RATE	TX Rate Selection. Under the Utility menu, select one of four (A, B, C, or D) pre-defined TX code/data rate combinations. On entry, the current TX rate is displayed on line 1. The data rate is displayed on line 2. Press [←] or [→] to select one of four pre-defined rates (A, B, C, or D). **Note:** When the TX rate has been programmed, the TX is automatically turned off to prevent swamping of other channels. To turn on the TX, use the IF Output function.
TX-IF FREQUENCY	Programs the modulator TX frequency between 50 and 180 MHz, in 2.5 kHz steps. On entry, the current TX frequency is displayed. 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 TX frequency is changed, the TX is automatically turned off to prevent the possible swamping of other channels. To turn the TX on, use the IF Output function.
TX-IF OUTPUT	Programs the modulator output on or off. On entry, the current status of the output is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.
TX POWER LEVEL	Programs the following modulator output power levels: • +5 to -20 dBm, in 0.1 dBm steps (no offset) • -5.0 to -30.0 dBm (offset) An offset can be added through the Utility menu to remove loses or gains in the system. On entry, the current TX power level is displayed. Press [↑] or [↓] to increase or decrease the output power level, in 0.1 dBm steps. Press [ENTER] to execute the change. **Note:** The actual front panel display may be changed in the power offset utility function. Using this function does not change the actual output power level.
DIFF. ENCODER	Programs the differential encoder on or off. On entry, the current status of the differential encoder is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.

CARRIER MODE (Test Mode Configuration Option)	Programs the modem for continuous wave mode. Four modes of operation are available: • Normal (OFF) • Center • Offset • Dual **Normal (OFF) Mode:** The Carrier mode is normally in the OFF position. To execute any of the Carrier continuous wave modes, the user must enter the Carrier mode and select the test mode of choice. **Center Mode:** Generates a carrier at the current modulator frequency. This can be used to measure the output frequency. **Offset Mode:** Generates a single upper sideband suppressed carrier signal. The upper sideband is at one-quarter of the symbol rate from the carrier. This is used to check the quadrature. **Dual Mode:** Generates a dual side-band suppressed carrier signal. Sidebands are at one-half of the symbol rate from the carrier. This is used to check the channel balance and carrier null. On entry, the Center mode is displayed. To activate this test mode, press [ENTER]. Press [←] or [→] to select the Dual or Offset modes. 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 TX is automatically turned off to prevent the possible swamping of other channels. To turn the TX on, use the IF Output function.
MODULATOR REF	Optional program for selecting the high stability 5 MHz internal reference and the 5, 10, and 20 MHz external references. On entry, the Internal mode is displayed. Press [↑] or [↓] to select external 5 MHz, external 10 MHz, or external 20 MHz references. Press [ENTER] to execute the change.
RS ENCODER	Programs the Reed-Solomon encoder on or off. On entry, the current status of the Reed-Solomon encoder is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change. **Note:** Programming the Reed-Solomon encoder automatically turns off the RF TX (because of symbol rate changes).

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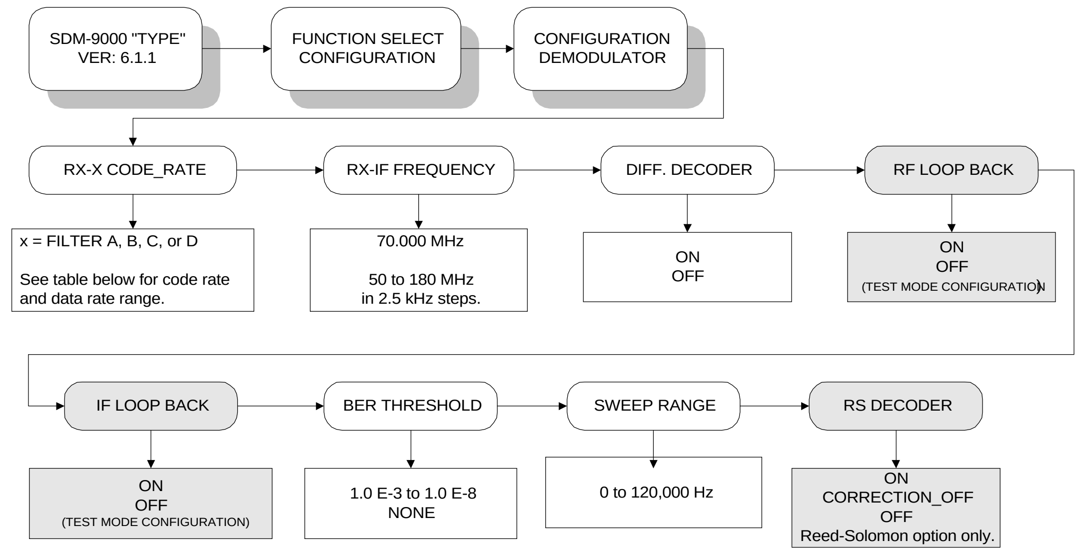

Code Rate	G.703 (Mbit/s)	ECL/PECL (Mbit/s)	MIL-STD-188 (Mbit/s)
QPSK 1/2	8.448, 32.064, 34.368	6.000 to 37.000	All code rates:
QPSK 3/4 QPSK 7/8 8PSK 2/3 8PSK 5/6 16QAM 3/4 16QAM 7/8	All other code rates: 32.064, 34.368 44.736, 51.840	All other code rates: 6.000 to 51.840	6.000 to 13.000

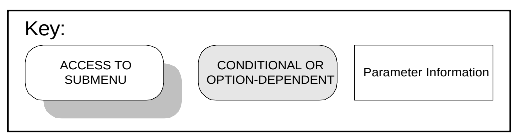

Figure 4-4. Configuration Demodulator Menu

4.2.1.2 Configuration Demodulator

RX X CODE_RATE	RX rate selection. Select one of four (A, B, C, or D) pre-defined RX decoder/data rate combinations. On entry, the current RX rate is displayed on line 1. The data rate is displayed on line 2. Press [←] or [→] to select one of four pre-defined rates (A, B, C, or D).
RX-IF FREQUENCY	Programs the demodulator RX frequency between 50 and 180 MHz, in 2.5 kHz steps. On entry, the current RX frequency 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.
DIFF. DECODER	Programs the differential decoder on or off. On entry, the current status of the differential decoder is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.
RF LOOP BACK (Test Mode Configuration Option)	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 4-17 for a block diagram of RF loopback operation. **Note:** RF loopback nullifies IF loopback. On entry, the current status of the RF loopback is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.
IF LOOP BACK (Test Mode Configuration Option)	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 4-18 for a block diagram of IF loopback operation. **Note:** IF loopback nullifies RF loopback. On entry, the current status of IF loopback is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.

BER THRESHOLD	This function is used to set the BER threshold. If the BER threshold set is exceeded, an RX fault will be indicated by the modem status indicators. BER threshold may be set from 1.0^{-3} to 1.0^{-8}, or may be disabled by specifying NONE. On entry, the current setting of the BER threshold is displayed. Press [↑] or [↓] to select the desired setting. 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 120000 Hz. When set at 120000 Hz, the modem is in the normal acquisition mode. 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. The smaller the range, the faster the modem will lock, provided the RX carrier center frequency is within the RX IF frequency sweep range.
RS DECODER	Programs the Reed-Solomon decoder ON, CORRECTION_OFF, or OFF. On entry, the current status of the Reed-Solomon decoder is displayed. Press [←] or [→] to select one of the following modes: • ON • CORRECTION_OFF • OFF Press [ENTER] to execute the change. **OFF Mode:** 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. **Correction OFF Mode:** This mode turns OFF the Reed-Solomon decoder data error correction circuitry. Data flow is then routed through normal data paths without error corrections. **ON Mode:** The ON mode enables the Reed-Solomon decoder to provide data error corrections. **Note:** 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).

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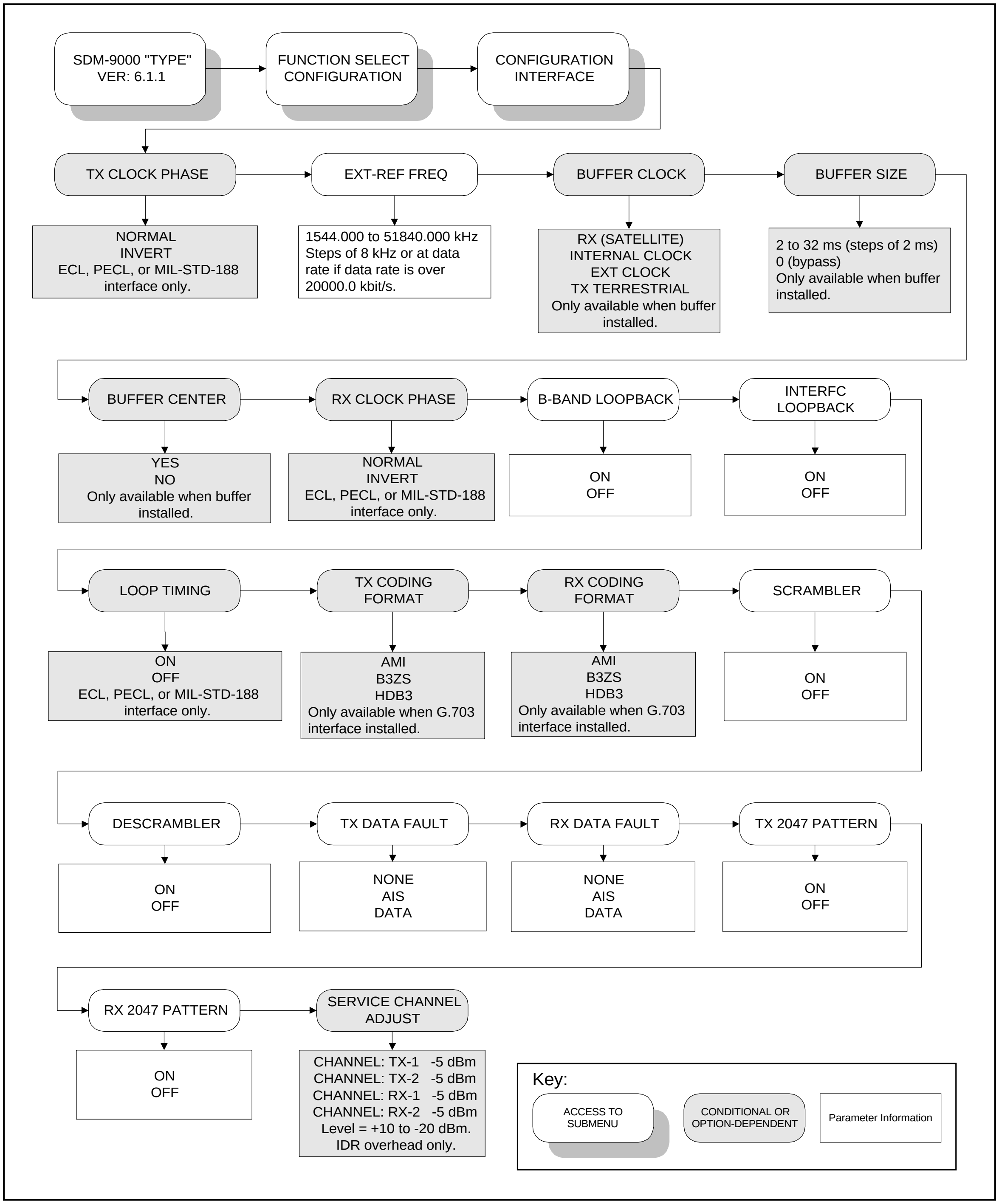

Figure 4-5. Configuration Interface Menu

4.2.1.3 Configuration Interface

TX CLOCK PHASE	Programs the TX clock phase to: • Normal • Invert On entry, the current setting for the TX clock phase is displayed. Press [↑] or [↓] to select Normal or Invert. Press [ENTER] to execute the change. **Note:** This menu is only available for the ECL, PECL, or MIL-STD-188 interface.
EXT-REF FREQ	Programs the external reference clock input frequency between 1544.000 and 51840.000 kHz, in steps of 8 kHz, or at data rate (if data rate is over 20000.0 kbit/s). On 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.
BUFFER CLOCK	Programs the interface buffer output clock to one of the following modes: • RX Satellite • Internal Clock • External Clock • TX Terrestrial **RX (Satellite) Mode:** Sets the buffer output clock to the satellite clock. **Internal Clock Mode:** Sets the buffer output clock to operate from the modem internal clock. This is also the fallback clock. **External Clock Mode:** Sets the clock source to the external supplied buffer clock. **TX Terrestrial Mode:** Sets the buffer output clock to recover timing from the incoming TX data clock. On entry, the current setting of the buffer clock is displayed. Press [←] or [→] to select Satellite, Internal, External Reference, or TX Terrestrial for the buffer clock. Press [ENTER] to execute the change. **Notes:** 1. This menu is only available when the buffer is installed. 2. The buffer clock source selection must fall within the parameters listed in Chapter 5.

BUFFER SIZE	This configuration function is used to set the size of the buffer. On entry, the current buffer length is displayed. Press [↑] or [↓] to select the desired buffer size. The buffer size will be displayed in ms. The user may choose from 2 to 32 ms, in increments of 2 ms, or 0 (bypass). Press [ENTER] to execute the change. **Note:** This menu is only available when the buffer is installed.
BUFFER CENTER	This configuration function is used to center the buffer. Press [ENTER] twice to center the plesiochronous buffer. **Note:** This menu is only available when the buffer is installed.
RX CLOCK PHASE	Programs the RX clock phase to: • Normal • Invert On entry, the current status of the RX clock is displayed. Press [←] or [→] to select Normal or Inverted. Press [ENTER] to execute the change. **Note:** This menu is only available for the ECL, PECL, or MIL-STD-188 interface.
B-BAND LOOPBACK (Test Mode Configuration Option)	Programs the modem for baseband loopback operation. When baseband loopback is turned on, the data and timing signals are hard-wired (via relays) from the demodulator to the modulator on the modem side of the interface. The DTE baseband signals are also looped back from the TX data and clock to RX data and clock on the customer side of the interface. This is a bi-directional loopback of the baseband data. Refer to Figure 4-19 for a block diagram of baseband loopback operation. On entry, the current status is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change. **Notes:** 1. If baseband loopback is turned on, the buffer clock will be programmed for RX satellite. 2. When baseband loopback is turned off, the previous buffer clock selection will be programmed back.
INTERFC LOOPBACK (Test Mode Configuration Option)	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 loopback of the data after the baseband data has had the overhead added. Refer to Figure 4-20 for a block diagram of interface loopback operation. On entry, the current status is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.
LOOP TIMING	Programs the send timing output reference clocking to the satellite clock. Refer to Figures 4-21 and 4-22 for the interface clocking diagram. On entry, the current status is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change. **Note:** This menu is only available with the ECL, PECL, or MIL-STD-188 interface.

<table>
<tr><td>TX CODING FORMAT</td><td>Programs the TX for the following coding of the baseband data:
AMI
B3ZS
HDB3
On entry, the current coding format is displayed. Press [←] or [→] to select the desired coding format. Press [ENTER] to execute the change.

Note: This menu is only available when the G.703 interface is installed.</td></tr>
<tr><td>RX CODING FORMAT</td><td>Programs the RX for the following coding:
AMI
B3ZS
HDB3
On entry, the current coding format is displayed. Press [←] or [→] to select the desired coding format. Press [ENTER] to execute the change.

Note: This menu is only available when the G.703 interface is installed.</td></tr>
<tr><td>SCRAMBLER</td><td>Programs the scrambler on or off.

On entry, the current status of the scrambler is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.</td></tr>
<tr><td>DESCRAMBLER</td><td>Programs the descrambler on or off.

On entry, the current status of the descrambler is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.</td></tr>
<tr><td>TX DATA FAULT</td><td>TX data fault. This configuration function is used to select a TX interface fault monitor of:
NONE
AIS
DATA
None Mode:
The TX interface fault Data/AIS is not activated.

AIS Mode:
Sets TX interface fault Data/AIS to monitor a fault condition of all 1s from customer data input to the modem.

Data Fault Mode:
Sets TX interface fault Data/AIS to monitor a fault condition of all 1s or all 0s. This is referred to as a data-stable condition, which means that the data is not transitioning.

On entry, the current TX data fault that is being monitored is displayed. Press [←] or [→] to select Data, AIS, or None. Press [ENTER] to execute the change.</td></tr>
</table>

RX DATA FAULT	RX data fault. This configuration function is used to select an RX interface fault monitor of: • NONE • AIS • DATA The data monitored for RX data is coming from the satellite. Refer to TX data fault for a description of the function choices. On entry, the current RX data fault that is being monitored is displayed. Press [←] or [→] to select Data, AIS, or None. Press [ENTER] to execute the change.
TX 2047 PATTERN (Test Mode Configuration Option)	Programs the TX to insert a 2047 pattern in lieu of the normal TX data. On entry, the current status is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.
RX 2047 PATTERN (Test Mode Configuration Option)	Programs the modem to RX a 2047 pattern as the normal RX data, and allows the BER monitor to work on that 2047 pattern. On entry, the current status is displayed. Press [←] or [→] to select ON or OFF. Press [ENTER] to execute the change.
SERVICE CHANNEL	This configuration function is used to set service channel audio levels between +10.0 and -20.0 dBm. On entry, press [←] or [→] to select the desired service channel: • TX-1 • TX-2 • RX-1 • RX-2 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. **Note:** This menu is only available when IDR has been selected for TX or RX overhead in the Interface Utility menu.

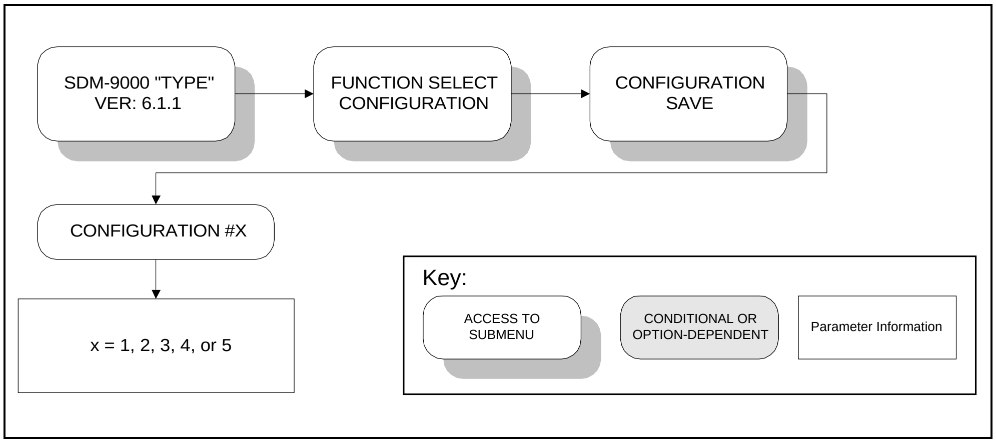

Figure 4-6. Configuration Save Menu

4.2.1.4 Configuration Save

This feature allows the user to program configuration parameters into memory on the M&C. There are five memory locations that may be used to store specific configuration setups that are used frequently. This feature speeds up the configuration process and allows faster configuration changes.

After setting all configuration parameters to the desired settings, enter the Configuration Save menu (Figure 4-6) and select memory location 1, 2, 3, 4, or 5. Press [ENTER] to execute the save.

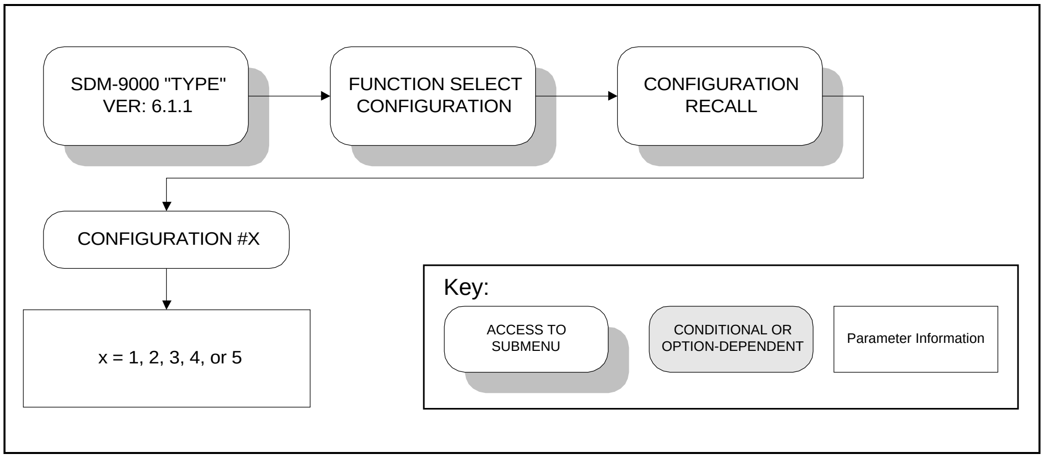

Figure 4-7. Configuration Recall Menu

4.2.1.5 Configuration Recall

Once a configuration setup has been saved, it may be recalled by entering Configuration Recall. On entry, select the appropriate memory location (1, 2, 3, 4, or 5) by pressing [←] or [→]. Press [ENTER] to execute the Recall. The modem will now be reconfigured to the setting that was in that memory location.

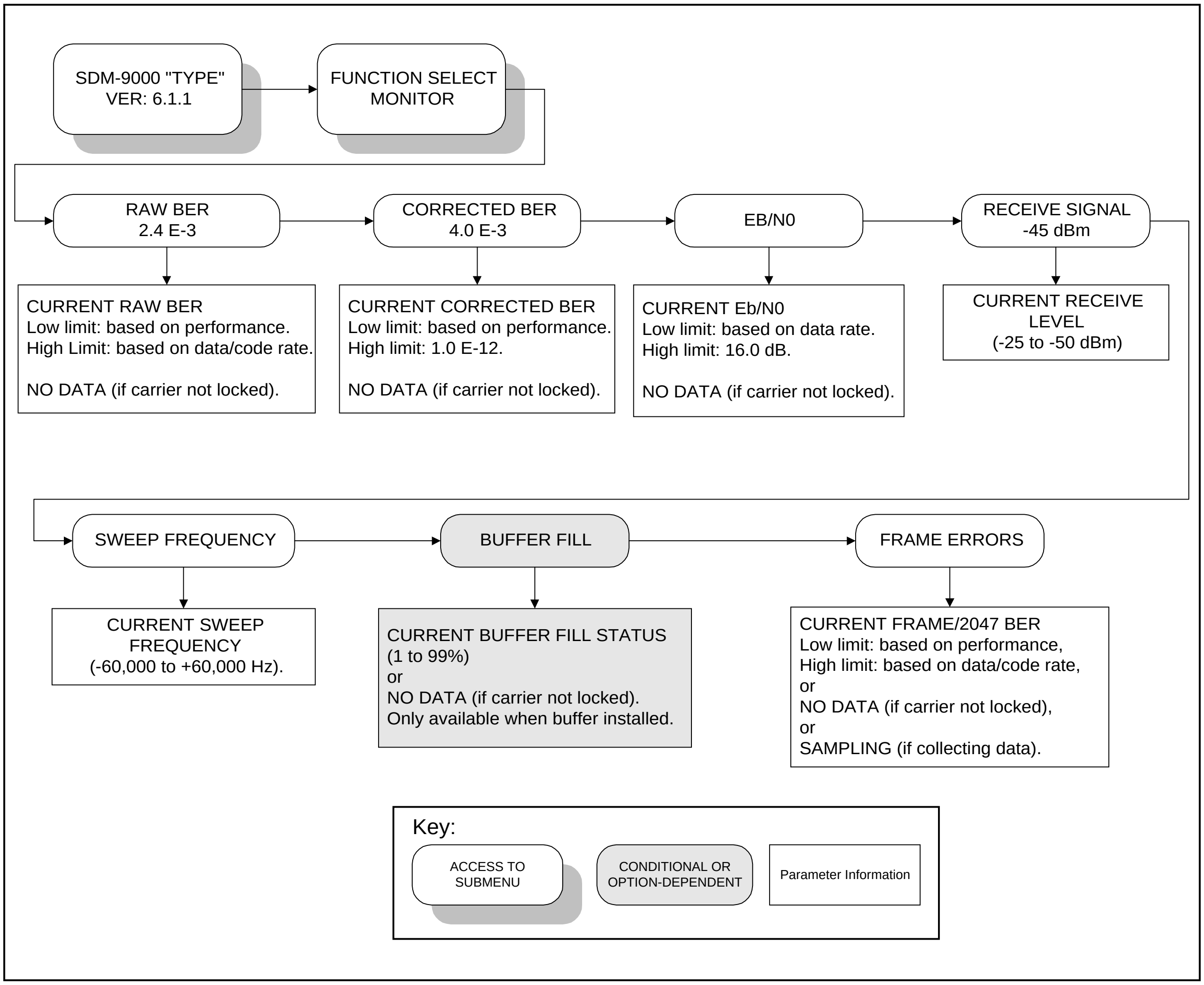

Figure 4-8. Monitor Menu

4.2.2 Monitor

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: $<m.m^{-e}$ to $>m.m^{-e}$. **Note:** Low limit based on performance. High limit based on data/code rate.
CORRECTED BER	Displays the current corrected BER or No Data (if carrier is not locked). Range: $<m.m^{-e}$ to $>m.m^{-e}$. **Note:** Low limit based on performance. High limit is 1.0^{-12}.
E_b/N_0	Displays the current E_b/N_0 or No Data (if carrier is not locked). Range: <mm.m to >mm.m. **Note:** Low limit based on performance. High limit is 16.0 dB.
RX SIGNAL	Displays the current RX signal level. Range: -mm dBm (-25 to -50 dBm).
SWEEP FREQUENCY	Displays the current sweep frequency. Range: -60,000 to +60,000 Hz.
BUFFER FILL	Displays the current plesiochronous buffer fill status percent, or No Data (if carrier not locked). Range: nn% (1% to 99%). **Note:** This menu is only available when buffer installed.
FRAME ERRORS	Displays the following information: • Current framing pattern BER. • “No Data” (if carrier is not locked). • “Sampling” if collecting data. Range: $<mm.m^{-e}$ to $>mm.m^{-e}$. **Note:** Low limit based on performance. High limit based on data/code rate.

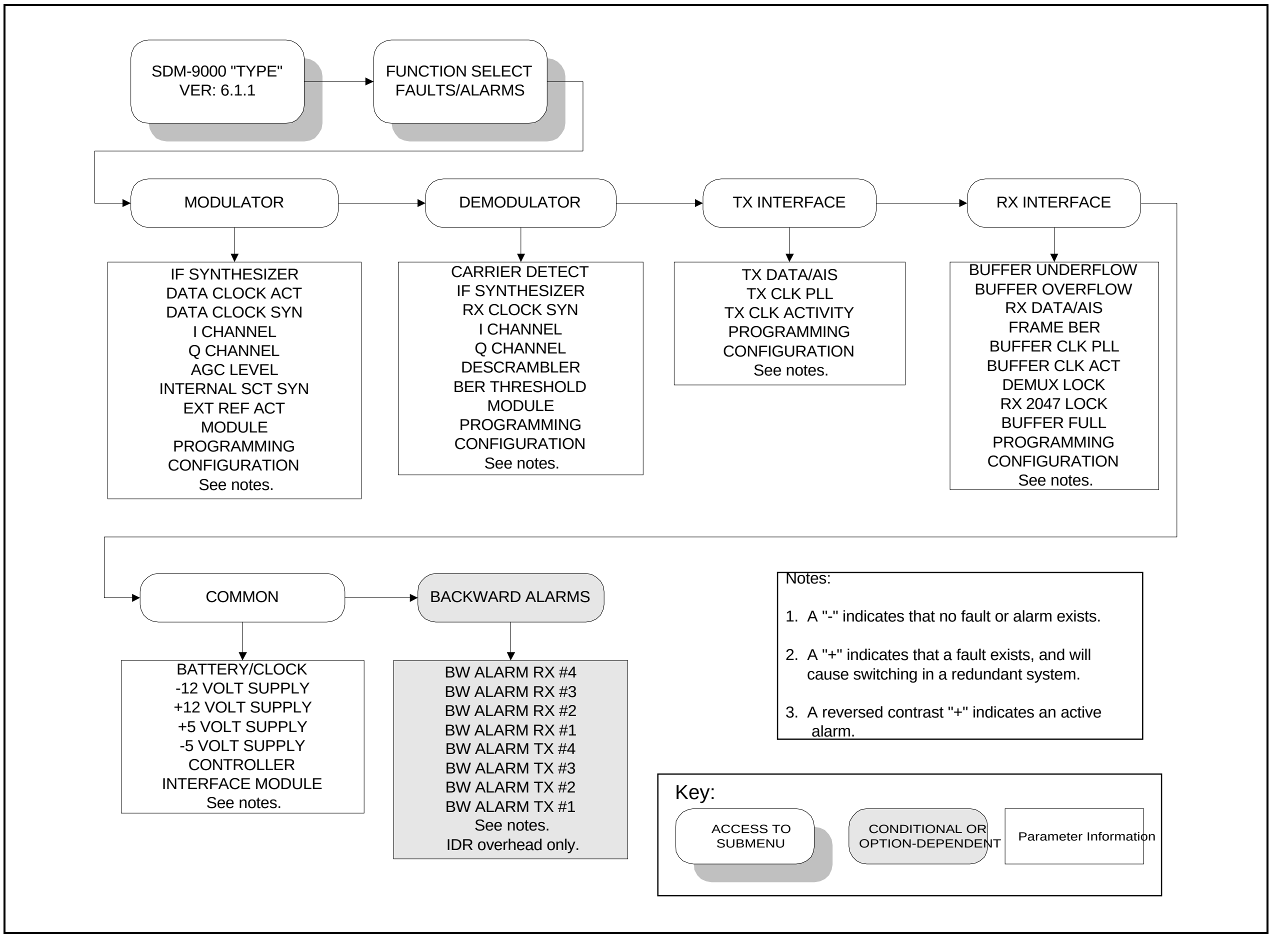

Figure 4-9. Faults/Alarms Menu

4.2.3 Faults/Alarms

The Faults/Alarms level is accessible from the Function Select menu. 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 Fault/Alarm groups:

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

The current Faults/Alarms status is displayed on line 2 of the display in real time.

For each parameter monitored, fault status is displayed as follows:

- "-" indicates that no fault or alarm exists.
- "+" indicates that a fault exists, and will cause switching in a redundant system.
- A reversed-contrast "+" indicates an alarm is active. 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 identify the fault or alarm. The label for that Fault/Alarm is then displayed on line 1.

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. Refer to the fault isolation section in Chapter 6 for more details on the causes of each fault.

4.2.3.1 Modulator Faults

IF SYNTHESIZER	Modulator IF synthesizer fault.
DATA CLOCK ACT	TX data clock activity alarm. Indicates that data clock activity was not detected.
DATA CLOCK SYN	TX clock synthesizer fault. Indicates the internal 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.
INTERNAL SCT SYN	Internal TX data clock synthesizer fault.
EXT REF ACT	Modulator fault. This is only used with the External Reference High Stability option. Indicates modulator does not have an external reference.
MODULE	Modulator module fault. Typically indicates that the modulator module is missing or will not program.
PROGRAMMING	Modulator programming fault.
CONFIGURATION	Modulator configuration fault. Indicates the modulator cannot execute a programmed configuration parameter.

4.2.3.2 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.
RX CLOCK SYN	RX data clock synthesizer fault. Indicates a loss of lock on the reference of the demodulator clock recovery oscillator.
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.
DESCRAMBLER	Descrambler activity alarm. Indicates a loss of activity in the descrambler.
BER THRESHOLD	BER threshold set in the Configuration Demod menu.
MODULE	Demodulator/decoder module fault. Typically indicates that the Demod/decoder module is missing or will not program.
PROGRAMMING	Demodulator programming fault.
CONFIGURATION	Demodulator configuration fault. Indicates the demodulator cannot execute a programmed configuration parameter.

4.2.3.3 TX Interface Faults

TX DATA/AIS	Data or AIS. When data fault is selected in the Configuration Interface menu, the fault indicates a data-stable condition. This indicates the data is all 1s or all 0s (i.e., the 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 Configuration Interface menu, the TX Data/AIS Fault/Alarm is not activated. **Note:** AIS is an alarm, not a switching fault.
TX CLOCK PLL	TX phase-locked loop fault. Indicates the TX PLL is not locked.
TX CLOCK ACTIVITY	Activity detector alarm interface TX clock. The interface will fall back to the internal clock when this alarm is active.
PROGRAMMING	TX Interface programming fault.
CONFIGURATION	TX Interface configuration fault. Indicates the TX interface cannot execute a programmed configuration parameter.

4.2.3.4 RX 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 Configuration Interface menu, the fault indicates a data-stable condition. This indicates the data coming from the satellite is all 1s or all 0s (i.e., the 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}.
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 RX 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 when RX 2047 is on.
BUFFER FULL	Buffer full alarm. Indicates the buffer is less than 10% or greater than 90% full.
PROGRAMMING	RX Interface programming fault.
CONFIGURATION	TX Interface configuration fault. Indicates the TX interface cannot execute a programmed configuration parameter.

4.2.3.5 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
-5V SUPPLY	-5V power supply 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.

4.2.3.6 Backward Alarms

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

Note: IDR overhead only.

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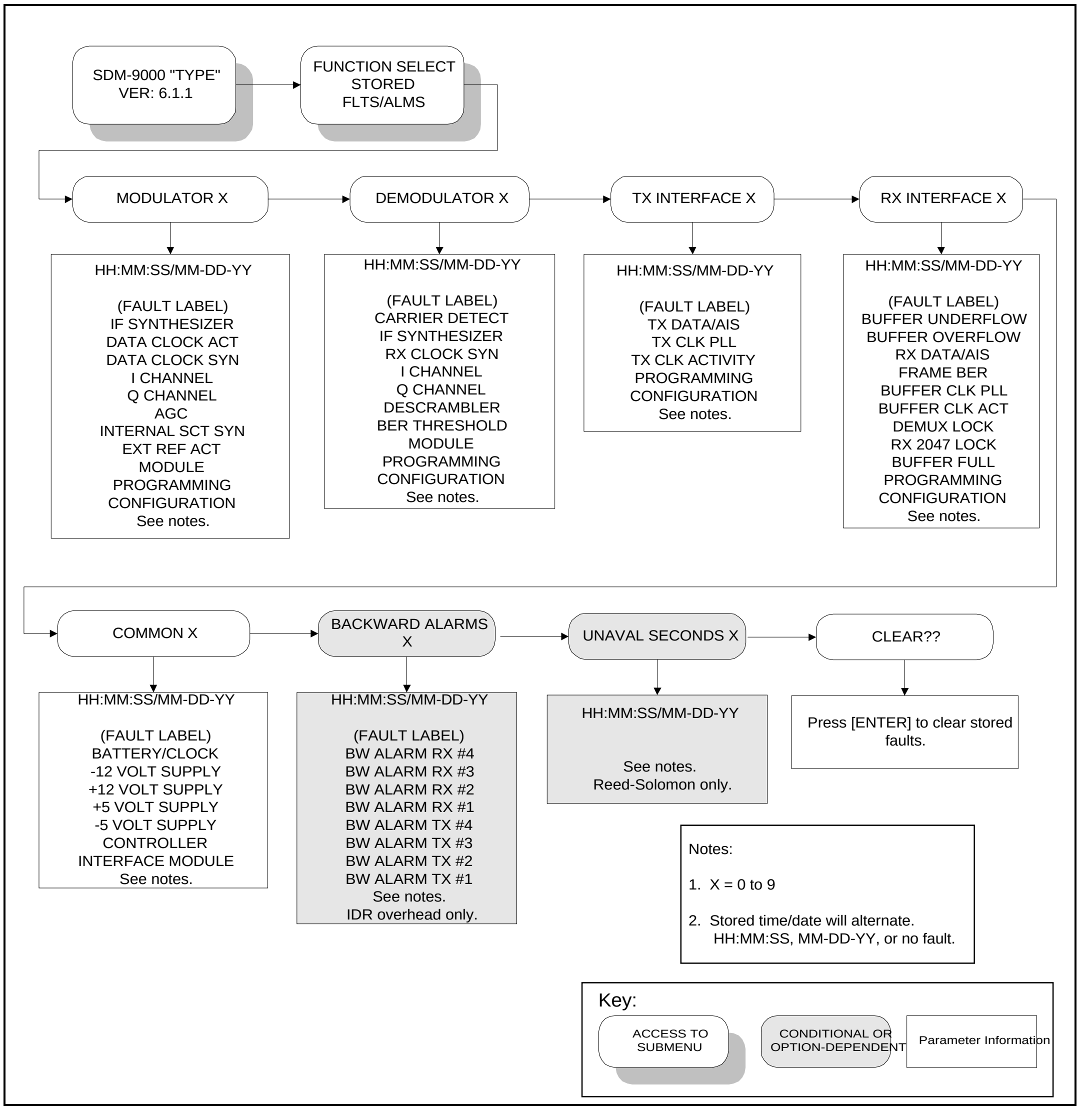

Figure 4-10. Stored Faults/Alarms Menu

4.2.4 Stored Faults/Alarms

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
- Backward Alarms (IDR overhead only)
- Unaval Seconds (Reed-Solomon only)

Each fault status change is stored with the time and date of the occurrence (i.e., when a fault occurs and clears). Stored faults may be viewed by entering the Stored Faults level from the Select menu.

All stored faults may be cleared by executing the Clear Stored Faults?? command from the Stored Faults level.

Stored faults are not maintained through a controller power-on reset cycle. However, the last known time is maintained in non-volatile RAM. On power-up, a common equipment fault is logged (Flt0) with that 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 six 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]. The user can now press [←] or [→] to move the flashing cursor to identify the fault.

To clear the stored faults currently logged, 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.

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4.2.5 Utility

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

- Modulator
- Demodulator
- Interface
- System
- Factory Setup

Refer to Figures 4-11 through 4-16 for different menu categories. The menu information includes:

- Terrestrial interface types
- Time/date
- Firmware information
- Test mode status
- Overhead type
- Revision emulation

Note: Changes in the Utility menu may cause changes in other front panel menus.

A lamp test function is provided for testing front panel optical indicators.

Note: The Factory Setup Utility menu is for EFData service personnel only. Entering this menu may cause the modem to operate incorrectly.

After entering the Utility functions level, press [←] or [→] to select the desired Utility menu and press [ENTER]. Press [←] or [→] to view the utility function of interest.

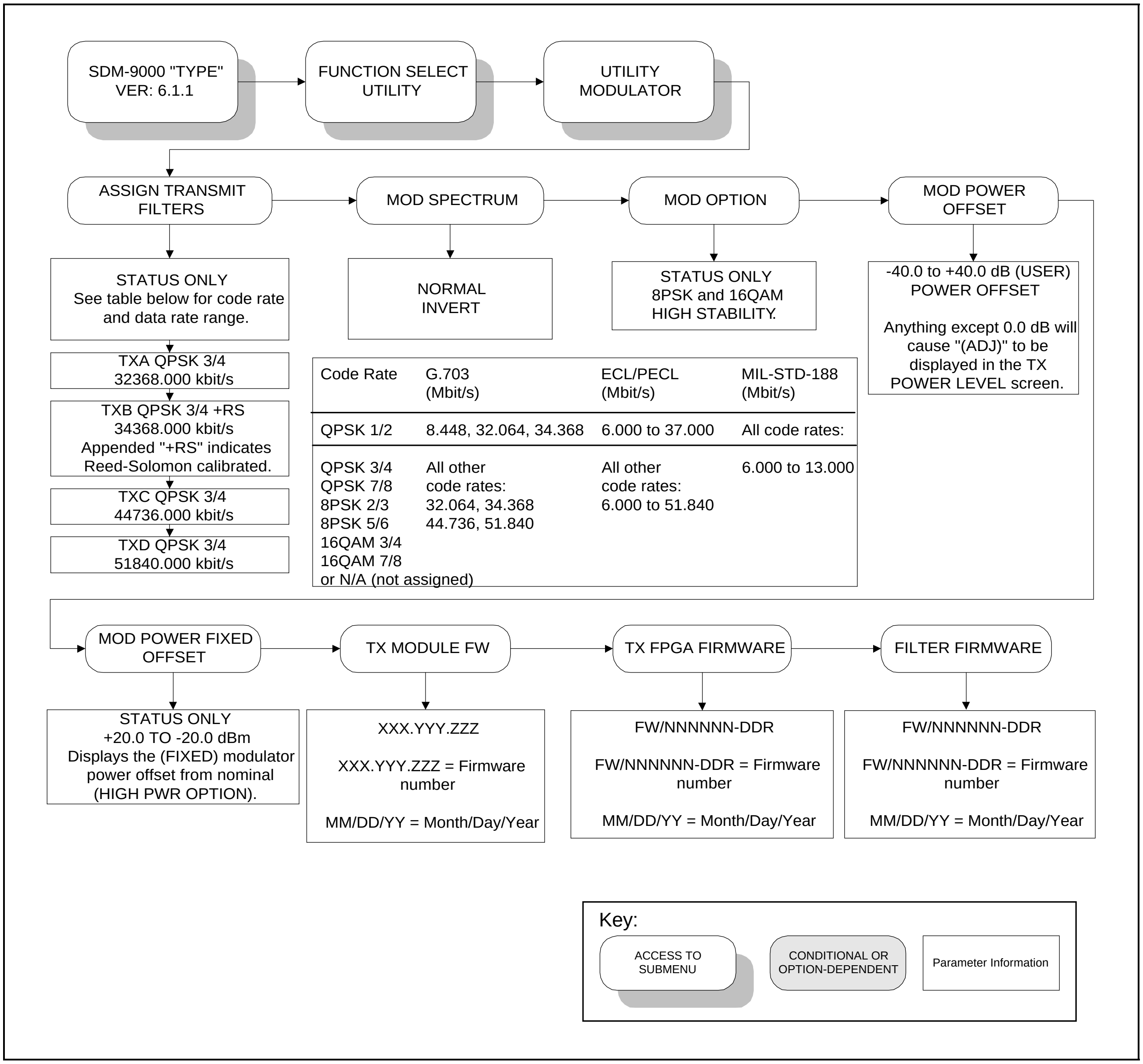
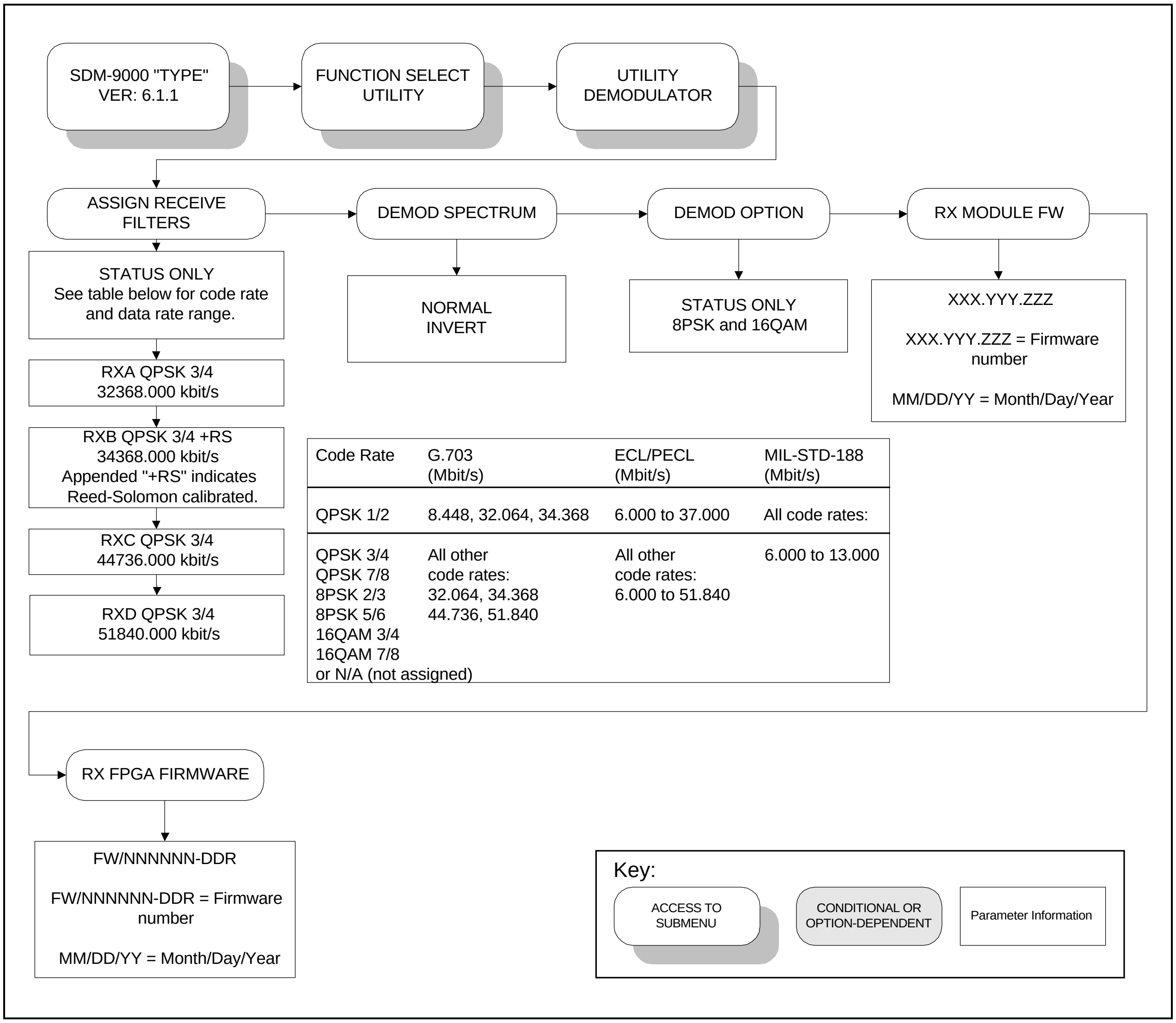


Figure 4-11. Utility Modulator Menu

4.2.5.1 Utility Modulator

ASSIGN TX FILTERS	TX filter display utility. Used to view filter rate assignments. The modulator has up to four symbol rate filters. Filters are designated as A, B, C, and D. To view the assignments, press [ENTER]. TXA appears on line 1 of the display, which indicates TX filter A. The code rate follows TXA on line 1. Line 2 displays the data rate assigned to preset A. Press [←] or [→] to view the assignments for B, C, and D (TXB, TXC, and TXD). **Notes:** 1. These assignments are used for the selection of TX rate in the Configuration Functions menu. 2. If the filter is optimized for Reed-Solomon, "+RS" will be appended to the code rate. 3. Refer to the table in Figure 4-11 for code rates and data rate ranges.
MOD SPECTRUM	Programmable vector rotation. Allows the operator to select Normal or Inverted for spectrum reversal of the I and Q baseband channels.
MOD OPTION	This program displays the following modulator options: • 8PSK and 16QAM • High Stability **Note:** This menu is status only.
MOD POWER OFFSET	Modulator power adjust offset. Allows the operator to offset the modulator output power readout in the Configuration menu. This feature does not actually change the modulator power level. The function is to change the actual reading to display an offset value in the monitor. The modulator power offset can be set from -40.0 to +40.0 dB, in 0.1 dB steps. **Note:** Anything except 0.0 dB will cause "ADJ" to be displayed in the TX power level screen.
MOD POWER FIXED OFFSET	Modulator power fixed (status only). Indicates the power of a modulator that has been provided with extra gain (+20.0 to -20.0 dBm). **Note:** This screen displays the fixed modulator power offset for nominal high power options. (+10 dBm is standard.)
TX MODULE FIRMWARE	Displays the TX module firmware version installed in TX module. The display includes the month, day, and year.
TX FPGA FIRMWARE	Displays the firmware installed in the TX field programmable gate array. The display includes the month, day, and year.
FILTER FIRMWARE	Displays modulator pre-filter information. The display includes the month, day, and year.



Code Rate	G.703 (Mbit/s)	ECL/PECL (Mbit/s)	MIL-STD-188 (Mbit/s)
QPSK 1/2	8.448, 32.064, 34.368	6.000 to 37.000	All code rates:
QPSK 3/4 QPSK 7/8 8PSK 2/3 8PSK 5/6 16QAM 3/4 16QAM 7/8 or N/A (not assigned)	All other code rates: 32.064, 34.368 44.736, 51.840	All other code rates: 6.000 to 51.840	6.000 to 13.000

Figure 4-12. Utility Demodulator Menu

4.2.5.2 Utility Demodulator

ASSIGN RX FILTERS	RX filter display utility. Used to view filter rate assignments. The modulator has up to four symbol rate filters. Filters are designated as A, B, C, and D. To view the assignments, press [ENTER]. RXA will be on line 1 of the display, which indicates TX filter A. Following RXA on line 1 will be the code rate (1/2, 3/4, or 7/8). On line 2 will be the data rate assigned to preset A. Press [←] or [→] to view the assignments for B, C, and D (RXB, RXC, and RXD). **Notes:** 1. These assignments are used for the selection of RX rate in the Configuration Functions menu. 2. If the filter is optimized for Reed-Solomon, “+RS” will be appended to the code rate. 3. Refer to the table in Figure 4-12 for code rates and data rate ranges.
DEMOD SPECTRUM	Programmable vector rotation. Allows the operator to select Normal or Inverted for spectrum reversal of the I and Q baseband channels.
DEMOD OPTION	This program displays the 8PSK and 16QAM option. **Note:** This menu is status only.
RX MODULE FIRMWARE	Displays the RX module firmware version installed in RX module. The display includes the month, day, and year.
RX FPGA FIRMWARE	Displays the firmware installed in the RX field programmable gate array. The display includes the month, day, and year.

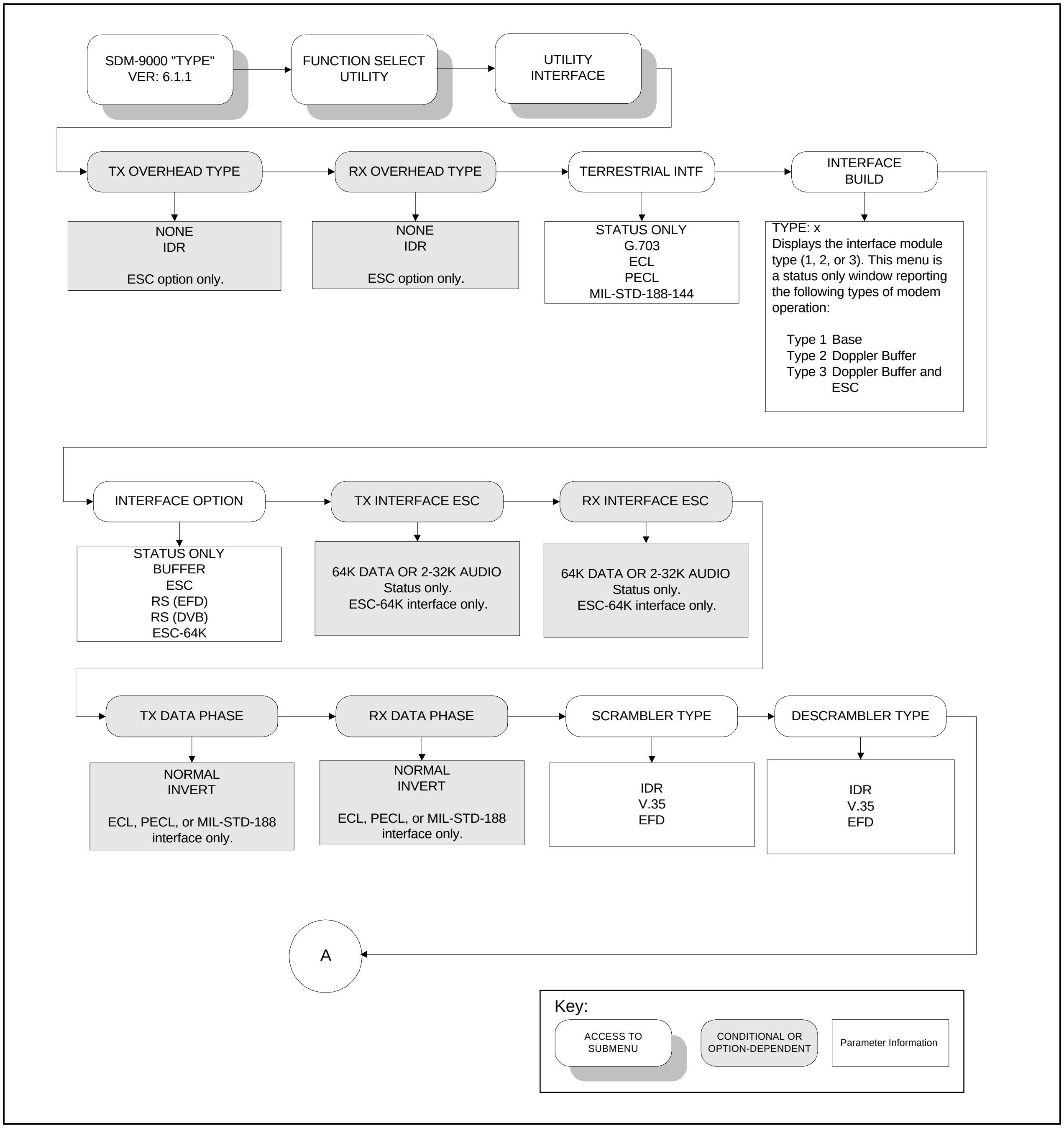


Figure 4-13. Utility Interface Menu

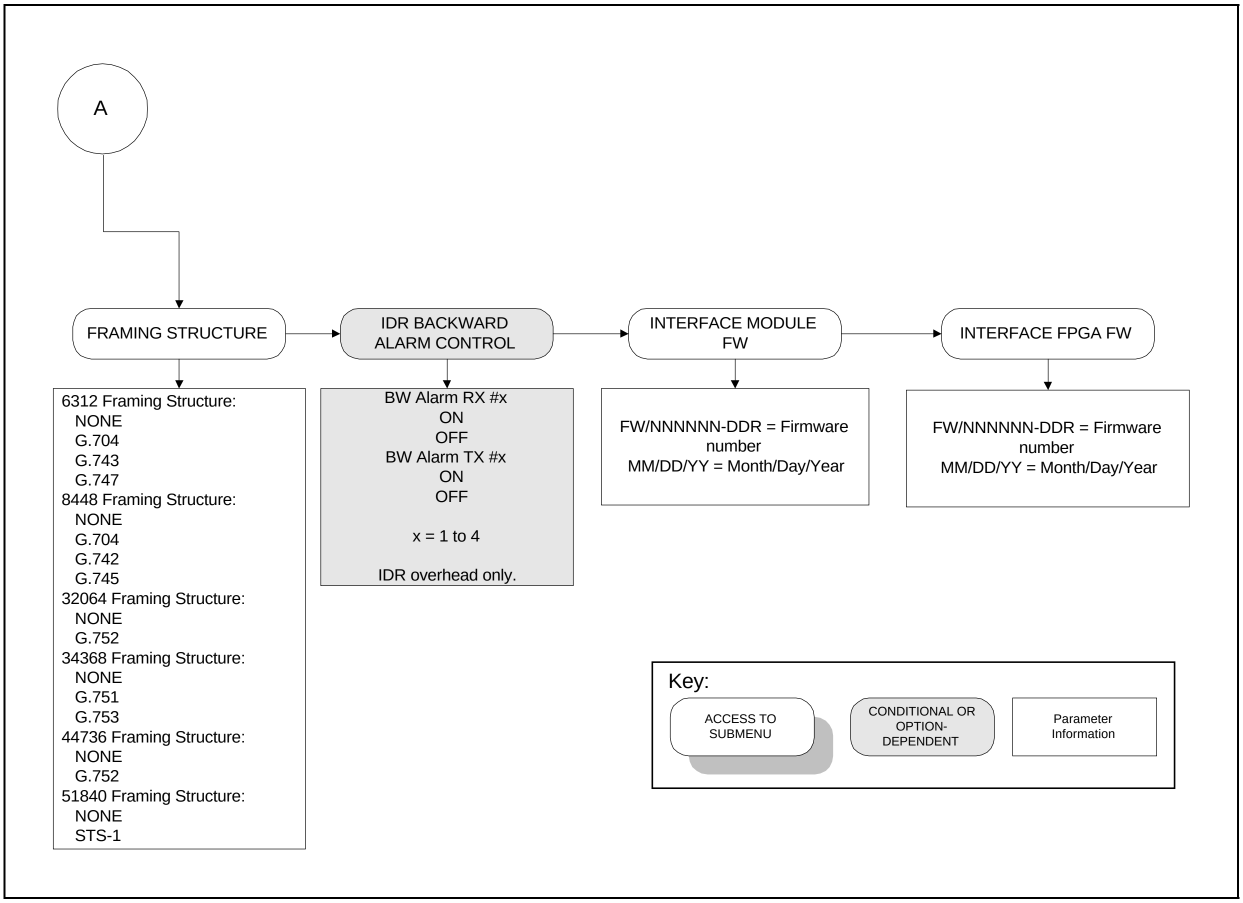


Figure 4-13. Utility Interface Menu Continued

4.2.5.3 Utility Interface

TX OVERHEAD TYPE	Select IDR or None for TX overhead type. **Note:** The ESC option must be installed.
RX OVERHEAD TYPE	Select IDR or None for RX overhead type. **Note:** The ESC option must be installed.
TERRESTRIAL INTF	Displays the following interface type: • G.703 • ECL • PECL • MIL-STD-188
INTERFACE BUILD	Displays the interface module type (1, 2, or 3). This menu is a status-only window reporting the following four types of modem operation: • Type 1 Base • Type 2 Doppler Buffer • Type 3 Doppler Buffer and ESC
INTERFACE OPTION	This menu is a status-only window reporting the interface options. The interface module options displayed are: • Buffer • ESC • RS (EFD) • RS (DVB) • ESC-64K
TX INTERFACE ESC	This menu is a status-only window reporting the status of the ESC interface. The TX options displayed are: • 64K Data • 2-32K Audio
RX INTERFACE ESC	This menu is a status-only window reporting the status of the ESC interface. The RX options displayed are: • 64K Data • 2-32K Audio
TX DATA PHASE	Allows the user to invert TX data coming from the terrestrial network. On entry, press [←] or [→] to select Normal or Inverted. Press [ENTER] to execute the change. **Note:** This menu is only available for the ECL, PECL, or MIL-STD-188 interface.

RX DATA PHASE	Allows the user to invert RX data going to the terrestrial network. On entry, press [←] or [→] to select Normal or Inverted. Press [ENTER] to execute the change. **Note:** This menu is only available for the ECL, PECL, or MIL-STD-188 interface.
SCRAMBLER TYPE	Programs the scrambler for the following types of operation: • IDR (per IESS-308) • V.35 (per CCITT V.35) • EFD (SDM-450 compatible) On entry, the current status of the scrambler is displayed. Press [←] or [→] to select the type. Press [ENTER] to execute the change.
DESCRAMBLER TYPE	Programs the descrambler for the following types of operation: • IDR (per IESS-308) • V.35 (per CCITT V.35) • EFD (SDM-450 compatible) On entry, the current status of the descrambler is displayed. Press [←] or [→] to select the type. Press [ENTER] to execute the change.
FRAMING STRUCTURE	Displays the currently selected framing type and structure of the data. Framing Type — Framing Structure 6312 — NONE, G.704, G.743, or G.747 8448 — NONE, G.704, G.742, or G.745 32064 — NONE or G.752 34368 — NONE, G.751, or G.753 44736 — NONE or G.752 51840 — NONE or STS-1
IDR BACKWARD ALARM CONTROL	Controls IDR monitor and alarm functions when not using a communications link. Allows the user to select ON or OFF for the RX and TX alarms. Press [←] or [→] to select BW alarm RX or TX numbers 1 through 4. Press [ENTER] to execute the change.
INTERFACE MODULE FIRMWARE	Displays the current version of the interface module firmware. The display includes the month, day, and year.
INTERFACE FPGA FIRMWARE	Displays the current firmware installed in the interface field programmable gate array. The display includes the month, day, and year.

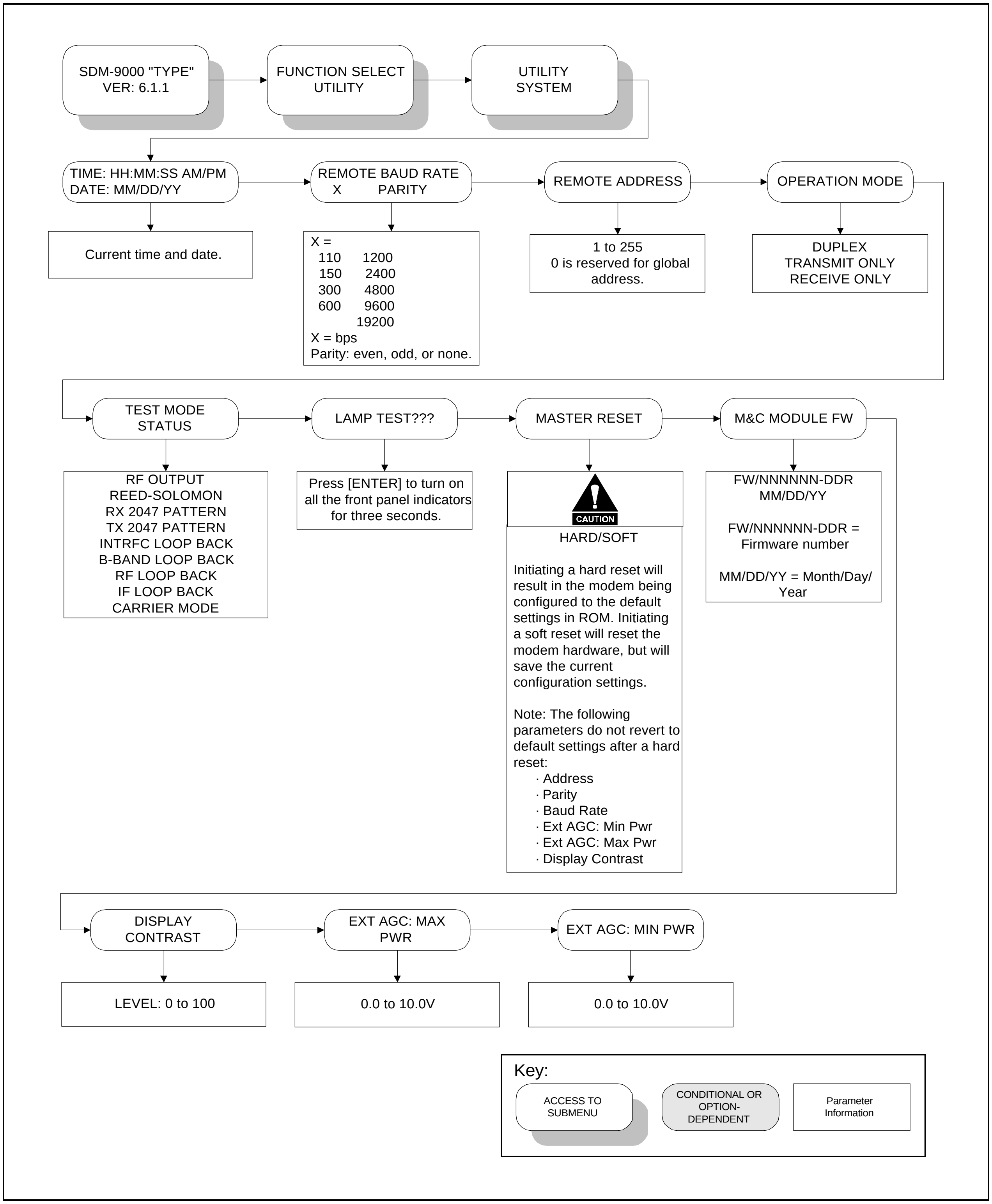


Figure 4-14. Utility System Menu

4.2.5.4 Utility System

TIME/DATE	Displays current time and date. To set the modem time and/or date, press [ENTER]. Press [←] or [→] to position the flashing cursor over the parameter to be changed. Press [↑] or [↓] to change the parameter to the desired value. Once the parameters are displayed as desired, press [ENTER] to execute the change.
REMOTE/BAUD RATE/PARITY	The current parity and baud rate of the modem are displayed. The parity can be set to: • Even • Odd • None The baud rate can be set from 110 to 19200 bit/s. To set the modem baud rate and/or parity, press [ENTER]. Press [←] or [→] to position the flashing cursor over the parameter to be changed. Press [↑] or [↓] to change the parameter to the desired value. Once the parameters are displayed as desired, press [ENTER] to execute the changes.
REMOTE ADDRESS	The current modem address is displayed (1 to 255). To set the remote address, press [ENTER]. Press [↑] or [↓] to change the parameter to the desired value. Press [ENTER] to execute the change.
OPERATION MODE	Operation mode. Programs the modem operation for the following operation: • Duplex • TX-only • RX-only On entry, the flashing cursor is displayed. Press [←] or [→] to select TX only, RX-only, or Duplex. Press [ENTER] to execute the change. **Note:** When TX-only or RX-only is selected, the appropriate faults are masked from the Faults and Stored Faults menu.

TEST MODE STATUS	Test mode status indicator. The following modem test points are listed in this window and will display a “+” when a test mode is active: • RF Output • Reed-Solomon • RX 2047 Pattern • TX 2047 Pattern • Interface Loopback • B-Band Loopback • RF Loopback • IF Loopback • Carrier Mode To view the test modes, press [ENTER]. Press [←] or [→] to move through the list of test modes.
LAMP TEST ??	Lamp test function to test all the front panel indicators. Press [ENTER] to turn on all of the front panel indicators for three seconds.
MASTER RESET	Master reset function. • HARD resets the switch to the defaults in ROM. • SOFT resets the switch to stored configuration. CAUTION ***Initiating a hard reset will result in the modem being configured to the default settings in ROM. Initiating a soft reset will reset the modem hardware, but will save the current configuration settings.*** **Note:** The following parameters do not revert to default settings after a hard reset: • Address • Parity • Baud Rate • Ext AGC: Min Pwr • Ext AGC: Max Pwr • Display Contrast Press [ENTER] to begin. Press [←] or [→] to select HARD or SOFT. Press [ENTER], then press [→] five times so the cursor is on YES. Press [ENTER] twice to reset.
M&C MODULE FW	Displays the M&C module firmware version. The display includes the month, day, and year.
DISPLAY CONTRAST	Sets the contrast setting of the front panel menu from 0 to 100%. Press [ENTER] to change the contrast of the front panel display. Press [↑] or [↓] to increment or decrement the number at the flashing cursor from 0 to 100. Press [ENTER] to execute the change.

EXT AGC: MAX PWR	Sets the AGC voltage for an RX signal level of -25 dBm. The voltage range is 0.0 to 10.0V, in 0.5V steps. On entry, the current external AGC voltage level is displayed. Press [↑] or [↓] to change the AGC voltage level in 0.5V steps. Press [ENTER] to execute the change. **Note:** For any RX signal level between -25 and -50 dBm, the software will interpolate the required AGC voltage.
EXT AGC: MIN PWR	Sets the AGC voltage for an RX signal level of -50 dBm. The voltage range is 0.0 to 10.0V, in 0.5V steps. On entry, the current external AGC voltage level is displayed. Press [↑] or [↓] to change the AGC voltage level in 0.5V steps. Press [ENTER] to execute the change. **Note:** For any RX signal level between -25 and -50 dBm, the software will interpolate the required AGC voltage.

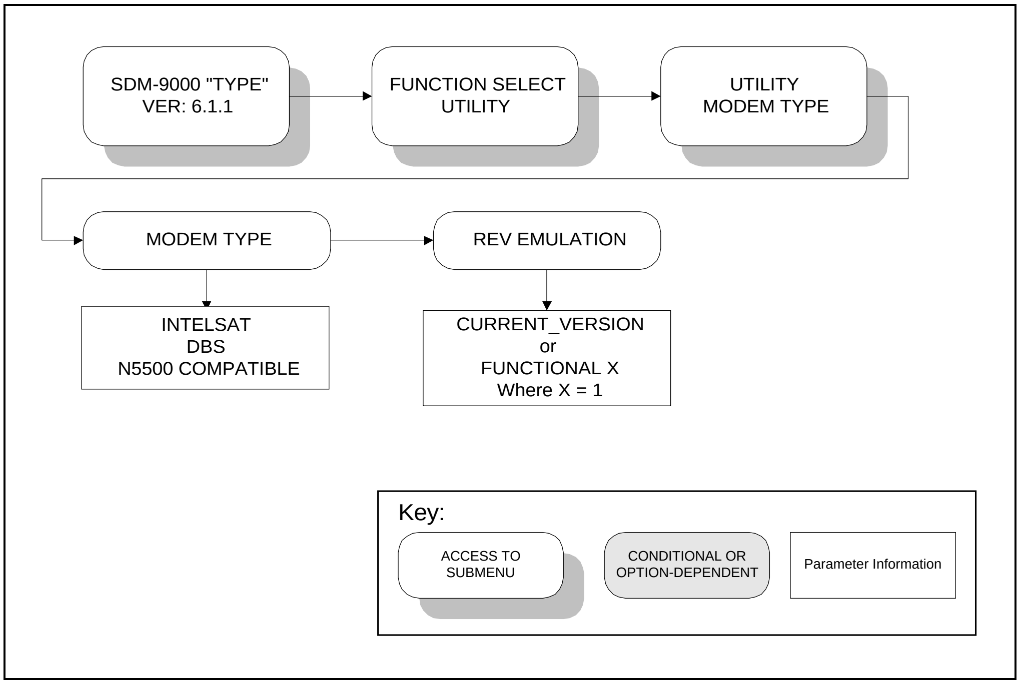


Figure 4-15. Utility Modem Type Menu

4.2.5.5 Utility Modem Type

<table>
<tr><td>MODEM TYPE</td><td>Programs the modem to operate as one of the following types:
INTELSAT
DBS
N5500 compatible
On entry, the flashing cursor is displayed. Press [←] or [→] to select INTELSAT, DVB, or N5500. Press [ENTER] to execute the change.</td></tr>
<tr><td>REV EMULATION</td><td>Programs an emulation mode of a previous functional revision. This allows the user to select the CURRENT_VERSION or Functional version (X).

Note: The Utility menu numbers will increase with each software version change (current version is 6.1.1). Refer to Chapter 3 for a description of the software configuration.

On entry, the CURRENT_VERSION is displayed. Press [←] or [→] to select the functional versions. Press [ENTER] to execute the change.

Notes:
Programming a current version (default) allows all features and options (if installed) to operate normally.
Programming a function eliminates anything that affects the later version. Only functional changes are affected by the revision emulation feature.
A correction change (e.g., VER 1.1.1) remains fixed in accordance with the latest version. Since the revision emulation default is the current version, the user must program the functional version at the start of each operation.
The revision emulation feature does not affect some user interface changes for the direct operation of the modem (configuration save/recall, test mode screen in the Utility/System, all factory setup modes, etc.).</td></tr>
</table>

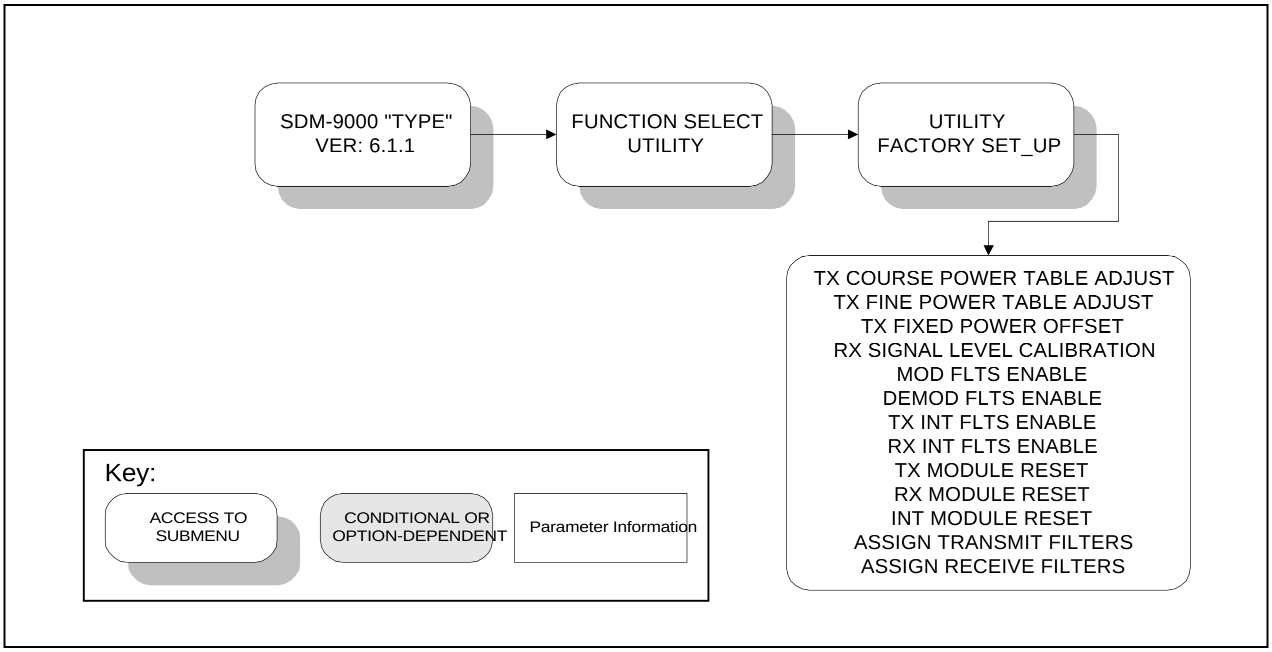


Figure 4-16. Utility Factory Setup Menu

4.2.5.6 Utility Factory Setup

CAUTION

This configuration is used for factory alignment. Factory setup should not be changed by unauthorized persons. To do so may cause modem failure.

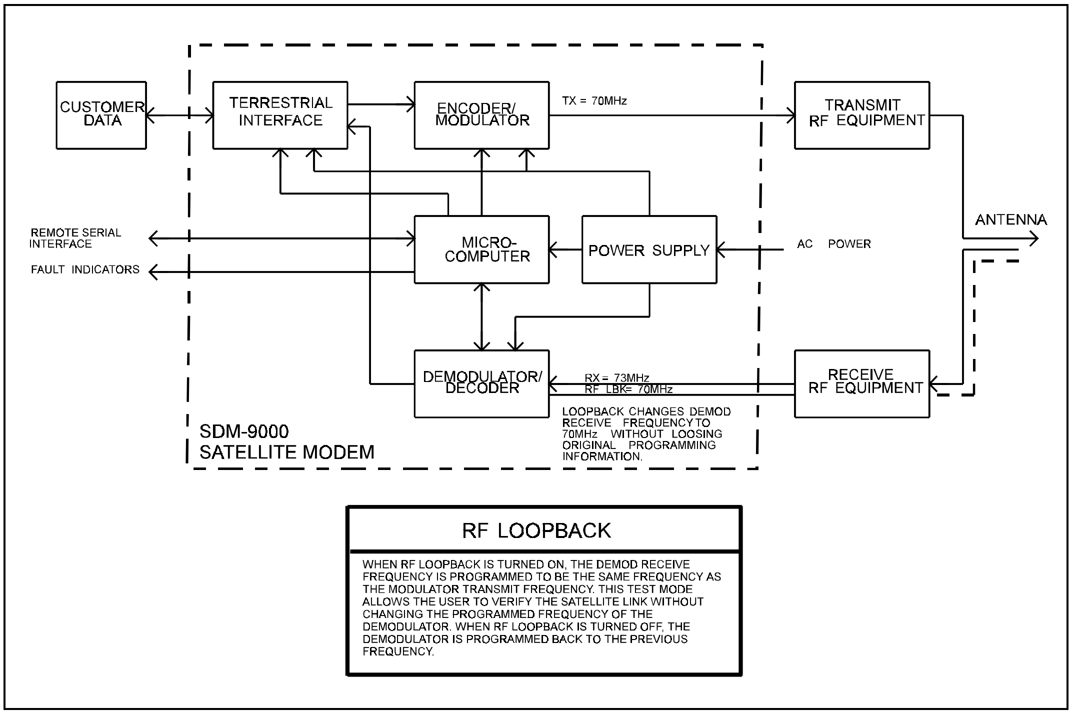


Figure 4-17. RF Loopback

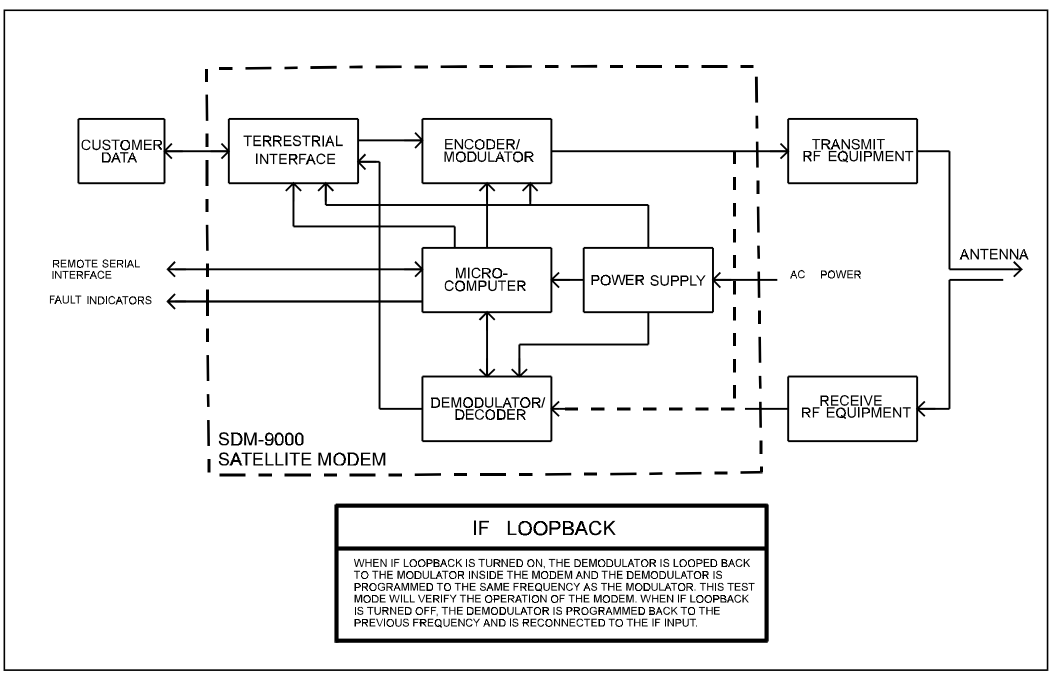


Figure 4-18. IF Loopback

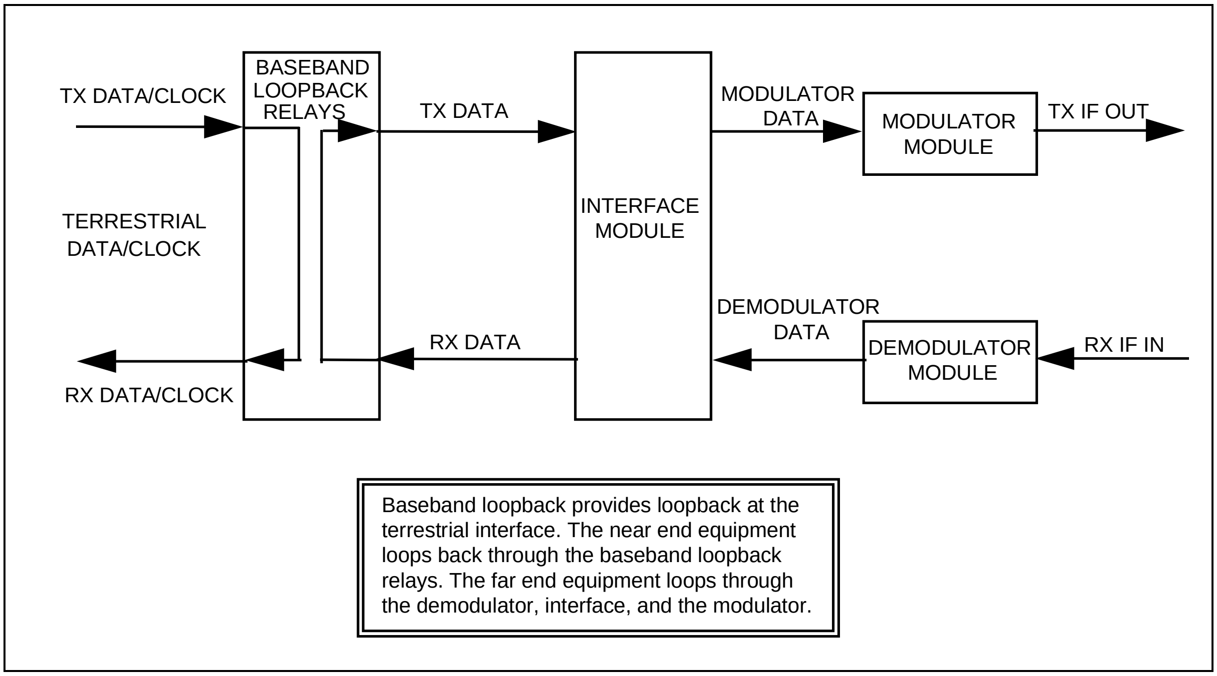


Figure 4-19. Baseband Loopback

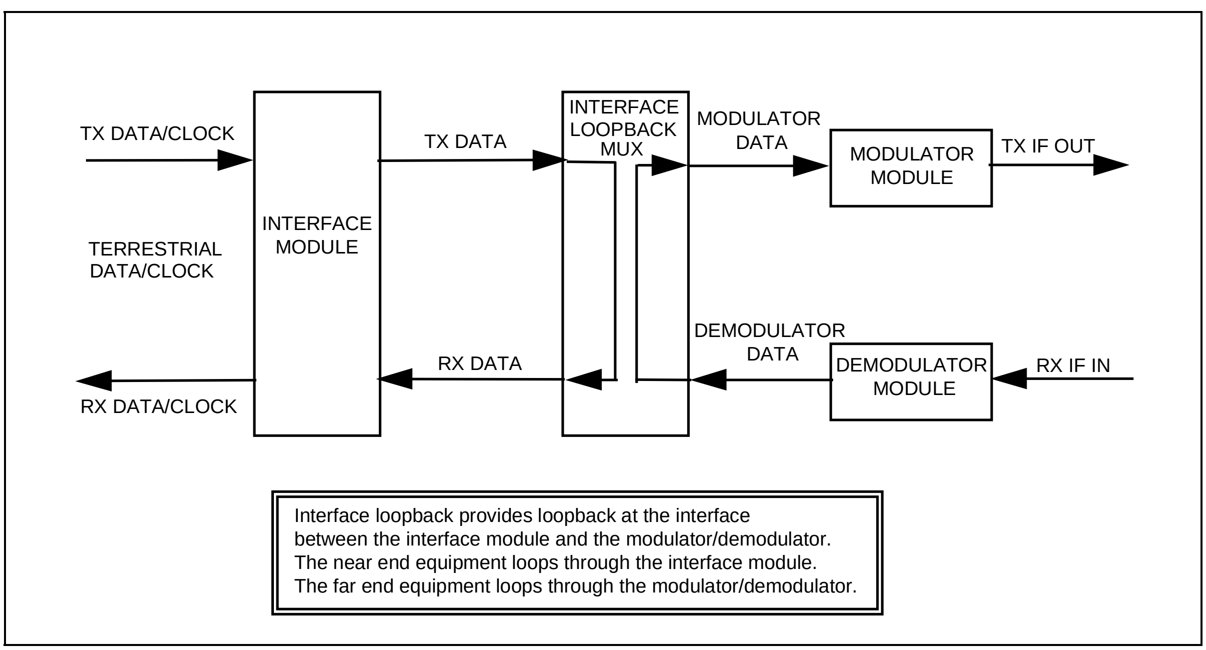


Figure 4-20. Interface Loopback

4.3 Clocking Options

Clocking of data between the terrestrial network and the satellite network depends on the application. Sections 4.3.1 and 4.3.2 define the G.703 and ECL/MIL-STD-188 clocking configurations.

4.3.1 G.703 Interface Clocking

Refer to Figure 4-21 for the clocking diagram.

4.3.1.1 TX Timing

The TX timing for the G.703 interface is always recovered from the send data supplied by the terrestrial network. The recovered TX terrestrial clock is used as the reference to send information over the satellite network.

4.3.1.2 RX Timing

The RX (satellite) clock is recovered from information demodulated and decoded from the satellite network.

4.3.1.2.1 RX Timing (with Buffer)

If a plesiochronous/Doppler buffer is used, data received from the satellite network is clocked into the buffer using the RX (satellite) clock. Data is clocked out of the buffer and to the terrestrial network referenced to one of the four selectable clock sources listed in the table below:

INTERNAL CLOCK	Generated internal to the modem
TX TERRESTRIAL CLOCK	Recovered from the terrestrial send data
EXT. REF. CLOCK	External reference supplied by the terrestrial network
RX CLOCK *(See note)*	Recovered from the RX satellite network

Note: When the RX clock is selected as the buffer clock source, the input and output of the buffer are clocked by the same source. In this mode, the buffer is virtually bypassed with a delay defined by the selected buffer size.

4.3.1.2.2 RX Timing (without Buffer)

If a plesiochronous/Doppler buffer is not used, RX data from the satellite network is clocked to the terrestrial network using the RX (satellite) clock.

4.3.2 ECL/MIL-STD-188 Interface Clocking

Refer to Figure 4-22 for the clocking diagram.

4.3.2.1 TX Timing

The TX timing for the ECL/MIL-STD-188 interface is always provided with the send data supplied by the terrestrial network. The TX clock provided by the terrestrial network is used as the reference to send information over the satellite network.

The modem provides a send timing reference clock to the terrestrial equipment. This clock is internally generated by the modem and can be used to time the send data to the modem. Optionally, the send timing reference can be switched to loop timing mode. The loop timing mode provides the RX (satellite) clock as the send timing reference.

4.3.2.2 RX Timing

The RX (satellite) clock is recovered from information demodulated and decoded from the satellite network.

4.3.2.2.1 RX Timing (with Buffer)

If a plesiochronous/Doppler buffer is used, data received from the satellite network is clocked into the buffer using the RX (satellite) clock. Data is clocked out of the buffer and to the terrestrial network referenced to one of the four selectable clock sources listed in the table below:

INTERNAL CLOCK	Generated internal to the modem.
TX TERRESTRIAL CLOCK	Provided by the terrestrial network.
EXT. REF. CLOCK	External reference supplied by the terrestrial network.
RX CLOCK *(See note)*	Recovered from the RX satellite network.

Note: When the RX clock is selected as the buffer clock source, the input and output of the buffer are clocked by the same source. In this mode, the buffer is virtually bypassed with a delay defined by the selected buffer size.

4.3.2.2.2 RX Timing (without Buffer)

If a plesiochronous/Doppler buffer is not used, data received from the satellite network is clocked to the terrestrial network using the RX (satellite) clock.

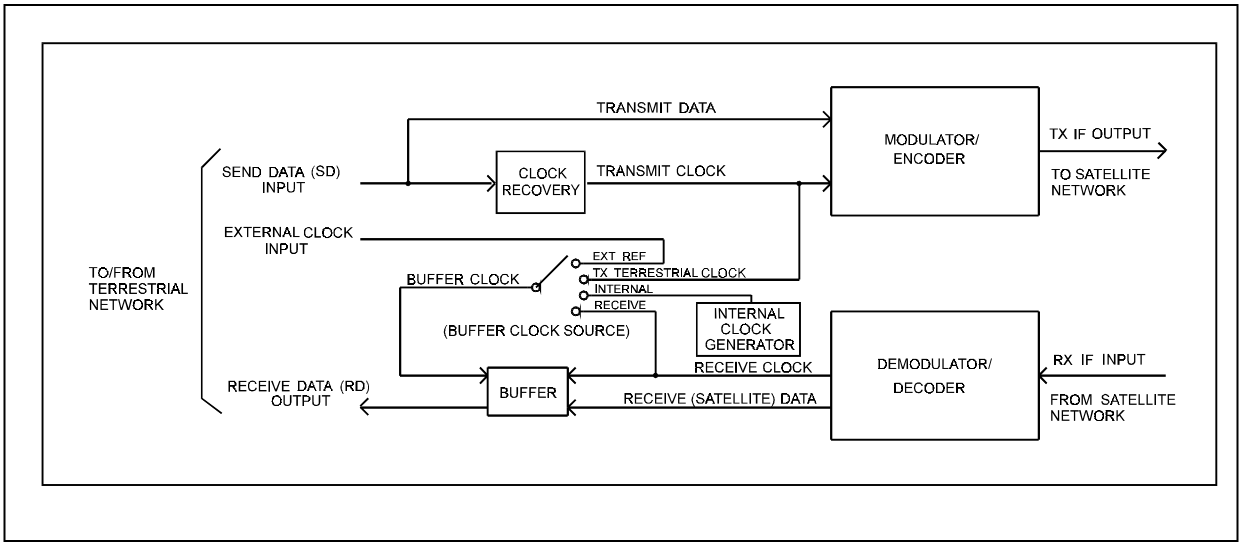


Figure 4-21. G.703 Interface Clocking Diagram

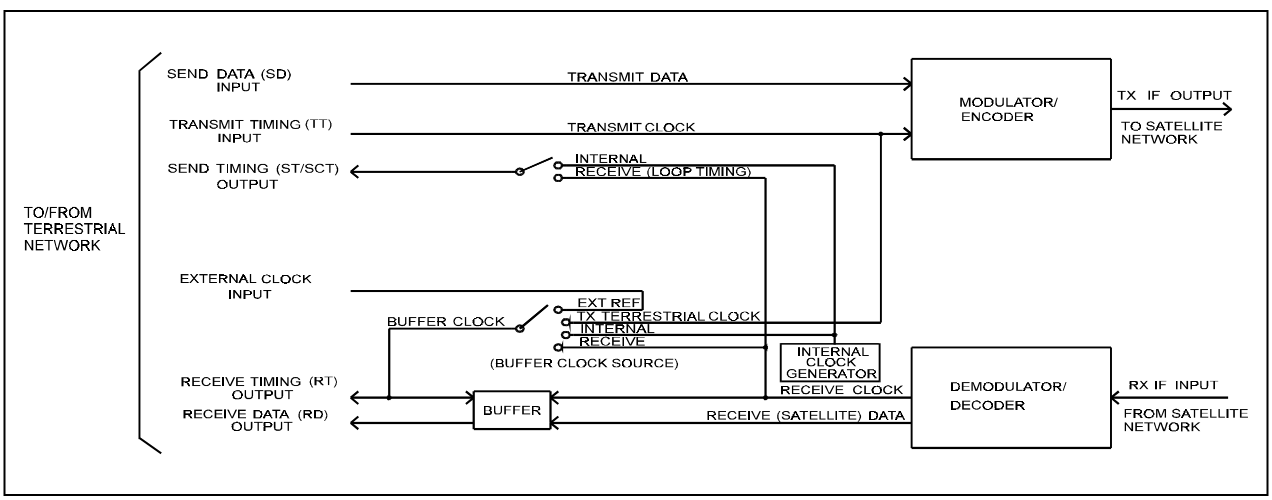


Figure 4-22. ECL/MIL-STD-188 Interface Clocking Diagram

Chapter 5. THEORY OF OPERATION

This chapter includes theory of operation for the various PCBs in the modem.

5.1 Display/M&C

5.1.1 Description

The display/Monitor & Control (M&C) PCB is located on the front panel. The M&C monitors the modem and provides configuration updates to other modules within the modem when necessary.

The modem configuration parameters are maintained in battery-backed Random Access Memory (RAM), which provides total recovery after a power-down situation. The M&C functions include extensive fault monitoring and status reporting. All modem functions are accessible through a local front panel interface and a remote communications interface.

Refer to Figure 3-1 for a drawing of the M&C card. A block diagram of the M&C is shown in Figure 5-1.

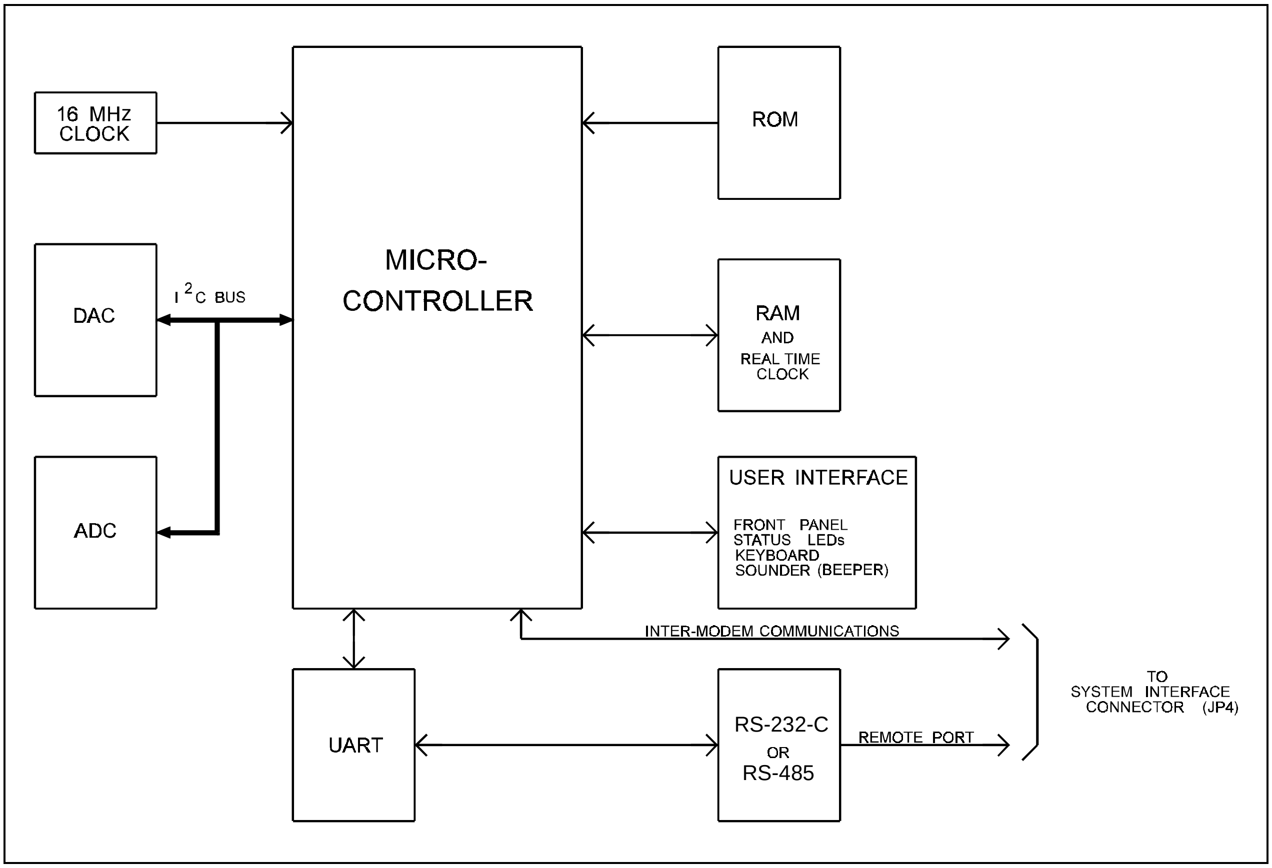


Figure 5-1. Display/M&C Block Diagram

5.1.2 Theory of Operation

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

- Microcontroller
- Digital-to-Analog Converter (DAC)
- Read Only Memory (ROM)
- Analog-to-Digital Converter (ADC)
- RAM
- Inter-modem communications
- Front panel user interface
- Remote communications (RS-232/RS-485) user interface

The heart of the M&C card is the Intel 80C32 (or a compatible microcontroller) operating at 16 MHz. This microcontroller contains 256 kbytes of internal RAM. At U17, a ROM can be:

- 27C010 (128 kbytes)
- 27C020 (256 kbytes)
- 27C040 (512 kbytes)

ROM access times must be ≥ 200 ns. The correct ROM size can be set by jumpers JP9 and JP10. The RAM can be 8 or 32 kbytes in size. This RAM chip is internally battery-backed and contains a real time clock used by the M&C.

The nonvolatile RAM on the M&C module will retain configuration information without prime power for up to one year. 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 nonvolatile memory to see if valid data has been retained. If valid data has been retained, the modem is reconfigured to those parameters.

2. If the nonvolatile 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 bit/s. The UART is memory mapped to the microcontroller. The communications type can be RS-232 or RS-485 (set with M&C jumpers JP1 and JP5). For RS-485 communications, 2- or 4-wire operation can be set by jumpers JP2 and JP3. The remote port is connected to the M&C system interface connector (JP4).

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 I^2C bus.

The inter-modem communications use the internal serial port located in the microcontroller. The inter-modem communications are connected to the M&C system interface connector (JP4) for communication between the modulator, demodulator, and interface cards.

The user interface includes the following parts:

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

All functions are memory mapped to the microcontroller.

5.2 Modulator

5.2.1 Description

The modulator PCB fits in the top slot of the modem chassis. The card provides a modulated carrier of 50 to 180 MHz from the interface PCB digital data stream. The types of modulation performed on the transmitted baseband data are:

- QPSK
- 8PSK (optional)
- 16QAM (optional)

The optional 8PSK and 16QAM modulation provide increased bandwidth efficiency over that of the standard QPSK. Refer to Section 5.6 for a description of the modulation types.

Figure 3-2 shows the modulator PCB. A block diagram of the modulator baseband section is shown in Figure 5-2, and the modulator RF section in Figure 5-3. All modulator jumper settings are listed in Table 3-2.

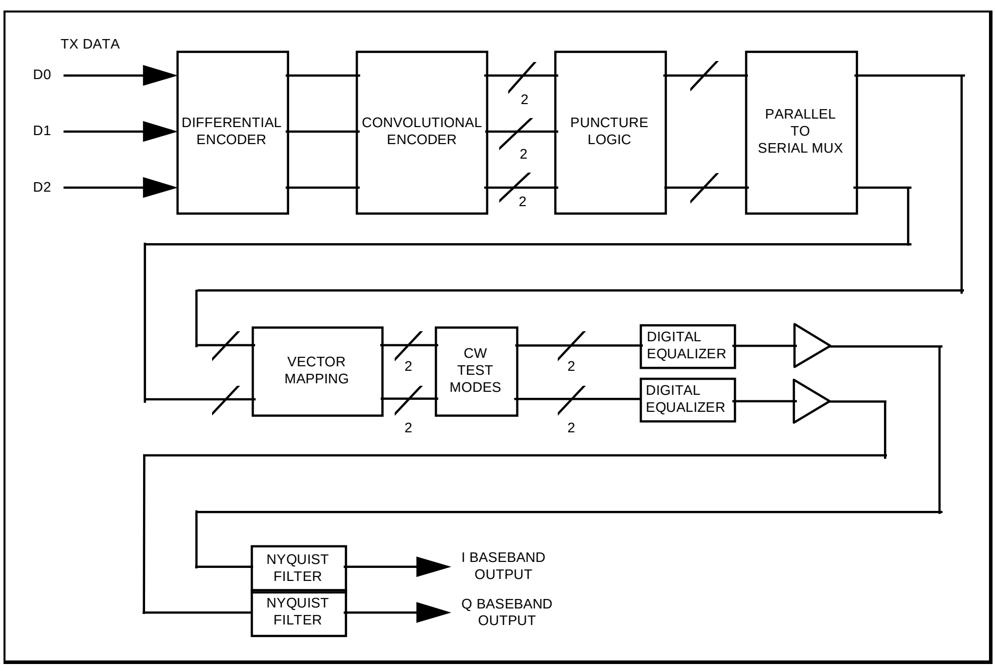


Figure 5-2. Modulator Baseband Section Block Diagram

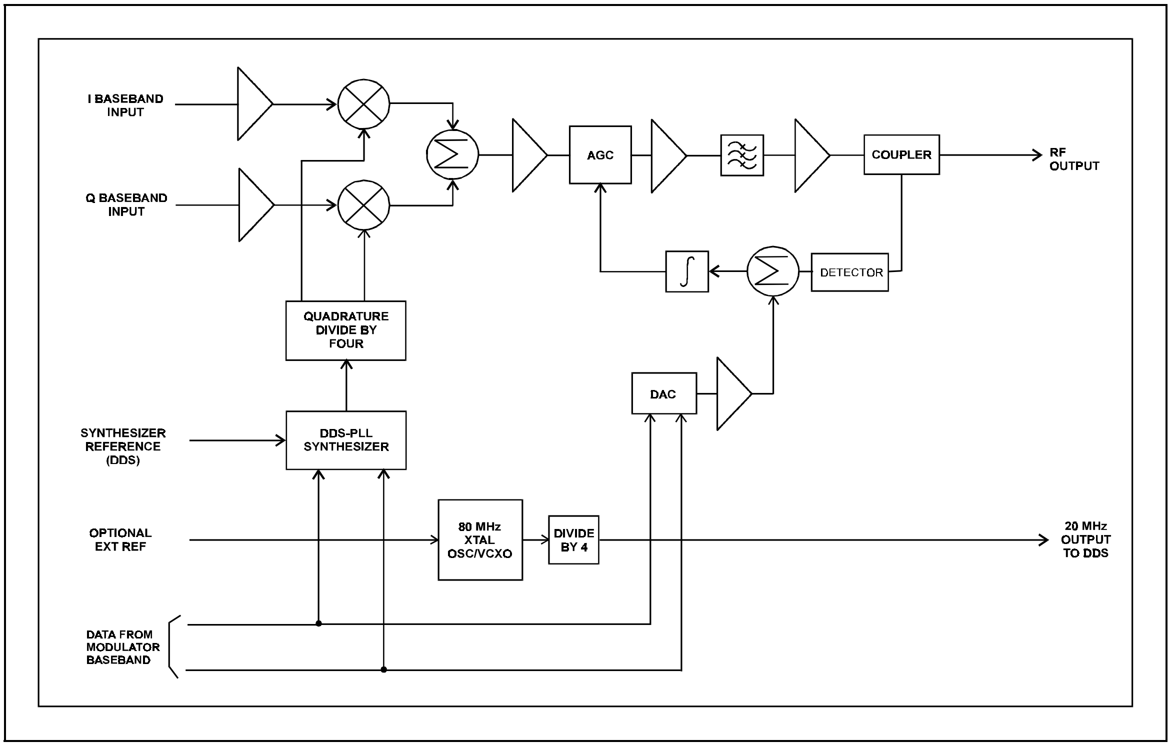


Figure 5-3. Modulator RF Section Block Diagram

5.2.2 Specifications

Modulation Types	• QPSK • 8PSK (optional) • 16QAM (optional)
Data Rate Range	6.0 to 52.0 Mbit/s (Four data rate plug-on module)
Symbol Rate Range	1.7 to 37.6 Ms/s
Frequency Range	50 to 180 MHz
Frequency Select Method	Synthesized
Frequency Step Size	2.5 kHz
Frequency Stability	Internal Reference: ± 10 PPM oscillator 0.2 PPM high stability option External Reference (supported with High Stability Option): Will lock to external 5, 10, or 20 MHz reference
Phase Error	2.0° maximum
Filtering Type	Nyquist, pre-equalized
Spectral Occupancy	Spectral density is -30 dB at ± 0.75 symbol rate
Spurious and Harmonics	-55 dBc
Output Power	-20 to +5 dBm, in 0.1 dB steps
Output Power Stability	± 0.5 dB
Output Power Adjustment	0.1 dB step size
Output Impedance	75Ω (50Ω optional)
Output Return Loss	> 18 dB
Differential Encoding	2-phase or none
FEC Encoding	• Convolutional, K = 7 • QPSK rates 1/2, 3/4, 7/8 • 8PSK rates 2/3, 5/6 (Trellis) • 16QAM rates 3/4, 7/8
I/O Connector	96-pin DIN
Reported Faults	• IF Synthesizer • Data Clock Activity • Data Clock Synthesizer • I Channel Activity • Q Channel Activity • AGC Level • External SCT Synthesizer • External Reference Activity

5.2.3 Theory of Operation

The modulator PCB is composed of eight basic subsections. The first five subsections comprise the baseband processing circuits, and the last three form the RF circuits.

Baseband Section	Slave processor Differential encoder Convolutional encoder Digital FIR equalizer filter Analog Nyquist filter
RF Section	Quadrature modulator IF strip RF synthesizer

The modulator M&C controls all the programmable functions of the module. Fault information from the modulator is sent to the host M&C. Faults reported include:

- IF Synthesizer
- Data Clock Activity
- Data Clock Synthesizer
- I Channel Activity
- Q Channel Activity
- AGC Level
- External SCT Synthesizer
- External Reference Activity

The data for transmission comes from the interface card. The data is first differentially encoded (QPSK operation), and then convolutional encoding takes place. For QPSK modulation, processing is done in accordance with IESS-308 for data rates above 10 Mbit/s.

Each of the three encoders output two parallel code bits (referred to as a symbol) from every data bit input. The encoder is a 7-bit shift register with two modulo-two adders.

The weighting function is an octal number denoting the taps of the shift register that go to the adders, and are $W_0 = 171$ and $W_1 = 133$. The code bits (designated C_0 and C_1) form the transmission symbol.

The symbols out of the encoder enable the Viterbi decoder at the other end of the link to correct received errors. “Puncturing” is used for 3/4 and 7/8 rate encoding. For 3/4 rate, 3 bits input to the encoder generate 6 parallel code bits out, of which 2 are deleted or “punctured.” For 7/8 rate, 7 bits input to the encoder generate 14 parallel code bits out, but 6 are deleted.

The puncture patterns for the 3/4 and 7/8 rate encoders are as follows:

Puncture Pattern		
Code Rate	**C0**	**C1**
3/4	101	110
7/8	1000101	1111010

Notes:

1. 1 = code bits to be transmitted
2. 0 = deleted code bits

When using 5/6 rate 8PSK operation, 3/4 rate puncturing is used for every five input bits to the encoder. No puncturing is done for 2/3 rate 8PSK. The 16QAM operation is similar to QPSK, except that twice as much information is sent per symbol time as in QPSK.

At the outputs of the encoders, the data is grouped and split into the following number of separate data streams:

Modulation Type	No. of Data Streams
QPSK	2
8PSK	3
16QAM	4

This data is fed into a look-up table for a Digital-to-Analog (D/A) converter to perform amplitude equalization of the rectangular pulses. The amplitude-equalized data is passed to the analog Nyquist filters for spectral shaping, as well as delay equalization.

The pulse-shaped I and Q baseband data is applied to the RF modulator, which performs translation to the desired IF frequency. The RF synthesizer is a hybrid DDS-PLL design, which accommodates a 2.5 kHz step size with low phase noise, using a single loop. The RF section has a stability of ± 10 PPM. An optional high stability TCXO can be installed to provide ± 0.2 PPM stability. The IF strip provides gain and amplitude stabilization to control the output from -20 to +5 dBm, in 0.1 dB steps. An AGC circuit maintains the output level to ± 0.5 dB over frequency and temperature.

5.2.4 Theory of Modulation Types

5.2.4.1 Description

The modulation types for the modem include:

- QPSK
- 8PSK (optional)
- 16QAM (optional)

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 QAM method uses a combination of differential phase shifts and amplitudes totaling 16 different states to represent different bit values.

The order of modulation is represented by mPSK or mQAM, where ***m*** relates to the number of discrete modulation states. The following table is a brief description of the modulation types:

QPSK	4 discrete phase angles represent the 4 possible combinations of 2 symbols.
8PSK	8 discrete phase angles represent 8 possible combinations of 3 symbols generated by the encoder.
16QAM	16 discrete modulation states represent 16 possible combinations of 4 symbols generated by the encoder.

5.2.4.2 QPSK Encoding/Modulation

The modulator converts transmitted baseband data into a modulated QPSK carrier.

Using vector analysis of the constellation pattern, QPSK represents two symbols with the carrier phase angle at 45°, 135°, 225°, or 315°. The 1/1, 1/2, 3/4, and 7/8 rates encoded at the convolutional encoder (k = 7) provide the desired bit rates as follows:

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

5.2.4.3 8PSK Encoding/Modulation

The modulator converts the transmit baseband data into a modulated 8PSK carrier by trellis encoding at 2/3 or 5/6 rate. The 2/3 rate encoder generates 3 symbols for every 2 bits input, while the 5/6 rate encoder generates 6 symbols for every 5 bits input. Using vector analysis of the constellation pattern generated by the modulator, 8 discrete phase angles (0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315°) represent 8 possible combinations of 3 symbols generated by the encoder. The 2/3 and 5/6 rates encoded at the trellis encoder provide the desired bit rates as follows:

Code Rate	Symbols/Bit	Bits/Hz
2/3	1.5	2
5/6	1.2	2.5

In 8PSK operation, the hardware to perform Reed-Solomon block encoding is required to achieve better performance. Refer to Appendix A for details on Reed-Solomon operation.

5.2.4.4 16QAM Encoding/Modulation

The modulator converts the transmit baseband data into a modulated 16QAM carrier at 3/4 or 7/8 rate. The modulator punctures the data by using the industry standard k = 7, 1/2 rate convolutional code and 3/4 and 7/8 punctured patterns. The 3/4 rate convolutional encoder generates 4 symbols for every 3 bits input, while the 7/8 rate convolutional encoder generates 8 symbols for every 7 bits input.

Using vector analysis of the constellation pattern generated by the modulator, 16 discrete phase angle/amplitude states represent the 16 possible combinations of 4 symbols generated by the encoder. The bit rates for 16QAM 3/4 and 7/8 rate convolutional encoding are as follows:

Code Rate	Symbols/Bit	Bits/Hz
3/4	1.33	3
7/8	1.143	3.5

In 16QAM operation, the hardware to perform Reed-Solomon block encoding is required to achieve the best operational characteristics and performance. Refer to Appendix A for information on Reed-Solomon operation.

5.3 Demodulator

5.3.1 Description

The demodulator PCB fits in the bottom slot of the modem chassis. The demodulator converts PSK and QAM modulated carriers within the 50 to 180 MHz range to a demodulated baseband data stream. The demodulator then performs FEC on the data stream, using the Viterbi decoding algorithm.

The converted modulation types are:

- QPSK
- 8PSK (optional)
- 16QAM (optional)

Refer to Section 5.6 for a description of the modulation types. Figure 3-3 shows the demodulator PCB. A block diagram of the demodulator is shown in Figure 5-4, and all demodulator jumper settings are listed in Table 3-3.

5.3.2 Specifications

Modulation Types	QPSK 8PSK (optional) 16QAM (optional)
Data Rate Range	6.0 to 52.0 Mbit/s (four data rate plug-on module)
Symbol Rate Range	1.7 to 37.6 Ms/s
IF Frequency	50 to 180 MHz, in 2.5 kHz steps
Input Power (Desired Carrier)	-45 to -25 dBm
Input Impedance	75Ω (50Ω optional)
Input Return Loss	> 18 dBm
Forward Error Correction	Viterbi k=7
Carrier Acquisition Range	± 60 kHz
Filtering Type	Nyquist

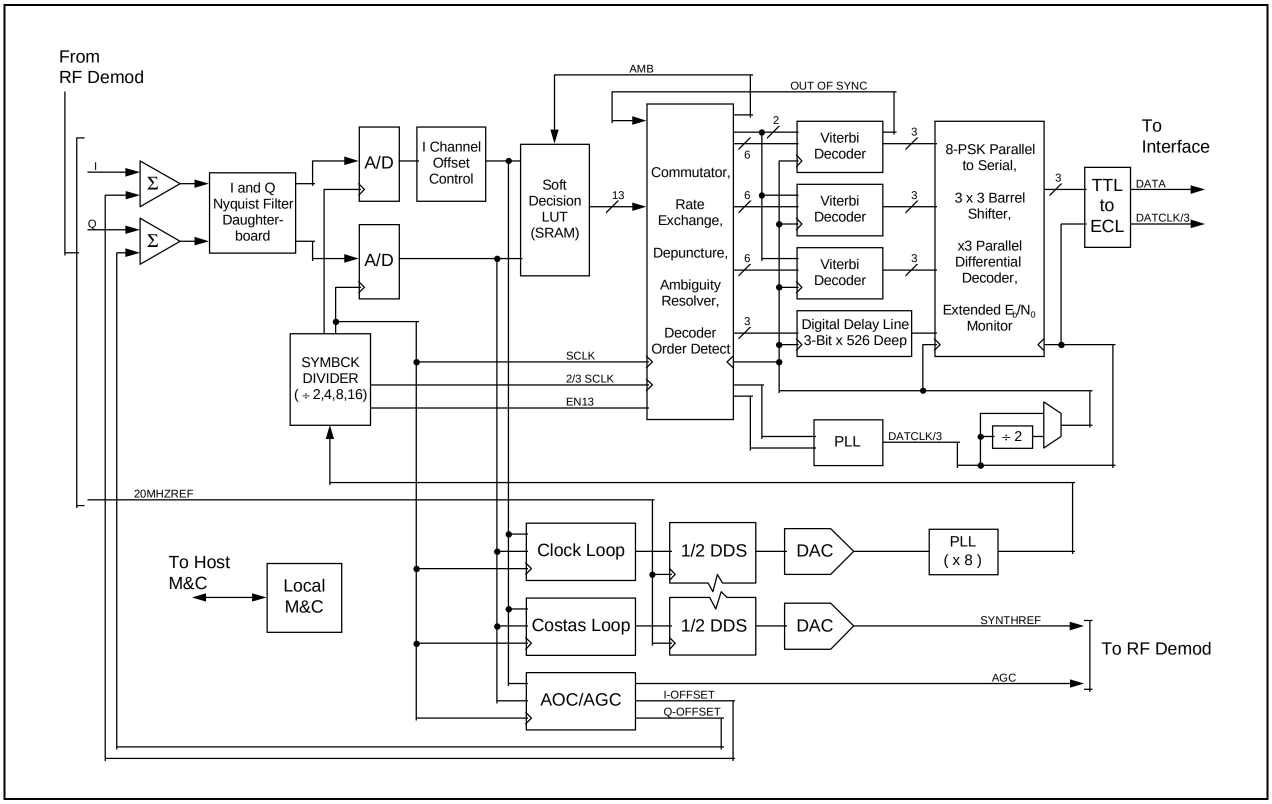


Figure 5-4. Demodulator Block Diagram

5.3.3 Theory of Operation

The demodulator functions as an advanced digital coherent phase-lock receiver and Viterbi decoder. The demodulator is intended to operate at data rates greater than 10 Mbit/s, and complies with the IESS-308 specifications for IDR carriers greater than 10 Mbit/s.

The demodulator provides the following functions:

- Analog-to-Digital (A/D) conversion of analog baseband data using Automatic Gain/Offset Control (AGC, AOC)
- Mapping I and Q values to eight-level soft-decision values
- Commutation of code words to three parallel decoders per IESS-308 specifications for IDR carriers greater than 10 Mbit/s
- Symbol clock to data clock rate exchange and depuncturing (null symbol insertion) logic
- Phase and puncture pattern ambiguity resolution
- Three parallel Viterbi decoders
- Three parallel differential decoders
- A DDS-based digital clock recovery PLL
- A DDS-based digital carrier recovery PLL (Costas Loop)
- Local microprocessor based M&C circuitry for control of all aspects of the demodulator operation, as well as performance and fault reporting to the host M&C

The 50 to 180 MHz modulated IF signal enters the RF Module for conversion to In-phase (I) and Quadrature (Q) analog baseband channels. The I and Q channels are then passed to the Nyquist filter daughter board, where I and Q are filtered through identical analog Nyquist filters. The output of the Nyquist filters is passed back down to the demodulator board through the offset amplifiers and A/D converters. Optionally, the output of the I channel A/D can be delayed by half a symbol period for Offset QPSK operation (OQPSK). The digitized I and Q data is a filtered, digital representation of the received signal.

The digital data is then sent to four separate circuits:

- AGC/AOC
- Carrier recovery (Costas) loop
- Clock recovery loop
- Soft decision mapping

The AGC/AOC provides a gain feedback signal to the RF module, and an offset feedback signal to the offset amplifiers just prior to the Nyquist filters. 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.

The digital Costas loop, in conjunction with a Direct Digital Synthesizer (DDS), performs the carrier recovery function. The Costas loop consists of the following circuits (all implemented digitally):

- Costas phase detector
- Loop filter
- DDS

The DDS performs the function of a VCO in an analog implementation, but can be easily programmed to the desired center frequency via the local M&C. The output of the DDS is sent to the RF module and provides the reference to which the quadrature local oscillator is locked. The local M&C sweeps the local oscillator (via DDS programming) through the user specified sweep range. When the Viterbi decoder determines that the modem is locked, the local 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 local M&C resumes the sweep process.

The digital clock loop, in conjunction with the other half of the DDS, performs the clock recovery function. The clock loop consists of the following circuits (all implemented digitally):

- Phase detector
- Loop filter
- DDS

The DDS performs the function of a VCO in an analog implementation, but can be easily programmed to the desired center frequency via the local M&C. Another PLL is used to generate the 1/3 data clock frequency (decoder clock) from the symbol clock. The decoder clock PLL uses outputs of the rate exchange circuit to maintain the proper phase relationship. The recovered decoder and symbol clocks are then used throughout the demodulator.

The soft-decision Look Up Table (LUT) converts the digital I and Q data from the analog-to-digital converters into 3-bit soft-decision values. The soft-decision values represent the binary data that was transmitted from the modulator, and subsequently corrupted by noise in the transmission channel. These values are then passed to the following circuits:

- Commutator
- Depuncture
- Ambiguity resolver

The soft-decision data is commutated into three parallel paths at 1/3 of the symbol rate. The commutator is simply a three-stage shift register, the output of which is loaded into the three parallel depuncture circuits on every third symbol clock.

The depuncture circuit inserts null symbols into the soft-decision data stream just prior to the Viterbi decoders. The positions of the null symbols are dictated by the code rate in use. Since additional symbols are inserted into the data stream, the decoder clock PLL is also synchronized to the depuncture logic.

The demodulator can lock up with phase and/or depuncture pattern ambiguities. Therefore, the ambiguity resolver cycles through every combination of these ambiguities until the Viterbi decoders achieve synchronization.

Each of the Viterbi decoders receives two parallel code words (G0 and G1) which are 3-bit soft decision data out of the depuncture logic. In addition to the code words, null symbol indicators are also received from the depuncture logic, which indicate to the Viterbi decoder which symbols were punctured out at the encoder. This data is processed by the k=7 Viterbi decoder algorithm embedded in the decoder. If, while the state metric normalization rate is monitored, it exceeds a pre-defined threshold, the out-of-sync condition is indicated. This indicator is fed back to the ambiguity resolution logic (see above) so that all possible ambiguity states can be tried. The Viterbi decoders each incorporate a BER monitor which the local M&C can interrogate for performance monitoring. The corrected data is output to the differential decoders.

After the differential decoders, the three serial bit streams, as well as the 1/3 data clock, are converted to differential ECL for transfer across the system motherboard to the interface board.

5.4 Viterbi Decoder

5.4.1 Description

The modem Viterbi decoder circuitry is located on the demodulator PCB (bottom slot of the modem chassis) and 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 5-5.

5.4.2 Specifications

BER	See Figure 1-4 and Table 1-2
Maximum Data Rate	25 Mbit/s (on each of 3 channels)
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
Constraint Length	7

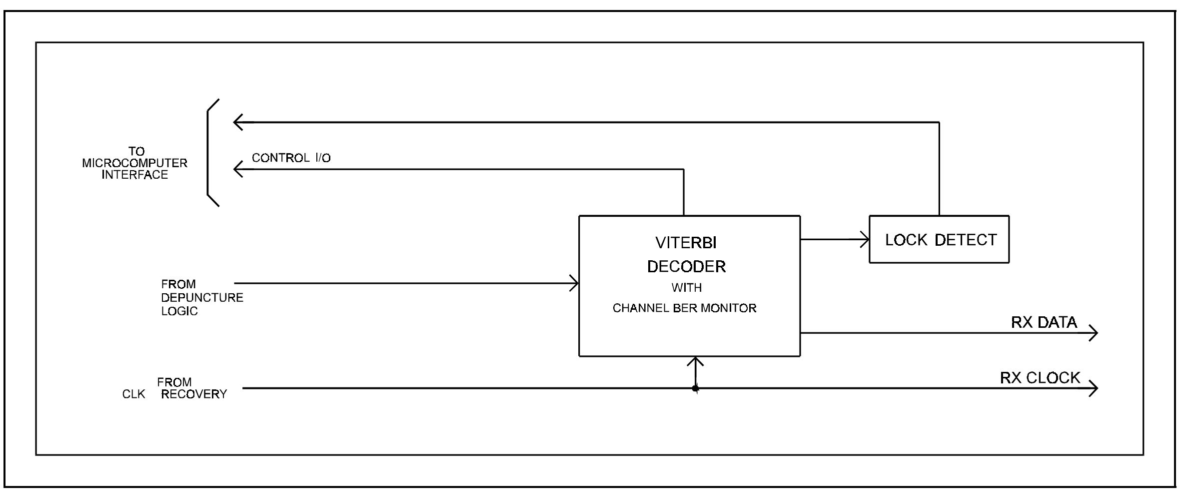


Figure 5-5. Viterbi Decoder Block Diagram

5.4.3 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 offset binary 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 to correct as many errors as possible. The code symbols produced by the encoder provide the data for this task.

The Viterbi decoder performs four functions for providing FEC. The functions used in processing the data stream are:

- Computing Branch Metric Values
- ASC Computer Processing
- Memory Storage
- Synchronization Detect

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.

The branch metrics are then processed by the Add-Select-Compare (ASC) computer. The ASC computer makes decisions about the most probable transmitted symbol stream. These decisions are made when the ASC processes the current branch metrics 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 maximum path metrics is used as the means of determining synchronization of the decoder. A 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 Table 1-2 and Figure 1-4 for typical Viterbi decoder BER performance specifications.

5.5 Interface

5.5.1 Description

The interface PCB fits in the middle slot of the modem chassis. The interface PCB provides synchronous data interfacing for terrestrial data and overhead signals and a means for modem fault reporting. The terrestrial interface functions include:

- MUX ESC overhead into the data
- DEMUX the received data
- Buffering the received data
- Monitoring and displaying the interface status without interruption of service

The following types of interfaces with options are available:

		Options			
Interface Type	**Interface P/N**	**Base**	**Buffer**	**ESC**	**RS**
G.703	3971-1	X			
G.703	3971-2		X		X
G.703 (IDR)	3971-3		X	X	X
G.703 (8.448)	3971-4	X			
G.703 (8.448)	3971-5		X		
G.703 (8.448)	3971-6			X	
G.703	5618-1	X			
G.703	5618-2		X		
G.703 (64K)	5618-3			X	X
ECL	4477-11	X			
ECL	4477-21		X		X
ECL	4477-31		X	X	X
PECL	4477-12	X			
PECL	4477-22		X		
PECL	4477-32		X	X	
MIL-STD-188	4477-13	X			
MIL-STD-188	4477-23		X		X
MIL-STD-188	4477-33		X	X	X

Note: In addition, an optional plug-on module supports Reed-Solomon (RS) coding and decoding. The Reed-Solomon Codec works in conjunction with the convolutional coding and Viterbi decoding. This includes additional framing, interleaving, and processing to provide concatenated FEC. This option can only be installed on interfaces with a buffer. Refer to Appendix A for further Reed-Solomon information.

Figures 3-4, 3-5, and 3-6 show the interface PCBs. A block diagram of the interface PCB is shown in Figure 5-6.

5.5.2 Digital Interface Specifications

Main Channel	
Physical Interfaces	G.703 ECL/PECL MIL-STD-188
Scrambling/Descrambling	IDR, per IESS-308 V.35, per CCITT V.35 EFD (SDM-450 compatible) None
Buffer (Optional)	Plesiochronous
Buffer Size	2 to 32 ms, in 2 ms steps
Buffer Clock Source	TX Terrestrial RX Satellite (Bypass) External Internal
Buffer Centering	Manual and automatic on buffer underflows/overflows
Buffer Depth	Displayed on front panel from 1 to 99%
Internal Clock Stability	± 100 PPM
Loopback	Baseband Interface
Reported Faults and Alarms	TX Data/AIS TX Clock PLL TX Clock Activity TX Programming TX Configuration Buffer Underflow/Overflow Buffer Full Buffer Clock PLL Buffer Clock Activity RX Data/AIS Frame BER DEMUX Lock RX 2047 Lock RX Programming RX Configuration
Engineering Service Channel	
ESC Audio AS/3971	2 duplex ADPCM channels
ESC Audio AS/5618	2 duplex ADPCM channels, or one 64 kbit/s RS-422 data channel
Audio Encoding	CCITT G.721
Audio Interface	600Ω transformer balanced 4-wire.
Audio Input Level	-20 to +10 dBm for 0 dBm, in 1 dB steps
Audio Output Level	-20 to +10 dBm for 0 dBm, in 1 dB steps
Audio Filtering	Internal 300 to 3400 Hz input/output
ESC Data Channel	8 kbit/s, RS-422
Data Phasing	Per RS-449: data changes on the rising clock transition and is sampled on the falling edge
Octet Timing	Octet high with every 8th bit: aligns with frame bit d8

5.5.2.1 G.703

G.703	
Data Rate	8.448 Mbit/s 32.064 Mbit/s 34.368 Mbit/s 44.736 Mbit/s 51.840 Mbit/s
External Clock Range	1.544 to 20.0 MHz, in 8 kHz steps, or at the receive data rate
External Clock Input	0.5 to 5.0V P-P Sine wave or square wave Duty cycle 50%, ± 10% 75Ω impedance

5.5.2.2 ECL

ECL	
Data Rate	6.0 to 52.0 Mbit/s, in 1 bit/s steps
External Clock Range	1.544 to 20.0 MHz, in 8 kHz steps, or at the receive data rate
External Clock Input	Standard ECL levels Duty cycle 50%, ± 10% 100Ω impedance

5.5.2.3 MIL-STD-188

MIL-STD-188	
Data Rate	6.0 to 13.0 Mbit/s, in 1 bit/s steps
External Clock Range	1.544 to 13.0 MHz, in 8 kHz steps, or at the receive data rate
External Clock Input	4V, ± 2V differential Duty cycle 50%, ± 10% 100Ω impedance

5.5.3 Theory of Operation

The Interface PCB consists of the following basic subsections:

- TX terrestrial receivers (data and clock)
- RX terrestrial drivers (data and clock)
- TX overhead MUX (ESC optional)
- TX overhead receivers and processor
- RX overhead DEMUX (ESC optional)
- RX overhead processor and drivers
- Baseband loopback relays
- Interface loopback MUX
- Plesiochronous buffer (optional)
- Buffer clock MUX
- Modem fault/alarm relays
- Modem fault TTL outputs
- Backward alarms (ESC optional)
- Local monitor and control processor

Refer to Figure 5-6 for the interface block diagram.

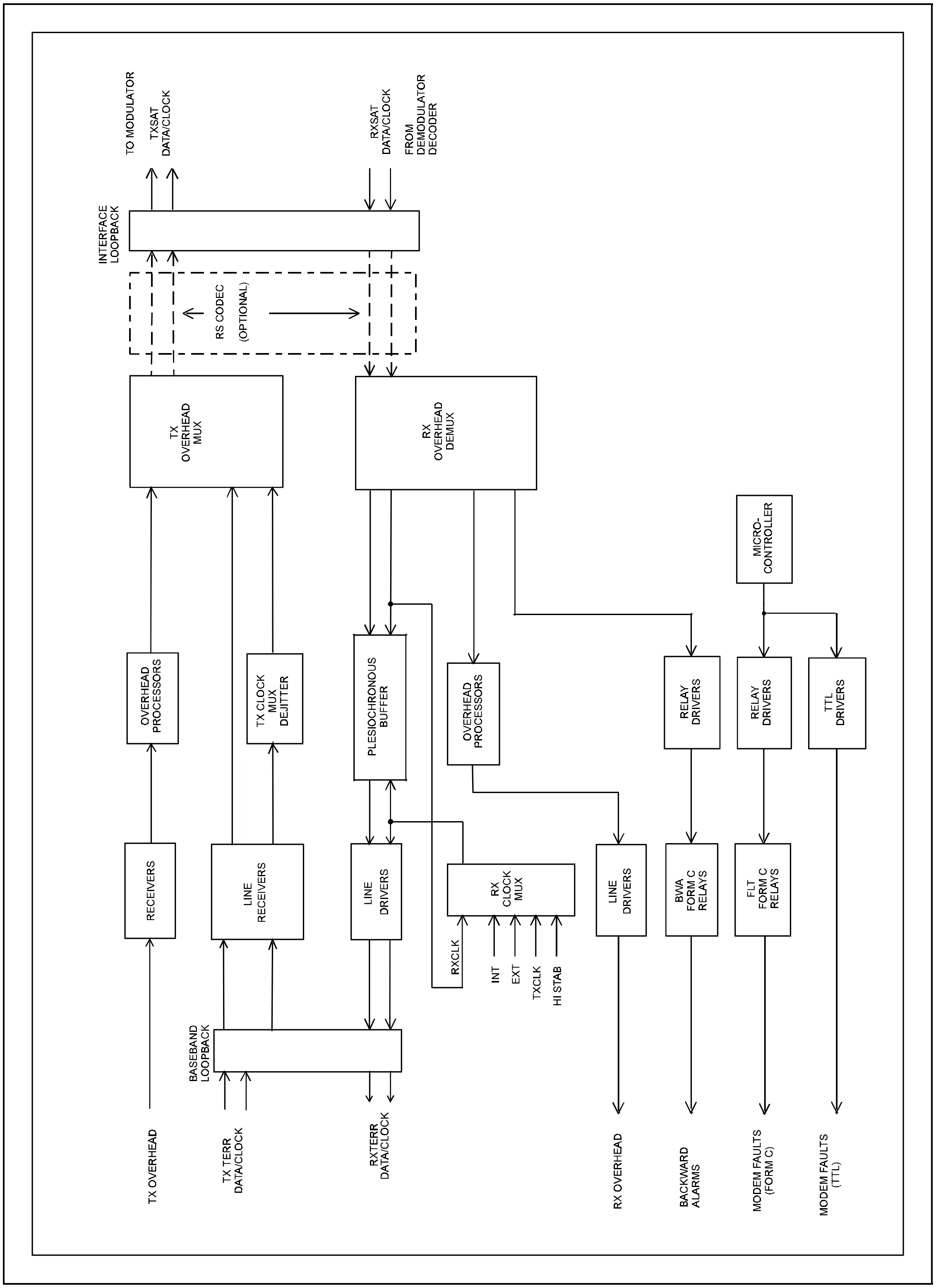


Figure 5-6. Interface Block Diagram

5.5.3.1 Transmit Data Path

Terrestrial data is passed through the baseband loopback relay, and is translated from the selected baseband format into TTL. If the terrestrial data is in G.703 format, the data rate clock is recovered from the data and line coding (B3ZS, etc.) is removed.

An alarm can optionally be set for AIS or data stable (AIS/Data) conditions. Blocks of 16 kbit/s of data are examined. If alarm on AIS is selected and fewer than 16 zeros are found in a block, the alarm is asserted. If alarm on data stable is selected and fewer than 16 zeros or fewer than 16 ones are found in a block, the alarm is asserted.

The data is dejittered to remove pattern jitter from the modulator spectrum. If a transmit fault is detected, AIS is substituted for the transmit data. If transmit 2047 data is selected, the transmit data is substituted with a pseudo-random 2047 pattern (using the internal clock if no data clock is available).

If ESC overhead is selected, 96 kHz of additional data is inserted into the transmit data stream per IESS-308, where applicable. This data includes:

- Two ADPCM audio channels or one 64 kbit/s digital data channel (64 kbit/s digital channel available only with the AS/5618 interface)
- Four backward alarms
- 8 kbit/s digital data channel

If the scrambler is enabled and Reed-Solomon encoding is not used, the data is then scrambled. The standard IDR scrambler is normally used. The following three scramblers are selectable:

IDR	IESS-308
V.35	CCITT V.35
EFD	Compatible with the proprietary alternate scrambler used by the SDM-450

Unscrambled data is passed to an installed and enabled Reed-Solomon Codec. This plug-on module includes a scrambler, and does not have interface board scrambler selection. Coded data is returned. The data is then sent through the interface loopback logic to the modulator.

5.5.3.2 Receive Data Path

Data from the demodulator is routed directly to an installed and enabled Reed-Solomon Codec and decoded data is returned. The returned data is descrambled by the Reed-Solomon onboard descrambler (if enabled).

If Reed-Solomon is not used, one of the three descramblers (or no descrambler) can be selected. The ESC overhead is then removed from the descrambled or decoded data.

If receive 2047 data is selected, the data is searched for the pseudo-random 2047 pattern. The error rate is measured after finding the pattern. If the error rate exceeds one error in a hundred bits (over a 16 kbit/s interval), the pattern search is resumed. The measured error rate can be monitored from the front panel of the modem. During the pattern search, “no data available” is reported. An alarm on AIS or a data stable state can be selected as in the transmit path.

An optional plesiochronous buffer removes Doppler shift and clock differences from the data. The frame size presumed to implement the plesiochronous slips is implied by the data rate. There are two standards for the 34.368 Mbit/s data rate (see table below). The selection must be made from the front panel.

Data Rate	Frame Structures
8.448 Mbit/s	None G.704 G.742 G.745
32.064 Mbit/s	None G.752
34.368 Mbit/s	None G.751 G.753
44.736 Mbit/s	None G.752
51.840 Mbit/s	None STS1

The buffer depth can be programmed from 2 to 32 ms, in 2 ms increments. The terrestrial side of the buffer can be clocked by one of the following sources:

- Clock recovered from the TX terrestrial data (dejittered)
- Clock recovered by the demodulator (RX satellite)
- External clock
- Internal clock
- High stability clock (if installed on the modulator)

The buffer clock source selection must fall within the following parameters:

G.703 Interface	
TX Terrestrial	No restrictions.
RX Satellite	No restrictions.
External Clock	Must be in the range from 1.544 to 20 MHz, in 8 kHz steps, or at the RX terrestrial data rate.
Internal Clock	No restrictions.
ECL Interface	
TX Terrestrial	TX and RX terrestrial clocks (data rates) must be divisible by 8 kHz, or the TX data rate must be the same as the RX data rate.
RX Satellite	No restrictions.
External Clock	The external clock must be in the range from 1.544 to 20 MHz, in 8 kHz steps, and the RX (data rate) clock must be divisible by 8 kHz. Additionally, the external clock may be at the RX (data) clock rate.
Internal Clock	Refer to “TX Terrestrial.” This clock is at the same frequency as the TX terrestrial clock.
MIL-STD-188 Interface	
TX Terrestrial	TX and RX terrestrial clocks (data rates) must be divisible by 8 kHz, or the transmit data rate must be the same as the receive data rate.
RX Satellite	No restrictions.
External Clock	The external clock must be in the range from 1.544 to 20 MHz, in 8 kHz steps, and the RX (data rate) clock must be divisible by 8 kHz. Additionally, the external clock may be at the RX (data) clock rate.
Internal Clock	Refer to “TX Terrestrial.” This clock is at the same frequency as the TX terrestrial clock.

Note: G.703 interfaces have the option of HDB3 or B3ZS line coding data to the terrestrial interface. This selection shall be made by the user.

5.5.3.3 Loopbacks

5.5.3.3.1 Baseband Loopback

Baseband loopback provides loopback at the terrestrial interface. The near end equipment loops back through the baseband loopback relays. The far end equipment loops through the demodulator, interface, and modulator. Refer to Figure 5-7 for a block diagram.

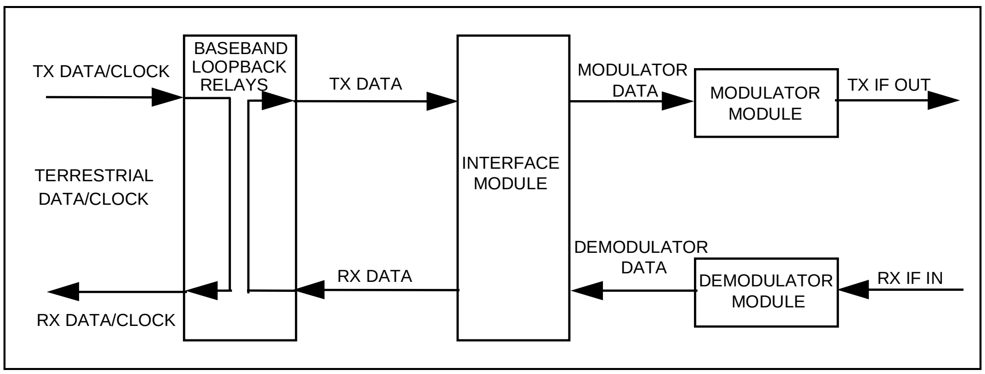


Figure 5-7. Baseband Loopback Block Diagram

5.5.3.3.2 Interface Loopback

Interface loopback provides loopback at the interface between the interface module and the modulator/demodulator. The near end equipment loops through the interface module and the far end equipment loops through the modulator/demodulator. Refer to Figure 5-8 for a block diagram.

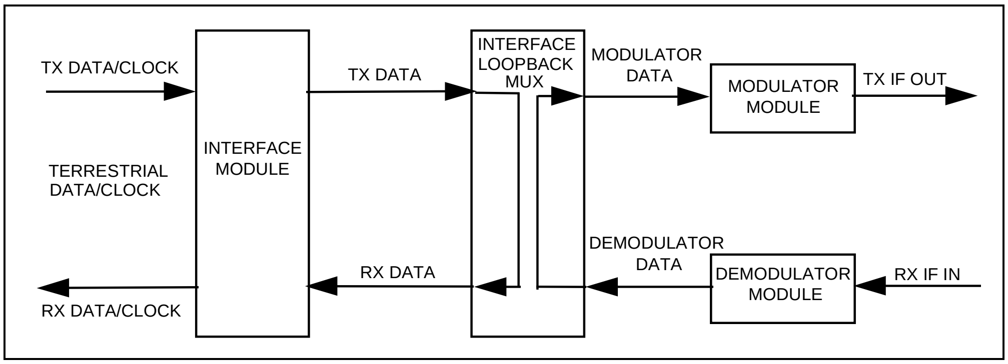


Figure 5-8. Interface Loopback Block Diagram

5.5.3.4 Engineering Service Channel (ESC)

The ESC includes the following features:

- Two full duplex audio channels or one 64 kbit/s data channel
- A full duplex 8 kbit/s data stream
- Four backward alarms (described in IESS-308)

5.6 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).

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 receive fault relay which de-energizes in the event of a receive fault. In order for this relay to be connected to the appropriate backward alarm input, the fault tree 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 receive fault relay are available as follows:

- Pins DF-C and DF-NO on the 50-pin D 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 modem single destination system is to connect the signals at the IDR data interface, either 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.

More complicated systems may be handled by connecting the appropriate outputs of the receive fault relay to the appropriate backward alarm inputs. In a multidestination system, the relay might only be connected to the particular backward alarm assigned to that link. Refer to IESS-308 for further clarification.
There are two methods for detecting a backward alarm that is being received on a particular link:

- Each backward alarm output drives a Form C relay with all three contacts available on the data connector.

- If a modem (or switch) is integrated into a computer network through the modem (or switch) RS-232-C or RS-485 remote interface connector, the status of all transmit and receive backward alarms may be read through that port.

Refer to Appendix B for remote control operation information.

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Chapter 6. MAINTENANCE

This chapter provides system checkout and troubleshooting information.

6.1 System Checkout

This section provides instructions for checking the modem setup within the earth station. Due to the complexity of the modem circuitry, this checkout procedure should be used as a basic guideline only. Maintenance tests that are more complicated are beyond the scope of this manual.

The system checkout consists of test instructions for the interface, modulator, and demodulator PCBs. The instructions include tables and test points for ensuring that the E_b/N_0, typical output spectrums, typical eye patterns, and constellation pictures are correct. If a test failure occurs, refer to Section 6.2 for the fault isolation procedures.

CAUTION

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

6.1.1 Interface

Use the following procedure and the test setup in Figure 6-1 to inspect the interface PCB. Refer to Chapter 5 for the interface specifications. Section 6.1.4.1 lists the interface test points and signal names. Figure 6-5 shows the test point locations.

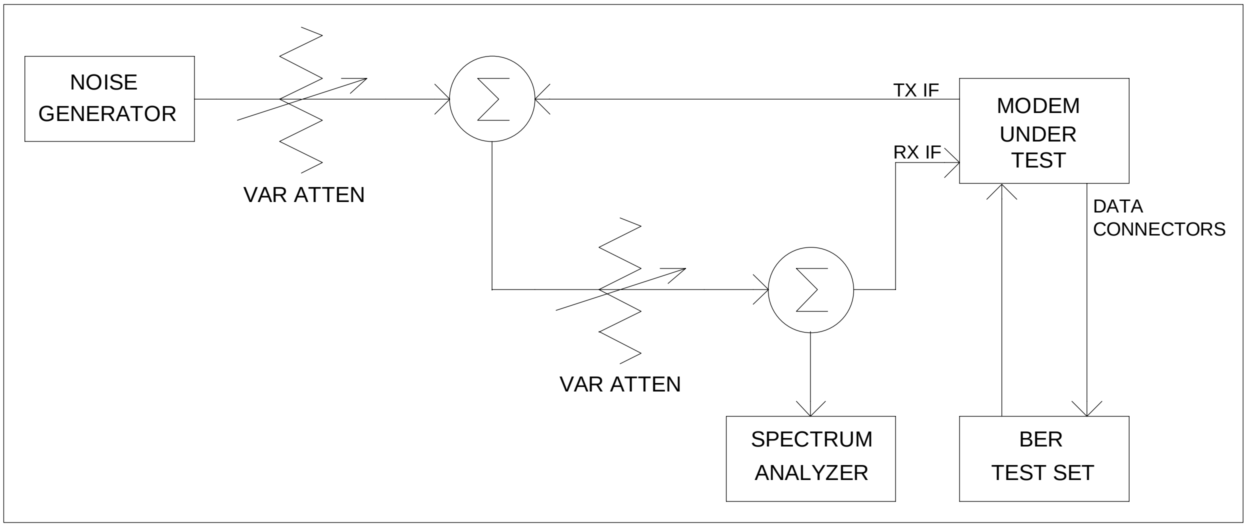


Figure 6-1. Fault Isolation Test Setup

1. Ensure the interface is configured for the proper mode of operation. Refer to Chapter 3 for configuration jumper settings.

2. Connect a BER test set to the appropriate modem data connector as shown in Figure 6-1. Refer to Chapter 2 for the following data connections:

   a. MIL-STD-188
   b. G.703
   c. ECL
   d. PECL

3. Set up the modem for baseband loopback operation by using the Configuration Interface front panel menu (refer to Chapter 4). The test set should run error free. Refer to Figure 4-19 for a block diagram of the baseband loopback operation.

4. Change the modem from baseband loopback to interface loopback operation by using the Configuration Interface front panel menu (refer to Chapter 4). The test set should run error free. Refer to Chapter 4 for a block diagram of the interface loopback operation.

6.1.2 Modulator

Use the following procedure and the test setup shown in Figure 6-1 to check out the modulator PCB. Refer to Chapter 5 for the modulator specifications. Section 6.1.4.2 lists the modulator test points and signal names. Figure 6-6 shows the test point locations.

1. Set up the modem for IF loopback operation by using the Configuration Demodulator front panel menu, or use an external IF loop with attenuation. Refer to Chapter 4 for a block diagram of the IF loopback operation.

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

3. Measure the E_b/N_0 with a receiver that is known to be properly operating. Refer to Figure 6-2 and the following tables to check for proper E_b/N_0 level:

Modulation Type	Table
QPSK	6-1
8PSK	6-2
16QAM	6-3

Figure 6-2 is an example of a 1/2 rate carrier operating at an E_b/N_0 of 7.8 dB. The (S+N)/N is measured by taking the average level of the noise and the average level of the modem spectrum top as shown. Use this measurement for the first column on the appropriate table as listed above. 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.

4. Connect a spectrum analyzer to the modem as shown in Figure 6-1. 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 6-3.

5. 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 (refer to Chapter 4). This sets the Carrier mode in the OFF condition. A pure carrier should now be present at the IF output. This should be used for frequency measurement only. 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 (refer to Chapter 4). This generates a single upper side-band suppressed carrier signal. Ensure the carrier and sideband suppression is less than -30 dBc.

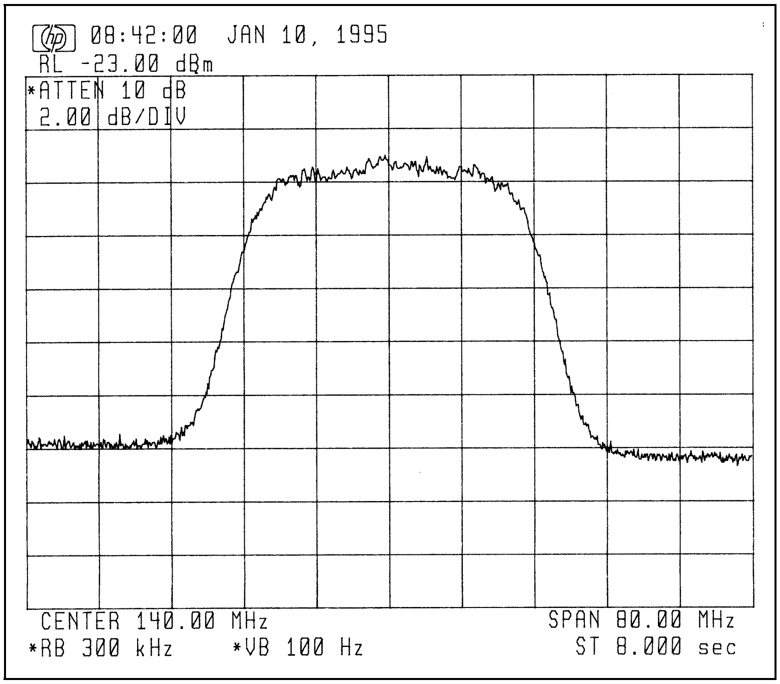


Figure 6-2. Typical Output Spectrum (with Noise)

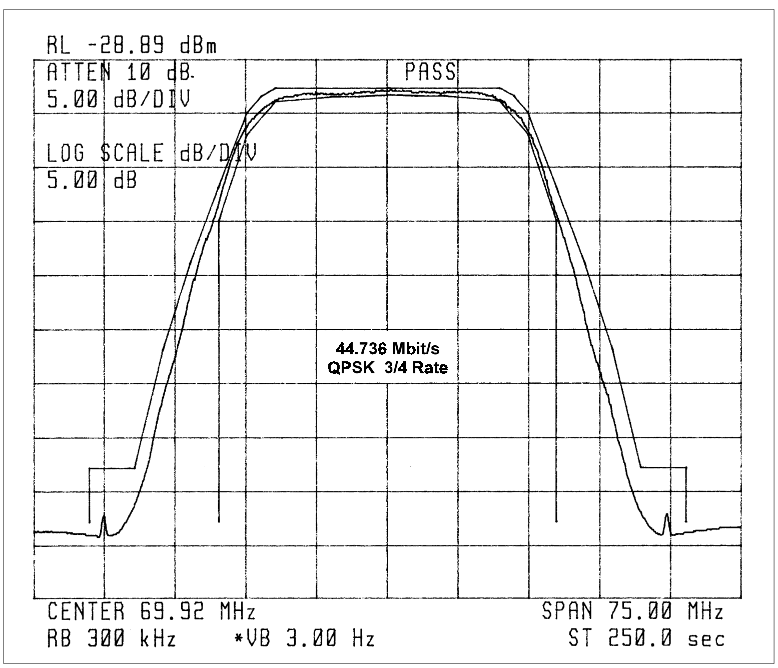


Figure 6-3. Typical Output Spectrum (without Noise)

Table 6-1. Conversion to S/N and E_b/N_0 Chart (QPSK)

(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

Table 6-2. Conversion to S/N and E_b/N_0 Chart (8PSK)

(dB)	Code Rate 2/3		Code Rate 5/6	
(S+N)/N	S/N	E_b/N_0	S/N	E_b/N_0
4.0	1.8	-1.2	1.8	-2.2
4.5	2.6	-0.4	2.6	-1.4
5.0	3.3	0.3	3.3	-0.6
5.5	4.1	1.1	4.1	0.1
6.0	4.7	1.7	4.7	0.8
6.5	5.4	2.4	5.4	1.4
7.0	6.0	3.0	6.0	2.1
7.5	6.6	3.6	6.6	2.7
8.0	7.3	4.2	7.3	3.3
8.5	7.8	4.8	7.8	3.9
9.0	8.4	5.4	8.4	4.4
9.5	9.0	6.0	9.0	5.0
10.0	9.5	6.5	9.5	5.6
10.5	10.1	7.1	10.1	6.1
11.0	10.6	7.6	10.6	6.7
11.5	11.2	8.2	11.2	7.2
12.0	11.7	8.7	11.7	7.7
12.5	12.2	9.2	12.2	8.3
13.0	12.8	9.8	12.8	8.8
13.5	13.3	10.3	13.3	9.3
14.0	13.8	10.8	13.8	9.8
14.5	14.3	11.3	14.3	10.4
15.0	14.9	11.9	14.9	10.9
15.5	15.4	12.4	15.4	11.4
16.0	15.9	12.9	15.9	11.9
16.5	16.4	13.4	16.4	12.4
17.0	16.9	13.9	16.9	12.9
17.5	17.4	14.4	17.4	13.4
18.0	17.9	14.9	17.9	14.0
18.5	18.4	15.4	18.4	14.5
19.0	18.9	15.9	18.9	15.0
19.5	19.5	16.4	19.5	15.5
20.0	20.0	16.9	20.0	16.0

Table 6-3. Conversion to S/N and E_b/N_0 Chart (16QAM)

(dB)	Code Rate 3/4		Code Rate 7/8	
(S+N)/N	S/N	E_b/N_0	S/N	E_b/N_0
4.0	1.8	-3.0	1.8	-3.6
4.5	2.6	-2.2	2.6	-2.8
5.0	3.3	-1.4	3.3	-2.1
5.5	4.1	-0.7	4.1	-1.4
6.0	4.7	-0.0	4.7	-0.7
6.5	5.4	0.6	5.4	-0.0
7.0	6.0	1.3	6.0	0.6
7.5	6.6	1.9	6.6	1.2
8.0	7.3	2.5	7.3	1.8
8.5	7.8	3.1	7.8	2.4
9.0	8.4	3.6	8.4	3.0
9.5	9.0	4.2	9.0	3.5
10.0	9.5	4.8	9.5	4.1
10.5	10.1	5.3	10.1	4.7
11.0	10.6	5.9	10.6	5.2
11.5	11.2	6.4	11.2	5.7
12.0	11.7	6.9	11.7	6.3
12.5	12.2	7.5	12.2	6.8
13.0	12.8	8.0	12.8	7.3
13.5	13.3	8.5	13.3	7.9
14.0	13.8	9.1	13.8	8.4
14.5	14.3	9.6	14.3	8.9
15.0	14.9	10.1	14.9	9.4
15.5	15.4	10.6	15.4	9.9
16.0	15.9	11.1	15.9	10.4
16.5	16.4	11.6	16.4	11.0
17.0	16.9	12.1	16.9	11.5
17.5	17.4	12.7	17.4	12.0
18.0	17.9	13.2	17.9	12.5
18.5	18.4	13.7	18.4	13.0
19.0	18.9	14.2	18.9	13.5
19.5	19.5	14.7	19.5	14.0
20.0	20.0	15.2	20.0	14.5

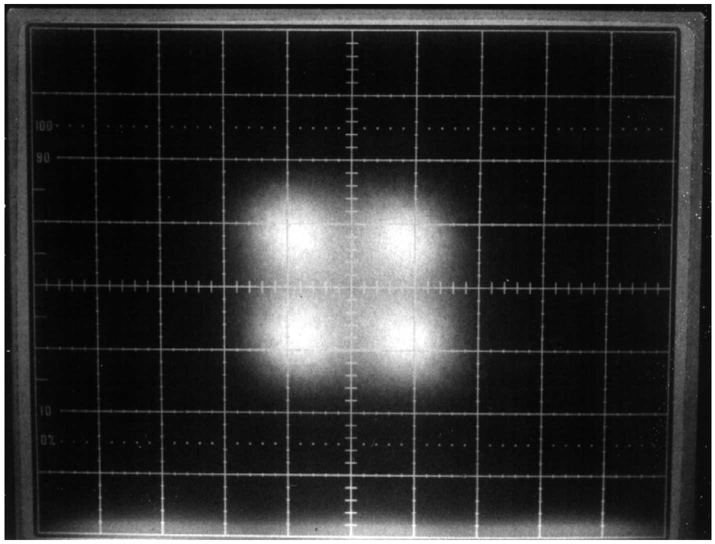
6.1.3 Demodulator

Use the following procedure and the test setup in Figure 6-1 to check out the demodulator PCB. Refer to Chapter 5 for the demodulator specifications. Section 6.1.4.3 lists the demodulator test points and signal names. Figure 6-7 shows the test point locations.

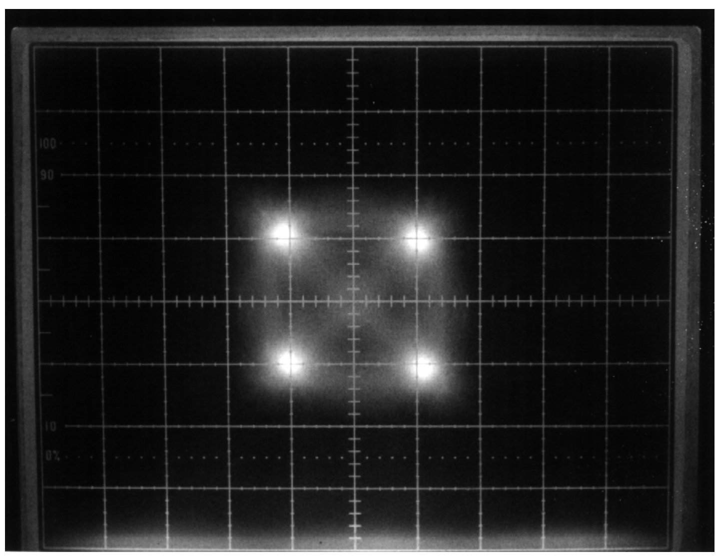
1. Set up the modem with an external IF loop, and level. Use a modulator that is known to be properly operating, and ensure power levels, data rates, code rates, etc., are compatible.

2. Allow the modem to lock up. When the green carrier detect LED is on and the DEMUX lock fault has been cleared (where applicable), the modem should 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 30 kHz. Ensure the modem still runs within the specified error rate.

3. 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 6-4.



WITH NOISE



WITHOUT NOISE

Figure 6-4. Typical Eye Constellations

6.1.4 Test Points

This section lists the interface, modulator, and demodulator PCB test points that can be accessed from the front panel. The list includes a signal description under normal operating conditions.

6.1.4.1 Interface PCB

Refer to Figure 6-5 for G.703, ECL, and MIL-STD-188 test point locations.

Test Points		
ECL/MIL-STD-188 (AS/4477)	G.703 (AS/3971, AS/5618)	Signal Name
TP12	TP6, 11	GND Ground
TP14	TP3	RX MFS Receive Sub-Frame Sync (overhead only)
TP11	TP8	TX MFS Transmit Sub-Frame Sync (overhead only)

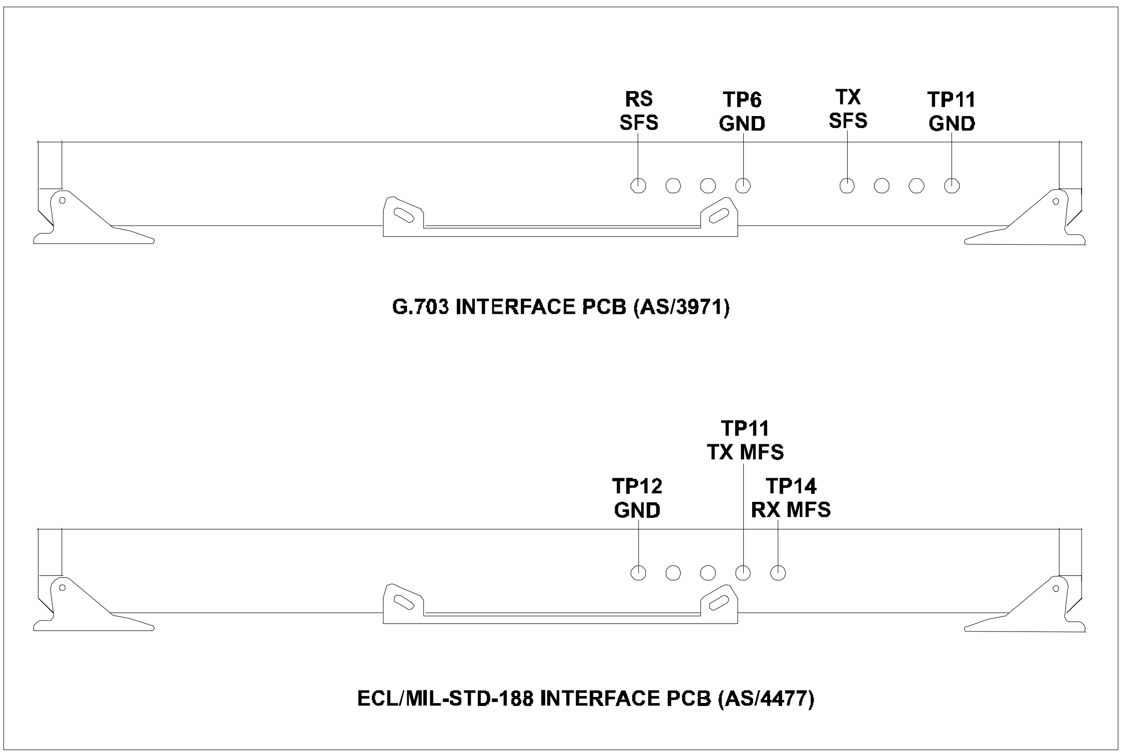


Figure 6-5. Interface PCB Test Points

6.1.4.2 Modulator PCB

Refer to Figure 6-6 for test point locations.

Test Points	Signal Name
TP4	SYMBOL CLK Symbol Clock
TP5	BIT CLK Data Clock/3
TP8	GND Ground test point

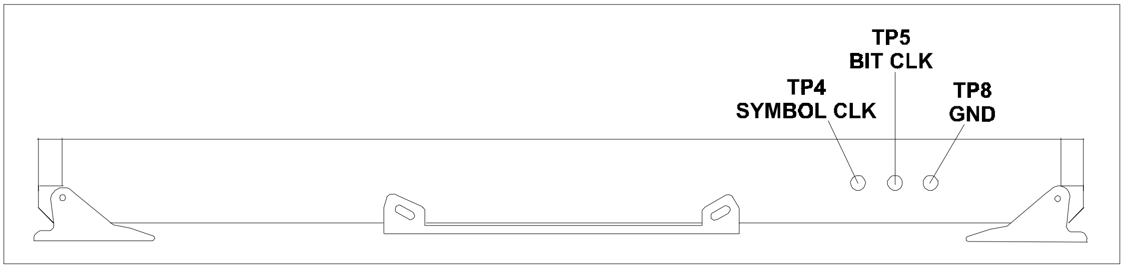


Figure 6-6. Modulator PCB Test Points

6.1.4.3 Demodulator PCB

Refer to Figure 6-7 for test point locations.

Test Points	Signal Name
TP1	AGND. Analog Ground.
TP2	I EYE. I channel monitor. See Q EYE test point.
TP3	DGND. Ground test point.
TP4	Q EYE. Q channel monitor. The I and Q test points are digital representations of the received filtered signal. To view these test points, use an oscilloscope in the X-Y mode. The display will be the constellation shown in Figure 6-4.
TP5	DGND. Ground test point.
TP6	DCLK. Data Clock/3.

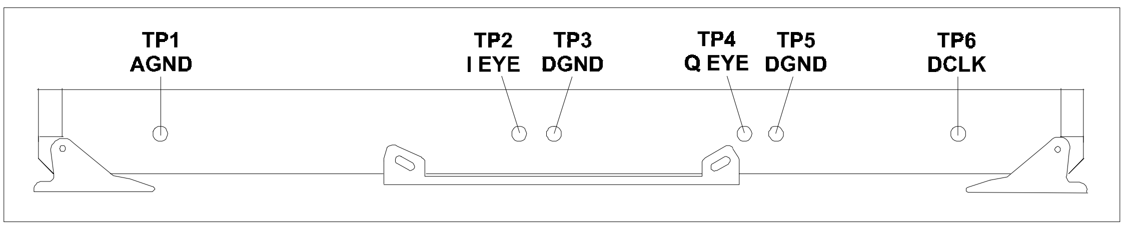


Figure 6-7. Demodulator PCB Test Points

6.2 Fault Isolation

6.2.1 Guidelines

The modem has been designed so that a competent technician can repair a faulty modem on location. All active circuits, except the power supply, can be removed from the modem through the front panel without requiring special tools. The power supply can be removed through the top cover with standard tools.

CAUTION

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

The fault monitoring capability of the modem is designed to assist the operator in determining which PCB has failed. The faulty PCB can be removed and returned to EFData for repair. Install a satisfactory spare PCB and continue with the operation.

The fault isolation procedure lists the following categories of faults or alarms. Each fault or alarm category includes possible problems and the appropriate action required to repair the modem.

- Modulator
- Demodulator
- TX Interface
- RX Interface
- Common Equipment
- Backward Alarms

If this troubleshooting procedure does not isolate the problem, and EFData Customer Support assistance is necessary, have the following information available for the representative:

- Modem configuration, including the modulator, demodulator, and interface sections

- Faults (active or stored) (refer to Table 6-4)

6.2.2 System Faults/Alarms

System faults are reported in the Faults/Alarms menu and stored faults are reported in the Stored Flts/Alms menu (Chapter 4). Refer to the fault tree (Table 6-4) and the list of possible problems in order to determine the appropriate action for repairing the modem (Section 6.2.1).

Table 6-4. SDM-9000 Modem Fault Tree

MODULATOR 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)	DEFERRED MAIN ALARM (6)	TX AIS	RX AIS
IF SYNTHESIZER	X	X	X										X	
DATA CLOCK ACT								X	X				X	
DATA CLOCK SYN	X	X	X										X	
I CHANNEL	X	X	X										X	
Q CHANNEL	X	X	X										X	
AGC	X	X	X										X	
INTERNAL SCT SYN	X	X	X										X	
EXT REF ACT								X	X				X	
MODULE	X	X	X										X	
PROGRAMMING	X	X	X										X	
CONFIGURATION	X	X	X										X	
DEMODULATOR FAULTS														
CARRIER DETECT				X	X									X
IF SYNTHESIZER				X	X									X
RX CLOCK SYN				X	X									X
I CHANNEL				X	X									X
Q CHANNEL				X	X									X
DESCRAMBLER				X	X									X
BER THRESHOLD										X	X	X		
MODULE				X	X									X
PROGRAMMING				X	X									X
CONFIGURATION				X	X									X

Legend

Test Note	Fault/Alarm Relay	Test Points Connector/Pins
1	TX FAULT	J7/Pin 4 (N.O.), 5 (COM), 6 (N.C.) *
2	RX FAULT	J7/Pin 7 (N.O.), 8 (COM), 9 (N.C.) *
3	COM EQ FAULT	J7/Pin 1 (N.O.), 2 (COM), 3 (N.C.) *
4	TX ALARM #2	J10/Pin 4 (N.O.), 5 (COM), 6 (N.C.) *
5	RX ALARM #3	J10/Pin 7 (N.O.), 8 (COM), 9 (N.C.) *
6	DEF MAINT ALARM	J8/Pin 17 **

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

Table 6-4. SDM-9000 Modem 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)	DEFERRED MAIN ALARM (6)	TX AIS	RX AIS
TX INTERFACE FAULTS														
TX DATA/AIS								X	X			X	X	
TX CLK PLL								X	X				X	
TX CLK ACTIVITY								X	X				X	
PROGRAMMING	X	X	X										X	
CONFIGURATION	X	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
BUFFER CLK PLL				X	X									X
BUFFER CLK ACT										X	X			
DEMUX LOCK				X	X									X
RX 2047 LOCK										X	X			
BUFFER FULL										X	X			
PROGRAMMING				X	X									X
CONFIGURATION				X	X									X

Legend

Test Note	Fault/Alarm Relay	Test Points Connector/Pins
1	TX FAULT	J7/Pin 4 (N.O.), 5 (COM), 6 (N.C.) *
2	RX FAULT	J7/Pin 7 (N.O.), 8 (COM), 9 (N.C.) *
3	COM EQ FAULT	J7/Pin 1 (N.O.), 2 (COM), 3 (N.C.) *
4	TX ALARM #2	J10/Pin 4 (N.O.), 5 (COM), 6 (N.C.) *
5	RX ALARM #3	J10/Pin 7 (N.O.), 8 (COM), 9 (N.C.) *
6	DEF MAINT ALARM	J8/Pin 17 **

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

Table 6-4. SDM-9000 Modem Fault Tree (Continued)

COMMON EQUIPMENT 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)	DEFERRED MAIN ALARM (6)	TX AIS	RX AIS
BATTERY/CLOCK						X						X		
-12V POWER SUPPLY						X	X							
+12V POWER SUPPLY						X	X							
+5V SUPPLY						X	X							
-5V SUPPLY						X	X							
CONTROLLER						X	X						X	X
INTERFACE MODULE						X	X						X	X
BACKWARD ALARMS (IDR 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	J7/Pin 4 (N.O.), 5 (COM), 6 (N.C.) *
2	RX FAULT	J7/Pin 7 (N.O.), 8 (COM), 9 (N.C.) *
3	COM EQ FAULT	J7/Pin 1 (N.O.), 2 (COM), 3 (N.C.) *
4	TX ALARM #2	J10/Pin 4 (N.O.), 5 (COM), 6 (N.C.) *
5	RX ALARM #3	J10/Pin 7 (N.O.), 8 (COM), 9 (N.C.) *
6	DEF MAINT ALARM	J8/Pin 17 **

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

6.2.2.1 Fault/Alarm Display and Description

This section consists of general fault, status, and alarm information that is indicated by the 10 LEDs on the front panel. The LEDs indicate the following information is in the on condition.

Faults		
Name	**Color**	**Description**
TX	Red	A fault condition exists in the TX chain.
RX	Red	A fault condition exists in the RX 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		
Name	**Color**	**Description**
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		
Name	**Color**	**Description**
TX	Yellow	A TX function is in an alarm condition.
RX	Yellow	A RX function is in an alarm condition.

A fault (red LED) indicates a fault that currently exists in the modem. The LED is turned off when the fault clears.

When a fault occurs, it is stored in the stored fault memory and indicated by the single yellow LED. If the fault clears, the occurrence is also cleared.

A total of 10 occurrences of any fault can be stored. Each fault or stored fault (indicated by a front panel LED) is the sum of many faults. To determine which fault has occurred, use 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 “+”.

6.2.2.2 Fault/Alarm Analysis

6.2.2.2.1 Modulator Faults

Fault/Alarm	Possible Problem and Action
IF SYNTHESIZER	Modulator IF synthesizer is faulted. This is considered a major fault and will turn off the modulator output. Return the modulator module for repair.
DATA CLOCK ACT	Transmit data clock activity alarm. This fault is not considered a major fault and will not turn off the modulator output. The problem is most likely on the interface card or external to the modem. Use the baseband loopback and interface loopback test modes for checking the interface. Ensure the incoming data clock is present at the modem DATA I/O connector. If data and clock are present at the DATA I/O, then replace the interface card to clear the alarm and return the card for repair.
DATA CLOCK SYN	Transmit data clock synthesizer fault. This fault is an indication 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 fault 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.
I CHANNEL	Activity fault for the I channel digital filter. This alarm is considered a major fault 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, it 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. If data is present, replace the interface card to clear the fault and return the interface card for repair. If the fault is active with the scrambler turned on, replace the modulator card and return it for repair.
Q CHANNEL	Activity fault for the Q channel digital filter. Use the I channel procedure above.
AGC LEVEL	Output power AGC level fault. Indicates the level at the modulator output is not the programmed level. Replace the modulator card and return it for repair.
INTERNAL SCT SYN	Internal TX data clock synthesizer fault. The SCT has failed to lock to the internal reference. Replace modulator board.
EXT REF ACT	External reference activity alarm. Activity alarm for the external reference clock. Indicates clock reference not detected.

MODULE	Modulator module fault. Typically indicates that the modulator module is missing or will not program. Ensure the modulator card is present and is properly seated. If the modulator card is properly seated, this could indicate a problem in the M&C card, or in the interface between the modulator and the M&C card. Another possible cause is the modulator firmware may be installed incorrectly or has a pin not making contact. Ensure the modulator firmware is correctly seated. Return the defective card for repair.
PROGRAMMING	Modulator programming fault. Indicates the modulator module has failed to program a current configuration parameter. If this fault occurs, contact EFData Customer Support for assistance.
CONFIGURATION	Modulator configuration fault. Indicates the modulator module does not support a programmed configuration parameter. This fault typically occurs when the programmed configuration does not match the module hardware. Ensure the programming of the modulator hardware matches the configuration parameters.

6.2.2.2.2 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. Verify the frequency of the data transmitted from the modulator is within 100 PPM. Check the test points on the demodulator and decoder for the eye pattern, data, and clock to verify proper levels, activity, and phase (Section 6.1.3).
IF SYNTHESIZER	Demodulator IF synthesizer fault. Indicates the demodulator IF synthesizer is faulted. This fault is a hardware failure. Return the demodulator card for repair.
RX CLOCK SYN	Receive data clock synthesizer fault. Indicates a loss of lock on the reference of the demodulator clock recovery oscillator. This is a hardware failure fault. Return the demodulator card for repair.
I CHANNEL	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. Return the demodulator card for repair.
Q CHANNEL	Loss of activity in the Q channel of the quadrature demodulator. Follow the same procedure as for the I channel fault.
DESCRAMBLER	Descrambler alarm. Indicates loss of activity in the descrambler.

BER THRESHOLD	The preset BER threshold has been exceeded. Setting of this alarm is done in the Configuration 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. Ensure the demodulator card is present and properly seated. If the card is properly seated, this could indicate a problem in the M&C card, or in the interface between the demodulator card and the M&C card. Return the defective card for repair.
PROGRAMMING	Demodulator programming fault. Indicates the demodulator module has failed to program a current configuration parameter. If this fault occurs, contact EFData Customer Support assistance.
CONFIGURATION	Demodulator configuration fault. Indicates the demodulator module does not support a programmed configuration parameter. This fault typically occurs when the programmed configuration does not match the module hardware. Verify the programming of the demodulator hardware matches the configuration parameters.

6.2.2.2.3 TX Interface Faults

Fault/Alarm	Possible Problem and Action
TX DATA/AIS	Data or incoming AIS fault. When AIS is selected in the Interface Configuration menu for TX data fault, the transmit interface fault TX data/AIS is monitoring an alarm condition of all 1s from customer data input to the modem. When data is selected in the Interface Configuration menu for TX data fault, the TX interface fault TX data/AIS is monitoring an alarm condition of all 1s or 0s. This is referred to as a data-stable condition (the 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 alarm. Indicates the transmitter PLL is not locked to the reference of the interface transmit clock recovery oscillator. Return the interface card for repair. The interface will fall back to the internal clock when this alarm is active.
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.
PROGRAMMING	Transmit interface programming fault. Indicates the TX interface module has failed to program a current configuration parameter. If this fault occurs, contact EFData Customer Support for assistance.
CONFIGURATION	Transmit interface configuration fault. Indicates the TX interface module does not support a programmed configuration parameter. This fault typically happens when the programmed configuration does not match the module hardware. Verify the programming of the TX interface hardware matches the configuration parameters.

6.2.2.2.4 RX 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 is continuously present). This fault is included in this section to be consistent with the fault reporting system and 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 fault. The data monitored for RX data is coming from the satellite. When the AIS is selected for RX Data Fault in the Interface Configuration 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 Configuration menu, the RX data/AIS is monitoring a fault condition of all 1s or 0s. This is referred to as a data-stable condition (meaning the data is not transitioning). The alarm indicates trouble in receiving data from the satellite. 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 1.0^{-3} over a 60-second period measured on the framing bits. This is defined as a major receive fault by INTELSAT specifications IESS-308. In a redundant system, a switchover will be attempted.
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, return the interface card for repair.
BUFFER CLK ACT	Activity detector alarm of the selected interface receive clock. The interface will fall back to the internal clock when this alarm 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 fault. 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. This probably indicates the transmitter is not set correctly.
BUFFER FULL	Buffer full alarm. Indicates the buffer is less than 10% or greater than 90% full.
PROGRAMMING	Receive interface programming fault. Indicates the RX interface module has failed to program a current configuration parameter. If this fault occurs, contact EFData Customer Support for assistance.
CONFIGURATION	Receive interface configuration fault. Indicates the RX interface module does not support a programmed configuration parameter. This fault typically occurs when the programmed configuration does not match the module hardware. Ensure the programming of the RX interface hardware matches the configuration parameters. Also, verify all jumpers have been set correctly for currently programmed configuration parameters.

6.2.2.2.5 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 will be active when a modem has been hard reset, the firmware has been changed, and the modem is first turned on. If the fault occurs without a firmware change or hard reset of the modem, replace the display/M&C card.
-12 VOLT SUPPLY	-12 VDC power supply fault. Indicates a high or low voltage condition. Level is ± 5%. Check for a short on the -12 VDC line from the power supply or on any of the plug-in boards. Check TP2 on the display/M&C card to verify the proper -12 VDC monitor voltage (1.06 VDC). If this voltage is not correct, it will verify that the -12 VDC supply is not at the proper level. Try isolating the fault to a single board. If removing each of the boards does not fix the problem, then the power supply is faulted. Return the faulty plug-in board or replace the chassis power supply.
+12 VOLT SUPPLY	+12 VDC power supply fault. Use the same procedure as with -12V fault. To verify the +12 VDC power supply voltage, check TP4 on the display/M&C card. A voltage of 3.81 VDC will be monitored when the +12 VDC is at the proper level.
+5 VOLT SUPPLY	+5 VDC power supply fault. Use the same procedure as with a -12 VDC fault. The +5 VDC supply requires a minimum load of 1A. This is accomplished with the display/M&C card and one other card being plugged into the chassis. To verify the +5 VDC power supply voltage, check TP5 on the display/M&C card. A voltage of 2.5 VDC will be monitored when the +5 VDC is at the proper level.
-5 VOLT SUPPLY	-5 VDC power supply fault. To verify the -5 VDC power supply voltage, check TP3 on the display/M&C card. A voltage of 2.03 VDC will be monitored when the -5 VDC is at the proper level.
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. Ensure the interface card is present and properly seated. If the card is properly seated, this could indicate a problem in the M&C card or in the interface between the interface card and M&C card. Return the defective card for repair.

6.2.2.2.6 Backward Alarms

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 is essentially a monitor function so 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 the *B141-1 Breakout Panel Installation and Operation Manual* for breakout panel pinouts.
BW ALARM RX3	Receive backward alarm #3. Refer to BW alarm RX 4 for details.
BW ALARM RX2	Receive backward alarm #2. Refer to BW alarm RX 4 for details.
BW ALARM RX1	Receive backward alarm #1. Refer to BW alarm RX 4 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 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 2 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 TX 4 for details.
BW ALARM TX2	Transmit backward alarm #2. Refer to BW alarm TX 4 for details.
BW ALARM TX1	Transmit backward alarm #1. Refer to BW alarm TX 4 for details.

6.3 Module Replacement

The modem consists of plug-in cards that can be easily replaced. Card ejectors are provided for ease in removing the modulator, demodulator, and interface PCBs. To replace the display/M&C PCB on the modem front panel, remove the six mounting screws and connector.

The power supply is attached to the modem chassis. For repair of the power supply module, it is recommended that all the plug-in cards be removed before shipping the chassis, with the power supply, to EFData.

6.4 Module Identification

The modem cards each have an assembly number that is marked on the board, and the latest revision and serial numbers are stamped on the board. EFData tracks the hardware by assembly, revision, and serial number. Data rate dependent hardware is labeled with the associated symbol rate on a board label.

When replacing a plug-in module, care must be taken to ensure the proper daughter card is used. Refer to the individual sections on each module for location of the configuration identification. Refer to Chapter 1 for a list of part numbers and descriptions of various modules used in the modem.

6.5 Repacking for Shipment

Ship the modem and modem cards in the factory packaging. The three main cards can be shipped in the caddypack boxes in which they were received. The display/M&C card must be shipped in the modem chassis.

When a modem is being transported, it is required that the three main cards be removed and sent with the modem packed in the caddypack boxes. The display/M&C card must be installed in the modem chassis.

Note: Failure to comply with the repacking procedure will void the warranty.

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Appendix A. OPTIONS

This appendix describes the Reed-Solomon Codec, Direct Broadcast Satellite (DBS), and Digital Video Broadcast (DVB) options.

A.1 Reed-Solomon Codec

The Reed-Solomon Codec PCB (AS/4080) is a 6.75” x 7.50” daughter card that is located on the interface PCB. The interface card fits in the middle slot of the modem chassis.

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 (per IESS-308).

Refer to Figure A-1 for the Reed-Solomon Codec block diagram.

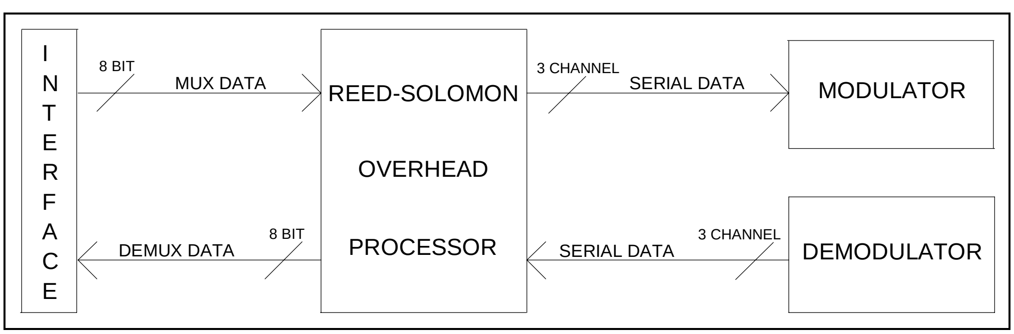


Figure A-1. Reed-Solomon Codec Block Diagram

A.1.1 Specifications

Reed-Solomon Codec word	n = 208 k = 192 t = 8
Interleaver	Modified block interleaving, depth = 4
Unique word insertion	Per IESS-308 specification

Note: The Reed-Solomon implementation conforms to the INTELSAT IESS-308 specification.

A.1.2 Theory of Operation

The Reed-Solomon Codec card works in conjunction with the Viterbi decoder to provide concatenated convolutional encoding and decoding. The Reed-Solomon Codec block diagram is shown in Figure A-1. The two main sections of the Codec that will be discussed in this section are the Reed-Solomon encoder (Section A.1.2.1) and the Reed-Solomon decoder (Section A.1.2.2).

A.1.2.1 Reed-Solomon Encoder

A block diagram of the Reed-Solomon encoder section is shown in Figure A-2. The Reed-Solomon encoder section includes the following circuits:

- 8-bit parallel scrambler
- Input FIFO
- Reed-Solomon Codec
- Output First In/First Out (FIFO)
- Interleaver
- 8-bit parallel to 3-bit serial channel reformatter

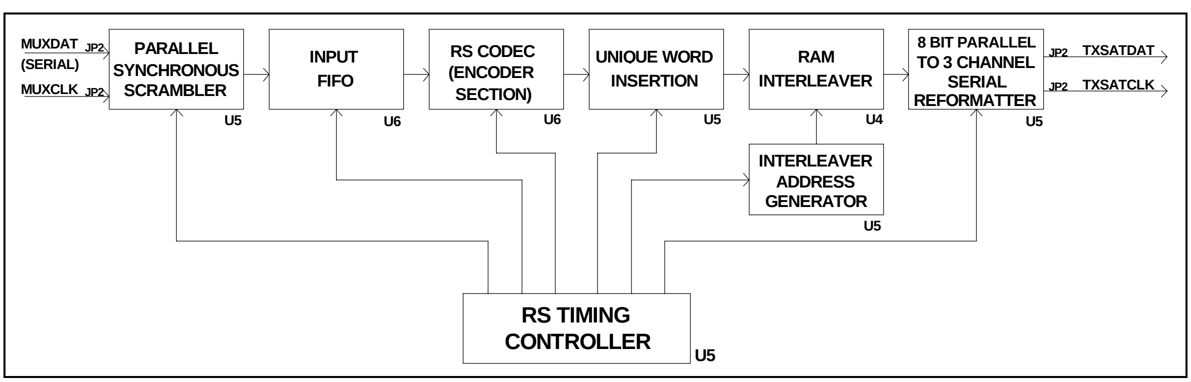


Figure A-2. Reed-Solomon Encoder Section Block Diagram

The 8-bit wide data and clock come from the multiplexer on the interface PCB, and are sent to the Reed-Solomon encoder section through connector JP1. The data passes through an 8-bit parallel self-synchronizing scrambler in accordance with IESS-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 is passed along with dummy check bytes to the input FIFO in the Reed-Solomon encoder chip. The term ***n - k = 2t*** is the total number of check bytes located at the end of each Reed-Solomon word. This is referred to as the Reed-Solomon overhead. The Reed-Solomon outer Codec reads the data in blocks of ***n*** bytes, and corrects errors. 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 output data is passed to the output FIFO, and then to the block interleaver.

Errors from the Viterbi decoder usually occur in bursts. A block interleaver with a depth of 4 is used in accordance with the IESS-308 Rev. 6B specification. The interleaver has the effect of spreading out the errors across several blocks of data instead of concentrating the errors in a single block. 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 RS words of the last RS page of the RS frame (Figure A-3).

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.

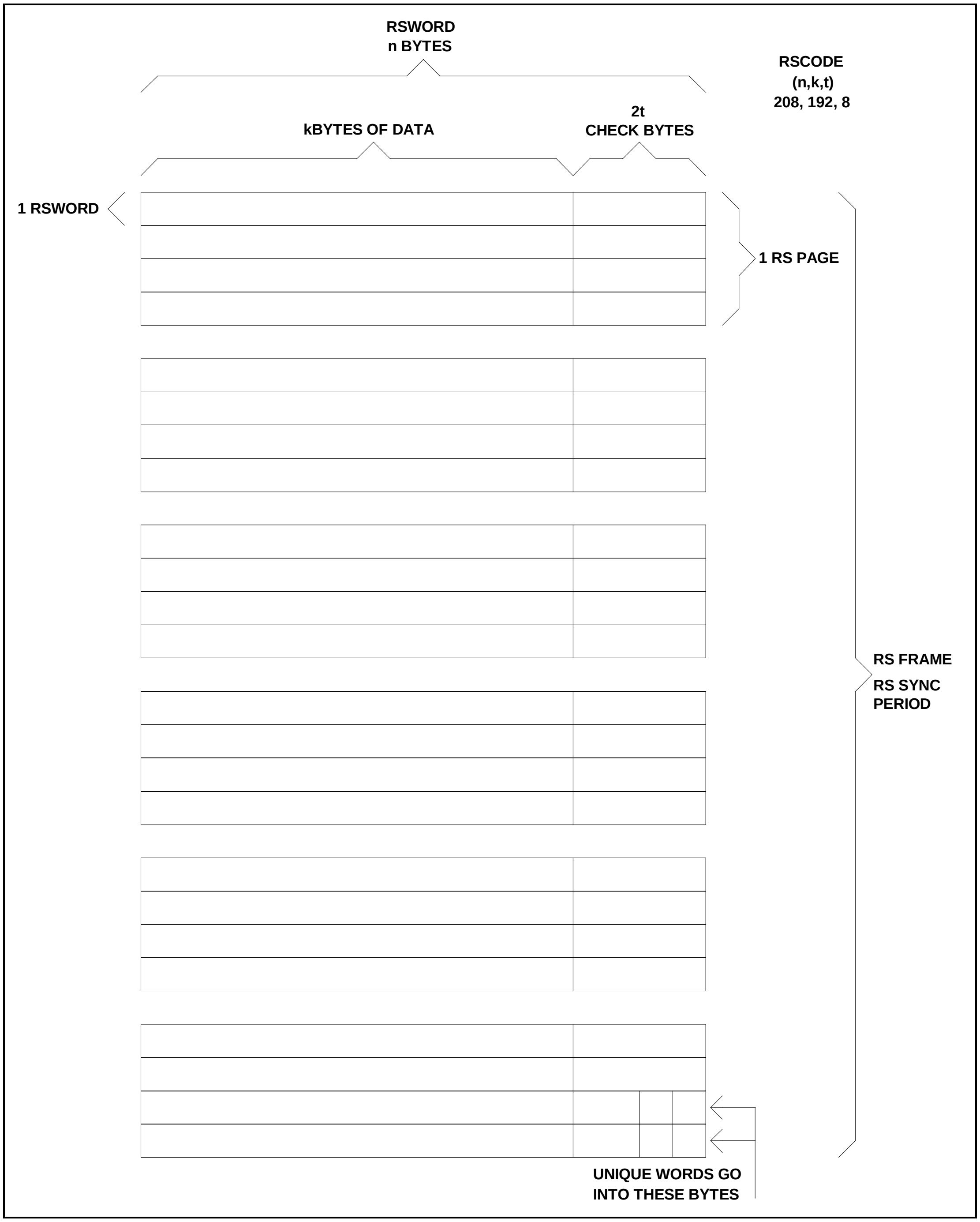


Figure A-3. Reed-Solomon Codec Frame Format

A.1.2.2 Reed-Solomon Decoder

A block diagram of the Reed-Solomon decoder section is shown in Figure A-4. The Reed-Solomon decoder section includes the following circuits:

- 3-channel serial unique word corrolater
- RAM interleaver
- Input FIFO
- Reed-Solomon decoder
- Output FIFO
- 8-bit parallel descrambler

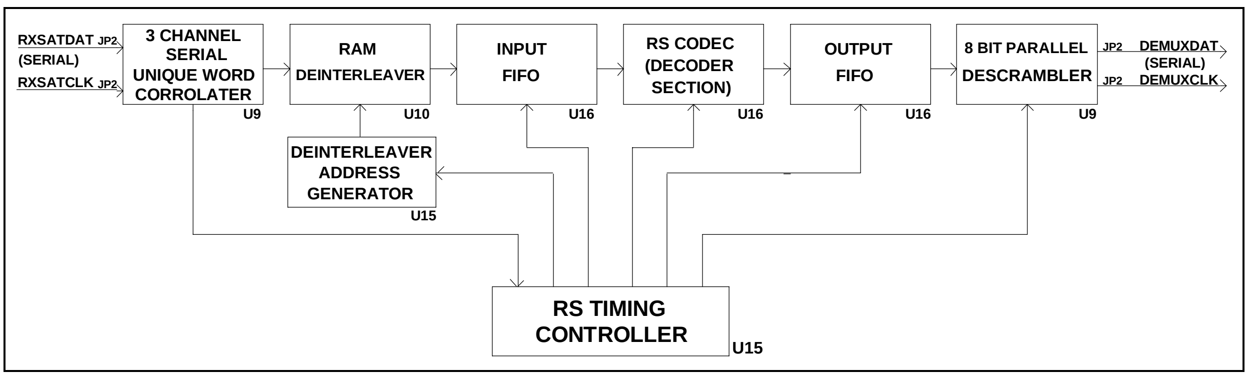


Figure A-4. Reed-Solomon Decoder Section Block Diagram

The three channels of serial data and the clock signals come from the demultiplexer on the interface PCB and are sent to the Reed-Solomon decoder section through connector JP3.

The data is passed to a 3-channel serial corrolater which locates the unique words and reformats the data to 8 bits on the appropriate byte boundaries.

Because the data was block interleaved by the encoder, 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 RS frame 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 IESS-308 Rev. 6B specification. The data is then sent to the input FIFO and on to the Reed-Solomon decoder.

Refer to Figure A-3 for the Reed-Solomon frame format. The term ***n* - *k* = 2*t*** is the total number of check bytes appended to the end of the data. The outer Codec reads the data in blocks of ***n*** bytes, and recalculates the check bytes. If the recalculated check 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 terms ***k*, *n*,** and ***t*** will vary depending on the data rate being used. The Codec then sends only the corrected data to an output FIFO.

The data is sent through a self-synchronizing 8-bit parallel descrambler in accordance with the IESS-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 frame. The data is then sent to the interface PCB for further processing.

A.1.3 Installation

Installation instructions for the Reed-Solomon Codec PCB (AS/4080) include:

- Unpacking and initial inspection
- Tools required
- Installation

A.1.3.1 Unpacking Instructions

CAUTION

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

1. Remove Reed-Solomon PCB and mounting hardware from the cardboard caddypack and anti-static material.

2. Check packing list to ensure the shipment is complete.

3. Inspect the Reed-Solomon PCB for any shipping damage. Ensure all ICs are seated properly.

A.1.3.2 Tools Required

The following tool is required to install the Reed-Solomon Codec PCB:

Tool	Description
Phillips ™ Screwdriver	To remove and replace cross-point screws.

A.1.3.3 Installation Procedure

Install the Reed-Solomon Codec PCB (AS/4080) as a daughter card on the interface PCB (AS/3971-1 or -2) as follows:

CAUTION ***Turn off power before installation. High current VDC is present. Failure to do so could result in damage to the modem components.***

1. Open modem front door and turn off the power.
2. Remove interface PCB (middle board) from the modem.
3. Install the Reed-Solomon PCB to the interface PCB. Mate the male header connectors JP2, JP3, and JP1 on the Reed-Solomon PCB with the interface PCB female header connectors J2, J3, and J4, respectively. Refer to Figure A-5 for the connector and mounting hardware locations.
4. Align Reed-Solomon PCB standoffs with the interface PCB mounting holes. Install the six mounting screws and washers.

   CAUTION ***The mounting hardware must be installed to provide proper grounding between the Reed-Solomon PCB and the interface PCB.***

5. Re-install interface PCB to the modem.
6. After completing the above installation procedure, turn on the modem.
   a. If the Reed-Solomon option was installed properly, the interface option screen for the Utility Interface subsection will display a “+”.
   b. For further information, see the operating instructions and front panel menus in Chapter 4.

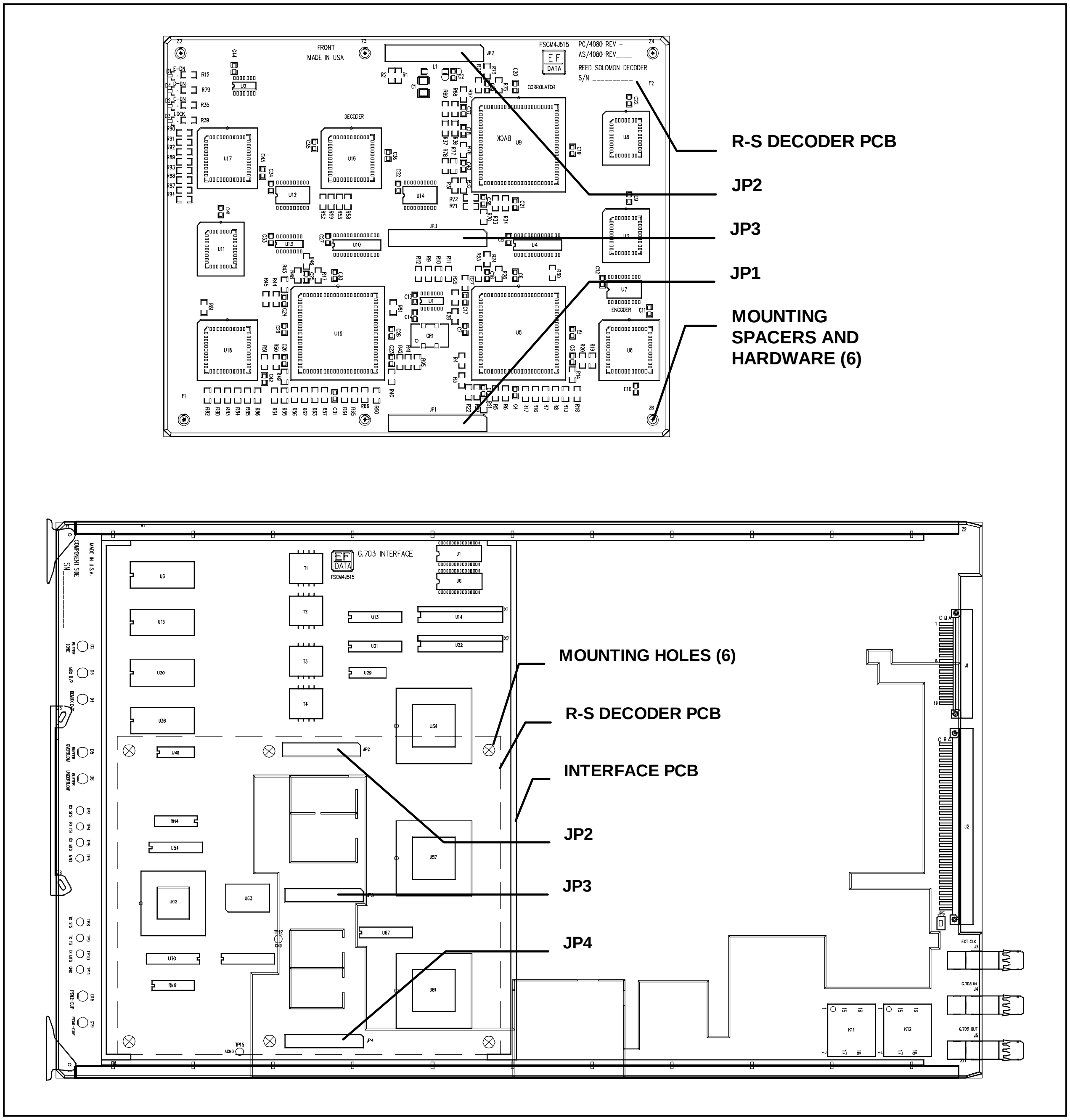


Figure A-5. Reed-Solomon Installation

A.2 Direct Broadcast Satellite

This section describes the optional Direct Broadcast Satellite (DBS) operating mode for the SDM-9000.

As implemented on the SDM-9000, the DBS mode supports data rates up to 44.736 Mbit/s using a single FEC (Forward Error Correction) channel. Single channel implementation differs significantly from the INTELSAT specifications (for carriers greater than 10 Mbit/s) for commutating the data across three channels.

In addition, DBS mode employs the following features:

- Special framing
- Scrambling
- Reed-Solomon coding
- Code rate puncturing

DBS operation with the SDM-9000 is based on the European Broadcasting Union (EBU) DVB specifications of DVB SB 5 (94) 5 and ETS 300 421. Both of these specifications describe channel coding, modulation, etc., for transmitting MPEG-2 (ISO/IEC 13818) coded television over a satellite link.

Figure A-6 shows the conceptual block diagrams for the transmit and receive processes of the SDM-9000 when configured for DBS operation.

Note: The IF physical interfaces and QPSK modulator are functionally equivalent to those used during INTELSAT operation, and will not be described here.

The blocks shown in Figure A-6 have special functionality when operating in DBS mode. Each block is described in the following sections.

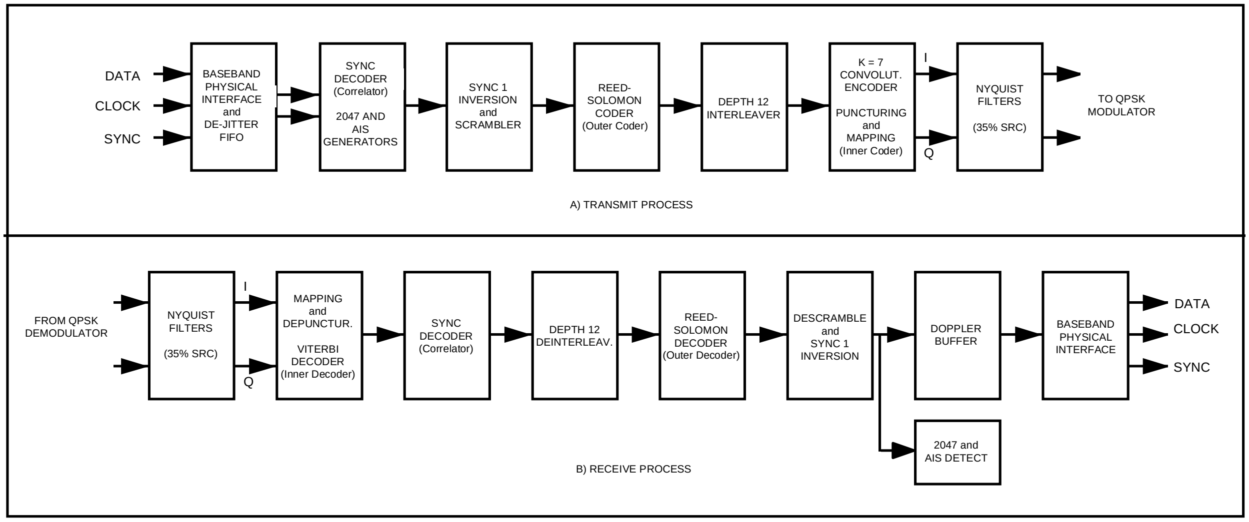


Figure A-6. Block Diagram of SDM-9000 Configured for DBS/DVB Operation

A.2.1 Requirements

This section covers the module types that are compatible with each option, and the minimum software requirements for the modem PCBs. The following options list the interface type and PCB assembly numbers.

The DBS option works in conjunction with the Viterbi decoder, and includes additional framing, interleaving, and Codec processing to provide:

- Concatenated FEC
- Convolutional encoding/decoding

This option can be factory or user installed. Refer to the following table for modem compatibility requirements.

Interface PCB	Type 2 or 3 (or greater) AS/4477-22 PECL w/buffer AS/4477-32 PECL w/ESC AS/4477-21 ECL w/buffer AS/4477-31 ECL w/ESC
Display/M&C PCB	AS/2305 Rev. C4 (or greater)
Modulator PCB	AS/3969
Demodulator PCB	AS/3970-5 or AS/3970-6
DVB Reed-Solomon PCB	AS/4524

A.2.2 Baseband Physical Interfaces

The baseband physical interface for the DBS mode is provided by the Emitter Coupled Logic (ECL) or Positive Emitter Coupled Logic (PECL) interface boards installed in the SDM-9000. Refer to Sections A.2.2.1 and A.2.2.2 for information about the respective interface boards.

Characteristics of the baseband physical interface are described in Section A.2.3.

Timing requirements for the baseband physical interface are presented in Section A.2.4.

A.2.2.1 ECL Physical Interface

The ECL interface uses MC10H115 differential line receivers and MC10H101 differential line drivers to provide the electrical interface to the SDM-9000. Figure A-7 shows a typical differential ECL receiver and driver diagram.

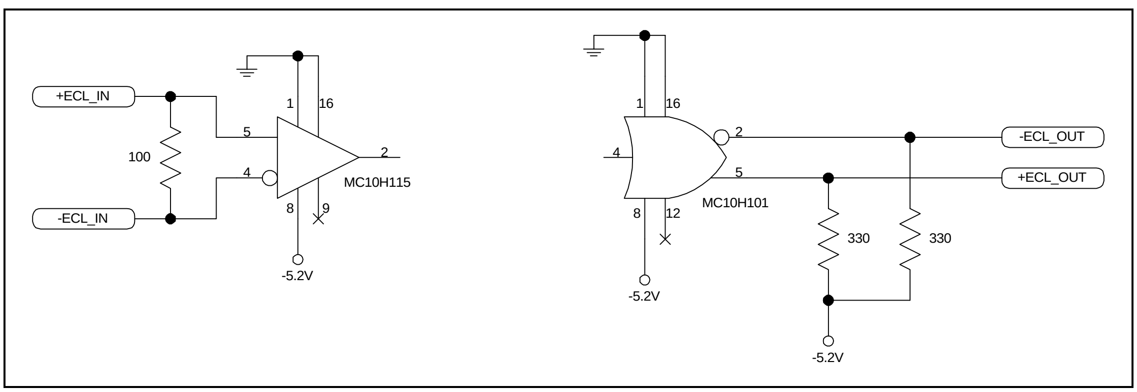


Figure A-7. Typical Differential ECL Receiver and Driver

A.2.2.2 PECL Physical Interface

The PECL interface uses the same interface devices as the ECL, but is referenced to the positive rail, as shown in Figure A-8. The electrical characteristics of both interface types are shown in Table A-1.

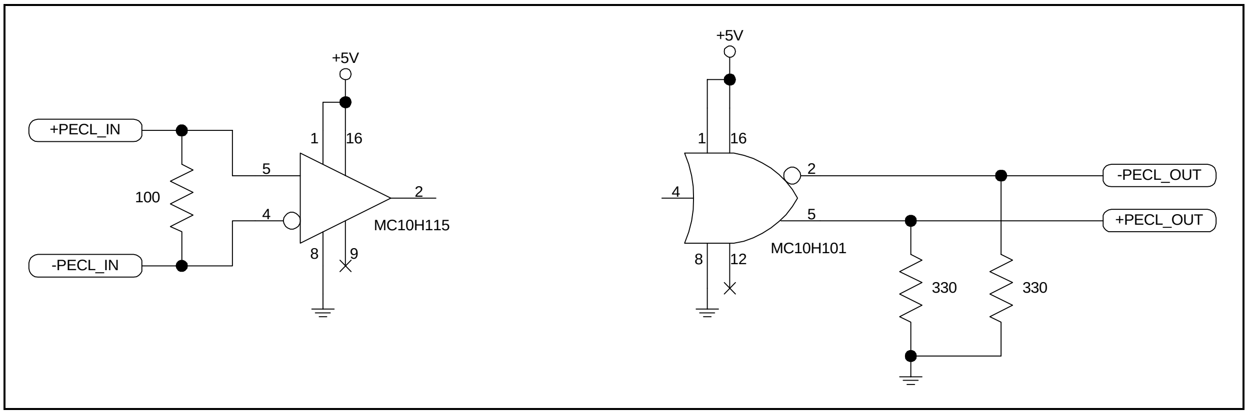


Figure A-8. Typical Differential PECL Receiver and Driver

Table A-1. Electrical Characteristics of ECL and PECL Interface Types

	Symbol	Parameter	Min	Max	Units
ECL	V_{OH}	Output High Voltage	-1.02	-0.74	V
	V_{OL}	Output Low Voltage	-1.95	-1.60	V
	V_{IH}	Input High Voltage	-1.17	-0.84	V
	V_{IL}	Input Low Voltage	-1.95	-1.48	V
PECL	V_{OH}	Output High Voltage	3.98	4.26	V
	V_{OL}	Output Low Voltage	3.05	3.40	V
	V_{IH}	Input High Voltage	3.83	4.16	V
	V_{IL}	Input Low Voltage	3.05	3.52	V

A.2.3 DBS Baseband Interface

A.2.3.1 DBS TX Baseband Interface

As illustrated previously by Figure A-6, the data and sync inputs are first passed through a dejitter FIFO register to hand off the data to the stable transmit clock, and then passed to the SYNC 1 inversion and scrambler block.

The transmit DBS baseband interface accepts data in 204-byte packets in bit serial format that are composed of 188-byte MPEG-2 packets. In addition, 16 null bytes are included as place holders for Reed-Solomon overhead. Figure A-9 shows the packet arrangement.

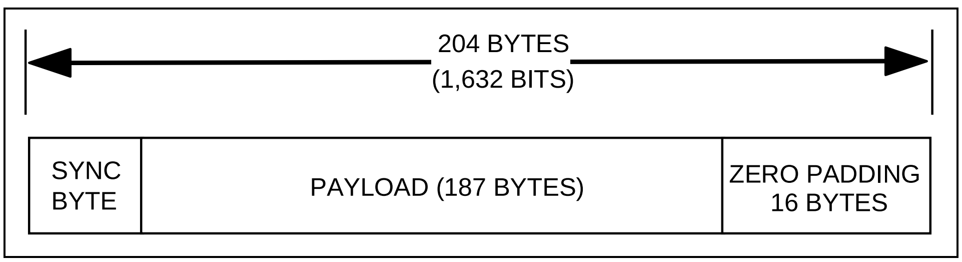


Figure A-9. DBS Mode Baseband Packet

Note: An additional sync input is used to indicate the position of the sync byte within the input stream.

A.2.3.2 DBS RX Baseband Interface

The receive DBS baseband interface takes data and sync pulses from the SYNC 1 inversion logic, and provides bit serial data and sync pulses in 204-byte packets (1,632 bits) to the outside world.

A.2.4 Baseband Interface Requirements

A.2.4.1 Timing for Transmit Baseband Interface

A diagram of the timing for the transmit baseband interface is shown in Figure A-10.

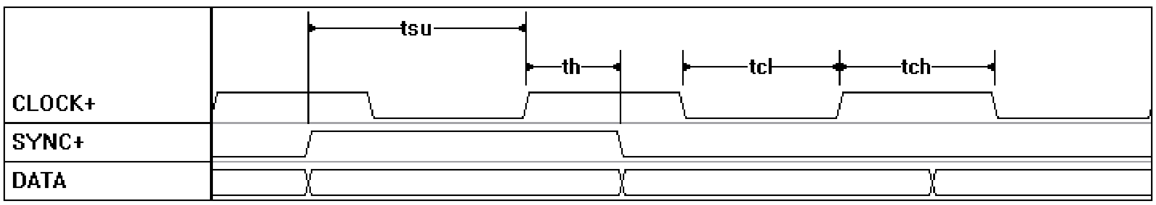


Figure A-10. Timing for Transmit Baseband Interface

Parameters for TX baseband interface timing are presented in Table A-2.

Table A-2. TX Baseband Interface Timing

Parameter	Description	Min
t_{su}	Setup time, DATA or SYNC to CLOCK	8 ns
t_h	Hold time, CLOCK to DATA or SYNC invalid	2 ns
t_{cl}	CLOCK low duration	8 ns
t_{ch}	CLOCK high duration	8 ns

Note: SYNC is only required in DBS mode (204-byte packets).

A.2.4.1.1 DBS Mode TX SYNC Pulse Timing

In DBS mode, a one clock-period-wide sync pulse must be supplied coincident with the first bit of the sync byte. However, it is not required that the MPEG-2 sync byte data (0x47) be present, because the DBS sync-detect logic writes a new sync byte pattern upon receiving the sync pulse.

After the sync byte interval, 187 bytes (1,496 bits) of packet data, followed by 16 bytes (128 bits) of zeros, are supplied to the modem. Refer to Figure A-11.

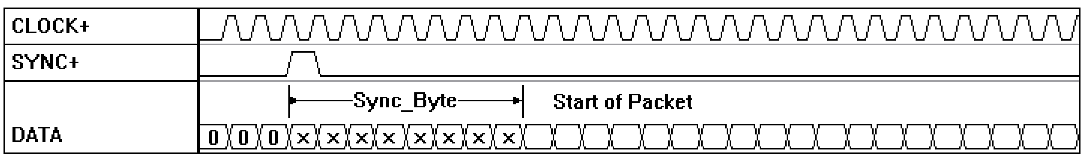


Figure A-11. DBS Mode TX SYNC Pulse Timing

A.2.4.2 Timing for Receive Baseband Interface

A diagram of the timing for the receive baseband interface is shown in Figure A-12.

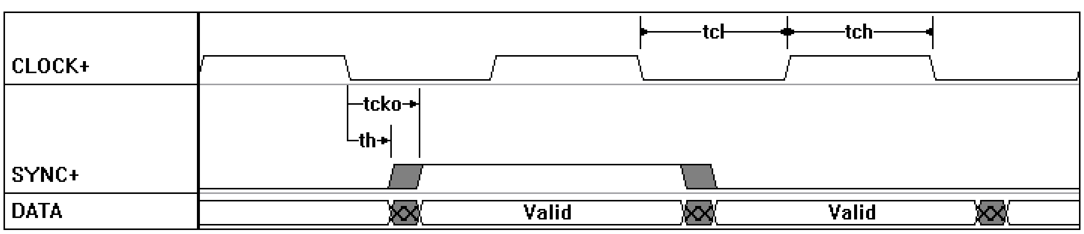


Figure A-12. Timing for Receive Baseband Interface

Parameters for TX baseband interface timing are presented in Table A-3.

Table A-3. Receive Baseband Interface Timing

Parameter	Description	Min	Max
t_{cko}	Delay time, CLOCK to DATA or SYNC valid		5 ns
t_h	Hold time, CLOCK to DATA or SYNC invalid	2 ns	
t_{cl}	CLOCK low time	8 ns	
t_{ch}	CLOCK high time	8 ns	

A.2.4.2.1 DBS Mode Receive SYNC Pulse Timing

In DBS mode, a one clock-period-wide sync pulse is supplied coincident with the first bit of the sync byte (0x47). After the sync byte interval, 187 bytes (1,496 bits) of packet data, followed by 16 bytes (128 bits) of zeros, are output from the modem. Refer to Figure A-13.

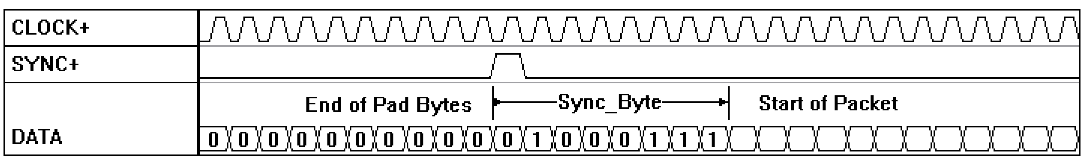


Figure A-13. DBS Mode Receive SYNC Pulse Timing

Receive packets that could not be corrected by the Reed-Solomon decoder are indicated with an extended sync pulse (two clock-periods-wide) as shown in Figure A-14.

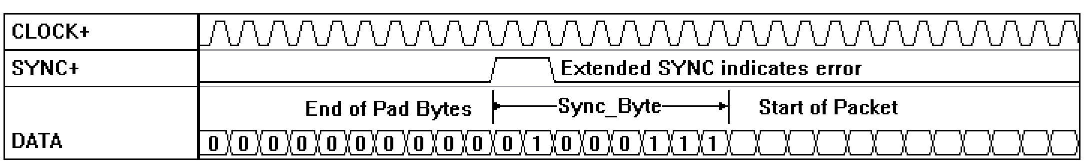


Figure A-14. DBS Mode Receive with Extended SYNC

A.2.5 SYNC Decoder (Correlater)

In DBS mode, an external sync pulse provides the reference for the frame structure used throughout the transmission process. This external sync pulse must be provided coincident with the first bit of the MPEG-2 sync byte.

A.2.5.1 DBS Mode SYNC Decoder for 204-Byte Packets

A.2.5.1.1 TX Functions of the DBS Mode SYNC Decoder

During the transmission process, the DBS mode sync-detect logic ignores the sync byte data in the data packet. Instead, the external sync pulse is used. Upon receiving the external sync pulse, a new sync byte is written over the existing sync byte in the data packet. In addition, every eighth sync byte is inverted.

Use of the external sync pulse means the data packet is already correlated, because its framing structure is in a known relationship to the scrambler, the Reed-Solomon Codec, and the interleaver.

If the external sync pulse is not supplied, the condition is detected. In this case, a new framing structure is written over the 204-byte packets in no particular relationship to the original packets. This preservation of the framing structure allows the modem to operate correctly; however, the original MPEG-2 packets will be corrupted.

If the clock input is not supplied, the internal clock is used, and a new framing structure is supplied. The internal Alarm Indication Signal (AIS) generator fills the 187-byte payload with all 1s, and the last 16 bytes of the packet are filled with 0s.

A.2.5.1.2 RX Functions of the DBS Mode SYNC Decoder

During the reception process, the sync decoder always operates as a correlater because the frame structure must be determined entirely from the MPEG-2 sync bytes (no external sync pulse is available). Once the frame structure is detected, the de-interleaver, Reed-Solomon decoder, and descrambler are synchronized to the 204-byte packets.

The sync decoder also recovers the π phase ambiguity of the QPSK demodulator that the Viterbi decoder cannot detect.

A.2.6 SYNC 1 Inversion and Scrambler/Descrambler

In compliance with the DVB specifications, and to ensure adequate binary transitions, the payload data (187 bytes) in the transport packet is scrambled using a Pseudo Random Binary Sequence (PRBS) generator.

The polynomial used for the PRBS is:

$$1 + X^{14} + X^{15}$$

The basic scrambler/descrambler is shown in Figure A-15.

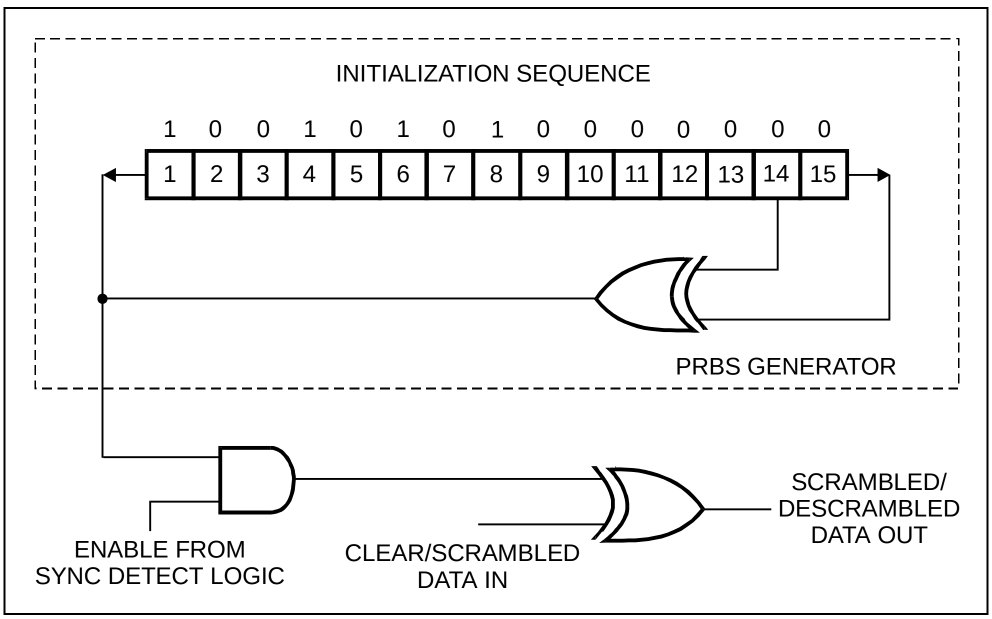


Figure A-15. Scrambler/Descrambler

At every eighth transport packet, the sequence “100101010000000” is loaded into the PRBS registers. The inverted sync byte is used to initialize the PRBS generator.

A.2.6.1 DBS Mode (De)Scrambler for 204-Byte Packets

The DVB specifications require that the inverted sync byte detection be used to load the PRBS generator every eight sync bytes, and that the PRBS generator run continuously until the next load (eight packet period).

The first bit at the output of the PRBS generator is applied to the first bit of the first byte following the inverted MPEG-2 sync byte (i.e., 0xB8). To aid other synchronization functions during the MPEG-2 sync bytes of the subsequent seven transport packets, the PRBS generation continues, but its output is gated off, leaving these bytes unscrambled.

In DBS mode, however, there is an additional 16 bytes of padding at the end of each transport packet. The padding is reserved for Reed-Solomon (RS) overhead. (To be compatible with the DVB specification, the PRBS generator must be halted and the scrambler disabled during these 16 padding bytes.) The period of the PRBS generator for DBS mode is:

$$\text{PERIOD} = 8\ \text{PACKETS} * \left(\frac{204\ \text{BYTES}}{\text{PACKET}} - \frac{16\ \text{PAD BYTES}}{\text{PACKET}} \right) - 1\ \text{INVERTED SYNC BYTE} = 1503\ \text{BYTES}$$

Figure A-16 illustrates the DBS scrambler sequence.

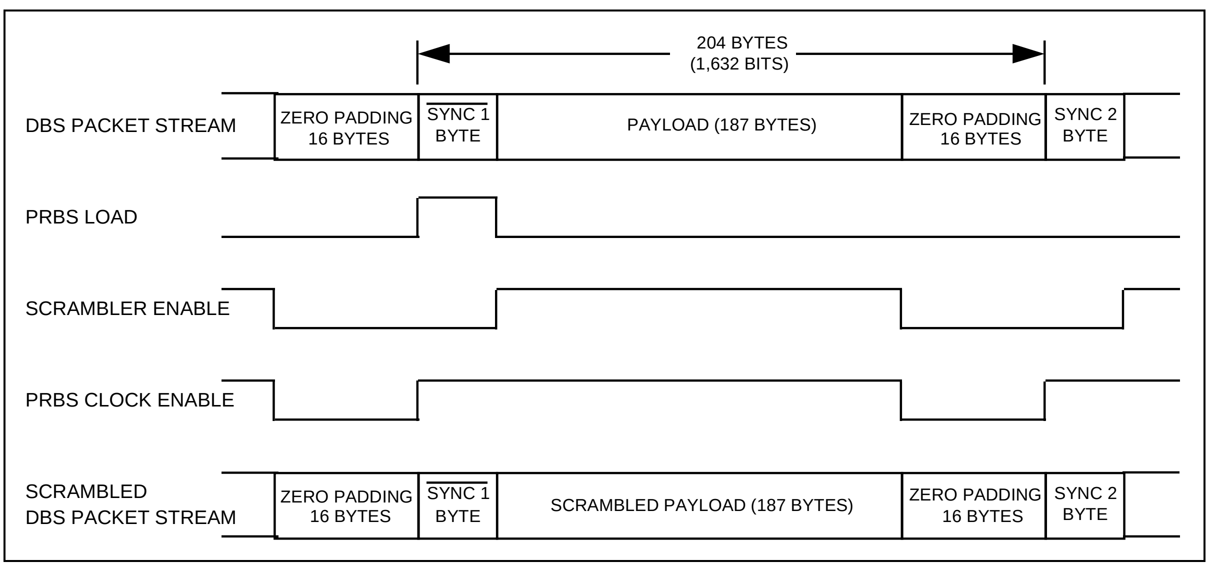


Figure A-16. DBS Scrambler Sequence

Note: The scrambler and the descrambler work in the same way, except that scrambled data is *input* and descrambled data is *output*.

A.2.7 Reed-Solomon Coder/Decoder

The Reed-Solomon coder receives scrambled data packets in byte serial format. RS(204,188,8) shortened code—from the original RS(255,239,8) code—is applied to each scrambled transport packet (188 bytes) to generate an error-protected packet. Refer to Figure A-17 for the packet arrangement.

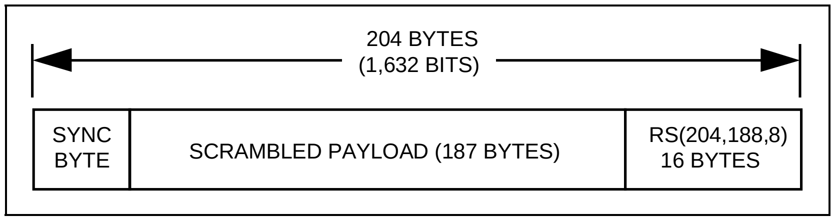


Figure A-17. Reed-Solomon RS(204,188,8) Error-Protected Packet

Note: RS coding is also applied to the non-inverted or inverted packet sync byte.

The shortened Reed-Solomon code is implemented by adding 51 bytes, all set to zero, to the information bytes at the input of a (255,239) encoder. These bytes are discarded after the encoding procedure.

The code and field generator polynomials are shown below.

Code Generator Polynomial:

$$g(x) = (x + \alpha^0)(x + \alpha^1)(x + \alpha^2) \ldots (x + \alpha^{15})$$

Field Generator Polynomial:

$$p(x) = x8 + x4 + x3 + x2 + 1$$

A.2.7.1 DBS Mode Check Byte Framing for 204-Byte Packets

When operating in DBS transmit mode, the 16 padding bytes are replaced with the 16 Reed-Solomon check bytes. The DBS mode allows a 1-for-1 byte replacement in the RS coder; therefore, no rate exchange is required. The 204-byte RS error-protected packet is then sent to the depth 12 interleaver.

Conversely, the DBS receive mode works by correcting byte errors in the first 188 bytes of the error-protected packet and replacing the 16 check bytes with 0s.

A.2.8 Depth 12 Interleaver/De-interleaver

Conceptually, the interleaver is composed of I = 12 branches, cyclically connected to the input byte stream by the input switch. Each branch is a FIFO shift register, with depth = 17 x branch index. The cells of the FIFO contain 1 byte, and the input and output branches are synchronized. For synchronization purposes, the sync bytes and inverted sync bytes are always routed in branch 0 of the interleaver, corresponding to a null delay.

The de-interleaver is similar in principle to the interleaver, but the branch indexes are reversed (i.e., branch 0 corresponds to the longest delay). De-interleaver synchronization is accomplished by routing the first recognized sync byte to branch 0.

Figure A-18 shows the interleaver/de-interleaver block diagram.

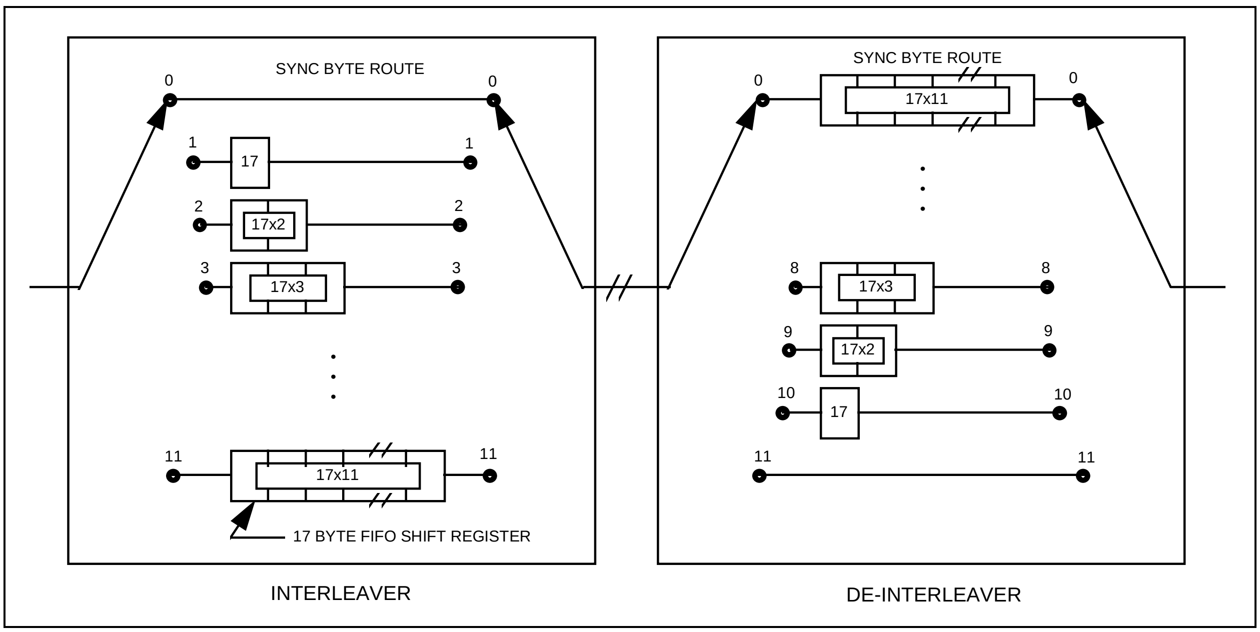


Figure A-18. Interleaver/De-interleaver

An interleaved frame is generated by applying convolutional interleaving (with depth I = 12) to the error-corrected packets.

Figure A-19 shows the interleaved frame structure.

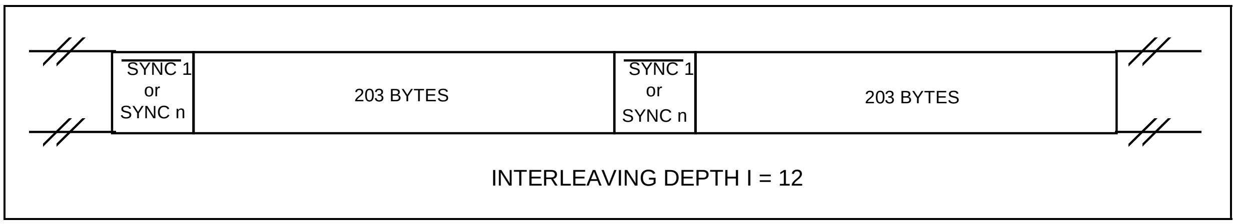


Figure A-19. Interleaved Frame Structure

The interleaved frame is composed of overlapping error-protected packets delimited by inverted or non-inverted MPEG-2 sync bytes, preserving the periodicity of 204 bytes.

A.2.9 Inner Coder/Decoder

The transmit convolutional coder is a standard k = 7, rate 1/2 (G1 = 171, G2 = 133), followed by a programmable puncturing unit. Code rates supported are 1/2, 3/4, and 7/8.

A.2.9.1 Punctured Operation

The DVB puncturing scheme differs from that specified by IESS-308 (INTELSAT), and is shown in Figure A-20.

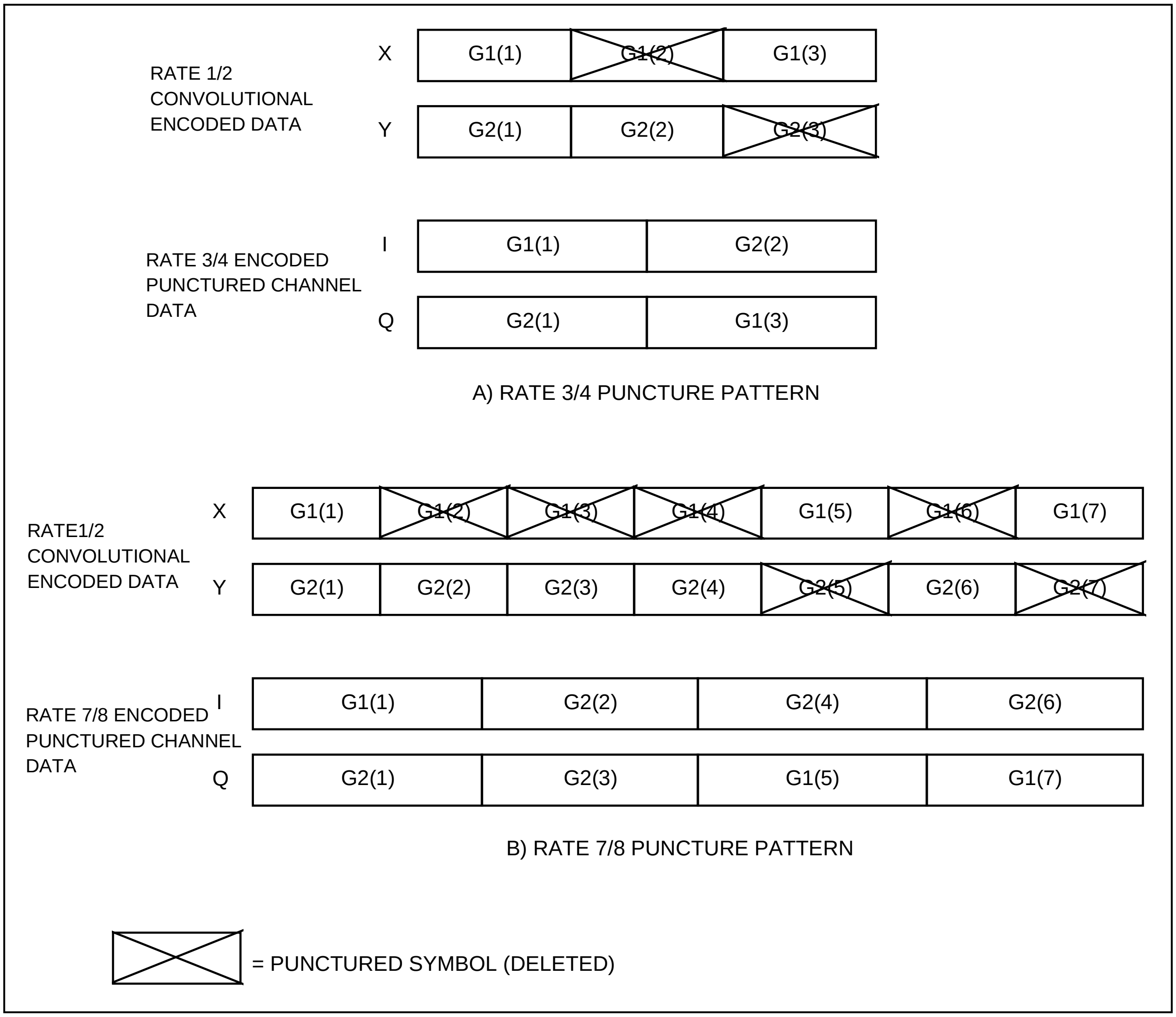


Figure A-20. DVB Puncturing

In punctured operation (rates 3/4 and 7/8), a rate exchange is required between the rate 1/2 convolutional encoded data and the encoded punctured channel data.

Note: The DVB specification also describes rate 2/3 and rate 5/6 puncturing, but the SDM-9000 does not support these code rates at this time.

Table A-4 shows the ratios between the convolutional encoder's clock and the symbol clock for each exchange rate.

Table A-4. Rate Exchange Ratios for DVB Puncturing

Rate	Ratio	Comment
7/8	7:4	
3/4	3:2	
1/2	1:1	No symbols are punctured, therefore no rate exchange is required.

The reception process works by shuffling the encoded punctured channel data to the appropriate positions for the rate 1/2 Viterbi decoder. Null symbol indicators are inserted into the punctured symbol positions in the rate 1/2 data stream.

Again, for rates 3/4 and 7/8, a rate exchange is required for the symbol clock to Viterbi clock hand-off. For rate 1/2, no symbols are punctured, and therefore, no rate exchange is required.

A.2.9.2 Signal Space Mapping

DBS/DVB operation employs conventional Gray-coded QPSK modulation with absolute mapping (no differential coding). Bit mapping in the signal space is shown in Figure A-21.

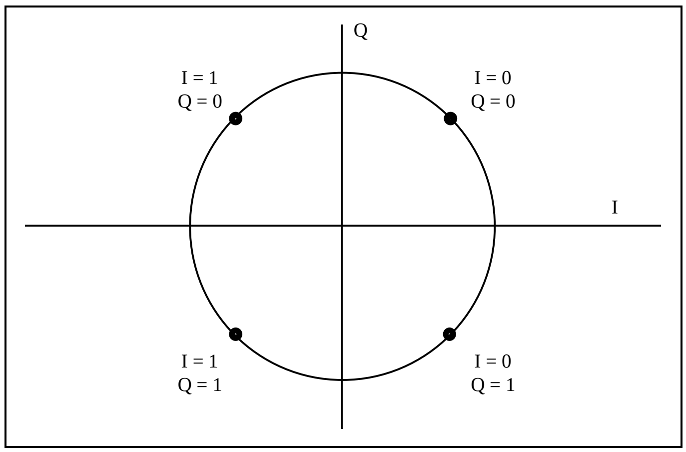


Figure A-21. QPSK Constellation

A.2.10 Nyquist Filters

Prior to modulation, the I and Q baseband signals are passed through Nyquist filters exhibiting a square-root, raised-cosine transfer function with a 35% rolloff factor. The theoretical transfer function is defined by the following expression:

$$H(f) = 1 \quad \text{for} \quad |f| < f_N(1-\alpha)$$

$$H(f) = \sqrt{\frac{1}{2} + \frac{1}{2}\sin\frac{\pi}{2f_N}\left[\frac{f_N - |f|}{\alpha}\right]} \quad \text{for} \quad f_N(1-\alpha) \le |f_N| \le f_N(1+\alpha)$$

$$H(f) = 0 \quad \text{for} \quad |f| > f_N(1+\alpha)$$

where:

$$\alpha = .35$$

$$f_N = \frac{1}{2T_S} = \frac{R_S}{2} \quad \text{is the Nyquist frequency}$$

The reception process uses Nyquist filters exhibiting the same transfer function as the transmission process (matched filters). The receiving Nyquist filters are incorporated directly after the QPSK demodulator. The I and Q outputs of these filters are digitized and mapped to 3-bit, soft-decision symbols for subsequent de-puncturing (if required) and Viterbi decoding.

A.2.11 DVB with Reed-Solomon BER (QPSK)

Table A-5 shows the DVB Reed-Solomon specifications for the E_b/N_0 required to achieve 10^{-6} to 10^{-10} BER for different configurations.

Table A-5. Reed-Solomon BER Data

Specification				Typical			
BER	1/2 Rate	3/4 Rate	7/8 Rate	BER	1/2 Rate	3/4 Rate	7/8 Rate
10^{-6}	3.7 dB	4.7 dB	5.4 dB	10^{-6}	3.1 dB	4.0 dB	5.0 dB
10^{-7}	3.9 dB	4.9 dB	5.6 dB	10^{-7}	3.2 dB	4.1 dB	5.2 dB
10^{-8}	4.0 dB	5.1 dB	5.8 dB	10^{-8}	3.3 dB	4.2 dB	5.3 dB
10^{-10}	4.3 dB	5.4 dB	6.2 dB	10^{-10}	3.6 dB	4.5 dB	5.5 dB

All values are for QPSK mode operation. Refer to Figure A-22 for the DVB Reed-Solomon BER curves.

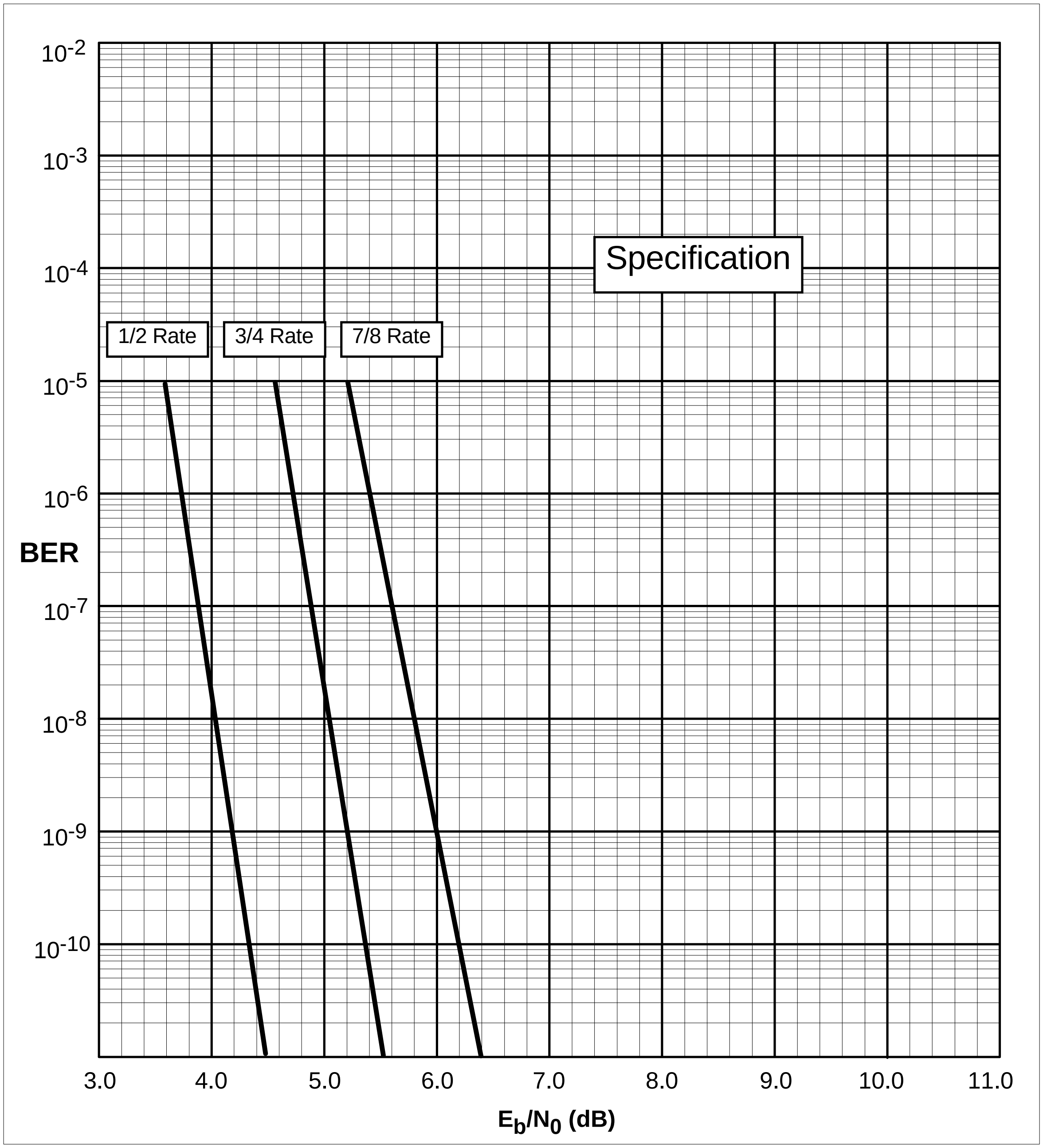


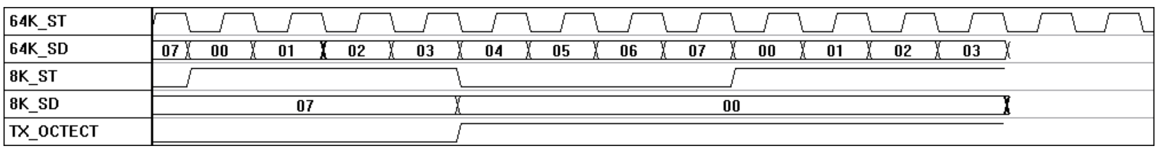
Figure A-22. QPSK (1/2, 3/4, 7/8 Rates) with Reed-Solomon (DVB)

A.3 ESC 64 kbit/s Data Option

The two audio channels in the ESC data stream can be replaced with a single 64 kHz data channel.

The data is transmitted and received on the same connector pins which were used for audio. The data is electrically similar to the 8 kHz data channel (except for the data rate). As with the 8 kHz channel, the data transitions on the falling edge of the clock, and is valid on the rising edge. Setup and hold times for the rising edge are 5 uS.

If byte alignment is required, the 8 kHz clock can be used. The first bit of data is valid with the first rising edge of the 64 kHz clock following the rising edge of the 8 kHz clock. The rising edge of the 8 kHz clock should occur within 5 uS of the falling edge of the 64 kHz clock.



The receive timing is identical to the transmit. Data transitions on the falling edge of the clock and is valid on the rising edge. If byte alignment is used, the rising edge of the first 64 kHz clock following the rising edge of the 8 kHz clock marks the first data bit.

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Appendix B. REMOTE CONTROL OPERATION

This appendix describes the remote control operation of the SDM-9000.

- Firmware number: FW/4100-1F
- Software version: 6.1.1

B.1 General

Remote controls and status information are transferred via an RS-485 (optional RS-232) serial communications link.

Commands and data are transferred on the remote control communications link as US ASCII-encoded character strings.

The remote communications link is operated in a half-duplex mode.

Communications on the remote link are initiated by a remote controller or terminal. The modem never transmits data on the link unless it is commanded to do so.

B.2 Message Structure

The ASCII character format used requires 11 bits/character:

- 1 start bit
- 7 information bits
- 1 parity bit
- 2 stop bits

Messages on the remote link fall into the categories of commands and responses.

Commands are messages which are transmitted to a satellite modem, while responses are messages returned by a satellite modem in response to a command.

The general message structure is as follows:

- Start Character
- Device Address
- Command/Response
- End of Message Character

B.2.1 Start Character

A single character precedes all messages transmitted on the remote link. This character flags the start of a message. This character is:

- "<" for commands
- ">" for responses

B.2.2 Device Address

The device address is the address of the one satellite modem which is designated to receive a transmitted command, or which is responding to a command.

Valid device addresses are 1 to 3 characters long, and in the range of 1 to 255. Address 0 is reserved as a global address which simultaneously addresses all devices on a given communications link. Devices do not acknowledge global commands.

Each satellite modem which is connected to a common remote communications link must be assigned its own unique address. Addresses are software selectable at the modem, and must be in the range of 1 to 255.

B.2.3 Command/Responses

The command/response portion of the message contains a variable-length character sequence which conveys command and response data.

If a satellite modem receives a message addressed to it which does not match the established protocol or cannot be implemented, a negative acknowledgment message is sent in response. This message is:

- >add/?ER1_parity error'cr''lf']
  (Error message for received parity errors.)
- >add/?ER2_invalid parameter'cr''lf']
  (Error message for a recognized command which cannot be implemented or has parameters which are out of range.)
- >add/?ER3_unrecognizable command'cr''lf']
  (Error message for unrecognizable command or bad command syntax.)
- >add/?ER4_modem in local mode'cr''lf']
  (Modem in local error; send the REM command to go to remote mode.)
- >add/?ER5_hard coded parameter'cr''lf']
  (Error message indicating that the parameter is hardware dependent and may not be changed remotely.)

Note: “add” is used to indicate a valid 1 to 3 character device address in the range between 1 and 255.

B.2.4 End Character

Each message is ended with a single character which signals the end of the message:

- “cr” Carriage return character for commands
- “]” End bracket for responses

B.3 Configuration Commands/Responses

B.3.1 Modulator

Modulator Frequency	Command: Response: Status: Response:	<add/MF_nnn.nnnn'cr' >add/MF_nnn.nnnn'cr' RF_OFF'cr''lf'] <add/MF_'cr' >add/MF_nnn.nnnn'cr''lf']	Where: nnn.nnnn = Frequency in MHz, 50.0000 to 180.0000, in 2.5 kHz steps. Note: When the modulator frequency is programmed, the RF output is switched OFF.
RF Output (IF Output)	Command: Response: Status: Response:	<add/RF_xxx'cr' >add/RF_xxx'cr''lf'] <add/RF_'cr' >add/RF_xxx'cr''lf']	Where: xxx = ON or OFF.
Modulator Rate Preset Assignment	Command: Response:	<add/AMRx_'cr' >add/AMRx_nnnnn_mmmmm.mmm'cr''lf']	Where: x = A, B, C, or D (preset designator). nnnnn = One of the following coder rates: 1/2 (QPSK 1/2) 3/4 (QPSK 3/4) 7/8 (QPSK 7/8) 16Q34 (16QAM 3/4) 16Q78 (16QAM 7/8) 8P23 (8PSK 2/3) 8P56 (8PSK 5/6) N/A (Not Assigned) mmmmm.mmm = Data rate in kHz. Note: If the filter is calibrated for the Reed-Solomon, '+RS' will be appended to the code rate. Example: 3/4+RS_44736.0.
Modulator Rate Preset Selection	Command: Response: Status:	<add/SMRx_'cr' >add/SMRx_'cr' RF_OFF'cr''lf'] See MR command.	Where: x = A, B, C, or D (preset designator). Notes: 1. Setting the modulator rate turns OFF the RF transmitter. 2. If the filter is calibrated for the Reed-Solomon, '+RS' will be appended to the code rate. Example: 3/4+RS_44736.0.
Modulator Power Offset	Command: Response: Status: Response:	<add/MPO_snn.n'cr' >add/MPO_snn.n'cr''lf'] <add/MPO_'cr' >add/MPO_snn.n'cr''lf']	Where: snn.n = +40.0 to -40.0, in 0.1 dB increments. Note: The modulator power offset is added to the nominal power level to adjust the transmit power range.
Modulator Output Power Level	Command: Response: Status: Response:	<add/MOP_snn.n'cr' >add/MOP_snn.n'cr''lf'] <add/MOP_'cr' >add/MOP_snn.n'cr''lf']	Where: snn.n = -20.0 to +5.0, in 0.1 steps (nominal range in dBm). Note: The nominal power range is modified relative to the value specified by the modulator power offset (MPO_).

Differential Encoder Enable	Command: Response: Status: Response:	<add/DENC_xxx'cr' >add/DENC_xxx'cr''lf'] <add/DENC_'cr' >add/DENC_xxx'cr''lf']	Where: xxx = ON or OFF.
Modulator Reference Clock	Command: Response: Status: Response:	<add/MRC_xxxxx'cr' >add/MRC_xxxxx'cr''lf'] <add/MRC_'cr' >add/MRC_xxxxx'cr''lf']	Where: xxxxx = INT, EXT5 (5 MHz), EXT10 (10 MHz), or EXT20 (20 MHz). Note: If the High Stability Internal 5 MHz/External Divider Option is not installed, only 'INT' will be allowed.
Reed-Solomon Encoder Enable	Command: Response: Status: Response:	<add/RSEN_xxx'cr' >add/RSEN_xxx'cr' RF_OFF'cr''lf'] <add/RSEN_'cr' >add/RSEN_xxx'cr''lf']	Where: xxx = ON or OFF. Notes: 1. Setting the Reed-Solomon Encoder turns OFF the RF transmitter. 2. If the Reed-Solomon Option is not installed, only OFF will be allowed.
Modulator Spectrum Rotation	Command: Response: Status: Response:	<add/MSR_xxxx'cr' >add/MSR_xxxx'cr''lf'] <add/MSR_'cr' >add/MSR_xxxx'cr''lf']	Where: xxxx = NRM (normal spectrum) or INV (inverted spectrum).

B.3.2 Demodulator

Demodulator Frequency	Command: Response: Status: Response:	<add/DF_nnn.nnnn'cr' >add/DF_nnn.nnnn'cr''lf'] <add/DF_'cr' >add/DF_nn.nnnn'cr''lf']	Where: nnn.nnnn = Frequency in MHz, 50.0000 to 180.0000, in 2.5 kHz steps.
Demodulator Rate Preset Assignment	Status: Response:	<add/ADRx_'cr' >add/ADRx_nnnnn_mmmmm.mmm'cr''lf']	Where: x = A, B, C, or D (preset designator). nnnnn = One of the following decoder rates: 1/2 (QPSK 1/2) 3/4 (QPSK 3/4) 7/8 (QPSK 7/8) 16Q34 (16QAM 3/4) 16Q78 (16QAM 7/8) 8P23 (8PSK 2/3) 8P56 (8PSK 5/6) N/A (Not Assigned) mmmmm.mmm = Data rate in kHz. Note: If the filter is calibrated for the Reed-Solomon, '+RS' will be appended to the code rate. Example: 3/4+RS_44736.0.
Demodulator Rate Preset Selection	Command: Response: Status:	<add/SDRx_'cr' >add/SDRx_'cr''lf'] See DR command.	Where: x = A, B, C, or D (preset designator). Note: If the filter is calibrated for the Reed-Solomon, '+RS' will be appended to the code rate. Example: 3/4+RS_44736.0.
Differential Decoder Enable	Command: Response: Status: Response:	<add/DDEC_xxx'cr' >add/DDEC_xxx'cr''lf'] <add/DDEC_'cr' >add/DDEC_xxx'cr''lf']	Where: xxx = ON or OFF.

RF Loopback	Command: Response: Status: Response:	<add/RFL_xxx'cr' >add/RFL_xxx'cr''lf'] <add/RFL_'cr' >add/RFL_xxx'cr''lf']	Where: xxx = ON or OFF.
IF Loopback	Command: Response: Status: Response:	<add/IFL_xxx'cr' >add/IFL_xxx'cr''lf'] <add/IFL_'cr' >add/IFL_xxx'cr''lf']	Where: xxx = ON or OFF.
Bit Error Rate Threshold	Command: Response: Status: Response:	<add/BERT_xxxx'cr' >add/BERT_xxxx'cr''lf'] <add/BERT_'cr' >add/BERT_xxxx'cr''lf']	Where: xxxx = NONE or 1^{-n} (where n = 3, 4, 5, 6, 7, or 8 [exponent of threshold]).
Reed-Solomon Decoder Enable	Command: Response: Status: Response:	<add/RSDE_xxx'cr' >add/RSDE_xxx'cr''lf'] <add/RSDE_'cr' >add/RSDE_xxx'cr''lf']	Where: xxx = ON, OFF, or CORR_OFF. Note: If the Reed-Solomon Option is not installed, only 'OFF' will be allowed.
Sweep Width Range	Command: Response: Status: Response:	<add/SWR_nnnnnn'cr' >add/SWR_nnnnnn'cr''lf'] <add/SWR_'cr' >add/SWR_nnnnnn'cr''lf']	Where: nnnnn = 0 to 120000, in 1 Hz steps.
Demodulator Spectrum Rotation	Command: Response: Status: Response:	<add/DSR_xxxx'cr' >add/DSR_xxxx'cr''lf'] <add/DSR_'cr' >add/DSR_xxxx'cr''lf']	Where: xxxx = NRM (normal spectrum) or INV (inverted spectrum).

B.3.3 Interface

Transmit Clock Phase	Command: Response: Status: Response:	<add/TCP_xxx'cr' >add/TCP_xxx'cr''lf'] <add/TCP_'cr' >add/TCP_xxx'cr''lf']	Where: xxx = NRM (normal clock phasing) or INV (inverted clock phasing).
External Reference Frequency	Command: Response: Status: Response:	<add/ERF_nnnnn.nnn'cr' >add/ERF_nnnnn.nnn'cr''lf'] <add/ERF_'cr' >add/ERF_nnnnn.nnn'cr''lf']	Where: nnnnn.nnn = 1544.000 to 51840.000 (steps of 8 kHz if data rate is under or equal to 20000.0 kbit/s or at data rate).
Buffer Clock	Command: Response: Status: Response:	<add/BC_xxx'cr' >add/BC_xxx'cr''lf'] <add/BC_'cr' >add/BC_xxx'cr''lf']	Where: xxx = INT (internal SCT clock), EXT (external TX terrestrial clock), SAT (receive satellite clock), or REF (external reference clock). Note: If the OPERATION MODE is set for RX_ONLY (non-G.703 interface only), 'INT' will not be allowed.
Interface Buffer Size	Command: Response: Status: Response:	<add/IBS_nn'cr' >add/IBS_nn'cr''lf'] <add/IBS_'cr' >add/IBS_nn'cr''lf']	Where: nn = 0 to 32 (in 2 millisecond steps).

Interface Buffer Center	Command: Response:	<add/IBC_'cr' >add/IBC_'cr''lf']	
Receive Clock Phase	Command: Response: Status: Response:	<add/RCP_xxx'cr' >add/RCP_xxx'cr''lf'] <add/RCP_'cr' >add/RCP_xxx'cr''lf']	Where: xxxx = NRM (normal clock phasing) or INV (inverted clock phasing).
Baseband Loopback	Command: Response: Status: Response:	<add/BBL_xxx'cr' >add/BBL_xxx'cr''lf'] <add/BBL_'cr' >add/BBL_xxx'cr''lf']	Where: xxx = ON or OFF.
Interface Loopback	Command: Response: Status: Response:	<add/ILB_xxx'cr' >add/ILB_xxx'cr''lf'] <add/ILB_'cr' >add/ILB_xxx'cr''lf']	Where: xxx = ON or OFF.
Interface Loop Timing	Command: Response: Status: Response:	<add/ILT_xxx'cr' >add/ILT_xxx'cr''lf'] <add/ILT_'cr' >add/ILT_xxx'cr''lf']	Where: xxx = ON or OFF.
Interface Coding Format Transmit	Command: Response: Status: Response:	<add/ICFT_xxxx'cr' >add/ICFT_xxxx'cr''lf'] <add/ICFT_'cr' >add/ICFT_xxxx'cr''lf']	Where: xxxx = AMI, B3ZS, or HDB3.
Interface Coding Format Receive	Command: Response: Status: Response:	<add/ICFR_xxxx'cr' >add/ICFR_xxxx'cr''lf'] <add/ICFR_'cr' >add/ICFR_xxxx'cr''lf']	Where: xxxx = AMI, B3ZS, or HDB3.
Scrambler Enable	Command: Response: Status: Response:	<add/SE_xxx'cr' >add/SE_xxx'cr''lf'] <add/SE_'cr' >add/SE_xxx'cr''lf']	Where: xxx = ON or OFF.
Descrambler Enable	Command: Response: Status: Response:	<add/DE_xxx'cr' >add/DE_xxx'cr''lf'] <add/DE_'cr' >add/DE_xxx'cr''lf']	Where: xxx = ON or OFF.
Transmit Data Fault	Command: Response: Status: Response:	<add/TDF_xxxx'cr' >add/TDF_xxxx'cr''lf'] <add/TDF_'cr' >add/TDF_xxxx'cr''lf']	Where: xxxx = NONE, DATA, or AIS.
Receive Data Fault	Command: Response: Status: Response:	<add/RDF_xxxx'cr' >add/RDF_xxxx'cr''lf'] <add/RDF_'cr' >add/RDF_xxxx'cr''lf']	Where: xxxx = NONE, DATA, or AIS.

Interface Substitute Pattern (Transmit 2047 Pattern)	Command: Response: Status: Response:	<add/ISP_xxx'cr' >add/ISP_xxx'cr''lf'] <add/ISP_'cr' >add/ISP_xxx'cr''lf']	Where: xxx = ON or OFF.
Interface Read Error Select (Receive 2047 Pattern)	Command: Response: Status: Response:	<add/IRE_xxx'cr' >add/IRE_xxx'cr''lf'] <add/IRE_'cr' >add/IRE_xxx'cr''lf']	Where: xxx = ON or OFF.
Interface Service Channel Level	Command: Response: Status: Response:	<add/ISCL_xxx_nnn'cr' >add/ISCL_xxx_nnn'cr''lf'] <add/ISCL_xxx'cr' >add/ISCL_xxx_nnn'cr''lf']	Where: xxx = TX1, TX2, RX1, or RX2 (service channel designator). nnn = -20 to +10, in steps of 1 (service channel level in dBm).
Interface Transmit Overhead Type	Command: Response: Status: Response:	<add/ITOT_xxxx'cr' >add/ITOT_xxxx'cr''lf'] <add/ITOT_'cr' >add/ITOT_xxxx'cr''lf']	Where: xxxx = NONE or IDR. Note: If the ESC Option is not installed, only 'NONE' will be allowed.
Interface Receive Overhead Type	Command: Response: Status: Response:	<add/IROT_xxxx'cr' >add/IROT_xxxx'cr''lf'] <add/IROT_'cr' >add/IROT_xxxx'cr''lf']	Where: xxxx = NONE or IDR. Note: If the ESC Option is not installed, only 'NONE' will be allowed.
Transmit Data Phase	Command: Response: Status: Response:	<add/TDP_xxxx'cr' >add/TDP_xxxx'cr''lf'] <add/TDP_'cr' >add/TDP_xxxx'cr''lf']	Where: xxxx = NRM (normal data phasing) or INV (inverted data phasing).
Receive Data Phase	Command: Response: Status: Response:	<add/RDP_xxxx'cr' >add/RDP_xxxx'cr''lf'] <add/RDP_'cr' >add/RDP_xxxx'cr''lf']	Where: xxxx = NRM (normal data phasing) or INV (inverted data phasing).
IDR Backward Alarm Enable	Command: Response: Status: Response:	<add/BW_xxx_nnn'cr' >add/BW_xxx_nnn'cr''lf'] <add/BW_xxx_'cr' >add/BW_xxx_nnn'cr''lf']	Where: xxx = TX1, TX2, TX3, TX4, RX1, RX2, RX3, or RX4 (backward alarm designator). nnn = ON or OFF.
Scrambler Type	Command: Response: Status: Response:	<add/SCRT_xxxx'cr' >add/SCRT_xxxx'cr''lf'] <add/SCRT_'cr' >add/SCRT_xxxx'cr''lf']	Where: xxxx = V.35, EFD, or IDR.
Descrambler Type	Command: Response: Status: Response:	<add/DSCT_xxxx'cr' >add/DSCT_xxxx'cr''lf'] <add/DSCT_'cr' >add/DSCT_xxxx'cr''lf']	Where: xxxx = V.35, EFD, or IDR.

Interface Receive Framing Structure	Command: Response: Status: Response:	<add/IRFS_fffff_ssss'cr' >add/IRFS_fffff_ssss'cr''lf'] <add/IRFS_fffff_ssss'cr' >add/IRFS_fffff_ssss'cr''lf']	Where: fffff = 6312, 8448, 32064, 34368, 44736, or 51840 (frame type). ssss = NONE, G704, G742, G743, G745, G747, G751, G752, G753, or STS1 (framing). Notes: 1. Valid 6312 frame structures are NONE, G704, G743, and G747. 2. Valid 8448 frame structures are NONE, G704, G742, and G745. 3. Valid 32064 frame structures are NONE and G752. 4. Valid 34368 frame structures are NONE, G751, and G753. 5. Valid 44736 frame structures are NONE and G752. 6. Valid 51840 frame structures are NONE and STS1.

B.3.4 System

Time of Day	Command: Response: Status: Response:	<add/TIME_hh:mmxx'cr' >add/TIME_hh:mmxx'cr''lf'] <add/TIME_'cr' >add/TIME_hh:mmxx'cr''lf']	Where: hh = 1 to 12 (hours). mm = 00 to 59 (minutes). xx = AM or PM.
Date	Command: Response: Status: Response:	<add/DATE_mm/dd/yy'cr' >add/DATE_mm/dd/yy'cr''lf'] <add/DATE_'cr' >add/DATE_mm/dd/yy'cr''lf']	Where: mm = 1 to 12 (month). dd = 1 to 31 (day). yy = 00 to 99 (year).
Remote	Command: Response:	<add/REM_'cr' >add/REM_'cr''lf']	The Remote command configures the modem for remote operation. The modem will respond to any status request at any time. However, the modem must be in Remote Mode to change configuration parameters.
Clear Stored Faults	Command: Response:	<add/CLSF_'cr' >add/CLSF_'cr''lf']	This command is used to clear all stored faults logged by the modem.
Modem Operation Mode	Command: Response: Status: Response:	<add/MOM_xxxxxxx'cr' >add/MOM_xxxxxxx'cr''lf'] <add/MOM_'cr' >add/MOM_xxxxxxx'cr''lf']	Where: xxxxxxx = TX_ONLY, RX_ONLY, or DUPLEX. This command configures the modem for simplex or duplex operation modes. When transmit-only mode is selected, receive faults are inhibited. When receive-only mode is selected, transmit faults are inhibited.
System Modem Type	Command: Response: Status: Response:	<add/SMT_xxxxxxxx'cr' >add/SMT_xxxxxxxx'cr''lf'] <add/SMT_'cr' >add/SMT_xxxxxxx'cr''lf']	Where: x = INTELSAT, DBS, or N5500.
Save Modem Config.	Command: Response:	<add/SMC_n'cr' >add/SMC_n'cr''lf']	Where: n = 1, 2, 3, 4, or 5 (stored configuration number).
Recall Modem Config.	Command: Response:	<add/RMC_n'cr' >add/RMC_n'cr''lf']	Where: n = 1, 2, 3, 4, or 5 (stored configuration number).

B.4 Status Commands/Responses

B.4.1 Configuration

Modulator Config. Status	Command: Response:	<add/MCS_'cr' >add/MCS_'cr' RF_xxx'cr' MF_nnn.nnnn'cr' MR_nnnnn_mmmmm.mmm'cr' AMRA_nnnnn_mmmmm.mmm'cr' AMRB_nnnnn_mmmmm.mmm'cr' AMRC_nnnnn_mmmmm.mmm'cr' AMRD_nnnnn_mmmmm.mmm'cr' MPO_snn.n'cr' MOP_snn.n'cr' DENC_xxx'cr' COM_xxx'cr' MSR_xxx'cr' MRC_xxx'cr' RSEN_xxx'cr''lf']	 RF Output (ON/OFF) Modulator Frequency Modulator Rate Preset 'A' Assignment Preset 'B' Assignment Preset 'C' Assignment Preset 'D' Assignment Modulator Power Offset Modulator Output Power Differential Encoder (ON/OFF) Carrier Only Mode (ON/OFF) Modulator Spectrum Rotation Modulator Reference Clock Reed-Solomon Encoder (ON/OFF) The Modulator Configuration Status command causes a block of data to be returned by the addressed modem. The block of data reflects the current configuration status of the modulator module. Additional configuration status of new options and features will always be appended to the end.

Modulator/ Coder Config. Program Status	Command: Response:	<add/MCP_'cr' >add/ MCP_'cr' SMT_xxxxxx'cr' ITOT_xxxx'cr' MOM_xxxxxxx'cr' MF_nnn.nnnn'cr' MR_nnnnn_mmmmm.mmm'cr' MPO_snn.n'cr' MOP_snn.n'cr' SE_xxx'cr' DENC_xxx'cr' TCP_xxx'cr' BBL_xxx'cr' ILB_xxx'cr' ILT_xxx'cr' ICFT_xxxx'cr' ISP_xxx'cr' TDF_xxxx'cr' ISCL_TX1_nnn'cr' ISCL_TX2_nnn'cr' TDP_xxxx'cr' MRC_xxx'cr' MSR_xxx'cr' RSEN_xxx'cr' BW_TX1_nnn'cr' BW_TX2_nnn'cr' BW_TX3_nnn'cr' BW_TX4_nnn'cr' SCRT_xxxx'cr' RF_xxx'cr''lf']	 System Modem Type Interface Transmit Overhead Type Modem Operation Mode Modulator Frequency Modulator Rate Modulator Power Offset Modulator Output Power Scrambler Enable (ON/OFF) Differential Encoder (ON/OFF) Transmit Clock Phase Baseband Loopback Interface Loopback Interface Loop Timing Interface Coding Format Transmit Interface Substitution Pattern (TX 2047) Transmit Data Fault Service Channel Level TX1 Service Channel Level TX2 Transmit Data Phase Modulator Reference Clock Modulator Spectrum Rotation Reed-Solomon Encoder (ON/OFF) Backward Alarm Enable TX1 Backward Alarm Enable TX2 Backward Alarm Enable TX3 Backward Alarm Enable TX4 Scrambler Type RF Output (ON/OFF) This command is used by the EFData M:N protection switch to collect information that is necessary to configure back-up modems. Because this command (content and/or order) can be changed at any time by EFData, it is advisable that other commands ('MCS_' and 'ICS_', or 'BCS_') be used for M&C systems.
Demodulato r Config. Status	Command: Response:	<add/DCS_'cr' >add/DCS_'cr' DF_nnn.nnnn'cr' DR_nnnn_mmmm.mmm'cr' ADRA_nnnn_mmmm.mmm'cr' ADRB_nnnn_mmmm.mmm'cr' ADRC_nnnn_mmmm.mmm'cr' ADRD_nnnn_mmmm.mmm'cr' DDEC_xxx'cr' RFL_xxx'cr' IFL_xxx'cr' BERT_xxxx'cr' DSR_xxx'cr' RSDE_xxx'cr' SWR_nnnnnn'cr''lf']	 Demodulator Frequency Demodulator Rate Preset 'A' Assignment Preset 'B' Assignment Preset 'C' Assignment Preset 'D' Assignment Differential Decoder RF Loopback IF Loopback BER Threshold Demodulator Spectrum Rotation Reed-Solomon Decoder Sweep Width Range The Demodulator Configuration Status command causes a block of data to be returned by the addressed modem. The block of data reflects the current configuration of the demod. Additional configuration status of new options and features will always be appended to the end.

Demod/	Command:	<add/DCP_'cr'	
Decoder	Response:	>add/DCP_'cr'	
Config.		SMT_xxxxxx'cr'	System Modem Type
Program		IROT_xxxx'cr'	Interface Receive Overhead Type
Status		MOM_xxxxxxx'cr'	Modem Operation Mode
		BERT_xxxx'cr'	BER Threshold
		DF_nnn.nnnn'cr'	Demodulator Frequency
		DR_nnnnn_mmmm.mmm'cr'	Demodulator Rate
		DE_xxx'cr'	Descrambler Enable (ON/OFF)
		DDEC_xxx'cr'	Differential Decoder (ON/OFF)
		RFL_xxx'cr'	RF Loopback (ON/OFF)
		IFL_xxx'cr'	IF Loopback (ON/OFF)
		ERF_nnnnn.nnn'cr'	External Reference Frequency
		BC_xxx'cr'	Buffer Clock
		RCP_xxx'cr'	Receive Clock Phase
		BBL_xxx'cr'	Baseband Loopback
		ILB_xxx'cr'	Interface Loopback
		ILT_xxx'cr'	Interface Loop Timing
		ICFR_xxxx'cr'	Interface Coding Format Receive
		IRE_xxx'cr'	Interface Read Error (RX 2047)
		RDF_xxxx'cr'	Receive Data Fault
		ISCL_RX1_nnn'cr'	Service Channel Level RX1
		ISCL_RX2_nnn'cr'	Service Channel Level RX2
		RDP_xxxx'cr'	Receive Data Phase
		IBS_nn'cr'	Interface Buffer Size
		DSR_xxx'cr'	Demodulator Spectrum Rotation
		RSDE_xxx'cr'	Reed-Solomon Decoder (ON/OFF/CORR_OFF)
		BW_RX1_nnn'cr'	Backward Alarm Enable RX1
		BW_RX2_nnn'cr'	Backward Alarm Enable RX2
		BW_RX3_nnn'cr'	Backward Alarm Enable RX3
		BW_RX4_nnn'cr'	Backward Alarm Enable RX4
		DSCT_xxxxxxx'cr'	Descrambler Type
		IRFS_6312_ssss'cr'	Interface Receive Frame Structure (6312)
		IRFS_8448_ssss'cr'	Interface Receive Frame Structure (8448)
		IRFS_32064_ssss'cr'	Interface Receive Frame Structure (32064)
		IRFS_34368_ssss'cr'	Interface Receive Frame Structure (34368)
		IRFS_44736_ssss'cr'	Interface Receive Frame Structure (44736)
		IRFS_51840_ssss'cr'	Interface Receive Frame Structure (51840)
		SWR_nnnnnn'cr''lf']	Sweep Width Range
			This command is used by the EFData M:N protection switch to collect information that is necessary to configure back-up modems. Because this command (content and/or order) can be changed at any time by EFData, it is advisable that other commands ('DCS_' and 'ICS_', or 'BCS_') be used for M&C systems.

Interface Config. Status	Command:	<add/ICS_'cr'	
	Response:	>add/ICS_'cr'	
		ERF_nnnnn.nnn'cr'	External Reference Frequency
		TCP_xxx'cr'	Transmit Clock Phase
		RCP_xxx'cr'	Receive Clock Phase
		BBL_xxx'cr'	Baseband Loopback
		ILB_xxx'cr'	Interface Loopback
		ILT_xxx'cr'	Interface Loop Timing
		ICFT_xxxx'cr'	Interface Coding Format Transmit
		ICFR_xxxx'cr'	Interface Coding Format Receive
		SE_xxx'cr'	Scrambler Enable
		DE_xxx'cr'	Descrambler Enable
		BC_xxx'cr'	Buffer Clock (Source)
		IBS_nn'cr'	Interface Buffer Size
		ITOT_xxxx'cr'	Interface Transmit Overhead Type
		IROT_xxxx'cr'	Interface Receive Overhead Type
		ISP_xxx'cr'	Interface Substitution Pattern (TX 2047)
		IRE_xxx'cr'	Interface Read Error (RX 2047)
		TDF_xxxx'cr'	Transmit Data Fault
		RDF_xxxx'cr'	Receive Data Fault
		ISCL_TX1_nnn'cr'	Service Channel Level TX1
		ISCL_TX2_nnn'cr'	Service Channel Level TX2
		ISCL_RX1_nnn'cr'	Service Channel Level RX1
		ISCL_RX2_nnn'cr'	Service Channel Level RX2
		TDP_xxxx'cr'	Transmit Data Phase
		RDP_xxxx'cr'	Receive Data Phase
		BW_TX1_nnn'cr'	Backward Alarm Enable TX1
		BW_TX2_nnn'cr'	Backward Alarm Enable TX2
		BW_TX3_nnn'cr'	Backward Alarm Enable TX3
		BW_TX4_nnn'cr'	Backward Alarm Enable TX4
		BW_RX1_nnn'cr'	Backward Alarm Enable RX1
		BW_RX2_nnn'cr'	Backward Alarm Enable RX2
		BW_RX3_nnn'cr'	Backward Alarm Enable RX3
		BW_RX4_nnn'cr'	Backward Alarm Enable RX4
		SCRT_xxxxxxx'cr'	Scrambler Type
		DSCT_xxxxxxx'cr'	Descrambler Type
		IRFS_6312_ssss'cr'	Interface Receive Frame Structure (6312)
		IRFS_8448_ssss'cr'	Interface Receive Frame Structure (8448)
		IRFS_32064_ssss'cr'	Interface Receive Frame Structure (32064)
		IRFS_34368_ssss'cr'	Interface Receive Frame Structure (34368)
		IRFS_44736_ssss'cr'	Interface Receive Frame Structure (44736)
		IRFS_51840_ssss'cr''lf']	Interface Receive Frame Structure (51840)
			The Interface Configuration Status command causes a block of data to be returned by the addressed modem. The block reflects the current configuration of the interface. Additional configuration status of new options and features will always be appended to the end.
Modem Faults Status (Summary)	Command:	<add/MFS_'cr'	
	Response:	>add/MFS_'cr'	
		DMD_xxx'cr'	Demodulator
		MOD_xxx'cr'	Modulator
		ITX_xxx'cr'	Interface Transmit Side
		IRX_xxx'cr'	Interface Receive Side
		CEQ_xxx'cr'	Common Equipment
		BWAL_xxx'cr''lf']	Backward Alarms

Modulator Status	Command: Response:	<add/MS_'cr' >add/MS_'cr' RF_xxx'cr' MOD_xxx'cr' SYN_xxx'cr' DCA_xxx'cr' DCS_xxx'cr' ICH_xxx'cr' QCH_xxx'cr' AGC_xxx'cr' SCT_xxx'cr' EXT_xxx'cr' PROG_xxx'cr' CONF_xxx'cr' SFLT_xx'cr''lf']	 RF Output (ON/OFF) Actual Status, Not Config. Module IF Synthesizer Data Clock Activity Data Clock Synthesizer I Channel Q Channel AGC Level Internal SCT Synthesizer External Reference Activity Programming Configuration Number of Stored Faults Logged (0 to 10)
Demodulator Status	Command: Response:	<add/DS_'cr' >add/DS_'cr' MOD_xxx'cr' CD_xxx'cr' SYN_xxx'cr' RCS_xxx'cr' ICH_xxx'cr' QCH_xxx'cr' DSCR_xxx'cr' BERT_xxx'cr' PROG_xxx'cr' CONF_xxx'cr' SFLT_xx'cr''lf']	 Demod Module Carrier Detect IF Synthesizer Lock Receive Clock Synthesizer I Channel Q Channel Descrambler BER Threshold Programming Configuration Number of Stored Faults Logged (0 to 10)
Interface Transmit Side Status	Command: Response:	<add/ITXS_'cr' >add/ITXS_'cr' TXD_xxx'cr' PLL_xxx'cr' CLK_xxx'cr' PROG_xxx'cr' CONF_xxx'cr' SFLT_xx'cr''lf']	 Transmit Data/AIS Transmit Synthesizer PLL Lock Selected Transmit Clock Activity Programming Configuration Number of Stored Faults Logged (0 to 10)
Interface Receive Side Status	Command: Response:	<add/IRXS_'cr' >add/IRXS_'cr' UNFL_xxx'cr' OVFL_xxx'cr' RXD_xxx'cr' FBER_xxx'cr' CLK_xxx'cr' PLL_xxx'cr' DMUX_xxx'cr' 2047_xxx'cr' BUFF_xxx'cr' PROG_xxx'cr' CONF_xxx'cr' SFLT_xx'cr''lf']	 Buffer Underflow Buffer Overflow Receive Data Loss/AIS Frame BER Selected Buffer Clock Activity Buffer Clock PLL Lock Demux Lock 2047 Pattern Lock Detect Buffer Full Programming Configuration Number of Stored Faults Logged (0 to 10)

Common Equipment Status	Command: Response:	<add/CES_'cr' >add/CES_'cr' M&C_xxx'cr' INT_xxx'cr' BAT_xxx'cr' +5_xxx'cr' -5_xxx'cr' +12_xxx'cr' -12_xxx'cr' MODE_xxxxxx'cr' SFLT_xx'cr''lf']	Monitor & Control Module Data Interface Module Battery/Clock +5V Power Supply -5V Power Supply +12V Power Supply -12V Power Supply Mode (LOCAL or REMOTE) Number of Stored Faults Logged (0 to 10) The common equipment status command causes a block of data to be returned which indicates the status of the common equipment.
Interface Alarms (Backward Alarm) Status	Command: Response:	<add/IAS_'cr' >add/IAS_'cr' TXBWA1_xxx'cr' TXBWA2_xxx'cr' TXBWA3_xxx'cr' TXBWA4_xxx'cr' RXBWA1_xxx'cr' RXBWA2_xxx'cr' RXBWA3_xxx'cr' RXBWA4_xxx'cr' SFLT_xx'cr''lf']	TX Backward Alarm 1 TX Backward Alarm 2 TX Backward Alarm 3 TX Backward Alarm 4 RX Backward Alarm 1 RX Backward Alarm 2 RX Backward Alarm 3 RX Backward Alarm 4 Number of Stored Faults Logged (0 to 10)

B.4.2 Error Performance

Raw BER	Command: Response:	<add/RBER_'cr' >add/RBER_xm.mE-ee'cr''lf']	Where: x = < or > (data modifier to indicate that the error rate is less than or greater than the returned value). m.m = 1.0 to 9.9 (error rate mantissa). ee = 1 to 99 (error rate exponent). Notes: 1. The 'x' (< or >) parameter is only returned if the error rate has exceeded the computational resolution of the system. 2. 'No Data' is returned if the error rate cannot be calculated. 3. 'Sampling' is returned if not enough data is currently available to calculate the error rate.

Corrected BER	Command: Response:	<add/CBER_'cr' >add/CBER_xm.mE-ee'cr''lf']	Where: x = < or > (data modifier to indicate that the error rate is less than or greater than the returned value). m.m = 1.0 to 9.9 (error rate mantissa). ee = 1 to 99 (error rate exponent). Notes: 1. The 'x' (< or >) parameter is only returned if the error rate has exceeded the computational resolution of the system. 2. 'No Data' is returned if the error rate cannot be calculated. 3. 'Sampling' is returned if not enough data is currently available to calculate the error rate.
Corrected BER Log	Command: Response: Examples:	<add/CBEL_'cr' >add/CBEL_t.t;s1, s2, s3...sn'cr''lf'] [No new compiled data from last poll] >add/CBEL_1.0 'cr''lf'] [Momentary lock in 32 time intervals: 2.0E-3, 5.2E-7, 1.0E-10, <1.0E-12] >add/CBEL_1.0; ,,,,,,,2003, 5207, 1010, <1012,,,,,,,'cr''lf'	Where: t.t = Time corrected BER samples in seconds ('0.1' to '9.9'). ; = At least one data point has been logged. s1 to sn = Corrected BER samples in the format of xmmee (where: x = the optional data modifier '<' or '>' [less than or greater than], mm = the corrected BER mantissa ['10' for 1.0 to '99' for 9.9], ee = the corrected BER negative exponent ['00' to '99']). Error data samples are compiled at the normal system rate indicated by the time parameter (t.t). The samples are stored in a 32-element FIFO. When the 'CBEL_' command is received, the samples in the FIFO are formatted and returned as indicated. The FIFO is then flushed. If the FIFO becomes full, the oldest sample will be lost as the current sample is written. Notes: 1. The most recent sample is represented by 'sn', while the least recent sample is represented by 's1'. 2. Data delimited by a comma (',') will be returned for all time intervals logged. 3. The optional data modifiers '<' and '>' are only present if the error rate exceeds the computational resolution of the system.

Interface Read Error Status	Command: Response:	<add/IRES_'cr' >add/IRES_tttt_xn.nE-ee'cr''lf']	Where: tttt = FRM (FRAME) or 2047 (indicates type of error being read). x = < or > (data modifier to indicate that the error rate is less than or greater than the returned value). m.m = 1.0 to 9.9 (error rate mantissa). ee = 1 to 99 (error rate exponent). This command returns frame or 2047 error rate. The 'IRE_' configuration command is used to select reading of frame or 2047 errors. Notes: 1. The 'x' (< or >) parameter is only returned if the error rate has exceeded the computational resolution of the system. 2. 'No Data' is returned if the error rate cannot be calculated. 3. 'Sampling' is returned if not enough data is currently available to calculate the error rate.
E_b/N_0 Status	Command: Response:	<add/EBN0_'cr' >add/EBN0_xnn.ndB'cr''lf']	Where: x = < or > (data modifier to indicate that the E_b/N_0 is less than or greater than the returned value). nn.n = 1.0 to 99.9 (E_b/N_0 value). Notes: 1. The 'x' (< or >) parameter is only returned if the E_b/N_0 has exceeded the computational resolution of the system. 2. 'No Data' is returned if the E_b/N_0 cannot be calculated. 3. 'Sampling' is returned if not enough data is currently available to calculate the E_b/N_0.
Modulator Rate Status	Command: Response:	<add/MR_'cr' >add/MR_nnnnn_mmmmm.mmm'cr''lf']	Where: nnnnn = One of the following coder rates: 1/2 (QPSK 1/2) 3/4 (QPSK 3/4) 7/8 (QPSK 7/8) 16Q34 (16QAM 3/4) 16Q78 (16QAM 7/8) 8P23 (8PSK 2/3) 8P56 (8PSK 5/6) N/A (Not Assigned) mmmmm.mmm = Data rate in kHz.

Demodulato r Rate Status	Command: Response:	<add/DR_'cr' >add/DR_nnnn_mmmm.mmm'cr''lf']	Where: nnnnn = One of the following decoder rates: 1/2 (QPSK 1/2) 3/4 (QPSK 3/4) 7/8 (QPSK 7/8) 16Q34 (16QAM 3/4) 16Q78 (16QAM 7/8) 8P23 (8PSK 2/3) 8P56 (8PSK 5/6) N/A (Not Assigned) mmmmm.mmm = Data rate in kHz.
Receive Signal Level Status	Command: Response:	<add/RSL_'cr' >add/RSL_xsnndBm'cr''lf']	Where: x = < or > (data modifier to indicate that the receive signal level is less than or greater than the returned value). s = + or - (receive signal level sign, plus or minus). nn = 0 to 99 (receive signal level magnitude). Notes: 1. The 'x' (< or >) parameter is only returned if the level has exceeded the computational resolution of the system. 2. 'No Data' is returned if the level cannot be calculated. 3. 'Sampling' is returned if not enough data is currently available to calculate the level.
Interface Buffer Fill Status	Command: Response:	<add/IBFS_'cr' >add/IBFS_nn%'cr''lf']	Where: nn = 1 to 99 (relative to buffer depth).
Current Sweep Value	Command: Response:	<add/CSV_'cr' >add/CSV_snnnnn'cr' CD_xxx'cr''lf']	Where: s = + or - (sweep offset from center). nnnnn = 0 to 60000. xxx = OK or FLT (decoder lock status OK or FAULT). This command returns the current sweep value and the decoder lock status.

B.5 Stored Faults

Information on stored faults is returned when requested. If no stored fault exists for a given fault number, the words “NO Fault” will be returned instead of the normal time/date status information.

The following symbols are commonly used to define the stored faults status commands:

- # Fault number (0 to 9). “0” is the first fault stored.
- hh Hours in 24-hr. format.
- mm Minutes.
- ss Seconds.
- MM Month.
- DD Day.
- YY Year.

Modulator Stored Faults	Command: Response:	<add/MSF_#'cr' >add/MSF_# hh:mm:ss MM/DD/YY'cr' MOD_xxx'cr' SYN_xxx'cr' DCA_xxx'cr' DCS_xxx'cr' ICH_xxx'cr' QCH_xxx'cr' AGC_xxx'cr' SCT_xxx'cr' EXT_xxx'cr' PROG_xxx'cr' CONF_xxx'cr''lf']	 Module IF Synthesizer Data Clock Activity Data Clock Synthesizer I Channel Q Channel AGC Level Internal SCT Synthesizer External Reference Activity Programming Configuration
Demodulator Stored Faults	Command: Response:	<add/DSF_#'cr' >add/DSF_# hh:mm:ss MM/DD/YY'cr' MOD_xxx'cr' CD_xxx'cr' SYN_xxx'cr' RCS_xxx'cr' ICH_xxx'cr' QCH_xxx'cr' DSCR_xxx'cr' BERT_xxx'cr' PROG_xxx'cr' CONF_xxx'cr''lf']	 Demod Module Carrier Detect IF Synthesizer Lock Receive Clock Synthesizer I Channel Q Channel Descrambler BER Threshold Programming Configuration
Interface Transmit Side Stored Faults	Command: Response:	<add/ITSF_#'cr' >add/ITSF_# hh:mm:ss MM/DD/YY'cr' TXD_xxx'cr' PLL_xxx'cr' CLK_xxx'cr' PROG_xxx'cr' CONF_xxx'cr''lf']	 Transmit Data/AIS Transmit Synthesizer PLL Lock Selected Transmit Clock Activity Programming Configuration

Interface Receive Side Stored Faults	Command: Response:	<add/IRSF_#'cr' >add/IRSF_# hh:mm:ss MM/DD/YY'cr' UNFL_xxx'cr' OVFL_xxx'cr' RXD_xxx'cr' FBER_xxx'cr' CLK_xxx'cr' PLL_xxx'cr' DMUX_xxx'cr' 2047_xxx'cr' BUFF_xxx'cr' PROG_xxx'cr' CONF_xxx'cr''lf']	 Buffer Underflow Buffer Overflow Receive Data Loss/AIS Frame BER Selected Buffer Clock Activity Buffer Clock PLL Lock Demux Lock 2047 Pattern Lock Detect Buffer Full Programming Configuration
Common Equipment Stored Faults	Command: Response:	<add/CSF_#'cr' >add/CSF_# hh:mm:ss MM/DD/YY'cr' M&C_xxx'cr' INT_xxx'cr' BAT_xxx'cr' +5_xxx'cr' -5_xxx'cr' +12_xxx'cr' -12_xxx'cr''lf']	 M&C Module Data Interface Module Battery/Clock +5V Power Supply -5V Power Supply +12V Power Supply -12V Power Supply
Interface Alarms Stored Faults	Command: Response:	<add/IASF_#'cr' >add/IASF_# hh:mm:ss MM/DD/YY'cr' TXBWA1_xxx'cr' TXBWA2_xxx'cr' TXBWA3_xxx'cr' TXBWA4_xxx'cr' RXBWA1_xxx'cr' RXBWA2_xxx'cr' RXBWA3_xxx'cr' RXBWA4_xxx'cr''lf']	 TX Backward Alarm 1 TX Backward Alarm 2 TX Backward Alarm 3 TX Backward Alarm 4 RX Backward Alarm 1 RX Backward Alarm 2 RX Backward Alarm 3 RX Backward Alarm 4
Reed-Solomon Unavailable Seconds	Command: Response:	<add/RSSF_#'cr' >add/RSSF_# hh:mm:ss MM/DD/YY'cr' UNASEC_xxx'cr''lf']	 Unavailable Seconds

Bulk Consol. Analog Status	Command: Response:	<add/BCAS_'cr' >add/BCAS_p1,p2,p3, . . . pn'cr''lf']	This command is similar to the 'BCS_' command, but returns modem analog parameters. Additional status of new options and features will always be appended to the end.

Where: 'pn' is the last parameter returned.

Parameter Number	**Parameter Name** (Command Reference)	**Description**
1	**Receive Signal Level** (ref. 'RSL_' command).	p1 = xsnn, receive signal level in dBm.
2	**Raw BER** (ref. 'RBER_' command).	p2 = xm.m^{-ee}.
3	**Corrected BER** (ref. 'CBER_' command).	p3 = xm.m^{-ee}.
4	**Interface Read Error** (ref. 'IRES_' command).	p4 = tttt_xm.m^{-ee}.
5	**E_b/N_0** (ref. 'EBN0_' command).	p5 = xnn.n, E_b/N_0 in dB.
6	**Buffer Fill Status** (ref. 'IBFS_' command).	p6 = nn%, buffer fill status.

Note: Parameters 2 through 6 are dependent on carrier acquisition. If the decoder is not locked, empty data blocks are returned (,,,,,).

Bulk Consol. Status	Command: Response:	<add/BCS_'cr' >add/BCS_p1,p2,p3, . . . pn'cr''lf']	This command causes bulk modem status to be returned. To reduce the length of the response, message parameter data are returned without identifiers. However, parameter identification can be determined by order of return. Each status parameter is terminated with a ',' (comma), except for the last parameter, which has the standard message termination sequence ('cr''lf']). Most of the data returned is formatted the same way as the single command status request (refer to the appropriate portions of this document in preceding sections).

Where: 'pn' is the last parameter returned.

Parameter Number	**Parameter Name** (Command Reference)	**Description**
1	**Modulator RF output** (ref. 'RF_' command).	p1 = n, where 'n' is '0' (OFF) or '1' (ON).
2	**Modulator IF frequency** (ref. 'MF_' command).	p2 = nnn.nnnn, IF frequency in MHz.
3	**Modulator rate** (ref. 'MR_' command).	p3 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
4	**Modulator preset 'A' assignment** (ref. 'ARMA_' command).	p4 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
5	**Modulator preset 'B' assignment** (ref. 'ARMB_' command).	p5 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
6	**Modulator preset 'C' assignment** (ref. 'ARMC_' command).	p6 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
7	**Modulator preset 'D' assignment** (ref. 'ARMD_' command).	p7 = nnnnn_mmmm.mmm, code rate/data rate in kbit/s.
8	**Modulator power offset** (ref. 'MPO_' command).	p8 = snn.n, modulator power offset in dB.
9	**Modulator output power level** (ref. 'MOP_' command).	p9 = snn.n, transmitter output power level in dBm.
10	**Differential encoder enable** (ref. 'DENC_' command).	p10 = n, where 'n' is '0' (OFF) or '1' (ON).
11	**Carrier only mode ON/OFF**.	p11 = n, where 'n' is '0' (OFF) or '1' (ON).
12	**Modulator Spectrum Rotation** (ref. 'MSR_' command).	p12 = n, where 'n' is '0' (NRM) or '1' (INV).
13	**Modulator Reference Clock** (ref. 'MRC_' command).	p13 = n, where 'n' is '0' (INT), '1' (EXT5), '2' (EXT10), or '3' (EXT20).
14	**Reed-Solomon Encoder Enable** (ref. 'RSEN_' command).	p14 = n, where 'n' is '0' (OFF) or '1' (ON).
15	**Demodulator IF frequency** (ref. 'DF_' command).	p15 = nnn.nnnn, demodulator IF frequency in MHz.
16	**Demodulator rate** (ref. 'DR_' command).	p16 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.

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Status
(continued)

	Parameter Number	Parameter Name (Command Reference)	Description
	17	**Demodulator preset A assignment** (ref. 'ADRA_' command).	p17 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
	18	**Demodulator preset B assignment** (ref. 'ADRB_' command).	p18 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
	19	**Demodulator preset C assignment** (ref. 'ADRC_' command).	p19 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
	20	**Demodulator preset D assignment** (ref. 'ADRD_' command).	p20 = nnnnn_mmmmm.mmm, code rate/data rate in kbit/s.
	21	**Differential decoder enable** (ref. 'DDEC_' command).	p21 = n, where 'n' is '0' (OFF) or '1' (ON).
	22	**RF loopback** (ref. 'RFL_' command).	p22 = n, where 'n' is '0' (OFF) or '1' (ON).
	23	**IF loopback** (ref. 'IFL_' command).	p23 = n, where 'n' is '0' (OFF) or '1' (ON).
	24	**BER threshold** (ref. 'BERT_' command).	p24 = xxxx, BER threshold.
	25	**Demodulator Spectrum Rotation** (ref. 'DSR_' command).	p25 = n, where 'n' is '0' (NRM) or '1' (INV).
	26	**Reed-Solomon Decoder Enable** (ref. 'RSDE_' command).	p26 = n, where 'n' is '0' (OFF), '1' (ON), or '2' (CORR_OFF).
	27	**External reference frequency** (ref. 'ERF_' command).	p27 = nnnnn.nnn, external reference frequency in kHz.
	28	**Transmit clock phase** (ref. 'TCP_' command).	p28 = n, where 'n' is '0' (NRM) or '1' (INV).
	29	**Receive clock phase** (ref. 'RCP_' command).	p29 = n, where 'n' is '0' (NRM) or '1' (INV).
	30	**Baseband loopback** (ref. 'BBL_' command).	p30 = n, where 'n' is '0' (OFF) or '1' (ON).
	31	**Interface loopback** (ref. 'ILB_' command).	p31 = n, where 'n' is '0' (OFF) or '1' (ON).
	32	**Interface loop timing** (ref. 'ILT_' command).	p32 = n, where 'n' is '0' (OFF) or '1' (ON).
	33	**TX Interface coding format** (ref. 'ICFT_' command).	p33 = n, where 'n' is '0' (AMI), '1' (B3ZS), or '2' (HDB3).
	34	**RX Interface coding format** (ref. 'ICFR_' command).	p34 = n, where 'n' is '0' (AMI), '1' (B3ZS), or '2' (HDB3).
	35	**Scrambler enable**	p35 = n, where 'n' is '0' (OFF) or '1' (ON).

		(ref. 'SE_' command).	

Bulk Consol. Status (continued)			
	Parameter Number	**Parameter Name** (Command Reference)	**Description**
	36	**Descrambler enable** (ref. 'DE_' command).	p36 = n, where 'n' is '0' (OFF) or '1' (ON).
	37	**Buffer clock source** (ref. 'BC_' command).	p37 = n, where 'n' is '0' (INT), '1' (REF), '2' (EXT), '3' (SAT), or '4' (HS).
	38	**Interface buffer size** (ref. 'IBS_' command).	p38 = nn, buffer size in milli-seconds.
	39	**Interface transmit overhead type** (ref. 'ITOT_' command).	p39 = n, where 'n' is '0' (NONE) or '1' (IDR).
	40	**Interface receive overhead type** (ref. 'IROT_' command).	p40 = n, where 'n' '0' (NONE) or '1' (IDR).
	41	**Interface substitution pattern** (ref. 'ISP_' command).	p41 = n, where 'n' is '0' (OFF) or '1' (ON).
	42	**Interface read error** (ref. 'IRE_' command).	p42 = n, where 'n' is '0' (FRM/OFF) or '1' (2047/ON).
	43	**Transmit data fault** (ref. 'TDF_' command).	p43 = n, where 'n' is '0' (NONE), '1' (DATA), or '2' (AIS).
	44	**Receive data fault** (ref. 'RDF_' command).	p44 = n, where 'n' is '0' (NONE), '1' (DATA), or '2' (AIS).
	45	**Interface service channel TX1** (ref. 'ISCL_' command).	p45 = nnn, service channel level in dBm.
	46	**Interface service channel TX2** (ref. 'ISCL_' command).	p46 = nnn, service channel level in dBm.
	47	**Interface service channel RX1** (ref. 'ISCL_' command).	p47 = nnn, service channel level in dBm.
	48	**Interface service channel RX2** (ref. 'ISCL_' command).	p48 = nnn, service channel level in dBm.
	49	**Transmit data phase** (ref. 'TDP_' command).	p49 = n, where 'n' is '0' (NRM) or '1' (INV).
	50	**Receive data phase** (ref. 'RDP_' command).	p50 = n, where 'n' is '0' (NRM) or '1' (INV).
	51	**Backward Alarm enable TX1** (ref. 'BW_TX1_' command).	p51 = n, where 'n' is '0' (OFF) or '1' (ON).
	52	**Backward Alarm enable TX2** (ref. 'BW_TX2_' command).	p52 = n, where 'n' is '0' (OFF) or '1' (ON).
	53	**Backward Alarm enable TX3** (ref. 'BW_TX3_' command).	p53 = n, where 'n' is '0' (OFF) or '1' (ON).
	54	**Backward Alarm enable TX4** (ref. 'BW_TX4_' command).	p54 = n, where 'n' is '0' (OFF) or '1' (ON).
	55	**Backward Alarm enable RX1** (ref. 'BW_RX1_' command).	p55 = n, where 'n' is '0' (OFF) or '1' (ON).

Bulk Consol. Status (continued)			
	Paramete r Number	**Parameter Name** (Command Reference)	**Description**
	56	**Backward Alarm enable RX2** (ref. 'BW_RX2_' command).	p56 = n, where 'n' is '0' (OFF) or '1' (ON).
	57	**Backward Alarm enable RX3** (ref. 'BW_RX3_' command).	p57 = n, where 'n' is '0' (OFF) or '1' (ON).
	58	**Backward Alarm enable RX4** (ref. 'BW_RX4_' command).	p58 = n, where 'n' is '0' (OFF) or '1' (ON
	59	**Scrambler type** (ref. 'SCRT_' command).	p59 = n, where 'n' is '0' (V.35), '1' (EFD), or '2' (IDR).
	60	**Descrambler type** (ref. 'DSCT_' command).	p60 = n, where 'n' is '0' (V.35), '1' (EFD), or '2' (IDR).
	61	**Interface RX 6321 frame structure** (ref. 'IRFS_' command)	p61 = n, where 'n' is '0' (NONE), '1' (G704), '3' (G743), or '5' (G747).
	62	**Interface RX 8448 frame structure** (ref. 'IRFS_' command).	p62 = n, where 'n' is '0' (NONE), '1' (G704), '2' (G742), or '4' (G745).
	63	**Interface RX 32064 frame structure** (ref. 'IRFS_' command).	p63 = n, where n is '0' (NONE) or '7' (G752).
	64	**Interface RX 34368 frame structure** (ref. 'IRFS_' command).	p64 = n, where n is '0' (NONE), '6' (G751), or '8' (G753).
	65	**Interface 44736 frame structure** (ref. 'IRFS_' command).	p65 = n, where n is '0' (NONE) or '7' (G752).
	66	**Interface 51840 frame structure** (ref. 'IRFS_' command).	p66 = n, where n is '0' (NONE) or '9' (STS1).
	67	**Modem operation mode** (ref. 'MOM_' command).	p67 = n, where n is '1' (TX_ONLY), '2' (RX_ONLY) or '3' (DUPLEX).
	68	**MODEM REMOTE/LOCAL mode.**	p68 = n, where n is '0' (LOCAL) or '1' (REMOTE).
	69	**System modem type** (ref. 'SMT_' command).	p69 = n, where n is '0' (INTELSAT), '1' (DBS), or '2' (N5500).
	70	**Sweep width range** (ref. 'SWR_' command).	P70 = nnnnnn, sweep range in Hz.

Bulk Consol. Status Faults	Command: Response:	<add/BCSF_'cr' >add/BCSF_abcdefghijklmno'cr''lf']	This command causes all modem fault status to be returned. To reduce the length of the response, fault status is embedded into the bit structure of the characters that are returned. Faults are indicated by a binary 1 in the designated bit position. Where: Character 'a': Modulator fault status character 1. Bit 6 = 1 always. Bit 5 = Modulator module fault. Bit 4 = RF output status actual, not programmed status (1 = ON, 0 = OFF). Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of modulator stored faults. Where: Character 'b': Modulator fault status character 2. Bit 6 = 1 always. Bit 5 = IF Synthesizer. Bit 4 = Data Clock Activity. Bit 3 = Data Clock Synthesizer. Bit 2 = I Channel. Bit 1 = Q Channel. Bit 0 = AGC Level. Where: Character 'c': Modulator fault status character 3. Bit 6 = 1 always. Bit 5 = Internal SCT Synthesizer. Bit 4 = Programming. Bit 3 = Configuration. Bit 2 = External Reference Activity. Bit 1 = reserved. Bit 0 = reserved. Where: Character 'd': Demodulator fault status character 1. Bit 6 = 1 always. Bit 5 = Demod module fault. Bit 4 = Carrier detect status (0 for decoder lock). Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of demodulator stored faults. Where: Character 'e': Demodulator fault status character 2. Bit 6 = 1 always. Bit 5 = IF Synthesizer Lock. Bit 4 = Receive Clock Synthesizer. Bit 3 = I Channel. Bit 2 = Q Channel. Bit 1 = Descrambler. Bit 0 = BER threshold. Where: Character 'f': Demodulator fault status character 3. Bit 6 = 1 always. Bit 5 = Programming. Bit 4 = Configuration. Bit 3 = reserved. Bit 2 = reserved. Bit 1 = reserved. Bit 0 = reserved. Where: Character 'g': Interface transmit side faults character 1. Bit 6 = 1 always. Bit 5 = reserved. Bit 4 = reserved. Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of interface transmit side stored faults. Where: Character 'h': Interface transmit side faults character 2.

			Bit 6 = 1 always. Bit 5 = Transmit Data/AIS. Bit 4 = Transmit Synthesizer PLL Lock. Bit 3 = Selected Transmit Clock Activity. Bit 2 = Programming. Bit 1 = Configuration. Bit 0 = reserved. Where: Character 'i': Interface receive side faults character 1. Bit 6 = 1 always. Bit 5 = reserved. Bit 4 = reserved. Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of interface receive side stored faults. Where: Character 'j': Interface receive side faults character 2. Bit 6 = 1 always. Bit 5 = Buffer Underflow. Bit 4 = Buffer Overflow. Bit 3 = Receive Data Loss/AIS. Bit 2 = Frame BER. Bit 1 = reserved. Bit 0 = Selected Buffer Clock Activity. Where: Character 'k': Interface receive side faults character 3. Bit 6 = 1 always. Bit 5 = Buffer Clock PLL Lock. Bit 4 = Demux Lock. Bit 3 = 2047 Pattern Lock Detect. Bit 2 = Buffer Full. Bit 1 = Programming. Bit 0 = Configuration. Where: Character 'l': Common equipment fault status character 1. Bit 6 = 1 always. Bit 5 = Monitor and Control Module. Bit 4 = Interface Module. Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of common equipment stored faults. Where: Character 'm': Common equipment fault status character 2. Bit 6 = 1 always. Bit 5 = Battery/Clock. Bit 4 = +5V Power Supply. Bit 3 = -5V Power Supply. Bit 2 = +12V Power Supply. Bit 1 = -12V Power Supply. Bit 0 = reserved. Where: Character 'n': Interface backward alarm status character 1. Bit 6 = 1 always. Bit 5 = TX Backward Alarm 1. Bit 4 = TX Backward Alarm 2. Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of backward alarm stored faults. Where: Character 'o': Interface backward alarm status character 2. Bit 6 = 1 always. Bit 5 = TX Backward Alarm 3. Bit 4 = TX Backward Alarm 4. Bit 3 = RX Backward Alarm 1. Bit 2 = RX Backward Alarm 2. Bit 1 = RX Backward Alarm 3. Bit 0 = RX Backward Alarm 4.

			Where: Character 'p': Interface Reed-Solomon Unavailable Seconds. Bit 6 = 1 always. Bit 5 = not used. Bit 4 = not used. Bit 3 through Bit 0 = Binary representation (0 to 10) of the number of Reed-Solomon Unavailable Seconds stored faults.
Change Status	Command: Response:	<add/CS_'cr' >add/CS_x'cr''lf']	Where: 'x' character is defined as follows: @ = No change since last BCS_ and BCSF_ polls. A = BCS_ response has changed since last BCS_ poll. B = BCSF_ response has changed since last BCSF_ poll. C = Both responses have changed since last BCS_ and BCSF_ polls. This command indicates that a change has or has not occurred on either the BCS_ or the BCSF_ response since the last BCS_ or BCSF_ poll.
Equipment Type	Command: Response:	<add/ET_'cr' >add/ET_ttttttt_xxx.yyy.zzz'cr''lf']	Where: ttttttt = Equipment type. xxx.yyy.zzz = Software version.
M&C Firmware Information	Command: Response:	<add/MCFI_'cr' >add/MCFI_'cr' VER_xxx.yyy.zzz'cr' FW/nnnnnn-ddr'cr' mm/dd/yy'cr''lf']	Where: xxx.yyy.zzz = Software version number (0.0.0 to 999.999.999). nnnnnn = Firmware number (0 to 999999). dd = Firmware dash number (0 to 99). r = Firmware revision (-, or A to Z).
Modulator Firmware Information	Command: Response:	<add/MFI_'cr' >add/MFI_'cr' VER_xxx.yyy.zzz'cr' FW/nnnnnn-ddr'cr' mm/dd/yy'cr' FPGA_FW/nnnnnn-ddr'cr' FPGA_mm/dd/yy'cr' FILTER_FW/nnnnnn-ddr'cr' FILTER_mm/dd/yy'cr''lf']	Where: xxx.yyy.zzz = Software version number (0.0.0 to 999.999.999). nnnnn = Firmware number (0 to 999999). dd = Firmware dash number (0 to 99). r = Firmware revision (-, or A to Z).
Demodulator Firmware Information	Command: Response:	<add/DFI_'cr' >add/DFI_'cr' VER_xxx.yyy.zzz'cr' FW/nnnnnn-ddr'cr' mm/dd/yy'cr' FPGA_FW/nnnnnn-ddr'cr' FPGA_mm/dd/yy'cr''lf']	Where: xxx.yyy.zzz = Software version number (0.0.0 to 999.999.999). nnnnnn = Firmware number (0 to 999999). dd = Firmware dash number (0 to 99). r = Firmware revision (-, or A to Z).
Interface Firmware Information	Command: Response:	<add/IFI_'cr' >add/IFI_'cr' VER_xxx.yyy.zzz'cr' FW/nnnnnn-ddr'cr' mm/dd/yy'cr' FPGA_FW/nnnnnn-ddr'cr' FPGA_mm/dd/yy'cr''lf']	Where: xxx.yyy.zzz = Software version number (0.0.0 to 999.999.999). nnnnnn = Firmware number (0 to 999999). dd = Firmware dash number (0 to 99). r = Firmware revision (-, or A to Z).
Modulator Options/ Misc. Information	Command: Response:	<add/MOI_'cr' >add/MOI_'cr' x,8PSK/16QAM'cr' x,HIGH_STABILITY'cr''lf']	Where: x = 0 (option not installed) or 1 (option installed).

Demodulator Options/ Misc. Information	Command: Response:	<add/DOI_'cr' >add/DOI_'cr' x,8PSK/16QAM'cr''lf']	Where: x = 0 (option not installed) or 1 (option installed).
Interface Options/ Misc. Information	Command: Response:	<add/IOI_'cr' >add/IOI_'cr' dddddd'cr' y,BUILD'cr' x,BUFFER'cr' x,ESC'cr' x,RS_EFD'cr' x,RS_DVB'cr' x,64K_ESC_'cr' z,TX_ESC_JUMPER'cr' z,RX_ESC_JUMPER'cr''lf']	Where: dddddd = G.703, ECL, PECL, or MIL-188-144 (interface type). y = 1, 2, or 3 (build type). x = 0 (option not installed) or 1 (option installed). z = 0 (N/A), 1 (AUDIO ESC jumpered), or 2 (64K DATA ESC jumpered).

Glossary

The following is a list of acronyms and abbreviations that may be found in this manual.

Acronym/ Abbreviation	Definition
Ω	Ohms
16QAM	16 Quadrature Amplitude Modulation
8PSK	8 Phase Shift Keying
A	Ampere
A/D	Analog to Digital
AC	Alternating Current
ADC	Analog to Digital Converter
ADJ	Adjust
ADMA	Amplitude Domain Multiple Access
ADPCM	Adaptive Differential Pulse Code Modulation
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
AIS	Alarm Indication Signal
AM	Amplitude Modulation
AMI	Alternate Mark Inversion
AOC	Automatic Offset Control
APM	Amplitude Phase Modulation
ASC	Add-Select-Compare
ASCII	American Standard Code for Information Interchange
ASK	Amplitude Shift Keying
ASYNC	Asynchronous
AUPC	Automatic Uplink Power Control
AUX 1	Auxiliary 1
AVC	Automatic Volume Control
BB	Baseband
BCD	Binary Coded Decimal
BER	Bit Error Rate
BER CONT	BIT Error Rate Continuous
bit/s	bits per second
BPSK	Bi-Phase Shift Keying
BTU	British Thermal Unit

BW	Backward Alarm or Bandwidth
BWR	Bandwidth Ratio
C	Celsius
CE	Customer Equipment
C/N	Carrier-to-Noise Ratio
C/No	Carrier-to-Noise Density Ratio
CCITT	International Telephone and Telegraph Consultative Committee
CDMA	Code Division Multiple Access
CH	Channel
CHNL	Channel
CIC	Common Interface Circuit
CL	Carrier Loss
CLK	Clock
CLNA	C-band LNA
CLR	Clear
CMOS	Complementary Metal Oxide Semiconductor
Coax	Coaxial
Codec	Coder/Decoder
COM	Common
CPFSK	Continuous-Phase Frequency Shift Keying
CPSK	Coherent Phase Shift Keying
CPU	Central Processing Unit
cr	Carriage Return
CRC	Cyclic Redundancy Check
CRT	Cathode Ray Tube
CS	Clear to Send
CSC	Comstream Compatible
CSMA	Carrier Sense Multiple Access
CTS	Clear to Send
CU	Channel Unit
CW	Continuous Wave
D&I	Drop and Insert
D/A	Digital-to-Analog
D/C	Down Converter
DAC	Digital-to-Analog Converter
DAMA	Demand Assignment Multiple Access
dB	Decibels
dB/Hz	Decibels/Hertz (unit of carrier-to-noise density ratio)
dBc	Decibels referred to carrier
dBm	Decibels referred to 1.0 milliwatt
dBm0	The signal magnitude in dBm referenced to the nominal level at that point
DBS	Direct Broadcast Satellite
dBW	Decibels referred to 1.0 watt
DC	Direct Current
DCE	Data Circuit Terminating Equipment
DCPSK	Differentially Coherent Phase Shift Keying
DDO	Drop Data Output
DDS	Direct Digital Synthesis
Demod	Demodulator
DEMUX	Demultiplexer
DET	Detector
DOD	Department of Defense
DM	Data Mode
DPCM	Differential Pulse Code Modulation
DPSK	Differential Phase Shift Keying
DSP	Digital Signal Processing
DSR	Data Signal Rate

DTE	Data Terminal Equipment
DVB	Digital Video Broadcast
E&M	Ear and Mouth
EBU	European Broadcasting Union
E_b/N_0	Bit Energy-to-Noise Ratio
ECL	Emitter Coupled Logic
EDP	Electronic Data Processing
EEPROM	Electrically-Erasable Programmable Read-Only Memory
EFD	EFData Compatible
EIA	Electronic Industries Association
EMC	Electro-Magnetic Compatibility
EMF	Electromotive Force
EPROM	Erasable Read-Only Memory
ESC	Engineering Service Circuit or Engineering Service Channel
ESD	Electrostatic Discharge
EXC	External Clock
EXT	External Reference Clock
FDC	Fairchild Data Compatible
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FET	Field Effect Transistor
FFSK	Fast Frequency Shift Keying
FIFO	First in/First Out
Flt	Fault
FM	Frequency Modulation
FPGA	Field Programmable Gate Array
FS	Frame Sync
FSK	Frequency Shift Keying
FW	Firmware
GHz	Gigahertz (10^9 hertz)
GND	Ground
HI STAB	High Stability
HPA	High Power Amplifier
Hz	Hertz (cycle per second)
I&Q	In-Phase and Quadrature
I/O	Input/Output
IBS	INTELSAT Business Services
IC	Integrated Circuit
IDI	Insert Data Input
IDR	Intermediate Data Rate
IESS	INTELSAT Earth Station Standards
IF	Intermediate Frequency
INMARSAT	International Maritime Satellite Organization
INT	Internal
INTELSAT	International Telecommunications Satellite Organization
ISD	Insert Send Data
ISO	International Standards Organization
k	kilo (10^3)
KΩ	kilo-ohms
kbit/s	Kilobits per second (10^3 bits per second)
kHz	Kilohertz (10^3 Hertz)
ks/s	Kilosymbols Per Second (10^3 symbols per second)
kW	Kilowatt (10^3 Watts)
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
lf	Line Feed

LNA	Low Noise Amplifier
LO	Local Oscillator
LSB	Least Significant Bit
LSI	Large Scale Integration (semiconductors)
m	mille (10^{-3})
M&C	Monitor and Control
mA	Milliamperes
Max	Maximum
Mbit/s	Megabits per second
MC	Monitor and Control
MFS	Multiframe Sync
MHz	Megahertz (10^{6} Hertz)
Min	Minimum or Minute
Mod	Modulator
MOP	Modulated Output Power
MPC	Microprocessor Controller
ms	Millisecond (10^{-3} second)
Ms/s	Megasymbols per second
MSB	Most Significant Bit
MUX	Multiplexer
n	nano (10^{-9})
N/A	Not Applicable
NACK	Negative Acknowledgment
NC	No Connection or Normally Closed
NO	Normally Open
NRZ	Non-Return to Zero (code)
ns	Nanosecond (10^{-9} second)
OQPSK	Offset Quadrature Phase Shift Keying
OSC	Oscillator
p	pico (10^{-12})
P-P	Peak-to-Peak
P/AR	Peak to Average Ratio
PAL	Programmable Array Logic
PC	Printed Circuit
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PECL	Positive Emitter Coupled Logic
pF	PicoFarads (10^{-12} Farads)
PK	Peak
PLL	Phase-Locked Loop
PN	Pseudo-Noise
PPM	Parts Per Million
PS	Power Supply
PSK	Phase Shift Keying
PWB	Printed Wiring Board
PWR	Power
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RAM	Random Access Memory
RD	Receive Data
REF	Reference
RF	Radio Frequency
RLSD	Receive Line Signal Detect
RMA	Return Material Authorization
ROM	Read-Only Memory
RR	Receiver Ready
RS	Ready to Send

RT	Receive Timing
RTS	Request to Send
RU	Rack Unit
RX	Receive (Receiver)
RXCLK	Receive Clock
RXD	Receive Data
RZ	Return-to-Zero
s	Second
S/N	Signal-to-Noise Ratio
SCPC	Single Channel Per Carrier
SCR	Serial Clock Receive
SCT	Serial Clock Transmit
SCTE	Serial Clock Transmit External
SD	Send Data
SFS	Subframe Sync
SMS	Satellite Multiservice System
SN	Signal-to-Noise Ratio
SSB	Single-sideband
SSPA	Solid State Power Amplifier
ST	Send Timing
SW	Switch
SYNC	Synchronize
TB	Terminal Block
TCXO	Temperature-Compensated Crystal Oscillator
TDMA	Time Division Multiple Access
TEMP	Temperature
TERR	Terrestrial
TP	Test Point
TT	Terminal Timing
TTL	Transistor-Transistor Logic
TX	Transmit (Transmitter)
TXCLK	Transmit Clock
TXD	Transmit Data
TXO	TX Octet
U/C	Up converter
UART	Universal Asynchronous Receiver/Transmitter
UHF	Ultra-high Frequency
UNK	Unknown
US	United States
UW	Unique Word
V	Volts
VAC	Volts, Alternating Current
VCO	Voltage-Controlled Oscillator
VCXO	Voltage-Controlled Crystal Oscillator
VDC	Volts, Direct Current
VSWR	Voltage Standing Wave Ratio
W	Watt
WG	Waveguide

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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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