



CDM-600/600L

Open Network Satellite Modem (2.4 kbps – 20 Mbps)
CDM-600 – 70/140 MHz (Firmware Version 2.2.6 or higher)
CDM-600L – L-Band (Firmware Version 1.5.0 or higher)
Installation and Operation Manual
(see *New in this Release* – Section 1.4)

Note: This manual incorporates data for the CDM-600 and CDM-600L Manuals

IMPORTANT NOTE: The information contained in this document supersedes all previously published information regarding this product. Product specifications are subject to change without prior notice.

Errata A

Comtech EF Data Documentation Update

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Part Number MN/CDM600L.IOM

Revision 3

June 25, 2009

Subject: Update CDM-600/L Flash Upgrade Procedure

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Comments: Affected manual page content will be updated, as indicated below, upon next formal manual revision.

Affected content: **Chapter 4 pages 4-2 and 4-3.**

Sect. 4.2 in Chapter 4 is superseded *in its entirety* with the pages provided in this Errata.

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4.2 Base Modem FTP Upload Procedure

1. **Identify the reflashable product** (firmware number and version) for download:

The current base modem M&C version number can be viewed on the front panel's Vacuum Fluorescent Display (VFD) opening screen (press the **CLEAR** key several times to view). Additionally, using serial remote control, query the firmware number and revision as follows:

Abbreviated: <0/SWR?

-or-

Detailed: <0/FRW?

2. **Create a temporary directory** (folder) on an external PC.

Windows: Select **File > New > Folder**, then rename the New Folder to "temp" or another convenient, unused name. Assuming "temp" works, a "c:\temp" folder should now be created.

Note: The c: is the drive letter used in this example. Any valid writable drive letter can be used.

CMD Prompt: At the command prompt (c:\>), type "**mkdir temp**" or "**MD temp**" without quotes (**mkdir** and **MD** stand for *make directory*). This is the same as creating a new folder from Windows. There should now be a "c:\temp" subdirectory created (where c: is the drive letter used in the example).

3. Download the correct firmware file to this temporary folder. As shown in **Figure 4-1**:

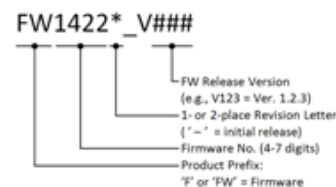
1. **Go online** to: www.comtechefdata.com;
2. **Click on:** *Support* tab;
3. **Click on:** *Software Downloads* drop-down *or* hyperlink from *Support* page;
4. **Click on:** *Download Flash and Software Update Files* icon;
5. **Click on:** *(Select a Product Line) Satellite Modems* hyperlink;
6. **Select** the CDM-600/L product hyperlink;
7. **Select** the appropriate firmware hyperlink.

The current version firmware release is provided. If applicable, a minimum of one version prior to the current release is also available. Be sure to identify and download the desired version. The downloadable files are stored in two formats: *.exe (self-extracting) and *.zip (compressed). Some firewalls will not allow the downloading of *.exe files. In this case, download the *.zip file instead.

For additional help with "zipped" file types, refer to *PKZIP for Windows*, *WinZip*, or *ZipCentral* help files. *PKZIP for DOS* is not supported due to file naming conventions.

About Firmware Numbers, File Versions, and Formats:

The flashable files on the download server are organized by product prefix; firmware number (verify that the correct firmware number is known – see Step 1); revision letter, if applicable; and release version. Where the asterisk is the 1- or 2-place revision letter and V### represents the firmware version: The bulk firmware for the CDM-600 is FW1422*_V###, while FW1451*_V### is the bulk firmware for the CDM-600L.



4. **Unzip the files** in the temporary folder on the PC. At least four files should be extracted (a CDM-600L firmware download shown in this example):

Name	Type
Release Notes FWC1451Y_v150.pdf	Adobe Acrobat Document
Flash600_v27.exe	Application
Fwc1451y.ccc	CCC File
CCCflash.hlp	Help File

- **Release Notes FWCXXXX*_v####.pdf** (or a variation of that filename): where “v####” denotes the firmware version.
 - **Flash600_v27.exe**: CEFD Flash Upload Utility Program.
 - **FwcXXX*.ccc**: Firmware, where “x” denotes the firmware revision letter.
 - **CCCflash.hlp**: Flash600 Help File.
5. **Connect the external PC serial port** to the CDM-600/600L modem P4B Remote Control interface (located on the modem rear panel) using a crossover cable.



If the modem is in any sort of redundancy system, the 25-pin P3B Data Interface data connector must be disconnected before flash uploading.

The Remote Control port RS-232 lines used for Flash upgrading are also connected to the 25-pin P3B Data Interface connector and are used when 1:N Redundancy Switch is connected.

Please ensure that NOTHING is connected to P3B pins 4, 21 and 22 – if these pins are used, the RS-232 remote control port will not function, and Flash upgrading will be impossible.

6. **Place the modem in Remote mode** (RS-232 assumed): Select 8N1 (8 data bits, no parity, 1 stop bit) asynchronous character format, and a baudrate of 9600.
7. **Run the Flash600 Upload Utility Program**: First, locate the Flash600 executable that was extracted from the archive file into the folder created in Step 2, then **run** the utility by double-clicking the icon.



8. The user should follow the instructions presented on the Flash600 screen, and the upload will take place automatically. Following the successful upload process, the modem will automatically reboot, running the new version of firmware. During this process, the non-volatile RAM storing the modem configuration will be erased, so the user is then required to re-enter the desired configuration parameters.



9. **Verify** that the new firmware file successfully loaded per the Step 8 process by observing the loaded firmware version, as displayed on the front panel VFD opening screen after reboot:

```
COMTECH CDM-600 OPEN NETWORK MODEM
TURBO: LOW RATE Q S/W VER X.X.X
```



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PREFACE

About this Manual

This manual provides installation and operation information for the Comtech EF Data CDM-600 and CDM-600L Open Network Satellite Modems. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the CDM-600/600L.

These two modems are essentially identical in their operation:

- The CDM-600 operates in the 70/140MHz IF band and includes support for externally connected Comtech EF Data Transceivers (CSAT-5060, KST-2000A/B)
- The CDM-600L operates at L-Band and includes support for externally connected Block Upconverters (BUCs) and Low-Noise Block Downconverters (LNBs).

About the Revision Level and Information Provided in this Manual

This revision incorporates the CDM-600 Satellite Modem Installation and Operation Manual (CEFD P/N MN/CDM600.IOM Revision 7). It is intended replace both CEFD MN/CDM600.IOM and the previous version of this document, CEFD P/N MN/CDM600L.IOM (Revision 2) in their entirety. All content from both documents has been integrated and reorganized to conform to current Comtech EF Data Technical Publications Standards and Practices.

Reporting Comments or Suggestions Concerning this Manual

Comments and suggestions regarding the content and design of this manual will be appreciated. To submit comments, please contact the Comtech EF Data Technical Publications Department:

TechnicalPublications@comtechefdata.com.

Conventions and References

Metric Conversion

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

Cautions and Warnings



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



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



Indicates information critical for proper equipment function.

Recommended Standard Designations

Recommended Standard (RS) is equivalent to the new designation of the Electronic Industries Association (EIA). While either designation is acceptable, Comtech EF Data has elected to continue use of the old (RS) designation in its documentation.

Electrical Safety



The user should make special note of the following information and instructions:

The CDM-600/600L Satellite Modem has been shown to comply with the following safety standard:

- EN 60950: Safety of Information Technology Equipment, including Electrical Business Machines.

The equipment is rated for operation over the range 100 - 240 VAC.

The CDM-600 has a maximum power consumption of 40 Watts and draws a maximum of 400mA.

The CDM-600L has a maximum power consumption of 290 Watts including maximum BUC power supply load, and draws a maximum of 2.9 A. The CDM-600L DC-powered version is rated for operation over the range of 38 to 60 VDC input.

Fuses

The AC-powered CDM-600/600L is fitted with two fuses – one each for line and neutral connections. These are contained within the body of the IEC power inlet connector, behind a small plastic flap.

For the CDM-600:

- For 115 VAC operation, use T1.25A, slow-blow 20mm fuses.
- For 230 VAC operation, use T0.75A, slow-blow 20mm fuses.

For the CDM-600L:

- For 115 and 230 VAC operation, use T5.0A, slow-blow 20 mm fuses (P/N FS/5ASB-IEC).

The DC-powered CDM-600L is fitted with two fuses – one each for positive and negative connections. These are contained within the body of the power inlet, behind a small plastic flap.

- For 38 to 60 VDC operation if the modem has no BUC power supply, use T3.15A, slow-blow 20mm fuses
- For 38 to 60 VDC operation if the modem is fitted with internal BUC power supply, use T8.0A, slow-blow 20mm fuses.



FOR CONTINUED OPERATOR SAFETY, ALWAYS REPLACE THE FUSES WITH THE CORRECT TYPE AND RATING.

Environmental

The CDM-600/600L must not be operated in an environment where the unit is exposed to extremes of temperature outside the ambient range 0 to 50°C (32° to 122°F), precipitation, condensation, or humid atmospheres above 95% RH, altitudes (non-pressurized) greater than 2000 meters, excessive dust or vibration, flammable gases, corrosive or explosive atmospheres.

Operation in vehicles or other transportable installations that are equipped to provide a stable environment is permitted. If such vehicles do not provide a stable environment, safety of the equipment to EN60950 may not be guaranteed.


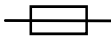

Installation

CDM-600/600L AC Modem Installation: The installation and connection to the line supply must be made in compliance to local or national wiring codes and regulations.

The CDM-600/600L is designed for connection to a power system that has separate ground, line and neutral conductors. The equipment is not designed for connection to a power system that has no direct connection to ground.

The CDM-600/600L is shipped with a line inlet cable suitable for use in the country of operation. If it is necessary to replace this cable, ensure the replacement has an equivalent specification. Examples of acceptable ratings for the cable include HAR, BASEC and HOXXX-X. Examples of

acceptable connector ratings include VDE, NF-USE, UL, CSA, OVE, CEPEC, NEMKO, DEMKO, BS1636A, BSI, SETI, IMQ, KEMA-KEUR and SEV.

International Symbols			
Symbol	Definition	Symbol	Definition
~	Alternating Current		Protective Earth
	Fuse		Chassis Ground

CDM-600L DC Modem Installation: The DC input CDM-600L is connected to a nominal 48 VDC prime power source. The DC input is isolated from the chassis and from the DC output to the BUC if equipped with internal BUC power supply. The chassis may be connected to a local system ground using a separate wire to the ground stud on the back of the chassis. Since the DC input is isolated, either the positive or the negative side of the DC input may be common with local ground. Labeling on the back of the chassis indicates the positive and negative terminals of the input power socket.

The modem is supplied with a 2-wire power cable (CEFD part number CA/WR10327-1) with one end terminated with a connector that mates with the modem input power socket. Positive DC input is on the red wire, while negative DC input is on the black wire. The DC input connector is Molex PN 03-12-1026 with Molex PN 08-12-1222 pins.

Telecommunications Terminal Equipment Directive

In accordance with the Telecommunications Terminal Equipment Directive 91/263/EEC, this equipment should not be directly connected to the Public Telecommunications Network.

EMC (Electromagnetic Compatibility)

In accordance with European Directive 89/336/EEC, the CDM-600/600L Modem has been shown, by independent testing, to comply with the following standards:

- Emissions:** EN 55022 Class B - Limits and methods of measurement of radio interference characteristics of Information Technology Equipment.
(Also tested to FCC Part 15 Class B)
- Immunity:** EN 50082 Part 1 - Generic immunity standard, Part 1: Domestic, commercial and light industrial environment.

Additionally, the CDM-600/600L has been shown to comply with the following standards:

- EN 61000-3-2 *Harmonic Currents Emission*
- EN 61000-3-3 *Voltage Fluctuations and Flicker*
- EN 61000-4-2 *ESD Immunity*
- EN 61000-4-4 *EFT Burst Immunity*
- EN 61000-4-5 *Surge Immunity*
- EN 61000-4-6 *RF Conducted Immunity*
- EN 61000-4-8 *Power frequency Magnetic Field Immunity*

EN 61000-4-9	<i>Pulse Magnetic Field Immunity</i>
EN 61000-4-11	<i>Voltage Dips, Interruptions, and Variations Immunity</i>
EN 61000-4-13	<i>Immunity to Harmonics</i>



To ensure that the Modem continues to comply with these standards, observe the following instructions:

- Connections to the transmit and receive IF ports (Type ‘BNC’ female connectors for the CDM-600, Type ‘N’ or ‘F’ female connectors for the CDM-600L) should be made using a good quality coaxial cable; e.g., RG58/U (50Ω) or RG59/U (75Ω).
- All 'D' type connectors attached to the rear panel must have back-shells that provide continuous metallic shielding. Cable with a continuous outer shield (either foil or braid, or both) must be used, and the shield must be bonded to the back-shell.
- The equipment must be operated with its cover on at all times. If it becomes necessary to remove the cover, the user should ensure that the cover is correctly re-fitted before normal operation commences.

Warranty Policy

Comtech EF Data products are warranted against defects in material and workmanship for a specific period from the date of shipment, and this period varies by product. In most cases, the warranty period is two years. During the warranty period, Comtech EF Data will, at its option, repair or replace products that prove to be defective. Repairs are warranted for the remainder of the original warranty or a 90 day extended warranty, whichever is longer. Contact Comtech EF Data for the warranty period specific to the product purchased.

For equipment under warranty, the owner is responsible for freight to Comtech EF Data and all related customs, taxes, tariffs, insurance, etc. Comtech EF Data is responsible for the freight charges only for return of the equipment from the factory to the owner. Comtech EF Data will return the equipment by the same method (i.e., Air, Express, Surface) as the equipment was sent to Comtech EF Data.

All equipment returned for warranty repair must have a valid RMA number issued prior to return and be marked clearly on the return packaging. Comtech EF Data strongly recommends all equipment be returned in its original packaging.

Comtech EF Data Corporation’s obligations under this warranty are limited to repair or replacement of failed parts, and the return shipment to the buyer of the repaired or replaced parts.

Limitations of Warranty

The warranty does not apply to any part of a product that has been installed, altered, repaired, or misused in any way that, in the opinion of Comtech EF Data Corporation, would affect the reliability or detracts from the performance of any part of the product, or is damaged as the result of use in a way or with equipment that had not been previously approved by Comtech EF Data Corporation.

The warranty does not apply to any product or parts thereof where the serial number or the serial number of any of its parts has been altered, defaced, or removed.

The warranty does not cover damage or loss incurred in transportation of the product.

The warranty does not cover replacement or repair necessitated by loss or damage from any cause beyond the control of Comtech EF Data Corporation, such as lightning or other natural and weather related events or wartime environments.

The warranty does not cover any labor involved in the removal and or reinstallation of warranted equipment or parts on site, or any labor required to diagnose the necessity for repair or replacement.

The warranty excludes any responsibility by Comtech EF Data Corporation for incidental or consequential damages arising from the use of the equipment or products, or for any inability to use them either separate from or in combination with any other equipment or products.

A fixed charge established for each product will be imposed for all equipment returned for warranty repair where Comtech EF Data Corporation cannot identify the cause of the reported failure.

Exclusive Remedies

Comtech EF Data Corporation's warranty, as stated is in lieu of all other warranties, expressed, implied, or statutory, including those of merchantability and fitness for a particular purpose. The buyer shall pass on to any purchaser, lessee, or other user of Comtech EF Data Corporation's products, the aforementioned warranty, and shall indemnify and hold harmless Comtech EF Data Corporation from any claims or liability of such purchaser, lessee, or user based upon allegations that the buyer, its agents, or employees have made additional warranties or representations as to product preference or use.

The remedies provided herein are the buyer's sole and exclusive remedies. Comtech EF Data shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Customer Support

Contact the Comtech EF Data Customer Support Department for:

- Product support or training
- Reporting comments or suggestions concerning manuals
- Information on upgrading or returning a product

A Customer Support representative may be reached at:

Comtech EF Data
Attention: Customer Support Department
2114 West 7th Street
Tempe, Arizona 85281 USA

480.333.2200 (Main Comtech EF Data number)
480.333.4357 (Customer Support Desk)
480.333.2161 FAX

To return a Comtech EF Data product (in-warranty and out-of-warranty) for repair or replacement:

- **Contact** the Comtech EF Data Customer Support Department. Be prepared to supply the Customer Support representative with the model number, serial number, and a description of the problem.
- **Request** a Return Material Authorization (RMA) number from the Comtech EF Data Customer Support representative.
- **Pack** the product in its original shipping carton/packaging to ensure that the product is not damaged during shipping.
- **Ship** the product back to Comtech EF Data. (Shipping charges should be prepaid.)

Online Customer Support

An RMA number request can be requested electronically by contacting the Customer Support Department through the online support page at www.comtechefdata.com/support.asp:

- **Click** on “**Service**” for detailed instructions on our return procedures.
- **Click** on the “**RMA Request Form**” hyperlink, then fill out the form completely before sending.
- **Send e-mail** to the Customer Support Department at service@comtechefdata.com.

For information regarding this product’s warranty policy, refer to the Warranty Policy, p.xix.

Chapter 1. INTRODUCTION

1.1 Overview

The CDM-600/600L Open Network Satellite Modem is intended for both Intelsat and closed network applications. Apart from the IF frequency band, the two modems are essentially identical: The CDM-600L (**Figure 1-1**) operates on the L-Band frequency, while the CDM-600 is the 70/140 MHz IF version of the same modem.



Figure 1-1. CDM-600/600L Open Network Satellite Modem (CDM-600L shown)

1.1.1 Standard Features

The CDM-600/600L provides a wealth of standard features which go far beyond the basic requirements of the Intelsat specifications:

- Low rate variable data rates – 2.4 kbps to 5.0 Mbps
- Mid-rate variable data rates – 2.4 kbps to 10.0 Mbps
- High-rate variable data rates – 2.4 kbps to 20.0 Mbps
- Selectable 50Ω / 75Ω IF port impedance (**CDM-600**)
- Asymmetric Loop Timing
- Modulation Types – BPSK, QPSK, and OQPSK
- **Embedded Distant-end Monitor and Control (EDMAC)** (see Note)
- **Automatic Uplink Power Control (AUPC)**
- Firmware – Flash Upgrading
- 1:1 and 1:10 redundancy switch compatibility

EDMAC Note: In EDMAC mode, an additional 5% overhead is combined with the traffic data (1.5% in Turbo BPSK modes, Turbo Rate 1/2 QPSK/OQPSK, and all data rates greater than 2 Mbps), which permits Monitor & Control (M&C) information to be added transparently to the user, allowing access to the distant-end modem. This mode does not require any additional cabling at either the local or distant-end modems; access to EDMAC is via the standard M&C control port.

Full M&C is possible and, importantly, the on/off status of the carrier at the distant-end carrier can be controlled. In addition, as of Firmware Ver. 1.2.0 (CDM-600L) or 1.5.0 (CDM-600) and higher, the proprietary D&I++ framing mode is available. This combines Drop & Insert (D&I) operation with a similar EDMAC link and a 2.2% overhead.

CDM-600/600L Common Features

- Compliance with IESS-308 / -309/ -310 / -315 specifications, with significant features added in Closed Network modes.
- Variable data rates from 2.4 kbps to 20 Mbps, in BPSK, QPSK, Offset QPSK, 8-PSK, 8-QAM, and 16-QAM modes are offered.
- Viterbi, Sequential, concatenated Reed-Solomon (RS), Trellis Coded Modulation (TCM), Turbo Product Coding (TPC), and Low Density Parity Check Coding (LDPC) are provided as Forward Error Correction (FEC) options.
- A full range of interface types is built-in and available on demand – no plug-in cards are required. This includes all G.703 types and D&I (both Open and Closed Network) operation.
- The CDM-600/600L front panel features a Video Fluorescent Display (VFD) and keypad for local configuration and control; additionally, the unit may be remote-controlled.

CDM-600L Features

- IF frequency range covers 950 to 1950 MHz, and supports external Block Upconverters (BUCs) and Low-Noise Block Downconverters (LNBs).
- A programmable 13, 18, or 24V LNB power supply at the Rx IF connector center conductor, and optionally includes a 24 or 48V BUC power supply at the Tx IF connector center conductor.
- A low phase noise 10 MHz reference output is available at both the Tx and Rx IF connectors for use by the BUC or LNB.
- The CDM-600L is compact – 1RU high and 18 inches deep, and consumes 57 watts (typical), excluding BUC and LNB power supply loads.

CDM-600 Features

- IF frequency range simultaneously covers 52-88 MHz and 104-176 MHz, and supports external Comtech EF Data RF Transceivers (CSAT-5060, KST-2000A/B).
*Note: Units manufactured after February 2005 cover 50-90 MHz and 100-180 MHz. The opening screen for these enhanced operation units displays **CDM-600 (E)** – meaning Extended IF range.*
- The CDM-600 is compact – 1RU high and 13.1 inches deep, and consumes only 25 Watts (typical).

Refer to **Sect. 1.3** for in-depth product information and **Sect. 1.5** for the CDM-600/600L Summary of Specifications.

1.2 Functional Description

The CDM-600/600L has two fundamentally different types of interface – IF and data:

- The IF interface provides a bidirectional link with the satellite via the uplink and downlink equipment.
- The data interface is a bidirectional path, which connects with the customer's equipment (assumed to be the DTE) and the modem (assumed to be the DCE).

Tx data is received by the terrestrial interface where line receivers convert the clock and data signals to CMOS levels for further processing. A small FIFO follows the terrestrial interface to facilitate the various clocking and framing options. If framing is enabled, the Tx clock and data output from the FIFO pass through the framer, where the overhead data (IDR, IBS, D&I, or EDMAC) is added to the main data; otherwise, the clock and data are passed directly to the Forward Error Correction encoder.

In the FEC encoder, the data is differentially encoded, scrambled, and then convolutionally encoded. Following the encoder, the data is fed to the Tx digital filters, which perform spectral shaping on the data signals. The resultant I and Q signals are then fed to the BPSK, QPSK, Offset QPSK, 8-PSK, or 16-QAM modulator. The carrier is generated by a frequency synthesizer, and the I and Q signals directly modulate this carrier to produce an IF output signal.

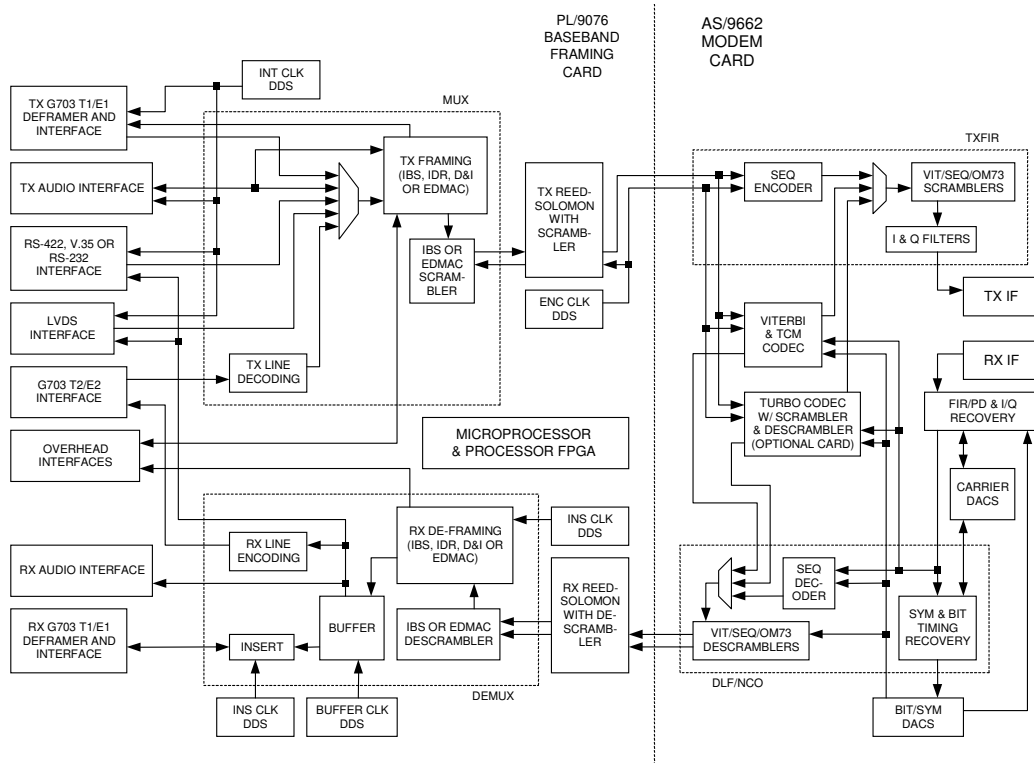
The Rx IF signal is translated to baseband using the carrier recovery VCO. This is a complex mix, resulting in the signal once more being split into an in-phase (I) and a quadrature (Q) component. An AGC circuit maintains the desired signal level constant over a broad range. Following this, the I and Q signals are sampled by high-speed (flash) A/D converters. All processing beyond this conversion is purely digital, comprising a Costas loop that performs the functions of Nyquist filtering, carrier recovery, and symbol timing recovery. The resultant demodulated signal is fed, in soft decision form, to the selected FEC decoder (which can be Viterbi, Sequential, TCM, Reed-Solomon, or Turbo if installed).

After decoding, the recovered clock and data pass to the de-framer (if IBS, IDR, D&I, or EDMAC framing is enabled) where the overhead information is removed. Following this, the data passes to the Plesiochronous/Doppler buffer, which has a programmable size, or alternatively bypasses the buffer. From here, the Rx clock and data signals are routed to the terrestrial interface, and are passed to the externally connected DTE equipment.

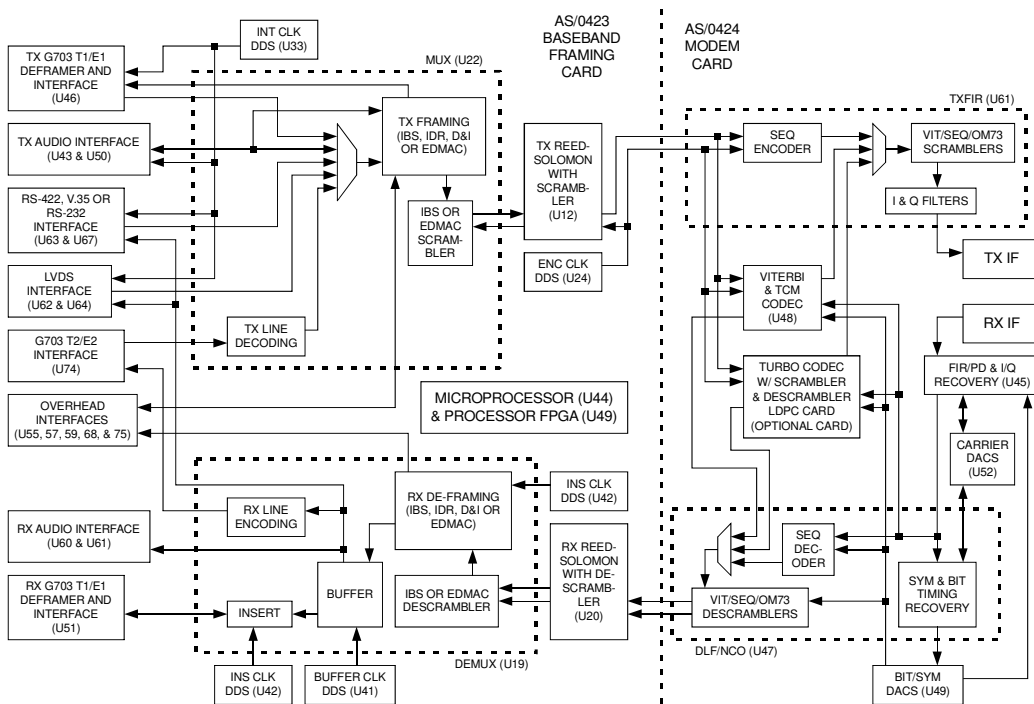
Physically the CDM-600/600L modem is comprised of two main card assemblies.

- The first of these is the baseband framer card, which includes all of the interface circuits, the framer/de-framer, plesiochronous/Doppler buffer, Reed Solomon outer codec, and the main microcontroller.
- The second card is the modem itself, that performs all of signal processing functions of modulation, demodulation, and Forward Error Correction.

These functions are illustrated in the block diagrams on the next page (**Figure 1-2**).



CDM-600L Block Diagram



CDM-600 Block Diagram

Figure 1-2. CDM-600/600L Open Network Satellite Modem Block Diagrams

1.3 Features

1.3.1 Physical Description

The CDM-600/600L Open Network Satellite Modem is constructed as a 1RU-high rack-mounting chassis, which can be free-standing if desired. Rack handles at the front facilitate removal from and placement into a rack.

1.3.2 Compatibility

The CDM-600L Open Network Satellite Modem is fully backwards-compatible with the CDM-600 modem. In turn, the CDM-600/600L is fully backwards-compatible with the Comtech EF Data CDM-500, CDM-550, and CDM-550T modems.

Being an Open Network modem, the CDM-600/600L is fully compatible with modems from other manufacturers that are compliant with the IESS-308 / -309 / -310 / -314 / -315 specifications.

The CDM-625 Open Network Satellite Modem, with its available CDM-600 Emulator Mode, serves as an operationally transparent replacement unit for the CDM-600/600L Open Network Satellite Modem.

1.3.3 Major Assemblies

CDM-600L Major Assemblies	
Assembly	Description
PL/9662-1	0.02 PPM Reference Modem Card – 75Ω Rx Type 'F'
PL/9662-2	1 PPM Reference Modem Card – 75Ω Rx Type 'F'
PL/9662-3	0.02 PPM Reference Modem Card – 50Ω Rx Type 'N'
PL/9662-4	1 PPM Reference Modem Card – 50Ω Rx Type 'N'
AS/0463	Turbo Codec – low rate
AS/9436	Turbo Codec – high rate
PL/9076-1	Baseband Framing Card
PL/9640-1	Chassis
PL/10341-1	LDPC and High RateTurbo Codec

CDM-600 Major Assemblies	
Assembly	Description
AS/11229-1	Modem Card – Extended IF bandwidth - units manufactured after February 2005
AS/0424-1	Modem Card – Standard IF bandwidth - units manufactured before February 2005
AS/0463	Turbo Codec – low rate
AS/9436	Turbo Codec – high rate
PL/9076-1	Baseband Framing Card
PL/9122-1	Chassis
PL/10341-1	LDPC and High RateTurbo Codec
PL/10290	High Stability Reference (p/o KT/9585-1)
KT/9585-1	High Stability Reference (<i>Consult factory for availability</i>)

1.3.4 Dimensional Envelopes

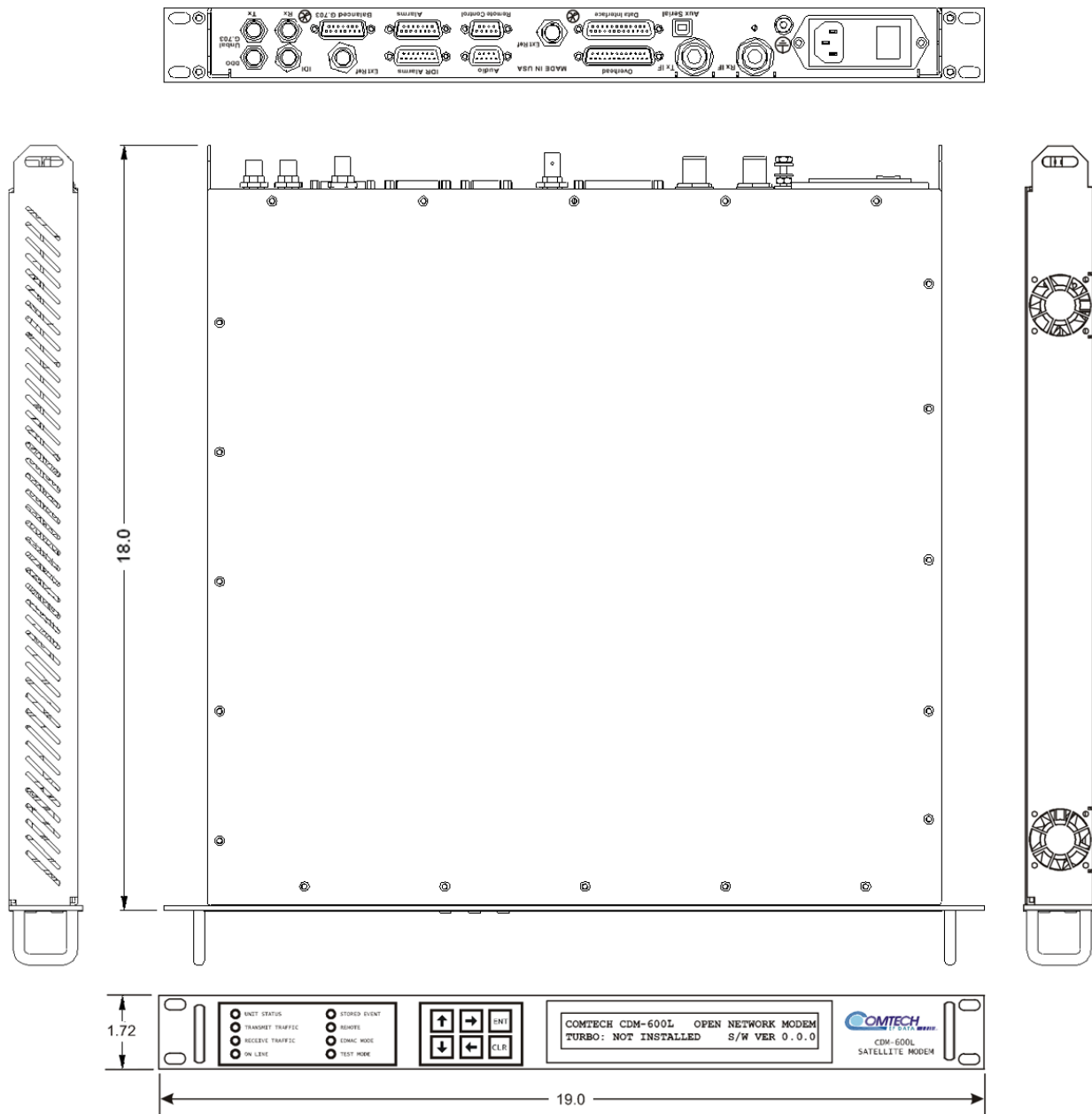


Figure 1-3. CDM-600L Dimensional Envelope

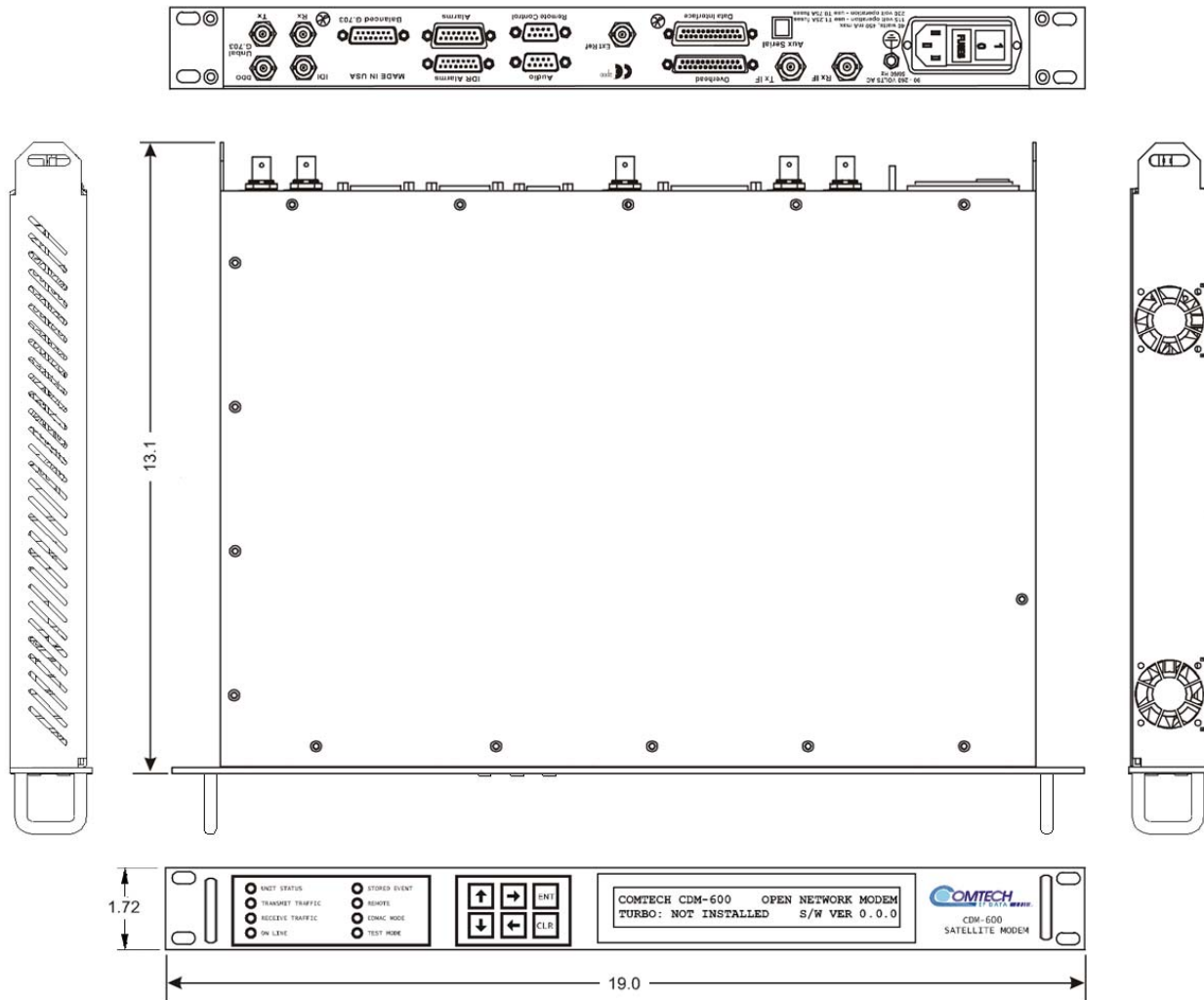


Figure 1-4. CDM-600 Dimensional Envelope

1.3.5 Physical Features

1.3.5.1 Front Panel

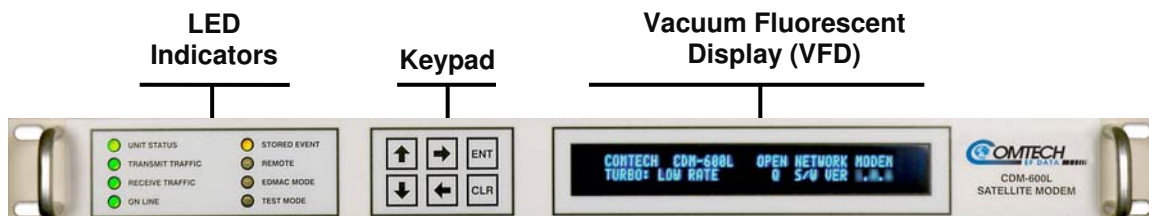


Figure 1-5. Front Panel View (CDM-600L shown)

Figure 1-5 shows the front panel of the CDM-600/600L Open Network Satellite Modem. The front panel features (from left) eight **L**ight-**E**mitting-**D**iode (LED) indicators; a keypad; and a **V**acuum **F**luorescent **D**isplay (VFD):

- The LEDs indicate, in a summary fashion, the status of the unit.
- The keypad comprises six individual keyswitches, mounted directly behind a fully sealed membrane overlay. They have a positive ‘click’ action, which provides tactile feedback. The user enters data via the keypad, and messages are displayed on the VFD.
- The VFD is an active display showing two lines of 40 characters each. It produces a blue light with adjustable brightness. Compared to a **L**iquid **C**rystal **D**isplay (LCD), the VFD has greatly superior viewing characteristics and does not suffer problems of viewing angle or contrast.

The function and behavior of the LED indicators, keypad, and VFD is described in detail in **Chapter 5. FRONT PANEL OPERATION**.

1.3.5.2 Rear Panel

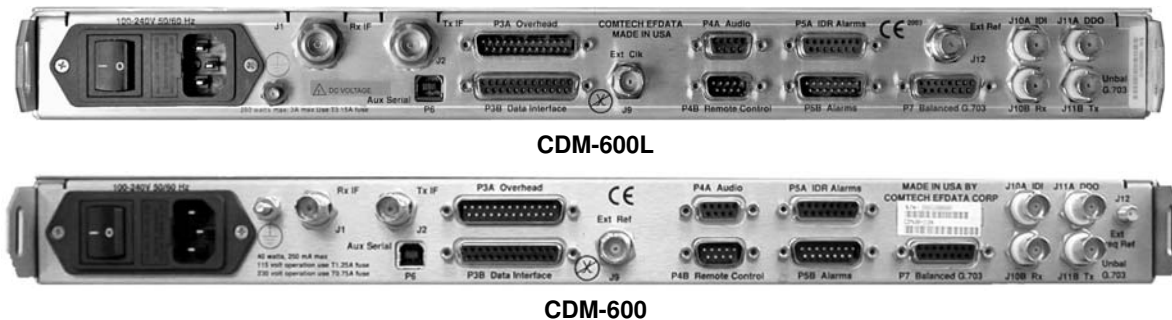


Figure 1-6. Rear Panel View

Figure 1-6 shows the connectors installed in the rear panel of the CDM-600/600L Open Network Satellite Modem. Each connector outlined in **Table 1-1** is described in detail in **Chapter 3. REAR PANEL CONNECTOR PINOUTS**. External cables are attached to these connectors.

Table 1-1. CDM-600/600L Rear Panel Connectors

Connector Group (Chapter 3 Sect. Ref.)	Ref Des / Name	Connector Type	Function	
IF (Sect. 3.2)	J1 Rx	CDM-600L: Type 'N' female (L-Band) CDM-600: BNC female (70/140MHz band)	IF Input	
	J2 Tx	CDM-600L: Type 'N' female (L-Band) CDM-600: BNC female (70/140MHz band)		
Terrestrial Data (Sect. 3.3)	P3A Overhead	25-pin Type 'D' male	INTELSAT overhead – 64kbps RS-422, 1/16 IBS overhead ESC @RS-232; IDR backward alarm	
	P3B Data Interface	25-pin Type 'D' female	Serial synchronous data Input/Output	
	P4A Audio	9-pin Type 'D' female	ADPCM audio Input/Output	
	G.703 Data	P7 Balanced	15-pin Type 'D' female	G.703 Balanced T1 (1.544 Mps) / E1 (2.048 Mbps) / T2 (6.312 Mbps)
		J10A IDI	BNC 75Ω female	Insert Data In – G.703 Unbalanced E1 (2.048 Mbps)
		J11A DDO	BNC 75Ω female	Drop Data Out – G.703 Unbalanced E1 (2.048 Mbps)
J10B Rx		BNC 75Ω female	G.703 Unbalanced E1 (2.048 Mbps) Rx	
J11B Tx	BNC 75Ω female	G.703 Unbalanced E1 (2.048 Mbps) Tx		
Utility (Sect. 3.4)	P6 Aux Serial	USB Type 'B' female	RS-232 Serial Remote interface for 1:1 Redundant operations	
	J9	CDM-600L: Ext Clk	BNC 50Ω female	External Clock Input
		CDM-600: Ext Ref		External Reference Input
	P4B Remote Control	9-pin Type 'D' male	Serial Remote Interface (RS-232/-485)	
	P5A IDR Alarms	15-pin Type 'D' female	Form C Alarms (backward alarm outputs)	
	P5B Alarms	15-pin Type 'D' male	Form C Alarms (relay closures)	
	J12	CDM-600L: Ext Ref	BNC 50Ω female	External reference for modem synthesizers
CDM-600: Ext Freq Ref		SMA female	High-stability External Reference (optional)	
Power/Ground (Sect 3.5)	AC	See Sect. 3.5.1	Chassis power	
	DC (optional, CDM-600L only)	See Sect. 3.5.2		
	Ground	#10-32 stud		Common Chassis Ground

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

1.3.6 Hardware Options

1.3.6.1 CDM-600L Hardware Option

There are seven hardware options available for the CDM-600L:

- The first three comprise including two Comtech EF Data Turbo Product Codecs, and a combination TPC (Turbo) / Low-Density Parity Check (LDPC) Codec that represents a very significant development in the area of FEC. All three options are field upgradeable, plug-in daughter cards (SIMM modules).
 - First, the Low Rate (1st Generation) TPC option provides data rate capability up to 5 Mbps, and code rates limited to Rate 5/16 (BPSK), Rate 21/44 (BPSK) and Rate 3/4 (QPSK, OQPSK, 8-PSK and 16-QAM).
 - Second, the High Rate (2nd Generation) TPC option provides data rate capability up to 20 Mbps, in addition to Rate 7/8 and Rate 0.95 capability.
 - Third, the combination Low-density Parity Check (LDPC) and TPC Codec is capable of data rates up to 20 Mbps, and provides Rate 1/2, Rate 2/3 and Rate 3/4 code rates across the range of modulation types.
- The fourth hardware option is the Internal Reference Stability. The high stability option includes a 2×10^{-8} 10 MHz reference oscillator on the modem board, while the low stability option places a 1×10^{-6} 10 MHz reference on the modem board. This option must be fitted in the factory at the time of order.
- The fifth hardware option is the Rx IF Impedance and Connector. The Rx IF may be configured with either a Type F female connector at 75 Ω impedance, or a Type N female connector at 50 Ω impedance. This option must also be fitted in the factory at the time of order.
- The sixth hardware option is prime power input for the modem. The modem chassis may be configured for either 100-240 VAC input, or 38-60 VDC input.
- The seventh hardware option is an internal power supply for the BUC. This power supply provides 24V (100W max.) or 48V (180W max.) power to the BUC on the center conductor of the Tx cable. This hardware option can be fitted in the factory at the time of order, or be installed in the field as an upgrade kit. The options include 100-240 VAC input, or 38-60 VDC input.

1.3.6.2 CDM-600 Hardware Options

There are four hardware options available for the CDM-600:

- The first three comprise including two Comtech EF Data Turbo Product Codecs, and a combination TPC (Turbo) / Low-Density Parity Check (LDPC) Codec that represents a very significant development in the area of FEC. All three options are field upgradeable, plug-in daughter cards (SIMM modules).
 - First, the Low Rate (1st Generation) TPC option provides data rate capability up to 5 Mbps, and code rates limited to Rate 5/16 (BPSK), Rate 21/44 (BPSK) and Rate 3/4 (QPSK, OQPSK, 8-PSK and 16-QAM).

- Second, the High Rate (2nd Generation) TPC option provides data rate capability up to 20 Mbps, in addition to Rate 7/8 and Rate 0.95 capability.
- Third, the combination Low-density Parity Check (LDPC) and TPC Codec is capable of data rates up to 20 Mbps, and provides Rate 1/2, Rate 2/3 and Rate 3/4 code rates across the range of modulation types.
- The fourth hardware option is the Internal/External High Stability Reference. It provides a frequency stability of 2×10^{-8} . This may be fitted in the factory at the time of order, or fitted in the field as an upgrade (provided the CDM-600 was manufactured after a certain date - consult the factory for further information).

This option provides an additional connector on the rear panel to permit the connection of a high-stability external reference signal, which in turn will phase-lock all of the internal frequency generation circuits of the CDM-600, including the IF synthesizers. The new connector is an SMA female type, located at the extreme right of the rear panel (when looking at the rear panel). This connector accepts signals at 1, 2, 5, 10 or 20MHz, over the range -5 dBm to +15 dBm, and is matched for both 50 and 75 Ω systems.

The frequency is selected from either the front panel or over the remote control interface. If the user selects external reference operation, the unit expects to see an appropriate signal at this connector. If the monitor circuit does not sense a signal at the connector, a Traffic Alarm is generated, and the High-Stability Internal Reference (stability of 5×10^{-8}) is automatically substituted.

If the user selects Internal Reference, the user may then adjust the exact frequency of the reference using the front panel, or the remote control interface.

In External mode, the High-Stability Internal/External Reference Module works by phase-locking the Internal Reference to the externally applied signal. If for some reason (perhaps an incorrect frequency being applied) the PLL circuit senses a loss of lock, a Unit Alarm is generated, and the TX carrier will be muted.

Because the High-Stability Internal Reference is comprised of an Ovenized Crystal Oscillator (OCXO) there is a warm up period associated with this scheme. The user may select, either from the front panel or via the remote control, to have the unit:

- Power-up instantly (in which case the frequency of the unit will drift until the oven has reached its correct operating temperature),

OR:

- Select a warm-up delay, where the unit will not become operational until the oven has reached a temperature close to stabilization value.

CDM-600 Hardware Option Notes:

1. The CDM-600 uses an intelligent algorithm that takes into account the internal temperature of the unit, and the amount of time it has been powered down. In this way, the unit does not wait for the full period (which can be as much as 200 seconds) if power is cycled over a short time.
2. If the warm-up feature has been activated, the time-out period can be instantly terminated by pressing **[CLR]** on the front panel keypad.

1.3.7 Data Interfaces

The CDM-600/600L includes, as standard, a universal data interface that eliminates the need to exchange interface cards for different applications. The interfaces offered include:

- RS-422 (RS-530) DCE (at rates up to 10 Mbps)
- X.21 DTE and DCE (at rates up to 10 Mbps)
- V.35 DCE (at rates up to 10 Mbps)
- Synchronous RS-232 DCE (at rates up to 300 kbps)
- G.703 E1, balanced and unbalanced
- G.703 T1, balanced
- G.703 E2, balanced and unbalanced
- G.703 T2, balanced
- Serial LVDS (at rates up to 20 Mbps)
- Dual Audio, 600 Ω (produces a single 64 kbps IBS data stream)

1.3.8 Verification

The unit includes many test modes and loopbacks for rapid verification of the correct function of the unit. In particular, the IF loopback permits the user to perform a quick diagnostic test without disturbing external cabling. During the loopback, all the Rx configuration parameters are temporarily changed to match the Tx side, and an internal RF switch connects the modulator output to the demodulator input. When normal operation is again selected, all of the previous values are restored.

1.3.9 AUPC

An important feature in the CDM-600/600L is the addition of **Automatic Uplink Power Control (AUPC)**. This feature enables the modem to automatically adjust its output power to maintain the Eb/No of the remote end of the satellite link constant. This provides protection against rain fading, a particularly severe problem with Ku-band links.

To accomplish this, either the EDMAC or D&I++ or ESC++ framing types may be used, and the distant end modem constantly sends back information about the demodulator Eb/No using reserved bytes in the overhead structure. Using the Eb/No, the local modem adjusts its output power, and a closed-loop feedback system is created over the satellite link.

A benefit of this **AUPC** feature is that the remote demodulator's Eb/No can be viewed from the front panel display of the local modem.

See **Chapter 7. Automatic Uplink Power Control (AUPC)** for further information.

1.3.10 EDMAC

To facilitate network management for small networks, the CDM-600/600L incorporates the proprietary **Embedded Distant-end Monitor And Control (EDMAC)**. In this mode, an additional 5% overhead is combined with the traffic data, (1.6% in Turbo BPSK modes, Turbo Rate 21/44

QPSK/OQPSK, and all data rates greater than 2 Mbps). M&C information is added (transparent to the user), allowing access to the distant-end modem.

In addition, **EDMAC-2** uses 1.6% overhead in all modes for those applications where the 5% overhead is excessive. The **EDMAC** and **EDMAC-2** modes do not require any additional cabling at either the local or distant-end Modems. Access to **EDMAC** is via the standard M&C control port. Full monitor and control is possible, and the on/off status at the distant-end carrier can be controlled.

See **Chapter 9. EDMAC CHANNEL** for further information.

1.3.11 Flash Upgrading Modem Firmware

The internal firmware is both powerful and flexible, permitting storage and retrieval of up to 10 different modem configurations. The modem uses ‘flash memory’ technology internally, and new firmware can be uploaded to the unit from an external PC. This simplifies software upgrading, and updates can be sent via the Internet (from Comtech EF Data’s Web server), e-mail, or on CD. The upgrade can be performed without opening the unit, by simply connecting the modem to the serial port of a computer.

See **Chapter 4. FLASH UPGRADING** for further information.

1.3.12 Fully Accessible System Topology (FAST)

The CDM-600/600L is extremely flexible and powerful, and incorporates a large number of optional features. In order to permit a lower initial cost, the modem may be purchased with only the desired features enabled.

If, at a later date, a user wishes to upgrade the functionality of a modem, Comtech EF Data provides **Fully Accessible System Topology (FAST)**, which permits the purchase and installation of options through special authorization codes loaded into the unit either via the front panel keypad or entered remotely via the remote port located on the modem rear panel.

These unique access codes may be purchased at any time from Comtech EF Data.

FAST System Theory

FAST facilitates on-location upgrade of the operating feature set without removing a modem from the setup.

With **FAST** technology, operators have maximum flexibility for enabling functions as they are required. **FAST** allows an operator to order a modem precisely tailored for the initial application.

When service requirements change, the operator can upgrade the topology of the modem to meet those requirements within minutes. This accelerated upgrade can be accomplished because of **FAST**’s extensive use of the programmable logic devices incorporated into Comtech EF Data products.

FAST Implementation

Comtech EF Data’s **FAST** system is factory-implemented in the modem. All **FAST** options are available through the basic platform unit at the time of order – **FAST** allows immediate activation of available options, after confirmation by Comtech EF Data, through the front panel keypad or via the remote control interface.

See **Appendix C. FAST ACTIVATION PROCEDURE** for further information.

FAST Accessible Options

Hardware options for basic modems can be ordered and installed either at the factory or in the field. The operator can select options that can be activated easily in the field, depending on the current hardware configuration of the modem. A unique access code enables configuration of the available hardware.

The base CDM-600/600L unit is equipped with Viterbi, Sequential and Reed-Solomon codecs. It offers BPSK, QPSK, and OQPSK modulation types, and data rates up to 5.0 Mbps, with all interface types. While it is limited to Closed Network operation, the base unit does include EDMAC and AUPC.

The following table shows the available FAST and FAST-accessible hardware options:

Option	CDM-600	CDM-600L	Description and Comments	Option Installation Method
Low Rate Variable	X	X	Data rate 2.4 to 5.0 Mbps	BASE UNIT
Mid-Rate Variable	X	X	Data rate 2.4 to 10.0 Mbps	FAST
Full Rate Variable	X	X	Data rate 2.4 kbps to 20.0 Mbps	FAST
8-PSK	X	X	Modulation Type (includes 8-QAM if the TPC / LDPC Codec is installed)	FAST
16-QAM	X	X	Modulation Type	FAST
High Rate IBS ESC	X	X	20 bits per Frame	FAST
IBS	X	X	Intelsat Business Services – IESS-309	FAST
IDR	X	X	Intermediate Data Rate – IESS-308	FAST
D&I	X	X	Drop and Insert (includes D&I++, S/W Ver 1.2.0 or higher)	FAST
Dual Audio mode	X	X	2 x 32 kbps ADPCM Audio as primary data	FAST
Turbo Codec – Low Rate (1 st Gen)	X	X	5 Mbps TPC Codec	Hardware
Turbo Codec – High Rate (2 nd Gen)	X	X	20 Mbps TPC Codec	Hardware
TPC / LDPC Codec	X	X	20 Mbps TPC/LDPC Codec	Hardware
LDPC (Mid-Rate)	X	X	Data rate to 10 Mbps	FAST
LDPC (High-Rate)	X	X	Data rate to 20 Mbps	FAST
High Stability Reference	X		Internal/External 10 MHz reference - 2×10^{-8}	Hardware
High Stability Reference*		X	Internal 10 MHz reference - 2×10^{-8}	Hardware
Low Stability Reference*		X	Internal 10 MHz reference – 1×10^{-6}	Hardware
75Ω Rx Impedance*		X	75Ω impedance with Type F female connector	Hardware
50Ω Rx Impedance*		X	50Ω impedance with Type N female connector	Hardware
BUC Power Supply		X	Internal 24V or 48V power supply for BUC	Hardware

*Factory installed only.

In order to operate in Turbo (TPC) Mode: To operate in the Low Rate range (up to 5 Mbps), the modem requires any of the three Codec cards to be installed.

To operate in the Mid- or High-Rate ranges (up to 10 or 20 Mbps), the modem requires either the High Rate TPC Codec or the TPC / LDPC Codec to be installed.

In order to operate in LDPC Mode: The unit will require the TPC/LDPC Codec to be installed. In the base configuration this will provide LDPC up to 5 Mbps. In order to operate at higher data rates,

there are two additional FAST options available that permit operation up to 10 Mbps or 20 Mbps. Note that these are *in addition to* the base modem rate options.

In order to operate in 8-QAM mode: The modem will require the TPC/LDPC Codec to be installed and have the 8-PSK / 8-QAM FAST option enabled.

For example, if LDPC operation at 20 Mbps, 8-QAM mode is required, the modem must be configured with the following:

- TPC/LDPC Codec hardware option
- Full rate variable FAST option
- High-Rate LDPC FAST option
- 8-PSK /8-QAM FAST option

1.3.13 Supporting Hardware and Software

SatMac Complete Systems Operation

The CDM-600/600L is supported by Comtech EF Data’s **SatMac** software, a Windows™-based application that provides a ‘point and click’ interface for complete systems of Comtech equipment, comprising Modems, Transceivers, and Redundancy Switches. For further information, or to order a free demo disk, contact Comtech EF Data Customer Support.

Redundancy Applications

For 1:1 and 1:N redundancy applications, the CDM-600/600L is supported by the following Comtech EF Data switching products:

CEFD Product	Description	CDM-600	CDM-600L
CRS-150	1:1 Redundancy Switch (70/140 MHz)	X	
CRS-150 <i>plus</i> CRS-170A	1:1 Redundancy Switch (L-Band)		X
CRS-300	1:10 Redundancy Switch	X	X
CRS-280*	IF Switch (70/140 MHz)	X	
CRS-280L*	IF Switch (L-Band)		X
CRS-350*	ESC Switch (IDR Overhead)	X	X

* For use in 1:N applications

ODU Interoperability via FSK / EDMAC

The CDM-600/600L incorporates a **F**requency **S**hift **K**eyed (FSK) serial link that, when activated on the Rx-IF port of a CDM-600, enables the modem to communicate with the Comtech EF Data line of RF Ku- and C-Band Transceivers.

On the CDM-600L, when activated on the Tx-IF port, this link can communicate with an FSK-capable Block Upconverter (BUC) or, conversely, when activated on the Rx-IF port, a Low-Noise Block Downconverter (LNB).

In this manner, a user may monitor, configure, and control the Transceiver, BUC or LNB via the modem’s front panel display and keypad, or by using the modem’s remote control interface.

The EDMAC overhead channel may also be used to convey M&C data to a RF Transceiver at the distant end of a satellite link if it is connected to a CDM-600, or to a BUC or LNB at the distant end of a satellite link if it is connected to a CDM-600L.

For the CDM-600L, this FSK interface with the BUC includes a BUC output power leveling mode, whereby the modem M&C monitors the detected BUC output power level reported on the FSK link and automatically adjusts the modem Tx output power to maintain a constant BUC Tx output level.

See **Appendix E. ODU (CSAT-5060, KST-2000A/B) OPERATION VIA THE CDM-600** or **Appendix F. ODU (BUC/LNB) OPERATION VIA THE CDM-600L** for further information.

1.4 New in this Release

Revision 3 of this manual incorporates the CDM-600 Satellite Modem Installation and Operation Manual (CEFD P/N MN/CDM600.IOM Revision 7). It is intended replace both CEFD MN/CDM600.IOM and the previous version of this document, CEFD P/N MN/CDM600L.IOM (Revision 2) in their entirety. All content from both documents has been integrated and reorganized to conform to current Comtech EF Data Technical Publications Standards and Practices.

Firmware revisions incorporate additional features and operational fixes/enhancements. Users are strongly urged to upgrade the CDM-600/600L to its most current firmware release – for further information, refer to **Chapter 4. FLASH UPGRADING**.

1.4.1 CDM-600L Modem Firmware Release Notes

Release Ver. 1.5.0 (7/9/08)

New Features:

- None.

Feature Enhancements:

- Revised Rx buffer step size calculation for D&I++.
- Resolved ‘set Rx buffer size’ issue when Rx data rate is changed via front panel.

1.4.2 CDM-600 Modem Firmware Release Notes

Release Ver. 2.2.6 (6/26/08)

New Features:

- None.

Feature Enhancements:

- Revised Rx buffer step size calculation for D&I++.

1.5 Summary of Specifications

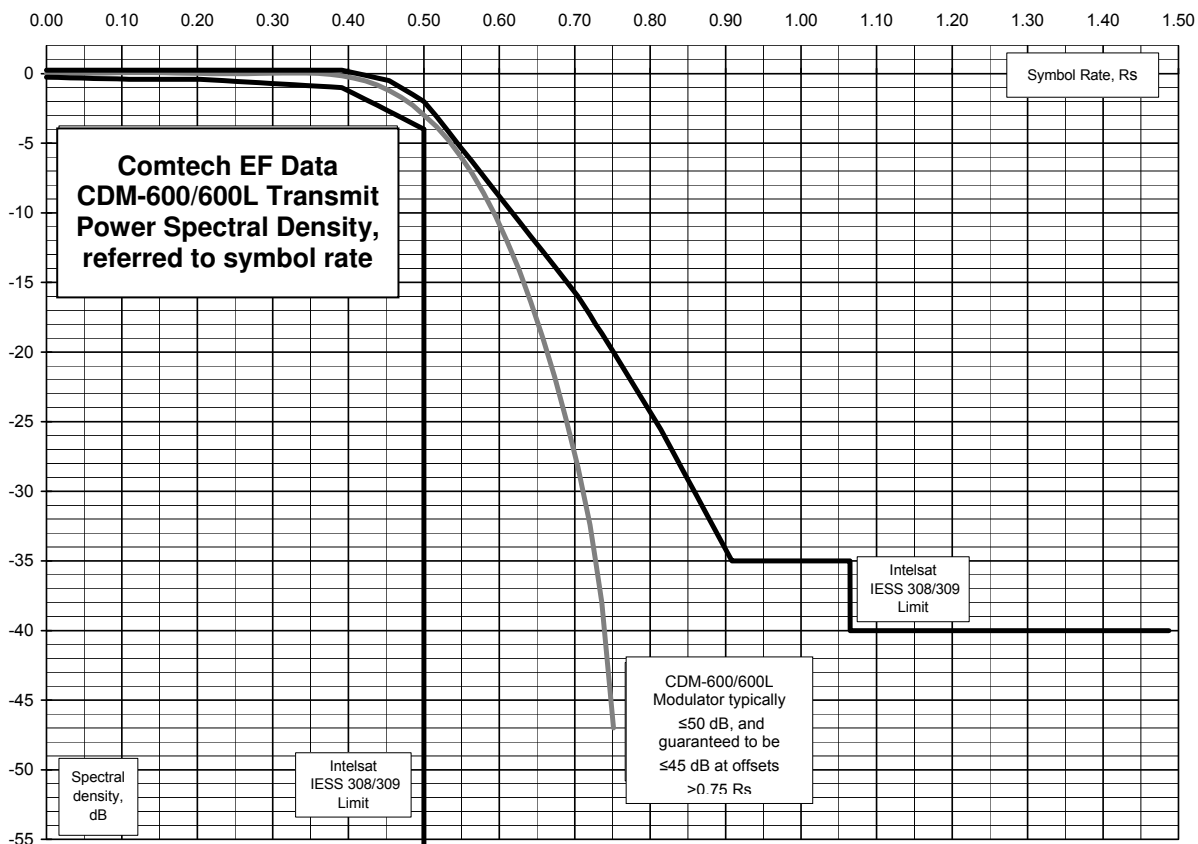
All specifications are typical for the CDM-600L and CDM-600 unless otherwise indicated.

1.5.1 Modulator

Modulation	BPSK, QPSK, OQPSK, 8-PSK, 8-QAM and 16-QAM
Symbol rate range	4.8 ksp/s to 10.0 Msps
Data rate range	See Section 1.5.5
Operating modes	<ul style="list-style-type: none"> • Open Network, per Intelsat IESS-308/309/310/314 (IDR, IBS/SMS) • E1/T1 Drop and Insert • Transparent, Closed Network, IESS-315 (VSAT Turbo) • Proprietary EDMAC framed mode: <ul style="list-style-type: none"> ◦ 5% overhead - all modes except BPSK Turbo, Rate 1/2 OQPSK Turbo, and data rates < 2.048 Mbps ◦ 1.5% overhead - Rate 21/44, 5/16 Turbo, Rate 1/2 OQPSK Turbo, and all other rates >2.048 Mbps • R-S Outer Codec • Turbo Product Codec – Low Rate, 1st Generation (optional): <ul style="list-style-type: none"> ◦ Rate 5/16 BPSK ◦ Rate 21/44 BPSK ◦ Rate 3/4 QPSK/OQPSK/8-PSK/16-QAM • Turbo Product Codec – High Rate, 2nd Generation (optional): <ul style="list-style-type: none"> ◦ Rate 21/44 BPSK ◦ Rate 5/16 BPSK ◦ Rate 1/2 QPSK/OQPSK (exact Code Rate is actually 0.477) ◦ Rate 3/4 QPSK/OQPSK/8-PSK/16-QAM ◦ Rate 7/8 QPSK/OQPSK/8-PSK/16-QAM ◦ Rate 0.95 QPSK/OQPSK/8-PSK (exact Code Rate is actually 0.944) • LDPC Codec (optional – includes all 2nd Generation TPC modes): <ul style="list-style-type: none"> ◦ Rate 1/2 BPSK/QPSK/OQPSK ◦ Rate 2/3 QPSK/OQPSK/8-PSK/8-QAM ◦ Rate 3/4 QPSK/OQPSK/8-PSK/8-QAM/16-QAM • Automatic Uplink Power Control (AUPC) mode • High Rate ESC: [CDM-600L] FAST [CDM-600] FAST, with Firmware Ver. 1.3.1 or higher • ESC++: [CDM-600L] with Firmware Ver.1.3.0 or higher [CDM-600] with Firmware Ver. 2.0.1 or higher • Drop & Insert ++ : [CDM-600L] with Firmware Ver. 1.2.0 or higher and with D&I FAST option [CDM-600] with Firmware Ver. 1.5.0 or higher
Tx filtering	Per INTELSAT IESS-308 (FIR digital filter implementation)
Scrambling	<ul style="list-style-type: none"> • IDR Mode, no R-S - per ITU V.35 (Intelsat variant) • IBS mode, no R-S - per IESS-309, externally frame synchronized • Transparent Closed Network mode, no R-S or Turbo coding - per ITU V.35 (Intelsat variant) • EDMAC mode, no RS coding - externally frame synchronized - proprietary • Turbo Product Code mode - externally frame synchronized - proprietary • All R-S modes - externally frame synchronized per IESS-308/-309/-310

FEC	<p>None: Uncoded BPSK/QPSK/OQPSK</p> <p>Viterbi: k=7, per IESS-308/309 BPSK: Rate 1/2 QPSK/OQPSK: Rate 1/2, Rate 3/4 and Rate 7/8 16-QAM: Rate 3/4 and Rate 7/8 (Viterbi plus Reed-Solomon only)</p> <p>Sequential: k=36 (Rate 1/2) per IESS-309 k= 63 (Rate 3/4) per IESS-309 k= 87 (Rate 7/8) <i>Important note: Sequential decoding limits the data rate to a maximum of 2.048 Mbps for OQPSK and 1.024 Mbps for BPSK.</i></p> <p>Reed-Solomon (Open Network): IDR modes: 225/205 for T1 219/201 for E1 and IESS-310 mode, 194/178 for T2 and E2 IBS modes: 126/112 219/201 for IESS-310 mode</p> <p>Reed-Solomon (Closed Network):</p> <ul style="list-style-type: none"> • 220,200 outer code (transparent mode) • 225,205 outer code (transparent mode, EF Data compatible, V.35 scrambling) • 126,112 outer code (transparent mode, IBS parameters, D&I++ mode) • 219,201 outer code (transparent mode, IESS-310 parameters) • 200,180 outer code (EDMAC modes) • Interleaver depth = 4 or 8 (Viterbi, depending on mode) • Interleaver depth = 8 (Sequential) <p>8-PSK/TCM Rate 2/3 (Trellis): Per IESS-310</p> <p>Turbo Product Codec, Low Rate (1st Generation) (Optional plug-in card):</p> <ul style="list-style-type: none"> • Rate 3/4 QPSK/OQPSK/8-PSK/16-QAM - 2 dimensional • Rate 21/44 BPSK - 3 dimensional • Rate 5/16 BPSK - 3 dimensional <p>Turbo Product Codec, High Rate (2nd Generation) (Optional plug-in card):</p> <ul style="list-style-type: none"> • Rate 5/16 BPSK - 2 dimensional • Rate 21/44 BPSK - 3 dimensional • Rate 1/2 QPSK/OQPSK - 3 dimensional (exact Code Rate is actually 0.477) • Rate 3/4 QPSK/OQPSK/8-PSK/16-QAM - 2 dimensional • Rate 7/8 QPSK/OQPSK/8-PSK/16-QAM - 2 dimensional • Rate 0.95 QPSK/OQPSK/8-PSK - 2 dimensional TPC (exact Code Rate is actually 0.944) <p>Low Density Parity Check (LDPC) Codec (Optional plug-in card):</p> <ul style="list-style-type: none"> • Rate 1/2 BPSK/QPSK/OQPSK • Rate 2/3 QPSK/OQPSK/8-PSK/8-QAM • Rate 3/4 QPSK/OQPSK/8-PSK/8-QAM/16-QAM
Output power	<p>CDM-600L: 0 to -40 dBm, 0.1 dB steps – manual mode. CDM-600: 0 to -20 dBm, 0.1 dB steps – manual mode. See Chapter 7. Automatic Uplink Power Control (AUPC).</p>
Power accuracy	<p>CDM-600L: ±1.5 dB over frequency and temperature CDM-600: ±0.5 dB over frequency and temperature</p>
Output connector	<p>CDM-600L: Type N Female, 50Ω CDM-600: BNC female</p>
Output frequency	<p>CDM-600L: 950-1950 MHz, 100 Hz resolution Stability ± 0.02 ppm, 0 to 50°C (32 ° to 122 °F) (<i>standard high-stability internal reference</i>) Stability ± 1 ppm, 0 to 50°C (32 ° to 122 °F) (<i>optional low-stability internal reference</i>)</p> <p>CDM-600: 52-88 MHz, 104-176 MHz, 100 Hz resolution – units manufactured prior to February 2005</p> <p>CDM-600(E): 50-90 MHz, 100-180 MHz, 100 Hz resolution – units manufactured after February 2005 Stability ±1.5 ppm, 0 to 50°C (32 to 122 °F) (<i>standard stability internal reference</i>) Stability ±0.02 ppm, 0 to 50°C (32 to 122 °F) (<i>optional high-stability internal reference</i>)</p>
Harmonics and spurious	<p>CDM-600L: Better than -55 dBC/4 kHz (typically <-60 dBC/4kHz) – measured from 50 to 2500 MHz CDM-600: Better than -55 dBC/4 kHz (typically <-60 dBC/4 kHz) – measured from 25 MHz to 2 GHz</p>

Tx On/Off ratio	CDM-600L: -75 dBm maximum CDM-600: 55 dB minimum	
External TX Carrier Off	By TTL 'low' signal or external contact closure - hardware function automatically overrides processor	
Clocking options	<p>CDM-600L: Internal, ± 1ppm or 0.02 ppm (SCT) External, locking over a ± 100 ppm range (TT) Loop timing (Rx satellite clock) - supports asymmetric operation - Rx and Tx data rates do not need to be identical External Clock at Tx data rate.</p> <p>CDM-600: Internal, ± 1.5ppm or 0.02 ppm (SCT) External, locking over a ± 100 ppm range (TT) Loop timing (Rx satellite clock) - supports asymmetric operation - Rx and Tx data rates do not need to be identical External Clock</p>	
CDM-600 ONLY:		
Output impedance	50 Ω and 75 Ω , front panel selectable 21 dB minimum return loss	
Output phase noise	< 0.48 ⁰ rms double sided, 100 Hz to 1MHz (minimum of 16 dB better overall than the INTELSAT IESS-308/309 requirement)	
CDM-600L ONLY:		
External Reference	1, 2, 5, 10, or 20 MHz @ 0 dBm to +20 dBm. Internal reference phase locks to external reference.	
BUC Reference (10 MHz)	On center conductor of L-Band output connector; 10.0 MHz \pm 0.02 ppm (Optional 1ppm) 0.0 dBm, \pm 3 dBm; programmable ON/OFF Source: 1. Internal Modem Reference 2. External Reference (10 MHz)	
Phase Noise	<u>dB/Hz</u>	<u>Frequency Offset</u>
	-80	1 Hz
	-110	10 Hz
	-135	100 Hz
	-140	1 kHz
	-150	10 kHz
	-150	100 kHz
Output Phase Noise	<u>dB/Hz</u>	<u>Frequency Offset</u>
	-63.0	100 Hz
	-73.0	1 kHz
	-83.0	10 kHz
	-93.0	100 kHz
	Fundamental AC line spurious is -42 dBc or lower The sum of all other single sideband spurious, from 0 to 0.75 x symbol rate, is -48 dBc or lower	
BUC Supply Voltage (Supplied through Tx IF center conductor and selectable ON/OFF via M&C control)	Standard unit has no BUC supply. Optional BUC Supply: <ul style="list-style-type: none"> • 24VDC, 4.0 Amps maximum, 100W • 48VDC, 3.75 Amps maximum, 180W 	
BUC Current Monitor	Min/Max programmable current alarm thresholds.	
BUC Monitoring (FSK ON)	Power level, temperature, power class, PLL lock.	
BUC Power Leveling (FSK ON)	Modem levels BUC output power by increasing or decreasing carrier output to match programmed target level.	
Tx Carrier ON Delay	Delay from power on to Tx IF output allowing BUC to warm up. Programmable 0 to 200 sec.	



1.5.2 Demodulator

NOTE: Data Rate Range, Operating modes, Descrambling, Input impedance/return loss etc., as per Modulator.

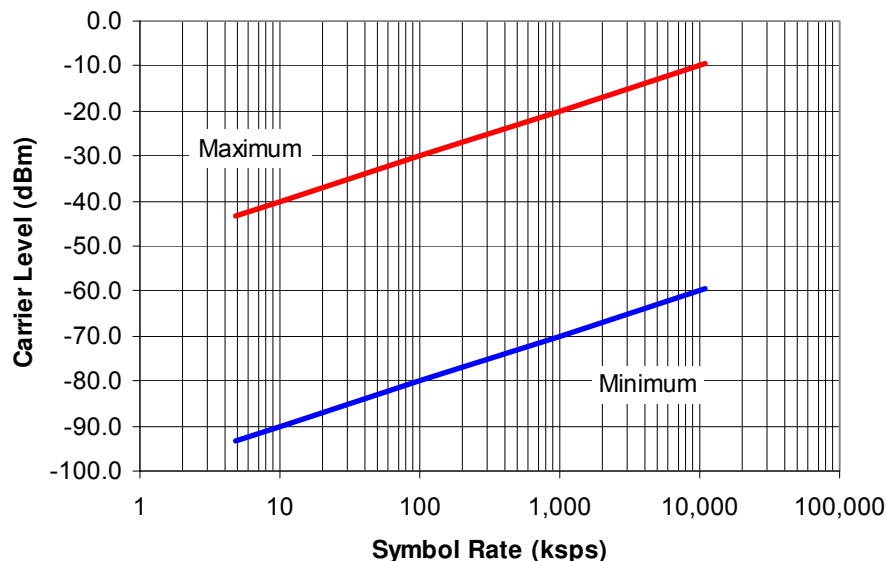
Input power range	CDM-600L: $-130 + 10\log(\text{symbol rate})$ (desired carrier) to $-130 + 10 \log(\text{symbol rate}) + 50$ dBm CDM-600: -30 to -60 dBm (desired carrier) +35 dBC maximum composite, up to -5 dBm
FEC	Viterbi: 3 bit soft decision Sequential: 2 bit soft decision Trellis: Per IESS-310 Reed-Solomon(Open Network): Per IESS-308/-309/-310 Reed-Solomon(Closed Network): Proprietary Turbo Product Codec: 6 bit soft decision, proprietary LDPC: 5 bit soft decision, proprietary
Plesiochronous/ Doppler Buffer	<ul style="list-style-type: none"> Selectable size of 64 to 262,144 bits, in 16-bit steps (with added limitations for G.704 frame boundaries) Size selection is displayed in bytes and milliseconds Supports asymmetric operation - when buffer is clocked from Tx clock, Rx and Tx rates do not need to be identical

Monitor Functions	<ul style="list-style-type: none"> • Eb/No estimate, 2 to 16 dB (± 0.25 dB accuracy) • Corrected Bit Error Rate, 1E-3 to 1E-10 • Frequency offset, ± 32 kHz range, 100 Hz resolution • Buffer fill state, in percent • Rx signal level, in dBm 			
Clock tracking range	± 100 ppm min			
Acquisition range	± 1 to ± 32 kHz, programmable in 1kHz increments			
Acquisition time (CDM-600L)	Viterbi QPSK 6db Eb/No with ± 32 kHz frequency Uncertainty			
	Code Rate	Data Rate	Tacq	P(t<Tacq)
	1/2	< 9.6 kbps	< 35 sec	95%
	1/2	≥ 9.6 kbps < 64 kbps	< 15 sec	95%
	1/2	≥ 64 kbps < 196 kbps	< 2 sec	95%
	1/2	≥ 196	< 1 sec	95%
	3/4	9.6 kbps	< 25 sec	95%
	7/8	9.6 kbps	< 30 sec	95%
	Sequential QPSK 6db Eb/No with ± 32 kHz Frequency Uncertainty			
	Code Rate	Data Rate	Tacq	P(t<Tacq)
	1/2	< 9.6 kbps	< 40 sec	95%
	1/2	≥ 9.6 kbps < 64 kbps	< 15 sec	95%
	1/2	≥ 64 kbps < 196 kbps	< 2 sec	95%
	1/2	≥ 196	< 1 sec	95%
	3/4	9.6 kbps	< 25 sec	95%
	7/8	9.6 kbps	< 30 sec	95%
	Turbo 6db Eb/No with ± 32 kHz Frequency Uncertainty			
	Code Rate/Mod	Data Rate	Tacq	P(t<Tacq)
	5/16 BPSK	9.6 kbps	< 6 sec	95%
	21/44 BPSK	9.6 kbps	< 15 sec	95%
Acquisition time (CDM-600)	<p>Highly dependent on data rate, FEC rate, and demodulator acquisition range. Examples: 200 ms average at 64 kbps, R1/2 QPSK, ± 32 kHz acquisition sweep range, 6dB Eb/No 5 s average at 9.6 kbps, R1/2 QPSK, ± 10 kHz, 6dB Eb/No Note that Reed-Solomon increases acquisition time, due to the additional time taken for the RS decoder to declare synchronization.</p>			
VITERBI BER performance (met in the presence of two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 1/2 (B, Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):
	BER= 10^{-5}	5.4 dB (4.9 dB)	6.8 dB (6.3 dB)	7.7 dB (7.2 dB)
	BER= 10^{-6}	6.0 dB (5.5 dB)	7.4 dB (6.9 dB)	8.4 dB (7.9 dB)
	BER= 10^{-7}	6.7 dB (6.2 dB)	8.2 dB (7.7 dB)	9.0 dB (8.6 dB)
SEQUENTIAL @ 64 kbps BER (met in the presence of two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 1/2 (B, Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):
	BER= 10^{-5}	4.8 dB (4.2 dB)	5.8 dB (5.3 dB)	7.0 dB (6.6 dB)
	BER= 10^{-6}	5.2 dB (4.5 dB)	6.4 dB (5.8 dB)	7.5 dB (7.2 dB)
	BER= 10^{-7}	5.6 dB (4.8 dB)	6.9 dB (6.3 dB)	8.0 dB (7.7 dB)
SEQUENTIAL @ 64 kbps BER (met in the presence of two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 1/2 (B, Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):
	BER= 10^{-5}	4.8 dB (4.2 dB)	5.8 dB (5.3 dB)	7.0 dB (6.6 dB)
	BER= 10^{-6}	5.2 dB (4.5 dB)	6.4 dB (5.8 dB)	7.5 dB (7.2 dB)
	BER= 10^{-7}	5.6 dB (4.8 dB)	6.9 dB (6.3 dB)	8.0 dB (7.7 dB)

VITERBI and RS 220,200 or 200,180 Outer Code BER (with two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 1/2 (B, Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):
	BER=10 ⁻⁵	4.3 dB (4.0 dB)	5.6 dB (4.7 dB)	6.5 dB (6.0 dB)
	BER=10 ⁻⁶	4.4 dB (4.1 dB)	5.8 dB (4.8 dB)	6.7 dB (6.2 dB)
	BER=10 ⁻⁷	4.5 dB (4.2 dB)	6.0 dB (5.2 dB)	6.9 dB (6.5 dB)
SEQUENTIAL and RS 220,200 or 200,180 Outer Code @ 512 kbps (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 1/2 (B, Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):
	BER=10 ⁻⁷	4.6 dB (4.3 dB)	5.3 dB (4.9 dB)	6.0 dB (5.7 dB)
	BER=10 ⁻⁸	4.8 dB (4.5 dB)	5.6 dB (5.3 dB)	6.4 dB (6.1 dB)
8-PSK/TCM CODEC BER (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 2/3 8-PSK/TCM Guaranteed Eb/No (typ value in parentheses):	Rate 2/3 8-PSK/TCM w/concatenated RS Guaranteed Eb/No (typ value in parentheses):	
	BER=10 ⁻⁵	7.9 dB (7.2 dB)	6.3 dB (5.4 dB)	
	BER=10 ⁻⁷	9.5 dB (8.7 dB)	6.7 dB (5.8 dB)	
	BER=10 ⁻⁸	10.4 dB (9.5dB)	6.9 dB (6.0 dB)	
TURBO PRODUCT CODEC BER Rate 1/2 QPSK Rate 21/44 BPSK Rate 5/16 BPSK BER (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 1/2 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 21/44 (B) Guaranteed Eb/No (typ value in parentheses):	Rate 5/16 (B) Guaranteed Eb/No (typ value in parentheses):
	BER=10 ⁻⁶	2.9 dB (2.6 dB)	2.8 dB (2.5dB)	2.4 dB (2.1dB)
	BER=10 ⁻⁷	3.1 dB (2.7 dB)	3.1 dB (2.8 dB)	2.6 dB (2.3dB)
	BER=10 ⁻⁸	3.3 dB (2.8 dB)	3.3 dB (2.90dB)	2.7 dB (2.4dB)
TURBO PRODUCT CODEC BER Rate 3/4 QPSK Rate 3/4 8-PSK Rate 3/4 16-QAM BER (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 3/4 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (8-PSK) Guaranteed Eb/No (typ value in parentheses):	Rate 3/4 (16-QAM) Guaranteed Eb/No (typ value in parentheses):
	BER=10 ⁻⁶	3.8dB (3.4dB)	6.2 dB (5.8 dB)	7.4dB (7.0 dB)
	BER=10 ⁻⁷	4.1dB (3.7dB)	6.4 dB (6.0 dB)	7.8 dB (7.3 dB)
	BER=10 ⁻⁸	4.4dB (4.0dB)	6.8 dB (6.3 dB)	8.2 dB (7.7 dB)
TURBO PRODUCT CODEC BER Rate 7/8 QPSK Rate 7/8 8-PSK Rate 7/8 16-QAM BER (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 7/8 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (8-PSK) Guaranteed Eb/No (typ value in parentheses):	Rate 7/8 (16-QAM) Guaranteed Eb/No (typ value in parentheses):
	BER=10 ⁻⁵	4.3 dB (4.0 dB)	7.0 dB (6.6 dB)	8.1 dB (7.7 dB)
	BER=10 ⁻⁸	4.5 dB (4.2 dB)	7.2 dB (6.8 dB)	8.3 dB (7.9 dB)
TURBO PRODUCT CODEC BER Rate 0.95 QPSK Rate 0.95 8-PSK BER (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	Rate 0.95 (Q, OQ) Guaranteed Eb/No (typ value in parentheses):	Rate 0.95 (8-PSK) Guaranteed Eb/No (typ value in parentheses):	
	BER=10 ⁻⁶	6.4 dB (6.0 dB)	9.3 dB (8.9 dB)	
	BER=10 ⁻⁷	6.7 dB (6.3 dB)	9.8 dB (9.4 dB)	
	BER=10 ⁻⁸	6.9 dB (6.5 dB)	10.3 dB (9.9 dB)	
16-QAM VITERBI/RS BER (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	16-QAM Rate 3/4 Viterbi/RS Guaranteed Eb/No (typ value in parentheses):	16-QAM Rate 7/8 Viterbi/RS Guaranteed Eb/No (typ value in parentheses):	
	BER=10 ⁻⁶	8.1 dB (7.5 dB)	9.5 dB (9.0 dB)	
	BER=10 ⁻⁸	8.6 dB (8.0 dB)	10.1 dB (9.5 dB)	

LDPC CODEC BER Rate 1/2 B/Q/OQPSK Rate 2/3 Q/OQPSK Rate 1/2 Q/OQPSK (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	BPSK/QPSK/OQPSK Rate 1/2 LDPC Guaranteed Eb/No (typ value in parentheses):	QPSK/OQPSK Rate 2/3 LDPC Guaranteed Eb/No (typ value in parentheses):	QPSK/OQPSK Rate 3/4 LDPC Guaranteed Eb/No (typ value in parentheses):
	BER=10 ⁻⁵	2.0 dB (1.7 dB)	2.3 dB (2.0 dB)	3.0 dB (2.6 dB)
	BER=10 ⁻⁹	2.3 dB (2.0 dB)	2.7 dB (2.3 dB)	3.3 dB (3.0 dB)
LDPC CODEC BER Rate 2/3 8-PSK Rate 3/4 8-PSK (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	8-PSK Rate 2/3 LDPC Guaranteed Eb/No (typ value in parentheses):	8-PSK Rate 3/4 LDPC Guaranteed Eb/No (typ value in parentheses):	
	BER=10 ⁻⁵	---	5.7 dB (5.3 dB)	
	BER=10 ⁻⁹	5.7 dB (5.2 dB)	6.0 dB (5.6 dB)	
LDPC CODEC BER Rate 2/3 8-QAM Rate 3/4 8-QAM (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	8-QAM Rate 2/3 LDPC Guaranteed Eb/No (typ value in parentheses):	8-QAM Rate 3/4 LDPC Guaranteed Eb/No (typ value in parentheses):	
	BER=10 ⁻⁵	4.6 dB (4.2 dB)	5.2 dB (4.7 dB)	
	BER=10 ⁻⁹	5.0 dB (4.6 dB)	5.7 dB (5.3 dB)	
LDPC CODEC BER Rate 3/4 16-QAM (With two adjacent carriers, each 7 dB higher than the desired carrier)	For:	16-QAM Rate 3/4 LDPC Guaranteed Eb/No (typ value in parentheses):		
	BER=10 ⁻⁵	6.8 dB (6.2 dB)		
	BER=10 ⁻⁹	7.1 dB (6.8 dB)		
CDM-600L ONLY:				
Rx Level Monitor	± 5 dB accuracy vs. frequency, temperature, and level			
Input Composite Power:	+30 dBc within 10 MHz of desired. Each adjacent carrier is like modulated and ≤ 7 dBc relative to neighboring carrier.			
Maximum Composite Operating Level	+40 dBc with respect to Rx signal. Total carrier power within the symbol rate BW at 1/2 the desired carrier frequency ≤10 dBc relative to the desired carrier power.			
Absolute Maximum No Damage	-5 dBm maximum			
Input Connector	Type F Female @ 75Ω, Type N Female @ 50 Ω			
Input Return Loss	≥ 10 Db			
LNB 10 MHz Reference	On center conductor of L-Band input connector, selectable ON/OFF. Level -3 ± 3 dBm. Source: 1. Internal modem reference 2. External reference Performance: For phase noise, refer to L-Band modulator 10 MHz. Frequency stability same as the modulator 10 MHz reference.			
LNB Voltage	On center conductor of L-Band input connector, selectable ON/OFF, 13, 18 volts per DiSEq 4.2 and 24VDC at 500 mA maximum.			
LNB Current Alarm	Programmable MIN and MAX current alarms.			

CDM-600/600L Demodulator Carrier Level (vs) Symbol Rate



1.5.3 Data Interfaces

Primary Data (3 selectable modes)	RS-422/RS-530 DCE (Rates up to 10 Mbps) (also supports X.21 DCE & DTE and 8k ESC orderwire for IDR) V.35 DCE (Rates up to 10 Mbps) Synchronous RS-232 (Rates up to 300 kbps) LVDS serial (Rates up to 20 Mbps) HSSI - Requires optional CIC-20 Converter (Rates up to 20 Mbps)	25-pin D-sub (female)
G.703 (Tx In, Drop Out, Insert In, Rx Out)	1.544 Mbps T1 (Balanced 100 Ω) 6.312 Mbps T2 (unbalanced 75 Ω or balanced 110 Ω) 2.048 Mbps E1 (unbalanced 75 Ω or balanced 120 Ω) 8.448 Mbps E2 (unbalanced 75 Ω) Note: All Drop and Insert modes are a FAST option.	15-pin D-sub (female) or BNC (female)
External Reference In	2.4 kHz – 10 MHz, in 1 Hz steps (locks baseband clocks only) TTL level (unbalanced) or sine wave @ 0dBm nominal	BNC (female)
Overhead Data	RS-422 octet clocks for IDR ESC & IBS RS-422 IDR 64 kbps ESC data & clock RS-232 IBS ESC data & clock RS-422 External Clock input IDR BWA Inputs RS-232 High Rate ESC data (with IBS FAST) RS-232 ESC++ data (with Firmware Ver. 1.3.0 or higher)	25-pin D-sub (male)
Modem Alarms	Relay outputs (Tx, Rx & unit faults) Demodulator I & Q test outputs (constellation) Demodulator Rx Signal Level output (0 to 2.5 volts) External carrier off input	15-pin D-sub (male)
IDR BWA Outputs	4 backward alarm Form C relay outputs	15-pin D-sub (female)
Remote Control	RS-232 or RS-485 modem control and monitoring	9-pin D-sub (male)
ADPCM Audio Interface	2 audio channels, each occupying 32 kbps bandwidth as part of IDR overhead or as a 64 kbps primary data rate option. 600 Ω balanced – 0 dBm0 nominal, -6 to +8 dB, 2 dB steps	9-pin D-sub (female)
Auxiliary Serial	RS-232 link to other modem in 1:1 pair, via CRS-150	USB Type B Socket

1.5.4 Automatic Uplink Power Control (AUPC)

Operating Mode	Requires Closed Network Framed mode for transport of Eb/No information from remote modem (EDMAC can be enabled or disabled)
Target Eb/No range	0 to 14.9 dB at remote demod (default is 4.0 dB)
Max AUPC range	0 to 9 dB (default is 3 dB)
Monitor functions	Remote demod Eb/No and Tx power level increase (front panel or via remote control interface)

1.5.5 Data Rate Ranges

Code Rate/Modulation	FEC Type	Data Rate Range	Comments	
Uncoded BPSK	None	4.8 kbps to 10.0 Mbps		
Uncoded QPSK/OQPSK	None	9.6 kbps to 20 Mbps		
Rate 1/2 BPSK	Viterbi	2.4 kbps to 5.0 Mbps		
Rate 1/2 BPSK	Sequential	2.4 kbps to 1.024 Mbps		
Rate 1/2 BPSK	Viterbi with R-S	2.4 kbps to 4.444 Mbps		
Rate 1/2 BPSK	Sequential with R-S	2.4 kbps to 1.024 Mbps		
Rate 1/2 QPSK/OQPSK	Viterbi	4.8 kbps to 10.0 Mbps		
Rate 1/2 QPSK/OQPSK	Sequential	4.8 kbps to 2.048 Mbps		
Rate 1/2 QPSK/OQPSK	Viterbi with R-S	4.8 kbps to 8.888 Mbps		
Rate 1/2 QPSK/OQPSK	Sequential with R-S	4.8 kbps to 2.048 Mbps		
Rate 3/4 QPSK/OQPSK	Viterbi	7.2 kbps to 15 Mbps		
Rate 3/4 QPSK/OQPSK	Sequential	7.2 kbps to 2.048 Mbps		
Rate 3/4 QPSK/OQPSK	Viterbi with R-S	7.2 kbps to 13.333 Mbps		
Rate 3/4 QPSK/OQPSK	Sequential with R-S	7.2 kbps to 2.048 Mbps		
Rate 7/8 QPSK/OQPSK	Viterbi	8.4 kbps to 17.5 Mbps		
Rate 7/8 QPSK/OQPSK	Sequential	8.4 kbps to 2.048 Mbps		
Rate 7/8 QPSK/OQPSK	Viterbi with R-S	8.4 kbps to 15.555 Mbps		
Rate 7/8 QPSK/OQPSK	Sequential with R-S	8.4 kbps to 2.048 Mbps		
Rate 2/3 8-PSK	TCM	9.6 kbps to 20.0 Mbps		
Rate 2/3 8-PSK	TCM with R-S	9.6 kbps to 17.777 Mbps		
Rate 3/4 16-QAM	Viterbi with R-S	14.4 kbps to 20.0 Mbps		
Rate 7/8 16-QAM	Viterbi with R-S	16.8 kbps to 20.0 Mbps		
Rate 21/44 BPSK	TPC	4.8 kbps to 3.2 Mbps	To 4.77 Mbps with High Rate Turbo card	
Rate 5/16 BPSK	TPC	4.8 kbps to 2.048 Mbps	To 3.12 Mbps with High Rate Turbo card	
Rate 3/4 QPSK/OQPSK	TPC	7.2 kbps to 5.0 Mbps	To 15 Mbps with High Rate Turbo card	
Rate 3/4 8-PSK	TPC	10.8 kbps to 5.0 Mbps	To 20 Mbps with High Rate Turbo card	
Rate 3/4 16-QAM	TPC	14.4 kbps to 5.0 Mbps	To 20 Mbps with High Rate Turbo card	
Rate 1/2 QPSK/OQPSK	TPC	4.8 kbps to 9.54 Mbps	High Rate Turbo card only	
Rate 7/8 QPSK/OQPSK	TPC	8.4 kbps to 17.5 Mbps		
Rate 0.95 QPSK/OQPSK	TPC	9.1 kbps to 18.888 Mbps		
Rate 7/8 8-PSK	TPC	12.6 kbps to 20 Mbps		
Rate 0.95 8-PSK	TPC	13.6 kbps to 20 Mbps		
Rate 7/8 16-QAM	TPC	16.8 kbps to 20 Mbps		
Rate 1/2 BPSK	LDPC	2.4 kbps to 5.0 Mbps		CDM-600L: TPC/LDPC codec only
Rate 1/2 QPSK/OQPSK	LDPC	4.8 kbps to 10.0 Mbps		
Rate 2/3 QPSK/OQPSK	LDPC	6.4 kbps to 13.333 Mbps		
Rate 3/4 QPSK/OQPSK	LDPC	7.2 kbps to 15.0 Mbps		
Rate 2/3 8-PSK/8-QAM	LDPC	9.6 kbps to 19.0 Mbps		
Rate 3/4 8-PSK/8-QAM	LDPC	10.8 kbps to 20.0 Mbps		
Rate 3/4 16-QAM	LDPC	14.4 kbps to 20.0 Mbps		

Important Notes:

1. If EDMAC framing is employed, the upper data rate will be reduced by 5% for data rates up to 2.048 Mbps, and by 1.58% for data rates above 2.048 Mbps)
2. If ESC++ framing is employed, the upper data rate will be reduced 1.58%.

1.5.6 Framing Summary

	Transparent	EDMAC	IDR	IBS	D&I	D&I++	ESC++
Overhead added	None	To 2 Mbps: 1.5% Above 2 Mbps: 1.5% (see Note 2)	Fixed 96 kHz	1/15 of front panel data rate	1/15 of front panel data rate Terrestrial is T1 or E1	1/45 of front panel data rate Terrestrial is T1 or E1	Variable: between 11.76% at 64 kbps to 1.58% above 7 Mbps
Available data rates and format	All rates and formats	All rates and formats	T1, E1, T2 and E2; all formats	64 to 2048 kbps only; all formats	Specific multiples of 64 kbps only	Any multiple of 64 kbps, up to n=24.	All rates and formats
Overhead components	None	Remote control link between modems' processor plus AUPC	RS-422 ESC (8 kbps) RS-422 ESC (64 kbps or 2 audio links) 4 BW alarms	RS-232 Earth station link at 1/480 th of primary data rate One BW alarm	RS-232 Earth station link at 1/480 th of primary data rate One BW alarm	Same as EDMAC, plus RS-232 Earth station link at 1/576 th of primary data rate	RS-232 Earth station link at variable rate, plus AUPC
Additional Reed-Solomon Overhead	200/180 219/201 for IESS-310 mode	200/180	T1 = 225/205 E1 = 219/201 and IESS-310 mode T2/E2 = 94/178	126/112 219/201 for IESS-310 mode	126/112 219/201 for IESS-310 mode	126/112	126/112
Scrambling (see Note 1)	Basic ITU V.35 (Intelsat)	Proprietary scrambler	Basic ITU V.35 (Intelsat)	IESS-309 scrambler	IESS-309 scrambler	Basic ITU V.35 (Intelsat)	Proprietary scrambler

Important Notes:

1. If EDMAC framing is employed, the upper data rate will be reduced by 5% for data rates up to 2.048 Mbps, and by 1.58% for data rates above 2.048 Mbps).
2. If ESC++ framing is employed, the upper data rate will be reduced 1.58%.

1.5.7 Miscellaneous

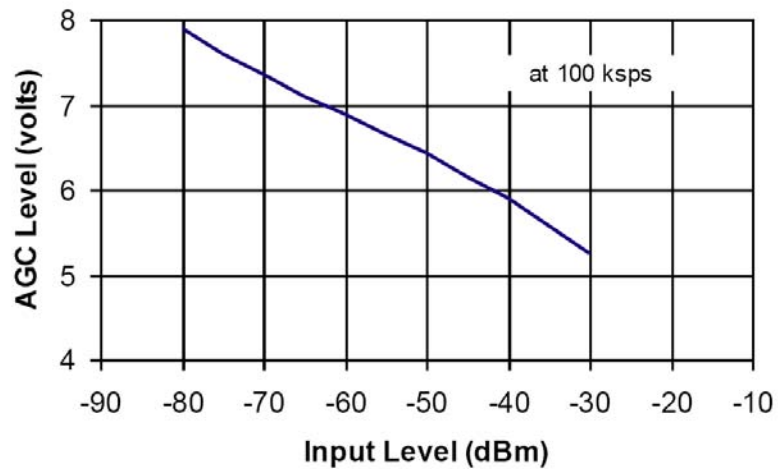
Front panel	Tactile keypad, 6 keys (Up/Down, Left/Right, Enter/Clear) Vacuum Fluorescent Display (blue) - 2 lines of 40 characters
Loopbacks	Internal IF loopback, RF loopback, digital loopback, and inward/outward loopback
Fault relays	Hardware fault, RX and TX Traffic Alarms, Open Network Backward Alarms Type: Form C Contacts. Rating: Less than ± 15 volts up to 1 Amp
M&C Interface	RS-232 and RS-485 (addressable multidrop, 2-wire or 4-wire)
M&C Software	SatMac or CMCS software for control of local and distant units
Dimensions	CDM-600L: 1RU high, 18 inches (457mm) deep CDM-600: 1RU high, 13.1 inches (333mm) deep
Weight	10 lbs (4.5 kgs) max
AC consumption	CDM-600L: 220V 50 Hz without BUC power supply – Power factor = 0.46, 130 VA, 60 Watts 120V 60 Hz without BUC power supply – Power factor = 0.64, 85 VA, 55 Watts 290 watts (maximum) with BUC power supply CDM-600: 25 watts (typical) 55 watts (maximum)
Operating voltage	100 - 240 volts AC, +6%/-10% - autosensing (total absolute max. range is 90 - 254 volts AC) Optional 38-60 volts DC
Operating temperature	0 to 50°C (32 to 122°F)

1.5.8 Approvals

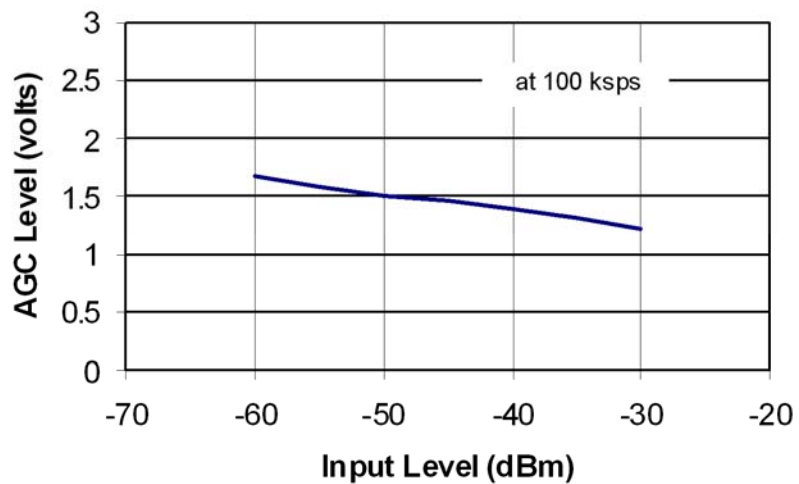
“CE” as follows:	EN 55022 Class B (Emissions) EN 5082-1 (Immunity) EN 60950 (Safety)	EN 61000-3-2 EN 61000-3-3 EN 61000-4-2 EN 61000-4-4 EN 61000-4-5	EN 61000-4-6 EN 61000-4-8 EN 61000-4-9 EN 61000-4-11 EN 61000-4-13
FCC	FCC Part 15 Class B		

1.5.9 AGC Voltage

These charts are provided for reference only:



CDM-600L AGC Voltage



CDM-600 AGC Voltage

Chapter 2. INSTALLATION

2.1 Unpacking

The CDM-600/600L Satellite Modem and its Installation and Operation Manual are packaged and shipped in a pre-formed, reusable cardboard carton containing foam spacing for maximum shipping protection.



Do not use any cutting tool that extends more than 1” into the container and cause damage to the unit.



Be sure to keep all shipping materials for the carrier's inspection.

Unpack and inspect the CDM-600/600L as follows:

Step	Procedure
1	Inspect shipping containers for damage. If shipping containers are damaged, keep them until the contents of the shipment have been carefully inspected and checked for normal operation.
2	Remove the packing list from the outside of the shipping carton.
3	Open the carton by cutting the tape at the top of the carton (indicated by OPEN THIS END).
4	Remove the cardboard/foam space covering the modem. Remove the modem, manual and power cord from the carton.
5	Check the contents against the packing list to verify completeness of the shipment.
6	Inspect the equipment for any possible damage incurred during shipment. If damage is evident, contact the carrier and Comtech EF Data immediately and submit a damage report.
7	Refer to the following sections for further installation instructions.

2.2 Mounting

If the CDM-600/600L is to be mounted in a rack, ensure that there is adequate clearance for ventilation, particularly at the sides. In rack systems where there is high heat dissipation, forced air cooling must be provided by top or bottom mounted fans or blowers. Under no circumstance should the highest internal rack temperature be allowed to exceed 50°C (122°F).



The CDM-600/600L CANNOT have rack slides mounted to the side of the chassis. Two cooling fans are installed in the right-hand side of the unit. Comtech EF Data therefore recommends that an alternate method of support, such as rack shelves, is employed within the rack. If there is any doubt, please consult the Comtech EF Data Customer Support department.

2.2.1 Optional Rear-Mounting Support Brackets

Install optional rear-mounting support brackets using mounting kit KT/6228-2:

Quantity	Part Number	Description
2	HW/10-32SHLDR	Screw, #10 Shoulder
4	HW/10-32FLT	Washer, #10 Flat
2	HW/10-32SPLIT	Washer, #10 Split
2	HW/10-32HEXNUT	Nut, #10 Hex
2	FP/6138-1	Bracket, Rear Support
4	HW/10-32x1/2RK	Bolt, #10 Rack Bracket

The tools required for this installation are a **medium Phillips™ screwdriver** and a **5/32-inch SAE Allen™ Wrench**. The kit is installed as illustrated in **Figure 2-1** via the following procedure:

Step	Procedure
1	Secure the #10 shoulder screws to the unit chassis through the rear right and left side mounting slots, using the #10 flat washers, #10 split washers, and #10 hex nuts as shown.
2	Install the rear support brackets onto the equipment rack threaded rear mounting rails, using the #10 rack bracket bolts.
3	Mount the unit into the equipment rack, ensuring that the shoulders of the #10 shoulder screws properly engage into the rear support bracket slots.

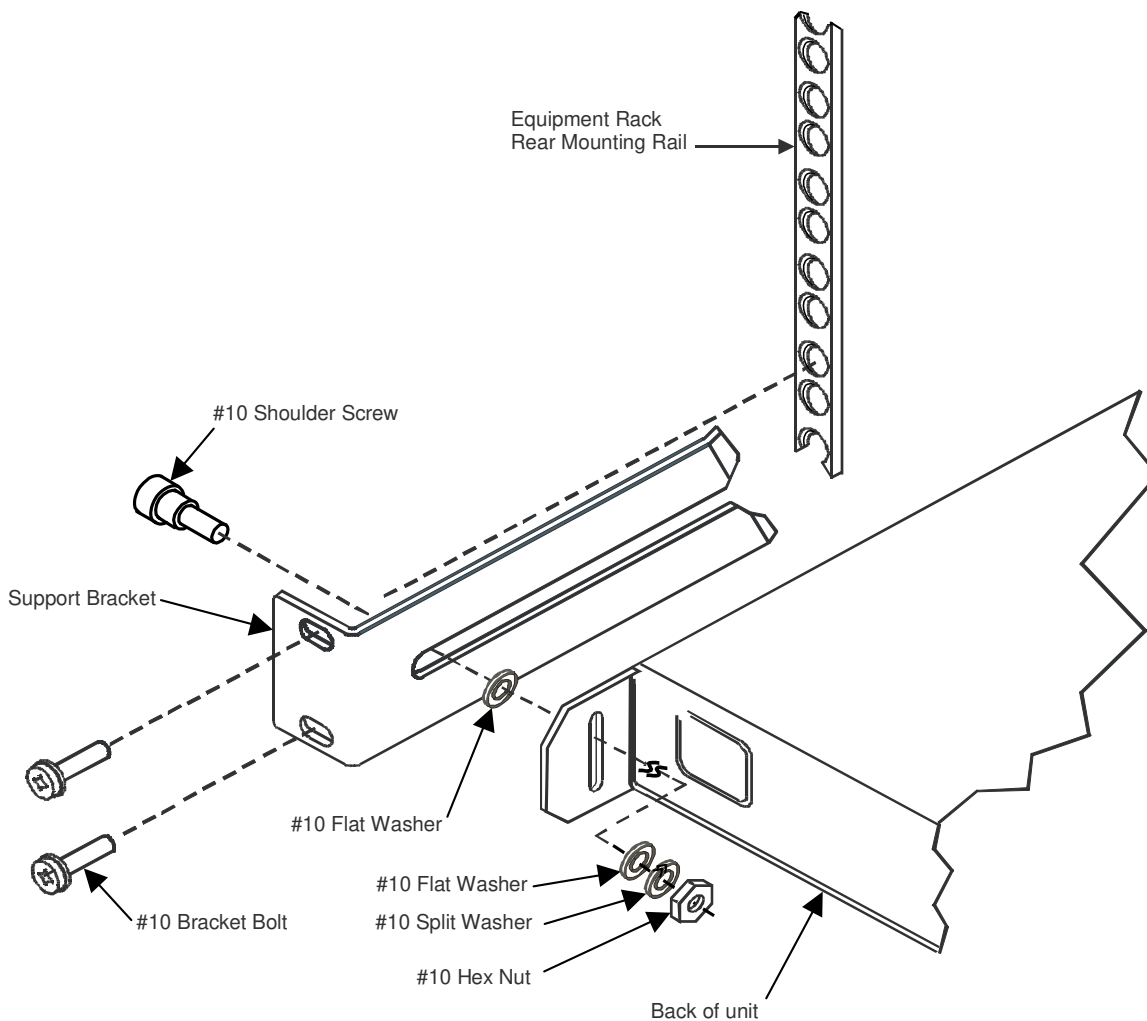


Figure 2-1. Optional Rear-Mounting Support Brackets Installation

2.3 Configuration

The unit ships with a default 64 kbps, QPSK, Rate 1/2 configuration. There are no internal jumpers to configure, no interface cards to install, and no other options to install: *all configurations are carried out entirely in software.*

The unit should first be configured locally, using the front panel keypad and display. Refer to **Chapter 5. FRONT PANEL OPERATION** for details on how to fully configure the unit for the desired operating parameters.

Note: The auto-sensing AC power supply does not require any adjustments. Simply plug in the supplied line cord, and turn on the switch on the rear panel.

2.4 Select Internal IF Loop

Correct operation of the unit may be verified rapidly, without the need for externally connected equipment. From the top level menu, select **TEST**, then **IF LOOP** (refer to **Chapter 5. FRONT PANEL OPERATION**). The demod should synchronize, and the green RECEIVE TRAFFIC LED should illuminate. If the unit does not pass this test, call Comtech EF Data Customer Support for assistance.

2.5 Connect External Cables

Having verified correct operation in IF loop, enter the desired configuration, and proceed to connect all external cables to the connectors outlined in the next chapter (**Chapter 3. REAR PANEL CONNECTOR PINOUTS**). Should difficulties occur, call Comtech EF Data Customer Support for assistance.

For the CDM-600: Note that the modulator gives an output power level in the range 0 to -20 dBm, and the demodulator expects to see a signal in the range -30 to -60 dBm.

For the CDM-600L: Note that the modulator gives an output power level in the range 0 to -40 dBm, and the demodulator expects to see a signal in the range $-130 + 10\log(\text{symbol rate})$ dBm to $-130 + 10\log(\text{symbol rate}) + 50$ dBm.



The CDM-600L includes an internal programmable 13, 18, or 24V LNB power supply at the receive IF connector, and optionally includes a 24 or 48V BUC power supply at the transmit IF connector. These power supply outputs are user-configurable from the front panel or remote control for ON/OFF state. Use appropriate DC blocks for external test equipment or other devices subject to damage by high DC voltage, or alternatively, assure that these power supply outputs are turned OFF before connecting DC sensitive external devices.

Chapter 3. REAR PANEL CONNECTOR PINOUTS

3.1 Connector Overview

The CDM-600/600L Satellite Modem rear panel connectors, shown here in **Figure 3-1**, provide all necessary external connections between the modem and other equipment. On the next page, **Table 3-1** summarizes the connectors provided on the rear panel interface, grouped according to service function.

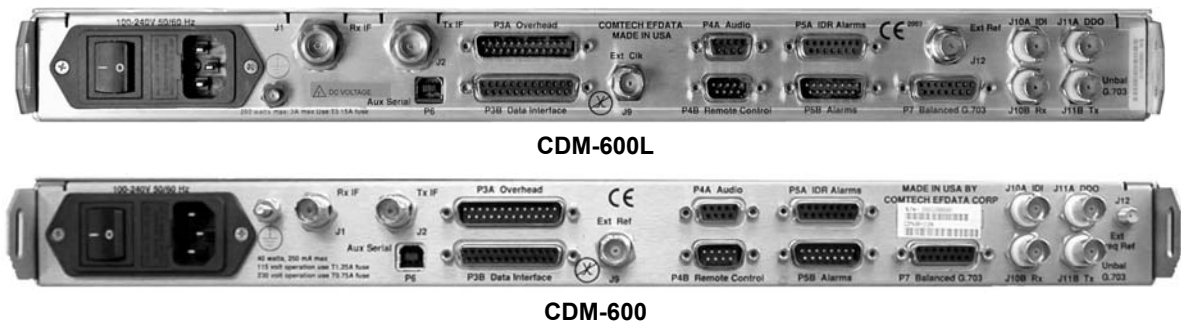


Figure 3-1. CDM-600/600L Rear Panel

Table 3-1. Rear Panel External Connections

Connector Group (Chapter 3 Sect. Ref.)	Ref Des / Name	Connector Type	Function	
IF (Sect. 3.2)	J1 Rx	CDM-600L: Type 'N' female (L-Band)	IF Input	
		CDM-600: BNC female (70/140MHz band)		
	J2 Tx	CDM-600L: Type 'N' female (L-Band)	IF Output	
		CDM-600: BNC female (70/140MHz band)		
Terrestrial Data (Sect. 3.3)	P3A Overhead		Intelsat overhead – 64kbps RS-422, 1/16 IBS overhead ESC @RS-232; IDR backward alarm	
	P3B Data Interface		Serial synchronous data Input/Output	
	P4A Audio		ADPCM audio Input/Output	
	G.703 Data	P7 Balanced	15-pin Type 'D' female	G.703 Balanced T1 (1.544 Mps) / E1 (2.048 Mbps) / T2 (6.312 Mbps)
		J10A IDI	BNC 75Ω female	Insert Data In – G.703 Unbalanced E1 (2.048 Mbps)
		J11A DDO	BNC 75Ω female	Drop Data Out – G.703 Unbalanced E1 (2.048 Mbps)
		J10B Rx	BNC 75Ω female	G.703 Unbalanced E1 (2.048 Mbps) Rx
J11B Tx	BNC 75Ω female	G.703 Unbalanced E1 (2.048 Mbps) Tx		
Utility (Sect. 3.4)	P6 Aux Serial		USB Type 'B' female	RS-232 Serial Remote interface for 1:1 Redundant operations
	J9	CDM-600L: Ext Clk	BNC 50Ω female	External Clock Input
		CDM-600: Ext Ref		External Baseband Input
	P4B Remote Control		9-pin Type 'D' male	Serial Remote Interface (RS-232/-485)
	P5A IDR Alarms		15-pin Type 'D' female	Form C Alarms (backward alarm outputs)
	P5B Alarms		15-pin Type 'D' male	Form C Alarms (relay closures)
	J12	CDM-600L: Ext Ref	BNC 50Ω female	External reference for modem synthesizers
		CDM-600: Ext Freq Ref	SMA female	High-stability External Reference (optional)
Power/Ground (Sect 3.5)	AC		Chassis power	
	DC (Opt., CDM-600L only)			
	Ground		#10-32 stud	Common Chassis Ground

3.2 IF Connections

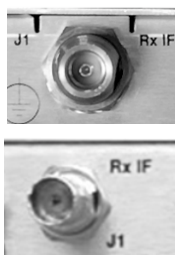
CDM-600L: The J1 Rx IF connector is either a 50Ω Type ‘N’ female or a 75Ω Type ‘F’ female. The J2 Tx connector is a 50Ω Type ‘N’ female.



There may be DC voltages present on the Type ‘N’ Rx and Tx IF connectors, up to a maximum of 48 volts.

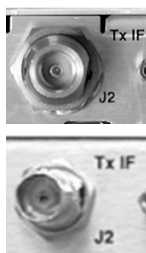
CDM-600: The J1 Rx and J2 Tx IF port connectors are both 50Ω Type ‘BNC’ female. 75Ω cable connectors (male) will have no problem mating with this 50Ω type. The electrical impedance presented by these connectors is controlled internally by an RF-switching arrangement. This selection between 50Ω and 75Ω is controlled either via the front panel menus, or via the remote control bus.

3.2.1 J1 Rx IF Connectors



Connector Type	Description	Direction
CDM-600L: 50Ω Type ‘N’ or 75Ω Type ‘F’ (Shown at top)	Rx IF signal, L- Band	In
CDM-600: 50Ω BNC (Shown at bottom)	Rx IF signal, 70/140 MHz band	

3.2.2 J2 Tx IF Connectors



Connector Type	Description	Direction
CDM-600L: 50Ω Type ‘N’ (Shown at top)	Tx IF signal, L- Band	Out
CDM-600: 50Ω BNC (Shown at bottom)	Tx IF signal, 70/140 MHz band	

3.3 Terrestrial Data Connections

3.3.1 P3A Overhead Data Connector, DB-25M



The 25-pin 'D' Type male (DB-25M) P3A Overhead data connector is used for passing components of Intelsat specified overhead frame structures. These include 64 kbps RS-422 and 1/16 IBS overhead ESC at RS-232. The IDR backward alarm inputs are found on this connector.

P3A Overhead Interface Connector (DB-25M)			
Pin #	Signal Function	Signal Name	Direction
14	IDR 64 kbps ESC TX Data +	TX-422DAT-B	In
2	IDR 64 kbps ESC TX Data -	TX-422DAT-A	In
12	IDR 64 kHz ESC TX Clock +	TX-422CLK-B	Out
15	IDR 64 kHz ESC TX Clock -	TX-422CLK-A	Out
11	IDR 1 kHz TX Octet Clock +	TX-OCT-B	Out
24	IDR 1 kHz TX Octet Clock -	TX-OCT-A	Out
16	IDR 64 kbps ESC RX Data +	RX-422DAT-B	Out
3	IDR 64 kbps ESC RX Data -	RX-422DAT-A	Out
9	IDR 64 kHz ESC RX Clock +	RX-422CLK-B	Out
17	IDR 64 kHz ESC RX Clock -	RX-422CLK-A	Out
19	IDR 1 kHz RX Octet Clock +	RX-OCT-B	Out
4	IDR 1 kHz RX Octet Clock -	RX-OCT-A	Out
20	Balanced Ext. Ref. Clock +	EXT-CLK-B	In
23	Balanced Ext. Ref. Clock -	EXT-CLK-A	In
13	IBS ESC RS232 TX Data	TX-232-DATA	In
22	IBS ESC RS232 TX Clock	TX-232-CLK	Out
8	IBS ESC RS232 RX Data	RX-232-DATA	Out
10	IBS ESC RS232 RX Clock	RX-232-CLK	Out
5	IBS TX High-Rate ESC Data	TX-ASYNC	In
6	IBS RX High-Rate ESC Data	RX-ASYNC	Out
1	IDR Back Alarm 1 H/W input	BW-IN1	In
18	IDR Back Alarm 2 H/W input	BW-IN2	In
21	IDR Back Alarm 3 H/W input	BW-IN3	In
25	IDR Back Alarm 4 H/W input	BW-IN4	In
7	Signal Ground	Ground	--

3.3.2 P3B Data Interface Connector, DB-25F



The 25-pin 'D' Type female (DB-25F) P3B Data Interface connector conducts data input and output signals to and from the modem, and connects to customer's terrestrial equipment, breakout panel, or protection switch. It conforms to the RS-530 pinout, which allows for connection of different electrical standards, including RS-422, V.35, and RS-232. A shielded 25-pin 'D' type connection provides a very solid solution to EMC problems, unlike the sometimes-used V.35 Winchester connector.



It is the User's responsibility to provide the appropriate cables to connect to this RS-530 connector.

P3B Data Interface Connector (DB-25F)						
Pin #	Generic Signal Description	Direction	RS-422 RS-530 LVDS	V.35	RS-232	Circuit #
2	TX Data A	DTE to Modem	SD A	SD A	BA	103
14	TX Data B	DTE to Modem	SD B	SD B	--	103
24	TX Clock A	DTE to Modem	TT A	SCTE A	DA	113
11	TX Clock B	DTE to Modem	TT B	SCTE B	--	113
15	INT TX Clock A	Modem to DTE	ST A	SCT A	DB	114
12	INT TX Clock B	Modem to DTE	ST B	SCT B	--	114
3	RX Data A	Modem to DTE	RD A	RD A	BB	104
16	RX Data B	Modem to DTE	RD B	RD B	--	104
17	RX Clock A	Modem to DTE	RT A	SCR A	DD	115
9	RX Clock B	Modem to DTE	RT B	SCR B	--	115
8	Receiver Ready A	Modem to DTE	RR A	RLSD *	CF	109
10	Receiver Ready B	Modem to DTE	RR B	--	--	109
23	External Carrier Off (RS-232 '1' or TTL 'low')	DTE to Modem	--	--	--	--
7	Signal Ground	--	SG	SG	AB	102
1	Shield	--	Shield	FG	AN	101

Notes:

1. Receiver Ready is an RS-232 -level control signal on a V.35 interface
2. **DO NOT** connect signals to pins which are not shown - these pins are reserved for use by the redundancy system
3. 'B' signal lines are not used for RS-232 applications
4. For X.21 operation, use the RS-422 pins, but ignore RX Clock if the Modem is DTE, and ignore TX clocks if the Modem is DCE
5. For IDR operation using G.703, this primary interface becomes the 8 kbps RS-422 overhead channel.

3.3.3 P4A Audio Connector, DB-9F



The 9-pin 'D' Type female (DB-9F) P4A Audio connector is used for the two 32 kbps ADPCM audio inputs and outputs (600Ω transformer coupled, balanced signals). These can be used for both ESC voice circuits in IDR mode, or as the primary data (**FAST** option).

P4A Audio Connector (DB-9F)		
Pin #	Signal Function	Direction
1	Tx Audio 1 +	In
6	Tx Audio 1 -	In
2	Rx Audio 1 +	Out
7	Rx Audio 1 -	Out
8	Tx Audio 2 +	In
4	Tx Audio 2 -	In
9	Rx Audio 2 +	Out
5	Rx Audio 2 -	Out
3	Common	

3.3.4 G.703 Connectors

3.3.4.1 P7 Balanced G.703 Interface Connector, DB-15F



The 15-pin 'D' Type female (DB-15F) P7 Balanced G.703 connection is used for balanced operation at the G.703 data rates of T1 (1.544 Mbps), E1 (2.048 Mbps), or T2 (6.312 Mbps).

P7 Balanced G.703 Interface Connector (DB-15F)			
Pin #	Signal Function	Name	Direction
1*	Drop Data Input (-)	DDI-	In
9*	Drop Data Input (+)	DDI+	In
2	Ground	GND	
10	Not Used		
3*	Insert Data Output (-)	IDO-	Out
11*	Insert Data Output (+)	IDO+	Out
4	Ground	GND	
12	Drop Data Output (-)	DDO-	Out
5	Drop Data Output (+)	DDO+	Out
13	Insert Data Input (-)	IDI-	In
6	Insert Data Input (+)	IDI+	In
14	Not Used		
7	Not Used		
15	Not Used		
8	Not Used		

*Use for all non-Drop and Insert and T2/E2 balanced applications.

3.3.4.1.1 T1/E1 RJ-48 Connection via P7 Balanced G.703 Interface Connector

For T1/E1 operation via RJ-48 user interface, the optional CN-0000268 Adapter, shown in **Figure 3-2**, may be purchased from Comtech EF Data to adapt the P7 Balanced G.703 DB-15F connector to an RJ-48 female connection.

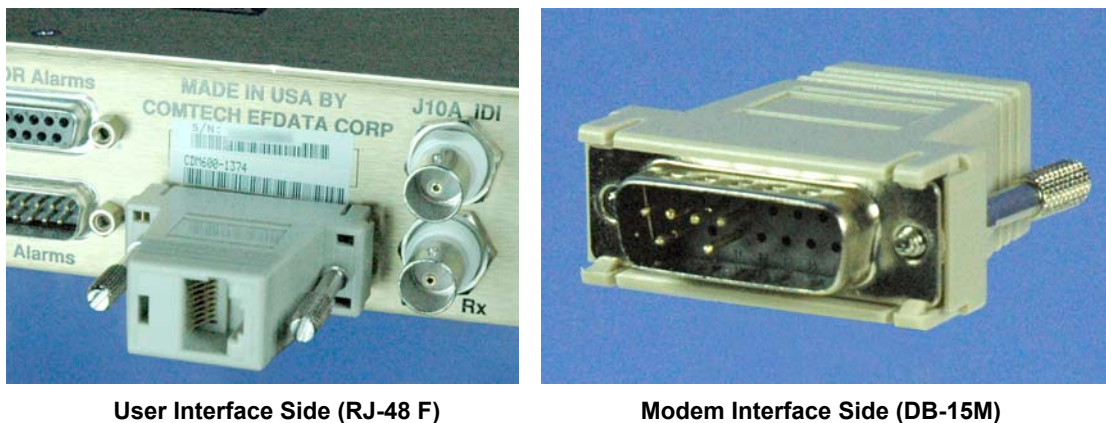


Figure 3-2. CN-0000268 DB-15M → RJ-48F Adapter for T1/E1 Operation

The pin assignments for the user and modem sides of the CN-0000268 Adapter are as follows:

Pin #		Signal Name
RJ-48 (User Side)	DB-15M (Modem Side)	
1	9	Tx+
2	1	Tx-
3	2	GND
4	11	Rx+
5	3	Rx-
6	4	GND
7	--	--
8	--	--

3.3.4.2 J10A IDI, J11A DDO Connectors, 75Ω BNC



Two female BNC 75Ω connectors are provided for Drop and Insert (D&I) unbalanced operation at the G.703 data rate of E1 (2.048 Mbps). These are the Insert Data In (IDI) and Drop Data Out (DDO) ports.

Another function of these connectors is for **auxiliary** G.703 data paths operating at 512, 1024, and 2048 kbps. When these rates are selected, the IDI port is the TX terrestrial G.703 input and the DDO port is the RX G.703 output.

BNC Connector	Description	Direction
J10A IDI	Insert Data Input	In
J11B DDO	Drop Data Output	Out

3.3.4.3 J10B Rx and J11B Tx Unbalanced G.703 Connectors, 75Ω BNC



Two 75Ω BNC female connectors are provided for unbalanced operation at the G.703 data rates of E1 (2.048 Mbps), T2 (6.312 Mbps), or E2 (8448 kbps).

BNC Connector	Description	Direction
J10B Rx	Rx G.703 (Unbalanced E1)	Out
J11B Tx	Tx G.703 (Unbalanced E1)	In

3.4 Utility Connections

3.4.1 P6 Aux Serial Receptacle, USB Type 'B'



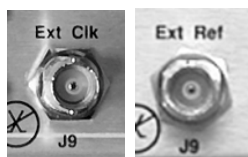
The USB Type 'B' P6 Aux Serial receptacle is an additional RS-232 serial port, which is only used when the modem is part of a 1:1 redundant pair.



Although this port uses a USB connector, the signals are not USB compatible. DO NOT connect this port to the USB port of a PC or other computing device.

P6 Aux Serial Receptacle (USB Type 'B')		
Pin #	Description	Direction
1	Ground	--
2	RS-232 TX Data	Out
3	RS-232 RX Data	In
4	Ground	--

3.4.2 J9 Ext Clk (CDM-600L) / Ext Ref (CDM-600), 50Ω BNC



This is 50Ω BNC female connector is used for operating the buffer with an external station clock for the CDM-600L, or an external station reference for the CDM-600. It requires an RS-422 compatible level, so this unbalanced input should have a zero volt offset and a swing of at least ±2V into the 120Ω termination provided.

Modem	BNC Connector	Description	Direction
CDM-600L	J9 Ext Clk	External Clock Input	In
CDM-600	J9 Ext Ref	External Baseband Input	In

3.4.3 P4B Remote Control Interface Connector, DB-9M



The 9-pin type 'D' male (DB-9M) P4B Remote Control connector is intended for connection to an M&C computer or terminal device. This interface is user selectable for either RS-232 or RS-485.

P4B Remote Control Interface (DB-9M)		
Pin #	Description	Direction
1	Ground	--
2	RS-232 Transmit Data	Out
3	RS-232 Receive Data	In
4	Reserved - do not connect to this pin	--
5	Ground	--
6	RS-485 Receive Data B *	In
7	RS-485 Receive Data A *	In
8	RS-485 Transmit Data B	Out
9	RS-485 Transmit Data A	Out

* Use for 2-wire RS-485 operation

3.4.4 P5A IDR Alarms Connector, DB-15F



The 15-pin Type 'D' female (DB-15F) P5A IDR Alarms interface connection provides four Form-C backward alarm outputs specified by Intelsat.

P5A IDR Alarms Connector (DB-15F)		
Pin #	Signal Function	Name
2	Backward Alarm 1 is active	BA-1-NO
9		BA-1-COM
1	Backward Alarm 1 is not active	BA-1-NC
10	TBD	MON-A
4	Backward Alarm 2 is active	BA-2-NO
11		BA-2-COM
3	Backward Alarm 2 is not active	BA-2-NC
6	Backward Alarm 3 is active	BA-3-NO
13		BA-3-COM
5	Backward Alarm 3 is not active	BA-3-NC
14	TBD	MON-B
8	Backward Alarm 4 is active	BA-4-NO
15		BA-4-COM
7	Backward Alarm 4 is not active	BA-4-NC
12	Ground	GND

3.4.5 P5B Alarms Connector, DB-15M



The 15-pin Type 'D' male (DB-15M) P5B Alarms connector provides the user with access to the Form-C relay contacts, which indicate the fault status of the unit. These are typically connected to an external fault monitoring system, often found in satellite earth stations. In addition, the receive I and Q demodulator samples are provided on this connector. Connecting these signals to an oscilloscope in X,Y mode will provide the receive signal constellation diagram, which is a useful diagnostic aid. A pin also is provided which can mute the transmit carrier. This requires that the pin be shorted to ground, or a TTL 'low', or an RS-232 'high' signal be applied.

As an aid to antenna pointing, or for driving step-track equipment, an analog AGC signal is provided on Pin 2 of this connector.

P5B Alarms Connector (DB-15M)		
Pin #	Signal Function	Name
8	RX Traffic (De-energized, Faulted)	RX-NC
15	RX Traffic (Energized, No Fault)	RX-NO
7	RX Traffic	RX-COM
14	TX Traffic (De-energized, Faulted)	TX-NC
6	TX Traffic (Energized, No Fault)	TX-NO
13	TX Traffic	TX-COM
5	Unit Fault (De-energized, Faulted)	UNIT-NC
12	Unit Fault (Energized, No Fault)	UNIT-NO
4	Unit Fault	UNIT-COM
11	RX I Channel (Constellation monitor)	RX-I
3	RX Q Channel (Constellation monitor)	RX-Q
10	No Connection	N/C
2	AGC Voltage (Rx signal level, 5 to 8 volts)	AGC
9	EXT Carrier OFF	EXT-OFF
1	Ground	GND

3.4.6 J12 Ext Ref (CDM-600L) / Ext Freq Ref (CDM-600)



CDM-600L: This 50Ω BNC female connector provides an external reference input for the Tx and Rx IF synthesizers, and for the internal transmit clock. The load impedance is 60.4Ω, so the VSWR is less than 1.25:1 at either 50Ω or 75Ω. Input level is 0 dBm minimum to +20 dBm maximum at 1, 2, 5, 10, or 20 MHz. When external reference is enabled, the internal 10 MHz reference oscillator is phase locked to the external reference input by a 10Hz bandwidth PLL. If no activity is present at the external reference input, the modem will revert to the internal 10 MHz reference.



CDM-600 (optional): This is optional SMA female connector is used to permit the connection of a high-stability external reference signal.

Modem	Connector	Connector Type	Description	Direction
CDM-600L	J12 Ext Ref	BNC	External Synthesizer Reference Input	In
CDM-600	J12 Ext Freq Ref	SMA	High-stability External Reference Input	In

3.5 Power / Ground Connections

3.5.1 Alternating Current (AC) Power Connector (Standard)



A standard Type 'IEC' detachable, non-locking, 3-prong power cord supplies the Alternating Current (AC) power to the modem.

Note the following:

AC Power Specifications	
Input Power	CDM-600L: 290W maximum, 55W typical without BUC power supply CDM-600: 40W maximum, 30W typical
Input Voltage	100-240 VAC, +6%/-10% - autosensing (total absolute max. range is 90-254 VAC)
Connector Type	IEC
Fuse Protection	CDM-600L: Line and neutral fusing 5.0A Slow-blow 20mm fuse CEFD P/N FS/5ASB-IEC (115 and 230 VAC operation) CDM-600: Line and neutral fusing T1.25A Slow-blow 20mm fuse (115 VAC operation) T0.75A Slow-blow 20mm fuse (230 VAC operation)



For continued operator safety, always replace the fuses with the correct type and rating.

3.5.2 Direct Current (DC) Power Connector (Optional, CDM-600L only)



This optional connector supplies the Direct Current (DC) power to the modem.

Note the following:

DC Power Specifications	
Input Power	250W maximum, 55W typical without BUC power supply
Input Voltage	38-60 VDC
Connector Type	Molex 03-12-1026 with 08-12-1222 terminals
Fuse Protection	T3.15A Slow-blow 20mm fuses without internal BUC power supply 8.0A Slow-blow 20 mm fuses with internal BUC power supply Positive and negative fusing



For continued operator safety, always replace the fuses with the correct type and rating.

3.5.3 Ground Connector



CDM-600L
LOCATION



CDM-600
LOCATION

A #10-32 stud is used for connecting a common chassis ground among equipment. The stud location differs between the CDM-600L and the CDM-600 chassis (see left).

Note: The AC power connector provides the safety ground.

Chapter 4. FLASH UPGRADING

4.1 Flash Updating via Internet

The CDM-600/600L Open Network Satellite Modem eliminates the need for updating firmware by physically replacing EPROMs. Instead, the CDM-600/600L uses 'Flash memory' technology internally. This makes software upgrading very simple, and updates can now be sent via the Internet (**Figure 4-1**), via E-mail, or on CD.

This chapter outlines the complete upgrading process as follows:

- New firmware can be downloaded via the Internet to an external PC.
- The upgrade can be performed without opening the CDM-600/600L by simply connecting the unit to the serial port of a computer.
- The firmware update is transferred, via File Transfer Protocol (FTP), to the CDM-600/600L.



Figure 4-1. Flash Update via Internet

4.2 Ethernet FTP Upload Procedure

1. **Identify** the reflashable product, firmware number, and version for download.

The current base modem M&C version can be viewed at the top level menu of the front panel display (press the **CLEAR** key several times to view). The firmware information can also be found within the **SELECT: UTIL → Firmware → Info → Image#1** or **Image#2** menu trees.

Using serial remote control, the firmware revision levels can be queried with the following commands:

Abbreviated: <0/SWR? or: Detailed: <0/FRW?

2. **Create** a temporary directory (folder) on an external PC.

Windows: Select **File > New > Folder**, then rename the New Folder to "temp" or another convenient, unused name. Assuming "temp" works, a "c:\temp" folder should now be created.

Note: The **c:** is the drive letter used in this example. Any valid writable drive letter can be used.

CMD Prompt: At the command prompt (c:\>), type "**mkdir temp**" or "**MD temp**" without quotes (**mkdir** and **MD** stand for *make directory*). This is the same as creating a new folder from Windows. There should now be a "c:\temp" subdirectory created (where **c:** is the drive letter used in the example).

3. **Download** the correct firmware file to this temporary folder.

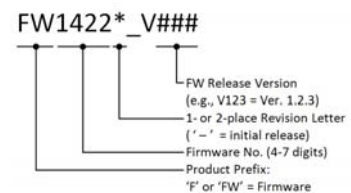
As shown in **Figure 4-1**:

1. **Go online** to: www.comtechefdata.com
2. **Click on:** *Support* tab
3. **Click on:** *Software Downloads* drop-down *or* hyperlink from *Support* page
4. **Click on:** *Download Flash and Software Update Files* icon
5. **Click on:** *(Select a Product Line) Satellite Modems* hyperlink
6. **Select** the **CDM-600/L** product hyperlink
7. **Select** the appropriate firmware hyperlink.

The current version firmware release is provided. If applicable, a minimum of one version prior to the current release is also available. Be sure to identify and download the desired version. The downloadable files are stored in two formats: *.exe (self-extracting) and *.zip (compressed). Some firewalls will not allow the downloading of *.exe files. In this case, download the *.zip file instead.

For additional help with "zipped" file types, refer to *PKZIP for Windows*, *WinZip*, or *ZipCentral* help files. *PKZIP for DOS* is not supported due to file naming conventions.

About Firmware Numbers, File Versions, and Formats: The flashable files on the download server are organized by product prefix; firmware number (verify that the correct firmware number is known – see Step 1); revision letter, if applicable; and release version. Where the asterisk is the 1- or 2-place revision letter and V### represents the firmware version: The bulk firmware for the CDM-600 is FW1422*_V###, while FW1451*_V### is the bulk firmware for the CDM-600L.



4. **Unzip** the files in the temporary folder on the PC. At least four files should be extracted (a CDM-600L firmware download shown in this example):

Name	Type
Release Notes FWC1451Y_v150.pdf	Adobe Acrobat Document
Flash600_v27.exe	Application
Fwc1451y.ccc	CCC File
CCCflash.hlp	Help File


- **Release Notes FWCXXXX*_v###.pdf** (or a variation of that filename): where “v###” denotes the firmware version.
 - **Flash600_v27.exe**: CEFD Flash Upload Utility Program.
 - **FwcXXX*.ccc**: Firmware, where "x" denotes the firmware revision letter.
 - **CCCflash.hlp**: Flash600 Help File.
5. **Connect** the external PC serial port to the CDM-600/600L modem P4B Remote Control interface (located on the modem rear panel) using a crossover cable.

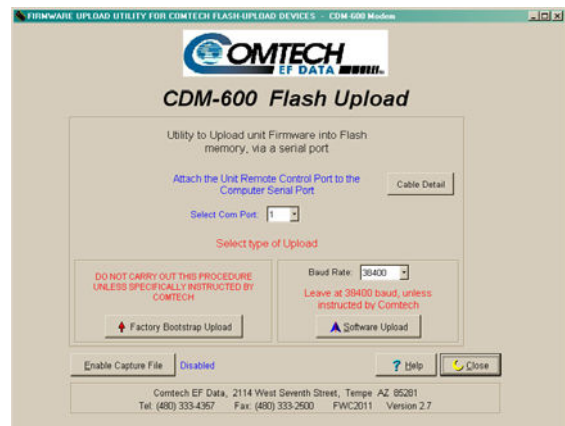


If the modem is in any sort of redundancy system, the 25-pin P3B Data Interface data connector must be disconnected before flash uploading.

The Remote Control port RS-232 lines used for Flash upgrading are also connected to the 25-pin P3B Data Interface connector and are used when 1:N Redundancy Switch is connected.

Please ensure that NOTHING is connected to P3B pins 4, 21 and 22 – if these pins are used, the RS-232 remote control port will not function, and Flash upgrading will be impossible.

6. **Run** the Flash600 Upload Utility Program by first locating the executable file that was extracted from the archive file into the folder created in Step 2, then double-clicking the icon to start the utility. 
7. The user should follow the instructions presented on the screen, and the upload will take place automatically. Following the successful upload process, the modem will automatically reboot, running the new version of firmware. During this process, the non-volatile RAM storing the modem configuration will be erased, so the user is then required to re-enter the desired configuration parameters.



8. **Verify** that the new firmware file successfully loaded per the Step 7 process by observing the loaded Firmware version, as displayed on the front panel VFD after reboot:

```

COMTECH CDM-600 OPEN NETWORK MODEM
TURBO: LOW RATE Q S/W VER X.X.X
    
```


Chapter 5. FRONT PANEL OPERATION

5.1 Description

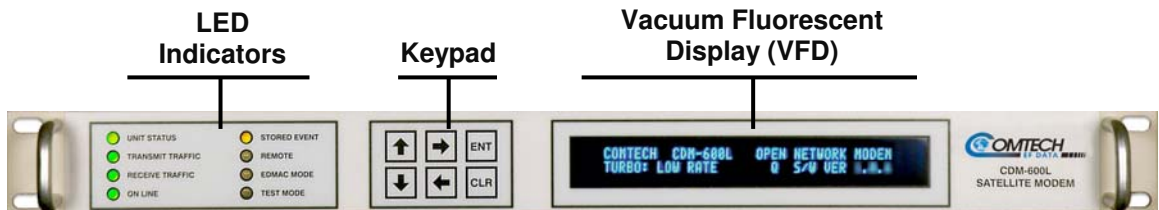


Figure 5-1. CDM-600/600L Front Panel (CDM-600L shown)

The user can fully control and monitor the operation of the CDM-600/600L from the front panel using the keypad and display. Nested menus are used, which display all available options, and prompt the user to carry out a required action.

Figure 5-1 identifies the key features of the front panel, which are explained in greater detail in this section.

5.1.1 Front Panel LED Indicators

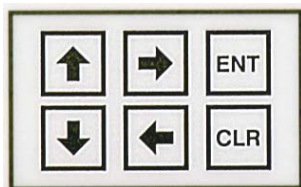


In general, the Alarm relay state will reflect the state of the Front Panel LEDs. For instance, if the Unit Status LED is red, the Unit Alarm relay will be active, etc. The one exception is the Transmit Traffic relay. This will only be activated if a Transmit Traffic Fault exists – it does not reflect the state of the TX carrier.

The function of the eight front panel LED indicators is as follows:

LED	CONDITION	DESCRIPTION
UNIT STATUS	Green	No Unit Faults, or Traffic Faults
	Orange	No Unit Faults, but a Traffic Fault exists
	Red	A Unit Fault exists (Example: PSU fault)
TRANSMIT TRAFFIC	Green	No Tx Traffic Faults
	Flashing	CDM-600L ONLY: On/Off once per second. The carrier-on delay is active. Refer to ODU, BUC, Config menu for setting countdown seconds remaining. It also is indicated via the Remote Command: TXO?; response: TXO=4, which means, OFF due to BUC carrier-on-delay.
	Off	A Tx Traffic fault exists OR the Tx Carrier is in OFF state
RECEIVE TRAFFIC	Green	No Rx Traffic Faults (demod and Viterbi decoder are locked, everything is OK)
	Off	An Rx Traffic fault exists (the demod may still be OK)
ON LINE	Green	The Unit is On Line, and carrying traffic
	Off	The Unit is Off Line (standby) – forced by externally connected 1:1 or 1:N redundancy system
STORED EVENT	Orange	There is a Stored Event in the log, which can be viewed from the front panel, or retrieved via the remote control interface
	Off	There are no Stored Events
REMOTE	Orange	The Unit is in Remote Mode – local monitoring is possible, but no local control
	Flashing	CDM-600 ONLY: ODU control has been enabled, and there is a communications fault, or there is an ODU status fault
	Off	The Unit is in Local Mode – remote monitoring is possible, but no remote control
EDMAC MODE	Orange	Framing on, EDMAC on, and unit defined as Slave – local monitoring is possible, but no local control
	Off	Either no EDMAC, EDMAC Master, or Transparent mode is selected
TEST MODE	Orange	A Test Mode is selected (Example: IF Loopback)
	Off	There is no Test Mode currently selected

5.1.2 Front Panel Keypad



The keypad has an auto-repeat feature. If a key is held down for more than 1 second, the key action will repeat, automatically, at the rate of 15 keystrokes per second. This is particularly useful when editing numeric fields, with many digits, such as frequency or data rate.

The keypad comprises six individual keyswitches, mounted directly behind a fully sealed membrane overlay. They have a positive ‘click’ action, which provides tactile feedback. The user enters data via the keypad, and messages are displayed on the VFD. The function of the keypad is as follows:

KEY	FUNCTION
[ENT] (ENTER)	This key is used to select a displayed function or to execute a modem configuration change.
[CLR] (CLEAR)	This key is used to back out of a selection or to cancel a configuration change which has not been executed using [ENT]. Pressing [CLR] generally returns the display to the previous selection.
[←] [→] (Left, Right)	These arrow keys are used to move between selections or to move the cursor functions. At times, they may also be used to move from one section to another.
[↑] [↓] (Up, Down)	These arrow keys are used primarily to change configuration data (numbers or characters). At times, they may also be used to move from one section to another.

5.1.3 Front Panel Vacuum Fluorescent Display (VFD)



The CDM-600/600L features a **V**acuum **F**luorescent **D**isplay (VFD). The VFD is an active display showing two lines of 40 characters each. It produces a blue light, the brightness of which can be controlled

by the user. Compared to a **L**iquid **C**rystal **D**isplay (LCD), it has greatly superior viewing characteristics and does not suffer problems of viewing angle or contrast.

On most menu screens, the user will observe a flashing solid block cursor, which blinks at a once-per-second rate. This indicates the currently selected item, digit, or field. Where this solid block cursor would obscure the item being edited (e.g., a numeric field) the cursor will automatically change to an underline cursor.

If the user were to display the same screen for weeks at a time, the display could become ‘burnt’ with this image. To prevent this, the unit has a ‘screen saver’ feature that activates after 1 hour.

The message moves from right to left across the screen, then wraps around. The top line of the display shows the Circuit ID (which can be entered by the user). The bottom line shows the circuit Eb/No value (if the demod is locked) followed by ‘**Press any key**’.

Pressing any key will restore the previous screen.

5.2 Opening Screen

A ‘welcome’ screen is displayed whenever power is first applied to the unit on the CDM-600L:

```
COMTECH  CDM-600L      OPEN NETWORK MODEM
TURBO:   TPC/LDPC      S/W VER  X.X.X
```

For CDM-600 units manufactured before February 2005, the display appears as follows:

```
COMTECH  CDM-600      OPEN NETWORK MODEM
TURBO:   TPC/LDPC      S/W VER  X.X.X
```

Otherwise, for CDM-600 units manufactured after February 2005 with the extended IF bandwidth feature, the display appears as follows:

```
COMTECH  CDM-600 (E)  OPEN NETWORK MODEM
TURBO:   TPC/LDPC      S/W VER  X.X.X
```

If the Internal Reference Warm-up Delay feature has been enabled on the CDM-600 (**CONFIG: → MISC → WARM-UP**), the ensuing countdown displays, in seconds, at the bottom right until the warm-up period is complete:

```
COMTECH  CDM-600 (E)  OPEN NETWORK MODEM
HIGH-STABILITY REF WARMING UP:   045 SEC
```

During this period, the Tx Carrier is deliberately muted. At the end of the warm-up period, the bottom line reverts to the ‘normal’ display of Firmware version, and the unit will enter its normal operational state. At this stage, pressing any key will take the user to the top level selection screen.



If the user wishes to bypass this feature, the warm-up period may be overridden at any time by pressing the [CLR] key.

On the next page, **Figure 5-2** illustrates the hierarchal structure of the front panel menu tree.

Press any key to go to the **SELECT:** (main menu) screen.

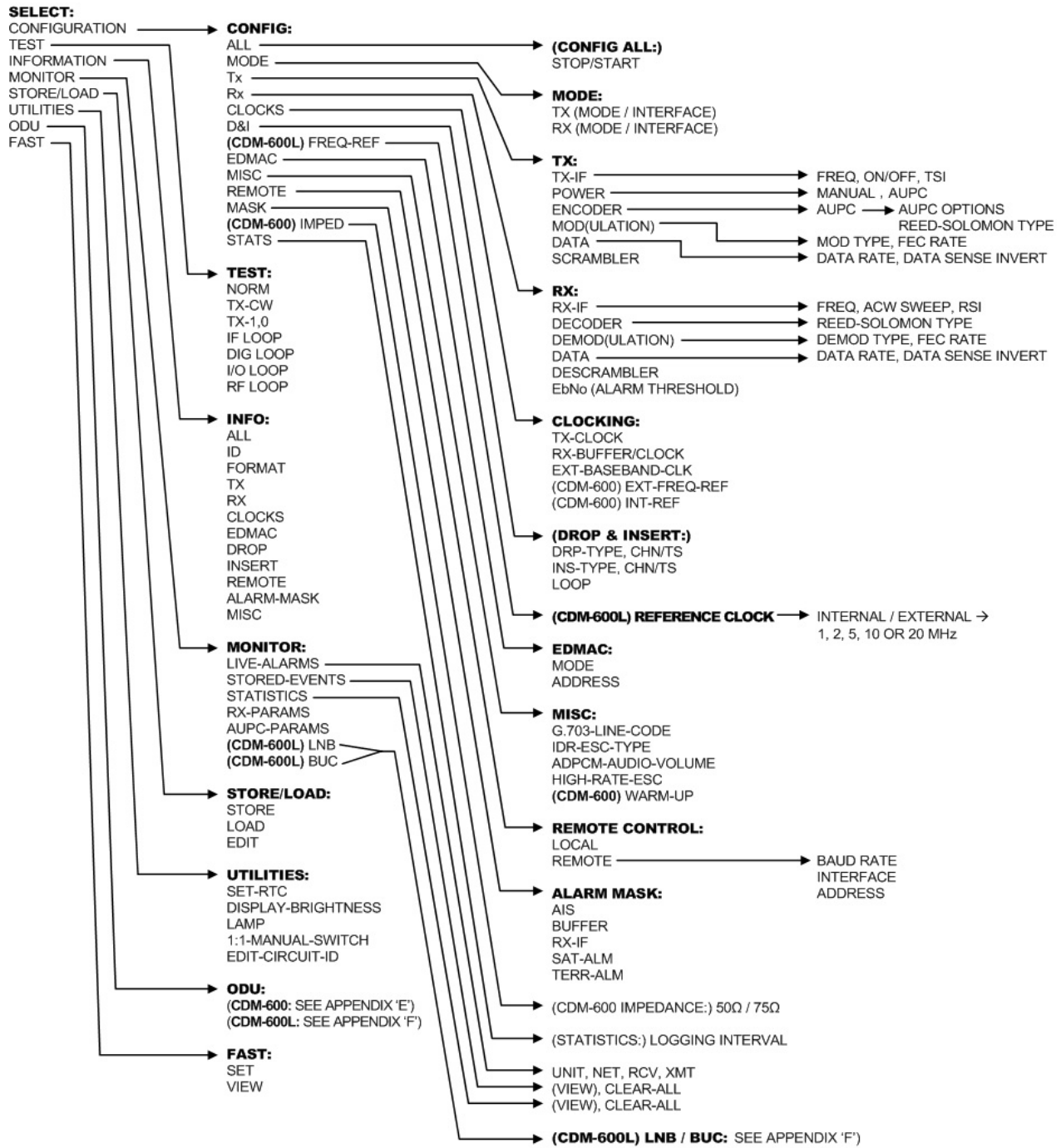


Figure 5-2. CDM-600/600L – Principal Menu Tree

5.3 SELECT: (Main Menu)

Select: CONFIGURATION TEST INFORMATION
MONITOR STORE/LOAD UTILITY ODU FAST

Use the [←][→] arrow keys to select from the choices shown, then press [ENT]. The following table identifies the menu branch, its content section in this chapter, and the functional description of each branch:

Menu Branch	Sect	Description
CONFIGURATION	5.4	Permits the user to fully configure the modem.
TEST	5.5	Permits the user to configure the modem into one of several Test modes, and configures/monitors the BER Tester.
INFORMATION	5.6	Permits the user to view information on the modem, without having to go into the Configuration screens.
MONITOR	5.7	Permits the user to monitor the current status of the modem and view the log of stored events for the modem.
STORE/LOAD	5.8	(Store/Load) Permits the user to store and retrieve up to 10 different modem configurations.
UTILITY	5.9	Permits the user to perform miscellaneous functions, such as setting the Real-Time Clock, adjusting the display brightness, etc.
ODU	5.10	(Outdoor Unit) On the CDM-600 only: Permits the user to monitor and control a Comtech EF Data RF Transceiver (CSAT-5060 or KST-2000A/B), if connected. See Appendix E for full details. On the CDM-600L only: Permits the user to monitor and control a BUC (Block Upconverter) or LNB (Low-noise Block Downconverter), if connected. See Appendix F for full details.
FAST	5.11	(Fully Accessible System Topology) Permits the user to configure different options, for extended data rates, interfaces, etc. Contact the factory for details.



The actual choices displayed in the submenus may vary according to which FAST options have been enabled. Where a FAST option affects a menu, this is shown in the descriptive text.

5.4 (SELECT:) CONFIGURATION

CDM-600L:

```
CONFIG:  ALL  MODE  TX  RX  CLOCKS  D&I
FREQ-REF  EDMAC  MISC  REMOTE  MASK  STATS
```

CDM-600:

```
CONFIG:  ALL  MODE  TX  RX  CLOCKS  D&I
EDMAC  MISC  REMOTE  MASK  IMPED  STATS
```

Use the [←][→]arrow keys to select from the submenu choices shown, then press [ENT]. The submenus available from the Configuration menu are as follows:

Submenu	Sect	Description
ALL	5.4.1	Permits the user to completely configure the unit, being prompted, step by step, to make choices, or edit data. This is highly recommended for new users, as it will clearly lead the user through all the configuration parameters.
MODE	5.4.2	Permits the user to select Frame Type and Data Format for Tx and Rx.
TX	5.4.3	(Transmit) Permits the user to define, on a parameter-by-parameter basis, the Tx configuration of the unit. These menu submenu branches would be used if the user wished to change, for example, just the Tx Frequency.
RX	5.4.4	(Receive) Permits the user to define, on a parameter-by-parameter basis, the Rx configuration of the unit. These menu submenu branches would be used if the user wished to change, for example, just the Rx data rate.
CLOCKS	5.4.5	Permits the user to select Tx-Clocking, Rx-Buffer/Clock, or External Reference (CDM-600 only) / External Clock (CDM-600L only).
D&I	5.4.6	Permits the user to select Drop & Insert options.
FREQ-REF	5.4.7	(CDM-600L ONLY) (Reference Clock) Permits the user to select a Reference Clock, either Internal 10 MHz Reference or an External Reference of 1, 2, 5, 10, or 20 MHz.
EDMAC	5.4.8	Permits the user to select EDMAC options.
MISC	5.4.9	(Miscellaneous) Permits the user to select, view, or change various other parameters.
REMOTE	5.4.10	(Remote Control) Permits the user to define whether the unit is being controlled locally or remotely, and to configure the serial Remote Control parameters: baud rate, I/O format, address.
MASK	5.4.11	Permits the user to activate or MASK an alarm condition.
IMPED	5.4.12	(CDM-600 ONLY) (Impedance) Permits the user to select the impedance at the IF connectors, either 50Ω or 75Ω.
STATS	5.4.13	Permits the user to enable and configure the logging of various statistics, including Eb/No and AUPC parameters



IMPORTANT

Only one method of remote access may control the modem at a time. The modem may be monitored over the remote control bus at any time (i.e., queries only), and the front panel may be viewed.

To make configuration parameter changes from the front panel, local mode is required. Via serial remote, remote mode is required, and via IP, Ethernet remote is required.

5.4.1 CONFIG: ALL

**All = Stop
(Stop, Start)**

The user may configure the unit, in a step-by-step process, by viewing each menu in succession. Use the [↑][↓] arrow keys to select **Stop** or **Start** then press [ENT] to continue. For each parameter, use the [←][→] arrow keys to select and [↑][↓] arrow keys to edit parameters as needed. Press [ENT] to continue through all the configurations. Press [CLR] to discontinue and return back to this top menu. Select **Stop**, then press [ENT] to exit to the main menu.

5.4.2 CONFIG: MODE



*The **MODE** is a key parameter when configuring the modem. To simplify the menu choices, the user must first determine the **INTERFACE** and **FRAMING** type for both **Transmit** and **Receive**. Once these have been selected, the user is only presented with menu choices that are applicable to those particular modes.*

Examples:

- *If a G.703 interface is selected, the data rate menu will be restricted to only the appropriate G.703 rates.*
- *If an IDR framing mode is selected, the data rate choices will be limited to only those rates specified by IESS-308.*

```
Mode :   Tx=RS422 : NONE       Rx=RS422 : None
         (RS422 V35 RS232 G703B G703U AUDIO LVDS)
```

Interface type and **Framing** for both **Tx** and **Rx** may be selected from this menu. Select the parameter to edit using the [←][→] arrow keys. The options available for the selected parameter are indicated on the bottom line. Not all options are always available: they depend on other settings or on the **FAST** options of the modems. (The above display depicts an **Interface Type** editing example.)

The first parameter is the **Interface** type. The Interface type options are as follows:

- ▶ RS422 (data rates up to 10 Mbps)
- ▶ V.35 (data rates up to 10 Mbps)
- ▶ RS232 (synchronous, data rates up to
- ▶ G.703:
 - G.703B (Balanced)
 - G.703U (Unbalanced)
- ▶ Audio (**FAST** option)
- ▶ LVDS (data rates up to 20 Mbps)

Note: The **AUDIO** choice permits the user to carry 2 x 32 kbps ADPCM audio as the primary data. This mode restricts the available framing types to **IBS** or **EDMAC** (see next paragraph/table).

Scroll through the available options using the [↑][↓] arrow keys, then press [ENT] once the desired selection is made.

If the cursor is on the second parameter – the **Framing Type** – the display appears as shown:

```
Mode: Tx=RS422 : NONE Rx=RS422 : None
      (None IBS IDR EDMAC D&I++ ESC++)
```

The Framing Tx and Rx options are as follows:

- ▶ NONE
- ▶ IBS (FAST option)
- ▶ IDR (FAST option)
- ▶ DROP (FAST Options)
- ▶ EDMAC
- ▶ D&I++ (FAST Option):
 - CDM-600L – FW Ver. 1.20 and greater
 - CDM-600 – FW Ver. 1.5.0 and greater
- ▶ ESC++ (FAST Option):
 - CDM-600L – FW Ver. 1.3.0 and greater
 - CDM-600 – FW Ver. 2.0.1 and greater

Scroll through the available options using the [↑][↓] arrow keys, then press [ENT] once the desired selection is made.

5.4.3 CONFIG: TX

```
Tx-IF: POWER ENCODER MOD DATA SCRAMBLER
      (DATA=00064.000kbps SYMBOL=00064.000ksym)
```

Select the parameter on the top line – the submenu branches available are **TX-IF**, **FREQ**, **POWER**, **EMCODER**, **MOD**, **DATA**, and **SCRAMBLERr** – using the [←][→] arrow keys, then press [ENT]. The bottom line provides *read-only* Data/Symbol rate information.

5.4.3.1 CONFIG: Tx → TX-IF

```
Tx-IF: CARRIER = ON (OFF, ON, RTI)
TX FREQ=12000.0000MHz SPECTRUM INVERT=OFF
```

Select the parameter to edit – **Carrier**, **TX FREQ** or **SPECTRUM INVERT** – using the [←][→] arrow keys.

To edit the **Carrier**, select **OFF**, **ON**, or **RTI** using the [↑][↓] arrow keys. Press [ENT] when done.



RTI means RECEIVE/TRANSMIT INHIBIT. When selected, it will prevent the Tx carrier from being transmitted until the demodulator is locked. To avoid the Tx Carrier from being turned off when the demodulator loses lock for a very short period of time, the demodulator must be unlocked continuously for a period of 10 seconds before the transmit carrier is inhibited. This time interval is fixed and the user cannot change it.

Having this feature enabled does not affect the internal IF loopback feature. Be aware, however, that if an external IF loopback is attempted (connecting an external cable from the Tx IF output to the Rx IF input), then this will not work! (The Tx carrier cannot turn on until the demod is locked, and the demod cannot lock because the Tx output is off. The net result is that the demod will not lock and the Tx carrier will not turn on. USE THE RTI FEATURE WITH EXTREME CARE!)

Edit the **Tx Frequency** by selecting each digit to be edited using the [←][→] arrow keys, then edit the value of the digit using the [↑][↓] arrow keys. When editing is complete, press [ENT].

For the CDM-600L: Note that the range is from 950-1950 MHz.

For the CDM-600: Note that the range is from 52-88 MHz, and 104-176 MHz. The resolution is 100Hz. For units manufactured after February 2005 that display **CDM-600(E)** on the opening menu, the range of IF frequencies has been extended to 50-90 MHz, and 100-180 MHz.

To set the Tx spectrum inversion, set **SPECTRUM INVERT** to **OFF** or **ON** using the [↑] [↓] arrow keys. Press [ENT] when done.



SPECTRUM INVERT should normally be in the OFF position. When in the ON position, for all FEC types, except BPSK, the transmit spectrum is inverted (which is the same as reversing the direction of phase rotation in the modulator). In BPSK, the time-order of bits out of the FEC encoder is reversed, to make the modem compatible with certain other manufacturer's modems.

5.4.3.2 CONFIG: TX → POWER

```
OUTPUT POWER: MODE = MANUAL (MANUAL, AUPC)
OUTPUT POWER LEVEL = -20.0 dBm
```

To configure the Tx Output Power (for CDM-600L only – if in Manual **Mode** and BUC Leveling is **Off**), select the parameter to edit – the output power **Mode** or the power **Level** – using the [←][→] arrow keys.

Select the output power **Mode** – **MANUAL** or **AUPC** – by using the [↑][↓] arrow keys.

To edit the output power **Level**, move the cursor to a digit of the Tx Power Level using the [←][→] arrow keys, then edit the value of that digit using the [↑][↓] arrow keys. Press [ENT] when done.

If the Tx framing is **EDMAC**, or **D&I++**, or **ESC++** or **D&I**, the power mode of **AUPC** may be selected (see **Chapter 7. AUTOMATIC UPLINK POWER CONTROL (AUPC)** for more information about this feature).

For these framing types, if **AUPC** mode is selected, the bottom line appears as shown:

```
OUTPUT POWER: MODE = AUPC (MANUAL, AUPC)
TARGET-EbNo-RANGE ALARM/ACTION
```

Select **TARGET-EbNo-RANGE** or **ALARM/ACTION** using the [←][→] arrow keys, then press [ENT].

CONFIG: TX → POWER → MODE → AUPC → TARGET-EbNo-RANGE

MINIMUM EbNo OF REMOTE MODEM = 5.0dB
MAXIMUM PERMITTED POWER INCREASE = 9dB

On the top line, to edit the Target Eb/No of the remote modem, use the [←][→] arrow keys to select a digit, then edit the value of that digit using the [↑][↓] arrow keys. The default value is 3.0 dB; the upper limit is 14.9 dB.

On the bottom line, to edit the maximum permitted increase in power level when in AUPC mode, use the [←][→] arrow keys to select a digit, then edit the value of that digit using the [↑][↓] arrow keys. The default value is 1dB; the upper limit is 9 dB.

Press [ENT] when done.

CONFIG: TX → POWER → MODE → AUPC → ALARM/ACTION

MAX TX PWR ACTION = NONE (NONE, TX-ALM)
REM DEMOD UNLOCK ACT = NOM-PWR (NOM, MAX)

On the top line, to determine the action that will occur if the **AUPC** causes the maximum output power level to be reached, select **None** or **Tx Alarm** using the [↑][↓] arrow keys.

On the bottom line, to determine the action that will occur if the remote demod is unlocked, using the [↑][↓] arrow keys. The choices are:

- | | |
|--------------------------------|---|
| NOM-PWR (Nominal Power) | The output level will revert to the nominal power level set under Manual . |
| MAX-PWR (Maximum Power) | The output level will change to the maximum permitted. |

Press [ENT] when done.

5.4.3.3 CONFIG: TX → ENCODER

```
ENCODER = TPC (NONE, VIT, SEQ, TCM, TPC, LDPC)
REED-SOLOMON = OFF (ON, OFF)
```

On the top line, select the parameter to edit using the [←][→] arrow keys. The available Encoder options are shown in the parentheses. Select using the [↑][↓] arrow keys, then press [ENT]. The choices are:

- ▶ None (i.e., uncoded) ▶ TPC (Turbo) (**Hardware option**)
- ▶ Vit (Viterbi) ▶ LDPC (**Hardware option**)
- ▶ Seq (Sequential)
- ▶ TCM (Trellis Coded Modulation)
8-PSK Rate 2/3 only (**FAST option**)

Notes:

1. The options of TPC (Turbo) is only displayed if a Turbo Codec is installed.
2. The option of LDPC is only displayed if a TPC/LDPC Codec is installed.

If **None** is selected for the Encoder setting, the bottom line of the display will change from the Reed-Solomon selection to a Differential Encoding selection, as shown:

```
ENCODER = NONE (NONE, VIT, SEQ, TCM, TPC, LDPC)
DIFF-ENCODER = OFF (ON, OFF)
```



If Differential Encoding=OFF is selected, there is no way for the modem to resolve the phase ambiguities associated with PSK modulations. For BPSK there is a 1 in 2 chance that the polarity of the data will be correct. In QPSK there is a 1 in 4 chance the data will be correct.

When selecting **Reed-Solomon On** on the bottom line, proceed as follows:

CONFIG: TX → ENCODER → REED-SOLOMON ON

```
REED-SOLOMON ENCODING = ON(200/180)
```

Use the [↑][↓] arrow keys to select one of the listed parameters, then press [ENT]. Possible selections, depending on the Framing mode, are as follows:

- ▶ IESS-310, open or closed network 219/201
- ▶ IBS, open or closed network 126/112
- ▶ EDMAC, closed network 200/180
- ▶ IDR, open network 225/205 or 194/178
- ▶ Unframed closed network:
 - Comtech standard 220/200
 - Legacy EF Data 225/205, with V.35 scrambling

5.4.3.4 CONFIG: TX → MOD (Modulation)

MODULATION = QPSK (B, Q, OQ, 8-PSK, 16QAM)
FEC RATE = 1/2 (1/2, 3/4, 7/8)

Using the [←][→] arrow keys, select the **MODULATION** type (top line) or the **FEC RATE** (bottom line), then change that selection by using the [↑][↓] arrow keys.

The Encoder type dictates the Modulation Type and FEC rate choices:

Encoder Type	Modulation Type	FEC Rate Choice
No Encoder	BPSK QPSK, OQPSK	Fixed at 1/1 Fixed at 1/1
Non-Turbo Encoder	BPSK TCM 8-PSK (FAST option) QPSK, OQPSK 16-QAM	Fixed at Rate 1/2 Fixed at Rate 2/3 1/2, 3/4, 7/8 3/4, 7/8
Turbo (with the 5Mbps Codec installed):	BPSK QPSK, OQPSK 8-PSK, 16-QAM (FAST option)	5/16, 21/44 Fixed at 3/4 Fixed at 3/4
Turbo (with the 20Mbps Codec installed, or the TPC/LDPC Codec installed):	BPSK QPSK, OQPSK 8-PSK (FAST option) 16-QAM (FAST option)	5/16, 21/44 1/2, 3/4, 7/8, 0.95 3/4, 7/8, 0.95 3/4, 7/8
LDPC (with TPC/LDPC Codec installed)	BPSK QPSK, OQPSK 8-PSK, 8-QAM (FAST option) 16-QAM (FAST option)	1/2 1/2, 2/3, 3/4 3/4, 7/8 3/4

Note: If the TPC/LDPC Codec is installed and **TPC** is selected from the **ENCODER** menu, the options appear as shown:

MODULATION= QPSK (B, Q, OQ, 8-PSK, 16Q, 8QAM)
FEC RATE = 1/2 (1/2, 3/4, 7/8)

5.4.3.5 CONFIG: TX → DATA

TRANSMIT DATA RATE =00064.000 kbps
DATA INVERT = OFF (ON, OFF)

The top line permits the data rate to be edited. Select the digit of **TRANSMIT DATA RATE** to be edited using the [←][→] arrow keys. The value of the digit is then changed using the [↑][↓] arrow keys. Press [ENT] when done.

NOTE: The minimum and maximum data rates are dependent on Modulation type and FEC Encoder Rate. If the user changes the Modulation or FEC, and the data rate becomes invalid, the **Data Rate** will be adjusted automatically. The upper range of data rate will be dictated by the **FAST option** installed.

When Drop Framing or the G.703 interface type is used, the [↑][↓] arrow keys will scroll through the available data rates. If in Drop Mode and the data rate is edited to 1920 kbps, a comment is shown to indicate that E1 fixed channel mode will be implemented.

When G.703 is used and the Modem is Hardware Revision 2.0 or higher, three auxiliary rates will also be available (512, 1024 and 2048 kbps) indicated by the word **AUX** appearing to the right of the decimal place (e.g., **00512.AUX kbps**).

Refer to **Sect. 3.3.4.2 J10A IDI, J11A DDO Connectors** for additional information about how to connect the cables for the AUX data rates.

The bottom line permits the user to select the data inversion feature (added for compatibility with certain older equipment). Set **DATA INVERT** to **ON** or **OFF** using the [↑][↓] arrow keys, then press [ENT] when done.

5.4.3.6 CONFIG: TX → SCRAMBLER

```
TX SCRAMBLER = NORMAL (NORMAL, OFF)
ENCODER SCRAMBLER
```

Select **Normal** or **Off** using the [↑][↓] arrow keys, then press [ENT]

The choice of scrambler used for **Normal** is selected automatically, and depends on the exact operating mode. For example:

- If no framing is being used, the ITU V.35 scrambler (Intelsat variant) will be used.
- If IBS framing is selected, the IESS-309 scrambler will be used, etc.

If LDPC encoding is selected, the standard ITU V.35 scrambler will be used.

If Turbo encoding is selected, a second scrambler, IESS-315 V.35, is available instead of the TPC scrambler:

```
TX SCRAMBLER = IESS (NORMAL, IESS, OFF)
IESS-315 V.35 SCRAMBLER
```

5.4.4 CONFIG: RX

```
RX-IF DECODER DEMOD DATA DESCRAM EbNo
DATA=00064.000kbps SYMBOL=00064.000ksym
```

From the top line, using the [←][→] arrow keys, select the parameter – **RxIF**, **Decoder**, **Demod**, **Data**, **Descram**, or **EbNo** – then press [ENT]. On the bottom line, *read-only* Data/Symbol rate information is provided.

5.4.4.1 CONFIG: RX → RX-IF

```
ACQUISITION SWEEP RANGE = +/- 10 kHz
RX FREQ=1200.0000MHz SPECTRUM INVERT=OFF
```

Select the parameter to edit – the **Acquisition Sweep Range**, **RX Freq**, or **SPECTRUM INVERT** – using the [←][→] arrow keys.

The **Acquisition Sweep Range** value determines the amount of frequency uncertainty the demodulator will sweep over in order to find and lock to an incoming carrier. When operating at low bit rates, large values of sweep range (compared to the data rate) cause excessively long acquisition times.

For example: Selecting ± 32 kHz with a data rate of 2.4 kbps, BPSK will result in an average acquisition time of around 3 minutes.

The Sweep Range limits are determined by the Rx symbol rate. To edit the **Acquisition Sweep Range** of the demodulator, change the value of the digit using the [↑][↓] arrow keys, then press [ENT] when done.

Edit the **Rx Frequency** by selecting each digit to be edited using the [←][→] arrow keys, then edit the value of the digit using the [↑][↓] arrow keys. When editing is complete, press [ENT].

For the CDM-600L: Note that the range is from 950-1950 MHz.

For the CDM-600: Note that the range is from 52-88 MHz, and 104-176 MHz. The resolution is 100Hz. For units manufactured after February 2005 that display **CDM-600(E)** on the opening menu, the range of IF frequencies has been extended to 50-90 MHz, and 100-180 MHz.

To set the Rx spectrum inversion, set **SPECTRUM INVERT** to **OFF** or **ON** using the [↑][↓] arrow keys. Press [ENT] when done.



SPECTRUM INVERT should normally be in the OFF position. When in the ON position, the receive spectrum is inverted (which is the same as reversing the direction of phase rotation in the demodulator). Note that in BPSK mode, the demodulator will automatically synchronize to either the normal time-ordering of bits FEC codeword pairs, or the inverted ordering used by certain other manufacturers.

5.4.4.2 CONFIG: RX → DECODER

```
DECODER = VIT (NONE, VIT, SEQ, TCM, TPC, LDPC)
REED-SOLOMON = OFF (ON, OFF)
```

Select the parameter to edit – **Decoder** or **Reed-Solomon** – using the [←][→] arrow keys, then press [ENT].

On the top line, select the parameter to edit using the [←][→] arrow keys. The available Decoder options are shown in the parentheses. Select using the [↑][↓] arrow keys, then press [ENT]. The choices are:

- ▶ None (i.e., uncoded) ▶ TPC (Turbo) (**Hardware option**)
- ▶ Vit (Viterbi) ▶ LDPC (**Hardware option**)
- ▶ Seq (Sequential)
- ▶ TCM (Trellis Coded Modulation)
8-PSK Rate 2/3 only (**FAST option**)

Notes:

1. The options of TPC (Turbo) is only displayed if a Turbo Codec is installed.
2. The option of LDPC is only displayed if a TPC/LDPC Codec is installed.

If **None** is selected for the Decoder setting, the bottom line of the display will change from the Reed-Solomon selection to a Differential Decoding selection, as shown:

```
DECODER = NONE (NONE, VIT, SEQ, TCM, TPC, LDPC)
DIFF-DECODER = OFF (ON, OFF)
```



If Differential Encoding=OFF is selected, there is no way for the modem to resolve the phase ambiguities associated with PSK modulations. For BPSK there is a 1 in 2 chance that the polarity of the data will be correct. In QPSK there is a 1 in 4 chance the data will be correct.

When selecting **Reed-Solomon On** on the bottom line, proceed as follows:

CONFIG: RX → DECODER → REED-SOLOMON ON

```
REED-SOLOMON DECODING = ON(200/180)
```

Use the [↑][↓] arrow keys to select one of the listed parameters, then press [ENT]. Possible selections, depending on the Framing mode, are as follows:

- ▶ IESS-310, open or closed network 219/201
- ▶ IBS, open or closed network 126/112
- ▶ EDMAC, closed network 200/180
- ▶ IDR, open network 225/205 or 194/178
- ▶ Unframed closed network:
 - Comtech standard 220/200
 - Legacy EF Data 225/205, with V.35 scrambling

5.4.4.3 CONFIG: RX → DEMOD (Demodulation)

DEMODULATION = QPSK (B, Q, OQ, 8-PSK, 16QAM)
FEC RATE = 1/2 (1/2, 3/4, 7/8)

Using the [←][→] arrow keys, select the **DEMODULATION** type (top line) or the **FEC RATE** (bottom line), then change that selection by using the [↑][↓] arrow keys.

The Decoder type dictates the Demodulation Type and FEC rate choices:

Encoder Type	Modulation Type	FEC Rate Choice
No Encoder	BPSK QPSK, OQPSK	Fixed at 1/1 Fixed at 1/1
Non-Turbo Encoder	BPSK TCM 8-PSK (FAST option) QPSK, OQPSK 16-QAM	Fixed at Rate 1/2 Fixed at Rate 2/3 1/2, 3/4, 7/8 3/4, 7/8
Turbo (with the 5Mbps Codec installed):	BPSK QPSK, OQPSK 8-PSK, 16-QAM (FAST option)	5/16, 21/44 Fixed at 3/4 Fixed at 3/4
Turbo (with the 20Mbps Codec installed, or the TPC/LDPC Codec installed):	BPSK QPSK, OQPSK 8-PSK (FAST option) 16-QAM (FAST option)	5/16, 21/44 1/2, 3/4, 7/8, 0.95 3/4, 7/8, 0.95 3/4, 7/8
LDPC (with TPC/LDPC Codec installed)	BPSK QPSK, OQPSK 8-PSK, 8-QAM (FAST option) 16-QAM (FAST option)	1/2 1/2, 2/3, 3/4 3/4, 7/8 3/4

Note: If the TPC/LDPC Codec is installed and **TPC** is selected from the **DECODER** menu, the options appear as shown:

DEMODULATION = QPSK (B, Q, OQ, 8-PSK, 16Q, 8QAM)
FEC RATE = 1/2 (1/2, 3/4, 7/8)

5.4.4.4 CONFIG: RX → DATA

RECEIVE DATA RATE = 00064.000 kbps
DATA INVERT = OFF (ON, OFF)

The top line permits the data rate to be edited. Select the digit of **RECEIVE DATA RATE** to be edited using the [←][→] arrow keys. The value of the digit is then changed using the [↑][↓] arrow keys. Press [ENT] when done.

NOTE: The minimum and maximum data rates are dependent on Demodulation type and FEC Decoder Rate. If the user changes the Modulation or FEC, and the data rate becomes invalid, the **Data Rate** will be adjusted automatically. The upper range of data rate will be dictated by the **FAST option** installed.

When Insert Framing or the G.703 interface type is used, the [↑][↓] arrow keys will scroll through the available data rates. If in Drop Mode and the data rate is edited to 1920 kbps, a comment is shown to indicate that E1 fixed channel mode will be implemented.

When G.703 is used and the Modem is Hardware Revision 2.0 or higher, three auxiliary rates will also be available (512, 1024 and 2048 kbps) indicated by the word **AUX** appearing to the right of the decimal place (e.g., **00512.AUX kbps**).

Refer to **Sect. 3.3.4.2 J10A IDI, J11A DDO Connectors** for additional information about how to connect the cables for the AUX data rates.

The bottom line permits the user to select the data inversion feature (added for compatibility with certain older equipment). Set **DATA INVERT** to **ON** or **OFF** using the [↑][↓] arrow keys, then press [ENT] when done.

5.4.4.5 CONFIG: RX → DESCRAMBLER

```
RX DESCRAMBLER = NORMAL (NORMAL, OFF)
DECODER DESCRAMBLER
```

Select **Normal** or **Off** using the [↑][↓] arrow keys, then press [ENT]

The choice of descrambler used for **Normal** is selected automatically, and depends on the exact operating mode. For example:

- If no framing is being used, the ITU V.35 descrambler (Intelsat variant) will be used.
- If IBS framing is selected, the IESS-309 descrambler will be used, etc.

If LDPC encoding is selected, the standard ITU V.35 descrambler will be used.

If Turbo encoding is selected, a second scrambler, IESS-315 V.35, is available instead of the TPC descrambler:

```
RX DESCRAMBLER = IESS (NORMAL, IESS, OFF)
IESS-315 V.35 DESCRAMBLER
```

5.4.4.6 CONFIG: RX → EbNo

```
RECEIVE EbNo ALARM POINT = 02.0 dB
( < > ◆ )
```

Edit the Rx EbNo Alarm Point by selecting the digit to be edited using the [←][→] arrow keys, then edit the value of that digit using the [↑][↓] arrow keys. Press [ENT] when done.

The permitted range is from 00.1 to 16.0 dB.

Note: If the Rx Eb/No falls below the permitted range value and the fault is NOT masked, a receive traffic fault will be generated.

5.4.5 CONFIG: CLOCKS

CDM-600L:

**CLOCKING: TX-CLOCK
RX-BUFFER/CLOCK EXTERNAL-BASEBAND-CLOCK**

CDM-600:

**CLOCKING: TX-CLOCK RX-BUFFER/CLOCK
EXT-BASEBAND-CLK EXT-FREQ-REF INT-REF**

Select a submenu branch using the [←][→] arrow keys – **TX-CLOCK**, **RX-BUFFER/CLOCK**, **EXTERNAL-BASEBAND-CLOCK** for the CDM-600L, or **TX-CLOCK**, **RX-BUFFER/CLOCK**, **EXT-BASEBAND-CLK**, **EXT-FREQ-REF**, or **INT-REF** for the CDM-600 – then press [ENT].

5.4.5.1 CONFIG: CLOCKS → TX-CLOCK

**TRANSMIT CLOCK = INTERNAL (SCT)
(INT (SCT), TX-TERR (TT), RX-LOOP, EXT-CLK)**

Use the [↑][↓] arrow keys to select from the choices shown in parentheses, then press [ENT].

INT(SCT)	Internal (SCT): Indicates that the unit will supply a clock to the DTE, which is derived from its internal high-stability source. This is the required setting when the Tx interface type is Audio.
TX-TERR(TT)	Tx-Terrestrial (TT): Indicates that the unit expects to receive a clock from the DTE, to which the unit can phase-lock its internal circuits. If no clock is detected the modem will substitute its internal clock and generate an alarm. This is the required setting when the modem's interface type is G.703.
RX-LOOP	Rx-Loop-timed: Will allow the modem's internal clock to be phase locked to the Rx buffer clock source. This output clock is Send Timing. Choosing Rx-Loop will not automatically select Rx-Sat as the buffer clock source. This allows for increased flexibility for modem clock selection. Normally the user will select Rx-Sat but the other choices also are available. Example: The user has an available high stability 10 MHz clock source but the end equipment will only accept a clock at the information data rate. Selecting Tx Clock = Rx-Loop and Rx Buffer Clock as EXT-REF will provide receive timing and send timing to the end equipment that is sourced from the 10 MHz reference.
EXT-CLK	External Clock: Indicates that an unbalanced high-stability source is expected at the J9 BNC connector, or a balanced version at the P3A connector. The frequency must match that programmed in the CONFIG: CLOCKS → EXTERNAL BASEBAND CLOCK menu, and must be equal to the Tx data rate.

5.4.5.2 CONFIG: CLOCKS → RX-BUFFER/CLOCK

```
CLK= RX-SAT (RX-SAT, TX-TERR, EXT-CLK, INS)
BUFFER-SIZE = 00016bytes (00002ms) CENTER
```

Use the [←][→] arrows keys to select for editing the **Rx Clock** (top line) or the **Buffer-Size** (bottom line).

CONFIG: CLOCKS → RX-BUFFER/CLOCK → RX CLOCK

On the top line, select **Rx-Sat**, **Tx-Terr**, **Ext-Clk**, or **Ins** using the [↑][↓] arrow keys. Note the following:

RX-SAT

Rx Satellite Clock: Sets the Receive buffer clock source to the satellite clock (The receive buffer will be bypassed.) **Note:** This will fix the buffer size to minimum.

TX-TERR

External Transmit Clock: In this timing mode, data is clocked out of the receive buffer using the external transmit clock.

EXT-CLK

External Clock: Data is clocked out of the buffer using the same reference that drives the modem Internal(SCT).

INS

Insert Stream: Sets the buffer clock to the Insert stream. Available in INSERT MODE ONLY.

CONFIG: CLOCKS → RX-BUFFER/CLOCK → BUFFER-SIZE

On the bottom line, **Buffer-Size** indicates the size in bytes (and size in milliseconds) of the Plesiochronous/Doppler Buffer. Edit each digit of the buffer size by using the [←][→] arrow keys to select the digit to edit, then use the [↑][↓] arrow keys to revise that digit. Press [ENT] when done.

Note: When the Rx data rate is set to one of the four G.703 rates, the minimum buffer size and step size are limited to the value shown in the table below. In addition, Insert Framing follows the same rule, regardless of n x 64 data rate, depending upon whether the Insert Type is T1 or E1. If none of these cases is true, the minimum buffer size is 16 bytes with a step size of 2 bytes.

RX Data Rate	Buffer Step Size
1544 kbps (T1) or open network D&I at T1	1158 bytes or 3 ms for D4 (6 ms for ESF)
2048 kbps (E1) or open network D&I at E1	1024 bytes or 4 ms
D&I++ at n = 1, 3 or 5	720 bytes
D&I++ at n = 2, 6 10 or 15	1440 bytes
D&I++ at n = 9	2160 bytes
D&I++ at n = 4, 12 or 20	2880 bytes
D&I++ at n = 18	4320 bytes
D&I++ at n = 7 or 21	5040 bytes
D&I++ at n = 8 or 24	5760 bytes
D&I++ at n = 11	7920 bytes
D&I++ at n = 13	9360 bytes
D&I++ at n = 14	10080 bytes
D&I++ at n = 16	11520 bytes
D&I++ at n = 17	12240 bytes
D&I++ at n = 19	13680 bytes
D&I++ at n = 22	15840 bytes

D&l++ at n = 23	16560 bytes
6312 kbps (T2)	1578 bytes or 2 milliseconds
8448 kbps (E2)	528 bytes or 0.5 milliseconds

CONFIG: CLOCKS → RX-BUFFER/CLOCK → CENTER

**PRESS ENTER TO CENTER THE BUFFER
OTHERWISE, PRESS CLEAR**

Press [ENT] or [CLR] as prompted on the screen.

5.4.5.3 CONFIG: CLOCKS → EXTERNAL BASEBAND CLOCK

**EXTERNAL-BASEBAND-CLOCK = 02048.000 kHz
TYPE = UNBAL (UNBAL, BAL)**

Select the digit to edit using the [←][→] arrow keys, then use the [↑][↓] arrow keys to revise that digit. Press [ENT] when done.

5.4.5.4 CONFIG: CLOCKS → EXT-FREQ-REF (CDM-600 ONLY)

**EXTERNAL FREQUENCY REFERENCE: INTERNAL
(HIGH-STABILITY INTERNAL, 1, 2, 5, 10, 20MHz)**

For CDM-600 units with Firmware Ver. 1.4.0 or higher, and with a High-Stability module installed:

Select **High-Stability Internal, 1, 2, 5, 10, or 20 MHz** using the [↑][↓] arrow keys, then press [ENT].

5.4.5.5 CONFIG: CLOCKS → INT-REF (CDM-600 ONLY)

**INTERNAL HI-STABILITY 10 MHz REFERENCE
FINE ADJUST: +048 (+/-999)**

For CDM-600 units with Firmware Ver. 1.4.0 or higher, with a High-Stability module installed and with the Hi-Stability Internal 10 MHz Reference selected:

With the High-Stability Internal 10 MHz Reference selected, very fine adjustment of the Internal 10MHz Reference is possible. The adjustment value is retained in EEPROM memory, and is therefore not lost when the NVRAM memory is cleared.

Select the digit to be edited using the [←][→] arrow keys, then edit the value of the digit using the [↑][↓] arrow keys. Press [ENT] when done.

Note: Changes made to the adjust value are implemented **immediately**, not after the [ENT] key is pressed.

5.4.6 CONFIG: D&I (Drop & Insert)



Drop and Insert operation is a FAST option. For a detailed discussion of Drop & Insert, refer to Chapter 8. CLOCK MODES and DROP & INSERT (D&I).

If D&I has not been selected, the menu displays as shown:

```
DRP-TYPE= N/A    CHAN/TS    LOOP=Y (Y/N)
INS-TYPE= N/A    CHAN/TS
```

If the modem is configured for Drop & Insert, the menu displays as shown:

```
DRP-TYPE= T1-D4  CHAN/TS    LOOP=Y (Y/N)
INS-TYPE= T1-D4  CHAN/TS
```

Using the [←][→] arrow keys, beginning on the top line select the **Drp-Type** (Drop-Type); its **Chan/TS** (Channel Timeslot); or the **Loop**.

From the bottom line, select the **Ins-Type** (Insert-Type); or its **Chan/TS** (Channel Timeslot). For any of these selections, press [ENT] to continue on to that selection's submenu branch, where the parameters are then individually edited using the [↑][↓] arrow keys.

5.4.6.1 CONFIG: D&I → LOOP

Selecting **Loop** will tie **Drop Data Out (DDO)** to **Insert Data Input (IDI)** without the user having to externally connect cables to these ports. Use the [↑][↓] arrows keys to select **Y(es)** or **N(o)** for the **Loop** feature.

5.4.6.2 CONFIG: D&I → DRP-TYPE or INS-TYPE

The Drop-Types and Insert-Types are:

▶ T1- D4 ▶ T1 – ESF ▶ E1 – CCS ▶ E1 – CAS

Use the [↑][↓] arrows keys to select the desired Drop-Type and Insert-Type. To edit the Channel Timeslots (**CHAN/TS**) for either Drop *or* Insert, press [ENT] to display the screens featured in the next section.

5.4.6.3 CONFIG: D&I → DROP or INSERT CHAN/TS (Channel Timeslots)

```
DRP-CH:  1   2   3   4
         TS: 01  02  03  04
```

```
INS-CH:  1   2   3   4
         TS: 01  02  03  04
```

For both the Drop-Type and Insert-Type Channel Timeslots, select the Channel to edit using the [←][→] arrow keys, then edit the timeslot value using the [↑][↓] arrow keys. Press [ENT] when done.

The number of available Channels depends on the data rate. If the data rate is 1920 kbps, then only the E1 formats are available and the **Chan/TS** menus are disabled. This is the 'Fixed Channel Mode' where all timeslots are allocated in order.

If the framing is D&I and Drop/Insert Type is E1-CAS, Timeslot 16 is completely used for CAS signalling and therefore may not be allocated by the user for traffic data.

5.4.7 CONFIG: FREQ-REF (CDM-600L ONLY)

```
REFERENCE CLOCK = INTERNAL
(INTERNAL, 1, 2, 5, 10, or 20 MHz)
```

Select either an **Internal** 10 MHz Reference or a **1, 2, 5, 10, or 20 MHz** External Reference using the [↑][↓] arrow keys. Press [ENT] when done.

5.4.8 CONFIG: EDMAC

```
EDMAC MODE = MASTER (IDLE/MASTER/SLAVE)
EDMAC ADDRESS = XXXX
```

EDMAC is a Comtech-proprietary framing which permits communication access to the distant-end modem. For further information, refer to **Chapter 9. EDMAC CHANNEL**.

Note the following:

- An **EDMAC Master** is a modem which is local to the M&C computer, and which passes messages, via the overhead, to a distant-end modem. The Master address will always end in 0.
- An **EDMAC Slave** is a modem that is not local to the M&C computer. It is at the 'distant-end' of a satellite link. The Slave EDMAC address will always end in 1. When configured as a Slave, re-configuration is expected to be via the EDMAC link, and hence is not permitted via the front panel or via serial remote control.

Select the mode using the [↑][↓] arrow keys. If the mode is **Master** or **Slave**, the bottom line will show an address. Use the [←][→] arrow keys to select the character to edit, then the [↑][↓] arrow keys to edit the value. Press [ENT] when done.

5.4.9 CONFIG: MISC

CDM-600L:

```
MISC:  G.703-LINE-CODE  IDR-ESC-TYPE  
        ADPCM-AUDIO-VOLUME  HIGH-RATE-ESC
```

CDM-600:

```
MISC:  G.703-LINE-CODE  IDR-ESC-TYPE  
        ADPCM-AUDIO-VOL HI-RATE-ESC  WARM-UP
```

Select **G.703-LINE-CODE**, **IDR-ESC-TYPE**, **ADPCM-AUDIO-VOLUME**, **HIGH-RATE-ESC**, or **WARM-UP** (CDM-600 only) using the [←][→] arrow keys, then press [ENT].

5.4.9.1 CONFIG: MISC → G.703-LINE-CODE (Ternary Code)

```
Tx G.703/DDO CODE= AMI  (AMI, B8ZS)  
Rx G.703/IDI CODE= AMI  (AMI, B8ZS) (◀ ▶ ◆)
```

Note: Parameters may only be edited if the Interface Type is G.703. The choices displayed depend on which G.703 interface type has been selected.

Use the the [←][→] arrow keys to select the parameter to edit. Select the appropriate G.703 code using the [↑][↓] arrow keys, then press [ENT]. The choices available are as follows:

- ▶ HDB3 (for E1, E2 or sub-rate operation) ▶ B6ZS (for balanced T2 operation)
- ▶ B8ZS (for T1 and unbalanced T2 operation) ▶ AMI

5.4.9.2 CONFIG: MISC → IDR-ESC-TYPE

```
IDR-ESC-Type Tx: 64k Data  (64kData, Audio)  
              Rx: 64k Data  (◀ ▶ ◆)
```

Note: Parameters may only be edited if the Framing Mode is IDR.

This menu permits a user to decide if the 64 kbps channel in the IDR Engineering Service Channel (ESC) overhead (normally reserved for the two 32 kbps ADPCM audio channels) should instead carry user data. The rear panel Overhead connector provides the appropriate RS-422 interface for this option.

Use the the [←][→] arrow keys to select the parameter to edit (**Tx** or **Rx**), then select the appropriate IDR-ESC-Type (**64kData** or **Audio**) using the [↑][↓] arrow keys. Press [ENT] when done.

5.4.9.3 CONFIG: MISC → ADPCM-AUDIO-VOLUME

```
TX-1 VOLUME= +0 dB    TX-2 VOLUME= -2 dB
RX-1 VOLUME= +2 dB    RX-2 VOLUME= -4 dB
```

```
ADPCM    Tx1 = +0 dB    Tx2 = -2 dB
Volumes: Rx1 = +2 dB    Rx2 = -4 dB  ( ◀ ▶ ◆ )
```

This menu permits varied gain (or volume) of the Tx and Rx Audio ESC circuits.

Select the volume to edit (Tx or Rx) using the [←][→] arrow keys, then edit the value using the [↑][↓] arrow keys. The permitted range of the volumes is -6 to +8 dB, in 2 dB steps. Press [ENT] when done.

5.4.9.4 CONFIG: MISC → HIGH-RATE-ESC

```
HIGH-RATE-ESC = OFF (ON,OFF)
BAUDRATE = 9600    PARITY:DATA:STOP = N81
```

The ESC (Engineering Service Channel) is determined by the framing type selected under **CONFIG: MODE**. The two options are **High-Rate IBS ESC** and **ESC++**.

Select the parameter to edit using the [←][→] arrow keys, then edit the value using the [↑][↓] arrow keys, then press [ENT]. The user may select:

- ▶ **On or Off**
- ▶ **RS-232 or RS485**
- ▶ *Baud rate* (range depends on other configuration parameters, see below)
- ▶ *Character format* (number of data bits, parity, number of stop bits): **8N1** (8-None-1), **7E2** (7-Even-2) or **7O2** (7-Odd-2).

For all CDM-600L units or for CDM-600 units with Firmware Ver. 1.3.1 or higher: The High Rate IBS (Engineering Service Channel) is available as a **FAST** option in conjunction with IBS framing. Both TX and RX framing must be IBS to enable this feature. If enabled, the lower of the TX or RX primary data rate limits the maximum baud rate, in accordance with the following table:

Data Rate (kbps)	Max ESC Baud Rate
64	2400
> 127.999	4800
> 255.999	9600
> 383.999	14400
> 511.999	19200
> 767.999	28800
> 1023.999	38400

See **Chapter 12. OPEN NETWORK OPERATIONS** for more information on Open Network framing.

For CDM-600L units with Firmware Ver. 1.3.0 or higher, or for CDM-600 units with Firmware Ver. 2.0.1 or higher: ESC++ is available as standard. Both Tx and Rx framing must be set to ESC++. When enabled, the lower of the Tx or Rx primary data rate limits the maximum baud rate, in accordance with the following table:

Data Rate (kbps)	Max ESC++ Baud Rate
≥ 64	4800
≥ 128	9600
≥ 192	14400
≥ 256	19200
≥ 384	28800
≥ 512	38400

See **Chapter 10. ESC++** for more information on ESC++ framing.

5.4.9.5 CONFIG: Misc → WARM-UP (CDM-600 ONLY)

**HIGH-STAB REFERENCE POWER-UP WARM-UP :
NO DELAY (INSTANT-ON) (INSTANT-ON, DELAY)**

For CDM-600 units with Firmware Ver. 1.4.0 or higher, and with a High-Stability module installed: The High-Stability Reference Module contains an oven for the crystal. It can take a little time for the oven & crystal to come up to temperature; during this time, the frequency accuracy is not guaranteed.

This menu permits the user to select a Warm-up Delay, which will be implemented on power-up. The delay is calculated by the modem, based on temperature and the amount of time the unit was turned off. This is much more important at L-Band (950-195 MHz) than at 50-180 MHz, where the 10 MHz reference may also be used for RF conversion equipment.

If the Warm-up Delay is enabled, when the modem is powered up, a Warm-Up Delay Countdown will be activated, during which the Tx is suppressed. A countdown of the remaining Warm-up Delay is displayed on the front panel, for example:

**COMTECH CDM-600 OPEN NETWORK MODEM
HIGH-STABILITY REF WARMING UP: 045 SEC**

If necessary, this warm-up period can be bypassed by pressing the [CLR] key.

5.4.10 CONFIG: REMOTE (Remote Control)

REMOTE CONTROL = LOCAL (LOCAL, REMOTE)

Select **Local** or **Remote** using the [↑][↓] arrow keys, then press [ENT].

If **Local** is selected, then reconfiguration via **Remote** is not permitted. Remote monitoring is still possible.

Selecting **Local** or **Serial Remote** displays the submenu that follows.

5.4.10.1 CONFIG: REMOTE → LOCAL or REMOTE Settings

```
INTERFACE= RS-485-4W (232, 485-2, 485-4)
ADDRESS= 0001 BAUDRATE= 9600
```

For either **Local** control or **Remote** control, select the parameter to edit – **Interface**, **Address**, or **Baudrate** – using the [←][→] arrow keys, then edit the parameter as follows:

- To set the **Interface** type, select **232**, **485-2** (2-Wire), or **484-4** (4-wire) using the [↑][↓] arrow keys. Press [ENT] when done.
- To edit the **Address**, select the digit to be edited using the [←][→] arrow keys, then edit the value of the digit using the [↑][↓] arrow keys. Press [ENT] when done.

Note the following:

- **For RS-485:** The permitted address range is 1 to 9999. Address 0 is reserved for universal addressing.
- **For RS-232:** The Address is fixed at 0000.
- Set the Baudrate using the [↑][↓] arrow keys, then press [ENT] when done.

CONFIG: REMOTE → CHAR FORMAT

```
PARITY:DATA-BITS:STOP-BITS = N81
(N81, E72, O72)
```

Edit the I/O character format using the [↑][↓] arrow keys. The options are:

- **N81** – No parity, 8 data bits, 1 stop bit.
- **E72** – Even parity, 7 data bits, 2 stop bits.
- **O72** – Odd parity, 7 data bits, 2 stop bits.

5.4.11 CONFIG: MASK

The MASK submenus permit the user to selectively mask, or make active, various alarms and traffic conditions that are monitored in the modem.

```
CONFIGURE ALARM MASK:  AIS  BUFFER
                       RXIF  SAT-ALM  TERR-ALM
```

Use the [←] [→] arrow keys to select the parameter – **AIS**, **Buffer**, **RxIF**, **Sat-Alm**, or **Terr-Alm** – then press [ENT].

5.4.11.1 CONFIG: MASK → AIS

```
AIS:  TX-TERR-AIS= MASKED  (ACTIVE, MASK)
      RX-SAT-AIS = ACTIVE  (ACTIVE, MASK)
```

Use the [←] [→] arrow keys to select a parameter – **Tx-Terr-AIS** or **Rx-Sat-AIS** – then set the status for either parameter as **Active** or **Masked** using the [↑][↓] arrow keys. Press [ENT] when done.

Note the following:

- If **Tx-Terr-AIS** is set to **Active**, a fault will be generated whenever the modulator senses that the ‘all ones’ condition is present in the terrestrial data.
- If **Rx-Sat-AIS** is set to **Active**, a fault will be generated whenever the demodulator senses that the ‘all ones’ condition is present in the receive data.
- If an alarm is **Masked**, no alarm will be generated.

5.4.11.2 CONFIG: MASK → BUFFER (Buffer Slip)

```
BUFFER SLIP= ACTIVE  (ACTIVE, MASK)
```

Set the alarm as **Active** or **Masked** using the [↑][↓] arrow keys, then press [ENT].

If the Buffer Slip Alarm is **Active**, then a Buffer Slip fault will be generated in the Rx faults whenever the receive circuitry senses that the buffer has either underflowed, or overflowed.

If the Buffer Slip Alarm is **Masked**, no alarm will be generated.

5.4.11.3 CONFIG: MASK → Rx-IF

```
RXIF:  AGC = ACTIVE  (ACTIVE, MASK)
       EbNo = MASKED  (ACTIVE, MASK)
```

Use the [←][→] arrow keys to select **AGC** or **EbNo**, then set the alarm for either as **Active** or **Masked** using the [↑][↓] arrow keys. Press [ENT] when done.

If **Active** is selected for **AGC**, then an **AGC fault** will be generated whenever the receive signal level exceeds -20 dBm (for the desired carrier). If **Masked** is selected, no alarm will be generated.

If **Active** is selected for **EbNo**, then an **Eb/No fault** will be generated whenever the demodulator sees the receive **Eb/No** fall below the pre-determined value. If **Masked**, no alarm will be generated.

5.4.11.4 CONFIG: MASK → SAT-ALM (Satellite Alarms)

```
SATELLITE ALARMS
TRANSMIT      RECEIVE
```

Select **TRANSMIT** or **RECEIVE** using the [←][→] arrow keys, then press [ENT].

CONFIG: MASK → SAT-ALM → TRANSMIT

```
PROCESS ALARMS FROM (H/W, S/W, OFF)
BWA1=OFF  BWA2=OFF  BWA3=S/W  BWA4=H/W
```

To determine how the **Tx IDR** backward alarm inputs are to be used, an activated alarm may respond to a hardware input at **P5A (H/W)** or be software controlled by a receive fault on the modem (**S/W**).

Select the **Backward Alarm** to be edited (**BWA1**, **BWA2**, **BWA3**, or **BWA4**) using the [←][→] arrow keys, then select the setting for that alarm – **Off**, **H/W**, or **S/W** – using the [↑][↓] arrow keys. Press [ENT] when done.

CONFIG: MASK → SAT-ALM → RECEIVE

```
PROCESS ALARMS RECEIVED FROM SATELLITE
BWA1=N, BWA2=N, BWA3=N, BWA4=N
```

Select which Receive IDR backward alarms are to be monitored (**BWA1**, **BWA2**, **BWA3**, or **BWA4**) using the [←][→] arrow keys, then select the setting for that alarm – **Yes** or **No** – using the [↑][↓] arrow keys. Press [ENT] when done.

5.4.11.5 CONFIG: MASK → TERR-ALM

```
TERR-ALM: TX = ACTIVE (ACTIVE, MASK)
           RX = OFF   (OFF, ENABLED)
```

Note: These alarms are applicable for D&I operation only.

Use the [←][→] arrow keys to select **Tx** or **Rx**, then select the alarms for either as **Active** or **Masked** using the [↑][↓] arrow keys. Press [ENT] when done.

5.4.12 CONFIG: IMPEDANCE (CDM-600 ONLY)

IF IMPEDANCE = 50 (50,75 OHMS)

Select **50** or **75** using the [↑][↓] arrow keys, then press [ENT]. Note that this affects both the Rx and Tx IF ports simultaneously.

5.4.13 CONFIG: STATISTICS

LINK STATISTICS LOGGING INTERVAL:
10 MINUTES (00 to 90) (◆)

The Logging Interval is the period of time over which the performance statistics will be measured. Set the logging interval – **10** through **90** minutes in 10-minute increments – using the [↑][↓] arrow keys, then press [ENT]. Setting a value of **00** disables the feature (no logging).

For more information about the Statistics data taken, refer to **Section 5.7.3 MONITOR: STATISTICS**.

To view the Statistic log information, from the ‘**SELECT: (Main)**’ menu, go to ‘**MONITOR: STATISTICS**’.

5.5 SELECT: TEST

MODEM TEST MODE = NORMAL
(NORM, TX-CW, TX-1/0, IF↓, RF↓, DIG↓, I/O↓)

Select **NORM** (Normal Operation) or a **Test Mode** from the parameters shown in the parentheses on the bottom line.

Use the [↑][↓] arrow keys, then press [ENT], to select one of the following modes:

Selection	Description
NORM	(Normal) This clears any test modes or loopbacks, and places the unit back into an operational state.
TX-CW	(Transmit CW) This is a test mode, which forces the modulator to transmit a pure carrier (unmodulated).
TX-1/0	(Transmit an alternating 1,0,1,0 pattern) This test mode forces the modulator to transmit a carrier modulated with an alternating 1,0,1,0 pattern, at the currently selected symbol rate. This causes two discrete spectral lines to appear, spaced at +/- half the symbol rate, about the carrier frequency. This mode is used to check the carrier suppression of the Modulator.
IF↓	(IF Loopback) This test mode invokes an internal IF loop. This is a particularly useful feature, as it permits the user to perform a quick diagnostic test without having to disturb external cabling. Furthermore, all of the receive configuration parameters are temporarily changed to match those of the transmit side. When Normal is again selected, all of the previous values are restored.
RF↓	(RF Loopback) This test mode is almost identical to the IF loop mode. All of the receive configuration parameters (except Rx Spectrum Invert) are temporarily changed to match those of the transmit side, however, no internal connection is made. This is useful for performing a satellite loopback. When Normal is again selected, all of the previous values are restored.
Dig↓	(Digital Loopback) This test mode invokes a digital loopback, which loops data at the output of the Reed-Solomon encoder on the transmit side, back into the Reed-Solomon decoder on the receive side. This tests all of the interface, transmit baseband circuits, FEC encoder, FEC decoder, and buffer.
I/O↓	(Inward/Outward Loopback) This test mode invokes two distinct loopbacks. The first of these is the inward loop, which takes data being received from the satellite direction, and passes it directly to the modulator. Simultaneously, the outward loop is invoked, whereby data being fed to the transmit data interface is routed directly back out of the receive data interface.

The IF, Digital, and I/O Loopback Test modes are illustrated in **Figure 5-3**.

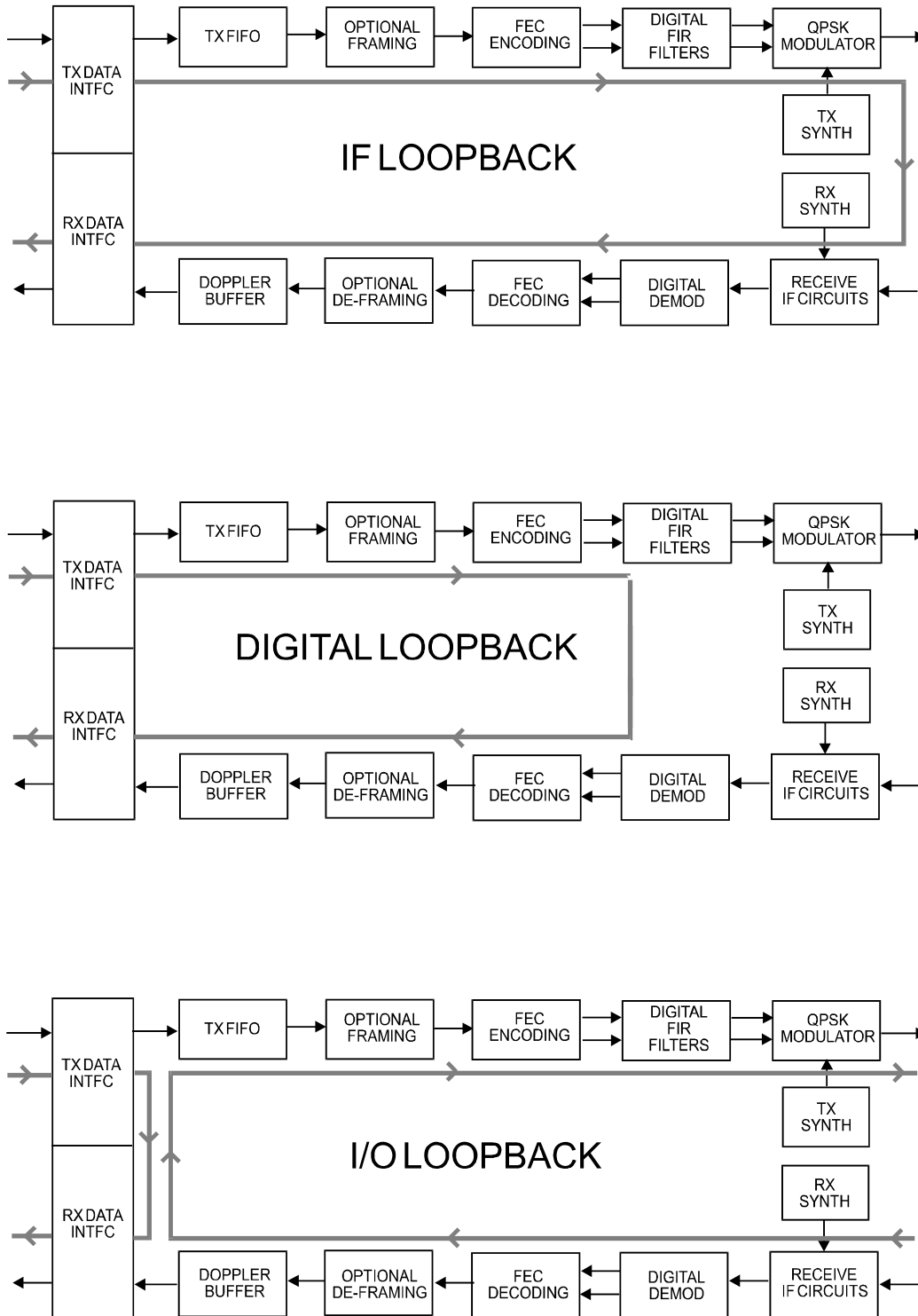


Figure 5-3. Loopback Modes

5.6 SELECT: INFORMATION

```
INFO: ALL ID FORMAT TX RX CLOCKS EDMAC
      DROP INSERT REMOTE ALARM-MASK MISC
```

The INFO screens provide information on the current configuration of the modem on a *read-only* basis, without risking inadvertent changes.

Select **All**, **ID**, **Mode**, **Tx**, **Rx**, **Clocks**, **EDMAC**, **Drop**, **Insert**, **Remote**, **Alarm-Mask**, or **Misc** using the [←][→] arrow keys, then press [ENT].

5.6.1 INFO: ALL

```
ALL = START
(STOP, START)
```

The user may view the configuration of the unit, in a step-by-step process, by scrolling through each display in succession. Use the [↑][↓] arrow keys to select between **Stop** and **Start**. Press [ENT] to continue through all the configurations.

Note that this display is *read-only*. The user may only *view* the configurations – *no editing is possible*.

To discontinue: Press [CLR], use the [↑][↓] arrow keys to select **Stop**, then press [ENT].

5.6.2 INFO: ID

```
MODEM CIRCUIT ID:
----A TEST MESSAGE TO SHOW CIRCUIT ID---
```

This screen displays the user-defined Circuit ID string (40 characters), which is entered via the menus: **UTILITIES** → **EDIT-CIRCUIT-ID**. Press [ENT] or [CLR] to return to the previous menu.

5.6.3 INFO: MODE

```
INFO:  MODE:  TX= G.703B:D&I  (B8ZS)
        RX= G.703B:IBS    (B8ZS)
```

An example of a Mode Information screen is shown above.

5.6.4 INFO: TX

CDM-600L:

```
TX:ON 1200.0000MHz PWR=-10.0 TSI=N
VIT+RS:220/220 00604.000 QPSK 1/2 SCRM
```

CDM-600:

```
TX:ON 070.0000MHz Z=50 PWR=-20.0 TSI=N
VIT+RS:220/200 00604.000 QPSK 7/8 SCRM
```

An example of the TX Information screen is shown above for the CDM-600L and CDM-600.

The information displayed is as follows:

TOP LINE	TX CARRIER	ON, OFF, or RTI
	TX FREQUENCY	xxxxx.xxx MHz
	IMPEDANCE (CDM-600 ONLY)	50 or 75 Ω
	POWER	Power Level (dB)
	TSI	TSI = TX Spectral Inversion, I=Inverted (on), N=Not inverted (off)
BOTTOM LINE	ENCODER	FEC type: VITERBI, SEQ, TCM, VIT+RS, SEQ+RS, TCM+RS, TPC, LDPC NONE: x (x = Differential Encoder setting, shown as DE-OFF or DE-ON)
	DATA RATE	xxxxx.xxx kbps (an asterix * indicates that the data sense is inverted)
	MODULATION	BPSK, QPSK, OQPSK, 8-PSK, 8-QAM, 16-QAM
	FEC RATE	1/2, 2/3, 3/4, 7/8, 0.95, 5/16, 21/44 or 1/1
	SCRAMBLER	SCRM, NONE, or IESS (Turbo Only)

5.6.5 INFO: RX

CDM-600L:

```
RX:1200.0000MHz 00.1dB +-10 RSI=N  
VIT+RS:126/112 00604.000 QPSK 1/2 SCRM
```

CDM-600:

```
RX:070.0000MHz Z=50 02.0dB +-30 RSI=N  
VIT+RS:126/112 00604.000 QPSK 1/2 SCRM
```

An example of the RX Information screen is shown above for the CDM-600L and CDM-600.

The information displayed is as follows:

TOP LINE	RX FREQUENCY	xxxxx.xxx MHz
	IMPEDANCE (CDM-600 ONLY)	50 or 75 Ω
	EbNo	12 dB (Alarm Point)
	SWEEP RANGE	up to \pm 32 kHz
	RSI	RSI = RX Spectral Inversion, I=Inverted (on), N=Not inverted (off)
BOTTOM LINE	ENCODER	FEC type: VITERBI, SEQ, TCM, VIT+RS, SEQ+RS, TCM+RS, TPC, LDPC NONE: x (x = Differential Encoder setting, shown as DE-OFF or DE-ON)
	DATA RATE	xxxxx.xxx kbps (an asterix * indicates that the data sense is inverted)
	DEMODULATION	BPSK, QPSK, OQPSK, 8-PSK, 8-QAM, 16-QAM
	FEC RATE	1/2, 2/3, 3/4, 7/8, 0.95, 5/16, 21/44 or 1/1
	SCRAMBLER	SCRM, NONE, or IESS (Turbo Only)

5.6.6 INFO: CLOCKS

CDM-600L:

```
CLOCKS : TX=INT (SCT) RX=EXT-CLK REF=INT10  
BUFFER-SIZE=00016 CLK=02048U
```

CDM-600:

```
CLOCKS : TX=INT (SCT) RX=EXT-CLK  
BUFFER-SIZE=00016 CLK=02048U
```

For the CDM-600L: The TX Clock, RX Clock, Reference, and Buffer information is displayed.

For the CDM-600: The TX Clock, RX Clock, and Buffer information is displayed.

Note: The Clock (CLK) information is shown only if Rx Clock is set to EXT-CLK.

5.6.7 INFO: EDMAC

```
EDMAC FUNCTION= ON
EDMAC MODE= MASTER      EDMAC ADDR= 0020
```

This screen shows if EDMAC is enabled or not. When enabled, the EDMAC Mode and Address are shown.

5.6.8 INFO: DROP (Drop Type)

```
DROP TYPE=      CH:1
E1-CCS         TS:01
```

This screen shows the Drop Type and channel allocations. Press [ENT] or [CLR] to return to the previous menu.

5.6.9 INFO: INSERT (Insert Type)

```
INSERT TYPE=    CH:1
E1-CCS         TS:01
```

This screen shows the Insert Type and channel allocations. Press [ENT] or [CLR] to return to the previous menu.

5.6.10 INFO: REMOTE

```
REMOTE-CONTROL= LOCAL  ADDRESS= 0000
INTERFACE = RS-232     9600 BAUD N81
```

This screen shows if the unit is in Local or Remote mode, provides the details of the electrical interface type selected, the unit's address, and the baud rate. Press [ENT] or [CLR] to return to the previous menu.

5.6.11 INFO: ALARM-MASK

```
ALARMS MASKED: TX-AIS  RX-AIS  BUF-SLIP
                AGC     EBNO   SAT   TERR
```

This modem screen shows only the alarm(s) that are currently **masked**, though all are shown in this example. If an alarm is *not* masked, a blank is displayed in the relevant screen position.

5.6.12 INFO-MISC

```
MISCELLANEOUS:  NORMAL
1:1 SWITCH = NOT CONNECTED    ONLINE
```

This screen shows the following:

- Operational Mode (Test Mode or Normal)
- 1:1 Link Status
- Redundancy Status: Offline or Online

5.7 SELECT: MONITOR

CDM-600L:

```
MONITOR: LIVE-ALARMS  STORED-EVENTS
STATISTICS RX-PARAMS  AUPC-PARAM  LNB  BUC
```

CDM-600:

```
MONITOR: LIVE-ALARMS  STORED-EVENTS
STATISTICS  RX-PARAMS  AUPC-PARAMS
```

For the CDM-600L: Select **Live-Alarms**, **Stored-Events**, **Statistics**, **Rx-Params**, **AUPC-Param**, **LNB**, or **BUC** using the [←][→] arrow keys, then press [ENT].

For the CDM-600: Select **Live-Alarms**, **Stored-Events**, **Statistics**, **Rx-Params**, or **AUPC-Param** using the [←][→] arrow keys, then press [ENT].

5.7.1 MONITOR: LIVE-ALARMS

```
LIVE      UNIT= NONE      NET= NONE
ALARMS    RECV=DEMOD LOCK  XMT= NONE
```

For the CDM-600: Per the example above, four alarm types are available on the CDM-600 on a single screen.

For the CDM-600L: Six alarm types are available between two screens. In addition to the screen example shown above for the CDM-600, this additional information is available by pressing the [↑][↓] arrow keys:

```
LIVE      BUC= NONE
ALARMS    LNB= NONE
```

The **highest** priority alarm currently active for each of the alarm types is shown in the tabulature that begins on the next page.

UNIT	PSU	Power supplies (+5V, +12V, -5V, +18V, -12V) are always monitored by an onboard supervisory IC.
	Tx and Rx Synth	The PLLs in the IF sections are monitored for an unlocked condition.
	Power Cal	Calibration data stored in EEPROM is checked at power up to verify that the factory calibration has not been corrupted.
	FPGA	Downloads are verified to have been loaded successfully.
	Hi-Stab Freq Ref Module (CDM-600)	No PLL Lock – This will suppress the Tx carrier.
	Internal Reference SYNTH (CDM-600L)	
NET (Unit Network)	Lose TxFrm	Loss of Tx frame occurs in Drop & Insert operation, when the incoming T1 or E1 frame cannot be found by the modem.
	BER >10E-3	This error rate monitor is enabled for IBS and IDR framing.
	Lose TxMul	Loss of Tx multiframe occurs in E1-CAS D&I operation, when the multiframe marker for CAS signaling data cannot be found.
	Tx Sig AIS	An AIS condition in the signaling positions of an incoming E1-CAS frame is monitored.
	Tx Terr RM	Indicates the presence of the Tx terrestrial remote alarm on the incoming T1 or E1 frame.
	IBS Rx Rem	Indicates the presence of the IBS satellite remote alarm (backward alarm) on the incoming IBS frame from the transmit side of the link.
	IDR Rx BW1-4	Multi-destinational backward alarms are the corresponding satellite alarms used by the IDR frame structure.
	IDR Tx BW1-4	Backward alarms 1-4 indicate that the hardware inputs available on the back panel of the modem have triggered, resulting in the corresponding Tx backward alarm being generated by the modem's IDR framer
RECV (Receive)	Demod Lock	Indicates either the demodulator or the following FEC decoder cannot lock to the incoming signal.
	AGC Alarm	Indicates if the demod signal level is out of range.
	Frame Sync	Indicates that the de-framing unit (EDMAC, IBS or IDR) or Reed-Solomon outer decoder cannot synchronize to the data being sent to it by the demod and/or FEC decoder.
	Buffer Slip	Occurs when Doppler or Plesiochronous effects cause the Rx data buffer to empty or fill completely, which results in a reset to 50%.
	Rx AIS	Alarm Indication Signal (all 1's) present at the Rx satellite input is monitored.
	EbNo Alarm	Occurs when the monitored level drops below that programmed by the user via menus: Config, Rx, EbNo Alarm point.
	Buffer Clock	Indicates that the desired buffer reference is not present, causing the buffer to fall back on Rx satellite timing to clock its output.
	LNB Fault Information (CDM-600L)	

XMT (Transmit)	No Clock	Clock activity from the Tx terrestrial source is checked, if expected. If absent, the modem falls back to the internal SCT clock to drive the modulator.
	FIFO Slip	Alarm occurs when the terrestrial clock source differs from the programmed data rate, or may indicate a hardware failure.
	Tx AIS	Alarm Indication Signal (all 1's) present at the Tx terrestrial input is monitored.
	AUPC Level	If AUPC is enabled, a Tx alarm occurs if the power increase limit has been reached.
	Hi-Stab Freq Ref Activity Fault	Reference not present; unit falls back to its internal 10MHz.
	BUC summary alarm	May occur only if ABA enabled.
	G.703 Loss of Signal	May only occur in Clock Extension Mode.
BUC (CDM-600L)	BUC current	
	BUC voltage	
	BUC checksum or bad comms	
	BUC PLL	
	BUC temperature	
LNB (CDM-600L)	LNB current	
	LNB voltage	

5.7.2 MONITOR: STORED-EVENTS

```

STORED EVENTS: CLEAR ALL: NO (NO, YES)
#199 FT-FRAME SYNC      23/07/01 16:25:24
    
```

An example of a Stored Events screen is shown here.

Use the [←][→] arrow keys to select the '#' character on the bottom line, then use the [↑][↓] arrow keys to scroll up and down through the event log entries. Press [ENT] or [CLR] to return to the previous menu.

The event log can store up to 199 events. When a fault condition occurs, it is time- & date-stamped and put into the log. Similarly, when the fault condition clears, this is also recorded.

Use the [←][→] arrow keys to select **Clear All**, then use the [↑][↓] arrow keys to change to **Yes** or **No**. Press [ENT] when done. If **Clear All=Yes** is selected, the event log is cleared and the user is returned directly to the previous menu. However, if there already are faults present on the unit at this time, they will be re-time-stamped, and new log entries will be generated.

Note that, in accordance with international convention, the date is shown in **DAY-MONTH-YEAR** format.

5.7.3 MONITOR: STATISTICS

```
STATISTICS: STA114: 16.0,16.0,9.0,9.0
09/12/99 14:48:06 CLEAR ALL: NO (N/Y)
```

Scroll backwards or forwards through the entries in the statistics log using the [↑][↓] arrow keys. Press [ENT] or [CLR] to return to the previous menu.

The top line displays the log entry number and Statistics log. The bottom line of the display indicates the time and date of the entry shown in **DAY-MONTH-YEAR** format.

The display shows the statistics data that has been measured and recorded. The statistics log can store up to 199 log entries. (To enable statistics logging, see **Sect. 5.4.13 CONFIG: STATISTICS**.)

The meaning and format of the numbers is as follows:

- The user defines a measurement interval (see **CONFIG: STATISTICS**) and during this interval, Eb/No and Transmit Power Level Increase (TPLI) are observed, at a 1 second rate.
- At the end of this period, the average Eb/No is calculated and recorded, and the minimum value seen in the interval.
- Similarly, the average TPLI is calculated, along with the highest value seen in the interval.



If the demod has lost lock during the measurement interval, the minimum Eb/No will show 'LOSS' rather than indicate a value. However, the average value (while the demod was locked) will still be calculated and shown. If, on the other hand, the demodulator has been unlocked for the entire measurement interval, the average Eb/No will also show 'Loss'. (The display will show 'Loss, Loss'.)

- If the measured values are ≥ 16.0 dB, the display will show 16.0 dB.
- If **AUPC** is not enabled, the values of maximum and average TPLI will both show '0.0'.

Example:

08.0, 13.5, 2.5, 1.8 means:

- Minimum Eb/No observed in the measurement interval = 8.0 dB
- Average Eb/No observed in the measurement interval = 13.5 dB
- Maximum TPLI observed in the measurement interval = 2.5 dB
- Average TPLI observed in the measurement interval = 1.8 dB

Example:

LOSS, 04.5, 0.0, 0.0 means:

- There was a loss of demod lock during the measurement interval
- Average Eb/No observed in the measurement interval = 4.5 dB
- Maximum TPLI observed in the measurement interval = 0 dB
- Average TPLI observed in the measurement interval = 0 dB (which indicates no AUPC activity, or that AUPC is disabled.)

Use the [←][→] arrow keys to select the [CLR]-All option. Select **Yes** or **No** using the [↑][↓] arrow keys and press [ENT] to implement, or [CLR].

5.7.4 MONITOR: RX-PARAMS

```
RX=PARAMETERS: EbNo=11.4dB   ΔF=+11.7kHz  
BER=0.0E-9   BUFFER=51%   RX-LEVEL=-43dBm
```

If the demodulator is locked, this screen shows the following:

Eb/No	This shows the value of Eb/No calculated by the demodulator. The value referred to here is the energy per information bit (Ebi), divided by the noise spectral density (No).
ΔF	The frequency offset of the received carrier, in kHz, with a displayed resolution of 100 Hz.
BER	This is an estimate of the corrected BER.
Buffer	(Buffer fill state) This shows the fill state (in percent), of the receive Buffer. After a reset, it will read 50. A value <50% indicates that the buffer is emptying, and >50% indicates that it is filling.
Rx-Level	A dBm reading indicating the signal level of the desired receive carrier. Resolution: 0.5dB

5.7.5 MONITOR: AUPC-PARAM

```
AUPC-PARAMS:   REMOTE EbNo=6.8 dB  
TRANSMIT POWER INCREASE=1.2 dB
```

The top line displays the value of Remote Eb/No of the demodulator at the distant end of the satellite link. The REMOTE Eb/No will display **UNLOCK** if the remote Demod is unlocked.

The bottom line shows how much the AUPC system has increased the output power. If AUPC is not enabled, the value of TRANSMIT POWER INCREASE will show as 0.0 dB.

5.7.6 MONITOR: LNB (CDM-600L ONLY)

```
LNB:   CURRENT = xxx mA   Voltage = xx V
```

This submenu item permits the user to monitor configure a LNB (Low-Noise Block Downconverter), if connected. The monitor display shows the measured LNB current load and LNB voltage at the receive IF connector. *Refer to Appendix F. ODU (BUC, LNB) OPERATION VIA THE CDM-600L for complete details about the ODU operations associated with this modem-specific submenu item.*

5.7.7 MONITOR: BUC (CDM-600L ONLY)

```
BUC: CURRENT= 0000mA VOLT= 47.9V CLASS=N/A  
PWR=N/A   Amb=N/A   PLL=N/A   VER=NA
```

This submenu item permits the user to monitor configure a BUC (Block Upconverter), if connected. *Refer to Appendix F. ODU (BUC, LNB) OPERATION VIA THE CDM-600L for complete details about this modem-specific submenu item.*

5.8 SELECT: STORE/LOAD

```
CONFIGURATION: 0 LOAD STORE
`AVAILABLE`
```

The user can store up to 10 different modem configurations – 0 through 9. A location that is available is noted on the bottom line as ‘AVAILABLE’.

Move the cursor to the configuration location number using the [←][→] arrow keys. Edit the value using the [↑][↓] arrow keys. Next, select **Load** or **Store** using the [←][→] arrow keys, then press [ENT].

As a modem configuration is stored, the time and date is recorded. This time and date information is shown on the bottom line as the location number is edited.

STORE/LOAD: OVERRIDE CONFIGURATION

Whether storing into a location or loading into the working memory from a stored location, the user is required to confirm the request, as information will be overwritten:

```
Configuration: XX OVERRIDE: NO (YES, NO)
14:06:37 26/10/06
```

Select the Override choice, **YES** or **NO**, using the [↑][↓] arrow keys, then press [ENT].

5.9 SELECT: UTILITIES

```
UTILITIES: SET-RTC DISPLAY-BRIGHTNESS
LAMP 1:1-MANUAL-SWITCH EDIT-CIRCUIT-ID
```

Select **Set-RTC**, **Display-Brightness**, **Lamp, 1:1-Manual-Switch**, or **Edit-Circuit-ID** using the [←][→] arrow keys, then press [ENT].

5.9.1 UTILITIES: SET-RTC

```
EDIT REAL-TIME CLOCK:
TIME: 12:01:02 DATE: 26/10/06
```

To edit the time and date settings of the Real-Time Clock, select the digit to be edited using the [←][→] arrow keys, then edit the value of the digit using the [↑][↓] arrow keys. Press [ENT] when done.



Note that in accordance with international convention, the date is shown in DAY-MONTH-YEAR format.

5.9.2 UTILITIES: DISPLAY-BRIGHTNESS

```
EDIT DISPLAY BRIGHTNESS:
```

100%

To edit the brightness of the VFD (Vacuum Fluorescent Display), use the [↑][↓] arrow keys to select a suitable brightness level. The selectable values are **25%**, **50%**, **75%** or **100%**. Press [ENT] when done.

5.9.3 UTILITIES: LAMP

FRONT PANEL LAMP TEST: DISABLED
(ENABLED, DISABLED)

Select **Enable** or **Disable** using the [↑][↓] arrow keys, then press [ENT] to test all of the LEDs on the front panel. Normal operations resume upon completion of the test.

5.9.4 UTILITIES: 1:1-MANUAL-SWITCH

PRESS ENTER KEY TO FORCE UNIT INTO
STANDBY (1:1 ONLY)

If the unit is part of a 1:1 redundant pair of modems, and this unit is currently online, press [ENT] to cause the unit to switch to standby.

5.9.5 UTILITIES: EDIT-CIRCUIT-ID

EDIT THIS MODEM'S CIRCUIT ID:

This menu allow the user to enter a Circuit ID string. Use the [←][→] arrow keys to position the cursor on to the character to be edited, then edit the character using [↑][↓] arrow keys. The following characters are available:

[Space] () * + - , . / 0-9 and A-Z.

Only the bottom line (40 characters) is available. Once the Circuit ID string is composed, press [ENT].

5.10 SELECT: ODU (OUTDOOR UNIT)

CDM-600:

```
ODU CONTROL=DISABLE (DISABLE, ENABLE)
SYSTEM TYPE=STANDALONE (STANDALONE, 1:1)
```

CDM-600L:

```
ODU:   BUC-FSK   BUC-CONFIG   BUC-LO
        LNB-CONFIG                               LNB-LO
```

On the CDM-600, this menu branch permits the user to monitor and control a Comtech EF Data RF Transceiver (CSAT-5060 or KST-2000A/B), if connected. *Refer to Appendix E. ODU (CSAT-5060, KST-2000A/B) OPERATION VIA THE CDM-600 for complete details about this modem-specific menu branch.*

On the CDM-600L, this menu branch permits the user to configure a BUC (Block Upconverter) or LNB (Low-Noise Block Downconverter), if connected. *Refer to Appendix F. ODU (BUC, LNB) OPERATION VIA THE CDM-600L for complete details about this modem-specific menu branch.*

5.11 SELECT: FAST

```
FAST OPTIONS: SET   VIEW
MOTHERBOARD S/N 123456789   HW REV 2.0
```

FAST (Fully Accessible System Topology) is the way to enable new options in the modem. Contact Comtech EF Data to obtain the **FAST** code for the desired option.

Select SET or VIEW using [←][→] arrow keys, then press [ENT].

5.11.1 FAST: SET

```
ENTER 20 CHAR CODE BELOW AND PRESS ENTER
XXXXXXXXXXXXXXXXXXXXXX
```

This menu is used to enable new **FAST** options in the modem. Obtain the **FAST** code for the new option from Comtech EF Data. Enter the code *carefully*. Use the [←][→] arrow keys to move the cursor to each character, then use the [↑][↓] arrow keys to edit the character. When all characters are edited, press [ENT].

The modem will respond with “**Configured Successfully**” if the new **FAST** option has been accepted; otherwise, you may return to the menu to edit further.

5.11.2 FAST: VIEW

```
VIEW OPTIONS: 10 9 8 7 6 5 4 3 2 1
2 Audio           Installed
```

Use the [↑][↓] arrow keys to show which **FAST** options are currently installed.

Chapter 6. FORWARD ERROR CORRECTION OPTIONS

6.1 Introduction

As standard, the CDM-600/600L Modem is equipped with four Forward Error Correction (FEC) encoders/decoders – Viterbi, Sequential, concatenated Reed-Solomon, and Trellis (TCM, available with the 8-PSK FAST option). The constraint lengths and encoding polynomials are not only Open Network compatible, but are also Closed Network compatible with the vast majority of existing modems from other manufacturers. Comtech EF Data has performed compatibility testing to ensure interoperability.

Turbo Coding represents a very significant development in the area of FEC and, optionally, the CDM-600/600L may be fitted with one of two Turbo Product Codecs They are plug-in daughter cards (SIMM modules), both field upgradeable:

- The Low Rate option provides data rate capability up to 5 Mbps, and code rates limited to Rate 5/16 (BPSK, Rate 21/44 (BPSK) and Rate 3/4 (QPSK, OQPSK, 8-PSK and 16-QAM).
- The High Rate option provides data rate capability up to 20 Mbps, in addition to Rate 7/8 and Rate 0.95 capability.

Now, **Low-Density Parity Check (LDPC)** coding is being offered in addition to the TPC options. In some instances this provides even better performance than TPC. A third option card, again field upgradeable, combines LDPC and TPC together on one module. This provides the best Forward Error Correction technology currently available, and is offered with a sufficient range of code rates and modulation types that link performance can be optimized under any conditions.

6.2 Viterbi

The combination of convolutional coding and Viterbi decoding has become an almost universal standard for satellite communications. The CDM-600/600L complies with the Intelsat IESS 308/309 standards for Viterbi decoding with a constraint length of seven. This is a *de facto* standard, even in a closed network environment, which means almost guaranteed inter-operability with other manufacturer's equipment. It provides very useful levels of coding gain, and its short decoding delay and error-burst characteristics make it particularly suitable for low data rate coded voice applications. It has a short constraint length, fixed at 7, for all code rates. (The constraint

length is defined as the number of output symbols from the encoder that are affected by a single input bit.)

By choosing various coding rates (Rate 1/2, 3/4 or 7/8) the user can trade off coding gain for bandwidth expansion. Rate 1/2 coding gives the best improvement in error rate, but doubles the transmitted data rate, and hence doubles the occupied bandwidth of the signal. Rate 7/8 coding, at the other extreme, provides the most modest improvement in performance, but only expands the transmitted bandwidth by 14%. A major advantage of the Viterbi decoding method is that the performance is independent of data rate, and does not display a pronounced threshold effect (i.e., does not fail rapidly below a certain value of E_b/N_o). This is not true of the Sequential decoding method, as explained in the section below. Note that in BPSK mode, the CDM-600/600L only permits a coding rate of 1/2. Because the method of convolutional coding used with Viterbi, the encoder does not preserve the original data intact, and is called *non-systematic*.

Table 6-1. Viterbi Decoding Summary

FOR	AGAINST
Good BER performance – very useful coding gain.	Higher coding gain possible with other methods
Almost universally used, with <i>de facto</i> standards for constraint length and coding polynomials.	
Shortest decoding delay (~100 bits) of any FEC scheme – good for coded voice, VOIP, etc.	
Short constraint length produces small error bursts – good for coded voice.	
No pronounced threshold effect – fails gracefully.	
Coding gain independent of data rate.	

6.3 Sequential

Although the method of convolutional coding and Sequential decoding appears to be very similar to the Viterbi method, there are some fundamental differences. To begin with, the convolutional encoder is said to be *systematic* – it does not alter the input data, and the FEC overhead bits are simply appended to the data. Furthermore, the constraint length, k , is much longer (Rate 1/2, $k=36$. Rate 3/4, $k=63$. Rate 7/8, $k=87$). This means that when the decoding process fails (that is, when its capacity to correct errors is exceeded) it produces a burst of errors which is in multiples of half the constraint length. An error distribution is produced which is markedly different to that of a Viterbi decoder. This gives rise to a pronounced threshold effect.

A Sequential decoder does not fail gracefully – a reduction in E_b/N_o of just a few tenths of a dB can make the difference between acceptable BER and a complete loss of synchronization. The decoding algorithm itself, called the Fano algorithm, uses significantly more path memory – 4 kbps in this case – than the equivalent Viterbi decoder, giving rise to increased latency.

Furthermore, a fixed computational clock is used to process input symbols, and to search backwards and forwards in time to determine the correct decoding path. At lower data rates there are sufficient number of computational cycles per input symbol to permit the decoding process to perform optimally. However, as the data rate increases, there are fewer cycles available, leading to a reduction in coding gain. This is clearly illustrated in the performance curves that follow. For

data rates above ~1 Mbps, Viterbi should be considered the better alternative. The practical upper limit at this time is 2.048 Mbps.

Table 6-2. Sequential Decoding Summary

FOR	AGAINST
Higher coding gain (1-2 dB) at lower data rates, compared to Viterbi.	Pronounced threshold effect – does not fail gracefully in poor E_b/N_o conditions.
	Higher processing delay than Viterbi (~4 k bits) – not good for low-rate coded voice.
	Upper data rate limit approximately 2Mbps
	Coding gain varies with data rate – favors lower data rates.

6.4 Reed-Solomon Outer Codec



It cannot be emphasized strongly enough that the purpose of the concatenated Reed-Solomon is to dramatically improve the BER performance of a link under given noise conditions. It should NOT be considered as a method to reduce the link EIRP requirement to produce a given BER. Factors such as rain-fade margin, particularly at Ku-band, are extremely important, and reducing link EIRP can seriously degrade the availability of such a link.

The concatenation of an outer Reed-Solomon (Reed-Solomon) Codec with Viterbi decoder first became popular when it was introduced by Intelsat in the early 1990's. It permits significant improvements in error performance without significant bandwidth expansion. The coding overhead added by the Reed-Solomon outer Codec is typically around 10%, which translates to a 0.4 dB power penalty for a given link. Reed-Solomon codes are block codes (as opposed to Viterbi and Sequential, which are convolutional), and in order to be processed correctly the data must be framed and de-framed.

Additionally, Reed-Solomon codes are limited in how well they can correct errors that occur in bursts. This, unfortunately, is the nature of the uncorrected errors from both Viterbi and Sequential decoders, which produce clusters of errors that are multiples of half the constraint length. (This is particularly severe in the case of Sequential, where the constraint lengths are considerably longer than Viterbi.) For this reason, the data must be interleaved following Reed-Solomon encoding, and is then de-interleaved prior to decoding. This ensures that a single burst of errors leaving the Viterbi or Sequential decoder is spread out over a number of interleaving frames, so errors entering the Reed-Solomon decoder do not exceed its capacity to correct those errors. In the case of the CDM-600/600L, different Reed-Solomon code rates are used, according to the mode of operation:

Closed Network Modes: A 220,200 code is used in transparent closed network modes, and a 200,180 code is used in framed (EDMAC) modes. (220,200 means that data is put into blocks of 220 bytes, of which 200 bytes are data, and 20 bytes are FEC overhead.) These two codes were chosen because they fit well into Comtech EF Data's clock generation scheme, and they have

almost identical coding gain. There is also a 225, 205 code available that it compatible with legacy EF Data modems.

When Viterbi decoding is used as the primary FEC, an interleaver depth of 4 is used. When Sequential decoding is used, an interleaver depth of 8 is used. The increase in coding gain is at the expense of delay. The interleaving/de-interleaving delay and the delay through the decoder itself can be as high as 25 kbps. At very low data rates, this equates to several seconds, making it highly unsuitable for voice applications. Additionally, the de-interleaver frame synchronization method can add significantly to the time taken for the demodulator to declare acquisition.

Open Network Modes:

Code Rate	Mode
219, 201	Standard IESS-308 E1, and IESS-310 mode
225, 205	Standard IESS-308 T1
194, 178	Standard IESS-308 T2/E2
126, 112	Standard IESS-309 modes

A characteristic of concatenated Reed-Solomon coding is the very pronounced threshold effect. For any given modem design, there will be a threshold value of E_b/N_o below which the demodulator cannot stay synchronized. This may be due to the carrier-recovery circuits, or the synchronization threshold of the primary FEC device, or both. In the CDM-600/600L, and Rate 1/2 operation, this threshold is around 4 dB E_b/N_o . Below this value, operation is not possible, but above this value, the error performance of the concatenated Reed-Solomon system produces exceptionally low error rates for a very small increase in E_b/N_o .



Care should be taken not to operate the demodulator near its sync threshold. Small fluctuations in E_b/N_o may cause total loss of the link, with the subsequent need for the demodulator to re-acquire the signal.

Table 6-3. Concatenated Reed-Solomon Coding Summary

FOR	AGAINST
Exceptionally good BER performance – several orders of magnitude improvement in link BER under given link conditions.	Very pronounced threshold effect – does not fail gracefully in poor E_b/N_o conditions. Additional coding overhead actually degrades sync threshold, and reduces link fade margin.
Very small additional bandwidth expansion	Significant processing delay (~25 kbps) – not good for voice, or IP applications
	Adds to demod acquisition time.

6.5 Trellis Coding (FAST Option)

In the other FEC methods described here, the processes of coding and modulation are independent – the FEC codec has no knowledge of, or interaction with the modulator. However, there are schemes in which the coding and modulation are combined together, where the encoder places FEC symbols in a precise manner into the signal constellation. This can yield an overall improvement in performance, and is used in higher-order modulation schemes, such as 8-PSK, 16-PSK, 16-QAM, etc. When convolution coding is used, the overall *coded modulation* approach is referred to as Trellis Coded Modulation (TCM). Ungerboeck was an early pioneer, and developed optimum mapping and decoding schemes. However, the decoding scheme was seen as complex, and

expensive, and Qualcomm Inc. developed a variation on the theme, which uses a Viterbi decoder at the core, surrounded by adjunct processing. The scheme is able to achieve performance very close to the optimum Ungerboeck method, but with far less complexity, and is called *pragmatic Trellis Coded Modulation*.

Now, Intelsat recognized that, as more and more high power transponders are put in to service, the transponders are no longer *power limited*, but *bandwidth limited*. In order to maximize transponder capacity, they looked at 8-PSK as a method of reducing the occupied bandwidth of a carrier, and adopted Qualcomm’s pragmatic TCM, at Rate 2/3.

A Rate 2/3 8-PSK/TCM carrier occupies only 50% of the bandwidth of a Rate 1/2 QPSK carrier. However, the overall coding gain of the scheme is not adequate by itself, and so Intelsat’s IESS-310 specification requires that the scheme be concatenated with an outer Reed-Solomon codec. When combined, there is a threshold value of E_b/N_o of around 6 dB, and above approximately 7 dB, the bit error rate is better than 1×10^{-8} .

The detractions of the concatenated Reed-Solomon approach apply here also, along with more stringent requirements for phase noise and group delay distortion – the natural consequences of the higher-order modulation.

The CDM-600/600L fully implements the IESS-310 specification at data rates up to 20 Mbps. In accordance with the specification, the Reed-Solomon outer code can be disabled. Performance curves for both cases are shown in the figures that follow later in this chapter.

Table 6-4. 8-PSK/TCM Coding Summary

FOR	AGAINST
Exceptionally bandwidth efficient compared to QPSK	Needs concatenated Reed-Solomon outer codec to give acceptable coding gain performance
	Demod acquisition threshold much higher than for QPSK
	8-PSK is more sensitive to phase noise and group delay distortion than QPSK

6.6 Turbo Product Codec (Hardware Option)

Turbo coding is an FEC technique developed within the last few years, which delivers significant performance improvements compared to more traditional techniques. Two general classes of Turbo Codes have been developed, Turbo Convolutional Codes (TCC), and Turbo Product Codes (TPC, a block coding technique). Comtech EF Data has chosen to implement an FEC codec based on TPC. A Turbo Product Code is a 2 or 3 dimensional array of block codes. Encoding is relatively straightforward, but decoding is a very complex process requiring multiple iterations of processing for maximum performance to be achieved.

Unlike the popular method of concatenating a Reed-Solomon codec with a primary FEC codec, Turbo Product Coding is an entirely stand-alone method. It does not require the complex interleaving/de-interleaving of the Reed-Solomon approach, and consequently, decoding delays are significantly reduced. Furthermore, the traditional concatenated Reed-Solomon schemes exhibit a very pronounced threshold effect – a small reduction in E_b/N_o can result in total loss of demod and decoder synchronization. TPC does not suffer from this problem – the demod and decoder remain synchronized down to the point where the output error rate becomes unusable. This is considered to be a particularly advantageous characteristic in a fading environment.

Typically, in QPSK, 8-PSK and 16-QAM TPC modes the demod and decoder can remain synchronized **2 – 3 dB below** the Viterbi/Reed-Solomon or TCM cases.

6.7 TPC and Low Density Parity Check (LDPC) coding

6.7.1 Introduction

In the past few years there has been an unprecedented resurgence in interest in Forward Error Correction (FEC) technology. The start of this new interest has its origins in the work done by Claude Berrou *et al*, and the landmark paper in 1993 – *Near Shannon Limit Error Correcting Coding and Decoding – Turbo Codes*. FEC is considered an essential component in all wireless and satellite communications in order to reduce the power and bandwidth requirements for reliable data transmission.

Claude Shannon, considered by many to be the father of modern communications theory, first established in his 1948 paper, *A Mathematical Theory of Communication*, the concept of Channel Capacity. This places an absolute limit on how fast it is possible to transmit error-free data within a channel of a given bandwidth, and with given noise conditions within that channel. He concluded that it would only be possible to approach this limit through the use of source encoding – what is familiar today as Forward Error Correction. He postulated that, if it were possible to store every possible message in the receiver, finding the stored message that most closely matched the incoming message would yield an optimum decoding method. However, for all but the shortest bit sequences, the memory required for this – and the time taken to perform the comparisons – makes this approach impractical. For all practical purposes, the memory requirement and the decoding latency become infinite.

For many years, there were few advances in the quest to approach the Shannon Limit. The Viterbi algorithm heralded a major step forward, followed in the early 1990s by the concatenation of a Viterbi decoder with Reed-Solomon hard-decision block codes. However, it remained clear that the Shannon Limit was still an elusive target. Berrou's work on Turbo Codes showed, through the use of an ingeniously simple approach – multiple, or *iterative* decoding passes – that it is possible to achieve performance close to the Shannon Limit. Berrou's early work dealt exclusively with iteratively-decoded convolutional codes (Turbo Convolutional Coding, or TCC) but, in time, the iterative approach was applied to a particular class of block codes called Product Codes – hence **Turbo Product Coding (TPC)**. TPC exhibits inherently low decoding latency compared with TCC, and so is considered much more desirable for 2-way interactive satellite communications applications.

In August 1999, Comtech became the first company in the world to offer, on a commercial basis, satellite modems that incorporate TPC. Since its inception, Comtech has continued to develop and refine its implementation of TPC in its products, and now offers a comprehensive range of code rates (from Rate 5/16 to Rate 0.95) and modulations (from BPSK to 16-QAM).

However, in the past few years, as part of the general interest in Turbo coding, a third class of Turbo coding has emerged, namely Low Density Parity Check Codes (LDPC). It is more like TPC than TCC, in that it is an iteratively-decoded block code. Gallager first suggested this in 1962, but at the time, the implementation complexity was considered to be too great, and for decades it remained of purely academic interest. In the present day, with silicon gates being

cheap, plentiful and fast, an LDPC decoder can easily be accommodated in a large Field Programmable Gate Array (FPGA) device. Further interest in LDPC was stimulated in 2003, when the Digital Video Broadcasting (DVB) committee adopted LDPC codes (proposed by Hughes Network Systems) as the basis for the new DVB-S2 standard.

The LDPC method on its own produces an undesirable ‘flaring’ in the Bit Error Rate (BER) vs. E_b/N_o characteristic, and for this reason it is desirable to concatenate a short BCH code with LDPC. This concatenation produces almost vertical BER vs. E_b/N_o curves, as can be seen in the performance graphs that are presented later in this chapter.

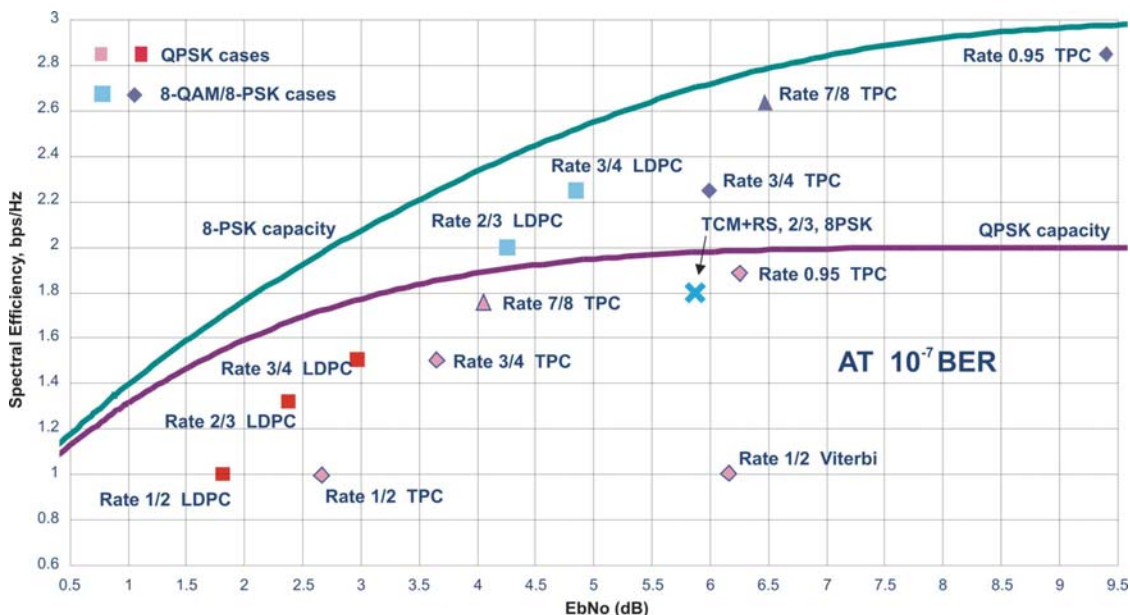
In order to take full advantage of the coding gain increase that LDPC provides, it became necessary to find an alternative to 8-PSK. Comtech EF Data has therefore developed an 8-QAM approach that permits acquisition and tracking at much lower values of E_b/N_o than 8-PSK. A discussion of this approach follows.

Comtech EF Data chose the CDM-600 platform as the first satellite modem in which to implement both LDPC and 8-QAM, followed by the CDM-600L.

6.7.2 LDPC versus TPC

So: Is LDPC better than TPC? The answer must be ‘sometimes, but not always’, and there are issues, such as latency, that must be taken into consideration. The graph shown below illustrates the performance of various TPC and LDPC modes relative to the Shannon Limit – the Channel Capacity is shown for both QPSK and 8-PSK. Error-free transmission is not possible for values of spectral efficiency (capacity) vs. E_b/N_o above these limit curves. The horizontal distance to the limit provides a metric of overall performance.

It can be seen from this graph that, for Code Rates above 3/4, Comtech’s TPCs are very close (1 to 1.5 dB) to the Shannon Limit. However, at 3/4 and below, LDPCs are performing 0.7 to 1.2 dB better than TPCs:



It is clear that, in order to provide the best possible performance over the range of code rates from 1/2 to 0.95, both an LDPC and a TPC codec need to be offered.

In order to meet this requirement, Comtech EF Data has developed a combination LDPC/TPC Codec module that can be added to the CDM-600/600L Modem, and which provides the operating modes shown in **Table 6-5**:

Table 6-5. Available TPC and LDPC Modes

Operating Mode	Rate	Data Rate Range	Comments
TPC Code Rate/ Modulation	Rate 21/44 BPSK	4.8 kbps to 3.2 Mbps	To 4.772 Mbps with High Rate Turbo card
	Rate 5/16 BPSK	4.8 kbps to 2.048 Mbps	To 3.12 Mbps with High Rate Turbo card
	Rate 1/2 QPSK, OQPSK	4.8 kbps to 9.54 Mbps	High Rate Turbo card only
	Rate 3/4 QPSK, OQPSK	7.2 kbps to 5.0 Mbps	To 15 Mbps with High Rate Turbo card
	Rate 3/4 8-PSK	10.8 kbps to 5.0 Mbps	To 20 Mbps with High Rate Turbo card
	Rate 3/4 16-QAM	14.4 kbps to 5.0 Mbps	
	Rate 7/8 QPSK, OQPSK	8.4 kbps to 17.5 Mbps	High Rate Turbo card only
	Rate 7/8 8-PSK	12.6 kbps to 20 Mbps	
	Rate 7/8 16-QAM	16.8 kbps to 20 Mbps	
	Rate 0.95 QPSK, OQPSK	9.1 kbps to 18.888 Mbps	
Rate 0.95 8-PSK	13.6 kbps to 20 Mbps		
LDPC Code Rate/ Modulation)	Rate 1/2 BPSK	4.8 kbps to 5.0 Mbps	TPC/LDPC Codec card only
	Rate 1/2 QPSK, OQPSK	4.8 kbps to 10.0 Mbps	
	Rate 2/3 QPSK, OQPSK	6.4 kbps to 13.3 Mbps	
	Rate 2/3 8-PSK , 8-QAM	9.6 kbps to 19.0 Mbps	
	Rate 3/4 QPSK, OQPSK	7.2 kbps to 15.0 Mbps	
	Rate 3/4 8-PSK , 8-QAM	10.8 kbps to 20.0 Mbps	
	Rate 3/4 16-QAM	14.4 kbps to 20.0 Mbps	

This new LDPC/TPC codec module may be installed in any existing CDM-600/600L, as a simple field upgrade, or already installed in new modems ordered from the factory. It requires Firmware Version 1.3.0 or higher to be installed in the CDM-600L; Firmware Version 1.6.0 or higher is required in the CDM-600.

Please contact the Sales Department at Comtech EF Data for pricing and delivery information.

Table 6-7 compares all TPC and LDPC modes available in Comtech EF Data’s CDM-600/600L, and shows E_b/N_0 performance and spectral efficiency (occupied bandwidth) for each case. This information will be of particular interest to satellite operators wishing to simultaneously balance transponder power and bandwidth. The large number of modes offered will permit, in the majority of cases, significant power and/or bandwidth savings when compared with existing schemes such as concatenated Viterbi/Reed-Solomon, or the popular 8-PSK/Trellis/Reed-Solomon (Intelsat IESS-310).

6.7.3 End-to-End Processing Delay

In many cases, FEC methods that provide increased coding gain do so at the expense of increased processing delay. However, with TPC, this increase in delay is very modest. Table 7-6 shows, for the CDM-600/600L, the processing delays for the major FEC types, including the three TPC modes:

Table 6-6. Turbo Product Coding Processing Delay Comparison

FEC Mode (64 kbps data rate)	End-to-end delay, ms
Viterbi, Rate 1/2	12
Sequential, Rate 1/2	74
Viterbi Rate 1/2 + Reed Solomon	266
Sequential Rate 1/2 + Reed Solomon	522
Turbo Product Coding, Rate 3/4, O/QPSK	47
Turbo Product Coding, Rate 21/44, BPSK	64
Turbo Product Coding, Rate 5/16, BPSK	48
Turbo Product Coding, Rate 7/8, O/QPSK	245 *
Turbo Product Coding, Rate 0.95, O/QPSK	69
LDPC Coding, Rate 1/2	248
LDPC Coding, Rate 2/3, O/QPSK	296
LDPC Coding, Rate 2/3, 8-PSK, 8-QAM	350
LDPC Coding, Rate 3/4, O/QPSK	321
LDPC Coding, Rate 3/4, 8-PSK, 8-QAM, 16-QAM	395

*A larger block is used for the Rate 7/8 code, which increases decoding delay.

Note that, in all cases, the delay is inversely proportional to data rate; so for 128 kbps, the delay values would be half of those shown above. It can be seen that the concatenated Reed-Solomon cases increase the delay significantly (due mainly to interleaving/de-interleaving), while the TPC cases yield delays which are less than or equal to Sequential decoding.

Table 6-7. Comparison of all Comtech EF Data TPC and LDPC Modes
(CDM-600L with LDPC/TPC Codec and Firmware Version 1.3.0)
(CDM-600 with LDPC/TPC Codec and Firmware Version 1.6.0)

Mode	Eb/No at BER = 10 ⁻⁶ (typical)	Eb/No at BER = 10 ⁻⁸ (typical)	Spectral Efficiency (bps per Hertz)	Symbol Rate	Occupied * Bandwidth for 1 Mbps Carrier
QPSK Rate 1/2 Viterbi *	5.5 dB	6.8 dB	1.00 bps/Hz	1.0 x bit rate	1190 kHz
BPSK Rate 1/2 LDPC	1.7 dB	1.9 dB	0.50 bps/Hz	2.0 x bit rate	2380 kHz
BPSK Rate 21/44 TPC	2.6 dB	2.9 dB	0.48 bps/Hz	2.1 x bit rate	2493 kHz
BPSK Rate 5/16 TPC	2.1 dB	2.4 dB	0.31 bps/Hz	3.2 x bit rate	3808 kHz
QPSK/OQPSK Rate 1/2 LDPC	1.7 dB	1.9 dB	1.00 bps/Hz	1.0 x bit rate	1190 kHz
QPSK/OQPSK Rate 1/2 TPC	2.6 dB	2.8 dB	0.96 bps/Hz	1.05 x bit rate	1246 kHz
QPSK/OQPSK Rate 2/3 LDPC	2.1 dB	2.3 dB	1.33 bps/Hz	0.75 x bit rate	892 kHz
QPSK/OQPSK Rate 3/4 LDPC	2.7 dB	2.9 dB	1.50 bps/Hz	0.67 x bit rate	793 kHz
QPSK/OQPSK Rate 3/4 TPC	3.3 dB	4.0 dB	1.50 bps/Hz	0.67 x bit rate	793 kHz
QPSK/OQSK Rate 7/8 TPC	4.0 dB	4.2 dB	1.75 bps/Hz	0.57 x bit rate	678 kHz
QPSK/OQPSK Rate 0.95 TPC	6.0 dB	6.5 dB	1.90 bps/Hz	0.53 x bit rate	626 kHz
8-PSK Rate 2/3 TCM ** and RS (IESS-310)	5.6 dB	6.2 dB	1.82 bps/Hz	0.56 x bit rate	666 kHz
8-QAM Rate 2/3 LDPC	4.3 dB	4.5 dB	2.00 bps/Hz	0.50 x bit rate	595 kHz
8-QAM Rate 3/4 LDPC	4.7 dB	5.0 dB	2.25 bps/Hz	0.44 x bit rate	529 kHz
8-PSK Rate 3/4 TPC	5.7 dB	6.3 dB	2.25 bps/Hz	0.44 x bit rate	529 kHz
8-PSK Rate 7/8 TPC	6.6 dB	6.8 dB	2.62 bps/Hz	0.38 x bit rate	453 kHz
8-PSK Rate 0.95 TPC	8.9 dB	9.9 dB	2.85 bps/Hz	0.35 x bit rate	377 kHz
16-QAM Rate 3/4 LDPC	6.4 dB	6.6 dB	3.00 bps/Hz	0.33 x bit rate	396 kHz
16-QAM Rate 3/4 TPC	7.0 dB	7.7 dB	3.00 bps/Hz	0.33 x bit rate	396 kHz
16-QAM Rate 7/8 TPC	7.7 dB	7.9 dB	3.50 bps/Hz	0.28 x bit rate	340 kHz
16-QAM Rate 3/4 ** Viterbi/Reed-Solomon	7.5 dB	8.0 dB	2.73 bps/Hz	0.37 x bit rate	435 kHz
16-QAM Rate 7/8 ** Viterbi/Reed-Solomon	9.0 dB	9.5 dB	3.18 bps/Hz	0.31 x bit rate	374 kHz

* The occupied bandwidth is defined at the width of the transmitted spectrum taken at the -10 dB points on the plot of power spectral density. This equates to 1.19 x symbol rate for the CDM-600L/600 transmit filtering.

** Included for comparative purposes

Table 6-8. TPC and LDPC Summary

FOR	AGAINST
Exceptionally good BER performance – significant improvement compared with every other FEC method in use today	Nothing!
Most modes have no pronounced threshold effect – fails gracefully	
Exceptional bandwidth efficiency	
Coding gain independent of data rate (in this implementation)	
Low decoding delay for TPC	
Easy field upgrade in CDM-600/600L	

6.8 Uncoded Operation (No FEC)

There are occasions where a user may wish to operate a satellite link with no forward error correction of any kind. For this reason, the CDM-600/600L offers this uncoded mode for three modulation types – BPSK, QPSK, and OQPSK. However, the user should be aware of some of the implications of using this approach.

PSK demodulators have two inherent undesirable features. The first of these is known as ‘phase ambiguity’, and is due to the fact the demodulator does not have any absolute phase reference, and in the process of carrier recovery, the demodulator can lock up in any of K phase states, where $K = 2$ for BPSK, $K = 4$ for QPSK. Without the ability to resolve these ambiguous states there would be a 1-in-2 chance that the data at the output of the demodulator would be wrong, in the case of BPSK. For QPSK, the probability would be 3 in 4.

The problem is solved in the case of BPSK by differentially encoding the data prior to transmission, and then performing the inverse decoding process. This is a very simple process, but has the disadvantage that it doubles the receive BER. For every bit error the demodulator produces, the differential decoder produces two.

The problem for QPSK is more complex, as there are 4 possible lock states, leading to 4 ambiguities. When FEC is employed, the lock state of the FEC decoder can be used to resolve two of the four ambiguities, and the remaining two can be resolved using serial differential encoding/decoding. However, when no FEC is being used, an entirely different scheme must be used. Therefore, in QPSK, a parallel differential encoding/decoding technique is used, but has the disadvantage that it again doubles the receive BER.

OQPSK is a different situation again, where the ambiguities result not only from not having an absolute phase reference, but also not knowing which of the two parallel paths in the demod, I or Q, contains the half-symbol delay. Another type of differential encoding is used, but yet again the error rate is doubled, compared to ideal.

NOTE: Whenever uncoded operation is selected, the modem offers the choice between enabling and disabling the differential encoder/decoder appropriate for the modulation type.

The second problem inherent in PSK demodulators is that of ‘data false-locking’.

In order to accomplish the task of carrier recovery, the demodulator must use a non-linear process. A second-order non-linearity is used for BPSK, and a fourth-order non-linearity is used for QPSK. When data at a certain symbol rate is used to modulate the carrier, the demodulator can lock at incorrect frequencies, spaced at intervals of one-quarter of the symbol rate away from the carrier. Fortunately, when FEC decoding is used, the decoder synchronization state can be used to verify the correct lock point has been achieved, and to reject the false locks.

However, if uncoded operation is used, there is no way to recognize a data false lock. The demodulator will indicate that it is correctly locked, but the data out will not be correct. In Firmware Version 1.3.1 or higher for both the CDM-600L and CDM-600, a new signal processing algorithm avoids this problem.



When using Firmware Versions prior to 1.3.0 for the CDM-600L and Firmware Versions prior to 1.3.1 for the CDM-600, Comtech EF Data strongly cautions users when using uncoded operation. If the acquisition sweep width exceeds one quarter of the symbol rate, there is a very high probability that the demodulator will false lock. For Firmware version 1.3.0 or higher for the CDM-600L, and FW Ver. 1.3.1 or higher for the CDM-600, the problem has been eliminated.

Example 1: A Firmware Version prior to 1.3.0 for the CDM-600L (FW Ver. 1.3.1 for the CDM-600) is being used, and the user selects 64 kbps QPSK, uncoded. The symbol rate will be half of this rate, or 32 ksymbols/second. One quarter of this equals 8 kHz. Therefore, the absolute maximum acquisition sweep range which should be considered is ± 8 kHz. If there is any frequency uncertainty on the incoming carrier, this should be subtracted from the sweep width. The problem becomes progressively better with increasing symbol rate.

Example 2: A Firmware Version of 1.3.0 (FW Ver. 1.3.1 for the CDM-600), or higher is used. There is no limitation on acquisition sweep width.

Comtech EF Data cannot be held responsible for incorrect operation if the user does not adhere to these guidelines when using uncoded operation.

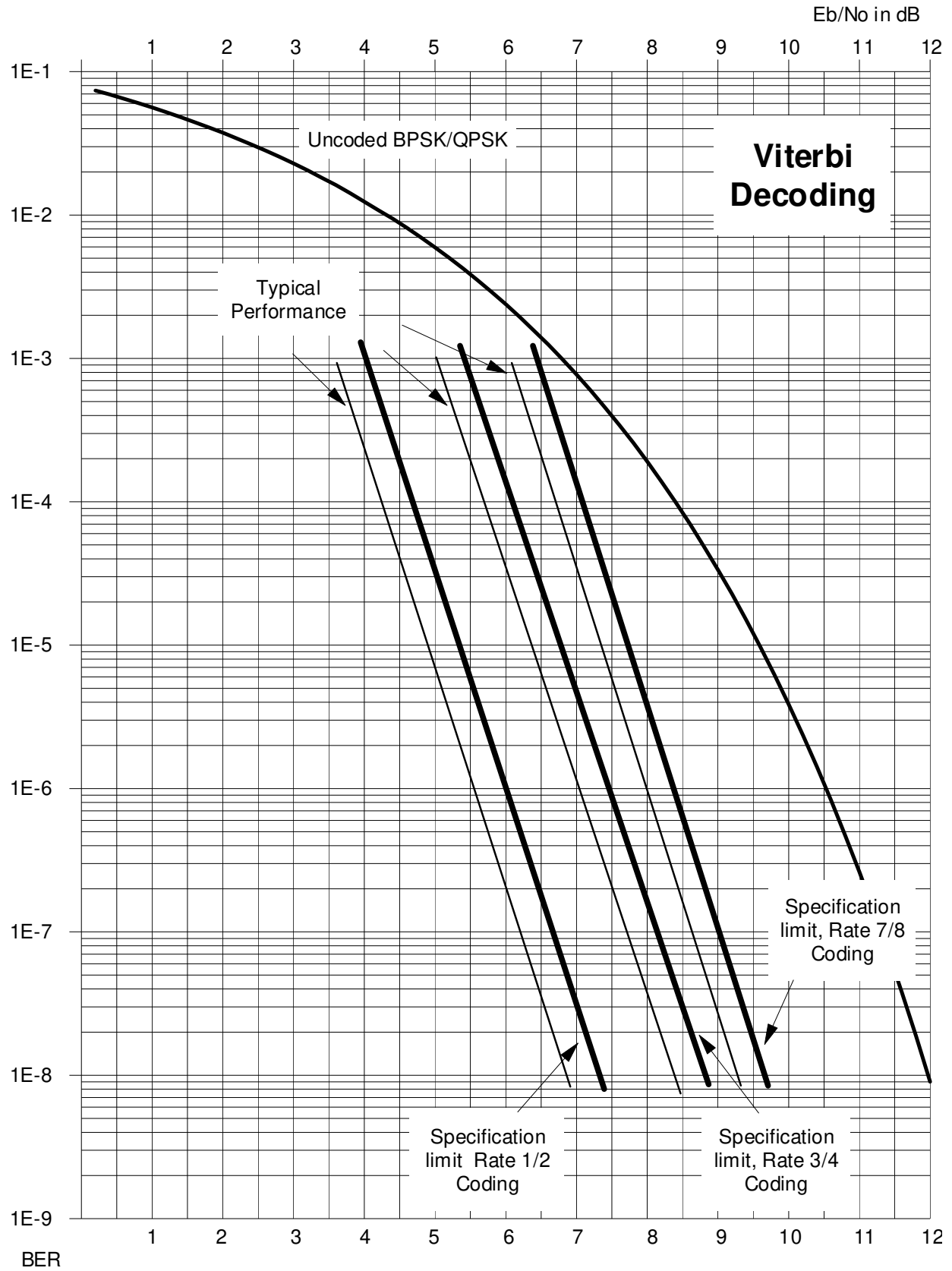


Figure 6-1. Viterbi Decoding

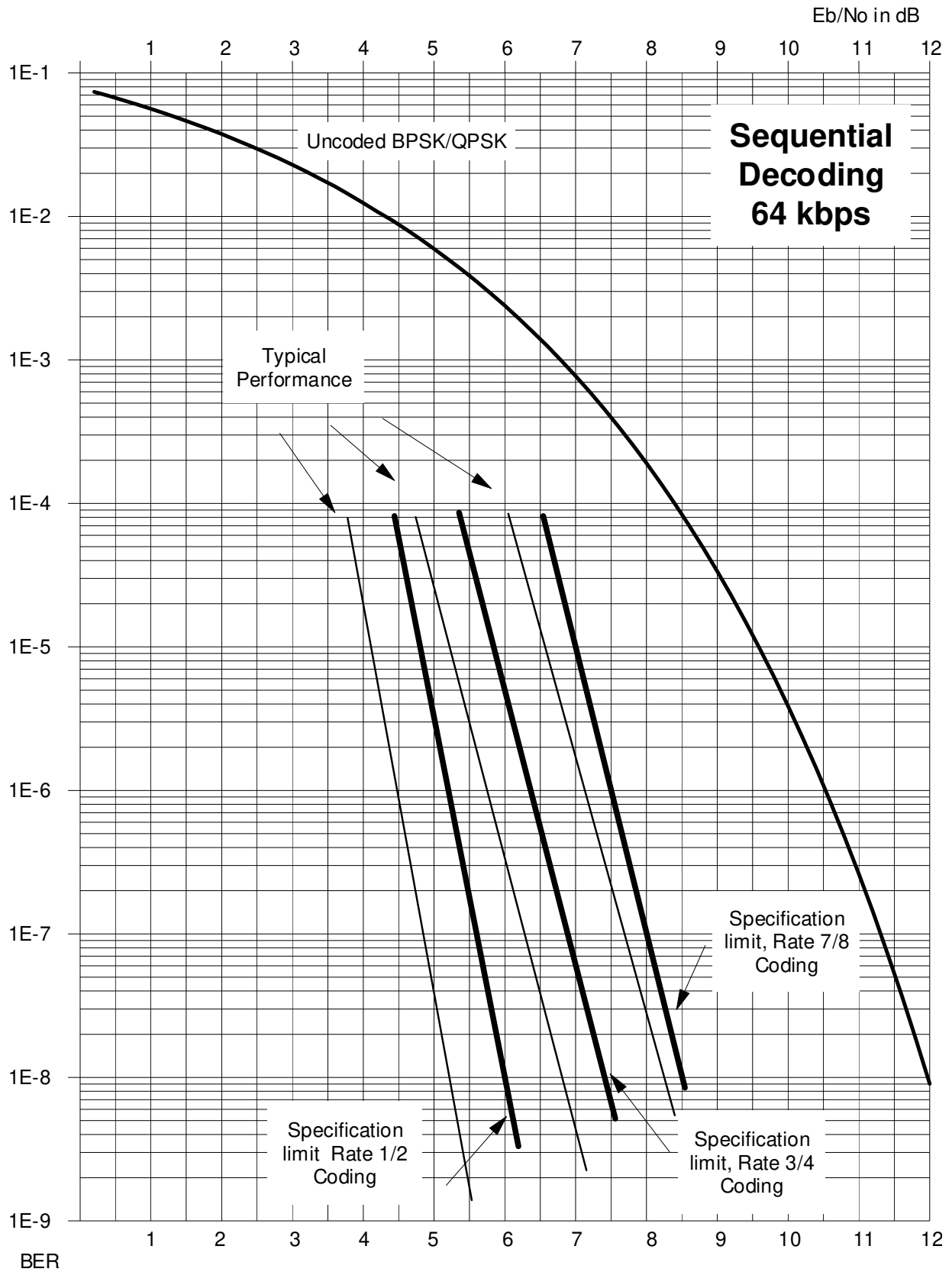


Figure 6-2. Sequential Decoding 64 kbps

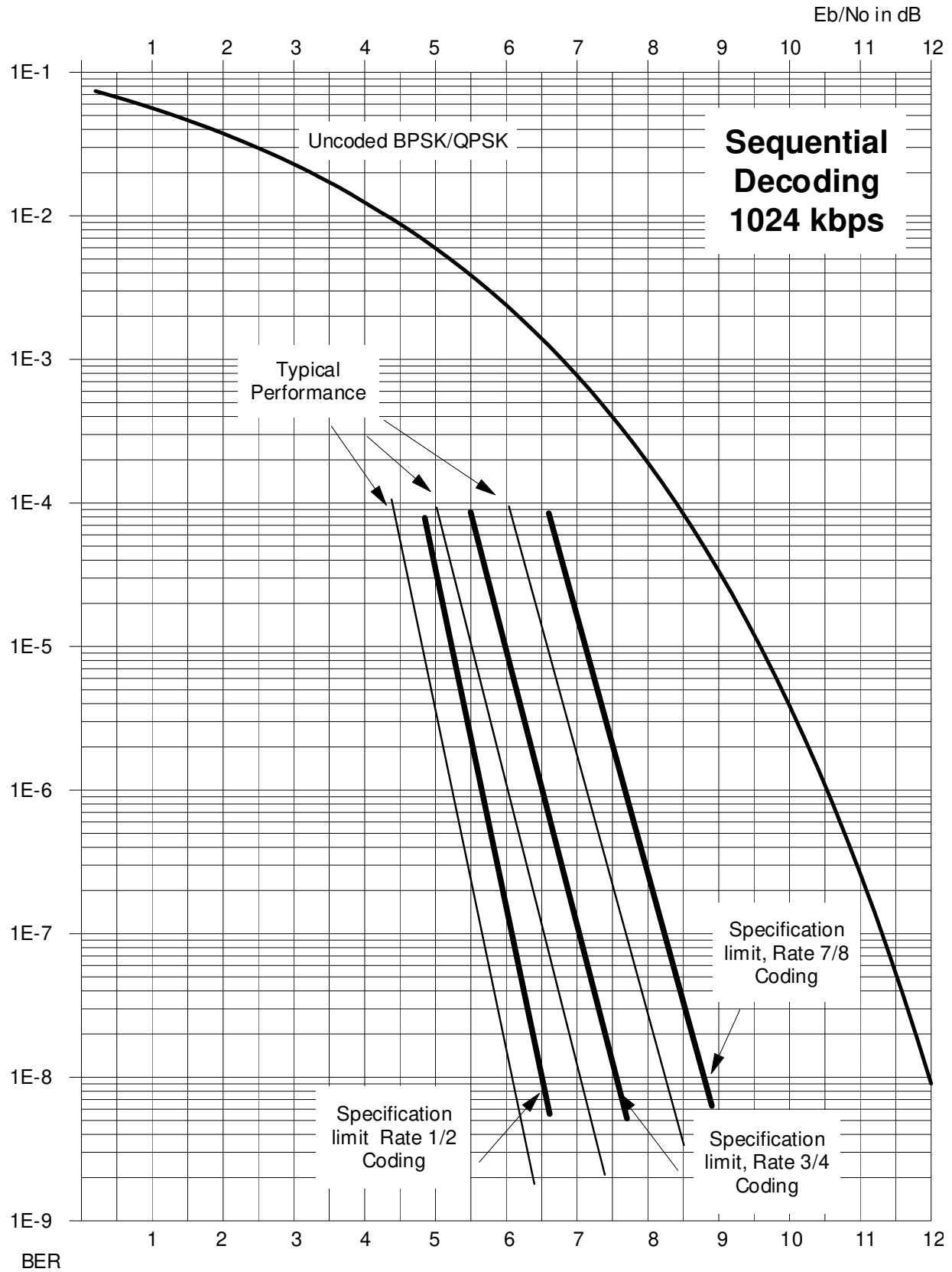


Figure 6-3. Sequential Decoding 1024 kbps

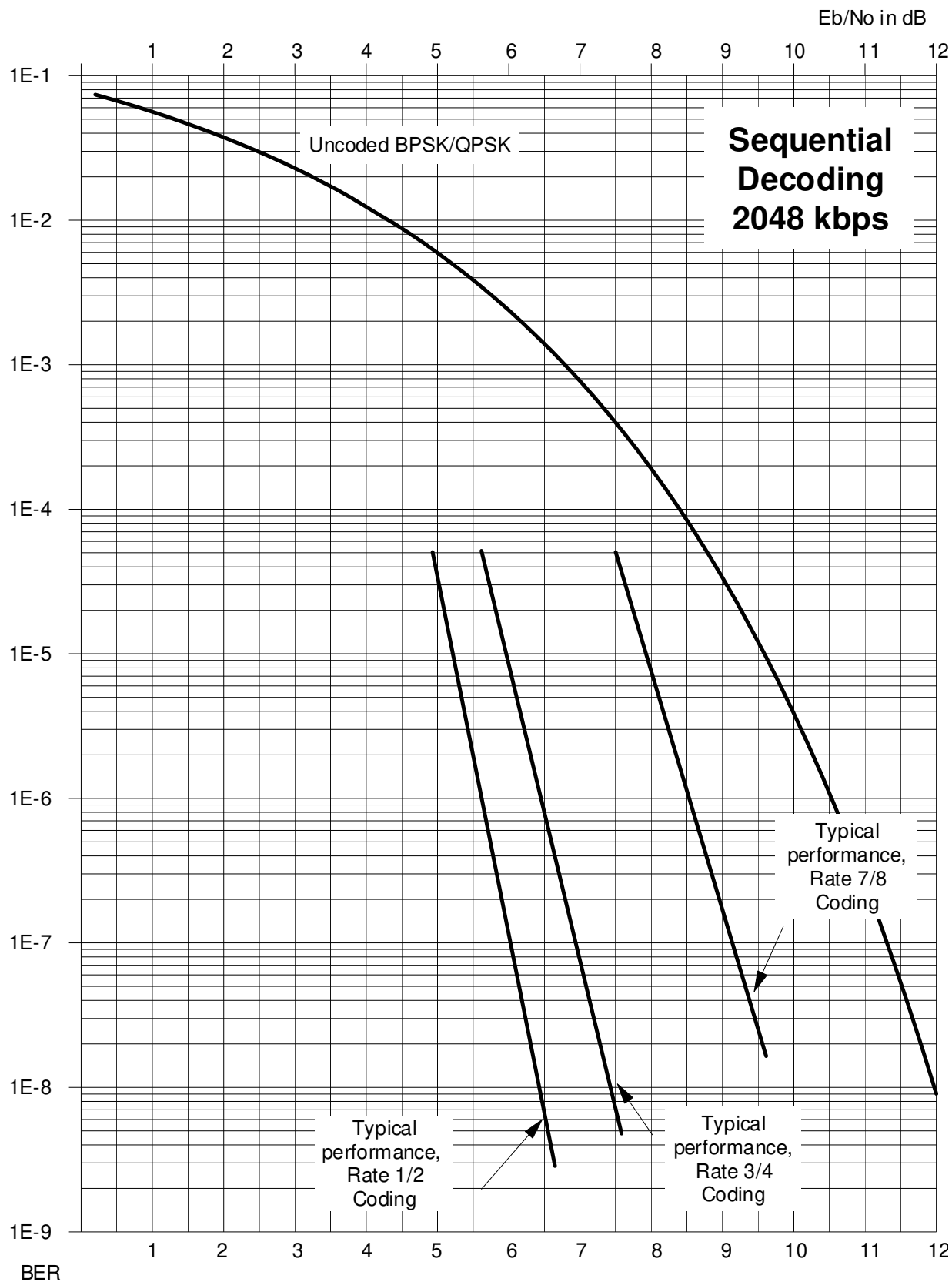


Figure 6-4. Sequential Decoding 2048 kbps

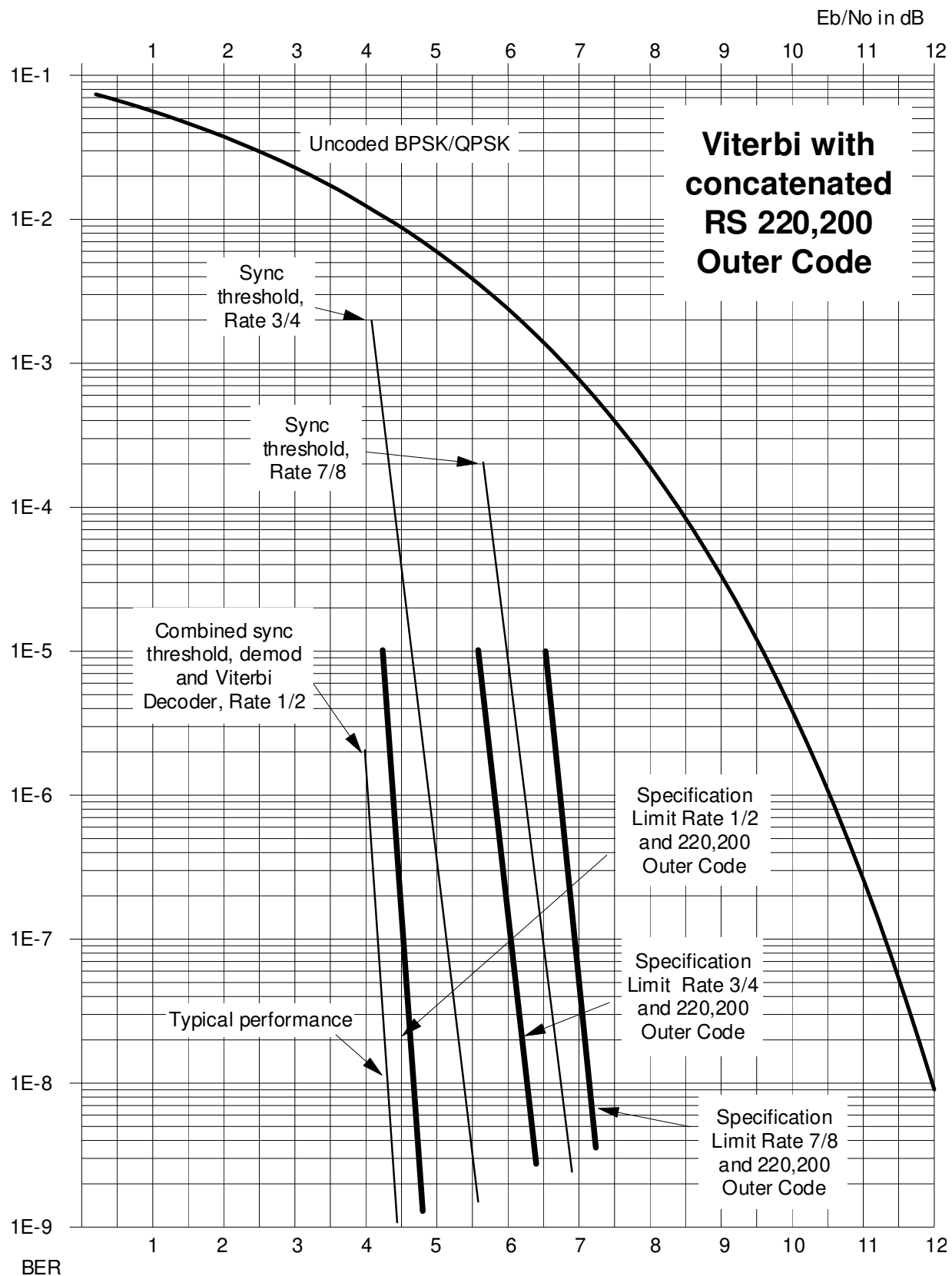


Figure 6-5. Viterbi with concatenated Reed-Solomon Outer Code

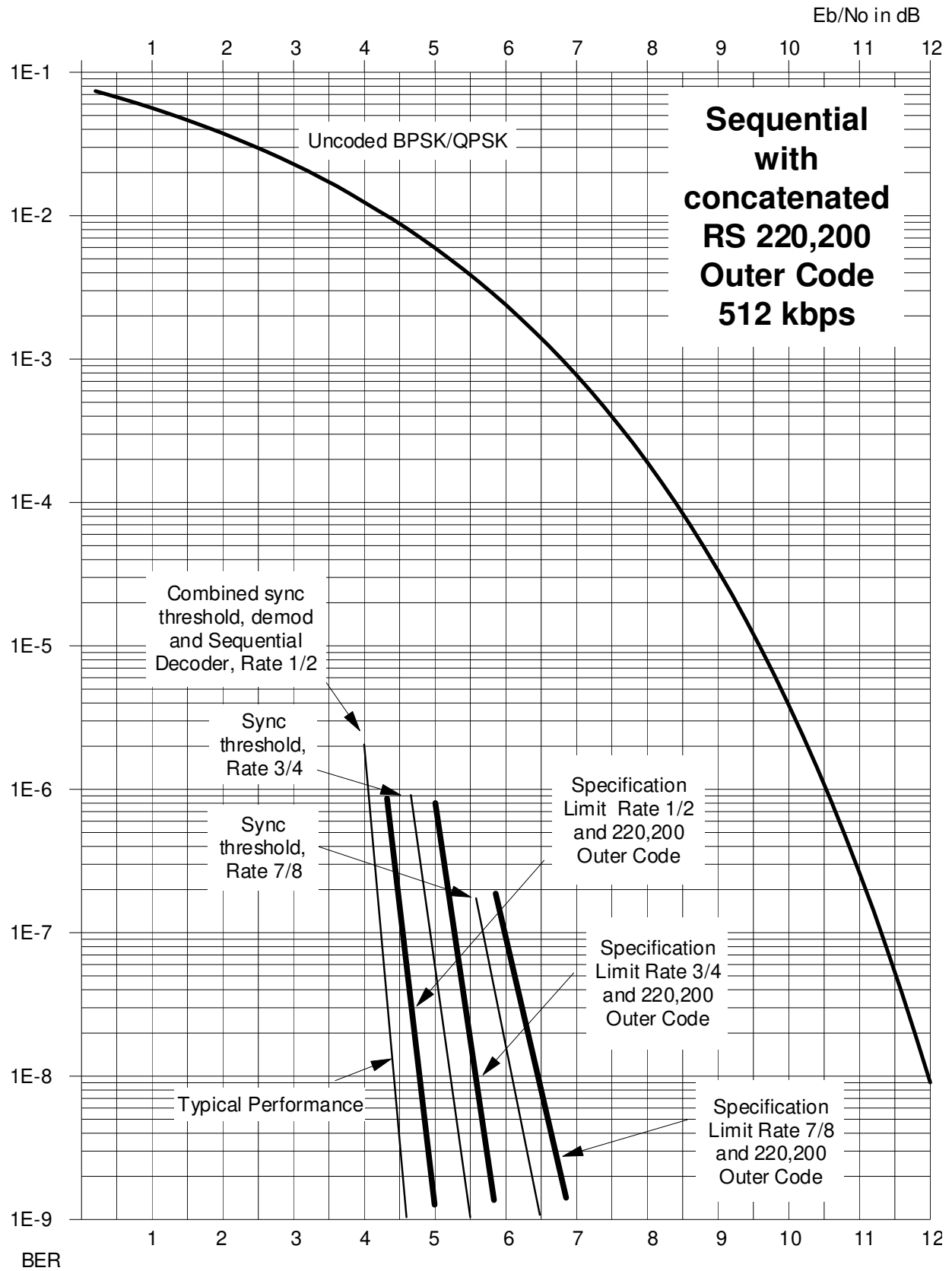


Figure 6-6. Sequential with concatenated Reed-Solomon Outer Code

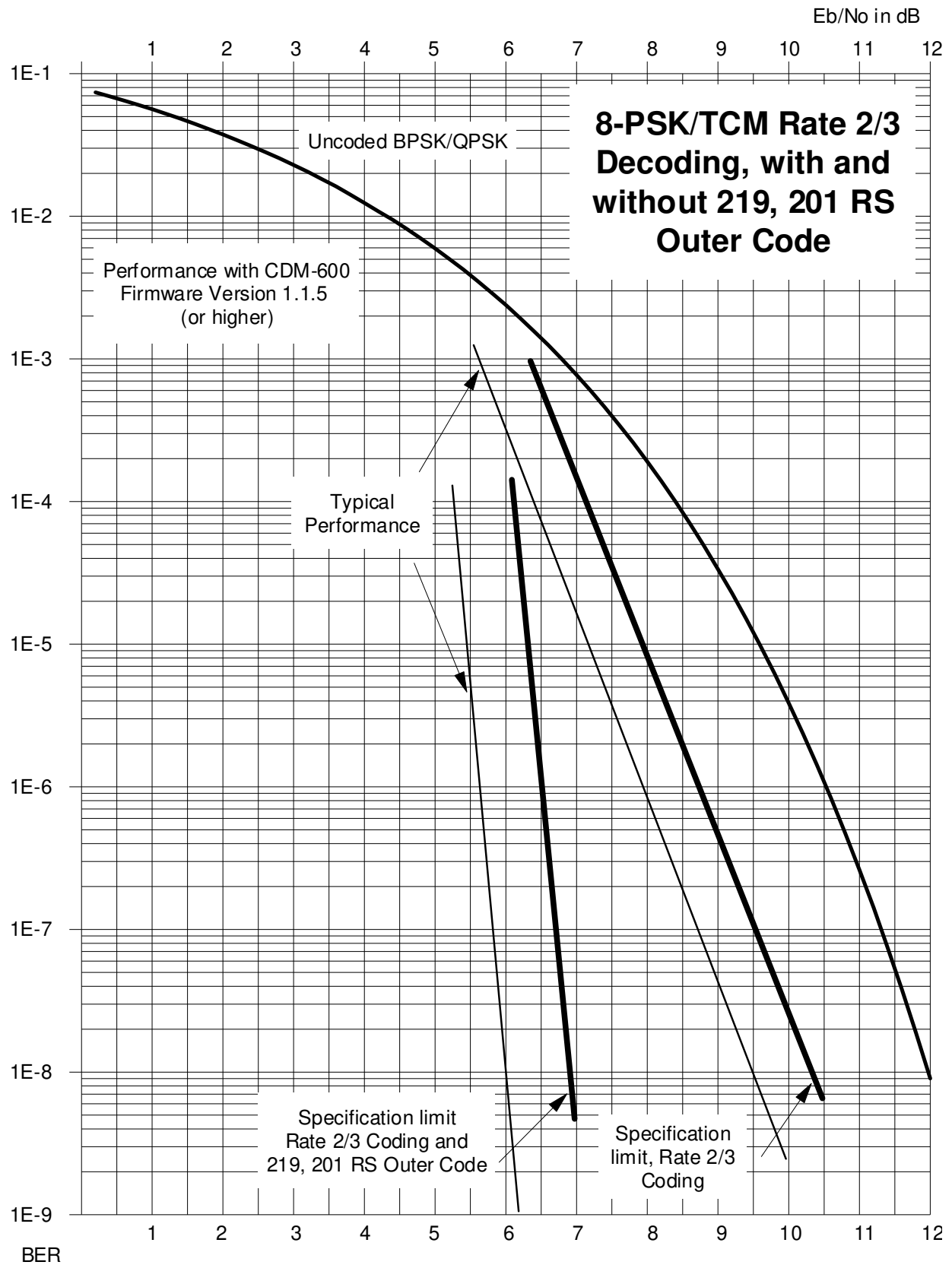


Figure 6-7. 8-PSK/TCM Rate 2/3 with and without concatenated Reed-Solomon Outer Code

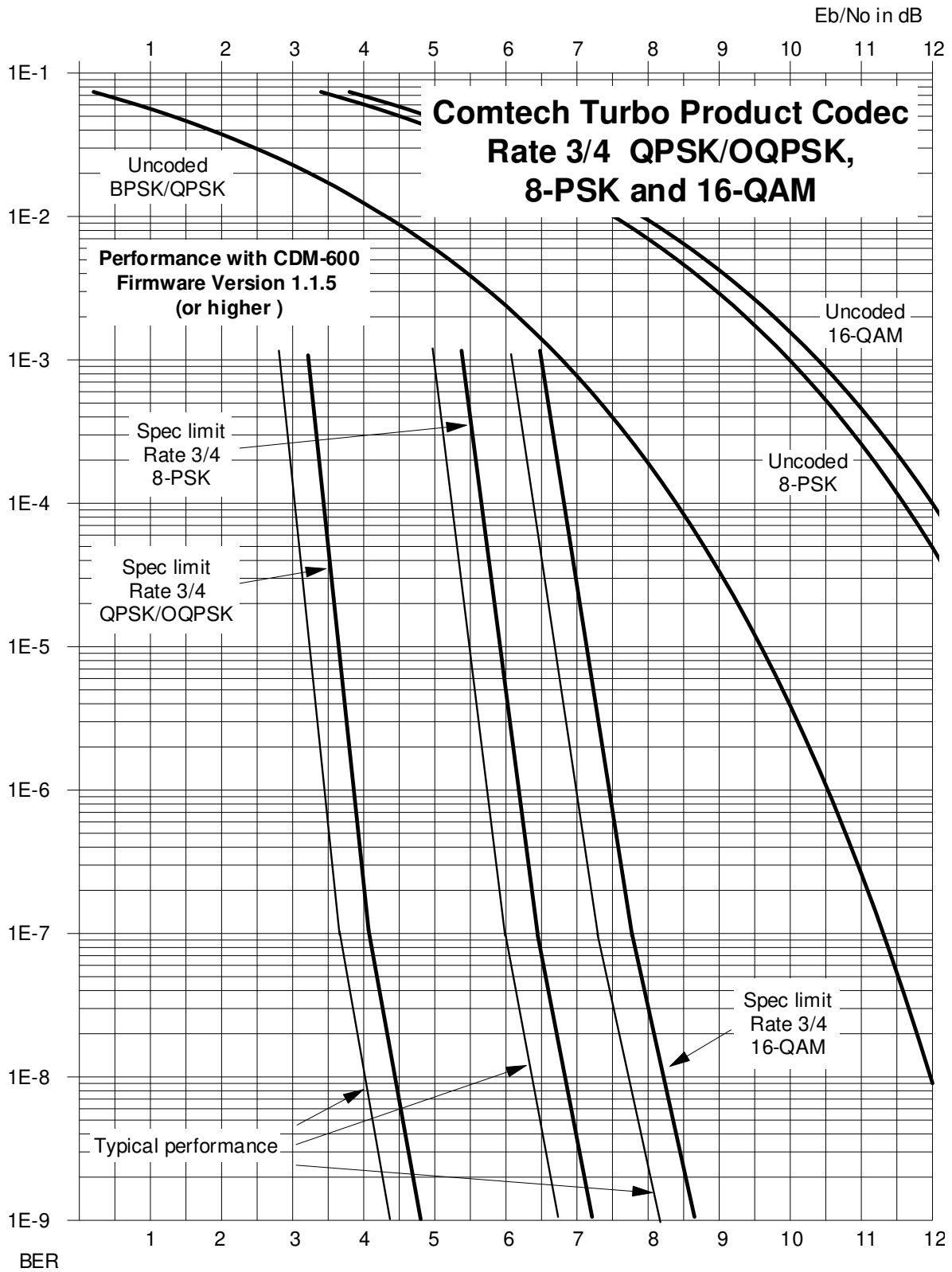


Figure 6-8. Comtech EF Data Turbo Product Codec Rate 3/4 QPSK/OQPSK, 8-PSK and 16-QAM

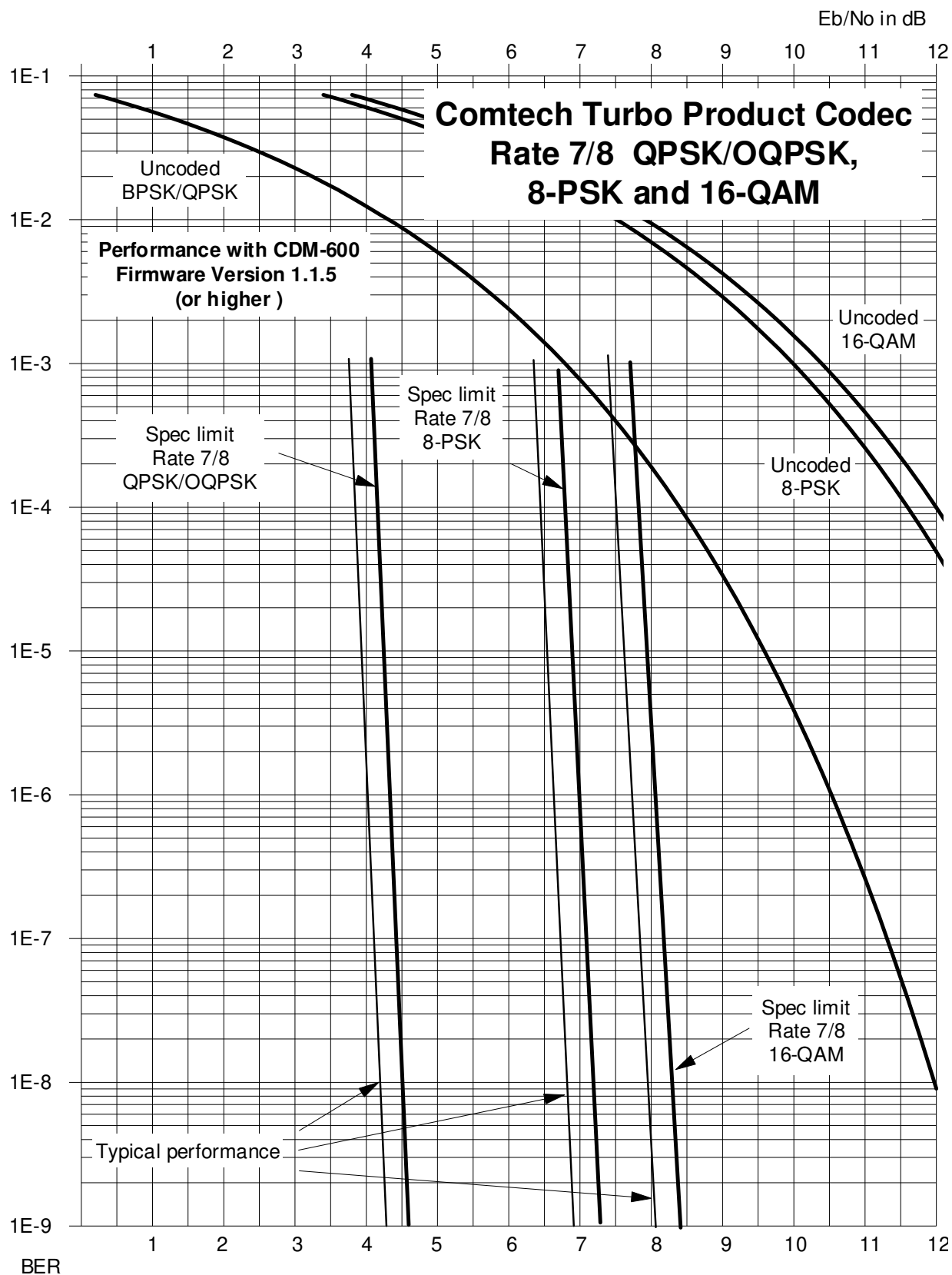


Figure 6-9. Comtech EF Data Turbo Product Codec Rate 7/8 QPSK/OQPSK, 8-PSK and 16-QAM

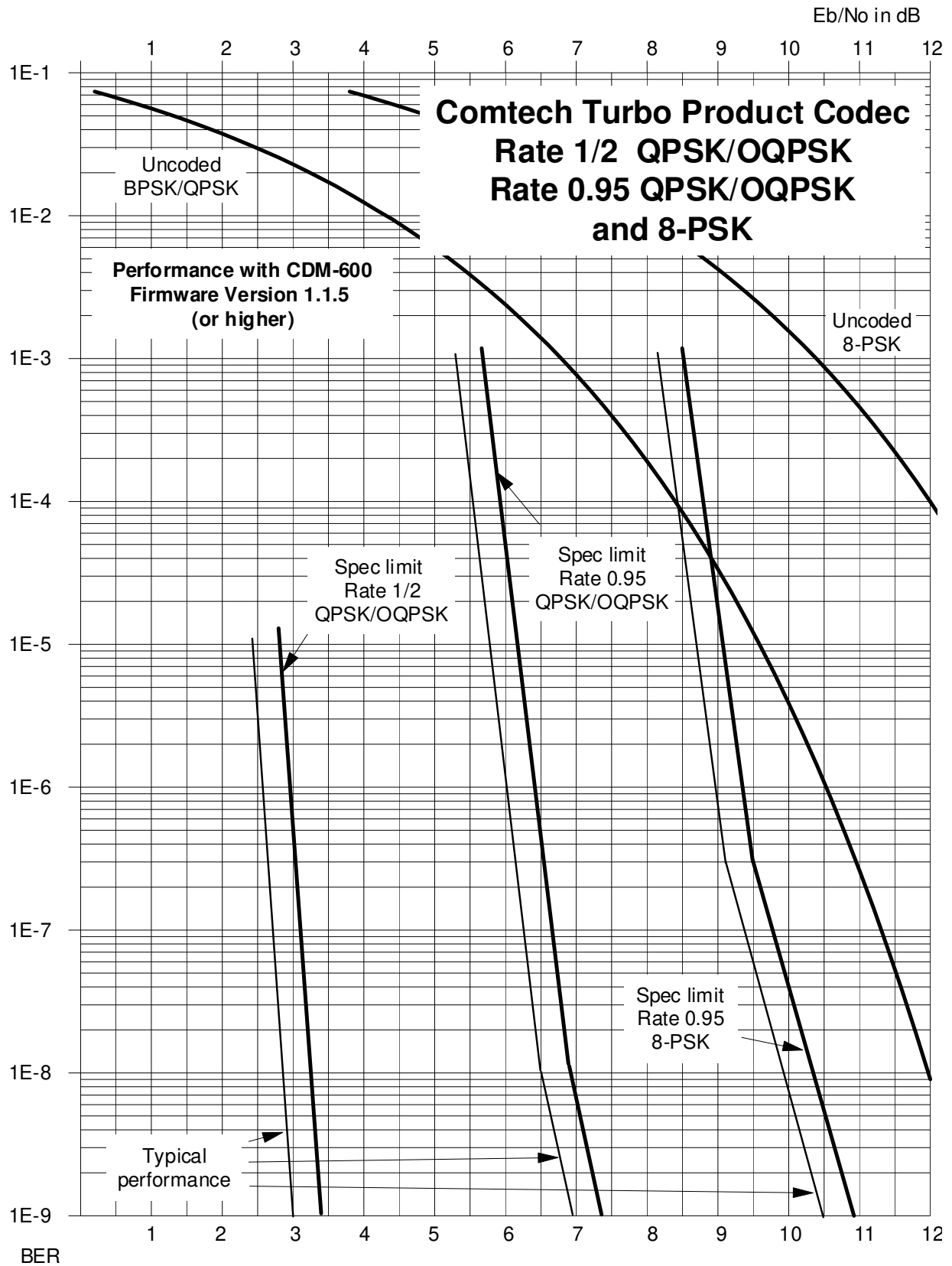


Figure 6-10. Rate 1/2 QPSK, Rate 0.95 QPSK and Rate 0.95 8-PSK

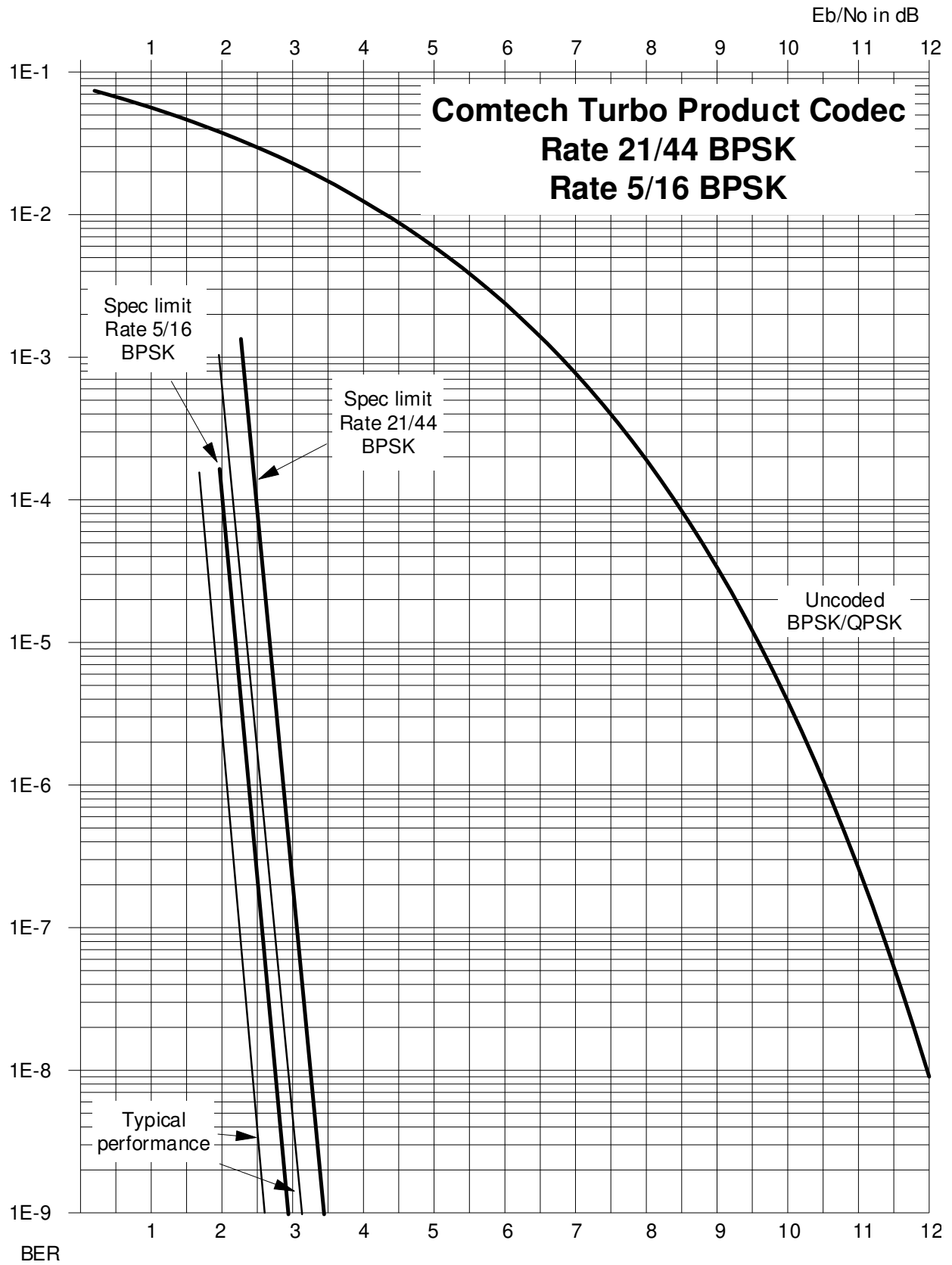


Figure 6-11. Rate 21/44 BPSK and Rate 5/16 BPSK Turbo

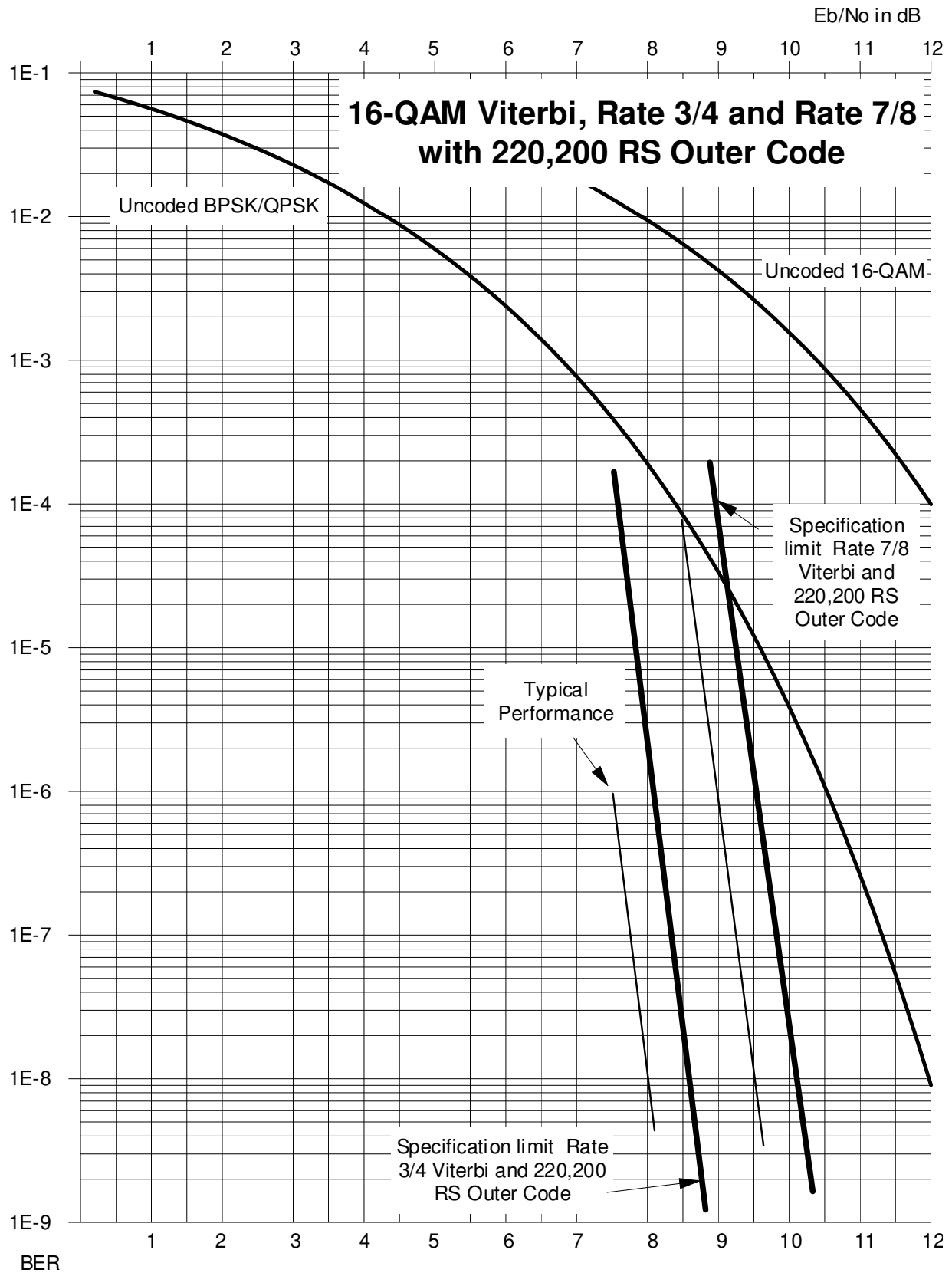


Figure 6-12. 16-QAM Viterbi, Rate 3/4 and Rate 7/8 with 220,200 Reed-Solomon Outer Code

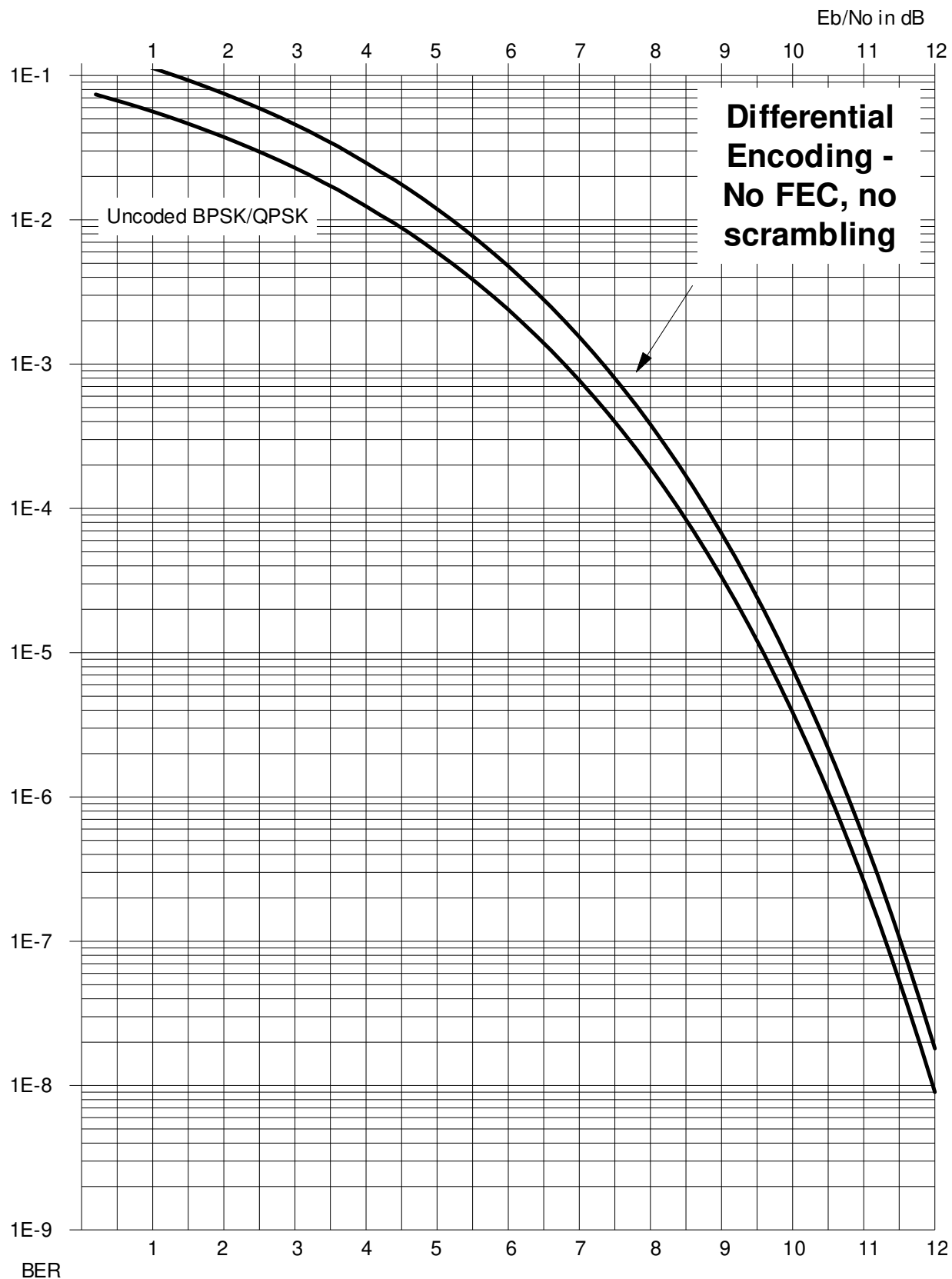


Figure 6-13. Differential Encoding – No FEC, No Scrambling

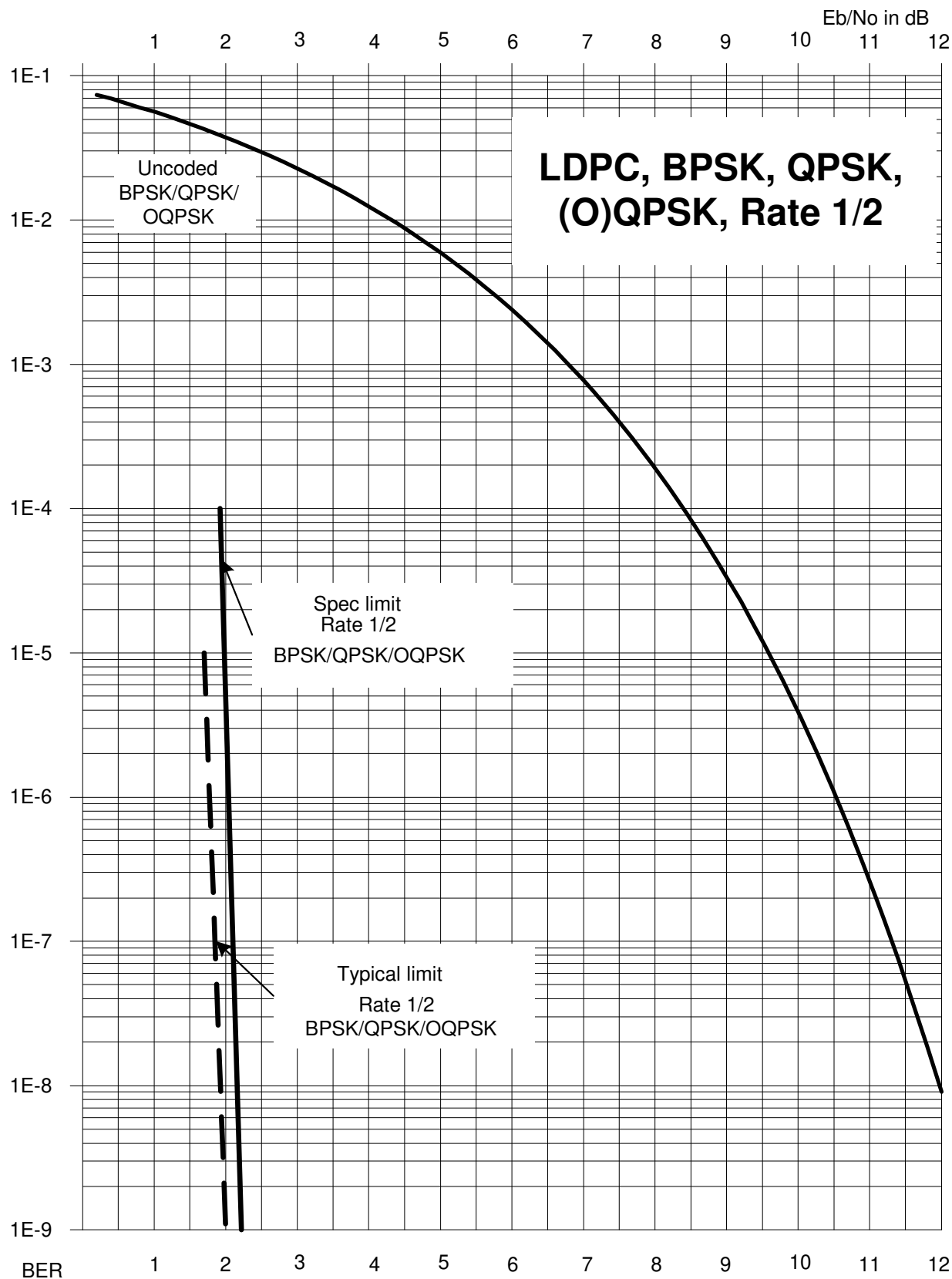


Figure 6-14. LDPC, Rate 1/2, BPSK, (O)QPSK

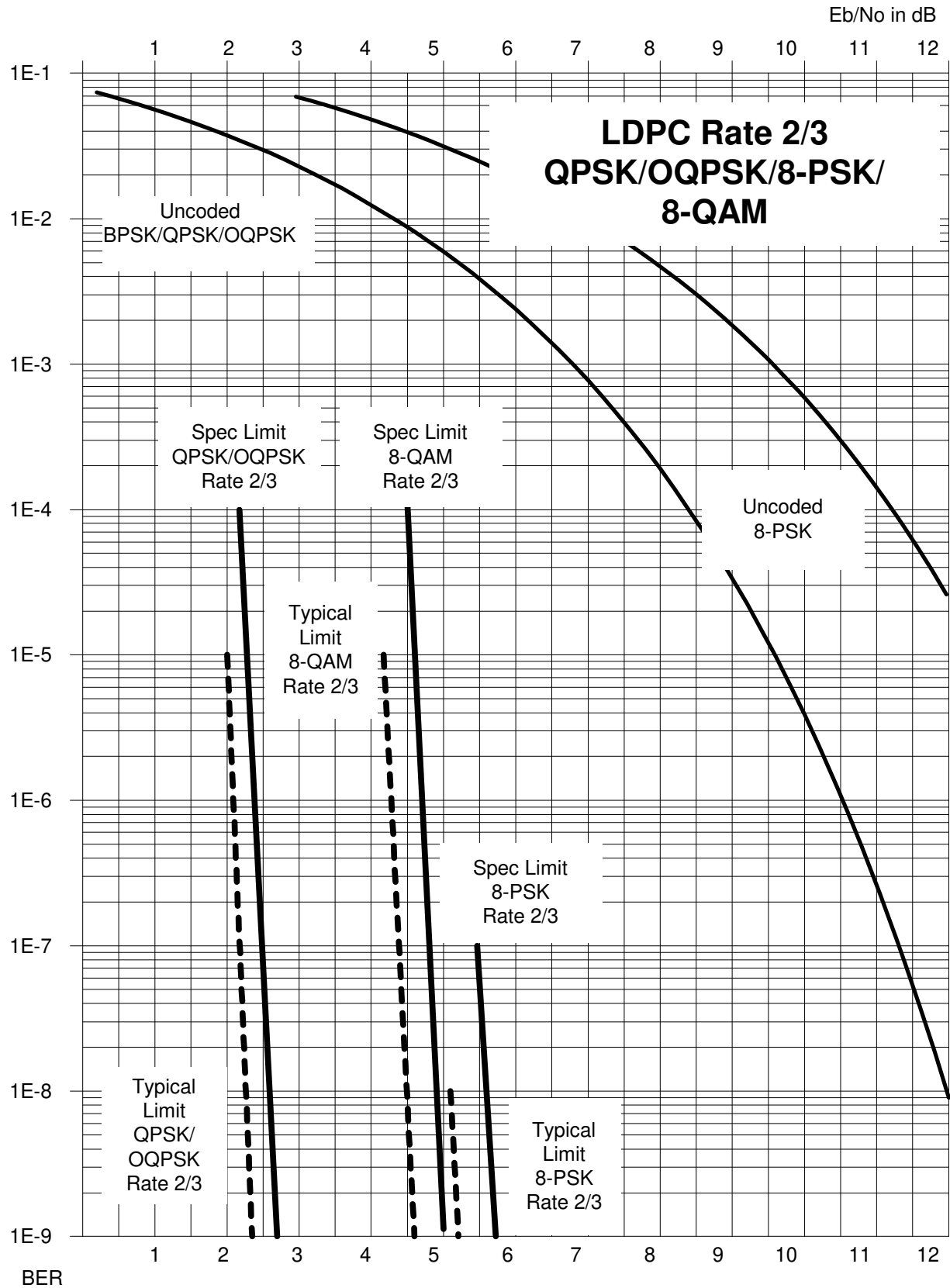


Figure 6-15. LDPC, Rate 2/3, (O)QPSK / 8-PSK / 8-QAM

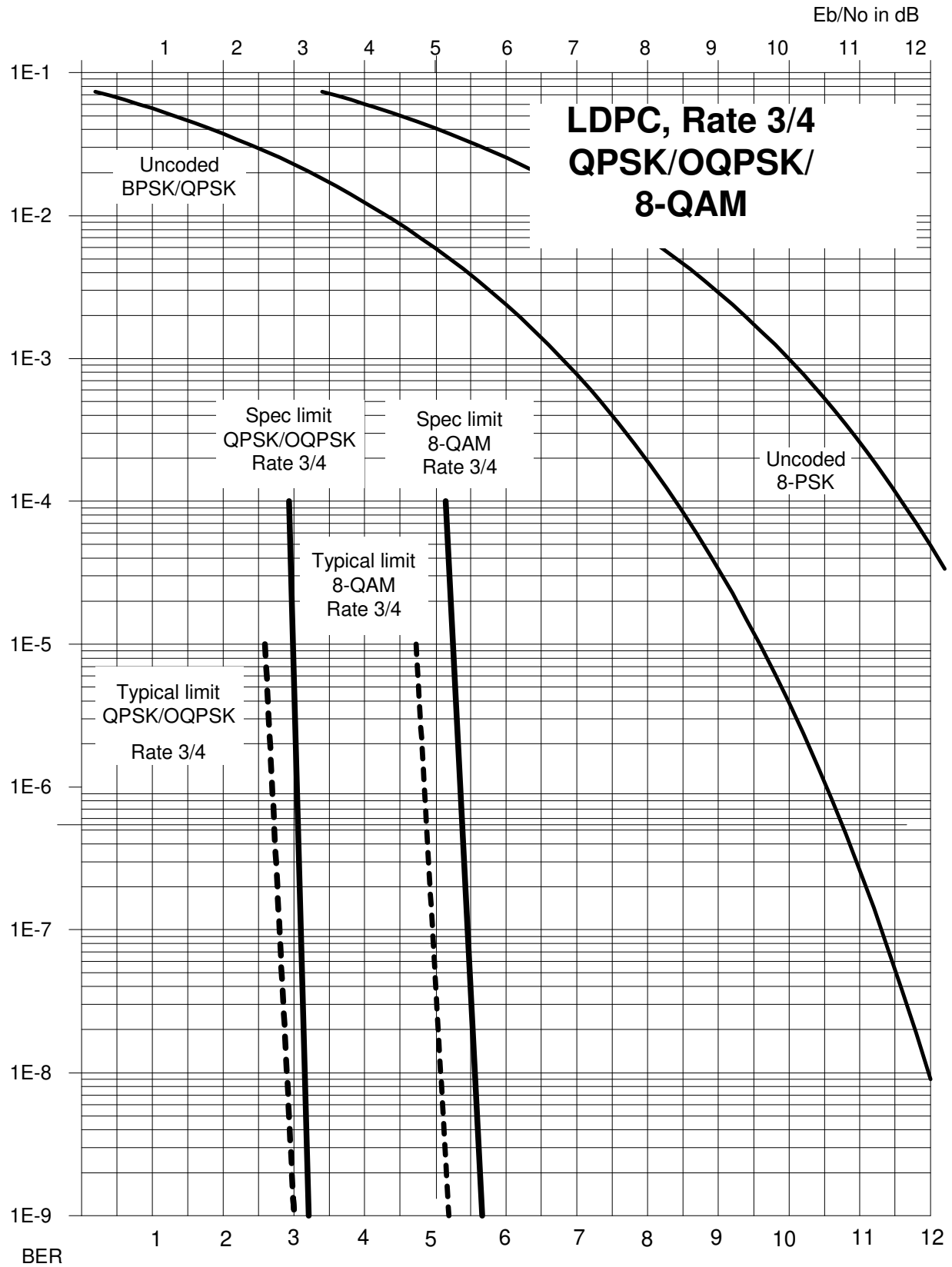


Figure 6-16. LDPC, Rate 3/4, (O)QPSK / 8-QAM

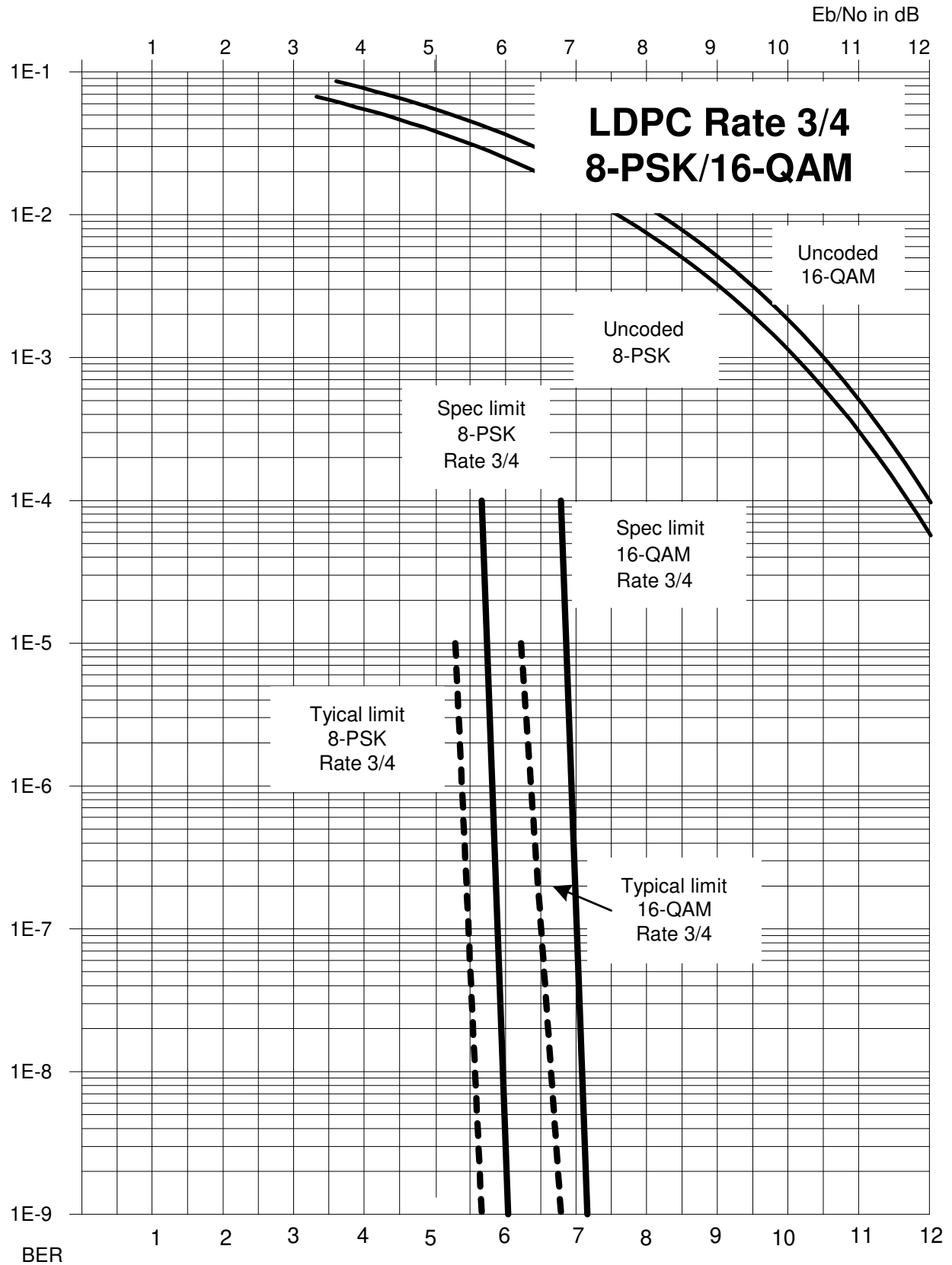


Figure 6-17. LDPC, Rate 3/4, 8-PSK / 16-QAM

Chapter 7. AUTOMATIC UPLINK POWER CONTROL (AUPC)

7.1 Introduction



*The user **MUST** obtain permission from the Satellite Operator to use this feature.*

Improper use of this feature could result in a transmitting terminal seriously exceeding its allocated flux density on the Operator's satellite. This could produce interference to other carriers, and could cause transponder saturation problems.

Automatic Uplink Power Control (AUPC) is a feature whereby a local modem is permitted to adjust its own output power level in order to attempt to maintain the E_b/N_0 at the remote modem. To accomplish this, the EDMAC, D&I++ or ESC++ framing types may be used.

The remote modem constantly sends back information about the demodulator E_b/N_0 using reserved bytes in the overhead structure. The local modem then compares this value of E_b/N_0 with a pre-defined target value. If the Remote E_b/N_0 is below the target, the local modem will increase its output power, and hence, a closed-loop feedback system is created over the satellite link. A particularly attractive benefit of this feature is that whenever framed operation is selected, the remote demodulator's E_b/N_0 can be viewed from the front panel display of the local modem. Note also that AUPC can be used simultaneously with EDMAC.

There are several important parameters associated with this mode of operation, and the user needs to understand how the AUPC feature works, and the implications of setting these parameters.

7.2 Setting AUPC Parameters

1. Under the menu (**CONFIG: MODE**), the user first ensures that the framing type is EDMAC, D&I++ or ESC++.
(EDMAC may be configured as IDLE, or the unit may be defined as an EDMAC Master or Slave.)

2. The user should verify that the remote modem is correspondingly configured for EDMAC, D&I++ or ESC++ framing.
3. Under the menu (**CONFIG: TX → POWER**), the user sets the nominal output power of the modem. This is done by selecting the **MANUAL** mode, then editing the displayed TX output power level.
4. The user will then select **AUPC** as the operating mode.

At this point the user will be prompted to define four key parameters: AUPC Target E_b/N_0 ; AUPC Max Range; AUPC Alarm; and Demod Unlock.

Note: For the CDM-600L, with the addition of the External 20dB Step Attenuator Kit (CEFD P/N KT/11202-1), functionality of the **CONFIG: TX → POWER** menu is enhanced with **MANUAL-** or **AUPC-LOW** Power Mode controls. See **Appendix J. KT/11202-1 STEP ATTENUATOR KIT (CDM-600L)** for further details on this operational upgrade.

7.2.1 AUPC Target E_b/N_0

TARGET E_b/N_0 is value of E_b/N_0 that the user desires to keep constant at the remote modem.

If the E_b/N_0 exceeds this value, the AUPC control will reduce the Tx output power, but will never drop below the nominal value set.

If the E_b/N_0 falls below this value, the AUPC control will increase the Tx output power, but will never exceed the value determined by the parameter **MAX RANGE**.

- The minimum value the user can enter is 0.0 dB
- The maximum value the user can enter is 9.9 dB
- The default value is 3.0 dB
- The resolution is 0.1 dB

7.2.2 AUPC Max Range

MAX RANGE defines how much the modem is permitted to increase the output level, under AUPC control.

- The minimum value the user can enter is 0 dB
- The maximum value the user can enter is 9 dB
- The default value is 1 dB
- The resolution is 1 dB

7.2.3 AUPC Alarm

The **ALARM** parameter defines how the user wants the modem to act if, under AUPC control, the maximum power limit is reached.

The two choices are:

- **NONE** (no action – this is the **default setting**).
- **TX ALARM** (generate a TX alarm).

7.2.4 Demod Unlock

DEMODO UNLOCK defines the action the modem will take if the remote demodulator loses lock.

The two choices are:

- **NOMINAL** (reduce the Tx Output Power to the nominal value – this is the **default setting**).
- **MAXIMUM** (increase the Tx Output Power to the maximum value permitted by the parameter **MAX RANGE**).

(**Note:** If the local demod loses lock, the modem will automatically move its output power to the nominal value.)

7.3 Compensation Rate

As with any closed-loop control system, the loop parameters must be chosen to ensure stability at all times. Several features have been incorporated to ensure that the AUPC system does overshoot, or oscillate.

- First, the rate at which corrections to the output power can be made is fixed at once every 4 seconds. This takes into account the round trip delay over the satellite link, the time taken for a power change to be reflected in the remote demodulator's value of E_b/N_0 , and other processing delays in the modems.
- Second, if the comparison of actual and target E_b/N_0 yields a result that requires a change in output power, the first correction made will be 80% of the calculated step. This avoids the possibility of overshoot. Subsequent corrections are made until the difference is less than 0.5 dB. At this point, the output power is only changed in increments of 0.1 dB, to avoid 'hunting' around the correct set point.

7.4 Monitoring

The remote demodulator's value of E_b/N_0 can be monitored at all times, either from the front panel (**MONITOR: AUPC**) or via the remote control interface. The resolution of the reading is 0.2 dB. For all values greater than or equal to 16 dB, the value 16.0 dB will be displayed. As long as framing is enabled, the value will still be available, regardless of the AUPC mode, or framing mix.

Also displayed is the current value of Tx power increase. If EDMAC framing is enabled, but AUPC is disabled, this will indicate 0.0 dB. This value is also available via the remote control interface.



Comtech EF Data strongly cautions against the use of large values of permitted power level increase under AUPC control. Users should consider using the absolute minimum range necessary to improve rain-fade margin.

Chapter 8. CLOCKING MODES AND DROP AND INSERT (D&I)

8.1 Introduction

When dealing with satellite modems, the subject of clocking can be a complex issue. This chapter describes the various clocking options that are available with the CDM-600/600L. There are two fundamentally different interfaces provided by the modem:

- Synchronous clock and data interfaces (RS-422, V.35, etc.) that permit great flexibility concerning the source and direction of clocks. These are complex and cause the most confusion.
- G.703 interfaces combine clock and data into a single signal – this is referred to as *self-clocking*. In their basic form these interfaces are less flexible, and therefore easier to understand. However, when used with Drop and Insert operation, the subject again becomes more complex.

8.2 Transmit Clocking

There are five transmit clocking modes in the CDM-600/600L. RS-422/449 signal mnemonics will be used for illustration, but the description applies equally to V.35 and synchronous RS-232.

8.2.1 Internal Clock

In this mode the modem, assumed always to be the DCE, supplies the clock to the DTE. (The RS-422/449 name for this signal is **Send Timing**, or **ST**.) The DTE then clocks from this source and gives the modem transmit data (**Send Data**, or **SD**), synchronous with this clock. It is optional whether the DTE also returns the clock (**Terminal Timing**, or **TT**). The modem can accept it if it is present, but uses ST if it is not. At rates above 2 Mbps, Comtech EF Data highly recommends that the user return TT to ensure the correct clock/data relationship.

G.703: The internal clock mode does not apply; the clock is always recovered from the incoming signal, and the modem locks its modulator clocks to this.

8.2.2 Tx Terrestrial Clock

In this mode, the modem expects to see the DTE provide the clock, so that it can phase-lock its internal circuits. In this case, the modem does not provide any signal on ST, but instead requires a clock signal on TT, synchronous with the data. If no clock is present, an alarm will be generated and the modem will substitute its internal clock.

G.703: This is the 'natural' clock mode.

8.2.3 Rx Loop-Timed, Rx=Tx

In certain circumstances, a terminal at the distant-end of a satellite link may be required to provide a clock to the DTE equipment which is locked to the receive satellite signal. This is similar to Internal Clock mode, in that the modem will source ST to the DTE, but now the timing is derived from the demodulator. The DTE then clocks from this source, and gives the modem transmit data (SD), synchronous with this clock. It is optional whether the DTE also returns the clock (TT); the modem can accept it, if it is present, but uses ST if it is not. If the demodulator loses lock, the modem's internal clock will be substituted, so an accurate and stable clock is present on ST, rather than a clock that may jitter and wander in a random fashion.

G.703: Does not apply.

8.2.4 Rx Loop-Timed, Rx<>Tx (Asymmetric Loop Timing)

The CDM-600/600L incorporates circuitry which permits loop timing when the Tx and Rx data rates are not the same. In this case the clock frequency appearing at ST will be whatever the TX data rate is programmed to, but phase-locked to the demodulator's receive symbol clock. In all other respects the operation is the same as for 'standard' loop timing.

G.703: Does not apply.

8.2.5 External Clock

The modem will accept a station clock at the rear of the modem to serve as its ST clock directly. In this case, the station clock must be equal to the transmit data rate being used.

G.703: Does not apply.

8.3 Receive Clocking

There are three receive clocking modes in the CDM-600/600L, plus an additional setting used for Drop and Insert only – refer to **Figure 8-1** for details.

8.3.1 Buffer Disabled (Rx Satellite)

When the buffer is disabled, the receive clock (RT) is derived directly from the demodulator, and hence will be subject to plesiochronous and Doppler offsets. In certain instances, this may be acceptable. There is still a minimum buffer in use to de-jitter the effects of removing overhead framing.

G.703: Applicable.

8.3.2 Buffer Enabled, Tx=Rx (Tx Terrestrial or External Clock)

In this instance, it is required that the buffer be enabled, so that the clock and data appearing on RT and RD are synchronous with the transmit clock. This is a relatively simple case, as the output clock for the buffer is derived directly from either ST, TT or the external source.

G.703: Applicable.

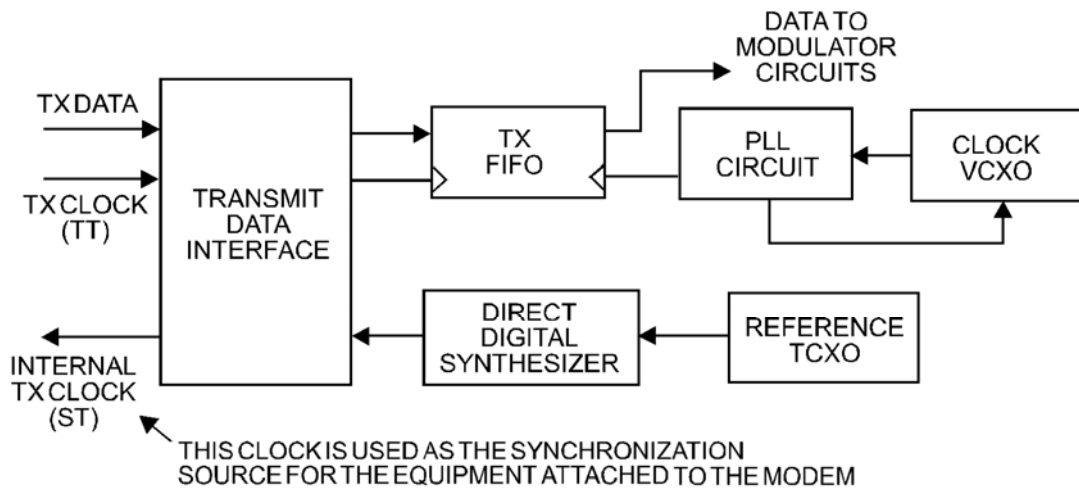
8.3.3 Buffer Enabled, Rx<>Tx (Tx Terrestrial or External Clock)

This is an uncommon case, where the receive data rate does not equal the transmit or external reference. The modem will generate a phase-locked buffer output clock which uses the selected reference, regardless of its frequency in relation to the receive data rate.

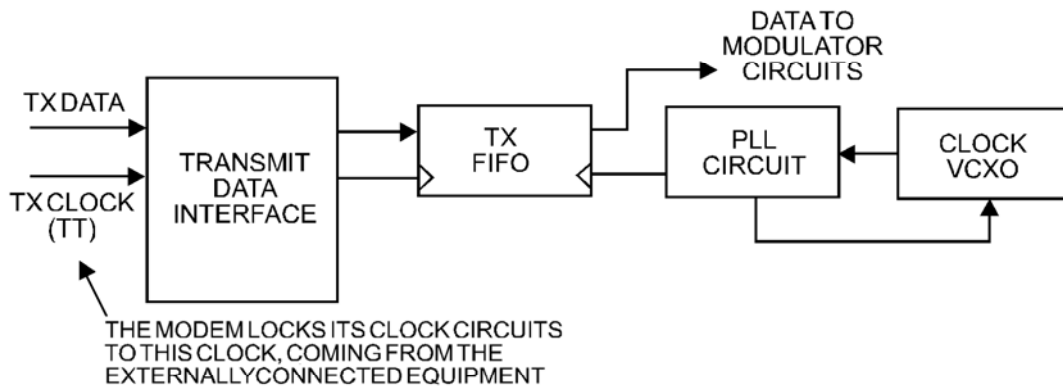
G.703: Applicable.

8.4 X.21 Notes

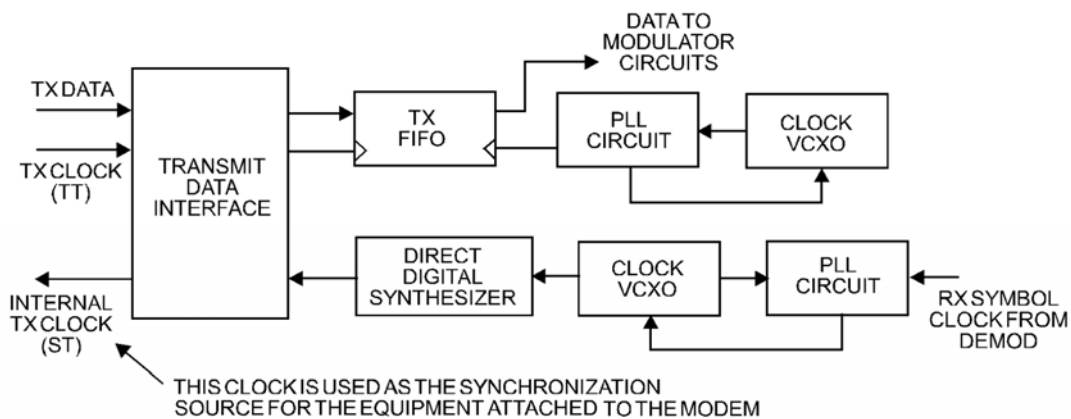
For X.21 operation, use the RS-422 pins, but ignore Receive Clock if the Modem is DTE, and ignore Transmit clocks if the Modem is DCE.



INTERNAL TX CLOCK MODE

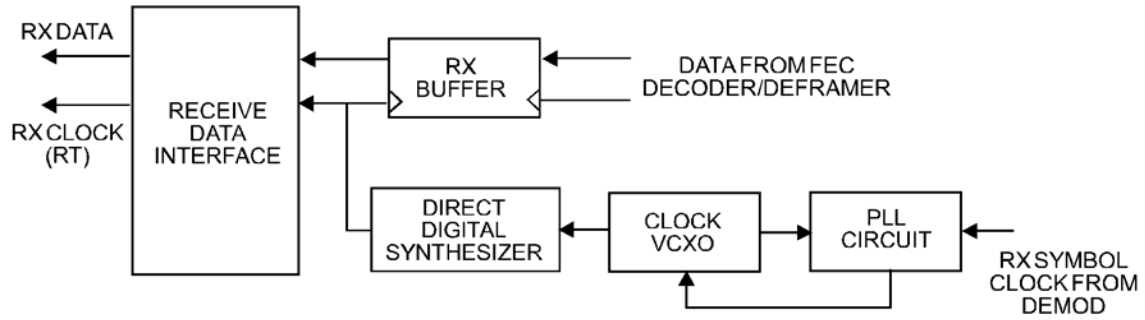


EXTERNAL TX CLOCK MODE

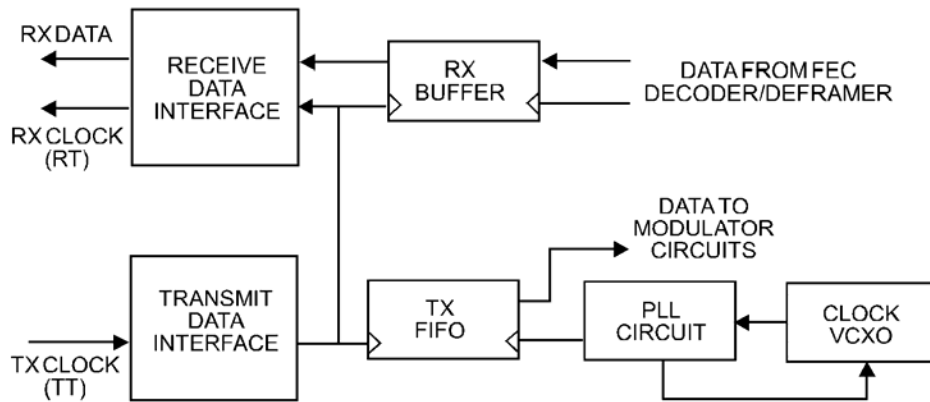


LOOP-TIMED TX CLOCK MODE TX=RX OR TX<>RX

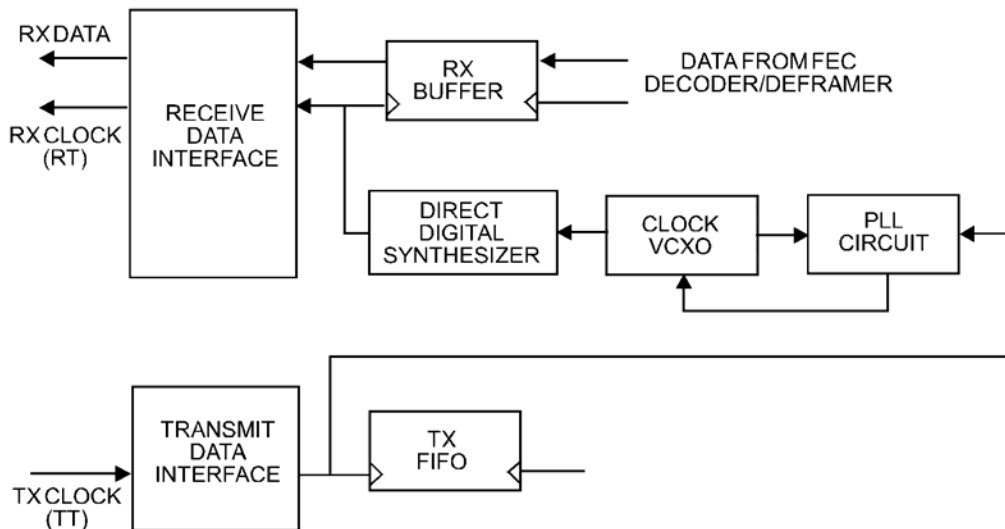
Figure 8-1. Tx Clock Modes



BUFFER DISABLE CLOCK MODE



**BUFFER ENABLE
 TX = RX CLOCK MODE**



**BUFFER ENABLE
 TX \neq RX CLOCK MODE**

Figure 8-2. Rx Clock Modes

8.5 Drop and Insert (D&I) with ESC and AUPC

The Drop and Insert (D&I) framing has been extended with the release of Firmware Version 1.4.0 for the CDM-600L and Firmware Version 2.1.0 for the CDM-600 to include the capability of adding high-rate ESC (Engineering Service Channel) and AUPC (Automatic Uplink Power Control). Currently this is available for E1 operation only. Refer to the pertinent manual section for details of each of these features.

The high-rate ESC channel operates the same for D&I as it does for IBS framing, using bytes 16 and 48 of the overhead channel, as well as half of byte 32, to pass the data characters over the satellite link. Because these bits are reserved for signaling, this new feature is not available for E1-CAS mode. The AUPC portion (which is not available with IBS framing) occupies the unused first bit of the unique word (byte 0).

Prior to firmware version releases mentioned above, neither ESC nor AUPC could be combined with D&I. To enable Drop and Insert with ESC and AUPC, the correct **sequence of configuration** must be followed – this applies when configuring via the front panel, or when using individual remote control commands.

From the modem front panel:

D&I WITH ESC AND AUPC – CONFIGURATION SEQUENCE			
Step	Front Panel Operation Parameter	Setting	Chapter 5 Sect. Ref.
1	CONFIG: MODE	D&I (Requires D&I FAST option)	5.4.2
2	CONFIG: D&I	E1-CCS	5.4.6
3	CONFIG: MISC → HIGH-RATE-ESC	On	5.4.9.4
4	CONFIG: TX → POWER → MODE	AUPC	5.4.3.2

The available ESC baud rates for D&I depend on Tx and Rx datarate. They are the same as those for high-rate IBS ESC. Pinout information for the P3A Overhead Interface Connector which carries the ESC channel is shown in **Sect. 3.3.1**.

The maximum ESC baud rate is limited by the lower of the Tx or Rx data rates. If a data rate is edited so that a baud rate is no longer available, the baud rate will automatically be reduced to the next permitted value. The data-rate breakpoints are as follows:

Data rate	Max ESC baud rate
64 kbps	2400
≥128 kbps	4800
≥256 kbps	9600
≥384 kbps	14400
≥512 kbps	19200
≥768 kbps	28800
≥1280 kbps	38400

(Note: breakpoint change)

Note: For AUPC to be effective, it must be enabled on both the local & remote modems.

8.6 Frame Formats

The E1 and T1 frame formats that are supported are shown in **Figure 8-3**:

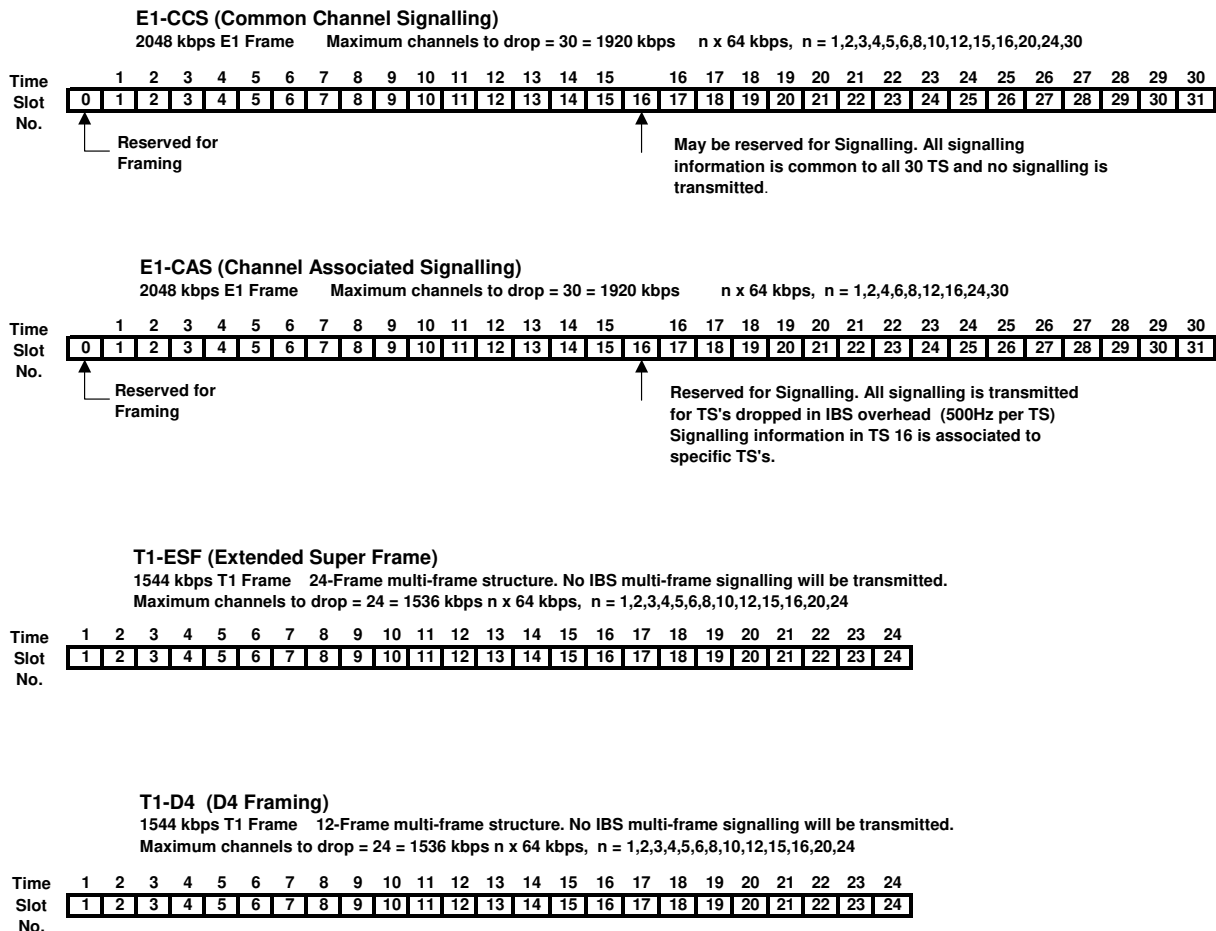


Figure 8-3. Supported T1 and E1 Framing formats

Note that, for D&I++, the smaller overhead frame structure does not support CAS signaling, although E1 timeslot 16 may still be one of the channels transmitted.

8.7 Time Slot Selection

Selection of the transmit and receive data rates may be made in certain 64 kbps increments and may be independent of each other. The actual satellite rates for Open Network D&I are 16/15 of the transmit or receive data rate to include IBS overhead per IESS-309, although this is transparent to the user. For E1, the user can select any time slot (TS) from 1 to 31.

Selection of TS 0 is *not* permitted.

For T1, the user can select any time slot (TS) from 1 to 24. The user may also select “N/A” to leave a satellite channel unused.

The configuration menu allows time slots to be selected for transmission or reception up to the maximum dictated by the selected transmit or receive data rate, and may be selected in arbitrary order. As an example, if the data rate is set to 256 kbps, the maximum number of time slots that can be dropped or inserted is 4 (being 4 x 64 kbps).

Note that, for 1920 kbps data rate the timeslots may not be manipulated. This is the ‘fixed channel’ mode where Timeslot 1 is assigned to Channel 1, and so on.

For D&I++ framing, all increments of 64 kbps are allowed up to a maximum of 24 (1536 kbps). For this mode, the satellite rate is 46/45 of the front panel data rate (2.22%).

8.8 Drop and Insert (D&I) Clocking

Figure 8-4 illustrates the general arrangement for Drop and Insert clocking in the CDM-600/600L.

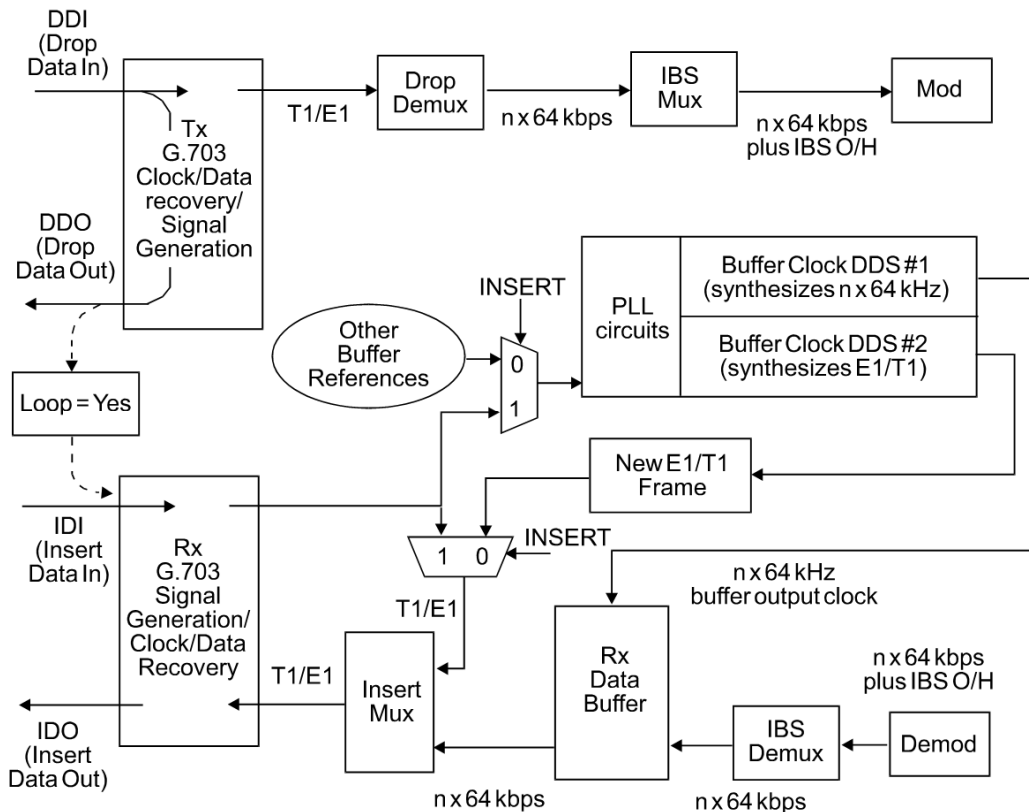


Figure 8-4. Drop and Insert Clocking

Note that there are two inputs and two outputs shown for Drop and Insert Operation:

- Drop Data In (DDI)
- Drop Data Out (DDO)
- Insert Data In (IDI)
- Insert Data Out (IDO)

This arrangement permits the user to choose between fully independent operation of the incoming and outgoing E1/T1 signal, or to use the same T1/E1 signal for both Dropping and Inserting (looped mode). If 'Loop' has been selected under the Drop and Insert configuration menu, the Drop Data Out (DDO) signal is automatically looped internally, to become the Insert Data In (IDI).

In this mode, timeslots are dropped from an incoming E1/T1 signal for transmission over the satellite, and the *same* E1/T1 signal has time slots re-inserted into it that will over-write data in existing timeslots.

8.9 Rx Buffer Clock = Insert (D&I only)

The E1 or T1 clock recovery from the IDI G.703 port serves as the Rx Buffer reference. In addition, the recovered data is the E1/T1 input to the Insert Mux. If the Rx G.703 recovery circuit detects no activity at IDI input, or cannot detect the expected frame format, Buffer Clock = Rx Satellite will be chosen as a fall-back.

If 'Insert' is *not* the selected buffer clock reference, the clock and data from the IDI port is ignored, and a new E1/T1 frame is generated. The time slots coming from the satellite are then re-inserted into the selected timeslots of this new blank frame, and output on the IDO port.

8.10 Single-Source Multiple Modems

Two ways to connect a single T1 or E1 stream to several modems are by looming or daisy-chaining modems. Looming method is illustrated in **Figure 8-5**, and **Figure 8-6** illustrates the daisy-chain method; each requires the RX Buffer Clock = Insert setting.

- Assign all timeslots to not overlap.
- Assign modems to number of TX/RX channels as required.

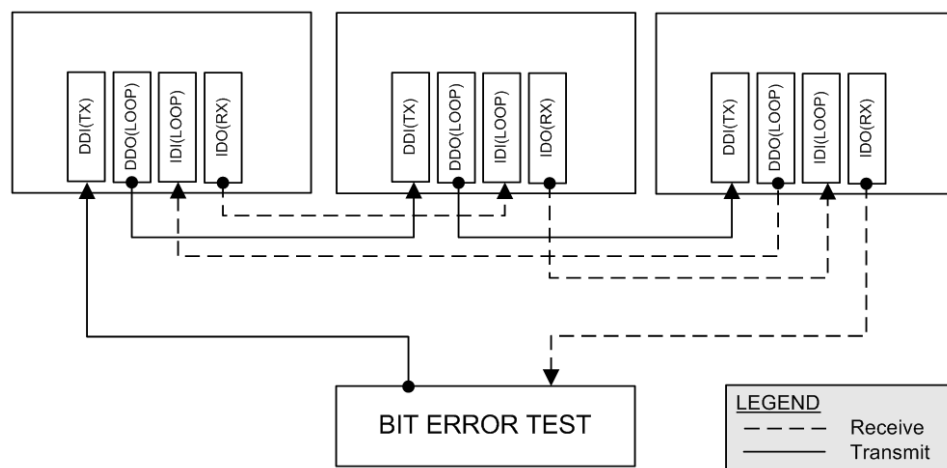


Figure 8-5. Single-Source Multiple Modems (Looming)

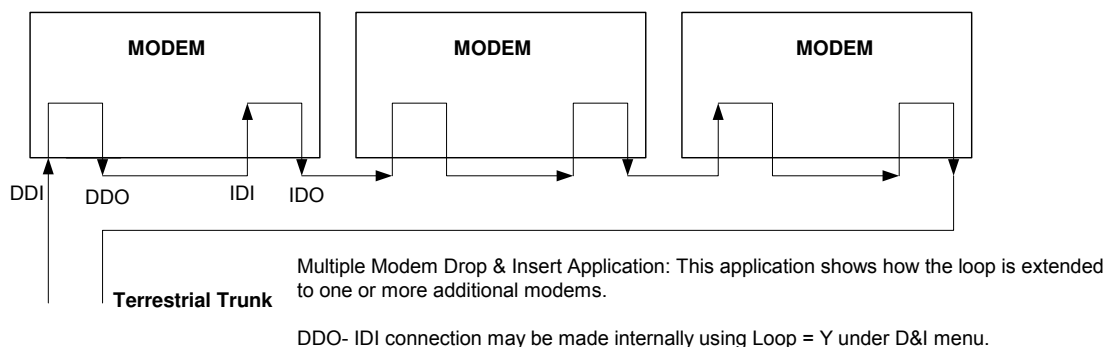


Figure 8-6. Single-Source Multiple Modems (Daisy-chain)

Chapter 9. EDMAC CHANNEL

9.1 Theory Of Operation

EDMAC, an acronym for **E**mbded **D**istant-end **M**onitor **A**nd **C**ontrol, is a feature that permits the user to access the M&C features of modems which are at the distant-end of a satellite link. This is accomplished by adding extra information to the user's data, but in a manner which is completely transparent to the user.

On the transmit side:

The data is split into frames – each frame containing 1008 bits (except Rate 21/44 BPSK Turbo, or when the data rates exceed 2048 kbps, where the frame length is 2928 bits, and Rate 5/16 BPSK Turbo where the frame length is 3072 bits). 48 bits in each frame are overhead, and the rest of these bits are the user's data. This increases the rate of transmission by 5% (approximately 1.6% for the Turbo BPSK cases, and for all data rates greater than 2.048 Mbps). For example, if the user's data rate is 64 kbps, the actual transmission rate will now be at 67.2 kbps. Note that the user may also select EDMAC-2 framing, which uses a 2928 bit frame, and yields a 1.6% overhead for all modulation types and data rates.

At the start of each frame, a 12-bit synchronization word is added. This allows the demodulator to find and lock to the start of frame. At regular intervals throughout the frame, additional data bytes and flag bits are added (a further 36 bits in total). It is these additional bytes which convey the M&C data.

When framing is used, the normal V.35 scrambler is no longer used. This V.35 approach is called 'self synchronizing' because, in the receiver, no external information is required in order for the descrambling process to recover the original data. The disadvantage of this method is that it multiplies errors.

On average, if one bit error is present at the input of the descrambler, three output errors are generated. However, there is an alternative when the data is in a framed format; in this case, a different class of scrambler may be used – one which uses the start of frame information to start the scrambling process at an exact known state. In the receiver, having synchronized to the frame, the descrambler can begin its processing at exactly the right time. This method does not multiply errors, and therefore has a clear advantage over V.35 scrambling.

This is fortunate, as there is a penalty to be paid for adding the framing. By adding the extra 5% to the transmitted data rate, the effective E_b/N_0 seen by the user will degrade by a factor of

$10\log(1.05)$, or 0.21 dB (0.07 dB in the case of the two BPSK Turbo rates). The use of an externally synchronized scrambler and descrambler almost exactly compensates for this degradation. The net effect is that the user will see effectively identical BER performance whether framing is used or not.

On the receive side:

When the demodulator locks to the incoming carrier, it must go through the additional step of searching for, and locking to, the synchronization word. This uniquely identifies the start of frame, and permits the extraction of the overhead bytes and flag bits at the correct position within the frame. In addition, the start of frame permits the descrambler to correctly recover the data. The user's data is extracted, and sent through additional processing, in the normal manner. The extracted overhead bytes are examined to determine if they contain valid M&C bytes.

9.2 M&C Connection

Data to be transmitted to the distant-end is sent to a local unit via the remote control port. A message for the distant-end is indistinguishable from a 'local' message – it has the same structure and content, only the address will identify it as being for a distant-end unit.

Before the M&C data can be successfully transmitted and received, pairs of units must be split into EDMAC Masters and EDMAC Slaves. Masters are local to the M&C Computer, and Slaves are distant-end.

Now, a unit which has been designated an EDMAC master not only responds to its own unique bus address, but it will also be configured to listen for the address which corresponds to its EDMAC Slave. When a complete message packet has been received by the EDMAC Master, it will begin to transmit this packet over the satellite channel, using the overhead bytes which become available.

Note: The 'normal' protocol for the message packet is not used over the satellite path, as it is subject to errors. For this reason, a much more robust protocol is used which incorporates extensive error checking.

At the distant-end, the EDMAC slave, configured for the correct address, receives these bytes, and when a complete packet has been received, it will take the action requested, and then send the appropriate response to the EDMAC Master, using the return overhead path on the satellite link. The EDMAC Master assembles the complete packet, and transmits the response back to the M&C Computer.

Apart from the round-trip satellite delay, the M&C Computer does not see any difference between local and distant-end units – it sends out a packet, addressed to a particular unit, and gets back a response. It can be seen that the EDMAC Master simply acts as forwarding service, in a manner which is completely transparent.

This approach does not require any additional cabling – connection is made using the normal M&C remote port. Furthermore, the user does not have to worry about configuring the baud rate of the M&C connection to match the lowest data rate modem in the system. The M&C system can have mixed data-rate modems, from 2.4 kbps to 2048 kbps, and still run at speeds in excess

of 19,200 baud. It should be pointed out that at 2.4 kbps, the effective throughput of the overhead channel is only 11 async characters/second. For a message of 24 bytes, the time between sending a poll request and receiving a response will be around 5 seconds. (Note that when either of the BPSK Turbo rates are in use, the overhead rate is reduced by a factor of three, and therefore the response time will be around 15 seconds.)

9.3 Setup Summary

To access a distant-end unit:

- Designate a Master/Slave pair: Master at the local-end, Slave at the distant-end.
- On the local-end unit, enable framing, and EDMAC, define the unit as MASTER, then enter the bus address. This is constrained to be 'base 10' meaning that only addresses such as 10, 20, 30, 40, etc, are allowed.
- Choose a unique bus address for the distant-end. This should normally be set to the 'base 10' address + 1. For example, if the MASTER unit is set to 30, choose 31 for the distant-end unit.
- On the distant-end unit, enable framing, and EDMAC, define the unit as SLAVE, then enter the bus address. The orange EDMAC Mode LED should be illuminated.
- Set the local-end unit to RS-485 remote control, and set the bus address of this local unit. The orange Remote Mode LED should be illuminated.
- Once the satellite link has been established, connect the M&C Computer, and begin communications, with both the local and distant end units.

Note: EDMAC modes are fully compatible with AUPC modes.

Chapter 10. ESC++

10.1 Introduction



In order to use ESC++, the following firmware versions must be installed:

CDM-600L – Firmware Version 1.3.0 or higher

CDM-600 – Firmware Version 2.0.1 or higher

The ESC++ mode of operation is a new, closed network frame structure which combines Automatic Uplink Power Control (AUPC) with a high speed asynchronous order-wire channel. The AUPC works identically to that offered with EDMAC and D&I++ framing, but is not compatible with either. This is because ESC++ framing uses a different overhead percentage than the other closed network framing modes.

10.2 Overhead Details

Baud rates from 1200 to 38400 bits/sec are offered using RS-232 format. As with the main remote port (P4B), three data formats are available: 8N1, 7E2 and 7O2. Pins 5 and 6 of P3A are the input and output, respectively, for this data channel. Because 38.4 kbaud is the maximum rate available, the actual overhead percentage for ESC++ framing changes as the data rate increases, thereby saving bandwidth at high data rates. The added overhead is as follows:

Data Rate	Overhead ratio (percentage)
64 kbps to < 768 kbps	19/17 (11.76%)
768 kbps to 1.5 Mbps	12/11 (9.09%)
> 1.5 Mbps to 2.5 Mbps	29/27 (7.4%)
> 2.5 Mbps to 7 Mbps	19/18 (5.56%)
> 7 Mbps	64/63 (1.58%)

Note that 64 kbps is the minimum data rate allowable with ESC++. Depending upon code rate and modulation used, the modem's maximum data rate of 20 Mbps may be used with ESC++. In all cases, if the Reed-Solomon outer codec is used, the 126/112 ratio is employed with ESC++. The new frame structure may be used with any FEC codec type available with the CDM-600/600L.

10.3 Available Baud Rates

At the lowest data rates, the 11.76% overhead may not allow all baud rates. The available rates are as follows:

Data Rate	Baud Rate Available
64 to 127.999 kbps	1200, 2400, 4800
128 to 191.999 kbps	1200 to 9600
192 to 255.999 kbps	1200 to 14400
256 to 383.999 kbps	1200 to 19200
384 to 511.999 kbps	1200 to 28800
512 kbps and above	1200 to 38400

10.4 Configuration

To use this mode, the user should select **ESC++** from the **CONFIG: MODE** menu. The baud rate and async character format are then selected from the **CONFIG: MISC → HIGH-RATE-ESC** menu. See **Chapter 5. FRONT PANEL OPERATION** for further information.

10.5 Effect on Eb/No performance

Because, particularly at lower data rates, where the percentage overhead is large, the increase in transmitted data rate will cause a decrease in the E_b/N_o performance. Therefore, all of the published data concerning BER versus E_b/N_o needs to be modified as follows:

Data Rate	Overhead ratio (percentage)	E_b/N_o Degradation
64 kbps to < 768 kbps	19/17 (11.76%)	0.48 dB
768 kbps to 1.5 Mbps	12/11 (9.09%)	0.38 dB
> 1.5 Mbps to 2.5 Mbps	29/27 (7.4%)	0.31 dB
> 2.5 Mbps to 7 Mbps	19/18 (5.56%)	0.23 dB
> 7 Mbps	64/63 (1.58%)	0.07 dB

The degradation is simply $10 * \log$ (Overhead ratio)

The E_b/N_o displayed by the modem (**MONITOR: RX-PARAMS**) takes this into account in the value that is calculated.

Chapter 11. OFFSET QPSK OPERATION

Offset QPSK modulation is a variation of normal QPSK, which is offered in the CDM-600/600L Open Network Satellite Modem. Normal, bandlimited QPSK produces an RF signal envelope that necessarily goes through a point of zero amplitude when the modulator transitions through non-adjacent phase states. This is not considered to be a problem in most communication systems, as long as the entire signal processing chain is linear.

However, when bandlimited QPSK is passed through a non-linearity (for instance, a saturated power amplifier), there is a tendency for the carefully-filtered spectrum to degrade. This phenomenon is termed 'spectral re-growth', and at the extreme (hard limiting) the original, unfiltered $\sin(x)/x$ spectrum would result. In most systems, this would cause an unacceptable level of interference to adjacent carriers, and would cause degradation of the BER performance of the corresponding demodulator.

To overcome the problem of the envelope collapsing to a point of zero amplitude, Offset QPSK places a delay between I and Q channels of exactly $1/2$ symbol. Now the modulator cannot transition through zero when faced with non-adjacent phase states. The result is that there is far less variation in the envelope of the signal, and non-linearities do not cause the same level of degradation.

The demodulator must re-align the I and Q symbol streams before the process of carrier recovery can take place. For various reasons this makes the process of acquisition more difficult, and acquisition times may be longer, especially at low data rates.

Chapter 12. OPEN NETWORK OPERATIONS

12.1 Introduction

This chapter summarizes the functionality and specifications of the various Open Network operating modes: IBS, Drop and Insert (D&I), and IDR.

12.2 IBS

Primary Data Rates Supported	
G.703	1544, 2048, 6321, 8448 kbps SD, RD
RS-422, V.35, LVDS	N x 64 kbps SD, RD (up to 8448 kbps)
ADPCM Audio (2 Channels)	64 kbps only, full duplex

Engineering Service Channel	
Earth Station-to-Earth Station Channel	RS-232 data synchronous at 1/480 of the primary data RS-232 data asynchronous at 1/2000 of the primary data

High Rate Engineering Service Channel	
ESC Data Interface Type	Async – configurable async character format, RS-232 (up to 1/20 th of the primary data rate)
ESC Data Rate	Example: 2400 baud at 64 kbps

Faults and Alarms	
Satellite Backward Alarm	1 (per IESS-309)
Receive BWA Output	Enabled onto terrestrial secondary alarm

12.2.1 IBS Clock/data recovery and De-jitter

Performs clock and data recovery on the G.703 format. Clock de-jitter and data encoding/decoding is done as with the IDR configuration.

12.2.2 IBS Framing

Multiplexes/demultiplexes the primary data in compliance with the standard IESS-309 overhead ratio of 1/15 (4 overhead bytes per 60 data bytes) and provides the rate exchanged transmit clock to the modulator portion of the base modem.

12.2.3 IBS Engineering Service Channel

Bi-directional processing of the components of the ESC channel, including the ASYNC or SYNC RS-232 data channel, and fault/alarm indications.

A second high-rate ESC channel, at up to 1/20th of the primary data rate is available, using ASYNC RS-232 format.

12.2.4 IBS Scrambling

Provides the synchronous scrambling/descrambling of the satellite-framed data specified in IESS-309. Base modem scrambling/descrambling is disabled in this mode.

12.3 Drop and Insert

Primary Data Rates Supported	
G.703, RS-422, V.35, and Serial LVDS	1544 kbps SD, RD, DDO, IDI 2048 kbps SD, RD, DDO, IDI
Satellite Data Rates Supported (all have 16/15 overhead)	N x 64 kbps N = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, or 24 (T1) N = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, or 30 (E1-CCS) N = 1, 2, 4, 6, 8, 12, 16, 24, 30 (E1-CAS)
Terrestrial Framing Supported	G.732/G.733, G.704
Satellite Overhead Rate	16/15 of data rate per IESS-308 Rev. 6 and IESS-309 Rev. 3, or higher
Timeslot Selection Range	1 to 24 (all T1 modes) 1 to 30 (E1-CAS and E1-CCS) Arbitrary order, non-contiguous available
Plesiochronous Buffer Sizes	Selectable size of 64 to 262,144 bits, in 16-bit steps (with added limitations for G.704 frame boundaries)
Buffer Clock Reference	Derived from Insert-Data-In (Insert Clock) External, Rx (satellite) or Tx (Terrestrial)

Asynchronous Engineering Service Channel	
ESC Data Interface Type	RS-232, Asynchronous
ESC Data Rate	1/2000 of primary data rate
ESC Data Circuits Supported	SD, RD, DSR

Synchronous Engineering Service Channel	
ESC Data Interface Type	RS-232, synchronous to primary data
ESC Data Rate	1/480 of primary data rate
ESC Data Circuits Supported	SD, ST, RD, RT, DSR

High Rate Engineering Service Channel (<i>Future Upgrade</i>)	
ESC Data Interface Type	Async – configurable async character format
ESC Data Rate	Example: 2400 baud at 64 kbps

Faults and Alarms	
Satellite Backward Alarm	1 (per IESS-309)
Receive BWA Output	Enabled onto terrestrial secondary alarm

12.3.1 D&I Primary Data Interfaces

When configured for D&I operation, multiplexing/demultiplexing follows the IBS satellite frame structure and ESC features, but with the following changes:

- Accepts and outputs primary data through the G.703 connectors.
- The data rate must be at T1 or E1 rates only. This includes additional links for Drop Data Out and Insert Data In.
- Clock recovery, dejitter, and encoding/decoding are performed as before.

12.3.2 D&I Framing

The IBS satellite framing/deframing is applied only to selected time slots of the data's G.704 terrestrial structure.

12.4 IDR

Primary Data Rates Supported	
G.703	1544 kbps SD, RD
RS-422 (Replaces 8K Overhead)	2048 kbps SD, RD
V.35 (Replaces 8K Overhead)	6312 kbps SD, RD 8448 kbps SD, RD

Engineering Service Channel	
ESC Audio	2 duplex ADPCM channels
Audio Encoding	CCITT G.721
Audio Interface Type	600Ω transformer-balanced 4-wire
Audio Input Level	Nominal Input : 0dBm0 (-3dBm, 600Ω) Adjustment range: -6 to +8 dB, 2 dB steps
Audio Output Level	Adjustment range: -6 to +8 dB, 2 dB steps
Audio Filtering	Internal 300 to 3400 Hz input and output
ESC Data Interface Type	RS-422
ESC Data Rate	8 kbps, also 64 kbps if ADPCM audio is not used
ESC Data Circuits Supported	SD, ST, RD, RT, Octet in, Octet out
Data Signal Phasing	Per RS-449, data changes on the rising clock transition, is sampled on the falling clock edge
Octet Timing	Octet high with every 8 th bit, aligns with frame bit d8

Faults and Alarms	
Backward Alarms Supported	4 input, 4 output
Backward Alarm Inputs	1 kΩ pull up to ground, set high to activate.
Backward Alarm Outputs	Form C Relay, N/O, N/C, Com

12.4.1 IDR Primary Data Interfaces

When configured for IDR operation, the board performs these functions:

- Receives and performs clock and data recovery on incoming G.703 T1 and E1 pseudo-ternary data.
- Clock dejitter is performed per G.823 and G.824, and any data decoding (AMI, B8Z5, or HDB3) required per G.703 also is accomplished.

12.4.2 IDR Framing

Multiplexes in compliance with the standard IESS-308 96 kbps ESC overhead onto the data and provides both the data and rate exchanged clock to the modulator portion of the base modem.

Performs the corresponding demultiplexing of Rx satellite data received from the demodulator portion of the modem. Resulting G.703 data is optionally encoded (AMI, B8ZS, or HDB3) before being output.

12.4.3 IDR Engineering Service Channel

Bi-directional processing of the components of the ESC channel, including the ADPCM audio channels, 8 kbps data channel, and fault indications specified by IESS-403 and IESS-308.

Option of using the ADPCM portion of the satellite overhead for a single 64 kbps ESC data channel in addition to (and with the same format as) the 8 kbps data channel.

When using G.703 format for the primary IDR data path, the P3B primary data interface (25-pin) is used for the 8kbps overhead channel. If RS-422 or V.35 is used, P3B becomes the primary interface and the 8kbps channel is unavailable.

Appendix A. CABLE DRAWINGS

A.1 Introduction

The RS-530 standard pinout provided on the CDM-600/600L is becoming more popular in many applications. However, there are still occasions, particularly with existing RS-422/449 and V.35 users, when a conversion must be made. For situations where such conversions are required, refer to the following table to select the appropriate cable.

In addition, the standard RS-232 cable used for performing Flash Upgrading is depicted. This cable connects the CDM-600/600L Remote Control Port to the serial communications port of an external PC.

App. A FIG	CEFD P/N	DESCRIPTION
A-1	CA/WR0049	Modem Conversion Cable: RS-530 → RS-422/449 DCE Conversion (DB-25M → DB-25F, 40")
A-2	CA/WR0059-2	Modem Conversion Cable: RS-530 → V.35 Winchester DCE Conversion (DB-25M → Winchester 34-pin Female, 8')
A-3	CA/WR9718-1	Modem Conversion Cable: CDM → RS-530 Conversion (DB-25M → DB-25F, 8')
A-4	N/A	Modem Conversion Cable: RS-530 → V.35 Winchester DCE Conversion (DB-25M → Winchester 34-pin Female)
A-5	N/A	RS-232 Switch Programming Cable (for Flash upgrading): CDM-600/600L Remote Port → PC Serial Port (DB-9F → DB-9F)
A-6	CN-0000268	E1/T1 Adapter CDM-600/600L P7 Balanced G.703 Port → Ethernet (DB-15M → RJ-48F)

A.1.1 RS-530 to RS-422/449 Data Cable

Figure A-1 shows the cable drawing for RS-530 to RS-422/449 DCE conversion for connections between the CDM-600/600L and the User data.

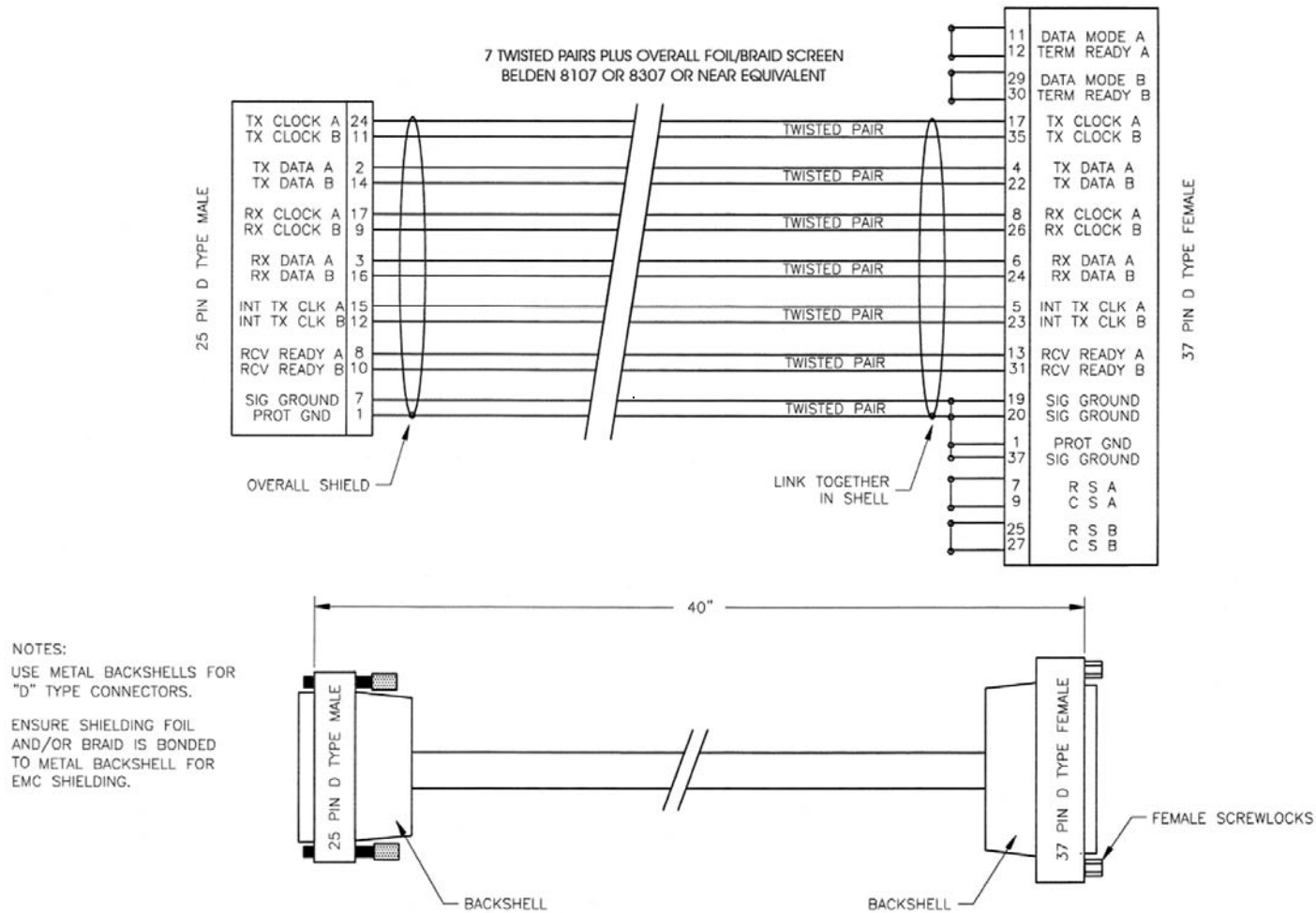


Figure A-1. DCE Conversion Cable: RS-530 to RS-422/449 (CA/WR0049)

A.1.2 RS-530 to V.35 Data Cable

Figure A-2 shows the cable drawing for RS-530 to V.35 DCE conversion for connections between the CDM-600/600L and the User data.

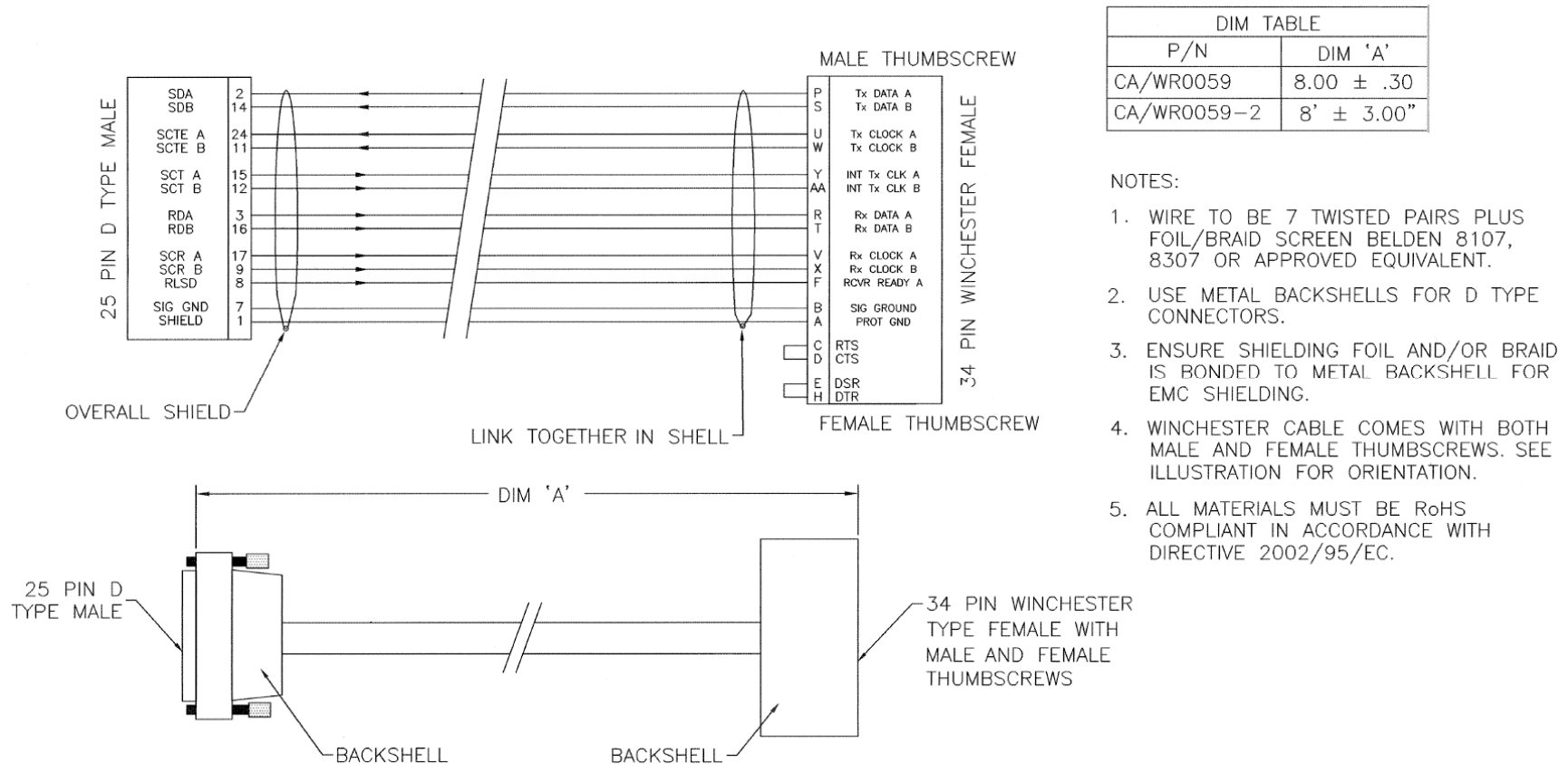


Figure A-2. DCE Conversion Cable: RS-530 to V.35 (CA/WR0059)

A.1.3 RS-530 to V.35 Data Cable

Figure A-3 shows the cable drawing for modem to RS-530 conversion for connections between the CDM-600/600L and the User data.

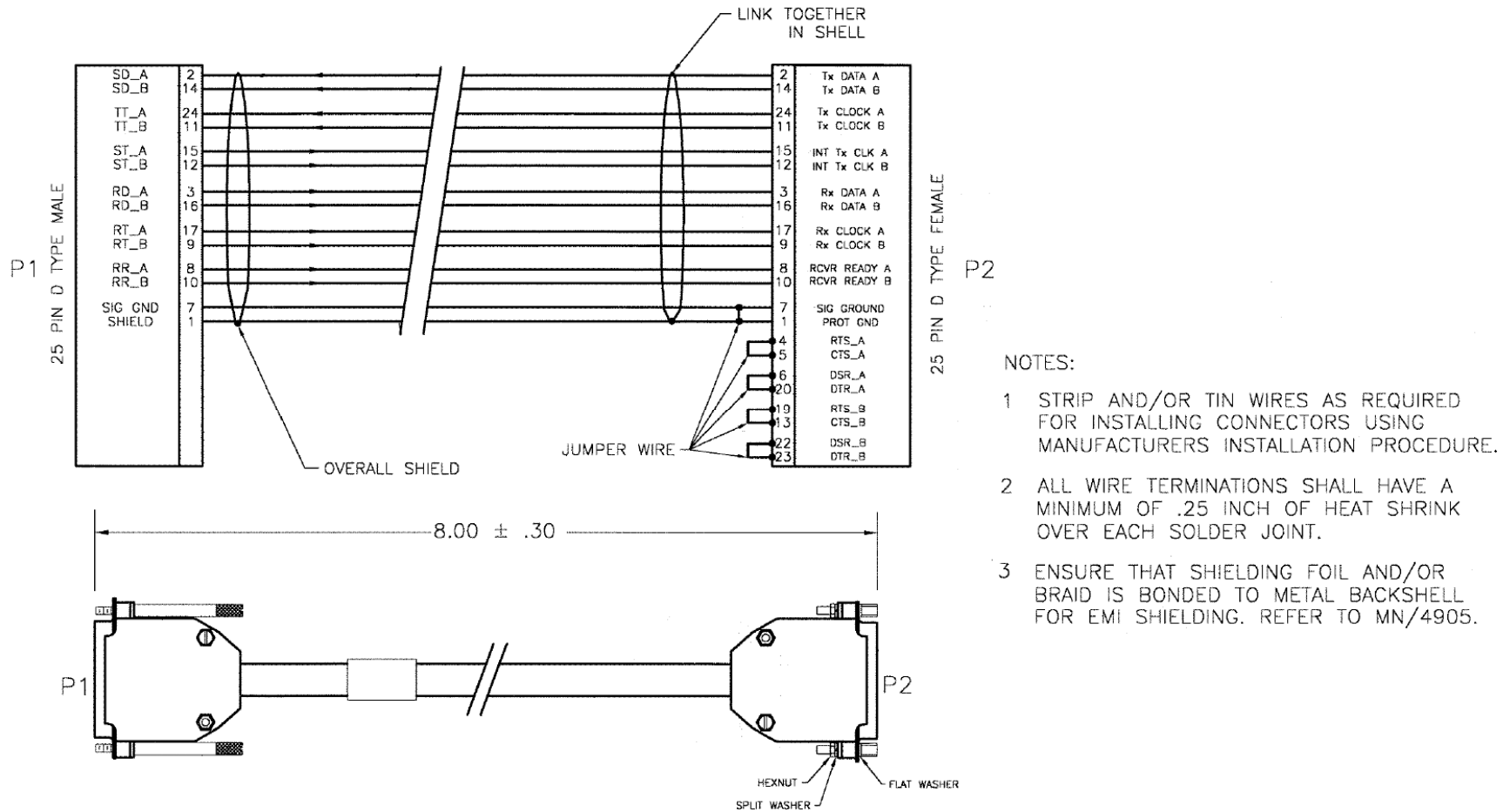


Figure A-3. DCE Conversion Cable: RS-530 (CA/WR9718-1)

A.1.4 RS-530 Conversion Cable

Figure A-4 shows the cable drawing for RS-530 to V.35 DCE conversion for connections between the CDM-600/600L and the User data.

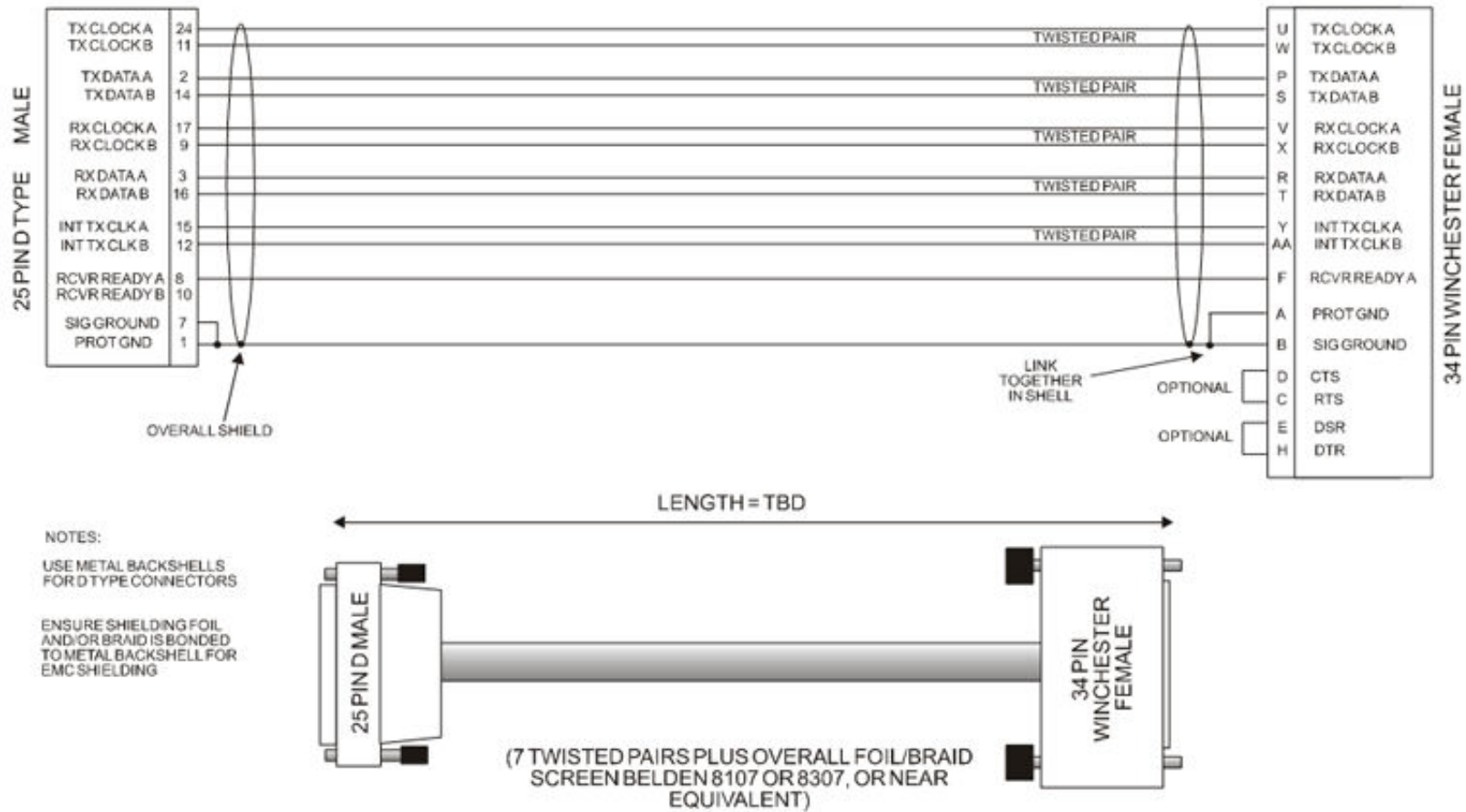


Figure A-4. DCE Conversion Cable: RS-530 to V.35

A.1.5 Switch Programming Cable

Figure A-5 shows the cable required for a simple RS-232 connection between the CDM-600/600L Remote Control port and an external PC serial port. This cable is needed for Flash upgrading.

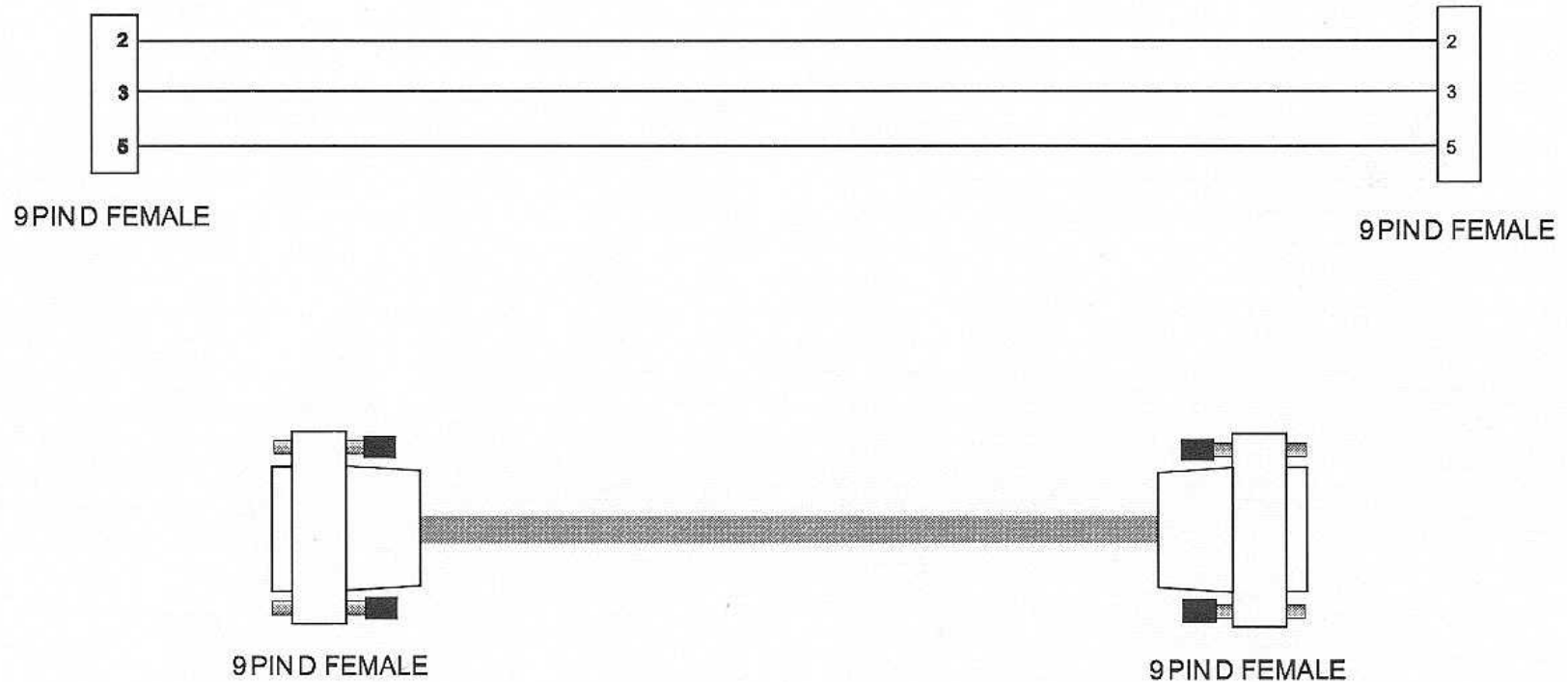
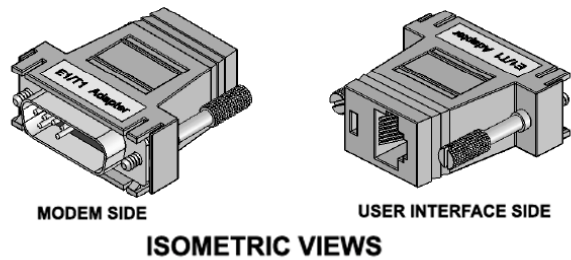
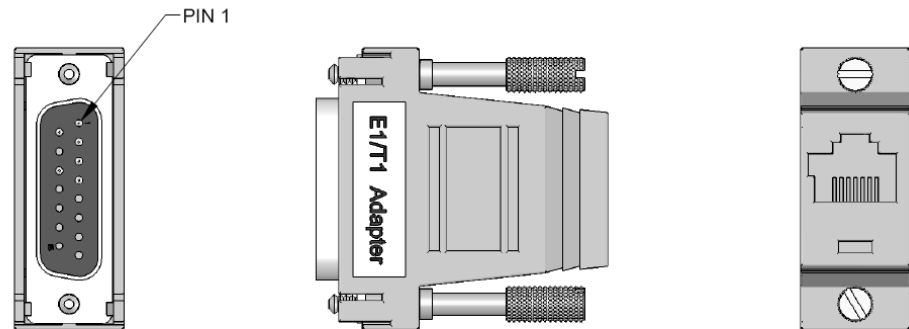


Figure A-5. Switch Programming Cable

A.1.6 E1/T1 Adapter

Figure A-6 shows the adapter required for conversion of the CDM-600/600L DB-15 P7 Balanced G.703 DB-15F connector to an external RJ-48 female connection.

WIRE LEGEND			
RJ-48 PIN #	DB-15M PIN #	WIRE COLOR	SIGNAL NAME
1	9	BLUE	Tx+
2	1	ORANGE	Tx-
3	2	BLACK	GND
4	11	RED	Rx+
5	3	GREEN	Rx-
6	4	YELLOW	GND
7		BROWN	NC
8		WHITE	NC



NOTES:

1. ALL MATERIALS USED MUST BE RoHS COMPLIANT IN ACCORDANCE WITH DIRECTIVE 2002/95/EC
2. VENDOR IS TO BE PCCABLES.COM, PART NUMBER: 01912
VENDOR SUBSTITUTION IS ACCEPTABLE WITH ENGINEERING APPROVAL ONLY

Figure A-6. E1/T1 DB-15 → RJ-48 Adapter (CN-0000268)

Notes:

Appendix B. E_b/N_0 MEASUREMENT

Although the CDM-600/600L calculates and displays the value of receive E_b/N_0 on the front panel of the unit, it is sometimes useful to measure the value using a spectrum analyzer, if one is available.

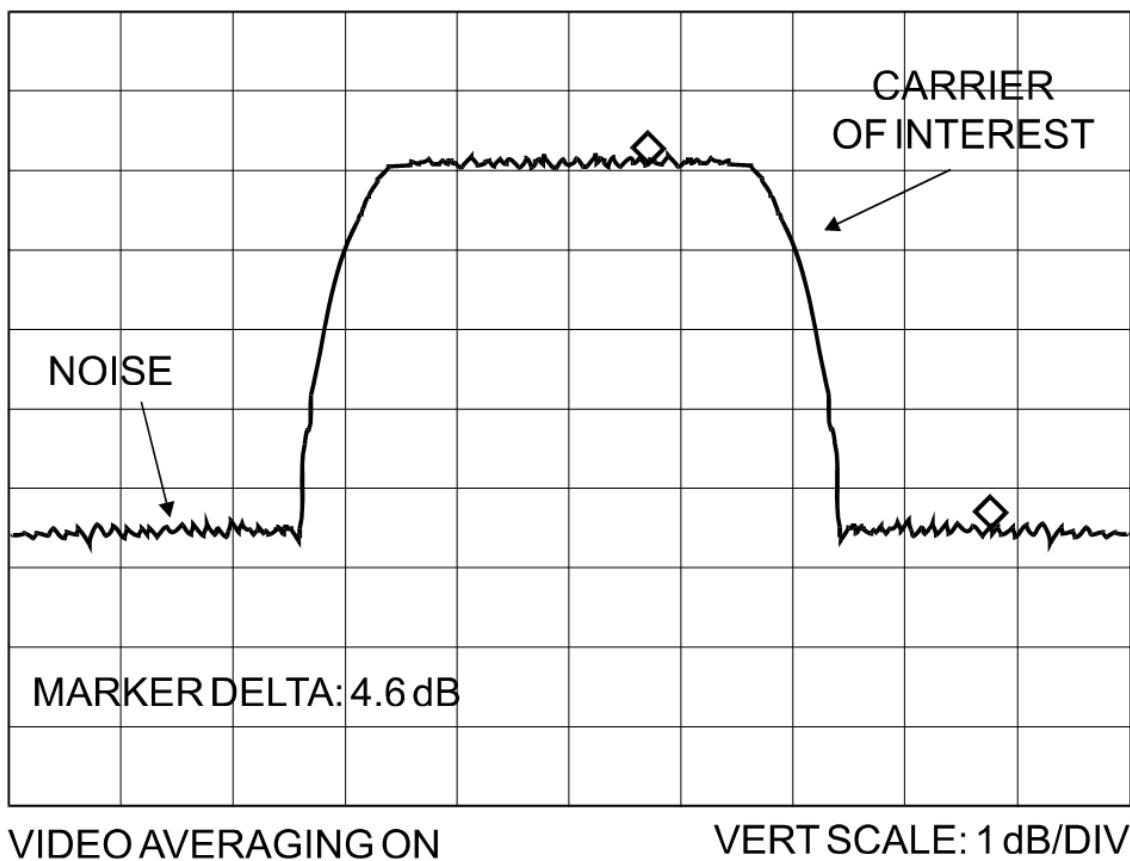
The idea is to accurately measure the value of $(C_0+N_0)/N_0$ (Carrier density + Noise density/Noise density). This is accomplished by tuning the center frequency of the Spectrum analyzer to the signal of interest, and measuring the difference between the peak spectral density of the signal (the flat part of the spectrum shown) and the noise density.

To make this measurement:

- Use a vertical scale of 1 or 2 dB/division.
- Set the Resolution Bandwidth of the Spectrum Analyzer to < 20% of the symbol rate.
- Use video filtering and/or video averaging to reduce the variance in the displayed trace to a low enough level that the difference can be measured to within 0.2 dB.
- Place a marker on the flat part of the signal of interest, then use the MARKER DELTA function to put a second marker on the noise to the side of the carrier. This value is $(C_0+N_0)/N_0$, in dB.
- Use this value of $(C_0+N_0)/N_0$ in the table on the following page to determine the E_b/N_0 . You will need to know the operating mode to read from the appropriate column.
- If the $(C_0+N_0)/N_0$ value measured does not correspond to an exact table entry, interpolate using the two nearest values.

Note that the accuracy of this method degrades significantly at low values of $(C_0+N_0)/N_0$ (approximately less than 6 dB).

Example: In the diagram that follows, the $(C_o+N_o)/N_o$ measured is 4.6 dB. If Rate 1/2 QPSK is being used, this would correspond to an E_b/N_o of approximately 2.6 dB.



The exact relationship used to derive the table values is as follows:

$$E_b/N_0 = 10 \log_{10} (10^{(C_o+N_o/N_o)/10} - 1) - 10 \log_{10} (\text{FEC Code Rate}) - 10 \log_{10} (\text{bits/symbol})$$

where:

- E_b/N_0 and $(C_o+N_o)/N_o$ are expressed in dB
- Bits/symbol = 1 for BPSK
- Bits/symbol = 2 for QPSK
- Bits/symbol = 3 for 8-PSK/8-QAM
- Bits/symbol = 4 for 16-QAM
- Code Rate for 'uncoded' = 1
- Pay close attention to the sign of the middle term

(Co+No)/No	Eb/No Uncoded BPSK	Eb/No Rate 1/2 BPSK	Eb/No Rate 21/44 BPSK	Eb/No Rate 5/16 BPSK	Eb/No Uncoded QPSK	Eb/No Rate 1/2 QPSK	Eb/No Rate 3/4 QPSK	Eb/No Rate 7/8 QPSK	Eb/No Rate 0.95 QPSK	Eb/No Rate 2/3 8-PSK	Eb/No Rate 3/4 8-PSK	Eb/No Rate 7/8 8-PSK	Eb/No Rate 0.95 8-PSK	Eb/No Rate 3/4 16-QAM	Eb/No Rate 7/8 16-QAM
1.4	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-
1.6	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-	-
1.8	-	-	-	2.1	-	-	-	-	-	-	-	-	-	-	-
2.0	-	0.7	0.9	2.7	-	-	-	-	-	-	-	-	-	-	-
2.2	-	1.2	1.4	3.2	-	-	-	-	-	-	-	-	-	-	-
2.4	-	1.7	1.9	3.7	-	-	-	-	-	-	-	-	-	-	-
2.6	-	2.1	2.3	4.2	-	-	-	-	-	-	-	-	-	-	-
2.8	-	2.6	2.8	4.6	-	-	-	-	-	-	-	-	-	-	-
3.0	0.0	3.0	3.2	5.0	-	-	-	-	-	-	-	-	-	-	-
3.5	0.9	3.9	4.1	5.9	-	0.9	-	-	-	-	-	-	-	-	-
4.0	1.8	4.8	5.0	6.8	-	1.8	-	-	-	-	-	-	-	-	-
4.5	2.6	5.6	5.8	7.6	-	2.6	0.8	-	-	-	-	-	-	-	-
5.0	3.3	6.3	6.5	8.4	-	3.3	1.5	0.9	-	-	-	-	-	-	-
5.5	4.1	7.1	7.3	9.1	1.1	4.1	2.3	1.7	1.3	-	-	-	-	-	-
6.0	4.7	7.7	7.9	9.8	1.7	4.7	2.9	2.3	1.9	-	-	-	-	-	-
6.5	5.4	8.4	8.6	10.4	2.4	5.4	3.6	3.0	2.6	-	-	-	-	-	-
7.0	6.0	9.0	9.2	11.1	3.0	6.0	4.2	3.6	3.2	-	-	-	-	-	-
7.5	6.6	9.6	9.8	11.7	3.6	6.6	4.8	4.2	3.8	-	-	-	-	-	-
8.0	7.3	10.3	10.5	12.3	4.3	7.3	5.5	4.9	4.5	-	-	-	-	-	-
8.5	7.8	10.8	11.0	12.9	4.8	7.8	6.0	5.4	5.0	4.8	-	-	-	-	-
9.0	8.4	11.4	11.6	13.4	5.4	8.4	6.6	6.0	5.6	5.4	4.9	-	-	-	-
9.5	9.0	12.0	12.2	14.0	6.0	9.0	7.2	6.6	6.2	6.0	5.5	4.8	4.5	-	-
10.0	9.5	12.5	12.7	14.6	6.5	9.5	7.7	7.1	6.7	6.5	6.0	5.3	5.0	-	-
10.5	10.1	13.1	13.3	15.1	7.1	10.1	8.3	7.7	7.3	7.1	6.6	5.9	5.6	5.3	-
11.0	10.6	13.6	13.8	15.7	7.6	10.6	8.8	8.2	7.8	7.6	7.1	6.4	6.1	5.8	5.2
11.5	11.2	14.2	14.4	16.2	8.2	11.2	9.4	8.8	8.4	8.2	7.7	7.0	6.7	6.4	5.8
12.0	11.7	14.7	14.9	16.7	8.7	11.7	9.9	9.3	8.9	8.7	8.2	7.5	7.2	6.9	6.3
12.5	12.2	15.2	15.4	17.3	9.2	12.2	10.4	9.8	9.4	9.2	8.7	8.0	7.7	7.4	6.8
13.0	12.8	15.8	16.0	17.8	9.8	12.8	11.0	10.4	10.0	9.8	9.3	8.6	8.3	8.0	7.4
13.5	13.3	16.3	16.5	18.3	10.3	13.3	11.5	10.9	10.5	10.3	9.8	9.1	8.8	8.5	7.9
14.0	13.8	16.8	17.0	18.8	10.8	13.8	12.0	11.4	11.0	10.8	10.3	9.6	9.3	9.0	8.4
14.5	14.3	17.3	17.5	19.4	11.3	14.3	12.5	11.9	11.5	11.3	10.8	10.1	9.8	9.5	8.9
15.0	14.9	17.9	18.1	19.9	11.9	14.9	13.1	12.5	12.1	11.9	11.4	10.7	10.4	10.1	9.5
15.5	15.4	18.4	18.6	20.4	12.4	15.4	13.6	13.0	12.6	12.4	11.9	11.2	10.9	10.6	10.0
16.0	15.9	18.9	19.1	20.9	12.9	15.9	14.1	13.5	13.1	12.9	12.4	11.7	11.4	11.1	10.5
16.5	16.4	19.4	19.6	21.4	13.4	16.4	14.6	14.0	13.6	13.4	12.9	12.2	11.9	11.6	11.0
17.0	16.9	19.9	20.1	21.9	13.9	16.9	15.1	14.5	14.1	13.9	13.4	12.7	12.4	12.1	11.5
17.5	17.4	20.4	20.6	22.4	14.4	17.4	15.6	15.0	14.6	14.4	13.9	13.2	12.9	12.6	12.0
18.0	17.9	20.9	21.1	23.0	14.9	17.9	16.1	15.5	15.1	14.9	14.4	13.7	13.4	13.1	12.5
18.5	18.4	21.4	21.6	23.5	15.4	18.4	16.6	16.0	15.6	15.4	14.9	14.2	13.9	13.6	13.0
19.0	18.9	21.9	22.1	24.0	15.9	18.9	17.1	16.5	16.1	15.9	15.4	14.7	14.4	14.1	13.5
19.5	19.5	22.5	22.7	24.5	16.5	19.5	17.7	17.1	16.7	16.5	16.0	15.3	15.0	14.7	14.1
20.0	20.0	23.0	23.2	25.0	17.0	20.0	18.2	17.6	17.2	17.0	16.5	15.8	15.5	15.2	14.6

Notes: IBS Framing: add 0.2 dB EDMAC Framing: rates below 2048 kbps add 0.2 dB, otherwise 0 Reed-Solomon: add an additional 0.4 dB to the values shown

Appendix C. FAST ACTIVATION PROCEDURE

C.1 Introduction

Fully Accessible System Topology (**FAST**) is an enhancement feature available in Comtech EF Data products, enabling on-location upgrade of the operating feature set – in the rack – without removing a modem from the setup.

This accelerated upgrade can be accomplished only because of FAST's extensive use of programmable devices incorporating Comtech EF Data-proprietary signal processing techniques. These techniques allow the use of a unique access code to enable configuration of the available hardware.

The access code can be purchased at any time from Comtech EF Data. Once obtained, the access code is loaded into the unit via the front panel keypad.

C.2 Activation Procedure

C.2.1 Serial Number

Obtain the Modem serial number as follows:

- a. From the **SELECT: (Main)** menu, select **FAST**, then press **[ENT]**.
- b. The Modem motherboard Serial Number is displayed on the FAST menu bottom line, to the left.
- c. Record the Serial Number: _____

C.2.2 View currently installed features

To view the currently installed features, proceed as follows:

- a. From the **SELECT: (main)** menu, select **FAST: VIEW**, then press **[ENT]**.
- b. Use the **[↑][↓]** arrow keys to scroll through the Modem Options and note which are '**Installed**' or '**Not Installed**':

Any option identified as '**Not Installed**' may be purchased as a **FAST** upgrade.

- c. Contact a Comtech EF Data sales representative to order features. You will be asked to provide the Modem Serial Number. Comtech EF Data Customer Support personnel will verify the order and provide an invoice and instructions, including a 20-character configuration code.

C.2.3 Enter Access Codes

Enter the access codes as follows:

- a. Press **[CLR]** to return to the FAST OPTIONS menu.
- b. Select **SET**, then press **[ENT]**.
- c. Enter the code *carefully*. Use the **[←][→]** arrow keys to move the cursor to each character, then use the **[↑][↓]** arrow keys to edit that character. Press **[ENT]** when done.

The modem will respond with "**Configured Successfully**" if the new FAST option has been accepted.

If, on the other hand, the 20-character FAST configuration code is invalid, the message "**FAST Code Rejected!**" displays. Re-enter the code as needed, or contact Comtech EF Data Customer Support for further assistance.

Appendix D. SERIAL REMOTE CONTROL

D.1 Overview

This appendix describes the protocol and message command set for remote monitor and control of the CDM-600/600L Modem.

The electrical interface is either an RS-485 multi-drop bus (for the control of many devices) or an RS-232 connection (for the control of a single device), and data is transmitted in asynchronous serial form, using ASCII characters. Control and status information is transmitted in packets, of variable length, in accordance with the structure and protocol defined in later sections.

D.2 RS-485

For applications where multiple devices are to be monitored and controlled, a full-duplex (or 4-wire) RS-485 is preferred. Half-duplex (2-wire) RS-485 is possible, but *is not preferred*.

In full-duplex RS-485 communication there are two separate, isolated, independent, differential-mode twisted pairs, each handling serial data in different directions. It is assumed that there is a 'Controller' device (a PC or dumb terminal), which transmits data, in a broadcast mode, via one of the pairs. Many 'Target' devices are connected to this pair, which all simultaneously receive data from the Controller. The Controller is the only device with a line-driver connected to this pair – the Target devices only have line-receivers connected.

In the other direction, on the other pair, each Target has a tri-stateable line driver connected, and the Controller has a line-receiver connected. All the line drivers are held in high-impedance mode until one (and only one) Target transmits back to the Controller.

Each Target has a unique address, and each time the Controller transmits, in a framed 'packet' of data, the address of the intended recipient Target is included. All of the Targets receive the packet, but only one (the intended) will reply. The Target enables its output line driver, and transmits its return data packet back to the Controller, in the other direction, on the physically separate pair.

RS-485 (full duplex) summary:

- Two differential pairs – one pair for Controller-to-Target, one pair for Target-to-Controller.
- Controller-to-Target pair has one line driver (Controller), and all Targets have line receivers.
- Target-to-Controller pair has one line receiver (Controller), and all Targets have tri-state drivers.

D.3 RS-232

This is a much simpler configuration in which the Controller device is connected directly to the Target via a two-wire-plus-ground connection. Controller-to-Target data is carried, via RS-232 electrical levels, on one conductor, and Target-to-Controller data is carried in the other direction on the other conductor.

D.4 Basic Protocol

Whether in RS-232 or RS-485 mode, all data is transmitted as asynchronous serial characters, suitable for transmission and reception by a UART. In this case, the asynchronous character formats include 7O2, 7E2, and 8N1. The baud rate may vary between 1200 and 38,400 baud.

All data is transmitted in framed packets. The Controller is assumed to be a PC or ASCII dumb terminal, which is in charge of the process of monitor and control. The Controller is the only device that is permitted to initiate, at will, the transmission of data. Targets are only permitted to transmit when they have been specifically instructed to do so by the Controller.

All bytes within a packet are printable ASCII characters, less than ASCII code 127. In this context, the Carriage Return and Line Feed characters are considered printable.

All messages from Controller-to-Target require a response (with one exception). This will be either to return data that has been requested by the Controller, or to acknowledge reception of an instruction to change the configuration of the Target. The exception to this is when the Controller broadcasts a message (such as Set time/date) using Address 0, when the Target is set to RS-485 mode.

D.5 Packet Structure

Controller-to-Target						
Start of Packet	Target Address	Address Delimiter	Instruction Code	Code Qualifier	Optional Arguments	End of Packet
< ASCII code 60 (1 character)		/ ASCII code 47 (1 character)		= or ? ASCII codes 61 or 63 (1 character)		Carriage Return ASCII code 13 (1 character)

Example: <0135/TFT=1{CR}

Target-to-Controller						
Start of Packet	Target Address	Address Delimiter	Instruction Code	Code Qualifier	Optional Arguments	End of Packet
> ASCII code 62 (1 character)		/ ASCII code 47 (1 character)		=, ?, !, or * ASCII codes 61,63,33 or 42 (1 character)	(From 0 to n characters)	Carriage Return, Line Feed ASCII codes 13,10 (2 characters)

Example: >0654/RSW=32{CR}{LF}

D.5.1 Start of Packet

Controller-to-Target: This is the character '<' (ASCII code 60).

Target-to-Controller: This is the character '>' (ASCII code 62).

Because this is used to provide a reliable indication of the start of packet, these two characters may not appear anywhere else within the body of the message.

D.5.2 Target Address

Up to 9,999 devices can be uniquely addressed. In RS-232 applications this value is set to 0. In RS-485 applications, the permissible range of values is 1 to 9999. It is programmed into a Target unit using the front panel keypad.



The Controller sends a packet with the address of a Target – the destination of the packet. When the Target responds, the address used is the same address, to indicate to the Controller the source of the packet. The Controller does not have its own address.

D.5.3 Address Delimiter

This is the character '/' (forward slash) (ASCII code 47).

D.5.4 Instruction Code

This is a three-character alphabetic sequence that identifies the subject of the message. Wherever possible, the instruction codes have been chosen to have some significance. **For Example: TFQ** for **Tx FreQuency**; **RMD** for **Rx MoDulation** type, etc. This aids in the readability of the message, should it be displayed in its raw ASCII form. Only upper case alphabetic characters may be used (A-Z, ASCII codes 65 - 90).

D.5.5 Instruction Code Qualifier

This single character further qualifies the preceding instruction code. Code Qualifiers obey the following rules:

1. From **Controller-to-Target**, the only permitted values are:

=
(ASCII code 61)

The = code is used as the **assignment** operator, and is used to indicate that the parameter defined by the preceding byte should be set to the value of the argument(s) that follow it. **For Example:** In a message from Controller-to-Target, TFQ=0950.0000 would mean 'set the Tx frequency to 950 MHz'

?
(ASCII code 63)

The ? code is used as the **query** operator, and is used to indicate that the Target should return the current value of the parameter defined by the preceding byte. **For Example:** In a message from Controller-to-Target, TFQ? would mean 'return the current value of the transmit frequency'.

2. From **Target-to-Controller**, the only permitted values are:

=
(ASCII code 61)

The = code is used in two ways:

First, if the Controller has sent a query code to a Target (**for Example: TFQ?**, meaning 'what is the Tx frequency?'), the Target would respond with **TFQ=xxxx.xxxx**, where **xxxx.xxxx** represents the frequency in question.

Second, if the Controller sends an instruction to set a parameter to a particular value, and if the value sent in the argument is valid, then the Target will acknowledge the message by replying with **TFQ=** (with no message arguments).

?
(ASCII code 63)

The ? code is only used as follows:

If the Controller sends an instruction to set a parameter to a particular value, then, if the value sent in the argument is not valid, the Target will acknowledge the message by replying, for example, with **TFQ?** (with no message arguments). This indicates that there was an error in the message sent by the Controller.

!
(ASCII code 33)

The ! code is only used as follows:

If the Controller sends an instruction code which the Target does not recognize, the Target will acknowledge the message by echoing the invalid instruction, followed by the ! character. **Example: XYZ!**

*
(ASCII code 42)

The * code is only used as follows:

If the Controller sends an instruction to set a parameter to a particular value, then, if the value sent in the argument is valid, BUT the modem will not permit that particular parameter to be changed at that time, the Target will acknowledge the message by replying, for example, with **TFQ*** (with no message arguments).

(ASCII code 35)

The # code is only used as follows:

If the Controller sends a correctly formatted command, BUT the modem is not in remote mode, it will not allow reconfiguration, and will respond with **TFQ#**.

~ (ASCII Code 126)	The ~ code is only used as follows: If a message was sent via a local modem to a distant end device or ODU, the message was transmitted transparently through the local modem. In the event of the distant-end device not responding, the local modem would generate a response. Example: 0001/RET~, indicating that it had finished waiting for a response and was now ready for further comms.
+ (ASCII Code 43)	The + code is only used as follows: This is similar to the = code (acknowledgement), indicating that a command has been accepted and processed, but in addition, indicates that some other configuration parameter has also been modified. Example: Suppose the user has selected Viterbi + Reed-Solomon, QPSK, Rate 1/2. Now, the user changes the modulation type from QPSK to 16-QAM by sending TMD=4. In this case, Rate 1/2 is no longer a valid code rate, and so it will be automatically changed to the nearest valid code rate (Rate 3/4). The Target will therefore respond with TMD+.
^ (ASCII Code 94)	The ^ code is only used as follows: This indicates that the modem is in Remote mode, so serial remote control is not possible. There are two exceptions to this: <ul style="list-style-type: none">• The LRS (local/remote status) command is still active, and may be used to change the operating mode to local or to serial remote control.• For the CDM-600L, the FPL (front panel lockout) command is active, and may be used to configure the Front Panel Lockout to be “No lockout” or “Active.”

D.5.6 Optional Message Arguments

Arguments are not required for all messages. Arguments are ASCII codes for the characters 0 to 9 (ASCII codes 48 to 57); period (ASCII code 46); and comma (ASCII code 44); plus miscellaneous printable characters.

D.5.7 End of Packet

Controller-to-Target: This is the 'Carriage Return' character (ASCII code 13).

Target-to-Controller: This is the two-character sequence 'Carriage Return' (ASCII code 13), and 'Line Feed' (ASCII code 10).

Both indicate the valid termination of a packet.

D.6 Remote Commands and Queries

Index Notes:

Column 'C' = Command; **Column 'Q'** = Query: Columns marked 'X' designate instruction code as *Command only*, *Query only*, or *Command/Query*.

Where Instruction Code (Column 'CODE') reads XXX^L = **CDM-600L only**.

Where Instruction Code (Column 'CODE') reads XXX⁰ = **CDM-600 only**.

CODE	C	Q	PAGE
A			
ADJ ⁰	X	X	D-37
APP	X	X	D-20
AUP	X	X	D-20
B			
BER		X	D-28
BFS		X	D-28
BSQ		X	D-29
C			
CAE	X		D-20
CAS	X		D-20
CID	X	X	D-20
CLD	X		D-21
CST	X		D-21
CTD ⁰	X	X	D-37
D			
DAY	X	X	D-21
DNI	X	X	D-31
DTS	X	X	D-10
DTY	X	X	D-10
E			
EBA	X	X	D-15
EBN		X	D-17
EFM	X	X	D-21
EFR ⁰	X	X	D-37
EID		X	D-26
ESA	X	X	D-21
ESC	X	X	D-21
F			
FLT		X	D-27/28
FPL ^L	X	X	D-10
FSW	X		D-22
G			
H			
HRV		X	D-29

CODE	C	Q	PAGE
I			
IEP	X		D-22
IRD	X	X	D-17
ISP	X		D-22
ITD	X	X	D-10
ITS	X	X	D-17
ITY	X	X	D-17
J			
K			
L			
LNB ^L	X	X	D-36
LNC ^L		X	D-36
LNH ^L	X	X	D-36
LNL ^L	X	X	D-36
LNR ^L	X	X	D-36
LNV ^L	X	X	D-36
LRS	X	X	D-22
M			
MGC	X	X	D-32
MRC ^L	X	X	D-22
MSK	X	X	D-22
N			
NUE		X	D-22
NUS		X	D-22
O			
OAD ^L	X	X	D-34
ODC ^L		X	D-34
ODH ^L	X	X	D-34
ODL ^L	X	X	D-34
ODP ^L	X	X	D-34
ODR ^L	X	X	D-34
ODT ^L		X	D-34
ODU	X	X	D-23
ODV ^L		X	D-34
OGC ^L	X	X	D-33

CODE	C	Q	PAGE
OLL^L		X	D-34
OOD ^L	X	X	D-35
OOL ^L		X	D-35
OOP ^L	X	X	D-35
OPC ^L		X	D-35
OPL ^L	X	X	D-35
OSV ^L		X	D-35
OTP ^L		X	D-35
OUS		X	D-29
P			
PLI		X	D-30
Q			
R			
RBA	X	X	D-17
RBS	X	X	D-17
RCB	X		D-23
RCK	X	X	D-17
RCR	X	X	D-15
RDR	X	X	D-15
RDS	X	X	D-18
REB		X	D-30
RED		X	D-30
REF	X	X	D-18
RET	X	X	D-18
RFM	X	X	D-15
RFO		X	D-30
RFQ	X	X	D-18
RFT	X	X	D-15
RIP ⁰	X	X	D-18
RIT	X	X	D-15
RLO	X	X	D-18
RMD	X	X	D-15
RNE		X	D-23
RNS		X	D-24
RRS	X	X	D-18
RSI	X	X	D-19
RSL		X	D-19
RSR ^L		X	D-19
RSW	X	X	D-19
RTC	X	X	D-19
RTE	X	X	D-19

CODE	C	Q	PAGE
RVL	X	X	D-19
S			
SCP	X	X	D-24
SNO		X	D-30
SSI	X	X	D-24
SWR		X	D-30
T			
TBA	X	X	D-11
TCK	X	X	D-11
TCR	X	X	D-9
TDR	X	X	D-10
TET	X	X	D-11
TFM	X	X	D-8
TFQ	X	X	D-11
TFT	X	X	D-9
TIM	X	X	D-25
TIT	X	X	D-8
TLO ^L	X	X	D-12
TMD	X	X	D-9
TMP		X	D-30
TPL ⁰	X	X	D-12
TRS	X	X	D-12
TSC	X	X	D-13
TSI	X	X	D-13
TSR		X	D-13
TST	X	X	D-25
TTA	X	X	D-13
TTC	X	X	D-13
TVL	X	X	D-13
TXO	X	X	D-13
U			
V			
W			
WRM ⁰	X	X	D-37
X			
Y			
Z			

Section D.6 Notes:

1. The remote commands and queries are arranged as subsections of this chapter as follows:

- Sect. D.6.1 Transmit (Tx) Commands and Queries
- Sect. D.6.2 Receive (Rx) Commands and Queries
- Sect. D.6.3 Unit Commands and Queries
- Sect. D.6.4 Queries
- Sect. D.6.5 Bulk Commands and Queries
- Sect. D.6.6 BUC Commands and Queries (CDM-600L ONLY)
- Sect. D.6.7 LNB Commands and Queries (CDM-600L ONLY)
- Sect. D.6.8 High-Stability Reference Option Commands and Queries (CDM-600 ONLY)

2. A command/query that is unique to the CDM-600L is noted in the '**Parameter Type**' column as **(CDM-600L ONLY)**.

Similarly, a command/query that is unique to the CDM-600 is noted in the '**Parameter Type**' column as **(CDM-600 ONLY)**.

For commands and queries common to both the CDM-600/600L, any operational difference is noted accordingly in the '**Description of Arguments**' column.

3. Typical for all tabature, the following codes are used in the '**Response to Command**' column:

- = Message ok
- ? Received ok, but invalid arguments found
- * Message ok, but not permitted in current mode
- # Message ok, but unit is not in **Remote** mode
- ~ Time out of an EDMAC pass-through message (added for CDM-600 in FW Ver 1.1.5)
- + Warning: Command accepted, but other parameters were changed in addition

D.6.1 Transmit (Tx) Commands and Queries

Tx Priority System = TIT (Highest priority) , TFM, TFT, TMD, TCR, and TDR (Lowest Priority), indicated by **shading**. Any change to a higher priority parameter can override any of the parameters of lower priority.

Exception: Select DROP or INSERT mode using TFM (Framing type) which is highest priority.

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx Interface Type	TIT=	1 byte, value 0 thru 6	<p>Command or Query. Tx Interface Type, where: 0=RS422 1=V.35 2=RS232 (synchronous) 3=Balanced G.703 4=Unbalanced G.703 5=Audio (Data rate fixed at 64 kbps) (IBS/EDMAC only) 6=LVDS</p> <p>Example: TIT=1 (selects V.35)</p>	TIT= TIT? TIT* TIT#	TIT?	TIT=x (see Description of Arguments)
Tx Framing Mode	TFM=	1 byte, value of 0 thru 6	<p>Command or Query. Tx Framing mode, where: 0=Unframed 1=IBS 2=IDR 3=DROP (Requires D&I FAST option) 4=EDMAC 5=D&I++ (Requires D&I FAST option) (CDM-600L requires FW Ver 1.2.0 or higher; CDM-600 requires FW Ver 1.5.0 or higher) 6=ESC++ (CDM-600L requires FW Ver 1.3.0 or higher; CDM-600 requires FW Ver 2.0.1 or higher)</p> <p>If TFM=4 is selected, Rx framing is driven to EDMAC to match. Example: TFM=0 (selects Unframed mode)</p>	TFM= TFM? TFM* TFM#	TFM?	TFM=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx FEC Type	TFT=	1 byte, value of 0 thru 9	<p>Command or Query. Tx FEC coding type, where: 0=None (uncoded, rate 1/1) with differential encoding ON 1=Viterbi 2=Viterbi + Reed-Solomon 3=Sequential 4=Sequential + Reed-Solomon 5=TCM (Trellis Code Modulation) (Forces TCR=3 [2/3]) 6=TCM + Reed-Solomon (Forces TCR=3 [2/3]) 7=Turbo (TPC) 8=None (uncoded, rate 1/1) with differential encoding OFF 9=LDPC (Requires TPC/LDPC codec)</p> <p>Example: TFT=1 (Viterbi coding)</p>	TFT= TFT? TFT* TFT#	TFT?	TFT=x (see Description of Arguments)
Tx Modulation Type	TMD=	1 byte, value of 0 thru 5	<p>Command or Query. Tx Modulation type, where: 0=BPSK 1=QPSK 2=OQPSK 3=8PSK 4=16QAM (Turbo or Viterbi+RS only) 5=8-QAM (LDPC only) (Requires TPC/LDPC codec and FAST option)</p> <p>Depending on FEC type, not all of these selections will be valid.</p> <p>Example: TMD=2 (OQPSK)</p>	TMD= TMD? TMD* TMD#	TMD?	TMD=x (see Description of Arguments)
Tx FEC Code Rate	TCR=	1 byte, value of 0 thru 7	<p>Command or Query Tx FEC Code Rate, where: 0 = Rate 1/2 1 = Rate 3/4 2 = Rate 7/8 3 = Rate 2/3 (8-PSK TCM or LDPC only) 4 = Rate 1/1 (Uncoded or No FEC) 5 = Rate 21/44 (Turbo Only) 6 = Rate 5/16 (Turbo Only) 7 = Rate 0.95 (Turbo Only)</p> <p>Depending on FEC type, not all of these selections will be valid.</p> <p>Example: TCR=1 (Rate 3/4)</p>	TCR= TCR? TCR* TCR#	TCR?	TCR=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx Data Rate	TDR=	9 bytes	<p>Command or Query. Tx Data Rate, in kbps, between 4.8 kbps and 20 Mbps (CDM-600L) or between 2.4 kbps and 20 Mbps (CDM-600) Resolution=1 bps.</p> <p>Example: TDR=02047.999 (2047.999 kbps)</p> <p>For Hardware Ver 2.0 or higher with CDM-600/600L FW Ver 1.3.1 or higher, additional auxiliary G.703 sub-rates are available. These are selected using: 00512.AUX 01024.AUX 02048.AUX</p> <p>The connectors used for the Aux rates are IDI/DDO. The Aux rates are not available with Drop & Insert or IDR.</p>	TDR= TDR? TDR* TDR#	TDR?	TDR=xxxxx.xxx (see Description of Arguments)
Drop Timeslot	DTS=	3 bytes	<p>Command or Query. (Drop parameter)</p> <p><i>(Note: Command and query have different formats)</i></p> <p>Command format: DTS=xy, where: xx = Channel 01 through 24 y = timeslot, 0-9, A=10, B=11, C=12, D=13 ... V=31</p>	DTS= DTS? DTS* DTS#	DTS?	DTS=yyyyyyyyyyyyyyyy yyyyyy indicating all 24 Drop timeslot values associated with the 24 Tx Satellite channels.
Drop Type	DTY=	1 byte, value of 0 thru 3	<p>Command or Query. (Drop/D&I++ mode parameter)</p> <p>Drop Type, where: 0=T1 – D4 1=T1 – ESF 2=E1 – CCS 3=E1 – CAS</p>	DTY= DTY? DTY* DTY#	DTY?	DTY=x (see Description of Arguments)
Front Panel Lockout (CDM-600L ONLY)	FPL=	1 byte, numeric	<p>Command or Query. Control the state of front-panel lockout, where: 0 = no lockout 1 = front panel lockout active.</p> <p>Disable the lockout by either FPL=0, or by setting into local mode using LRS=0.</p>	FPL= FPL? FPL* FPL#	FPL?	FPL=x (see Description of Arguments)
Invert Tx Data	ITD=	1 byte, value 0 or 1	<p>Command or Query. Invert Tx Data 0=Normal 1=Inverted</p> <p>Example: ITD = 1 (selects Inverted TX Data)</p>	ITD= ITD? ITD* ITD#	ITD?	ITD=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Transmit Backward Alarms Enable	TBA=	4 bytes, each a value of 0 thru 2	Command or Query. (IDR Parameter) Transmit Backward Alarm enable: 0=Disable 1=Enable Internal (S/W) 2=Enable External (H/W) Position indicates backward alarm numbers: 1234 Example: TBA=0120	TBA= TBA? TBA* TBA#	TBA?	TBA=xxxx (see Description of Arguments)
Tx Clock Source	TCK=	1 byte, value 0 thru 3	Command or Query. Tx Clock Source, where: 0=Internal 1=Tx Terrestrial 2=Rx Loop-Timed 3=External Clock Example: TCK=0 (selects Internal)	TCK= TCK? TCK* TCK#	TCK?	TCK=x (see Description of Arguments)
Transmit ESC Type	TET=	1 byte, value of 0 or 1	Command or Query. (IDR Parameter) Sets or queries IDR Transmit ESC Type, where: 0=64k data channel 1=2 Audio channels	TET= TET? TET* TET#	TET?	TET=x (see Description of Arguments)
Tx Frequency	TFQ=	9 bytes	Command or Query. FOR CDM-600L: Tx Frequency, 950 to 1950 MHz, Resolution=100Hz. Example: TFQ=0950.9872 FOR CDM-600: With hardware revision xx.0 , standard frequency range: 52 MHz to 88 MHz, or 104 MHz to 176 MHz. With hardware revision xx.1 , extended frequency range: 50 MHz to 90 MHz, or 100 MHz to 180 MHz. (Use HRV? to obtain the hardware revision level) Resolution=100Hz. Example: TFQ=072.9872 Note: The CDM-600 supports both 70 and 140 MHz bands.	TFQ= TFQ? TFQ* TFQ#	TFQ?	TFQ=xxxx.xxxx (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx LO Frequency (CDM-600L ONLY)	TLO=	6 bytes	<p>Command or Query. BUC transmit LO frequency information in the form: xxxxs, where: xxxx is the LO frequency in the range of 3000 to 65000 MHz or 0=OFF s=sign for the MIX</p> <p>Note: For additional information refer to Appendix G. BUC FSK COMMUNICATION; LO, MIX , and Spectrum Settings. Terminal Frequency = BUC LO \pm TFQ</p>	TLO= TLO? TLO* TLO#	TLO?	TLO=xxxxs (see Description of Arguments)
Tx Power Level	TPL=	4 bytes	<p>Command or Query. NOTE: COMMAND NOT VALID IN AUPC MODE.</p> <p>FOR CDM-600L: Tx Output power level between 0 and -45 dBm in the form xx.x (minus sign assumed). <i>[Beyond -40 dBm exceeds the specification].</i> Example: TPL=13.4</p> <p>Note: When Output Power Leveling is enabled, power level configuration is not allowed, and this command is rejected. Response will be TPL*. The response to the query TPL? will be the adjusted leveled value.</p> <p><u>WHEN EXTERNAL 20dB ATTENUATOR IS PRESENT ON CDM-600L:</u> The power level indicated is the final power after the attenuator, if the External 20dB Attenuator is present.</p> <p>IN MANUAL (Normal) POWER MODE (AUP=0): Tx Output power level may be configured between -45 and 0 dBm. <i>[Between -45 and -40 dBm exceeds the specification.]</i></p> <p>IN MANUAL-LOW (Low Power) MODE (AUP=2): Tx Output power level may be configured between -65 and -20 dBm in the form xx.x (minus sign assumed). <i>[Between -65 and -60 dBm exceeds the specification. The power levels exceeding the specification are indicated on the front panel menu by a *.]</i></p> <p>See Appendix J. KT/11202-1 STEP ATTENUATOR KIT for further details.</p> <p>FOR CDM-600: Tx Output power level between 0 and -20 dBm (minus sign assumed). Example: TPL=13.4</p>	TPL= TPL? TPL* TPL#	TPL?	TPL=xx.x (see Description of Arguments)
Tx Reed-Solomon Encoding	TRS=	1 byte, value of 0 to 3	<p>Command or Query. Tx RS encoding 0=Normal (based on the Open Network framing mode selected) 1=IESS-310 mode – Available all framing modes, except EDMAC. 2=EF Data legacy standard (225,205) – Unframed only 3=IBS (126,112) – Unframed only</p> <p>Available all framing modes, except EDMAC (this is a 'don't care' if no RS is selected under FEC Type)</p> <p>Example: TRS=0</p>	TRS= TRS? TRS* TRS#	TRS?	TRS=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx Scrambler	TSC=	1 byte, value of 0 or 1	Command or Query. Tx Scrambler state, where: 0=Off 1=On 2=IESS-315 when in Turbo mode 2=Special when uncoded or Viterbi (needs FAST Special Option 1 installed) Example: TSC=1 (Scrambler On)	TSC= TSC? TSC* TSC#	TSC?	TSC=x (see Description of Arguments)
Tx Spectrum Invert	TSI=	1 byte, value of 0 or 1	Command or Query. Tx Spectrum Invert selection, where: 0=Normal, 1=Tx Spectrum Inverted Example: TSI=0 (normal)	TSI= TSI? TSI* TSI#	TSI?	TSI=x (see Description of Arguments)
Tx Symbol Rate	N/A	9 bytes, numeric	Query only. Returns the Tx symbol rate (shown on front panel), where in the form ddddd.dd	TSR? TSR=	TSR?	TSR=dddd.d (see Description of Arguments)
Transmit Terrestrial Alarm Mask	TTA=	1 byte, value of 0 or 1	Command or Query. (Drop mode parameter) Transmit Terrestrial Alarm mask conditions, where: 0=Alarm Active (unmasked) 1=Alarm Masked Example: TTA=0 (Alarm Active/unmasked)	TTA= TTA? TTA* TTA#	TTA?	TTA=x (see Description of Arguments)
Tx Ternary Code	TTC=	1 byte, value of 0 thru 3	Command or Query. (G.703 Parameter) Tx Ternary Code, where: 0=AMI 1=B8ZS 2=B6ZS 3=HDB3 Example: TTC=1 (selects B8ZS)	TTC= TTC? TTC* TTC#	TTC?	TTC=x (see Description of Arguments)
Tx Audio Volume Control	TVL=	4 bytes	Command or Query. (Audio/IDR Parameter) Tx Audio Volume control, in the form aabb, where: aa=Tx 1 volume control in dB, values defined below. bb=Tx 2 volume control in dB, values defined below. Valid values: -6, -4, -2, +0, +2, +4, +6, +8 Example: TVL= -2+4 (sets Tx 1 to 2 dB and Tx 2 to +4 dB)	TVL= TVL? TVL* TVL#	TVL?	TVL=aabb (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx Carrier State	TXO=	1 byte, value of 0 thru 4	<p>Command or Query. Tx Carrier State, where: 0=OFF due to front panel or remote control command 1=ON 2=RTI (receive/transmit inhibit)</p> <p>FOR CDM-600L: 3=OFF due to ext H/W Tx Carrier Off command (not a valid argument when used as a command) 4=Off due to BUC warm up delay (not a valid argument when used as a command) Note: the front panel Tx LED will flash during this warm-up period.</p> <p>FOR CDM-600: 3=OFF due to ext H/W Tx Carrier Off command (not a valid argument when used as a command, and not indicated in MGC? response) Example: TXO=1 (Tx Carrier ON)</p>	TXO= TXO? TXO* TXO#	TXO?	TXO=x (see Description of Arguments)

D.6.2 Receive (Rx) Commands and Queries

RX Priority System = RIT (Highest priority) , RFM, RFT, RMD, RCR, and RDR (Lowest Priority), indicated by **shading**. Any change to a higher priority parameter can override any of the parameters of lower priority.

Exception: Select DROP or INSERT mode using TFM or RFM (Framing type) which is highest priority.

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Rx Interface Type	RIT=	1 byte, value of 0 thru 6	<p>Command or Query. Rx Interface Type, where: 0=RS422 1=V.35 2=RS232 (synchronous) 3=Balanced G.703 4=Unbalanced G.703 5=Audio (Data rate is fixed at 64 kbps) (IBS/EDMAC only) 6=LVDS</p> <p>Example: RIT=1 (selects V.35)</p>	RIT= RIT? RIT* RIT#	RIT?	RIT=x (see Description of Arguments)
Rx Framing Mode	RFM=	1 byte, value of 0 thru 6	<p>Command or Query. Rx Framing mode, where: 0=Unframed 1=IBS 2=IDR 3=INSERT (requires D&I FAST option) 4=EDMAC 5=D&I++ (requires D&I FAST option) (CDM-600L requires FW Ver 1.2.0 or higher; CDM-600 requires FW Ver 1.5.0 or higher) 6=ESC++ (CDM-600L requires FW Ver 1.3.0 or higher; CDM-600 requires FW Ver 2.0.1 or higher)</p> <p>Example: RFM=0 (selects Unframed mode)</p>	RFM= RFM? RFM* RFM#	RFM?	RFM=x (see Description of Arguments)
Rx FEC Type	RFT=	1 byte, value of 0 thru 9	<p>Command or Query. Rx FEC Type, where: 0=None (uncoded [rate 1/1]) with differential encoding ON 1=Viterbi 2=Viterbi + Reed-Solomon 3=Sequential 4=Sequential + Reed-Solomon 5=TCM (Trellis Code Modulation) 6=TCM + Reed-Solomon 7=Turbo (TPC) 8=None (uncoded [rate 1/1]) with differential encoding OFF 9=LDPC (Requires TPC/LDPC codec)</p> <p>Example: RFT=1 (Viterbi only)</p>	RFT= RFT? RFT* RFT#	RFT?	RFT=x (same format as command argument)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Rx Demod Type	RMD=	1 byte, value of 0 thru 5	<p>Command or Query. Rx Demodulation, where: 0=BPSK 1=QPSK 2=OQPSK 3=8PSK 4=16QAM (Turbo or Viterbi + RS only) 5=8-QAM (LDPC only) (Requires TPC/LDPC codec and FAST option) Depending on FEC type, not all of these selections will be valid. All other codes are invalid. Example: RMD=2 (selects OQPSK)</p>	RMD= RMD? RMD* RMD#	RMD?	RMD=x (see Description of Arguments)
Rx FEC Code Rate	RCR=	1 byte, value of 0 thru 7	<p>Command or Query. Rx FEC Code Rate, where: 0 = Rate 1/2 1 = Rate 3/4 2 = Rate 7/8 3 = Rate 2/3 (8-PSK [TCM or LDPC only]) 4 = Rate 1/1 (Uncoded [no FEC]) 5 = Rate 21/44 (Turbo Only) 6 = Rate 5/16 (Turbo Only) 7 = Rate 0.95 (Turbo Only) Depending on FEC type, not all of these selections will be valid. Example: RCR=1 (selects Rate 3/4)</p>	RCR= RCR? RCR* RCR#	RCR?	RCR=x (see Description of Arguments)
Rx Data Rate	RDR=	9 bytes	<p>Command or Query. Rx Data Rate, in kbps, between 2.4 kbps to 20 Mbps. Resolution=1 bps Example: RDR=02047.999. For Hardware Version 2.0 or higher with CDM-600/600L FW Ver 1.3.1 or higher, additional auxiliary G.703 sub-rates are available. These are selected using: 00512.AUX 01024.AUX 02048.AUX The connectors used for the Aux rates are IDI/DDO. These Aux rates are not available with D&I or IDR.</p>	RDR= RDR? RDR* RDR#	RDR?	RDR=xxxxx.xxx (see Description of Arguments)
Eb/No Alarm Point	EBA=	4 bytes	<p>Command or Query. Eb/No alarm point in dB, with a range between 0.1 and 16 dB. Resolution=0.1 dB Example: EBA=12.3</p>	EBA= EBA? EBA* EBA#	EBA?	EBA=xx.x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Rx Eb/No	N/A	4 bytes	Query only. Unit returns the value of Eb/No, between 0 to 16 dB. Resolution 0.1 dB. Returns 99.9 if demod is unlocked. Returns +016 for values greater than 16.0 dB. Example: EBN=12.3 (Eb/No = 12.3 dB)	N/A	EBN?	EBN=xxxx (see Description of Arguments)
Invert Rx Data	IRD=	1 byte, value 0 or 1	Command or Query. Invert Rx Data, where: 0=Normal 1=Inverted Example: IRD = 1 (selects Inverted RX Data)	IRD= IRD? IRD* IRD#	IRD?	IRD=x (see Description of Arguments)
Insert Timeslot	ITS=	3 bytes	Command or Query. (Insert mode parameter) <i>(Note: Command and query have different formats)</i> Command is in the form xy, where: xx = Channel 01 through 24 y = timeslot: 0-9, A=10, B=11, C=12, D=13 ... V=31	ITS= ITS? ITS* ITS#	ITS?	ITS=yyyyyyyyyyyyyyyyyy yyyyyy indicating all 24 Insert timeslot values associated with the 24 Rx Satellite channels.
Insert Type	ITY=	1 byte, value of 0 thru 3	Command or Query. (Insert/D&I++ parameter) Insert Type, where: 0=T1 – D4 1=T1 – ESF 2=E1 – CCS 3=E1 – CAS	ITY= ITY? ITY* ITY#	ITY?	ITY=x (see Description of Arguments)
Rx Backward Alarms Enable	RBA=	4 bytes, each a value of 0 or 1	Command or Query. (IDR Parameter) Rx Backward Alarm enable: 0=Disable 1=External trigger Enable Position indicates backward alarm numbers: 1234 Example: RBA=0101	RBA= RBA? RBA* RBA#	RBA?	RBA=xxxx (see Description of Arguments)
Rx Buffer Size	RBS=	5 bytes	Command or Query. Rx Buffer Size, 16 to 32768 bytes, in 2-byte steps, unless other limitations apply (see Sect. 5.4.5 CONFIG: CLOCKS). Example: RBS=08192 (selects 8192 bytes)	RBS= RBS? RBS* RBS#	RBS?	RBS=xxxxx (see Description of Arguments)
Rx Clock Source	RCK=	1 byte, value of 0 thru 3	Command or Query. Rx Clock Source (for data rate accuracy), where: 0=Rx Satellite 1=Tx-Terrestrial 2=External Clock 3=INSERT (Valid as a command only when Rx framing is Insert or D&I++ and the interface is G.703 or set for D&I loop) Example: RCK=1 (selects Tx-Terrestrial)	RCK= RCK? RCK* RCK#	RCK?	RCK=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Rx Descrambler	RDS=	1 byte, value of 0 or 1	Command or Query. Rx Descrambler state, where: 0=Off 1=On 2=IESS-315 when in Turbo mode 2=Special when uncoded or Viterbi (needs FAST Special Option 1 installed) Example: RDS=1 (Scrambler On)	RDS= RDS? RDS* RDS#	RDS?	RDS=x (see Description of Arguments)
External Clock	REF=	10 bytes	Command or Query. x=External Baseband Clock between 2.4 kHz and 20 MHz. y=U for Unbalanced, B for Balanced. Example: REF=10000.000U (Selects 10MHz, Unbalanced)	REF= REF? REF* REF#	REF?	REF=xxxx.xxy (see Description of Arguments)
Rx ESC Type	RET=	1 byte, value of 0 or 1	Command or Query. (IDR Parameter) Sets or queries IDR Rx ESC Type, where: 0=64k data channel 1=2 Audio channels	RET= RET? RET* RET#	RET?	RET=x (see Description of Arguments)
Rx Frequency	RFQ=	9 bytes	Command or Query. Rx Frequency, 950 to 1950 MHz Resolution=100 Hz Example: RFQ=0950.9872	RFQ= RFQ? RFQ* RFQ#	RFQ?	RFQ=xxxx.xxxx (see Description of Arguments)
Rx IF Impedance (CDM-600 ONLY)	RIP=	1 byte, value of 5 or 7	Command or Query. Rx IF Impedance, where: 5=50Ω 7=75Ω Both Tx and Rx sides will change with this selection. Example: RIP=5 (50Ω)	RIP= RIP? RIP* RIP#	RIP?	RIP=x (see Description of Arguments)
RX LO Frequency (CDM-600L ONLY)	RLO=	6 bytes	Command or Query. LNB receive LO frequency information in the form xxxxs, where: xxxx is the LO frequency, in the range of 3000 to 65000 MHz or 0 (OFF) s is the sign for the MIX Note: For additional information refer to Appendix F. BUC FSK COMMUNICATION ; LO, MIX, and Spectrum Settings. Note: Terminal Frequency = LNB LO ± RFQ	RLO= RLO? RLO* RLO#	RLO?	RLO=xxxxs (see Description of Arguments)
Rx Reed-Solomon Decoding	RRS=	1 byte, value of 0 to 3	Command or Query. Rx Reed-Solomon decoding, where: 0=Normal (based on the Open Network framing mode selected) 1=IESS-310 mode – Available all framing modes, except EDMAC. 2=EF Data legacy standard (225,205) – Unframed only 3=IBS (126,112) – Unframed only Note: Available in all framing modes, except EDMAC (This is a 'don't care' if no RS is selected in FEC type) Example: RRS=0 (selects Normal)	RRS= RRS? RRS* RRS#	RRS?	RRS=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Rx Spectrum Invert	RSI=	1 byte, value of 0 or 1	Command or Query. Rx Spectrum Invert, where: 0=Normal 1=Rx Spectrum Invert Example: RSI=0 (selects Normal)	RSI= RSI? RSI* RSI#	RSI?	RSI=x (see Description of Arguments)
Rx Signal Level	N/A	5 bytes	Query Only. Unit returns the value of the Rx signal level, in dBm, between -20 and -60 dBm: <ul style="list-style-type: none"> If >-20dBm, returns RSL=GT-20 (GT means 'greater than') If in the range of -20 to -60dBm, returns RSL====xx If <-60 dBm, returns RSL=LT-60 (LT means 'less than') Example: RSL=== -45 (-45 dBm)	N/A	RSL?	RSL=xxxxx (see Description of Arguments)
Rx Symbol Rate	N/A	9 bytes, numeric	Query only. Returns the Rx symbol rate (shown on front panel), where in the form ddddd.d	RSR? RSR=	RSR?	RSR=dddd.d (see Description of Arguments)
Rx Demod Acquisition Sweep Width	RSW=	2 bytes	Command or Query. Rx ± acquisition sweep range of demodulator, in kHz, ranging from ±1 to ±32 kHz. Example: RSW=09 (selects ±9kHz)	RSW= RSW? RSW* RSW#	RSW?	RSW=xx (see Description of Arguments)
Rx Ternary Code	RTC=	1 byte, value of 0 thru 3	Command or Query. (G.703 Parameter) Rx Ternary Code, where: 0=AMI 1=B8ZS 2=B6ZS 3=HDB3 Example: RTC=1 (selects B8ZS)	RTC= RTC? RTC* RTC#	RTC?	RTC=x (see Description of Arguments)
Receive Terrestrial Alarm Enable	RTE=	1 byte, value of 0 or 1	Command or Query. (Insert mode parameter) Receive Terrestrial Alarm Enable conditions, where: 0=Disables the alarm 1=Enables the alarm. Example: RTE=0 (Alarm disabled).	RTE= RTE? RTE* RTE#	RTE?	RTE=x (see Description of Arguments)
Rx Audio Volume Control	RVL=	4 bytes	Command or Query. (Audio/IDR Parameter) Rx Audio Volume control, in the form aabb, where: aa=Rx 1 volume control in dB, values defined below. bb=Rx 2 volume control in dB, values defined below. Valid values: -6, -4, -2, +0, +2, +4, +6, +8 Example: RVL= -2+4 (sets Rx 1 to -2 dB and Rx 2 to +4 dB)	RVL= RVL? RVL* RVL#	RVL?	RVL=aabb (see Description of Arguments)

D.6.3 Unit Commands and Queries

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
AUPC Parameters	APP=	6 bytes	<p>Command or Query. Defines AUPC operating parameters in the form abc.cd, where:</p> <ul style="list-style-type: none"> a=Defines action on max. power condition: (0=do nothing, 1=generate Tx alarm) b=Defines action on remote demod unlock: (0=go to nominal power, 1=go to max power) c.c=target Eb/No value for remote demod, from 0.0 to 14.9 dB, where numbers above 9.9 use hex representation for the 1st character – i.e., 14.9 is coded as E.9. d =Max increase in Tx Power permitted, from 0.0 to 9.0 dB <p>Example: APP=015.67 (Sets no alarm, max power, 5.6 dB target and 7 dB power increase.)</p>	APP= APP? APP* APP#	APP?	APP=abc.cd (see Description of Arguments)
AUPC Enable (with AUPC Power mode selector, CDM-600L ONLY)	AUP=	1 byte, value 0, 1, 2 or 3 (CDM-600L) or 0,1 (CDM-600)	<p>Command or Query. AUPC mode enable/disable and/or (with CDM-600L External Attenuator) power mode selection, where x is:</p> <p>FOR CDM-600L:</p> <ul style="list-style-type: none"> 0=MANUAL – Normal power mode (-45 to 0dBm) 1=AUPC (requires EDMAC or D&I++ framing) 2=MANUAL-LOW – Low power mode (-65 to -20dBm) – <i>When 20dB External Attenuator is activated</i> 3=AUPC-LOW – <i>When AUPC is enabled and 20dB External Attenuator is activated</i> <p>FOR CDM-600:</p> <ul style="list-style-type: none"> 0=Disabled 1=Enabled (EDMAC or D&I++ or ESC++ framing must be selected) <p>Example: AUP=1 (AUPC enabled)</p>	AUP= AUP? AUP* AUP#	AUP?	AUP=x (see Description of Arguments)
Clear All Stored Events	CAE=	None	<p>Command only. Forces the software to clear the software events log.</p> <p>Example: CAE=</p> <p>Note: This command takes no arguments</p>	CAE= CAE? CAE* CAE#	N/A	N/A
Clear All Stored Statistics	CAS=	None	<p>Command only. Forces the software to clear the software statistics log.</p> <p>Example: CAS=</p> <p>Note: This command takes no arguments</p>	CAS= CAS? CAS* CAS#	N/A	N/A
Circuit ID String	CID=	40 bytes	<p>Command or Query. Sets or queries the user-defined Circuit ID string, which is a fixed length of 40 characters. Valid characters include: Space () * + - , . / 0 9 and A thru Z</p>	CID= CID? CID* CID#	CID?	CID=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Configuration Load	CLD=	1 byte	Command only. Causes the modem to retrieve a previously stored modem configuration from Configuration Memory location defined by the one-byte argument (0 to 9). Example: CLD=4 (retrieve modem configuration from location 4)	CLD= CLD? CLD* CLD#	N/A	N/A
Configuration Save	CST=	1 byte	Command only. Command causes the modem to store the current modem configuration in Configuration Memory location defined by the one-byte argument (0 to 9). Example: CST=9 (store the current configuration in location 9)	CST= CST? CST* CST#	N/A	N/A
RTC Date	DAY=	6 bytes	Command or Query. A date in the form ddmmyy (international format), where dd = day of the month (01 to 31), mm = month (01 to 12) yy = year (00 to 99) Example: DAY=240457 (April 24, 2057)	DAY= DAY? DAY* DAY#	DAY?	DAY=ddmmyy (see Description of Arguments)
EDMAC Framing Mode	EFM=	1 byte, value of 0 or 1	Command or Query. EDMAC mode, where: 0=EDMAC OFF (Idle Mode) 1=EDMAC ON (Master Mode) 2=EDMAC ON (Slave Mode, Query Only) Example: EFM=1 (EDMAC Enabled as Master)	EFM= EFM? EFM* EFM#	EFM?	EFM=x (see Description of Arguments)
EDMAC Slave Address Range	ESA=	4 bytes	Command or Query. EDMAC Slave Address Range - sets the range of addresses of distant-end units (modems or transceivers) for which this unit, as the Master, will forward messages. Only values which are integer multiples of ten are permitted. (0010, 0020, 0030, 0040 etc.) Example: ESA=0090 This command is only valid for an EDMAC master. When used as a Query, it may be sent to an EDMAC slave, which will respond with the appropriate address.	ESA= ESA? ESA* ESA#	ESA?	ESA=xxxx (see Description of Arguments)
Engineering Service Channel	ESC=	1 byte, 0 or 1	Command or Query. (IBS or ESC++ parameter) Turn ESC on or off, where: 0=off (disable high-rate ESC) 1=on (enable high-rate ESC) IBS ESC may only be enabled when: 1. Both Tx & Rx framing modes are set to IBS. 2. Data rate is NOT 1544Mbps (as there are no spare overhead bits) 3. IBS high-rate ESC FAST option is enabled.	ESC= ESC? ESC* ESC#	ESC?	ESC=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Force 1:1 Switch	FSW=	1 byte	Command only. Forces the unit to toggle the Unit Fail relay to the "fail" state for approx 500ms. If the unit is a 1:1 pair, and it is currently the 'Online' unit, this will force a switchover, so the unit will then be in 'Standby' mode. The command is always executed by the unit, regardless of whether it is stand-alone, in a 1:1 pair, or part of a 1:N system. Note: This command takes no arguments.	FSW=	N/A	N/A
Initialize Events Pointer	IEP=	None	Command only. Resets internal pointer to allow RNE? queries to start at the beginning of the stored events log.	IEP=	N/A	N/A
Initialize Statistics Pointer	ISP=	None	Command only. Resets internal pointer to allow RNS? queries to start at the beginning of the statistics log.	ISP=	N/A	N/A
Local/Remote Status	LRS=	1 byte, value of 0 or 1	Command or Query. Local/Remote status, where: 0=Local 1=Remote Example: LRS=1 (selects Remote)	LRS=	LRS?	LRS=x (see Description of Arguments)
Modem Reference Clock (CDM-600L ONLY)	MRC=	1 byte, value of 0 thru 3	Command or Query. Modem Reference Clock (For Frequency Accuracy), where: 0=Internal 1=External 1 MHz 2=External 2 MHz 3=External 5 MHz 4=External 10 MHz 5=External 20 MHz	MRC=	MRC?	MRC=x (see Description of Arguments)
Unit Alarm Mask	MSK=	6 bytes	Command or Query. Alarm mask conditions in form abcdef, where: a=Tx AIS (0=unmasked, 1=masked) b=Rx AIS (0=unmasked, 1=masked) c=buffer slip Alarm (0=unmasked, 1=masked) d=spare e=Rx AGC Alarm (0=unmasked, 1=masked) f=Eb/No Alarm (0=unmasked, 1=masked) Example: MSK=010110	MSK=	MSK?	MSK=abcdef (see Description of Arguments)
Number of Unread stored Events	N/A	3 bytes	Query only. Unit returns the Number of stored Events which remain Unread (via Remote Control), in the form xxx. Example: NUE=126	N/A	NUE?	NUE=xxx (see Description of Arguments)
Number of Unread stored Statistics	N/A	3 bytes	Query only. Unit returns the number of stored Statistics which remain Unread (via Remote Control), in the form xxx. Example: NUS=187	N/A	NUS?	NUS=xxx (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Outdoor Unit Comms enable	ODU=	1 byte, value of 0 or 1	Command or Query. Enables or disables communications, via the FSK link, with a compatible Comtech EF Data outdoor unit (ODU), where: 0=Disabled 1=Enabled Example: ODU=0 (Disabled)	ODU= ODU? ODU* ODU#	ODU?	ODU=x (see Description of Arguments)
ReCenter Buffer	RCB=	None	Command only Forces the software to recenter the Rx Plesiochronous/Doppler buffer. Example: RCB= Note: This command takes no arguments.	RCB= RCB? RCB* RCB#	N/A	N/A
Retrieve next 5 unread Stored Events	N/A	80 bytes	Query only. Unit returns the oldest 5 Stored Events which have not yet been read over the remote control, in the reply form [CR]Sub-body[CR]Sub-body[CR]Sub-body[CR]Sub-body[CR]Sub-body; Sub-body = ABCddmmyyhhmss, where: A being the fault/clear indicator. F = Fault C = Clear I = Info B being the fault type where: 1 = Unit 2 = Rx Traffic 3 = Tx Traffic 4 = Power on/off, or log cleared 5 = Open Network C is Fault Code number (as in FLT?) or Info Code, which is: 0 = Power Off 1 = Power On 2 = Log Cleared 3 = Global Config Change 4 = Redundancy Config Change If there are less than 5 events to be retrieved, the remaining positions are padded with zeros. If there are no new events, the response is RNE*.	N/A	RNE?	RNE=[CR]ABCddmmyyhhmss[CR]ABCddmmyyhhmss[CR]ABCddmmyyhhmss[CR]ABCddmmyyhhmss[CR]ABCddmmyyhhmss (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
RTC Time	TIM=	6 bytes	Command or Query. The time in the form hhmmss, indicating the time from midnight, where: hh = hours (00 to 23) mm = minutes (00 to 59) ss = seconds (00 to 59) Example: TIM=231259 (23 hours:12 minutes:59 seconds)	TIM= TIM? TIM* TIM#	TIM?	TIM=hhmmss (see Description of Arguments)
Unit Test Mode	TST=	1 byte, value of 0 thru 6	Command or Query. Test Mode, where: 0= Normal Mode (no test) 1=Tx CW 2=Tx Alternating 1,0 Pattern 3=IF Loopback 4=RF Loopback 5=Digital Loopback 6=I/O Loopback Example: TST=3 (IF Loopback)	TST= TST? TST* TST#	TST?	TST=x (see Description of Arguments)

D.6.4 Queries

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Equipment ID	N/A	10 bytes	<p>Query only. Unit returns the equipment identification and installed options information, in the form abbbcdefgh; where: a=Turbo codec: 0=None, 1=Lo-Rate Turbo, 2=Hi-Rate Turbo, 3=TPC/LDPC codec to 5Mbps, 4=TPC/LDPC codec and FAST option to 10Mbps, 5=TPC/LDPC codec and FAST option to 20Mbps. bbb=modem model number: 600 is the CDM-600 601 is the CDM-600L 602 is the CLM-9600L c=Data Rate Option: 0=Base (to 5 Mbps), 1=to 10 Mbps, 2=to 20 Mbps. d=Higher-order modulation option: 0=None, 1=8-PSK and 8-QAM, 2=16-QAM, 3=8-PSK, 8-QAM and 16-QAM. e=Framing option: 0=None, 1=IBS, 2=IDR, 3=IBS and IDR, 4=IBS with high-rate ESC, 5=IBS with high-rate ESC and IDR. f=Drop and Insert/Audio mode: 0=None, 1=D&I, 2=Audio, 3=D&I and Audio. (Note: D&I FAST option provides access to both Open Network D&I and Closed Network D&I++) g=Special Options: 0=None, 1=Opt1, 2=Opt2, 3=Opt 1 and 2. FOR CDM-600L: h=External 20dB Attenuator: 0=None, 1=External 20dB Attenuator installed FOR CDM-600: h=High-Stability Reference module: 0=None, 1=High-Stability Reference module installed Example: EID=1601213300 = CDM-600L, Turbo 1 (Low-Rate), 8-PSK/IDR/IBS, Drop and Insert, Audio, up to 20 Mbps</p>	N/A	EID?	EID=abbbcdefgh (see Description of Arguments)

Notes:

1. To achieve LDPC to 20 Mbps, the unit will require the TPC/LDPC Codec, base modem data rate FAST option to 20 Mbps and the LDPC data rate FAST option to 20 Mbps.
2. D&I FAST option provides access to both Open Network D&I and Closed Network D&I++.

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Faults and Status	N/A	6 bytes	<p>Query only. Unit returns the current fault and status codes for the Unit (hardware), Tx Traffic, and Rx Traffic, in the form abcdef, where:</p> <p>a = Unit faults: 0=No faults 1=Power supply fault, +5 volts 2=Power supply fault, +12 volts 3=Power supply fault, -5 volts 4=Power supply fault, +18 volts 5=Power supply fault, -12 volts 6=Spare 7=Tx synthesizer lock 8=Rx synthesizer 9=Power cal Checksum error A=FPGA main chain load fail B=Turbo FPGA load fail C=Modem (top) card FPGA load fail D=MUX FPGA load fail E=Demux FPGA load fail F=Rx synthesizer2 (CDM-600L) F=(Hi-stability module) No PLL Lock (Suppresses Tx) (CDM-600)</p> <p>b = Tx Traffic status: 0=Tx traffic OK 1=No clock from terrestrial interface 2=Tx FIFO slip 3=AIS detected on incoming data 4=AUPC upper limit reached 5=Ref PLL (CDM-600L) 5=(Hi-Stab module) Ref Activity fault (CDM-600)</p> <div style="border: 1px solid black; padding: 2px;"> 6=BUC current (CDM-600L) 7=BUC voltage 8=BUC no comms or bad checksum 9=BUC PLL A=BUC temperature </div>	N/A	FLT?	FLT=abcdef (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Faults and Status (cont)			<p>c = Rx Traffic status: 0=Rx Traffic OK 1=Demodulator unlocked 2=AGC Alarm - signal out of range 3=Demux Lock (Frame SYNC) 4=Spare 5=Buffer Slip 6=AIS detected on incoming data 7=Eb/No alarm 8=Buffer Clock activity 9=LNB current (CDM-600L) A=LNB voltage (CDM-600L)</p> <p>d = Open Network: 0=No Faults 1=Loss of Tx frame 2=BER Alarm 3=Loss of Tx multiframe 4=Tx signaling AIS 5=Tx Remote alarm 6=IBS satellite alarm 7=IDR Rx BWA1 8=IDR Rx BWA2 9=IDR Rx BWA3 A=IDR Rx BWA4 B=IDR Tx BWA1 C=IDR Tx BWA2 D=IDR Tx BWA3 E=IDR Tx BWA4</p> <p>e = Change in fault status since last poll f = Change in unit configuration since last poll</p>			
Rx BER	N/A	5 bytes	<p>Query only. Units returns the value of the estimated corrected BER in the form a.b x 10^c. First three bytes are the value. Last two bytes are the exponent. Returns 99999 if the demodulator is unlocked or BER data is unavailable. Example: BER=4.8E3 (BER=4.8 x 10⁻³)</p>	N/A	BER?	BER=a.bEc (see Description of Arguments)
Buffer Fill State	N/A	2 bytes	<p>Query only. Unit returns the value of the buffer fill state, between 1 and 99%. Returns 00 if demodulator is unlocked. Example: BFS=33 (33%)</p>	N/A	BFS?	BFS=xx (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Bulk Status Query	N/A	28 bytes	<p>Query only. Note: The CDM-600L requires FW Ver 1.2.0 or higher) The response is in the form lreeeebbbbbffooooossssttt, where:</p> <p>l=local/remote status same as LRS r=redundancy state offline/online same as RED eeee=Eb/No same as EBN bbbbb=BER same as BER ff= Buffer Fill state same as BFS ooooo=Rx Frequency offset same as RFO ssss=Rx Signal Level same as RSL ttt=Temperature same as TMP</p> <p>This command is intended to <u>reduce</u> the need for excessively frequent queries to the modem, and will be useful for a unit in a redundancy system, where the redundancy system has monitoring of its own occurring. The latter 6 parameters are only updated <u>once per second</u>.</p>	N/A	BSQ?	BSQ=lreeeebbbbbffooooossssttt (see Description of Arguments)
Hardware Revision	N/A	4 bytes	<p>Query only. CDM-600/600L unit returns hardware revision level of both main circuit boards in the form xxy, where:</p> <p>xx=the main (bottom) PCB y=indicates the modem (top) PCB.</p> <p>FOR CDM-600: y=0, Units manufactured <i>before</i> February 2005, or 1, Units manufactured <i>after</i> February 2005 (unit provides extended IF frequency range)</p>	N/A	HRV?	HRV=xxy (see Description of Arguments)
Offline Unit Status	N/A	6 bytes	<p>Query only. (1:1 set-up) This query is sent to the online modem of a 1:1 pair. It provides access to the fault status information (FLT?) of the offline modem. This is the only way to interrogate the status of an offline modem at the distant-end of a link. The response may be in one of the following forms:</p> <p>No1for1: Indicates that no 1:1 system has been detected. The presence of a 1kHz signal from the CRS-150 is used to indicate a 1:1 set-up.</p> <p>NoComm: Indicates that a 1kHz signal has been detected, but that there is no (or not yet) a response from the modem.</p> <p>abcdef: Represents the FLT? response information from the offline unit.</p>	N/A	OUS?	OUS=xxxxxx (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Tx Power Level Increase	N/A	3 bytes	Query only. (AUPC) Returns the increase in Tx power level, in dB (from the nominal setting) due to the action of AUPC. Responds in the form x.x if AUPC is disabled. Example: PLI=2.3	N/A	PLI?	PLI=x.x (see Description of Arguments)
Remote Eb/No	N/A	4 bytes	Query only. Return the value of Eb/No of the remote demod, where xx.x=02.0 to 16.0. Responds 99.9=remote demod unlocked. Responds xx.x if AUPC (CDM-600L) or EDMAC (CDM-600) is disabled. Example: REB=12.4 Note: For values > 16.0 dB, the reply will be 16.0	N/A	REB?	
Redundancy State	N/A	1 byte, value of 0 or 1	Query only. Unit returns the redundancy state of the unit, where 0=Offline 1=Online Example: RED=1 (Online)	N/A	RED?	RED=x (see Description of Arguments)
Rx Frequency Offset	N/A	5 bytes	Query only. Unit returns the value of the measured frequency offset of the carrier being demodulated. Values range from ± 0 to ± 30 kHz, 100 Hz resolution. Responds 99999 if the demodulator is unlocked. Example: RFO=+02.3 (+ 2.3 kHz)	N/A	RFO?	RFO=xxxxx (see Description of Arguments)
Serial Number	N/A	9 bytes	Query only. Used to query the unit 9-digit serial number. Unit returns its S/N in the form xxxxxxxxx. Example: SNO=176500143	N/A	SNO?	SNO=xxxxxxxxx (see Description of Arguments)
Software Revision	N/A	5 bytes	Query only. Unit returns the value of the internal software revision installed in the unit, in the form x.x.x Example: SWR=1.0.3	N/A	SWR?	SWR=x.x.x (see Description of arguments)
Temperature	N/A	3 bytes	Query only. Unit returns the value of the internal temperature, in the form xxx (degrees C). Example: TMP=+26	N/A	TMP?	TMP=xxx (see Description of Arguments)

D.6.5 Bulk Commands

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Drop & Insert	DNI=	51 bytes	<p>Command or Query. In the form ddddddddddddddddddddtiiiiiiiiiiiiiiiiiiTL, where:</p> <p><i>25 bytes of Drop information:</i> d=24 bytes defining Timeslot locations t=Drop Type: 0=T1-D4, 1=T1-ESF, 2=E1-CCS, 3=E1-CAS (same as DTY)</p> <p><i>25 bytes of Insert information:</i> i=24 bytes defining Timeslot locations T=Insert Type: 0=T1-D4, 1=T1-ESF, 2=E1-CCS, 3=E1-CAS (same as ITY)</p> <p><i>1 byte for Drop and Insert Internal Loop:</i> L= 0 (OFF), 1 (ON)</p> <p><i>D&I Timeslot locations definition:</i> 0 = Unused channel 1-9 for timeslots 1-9, A=10, B=11, C=12, D=13 ... V=31.</p> <p>Example: 123456789ABC0000000000003123456789ABC00000000000031 <i>where:</i></p> <p>For both Drop & Insert: Channels 1-12 using timeslots 1-12, and unused channels 13-24, E1-CAS type, Internal Loop ON.</p> <p>If framing is D&I and data rate is 1920 kbps and DNI Type is E1-CCS or E1-CAS, then channels cannot be programmed. The DNI? query will display all 'x' in the time-slot positions.</p>	<p>DNI= DNI? DNI* DNI#</p>	<p>DNI? DNI?n</p>	<p>DNI=ddddddddddddddddd dddddddtiiiiiiiiiiiiiiiiiiTL (see Description of Arguments)</p> <p>Returns current D&I configuration</p> <p>Where n=0 to 9 returns the DNI portion of 1 of 10 stored configurations</p> <p>(see Description of Arguments)</p>

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Global Configuration	MGC=	118 bytes, with numerical entries, fixed values and delimiters	<p>Command or Query. Global Configuration of CDM600/600L, in the forms shown in the 'Response to Query' column, where: FFFFFFFF = Tx Frequency (CDM-600L) or FFF.FFFFF = Tx Frequency (CDM-600) DDDDD.DDD = Tx Data Rate G = Tx FEC Type Y = Tx Reed-Solomon type R = Tx FEC Rate M = Tx Modulation type V = Tx Spectrum Inversion S = Tx Scrambler state PP,P = Tx Power Level B = AUPC Enable aaa.aa = AUPC parameter setup C = Tx Clock Source X = Tx Carrier State I = Tx Interface Type K = Tx Ternary Code N = Tx Framing Mode W = Spare byte ffffff = Rx Frequency (CDM-600L) or fff.fffff = Rx Frequency (CDM-600) dddd.ddd = Rx Data Rate g = Rx FEC Type y = Rx Reed-Solomon type r = Rx FEC Rate m = Rx Modulation Type v = Rx Spectrum Inversion s = Rx Scrambler state ww = Rx Sweep Width c = Rx Clock Source tt,t = Eb/No Alarm Point bbbb = Rx Buffer Size i = Rx Interface Type k = Rx Ternary Code n = Rx Framing Mode W = Spare byte O = Unit EDMAC Mode</p> <p>EEEE = EDMAC Address</p> <p>T = Unit test Mode AAAAAA Unit Alarm Mask Z=Modem Reference e = Statistics Sampling Interval L = Rx Terrestrial Alarm Enable Q = Tx Terrestrial Alarm Enable U = ODU FSK Comms Enable HHHH = Tx Backward Alarms hhhh =Rx Backward Alarms JJJJ = Tx Audio volume jjjj = Rx Audio volume k = Drop Type k = Insert Type p =Tx ESC Type q =Rx ESC Type u = Invert Tx Data x = Invert Rx Data</p>	<p>MGC= MGC? MGC* MGC#</p>	<p>MGC?</p> <p>MGC?n</p>	<p>CDM-600L: MGC=FFFFFFFFDDDDDD. DDDGyRMVSPp.PBaaa.a aCXiKNWffffffddddd.ddd gyrmvswwctt.tbbbbbiknW OEEEEetAAAAAAZeLQU HHHHhhhhJJJJjjjKkpqux</p> <p>CDM-600: MGC=FFF.FFFFDDDDDD. DDDGyRMVSPp.PBaaa.a aCXiKNWfff.ffffddddd.ddd gyrmvswwctt.tbbbbbiknW OEEEEetAAAAAAZeLQU HHHHhhhhJJJJjjjKkpqux</p> <p>(see Description of Arguments)</p> <p>Returns current configuration</p> <p>Where n=0 to 9 returns the MGC portion of 1 of 10 stored configurations (see Description of Arguments)</p>

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
OGC Outdoor Unit Global Copy (CDM-600L ONLY)	OGC=	50 Bytes	<p>Command or Query ODU Global Configuration of CDM-600L in the form: abcdemm:ssgggghhhpp.pijklInnnFFFFSffffsxxxxxx, where:</p> <p>aa=BUC Address same as OAD b=BUC Tx Output Power Enable same as OOP c=BUC Power Leveling Enable same as OPL d=BUC Power Supply State same as ODP e=BUC 10MHz Reference State same as ODR mm:ss=BUC Carrier Output Delay same as OOD gggg=BUC Low Alarm Limit same as ODL hhh=BUC High Alarm Limit same as ODH pp.p=Output Target Power same as OTP i=LNB Voltage same as LNV j=LNB Power State same as LNB k=LNB 10MHz Reference same as LNR lll=LNB Low Alarm Limit same as LNL nnn=LNB High Alarm Limit same as LNH FFFFS=TX LO Frequency same as TLO ffffs=RX LO Frequency same as RLO xxxxx=Spare Bytes</p> <p>A response to a query will fill any unavailable parameters with xxx.</p>	OGC= OGC? OGC* OGC#	OGC? OGC?n	<p>OGC=abcdemm:ssgggghhhpp.pijklInnnFFFFSffffsxxxxxx (see Description of Arguments)</p> <p>Returns current OGC configuration</p> <p>Where n=0 to 9 returns the OGC portion of 1 of 10 stored configurations (see Description of Arguments)</p>

D.6.6 BUC Commands and Queries (CDM-600L ONLY)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
BUC Address	OAD=	1 byte, value of 1 to 15	Command or Query. Sets BUC Address, in the form xx, where: xx= a value between 1 and 15. Note: Valid only when the FSK and BUC power are enabled.	OAD= OAD? OAD* OAD#	OAD?	OAD=xx (see Description of Arguments)
BUC Current	N/A	4 bytes	Query only. Unit returns the value of the BUC Current, in mA, in the form xxxx, where: xxxx=a value between 0 and 9999 Note: Unit returns 0000 when BUC power is turned OFF.	N/A	ODC?	ODC=xxxx (see Description of Arguments)
BUC High Current Limit	ODH=	4 bytes	Command or Query. Sets BUC High Current Limit, in mA, in 100mA increments, in the form xxxx, where: xxxx= a value between 0 and 4000.	ODH= ODH? ODH* ODH#	ODH?	ODH=xxxx (see Description of Arguments)
BUC Low Current Limit	ODL=	4 bytes	Command or Query. Sets BUC Low Current Limit, in mA, in 100mA increments, in the form xxxx, where: xxxx= a value between 0 and 4000.	ODL= ODL? ODL* ODL#	ODL?	ODL=xxxx (see Description of Arguments)
BUC Power enable	ODP=	1 byte, value of 0 or 1	Command or Query. Selects BUC operation, where: 0=Disable BUC DC Power Supply 1=Enable BUC DC Power Supply	ODP= ODP? ODP* ODP#	ODP?	ODP=x (see Description of Arguments)
BUC 10 MHz Reference	ODR=	1 byte	Command or Query. Selects BUC 10 MHz Reference, where: 0=OFF 1=ON	ODR= ODR? ODR* ODR#	ODR?	ODR=x (see Description of Arguments)
BUC Temperature	N/A	4 bytes	Query only. Unit returns BUC temperature in the form sxxx, where: s=sign xxx=number Note: Valid only when the FSK and BUC power are turned On.	N/A	ODT?	ODT=sxxx (see Description of Arguments)
BUC Voltage	N/A	4 bytes	Query only. Unit returns the value of the BUC Voltage, in volts, in the form xx.x, where: xx.x= a value between 0 and 64.0.	N/A	ODV?	ODV=xx.x (see Description of Arguments)
BUC Phase Lock Loop	N/A	1 byte, value of 0 or 1	Query only. Unit returns BUC phase lock loop, where: 0=Locked 1=Unlocked Note: Valid only when the FSK and BUC power are turned On.	N/A	OLL?	OLL=x (see Description of Arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
BUC Carrier Output Delay	OOD=	5 bytes	Command or Query. Sets power-up delay for the BUC to warm-up prior to the Tx Carrier On, where: mm=minutes (0–20) ss = seconds (0–59)	OOD= OOD? OOD* OOD#	OOD?	OOD=mm:ss (see Description of Arguments)
BUC Output Power Level	N/A	4 bytes	Query only. Unit returns BUC Output Power Level, in the form xx.x, where: xx.x=value in dBm. Example: OOL=37.4 Note: Unit returns xxxx when FSK and BUC power are not enabled.	N/A	OOL?	OOL=xx.x (see Description of Arguments)
BUC Output Power Enable	OOP=	1 byte, value of 0 or 1	Command or Query. Selects BUC Tx Carrier Output Power, where: 0=OFF 1=ON Note: Valid only when the FSK and BUC power are enabled.	OOP= OOP? OOP* OOP#	OOP?	OOP=x (see Description of Arguments)
BUC Power Class	N/A	2 bytes	Query only. Unit returns BUC Power class, where xx indicates the power class in watts. Example: OPC=25 Note: Valid only when the FSK and BUC power are enabled.	N/A	OPC?	OPC=xx (see Description of Arguments)
BUC Power Leveling Enable	OPL=	1 byte, value of 0 or 1	Command or Query. Selects BUC Power Leveling, where: 0=Leveling OFF 1=Leveling ON Note: Valid only when the FSK and BUC power are enabled.	OPL= OPL? OPL* OPL#	OPL?	OPL=x (see Description of Arguments)
BUC Software Version	N/A	2 bytes	Query only. Unit returns BUC software version, in the form xx, where: xx=a value between 0 and 15. Note: Valid only when the FSK and BUC power are turned On.	N/A	OSV?	OSV=xx (see Description of Arguments)
BUC Target Power	OTP=	4 bytes	Query only. Sets target level for leveling control of output power (negative sign is assumed), in the form xx.x, where: xx= range of 0 to -40 dBm Note: Used only between CDM-600L units in a 1:1 system.	OTP= OTP? OTP* OTP#	OTP?	OTP=xx.x (see Description of Arguments)

D.6.7 LNB Commands and Queries (CDM-600L ONLY)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
LNB Power Control	LNB=	1 byte	Command or Query. Selects LNB DC Power Supply, where: 0=OFF 1=ON	LNB= LNB? LNB* LNB#	LNB?	LNB=x (see Description of Arguments)
LNB Current	N/A	4 bytes	Query only. Unit returns LNB current value in mA.	N/A	LNC?	LNC=xxxx (see Description of Arguments)
LNB High current limit	LNH=	3 bytes	Command or Query. Sets LNB High Current Limit, in mA, in the form xxx, where: xxx=a value between 0 and 500	LNH= LNH? LNH* LNH#	LNH?	LNH=xxx (see Description of Arguments)
LNB Low current limit	LNL=	3 bytes	Command or Query. Sets LNB Low Current Limit, in mA, in the form xxx, where: xxx=a value between 0 and 500	LNL= LNL? LNL* LNL#	LNL?	LNL=xxx (see Description of Arguments)
LNB Reference Enable	LNR=	1 byte, value of 0 or 1	Command or Query. Selects LNB 10 MHz Reference, where: 0=Disable LNB Reference 1=Enable LNB Reference	LNR= LNR? LNR* LNR#	LNR?	LNR=x (see Description of Arguments)
LNB Voltage	LNV=	1 byte, value of 0, 1, or 2	Command or Query. Sets the LNB Voltage, where: 0=13V LNB Voltage 1=18V LNB Voltage 2=24V LNB Voltage	LNV= LNV? LNV* LNV#	LNV?	LNV=x (see Description of Arguments)

D.6.8 High-Stability Reference Option Commands and Queries (CDM-600 ONLY)

The commands and queries in this section require CDM-600 Hardware Rev. 2.0 or higher and installation of the optional High-Stability Frequency Reference module.

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Internal 10MHz Reference Adjustment	ADJ=	4 bytes, numeric	Command or Query. This command provides fine adjustment of the Internal 10MHz Reference on the High-Stability Frequency Reference module, in the form sddd, where: s = sign (+ or -) ddd = value, 0-999 If High-Stability module is not installed, response to query is ADJ*.	ADJ= ADJ? ADJ* ADJ#	ADJ?	ADJ=sddd (see Description of Arguments)
Countdown of Warm-up Delay remaining	CTD=	3 bytes, numeric	Command or Query. xxx = countdown of the number of seconds remaining of the Warm-up time. As a command, the only permitted format is CTD=000, which abandons the delay. If Hi-Stability module is not installed, response to query is CTD*.	CTD= CTD? CTD* CTD#	CTD?	CTD=xxx (see Description of Arguments)
External Frequency Reference	EFR=	1 byte, value of 0 thru 5	Command or Query. 0 = Internal 10MHz (default when module is not installed) 1 = External 1 MHz 2 = External 2 MHz 3 = External 5 MHz 4 = External 10 MHz 5 = External 20 MHz See the EID response for indication that a high-stability module is installed.	EFR= EFR? EFR* EFR#	EFR?	EFR=x (see Description of Arguments)
Warm-up Delay	WRM=	1 byte, 0 or 1	Command or Query. 0 = Delay off (instant on) 1 = Warm-up Delay on If Hi-Stability module is not installed, response to query is WRM*.	WRM= WRM? WRM* WRM#	WRM?	WRM=x (see Description of Arguments)

Appendix E. ODU (CSAT-5060, KST-2000A/B) OPERATION VIA THE CDM-600

E.1 Introduction

The CDM-600 permits the user to configure, monitor, and control a Comtech EF Data RF Transceiver (referred to throughout this appendix as an ODU – Outdoor Unit). The following ODUs are compatible for operation with the CDM-600 Modem:

- CSAT-5060 series (5 to 25, 50 & 100 Watts) C-Band Transceivers
- KST-2000A (LNA) Ku-Band Satellite Transceiver
- KST-2000B (LNB) Ku-Band Satellite Transceiver

The user can fully control and monitor the operation of an ODU in the following ways:

- By using ODU remote commands and queries through Serial Remote Control.
- By using the CDM-600 modem keypad and display (via the front panel) to access ODU configuration, operation, and monitoring commands.

E.2 ODU Operations via Serial Remote Control

For a complete overview of Serial Remote Control and the commands and queries associated with remote ODU configuration, operation, and monitoring, refer to **Appendix D. SERIAL REMOTE CONTROL**.

E.2.1 Remote Control Address Setup

The Outdoor Unit (ODU) connected to a CDM-600 Modem through FSK can be remotely monitored and controlled by using ODU remote commands through Serial Remote or Telnet. The address of the ODU is set up as follows:

- **For local-end ODUs:**
 - Use Modem's RC address + 1 for Standalone unit or Online unit in a 1:1 Redundancy System.
 - Use Modem's RC address + 2 for Offline unit in a 1:1 Redundancy System.
- **For distant-end ODUs in an EDMAC setup:**
 - Use EDMAC Slave Address (ESA) Range + 4 for Standalone unit or Online unit in a 1:1 Redundancy System.
 - Use EDMAC Slave Address (ESA) Range + 5 for Offline unit in a 1:1 Redundancy System.

E.3 ODU Operations via the CDM-600 Front Panel

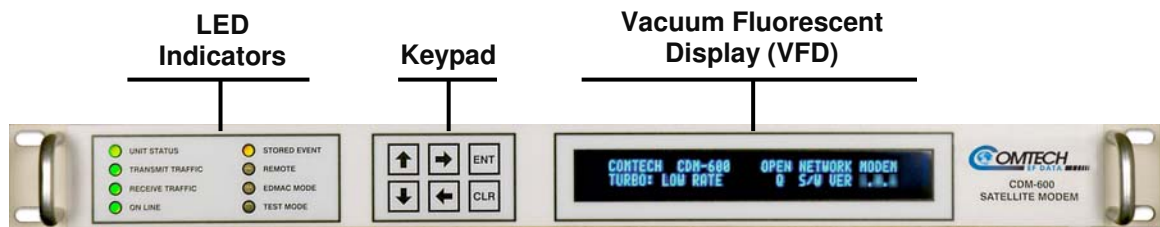

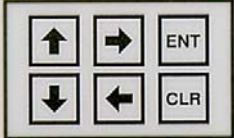



Figure E-1. CDM-600 Front Panel View

The user can configure, monitor, and control ODU operation via the CDM-600 front panel, using the keypad and display. Nested menus are used, which display all available options, and prompt the user to carry out a required action.

Figure E-1 identifies the key features of the CDM-600 front panel; in-depth explanations of the function and operation of these features is provided in **Chapter 5. FRONT PANEL OPERATION**. For this appendix, however, their purpose is summarized as follows:

Feature	Description
LED Indicators	 <p>Used to indicate the operational status of the CDM-600 Modem.</p>
Keypad	 <p>Used to select and navigate the available CDM-600 menu functions as displayed on the Vacuum Fluorescent Display (VFD).</p>
Vacuum Fluorescent Display (VFD)	 <p>Used to fully control and monitor operation of the CDM-600 Modem. Consisting of two lines with a width of 40 characters each, nested menus displayed on the VFD provide all available options and prompt the user to carry out a required action via the keypad.</p>

E.3.1 ODU Operation – Front Panel Menu Tree (Basic)

Figure E-2 identifies the basic CDM-600 front panel menu hierarchy that pertains specifically to the operation of a CSAT-5060, KST-2000A or KST-2000B ODU. In this particular figure, the menu branch dedicated to ODU operations is shown in **bold italics**.

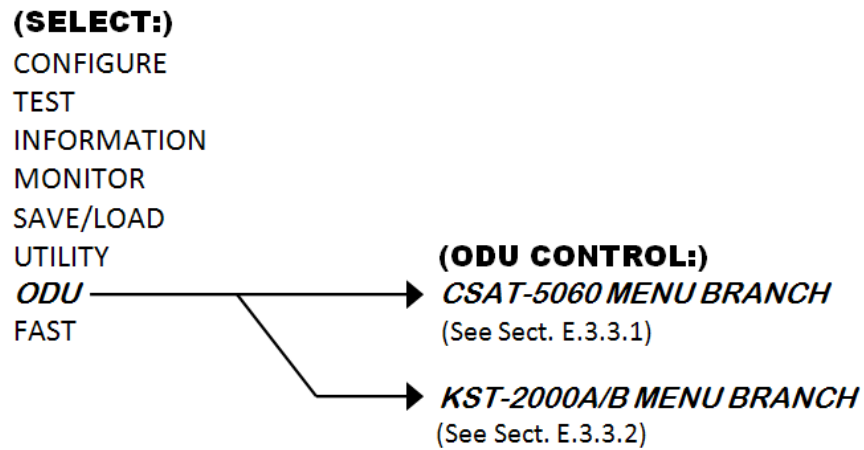


Figure E-2. CDM-600 ODU Operation Principal Menu Tree

Note: The ODU menu branch is accessible from the CDM-600 front panel menu only when the presence of an ODU is detected. Also note that, as this appendix deals with strictly with ODU operations, **Chapter 5. FRONT PANEL OPERATION** provides a complete overview for any CDM-600 menu operations or selections not defined in this appendix.

E.3.2 (SELECT:) (Main) Menu

**Select : CONFIGURATION TEST INFORMATION
MONITOR STORE/LOAD UTILITY ODU FAST**

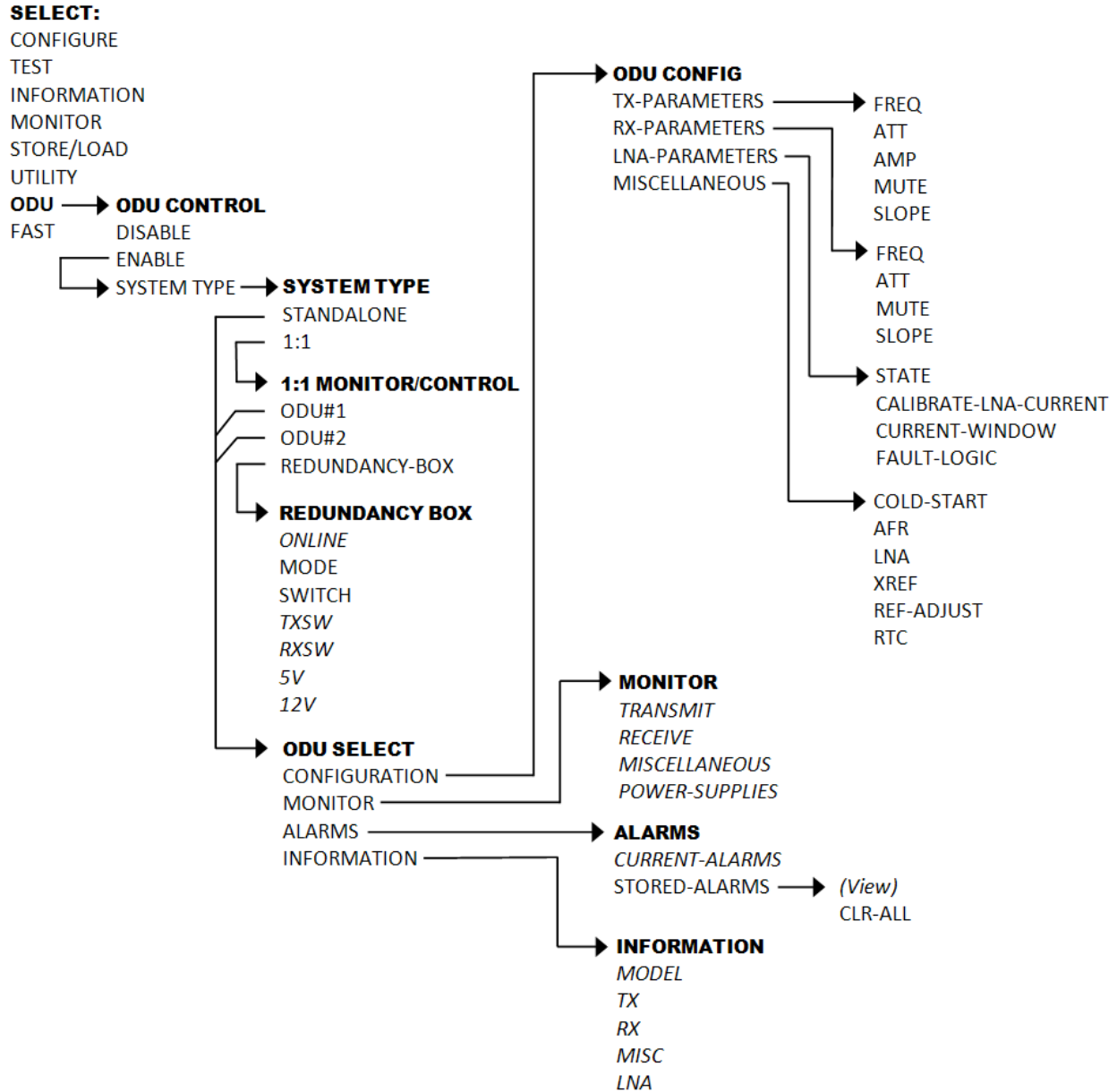
The following table identifies the commands comprising the CDM-600 main menu, and the content section in this manual where explicit information is referenced, either in this appendix or in **Chapter 5. FRONT PANEL OPERATION**:

Menu Branch <i>(For more info, see...)</i>	Description
CONFIGURATION <i>(Chapter Sect. 5.4)</i>	Permits the user to fully configure the modem.
TEST <i>(Chapter Sect. 5.5)</i>	Permits the user to configure the modem into one of several Test modes, and configures/monitors the BER Tester.
INFORMATION <i>(Chapter Sect. 5.6)</i>	Permits the user to view information on the modem, without having to go into the Configuration screens.
MONITOR <i>(Chapter Sect. 5.7)</i>	Permits the user to monitor the current status of the modem and view the log of stored events for the modem.
STORE/LOAD <i>(Chapter Sect. 5.8)</i>	(Store/Load) Permits the user to store and retrieve up to 10 different modem configurations.
UTILITY <i>(Chapter Sect. 5.9)</i>	Permits the user to perform miscellaneous functions, such as setting the Real-Time Clock, adjusting the display brightness, etc.
ODU In this Appendix: E.3.3.1 for CSAT-5060 E.3.3.2 for KST-2000A/B	(Outdoor Unit) On the CDM-600, this menu branch permits the user to monitor and control a Comtech EF Data RF Transceiver (CSAT-5060 or KST-2000A/B), if connected.
FAST <i>(Chapter Sect. 5.11)</i>	(Fully Accessible System Topology) Permits the user to configure different options, for extended data rates, interfaces, etc. Contact the factory for details.

E.3.3 (SELECT:) ODU – Product-specific Menu Operations

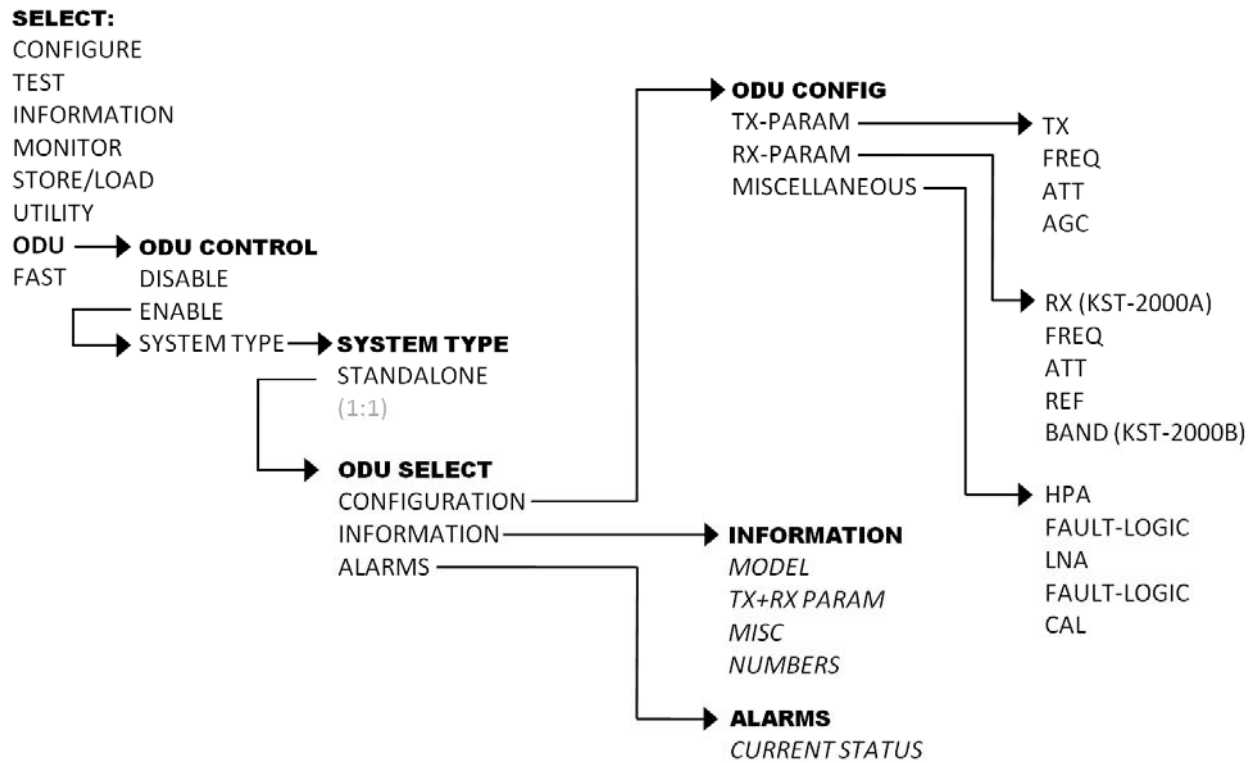
Once the FSK link to the ODU is **enabled**, the CDM-600 senses the active ODU model and automatically adjusts the **(SELECT:) ODU** front panel menu displays specific to that product.

Sect. E.3.3.1 addresses **(SELECT:) ODU** front panel operation functionality as it appears in the presence of the CSAT-5060 Transceiver; **Sect. E.3.3.2** addresses the **(SELECT:) ODU** menu structure and functionality for the KST2000A/B Transceivers. For an graphic representation of these ODU-specific menu trees, refer to **Figure E-3** or **Figure E-4**.



NOTE: Feature shown in *ITALICS* indicates a **read-only** display item – no configurable action is possible.

Figure E-3. (SELECT:) ODU → CSAT-5060 Transceiver Menu Tree



NOTE: Feature shown in *ITALICS* indicates a *read-only* display item – no configurable action is possible.

Figure E-4. (SELECT:) ODU → KST-2000A/B Transceiver Menu Tree

E.3.3.1 (SELECT:) ODU (CSAT-5060 Transceiver)

```
ODU CONTROL=ENABLE      (DISABLE/ENABLE)
SYSTEM TYPE=STANDALONE  (STANDALONE, 1:1)
```

Select the parameter to edit – **ODU CONTROL** or **SYSTEM TYPE** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

ODU CONTROL:
DISABLE, ENABLE

DISABLE Turns *OFF* the FSK link to the ODU.

ENABLE Turns *ON* the FSK link to the ODU. Once the FSK link to the ODU is **enabled**, the CDM-600 senses the active ODU model and automatically adjusts the front panel menu displays specific for that product (i.e., CSAT-5060 or KST-2000A/B).

SYSTEM TYPE:
STANDALONE, 1:1

Select **STANDALONE** when the CDM-600 is linked via the Rx IF cable to a *single (standalone)* Comtech EF Data CSAT-5060 ODU.

Select **1:1** when the CDM-600 is linked to a *redundant* CSAT-5060 system via connection between the Rx IF and the ODU Redundancy Controller Box.



When the following menu selections are made:

```
ODU → ENABLE → SYSTEM TYPE=STANDALONE
ODU → ENABLE → SYSTEM TYPE=1:1 → ODU#1
ODU → ENABLE → SYSTEM TYPE=1:1 → ODU#2
```

The user is directed to a common ODU SELECT submenu branch:

```
SELECT:  CONFIGURATION  MONITOR  ALARMS
          INFORMATION
```

For clarity, this common submenu branch is defined in detail in Sect. 3.3.1.3.

E.3.3.1.1 ODU: ENABLE → SYSTEM TYPE=STANDALONE

```
SELECT:  CONFIGURATION  MONITOR  ALARMS
          INFORMATION
```

Select **CONFIGURATION**, **MONITOR**, **ALARMS**, or **INFORMATION** using the [←][→] arrow keys, then press [ENT].

The selections for this common submenu branch are defined in detail in **Sect. 3.3.1.3**.

E.3.3.1.2 ODU: ENABLE → SYSTEM TYPE=1:1

```
1:1 MONITOR & CONTROL:
      ODU#1   ODU#2   REDUNDANCY-BOX
```

For Monitor/Control of a redundant CSAT-5060 system, select **ODU#1**, **ODU#2**, or **REDUNDANCY-BOX** using the [←][→] arrow keys, then press [ENT].

1:1 MONITOR & CONTROL →ODU#1 or ODU#2

```
SELECT:  CONFIGURATION  MONITOR  ALARMS
          INFORMATION
```

Select **CONFIGURATION**, **MONITOR**, **ALARMS**, or **INFORMATION** using the [←][→] arrow keys, then press [ENT].

The selections for this common submenu branch are defined in detail in **Sect. 3.3.1.3**.

1:1 MONITOR & CONTROL →REDUNDANCY-BOX

```
RED:  ONLINE:ODU2  MODE:AUTO  SWITCH:N
      TXSW:OK     RXSW:OK     5V:5.0   12V:12.0
```

On the top line, select the parameter to edit – **MODE** or **SWITCH** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. The remaining parameters provide *read-only* redundant system status information. Observe the following:

ONLINE	(Online ODU – read-only) Indicates the currently online unit as ODU1 or ODU2
MODE	(Switchover Mode) Set the switchover mode as AUTO or MANUAL . In AUTO mode, when the Online ODU faults, switchover is done automatically to replace the faulty unit. Note: If the ODU Redundancy system is in AUTO mode, a ‘forced switchover’ can only occur if the currently OFFLINE unit is fault-free.
SWITCH	(Force Switchover) Select YES to force a Switchover to the other unit. (Default is NO).
TXSW	(Waveguide Switch Status – <i>read-only</i>) These display status for both the Tx and Rx Waveguide Transfer Switches. If either Switch is reporting an ambiguity from the commanded position, “OK” will change to “FT” to indicate a switch fault.
RXSW	
5V	(Redundancy Controller Box Voltages – <i>read-only</i>) The monitored 5V and 12V voltage values inside the Redundancy Control box can assist in troubleshooting system problems.
12V	

E.3.3.1.3 COMMON 'ODU SELECT' SUBMENU

ODU → Enable → SYSTEM TYPE=STANDALONE →
ODU → Enable → SYSTEM TYPE=1:1 → ODU#1 →
ODU → Enable → SYSTEM TYPE=1:1 → ODU#2 →

```
SELECT:  CONFIGURATION  MONITOR  ALARMS
          INFORMATION
```

Select **CONFIGURATION**, **MONITOR**, **ALARMS**, or **INFORMATION** using the [←][→] arrow keys, then press [ENT].

E.3.3.1.3.1 ODU SELECT: CONFIGURATION

```
CONFIG:  TX-PARAMETERS  RX-PARAMETERS
          LNA-PARAMETERS  MISCELLANEOUS
```

Select **TX-PARAMETERS** (Transmitter configuration submenu), **RX-PARAMETERS** (Receiver configuration submenu), **LNA-PARAMETERS** (Low-noise Amplifier configuration submenu), or **MISCELLANEOUS** (Miscellaneous configuration submenu) using the [←][→] arrow keys, then press [ENT].

CONFIGURATION → TX-PARAMETERS

```
TX:  FREQ=6427.0 MHz  ATT=23.00 dB
      AMP=OFF  MUTE=UNMUTED  SLOPE
```

Select the parameter to edit – **FREQ**, **ATT**, **AMP**, **MUTE**, or **SLOPE** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

FREQ	(Frequency) Edit the Tx frequency by first selecting the digit to be edited using the [←][→] arrow keys, then changing the value of that digit using the [↑][↓] arrow keys. Press [ENT] when done or [CLR] to cancel the edit and return to the previous menu.
ATT	(Attenuation) Edit the Tx attenuation by first selecting the digit to be edited using the [←][→] arrow keys, then changing the value of that digit using the [↑][↓] arrow keys. Press [ENT] when done or [CLR] to cancel the edit and return to the previous menu.
AMP	(Tx Amplifier State) Select as ON or OFF .
MUTE	(ODU Tx Mute State) Select as MUTED or UNMUTED .
SLOPE	Slope parameters are edited as per the information that follows.

CONFIGURATION → TX-PARAMETERS → SLOPE

```
TX SLOPE:  MODE=MANUAL  (MANUAL, CAL)
            SLOPE=0.3    (0.0 - 1.0)
```

Select **MANUAL** or **CALIBRATED** using the [↑][↓] arrow keys. If **Manual** mode is selected, the slope may be edited. Select the digit to edit using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that digit. Press [ENT] when done, or [CLR] to cancel the edit and return to the previous menu.

CONFIGURATION → RX-PARAMETERS

```
RX:  FREQ=3600.0 MHz  ATT=18.00 dB
      MUTE=UNMUTED    SLOPE
```

Select the parameter to edit – **FREQ**, **ATT**, **AMP**, **MUTE**, or **SLOPE** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

FREQ	(Frequency) Edit the Rx frequency by first selecting the digit to be edited using the [←][→] arrow keys, then changing the value of that digit using the [↑][↓] arrow keys. Press [ENT] when done or [CLR] to cancel the edit and return to the previous menu.
ATT	(Attenuation) Edit the Rx attenuation by first selecting the digit to be edited using the [←][→] arrow keys, then changing the value of that digit using the [↑][↓] arrow keys. Press [ENT] when done.
MUTE	(ODU Rx Mute State) Select as MUTED or UNMUTED .
SLOPE	Slope parameters are edited as per the information that follows.

CONFIGURATION → RX-PARAMETERS → SLOPE

```
RX SLOPE:  MODE=MANUAL  (MANUAL, CAL)
            SLOPE=0.2    (0.0 - 1.0)
```

Select **MANUAL** or **CALIBRATED** using the [↑][↓] arrow keys. If **Manual** mode is selected, the slope may be edited. Select the digit to edit using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that digit. Press [ENT] when done, or [CLR] to cancel the edit and return to the previous menu.

CONFIGURATION → LNA-PARAMETERS

```
LNA:  STATE=OFF  CALIBRATE-LNA-CURRENT=NO
      CURRENT-WINDOW=48%  FAULT-LOGIC=SUMMARY
```

Select the parameter to edit – **STATE**, **CALIBRATE-LNA-CURRENT**, **CURRENT-WINDOW**, or **FAULT-LOGIC** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

STATE	Set the LNA State as ON or OFF to define whether or not the CSAT will provide LNA Power via the Receive RF Cable.
CALIBRATE-LNA-CURRENT	Select YES or NO to define whether or not if the LNA Current is calibrated for use with the Current-Window function. (Default is NO).
CURRENT-WINDOW	Use the [↑][↓] arrow keys to define a value – between 20% and 50% - for the allowable LNA Current change before declaring a fault. Select 99% to disable the Current-Window function.
FAULT-LOGIC	Set FAULT-LOGIC as SUMMARY or NO-SUMMARY to control whether or not a LNA Current-Window fault will activate the Summary Fault Relay. This determines whether or not to switch the Online/Offline CSAT in the event of a LNA Current-Window fault.

CONFIGURATION → MISCELLANEOUS

MISC: COLD-START=DISABLE AFR=ENABLE
XREF=NO REF-ADJUST=087 RTC=OFF

Select the parameter to edit – **COLD-START**, **AFR**, **XREF**, **REF-ADJUST**, or **RTC** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

COLD-START	Select ENABLE or DISABLE to determine whether or not the IF and RF outputs are muted once the CSAT is powered on. <ul style="list-style-type: none"> When Cold-Start is ENABLED, the IF and RF outputs will mute for 15 minutes once the CSAT is powered on. When Cold-Start is DISABLED, no output muting occurs.
AFR	(Automatic Fault Recovery) Select ENABLE or DISABLE to define how CSAT will react to momentary fault conditions: <ul style="list-style-type: none"> When AFR is ENABLED, the CSAT will mute when faulted, but unmute after the fault goes away. When AFR is DISABLED, a fault will cause the CSAT to mute and remain muted.
XREF	(External Reference Lock) Select YES or NO to define whether or not the Summary Fault Relay is activated if the CSAT loses lock with the external reference: <ul style="list-style-type: none"> When YES is selected, the CSAT will automatically lock to an external 5 or 10 MHz reference independent of the state of this selection.
REF-ADJUST	(Internal Reference Adjustment) Edit the Internal 10MHz Reference setting by using the [↑][↓] arrow keys to scroll between 000 and 255 . NOTE: The Internal Reference is adjusted in the factory to be very accurate with the default setting of 087 . This parameter is made available to compensate for the long-term frequency drift of the oscillator.
RTC	(Real-Time Clock) Select ON or OFF to determine whether or not to synchronize the CSAT RTC to the CDM-600 RTC. (Default is OFF .)

E.3.3.1.3.2 ODU SELECT: MONITOR

```
MONITOR:  TRANSMIT  RECEIVE  MISCELLANEOUS
          POWER-SUPPLIES
```

This menu provides the user with access to real-time, *read-only* information displays on the ODU *currently in operation*. Select **TRANSMIT**, **RECEIVE**, **MISCELLANEOUS** or **POWER-SUPPLIES** using the [↑][↓] arrow keys, then press [ENT].

MONITOR: TRANSMIT

```
TX: SYNTUNE = 09.6 VDC  POWER = <24 dBm
    IFLO = 11.1 VDC    TEMP = 26 C
```

Per the example shown, this *read-only* display provides the Tx Synthesizer and IFLO tuning voltages, the RF Output Power in dBm and the Transmitter temperature. Press [ENT] or [CLR] to return to the previous menu.

MONITOR: RECEIVE

```
RX: SYNTUNE = 01.4 VDC
    IFLO = 11.2 VDC    TEMP = 26 C
```

Per the example shown, this *read-only* display provides the Rx Synthesizer and IFLO tuning voltages and the Receiver temperature. Press [ENT] or [CLR] to return to the previous menu.

MONITOR: MISCELLANEOUS

```
MISC: REF TUNE = 03.0 VDC
      LNA = 00.05 mA    FAN = 550 mA
```

Per the example shown, this *read-only* display provides the Internal Reference Oscillator tuning voltages, the LNA Current in milliamps and the Fan Current in milliamps. Press [ENT] or [CLR] to return to the previous menu.

MONITOR: POWER-SUPPLIES

```
24V=24.1 VDC  12V=12.5VDC  +5V=+5.4VDC
20V=21.2 VDC  10V=10.2VDC  -5V=-5.3VDC
```

Per the example shown, this *read-only* display provides a monitor for the six internal power supplies. Press [ENT] or [CLR] to return to the previous menu.

E.3.3.1.3.3 ODU SELECT: ALARMS

```
ALARMS:  CURRENT-ALARMS  STORED-ALARMS
```

Select **CURRENT-ALARMS** or **STORED-ALARMS** using the [←][→] arrow keys, then press [ENT].

ALARMS: CURRENT-ALARMS

```
CURRENT STATUS:  TX = OK      RX = OK  
                  POWER-SUPPLY = OK  MISC = OK
```

Selecting **CURRENT-ALARMS** provides a *read-only* summary of the current CSAT status. If any of the items display “FT,” then that feature is faulted, and the user should view the **Stored Events Log** for details.

ALARMS: STORED-ALARMS

As the stored events are being read, this screen displays as follows:

```
READING STORED FAULTS..... PLEASE WAIT
```

Once events are collated, the Stored Alarms screen updates as per the following example:

```
STORED ALARMS:  CLR-ALL: NO  (NO, YES)  
IF #84: 10/14/04  12:52:08  POWER ON
```

Events are shown on the bottom line of the display. Using the example, observe the following:

IF	The entry type, where: <ul style="list-style-type: none">• IF = Information• FT = Fault• OK = Fault CLEARED
#84	The event / entry number. Up to 100 entries, numbered 00 through 99, are stored.
10/14/04	The date, in international format, that the event was logged.
12:52:08	The time that the event was logged.
POWER ON	Event information / description of the fault.

Use the [←][→] arrow keys move the cursor between the **CLR-ALL** option on the top line and the stored even on the bottom line, then use the [↑][↓] arrow keys to select entries on a per-event basis.

To clear the Stored Alarms log, use the [←][→] arrow keys move the cursor to the **CLR-ALL** option on the top line, then use the [↑][↓] arrow keys to select **NO** or **YES**, then press [ENT].

E.3.3.1.3.4 ODU SELECT: INFORMATION

```
INFO:  MODEL  TX  RX  MISC  LNA
```

This menu provides the user with access to *read-only* information displays on the ODU *as configured for operation*. Select **MODEL**, **TX**, **RX**, **MISC**, or **LNA** using the [←][→] arrow keys, then press [ENT].

The following INFORMATION display examples are intended for reference only – the information and values displayed in each example may differ, depending on the configuration in use. After viewing each information screen, press [ENT] or [CLR] to return to previous menu.

INFORMATION: MODEL

```
MODEL:  CSAT-5060/025  V2.19  
S/N:    010300346
```

Per the example shown, this *read-only* display provides the model, serial number, and firmware version for the ODU in use.

INFORMATION: TX

```
INFO:  TX:OFF  6427.0MHz  23.00dB  
AMP:OFF  UNMUTED  SLOPE:0.3
```

Per the example shown, this *read-only* display provides information on the CSAT transmitter status: Tx operating state (**ON** or **OFF**), Tx Frequency, Tx Attenuation, Amplifier state (**ON** or **OFF**), Tx Mute state (**Muted** or **Unmuted**), and Tx Slope adjustment.

INFORMATION: RX

```
INFO:  RX:ON  3400.0MHz  18.00dB  
REF:087  UNMUTED  SLOPE:0.2
```

Per the example shown, this *read-only* display provides information on the CSAT receiver status: Rx operating state (**ON** or **OFF**), Rx Frequency, Rx Attenuation, Rx Mute state (**Muted** or **Unmuted**), and Rx Slope adjustment.

INFORMATION: MISC

```
INFO:  COLD START:OFF  
AUTO FAULT RECOVERY:ENABLED
```

Per the example shown, this *read-only* display provides the current state of the Cold Start (**ON** or **OFF**) and the Auto Fault Recovery function (**ENABLED** or **DISABLED**).

INFORMATION: LNA

```
INFO:      LNA:OFF      FAULT-LOGIC:SUMMARY
           WINDOW:48%
```

Per the example shown, this *read-only* display provides the current state of the LNA functions: the LNA operating status (**ON** or **OFF**), the Current Window, the Fault-Logic setting (**SUMMARY** or **NO-SUMM**), Current-Window threshold setting.

E.3.3.2 (SELECT:) ODU (KST-2000A/B Transceiver)

```
ODU CONTROL=ENABLE      (DISABLE/ENABLE)
SYSTEM TYPE=STANDALONE  (STANDALONE,1:1)
```

Select the parameter to edit – **ODU CONTROL** or **SYSTEM TYPE** – using the [**←**][**→**] arrow keys, then use the [**↑**][**↓**] arrow keys to modify that parameter setting. Press [**ENT**] when done. Observe the following:

```
ODU CONTROL:
DISABLE, ENABLE
```

DISABLE turns *OFF* the FSK link to the ODU.

ENABLE turns *ON* the FSK link to the ODU. Once the FSK link to the ODU is **enabled**, the CDM-600 senses the active ODU model and automatically adjusts the front panel menu displays specific for that product (i.e., CSAT-5060 or KST-2000A/B).

```
SYSTEM TYPE:
(STANDALONE)
```

If the CDM-600 detects a KST-2000A/B ODU in use, this selection defaults to **STANDALONE**: Note that **1:1** is *disabled* and *non-selectable*, and the user is directed to the **KST SELECT**: menu depicted next.

ODU: STANDALONE → KST SELECT

```
KST SELECT:
CONFIGURATION INFORMATION  ALARMS
```

Select **CONFIGURATION**, **INFORMATION**, or **ALARMS** using the [**←**][**→**] arrow keys, then press [**ENT**].

E.3.3.2.1 KST SELECT: CONFIGURATION

```
KST CONFIG:
TX-PARAM    RX-PARAM    MISCELLANEOUS
```

Select **TX-PARAM**, **RX-PARAM**, or **MISCELLANEOUS** using the [**←**][**→**] arrow keys, then press [**ENT**].

CONFIGURATION → TX-PARAM

**TX:OFF FREQ=13955 MHz ATT=23 dB
AGC=OFF**

Select the parameter to edit – **TX, FREQ, ATT, or AGC** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

TX	(Tx State) Select ON or OFF .
FREQ	(Frequency) Edit the Tx frequency by first selecting the digit to be edited using the [←][→] arrow keys, then change the value of the digit using the [↑][↓] arrow keys. Press [ENT] when done. Note: The frequency limits of the KST-2000A are known and the frequency values are constrained accordingly.
ATT	(Attenuation) Edit the attenuation value by first selecting the digit to be edited using the [←][→] arrow keys, then change the value of the digit using the [↑][↓] arrow keys. Press [ENT] when done.
AGC	(Automatic Gain Control) Select ON or OFF .

CONFIGURATION → RX-PARAM

(Displayed only when the ODU is a KST-2000A unit)

**RX:OFF FREQ=11950 MHz ATT=20 dB
REF=087**

(Displayed only when the ODU is a KST-2000B unit)

**RX: FREQ=11950 MHz ATT=20 dB REF=087
BAND=B**

Select the parameter to edit – **RX (KST-2000A only), FREQ, ATT, REF, or BAND (KST-2000B only)** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

RX	(Rx State, KST-2000A only) Select ON or OFF .
FREQ	(Frequency) Edit the Rx frequency by first selecting the digit to be edited using the [←][→] arrow keys, then change the value of the digit using the [↑][↓] arrow keys. Press [ENT] Press [ENT] when done. Note: The frequency limits of the KST-2000A are known and the frequency values are constrained accordingly.
ATT	(Attenuation) Edit the attenuation value by first selecting the digit to be edited using the [←][→] arrow keys, then change the value of the digit using the [↑][↓] arrow keys. Press [ENT] when done.
REF	(Reference) Edit the Internal 10 MHz Reference value by using the [↑][↓] arrow keys – the value will scroll between 000 and 255 . Press [ENT] when done. NOTE: The Internal Reference is adjusted in the factory to be very accurate with the default setting of 087 . This parameter is made available to compensate for the long-term frequency drift of the oscillator.
BAND=?	(LNB Rx Frequency Band, KST-2000B only) See next item for further details.

CONFIGURATION → RX-PARAM → BAND

```
LNB RX BAND :
A   B   C
```

This menu is available only for use with the KST-2000B unit, and is used to set the LNB Rx Frequency Band. Select **A**, **B**, or **C** using the [←][→] arrow keys, then press [ENT].

CONFIGURATION → MISCELLANEOUS

(Displayed only when the ODU is a KST-2000A unit)

```
HPA : OFF      FAULT-LOGIC=SUMMARY
LNA : OFF      FAULT-LOGIC=SUMMARY  CAL : NO
```

(Displayed only when the ODU is a KST-2000B unit)

```
HPA : OFF      FAULT-LOGIC=SUMMARY
LNB : OFF      FAULT-LOGIC=SUMMARY  CAL : NO
```

Select the parameter to edit – **HPA**, (**HPA**) **FAULT-LOGIC**, **LNA/LNB**, (**LNA/LNB**) **FAULT-LOGIC**, or **CAL** – using the [←][→] arrow keys, then use the [↑][↓] arrow keys to modify that parameter setting. Press [ENT] when done. Observe the following:

HPA	(HPA State) Select OFF or ON to enable HPA power.
FAULT-LOGIC	Select SUMMARY or NO_SUMMARY . Fault-Logic controls whether or not a HPA fault will be indicated on the Fault status and will activate the Summary Fault Relay.
LNA / LNB	(Operating State: LNA = KST-2000A / LNB= KST-2000B) Select OFF or ON to enable LNA/LNB power.
FAULT-LOGIC	Select SUMMARY or NO_SUMMARY . Fault-Logic controls whether or not a LNA/LNB fault will be indicated on the Fault status and will activate the Summary Fault Relay.
CAL	(Calibration) <i>Performed at initial installation only.</i> Calibration allows the system to determine nominal LNA/LNB power consumption. Select YES , then press [ENT] to calibrate. (Default = NO .)

E.3.3.2.2 KST SELECT: INFORMATION

```
KST INFO:   MODEL   TX+RX-PARAM
              MISC     NUMBERS
```

This menu provides the user with access to *read-only* information displays on the ODU *as configured for operation*. Select **MODEL**, **TX+RX-PARAM**, **MISC**, or **NUMBERS** using the [←][→] arrow keys, then press [ENT].

The following INFORMATION display examples are intended for reference only – the information and values displayed in each example may differ, depending on the configuration in use. After viewing each information screen, press [ENT] or [CLR] to return to previous menu.

INFORMATION → MODEL

```
MODEL:  KST-2000B
HPA:    CEFD-SSPA
```

Per the example shown, this *read-only* display provides the model, serial number, and firmware version for the ODU and HPA or LNA in use.

INFORMATION → TX+RX-PARAM

```
INFO:  TX:OFF  13955MHz  10dB
      RX:      11950MHz  20dB  REF:087
```

Per the example shown, this *read-only* display provides information on the KST Tx/Rx status: Tx operating state (**ON** or **OFF**); Tx Frequency; Tx Attenuation; Rx Frequency; Rx Attenuation; and Rx Reference.

INFORMATION → MISC

(Displayed only when the ODU is a KST-2000A unit)

```
INFO:      HPA:OFF  FLT-LOGIC:NO-SUMM
          LNA:OFF  FLT-LOGIC:SUMMARY
```

(Displayed only when the ODU is a KST-2000B unit)

```
INFO:      HPA:OFF  FLT-LOGIC:NO-SUMM
      Band:B  LNB:OFF  FLT-LOGIC:SUMMARY
```

Per the example shown, *read-only* information on the current configuration of the HPA and LNA functions is displayed: Unit State (**ON** or **OFF**) and Fault Logic (**SUMMARY** or **NO-SUMM**). Additionally, the LNB Rx Frequency Band (**A**, **B**, or **C**) is displayed when a KST-2000B unit is in use.

INFORMATION → NUMBERS

```
M&C:      F/W:9364-1B  VER:01.01.03
          assy:9357-1A  S/N:021476493
```

Detailed information, including firmware and hardware information, is provided for the configured and operating Up Converter, Down Converter, and HPA assemblies. Use the [↑][↓] keys to scroll through all the available NUMBERS info screens.

E.3.3.2.3 KST SELECT: ALARMS

**CURRENT STATUS: UP:OK REF:OK AGC:OK
P-SUPPLIES:OK DN:OK HPA:OK LNA:OK**

This menu provides the user with access to continually-updated, *read-only* operational summary information, as per the following tables:

Feature Abbreviation	Designates	Detailed Status Display Available? (Y/N)
UP	Upconverter	Y
REF	Reference	Y
AGC	Auto Gain Control	Y
P-SUPPLIES	Power Supplies	Y
DN	Downconverter	Y
HPA	High Power Amplifier	Y
LNA	Low Noise Amplifier	N

Summary Status Abbreviation	Designates
OK	OK – No Fault
FT	Fault
NA	Not Applicable

By using the [←][→] arrow keys then pressing [ENT], the user may view more detailed status information, as shown per the following examples (press [ENT] or [CLR] to return to the previous menu):

**UP-CONVERTER: COMMS:OK L-SYNTH:OK
OVER-TEMP:OK Ku-SYNTH:OK**

**REFERENCE:WARM 72M-LOCK:OK RANGE:NA
SOURCE:INT xREF-LOCK:NA PHASE:NA**

**AGC STATUS: EXCESS-POWER-IN:OK
LOOP-CONV:OK INSUFF-POWER-IN:OK**

**P-SUPPLIES: 7V:OK 17V:OK
-7V:OK 12V:OK (ENTER)**

**DOWN-CONVERTER: COMMS:OK L-SYNTH:OK
OVER-TEMP:OK Ku-SYNTH:OK**

**HPA: COMMS:OK 9.75V:OK
OVER-TEMP:OK BIAS:OK -CONV:5V:OK**

Appendix F. ODU (BUC, LNB) OPERATION VIA THE CDM-600L

F.1 Introduction

The user can fully configure, monitor, and control an ODU (Outdoor Unit) – the mnemonic for a BUC (Block Upconverter) or LNB (Low-Noise Block Downconverter) – from the CDM-600L in the following ways:

- By using ODU remote commands and queries through Serial Remote Control.
- By using the CDM-600L modem keypad and display (via the front panel) to access ODU configuration, operation, and monitoring commands.

F.2 ODU Operations via Serial Remote Control

For a complete overview of Serial Remote Control and the commands and queries associated with remote ODU configuration, operation, and monitoring, refer to **Appendix D. SERIAL REMOTE CONTROL**.

F.2.1 Remote Control Address Setup

The ODU connected to a CDM-600L Modem through FSK can be remotely monitored and controlled by using ODU remote commands through Serial Remote Control. The address of the ODU is set up as follows:

- **For local-end ODUs:**
 - Use Modem's RC address + 1 for Standalone unit or Online unit in a 1:1 Redundancy System
 - Use Modem's RC address + 2 for Offline unit in a 1:1 Redundancy System
- **For distant-end ODUs in an EDMAC setup:**
 - Use EDMAC Slave Address (ESA) Range + 4 for Standalone unit or Online unit in a 1:1 Redundancy System.
 - Use EDMAC Slave Address (ESA) Range + 5 for Offline unit in a 1:1 Redundancy System.

F.3 ODU Operations via the CDM-600L Front Panel

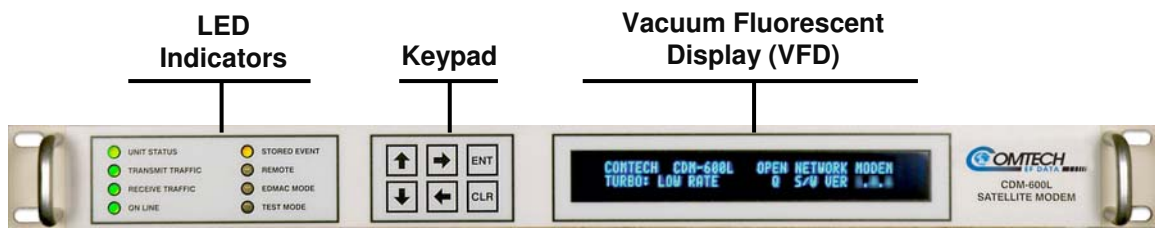

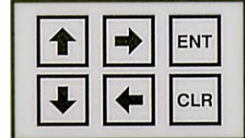
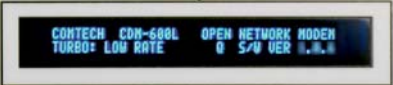


Figure F-1. CDM-600L Front Panel View

The user can configure, monitor and control BUC/LNB operation via the CDM-600L front panel, using the keypad and display. Nested menus are used, which display all available options, and prompt the user to carry out a required action.

Figure F-1 identifies the key features of the CDM-600L front panel; in-depth explanations of the function and operation of these features is provided in **Chapter 5. FRONT PANEL OPERATION**. For this appendix, however, their purpose is summarized as follows:

Feature	Description
LED Indicators	 <p>Used to indicate the operational status of the CDM-600L Modem.</p>
Keypad	 <p>Used to select and navigate the available CDM-600L menu functions as displayed on the Vacuum Fluorescent Display (VFD).</p>
Vacuum Fluorescent Display (VFD)	 <p>Used to fully control and monitor operation of the CDM-600L Modem. Consisting of two lines with a width of 40 characters each, nested menus displayed on the VFD provide all available options and prompt the user to carry out out a required action via the keypad.</p>

F.3.1 ODU Operation – Front Panel Menu Tree

Figure F-2 identifies the CDM-600L front panel menu hierarchies that pertain specifically to the configuration, monitor and control of a BUC or LNB. In this particular figure, menu branches that incorporate ODU operations are shown in **bold**; menu content that is dedicated to ODU operations is additionally *italicized*.

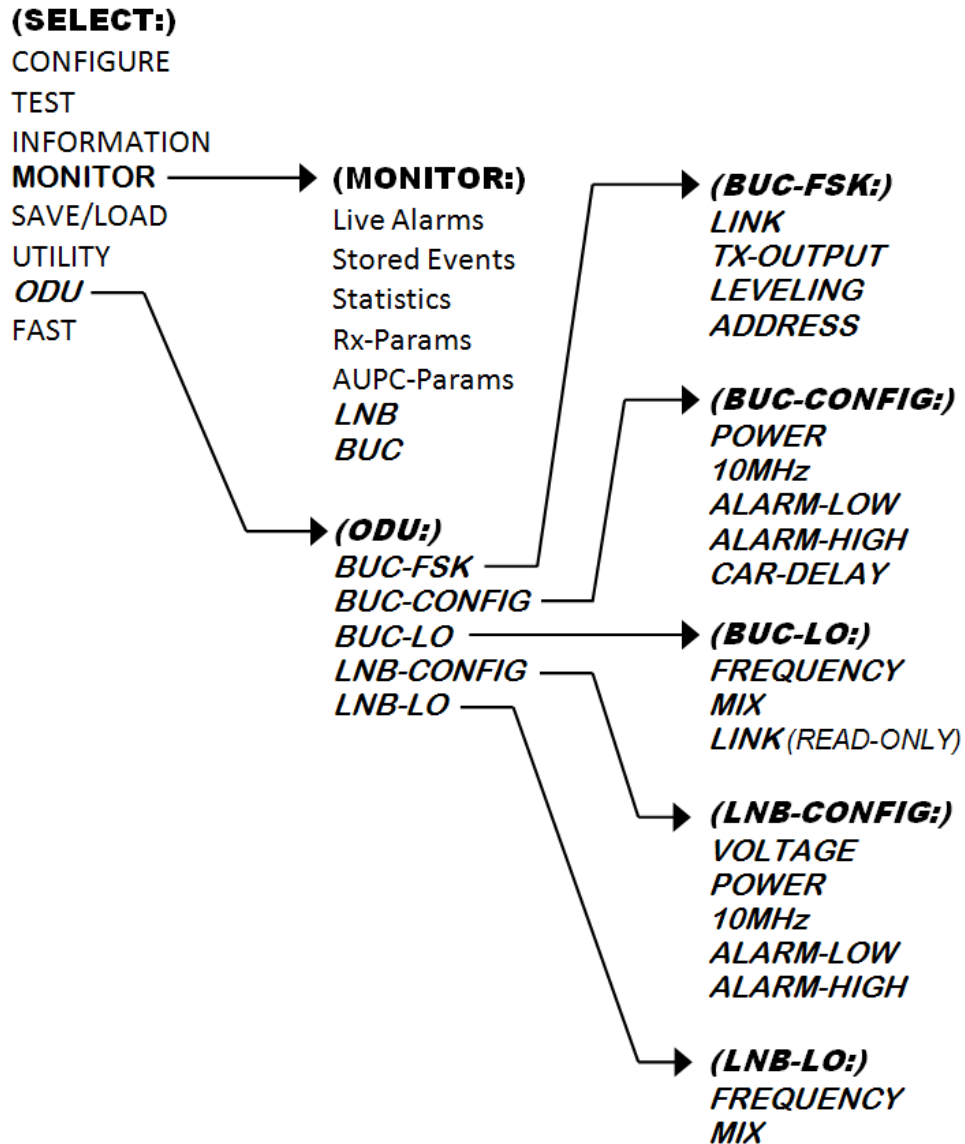


Figure F-2. CDM-600L ODU Operation Principal Menu Tree

Note: The ODU menu branches depicted are accessible from the CDM-600L front panel menu only when the presence of an ODU is detected. Also note that, as this appendix deals strictly with ODU operations, **Chapter 5. FRONT PANEL OPERATION** provides a complete overview for any CDM-600L menu operations or selections not explicitly defined in this appendix.

F.3.2 Front Panel Menu Operations

The **ODU** menu allows the user to access an FSK menu that permits the CDM-600L to interface directly with an FSK-capable BUC. The interface is accomplished using a low-speed, half-duplex FSK link on the Tx IF port, with a carrier frequency around 650 kHz.

Configuration menus for the LNB and BUC allow the user to set up the power supply, 10 MHz reference and low/high current alarm thresholds for the BUC and LNB, and power-up carrier output turn-on delay for the BUC. LO menus for the BUC and LNB allow the user to set up the up-convert and down-convert parameters for the BUC and LNB so that the TX and RX frequencies are handled as the satellite frequencies rather than the modem IF input/output frequencies.

F.3.3 SELECT: (Main) Menu

```
Select: CONFIGURATION TEST INFORMATION
        MONITOR    STORE/LOAD UTILITY ODU FAST
```

The following table identifies the menu branch, its content section in this appendix, and the functional description of each branch that incorporates or is dedicated to ODU-specific operations:

Menu Branch* (Appendix Sect.)	Description
ODU (F.3.4)	(Outdoor Unit) Permits the user to monitor and control a Comtech EF Data Block Upconverter (BUC) or Low-noise Block Downconverter (LNB), if connected.
Monitor (F.3.5)	Permits the user to monitor the current status of the ODU and view the log of stored events for the ODU.

* To prioritize operational sequence, the ODU menu information featured here is presented out of the selection order displayed on the Main menu.

Select **ODU** or, once configured for proper ODU operation, **Monitor** using the [←][→] arrow keys, then press [ENT].

F.3.4 (SELECT:) ODU (Outdoor Unit)

ODU: BUC-FSK BUC-CONFIG BUC-LO
LNB-CONFIG LNB-LO

Select **BUC-FSK**, **BUC-CONFIG**, **BUC-LO**, **LNB-CONFIG**, or **LNB-LO** using the [←][→] arrow keys, then press [ENT]. The menu branch submenus are as follows:

BUC-FSK	If an FSK-capable BUC is employed, provides access to a further set of menus that define the FSK setup, and use it for control and monitor.
BUC-CONFIG	If a BUC supply is installed, permits the user to configure BUC-related items.
BUC-LO	Allows setup to program Transmit frequency in terms of terminal uplink frequency rather than modem IF output frequency. Entering a nonzero value for BUC LO will cause the TX IF frequency programming under CONFIG: TX → TX-IF to be entered and displayed as the actual TX frequency for the satellite terminal.
LNB-CONFIG	If an LNB supply is installed, permits the user to configure LNB-related items.
LNB-LO	Allows setup to program Receive frequency in terms of terminal downlink frequency rather than modem IF input frequency. Entering a nonzero value for LNB LO will cause the RX IF frequency programming under CONFIG: RX → RX-IF to be entered and displayed as the actual RX frequency for the satellite terminal.

F.3.4.1 ODU: BUC-FSK

FSK: LINK =OFF TX-OUTPUT=N/A
LEVELING=N/A ADDRESS=N/A

Select a parameter to edit – **LINK**, **TX-OUTPUT**, **LEVELING**, or **ADDRESS** – using the [←][→] arrow keys, then use the [↑][↓] arrows keys to edit the settings for that parameter. Press [ENT] when done. Observe the following:

LINK	To control FSK communications with the BUC, use the [↑] [↓] arrow keys to select communications as ON or OFF , then press [ENT] when done.
TX-OUTPUT	<i>Disabled in LINK OFF position.</i> To control the TX RF output from the BUC, use the [↑] [↓] arrow keys to select output as ON or OFF , then press [ENT] when done.
LEVELING	<i>Disabled in LINK OFF position.</i> To control the automatic BUC output power leveling loop, use the [↑] [↓] arrow keys to select the leveling as ON or OFF , then press [ENT] when done.
ADDRESS	<i>Disabled in LINK OFF position.</i> To set the FSK address for the BUC, use the [↑] [↓] arrow keys to assign an address from 1 to 15 , then press [ENT] when done.

F.3.4.2 ODU: BUC-CONFIG

**BUC: POWER=OFF 10MHz=OFF ALARM-LOW=0.0A
ALARM-HIGH=2.0A CAR-DELAY=00:00 MIN:SEC**

Select a parameter to edit – **POWER**, **10MHz**, **ALARM-LOW**, **ALARM-HIGH**, or **CAR-DELAY MIN:SEC** – using the [←][→] arrow keys, then use the [↑][↓] arrows keys to edit the settings for that parameter. Press [ENT] when done. Observe the following:

POWER	To control BUC operation, use the [↑] [↓] arrow keys to select power as ON or OFF , then press [ENT] when done.
10 MHz	To control the 10MHz Reference output to the BUC, use the [↑] [↓] arrow keys to select the 10MHz Reference output as ON or OFF , then press [ENT] when done.
ALARM-LOW	To set the BUC low current alarm threshold, use the [↑] [↓] arrow keys to set the threshold (in amps), then press [ENT] when done.
ALARM-HIGH	To set the BUC high current alarm threshold, use the [↑] [↓] arrow keys to set the threshold (in amps), then press [ENT] when done.
CAR-DELAY MIN:SEC	This sets a carrier 'on' time delay from modem power-up to TX carrier output turn-on, allowing the BUC to warm up for stable operating frequency or output power prior to transmitting a carrier. To set the carrier 'on' time delay, use the [←] [→] arrows keys to select a digit to edit, then the [↑] [↓] arrow keys to adjust the value of that digit (typical for the MIN and SEC values). Press [ENT] when done. If a nonzero carrier 'on' time delay value is assigned, this menu also shows the time remaining for the output delay countdown. When the cursor is not on the CAR-DELAY field, the timer resumes countdown and indicates this on the front panel by a flashing TX LED.

F.3.4.3 ODU: BUC-LO

**BUC-LO: FREQUENCY = 00000 MHz
MIX = HIGH (-) FSK: LINK =OFF**

Select **Frequency** or **Mix** using the [←][→] arrow keys, then press [ENT] to continue. Observe the following:

FREQUENCY	To set the lockout frequency in the BUC for the up conversion, use the [←] [→] arrows keys to select a digit to edit, then the [↑] [↓] arrow keys to adjust the value of that digit. Press [ENT] when done. Note that entering a nonzero value for the BUC lockout frequency will cause the TX IF frequency programming under CONFIG: TX: TX-IF to be entered and displayed as the actual TX frequency for the satellite terminal.
MIX	To set the polarity for the upconversion mix in the BUC, use the [↑] [↓] arrow keys to select HIGH (-) for high side inverting mix, or LOW (+) for low side noninverting mix. Press [ENT] when done.
FSK: LINK	This <i>read-only</i> parameter displays the FSK communications setting established (ON or OFF) via the ODU: BUC-FSK → LINK menu.

F.3.4.4 ODU: LNB-CONFIG

**LNB: VOLTAGE=13VOLT POWER=OFF 10MHz=OFF
ALARM-LOW = 000mA ALARM-HIGH = 500mA**

Select a parameter to edit – **POWER**, **10MHz**, **ALARM-LOW**, **ALARM-HIGH**, or **CAR-DELAY MIN:SEC** – using the [←][→] arrow keys, then use the [↑][↓] arrows keys to edit the settings for that parameter. Press [ENT] when done. Observe the following:

VOLTAGE	To set the voltage for the LNB power supply, use the [↑] [↓] arrow keys to select 13VOLT , 18VOLT , or 24VOLT , then press [ENT] when done.
POWER	To control LNB operation, use the [↑] [↓] arrow keys to select power as ON or OFF , then press [ENT] when done.
10 MHz	To control the 10MHz Reference output to the LNB, use the [↑] [↓] arrow keys to select the 10MHz Reference output as ON or OFF , then press [ENT] when done.
ALARM-LOW	To set the LNB low current alarm threshold, use the [↑] [↓] arrow keys to set the threshold (in mA), then press [ENT] when done.
ALARM-HIGH	To set the LNB high current alarm threshold, use the [↑] [↓] arrow keys to set the threshold (in mA), then press [ENT] when done.

F.3.4.5 ODU: LNB-LO

**LNB-LO: FREQUENCY = 00000 MHz
MIX = HIGH (-)**

Select **Frequency** or **Mix** using the [←][→] arrow keys, then press [ENT] to continue. Observe the following:

FREQUENCY	To set the lockout frequency in the LNB for the downconversion, use the [←] [→] arrows keys to select a digit to edit, then the [↑] [↓] arrow keys to adjust the value of that digit. Press [ENT] when done. Note that entering a nonzero value for the LNB lockout frequency will cause the RX IF frequency programming under CONFIG: RX→ RX-IF to be entered and displayed as the actual RX frequency for the satellite terminal.
MIX	To set the polarity for the upconversion mix in the LNB, use the [↑] [↓] arrow keys to select HIGH (-) for high side inverting mix, or LOW (+) for low side noninverting mix. Press [ENT] when done.

F.3.5 (SELECT:) MONITOR

```
MONITOR: LIVE-ALARMS   STORED-EVENTS  
STATISTICS RX-PARAMS  AUPC-PARAM  LNB  BUC
```

For ODU operation, select **LNB** or **BUC** using the [←][→] arrow keys, then press [ENT].

F.3.5.1 MONITOR: LNB

```
LNB:  CURRENT = xxx mA   Voltage = xx V
```

The *read-only Monitor: LNB* screen displays the measured LNB current load and LNB voltage at the Rx IF connector.

F.3.5.2 MONITOR: BUC

```
BUC:CURRENT =0000mA VOLT =47.9V CLASS =N/A  
PWR =N/A Amb =N/A PLL =N/A VER =NA
```

The *read-only Monitor: BUC* screen displays the following operating parameters:

CURRENT	If a BUC supply is installed, displays the BUC supply load current, measured at the Tx-IF connector.
VOLT	If a BUC supply is installed, displays the BUC supply voltage, measured at the Tx-IF connector.
CLASS	If BUC FSK is enabled, displays the output power rating of the BUC.
PWR	If BUC FSK is enabled, displays the output power of the BUC, as measured by the BUC power monitor.
AMB	If BUC FSK is enabled, displays BUC ambient temperature in °C.
PLL	If BUC FSK is enabled, displays the fault status of the BUC PLL synthesizers.
VER	If BUC FSK is enabled, displays the M&C software version of the BUC.

Appendix G. BUC FSK COMMUNICATIONS (CDM-600L)

G.1 Introduction

The CDM-600L Open Network Satellite Modem's modulator includes capability to communicate with a **Block Up Converter (BUC)** using an FSK signal multiplexed onto the IF output connector along with the Tx IF signal, 10 MHz reference, and DC power to the BUC. The M&C implements commands to control BUC functions and to query the BUC for configuration or status information.

FSK Transmitter	
Frequency	650 kHz \pm 5 %
FSK Deviation	\pm 60 kHz nominal (+60 kHz mark)
Deviation Tolerance	\pm 50 kHz minimum, \pm 70 kHz maximum
Output Level	-5 to -15 dBm
Start Tone Time	10 ms minimum
Output Impedance	50 Ω
Start Tone	710 kHz
FSK Receiver	
Locking Range	\pm 32.5 kHz
Input Sensitivity	-15 dBm (50 Ω)
Transmission Protocol	
Baud Rate	9600 bps
Data Bits	8
Parity	None
Stop Bits	1
Message Rate	1 every 40 msec
BUC Response Time	12 msec, typical
Maximum Response Time	40 msec

Note: If the BUC does not respond within the maximum response time the IDU should cyclically repeat the command.

On power-up, the Tx carrier is Off until the BUC is commanded to turn the carrier on (unless the unit is commanded into the power On mode at the factory). The BUC does not allow the carrier to be turned On unless the PLL is locked, and automatically turns the carrier Off in the event the PLL goes out-of-lock. If the PLL then comes back into lock, the BUC restores the carrier to the most

recent requested state by the IDU. The carrier enable/disable function is implemented by switching On/Off the switched regulators of the BUC amplifier chains (a “sleep mode”).

The BUC is equipped with a calibrated power sensor for measuring the power delivered to the antenna for rated output to 20 dB backed off. This value, in dBm, is available via the M&C for power level monitoring and AGC.

Refer to BUC manufacturer specifications for reported power accuracy.

G.1.1 Transmission Interface

Each transmitted data packet consists of 7 bytes of information. The BUC only accepts a command if the first data byte contains the appropriate address. Commands are only executed if the checksum coincides, but a status response is sent if the address is correct and the command number is within the valid range.

G.2 Message Structure

G.2.1 Command Message Structure (CDM-600L to BUC)

Byte	Name	Description	Value
1	Address	Address of BUC	0x01 to 0x0f
2	Command	Request Status Tx On/Off Change Address Set Carrier Frequency	0x01 0x02 0x03 0x04
3	Data Byte 1	Not used if command: = 0x01 Tx control if command: = 0x02 New address if command: = 0x03 Carrier Frequency if command: = 0x04	0xAA 0=Off, 1=On 0x01 to 0x0f MSbyte
4	Data Byte 2	Not used if command: = 0x01 Not used if command: = 0x02 Not used if command: = 0x03 Carrier Frequency if command: = 0x04	0xAA 0xAA 0xAA LSbyte
5	Data Byte 3	Not Used	0xAA
6	Data Byte 4	Not Used	0xAA
7	Checksum	Algebraic sum of bytes 1 - 6	

G.2.2 Response Message Structure (BUC to CDM-600L)

Byte	Name	Description	Value
1	Address	Address of BUC shifted left by 4	0x10 to 0xf0
2	Level Byte 1	MSbyte of TX output power	
3	Level Byte 2	LSbyte of TX output power	
4	Temperature	Temperature in °C	
5	Status Byte 1	Bit 0: Temperature out-of-range Bit 1: PLL out-of-lock Bit 2: Checksum error Bit 3: TX Status Bits 4 thru 7: Power Class	1: OOR, 0: Normal 1: OOL, 0: Normal 1: error in command message, 0: Normal 1: TX ON, 0: TX Off 0x1 to 0xf
6	Status Byte 2	Bits 0 – 3: Not used Bits 4 –7: Software version	0xAA 0x0 to 0xf
7	Checksum	Algebraic sum of bytes 1 - 6	

Data Field Definitions	
TX Power Level	Unsigned integer in 1/100 dBm
Carrier Frequency	Unsigned integer in MHz.
Temperature	Signed character in °C

G.3 BUC Power Class

Includes all power levels for C- and Ku-Bands.

Value	Power
0x1	2 watt
0x2	4 watt
0x3	5 watt
0x4	8 watt
0x5	10 watt
0x6	16 watt
0x7	20 watt
0x8	25 watt
0x9	40 watt
0xa	60 watt

G.4 BUC Output Power Leveling

The BUC's capability to report the detected high power BUC output carrier level via the FSK link with the modem makes possible an automatic BUC output power leveling scheme. In this scheme, the CDM-600L M&C continually monitors the reported output power level from the BUC, and adjusts the modem transmit output carrier level to maintain the BUC output level at a target tracking value.

This process is enabled when the **FSK LEVELING** is turned **ON**. When **LEVELING** changes from **OFF** to **ON**, the CDM-600L M&C reads the output power level reported by the BUC, and establishes that current output level as the target tracking level. Then, the M&C continues to monitor the BUC output level at 10-second intervals, and adjusts the modem output carrier level if needed to keep the BUC output level at the established target value.

With **LEVELING** turned **ON**, the BUC output power level is held constant within the stability of the BUC output power detector.

BUC output power leveling cannot be used in conjunction with AUPC since the two processes conflict directly with each other. Therefore, BUC output power leveling cannot be turned **ON** if AUPC is **ON**, and vice versa. Further, BUC output power leveling cannot be turned **ON** if the BUC output is turned off by the **FSK** command, or if the BUC PLL is faulted. In these cases, there is no carrier output from the BUC so a valid tracking level cannot be established.

Once leveling loop operation is established, however, the loop will "freeze" if :

- A PLL fault in the BUC causes an automatic shut down of the output power amplifier.
- FSK communication fails.
- FSK is turned **OFF**.
- Modem IF output is turned **OFF**.
- **FSK** command turns **OFF** the BUC output.

Any of these events opens the feedback loop preventing valid level correction. Once the stimulus causing the loop to freeze is removed, the leveling loop will resume normal operation using the previously established target tracking level.

A convenient way to verify that the leveling loop does indeed function is to first establish leveling loop operation, then turn FSK **OFF** and change the modem transmit output power level, and finally turn FSK back **ON**. Observe either the modem output power level in the **CONFIG: TX → POWER** menu, or the monitored BUC output power level in the **MONITOR: BUC** menu. The levels will incrementally change at 10-second intervals to bring the BUC output back to the target tracking level.

Turning both BUC FSK and output power leveling **ON** inhibits capability to manually change the modem transmit output carrier level since the leveling loop has control of the modem output. When leveling is turned **ON**, **(ADJ)** appears in the front panel display after the transmit power level in the **CONFIG: TX → POWER** menu. Each time this menu is entered, the displayed transmit output power level is updated with the current value set by the leveling loop.

BUC FSK related parameters, including leveling ON/OFF state and target tracking level, are stored in nonvolatile memory like all other modem parameters that determine the set up state. If FSK is turned **ON**, the modem M&C will set up FSK in the **ON** state if modem power is cycled **OFF/ON**. Likewise, if leveling is **ON** and operating, the modem will reestablish the leveling operation using the same target tracking level after a power cycle or after cycling the FSK state **OFF** and then back **ON**.

Appendix H. DST SETUP (CDM-600L)

H.1 Overview

This chapter describes the general setup of the CDM-600L Open Network Satellite Modem in Digital Satellite Terminal (DST) using the front panel keys. Operation of the modem is otherwise the same as specified throughout the remainder of this manual.

H.2 Initial Operation



Careful setup is necessary to prevent damage to electronic components. Replacement of a component(s) may be the result.

DC voltages for BUC or LNB power may be present at the modem transmit and receive IF connectors. Protect spectrum analyzers and other equipment sensitive to DC voltage with a DC block, such as Weinschel Model 7003, to prevent accidental damage.

H.2.1 Prior to Turning On Power

Note: Ensure DST system is installed properly and all connections all secure, with the exception of the L-Band Tx and RX IF connectors, which are initially disconnected.

Observe the following steps:

Step	Procedure	Front Panel Menu Reference
1	Make sure prime power to the Modem is removed.	N/A
2	Verify the IFL L-Band cables are not connected to the modem.	N/A

H.2.2 Initial Power Up – Modem Only

Note: Refer to **Chapter 5. FRONT PANEL OPERATION** for detailed modem configuration information.

Initially, the modem is set up and checked out and **not** connected to the IFL cables.

Set the modem for a known operating configuration. This includes some of the steps that follow:

Step	Procedure	Front Panel Menu Reference
3	Disconnect the L-Band Tx and RX cables from the modem.	N/A
4	Connect prime power to the modem.	N/A
5	Allow modem to complete initialization.	N/A
6	BUC Power = OFF	BUC
7	Modem Transmitter = ON (Transmitter ON (Green LED) at front panel LED is On)	CONFIG: TX → TX-IF
8	LNB Power = OFF	LNB
9	IF Loopback = ON (Test Mode LED turns ON). This forces the receive parameters to match the transmit parameters.	TEST
10	Verify the carrier is locked (Receive Traffic LED is green).	Front Panel LEDs
11	Make sure all faults are resolved before going forward.	Front Panel LEDs and Display Faults/Alarms
12	IF Loopback = Off (Test Mode LED turns Off).	TEST

H.3 LO, Mix, and Spectrum (Inversion) Settings

The CDM-600L Satellite Modem permits configuration of terminal (satellite) frequencies instead of the L-Band frequencies. This is useful because it allows direct entry of the assigned Tx and RX frequencies. Three parameters are adjusted to set up the modem with the BUC/LNB:

- **LO**
(Local Oscillator Frequency)
- **Mix Sign:** “+” or “-”
Determines whether the L-Band carrier is added or subtracted from the LO to translate to the satellite frequency).
- **Mod Spectrum and Demod Spectrum (Inversion)**
(Needed to correct for any inversion caused by the frequency translation).

The LO and MIX are entered into the modem to program the satellite frequency for the terminal. Consult the BUC manufacturer’s specifications for BUC LO specifications.

- MIX = “+” when LO < Satellite Operating Frequency
- MIX = “-” when LO > Satellite Operating Frequency

Whenever MIX = “-” the spectrum of the carrier is inverted. The CDM-600L easily corrects for this with the Invert ON/OFF selection located under the **CONFIG:TX →TX-IF** and **CONFIG:RX: →RX-IF** menus.

Match the Tx inversion to the MIX in the BUC and the Rx inversion to the MIX in the LNB using the following:

- Spectrum = Normal when MIX = “+”
- Spectrum = Invert when MIX = “-”

As a general rule it is best to radiate the spectrum toward the satellite in the Normal spectral sense. Then transmission links with any other corresponding sites are always consistent at the satellite interface.

When doing RF loopback testing over the satellite or end-to-end the settings are correct with this setup. If there is a single inversion in the modem, however, for operation over the satellite, it will be necessary to temporarily match the spectral inversion of modulator and demodulator when performing IF loopback testing.

Note: The modem will only allow configuration of terminal frequencies that are within its valid L-Band frequency limits.

H.4 Applying Power To The BUC



1. ***Care should be exercised in cable installation. Install the cables using the most direct route and secure with clamps and ties. Avoid all sharp bends. Replacement of the cables can be the result.***
2. ***If the ODU voltage is not correct, DO NOT connect the Tx-IF Cable to the modem or damage may result. Contact Comtech EF Data Customer Service department.***
3. ***Ensure Tx and RX L-Band cables are not connected. After the modem is checked out, then configure to operate with the ODU.***
4. ***Initially, set LNB and BUC current wide enough to avoid false reports during installation. Readjust the limit at a later time.***
5. ***For FSK operation with an FSK capable BUC see Chapter 5. FRONT PANEL OPERATION and Appendix H. CDM-600L BUC FSK COMMUNICATIONS.***
Complete Steps 13 through 29 prior to continuing.

The conditions for the BUC to function are as follows:

- Proper Tx L-Band power to the BUC from modem.
- Sufficient and correct DC power at the BUC.
- 10 MHz reference supplied to the BUC.

Note: To ensure proper performance, Comtech EF Data recommends a 5-minute warm-up period at initial turn-on for the BUC. This can be accomplished by performing Steps 15 through 18, prior to initiating the power start-up.

H.5 Tx Side Setup

Step	Procedure	Front Panel Menu Reference
13	Disconnect BUC.	N/A
14	Determine the voltage required by the BUC and record for reference	N/A
15	Turn the BUC Power = ON and Verify the BUC Voltage is correct. The voltage sent to the BUC is verified two ways per the next step.	BUC
16	The BUC voltage is reported under the Monitor Menu. Alternatively, the BUC voltage can be measured at the center conductor of the transmit IF connector. Use care to assure that the volt meter probe does not short to the connector outer conductor. To avoid damage to the BUC, confirm voltage matches the BUC voltage requirement. (Typical Voltage is +24 or +48 VDC \pm 5%)	MONITOR
17	To protect the equipment, select the BUC Power = OFF. This is necessary before connecting the L-Band coaxial cables to the unit	BUC
18	Set the TX Terminal LO (MHz) and MIX (+ or -). The LO frequency is the BUC local oscillator frequency; Mix = "-" if the BUC LO > Satellite Frequency Mix = "+" if the BUC LO < Satellite Frequency	BUC: MORE Consult BUC manufacturer's LO specifications.
19	Set Tx Spectrum Invert ON if MIX is "-".	CONFIG:TX \rightarrowTX-IF
20	Program the satellite frequency under the TX Terminal Frequency menu	CONFIG:TX \rightarrowTX-IF
21	Set the TX Power Level to a safe (low) value	CONFIG:TX \rightarrowTX-IF
22	Turn TX carrier to Off.	CONFIG:TX \rightarrowTX-IF
23	Connect BUC.	N/A
24	Turn BUC 10 MHz reference to ON.	BUC
25	Turn BUC power supply ON.	BUC
26	To automate warm up and delay carrier turn ON for a programmed delay after prime power is applied see the BUC carrier output delay menu.	BUC: MORE
27	Record the nominal BUC current after the unit is warmed up and functioning normally.	MONITOR: BUC
28	Set the High alarm about 20% higher than nominal	BUC
29	Set the Low alarm about 20% to 40% lower than nominal.	BUC



At this point, the unit will start transmitting when the TX-IF output is tuned On (under CONFIG: TX \rightarrow TX-IF menu).

H.6 Initial Operation of the Modem with the BUC and LNB

The conditions for the LNB to function are as follows:

- Sufficient and correct DC power at the LNB.
- 10 MHz reference supplied to the LNB for EXT REF units.

H.6.1 RX Side Setup

Step	Procedure	Front Panel Menu Reference
30	Disconnect LNB.	N/A
31	Set the RX Terminal LO (MHz) and MIX (+ or -). The LO frequency is the BUC local oscillator frequency; Mix = "-" if the LNB LO > Satellite Frequency Mix = "+" if the LNB LO < Satellite Frequency	LNB: MORE Consult LNB manufacturer's specifications for LO
32	Set Demod Spectrum Invert ON if LNB mix is "-".	CONFIG: RX → RX-IF
33	Program the satellite frequency under the Rx Terminal Frequency menu	CONFIG: RX → RX-IF
34	Select 10 MHz Ref = ON (if LNB is external reference unit)	LNB
35	Program LNB Voltage to the correct value (13, 18, or 24 VDC)	LNB
36	LNB Voltage OFF.	LNB
37	Connect LNB.	N/A
38	Program LNB Power = ON	LNB
39	Record the nominal LNB current after the units are warmed up and functioning normally.	MONITOR: LNB
40	Set the High alarm about 20% higher than nominal.	LNB
41	Set the Low alarm about 20% to 40% lower than nominal.	LNB

Appendix J. KT/11202-1 STEP ATTENUATOR KIT (CDM-600L)

J.1 Introduction

The External 20 dB Step Attenuator Kit, CEFD P/N KT/11202-1, provides the CDM-600L modem with the capability of extending the programmable output power range down to -60 dBm (-65 dBm uncalibrated) from the standard -40 dBm (-45 dBm uncalibrated).

The following sections identify installation instructions, relevant front panel operations and remote control commands for the KT/11202-1 External 20 dB Step Attenuator Kit for the CDM-600L Open Network Satellite Modem.

J.2 Kit Installation

When the kit is installed, the CDM-600L (Firmware Ver 1.2.2 or higher) provides two set-up modes for programming output power:

- The normal manual power mode allows the standard 0 dBm to -40 dBm (-45 dBm uncalibrated) output power programming. In this mode, the external step attenuator is set to minimum attenuation.
- The additional low power mode allows the output power programming from -20 dBm to -60 dBm (-65 dBm uncalibrated). In this mode, the external 20 dB attenuator is switched in.

The external 20dB step attenuator on/off control is achieved by multiplexing a 5 VDC relay activation signal onto the center conductor of the transmit output connector. The External Attenuator design will not tolerate BUC power supply voltages, and will not pass 10MHz BUC frequency reference or BUC FSK control signals. Hence, the External Attenuator kit is NOT applicable in applications where the modem must supply BUC power supply, 10MHz frequency reference, or FSK control.

The components included in the KT/11202-1 External 20 dB Step Attenuator Kit are shown in **Figure J-1**.

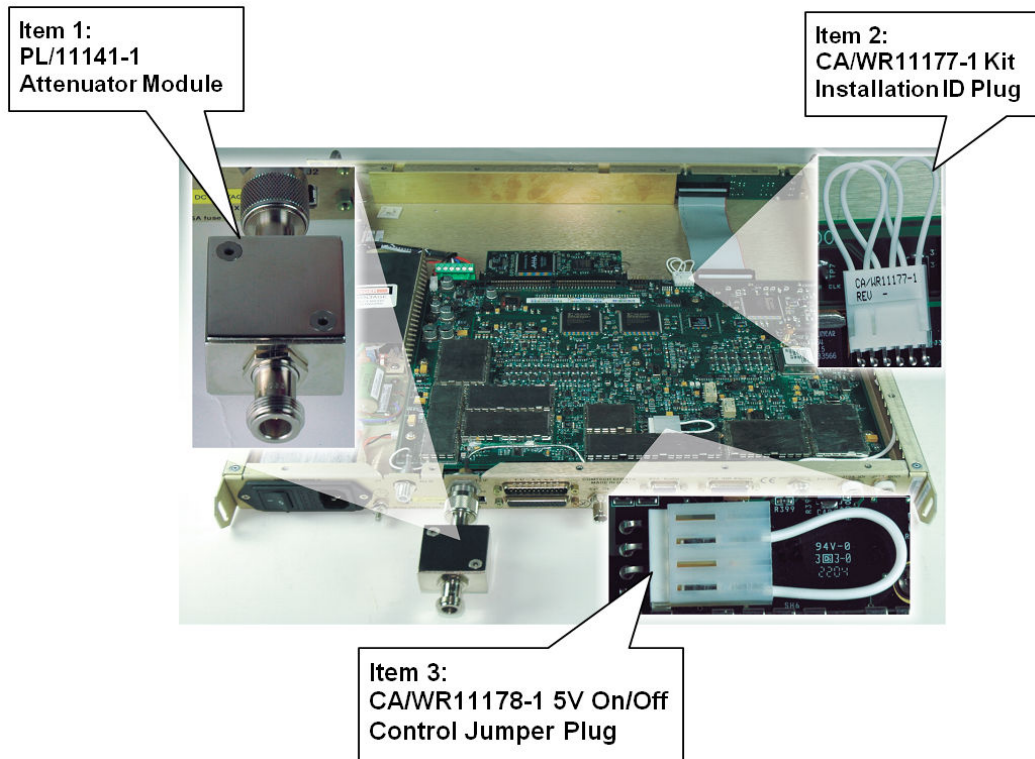


Figure J-1. KT/11202-1 External 20 dB Step Attenuator Kit

Installation of the kit jumper plugs (Items 2 and 3) require removal of the modem chassis cover. Once the cover has been removed:

- Item 2, the CA/WR11177-1 Kit Installation ID Plug, creates an identification signal that indicates to the modem firmware that the External Attenuator kit is installed. To install, mate the plug with the 6-pin J3 connector on the modem top board PL/9662-x.
- Item 3, the CA/WR11178-1 5V On/Off Control Jumper plug, loops a 5V control signal to the output connector center conductor via the path normally used for BUC power supply output. To install, mate the plug with the 4-pin J7 connector on the modem top board PL/9662-x.

Once the jumper plugs have been installed as shown in **Figure J-1**, complete the kit component installation:

- Re-install the modem chassis cover.
- Installing Item 1, the PL/11141-1 Attenuator Module, on the modem rear panel. The module has a Type 'N' male connector on one end, and a Type 'N' female connector on the other. The male connector mates with the transmit IF output connector J2 on the modem rear panel, leaving the female connector for transmit cable connection.

J.3 Front Panel Operation

For complete information on modem operations via the CDM-600L front panel, refer to **Chapter 5. FRONT PANEL OPERATION.**

Features associated with enhanced operation via the External 20 dB Step Attenuator Kit are shown **IN BOLD**. From the CDM-600L front panel:

CONFIG: TX → POWER

Without the External 20 dB Step Attenuator Kit installed, the **CONFIG: TX → POWER** menu may appear as follows:

```
OUTPUT POWER: MODE= MANUAL (MANUAL, AUPC)
OUTPUT POWER LEVEL= -15.0 dBm
```

When the programmable External Attenuator is detected, the appearance of the menu display updates accordingly:

```
TX PWR MODE= MANUAL-LOW (MAN, AUPC (LOW) )
OUTPUT POWER LEVEL= -35.0 dBm
```

Use the [←][→] arrow keys to select the **TX PWR MODE** parameter (on the top line of the display), then use the [↑][↓] arrow keys to select the Tx Power Mode. Selections may include:

Tx Power Mode	Description
MANUAL	This is the normal power mode, with a calibrated Tx power level range of -40 to 0dBm. Level values of -45 to 0 dBm are permitted; values noted with * indicate when a level exceeds the specification. The External Attenuator will be switched off, if present.
MANUAL-LOW	This is a manual power mode with the programmable External Attenuator activated. The calibrated Tx power level range is -60 to -20 dBm. Level values of -65 to -60 dBm are permitted; values noted with * indicate when a level exceeds the specification.
AUPC	Available only if EDMAC or D&I++ is enabled. The External Attenuator will be switched off, if present.
AUPC-LOW	This is the AUPC mode, available only if EDMAC or D&I++ is enabled, with the External Attenuator activated.

CONFIG: TX → POWER → MODE → MANUAL

CONFIG: TX → POWER → MODE → MANUAL-LOW

For either of the **Manual** modes selected, select each digit of the **LEVEL** (Tx Power Level) parameter (on the bottom line of the display) using the [←][→] arrow keys, then edit the value of the digit using the [↑][↓] arrow keys.

Press [ENT] when done.

CONFIG: TX → POWER → MODE → AUPC

CONFIG: TX → POWER → MODE → AUPC-LOW

For either of the AUPC modes selected, the lower line of the menu changes as follows:

```
TX POWER MODE=AUPC      (MAN, AUPC (LOW) )  
TARGET-EbNo/RANGE      ALARM/ACTION
```

Select either **TARGET-EbNo/RANGE** or **ALARM ACTION** using the [←][→] arrow keys then press [ENT].

CONFIG: TX → POWER → MODE → AUPC → TARGET-EbNo/RANGE

CONFIG: TX → POWER → MODE → AUPC-LOW → TARGET-EbNo/RANGE

```
MINIMUM EbNo OF REMOTE MODEM = 5.0dB  
MAXIMUM PERMITTED POWER INCREASE =14.9dB
```

Edit the target Eb/No of the remote modem. The default value is 3.0 dB, and upper limit is 14.9 dB. Then, edit the maximum permitted increase in power level when in AUPC mode. The default value is 1dB, and upper limit is 14.9 dB. Press [ENT] when done.

CONFIG: TX → POWER → MODE → AUPC/AUPC-LOW → ALARM/ACTION

```
MAX TX PWR ACTION = NONE  (NONE, TX-ALM)  
REM DEMOD UNLOCK ACT = NOM-PWR (NOM, MAX)
```

Use the [←][→] arrow keys to select the **MAX TX PWR ACTION** parameter (on the top line of the display), then use the [↑][↓] arrow keys to select **NONE** or **Tx ALARM** to determine the action that will occur if the AUPC causes the maximum output power level to be reached.

Next, use the [←][→] arrow keys to select the **REM DEMOD UNLOCK ACT** parameter (on the bottom line of the display), then use the [↑][↓] arrow keys to select **NOM-PWR** or **MAX-PWR** to determine the action that will occur if the remote demod is unlocked:

- When **NOM-PWR** (Nominal Power) is selected, the output level will revert to the nominal power level set under **MANUAL**
- When **MAX-PWR** (Maximum Power) is selected, the output level will change to the maximum power level permitted under **MANUAL**.

Press [ENT] when done.

J.4 Remote Control Operation

For complete information on remote control operations for the CDM-600L, refer to **Appendix D. REMOTE CONTROL**

The following CDM-600L commands/queries are enhanced when the programmable External Attenuator is detected (features associated with enhanced operation via the External 20 dB Step Attenuator Kit are shown in **bold**):

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
AUPC Enable or Power mode selector	AUP=	1 byte, value 0, 1, 2 or 3	Command or Query. AUPC mode enable/disable and/or (with CDM-600L External Attenuator) power mode selection, where x is: 0=MANUAL – Normal power mode (-45 to 0dBm) 1=AUPC (requires EDMAC or D&I++ framing) 2=MANUAL-LOW – Low power mode (-65 to -20dBm) – <i>When 20dB External Attenuator is activated</i> 3=AUPC-LOW – <i>When AUPC is enabled and 20dB External Attenuator is activated</i> Example: AUP=1 (AUPC enabled)	AUP= AUP? AUP* AUP#	AUP?	AUP=x (see description of arguments)
Tx Power Level	TPL=	4 bytes	Command or Query. NOTE: COMMAND NOT VALID IN AUPC MODE. Tx Output power level between 0 and -45 dBm in the form xx.x (minus sign assumed). [<i>Beyond -40 dBm exceeds the specification</i>]. Example: TPL=13.4 Note: When Output Power Leveling is enabled, power level configuration is not allowed, and this command is rejected. Response will be TPL*. The response to the query TPL? will be the adjusted leveled value. WHEN EXTERNAL 20dB ATTENUATOR IS PRESENT ON CDM-600L: The power level indicated is the final power after the attenuator, if the External 20dB Attenuator is present. IN MANUAL (Normal) POWER MODE (AUP=0): Tx Output power level may be configured between -45 and 0 dBm. [<i>Between -45 and -40 dBm exceeds the specification.</i>] IN MANUAL-LOW (Low Power) MODE (AUP=2): Tx Output power level may be configured between -65 and -20 dBm in the form xx.x (minus sign assumed). [<i>Between -65 and -60 dBm exceeds the specification. The power levels exceeding the specification are indicated on the front panel menu by a *.</i>]	TPL= TPL? TPL* TPL#	TPL?	TPL=xx.x (see description of arguments)

Parameter Type	Command (Instruction Code and Qualifier)	Arguments for Command or Response to Query	Description of Arguments	Response to Command	Query (Instruction Code and Qualifier)	Response to Query
Equipment ID	N/A	10 bytes	<p>Query only. Unit returns the equipment identification and installed options information, in the form abbbcdefgh, where:</p> <p>a=Turbo codec 0=None, 1=Lo-Rate Turbo, 2=Hi-Rate Turbo.</p> <p>bbb=defines the modem model number: 600 is the CDM-600 601 is the CDM-600L (this case) 602 is the CLM-9600L</p> <p>c=Data Rate Option: 0=Base (to 5 Mbps), 1=to 10 Mbps, 2=to 20 Mbps.</p> <p>d=Higher-order modulation option: 0=None, 1=8-PSK, 2=16-QAM, 3=8-PSK and 16-QAM.</p> <p>e=Framing option: 0=None, 1=IBS, 2=IDR, 3=IBS and IDR, 4=IBS with high-rate ESC, 5=IBS with high-rate ESC and IDR.</p> <p>f=Drop and Insert/Audio mode 0=None, 1=D&I, 2=Audio, 3=D&I and Audio. (Note: D&I FAST option provides access to both Open Network D&I and Closed Network D&I++)</p> <p>g=Special Options: 0=None, 1=Opt1, 2=Opt2, 3=Opt 1 and 2.</p> <p>h=External 20dB Attenuator: 0=None 1=Attenuator attached</p> <p><i>Example:</i> EID=2601213301 indicates CDM-600L, Turbo 2 codec installed, 8-PSK/IDR/IBS, D&I, Audio, data rate to 20 Mbps, External Attenuator installed.</p>	N/A	EID?	<p>EID=abbbcdefgh (see description of arguments)</p> <p>601 indicates the CDM-600L</p>

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

Temperature	° Fahrenheit	° Centigrade
Water freezes	32	0
Water boils	212	100
Absolute 0	-459.69	-273.16

Formulas
$^{\circ}\text{C} = (\text{F} - 32) * 0.555$
$^{\circ}\text{F} = (\text{C} * 1.8) + 32$

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoirdupois	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoird.	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. avoird.	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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