

ADC

TELECOMMUNICATIONS

TECHNICAL MANUAL

EXHIBIT III

(PRELIMINARY)

CM720M

**QAM
DIGITAL CABLE
MODULATOR**

REV: 0

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CM720M

QAM Digital Cable Modulator

Installation and Operation Manual

COMSTREAM
A Spar Company

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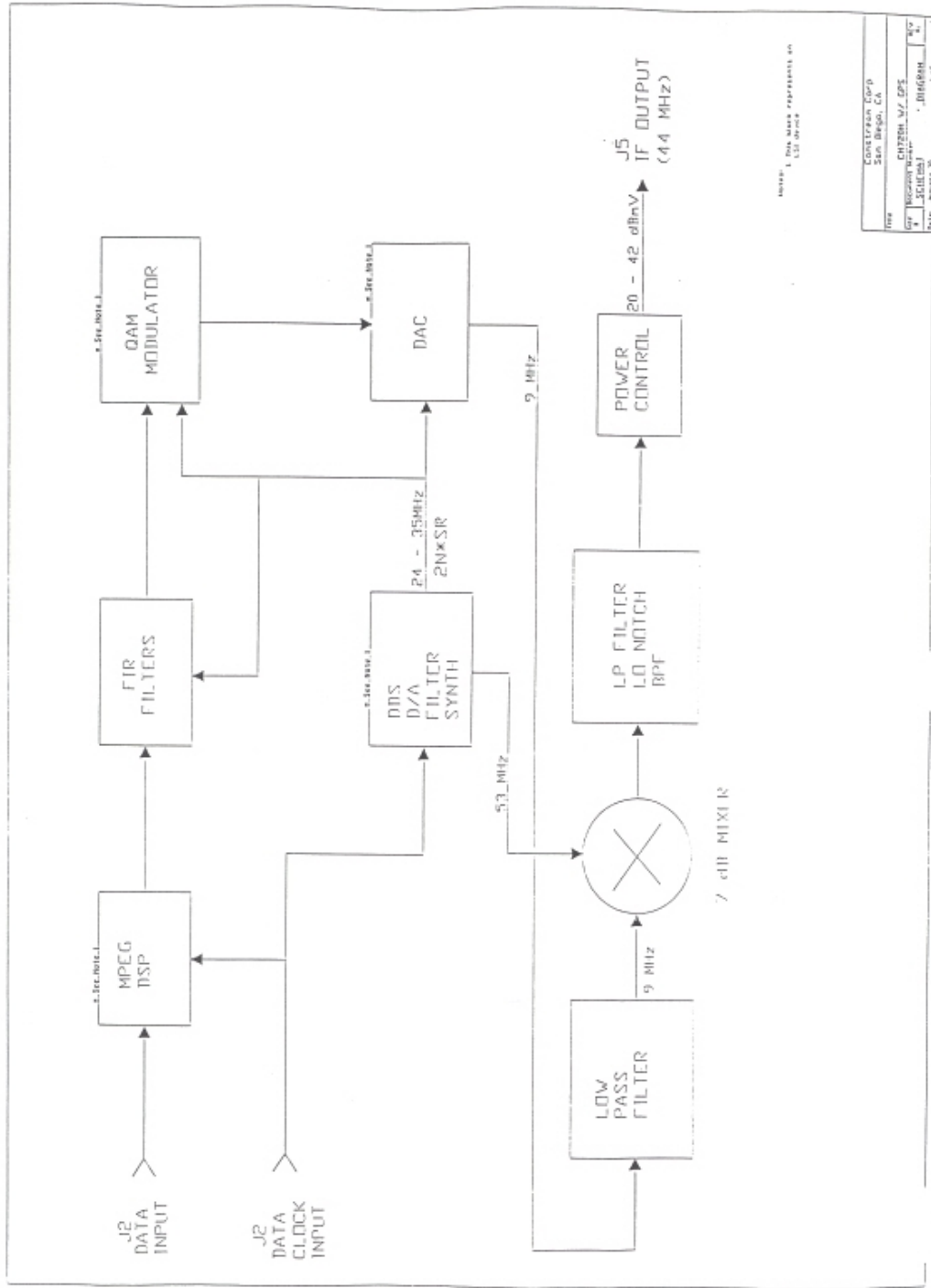
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and radiates radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

WARNING

Shock Hazard!

Do Not Open The CM720M Equipment!
Service Only By ComStream!

The CM720M contains no user-serviceable parts. Do not attempt to service this product yourself.
Any attempt to do so will negate any and all warranties.



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Table of Contents

Introduction

Using this Guide	vii
Warranty Statement	viii
Return Procedure	ix
Revision History	x
Customer Support	x

Chapter 1: Features, Functional Description, and Theory of Operation

Overview	1-1
CM720M Components	1-1
CM720M Features	1-2
Functional Description/Theory of Operation	1-3
Digital Data Input Card	1-3
Modulator Card	1-3

Chapter 2: Installation and Startup

Overview	2-1
Planning the Site	2-1
Installing the CM720M	2-1
Starting Up the System	2-5
Validating Installation	2-5
Startup Problems	2-6

Chapter 3: Front Panel Operation

Overview	3-1
Keypad Definitions	3-1
Operation	3-2
Main Menu	3-2
System Commands	3-3

Modulator Commands.....	3-4
Fault Commands.....	3-5
Chapter 4: Remote Monitor and Control Operation	
Overview.....	4-1
Parameter Query.....	4-1
Valid Commands.....	4-1
Invalid Command Error Responses.....	4-2
System Commands.....	4-2
Descriptions.....	4-3
Modulator Commands.....	4-4
Summary.....	4-4
Descriptions.....	4-5
Fault Commands.....	4-6
Summary.....	4-6
Descriptions.....	4-6
RS-485 Interface and Packet Protocol.....	4-7
RS-485 Line Settings.....	4-7
Packet Protocol.....	4-8
Packet Format and Content.....	4-8
Chapter 5: Maintenance, Operation Faults, and Troubleshooting	
Overview.....	5-1
Maintenance.....	5-1
Operational Fault Messages.....	5-2
Troubleshooting.....	5-3
Before Troubleshooting.....	5-3
Symptoms and Actions.....	5-3

Chapter 6: Technical Specifications and Port Information

IF Modulator.....	6-1
Mechanical	6-2
Power	6-2
Environmental.....	6-3
Rear Panel Ports	6-3
M&C Port	6-3
Digital Data Input Port.....	6-4

Appendix A: Interface Pinouts

Digital Data Input Port	A-1
M&C Port	A-1
M&C Port Adapter Cable (DB-9-to-DB-25)	A-2

List of Figures

Figure 1-1. MPEG-2 Transport MUX Packet	1-3
Figure 1-2. Randomized Transport Packets	1-4
Figure 1-3. Encoded Packet.....	1-5
Figure 1-4. Interleaved Packets	1-5
Figure 1-5. Byte-to-6-tuple Conversion	1-6
Figure 1-6. 64-QAM Constellation Diagram	1-7
Figure 1-7. CM720M Front Panel Indicators	1-8
Figure 2-1. CM720M Rear Panel Connectors.....	2-2
Figure 4-1. Packet Protocol Format.....	4-8

List of Tables

Table 1. Revision History.....	x
Table 2-1. Common Startup Problems	2-6
Table 3-1. System Command Parameters.....	3-3
Table 3-2. Modulator Command Parameters	3-4
Table 3-3. Fault Command Parameters	3-5
Table 4-1. Command Error Messages	4-2
Table 4-2. System Command Summary	4-2
Table 4-3. System Commands and Descriptions.....	4-3
Table 4-4. Modulator Commands Summary	4-4
Table 4-5. Modulator Commands and Descriptions.....	4-5
Table 4-6. Fault Command Summary	4-6
Table 4-7. Fault Commands Descriptions	4-6
Table 4-8. Fault Bit Maps	4-7
Table 4-9. Device Address Bit Map	4-9
Table 4-10. Control Byte Bit Map	4-9
Table 5-1. Faults and Conditions.....	5-2
Table 5-2. Troubleshooting Symptoms and Actions	5-3
Table A-1. Shielded RJ-45 Jack	A-1
Table A-2. DB-9 Female, RS-232 Mode	A-1
Table A-3. DB-9 Female, RS-485 Mode	A-2
Table A-4. M&C Port Adapter Cable.....	A-2

Introduction

Using this Guide

Welcome to the ComStream world of communication systems and networks. This guide is your sourcebook for using ComStream's CM720M QAM Digital Cable Modulator. It describes the installation, operation, and performance specifications of this product.

The chapters in this guide provide step-by-step instructions for a variety of tasks and activities including operation of the CM720M. The chapters also provide technical specifications and troubleshooting procedures.

Conventions Used in this Guide

This guide is designed to help you find and use information quickly and easily. To take full advantage of this design, please take a moment to review the specific formats.

Locating Information

There are several tools located in this guide to help you quickly locate information. The table of contents, located at the beginning, provides you with an outline of the chapters and major topics contained within them.

Special Paragraphs

Throughout this guide you will find two special paragraphs designed to help you identify important information. These paragraphs are:

NOTE: This identifies information for the proper operation of your equipment, including helpful hints, shortcuts, or important reminders.

CAUTION: This identifies information that requires careful attention in order to prevent equipment damage and/or injury to the operator.

Warranty Statement

ComStream warrants that its products are free from defects in material and workmanship at the time of shipment and that they conform to applicable specifications. In no event will ComStream be liable for consequential misuse or damages.

The ComStream CM720M QAM Digital Cable Modulator is warranted against any above-mentioned defects that appear within one year of shipping date.

Should it be necessary to make a claim against this warranty, the buyer shall first notify ComStream's Customer Service Department to define the nature of the problem. When returning products, please be aware of the following:

1. Products returned to ComStream, whether for upgrade, warranted or out-of-warranty repair work, or maintenance, must comply with the ComStream Return Procedure (located on the next page).
2. Products shall be forwarded to ComStream, transportation prepaid.
3. Products returned to ComStream freight collect or without a return material authorization (RMA) number will NOT be accepted.
4. ComStream shall not accept any responsibility for returned products that are improperly packaged and/or damaged in shipment. If possible, please use original shipping and packaging materials.
5. Original product identification markings and labels must not be removed, defaced, or altered. Further, to preserve the warranty, the product should not be subjected to abuse, improper installation or application, alteration, accident, or negligence in use, storage, transportation, or handling.
6. Any returned product shall be completely evaluated in an attempt to duplicate the problem so that appropriate corrective action and repair may be completed. Following repair, the product shall be thoroughly tested for compliance with appropriate specifications. This process will be handled in an expedient and prompt manner but may be subject to available labor and material resources.

The ComStream warranty, as stated herein, is in lieu of all other warranties, expressed, implied, or statutory.

For further information, please contact
ComStream Customer Service at
619-657-5454.

Return Procedure

If it is necessary to return a product for out-of-warranty repair, upgrade, or any modification, the following procedures must be followed:

1. Contact ComStream Customer Service, located in the United States, via phone or fax:
 - Phone 619-657-5454
 - Fax 619-657-5455
2. Speak to a ComStream customer service representative about any questions, issues, or problems. Quite often equipment problems can be corrected over the phone, which keeps your equipment in service and avoids unnecessary and costly downtime.
3. Should it be necessary to return a product to ComStream for any reason, the ComStream customer service representative will issue you a return material authorization (RMA) number. To issue an RMA number, the ComStream representative will need the product's serial number, model number, and a description of the problem.
4. You may be returning a product for either repair, upgrade, or modification. If you are returning the product for:
 - Repair, please include a complete description of the problem, the operating conditions which caused the problem, and any circumstances which may have led to the problem. This information is essential for ComStream repair technicians to reproduce, diagnose, and correct the problem.
 - Upgrade or modification, please include a complete description of the current configuration and the desired change(s). This information will allow a ComStream customer service representative to provide a formal quote for the upgrade.
5. Include a purchase order for any upgrade or out-of-warranty repair work being performed. ComStream will begin repair work after a PO is received.
6. Reference the RMA number on all paperwork that accompanies the equipment, and write the RMA number clearly on the outside of the shipping container.
7. Ship your module in the original shipping carton and packaging (or its equivalent), prepaid, to the following address.

ComStream, A Spar Company
10180 Barnes Canyon Road
San Diego, CA 92121 USA

RMA Unit number

Do not include product accessories such as Installation and Operation guides or rack-mount brackets.

CAUTION: When handling or shipping static-sensitive equipment, observe antistatic procedures and always use antistatic bags for shipment. Upon request, ComStream will provide you with ESD bags for your use.

All equipment upgrade and repair requests will be completely evaluated and the required work performed in an expedient and prompt manner. The equipment will then be thoroughly tested for compliance with appropriate specifications.

Revision History

This guide is periodically updated and revised. The following table lists the revision number and date and provides a description of the type of revision made to the guide.

To determine if you have the most current documentation, you can compare the revision information at the bottom of each page to those listed in the Revision History table below. For documentation updates, call ComStream Customer Service (located in the United States) at 619-657-5454 or fax your request to 619-657-5455.

NOTE: Revision A is always the first release to ComStream customers.

Table 1. Revision History

Revision	Date	Pages Affected
Rev. A	12/94	Initial release

Customer Support

We hope this guide provides all of the information and instructions you need to operate the CM720M Digital Cable Modulator.

However, in the event that you need further assistance, or if problems are encountered, ComStream has set up a Customer Support Line for your use. Please feel free to contact ComStream Customer Support, located in the United States, by phone or fax at the following numbers:

- Phone 619-657-5454
- Fax 619-657-5455

Customer service hours are Monday through Friday 8:00 a.m. to 5:00 p.m. Pacific time.



Chapter 1: Features, Functional Description, and Theory of Operation

Overview

The CM720M QAM Digital Cable Modulator accepts a digital signal consisting of multiplexed MPEG-2 transport streams and provides an intermediate frequency (IF) signal output.

The IF signal output is upconverted to RF using a standard cable upconverter. The RF signal is delivered to the RF combiner to be combined with other digital and analog signals. The combined RF signal is then delivered to digital video home terminals, analog set-top boxes, and cable-ready TVs via coax cable, fiber optics, and/or microwave links.

CM720M Components

The CM720M system consists of the following:

- Digital data input card
- IF output QAM modulator card
- Front panel display and control
- Power supply
- Chassis

CM720M Features

The CM720M has the following features:

- Complies with DVB recommendations
- Accepts MPEG-2 Transport layer digital input
- Uses a synchronous scrambler to randomize the data stream for spectral shaping purposes
- Applies a shortened Reed-Solomon code (188,204) and a length 17 interleaver for error correction
- Converts data bytes into (16/64) QAM symbols
- Applies differential encoding to get a rotational invariant constellation
- Performs a square-root raised cosine filter
- Provides an Intermediate Frequency (IF) output with a programmable power level
- Is equipped with a user interface on the front panel
- Has a nonvolatile memory so that configuration and operating parameters are not lost in the event of a power outage.
- Is equipped with a low speed (300 to 19,200 baud), RS-232/RS-485 remote control port
- Continuously monitors the input data, the output signal, and internal signals for fault conditions
- Is controlled by an Intel 80188EB micro controller
- Is cooled with convection fans to allow maximum units per rack
- Uses an efficient universal voltage switching power supply
- Is rack-mountable (1RU)

Functional Description/Theory of Operation

Digital Data Input Card

The digital data input rate is 18.6667 or 28.0000 Mbps for 16 QAM or 64 QAM, respectively. The data is transmitted/received using an IC chip set known as TAXI® (Transparent Asynchronous Transmitter/Receiver Interface). TAXI is a registered trademark of Advanced Micro Devices (AMD).

The TAXI receiver reference clock is 5 MHz. The transmission rate on the channel is 60 MHz. The TAXI receiver operates in 10-bits-per-byte mode (8 data bits, 1 even parity bit, 1 active low-frame sync bit).

The physical connector is a shielded RJ-45 jack. For proper operation, shielded cable must be used.

The received data/clock is transmitted to the modulator.

Modulator Card

Input Data Integrity

The $16/64$ Quadrature Amplitude Modulator (QAM) digital modulator accepts bytes of data (and the associated clock) from the I/O card and produces an IF signal output.

The incoming data/clock is continuously monitored for:

- Clock out of spec (more/less than 100 ppm out of spec)
- Loss of clock
- Parity errors
- Frame sync errors
- Sync acquisition errors
- TAXI decoding violations

It is assumed that the incoming data is formatted according to MPEG-2, as shown in Figure 1-1.

Sync 1 byte	187 Bytes
----------------	-----------

Figure 1-1. MPEG-2 Transport MUX Packet

A frame sync error occurs if the incoming data is not a sync pattern when the frame sync bit is active. A sync acquisition error is reported if the sync byte is wrong in four successive frames. Sync is reacquired if the correct sync pattern is present in four successive frames. A TAXI decoding violation indicates that data was corrupted in the TAXI channel.

Normally the system is frequency-locked to the input clock. If it is determined that there is no input clock, a fault will be logged and the system switches over to internal timing to preserve the output spectrum. (Scrambling is forced on.) When the input clock returns, the system will return to normal operation.

Scrambling

To ensure adequate binary transitions for clock recovery, the data is randomized. The polynomial for the pseudo random binary sequence (PRBS) is:

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

Loading of the sequence "100101010000000" into the PRBS shift registers is done at the start of every eight transport packets. To provide an initialization signal for the descrambler, the sync byte of the first transport packet in a group of eight is inverted to B8h. During the transmission of the sync bytes, the PRBS generation continues, but the sync bytes themselves are not randomized. The transport packet is illustrated in Figure 1-2.

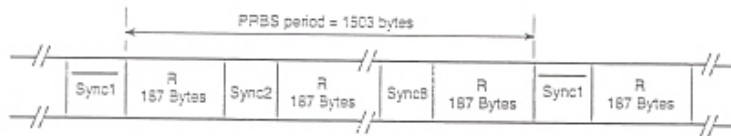


Figure 1-2. Randomized Transport Packets

Encoding

Systematic, shortened Reed-Solomon encoding is then performed, as shown in Figure 1-3, on each randomized packet, with $T=8$. This adds 16 parity bytes to each packet and allows for the correction of eight erroneous bytes per packet. The generator polynomial is:

$$x^8 + x^4 + x^3 + x^2 + 1$$

The code is shortened from (255,239) to (204,188) by the insertion of 51 bytes, all set to zero. After encoding these bytes are discarded.

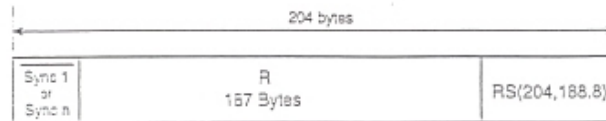


Figure 1-3. Encoded Packet

Interleaving

Following encoding, convolutional interleaving with depth=17 is applied to the packets, as shown in Figure 1-4. The interleaving is based on the Forney approach, which is compatible with a Ramsey type III.

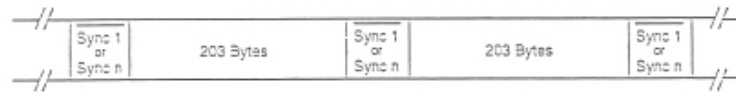
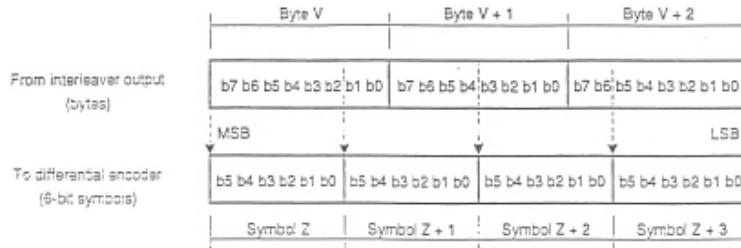


Figure 1-4. Interleaved Packets

Data-to-Symbol Conversion

The 8-bit bytes of data are then converted to m-bit symbols as shown in Figure 1-5. The MS bit of the first symbol is taken from the MS bit of the first byte of data in a packet (the sync byte).



Note 1: b0 shall be understood as being the Least Significant Bit (LSB) of each byte of m-tuple.

Note 2: In this conversion, each byte results in more than one m-tuple, labeled Z, Z + 1, etc., with Z being transmitted before Z + 1.

Figure 1-5. Byte-to-6-tuple Conversion

Differential Encoding

The two MS bits of each symbol are differentially encoded in order to obtain a rotational invariant constellation. The differential encoding is given by the following expression:

$$I_k = (\overline{A_k \oplus B_k}) \cdot (A_k \oplus I_{k-1}) + (A_k \oplus B_k) \cdot (A_k \oplus Q_{k-1})$$

$$Q_k = (\overline{A_k \oplus B_k}) \cdot (B_k \oplus Q_{k-1}) + (A_k \oplus B_k) \cdot (B_k \oplus I_{k-1})$$

Symbol Mapping

The constellation diagram for 64-QAM is given in Figure 1-6.

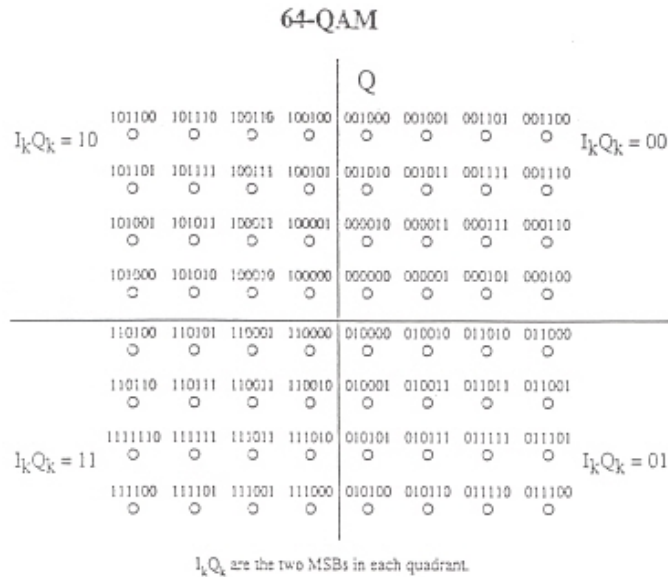


Figure 1-6. 64-QAM Constellation Diagram

Transmit Filter

Prior to modulation, the I and Q signals are filtered. The transmit filter is nominally described by the square-root raised cosine function, with $\alpha=18\%$. After filtering the spectrum is upconverted to IF.

Power Control

Output power range is 20.0 to 42.0 dBmV. Output power level is continuously monitored. The user has the option to disable output power or to output a pure carrier.

Front Panel Display

The front panel of the CM720M, as shown in Figure 1-7, contains the following (left to right):

- IF output test port
- 4 seven-segment LEDs
- 2 LED fault indicators
- 2x24 LCD display
- 6 control keys
- numerical keys
- RF output test port

Refer to *Chapter 3: Front Panel Operation* for a complete description of front panel operation.

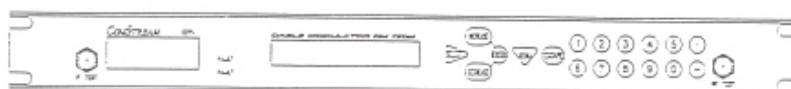


Figure 1-7. CM720M Front Panel Indicators

Power Supply

The power supply AC input operating voltage requirement is 90 to 264 VAC at 47 to 63 Hz. The unit typically consumes 50 watts of power when the symbol rate is 5 Mbps.

Chassis

The CM720M unit mounts in a standard 19 inch equipment rack, occupying one rack unit of height (1.75 inches), using four front panel screws.

NOTE: Rack-mount hardware is not supplied with the unit.

Chapter 2: Installation and Startup

Overview

This chapter describes the steps necessary to install and start up a CM720M.

The overall steps for installing and starting up the CM720M are as follows:

1. Plan the site.
2. Install the CM720M.
3. Connect the CM720M.
4. Start up the system.
5. Validate or verify the installation.

These steps are described in detail below.

Planning the Site

Installation of the cable modulator is relatively simple. Several recommendations to consider are:

- To minimize cable length, locate the modulator physically near the MPEG-2 digital data source.
- To minimize cable loss, locate the modulator physically near the RF upconverter.
- To prolong the operating lifetime of the equipment, keep the ambient temperature as cool as possible, with as much circulating airflow as possible.
- The cable modulator has been designed to be rack-mounted.
- Each cable modulator will typically require 50 watts of power, so plan accordingly.

Installing the CM720M

The CM720M functions over a wide range of power and environmental conditions. An autoranging power supply allows the receiver to use most common utility power feeds. For maximum availability and reliability, connect the receiver to an uninterrupted power supply (UPS) to allow continued operation during power outages.

The small size of the unit make it adaptable to most installations. For detailed environmental specifications, refer to *Chapter 6: Technical Specifications and Port Information*.

The physical location of the CM720M is flexible and largely depends on the location of the equipment it will serve.

The maximum ambient temperature specification for the CM720M is 50° C. This temperature is measured one inch from the side (where airflow is in) within the rack enclosure. This temperature must not exceed 50° C to maintain the product's warranty. Proper rack ventilation and forced airflow techniques should be used to ensure the internal ambient temperature within the rack does not exceed the CM720M specifications.

ComStream strongly recommends that surge suppression be used on the AC input to the CM720M, or any rack that contains a CM720M. There are many surge suppression vendors that can recommend and supply products to meet your voltage and power requirements.

In addition, placement of the CM720M should allow access to its rear panel.

NOTE: The unit should be rack-mounted only in enclosures that will not exceed an ambient temperature of 50° C.

External Connection Description

This section describes the physical and electrical connections to the CM720M. All nontest external connections to the CM720M are made through the rear panel connectors. The CM720M has seven possible connections on the rear panel. The location of these connectors is shown in Figure 2-1.

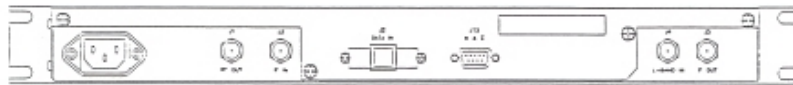


Figure 2-1. CM720M Rear Panel Connectors

NOTE: To ensure compliance with emission standards, all signal cables connected to the receiver should be shielded. The shield must be electrically attached to the mating connector.

Power Connector

Connector Type: IEC 320, Male socket

The CM720M power supply is autoranging from 90 to 264 VAC and 47 to 63 Hz. Maximum power supply output for the CM720M is 75 watts; typical power consumption is less than 65 watts. There is no power on/off switch on the modulator. Remove the AC power cable from the unit to turn the power off.

If an unterminated power cord is supplied with the unit, the appropriate certified termination plug must be installed. The power cord wires are color-coded as follows:

- Green and Yellow: earth/ground
- Blue: neutral
- Brown: live

If the color code described does not correspond to the colored markings identifying the terminals in your plug, proceed as follows:

1. The green and yellow wire must be connected to the terminal in the plug marked by the letter E or by the earth symbol or colored green and yellow.
2. The blue wire must be connected to the terminal marked with the letter N or colored black.
3. The brown wire must be connected to the terminal marked with the letter P or colored red.

RF Out (J1)

Connector Type: F, 75 ohm, Female (RF)

RF Out transmits the RF signal from the optional RF upconverter. This is plugged if no upconverter is installed.

IF In (J3)

Connector Type: F, 75 ohm, Female (RF)

IF In is the IF input to the optional RF upconverter. This is plugged if no upconverter is installed.

Data In (J2)

Connector Type: RJ-45, Female

Data In is the digital data input from MPEG-2 source.

M&C (J15)

Connector Type: DB-9, Female (RS-232/RS-485)

The M&C remote control port is used to connect an RS-232/RS-485 control terminal to the CM720M. Control and diagnostic commands can also be issued/received to/from the unit through this port.

The M&C port is normally configured via the front panel as described in *Chapter 4: Front Panel Operation*.

NOTE: The default port configuration is 9600 baud, 7 data bits, 1 stop bit, and odd parity.

L-band In (J4)

Connector Type: F, 75 ohm, Female (RF)

The L-band In is the L-band input to the optional satellite receiver. This is plugged if the receiver is not installed.

IF Out (J5)

Connector Type: F, 75 ohm, Female (RF)

IF Out is the IF signal from the modulator.

Starting Up the System

This section describes the activities necessary to bring a CM720M unit online. The following steps assume that the CM720M has been properly installed and connected. Do not proceed until this setup is complete.

If problems are encountered in the startup sequence, refer to the "Startup Problems" section and *Chapter 6: Maintenance and Troubleshooting*.

To start up the CM720M:

1. Make sure the CM720M is properly installed in the equipment rack with all cables connected.
2. Turn on the unit by connecting the AC power cable to the unit and observing the front panel LEDs. The front panel lights flash through a consistent sequence when the unit is first powered on. When power-up is complete, the four seven-segment LED's are illuminated, and the Fault LED's are not illuminated.
3. Verify that the power-up message is displayed on the front panel LCD. If necessary, adjust LCD contrast at this time by pressing the increase/decrease buttons.
4. Set the time/date.
5. Set the transmit power to the desired level.
6. Confirm that transmit power is enabled.
7. Use the front panel to verify that the QAM mode is at the desired setting.
8. Use the front panel to verify that the scrambler, Reed-Solomon encoder, interleaver, and differential encoder are all enabled.
9. If desired, enable front panel lockout.

At this point, the CM720M is ready for validation testing.

Validating Installation

Once the CM720M has been powered up, the following steps can be used to verify proper system operation.

1. Use a spectrum analyzer to verify the following:
 - a. A spectrum is available at the rear IF output port
 - b. The spectrum is the proper shape and is centered at 44 MHz
 - c. Output power level equals the desired power level
2. Use a digital video home terminal to verify data transfer.

At this point, the CM720M installation is verified and ready for normal operation.

Startup Problems

Table 2-1 describes common problems encountered during startup. In general, the CM720M has been designed for unattended operation and, therefore, few problems should be encountered.

Table 2-1. Common Startup Problems

Problem	Check
No power-up message on LCD display at power-up	Verify that power is on (LED displays "44.00"; fans turn on)
Does not communicate to remote terminal	1. Use front panel to change to 232 mode if necessary. 2. Use front panel to verify remote settings. 3. Verify that remote cable is connected to M&C port.
No signal is present at the IF output port	1. Verify that output power is enabled. 2. Verify that output power is at proper level. 3. Verify that pure carrier is disabled. 4. Verify that scrambling is enabled.
Does not pass data to demod	1. Verify that scrambling, RS encoding, interleaving, and differential encoding are all enabled on both modulator and demodulator. 2. Verify QAM mode and data rate are the same for modulator and demodulator. 3. Verify that output power level is sufficient (check demod AGC reading). 4. Verify that upconverter and digital receiver are tuned to the same channel. 5. Verify that the modulator is not reporting any data input errors.

For other problems or ideas, refer to *Chapter 5: Maintenance, Operational Faults, and Troubleshooting*.

Chapter 3: Front Panel Operation

Overview

This chapter describes the function and operation of the front panel user interface.

The front panel user interface can be used to:

- Change unit configuration
- Check status/faults
- Issue commands

For a complete description of the commands, refer to *Chapter 4: Remote Monitor and Control Operation*.

Keypad Definitions

Select

Press to select the next submenu or parameter.

Increase/Decrease

Press INCREASE to increment the selected parameter to its next valid value. Press DECREASE to decrement the selected parameter to its next valid value.

Enter

Press to enter the selected submenu or to register a parameter change.

Menu

Press to change to the next available submenu.

Escape

Press at any time to return to the main menu.

0-9/- (minus)/. (period)

In some cases it is quicker to enter a parameter value directly using the numerical keypad instead of incrementing or decrementing.

Operation

Main Menu

After power-up, an initialization message appears. Press any key to enter the main menu. The word System will blink to indicate it is selected.

System-Mod-Faults Menus

To navigate through the menu structure follow these steps:

1. Press ENTER to enter the system submenu structure.
2. To enter the modulator submenu structure, press SELECT to make the word "Mod" blink, then press ENTER.
3. To enter the fault submenu structure, press Select until the word "Faults" blinks, then press ENTER.

Pressing ESCAPE at any time will return you to the main menu.

LCD Contrast Control

When in the main menu, press INCREASE or DECREASE to adjust the front panel LCD display contrast.

No-Activity Mode

After five minutes of no front panel activity, the display will automatically switch to the modulator submenu #1 (output power control/monitor).

System Commands

System submenu 1

- Type
- Protocol
- Addr
- Echo

System submenu 2

- Bits
- Parity
- Baud

System submenu 3

- Lock
- Reset

System submenu 4

- Date
- Time
- Temp

Table 3-1 lists system command parameters and descriptions.

Table 3-1. System Command Parameters

Command	Parameters	Description
Type	RS232, RS-485 ¹	Remote interface type
Protocol	ASCII, PACKET	Remote interface protocol
Addr	1, 2, ..., 32	Address for packet protocol
Echo	ON, OFF	Echo enable for ASCII protocol
Bits	7, 8	Bits per character
Parity	NONE, ODD, EVEN	Parity
Baud	300, 600, 1200, 2400, 4800, 9600, 19200	Baud rate
Lock	OFF, ON	Front panel lockout
Reset	OFF, ON	System Reset
Date	XX.XX.XX	Date
Time	XX.XX	Time
Temp ²	0 to 50	Ambient Temperature

¹ Bold indicates factory default settings.

² Query Only

Modulator Commands

Modulator submenu 1

- PwrEn
- PwrLvl
- PwrMon

Modulator submenu 2

- DataRate
- QAM
- SymRate

Fault Commands

Fault submenu 1

- Current
- History
- Clear

Table 3-3 lists modulator command parameters and descriptions.

Table 3-3. Fault Command Parameters

Command	Parameters	Description
Current ²	Verbose	Current Faults
History ²	Verbose	Fault History
Clear	OFF ¹ , ON	Clear Fault History

¹ Bold indicates factory default settings.

² Query Only

Fault Lights

Current Fault

If the red fault light is lit, there exists at least one current fault. To determine what the fault is, press Select until "Current" is blinking, then press Enter. Press Increase to display the next fault (if any).

NOTE: Whenever the red fault light is lit, the orange fault light will also be lit.

Fault History

If just the orange fault light is lit, there exists at least one logged fault. This means that a fault has occurred since the last fault clear command, but is no longer present. To determine what the fault is, and when it first occurred, press Select until "History" is blinking, then press Enter. Press Increase to display the next fault (if any).

NOTE: The date/time stamp corresponds only to the first occurrence of the logged fault.

Modulator submenu 3

- Scram
- Encod
- Inter
- Diff

Modulator submenu 4

- Pure
- Bert
- DataClock

Modulator submenu 5

- ClrChn
- Filter

Table 3-2 lists modulator command parameters and descriptions.

Table 3-2. Modulator Command Parameters

Command	Parameters	Description
PwrEn	OFF, ON ¹	IF output power enable
PwrLvl	20.0 to 42.0	IF output power setting (dBmV)
PwrMon ²	20.0 to 42.0	IF output power monitor (dBmV)
DataRate ²	18666667, 28000000	Input data rate (bps)
QAM	16, 64	Modulation mode (affects DataRate)
SymRate ²	5063830	Symbol rate (sps, fixed)
Scram	ON, OFF	Scrambler enable
Encod	ON, OFF	Reed-Solomon encoder enable
Inter	ON, OFF	Interleave enable
Diff	ON, OFF	Differential encoder enable
Pure	ON, OFF	Pure carrier enable
Bert	PN, OFF, 1S, 0S	Bert Mode Enable
DataClock ²	0 to 3500000	Measured input data clock
ClrChn	ON, OFF	Clear Channel Enable
Filter	DVB, CUSTOM	Transmit Filter Type

¹ Bold indicates factory default settings.

² Query Only



Chapter 4: Remote Monitor and Control Operation

Overview

This chapter details the remote control operation of the CM720M. Complete monitoring and control of the unit is available to the user via a remote serial interface. The serial interface can be either RS-232 or RS-485 compatible, and can operate in either ASCII or PACKET mode.

This chapter is divided into several sections, each of which describes a group of commands. For each group, a summary of the command syntax is given, followed by detailed command descriptions.

Parameters shown in uppercase should be typed exactly as shown. Parameters shown in lowercase italics are numeric parameters. See the "Descriptions" section for information about numeric parameters.

If a parameter is enclosed in square brackets [], it is optional; if the parameter is also in italics, it is variable. If multiple choices are available for a parameter, they are separated by a vertical bar |.

Parameter Query

If a command has optional parameters, and you issue the command without supplying the parameter, the software displays the current value of the parameter.

Valid Commands

Command actions are performed if the:

- Command is valid
- Parameter value is within the valid range
- Parameter value or command is compatible with the present system configuration



Descriptions

Table 4-3 lists system commands and descriptions.

Table 4-3. System Commands and Descriptions

System Command	Description
DEVCON	This command displays device configuration information, such as software version, serial number, etc.
DISPLAY	This command displays the current setting of the system parameters.
HELP	This command displays a list of all available commands. The list shows the full command name, the command name abbreviation, and the command description. If the user types HELP followed by a command name, the usage information for that command is displayed.
TYPE	This command is used to select between RS-232 and RS-485 electrical characteristics for the serial interface.
PROTOCOL	This command is used to select between ASCII protocol and PACKET protocol.
ADDRESS	This command sets the packet address for PACKET protocol. The packet address must be a whole number between 1 and 31. The packet address has no effect in ASCII protocol.
ECHO	This command enables/disables character echo in ASCII protocol. Echo has no effect in PACKET protocol.
BITS	This command sets the number of bits per character for the serial interface. The choices are 7 or 8.
PARITY	This command sets the parity mode for the serial interface. The choices are odd, even, or none.
BAUDRATE	This command is used to set the baud rate for the serial interface. Valid baud rates are 300, 600, 1200, 2400, 4800, 9600, and 19200.
FPLOCK	This command is used to enable/disable the front panel lockout. When the front panel lockout is enabled, configuration parameters cannot be changed and commands cannot be issued (except to turn off the lockout) from the front panel.
RESET	This command resets the system. It is equivalent to turning the unit power off and on.
DATE	This command is used to display and set the real-time calendar. The date parameter consists of a month, day, and year separated by periods, (3.23.1993). Spaces are not allowed between the numbers and the periods. To display the date, type DATE without any parameters. The factory default is the date of California, USA.
TIME	This command is used to display and set the real-time clock. The time parameter consists of an hour and minute separated by a period. The time is entered in 24-hour format (23.32). To display the time, type TIME without any parameters. The factory default is set to the time of California, USA (Pacific time).
TEMP	This command queries the estimated ambient temperature.
CONTRAST	This command controls the front panel LCD contrast. The level must be a whole number between 0 (lightest) and 63 (darkest). The factory default is 63.

Invalid Command Error Responses

Commands that do not follow these guidelines will return one of the error messages in Table 4-1.

Table 4-1. Command Error Messages

Error	Action
Unrecognized command	Enter the command "HELP" to get a list of valid commands.
Too many/few arguments	Enter the command "HELP XXXX" (where XXXX represents the command) to see how many arguments are expected.
No match for 1 of <i>x</i> parameters	Enter the command "HELP XXXX" to see what are valid parameters for this command.
Parameter out of range	Enter the command "HELP XXXX" to see what the valid parameter range is.

System Commands

Table 4-2 details the system command summary.

Table 4-2. System Command Summary

Mnemonic	Command	Parameters	Description
DC	DEVCON	—	Device Configuration
DP	DISPLAY	[SYSTEM MOD]	Display parameters
HP	HELP	[cmdname]	Display command names
RT	TYPE	[RS232 RS485] ¹	Remote interface type
RP	PROTOCOL	[ASCII PACKET]	Remote interface protocol
RA	ADDRESS	[address]	Remote packet address
RE	ECHO	[ON OFF]	Remote echo enable
BT	BITS	[7 8]	Remote bits per character
PR	PARITY	[NONE ODD EVEN]	Remote parity
RB	BAUDRATE	[rate]	Remote baud rate
FPL	FPLOCK	[ON OFF]	Enable / Disable Lockout
RS	RESET	—	System reset
DT	DATE	[XX.XX.XX]	Display/set current date
TI	TIME	[XX.XX]	Display/set current time
TM	TEMP ²	—	Display temperature
LC	CONTRAST	[level]	LCD contrast control

¹ Bold indicates factory default setting

² Query only

Modulator Commands

Summary

Table 4-4 lists a summary of the modulator commands.

Table 4-4. Modulator Commands Summary

Mnemonic	Command	Parameters	Description
PE	PWREN	[ON OFF] ¹	Output power enable
PL	PWRLVL	[level]	Set output power level
PM	PWRMON ²	—	Displays measured output power level
DR	DATARATE ²	—	Query data rate
Q	QAM	[16 64]	Set QAM mode
SR	SYMRATE ²	—	Displays symbol rate
EY	BYPASS	[SCRAM ENCODE INTRLV DIFF]	Enable / disable features
PR	PURE	[ON OFF]	Pure carrier output enable
BER	BERT	[PN ONE ZERO OFF]	BERT Mode
DCK	DATA CLOCK ²	—	Measured input clock (bytes/sec)
CC	CLRCHN	[ON OFF]	Clear Channel Enable
FLT	FILTER	[DVB CUSTOM]	Transmit Filter Type

¹ Bold indicates factory default setting

² Query only

Table 4-8 is a summary of the packet mode fault bit maps for remote control.

Table 4-8. Fault Bit Maps

Bit Map	Fault
0x00000001	System Fault
0x00000002	Data In clock too slow
0x00000004	Data In clock too fast
0x00000008	Data In clock gone
0x00000010	Data in parity error
0x00000020	Data in sync loss
0x00000040	Data in frame loss
0x00000080	Input card error
0x00000100	Cooling fan failure
0x00000200	Ambient temperature too hot
0x00000400	Ambient temperature too cold
0x00000800	Loss of power detected
0x00001000	Output power level fault
0x00002000	Not defined
.	.
.	.
0x80000000	Not defined

RS-485 Interface and Packet Protocol

The RS-485 interface may be used to control multiple modulators simultaneously using the ComStream packet protocol.

RS-485 Line Settings

The RS-485 signal levels and electrical characteristics are in accordance with the EIA RS-485 full-duplex, tri-state interface bus standards. This bus is configured as a party-line with a maximum of 32 devices connected to a single bus. The connector pinout is described in Appendix A. A positive differential voltage presented at RCV (the voltage at RCV+ is greater than the voltage at RCV-), also known as space, will be interpreted as a TTL low. This is considered a start bit per EIA specification.

Fault Commands

Summary

Table 4-6. lists a summary of the fault commands.

Table 4-6. Fault Command Summary

Mnemonic	Command	Description
FP	FLTPRES	Display present faults
FH	FLTHIST	Display fault history
FC	FLTCLR	Clear fault history

Descriptions

Table 4-7 lists a summary of the fault commands and how they function.

Table 4-7. Fault Commands Descriptions

Fault Command	Description
FLTPRES	This command displays a list of the currently active faults. In ASCII mode the faults are listed in text. In packet mode a bit map of the faults is returned.
FLTHIST	This command displays a list of faults that have occurred since power-up or since the last FLTCLR command. In ASCII mode the faults are listed in text. In packet mode a bit map of the faults is returned.
FLTCLR	This command clears the fault history.

Byte Count

The byte count represents the total number of characters in the packet, including the STX and ETX. The minimum count is six; the maximum count is 127. The minimum packet has no data field (for example, STX, Byte Count, Address, Control, Checksum, ETX).

Device Address

This field indicates the destination of a packet and is bit mapped as shown in Table 4-9.

Table 4-9. Device Address Bit Map

Bit	Description
Bit 0-4	Signify the slave address
Bit 5	Always 1
Bit 6	Always 0

Control Byte

This byte provides control information to the receiving device and is bit mapped as shown in Table 4-10.

Table 4-10. Control Byte Bit Map

Purpose	Bit	Description
For host-to-slave communications:	Bit 0	Packet Acknowledgment request
	Bit 1-6	Always 0
For slave-to-host communications:	Bit 0-5	Always 0
	Bit 6	Always 1; signifies a response packet

Packet Protocol

Each ComStream packet protocol device can be controlled via the RS-485 bus interface. Each device residing on the bus has an address from 1 to 30 and responds to remote control commands containing their specific address. In the party-line configuration there is one host controller and multiple slaves.

Messages are sent between the host controller and individually addressable slaves via information packets. Each packet consists of:

- Opening character
- Byte count
- Device address
- Control information
- Data field
- Checksum
- Closing character

Received packets that do not meet the appropriate format are discarded.

A packet sent from the host may request an acknowledgment packet from the slave. The acknowledgment packet indicates whether the command just issued has been executed and provides appropriate error and/or status messages. In addition, the acknowledgment packet is an indication that the slave can receive and process another packet.

The CM720M is always an addressable slave.

Packet Format and Content

All host- or slave-generated packets have a maximum length of 127 bytes, including delimiters and checksum. Any packet with a length exceeding 127 bytes will be discarded. The packet protocol format is shown in Figure 4-1.

STX	Byte Count	Device Address	Control Byte	Data	Checksum	ETX
-----	---------------	-------------------	-----------------	------	----------	-----

Figure 4-1. Packet Protocol Format

STX\ETX

These characters signify the beginning and end of a packet, respectively. Their ASCII values are STX=02h and ETX=03h.

Chapter 5: Maintenance, Operation Faults, and Troubleshooting

Overview

This chapter provides maintenance information for the CM720M. It also provides a listing of fault conditions that can occur with the CM720M.

The last section of this chapter presents information that can help troubleshoot any problems that can occur with the CM720M.

Maintenance

The CM720M does not require periodic or preventive maintenance. There are no adjustments or configuration switches or jumpers external or internal to the unit.

The power input is protected with an in-line fuse located within the power supply inside the receiver. The fuse is designed to protect the unit from internal damage in the event of a severe power line condition or internal failure.

NOTE: This fuse is NOT serviceable by the user.

A lithium battery is used to power the nonvolatile memory while power is off. The lifetime of the battery is 10 years.



Troubleshooting

This troubleshooting section is provided to aid in isolating equipment problems and suggesting appropriate actions toward solving those problems. If a particular problem cannot be resolved after reviewing the following material, or if a ComStream equipment failure is suspected, seek further assistance by contacting your ComStream distributor. If equipment is purchased directly from ComStream, contact ComStream Customer Service for assistance.

Before Troubleshooting

Before troubleshooting the unit, answer the following questions:

- Have there been any power or bad weather problems in the area?
- Is the CM720M rack-mounted or free-standing?
- Is the CM720M near a heat-generating source?
- What is the ambient temperature? Does it exceed 50° C?
- Is the unit connected to an uninterruptible power source (UPS)?

Symptoms and Actions

Table 5-2 has been developed to help you diagnose and correct minor problems in the unlikely event that you experience difficulties with your CM720M.

Table 5-2. Troubleshooting Symptoms and Actions

Symptom	Action
Seven segment LEDs not illuminated	1. Ensure the unit is plugged into an active AC outlet and the power cord is firmly plugged into the rear panel receptacle. 2. Verify the AC power source is supplying 90 to 264 VAC, 47 to 63 Hz. 3. Ensure the power cord is not at fault by replacing it with a known working cord. 4. Ensure the power supply is functional by observing that the fans turn on. 5. If the problem persists, it indicates a possible internal fuse failure. Do NOT attempt to repair it. Contact ComStream Customer Service for technical support.

Operational Fault Messages

Table 5-1 provides a detailed description of each operational fault condition to aid in troubleshooting.

Table 5-1. Faults and Conditions

Fault	Condition
Data In Clock Too Slow	The input clock frequency is below spec. No further action has been taken. The measured input clock frequency may be queried using the DCK command.
Data In Clock Too Fast	The input clock frequency is above spec. No further action has been taken. The measured input clock frequency may be queried using the DCK command.
Data In Clock Gone	The input clock frequency is below 76 kHz. The unit has immediately switched over to internal timing (with scrambling forced on) to preserve an output spectrum.
Data In Parity Errors	At least one parity error on the incoming data has occurred. The incoming data may be noisy or the cable faulty.
Data In Sync Loss	At least one sync pattern was incorrect. The incoming data may be noisy or the cable faulty.
Data In Frame Loss	Unable to synchronize on input data. Incoming data is very noisy or cable is faulty.
Input Card Fault	At least one TAXI violation has occurred. The incoming data may be noisy or the cable faulty.
Cooling Fan Failure	This indicates that one or both fans has failed. If only one fan has failed the unit should be removed for service as soon as possible. If both fans have failed, the unit must be immediately powered down to prevent equipment damage.
Ambient Temperature Too Hot	The ambient temperature is too hot. To prevent possible operational problems and equipment damage, the ambient temperature needs to be lowered.
Ambient Temperature Too Cold	The ambient temperature is too cold. To prevent possible operational problems and equipment damage, the ambient temperature needs to be raised.
Loss of Power Detected	This fault indicates that the unit has lost power since the last time faults were cleared.
Output Power Level Fault	The measured output power level is at least 3 dB more or less than the desired level. The unit requires service. Call ComStream Customer Service.
System Failure	The unit requires service. Call ComStream Customer Service.



Chapter 6: Technical Specifications and Port Information

IF Modulator

Data Rates	18.67 Mbps, 28 Mbps ± 20 ppm	
Symbol Rates	5.06383 Msps ± 20 ppm	
Modulation Types	16, 64 QAM	
Code Types and Rates	Reed-Solomon 188/204, synchronous with MPEG-2 packets	
Interleaver	Convolutional, 17 x 204 bytes, synchronous with MPEG-2 packets	
Scrambling	IBS IESS-309, modified for compatibility with MPEG-2 TS packets	
IF Output	Frequency	44 MHz ± 440 Hz
	Impedance	75 ohms
	Return Loss	> 17 dB (41 MHz $\leq f \leq 47$ MHz)
Out-of-Band (adjacent channels)	$35 \leq f \leq 41$ MHz	55 dB down
	$47 \leq f \leq 53$ MHz	55 dB down
Out-of-Band (non-adjacent channels)	$23 \leq f \leq 35$ MHz	55 dB down
	$53 \leq f \leq 65$ MHz	55 dB down
	$DC \leq f \leq 23$ MHz	40 dB down
	$65 \leq f \leq 1,000$ MHz	40 dB down
Spurious	$35 \leq f \leq 53$ MHz	< 57 dB
	$23 \leq f \leq 35$ MHz	< 52 dB
	$53 \leq f \leq 65$ MHz	< 52 dB
	$DC \leq f \leq 23$ MHz	< 42 dB
	$65 \leq f \leq 1,000$ MHz	< 42 dB

Table 5-2. Troubleshooting Symptoms and Actions (continued)

Symptom	Action
Unable to remotely communicate with the unit	1. Use the front panel to confirm the mode (RS-232/RS-485) of the remote interface. 2. Use the front panel to confirm that baud rate, parity, and data bits are all correct. 3. Ensure the correct terminal and cable are being used: a. Ensure an ASCII terminal or a PC with a terminal emulator program, such as PROCOMM®, is being used. b. Ensure the RS-232 cable is connected to the M&C port via the DB-9-to-DB-25 adapter cable supplied with the receiver. If the adapter cable is too short, extend it with a straight-thru cable. NOTE: If a DB-9-to-DB-9 cable is being used, the pin assignment is straight-thru. c. Verify the connection between pins 2 and 3 at both ends of the cable. 4. Once the terminal has been connected and configured, type DC followed by the enter key. If the device configuration: a. Does not display on the remote terminal, contact ComStream. b. Displays, but the DC command is not echoed to the display, ensure the command echo is enabled by entering RE ON. If they do not display after enabling the echo feature, contact ComStream Customer Service for technical support.
Front panel LCD display is too soft, too dark, or not visible	Adjust front panel LCD contrast.
Front panel changes are not being accepted	Check if front panel lockout is enabled.
Frame sync error, parity error, input card fault, or sync loss error reported	Integrity of input data stream is questionable. Possible cable/connector problem. Possible noise on interface. Confirm that cable is shielded.
Data In clock too slow/fast error reported	Check input clock frequency using the DCK command (DataClock on the front panel). This error is reported if the clock is more than 100 ppm off. Refer to the DATARATE command description in Chapter 4 for the relationship between symbol clock and data clock.
Clock gone error reported	Probably indicates that there is no data input. Possible cable problem.
Input data is not being transmitted	Check if BERT mode is disabled.
No input faults are being reported	Check if BERT mode is disabled.
No IF output	Check if transmit power is enabled.
IF output power level is too high/low	Check transmit power level setting. Check power monitor level.
Power monitor fault reported, power monitor reading 3 dB off	Confirm there is a 75 ohm load on the rear IF output.
Spectrum on IF test output is distorted	Confirm there is a 75 ohm load on the rear IF output.
IF output is a tone	Check if pure carrier is disabled. Check if scrambling is enabled.

Environmental

Temperature	Operating	0 to 50°C
	Nonoperating	-20 to 70°C
Humidity	Operating condensing	5 to 95% non-
	Nonoperating condensing	5 to 95% non-
Atmospheric Pressure	Operating	0 to 10,000 feet above sea level
	Nonoperating	0 to 10,000 feet above sea level
Electrostatic Discharge	ANSI T1.308-1990	
Vibration	Bellcore specification TR-NWT-000063, issue 4, section 4.5	
Safety/Emissions	UL 1950; CSA 950; FCC Part 15B Class A	

Rear Panel Ports

M&C Port

Interface type	Asynchronous RS-232 and addressable RS-485 multidrop using ComStream's packet protocol
Connector	DB-9, female
Default parameters	9600, 7 data bits, odd parity, 1 stop bit, RS-232
Functions	Unit configuration, diagnostics, and status; connects to ASCII terminal

Signal-to-Noise	> 47 dBc (measured in a bandwidth of 5.0638 MHz centered at 44 MHz)	
Intermodulation Noise	> 50 dBc (measured in a bandwidth of 5.0638 MHz centered at 44 MHz)	
Transmit Power	Resolution	0.2 dB steps
	Accuracy	±0.5 dB
	On/Off Isolation	> 60 dB
Spectral Shape	Square root raised cosine 18% roll-off	
Modulator Timing	External	
Throughput Delay	< 3 milliseconds	
MTBF	>44,000 hours (5 years)	

Mechanical

Size	1.75" H x 19" W x 18" D (standard 19" rack-mount)
Weight	< 12 pounds
Shipping weight	< 24 pounds

Power

Input voltage (AC)	90 to 264 VAC
Frequency	47 to 63 Hz
Consumption	50 W (typical)
	55 W (maximum) SR=5 M
	58 W (typical)
	63 W (maximum) SR =7 M



Appendix A: Interface Pinouts

Digital Data Input Port

The definition of the RF-45 port that is used to receive digital data is shown in Table A-1.

Table A-1. Shielded RJ-45 Jack

Pin #	I/O	Name	Description
1	I	SERIN+	Serial Data In +
2	I	SERIN-	Serial Data In -
3	—	—	Not Used
4	—	—	Not Used
5	—	—	Not Used
6	—	—	Not Used
7	—	—	Not Used
8	—	—	Not Used

M&C Port

The definition of the DB-9 connector used in the RS-232 mode of remote control is shown in Table A-2.

Table A-2. DB-9 Female, RS-232 Mode

Pin #	I/O	Name	Description
1	O	DCD	—
2	O	RXD	Receive Data
3	I	TXD	Transmit Data
4	—	—	Reserved
5	—	GND	Signal Ground
6	O	DSR	Data Set Ready
7	I	RTS	Request To Send
8	O	CTS	Clear To Send
9	—	—	Reserved

Digital Data Input Port

Interface type	AMD TAXI receiver; 10 bits per byte, 5 M reference clock
Connector	RJ-45, shielded
Default parameters	18.6667 Mbps or 28.0000 Mbps for 16 QAM or 64 QAM, respectively
Functions	Receives digital data from MPEG-2 data source

The definition of the DB-9 connector used in the RS-485 mode of remote control is shown in Table A-3.

Table A-3. DB-9 Female, RS-485 Mode

Pin #	I/O	Name	Description
1	—	GND	Signal Ground
2	—	—	Reserved
3	I	XMIT+	Transmit Data +
4	—	—	Reserved
5	O	RCV+	Receive Data +
6	—	—	Reserved
7	I	XMIT-	Transmit Data -
8	—	—	Reserved
9	O	RCV-	Receive Data -

M&C Port Adapter Cable (DB-9-to-DB-25)

The M&C Port Adapter Cable connects the CDTV720M with a 25-pin, RS-232 port as shown in Table A-4. This cable is VT-100 compatible and is supplied with the unit.

Table A-4. M&C Port Adapter Cable

Male DB-9	Female DB-25
1	8
2	3
3	2
4	20
5	7
6	6
7	4
8	5
9	22



invites you to comment on our manual...

Since our manuals are designed and written for you, we would like your input to ensure that we continually deliver the best in customer documentation. Thank you in advance for taking a few minutes to complete this survey.

Which ComStream manual are you providing input to? _____

Please circle your response to each of the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Applicable
The manual is well organized.	1	2	3	4	N/A
The information is easy to locate.	1	2	3	4	N/A
The information is complete and accurate.	1	2	3	4	N/A
The instructions and procedures are easy to follow.	1	2	3	4	N/A
The illustrations are accurate.	1	2	3	4	N/A
The illustrations help clarify the text.	1	2	3	4	N/A
The number of illustrations is about right.	1	2	3	4	N/A

Please answer these questions.

What did you like about this manual? _____

What would you change in this manual? _____

What would you like to see in this manual? _____

What other comments about the manual do you have? _____

Please tell us a little about yourself.

Is this your first ComStream product? ____ Yes ____ No

How many years have you been installing, operating, or using digital satellite communications equipment? ☐ Less than 1 year ☐ 1-2 ☐ 3-5 ☐ 6-10 ☐ More than 10

Name _____ Title _____

Company _____

Address _____

City/State/Province/Country _____

Postal/Zip Code _____ Phone _____

Fold here, tape at bottom, and mail

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