

CM720M

QAM Digital Cable Modulator

Installation and Operation Manual

COMSTREAM
A Spar Company

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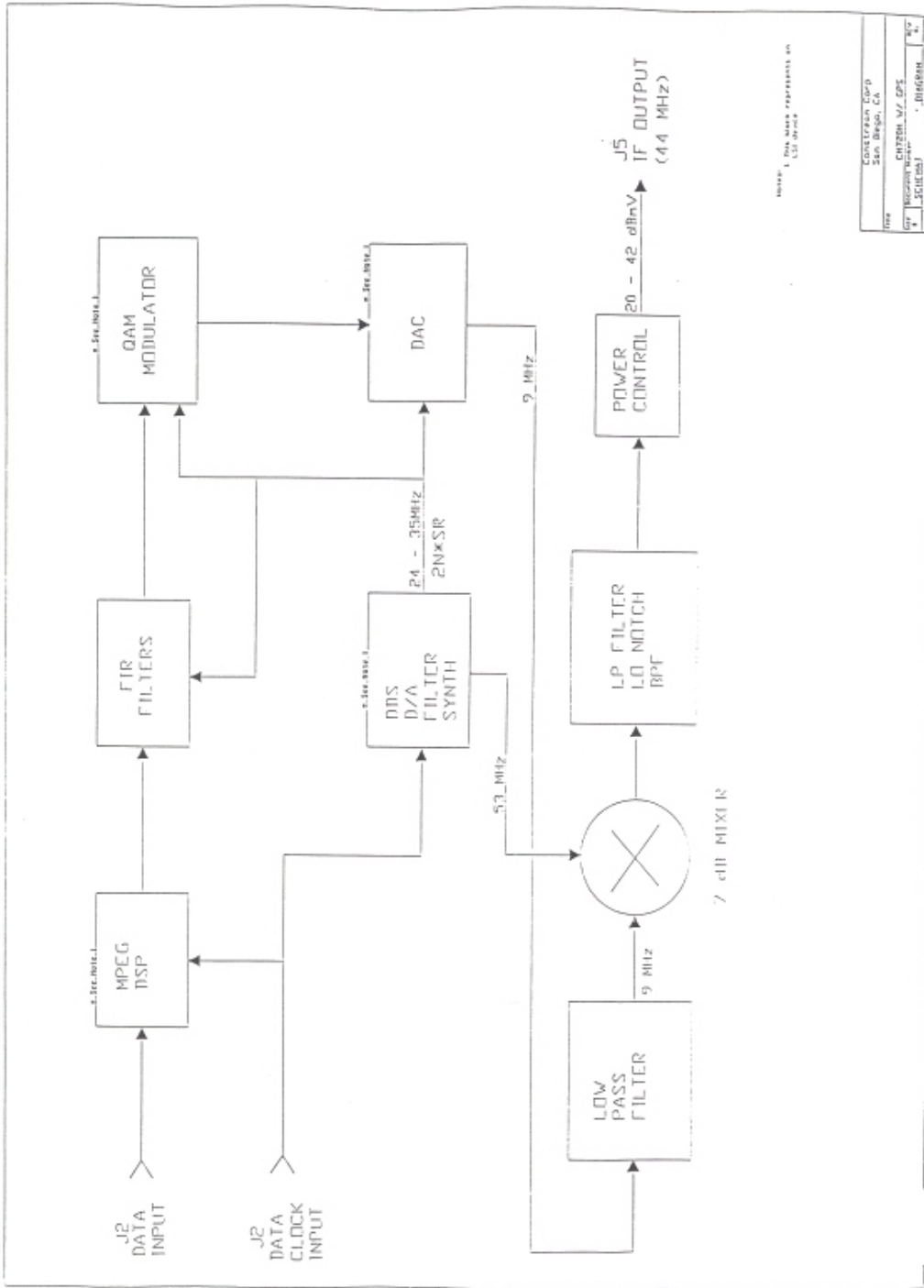
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, 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.



Notes: 1. This block represents an LSI device.

DATE	CONTRACTOR	COMP
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■ 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.



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.

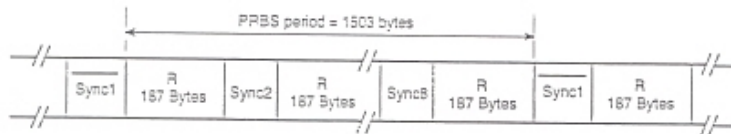


Figure 1-2. Randomized Transport Packets

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.

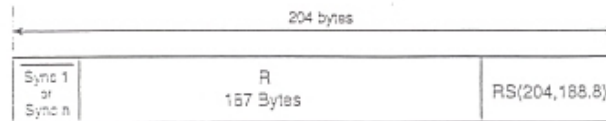


Figure 1-3. Encoded Packet

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.

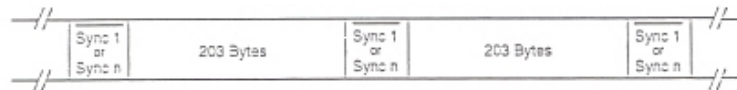
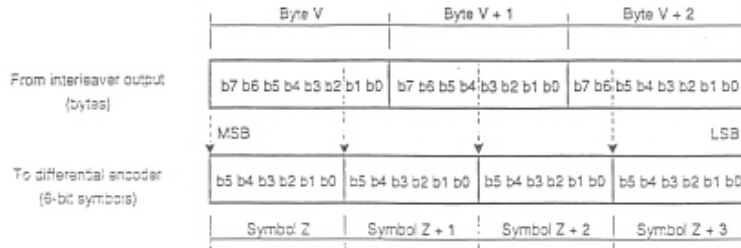


Figure 1-4. Interleaved Packets

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.

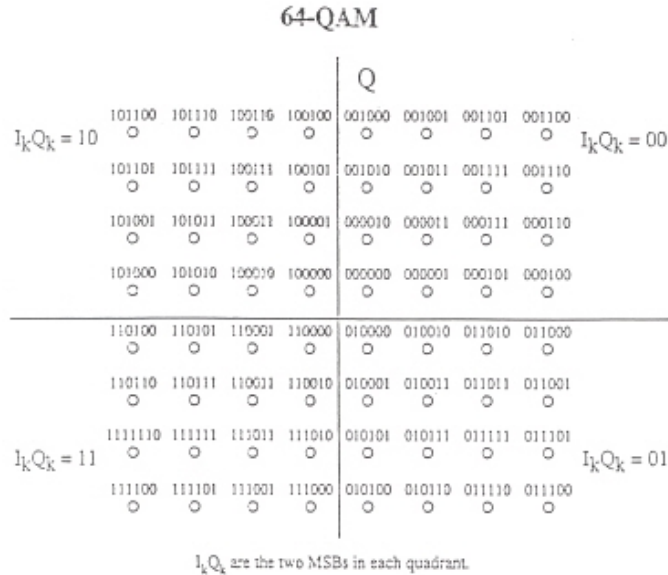


Figure 1-6. 64-QAM Constellation Diagram

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.

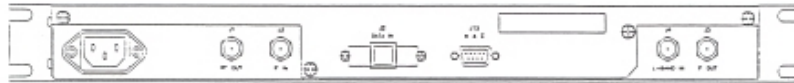


Figure 2-1. CM720M Rear Panel Connectors

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	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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*.