## 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

1-1 thru 1-8

## 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<br>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.

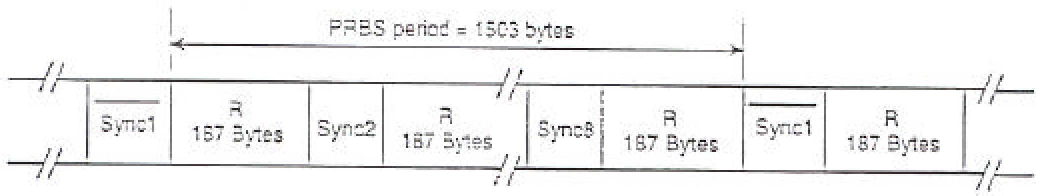



*Figure 1-2. Randomized Transport Packets*

## 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.

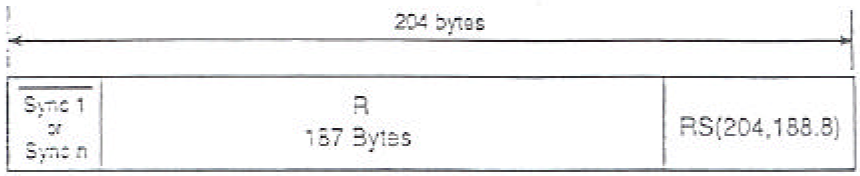



*Figure 1-3. Encoded Packet*

## 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.

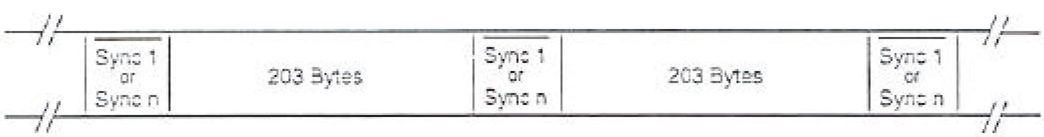
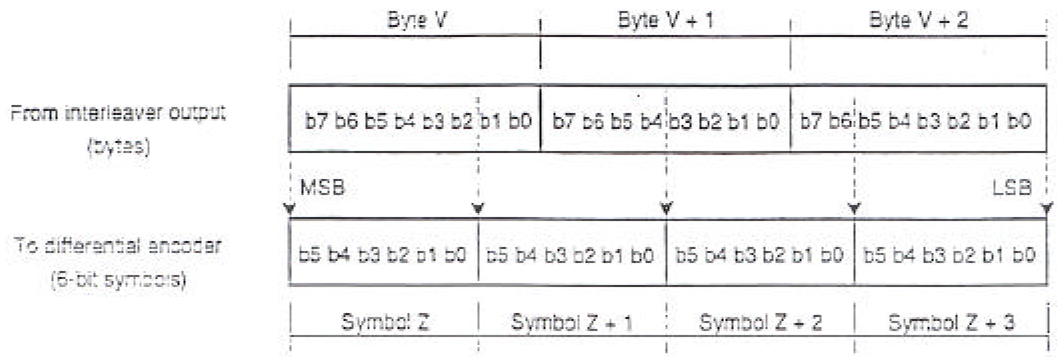



*Figure 1-4. Interleaved Packets*

## 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

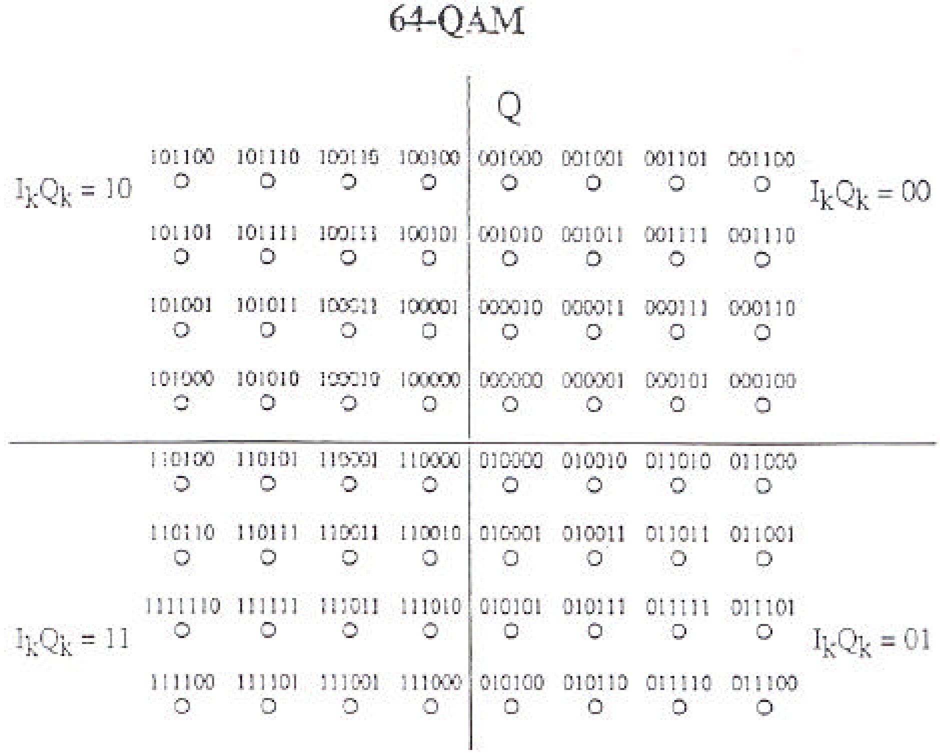
The two MS bits of each symbol are differentially encoded in order to obtain a rotational invariant constellation. The differential encoding is given by the following expression:

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

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

## Symbol Mapping

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




$I_kQ_k$ are the two MSBs in each quadrant.

*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.*