

# CDM-Qx & CDM-QxL Multi-Channel Satellite Modems with DoubleTalk™ Carrier-in-Carrier®



## INTRODUCTION

CDM-Qx and CDM-QxL are the first satellite modems to offer DoubleTalk™ Carrier-in-Carrier® bandwidth compression capability that allows transmit and receive carriers of a full-duplex satellite link to share the same transponder space. DoubleTalk Carrier-in-Carrier enables multi-dimensional optimization, thereby allowing satellite communications users to:

- Reduce operating expenses (OPEX)
- Increase throughput without using additional transponder resources
- Increase availability (margin) without using additional transponder resources
- Reduce capital expenses (CAPEX) by allowing a smaller BUC/HPA and/or antenna
- Or, a combination to meet specific user needs

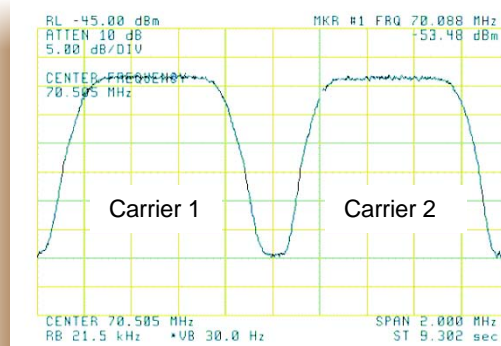
## FEATURES

- DoubleTalk Carrier-in-Carrier bandwidth compression
- Four slot chassis, allowing flexible configuration
- CDM-Qx: 50 to 90, 100 to 180 MHz  
CDM-QxL: 950 to 1950 MHz
- Data Rate: 32 kbps to 20 Mbps
- Modulation: BPSK, QPSK, 8-PSK and 16-QAM
- Forward Error Correction (FEC): Viterbi, Concatenated Reed Solomon and Turbo Product Coding (IESS-315 Compliant)
- Data Interface: EIA-422, V.35, Sync EIA-232, G.703 T1, G.703 E1, Quad G.703 E1, G.703 E2 and HSSI
- Enhanced D&I++ for Single & Quad E1
- M&C: EIA-232, EIA-485, and 10/100BaseT Ethernet with SNMP, HTTP and Telnet support
- Embedded Distant-end Monitor and Control (EDMAC)
- Automatic Uplink Power Control (AUPC)
- Spectrum Analyzer Function
- Asymmetric Loop Timing
- Common frequency reference for all modules
- Individual modulator output power control
- CDM-QxL: 10 MHz reference for BUC, FSK communications and optional BUC power supply
- CDM-QxL: 10 MHz reference and LNB power supply
- Interoperable with many Comtech EF Data satellite modems: CDM-550T, 570, 570L, 600, 600L, SDM-8000, 300A, and 300L3

## DOUBLETALK CARRIER-IN-CARRIER

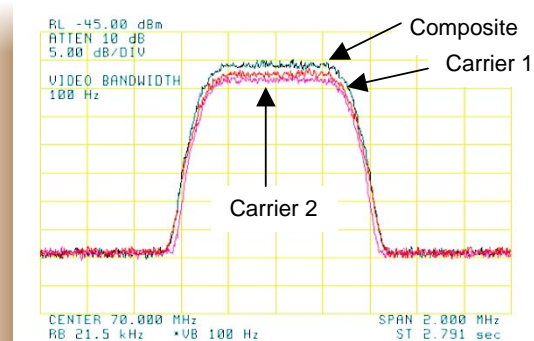
DoubleTalk Carrier-in-Carrier is based on patented bandwidth compression technology originally developed by Applied Signal Technology, Inc. Using "Adaptive Cancellation" it allows transmit and receive carriers of a two-way link to share the same transponder space.

Figure 1 shows the typical full-duplex satellite link, where the two carriers are adjacent to each other. Figure 2 shows the typical DoubleTalk Carrier-in-Carrier operation, where the two carriers are overlapping, thus sharing the same spectrum.



**Without DoubleTalk Carrier-in-Carrier**

**Figure 1**



**With DoubleTalk Carrier-in-Carrier**

**Figure 2**

When observed on a spectrum analyzer, only the Composite is visible. Carrier 1 and Carrier 2 are shown in Figure 2 for reference only.

Carrier-in-Carrier® is a Registered Trademark of Comtech EF Data

DoubleTalk™ is a Trademark of Applied Signal Technology, Inc

## CDM-Qx & CDM-QxL Satellite Modems with DoubleTalk™ Carrier-in-Carrier®

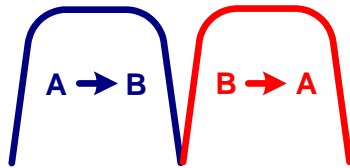
DoubleTalk Carrier-in-Carrier is complementary to all advances in modem technology, including advanced FEC and modulation techniques. As these technologies approach theoretical limits of power and bandwidth efficiencies, DoubleTalk Carrier-in-Carrier utilizing advanced signal processing techniques provides a new dimension in bandwidth efficiency.

DoubleTalk Carrier-in-Carrier allows satellite users to achieve spectral efficiencies (i.e. bps/Hz) that cannot be achieved with traditional links. For example, DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8bps/Hz).

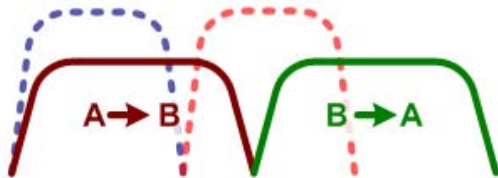
As DoubleTalk Carrier-in-Carrier allows equivalent spectral efficiency using a lower order Modulation and/or FEC Code, it can simultaneously reduce CAPEX by allowing a smaller BUC/HPA and/or antenna.

DoubleTalk Carrier-in-Carrier can be used to save transponder bandwidth and/or transponder power thereby allowing successful deployment in *bandwidth-limited* as well as *power-limited* scenarios. The following example illustrates the typical process for implementing DoubleTalk Carrier-in-Carrier in a *power-limited* scenario:

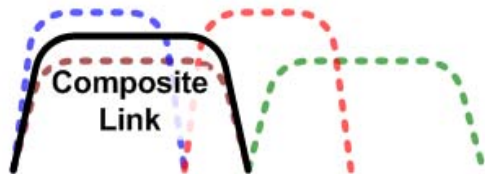
The conventional link is using 8-PSK, TPC 3/4:



Spread the signal by switching to a lower order modulation and/or FEC code – say QPSK, TPC 7/8. This increases the total transponder bandwidth, while reducing the total transponder power:



Now using DoubleTalk Carrier-in-Carrier, the second QPSK, TPC 7/8 carrier can be moved over the first carrier – thereby reducing the total transponder bandwidth and total transponder power when compared to the original side-by-side 8PSK, TPC 3/4 carriers:



### TURBO PRODUCT CODING

The CDM-Qx/QxL offer 2<sup>nd</sup> generation Turbo Product Codec (TPC) as an option. TPC provides increased coding

gain with low decoding delay. Combined with DoubleTalk Carrier-in-Carrier, they provide unprecedented savings in transponder bandwidth and power utilization as well as Earth Station BUC/HPA size.

### QUAD E1 INTERFACE (QDI) WITH ENHANCED D&I++

The CDM-Qx/QxL supports a Quad E1 interface that can aggregate up to 4 synchronous full or fractional E1s into a single carrier, with very low overhead. This provides significant CAPEX savings by reducing the number of modems and the simultaneous reduction in BUC/HPA size due to the elimination of multi-carrier backoff.

A proprietary, closed network Drop & Insert (D&I++) allows for Dropping or Inserting any combination of 1 to 31 Time Slots on each E1. D&I++ is supported for E1-CCS only.

### EDMAC & AUPC

The CDM-Qx/QxL support EDMAC, EDMAC-2, and AUPC. EDMAC/AUPC is compatible with CDM-600/600L and CDM-570/570L. EDMAC-2/AUPC is compatible with CDM-570/570L.

### MONITORING & CONTROL

The CDM-Qx/QxL provide a range of options for local and remote management. The modem can be managed via the front panel, the remote M&C port (EIA-232/EIA-485), or the 10/100BaseT Ethernet port. With support for SNMP, http and telnet, the modems can be easily integrated into an IP based management system.

### FEATURE ENHANCEMENTS

Enhancing the capability of CDM-Qx/QxL in the field is easy. Features that do not require additional hardware can be added on site, using FAST access codes purchased from Comtech EF Data.

### DATA INTERFACES

The CDM-Qx/QxL support a range of data interfaces – EIA-422, V.35, Sync EIA 232, G.703 T1, G.703 E1, Quad G.703 E1, G.703 E2 and HSSI.



#### CDM-Qx Shown With:

Slot 1	Modulator Card with G.703 Balanced Interface
Slot 2	Modulator Card with G.703 Balanced Interface
Slot 3	Modulator Card with EIA-530 Interface
Slot 4	Modulator Card with EIA-530 Interface

#### Notes:

- Also shown, placed above the CDM-Qx are the modulator and demodulator cards with G.703 Unbalanced (BNC) interface.
- Typically each modulator and demodulator card requires a data interface. However, if configured as a modem, only the demodulator card requires a data interface.
- Unlike other data interfaces, the Quad E1 interface requires 2 slots in the CDM-Qx/QxL chassis

## SYSTEM SPECIFICATIONS

Data Rate (See Summary Table)	32 kbps to 20 Mbps, in 1 bps steps (data interface dependant)
Symbol Rate	Up to 10 Msps
Scrambling	V.35, or synchronous
FEC (See Summary Table)	Viterbi 1/2, 3/4 and 7/8 Concatenated Reed-Solomon 1/2, 2/3, 3/4, and 7/8
Turbo Product Coding (TPC) - 2 <sup>nd</sup> Generation	Hardware option BPSK Rate 5/16 and 21/44 QPSK Rate 21/44, 3/4, 7/8, and 17/18 8-PSK Rate 3/4, 7/8, and 17/18 16-QAM Rate 3/4 and 7/8
M&C Interface	EIA-232, EIA-485 (2- or 4-wire), 10/100 BaseT Ethernet with SNMP, HTTP and Telnet support
Form C Relays	Tx, Rx traffic alarms and Unit faults
External Reference	1, 2, 5, 10 or 20 MHz, BNC Connector
IF Impedance & Connectors	CDM-Qx: 75Ω (Optional 50Ω), BNC female CDM-QxL: 50Ω, Type-N female
Monitor Functions	E <sub>v</sub> /N <sub>0</sub> , Frequency Offset, BER, Buffer fill status, Rx signal level, Carrier Power Ratio

## FEC, MODULATION & DATA RATE SUMMARY

FEC Type	Modulation	Code Rate	Data Rate Range*
Viterbi	BPSK	1/2	32 kbps - 5 Mbps
Viterbi	QPSK	1/2	32 kbps - 10 Mbps
Viterbi	QPSK	3/4	32 kbps - 15 Mbps
Viterbi	QPSK	7/8	32 kbps - 17.5 Mbps
Viterbi + RS (201/219)	BPSK	1/2	32 kbps - 4.5 Mbps
Viterbi + RS (201/219)	QPSK	1/2	32 kbps - 9.1 Mbps
Viterbi + RS (201/219)	QPSK	3/4	32 kbps - 13.7 Mbps
Viterbi + RS (201/219)	QPSK	7/8	32 kbps - 16 Mbps
Viterbi + RS (201/219)	16-QAM	3/4	352.4 kbps - 20 Mbps
Viterbi + RS (201/219)	16-QAM	7/8	411.1 kbps - 20 Mbps
TCM + RS (201/219)	8-PSK	2/3	234.9 kbps - 18.3 Mbps
TPC	BPSK	5/16	32 kbps - 3.1 Mbps
TPC	BPSK	21/44	32 kbps - 4.7 Mbps
TPC	QPSK	21/44	32 kbps - 9.5 Mbps
TPC	QPSK	3/4	32 kbps - 15 Mbps
TPC	QPSK	7/8	32 kbps - 17.5 Mbps
TPC	QPSK	17/18	32 kbps - 18.8 Mbps
TPC	8-PSK	3/4	288 kbps - 20 Mbps
TPC	8-PSK	7/8	336 kbps - 20 Mbps
TPC	8-PSK	17/18	362.7 kbps - 20 Mbps
TPC	16-QAM	3/4	384 kbps - 20 Mbps
TPC	16-QAM	7/8	448 kbps - 20 Mbps

\*Unframed operation

## MODULATOR

Frequency Range	CDM-Qx: 50 to 90, 100 to 180 MHz CDM-QxL: 950 to 1950 MHz 100 Hz frequency resolution (both)
Frequency Stability	CDM-Qx: ± 1.0 ppm (standard), ± 0.1 ppm (optional), 0 to 50°C (32 to 122°F) CDM-QxL: ± 0.1 ppm, 0 to 50°C (32 to 122°F)
Harmonics and Spurious	<-55 dBc/4 kHz (Typically <-60 dBc/4 kHz)
Transmit On/Off Ratio	55 dB minimum
Phase Noise	< 0.75 degrees RMS double-sided, 100 Hz to 1 MHz
Output Power (per Modulator)	CDM-Qx: -5 to -25 dBm, 0.1 dB step CDM-QxL: -5 to -45 dBm, 0.1 dB step
Power Accuracy	± 1 dB over frequency and temperature

External Carrier Off	By TTL low signal
BUC FSK Communications	CDM-QxL: Via Tx center conductor with FSK capable BUCs
BUC Power Supply	CDM-QxL: None, 24 VDC, 48 VDC (option)

## DEMODULATOR

Frequency Range	CDM-Qx: 50 to 90, 100 to 180 MHz CDM-QxL: 950 to 1950 MHz 100 Hz frequency resolution (both)
Input Power	CDM-Qx: -15 to -45 dBm, ≤ 2.048 Msps -15 to -40 dBm, > 2.048 Msps ≤ 4.096 Msps -15 to -35 dBm, > 4.096 Msps CDM-QxL: -130 + 10log(Symbol Rate) dBm (minimum)
Automatic Gain Control	CDM-QxL: 50 dB
Max Composite Level	CDM-Qx: +35 dBc, up to -5 dBm, +76 - 10log(Symbol Rate) dBc within 10 MHz of desired carrier CDM-QxL: +87 - 10log(Symbol Rate) dBc (Broadband), +76 - 10log(Symbol Rate) dBc within 10 MHz of desired carrier, -5 dBm absolute maximum
Acquisition Range	CDM-Qx: ±1 to ±32 kHz, programmable, in 1 kHz steps (Symbol Rate > 64 kbps) ±1 to ± (SR/2) kHz, programmable, in 1 kHz steps (Symbol Rate ≤ 64 kbps) CDM-QxL: ±1 to ±200 kHz, programmable, in 1 kHz steps (Symbol Rate > 625 kbps) ±1 to ±32 kHz, programmable, in 1 kHz steps (64 kbps < Symbol Rate < 625 kbps) ±1 to ± (SR/2) kHz, programmable, in 1 kHz steps (Symbol Rate ≤ 64 kbps)
Receive Buffer	512, 1024, 2048, 4096, 8182, or 16384 bits
Receive Clock Options	Rx Satellite, Tx Terrestrial, External Reference
Clock Tracking	± 100 ppm minimum
LNB Voltage	CDM-QxL: Off, 13 VDC or 18 VDC, 500 mA (max)

## DOUBLETALK CARRIER-IN-CARRIER

Minimum Symbol Rate	256 kbps
Propagation Delay	0 to 330 ms
Max Symbol Rate Ratio (See Whitepaper)	3:1 (Tx:Rx or Rx:Tx)
Max Power Ratio (See Whitepaper)	Tx Carrier Power (Interferer) - Rx Carrier Power (Desired), in dB, < 10 dB (except for 16-QAM, TPC, R=7/8) Tx Carrier Power (Interferer) - Rx Carrier Power (Desired), in dB, < 7 dB (16-QAM, TPC, R=7/8)
Satellite Restrictions	Satellite in "loop-back" mode (i.e. Tx station must be able to receive itself) "Non-processing" satellite (i.e. does not demodulate/remodulate the signal)

## DATA INTERFACES

EIA-422	32 kbps to 12 Mbps, DB-25F
V.35	32 kbps to 12 Mbps, DB-25F
HSSI	32 kbps to 20 Mbps, 50-pin, mini-D (F)
G.703 T1/E1 (Balanced)	DB-15F, 120 Ω
G.703 T1/E1 (Unbalanced)	BNC, 75 Ω
G.703 E2 (Unbalanced)	BNC, 75 Ω
Quad G.703 E1 (Balanced)	4 x RJ-45, 120 Ω

# CDM-Qx & CDM-QxL Multi-Channel Satellite Modems with DoubleTalk™ Carrier-in-Carrier®



## ENHANCED D&I++ FOR G.703 E1

### Single G.703 E1

Frame Format	E1-CCS Only
Time Slots	Any combination of 1 to 31 time slots can be dropped or inserted
Interoperability	Interoperable with CDM-600/600L for combinations of up to 24 time slots (E1-CCS Frame Format, Viterbi and TPC FEC only).

### Quad G.703 E1

Frame Format	E1-CCS Only
Time Slots	For each E1, any combination of 1 to 31 time slots can be dropped or inserted
Framing Overhead	0.4% (EDMAC/AUPC additional if needed)
Interoperability	Quad G.703 E1 Only

## BER PERFORMANCE

Met with two adjacent carriers 7 dB higher at 1.3 channel spacing  
Guaranteed  $E_b/N_0$ , in dB

*Consult the CDM-Qx Manual for a comprehensive listing of the performance of all FEC types, Code Rates, Modulation types, and Data Rate ranges.*

TPC	BPSK			QPSK		
	5/6	21/44	21/44	3/4	7/8	17/18
10 <sup>-6</sup>	2.4	2.9	3.5	3.8	4.3	6.8
10 <sup>-8</sup>	2.8	3.3	3.6	4.4	4.5	7.4
TPC	8-PSK			16-QAM		
	3/4	7/8	17/18	3/4	7/8	
10 <sup>-6</sup>	6.2	7.0	9.3	7.4	8.1	
10 <sup>-8</sup>	6.8	7.2	10.3	8.2	8.3	

*Refer to the Whitepaper for  $E_b/N_0$  Degradation due to DoubleTalk Carrier-in-Carrier.*

## ENVIRONMENTAL AND PHYSICAL

Temperature	Operating: 0 to 50°C (32 to 122°F) Storage: -25 to 85°C (-13 to 185°F)
Power Supply	100 to 240 VAC, 50/60 Hz, Auto sensing -48 VDC (option)
Power Consumption	CDM-Qx: < 90W typical (Depending on configuration) CDM-QxL: < 90W typical, w/o BUC PS (Depending on configuration)
Physical Dimensions (1RU)	CDM-Qx: 1.75H x 19.0W x 19 D inch (4.4H x 48W x 48D cm) approximate
Weight	< 20 lbs (7.0 kg) approximate (Depending on configuration)
CE Mark	EMC Safety
FCC	Part 15

## AVAILABLE OPTIONS

### Chassis

How Enabled	Option
Hardware	75 or 50Ω IF Connector (CDM-Qx Only)
Hardware	Redundant Primary Power Supply
Hardware	0.1 ppm Reference (CDM-Qx Only)
Hardware	-48 VDC power supply
Hardware	BUC PS 24 VDC, 100 W, AC or DC input (CDM-QxL Only)
Hardware	BUC PS 48 VDC, 180 W, AC or DC input (CDM-QxL Only)
FAST	1:1, 1:2, or 1:3 Internal Redundancy*
FAST	DoubleTalk Carrier-in-Carrier to 512 kbps
FAST	DoubleTalk Carrier-in-Carrier to 1 Mbps
FAST	DoubleTalk Carrier-in-Carrier to 2.5 Mbps
FAST	DoubleTalk Carrier-in-Carrier to 5 Mbps
FAST	DoubleTalk Carrier-in-Carrier to 10 Mbps
FAST	DoubleTalk Carrier-in-Carrier to 20 Mbps
FAST	Enhanced D&I++ for One/Both Modems

\* 1:1 Internal Redundancy for Modem  
1:1 or 1:2 or 1:3 Internal Redundancy for Modulator/Demodulator

### Modulator/Demodulator/Interface

How Enabled	Option
Hardware	2 <sup>nd</sup> Generation Turbo Product Coding Module
Hardware	25-Pin EIA-422, V.35 or Sync EIA-232 Interface*
Hardware	G.703 E1/T1 Balanced Interface*
Hardware	G.703 E1/T1 Unbalanced Interface*
Hardware	G.703 E2 Unbalanced Interface*
Hardware	HSSI Interface*
Hardware	Quad G.703 E1 Interface**
FAST	Data Rate to 10 Mbps
FAST	Data Rate to 20 Mbps
FAST	8-PSK
FAST	16-QAM

\* A data interface is only needed for the demodulator card when the modulator and demodulator are used together as a modem. In this case, all input and output data is routed through the demodulator's data interface.

\*\* Unlike other data interfaces, Quad G.703 E1 interface requires 2 full slots (3 and 4) in the CDM-Qx/QxL chassis.

## ACCESSORIES

CRS-311-Qx	1:1 Modem Redundancy Switch
CRS-300-Qx	1:10 Modem Redundancy Switch

A white paper, *DoubleTalk™ Carrier-in-Carrier® Bandwidth Compression Providing Significant Improvements in Satellite Transponder Bandwidth*, is available on the Comtech EF Data web site on the CDM-Qx product page, under Satellite Modems.