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

Overview

The CDM-Qx and CDM-QxL Multi-Channel Satellite Modems offer DoubleTalk® Carrier-in-Carrier® bandwidth compression capability, allowing 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

Typical Users

- Satellite Service Providers
- Fixed Line Operators
- Service Providers
- Government & Military
- Enterprise
- Oil Field Service Providers

Common Applications

- Cellular Backhaul
- G.703 Trunking
- Offshore & Maritime Communications

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, 8PSK and 16-QAM
- Forward Error Correction (FEC): Viterbi, Concatenated Reed Solomon and Turbo Product Coding (TPC) (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 10/100Base-T 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

Turbo Product Coding

The CDM-Qx/QxL offer 2nd generation Turbo Product Codec 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 four 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.

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.

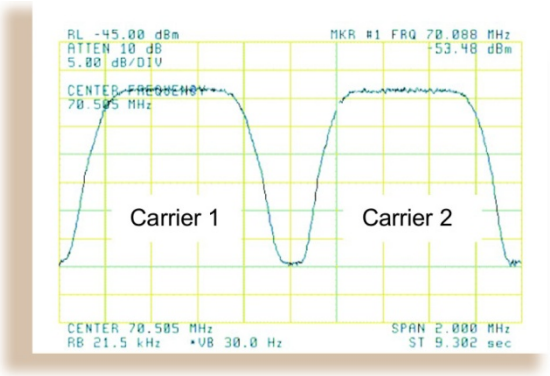


Figure 1

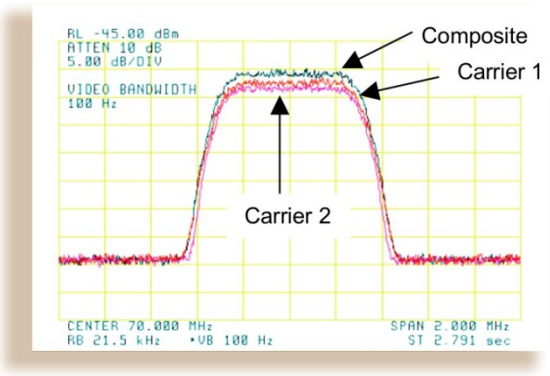


Figure 2

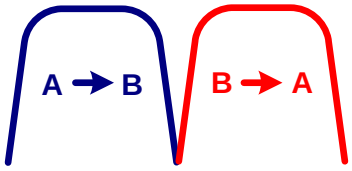
When observed on a spectrum analyzer, only the Composite is visible. Carrier 1 and Carrier 2 are shown in Figure 2 for reference only.

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.

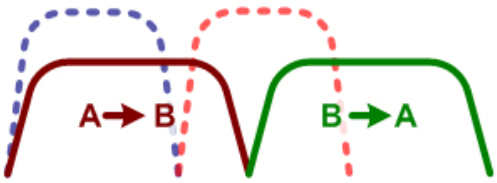
DoubleTalk Carrier-in-Carrier allows satellite users to achieve spectral efficiencies (i.e. bps/Hz) that cannot be achieved with traditional links. For example, DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8bps/Hz). As DoubleTalk Carrier-in-Carrier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

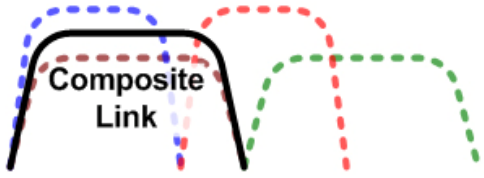
The conventional link is using 8PSK, TPC 3/4:



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:



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DoubleTalk® is a Registered Trademark of Raytheon Applied Signal Technology

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 10/100Base-T 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

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) - 2nd Generation	Hardware option BPSK Rate 5/16 and 21/44 QPSK Rate 21/44, 3/4, 7/8, and 17/18 8PSK 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 Base-T 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: 75 Ω (Optional 50 Ω), BNC female CDM-QxL: 50 Ω, Type-N female
Monitor Functions	E_b/N_0, Frequency Offset, BER, buffer fill status, RX signal level, carrier power ratio

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 50ºC (32 to 122ºF) CDM-QxL: ± 0.1 ppm, 0 to 50ºC (32 to 122ºF)
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 BUC FSK Communications BUC Power Supply	By TTL low signal CDM-QxL: Via TX center conductor with FSK capable BUCs 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 ksps) ± 1 to ± (SR/2) kHz, programmable, in 1 kHz steps (symbol rate <= 64 ksps) CDM-QxL: ± 1 to ± 200 kHz, programmable, in 1 kHz steps (symbol rate > 625 ksps) ± 1 to ± 32 kHz, programmable, in 1 kHz steps (64 ksps < symbol rate < 625 ksps) ± 1 to ± (SR/2) kHz, programmable, in 1 kHz steps (symbol rate <= 64 ksps)
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 ksps
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)

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)	8PSK	2/3	234.9 kbps – 18.3 Mbps
TCP	BPSK	5/16	32 kbps – 3.1 Mbps
TCP	BPSK	21/44	32 kbps – 4.7 Mbps
TCP	QPSK	21/44	32 kbps – 9.5 Mbps
TCP	QPSK	3/4	32 kbps – 15 Mbps
TCP	QPSK	7/8	32 kbps – 17.5 Mbps
TCP	QPSK	17/18	32 kbps – 18.8 Mbps
TCP	8PSK	3/4	288 kbps – 20 Mbps
TCP	8PSK	7/8	336 kbps – 20 Mbps
TCP	8PSK	17/18	362.7 kbps – 20 Mbps
TCP	16-QAM	3/4	384 kbps – 20 Mbps
TCP	16-QAM	7/8	448 kbps – 20 Mbps

*Unframed operation

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^{-6}	2.4	2.9	3.5	3.8	4.3	6.8
10^{-8}	2.8	3.3	3.6	4.4	4.5	7.4
TPC	**8PSK**			**16-QAM**		
	3/4	7/8	17/18	3/4	7/8	
10^{-6}	6.2	7.0	9.3	7.4	8.1	
10^{-8}	6.8	7.2	10.3	8.2	8.3	

Refer to the Whitepaper for Eb/No Degradation due to DoubleTalk Carrier-in-Carrier.

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 White Papers page, under All Collateral.

Environmental And Physical

Temperature	Operating: 0 to 50ºC (32 to 122°F)
	Storage: -25 to 85ºC (-13 to 185ºF)
Power Supply	100 to 240 VAC, 50/60 Hz, auto sensing -48 VDC (option)
Power Consumption	CDM-Qx: < 90 W typical (Depending on configuration) CDM-QxL: < 90 W typical, w/o BUC PS (Depending on configuration)
Dimensions (1RU) (height x width x depth)	CDM-Qx: 1.75" x 19.0"" x 19" (4.4 x 48 x 48 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 50 Ω 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, 80 W @ 50°C, 100 W @ 30°C, AC or DC input (CDM-QxL only)
Hardware	BUC PS 48 VDC, 150 W @ 50°C,180 W @ 30°C, 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	2nd 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	8PSK
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

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