

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

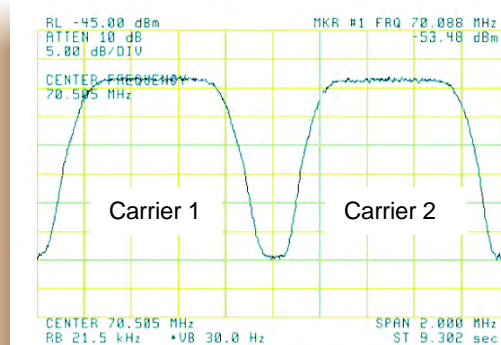
FEATURES

- 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

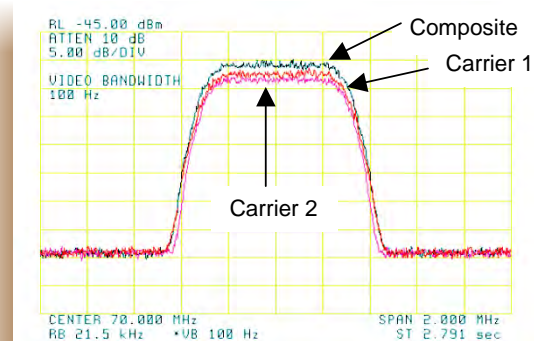
DoubleTalk Carrier-in-Carrier is based on patented bandwidth compression technology originally developed by Applied Signal Technology, Inc. Using "Adaptive Cancellation" it allows transmit and receive carriers of a two-way link to share the same transponder space.

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®

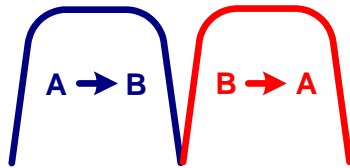
DoubleTalk Carrier-in-Carrier is complementary to all advances in modem technology, including advanced FEC and modulation techniques. As these technologies approach theoretical limits of power and bandwidth efficiencies, DoubleTalk Carrier-in-Carrier utilizing advanced signal processing techniques provides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

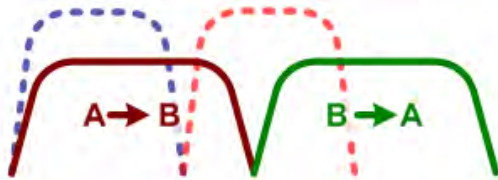
As DoubleTalk Carrier-in-Carrier allows equivalent spectral efficiency using a lower order Modulation and/or FEC Code, it can simultaneously reduce CAPEX by allowing a smaller BUC/HPA and/or antenna.

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:

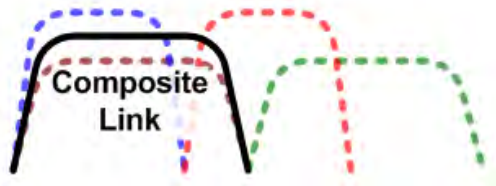
The conventional link is using 8-PSK, TPC 3/4:



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 2nd 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 nd 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 _v /N ₀ , 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-Qx: 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 ⁻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 | 8-PSK | | | 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 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, 80W @ 50°C, 100W @ 30°C, AC or DC input (CDM-QxL Only) |
| Hardware | BUC PS 48 VDC, 150W @ 50°C, 180W @ 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 | 2 nd 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.