Modems

INTRODUCTION

CDM-625 Advanced Satellite Modem builds on Comtech EF Data's legacy of providing the most efficient satellite modems. It is the first modem to combine advanced FEC such as Low Density Parity Check (LDPC) codes with the revolutionary DoubleTalk® Carrier-in-Carrier® bandwidth compression allowing for maximum savings under all conditions. This combination of advanced technologies enables multi-dimensional optimization, allowing satellite communications users to:

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

CDM-625 is backward compatible with CDM-600/L. It even supports a CDM-600/L emulation mode that makes it easy to deploy in existing networks using CDM-600/L without any changes to the redundancy switches or the management platform.

KEY FEATURES

- DoubleTalk Carrier-in-Carrier bandwidth compression
- 70/140 MHz and L-band capability in the same unit
- Data Rate: 18 kbps to 25 Mbps
- Symbol Rate:18 ksps to 12.5 Msps
- Modulation: BPSK, QPSK/OQPSK, 8-PSK/8-QAM and 16-QAM
- Forward Error Correction (FEC): Viterbi, Concatenated Reed Solomon, Turbo Product Code (TPC) (IESS-315 Compliant), Low Density Parity Check (LDPC) Code and TCM
- Open Network Support: IBS with High Rate IBS ESC, IDR and Audio
- 5-tap Adaptive Equalizer
- Widest Range of Data Interfaces: EIA-422/530, V.35, G.703 T1, G.703 E1, G.703 T2, G.703 E2, Quad G.703 E1, ASI, LVDS, HSSI, 4-port 10/100BaseT Ethernet
- Drop & Insert for T1/E1
- Enhanced D&I++ for Single T1/E1 & Quad E1
- Engineering Service Channel (ESC/ESC++)
- Management: 10/100BaseT Ethernet with SNMP, HTTP and Telnet support and EIA-232/EIA-485
- Embedded Distant-end Monitor and Control (EDMAC)
- Automatic Uplink Power Control (AUPC)
- Standard High Stability Internal Reference (±6 x 10^{-8})
- L-Band: 10 MHz reference for BUC, FSK communications and optional BUC power supply
- L-band: 10 MHz reference and LNB power supply
- CDM-600/L emulation mode

- 1:1 and 1:10 Redundancy Switches Available
- Backwards compatible with CDM-500/CDM-550, CDM-550T, CDM-570/L and CDM-600/L
- Interoperable with many Comtech EF Data satellite modems: CDM-Qx/L, SDM-8000, 300A, and 300L3

DOUBLETALK CARRIER-IN-CARRIER

DoubleTalk Carrier-in-Carrier, based on patented "Adaptive Cancellation" technology, allows transmit and receive carriers of a duplex 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.
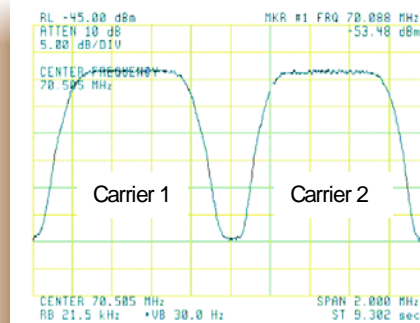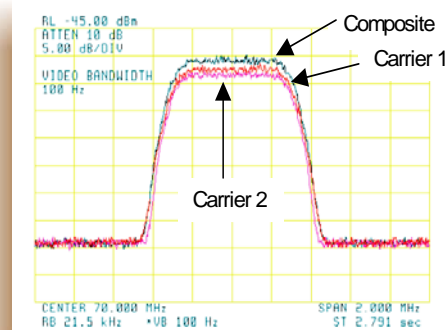

Figure 1. Traditional Full Duplex Link

Figure 2. Duplex Link with DoubleTalk Carrier-in-Carrier

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 Registered Trademark of Applied Signal Technology, Inc.

# CDM-625 Advanced Satellite Modem 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 efficiency, DoubleTalk Carrier-in-Carrier utilizing advanced signal processing techniques provides a new dimension in bandwidth and power efficiency.

DoubleTalk Carrier-in-Carrier allows satellite users to achieve spectral efficiencies (i.e. bps/Hz) that cannot be achieved with traditional links. E.g., DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8bps/Hz).
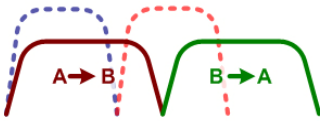
As DoubleTalk Carrier-in-Carrier allows equivalent spectral efficiency using a lower order Modulation and/or FEC Code, it can simultaneously reduce CAPEX by allowing a smaller BUC/HPA and/or antenna.

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:
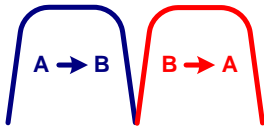
Switching to LDPC and using a lower code rate – say 8-QAM, LDPC 2/3 increases the total transponder bandwidth, while reducing the total transponder power:

Now using DoubleTalk Carrier-in-Carrier, the second carrier can be placed over the first carrier – thereby significantly reducing the total transponder bandwidth and total transponder power when compared to the original side-by-side 8PSK, TPC 3/4 carriers:
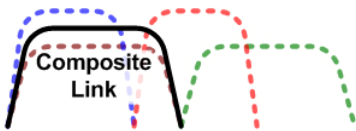
LOW DENSITY PARITY CHECK CODES (LDPC) & TURBO PRODUCT CODES (TPC)
CDM-625 offers an integrated LDPC and 2nd Generation TPC codec. LDPC is an advanced Forward Error Correction technique capable of providing performance much closer to Shannon limit compared to any other FEC technique. The current implementation is generally 0.7 to 1.2 dB better than an equivalent TPC code.

When combined with DoubleTalk Carrier-in-Carrier, LDPC/TPC provide unprecedented savings in transponder bandwidth and power utilization as well as Earth Station BUC/HPA size.

In order to take full advantage of the increased coding gain provided by LDPC, Comtech EF Data has developed an 8-QAM modulation that allows for acquisition and tracking at much lower Eb/No compared to 8-PSK.

70/140 MHz AND L-BAND CAPABILITY
CDM-625 supports 70/140 MHz and L-Band capability in the same unit with independently selectable transmit and receive IF. This simplifies sparing and stocking in networks requiring 70/140 MHz and L-band units.

CDM-600/CDM-600L EMULATION MODE
CDM-625 can be placed in CDM-600 or CDM-600L emulation mode. This allows for easy integration into an existing CDM-600/L setup without changes to M&C platform or redundancy switches.

QUAD E1 INTERFACE (QDI) WITH ENHANCED D&I++
The CDM-625 supports a Quad E1 interface that can aggregate up to 4 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.

4-PORT ETHERNET SWITCH
CDM-625 supports a 4-port 10/100BaseT managed Ethernet switch.

EDMAC & AUPC
The CDM-625 support EDMAC, EDMAC-2, and AUPC. EDMAC/EDMAC-2 can be used to monitor and control the distant end of a satellite link using a proprietary overhead channel. AUPC enables automatic uplink power control for a duplex link.

MANAGEMENT
The CDM-625 provides 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 modem can be easily integrated into an IP based management system.

FEATURE ENHANCEMENTS
Enhancing the capability of CDM-625 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.

Advanced Communication Solutions

COMTECH EF DATA

SYSTEM SPECIFICATIONS

Data Rate	18 kbps to 25 Mbps, in 1 bps steps (Modulation, FEC & Data Interface dependant)
Symbol Rate	18 ksps to 12.5 Msps
Operating Frequency	50 – 180 MHz (Standard) AND 950 – 1950 MHz (Option), 100 Hz Resolution, Independent TX and RX operation
Major Operating Modes (See User Manual For Details)	Open Network, per IESS-308 / 309 / 310 / 314 Transparent, Closed Network per IESS-315 LDPC / TPC Codec (Optional Plug-in Module) EDMAC Framed with/without AUPC RS Outer Codec High Rate ESC / Enhanced ESC (ESC++) Drop & Insert (D&I) /Enhanced D&I++ Quad E1 Drop & Insert (QDI) DoubleTalk Carrier-in-Carrier
FEC Options	
None	Uncoded BPSK/QPSK/OQPSK
Viterbi: k=7, per IESS-308/309	Rate 1/2 BPS/QPSK/OQPSK Rate 3/4 QPSK/OQPSK Rate 7/8 QPSK/OQPSK
Viterbi with Reed Solomon	Rate 3/4 16-QAM Rate 7/8 16-QAM
Reed Solomon	Open Network and Closed Network modes
TCM (Per IESS-310)	8-PSK/TCM Rate 2/3
Integrated LDPC and TPC (2nd Gen) Codec (Optional Plug-in Module)	LDPC Code Rates Rate 1/2 BPSK/QPSK/OQPSK Rate 2/3 QPSK/OQPSK/8-PSK/8-QAM Rate 3/4 QPSK/OQPSK/8-PSK/8-QAM/16-QAM TPC Code Rates Rate 5/16 BPSK Rate 21/44 BPSK/QPSK/OQPSK Rate 3/4 QPSK/OQPSK/8-PSK/8-QAM/16-QAM Rate 7/8 QPSK/OQPSK/8-PSK/8-QAM/16-QAM Rate 0.95 QPSK/OQPSK/8-PSK/8-QAM
Scrambling	IDR Mode, no RS, - per ITU V.35 (Intelsat variant) IBS mode, no RS - per IESS-309, externally frame synchronized Transparent Closed Network mode, no RS or TPC/LDPC - per ITU V.35 (Intelsat variant) EDMAC mode, no RS coding - externally frame synchronized (proprietary) TPC/LDPC modes - externally frame synchronized (proprietary) All RS modes - externally frame synchronized per IESS-308/309/310
Management	10/100 BaseT Ethernet with SNMP, HTTP and Telnet support, EIA-232, EIA-485 (2- or 4-wire)
Form C Relays	Hardware fault, Rx and Tx Traffic Alarms, Open Network Backward Alarms
External Reference (Input OR Output)	BNC Connector Input: 1, 2, 5, or 10 MHz, -6 dBm to +10 dBm, 50Ω/75Ω (nominal) Output: 10 MHz, 2.7 V peak-to-peak ± 0.4 V, Low Impedance Output

DATA INTERFACES

EIA-422/-530 DCE , Up to 14 Mbps	
V.35 DCE , Up to 14 Mbps	25-pin D-sub (Female)
LVDS Serial , Up to 25 Mbps	

HSSI Serial , Up to 25 Mbps	
G.703 T1, 1.544 Mbps (Balanced 100 Ω)	9-pin D-sub (Female) or BNC (Female)
G.703 T2, 6.312 Mbps (Unbalanced 75 Ω or balanced 110 Ω)	
G.703 E1, 2.048 Mbps (Unbalanced 75 Ω or balanced 120 Ω)	
G.703 E2, 8.448 Mbps (Unbalanced 75 Ω)	
ASI , Up to 25 Mbps	BNC (Female)
Additional 2.048 Mbps E1 Ports for Quad-E1 (Balanced 120 Ω)	9-pin D-sub (Female)
Overhead Data	44-pin High-density D-sub (Male)
Modem Alarms	15-pin D-sub (Male)
4-port 10/100BaseT Ethernet	4 x RJ-45

MODULATOR

Frequency Stability	±0.06 ppm (±6 x 10-8), 0° to 50°C (32° to 122° F) with Internal Reference
Transmit Filtering	Per IESS-308
Harmonics and Spurious	Better than -60 dBc/4 kHz (typically <-65 dBc/4kHz) Measured from 1 to 500 MHz (50-180 MHz band) Measured F_0 ± 500 MHz (950-1950 MHz band)
Transmit On/Off Ratio	-60 dBc minimum
Output Phase Noise	< 0.480° rms double sided, 100 Hz to 1MHz (Minimum 16 dB better overall than the INTELSAT IESS-308/309 requirements) dB/Hz Frequency Offset -63.0 100 Hz -73.0 1 kHz -83.0 10 kHz -93.0 100 kHz Fundamental AC line spurious is -42 dBc or lower The sum of all other single sideband spurious, from 0 to 0.75 x symbol rate, is -48 dBc or lower
Output Power	50-180 MHz: 0 to -25 dBm, 0.1 dB steps (0 to -20 dBm in CDM-600 emulation mode) 950-1950 MHz: 0 to -40 dBm, 0.1 dB steps (0 to -45 dBm in CDM-600L emulation mode, but power accuracy and spurious only guaranteed to -40 dBm)
Power Accuracy	50-180 MHz: ±0.5 dB over frequency, data rate, modulation type and temperature range of 15 to 35° C ±0.8 dB over frequency, data rate, modulation type and temperature range of 0 to 50° C 950-1950 MHz: ±0.7 dB over frequency, data rate, modulation type and temperature range of 15 to 35° C ±1.0 dB over frequency, data rate, modulation type and temperature range of 0 to 50° C
Output Impedance & Return Loss	50-180 MHz: 50Ω/75Ω, 16 db minimum return loss (18 dB typical), BNC Connector 950-1950 MHz: 50Ω, 19 db minimum return loss (21 dB typical), Type-N Connector
Clocking Options	Internal, ±0.06 ppm (SCT) External, locking over a ±100 ppm range (TT) Loop timing (Rx satellite clock) - supports asymmetric operation External Clock
External Tx Carrier Off	By TTL 'low' signal or external contact closure
BUC Reference (10 MHz)	Via TX IF center conductor, 10.0 MHz ± 0.06 ppm (With internal reference), selectable ON/OFF, 0.0 dBm ± 3 dB

BUC Power Supply (HW Option)	24VDC, 4.17 Amps max., 90 W @ 50° C 48VDC, 3.125 Amps max., 150W @ 50° C (180 W @ 30° C) Supplied through Tx IF center conductor and selectable ON/OFF via M&C control.

DEMODULATOR

Input Power Range, Desired Carrier	50-180 MHz: -105 + 10 log (symbol rate) to -70 + 10 log (symbol rate) dBm 950-1950 MHz: -130 + 10 log (symbol rate) to -80 + 10 log (symbol rate) dBm
Max Composite Operating Level	50-180 MHz: 94 - 10 log (symbol rate, desired carrier) dBc, +10 dBm max, with the additional requirement that within ±10 MHz of the desired carrier the composite power is ≤ +30 dBc 950-1950 MHz: 102 - 10 log (symbol rate, desired carrier) dBc, +10 dBm max, with the additional requirement that within ±10 MHz of the desired carrier the composite power is ≤ +30 dBc
Absolute Maximum	+20 dBm
Adaptive Equalizer	5-tap design, selectable ON/OFF
Acquisition Range	Programmable in 1kHz increments Below 32 ksymbols/sec: ±1 kHz to ± (Rs) kHz, where Rs = symbol rate in ksymbols/sec Between 32 and 389 ksymbols/sec: ±1 kHz to ±32 kHz Above 389 ksymbols/sec: ±1 kHz to ± (0.1 * Rs) kHz, up to a maximum of ± 200 kHz
Acquisition Time	Highly dependent on data rate, FEC rate, and demodulator acquisition range. E.g.: 120 ms average at 64 kbps, R1/2 QPSK, ±10 kHz acquisition sweep range, 6 dB Eb/No
Plesiochronous/ Doppler Buffer	Selectable from 64 to 262,144 bits, in 16-bit steps (Additional limitations for G.704 frame boundaries)
Receive Clock	Rx Satellite, Tx Terrestrial, External Reference
Clock Tracking	± 100 ppm minimum
LNB Reference (10 MHz)	Via RX IF center conductor, 10.0 MHz ± 0.06 ppm (With internal reference), selectable ON/OFF, -3.0 dBm ± 3 dB
LNB Voltage	Selectable ON/OFF, 13 VDC, 18 VDC per DiSEq 4.2 and 24 VDC at 500 mA maximum
Monitor Functions	E_b/N_0 estimate, Corrected BER, Frequency offset, Buffer fill state, Receive signal level

DOUBLETALK CARRIER-IN-CARRIER

Delay Range	0 to 330 ms
Power Spectral Density Ratio	–7 dB to +11 dB (Interferer to Desired)
Eb/No Degradation	0 dB Power Spectral Density Ratio BPSK/QPSK/OQPSK: 0.3 dB 8-QAM: 0.4 dB 8-PSK: 0.5 dB 16-QAM: 0.6 dB +10 dB Power Spectral Density Ratio Additional 0.3 dB

Satellite Restrictions	Satellite in "loop-back" mode (i.e., the Transmit Station can receive itself) "Non-processing" satellite (i.e., does not demodulate/remodulate the signal)

ENVIRONMENTAL AND PHYSICAL

Temperature	Operating: 0 to 50ºC (32 to 122°F)	
	Storage: -25 to 85ºC (-13 to 185ºF)	
Power Supply	100 - 240 VAC, +6%/-10%, 50/60 Hz, Auto sensing -48 VDC (HW Option)	
Power Consumption	48 watts (typical with TPC/LDPC Codec and Carrier-in-Carrier module installed), 55 watts (max.) 280 watts (typical with TPC/LDPC Codec, Carrier-in-Carrier module and 48 VDC BUC power supply installed), 300 watts (max.)	
Physical Dimensions (1RU)	1.75H x 19.0W x 17.65D inches (4.4H x 48W x 44.8D cm) approximate	
Weight	10.5 lbs (4.8 kgs) maximum, with all option modules and 48 VDC BUC power supply installed	
CE Mark	EN 55022 Class B (Emissions) EN 50082-1 (Immunity) EN 60950 (Safety) EN 61000-3-2 EN 61000-3-3 EN 61000-4-2	EN 61000-4-4 EN 61000-4-5 EN 61000-4-6 EN 61000-4-8 EN 61000-4-9 EN 61000-4-11 EN 61000-4-13
FCC	Part 15 Class B	

AVAILABLE OPTIONS

Hardware	-48 VDC, 65 W Primary Power Supply
Hardware	24 VDC, 90 W @ 50° C BUC Power Supply, AC or DC Primary Power Supply
Hardware	48 VDC, 150 W @ 50° C (180 W @ 30° C) BUC Power Supply, AC or DC Primary Power Supply
Hardware	Integrated TPC (2nd Generation) and LDPC Codec Module
Hardware	DoubleTalk Carrier-in-Carrier Module
FAST	L-Band IF (in addition to 70/140 MHz)
FAST	Modem Data Rate – 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	8-PSK and 8-QAM Modulation (8-QAM requires TPC/LDPC Codec)
FAST	16-QAM Modulation
FAST	TPC/LDPC Codec Data Rate – 10 Mbps, 15 Mbps, 20 Mbps or 20 Mbps
FAST	DoubleTalk Carrier-in-Carrier License – 512 kbps, 1 Mbps, 2.5 Mbps, 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	Open Network – IBS with High Rate IBS ESC, IDR and Audio
FAST	D&I / D&I++ For Single Port T1/E1
FAST	D&I++ For Quad E1 Port 2, 3 and 4

ACCESSORIES

CRS-170A	1:1 Modem Redundancy Switch (L-Band)
CRS-180	1:1 Modem Redundancy Switch (70/140 MHz)
CRS-300	1:10 Modem Redundancy Switch
CRS-280	1:10 IF Redundancy Switch (70/140 MHz)
CRS-280L	1:10 IF Redundancy Switch (L-Band)

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