CDM-625 Advanced Satellite Modem with DoubleTalk® Carrier-in-Carrier®

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 VersaFEC™ and 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

The advanced technologies and features of CDM-625 are covered by a number of US Patents including 7,254,188, 7,353,444, 7,415,659 and other pending patents.

KEY FEATURES

- DoubleTalk Carrier-in-Carrier bandwidth compression
- Adaptive Coding and Modulation (ACM)
- Dual Band Capability: 70/140 MHz and L-Band in 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, 16-QAM
- Forward Error Correction (FEC): Viterbi, Sequential, Concatenated Reed Solomon, TCM, Turbo Product Code (TPC) (IESS-315 Compliant), Low Density Parity Check (LDPC) Code and VersaFEC (low latency LDPC)
- 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 10/100 BaseT Ethernet
- 4-port Managed Ethernet Switch with VLAN and QoS
- Sub Mux to multiplex IP/Ethernet traffic with serial or G.703 traffic
- Drop & Insert for T1/E1
- Enhanced D&I++ for Single T1/E1 & Quad E1
- Management: 10/100 BaseT Ethernet with SNMP, Distant End SNMP Proxy, HTTP and Telnet and EIA-232/EIA-485
- Embedded Distant-end Monitor and Control (EDMAC)
- Automatic Uplink Power Control (AUPC)
- Engineering Service Channel (ESC/ESC++)
- Standard High Stability Internal Reference (± 6 x 10^{-8})
- 5-tap Adaptive Equalizer
- L-Band Tx: 10 MHz reference for BUC, FSK communications and optional BUC power supply
- L-Band Rx: 10 MHz reference and LNB power supply
- Open Network Modes
- 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.
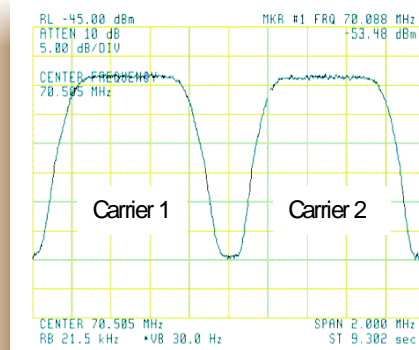

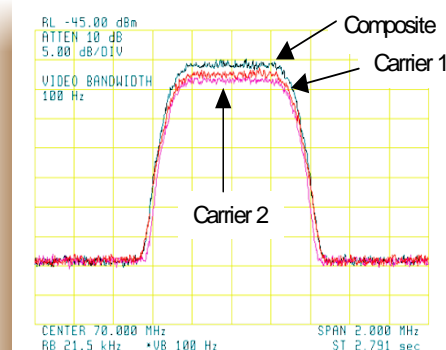**Figure 1. Traditional Full Duplex Link**

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.
VersaFEC™ is a Trademark of Comtech AHA Corp.

Modems

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.

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. Alternatively, DoubleTalk Carrier-in-Carrier can be used to achieve very high spectral efficiencies E.g., DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8bps/Hz).

When combined with VersaFEC or LDPC/TPC, it can provide unprecedented savings in transponder bandwidth and power utilization. This allows for its successful deployment in *bandwidth-limited* as well as *power-limited* scenarios as well as reduction in Earth Station BUC/HPA power requirements.

VERSAFEC FORWARD ERROR CORRECTION
CDM-625 is the first modem to offer VersaFEC, a patented (Covered by US Patents 7,353,444 and 7,415,659. Other patents pending) system of high performance short-block low latency LDPC codes designed to support latency-sensitive applications, such as cellular backhaul over satellite. VersaFEC provides excellent coding gain with lowest possible latency. VersaFEC's Eb/No performance is similar to that of DVB-S2 (short block) or LDPC (16k block) with 70-90% lower latency. Compared to TPC, VersaFEC can provide coding gain of 1.0 dB or more.

ADAPTIVE CODING & MODULATION (ACM)

Satellite users have traditionally relied on worst case link margin to overcome rain fade which leads to significant inefficiencies. ACM converts the fade margin into increased throughput – gain of 100% or more is possible. CDM-625 with VersaFEC was specifically architected to support ACM for IP/Ethernet traffic. ACM maximizes throughput under all conditions – rain fade, inclined orbit satellite operation, antenna mispointing, noise, interference and other impairments.

VersaFEC ACM can provide almost 85% reduction in latency compared to DVB-S2 (short block).

ACM can also be used with DoubleTalk Carrier-in-Carrier.

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. The current LDPC implementation can provide 0.7 to 1.2 dB additional coding gain compared to an equivalent TPC code.

In order to take full advantage of the increased coding gain provided by LDPC, Comtech EF Data has developed a patented 8-QAM modulation (US Patent 7,254,188) that allows for acquisition and tracking at much lower Eb/No compared to 8-PSK.

DUAL 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.

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 could possibly reduce the BUC/HPA size by eliminating the 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.

For QDI operation, all E1s must have a common clock source.

IP SUB MULTIPLEXER
IP Sub Mux allows multiplexing IP/Ethernet traffic with serial or G.703 traffic into a single carrier. This is particularly useful for cellular backhaul when both E1 and IP backhaul is required. This reduces the number of modems and could possibly reduce the BUC/HPA size by eliminating the multi-carrier backoff.

4-PORT MANAGED ETHERNET SWITCH WITH VLAN & QOS
CDM-625 incorporates a 4-port 10/100 BaseT Managed Ethernet Switch with VLAN capability and priority based Quality of Service (QoS). Access (Native) Mode and Trunk Mode are supported. Traffic can be prioritized using port based priority or VLAN priority.

EDMAC & AUPC
The CDM-625 support EDMAC, EDMAC-2, EDMAC-3 and AUPC. EDMAC/EDMAC-2/EDMAC-3 can be used to monitor and control the distant end of a satellite link using a proprietary overhead channel. EDMAC-3 is also used for SNMP management of the distant end modem. AUPC enables automatic uplink power control for a duplex link.

MANAGEMENT & SNMP PROXY
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.

The CDM-625 can also act as SNMP proxy for the distant end modem. This allows distant end modem management using SNMP without requiring an end-to-end IP link.

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

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.

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 – 2000 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) VersaFEC Codec (Optional Plug-in Module) with Adaptive Coding & Modulation or Constant Coding & Modulation 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 (Optional Plug-in Module)
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
Sequential	See CDM-625 User Manual for details
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
VersaFEC Codec (Optional Plug-in Module)	BPSK Rate 0.488 QPSK Rate 0.533, 0.631, 0.706, 0.803 8-QAM Rate 0.642, 0.711, 0.780 16-QAM Rate 0.731, 0.780, 0.829, 0.853
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	25-pin D-sub (Female)
V.35 DCE , Up to 14 Mbps	
LVDS Serial , Up to 25 Mbps	25-pin D-sub (Female)
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 10/100 BaseT Managed Ethernet Switch	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
Transmit Filter Rolloff	25%, 35%
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 (950-2000 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) 950-2000 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
	950-2000 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 950-2000 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
	950-2000 MHz: -130 + 10 log (symbol rate) to -80 + 10 log (symbol rate) dBm
Max Composite Operating Level	<u>50-180 MHz:</u>
	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
	<u>950-2000 MHz:</u>
	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	<u>0 dB Power Spectral Density Ratio</u>
	BPSK/QPSK/OQPSK: 0.3 dB
	8-QAM: 0.4 dB
	8-PSK: 0.5 dB
	16-QAM: 0.6 dB
	<u>+10 dB Power Spectral Density Ratio</u>
	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 or remodulate the signal)

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 – 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 61000-4-4
	EN 50082-1 (Immunity)	EN 61000-4-5
	EN 60950 (Safety)	EN 61000-4-6
		EN 61000-4-8
	EN 61000-3-2	EN 61000-4-9
	EN 61000-3-3	EN 61000-4-11
	EN 61000-4-2	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
Hardware	VersaFEC Codec 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 (Full) – 512 kbps, 1.1 Mbps, 2.5 Mbps, 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	DoubleTalk Carrier-in-Carrier License (Fractional) – 2.5 Mbps, 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps or 25 Mbps
FAST	VersaFEC Codec Data Rate (CCM) – 2.5 Mbps, 5 Mbps or 16 Mbps
FAST	VersaFEC Codec Symbol Rate (ACM) – 300 ksps, 1.2 Msps or 4.1 Msps
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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