Overview

The CDM-650 Satellite Modem is designed for use by foreign government entities that need a modem which employs state-of-the-art modulation and coding techniques to optimize satellite transponder bandwidth usage while retaining backward compatibility with a wide range of Comtech EF Data modems currently in use. The CDM-650 leverages the heritage and feature set of our very successful SLM-5650B/C, CDM-625A and CDM-425 modems. The CDM-650 supports backwards compatibility / interoperability in certain modes of operation with the SLM-5650B/C, CDM-625A and CDM-425 modems.

The CDM-650 offers data rates from 18 kbps to 155 Mbps and symbol rates from 32 ksps to 64 Msps (coding / FEC dependent). The modem supports an Ethernet 10/100/1000T user traffic data interface that can be used in Bridge mode or Routed mode offering Quality of Service protocols and traffic shaping / congestion control methods.

Advanced forward error correction (FEC) capabilities are a Comtech EF Data standard feature. Turbo Product Codes (TPC), and three Low Density Parity Check codes (LDPC) families, VersaFEC®-2 high performance LDPCs short and long block and Direct Sequence Spread Spectrum (DSSS) are all supported.

Direct sequence spread spectrum is available to support both point-to-point and point-to-multipoint applications as an option in conjunction with LDPC-based FEC and BPSK. Spreading factors up to 64 are supported. Maximum supported chip rate is 64 Mcps. Spread spectrum results in operation with ultra-low power spectral densities. This enables use of small antenna apertures when adjacent satellite interference (ASI) is an important consideration.

The IF interface supports 950 to 2000 MHz frequency ranges.

Typical Users
- Foreign Government
- Foreign MoD
- Secure Commercial Networks

Common Applications
- Communications at-the-Pause
- Communications on-the-move
- Secure Networks

Features

- Support for bridged point-to-multipoint network architecture
- BPSK, QPSK, OQPSK, 8-ARY, 16-ARY, 32-ARY
- TPC, LDPC family, VersaFEC-2, DSSS
- Direct sequence spread spectrum, integer factors 2,3,4…62, 63, 64
- Direct sequence spread spectrum, chip rates up to 64 Mcps

- 18 kbps to 155.52 Mbps
- Asymmetrical loop timing & data source bit synchronization
- Ethernet interface for remote control using HTTP, Telnet and Simple Network Management Protocol (SNMP)
- EIA-232 interface for remote control
- LNB reference and voltage
- BUC reference

Compatibility
The CDM-650 is interoperable with the SLM-5650B/C, CDM-625A and CDM-425 modems.

Data Interfaces
10/100/1000T Ethernet Auto Negotiate supporting Layer 2 Bridge Mode (BPM) and Layer 3 Routed mode. Maximum size of Ethernet frame including FCS/CRS is 2,000 Bytes.

Advanced Iterative Forward Error Correction
High performance LDPC, Turbo Product Codes and VersaFEC-2 waveforms provide superior error correction performance over Viterbi, Trellis and Reed-Solomon FEC.

Network Processor

The Network Processor (NP) module provides a wide variety of advanced Internet Protocol (IP) features including routing, switching and Quality of Service.

Networking	The modem can be configured as an Ethernet switch (NP Disabled) or as a high-speed router.
Multicast	Multicast traffic forwarding is supported via static multicast addressing.
Flow Control	Flow Control is supported via Ethernet pause frames (IEEE 801.3).
Proxy ARP	Proxy ARP is supported to enable transparent subnets.
Quality of Service (QoS)	The NP module supports multi-level QoS to reduce jitter and latency for real time traffic, provide priority treatment to mission critical applications and allow non-critical traffic to use the remaining bandwidth. Supported functionality is through differentiated services code point (DSCP) in accordance with RFCs 2474 and 2475.

Redundancy

Ultra-high reliability, redundant configurations are supported in conjunction with our CRS-170A switches. The CRS-170A can be configured to support 1:1 redundancy for any CDM-650 configuration.

Network Management / Remote Control

The modem supports access to network management information via HTTP using a standard web browser. SNMP and Telnet remote control is also supported. The modem includes separate Ethernet and EIA-232 remote control interfaces.

Specifications

Operating Frequency Range	950 to 2000 MHz in 1KHz steps
Modulation Types	BPSK, QPSK, OQPSK, 8-ARY, 16-ARY, 32-ARY
Spreading Factors	Integer factors 2-64; BPSK LDPC only
Digital Data Rate	Gigabit Ethernet: 18 kbps to 155.52 Mbps
Symbol Rate	32 ksps to 64 Msps
Chip Rate	32 kcps to 64 Mcps
INT REF Stability	$\pm$ 0.06 ppm ($\pm$ 6 x 10-8), 0° to 50°C
Scrambling	None, V.35 or Turbo Frame Synchronous
Built-in Test (BIT)	Fault and status reporting, BER performance monitoring, IF loopback, programmable test modes, built in Fireberd emulation
Summary Faults	Reported via front panel LEDs, 15-pin D sub, FORM C relay contacts for TX, RX, common equipment faults, and TX and RX alarms
Unit Management	EIA-232, 10/100/1000Base-T Ethernet with HTTP, Telnet and SNMP

Modulation

Output Power	+10 to –40 dBm, adjustable in 0.1 dB steps
Output Return Loss	L-Band: min 16 dB (VSWR < 1.37:1)
Output Impedance	50 Ω
Spurious	Relative to the modulated carrier measured in a 10 kHz bandwidth shall be less than -51 dBc for a frequency offset from the carrier of (1.0 Rs to 500 MHz).
Harmonics	60 dBc below the level of an un-modulated (CW) carrier. Frequency range shall be up to the greater of the 12th harmonic or 4,000 MHz.
TX Clock Source	Internal
Output Connectors	Type "N" female 950 to 2000 MHz

Demodulation

Input Carrier Power	L-Band: +10 to –55 dBm carrier (SR > 3.2 Msps) +10 to [-55 - $10\log_{10}$(3.2/SR)], (SR ≤ 3.2 Msps)
Maximum Composite Power	102 – 10·log10(symbol rate, desired carrier) dBc, +10dBm max, with the additional requirement that within ±10Mhz of the desired carrier, composite power is ≤ +30 dBc
Input Impedance	50 Ω
Input Connectors	Type "N" female 950 to 2000 MHz
Carrier Acquisition Range	+/-5% of Modulated Symbol Rate
Input Return Loss	L-Band: min 16 dB (VSWR < 1.37:1)
Buffer Clock	Internal

Coding Options

Turbo Product Code (TPC)	Standard	5/16, 21/44, 3/4, 7/8, 17/18
Low Density Parity Check (LDPC)	Optional	1/2, 2/3, 3/4, 7/8
VersaFEC-2	Optional	.489, .521, .537, .562, .586, .611, .635, .660, .684, .708, .733, .757, .782, .801, .831, .855, .879

Available Options

How Enabled	Option
FAST	Data rates 52 (std) or 155 Mbps
FAST	LDPC
FAST	VersaFEC-2 CCM
FAST	VersaFEC-2 ACM
FAST	Spread Spectrum (DSSS)
FAST	NP Network Processor and Diff Serv / QoS
Hardware	24 or 48 VDC BUC power supply
Hardware	-48VDC Modem Source Supply

Environmental And Physical

Prime Power	100 to 240 VAC, 47 to 63 Hz 60 W (max), 40 W typical 48 VDC optional
Mounting	1RU
Dimensions (height x width x depth)	1.71" x 19" x 15.0" (4.3 x 48 x 38.1 cm)
Weight	≤ 12 lbs (5.5 kg)
Temperature, Operating	0 to 50°C (32 to 122°F)
Temperature, Storage (Non-operational)	-40 to +70°C (-40 to 158°F)
Humidity	0 to 95%, non-condensing

BER Performance
Example Modes and Performance

Turbo Product Code and Turbo ACM Modes

	TURBO Decoder E_b/N_0 Specifications										
BER	**BPSK**		**QPSK/OQPSK**				**8PSK / 8-QAM**			**16-QAM**	
	21/44	5/16	21/44	3/4	7/8	17/18	3/4	7/8	17/18	3/4	7/8
10^{-6}	3.3	2.5	3.3	3.9	4.3	6.8	6.5	7.1	10.0	7.6	8.2
10^{-7}	3.4	2.8	3.4	4.1	4.4	7.1	6.9	7.2	10.6	8.0	8.4
10^{-8}	3.5	3.1	3.5	4.3	4.5	7.4	7.2	7.3	11.2	8.4	8.5
10^{-9}	3.6	3.4	3.6	4.8	4.6	7.7	7.5	7.4	11.8	8.7	8.7
10^{-10}	3.7		3.7		4.7		7.8	7.5		9.0	8.8

LDPC Modes

	ULL Decoder E_b/N_0 Specifications			
BER	**BPSK**	**QPSK**		
	1/2	1/2	2/3	3/4
10^{-5}	3.1	3.1	3.6	4.1
10^{-8}	3.7	3.7	4.2	4.7

	LL Decoder E_b/N_0 Specifications											
BER	**BPSK**			**QPSK**				**8-QAM**			**16-QAM**		
	.378	.451	.541	1/2	2/3	3/4	7/8	2/3	3/4	7/8	2/3	3/4	7/8
10^{-5}	1.8	2.0	2.2	2.4	3.0	3.6	4.4	5.0	5.6	6.6	6.1	6.8	8.0
10^{-8}	2.1	2.3	2.5	2.7	3.3	3.9	4.9	5.3	5.9	7.0	6.4	7.1	8.3

	HP Decoder E_b/N_0 Specifications							
BER	**BPSK**		**QPSK**			**8-QAM**		**16-QAM**
	1/3	1/2	1/2	2/3	3/4	2/3	3/4	3/4
10^{-5}	2.0	2.0	2.0	2.4	3.0	4.7	5.7	6.8
10^{-8}	2.3	2.3	2.3	2.7	3.3	5.0	6.0	7.1

VersaFEC-2 - Long Block Modes

ModCod	Modulation	Code Rate	Spectral efficiency, bps/Hz	Block size, bits	Typical * Es/No (SNR), for BER = 1 x 10⁻⁸ (dB)	Latency at 128 kbps (ms)	Min. Data Rate, CCM Mode (kbps)	Max. Data Rate, CCM Mode (Mbps)	Min Sym Rate, ACM Mode (ksps)	Max Sym Rate, ACM Mode (Msps)
00	BPSK	0.489	0.489	4800	-1.3	79	18.0	6.1	37	12.5
01	QPSK	0.489	0.977	9600	1.5	153	18.0	12.2	37	12.5
02	QPSK	0.537	1.075	10560	2.0	170	19.3	13.4	37	12.5
03	QPSK	0.586	1.173	11520	2.6	185	21.1	14.7	37	12.5
04	QPSK	0.611	1.221	12000	2.8	193	22.0	15.3	37	12.5
05	QPSK	0.635	1.270	12480	3.2	200	22.9	15.9	37	12.5
06	QPSK	0.660	1.319	12960	3.5	208	23.7	16.5	37	12.5
07	QPSK	0.684	1.368	13440	3.7	215	24.6	17.1	37	12.5
08	QPSK	0.733	1.466	14400	4.4	231	26.4	18.3	37	12.5
09	8-ARY	0.521	1.564	15360	5.1	246	28.1	19.5	37	12.5
10	8-ARY	0.537	1.612	15840	5.4	254	29.0	20.2	37	12.5
11	8-ARY	0.562	1.686	16560	5.6	265	30.3	21.1	37	12.5
12	8-ARY	0.586	1.759	17280	5.8	276	31.7	22.0	37	12.5
13	8-ARY	0.611	1.832	18000	6.0	287	33.0	22.9	37	12.5
14	8-ARY	0.635	1.906	18720	6.2	299	34.3	23.8	37	12.5
15	8-ARY	0.660	1.979	19440	6.5	311	35.6	24.7	37	12.5
16	8-ARY	0.684	2.052	20160	6.9	322	36.9	25.0	37	12.2
17	8-ARY	0.708	2.125	20880	7.2	333	38.3	25.0	37	11.8
18	8-ARY	0.733	2.199	21600	7.5	345	39.6	25.0	37	11.4
19	16-ARY	0.586	2.345	23040	8.1	368	42.2	25.0	37	10.7
20	16-ARY	0.611	2.443	24000	8.6	383	44.0	25.0	37	10.2
21	16-ARY	0.635	2.541	24960	8.9	398	45.7	25.0	37	9.8
22	16-ARY	0.660	2.638	25920	9.2	413	47.5	25.0	37	9.5
23	16-ARY	0.684	2.736	26880	9.6	429	49.3	25.0	37	9.1
24	16-ARY	0.708	2.834	27840	10.0	444	51.0	25.0	37	8.8
25	16-ARY	0.733	2.932	28800	10.5	459	52.8	25.0	37	8.5
26	16-ARY	0.757	3.029	29760	10.9	474	54.5	25.0	37	8.3
27	16-ARY	0.782	3.127	30720	11.4	489	56.3	25.0	37	8.0
28	32-ARY	0.660	3.298	32400	12.0	517	59.4	25.0	37	7.6
29	32-ARY	0.684	3.420	33600	12.5	535	61.6	25.0	37	7.3
30	32-ARY	0.708	3.542	34800	12.9	554	63.8	25.0	37	7.1
31	32-ARY	0.733	3.664	36000	13.3	573	66.0	25.0	37	6.8
32	32-ARY	0.757	3.787	37200	13.7	592	68.2	25.0	37	6.6
33	32-ARY	0.782	3.909	38400	14.2	610	70.4	25.0	37	6.4
34	32-ARY	0.801	4.007	39360	14.7	625	72.1	25.0	37	6.2
35	32-ARY	0.831	4.153	40800	15.2	648	74.8	25.0	37	6.0
36	32-ARY	0.855	4.275	42000	16.0	667	77.0	25.0	37	5.8
37	32-ARY	0.879	4.397	43200	16.7	685	79.2	25.0	37	5.7

VersaFEC-2 - Short Block Modes

ModCod	Modulation	Code Rate	Spectral efficiency, bps/Hz	Block size, bits	Typical * Es/No (SNR), for BER = 1 x 10⁻⁸ (dB)	Latency at 128 kbps (ms)	Min. Data Rate, CCM Mode (kbps)	Max. Data Rate, CCM Mode (Mbps)	Min Sym Rate, ACM Mode (ksps)	Max Sym Rate, ACM Mode (Msps)
00	BPSK	0.489	0.489	800	-0.2	16	18.0	2.0	37	1
01	QPSK	0.489	0.977	1600	2.3	30	18.0	2.0	37	1
02	QPSK	0.537	1.075	1760	2.8	33	19.3	2.0	37	1
03	QPSK	0.586	1.173	1920	3.4	36	21.1	2.0	37	1
04	QPSK	0.611	1.221	2000	3.7	37	22.0	2.0	37	1
05	QPSK	0.635	1.270	2080	3.9	38	22.9	2.0	37	1
06	QPSK	0.660	1.319	2160	4.2	39	23.7	2.0	37	1
07	QPSK	0.684	1.368	2240	4.5	41	24.6	2.0	37	1
08	QPSK	0.733	1.466	2400	5.2	43	26.4	2.0	37	1
09	8-ARY	0.521	1.564	2560	5.6	46	28.1	2.0	37	1
10	8-ARY	0.537	1.612	2640	5.9	47	29.0	2.0	37	1
11	8-ARY	0.562	1.686	2760	6.2	49	30.3	2.0	37	1
12	8-ARY	0.586	1.759	2880	6.4	51	31.7	2.0	37	1
13	8-ARY	0.611	1.832	3000	6.6	53	33.0	2.0	37	1
14	8-ARY	0.635	1.906	3120	6.9	55	34.3	2.0	37	1
15	8-ARY	0.660	1.979	3240	7.2	57	35.6	2.0	37	1
16	8-ARY	0.684	2.052	3360	7.5	59	36.9	2.0	37	1
17	8-ARY	0.708	2.125	3480	7.8	61	38.3	2.0	37	1
18	8-ARY	0.733	2.199	3600	8.3	63	39.6	2.0	37	1
19	16-ARY	0.586	2.345	3840	8.7	67	42.2	2.0	37	1
20	16-ARY	0.611	2.443	4000	9.0	70	44.0	2.0	37	1
21	16-ARY	0.635	2.541	4160	9.3	73	45.7	2.0	37	1
22	16-ARY	0.660	2.638	4320	9.7	76	47.5	2.0	37	1
23	16-ARY	0.684	2.736	4480	10.3	79	49.3	2.0	37	1
24	16-ARY	0.708	2.834	4640	10.7	82	51.0	2.0	37	1
25	16-ARY	0.733	2.932	4800	11.0	85	52.8	2.0	37	1
26	16-ARY	0.757	3.029	4960	11.6	88	54.5	2.0	37	1
27	16-ARY	0.782	3.127	5120	12.2	91	56.3	2.0	37	1
28	32-ARY	0.660	3.298	5400	12.8	93	59.4	2.0	37	1
29	32-ARY	0.684	3.420	5600	13.1	96	61.6	2.0	37	1
30	32-ARY	0.708	3.542	5800	13.4	99	63.8	2.0	37	1
31	32-ARY	0.733	3.664	6000	14.0	102	66.0	2.0	37	1
32	32-ARY	0.757	3.787	6200	14.4	105	68.2	2.0	37	1
33	32-ARY	0.782	3.909	6400	14.8	109	70.4	2.0	37	1
34	32-ARY	0.801	4.007	6560	15.2	112	72.1	2.0	37	1
35	32-ARY	0.831	4.153	6800	15.8	117	74.8	2.0	37	1