Overview

The SLM-5650B Satellite Modem is our latest generation USARSTRAT WGS certified modem product targeted for critical commercial backhaul and government and military applications. It is fully compliant with MIL-STD-188-165A/B and fully complies with STANAG 4486 Edition 3, Annex E (EBEM) and supports FIPS 140-2 certified encryption. The SLM-5650B leverages the heritage and feature set of our very successful SLM-5650A modem. The SLM-5650B supports backwards compatibility / inter-operability for existing SLM-5650A networks while providing enhanced performance and new features including:

Embedded:
- Gigabit Ethernet Bridge interface
- LNB reference and voltage
- BUC reference

Increased/Improved:
- Field Programmable Gate Array (FPGA) resource increased by x5 (future proof)
- Maximum spreading factor (512)
- Maximum chip rate (64 Mcps)
- Maximum symbol rate with LDPC (40Msps)

Decreased:
- DSSS acquisition times (x8 faster)
- Power consumption (reduced ~ 25%)
- Chassis length (reduced 1.5 inches)

The SLM-5650B is compliant with the strict requirements defined in MIL-STD-188-165A, modem types I, II, IV, V and VI for applications on DSCS, WGS and commercial satellites. Data rates from 8 kbps to 155 Mbps and symbol rates from 32 ksps to 64 Msps are supported. The modem provides standard MIL-STD-188-114 (EIA-530 / RS-422), and EIA-613 (HSSI) serial interfaces, and can be optionally configured to support G.703 and Low Voltage Differential Signaling (LVDS) serial interfaces. It can also optionally be equipped with a 4-port 10/100/1000Base-T Ethernet Network Processor module that supports switching, routing and advanced Quality of Service protocols.

The SLM-5650B can be integrated with the Vipersat Management System (VMS) to provide fully automated network and capacity management (future software upgrade). An AES-256 TRANSEC module, compliant with the FIPS 140-2 standard, is also available as an option. All traffic (including overhead and all VMS control traffic) is encrypted when using the TRANSEC module.

Advanced forward error correction (FEC) capabilities are a Comtech EF Data standard feature. Viterbi, Trellis, Concatenated Reed-Solomon, Sequential, Turbo Product Codes, and three Low Density Parity Check codes (LDPC) families 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 512 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 52 to 88, 104 to 176, and 950 to 2000 MHz frequency ranges.

Typical Users
- Government
- Military
- Secure Commercial Networks

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

Features

- MIL-STD-188-165A compliant (Types I, II, IV, V, VI)
- Selectable 70/140 MHz and 950 – 2000 MHz IFs
- AES-256 TRANSEC, FIPS 140-2 certified
- Dynamic bandwidth allocation with Vipersat Management System (future software upgrade)
- Support for bridged point-to-multipoint network architecture
- BPSK, QPSK, OQPSK, 8PSK, 8-QAM, 16-QAM
- Viterbi, Reed Solomon, Trellis, Sequential, Turbo Product Code (TPC), EBEM, & Low Density Parity Check (LDPC) FEC
- FEC rates 1/1, 5/16, 1/2, 2/3, 3/4, 5/6, 7/8, and others

- Direct sequence spread spectrum, integer factors 2,3,4…510, 511, 512
- Direct sequence spread spectrum, chip rates up to 64 Mcps
- 8 kbps to 155.52 Mbps
- IESS-308, -309, -310, -315
- ASYNC RS-485 overhead channel & AUPC
- Asymmetrical loop timing & data source bit synchronization
- Ethernet interface for remote control using HTTP, Telnet and Simple Network Management Protocol (SNMP)
- EIA-485 and EIA-232 interface for remote control

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Compatibility

The SLM-5650B is interoperable with the OM-73, SLM-3650, MD-1352(P)/U (BEM-7650), SLM-7650, SLM-8650, SLM-5650A, DMD20, DMD2050, DMD1050T, DMD1050TS and DMD2050E satellite modems. It is also compatible with modems from other vendors that are compliant with MIL-STD-188-165A/B and STANAG 4486 Ed. 3, Annex E.

Data Interfaces

The modem supports EIA-530 (RS 422), EIA-612/613 (HSSI) and single Gigabit Ethernet port as standard features. An optional 4-port Gigabit Ethernet interface is also available.

TRANSEC Module

An optional transmission security (TRANSEC) module provides bulk AES-256 encryption/decryption certified to FIPS 140-2. The TRANSEC module encrypts all traffic sent over the air, including data traffic, overhead channel and Vipersat Management System messages (if present). The TRANSEC module supports both EBEM mode using AES-256 CTR (Counter) mode and Static Key mode using AES-256 CBC mode.

Advanced Iterative Forward Error Correction

High performance LDPC and Turbo coding (both TPC and EBEM Turbo) provides superior error correction performance over Viterbi, Trellis and Reed-Solomon FEC. The SLM-5650B TPC is compatible with Intelsat IESS 315 and Comtech EF Data's CDM-570(A), CDM 600, CDM-625(A), SLM 3650, SLM 7650, DMD20, DMD2050, DMD1050T and DMD2050E Satellite Modems. The high-performance LDPC is compatible with the CDM570A, CDM-625A, DMD2050E, and DMD1050TS. The EBEM Turbo mode is compatible with the MD1366 modem.

EBEM Information Throughput Adaptation (ITA)

In ITA mode, modems automatically communicate the maximum efficiency modulation and coding mode to the be used by the distant end modem, maximizing throughput and link availability under all conditions.

ASYNC Overhead Channel / AUPC

An asynchronous overhead channel supporting 2- and 4-wire RS-485, as well as RS-232 can be optionally configured. Automatic Uplink Power Control (AUPC) is available to maintain a desired Eb/No at the demodulator despite link fades due to excessive rain or other power level variations.

Network Processor

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

Networking	With the NP module installed, the modem can be configured as an Ethernet switch or as a high-speed router. Networking options include configuration of a bridged point–to-multipoint network, which enables bridged network connectivity (desired in many satellite networks carrying encrypted traffic) in a hub-spoke network architecture.
Multicast	Multicast traffic forwarding is supported via static multicast addressing, dynamic multicast address learning through IGMP router and IGMP Proxy, and via the bridged point-to-multipoint mode of operation.
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 includes differentiated services code point (DSCP) in accordance with RFCs 2474 and 2475, Expedited Forwarding in accordance with RFC 3246, and Per Hop Behavior in accordance with RFC 3247.
VMS Bandwidth Management	The Vipersat Management System (VMS) is the engine that provides dynamic Single Carrier per Channel (dSCPC) bandwidth management of the space segment (future software upgrade).

Antenna Handover

Supports lossless, low-latency antenna handover in conjunction with the CRS-311-AH antenna handover switch controller.

Expanded Dynamic Range

The modem exceeds the MIL-STD-188-165A input signal dynamic range requirements by extending the low signal input level requirement of –55 dBm to down to –70 dBm for lower baud rate carriers.

Redundancy

Ultra high reliability, redundant configurations are supported in conjunction with Comtech EF Data's CRS-311 and CRS-300 switches. The CRS-311 can be configured to support 1:1 redundancy for any SLM-5650B configuration. The CRS-300 provides the same functionality for 1:N redundant system architectures.

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-485/EIA-232 remote control interfaces. Remote control can also be accomplished via the Ethernet ports of the optional Network Processor. Secure network management via Secure Sockets Layer (SSL), Secure Shell (SSH) and SNMPv3 are available as options.

Specifications

Operating Frequency Range	52 to 88 MHz, 104 to 176 MHz, 950 to 2000 MHz in 100 Hz steps
Modulation Types	BPSK, QPSK, OQPSK, 8PSK, 8QAM, 16APSK, 16QAM
Spreading Factors	Integer factors 2-512; BPSK LDPC only
Digital Data Rate	EIA-530: 64 kbps to 20 Mbps, 1 bps steps EIA-613: 64 kbps to 51.84 Mbps, 1 bps steps Gigabit Ethernet: 8 kbps to 155.52 Mbps
Symbol Rate	32 ksps to 64 Msps
Chip Rate	32 kcps to 64 Mcps
External Reference Input	TNC connector, 1, 5, or 10 MHz, selectable
INT REF Stability	± 0.06 ppm (± 6 x 10-8), 0° to 50°C
Scrambling	V.35, OM-73 and synchronous
IDR/IBS Framing Compatibility	Support for IDR and IBS framing. Allows basic IDR/IBS open network compatible operation
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-485, EIA-232, 10/100Base-T Ethernet with HTTP, Telnet and SNMP

Modulation

Output Power	+10 to –40 dBm, adjustable in 0.1 dB steps
Output Return Loss	14 dB (70/140 MHz) 9 dB (L-Band)
Output Impedance	50 Ω
Spurious	From Carrier + symbol rate to 500 MHz: -51 dBc
Harmonics	From carrier (CW) to 4000 MHz: -60 dBc
TX Clock Source	INT, TX terrestrial, and data source sync, RX satellite
Output Connectors	TNC for 52 to 88 MHz, 104 to 176 MHz Type "N" for 950 to 2000 MHz

Demodulation

Input Carrier Power	70/140MHz bands: +10 to -55dBm L-Band: +10 to –55 dBm carrier (SR > 3.2 Msps) +10 to [-55 - 10log$_{10}$(3.2/SR)], (SR ≤ 3.2 Msps)
Maximum Composite Power	+20 dBm or +40 dBc
Input Impedance	50 Ω
Input Connectors	TNC for 52 to 88 MHz, 104 to 176 MHz Type "N" for 950 to 2000 MHz
Carrier Acquisition Range	± 30 kHz, selectable
Input Return Loss	14 dB (70/140 MHz) 9 dB (L-Band)
Buffer Clock	INT, TX terrestrial, RX satellite
Doppler Buffer	32 to 16,777,216 bits, selectable

Coding Options

Uncoded	Standard	1/1
Viterbi	Standard	K=7,1/2, 3/4, and 7/8 rates
Viterbi & Reed-Solomon	Standard	Closed network, per IESS-308 and IESS-309
Trellis	Standard	Per IESS-310
Trellis and Reed-Solomon	Standard	Per IESS-310
Sequential	Optional	1/2, 3/4, and 7/8 rates
Turbo Product Code (TPC)	Optional	5/16, 21/44, 3/4, and 7/8 TPC per IESS-315
Low Density Parity Check (LDPC)	Optional	1/2, 2/3, 3/4, and 7/8 HP, LL, and ULL modes
EBEM Turbo	Optional	1/2, 2/3, 3/4, 7/8 and 19/20 (CCM or ITA)

Available Options

How Enabled	Option
FAST	Data rates to 5, 10, 20, 52 or 155 Mbps
FAST	8PSK/8-QAM and 16-QAM
FAST	TPC to 5, 10, 20, 52 or 155 Mbps
FAST	LDPC & EBEM
FAST	Vipersat Management System (future)
FAST	Carrier-in-Carrier (future)
FAST	Diff-Serv QoS
FAST	Secure Network Management (SSL/SSH/SNMPv3)
FAST	ASYNC RS-485/232 overhead channel /AUPC
FAST	Sequential FEC
FAST	Asymmetric TX/RX data rate levels
FAST	Bridged point- to-multipoint
FAST	Spread Spectrum (DSSS and/or DSSS-MA)
Hardware	G.703 data interface
Hardware	LVDS data interface
Hardware	TRANSEC module
Hardware	Gigabit Ethernet Bridge or Network Processor
Hardware	Extended Operational Temperature
Hardware	24 VDC power supply

Environmental And Physical

Prime Power	90 to 264 VAC, 47 to 63 Hz 110 W (max), 80 W typical 24 VDC optional
Mounting	1RU
Dimensions (height x width x depth)	1.71" x 19" x 17.5" (4.3 x 48 x 48 cm)
Weight	≤ 12 lbs (5.5 kg)
Temperature, Operating Extended Temp Option:	0 to 50°C (32 to 122°F) -32° to 50°C (-25 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

Mod / FEC	Code Rate	Eb/No Guaranteed (Typical)				Data Rate Range (kbps)
		10^{-5}	10^{-6}	10^{-7}	10^{-8}	
Legacy Modes						
QPSK/OQPSK VIT	1/2	5.5 (5.1)	6.1 (5.7)	6.7 (6.2)	7.2 (6.6)	64 - 51,840
QPSK/OQPSK VIT	3/4	6.8 (6.3)	7.5 (6.9)	8.2 (7.6)	8.8 (8.3)	64 - 51,840
QPSK/OQPSK VIT	7/8	7.9 (7.2)	8.6 (7.9)	9.2 (8.5)	10.2 (9.4)	64 - 51,840
QPSK/OQPSK VIT R-S	1/2	3.8 (3.4)	4.1 (3.6)	4.2 (3.8)	4.4 (4.0)	64 - 51,840
QPSK/OQPSK VIT R-S	3/4	5.4 (4.7)	5.6 (4.9)	5.8 (5.1)	6.0 (5.3)	64 - 51,840
QPSK SEQ	1/2	4.8 (4.4)	5.0 (4.5)	5.4 (4.9)	5.8 (5.3)	64 - 2,500
QPSK SEQ	3/4	5.7 (5.2)	5.9 (5.4)	6.4 (5.9)	6.8 (6.3)	64 - 3,750
QPSK SEQ	7/8	7.1 (6.6)	7.3 (6.8)	7.8 (7.3)	8.4 (7.9)	64 - 4,375
8PSK TRE	2/3	7.1 (6.6)	7.3 (6.8)	8.1 (7.6)	8.8 (8.3)	256 - 51,840
8PSK TRE R-S	2/3	6.0 (5.5)	6.2 (5.7)	6.5 (6.0)	6.7 (6.2)	256 - 51,840
TPC Modes						
BPSK TPC	5/16	2.4 (1.9)	2.5 (2.0)	2.8 (2.3)	3.1 (2.6)	64 - 20,000
BPSK TPC	21/44	3.2 (2.7)	3.3 (2.8)	3.4 (2.9)	3.5 (3.0)	64 - 30,545
QPSK TPC	21/44	3.2 (2.7)	3.3 (2.8)	3.4 (2.9)	3.5 (3.0)	64 - 61,091
QPSK TPC	3/4	4.0 (3.5)	4.1 (3.6)	4.3 (3.8)	4.6 (4.1)	64 - 96,000
QPSK TPC	7/8	4.4 (3.9)	4.5 (4.0)	4.6 (4.1)	4.7 (4.2)	64 -112,000
8PSK TPC	3/4	6.4 (5.7)	6.5 (5.8)	6.9 (6.0)	7.2 (6.3)	64 -144,000
8PSK TPC	7/8	7.0 (6.5)	7.1 (6.6)	7.2 (6.7)	7.3 (6.8)	64 -155,000
16-QAM TPC	3/4	7.5 (6.9)	7.6 (7.0)	7.95(7.3)	8.3(7.7)	64 -155,000
16-QAM TPC	7/8	8.1 (7.6)	8.2 (7.7)	8.35(7.8)	8.5(7.9)	64 -155,000
STANAG 4486 Edition 3 (EBEM) Turbo Modes						
BPSK 4486 Turbo (EBEM)	1/2	1.95 (1.6)	2.05 (1.6)	2.1 (1.7)	2.15 (1.7)	64 – 14910
BPSK 4486 Turbo (EBEM)	2/3	2.8 (2.4)	2.85 (2.4)	2.9 (2.5)	2.95 (2.6)	64 – 19,861
BPSK 4486 Turbo (EBEM)	3/4	3.4 (2.9)	3.45 (3.0)	3.5 (3.0)	3.55 (3.1)	64 – 22,329
BPSK 4486 Turbo (EBEM)	7/8	4.5 (4.1)	4.55 (4.1)	4.6 (4.2)	4.65 (4.2)	64 – 26,029
BPSK 4486 Turbo (EBEM)	19/20	6.0 (5.6)	6.1 (5.7)	6.2 (5.8)	6.3 (5.9)	64 – 28,249
QPSK 4486 Turbo (EBEM)	1/2	2.15 (1.7)	2.2 (1.8)	2.25 (1.8)	2.3 (1.9)	64 – 29,731
QPSK 4486 Turbo (EBEM)	2/3	3.05 (2.6)	3.1 (2.6)	3.15 (2.7)	3.2 (2.7)	64 – 39,561
QPSK 4486 Turbo (EBEM)	3/4	3.75 (3.3)	3.8 (3.4)	3.8.5 (3.4)	3.9 (3.5)	64 – 44,456
QPSK 4486 Turbo (EBEM)	7/8	4.55 (4.1)	4.6 (4.2)	4.65 (4.2)	4.7 (4.3)	64 – 51,784
QPSK 4486 Turbo (EBEM)	19/20	6.1 (5.7)	6.2 (5.8)	6.3 (5.9)	6.4 (6.0)	64 – 56,176
8PSK 4486 Turbo (EBEM)	1/2	3.8 (3.4)	3.9 (3.5)	4.0 (3.6)	4.05 (3.7)	256 – 44,456
8PSK 4486 Turbo (EBEM)	2/3	5.35 (4.9)	5.4 (5.0)	5.45 (5.0)	5.5 (5.1)	256 – 59,103
8PSK 4486 Turbo (EBEM)	3/4	6.4 (6.0)	6.45 (6.0)	6.5 (6.1)	6.55 (6.1)	256 – 66,388
8PSK 4486 Turbo (EBEM)	7/8	7.75 (7.3)	7.8 (7.4)	7.85 (7.4)	7.9 (7.5)	256 – 77,275
8PSK 4486 Turbo (EBEM)	19/20	9.8 (9.4)	9.9 (9.5)	10.0 (9.6)	10.1 (9.7)	256 – 83,774
16APSK 4486 Turbo (EBEM)	1/2	4.85 (4.4)	4.9 (4.5)	4.95 (4.5)	5.0 (4.6)	256 – 59,103
16APSK 4486 Turbo (EBEM)	2/3	6.6 (6.2)	6.65 (6.2)	6.7 (6.3)	6.75 (6.3)	256 – 78488
16APSK 4486 Turbo (EBEM)	3/4	7.55 (7.2)	7.6 (7.2)	7.7 (7.3)	7.75 (7.3)	256 – 88,112
16APSK 4486 Turbo (EBEM)	7/8	8.6 (8.2)	8.7 (8.3)	8.8 (8.4)	8.9 (8.5)	256 – 102,484
16APSK 4486 Turbo (EBEM)	19/20	10.6 (10.2)	10.7 (10.3)	10.8 (10.4)	10.9 (10.5)	256 – 111,024

LPDC Modes						
High Performance						
BPSK LDPC	1/3	1.8 (1.6)	1.9 (1.7)	2.0 (1.8)	2.1 (1.9)	8 – 13,333
BPSK LDPC	1/2	2.0 (1.7)	2.1 (1.8)	2.2 (1.9)	2.3 (2.0)	8 - 20,000
QPSK LDPC	1/2	2.0 (1.7)	2.1 (1.8)	2.2 (1.9)	2.3 (2.0)	32 - 40,000
QPSK LDPC	2/3	2.3 (2.0)	2.4 (2.1)	2.5 (2.2)	2.6 (2.3)	42.7 -53,333
QPSK LDPC	3/4	3.0 (2.6)	3.1 (2.7)	3.2 (2.8)	3.3 (3.0)	48 - 60,000
8-QAM LDPC	2/3	4.6 (4.2)	4.7 (4.3)	4.8 (4.4)	4.9 (4.5)	256 - 60,000
8-QAM LDPC	3/4	5.6 (5.2)	5.7 (5.3)	5.8 (5.4)	5.9 (5.5)	256 - 60,000
16-QAM LDPC	3/4	6.8 (6.2)	6.9 (6.4)	7.0 (6.6)	7.1 (6.8)	256 – 60,000
Low Latency						
BPSK LL	0.378	1.9 (1.6)	2.0 (1.7)	2.1 (1.8)	2.2 (1.9)	8 - 5,000
BPSK LL	0.451	2.1 (1.8)	2.2 (1.8)	2.3 (2.0)	2.4 (2.1)	8 - 5,000
BPSK LL	0.541	2.2 (1.9)	2.3 (2.0)	2.4 (2.1)	2.5 (2.2)	8 - 5,000
QPSK LL	1/2	2.3 (2.0)	2.4 (2.1)	2.5 (2.2)	2.6 (2.3)	32 - 5,000
QPSK LL	2/3	3.1 (2.8)	3.2 (2.9)	3.3 (3.0)	3.4 (3.1)	42.5 – 5,000
QPSK LL	3/4	3.8 (3.5)	3.9 (3.6)	4.0 (3.7)	4.1 (3.8)	47.7 – 5,000
QPSK LL	7/8	4.6 (4.3)	4.7 (4.4)	4.8 (4.5)	4.9 (4.6)	55.8 – 5,000
8-QAM LL	2/3	5.5 (5.2)	5.6 (5.3)	5.7 (5.4)	5.8 (5.5)	256 – 5,000
8-QAM LL	3/4	6.3 (6.0)	6.4 (6.1)	6.5 (6.2)	6.6 (6.3)	256 – 5,000
16-QAM LL	2/3	6.6 (6.3)	6.7 (6.4)	6.8 (6.5)	6.9 (6.6)	256 – 5,000
16-QAM LL	3/4	7.4 (7.1)	7.5 (7.2)	7.6 (7.3)	7.7 (7.4)	256 – 5,000
Ultra Low Latency						
BPSK ULL	1/2	3.1 (2.8)	3.4 (3.1)	3.7 (3.4)	3.8 (3.5)	8 - 2,000
QPSK ULL	1/2	3.1 (2.8)	3.4 (3.1)	3.7 (3.4)	3.8 (3.5)	32 - 2,000
QPSK ULL	2/3	3.6 (3.3)	3.9 (3.6)	4.2 (3.9)	4.3 (4.0)	41.8 - 2,000
QPSK ULL	3/4	4.1 (3.8)	4.2 (3.9)	4.7 (4.4)	4.8 (4.5)	47.0 - 2,000

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