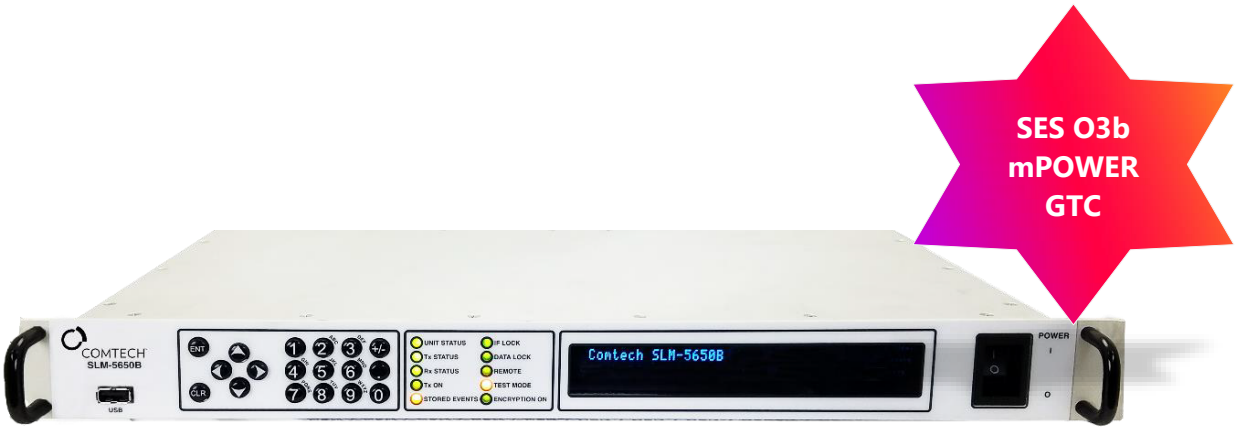
SLM-5650B Satellite Modem



Overview

The SLM-5650B Satellite Modem is our latest generation software defined multi-orbit modem supporting Medium Earth Orbit (MEO) and Geostationary Earth Orbit (GEO) operation. It's the first Transmission Security (TRANSEC) enabled satellite modem to receive Government Terminal Certification (GTC) for Sovereign networks on the SES O3b mPOWER satellite constellation. As the first TRANSEC enabled GTC modem for Sovereign networks on mPOWER, the SLM-5650B provides critical hybrid communications services to Department of Defense ("DoD") and coalition partners operating in some of the world's most challenging environments.

The SLM-5650B is WGS certified for critical government and military applications. It is fully compliant with MIL-STD-188-165A and complies with STANAG 4486 Edition 3, Annex E (EBEM) and supports FIPS 140-2 validated encryption.

The SLM-5650B also addresses the requirements for high performance commercial trunking and backhaul applications.

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:

- SES O3b mPOWER operation
- STANAG 4486 Edition 3, Annex E (EBEM)
- Direct Sequence Spread Spectrum (DSSS) with spread factor up to 512 and chip rate up to 64 Msps
- Significant reduction in DSSS acquisition time
- DVB-S2X
- FIPS 140-3 TRANSEC (Roadmap)
- Gigabit Ethernet Bridge interface
- LNB reference and voltage
- BUC reference

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. It supports data rates from 8 kbps to 155 Mbps and symbol rates from 32 ksps to 64 Msps. The modem provides MIL-STD- 188-114 (EIA-530/RS-422), and EIA-613 (HSSI) serial interfaces, and can optionally be 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, bridged point-to-multipoint (BPM) topology, routing and advanced Quality of Service protocols.

SLM-5650B includes an AES-256 TRANSEC module, compliant with the FIPS 140-2 standard. All traffic (including overhead) is encrypted when using the TRANSEC module.

It supports a wide range of advanced forward error correction (FEC) capabilities Including Viterbi, Trellis, Concatenated Reed- Solomon, Sequential, Turbo Product Codes, three Low Density Parity Check codes (LDPC) families and DVB-S2/S2X.

Direct sequence spread spectrum (DSSS) is available as an option to support both point-to-point and point-to-multipoint applications in conjunction with LDPC-based FEC and BPSK. DSSS supports integer spreading factors up to 512 with chip rate up to 64 Mcps. Spread spectrum allows operation with ultra-low power spectral densities enabling the use of small antenna apertures when adjacent satellite interference (ASI) is an important consideration.

The SLM-5650B is available with or without firmware capable of supporting DSSS. SLM-5650B with firmware capable of supporting DSSS is controlled under International Traffic in Arms Regulations (ITAR).

The IF interface supports 52 MHz to 88 MHz, 104 MHz to 176 MHz, and 950 MHz to 2000 MHz frequency ranges.

Typical Users

- Government & Military
- Secure Commercial Networks

Common Applications

- MEO operations
- Communications at-the-Pause
- Communications On-the-Move
- Rugged Environments
- Secure Network

Features

- WGS Certified (Viterbi, TPC, LDPC, DSSS, STANAG)
- MIL-STD-188-165A compliant (Types I, II, IV, V, VI)
- DVB- S2X with ACM (QPSK to 256APSK)
- Direct sequence spread spectrum with integer spread factors of 2,3,4…510, 511,
- STANAG 4486 Edition 3, Annex E (EBEM) (excluding OQPSK, AHO, DEM and Pre-distortion)
- SES O3b mPOWER Sovereign network operation with DVB-S2X or DSSS
- Selectable 70/140 MHz and 950 – 2000 MHz IFs
- AES-256 TRANSEC, FIPS 140-2 validated
- Support for bridged point-to-multipoint network architecture
- BPSK, QPSK, OQPSK, 8PSK, 8-QAM, 16-QAM (non DVB-S2X operation)
- Viterbi, Reed Solomon, Trellis, Sequential, Turbo Product Code (TPC), EBEM, & Low Density Parity Check (LDPC) FEC
- DVB- S2X with ACM (QPSK to 256APSK)
- Direct sequence spread spectrum, chip rates up to 64 Mcps
- Data rate from 8 kbps to 155.52 Mbps
- Symbol rate from 32 ksps to 64 Msps
- 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

SES O3b mPOWER Sovereign Networks

The SLM-5650B is the first Transmission Security (TRANSEC) enabled satellite modem to receive Government Terminal Certification (GTC) for Sovereign networks on the SES O3b mPOWER satellite constellation. It supports Make Before Break (MBB) or Break Before Make (BBM) handover over mPower. MBB handover requires 2 modems and 2 antenna systems.

- Supported waveforms:
  - DVB-S2X with ACM
    - QPSK/8PSK/16APSK: 5 – 62 Msps
    - 32APSK: 5 – 48 Msps
    - 64APSK: 5 – 37 Msps
    - 128APSK/256APSK: 5 – 30 Msps
  - DSSS
- Layer 2 operation (Bridge mode)
- AES-256 TRANSEC, FIPS 140-2
- Gen 2 Network Processor
- OpenAMIP
- OpenBMIP (Roadmap)

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

A transmission security (TRANSEC) module provides bulk AES-256 encryption/decryption validated to FIPS 140-2. The TRANSEC module encrypts all traffic sent over the air, including data traffic and overhead channel. The TRANSEC module supports both EBEM mode using AES-256 CTR (Counter) mode and Static Key mode using AES-256 CBC mode.
FIPS 140-3 validated TRANSEC is on the roadmap.

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 CDM-625A, DMD2050E, and DMD1050TS. The EBEM Turbo mode is compatible with the MD1366 modem.

DVB-S2/S2X with ACM

SLM-5650B supports DVB-S2/S2X with ACM with MODCODs ranging from QPSK to 256APSK..

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, bridged point-to-multipoint (BPM) mode and Quality of Service.

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.

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.

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 DVB-S2X: QPSK, 8PSK, 16APSK, 32APSK, 64APSK, 128APSK, 256APSK
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 - 10log10(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)
DVB-S2/S2X	Optional	QPSK to 256APSK

Available Options

How Enabled	Option
FAST	TX & RX Data rates to 5, 10, 20, 52 or 155 Mbps
FAST	8PSK/8-QAM and 16-QAM
FAST	TPC
FAST	LDPC
FAST	EBEM
FAST	Carrier-in-Carrier data rate tiers up to 70 Mbps
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 rates
FAST	Bridged point- to-multipoint (BPM)
FAST	Spread Spectrum (DSSS)
FAST	DVB-S2/S2X with ACM
FAST	MEO Mode (SES O3b mPOWER)
FAST	STANAG Split Mode
FAST	PPPoE
FAST	Wide Acquisition +/- 100KHz (For Use on HEO)
FAST	OpenAMIP
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

LDPC 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

*Additional margin required at higher symbol rates

Preliminary Es/No Performance (DVB-S2X, MEO Mode)

Normal Frame (Pilots ON)								
	Modulation	Code Rate	Spectral Eff (Bits/symbol)	Minimum Symbol Rate (Msps)	Maximum Symbol Rate (Msps)	Minimum Data Rate (kbps)	Maximum Data Rate (Mbps)	QEF Es/No* (dB)
1	QPSK	1/4	0.47858	5.000	62.000	2.39	29.67	-2.0
2	QPSK	13/45	0.55429	5.000	62.000	2.77	34.37	-1.8
3	QPSK	1/3	0.64083	5.000	62.000	3.20	39.73	-0.9
4	QPSK	2/5	0.77063	5.000	62.000	3.85	47.78	0.0
5	QPSK	9/20	0.86798	5.000	62.000	4.34	53.81	0.4
6	QPSK	1/2	0.96533	5.000	62.000	4.83	59.85	1.4
7	QPSK	11/20	1.06268	5.000	62.000	5.31	65.89	1.7
8	QPSK	3/5	1.16003	5.000	62.000	5.80	71.92	2.6
9	QPSK	2/3	1.29079	5.000	62.000	6.45	80.03	3.4
10	QPSK	3/4	1.45208	5.000	62.000	7.26	90.03	4.4
11	QPSK	4/5	1.54943	5.000	62.000	7.75	96.06	5.0
12	QPSK	5/6	1.61529	5.000	62.000	8.08	100.15	5.5
13	QPSK	8/9	1.72442	5.000	62.000	8.62	106.91	6.5
14	QPSK	9/10	1.74605	5.000	62.000	8.73	108.26	6.7
15	8PSK	5/9-L	1.60980	5.000	62.000	8.05	99.81	4.9
16	8PSK	26/45-L	1.67469	5.000	62.000	8.37	103.83	5.3
17	8PSK	3/5	1.73957	5.000	62.000	8.70	107.85	6.2
18	8PSK	23/36	1.85311	5.000	62.000	9.27	114.89	6.3
19	8PSK	2/3	1.93566	5.000	62.000	9.68	120.01	6.6
20	8PSK	25/36	2.01532	5.000	62.000	10.08	124.95	7.2
21	8PSK	13/18	2.09642	5.000	62.000	10.48	129.98	7.7
22	8PSK	3/4	2.17753	5.000	62.000	10.89	135.01	8.3
23	8PSK	5/6	2.42228	5.000	62.000	12.11	150.18	9.7
24	8PSK	8/9	2.58592	5.000	60.141	12.93	155.52	11.1
25	8PSK	9/10	2.61837	5.000	59.396	13.09	155.52	11.4
26	16APSK	1/2-L	1.92545	5.000	62.000	9.63	119.38	6.3
27	16APSK	8/15-L	2.05490	5.000	62.000	10.27	127.40	6.8
28	16APSK	5/9-L	2.14120	5.000	62.000	10.71	132.75	7.1
29	16APSK	26/45	2.22750	5.000	62.000	11.14	138.10	7.8
30	16APSK	3/5	2.31380	5.000	62.000	11.57	143.46	8.1
31	16APSK	3/5-L	2.31380	5.000	62.000	11.57	143.46	7.7
32	16APSK	28/45	2.40010	5.000	62.000	12.00	148.81	8.4
33	16APSK	23/36	2.46482	5.000	62.000	12.32	152.82	8.6
34	16APSK	2/3-L	2.57270	5.000	60.450	12.86	155.52	8.7
35	16APSK	2/3	2.57461	5.000	60.405	12.87	155.52	9.6
36	16APSK	25/36	2.68057	5.000	58.017	13.40	155.52	9.6
37	16APSK	13/18	2.78845	5.000	55.773	13.94	155.52	10.0
38	16APSK	3/4	2.89632	5.000	53.695	14.48	155.52	10.7
39	16APSK	7/9	3.00420	5.000	51.767	15.02	155.52	10.9
40	16APSK	4/5	3.09050	5.000	50.322	15.45	155.52	11.5
41	16APSK	5/6	3.22186	5.000	48.270	16.11	155.52	12.1
42	16APSK	77/90	3.30624	5.000	47.038	16.53	155.52	12.3
43	16APSK	8/9	3.43953	5.000	45.215	17.20	155.52	13.3
44	16APSK	9/10	3.48268	5.000	44.655	17.41	155.52	13.6
45	32APSK	2/3-L	3.22087	5.000	48.000	16.10	154.60	11.5
46	32APSK	32/45	3.43440	5.000	45.283	17.17	155.52	12.1
47	32APSK	11/15	3.54236	5.000	43.902	17.71	155.52	12.6
48	32APSK	3/4	3.62333	5.000	42.921	18.12	155.52	13.3
49	32APSK	7/9	3.75828	5.000	41.380	18.79	155.52	13.4
50	32APSK	4/5	3.86625	5.000	40.225	19.33	155.52	14.1
51	32APSK	5/6	4.03059	5.000	38.584	20.15	155.52	14.9
52	32APSK	8/9	4.30289	5.000	36.143	21.51	155.52	16.3
53	32APSK	9/10	4.35688	5.000	35.695	21.78	155.52	16.6
54	64APSK	32/45-L	4.11129	5.000	37.000	20.56	152.12	14.5
55	64APSK	11/15	4.24053	5.000	36.674	21.20	155.52	15.3
56	64APSK	7/9	4.49901	5.000	34.567	22.50	155.52	16.0
57	64APSK	4/5	4.62825	5.000	33.602	23.14	155.52	16.4
58	64APSK	5/6	4.82499	5.000	32.232	24.12	155.52	17.0
59	128APSK	3/4	5.04678	5.000	30.000	25.23	151.40	18.9
60	128APSK	7/9	5.23475	5.000	29.709	26.17	155.52	19.7
61	256APSK	29/45-L	4.95675	5.000	30.000	24.78	148.70	18.2
62	256APSK	2/3-L	5.12879	5.000	30.000	25.64	153.86	18.2
63	256APSK	31/45-L	5.30084	5.000	29.338	26.50	155.52	19.4
64	256APSK	32/45	5.47288	5.000	28.416	27.36	155.52	19.8
65	256APSK	11/15-L	5.64492	5.000	27.550	28.22	155.52	20.0
66	256APSK	3/4	5.77395	5.000	26.934	28.87	155.52	20.9

*Additional margin required at higher symbol rates

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Approved for Public Release
Ref: DS-SLM5650B-091025

305 N 54th Street
Chandler, AZ 85226 USA
Phone: 480-333-2200
www.comtech.com