# STEP ELECTRONICS
*A Division of Av-Comm*

# SLM-5650BD SATELLITE DEMODULATOR
SATELLITE DEMODULATOR



## Overview

The SLM-5650BD Satellite Demodulator is a receive only version of our latest generation USARSTRAT WGS certified modem product targeted for critical commercial backhaul and government/military applications. It is fully compliant with MIL-STD-188-165A/B and supports FIPS 140-2 certified encryption. The SLM-5650BD leverages the heritage and feature set of our very successful SLM-5650B modem. The SLM-5650BD supports backwards compatibility and inter-operability with 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-5650BD 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 155.52 Mbps and symbol rates from 32 ksps to 64 Msps are supported. The SLM-5650BD is designed to support cost-effective point-to-multipoint Internet protocol (IP) applications in both Layer-2 bridged and Layer-3 routed networks. The SLM-5650BD can be equipped with either a single 10/100/1000Base-T Ethernet interface (standard) or 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-5650BD 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 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
- Ethernet interface for remote control using HTTP, Telnet and Simple Network Management Protocol (SNMP)
- EIA-485 and EIA-232 interface for remote control

# COMTECH EF DATA™

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## Compatibility
The SLM-5650BD is interoperable with the SLM-5650A and the SLM-5650B satellite modems.

## Data Interfaces
The modem 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 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-5650BD TPC is compatible with Intelsat IESS 315,

## 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). |

## 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, 8-QAM, 16APSK, 16-QAM |
| Spreading Factors | Integer factors 2-512; BPSK LDPC only |
| Digital Data Rate | 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 |
| Built-in Test (BIT) | Fault and status reporting, BER performance monitoring, built in Fireberd emulation |
| Summary Faults | Reported via front panel LEDs, 15-pin D sub, FORM C relay contacts for RX, common equipment faults, and RX alarms |
| Unit Management | EIA-485, EIA-232, 10/100Base-T Ethernet with HTTP, Telnet and SNMP |

### 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, 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) | Standardl | 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 |

## 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 |
| FAST | Vipersat Management System (future) |
| FAST | Diff-Serv QoS |

| | |
|---|---|
| FAST | Secure Network Management (SSL/SSH/SNMPv3) |
| FAST | Sequential FEC |
| FAST | Bridged point- to-multipoint |
| FAST | Spread Spectrum (DSSS and/or DSSS-MA) |
| Hardware | TRANSEC module |
| Hardware | Gigabit Ethernet Bridge or Network Processor |
| 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 |
| **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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