Overview

Comtech EF Data’s SLM-5650A Satellite Modem 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 kbps 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-5650A can be integrated with the Vipersat Management System (VMS) to provide fully automated network and capacity management. An AES-256 TRANSEC module, compliant with the FIPS-140-2 NIST 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 Low Density Parity Check codes (LDPC) are all supported.

Advanced FEC and modulation capabilities are integrated with the revolutionary DoubleTalk® Carrier-in-Carrier® bandwidth compression allowing for maximum state-of-the-art performance under all conditions. This combination of advanced technologies enables multi-dimensional optimization, allowing satellite communications users to:
- Minimize required satellite bandwidth
- Maximize throughput without using additional transponder resources
- Maximize availability (margin) without using additional transponder resources
- Enable use of a smaller BUC/HPA and/or antenna
- Or, a combination of the above to meet specific mission needs

Direct sequence Spread Spectrum is available as an option in conjunction with LDPC-based FEC and BPSK modulation. Spreading factors up to 128 are supported. 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. It can also be utilized to provide low probability of detection / intercept (LPD/LPI) operation and/or strong resistance to jamming.

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

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 L2 certified
- Dynamic bandwidth allocation with Vipersat Management System
- Support for bridged point-to-multipoint network architecture
- DoubleTalk Carrier-in-Carrier bandwidth compression
- BPSK, QPSK, OQPSK, 8-QAM, 16-QAM
- Viterbi, Reed Solomon, Trellis, Sequential, Turbo Product Code (TPC), & Low Density Parity Check FEC
- FEC rates 1/1, 5/16, 1/2, 2/3, 3/4, 5/6, 7/8, 8/8, and others
- Direct sequence spread spectrum, integer factors 2-128, plus 256 and 512
- 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

Typical Users

- Government
- Military
- Secure Commercial Networks

Common Applications

- Communications at-the-Pause
- Communications on-the-Move
- Rugged Environments
- Secure Networks
Both shared forward link and multiple point-to-point hub-spoke architectures can be configured and dynamically controlled by the VMS. Network capacity in a variety of ways. Supported modes for capacity allocation include: operators to easily configure and monitor dynamically controlled networks. The VMS can be configured to dynamically allocate satellite bandwidth utilization while optimizing space segment efficiency. It allows intelligent management of satellite networks carrying encrypted traffic) in a hub-spoke network architecture.

**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. When a remote in the network has an application to transport over the satellite link, dSCPC technology provides the mechanism to automatically establish the SCPC carrier for that transmission. dSCPC resizes the carrier based on the increase or decrease in applications being sent over the link, and it returns the remote to its home state once the application is completed. dSCPC yields true bandwidth-on-demand, giving the user the low-latency, low-jitter dedicated SCPC connection when it is needed for real-time applications, such as Voice over IP (VoIP), video conference, broadcasts and large applications (file or image transfers).

VMS automates bandwidth utilization while optimizing space segment efficiency. It allows intelligent management of satellite networks through port and system configuration and alarm management of the protocol, modem, RF equipment and IP broadband networking. The graphical user interface of VMS enables centralized network configuration and management. It provides auto-detection of satellite modems, configuration and monitoring of the modems, and real-time views of network health and transmission quality. These allow operators to easily configure and monitor dynamically controlled networks. The VMS can be configured to dynamically allocate satellite network capacity in a variety of ways. Supported modes for capacity allocation include:

1. **Entry channel mode**, which allows a modem to automatically enter/exit a network, sets a fixed capacity for the terminal when in the network.
2. **Load**: Capacity allocation based on load demand of terminals on the network.
3. **Type of Service (ToS)**: Type and priority based allocation using DiffServ Code Point (DSCP) fields.

Both shared forward link and multiple point-to-point hub-spoke architectures can be configured and dynamically controlled by the VMS.

**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-5650A 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.

**Doubletalk Carrier-In-Carrier**
DoubleTalk Carrier-in-Carrier is based on patented bandwidth compression technology originally developed by Applied Signal Technology, Inc. Using “Adaptive Cancellation” it allows transmit and receive carriers of a two-way 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](image1.png)  
**Figure 1**

When observed on a spectrum analyzer, only the Composite is visible. Carrier 1 and Carrier 2 are shown in Figure 2 for reference only.

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 efficiencies, DoubleTalk Carrier-in-Carrier utilizing advanced signal processing techniques provides a new dimension in bandwidth efficiency.

DoubleTalk Carrier-in-Carrier allows satellite users to achieve spectral efficiencies (i.e. bps/Hz) that cannot be achieved with traditional links. For example, DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8bps/Hz). 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.

DoubleTalk Carrier-in-Carrier can be used to save transponder bandwidth and/or transponder power thereby allowing successful deployment in bandwidth-limited as well as power-limited scenarios. The following example illustrates the typical process for implementing DoubleTalk Carrier-in-Carrier in a power-limited scenario:

The conventional link is using 8PSK, TPC 3/4: Spread the signal by switching to a lower order modulation and/or FEC code – say QPSK, TPC 7/8. This increases the total transponder bandwidth, while reducing the total transponder power:

Now using DoubleTalk Carrier-in-Carrier, the second QPSK, TPC 7/8 carrier can be moved over the first carrier – thereby reducing the total transponder bandwidth and total transponder power when compared to the original side-by-side 8PSK, TPC 3/4 carriers:
Demodulation Only & Asymmetric Data Rates

In order to cost-effectively enable hub-spoke networks, two cost saving configurations are supported. First, the SLM-5650A is available in a demodulation-only version (SLM-5650AD). This configuration is often used as a hub demodulator. Hub-spoke networks using the CDD-564 multi-channel demodulators are also supported.

There is also a reduced cost configuration option that allows the remote modems to receive a large shared outbound and transmit a smaller return channel.

Specifications

**Modulation**

- **Output Power**: +10 to –40 dBm, adjustable in 0.1 dB steps
- **Output Return Loss**: 14 dB (70/140 MHz)
- **Output Impedance**: 9 dB (L-Band)
- **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**: +10 to –55 dBm carrier (SR > 3.2 Msp) -55 - 10log<(3.2/SR), (SR < 3.2 Msp)
- **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)
- **Buffer Clock**: INT, TX terrestrial, RX satellite
- **Doppler Buffer**: 32 to 16,777,216 bits, selectable

**Coding Options**

- **Uncoded**: Standard
- **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
- **Triple Viterbi**: Optional 1/2 and 3/4 Legacy SDM-9000 compatibility
- **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

**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/Hardware**: TPC and LDPC to 5, 10, 20, 52 Mbps
- **FAST**: Vipersat Management System
- **FAST**: Diff-Serv QoS
- **FAST**: Secure Network Management (SSL/SSH/SNMPv3)
- **FAST**: ASYNC RS-485/232 overhead channel /AUPC
- **FAST**: Sequential FEC
- **FAST**: DoubleTalk Carrier-in-Carrier
- **FAST**: Asymmetric TX/RX data rate levels
- **FAST**: Bridged point-to-multipoint
- **FAST**: SDM-9000 compatibility (including Triple Viterbi)
- **FAST**: Spread Spectrum
- **FAST**: Hardware G.703 data interface
- **FAST**: Hardware LVDS Data interface
- **Hardware**: TRANSEC module
- **Hardware**: Gigabit Ethernet Network Processor
- **Hardware**: Extended Operational Temperature
- **Hardware**: 24 VDC power supply

**Environmental And Physical**

- **Prime Power**: 90 to 264 VAC, 47 to 63 Hz 130 W (max), 90 W typical 24 VDC optional
- **Mounting**: 1RU
- **Dimensions (height x width x depth)**: 1.71” x 19” x 19” (4.3 x 48 x 48 cm)
- **Weight**: ≤ 12 lbs (5.5 kg)
- **Temperature, Operating**: 0 to 50°C (32 to 122°F)
- **Extended Temp Option**: -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

<table>
<thead>
<tr>
<th>Mod / FEC</th>
<th>Code Rate</th>
<th>Eb/No Guaranteed (Typical)</th>
<th>Data Rate Range (kbps)</th>
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<td></td>
<td>10^{-6}</td>
<td>10^{-7}</td>
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<td><strong>Legacy Modes</strong></td>
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<td>QPSK/OQPSK VIT</td>
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