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ENERDYNE
a ViaSat company

EnerLinks™III

Software Defined, Full Duplex, Digital Datalink



ENERLINKSIII SYSTEM AT-A-GLANCE

- Complete sensor-to-ground display, full duplex digital data link
- Support for ISR and C2 in manned or unmanned tactical platforms
- Range performance to the horizon with small, tactical ground antennas
- Software defined radio architecture supports life cycle growth
- High performance waveform modes, including legacy analog FM video
- Total system design focus on bandwidth efficiency
- Rugged, submersible packaging

EnerLinksIII can be software configured in minutes to meet major program requirements for interoperability and advanced performance.

The EnerLinksIII system is the industry's most advanced data link for EO, IR, and other sensor applications using manned or unmanned platforms for Intelligence, Surveillance, and Reconnaissance (ISR). Based on a configurable architecture that provides unprecedented flexibility, EnerLinksIII allows customers to meet major program requirements for interoperability, as well as mission-specific needs for advanced performance and functionality. Moreover, this software-defined data link adapts to normal life cycle changes in data link requirements and technology insertions. Even major capability upgrades can be made at the field depot level in just minutes.

Ideal for Tactical Unmanned Aerial Systems (TUAS) and other airborne platforms, the EnerLinksIII system accepts IP data, serial digital data, analog video, and other sensor output. It also provides advanced U264 or MJPEG video compression technology, frame-synchronized metadata, efficient data multiplexing, FEC coding, minimized SWaP, Line-of-Sight (LOS) coverage to the horizon with small antennas, and more.

Ideal for Tactical Unmanned Aerial Systems (TUAS) and other airborne platforms, the complete EnerLinksIII system includes an Airborne Modem Transceiver (AMT) and Ground Modem Transceiver (GMT). The AMT is I/O rich, with interfaces for TCP/IP or UDP/IP over Ethernet, multiple analog video sources, multiple high-speed serial ports, a dedicated GPS port, and audio. The flexible I/O capability of EnerLinksIII allows the system to serve both as an ISR link and as a vehicle control link, minimizing equipment size, weight, power, and antennas. The AMT includes H.264 or MJPEG video compression for

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transmission of one or two simultaneous streams of standard definition video, selectable modulation bit rates, spectrally efficient Gaussian-shaped Minimum Shift Keying (GMSK) modulation, FEC with selectable code rates, and more. The AMT can be configured to operate in L- and S-bands (one band for the downlink and the other for the uplink) or in C-band. A Ku-band option is in development.

The GMT provides all signal processing and I/O needed to complement the AMT functions, including a dual diversity RF receiver, demodulator, demultiplexer, and decompressors for the downlink signal and multiplexing, modulation and RF transmission for the uplink. The GMT also supports several diversity-combining receiver configurations that are useful to combat multipath fading, interference, and antenna shadowing. Every AMT input has a corresponding GMT output port. System settings and status for both airborne and ground modules may be controlled and viewed in real time through a serial command line interface or through a supplied web-based GUI.

Included with the EnerLinksIII system are power amplifier modules, integrated duplexer/LNA and filter LNA modules, and ground and aircraft antennas.

KEY FEATURES

- Hardware options for swappable L-, S-, and C-band transmitters and receivers
- TCP or UDP IP, serial data, synchronous data, audio
- Video latency < 250 msec
- Selectable bit rates from 50Kbps to 11Mbps
- Dual independent H.264 video compression engines or MJPEG
- Efficient multiplexing for compressed video, IP, asynchronous data, audio
- GMSK modulation, Turbo Product Code FEC and interleaving for superior received threshold performance
- MISB RP0604 Synchronized video and KLV metadata via MPEG-2 Transport Stream
- Migration path to Ku Band, and CDL waveforms
- EnerView™ content viewing, management and exploitation system with DVR support, archival store, search and retrieve functions, and geo-referenced mapping when used with FalconView™ mapping software



Airborne Modem Transceiver

Ground Modem Transceiver



EnerLinksIII Description

The EnerLinksIII system features a full duplex, variable bit rate modem that allows any user-selectable bit rate from 50 kbps to 11 Mbps, with a future field-upgrade option for 22 Mbps. Gaussian-shaped Minimum Shift Keying (GMSK) is used as the modulation waveform because receiver threshold performance with GMSK is as good as COFDM in the air to ground channel, and—unlike COFDM—GMSK allows the use of efficient class C power amplifiers that substantially reduce aircraft power consumption. The receiver uses all-digital techniques for demodulation and provides performance within tenths of a dB of theoretical performance. GMSK is spectrally efficient with very low out-of-band emissions. Coupled with the outstanding selectivity performance of the EnerLinksIII receiver, use of GMSK allows close spacing of transmissions in scenarios with multiple UAVs operating in the same airspace. The outstanding threshold performance of EnerLinksIII allows reliable transmission to the horizon using 5 watt RF power amplifiers in the aircraft and small, low-cost, rugged antennas at the ground that can be manually pointed by unskilled personnel.

Turbo product code FEC is a key to the system's high-link performance. User selectable rates of approximately 1/2, 2/3 and 4/5 (as well as uncoded) are provided. In most scenarios, the rate 4/5 code provides sufficient performance benefit to extend the range by a factor of nearly 4 beyond uncoded operation. Interleaving is available with user-selectable depth for burst interference protection. The GMT's diversity-combining ground receiver provides either receiver antenna space diversity to overcome multipath fading, or transmit frequency diversity to overcome aircraft antenna shadowing.

The AMT and GMT can be configured with one of two frequency options:

- ✓ L-band (1700-1850 MHz) and S-band (2200-2500 MHz)
- ✓ Lower C-band (4400-4950 MHz) and upper C-band (5250-5850 MHz)

For a given option, the frequency band plan can be reversed (that is, a system can use L-band for the downlink and S-band for the uplink or vice versa).

System interoperability through the adoption of standards is an important component of the EnerLinksIII system. The EnerLinksIII can transmit two concurrent streams of H.264 compressed video, or one H.264 and one MJPEG stream. KLV metadata compliant with STANAG 4586 can be provided to the AMT via Ethernet. The system maintains alignment of the metadata to individual video frames using the MISB RP0604 protocol. The GMT H.264 video streams and RP0604 KLV frame-aligned metadata elementary streams are encapsulated in an MPEG2 transport stream. This stream can be viewed and archived with the EnerView™ viewer or with other standard viewers.

EnerLinksIII is fully interoperable with its predecessor system, Enerdyne's EnerLinks™II video data link.



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EnerView™ Content Management

EnerLinksIII includes EnerView, an ISR sensor and metadata content management application. Compatible with Windows XP or Windows 2000, this feature-rich application serves both as a real-time viewer of live video and other UAV data and as a non-real time video exploitation system. In live mode, EnerView provides real-time video display with an interface to mapping applications, including FalconView™, an application that displays various types of maps and geographically referenced overlays.



EnerView can archive all downlink content, retaining time-tagged links between each video frame and all other downlink data including metadata. Mission-related chat sessions can also be recorded and replayed in synchrony with archived video for forensic applications. When dual video streams are transmitted on the downlink, they can be played simultaneously either side-by-side as with picture-in-picture mode, and when played from an archive their time association is preserved as well. Archives can be quickly searched by time, proximity to a location, keywords embedded in user tags, as well as combinations of these.

Real-time and non-real time modes include full DVR support for reverse, forward, pause and single step. Video clips and individual JPEG frames can be extracted for situation awareness, targeting, and dissemination. Video can be streamed via UDP in unicast or multicast. Archived content can be searched by keyword, date/time, or geolocation using a latitude/longitude or MGRS coordinate range. Geo-location areas may be typed in or selected from mapping tools.

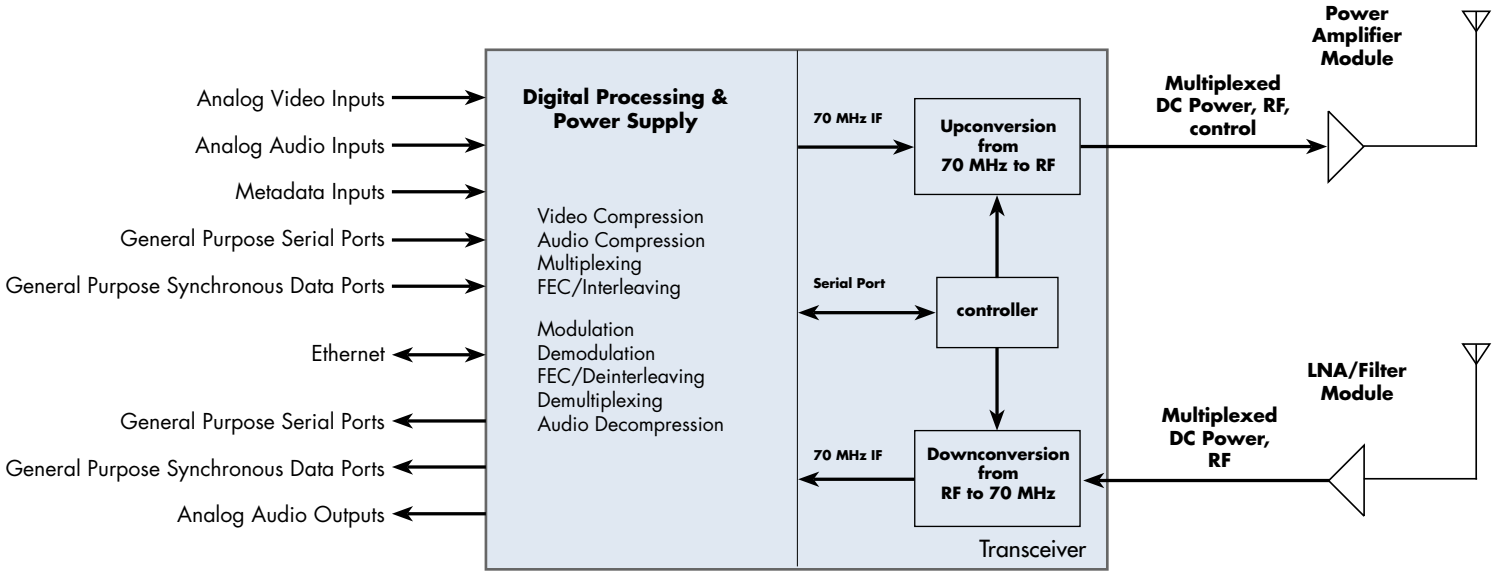
Customization

The SWaP envelope available for data link hardware in tactical UAVs is typically both limited and platform-specific. Requirements are driven by programs, customers, and specific UAVs. Enerdyne's business model is to design products for markets and shape them to address these specific needs. The EnerLinksIII system can be tailored and repackaged to meet the unique constraints of the aircraft and ground equipment, and responds to performance and functional specifications with an integrated solution.



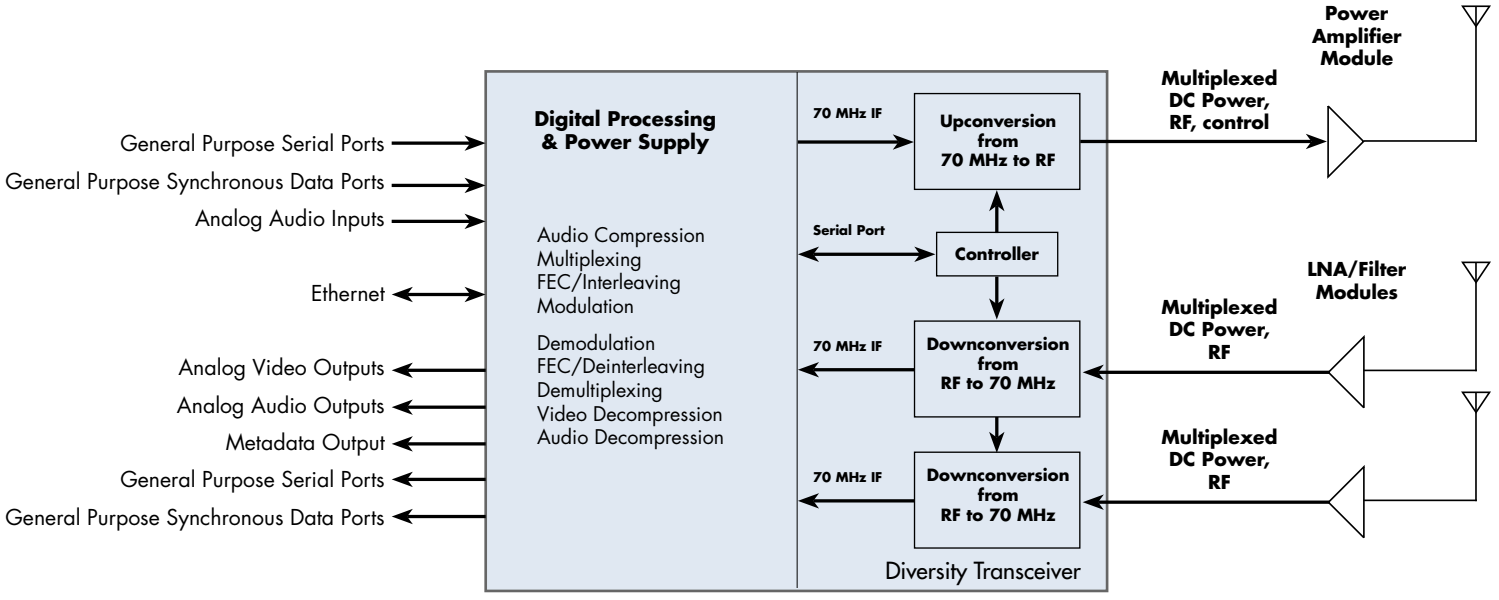
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ENERLINKSIII SYSTEM AIRBORNE TRANSCEIVER BLOCK DIAGRAM



Airborne Modem / Transceiver (AMT)

ENERLINKSIII SYSTEM GROUND TRANSCEIVER BLOCK DIAGRAM



Ground Modem / Transceiver (GMT)

EnerLinks™III Specifications

INPUT

Analog Video

NTSC, PAL, CCIR and RS-170 monochrome input
Composite video (3), or Y/C (1) selectable; SMA type connectors
Adjustments for brightness, contrast, tint, saturation

Digital Interface

Ethernet 100 Base-T for IP-based data sources

Other Input

Asynchronous ports (6): RS-232 up to 115 kbaud or RS-422 up to 999.6 kbaud
Synchronous port (clock and data): up to 4 Mbps, RS-422 or TTL
Audio (2): mic levels (source), line levels (destination). Toll quality

VIDEO COMPRESSION

H.264:
One or two concurrent channels
Baseline Profile Codec (level 3), I and P frames
Resolutions: NTSC: 640x480, 640x240, 320x240
PAL: 720x576, 356x288
Video bit rate adjustable from 50 Kbps to 3.5 Mbps

MJPEG:
Automatically adjusts frame rate to fill available multiplex bandwidth.
Option to mux with one channel of H.264
Compression ratio: User adjustable in 240 steps
Resolution: NTSC 560x480, 560x240, 280x240
PAL: 550x576, 560x288, 280x288

METADATA

KLV format, MISB RP0604 synchronization to H.264 video
GPS tagged to MJPEG video frames using RTC
MJPEG time stamped via real-time clock

MULTIPLEXED DATA

Dynamic allocation of bandwidth transporting any combination of:
Compressed Video (1 or 2 channels H.264, or 1 channel MJPEG, or 1 each of H.264 and MJPEG)
IP Data
Supports IP gateway as proxy bridge between an aircraft subnet and a ground subnet
Asynchronous Data
Synchronous Data
Audio: 2 channels

DATA LINK

Turbo Product Code FEC: user-selectable options for:

- Uncoded operation
- Rates 4/5, 2/3 or 1/2

Interleaving: row column interleaver for burst interference mitigation

- Row length equal to one FEC code block
- Options for numbers of rows up to 1 Mbit total interleaver depth
- Option for interleaver off

Modulation: Gaussian-filtered Minimum Shift Keying (GMSK). User-selectable modulation bit rates from 50 kbps to 11Mbps in 1 bps increments

RF FREQUENCY

User selectable in 50 kHz steps

L/S band 1710 to 1850 MHz (L-band) and 2200 to 2500 MHz (S-band)
C-band: 4400 to 4950 MHz (lower C-band) and 5250 to 5850 MHz (upper C-band) Either band can be used for uplink or downlink

RF Bandwidth: Scales with modulation bit rate (<12 MHz at -20 dBc, <24 MHz, -50 dBc at 10 Mbps)

Receiver Sensitivity (dBm at LNA input):

FEC CODING	THRESHOLD
Rate 1/2	-169+10log10(modem bit rate in bps) (e.g., at 10 Mbps, threshold is -99 dBm)
Rate 2/3	-168+10log10(modem bit rate in bps) (e.g., at 10 Mbps, threshold is -98 dBm)
Rate 4/5	-167+10log10(modem bit rate in bps) (e.g., at 10 Mbps, threshold is -97 dBm)
None	-157+10log10(modem bit rate in bps) (e.g., at 10 Mbps, threshold is -87 dBm)

CONTROL & CONFIGURATION

GUI via web-based interface over Ethernet or Command line interface via serial port or USB
Airborne system can be accessed and controlled from the ground

ENVIRONMENTAL

Airborne System

Cooling by conduction to the mounting baseplate
Operating Temp: -20° to +70°C baseplate temperature
Non-operating: -40° to +85°C
Altitude: 70,000 feet
Humidity: to 95% non-condensing
Shock and Vibration: consistent with fixed-wing and helicopter environments in MIL-STD-810F
Submersible in 1 meter water per MIL-STD-810F

Ground System

Fanless chassis
Operating Ambient Air Temperature: 0° to 60°C
Non-operating: -40° to +85°C
Vibration: consistent with section 514.4 category 20 of MIL-STD-810F Procedure 1, Figure 514.5 C-3 (wheeled vehicles)
Submersible in 1 meter water per MIL-STD-810F

SIZE (L x W x H):

Airborne unit: 1.8" x 5" x 7.5"
Ground unit: 3.2" x 7.9" x 10.5"

WEIGHT:

Airborne unit: 3.31 lbs
Ground unit: 8.5 lbs

POWER

Airborne System

28 VDC (per MIL-STD-704) normal operation
Power consumption < 30 watts

Ground System

24 VDC +/-4 V
Power consumption < 30 watts

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