INTRAPLEX® HD LINK™

Digital 950 MHz STL and Data Gateway

Our challenge: to design a studio-to-transmitter link (STL) for your most demanding 950 MHz applications — one as reliable and robust as Intraplex® T1 and IP audio links. Digital STL manages much more than audio, so installation and configuration need to be straightforward, not a science project. Data should not be optional, requiring additional boxes and complexity. Your STL should be ready, out of the box, for AM, FM and HD Radio™, as well as future multimedia applications.

Earlier digital STLs were not designed for IP data transport. Adding IP data to them required optional modules and external add-ons, and many engineers working on HD Radio installations reported spending much time and money trying to eliminate glitches.

Our solution: HD Link™ is designed to manage all HD Radio™ transport scenarios, regardless of where you place your importer and exporter. Its two prioritized Ethernet paths give preference to HD Radio™ data over control and other LAN/WAN data. It supports both UDP and TCP, and even handles the switching of TCP return packets over asymmetric IP paths with plug-and-play simplicity

HD Link offers RF power to spare, an integrated IP gateway with sophisticated data handling capabilities, and multiple channels of audio. The intuitive front panel and remote interfaces tap into the most complete feature set of any microwave STL, yet take less time to configure. It can even operate on both RF and IP simultaneously, and allows automatic backup of all services from one to the other.

Intraplex is broadcasting's first choice for rock-solid, full-time operation of T1 STLs. With HD Link, you can now count on the same dependable performance, superior support and long-term value for your microwave links.

Powerful, reliable RF performance

- Up to 5 W of RF power
- GatesAir-designed transmitter and receiver with 200, 250, 300, 375 or 500 kHz of RF bandwidth
- Low-density parity check (LDPC) coding advanced error correction — requires less receive signal than Reed-Solomon to achieve an equivalent bit error rate (BER), a critical parameter for glitch-free HD Radio performance
- State-of-the-art modulation technology operates at 32, 64, 128 or 256 QAM, providing more than 3 Mb/s throughput under optimal conditions
- Built-in circulator provides a high degree of isolation and VSWR protection

Designed for data

- Integrated IP channel with up to 1.5 Mb/s throughput for HD Radio (importer-to-exporter or exporter-to-exciter)
- At least three times the nominal IP data throughput of other digital STLs
- Does not require an external adapter to work with an external TCP return path — suitable for use over private and public networks
- Capable of taking advantage of available IP audio paths to provide integral backup in the event of radio link failure
- Two prioritized Ethernet ports — high priority for HD Radio traffic, low priority for control data and LAN traffic
- Each main program channel includes an RS-232 asynchronous data channel, up to 9600 b/s

Superior multichannel audio performance

- One or two stereo main program channels, each available with linear uncompressed or Enhanced apt-X® compressed audio
- User-selectable 32, 44.1, or 48 kHz sample rates — transports 15, 20 or 22 kHz audio
- Two monaural, 7 kHz audio channels with G.722 coding available for AM, radio reading services, SCA, EAS and other auxiliary audio applications

Easy setup and reliable operation

- Advanced Web browser user interface and SNMP remote control
- Front-panel Ethernet port for access to Web GUI and diagnostics
- USB port for saving configurations and updating software
- FTP access for remote software uploads
- User-configurable control input and alarm output contacts

Convenient connections and display

- Intuitive front-panel interface
- XLR AES/EBU digital and L/R analog input/output connectors
- Headphone jack on the receiver for audio monitoring
- AES/EBU sync port on the receiver
- LCD level displays for all audio programs at each end
- Analog level outputs for forward power and reflected power (on transmitter unit) and for received signal level and signal-to-noise (on receive unit)
- Optional main/alternate interface for redundancy switching

Product Details

The ability to do more

Our RF and audio engineering teams designed HD Link for maximum reliability and to carry higher-quality audio and more data over the STL path than was possible with earlier 950 MHz STLs.

- **More power**
  Sometimes you just need a little more RF power to get the job done. Out of the box, HD Link can operate at 1 W, 2 W, or 5 W, selectable in the field. It's the most powerful 950 MHz digital STL you can buy.
- **Advanced error correction**
  HD Link is the only radio STL using LDPC coding for forward error correction (FEC). This highly efficient scheme contributes to increased data throughput.
- **21st-century design**
  By applying GatesAir know-how to the technologies not available when legacy STLs were designed, we optimized HD Link for state-of-the-art performance with minimal circuit noise.

The advantages to you

The combined benefits of more transmitter power, LDPC error correction and enhanced circuit design add up to as much as 10 dB signal improvement over older digital STLs. Depending on your requirements, this can enable any or all of the following:

- Use of smaller antennas, for less tower load and lower costs
- Increased path distance
- Improved fade margin
- Operation at higher quadrature amplitude modulation (QAM) orders for increased carrying capacity

Sounds great

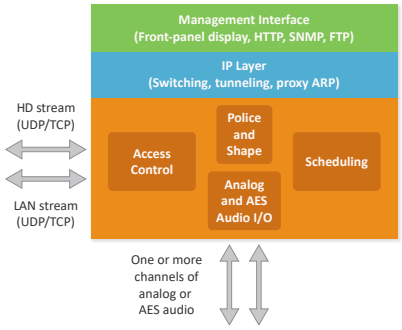
As with any Intraplex product, audio quality is a top priority. Uncompressed audio transport is fully transparent. In the event bandwidth limitations require audio compression, HD Link offers Enhanced apt-X® coding to prevent the occurrence of audio artifacts that can occur with multiple generations of MPEG compression in the air chain.

Audio and data. And more data.

The architecture of HD Link starts with an integrated IP gateway, the first in a radio STL. This provides you with options for nearly every practical combination of audio, data, control and status used by radio stations — as well as future media applications. With the HD Link system's 1536 kb/s of allocatable IP data, you'll no longer consider your STL to be merely an audio transport system that happens to provide some data options. In addition, an asynchronous RS-232 serial data channel accompanies each main program audio channel for use with legacy control systems.

IP done right — the Intraplex way

If you like what Intraplex has done for you with T1 and IP audio and data codecs, you'll love our implementation in HD Link. The integrated IP gateway includes numerous features:



- **IP prioritization** allows it to carry other IP data, such as control signals and LAN traffic, separately from the high-priority HD Radio stream.
- **Dual domain access control** provides the tightest, most practical security. One access list is for control of the HD Link units Another manages the firewall that keeps unwanted traffic off the transport link.
- **Layer 3 switching** supports an asymmetric TCP return path, allowing integrated "plug and play" support for TCP wherever a return path exists. Using TCP allows quality HD Radio transport under 30 times higher Bit Error Rate (BER) conditions than UDP (3 x 10-4 for TCP versus 10-5 for UDP).
- **IP tunneling** allows TCP return packets with private addresses to traverse third-party networks like ISPs.

HD Link IP Gateway Architecture

How HD Link Technology Improves Link Quality

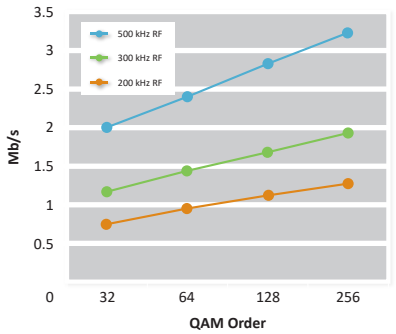


Figure 1. Higher-order QAM levels enable greater data carrying capacity

Like most digital microwave systems, HD Link uses quadrature amplitude modulation to maximize data throughput. All other factors being equal, higher-order QAM can deliver more data using the same RF bandwidth than lower-order QAM (Figure 1), but each step up in QAM order requires about 3 dB to 4 dB better signal-to-noise ratio on the RF link to maintain the same level of quality. RF link quality is thus a critical factor in determining the amount of data that any given 950 MHz STL can carry.

Forward error correction is a useful tool for improving link quality in digital transmission. Essentially, it involves adding redundant data to the transmission stream to allow the detection and reconstruction of missing information. All digital RF STLs use some form of FEC, typically using either the Reed-Solomon or the Viterbi coding method.

However, adding FEC increases the bit rate of the STL. Adding enough extra bits may require the use of a higher QAM order, which places greater demands on the link quality, thereby creating a Catch-22 situation — adding FEC to improve link quality may cause an increase in QAM order, which requires yet higher link quality.

With HD Link, GatesAir has taken significant steps to improve this situation.

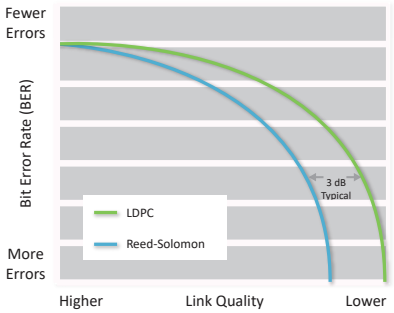


Figure 2. The HD Link system's advanced error correction handles difficult links better than STLs using older technology

First, HD Link uses LDPC to do its FEC coding. LDPC is more efficient than either Reed-Solomon or Viterbi, requiring less overhead data to provide the same level of error correction; given the same overhead, it typically provides about 3 dB improvement in link performance over traditional FEC methods (Figure 2). While the mathematical principles underlying LDPC have been understood for some time, only recently have DSP chips become available with the speed and processing power to run LDPC on digital STL signals in real time.

In addition, whereas the performance of Reed-Solomon FEC falls off directly if the link quality is degraded due to environmental or other interference, LDPC maintains superior performance in the face of link deterioration.

Further, where other STLs add a fixed level of FEC regardless of the system configuration, HD Link uses adjustable amounts of FEC and employs a sophisticated algorithm to calculate the optimum balance between QAM order and FEC overhead to achieve the maximum data throughput for any given configuration.

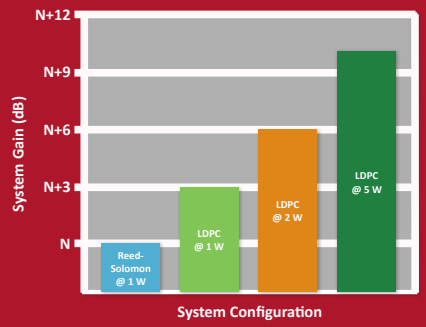


Figure 3. The combination of HD Link technology advantages can offer you a dramatically improved STL system

The result? Combined with the increased performance afforded by its 5 W amplifier, HD Link can provide up to 10 dB of system enhancement, right out of the box, compared with older digital STL systems (Figure 3).

Elegantly simple installation, configuration and operation

Your time is valuable, so HD Link is designed to make setup quick and painless. The front-panel display is bright and clear, with easy-to-understand labels. Menu hierarchies are shallow, so accessing most functions takes only a few steps.

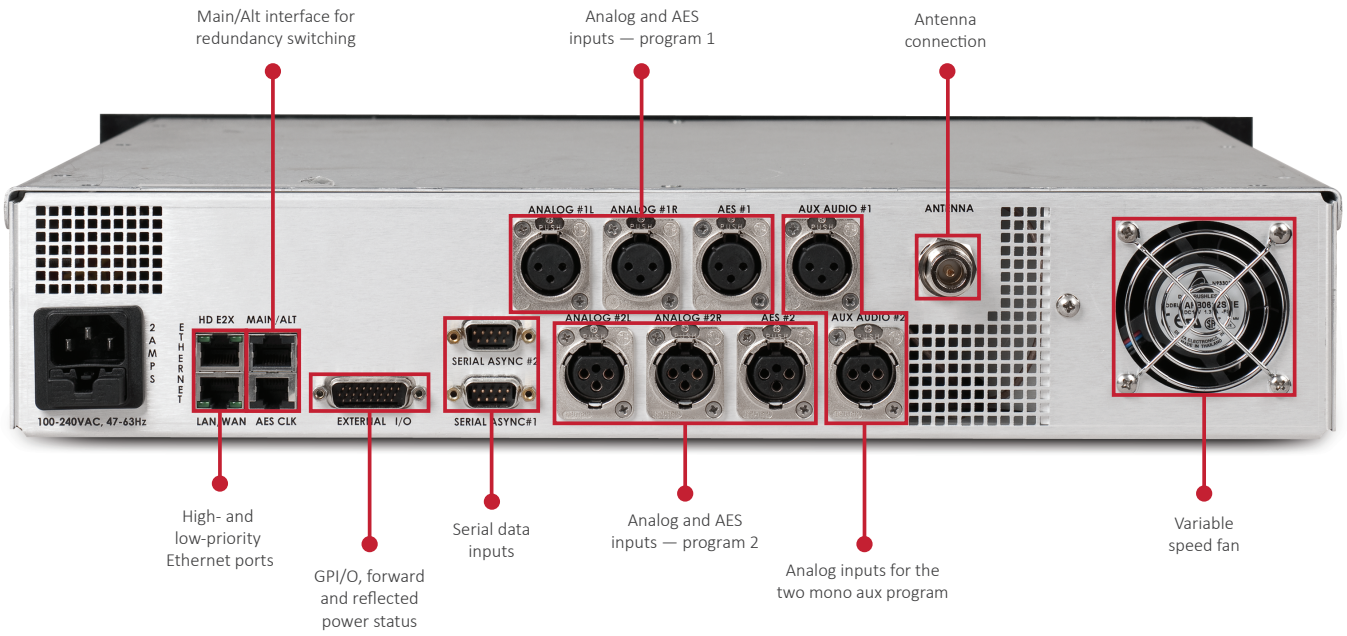
Modem settings automatically synchronize between the transmitter and receiver units. With both units set for the same frequency and RF bandwidth, changes to QAM, IP bandwidth, etc., on the transmitter automatically sync to the receiver.

HD Link has tools to help you in planning your overall STL system. Select the active audio channels and IP bandwidth you want it to carry, and HD Link automatically calculates the optimum settings for QAM and forward error correction, along with the receive signal strength necessary to achieve the desired level of throughput. These auto-calculated values enable you to prepare a reliable path calculation and determine the requisite transmitter power, antenna size and other variables.

HD Link provides numerous interfaces for setup, diagnostics and updates, with Ethernet and USB ports on each unit, plus remote access via HTTP, FTP and SNMP.

Additional convenience features include a headphone jack and AES/EBU sync port on the receiver, and variable-speed fans to minimize noise. And HD Link is physically compact at only two rack units per end.

HD Link Transmitter Rear Panel



Built-In Backup

When your HD Link is connected to a bidirectional IP network with sufficient bandwidth, the program channels will automatically switch to should the 950 MHz link fail. In effect, HD Link is both a 950 MHz RF STL and an IP audio STL in one box, with automatic fallback from one to the other.

It's easy to choose the HD Link that is right for you

To choose the right HD Link model for your STL, all you have to decide is how many stereo audio programs you need and whether you want linear or Enhanced apt-X compressed audio. The auxiliary audio channels, control options, selectable output power, and data handling flexibility come standard with every unit.

Choose from:

- IP plus one linear stereo program
- IP plus two linear stereo programs
- IP plus one Enhanced apt-X stereo program
- IP plus two Enhanced apt-X stereo programs
- IP plus two stereo programs, one Enhanced apt-X and one linear
- IP data and auxiliary audio only

HD Link Accessories

Bandpass filters

Single- and dual-cavity bandpass filters are available to attenuate interference at sites with congestion in the 950 MHz band

Main/alternate interface

This system detects hardware and system faults in the HD Link transmitter and receiver, switching to an alternate pair should conditions fall out of normal operational boundaries.

Intraplex® HD Link™

Specifications

Specifications and designs are subject to change without notice

RF		
Frequency	932.500 to 959.875 MHz fully synthesized	
Step Size	25 kHz	
Frequency Accuracy	±4 PPM (±0.0004%)	
Occupied Bandwidth	200/250/300/375/500 kHz	
Identifier	V-HDL950	
FCC Emission Type Designator(s)	200KD7W, 250KD7W, 300KD7W, 500KD7W	
Modulation	Digital, 32/64/128/256 QAM	
Antenna Connector	Type N (female), 50 ohms	
Error Correction	LDPC	
Error Correction Overhead	8 to 25% depending on mode	
Transmitter	Power	1/2/5 W RMS
	Monitoring	Forward power, reverse power, VSWR, PLL lock
Receiver	Sensitivity	-95 to -82 dBm depending on mode
	Dynamic Range	0 to -95 dBm
	Spurious and Harmonic Equalizer	24-tap feed-forward filter and 3-tap decision feedback filter
	Monitoring	Receive lock, receive signal level, receive signal-to-noise ratio, PLL lock
System		
Delay	Main audio end-to-end delay is 50 to 300 mS based on mode. HD Radio™ and Ethernet end-to-end delay less than 20 mS	
Networking		
Ethernet	• Up to 1.5 Mb/s UDP/IP or TCP/IP* transport (*TCP/IP transport requires an external IP return path) • Three 10/100Base-T, full-duplex, auto-negotiation • 1 port for monitoring and remote control • 1 port for high-priority data • 1 port for low-priority data	
Ethernet Connectors	3 RJ-45, each connector with integrated LEDs for link and activity monitoring	
Protocols	IP, TCP, UDP, HTTP, FTP, NTP, Syslog, and SNMPv2c	
IP Gateway	Port or IP based prioritization, static routing, proxy ARP, policing, firewall, public or private network for return path	
Control and Monitoring		
Front Panel	Intuitive, graphical front-panel user interface 4.3 in. display, 480x272, TFT Color LCD with LED backlight and 7 button keypad	
Remote User Interface	Monitoring and control using embedded Web server	
Network Management	SNMP	
VU Meter	Front-panel display, 6 segment audio level indicator for all audio channels	
Contacts, Output	• 4 output contacts with both normally closed and normally open outputs • 2 output contacts: normally closed • Maximum current: 120 mA • Maximum voltage: 350 VDC • Closed resistance: 23 ohms typical	
Contacts, Input	2 input contacts, TTL compatible	

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Telemetry Output	• 2 analog outputs (0 to 5 V) for RF transmit forward and reverse power (transmitter) • 2 analog outputs (0 to 5 V) for RF receive signal level and signal/noise ratio (receiver)	
Contact/Analog Connector	26-pin D Sub and RJ-45	
USB	1 USB 2.0 port for saving settings and software upgrade	
Audio Monitoring	1 stereo 1/4 in. headphone jack (receiver)	
Fault Detection and Logging	Internal log files, SNMP traps, syslog, and automatic upload of log files	
Audio and Serial Data		
Main	Channels	1 or 2 stereo program channels, individually configurable for linear or Enhanced apt-X® audio
	Sample Rate and Audio Bandwidth	• 48 ks/s for 22.5 kHz operation • 44.1 ks/s for 20 kHz operation • 32 ks/s for 15 kHz operation • 24 ks/s for 12 kHz operation (apt-X) • 16 ks/s for 7.5 kHz operation (apt-X)
	Coding	Linear or Enhanced apt-X
	Sample Size	• 16-bit (linear) • 16/20/24-bit (apt-X)
	Connectors	• Audio Inputs: XLR female on left, right, and digital AES/EBU • Audio Outputs: XLR male on left, right, and digital AES/EBU • External AES/EBU Input Clock: RJ-11 • RS-232 Data: RJ-11
	Digital/Analog Operation	• For input, digital/analog autodetection • For output, digital and analog simultaneous
	Data Channel	• RS-232 data transport 9.6 kb/s (linear) • RS-232 data transport 1.2, 2.4, 4.8 and 9.6 kb/s, mode dependent (apt-X)
Main Digital Audio	Accepted Audio Sampling Rates	• Accepts any AES/EBU rate between 32 and 48 ks/s (linear) • Accepts any AES/EBU rate between 24 and 48 ks/s (apt-X)
	Rate Conversion	Rate converts any AES/EBU input rate to 48, 44.1 or 32 ks/s. In addition, for apt-X, rate conversion includes 24 and 16 ks/s
	External Sync (Receive Only)	Accepts external AES/EBU reference signal or RS-422 clock to synchronize output to facility timing
	Input/Output Impedance	Balanced, 110 ohms ±20%
	AES/EBU Channel Status	A&B channel status bits are transported
Main Analog Audio	Audio Frequency Response ±0.5 dB	• 48 ks/s: 1 Hz to 22 kHz • 44.1 ks/s: 1 Hz to 20.5 kHz • 32 ks/s: 1 Hz to 15 kHz
	Audio Full Load Level	9 to +24 dBu
	Crosstalk	Better than -80 dB
	Total Distortion	• THD+N, less than 0.003% at 1 kHz – 1 dBFS input (linear) • THD+N, less than 0.004% at 1 kHz – 1 dBFS input (apt-X)
	Dynamic Range	• Greater than 91 dB (for linear) • Greater than 92 dB (16bit apt-X) • Greater than 105 dB (20bit apt-X) • Greater than 110 dB (24bit apt-X)
	Input Impedance	Balanced, greater than 10 K ohms
	Output Impedance	Balanced, less than 52 ohms
Main Diagnostics	Test Tone Generator	1004 Hz test tone at -12 dBFS, which is equivalent to +8 dBm input

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HD Audio	Integrated IP channel for UDP or TCP HD Radio (importer-to-exporter or exporter-to-exciter)	
Auxiliary Audio	Channels	2 analog
	Sample Rate and Audio Bandwidth	16 ks/s for 7.5 kHz operation
	Audio Connectors	• Audio Inputs: XLR female • Audio Outputs: XLR male
	Coding	ITU G.722 mode 1
	Sample Size	14-bit
	Audio Frequency Response	100 to 6400 Hz ±1 dB
	Data Rate	64 kb/s per active channel
	Total Distortion	THD+N, less than 0.1% at 1 kHz to 1 dBFS input
	Dynamic Range	Greater than 65 dB
	Input Impedance	Balanced, greater than 10 K ohms
	Output Impedance	Balanced, less than 52 ohms
Mechanical and Environmental		
Dimensions (H X W X D)	• 2RU: 3.5 x 19 x 14 in. (8.9 x 48.3 x 35.6 cm) • EIA rack mountable	
Weight	• Transmitter: 18.5 lbs (8.4 kg) • Receiver: 14.5 lbs (6.6 kg)	
Power Requirements	Universal AC 100 to 240 VAC, 50/60 Hz	
Power Consumption	• Transmitter: 104 W maximum • Receiver: 34 W maximum	
Fuse Protections	2A AC input fuse	
Cooling	Forced air using variable-speed internal fan	
Humidity	To 95% non-condensing	
Operating Temperature	32° to 122° F (0° to 50° C)	
Compliance		
Regulatory Compliance	• FCC Part 15 • FCC Part 74, subpart E • EN60950	