HARRIS®
assuredcommunications®

Intraplex® HD Link™

Integrated 950 MHz Audio
and Data Gateway for Radio

Introducing the Harris® Intraplex® HD Link™ — the first digital 950 MHz STL system designed to operate in today's world of data communications.

The next generation of digital STL

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

Earlier digital STLs were not designed for IP data transport. Adding IP data to them requires 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 great 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.

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.

Intraplex® HD Link™

KEY FEATURES AND BENEFITS

Powerful, reliable RF performance

- Up to 5 W of RF power
- Harris-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 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

Top-notch, 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

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. This highly efficient scheme contributes to increased data throughput.
- **21st century design**
  By applying Harris 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.

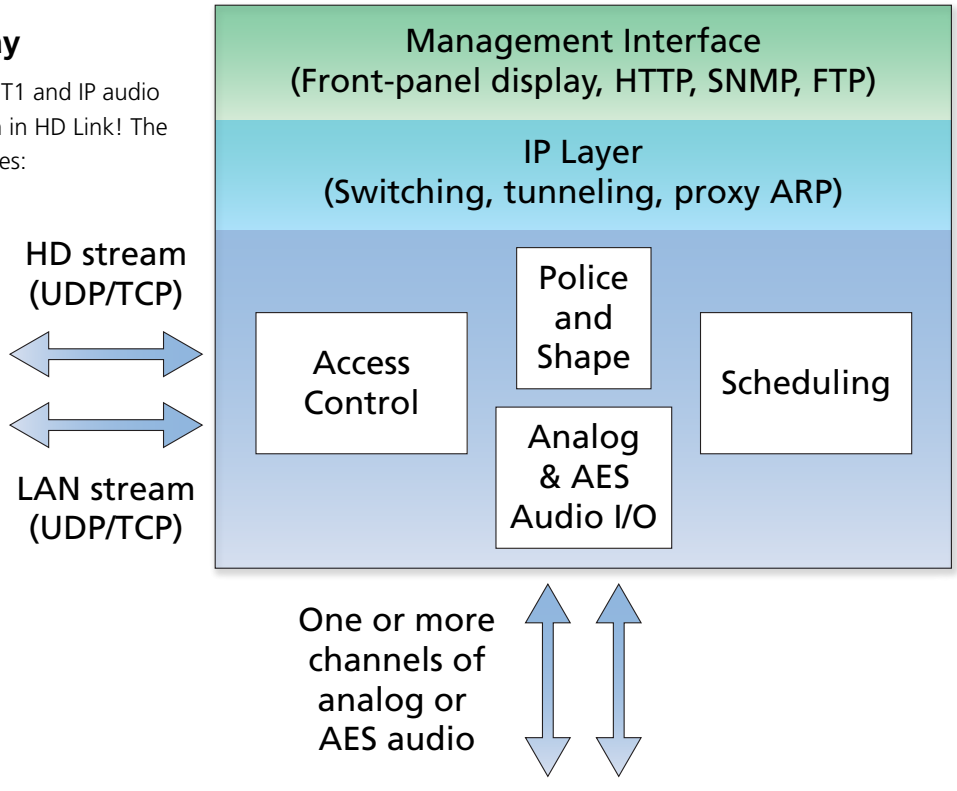
Audio and data. And more data.

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

Like most digital microwave systems, HD Link uses quadrature amplitude modulation (QAM) 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 (FEC) 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.

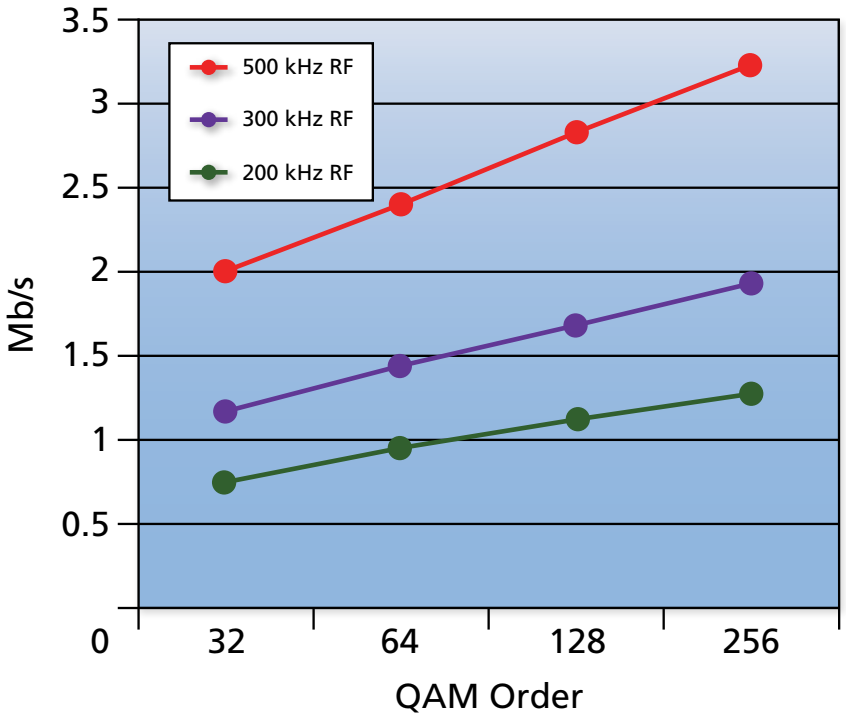


Figure 1. Higher-order QAM levels enable greater data carrying capacity.

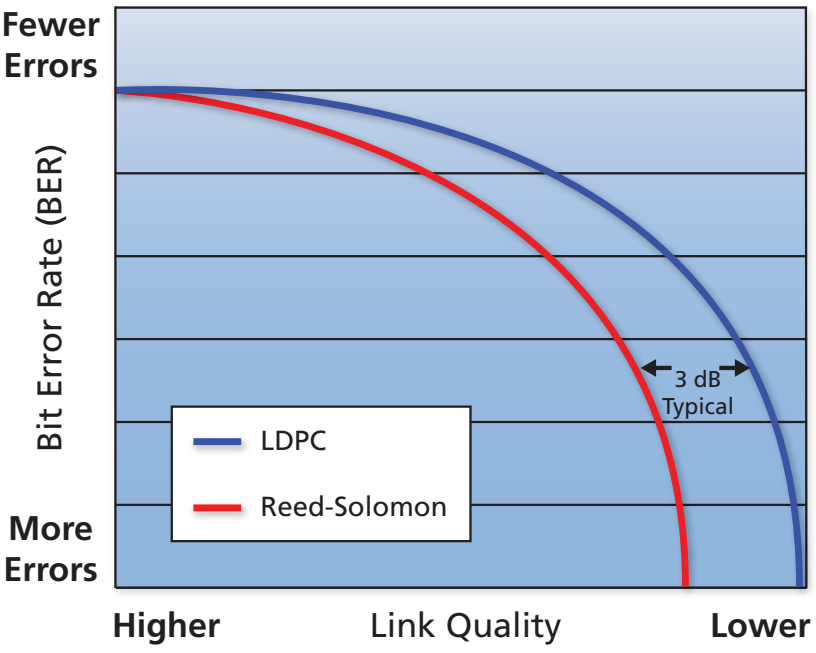


Figure 2. The HD Link system's advanced error correction handles difficult links better than STLs using older technology.

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

First, HD Link uses Low-Density Parity Check (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.

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).

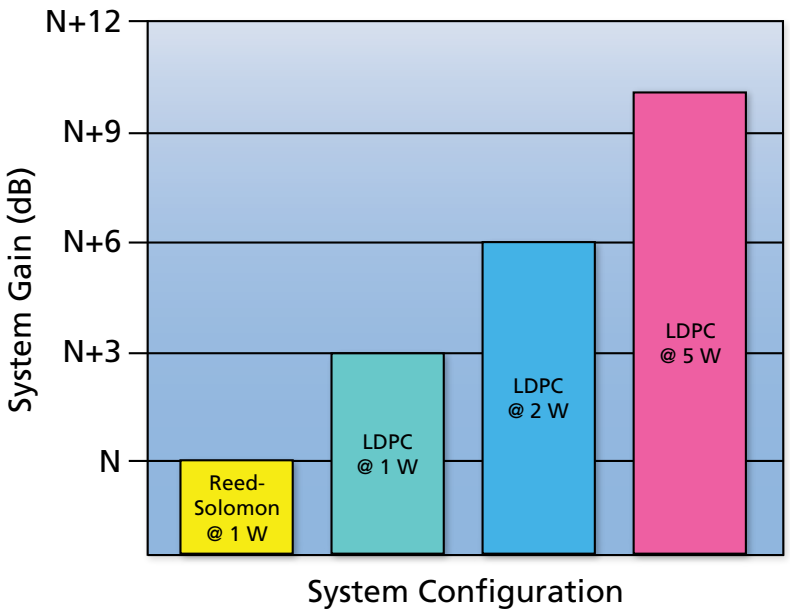
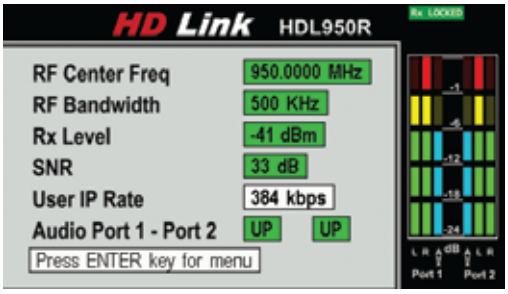
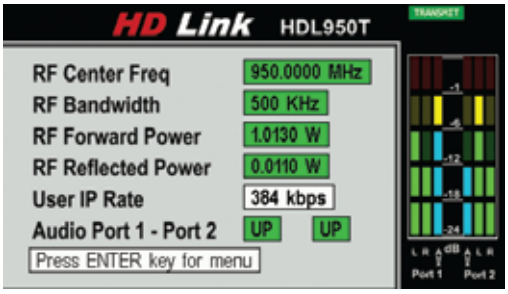


Figure 3. The combination of HD Link technology advantages can offer you a dramatically improved STL system.

Elegantly simple installation, configuration and operation



HD Link Receiver front-panel display



HD Link Transmitter front-panel display

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.

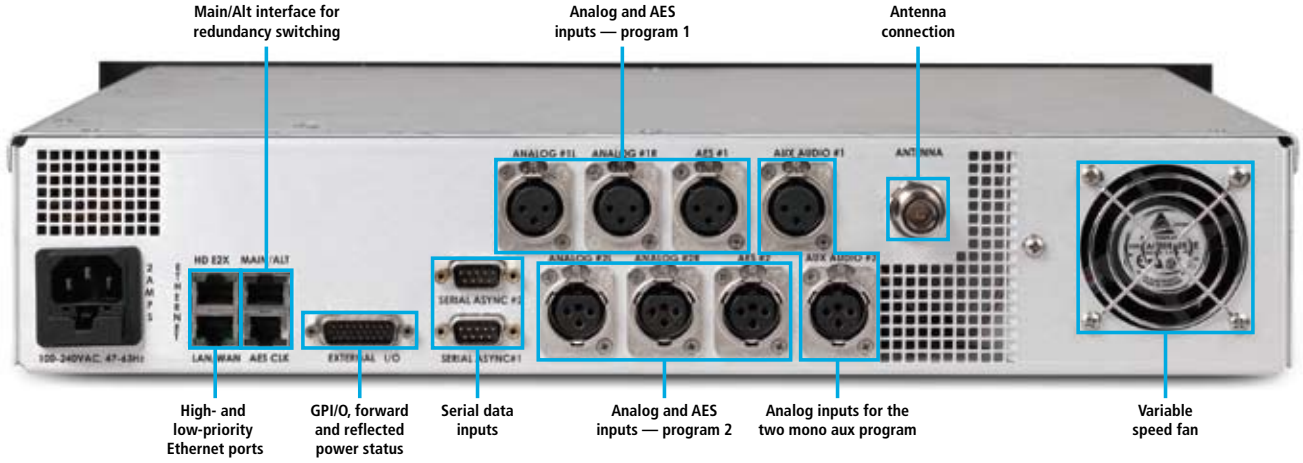
HD Link has tools to help you in planning your overall STL system. Select the active audio channels and IP bandwidth you want it to carry, and HD Link automatically calculates the optimum settings for QAM and forward error correction, along with the receive signal strength necessary to achieve the desired 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.

Great Features, Powerful Options

HD Link Transmitter Front Panel



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 IP 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.

Specifications

Specifications are subject to change without notice.

RF

Frequency	944 to 960 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 (Low Density Parity Check)
Error Correction Overhead	8 to 25% depending on mode

Transmitter

Power	1/2/5 Watts 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	Three 10/100Base-T, full-duplex, auto-negotiation One port for monitoring and remote control One port for high-priority data One port for low-priority data
Ethernet Connectors	Three RJ-45, each connector with integrated LEDs for link and activity monitoring
Protocols	IP, TCP, UDP, HTTP, FTP, NTP, Syslog and SNMP v2c
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 seven button keypad
Remote User Interface	Monitoring and control using embedded Web server
Network Management	SNMP
VU Meter	Front-panel display, six-segment audio level indicator for all audio channels
Contacts, Output	Four output contacts with both normally closed and normally open outputs Two output contacts: normally closed Maximum current: 120 mA Maximum voltage: 350 VDC Closed resistance: 23 ohms typical
Contacts, Input	Two input contacts, TTL compatible
Telemetry Output	Two analog outputs (0 to 5 V) for RF transmit forward and reverse power (transmitter) Two 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	One USB 2.0 port for saving settings and software upgrade
Audio Monitoring	One 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	One or two 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 auto-detection 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 (16-bit apt-X) Greater than 105 dB (20-bit apt-X) Greater than 110 dB (24-bit apt-X)
Input Impedance	Balanced, greater than 10 Kohms
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

HD Audio	Integrated IP channel for UDP or TCP HD Radio (Importer-to-Exporter or Exporter-to-Exciter)

Auxiliary Audio

Channels	Two 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 -1 dBFS input
Dynamic Range	Greater than 65 dB
Input Impedance	Balanced, greater than 10 Kohms
Output Impedance	Balanced, less than 52 ohms

Mechanical and Environmental

Dimensions (2RU)	Width: 19 in. (48.3 cm) Depth: 14 in. (35.6 cm) Height: 3.5 in. (8.9 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 Protection	2 A 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

For more information, please visit www.intraplex.com.

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