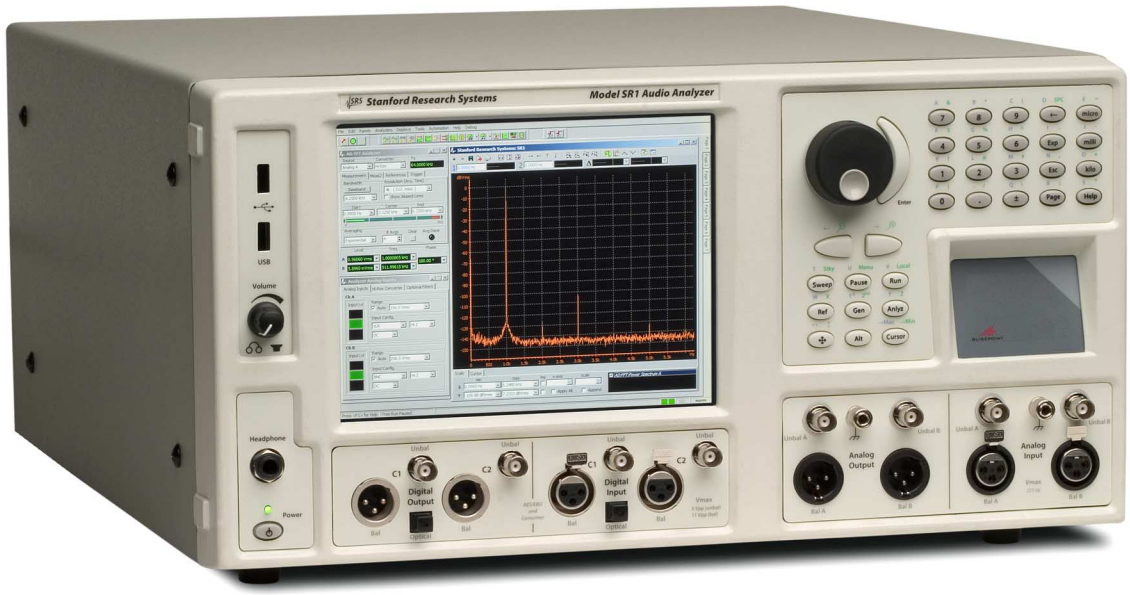
Audio Analyzer

SR1 — Dual-domain audio analyzer



SR1 Audio Analyzer

- **Analog/digital domain measurements**
- **–112 dB THD + N (at 1 kHz, 20 kHz BW)**
- **200 kHz frequency range**
- **–118 dBu analyzer noise (20 kHz BW)**
- **±0.008 dB flatness (20 Hz to 20 kHz)**
- **–140 dB input crosstalk**
- **–125 dB output crosstalk**
- **<600 ps jitter (50 Hz to 100 kHz)**
- **Dual-channel FFT measurements**

- **SR1 ... $6900** *(U.S. list)*

Introducing SR1 Dual-Domain Audio Analyzer — high performance audio analysis at a very affordable price.

SR1 is a stand-alone instrument that delivers cutting edge performance in a wide variety of audio measurements. With a versatile high-performance generator, an array of analyzers that operate symmetrically in both the analog and digital domains, and digital audio carrier measurements at sampling rates up to 192 kHz, SR1 is the right choice for the most demanding analog and digital audio applications.

User Interface

SR1 uses an integrated computer running the Windows XP embedded operating system, so operation will be immediately familiar and intuitive. Depending on the application, SR1 can be operated with an external mouse and keyboard, or by using the front-panel knob, keypad and touchpad.

Seven on-screen tabbed pages are available for arranging panels, graphs, and displays. Screen setups, data, and instrument configurations can be quickly saved and recalled to either the internal hard disk or to a flash drive connected to one of the two front-panel USB connectors. An optional 1024 × 768 XVGA monitor (opt. 02) provides better resolution and allows more information to be displayed.

While SR1's configuration panels offer total flexibility in setting up every detail of the analyzer, at times it is useful to

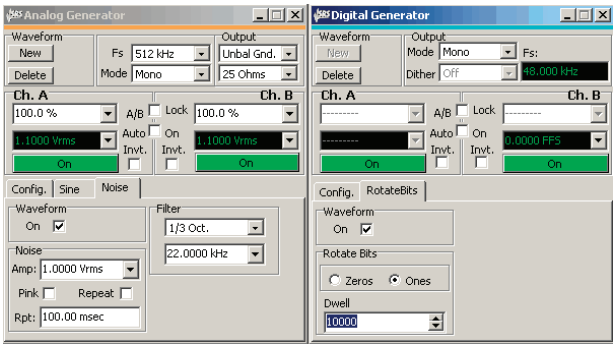
get a measurement going quickly, without worrying about infrequently used parameters. That's where QuickMeas comes in. QuickMeas gives SR1 users the ability to get up and running on many common audio measurements such as Level, SNR, Frequency Response, and Crosstalk after answering just a few simple questions about the inputs and outputs of the DUT. When the measurements are finished, the results are available in a clear, easy-to-understand report.

Analog Signal Generator

At the heart of SR1 is a uniquely flexible analog signal generator. All of the standard audio waveforms are available including sine, log-swept sine chirp, synchronous burst sine, noise (white, pink, and filtered), standard intermodulation test signals (SMPTE, CCIF, DIM), square waves, arbitrary waveforms (ASCII and .WAV), ramps, MLS and multitone waveforms. Many of these signals can be combined in the generator allowing you to create an unlimited number of test waveforms.

But the analog signal generator doesn't sacrifice performance for flexibility. With a flatness of ±0.008 dB (20 Hz to 20 kHz) and a residual THD + N of –106 dB (20 Hz to 20 kHz), SR1's *Low Distortion Sine* rivals the performance of any analyzer.

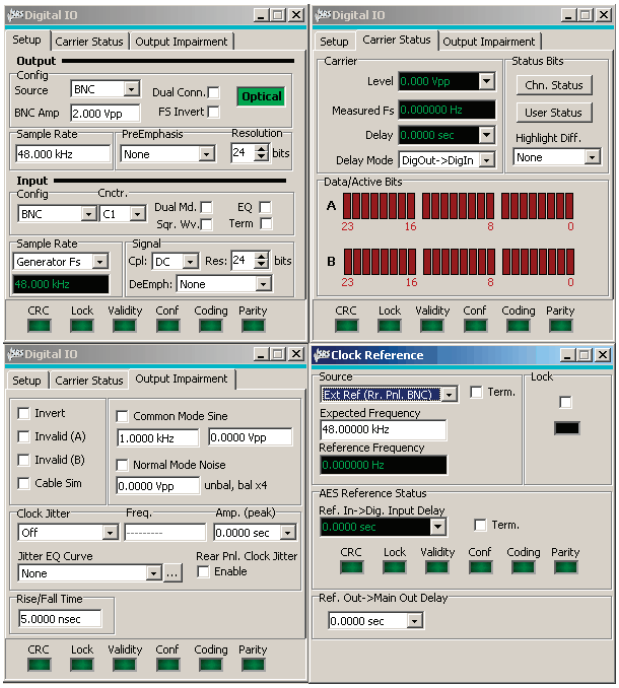
Multitone waveforms with up to 50 tones, each adjustable in frequency, amplitude, and phase are calculated and loaded in real-time, without having to run a cumbersome off-line program to generate arbitrary waveform tables. A convenient *FFT Chirp* waveform is automatically synchronized to the FFT analyzer allowing instant FFT measurements of frequency response (magnitude and phase).



Analog and Digital Signal Generator Panels

Digital Audio Signal Generator

The same flexibility and performance is found in SR1's digital audio signal generator. Almost all the same waveforms found in the analog generator are available in the digital generator with the addition of several special digital test waveforms including digital constant, walking bits, and a staircase waveform (for D/A testing).



Digital I/O Panels

The digital audio output sampling rate is continuously adjustable from 24 kHz to 216 kHz (single and dual connector). Full control over transmitted status bits (in both professional and consumer formats), user bits, and validity bits, is provided.

For digital interface testing, a variety of impairment signals can be imposed on the digital audio carrier. Carrier impairments include variable rise time (5 ns to 400 ns), common mode sine waves, normal mode noise, and several jitter waveforms (sine, square, and noise).

Timebase

All of SR1's sampling clocks are derived from an internal timebase with 5 ppm accuracy. For the most demanding applications, an optional atomic rubidium (FS725) timebase is available with an accuracy at shipment is $\pm 5 \times 10^{-11}$, and a 20-year aging specification of less than 5 ppb. Additionally, the timebase may be synchronized to an external clock, an AES11 reference signal, or any standard video signal.

Analyzers

The heart of SR1's measurement abilities is its versatile set of analyzers which operate symmetrically on both analog and digital audio signals with no need to purchase additional options. Up to two analyzers can be run simultaneously on either the analog or digital inputs.

The *Time Domain Detector* makes all of the standard audio measurements including Amplitude, Crosstalk, and THD + N. Continuously variable bandwidth limiting and standard weighting filters are included. The post notch-filter distortion signal can be fed to an FFT analyzer for a live spectral display of distortion, or to the rear-panel monitor output or speaker.

The *Single-Channel FFT* and *Dual-Channel FFT* analyzers offer live spectral displays with full zoom and heterodyne capability. The full resolution of the analyzer can be applied to any frequency range down to 1/512th of the full measurement bandwidth, leading to an effective resolution of 16M FFT lines. Several averaging algorithms can be applied to bring out low level signals.

The two-channel FFT analyzer offers true single-shot frequency response measurements for the ultimate in accuracy. SR1 also has a complete set of impulse response measurements including impulse response, quasi-anechoic frequency response, and energy time-curve. Since SR1 is a true two-channel FFT, it isn't limited to MLS waveforms, but can use virtually any waveform.

The *THD Analyzer* makes frequency selective THD measurements on two user-selectable sets of up to 13 harmonics of the input signal.

The *IMD Analyzer* makes standard audio distortion measurements including SMPTE, CCIF, and DIM. Frequency selective analysis ensures high measurement accuracy.

The *Histogram Analyzer* displays live histograms of input signal amplitudes and probability distributions. Realtime fits to Gaussian distributions can be generated.

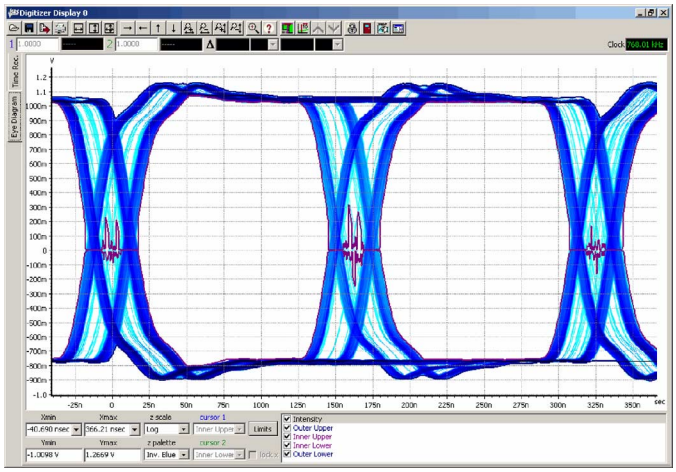
The *Multitone Analyzer*, in combination with the *Multitone Generator*, can be configured to make fast single-shot measurements of a variety of audio parameters including Level, Frequency Response, THD + N, THD Total Distortion, Noise, Crosstalk, and IMD.

Digital Audio Interface Measurements

SR1 provides a complete set of measurements for digital interface testing. Carrier level and sampling frequency are measured directly. Status bits are fully decoded in both professional and consumer formats, and user bits are displayed as well. SR1's *Jitter Analyzer* measures jitter in both the time and frequency domain, including continuously variable bandwidth limiting and weighting in both domains. For frequency domain measurements, live zoomable and heterodyned spectral displays of jitter are available. Using the jitter chirp waveform, you can characterize jitter transfer functions in under a second. With a residual jitter of only 600 ps, the performance of SR1's jitter analyzer is unbeatable.

Digitizer

An optional 80 MHz transient digitizer (opt. 01) provides additional digital audio carrier analysis. Operating on a record of up to 2M samples, the digitizer computes and displays the time record of the input signal and its jitter, input spectrum, jitter spectrum, and the probability distributions of the input and jitter amplitudes as well as the pulse width and pulse rate. Full color eye-diagrams can be generated allowing easy testing against user-configurable eye limits.



Eye Diagram

Automation and Programming

SR1 offers unprecedented flexibility for user scripting and remote programming. On-board scripts can be written in VBScript, Jscript, or Python with full access to all of the instrument's capabilities as well as the ability to create simple user-interfaces for running tests. SR1 has a complete hierarchical GPIB command set, and GPIB commands can be sent over the standard IEE-488 interface, RS-232 port, or over the Ethernet on a TCP/IP network (VXI-11). Finally, SR1 has a complete COM interface alowing instrument operation to be automated from any COM capable application such as Visual Basic, LabView, or Microsoft Office.

SR1 Rear Panel

Ordering Information

SR1	Audio analyzer	$6900
Option 01	80 MHz digitizer	$1500
Option 02	High resolution display	$1200

Analog signal Generator

General Characteristics

Amplitude range (rms)	1 µV to 28.3 V (balanced) 1 µV to 14.1 V (unbalanced)
Amplitude accuracy	±0.5 % (±0.043 dB) at 1 kHz
Frequency range	
Hi BW DAC	10 Hz to 200 kHz
Hi Res DAC	10 Hz to 0.45 Fs (Fs: 128 kHz or 64 kHz fixed, 24 kHz to 216 kHz adj.)
Frequency accuracy	±0.0005 % (5 ppm)
Frequency resolution	<Fs/2^{24}
Output configuration	Balanced Ground, Balanced Float, Unbalanced Ground, Unbalanced Float, Common Mode Test
Source impedance	50 Ω, 150 Ω , 600 Ω (balanced) 25 Ω, 75 Ω, 600 Ω (unbalanced)
Max. power (600 Ω load)	
Balanced	30.5 dBm
Unbalanced	24.9 dBm
Float voltage	±40 V
Crosstalk	
10 Hz to 20 kHz	–125 dB
>20 kHz	–100 dB

Waveforms

Low Distortion Sine

Flatness (relative to 1 kHz)	
20 Hz to 20 kHz	±0.020 dB (typ. ±0.012 dB)
10 Hz to 64 kHz	±0.025 dB
10 Hz to 200 kHz	±0.05 dB
Res. THD + N (Hi BW DAC)	
1 kHz, 4 Vrms	–112 dB (22 kHz BW)
22 Hz to 20 kHz	–106 dB + 1 µV (22 kHz BW) –100.5 dB + 1.7 µV (80 kHz BW) –97 dB + 2.5 µV (200 kHz BW)
10 Hz to 100 kHz	–89 dB + 2.5 µV (200 kHz BW)
Residual THD + N (Hi Res DAC, Fs = 128 kHz)	
1 kHz, 4 Vrms	–112 dB
20 Hz to 20 kHz	–106 dB + 1 µV (22 kHz BW)
20 Hz to 57.6 kHz	–102 dB + 1.4 µV (57.6 kHz BW)
Residual THD + N (Hi Res DAC, Fs = 64 kHz)	
1 kHz, 4 Vrms	–112 dB (22 kHz BW)
20 Hz to 20 kHz	–106 dB + 1 µV (22 kHz BW)

Regular Sine

Flatness (relative to 1 kHz, amplitude ≤4 Vrms)	
20 Hz to 20 kHz	±0.008 dB (typ. ±0.003 dB)
10 kHz to 64 kHz	±0.02 dB
10 Hz to 200 kHz	±0.03 dB
Residual THD + N (Hi BW DAC)	
1 kHz	–86 dB (22 kHz BW)
22 Hz to 20 kHz	–85 dB + 1 µV (22 kHz BW) –84.5 dB + 1.7 µV (80 kHz BW) –82 dB + 2.5 µV (200 kHz BW)
10 Hz to 100 kHz	–77 dB + 2.5 µV (200 kHz BW)
Residual THD + N (Hi Res DAC, Fs = 128 kHz))	
1 kHz	–99 dB (22 kHz BW)
22 Hz to 20 kHz	–98 dB + 1 µV (22 kHz BW)
20 Hz to 57.6 kHz	–96.5 dB + 1.4 µV (57.6 kHz BW)
Residual THD + N (Hi Res DAC, Fs = 64 kHz))	
1 kHz	–106 dB (22 kHz BW)
20 Hz to 20 kHz	–101 dB + 1 µV (22 kHz BW)
Phased Sines	0 to 360°, 0.001° resolution
IMD	SMPTE/DIN, CCIF/DFD, DIM/TIM
Noise	White, Pink, Filtered White/Pink, USASI
Multitone	1 to 50 tones
MLS	Repetition rates from 2^8 to 2^{20}
FFT Chirp	Equal power in each FFT bin
Log-swept sine chirp	Swept-sine with log increasing frequencies
Square	10 Hz to 50 kHz frequency range
Ramp	Fs/N frequency range (N≥20)
Arbitrary	256 Samples to 136k Samples
Polarity	10 Hz to Fs/4 frequency range
Constant (Offset)	DC to 20 V_p (unbal) / 40 V_p (bal)
Bursts	
Burst types	Timed, ext. triggered, ext. gated, synchronous sine, shaped.

Digital Audio Signal Generator

Digital Audio Carrier Characteristics

Output amplitude	
Balanced	
Range	16 mV to 10.2 V (110 Ω load)
Accuracy	±10 % + 80 mV
Unbalanced	
Range	4 mV to 2.55 V (75 Ω load)
Accuracy	±10 % + 20 mV
Output format	Balanced XLR (AES/EBU), dual-connector XLR, unbalanced BNC (SPDIF-EIAJ), dual-connector BNC, Optical (Toslink)
Output sample rate	24 kHz to 216 kHz
Sample rate accuracy	±5 ppm
Output impedance	110 Ω (balanced) 75 Ω (unbalanced)

Digital Audio Waveforms

Sine

Frequency range	10 Hz to Fs/2
Frequency resolution	<Fs/2^{24}
Flatness	±0.001 dB
Harmonic/spurious	–148 dB
Phased Sine	0 to 360° range, 0.01° resolution
Square	10 Hz to Fs/2 frequency range
IMD	SMPTE/DIN, CCIF/DFD, DIM/TIM
Noise	White, Pink, Filtered White/Pink, USASI
MLS	Repetition rates from 2^8 to 2^{20}

Ramp	Fs/N frequency range (N≥20)
Arbitrary	256 Samples to 136k Samples
FFT Chirp	Equal power in each FFT bin.
Log-swept sine chirp	Swept-sine with log increasing frequencies
Polarity	10 Hz to Fs/4 frequency range
Bursts	
Burst waveforms	All allowed waveforms
Burst types	Timed
Digital Test Waveforms	Digital Constant, Count, Rotating Bits, Staircase, J-Test
Dither	None, triangle and rectangular probability distribution

Digital Audio Carrier Impairments

Jitter	
Waveforms	Sine, square, uniform noise, BP filtered noise, chirp
Frequency range	2 Hz to 200 kHz
Amplitude range	0 UI to 13 UI
Normal Mode Noise	
Amplitude range	
Unbalanced	0 to 637 mV_{pp}
Balanced	0 to 2.55 V_{pp}
Common Mode Sine	
Amplitude range	0 to 20 V_{pp} (balanced only)
Frequency range	10 Hz to 100 kHz
Cable Simulation	Simulates 100 m of digital cable
Variable Rise Time	5 ns to 400 ns

Signal Measurements

General Analog Input characteristics

Input range (Vrms)	62.5 mV to 160 V
Input configuration	XLR, BNC, Generator Monitor, Digital Audio Common Mode
Input impedance	
Balanced	200 kΩ / 95 pF
Unbalanced	100 kΩ / 185 pF
Input termination (bal)	300 Ω, 600 Ω, 200 kΩ
Crosstalk	
10 Hz to 50 kHz	≤–140 dB
>50 kHz	≤–135 dB
Hi BW ADC	
Type	16-bit sigma-delta
Sampling freq.	512 kHz
Frequency range	DC to 228 kHz
Hi Res ADC	
Type	24-bit sigma-delta
Sampling freq.	128 kHz or 64 kHz (fixed), 24 kHz to 216 kHz (adj.)
Frequency range	DC to 0.45Fs

General Digital Input Characteristics

Input format	Balanced XLR (AES/EBU), dual-connector XLR, unbalanced BNC (SPDIF-EIAJ), dual-connector BNC, Optical (Toslink)
Input sample rate	24 kHz to 216 kHz
Input impedance	Hi Z or 110 Ω (balanced) Hi Z or 75 Ω (unbalanced)

Analog Signal Meters

RMS Level Meter	
Accuracy (1 kHz ref)	±0.5 % (±0.043 dB)
Flatness (1 kHz ref, amplitude less than 4 Vrms)	
20 Hz to 20 kHz	<±0.008 dB (typ. <±0.003 dB)
10 Hz to 64 kHz	<±0.02 dB
10 Hz to 200 kHz	<±0.03 dB
Frequency Meter	
Range	8 Hz to 300 kHz
Accuracy	timebase error ± (2 ppm + 10 mHz)
Phase Meter	
Accuracy	±1.0°

Digital Signal Meters

Frequency Meter	10 Hz to 0.45Fs, ±100 ppm accuracy
Phase Meter	±0.05° accuracy (f ≥ 50 Hz)

Analyzers (Analog and Digital Audio)

Time Domain Analyzer	
Measurements	Amplitude, amplitude ratio, THD + N, THD + N ratio, SINAD
Analog Inputs:	
Amplitude accuracy	±0.5 % (±0.043 dB)
Flatness (1 kHz ref)	
50 Hz to 20 kHz	<±0.008 dB (typ. ±0.003 dB)
20 Hz to 64 kHz	<±0.02 dB
10 Hz to 200 kHz	<±0.05 dB
Residual noise (62.5 Vrms input range, shorted input)	
Hi Res ADC (Fs = 128 kHz)	
22 Hz to 22 kHz	<–117.5 dBu
22 Hz to 57.6 kHz	<–115 dBu
A-Weighted	<–120 dBu
Hi BW ADC	
22 Hz to 22 kHz	<–118 dBu
22 Hz to 80 kHz	<–113 dBu
22 Hz to 200 kHz	<–110 dBu
A-Weighted	<–120 dBu
Residual THD + N	
Hi Res ADC (Fs = 128 kHz)	
1 kHz, 4 Vrms	–111 dB (22 kHz BW)
20 Hz to 20 kHz	–107 dB + 0.8 µV (22 kHz BW) –101 dB + 1.3 µV (57.6 kHz BW)

Hi Res ADC (Fs = 64 kHz)	
1 kHz, 4 Vrms	–111 dB (22 kHz BW)
20 Hz to 20 kHz	–107 dB + 0.8 µV (22 kHz BW)
Hi BW ADC	
1 kHz, 4 Vrms	–113 dB (22 kHz BW)
20 Hz to 20 kHz	–109 dB + 0.8 µV (22 kHz BW)
	–102 dB + 1.5 µV (80 kHz BW)
	–98 dB + 2.5 µV (200 kHz BW)
10 Hz to 100 kHz	–91 dB (200 kHz BW)

Digital Inputs:

Amplitude accuracy	±0.001 dB (at 1 kHz)
Flatness	±0.001 dB (15 Hz to 22 kHz)
Residual THD + N	–140 dBFS

Bandwidth limiting filters	
Low pass filter	4th order Butterworth, adj. from Fs/40 to 0.45Fs, 20 kHz, 40 kHz and 80 kHz fixed elliptical filters per AES17.
High pass filter	4th order Butterworth, @ 22 Hz, 100 Hz, and 400 Hz. 20 kHz, 40 kHz and 80 kHz fixed elliptical filters per AES17.
Band pass filter	
Response	
Hi BW ADC	1/3 Octave, Class II (4-pole)
Hi Res ADC	1/3, 1/6, 1/12, 1/24 Octave, Class III (6-pole)
Tuning range	
Hi BW ADC	10 Hz to 200 kHz
Hi Res ADC	10 Hz to 0.44Fs
Tuning accur.	±2.5 %
Amplitude accur.	±0.5 %
Notch filters	
Tuning range	
Hi BW ADC	10 Hz to 200 kHz
Hi Res ADC	10 Hz to 0.44Fs
Tuning accuracy	±2.5 %
Response	–3 dB at 0.73 Fc and 1.37 Fc
Ampl. accuracy	±0.2 dB (20 Hz to 180 kHz, $f < 0.5f_0$ or $f > 2f_0$)
Weighting filters	A-wt, C-Msg wt, CCITT, CCIR (weighted, unweighted, 2 kHz norm)
Detector response	RMS, Peak, Quasi-Peak (CCIR-468)

Single-Channel and Dual-Channel FFT Analyzers

Frequency range	
Hi BW ADC	DC to 200 kHz
Hi Res ADC	DC to 0.45Fs
Number of FFT lines	256, 512, ... 32k
Processing	40-bit floating point
Windows	Blackman Harris, Enhanced Blackman Harris, Hann, Hamming, Equiripple, Flattop, Gaussian, Kaiser, Uniform, Rife Vincent 4, 5 and 10 term
Zoom	Span can be narrowed by up to 512×
Heterodyne	Narrowed span can be centered anywhere in the measurement range
Averaging	fixed length and continuous
Dual-channel meas.	Frequency response, coherence, impulse response

THD Analyzer — Measures two independent sets of user-selectable harmonics (2× to 14×)

IMD Analyzer — SMPTE/DIN, CCIF/DFD, DIM/TIM

Histogram Analyzer — Time vs. amplitude, Histogram, PDF, Gaussian fit to PDF

Multitone Analyzer — Level, Frequency Response, THD THD + N, noise, IMD, Crosstalk

Digital Audio Carrier Measurements

Measurements	Carrier amplitude, sample rate, jitter amplitude, jitter spectrum
Sample rate	24 kHz to 216 kHz
Sample rate accuracy	±5 ppm
Carrier amplitude measurements	
Balanced (XLR)	±10 % + 80 mV
Unbalanced (BNC)	±10 % + 20 mV
Optical	Displays voltage of Toslink receiver
Output to input delay	Measures delay from Digital Audio Output or AES11 reference output to Digital Audio Input
Range	–12.7 UI to +115.1 UI in seconds
Resolution	60 ns
Residual jitter	
50 Hz to 100 kHz	≤600 ps
Reference	
Input sources	AES11 (24 Hz to 216 kHz), sine or TTL (8 kHz to 32 MHz), video (NTSC/PAL/SECAM)

General

Optional digitizer (Opt. 01)	
Sampling rate	80 MHz
Acquisition length	4k, 8k, 16k, 128k, 256k, 512k, 1M, 2M samples
Measurements	Input vs. time, jitter vs. time, input spectrum, jitter spectrum, pulse width/rate histograms, jitter probability histogram, eye diagrams
Computer interfaces	GPIB, RS-232, Ethernet, COM.
Video out	VGA output for external monitor
Power	<250 W, 90 to 264 VAC, 47 to 63 Hz,
Dimensions	17" × 8.5" × 20.25" (WHD)
Weight	40 lbs.
Warranty	One year parts and labor on defects in materials and workmanship