FFT Spectrum Analyzers

SR780 — 100 kHz two-channel dynamic signal analyzer

- DC to 102.4 kHz bandwidth
- 90 dB dynamic range
- Low-distortion synthesized source
- 145 dB dynamic range in swept-sine mode
- Real-time octave analysis
- Up to 32 Mbyte memory
- GPIB and RS-232 interfaces

SR780 Dynamic Signal Analyzer

The SR780 Dynamic Signal Analyzer combines high performance and low cost in a full-featured package. It offers 102.4 kHz FFTs with 90 dB dynamic range, swept-sine measurements, ANSI standard octave analysis, waterfall displays, and transient capture for less than half the cost of other similarly equipped analyzers.

Spectrum Analysis

The SR780 delivers true two-channel, 102.4 kHz FFT performance. Its fast 32-bit floating-point DSP processor gives the SR780 a 102.4 kHz real-time rate with both channels selected. Two precision 16-bit ADCs provide a 90 dB dynamic range in FFT mode. Selectable 100 to 800 line analysis optimizes time and frequency resolution, and you can zoom in on any portion of the 102.4 kHz range with a frequency span down to 191 mHz.

The SR780's unique architecture lets the two displays function independently. You can choose separate frequency spans, starting frequencies, number of FFT lines, or averaging modes for each display. So it's easy to look at a wideband display and zoom in on a specific feature simultaneously. The SR780 lets you select from two sampling rates: 256 kHz or 262 kHz, so frequency spans come out in either a binary (102.4 kHz, 51.2 kHz, ...) or decimal (100 kHz, 50 kHz, 25 kHz, ...) sequence depending on your requirements.

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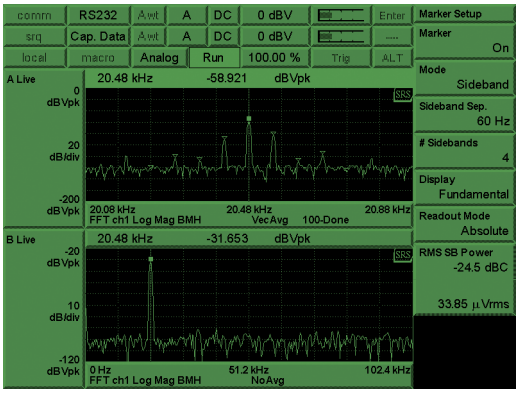


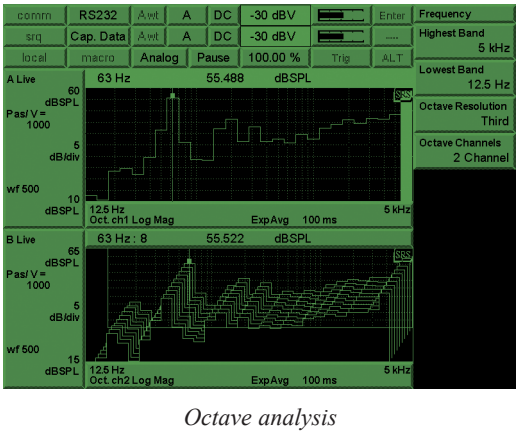
Narrow band FFT (top), wideband FFT (bottom)

Flexible Averaging

Several averaging choices are provided. RMS averaging reduces signal fluctuations, while vector averaging minimizes noise from synchronous signals. You can choose linear averaging (stable averaging) for fixed signals, or exponential averaging to track drifting features. Because the SR780's 102.4 kHz real-time bandwidth lets it take data seamlessly, vector averaging can be selected for any signal that's repetitive within the time record — no trigger is necessary.

Transducer Units

Automatic unit conversion makes translating accelerometer data easy. You can enter your accelerometer conversions directly in V/EU, EU/V or dB (1 V/EU). The SR780 will display results in units of meters, inches, mil, g, kg, lbs., N, dynes, pascals, bars or dBSPL. Accelerometer data is automatically converted to velocity or displacement units. Built-in ICP power means you won't need an external power supply for your accelerometer.



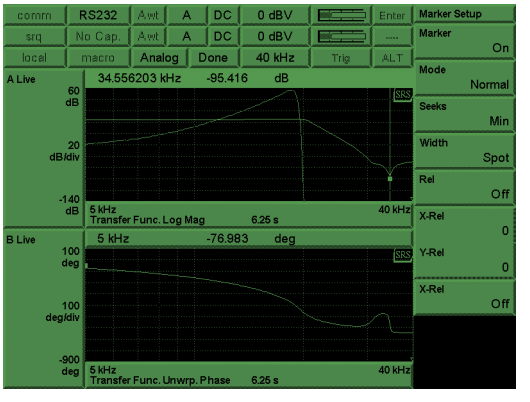
Octave analysis

Octave Analysis

Real-time octave analysis, at frequencies up to 40 kHz (single channel) or 20 kHz (dual channel), is standard in the SR780. Octave analysis is fully compliant with ANSI and IEC standards. Full octave, 1/3 octave and 1/12 octave analysis are all available. Switchable analog A-weighting filters, as well as built-in user math weighting functions (A, B and C), are included. Octave averaging choices include exponential time averaging, linear time averaging, peak hold, and equal confidence averaging. IEC compliant peak hold, impulse, fast and slow sound level measurements are all calculated.

Swept-Sine Analysis

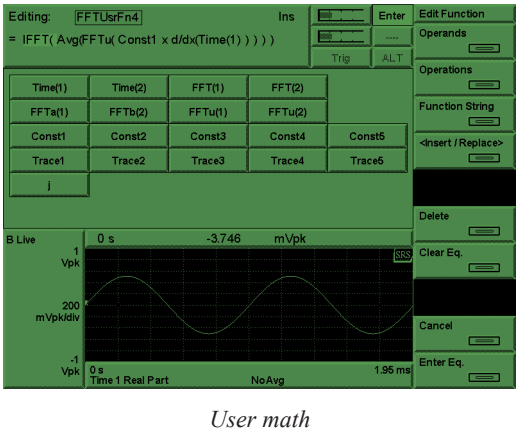
Swept-sine analysis is used for measurements involving high dynamic range or wide frequency intervals, and is also a standard feature of the SR780. Selectable auto-ranging optimizes the input range at each point in the measurement, providing up to 145 dB of dynamic range. Auto-ranging can be used with source auto-leveling to maintain a constant input or output level at the device under test. To ensure the fastest sweeps possible, auto-resolution can also be selected, providing a variable scan speed tailored precisely to the signal being measured.



Swept-sine Bode plot of low-pass filter response

User Math

User-defined math functions are available in all measurement groups. Equations are created from time or frequency data,



User math

stored files, constants, or a rich array of supplied operations including the arithmetic functions, FFT, inverse FFT, jω, d/dω, exp, ln *x* and many others. Unlike many analyzers, the SR780's measurement rate isn't reduced when user math is selected. For instance, the function exp(ln(conj(Avg(FFT2/FFT1))) can be calculated with a 50 kHz real-time bandwidth.

Source

Six source types are available: low distortion (–80 dBc) single or two-tone sine waves, chirp, white noise, pink noise and arbitrary waveforms. The chirp and noise sources can both be bursted to provide a source that's active only over a selected portion of the time record for FFT measurements, or to provide an impulsive noise source for acoustic measurements. The digitally synthesized source provides output levels from 0.1 mV to 5 V, and delivers up to 100 mA of current.

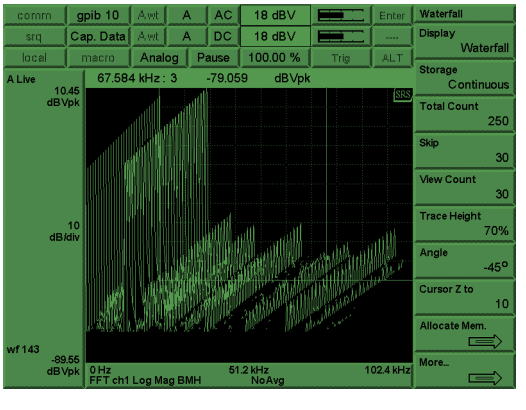
Arbitrary waveform capability is standard on the SR780. The arbitrary source can be used to playback a section of a captured waveform, play a selected FFT time record, or upload a custom waveform.

Capture

The SR780 comes standard with 2 Msamples of capture memory. Waveforms can be captured at 262 kHz or any sub-multiple of 262 kHz, allowing you to select the sample rate and capture length that's right for your data. Once captured, any portion of the signal can be played back in FFT or Octave mode. The convenient AutoPan feature lets you display the measurement results synchronously with the corresponding portion of the capture buffer to easily identify important features. An optional memory expansion module lets you extend the SR780's capture depth to 8 Msamples—that's almost 30 seconds of capture at the maximum sampling rate.

Waterfall

All Octave and FFT measurements can be stored in the SR780's 2k-deep waterfall buffers. Waterfall storage is selectable as every n^{th} time record for FFT measurements, or you can select a storage interval in seconds (down to 4 ms) for octave measurements. While displaying waterfalls, you can adjust the skew angle to reveal important features, or change the baseline threshold to eliminate low-level clutter. Any z-axis slice or x-axis record can be saved to disk or displayed separately for individual analysis.



Waterfall plot

Analysis

The SR780 includes a wide variety of analysis features. Marker analysis lets you use the marker to measure the power contained in the harmonics, sidebands or within a given band of frequencies. THD, THD + N, sideband power relative to carrier, and total integrated power are calculated in real time and displayed on the screen. Marker statistics quickly calculate the maximum, minimum, mean and standard deviation of data at any point in the display.

A data table feature lets you display up to 100 selected data points in tabular format. Limit tables let you to define up to 100 upper and lower limit segments in each display for GO/NO-GO testing.

Output

The SR780's USB drive, computer interfaces (GPIB and RS-232) and printer port provide flexibility when saving, printing and exporting data. Data can be saved in binary or ASCII formats, and displays can be printed/plotted to any of the ports or the disk drive. Supported formats include PCL (LaserJet/DeskJet), dot-matrix, postscript, HP-GL, PCX or GIF. Utilities are included to translate HP SDF files into SR780 format.

FFT Measurement Group
FFT, Time Record, Windowed Time, Time Capture, Transfer Function, Cross Spectrum, Coherence, Cross-Correlation, Auto-Correlation, Orbit, User Math

Octave Analysis Measurement Group
1/1, 1/3, 1/12 Octave, Time Capture, User Math, L_{eq}, Impulse, Total Power

Swept-Sine Measurement Group
Spectrum, Transfer Function, Cross Spectrum, User Math

FFT Resolution
100, 200, 400, 800 lines

Views
Linear Magnitude, Log Magnitude, Magnitude Squared, Real Part, Imaginary Part, Phase, Unwrapped Phase, Nichols, Nyquist

Units
V, V^2, V^2/Hz, V/√Hz, meters, inches, mils, g, kg, lbs., N, dynes, pascals, bars, SPL, user-defined engineering units

Displays
Single, Dual, Waterfall with Skew, Zoom and Pan

Averaging
RMS, Vector, Peak Hold, Linear, Exponential, Equal Confidence (Octave), Preview Time Record

Triggering
Continuous, Internal, External (Analog or TTL), Source, Auto/Manual Arming

Source Outputs
Sine, Two-Tone, Swept-Sine, White/Pink Noise, Burst Noise, Chirp, Burst Chirp, and Arbitrary

Windows
Hanning, Blackman-Harris, Flat-Top, Kaiser, Force/Exponential, User-Defined, ±T/2, ±T/4, T/2, Uniform

User Math
+, –, ×, ÷, Conjugate, Magnitude/Phase, Real/Imaginary, Sqrt, FFT, Inverse FFT, jω, Log, Exp, d/dx, Group Delay, A-Weighting, B-Weighting, C-Weighting, x/x–1

Analysis
Harmonic, Band, Sideband, THD, THD + N, Limit Test, Data Table, Exceedance, Statistics

Time Capture
Captures time data for later analysis (FFT or Octave). Up to 2 Msamples (8 Msamples opt.) of data can be saved.

Storage
USB drive

Hard Copy and Interfaces
Print to dot-matrix or PCL (LaserJet and DeskJet) printers. Plot to HP-GL or postscript plotters. Print/plot on-line (RS-232 serial, Centronics parallel or IEEE-488.2) or to disk file. EPS, GIF, PCX graphic formats also available for disk storage.

Help
Full, context-sensitive help screens for all SR780 features mean you will rarely have to refer to a printed manual. Hypertext links let you quickly switch between related help pages or instantly reference the remote command corresponding to any SR780 function. Use the help index to quickly locate help on any topic, jump to the online troubleshooting guide, browse a complete listing of the SR780's specifications, or examine a comprehensive description the SR780's remote commands.

SR780 rear panel

Ordering Information

SR780	Dynamic signal analyzer
O780M1	8 Msample (32 Mbyte) memory
O780RM	Rack mount kit

SR780 Specifications

Specifications apply after 30 minutes warm-up and within two hours of last auto-offset. Measured with 400-line resolution and anti-alias filters enabled unless stated otherwise.

Measurement Groups

Group	FFT, Octave Analysis, Swept-Sine

Frequency

Range	102.4 kHz or 100 kHz (both displays have the same range)
FFT spans	195.3 mHz to 102.4 kHz or 191 mHz to 100 kHz. The two displays can have different spans and start frequencies.
FFT resolution	100, 200, 400 or 800 lines
Real-time bandwidth	102.4 kHz (highest FFT span with continuous data acquisition and averaging)
Accuracy	25 ppm from 20 °C to 40 °C

Dynamic Range

Dynamic range	
FFT and Octave	90 dB typical, 80 dB guaranteed
Swept-Sine	145 dB Includes spurs, harmonic and intermodulation distortion and alias products. Excludes alias responses at extremes of span.
Harmonic distortion	<–80 dB (single tone in band)
Intermodulation dist.	<–80 dB (two tones in band, each less than –6.02 dBfs)
Spurious	<–80 dBfs
Alias responses	<–80 dBfs (single tone outside of span, <0 dBfs, <1 MHz)
Full-span FFT noise floor	–100 dBfs typical (input grounded, range >–30 dBV, Hanning window, 64 rms averages)
Residual DC response	<–30 dBfs (FFT with Auto-Cal on)

Amplitude Accuracy

Single channel	±0.2 dB (excluding windowing)
Cross channel	±0.05 dB (DC to 102.4 kHz) (transfer function meas., both inputs on same range, rms averaged)

Phase Accuracy

Single channel	±3.0 deg. relative to external TTL trigger (–50 dBfs to 0 dBfs, frequency <10.24 kHz, center of frequency bin, DC coupled). For Blackman-Harris, Hanning, Flattop and Kaiser windows, phase is relative to a cosine wave at the center of the time record. For Uniform, Force and Exponential windows, phase is relative to a cosine wave at the beginning of the time record.
Cross channel	±0.5 deg. (DC to 51.2 kHz) ±1.0 deg. (DC to 102.4 kHz) (transfer function measurement, both inputs on the same input range, vector averaged)

Signal Inputs

Number of inputs	2
Full-scale input range	–50 dBV (3.16 mVp) to +34 dBV (50 Vp) in 2 dB steps
Maximum input level	57 Vp
Input configuration	Single-ended (A), differential (A–B)
Input impedance	1 MΩ + 50 pF
Shield to chassis	Floating mode: 1 MΩ + 0.01 µF Grounded mode: 50 Ω Shields are always grounded in differential input (A–B)
Max. shield voltage	4 Vp
AC coupling	0.16 Hz cutoff frequency
CMRR	90 dB at 1 kHz (input range <0 dBV) 80 dB at 1 kHz (input range <10 dBV) 50 dB at 1 kHz (input range ≥10 dBV)
ICP signal	Current source: 4.8 mA Open circuit voltage: +26 V
A-weight filter	Type 0 tolerance, ANSI standard S1.4-1983 (10 Hz to 25.6 kHz)
Crosstalk	<–145 dB below signal (input to input and source to inputs, 50 Ω receiving input source impedance)
Input noise	<10 nVrms/√Hz above 200 Hz (<–160 dBVrms/√Hz)

Trigger Input

Modes	Free Run, Internal, External, or External TTL
Internal	Level adjustable to ±100 % of input scale. Positive or negative slope. Min. trigger level: 5 % of input range
External	Level adjustable to ±5 V in 40 mV steps. Positive or negative slope. Input impedance: 1 MΩ Max. input: ±5 V Min. trigger level: 100 mV
External TTL	Requires TTL level to trigger (low <0.7 V, high >3.0 V)
Post-trigger	Measurement record is delayed up to 8192 samples after the trigger.

Pre-trigger	Measurement record starts up to 8192 samples prior to the trigger.

Transient Capture

Mode	Continuous data recording
Maximum rate	262,144 samples/s for both inputs
Max. capture length	2 Msamples (single input) 8 Msamples with optional memory

Octave Analysis

Standards	Conforms to ANSI std. S1.11-1986 Order 3 Type 1-D and IEC 225-1966
Frequency range	*Single channel:* 1/1 Octave 0.125 Hz to 32 kHz 1/3 Octave 0.100 Hz to 40 kHz 1/12 Octave 0.091 Hz to 12.3 kHz *Two channels:* 1/1 Octave 0.125 Hz to 16 kHz 1/3 Octave 0.100 Hz to 20 kHz 1/12 Octave 0.091 Hz to 6.17 kHz
Accuracy	<0.2 B (1 second stable average, single tone at band center)
Dynamic range	80 dB (1/3 octave, 2 second stable average) per ANSI S1.11-1986
Sound level	Impulse, Peak, Fast, Slow and L_{eq} per ANSI S1.4-1983 Type 0 and IEC 651-1979 Type 0

Source Output

Amplitude range	0.1 mVp to 5 Vp
Amplitude resolution	0.1 mVp (output >500 mVp)
DC offset	<10.0 mV (typ.)
Offset adjust	±5 VDC (sine, two-tone)
Output impedance	<5 Ω, ±100 mA peak output current

Sine Source

Amplitude accuracy	±1 % of setting, 0 Hz to 102.4 kHz, 0.1 Vp to 5.0 Vp, Hi-Z load
Harmonics, sub-harm. & spurious	0.1 Vp to 5 Vp <–80 Bc (fundamental <30 kHz) <–75 dBc (fundamental <102 kHz)

Two-Tone Source

Amplitude accuracy	±1 % of setting, 0 Hz to 102.4 kHz, 0.1 Vp to 5 Vp, Hi-Z load
Harmonics, sub-harm.	<–80 dBc, 0.1 Vp to 2.5 Vp

White Noise Source

Time Record	Continuous or burst
Bandwidth	DC to 102.4 kHz or limited to span
Flatness	<0.25 dBpp (typ.), <1.0 dBpp (max.), 5000 rms averages

Pink Noise Source

Bandwidth	DC to 102.4 kHz
Flatness	<2.0 dBpp, 20 Hz to 20 kHz (using averaged 1/3 octave analysis)

Chirp Source

Time record	Continuous or burst
Output	Sine sweep across the FFT span
Flatness	±0.25 dBpp (amplitude: 1.0 Vp)

Swept-Sine Source

Auto functions	Source level, input range and frequency resolution
Dynamic range	145 dB

Arbitrary Source

Amplitude range	±5 V
Record length	2 Msamples (playback from arbitrary waveform memory or capture buffer), variable sample rate

General

Interfaces	IEEE-488.2, RS-232 and printer interfaces standard. All instrument functions can be controlled through the computer interfaces. A PC (XT) keyboard input is provided for additional flexibility.
Hardcopy	Print to dot matrix and PCL compatible printers. Plot to HP-GL or postscript plotters. Print/Plot to RS-232 or IEEE-488.2 interfaces or to disk file. Additional file formats include GIF, PCX and EPS.
Data storage	USB drive
Preamp Power	Power connector for SRS preamps
Power	70 W, 100/120/220/240 VAC, 50/60 Hz
Dimensions	17" × 8.25" × 24" (WHD)
Weight	56 lbs.
Warranty	One year parts and labor on defects in materials and workmanship