

# FFT Spectrum Analyzers

SR780 — 100 kHz, 2-channel dynamic signal analyzer



## SR780 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**
- **GIF, EPS, PCX, HP-GL graphics output**
- **GPIB and RS-232 interfaces**

• **SR780 ... \$9950 (U.S. list)**

The SR780 Dynamic Signal Analyzer combines high performance, low cost and all the features you need without forcing you to buy an array of expensive options. It offers 102.4 kHz dual-channel FFTs with 90 dB dynamic range, 145 dB dynamic range swept-sine measurements, real-time ANSI standard octave analysis, waterfalls, transient capture and more, for less than half the cost of other similarly equipped analyzers.

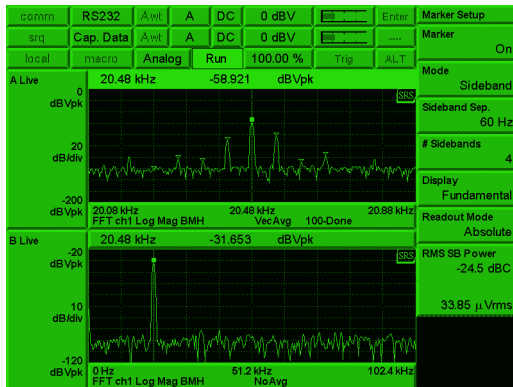
Whether your application involves acoustic measurements, vibration testing, servo systems or filter design, the SR780's features, performance and low cost are unmatched.

### Spectrum Analysis

The SR780 delivers true two-channel 102.4 kHz FFT performance. Unlike other analyzers, the SR780 doesn't make you sacrifice two-channel performance for bandwidth—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 as separate analyzers. You can choose separate frequency spans, starting frequencies, number of FFT lines, or

averaging modes for each display. So it's no problem 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.



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

## Flexible Averaging

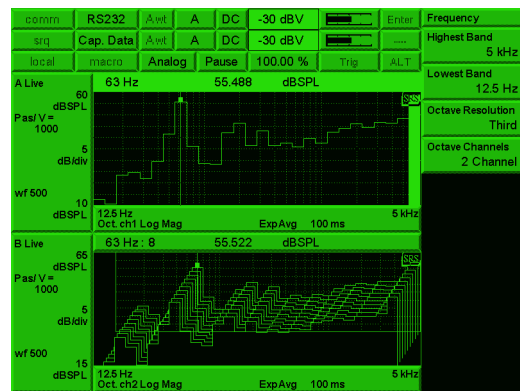
Several averaging choices are provided. Choose rms averaging to reduce signal fluctuations, or vector averaging to actually eliminate noise from synchronous signals. Choose linear averaging (stable averaging) for fixed signals, or exponential averaging to track drifting features. Because the SR780's 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.

## Automatic Unit Conversion

Automatic unit conversion makes translating accelerometer data easy. Enter your accelerometer conversion 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 have to take along an external power supply for your accelerometer.

## Octave Analysis

Real-time octave analysis, at frequencies up to 40 kHz (single channel) or 20 kHz (dual channel), is standard on the SR780. Octave analysis is fully compliant with ANSI S1.11-1986 (Order 3, type 1-D) and IEC 225-1966. 1/1 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 all included. Octave averaging choices include exponential time averaging, linear time

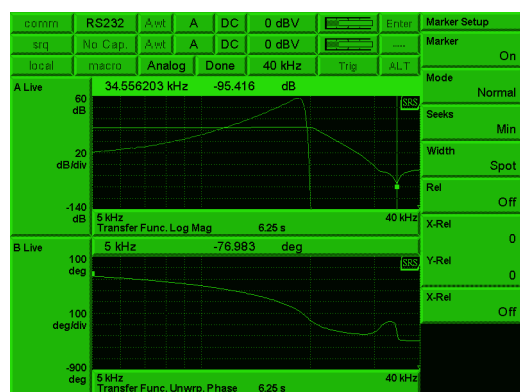


Octave analysis

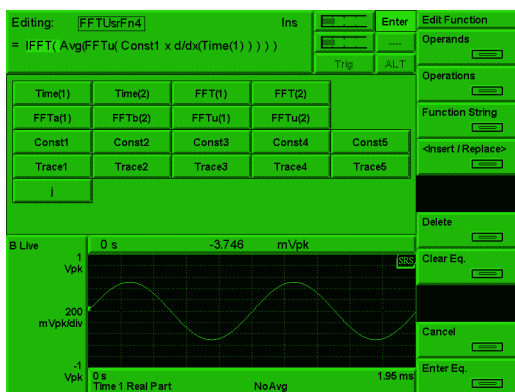
averaging, peak hold and equal confidence averaging. IEC 651-1979 Type 0 compliant peak hold, impulse, fast and slow sound level measurements are all calculated.

## Swept-Sine Analysis

Swept-sine analysis for measurements involving high dynamic range or wide frequency intervals 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. Choose linear sweeps for high frequency resolution or logarithmic sweeps (up to 8 decades) for the widest frequency coverage.



Swept-sine Bode plot of LPF response



User math

**User Math**

All three measurement groups: FFT, Octave, and Swept-Sine, allow you to create your own measurement using the SR780's user math menu. Enter any equation involving time or frequency data, stored files, constants, or a rich array of supplied operations including the arithmetic functions, FFT, inverse FFT,  $j\omega$ ,  $d/d\omega$ , exp, ln x and many others. Unlike many analyzers, the SR780 doesn't slow to a snail's pace when user math is selected. For instance, the function  $\exp(\ln(\text{conj}(\text{Average}(\text{FFT2}/\text{FFT1})))$  can be calculated with a 50 kHz real-time bandwidth.

**Source**

Choose from six source types: low distortion (-80 dBc) single or two-tone sine waves, chirps, white noise, pink noise or 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. Use the arbitrary source to playback a section of a captured waveform, play a selected FFT time record, or upload your own custom waveform from disk or over the remote interface.

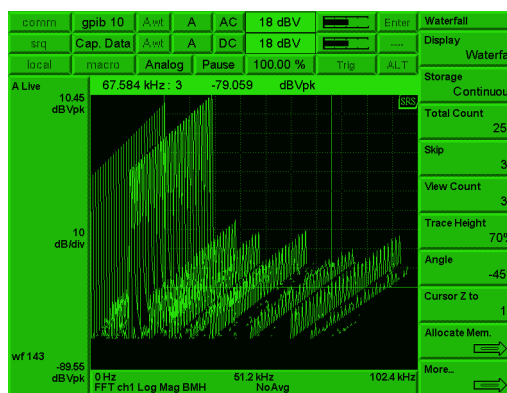
**Capture**

The SR780 comes with 2 Msamples of standard 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 any FFT or Octave measurement. The convenient "AutoPan" feature lets you display the measurement results synchronously with the corresponding portion of the capture buffer to easily identify important features. Optional memory expansion modules let

you expand 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 two, 2k-deep waterfall buffers. Waterfall storage is selectable as every  $n^{\text{th}}$  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 a frequency domain measurement. 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.

Use data tables to display up to 100 selected data points in a 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 3.5" disk 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.

**Measurement—FFT Group**

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

**Measurements—Octave Analysis Group**

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

**Measurements—Swept-Sine 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,  $V^2$ ,  $V^2/Hz$ ,  $V/\sqrt{Hz}$ , 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,  $\pm T/2$ ,  $\pm T/4$ ,  $T/2$ , Uniform

**User Math**

+, -,  $\times$ , /, Conjugate, Magnitude/Phase, Real/Imaginary, Sqrt, FFT, Inverse FFT,  $j\omega$ , Log, Exp,  $d/dx$ , Group Delay, A, B, C Weighting,  $x/x-1$

**Analysis**

Harmonic, Band, Sideband, THD, THD + N, Limit Test with Pass/Fail, Data Table, Exceedance, Statistics

**Time Capture**

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

**Storage**

3.5", 1.44 Mbyte, DOS formatted disk. Save data, setups and hard copy data.

**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	\$9950
O780M1	8 Msample (32 Mbyte) memory	\$800
O780RM	Rack mount kit	\$85
CT100	SRS instrument cart	\$850

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 Swept-Sine 90 dB typical, 80 dB guaranteed 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 octaves 0.100 Hz to 40 kHz  
 1/12 octaves 0.091 Hz to 12.3 kHz  
*Two channels:*  
 1/1 octave 0.125 Hz to 16 kHz  
 1/3 octaves 0.100 Hz to 20 kHz  
 1/12 octaves 0.091 Hz to 6.17 kHz  
 Accuracy <0.2 dB (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 1.0 mVp to 5 Vp  
 Amplitude resolution 1 mVp (output >500 mVp)  
 DC offset <10.0 mV (typ.)  
 Offset adjust  $\pm 5$  VDC (sine, two-tone)  
 Output impedance <5  $\Omega$ ,  $\pm 100$  mA peak output current

**Sine Source**

Amplitude accuracy  $\pm 1$  % 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 dBc (fundamental <30 kHz)  
 < -75 dBc (fundamental <102 kHz)

**Two-Tone Source**

Amplitude accuracy  $\pm 1$  % 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  $\pm 0.25$  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  $\pm 5$  V  
 Record length 2 Msamples (playback from arbitrary waveform memory or capture buffer). Variable sample rate.

**General**

CRT monitor Monochrome, 800H by 600V resolution  
 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.  
 Disk drive 3.5" DOS format, 1.44 MB. Storage of displays, setups and hardcopy.  
 Preamp Power Power connector for SRS preamps  
 70 W, 100/120/220/240 VAC, 50/60 Hz  
 Dimensions 17" x 8.25" x 24" (WHD)  
 Weight 56 lbs.  
 Warranty One year parts and labor on defects in materials and workmanship