Frequency Counters

SR620 — Universal time interval and frequency counter

SR620 Time Interval & Frequency Counter

- · 25 ps single-shot time resolution
- · 1.3 GHz frequency range
- · 11-digit frequency resolution (1 s)
- · 0.001° phase resolution
- · Statistical analysis & Allan variance
- · Graphical output to X-Y scopes
- · Hardcopy to printers and plotters
- · GPIB and RS-232 interfaces
- · Optional ovenized timebase

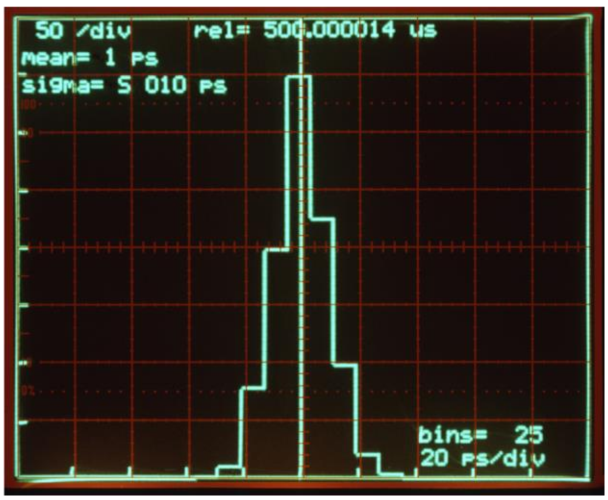
The SR620 Time Interval Counter performs virtually all of the time and frequency measurements required in a laboratory or ATE environment. The instrument's single-shot timing resolution and low jitter make it the counter of choice for almost any application.

SR620 Measurements

The SR620 measures time interval, frequency, pulse-width, rise and fall time, period, phase and events. Time intervals are measured with 25 ps rms resolution, making the SR620 one of the highest resolution counters available. Frequency is measured from 0.001 Hz to 1.3 GHz, and a choice of gates ranging from 1 period to 500 seconds is provided. The SR620 delivers up to 11 digits of frequency resolution in one second, making it suitable for measurement applications ranging from short-term phase locked loop jitter, to the long-term drift of atomic clocks. All measurement modes are supported by a wide variety of flexible arming and triggering options.

Histograms and Strip Charts

Unlike conventional counters that only have numeric displays, the SR620 provides live, graphical displays of measurement results. Graphical data is available in three formats: a histogram showing the distribution of values within a set of measurements, a strip chart of mean values from successive measurements, or a strip chart of jitter (standard deviation or Allan variance) values from successive measurements. Up to 250 strip-chart points or histogram bins can be displayed.



Histogram display

Both histograms and strip charts can be displayed on any oscilloscope with an X-axis input (see pictures), or can be plotted on an HP-GL compatible plotter or dot-matrix printer. Convenient cursors allow you to read the value of any data point in the histogram or strip chart. Autoscale and zoom features make it simple to display all, or any portion, of the graphs.

Complete Statistical Calculations

The SR620 can make measurements on a single-shot basis, or calculate the statistics of a set of measurements. Sample sizes from one to one million can be selected. The SR620 will automatically calculate the mean, standard deviation or Allan variance, minimum and maximum for each set of measurements.

Reference Output

A precision 50 % duty cycle square wave (1 kHz) is available at the front-panel REF output. The REF output can be used as a source of start or stop pulses for any of the SR620's measurement modes. For instance, the length of a cable connected between REF and the B input can be precisely determined by measuring the time delay between REF and B.

Built-In DVMs and Analog Outputs

Two rear-panel DVM inputs make measurements of DC voltages with 0.3 % accuracy (±20 VDC range). These values may be read via the interfaces or displayed directly on the front panel.

SR620 rear panel

Two DAC outputs continuously provide voltages proportional to the mean and the jitter of the measurement sample. These 0 to 10 V outputs can drive strip-chart recorders, or they can be set to provide fixed or scanned output voltages.

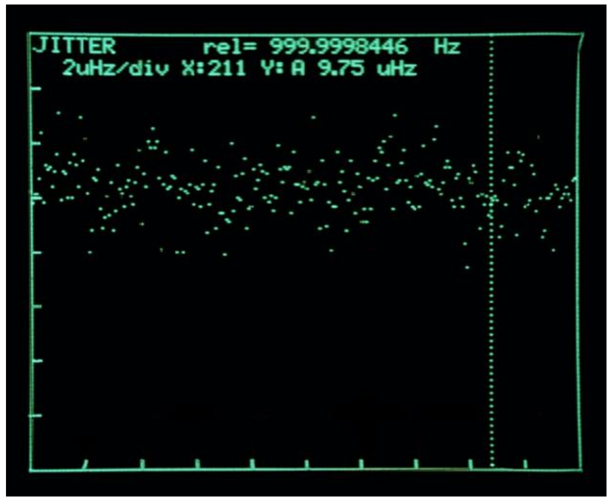
Built-In Auto-Calibration

A sophisticated, built-in auto-calibration routine nulls insertion delays between start and stop channels, and compensates for the differential nonlinearites inherent in analog timemeasurement circuitry. The auto-calibration routine takes about two minutes to perform, and should be run every 1000 hours of operation.

10 MHz Reference

The choice of timebase affects both the resolution and accuracy of measurements made with the SR620. SRS offers a standard timebase with an aging coefficient of 1×10^{-6}/year, or an optional ovenized-oscillator timebase with only 5×10^{-10}/day aging and about an order of magnitude better short-term stability than the standard timebase. A rear-panel input lets you connect any external 5 MHz or 10 MHz source as a timebase.

Timebase



Allan variance plot

Computer Interfaces

Standard GPIB (IEEE-488.2) and RS-232 interfaces allow remote control of the SR620. All instrument functions and configuration menu settings are accessible via the interfaces. A fast binary dump mode outputs up to 1400 measurements per second to a computer. A parallel printer port allows direct printing from the instrument. Standard IEEE-488.2 communications are supported, and plotter outputs are provided in HP-GL format. For debugging, the last 256 characters transmitted over the interfaces can be viewed on the front panel.

Frequency 10.000 MHz 10.000 MHz

Type	TCVCXO	Ovenized VCXO	Error

Aging	1×10^{-6}/yr.	5×10^{-10}/day

Allan variance (1 s) 3 × 10^{-10} (typ.) <5 × 10^{-12} Gates

Stability (0 to 50 °C) 1 ppm <2 × 10^{-9}

Settability	0.01 ppm	0.001 ppm

External timebase User may supply 5 MHz or 10 MHz timebase (1 V nominal)

Range	–1000 s to +1000 s in ±TIME mode	Error

–1 ns to +1000 s in all others modes

Trigger rate 0 to 100 MHz Gates

Display LSD 4 ps single sample, 1 ps with avg.

Standard timebase $(((25 \text{ ps typ. } [50 \text{ ps max.}])^2 +$

$(0.2\ \text{ppb} \times \text{Interval})^2) / N)^{1/2}$ rms

Error

internal UHF prescalers. RATIO

Option 01 (((25 ps typ. [50 ps max.])^2 + A/B range: 10^{-9} to 10^3

(0.05 ppb × Interval)^2) / N)$^{1/2}$ rms, (N = sample size)

Error: < ±(500 ps typ. [1 ns max.] + Timebase Error × Interval + Trigger Error)

Relative error: < ±(50 ps typ. [100 ps max.] + Timebase Error × Interval)

Arming modes: +TIME (Stop is armed by Start)
+TIME EXT (Ext arms Start)
+TIME EXT HOFF (Leading EXT edge arms Start, trailing EXT edge arms Stop)
±TIME (Armed by Start/Stop pair),
±TIME CMPL (Armed by Stop/Start pair)
±TIME EXT (Armed by EXT input edge)
EXT arming may be internally delayed or scanned with respect to the EXT input in variable steps. The step size may be set in a 1-2-5 sequence from 1 µs to 10 ms. The maximum delay is 50,000 steps.

Display: 16-digit fixed point with 1 ps LSD

Sample rate: N × (800 µs + measured time interval) + calculation time (N = sample size)
The calculation time occurs only after N measurements are completed and varies from zero (N = 1, no graphics, binary) to 5 ms (N = 1, no graphics) to 10 ms (display mean or standard dev.) to 60 ms (histogram).

Frequency

Range: 0.001 Hz to 300 MHz via comparator inputs. 40 MHz to 1.3 GHz via

Gates: < ±((100 ps typ. [350 ps max.]) / Gate + Timebase Error) × Frequency
External, 1 period, 1 µs to 500 s in 1-2-5 sequence. Gates may be externally triggered with no delay. Gates may be delayed relative to an EXT trigger. The delay from trigger is set from 1 to 50,000 gate widths.

Display: 16-digit fixed point with LSD = Freq. × 4 ps / Gate. 1 µHz maximum resolution (1 nHz with ×1000 for frequencies <1 MHz)

Period

Range: 0 to 1000 s
RATIO A/B range: 10^{-9} to 10^{3}

Error: < ±((100 ps typ. [350 ps max.]) / Gate + Timebase Error) × Period

Gates: Same as frequency

Display: 16-digit fixed point, LSD = 1 ps (1 fs with × 1000 for periods <1 s)

Phase

Definition: Phase = 360 × (T_b – T_a) / Period A

Range: –180 to +180 degrees, 0 to 100 MHz

Resolution: (25 ps × Freq. × 360 + 0.001)°

Gate: 0.01 seconds (1 period min.) for period measurement and 1 sample for time interval measurement. Period may also be measured using externally triggered internal gates as in frequency mode.

Error: < ±(1 ns × Freq. × 360 + 0.001)°

Counts

Range: 10^{12}, RATIO A/B range: 10^{-9} to 10^{3}

Count rate: 0 to 300 MHz

Gates: Same as frequency

Display: 12 digits

Inputs

Bandwidth: 300 MHz (1.2 ns rise time)

Threshold: –5.00 to +5.00 VDC (10 mV resolution)

Accuracy: 15 mV + 0.5 % of setting

Sensitivity: see graph next page

Auto level: Threshold set between peak input excursions. (f >10 Hz, duty cycle >10^{-6})

Slope: Rising or falling edge

Impedance: (1 MΩ + 30 pF) or 50 Ω
50 Ω termination has SWR < 2.5:1 from 0 to 1.3 GHz

Coupling: AC or DC (Ext is always DC coupled)

Input noise 350 µVrms (typ.)
Prescaler see graph
Protection 100 V, 50 Ω terminator is released if input exceeds ±5 Vp

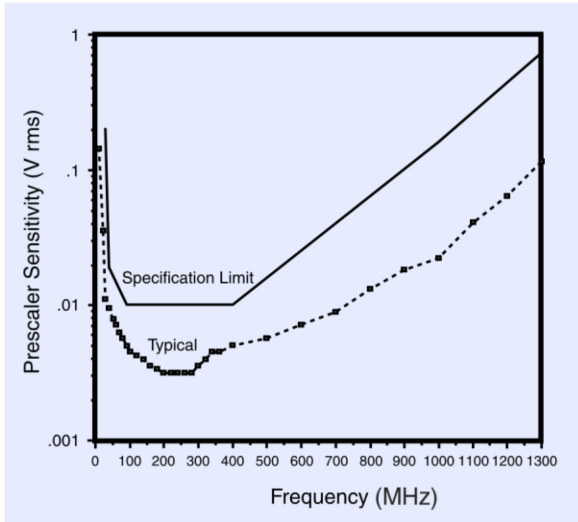
REF Output

Frequency 1.00 kHz (accuracy same as timebase)
Rise/fall time 2 ns
Amplitude TTL: 0 to 4 V (2 V into 50 Ω)
ECL: –1.8 to –0.8 V into 50 Ω

DVM Inputs

Full scale ±1.999 VDC or ±19.99 VDC Type Sample & hold with successive approximation

Speed Approximately 5 ms



converter Impedance
1 MΩ
Input sensitivity
Accuracy
0.3 % of full scale

and
deviation

D/A Outputs

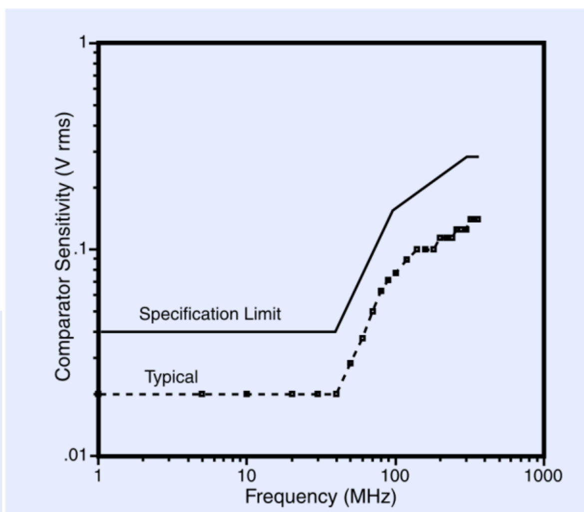
Full scale ±10.00 VDC
Resolution 5 mV
Impedance <1 Ω
Default Voltage proportional to mean
Accuracy 0.3 % of full scale

Graphics

Scope Two rear-panel outputs to drive x-y analog oscilloscope
Displays Histograms and strip charts of mean and jitter
X-axis –5 V to +5 V for 10 division deflection
Y-axis –4 V to +4 V for 8 division deflection

Ordering Information

SR620	Time interval & frequency counter	$4950
Option 01	2 ppb OCXO timebase	$950
O620RM	Rack mount kit	$100



GPIB IEEE-488.2 interface. All instrument functions may be controlled.
Speed Approximately 150 ASCII formatted responses per second,
1400 binary responses per second.

Resolution
250 (H) ×
Prescaler sensitivity
200 (V) pixels
Hardcopy
Centronics port for dot-matrix

General

printers. RS-232, IEEE-488.2 for HP-GL compatible plotters.

Interfaces

RS-232 300 baud to 19.2 kbaud. All instrument functions may be controlled.

Operating	0 °C to 50 °C
Power	70 W, 100/120/220/240 VAC, 50/60 Hz
Weight, dimensions	11 lbs., 14" × 3.5" × 14" (WHD)
Warranty	One year parts and labor on defects in materials and workmanship