FMCW Radar Analysis
89600 VSA Software

Option 89601BHPC (Replacing 89601B/BN/BK-BHP)

- Analyze Frequency Modulated Continuous Wave (FMCW) radar signals used in automotive radar, industrial, surveillance, aerospace and defense radar applications

- Automatically synchronize to FMCW radar signals comprised of multi-chirp linear FM modulation patterns

- Visualize FMCW signal modulation characteristics and impairment errors within the synchronized amplitude, phase, frequency (FM) and frequency slope (FM Slope) trace results

- Verify all key FMCW signal modulation performance indicators relating to power, time, phase, frequency (FM) and frequency slope rate using a comprehensive FMCW region table

- Accumulate performance data statistics for each reported FMCW metric over single or multiple acquisitions using the FMCW current record statistics and cumulative statistics, along with graphical histogram and trend line trace plots

- Gain deeper insight into your signal's time and frequency dynamic and spurious performance with powerful and flexible trace views such as spectrogram and cumulative history

- Select from more than 40 Keysight measurement platforms to meet your specific design and test goals

89600 VSA

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FMCW Radar Analysis

The Keysight 89600 VSA software is a comprehensive set of tools for signal demodulation, vector signal analysis and time domain analysis. Option BHP for Frequency Modulated Continuous Wave (FMCW) radar analysis helps R&D and design verification test engineers quickly and easily make automated modulation quality measurements on multi-chirp linear FM signals according the evolving requirements for radar sensor performance and detection techniques in automotive, aerospace and defense applications. The new 89601BHPC FMCW option provides signal synchronization, quick access to multiple FMCW modulation domain result traces, metrics, statistics, histograms and trend lines. 89600 VSA software with Option BHP provides design engineers more insight into and confidence in product design and quality in a shorter test time and accelerates time to market.

Figure 1: Spectrum and time domain results on multi-chirp FM signals, highlighting 6 selected FM regions (number 21 through 26) in synchronized time domain traces. The FMCW cumulative statistic table at the bottom provides accumulated results over all detected regions

FMCW Radar Technology

FMCW is common in radar applications and is typically used for determining the distance and speed of target objects. For example, automotive companies are developing FMCW radar components, antennas, and sensors for use in adaptive cruise control (ACC), blind spot monitoring, traffic alerts, and even automated driving. These applications are at frequencies of 24 GHz, 77 GHz, and 79 GHz, with wider bandwidths of up to 2 GHz. Other radar applications such as high resolution image radar, weather monitoring radar, and ground surveillance radar use FMCW signals as well.

Scalable Measurements Across Various Hardware Platforms

The 89600 VSA software is supported by over 40 Keysight measurement platforms at analog and digital baseband, IF, RF and mmWave, so you can select the appropriate hardware necessary to acquire signal data and meet your performance requirements and test margins. To meet the wide bandwidth requirements of FMCW radar analysis, Keysight's UXA X-Series signal analyzers can offer the highest performance signal analysis capability, with the greatest dynamic range with up to 510 MHz analysis bandwidth. The Keysight Infiniium oscilloscopes and M9703A AXIe wideband digitizers are the ideal solution for even wider bandwidths.

Figure 2: 89600 VSA Option 89601BHPC for FMCW radar analysis supports scalable RF and bandwidth performance to meet your specific application needs. Choose from Keysight's portfolio of X-Series signal analyzers, including the UXA with 510 MHz real-time bandwidth. For much wider signal bandwidths, combine the 89600 VSA software with Keysight Infiniium oscilloscopes or the M9703A AXIe wideband digitizer

FMCW Radar Analysis in Spectrum and Time Domains

Keysight 89600 VSA software has various analysis capabilities for measuring signal quality and troubleshooting problems with its standard vector analysis and optional modulation analysis. FMCW radar sensor testing can be performed using basic vector analysis in frequency and time domains. Therefore, using the 89600 VSA software with Option BHP to verify measured time, reference and error traces for amplitude, phase, frequency (FM), and FM slope offers an easy way to visually compare multiple linear FM chirps with customized traces.

Figure 3: Acquired spectrum and power vs time traces are displayed for 21 detected pulses within 2 msec acquisition time intervals. The first 6 FM regions are highlighted for closer inspection within the synchronized amplitude, frequency (FM) and phase selected results. The trace overlay feature is used to compare the measured, reference, and error results for each of the amplitude plus phase, FM measured plus FM error, and FM slope traces in parallel

Statistical Linear FM Analysis

To capture unknown signal errors, irregular events, or intermittent signal events introducing risks to system design integrity, it is essential to use the appropriate analysis and diagnostic tools to record long time samples and monitor trends. Statistical analysis tools provide more insight into your FMCW system with views of various parameters.
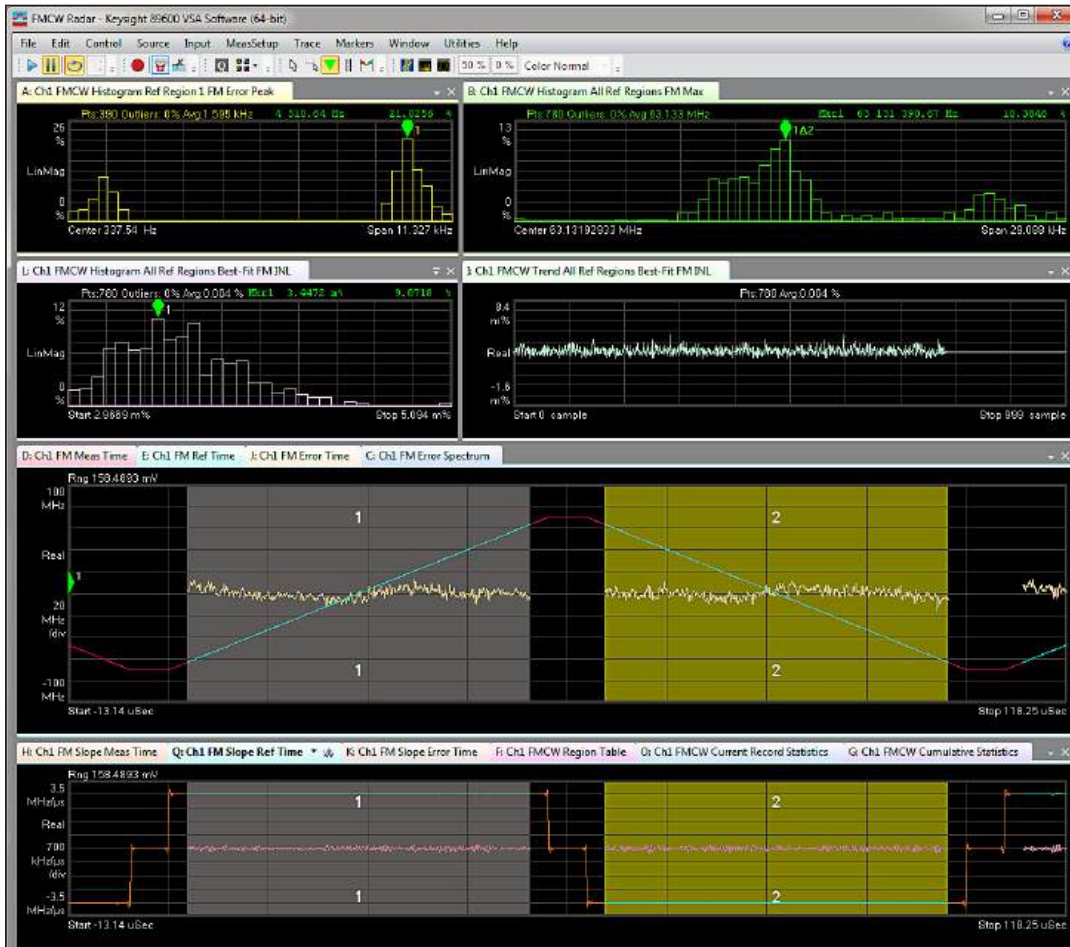

Figure 4: Histograms and trend lines can help you visualize trend and peak values of any tabulated FMCW metric over long time sequences. Shown here are histograms and a trend line for three metrics, with simultaneous plots of modulation analysis details over selected regions of the most current measurement. Markers are supported on histograms and trend lines

Software Features

Note: The following features are independent of hardware platform used, unless otherwise noted.

Reference synchronization	
Region synchronization	Specifies the FMCW region synchronization method – choices are automatic, sync to manual reference, or triggered. Automatic synchronization is based on detected valid FM regions and its measured FM slope. Sync to manual reference is based on user-described reference regions (defined by time length and start/stop frequency). Triggered synchronization uses a trigger event to time align the start with the manual reference description.
Reference data selection	Specifies how both FM and FM slope reference data is calculated – choices are best-fit FM results or manual reference description
Auto-detect setup	
	Only valid when region synchronization is set to automatic.
Min region time length	The minimum time length for auto-detected FMCW regions.
Max region time length	The maximum time length for auto-detected FMCW regions. FMCW regions longer than this are ignored.
Min region FM slope	The minimum FM slope for auto-detected FMCW regions. FMCW regions with an FM slope less than this are ignored.
Max region FM slope	The maximum FM slope for auto-detected FMCW regions. FMCW regions with an FM slope greater than this are ignored.
Max region FM slope deviation	The maximum FM slope deviation for auto-detected FMCW regions. Specified either manually or as a percentage of the auto-detected deviation limit.
Reference region count	The number of FMCW regions forming the repeating region group. Can be auto-detected or manually specified.
First region FM slope	Specifies which of the automatically detected FM regions should be identified as the first region with reference region index #1. Can be the region with maximum or minimum FM slope, or the region with FM slope nearest to a manually-specified value.
Manual reference description	
	Only valid when region synchronization is set to either sync to manual reference or triggered. Describes the ideal reference signal LFM region-group pattern which repeats within the measured signal's FMCW modulation.
Add region/remove region	Adds a new reference region index to the manual reference description or removes the last reference region index.
Time length (s)	Specifies the length of the reference region in seconds.
Start frequency (Hz)	Specifies the reference region start frequency in Hz.
Stop frequency (Hz)	Specifies the reference region stop frequency in Hz.
Sync	Reference regions with the sync check-box enabled are used for FMCW region time synchronization.
Analysis	Reference regions with the analysis check-box enabled are reported within FMCW region analysis results.
FM filter bandwidth	Sets the FM filter bandwidth, either automatically based on region time lengths, or as a % of measurement span.

Time	
Acquisition length	Specifies the total measurement acquisition length in seconds.
Extra acquisition	Sets the number of extra acquisition samples before and after the valid detected FMCW region results.
Sample rate	Specifies the measurement sample rate in Hz
Bandwidth	The measurement span (or bandwidth) in Hz is calculated as the measurement sample rate / 1.28. Alternatively this property can be set directly as Span (Hz) under VSA MeasSetup property on the frequency tab.
Maximum region count	When enabled, users can set an upper limit for the number of detected FMCW regions to process for FMCW analysis.
Time values are relative to	Specifies the reference point used for reported time values within time trace results and FMCW region table metrics – choices are first region or trigger event time.
Frequency values are	Specifies whether frequencies are reported as absolute values, or relative to the measurement center frequency.
Exclude during analysis	
Exclude mode	Specifies a portion of each detected FM region's start and end time samples to be excluded from the FMCW analysis – choices are percent of detected region or time sample duration in seconds.
Start/End percent or time	Specifies % of detected FM region time length or time – used to exclude FM transition and settling effects.
Selected regions	
Select all regions	All detected FMCW regions are reported in amplitude, phase, and frequency (FM) vs. time trace results.
Select subset	Users can specify a subset of detected FMCW regions for amplitude, phase and frequency (FM) vs. time trace results.
Highlight selected regions on traces	Enables or disables region highlighting within the time trace results.
Include extra data before and after	Enables or disables inclusion of extra data samples acquired before and after selected pulse trace results.
Advanced	
Trend/Histogram enable	Enables or disables all trend/histogram data gathering and trace results.
Remove mean	Specifies whether the mean is removed from trend lines and histograms
Remove slope	Specifies whether the best-fit slope is removed from trend lines and histograms.
Remove second order	Specifies whether a 2nd-order (parabolic) curve is removed from trend lines and histograms.
Display length	Specifies the number of points displayed within trend trace results.
Internal buffer length	Specifies the maximum number of points used for trend/histogram data gathering and analysis.

Histogram range	Choose from automatic (min/max limits of histogram set to mean ± 3 * standard deviation of the data), or full (actual min/max limits of the data are used for histogram).
Measurement pause enable	Allows a continuous measurement to pause based on the defined measurement metric, operator (conditional test), and threshold combination.
FM slope base unit	Determines the base unit of FM slope results reported in FM slope trace and FMCW table metrics – choices are automatic, Hz/s, Hz/ms, Hz/us, Hz/ns, or Hz/ps.
Measurement results	
Channel <N>	Acquisition time, auto correlation, CCDF, CDF, correction, instantaneous spectrum, PDF, PSD, raw main time, spectrum.
Amplitude	Amplitude meas time, instantaneous amplitude meas time.
Phase	Phase error time, phase meas time, phase ref time, instantaneous phase error time, instantaneous phase meas time.
FM	FM error spectrum, FM error time, FM meas spectrum, FM meas time, FM ref spectrum, FM ref time, Instantaneous FM error spectrum, Instantaneous FM error time, Instantaneous FM meas spectrum, Instantaneous FM meas time, FM filter coefficients.
FM slope	FM slope error time, FM slope meas time, FM slope ref time, Instantaneous FM slope error time, Instantaneous FM slope meas time.
Result tables	Region table (reports metrics for power, time, best-fit FM, FM, phase error, FM error, FM slope error), Cumulative statistics (reports, min., max., RMS, average, std. dev. and count for all metrics on all detected regions since the last measurement restart.), Current statistics (same as cumulative statistics, but only for the current acquisition), Summary (# of FM region, # of reference region, Avg power, peak power, time offset, timing error, frequency error, FM slope max. dev. limit)
Region table metrics, trend lines, histograms	
Power	Power mean (dBm), power max.(dBm), power min. (dBm), power pk-pk deviation (dB)
Time	Time start (sec), time length (sec)
Best-fit FM	Best-fit FM mean (Hz), best-fit FM start (Hz), best-fit FM stop (Hz), best-fit FM pk-pk deviation (Hz), best-fit FM slope (Hz/μsec), best-fit FM INL (%, integral non linearity)
FM	FM max. (Hz), FM min. (Hz), FM pk-pk deviation (Hz)
Phase error	Phase error RMS (deg), phase error peak (deg), phase error peak location (sec)
FM error	FM error RMS (Hz), FM error peak (Hz), FM error peak location (sec)
FM slope error	FM slope error RMS (Hz), FM slope error peak (Hz), FM slope error peak location (sec)

Key Specifications

This technical overview provides nominal performance specifications for the software when making measurements with the specified platform [1]. Nominal values indicate expected performance, or describe product performance that is useful in the application of the product. For a complete list of specifications refer to the measurement platform literature.

General	
Frequency	Depends on connected hardware platforms
Trigger types	Free run, external, IF magnitude, frequency mask [2]
Sample intervals, time resolution	Depends on analysis bandwidth (BW) of connected hardware
	Min sample interval = 1/(1.28*BW)
	Max sample rate = 1/(SampleInterval) = 1.28 * BW
Live acquisition length	10 MSa per 4 GB of physical memory on the PC running the 89600 VSA software.
	5 MSa on 89600 VSA software running with X-Series signal analyzer
Recording length	Depends on the measurement hardware. Visit http://www.keysight.com/find/89600_hardware to find the maximum capture depth supported by each hardware platform.
Measurement accuracy	
FM step response	These values provide the maximum overshoot and settling time of the FM demodulator in response to an ideal frequency step. The step size is 80% of the measurement bandwidth. The settling time is calculated using the following equation:
	Settling time = (settling samples) * (sample period)
	Sample period = 1 / (1.28 * measurement bandwidth)
	With these equations, you can calculate the settling time for an arbitrary measurement bandwidth.
	Settling time is calculated as the time between the 50% crossing of the FM step and the time at which the step response is bounded by (FM step size)/2 ± (1% of the step size).
	The step response was 20x up-sampled before measuring the settling start and stop samples.

1. Data subject to change.

2. Frequency mask is included with RT1 and RT2 real-time spectrum analysis licenses. It works with UXA, PXA, and MXA X-Series signal analyzers with required hardware. Refer to instrument configuration guides for more deta.

Settling time for each bandwidth

FM filter bandwidth	Overshoot	Measurement bandwidth								
		10 MHz	25 MHz	40 MHz	80 MHz	160 MHz	320 MHz	1 GHz	2 GHz	4 GHz
50%	< 11% of FM step size	< 605 nsec	< 242 nsec	< 151 nsec	< 75.7 nsec	< 37.8 nsec	< 18.9 nsec	< 6.05 nsec	< 3.03 nsec	< 1.51 nsec
25%	< 7.82% of FM step size	< 480 nsec	< 192 nsec	< 120 nsec	< 60.1 nsec	< 30 nsec	< 15 nsec	< 4.8 nsec	< 2.4 nsec	< 1.2 nsec
10%	< 7.89% of FM step size	< 1.5 μsec	< 600 nsec	< 375 nsec	< 188 nsec	< 93.8 nsec	< 46.9 nsec	< 15 nsec	< 7.5 nsec	< 3.75 nsec
5%	< 7.68% of FM step size	< 2.99 μsec	< 1.2 μsec	< 748 nsec	< 374 nsec	< 187 nsec	< 93.5 nsec	< 29.9 nsec	< 15 nsec	< 7.48 nsec
1%	< 7.66% of FM step size	< 15.1 μsec	< 6.03 μsec	< 3.77 μsec	< 1.88 μsec	< 942 nsec	< 471 nsec	< 151 nsec	< 75.4 nsec	< 37.7 nsec
0.10%	< 7.66% of FM step size	< 153 μsec	< 61.1 μsec	< 38.2 μsec	< 19.1 μsec	< 9.55 μsec	< 4.77 μsec	< 1.53 μsec	< 764 nsec	< 382 nsec

FM chirp response	These values provide the maximum overshoot and settling time of the FM demodulator in response to an ideal chirp transition from a negative chirp rate to a positive chirp rate of f/M where f = 80% measurement bandwidth and M is time length of the chirp.
	The settling time is calculated by the following equation:
	Settling time = (settling samples) * (sample period)
	Sample period = 1 / (1.28 * measurement bandwidth)
	With these equations, you can calculate the settling time for an arbitrary measurement bandwidth.
	Settling time is calculated as the time between the 50% crossing of the FM chirp step to th time at which the step response is bounded by (FM step size)/2 ± (1% of FM chirp step size).
	The step response was 20x up-sampled before measuring the settling start and stop samples.

Settling time for each bandwidth

FM filter bandwidth	Overshoot	Measurement bandwidth								
		10 MHz	25 MHz	40 MHz	80 MHz	160 MHz	320 MHz	1 GHz	2 GHz	4 GHz
50%	< 6.28% of FM step size	< 629 nsec	< 252 nsec	< 157 nsec	< 78.6 nsec	< 39.3 nsec	< 19.7 nsec	< 6.29 nsec	< 3.14 nsec	< 1.57 nsec
25%	< 6.26% of FM step size	< 633 nsec	< 253 nsec	< 158 nsec	< 79.1 nsec	< 39.6 nsec	< 19.8 nsec	< 6.33 nsec	< 3.16 nsec	< 1.58 nsec
10%	< 7.96% of FM step size	< 1.69 μsec	< 677 nsec	< 423 nsec	< 211 nsec	< 106 nsec	< 52.9 nsec	< 16.9 nsec	< 8.46 nsec	< 4.23 nsec
5%	< 7.94% of FM step size	< 3.39 μsec	< 1.36 μsec	< 848 nsec	< 424 nsec	< 212 nsec	< 106 nsec	< 33.9 nsec	< 17 nsec	< 8.48 nsec
1%	< 7.93% of FM step size	< 17 μsec	< 6.81 μsec	< 4.26 μsec	< 2.13 μsec	< 1.06 μsec	< 532 nsec	< 170 nsec	< 85.2 nsec	< 42.6 nsec
0.10%	< 7.93% of FM step size	< 173 μsec	< 69.1 μsec	< 43.2 μsec	< 21.6 μsec	< 10.8 μsec	< 5.4 μsec	< 1.73 μsec	< 863 nsec	< 432 nsec

FM uncertainty	These values represent the 95% confidence interval (±) around the listed center frequency. The input signal to the measurement instrument is a 0 dBm unmodulated carrier at the listed center frequency. In this case, the output of the FM meas time trace should be a constant zero value. However, due to random noise (phase noise and other), the FM meas time trace will contain a non-zero signal with a particular mean and standard deviation. The contents of the cells represent (1.96 * stddev). Standard deviation does not include the error due to frequency offset. Measurement time: < 10 ms. Input range is optimized without overloading. 10 MHz reference source is locked with signal source.					

Frequency error

PXA N9030A Signal Analyzer

See PXA data sheet (5990-3952EN) for frequency accuracy specifications

FM filter bandwidth (% of measurement bandwidth)	50%	25%	10%	5%	1%	0.1%
2 GHz center frequency						
10 MHz	± 1.1 kHz	± 420 Hz	± 170 Hz	± 120 Hz	± 25 Hz [1]	± 1.0 Hz [1]
25 MHz	± 4.2 kHz	± 1.5 kHz	± 420 Hz	± 200 Hz	± 80 Hz	± 3.2 Hz [1]
28 MHz	± 5.4 kHz	± 2.0 kHz	± 560 Hz	± 240 Hz	± 82 Hz	± 4.0 Hz [1]
40 MHz	± 8.7 kHz	± 3.3 kHz	± 920 Hz	± 360 Hz	± 100 Hz	± 6.4 Hz [1]
80 MHz	± 22 kHz	± 7.8 kHz	± 2.1 kHz	± 760 Hz	± 150 Hz	± 19 Hz [1]
160 MHz	± 65 kHz	± 22 kHz	± 5.6 kHz	± 2.0 kHz	± 250 Hz	± 51 Hz [1]
8 GHz center frequency						
10 MHz	± 1.5 kHz	± 630 Hz	± 300 Hz	± 230 Hz	± 75 Hz [1]	± 2.9 Hz [1]
25 MHz	± 4.6 kHz	± 1.8 kHz	± 560 Hz	± 330 Hz	± 170 Hz	± 9.4 Hz [1]
28 MHz	± 6.3 kHz	± 2.4 kHz	± 700 Hz	± 360 Hz	± 180 Hz	± 10 Hz [1]
40 MHz	± 11 kHz	± 4.0 kHz	± 1.1 kHz	± 490 Hz	± 220 Hz	± 18 Hz [1]
80 MHz	± 27 kHz	± 9.6 kHz	± 2.6 kHz	± 950 Hz	± 270 Hz	± 59 Hz [1]
160 MHz	± 77 kHz	± 27 kHz	± 6.8 kHz	± 2.5 kHz	± 400 Hz	± 130 Hz [1]
26 GHz center frequency						
10 MHz	± 3.5 kHz	± 1.6 Hz	± 910 Hz	± 690 Hz	± 230 Hz [1]	± 9.8 Hz [1]
25 MHz	± 13 kHz	± 4.9 kHz	± 1.6 kHz	± 970 Hz	± 500 Hz	± 31 Hz [1]
28 MHz	± 17 kHz	± 6.4 kHz	± 1.9 kHz	± 1.1 kHz	± 540 Hz	± 36 Hz [1]
40 MHz	± 27 kHz	± 10 kHz	± 3.0 kHz	± 1.4 kHz	± 630 Hz	± 67 Hz [1]
80 MHz	± 68 kHz	± 25 kHz	± 6.8 kHz	± 2.7 kHz	± 820 Hz	± 190 Hz [1]
160 MHz	± 190 kHz	± 70 kHz	± 18 kHz	± 6.9 kHz	± 1.1 kHz	± 360 Hz [1]
43 GHz center frequency						
10 MHz	± 4.7 kHz	± 2.4 kHz	± 1.5 kHz	± 1.2 kHz	± 370 Hz [1]	± 17 Hz [1]
25 MHz	± 15 kHz	± 6.5 kHz	± 2.4 kHz	± 1.6 kHz	± 860 Hz	± 47 Hz [1]
28 MHz	± 19 kHz	± 7.9 kHz	± 2.7 kHz	± 1.7 kHz	± 910 Hz	± 59 Hz [1]
40 MHz	± 31 kHz	± 12 kHz	± 3.9 kHz	± 2.1 kHz	± 1.1 kHz	± 110 Hz [1]
80 MHz	± 85 kHz	± 31 kHz	± 9.1 kHz	± 3.8 kHz	± 1.4 kHz	± 270 Hz [1]
160 MHz	± 230 kHz	± 88 kHz	± 23 kHz	± 9.0 kHz	± 1.8 kHz	± 530 Hz [1]

1. With PXA phase noise optimization set to best close in. Others are set to best wide offset.

Infiniium DSO/MSO S-Series Oscilloscope

FM filter bandwidth (% of measurement bandwidth)	50%	25%	10%	5%	1%	0.1%
1 GHz center frequency						
10 MHz	± 1.7 kHz	± 720 Hz	± 280 Hz	± 190 Hz	± 62 Hz	± 2.3 Hz
25 MHz	± 6.5 kHz	± 2.4 kHz	± 730 Hz	± 340 Hz	± 140 Hz	± 7.6 Hz
28 MHz	± 7.7 kHz	± 2.9 kHz	± 830 Hz	± 380 Hz	± 150 Hz	± 9.3 Hz
40 MHz	± 13 kHz	± 4.8 kHz	± 1.3 kHz	± 560 Hz	± 180 Hz	± 15 Hz
80 MHz	± 37 kHz	± 13 kHz	± 3.5 kHz	± 1.3 kHz	± 260 Hz	± 45 Hz
160 MHz	± 100 kHz	± 37 kHz	± 9.8 kHz	± 3.6 kHz	± 430 Hz	± 110 Hz
320 MHz	± 290 kHz	± 100 kHz	± 27 kHz	± 9.8 kHz	± 980 Hz	± 140 Hz
500 MHz	± 580 kHz	± 210 kHz	± 53 kHz	± 19 kHz	± 1.9 kHz	± 190 Hz
1 GHz	± 1.6 MHz	± 590 kHz	± 150 kHz	± 53 kHz	± 4.9 kHz	± 300 Hz
2 GHz	± 9.4 MHz	± 1.6 MHz	± 430 kHz	± 150 kHz	± 13 kHz	± 680 Hz
2 GHz center frequency						
10 MHz	± 2.1 kHz	± 1.0 kHz	± 520 Hz	± 380 Hz	± 120 Hz	± 4.6 Hz
25 MHz	± 7.0 kHz	± 2.9 kHz	± 1.0 kHz	± 580 Hz	± 290 Hz	± 14 Hz
28 MHz	± 8.1 kHz	± 3.4 kHz	± 1.2 kHz	± 630 Hz	± 310 Hz	± 19 Hz
40 MHz	± 13 kHz	± 5.4 kHz	± 1.7 kHz	± 830 Hz	± 340 Hz	± 30 Hz
80 MHz	± 36 kHz	± 14 kHz	± 4.1 kHz	± 1.7 kHz	± 470 Hz	± 93 Hz
160 MHz	± 100 kHz	± 37 kHz	± 10 kHz	± 4.1 kHz	± 690 Hz	± 210 Hz
320 MHz	± 290 kHz	± 110 kHz	± 27 kHz	± 10 kHz	± 1.3 kHz	± 290 Hz
500 MHz	± 580 kHz	± 200 kHz	± 52 kHz	± 19 kHz	± 2.2 kHz	± 400 Hz
1 GHz	± 1.6 MHz	± 590 kHz	± 150 kHz	± 52 kHz	± 5.5 kHz	± 490 Hz
2 GHz	± 4.9 MHz	± 1.8 MHz	± 430 kHz	± 150 kHz	± 14 kHz	± 740 Hz
4 GHz	± 22 MHz	± 5.1 MHz	± 1.3 MHz	± 420 kHz	± 38 kHz	± 1.8 kHz
4 GHz center frequency						
10 MHz	± 3.3 kHz	± 1.8 Hz	± 990 Hz	± 730 Hz	± 240 Hz	± 8.9 Hz
25 MHz	± 9.2 kHz	± 4.4 kHz	± 1.8 kHz	± 1.1 kHz	± 580 Hz	± 32 Hz
28 MHz	± 10 kHz	± 5.1 kHz	± 2.1 kHz	± 1.2 kHz	± 600 Hz	± 38 Hz
40 MHz	± 16 kHz	± 7.5 kHz	± 2.8 kHz	± 1.5 kHz	± 700 Hz	± 65 Hz
80 MHz	± 40 kHz	± 16 kHz	± 6.0 kHz	± 2.8 kHz	± 920 Hz	± 200 Hz
160 MHz	± 100 kHz	± 41 kHz	± 13 kHz	± 6.1 kHz	± 1.3 kHz	± 440 Hz
320 MHz	± 290 kHz	± 110 kHz	± 31 kHz	± 13 kHz	± 2.4 kHz	± 660 Hz
500 MHz	± 560 kHz	± 210 kHz	± 56 kHz	± 22 kHz	± 3.3 kHz	± 690 Hz
1 GHz	± 1.6 MHz	± 580 kHz	± 150 kHz	± 56 kHz	± 7.5 kHz	± 950 Hz
2 GHz	± 4.6 MHz	± 1.6 MHz	± 420 kHz	± 150 kHz	± 17 kHz	± 1.6 kHz
4 GHz	± 13 MHz	± 4.7 MHz	± 1.2 MHz	± 410 kHz	± 41 kHz	± 2.4 kHz

Phase error	
Phase uncertainty	These values represent the 95% confidence interval (±) around the expected phase of the input signal. The input signal to the measurement instrument is a 0 dBm unmodulated carrier at the listed center frequency. In this case, the output of the phase meas time trace should be a constant zero value. However, due to random noise (phase noise and other), the phase meas time trace will contain a non-zero signal with a particular mean and standard deviation. The contents of the cells represent (1.96 * stddev). PXA phase noise optimization is set to Best Wide Offset. Measurement time: < 10 ms. Input range is optimized without overloading. 10 MHz reference source is locked with signal source.

PXA N9030A Signal Analyzer

	Center frequency			
Measurement bandwidth	2.0 GHz	8.0 GHz	26.0 GHz	43.0 GHz
10 MHz	± 0.06°	± 0.15°	± 0.33°	± 0.49°
25 MHz	± 0.07°	± 0.10°	± 0.34°	± 0.51°
28 MHz	± 0.06°	± 0.12°	± 0.40°	± 0.49°
40 MHz	± 0.08°	± 0.16°	± 0.35°	± 0.55°
80 MHz	± 0.08°	± 0.12°	± 0.33°	± 0.51°
160 MHz	± 0.09°	± 0.14°	± 0.35°	± 0.66°

Infiniium DSO/MSO S-Series Oscilloscope

	Center frequency		
Measurement bandwidth	1.0 GHz	2.0 GHz	4.0 GHz
10 MHz	± 0.11°	± 0.15°	± 0.33°
25 MHz	± 0.11°	± 0.18°	± 0.33°
28 MHz	± 0.11°	± 0.16°	± 0.29°
40 MHz	± 0.10°	± 0.19°	± 0.36°
80 MHz	± 0.12°	± 0.18°	± 0.30°
160 MHz	± 0.15°	± 0.20°	± 0.33°
320 MHz	± 0.24°	± 0.23°	± 0.38°
500 MHz	± 0.25°	± 0.29°	± 0.36°
1 GHz	± 0.39°	± 0.42°	± 0.46°
2 GHz	± 0.83°	± 0.68°	± 0.54°
4 GHz	N/A	± 1.0°	± 0.92°

Ordering Information

Software licensing and configuration

Flexible licensing and configuration

- **Perpetual:** License can be used in perpetuity.
- **Time-based:** License is time limited to a defined period, such as 12-months.
- **Node-locked:** Allows you to use the license on one specified instrument/computer.
- **Transportable:** Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- **Floating:** Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
- **USB portable:** Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- **Software support subscription:** Allows the license holder access to Keysight technical support and all software upgrades

Basic vector signal analysis and hardware connectivity (89601200C) (required)

FMCW Radar Analysis (89601BHPC)

Software license type	Software license	Support subscription
Node-locked perpetual	R-Y5A-001-A	R-Y6A-001-z [2]
Node-locked time-based	R-Y4A-001-z [1]	Included
Transportable perpetual	R-Y5A-004-D	R-Y6A-004-z [2]
Transportable time-based	R-Y4A-004-z [1]	Included
Floating perpetual (single site)	R-Y5A-002-B	R-Y6A-002-z [2]
Floating time-based (single site)	R-Y4A-002-z [1]	Included
Floating perpetual (regional)	R-Y5A-006-F	R-Y6A-006-z [2]
Floating time-based (regional)	R-Y4A-006-z [1]	Included
Floating perpetual (worldwide)	R-Y5A-010-J	R-Y6A-010-z [2]
Floating time-based (worldwide)	R-Y4A-010-z [1]	Included
USB portable perpetual	R-Y5A-005-E	R-Y6A-005-z [2]
USB portable time-based	R-Y4A-005-z [1]	Included

1. z means different time-based license duration. F for six months, L for 12 months, X for 24 months, and Y for 36 months. All time-based licenses have included the support subscription same as the time-base duration.

2. z means different support subscription duration. L for 12 months (as default), X for 24 months, Y for 36 months, and Z for 60-months. Support subscription must be purchased for all perpetual licenses with 12-months as the default. All software upgrades and KeysightCare support are provided for software licenses with valid support subscription.

You can upgrade!

UP GRADE

All 89600 VSA Software options can be added after your initial purchase and are license-key enabled. For more information please refer to www.keysight.com/find/89600B_upgrades

Upgrade your 89600 VSA software up to date (89601B to 89601C)

Keysight now launches the totally new 89600 VSA software as 89601C after September 2019 as version 2019 update 1.0, the existing 89601B customers can continue to use the new 89601C software with valid licenses or can visit the Keysight software upgrade webpage to fill in their current 89601B software license information and get a quote for upgrading from 89601B licenses to 89601C licenses.

https://upgrade.software.keysight.com/software_upgrade_form.html

Additional Information

- 89600 VSA Software, Brochure, literature number 5990-6553EN
- 89600 VSA Software, Configuration Guide, literature number 5990-6386EN
- 89600 VSA Software Pulse analysis Option 89601BHQC, Technical Overview, 5998-4197EN

Web

- www.keysight.com/find/89600vsa
- www.keysight.com/find/vsa_trial

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