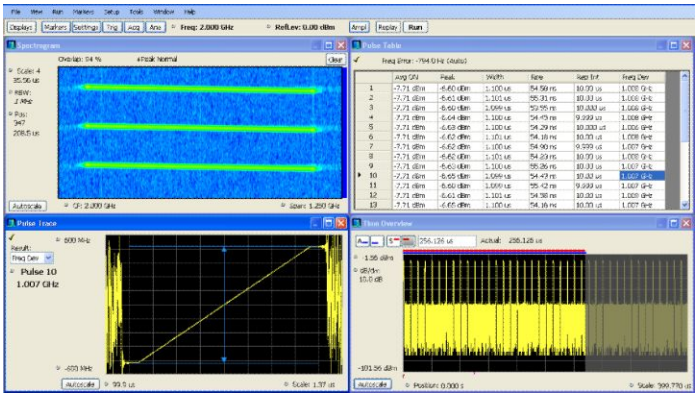
Vector Signal Analysis Software for PC

SignalVu-PC Datasheet



SignalVu-PC vector signal analysis software helps you easily validate wideband designs. Using the signal analysis engine of the RSA5000 and RSA6000 Series real-time signal analyzer on an external computer or Windows tablet, you can now move your analysis of acquisitions off the instrument, and anywhere. Whether your design validation needs include wideband radar, high data rate satellite links, wireless LAN or frequency-hopping communications, SignalVu-PC vector signal analysis software can speed your time-to-insight by showing you the time-variant behavior of these wideband signals.

Key features

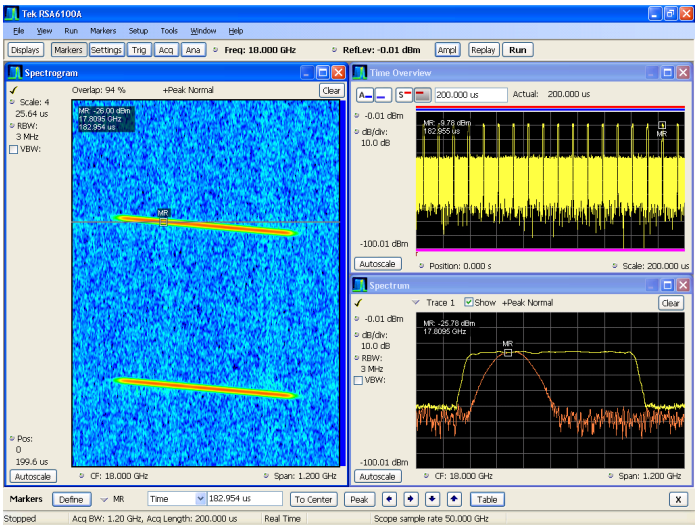
- PC-based multi-domain vector signal analysis for waveforms acquired by Tektronix real-time signal analyzers and oscilloscopes:
  - Tektronix real-time and mixed-domain oscilloscopes (MSO/DPO3000, MDO/MSO/DPO4000, MSO/DPO5000, DPO7000, DPO/ DSA/MSO70000 Series)
  - Tektronix real-time signal analyzers (RSA3000, RSA5000, RSA6000 Series)
  - Turn the MDO4000B into the industry's only 1 GHz Vector Signal Analyzer using the Live Link option (Option CON)
- Analyze without acquisition hardware present
- Analyze wideband designs
- Free up instruments for further use while analysis occurs offline
- Enable analysis at multiple sites without purchasing additional hardware
- Use your Windows tablet or your powerful PC workstation
  - Windows XP (32 bit), Windows 7 (64 bit), and Windows 8 (64 bit) versions available
- Analyze
  - Extensive time-correlated, multi-domain displays connect problems in time, frequency, phase, and amplitude for quicker understanding of cause and effect when troubleshooting
  - Power measurements and signal statistics help you characterize components and systems: ACLR, Multicarrier ACLR, Power vs. Time, CCDF, and OBW/EBW
  - WLAN spectrum and modulation transmitter measurements based on IEEE 802.11 a/b/g/j/p/n/ac standards (Option SV23, SV24 and SV25, or the bundle option SV2C)
  - Settling time measurements, frequency, and phase (Option SVT) for characterization of wideband frequency-agile oscillators
  - Advanced signal analysis suite (Option SVP) - automated pulse measurements including rise time, pulse width, and pulse-to-pulse phase provide deep insight into pulse train behavior
  - General purpose digital modulation analysis (Option SVM) provides modulation analysis of 23 modulation types
  - Flexible OFDM analysis (Option SVO) of custom OFDM signals
  - Frequency offset control for analyzing baseband signals with near-zero intermediate frequencies (IF)
  - AM/FM/PM modulation and audio measurements (Option SVA) for characterization of analog transmitters and audio signals

Applications

- Wideband radar and pulsed RF signals
- Frequency agile communications
- Broadband satellite and microwave backhaul links
- Wireless LAN
- Education

Capture with a variety of tools

Capture once - make multiple measurements without recapturing. Using oscilloscopes, up to four channels can be captured simultaneously; each of which can be independently analyzed by SignalVu-PC software. Channels can be RF, I and Q, or differential inputs. You can also apply math functions to the acquisition before analysis by SignalVu-PC. Acquisition lengths vary depending upon the selected capture bandwidth: full-bandwidth acquisitions can range from 1 ms to 25 ms depending upon model and option selections. Real-time signal analyzer captures range from up to 7.15 seconds at maximum acquisition bandwidth to several hours at reduced bandwidths.



Once captured into memory, SignalVu provides detailed analysis in multiple domains. The spectrogram display (left panel) shows the frequency of an 800 MHz wide LFM pulse changing over time. By selecting the point in time in the spectrogram during the On time of the pulse, the chirp behavior can be seen as it sweeps from low to high (lower right panel).

Live Link with the MDO4000B

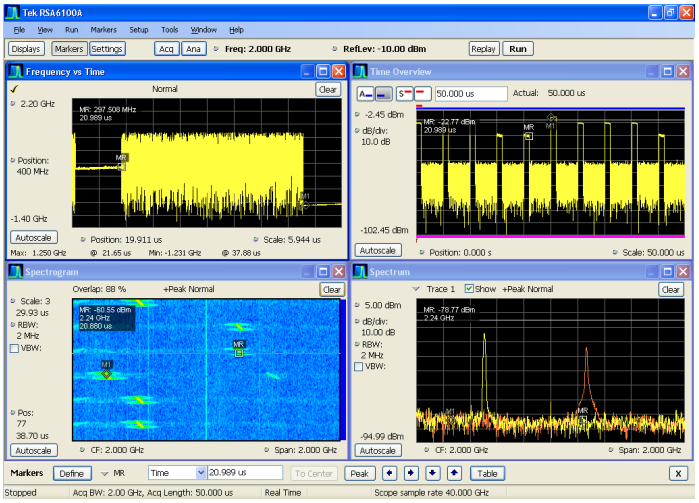
With the Live Link option (Option CON), SignalVu-PC extends the functionality of the Mixed Domain Oscilloscope MDO4000B and turns it into the industry's only 1 GHz Vector Signal Analyzer. SignalVu-PC controls the MDO4000B RF section, acquires the vector-calibrated I/Q data, and makes wide-band, time-correlated, multi-domain measurements. You can analyze, correlate and troubleshoot issues in time, frequency, phase, amplitude, and even modulation without having to sweep since you can acquire up to 1 GHz of bandwidth in one shot. You can leverage the MDO4000B triggering capability and extend your debugging work into system-level troubleshooting of your embedded RF devices.

Analyze

SignalVu-PC vector signal analysis software uses the same analysis capabilities found in the RSA5000 and RSA6000 Series real-time signal analyzers.

Time-correlated measurements can be made of frequency, phase, amplitude, and modulation versus time. This is ideal for signal analysis that includes frequency hopping, pulse characteristics, modulation switching, settling time, bandwidth changes, and intermittent signals.

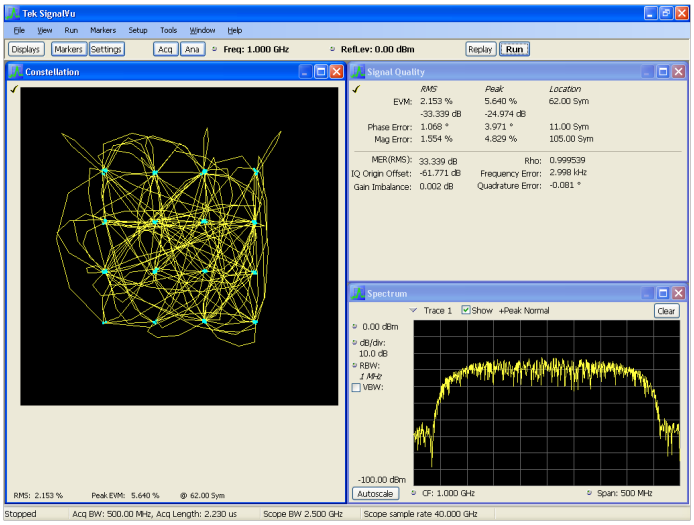
Acquisitions from all Tektronix MDO/MSO/DPO Series oscilloscopes, including the spectrum analyzer in the Mixed Domain Oscilloscope can be analyzed with SignalVu-PC, adding deep analysis capabilities to these broadband acquisition systems. Signals acquired with RSAs and Specmon can also be analyzed with all of the post-acquisition analysis capabilities of those instruments.



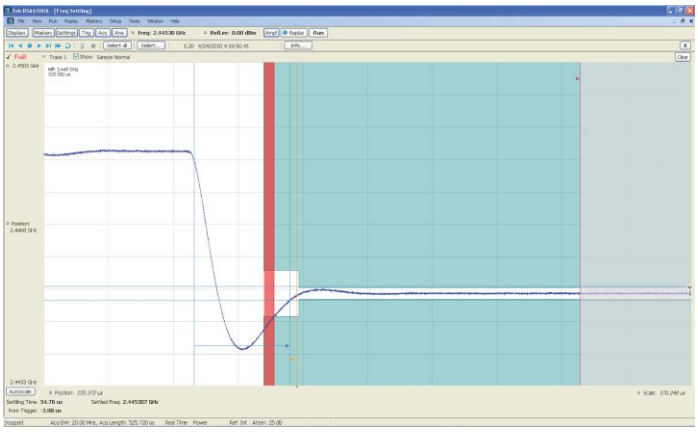
Time-correlated, multi-domain view provides a new level of insight into design or operational problems not possible with conventional analysis solutions. Here, the hop patterns of a narrowband signal can be observed using Spectrogram (lower left) and its hop characteristics can be precisely measured with Frequency vs Time display (upper left). The time and frequency responses can be observed in the two views on the right as the signal hops from one frequency to the next. All of the analysis shown above is available in the base version of SignalVu-PC.

Options tailored for your wideband applications

The basic SignalVu-PC enables spectrum analysis, RF power and statistics, spectrograms, amplitude, frequency and phase vs. time, and analog modulation measurements. Options are available for WLAN, settling time, audio, modulation, pulse, and OFDM analysis.



Wideband satellite and point-to-point microwave links can be directly observed with SignalVu-PC analysis software. Here, General Purpose Digital Modulation Analysis (Option SVM) is demodulating a 16QAM backhaul link running at 312.5 MS/s.



Settling time measurements (Option SVT) are easy and automated. The user can select measurement bandwidth, tolerance bands, reference frequency (auto or manual), and establish up to 3 tolerance bands vs. time for Pass/Fail testing. Settling time may be referenced to external or internal trigger, and from the last settled frequency or phase. In the illustration, frequency settling time for a hopped oscillator is measured from an external trigger point from the device under test.

WLAN transmitter testing

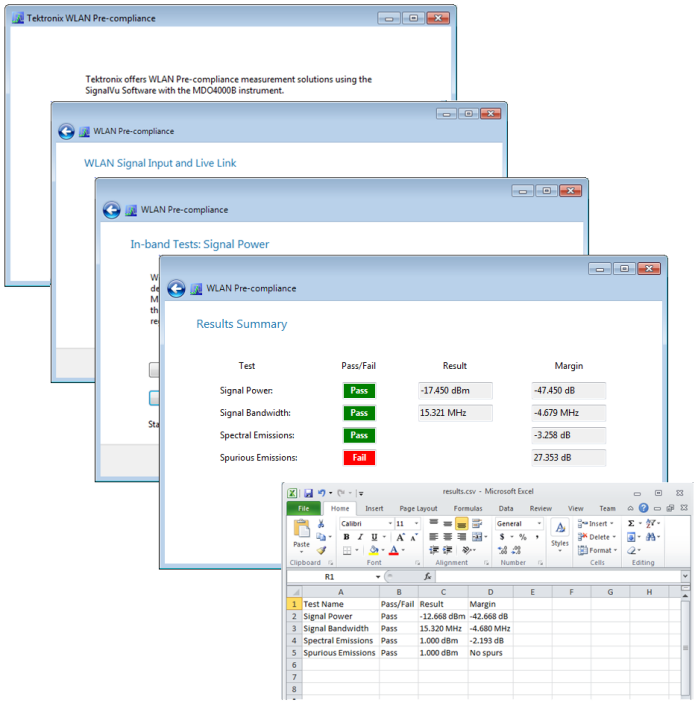
With the WLAN measurement options, you can perform standards-based transmitter measurements in the time, frequency, and modulation domains.

- Option SV23 supports IEEE 802.11a, b, g, j and p signals
- Option SV24 supports 802.11n 20 MHz and 40 MHz SISO signals
- Option SV25 802.11ac 20/40/80/160 MHz SISO signals
- Option SV2C is a bundle of the live link option CON to MDO4000B and all the WLAN measurement options described above (SV23, SV24 and SV25)

All modulation formats, as shown in the following table can be measured.

Standard	Std PHY	Freq band(s)	Signal	Modulation formats	Bandwidth (max)	802.11-2012 section
802.11b	DSSS HR/DSSS	2.4 GHz	DSSS/CCK 1 - 11 Mbps	DBSK, DQPSK CCK5.5M, CCK11M	20 MHz	16 & 17
802.11g	ERP	2.4 GHz	DSSS/CCK/PBCC 1 - 33 Mbps	BPSK DQPSK	20 MHz	17
802.11a	OFDM	5 GHz	OFDM 64 <54 Mbps	BPSK QPSK 16QAM 64QAM	20 MHz	18
802.11g		2.4 GHz			20 MHz	19
802.11j/p		5 GHz			5, 10, 20 MHz	18
802.11n	HT	2.4 GHz & 5 GHz	OFDM 64, 128 ≤ 150 Mbps	BPSK QPSK 16QAM 64QAM	20 , 40 MHz	20
802.11ac	VHT	5 GHz	OFDM 64, 128, 256, 512 ≤ 867 Mbps	BPSK QPSK 16QAM 64QAM 256QAM	20, 40, 80, 160 MHz	22

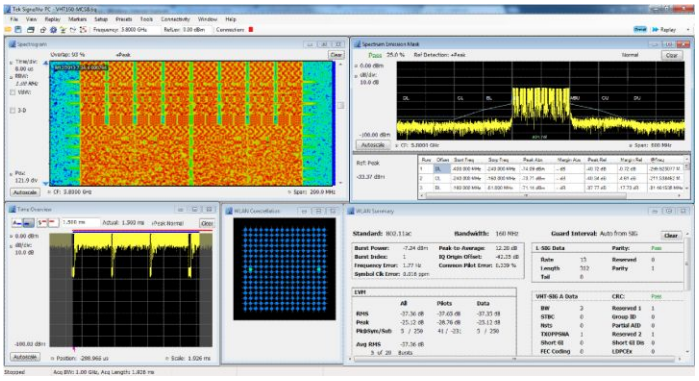
The WLAN presets make the Error Vector Magnitude (EVM), Constellation, and Spectral Emission Mask (SEM) measurements push-button. In addition, you can download the WLAN pre-compliance wizard to easily and quickly prepare for compliance regulatory tests. The Wizard automatically measures Transmit Power, Occupied Bandwidth, Spectral Power Density, Spectral Emission Mask and Spurious Emission Mask.



The WLAN RF transmitter measurements are defined by the IEEE 802.11-2012 revision of the standard.

IEEE 802.11 RF layer test	IEEE reference 802.11-2012	Limit tested
Transmit power	16.4.7.2 (DSSS)	country dependent
	17.4.7.2 ("b")	country dependent
	18.3.9.2("a")	country dependent
	19.4.8.2 ("g")	country dependent
	20.3.20.3 ("n")	country dependent
Transmit Power On/Off Ramp	16.4.7.8 (DSSS)	(10%-90%) 2 usec
	17.4.7.7 ("b")	(10%-90%) 2 usec
Transmit Spectrum mask	16.4.7.5 (DSSS)	Std mask
	17.4.7.4 ("b")	Std mask
	18.3.9.3 ("a")	Std mask
	19.5.5 ("g")	Std mask
	20.3.20.1 ("n")	Std mask
	22.3.18.1 ("ac")	Std mask
RF Carrier suppression	16.4.7.9 ("DSSS")	-15dB
	17.4.7.8 ("b")	-15dB
Center frequency leakage	18.3.9.7.2 ("a")	-15 dBc or +2 dB w.r.t. average subcarrier power
	20.3.20.7.2 ("n")	20 MHz: follow 18.3.9.7.2
		40 MHz: -20 dBc or 0 dB w.r.t. average subcarrier power
Transmit Spectral flatness	18.3.9.7.3 ("a")	+/- 4 dB (SC = -16…16), +4/-6 dB (other)
	20.3.20.2 ("n")	+/- 4 dB, +4/-6 dB
	22.3.18.2 ("ac")	+/- 4 dB, +4/-6 dB (various BWs, 20-160 MHz)
Transmission spurious	18.3.9.4 ("a")	country dependent
Transmit Center frequency tolerance	16.4.7.6 ("DSSS")	+/-25 ppm
	17.4.7.5 ("b")	+/-25 ppm
	18.3.9.5 ("a")	+/-20 ppm (20 MHz and 10 MHz), +/-10 ppm (5 MHz)
	19.4.8.3 ("g")	+/-25 ppm
	20.3.20.4 ("n")	+/-20 ppm (5 GHz band), +/-25 ppm (2.4 GHz band)
	22.3.18.3 ("ac")	+/-20 ppm
Symbol clock frequency tolerance	16.4.7.7 ("DSSS")	+/-25 ppm
	17.4.7.6 ("b")	+/-25 ppm
	18.3.9.6 ("a")	+/-20 ppm (20 MHz and 10 MHz), +/-10 ppm (5 MHz)
	19.4.8.4 ("g")	+/-25 ppm
	20.3.20.6 ("n")	+/-20 ppm (5 GHz band), +/-25 ppm (2.4 GHz band)
	22.3.18.3 ("ac")	+/-20 ppm
Transmit Modulation accuracy	16.4.7.10 ("DSSS")	Peak EVM < 0.35
	17.4.7.9 ("b")	Peak EVM < 0.36

IEEE 802.11 WLAN transmitter test summary				
IEEE 802.11 RF layer test	IEEE reference 802.11-2012	Limit tested		
Transmitter Constellation Error	18.3.9.7.4 ("a")	Modulation	Coding rate (R	Relative constellation error (dB)
		BPSK	1/2	-5
		BPSK	3/4	-8
		QPSK	1/2	-10
		QPSK	3/4	-13
		16-QAM	1/2	-16
		16-QAM	3/4	-19
		64-QAM	2/3	-22
		64-QAM	3/4	-25
	20.3.20.7.3 ("n")	BPSK	1/2	–5
		QPSK	1/2	–10
		QPSK	3/4	–13
		16-QAM	1/2	–16
		16-QAM	3/4	–19
		64-QAM	2/3	–22
		64-QAM	3/4	–25
		64-QAM	5/6	–27
	22.3.18.4.3 ("ac")	BPSK	1/2	-5
		QPSK	1/2	-10
		QPSK	3/4	-13
		16-QAM	1/2	-16
		16-QAM	3/4	-19
		64-QAM	2/3	-22
		64-QAM	3/4	-25
		64-QAM	5/6	-27
		256-QAM	3/4	-30
		256-QAM	5/6	-32
Out-of-band spurious emission	16.4.6.6 ("DSSS")	country dependent		
	17.4.6.9 ("b")	country dependent		
	18.3.8.5 ("a")	country dependent		
	19.4.4 ("g")	country dependent		

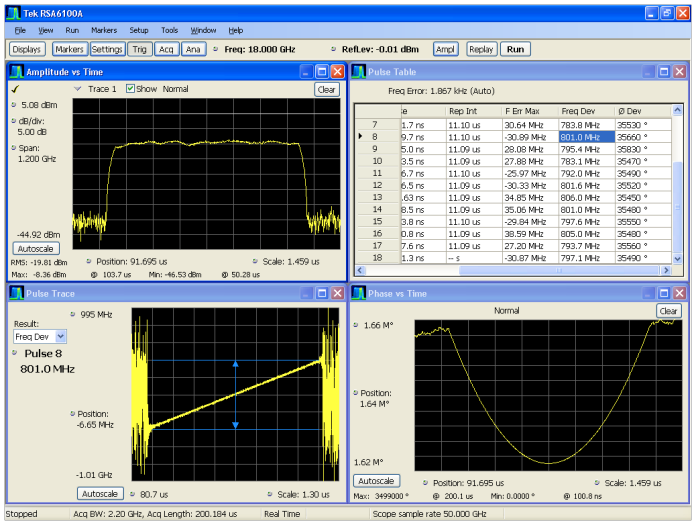


Education license

Qualified educational facilities can cost-effectively use SignalVu-PC in teaching environments. The specially priced education version includes all available analysis options standard and provides results watermarked 'Education Version'.

Measurement functions

Spectrum analyzer measurements (base software)	Channel power, Adjacent channel power, Multicarrier adjacent channel Power/Leakage ratio, Occupied bandwidth, xdB down, dBm/Hz marker, dBc/Hz marker
Time domain and statistical measurements (base software)	RF IQ vs time, Amplitude vs time, Power vs time, Frequency vs time, Phase vs time, CCDF, Peak-to-Average ratio, Amplitude, Frequency, and Phase modulation analysis
WLAN 802.11a/b/g/j/p measurement application (Opt. SV23)	All of the RF transmitter measurements as defined in the IEEE standard, and a wide range of additional scalar measurements such as Carrier Frequency error, Symbol Timing error, Average/peak burst power, IQ Origin Offset, RMS/Peak EVM, and analysis displays, such as EVM and Phase/ Magnitude Error vs time/frequency or vs symbols/ subcarriers, as well as packet header decoded information and symbol table. Option SV24 requires option SV23. Option SV25 requires option SV24.
WLAN 802.11n measurement application (Opt. SV24)	
WLAN 802.11ac measurement application (Opt. SV25)	
AM/FM/PM modulation and audio measurements (Opt. SVA)	Carrier power, frequency error, modulation frequency, modulation parameters (±peak, peak-peak/2, RMS), SINAD, modulation distortion, S/N, THD, TNHD, hum and noise
Settling time (frequency and phase) (Opt. SVT)	Measured frequency, Settling time from last settled frequency, Settling time from last settled phase, Settling time from trigger. Automatic or manual reference frequency selection. User-adjustable measurement bandwidth, averaging, and smoothing. Pass/Fail mask testing with 3 user-settable zones
Advanced signal analysis (Opt. SVP)	Average on power, Peak power, Average transmitted power, Pulse width, Rise time, Fall time, Repetition interval (seconds), Repetition interval (Hz), Duty factor (%), Duty factor (ratio), Ripple (dB), Ripple (%), Droop (dB), Droop (%), Overshoot (dB), Overshoot (%), Pulse-Pulse frequency difference, Pulse-Pulse phase difference, RMS frequency error, Max frequency error, RMS phase error, Max phase error, Frequency deviation, Phase deviation, Impulse response (dB), Impulse response (time), Time stamp
Flexible OFDM analysis (Opt. SVO)	OFDM analysis with support for WLAN 802.11a/g/j and WiMAX 802.16-2004. Constellation, Scalar measurement summary, EVM or power vs carrier, Symbol table (Binary or Hexadecimal)
General purpose digital modulation analysis (Opt. SVM)	Error vector magnitude (EVM) (RMS, Peak, EVM vs Time), Modulation error ratio (MER), Magnitude Error (RMS, peak, mag error vs time),Phase error (RMS, Peak, Phase error vs time), Origin offset, Frequency error, Gain imbalance, Quadrature error, Rho, Constellation, Symbol table. FSK only: Frequency deviation, Symbol timing error



The Advanced Signal Analysis package (Option SVP) provides 27 individual measurements to automatically characterize long pulse trains. An 800 MHz wide LFM chirp centered at 18 GHz is seen here with measurements for pulses 7 through 18 (upper right). The shape of the pulse can be seen in the Amplitude vs Time plot shown in the upper left. Detailed views of pulse #8's frequency deviation and parabolic phase trajectory are shown in the lower two views.

Specifications

Performance (typical)

The following is typical performance of SignalVu-PC analyzing acquisitions from any MSO/DPO5000, DPO7000, or DPO/DSA/MSO70000 Series oscilloscopes. Vector modulation analysis is provided for the MDO4000B spectrum analyzer acquisitions. All other MDO spectrum analysis specifications are available in the MDO4000 datasheet. No published performance is available for MSO/DPO3000/2000 and MDO4000 Series oscilloscope acquisitions.

Frequency-related

Frequency range	See appropriate oscilloscope data sheet
Initial center frequency setting accuracy	Equal to time-base accuracy of oscilloscope
Center frequency setting resolution	0.1 Hz
Frequency offset range	0 Hz to the maximum bandwidth of the oscilloscope
Frequency marker readout accuracy	±(Reference Frequency Error × Marker Frequency + 0.001 × Span + 2) Hz
Span accuracy	±0.3%
Reference frequency error	Equal to oscilloscope reference frequency accuracy, aging, and drift. Refer to appropriate DPO/DSA/MSO data sheet.

3rd order inter-modulation distortion [1]

Center frequency	MSO/DPO5000	DPO7000	DPO/DSA/MSO70000
2 GHz	-38 dBc	-40 dBc	-55 dBc
10 GHz	--	--	-48 dBc
18 GHz	--	--	-50 dBc

Residual responses [2]

DPO/DSA/ MSO70000 series (all spans)	–60 dBm
DPO7000 series (all spans)	–65 dBm
MSO/DPO5000 series (all spans)	–70 dBm

Displayed average noise level [3]

Span	MSO/DPO5000	DPO7000	DPO/DSA/MSO70000
DC - 500 MHz	-94 dBm	-100 dBm	-103 dBm
>500 MHz - 3.5 GHz	-	-102 dBm	-103 dBm
>3.5 GHz - 14 GHz	-	-	-101 dBm
>14 GHz - 20 GHz	-	-	-88 dBm
>20 GHz - 25 GHz	-	-	-87 dBm
>25 GHz - 33 GHz	-	-	-85 dBm

1 Conditions: Each signal level -5 dBm, reference level 0 dBm, 1 MHz tone separation. Math traces off. DPO7054/7104 and MSO/DPO5034/5054/5104 performance not listed.

2 Conditions: RF input terminated, reference level 0 dBm, measurements made after specified oscilloscope warm-up and SPC calibration. Does not include zero Hz spur.

3 Conditions: RF input terminated, 10 kHz RBW, 100 averages, reference level -10 dBm, trace detection average. Measurements made after specified oscilloscope warm-up and SPC calibration. MSO/DPO5034 and MSO/DPO5054 performance not listed.

Performance (typical)

Acquisition-related

Maximum acquisition time will vary based on the oscilloscope available memory and analog bandwidth. The following table highlights the single-channel capabilities for each model given maximum available memory configuration.

Model [4]	Max span	Max acquisition time at max sample rate	Min RBW at max sample rate	Min IQ time resolution	Max number of FastFrames [5]
DPO/DSA73304D	33 GHz	2.5 ms	1.2 kHz	20 ps	65,535
DPO/DSA72504D	25 GHz				
DPO/DSA/ MSO72004C	20 GHz				
DPO/DSA/ MSO71604C	16 GHz				
DPO/DSA/ MSO71254C	12.5 GHz				
DPO/DSA/ MSO70804C	8 GHz	5 ms	600 Hz	80 ps	
DPO/DSA/ MSO70604C	6 GHz				
DPO/DSA/ MSO70404C	4 GHz				
DPO7354C	3.5 GHz	12.5 ms	300 Hz	50 ps	
DPO7254C	2.5 GHz				
DPO7104C	1 GHz			100 ps	
DPO7054C	500 MHz				
MSO/DPO5204	2 GHz	25 ms	100 Hz	200 ps	
MSO/DPO5104	1 GHz				
MSO/DPO5054	500 MHz			400 ps	
MSO/DPO5034	350 MHz				
MDO4000B Spectrum Analyzer	3 GHz or 6 GHz [4]	20 ms	111 Hz	200 ps	Not available
MSO/DPO/ MDO4000	1 GHz	4 ms	557 Hz	2 ns	
MSO/DPO2000	200 MHz	1 ms	2.23 kHz	2 ns	
MSO/DPO3000	500 MHz	2 ms	1.11 kHz	800 ps	

4 Maximum span when used as a spectrum analyzer is the entire frequency range of the instrument.

5 Maximum number of frames available will depend upon the oscilloscope record length, sample rate, and the acquisition length settings.

Performance (typical)

Analysis-related

Frequency (base software)	Spectrum (amplitude vs linear or log frequency)
	Spectrogram (amplitude vs frequency over time)
Time and statistics (base software)	Amplitude vs time
	Frequency vs time
	Phase vs time
	Amplitude modulation vs time
	Frequency modulation vs time
	Phase modulation vs time
	RF IQ vs time
	Time overview
	CCDF
	Peak-to-Average ratio
Settling time, frequency, and phase (Opt. SVT)	Frequency settling vs time
	Phase settling vs time
Advanced measurements suite (Opt. SVP)	Pulse results table
	Pulse trace (selectable by pulse number)
	Pulse statistics (trend of pulse results, FFT of trend, and histogram)
Digital demod (Opt. SVM)	Constellation diagram
	EVM vs Time
	Symbol table (binary or hexadecimal)
	Magnitude and phase error vs time, and signal quality
	Demodulated IQ vs time
	Eye diagram
	Trellis diagram
	Frequency deviation vs time

Performance (typical)

Flexible OFDM (Opt. SVO)	EVM vs Symbol, vs Subcarrier
	Subcarrier power vs symbol, vs subcarrier
	Subcarrier constellation
	Symbol data table
	Mag error vs Symbol, vs Subcarrier
	Phase error vs Symbol, vs Subcarrier
	Channel frequency response
WLAN measurements (Opt. SV23, SV24, SV25 or SV2C)	Burst index
	Burst power
	Peak to average burst power
	IQ origin offset
	Frequency error
	Common pilot error
	Symbol clock error
	RMS and Peak EVM for Pilots/Data
	Peak EVM located per symbol and subcarrier
	Packet header format information
	Average power and RMS EVM per section of the header
	WLAN power vs Time or vs Symbol
	Burst Width
	WLAN symbol table
	WLAN Constellation
	Spectrum emission mask
	Spurious
	EVM vs symbol (or time), vs subcarrier (or frequency)
	Mag error vs symbol (or time), vs subcarrier (or frequency)
	Phase error vs symbol (or time), vs subcarrier (or frequency)
	WLAN channel frequency response vs symbol (or time), vs subcarrier (or frequency)
	WLAN spectral flatness vs symbol (or time), vs subcarrier (or frequency)

RF and spectrum analysis performance

Resolution bandwidth

Resolution bandwidth (spectrum analysis)	1, 2, 3, 5 sequence, auto-coupled, or user selected (arbitrary)
Resolution bandwidth shape	Approximately Gaussian, shape factor 4.1:1 (60:3 dB) ±10%, typical
Resolution bandwidth accuracy	±1% (auto-coupled RBW mode)
Alternative resolution bandwidth types	Kaiser window (RBW), –6 dB Mil, CISPR, Blackman-Harris 4B window, Uniform window (none), flat-top window (CW ampl.), Hanning window

Video bandwidth

Video bandwidth range	Dependent on oscilloscope record length setting. approximately 500 Hz to 5 MHz
RBW/VBW maximum	10,000:1

RF and spectrum analysis performance

RBW/VBW minimum	1:1
Resolution	5% of entered value
Accuracy (typical)	±10%
Time domain bandwidth (amplitude vs. time display)	
Time domain bandwidth range	At least 1/2 to 1/10,000 of acquisition bandwidth
Time domain bandwidth shape	Approximately Gaussian, shape factor 4.1:1(60:3 dB), ±10% typical
	Shape factor <2.5:1 (60:3 dB) typical for all bandwidths
Time domain bandwidth accuracy	±10%
Spectrum display traces, detectors, and functions	
Traces	Three traces + 1 math trace + 1 trace from spectrogram for spectrum display
Detector	Peak, –peak, average, CISPR peak
Trace functions	Normal, Average, Max Hold, Min Hold
Spectrum trace length	801, 2401, 4001, 8001, or 10401 points

AM/FM/PM modulation and audio measurements (Opt. SVA) [6]

Analog demodulation [7]	
Carrier frequency range	1 kHz or (1/2 × audio analysis bandwidth) to maximum input frequency
Maximum audio frequency span	10 MHz
Audio filters	
Low pass (kHz)	0.3, 3, 15, 30, 80, 300, and user-entered up to 0.9 × audio bandwidth
High pass (Hz)	20, 50, 300, 400, and user-entered up to 0.9 × audio bandwidth
Standard	CCITT, C-Message
De-emphasis (µs)	25, 50, 75, 750, and user-entered
File	User-supplied .TXT or .CSV file of amplitude/frequency pairs. Maximum 1000 pairs.
FM modulation analysis	
FM measurements,	Carrier power, carrier frequency error, audio frequency, deviation (+peak, –peak, peak-peak/2, RMS), SINAD, modulation distortion, S/N, total harmonic distortion, total non-harmonic distortion, hum and noise
FM deviation accuracy	±1.5% of deviation
FM rate accuracy	±1.0 Hz
Carrier frequency accuracy	±1 Hz + (transmitter frequency × reference frequency error)

6 All published performance based on conditions of Input Signal: 0 dBm, Input Frequency: 100 MHz, RBW: Auto, Averaging: Off, Filters: Off. Sampling and input parameters optimized for best results.

7 Sampling rates of the oscilloscope are recommended to be adjusted to no more than 10X the audio carrier frequency for modulated signals, and 10X the audio analysis bandwidth for direct input audio. This reduces the length of acquisition required for narrow-band audio analysis.

AM/FM/PM modulation and audio measurements (Opt. SVA)

Residuals (FM) (rate: 1 kHz to 10 kHz, deviation: 5 kHz)

THD	0.2% (MSO/DPO7000, 70000 Series)
	1.0% (MSO/DPO5000 Series)
	1.0% (MDO4000B Series)
SINAD	44 dB (MSO/DPO7000, 70000 Series)
	38 dB (MSO/DPO5000 Series)
	38 dB (MDO4000B Series)

AM modulation analysis

AM measurements	Carrier power, audio frequency, modulation depth (+peak, –peak, peak-peak/2), RMS, SINAD, modulation distortion, S/N, total harmonic distortion, total non-harmonic distortion, hum and noise
AM depth accuracy (rate: 1 kHz, depth: 50%)	±1% + 0.01 × measured value
AM rate accuracy (rate: 1 kHz, depth: 50%)	±1.0 Hz

Residuals (AM)

THD	0.3% (MSO/DPO7000, 70000 Series)
	1.0% (MSO/DPO5000 Series)
	1.0% (MDO4000B Series)
SINAD	48 dB (MSO/DPO7000, 70000 Series)
	43 dB (MSO/DPO5000 Series)
	43 dB (MDO4000B Series)

PM modulation analysis

PM measurement	Carrier power, carrier frequency error, audio frequency, deviation (+peak, –peak, peak-peak/2, RMS), SINAD, modulation distortion, S/N, total harmonic distortion, total non-harmonic distortion, hum and noise
PM deviation accuracy (rate: 1 kHz, deviation: 0.628 rad)	±100% × (0.01 + (rate / 1 MHz))
PM rate accuracy (rate: 1 kHz, deviation: 0.628 rad)	±1 Hz

Residuals (PM)

THD	0.1% (MSO/DPO7000, 70000 Series)
	0.5% (MSO/DPO5000 Series)
	0.5% (MDO4000B Series)
SINAD	48 dB (MSO/DPO7000, 70000 Series)
	43 dB (MSO/DPO5000 Series)
	43 dB (MDO4000B Series)

Direct audio input

Audio measurements	Signal power, audio frequency (+peak, –peak, peak-peak/2, RMS), SINAD, modulation distortion, S/N, total harmonic distortion, total non-harmonic distortion, hum and noise
Direct input frequency range (for audio measurements only)	1 Hz to 10 MHz

AM/FM/PM modulation and audio measurements (Opt. SVA)

Maximum audio frequency span 10 MHz

Audio frequency accuracy ±1 Hz

Residuals (PM)

THD 1.5%

SINAD 38 dB

Minimum audio analysis bandwidth and RBW vs. oscilloscope memory and sample rate (Opt. SVA)

Model	Sample rate: 1 GS/s				Sample rate: maximum			
	Standard memory		Maximum memory		Standard memory		Maximum memory	
	Min. Aud. BW	RBW (Auto)	Min. Aud. BW	RBW (Auto)	Min. Aud. BW	RBW (Auto)	Min. Aud. BW	RBW (Auto)
MSO/ DPO 5034 MSO/DPO 5054	200 kHz	400 Hz	20 kHz	40 Hz	1 MHz	2 kHz	100 kHz	200 hz
MSO/DPO 5104 MSO/DPO 5204	100 kHz	200 Hz	10 kHz	20 hz	1 MHz	2 kHz	100 kHz	200 Hz
DPO 7000	50 kHz	100 Hz	50 kHz	100 Hz	2 MHz	4 kHz	2 MHz	4 kHz
DPO/DSA/ MSO 70000 ≥12.5 GHz BW	200 kHz	400 Hz	10 kHz	20 Hz	not recom-mended	>4 kHz	1 MHz	2 kHz
DPO/DSA/ MSO 70000 <12.5 GHz BW	200 kHz	400 Hz	20 kHz	40 Hz	not recom-mended	>4 kHz	500 kHz	1 kHz

Minimum audio analysis bandwidth for MDO4000B RF input 7.8 kHz

Minimum audio analysis RBW for MDO4000B RF input ≥ 15 Hz (Span set to minimum 1 kHz)

Settling time, frequency, and phase (Opt. SVT) [8]

Settled frequency uncertainty,

Measurement frequency: 1 GHz

Averages	Frequency uncertainty at stated measurement bandwidth			
	1 GHz	100 MHz	10 MHz	1 MHz
Single measurement	20 kHz	2 kHz	500 Hz	100 Hz
100 averages	10 kHz	500 Hz	200 Hz	50 Hz
1000 averages	2 kHz	200 Hz	50 Hz	10 Hz

Measurement frequency: 9 GHz

Averages	Frequency uncertainty at stated measurement bandwidth			
	1 GHz	100 MHz	10 MHz	1 MHz
Single Measurement	20 kHz	5 kHz	2 kHz	200 Hz
100 Averages	10 kHz	2 kHz	500 Hz	50 Hz
1000 Averages	2 kHz	500 Hz	200 Hz	20 Hz

Settled phase uncertainty,

Measurement frequency: 1 GHz

Averages	Phase uncertainty at stated measurement bandwidth			
	1 GHz	100 MHz	10 MHz	1 MHz
Single measurement	2°	2°	2°	2°
100 averages	0.5°	0.5°	0.5°	0.5°
1000 averages	0.2°	0.2°	0.2°	0.2°

Measurement frequency: 9 GHz

Averages	Phase uncertainty at stated measurement bandwidth			
	1 GHz	100 MHz	10 MHz	1 MHz
Single measurement	5°	5°	5°	5°
100 averages	2°	2°	2°	2°
1000 averages	0.5°	0.5°	0.5°	0.5°

Advanced measurement suite (Opt. SVP)

General characteristics

Measurements	Average On Power, Peak Power, Average Transmitted Power, Pulse Width, Rise Time, Fall Time, Repetition Interval (seconds), Repetition Interval (Hz), Duty Factor (%), Duty Factor (ratio), Ripple (dB), Ripple (%), Droop (dB), Droop (%), Overshoot (dB), Overshoot (%), Pulse-Pulse Frequency Difference, Pulse-Pulse Phase Difference, RMS Frequency Error, Max Frequency Error, RMS Phase Error, Max Phase Error, Frequency Deviation, Phase Deviation, Impulse Response (dB), Impulse Response (time), Time Stamp
Number of pulses	1 to 10,000
System rise time (typical)	Equal to oscilloscope rise time

8 Settled Frequency or Phase at the measurement frequency. Measured signal level > -20 dBm, Attenuator: Auto.

Advanced measurement suite (Opt. SVP)

Minimum pulse width for detection [9]

Model	Minimum PW
DPO/DSA72004B MSO72004	400 ps
DPO/DSA71604B MSO71604	500 ps
DPO/DSA71254B MSO71254	640 ps
DPO/DSA70804B MSO70804	1 ns
DPO/DSA70604B MSO70604	1.3 ns
DPO/DSA70404B MSO70404	2 ns
DPO7354	2.25 ns
DPO7254	3 ns
DPO7104	8 ns
DPO7054	16 ns
MSO/DPO5204	4 ns
MSO/DPO5104	8 ns
MSO/DPO5054	16 ns
MSO/DPO5034	25 ns
MDO4000B	≥5 ns

Pulse measurement accuracy (typical) [10]

Average on power	±0.3 dB + Absolute Amplitude Accuracy of oscilloscope
Average transmitted power	±0.4 dB + Absolute Amplitude Accuracy of oscilloscope
Peak power	±0.4 dB + Absolute Amplitude Accuracy of oscilloscope
Pulse width	±(3% of reading + 0.5 × sample period)
Pulse repetition rate	±(3% of reading + 0.5 × sample period)

Digital modulation analysis (Opt. SVM)

Modulation formats	π/2DBPSK, BPSK, SBPSK, QPSK, DQPSK, π/4DQPSK, D8PSK, 8PSK, OQPSK, SOQPSK, CPM, 16/32/64/128/256QAM, MSK, GMSK, GFSK, 2-FSK, 4-FSK, 8-FSK, 16-FSK, C4FM, D16PSK, 16APSK, and 32APSK
Analysis period	Up to 80,000 samples
Measurement filters	Square-root raised cosine, raised cosine, Gaussian, rectangular, IS-95, IS-95 EQ, C4FM-P25, half-sine, None, User Defined
Reference filters	Raised cosine, Gaussian, rectangular, IS-95, SBPSK-MIL, SOQPSK-MIL, SOQPSK-ARTM, None, User Defined
Alpha/B x T range	0.001 to 1, 0.001 step
	Constellation, Error vector magnitude (EVM) vs time, Modulation error ratio (MER), Magnitude error vs time, Phase error vs time, Signal quality, Symbol table rhoFSK only: Frequency deviation, Symbol timing error

9 Conditions: Approximately equal to 10/(IQ sampling rate). IQ sampling rate is the final sample rate after digital down conversion from the oscilloscope. Pulse measurement filter set to max bandwidth.

10 Conditions: Pulse Width > 450 ns, S/N Ratio ≥30 dB, Duty Cycle 0.5 to 0.001, Temperature 18 °C to 28 °C.

Digital modulation analysis (Opt. SVM)

Symbol rate range 1 kS/s to (0.4 * Sample Rate) GS/s (modulated signal must be contained entirely within the acquisition bandwidth)

Adaptive equalizer

Type	Linear, decision-directed, feed-forward (FIR) equalizer with coefficient adaptation and adjustable convergence rate
Modulation types supported	π/2 DBPSK, BPSK, SBPSK, QPSK, DQPSK, π/4 DQPSK, D8PSK, 8PSK, D16PSK, OQPSK, SOQPSK, CPM, 16/32/64/128/256QAM, MSK, 2-FSK, 4-FSK, 8-FSK, 16-FSK, C4FM
Reference filters for all modulation types except OQPSK	Raised Cosine, Rectangular, None
Reference filters for OQPSK	Raised Cosine, Half Sine
Filter length	1-128 taps
Taps/symbol: raised cosine, half sine, no filter	1, 2, 4, 8
Taps/symbol: rectangular filter	1
Equalizer controls	Off, Train, Hold, Reset

16QAM Residual EVM (typical) for DPO7000 and DPO/DSA/MSO70000 series [11]

Symbol Rate	RF	IQ
100 MS/s	<2.0%	<2.0%
312.5 MS/s	<3.0%	<3.0%

16QAM Residual EVM (typical) for MSO/DPO5000 series [12]

Symbol Rate	RF	IQ
10 MS/s	1.5%	1.0%
100 MS/s	4.0%	2.0%

OFDM residual EVM, 802.11g Signal at 2.4 GHz, input level optimized for best performance

DPO7000 Series	–33 dB
DPO/DSA/MSO70000 Series	–38 dB

QPSK Residual EVM (typical) for MDO4000B RF Input [13] Single Carrier, measured at 1GHz

0.1 MSymbols/sec rate	0.26%
10 MSymbols/sec rate	0.28 %
100 MSymbols/sec rate	1.0 %
312.5 MSymbols/sec rate	3.0 %

11 CF = 1 GHz, Measurement Filter = root raised cosine, Reference Filter = raised cosine, Analysis Length = 200 symbols.

12 Carrier frequency 700 MHz. MSO/DPO5054 and MSO/DPO5034 performance not listed. Use of external reference will degrade EVM performance.

13 Measurement filter = root raised cosine, reference filter = raised cosine, analysis Length = 400 symbols, 20 averages

WLAN IEEE802.11a/b/g/j/p (Opt. SV23)

General characteristics

Modulation formats	DBPSK (DSSS1M), DQPSK (DSSS2M), CCK5.5M, CCK11M , OFDM (BPSK, QPSK, 16 or 64QAM)
Measurements and displays	Burst Index, Burst Power, Peak to Average Burst Power, IQ Origin Offset, Frequency Error, Common Pilot Error, Symbol Clock Error
	RMS and Peak EVM for Pilots/Data, Peak EVM located per Symbol and Subcarrier
	Packet Header Format Information
	Average Power and RMS EVM per section of the header
	WLAN Power vs Time, WLAN Symbol Table, WLAN Constellation
	Spectrum Emission Mask [14], Spurious
	Error Vector Magnitude (EVM) vs Symbol (or Time), vs Subcarrier (or Frequency)
	Mag Error vs Symbol (or Time), vs Subcarrier (or Frequency)
	Phase Error vs Symbol (or Time), vs Subcarrier (or Frequency)
	WLAN Channel Frequency Response vs Symbol (or Time), vs Subcarrier (or Frequency)
	WLAN Spectral Flatness vs Symbol (or Time), vs Subcarrier (or Frequency)
Typical residual EVM - 802.11b (CCK-11Mbps) with MDO4000B [15]	RMS-EVM over 1000 chips, EQ On; 2.4 GHz: 1.04%
Typical residual EVM - 802.11a/g/j (OFDM, 20 MHz, 64-QAM), with MDO4000B [15]	2.4 GHz: -44 dB; 5.8 GHz: –43 dB ; (RMS-EVM averaged over 20 bursts, 16 symbols each)

14 SEM is specified with noise reduction and at least 30 averages for 802.11a/n/ac signals in 5 GHz band. Residual noise performance of the MDO4000B may exceed SEM mask at frequency above 5.85 GHz

15 Signal input power optimized for best EVM

WLAN IEEE802.11n (Opt. SV24)

General characteristics

Modulation formats	SISO, OFDM (BPSK, QPSK, 16 or 64QAM)
Measurements and displays	Burst Index, Burst Power, Peak to Average Burst Power, IQ Origin Offset, Frequency Error, Common Pilot Error, Symbol Clock Error, RMS and Peak EVM for Pilots/Data, Peak EVM located per Symbol and Subcarrier Packet Header Format Information Average Power and RMS EVM per section of the header WLAN Power vs Time, WLAN Symbol Table, WLAN Constellation Spectrum Emission Mask [16], Spurious Error Vector Magnitude (EVM) vs Symbol (or Time), vs Subcarrier (or Frequency) Mag Error vs Symbol (or Time), vs Subcarrier (or Frequency) Phase Error vs Symbol (or Time), vs Subcarrier (or Frequency) WLAN Channel Frequency Response vs Symbol (or Time), vs Subcarrier (or Frequency) WLAN Spectral Flatness vs Symbol (or Time), vs Subcarrier (or Frequency)
Typical residual EVM - 802.11n (40 MHz QAM) with MDO4000B [17]	–41 dB typical (5.8 GHz); -42 dB (2.4 GHz), RMS-EVM averaged over 20 bursts, 16 symbols each

WLAN IEEE802.11ac (Opt. SV25)

General characteristics

Modulation formats	SISO, OFDM (BPSK, QPSK, 16/64/256QAM)
Measurements and displays	Burst Index, Burst Power, Peak to Average Burst Power, IQ Origin Offset, Frequency Error, Common Pilot Error, Symbol Clock Error, RMS and Peak EVM for Pilots/Data, Peak EVM located per Symbol and Subcarrier Packet Header Format Information Average Power and RMS EVM per section of the header WLAN Power vs Time, WLAN Symbol Table, WLAN Constellation Spectrum Emission Mask [18], Spurious Error Vector Magnitude (EVM) vs Symbol (or Time), vs Subcarrier (or Frequency) Mag Error vs Symbol (or Time), vs Subcarrier (or Frequency) Phase Error vs Symbol (or Time), vs Subcarrier (or Frequency) WLAN Channel Frequency Response vs Symbol (or Time), vs Subcarrier (or Frequency) WLAN Spectral Flatness vs Symbol (or Time), vs Subcarrier (or Frequency)
Typical residual EVM - 802.11ac(160 MHz 256-QAM) [19]	–37.3 dB (5.8 GHz), RMS-EVM averaged over 20 bursts, 16 symbols each

16 SEM is specified with noise reduction and at least 30 averages for 802.11a/n/ac signals in 5 GHz band. Residual noise performance of the instrument may exceed SEM mask at frequency above 5.85 GHz

17 Signal input power optimized for best EVM

18 SEM is specified with noise reduction and at least 30 averages for 802.11a/n/ac signals in 5 GHz band. Residual noise performance of the instrument may exceed SEM mask at frequency above 5.85 GHz

19 Signal input power optimized for best EVM

General characteristics

Option CON	Provides the Live Link to the MDO4000B
Update rate	< 0.2 /sec (802.11ac EVM, acq BW: 200 MHz, record length: 400 µs)
Programmatic interface	SCPI-compliant command set. Requires installation of Tektronix Virtual Instrument Software Architecture (VISA) drivers

System requirements

Operating systems	Windows 8 x64
	Windows 7 Service Pack 1 x86 or x64
	Windows XP Service Pack 3 x86
Disk space	6 GB free on C: drive
RAM	1 GB (4 GB recommended)

Instruments and file types supported

Instrument family

Oscilloscopes

	File type				
	.WFM	**.ISF**	**.TIQ**	**.IQT**	**.MAT**
Performance: MSO/DPO5000 DPO7000 DPO/DSA/ MSO70000	X		X [20]		
Mixed-domain: MDO4000 & MDO4000B		X	X [21]		
Bench: MSO/ DPO2000/3000 MSO/DPO4000		X			

Real-time signal analyzers

	File type				
	.WFM	**.ISF**	**.TIQ**	**.IQT**	**.MAT**
RSA3000				X	
RSA5000/ 6000			X		X

Other

	File type				
	.WFM	**.ISF**	**.TIQ**	**.IQT**	**.MAT**
3rd party waveforms in MATLAB Level 5 format					X

SignalVu-PC vs. SignalVu

SignalVu for oscilloscopes is a separate product made to run directly on Tektronix performance oscilloscopes. SignalVu directly controls the acquisition settings of the oscilloscopes and automatically transfers data from the oscilloscope acquisition channel to the SignalVu software.

SignalVu-PC runs on a separate PC. Files from oscilloscopes and signal analyzers can be opened and analyzed. SignalVu-PC does not communicate with the acquisition instrument or control its acquisition settings.

20 .TIQ files can be created on performance oscilloscopes with SignalVu installed. SignalVu is a separate product from SignalVu-PC.

21 The MDO RF channel saves waveforms in the .TIQ format. MDO oscilloscope waveforms are stored in .ISF format.

Ordering information

SignalVu-PC Vector Signal Analysis Software is compatible with Windows XP (x86, 32 bit), Windows 7 (x86/x64, 32 or 64 bit), and Windows 8 x64. SignalVu-PC SVE is the base product for SignalVu-PC and is required for all options. SignalVu-PCEDU is a separate version that includes all options for educational institutions.

Purchasing, licensing and activation	SignalVu-PC is available for download at www.tek.com/SignalVu-PC. Purchasers can specify whether to receive the software and activation keys electronically or through physical media. Purchasers of SignalVu-PC receive activation codes for the base software and each option purchased. Activation of purchased licenses requires internet access. In secure applications, activation can be performed on an internet-enabled PC and applied to a secure PC without internet access. SignalVu-PCEDU education licenses require internet access by the PC on which they are installed. Licensing is perpetual and no maintenance contract is offered or required. Licenses can be deactivated and re-applied to a new PC should you need to move the software. Owners of SignalVu-PC and SignalVu-PCEDU can download any bug fixes or enhancements to existing products free of charge. New options with new measurements may become available and upgrades can be purchased to add the new functionality.
Demonstration Version of SignalVu-PC	SignalVu-PC demonstration software is available at www.tek.com/SignalVu-PC . Demonstration licenses can be activated immediately with no internet connection required and are valid for 30 days after activation.

SignalVu-PC-SVE Vector Signal Analysis Software

SignalVu-PC-SVE is required.

Opt. CON	SignalVu-PC live link to the MDO4000B series
Opt. SV23	WLAN 802.11a/b/g/j/p measurement application
Opt. SV24	WLAN 802.11n measurement application (requires opt SV23)
Opt. SV25	WLAN 802.11ac measurement application (requires opt SV24)
Opt. SV2C	Live Link to MDO4000B and WLAN 802.11a/b/g/j/p/n/ac measurements (includes options CON, SV23, SV24 and SV25)
Opt. SVP	Advanced signal analysis (including pulse measurements)
Opt. SVM	General purpose digital modulation analysis
Opt. SVT	Settling time, frequency, and phase
Opt. SVO	Flexible OFDM with support for 802.11a/j/g and 802.16-2044 (fixed WiMAX) modulation types
Opt. SVA	AM/FM/PM modulation and audio measurements
SHIP	Activation keys, software CD, and instructions shipped in hard copy. Activation keys are also e-mailed.
NO SHIP	Software and support materials are downloaded from Tektronix.com and activation keys are e-mailed.

SignalVu-PCEDU Vector Signal Analysis Software, Education Version

SignalVu-PCEDU is required.

SHIP	Activation keys, software CD, and instructions shipped in hard copy. Activation keys are also e-mailed
NO SHIP	Software and support materials are downloaded from Tektronix.com and activation keys are e-mailed

SVCUP SignalVu-PC upgrades

SignalVu-PC-SVE is required.

Opt. SV23	WLAN 802.11a/b/g/j/p measurement application
Opt. SV24	WLAN 802.11n measurement application (requires opt SV23)
Opt. SV25	WLAN 802.11ac measurement application (requires opt SV24)
Opt. CON	SignalVu-PC live link to the MDO4000B series
Opt. SVP	Advanced signal analysis (including pulse measurements)
Opt. SVM	General purpose digital modulation analysis
Opt. SVT	Settling time, frequency, and phase
Opt. SVO	Flexible OFDM with support for 802.11a/j/g and 802.16-2044 (fixed WiMAX) modulation types
Opt. SVA	AM/FM/PM modulation and audio measurements
SHIP	Activation keys, software CD, and instructions shipped in hard copy (activation keys are also e-mailed)
NO SHIP	Software and support materials are downloaded from Tektronix.com and activation keys are e-mailed

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ASEAN / Australasia (65) 6356 3900
Belgium 00800 2255 4835*
Central East Europe and the Baltics +41 52 675 3777
Finland +41 52 675 3777
Hong Kong 400 820 5835
Japan 81 (3) 6714 3010
Middle East, Asia, and North Africa +41 52 675 3777
People's Republic of China 400 820 5835
Republic of Korea 001 800 8255 2835
Spain 00800 2255 4835*
Taiwan 886 (2) 2722 9622

Austria 00800 2255 4835*
Brazil +55 (11) 3759 7627
Central Europe & Greece +41 52 675 3777
France 00800 2255 4835*
India 000 800 650 1835
Luxembourg +41 52 675 3777
The Netherlands 00800 2255 4835*
Poland +41 52 675 3777
Russia & CIS +7 (495) 6647564
Sweden 00800 2255 4835*
United Kingdom & Ireland 00800 2255 4835*

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
Canada 1 800 833 9200
Denmark +45 80 88 1401
Germany 00800 2255 4835*
Italy 00800 2255 4835*
Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90
Norway 800 16098
Portugal 80 08 12370
South Africa +41 52 675 3777
Switzerland 00800 2255 4835*
USA 1 800 833 9200

* European toll-free number. If not accessible, call: +41 52 675 3777

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For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com.

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