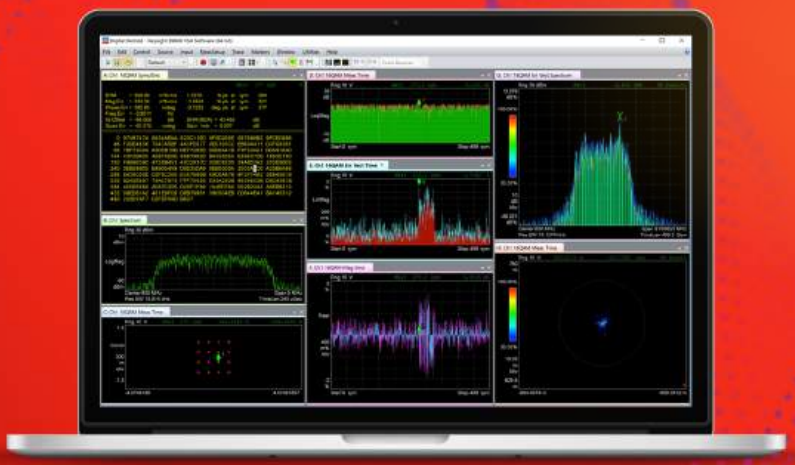
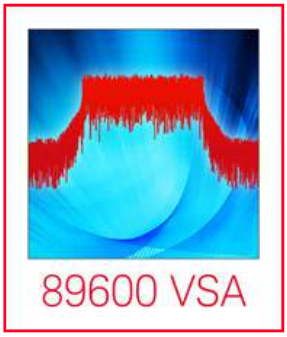


TECHNICAL OVERVIEW

Digital Modulation Analysis 89600 VSA Software

Option 89601AYAC (Replacing 89601B/BN/BK-AYA, BHA and BHK)



- Over 40 digital modulation formats, including PSK, QPSK, QAM, FSK, VSB, custom APSK, SOQPSK
- Over 30 standard communication formats, including GSM/EDGE/EDGE Evolution, Wi-SUN, ZigBee, *Bluetooth*® (Previously support as 89601B/BN/BK-AYA)
- Perform digital modulation analysis on non-standard user defined IQ signals (Previously support as 89601B/BN/BK-BHK)
- Perform TETRA Enhanced Data Services (TEDS) modulation analysis (Previously support as 89601B/BN/BK-BHA)
- Perform Flex Frame modulation analysis with flexible frame structure definition including multiple segments of preamble, pilot, data or idle with different modulation type (for data) or specific training sequence (for preamble or pilot). Users can identify each segment for synchronization, channel estimation, and EVM calculation
- Troubleshoot signals using modulation error analysis tools: EVM, IQ errors, and more
- Identify linear errors with adaptive equalization
- Automate tests with SCPI or .NET programmability

Flexible Vector Modulation Analysis

Option 89601AYAC is designed to analyze a wide range of digital modulations and standards including types as simple as BPSK or as complex as 4096 QAM, with presets for many cellular, wireless networking, and digital video standards as well. Flexible measurement parameter setup, powerful error analysis, including EVM, and insightful displays help explain every aspect of a signal.

The many modulation types in Option 89601AYAC are just some of over 75 signal standards and modulation types supported by the 89600 VSA software. The 89600 VSA software is a comprehensive set of tools for demodulation and vector signal analysis. These tools enable you to explore virtually every facet of a signal and optimize your most advanced designs. As you assess the tradeoffs, the 89600 VSA helps you see through the complexity.

Option 89601AYAC also includes the more flexibility on digitally modulated signal analysis (custom IQ modulation analysis). This capability enables longer symbol length analysis capability with fully IQ map for signal quality measurements.

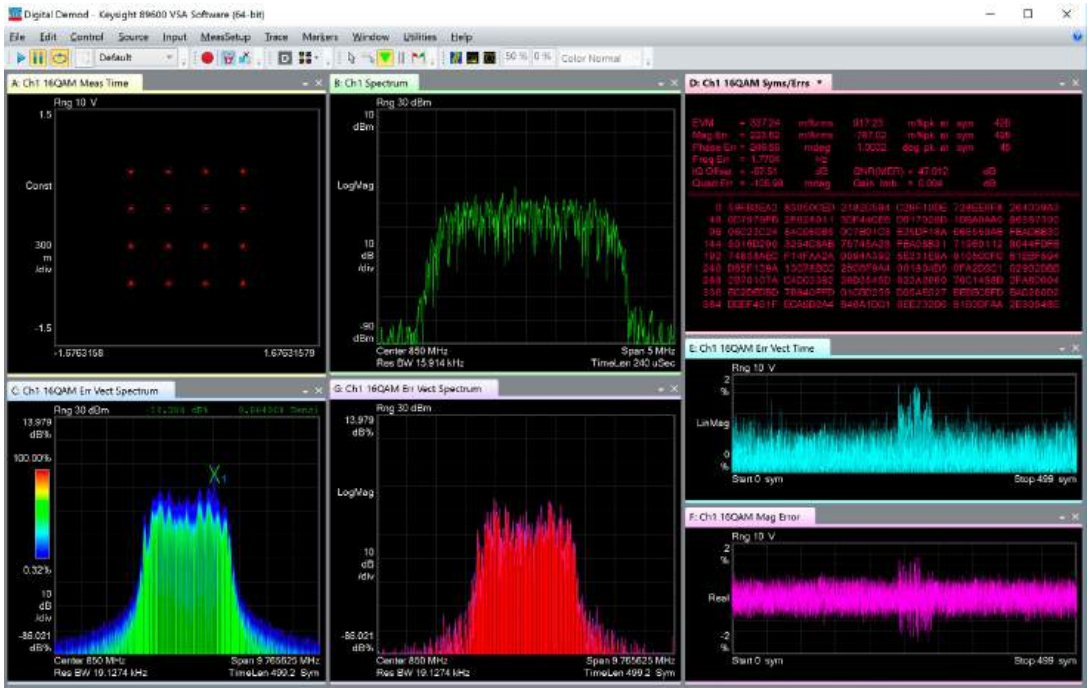


Figure 1: Option 89601AYAC's error measurements combined with insightful displays highlight and identify even transient anomalies for a wide range of modulation formats

Try before you buy!

Download the 89600 software and use it for 30 days to make measurements with your analysis hardware, or use our recorded demo signals which are available by selecting File > Recall > Recall Demo > QPSK (or QAM, DTV, APSK, Zigbee, Custom IQ and TEDS) on the software toolbar. Request your free trial license today:

www.keysight.com/find/89600_trial

Technology Overview

Vector modulation, also referred to as digital or complex, refers to modulation where both amplitude and phase are used simultaneously to carry information on a signal. Common examples are BPSK, QPSK, QAM and their many derivative forms.

Because they use two dimensions to carry information, these systems can transmit more data over the same bandwidth, making them more spectrally efficient. However, this comes at the cost of increasing complexity in system design, test, and build.

Versatile tools are needed to deal with the many inventive ways vector modulation is used. Both phase and amplitude must be acquired and analyzed. The modulation format and symbol rate used are specific to the application, and numerous transmit and receive filter designs exist to minimize spectral splatter.

Analysis and Troubleshooting

Complex modulation formats require modern tools for troubleshooting. Option 89601AYAC provides a rich set of flexible vector modulation displays, useful for everything from examining simulations to measuring prototype hardware's results output. In all cases, error measurements help track down the source of problems in a signal.

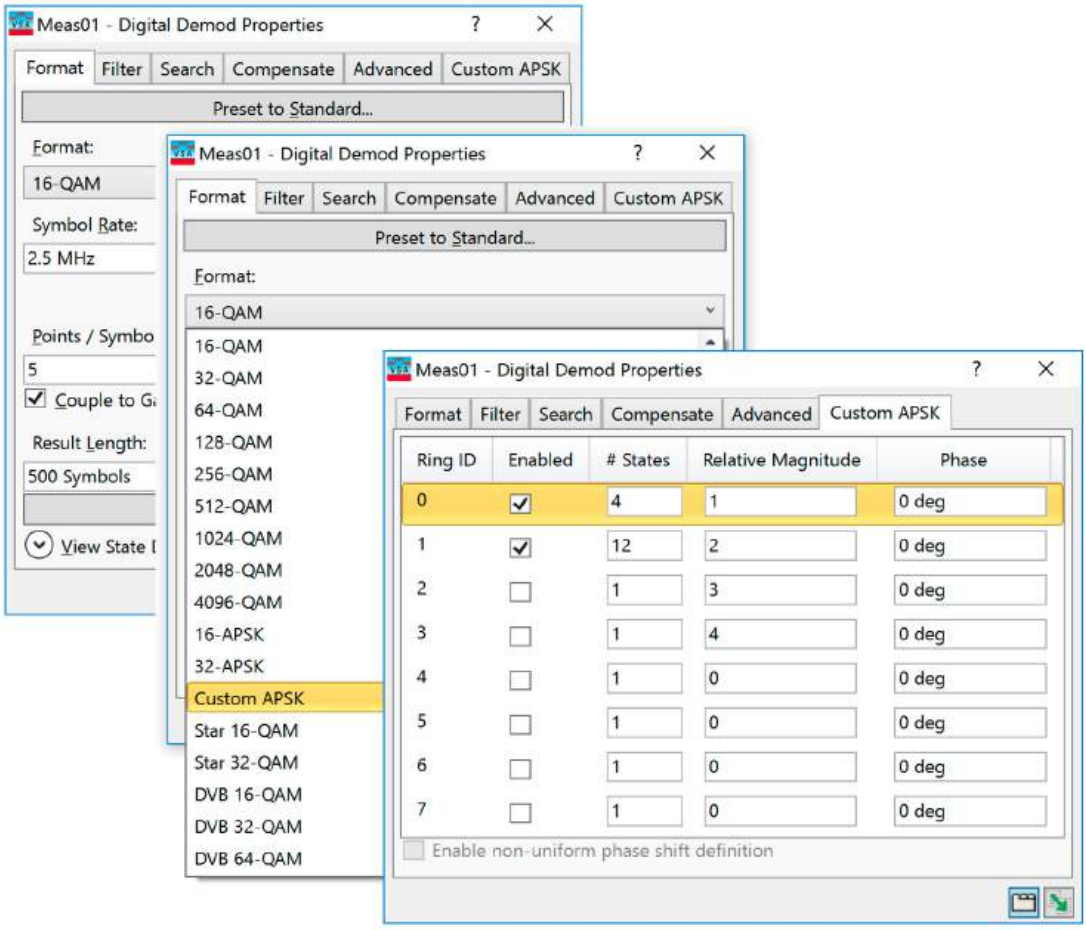


Figure 2: Flexible digital demodulation lets you adjust many important modulation parameters, and customize your own APSK signal analysis

Advanced Digital Demodulators

Successfully demodulate a signal knowing just the carrier frequency, filter type, and symbol rate; no need for external filtering, coherent carrier signals or symbol-clock timing signals.

Use the custom APSK capability to analyze signal types like on-off keying, 64 APSK as well as non-standard formats. Define a custom constellation based on up to 8 arbitrarily spaced rings and up to 256 points.

Unique Error Analysis Tools

Reveal both RF and DSP problems using error vector magnitude (EVM), error vector spectrum and adaptive equalization.

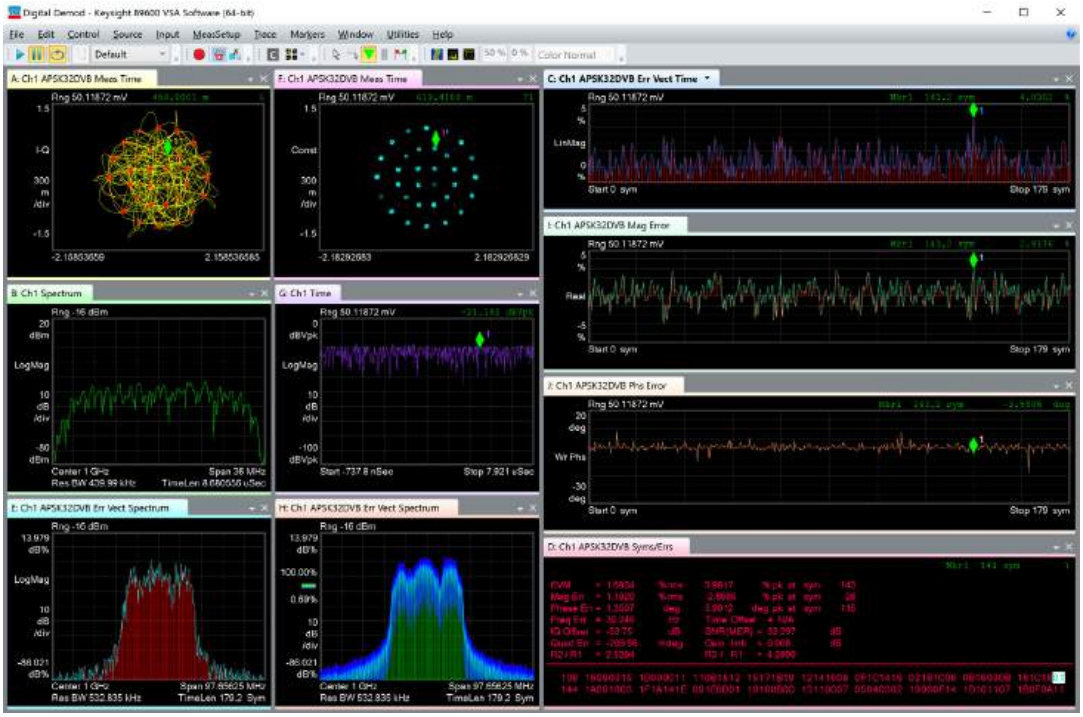


Figure 3: Unlimited traces, with unlimited markers, may be displayed simultaneously, each sized to meet your needs

Error Vector Magnitude

Pinpoint marginal conditions before they become system performance problems using the powerful EVM analysis tool.

- Compare the phase and magnitude of the input signal with an ideal reference signal stream
- View the average error as a single overall number, or on a symbol-by-symbol basis
- Use the EVM time or spectrum measurement to identify systematic
- impairments not visible otherwise

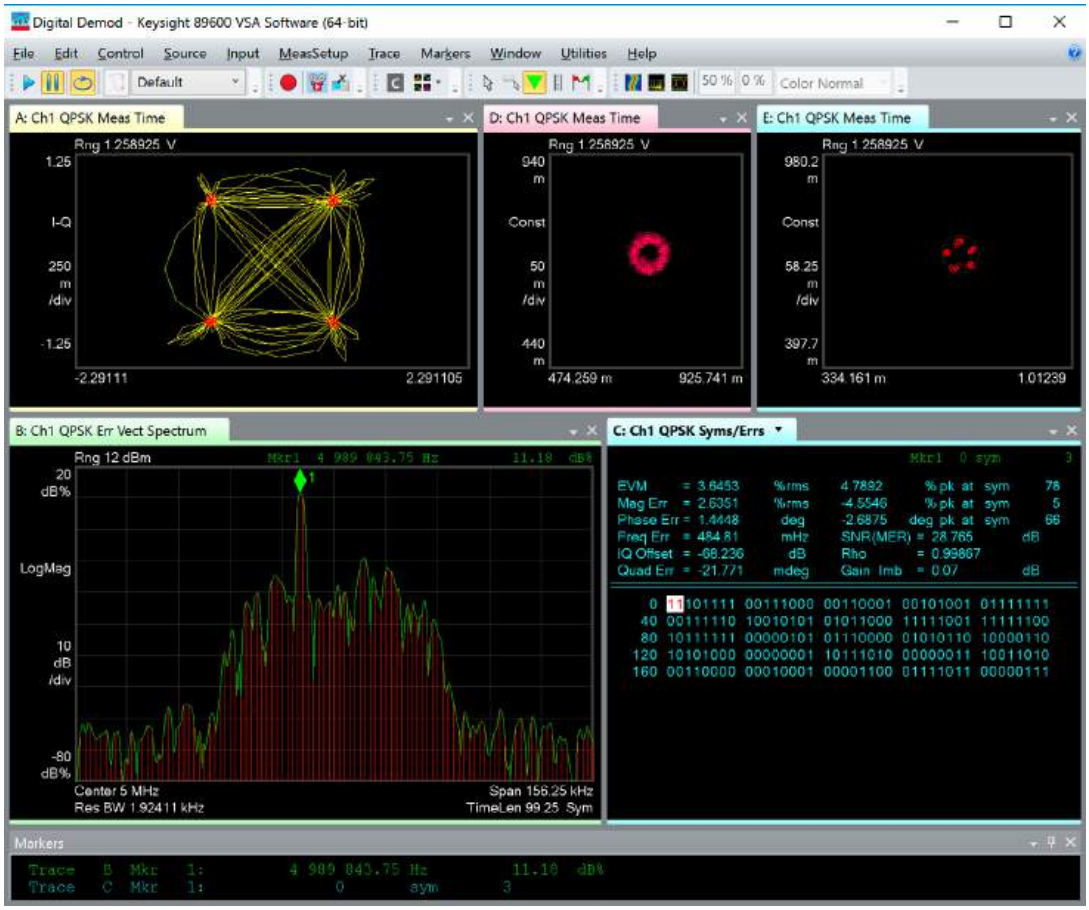


Figure 4: The EVM spectrum measurement shows an interfering signal coupling in from another part of the circuit

Adaptive Equalization

Identify and remove linear errors such as group delay distortion, frequency response errors, and reflections or multi-path distortion from I-Q modulated signals. Uncover DSP errors such as mis-coded bits or incorrect filter coefficients.

Figure 5: The equalizer channel frequency response is used to evaluate multi-path effects, and its impulse response coeffi cients are available for download. When running the equalizer, the Demod Properties window remains conveniently visible for access to the Run/Hold control during tuning

Save and Recall Signals for More Effective Troubleshooting

Capture a signal for later analysis or for comparison with later design iterations. Even if a production line across the world suddenly fails important tests, or you're working with remote design teams, you can analyze the vector signal using Option AYA tools by recording the signal and re-analyzing at your convenience. A player window provides detailed access to the recording. You can also use the stop/play buttons on the main toolbar.

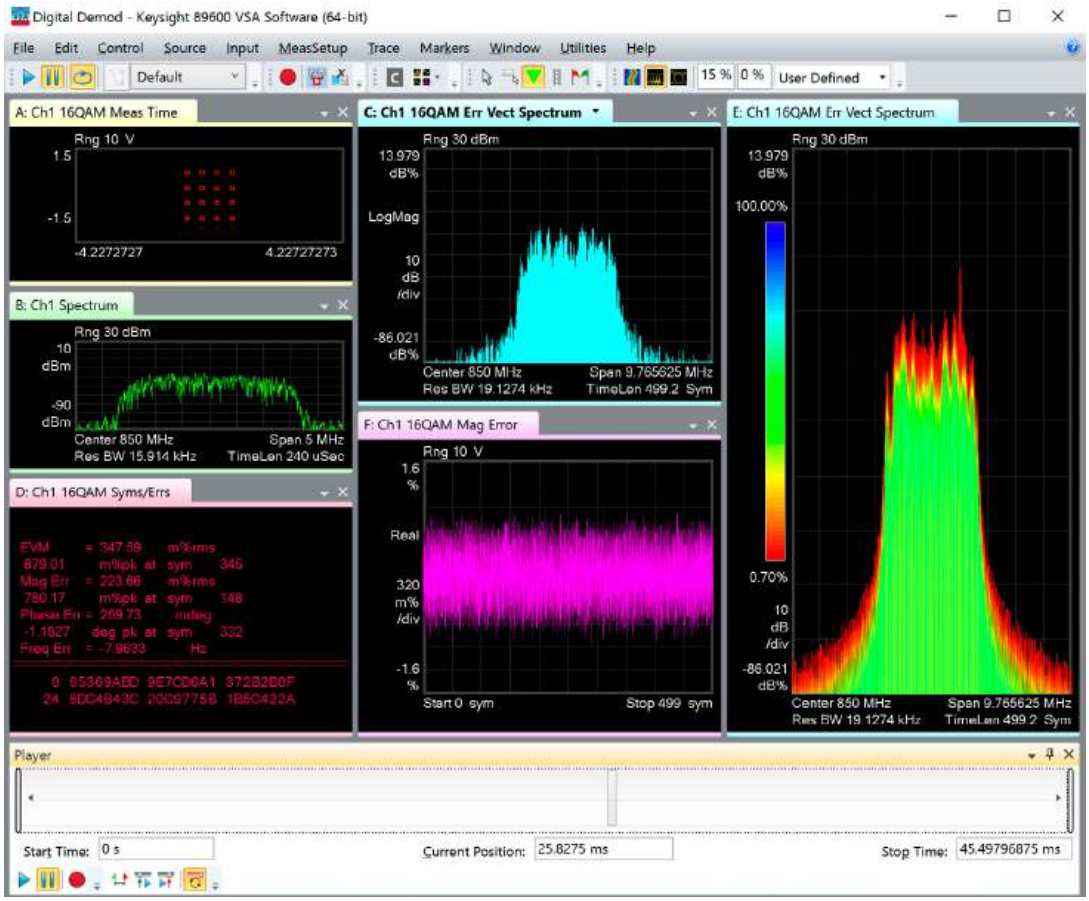


Figure 6: Save a signal and re-analyze it later with the Option AYA tools. Here, the spectrum and constellation appear to be fine. Even the EVM spectrum (trace C) is fine. But the cumulative history display of the EVM spectrum (trace E), which can highlight signal performance over > 500 hours, detects a transient error.

Custom IQ Modulation Analysis

89601AYAC now also supports the more flexible digital modulation analysis based on custom defined IQ signals (Previously support as 89601B option BHK). The right window is a demo for 24QAM signals with the constellation defined by the customer configuration. This is not a normal digital modulation analysis with preset as 16QAM or 32QAM, but you can make this kind of flexible modulation analysis using Custom IQ.

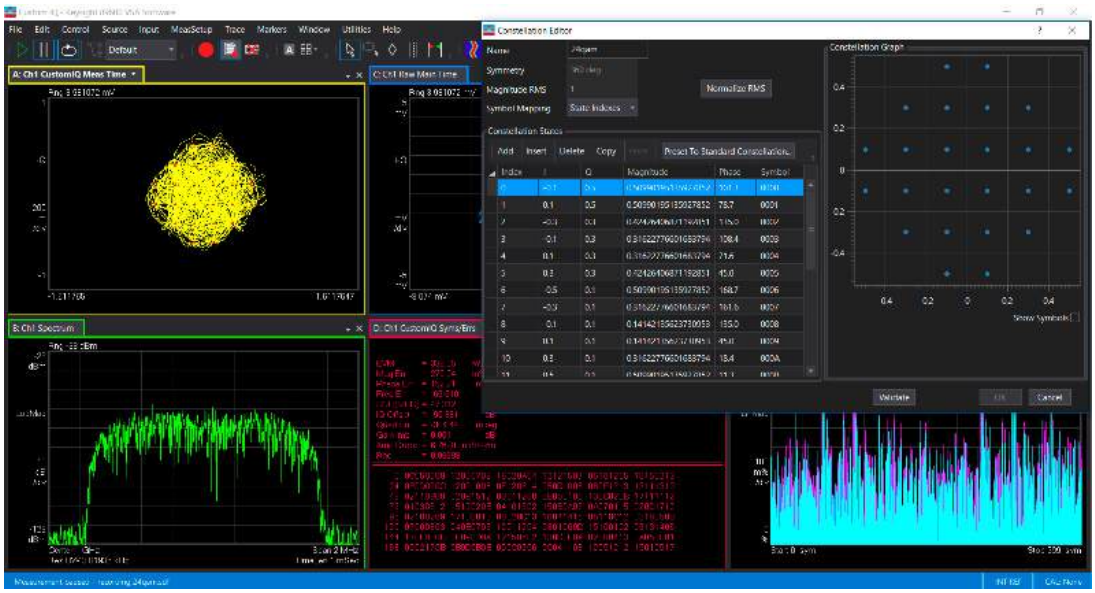


Figure 7: Flexible digital modulation analysis for 24QAM, which is an example under the Custom IQ

TEDS Modulation Analysis

89601AYAC now also supports TEDS (TETRA Enhanced Data Services) modulation analysis (Previously support as 89601B option BHA). The right window is a demo for TEDS CUB signals with 100 kHz bandwidth configuration. Furthermore TEDS measurement also supports slot formats as NUB (Normal Uplink Bandwidth), NDB (Normal Downlink Bandwidth), RAB (Random Access Burst) with bandwidth options of 25 kHz, 50 kHz, 100 kHz or 150 kHz.

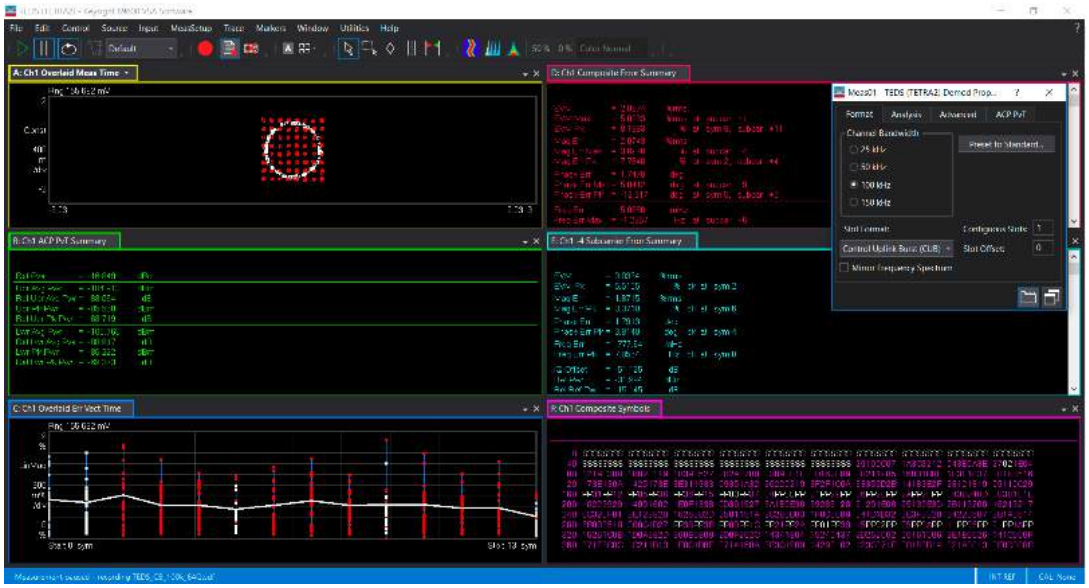


Figure 8: TEDS digital modulation analysis for CUB (Control Uplink Burst) signal with 100 kHz bandwidth

Flex Frame Modulation Analysis

89601AYAC adds more flexible analysis targeting very wideband application like early 6G research and satellite communications. You can define multiple component carriers with one as reference carrier. Flexible frame structure can be defined with multiple segments as Preamble, Pilot, Data, or Idle. Users can identify each segment used for synchronization, channel estimation, and EVM calculation. Demos for 802.11ad, 802.11ay, DVB-S2X, and mixed modulation for Preamble and Data segments are provided which provide you the reference for powerful configurations with Flex Frame measurement.

Figure 9: This picture shows the Enhanced Directional Multi-Gigabit (EDMG) measurement of 802.11ay signal with channel bonding of two 2.16 GHz channels using Flex Frame. It shows how Flex Frame can be used to measure EDMG-STF, EDMG-CEF, guard interval, and data portions of the 802.11ay signals.

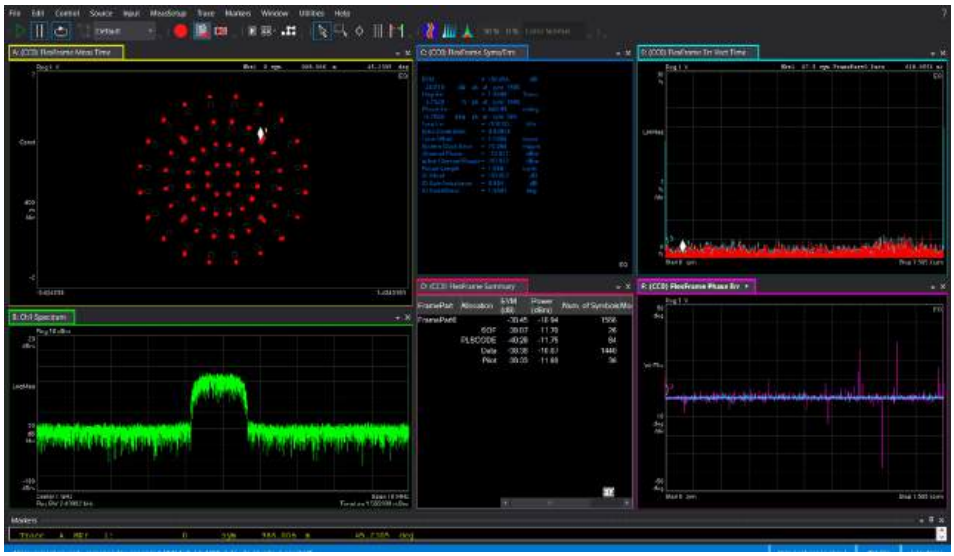


Figure 10: shows the DVB-S2X signal with 32APSK 4+12+16 with 2/3 rate modulation analysis. It shows how Flex Frame can be used to measure DVB-S2X SOF, PLSCODE, data, and Pilot portions of DVB-S2X signals.

Software Features

Signal setup

Signal acquisition	
Number of input channels supported	2, plus dual ch1 + jch2
Carrier lock	Internally generated
Triggering	Single/continuous, external, pulse search (searches data block for beginning of TDMA burst and performs analysis over selected burst length)
Supported data formats	
Carrier types	Continuous, pulsed (burst, such as TDMA)
Modulation formats [1]	FSK: 2, 4, 8, 16 level (including GFSK) MSK (including GMSK) Type 1, Type 2, CPM, BPSK, QPSK, OQPSK, DQPSK, D8PSK, π/4DQPSK, SOQPSK, 8PSK, 3π/8 8PSK (EDGE); π/8 D8PSK; CPM(FM); QAM (absolute encoding): 16, 32, 64, 128, 256, 512, 1024, 2048, 4096; CPM(FM); QAM (differential encoding per DVB standard): 16, 32, 64, 128, 256; Star QAM: 16, 32; APSK: 16, 16 w/DVB, 32, 32 w/DVB; VSB: 8, 16; custom APSK
Data block length [1]	10 to 4,096 symbols, user adjustable
FSK deviation reference	Frequency deviation reference value for FSK signals (automatic or manual)
Samples per symbol	1 to 20, user adjustable
Symbol clock	Internally generated
Maximum symbol rate	Frequency span/(1 + α) (maximum symbol rate doubled for VSB modulation format). Symbol rate is limited only by the measurement span; that is, the entire signal must fit within the analyzer's currently selected frequency span.
State definitions	Recalls state definitions for the current demod format from a .CSD state definitions file; editor available as well.
Single button pre-sets	**EDGE Evolution analysis and pre-set available as separate mode**
Cellular	CDMA (base), CDMA (mobile), CDPD, EDGE, GSM, NADC, PDC, PHP (PHS), W-CDMA
Wireless networking	*Bluetooth* (BR), HiperLAN1 (HBR), HiperLAN1 (LBR), IEEE 802.11b, Wi-SUN (IEEE 802.15.4g), ZigBee 868 MHz, ZigBee 915 MHz, ZigBee 2450 MHz
Digital video	J.83A/DVB-C, J.83B/DOCSIS, J.83C/ISDB-C, DVB-S2 16APSK, DVB-S2 32APSK, ATSC, ATSC-M/H
Other	APCO-25, APCO-25 P2 (HCPM), APCO-25 P2 (HDQPSK), DECT, TETRA, VDL mode 3 MIL-STD 188-181C:CPM (Option 21), SOQPSK-TG (IRIG 106-04), SOQPSK-A, SOQPSK-B

1. For more flexibility with format and longer symbol length, consider Option BHK (custom IQ modulation analysis).

Filtering

Filter types	Raised cosine, square-root raised cosine, IS-95 compatible, Gaussian, EDGE, low pass, rectangular, half-sine (reference filter only, for use with ZigBee), none, user defined, 1REC, 3RC, EDGE (Windowed RC), SOQPSK-TG
Filter length	40 symbols: VSB (any filter α); QAM, DVB-QAM, BPSK, QPSK, DQPSK, 8-PSK, D8PSK, 16-APSK, 16-APSK w/ DVB, custom APSK (filter $\alpha < 0.4$)
	30 symbols: Star 16-QAM, Star 32-QAM, CPM, SOQPSK (any filter α); Offset QPSK (low SNR mode) 20 symbols: all other cases
User-selectable alpha/BT	Continuously adjustable from 0.05 to 10
User-defined filters	Maximum 40 symbols in length or 801 points when alpha < 0.4, maximum 20 symbols or 401 points otherwise

Search parameters

Pulse search	Defined search length in ms or symbols
Constellation synch search	User-selected synchronization words, plus ability to edit search pattern
Search offset	Determines the location of result length within search length

Compensate

Pulse search	Defined search length in ms or symbols
Constellation synch search	User-selected synchronization words, plus ability to edit search pattern
Search offset	Determines the location of result length within search length
Clock adjust	Determines when the analyzer's digital demodulator samples the I/Q trajectory
IQ normalize	Turns normalization on/off; when on, the analyzer normalizes or scales the demodulated trace data results to a nominal value of 1
Mirror frequency spectrum	Allows correct demodulation of frequency spectrums that are mirrored (flipped) about the center frequency
OQPSK align I & Q	On/off; OQPSK only
EVM normalization reference	Allows selection of the normalization value for certain error summary metrics from default Constellation Maximum to Reference RMS

Compensate (Continued)

Adaptive equalization	Removes linear errors from modulated signals by dynamically creating and applying a FIR (feed-forward) compensating filter
Type	Decision directed, LMS, feed forward, equalization with adjustable convergence rate
Filter length	Sets the length of the analyzer's equalization filter; 3-99 symbols, odd values only
Filter taps	1, 2, 3, 4, 10 or 20 taps/symbol
Convergence	Determines the rate at which the equalization filter converges
Run/hold	"Run" reshapes the equalization filter after each subsequent measurement; "hold" keeps the filter at the current values
Reset equalizer	Resets the equalization filter to a unit impulse response
Measurement results provided	Equalizer impulse response, channel frequency response
Supported modulation formats	All supported modulation formats, except FSK and GSM/EDGE/EDGE Evolution

Advanced

APSK ring ratios	Sets ring ratios for DVB 16 APSK and 32 APSK formats
CPM auto {h1,h2}	Sets the value of the modulation indexes, H1 and H2, for CPM signals
StarQAM R2/R1	Determines the Ring 2 to Ring 1 ratio for StarQAM format measurements
Low SNR enhancement	Enables additional filtering of the frequency and phase estimates during the synchronization part of demod for many digital demod formats

Custom APSK

Signals	Defined by constellation states on concentric rings (ex. on-off keying, high-order PSK)
Parameters	Maximum of 256 states arranged on up to 8 concentric rings

GSM/EDGE/EDGE Evolution setup provided as part of Option 89601AYAC

Standard supported	3GPP TS 45.912
	3GPP TS 45.001
	3GPP TS 45.002
	3GPP TS 45.003
	3GPP TS 45.004
	3GPP TS 45.005
	3GPP TS 51.021
GSM/EDGE/EDGE Evolution format	
Preset to standard	Sets default format parameters; manual setting available
Burst type	Sync (SCH); Normal (TCH & CCH); HSR (TCH & CCH); Mixed (NB/HB); Access (RACH)
Burst sync mode	Training Seq (TSC); RF Amp; Polar Mod; None
TSC Index	Auto select or manual, 0-7
Modulation scheme	Auto select or manual: GMSK, 8PSK (EDGE), 16QAM, 32QAM, HSR QPSK, HSR 16QAM, HSR 32QAM
Discard non-matching slots	Yes, no
HSR pulse shape filter	Narrow, wide; only for HSR, Access bursts
GSM/EDGE/EDGE Evolution time	
Search length	Length of time acquired by the analyzer over which pulse search is performed; sec or slots
Time slot	Auto select or manual, 0-7
GSM/EDGE/EDGE Evolution advanced	
Normal symbol rate	Specifies the symbol rate for normal (not HSR) signals
High symbol rate	Specifies the symbol rate for HSR signals
Burst search threshold	Specifies the relative threshold from the peak power level, which is used to determine the burst rising and falling edges
IQ constellation type	Determines constellation displayed: meas filtered only; meas and complementary filtered; derotated meas and complementary filtered

Custom IQ modulation analysis

Signal settings	
Quick setup	QPSK, 16QAM, 32QAM, 64QAM, 128 QAM, 256QAM, 1024QAM, 8QAM-v29, 16AM-v29
Constellation	Customized definition with I, Q, magnitude, phase and symbol settings
Measurement results	
Raw main time	Raw data read from the input hardware or playback file before time corrections and resampling, but including filter settling time
IQ meas time	Result of resampling the data to an integer number of points per symbol and applying carrier/symbol locking, IQ origin offset and optional amplitude droop compensation, system gain normalization, and filtering to the input signal

Custom IQ modulation analysis (Continued)

Measurement results (Continued)	
Spectrum	Averaged frequency spectrum of the data from the time trace; derived from pre-demodulated time data, which is 25% longer than the timeslot that is demodulated
Err vector spectrum	Shows the time-domain error vector trace data results
Error vector time	Error vector trace data results for each symbol
Symbol/Errors	Error summary table show EVM, IQ errors, frequency errors, and more
Demod bits	Table including demodulated symbol bits
Eq Impulse Response	The equalizer is ON, the Eq Impulse Response trace shows the impulse response of the equalization filter
PDF/CDF/CCDF	Shows the probability distribution function (PDF), cumulative distribution function (CDF) or complementary cumulative distribution function (CCDF) of the signal from the time trace
ccEVM	Shows the cross-correlated EVM results (requires 89601EVMC)

TEDS modulation analysis

Signal settings	
Channel bandwidth	25 kHz, 50 kHz, 100 kHz or 150 kHz
Slot format	NUB (Normal Uplink Burst), NDB (Normal Downlink Burst), RAB (Random Access Burst) or CUB (Control Uplink Burst)
Modulation type	M-4QAM (QPSK), M-16QAM, or M-64QAM
Analysis subcarrier	Subcarrier from left -24 to -1 and right +1 to +24
Measurement results	
Overlaid meas time	Shows all subcarrier symbols, overlaid on an ideal symbol pattern with circles for data symbols and cross-marks for sync and pilot symbols
Overlaid err vector time	Shows error vector time for all the TEDS subcarriers corresponding to your channel bandwidth setting, on a symbol-by-symbol basis
PvT time	Shows a non-complex time display with time = 0 aligned to the first symbol
ACP lower/upper PvT	Shows the power in the lower or upper adjacent channels versus time
ACP PvT summary	Shows the adjacent channel powers for both the upper and lower channels
Composite error summary	Shows quality metrics for the composite TEDS signal (all valid TEDS subcarriers). You can choose which symbols to include in the calculation using the Include Sync/ Pilot Symbols and Include Header Symbols settings plus the effects of droop using Include Droop and also Pilot Tracking
Subcarrier error summary	Shows an error summary for one specific TEDS subcarrier
Composite symbols	displays all the symbols for the selected slot format (Normal Downlink, Normal Uplink, Random Access, and Control Uplink)

Flex Frame modulation analysis

Signal settings	
Demo for early 6G and Satellite Communication	802.11ad_SC_Data, 802.11ay_Ncb2_EDMG, 802.11ay_Ncb2_PreEDMG, 80211ay_Ncb2_EDMG, 80211ay_Ncb2_preEDMG_Highband, 80211ay_Ncb2_preEDMG_Lowband, 802_15_3d DVB_S2X_16APSK_4_12_rate26_per_45 DVB_S2X_32APSK_4_12_16_rate_2_per_3 QPSK Preamble and 16QAMData 8PSK Preamble and 64QAM Data 16QAM Preamble and 64QAM Data 256QAM Preamble and 1024QAM Data 1024QAM Preamble and 4096QAM Data Mixed Modulation for Sync and Data Scrambled_DVB_S2X_8_APSK_2_4_2_rate_100_per_180 HW_generated_DVB_S2X_64_APSK_8_16_20_20_rate_7_per_9 Idea_DVB_S2X_16_APSK_4_12_rate_26_per_45 Idea_DVB_S2X_32_APSK_4_12_16_rate_2_per_3
Reference carrier	Sets the carrier to be used as the reference carrier
Component carrier	Add multiple carriers with different settings of absolute center and offset
Frame Type	**Burst**: the demodulator firstly does a burst search using power thresholding **Periodic**: the demodulator doesn't perform a burst search and tries to find the beginning of the frame using the sync segments
Symbol Rate	Sets the frame symbol rate in Hz
Frame Length	Sets the length of the frame in number of symbols
Frame Configuration	Specify the name, the type from Preamble, Data, Pilot or Idle and Power Boot
Frame Payload	**Sequence**: PN sequence (PN9/11/15/20/23), Custom (IQ Symbol Sequence or Bit Sequence) or Unknown **Modulation**: selects the allocation's modulation format from BPSK, 16/64/256/1024 QAM, 8-PSK, Pi/2 BPSK, Pi/2-QPSK, Pi/2 16-QAM, DVB-S2/S2X APSK, DVB-S2/S2X Pi/2 BPSK **MODCOD**: For DVB-S2/S2X, this parameter selects the S2X APSK modulation defined in the standard
Frame Location	Specify the location with start symbol, last symbol
Repeat Pattern	Specify the range of active symbol with repeat period
Synchronization source	**Auto**: all allocations with a known sequence (PN or custom IQ/Real sequence) are used for initial synchronization **Customized**: the synchronization checkboxes in the Overall Allocation Control grid are used to determine whether an allocation is used for initial synchronization
Equalization Mode	**Zero-forcing**: equalization filter is inversion of estimated channel response **Last-mean squares**: equalization filter is the filter that will minimize the mean square error at the symbol decision points.

Flex Frame modulation analysis (Continued)

Signal settings (Continued)	
Initial Equalization	Enable or disable the first round channel estimation and compensation for wideband signal ex. pre-6G
Channel Estimation Source	Determines which allocations are used to determine the channel estimate used to equalize the frame as None, Preamble Only, Pilots Only, Preamble and Pilots, Preamble & Pilots & Data, Allocation with Known Sequences, or Customized
Normalized Channel Delay Spread	Sets the expected delay spread of the channel in units of symbols.
Compensate Symbol Clock Error	Enables or disables compensation for measured symbol clock error
Compensate IQ Offset	Enables or disables compensation for measured IQ offset
Compensate IQ Gain Imbalance	Enables or disables compensation for measured IQ imbalance
Use Multi-carrier Filter	Specifies whether to apply a filter to the carrier to filter out adjacent carriers
Show EVM Result in dB	Specifies the EVM units as percentage or dB for all traces.
Points per Symbol	Determines the number of points displayed between symbols for digitally demodulated data.
Results Length	this setting defines the number of symbols used to compute measurement results shown in the IQ traces, Error traces, and Time trace
Measurement Filter	Specifies the filter to apply to the time data before demodulation
Reference Filter	Specifies the filter to apply to the reference signal that is created based on the input signal
Alpha/BT	Determines the filter characteristics of the filters used by Flex Frame
EQ Length	The Length parameter sets the length of the VSA's equalization filter
Measurement results	
Carrier Summary	Shows the settings for each component carrier with center frequency, offset, Symbol Rate, EVM, Channel Power, Frequency Error, Symbol Clk Error, Mag Error, Phase Error and BER
Frame Summary	This trace shows the EVM, power, number of symbols and modulation format and BER of each frame part
IQ Meas Time	IQ Meas Time is the data result for the measured input signal
IQ Reference Time	IQ Ref Time trace data is the data result that would be derived from an ideal input signal(reference signal)
Spectrum	Spectrum is the averaged Instantaneous spectrum trace. If averaging is OFF, the Spectrum and InstSpectrum displays are identical.
Error Vector Time	Shows the time-domain error vector trace data results.
Syms/Errs	Shows the error information including EVM, Mag Error, Phase Err, Freq Err, Sync Correlation, Time Offset, System Clock Error, Channel Power, Active Channel Power, Results Length, IQ Offset, IQ Gain Imbalance, IQ Quad Skew
Demod Bits	Table including demodulated symbol bits

Measurement Results

Not including GSM/EDGE/EDGE Evolution

Pre-demodulation (vector) trace results	
Auto-correlation	Correlation of a signal with itself
CCDF	Complementary cumulative density function
CDF	Cumulative density function of the measurement data used for demodulation
Correction	Displays frequency domain correction applied to raw measured time data
Gate Time	Portion of the main time-record to be used by the FFT function
Instantaneous main time	Entire time record used by the FFT function, without averaging
Instantaneous spectrum	Frequency spectrum of time trace; always un-averaged
Main time	Time record used by the FFT function
PDF	Probability density function
PSD	Power spectral density showing the power density of a signal as a function of frequency
Raw main time	Block of time data acquired by the hardware, including additional time samples for filter settling, with no time-domain corrections or re-sampling
Spectrum	Frequency spectrum of the time trace, including any averaging selected
Marker	Shows detailed summary tables of occupied bandwidth (OBW) or adjacent channel power (ACP) data of selected trace
Demod trace results	**Not including FSK**
Channel frequency response	Frequency response of adaptive equalizer on the given channel
Correction	Correction curve used to correct for the frequency response of the input hardware and input digital filtering
Eq impulse response	Impulse response of the adaptive equalizer
Error vector spectrum	Spectrum of the error vector time trace after windowing and FFT are applied
Error vector time	Difference between the IQ measured vector time and the IQ reference vector time
Instantaneous error vector spectrum	Unaveraged error vector spectrum trace
Instantaneous IQ meas spectrum	Unaveraged IQ measured spectrum trace
Instantaneous IQ ref spectrum	Unaveraged IQ reference spectrum trace
Instantaneous spectrum	Unaveraged spectrum trace
IQ mag error	Error between the magnitude of the measured IQ measured signal and the magnitude of the reference signal
IQ meas spectrum	Spectrum of the IQ Meas Time trace
IQ meas time	IQ data results for the measured input signal
IQ phase error	Error between the phase of the measured IQ measured signal and the phase of the reference signal
IQ ref spectrum	Frequency spectrum of the IQ Ref Time trace
IQ ref time	IQ data results that would have been derived for the ideal input signal
Offset EVM	Included on symbols/error table for offset QPSK only

Demod trace results	Not including FSK
Raw main time	Raw data read from the input hardware or playback file without time corrections or resampling
Search time	Acquired time data used to search for analysis timeslot
Spectrum	Averaged Instantaneous Spectrum derived from time data that has been windowed and passed through an FFT
Symbols/Errors	Table including demodulated symbol bits and summary error table containing digital modulation error information specific to each format
Time	Time record before digital demodulation and after pulse search

Measurement results FSK

FSK measurement	Time, spectrum
FSK reference	Time, spectrum
Carrier error	Magnitude
FSK error	Time, spectrum

Measurement results GSM/EDGE/EDGE Evolution

CCDF	Complementary cumulative distribution function for the active part of burst
CDF	Cumulative distribution function for the active part of burst
Correction	Correction data derived by the analyzer from the calibration
Error vector time	Error vector trace data results for each symbol
Instantaneous spectrum	Displays unaveraged frequency spectrum of the time trace data
IQ magnitude error	Magnitude error between the measured and reference IQ signals
IQ measured time	Result of resampling the data to an integer number of points per symbol and applying carrier/symbol locking, IQ origin offset and optional amplitude droop compensation, system gain normalization, and filtering to the input signal
IQ phase error	Phase error between the measured and reference IQ signals
IQ reference time	Data that would be derived from an ideal input signal (reference signal)
PDF	Normalized probability density function histogram of the active part of the burst
Raw main time	Raw data read from the input hardware or playback file before time corrections and resampling, but including filter settling time
Search time	Shows time-data before pulse search and demodulation
Spectrum	Averaged frequency spectrum of the data from the time trace; derived from pre-demodulated time data, which is 25% longer than the timeslot that is demodulated
Subchannel A symbols	Raw data bits for each symbol in subchannel A
Subchannel B symbols	Raw data bits for each symbol in subchannel B
Summary	Error summary table show EVM, IQ errors, frequency errors, AM/PM skew, and more
Symbols	Table containing raw data bits for each symbol where the first bit in the table corresponds to the first bit of the first symbol in the demodulated timeslot
Time	Time data of the slot that was demodulated
Marker	Shows detailed summary tables of occupied bandwidth (OBW) or adjacent channel power (ACP) data of selected trace

Display Formats

The following trace formats are available for measured data and computed ideal reference data, with complete marker and scaling capabilities and automatic grid line adjustment to ideal symbol and constellation states.

Polar diagrams	
Constellation	Samples displayed only at symbol times
Vector	Display of trajectory between symbol times with 1 to 20 points/symbol
I-Q versus time	
I or Q only	Continuous versus time
Eye diagram	Adjustable from 0.1 to 40 symbols
Trellis diagram	Adjustable from 0.1 to 40 symbols
Error vector magnitude	Continuous versus time
Errors table	Measurements of modulation quality made automatically and displayed by the symbol/error trace type. RMS and peak values
Formats other than FSK	Error vector magnitude, magnitude error, phase error, frequency error (carrier offset frequency), I-Q/origin offset, amplitude droop (PSK and MSK formats), SNR (8/16 VSB, 8PSK and QAM formats), quadrature error, gain imbalance For VSB formats: VSB pilot level is shown in dB relative to nominal. SNR is calculated from the real part of the error vector only. For DVB formats: EVM is calculated without removing IQ offset
FSK format	FSK error, magnitude error, carrier offset, frequency deviation, frequency deviation offset, zero crossing error, symbol clock error
Symbols table (detected bits)	
Table information	Bits are displayed in binary and grouped by symbol. Multiple pages can be scrolled for viewing large data blocks. The symbol marker (current symbol shown in inverse video) is coupled to measurement trace displays to identify states with corresponding bits. For modulation formats other than DVBQAM and MSK, bits are user-definable for absolute or differential symbol states [1].

1. Synchronization words are required to resolve carrier phase ambiguity in non-differential modulation formats.

Key Specifications [1]

This technical overview provides nominal performance specifi cations for the software when making measurements with the specified platform. 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 appropriate measurement platform specifications guide.

X-Series signal analyzers

Accuracy		PXA	MXA	EXA	CXA	BBIQ 2
Conditions	Modulation formats include BPSK, D8PSK, DQPSK, QPSK, (16/32/64/128/256/512/1024) QAM, (16/32/64/128/256) DVBQAM, π/4-DQPSK, 8-PSK. EVM normalization reference set to Constellation Maximum. Transmit filter is Root Raised Cosine with alpha=0.35. Center frequency 1 GHz. Signal amplitude of –16 dBm, analyzer range set to –10 dBm. Result length set to at least 150 symbols, or 3×{Number of ideal state locations}. RMS style averaging with a count of 10. Phase noise optimization adjusted based on symbol rate of measurement. Available span dependent on analyzer hardware bandwidth options.					
Residual errors	**Symbol rate/Span**					
Residual EVM	1 Msps/5 MHz	≤ 0.5% rms	≤ 0.7% rms	≤ 0.7% rms	≤ 0.7% rms	≤ 0.5% rms
	10 Msps/25 MHz	≤ 0.5% rms	≤ 0.7% rms	≤ 0.7% rms	≤ 0.9% rms	≤ 0.5% rms
	25 Msps/40 MHz	≤ 0.7% rms	≤ 1.1% rms	≤ 1.1% rms	—	≤ 0.6% rms
	100 Msps/160 MHz	≤ 1.0% rms	≤ 1.3% rms	—	—	—
Magnitude error	1 Msps/5 MHz	≤ 0.4% rms	≤ 0.5% rms	≤ 0.5% rms	≤ 0.5% rms	≤ 0.5% rms
	10 Msps/25 MHz	≤ 0.5% rms	≤ 0.5% rms	≤ 0.5% rms	≤ 0.6% rms	≤ 0.5% rms
	25 Msps/40 MHz	≤ 0.6% rms	≤ 0.8% rms	≤ 0.8% rms	—	≤ 0.6% rms
	100 Msps/160 MHz	≤ 0.9% rms	≤ 1.0% rms	—	—	—
Phase error	1 Msps/5 MHz	≤ 0.5° rms	≤ 0.6° rms	≤ 0.6° rms	≤ 0.7° rms	≤ 0.6° rms
	10 Msps/25 MHz	≤ 0.6° rms	≤ 0.6° rms	≤ 0.6° rms	≤ 0.8° rms	≤ 0.6° rms
	25 Msps/40 MHz	≤ 0.6° rms	≤ 1.1° rms	≤ 1.1° rms	—	≤ 0.6° rms
	100 Msps/160 MHz	≤ 1.0° rms	≤ 1.3° rms	—	—	—
Frequency error	Added to frequency accuracy if applicable	≤ Symbol rate/500,000				
I-Q/ origin offset 2		≤ –60 dB				
Conditions	Modulation formats include MSK and MSK2. Transmit filter is Gaussian with BT=0.3. Center frequency 1 GHz. Signal amplitude of –16 dBm. Analyzer range set to –10 dBm. Result length set to 150 symbols. RMS style averaging with a count of 10. Available span dependent on analyzer hardware bandwidth options.					
Residual errors	**Symbol rate/Span**					
Residual EVM	10 Msps/25 MHz	≤ 0.5% rms	≤ 0.9% rms	≤ 0.9% rms	≤ 1.0% rms	≤ 0.8% rms
	80 Msps/160 MHz	≤ 1.4% rms	≤ 1.8% rms	—	—	—
Phase error	10 Msps/25 MHz	≤ 0.4° rms	≤ 0.5° rms	≤ 0.5° rms	≤ 0.5° rms	≤ 0.5° rms
	80 Msps/160 MHz	≤ 1.3° rms	≤ 1.3° rms	—	—	—

1. Data subject to change.
2. I+jQ measurements performed using signal amplitude and analyzer range near 0 dBm, with a 0 Hz center frequency. I/Q origin offset metric does not include impact of analyzer DC offsets.

	PXA	MXA	EXA	CXA
Video modulation formats				
Residual EVM 8/16 VSB	Symbol rate = 10.762 MHz; alpha = 0.115; frequency < 3.6 GHz; 7 MHz span, full-scale signal, range ≥ –30 dBm, result length = 800, averages = 10			
	≤ 1.5% (SNR ≥ 36 dB)			
Residual EVM 16, 32, 64, 128, 256, 512, or 1024 QAM	Symbol rate = 6.9 MHz; alpha = 0.15; frequency < 3.6 GHz; 8 MHz span, full-scale signal, range ≥ –30 dBm, result length = 800, averages = 10			
	≤ 1.0% (SNR ≥ 40 dB)	≤ 1.0% (SNR ≥ 40 dB)	≤ 1.0% (SNR ≥ 40 dB)	≤ 1.0% (SNR ≥ 36 dB)
GSM/EDGE/EDGE Evolution mode formats				
Accuracy	Signal within 2 dB of full scale signal range; span = 1 MHz; RMS averages = 20			
• EVM	≤ 0.25%	≤ 0.5% (≤ 0.4%) [2]	≤ 0.5% [2]	≤ 0.5%
• Frequency accuracy	≤ 0.5 Hz	≤ 1 Hz (≤ 0.2 Hz) [1]	≤ 1 Hz [2]	≤ 1 Hz
• Frequency accuracy	± 400 kHz	± 400 kHz (± 400 kHz) [1]	± 400 kHz [2]	± 400 kHz

1. MXA Option BBA result.
2. Results valid for EXA with Option B25.

Ordering Information

Software licensing and configuration

Flexible licensing and configuration

- **Perpetual:** License can be used in perpetuity.
- **Subscription:** 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)

Digital demodulation analysis (89601AYAC)

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.

Additional Resources

Literature

- 89600 VSA Software - Brochure, literature number 5990-6553EN
- 89600 VSA Software - Configuration Guide, literature number 5990-6386EN
- Basic Vector Signal Analysis and Hardware Connectivity 89600 VSA Software Option 89601200C - Technical Overview, literature number 5992-4210EN
- Digital Modulation in Communications Systems — An Introduction - Application Note, literature number 5965-7160E

Web

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

Keep your 89600 VSA up-to-date

With rapidly evolving standards and continuous advancements in signal analysis, the 89600 VSA software with valid 89601200C and 89601AYAC KeysightCare support subscription can offers you the advantage of immediate access to the latest features and enhancements available for the 89600 VSA software. Refer the VSA Configuration Guide (5990-6386EN) for more details.

You can upgrade!

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

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

Keysight now launches the new 89600 VSA software as 89601C after September 2019 as version 2019 update 1.0, the existing 89601B customers can continue to use 89601C software with valid license 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