Digital Modulation Analysis 89600 VSA Software

Option 89601AYAC for Digital Demodulation Analysis

Option 89602AYAC for Flex Frame Generation

Key Features

- Support over 30 digital modulation formats, including BPSK, QPSK, QAM (16 to 4096QAM), OQPSK, DQPSK, D8PSK, DVB-QAM, FSK, MSK, CPM, VSB, APSK, custom APSK, SOQPSK, EDGE, and more
- Support over 75 standard communication formats for cellular, wireless connectivity, digital video, and others, including CDMA, GSM/EDGE, NADS, PDC, PHP, W-CDMA, WLAN, Wi-SUN, ZigBee, Bluetooth®, DVB-C, DOCSIS, DVB-S2, ATSC, ATSC-M/H, APCO, TERTRA, DECT, VDL, MIL-STD, SOQPSK, and more
- Perform digital modulation analysis on non-standard user-defined IQ signals with Custom IQ modulation analysis
- Perform TETRA Enhanced Data Services (TEDS) modulation analysis
- Perform Flex Frame modulation analysis with basic mode or advanced mode, which supports more flexible frame structure definition, including multiple segments of preamble, pilot, data, or idle with different power, modulation type, sequence, and scrambling for each segment
- Support ideal waveform generation using the same Flex Frame modulation analysis settings. The user can also apply pre-distortion and/or AWGN, then output as a playback recording in VSA, save to file (*.mat unencrypted waveform), or directly download to signal generator (requires 89602AYAC)
- Support cross-correlated EVM (ccEVM) and IQ Noise Correction (IQ-NC) technologies with Flex Frame measurement to improve the EVM performance (requires 89601EVMC)
- 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

KEYSIGHT

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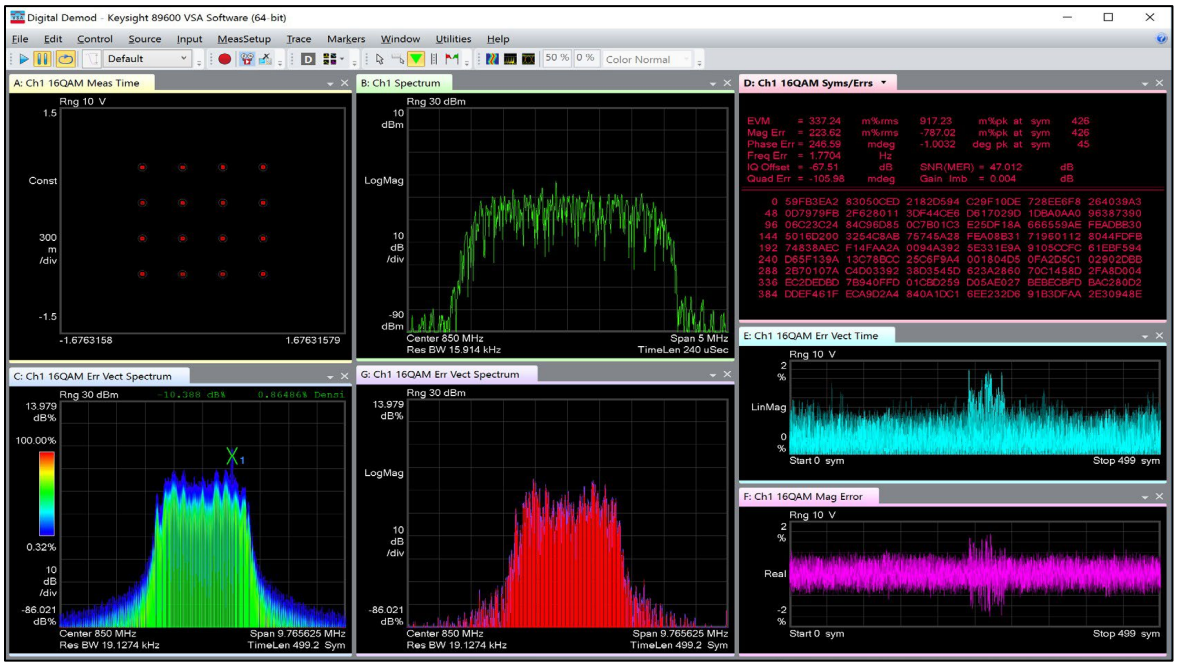
Flexible Vector Modulation Analysis

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, digital video and other 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.

Furthermore, option 89601AYAC also supports more flexibility on digitally modulated signal analysis with custom IQ or Flex Frame modulation analysis measurements. Custom IQ measurement can enable longer symbol length analysis capability with fully IQ map for signal quality measurement. Flex Frame measurement can support more flexible and complex frame structure definition, including multiple segments of preamble, pilot, data, or idle.



30-day Trial License

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.

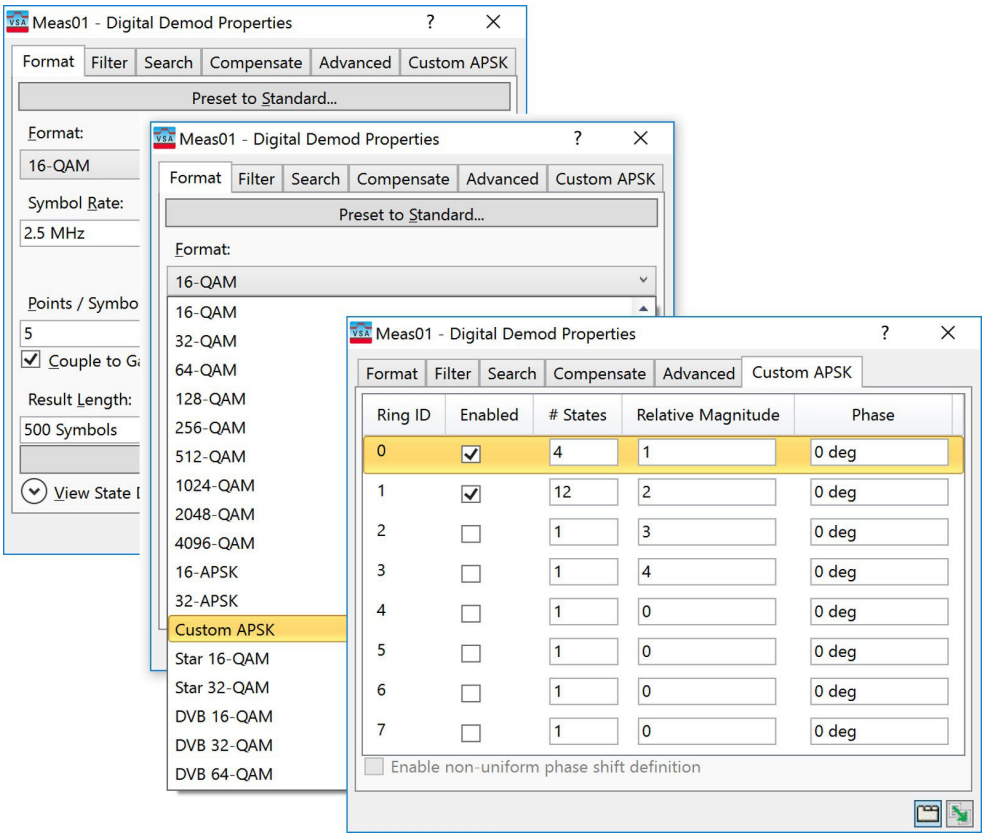


Figure 2. Flexible digital demodulation lets you adjust many important modulation parameters and customize your own APSK signal analysis.

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.

Ubique Error Analysis Tool

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

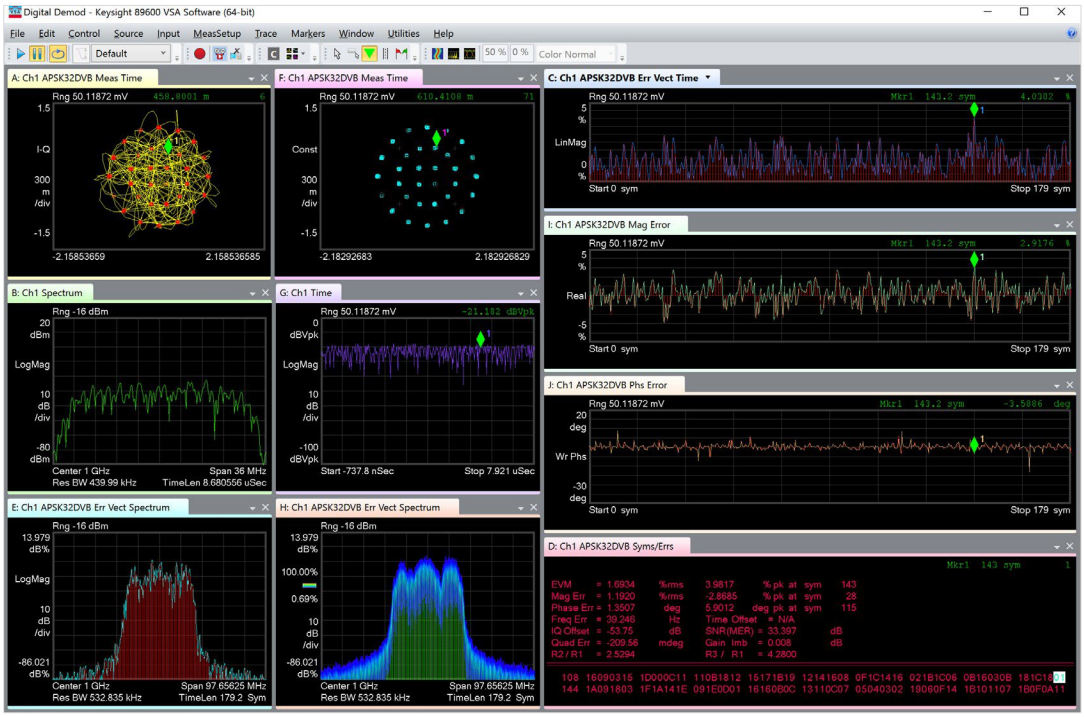


Figure 3. Unlimited traces, with unlimited markers, may be displayed simultaneously, each sized to meet your needs

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

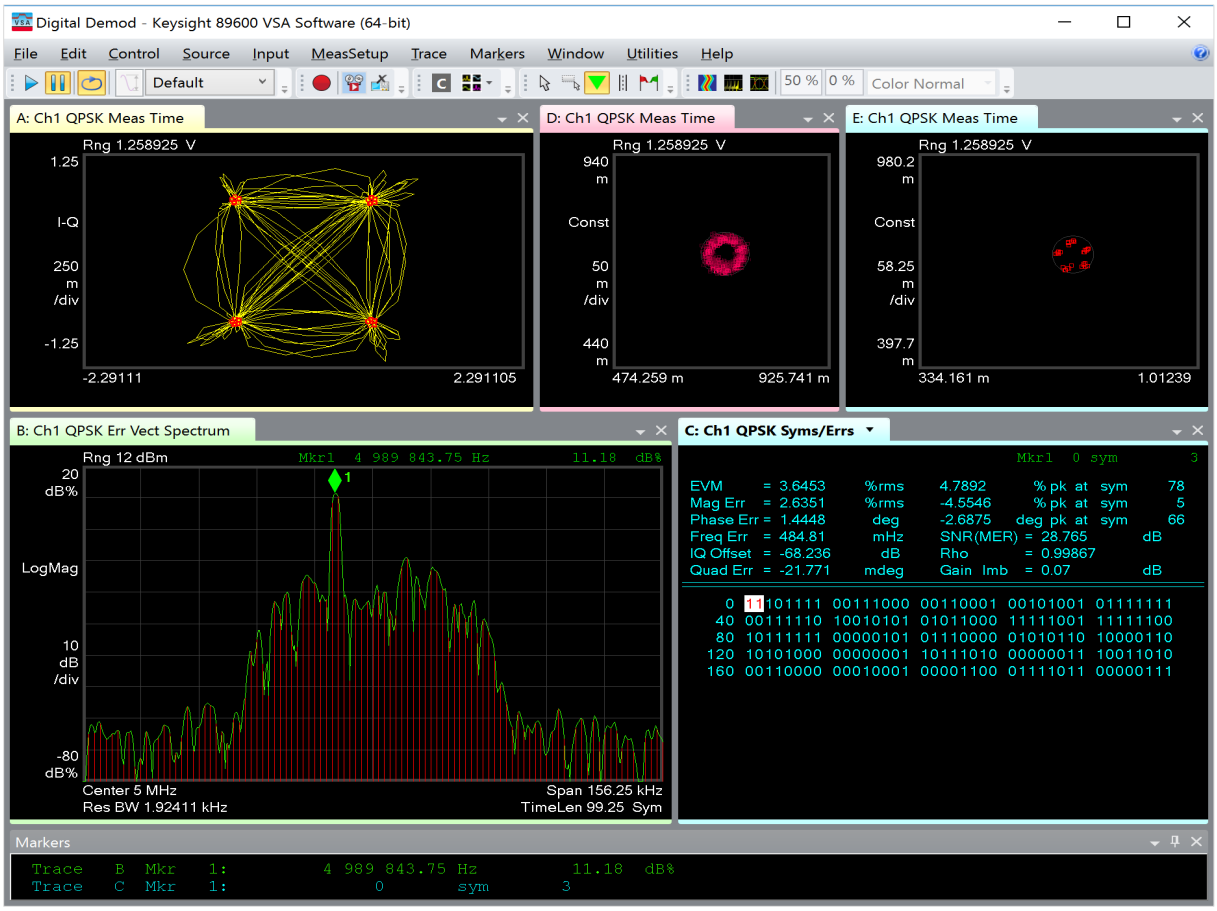


Figure 4. The EVM spectrum measurement shows an interfering signal coupling in from another part of the circuit

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.

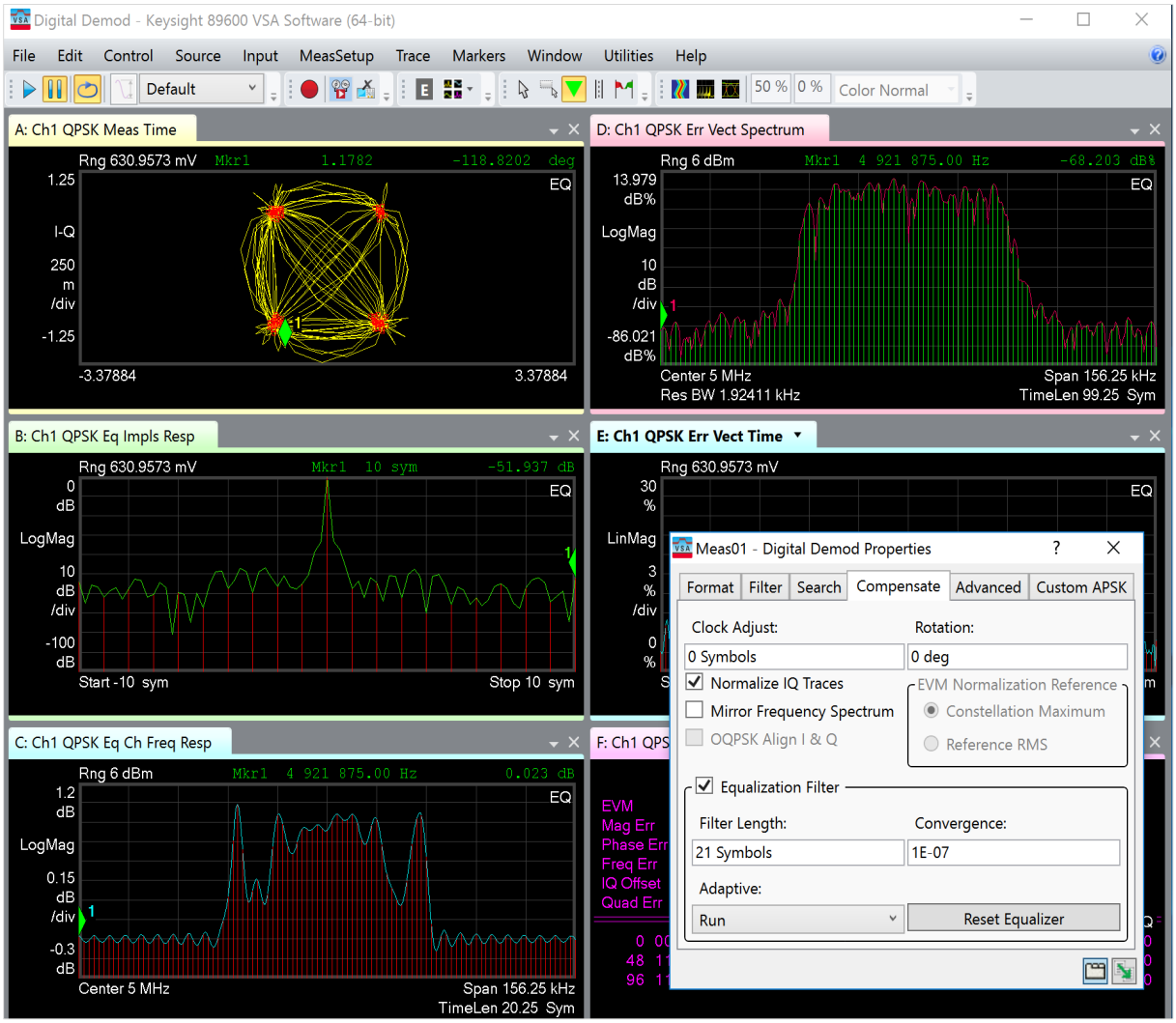


Figure 5. The equalizer channel frequency response is used to evaluate multi-path effects, and its impulse response coefficients are available for download. When running the equalizer, the Demod Properties window remains conveniently visible for access to the Run/Hold control during tuning.

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.

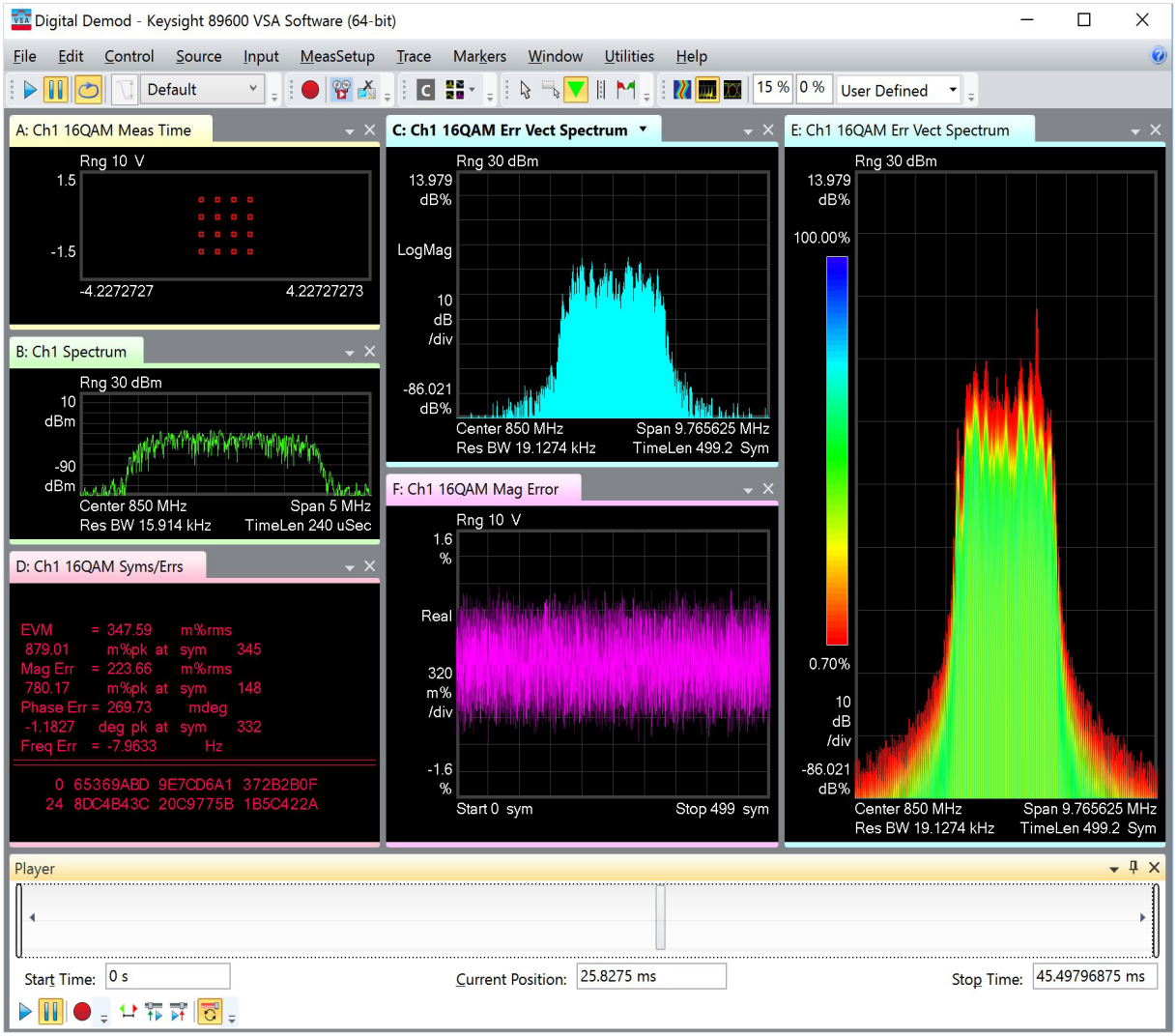


Figure 6. Save a signal and re-analyze it later with the Option AYA tools. Here, the spectrum and constellation appear to be fine. Even the EVM spectrum (trace C) is fine. But the cumulative history display of the EVM spectrum (trace E), which can highlight signal performance over > 500 hours, detects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

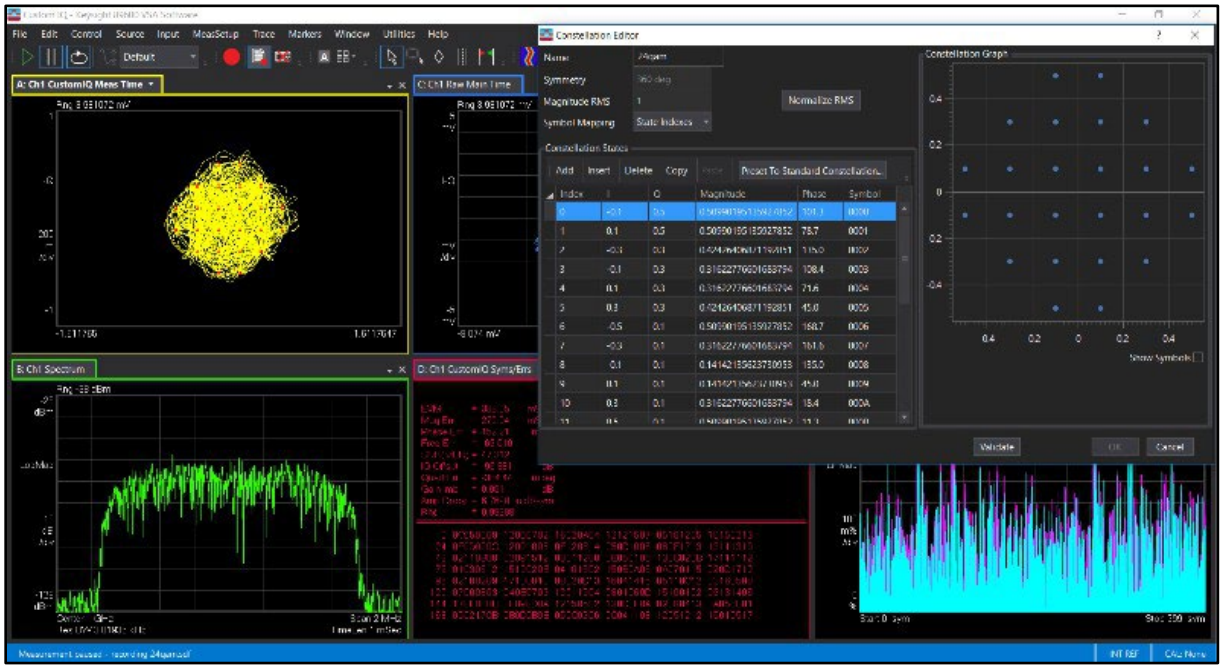


Figure 7. Flexible digital modulation analysis for 24QAM, which is an example under the Custom IQ

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.

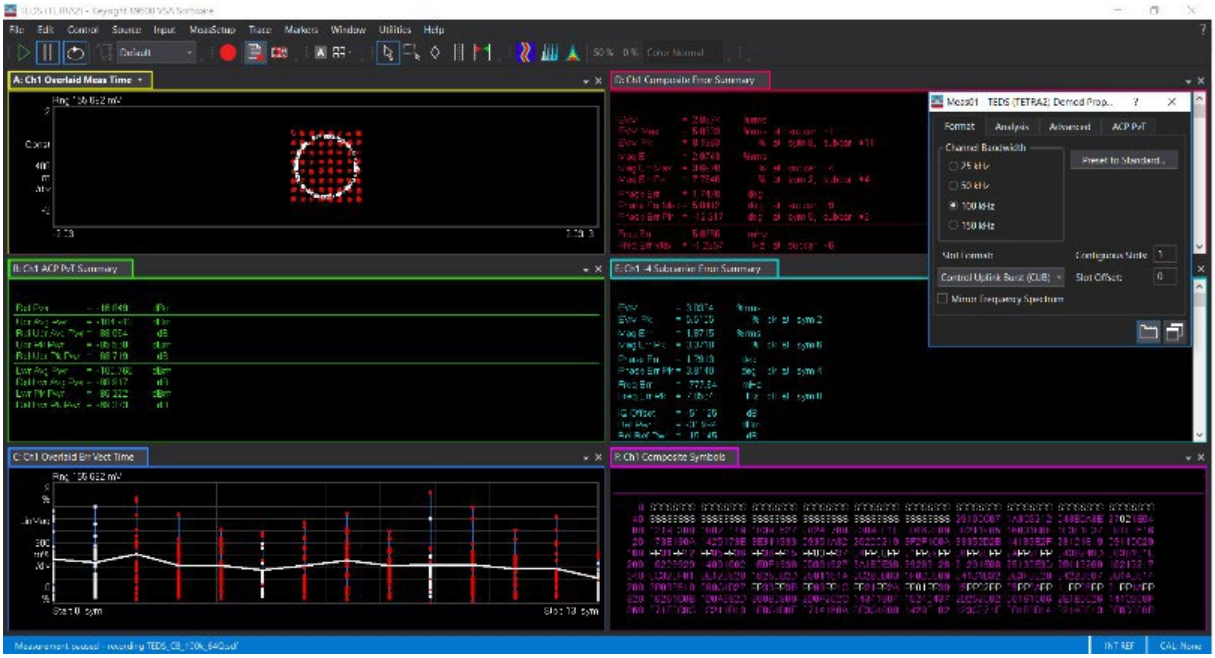


Figure 8. TEDS digital modulation analysis for CUB (Control Uplink Burst) signal with 100 kHz bandwidth

Flex Frame Modulation Analysis

89601AYAC adds more flexible analysis targeting very wideband applications 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.

Furthermore, with VSA2026 release Flex Frame introduces the basic mode which simplify the frame structure as data only similar to the digital demod. Advanced mode provides you the full capability of flexible frame structure as provided previously.

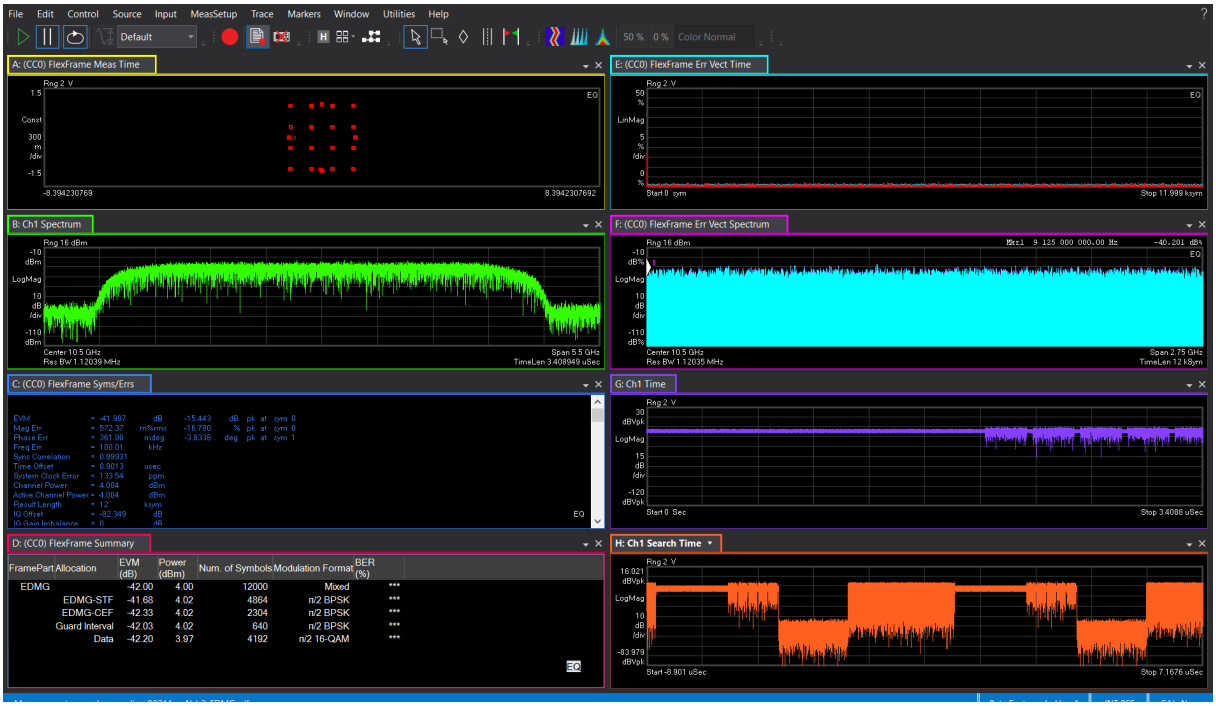


Figure 9. This picture shows the Enhanced Directional Multi-Gigabit (EDMG) measurement of 802.11ay signal with channel bonding of two 2.16 GHz channels using Flex Frame. It shows how Flex Frame can be used to measure EDMG-STF, EDMG-CEF, guard interval, and data portions of the 802.11ay signals.

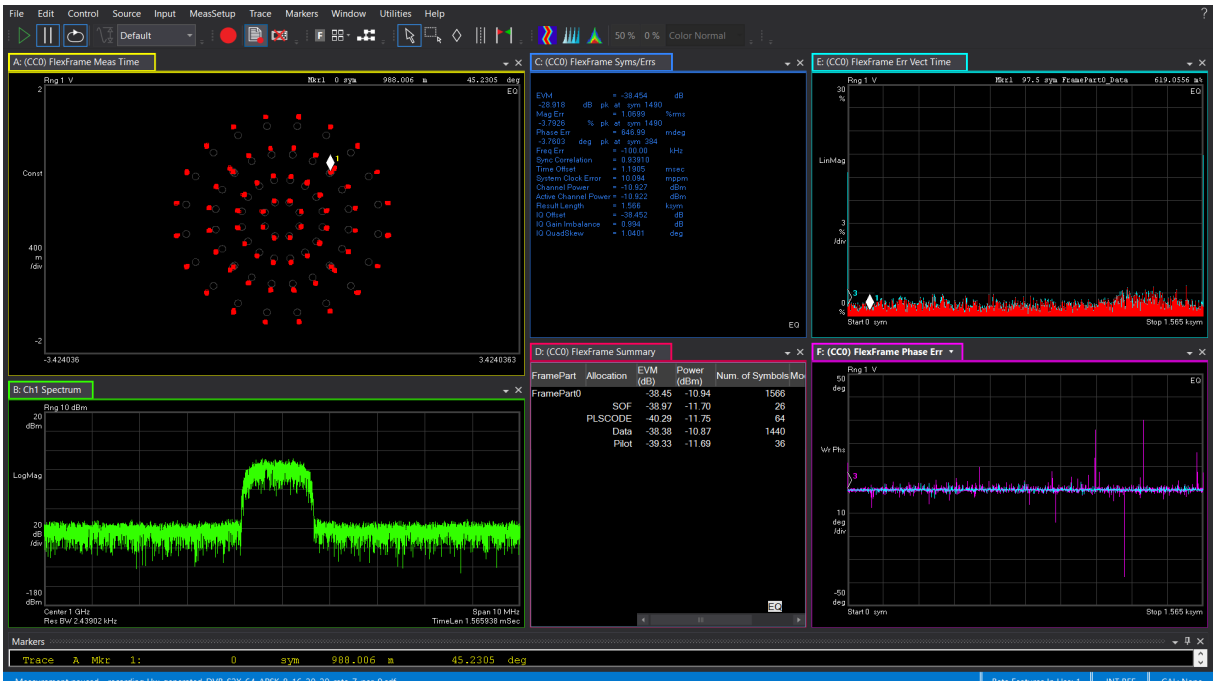


Figure 10. shows the DVB-S2X signal with 32APSK 4+12+16 with 2/3 rate modulation analysis. It show Flex Frame can be used to measure DVB-S2X SOF, PLSCODE, data, and Pilot portions of DVBS2X signals.

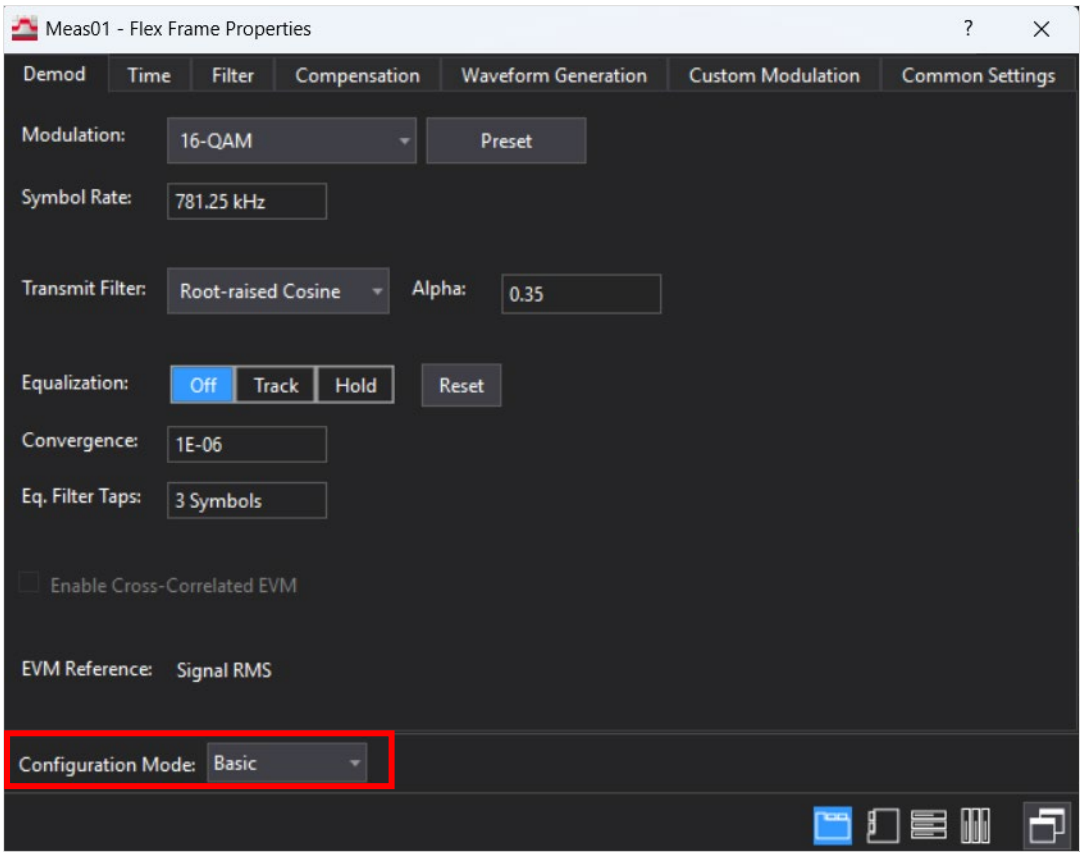


Figure 11. Flex Frame with basic mode is similar to the digital demodulation with simple parameters

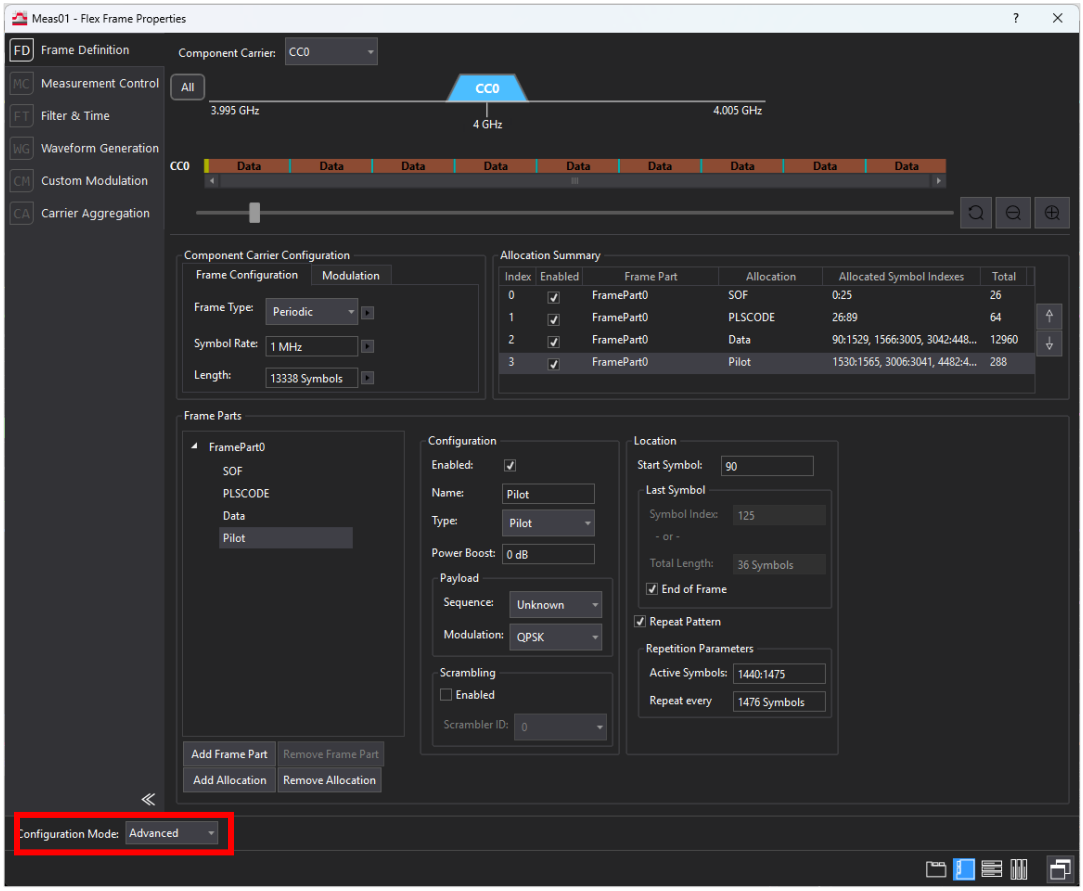
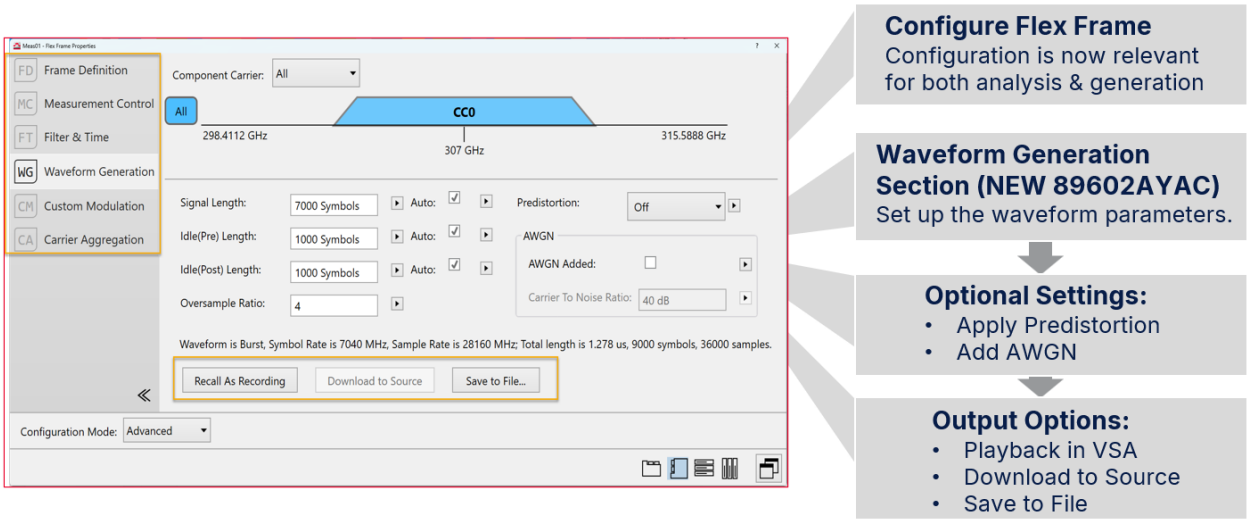


Figure 12. Flex Frame with Advanced mode to support the more flexible frame structure

Flex Frame Waveform Generation

Flex Frame wave generation is a new feature added with VSA2026 release which can allow the user to generate and then analyze IQ signals using the same configuration. This feature requires a new license as 89602AYAC but it will also require the 89601AYAC license as digital demod analysis. Beyond the ideal waveform, you can also apply pre-distortion or AWGN.



The user can apply Predistortion with the ideal waveform which can compensate the waveform for channel flatness using FIR filter based on measured EQ response from Eq correction spectrum trace.

- Off – No predistortion applied
- Measured channel – predistortion is applied to the ideal waveform

The user can also apply AWGN to the generated Flex Frame waveform. You can setup the Carrier to Noise Ratio (CNR) as the ratio of active signal power to noise power. The noise will be applied across the entire signal either active or inactive part.

Finally the user can specify the flexible output with three options for the generated Flex Frame waveform

- Recall as Recording – allow you to play generated waveform as recording so it can work even without passing the signal source
- Download to Source – allow you to send the generated waveform to the specified signal source like M9484C VXG, N5186A MXG, M8198/99A AWG, PXI VXT etc
- Save to File – allow you to export generated waveform saving as supported file as MATLAB file

Software Features

Signal Setup

Feature	Description
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.
Signal Acquisition	
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 custom IQ modulation analysis.

Filtering

Feature	Description
Signal Acquisition	
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 Triggering	40 symbols: VSB (any filter α); QAM, DVB-QAM, BPSK, QPSK, DQPSK, 8-PSK, D8PSK, 16-APSK, 16-APSK w/DVB, custom APSK (filter α < 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

Feature	Description
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

Feature	Description
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
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	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
Adaptive equalization	Removes linear errors from modulated signals by dynamically creating and applying a FIR (feedforward) 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
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

Feature	Description
APSK ring ratios	Sets ring ratios for DVB 16 APSK and 32 APSK
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

Feature	Description
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 Preset

Feature	Description
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

Feature	Description
Signal Settings	
Quick setup	QPSK, 16QAM, 32QAM, 64QAM, 128 QAM, 256QAM, 1024QAM, 8QAM-v29, 16AM-v29, 8PSK
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
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
Demod bits	Table including demodulated symbol bits
Eq impulse response	The equalizer is ON, the Eq Impulse Response trace
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-
ccEVM	Shows the cross-correlated EVM results (requires 89601EVMC)

Flex Frame modulation analysis

Feature	Description
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.
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
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
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
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

TEDS Modulation Analysis

Feature	Description
Signal Settings	
Channel bandwidth	25 kHz, 50 kHz, 100 kHz or 150 kHz
Slot format	(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)

Measurement results for FSK

Feature	Description
Measurement Results	
FSK measurement	Time, spectrum
FSK reference	Time, spectrum
Carrier error	Magnitude
FSK error	Time, spectrum

Measurement results GSM/EDGE/EDGE Evo

Feature	Description
Measurement Results	
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 magnitude 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.

Feature	Description
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 (EVM)	Continuous versus time
Error 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
Symbol 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.

Flex Frame Waveform Generation (89602AYAC)

Feature	Description
Configuration mode	Basic, advanced
Component carrier	All; CC0, CC1 ...
Signal Settings	
Signal length	1000 symbols (default)
Idle (Pre) length	1000 symbols (default)
Idle (Post) length	1000 symbols (default)
Oversampling	4 (default)
Predistortion	
Predistortion	Off, measured chanel
AWGN	
AWGN added	Off, On
Carrier to noise ratio	40 dB (default) or manual input
Output	
Recall as recording	Recording is used for Flex Fram analysis
Download to source	Source as selected
Save to file	*.mat (unencrypted waveform)

Key Specification

This technical overview provides nominal performance specifications 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]
Signal Acquisition						
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 [1]	**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	≤0.6% 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 [1]	**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.

Ordering Information

Software Licensing and Configuration

Flexible Licensing and Configuration

Perpetual: License can be used in perpetuity.

Subscription (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

Licenses Ordering Information

Option	Title	Description
89601200C (Legacy) 89601201C/89601202C/89601203C (New)	Basic vector signal analysis and hardware connectivity	(One Required) This option provides the foundational vector signal analysis functionality and hardware connectivity necessary for WLAN signal analysis.
89601201C (or 89601200C)	Basic vector signal analysis and hardware connectivity	Advanced vector signal analysis all-inclusive with no frequency, bandwidth limits, up to 64 channels.
89601202C	Basic vector signal analysis and hardware connectivity	Standard vector signal analysis up to 55 GHz center frequency, 2.16 GHz bandwidth, and up to 4 channels support.
89601203C	Basic vector signal analysis and hardware connectivity	Essentials tier up to 8 GHz center frequency, 160 MHz bandwidth, single measurement channel and VSA instance.
89601AYAC	Digital demodulation analysis	Demodulate captured IQ signal with Digital Demod, Custom IQ, or Flex Frame measurements
89602AYAC	Flex Frame waveform generation	Generate an ideal waveform using Flex Frame settings, apply pre-distortion and/or AWGN, then output as playback in VSA, save to file, or download to signal generator directly
89601EVMC	ccEVM and IQ-NC	Improve EVM measurement through the Cross-Correlated EVM (ccEVM) or IQ Noise Correction (IQ-NC) technologies

Software License Types and Terms

Software License Type	Software License	Support Subscription
Node-locked perpetual	SW1000-LIC-01	SW1000-SUP-01
Node-locked time-based	SW1000-SUB-01	Included
Transportable perpetual	SW1000-LIC-01	SW1000-SUP-01
Transportable time-based	SW1000-SUB-01	Included
Floating perpetual (single site)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (single site)	SW1000-SUB-01	Included
Floating perpetual (regional)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (regional)	SW1000-SUB-01	Included
Floating perpetual (worldwide)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (worldwide)	SW1000-SUB-01	Included
USB portable perpetual	SW1000-LIC-01	SW1000-SUP-01
USB portable time-based	SW1000-SUB-01	Included

For time-based licenses, KeysightCare support is included. For perpetual licenses, KeysightCare support subscription may be purchased using the following model numbers. For example, a one-month

One Month Software Support Subscription Extensions

Support Subscription	Description
SW1000-SUP-01	Perpetual KeysightCare support (1 month to 60 months)
SW1000-B2S	Back to KeysightCare support fee (Perpetual support only, one time fee) Minimum of 12 months required for a renewal

Hardware Configuration

The 89600 VSA software supports more than 45 Keysight hardware platforms. The table below shows the recommended signal analyzer hardware for IEEE 802.11n/ac/ax/be/bn transmitter test. For a complete list of currently supported hardware, please visit:
www.keysight.com/find/89600_hardware

Product	Frequency Range (Option Dependent)	Internal Analysis Bandwidth
X-Series Signal Analyzers		
N9042B UXA	Up to 75 GHz	Up to 4 GHz
N9042B+V3050A	Up to 110 GHz	Up to 4 GHz
N9041B UXA	Up to 110 GHz	Up to 1 GHz
N9040B UXA	Up to 50 GHz	Up to 1 GHz
N9032B PXA	Up to 55 GHz	Up to 2 GHz
N9030B PXA	Up to 50 GHz	Up to 510 MHz
N9021B MXA	Up to 50 GHz	Up to 510 MHz
N9020B MXA	Up to 50 GHz	Up to 160 MHz
N9010B EXA	Up to 44 GHz	Up to 40 MHz
Modular Product		
M9415A/16A VXT PXIe Vector Transceiver	Up to 12 GHz per channel	Up to 1.2 GHz per channel
M9410A/11A VXT PXIe Vector Transceiver	Up to 6 GHz per channel	Up to 1.2 GHz per channel

M9421A VXT PXIe Vector Transceiver	Up to 6 GHz per channel	Up to 160 MHz per channel
Wireless Test Set		
E6680A/E6680E Wireless Test Set	6 GHz or 7.3 GHz per channel	Up to 800 MHz per channel

Keep Your 89600 VSA Software Up to Date

With rapidly evolving WLAN standards and continuous advancements in signal analysis, maintaining an active 89600 VSA software license ensures access to the latest features and enhancements.

To stay current, users must have a valid KeysightCare support subscription for one of the following base platform for vector signal analysis and hardware connectivity option:

- Legacy base platform option: 89601200C
- New base platform tiered option: 89601201C, 89601202C, or 89601203C

Only one of the above base platform options (legacy or new) is required. In addition, users can select 89601AYAC analysis capabilities:

- 89601AYAC — Digital Demodulation Analysis (including Digital Demod, Custom IQ, and Flex Frame)
- 89602AYAC — Flex Frame Waveform Generation

Refer to the 89600 VSA Configuration Guide (5990-6386EN) for more details.

Upgrade

All 89600 VSA 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

Hardware configuration

The 89600 VSA software supports more than 45 Keysight hardware platforms including signal analyzers, one-box-testers, and oscilloscopes. For a complete list of currently supported hardware, please visit: www.keysight.com/find/89600_hardware

Upgrade

- All 89600 VSA 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

Additional Resource

Literature

Model Option	Description
5990-6553EN	**89600 VSA Software - Brochure**
5990-6386EN	89600 VSA Software - Configuration Guide
5992-4210EN	Tiered Options 89601200C/201C/202C/203C Basic Vector Signal Analysis & Hardware Connectivity, 89600 VSA Software - Technical Overview
5992-4238EN	Option 89601BHFC Custom OFDM Modulation Analysis – Technical Overview
3121-1438EN	Option 89601PSMC PowerSuite Measurement, 89600 VSA Software – Technical Overview

Web

www.keysight.com/find/89600

www.keysight.com/find/89601AYAC

www.keysight.com/find/89601BHFC

www.keysight.com/find/vsa_trial

www.keysight.com/find/89600_software

www.keysight.com/find/89600_hardware

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.