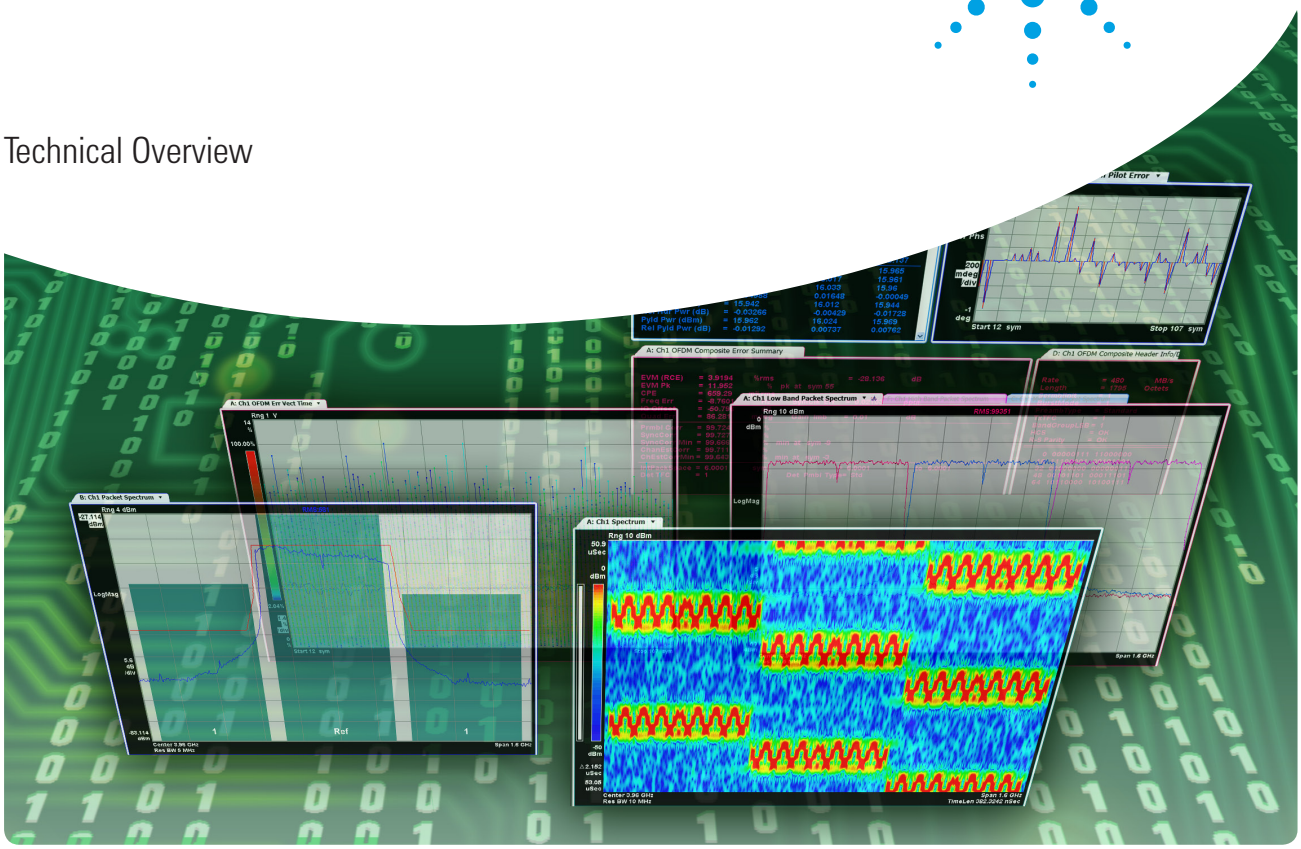
Beginning with release 16.0 of the 89600 VSA software,
Option BHB (UWB Modulation Analysis) will be discontinued.

89601B/BN-BHB MB-OFDM UWB Modulation Analysis
89600B Vector Signal Analysis Software

Technical Overview



Key Features

- Analyze all MB-OFDM ultra-wideband formats
- Capture complete UWB bursts
- Troubleshoot errors down to the individual band, carrier, or symbol
- Measure EVM, CCDF, CPE, frequency error, I/O offset, and more
- Evaluate UWB packets with PSD spectral masks and ACPR
- Gain 20:20 insight—20 traces each with 20 markers

Agilent Technologies

Table of Contents

MB-OFDM UWB Modulation Analysis

The 89600B VSA software with Option BHB multi-band-OFDM modulation analysis offers the advanced measurement tools needed to analyze and troubleshoot the complex wide-bandwidth and time-varying nature of UWB MB-OFDM PHY layer signals. Combined with Infiniium oscilloscopes, Option BHB covers all frequency ranges as defined by the WiMedia Alliance standard. It also analyzes and demodulates any of the ten possible TFCs over any of the band groups, with automatic or manual TFC detection. Test the maximum throughput of the UWB devices, up to 480 Mb/s using the optional higher data rates. For these higher data rate systems, Option BHB supports burst preambles and DCM modulation analysis.

MB-OFDM is just one of over 70 signal standards and modulation types for which the 89600B vector signal analysis (VSA) software creates a window into what's happening inside your complex wireless devices. The 89600B tools provide views of virtually every facet of a problem, helping you see the "why?" behind signal problems. Whether you're working with emerging or established standards, Agilent's industry-leading 89600B VSA software helps you see through the complexity.

Try before you buy!

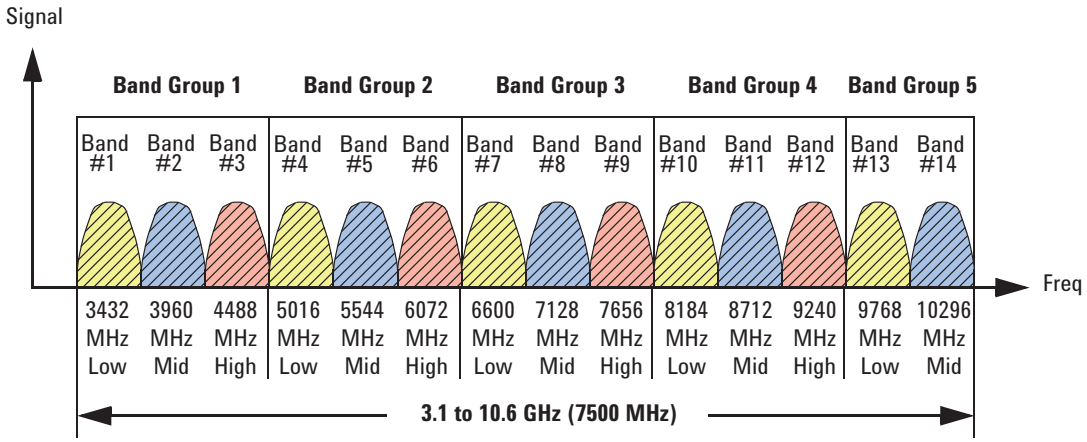
Download the 89600B software and use it free for 14 days to make measurements with your analysis hardware, or use our recorded demo signals by selecting **File > Recall > Recall Demo > MB-OFDM >** on the software toolbar. Request your free trial license today:

www.agilent.com/find/89600B_trial

MB-OFDM UWB technology overview

The WiMedia Alliance defines and supports the ultra-wideband (UWB) common radio platform, which is designed for use in wireless personal area networks (WPAN). The WiMedia Alliance standard defines the physical (PHY) and media access control (MAC) layers for the UWB common radio platform.

Certified Wireless USB, an extension to existing wired USB, uses the WiMedia UWB common radio platform. The wireless USB specification promoted by the WiMedia Alliance is based on Multiband Orthogonal Frequency Division Multiplexing (MB-OFDM). This implementation divides a 7500 MHz spectrum bandwidth into 6 band groups comprised of 14 non-overlapping bands, each 528 MHz wide. Each band provides a carrier frequency for an OFDM baseband signal. To allow for such a large signal bandwidth, there are power restrictions which prevent MB-OFDM devices from disturbing narrower band devices nearby, such as 802.11ab/g radios. Typically, MB-OFDM devices operate within a 10 meter radius.

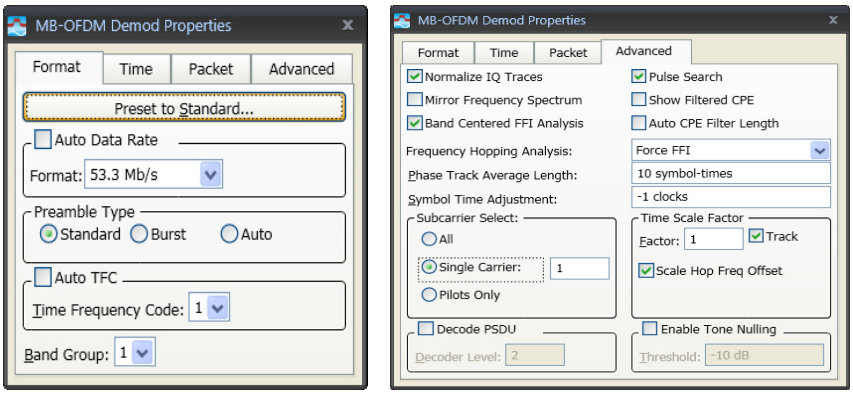


MB-OFDM band groups and bands

Analysis and Troubleshooting

Set up measurements easily

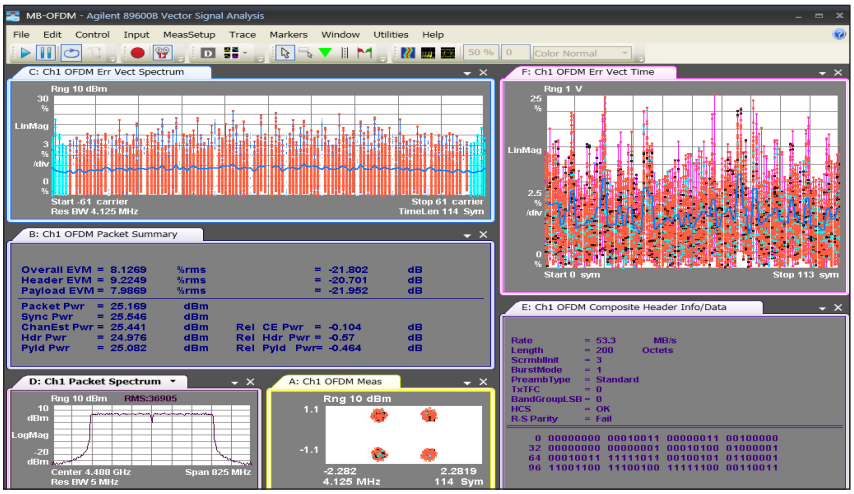
Presets let you choose band groups. Select the TFC or let Option BHB do so automatically, including FFI non-hopped, and TFI and TFI2 hopped modes. The software can also automatically determine data rates, modulation formats, including DCM, and burst or standard preamble type.



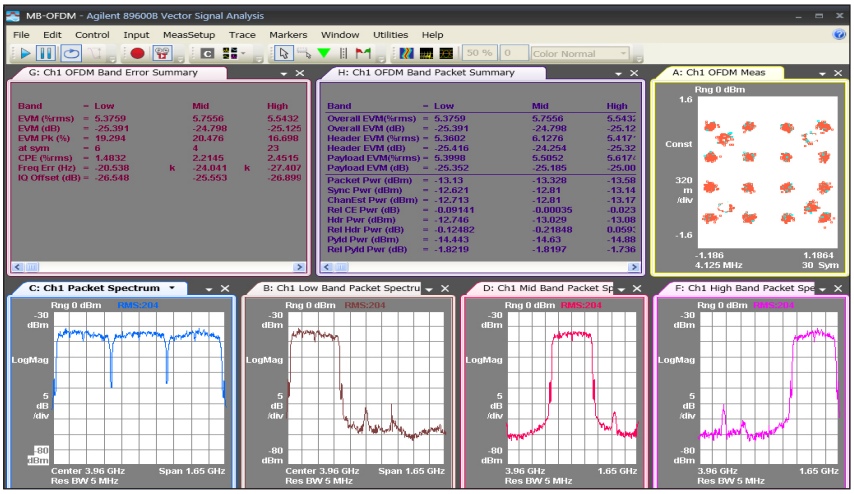
Option BHB simplifies measurement setup with automatic setting of many parameters. When you need to expose and investigate signal anomalies, the Advanced tab lets you access and adjust many detailed parameters.

Capture the complete UWB burst

Use Option BHB with the high performance Agilent Infiniium oscilloscopes, for frequency coverage up to 31 GHz, and logic analyzers for baseband FPGA and ASIC development. Use Option BHB to make measurements with Agilent EEsof ADS or SystemVue simulation software before hardware is available.



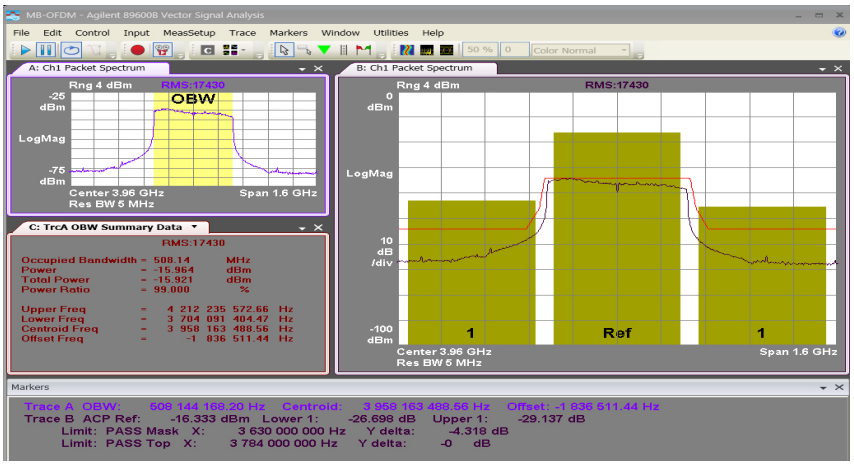
This signal was generated by an Agilent ADS simulation and represents a non-hopping signal, often used in the early stages of system development. Here, you can see the entire signal's error vector spectrum and time performance, as well as summary header and packet information.



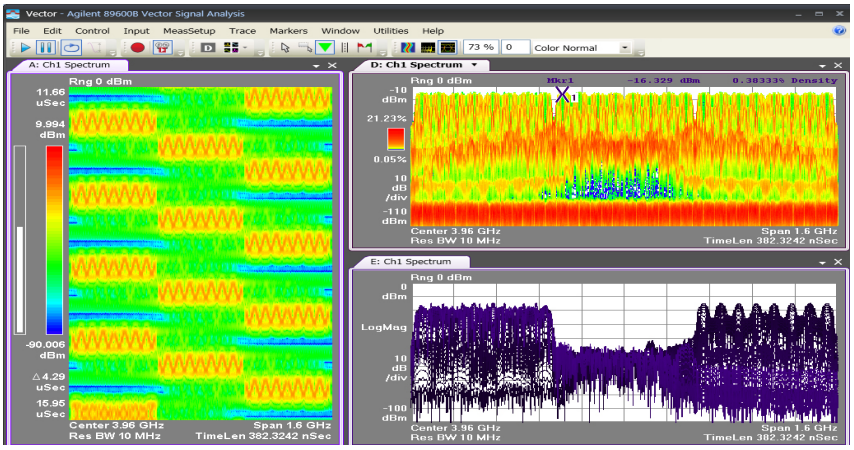
View the entire packet spectrum, or a single band. Choose from multiple summary tables to see EVM and power values per band. More detailed analysis per band is also available.

Choose from a wide selection of analysis tools

Display up to 20 simultaneous error traces like EVM over time or frequency, statistical performance data like CCDF, I/Q parameters, common pilot error (CPE), packet spectrum, plus powerful tabular reports of header info, demodulated bits, and more.



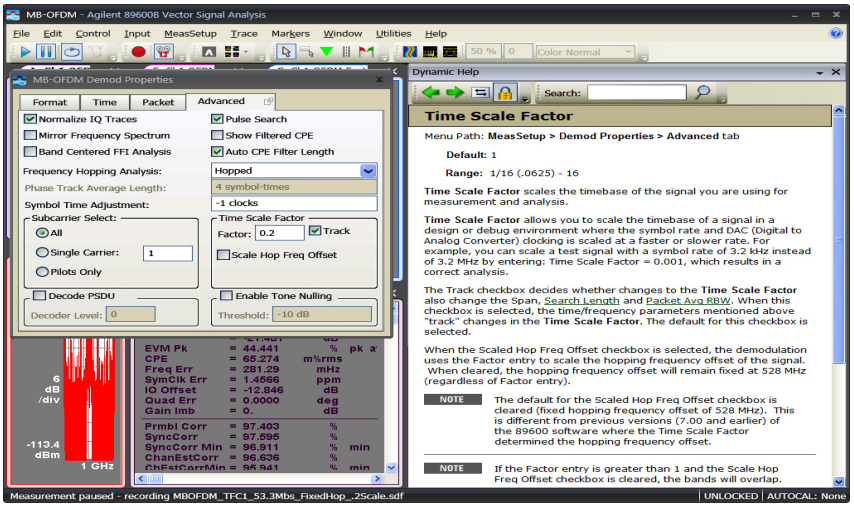
Make PSD measurements on each band to verify signal compliance using provided limit lines, or use the ACPR marker to characterize the power profile of your signal. Use the OBW marker and the detailed marker summary data to gain info on the occupied bandwidth.



View the spectrum of the time-varying MB-OFDM signals over time in three very different ways. Spectrograms emphasize any frequency excursions over time. The digital persistence display (Trace E) does the same, but highlights amplitude variations. The cumulative history display (Trace D) provides data on the frequency of occurrence for a given point, making it particularly useful for monitoring error traces.

Debug systems using time-scaling analysis for hopped and non-hopped signals

Time-scaling lets you scale the time base of a signal in a design or debug environment where the symbol rate and DAC clocking is scaled at a faster or slower rate. Early chip designers can run baseband hardware at reduced speeds even when the RF subsystem hops at full frequency steps for easier system debugging.



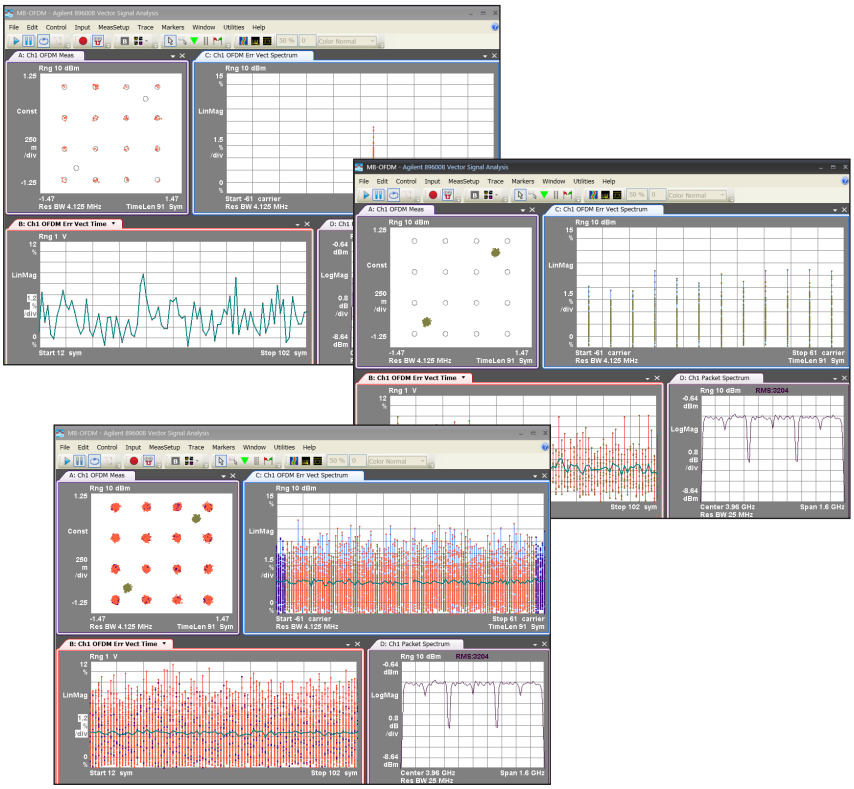
Click on a menu or trace and use Dynamic Help to access the topic of interest. Here you can learn important information about time scaling. As you progress through each 89600B menu pick, the Help text dynamically follows your choices and displays the pertinent topic. Detach the Help window and display it anywhere in your desktop.

Examine MB-OFDM bands and packets, down to the specific carrier

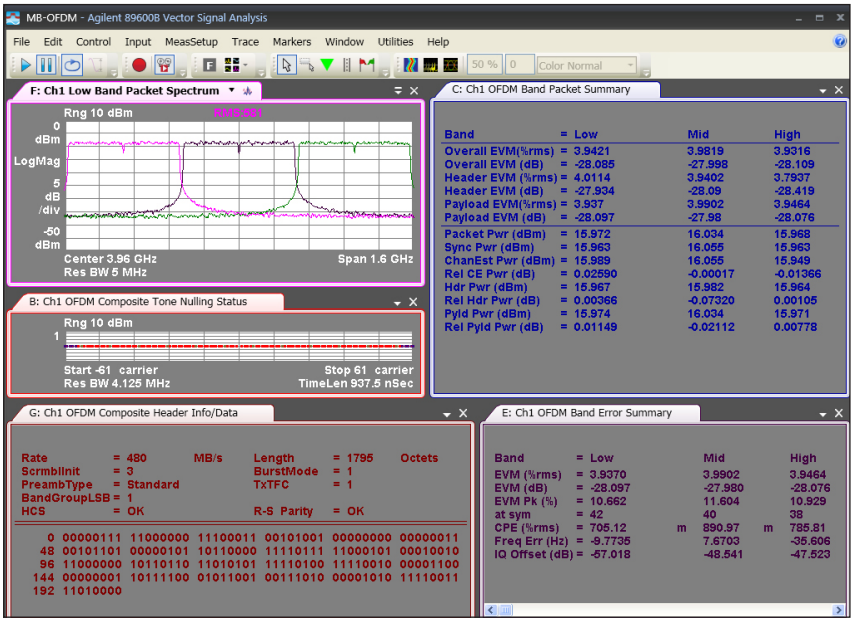
View the low, mid, or high band, the composite signal, or the un-demodulated signal. Summary tables provide information on band errors, packet errors, packet power reports, and more. A subcarrier select feature lets you examine all subcarriers, only pilots, or a single selected carrier.

Take advantage of sophisticated MB-OFDM-specific troubleshooting tools

These include tone nulling, selectable frequency hopping mode, and more. Option BHB detects tone nulls at a threshold value you select, allowing you to verify your system's performance in the presence of subcarrier interference. Set the frequency hopping analysis function on the Advanced tab to measure non-hopped signals, such as baseband receiver signals. You can also choose to analyze a hopping TFC in non-hopped mode.



View the EVM performance of all carriers, pilots only, or a single selected carrier (#6) using the Subcarrier Select parameter on the Advanced tab.



A wide range of MB-OFDM-specific measurement traces and tables help you understand hopping UWB signals. In addition, the Advanced tab allows you to modify many parameters to investigate signals during early system development in order to troubleshoot problems.

Software Features

Adjustable setup parameters	
Signal acquisition	
Standards supported	Release 1.2 (February, 2007) "MultiBand OFDM Physical Layer Specification", published by the WiMedia Alliance, plus selected version 1.2 enhancements (February 22, 2007)
Presets	Selected TFC in selected band group
Band groups supported	1-6
Channels supported	9-15; 17-23; 25-31; 33-39; 45-46; 49-52; 72-74; 80-82; 88-90; 96-98; 112-113; 150
Data rate (Mb/s)	Choose from menu or auto-detect
PSDU (data)	53.3, 80, 106.7, 160, 200, 320, 400, 480
Modulation format	
Data rates ≤ 200 Mb/s	QPSK
Data rates > 200 Mb/s	Dual carrier modulation
Header	QPSK
Preamble	Select type: auto detect; Standard–30 symbols; Burst–18 symbols; includes 6 symbol channel estimation sequence
Time Frequency Code (TFC)	1-4 (TFI–hopping); 5-7 (FFI–non-hopping); 8-10 (TFI2); or select auto-detect
Time parameters	
Search length	Time length used when searching for packet
Result length	Number of symbol times after the preamble which are to be available for EVM analysis, defining the packet length. This may be auto-selected by the software, or read from the header. Alternatively, you may manually override and enter a value for the result length in symbol times or octets.
Payload octets	Same as result length minus the header, but in octets
Measurement offset	Number of symbol times from the start of the PLCP Header at which to begin EVM analysis
Measurement interval	The number of symbol times to include in analysis after the measurement offset
Packet parameters	**Apply to analysis provided in the Composite/low/Mid/High Packet time displays and corresponding spectrum traces**
Packet average RBW	RBW of Hanning window used in overlap-window-FFT-RMS processing; defaults to 5 MHz, as called out by standard for Spectral Mask and ACPR tests
Pre-symbol time	Defines beginning of time gate for each symbol in a given band; applies to low/mid/high packet time and spectrum displays; default 0 symbol-times per standard for Spectral Mask and ACPR tests
Post symbol time	Defines the end of time gate for each symbol in a given band; applies to low/mid/high packet time and spectrum displays; default 0.194 per standard
Pre-packet time	Additional time shown before first symbol of packet; applies to all packet displays; default 0 symbol-times per standard for Spectral Mask and ACPR tests
Post-packet time	Additional time shown after last symbol of packet; applies to all packet displays; default 0 symbol-times per standard for Spectral Mask and ACPR tests
Symbol gate length	Alternative to post-symbol time entry; samples, symbol-times, or seconds

Software Features

Advanced parameters	
IQ normalize	On/off; enables IQ normalize function, which sets the outermost state of the ideal constellation diagram to magnitude of one
Mirror frequency spectrum	On/off; specifies whether to do frequency inversion before attempting to demodulate the signal; allows demodulation of frequency spectrums that are mirrored (flipped) about the center frequency
Pulse search	On/off; tells demodulator to search for amplitude rise at beginning of packet, ignoring "off times" between symbols
Phase track average length	1-1000 symbol-times; sets the length of the average used in tracking phase changes during demodulation
Frequency hopping analysis	On/off; default on; when off, synchronization pattern of selected TFC is used, but signal is assumed to occupy only one band
Show filtered CPE	Display output of CPE filter instead of raw CPE values; default off
Subcarrier select	Determines which subcarriers are selected for symbol-domain or subcarrier-domain analysis; all, single carrier, pilots only
Symbol timing adjust	Fine positioning of the demodulation FFT
Time Scale Factor	Scales all modulation time/frequency parameters; use for designs with scaled-down speeds or bandwidths
Scale Hop Freq Offset	On/off; default off; scales the hopping frequency offset with the Time Scale Factor entry
Decode PSDU	Turns on decoding of PSDU bits, FSU on/off; default is off
Decoder level	Controls complexity of decoding algorithm; default 0, range 0-5
Enable tone nulling	Determines if null tones will be ignored in EVM algorithm; on/off
Threshold	Value below which a tone will be labeled as null; dB
Band centered FFI analysis	On/off; selects whether the FFI analysis is centered on the active band or the center of the Band Group, making the center frequency the same for all TFCs in a Band Group
Auto CPE Filter Length	On/off; dynamically select CPE filter length, depending on TFC

Software Features

Trace data	
Composite	**Includes results from all bands**
Composite	
Band	Band ID reference: low, medium, high
EVM	Error Vector Magnitude; % rms, dB
EVM pk	Error Vector magnitude Peak, plus symbol location for peak; %
CPE	Common Pilot Error; % rms
Freq Err	Error between carrier frequency, relative to analyzer's center frequency; Hz
IQ Offset	Magnitude of carrier feedthrough signal, as measured during channel estimation sequence portion of preamble; dB
Band packet error summary	Table provides summary information for all bands, individually and simultaneously. For all bands, low, mid, high, the following information is available:
Channel estimation power	Value of power in the channel estimation sequence; dBm
Header EVM	Error vector magnitude in Header section of current packet averaged over each band individually; % rms and dB
Header power	Value of power in header; dBm
Overall EVM	Error vector magnitude averaged over each band individually; % rms and dB
Packet power	Value of power in the packet; used for testing the Tx Power Control (TPC) attenuator settings; dBm
Payload EVM	Error vector magnitude averaged over each band individually; % rms and dB
Payload power	Power in payload; dBm
Relative channel estimation (CE) power	Power of channel estimation relative to sync power; dB
Relative header power	Power of header relative to sync power, dB
Relative payload power	Power of payload relative to sync power; dB
Sync power	Value of power in the sync correlation portion of the signal; dBm
Channel frequency response	Channel frequency response of the equalizer, combined for all bands
Common pilot error	Difference between the measured and ideal pilot subcarrier symbols
Eq impulse response	Impulse response of equalization filter
Error summary table	Composite results
EVM	EVM averaged over all subcarriers and all detected OFDM symbols, computed as a percentage (%rms) and dB
EVM peak at symbol	Peak EVM level over all subcarriers and all detected OFDM symbols, in percentage RCE (%) along with number of symbol where EVM Pk occurred
Frequency error	Error between carrier frequency, relative to analyzer's center frequency
Symbol clock error	Difference between ideal and actual symbol clock frequency, (ppm)
I/Q offset	Magnitude of carrier feedthrough signal, as measured during channel estimation sequence portion of preamble
Quadrature error	Orthogonal error between I and Q
Gain imbalance	Difference in gain between I and Q paths
Common pilot error (RMS)	RMS level of common pilot error trace data, expressed as percentage of ideal signal
Sync correlation	Correlation coefficient between measured preamble and ideal preamble
Sync correlation (minimum)	Per the standard, the minimum sync correlation value across all of the PS/FS symbols; symbol location of minimum value given as well
Preamble correlation	Symbol by symbol correlation of the PS/FS (sync) and CE (channel estimation) portions; %
Channel estimation correlation	Correlation of channel estimation sequence; %
Channel estimation correlation (minimum)	Minimum CE correlation and symbol location at which it occurred
Inter-packet spacing	Gap between the last symbol of the current packet and the first symbol of the next, in symbol times; includes a range of values detected if averaging is turned on
Detected Time Frequency Code	TFC detected using automatic TFC detection algorithm
Detected preamble type	Preamble type detected: standard, burst

Software Features

Trace data	
Composite (continued)	**Includes results from all bands**
Error vector spectrum	Error vector spectrum of the combined Low, Mid, High Bands
Error vector time	EVM value for all carriers in all bands, across symbols
Header info/data	Values extracted and decoded from the PLCP Header. Decoded header bits are presented as well
Band group LSB	1/0
Burst mode	Burst type for the following packet; 1, if next packet is part of a burst; 0, if is not
HCS	Status results from HS check
PLCP data rate	MB/s
Preamble type	Preamble type used for the current packet; standard/burst
PSDU length	Octets
R-S parity	Reed-Solomon parity check
Scrambler initialization	Seed value used for the data scrambler; 1/0
TFC	Transmitter time frequency code for the current packet
IQ measurement	Subcarrier-domain trace that shows the measured IQ symbol values of the subcarriers across the selected symbol-times (bursts) for all low, mid, and high bands combined
IQ measurement time	Symbol-domain trace that shows IQ constellation diagram for the combined high, low, and mid band_IDs
IQ reference spectrum	Subcarrier-domain trace that shows ideal IQ symbol values of subcarriers across the selected symbol-times (bursts) for all low, mid, and high bands combined
Instantaneous channel frequency response	Non-averaged channel frequency response
Packet spectrum	Shows combined packet spectrum across full frequency span
Packet summary table	Table provides summary information for all bands, averaged collectively
Channel estimation power	Absolute value of the power in the channel estimation sequences; dB
Channel estimation relative power	Channel estimation power relative to the sync power; dB
Header EVM	EVM of header only; % rms & dB
Header relative power	Header power relative to the sync power; dB
Overall EVM	EVM of the headers + payloads; % rms and dB
Packet power	Absolute value of average power in the packets; dBm
Payload EVM	EVM of payload (PSDU) portions only; % rms & dB
Payload power	Absolute value of the power in the payloads; dBm
Payload relative power	Payload power relative to the sync power; dB
Sync power	Absolute value of average power in the syncs; dBm
Packet time	Shows packet waveform across full frequency span
Preamble correlation	Symbol by symbol correlation of the entire preamble, including the sync and channel estimation portions
Preamble phase err	Phase error in the preamble, in degrees
RMS error vector spectrum	RMS average EVM across each subcarrier for all symbols within the measurement interval
RMS error vector time	RMS average EVM at each symbol
Symbols	Detected symbols; includes DCM symbols
Tone nulling status	Values are 1, if sub-carrier is used; 0, if nulled, as determined by whether the power is above or below the tone nulling threshold setting

Software Features

Band-specific demodulation traces	**Available for high, mid, and low bands, displayable simultaneously**
Channel frequency response	Equalizer channel frequency response
Common pilot error	Difference between the measured and ideal pilot subcarrier symbols
Equalizer impulse response	Impulse response of the equalization filter
Error vector spectrum	Error vector spectrum of the high band, low band, or mid band, separately
Error vector time	For a given band, shows a series of vertical lines where each line represents a band burst of 122 sub-carriers organized by magnitude of the error vector time
Instantaneous channel frequency response	Non-averaged channel frequency response
IQ meas	Subcarrier-domain trace showing measured IQ values of subcarriers across the selected symbol-times (bursts) for the selected band
Packet time	Shows packet waveform for selected band for hopping sequence determined by time-frequency code
Packet spectrum	Shows just the selected band's spectrum portion of the composite spectrum for analysis
Non-demodulation traces	
Raw main time	Time data that was acquired by the hardware, including any extra acquisition to allow for filter settling
Search time	Shows time-data before pulse search and demodulation; is the acquired time data used to search for the burst
Time	Shows the time record used for EVM analysis
Spectrum	Shows averaged frequency spectrum of Time trace used for EVM analysis
Instantaneous spectrum	Shows frequency spectrum of the Time trace used for EVM analysis
CDF	Displays the Cumulative Distribution Function for the selected input channel
CCDF	Displays the Complementary Cumulative Distribution Function for the selected input channel
PDF	Shows the Probability Density Function
Correction	Shows the correction curve used to correct for frequency response of input hardware and digital filtering
ACPR measurements	
Reference offset	Used with the existing standard Adjacent Channel Power marker capabilities to allow the markers to be centered anywhere on the screen. This allows ACPR measurements per the WiMedia test specifications to be made on low and high hopped bands.
Spectral mask measurements	
Limit test functionality	Enhanced to allow its Y Reference to track the output of a measurement, allowing MB-OFDM Spectral Mask measurements to be made with the top of the mask always positioned at the highest point in the carrier band, in compliance with the WiMedia test specifications.

Key Specifications[1]

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, but is not covered by the product warranty. For a complete list of specifications refer to the measurement platform literature.

Infiniium oscilloscope specifications

General

Supported standards	Release 1.2 (February 2007) "MultiBand OFDM Physical Layer Specification," published by the MultiBand OFDM Alliance in cooperation with the WiMedia Alliance		
Supported hardware	Agilent Series high performance Infiniium oscilloscopes		
Model (bandwidth)[2]	Model	Bandwidth (standard)	Max UWB freq (MHz)
	81304	13 GHz	10296
	81204	12 GHz	10296
	81000	10 GHz	9240
	80804	8 GHz	7656
	80604	6 GHz	5544
	91304	13 GHz	10296
	91204	12 GHz	10296
	90804	8 GHz	7656
	90604	6 GHz	5544
	91604	16 GHz	10296
	92004	20 GHz	10296
	92504	25 GHz	10296
	92804	28 GHz	10296
	93204	31.25 GHz	10296

1. Data subject to change
2. For a complete listing of supported models, including bandwidth and time capture specifications, see Infiniium Oscilloscopes with 89600B VSA Software, literature part number 5990-6819EN.

Key Specifications[1]

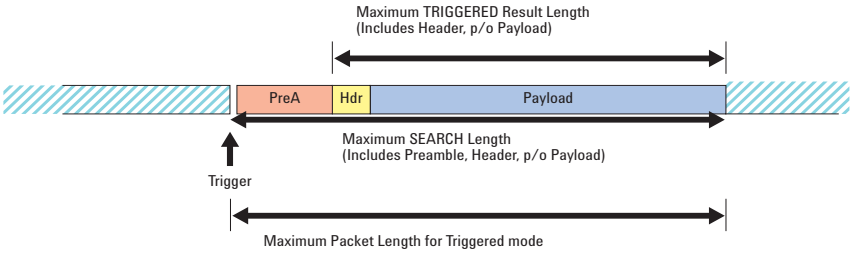
Acquisition[2]

User rate		Band groups 1, 2 user rate = 20 Gsa/s or 40 Gsa/s Band groups 3-6 user rate = 40 GSa/s
Search length µs		1020
Packet length µs (syms)[3, 4]	External trigger Pulse search[6]	632 (2010)[5] 508 (1626)

Triggered measurement:

Packet may be > maximum search length

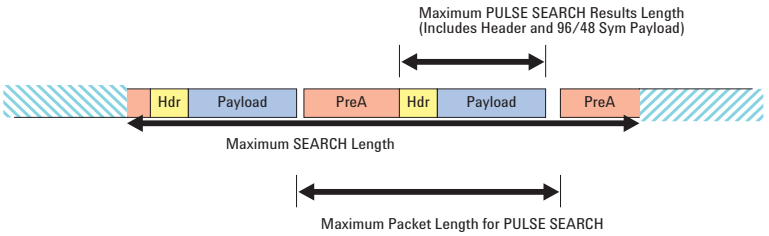
Result length limited to maximum results length



Pulse search measurement:

Packet time must be < 0.5 * (maximum search length – 1.875 µs)

Payload limited to 96 or 48 symbols (see table)



Timing diagram showing the relationship between triggered and pulse search measurements with respect to frame structure.

Accuracy

Residual EVM

20 averages, input within 2 dB of full scale

Bandgroup	Band IDs	EVM dB (%)
1	1-3	–31.5 dB (2.6 %)
2	4-6	–29.1 dB (3.5 %)
3	7-9	–30.1 dB (3.1 %)
4	10-12	–27.3 dB (4.3 %)
5	13, 14	–27.3 dB (4.3 %)
6	9	–30.1 dB (3.1 %)
6	10, 11	–27.3 dB (4.3 %)

Frequency error accuracy

Lock range	± 300 kHz offset from nominal ch frequency (87 ppm @ 3.432 GHz)
Frequency accuracy	± 3.4 kHz (1 ppm) @ 3.432 GHz within 1 year of calibration

1. Data subject to change
2. 1.65 GHz span.
3. Includes 12 header symbols + preamble.
4. Refer to the timing diagram for differences between using external trigger and pulse search.
5. Equals max packet length per standard.
6. Separation = 1.875 µs (MIFS).

Ordering Information

Software licensing and configuration

Choose from two license types:

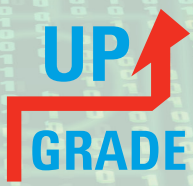
- **PC/instrument license:** Order 89601B if the software license will reside on a PC/instrument. The license can be transferred to another PC/instrument at any time.
- **Floating license:** Order 89601BN if the software license will reside on a server to be accessed by multiple users, one at a time.

Model-Option		Description	Notes
PC/Instrument license	**Floating license**		
89601B	89601BN	89600B VSA software	Required
89601B-BHB	89601BN-BHB	MB-OFDM UWB modulation analysis	Required for MB-OFDM UWB modulation analysis
89601B-200	89601BN-200	Basic vector signal analysis	Required
89601B-300	89601BN-300	Hardware connectivity	Required

Keep your 89600B VSA up-to-date

With rapidly evolving standards and continuous advancements in signal analysis, the 89601BU/BNU software update and subscription service offers you the advantage of immediate access to the latest features and enhancements available for the 89600B VSA software. **www.agilent.com/find/89600B**

You can upgrade!



All 89600B options can be added after your initial purchase and are license-key enabled. For more information please refer to

www.agilent.com/find/89600B_upgrades

Additional Resources

www.agilent.com

Literature

89600B Vector Signal Analysis Software, Brochure,
literature number 5990-6553EN

89600B Vector Signal Analysis Software, Configuration Guide,
literature number 5990-6386EN

89600B Opt 200 Basic VSA and Opt 300 Hardware Connectivity,
Technical Overview,
literature number 5990-6405EN

89600B BHB MB-OFDM UWB Modulation Analysis, Self-Guide Demonstration Guide,
literature number 5989-5452N

Agilent Technologies Solutions for MB-OFDM Ultra-wideband,
Application Note, 5989-5280EN

Web

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A personalized view into the information most relevant to you.

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Agilent Electronic Measurement Group
DEKRA Certified
ISO 9001:2008
Quality Management System

www.agilent.com/quality

LXI

www.lxistandard.org

LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Agilent is a founding member of the LXI consortium.

Agilent Channel Partners

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