Agilent Technologies Solutions for MB-OFDM Ultra-wideband

Application Note

Bringing proven experience in emerging technologies to UWB

Agilent Technologies provides the most complete range of product solutions for WiMedia-based MB-OFDM ultra-wideband. Whether you need design simulation or test, signal generation or analysis, measurement software or hardware, you can find it with Agilent Technologies' solutions.

Agilent Technologies

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Overview

Signal analysis

89600 VSA software

The 89600 vector signal analysis software is the industry's premier tool for developing and troubleshooting new and emerging technologies like ultra-wideband. Its rich tool set of flexible and powerful measurements and displays includes advanced demodulation measurements. Extensive vector features like time-gating, spectrogram displays, built-in ACPR and OBW capabilities, and more, make it well-equipped for the most demanding R&D tasks. Its PC-based architecture allows for quick and easy updates as standards change. And its ability to acquire and analyze signals with a logic analyzer front-end makes it invaluable when dealing with digitized baseband or IF signals. More information can be found on page 4.

Infiniium Series oscilloscopes

Capture the complete UWB burst all at once – up to 13 GHz. Key features include approximately 1 ps rms jitter, 40 gigasample/second (GSa/s) data rate, and 2 Mpts memory length (50 µs). Use these oscilloscopes with an InfiniiMax Probing System for differential inputs. The Infiniium Series scopes can provide data to the 89600 VSA software, and some models can even run the software embedded in the oscilloscope. More information can be found on page 7.

Signal generation

N7619A Signal Studio for multiband OFDM UWB software

Agilent N7619A Signal Studio for Multiband Orthogonal Frequency Division Multiplexing (OFDM) ultra-wideband (UWB) provides flexible, fast waveform creation for your design and verification of OFDM UWB transceivers and components. The software helps increase your design confidence by generating accurate UWB waveforms based on the WiMedia Ultra-Wideband (UWB) Common Radio Platform. More information can be found on page 7.

N6030A arbitrary waveform generator

The N6030A is a wideband arbitrary waveform generator (AWG) capable of creating high-resolution waveforms for UWB systems. The N6030A gives designers access to the most advanced Digital-to-Analog (DAC) technology available in a commercial AWG with 500MHz of signal bandwidth. More information can be found on page 9.

E8267D PSG vector signal generator, up to 44 GHz

The E8267D PSG features a built-in wideband I/Q modulator that delivers up to 2 GHz RF modulation bandwidth (at frequencies above 3.2 GHz). Use the PSG with Signal Studio to generate multiband OFDM UWB signals. More information can be found on page 9.

Design simulation software

Advanced Design System E8872 ultra wideband (UWB) wireless library

This software provides rapid setup, analysis and data display to verify the most common performance characteristics of UWB transmitters and receivers. More information can be found on page 10.

Signal analysis solutions

89600 vector signal analysis software

MB-OFDM ultra-wideband modulation analysis (Option BHB)
Troubleshoot your WiMedia-based multi-band OFDM ultra-wideband PHY layer signals, such as those in certified wireless USB, with the industry's most complete set of easy-to-use measurement tools, providing you with an unparalleled view into your PHY layer signals. Use Option BHB running on the high performance Agilent DSO80000 Series oscilloscopes to help you identify the root causes of problems, sooner.

Supporting all Time Frequency Codes (TFC1 through TFC7), including FFI (non-hopped) and TFI (hopped) modes, Option BHB lets you analyze a wide range of formats, including QPSK modulation (utilized for data rates from 53.3 Mb/s to 200 Mb/s), and DCM (at data rates from 200 Mb/s to 480 Mb/s), using burst or standard preamble types. In addition, you can manually turn off/on frequency hopping analysis. In the off mode, the synchronization pattern of the TFC selected will be used, but the software assumes that the signal occupies only one band. This mode of operation is especially useful when bringing up and testing TFC 1-4.

See low, mid, and high band error vector spectrum and IQ measurement time for hopped signals as well as composite traces for both of these types of results. These measurements can help you troubleshoot errors down to the individual band, carrier, or symbol, for in-depth error analysis. A band error summary provides EVM, CPE, frequency error and IQ offset for each band individually, while the composite error summary provides overall error measurements.

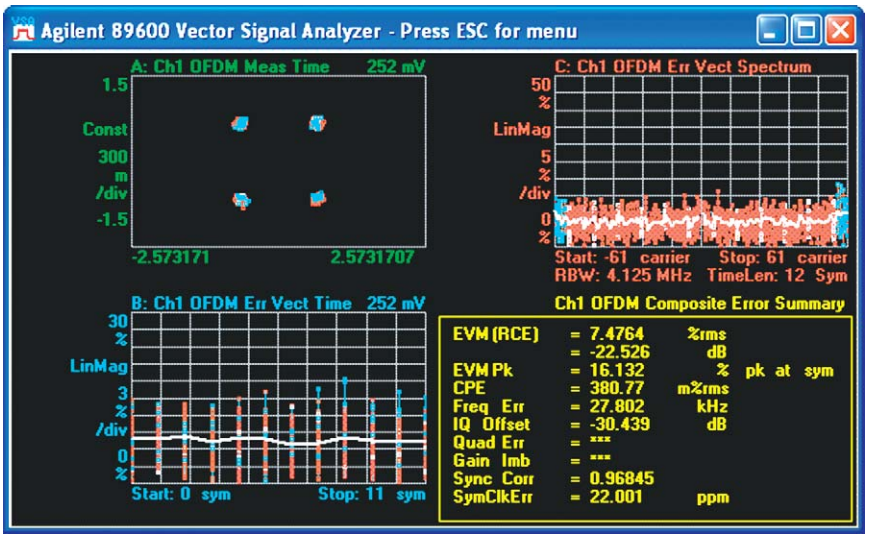

Figure 1. Option BHB MB-OFDM ultra-wideband modulation analysis offers detailed error analysis down to the individual carrier (Trace C, upper right) or individual symbol (Trace B, lower left). For an overall view, composite errors are shown in the table (Trace D, lower right).

As an added advantage, the Agilent DSO80000 Series and 89601A Option BHB combination is scalable. Using the oscilloscope's unique ability to upgrade acquisition bandwidth, you can start with the lower UWB bands (up to Band ID 5), using the DSO80604B today. Later, you can easily upgrade the hardware to the DSO81204B, providing coverage of all of the band IDs (1 through 14.)

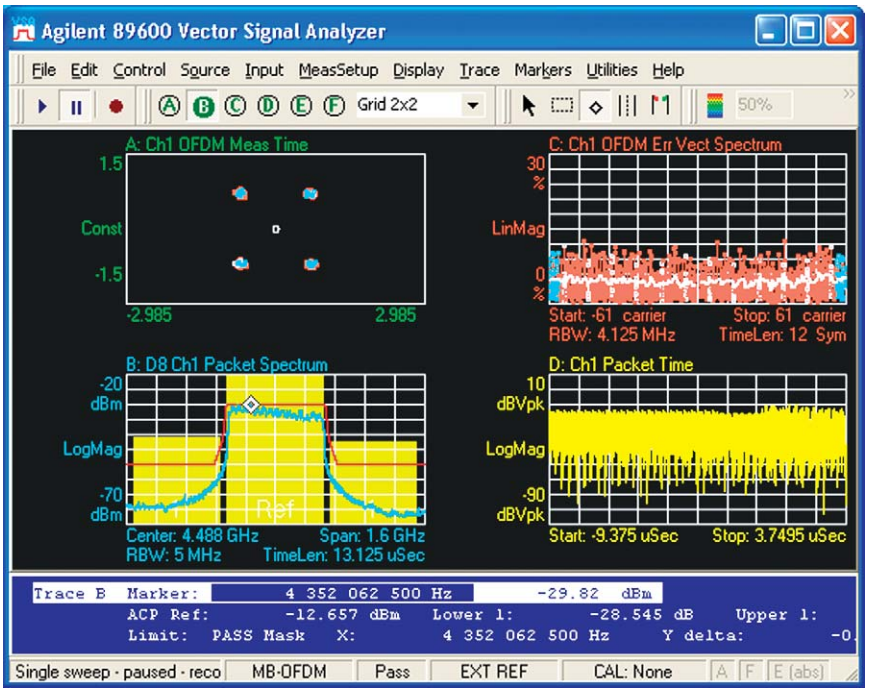

Figure 2. Use the powerful ACP calculation markers and limit lines on the packet spectrum displays to perform important spectral measurements.

Besides specialized UWB measurements, the analyzer's standard vector measurements and displays can provide insight into the behavior of your signals. For instance, the spectrogram display provides a good visual tool for providing a wider perspective of your signal over time, particularly for hopping signals. You can use the time gating markers to easily focus in on a selected portion of your signal, such as the preamble, or any other area that might require closer inspection.

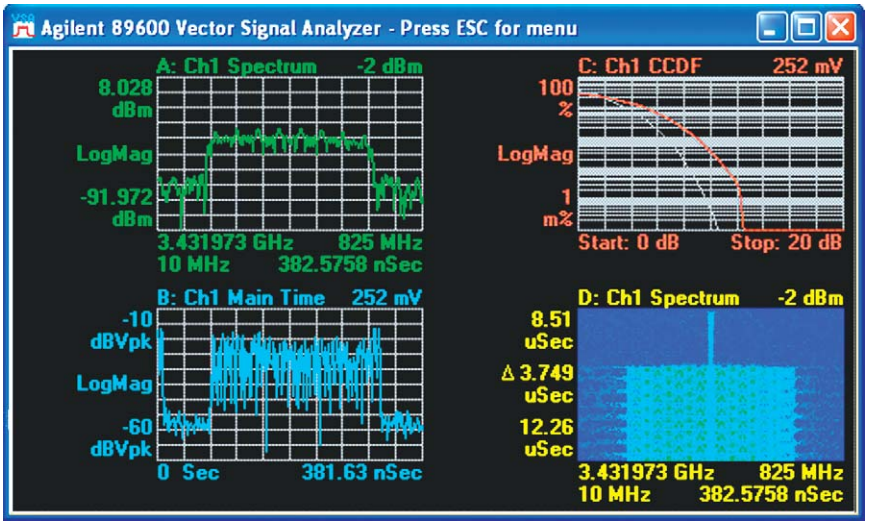

Figure 3. Even without digital demodulation turned on, the 89600 VSA software makes many useful measurements, especially for characterizing components. Instantaneous views of time and spectrum (left hand displays) are enhanced with a spectrogram display (lower right). This provides a longer term view of any desired data (here, spectrum), and CCDF (upper right), giving important statistical information about the behavior of your component or system over time. This is useful in determining or confirming system margins.

Option BHB MB-OFDM ultra-wideband modulation analysis features –
Preliminary (partial listing only)

Table 1.

Data setup	
Formats supported	WiMedia Alliance PHY Interface Specification, Rev 1.1; TFC 1-7, includes both FFI (non-hopped) and TFI (hopped)
Data rates	(in Mb/Sec): 480, 400, 320, 200, 160, 106.7, 80, 53.3
Preamble types	Standard, Burst
Frequency hopping analysis	On/off
Phase track average length	Number of symbol times over which phase track averaging occurs
Measurement displays	
Band errors	Table of errors for low, mid, and high band, including: EVM (%, dB), EVM Peak (%, and symbol location), CPE (%RMS), Frequency Error (Hz), IQ offset (dB)
CCDF	Complementary Cumulative Distribution Function of the time trace
CDF	Cumulative Distribution Function of the time trace
Common pilot error	Shows the common pilot error (phase and magnitude), with one point per OFDM symbol
Correction	Shows frequency domain correction applied to the raw measured time data to ensure that the input hardware has a flat frequency response
Error vector spectrum	Shows the error vector by subcarrier for every OFDM symbol time analyzed; also available for low-, mid-, and high-band separately
Error vector time	Shows the error vector by OFDM symbol time for every subcarrier; also available for low-, mid-, and high-band separately
IQ measured time	Shows IQ measured data by OFDM symbol time for every subcarrier
IQ measured spectrum	IQ measured data by subcarrier for every OFDM symbol time analyzed; also available for low-, mid-, and high-band separately
IQ REF	IQ reference data, with one point per subcarrier per analyzed OFDM symbol time
PDF	Probability density function of the time trace
Packet spectrum	Spectrum of the entire packet; also available for low-, mid-, and high-band separately
Packet time	Time display of the entire packet; also available for low-, mid-, and high-band separately. RBW is independently adjustable via internal overlapped averaging
Raw main time	Block data acquired by the hardware, before any software time-domain corrections or any software re-zooming or re-sampling
RMS error vector time	Instantaneous RMS averaged error vector, shown with one point per subcarrier, calculated for current scan only
RMS error vector spectrum	RMS averaged error vector, shown with one point per OFDM symbol analyzed
Search time	Shows block of data that was acquired and searched through for the packet
Spectrum	Frequency spectrum of the time trace, including averaging, if any
Time	Block of data undergoing EVM analysis

Signal analysis hardware

DSO80000 Series ultra-high performance Infiniium oscilloscopes

The DSO80000 Series provides the lowest noise floor of any digitizer currently available on the market capable of direct capture of UWB signals. Using Agilent's 89601A VSA SW Option BHB running on the Agilent DSO80000 Series oscilloscopes allows you to run key compliance-based tests, along with a host of troubleshooting and debugging measurements.

Capture the complete UWB burst all at once – up to 13 GHz. Key features include approximately 1 ps rms jitter, 40 gigasample/second (GSa/s) data rate, and 2 Mpts memory length (50 µs). Use these oscilloscopes with an InfiniiMax Probing System for differential inputs. The unique scalability allows you to purchase an acquisition bandwidth of 2 GHz, and upgrade to as much as 13 GHz, depending on your needs and budget.

Signal generation solutions

N7619A Signal Studio for multiband OFDM UWB software

Signal Studio for multiband OFDM UWB enables designers to generate accurate and standard-compliant UWB signals when used with the Agilent E8267C/D PSG vector signal generator and an N6030A wideband arbitrary waveform generator. The software's wide range of easily produced signal configurations provides designers with the test signals needed for thorough receiver performance verification.

Easy-to-use interface
Signal Studio for UWB produces a digital version of the baseband I and Q waveforms that get loaded into test equipment to generate UWB radio frequency signals. The easy-to-use interface lets you get started quickly, enabling you to focus on the evaluation of the UWB transceiver and perform key measurements, such as sensitivity and interference rejection.

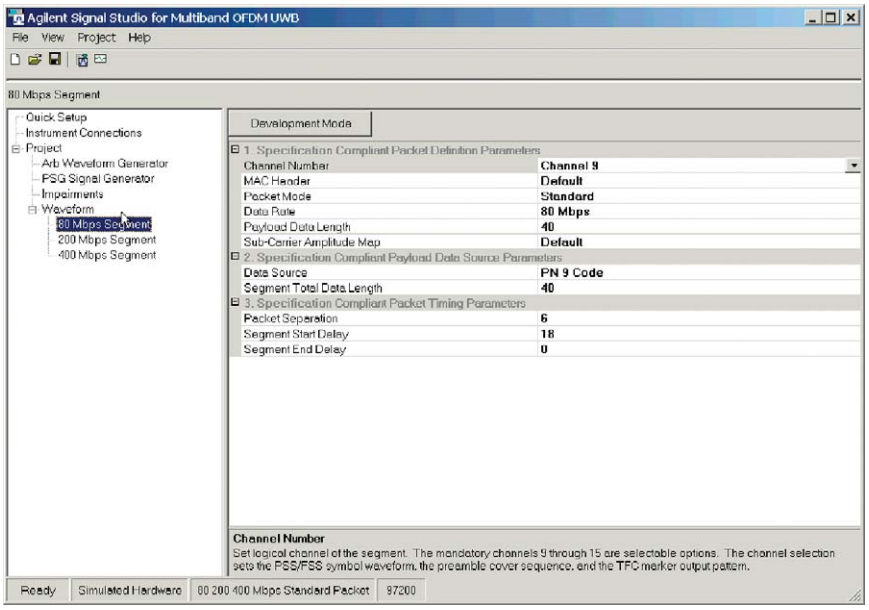

Figure 4. The Signal Studio for UWB user interface gives you the flexibility to easily develop and modify WiMedia-based MB-OFDM ultra-wideband signals for wireless USB and other applications.

Build custom waveforms
Signal Studio for UWB provides the ability to produce waveforms consisting of groups of packets with varying signal parameters. You can define the packet parameters for multiple waveform segments and then combine the segments into a single waveform. Signal Studio for UWB provides you with the flexibility to define the complicated waveforms to meet a wide variety of test requirements. You can decide which cases need to be tested and quickly assemble test signals for those cases. The ability to test a wide variety of scenarios makes realistic verification of receiver performance possible.

Create custom packets
Packet parameters can be quickly configured to produce required test signals. To test more advanced receiver functions, waveforms can be created from multiple groups of packets with each group having different parameter settings such as packet length, data rate, or MAC header values. The N7619A gives you full control of parameters for waveforms that are compliant to the specification. This is valuable for performing many receiver verification tests, such as sensitivity and immunity to impairments and interference.

Test sub-carrier omission for coexistence testing
Signal sources that are fully configurable for requirements of specific interference tests are needed for narrow band receiver interference reduction. This coexistence testing is needed to gain regulatory approval worldwide. Signal Studio for UWB provides the signal source needed for this testing. It also allows you to control the specific number of waveforms to be played with burst mode capability.

Add waveform impairments
Correctly determining the tolerances of critical design specifications is crucial when creating designs that optimize performance, yields, and costs. Signal Studio for UWB provides the test signals needed to accurately verify requirements and create optimized designs and allows you to add impairments like frequency offsets and I/Q phase and amplitude imbalance

Signal generation hardware

N6030A arbitrary waveform generator

Create baseband I/Q waveforms using the N6030A arbitrary waveform generator
The Signal Studio software produces a digital representation of the multiband OFDM UWB baseband I/Q waveforms. Use this software to easily load the digital UWB baseband waveforms into an N6030A arbitrary waveform generator (AWG) which converts the digital versions of the I/Q signals to create real analog baseband waveforms. The baseband I/Q waveforms that are output from the AWG can be used as test signals for designers creating the analog and digital baseband sections of multiband OFDM UWB receivers. These signals are also useful for transmitter designers who need a baseband signal to test their circuits.

Agilent's N6030A arbitrary waveform generator delivers unprecedented performance for creation of these complex WiMedia-based ultra-wideband waveforms. High sampling rate and high bit resolution provided in a single instrument enable designers to create ideal waveforms for accurate test of wireless USB, high-speed *Bluetooth*, or other UWB applications. Each channel of the N6030A provides 500 MHz of modulation bandwidths and over 65 dBc of spurious free dynamic range.

E8267D PSG vector signal generator

Generate a full RF waveform with E8267C/D PSG wideband inputs
The Agilent E8267C/D PSG signal generator's wideband external I/Q baseband inputs are driven by the output from the N6030A arbitrary waveform generator. The PSG signal generator's wideband quadrature modulator produces the multiband OFDM UWB symbols with 500 MHz of RF modulation bandwidth. This very accurate source provides you with the test signals needed to verify your designs.

The E8267D PSG vector signal generator is the industry's first integrated microwave vector signal generator with I/Q modulation up to 44 GHz. It features groundbreaking integrated vector functionality, only available in the E8267D PSG, and drastically simplifies the generation of complex modulated signals, like WiMedia-based MB-OFDM ultra-wideband signals, for design and manufacturing test applications.

Design simulation solutions

E8872 ultra-wideband (UWB) wireless library

The Agilent EEsof Wireless Library allows users of ADS to perform a complete system simulation of both the transmitter and receiver portions, compliant with the multi-band, Orthogonal Frequency Division Multiplexing (OFDM) specification (MBOA-SIG September 2004). The library will be updated to track the WiMedia standard changes.

The Wireless Library also provides preconfigured simulation setups, signal sources and test benches for quick simulation of circuitry used in ultra-wideband applications. This makes it possible to analyze the circuitry's system performance before all the system components are designed.

The UWB wireless library provides valuable projects for UWB-OFDM based systems. The UWB wireless library project is accessible in the example section of ADS.

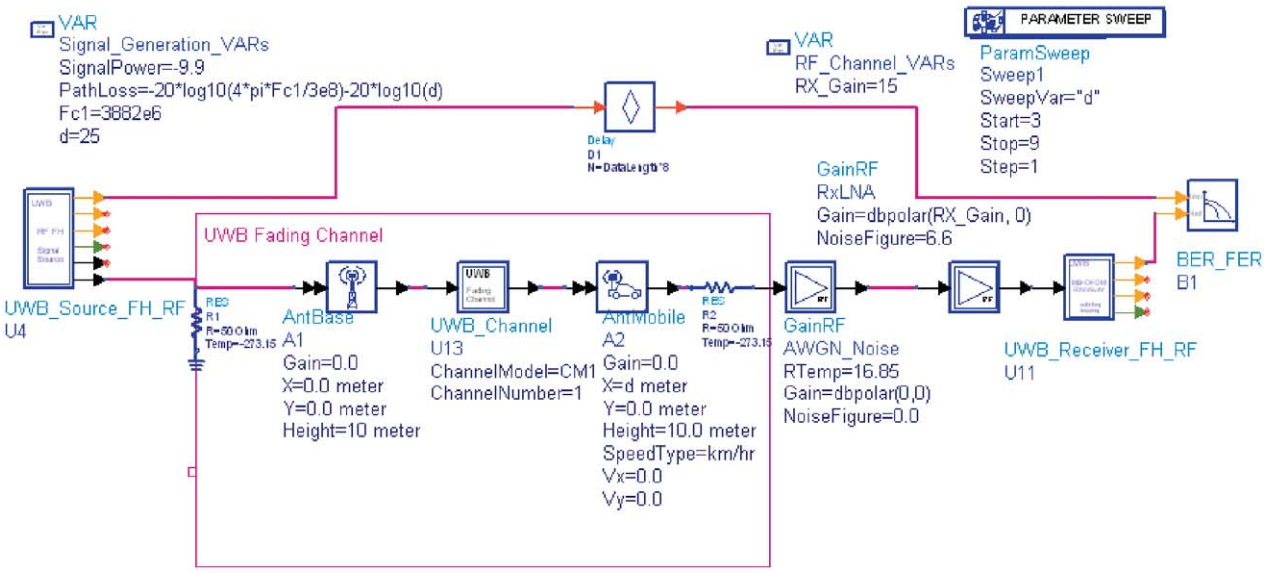

Figure 5. Schematic of UWB MB-OFDM BER measurement with fading channel

As an aid to design development, the following are offered in the UWB MB-OFDM test benches:

UWB MB-OFDM Tx test benches:

- **UWB_OFDM_Demo.dsn** - implement the example in Annex A in IEEE P802.15-04/0493r1 to verify the format of UWB signal source
- **UWB_OFDM_TxCCDF.dsn** - measure CCDF and show waveform of MB-OFDM
- **UWB_OFDM_TxEVM.dsn** - measure EVM and show the demodulated constellation
- **UWB_OFDM_TxSpectrum.dsn** - measure spectrum mask and show frequency hopping function

UWB MB-OFDM Rx test benches:

- **UWB_OFDM_PER_vs_Range_AWGN.dsn** - measure PER vs. Range in AWGN environment for MB-OFDM
- **UWB_OFDM_RxSensitivity.dsn** - measure UWB MB-OFDM sensitivity

Related literature

Ultra-wideband Communication RF Measurements, Application Note, literature number 5989-0506EN

89600S Vector Signal Analyzer CD, literature number 5980-1989E

89600 Series Vector Signal Analysis Software 89601A/89601AN/89601N12, Technical Overview, literature number 5989-1679EN

89600 Series Vector Signal Analysis Software 89601A/89601AN/89601N12, Data Sheet, literature number 5989-1786EN

Agilent N7619A Signal Studio for Multiband OFDM UWB, literature number 5989-2927EN

Agilent E8267D PSG Vector Signal Generator, Data Sheet, literature number 5989-0697EN

Agilent PSG Signal Generators, Brochure, literature number 5989-1324EN

Agilent E8267C PSG Vector Signal Generator, Data Sheet, literature number 5988-6632EN

Agilent PSG Vector Signal Generator Self Guided Demo, literature number 5988-8087EN

Infiniium 80000B Series Oscilloscopes & InfiniiMax Series Probes, Data Sheet, literature number 5989-4604EN.pdf

Publications and seminars

November 2, 2004 – *Agilent Technologies announces Ultra-Wideband Design Exploration Library that speeds emerging wireless product development*
www.agilent.com/about/newsroom/presrel/2004/02nov2004a.html

Web Seminar: 19 October 2004 – *Early Verification of Emerging UWB and WMAN Radio Systems*, **http://eesof.tm.agilent.com/news/news400.html#uwb_seminar**

October 18, 2004 – *IWT selects Agilent Technologies' EDA tools to help prove ultra-wideband designs for design prototyping*,
www.agilent.com/about/newsroom/presrel/2004/18oct2004a.html

Cheryl Ajluni, Editor, *Software Drives Ultra Wideband Home, Cover Story, Wireless System Design*, July/August 2004. **www.wsdmag.com/Articles/ArticleID/8622/8622.html**

Resources

For more information, see **www.Agilent.com/find/uwb**

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Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

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Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise
Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you receive your new Agilent equipment, we can help verify that it works properly and help with initial product operation.

Your Advantage
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For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office.

Phone or Fax

United States:
(tel) 800 829 4444
(fax) 800 829 4433
Canada:
(tel) 877 894 4414
(fax) 800 746 4866
China:
(tel) 800 810 0189
(fax) 800 820 2816
Europe:
(tel) 31 20 547 2111
Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (080) 769 0800
(fax) (080) 769 0900
Latin America:
(tel) (305) 269 7500
Taiwan:
(tel) 0800 047 866
(fax) 0800 286 331
Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6755 0042
Email: tm_ap@agilent.com
Contacts revised: 09/26/05

The complete list is available at:
www.agilent.com/find/contactus

Product specifications and descriptions in this document subject to change without notice.

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