

TECHNOLOGY LEADER SERIES

Signal Generation & Analysis for W-i-d-e-b-a-n-d Aerospace/Defense Systems

Choosing the right broadband measurement solution for your application

The ever evolving need for improved radar resolution, high data rate communications, and robust interference immune reception is the driving force behind the increase in wide bandwidth signals used in modern Electronic Warfare (EW), MILitary COMmunications (MILCOMS), Electronic INTElligence (ELINT), and Direction Finding (DF) systems.

Finding instrumentation to test these ever evolving wideband aerospace/defense systems can be a challenge. Many of these advanced wideband systems are coherent multi-channel designs, employing phased array antennas that require multi-port test capability. Both wideband signal generation and analysis are needed,

and with the current state-of-the-art, the wideband signal being generated or analyzed may be in a digital form rather than an analog form. As signal bandwidth exceeds 200 MHz, finding effective test equipment solutions for today's advanced RF system becomes increasingly difficult.

In this article, we look at some

of the unique test instrumentation that is available to address the special needs of advanced aerospace/defense applications.

New Architectures to Meet the Challenge

Historically, these wideband test signal demands have required complex, custom-built test instrumentation.

Agilent now offers test equipment architectures with the features and interconnection ports needed to enable advanced wideband multi-port microwave signal generation and analysis.

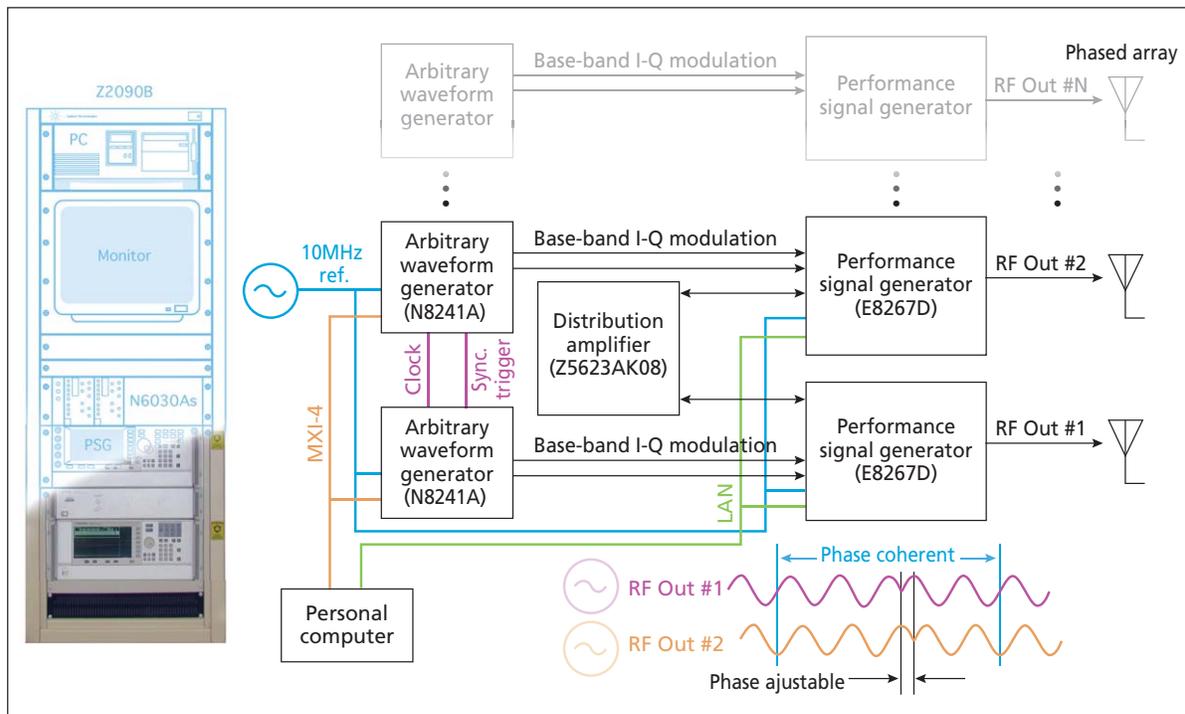


Figure 1: The Z2090B system can produce multiple modulated signal outputs that are phase coherent with precisely synchronized modulation patterns. This allows simulation of the spatial relationships of an arriving wave-front arriving at multiple antennas.

To illustrate, let's explore some of the specific test and analysis solutions beginning with signal generation.

Wideband Signal Source Solutions

Agilent's Z2090B wideband signal source solution utilizes the low phase noise E8267D Performance Signal Generator (PSG) and the high-resolution N8241A arbitrary waveform generator. The unique N8241A leads the industry with an amazing 15 bits of amplitude resolution at sample rates of 1.25 GS/s.

Working together, the 44 GHz PSG and high dynamic range N8241A arbitrary waveform generator deliver superb performance for a number of difficult wideband applications.

Phased Array & DF Testing

Agile phased array antennas dominate new designs, many of which operate over wide bandwidths. Testing the agile array's ability to track a target hundreds of miles away often requires a challenging test stimulus that is precisely phased across multiple channels to simulate an arriving wave-front.

Similarly, some intelligence receivers use multiple phase coherent receivers to determine the bearing angle to the signal emitter.

Testing these systems is difficult. Their wideband designs require pre-

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cisely phased signal inputs at multiple input ports to simulate the spatial relationships of various emitters.

Field-testing multi-port electronic systems is often cost prohibitive as well, requiring expensive configurations of multiple airborne or surface assets spaced hundreds of miles apart.

Responding to this demand, the Agilent Z2090B system architecture is uniquely capable of addressing the

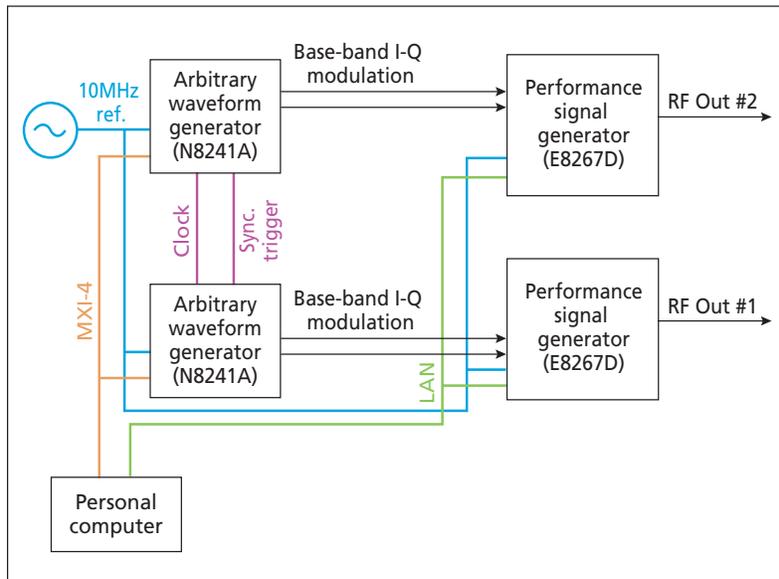


Figure 2: To generate entire spectral environments multiple N8241A arbitrary waveform generators can be up-converted to different frequency bands with the E8267D performance signal generators.

challenges of Phased Arrays and DF equipment. Architectural interconnections have been provided to allow multiple PSGs to be modulated with multiple N8241A arbitrary waveform generators. The modulated outputs of the PSGs can then be connected to a phase coherent array. This arrangement can synthesize signal bandwidths up to 1 GHz from flexible digital files defined in Agilent's Signal

ing of modulated waveforms.

Phase offsets between multiple phase coherent signals from the 44 GHz E8267Ds are implemented using digitally synthesized modulation. This allows synthesis of complex signals arriving at antenna ports with the proper delays to simulate an arriving wave front.

Broadband EW Spectral Environments

Bandwidth requirements for military communications have also grown over the years as systems move from voice to bandwidth hungry high-resolution video.

Aerospace/defense systems typically function in complex RF spectral environments, with jammers and interferers that utilize many octaves of bandwidth. Compounding the growth in data rate, many communications systems have gone to spread spectrum signals that frequency hop over huge bandwidths to reduce the probability of intercept and improve performance in messy signal environments.

Generating gigahertz of spectral environment to test the robustness of

these data links can require extreme bandwidth capability.

When confronted with the need to generate such a test environment, multiple PSGs modulated with N8241A arbitrary waveform generators can be offset in frequency to provide continuous signal bandwidths greater than the 1 GHz available with a single PSG and N8241A system.

For example, five PSGs and N8241As can generate up to 5 GHz of spectrum to test a broad range of spectral situations.

Furthermore, the N8241A's superior sequencing ability allows it to create complex signals using sequencing of short repetitive signal snippets without massive amounts of signal memory. This important feature enables long or continuous play of wide bandwidth spectral environments, without Tera bytes of high-speed waveform storage memory.

In addition, the N8241A incorporates a built-in Direct Digital Synthesis (DDS) feature that expands simulation capabilities without using additional memory.

The Z2090B can also be configured to playback wideband signal recordings taken from the field. MILCOM engineers can employ the Z2090B to analyze system responses to multi-path, interference and more, using either recorded or synthesized signals.

Advanced tools, like Signal Studio or third party software solutions, can quickly and easily generate complex multi-carrier spectral environments that include moving emitters with changing Doppler shifts.

The Agilent Z2090B series signal simulation systems offer the flexibility and performance for addressing challenging wideband signal stimulus requirements.

Broadband Signal Analysis Options

Many of the same challenges that exist for creating test signals exist for analyzing broadband modulated signals: bandwidth, multi-port capabil-

ity, coherency and the like, all present measurement challenges.

For this reason, Agilent offers a variety of signal analysis options for broadband system analysis and test.

Coherent Receiver Array Measurements

Whether comparing the phase of arrival of two complex modulations to resolve a bearing angle or characterizing the spectral shape of an Ultra Wide Band (UWB) signal, the Infiniium Oscilloscope offers a tremendous variety of wideband measurements.

Agilent's Infiniium 90000A series oscilloscopes sample at rates up to 40 GS/s, providing analysis bandwidths up to 13 GHz wide. Furthermore,

Field-testing multi-port electronic systems is often cost prohibitive as well, requiring expensive configurations of multiple airborne or surface assets spaced hundreds of miles apart.

the 90000A has the industry's lowest noise floor, best phase noise performance and the flattest frequency response.

These superior performance traits allow the multi-channel Infiniium oscilloscope to capture ultra narrow time domain events and conduct RF modulation analysis.

The 'VSA 90000A Ultra Wideband Signal Analyzer,' bundles the Infiniium 90000A oscilloscope with the 89600A Vector Signal Analyzer (VSA) software. This powerful combination expands the Infiniium's measurement capability far beyond traditional time domain measurements. The VSA software enables frequency domain spectral measurements as well as in depth modulation measurements.

In addition to performing these measurements on signals with many gigahertz of bandwidth, the multiple input ports of the high-speed oscilloscope allow simultaneous two-channel analysis.

Even cross channel signal correlations and phase measurements can be

made. These unique capabilities are ideal for comparing the phase differences between two different wideband receiver channels.

The VSA 90000A's unique wideband two-port measurement capability makes it an effective measurement solution for advanced wideband multi-channel systems.

Software Defined Radios

When considering broadband signal measurement capability, logic analyzers may not immediately come to mind; however, with the ubiquitous trend to implement greater portions of complex systems in software defined hardware with ultra fast FPGA digital processing,

increasingly the wideband signal is digital rather than analog.

The Agilent analysis product line is unique in that the 89600A VSA software is available on a variety of hardware platforms. Spectrum analyzers, oscilloscopes and logic analyzers can all host this powerful analysis tool.

The Agilent 16800 series logic analyzers, for example, support measurement of wideband modulations in digital formats with the 89600A VSA software.

Not only do these high speed wide bandwidth logic analyzers provide a means to measure digital signal modulation performance while still in a binary bus format, but the 89600A software interface is identical to that used on Infiniium oscilloscopes and traditional vector signal analyzer instruments.

The 89600A analysis software can then be applied to vastly different signal formats. Logic analyzers can perform modulation analysis on digital I-Q busses. Even bus signals deep inside Field Program-

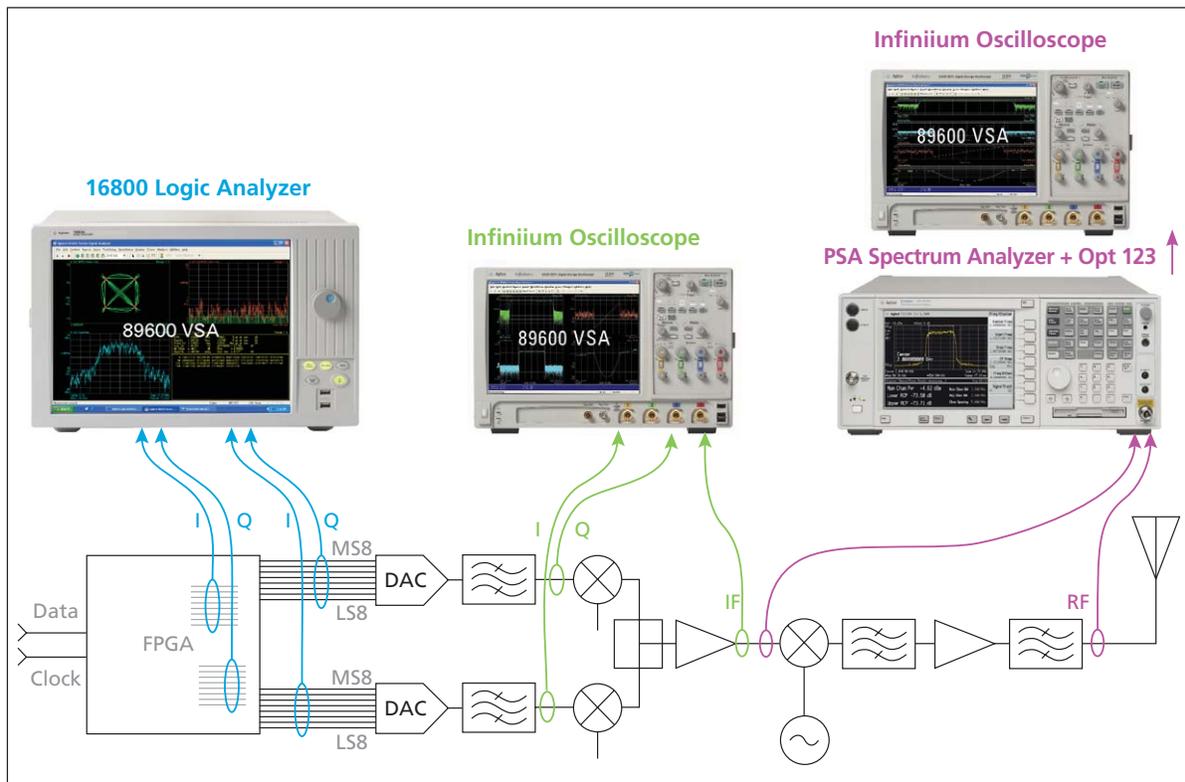


Figure 3: Agilent offers a unique set of wide bandwidth analysis tools that all use the powerful 89600A vector signal analyzer software. High-speed logic analyzers, broadband oscilloscopes and high performance spectrum analyzers allow consistent detailed modulation analysis, no matter what signal format is used.

mable Gate Arrays (FPGA) can be probed with Agilent's FPGA dynamic probing.

The view scope function coordinates precision timing of the logic analyzer and oscilloscope signals on a single screen, to reveal the exact digital bus state of signal errors found with the 89600A VSA software.

The MXA or E4440 PSA series of Performance Spectrum Analyzers (PSA) also support the same 89600A software, allowing uniform analysis of all types of signal formats at vastly different frequencies and with vastly different signal formats. Now, one consistent set of analysis software can compare modulated signals across digital and analog format transitions.

For wideband analysis the PSA spectrum analyzer with option 123 can function as a broadband down-converter whose IF output can be digitized using the Infiniium oscilloscope

to achieve measurement bandwidths up to 230 MHz throughout the PSA's frequency range of 3 Hz to 50 GHz.

Other external down-converters can be used for wider bandwidths. In addition to the broad frequency range and high bandwidth of these instruments, the 89600A VSA software provides error corrected data with its new down-converter calibration algorithms. These routines remove I and Q gain, offset, and quadrature errors introduced by the down-converter interface. This unique combination of high-performance hardware and software provides a powerful measurement tool for broadband MILCOM signals as well as characterization of radar pulses containing complex intra-pulse modulation.

Outlook

Agilent offers the wideband measurement solutions needed to extend performance far beyond typical test instruments.

Whether the requirements are for radar, EW, ELINT, phased arrays, or just terrestrial Ultra Wide Band (UWB) communications, the Z2090B provides a test stimulus platform for wideband success.

The advanced measurement capabilities of Agilent's 89600A VSA software and variety of hardware front ends ranging from the E4440 PSA, Infiniium oscilloscopes to the 16800 series logic analyzers, can tackle tough wideband, coherent multi-port analysis problems.

Agilent would like to help. Supported by factory experts, the Agilent field representative is trained to assist you in electing the right broadband stimulus and analysis test solutions for demanding aerospace and defense applications. ■

FOR MORE INFORMATION

Visit www.agilent.com/find/wideband or call 1-800-829-4444 to speak with your Agilent sales representative.

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