

## BACKGROUND

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### The Importance of Baseband Verification at Early Stages of Product Development

Designers of modern transceiver systems are working to verify baseband performance at earlier stages of design to avoid costly rework after system integration. As product complexities increase, verification at the baseband level becomes more important as most of the intelligence in the modern transceiver resides at the baseband. What is needed to accomplish this early-stage verification is a comprehensive set of tools that allows for hardware and algorithms to be tested at the baseband level, as well as at every other stage through prototyping, using signals that accurately portray the environment in which the end product will operate.

The Agilent Baseband Studio is a new suite of baseband signal applications and accessories designed specifically for this task. The Baseband Studio suite includes four products that initially work with the Agilent E4438C ESG or Agilent E8267C PSG vector signal generators to enhance Agilent's signal-creation and

signal-generation tool sets for design engineers in the cellular communications, WLAN, and aerospace industries. These products enable three applications:

- o Digitally integrated fading and calibrated noise in one easy setup solution for the ESG signal generator;
- o Hours of unique RF and baseband waveform streaming in a commercial-off-the-shelf (COTS) solution for the ESG or PSG signal generators; and
- o Digital I/Q and IF outputs for the ESG and PSG signal generators.

Looking individually at the benefits of each Baseband Studio application illustrates how this versatile suite of tools can enhance the process of baseband design verification.

### Fading

Baseband Studio for fading is a powerful channel simulation software tool for verifying cellular radio and WLAN receiver designs under real-world signal conditions. It allows designers to achieve realistic channel simulation using multipath fading with the addition of additive white Gaussian noise (AWGN), and simulate a diversity antenna or an interfering signal by adding a second channel. Preconfigured fading profiles for W-CDMA, TD-SCDMA, cdma2000, cdmaOne, 1xEV-DO, 1xEV-DV, GSM, EDGE, and WLAN standards simplify initial setup, or user-defined fading profiles can be used to meet specific test needs.

The complete fading solution is comprised of hardware and software that work together with the E4438C ESG vector signal generator. The ESG creates digital baseband I/Q signals, and sends the signal to a PC equipped with the N5101A Baseband Studio PCI card and N5115A Baseband Studio for fading software. The software has a PC-based interface that is used to configure the channel simulation parameters. The baseband signal is faded digitally in the PCI card and then sent back to the ESG for conversion to analog I/Q or RF. The faded signal can then be used to test receiver performance under fading conditions. The user-friendly software includes an array of standard fading profiles, including Rayleigh, Rician, Suzuki, log normal, Doppler shift, and constant phase while retaining the ability for the user to modify any settings. Baseband Studio for fading is available in two bandwidths, one or two-channel versions, with or without additive noise.

## Waveform Streaming

Baseband Studio for waveform streaming was created in response to the need by designers of radar and communications systems for a commercial product that could stream large signal files continuously into a receiver under test. Since there was no COTS solution available with this capability, designers had two choices. They could separate long files into shorter segments that fit in the memory space of a signal generator, and then load and play back each segment, one by one. They could also take working hardware into the field where jammers and other interferes were present to evaluate performance.

The first alternative can be extremely tedious because some signal files can represent hours of information. Playing such large files back in segments can take too long to be practical, so often just a few segments are selected, which sometimes cannot fully represent all expected signal conditions. The second alternative is expensive, inconvenient and potentially dangerous, since for radar receiver evaluation the chosen location could be the flight deck of an aircraft carrier.

Baseband Studio for waveform streaming enables real-time streaming of a very long waveform file from the hard disk drive of a PC (equipped with the streaming software and the N5101A PCI card) to the ESG or PSG vector signal generator, using it as stimulus to test satellite, radar or wireless communication receivers. It is useful for a wide array of tests, including multicarrier power amplifier (MCPA) predistortion testing, base station transceiver testing, mobile receiver testing, and satellite and radar testing.

## Digital Outputs

The Agilent N5102A digital signal interface module could be considered a simple adapter-type device, as it converts the output of an instrument to a digital baseband or digital IF signal. However, the complexity of modern digital modulation schemes makes this task considerably more difficult. This is especially true considering the wide variety of formats that must be supported, including W-

CDMA, multitone, 1xEV-DO, 1xEV-DV, WLAN, GSM, EDGE, TD-SCDMA, PHS, DECT and many others.

The interface module essentially provides bit-level access to the entire set of complex test signals provided by the ESG and PSG vector signal generators. The instruments generate the signals required to simulate a particular communications or radar environment, and the interface module delivers the test signals to the device under test (DUT) as digital I/Q or digital IF data.

The interface module can also reduce the task of supporting a variety of different signal interfaces (required to meet different operating environments) to simple menu choices, rather than having to design custom fixtures for each one. Agilent also provides the interchangeable breakout boards needed to easily connect to the DUT. In addition, the module simplifies the connection process by allowing the user to accommodate virtually any data format, clock setting and signal interface (usually without custom fixturing).

These tools help designers gain insight into their designs far earlier and with less equipment than other techniques. Although the re-configurable architecture of these products provides the flexibility to enable future applications, they currently provide capabilities found nowhere else that can bring baseband verification to the early stages of design, enabling a smooth transition to prototype hardware.

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