AXIe Delivers Multi-Vendor Solutions
for Advanced Radar and Electronic Warfare Applications

By Mark Elo, Giga-tronics

Whether designing operational radar and EW (electronic warfare) systems, or testing the associated LRUs (Line Replaceable Units) after deployment, a testing team is often challenged to accomplish the tasks using COTS (Commercial Off-the-Shelf) test equipment. Until recently, the advanced nature of the signals and the lack of a high power modular infrastructure made this a nearly impossible goal. Thanks to AXIe® (AdvancedTCA® eXtensions for Instrumentation), this is no longer the case.

AXIe is a high performance modular system that is based on LAN and a high speed PCIe® backplane. Like PXI®, It is an open system, which allows a user to mix and match modules from various vendors to create the test system of their choice. The COTS requirement is met by acquiring modules, chassis, and software from commercial vendors. AXIe supports up to 200 watts per slot. This, coupled with a board area and module volume that is several times that of PXI, makes it an ideal platform for addressing high performance testing applications. In the software domain, AXIe systems act like PXI systems, leveraging the same software. Therefore, familiar software products such as Microsoft Visual Studio, National Instrument LabVIEW®, or MathWorks MATLAB® easily work with AXIe systems.

This paper will present example AXIe systems configured to address radar and EW applications. It is useful to note that there are generally two classes of measurements- receiver testing (where signal generation is required), and transmitter testing (where signal analysis is required). HIL testing (Hardware in the loop), typically requires both. Fortunately, high performance AXIe signal generation and analysis modules make all of this possible.

Receiver Testing
To test a receiver, one must generate the appropriate signal at the appropriate frequency. Typically the complex modulation is created using off-line tools, and then executed in real time. The example in Figure 1 shoes how a chirp function can be easily created using National Instruments Graphical programing language LabVIEW.

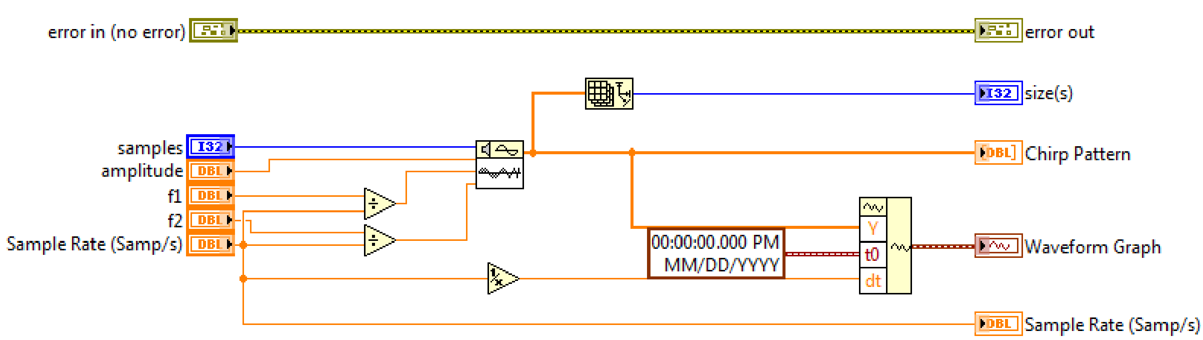

Figure 1. A Simple LabVIEW VI (Virtual Instrument) Generating a Chirp Waveform.

The resultant output of an NI LabVIEW® VI or a MATLAB Script can be down loaded as a waveform file into AXIe instrumentation such as the Keysight® M8190A Arbitrary Waveform Generator (AWG). Many thousands of waveforms can be stored in the instruments memory. This is especially useful when emulating specific rise and fall times of specific radars.

AWGs by themselves may not offer the required frequency range, and must be complemented with up-converters. Two methods of up-conversion are available in AXIe. The Synopsys AWGUP series of up converters offer banded up-conversions (either 2GHz or 4GHz of Bandwidth) up to 36GHz. Fast frequency switching times within these bandwidths make it ideal for testing a specific radar within a known operating band. However, when ultra-broadband up-conversion is required the Giga-tronics® GT-ASG18A offers wide instantaneous bandwidth up-conversion from 10MHz to 18GHz, making an ideal platform for multiple types of radars or electronic warfare applications.

Transmitter Testing

For radar signal analysis the The Guzik® ADC6131 can acquire at 13GHz of Instantaneous bandwidth. It has a powerful FPGA processing engine that allows high-speed analysis of radar signals within its acquisition bandwidth. Figure 2 shows how the output of a broadband acquisition performed by the ADC6131 using the W2650A Oscilloscope Signal Analyzer (OSA) Software form Keysight Technologies to display the results of the acquisition of a series of pulses in the X-band.

26-Jan-2011 05:31:36.203	Start Time	Pulse Width (PW)	Pulse Rep Intvl (PRI)	Frequency Average
1	-11.790 ns	1.0160 µs	-11.790 ns	10.008 GHz
2	49.992 µs	1.0160 µs	50.004 µs	10.008 GHz
3	99.996 µs	1.0160 µs	50.004 µs	10.008 GHz
4	150.00 µs	1.0155 µs	50.004 µs	10.006 GHz
5	200.00 µs	1.0160 µs	50.004 µs	10.008 GHz
6	250.01 µs	1.0160 µs	50.004 µs	10.007 GHz
7	300.01 µs	1.0155 µs	50.004 µs	10.007 GHz
8	350.01 µs	1.0155 µs	50.004 µs	10.005 GHz
9	400.02 µs	1.0160 µs	50.004 µs	10.007 GHz
10	450.02 µs	1.0160 µs	50.004 µs	10.007 GHz
11	500.03 µs	1.0160 µs	50.004 µs	10.007 GHz
12	550.03 µs	1.0160 µs	50.004 µs	10.007 GHz
13	600.03 µs	1.0160 µs	50.004 µs	10.007 GHz
14	650.04 µs	1.0160 µs	50.004 µs	10.008 GHz
15	700.04 µs	1.0160 µs	50.004 µs	10.007 GHz
16	750.05 µs	1.0160 µs	50.004 µs	10.008 GHz
17	800.05 µs	1.0160 µs	50.004 µs	10.008 GHz
18	850.05 µs	1.0160 µs	50.004 µs	10.008 GHz

Figure 2. W2650A Oscilloscope Signal Analyzer (OSA) Software form Keysight Technologies showing the output of an acquisition from the Guzik ADC6131.

The Keysight Technologies 89601 VSA Software allows deeper analysis of signal quality. Figure 3 shows an AXIe generated 1GHz chirp centered at 10GHz, simultaneously analyzed in three different domains: amplitude over frequency, and frequency shift over a time period, and group delay over time.

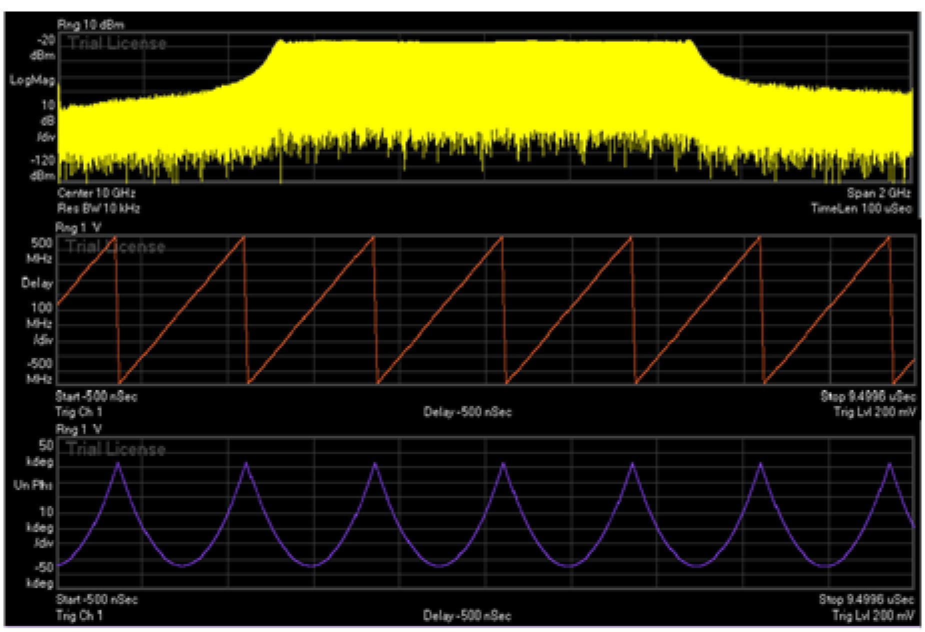

Figure 3. The analysis of wide instantaneous chirp (generated by an AXIe system) is shown analyzed by another AXIe system consisting of a Guzik ADC6131 Digitizer combined with the Keysight 89601 VSA Software.

Advantages of AXIe

For advanced ATE applications AXIe offers a compact generation and analysis tool set. AXIe delivers best-in-class performance for many product categories. The high speed PCIe bus allows waveform up-loads and measurement to run much faster than traditional instruments and its compact design reduces the amount of rack or bench space required to perform measurements.

Leveraging from a pool of pre-developed radar IP (intellectual property) designed for the test and measurement applications, AXIe allows the same IP to be used for advanced applications such as environment generation, theater threat simulations, and HIL (Hardware in the Loop) applications.
Figure 4 shows an example of such an HIL system, composed of two AXIe chassis.

Figure 4. Hardware realization of a closed loop radar test system. While transmitter and receiver testing can each be performed in a single chassis, the two may be combined for sophisticated HIL simulation and analysis.

The two AXIe chassis include the following hardware: On the signal generation side, the Keysight M8190A AWG provides up to 2Gs of waveform storage and playout. The Giga-tronics GT-ASG18A up-converts the baseband signals to anywhere between 10MHz and 18GHz. Waveform playout is scheduled by the Giga-tronics GT-FPGA6A to the device under test. On the signal analysis side, the Guzik ADC6131 acquires up to 13GHz of instantaneous bandwidth, and utilizes special FPGA-based analysis implemented by the companion SDK (System Development Kit). New waveforms can be rescheduled based on the response of the system under test. Each chassis also contains a Giga-tronics GT-SRM100A reference, locking all the instrumentation coherently. Fast dynamic refresh rates allow the user to change the waveform every microsecond.

A key feature of AXIe is its scalability. Chassis sizes range from 2-slot horizontal configurations up to the Keysight M9514A AXIe 14-Slot Chassis. The latter is useful extremely high densities of multi-emitter configurations.

Conclusion

AXIe is an ideal platform for radar and EW simulation and analysis. Popular software tools can generate or analyze complex waveforms, while the growing selection of COTs modules gives the user the ability to generate almost any type of signal they (or their adversary) care to dream up. Current products support frequencies from 10MHz to 39GHz, with many more on the way.