Roos Instruments

Active Electronically Scanned Array Radar Module Test

Image Source: Air Power Australia

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The architecture of Roos Instruments' Cassini High Speed Precision RF & Microwave Automated Test Equipment (ATE) system delivers exceptional value in the production testing of Active Electronically Scanned Arrays (AESA), also called Active Phased Array Radar, for both aircraft and shipboard programs.

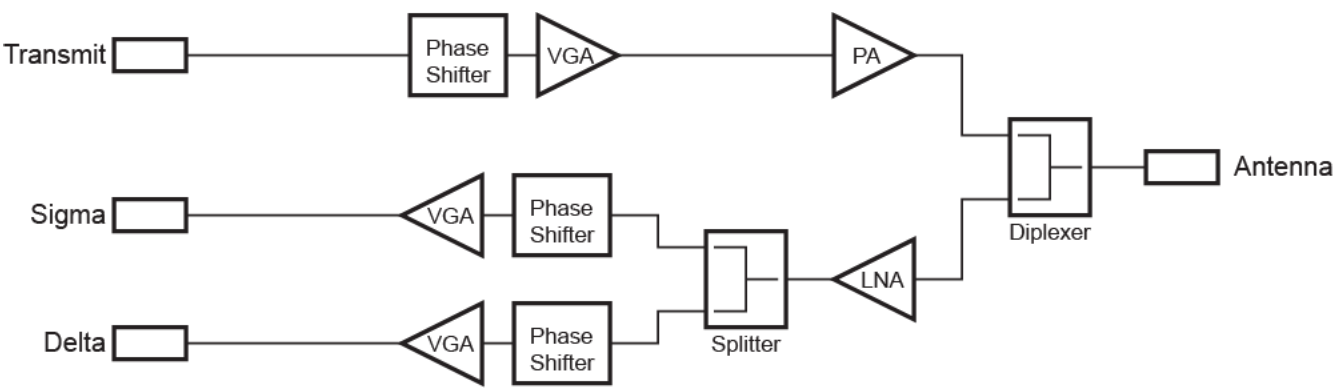
Thales APAR on a Dutch LCF De Zeven Provinciën class frigate

Image source:Royal Netherlands Navy / Koninklijke Marine

AESAs are typically comprised of hundreds of active transmit/receive (T/R) modules. The radar antenna beam pattern is electronically steered by varying the relative amplitude and phase of the modules.

RI's Cassini ATE is ideally suited to enable cost effective manufacturing of systems such as Thales' APAR, Raytheon's XBR, or CEA Technologies' CEAFAR. Dramatic improvements in test time and accuracy are possible for all stages of the radar's production, from individual components to the full radar assembly.

The modern Active Array Radar module is typically made up of multiple digitally controlled and highly tuned microwave switches, phase shifters and variable gain amplifiers. The interaction of these components at each of their respective control states must be measured, checked against valid limits, and calibration data stored to control the electronic steering of the antenna's focused beam. Depending on the design, this typically encompasses thousands of individual measurements.



Block Diagram of a typical AESA element

The accuracy required for measuring multiple states in each module is frequently only a few tenths of a dB and a few degrees of phase. The module is combined with a fixture interface that quickly switches the many signal paths to the required instrumentation and provides reliable connections to the module. The added losses, mismatches, and side effects in the fixturing interface must be characterized and removed from the final module test results. To accomplish this task, S-parameter vector measurements and advanced calibration techniques are used to calibrate and mathematical remove errors of the fixture. The vector math allows a complete model of the actual measurement to be made in software. Due to the accuracy required, complexity of the math, and the calibration techniques needed, typical ATE systems are not up to the task.

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A "rack & stack" measurement system could be designed that uses accurate bench test equipment to overcome the measurement accuracy issues, but the test time for a rack & stack solution would range from several hours to a few days for each module, depending on specific requirements. Therefore, a rack & stack system is not a viable or cost effective solution for volume production.

Roos Instruments brings 20 years experience to RF module test. In 1989, RI developed a production test solution for the US government focused on accuracy and repeatability for monolithic microwave integrated circuits. RI leverages that technology to create economical solutions for production level testing of AESA modules and packages.

RI's latest generation test systems featuer highly configurable hardware and software combined with integrated vector calibration technology to deliver the fastest and most accurate systems available today.

- <u>Single Channel Receiver</u> is used for coherent measurements to provide exceptional repeatability.
- <u>Compiled Vector Calibration</u> ensures accuracy on multiple ports.
- <u>Extendable Calibration</u> all the way to the device ports ensures accuracy at the DUT.
- <u>Graphical User Interface</u> simplifies test plan development.

RI's latest generation ATE systems provide unequaled configurability while maintaining speed and accuracy

RI hardware is designed to be highly reliable, tolerant to temperature fluctuations, and extremely fast. Other test solutions must constantly calibrate to remove the drift factors, but RI has been successful in minimizing them. As a result, RI engineers are able to use a simple block diagram to produce accurate models that consistently produce the highest possible measurement speed while still maintaining accuracy. This innovative system architecture allows a flexible combination of graphical software user interfaces and standard hardware device interfaces.

RF measurements are made with a single channel vector receiver that uses advanced computing power of the system controller to translate those direct measurements into the desired scattering parameters, power measurements, or noise measurements. Vector S-parameter measurements are executed extremely fast and with high accuracy using an innovative time reference approach with the single channel receiver. This design eliminates the need for extensive error correction in matching two sets of I & Q demodulators. Normally, S-parameters ratios are typically measured with two receivers that must be matched perfectly in order to make the same accurate measurements RI does with a single channel. Any small drifts due to time or temperature are canceled out by common mode rejection.

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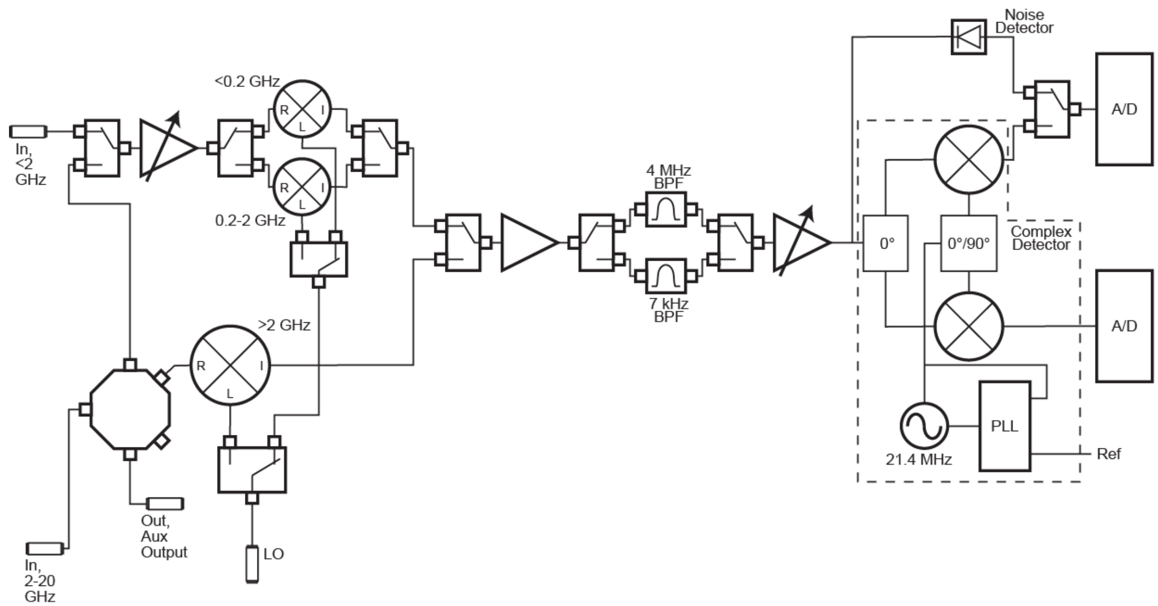

The RI vector receiver can make up to 80,000 complex voltage measurements per second

The simplified hardware is under direct control of the software instead of cascading layers of firmware found in off-the-shelf bench instruments. A low overhead command and control interface replaces the commonly used GPIB bus to enable fast communication with the sources, switching and measuring devices. The incredible processing power of modern PC hardware is used to calculate the desired result from the raw measurement data.

A typical Active Array Radar Module manufacturer will be able to accurately measure their modules while dramatically reducing their test time. Actual test time reductions of up to 420% have been seen in previous applications. For example, a five hour test time using bench equipment can be reduced to only seven minutes with RI ATE. The US government was looking for a single order of magnitude improvement to make Active Array Radar Module testing an economic reality and RI delivered over 4 orders of magnitude improvement in test time!

RI's ability to make accurate relative phase and amplitude measurements on multiple RF & Microwave ports makes the production process of Active Array Radar Modules economically feasible. Our single channel receiver design combined with an extensible, all inclusive, calibration technique increases the repeatability by using the same receiver for coherent measurements and increases the accuracy with multiple port vector calibrations. Our latest generation of RI test solutions helps our customers dramatically reduce cost and test time.

Make sure your program is using an RI Microwave ATE system for lowest life cycle cost and highest precision measurement throughput available!

Contact Roos Instruments, Inc. at 408-748-8589, at Sales@roos.com or visit our web site at www.roos.com

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