2095P PULSED MICROWAVE MEASUREMENT SYSTEM FOR THE NAVAL SURFACE WARFARE CENTER, CRANE DIVISION

R. S. Sauerman
Scientific-Atlanta, Inc.

A. R. Tillerson
Naval Surface Warfare Center, Crane Division

ABSTRACT

Modern pulsed phased array radar systems bring new challenges to antenna measurement. These antennas generally consist of hundreds of Transmit-Receive (TR) modules controlled via a beam steering computer to form the antenna beam. Attempting to operate these modules with a CW waveform will not only quickly damage the modules but will not properly characterize the antenna. The Navel Surface Warfare Center, Crane Division, recognized the need to add pulsed capability when specifying their latest antenna measurement system. Scientific-Atlanta met these requirements by integrating their newly introduced Model 1795P Pulsed Microwave Receiver into their proven 2095 Microwave Measurement System to make the Model 2095P Pulsed Microwave Measurement System.

Keywords: Antenna Measurements, Pulsed Radar

1.0 INTRODUCTION

Naval Surface Warfare Center (NSWC), Crane Division, located in Crane, Indiana required two antenna measurement systems in conjunction with the development of two new antenna ranges. The systems should not only meet the requirements of current workload, but also have the capability to handle the requirements of the next generation antennas. NSWC Crane also desired antenna measurement systems having the versatility to allow future expansion into areas such as near-field measurement and radar cross section measurement. Further, these requirements had to be met with limited personnel while trying to remain competitive in both price and time and provide a quality product.

NSWC Crane's primary goal was to have systems capable of meeting the requirements of the two newly constructed far-field antenna ranges. One system would be dedicated to an indoor 30-foot by 30-foot by 100-foot anechoic chamber which would be used in system test and verification of a shipboard electronic warfare defense system. The test scenario would require a system capable of making pulsed measurements over many different test channels in the least amount of time possible. The second measurement system would be dedicated to an outdoor range with length of 6280 feet. This range will be used to verify the radiation characteristic specifications of overhauled, planar-array frequency scanned shipboard antennas. To meet the specifications of this test, a receiver with increased sensitivity, dynamic range and measurement speed was required. (The ability to take measurements with the transmit signal being pulsed is also required.)

The secondary goal, however none the less important, is to have expandable antenna measurement systems. To meet future fleet requirements, characterization of next-generation antennas is required. The new technology antenna systems are electronically steerable phased array antennas. These antennas are constructed of hundreds and even thousands of separate Transmit/Receive (T/R) modules whose phase is controlled by a beam steering computer to form a single steerable beam. These modules are designed to be pulsed at a particular duty factor and generate high power levels while transmitting. In order to properly test these antennas, the measurement system must have traditional antenna measurement capability as well as the ability for pulse measurements such as ringing, droop, and phase shift during the pulse period. The procurement package submitted by NSWC Crane reflected these requirements

2.0 SOLUTION

The NSWC selected Scientific-Atlanta Model 2095P Pulsed Microwave Measurement Systems with special options to meet the special requirements of each of the two systems. The 2095P differs from the standard 2095 Measurement System with the introduction of the 1795P Pulsed Microwave Receiver into the system. This addition gives the system the capability to accurately measure pulsewidths as narrow as 100 nsec, at pulse repetition rates from 1 μsec up to seconds, minutes, or even hours if necessary. In addition, the new receiver gives the 2095P system the ability to take measurements at a

10,000-measurement-per-second rate, twice as fast as any previous measurement system.

The 1795P Receiver accomplishes these specifications through advanced digital signal processing techniques. Direct sampling of the 45 MHz Local Oscillator (LO) eliminates the need to split the analog signal into In-phase (I) and Quadrature Phase (Q) channels. This eliminates the gain and phase mismatches associated with the traditional approach. This new approach allows the signal to be processed in a variety of ways, allowing for traditional phase and amplitude measurements, as well as noise power measurements and spectral analysis, all performed with the same receiver.

Commercial analog-to-digital converters cannot approach the required 100 + dB of dynamic range required by typical antenna ranges. Some type of gain control must be used by the typical receiver to accomplish the dynamic range requirements. In CW mode the receiver simply measures a portion of the signal with no gain applied and then adjusts the gain accordingly. In pulse mode this is impractical due to the large variations of pulse widths and pulse repetition frequencies.

For pulse mode application the 1795P Receiver uses the previous channel measurement to determine its gain setting. This differs from other receivers using this technique in that the 1795P keeps track of the previous measurement taken for as many as 16 different channels. This is important when large variations occur channel to channel, such as the measurement of sum and difference channels of a monopulse antenna. Errors in the gain calculation by simply using the previous measurement without regard to channel can lead to an overvoltage condition at the A/D, causing saturation and measurement errors.

The 2095P provides user screens to set up the necessary pulse measurement scenario. One of these screens is shown in Figure 1. The system maintains pulse synchronization by an external TTL trigger located on the rear of the 1795P IF unit. The user may select any delay in increments of 33.33 nsec (1/30 MHz) before starting the sample interval. This removes the delay associated with the pulse traveling the range length. In addition, three TTL outputs are provided on the rear of the 1795P IF unit which may be programmed by the user for such things as RF triggering or bias voltage control of the transmitter.

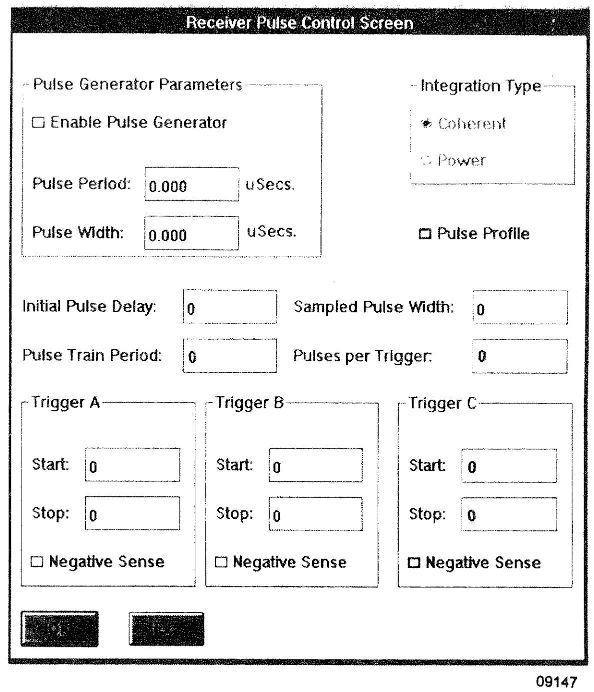

Figure 1. Sample User Screen

Both systems provided to NSWC contain digital delay generators to control pulse generation as well as an RF modulator to provide for a pulsed RF source. Screens are provided as part of the 2095P setup to control this delay generator. This control can be disabled if the UUT provides the TTL trigger.

Another addition to the normal 2095 software is the test state control screen. This allows the user to control 16 bits on the auxiliary output of the system's Data Acquisition Coprocessor (DAC). This provides control for a beam steering computer or any user test equipment which requires synchronization with the measurement.

3.0 CONCLUSION

The 2095P Pulsed Microwave Measurement System provides new solutions to pulsed measurement requirements as those foreseen by NSWC, Crane Division. The system combines advanced digital signal processing techniques to add pulse measurement capability and improved measurement speed. The personnel at NSWC and Scientific-Atlanta have teamed to provide a common system which meets the requirements of two different testing environments.