AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

Conf-94/231--1

LA-UR-94-- 2 7 6 3

Title:

S-PARAMETER TEST SET FOR PULSED NETWORKS

Author(s):

A. H. Regan, C. D. Ziomek, T. R. Brooks

Submitted to:

IEEE MTTTS RF TECHNIQUES GROUP

Boulder, Colorado

December 1-2, 1994

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Los Alamos
NATIONAL LABORATORY

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the U.S. Department of Energy under contract W-7405-ENG-36. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. The Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy.

Form No. 836 R5
ST 2629 10/91

S-PARAMETER TEST SET FOR PULSED NETWORKS

A.H. REGAN, C.D. ZIOMEK, T.R. BROOKS

LOS ALAMOS NATIONAL LABORATORY

A scattering parameter test set that operates in a pulsed mode for analyzing RF/microwave networks has been developed. Designed for analyzing various components of accelerator RF systems, the test set is applicable to a variety of components at different frequencies. The test set consists of an embedded processor, a tracking downconverter, a dual channel vector detector, a timing distribution module, a pulse generator, and a signal generator. The majority of the hardware is packaged in the modular VXIbus architecture, and the control software is National Instruments' LabVIEW®. Measurements of systems have been made centered around 425 MHz, 850 MHz and 1300 MHz, although other frequency regimes are available. This test set sweeps frequency and amplitude levels while measuring the in-phase and quadrature components of the incident, reflected, and transmitted signals. With this system, gain and phase measurements have been made on high-power amplifiers, transmission lines, and low-level control systems individually and as a combined entity. In addition, utilization of this system for material characterization (e.g., microwave absorption versus frequency, amplitude, temperature, pressure, etc.) is planned. This paper will discuss the test set architecture, implementation, and present typical results obtained measuring pulsed components.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Amy H. Regan
Los Alamos National Laboratory
P.O. Box 1663, MS H827
Los Alamos, NM 87545
(505) 665-0658

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

for

S-PARAMETER TEST SET FOR PULSED NETWORKS

A.H. REGAN, C.D. ZIOMEK, T.R. BROOKS
LOS ALAMOS NATIONAL LABORATORY

A scattering parameter test set that operates in a pulsed mode for analyzing RF/microwave networks has been developed. Designed for analyzing various components of accelerator RF systems, the test set is applicable to a variety of components at different frequencies. The test set consists of an embedded processor, a tracking downconverter, a dual channel vector detector, a timing distribution module, a pulse generator, and a signal generator. The majority of the hardware is packaged in the modular VXIbus architecture, and the control software is National Instruments' LabVIEW®. Measurements of systems have been made centered around 425 MHz, 850 MHz and 1300 MHz, although other frequency regimes are available. This test set sweeps frequency and amplitude levels while measuring the in-phase and quadrature components of the incident, reflected, and transmitted signals. With this system, gain and phase measurements have been made on high-power amplifiers, transmission lines, and low-level control systems individually and as a combined entity. In addition, utilization of this system for material characterization (e.g., microwave absorption versus frequency, amplitude, temperature, pressure, etc.) is planned. This paper will discuss the test set architecture, implementation, and present typical results obtained measuring pulsed components.

Figure 1 depicts the test set block diagram. Note that the device-under-test (DUT) is depicted after the microwave amplifier in this configuration. This is not always necessary. When one wishes to measure the s-parameters of a high power amplifier, the incident and reflected voltage pickups occur at the amplifier's input and in this case the microwave amplifier itself is the DUT.

Figure 1. S-parameter test set block diagram.

Examples of the type of measurements obtained with the s-parameter test set are shown in figures 2-8. It should be noted that the data are collected on a Macintosh computer with this system, thus enabling easy use of many data manipulation software packages. Figure 2 depicts the S_{21} data measured on the first stage of a RF driver utilized in a 1300 MHz system. Figure 3 is the driver's associated S_{21} phase.

Figure 2.

Figure 3.

Figure 4 depicts the gain of the RF system for a 1300 MHz accelerator. This system consists of the low-level RF (LLRF) control electronics, the transmission lines, the high power 1300 MHz klystron, and the accelerating cavity.

Figure 4. Gain of 1300 MHz RF system.

Figure 5 is the |S₂₁| measurement of just the LLRF control electronics. The LLRF control system contains a tracking downconverter in addition to proportional, integral, and differential control circuitry. Note that the lock-in range of the tracking downconverter is approximately ± 16 MHz centered at the fundamental frequency of 1300 MHz. The system may be run under open-loop or closed-loop control, hence the different curves.

Figure 5.

As stated previously, the s-parameter test set may be used to determine the operating characteristics of high power amplifiers. Figure 6 shows the measured bandwidth of an 1 MW, 850 MHz klystron at various operating points, while figure 7 shows the its gain.

Klystron Bandwidth @ Various Operating Points

Figure 6.

Klystron Gain @ Various Operating Points

Figure 7.

Lastly, a 300 kW, 425 MHz tetrode-based amplifier (consisting of a solid-state driver amplifier, a triode second stage and tetrode output) was measured. Each of its internal amplifiers were measured individually and then as a single unit. Figure 8 is a plot of its insertion phase versus input power.

Figure 8.

Various types of measurements may be made with the s-parameter test set. The above plots depict a number of component characteristics that can be measured and displayed.

DATE

FILMED

11 / 2 / 94

END