

PXI Based RF Antenna Testing System

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The Challenge

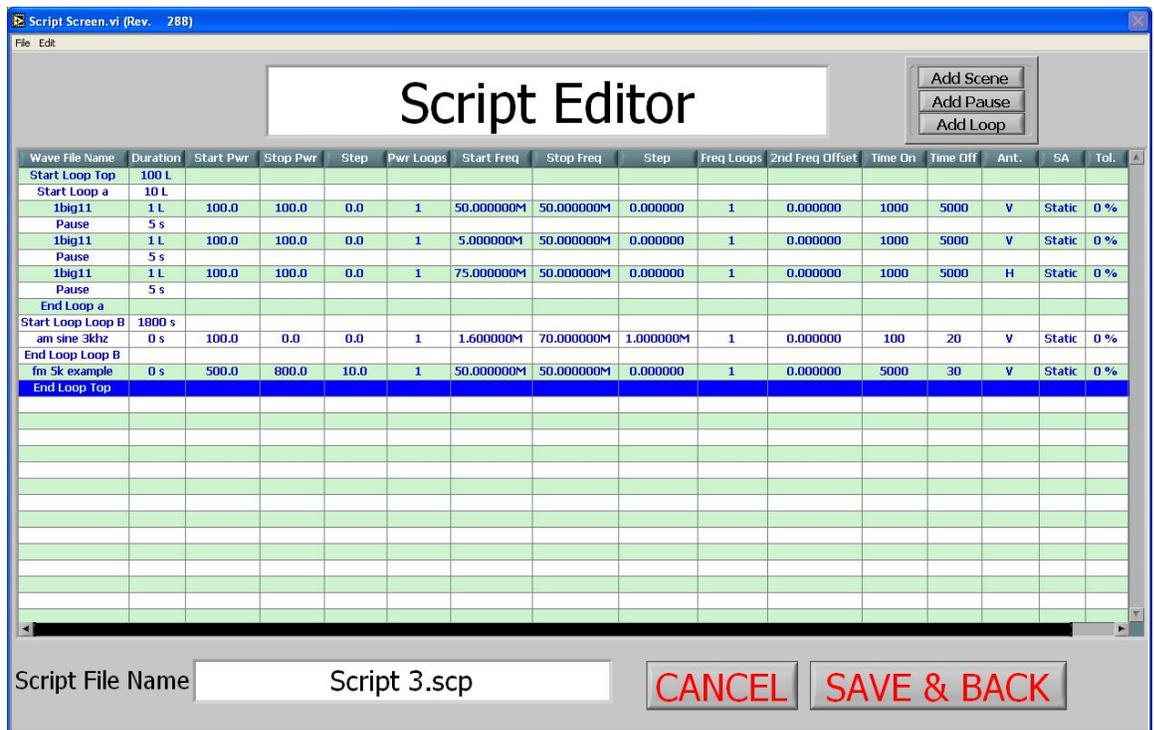
To develop a cost effective, portable system to generate modulated RF transmissions at specific times over a variety of frequencies, power levels, and modulation types.

The NTS Solution

The PXI platform provides the ability to generate RF signals with a variety of parameters and transmit them through various signal paths at very precise times. The NI-PXI5671 provides a very flexible signal generation ability while the NI-PXI5660 allows the signals to be analyzed and verified. Choosing PXI allows us to integrate specialized cards from other manufacturers.

Abstract

The payload waveform is designed using a separate custom application and can be modulated using AM, FM, PM, PSK, FSK, MSK, or QAM. Scripts are then setup to send these waveforms at specific times for specific durations. The script utility allows the user to define virtually any form of looping including iteration or time based loops, frequency stepping, power stepping, and also supports multiple payload waveforms. In addition to the payload waveform, a header waveform is transmitted during each step of the script that provides a GPS timestamp and other parameters.



Script Editor Screen

Introduction

Our customer required a system capable of transmitting a variety of RF signals in a very controlled and flexible environment. The system was built on PXI in order to minimize cost and size while maximizing performance and flexibility. Three systems were called for: one portable system for field

work, one static system for main testing, and one backup system to fill in for the static system in the case of any malfunction.

Testing

To begin a test the user runs the LabVIEW based waveform creator to modulate a given signal using AM, FM, PM, PSK, FSK, MSK, or QAM. This software is run on any PC and the resulting files are then transferred to the system.

A script is then designed in the main application to determine which waveforms will be played, the frequencies to play them at, the power levels to use, and the timing between each step.

As an example, a typical script might call for waveform A (modulated using FSK) to be played at frequencies from 10 MHz to 70 MHz in increments of 10 MHz with a 30 millisecond delay between transmissions. Each of these cycles might be transmitted at powers from 100 watts to 500 watts in 100 watt steps. The entire script might then be repeated for waveform B (modulated as PSK).

The script is then run through a LabVIEW queue by loading the waveform in to the NI-PXI5671 and setting it to trigger from the GPS card. The GPS card is then loaded with the appropriate times for each transmission to begin. Using GPS for the timing allows extreme accuracy in the start times of the transmissions.

Diagnostics and Other Features

Signal diagnostics are fully integrated into the system and include the use of the NI-PXI5660 to provide a pseudo-real-time FFT of the transmitted signal, and two ZTEC ZT002 cards to provide forward and reflected power measurements. Diagnostic scripts are used to define a system baseline that measures power and VSWR at various frequencies. Periodically a system check is performed and compared to the baseline to ensure that all system components are functioning correctly. A power calibration mode allows power output to be corrected over the entire frequency range.

For any given transmission one of twelve antennas is chosen by the software based upon frequency. The antenna switching is accomplished through RF relays and is controlled by the 6527 DIO card. In addition to switching antennas, the 2565 relay card is used to switch the signal path into a dummy load for baseline and calibration modes.

A manual mode screen allows the user to operate each of the instruments independently in order to test various aspects of the system and function in an R&D mode. This feature combines with the signal diagnostics and remote access provide by XP Remote to allow the system be operated from hundreds of miles away with confidence.

A scheduling utility allows the user to schedule given scripts at any time in the future to allow the system to run unattended. In this way, users can remote in and apply all of the setting necessary for months of unattended testing.

Security and user monitoring for the system are provided in two layers. Standard security measures such as a firewall to the Internet and Windows XP accounts provide the first layer. The second layer is provided through an access system in LabVIEW that requires users to log in to the LabVIEW

system separately. Three levels of users provide differing functionality for different users. The system logs out a user after a given period of inactivity, but allows the system to continue running scripts.

Because the system is considered mission critical, backup power and a back system are provided. Backup power sources include solar, battery, and generator that are automatically switched with no power interruption. The backup system is a complete identical PXI system that can be switched to in case of a problem with the primary system simply by moving the antenna cables from one rack to the other.

The PXI RF Platform

The initial design of this system used Agilent rack and stack equipment rather than NI-PXI. The change to PXI changed the portable version from a trailer into a box that can be checked as airline baggage. The cost savings (after selling the Agilent equipment) was enough to completely pay for a third system with money left over. The performance benefit of PXI allowed much more advanced scripting to be added by driving the signal generator from the GPS card.



The PXI chassis packaged with other RF components in a shippable container.

The PXI platform, combined with the RF instruments available from National Instruments allowed us to design and implement a system that was not feasible only a few years ago. The open standard nature of this bus allowed for additions from multiple vendors to fill needs for features such as GPS time synchronization and simple RF power measurement.

Flexibility and Power of LabVIEW Combined with PXI

A great example of the benefits of LabVIEW and PXI came during the development of the system when we needed to verify the signals we were sending. There was no hardware set aside for demodulating and analyzing our signal.

Our customer thought that RFSA stood for RF Spectrum Analyzer since we had used it to replace an old rack and stack spectrum analyzer. We pointed out that the RFSA is an RF Signal Analyzer and had capabilities for beyond a spectrum analyzer.

When we used it to demodulate and decode the signal by writing a simple LabVIEW program using the modulation toolkit our customer was pleasantly surprised that not only was the PXI RFSA much smaller and cheaper than the old Agilent unit it replaced, but was also a much more flexible

instrument. Combining the RFSA with LabVIEW and the modulation toolkit allowed us to far exceed our customer's expectations in the analysis department.

Products used in this Program

- NI PXI-5660 2.7 GHz RF Vector Signal Analyzer
- NI PXI-5671 2.7 GHz RF Vector Signal Generator with Digital Up-conversion
- NI PXI-6040E Multi-function Data Acquisition
- NI PXI-2565 Relay
- NI PXI-6527 Digital I/O
- NI PXI-1045 18 Slot PXI Chassis
- NI PXI-8186 P4 2.2 GHz Controller with Windows XP
- LabVIEW 7.1.1
- RFSA 1.5
- RFSG
- Spectral Measurements Toolkit
- NI FGEN
- NI Scope
- NI Switch
- NI DAQ
- Modulation Toolkit

About NTS Test Systems Engineering

NTS TSE, located in Albuquerque, NM, designs and integrates test, measurement, automation, data acquisition and control systems utilizing diverse hardware platforms, operating systems, and instrumentation standards. Our expertise involves projects ranging from LabVIEW instrument drivers to full-blown automated turnkey systems. The dedicated staff of electrical and mechanical engineers, project managers and technicians of NTS are well versed in designing, integrating and programming real world solutions for industrial applications for a diverse set of operating systems and standards.

Test & Automation Services Include

- Requirements Analysis & Development
- Hardware Design
- Software Design & Architecture
- Instrument Drivers
- Test System Management (TestStand)
- Software Development (LabVIEW)
- Data Management & Analysis (DIAdem)
- Enterprise Solutions
- Fabrication
- Integration
- Installation & Training
- Maintenance & Support

Contact

To discuss how NTS can help you solve your next test system engineering challenge, contact Tim Brooks at 505-345-9499 or email tim.brooks@ntscorp.com

