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Establishing a Validated Automated System for Attenuation Measurement at DC-18GHz Frequencies

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Abstract

A computer aided calibration application is developed and is described in the paper. The graphical programming language, National Instruments LabVIEW, is used to develop the application for calibrating completely programmable attenuators. The application is capable enough to provide the complete control of the experiment over the computer system and the data is of course acquired and saved automatically. The development process carried out in LabVIEW is in accordance with the traditional software engineering methodologies, such as Waterfall Model or Spiral Model, implemented using various toolkits available. The experimental readings, expanded uncertainties and application testing are described. The LabVIEW application developed came out as a complete calibration suite that can be used in the attenuation measurement laboratories for reducing the human error that may occur during the manual control. It was also found that there is an improvement in the uncertainties during the measurements.

Keywords: Attenuator, LabVIEW, SDLC, Waterfall Model.

1. Introduction

With the advent of the computer technologies and its application in the electronics laboratories, it is becoming easier to interface the hardware without the need of any special assembly or low-level language. LabVIEW is one of the languages that make it easier to communicate with the hardware via computer systems that gives the additional advantage of controlling the devices over any network, such as the Internet. With the use of LabVIEW, it is possible to play with all the features of the hardware connected or to have an application that particularly supports a technique or experiment, as otherwise what programmed by the LabVIEW programmer.

The Agilent Technologies 11713A Attenuator/Switch Driver can drive the fully programmable attenuator; in our work, we used Agilent's 8496H attenuator. The attenuator driver is capable to provide control of up to two four-section programmable step attenuators. The attenuator is calibrated with the application created on the LabVIEW Platform for frequency from 30MHz-18GHz using 30MHz Intermediate Frequency (IF) Substitution Technique. Since the setup is fully programmable, we expected to reduce the human error in the calibration process with respect to the attenuators that are not programmable. We found that with the advantages of an automatic system, higher number of observations per frequency could be taken to reduce the standard deviation in the observations and hence an improved uncertainty.

Figure 1: Measurement Setup. The hardware consists of a PC, Signal Generator, Attenuator Driver and a precision receiver, VM-7.

2. System Description

The system consists of simple set-up of 30MHz Intermediate Frequency (IF) Substitution Technique that used a signal generator, which have a range of 30MHz-18GHz, an attenuator driver and 30MHz tuned receiver, VM-7, shown in Fig. 1. The GPIB is networked to all the instruments in a star configuration for acquiring their remote control, shown in Fig. 2. Particularly to drive the attenuator, the attenuator driver is connected to the attenuator under calibration with a Viking connector cable.

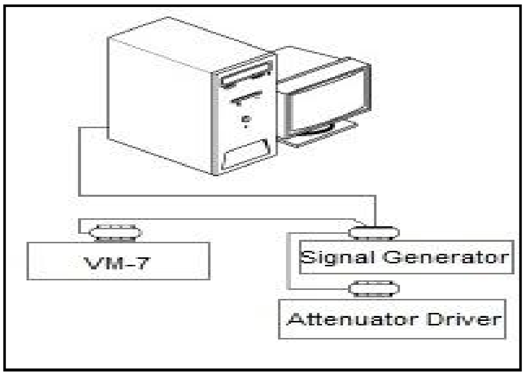

Figure 2: Schematic Diagram showing GPIB connections between the Instruments, named as Star Configuration.

2.1 Software Development

The LabVIEW Platform is used to develop the control software. The development process follows the traditional software engineering methodology. Generally, the Software Development Life Cycle (SDLC) is a predetermined sequential development process. The main phases involved in this process are requirement analysis, design phase, implementation phase, testing phase and maintenance phase. Like any other software, LabVIEW applications can also be developed using the same process.

2.2 Software Implementation

A program in LabVIEW is termed as a virtual instrument (VI). This VI provides the front panel as a graphical user interface (GUI) and block diagram to support dataflow programming. To control the instruments, simple message based programming is used. The message is sent to and received from the instrument using GPIB read/write functions. For sending the command to the instrument, GPIB Write function is used and to read the result of the command from the memory buffer of the instrument GPIB Read function is used. The application creates the observation sheet at the end of the process and saves result in the MS Excel Sheet.

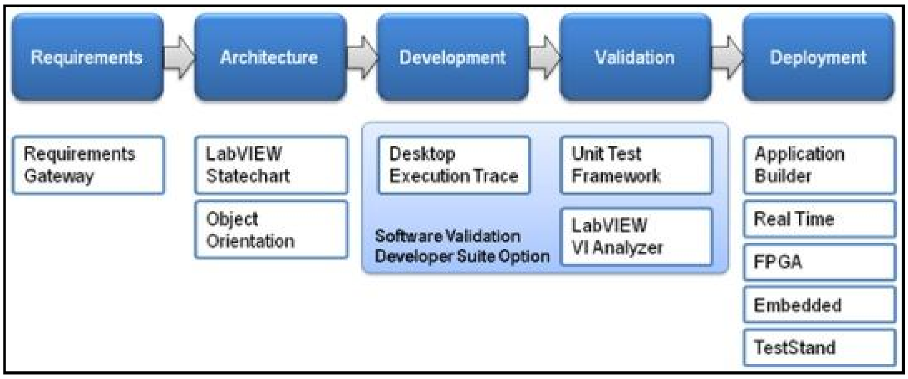

Figure 3: National Instruments offers a number of tools and add-ons to improve and automate common software engineering practices (NI, 2012).

3. LABVIEW Application Development and Testing

In the large applications, it becomes a tedious job to add any code or to debug the VI, unless the code is of good quality and have better scalability and readability. The Software Validation Developer Suite (Fig. 3) provides a number of toolkits that help in the easy development of readable code, validation and testing of the application.

3.1 Analyzer and Desktop Execution Trace

During the development, LabVIEW VI Analyzer works as a debugging tool that lists all the errors that violate the principle of developing a quality code, as shown in Fig. 4. The desktop execution trace toolkit on the other hand provides the execution data on the desktop, to keep track of the execution of large LabVIEW applications and to optimize the code.

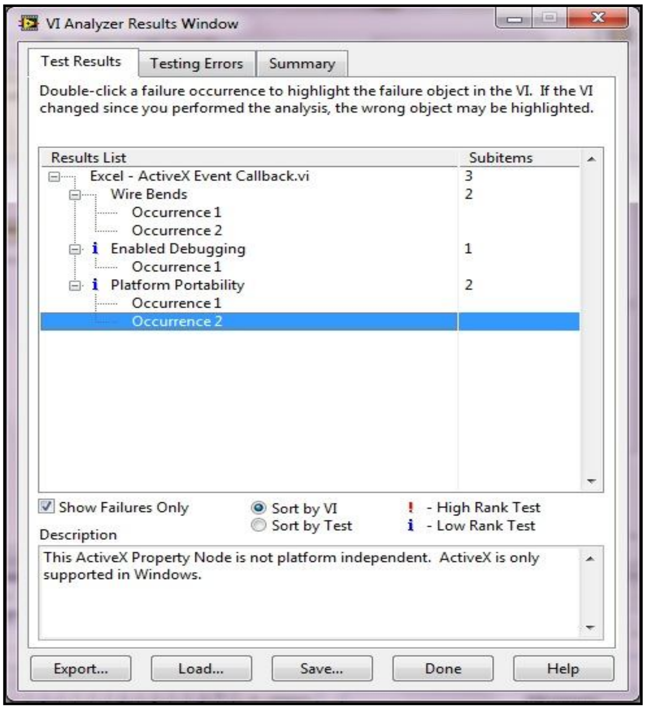

Figure 4: VI Analyzer Results. It lists all the occurrences of the failures that can result in poor quality graphical code. It can prove as great tool to develop a more readable and clean graphical code.

3.2 Unit Test Framework

This toolkit is used to automate the generation of test cases for unit testing. Unit testing is a process in LabVIEW where each control and indicator is tested for different values. It is therefore a good practice to get the unit tests in order to determine if the application generated the proposed output or if there are some exceptions.

4. Experimental Results and Discussion

The 8496H attenuator is calibrated for frequencies from 30MHz to 18GHz. The measurements, shown for 60dB attenuation in Fig. 5, are within the range specified by the manufacturer. The results taken by the automated software can be verified with the attenuation accuracy provided by the manufacturer or can also be compared to the manual operation of the attenuator driver.

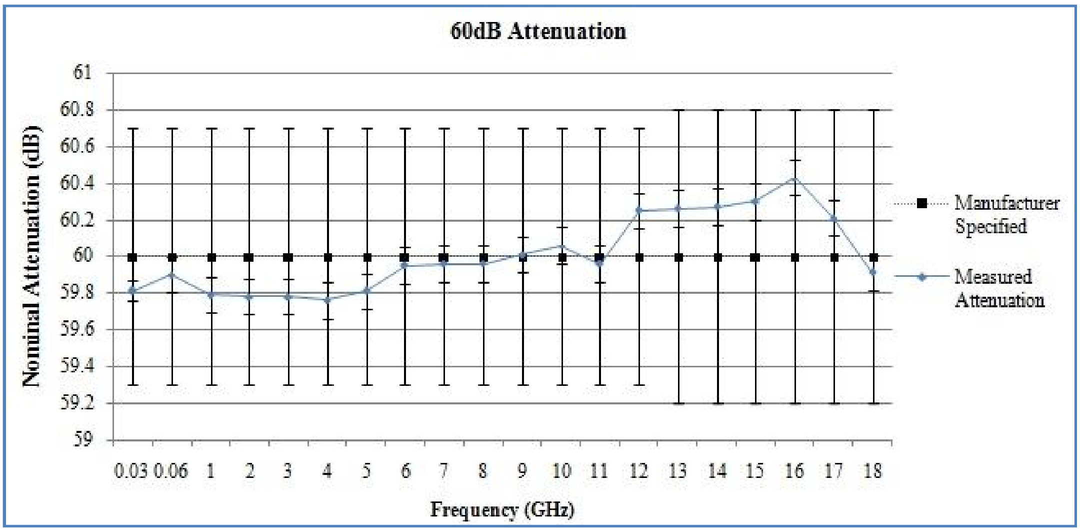

Figure 5: Experimental Results for 60dB Attenuation.

5. Conclusion

From the experiment, the use of an automated measurement setup has proven to be more effective as the data acquisition is consistent and the uncertainties are comparable to that of the manual setup with the elimination of human error. Since the process is repetitive, the application facilitates user-defined number of observations. In addition, the LabVIEW software is provided with the facility to calibrate lower steps of attenuation such as a 0-11dB attenuator of 1dB step.

References

[1] Overview of Software Engineering with LabVIEW, http://www.ni.com/white-paper/9364/en/, 2012.