

The development of the Function Generator and the Digital Multi-Meter to be used with LabVIEW^ã

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ABSTRACT

A Virtual Instrument (VI) is a computer model of a scientific instrument that is designed to be used in a laboratory. My objective for this project is to create two VIs, the Function Generator (FG) and the Digital Multi-Meter (DMM), that will be made available to the McPherson College Science Faculty and students. The FG generates functions such as sine, saw-tooth, square, and triangle waves created by input from the user. The DMM is used for data acquisition, testing, and research. Benefits of using these VIs versus scientific instruments include cost efficiency, flexibility, and speed. The FG is currently available for use; the DMM will ideally be completed by May 13, 1998. Keywords: *block diagram, Digital Multi-Meter, Function Generator, graphical programming language G, LabVIEW, virtual instrument.*

INTRODUCTION

A Virtual Instrument (VI) is a computer model of a scientific instrument that is designed to be used in a laboratory. It combines elements of hardware and/or software to perform functions like that of a stand-alone instrument. The basic hardware that is used is an input/output board, which is capable of receiving and transmitting both analog and digital data. A VI has two main parts that this data is passed between. The first is an interactive user interface, known as the front panel. This panel simulates knobs, push buttons, and other controls that are used in the same manner that a physical instrument would be. There are also indicators where the user can view the results being produced or the measurements being obtained. The second main part of a VI is the source code equivalent, referred to as the block diagram. This diagram appears in a pictorial form but is actually the executable program.

In today's rapidly changing world of technology, the main concerns are cost efficiency, flexibility, and speed. The use of VIs as opposed to scientific instruments gives us a head start in these three areas. The VIs will be created on the software called LabVIEW, which was purchased by the McPherson College Science Department for about a thousand dollars. This one time purchase of software will allow many VIs to be created and used. Most of the scientific instruments that have been purchased in the past and those that could possibly be purchased in the future cost approximately this much per instrument. Therefore, VIs would be a better financial investment. Another asset of using VIs is the software-based flexibility. For instance, LabVIEW allows changes to be made to the VIs at any time, with only minor modifications to the block diagram. To make similar changes to a scientific instrument, a whole new instrument would need to be purchased. Finally, the use of VIs is more desirable than most scientific instruments due to the speed of measurements, such as logging and analyzing data. The only foreseeable

downside to using LabVIEW is the fact that many people do not have the programming ability or background to make the VIs; however, this language is one that is easily learned and user friendly.

LabVIEW uses a graphical programming language called G to create the block diagrams. Traditional programming systems, such as C, Pascal, or BASIC, use text-based languages to create programs. G creates programs similar to a flow chart using graphics. This makes it possible to concentrate on the flow of data within the VI without having to deal with programming basics. Thus, the language of LabVIEW makes it more practical for amateur programmers.

The purpose of my senior research is to create the Function Generator (FG) and the Digital Multi-Meter (DMM) for the McPherson College Science Faculty. These are two stand-alone VIs that accomplish such tasks as data acquisition, analysis, and generation. The FG will be able to create functions such as sine, saw-tooth, square, and triangle waves. The DMM will measure AC/DC voltage and current, resistance, and temperature.

MATERIALS AND METHODS

LabVIEW 3.1 for Windows (© National Instruments 1994) is the major material that will be used. The software is provided in the Natural Sciences computer room in McPherson College's Harnly Hall. There will be some signal conditioning using the SC-2071 to convert the electrical signals generated to the form that the data acquisition board can accept. The SC-2071 is a general-purpose termination breadboard that has a 4 by 1.5-inch breadboard area to allow the custom building of analog to digital circuits (National Instruments 3-256). The data acquisition board that the department has is the Lab-PC+. "It has a 12-bit ADC (analog to digital converter) with eight analog inputs, configurable as eight single ended or four

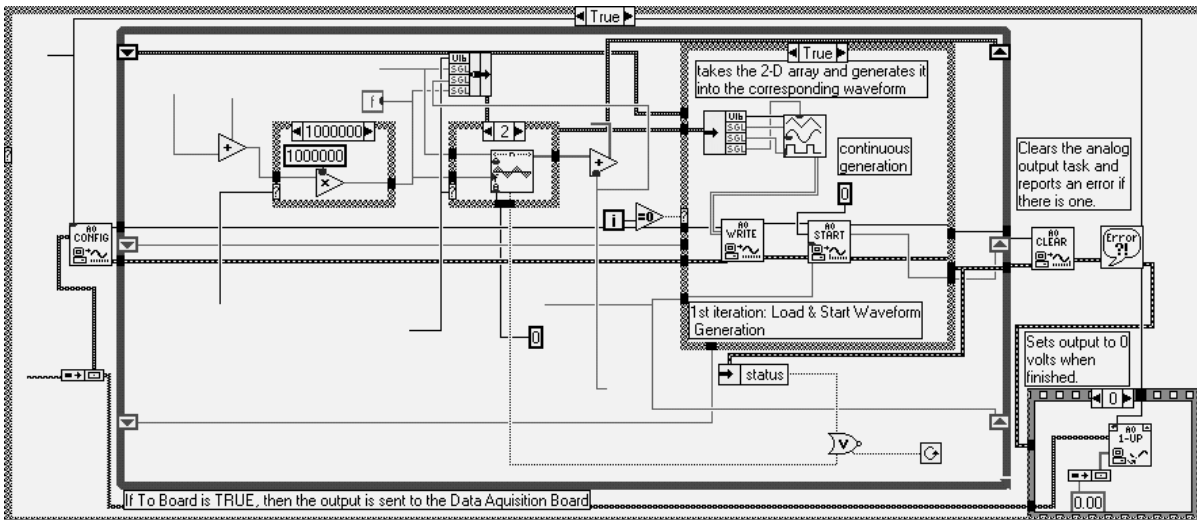


Figure 1. This is an example of a block diagram, which happens to be the block diagram for the FG.

differential inputs, two 12-bit DAC's (digital to analog converter) with voltage outputs, and three user-available 16-bit counter/timer channels for timing input/output" (National Instruments 3-87). The FG will be tested with a stand-alone multi-meter and an oscilloscope that will measure the output of the FG. Once the FG is working properly, it will be used to test the DMM. This testing is made possible by wiring the output of the FG to the input acceptor for the DMM. After both the FG and the DMM have been configured properly, the data output of the FG and the DMM will appear at approximately the same time. The difference in time is attributed to the settling time, which is the length of time it takes for the DMM to decipher the input of data.

RESULTS & DISCUSSION

I have created the Function Generator (FG) and set the foundation for the creation of a Digital Multi-Meter (DMM), which is a duo of stand alone VIs that has the potential to accomplish such tasks as data acquisition, analysis, and generation. These VIs are among the most commonly needed and used. The FG has been made available to the McPherson College Science Faculty for future use; the DMM will ideally be ready for use by May 13, 1998. The FG has predefined waveforms that generate functions such as sine, saw-tooth, square, and triangle waves. The DMM will be used for data acquisition, testing, and research. It measures AC/DC voltage and current, resistance, and temperature. The operator of one of these VIs can choose between the best of the two to obtain the desired outcome or the recording and analysis of data. The operator can use the FG to create a function that the DMM will be able to record and analyze. The VIs are composed of many sub-VIs which accomplish different tasks that were specified by my client. Each

of these sub-VIs is made up of block diagrams (see Figure 1) that act as instructional codes for the use of the VIs. Most of the sub-VIs that have been used were created by National Instruments Corporation and have been included with the software.

The FG continuously generates the selected waveform until the Stop is pressed (see Figure 2). The different waveforms are the sine, saw-tooth, triangle and the square wave. The FG changes the waveform instantaneously, responding to changing signal type, amplitude, offset, and coarse/fine adjustment on the front panel. The FG incorporates the following intermediate analog output (AO) VIs: AO Config, AO Write, AO Start and AO Clear. One Advanced AO VI, AO Clock Config, is used. Each of the above are sub-VIs that have been included with the software.

How the FG works: The entire VI runs in two loops. The first loop, if true, sends output to the data acquisition board. If this loop is false, the data is only sent to the screen. The second loop is a loop that runs the VI while the Run/Stop button is on. If the Run/Stop

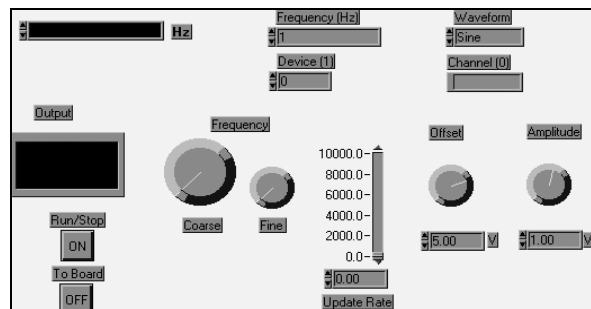


Figure 2. This is the front panel of the FG. This is what the user will be able to interact with.

button is off, the VI will not be active. The analog output channel (default is 0), which is set by the user, is configured and the waveform buffer is allocated by AO Config. In the first iteration of the loop, the initial waveform is computed (Compute Waveform) and loaded into the waveform buffer (AO Write). Continuous waveform generation is started at the point rate specified (AO Start). In subsequent loop iterations, the front panel controls are checked for changes. If the signal specifications change, the waveform is recomputed and written to the waveform buffer (AO Write). AO Write takes care of writing the buffer one half at a time for a smooth waveform transition. The loop uses the wait to check the front panel control every quarter of a second. This conserves CPU time, which may be needed by other VIs running simultaneously with this one. The loop runs until the Stop button is pressed or until an error occurs. The waveform generation is then stopped (AO Clear) and the analog output channel is set to 0 volts (AO Single Update). The operator is given the option of sending the data to the acquisition board. If he/she chooses to do this, the To Board button must be pressed before running the generator. The operator must specify which device is being used (default is 1). If the generator has been running without this button being pressed, it must be restarted before the data can be sent to the board.

LITERATURE CITED

National Instruments. 1996. Instrumentation: Reference and Catalogue. National Instruments, Austin, TX.