A SIMPLE PC-BASED VIRTUAL INSTRUMENTATION

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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Date : 18 November 2005

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"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

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Date : 18 November 2005

ABSTRACT

The integration of personal computers with the present-day measurement and instrumentation world has opened up the door for "virtual instrumentation." Virtual instruments are centered on a PC and used with as little specialized hardware as possible to link it to the devices it must measure/control. This project is about to develop a low-cost, PC-based virtual instrumentation. It is a data acquisition device by using the parallel port and has been fabricated with full analog interface and 8-bit analog to digital converter with associated control-logic and timing circuitries. This virtual instrumentation is a simple plug-in board and incorporated with any IBM PC parallel port, thus in many cases the output are similarly same with multiple and expensive digital Oscilloscope. The requirement system for the PC is Pentium Processor, preferably 32-M RAM with have Windows 95/98 or higher operating system. This project is developing by using Visual Basic and C programming. In addition as an idea, several other menu-driven functions for data-storage, display, analysis, and printing can also be demonstrated.

ABSTRAK

Perkembangan dan pengintegrasian komputer peribadi sebagai suatu alatan pengukuran pada masa kini telah membuka ruang kepada instrumen maya. Instrumen maya adalah satu alatan pengukuran yang menggunakan komputer peribadi dan kad antara-muka bagi menghubungkannya dengan alatan yang perlu diukur. Projek Sarjana Muda ini adalah bagi mendirikan instrumen maya dan kad antara-muka pada harga serendah RM200. Ianya merupakan kad perolehan data yang beroperasi menggunakan labuhan pencetak dan dibangunkan bersama litar penukar 8-bit analog kepada digital, litar kawalan logik serta litar pemasa. Pengoperasiannya adalah semudah "sumbat dan masuk" menerusi labuhan pencetak komputer IBM dan dalam kebanyakan kes keputusan perolehan datanya adalah sama menyerupai sesebuah osiloskop. Sistem ini memerlukan prosesor *Pentium* sebaik-baiknya dengan keupayaan RAM 32M-bit dan *Window* 95/98 atau lebih tinggi bagi pengoperasiannya. Papan muka dan programnya dibangunkan dengan menggunakan perisian *Visual Basic* dan pengaturcaraan C. Pada masa akan datang sistem ini akan dapat beroperasi sebagai penyimpanan data bagi tujuan analisis dan pencetakan.

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CHAPTER 1

INTRODUCTION

In today's educational institute, especially in electrical engineering and allied streams virtual instrumentation have become popular for signal acquisition and analysis. Because of their inherently high-input impedance, virtual instrumentation can be used for analysis of both analog and digital circuits with high accuracy. Another attractive feature of the virtual instrumentation it is similarly device like digital oscilloscope which have effective storage of the data for subsequent analysis. However, with increasing futures, this virtual instrumentation has become more expensive and less accessible for undergraduate-level novice students. The advanced features of this commercially available virtual instrumentation often are underutilized in the low-power and low-frequency requirements of common undergraduate laboratories. Moreover, the used of PCs is almost every step of any laboratory course, for analysis to data representation to report preparation, motivated the development of a device that will combine to a great extent the features of the virtual instrumentation and the PC. The idea was to develop a simple PC-based virtual instrumentation, affordable, plug-in kind of data acquisition hardware that can be used with any common-purpose PC with the associated software that can make the expensive digital oscilloscope redundant for elementary signal analysis purpose.

The objective of this project is to develop a simple PC-based virtual instrumentation circuit that can be incorporated with the PC by using the parallel port. The measurement output (in a waveform) is view on the PC by using graphical user interface (GUI), built in Virtual Basic 6.0 software. The modern oscilloscopes are too expensive, yet undergraduate students does not fully utilized. For example: Instek GOS6103 100 MHz Analog Oscilloscope retail price is around RM5000 compare with this virtual instrumentation circuit that cost around only RM200. Normal oscilloscope also does not have RMS value. The advantage of this virtual instrumentation project is flexibility, modularity with low cost, suitable for undergraduate's-level novice student because they can see the amplitude and the RMS value due to the study. This virtual instrumentation is also can be used in the laboratory demonstration and for instructional purpose. It is low frequency, yet it can be familiar to the student user. Undergraduates student have not study until high frequency, oscilloscope is more suitable for research study only. At the end of this project, the expected result is to get the measurement output in the PC. For example, let say measurement is been taken for 4 volt AC signal from the signal generator, the output should get also 4 volt AC signal waveform in the PC. As the advantages, it has 8 analog input signals, the RMS value and the phase angle at the same time. Student can use the data to calculate the power. This is the easy way to learn as an undergraduate student because they can compare the theory with the actual condition.

CHAPTER 2

BACKGROUND STUDY

The instrumentation industry is moving steadily and rapidly in the direction of virtual instrumentation. Virtual instrumentation is centered on a PC, used with as little specialized hardware as possible to link it to the devices it must measure/control. This hardware typically is plug-in boards for digitizing a signal directly or for controlling stand-alone instruments. Virtual instrumentation is known for its flexibility, modularity, and low cost.

S. Celma [1] presents the idea behind development of a PC-based spectrum analyzer suitable for used in undergraduate laboratories. They pointed out the requirements of such a data acquisition system are not very high in view of the limited range of signals encountered in undergraduate laboratories. Chickamenahalli [2] presented an undergraduate research project that involved the interface of a HP digital oscilloscope to an IBM PC using National Instruments' General Purpose Interface Board. Smith [3], [4] in their paper described the setting up of a simple DSO (digital storage oscilloscope) integrated with the printer/plotter system for quick reproduction of the signal. However, they were skeptical about the bench-space requirements for such a scheme involving the DSO, printer/plotter, and the PC. This discovery led to the concept of integrated DSO as a virtual instrumentation-PC-printer system, sufficient and affordable for most undergraduate-level laboratories

Several data acquisition systems through the parallel port have been built in the past [5][6] with various combinations of hardware and software. However, either those works have not been reported comprehensively or there have been too many variations in the development approaches which confuse the reader. The aim of this PSM project is to built up a complete working system and its report with less complexity, yet reasonable usefulness in undergraduate-level laboratories.

In recent times, the idea of a web-based virtual laboratory [7][8] has led to the development of a variety of virtual instruments, including virtual oscilloscope. However, many of the virtual oscilloscopes do not come with associated data acquisition hardware, are too versatile for common undergraduate use, or are expensive. These are literally "virtual" in nature – demonstrating only the front-panel functionalities of the oscilloscope – without real-time data acquisition and display. The contribution of this project is in developing a fully functional, PC-Based Virtual Instrumentation with associated modules of data acquisition hardware, software, interfacing, and graphical user interface (GUI).

The lab view virtual oscilloscope from National Instruments [9] offers a versatile tool for PC-based data acquisition. However, the relatively high cost of such a system (along with the National Instrument Data Acquisition Card) often cannot be justified for undergraduate laboratories where the requirements are not up to that level sophistication, accuracy, and speed. Therefore, lab view is more suitable for industrial or higher research applications than undergraduate education/ teaching.

With this background, the proposed system is intended to provide a low-cost, simple, yet effective solution for integrated multi-channel data acquisition, display, and analysis in an undergraduate laboratory. It uses the conventional PC parallel port, interfacing circuitry costing less than RM 200.00, and commonly used GUI development tool and other programming languages, such as Visual Basic (VB). The system is ideal for use in undergraduate student for real-time applications as well.

2.1 System Description

The data acquisition system (DAQ) is designed for sensing multi-channel analog inputs and for converting them into digital formats before transferring them to the PC. The digital data is stored in the PC memory and display in the PC screen; the provisions are kept for processing the data as well. The block diagram of the developed system is shown in Fig 2.1.

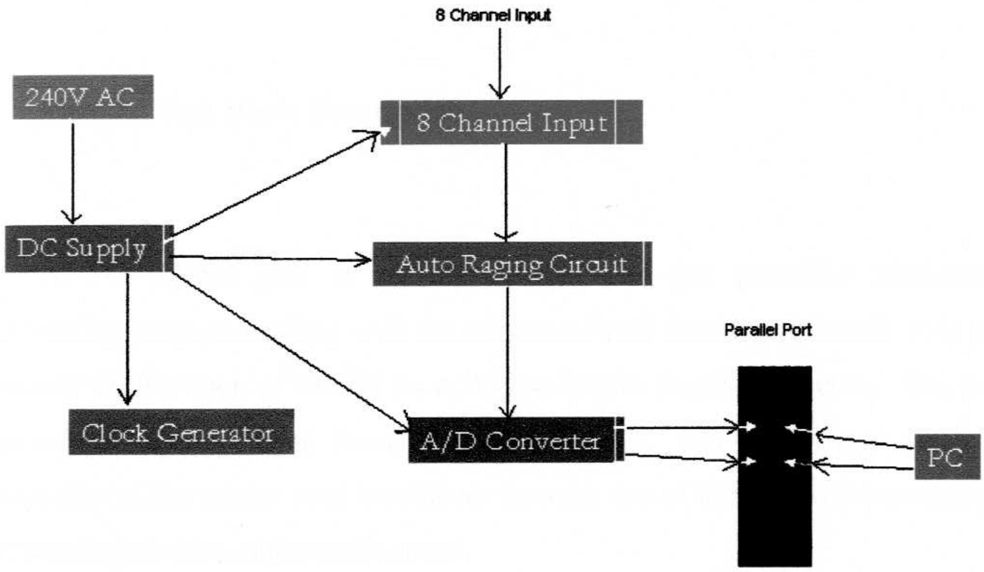

Fig 2.1: System developed block diagram.

The hardware design is primarily intended to perform interfacing and input/output (I/O) function. The system is capable of acquiring and displaying eight signals at a time with additional provisions for data storage and printing. The user-friendly GUI enable used as a guide due to the basic functions of a virtual instrumentation, such as amplitude and time setting. As an idea, in addition, several other menu-driven functions for data-storage, display, analysis, and printing can also be demonstrated.

2.2 System Requirement

For this virtual instrumentation, the minimum requirement for the PC is Pentium processor, preferably 32-MB RAM, operating system Windows95/98 or higher, and parallel or connection; due to Microsoft Visual Basic 6.0 and Microsoft Visual C++ 6.0 system requirement. For using/running the application, only executable (exe) files are sufficient, and need not have any compilers.

2.3 Parallel Port Basic Description

A PC printer port is an inexpensive and yet powerful platform for implementing projects dealing with the control of real world peripherals. It is found commonly on the back of the PC as a D-type 25-pin female connector. The port is composed of four control lines, five status lines, and eight data lines. The functionality of the printer port is achieves through use of this three addressable ports corresponding to data, status and control.

The IEEE 1284 Data Transfer Modes standard provides a high-speed bidirectional communication between the PC and any external peripheral. The standard can communicate 50-100 times faster than using the original parallel port. This standard defines five operational modes to enable communication with external peripheral or data transfer. Each mode fixes a protocol for transferring data in either the forward direction (PC to peripheral), the reverse direction (peripheral to PC), or the bidirectional (half-duplex).

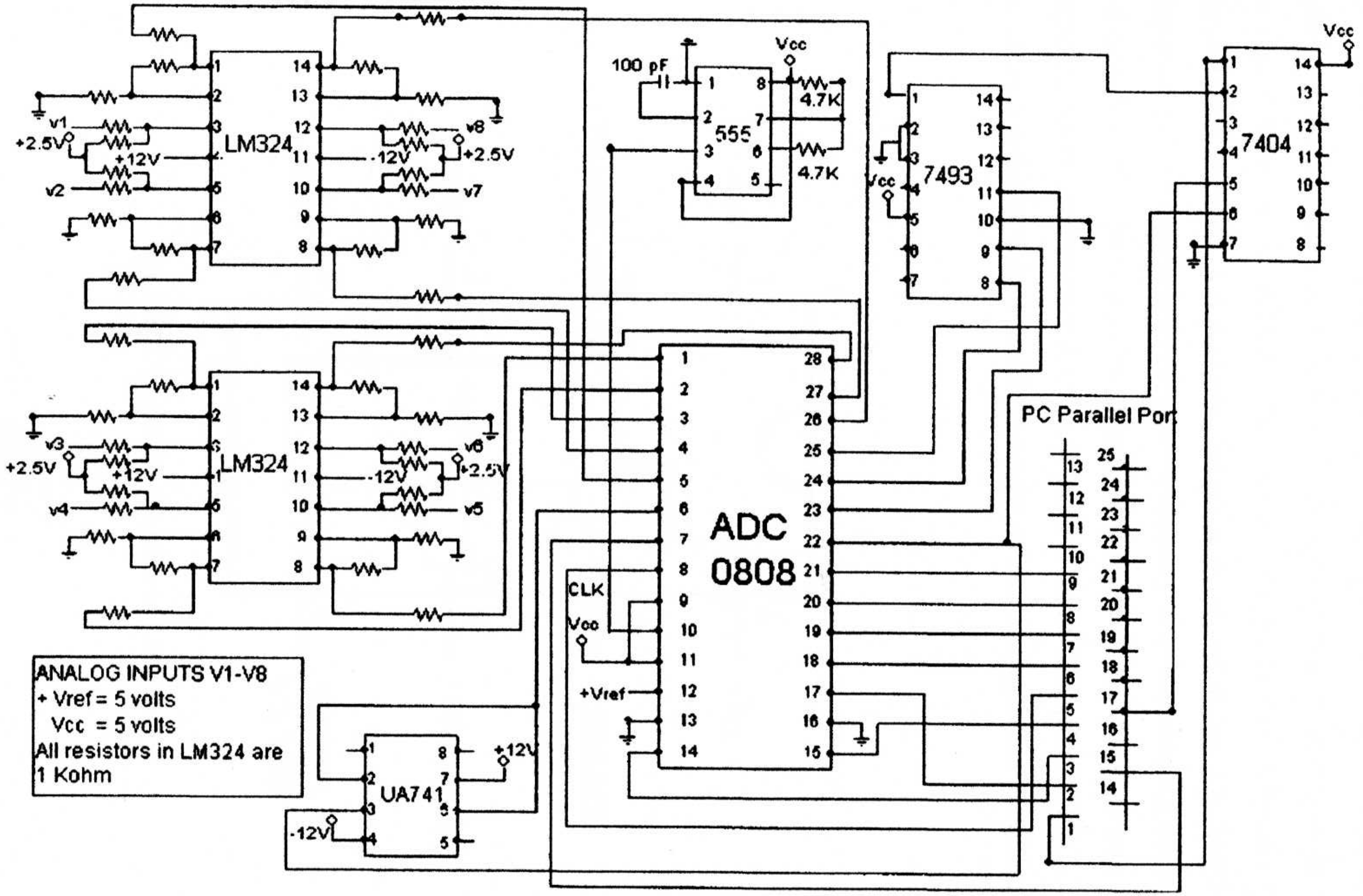

Fig. 2.2: Schematic layout of the virtual instrumentation interface circuit hardware

2.4.1.1 General Description

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200mA or drive TTL circuits. Fig 2.3 shows the connection diagram and Fig 2.4 shown the schematic diagram of LM555.

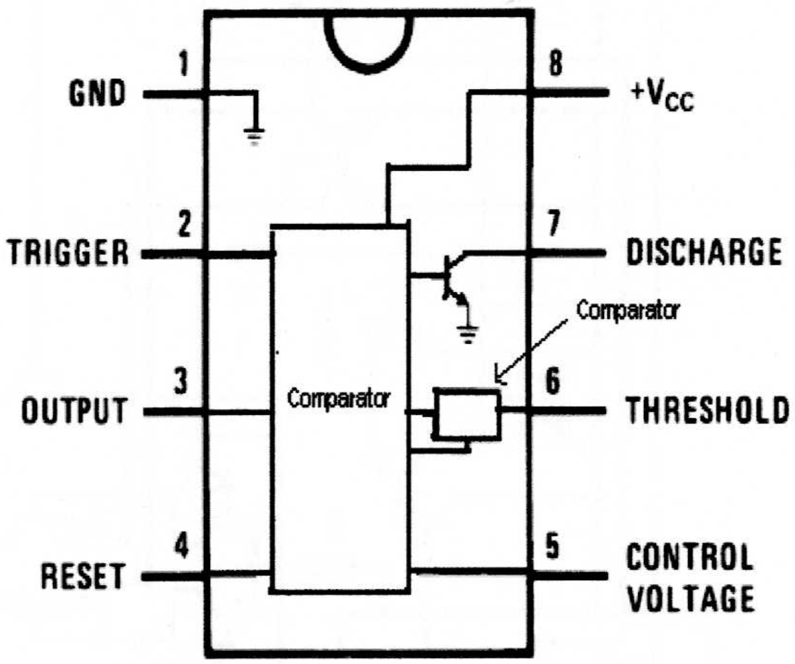

Fig. 2.3: Connection diagram of LM555

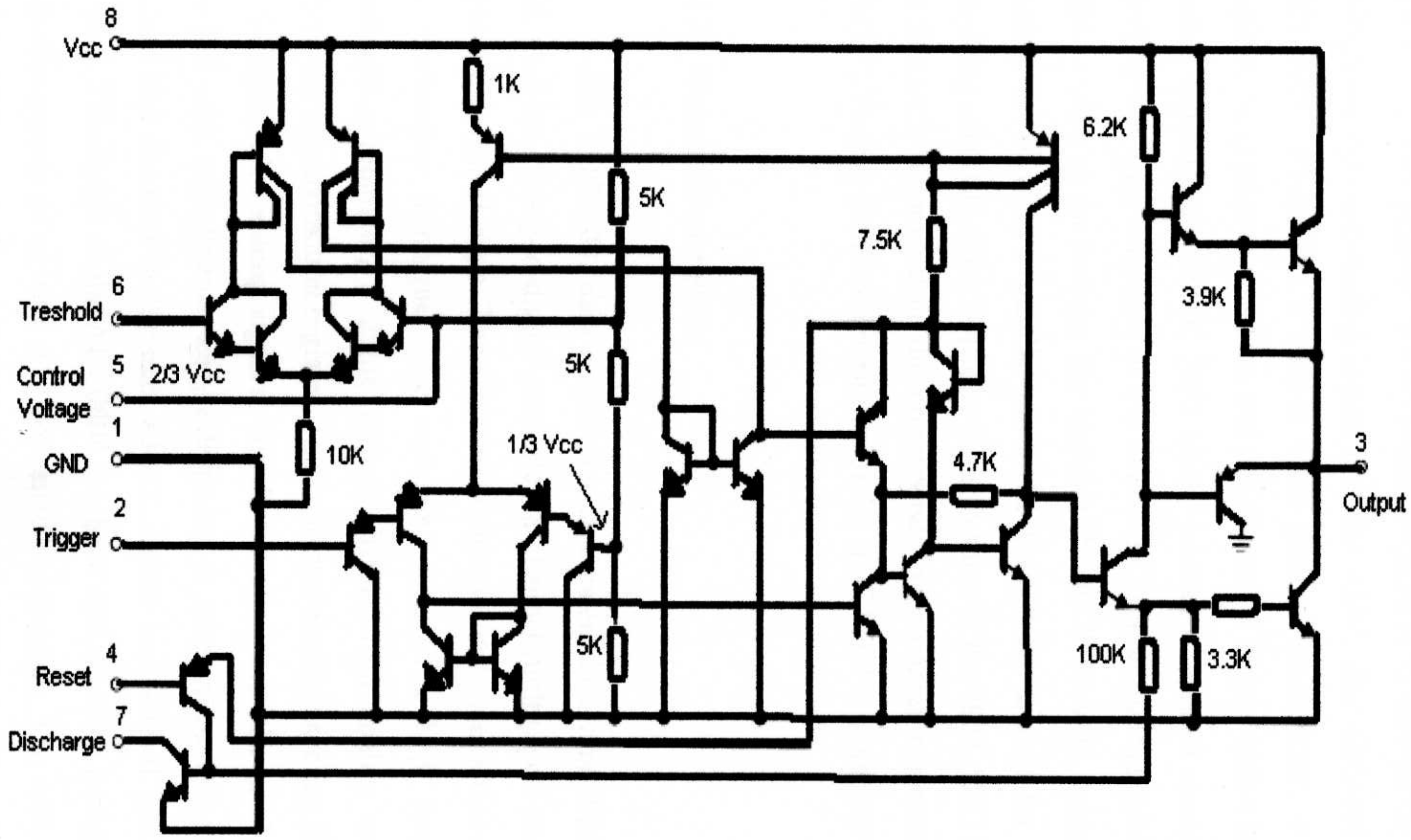

Fig. 2.4: Schematic diagram of LM555

2.4.2 Analog-to-Digital (A/D) Conversion Module

For A/D conversion, an option is required to take care of eight channels of analog input signals, and all of these channels have to be sampled at the same instant of time. For this purpose, the economical option is to incorporate an eight-channel multiplexer between analog inputs and the ADC. The National Semiconductor's 0808 ADC, which has a built-in eight channel multiplexer, is suitable for this purpose. Its average conversion rate per channel is 100μs, which is quite fast for the present application. The IC 7493 binary counter integrated circuit (IC) is used for selecting the eight channels of the 0808 ADC for sequential data transfer. The IC 7404 is used as an inverter for strobing the IC 7493 with proper level of signal coming out of the PC parallel port. The UA741 IC is used for the purpose of providing adequate delay between the activation of the 0808 ADC input channel and the start of A/D conversion; this corresponds to the normal response time of the 0808 ADC IC. Further detailed description of the ADC 0808 is in general description.

2.4.2.1 General Description

The ADC0808, data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full scale adjustments. Easy interfacing to microprocessors is provided by the latched and decoded multiplexer address inputs and latched TTL TRI –STATEÉ outputs. The design of the ADC0808 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The ADC0808 offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These features make this device ideally suited to applications from process and machine control to consumer and automotive applications.