Bring Down the Automatic Test Equipment – A Call for the Low Cost Automatic Test Equipment and a Solution

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Abstract: - This document describes and justifies the need for low cost Automatic Test Equipment (ATE) for the low end user and gives one of the solutions to it. The Presentation is basically about the hardware design, software required to run the ATE and the type of interface between the hardware and the Personal Computer (PC). A comparative analysis among manual testing, high cost ATE and a low cost ATE was also put forth.


1 Introduction

In this fast moving world, the output expected from each and everyone is always a reliable one. Any system is always under testing in order to meet its demand. Even, the human system is assessed at every point of life. This testing may go wrong as humans everywhere do it, as they are prone to errors. In today’s increasingly competitive world, every industry is automated day by day. The output is optimised in order to meet the customers demand by all the possible ways. To increase the productivity and reliability we have to accept that we need some automation in machines[10]. These automations give a consistent level of reliability, and also the production time is reduced a lot. Customer value must be the predominant goal of any corporation in order to stay economically viable in to future.

The cost of test is an important issue and one, which continuously attract a lot of attention even though it is not understood properly. Most industry designers lapsed in devoting time for economic analysis of testing options, but it is quite clear that benefits of doing are so enormous – ultimately very large sums of money can be saved through the use of ‘appropriate’ test[7].

Consider the PC manufacturer with enormous production volumes of high-end products having worldwide product distribution and Military with smaller volumes of higher complexity items, which require for maintainability. Both these users need the high end ATE to test their products. But there are low end users who require testing their product with a cost effective solution.

Whenever we speak of automation in testing, it always deals with the digital testing. The power Electronics technology does not enjoy the privilege of automation as compared to digital circuits[1]. However many low end users need these equipments, but with lower specifications, which include testing of voltage levels alone.

2 Testing Methods

2.1 Manual Testing

The traditional way of testing is being carried out by using various equipments such as function generators, digital multimeters and a cathode ray oscilloscope[11]. Manual testing of device as indicated by figure1 requires a qualified personnel.

![Fig 1 Manual Testing](image-url)
The main dips in manual testing are

- Increased labour cost involved
- High staff training costs
- Inconsistency in service due to highly dependent on human interaction
- Degradation in reliability

2.1 Automated Testing

Automation can be regarded as a method of transferring engineering knowledge into a machine which then interprets the commands and subsequently performs the task exactly as programmed. [3]

In order to eliminate the inherent deficiencies of traditional testing, it was decided to migrate very quickly to an automated testing stage. This drastic change of testing had to be performed quickly and error-free primarily due to scheduling and budgetary constraints[9]. Thus, teamwork is an absolute essential from the initial design stage to the final manufacturing stage from all parties involved if all the benefits of test automation are to be enjoyed.

There are many reasons for choosing an automated testing solution over a manual one such as increased productivity is often achieved and more consistent test methods are also possible[3]. In today’s workplace automation can bring both these benefits whilst at the same time reducing the labour content of a job and therefore reducing cost.

- The Unit Under Test (UUT)
- Cables and connectors linking it all[6].

Apart from the above modules, there are Powerful test and measurement programming language such as National Instrument’s LabVIEW, which make it possible to develop powerful ATE. In traditional testing, an input signal is given to the UUT from the Functional Generator whereas in the ATE, it is given by stimulus Instruments. The measurement instruments get back the response and send it to the test controller. Then test controller decides on the UUT and gives the output according to this. Once the output is stored in the PC, this can be called whenever required. Thus offline and online analysis are possible. Compared to manual testing the time taken for the same test for the automated test is less. The number of testing professional can be reduced a lot, by using ATE[10]. Even though it has many advantages, it has also some drawbacks, which are as follows

- The whole system is bulkier as it will be placed in various racks and hence cannot be space efficient for the low end users.
- Its normal cost is around million US dollars, which is very high for the low end users.

3 Low Cost ATE

3.1 Need for low cost ATE

The highly sophisticated ATE is much costlier, as it has many features. Considering the ATE manufacturers, many of the features are self imposed and not required by the users[2]. Hence the cost is always high for the low end users. Traditionally, the low end users use low cost measuring instruments like multimeter for single point testing. But, for multi point testing they cannot afford to buy the million dollars sophisticated ATE. This requires a low cost test solution, which does the basic testing for these low end users automatically with minimum human intervention.

- A modern PC
- Analog and Digital Input/Output Boards
- Sensors and Transducers

Fig. 2. Automatic Test Equipment

As shown in above figure 2, a complete Automatic testing equipment consists of

![Diagram of Automatic Test Equipment](image1.png)

Fig 3. Low cost Automatic Test Equipment
3.2 Basic blocks of ATE

The figure 3 shows the typical low cost ATE, which has a PC, Analog to Digital converter (ADC) module and a Digital to Analog converter (DAC) module[11]. The power stimulus controlled by the PC, given from the DAC. The response is obtained from ADC, which is fed to the PC. Thus a common algorithm is written in PC to generate various test signal and the response is stored, viewed online for testing purposes.

The interface between the PC and the hardware unit plays a major role in deciding the speed at which the test is being conducted. Data is sometimes available from the UUT in binary form, and can be read serially or parallel through a digital interface. [6] Common interfaces are the PC’s serial port and parallel port. Compared to the parallel port, the programming for serial port is easier. Data can be read in a timed, handshaken manner or asynchronously with simple handshake protocol. Considering ease of programming and time taken to execute it, serial port and parallel port are employed rather than USB and GBIB. A variety of other powerful multi-purpose Input/Output boards for a PCI bus are commercially available. Common buses like VXI, PXI, and SCXI can also be used, but their use raises the cost of the system, due to their costlier boards.

Signal conditioning is often necessary and can be done with custom circuitry modules. Some of the conditioning circuits that are normally used in ATE industry are

- Amplification
- Attenuation
- Filter
- Isolation [6]

In a Low Cost ATE measuring analog voltage is the usual way of acquiring data. Often, the voltage measured repeatedly at various sampling rates from 10Hz to 10 MHz. Such large Bandwidth of sampling rate are not required for low end users. Hence for low cost applications, cheaper ADC and DAC can be used.

4 Implementation

The implementation of low cost ATE has been carried out with the hardware modules as shown in figure 4. A Microcontroller Unit is used as the Hardware interface between the Unit Under Test (UUT) and PC. The Microcontroller chosen to this setup is 8-bit microcontroller named P89C51RD2, which is a Philips make. This microcontroller can be operated at clock frequency of 33MHz at 12-clock mode and 20 MHz at 6-clock mode. This low cost chip has various features like In-System Programming (ISP), In-Application Programming (IAP), which make this system more flexible for future up gradation[12].

The interface between the microcontroller and PC is serial communication, which can be set at various baud rates such as 9600 bauds, 19200 bauds, and 38400 bauds[3]. The National Semiconductor’s ADC0809 IC is used for the ADC module, which has 8-channel multiplexed input and the conversion time is about 100 μs. The input analog channel, which has to be converted into digital, can be chosen by the microcontroller, which is truly chosen by the program written in the PC. DAC 0808 serves as the DAC module, which has settling time of 150ns. DAC is used to give the input signal to the UUT. The input voltage level to the ADC is only about 0 to 5V. Hence by using signal conditioning circuits the input signals are attenuated or amplified according to the testing points. The data from microcontroller to the PC are transmitted through serial communication.

The software that runs the ATE is programmed in Visual Basic (VB). In ATE systems, the event (test) should take place only after the completion of the other event (test). VB executes its codes only when its events are triggered. Hence it is called event driven programming. The program is written such that, it serves as the basic tool to get the data transmitted serially, process the data and generate the output according to the testing algorithm[4].

![Fig 4. Low Cost ATE - Solution](image-url)
The screenshot in the figure 5 shows the basic interface during the online viewing of the various test channels. In the particular screen shot there were 8 channels were captured and their various voltage level are shown in both graphical form and text form. The various test point outputs are stored in the database through VB. These data can be accessed at any point of time once it is stored.

A simple protocol has to be formulated to talk between the ATE and software. In this ATE the protocol has been formulated by passing the testing point number with the voltage that has to be tested. This is sent to the microcontroller serial port which analyses and gives the address pins of the ADC to choose the particular test point or test channel. The microcontroller is programmed such that it initiates the ADC by giving start-of-conversion, address latch enable, output enable after receiving the End of Conversion signals.

Fig.6.Screen shot - Graphical User Interface

The output digital value of the converted test point voltage is read by the microcontroller and sent to the PC’s Serial port in the same protocol. Once the voltage of the particular test point is obtained, according to the test algorithm the next test point is passed. Thus the whole setup is programmed in modular fashion, which makes it to work for many types of test points and at the same time with less hardware change.

This type is used for automatic testing of various analog IC’s and also for testing of power supplies. Since Universal analog IC testers are very much costlier, this type of dedicated automatic test solution can be used for these purposes[10]. Considering the power supplies their regulation can also be calculated using simple switching circuits by varying the load.

5 Conclusion

The high cost ATE systems are said to be Universal testing solution, whereas the low cost ATE’s are used for more dedicated systems applicable to the low end users. Even though economic analysis alone does not help in choosing the right ATE systems, the dedicated approach is much simpler. Therefore, they are highly reliable and less expensive for the low end users.

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7 References

supply testing, *M.E Phase I Thesis*, Anna University.


