Testing Digital Signals by Low Cost ARM Based Logic Analyzer

Varsha Karambelkar, A.A.Shinde

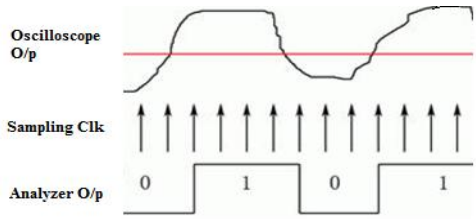
Abstract— Due to the fast development of electronic devices, the digital circuit designing takes up more and more percentage in total electronic developments thus in the process of debugging and doing validation in a digital system, one of the common task a designer need to do is the acquisition of digital waveforms. The waveforms can be captured by the device Logic Analyzer.
As digital circuit is too fast to be observed by a human being, the basic idea to capture waveforms at higher speed is to implement the design using ARM controller which internally uses RISC Machine unlike simple processors. ARM based embedded systems, providing a low-cost solution to meet the request of flexibility and testability
Logic analyzer is a dedicated application The main objective is to use module as powerful Lab equipment to check and verify the design under test (digital circuit) for design and verification engineers with smaller size and less expensive.

Keywords: Logic analyzer, ARM, RISC.

I. INTRODUCTION

In order to deliver correct-the-first-time products with complex system requirements and time-to-market pressure design verification is vital in the embedded system design process. A possible choice for verification is to simulate the system being designed. If a high-level model for the system is used, simulation is fast but may not be accurate enough, with a low-level model too much time may be required to achieve the desired level of confidence in the quality of the evaluation. Since debugging of real systems has to take into account the behavior of the target system as well as its environment, runtime information is extremely important

Along with the designing of any digital system it also necessary to debug and validate the system For debugging the system, different tests are needed to perform on digital waveforms[1]. Logic Analyzer is a tool that allows numerous digital waveforms to be acquired simultaneously. To acquire different digital waveforms a Logic Analyzer is a multi-channel device. The major function of a oscilloscope is to display the analogue characteristics, voltage scope and the spurious interference of a signal.



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The logic analyzer is designed for digital circuits because of inherence of a signal, it works on the aspects of voltage level.

Each channel inputs one digital signal. We have an aim that in near future this system shall gain the same popularity as a DMM (digital multi-meter) in present time.

When we connect an analyzer to a digital circuit, we are only concerned with the logic state of the signal. It measures and analyzes signals differently than an oscilloscope. It doesn't measure analog details. Instead, it detects logic threshold levels. The advantages of Logic analyzer over oscilloscope are it can monitor multiple channel at a time with good and various triggers .It can be used as a powerful analysis function [3]

For testing a digital circuit using analyzer, only logic state of the signal is considered. The digital systems are faster compared to analog systems so acquiring the data will require higher rate and acquisition of data with high speed is possible with ARM machine as RISC machines are faster.[1]

The acquisition can be clocked internally, or the test system can provide the sample clock. It would trigger on a complicated sequence of digital events, and then copy a large amount of digital data from the system under test. The captured data will enable the user to locate failure of the digital system.

The acquisition channel is connected to the System Under Test through test probe. The input voltage is compared against the threshold voltage and decision about the signal's logic state (1or 0) is made.[2] The Logic Analyzer uses the PC as its displaying platform and communicates with the devices through USB ports. It also supports the most popular windows system and provides with convenient User Interface. With its powerful triggering abilities user can easily find out even slightest errors within the system.

Logic Analyzer is used to debug and verify digital system operation, used to detect and analyze timing violations and transients on buses and to trace embedded software execution [3]

II. SYSTEM ARCHITECTURE

A logic analyzer is an electronic instrument which displays signals of a digital circuit. A logic analyzer may convert the captured data into timing diagrams, protocol decodes, state machine traces, assembly language, or correlate assembly with source-level software. Logic Analyzer is a multi-channel device which helps in displaying the digital waveforms.

With the rapid development of the field of industrial process control and the fast popularization of embedded ARM processor, it has been a trend that ARM processor can substitute the single-chip to realize data acquisition and control.

Proposed system is based on embedded ARM processor.

The module includes different parts -The first part includes different testing digital circuit like timer, flip flop, counter Timer can be used to generate a square waveform of particular frequency or variable frequency or it can be different microcontroller signals

As embedded systems are getting more complex, the needs for thorough testing become increasingly important.

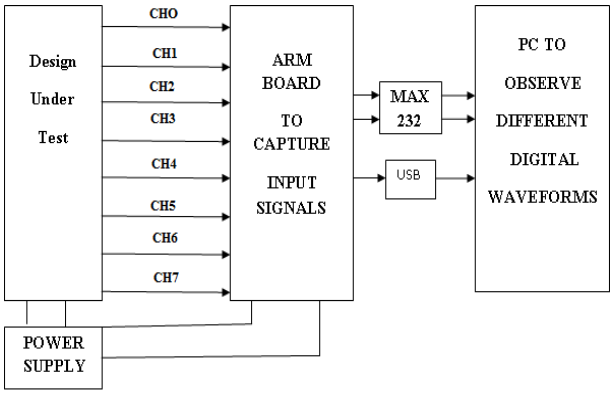
Advances in surface-mount packaging and multiple-layer PCB fabrication have resulted in smaller boards and more compact layout, making traditional test methods, e.g., external test probes and "bed-of-nails" test fixtures, harder to implement. As a result, acquiring signals on boards, which is beneficial to hardware testing and software development, It also include the probe to be connected from testing circuit to ARM board

The second part includes actual ARM board to capture real time signals of digital circuits The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers (CISC). This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core.

Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory.

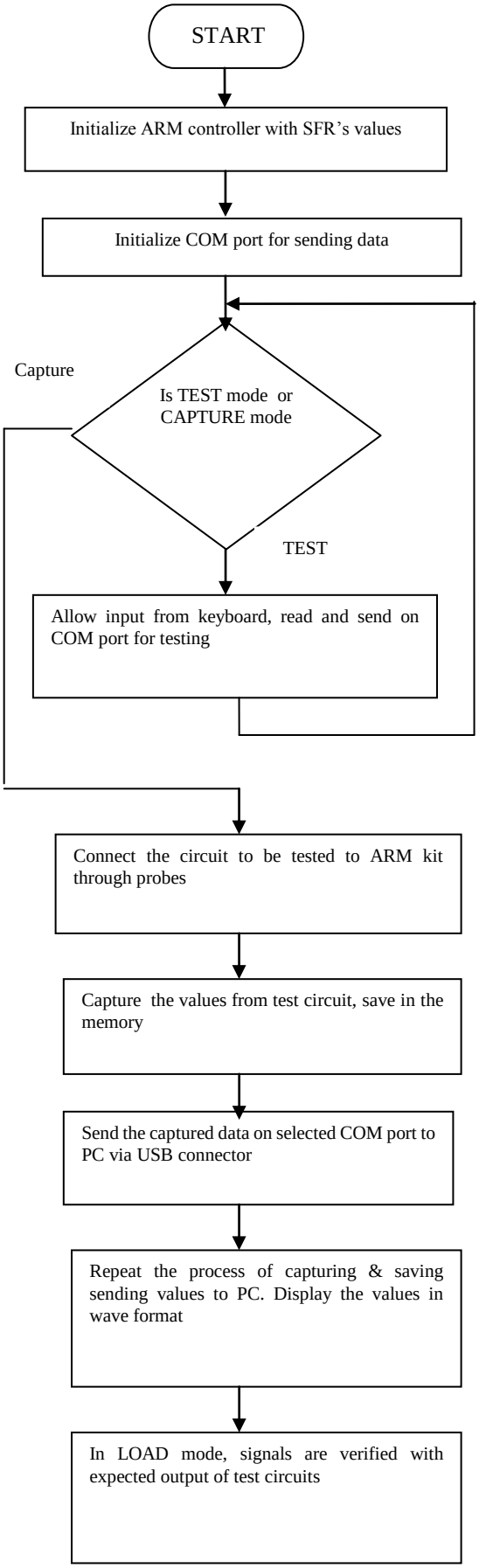
The advantages of using RISC processor as they uses ssmaller die sizes and requires shorter time to develop. The processors gives higher performance than CISC. It uses high clock rate with single cycle The ARM board is connected to PC through USB connector

The further part includes displaying the captured waveforms on the PC with the help of GUI control signals. The waveforms can be saved on the PC and retrieved back to analyze or to debug the different timing signals



The GUI (Graphical User Interface) includes different control buttons to connect different serial ports, hardware testing, debugging i.e capturing as data logging and analyzing i.e loading timing signals which are saved in data logging window

III. FLOW CHART



IV. RESULT

The basic hardware connection is tested using hardware test window. Initially all channels are at logic 1.When testing circuit is connected the value changes accordingly. Fig 1 shows the logic 1 or 0 accordingly.

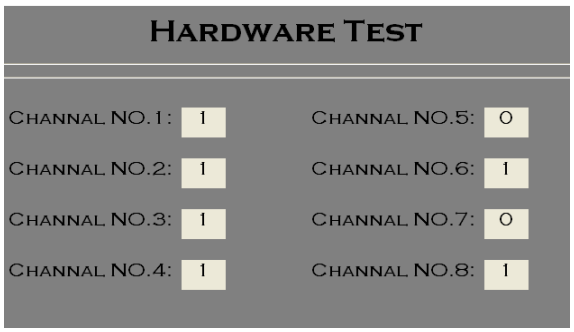


Fig 1.Hardware Test Window

In Data Logger window signal is captured and saved. In Load graph or Measurement window same signal is loaded and measured.

A simple Astable circuit is connected to channel one of the testing instrument. A time period can be verified as per the components connected to it, The sampling period 1 mS is taken to read the input. As Ra=12.2KHz, Rb=95KHz resistor and 1uf capacitor gives 7.121Hz theoretically .

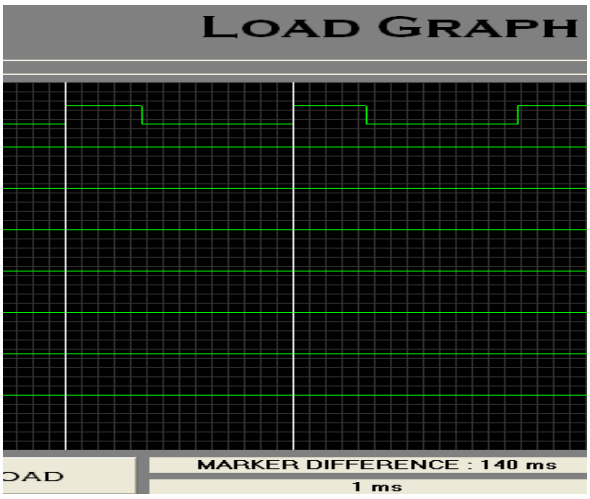


Fig 2. Measurement window

Fig 2 shows the marker difference is 140ms thus frequency is 7.14Hz. Hence theoretical and practical frequency results are same.

V. APPLICATIONS

Laboratory Purpose

Oscillator measurement: Observe the waveforms to find out if there are burrs or interferes or if change in frequency

Timing measurements Measure the timing of signals to find out conflicts or timing problems

Assistance on analysis It provides additional analysis to bus signals or protocol to simplify the development cycle.

Bug finder; Logic analyzer can be used for error tracing or finding error bugs.

Multichannel Measuring: It has 8 channels it can handle this kind of measurement easily.

Bus Frequency measurement

Trigger ability

Error Captures

VI. CONCLUSION

The successful completion of the nodule can be used as powerful lab equipment to debug and verify different digital systems with smaller size and less expensive

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