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Research Paper Engineering

Microcontroller Based Programmable Input Output (I/O) Simulator

Smt. A.M.CH.Jyothi Student of Masters of Technology (Embedded Systems & VLSI Design) Gayatri Vidya Parishad College of Engineering Madhurawada, Visakhapatnam, Andhra Pradesh

Smt. V Leela Rani Associate Professor, Gayatri Vidya Parishad College of Engineering Madhurawada, Visakhapatnam, Andhra Pradesh

ABSTRACT

The project titled "MICROCONTROLLER BASED Programmable I/O SIMULATOR" is proposed to be used as a generic system for controlling various devices under program control. It can be used as a test jig for different purposes like testing relays, checking the continuity of large number of cables etc. there by reducing time and man power. The unit is programmable using the user information provided through keypad and also from remote pc through RS-232 and Ethernet interface. This system is designed using rabbit microcontroller for controlling various inputs and an FPGA is used for activating various outputs.

KEYWORDS

INTRODUCTION

In the world of embedded electronics especially in the armed forces (defence) space, as a novel approach and as a part of quality checking with test jigs i.e., MICROCONTROLLER BASED I/O SIMULATOR is proposed for comprehensive internal application that can validate the health of a specific system by way of measuring the resistances amongst the numerous pins of various connectors and cables of the system (**Aiwu Ruan, et all, 2014**). This approach is novel as in till date, for 360 degrees quality checking, the general method of measuring these resistances is through a digital multimeter which might not suffice in the Defense space which commands 100% accuracy.

As a primary variable, the task of measuring the resistances becomes cumbersome and time consuming when the number of connectors and cables are populous. For this purpose, this research intends to develop a system which can measure and display the resistance values, which in turn indicates the health of the system whether it can be operated precisely or not. This accurate measurement of resistance is pivotal in that, if the resistance measured is above/below the threshold value, it may indicate to a major fault in the system (**Ana Toledo Moreo, et all, 2005**). This research output ensures a remedial action enforcing the user to take proper care before connecting the system to the primary power supply.

RESEARCH OBJECTIVE

The objective of this thesis is to develop a system which checks the continuity of devices under test and to display its value of resistance and also display whether it is suitable to use in system chosen taking into account its threshold value. As per the requirement, input can be given through keypad, RS-232 or through Ethernet communication and display them on LCD or PC accordingly. Any controller will have only limited I/O lines. So FPGA module is chosen for availability of large number of I/O lines (**Li Wan, et al, 2014**). The apt design for this is to use controller for processing and controlling the FPGA module. Through the FPGA module, "device under test" is connected and tested for its continuity and validates the resistance value.

The microcontroller provides multiple functions i.e., Input mode selection, provides for a keypad, an LCD monitor, RS-232 and the Ethernet module is interfaced and controlled through the microcontroller. Subsequently, FPGA module is interfaced to the controller and inputs are given and controlled by the microcontroller (**Soto Valles, et al, 2005**). The ADC is interfaced to the controller and communication is routed through the SPI protocol with controller as the master and ADC as the slave. The FPGA provides functions to use inputs provided to it, and it then switches on the required relays. The unused relays are powered off to reduce power overload.

LITERATURE SURVEY

RMACS is an effective on-line monitoring and control system and to transmit the real time data on to the terminal. Using Ethernet Based Remote Monitoring and Control of Temperature by Using Rabbit Processor paper, [**Gayathri Rema Narayan, 2012**]. Automatic generation of event alarm and sensor data reports is absolutely useful in chemical factories and industries and can be implemented using low cost tools like Rabbit controller as described in the below mentioned paper [**Ignacio Bravo, 2011**]. One major challenge in industries is loading a program and debugging at remote site. One basic motive of this research is to develop an "E-Programmer" **Katarina Paulsson, 2009**. It is a system kept at remote site with online program download facility. This program will be connected to Internet and program will be changed and downloaded in remote application unit from a remote server.

HARDWARE

A Rabbit Controller (RCM 5700), a Xilinx Spartan 3an, an input handle (Keypad), a visual monitor LCD 20x4, an ADC, a Buffer, a Voltage Regulator, an Instrumentation amplifier, a level converter, a regulated voltage, a voltage inverter, a D Flip-flop and a DeMultiplexer.

Figure 1

Laboratory Research Exhibit 1 - Layout – Top Silk

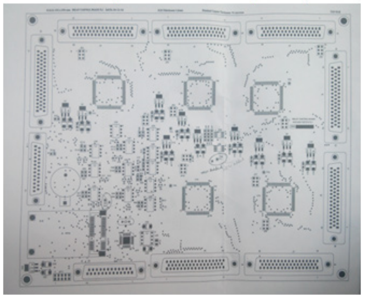

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Figure 2

Laboratory Research Exhibit 2 - Layout – Bottom Silk

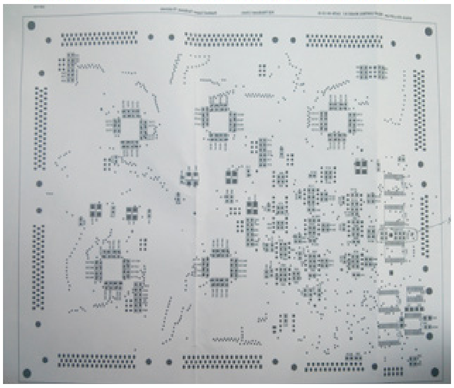


Illustration 1
Proposed Rabbit Prog Cable Dg

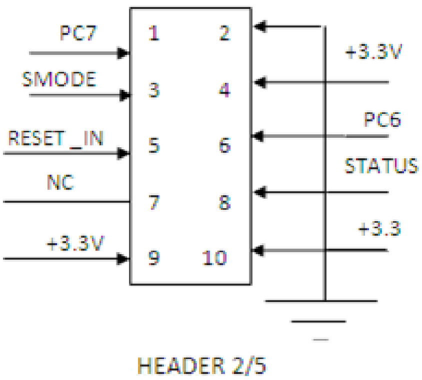


Illustration 2
Proposed XiLinx Prog Cable Diagram

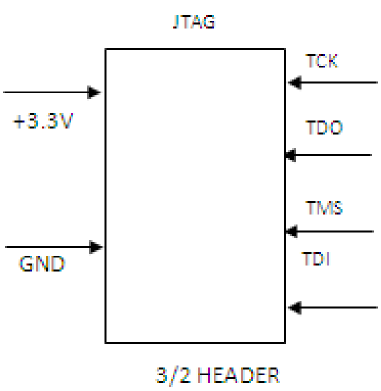


Illustration 3
Schematic – Page 1

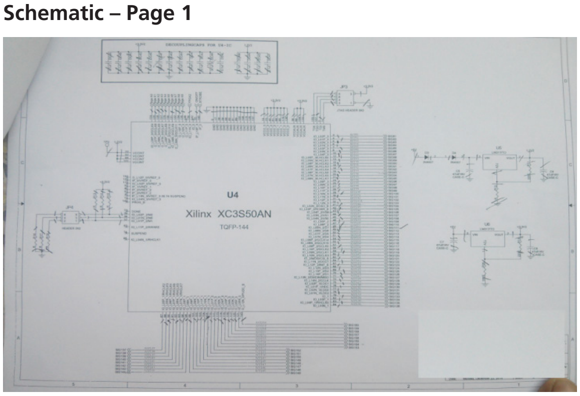


Illustration 4
Schematic – Page 2

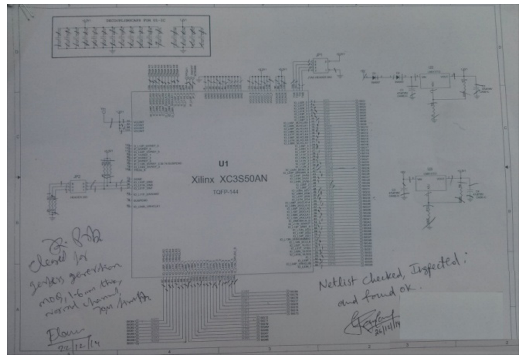


Illustration 5
Schematic – Page 3

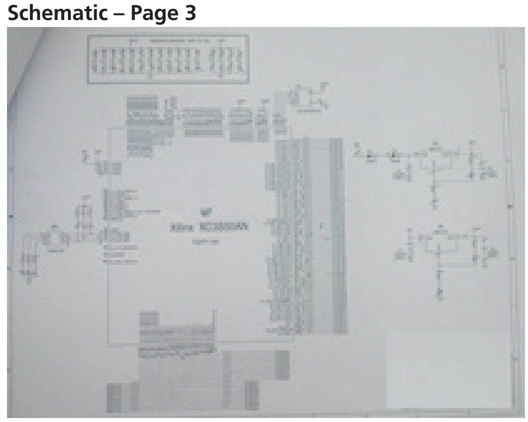


Illustration 6
Schematic – Page 4

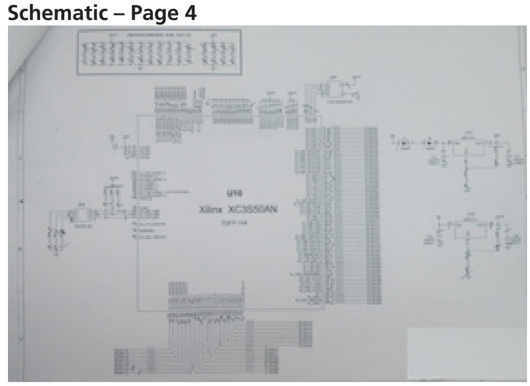


Illustration 7
Schematic – Page 5

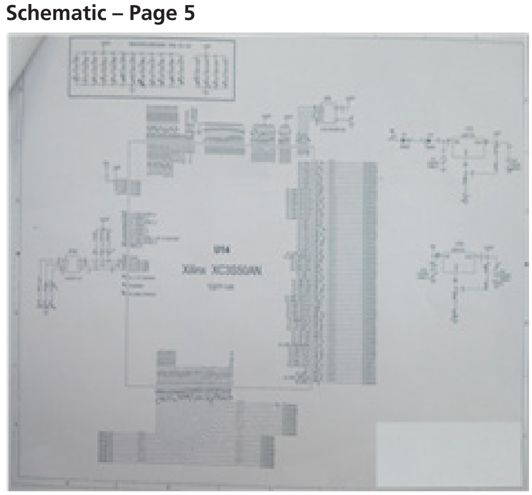
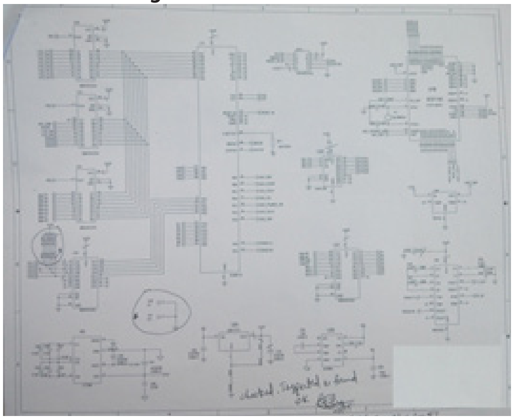


Illustration 8
Schematic – Page 6



SYSTEM DESIGN – PROPOSED SYSTEM

"MICROCONTROLLER BASED Programmable I/O SIMULATOR" is proposed to be used for internal purpose to know the health of various devices under program control. It can be used for testing different components like relays, validating the continuity of large number of cables etc. there by reducing time and man power. The unit can be operated in manual mode by providing the user information through keypad and also through auto mode by providing information through remote pc through RS-232 and Ethernet interface. This system is designed using rabbit microcontroller which controls overall system and an FPGA is used for increasing the devices under test which is internally controlled by the rabbit controller.

TECHNICAL SPECIFICATIONS

The range of resistance measured is 0 to 20 ohm, tolerance is +/-0.05ohm and total number of resistors/wires measured is up to 200. Basic power supply to the system is provided through the connector, input voltage=+5V and load current=-600mA and the voltage regulator is used to convert basic +5v to +3.3V, Power the Rabbit Controller 3.15 V DC (min.) – 3.45 V DC (max.). 70 mA @ 3.3 V (typical — without Ethernet), 200 mA @ 3.3 V (typical — with Ethernet), Xilinx SPARTAN 3A: Two voltage regulators are used to supply voltage to FPGA module +5V to +3.3V and +1.2V.

Basic Principle:

A known amount of current is passed through the device under test. Voltage obtained is measured and amplified by giving the obtained voltage through device under test to instrumentation amplifier. Now this voltage is fed to ADC. The digital voltage is fed back to microcontroller which calculates the resistance value by making use of the known current value using the ohms law. **V=IR**

Figure 3
Basic Principal Illustration

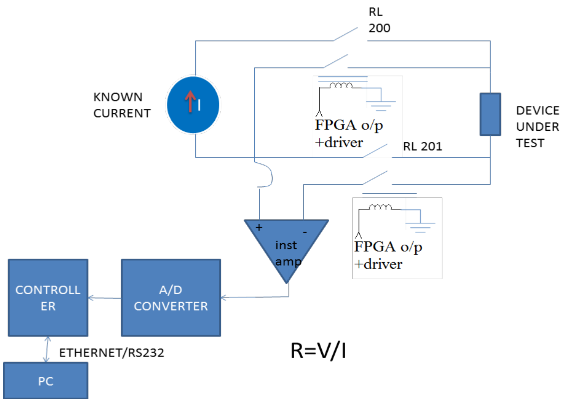
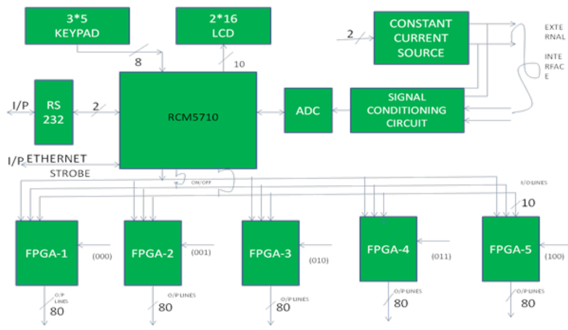


Figure 4
Block Diagram



Device under test is connected to the output lines of FPGA through relays. Input to the system is the connection details of the two ends of the device under test (e.g.: resistor) and threshold value of device. The input given through any mode is fed to microcontroller which processes the inputs and gives the outputs to the FPGA which acts like a decoder and switches on the particular two relays to which device under test is connected. Through constant current source known amount of current is passed to the device under test. A voltage is developed across device under test which is fed to ADC through instrumentation amplifier through ADC the voltage is converted to digital and fed to microcontroller. Once again microcontroller processes the outputs from ADC and obtains the value of resistance, compares it with threshold value given. Value of resistance, its threshold value and whether it is faulty or not displayed on LCD.

Figure 5
Design Flow

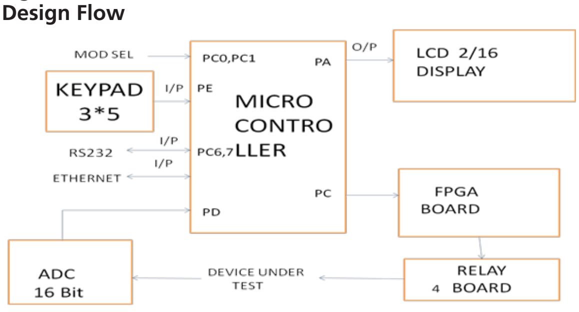


Figure 6
System Software Flow Chart

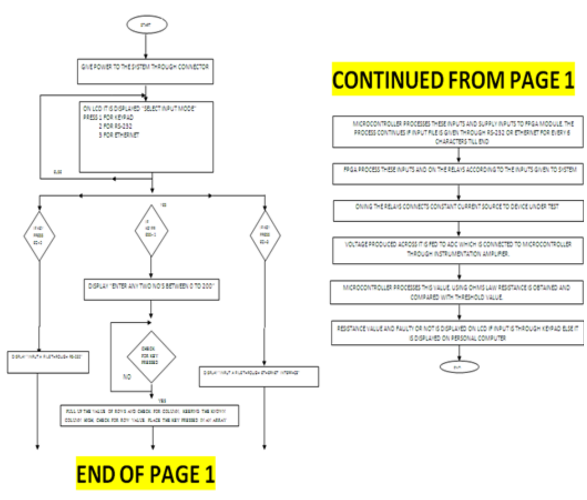
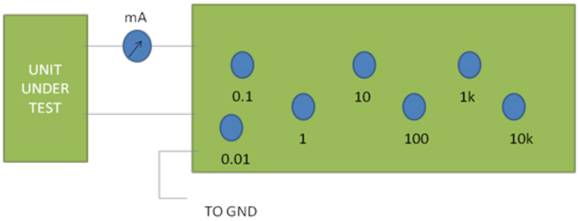


Figure 6
System Software Flow Chart



EXPERIMENTAL RESULTS

Once all the software dumping stood completed, inputs for testing were connected to the system. For this purpose high precision decade resistance box was used. It was designed and fabricated to meet the standard calibration requirements. It had the following standards. Resistors with accuracy of 0.02% to 0.05% and Low temperature coefficient of +/-1ppm (Between 20 to 40 degree c).

This is connected to the system to give inputs. An input to be given to the system is chosen and output is verified. Results are rendered below for reference and record. If the wire resistance value is below the threshold value, the wire can be used in the system else it is displayed as "faulty".

Table 1
Experimental Results

Channel No	Resistance Value	Measured Value	Threshold Value	Remarks
10	0.1	0.1	1	ok
20	0.05	0.05	2	ok
40	0.02	0.02	2	ok
80	0.6	0.6	1.5	ok
95	1	1	0.8	faulty

Illustration 9
Snap of the Live Printed Circuit Board (PCB)

Illustration 10
Code for FPGA is dumped

Illustration 11
Pyro Resistance Measurement System

Illustration 12
Simulation Results of Xilinx FPGA XC3S50AN

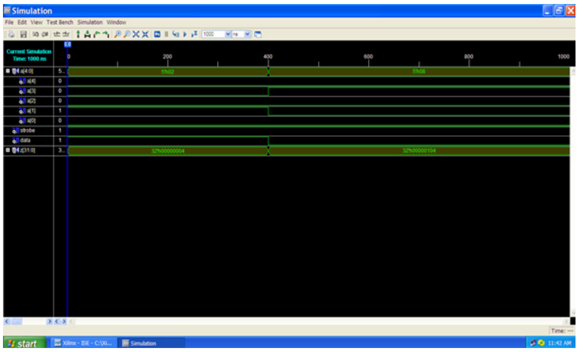


Illustration 13
Simulation Results of Xilinx FPGA XC3S50AN

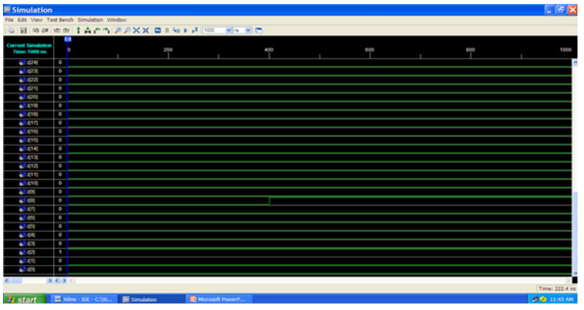
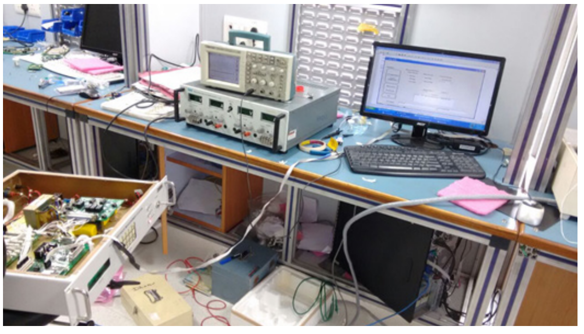


Illustration 14
PHOTOGRAPH OF THE CONNECTED RABBIT TO THE COMPUTER FOR CODE DUMP



CONCLUSION

Microcontroller based programmable I/O SIMULATOR was designed to measure the resistance of wire to be used in missiles and other defence equipments within a range of 0 to 20 ohms. Instead of wires a decade box is used as device under test to test the system designed as the resistance to be measured will be known accurately. Results obtained are 99.99% accurate. Threshold value is also given as one of the input, the system compares it with resistance measured and tells whether it can be used in the system or not .This can be done for

200 pairs of wires connecting all at a time to the output lines of Xilinx IC through relays.

Wires whose resistance is to be measured are connected to the output lines of Xilinx IC. The source and destination points of wires are given as input to the system. The inputs can be given through Keypad, RS-232 or through Ethernet and threshold value is also given as other input. If input is given through keypad, output is displayed on LCD. If it is through RS-232 or Ethernet it is displayed on monitor and also displays is it "ok" or "faulty".

Xilinx FPGA code is implemented using VHDL and Rabbit controller is coded using Dynamic C. Using the project designed, health of the system can be known before switching on the system.

REFERENCES

• Aiwu Ruan, Bairui Jie, Li Wan, Junhao Yang, Chuanyin Xiang, Zujian Zhu, Yu Wang; (2014, Agust); "A bitstream readback-based automatic functional test and diagnosis method for Rabbit Microcontroller"; Microelectronics Reliability, Volume 54, Issue 8, Pages 1627-1635 | • Ana Toledo Moreo, Pedro Navarro Lorente, F. Soto Valles, Juan Suardíaz Muro, Carlos Fernández Andrés (2005, November); "Experiences on developing computer vision hardware algorithms using Xilinx system generator"; Microprocessors and Microsystems, Volume 29, Issues 8–9, Pages 411-419 | • Gayathri Rema Narayan, Mr. Vinoth James (2012, November); "Barcode Recognition from Video by Combining Image Processing and Xilinx"; Procedia Engineering, Volume 38, Pages 2140-2146 | • Ignacio Bravo, Alfredo Gardel, Beatriz Pérez, José Luis Lázaro, Jorge García, David Salido (2011, September); "A new approach to evaluating internal Xilinx FPGA resources"; Journal of Systems Architecture, Volume 57, Issue 8, Pages 749-760 | • Katarina Paulsson, Michael Hübner, Jürgen Becker (2009, February); "Dynamic power optimization by exploiting self-reconfiguration in Xilinx Spartan 3-based systems"; Microprocessors and Microsystems, Volume 33, Issue 1, Pages 46-52 | • Girish Rajan (2014, February) "Online Parameter Monitoring System with Program Download Facility" International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 2. | |