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Universal Test Bench For Sensors

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Abstract

The rapid development in the research and innovation field was supposed to ease the workload of scientists and engineer, but the pressure has kept on building with larger magnitude, the reason being "Time". As more and more sensors are being introduced in the market, engineers are having trouble to pick the best suited sensor for the application.
The most time consuming tasks are developing data comparison schemas, writing firmware for the controllers so as to read the specific characteristics and need to rush to a costlier electronic work bench, every time we need to test a new sensor.
In industry, many times sensors need to be evaluated online in closed loop system. Also, there is a need of an instrument in a lab, with which students get practical knowledge about sensors.
Universal Test Bench is developed as a Portable Instrumentation Lab to provide testing, evaluating characteristics of various sensors.
The main objective is to reduce cost and time by testing various sensors under one roof.

Keywords: Sensor, Characteristics, Testing, Portable

1. Introduction

To succeed in the global competition, it is necessary to cut costs, to produce efficiently, and to optimize processes. None of these objectives can be realized without sensors and measuring technology and neither can the continuously increasing standards of quality be maintained without the testing technology.

Without sensors most electronic applications would not exist—they perform a vital function, namely providing an interface to the real world.

Sensors are the "organs of perception" in any field, be it MEMS microphones in a cell phone or a level sensor in the oil and gas industry. Wherever sensors are used, they are basically used to detect and measure four main parameters i.e. physical, mechanical, chemical and electromagnetic.

Sensors are becoming the central elements of bringing either new functionalities or reducing the total cost of ownership.

All manufacturers are very interested to verify announced functionality of a given product. Due to the fast development of sensors and transducers, the electronic circuit designing takes up more and more percentage in total electronic developments. The engineers and scientists are taking more and more time to pick up the best suited sensor for the application. Also, in the process of debugging and doing validation one of the major requirements is to evaluate sensor online in closed loop system, in industries.

The existing instrumentation labs are all filled with different boards for different transducers [7] [8]. Thus if you need to test characteristics of ten sensors you will be required to work through around ten different boards. Moreover these boards need to be plugged in with a PC to save the reports. The PC needs to have dedicated

software to study and compare the characteristics of these transducers. To conclude it is really hard to carry the whole lab set.

The Universal Test Bench allows us all, the access to a single compact portable mother board, of the size of a laptop which one can carry anywhere. One can quickly and easily evaluate any sensor. It allows comparing two sensors and finding the one which suits the application. One can easily find out erroneous sensor. One of the major requirements in industry is to analyze sensor online in closed loop system, which can be catered by Universal Test Bench by viewing Real time characteristics of the sensor.

The Universal Test Bench can be used as powerful lab equipment. It gives students the chance to get practical knowledge about sensors. It provides a detailed introduction to how electronic sensors work, the signals they produce etc.

The basic idea behind Universal Test Bench is to have a single system to test and verify the features, functions and characteristics of various sensors. The main objective is to reduce cost and time by testing various sensors under one roof.

The system has slots for various sensors to plug and play sensors anytime by placing daughter cards/signal conditioning cards into those slots. The motherboard is high precision and compact with most efficient ADC. Since the system is portable, there is a facility for viewing electrical characteristics, test reports of sensors. Graphical LCD serves this purpose and displays real-time analysis. The system provides user friendly GUI which can be navigated through keypad for fast and easy operation of the device.

There is an aim that in near future this system will gain the same popularity as a DMM (digital multi-meter) in present time.

2. System Architecture

The system is as follows:

1. The system contains a high precision but compact motherboard.
2. Microcontroller is the heart of the system, performing lots of functions. Few of them are

   - Scan all slots for available sensors.
   - Display available test profile options.
   - Interface with keypad to navigate through GUI.
   - Perform real time interpolation of sensor data from selected sensors.
   - Convert analog input to digital output with inbuilt ADC.
   - Display the test results on Graphical LCD

The system is based on embedded ARM processor. 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.

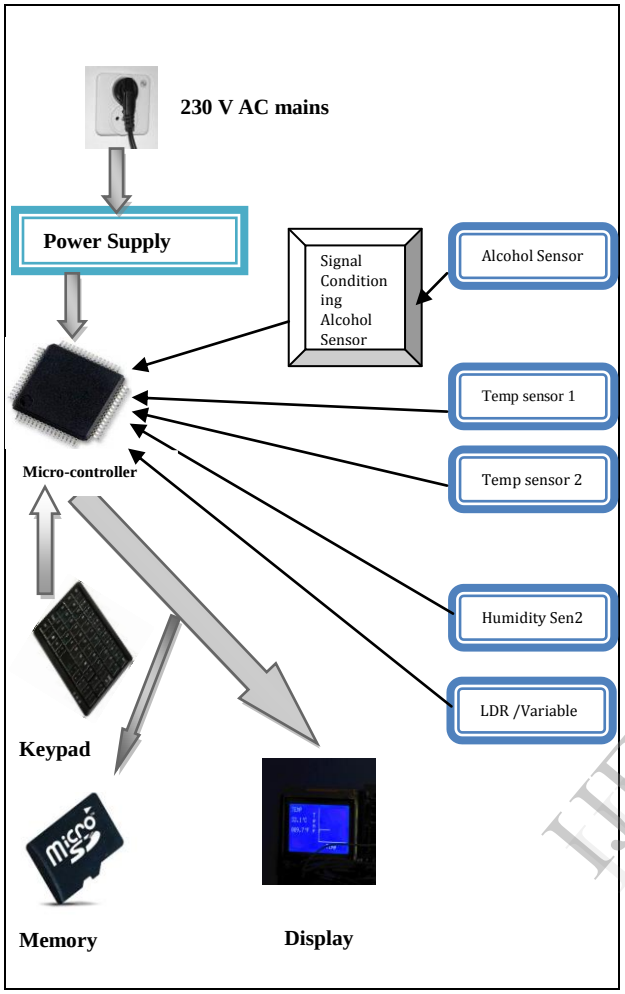
The LPC2148 incorporate 512 kB flash memory system. This memory may be used for both code and data storage. Programming of the flash memory may be accomplished in several ways. It may be programmed In System via the serial port.

Sensor O/P is directly given to ADC channels.10-bit ADCs provide a total of 14 analog inputs, with conversion times as low as 2.44 µs per channel and measurement range of 0 V to VREF (2.0 V ≤ VREF ≤ VDDA).

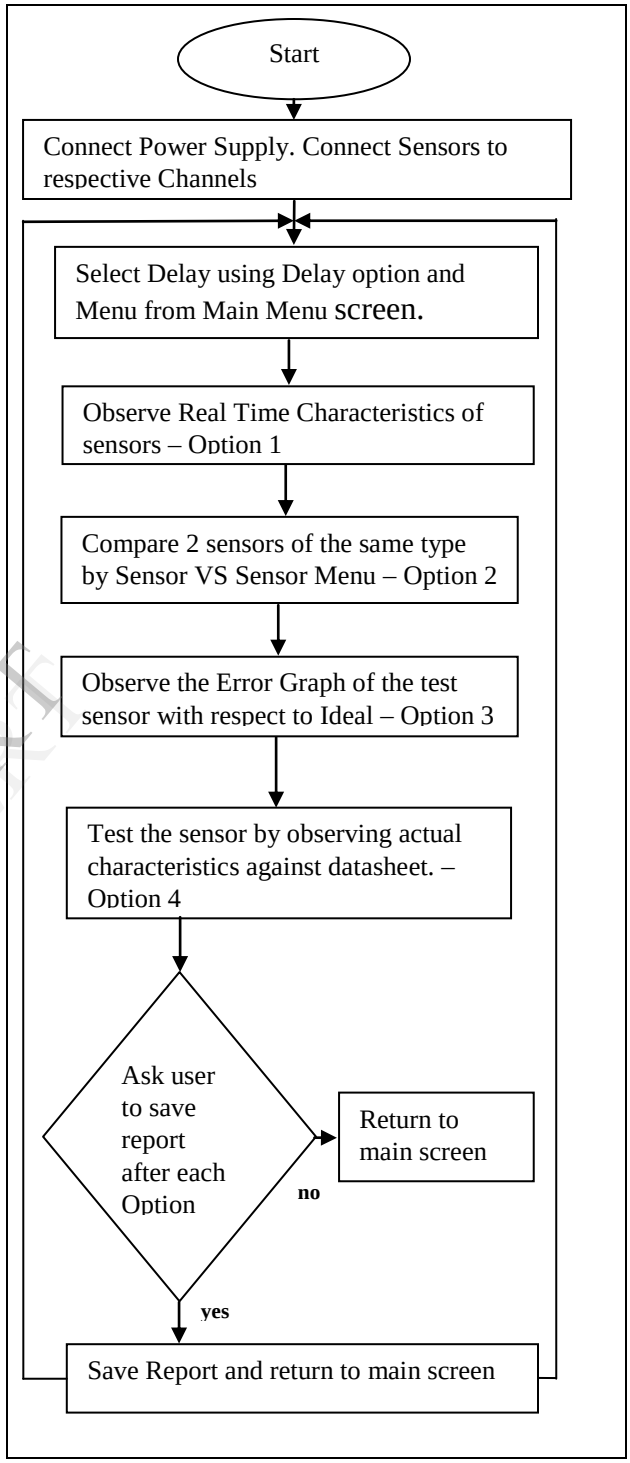
3. Since the system needs to be portable, there is a facility for viewing electrical characteristics / test report. Graphical monochrome LCD would serve the purpose. It also displays real time analysis and user friendly GUI that can be navigated by using keypad.
4. The motherboard has slots. One can plug and play sensors anytime by placing daughter cards/signal conditioning cards into those slots.
5. The system also provides a user friendly GUI on the LCD using keypads for fast and easy operation of the device. It allows to select the sensors for testing and to select the test profile.
   Keypad and graphical LCD are driven through fast general purpose parallel I/O lines.

There is an aim that in near future the system will gain the same popularity as DMM.

3. Block Diagram



4. Flow Chart



5. Result

5.1. Real Time Characteristics

Real Time Characteristics of Humidity sensor SY-HS-220 are observed with sampling period =2500ms

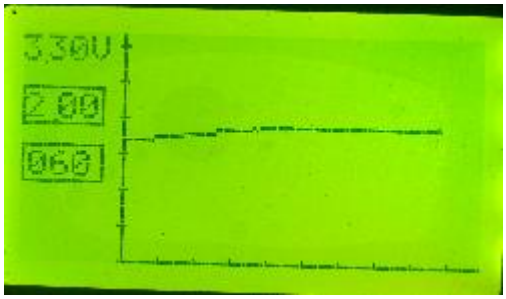


Figure 1. Humidity sensor characteristics

The Upper box shows current voltage and lower box shows humidity i.e. 60%RH

5.2. Sensor Error

Two temperature sensors are connected, one standard and other erroneous and error graph is observed.

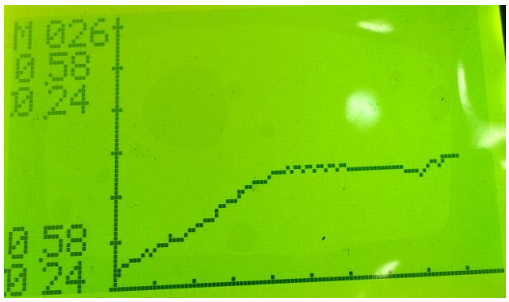


Figure 2. Error graph of erroneous LM35

The upper figures show voltages of two sensors when maximum error has occurred. And lower boxes show current voltages.

5.3. Characteristics

Characteristics of temperature sensor LM35 are observed and compared with the ideal i.e. datasheet. Here LM35 is evaluated for temperatures 30°C to 120°C. On X axis actual temperature observed, is plotted and on Y axis voltage is plotted. Lower box shows calculated temperature according to voltage.

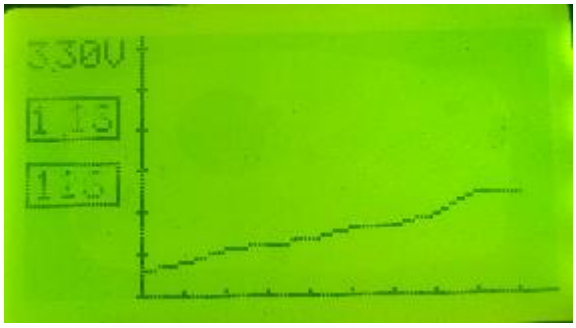


Figure 3. LM35 Characteristics testing

Table 1. Result: LM35 Characteristics testing

Actual Temperature Measured on Thermometer in °C	Voltage in Volts	Temperature calculated as per data sheet, in °C
30	0.29	29
40	0.42	42
50	0.54	54
60	0.62	62
70	0.70	70
80	0.84	84
90	0.84	84
100	0.97	97
110	1.16	116
120	1.16	116

6. Applications

1. Laboratory Purpose

Sensor Characteristics Study

UTM Machines

2. Industrial Purpose

CNC Machines

RTM Machines

Multi channel Data Loggers [1] [2].

Environmental Monitoring [5] [6].

7. Conclusion

The system can be used as low cost powerful lab equipment to test and evaluate various sensors. Students would get practical knowledge of the sensors. The system proposes to be used to evaluate sensors online in closed loop system, in industry. The system exhibits its use to pick up the best suited sensor for the application, for scientists and engineers.

The project would ease the workload /pressure from the minds of scientists, engineers and students all alike. Thus they will be able to concentrate on bigger projects and contribute to the development /knowledge acquisition and thus benefit the humanity at a much better pace.

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