Super Scope All-in-One Electronics Lab Assistant Device with USB Connectivity

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Abstract— Test and measurement instruments such as oscilloscopes and multimeters are the traditional hardware tools, an electronics engineer would have on his bench. Students in engineering curriculum, when exposed to these instruments, often come across a multitude of equipment’s such as voltmeters, ammeters, oscilloscopes and even simple things like calculator. Even after the touchscreen based smartphone revolution, most of the engineering colleges in India continue the tradition of introducing the students to a decade old instruments. The main objective is to design and develop a portable device called Super-Scope which is ALL-IN-ONE electronics lab equipment that has multiple functionalities needed by a modern day engineering student for his practical experiments in electronics and computer labs that would replace the existing plethora of instruments. The device is a fully operated from touchscreen using menus and touch buttons. The device has a USB-UART bridge circuit that gives USB connectivity for Desktop/Laptop communication for data logging the measured quantities such as current, voltage, speed, voice frequency, frequency, intensity of light and temperature. This process can be fully controlled by the user from the device UI. It also helps to easily upgrade the firmware of the device from a desktop/Laptop. The device is controlled by LPC1313, a powerful 32-bit ARM Cortex-M3 microcontroller from NXP Semiconductors.

Index Terms— ARM, Measurement instrument, All-IN-ONE electronics lab, UART, LPC1313.

I. INTRODUCTION

Test and measurement instruments such as oscilloscopes and multimeters are the traditional hardware tools, an electronics engineer would have on his bench. Students in engineering curriculum, when exposed to these instruments [1], often come across a multitude of equipment’s such as voltmeters, ammeters, oscilloscopes and even simple things like calculator. Even after the touchscreen based smartphone revolution, most of the engineering colleges in India continue the tradition of introducing the students to a decade old instruments [3].

Proposed System

This project is to design and develop a portable device called Super-Scope which is ALL-IN-ONE [5] electronics lab equipment that has multiple functionalities needed by a modern day engineering student for his practical experiments in electronics and computer labs that would replace the existing plethora of instruments [4]. The device is a fully operated from touchscreen using touch buttons and menus. The following features are been implemented in this project:

- Logic Analyzer
- Voltmeter
- Ammeter
- Ohmmeter
- Tachometer
- Audiometer
- 3-axis Motion Monitor
- Light Meter
- Temperature Probe
- Calculator.

II. SYSTEM DESCRIPTION

Block Diagram

The below figure 3.1 shows the block diagram for the proposed system for the All-in-one Electronics Lab assistant device with USB connectivity.

ARM CORTEX – M3

The ARM Cortex - M3 processor [8] is the industry-leading 32-bit processor for highly deterministic real-time applications and has been specifically developed to enable partners to develop high-performance low-cost platforms for a broad range of devices including microcontrollers, automotive body systems, industrial control systems and wireless networking and sensors. The processor delivers outstanding computational performance and exceptional system response to events while meeting the challenges of low dynamic and static power constraints. The processor is highly configurable enabling a wide range of
implementations from those requiring memory protection and powerful trace technology through to extremely cost sensitive devices requiring minimal area.

**LPC1313**

The LPC1313 are ARM Cortex-M3 based microcontrollers for embedded applications featuring a high level of integration and low power consumption. The ARM Cortex-M3 is a next generation core that offers system enhancements such as enhanced debug features and a higher level of support block integration [7].

**Temperature Sensor**

The LM35 [9] is an integrated circuit sensor shown below in figure 3.4 can be used to measure temperature with an electrical output proportional to the temperature (in °C). The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy).

**Light-Dependent Resistor**

An LDR alternatively called, photoresist or, photoconductor, or photocell, is a variable resistor whose value decreases with increasing incident light intensity. An LDR is made of a high-resistance semiconductor. The LDR is shown in the below figure 3.5. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

**MEMS ACCELEROMETER**

An accelerometer is a device for measuring acceleration and gravity induced reaction forces. Single- and multi-axis models are available to detect magnitude and direction of the acceleration as a vector quantity. The LIS302DL is an ultra-compact low-power three axes linear accelerometer.

**BUZZER**

An electronic device for signalling with sound is called as a buzzer or beeper. The major use of the buzzers is in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the
metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to “driver” circuits which varied the pitch of the sound or pulsed the sound on and off.

电压和电流传感器

这些传感器用于查找电路中的简单电流和电压。这些传感器适用于学生或研究者在实验室工作时。代替使用标准安培计和电压表，可以使用这些设备。

旋转编码器

旋转编码器，也称为转轴编码器，是一种机电设备，将转轴或轴的角位置或运动转换为模拟或数字信号。旋转编码器用于许多需要精确无限旋转的应用，包括工业控制、机器人、特殊用途的摄影镜头、计算机输入设备控制的应力测量仪和旋转的雷达平台。

图2. MEMS加速度计

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一个旋转编码器，也称为转轴编码器，是一种机电设备，将转轴或轴的角位置或运动转换为模拟或数字信号。旋转编码器用于许多需要精确无限旋转的应用，包括工业控制、机器人、特殊用途的摄影镜头、计算机输入设备控制的应力测量仪和旋转的雷达平台。

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III. 软件

LPCXpresso是一个新的低成本开发平台，由NXP提供。该软件包括一个增强的、基于Eclipse的IDE，一个GNU C编译器、链接器、库和一个增强的GDB调试器。硬件包括LPCXpresso开发板，该板包含一个LPC-Link调试接口和一个NXP LPC ARM平台的微控制器目标。LPCXpresso是一个端到端的解决方案，它使嵌入式工程师能够开发其应用程序从初步评估到最终生产。

LPCXpresso IDE，由Code Red Technologies提供，基于流行的Eclipse开发平台，并包括几个LPC特定的增强功能。它是一个符合行业标准的GNU工具链，带有优化的C库，为工程师提供了所有必要的工具，以快速有效地开发高质量的软件解决方案。C语言编程环境包括专业级的特性。它具有语法着色、源格式化、函数折叠、在和离线帮助，以及专业的项目管理自动化。
IV. SIMULATION RESULTS

The device has the following features built in: Digital Signal Oscilloscope – used to monitor signals acquisitioned through the inbuilt 10-bit A to D converter. This device is single channel, 100 KHz bandwidth. The signals will be shown in color waveforms in a nice 65K Color QVGA Touch screen TFT Graphical LCD Display.

- Waveform Storage and Playback – used to save the acquired signals for analyzing and viewing. The storage medium is a 2GB Micro SD memory card.
- Frequency Generator – used to generate pulses at variable frequencies with added pulse width control
- Logic Analyzer – used to analyze serial protocols such as UART
- Voltmeter – used to measure the input DC voltage
- Ammeter – used to measure the input DC current using current shunt resistor drop
- Ohmmeter – used to find the resistor values, short circuits and components such as diodes
- Tachometer – used to measure the speed of the rotating shaft of the motor using the Rotary Encoder
- Audiometer – used to monitor the audible frequency signals sensed via Microphone circuitry.
- 3-axis Motion Monitor – used to measure acceleration or tilt or motion on all three-axis using 3-Axis MEMS Accelerometer
- Light Meter – used to measure the brightness of the incident light in terms of Luminosity using Light Sensor
- Temperature Probe – used to measure the temperature or heat of atmosphere or an object in degree Celsius
- Calculator – used to perform math calculations using touch screen keypad.

For example for the waveform storage and playback output is show in the fig. 5.

V. CONCLUSION

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REFERENCES


