

REAL TIME DATA LOGGER WITH ANDROID APPLICATION

Nikhil Sinnarkar¹, T Saminathan²

^{1,2} ECE Department, SRM University, (India)

ABSTRACT

Over the years data loggers have found widespread use in many different domains ranging from home application to industrial use. They can be designed to serve a specific purpose or a more general use depending on the requirement of the end user. The flexibility in their design provides the user with a cost effective solution to the task in hand. This paper introduces a low cost data logger along with a supporting android application to access the data on the system. The proposed data logger samples the analog input channel, converts the input data using analog-to-digital converter (ADC), uses a real time clock (RTC) to time stamp the collected data and then stores it in permanent memory. The data can be retrieved to any android powered Smartphone using the companion app. The sampling interval of the data logger can be configured by the user as desired.

Keywords : Data Logger, Microcontroller, Bluetooth Communication, Android, Low Cost

I. INTRODUCTION

Data loggers are devices which capture and store the data for later time. Data loggers are nowadays based on the microcontroller technology. Typically, data logger is equipped with microcontroller, memory, and sensor for data collection. Most of the data logger equipped together with time stamp system so that it will be able to stamp time and date while logging every data. They are usually portable, battery-operated devices with internal storage and some incorporating sensors to measure physical quantities such as temperature, pressure, humidity, flow, displacement and so on. Data loggers can be divided into two basic groups: standalone data loggers and data capturing data Loggers.

1.1. Standalone Data Loggers

This type of data loggers can be used on their own, without requiring other devices for data collection and storage. Standalone data loggers have large amounts of internal non-volatile memories. They may also have real time clock chips. The collected data can be saved in the memory with time stamping. This type of data logger is configured before installation at the site. Once it is installed it does not require any human intervention. The data collected by such types of data loggers is typically analysed offline. The amount of data that it can store depends primarily upon two things- available memory and the battery capacity. Some data loggers have the ability to switch from one memory to another when the former is full [1].

1.2. Data Capturing Data Loggers

Data capturing data loggers are used only to capture the data. These devices do not have large internal memories and are normally connected to a PC. The captured data is sent to the PC for storage or for analysis. The data can either be analysed offline or online. One of the disadvantages of data capturing data loggers is that the devices cannot be used on their own as another device (e.g. a PC) is required to store the captured data.

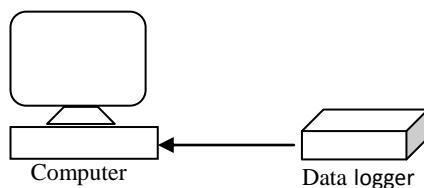


Fig. 1: Data logger (data capture type)

The design of the data logger can be made based on the needs of specific environment or application type. Many of the general purpose data loggers are machines with fixed parameters. However, there are some with re-programmable capability.

In this paper a low cost development of standalone real time data logger is proposed using ARM microcontroller and a supporting Android app to interact with the system.

II. METHODOLOGY

The proposed data logging system consist of a microcontroller, real time clock, SD card, a Bluetooth transceiver to communicate with Android phones/tablets and a few sensor input channels, to which multiple sensors can be connected for measurement of parameters like temperature, humidity etc [2]. The block diagram of the system is shown in Fig. 2.

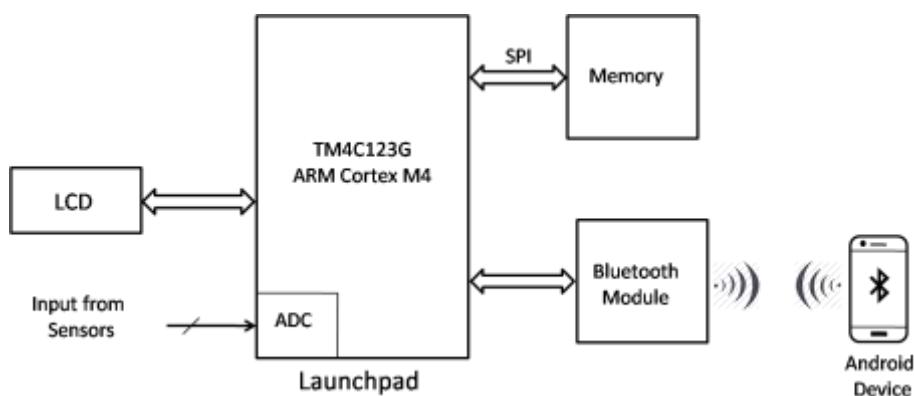


Fig. 2: Block diagram of Data logger

As shown in the block diagram the microcontroller receives input from the sensors and converts it to digital form. This digital data is then time stamped using RTC present inside the microcontroller. The time stamped data is then saved to memory & also transmitted to the user upon request.

III. HARDWARE

3.1. Microcontroller

The microcontroller used here is TM4C123GH6PM by Texas Instruments. It employs ARM Cortex M4 architecture based SoC. The various features of microcontroller which favours its use in the data logging system are:

- Two 12-bit ADC modules, each with a maximum sample rate of one million samples/second.
- Low-power battery-backed Hibernation module.
- Eight Universal Asynchronous Receivers/Transmitter (UART).
- Synchronous Serial Interface (SSI).
- Six physical General Purpose Input/output (GPIO) blocks.

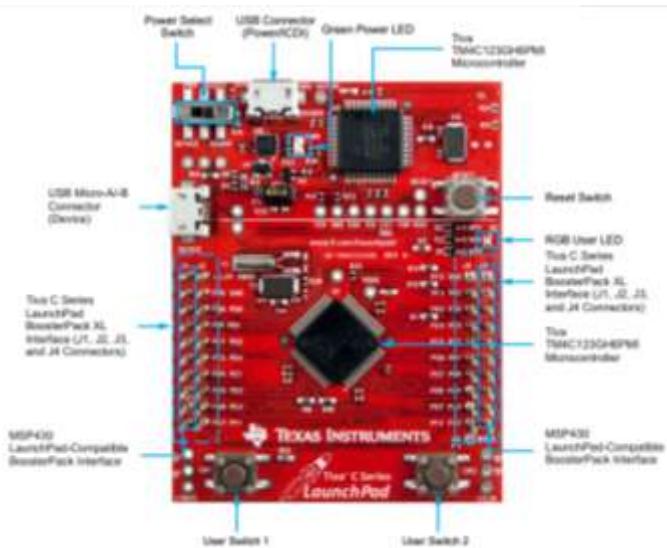


Fig. 3: Microcontroller board used for system development.

3.2. ADC

The TM4C123GH6PM ADC module features 12-bit conversion resolution and supports 12 input channels, plus an internal temperature sensor. Each ADC module contains four programmable sequencers allowing the sampling of multiple analog input sources without controller intervention. Each sample sequencer provides flexible programming with fully configurable input source, trigger events, interrupt generation, and sequencer priority. Out of the 12 available input channels 4 have been configured to receive input from sensors.

3.3. LCD

A 16x2 LCD is interfaced to the system to provide the user with relevant information during system operation. This LCD is also helpful during system debugging and testing.

3.4. RTC

Real-Time Clock (RTC) is built into the Hibernation module present on SoC. The RTC has a 32 bit counter with a resolution of 1/32,768 second. Clock source to RTC is a 32.768-kHz external crystal. The RTC counter increments every second. This counter is used to create a clock which is then used to time stamp the data.

3.5. Memory

A SD Card is interfaced to the system using SPI. A SD card can work in two modes- SPI mode and SD mode. Here it is used in SPI mode. In this mode no file system is implemented on the SD Card and the data written to it is in raw format.

3.6. Bluetooth

The Bluetooth module interfaced to the microcontroller is used for communication with the Android device. The Bluetooth module is configured to be a slave device. Whenever data is requested from the master, it is retrieved from the memory and transmitted as a string of ASCII characters. The microcontroller communicates with the Bluetooth adapter through UART interface.

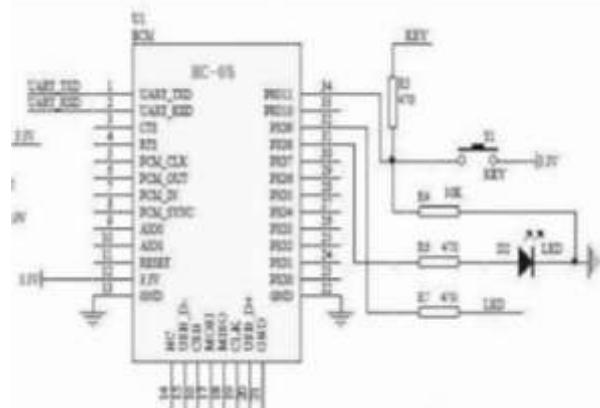


Fig. 4: HC-05 connection diagram

3.7. Android device

The user can retrieve data logged by the system using any android device. The android device requires a Bluetooth terminal app which is used to connect to the slave Bluetooth module present on the data logger. Once connected to the slave, the user needs to send appropriate command to get the data. The data received can be stored into the phone memory as a text (.txt) file.

IV. SOFTWARE

The software is developed in Code Composer Studios which is an IDE provided by Texas Instruments. The software for running each peripheral is done in separate modules. Each of these modules are tested individually for proper functioning and then integrated into a single code file.

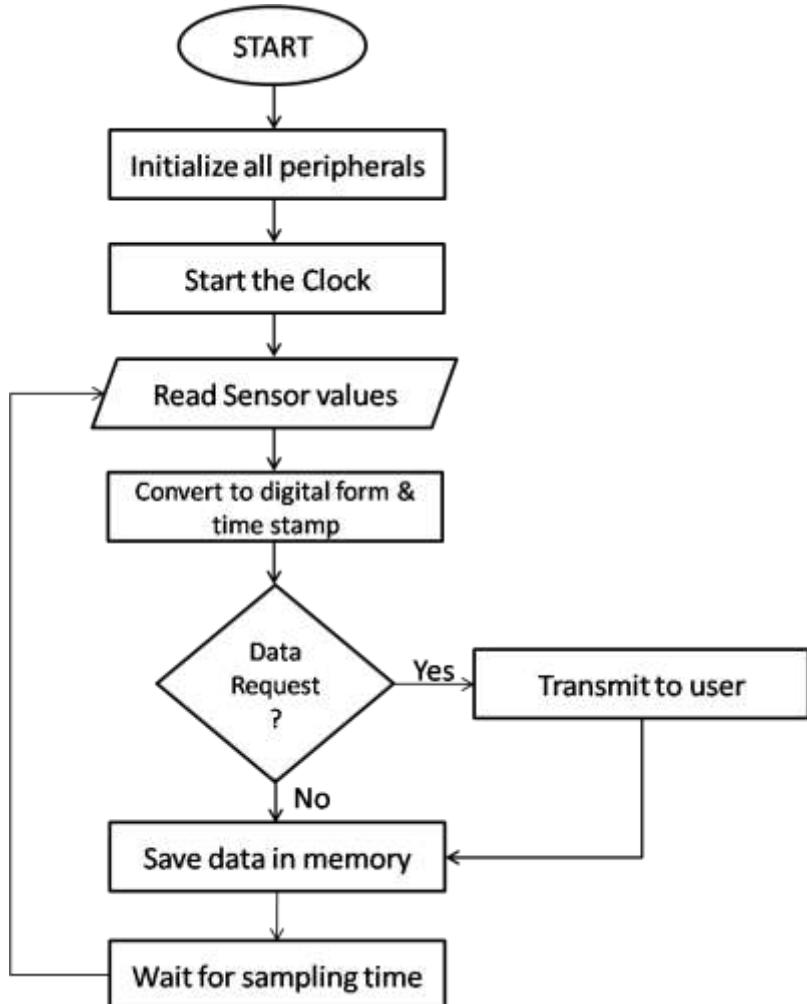


Fig. 5: Software flow diagram

After the system is powered up the software initializes all the peripherals during which Initial clock value is written into the counter, ADC operating modes are set up, input channels are configured. The user is then asked to determine the sampling interval (t_s) which is the time interval between successive samples acquired by the ADC. Once the initialization is over the real-time clock is started and sensor values are read. Conversion is performed in ADC and the converted data is time stamped using time values from RTC. If the user has requested the data then it is transmitted to through Bluetooth to the user device. This data is also saved into the memory. After waiting for t_s the process is repeated again. An android application is developed for the user device [3]. This should be installed on the user device in order to communicate with the system. The Bluetooth

module with the Data logger is configured as a slave device and the android device acts as master device. The app shows the list of available Bluetooth devices out of which user needs to select the Data logger (Fig. 6).



Fig. 6: Making connection with data logger (HC-05)

V. RESULT & CONCLUSION

The microcontroller based data logger has been developed successfully. The system is tested with varying sampling rate and different number of sensors. As the system is having 12 bit ADC, it is possible to detect a change of minimum 0.8056mV on the analog input channel for the sensors. Using the android app the user can also monitor the data in real time.

The prototype hardware developed is shown in Fig. 7. As seen in Fig. 7 the LCD is displaying the current clock/time on row 1 and the acquired sensor values on row 2.

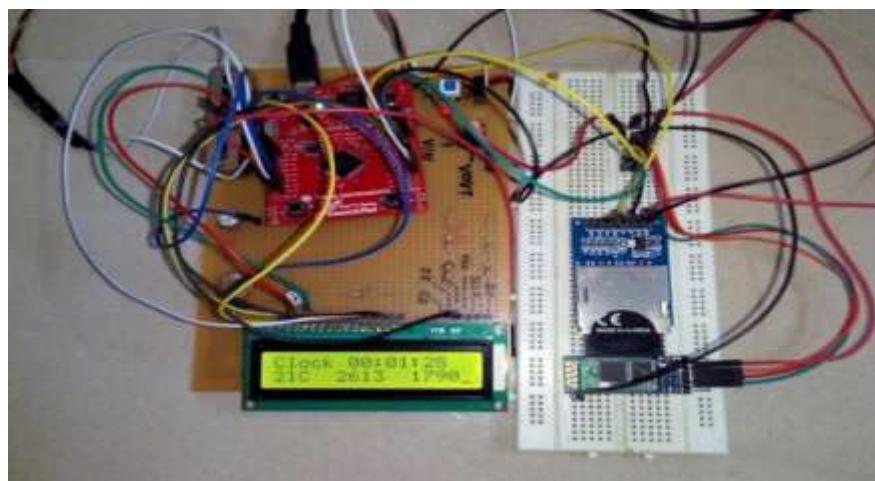
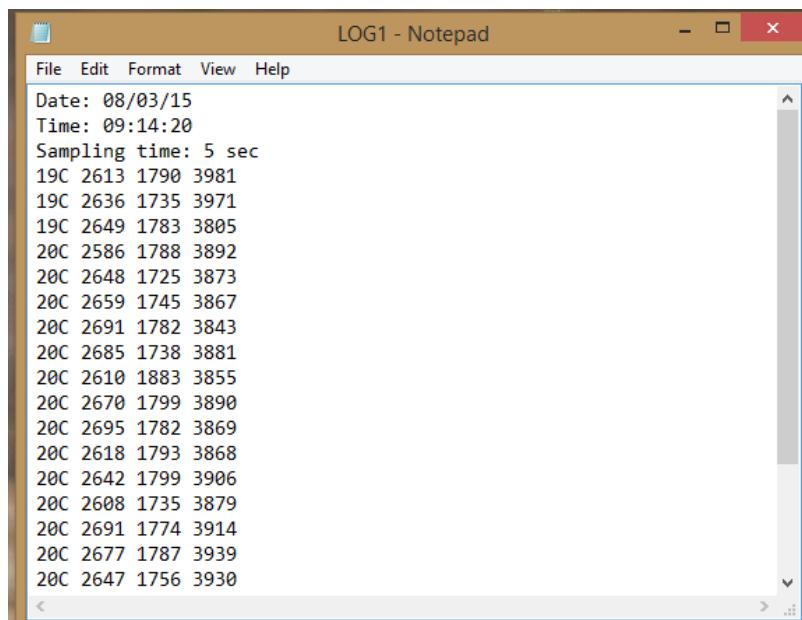
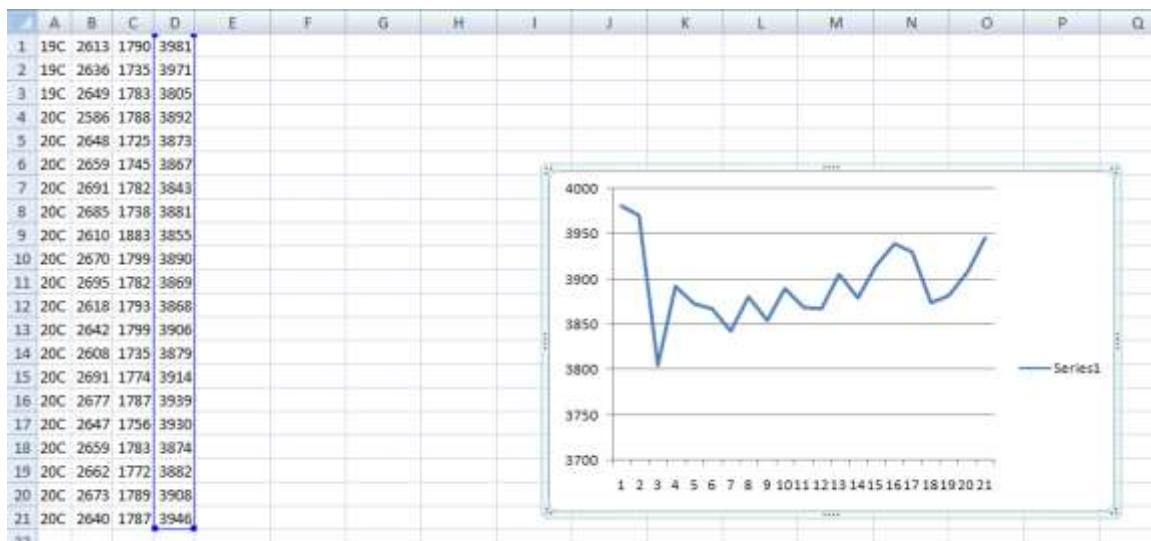


Fig. 7: Developed hardware prototype

**Fig. 8: Log file saved on android device**

The log file saved in text format is shown in Fig. 8. The 4 different columns represent the data from 4 different sensors interfaced to the system. This text file can easily be imported in Excel software and graph can be plotted. The graph for data in column 4 corresponding to light sensor is shown in Fig. 9. Here each data value is taken at interval of 5 seconds.

**Fig. 9: Creating graph from logged data values.**

VI. FUTURE WORK

The number of input channels can be extended using multiplexer. A file system can be implemented on the SD Card which will allow the use of high capacity memory card (SDHC). The companion app is currently

developed on Android operating system; this can be done for iOS and Windows OS also. The application can be extended further to automatically plot the graph based on the acquired data from the data logger.

REFERENCES

- [1] N.N. Mahzan, A.M. Omar, S.Z.Mohammad Noor, M.Z.Mohd Rodzi, "Design of Data Logger with Multiple SD Cards," IEEE Conference on Clean Energy and Technology (CEAT), pp. 175-180, 2013.
- [2] G.S. Nhivekar, R.R.Mudholker "Data logger and remote monitoring system for multiple parameter measurement applications," e -Journal of Science & Technology (e-JST), pp. 55-62, June 2011.
- [3] Zhan Wei Siew, Chen How Wong, Shee Eng Tan, Hou Pin Yoong, Kenneth Tze Kin Teo, "Design and Development of a Tablet Based Real Time Wireless Data Logger," IEEE Global High Tech Congress on Electronics, pp.111-116, 2012.