PSoC1 based system for measurement for Air temperature, Ambient Light and Relative Humidity of the Environment

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Abstract: **The measurement of the meteorological parameters is the very important in many areas like industry, framing, and weather forecasting to analyze a data for predict the results. In this research paper the some meteorological parameters are described to study the meteorological conditions with a new advanced, low cost, portable embedded system fabricated through flexibility and ease of designing created by programmable system on chip controllers. The designed system uses the dynamic reconfiguration ability of PSoC and the provided pre-packaged libraries to conveniently connect multiple weather parameter sensors on a single chip.**

***Index Terms*—HIH4031, LDR, LM-35 PSoC1.**

• INTRODUCTION

The importance of weather monitoring is existed in many aspects. The weather conditions are required to be monitored to maintain the healthy growth in crops and to ensure the safe working environment in industries, etc. Due to technological growth, the process of reading the environmental parameters became easier as compared to the past days. The sensors are the miniaturized electronic devices used to measure the physical and environmental parameters. By using the sensors for monitoring the weather conditions, the results will be accurate and the entire system will be faster and less power consuming [1]. Modern embedded control systems incorporate a microcontroller as the principle component - a self contained computer-on-a-chip consisting of a central processing unit, RAM memory for data storage, a variety of input/output functions and non-volatile program memory to hold the software written to implement the specific application [2]. A PSoC integrated circuit is composed of a core, configurable analog and digital blocks, and programmable routing and interconnects. The configurable blocks in a PSoC are the biggest difference from other microcontrollers. PSoC has three separate memory spaces: paged SRAM for data, Flash memory for instructions and fixed data, and I/O Registers for controlling and accessing the configurable logic blocks and functions. The device is created using SONOS technology. PSoC mixed-signal arrays flexible routing allows designers to route signals to and from I/O pins more freely than with many competing microcontrollers. Global buses allow for signal multiplexing and for performing logic operations. PSoC system is the user friendly system; each can operated it very easily. Here system can be design for any application with in short time. On chip analog blocks are present which is programmable, so we reconfigure pin connections, or completely change the block function if necessary [3]

In this system PSoC1 microcontroller is used which is designed by the Cypress Semiconductor. PSoC1is consist of 8–bit microcontroller processor with analog peripheral and digital peripheral. Traditional MCU- based system component is replaced by PSoC1 (CY8C2764324).

• PROPOSED METHODOLOGY

The design and implementation of weather monitoring system is the model with the ability to perform data acquisition on temperature, ambient light and relative humidity sensors. LM35, LDR and HIH4031 are interface with PSoC1-CY8C2764324 and convert analog value of temperature sensor, light and humidity to digital using incremental ADC (Analog Digital Converter) ADCINCVR with the programmable system on chip controller PSoC1 CY8C2764324. It can give according to the sensors output it can be displayed on the PC through the output of connected sensors can be obtained on PC through USB bridge circuit continuously.

Block Diagram

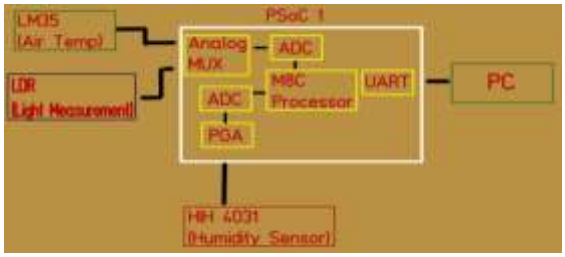

Figure 1 Internal Block Diagram of System

- **HARDWARE IMPLEMENTATION OF PROPOSED SYSTEM**

PSOC1 Microcontroller (CY8C2764324 ***Development Board)***

The PSoC family consists of many Mixed- Signal Array with On-Chip Controller devices. These devices are designed to replace multiple traditional MCU-based system components with one, low cost single-chip programmable device.PSOC-1 module is used for this project and the chip is CY8C2764324PVXI by cypress semiconductors. This chip belongs to CY8C27X43 family. The PSoC-1architecture is comprised of four main areas: PSoC Core, Digital System, Analog System, and System Resources. Configurable global busing allows all the device resources to be combined into a complete custom system. The PSoC CY8C27x43 family can have up to five IO ports that connect to the global digital and analog interconnects, providing access to 8 digital blocks and 12 analog blocks.(4).

Figure 2 Development Board of PSoC1 (CY8C2764324)

LM35 Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C). It has an advantage over linear temperature sensors. It does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. Its low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

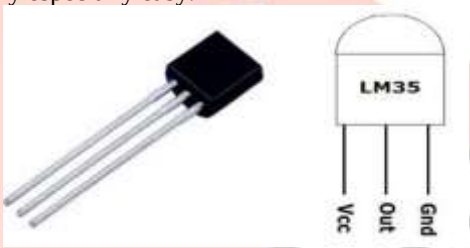

Figure 3 LM35 Sensor

In this system LM35 is used for measurement of air temperature. The output is fed to the analog 4 bit MUX and when the proper channel is selected then the analog value is provided to the 10 bit ADCINCVR and this analog value is converted in the digital value.

Light Sensor

Typical LDR is made up of cadmium sulfide (CdS). Light dependent resistor (LDR) is a sensor whose resistance inversely depends on the amount of light falling on it. It is known by many names including the photo resistor, photoconductor, photoconductive cell, or simply the photocell.

The SI unit of luminous is lux. This sensor effectively measures the amount of light falling on a given unit of area. A simple way to display a lux meter is to say that it measure the brightness of light falling on the sensor.

The figure given below shows the typical LDR.

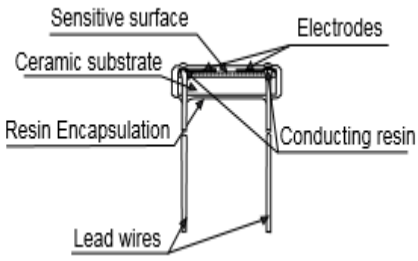

Figure 4 LDR (Light Dependent Resistor)

This sensor is used in the voltage divider format to find the amount of light. The voltage divider converts light in the form of voltage. This voltage is provide to another channel of analog MUX and further converted into LUX or luminous value and display on the GUI.

The figure given below shows the wavelength vs. relative sensitivity of LDR.

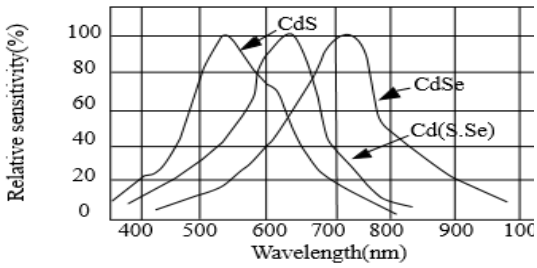

Figure 5 Spectral Sensitivity Characteristic

HIH4031 humidity sensor

Honeywell has expanded HIH Series to include an SMD (Surface Mount Device) product HIH 4031. SMD packaging on tape and reel allows the use of high volume, automated pick and place manufacturing, eliminating lead misalignment to printed circuit board through a hole.

The sensing element's multilayer construction provides excellent resistance to most application hazards such as condensation, dust, dirt, oils and common environmental chemicals.

It is analog sensor which generates the output voltage proportional to the relative humidity. This value is fed to the PSoC device and converts the output voltage in the relative humidity. The ideal graph given below shows the output voltage vs. relative humidity at 25°C and 5V.

Figure 6 HIH4031 Sensor Module

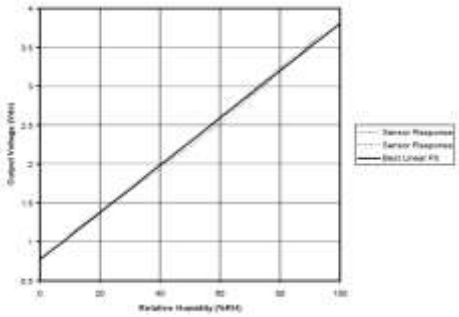

Figure 7 Characteristic of Humidity Sensor

Software Implementation of Proposed System

PSoC Designer 5.4

PSoC Designer 5.4 is the Integrated Design Environment (IDE) that you use to customize PSoC to meet your specific application requirements. PSoC Designer software accelerates system bring-up and time-to-market.

A library of pre characterized analog and digital peripherals in a drag-and-drop design environment helps you easily develop your applications. You then use the dynamically generated API code libraries to customize your designs. Finally, debug and test your systems with the integrated debug environment, which includes in-circuit emulation and standard software debug features.

PSoC Designer Application Flow

Step 1: Create a new project in PSoC Designer 5.4

Step 2: Choose a base device CY8C2764324 for work.

Step 3: Choose and configure PSoC Device that has user modules for designing.

Configure Global resource- Global resources are those shared by all user modules in a particular configuration. All the proper configuration of the project is given in the Global resources properties shown in the figure

Figure 8 Global Resources

User Modules

There are number of User modules available in the PSoC device CY8C28433. In this project we configured following resources.

Resources are

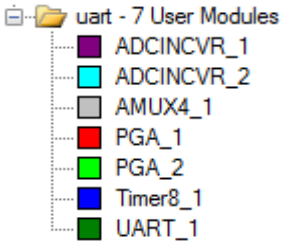

Figure 11 User Module

Integrating ADC (ADCINCVR_1 and ADCINVR_2):

The ADCINCVR is an integrating ADC with an adjustable resolution between 7 to 13 bits. In this project ADCINCVR_1 configure in 10-bit resolution and ADCINCVR_2 configure in 12-bit resolution. Sample rates from 4 to 10,000 sps are achievable depending on the selection of the resolution, Data Clock, and Calc Time parameters.

4 to 1 Analog Multiplexer (AMUX4_1):

The AMux4 User Module provides a four input analog signal multiplexer to a Continuous Time (CT) block that can be controlled programmatically by way of an API. One of the four input signals may be selected as the input of the amplifier in the CT block. AMux4 module is used for selecting proper sensor in the project for example air temperature sensor or light sensor programmatically.

Programmable Gain Amplifier (PGA):

All PSoC Devices have thirty-three user-programmable gain settings with a maximum gain of 48.0. The PGA User Module implements an operational amplifier based non-inverting amplifier with user-programmable gain. In this project PGA is configure as a buffer for the input of air temperature, light intensity and humidity.

Timer (Timer8_1):

The 8, 16, 24, and 32-bit Timer User Modules provide down counters with programmable period and capture ability. The clock and enabled signals can be selected from any system time base or external source. Once started, the timer operates continuously and reloads its internal value from the period register upon reaching terminal count.

In this project 8-Bit Timer is used to generate clock frequency for baud rate to UART serial communication module.

Step 4: Connect the user modules to each other, as appropriate, and to the proper pins.

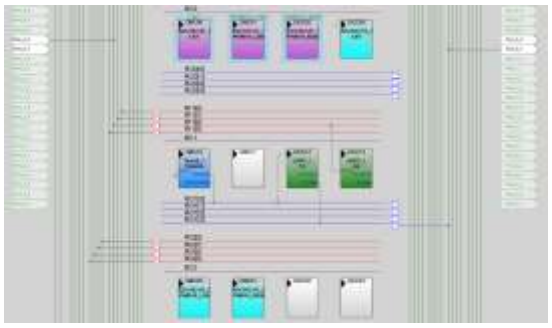

Figure 12 Digital I/O routing

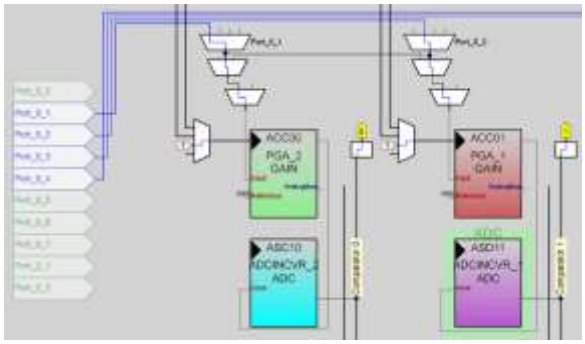

Figure 13 Analog Input configuration

Step 5: Write firmware for project in C or assembly language.

Step 6: Program the PSoC device CY8C28433 and test the program.

Termite 2.8 Software

Termite supports plug-in filters that allow you to filter, insert and modify any incoming or outgoing data. Filters allow you to give different representations of the data —for example in a graph, or to add functions that Termite does not support out-of-the-box. To write a filter, you must create a DLL with a set of exported functions. The main purpose of this document is to describe those functions. For particular filters, tighter interaction with Termite is needed, and for those Termite defines two messages that your filter can send. If a filter does not use a particular function, it may omit it completely.

- **RESULT**

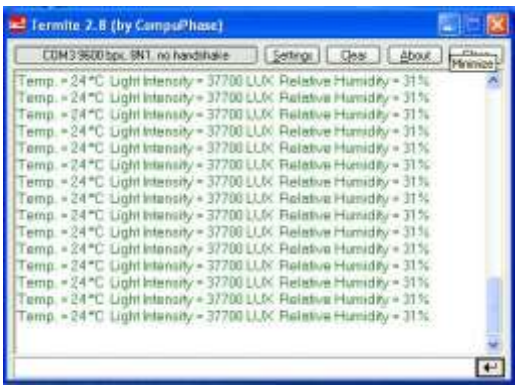

Figure 14 Readings on Termite 2.8 Software

CONCLUSION

- PSOC provides a new methodology to measure a weather parameters very easily, cost effective and easy to construction.
- The implementation takes the advantage of dynamically Configuration changing for measuring physical parameters.
- Its simplicity and effectiveness makes it suitable for fast prototyping and low cost solutions.
- In PSOC, on chip analogue and digital blocks are present which are programmable. So we can reconfigure pin connections, or completely change the block functions if necessary, so that system can be upgraded in minimum time.

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