Integration of Tire Pressure Monitoring System using PSoC.

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***Abstract*—Tire pressure monitoring system is developed for the measurement of tire pressure and temperature. Tire is more important part in the automobile moving system and plays role of supporting and moving. If tire pressure is below or above threshold value causes decrease in fuel economy, sluggish handling, longer stopping distance and heat buildup that can lead to catastrophic failure of tire. This failure of tire can cause lose of vehicle control and may result in accident. To convey pressure and temperature of tire to driver is essential. In the developed system temperature and pressure sensor value are taken and process on Programmable System on Chip(PSoC) controller and transmitted via Bluetooth on dashboard, Smartphone.**

Keywords-PSoC(Programmable System on Chip CY8C29466),bluetooth HC-05, android,MPX6400,LM35 .

I. INTRODUCTION

Tire Pressure Monitoring System(TPMS) is a system which gives alert of tire pressure if it is below normal pressure and above normal pressure by Liquid Crystal Display(LCD) , light Emitting Diode(LED), and Buzzer so it get filled by proper inflation of air. Total weight of vehicle on the inflation in the tire. If air filled in the tire is not proper as recommended by the manufacturer of vehicle, action on the sidewall of tire are increases as a result tire get more contact with ground surface. Also more fuel is required as compared to tire with proper inflation. If tire pressure is not proper, stopping distance of vehicle changes and possible of rollover of vehicle. Report provided by National Highway Traffic Safety Administration (NHTSA) shows the effectiveness of TPMS by comparing TPMS equipped vehicle with without TPMS vehicle. As the fuel economy is depended on use of fuel if tire pressure is under inflated then it require more fuel it increase the fuel economy as a result more emphasis is on the TPMS so as to avoid the fuel consumption and accident.[1][2][3]

There are two types of TPMS as indirect TPMS and direct TPMS in indirect TPMS the tire pressure is calculated on the angular velocity of each tire of vehicle in indirect TPMS system the tire pressure is provided is inaccurate if all the tire of vehicle is low then by using indirect TPMS will not give warning also in the curved surface the rotation speed of each tire may differ and produce faulty alarm

Direct TPMS measure the accurate tire pressure each sensor on each vehicle measure the tire pressure and temperature which is installed on the tire and send to the receiver installed on the dashboard of vehicle as compared to the indirect TPMS direct TPMS is accurate than the indirect TPMS [4]

Alexander Brown, Sittikorn Lapapong, Kevin Swanson, Sean Brennan research on the calculation of pressure of tire using indirect TPMS in this they calculated the radius of tire as due to low pressure the cornering stiffness changes considering this value this system predict the tire pressure level.[5]. Jingang Yll, Luis Alvarez, Xavier Clayes And Rober To Horowitz proposed a control scheme in which as for the safety of vehicle proper inflation of tire is necessary if the pressure is not proper then it affects on the braking system of vehicle so in this control scheme the friction of tire with road and control scheme is designed for emergency braking[6]

Another TPMS designed which is based on the arm as controller and data is transmitted through the RF modem wirelessly [7]

In Direct TPMS four transmitting unit and one receiving unit SPI protocol are used for the configuration of master and slave in the paper Wireless Tire Pressure Monitoring System for Vehicles using SPI Protocol by Author Avinash D. Kale, Shubhada S. Thakare, Dr. D. S. Chaudhari[8] Another Intelligent Tire Pressure Monitoring System developed by the Zhiping Jiang, Huachun Liu, Qingguang Dai in which the CAN bus used for the transmission the data to the dashboard. Another TPMS Implemented based on ZigBee by the author Zuo-Xun Wang, Yuan Xu, Gui-Juan Wang in order to transmit data through ZigBee network and share this data with CAN bus which is already in the vehicle. [9][10]

Transmitter side the antenna are used for transmission the data so new odd mode excited tire wheel assembly for the advances in the gain is describe in paper by author Hideo Iizuka, Member, IEEE, Nobuhiro Ide, Katsutoshi Nakatsu, Hiroshi Yoshimoto, and Kazuo Sato, Member, IEEE[11]

Jyotika Kapur developed system for the prevention of accidents using Bluetooth as signaling element for overtake between different vehicles.[12]

Author Robert Murphy in paper Getting Started with PSoC® 1 explains the basic meaning of PSoC with its functional diagram and the analog and digital block and capabilities of PSoC1 and its development environment [13]

Automatic Baud Rate Detection Using Programmable System on Chip (PSoC) by author Priya Mukherjee, P.A.Nageswara Rao in which UART module explain in detail how UART user module configure to use in PSoC 1. [14]

In proposed TPMS system calibration of temperature and pressure sensor are more important for pressure sensor used in the system is absolute type for calibration of absolute pressure sensor offset and sensitivity is calculated.[15]

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II. PROPOSED METHODOLOGY

Transmitter is located on each tire of vehicle for transmission of temperature and pressure value of each tire consist of Pressure sensor mpx6400 interface with PSoC CY8C29466 and convert analog value of pressure sensor to digital using incremental ADC(Analog Digital Converter) ADCINCVR temperature sensor interface with the programmable system on chip controller PSoC CY8C29466 analog value of temperature sensor are converted into digital value using on chip incremental ADC block In PSoC and transmitted via Bluetooth HC-05 using the specific frame.

Receiver located on dashboard of vehicle. Receives the frame and decode the value of temperature and pressure and display it on 20X4 Alphanumeric Liquid Crystal Display. If the values is above or below threshold LED and Alarm indication is given on the dashboard unit.

Smartphone also receive the frame and display the values of temperature and pressure on smartphone of driver

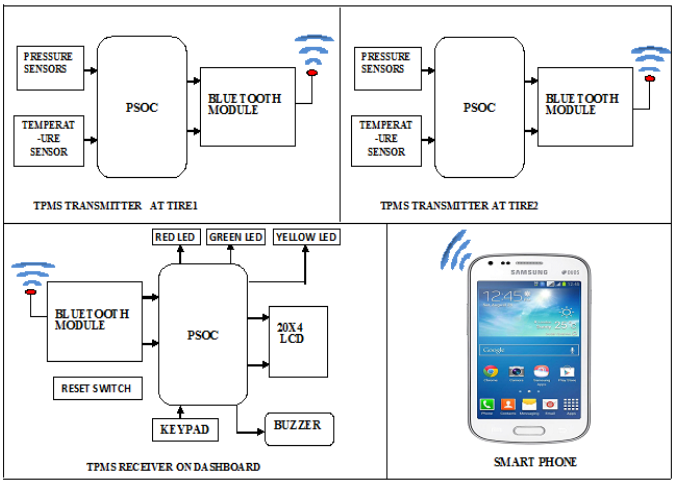

Figure 1:Detailed Block diagram TPMS

III. HARDWARE IMPLEMENTATION OF PROPOSED SYSTEM

PSoC:

PSoC stands for Programmable System on Chip, and it is a variety of the Cypress programmable microcontrollers' family. It has a core, a configurable system integrated which includes mixed-signal arrays of configurable analog and digital blocks, and a programmable routing and interconnect. These configurable blocks can be programmed as peripherals to perform a wide variety of functions, and then they can be interconnected to perform a specific task. Between these functions there are ADCs, PGAs, filters, DACs, counters or UART communication.

Pressure sensor:

Absolute Pressure Transducer MPXH6400AC6T1 is selected for purposed system as it provide an accurate, high level analog output signal that is proportional to applied pressure. The pressure sensor MPXH6400AC6T1 produced by Freescale which can measure pressure in the range 20kPa to 400kPa is used here. The power supply voltage range of this sensor is 4.64V to 5.36V. The pressure sensor is an 8 pin device with pins 1,5,6,7 and 8 being the internal device connections (NC). Pins 2 and 3 serve as the power supply and ground respectively while pin 4 generates a voltage Vout proportional to the pressure, which is interfaced to the PSoC.

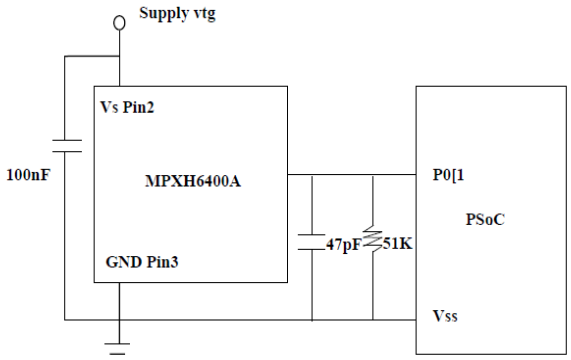

Figure 2:Pressure sensor interface with PSoC

Temperature sensor:

Above 80°C the temperature is dangerous to tire so the alarm will be give on the above 80°C LM35 is selected for the temperature sensing as it has linear output. LM35 Precision Centigrade Temperature Sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration over a full −55°C to +150°C temperature range.

Bluetooth

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.

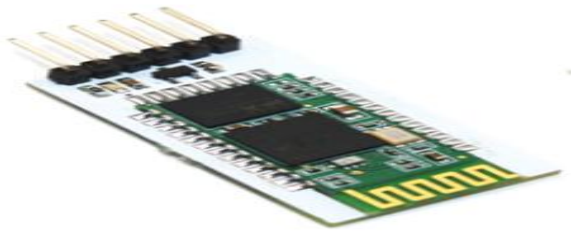

Figure 3:Bluetooth module HC-05

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Implemented Hardware of Transmitter and Receiver TPMS.

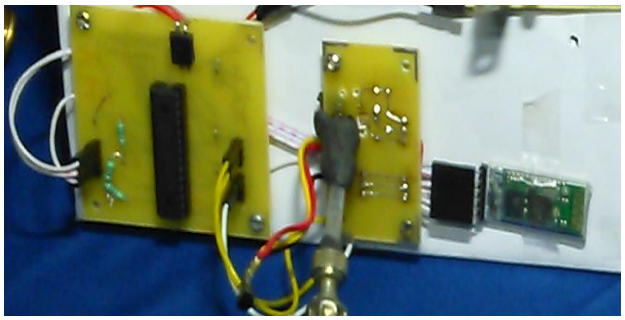

Figure 3: Implemented Transmitter TPMS.

Figure shows the transmitter having PSoC lm35 and mpx6400 connected to it analog value process in it and transmit via Bluetooth hc-05 module in frame.

Figure 4: Implemented Receiver TPMS.

Receiver at dashboard shoes the 20x4 alphanumeric display buzzer and led for indication and warning to driver.

Android application is written in java which shows the pressure and temperature value on the smartphone.

IV. SOFTWARE IMPLEMENTATION OF PROPOSE SYSTEM

PSoC Designer IDE

PSoC Designer is an integrated development environment (IDE) used to customize, configure, and program .PSoC Designer is a fully contained environment where one can create PSoC application by configuring the analog and digital peripherals, writing application code, and perform other functions

- Create a Project
- Choose a Base Device to Work With The device editor that powers the Chip-Level view shows the resources available on chosen PSoC device and allows to configure and route those resources.
- Choose and Configure User Modules .User modules required for this project are:

PGA - A programmable gain amplifier is used to buffer the input from the potentiometer.

ADCINC - An incremental ADC is used to convert the analog input from the LM35 to a digital value that you can use for the program logic.

ADCINCVR- An incremental ADC is used to convert the analog input from the MPX6400 to a digital value that you can use for the program logic.

PWM-Pulse Width Modulator used for indication of Alarm and LED.

UART-The UART User Module is an 8-bit Universal Asynchronous Receiver Transmitter that supports serial communications over two wires.

Global Resources

Global resources are those shared by all user modules in a particular configuration. The IDE Guide (Help > Documentation) contains a complete reference on the effect of each of the Global Resources.

1. Set the CPU Clock to SysClk/1. Since the Power Settings at its default of 5 V operations and a SysClk of 24 Mhz, the CPU will also run at 24 Mhz.
2. Set the VC1 clock to SysClk/16. Set the VC3 source to VC1 and the VC3 Divider to 5.

Global Resources - finaltpmsreceiver

Power Setting [Vcc / SysClk freq]	5.0V / 24MHz
CPU_Clock	SysClk/2
32K_Select	Internal
PLL_Mode	Disable
Sleep_Timer	512_Hz
VC1= SysClk/N	16
VC2= VC1/N	1
VC3 Source	VC1
VC3 Divider	5
SysClk Source	Internal
SysClk*2 Disable	No
Analog Power	SC On/Ref Low
Ref Mux	(Vdd/2)+/-(Vdd/2)
AGndBypass	Disable
Op-Amp Bias	Low
A_Buff_Power	Low
SwitchModePump	OFF
Trip Voltage [LVD (SMP)]	4.81V (5.00V)
LVDThrottleBack	Disable

- Connect the User Modules

Each user module has inputs and outputs that can be routed to other user modules and to pins.

- Write Firmware in c language.

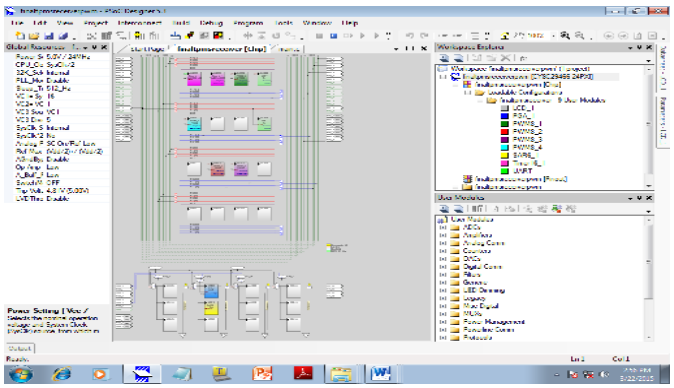

Figure 5: PSoC designer IDE

Android application development

Different software require to develop application are,

- The Java Development Kit (JDK)

The JDK provides tools, such as the Java compiler, used by IDEs and SDKs for developing Java programs.

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- Java Runtime Environment (JRE), which enables Java programs, such as Eclipse, to run on your system.
- Eclipse Integrated Development Environment (IDE)
  Eclipse is a general-purpose technology platform. It has been applied to a variety of uses in creating IDEs for multiple languages and in creating customized IDEs for many specialized SDKs.
- The Android SDK
  With the JDK and Eclipse installed, you have the prerequisites for the Android SDK.

After installing this software following steps to develop android application:

1. Create a workspace. Every project belongs to a workspace.
2. Choose File → New→ Android application project
3. Give name and select API level for the android application→ select launcher icon →name blank activity →finish.
4. Write code in the main activity xml file for the user interaction such as button, textbox, and images.
5. Write code in the main activity java for buildup of application
6. Run the program.

V. RESULT

- Figure Shows the transmitter and receiver is successfully connected and temperature and pressure is successfully received on the dashboard receiver

Figure 6: Display of LCD and LED is on for temperature and pressure of tire

- Figure Shows the transmitter is selected on the application and values if temperature and pressure is successfully displayed on mobile screen.

Figure 7: Display of various screen of developed android application

VI. CONCLUSION

Integration of Tire Pressure Monitoring System Using Programmable System on Chip (PSoC) reduces the components required to develop system and using Bluetooth it is possible to see parameter on android smartphone.

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