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Respiration Measurement System Using PSoC1

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Abstract:Human Machine Interaction (HMI) is becoming increasingly popular in the medical industry.This research demonstrates real-time and long-term monitoring of breathing rate, which is essential for mobility from the user's perspective.Thermistor was employed in this work to measure the rate of respiration.Thermistor-based respiration monitoring provides a non-contactmeasurement of breathing rate. Practically this technology offers a potentially inexpensive means to enhance application to consumer health care products and home health care products.

***Index Terms*–PSoC1,Respiration System,Wireless,Bluetooth HC05.**

I. Introduction

Medical technology is having good exposure in our country due to the advancement of digitalization. Yet people living in the countryside have very less access to the technology. In the medical field Vital signs are plays very important role of the body's basic functions. Generally vital signs change with gender, age, body mass, exercise tolerance and overall health. The four main important signs that are usually monitored like:

- Temperature of Body
- Heart rate (pulse rate)
- Respiration Rate (Rate of breathing)
- Blood pressure (BP)

This research paper focused on respiration rate. The respiration is the number of breaths a person takes per minute. [1] Generally respiration rate is taken by simply counting the number of breaths over one minute by watching, how many times the chest rises.
Respiration rates can increase due to illness, fever or with some medical conditions such as lung disease, asthma and so on. Normal respiration rates in an adult at rest range from 12 to 20 breaths per minute.[2]
The respiration system uses thermistor sensor module for calculating respiration rate of patients. The device will be mounted near the nose specially designed headphone type arrangement. Thisdevice will detect the temperature change during respiration process and easily calculates respiration rate. The device uses Thermistor module, Bluetooth and PSoC (Programmable System On-chip) CY8C28433 microcontroller. The programming for the device is implemented through PSoC Designer 5.0 IDE.

II. Proposed Methodology

The proposed research employ Thermistor Sensor module which is placed near the nose. This sensor module changes physical quantity temperature into analog voltage and provides the analog value to the PSoC microcontroller CY8C28433.
PSoCCY8C28433 microcontroller plays vital role in this system. It sends the real time information to the Laptop applicationthrough Bluetooth module (HC-05). This Bluetooth device is configurewith laptop when application runs.The internal block diagram of system as shown in Figure 1:

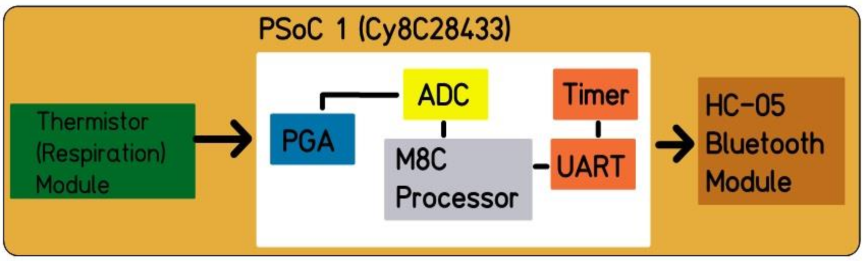

Figure1. Internal Block Diagram of System

III. Hardware Implementation Of Proposed System

3.1PSoC1 CY8C28433 Microcontroller

Cypress semiconductor provides large number of evaluation kits and documentation for development of hardware and software. In the present work a CY8C28433 Evaluation Board designed by ENTESLA Pvt. Ltd has been used. Figure 2 shows image of development board.

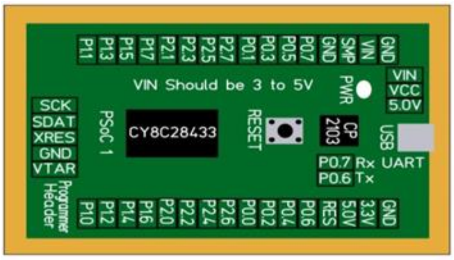

Figure 2 Development Board of CY8C28433

The development board consists of all the required functionality which is helpful in development of the system. On the development board CY8C28433 SSOP chip, reset, Oscillator circuit, USB to UART circuit and ISSP programmer header is available.

3.2 Thermistor Sensor Module

The most well-known NTC (Negative Temperature Coefficient) 10K Thermistor is used in this module. The thermistor based sensing circuit has been designed using a resistor in series with a NTC 10K thermistor to form a voltage divider, which has the effect of producing an output voltage that is linear over 25C to 50C temperature. In the circuit, an op amp LM358 has been used in a non–inverting configuration with inverting reference to offset and gain the signal, which helps to utilize the full ADC resolution and increase measurement accuracy.

Figure 3 Thermistor Sensor Module

3.3 Bluetooth HC-05 Module

Bluetooth HC-05 consists of BC417 Bluetooth IC which is operated at the frequency of 26MHz with on board crystal. Bluetooth module operates on 3.3V. Hence a regulator is used on the board. One push button is present on the board to configure module in AT command mode.

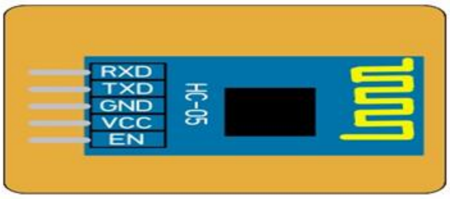

Figure 4 HC-05 Bluetooth Module

3.4Interface Thermistor Sensor Module with PSoC 1 CY8C28433 Microcontroller

The thermistor sensor module and Bluetooth module has been interfaced with CY8C28433 port pins as shown in Figure5. The thermistor sensor module is connected to the port pin P0.0 and Bluetooth module is connected to the port pin P0.6 to receive the data and port pin is connected to P0.7 to send the data.

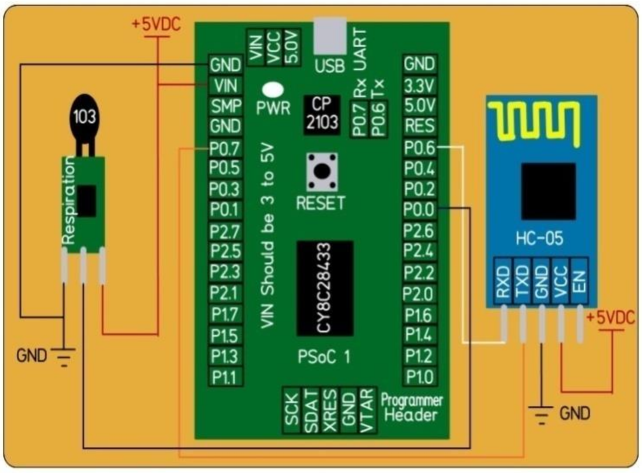

Figure 5 Interconnection Diagram of Respiration System

In PSoC Designer 5.0 hardware configuration for CY8C28433 setup as given in the following table 1:

Table 1: Hardware Configuration of Respiration System

Sr. No.	User Module	Parameters	Configured value
1	Global Resource		
		PowerSetting [VCC/SysClkfreq]	5.0V / 24MHz
		CPU_Clock	SysClk/8
		32K_select	Internal
		PLL_Mode	Disable
		Sleep Timer Period	1.95ms
		VC1=SysClk/N	12
		VC2=VC1/N	6
		VC3 Source	VC2
		VC3 Divider	256
		SysClk Source	Internal
		SysClk*2 Disable	No
		Analog Power	SC On/Ref High
		Ref Mux	(Vdd/2)+/-(Vdd/2)
		AGndBypass	Disable
		Op-amp Bias	Low
		Switch Mode Pump	Off
		Trip Voltage [LVD (SMP)]	4.81V [5.0V]
		LVD ThrottleBack	Disable
		Watchdog Enable	Disable
2	PGA_1		
		Version	3.2
		Gain	1.000
		Input	AnalogColumnMUXBusSwitch_1
		Reference	VSS
		AnalogBus	Disable
3	ADCINCVR_1		
		Version	3.1
		Input	ACC01
		ClockPhase	Norm
		Clock	VC2
		ADC Resolution	10 Bit
		Calc Time	100
		Data format	Unsigned
4	UART_1		
		Version	5.2
		Clock	Row_1_Output_0
		RX Input	Row_1_Input_2
		TX Output	Row_1_Output_3
		TX Interrupt Mode	TXComplete
		Clock Sync	Sync to SysClk
		RxCmdBuffer	Enable
		RxBufferSize	16
		Command Terminator	13
		Param_Delimiter	32
		IgnoreCharsBelow	32
		Enable Back Space	Disable
		RX Output	None
		RX Clock Out	None
		TX Clock Out	None
		Invert Rx Input	Normal
5	Timer8_1		
		Version	2.6
		Clock	VC1
		Capture	Low
		TerminalCountOut	None
		CompareOut	Row_1_Output_0
		Period	26

		Compare Value	13
		Compare Type	Less then or Equal
		Interrupt Type	Compare True
		ClockSync	Sync to SysClk
		TC_Pulsewidth	Full Clock
		Invert Capture	Normal

3.5 Digital and Analog Routing of Respiration Measurement System

The chip level editor connects the user module and port pins as per parameter configuration. The digital and analog user module routing in chip level editor for Respiration rate measurement module is as shown in Figure 6 and 7 respectively.

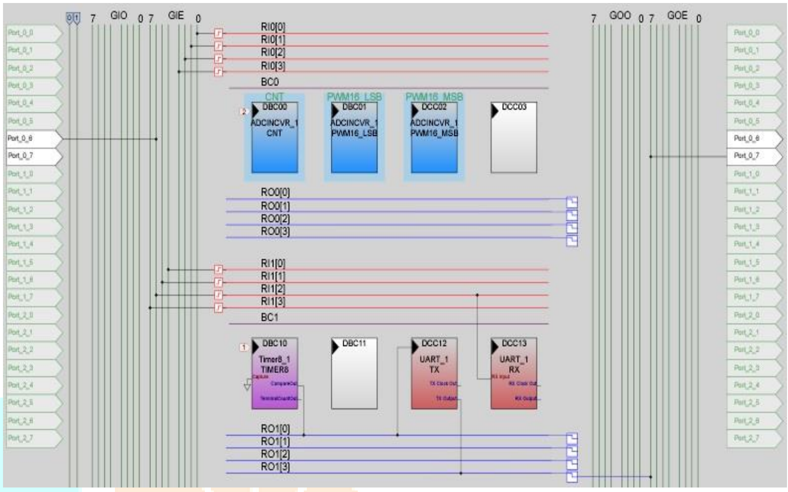

Figure 6Digital RoutingView

PSoC 1 CY8C28433 Board Connections:

Port0_pin6 -> RX = HC-05 Bluetooth Module RX

Port0_pin7 -> TX = HC-05 Bluetooth Module TX

Used Digital Block:

DBC10 -> Timer8_1

DCC12 -> UART_1_TX

DCC13 -> UART_1_RX

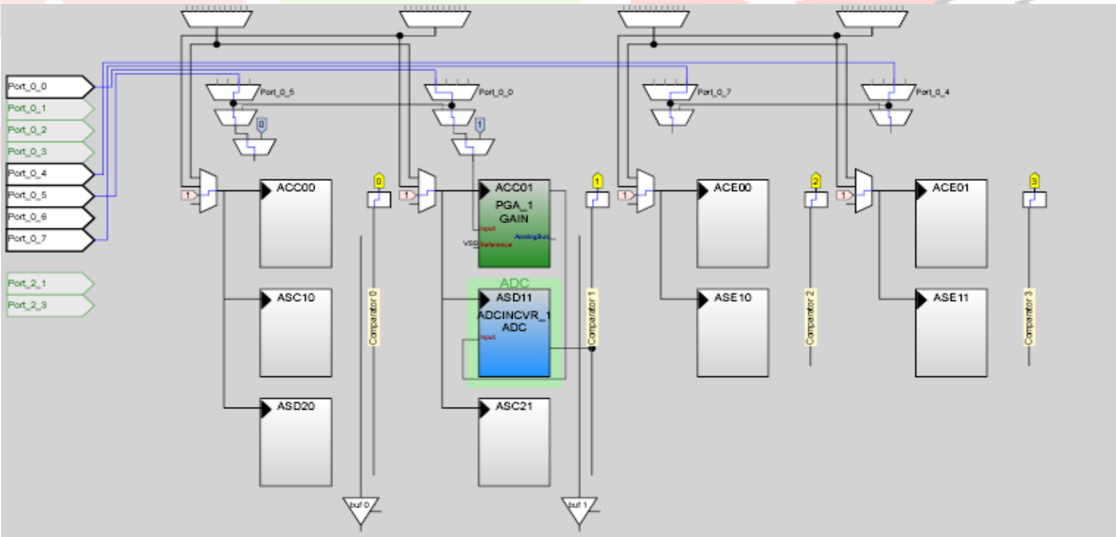

Figure 7 Analog Routing View

PSoC 1 CY8C28433 Board Connection:

Port0_pin0 -> Sensor Input = NTC Thermistor 10K Sensor

Used Analog Block:

ACC00 -> PGA_1

ASD11 -> ADCINCVR_1

3.6Developed Respiration Hardware Module

Figure 8 Hardware Module of Respiration System

IV. SOFTWARE IMPLEMENTATION

4.1 Hardware programming:

A basic "C" programming has been used to program the hardware module in PSoC Designer 5.0 and is transferred to PSoC device through MiniProg 3 Programmer Kit. The flow chart of hardware code module given in the Figure9:

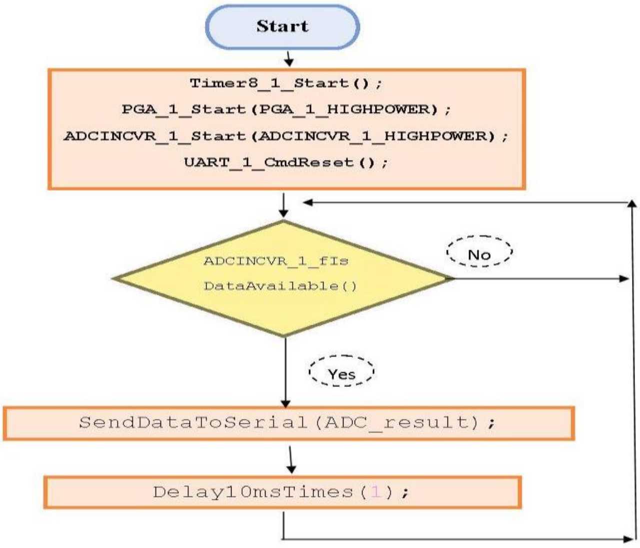

Figure 9 Flowchart of Real-time Respiration System

4.2 PC software programming :

The JAVA mode in processing3.0software has been used to design GUI (Graphical User Interface) for this system.The Respiration sensor data will be continuously transferred from Bluetooth module to PC (Personal Computer) /Laptop. The respiration data transferred is in arbitrary values. This data from Bluetooth is received and converted in Respiration Rate and displayed on the screen using Processing 3.0 software. Output GUI shown in Figure 10:

Figure 10 GUI Output of Respiration System

V. Results and Discussion

The developed sensor module for measurement of Respiration rate has been calibrated using regular manual method. Hundreds of sample readings have been taken out of which some of readings are given in the table2 along with accuracy of the developed system. The mentioned values are the number of breaths per minute i.e. Respiration Rate.

Table 2: Comparative Result of Respiration Rate Measurement

Sr. No.	System Result Breaths/min	Manual Result Breaths/min	Accuracy
Person 1	17	18	94.44
Person 2	19	20	95.00
Person 3	22	20	90.00
Person 4	17	18	94.44
Person 5	15	16	93.75
Person 6	20	18	88.88
Person 7	18	16	87.50
Person 8	16	18	88.88
Person 9	18	18	100.00
Person 10	17	16	93.75

From the comparative values it is clear that, the designed system for measurement of Respiration rate, the accuracy is about 92.66%

VI. Acknowledgment

We hereby thank our Research guide Professor Dr. S. N. Helambe for supporting us at each and every level in this project whenever we were blank; he has guided us to what to do next. We also thank all other faculty members of Department of Electronics, Physics and Computer Science, Deogiri College for helping us and taking out time from their busy schedule.

We are especially indebted to our parents for their love and support. Our full dedication to the work would have not been possible, without their blessings and moral support.

References

[1] https://www.healthline.com/health/normal-respiratory-rate

[2] https://my.clevelandclinic.org/health