IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p-ISSN: 2278-8735
PP 07-10
www.iosrjournals.org

Design and Implementation of Digital Breathe Alcohol Threshold Limit Detector Using Microcontroller

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Abstract: *In many countries of the world a major course of vehicle accident is attributed to driving under the influence of alcohol. Various solutions to this problem have been found by the use of different types of technology. The digital breathe alcohol threshold limit detector proposed in this paper correlates the breathe alcohol concentration (BrAC) to the blood alcohol concentration (BAC) and determines the amount of BrAC required for safe driving. This is achieved by using a stable and sensitive gas sensor to detect the amount of alcohol particularly ethanol in the breath of the driver. The output of the sensor in form of voltage is processed by a microcontroller that warns the driver in both visual and audible forms if it is safe to drive or not. The electronic circuit including the sensor, buzzer and LCD was designed. The sensor is calibrated using ethanol solutions in the range that includes legal limits allowed for driving. The project achieves the objective of being a screening type device that is meant to detect the presence of alcohol beyond a threshold value and to give appropriate advice to the vehicle driver. The device may also be useful to regulatory agencies that monitor the amount of alcohol intake by the drivers.*

Keywords: *Alcohol, alcohol detector, blood, breath, Microcontroller, Road Safety.*

I. Introduction:

Accidents due to road traffic that are caused due to alcohol. Nearly 1.3 million people die in road crashes each year on average 3,287 deaths a day. An additional 20-50million is injured or disabled. More than half of all road traffic deaths occur among young adult ages 15-44.Road traffic crashes rank as the 9th leading cause of death and account for 2.2% of all deaths globally. Road crashes are the leading cause of death among young people ages 15-29,and the second leading cause of death worldwide among young people ages 5-14.Each year nearly 400,000 people under 25 die on the world's roads, on average over 1000 a day. Over 90% of all road fatalities occur in low and middle income countries, which have less than half of the world's vehicles. Road safety has been one of the major concerns of the last decade especially in India. In this regard, proper laws need to be devised and implemented effectively. The first law banning drinking and driving was introduced in 1936 that set a legal limit of 50mg/100ml for safe driving. Driving by a drunken person or by a person under the influence of drugs, whoever while driving, or attempting to drive, motor vehicle (a) has in his blood, alcohol exceeding 30mg per 100ml of blood detected in a test by a breath analyzer. (b) is under this influence of drug to such an extent as to be incapable of exercising proper control over the vehicle. When a person consumes alcohol it enters the blood stream. This forms the blood alcohol concentration (BAC). As a result of exchange of chemicals and air in the alveoli, the exhaled human breath contains a concentration of alcohol known as breath alcohol concentration (BrAC). The blood breath radio (BBR) or partition ratio gives the relationship between the BrAC and BAC as 2100:1. This assumes that the amount of alcohol in 2100 litres of expired air from the lung is the same as is found in 1 litre of blood.

In addition to alcohol the human breath contains a variety of gaseous components and condensates called volatile organic compounds (VOCs) that correlate physiological and metabolic processes to these compounds released from one's mouth. In many countries statutory limits are set for breath alcohol concentration; for most European countries the legal concentration limit is 0.25 mg/L or 0.05% BrAC. In Great Britain the Road Traffic Act 1988 set the statutory limits as 9 μg/100mL and 35 μg/100mL. In South Africa the legal limits are 0.24 mg/L for normal drivers and 0.10 mg/L for professional drivers while in India the limit is 30 mg/L. In Hong Kong the prescribed limit is stated as 22 μg/100mL of breath or 50 mg/100mL of blood or 67 mg/100mL of urine. A variety of technologies have been used in non-invasive or unobtrusive breath analysis. These methods have used sophisticated sensors based on electrochemical and infrared spectroscopy such as Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) and Laser Absorption Spectroscopy (LAS). When responses to a number of VOCs rather than one analyst are required, the use of electronic nose detection system (eNose) may be preferred. The system described in this work uses a gas sensor that is sensitive to the detection of ethanol which is a prominent component in the breath of a person who has consumed alcohol. The system that has been designed in this work is built around a single microcontroller and it is cheap to implement in comparison to many existing breath analyzers.

II. Materials And Method

The block diagram of the digital breath alcohol threshold limit detector is depicted in Fig. 1. The alcohol contained in the breath is detected by the alcohol sensor which, in this case, is the MQ3 gas sensor. The sensor gives an analogue output voltage that is proportional to the amount of alcohol contained in the breath. This voltage is processed by the microcontroller which sends the output to visual and audible displays.

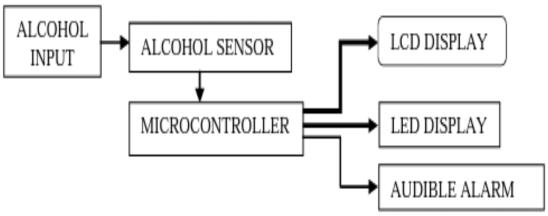

Fig. 1: Block diagram of a digital breath alcohol threshold limit detector

The block diagram was developed into the schematic diagram shown in Fig. 2 that was used to simulate the hardware. The variable resistor RV2 is used to generate the voltage that represents the output of the alcohol sensor. The microcontroller used in this system is the PIC16F887.

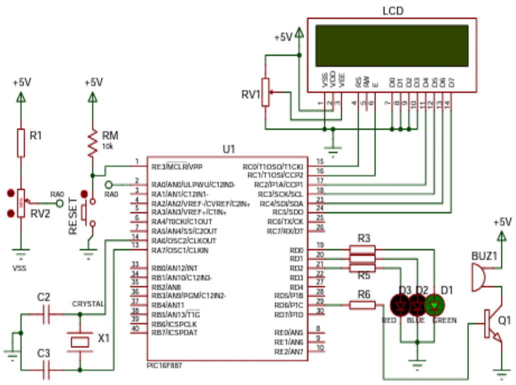

Fig. 2: Schematic diagram of digital breath alcohol threshold limit detector

2.1. Sensor Calibration

Solutions that contained ethanol of various concentrations were made. The concentrations of the solutions were correlated to the blood alcohol concentration which is defined to be the percentage of alcohol, in grams, in 100 ml of blood. Thus 0.02% BAC implies that there is 20 mg of alcohol in 100 ml of blood. The concentration range varies from below the legal limit to values above the legal limit. The concentrations were thus made to correspond to BAC values of 0.00, 0.02, 0.04, 0.06, 0.08, 0.10, 0.12, 0.14, 0.15, 0.16, 0.18, and 0.20. The solutions were placed on the sensor and the corresponding output voltages were recorded on a digital voltmeter. These voltages were reproduced by the variable resistor RV2 in Fig. 2 during hardware simulation; the voltages were also used to set the threshold values during the implementation of the hardware.

III. Firmware Development

The flowchart of the firmware of the system is depicted in Fig. 3. When the system is powered ON, it monitors the analogue input from the alcohol sensor. This input is then converted into the corresponding blood alcohol concentration (BAC). The program then checks if this BAC is within the legal range. Appropriate decisions are taken and these are sent to the visual and audible displays to advise the driver. The legal limits vary from one country to another and these can be set in the firmware of the system.

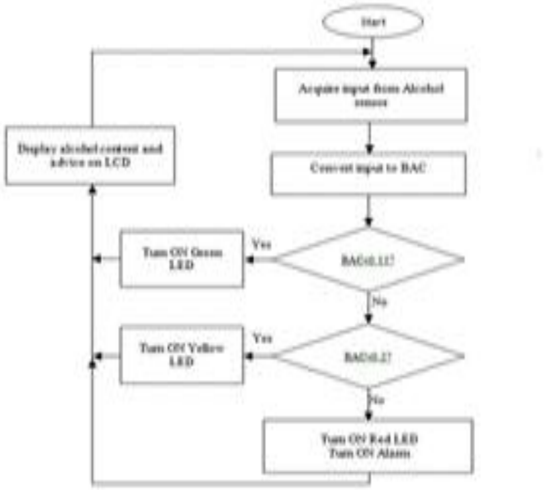

Fig. 3: Flowchart for program of the digital alcohol breath alcohol threshold limit detector

IV. Results And Discussion

The firmware for the system was written in C language. Upon successful simulation of the firmware in this environment, the executable file can then import into hardware. A screenshot of the program development is shown in Fig. 4. Figs. 5, 6 and 7 show the simulation results for the three possible cases: the alcohol in the breath is less than the set limit; the alcohol in the breath is within the range of set limit and the alcohol in the breath is greater than the set limit. These three situations are also explained in Table 1.

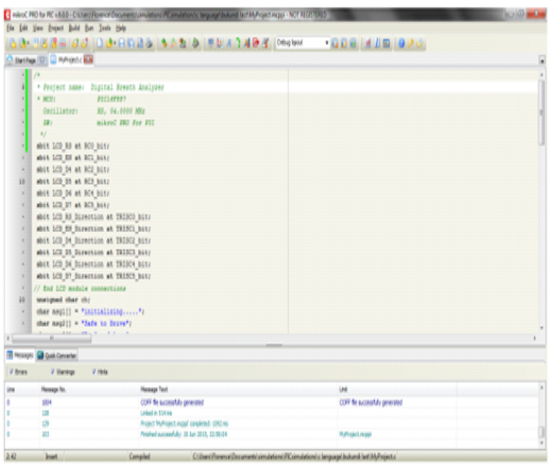

Fig. 4: Development of program using mikroC IDE

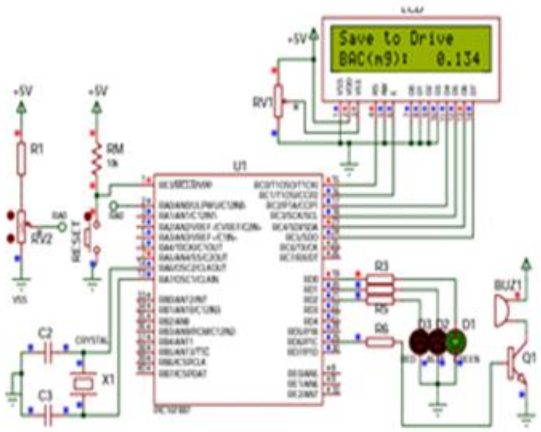

Fig. 5: Simulation results for alcohol content less than the set limit

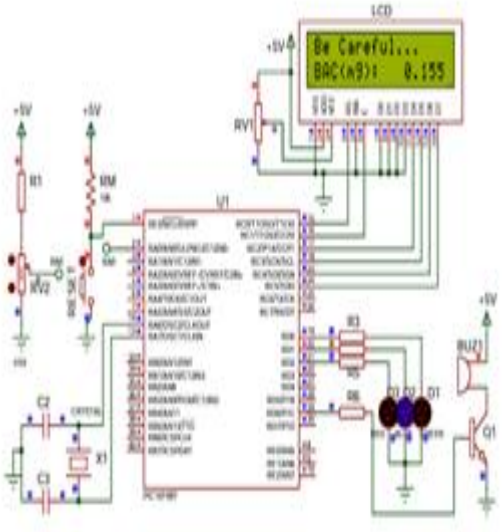

Fig. 6: Simulation results for alcohol content within the range of the set limit

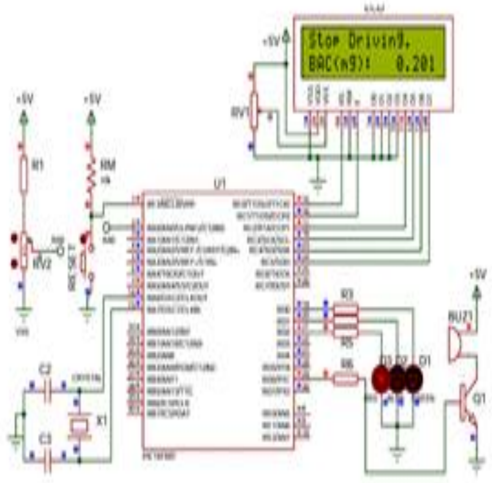

Fig. 7: Simulation results for alcohol content greater than the set limit

Table1: Sensor Conditions and Microcontroller Decisions

Indication	**Output**
Alcohol content is less than set digital value of 0.2mg (BAC).	Displays "Save To Drive" on the LCD and green LED turns ON.
Alcohol content is between the digital values of 0.155 to 0.1992mg (BAC).	Displays "Be Careful" on the LCD and blue LED turns ON.
Alcohol content is greater than digital value of 0.22mg (BAC).	Displays "Stop Driving" on the LCD, red LED turns ON and buzzer turns ON.

V. Conclusion

A digital breath alcohol threshold limit detector that uses a microcontroller as a major component has been designed. This purely advisory system takes the breath of the driver as input and, through indications, advises the driver whether to continue driving or not. The system can be installed in a car or it can be made as a handheld device to be used by relevant regulatory agencies for checking drivers on the highways.

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