Volume 5, Issue 5, MAY 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Wireless Sensor Network for Tracking Pilgrims and Their Medical Parameters

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Abstract*— Every year, pilgrims from all over India gather at Kumbh Mela held every twelve years; the locationis rotated among Allahabad, Haridwar, Nashik, and Ujjain Moreover pilgrim gathering such as the one at Uttarakhand is also under consideration, tracking the movement of such a large number of people is crucial to the pilgrims themselves and the authorities managing the whole event. This letter reports a real-time pilgrim tracking system that has been designed and implemented at Makka (Saudi Arabia).

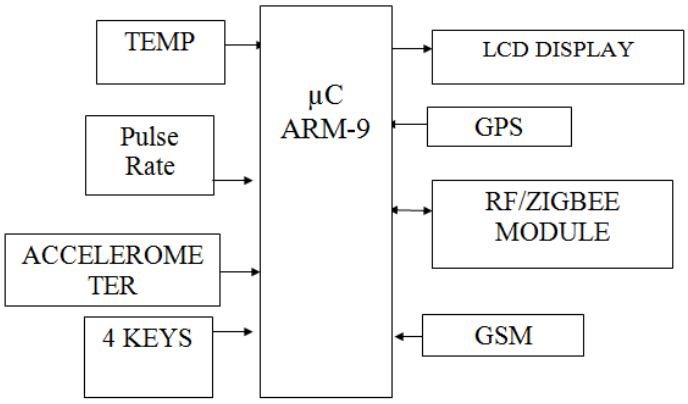
Keywords*— WSN, Pilgrim tracking, ZigBee, GSM, GPS, RFID, medical assistance.

I. INTRODUCTION

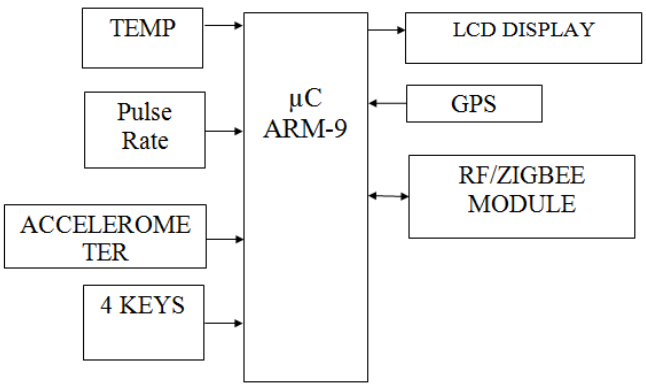
The system relies on a dedicated delay-tolerant wireless sensor network (WSN). This WSN is interfaced to the Internet through gateway(s) available from an internet service provider (ISP). Energy efficiency, robustness, and reliability are key factors in the design of the system. Each pilgrim is given a mobile sensor unit which includes a GPS chip, a microcontroller, and antennas. A network of fixed units is installed in the Holy area for receiving and forwarding data. Periodically, each mobile unit sends its user identification (UID), latitude, longitude, and a time stamp. A central server maps the latitude and longitude information on a geographical information system (GIS). The developed system can be used to track a specific or a group of pilgrims. The developed system was tested during the last two pilgrim seasons. The pilot system was able to successfully track all pilgrims who participated in the experiment.

II. SYSTEM DESIGN

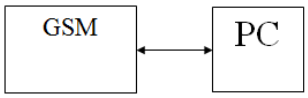
MASTER



Slave 1/2



SERVER UNIT



BLOCK DIAGRAM DESCRIPTION

PC MASTER:

Here we making RF based network for environment application .Here we have master and slave structure for the Application .The range of RF is about 30 meters. So, the whole area cannot be covered by a single Master slave combination .For this we are covering the whole mine by a master and slave combination.

We have a main PC master terminal which has the VB software on it .The PC master terminal is used to monitor the status of all the slaves which covers the whole area.

GPS:

The GPS smart receiver features the 16 channels .Ultra low power GPS architecture. This complete enabled GPS receiver provides high position, velocity and time accuracy performances as well as high sensitivity and tracking capabilities.

A GPS tracker essentially contains GPS module to receive the GPS signal and calculate the coordinates. For data loggers it contains large memory to store the coordinates, data pushers additionally contains the GSM/GPRS modem to transmit this information to a central computer either via SMS or via GPRS in form of IP packets. The diagram depicts a hardware architecture of an advanced GPS tracker.

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real time or when analysing the track later, using GPS tracking software (e, g, Telematics 2.0).

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Benefits-

Ultra low power consumption

Easy and fast to install

Superior urban canyon performance

Low cost with high performance

LIQUID CRYSTAL DISPLAY:

LCD is used in a project to visualize the output of the application. We have used 16x2 LCD which indicates 16 columns and 2 rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2 LCD.

LCD can also be used in a project to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

TEMPERATURE SENSOR:

Temperature sensor is used to sense the temperature. We have used a Temperature sensor called LM35. This temperature sensor can sense the temperature of the atmosphere around it or the temperature of any machine to which it is connected or even can give the temperature of the human body in case if used. So, irrespective of the application to which it is used, it gives the reading of the temperature. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

Temperature sensor is an analogue sensor and gives the output into form of analogue signal. This signal is feed to ADC which will convert it into digital form. Once converted into analogue form, the microcontroller can process the digital temperature signal as per the application.

RF TX-Rx (ZIGBEE)-

In the wireless world, the name Bluetooth and Wi-Fi have become a household name in recent years. They quickly find applications amongst others in mobile computing and mobile phones. ZigBee is the result of the demand from industry and consumer for wireless applications that demand for lower data rate, longer battery life, simple design, shorter range and low cost solutions.

Introduction to IEEE 802.15.4

IEEE 802.15.4 is a simple standard that specifies the media access controller (mac) and physical (phy) networking layers For packet data protocol. Its license free frequency bands are:

2.4 GHz (16 channels with baud rate of 2500 Kbs)

902 MHz-928 MHz (10 channels with baud rate of 40 Kbs)

868 MHz-870 MHz (1 channel with baud rate of 20 Kps)
North America, Europe, Australia and new Zealand use the sub 1 GHz bands whereas the rest of the world uses 2.4 GHz bands.
It uses carrier sense multiple access with Collison avoidance for channel access.
The security method used is aes-128.
Has message acknowledgement and a host of other features.

ZigBee applications

ZigBee technology is based on IEEE 802.15.4 industry standard. It incorporates the standard, adding the logical network, security and software to it. It supports up to 3 network topologies namely star, mesh and cluster tree. Developers need only have to focus on application while the mcu /microprocessor/RF transceiver makers and ZigBee alliance take care of the RF transmitter, RF receiver, RF channel and its protocol.
There are 3 types of traffics that can be used.

A) Periodic data

An example of this traffic is a wireless sensor to read the water meter. The sensor is programmed to wake up at certain interval to transmit the information needed and goes back to sleep after this is done.

B) Intermittent data

An example of this traffic is a wireless light switch to on or off a light manually. It is triggered only by external input and hence wakes up to transmit the message to the network. When done, it is disconnected to the network and hence save energy.

C) Repetitive data

An example of this traffic is the security system monitoring. The devices are time multiplex to return its status to the network. This type uses more energy.
There are numerous applications that can be implemented using ZigBee. Amongst others are in the industry and home applications.
In the industry, the applications include utility and metering where gas/water/electricity meter readings are automated and send back to utility headquarter for further action. This saves the time it takes for their personnel to come to the premises to take its reading. In the area of warehousing/inventory management, the wireless technology will enable accurate and hassle free management of goods. Security and access control, building management system and lighting control are among the applications that can be implemented with ease.
In the home, a total home automation system to control lightings, blinds, air conditioning, security system, remote control and appliances can be implemented.
We are going to use zigbee technology to control various electrical appliances remotely.

GSM MODEM:

GSM (Global System for Mobile communication) is a digital mobile telephony system.

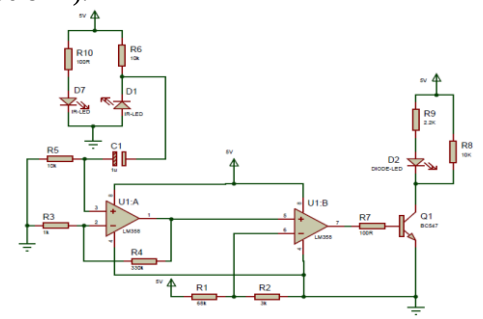
With the help of GSM module interfaced, we can send short text messages to the required authorities as per the application. GSM module is provided by sim uses the mobile service provider and send SMS to the respective authorities as per programmed. This technology enable the system a wireless system with no specified range limits.

GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

PULSE RATE SENSOR:

INPUT STAGE:

Here we are connecting a IR based obstacle sensor. The 100 ohm resistor is for current limiting .The current through the LED is 5v / 100 ohm = 50 m-amp, which is high for an LED. But to increase the range of the obstacle sensor we are using a lower range resistor (100 ohm).



1st stage 2nd stage

On the receiver side we have connected the IR receiver in reverse bias. So as soon as the light falls in the IR receiver, the anode voltage increases and when the anode voltage is more than the cathode voltage then the LED is in forward bias mode and start conducting.

1ST STAGE:

Here at the Non-inverting I/P we are giving the pulse rate signal..

So according to the formula for Non inverting amplifier

Voltage gain = 5v =R3 + R4 / R3 = 330K+1k / 1k = 331

Gain = 331

2ND STAGE:

2d stage is Non Inverting Amplifier

Voltage divider circuit

V Out = Vin * 65K / 65+3K = Vin * 65 / 68

THE TRANSISTOR:

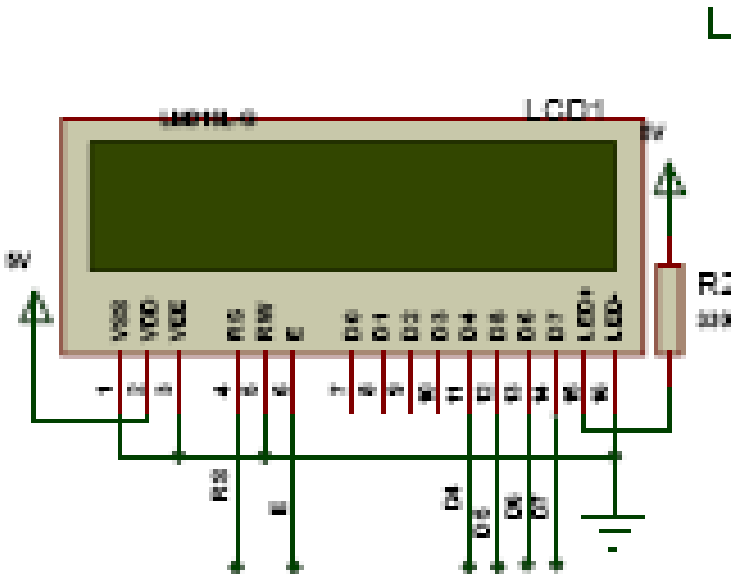
There is a R7 (100 Ohm) resistor at the base of transistor it used to limit the current flowing to the base of transistor. The R8 (10 K ohm) resistor is the pull up for the collector pin of transistor. The BC547 is used in saturation mode, which means that it is used in On / OFF region and not for amplification.

Also as soon as the voltage across this resistor increases beyond 0.7V the transistor turns ON and at the output we get 0v and the LED D2 glows. The resistor R9 is current limiting for LED.

If the output at the base of Q1 is below 0.7V the transistor turns OFF and at the output we get 5v and the LED D2 is off.

Circuit Diagram Description

LCD SECTION:



1. LCD has 2 power sources,

1st VCC and GND are at 1 and 2 no. pins of LCD. Used to drive the LCD 3ma current consumption.

2nd VCC and GND are at 15 and 16 no. pins of LCD. Used to drive the backlight of LCD 100 ma current

Total current consumption = 3ma + 100ma = 103 ma

So, in order to reduce the current requirement we are connecting a 330 ohm resistance in series with the backlight pin VCC. This reduces the current consumption (100ma / 330ohm = 0.303 ma).

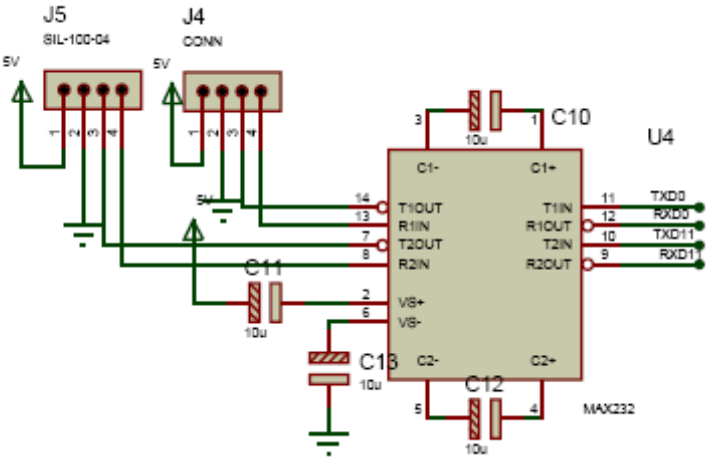
Therefore new total current consumption = 0.303ma+3 ma =3.303 ma.

2. LCD data and control lines

LCD has 8 / 4 data lines and 3 control lines .The 4 data lines of LCD (pin 11 to pin 14 of LCD) are connected to port 0 of the µC (0.17 , 0.18 , 0.19 , 0.20).

The control lines are LCD RS, LCD R/W, and LCD E. In this we are connecting only 2 lines, viz, LCD E and LCD RS. The LCD RD/WR pin is grounded, since we only write into the LCD and never read from LCD. These 2 lines are connected to the port 0 (0.14, 0.15) of the ARM µC. The LCD RS is for selecting the data or the code register .The LCDR/W is for choosing between reading or writing on LCD. LCDE is for enabling or disabling the LCD.

RS 232:



RS 232 IC is a driver IC to convert the µC TTL logic (0-5) to the RS 232 logic (+-9v).Many device today work on RS 232 logic such as PC, GSM modem, GPS etc. so in order to communicate with such devices we have to bring the logic levels to the 232 logic (+/-9v).

Here as we can see the RS 232 chips have 2 pairs of TTL and 232 logic viz,

Pair 1: Pin 7, 8,9,10 of RS 232

Pair 2: pin 11,12,13,14 of RS 232

We can use any one pair in our project either 7, 8,9,10 pair or 11,12,13,14 pair. If we require 2 serial ports then Depending on the requirement of the project we may have to use both the pair in the same project.

The µC works on TTL logic (0-5 v).So to convert the TTL logic to 232 logic we use the 4 capacitors connected to the RS232 IC. These capacitors are called charge pumps used to convert the TTL voltage to the +/- 9 v swing required by the 232 IC.

Dual Charge-Pump Voltage Converter

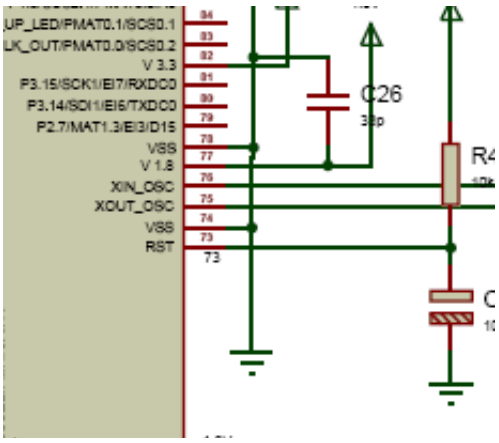
The MAX220–MAX249 have two internal charge-pumps that convert +5V to ±10V (unloaded) for RS-232 driver operation. The first converter uses capacitor C1 to double the +5V input to +10V on C3 at the V+ output. The second converter uses capacitor C2 to invert +10V to -10V on C4 at the V- output.

RESET AND CRYSTAL DESIGN:

RESET CIRCUIT:

Reset is used for putting the microcontroller into a 'known' condition. That practically means that microcontroller can behave rather inaccurately under certain undesirable conditions. In order to continue its proper functioning it has to be reset, meaning all registers would be placed in a starting position. Reset is not only used when microcontroller doesn't behave the way we want it to, but can also be used when trying out a device as an interrupt in program execution, or to get a microcontroller ready when loading a program.

In order to prevent from bringing a logical zero RESET pin accidentally, RESET has to be connected via resistor to the positive supply pole AND a capacitor from RESET to the ground. Resistor should be between 5 and 10K and the capacitor can be in between 1µf to 10 µf. This kind of resistor capacitor combination, gives the RC time delay for the µc to reset properly.

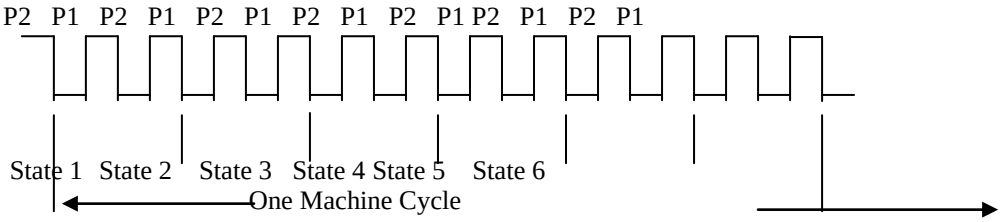


As shown in the above circuit we are connecting an RC circuit to the RESET (pin 57) of µC .The ARM µC has an active low reset, therefore we connect an RC circuit. As shown the capacitor is initially at 0v.It charges via the supply through a 10 k ohm resistance in series, therefore the reset time of our circuit is:

R*C = 10kohm * 0.1 µf = 1 m sec
Recommended time of reset = 1 µsec
Here the RC time can vary from 10 µsec to 1 msec.

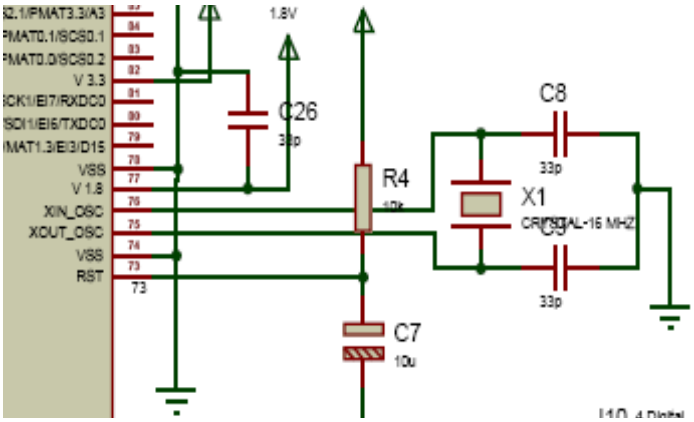
CRYSTAL CIRCUIT:

Pins OSC1 & OSC2 are provided for connecting a resonant network to form oscillator. Typically a quartz crystal and capacitors are employed. The crystal frequency is the basic internal clock frequency of the microcontroller. The manufacturers make available PIC designs that can run at specified maximum & minimum frequencies, typically 1 MHz to 32 MHz

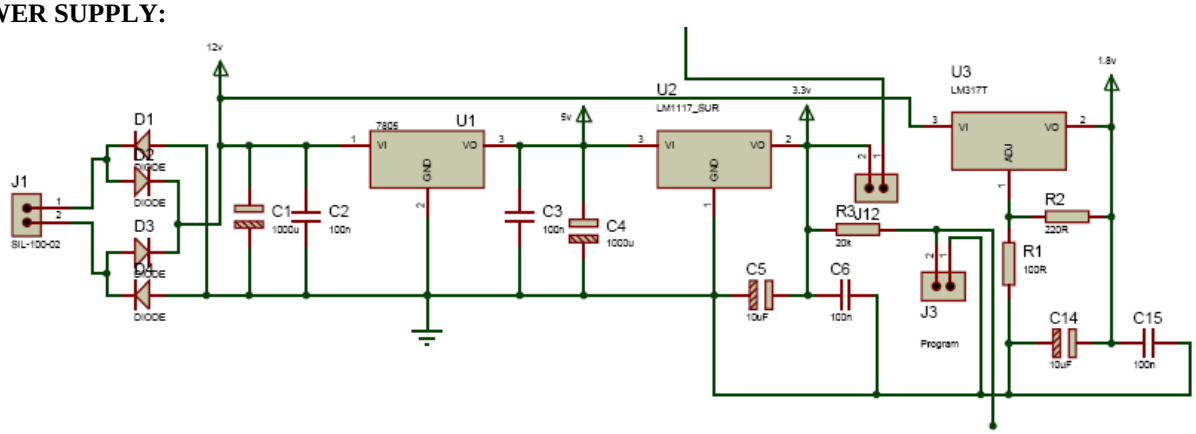


Here we are connecting two ceramic capacitors which are basically used for filtering. In other words to give a pure square wave to the µC we are connecting the two capacitors.

The basic rule for placing the crystal on the board is that it should be as close to the µC as possible to avoid any interference in the clock.



POWER SUPPLY:



5v supply design

The basic step in the designing of any system is to design the power supply required for that system. The steps involved in the designing of the power supply are as follows,

1) Determine the total current that the system sinks from the supply.
2) Determine the voltage rating required for the different components.

The bridge rectifier and capacitor i/p filter produce an unregulated DC voltage which is applied at the I/P of 7805.As the minimum dropout voltage is 2v for IC 7805, the voltage applied at the input terminal should be at least 7 volts.

C1 (1000 µf / 65v) is the filter capacitor and C2 and C3 (0.1 pf) is to be connected across the regulator to improve the transient response of the regulator.

Assuming the drop out voltage to be 2 volts, the minimum DV voltage across the capacitor C1 should be equal to 7volts (at least).

Power supply design of the Project:

The average voltage at the output of a bridge rectifier capacitor filter combination is given by

VIN (DC) = Vm – Idc / 4 f C1

Where, Vm=√2 Vs and Vs = rms secondary voltage

Assuming Idc to be equal to max. Load current, say 100mA

C = 1000 Gf / 65v, f=50hHz

19 = Vm – 0.1 / 4*50*1000*10¯6

19= Vm – 0.1 / 0.2

Vm=19.5 volts

Hence the RMS secondary Voltage

Vrms = Vm / √2

= 19.5 / √2

=19, 5 / 1.4421

=13.5 volts

So we can select a 15v secondary Voltage

In our system most of the components used require 5 V as operating voltage such as micro controller, MAX 232, MCT2E etc. The total current, which our circuit sinks from the power supply, is not more than 100 mA. We have used Regulator IC 7805 that gives output voltage of 5V.The minimum input voltage required for the 7805 is near about 7 v. Therefore we have used the transformer with the voltage rating 230v-10v and current rating 500 mA. The output of the transformer is 12 V AC. This Ac voltage is converted into 12 V DC by Bridge rectifier circuit.

The reasons for choosing the bridge rectifier are

a) The TUF is increased to 0.812 as compared the full wave rectifier.
b) The PIV across each diode is the peak voltage across the load $=V_m$, not $2V_m$ as in the two diode rectifier

Output of the bridge rectifier is not pure DC and contains some AC some AC ripples in it. To remove these ripples we have used capacitive filter, which smoothens the rippled out put that we apply to 7805 regulators IC that gives 5V DC. We preferred to choose capacitor filters since it is cost effective, readily available and not too bulky.

3.3 v design

The formula for calculating the output voltage of ARM is (As given in the datasheet of LM317)

$$\dagger\dagger V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right) + I_{ADJ}(R_2)$$

Assuming R2=470 ohms and I adj =0 then,

V out= 3.3v = 1.25v (1+R2/450)

3.3v/1.25v= (450+R2)/450

2.64* 0.45 K ohm = 0.45kohm+R2

III. SOFTWARE

- Embedded C Programming in Keil
- Circuit & Layout Designing: Proteus 7.7
- Programming At Pc Using VB 6.0

IV. ADVANTAGES

- Less time delays
- Quick response time
- Fully automate system
- Robust system
- Low power requirement

V. CONCLUSIONS

Tracking and monitoring of individuals in a large group is a very complex task. It becomes even tough when hundreds of languages, traditions and beliefs are involved. Many difficulties may occur due to such a situation. Especially during pilgrimage, crowd control, health and security issues rise to an optimum point. Most of these problems can be solved with the help of those technological means which are acceptable in society. There is no reason for employing these technologies to solve current issues of human sufferings. Even though provisions exist, the security systems lapse due to people's sectarian perceptions or ignorance. There are many works related with RFID technology which has helped in tracking. Apart from tracking, the proposed system has a great advantage. It presents an option for a pilgrim in case of medical emergency. The developed system automatically monitors the body conditions of the pilgrim under pressure which helps in getting medical aid in no time. Thus the system can satisfy the need of pilgrim without any objection.

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