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INTELLIGENT FAULT DETECTING SYSTEM IN AN OPTICAL FIBRE

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ABSTRACT

In this intelligent fault detecting system in an optical fibre used to find the fault in optic fibre line. To design a fault monitoring module and find the fault in the line says across the customer sides. The idea behind this module is to monitor the received power supply in optical fibre using a Microcontroller. Laser output power monitoring circuit is designed using ISIS simulator to monitor the received power supply in the optical fibre. If there is any abrupt changes in power of optical line the automatic message will be transmitted to monitoring person regarding the fault in fibre via of GSM. Here we can operate Microcontroller in low power mode (sleep mode) to save power consumption. Automatic message is transmitted to monitoring person about the fault in optical line.

Keywords: *Optical fibre, Microcontroller, Global System for Mobile Communication (GSM).*

1. INTRODUCTION

The field of fibre optics communications has exploded over the past two decades. Fibre is an integral part of modern day communication infrastructure and can be found along roads, in buildings, hospitals and machinery. The fibre itself is a strand of silica based glass, its dimensions similar to those of a human hair, surrounded by a transparent cladding. Light can be transmitted along the fibre over great distances at very high data rates providing an ideal medium for the transport of information.

In these recent years fibre optic communication play a vital role in fibre optic based development in present and future year. Here finding the exact location of fault in the fibre optic cable. So we are proposing the intelligent fault detecting system in an optical fibre to find the fault in the optical fibre line. From the fibre we can monitor many number of parameters includes temperature, current, Transmitted power, Received power, Power supply. In our case we are going to monitor the Received power of fibre optic cable. Likewise we can use different parameters to monitor the fault in that cable.

Microcontroller set up to monitor the 8 fibre optic cables at a time. Likewise we can add these microcontroller units to Monitoring box to find the optical power in each cable in the fibre optic line.

ISIS proteus software used to simulate circuits. PIC 16 series Microcontroller is used for this system. The unique nature of schematic based microcontroller simulation with Proteus facilitates rapid, flexible and parallel development of both the system hardware and the system firmware. This design synergy allows engineers to evolve their projects more quickly, empowering them with the flexibility to make hardware or firmware changes at will and reducing the time to market [8].

Proteus VSM uses our proven schematic capture software to provide the environment for design entry and development. ISIS is a long established product and combines ease of use with powerful editing tools. It is capable of supporting schematic capture for both simulation and PCB design. ISIS also provides a very high degree of control over the drawing appearance, in terms of line widths, fill styles, fonts, etc. These capabilities are used to the full in providing the graphics necessary for circuit animation.

The following sections shows the flow of this paper which includes related works from reference papers, system overview, Design Process, AT commands, Simulation Results, Reference and Conclusion. The System overview discusses the block diagram, detailed overview of the proposed system and street local monitoring system. The

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algorithm and flow chart diagram explain the implementation scenario behind the implementation part. The design process includes circuit designing like LED and Laser power monitoring circuit and PIC circuit diagram design. By using AT commands message are automatically sent to monitoring person. Simulation Results describes the obtained circuit simulated results from designed circuits include LED and Laser power circuit and simulation of entire circuit diagram.

2. RELATED WORK

In this paper Correspondence Optical Fibre Automatic Monitoring System Development they have proposed two paths one is primary route and other is spare route and in normal condition both routes are monitored by comparing the luminous real time sampling and light threshold value of warning. Based on the comparison switching of path take places the light signal transmits through both the route. The protection equipment at the sink transmits one of the routes to the optical transmission equipment. They new idea is when there is any break in optic fibre across the primary route the master control unit automatically switches the optical path from primary optical router to spare router path by issuing control command. So Optical Fibre Automatic Monitoring System implements 1+1 line protection plan. The main idea of this paper is to perform real time monitoring on fibre optic and to switch to standby channel instantly in case of any break in fibre optic network [1].

In this paper Design of Embedded Signal Acquisition System for Fibre Optic Sensor they have proposed the new idea of fibre optic sensor signal acquisition system based on Embedded System. The fibre optic strain sensor measuring system is based on the principle of Fabry-Parot (F-P) interference and online data processing of fibre optic sensor includes FPGA and embedded platform which are accurate and real time. The data acquisition is done by CCD devices and data processing is done by doing A/D, FPGA and embedded platform. The output data from fiber optic sensor is sampled by A/D and processing and storing in embedded platform and that output data is sent to network [2].

The realization of digital diagnostics monitoring of SFP is explained in detail by this paper “The application and realization of the digital diagnostic are monitoring function for SFP optical transceiver module”. This paper proposes a design and realization of a monitoring platform for SFP optical transceiver module. With the adoption of this platform, the real-time temperature, power supply, bias current, transmit power and receive power of optical transceiver module's monitoring can be realized in reference [3].

In this paper monitor system of power network parameters basing on optical fibre sensor they have proposed remote monitoring all parameters using optic-fibre sensor array and Embedded web server arrangements.The parameters of Power Network is calculated using optical-fiber sensor array for measuring different parameters like voltage, current, temperature, humidity, Radiations. And the processing of all parameters by computer and data is transmitted to optical network. Supervisors can remotely monitor using the embedded web server [4].

In this paper Design of Network Management System for Optical Terminal based on Embedded Web Server discuss the Embedded web server enabled users to access the system with browser in remote in anytime and anywhere, which realized remote control and historical data query. A multi-user optical terminal network management system based on embedded web server was designed to meet the requirement of centralized management of numerous transmission devices in video surveillance system. This design is based on ARM9 S3C2440 and Linux platform, getting card information of the devices by serial port, porting Lighttpd in Linux to achieve HTTP protocol, using AJAX(Asynchronous JavaScript and XML) to implement browser and server data interaction in real-time[5].

The SFF-8472MSA covers the digital diagnostic register specification and the relevant details of SFF-8472. The enhanced memory map with a digital diagnostic monitoring interface for optical transceivers that allows pseudo real time access to device operating parameters. In the A2 bank the first 56 bytes are used for Alarm and warning Thresholds values and 24 bytes for Real Time Diagnostic Interface, 16bytes for vendor specific and 120 bytes are user writable in EEPROM. The enhanced interface uses the two wire serial bus address 1010001X (A2h) to provide diagnostic information about the module’s present operating conditions. The Transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture [6].

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System automatically transmit GSM message having location of fault say (Street name) to monitoring person and main monitoring system regarding the fault in optical line. So that monitoring person come and rectify the fault fastly. The main monitoring system keeps the record about the fault for future reference. A cost effective system is fault detection system or Street Local monitoring system is designed using the proposed method.

3. SYSTEM OVERVIEW

In this intelligent fault detecting system in an optical fibre can be designed by following steps and its block diagram is shown in Fig 1. In the customer side we used to implement Street Local Monitoring System. This Street Local Monitoring System is intermediate between the Customers and Main monitoring System. In customer side say individual house receive or transmit data to other customer in some other network. The data will send to the Street Local Monitoring System and Main Monitoring System. Then the Main Monitoring System accepts data transmit the data to core Network. From the core network the other customer receives the data.

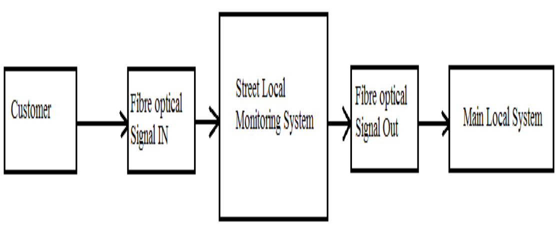

Fig1. Block Diagram Overview

The below shown Fig2 will give the detailed block diagram of this project. In the customer side we had larger number of house say house1, house2, etc. Say here we have considered 8 houses. From the splitter we can take many numbers of connections. At a maximum we can take 64 connections. So each houses got their fibre optic connection by means of splitters. In our case we are implementing this idea across each splitter and Check the power in optical power. And here we are implementing the intelligent fault detecting system in an optical fibre.

In Street Local Monitoring System we have LED and Laser Power meter and Microcontroller Module with GSM. This LED and Laser Power meter measure the received power supply of light in optical fibre. The Microcontroller and GSM module receives the power and if the power below the particular predefined value the GSM module transmits automatic message to monitoring person.

After the electrical signals are received by the interface circuit, the source drive circuit then transforms the electrical signals into light signals. In contrast to electrical signals, light signals transmit information by changes in pulse intervals and light intensities. The source drive circuit is the one that triggers the third and last parts of the Fibre optics transmitters' component called the optical source. This optical source is the portion of the transmitter that contains a light emitting diode (LED) or a laser diode. This component is the one that lights up and passes on the light signals to the fibre optics. Then it will be transmitted to Main Monitoring System.

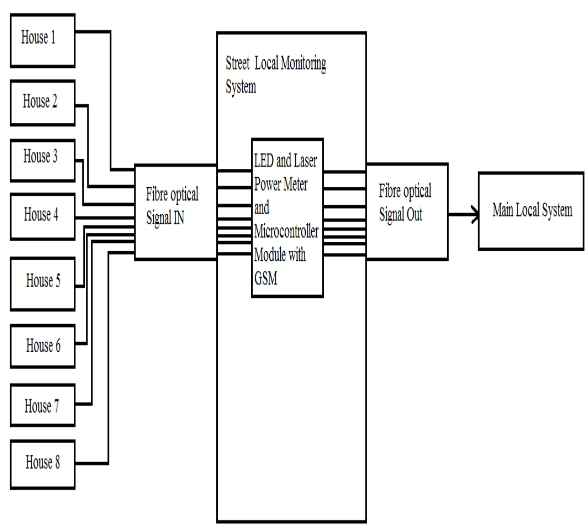

Fig2. Detailed Block Diagram

This LED and Laser Power meter and Microcontroller Module with GSM Street Local Monitoring block diagram as shown in Fig 3. This LED and Laser Power meter measure the power of light in optical fibre. The Power values depend on the light incident on the photodiode. When a photodiode receives the optical signal based on the incident light, photocurrent is developed across it.

The LCD arrangement used to check the optical power of the optical power line. In Simulation software we used to check the power of laser or LED. This used to check whether the circuit behaves properly or not.

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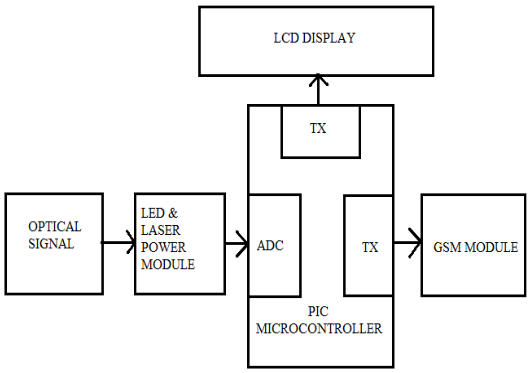

Fig3. Street Local Monitoring block diagram

In laser Power Monitors, a detector for converting the light and convert optical signal from fiber core into an electrical current (Ip). This current is typically used to control other optoelectronic components, or to generate digital representations of optical power (for example, for an LCD display).InGaAs PIN photodiodes are the most common detectors used for telecommunications applications. They cover the wavelength range from approximately 900 nm to 1620 nm.For shorter wavelength applications Silicon PIN photodiodes are preferred.

3.1. Flow chart

The flowchart is shown below in Fig4 and its Algorithm is explained below.

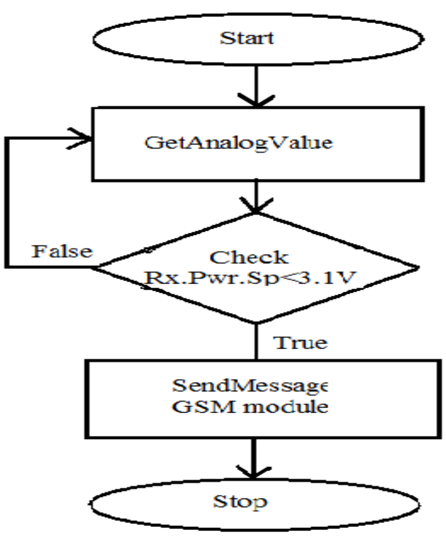

Fig4.Flow Chart

Algorithm for this Project:

Step1: Initializing and configure all Ports of PIC Microcontroller.
Step2: Initialize LCD
Step3: Get electrical power of optical fiber from ADC.
Step4: Read the analog values and display it LCD.
Step5: Check the condition.
Step6: If condition true automatic message will be sent to Monitoring person stating the address location via of GSM module.
Step7: If condition is falls then it will check the condition and it will go to step number 3.

4. DESIGN PROCESS

4.1. LED and Laser power Monitoring Circuit

The LED and Laser power Monitoring circuit diagram is shown in Fig5. In the below circuit diagram we used OP-AMP and LDR. In ISIS software photodiode is not available. So the LDR and photodiode receives the solar light and as well as photodiode receive LED or LASER. So here instead of Photodiode we are using LDR. We used LDR based circuit in simulation. The resultant output ie) Laser received power supply output is fed back to microcontroller.

We designed OP-AMP circuit using LF411 and their pins connections are described below. The inverting pin of op-amp is connected to photodiode. The non inverting pin is connected to the reference voltage of 5v. The 7^{th} pin is connected to 9v power supply. The pins 1st, 5th are left free. Across the 6^{th} pin output voltage is taken.

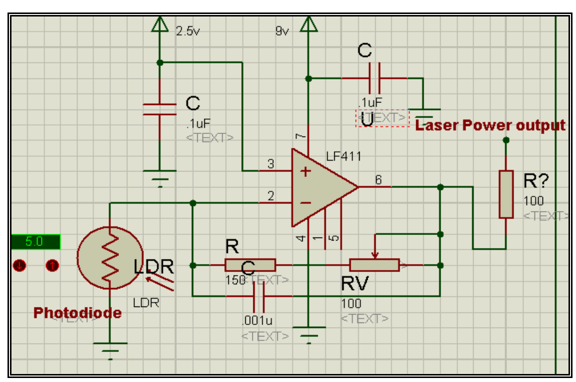

Fig5.LED and Laser power Monitoring circuit

4.2. PIC Circuit Diagram

In this circuit diagram we have PIC16F877A Microcontroller and LCD connection. The datasheet for PIC 16F877a is referred in reference

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[7]. Across PORTA and PORTE we can use pins for Analog to Digital Conversion purpose. In this circuit diagram we are giving the analog voltage to RA0 of portA. The PORTB is connected to LCD display from 7 to 14. RD0 pin is connected to RS of LCD, RD1is connected to R/W and RD2 is connected to E of LCD. 2nd pin of LCD is connected to power supply and 1st and 3rd are grounded.

The oscillator is connected across the 13th and 14th pin of microcontroller. 1st pin of microcontroller is connected to the 5v power supply. The 25th and 26th pin are used for transmitting and receiving data via of MAX232 IC to GSM modem. The MAX232 chip, this is a chip specially designed to interface between 5V logic levels and the +12V/-12V of RS232 - it generates the +12V/-12V internally using capacitor charge pumps, and includes four converters, two transmit and two receive, the Serial Board only makes use of one of each - the other two are clearly marked on the circuit, and can be used for something else if required.

The 11th pin of MAX232 is connected to 25th pin of Microcontroller. The 12th pin of MAX232 is connected to 26th pin of Microcontroller. Across 1st and 3rd pin capacitor of 1uF is connected. Across 4th and 5th pin we are connecting another capacitor. Likewise we are connecting a capacitor across 2nd and 16th pin. Then one more capacitor is connected across 6th and 15th pin. The 14th pin of Max232 is connected to DB9 Male connector 2nd pin. Then 13th pin of MAX is connected to 3rd pin of DB9 connector. of Male. The PIC circuit diagram is shown in below in fig6.

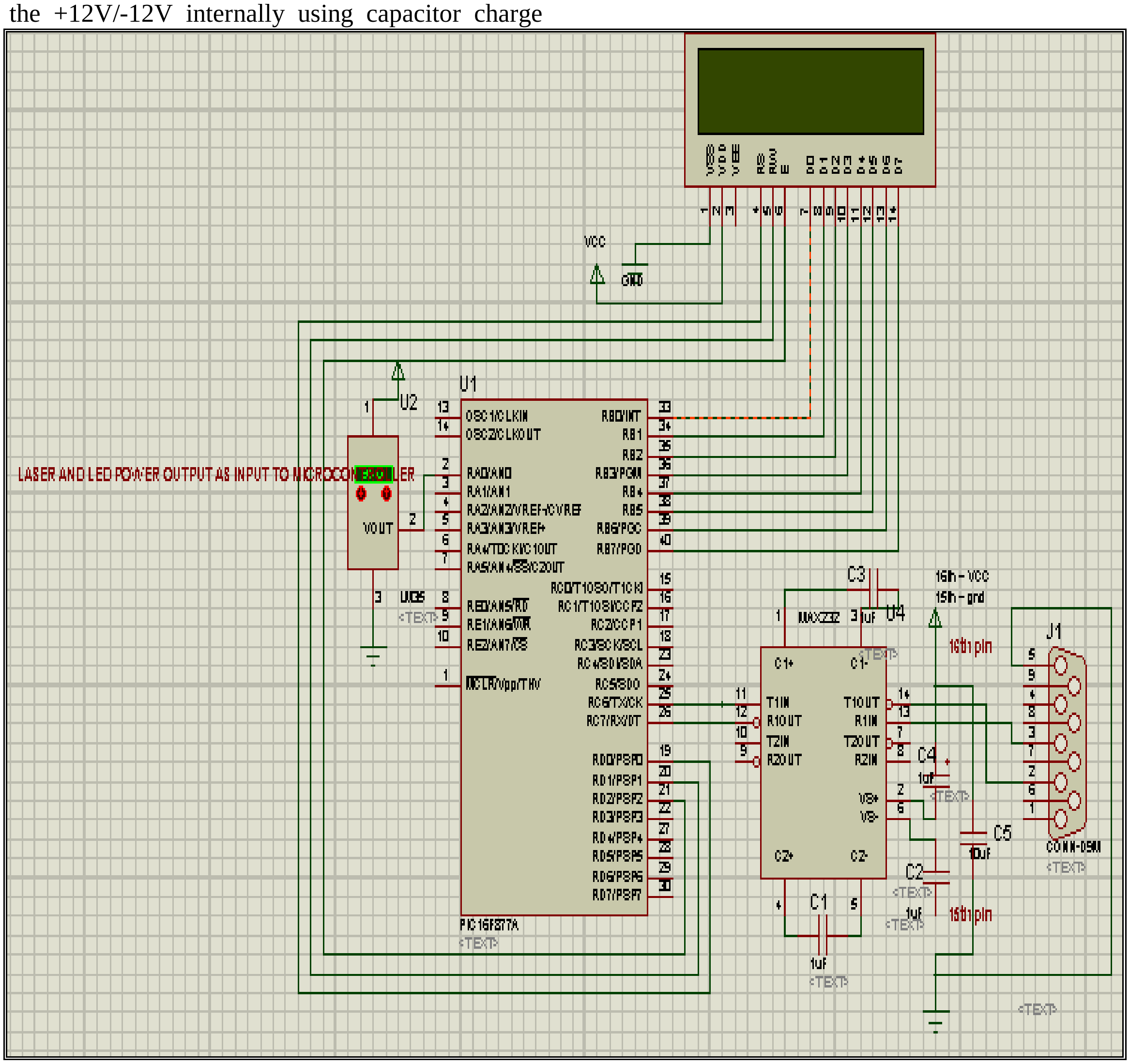

Fig6.PIC circuit Diagram

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5. ATCOMMANDS

AT is the abbreviation of ATtention. Every command line starts with "**AT**" or "at". That's why modem commands are called AT commands. Send (AT+CMGS, AT+CMSS), read (AT+CMGR, AT+CMGL), write (AT+CMGW) or delete (AT+CMGD) SMS messages and obtain notifications of newly received SMS messages (AT+CNMI).

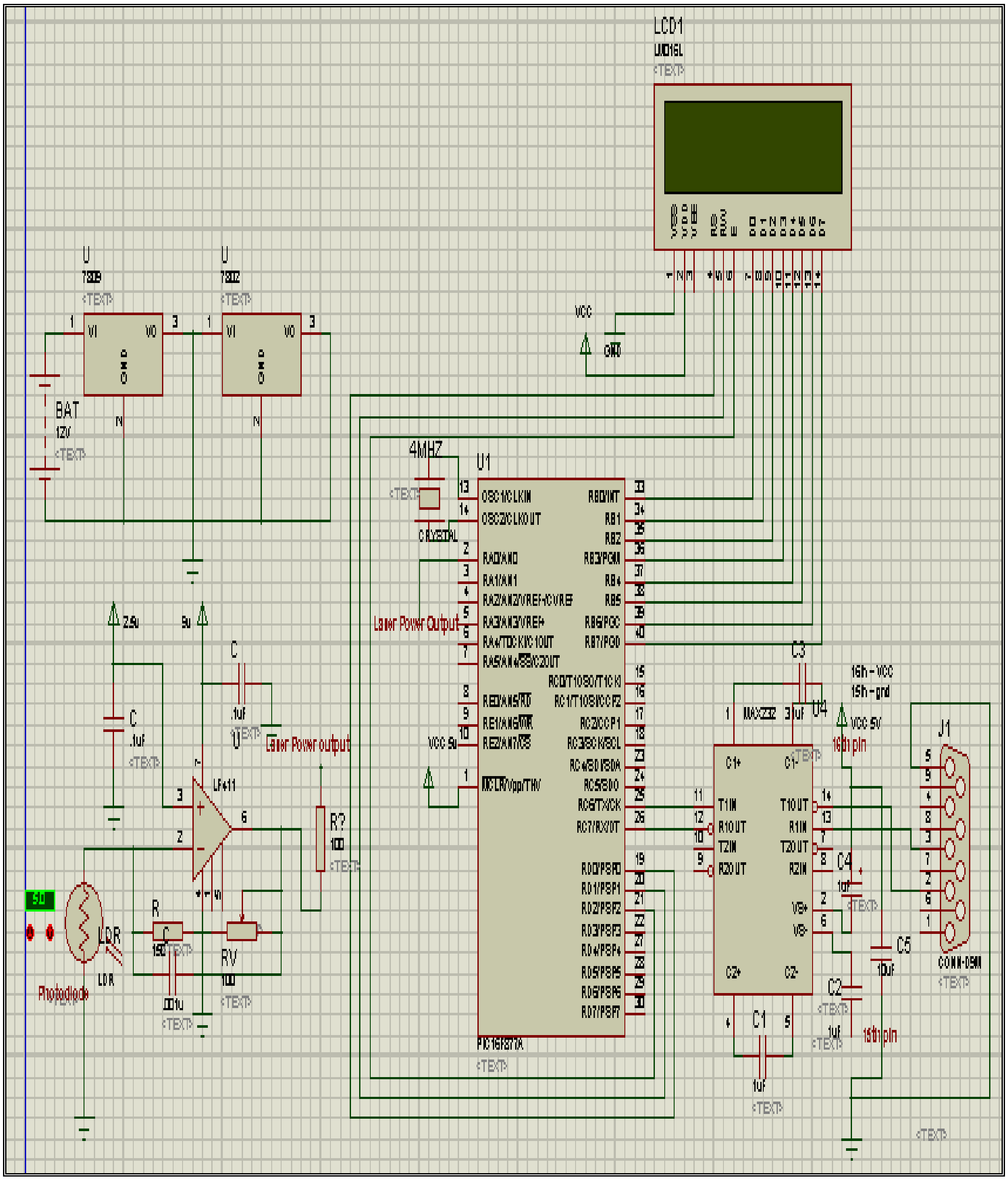

Fig7.Circuit Diagram

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6. SIMULATION RESULT

The Complete Circuit diagram for this project is shown below in Fig.7.

These are the simulated circuit diagram results Fig 8, 9, 10, 11 software. The Figure 8, 9 shows the simulated results when a LDR response from low to high value and is output results across the output terminal of OP-AMP. The Fig11 shows the simulated output when giving a variable voltage across RA0 pin in microcontroller using variable voltage. Here for example for generating variable voltage we took LM35. So we can confirm that the circuit working fine. So in figure 10, 11 show the full simulated output of LDR under bright Light and dark light. In full simulated output of LDR under bright Light shows when the received power supply goes below the particular value sending automatic message and virtual terminal shows the transmitted output from microcontroller to MAX232. In full simulated output of LDR under bright Light shows the received power supply.

Circuit description

The photodiode collects photons from the light source and converted it into current (Is). This current is extremely small and corresponds to the sensitivity of the photodiode. The current varies in the range of 0 to .5A. In dark resistance value is high in the range of 500k ohm and in bright light the resistance value in the range of 5k ohm. The photodiodes used in these types of sensors offer high sensitivity and low noise, enabling them to detect very low light levels. Attenuating filters must be used when operating above the milli watt level to avoid saturation. Photodiodes also have a fast response time, so they are convenient for tuning and peaking lasers.

A high-impedance technique is often used to develop a voltage proportional to the light detector current (op-amp). The impedance serves to reduce the thermal noise and improve the receiver sensitivity. However, the leakage current could saturate the PIN diode preventing the modulated signal from being detected. The PIN photodiode generated current is low, thus the noise should be kept significantly lower.

If the laser is in the nW to low mW range, a measurement system based upon an optical sensor is likely a great choice. If the laser output is much above the tens of mW level then you should probably lean toward a thermopile sensor, or a pyroelectric sensor. Typically the photodiode generates about 0.55 uA for 1 uW optical power received. But here in ISIS simulator photodiode is not there so we are using LDR based circuit to detect the light ray from LED or laser.

LED and laser power output in dark light:

Circuit function

LDR (light dependent resistor) is a resistor whose resistance is dependent on light. The resistance of LDR is of the order of Mega Ohms in the absence of light and reduces to a few ohms in presence of light. In this circuit when the absence of light on LDR, the resistance of LDR in the order of Mega ohm and the voltage drop across the Load resistance is 3.7v. The simulated results for LED and laser output in dark light shown below in fig 8.

Reference parameter values:

Op-amp 7th terminal=9v, op-amp 4th terminal=0v, op-amp 3rd terminal=5v, op-amp 2nd terminal=LDR input(3.1), R21=150 ohm, RV5=100 ohm, C7=.1uF, C8=.1uF

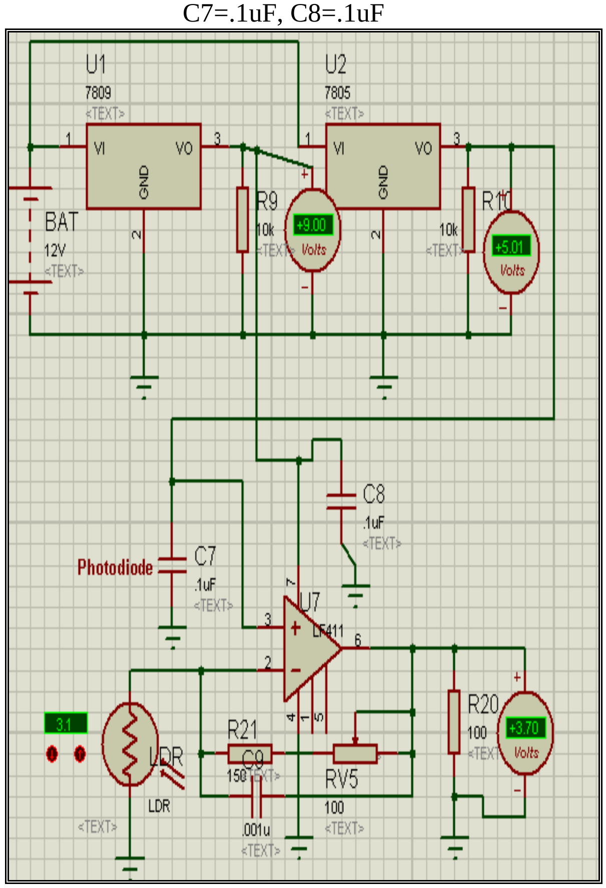

Fig8.LED and LASER output in dark light

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Output:

Vout=3.70v

LED and laser power output in bright light:

LDR (light dependent resistor) is a resistor whose resistance is dependent on light. The resistance of LDR is of the order of Mega Ohms in the absence of light and reduces to a few ohms in presence of light. In this circuit when the light falls on LDR, the resistance of LDR becomes low and the entire voltage drop takes place across the Load resistance. So the voltage drops to 3.12v. Capacitor used to pass high frequency to ground. The simulated results for LED and laser output in bright light shown below in fig 9.

Reference parameter values:
Op-amp 7th terminal=9v, op-amp 4th terminal=gnd, op-amp 3rd terminal=5v, op-amp 2nd terminal=LDR input(981), R21=150 ohm, RV5=100 ohm, C7=.1uF, C8=.1uF
Output:
Vout=3.1v

Reference parameter values:
Op-amp 7th terminal=9v, op-amp 4th terminal=gnd, op-amp 3rd terminal=5v, op-amp 2nd terminal=LDR input(1000), R21=150 ohm, RV5=100 ohm, C7=.1uF, C8=.1uF

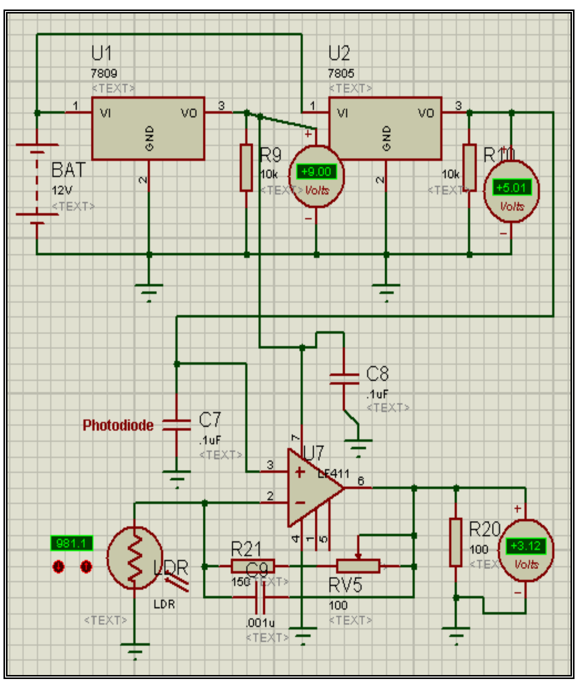

Fig9. LED and LASER output in bright light
Output:Vout=2.9

Fig10 shows the full simulated output of LDR under bright Light. This LED and laser power output to feed to the input terminal RA0 pin of microcontroller. We convert the input voltage analog to digital by ADC in microcontroller. In the program we used to check the voltages continuously. Once if the condition is satisfied it will automatically send message (street name) to monitoring person. So that monitoring person can solve the problem easily and quickly. Here in full simulated output of LDR under bright light the received voltage is 3.12v. Once the condition is satisfied it transmits the message sending automatic message and virtual terminal shows the transmitted output from microcontroller to MAX232. This virtual terminal show the data is transmitted from microcontroller. Fig11 shows the full simulated output of LDR under dark Light. This LED and laser power output to feed to the input terminal RA0 pin of microcontroller. We convert the input voltage analog to digital by ADC in microcontroller. In the program we used to check the voltages continuously.

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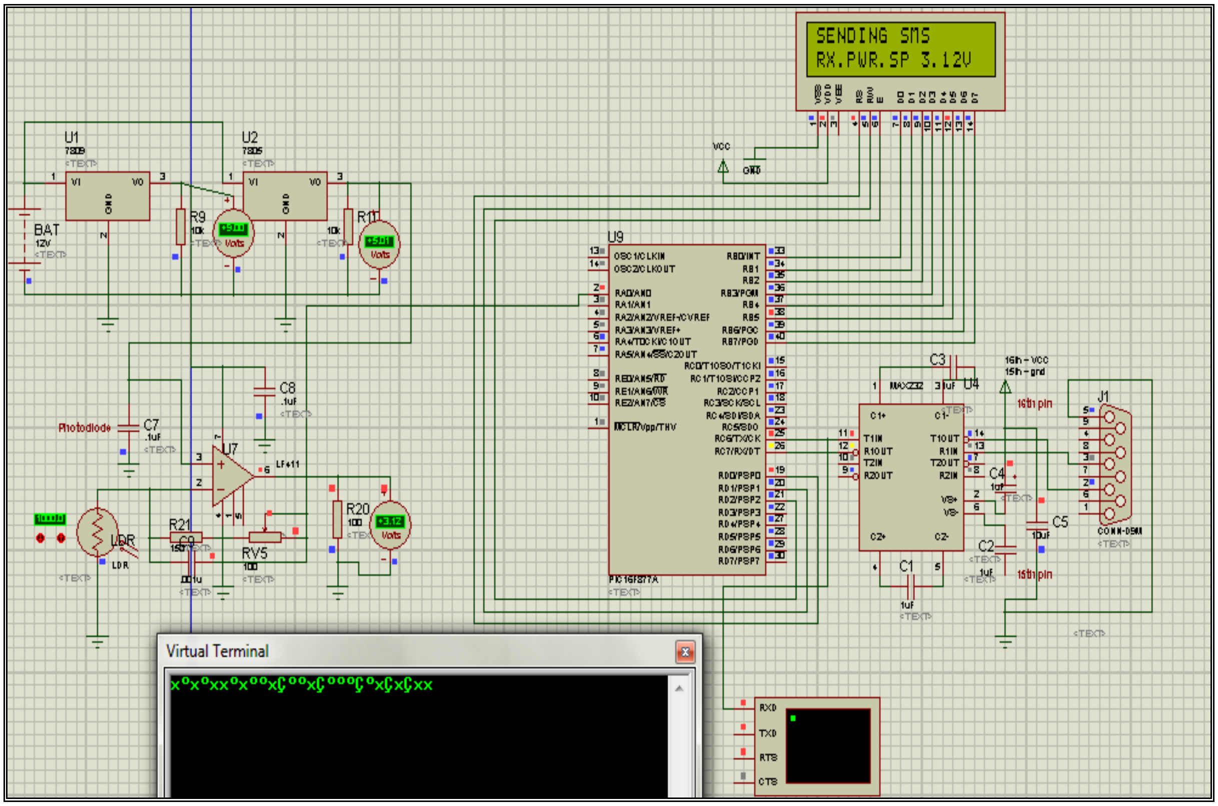

Fig10.Full Simulated output of LDR under bright light

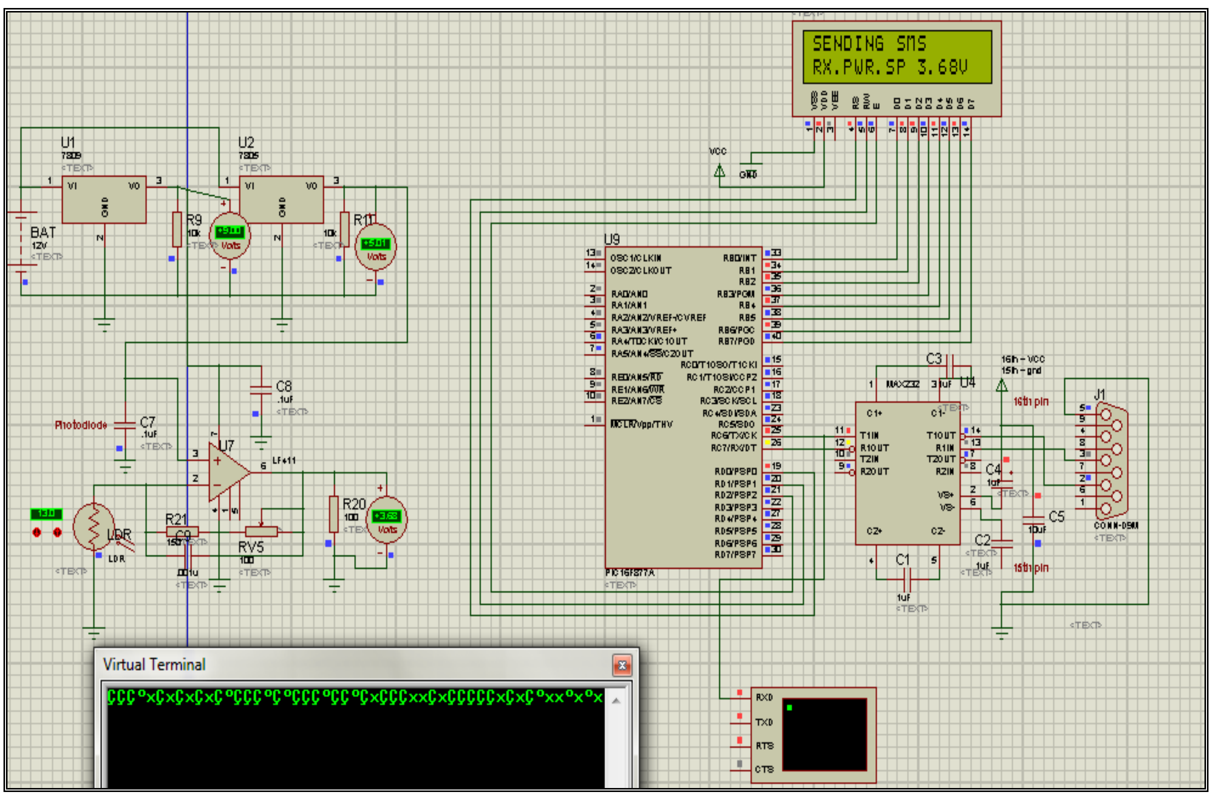

Fig11.Full Simulated output of LDR under dark light

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Once if the condition is satisfied it will automatically send message (street name) to monitoring person. So that monitoring person can solve the problem easily and quickly. Here in full simulated output of LDR under bright light the received voltage is 3.68v. Once the condition is satisfied it transmits the message sending automatic message and virtual terminal shows the transmitted output from microcontroller to MAX232. This virtual terminal show the data is transmitted from microcontroller.

7. CONCLUSION

In this intelligent fault detecting system in an optical fibre used to detect the fault in optic fibre line, detect fault in the line by designing a fault monitoring module. Fault monitoring module is designed by LED and laser power monitoring circuit and PIC based circuit diagram helps in alerting the monitoring person about the fault in the line say across the streets. When compare to previous monitoring system, our proposed system response quickly alert the system behaviour by sending SMS to monitoring person and main monitoring system.

In Fault detection module is designed using ISIS simulator. In ISIS software photodiode is not available. So the LDR and photodiode receives the solar light and photodiode receive LED or LASER. So here instead of Photodiode we used LDR. Thus designed fault detecting module for street Local monitoring module and its working fine in ISIS simulation. If there is any fault in the fibre received power varies. Based on the received power, message will be automatically transmitted to monitoring person and main monitoring system.

To implement hardware design make PCB layout for designed circuit like LED and Laser power monitoring circuit and PIC controller based circuit design in designed process which are discussed earlier. Then check the real time performance of the hardware design and compare it with ISIS simulated results. The design can operate in low power mode (sleep mode) to save power consumption in real time. Further it can be improved it by online monitoring of Received power and locating the fault in the streets.

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