HUMAN FALL DETECTION AND LOCATION TRACKING SYSTEM

PROJECT REPORT

submitted by

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CERTIFICATE

This is to certify that the report entitled **"HUMAN FALL DETECTION AND LOCATION TRACKING SYSTEM''** submitted by

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to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Electronics And Communication Engineering is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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ABSTRACT

Here in this project we design a fall detection and safety unit for elderly people. This aims to detect fall of the elderly people, the smart sensors and electronics used in this project will notify the respective care units such as police station, family members and hospitals with exact location data. This safety gadget is implemented using a waist band structure and this is easily wearable for the old people. This design aims for the safety of elderly people so that they can walk outside without any fear. This gadget is highly portable and effective and is also cost effective. In this project we make use of Arduino is an open-source electronics platform based on easy-to-use hardware and software and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. The arduino is programmed to read the sensors continuously and takes sufficient decision according to the readings. The accelerometer and vibration sensors are inputs to the system. The accelerometer detects the axis changes and vibration sensor detects the impact or oscillations produced. With the introduction of smart sensors this product gives accurate data and measurements. When the fall is detected beyond the threshold value, the program loaded in arduino if show abnormal readings then the SMS notification will be sent to the registered mobile numbers through GSM module and the location is detected using GPS and is sent. The alarm beeps to indicate if person needs help and cancellation switch to abort the process. With this new safety gadget every elderly person can travel outside without any fear and this gadget can also be used by other age groups making it reliable to everyone.

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ABBREVIATIONS

AALS	Ambient Assisted Living Systems
AC	Alternating Current
ADC	Analog to Digital Converter
ADL	Activities of Daily Living
ANT	Antenna
ARM	Advanced RISC Machine
AVR	Automatic Voltage Regulator
BCKP	Back Up
CAN	Controller Area Network
CDC	Centers for Disease Control
COM	Common Operating Machine
CPU	Control Processing Unit
DC	Direct Current
DIP	Dual Inline Package
EEPROM	Electrically Erasable Programmable Read Only Memory
FTDI	Future Technology Devices International
GLONASS	GLObal NAvigation Satellite System
GPS	Global Positioning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HMM	Hidden Markov Model
IC	Integrated Circuit
ICSP	In Circuit Serial Programming
IDE	Integrated Development Environment
I2C	Inter-Integrated Circuit
LAN	Local Area Network
LBS	Location Based Service
LCC	Leadless Chip Carrier
LCD	Liquid Crystal Display
LDO	Low Drop Out
LED	Light Emitting Diode
LFCSP	Lead Frame Chip Scale Package

LIB	Lithium Ion Battery
MEMS	Microelectro Mechanical Systems
MISO	Master In Slave Out
M2M	Machine to Machine
MOSI	Master Out Slave In
MPU	Micro Processing Unit
NG	Noise Gain
NPHCE	National Program for Health Care of the Elderly
OP-AMP	Operational Amplifier
PB	Panic Button
PCB	Printed Circuit Board
PSoC	Programmable System on a Chip
PWM	Pulse Width Modulation
RAM	Random Access Memory
RMS	Root Mean Square
RoHS	Restriction of Hazardous Substances
ROM	Read Only Memory
RX	Receiver
RxD	Received Data
SCL/SCK	Serial Clock
SDA	Serial Data
SMS	Short Message Service
SPI	Serial Peripheral Interface
SR	Slew Rate
SRAM	Static Random Access Memory
TTFF	Time To First Fix
TX	Transmitter
TxD	Transmitted Data
UART	Universal Asynchronous Receiver Transmitter
URL	Universal Resource Locator
USB	Universal Serial Bus
VCC	Voltage Common Collector
WSS	Wearable Sensor System

NOTATIONS

Ω	Ohms
µA	Micro Ampere
2D	Two Dimension
3D	Three Dimension
D	Diode
dB	Decibel
F	Farad
g	Gravity
G	Gain
GHz	Giga Hertz
hFE	Hybrid Parameter Forward Current Gain
Hz	Hertz
K	Kilo
KB	Kilo Bytes
mA	Milli Ampere
MHz	Mega Hertz
mm	Milli Meter
m/s2	Meter Per Seconds Square
mV/g	Milli Volt Per Gravity
R	Resistor
V	Volt

CHAPTER 1
INTRODUCTION

Falls are a very dangerous situation especially among elderly people, because they may lead to fractures, concussion, and other injuries. Without timely rescue, falls may even endanger their lives. According to the World Health Organization, falls are the second leading cause of accidental or unintentional injury deaths worldwide, and more than one third of elderly people fall once or more each year. For this group of people, once they fall, they may suffer serious health problems. Falls are responsible for 40% of all injury related deaths and need immediate medical attention. The reason for a fall may be heart problems, loss of consciousness, fatigue, exhaustion, diseases and loss of balance. Although falls occur through all age groups, the major chunks of incidents are those of senior citizens. Approximately 28-35% of people aged 65 and above fall every year. This figure only increases for the age group of 70+ with 32-42%. The major talking point is the need for swift medical aid. 50% of all injury-type hospitalizations for the concerned age group are fall related. Thirty-two percent of elderly people aged over 75 years have ever fallen at least once a year, and among them, 24% have been seriously injured. Approximately 3% of all fallers lie unattended for periods greater than 20 minutes, leading to insufficient medical action. An upsetting figure is that 40% of nursing home admissions are directly linked with incidents of falls. Damage may be greatly reduced if they have access to timely rescue.

Intelligent IoT-based ambient assisted living systems (AALS) for the elderly have been a major research focus area in recent times. According to the studies conducted by National Program for Health Care of the Elderly (NPHCE), elderly population in India will increase to 12% of the national population by 2025 with 8%–10% requiring utmost care. Application of machine learning in areas of AALS such as fall detection, therefore, has the potential to have a huge public impact. Much work has been done in the area of fall detection systems and the application of machine learning to such systems to enable fall classification, detection, and prediction. Thus, a reliable fall monitoring system has great application value and development prospects. The existing optical sensor-based fall monitoring systems have some disadvantages, such as limited monitoring range and inconvenience to carry for users.

In the world of technology, wearable have always had a special appeal. This is due to the ease of access and usage, as well as the seamless nature of the product. One does not bear the brunt of social stigma by wearing such a device, thus satisfying the user. Efficiency of the system is paramount, as the message must be delivered from point A to point B in a matter of seconds. An established mode of communication must be employed; in this case the Short Message Service (SMS) can reach people the quickest. False alarms can be both extremely annoying and wastes both time and money. So in order to ensure accuracy, the fall-detection algorithm must be perfected and the device must be made interactive. We propose a human fall monitoring and location tracking system consisting of a highly portable sensor unit including a triaxis accelerometer and an arduino.

1.1 PROJECT DEFINITION

Accelerometer-based 2 methods measure acceleration of the human body by an accelerometer, and falls are detected based on a threshold value of acceleration. With the obtained datas, we obtain the acceleration and Euler angle (yaw, pitch, and roll), which represents the orientation of the user's body. Then, a proposed fall detection algorithm is used to detect falls based on the acceleration and Euler angle.

Here in this project we design a fall detection and safety unit for elderly people. This aims to detect fall of the elderly people, the smart sensors and electronics used in this project will notify the respective care units such as police station, family members and hospitals with exact location data. This safety gadget is implemented using a waist band structure and this is easily wearable for the old people. This design aims for the safety of elderly people so that they can walk outside without any fear. This gadget is highly portable and effective and is also cost effective. In this project we make use of Arduino is an open-source electronics platform based on easy-to-use hardware and software and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. The arduino is programmed to read the sensors continuously and takes sufficient decision according to the readings. The accelerometer and vibration sensors are inputs to the system. The accelerometer detects the axis changes and vibration sensor detects the impact or oscillations produced. With the introduction of smart sensors this product gives accurate data and measurements. When the fall is detected beyond the threshold value, the program loaded in arduino if show abnormal readings then the SMS notification will be sent to the registered mobile numbers through GSM module and the location is detected using GPS and is sent. The alarm beeps to indicate if person needs help and cancellation switch to abort the process.

1.2 FUNCTIONAL REQUIREMENTS

- Detects fall and tracks down location.
- Semi-automated
- Real time updating
- SMS is send to the caretakers, hospital etc.
- Alarm is provided such that can alert the other people nearby so that help can be given on spot.
- Provides the accelerometer reading, that senses the tilt

1.3 TECHNICAL SPECIFICATIONS

- Length : 18 cm
- Width : 14.8 cm
- Weight : 0.8 Kg
- Battery : Lithium Ion Battery
- Power Rating : 1500 Milliamp Hours
- Battery Capacity : 1500 Milliamp Hours
- Voltage : 8V for 2 Batteries (4V each)
- Average Life : 2 months

CHAPTER 2
LITERATURE SURVEY

2.1 GENETIC ALGORITHM FOR EFFECTIVE FALL DETECTION WITH WRIST WEARABLE DEVICE

- Abhilash Unnikrishnan, Abraham Sudharson Ponraj - 2019

Falls have always been a major cause of injury related deaths among the old aged population in our country. It causes mental trauma and severe fractures to the bones and spine which impacts their quality of life. Therefore a proper fall prediction and alert system along with a timely rapid response could enable us to tackle such serious fall events and decrease the fatality. Various sensors and embedded controllers are used in conjunction with various machine learning classifiers to help us predict and optimize the falls effectively. This work presents a wrist wearable device using MPU-6050 sensor and raspberry-pi controller with help of machine learn algorithm which help us to predict the falls. Five different supervised learning algorithms and one unsupervised algorithm was implemented and evaluated on the basis of their accuracy, sensitivity and specificity. Out of all these classifiers, the decision tree with an accuracy of 85% was implemented in the system which classified the fall from the real time non-fall data sets. Further the performance of system was increased using genetic algorithm which gave better classification results unlike the normal decision tree classifier. Once the falls are predicted we can give a real-time response which can be an added feature to this system.

2.2 A REAL-TIME FALL DETECTION SYSTEM BASED ON THE ACCELERATION SENSOR OF SMARTPHONE

- Youngmin Lee,Hongjin Yeh - 2018

Falls are a major problem for the elderly people leading to injury, disability, and even death. In this article, we propose a fall detection system that uses the acceleration sensor of a smartphone to detect a senior citizen falling in real time and to use the communication capabilities of the smartphone to notify the administrator of such an event. The proposed system conducts real-time location tracking using Google’s Map and 3D information to cope with a critical situation and to make an urgent intervention in an emergency. Since Google’s 3D mapping service can provide information on the surrounding buildings and their shapes with more precision than a 2D service or text-based service, it is possible to ensure a prompt response for senior citizens when such location information is available. To verify the validity and efficiency of this article, we measured the change in acceleration sensor value by classifying the subjects by age group and gender. As a result, we found that the signal vector magnitude value of the acceleration sensor value variation showed a great difference in daily life such as walking, running, sitting, and falling.

2.3 FALL DETECTION FOR ELDERLY PEOPLE USING IOT AND BIG DATA

-Diana Yacchiremaab, ManuelEstevea-2018

Falls represent a major public health risk worldwide for the elderly people. A fall not assisted in time can cause functional impairment in an elder and a significant decrease in his mobility, independence and life quality. In that sense, the present work proposes an innovative IoT-based system for detecting falls of elderly people in indoor environments, which takes advantages of low-power wireless sensor networks, smart devices, big data and cloud computing. For this purpose, a 3D-axis accelerometer embedded into a 6LowPAN device wearable is used, which is responsible for collecting data from movements of elderly people in real-time. To provide high efficiency in fall detection, the sensor readings are processed and analyzed using a decision trees-based Big Data model running on a Smart IoT Gateway. If a fall is detected, an alert is activated and the system reacts automatically by sending notifications to the groups responsible for the care of the elderly people. Finally, the system provides services built on cloud. From medical perspective, there is a storage service that enables healthcare professional to access to falls data for perform further analysis. On the other hand, the system provides a service leveraging this data to create a new machine learning model each time a fall is detected. The results of experiments have shown high success rates in fall detection in terms of accuracy, precision and gain.

2.4 HIGHLY PORTABLE SENSOR BASED SYSTEM FOR HUMAN FALL MONITORING

- Aihua Mao et al (Basel) - 2017

Falls are a very dangerous situation especially among elderly people, because they may lead to fractures, concussion, and other injuries. Without timely rescue, falls may even endanger their lives. The existing optical sensor-based fall monitoring systems have some disadvantages, such as limited monitoring range and inconvenience to carry for users. Furthermore, the fall detection system based only on an accelerometer often mistakenly determines some activities of daily living (ADL) as falls, leading to low accuracy in fall detection. We propose a human fall monitoring system consisting of a highly portable sensor unit including a triaxis accelerometer, a triaxis gyroscope, and a triaxis magnetometer, and a mobile phone. With the data from these sensors, we obtain the acceleration and Euler angle (yaw, pitch, and roll), which represents the orientation of the user's body. Then a proposed Algorithm was used to detect falls based on the acceleration and Euler angle. With this monitoring system, we design a series of simulated falls and ADL and conduct the experiment by placing the sensors on the shoulder, waist, and foot of the subjects. Through the experiment, we re-identify the threshold of acceleration for accurate fall detection and verify the best body location to place the sensors by comparing the detection performance on different body segments. We also compared this monitoring system with other similar works and found that better fall detection accuracy and portability can be achieved by our system.

2.5 PERVASIVE FALL DETECTION SYSTEM USING MOBILE PHONES

-Jiangpeng Dai, Xiaole Bai, Zhimin Yang, Zhaohui Shen, Dong Xuan-2016

Falls are a major health risk that diminish the quality of life among elderly people. With the elderly population surging, especially with aging "baby boomers", fall detection becomes increasingly important. However, existing commercial products and academic solutions struggle to achieve pervasive fall detection. In this paper, we propose utilizing mobile phones as a platform for pervasive fall detection system development. To our knowledge, we are the first to do so. We design a detection algorithm based on mobile phone platforms. We propose PerFallD, a pervasive fall detection system implemented on mobile phones. We implement a prototype system on the Android G1 phone an conduct experiments to evaluate our system. In particular, we compare PerFallD's performance with that of existing work and a commercial product. Experimental results show that PerFallD achieves strong detection performance and power efficiency.

2.6 OPTIMIZATION OF AN ACCELEROMETER AND GYROSCOPE-BASED FALL DETECTION ALGORITHM

-Quoc T. Huynh,Uyen D. Nguyen,Lucia B. Irazabal,Nazanin Ghassemian,and Binh Q. Tran - 2015

Falling is a common and significant cause of injury in elderly adults (>65 yrs old), often leading to disability and death. In the USA, one in three of the elderly suffers from fall injuries annually. This study's purpose is to develop, optimize, and assess the efficacy of a falls detection algorithm based upon a wireless, wearable sensor system (WSS) comprised of a 3-axis accelerometer and gyroscope. For this study, the WSS is placed at the chest center to collect real-time motion data of various simulated daily activities (i.e., walking, running, stepping, and falling). Tests were conducted on 36 human subjects with a total of 702 different movements collected in a laboratory setting. Half of the dataset was used for development of the fall detection algorithm including investigations of critical sensor thresholds and the remaining dataset was used for assessment of algorithm sensitivity and specificity. Experimental results show that the algorithm detects falls compared to other daily movements with a sensitivity and specificity of 96.3% and 96.2%, respectively. The addition of gyroscope information enhances sensitivity dramatically from results in the literature as angular velocity changes provide further delineation of a fall event from other activities that may also experience high acceleration peaks.

2.7 DEVELOPMENT OF A WEARABLE – SENSOR BASED FALL DETECTION

-Falin Wu, Hengyang Zhao and Haibo Zhong - 2015

Fall detection is a major challenge in the public healthcare domain, especially for the elderly as the decline of their physical fitness, and timely and reliable surveillance is necessary to mitigate the negative effects of falls. This paper develops a novel fall detection system based on a wearable device. The system monitors the movements of human body, recognizes a fall from normal daily activities by an effective quaternion algorithm, and automatically sends request for help to the caregivers with the patient's location.Progress of technology brings more possibilities to help us protect the elderly. Low power consumption components make it possible to realize wearable monitoring device. MEMS (microelectro mechanical systems) sensors have simplified the design and implementation of sensor system. Location based service (LBS) makes it more convenient to locate the elderly in health monitoring. Beside these, mobile computing makes remote health monitoring easier to realize.

2.8 HUMAN FALL DETECTION WITH SMART PHONES

-Luis N Valcourt Colon-2014

According to the CDC (Centers for Disease Control and Prevention), one in three people over the age of 65 are likely to experience a fall. Twenty to thirty percent of these people sustain injuries such as fractures, loss of independence, and even death. Fall detection is an active research area that strives to improve people's lives through the use of pervasive computing. This paper presents an approach to detect falls based on data gathered from a smartphone. It utilizes the smartphone's built-in sensors (accelerometer, gyroscope) to identify the location of the cellphone in the user's body (chest, pocket, holster, etc), and to find known patterns associated with falls. A general description on fall detection systems is provided, including the different types of sensors used nowadays. The proposed solution is presented and described in great detail. Finally, the system is assessed using known performance indicators. A total accuracy of 81.3% was calculated from the fall detection proposed algorithm. The top three locations to detect a fall were: texting with a 95.8% fall detection accuracy, pants' side pocket with an 87.5% accuracy, and shirt chest's pocket with an 83.3% accuracy.

2.9 FALL - DETECTION ALGORITHM USING 3-AXIS ACCELERATION

- Dongha Lim,Chulho Park,Nam Ho Kim,Sang-Hoon Kim,and Yun Seop Yu - 2014

Falls are a serious medical and social problem among the elderly. This has led to the development of automatic fall-detection systems. To detect falls, a fall-detection algorithm that combines a simple threshold method and hidden Markov model (HMM) using 3-axis acceleration is proposed. To apply the proposed fall-detection algorithm and detect falls, a wearable fall-detection device has been designed and produced. Several fall-feature parameters of 3-axis acceleration are introduced and applied to a simple threshold method. Possible falls are chosen through the simple threshold and are applied to two types of HMM to distinguish between a fall and an activity of daily living (ADL). The results using the simple threshold, HMM, and combination of the simple method and HMM were compared and analyzed. The combination of the simple threshold method and HMM reduced the complexity of the hardware and the proposed algorithm exhibited higher accuracy than that of the simple threshold method. Their principal advantage is that a person is not required to wear any special equipment. Wearable device-based approaches rely on clothing with embedded sensors to detect the motion and location of the body of the subject. The advantages of wearable devices are the cost efficiency, ease of installation, setup, and operation of the design.

2.10 DETECTING HUMAN FALLS WITH A 3 AXIS ACCELERO – METER

-Ning Jia-2009

For a human, experiencing a fall unobserved can be doubly dangerous. The obvious possibility of initial injury may be further aggravated by the possible consequences if treatment is not obtained within a short time. In light of this need to warn of falls, the development of devices for detection and prediction of all types of falls has become a hot topic. In recent years, technological advances in microelectro mechanical system (MEMS) acceleration sensors have made it possible to design fall detectors based on a 3-axis integrated MEMS (iMEMS) accelerometer. The technique is based on the principle of detecting changes in motion and body position of an individual, wearing a sensor, by tracking acceleration changes in three orthogonal directions. The data is continuously analyzed algorithmically to determine whether the individual's body is falling or not. If an individual falls, the device can employ GPS and a wireless transmitter to determine the location and issue an alert in order to get assistance. The core element of fall detection is an effective, reliable detection principle and algorithm to judge the existence of an emergency fall situation. This article, based on research into the principles of fall detection for an individual body, proposes a new solution for detection of fall situations utilizing the a 3-axis accelerometer from Analog Devices.

CHAPTER 3

DESIGN APPRAOCH

3.1 BLOCK DIAGRAM

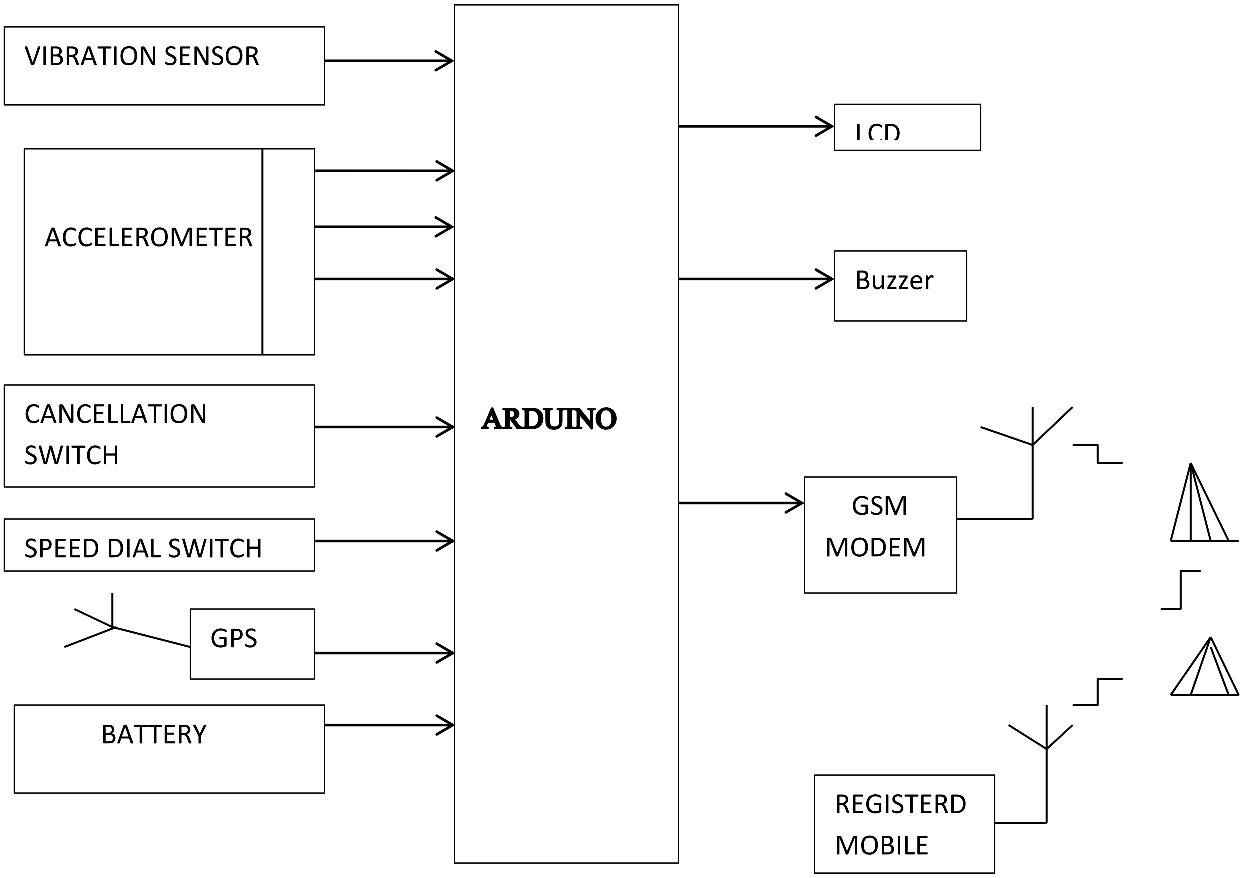


Fig 3.1 Block Diagram

Arduino is used for controlling whole the process with a GPS Receiver and GSM module. GPS Receiver is used for detecting coordinates of the fall location, GSM module is used for sending the alert SMS with the coordinates and the link to Google Map. We have used GPS Module NEO 6M and GSM Module SIM 900. The block diagram consists of a Arduino which is programmed to respond and to command according to our requirements, it also has an triaxial accelerometer which detects the axis change that is the X,Y,Z directions are used to measure the tilt of the fall. The tilt is the deviation from the normal axis. The vibration sensor used which is a piezoelectric crystal to detect the impacts of the fall by sensing the sudden vibrations caused during the fall and gives the required output. The speed dial switch is used in case of extremely emergency situations that is if a fall causes an emergency situation the speed dial switch is pressed to notify about the situation. The cancellation switch is used to abort the process in case any false emergency or false alarm is notified. This false alarm can be generated by unintentionally pressing the speed dial switch. Thus cancellation switch is used to abort the process. The GPS is used to track the location of the person in need of help. Once the fall is detected the information is provided to the GPS as input and the GPS locks itself with the satellite for the transmission and reception of the datas required. Once it's locked, the GPS provides continues full time signal to the Arduino through the serial data transmit port via serial data communication. A buzzer is used as an alarm that beeps in order to alert the person wearing the device or to the nearby people who are within the hearing range to notify about the emergency situation as well as to notify if the false alarm is generated and thus helping to terminate it. It beeps till the time allotted to it and then stops. The LCD is used for the displaying the required contents. The GSM Modem is the modem used to notify the respective individuals either family or friends who are related to the person in need. It works with the help of towers and it depends upon a carrier. A 8V battery is used as an supply for the entire system to work. If an abnormal situation arises the GPS reads the latitude and longitude of the place and sends SMS to the numbers already alloted before hand. The message also contains a Google Map link to the fall location, so that location can be easily tracked. When we receive the message then we only need to click the link and we will redirect to the Google map and then we can see the exact location of a person.

3.2 HARDWARE DESCRIPTIONS

3.2.1 Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

Fig 3.2.1 Arduino Uno

Each of the 14 digital pins and 6 Analog pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution.

3.2.2 GSM

The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in your M2M application, especially for slim and compact demand of design. SIM900 is designed

- With a very powerful single-chip processor integrating AMR926EJ-S core .
- Quad - band GSM/GPRS module with a size of 24mmx24mmx3mm.
- SMT type suit for customer application.
- An embedded Powerful TCP/IP protocol stack.
- Based upon mature and field-proven platform, backed up by our support service, from definition to design and production.

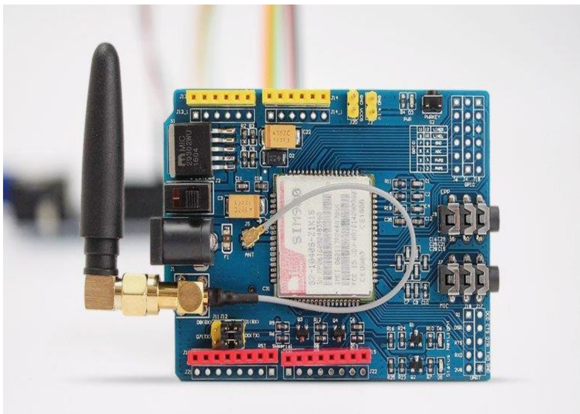


Fig 3.2.2 GSM

3.2.3 GPS

The GPS module that this system has used is the cost effective, high-performance u-blox 6 based NEO-6 series of GPS modules that brings the high performance of the u-blox 6 positioning engine to the miniature NEO form factor. These receivers combine a high level of integration capability with flexible connectivity options in a small package. This makes them perfectly suited for mass-market end products with strict size and cost requirements. The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints. The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

Fig 3.2.3 NEO 6 GPS

3.2.4 Accelerometer

An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations. With this small device, you can determine if an object is moving uphill, whether it will fall over if it tilts any more, or whether it's flying horizontally or angling downward. For example, smartphones rotate their display between portrait and landscape mode depending on how you tilt the phone. The sensitivity of these devices is quite high as they're intended to measure even very minute shifts in acceleration. The more sensitive the accelerometer, the more easily it can measure acceleration. Single- and multi-axis models of accelerometer are available to detect magnitude and direction of the proper acceleration, as a vector quantity, and can be used to sense orientation (because direction of weight changes), coordinate acceleration, vibration, shock, and falling in a resistive medium (a case where the proper acceleration changes, since it starts at zero, then increases). An accelerometer is a device that measures proper acceleration. Proper acceleration, being the acceleration (or rate of change of velocity) of a body in its own instantaneous rest frame, is not the same as coordinate acceleration, being the acceleration in a fixed coordinate system. For example, an accelerometer at rest on the surface of the Earth will measure an acceleration due to Earth's gravity, straight upwards (by definition) of $g \approx 9.81$ m/s2 . By contrast, accelerometers in free fall (falling toward the center of the Earth at a rate of about 9.81 m/s2) will measure zero.

Fig 3.2.4 Accelerometer

3.2.5 Vibration Sensor

The vibration sensor is also called a piezoelectric sensor. These sensors are flexible devices which are used for measuring various processes. This sensor uses the piezoelectric effects while measuring the changes within acceleration, pressure, temperature, force otherwise strain by changing to an electrical charge. This sensor is also used for deciding fragrances within the air by immediately measuring capacitance as well as quality. The working principle of vibration sensor is a sensor which operates based on different optical otherwise mechanical principles for detecting observed system vibrations. The sensitivity of these sensors normally ranges from 10 mV/g to 100 mV/g, and there are lower and higher sensitivities are also accessible. The sensitivity of the sensor can be selected based on the application. So it is essential to know the levels of vibration amplitude range to which the sensor will be exposed throughout measurements.

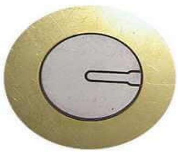


Fig 3.2.5 Piezoelectric Sensor

3.2.6 Switch

A switch, in the context of networking is a high-speed device that receives incoming data packets and redirects them to their destination on a local area network (LAN). A LAN switch operates at the data link layer (Layer 2) or the network layer of the OSI Model and, as such it can support all types of packet protocols. Essentially, switches are the traffic cops of a simple local area network. Switches are similar to hubs, only smarter. A hub simply connects all the nodes on the network communication is essentially in a haphazard manner with any device trying to communicate at any time, resulting in many collisions. A switch, on the other hand, creates an electronic tunnel between source and destination ports for a split second that no other traffic can enter. This results in communication without collisions. Switches are similar to routers as well, but a router has the additional ability to forward packets between different networks, whereas a switch is limited to node-to-node communication on the same network.

Fig 3.2.6 Switch

3.2.7 Battery

A lithium-ion battery or Li-ion battery (abbreviated as LIB) is a type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications. In the batteries, lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. The batteries have a high energy density, no memory effect (other than LFP cells) and low self-discharge. They can however be a safety hazard since they contain a flammable electrolyte, and if damaged or incorrectly charged can lead to explosions and fires.

Fig 3.2.7 Battery

3.2.8 Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used alert a user of an event corresponding to a switching action, counter signal or sensor input. They are also used in alarm circuits. The buzzer produces a same noisy sound irrespective of the voltage variation applied to it.

Buzzer Features and Specifications :

• Rated Voltage: 6V DC

• Operating Voltage: 4-8V DC

• Rated current: <30mA

• Sound Type: Continuous Beep

• Resonant Frequency: ~2300 Hz

• Small and neat sealed package

Fig 3.2.8 Buzzer

3.2.9 Liquid Crystal Display

Features

1. 5x8 dots with cursor
2. 16characters *2lines display
3. 4-bit or 8-bit MPU interfaces
4. Built-in controller (ST7066 or equivalent)
5. Display Mode & Backlight Variations
6. ROHS Compliant

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance.

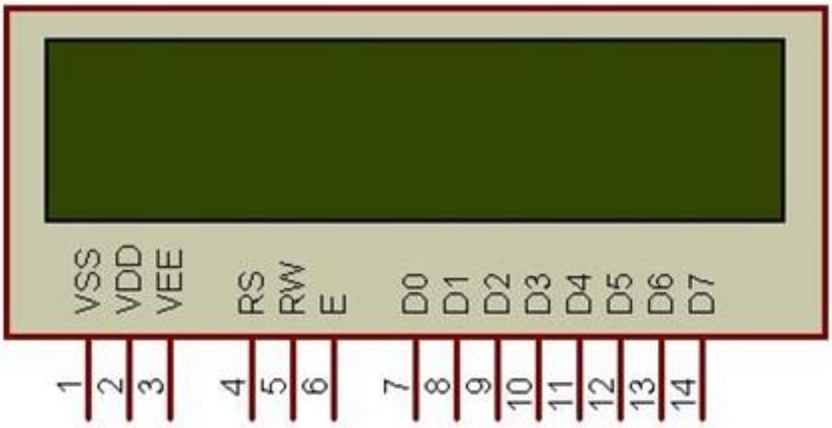


Fig 3.2.9 LCD

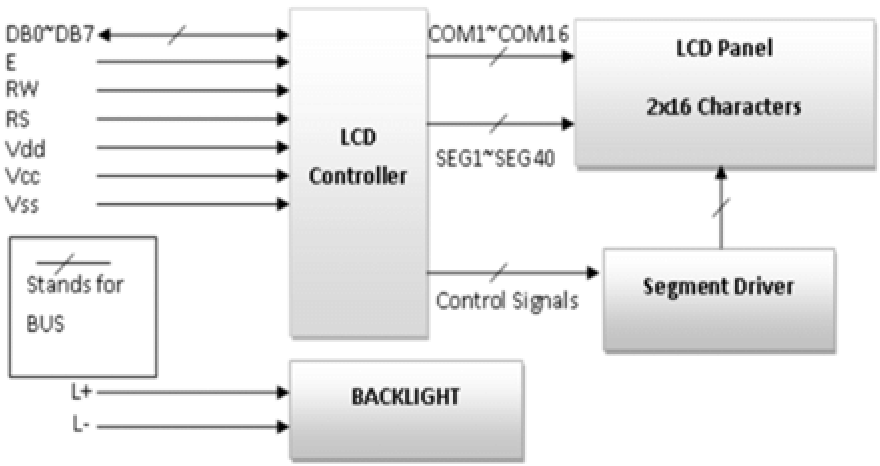


Fig 3.2.9 (i) Block Diagram Of LCD

Table 3.2.9 Interface Pin Description

Pin no.	Symbol	External connection	Function
1	Vss	Power supply	Signal ground for LCM
2	V_{DD}		Power supply for logic for LCM
3	V_0		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-		Power supply for BKL

The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So, little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others. For making an LCD screen, a reflective mirror has to be setup in the back. An electrode plane made of indium-tin oxide is kept on top and a glass with a polarizing film is also added on the bottom side. The entire area of the LCD has to be covered by a common electrode and above it should be the liquid crystal substance.

3.3 SOFTWARE DESCRIPTIONS

3.3.1 Arduino

(i) Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

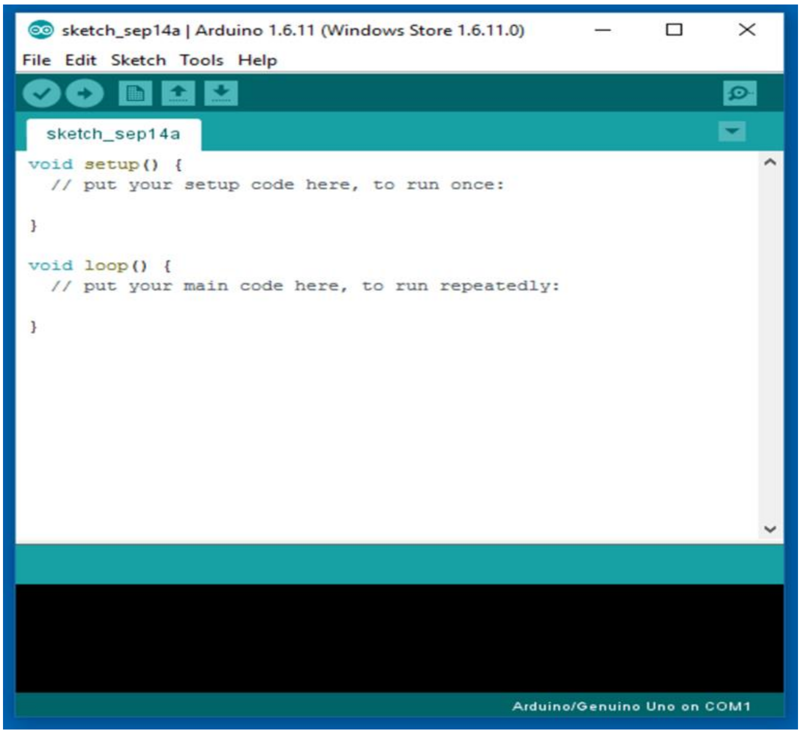


Fig 3.3.1 Arduino Window

(ii) Arduino Library

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

A sketch is a program written with the Arduino IDE. Sketches are saved on the development computer as text files with the file extension.ino. Arduino Software (IDE) pre-1.0 saved sketches with the extension.pde.

A minimal Arduino C/C++ program consists of only two functions:

- setup(): This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch. It is analogous to the function main().
- loop(): After setup() function exits (ends), the loop() function is executed repeatedly in the main program. It controls the board until the board is powered off or is reset. It is analogous to the function while(1).

(iii) Uploading

Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus.On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

When you upload a sketch, you're using the Arduino bootloader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

3.3.2 Proteus Suite

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

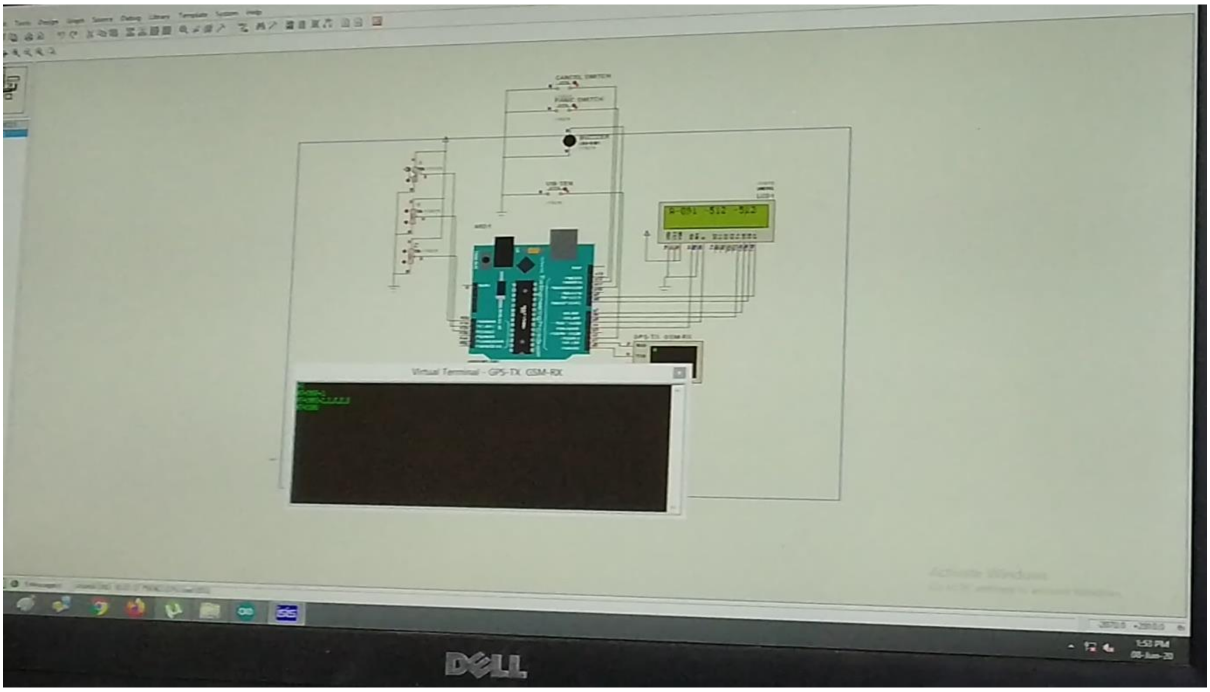


Fig 3.3.2 Proteus Suite Window

3.4 MODULE DESIGN

3.4.1 Arduino Atmega328p

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8- bit RISC processor core. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

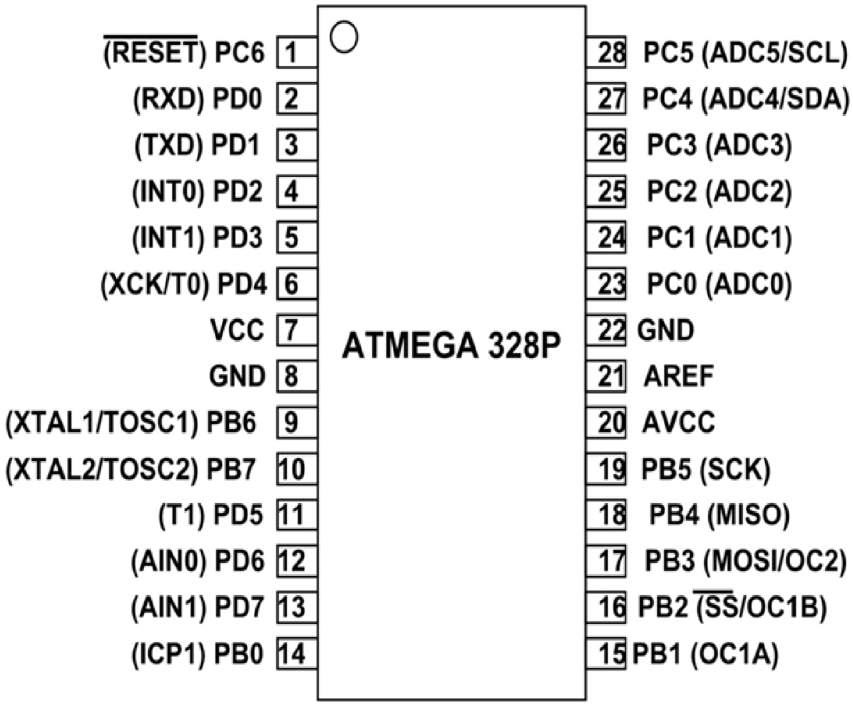


Fig 3.4.1 Pin Diagram Of Atmega328P

(i) Specifications

Microcontroller: ATmega328

Operating Voltage: 5V

Input Voltage (recommended) : 7-12V

Input Voltage (limits): 6-20V

Digital I/O Pins: 14 (of which 6 provide PWM output)

Analog Input Pins: 6

DC Current per I/O Pin: 40 mA

DC Current for 3.3V Pin: 50 mA

Flash Memory: 32 KB (ATmega328) of which 0.5 KB used by bootloader

SRAM: 2 KB (ATmega328)

EEPROM: 1 KB (ATmega328)

Clock Speed: 16 MHz

(ii) Arduino Over Raspberry Pi

Limitations of raspberry pi

- Accessing hardware is not real-time. If the CPU is busy, then interfacing with hardware can be delayed

- No built-in Analog to Digital converter available
- Does not have enough power to drive inductive loads
- The hardware design is not open source. Even though it is not a big deal, for some people it might a deal breaker.

Advantages of arduino

- Very easy to extend it and has tons of user contributed shields and libraries. Shields are available to do pretty much anything
- Can be used to for real-time applications
- Everything (both hardware, software and IDE) are open source
- Not much programming knowledge needed to do basic stuff
- Very easy to get started.

Table 3.4.1 Compariosn Between Arduino And Raspberry Pi

FEATURE	**RASPBERRY PI**	**ARDUINO**
Processor Speed	700 MHz	16 MHz
Programming Language	No limit	Arduno, C/C++
Real-time Hardware	No real-time	In real-time
Analog to Digital Convertor	No	Yes
Hardware Design	Closed source	Open source
Internet Connection	Very easy	Not easy, but doable

(iii) Why Arduino?

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Table 3.4.2 Compariosn Between All Micocontrollers

Specifications	**8051**	**PSOC**	**AVR**	**PIC**	**Arduino**	**DSP**	**ARM**	**Raspberry Pi**
I/O Pins	32	32	32	33	54	60	90	105
ROM	2k	2k	6k	8k	12k	64k	1 mb	expandable
RAM	128bytes	128bytes	256bytes	368bytes	1k	32k	64k	1gb
EEPROM	-	-	✓	✓	✓	✓	✓	✓
Flash	-	-	✓	✓	✓	✓	✓	✓
Tuner	✓	✓	✓	✓	✓	✓	✓	✓
ADC	-	-	✓	✓	✓	✓	✓	✓
UART	✓	✓	✓	✓	✓	✓	✓	✓
PWM	-	-	✓	✓	✓	✓	✓	✓
I^2C	✓	✓	✓	✓	✓	✓	✓	✓
SPI	-	-	✓	✓	✓	✓	✓	✓
Comparator	-	-	✓	✓	✓	✓	✓	✓
PSP	-	-	✓	✓	✓	✓	✓	✓
RTC	-	-	✓	✓	✓	✓	✓	✓
CAN	-	-	-	✓	-	-	✓	✓
Cost (INR)	45	50	60	140	620	1500	2000	3500

(iv) Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V.This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.

3.4.2 Power Supply

We design power supply for regulating 8VDC to 5V DC using voltage regulator 7805 IC.

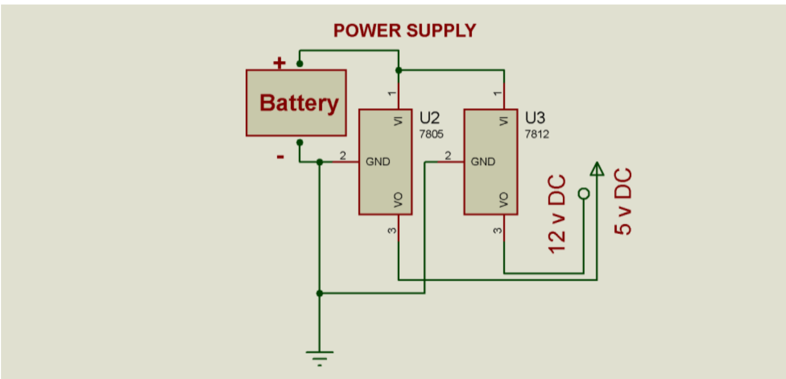


Fig 3.4.2 Circuit Diagram Of Power Supply

(i) Regulating 8V DC into 5V DC using Voltage Regulator

8V DC voltage can be stepped down to 5V DC voltage using a DC step-down converter called as voltage regulator IC7805. The first two digits '78' of IC7805 voltage regulator represent positive series voltage regulators and the last two digits '05' represents the output voltage of the voltage regulator.

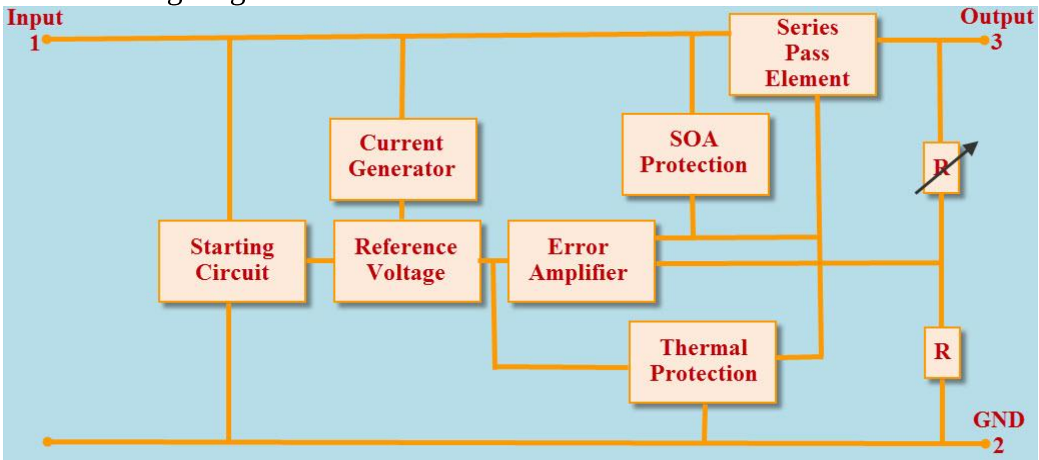


Fig 3.4.2 (i) IC 7805 Internal Block Diagram

Transistor as a series pass element used for dissipating extra energy as heat; SOA protection (Safe Operating Area) and heat sink are used for thermal protection in case of excessive supply voltages. In IC 7805 voltage regulator, lots of energy is exhausted in the form of heat. The difference in the value of input voltage and output voltage comes as heat. So, if the difference between input voltage and the output voltage is high, there will be more heat generation. Without a heat sink, this too much heat will cause malfunction.

We call, the bare minimum tolerable difference between the input and output voltage to keep the output voltage at the proper level as dropout voltage. It is better to keep the input voltage 2 to 3V greater than the output voltage, or a suitable heat sink should be placed to dissipate excess heat. We have to calculate the heat sink size properly. The following formula will give an idea of this calculation.

Heat generated= (input voltage – output voltage) x output current

Here the input voltage is 8V and output voltage of 7805 is 5V

In this project we have taken two 4V battery its current rate is 1.5A

Heat generated = (8-5) ×1.5

= 4.5 W

3.4.3 Design Requirements Of LM358

Here we are designing an inverting configuration of LM 358. The LM358 IC is available in a chip sized package and applications of this op amp include conventional op-amp circuits, DC gain blocks and transducer amplifiers. LM358 IC is a good, standard operational amplifier and it is suitable for your needs. It can handle 3-32V DC supply & source up to 20mA per channel. This op-amp is apt, if you want to operate two separate op-amps for a single power supply. It's available in an 8-pin DIP package.

Features

- It consists of two op-amps internally and frequency compensated for unity gain
- The large voltage gain is 100 dB
- Wide bandwidth is 1MHz
- Range of wide power supplies includes single and dual power supplies
- Range of Single power supply is from -3V to 32V
- Range of dual power supplies is from + or -1.5V to + or -16V
- The supply current drain is very low, i.e., 500 µA
- 2mV low i/p offset voltage

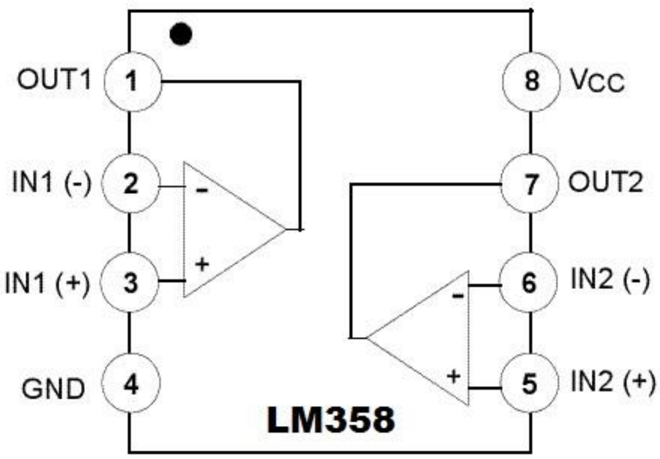


Fig 3.4.3 Pin Configuration Of LM 358

(i) Design Requirement

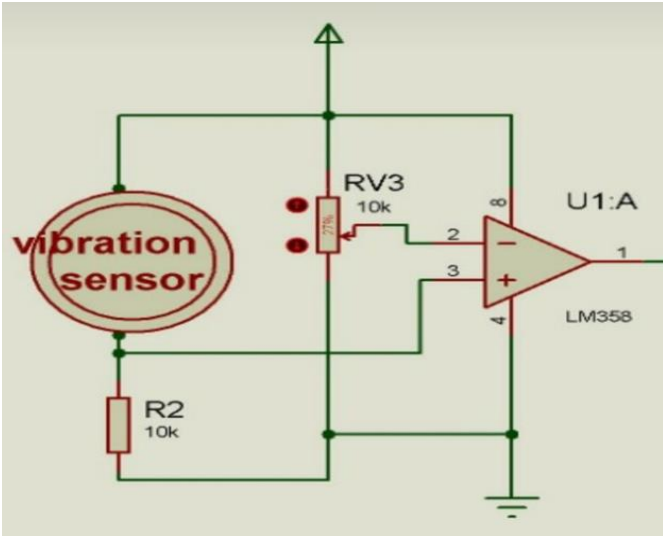


Fig 3.4.3(i) Circuit Design

Here LM358 act as a comparator. shows a typical configuration for a comparator that does not use hysteresis. This configuration uses a voltage divider (R1 and R2) to set up the threshold voltage. The comparator will compare the input signal (Vin) to the threshold voltage (Vth). The comparator input signal is applied to the inverting input, so the output will have an inverted polarity. When the Vin > Vth the output will drive to the negative supply (GND or logic low in this example). When Vin < Vth the output will drive to the positive supply (Vcc = 5V or logic high in this case). This simple method can be used to determine if a real world signal such as temperature is above some critical value. However, this method has a shortcoming. Noise on the input signal can cause the input to transition above and below the threshold causing an erratic output.

Let $V_{th} = 2.5V$

$R_1 = 10k\Omega$

To find R_2

$$R_2 = \frac{V_{TH}}{V_{CC} - V_{TH}} \times R_1 = \frac{2.5}{5 - 2.5} \times 10k\Omega$$

$R_2 = 10k\Omega$

(ii) Features Of Piezoelectric Sesnsor

- Impedance:≤500Ω;
- Voltage:≤30Vp-p;
- Operating temperature:-20°C~+60°C
- Storage temperature:-30°C~+70°C
- Low Soldering temperature
- Strain sensitivity: 5V/µƐ

3.4.4 Adxl335 Accelerometer

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the C X , C Y , and C Z capacitors at the X OUT , Y OUT , and Z OUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

Features

- 3-axis sensing
- Small, low profile package
- 4 mm × 4 mm × 1.45 mm LFCSP
- Low power : 350 µA (typical)
- Single-supply operation: 1.8 V to 3.6
- V 10,000 g shock survival
- Excellent temperature stability
- BW adjustment with a single capacitor per axis
- RoHS/WEEE lead-free compliant

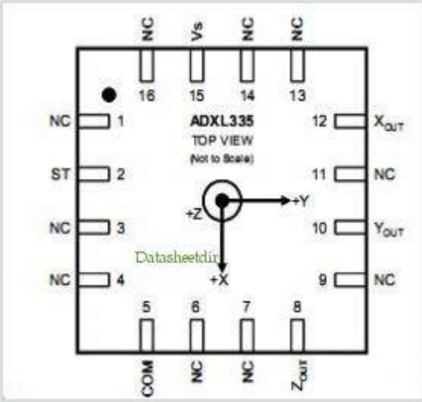


Fig 3.4.4 Pin Configuration

(i) Functional Block Diagram

The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The demodulator output is amplified and brought off-chip through a 32 kΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

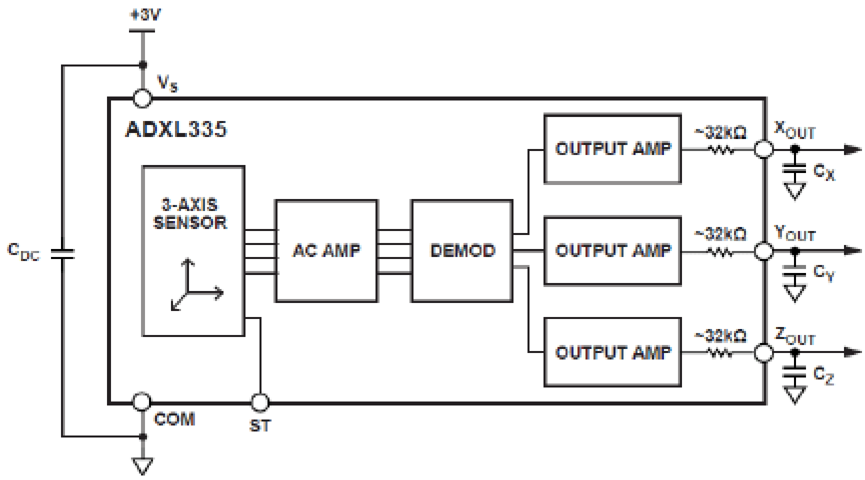


Fig 3.4.4(i) Functional Block Diagram

(ii) Setting The Bandwidth Using Cx, Cy, And Cz

The ADXL335 has provisions for band limiting the XOUT, YOUT, and ZOUT pins. Capacitors must be added at these pins to implement low-pass filtering for antialiasing and noise reduction. The equation for the 3 dB bandwidth is

$F_{-3\ dB} = 1/(2\pi(32\ k\Omega) \times C(X, Y, Z))$ or more simply

$F_{-3\ dB} = 5\ \mu F/C(X, Y, Z)$

The tolerance of the internal resistor (RFILT) typically varies as much as ±15% of its nominal value (32 kΩ), and the bandwidth varies accordingly.A minimum capacitance of 0.0047 µF for CX, CY, and CZ is recommended in all cases.

Table 3.4.4 Filter Capacitor Selection, CX, CY, and CZ

Filter Capacitor Selection, Cx, Cy, and Cz Bandwidth (Hz)	Capacitor (µF)
1	4.7
10	0.47
50	0.10
100	0.05
200	0.027
500	0.01

(iii) Design Trade-Offs For Selecting Filter Characteristics: The Noise/BW Trade-Off

The selected accelerometer bandwidth ultimately determines the measurement resolution (smallest detectable acceleration). Filtering can be used to lower the noise floor to improve the resolution of the accelerometer. Resolution is dependent on the analog filter bandwidth at XOUT, YOUT, and ZOUT. The output of the ADXL335 has a typical bandwidth of greater than 500 Hz. The user must filter the signal at this point to limit aliasing errors. The analog bandwidth must be no more than half the analog-to-digital sampling frequency to minimize aliasing. The analog bandwidth can be further decreased to reduce noise and improve resolution. The ADXL335 noise has the characteristics of white Gaussian noise, which contributes equally at all frequencies and is described in terms of $\mu g/\sqrt{Hz}$ (the noise is proportional to the square root of the accelerometer bandwidth). The user should limit bandwidth to the lowest frequency needed by the application to maximize the resolution and dynamic range of the accelerometer. With the single-pole, roll-off characteristic, the typical noise of the ADXL335 is determined by

Noise rms = Noise Density $\times\sqrt{BW} \times 1.6$

It is often useful to know the peak value of the noise. Peak-topeak noise can only be estimated by statistical methods. It is useful for estimating the probabilities of exceeding various peak values, given the rms value.

3.4.5 NEO 6M

The u-blox 6 leadless chip carrier (LCC) modules are standalone GPS and GPS/GLONASS/QZSS1 modules featuring the high performance u-blox-6 positioning engine. These compact, easy to integrate modules combine exceptional GPS performance with highly flexible power, design, and connectivity options. Their compact form factors and SMT pads allow fully automated assembly with standard pick & place and reflow-soldering equipment for cost-efficient, high-volume production enabling short time-to-market. u-blox positioning modules are not designed for life saving or supporting devices or for aviation and should not be used in products that could in any way negatively impact the security or health of the user or third parties or that could cause damage to goods.

(i) GPS Receiver Module

GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located. These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time.

How GPS Receiver Calculates its Position and Time?

GPS receiver receives information signals from GPS satellites and calculates its distance from satellites. This is done by measuring the time required for the signal to travel from satellite to the receiver.

$$\text{Distance} = \text{Speed x Time}$$

Where,

Speed = Speed of Radio signal which is approximately equal to the speed of light i.e.$3 * 10^8$

Time = Time required for a signal to travel from the satellite to the receiver.

By subtracting the sent time from the received time, we can determine the travel time.

3.4.6 Design Of Bc 547 Npn Transistor

Here we are considering hfe of a BC547 transistor as 200. Since according to data sheet we know hfe ranges for max. 800 and min 110. So for our design we assume hfe as 200. And also we know the DC collector currentI_C taken by BC547 is 100mA.

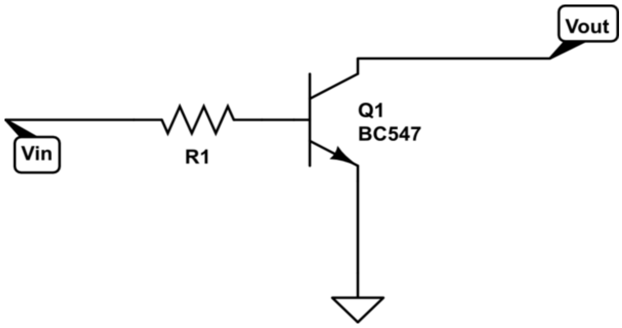


Fig 3.4.6 Design Of BC547

We now can find base current I_b

We know, $I_c = \beta I_b$

$$I_b = \frac{I_C}{\beta}$$

$$= \frac{100mA}{200}$$

$$I_b = 0.5mA$$

In order to find base resistor ,

$$R_b = \frac{V_{CC} - V_{be}}{I_b}$$

$$= \frac{8-3}{0.5mA}$$

R_b =10kΩ

3.5 CIRCUIT DIAGRAM

In this circuit diagram the first and foremost thing to understand is the power output of the device. The maximum output is 12V for GSM and Arduino board and Arduino driver IC takes 5V. The battery used is li-ion battery which is connected as in series of two 4V each that is total 8V. The battery can deliver a steady of 1.5 amps of current for one hour. Each sensor module takes 5V power supply.

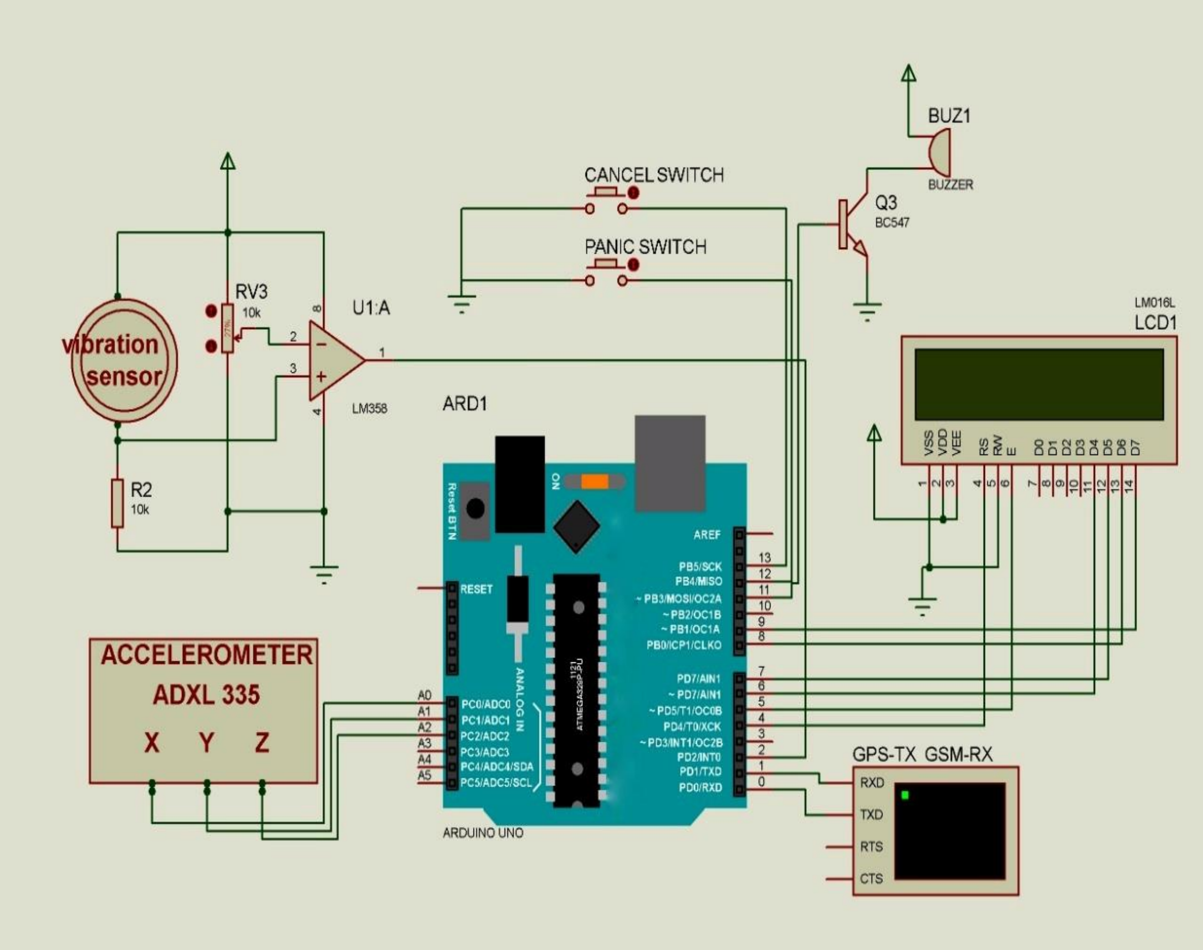


Fig 3.5 Circuit Diagram

Since the board takes only 8V but the sensor takes 5V we need to regulate the voltage using LM7805 which act as voltage regulation device and converts 8V to 5V. LM 7805 is a positive voltage regulator series and produce a constant linear output voltage, so if the input is given as max of 14-32 V then the output should have a steady of 5V. Then the power is distributed to all the modules. LCD is 16*2 matrix has a VCC and Gnd. The VCC is connected to output of the regulator and ground is connected to left side of the regulator. In our project we have used LCD with a driver shield which eases to provide use of less pins than the ordinary LCD. While making use of this driver I2C LCD we need only 2 pins to connect to arduino.

Here the triaxial accelerometer contains 3 axis X,Y and Z and these three axis are connected to A0,A1,A3 pins of Arduino. The accelerometer takes values upon tilting and the values are shown on the LCD display. The accelerometer reads analog values and then converted to digital using analog to digital converter. We do not need extra ADC circuit, this the advantage of Arduino that it has its own in built 12bit ADC that reads this changing voltage and converts to value that is between 0 and 1023. We then define vibration sensor and connected to pin 2, buzzer to pin 11, panic switch to pin 12 and cancellation switch to pin 13. GPS is connected using transmitter of GPS to Arduino's receiver point and receiver of GSM to transmitter of Arduino. That is Rx of GSM is connected to PIN 1 of Arduino and Tx of GPS to PIN 0 of Arduino.

The vibration sensor is connected to comparator LM358 which act as comparator. The comparator VCC is connected to 5V and this configuration uses voltage divider to set up the threshold voltage. The threshold voltage determines whether the fall is detected or not that is when the voltage increases beyond threshold value a low pin is generated that means sensor detects the vibration due to fall and the output is generated. If the fall does not occur means the voltage will be less than threshold value which we define as normal case and output is high. The buzzer is connected with a transistor BC547 to Arduino which act as switch. When transistor is in saturation region it act as switch.

Here we are tilting the board to one side such that the accelerometer reads the values of X, Y and Z and this is shown in LCD. When the tilt happens the vibrations produced due to fall is detected and the buzzer starts beeping with a timer of 10s which we have set using the Arduino program. The buzzer will help the person to notify him the timer which can be cancelled using cancellation switch to avoid any help and in other situation if he/she had a serious fall then the timer after 10s will send the SMS alert showing HELP NEEDED and is send with location URL to the police stations , personal care etc. The person receiving the SMS will get the location of the fall incident. Here GPS is receiving continuous data by serial data communication. So when the fall happens this GPS will get the location and is added on to the variable and using the variable and the data location is sent as SMS alert.

CHAPTER 4

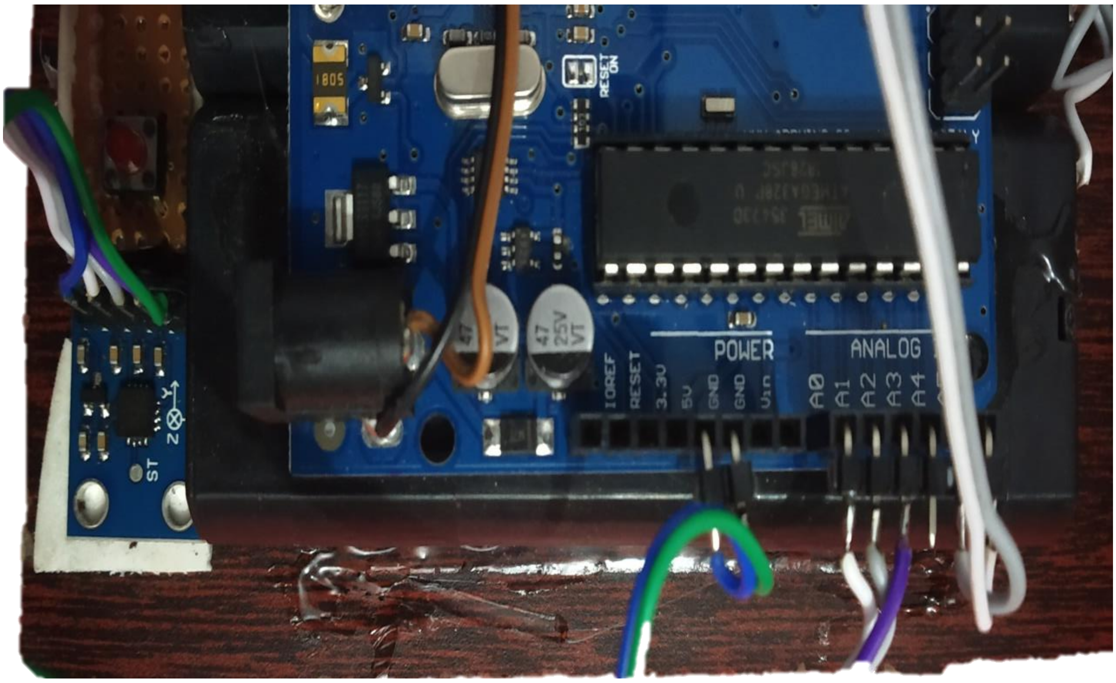
IMPLEMENTATION AND INTEGRATION

4.1 ADXL335 INTERFACED WITH ARDUINO

ADXL335 is a small, thin, low power, complete 3-axis accelero-meter with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. ADXL335 is 3.3V compatible device, it's powered by a 3.3V source and also generates 3.3V peak outputs. It has three outputs for each axis i.e. X, Y & Z. These are analog outputs and thus require an ADC in a micro-controller. Arduino solves this problem. We will be using the analog functions of Arduino.

The accelerometer module has 5 pins, namely

1. GND-To be connected to Arduino's GND
2. VCC-To be connected to Arduino's 5V
3. X-To be connected to Analog Pin A0
4. Y-To be connected to Analog Pin A1
5. Z-To be connected to Analog Pin A3



.Fig 4.1 Accelerometer Interfaced With Arduino

4.2 LCD(I2C) INTERFACED WITH ARDUINO

Since the use of an LCD requires many microcontroller pins, we will reduce that number using serial communication, which is basically sending "packages" of data one after another, using only two pins of our microcontroller , pins SDA and SCL which are the analog pins A4 and A5 of the Arduino . Each I2C bus consists of two signals: SCL and SDA. SCL is the clock signal, and SDA is the data signal. The clock signal is always generated by the current bus master; some slave devices may force the clock low at times to delay the master sending more data (or to require more time to prepare data before the master attempts to clock it out).

- Power the LCD module to 5 volts to LM7805 and connect the ground as well.
- The SDA pin of the i2c module conected to arduinio A5 and the SCL pin to A4.
- We connect the arduino to USB and we are ready to program. In order to make the LCD work we need to inport the LCD library for arduino.

➢ Grey Wire – A4

➢ White Wire – A5

➢ Blue Wire – Vcc of LM 7805

➢ Green Wire- Gnd of LM7805

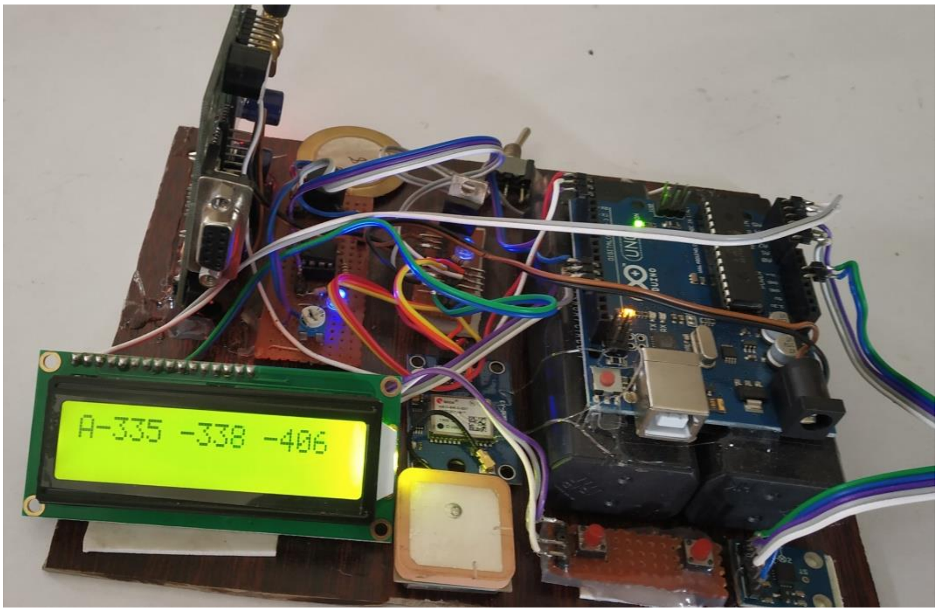


Fig 4.2 I2C LCD Interfaced With Arduino And LM 7805

4.3 SWITCH INTERFACED WITH ARDUINO

Here the cancellation and timer switch is connected to two digital pins of arduino and one pin to ground i.e here switch is connected to digital pins, Pin no. 12 and 13 and other end is connected to ground.

- Purple wire is connected to Gnd.
- White and grey wire connected to digital pins 12 and 13.

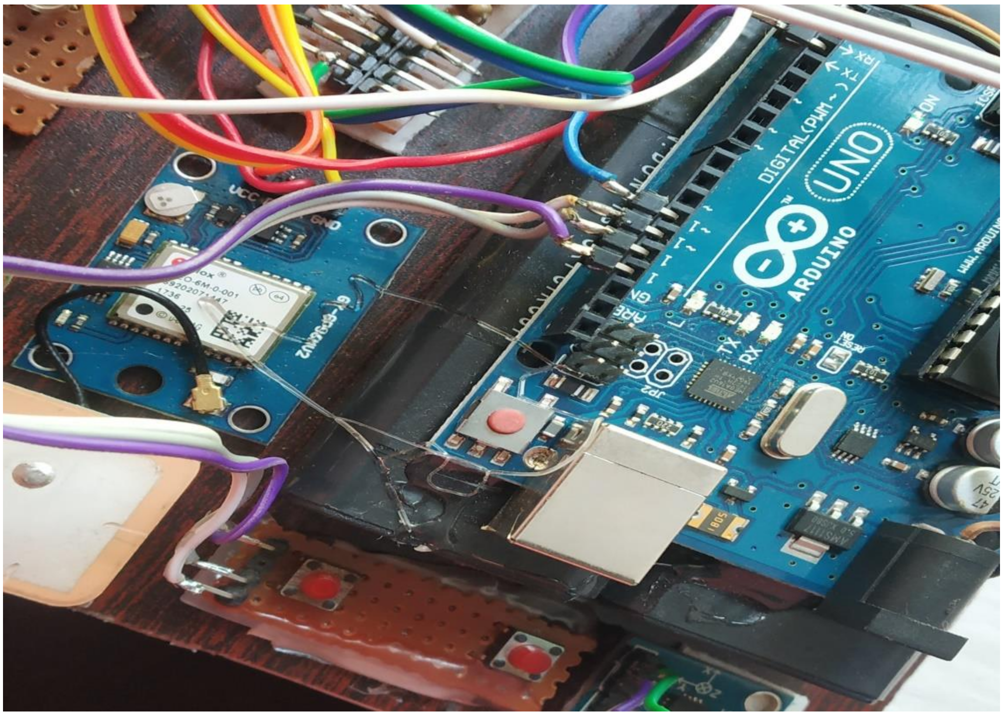


Fig 4.3 Switch Interfacing

4.4 GPS INTERFACED WITH ARDUINO

U-BLOX Neo 6M used here can only support a maximum voltage of 3.6V. If you look closely on the GPS board you will see a tiny 3.3V voltage regulator. The communication is taking place is serial communication. The module is incredibly simple: it just spits non stop NMEA data strings to the TX pin. “NMEA” stands for “National Marine Electronics Association” and is a standard text protocol shared by all GPS.

- Connect Vcc to LM7805 Vcc (orange)
- Connect Gnd to LM7805 Gnd (yellow)
- Connect Tx of GPS to Rx Pin 0 of Arduino (red wire).

Reading raw data from the GPS is a very trivial matter: simply create a new serial connection using Software Serial and match the default baud rate of your GPS module. On most, it should be 9600 bauds.

This module is compatible with AMP2 and AMP2.5, and EEPROM can save all our configuration data.

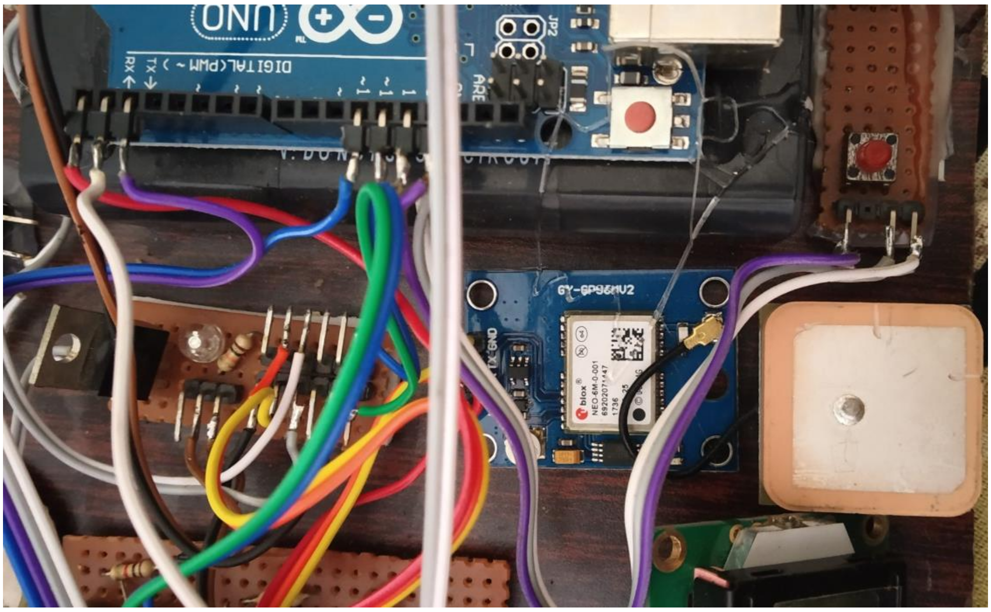


Fig 4.4 GPS Interfaced with Arduino

4.5 GSM INTERFACING WITH ARDUINO

We are using GSM SIM900 to interface with Arduino. A GSM Module is basically a GSM Modem (like SIM 900) connected to a PCB with different types of output taken from the board – say TTL Output for Arduino and RS232 Output to interface directly with a PC (personal computer). The board will also have pins or provisions to attach mic and speaker, to take out +5V or other values of power and ground connections. In our project of connecting a gsm modem or module to arduino and hence send and receive sms using arduino – its always good to choose an arduino compatible GSM Module – that is a GSM module with TTL Output provisions. Check the power requirement- you are having a 5V module, you can power it directly from Arduino’s 5V out.

Booting the GSM Module-

- Insert the SIM card to GSM module and lock it.
- Switch ON the arduino.
- Now wait for some time (say 1 minute) and see the blinking rate of ‘status LED’ or ‘network LED’ (GSM module will take some time to establish connection with mobile network)
- Once the connection is established successfully, the status/network LED will blink continuously every 3 seconds. You may try making a call to the mobile number of the sim card inside GSM module. If you hear a ring back, the gsm module has successfully established network connection.

The communication between Arduino and GSM module is serial. GSM Rx is connected to Tx of Arduino with a white wire and power supply and ground is connected using black and brown wires. The arduino will communicate with GSM module by using AT commands and sends “MESSAGE” to the programmed mobile number. AT+CMGS at command is used to send SMS.

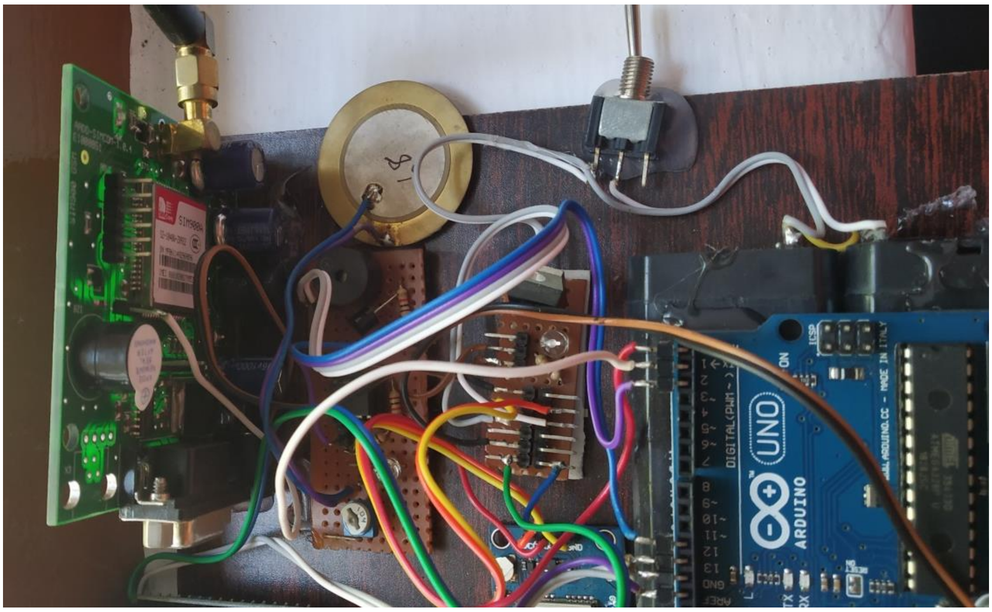


Fig 4.5 GSM Interfaced With Arduino

4.6 PIEZOSENSOR INTERFACING WITH ARDUINO

A piezo is an electronic device that generates a voltage when it's physically deformed by a vibration, sound wave, or mechanical strain. Similarly, when you put a voltage across a piezo, it vibrates and creates a tone. Piezos can be used both to play tones and to detect tones.

Hardware Required :

- Arduino Board
- Piezo Electric Disc
- 1 Megohm resistor
- Solid Surface

Piezos are polarized, meaning that voltage passes through them (or out of them) in a specific direction. Connect the black wire (the lower voltage) to ground and the red wire (the higher voltage) to Analog pin 0. Additionally, connect a 1-megohm resistor in parallel to the Piezo element to limit the voltage and current produced by the piezo and to protect the Analog input. It is possible to acquire piezo elements without a plastic housing. These will look like a metallic disc, and are easier to use as input sensors. Piezo sensors work best when firmly pressed against, taped, or glued their sensing surface.

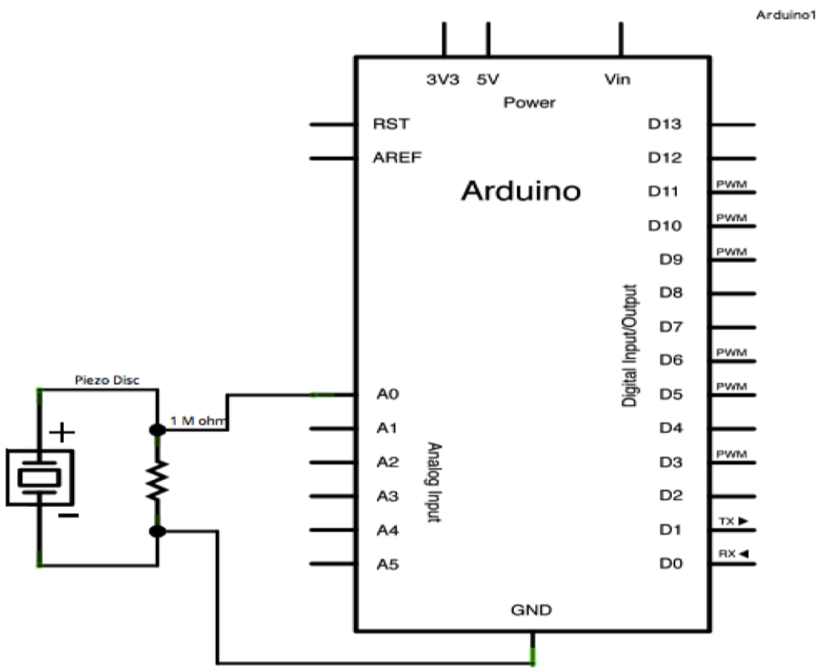


Fig 4.6 Piezo Sensor Interfaced With Arduino

CHAPTER 5

TESTING

The project mainly focuses on fall which is due to tilt caused by the human body and accelerometer starts reading the tilted position. The accelerometer is tested by tilting the board and then gets the reading. The LCD display mounted on the board gives the accelerometer three axis reading as shown below.

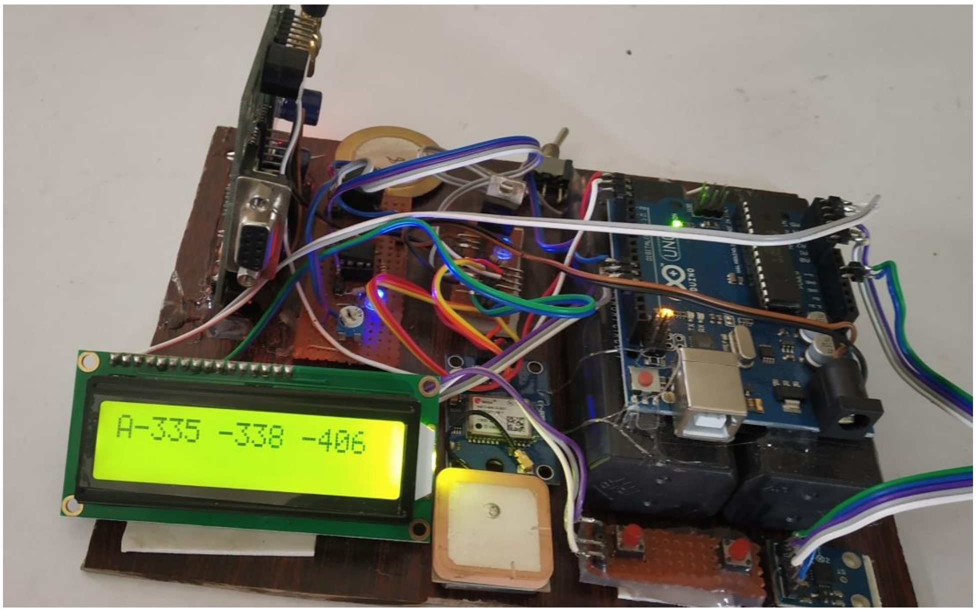


Fig 5.1 Accelerometer Reading On LCD Display

Now the tilt occurs the vibration caused due to fall will trigger the circuit and detects the fall and location is tracked. Then a display showing fall detected and location tracking is shown .

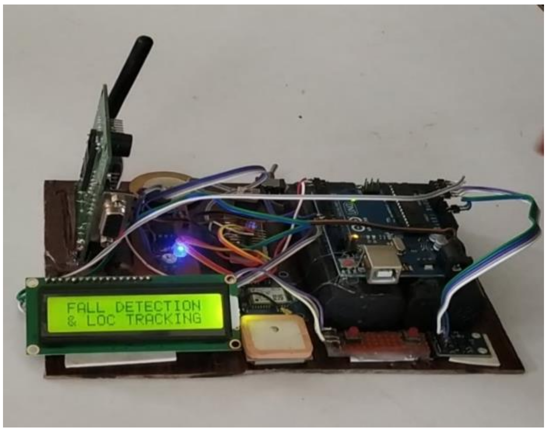


Fig 5.2 Fall Detection And Location Tracking

If the fall is not serious or might have fallen randomly can cancel the trigger by cancellation switch which comes with a timer that gives the idea to the victim whether he/she can cel the trigger and the timer lasts for 10s after which the person can or not cancel depends on the fall he/she came up with

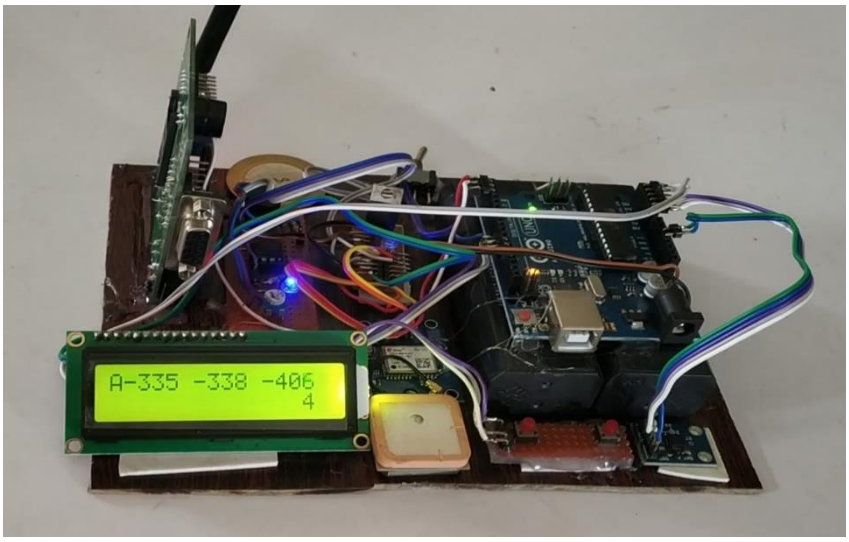


Fig 5.3 Timer Counting Upto 10s

Let say the cancellation switch is not pressed then the arduino which is programmed to send the registered mobile number and the location is detected using GPS and the system then performs the sending of information to the registered mobile user via SMS containing the person’s location URL and pointing “HELP NEEDED”!!

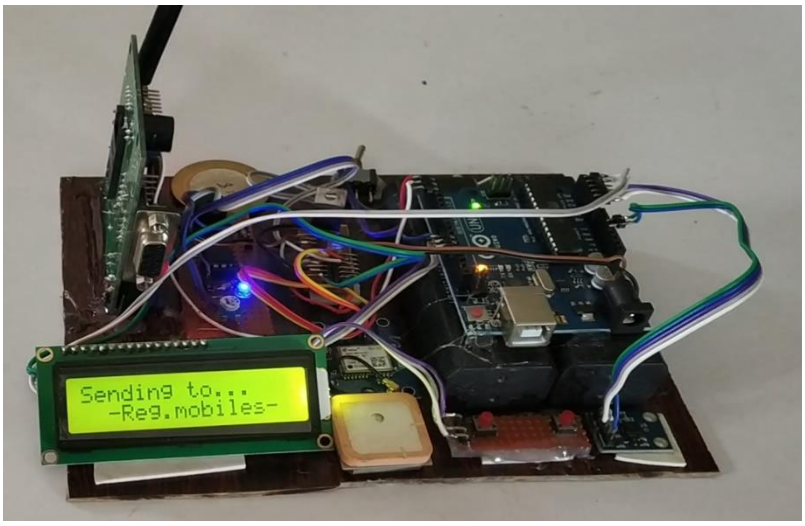


Fig 5.4 SMS Sending To Registerd Mobile User

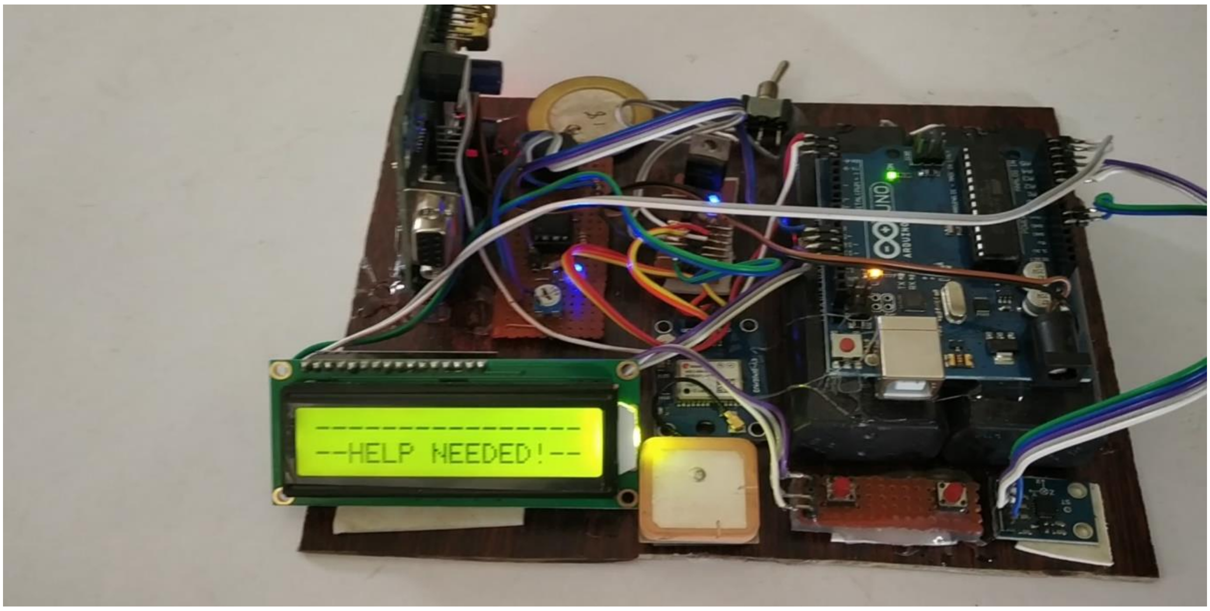


Fig 5.5 Help Needed On Display

The mobile number of the user is included in the software programming in order to receive the accident location values from the SIM card which we are using in GSM modem.The message intended to that user is received via SMS which is shown below.

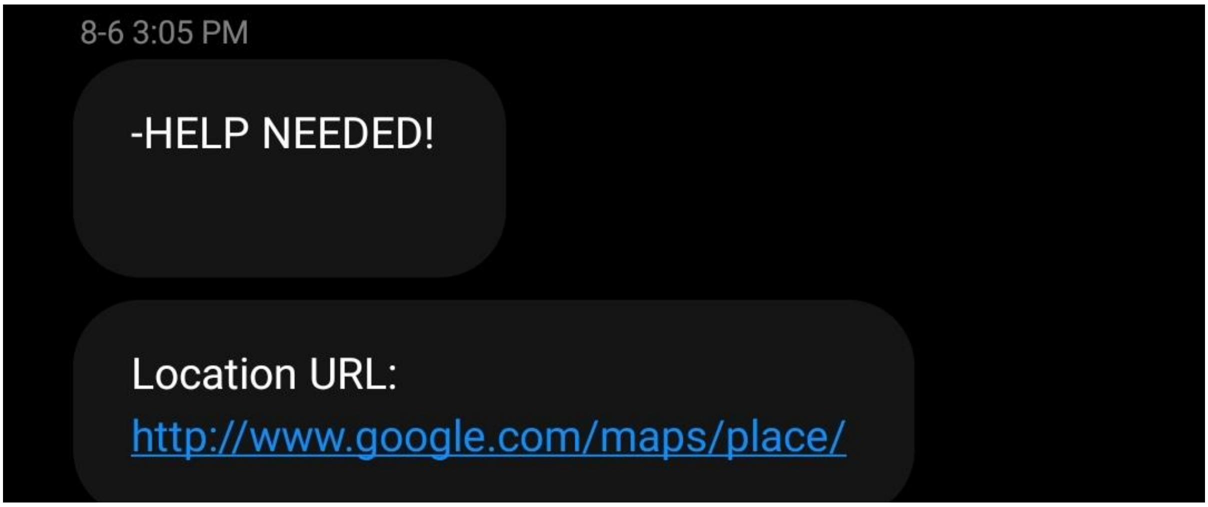


Fig 5.6 SMS Display

CHAPTER 6
RESULTS AND DISCUSSIONS

The fall alert and reporting system provides an excellent system in case of emergencies. The project targets to decreasing the number of fall. The mobile number of the user should be included in the software programming in order to receive the accident location from the SIM card which we are using in GSM modem. The SMS shows HELP NEEDED and location URL.

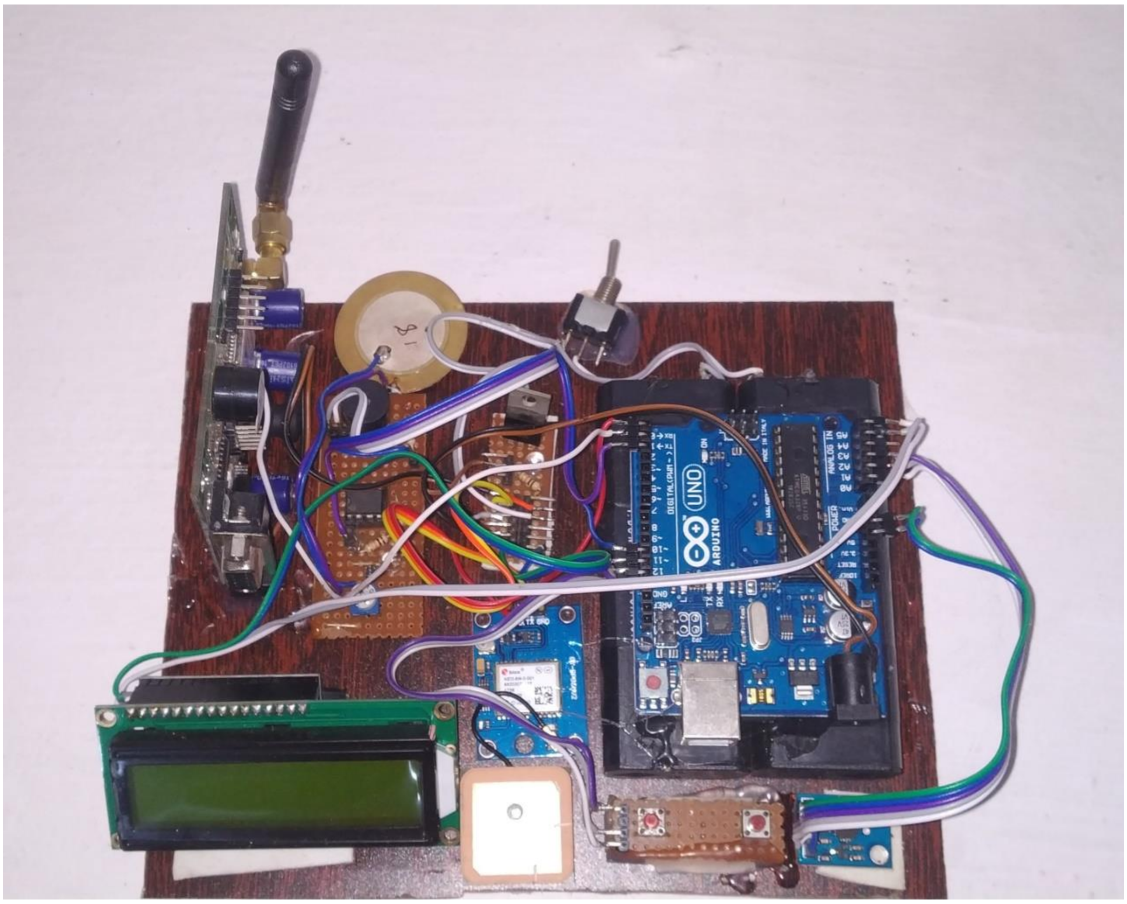


Fig 6.1 Prototype

The circuit can be simulated using proteus design suite which is a software design to simulate circuits in real time simulation.

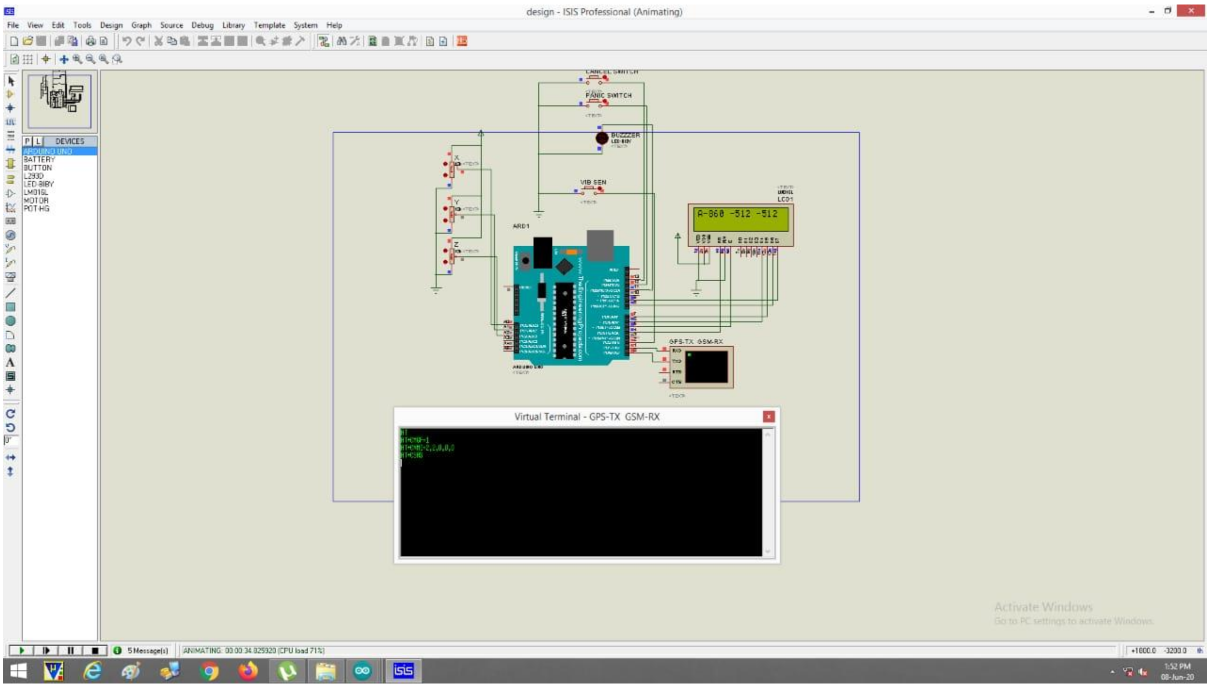


Fig 6.2 Simulated Result

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

This system provides the optimum solution to help elderly people and immediate care can be taken. With the help of this technology immediate action can be taken when a fall occurs by alerting the respective people by sending a message and location is detected. The drawback with this system is that it does not work without network. So in areas where no network is available the system will not be able to send the alert message. The proposed method is highly beneficial to the elderly people. This will help the medical teams to reach the incident spot in time and save the valuable human lives. There is always scope for new improvements by interfacing it with different systems. Researchers are coming up with different ways of detecting fall using Machine Leaning, IOT etc. This fall detection and reporting systems provide crucial information to emergency responders in the earliest possible time. This system provides better safety rather than no safety. In future we can interface it with neural networks and vision based system is still increasing and this will optimize the proposed technology to the maximum extent and deliver the best fall detection systems.

The pursuit of self-improvement can seem never-ending, whether it is to perform better, learn more skills, or new experiences. The application of Machine Learning can be used in the area of fall detection to analyze the challenges in Fall Detection Systems. Artificial Intelligence can be incorporated so that Human motion data can then be used to generate quantifiable insight into human behavior, and create interactive applications within real, augmented, or virtual worlds. In other words, human-centric computer vision provides the tools needed for machines to work precisely and interact with the components used to give an accurate result of the location, distance & the condition of the fall. We can incorporate Automatic Medical Alert Systems along with the speed dial switch which is pressed to notify the emergency situation. If the person in need can't press the button after a fall or during a medical emergency, automatic medical alert fall detection system ensures that help is still on the way and installing a Fall Detection Pendant that constantly detects your movements. These sensors are sampled up to 100 times per second, and they are monitored in real-time to detect tiny changes in motion that you may make. The fall detection pendant is constantly detecting your movements. These sensors are sampled up to 100 times per second, and they are monitored in real-time to detect tiny changes in motion that you may make. Personal emergency response systems represent one commercial solution to addressing this issue.

These clinical alarm systems provide a way for individuals who fall to contact an emergency center by pressing a button.

Other solutions include technologies embedded in the residential setting such as cameras, microphones or pressure sensors installed underneath the flooring. These falls detection technologies enable rapid detection and intervention for individuals who have experienced a fall. This ability could reduce the physical and mental damage caused not only by the fall but time after a fall before discovery. These technologies will help to reassure those at a risk of falling as well as their caregivers and family.

REFERENCES

(Journal papers)

1. **Abhilash Unnikrishnan, Abraham Sudharson Ponraj** (December 2019) Genetic algorithm for effective fall detection with wrist wearable device, *International Journal of Engineering and Advanced Technology (IJEAT),* ISSN: 2249 – 8958, Volume-9 Issue-1S3.
2. **Oungmin Lee, Hongjin Yeh, Ki-Hyung Kim** (January 9, 2018) A Real-Time Fall Detection System Based On The Acceleration Sensor Of Smartphone ,Volume: 10.
3. **Diana Yacchiremaa, Jara Suárez de Pugaa , Carlos Palaua , Manuel Estevea** (2018) Fall detection for elderly people using iot and big data , *The 9th International Conference on Ambient Systems, Networks and Technologies,* 603–610.
4. **Aihua Mao , Xuedong Ma , Yinan He , Jie Luo** (2017) Highly portable, sensor based system for human fall monitoring, *Sensors* .
5. **Jiangpeng Dai , Xiaole Bai , Zhimin Yang , Zhaohui Shen and Dong Xuan** (2016) Pervasive fall detection system using mobile phones, *IEEE.*
6. **Quoc T. Huynh,Uyen D. Nguyen,Lucia B. Irazabal,Nazanin Ghassemian,and Binh Q. Tran** (2015) Optimization of an accelerometer and gyroscope-based fall detection algorithm, Article ID 452078.
7. **Falin Wu, Hengyang Zhao and Haibo Zhong** (2015) Development of a wearable sensor based fall detection, *International Journal of Telemedicine and Applications.*
8. **Luis N, Valcourt Colon** (2014)Human fall detection with smart phones, *IEEE*, **ISSN:** 2330-989X .
9. **Dongha Lim,Chulho Park,Nam Ho Kim,Sang-Hoon Kim,and Yun Seop Yu** - (2014) Fall-detection algorithm using 3-axis acceleration, *Journal of Applied Mathematics.* 10.1155/2014/896030
10. **Ning Jia** (2009) Detecting human falls with a 3axis accelerometer, *Journal of Applied Mathematics* .
11. **de Quadros, Thiago, Andre Eugenio Lazzaretti, and Fábio Kürt Schneider**. (2018) "A movement decomposition and machine learning-based fall detection system using wrist wearable device." *IEEE Sensors Journal* , 5082-5089.

12. **Sposaro, Frank, and Gary Tyson(**2009.) iFall: an Android application for fall monitoring and response, *Engineering in Medicine and Biology Society, EMBC* Annual International Conference of the IEEE.
13. **Mao, Aihua** (2017): "Highly portable, sensor-based system for human fall monitoring." *Sensors*, 2096.
14. **Liu, Chien-Liang, Chia-Hoang Lee, and Ping-Min Lin.** (2010): "A fall detection system using k-nearest neighbor classifier." *Expert systems with applications* 7174-7181.
15. **Aziz, Omar** (2017)"A comparison of accuracy of fall detection algorithms (threshold-based vs. machine learning) using waist-mounted tri-axial accelerometer signals from a comprehensive set of falls and non-fall trials." *Medical & biological engineering & computing* ,45-55.
16. **Guo, Han Wen** (2015)"A threshold-based algorithm of fall detection using a wearable device with tri-axial accelerometer and gyroscope." *Intelligent Informatics and Biomedical Sciences (ICIIBMS)*, International Conference on. IEEE.
17. **Vallabh, Pranesh** (2016) "Fall detection using machine learning algorithms." *SoftCOM.*
18. **Aguiar, Bruno** (2014) "Accelerometer-based fall detection for smartphones." *Medical Measurements and Applications (MeMeA), IEEE International Symposium* .
19. **De Cillis, Francesca** (2015)"Fall-detection solution for mobile platforms using accelerometer and gyroscope data." *Engineering in Medicine and Biology Society (EMBC)*, 37th Annual International Conference of the IEEE. IEEE.
20. **Yuan, Jian** (2015): "Power-efficient interrupt-driven algorithms for fall detection and classification of activities of daily living." *IEEE Sensors Journal* : 1377-1387.

APPENDIX – A

PROGRAM CODE

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

#include <TinyGPS++.h>


#define vib_sen   2

#define buzzer    11

#define panic_sw  12

#define cancel_sw 13


#define acc_x     A0

#define acc_y     A1

#define acc_z     A2


unsigned long previousMillis1 = 0;

unsigned int interval1 = 1000, sec = 0;

unsigned int acc_x_read=0,acc_y_read=0,acc_z_read=0;

unsigned char flag,message=0;

unsigned char chk=0,vib_read=0,tilt=0,fall_det=0;

String lattitude,longtitude,URL_location,URL_send ;

void GPS_LOC_TAKE();

void gsm_init();

void message_send();
```

```
void accelerometer_read();

LiquidCrystal_I2C lcd(0x27, 16, 2);

TinyGPSPlus gps;

void setup()

{

  lcd.begin();


  pinMode(vib_sen,INPUT_PULLUP);

  pinMode(panic_sw,INPUT_PULLUP);

  pinMode(cancel_sw,INPUT_PULLUP);

  pinMode(acc_x,INPUT);

  pinMode(acc_y,INPUT);

  pinMode(acc_z,INPUT);


  pinMode(buzzer,OUTPUT);


  attachInterrupt(digitalPinToInterrupt(vib_sen),vib_accident,LOW);


  digitalWrite(buzzer,LOW);

  lcd.setCursor(0,0); lcd.print(" FALL DETECTION ");

  lcd.setCursor(0,1); lcd.print(" & LOC TRACKING ");

  delay(500);

  Serial.begin(9600);

  gsm_init();

  lcd.setCursor(0,0); lcd.print("A-0000-0000-0000");
```

```
 lcd.setCursor(0,1); lcd.print("                ");
}

void loop()
{
  while (Serial.available() > 0)
  if (gps.encode(Serial.read()))
  GPS_LOC_TAKE();
  unsigned long currentMillis = millis();
  if ((unsigned long)(currentMillis - previousMillis1) >= interval1)   // check for rollover delay 1
  {
    sec++;
    previousMillis1 = currentMillis;
  }

  if (flag == 0)
  {
    accelerometer_read();
    if  (vib_read==1||tilt==1)
    {
      flag=1;fall_det=1;
      digitalWrite(buzzer,HIGH);
      lcd.setCursor(0,1);lcd.print("-FALL DETECTED  ");
    }
     if(digitalRead(panic_sw)==LOW&&chk==0)
```

```
 {
   lcd.setCursor(0, 1); lcd.print("                ");
   digitalWrite(buzzer,HIGH);
   chk=1;
   sec=0;
  }
  if(chk==1&&sec>10)
  {
   lcd.setCursor(0,1);lcd.print("-HELP NEEDED");
   flag=1;
   lcd.setCursor(14, 1); lcd.print("  ");
  }
  else if(chk==1&&sec<=10)
  {
   lcd.setCursor(14, 1); lcd.print(sec);
   if(digitalRead(cancel_sw)==LOW)
   {
    lcd.setCursor(0, 1); lcd.print("                ");
    digitalWrite(buzzer,LOW);
    sec=0;  chk=0;
   }
  }
}
else if (flag == 1)
{
  lcd.setCursor(0, 0); lcd.print("GPS Location    ");
```

```
    lcd.setCursor(0, 1); lcd.print("receiving.......");
   message=1;message_send(); delay(8000); message=2;message_send();
   flag = 2;
   lcd.setCursor(0, 0); lcd.print("----------------");
   lcd.setCursor(0, 1); lcd.print("                ");
   if     (chk==1)     {lcd.setCursor(0,1);lcd.print("--HELP NEEDED!--");}
   else if(fall_det==1){lcd.setCursor(0,1);lcd.print("-FALL DETECTED!-");}
  }
}
void vib_accident() {vib_read=1;}
void accelerometer_read()
{
 acc_x_read = analogRead(acc_x);
 acc_y_read = analogRead(acc_y);
 acc_z_read = analogRead(acc_z);
 if     (acc_x_read<10)  {lcd.setCursor(3,0);lcd.print("   ");}
 else if(acc_x_read<100) {lcd.setCursor(4,0);lcd.print("  "); }
 else if(acc_x_read<1000){lcd.setCursor(5,0);lcd.print(" ");  }

 if     (acc_y_read<10)  {lcd.setCursor(8,0);lcd.print("   ");}
 else if(acc_y_read<100) {lcd.setCursor(9,0);lcd.print("  "); }
 else if(acc_y_read<1000){lcd.setCursor(10,0);lcd.print(" "); }

  if     (acc_z_read<10)  {lcd.setCursor(13,0);lcd.print("   ");}
 else if(acc_z_read<100) {lcd.setCursor(14,0);lcd.print("  "); }
 else if(acc_z_read<1000){lcd.setCursor(15,0);lcd.print(" ");  }
```

```
 lcd.setCursor(2,0); lcd.print(acc_x_read,DEC);
 lcd.setCursor(7,0); lcd.print(acc_y_read,DEC);
 lcd.setCursor(12,0);lcd.print(acc_z_read,DEC);
 if(acc_x_read<300) {tilt=1;}
 else               {tilt=0;}
}
void GPS_LOC_TAKE()
{
  URL_location = "http://www.google.com/maps/place/";
  if (gps.location.isValid())
  {
    lattitude = String(gps.location.lat(), 6);
    longtitude = String(gps.location.lng(), 6);
    URL_location = URL_location + lattitude;
    URL_location = URL_location + ",";
    URL_location = URL_location + longtitude;
  }
}
void gsm_init()
{
  Serial.print("AT");
  Serial.write(0x0d); Serial.write(0x0a);
  delay(1000);
  Serial.print("AT+CMGF=1");
  Serial.write(0x0d); Serial.write(0x0a);
```

```
  delay(1000);
  Serial.print("AT+CNMI=2,2,0,0,0");
  Serial.write(0x0d); Serial.write(0x0a);
  delay(1000);
  Serial.print("AT+CSAS");
  Serial.write(0x0d); Serial.write(0x0a);
  delay(1000);
}

void message_send()
{
  lcd.setCursor(0, 0); lcd.print("Sending to...   ");
  lcd.setCursor(0, 1); lcd.print("  -Reg.mobiles- ");
  Serial.print("AT+CMGS=");
  Serial.write(0X22);
  Serial.print("7034124005");
  Serial.write(0X22);
  Serial.write(0x0d); Serial.write(0x0a);
  delay(1000);
  if(message==1)
  {
    if     (chk==1)     {Serial.println("-HELP NEEDED!");   delay(300);}
    else if(fall_det==1){Serial.println("-FALL DETECTED!"); delay(300);}
    Serial.write(0x0d); Serial.write(0x0a);
  }
```

```
 else if(message==2)
  {
    Serial.print("Location URL: ");
    Serial.print(URL_location);
    delay(300);
  }
  Serial.write(0x1a);
  delay(1000);
}
```

APPENDIX –B

Small, Low Power, 3-Axis ±3 *g* Accelerometer

ADXL335

FEATURES

3-axis sensing

Small, low profile package

4 mm × 4 mm × 1.45 mm LFCSP
Low power : 350 µA (typical)

Single-supply operation: 1.8 V to 3.6 V
10,000 *g* shock survival

Excellent temperature stability

BW adjustment with a single capacitor per axis
RoHS/WEEE lead-free compliant

APPLICATIONS

Cost sensitive, low power, motion- and tilt-sensing applications

Mobile devices
Gaming systems Disk drive protection Image stabilization

Sports and health devices

GENERAL DESCRIPTION

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the C_X, C_Y, and C_Z capacitors at the X_{OUT}, Y_{OUT}, and Z_{OUT} pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

FUNCTIONAL BLOCK DIAGRAM

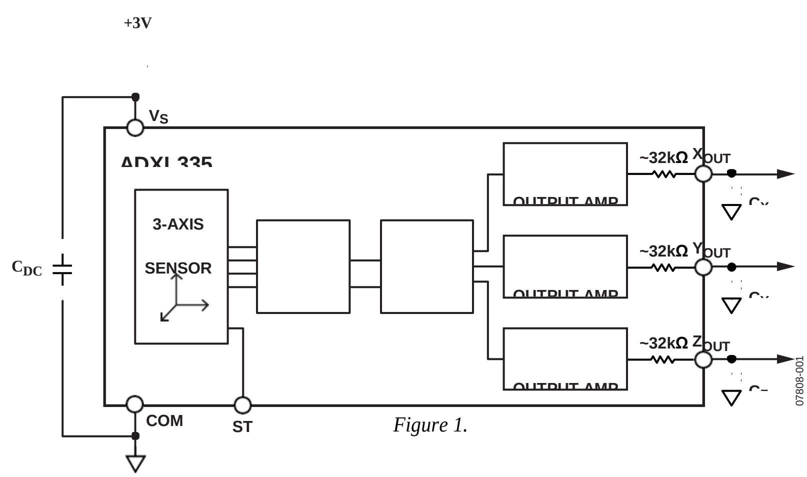


Figure 1.

SPECIFICATIONS

T_A = 25°C, V_S = 3 V, C_X = C_Y = C_Z = 0.1 μF, acceleration = 0 *g*, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
SENSOR INPUT	Each axis				
Measurement Range		±3	±3.6		*g*
Nonlinearity	% of full scale		±0.3		%
Package Alignment Error			±1		Degrees
Interaxis Alignment Error			±0.1		Degrees
Cross-Axis Sensitivity[1]			±1		%
SENSITIVITY (RATIOMETRIC)[2]	Each axis				
Sensitivity at X_{OUT}, Y_{OUT}, Z_{OUT}	V_S = 3 V	270	300	330	mV/*g*
Sensitivity Change Due to Temperature[3]	V_S = 3 V		±0.01		%/°C
ZERO *g* BIAS LEVEL (RATIOMETRIC)					
0 *g* Voltage at X_{OUT}, Y_{OUT}	V_S = 3 V	1.35	1.5	1.65	V
0 *g* Voltage at Z_{OUT}	V_S = 3 V	1.2	1.5	1.8	V
0 *g* Offset vs. Temperature			±1		m*g*/°C
NOISE PERFORMANCE					
Noise Density X_{OUT}, Y_{OUT}			150		μ*g*/√Hz rms
Noise Density Z_{OUT}			300		μ*g*/√Hz rms
FREQUENCY RESPONSE[4]					
Bandwidth X_{OUT}, Y_{OUT}[5]	No external filter		1600		Hz
Bandwidth Z_{OUT}[5]	No external filter		550		Hz
R_{FILT} Tolerance			32 ± 15%		kΩ
Sensor Resonant Frequency			5.5		kHz
SELF-TEST[6]					
Logic Input Low			+0.6		V
Logic Input High			+2.4		V
ST Actuation Current			+60		μA
Output Change at X_{OUT}	Self-Test 0 to Self-Test 1	−150	−325	−600	mV
Output Change at Y_{OUT}	Self-Test 0 to Self-Test 1	+150	+325	+600	mV
Output Change at Z_{OUT}	Self-Test 0 to Self-Test 1	+150	+550	+1000	mV
OUTPUT AMPLIFIER					
Output Swing Low	No load		0.1		V
Output Swing High	No load		2.8		V
POWER SUPPLY					
Operating Voltage Range		1.8		3.6	V
Supply Current	V_S = 3 V		350		μA
Turn-On Time[7]	No external filter		1		ms
TEMPERATURE					
Operating Temperature Range		−40		+85	°C

[1] Defined as coupling between any two axes.

[2] Sensitivity is essentially ratiometric to V_S.

[3] Defined as the output change from ambient-to-maximum temperature or ambient-to-minimum temperature.

[4] Actual frequency response controlled by user-supplied external filter capacitors (C_X, C_Y, C_Z).

[5] Bandwidth with external capacitors = 1/(2 × π × 32 kΩ × C). For C_X, C_Y = 0.003 μF, bandwidth = 1.6 kHz. For C_Z = 0.01 μF, bandwidth = 500 Hz. For C_X, C_Y, C_Z = 10 μF, bandwidth = 0.5 Hz.

[6] Self-test response changes cubically with V_S

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

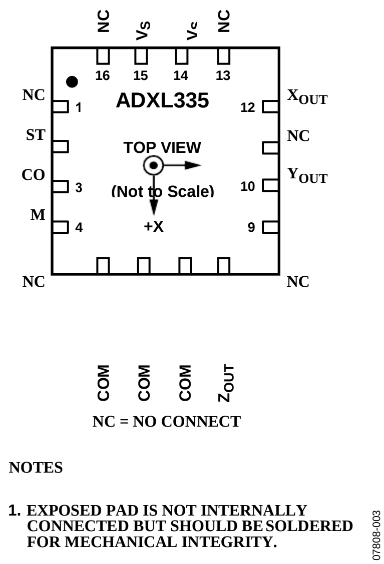


Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	NC	No Connect.[1]
2	ST	Self-Test.
3	COM	Common.
4	NC	No Connect.[1]
5	COM	Common.
6	COM	Common.
7	COM	Common.
8	Z_{OUT}	Z Channel Output.
9	NC	No Connect.[1]
10	Y_{OUT}	Y Channel Output.
11	NC	No Connect. [1]
12	X_{OUT}	X Channel Output.
13	NC	No Connect. [1]
14	V_S	Supply Voltage (1.8 V to 3.6 V).
15	V_S	Supply Voltage (1.8 V to 3.6 V).
16	NC	No Connect. [1]
EP	Exposed Pad	Not internally connected. Solder for mechanical integrity.

[1] NC pins are not internally connected and can be tied to COM pins, unless otherwise noted.

NEO-6

u-blox 6 GPS Modules

Data Sheet

locate, communicate, accelerate

Abstract

Technical data sheet describing the cost effective, high-performance u-blox 6 based NEO-6 series of GPS modules, that brings the high performance of the u-blox 6 positioning engine to the miniature NEO form factor.
These receivers combine a high level of integration capability with flexible connectivity options in a small package. This makes them perfectly suited for mass-market end products with strict size and cost requirements.

16.0 x 12.2 x 2.4 mm

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Document Information	
Title	NEO-6
Subtitle	u-blox 6 GPS Modules
Document type	Data Sheet
Document number	GPS.G6-HW-09005-E
Document status	

Document status information	
Objective Specification	This document contains target values. Revised and supplementary data will be published later.
Advance Information	This document contains data based on early testing. Revised and supplementary data will be published later.
Preliminary	This document contains data from product verification. Revised and supplementary data may be published later.
Released	This document contains the final product specification.

This document applies to the following products:

Name	Type number	ROM/FLASH version	PCN reference
NEO-6G	NEO-6G-0-001	ROM7.03	UBX-TN-11047-1
NEO-6Q	NEO-6Q-0-001	ROM7.03	UBX-TN-11047-1
NEO-6M	NEO-6M-0-001	ROM7.03	UBX-TN-11047-1
NEO-6P	NEO-6P-0-000	ROM6.02	N/A
NEO-6V	NEO-6V-0-000	ROM7.03	N/A
NEO-6T	NEO-6T-0-000	ROM7.03	N/A

1 Functional description

1.1 Overview

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints.

The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

1.2 Product features

Model	Type					Supply		Interfaces				Features						
	GPS	PPP	Timing	Raw Data	Dead Reckoning	1.75 V - 2.0 V	2.7 V - 3.6 V	UART	USB	SPI	DDC (I^2C compliant)	Programmable (Flash) FW update	TCXO	RTC crystal	Antenna supply and supervisor	Configuration pins	Timepulse	External interrupt/ Wakeup
NEO-6G	●					●		●	●	●	●		●	●	O	3	1	●
NEO-6Q	●						●	●	●	●	●		●	●	O	3	1	●
NEO-6M	●						●	●	●	●	●			●	O	3	1	●
NEO-6P	●	●		●			●	●	●	●	●			●	O	3	1	●
NEO-6V	●				●		●	●	●	●	●			●	O	3	1	●
NEO-6T	●		●	●			●	●	●	●	●		●	●	O	3	1	●

O = Requires external components and integration on application processor

Table 1: Features of the NEO-6 Series

All NEO-6 modules are based on GPS chips qualified according to AEC-Q100. See Chapter 5.1 for further information.

1.3 GPS performance

Parameter	Specification			
Receiver type	50 Channels GPS L1 frequency, C/A Code SBAS: WAAS, EGNOS, MSAS			
Time-To-First-Fix[1]		NEO-6G/Q/T	NEO-6M/V	NEO-6P
	Cold Start[2]	26 s	27 s	32 s
	Warm Start[2]	26 s	27 s	32 s
	Hot Start[2]	1 s	1 s	1 s
	Aided Starts[3]	1 s	<3 s	<3 s
Sensitivity[4]		NEO-6G/Q/T	NEO-6M/V	NEO-6P
	Tracking & Navigation	-162 dBm	-161 dBm	-160 dBm
	Reacquisition[5]	-160 dBm	-160 dBm	-160 dBm
	Cold Start (without aiding)	-148 dBm	-147 dBm	-146 dBm
	Hot Start	-157 dBm	-156 dBm	-155 dBm
Maximum Navigation update rate		NEO-6G/Q/M/T	NEO-6P/V	
		5Hz	1 Hz	
Horizontal position accuracy[6]	GPS	2.5 m		
	SBAS	2.0 m		
	SBAS + PPP[7]	< 1 m (2D, R50)[8)]		
	SBAS + PPP[7]	< 2 m (3D, R50)[8]		
Configurable Timepulse frequency range		NEO-6G/Q/M/P/V	NEO-6T	
		0.25 Hz to 1 kHz	0.25 Hz to 10 MHz	
Accuracy for Timepulse signal	RMS	30 ns		
	99%	<60 ns		
	Granularity	21 ns		
	Compensated[9]	15 ns		
Velocity accuracy[6]		0.1m/s		
Heading accuracy[6]		0.5 degrees		
Operational Limits	Dynamics	≤ 4 g		
	Altitude[10]	50,000 m		
	Velocity[10]	500 m/s		

Table 2: NEO-6 GPS performance

---

[1] All satellites at -130 dBm

[2] Without aiding

[3] Dependent on aiding data connection speed and latency

[4] Demonstrated with a good active antenna

[5] For an outage duration 10s≤

[6] CEP, 50%, 24 hours static, -130dBm, SEP: <3.5m

[7] NEO-6P only

1.4 Block diagram

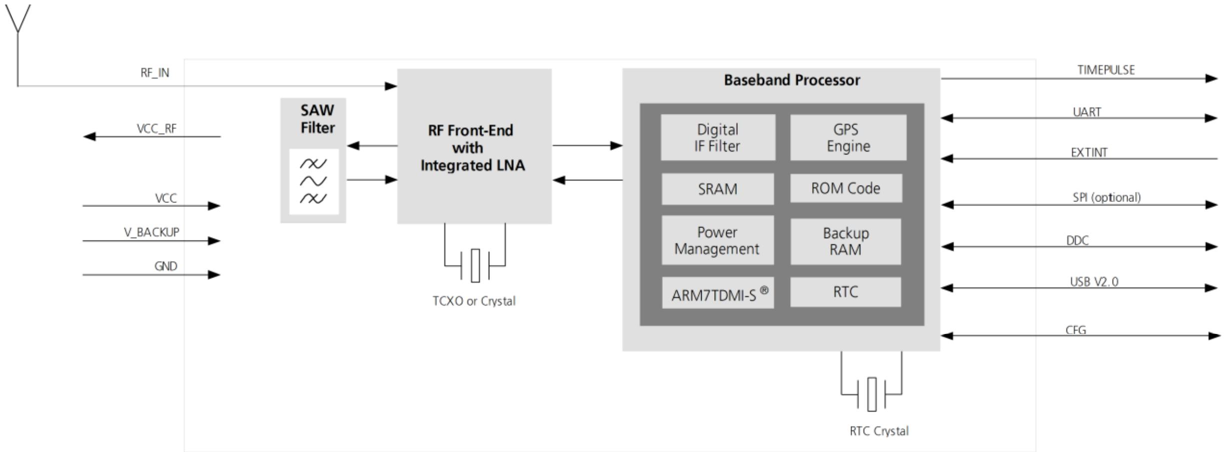


Figure 1: Block diagram (For available options refer to the product features table in section 1.2).

1.5 Assisted GPS (A-GPS)

Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status and an optional time synchronization signal will reduce time to first fix significantly and improve the acquisition sensitivity. All NEO-6 modules support the u-blox AssistNow Online and AssistNow Offline A-GPS services[11] and are OMA SUPL compliant.

1.6 AssistNow Autonomous

AssistNow Autonomous provides functionality similar to Assisted-GPS without the need for a host or external network connection. Based on previously broadcast satellite ephemeris data downloaded to and stored by the GPS receiver, AssistNow Autonomous automatically generates accurate satellite orbital data ("AssistNow Autonomous data") that is usable for future GPS position fixes. AssistNow Autonomous data is reliable for up to 3 days after initial capture.

u-blox' AssistNow Autonomous benefits are:

- Faster position fix
- No connectivity required
- Complementary with AssistNow Online and Offline services No
- integration effort, calculations are done in the background

☞ For more details see the u-blox 6 Receiver Description including Protocol Specification [2].

[11] AssistNow Offline requires external memory.

1.7 Precision Timing

1.7.1 Time mode

NEO-6T provides a special Time Mode to provide higher timing accuracy. The NEO-6T is designed for use with stationary antenna setups. The Time Mode features three different settings described in Table 3: Disabled, Survey-In and Fixed Mode. For optimal performance entering the position of the antenna (when known) is recommended as potential source of errors will be reduced.

Time Mode Settings	Description
Disabled	Standard PVT operation
Survey-In	The GPS receiver computes the average position over an extended time period until a predefined maximum standard deviation has been reached. Afterwards the receiver will be automatically set to Fixed Mode and the timing features will be activated.
Fixed Mode	In this mode, a fixed 3D position and known standard deviation is assumed and the timing features are activated. Fixed Mode can either be activated directly by feeding pre-defined position coordinates (ECEF - Earth Center Earth Fixed format) or by performing a Survey-In. In Fixed mode, the timing errors in the TIMEPULSE signal which otherwise result from positioning errors are eliminated. Single-satellite operation is supported. For details, please refer to the *u-blox 6 Receiver Description including Protocol Specification* [2].

Table 3: Time mode settings

1.7.2 Timepulse and frequency reference

NEO-6T comes with a timepulse output which can be configured from 0.25 Hz up to 10 MHz. The timepulse can either be used for time synchronization (i.e. 1 pulse per second) or as a reference frequency in the MHz range. A timepulse in the MHz range provides excellent long-term frequency accuracy and stability.

1.7.3 Time mark

NEO-6T can be used for precise time measurements with sub-microsecond resolution using the external interrupt (EXTINT0). Rising and falling edges of these signals are time-stamped to the GPS or UTC time and counted. The Time Mark functionality can be enabled with the UBX-CFG-TM2 message

For details, please refer to the *u-blox 6 Receiver Description including Protocol Specification* [2].

1.8 Raw data

Raw data output is supported at an update rate of 5 Hz on the NEO-6T and NEO-6P. The UBX-RXM-RAW message includes carrier phase with half-cycle ambiguity resolved, code phase and Doppler measurements, which can be used in external applications that offer precision positioning, real-time kinematics (RTK) and attitude sensing.

1.9 Automotive Dead Reckoning

Automotive Dead Reckoning (ADR) is u-blox' industry proven off-the-shelf Dead Reckoning solution for tier-one automotive customers. u-blox' ADR solution combines GPS and sensor digital data using a tightly coupled Kalman filter. This improves position accuracy during periods of no or degraded GPS signal.

The NEO-6V provides ADR functionality over its software sensor interface. A variety of sensors (such as wheel ticks and gyroscope) are supported, with the sensor data received via UBX messages from the application processor. This allows for easy integration and a simple hardware interface, lowering costs. By using digital sensor data available on the vehicle bus, hardware costs are minimized since no extra sensors are required for Dead Reckoning functionality. ADR is designed for simple integration and easy configuration of different sensor options (e.g. with or without gyroscope) and vehicle variants, and is completely self-calibrating.

For more details contact the u-blox support representative nearest you to receive dedicated *u-blox 6 Receiver Description Including Protocol Specification* [3].

1.10 Precise Point Positioning

u-blox' industry proven PPP algorithm provides extremely high levels of position accuracy in static and slow moving applications, and makes the NEO-6P an ideal solution for a variety of high precision applications such as surveying, mapping, marine, agriculture or leisure activities.

Ionospheric corrections such as those received from local SBAS[12] geostationary satellites (WAAS, EGNOS, MSAS) or from GPS enable the highest positioning accuracy with the PPP algorithm. The maximum improvement of positioning accuracy is reached with PPP+SBAS and can only be expected in an environment with unobstructed sky view during a period in the order of minutes.

1.11 Oscillators

NEO-6 GPS modules are available in Crystal and TCXO versions. The TCXO allows accelerated weak signal acquisition, enabling faster start and reacquisition times.

1.12 Protocols and interfaces

Protocol	Type
NMEA	Input/output, ASCII, 0183, 2.3 (compatible to 3.0)
UBX	Input/output, binary, u-blox proprietary
RTCM	Input, 2.3

Table 4: Available protocols

All listed protocols are available on UART, USB, and DDC. For specification of the various protocols see the *u- blox 6 Receiver Description including Protocol Specification* [2].

1.12.1 UART

NEO-6 modules include one configurable UART interface for serial communication (for information about configuration see section 1.15).

1.12.2 USB

NEO-6 modules provide a USB version 2.0 FS (Full Speed, 12Mbit/s) interface as an alternative to the UART. The pull-up resistor on USB_DP is integrated to signal a full-speed device to the host. The VDDUSB pin supplies the USB interface. u-blox provides a Microsoft® certified USB driver for Windows XP, Windows Vista and Windows 7 operating systems.

1.12.3 Serial Peripheral Interface (SPI)

The SPI interface allows for the connection of external devices with a serial interface, e.g. serial flash to save configuration and AssistNow Offline A-GPS data or to interface to a host CPU. The interface can be operated in master or slave mode. In master mode, one chip select signal is available to select external slaves. In slave mode a single chip select signal enables communication with the host.

☞ The maximum bandwidth is 100kbit/s.

[12] Satellite Based Augmentation System

1.12.4 Display Data Channel (DDC)

The I^2C compatible DDC interface can be used either to access external devices with a serial interface EEPROM or to interface with a host CPU. It is capable of master and slave operation. The DDC interface is I^2C Standard Mode compliant. For timing parameters consult the I^2C standard.

☞ The DDC Interface supports serial communication with u-blox wireless modules. See the specification of the applicable wireless module to confirm compatibility.

☞ The maximum bandwidth is 100kbit/s.

1.12.4.1 External serial EEPROM

NEO-6 modules allow an optional external serial EEPROM to be connected to the DDC interface. This can be used to store Configurations permanently.

☞ For more information see the *LEA-6/NEO-6/MAX-6 Hardware Integration Manual* [1].

⚠ *Use caution when implementing since forward compatibility is not guaranteed.*

1.13 Antenna

NEO-6 modules are designed for use with passive and active[13] antennas.

Parameter	Specification	
Antenna Type		Passive and active antenna
Active Antenna Recommendations	Minimum gain Maximum gain Maximum noise figure	15 dB (to compensate signal loss in RF cable) 50 dB 1.5 dB

Table 5: Antenna Specifications for all NEO-6 modules

1.14 Power Management

u-blox receivers support different power modes. These modes represent strategies of how to control the acquisition and tracking engines in order to achieve either the best possible performance or good performance with reduced power consumption.

☞ For more information about power management strategies, see the *u-blox 6 Receiver Description including Protocol Specification* [2].

1.14.1 Maximum Performance Mode

During a Cold start, a receiver in Maximum Performance Mode continuously deploys the acquisition engine to search for all satellites. Once the receiver has a position fix (or if pre-positioning information is available), the acquisition engine continues to be used to search for all visible satellites that are not being tracked.

1.14.2 Eco Mode

During a Cold start, a receiver in Eco Mode works exactly as in Maximum Performance Mode. Once a position can be calculated and a sufficient number of satellites are being tracked, the acquisition engine is powered off resulting in significant power savings. The tracking engine continuously tracks acquired satellites and acquires other available or emerging satellites.

☞ Note that even if the acquisition engine is powered off, satellites continue to be acquired.

[13] For information on using active antennas with NEO-6 modules, see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

1.14.3 Power Save Mode

Power Save Mode (PSM) allows a reduction in system power consumption by selectively switching parts of the receiver on and off.

Power Save mode is not available with NEO-6P, NEO-6T and NEO-6V.

1.15 Configuration

1.15.1 Boot-time configuration

NEO-6 modules provide configuration pins for boot-time configuration. These become effective immediately after start-up. Once the module has started, the configuration settings can be modified with UBX configuration messages. The modified settings remain effective until power-down or reset. If these settings have been stored in battery-backup RAM, then the modified configuration will be retained, as long as the backup battery supply is not interrupted.

NEO-6 modules include both **CFG_COM0** and **CFG_COM1** pins and can be configured as seen in Table 6. Default settings in bold.

CFG_COM1	CFG_COM0	Protocol	Messages	UARTBaud rate	USB power
1	**1**	**NMEA**	**GSV, RMC, GSA, GGA, GLL, VTG, TXT**	**9600**	**BUS Powered**
1	0	NMEA	GSV, RMC, GSA, GGA, GLL, VTG, TXT	38400	Self Powered
0	1	NMEA	GSV[14], RMC, GSA, GGA, VTG, TXT	4800	BUS Powered
0	0	UBX	NAV-SOL, NAV-STATUS, NAV-SVINFO, NAV-CLOCK, INF, MON-EXCEPT, AID-ALPSERV	57600	BUS Powered

Table 6: Supported COM settings

NEO-6 modules include a **CFG_GPS0** pin, which enables the boot-time configuration of the power mode. These settings are described in Table 7. Default settings in bold.

CFG_GPS0	Power Mode
0	Eco Mode
1	**Maximum Performance Mode**

Table 7: Supported CFG_GPS0 settings

Static activation of the **CFG_COM** and **CFG_GPS** pins is not compatible with use of the SPI interface.

1.16 Design-in

In order to obtain the necessary information to conduct a proper design-in, u-blox strongly recommends consulting the *LEA-6/NEO-6/MAX-6 Hardware Integration Manual* [1].

[14] Every 5th fix.

2 Pin Definition

2.1 Pin assignment

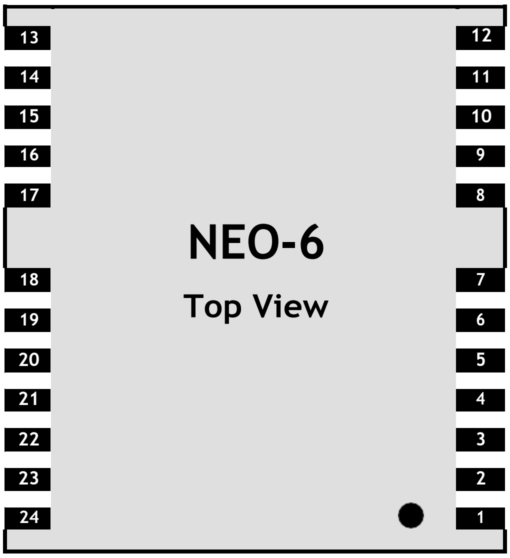


Figure 2 Pin Assignment

No	Module	Name	I/O	Description
1	All	Reserved	I	Reserved
2	All	SS_N	I	SPI Slave Select
3	All	TIMEPULSE	O	Timepulse (1PPS)
4	All	EXTINT0	I	External Interrupt Pin
5	All	USB_DM	I/O	USB Data
6	All	USB_DP	I/O	USB Data
7	All	VDDUSB	I	USB Supply
8	All	Reserved		See Hardware Integration Manual Pin 8 and 9 must be connected together.
9	All	VCC_RF	O	Output Voltage RF section Pin 8 and 9 must be connected together.
10	All	GND	I	Ground
11	All	RF_IN	I	GPS signal input
12	All	GND	I	Ground
13	All	GND	I	Ground
14	All	MOSI/CFG_COM0	O/I	SPI MOSI / Configuration Pin. Leave open if not used.
15	All	MISO/CFG_COM1	I	SPI MISO / Configuration Pin. Leave open if not used.
16	All	CFG_GPS0/SCK	I	Power Mode Configuration Pin / SPI Clock. Leave open if not used.
17	All	Reserved	I	Reserved
18	All	SDA2	I/O	DDC Data
19	All	SCL2	I/O	DDC Clock
20	All	TxD1	O	Serial Port 1
21	All	RxD1	I	Serial Port 1

No	Module	Name	I/O	Description
22	All	V_BCKP	I	Backup voltage supply
23	All	VCC	I	Supply voltage
24	All	GND	I	Ground

Table 8: Pinout

3 Electrical specifications

3.1 Absolute maximum ratings

Parameter	Symbol	Module	Min	Max	Units	Condition
Power supply voltage	VCC	NEO-6G	-0.5	2.0	V	
		NEO-6Q, 6M, 6P, 6V, 6T	-0.5	3.6	V	
Backup battery voltage	V_BCKP	All	-0.5	3.6	V	
USB supply voltage	VDDUSB	All	-0.5	3.6	V	
Input pin voltage	Vin	All	-0.5	3.6	V	
	Vin_usb	All	-0.5	VDDUSB	V	
DC current trough any digital I/O pin (except supplies)	Ipin			10	mA	
VCC_RF output current	ICC_RF	All		100	mA	
Input power at RF_IN	Prfin	NEO-6Q, 6M, 6G, 6V, 6T		15	dBm	source impedance = 50Ω continuous wave
		NEO-6P		-5	dBm	
Storage temperature	Tstg	All	-40	85	°C	

Table 9: Absolute maximum ratings

GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. For more information see chapter 6.4.

Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes. For more information see the LEA-6/ NEO-6/ MAX-6 Hardware Integration Manual [1].

3.2 Operating conditions

☞ All specifications are at an ambient temperature of 25°C.

Parameter	Symbol	Module	Min	Typ	Max	Units	Condition
Power supply voltage	VCC	NEO-6G	1.75	1.8	1.95	V	
		NEO-6Q/M NEO-6P/V/T	2.7	3.0	3.6	V	
Supply voltage USB	VDDUSB	All	3.0	3.3	3.6	V	
Backup battery voltage	V_BCKP	All	1.4		3.6	V	
Backup battery current	I_BCKP	All		22		µA	V_BCKP = 1.8 V, VCC = 0V
Input pin voltage range	Vin	All	0		VCC	V	
Digital IO Pin Low level input voltage	Vil	All	0		0.2*VCC	V	
Digital IO Pin High level input voltage	Vih	All	0.7*VCC		VCC	V	
Digital IO Pin Low level output voltage	Vol	All			0.4	V	Iol=4mA
Digital IO Pin High level output voltage	Voh	All	VCC -0.4			V	Ioh=4mA
USB_DM, USB_DP	VinU	All	Compatible with USB with 22 Ohms series resistance				
VCC_RF voltage	VCC_RF	All		VCC-0.1		V	
VCC_RF output current	ICC_RF	All			50	mA	
Antenna gain	Gant	All			50	dB	
Receiver Chain Noise Figure	NFtot	All		3.0		dB	
Operating temperature	Topr	All	-40		85	°C	

Table 10: Operating conditions

☞ Operation beyond the specified operating conditions can affect device reliability.

3.3 Indicative power requirements

Table 11 lists examples of the total system supply current for a possible application.

Parameter	Symbol	Module	Min	Typ	Max	Units	Condition
Max. supply current [15]	Iccp	All			67	mA	VCC = 3.6 V[16] / 1.95 V[17]
Average supply current[18]	Icc Acquisition	All		47[19]		mA	VCC = 3.0 V[16] / 1.8 V[17]
	Icc Tracking (Max Performance mode)	NEO-6G/Q/T		40[20]		mA	
		NEO-6M/P/V		39[20]		mA	
	Icc Tracking (Eco mode)	NEO-6G/Q/T		38[20]		mA	
		NEO-6M/P/V		37[20]		mA	
	Icc Tracking (Power Save mode / 1 Hz)	NEO-6G/Q		12[20]		mA	
		NEO-6M		11[20]		mA	

Table 11: Indicative power requirements

☞ Values in Table 11 are provided for customer information only as an example of typical power requirements. Values are characterized on samples, actual power requirements can vary depending on FW version used, external circuitry, number of SVs tracked, signal strength, type of start as well as time, duration and conditions of test.

---

[15] Use this figure to dimension maximum current capability of power supply. Measurement of this parameter with 1 Hz bandwidth.

[16] NEO-6Q, NEO-6M, NEO-6P, NEO-6V, NEO-6T

[17] NEO-6G

[18] Use this figure to determine required battery capacity.

3.4 SPI timing diagrams

In order to avoid a faulty usage of the SPI, the user needs to comply with certain timing conditions. The following signals need to be considered for timing constraints:

Symbol	Description
SS_N	Slave Select signal
SCK	Slave Clock signal

Table 12: Symbol description

Figure 3: SPI timing diagram

3.4.1 Timing recommendations

Parameter	Description	Recommendation
t_{INIT}	Initialization Time	500 µs
t_{DES}	Deselect Time	1 ms
Bitrate		100 kbit/s

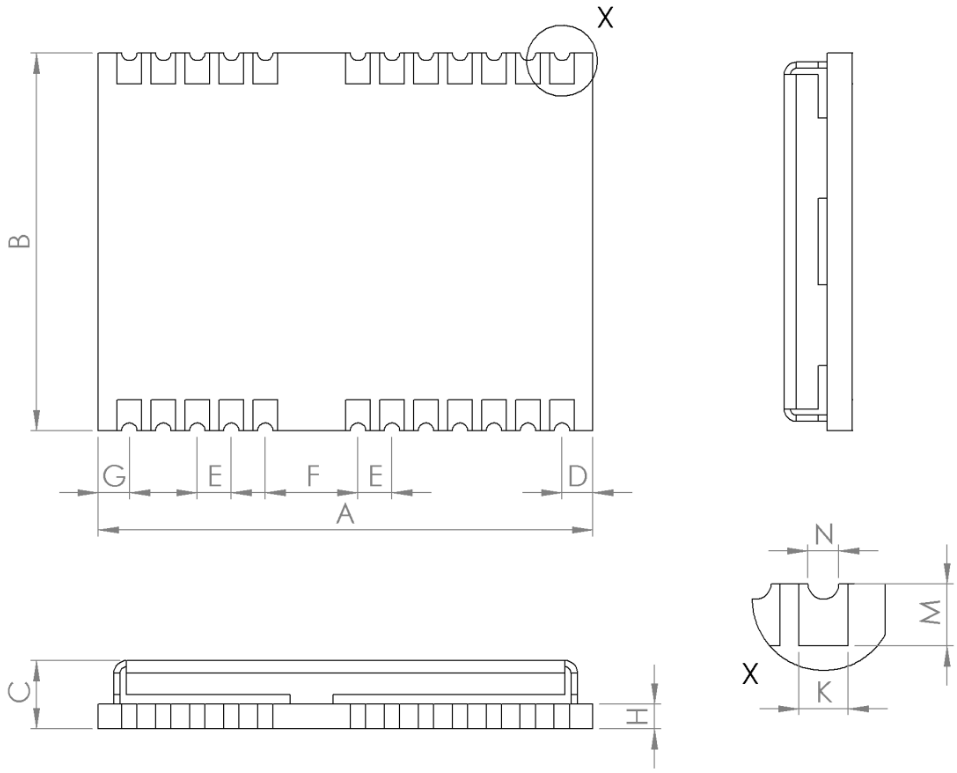
Table 13: SPI timing recommendations

☞ The values in the above table result from the requirement of an error-free transmission. By allowing just a few errors, the byte rate could be increased considerably. These timings – and therefore the byte rate – could also be improved by disabling other interfaces, e.g. the UART. ☞

The maximum bandwidth is 100 kbit/s[21].

[21] This is a theoretical maximum, the protocol overhead is not considered.

4 Mechanical specifications



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	15.9	16.0	16.6
B	12.1	12.2	12.3
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
G	0.9	1.0	1.3
H		0.82	
K	0.7	0.8	0.9
M	0.8	0.9	1.0
N	0.4	0.5	0.6
Weight		1.6g	

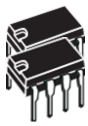
Figure 4: Dimensions

☞ For information regarding the Paste Mask and Footprint see the *LEA-6/NEO-6/MAX-6 Hardware Integration Manual* [1].

LM158,A-LM258,A
LM358,A

LOW POWER DUAL OPERATIONAL AMPLIFIERS

- INTERNALLY FREQUENCY COMPENSATED
- LARGE DC VOLTAGE GAIN: 100dB
- WIDE BANDWIDTH (unity gain): 1.1MHz (temperature compensated)
- VERY LOW SUPPLY CURRENT/OP (500µA) ESSENTIALLY INDEPENDENT OF SUPPLY VOLTAGE
- LOW INPUT BIAS CURRENT: 20nA (temperature compensated)
- LOW INPUT OFFSET VOLTAGE: 2mV
- LOW INPUT OFFSET CURRENT: 2nA
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE POWER SUPPLY VOLTAGE
- LARGE OUTPUT VOLTAGE SWING 0V TO (Vcc - 1.5V)



N

DIP8

(Plastic Package)

D & S

SO8 & miniSO8

DESCRIPTION

These circuits consist of two independent, high gain, internally frequency compensated which were designed specifically to operate from a sin- gle power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op-amp circuits which now can be more easily implement- ed in single power supply systems. For example, these circuits can be directly supplied with the standard +5V which is used in logic systems and will easily provide the required interface electron- ics without requiring any additional power supply.

Inthe linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

ORDER CODE

Part Number	Temperature Range	Package			
		N	S	D	P
LM158,A	-55°C, +125°C	•		•	•
LM258,A	-40°C, +105°C	•		•	•
LM358,A	0°C, +70°C	•	•	•	•
Example : LM258N					

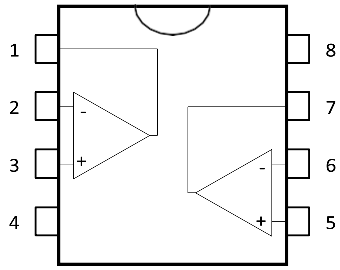
N = Dual in Line Package (DIP)

D = Small Outline Package (SO) - also available in Tape & Reel (DT)

S = Small Outline Package (miniSO) only available in Tape & Reel (DT)

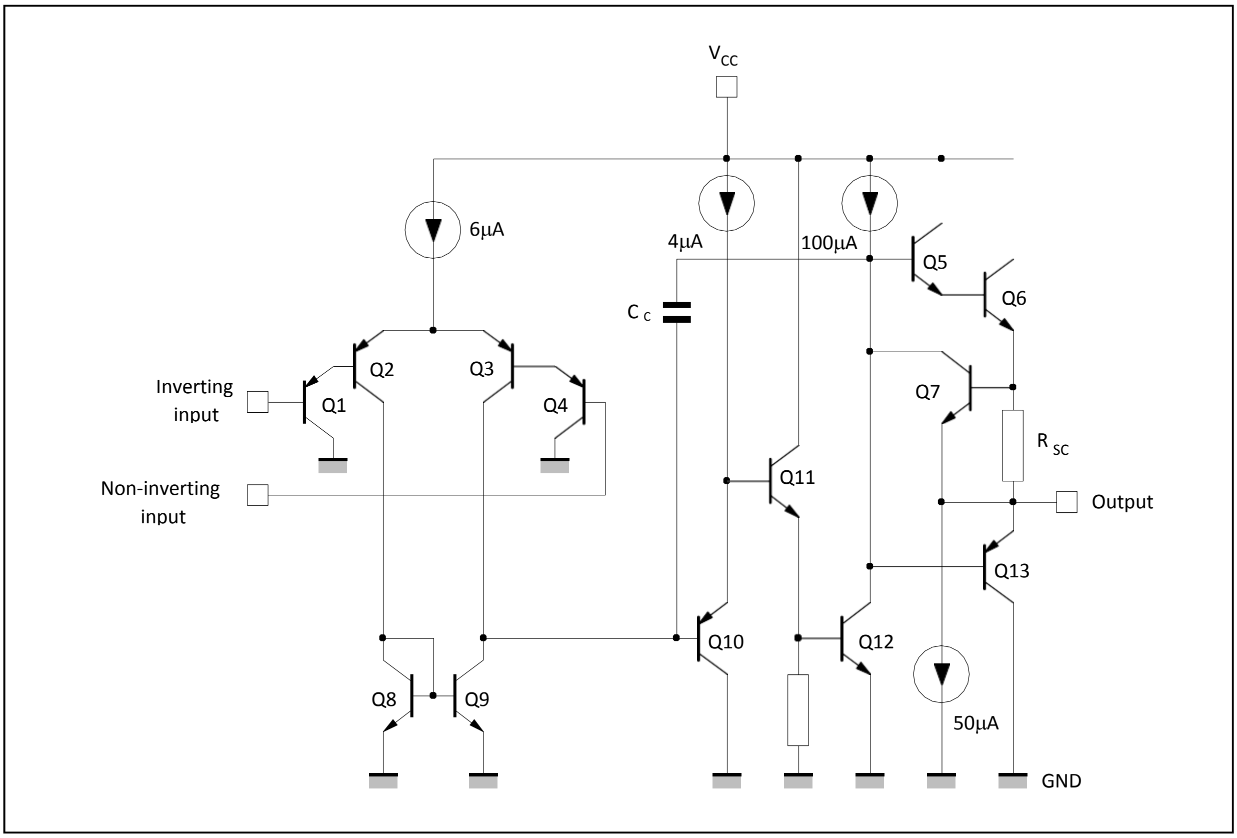
P = Thin Shrink Small Outline Package (TSSOP) - only available in Tape &Reel (PT)

PIN CONNECTIONS (top view)



1 - Output 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - V_{CC}^+

SCHEMATIC DIAGRAM (1/2 LM158)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM158,A	LM258,A	LM358,A	Unit
V_{CC}	Supply voltage	+/-16 or 32			V
V_i	Input Voltage	-0.3 to +32			V
V_{id}	Differential Input Voltage	+32			V
P_{tot}	Power Dissipation 1)	500			mW
	Output Short-circuit Duration 2)	Infinite			
I_{in}	Input Current 3)	50			mA
T_{oper}	Opearting Free-air Temperature Range	-55 to +125	-40 to +105	0 to +70	°C
T_{stg}	Storage Temperature Range	-65 to +150			°C

1. Power dissipation must be considered to ensure maximum junction temperature (Tj) is not exceeded.
2. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15V. The maximum output current is approximately 40mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuit on all amplifiers.
3. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diodes clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. this transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time duration than an input is driven negative.
This is not destructive and normal output will set up again for input voltage higher than -0.3V.

ELECTRICAL CHARACTERISTICS

$V_{CC}^{+} = +5V$, V_{CC}^{-} = Ground, $V_O = 1.4V$, $T_{amb} = +25°C$ (unless otherwise specified)

Symbol	Parameter	LM158A-LM258A LM358A			LM158-LM258 LM358			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage - note 1) $T_{amb} = +25°C$ LM158, LM258 LM158A $T_{min} \leq T_{amb} \leq T_{max}$ LM158, LM258		1	3 2 4		2	7 5 9 7	mV
I_{io}	Input Offset Current $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		2	10 30		2	30 40	nA
I_{ib}	Input Bias Current - note 2) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		20	50 100		20	150 200	nA
A_{vd}	Large Signal Voltage Gain $V_{CC} = +15V$, $R_L = 2k\Omega$, $V_o = 1.4V$ to $11.4V$ $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	50 25	100		50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10k\Omega$) $V_{CC}^{+} = 5V$ to $30V$ $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	65 65	100		65 65	100		dB
I_{CC}	Supply Current, all Amp, no load $T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = +5V$ $T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = +30V$		0.7	1.2 1		0.7	1.2 2	mA
V_{icm}	Input Common Mode Voltage Range $V_{CC} = +30V$ - note 3) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	0 0		$V_{CC}^{+} -1.5$ $V_{CC}^{+} -2$	0 0		$V_{CC}^{+} -1.5$ $V_{CC}^{+} -2$	V
CMR	Common Mode Rejection Ratio ($R_S \leq 10k\Omega$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	70 60	85		70 60	85		dB
I_{source}	Output Current Source $V_{CC} = +15V$, $V_o = +2V$, $V_{id} = +1V$	20	40	60	20	40	60	mA
I_{sink}	Output Sink Current ($V_{id} = -1V$) $V_{CC} = +15V$, $V_o = +2V$ $V_{CC} = +15V$, $V_o = +0.2V$	10 12	20 50		10 12	20 50		mA µA
V_{OPP}	Output Voltage Swing ($R_L = 2k\Omega$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	0 0		$V_{CC}^{+} -1.5$ $V_{CC}^{+} -2$	0 0		$V_{CC}^{+} -1.5$ $V_{CC}^{+} -2$	

Symbol	Parameter	LM158A-LM258A LM358A			LM158-LM258 LM358			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{OH}	High Level Output Voltage (V_{CC}^{+} = 30V) T_{amb} = +25°C R_L = 2kΩ $T_{min} \leq T_{amb} \leq T_{max}$ T_{amb} = +25°C R_L = 10kΩ $T_{min} \leq T_{amb} \leq T_{max}$	26 26 27 27	27 28		26 26 27 27	27 28		V
V_{OL}	Low Level Output Voltage (R_L = 10kΩ) T_{amb} = +25°C $T_{min} \leq T_{amb} \leq T_{max}$		5	20 20		5	20 20	mV
SR	Slew Rate V_{CC} = 15V, V_i = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, unity Gain	0.3	0.6		0.3	0.6		V/μs
GBP	Gain Bandwidth Product V_{CC} = 30V, f =100kHz, V_{in} = 10mV, R_L = 2kΩ, C_L = 100pF	0.7	1.1		0.7	1.1		MHz
THD	Total Harmonic Distortion f = 1kHz, A_V = 20dB, R_L = 2kΩ, V_o = $2V_{pp}$, C_L = 100pF, V_O = 2Vpp		0.02			0.02		%
e_n	Equivalent Input Noise Voltage f = 1kHz, R_S = 100Ω, V_{CC} = 30V		55			55		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input Offset Voltage Drift		7	15		7	30	μV/°C
DI_{Iio}	Input Offset Current Drift		10	200		10	300	pA/°C
V_{o1}/V_{o2}	Channel Separation - note 4) 1kHz ≤ f ≤ 20kHZ		120			120		dB

GSM

It is built with SIMCOM Make SIM900 Quad-band GSM/GPRS engine, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with RS232 Level converter circuitry, which allows you to directly interface PC Serial port .The baud rate can be configurable from 9600-115200 through AT command. Initially Modem is in Autobaud mode. This GSM/GPRS RS232 Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS as well as DATA transfer application in M2M interface.

BC546/547/548/549/550

Switching and Applications

- High Voltage: BC546, V_{CEO}=65V
- Low Noise: BC549, BC550
- Complement to BC556 ... BC560

1 TO-92

1. Collector 2. Base 3. Emitter

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage : BC546 : BC547/550 : BC548/549	80 50 30	V V V
V_{CEO}	Collector-Emitter Voltage : BC546 : BC547/550 : BC548/549	65 45 30	V V V
V_{EBO}	Emitter-Base Voltage : BC546/547 : BC548/549/550	6 5	V V
I_C	Collector Current (DC)	100	mA
P_C	Collector Power Dissipation	500	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C

Electrical Characteristics T_a=25°C unless otherwise noted

 Rev. A2, August 2002

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}=30V, I_E=0			15	nA
h_{FE}	DC Current Gain	V_{CE}=5V, I_C=2mA	110		800	

V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA I_C=100mA, I_B=5mA		90 200	250 600	mV mV
V_{BE} (sat)	Base-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA I_C=100mA, I_B=5mA		700 900		mV mV
V_{BE} (on)	Base-Emitter On Voltage	V_{CE}=5V, I_C=2mA V_{CE}=5V, I_C=10mA	580	660	700 720	mV mV
f_T	Current Gain Bandwidth Product	V_{CE}=5V, I_C=10mA, f=100MHz		300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		3.5	6	pF
C_{ib}	Input Capacitance	V_{EB}=0.5V, I_C=0, f=1MHz		9		pF
NF	Noise Figure : BC546/547/548 : BC549/550 : BC549 : BC550	V_{CE}=5V, I_C=200μA f=1KHz, R_G=2KΩ V_{CE}=5V, I_C=200μA R_G=2KΩ, f=30~15000MHz		2 1.2 1.4 1.4	10 4 4 3	dB dB dB dB

h_{FE} Classification

Classification	A	B	C
h_{FE}	110 ~ 220	200 ~ 450	420 ~ 800

APPENDIX C

GSM AT COMMAND SET

Call Control

```
ATA         Answer Command
ATD         Dial Command
ATH         Hang Up Call
ATL         Monitor Speaker Loudness
ATM         Monitor Speaker Mode
ATO         Go On-Line
ATP         Set Pulse Dial as Default
ATT         Set Tone Dial as Default
AT+CSTA     Select Type of Address
AT+CRC      Cellular Result Codes
```

SMS Commands SMS Text Mode

```
AT+CSMS     Select Message Service
AT+CPMS     Preferred Message Storage
AT+CMGF     Message Format
AT+CSCA     Service Centre Address
AT+CSMP     Set Text Mode Parameters
AT+CSDH     Show Text Mode Parameters
AT+CSCB     Select Cell Broadcast Message
Types
AT+CSAS     Save Settings
AT+CRES     Restore Settings
AT+CNMI     New Message Indications to TE
```

AT+CMGL   List Messages
AT+CMGR   Read Message
AT+CMGS   Send Message
AT+CMSS   Send Message from Storage
AT+CMGW   Write Message to Memory
AT+CMGD   Delete Message

SMS PDU Mode

AT+CMGL   List Messages
AT+CMGR   Read Message
AT+CMGS   Send Message
AT+CMGW   Write Message to Memory

Data Card Control Commands

ATI   Identification
ATS   Select an S-register
ATZ   Recall Stored Profile
AT&F   Restore Factory Settings
AT&V   View Active Configuration
AT&W   Store Parameters in Given Profile
AT&Y   Select Set as s Powerup Option
AT+CLCK   Facility Lock Command
AT+COLP   Connected Line Identification Presentation
AT+GCAP   Request Complete Capabilities List

AT+GMI Request Manufacturer Identification
AT+GMM Request Model Identification
AT+GMR Request Revision Identification
AT+GSN Request Product Serial Number Identification

Phone Control Commands

AT+CBC Battery Charge
AT+CGMI Request Manufacturer Identification
AT+CGMM Request Model Identification
AT+CGMR Request Revision Identification
AT+CGSN Request Product Serial Number Identification
AT+CMEE Report Mobile Equipment Error
AT+CPAS Phone Activity Status
AT+CPBF Find Phone Book Entries
AT+CPBR Read Phone Book Entry
AT+CPBS Select Phone Book Memory Storage
AT+CPBW Write Phone Book Entry
AT+CSCS Select TE Character Set
AT+CSQ Signal Quality

Computer Data Card Interface Commands

ATE Command Echo

ATQ	Result Code Suppression
ATV	Define Response Format
ATX	Response Range Selection
AT&C	Define DCD Usage
AT&D	Define DTR Usage
AT&K	Select Flow Control
AT&Q	Define Communications Mode Option
AT&S	Define DSR Option
AT+ICF	DTE-DCE Character Framing
AT+IFC	DTE-DCE Local Flow Control
AT+IPR	Fixed DTE Rate

Service

AT+CLIP	Calling Line Identification Presentation
AT+CR	Service Reporting Control
AT+DR	Data Compression Reporting
AT+ILRR	DTE-DCE Local Rate Reporting

Network Communication Parameter Commands

ATB	Communications Standard Option
AT+CBST	Select Bearer Service Type
AT+CEER	Extended Error Report
AT+CRLP	Radio Link Protocol
AT+DS	Data Compression

Miscellaneous Commands

```
A/          Re-Execute Command Line
AT?         Command Help
AT*C        Start SMS Interpreter
AT*T        Enter SMS Block Mode Protocol
AT*V        Activate V.25bis Mode
AT*NOKIATEST     Test Command
AT+CESP     Enter SMS Block Mode Protocol
```