VOICE CONTROLLED ROBOT USING ZIGBEE

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Finally we thank our parents for their immense support.

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Chapter 1

INTRODUCTION

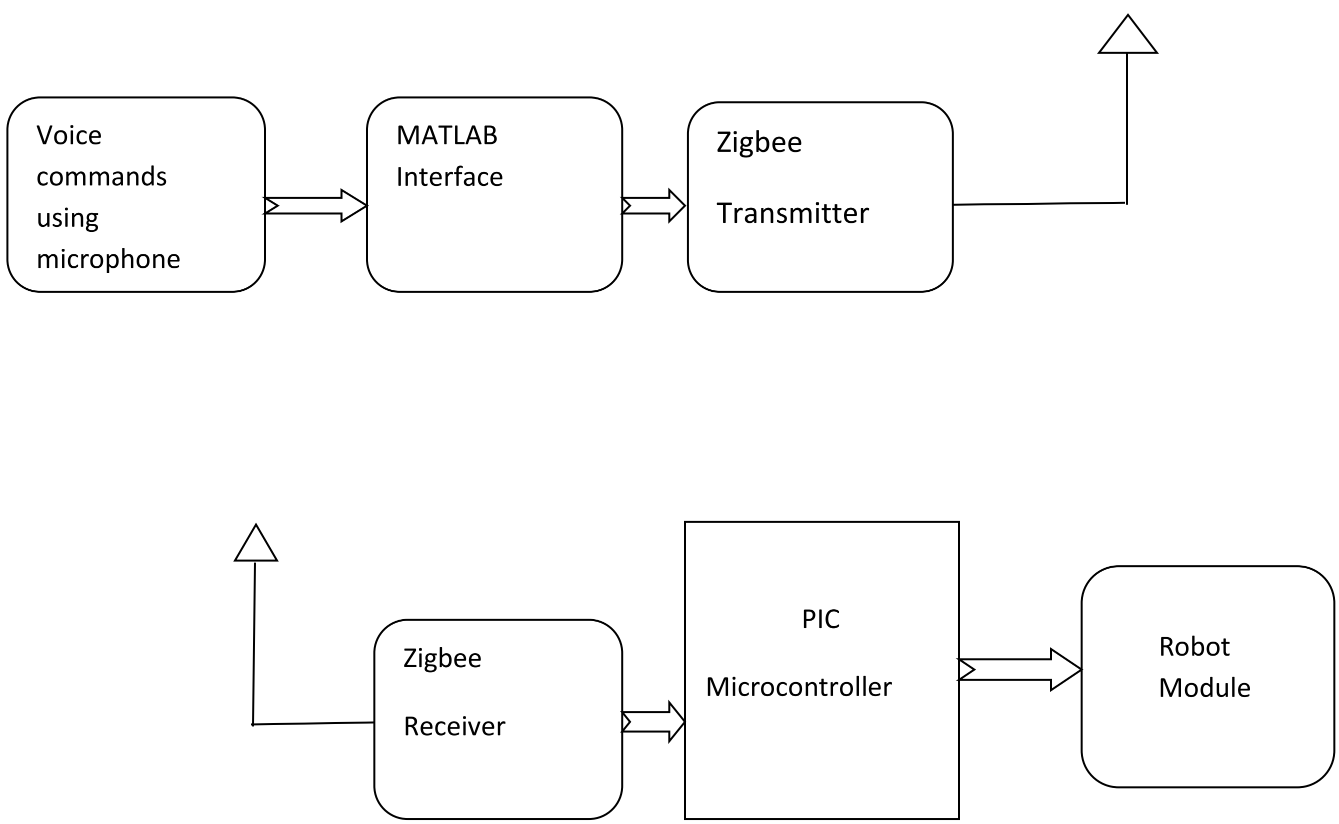
Speech is the most used way of communication for people. We born with the skills of speaking, learn it easily during our early childhood and mostly communicate with each other with speech throughout our lives. By the developments of communication technologies in the last era, speech starts to be an important interface for many systems.

In this project, it is aimed to control a robot with speech commands. The robot is able to recognize spoken commands to move accordingly. To give a direction to robot, first the voice command is sent to the computer using a microphone. The computer recognizes the command by speech recognition system. And then computer converts the voice command to direction command that is predefined and recognized by the robot. When the robot gets the direction command, it moves according to spoken command.

Chapter 2

HARDWARE DESCRIPTION

2.1 GENERAL BLOCK DIAGRAM



2.2PIC MICROCONTROLLER

2.2.1 GENERAL DESCRIPTION

Manufactured by Microchip, the PIC ("Programmable Intelligent Computer" or "Peripheral Interface Controller") microcontroller is popular among engineers and hobbyists alike. PIC microcontrollers come in a variety of "flavors", each with different components and capabilities.

Many types of electronic projects can be constructed easily with the PIC family of microprocessors, among them clocks, very simple video games, robots, servo controllers, and many more. The PIC is a very general purpose microcontroller that can come with many different options, for very reasonable prices.

PIC is a family of modified Harvard architecture microcontrollers derived from the PIC1650 originally developed by General Instrument's Microelectronics Division.

PICs are popular with industrial developers due to wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

Table 2.2.1

PICmicrocontroller Feature	**PIC microcontroller feature description**
Flash memory	Re-programmable program storage.
RAM	Memory storage for variables.
EEPROM	Long term stable memory : Electrically Erasable Programmable Read Only Memory.
I/O ports	High current Input/output ports (with pin direction change).
Timers/Counters	Typically 3.
USART	Built in RS232 protocol (only needs level translator chip).

CCP	Capture/Compare/PWM module.
SSP	I2C and SPI Interfaces.
Comparator	An analogue comparator and internal voltage reference.
ADC	Analogue to digital converter.
PSP	Parallel Slave Port (for 8 bit microprocessor systems).
LCD	LCD interface.
Special features	ICSP,WDT,BOR,POR,PWRT,OST,SLEEP
ICSP	Simple programming using In CircuitSerial Programming.

2.2.2PIN DESCRIPTION

Fig. 2.2.2

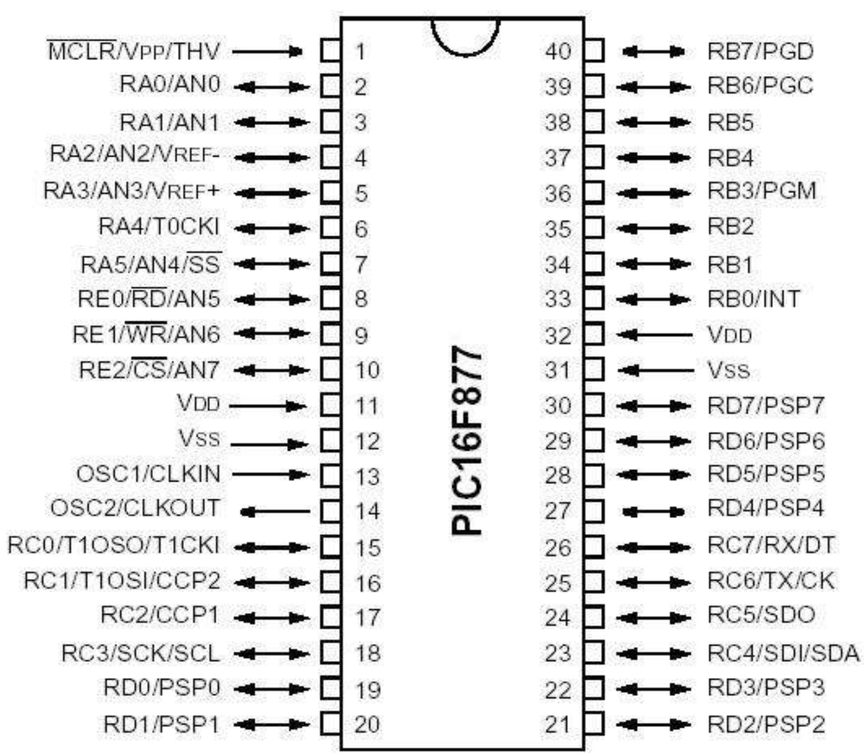


Table 2.2.2

Pin Name | DIP Pin# | PLCC Pin# | QFP Pin# | I/O/P Type | Buffer Type | Description

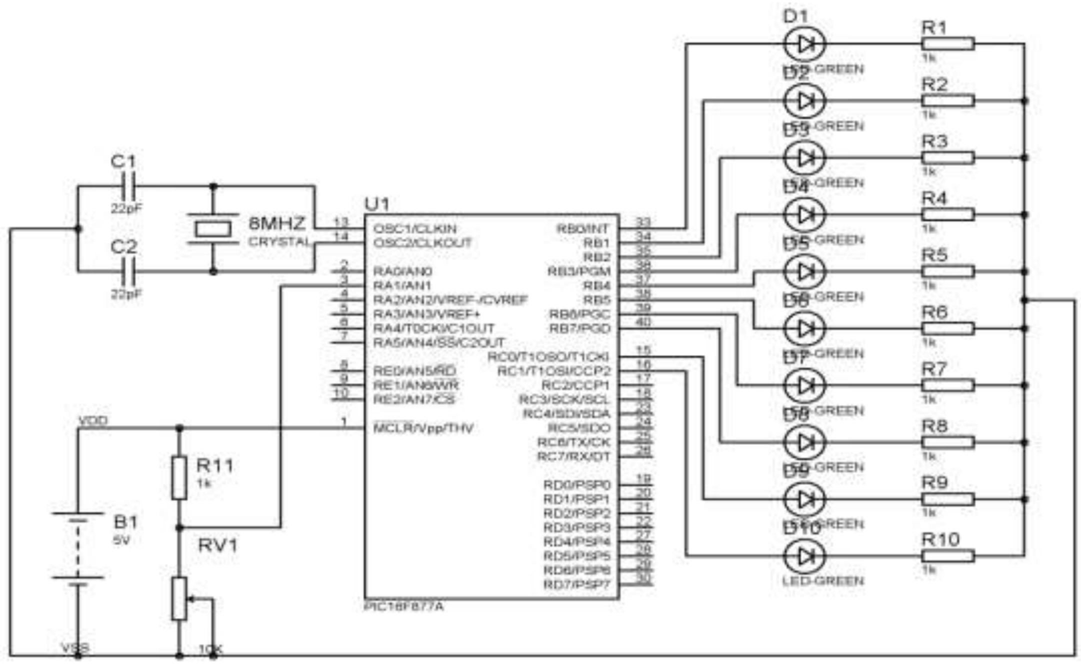
Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
						PORTC is a bi-directional I/O port.
RC0/T1OSO/T1CKI	15	16	32	I/O	ST	RC0 can also be the Timer1 oscillator output or a Timer1 clock input.
RC1/T1OSI/CCP2	16	18	35	I/O	ST	RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.
RC2/CCP1	17	19	36	I/O	ST	RC2 can also be the Capture1 input/Compare1 output/ PWM1 output.
RC3/SCK/SCL	18	20	37	I/O	ST	RC3 can also be the synchronous serial clock input/ output for both SPI and I^2C modes.
RC4/SDI/SDA	23	25	42	I/O	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	24	26	43	I/O	ST	RC5 can also be the SPI Data Out (SPI mode).
RC6/TX/CK	25	27	44	I/O	ST	RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.
RC7/RX/DT	26	29	1	I/O	ST	RC7 can also be the USART Asynchronous Receive or Synchronous Data.
						PORTD is a bi-directional I/O port or parallel slave port when interfacing to a microprocessor bus.
RD0/PSP0	19	21	38	I/O	ST/TTL(3)	
RD1/PSP1	20	22	39	I/O	ST/TTL(3)	
RD2/PSP2	21	23	40	I/O	ST/TTL(3)	
RD3/PSP3	22	24	41	I/O	ST/TTL(3)	
RD4/PSP4	27	30	2	I/O	ST/TTL(3)	
RD5/PSP5	28	31	3	I/O	ST/TTL(3)	
RD6/PSP6	29	32	4	I/O	ST/TTL(3)	
RD7/PSP7	30	33	5	I/O	ST/TTL(3)	
						PORTE is a bi-directional I/O port.
RE0/$\overline{RD}$/AN5	8	9	25	I/O	ST/TTL(3)	RE0 can also be read control for the parallel slave port, or analog input5.
RE1/$\overline{WR}$/AN6	9	10	26	I/O	ST/TTL(3)	RE1 can also be write control for the parallel slave port, or analog input6.
RE2/$\overline{CS}$/AN7	10	11	27	I/O	ST/TTL(3)	RE2 can also be select control for the parallel slave port, or analog input7.
V_{SS}	12,31	13,34	6,29	P	—	Ground reference for logic and I/O pins.
V_{DD}	11,32	12,35	7,28	P	—	Positive supply for logic and I/O pins.

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	13	14	30	I	ST/CMOS(4)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	14	15	31	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP/THV	1	2	18	I/P	ST	Master clear (reset) input or programming voltage input or high voltage test mode control. This pin is an active low reset to the device.
						PORTA is a bi-directional I/O port.
RA0/AN0	2	3	19	I/O	TTL	RA0 can also be analog input0
RA1/AN1	3	4	20	I/O	TTL	RA1 can also be analog input1
RA2/AN2/VREF-	4	5	21	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage
RA3/AN3/VREF+	5	6	22	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage
RA4/T0CKI	6	7	23	I/O	ST	RA4 can also be the clock input to the Timer0 timer/counter. Output is open drain type.
RA5/$\overline{SS}$/AN4	7	8	24	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
						PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	34	37	9	I/O	TTL	
RB2	35	38	10	I/O	TTL	
RB3/PGM	36	39	11	I/O	TTL	RB3 can also be the low voltage programming input
RB4	37	41	14	I/O	TTL	Interrupt on change pin.
RB5	38	42	15	I/O	TTL	Interrupt on change pin.
RB6/PGC	39	43	16	I/O	TTL/ST(2)	Interrupt on change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	40	44	17	I/O	TTL/ST(2)	Interrupt on change pin or In-Circuit Debugger pin. Serial programming data.

2.2.3 ANALOG TO DIGITAL CONVERSION

Block Diagram:

Fig 2.2.3



The Analog-to-Digital (A/D) Converter module has five inputs for the 28-pin devices and eight for the 40/44-pindevices. The conversion of an analog input signal results in a corresponding 10-bit digital number. The A/D modulehas high and low-voltage reference input that is software selectable to some combination of VDD, VSS, RA2or RA3.

The A/D converter has a unique feature of being able to operate while the device is in Sleep mode. To operate in Sleep, the A/D clock must be derived from the A/D's internal RC oscillator.

The A/D module has four registers. These registers are:

- A/D Result High Register (ADRESH)
- A/D Result Low Register (ADRESL)
- A/D Control Register 0 (ADCON0)
- A/D Control Register 1 (ADCON1)

2.2.4 DATA MEMORY ORGANISATION

The Data Memory is the part of the PIC that the Special Function Registers and the General Purpose Registers are stored. The Data Memory is divided into 4 banks, each one having 128 bytes length. To access each bank, the RP0 and RP1 bits of the STATUS register needs to be accessed. To access a register that is located in another bank, one should access it inside the program. The following table shows how to select each bank:

Table 2.2.4

RP1	RP0	Selected bank
0	0	0
0	1	1
1	0	2
1	1	3

In order to start programming and build automated system, there is no need to study all the registers of the memory map, but only a few most important ones:

STATUS register – changes/moves from/between the banks

PORT registers – assigns logic values (“0”/”1”) to the ports

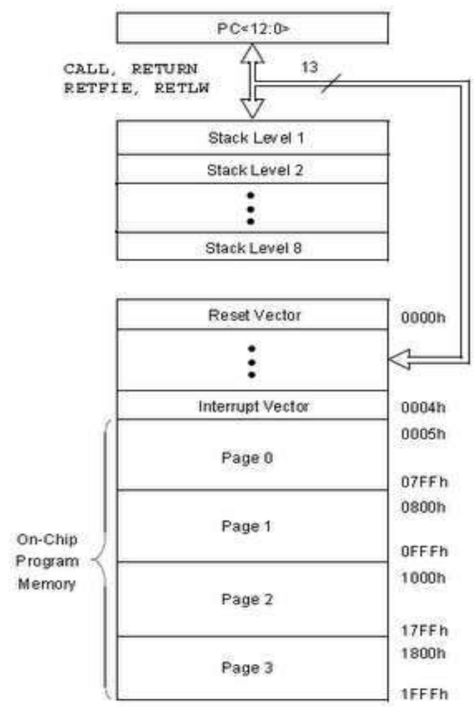
TRIS registers - data direction register (input/output)

2.2.5 PROGRAM MEMORY

Program Memory and Data EEPROM they are non-volatile memories, which store the information even after the power is turn off. These memories called Flash or EEPROM.

The PIC16F87XA devices have a 13-bit program counter capable of addressing an 8K word x 14 bit program memory space. This memory is used to store the program after we burn it to the microcontroller. The PIC16F876A/877A devices have 8K words x 14 bits of Flash program memory that can be electrically erased and reprogrammed. Each time we burn program into the micro, we erase an old program and write a new one.

Fig 2.2.5



PIC16F876A/877A program memory map and stack

Program Counter (PC) keeps track of the program execution by holding the address of the current instruction. It is automatically incremented to the next instruction during the current instruction execution.

The PIC16F87XA family has an 8-level deep x 13-bit wide hardware stack. The stack space is not part of either program or data space and the stack pointer is not readable or writable. In the PIC microcontrollers, this is a special block of RAM memory used only for this purpose.

The CALL instruction is used to jump to a subroutine, which must be terminated with the RETURN instruction. CALL has the address of the first instruction in the subroutine as its operand. When the

CALL instruction is executed, the destination address is copied to the PC. The PC is PUSHed onto the stack when a CALL instruction is executed, or an interrupt causes a branch. The stack is POP'ed in the event of a RETURN, RETLW or a RETFIE instruction execution.

The stack operates as a circular buffer. This means that after the stack has been PUSHed eight times, the ninth push overwrites the value that was stored from the first push. The tenth push overwrites the second push (and so on).

Each time the main program execution starts at address 0000 - Reset Vector. The address 0004 is "reserved" for the "interrupt service routine" (ISR).

If we plan to use an interrupt, our program will begin after the Interrupt Vector; and if not we can start to write from the beginning of the Reset Vector.

2.3 Zigbee Transceiver

2.3.1 GENERAL DESCRIPTION

ZigBee is the name of a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology is intended to be simpler and cheaper than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications which require a low data rate, long battery life, and secure networking.
ZigBee builds upon the physical layer and medium access control defined in IEEE standard 802.15.4 (2003 version) for low-rate WPAN's. The specification goes on to complete the standard by adding four main components: network layer, application layer, ZigBee device objects (ZDO's) and manufacturer-defined application objects which allow for customization and favor total integration. Besides adding two high-level network layers to the underlying structure, the most significant improvement is the introduction of ZDO's. These are responsible for a number of tasks, which include keeping of device roles, management of requests to join a network, device discovery and security.

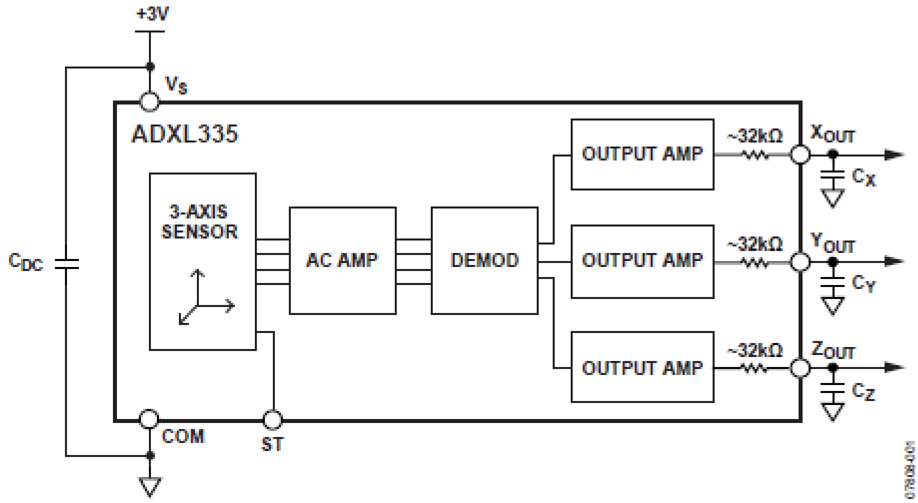


Fig 2.3.1

2.3.2 PIN CONFIGURATION

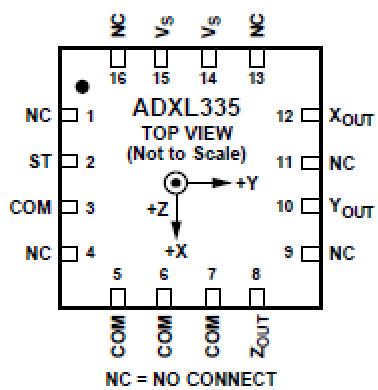


Fig 2.3.2

Pin no	Mnemonic	Description
1	NC	No Connect
2	ST	Self-Test
3	COM	Common
4	NC	No Connect
5	COM	Common
6	COM	Common
7	COM	Common
8	Zout	Z Channel Output
9	NC	No Connect
10	Yout	Y Channel Output

11	NC	No Connect
12	Xout	X Channel Output
13	NC	No Connect
14	Vs	Supply Voltage(1.8-3.6V)
15	Vs	Supply Voltage(1.8-3.6V)
16	NC	No Connect

2.3.3SPECIFICATIONS

Dynamic Range is the +/- maximum amplitude that the accelerometer can measure before distorting or clipping the output signal. Typically specified in g's.

Frequency Response is determined by the mass, the piezoelectric properties of the crystal, and the resonance frequency of the case. It is the frequency range where the output of the accelerometer is within a specified deviation, typically +/- 5%.

g 1g is the acceleration due to the earth's gravity which is 32.2 ft/sec2, 386 in/sec2 or 9.8 m/sec2.

Grounding - There are two types of signal grounding in accelerometers. Case Grounded accelerometers have the low side of the signal connected to their case. As the case is part of the signal path and may be attached to a conductive material, care must be used when using this type of accelerometer to avoid noise from the ground plain. Ground Isolated accelerometers have the electrical components isolated from the case and are much less susceptible to ground induced noise.

High Frequency Limit is the frequency where the output exceeds the stated output deviation. It is typically governed by the mechanical resonance of the accelerometer.

Low Frequency Cut-off is the frequency where the output starts to fall off below the stated accuracy. The output does not "cut-off " but the sensitivity decreases rapidly with lower frequencies.

Noise - Electronic noise is generated by the amplifying circuit. Noise can be specified either broad band (specified over the a frequency spectrum) or spectral - designated at specific frequencies. Noise levels are specified in g's, i.e. 0.0025 g 2-25,000 Hz. Noise typically decreases as frequency increases so noise at low frequencies is more of a problem than at high frequencies.

Resonance Frequency is the frequency at which the sensor resonates or rings. Frequency measurements want to be well below the resonance frequency of the accelerometer.

Sensitivity is the output voltage produced by a certain force measured in g's. Accelerometers typically fall into two categories - producing either 10 mV/g or 100 mV/g. The frequency of the AC output voltage will match the frequency of the vibrations. The output level will be proportional to the amplitude of the vibrations. Low output accelerometers are used to measure high vibrational levels while high output accelerometers are used to measure low level vibrations.

Temperature Sensitivity is the voltage output per degree of measured temperature. The sensors are temperature compensated to keep the change in output to within the specified limits for a change in temperature.

Temperature Range is limited by the electronic micro circuit that converts the charge to a low impedance output. Typically the range is -50 to 120C.

2.3.4FEATURES

- 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

2.4FLEX SENSORS

2.4.1GENERAL DESCRIPTION

The Flex Sensor technology is based on resistive carbonelements. As a variable printed resistor, the Flex Sensor achieves great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius—the smaller the radius, the higher the resistance value. Flex sensors have various applications, some of them are:

- Automotive controls
- Medical devices
- Industrial controls
- Computer peripherals
- Fitness products
- Musical instruments

- Measuring devices
- Virtual reality games
- Consumer products
- Physical therapy

Fig 2.4.1

2.4.2 SPECIFICATIONS

Electrical:

-Flat Resistance: 5K Ohms

-Resistance Tolerance: ±30%

-Bend Resistance Range: 5K to 10K Ohms

(depending on bend radius)

-Power Rating : 0.50 Watts continuous. 1 Watt peak

Mechanical:

-Life Cycle: >1 million

-Height: 0.43mm (0.017")

-Temperature Range: -35°C to +80°C

Fig 2.4.2

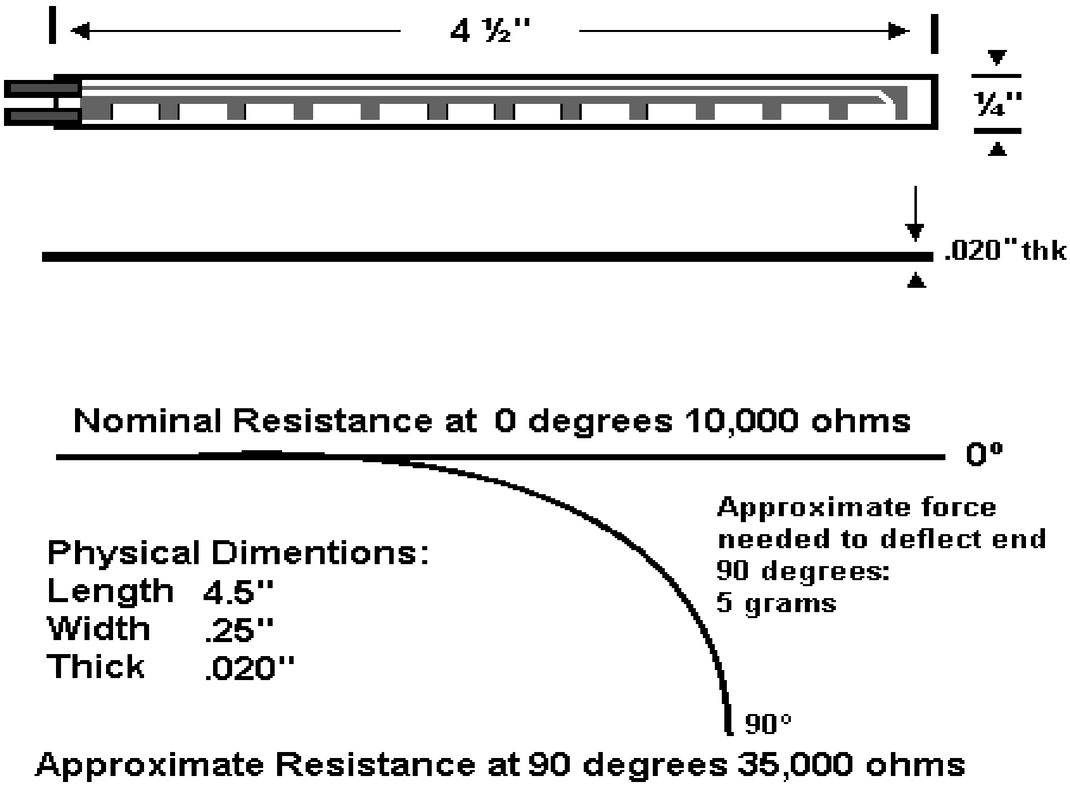


Fig 2.4.2

2.4.3 FEATURES

-Angle Displacement Measurement

- Bends and Flexes physically with motion device

- Possible Uses:

 - Robotics

 - Gaming (Virtual Motion)

 - Medical Devices

 - Computer Peripherals

 - Musical Instruments

- Physical Therapy

- Simple Construction

- Low Profile

2.5DC MOTOR

2.5.1 GENERAL DESCRIPTION

Electric motors are broadly classified into two different categories: DC (Direct Current) and AC (Alternating Current). Within these categories are numerous types, each offering unique abilities that suit them well for specific applications. In most cases, regardless of type, electric motors consist of a stator (stationary field) and a rotor (the rotating field or armature) and operate through the interaction of magnetic flux and electric current to produce rotational speed and torque. DC motors are distinguished by their ability to operate from direct current.
DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion.

2.5.2 PARTS

Stator

- The stator is the stationary outside part of a motor.

-The stator of a permanent magnet dc motor is composed of two or more permanent magnet pole pieces.

- The magnetic field can alternatively be created by an electromagnet. In this case, a DC coil (field winding) is wound around a magnetic material that forms part of the stator.

Rotor

-The rotor is the inner part which rotates.

-The rotor is composed of windings (called armature windings) which are connected to the external circuit through a mechanical commutator.

- Both stator and rotor are made of ferromagnetic materials. The two are separated by air-gap.

Winding

A winding is made up of series or parallel connection of coils.

- Armature winding - The winding through which the voltage is applied or induced.

- Field winding - The winding through which a current is passed to produce flux (for the electromagnet)

- Windings are usually made of copper.

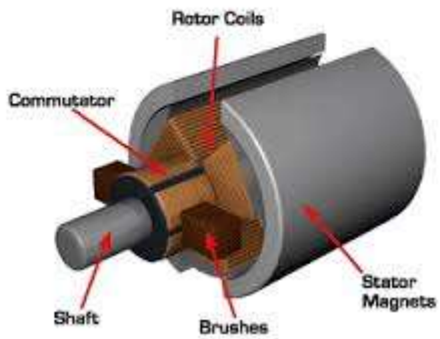


Fig 2.5.2

2.5.3 PRINCIPLE OF OPERATION

Consider a coil in a magnetic field of flux density B . When the two ends of the coil are connected across a DC voltage source, current I flows through it. A force is exerted on the coil as a result of the interaction of magnetic field and electric current. The force on the two sides of the coil is such that the coil start to move in the direction of force.
In an actual DC motor, several such coils are wound on the rotor, all of which experience force, resulting in rotation. The greater the current in the wire, or the greater the magnetic field, the faster the wire moves because of the greater force created. At the same time this torque is being produced, the conductors are moving in a magnetic field.

At different positions, the flux linked with it changes, which causes an emf to be induced ($e = dw/dt$). This voltage is in opposition to the voltage that causes current flow through the conductor and is referred to as a counter-voltage or back emf.
The value of current flowing through the armature is dependent upon the difference between the applied voltage and this counter-voltage.

The current due to this counter-voltage tends to oppose the very cause for its production according to Lenz's law. It results in the rotor slowing down. Eventually, the rotor slows just enough so that the force created by the magnetic field ($F = Bil$) equals the load force applied on the shaft. Then the system moves at constant velocity.

Torque Developed

The equation for torque developed in a DC motor can be derived as follows.

The force on one coil of wire F =i l x B Newton

Note that l and B are vector quantities

Since B = phi/A where A is the area of the coil,

Therefore the torque for a multi turn coil with an armature current of Ia:

T = K *phi*Ia

Where phi is the flux/pole in weber, K is a constant depending on coil geometry, and Ia is the current flowing in the armature winding.

The mechanical power generated is the product of the machine torque and the mechanical speed of rotation,

Or, Pm = wm T

= Wm* K *phi* Ia

It is interesting to note that the same DC machine can be used either as a motor or as a generator, by reversing the terminal connections.

Induced Counter-voltage (Back emf):

Due to the rotation of this coil in the magnetic field, the flux linked with it changes at different positions, which causes an emf to be induced.

The induced emf in a single coil, e = d(phic) /dt

Since the flux linking the coil, phic = phi Sin wt

Induced voltage : e = w*phi*Cos (wt)……(4)

As there are several coils wound all around the rotor, each with a different emf depending on the amount of flux change through it, the total emf can be obtained by summing up the individual emfs.

The total emf induced in the motor by several such coils wound on the rotor can be obtained by integrating (4) and expressed as:

Eb = K *phi*Wm (5)

where K is an armature constant, and is related to the geometry and magnetic properties of the motor, and Wm is the speed of rotation.

The electrical power generated by the machine is given by:

Pdev = EbIa = K *phi*Wm*Ia

2.5.4 THEORY OF OPERATION

A **DC motor** relies on the fact that like magnet poles repels and unlike magnetic poles attracts each other. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. By switching the current on or off in a coil its magnet field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°. A simple *DC motor* typically has a stationary set of magnets in the stator and an armature with a series of two or more windings of wire wrapped in insulated stack slots around iron pole pieces (called stack teeth) with the ends of the wires terminating on a commutator.

The armature includes the mounting bearings that keep it in the center of the motor and the power shaft of the motor and the commutator connections. The winding in the armature continues to loop all the way around the armature and uses either single or parallel conductors (wires), and can circle several times around the stack teeth. The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created. The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. At high power levels, DC motors are almost always cooled using forced air.

The commutator allows each armature coil to be activated in turn. The current in the coil is typically supplied via two brushes that make moving contact with the commutator. Now, some brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes to wear out or create sparks.

Different number of stator and armature fields as well as how they are connected provides different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems which adjust the voltage by "chopping" the DC current into on and off cycles which have an effective lower voltage.

Since the series-wound DC motor develops its highest torque at low speed, it is often used in traction applications such as electric locomotives, and trams. The DC motor was the mainstay of electric traction drives on both electric and diesel-electric locomotives, street-cars/trams and diesel electric drilling rigs for many years. The introduction of DC motors and an electrical grid system to run machinery starting in the 1870s started a new second Industrial Revolution. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles and today's hybrid cars and electric cars as well as driving a host of cordless tools. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines.

If external power is applied to a DC motor it acts as a DC generator, a dynamo. This feature is used to slow down and recharge batteries on hybrid car and electric cars or to return electricity back to the electric grid used on a street car or electric powered train line when they slow down. This process is called regenerative braking on hybrid and electric cars. In diesel electric locomotives they also use their DC motors as generators to slow down but dissipate the energy in resistor stacks. Newer designs are adding large battery packs to recapture some of this energy.

2.5.5 SPECIFICATIONS

Physical Specification

The Physical Specification table lists information about the motor's physical size and weight. This table provides a general overview; detail is offered via a technical drawing in the Product Dimensional Specification section. Motor and gear motor datasheets, such as the Gearmotor 212-107 shown below, include the shaft diameter and length.

•

Unit Weight		9.5 g	
Shaft Diameter		3 mm	+ 0/- 0.02 mm
Shaft Length	Measured from motor body face	8 mm	+/- 0.2 mm

Construction Specification

The type of motor design, materials used, number of poles, and other information can all be found in the table. Therefore, most of the entries here are descriptive.

•

No. of Poles		3
Bearing Type		Sintered Bronze
Gear Ratio		29.5 :1
Gearhead Type		Spur

Leads & Connectors Specification

Details of motor electrical connections are found here - e.g. flying lead lengths, or PCB mountings. Like values in the Physical Specification section, a more detailed graphical representation of this data can be found in the Product Dimensional Specification section.

•

Lead Strip Length		1.5 mm	+/- 0.5 mm
Lead Wire Gauge		32 AWG	
Lead Configuration		Straight	

Conformity Limits Specification

This table details within what limits the motor can operate; for example, Rated and Maximum Operating Voltages. These figures are a great way of checking if the motor meets the application requirements of your design. During test we compare all the measured values against our expected values to ensure our components meet specification, and any motor performing outside of these limits is rejected.

•

N/L Certified Start Voltage	Measured at no load	1 V	
N/L Speed	Measured at rated voltage	410 rpm	+/- 82 rpm
Max. N/L Current	Measured at rated voltage	60 mA	
Rated Torque		5 mNm	

2.5H-BRIDGE

2.5.1 GENERAL DESCRIPTION

An **H bridge** is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used in robotics and other applications to allow DC motors to run forwards and backwards.[1]

Most DC-to-AC converters (power inverters), most AC/AC converters, the DC-to-DC push–pull converter, most motor controllers, and many other kinds of power electronics use H bridges. In particular, a bipolar stepper motor is almost invariably driven by a motor controller containing two H bridges.

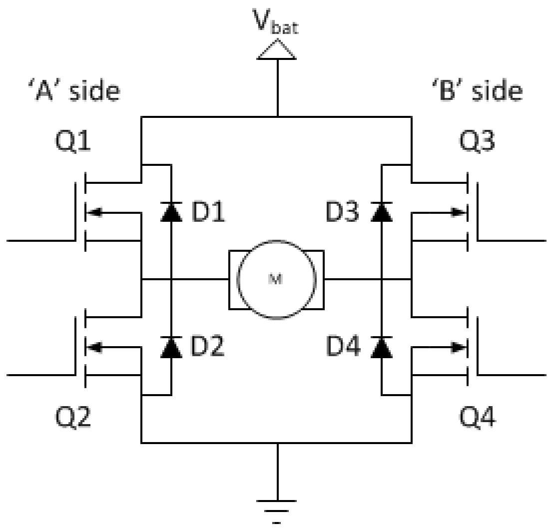


Fig 2.6.1

The switching elements (Q1..Q4) are usually bi-polar or FET transistors, in some high-voltage applications IGBTs. Integrated solutions also exist but whether the switching elements are integrated with their control circuits or not is not relevant for the most part for this discussion. The diodes (D1..D4) are called catch diodes and are usually of a Schottky type. The top-end of the bridge is connected to a power supply (battery for example) and the bottom-end is grounded. In general all four switching elements can be turned on and off independently, though there are some obvious restrictions. Though the load can in theory be anything you want, by far the most pervasive application if H-bridges is with a brushed DC or bipolar stepper motor (steppers need two H-bridges per motor) load. In the following I will concentrate on applications as a brushed DC motor driver.

2.6.2STATIC OPERATION

The basic operating mode of an H-bridge is fairly simple: if Q1 and Q4 are turned on, the left lead of the motor will be connected to the power supply, while the right lead is connected to ground. Current starts flowing through the motor which energizes the motor in (let's say) the forward direction and the motor shaft starts spinning.

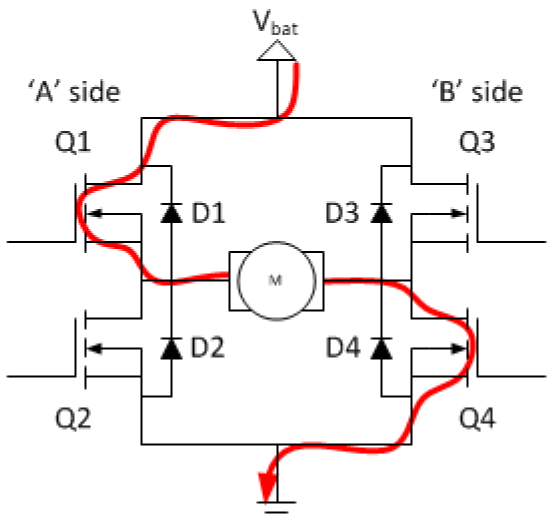


Fig 2.6.2

If Q2 and Q3 are turned on, the reverse will happen, the motor gets energized in the reverse direction, and the shaft will start spinning backwards.

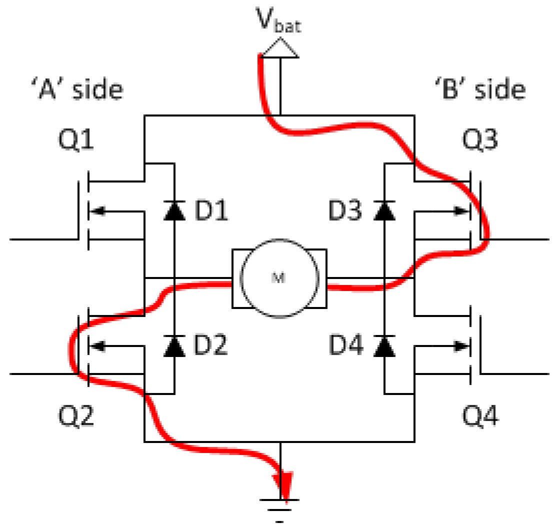


Fig 2.6.2

In a bridge, you should never ever close both Q1 and Q2 (or Q3 and Q4) at the same time. If you did that, you just have created a really low-resistance path between power and GND, effectively short-circuiting your power supply. This condition is called 'shoot-through' and is an almost guaranteed way to quickly destroy your bridge, or something else in your circuit.

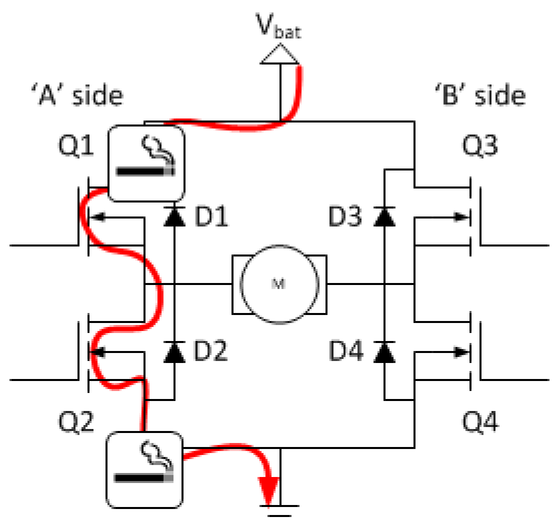


Fig 2.6.2

2.7 IR SENSOR

2.7.1 GENERAL DESCRIPTION

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. It is also capable of measuring heat of an object and detecting motion. Infrared waves are not visible to the human eye.

In the electromagnetic spectrum, infrared radiation is the region having wavelengths longer than visible light wavelengths, but shorter than microwaves. The infrared region is approximately demarcated from 0.75 to 1000µm. The wavelength region from 0.75 to 3µm is termed as near infrared, the region from 3 to 6µm is termed mid-infrared, and the region higher than 6µm is termed as far infrared.

Infrared technology is found in many of our everyday products. For example, TV has an IR detector for interpreting the signal from the remote control. Key benefits of infrared sensors include low power requirements, simple circuitry, and their portable feature.

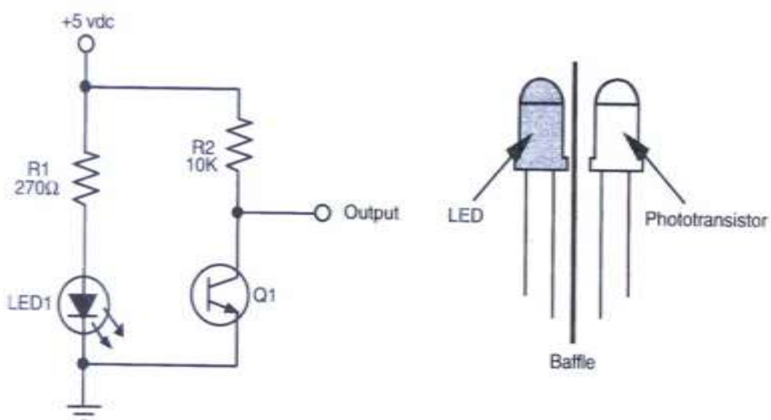


Fig 2.7.1

Types of Infra-Red Sensors

Infra-red sensors are broadly classified into two types:

- **Thermal infrared sensors** – These use infrared energy as heat. Their photo sensitivity is independent of wavelength. Thermal detectors do not require cooling; however, they have slow response times and low detection capability.
- **Quantum infrared sensors** – These provide higher detection performance and faster response speed. Their photo sensitivity is dependent on wavelength. Quantum detectors have to be cooled so as to obtain accurate measurements. The only exception is for detectors that are used in the near infrared region.

2.7.2 OPERATION

A typical system for detecting infrared radiation using infrared sensors includes the infrared source such as blackbody radiators, tungsten lamps, and silicon carbide. In case of active IR sensors, the sources are infrared lasers and LEDs of specific IR wavelengths. Next is the transmission medium used for infrared transmission, which includes vacuum, the atmosphere, and optical fibers.

Thirdly, optical components such as optical lenses made from quartz, CaF_2, Ge and Si, polyethylene Fresnel lenses, and Al or Au mirrors, are used to converge or focus infrared radiation. Likewise, to limit spectral response, band-pass filters are ideal. Finally, the infrared detector completes the system for detecting infrared radiation. The output from the detector is usually very small, and hence pre-amplifiers coupled with circuitry are added to further process the received signals.

2.8GSM MODULE

2.8.1 GENERAL DESCRIPTION

It enables you to control many of the functions of the system from anywhere in the world provided your GSM mobile handset has a network connection. The system uses the SMS messaging protocol to communicate.

This means you can virtually be anywhere in the world and control your lights, heating, cooling, sprinklers, pool pump, security systems, etc all from your mobile phone. In addition you can be advised of alarm violations or power outages and well as request a range of reports showing the status of different devices connected to the system.

A GSM module records up to 6 different individual GSM phone numbers. While a control command can be sent from any GSM phone, a report will only be sent back to one or all of the registered phone numbers in the system. Security is via a user selected password that must be located at the start of all SMS messages. The system supports alphanumeric passwords for up to 10 different users.

On validation of the password the system examines the body of the SMS message and then extracts the commands and instructions. The interface encompasses a complex multi-command interpreter. This enables SMS messages containing multiple complex commands to be sent to the unit. The system will interpret as many commands as can fit within the SMS message. The sequence of the commands can be in any order.

GSM modules have a multi-command buffer. In the event the system is in the process of transmitting information while an incoming SMS message arrives, the system buffers the incoming message and ensures it is processed in a logical sequence, without any messages being lost. Similarly if the system is presented with multiple simultaneous events, the system prioritizes all the messages and sends each message out sequentially without any losses.

In addition the module continually monitors the signal strength of the GSM signal to the phone network. If the signal becomes weak the system holds back from transmitting any SMS message until the signal returns to a reliable level, again ensuring that messages are not lost.

Fig 2.7.1

2.8.2 AT COMMANDS

AT commands are used to control MODEMs. AT is the abbreviation for Attention.The dial up and wireless MODEMs (devices that involve machine to machine communication) need AT commands to interact with a computer. These include the Hayes command set as a subset, along with other extended ***AT commands***.

AT commands with a GSM/GPRS MODEM or mobile phone can be used to access following information and services:

1. Information and configuration pertaining to mobile device or MODEM and SIM card.

2. SMS services.
3. MMS services.
4. Fax services.
5. Data and Voice link over mobile network.

Types of AT Commands:

There are four types of AT commands:

- **Test commands** - used to check whether a command is supported or not by the MODEM.

SYNTAX: AT<command name>=?

For example: ATD=?

- **Read command** - used to get mobile phone or MODEM settings for an operation.

SYNTAX: AT<command name>?

For example: AT+CBC?

- **Set commands** - used to modify mobile phone or MODEM settings for an operation.

SYNTAX: AT<command name>=value1, value2, …,valueN

Some values in set commands can be optional.

For example: AT+CSCA=”+9876543210”, 120

- **Execution commands** - used to carry out an operation.

SYNTAX: AT<command name>=parameter1, parameter2, …,parameterN

The read commands are not available to get value of last parameter assigned in execution commands because parameters of execution commands are not stored.

For example: AT+CMSS=1,”+ 9876543210”, 120

Explanation of commonly used AT commands:

1. **AT** - This command is used to check communication between the module and the computer.
   For example,
   AT
   OK

The command returns a result code OK if the computer (serial port) and module are connected properly. If any of module or SIM is not working, it would return a result code ERROR.

2. **+CMGF** - This command is used to set the SMS mode. Either text or PDU mode can be selected by assigning 1 or 0 in the command.

SYNTAX: AT+CMGF=<mode>
0: for PDU mode
1: for text mode

The text mode of SMS is easier to operate but it allows limited features of SMS. The PDU (protocol data unit) allows more access to SMS services but the operator requires bit level knowledge of TPDUs. The headers and body of SMS are accessed in hex format in PDU mode so it allows availing more features.

For example,
AT+CMGF=1
OK

3. **CMGW** - This command is used to store message in the SIM.

SYNTAX: AT+CMGW=" Phone number"> *Message to be stored* Ctrl+z
As one types AT+CMGW and phone number, '>' sign appears on next line where one can type the message. Multiple line messages can be typed in this case. This is why the message is terminated by providing a 'Ctrl+z' combination. As Ctrl+zis pressed, the following information response is displayed on the screen.

+CMGW: Number on which message has been stored

4. **+CMGS** - This command is used to send a SMS message to a phone number.

SYNTAX: AT+CMGS= serial number of message to be send.
As the command AT+CMGS and serial number of message are entered, SMS is sent to the particular SIM.
For example,
AT+CMGS=1
OK

5. **ATD** - This command is used to dial or call a number.

SYNTAX: ATD<Phone number>;(Enter)
For example,
ATD123456789;

6. **ATA** - This command is used to answer a call. An incoming call is indicated by a message 'RING' which is repeated for every ring of the call. When the call ends 'NO CARRIER' is displayed on the screen.

SYNTAX: ATA(Enter)

As ATA followed by enter key is pressed, incoming call is answered.

For example,

RING

RING

ATA

7. **ATH** - This command is used to disconnect remote user link with the GSM module.

SYNTAX: ATH (Enter)

Chapter 3

SOFTWARE DESCRIPTION

MPLAB IDE v8.60

3.1General description

MPLABIDE(Integrated Development Environment) is a software program that runs on a PC to develop applications for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment (IDE), because it provides a single integrated "environment" to develop code for embedded microcontrollers.

It used to program the pic microcontroller and the main steps are as follows:

1)Create a new project file

2)Writing the required code and compiling it

3)Burning the code onto the microcontroller and the hyper terminal window

3.1.1 Creating a new project file

Step 1: Open the MPLAB IDE icon on the desktop

Step 2: Click the project option in the tool bar and select project wizard.

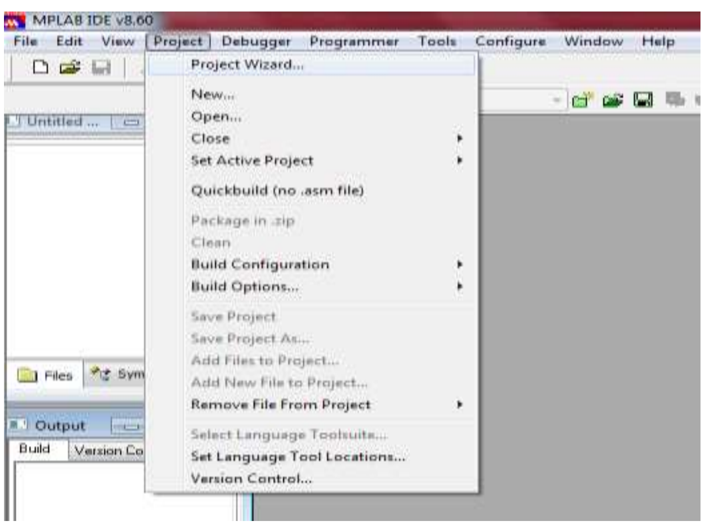


Fig 3.1.1

Step 3: Select the device to be PIC 167F877A and the language tool suite to CCS C compiler

Fig 3.1.1

Step 4: Click on browse and select the folder you want your programs to be stored in.

Step 5: Click next and then finish creating your .mcp file.

2.1.2. Writing the required program and compiling it

Step 1: Create new file and write the required program and save it in the .c format.

Step 2: Go to the .mcw window and add the C file in the source folder.

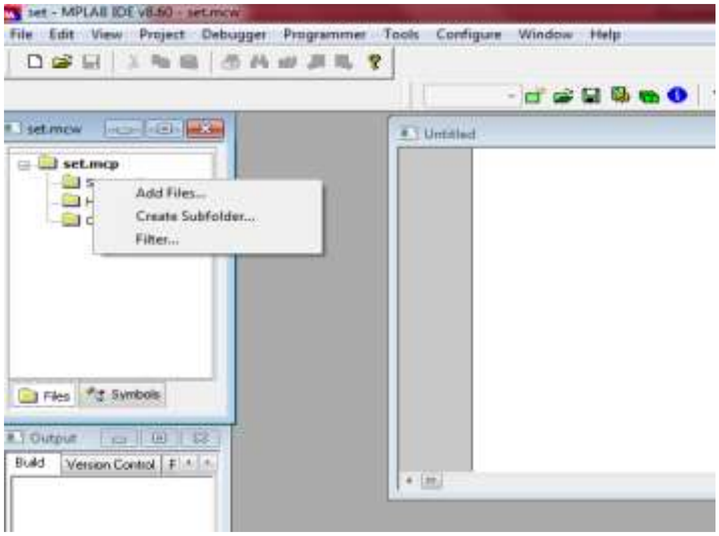


Fig 3.1.2

Step 3: Right click on the C file and compile it. A “Build Succeeded” appears in the output window if it is compiled properly.

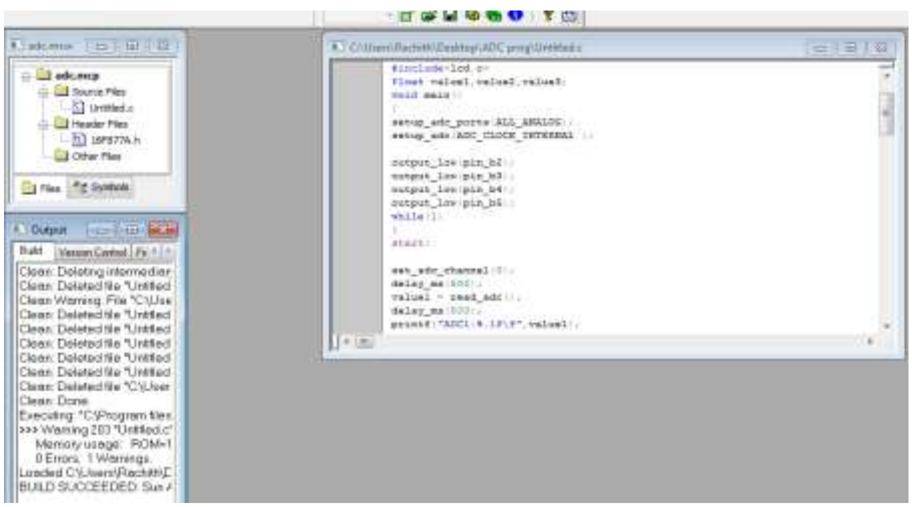


Fig 3.1.2

2.1.3 <u>Burning the program onto the micro controller and the Hyper Terminal window</u>

Step 1: Connect the USB to UART converter to the microcontroller board

Step 2: Click the PIC boot plus on the desktop

Step 3: Click on search and load the *.hex* file onto it.

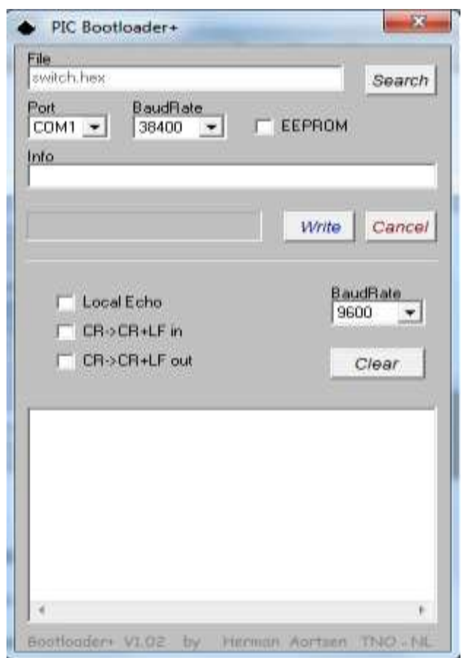


Fig 3.1.3

Step 4: Let the Port be ‘COM 1’ and the Baud Rate ‘38400’

Step 5: Click on *Write* to successfully burn the program onto the microcontroller

Step 6: The subsequent output values can be observed on the Hyper Terminal Window

Chapter 4 Methodology

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[3] Dr ShaikMeeravali and Dr Aparna , Design and Development of a Hand-glove Controlled Wheel Chair Based on MEMS, *International Journal of Engineering Trends and Technology (IJETT),* Aug 2013

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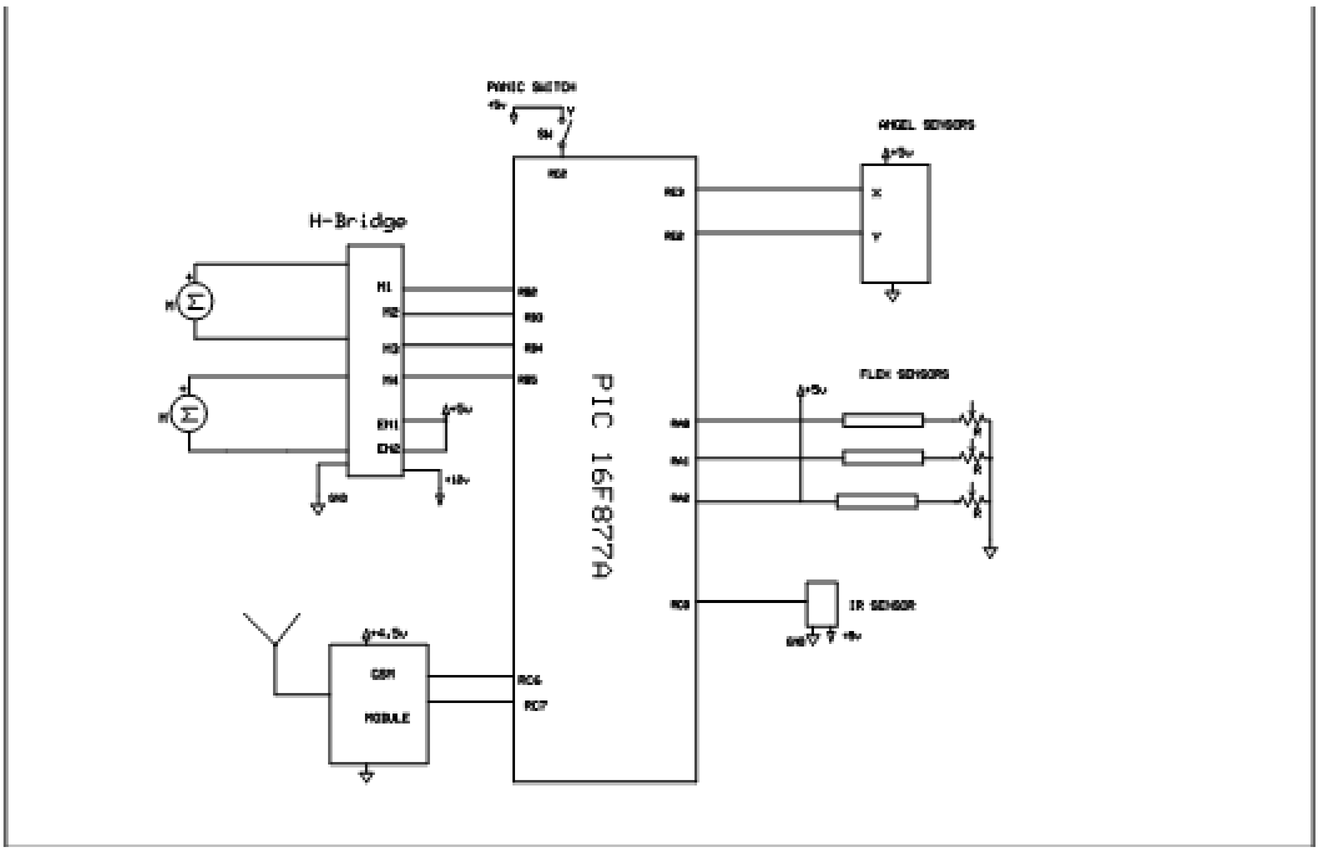
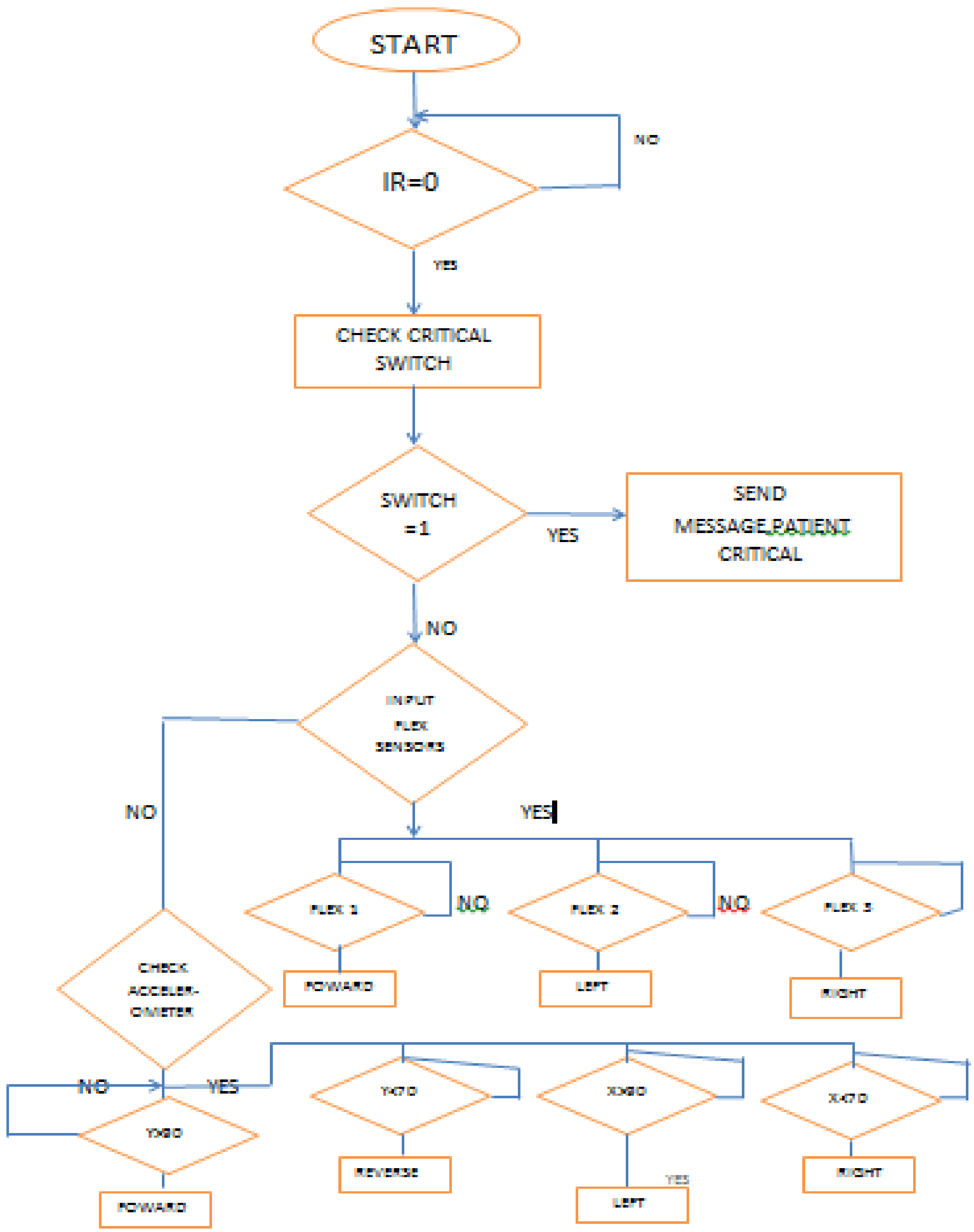
SCHEMATIC


PANIC SWITCH
ANGEL SENSORS
H-Bridge
PIC 16F877A
FLEX SENSORS
IR SENSOR
GSM
MODULE

FLOW CHART



SCREENSHOTS


ENJOY
PURE SHOCK

APPENDIX

DATA SHEETS

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		mg/°C
NOISE PERFORMANCE					
Noise Density X_{OUT}, Y_{OUT}			150		µg/√Hz rms
Noise Density Z_{OUT}			300		µg/√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

Feature	Implementation
Power supply	Single supply voltage 3.4V – 4.5V
Power saving	Typical power consumption in SLEEP mode to 2.5mA
Frequency bands	• SIM300 Tri-band: EGSM 900, DCS 1800, PCS 1900. The band can be set by AT COMMAND, and default band is EGSM 900 and DCS 1800. • Compliant to GSM Phase 2/2+
GSM class	Small MS
Transmit power	• Class 4 (2W) at EGSM900 • Class 1 (1W) at DCS1800 and PCS 1900
GPRS connectivity	• GPRS multi-slot class 10 • GPRS mobile station class B
Temperature range	• Normal operation: -20°C to +55°C • Restricted operation: -25°C to -20°C and +55°C to +70°C • Storage temperature -40°C to +80°C
DATA *GPRS:* *CSD:*	• GPRS data downlink transfer: max. 85.6 kbps • GPRS data uplink transfer: max. 42.8 kbps • Coding scheme: CS-1, CS-2, CS-3 and CS-4 • SIM300 supports the protocols PAP (Password Authentication Protocol) usually used for PPP connections. • The SIM300 integrates the TCP/IP protocol. • Support Packet Switched Broadcast Control Channel (PBCCH) • CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent • Unstructured Supplementary Services Data (USSD) support
SMS	• MT, MO, CB, Text and PDU mode • SMS storage: SIM card • Support transmission of SMS alternatively over CSD or GPRS. User can choose preferred mode.
FAX	Group 3 Class 1
SIM interface	Supported SIM card: 1.8V ,3V
External antenna	Connected via 50 Ohm antenna connector or antenna pad
Audio features	Speech codec modes: