GESTURE BASED ROBOTICS

Skyfi labs
LEARN ENGINEERING. PRACTICALLY!

Roboversity

BRIEF DESCRIPTION OF ELECTRONIC COMPONENTS

 http://www.roboversity.com/

Table of Contents

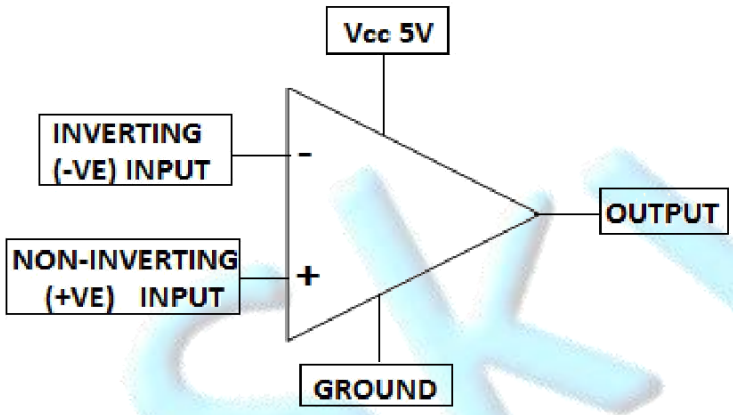
COMPARATOR:

It is an operational amplifier, which compares two input voltages and generates a high/low (binary) output.

Comparators are also used as Null detectors, Zero Crossing Detectors, Relaxation Oscillators, Level Shifters, in addition to its application as an Analog to Digital Converter (ADC).

When a comparator performs the function of deciding if an input voltage is above or below a given threshold, it is essentially performing a 1-bit quantization. This function is used in nearly all Analog to Digital Converters (ADC) and hence we use them to generate digital data from sensors' analog voltage input.

In a circuit diagram it is normally represented by a triangle having Inverting (-) and Non-Inverting (+) inputs, V_{cc}, Ground and Output.



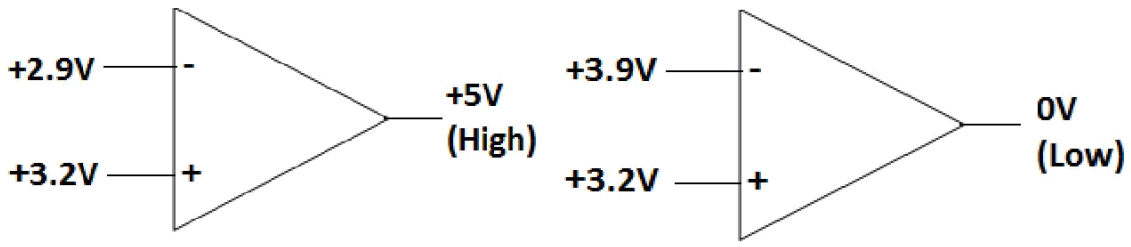
OPERATION OF A COMPARATOR:

CASE1:

Assume

V_{ref} (from Potentiometer) is connected to **Non-Inverting Input**

V_{in} (sensors' voltage) is connected to **Inverting input** then the output will be as follows:



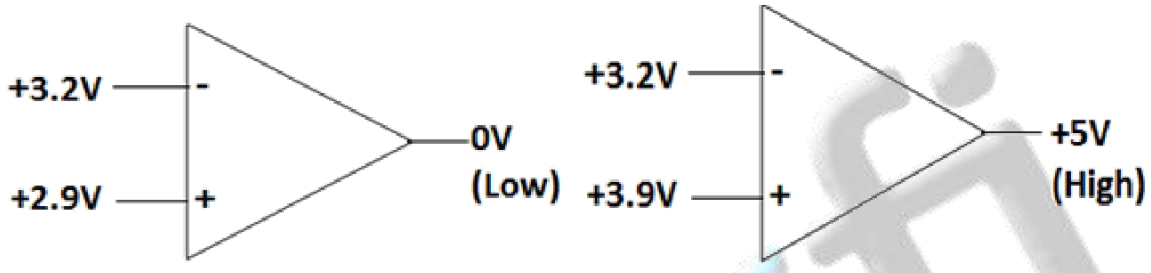
V_{in}<V_{ref}, output will be **high;** V_{in}>V_{ref}, output will be **low.**

CASE2:

Assume

V_{ref}(from Potentiometer) is connected to **Inverting Input**

V_{in} (sensors' voltage) is connected to **Non- Inverting input** then the output will be as follows:



V_{in}<V_{ref}, output will be **low;** V_{in}>V_{ref}, output will be **high.**

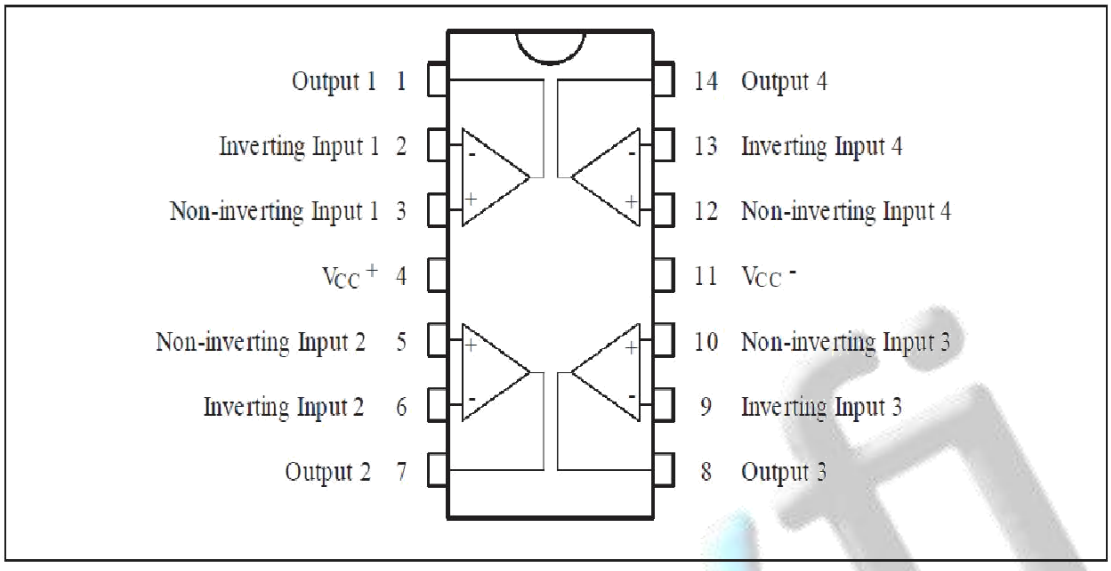
NOTE:

From the above observation it is very clear that when sensor Input is connected to the Inverting Input terminal then output changes inversely i.e. for inputs lower than the reference value, higher outputs are obtained and vice versa. When sensor input is connected to Non-Inverting input terminal then output would be same i.e. for inputs lower than reference value, lower outputs are obtained and vice versa. Hence the corresponding names for the input terminals.

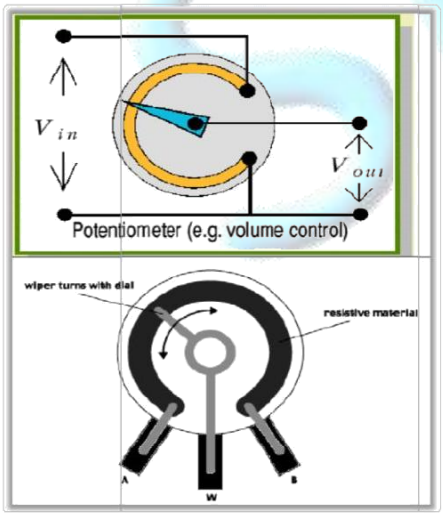
We can set the reference voltage by using the potentiometer, and for comparator circuitry operation LM324 IC is used which has got four Op-Amps in it.

LM324:

PIN CONNECTIONS (top view)



POTENTIOMETERS (VARIABLE RESISTOR):



A potentiometer is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

Potentiometers are used for setting up the reference voltage (V_{ref}).

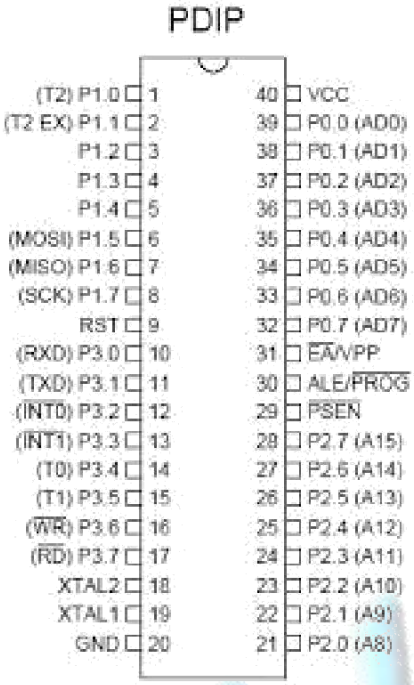
MICRO CONTROLLER:

The Skyfi Labs Development Board use AT89S52 microcontroller which comes under 8051 family. It is equipped with a 8kB flash memory and 256 bytes of data RAM.

FEATURES OF AT89S52:

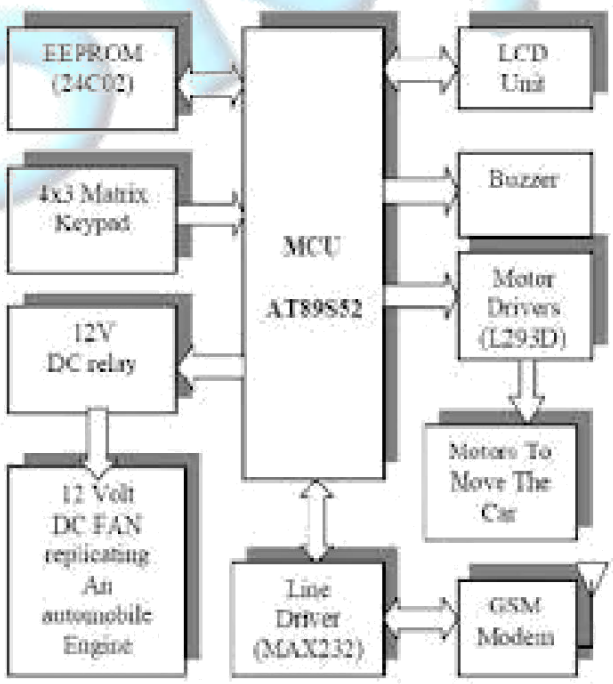
- 4.0V to 5.5V Operating Range.
- Fully Static Operation: 0 Hz to 33 MHz.
- Three-level Program Memory Lock.
- 256 x 8-bit Internal RAM.
- 32 Programmable I/O Lines.
- Three 16-bit Timer/Counters.
- Eight Interrupt Sources.
- Full Duplex UART Serial Channel.
- Low-power Idle and Power-down Modes.
- Interrupt Recovery from Power-down Mode.
- Watchdog Timer.
- Dual Data Pointer.
- Power-off Flag.
- Fast Programming Time.
- Flexible ISP Programming.

PIN DIAGRAM OF AT89S52:



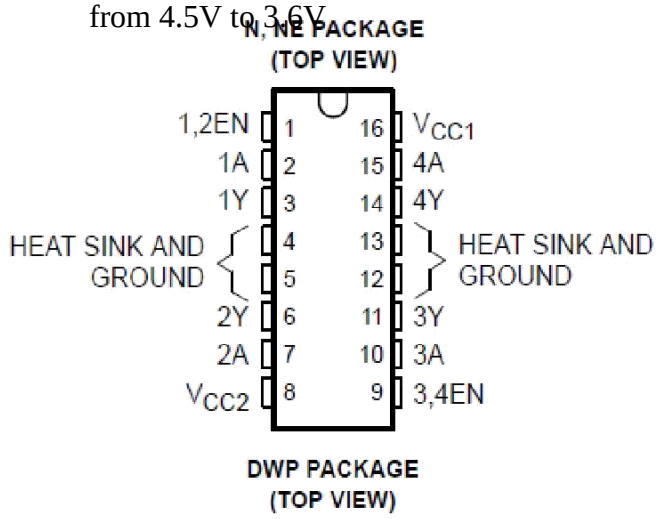
In Skyfi Labs' development board, thePort1 Lower has been used for input (connected to comparator) and Port2 Lower for output (connected to motor driver).

BLOCK DIAGRAM:

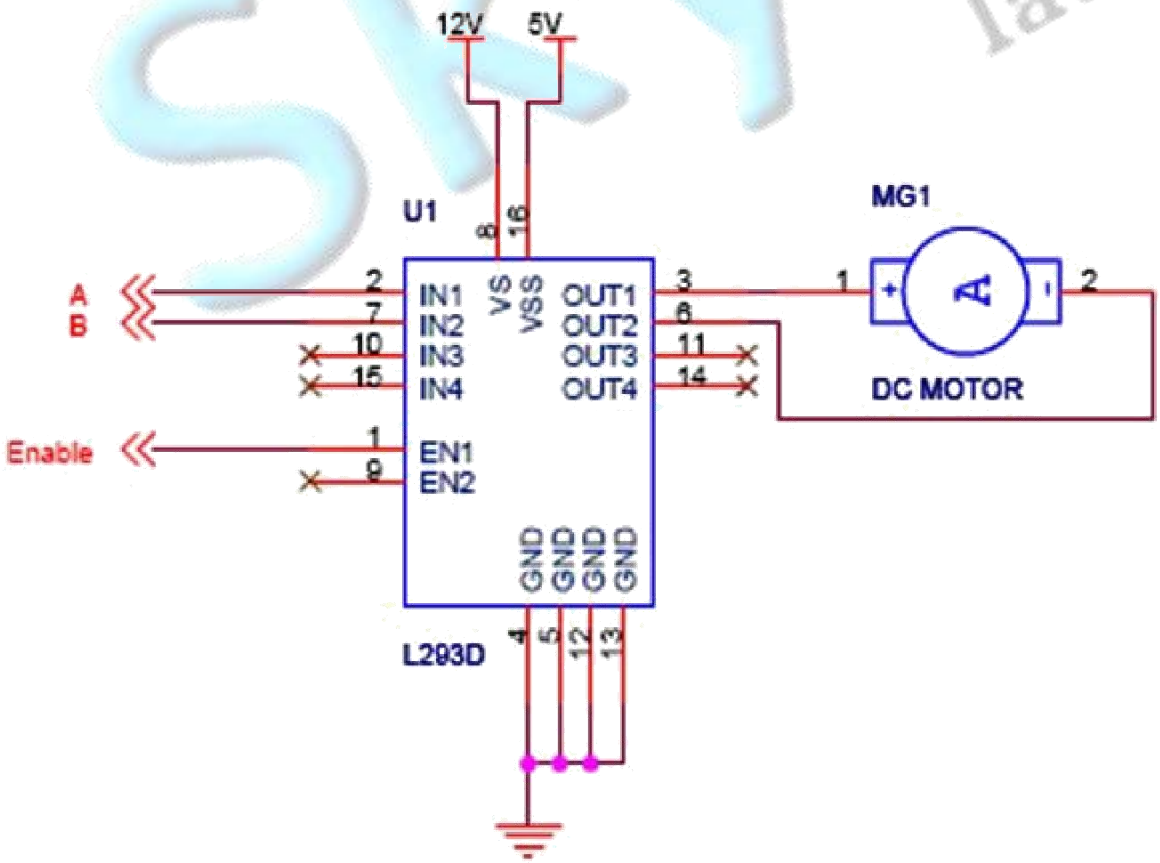


MOTOR DRIVER:

- The L293 and L293D are quadruple high-current half-H drivers.
- The L293 is designed to provide bidirectional drive currents of up to 1A at voltages from 4.5V to 36V.



OPERATION OF MOTOR DRIVER (L293D):



TRUTH TABLE:

A	B	DESCRIPTION
0	**0**	Motor stops or Breaks
0	**1**	Motor Runs Anti-Clockwise
1	**0**	Motor runs Clockwise
1	**1**	Motor stops or breaks

For the above table, the Enable has to be set 1. Motor power is mentioned as 12V, but the power supply can be connected according to the rating of the motors used.

NOTE:

- The above operation of a Motor Driver demonstrates its working with only one DC motor connected to it. Note that in our robot the PCB is used to drive two motors and the settings need to be done accordingly.

DC MOTORS:

D.C Motors are the easiest to control. One D.C Motor requires two signals for its operation. To change its direction one just needs to reverse the polarity of power supply across it.

Figure of DC Motor

Speed of motor depends upon its RPM rating and we can vary the speed of motor by changing the voltage across the motor terminals. Gears are used to increase the torque of D.C Motor on the expense of its speed.

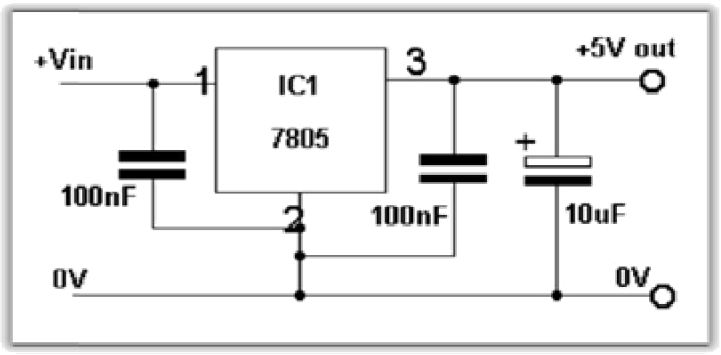
SPECIFICATIONS OF THE MOTORS USED IN WORKSHOP:

60 RPM-12V DC Geared Motor.

VOLTAGE REGULATOR:

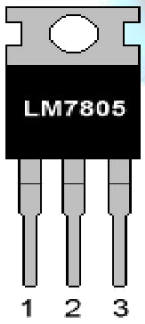
7805 is a **Voltage Regulator** Integrated Circuit. It is a member of 78xx series of fixed linear voltage regulator ICs.

BLOCK DIAGRAM:



The **Voltage Regulator IC** maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage to which it is designed to provide. 7805 provides +5V regulated power supply.

PIN DIAGRAM OF 7805:



PIN CONFIGURATION OF 7805:

Pin No	NAME	FUNCTION
1	Input	Input Voltage; (5V-18V)
2	Ground	Ground (0V)
3	Output	Output Voltage; (4.8V-5.2V)

ACCELEROMETER:

It's an electromechanical device that measures acceleration forces and tilt angles by using the MEMS (Micro Electro Mechanical Systems) technology, where acceleration is the rate of change of velocity with respect to the time. Acceleration forces may be Static acceleration or Dynamic acceleration depending upon the way one uses the accelerometer.
Example: ADXL335

STATIC ACCELERATION:

Static acceleration is the constant force of gravity and by measuring the amount of it, one can find out the angle at which the device tilted (with respect to the earth).
Example: Gravity pulling at your feet.

DYNAMIC ACCELERATION:

Dynamic acceleration is the dynamic (variable) force of gravity and by measuring the amount of it, one can analyse the way the device is moving.
Example: Moving Car

HOW DOES AN ACCELEROMETER WORKS?

Accelerometer works by sensing the changes in the capacitance. If one places two microstructures next to each other, then they'll have a certain capacitance between them. If an accelerative force moves one of the structures, then the capacitance will change. Adding some circuitry to convert from capacitance to voltage, and one will get an accelerometer- where the output voltage can be used to send signals for microcontroller.

There are even other methods like including the use of piezoresistive effect, hot air bubbles, and light.

TERMINOLOGY IN ACCELEROMETER SENSORS:

- SENSITIVITY:

  Sensitivity is a measure of how much the output of a sensor changes as the change in input acceleration occurs. Where it is measured in Volts/g

  $$\text{Sensitivity} = \frac{\text{Vout}}{g} = \frac{V_{max-1g} - V_{min-1g}}{2g}$$

- RESOLUTION:

  It's the smallest detectable acceleration and one can improve it by adding filtering techniques in the circuit.

- Vcc:

  The voltage supplied to the input of the accelerometer sensor

- % Vcc:

  Often represented as a percentage (%) of the supply voltage and this is mainly considered for the correction due to supply voltage variances between readings

- RATIOMETRIC:

  The output of the sensor changes with a change in the input voltage.

  - Here, the outputs are ratio metric which means that at 0g measurement output is always at half of the 3.3V output (i.e. 1.65V), -3g is at 0V and 3g is at 3.3V.

- BANDWIDTH

  Bandwidth is the amount of times/second one can take a reliable acceleration reading. For small tilt sensing applications, a bandwidth of 50Hz will be required and for vibration measurement one need to have a bandwidth of several hundred Hz and one can select the bandwidth of an accelerometer using the capacitors (Cx, Cy, Cz).

  - Bandwidth Range of 0.5 Hz - 1600 Hz for X and Y axes, and for the Z axis range of 0.5 Hz to 550 Hz is available.
  - The XYZ filter capacitors are 0.1µF for a 50 Hz bandwidth

WHAT'S THE USE OF AN ACCELEROMETER?

- Feedback for Control Systems.
- Tilt, Tilt Angle, Rotation, Gravity, Acceleration, Vibration factors can be measured
- Accelerometer sensors are used in Self-balancing Robots, Model Aeroplane Auto Pilot, Crash Detection/Airbag Deployment, Tilt-Mode Game Controllers.

ADXL335:

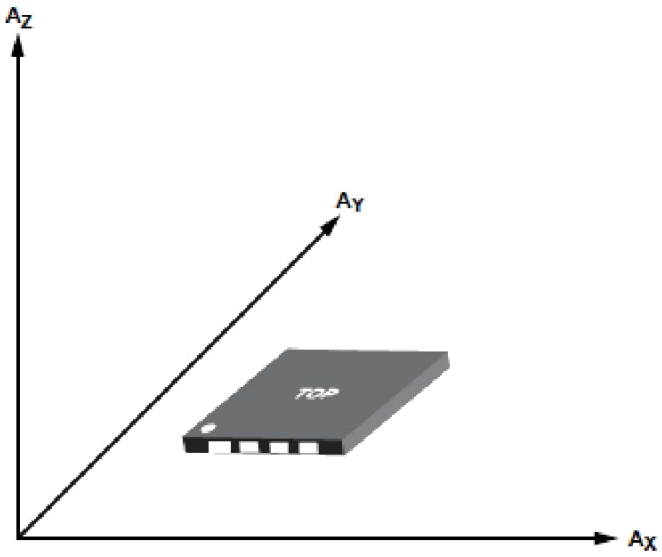
It's a 3 axis accelerometer with signal conditioned voltage outputs where it measures acceleration within minimum full-scale range of ±3 g.

Where 'g' is a unit of acceleration equal to Earth's gravity at sea level-32.2 ft/ ^{2} or 9.81m/ ^{2}

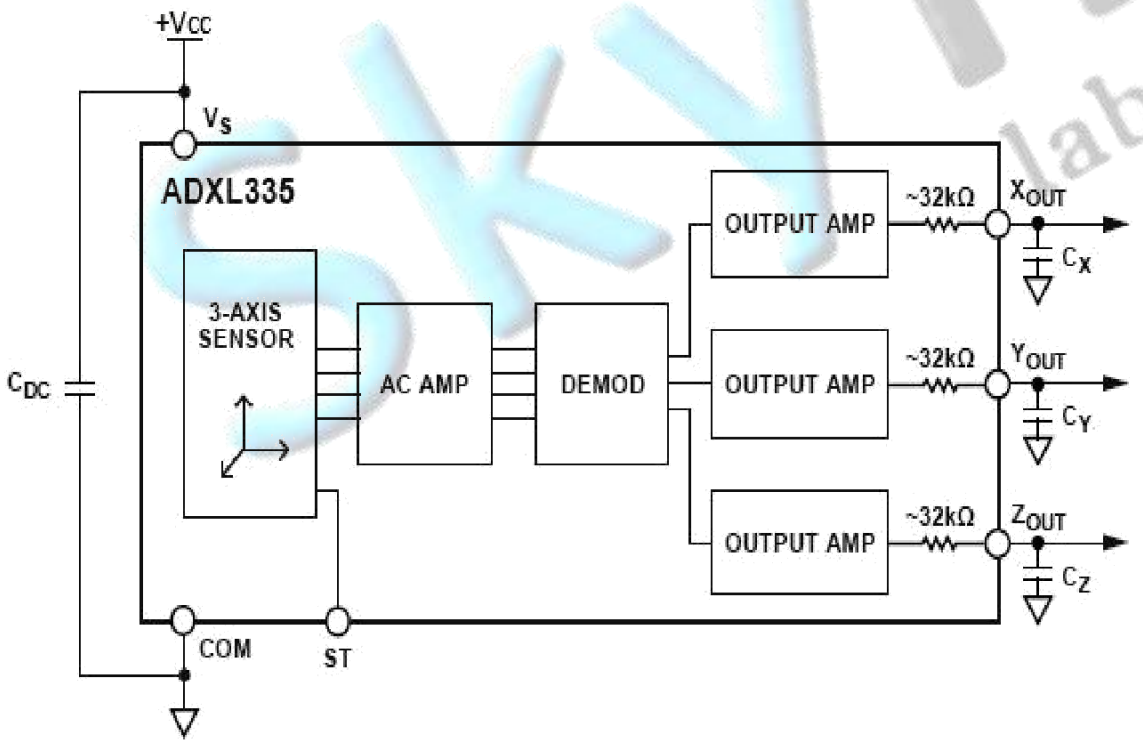
FEATURES OF ADXL335:

- 3-axis sensing
- It can measure the static acceleration of gravity.
  - Example: Tilt sensing applications
- It can also measure dynamic acceleration.
  - Example: Shock, Vibration and Motion measurement Applications
- Temperature stability of ADXL335 is excellent.
- Supply voltage of 5V and an operating voltage of 3.3V
  - Has an in-built Voltage Regulator to regulate 5V to 3.3V.

AXES OF ADXL 335:



BLOCK DIAGRAM OF ADXL335:



ADXL 335 is a 3-axis accelerometer sensor and made up of a polysilicon surface-micro machined structure built on the top of a silicon wafer and polysilicon springs suspend the structure over the wafer surface, providing a "resistance" against the acceleration forces. Deflection of the structure is measured by using a differential capacitor which consists of independent fixed plates, and those plates are attached to the moving mass, where fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and

thus unbalances the differential capacitor resulting in a sensor output, whose amplitude is proportional to the acceleration.

Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The demodulator's output is amplified and brought off-chip through a resistor. One has to set the signal bandwidth of 50 Hz to the device by adding a 0.1µF capacitor, and this filtering improves measurement resolution and also helps in preventing aliasing.

OUTPUT RESPONSE VS ORIENTATION TO GRAVITY: