ACCELEROMETER BASED HAND CONTROLLED ROBOT

Submitted in partial fulfillment of the Degree of

Bachelor of Technology

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CERTIFICATE

This is to certify that project report entitled “--”, submitted by ----------------- (roll no.), ------------- (roll no), ------------------------------ (roll no) in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date:

Supervisor’s Name: Prof. T.S. Lamba

Designation: Dean (Academic& research)

ABSTRACT

In many application of controlling robotic gadget it becomes quite hard and complicated when there comes the part of controlling it with remote or many different switches mostly in military application, industrial robotics, and construction vehicles in civil side and medical application for surgery. In this field it is quite complicated to control the robot or particular machine with remote or switches, sometime the operator may get confused in the switches and button itself, so in this project a new concept is introduced to control the machine with the movement of hand which will simultaneously control the movement of robot.

The aim of this project is to controlling a small four wheeled robot by using ACCELEROMETER SENSOR (Micro Electro-Mechanical Systems) technology. M.E.M.S.ACCELEROMETER SENSOR is a Sensor which is a highly sensitive sensor and capable of detecting the tilt. This sensor finds the tilt and makes use of the accelerometer to change the direction of the robot depending on tilt. For example if the tilt is to the right side then the robot moves in right direction or if the tilt is to the left side then the robot moves in left direction

A embedded circuit mounted on the palm of the hand will do the purpose of a remote control unit and by mere changing the orientation of our palm we can control our robot.

______________________	______________________
Signature of Student	Signature of Supervisor
Name(s):	Name:
Date	Date

INTRODUCTION

Automation is common word in electronics and heart of many modern control systems. In the past few decades there has been a tremendous change in the automation technology with new technologies emerging at a very fast pace. One such technology that came up in the past decade was the introduction of microelectronic mechanical sensors (M.E.M.S.). These had greater importance than any other technologies due its user-friendly nature and find its use in several daily applications like mobile phones, motor vehicles etc.

Most of the applications and control systems we know today are controlled by a remote control unit which may be wired or wireless the remote controlled units operate against the press of the buttons or gears of other similar hardware interface.

But now we are equipped with various intelligent technologies like image processing, micro electro mechanical chips that we can control processes with gestures of limb movement. We will be discussing about the latter one we mentioned as our project is entirely based on the accelerometer technology

We have worked on a accelerometer controlled four wheeled robot which moves in four different direction according to the respective shift in the orientation of the accelerometer which is held at a distance and operates wirelessly. The accelerometer mentioned above is basically a solid state microelectronic mechanical sensor chip.

REVIEW AND BACKGROUND MATERIAL

There has been a lot of research in the field of Robotics where scientists and researchers have developed Robots which are operated with the help of joystick or remote, latest with accelerometer in the picture they have started developing Robots which can be operated without the use of remotes.

There are many ways in which we can develop our Accelerometer based Hand controlled Robot because the basic principle is to utilize the values of accelerometer accordingly and process is to make the motor moves in certain fashion.

We can use Microcontroller at the place of Comparator IC to process the signal coming from Accelerometer and proceed with the set of processed values from the microcontroller. This style of operation is being utilized at many places and people have developed Accelerometer Based Hand Controlled Robot using Microcontroller.

Neverthless there have been various issues regarding the working of the project in the past like the transmission of signal from transmitter end to the receiver end effectively and thus giving the same set of values to the motor driver IC i.e. to the Actuator IC, further the Decoder and Encoder pairs if used must be matched appropriately (address matching if used) otherwise the decoder will not be able to catch the data sent by its corresponding encoder pair.

Keeping all the above things in mind the project is advancement in the field of Robotics where we are eliminating the use of traditional remotes and making the Robot move with the hand movements with the help of Accelerometer. We can find its wide range of applications like it can help handicapped people who cannot use remotes to just control robot with their hand movement, since it is quite handy so it can be employed in defense applications also where just by moving hands we can send robot any where we like, apart from all this it is very useful in day to day life where use of robot is required.

OVERVIEW AND PROJECT AT A GLANCE

The project comprises of a four wheeled robot which is capable of turning in four directions and a remote control unit which is accelerometer based and the movement of the robot is controlled wirelessly by the hand mounted remote control unit which is accelerometer based

Our whole working model can be divided into two parts i.e.

- The transmitting station.
- The receiver station

(A) The transmitting station: The transmitting station is essentially the control unit that generates the decision and wirelessly transmits the information to the receiver station.
It consists of a accelerometer (measuring static acceleration). The accelerometer senses the acceleration in the x and y directions. The output from the x and y terminals of the accelerometer (change in voltage due to change in orientation) is fed to a comparator (four operational amplifiers in one IC). A set of reference voltages is fed the op amps for comparison and by adjusting the reference voltages of the two sets we get five different set of output values which will correspond to the different spatial orientation of the accelerometer i.e. one for rest and four for +x,-x,+y,-y. The output from the comparator is parallel and has to be converted to serial output before being wirelessly transmitted. This job is done by a 12bit series encoder. The encoder receives the parallel input and then the serial output from the output pin is fed to the radio frequency transmitter. The transmitter transmits the data wirelessly over to the receiver.

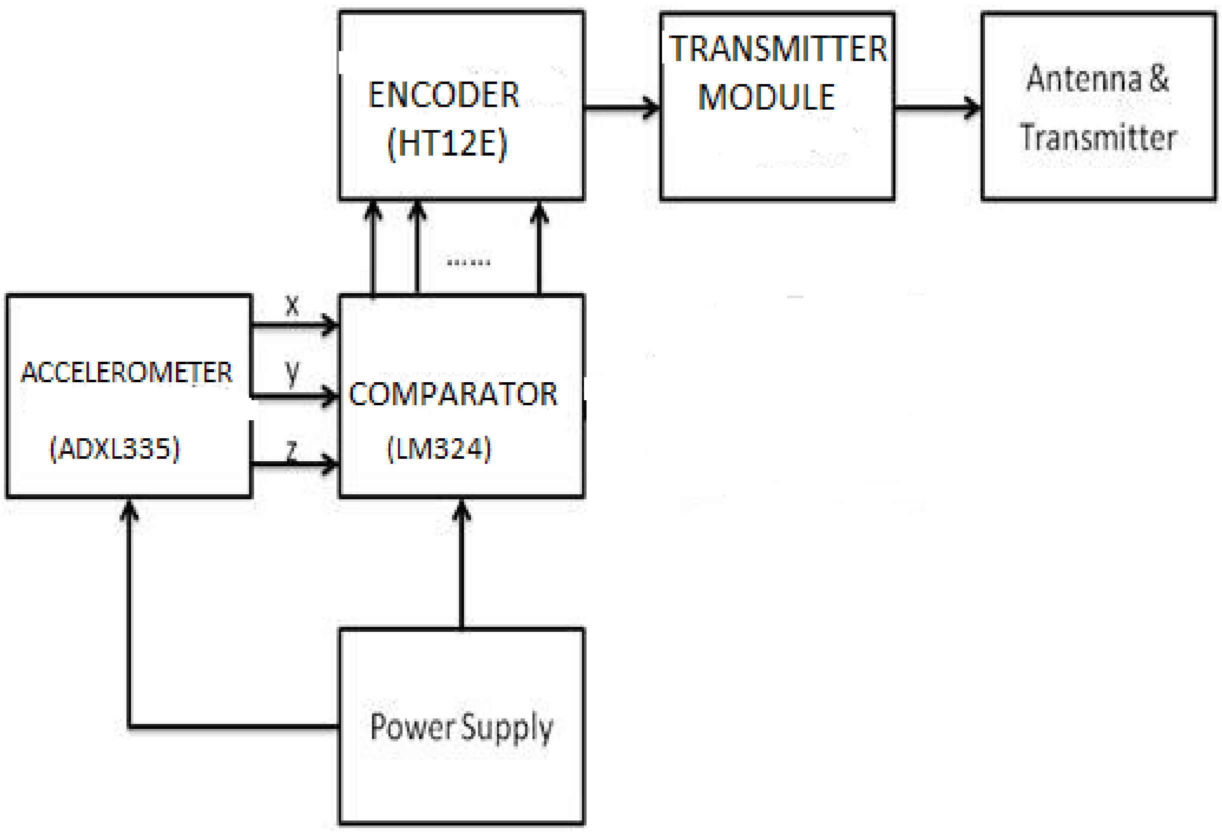
(B) The receiving station: The receiver station is basically the four wheeled robot with electronic circuitry. The wireless signal sent by the radio transmitter is received by a Radio frequency module at the receiver side. The serial input received is fed to the decoder which converts back the serial data into parallel. The parallel output is fed to a microcontroller which is programmed for the required suitable output as per the given set of inputs. The outputs are the fed to the actuators (motor drivers). The rpm of the motors can be controlled by adjusting the voltages of the actuators. The actuators drive the four wheels in different directions based on the input fed from the microcontroller.

Finally when everything is at place the robot moves in forward direction when we tilt the accelerometer in forward direction and vice versa. Similarly when the sensor is tilted in left position .In the subsequent chapters we will be dealing with each component in detail.

CHAPTER 4

THE TRANSMITTING STATION (CONTROL UNIT)

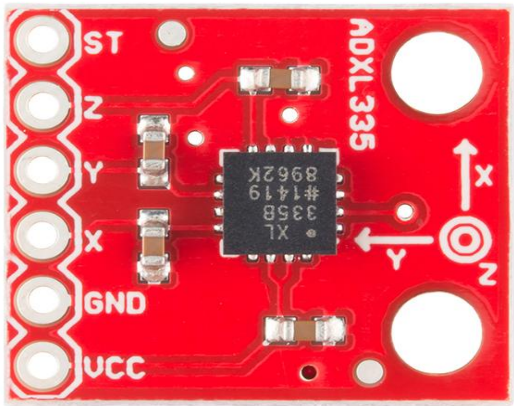
Transmitter block diagram



THE FIRST AND MOST IMPORTANT THING WE COME ACROSS WHILE WE ARE DEALING WITH THE TARNSMITTER IS THE ACCELEROMETER WHICH IS THE HEART OF THE PROJECT

(4.1)

ACCELEROMETER (ADXL 335)

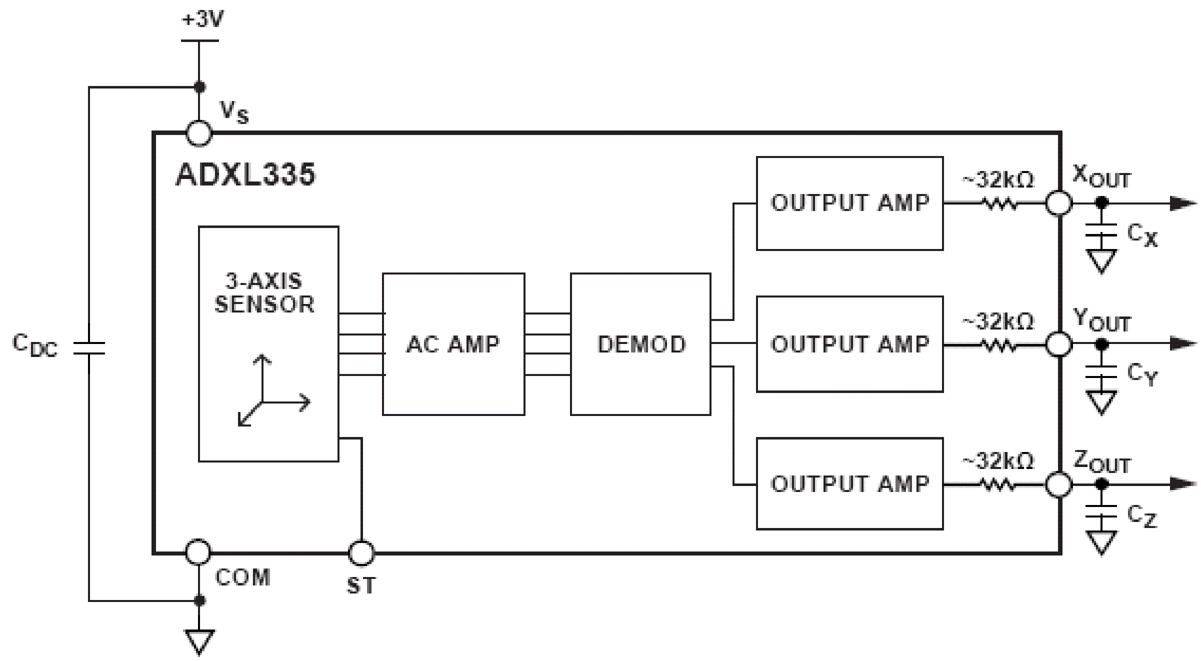


The ADXL335 is a complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock,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

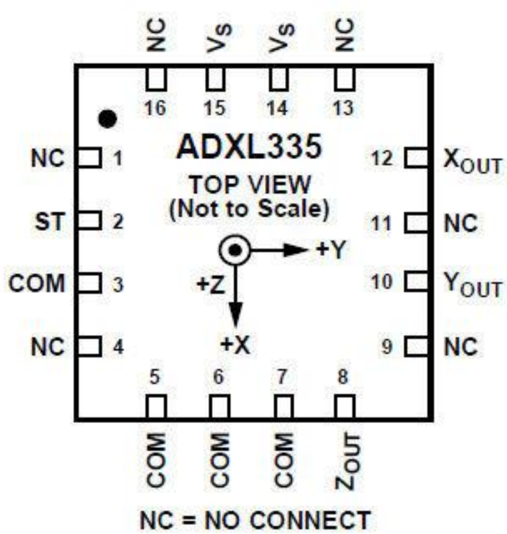
THEORY OF OPERATION

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

Block diagram of ADXL335



Pin description of adxl335



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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		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

The above chart gives the specifications of the adxl335.

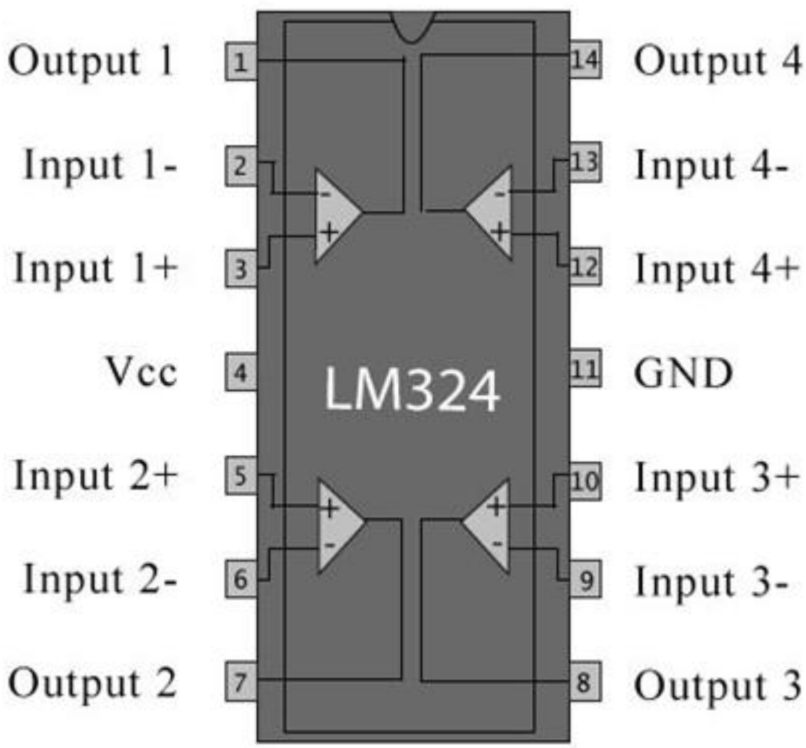
(4.2)

COMPARATOR(LM324)

Description

These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V and V_{CC} is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Pin description and internal alignment of the operational amplifiers



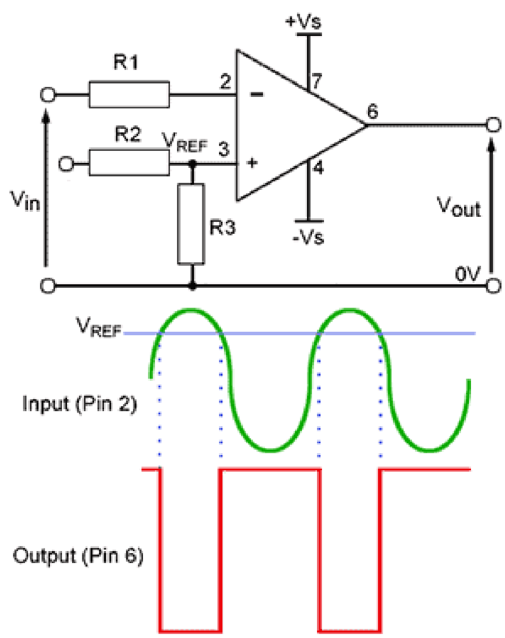
Operational amplifier

An **operational amplifier** (op-amp) is a D.C.-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output.In this configuration, an op-amp produces an output potential (relative to circuit ground) that is typically hundreds of thousands of times larger than the potential difference between its input terminals.

LM324 has four built in amplifiers.

Operation:

The amplifier's differential inputs consist of a non-inverting input (+) with voltage V_+ and an inverting input (–) with voltage V_-; ideally the op-amp amplifies only the difference in voltage between the two, which is called the *differential input voltage*. The output voltage of the op-amp V_{out} is given by the equation: Vout = Aol (V+ - V-). where A_{OL} is the open-loop gain of the amplifier (the term "open-loop" refers to the absence of a feedback loop from the output to the input).



Features:

Internally Frequency Compensated for Unity gain.

Large DC Voltage Gain 100 dB

Wide Bandwidth (Unity Gain) 1 MHz

Low Input Biasing Current 45 nA

Large Output Voltage Swing 0V to V+ − 1.5V

DATASHEET

ABSOLUTE MAXIMUM RATINGS[1][2]

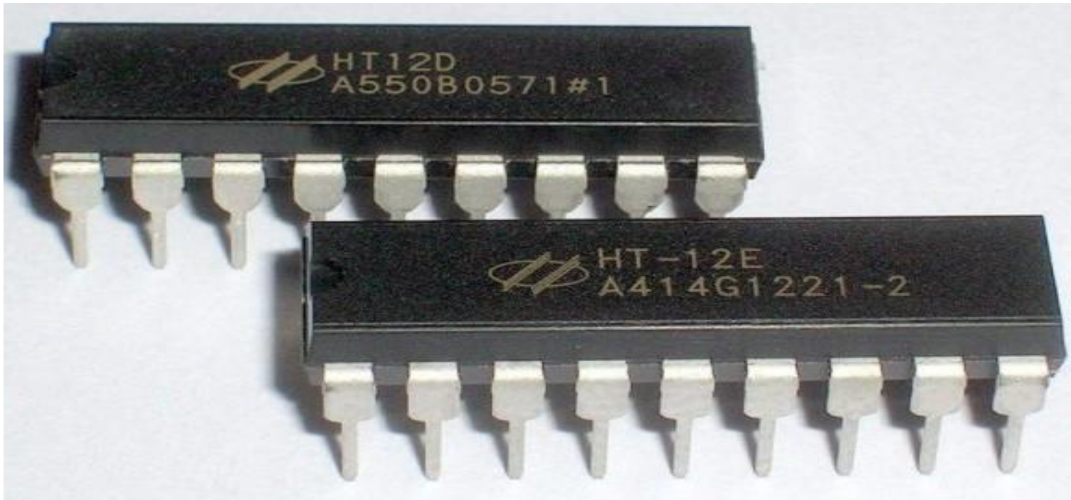
			LM124-N/LM224-N/LM324-N LM124A/LM224A/LM324A	LM2902-N
Supply Voltage, V^+			32V	26V
Differential Input Voltage			32V	26V
Input Voltage			−0.3V to +32V	−0.3V to +26V
Input Current ($V_{IN} < -0.3V$)[3]			50 mA	50 mA
Power Dissipation[4]	PDIP		1130 mW	1130 mW
	CDIP		1260 mW	1260 mW
	SOIC Package		800 mW	800 mW
Output Short-Circuit to GND (One Amplifier)[5]				
$V^+ \leq 15V$ and $T_A = 25°C$			Continuous	Continuous
Operating Temperature Range				−40°C to +85°C
LM324-N/LM324A			0°C to +70°C	
LM224-N/LM224A			−25°C to +85°C	
LM124-N/LM124A			−55°C to +125°C	
Storage Temperature Range			−65°C to +150°C	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)			260°C	260°C
Soldering Information	Dual-In-Line Package	Soldering (10 seconds)	260°C	260°C
	Small Outline Package	Vapor Phase (60 seconds)	215°C	215°C
		Infrared (15 seconds)	220°C	220°C
ESD Tolerance[6]			250V	250V

(4.3)

ENCODER (HT12E)

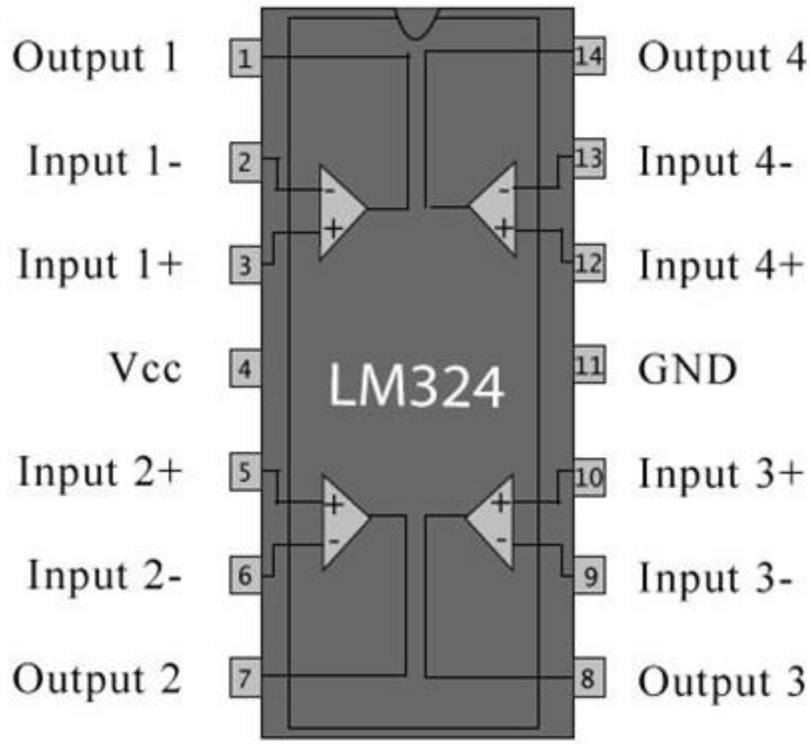
HT12E is a 2^{12} series encoder IC (Integrated Circuit) for remote control applications. It is commonly used for radio frequency (RF) applications. By using the paired HT12E encoder and HT12D decoder we can easily transmit and receive 12 bits of parallel data serially. HT12E simply converts 12 bit parallel data in to serial output which can be transmitted through a RF transmitter. These 12 bit parallel data is divided in to 8 address bits and 4 data bits. By using these address pins we can provide 8 bit security code for data transmission and multiple receivers may be addressed using the same transmitter.

HT12E is able to operate in a wide voltage range from 2.4V to 12V and has a built in oscillator which requires only a small external resistor. Its power consumption is very low, standby current is 0.1µA at 5V VDD and has high immunity against noise. It is available in 18 pin DIP (Dual Inline Package) and 20 pin SOP (Small Outline Package).



Encoder decoder pair.(DIP)

Pin Diagram and Description



VDD and VSS are power supply pins which are used to connect positive and negative of the power supply respectively.

- OSC1 and OSC2 are used to connect external resistance for the internal oscillator. OSC1 is the oscillator input pin and OSC2 is the oscillator output pin.
- Oscillator of HT12E
- TE is used for enabling the transmission and is an active low input.
- A0 – A7 are the input address pins. By using these pins we can provide a security code for the data. These pins can be connected to VSS or left open.
- D8 – D11 are the input data pins. These pins can be connected to VSS or may left open for sending LOW and HIGH respectively.
- DOUT – It is the serial data output of the encoder and can be connected to a RF transmitter**.**

ELECTRICAL CHARACTERSTICS

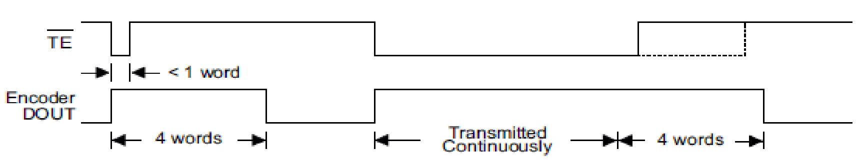
HT12E Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.4	5	12	V
I_{STB}	Standby Current	3V	Oscillator stops	—	0.1	1	μA
		12V		—	2	4	μA
I_{DD}	Operating Current	3V	No load f_{OSC}=3kHz	—	40	80	μA
		12V		—	150	300	μA
I_{DOUT}	Output Drive Current	5V	$V_{OH}=0.9V_{DD}$ (Source)	-1	-1.6	—	mA
			$V_{OL}=0.1V_{DD}$ (Sink)	1	1.6	—	mA
V_{IH}	"H" Input Voltage	—	—	$0.8V_{DD}$	—	V_{DD}	V
V_{IL}	"L" Input Voltage	—	—	0	—	$0.2V_{DD}$	V
f_{OSC}	Oscillator Frequency	5V	R_{OSC}=1.1MΩ	—	3	—	kHz
$R_{\overline{TE}}$	$\overline{TE}$ Pull-high Resistance	5V	$V_{\overline{TE}}$=0V	—	1.5	3	MΩ

Functional Description

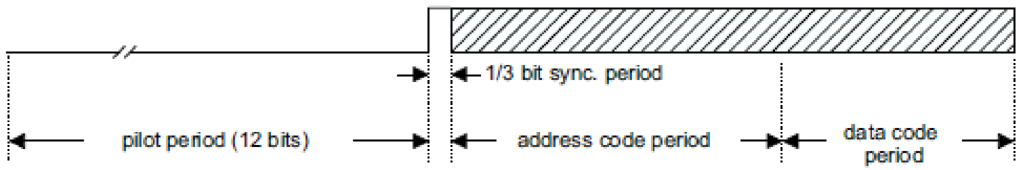
Operation

The 212 series of encoders begin a 4-word transmission cycle upon receipt of a transmission enable (TE for the HT12E or D8~D11 for the HT12A, active low). This cycle will repeat itself as long as the transmission enable (TE or D8~D11) is held low. Once the transmission enable returns high the encoder



Transmission timing for the HT12E

Information word

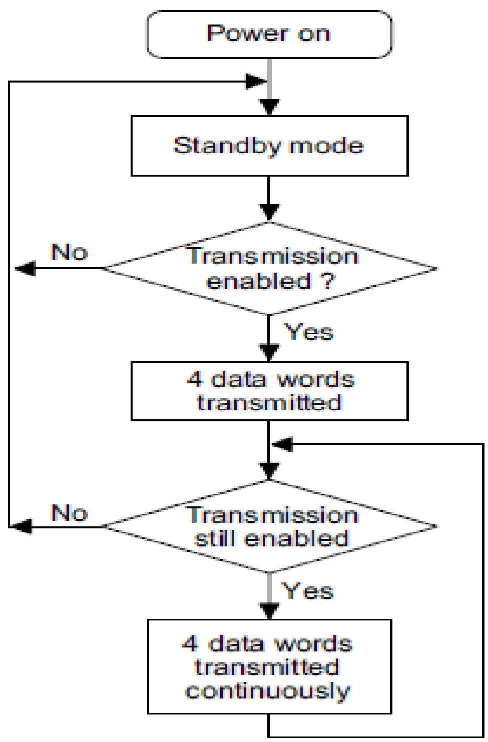


Composition of information

If L/MB=1 the device is in the latch mode (for use with the latch type of data decoders). When the transmission enable is removed during a transmission, the DOUT pin outputs a complete word and then stops. On the other hand, if L/MB=0 the device is in the momentary mode (for use with the momentary type of data decoders). When the transmission enable is removed during a transmission, the DOUT outputs a complete word and then adds 7 words all with the _1_ data code.

FLOWCHART OF THE WORKING

- **HT12E**



RADIO FREQUENCY MODULE (RF)

An **RF module** (radio frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices

As with any other radio-frequency device, the performance of an RF module will depend on a number of factors. For example, by increasing the transmitter power, a larger communication distance will be achieved. However, this will also result in a higher electrical power drain on the transmitter device, which will cause shorter operating life for battery powered devices. Also, using a higher transmit power will make the system more prone to interference with other RF devices, and may in fact possibly cause the device to become illegal depending on the jurisdiction. Correspondingly, increasing the receiver sensitivity will also increase the effective communication range, but will also potentially cause malfunction due to interference with other RF devices.

The performance of the overall system may be improved by using matched antennas at each end of the communication link

TRANSMITTER

An RF transmitter module is a small PCB sub assembly capable of transmitting a radio wave and modulating that wave to carry data.

This is an ASK transmitter module with an output of up to 8mW depending on power supply voltage. The transmitter is based on SAW resonator and accepts digital inputs, can operate from 2 to 12 Volts-DC,.

FEATURES:

Frequency Range: 315MHz

Modulate Mode: ASK

Circuit Shape: SAW

Date Rate: 8Kbps

Supply Voltage: 1.5~12V

Output Power : 14dBm

Working temperature: -20~+85℃

Solder temperature: 230℃(10 seconds).

PIN DESCRIPTION:

Pin	Function
1	GND
2	Data in
3	Vcc
4	ANT

ELECTRICAL CHARACTERSTICS

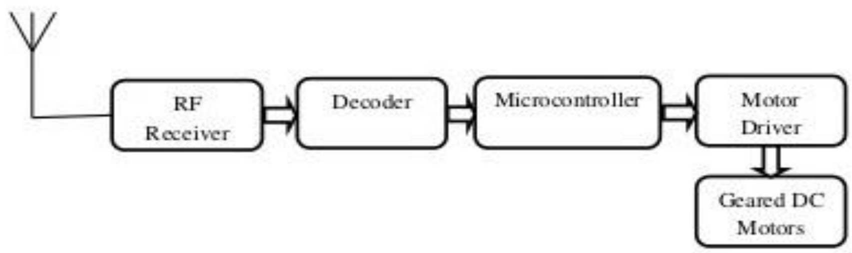
Characteristic	Min	Type	Max	Unit
Operating Frequency (±250KHz)	314.75	315.00	315.25	MHz
Data Rate			8	Kbps
Current Consumption			8	mA
Output Power			32	mW
Operating Voltage	3		12	VDC
Operating Ambient Temperature	-20		+85	℃

(CHAPTER 5)

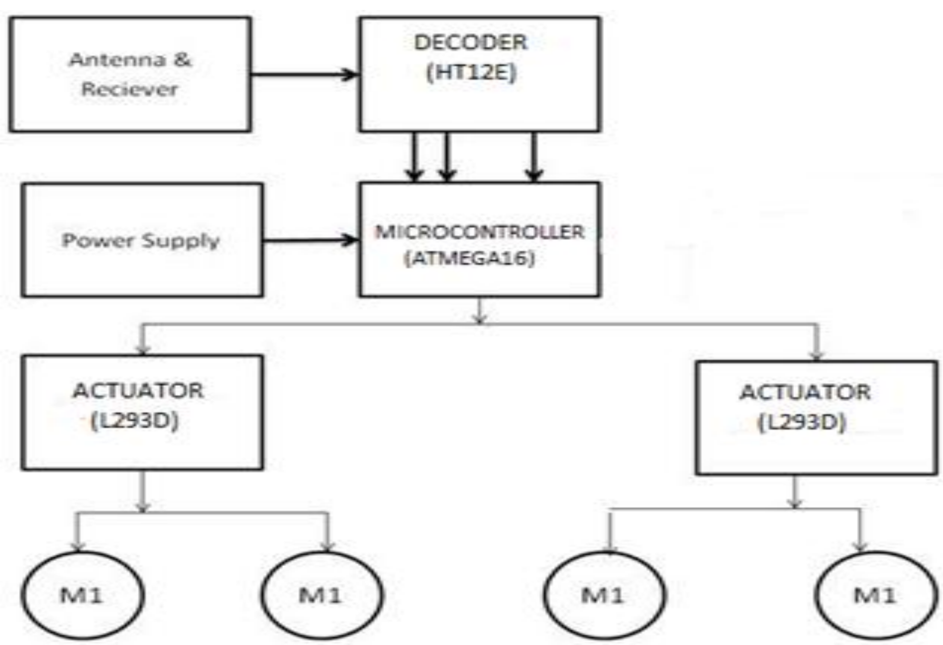
THE RECEIVING STATION

(FOUR WHEELED ROBOT)

Here we will be talking about the four wheeled robot controlled by four independent motors build on stiff chassis housing a electronic circuit over it.



BLOCK DIAGRAM



(5.1)

RECIEVER RADIO FREQUENCY MODULE

The first component we come across in the bread board is radio frequency receiver module .

1. Product Model: MX-05V
2. Operating voltage: DC5V
3. Quiescent Current: 4mA
4. Receiving frequency:315Mhz
5. Receiver sensitivity:-105DB
6. Size: 30 * 14 * 7mm

The receiver pin description is same as the transmitter chip

It contains 4 pins i.e.

VCC

Tx

Gnd

Data: The serial output which is fed to the comparator.

(5.2)

DECODER(HT12D)

The decoder (ht12d) is a complimentary pair of the encoder (ht12e). **HT12D** is a **decoder integrated circuit** that belongs to 2^{12} series of decoders .

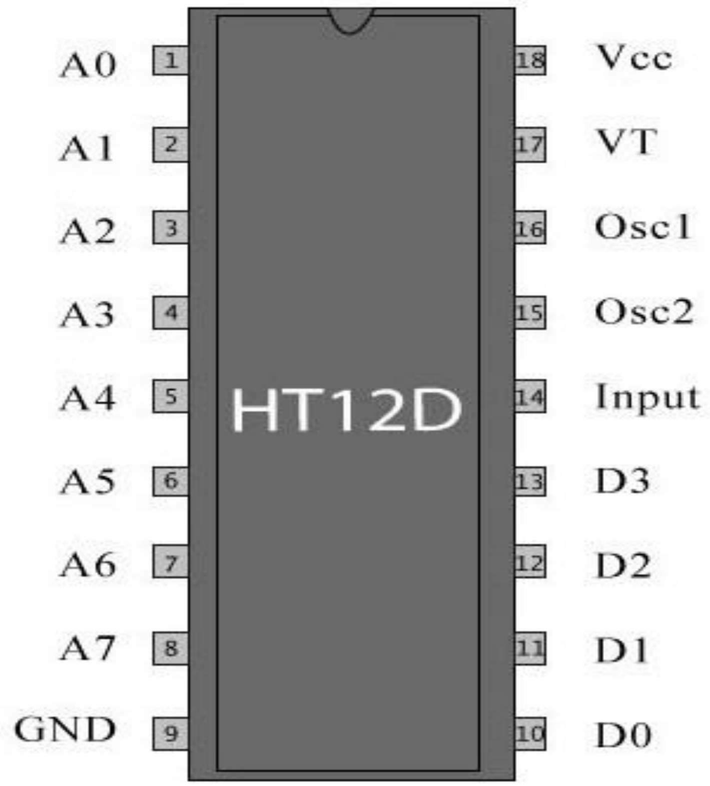
In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin. We have put a led at the VT pin, glowing of the led indicates a valid transmission.

Electrical Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.4	5	12	V
I_{STB}	Standby Current	5V	Oscillator stops	—	0.1	1	μA
		12V		—	2	4	μA
I_{DD}	Operating Current	5V	No load, f_{OSC}=150kHz	—	200	400	μA
I_O	Data Output Source Current (D8~D11)	5V	V_{OH}=4.5V	−1	−1.6	—	mA
	Data Output Sink Current (D8~D11)	5V	V_{OL}=0.5V	1	1.6	—	mA
I_{VT}	VT Output Source Current	5V	V_{OH}=4.5V	−1	−1.6	—	mA
	VT Output Sink Current		V_{OL}=0.5V	1	1.6	—	mA
V_{IH}	"H" Input Voltage	5V	—	3.5	—	5	V
V_{IL}	"L" Input Voltage	5V	—	0	—	1	V
f_{OSC}	Oscillator Frequency	5V	R_{OSC}=51kΩ	—	150	—	kHz

Pin diagram and description



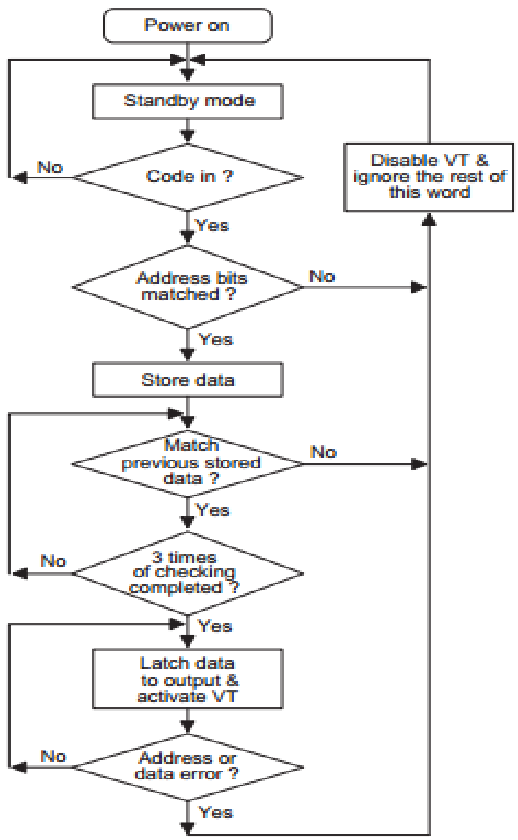
Pin Description

- **VDD and VSS** are used to provide power to the IC, Positive and Negative of the power supply respectively. As I said earlier its operating voltage can be in the range 2.4V to 12V
- **OSC1 and OSC2** are used to connect external resistor for internal oscillator of HT12D. OSC1 is the oscillator input pin and OSC2 is the oscillator output pin as shown in the figure below.

- **A0 – A7** are the address input pins. Status of these pins should match with status of address pin in HT12E (used in transmitter) to receive the data. These pins can be connected to VSS or left open.
- **DIN** is the serial data input pin and can be connected to a RF receiver output.
- **D8 – D11** are the data output pins. Status of these pins can be VSS or VDD depending upon the received serial data through pin **DIN**.

- **VT** stand for Valid Transmission. This output pin will be HIGH when valid data is available at D8 – D11 data output pins.

<u>Flowchart and working</u>



HT12D decoder will be in standby mode initially ie, oscillator is disabled and a HIGH on DIN pin activates the oscillator. Thus the oscillator will be active when the decoder receives data transmitted by an encoder. The device starts decoding the input address and data. The decoder matches the received address three times continuously with the local address given to pin A0 – A7. If all matches, data bits are decoded and output pins D8 – D11 are activated. This valid data is indicated by making the pin VT (Valid Transmission) HIGH. This will continue till the address code becomes incorrect or no signal is received.

(5.3)

MICROCONTROLLER

(ATMEGA 16)

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz.

ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively.

ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.

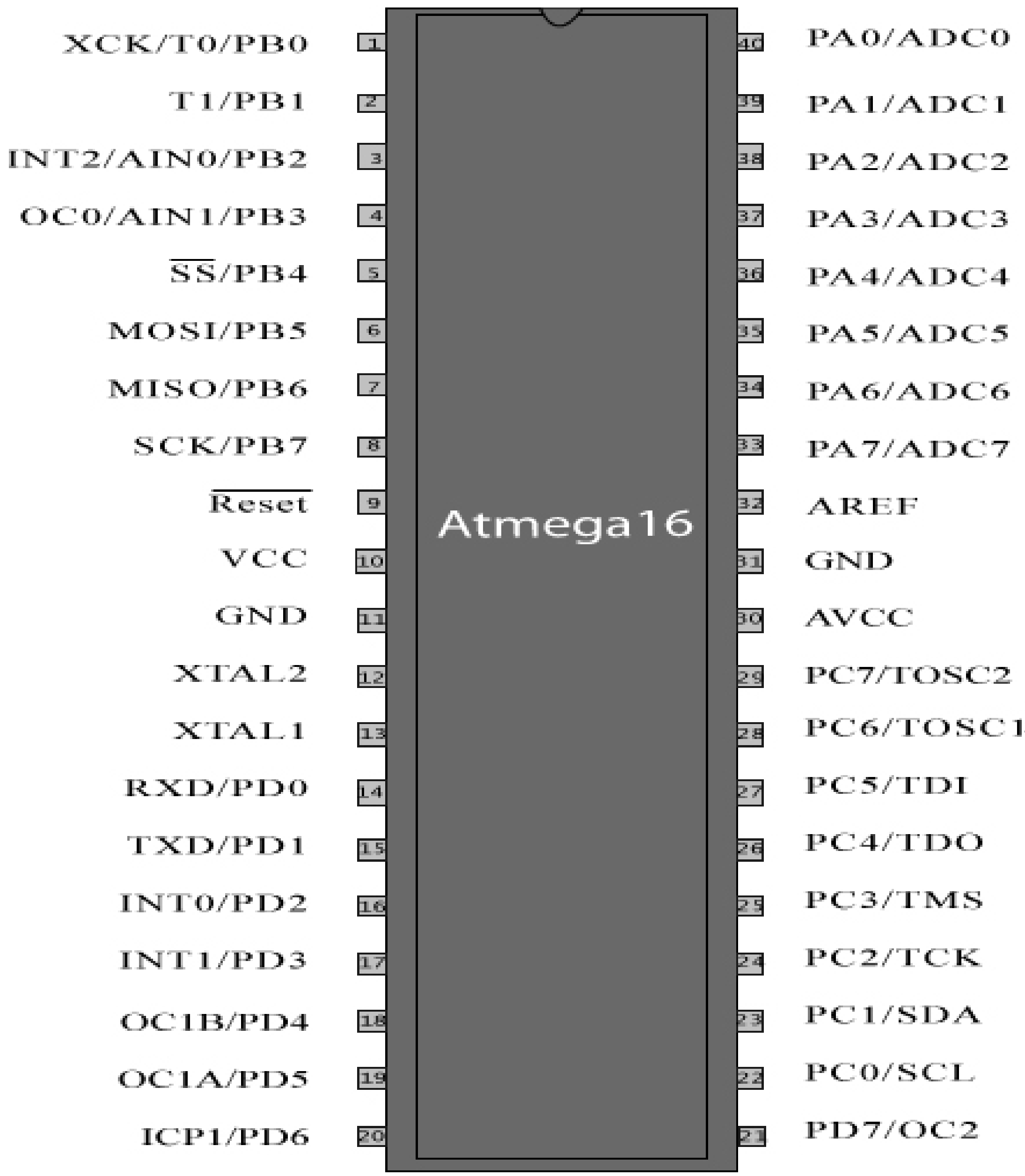
ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator , SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16.

Features

- High Performance, Low Power Atmel®AVR® 8-bit Microcontroller
- Advanced RISC Architecture
- 131 Powerful Instructions - Most Single Clock Cycle Execution
- 32 × 8 General Purpose Working Registers
- Fully Static Operation
- Up to 1 MIPS throughput per MHz
- On-chip 2-cycle Multiplier
- Data and Non-Volatile Program Memory
- 16/32/64K Bytes Flash of In-System Programmable Program Memory
- 512B/1K/2K Bytes of In-System Programmable EEPROM
- 1/2/4K Bytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/ 100,000 EEPROM

- Data Retention: 20 years at 85°C/ 100 years at 25°C(1)
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- –Programming Lock for Flash Program and EEPROM Data Security
- On Chip Debug Interface (debugWIRE)
- CAN 2.0A/B with 6 Message Objects - ISO 16845 Certified
- LIN 2.1 and 1.3 Controller or 8-Bit UART
- One 12-bit High Speed PSC (Power Stage Controller)
- Non Overlapping Inverted PWM Output Pins With Flexible Dead-Time
- Variable PWM duty Cycle and Frequency
- Synchronous Update of all PWM Registers
- Auto Stop Function for Emergency Event
- Peripheral Features
- One 8-bit General purpose Timer/Counter with Separate Prescaler, Compare Mode and Capture Mode
- One 16-bit General purpose Timer/Counter with Separate Prescaler, Compare
- Mode and Capture Mode
- One Master/Slave SPI Serial Interface
- 10-bit ADC
- Up To 11 Single Ended Channels and 3 Fully Differential ADC Channel Pairs
- Programmable Gain (5×, 10×, 20×, 40×) on Differential Channels
- Internal Reference Voltage
- Direct Power Supply Voltage Measurement
- 10-bit DAC for Variable Voltage Reference (Comparators, ADC)
- Four Analog Comparators with Variable Threshold Detection
- 100µA ±2% Current Source (LIN Node Identification)
- Interrupt and Wake-up on Pin Change
- Programmable Watchdog Timer with Separate On-Chip Oscillator
- On-chip Temperature Sensor

PIN DIAGRAM



XCK/T0/PB0
T1/PB1
INT2/AIN0/PB2
OC0/AIN1/PB3
SS/PB4
MOSI/PB5
MISO/PB6
SCK/PB7
Reset
VCC
GND
XTAL2
XTAL1
RXD/PD0
TXD/PD1
INT0/PD2
INT1/PD3
OC1B/PD4
OC1A/PD5
ICP1/PD6
Atmega16
PA0/ADC0
PA1/ADC1
PA2/ADC2
PA3/ADC3
PA4/ADC4
PA5/ADC5
PA6/ADC6
PA7/ADC7
AREF
GND
AVCC
PC7/TOSC2
PC6/TOSC1
PC5/TDI
PC4/TDO
PC3/TMS
PC2/TCK
PC1/SDA
PC0/SCL
PD7/OC2

(5.4)

Actuator (L293D):

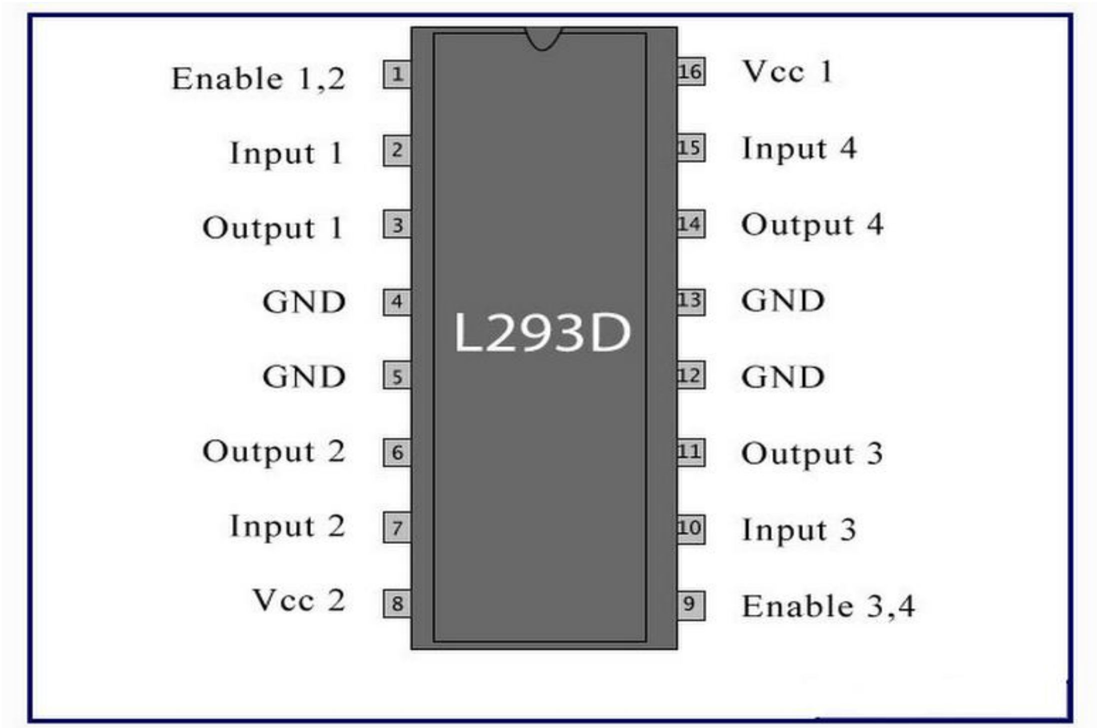
The L293D is a quadruple high-current half-H driver. The L293D is designed to provide bidirectional drive currents of up to 600 mA at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to at voltages from 4.5 V to 36 V. This device is designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

L293D is a motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

PIN DIAGRAM AND DESCRIPTION



Pin Description:

The L293D chip has 16 pins. Here is how each of the pins should be connected:

Pin 1, 9 Enable pins. Hook them together and you can either keep them high and run the motor all the time, or you can control them with you own controller (e.g. 68HC11).

Pin 3, 6, 11, 14 Here is where you plug in the two coils. To tell which wires correspond to each coil, you can use a multimeter to measure the resistance between the wires. The wires correspond to the same coil has a much lower resistance than wires correspond to different coils. (This method only applies to bipolar stepper motors. For unipolar stepper motors, you have to refer to the spec. sheet to tell which wires correspond to each coil.) You can then get one coil hooked up to pin 3,6 and another one hooked up to pin 11, 14.

Pin 4, 5, 12, 13 Gets hooked to ground.

Pin 8 Motor voltage, for the motors we are using, it is 12V.

Pin 16 +5V. It is the power supply of the chip and it's a good idea to keep this power supply separate from your motor power.

Pin 2, 7, 10, 15 Control signals. Here is where you supply the pulse sequence.

Working of L293D:

The there 4 input pins for this l293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

L293D Logic Table

Lets consider a Motor connected on left side output pins (pin 3,6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

• Pin 2 = Logic 1 and Pin 7 = Logic 0 | Clockwise Direction

• Pin 2 = Logic 0 and Pin 7 = Logic 1 | Anticlockwise Direction

• Pin 2 = Logic 0 and Pin 7 = Logic 0 | Idle [No rotation] [Hi-Impedance state]

• Pin 2 = Logic 1 and Pin 7 = Logic 1 | Idle [No rotation]

D.C. Motor

A dc motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by an alternator, generator or dynamo. Many types of electric motors can be run as generators, and vice versa. The input of a DC motor is current/voltage and its output is torque (speed).

CHAPTER 6

BUILD UP OF THE PROJECT

This chapter describes the buildup of the project in step by step manner i.e. how we made the project by using the components which were described in earlier chapters.

Here we describe the making of the entire project from the accelerometer up to the D.C. motors.

ACCELEROMETER:

ADXL335 as we described earlier is a integrated circuit based on microelectronic mechanical sensor but it only measured the dynamic acceleration.

In electronics from dynamic acceleration we mean that it measured only jerks or change in inertia, we got change in output voltage only by dynamic movement, the sensor did not respond to static acceleration i.e. there was no output when we tilted or inclined the sensor.

To solve the problem we had to program the ADXL335 using Aurdino kit.

Aurdino kit: An Arduino board consists of an Atmel 8-, 16- or 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors.

We programmed the adxl335 for x and y directions and hence after the programming we got the required voltage changes as per our requirements in the project.

In the static or horizontal position when a source voltage of 5V was fed to the VCC we got 1.8V in the outputs of the X and Y axis.

When we tilt the sensor in forward direction here we assume it as +x direction we got a change in reading of the sensor gradually increasing from 1.8V to 2.2V and similarly decreasing to 1.4V in the reverse direction. The same went for the Y axis or sideways tilt, where we got the same set of gradual voltage change.

COMPARATOR

The output from the X and Y output pins of the ADXL335 is analog voltage changes. We needed a crisp high or low voltage to differentiate the two states so we have used a comparator in our project that basically consists of four built in op amps as we had discussed in our previous chapters.

The output from the accelerometer is fed to the comparator. There are two outputs from the accelerometer X and Y each output is further divided to two lines to be fed to two different amplifiers inputs namely one input to the inverting terminal and other input to the non inverting terminal. Similar is the case for Y too.

The output of X is fed to one of the inputs of the two op amps say 1st and 2nd, the other input to 1st op amp is a reference voltage V1 which is adjusted according to need, same reference voltage is fed to input of the 3rd operational amplifier. Other input to the second op amp is another reference voltage V2 which is adjusted accordingly and is also the reference voltage of 4th op amp. Similarly Y axis output is fed to one of the inputs of two operational amplifiers say 3rd and 4th. We have four different outputs from four amplifiers.

We selected the first reference voltage as 1.6V and other is 2V. We adjust the two voltages with the help of two variable resistors.

Now we know that the output voltage from X and Y terminals at static horizontal position (0g) is 1.8 V (at 5 V regular supply as Vcc used for biasing).

Different observations are as follows :

At 0 g level (static horizontal level)

- ➔ Input X1= 1.8 V
- ➔ V1 (Reference voltage to positive terminal)= 1.6V
- ➔ Output at Pin No.1= 0.02 V

- ➔ Input X2=1.80 V
- ➔ V2 (reference voltage at negative terminal) = 2V
- ➔ Output at pin number 7= 0.02 V

- ➔ Input Y2=1.80 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 8= 0.02 V

- ➔ Input Y1=1.80 V
- ➔ V1 (reference voltage at positive terminal) = 1.6 V
- ➔ Output at pin number 14= 0.02 V

At 1 g level (in positive X direction)

- ➔ Input X1=1.40 V
- ➔ V1 (reference voltage at positive terminal) = 1.6V
- ➔ Output at pin number 1= 3.73 V

- ➔ Input X2=1.40 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 7= 0.02 V

- ➔ Input Y2=1.80 V
- ➔ V2 (reference voltage at negative terminal) = 2V
- ➔ Output at pin number 8= 0.02 V

- ➔ Input Y1=1.80 V
- ➔ V1(reference voltage at positive terminal) = 1.6V
- ➔ Output at pin number 14= 0.02 V

At -1 g level (in negative X direction)

- ➔ Input X1=2.30 V
- ➔ V1 (reference voltage at positive terminal) = 1.6V
- ➔ Output at pin number 1= 0.02 V

- ➔ Input X2=2.30 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 7= 3.73 V

- ➔ Input Y2=1.80 V
- ➔ V2(reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 8 = 0.02 V

- ➔ Input Y1=1.80 V
- ➔ V1 (reference voltage at positive terminal) = 1.6 V
- ➔ Output at pin number 14= 0.02 V
- ➔

At 1 g level (positive Y direction)

- ➔ Input X1=1.80 V
- ➔ V1 (reference voltage at positive terminal) =1.6 V
- ➔ Output at pin number 1= 0.02 V

- ➔ Input X2=1.80 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 7= 0.02 V

- ➔ Input Y2=2.30 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 8= 3.73 V

- ➔ Input Y1=2.30 V
- ➔ V1(reference voltage at positive terminal) =1.6 V
- ➔ Output at pin number 14= 0.02 V

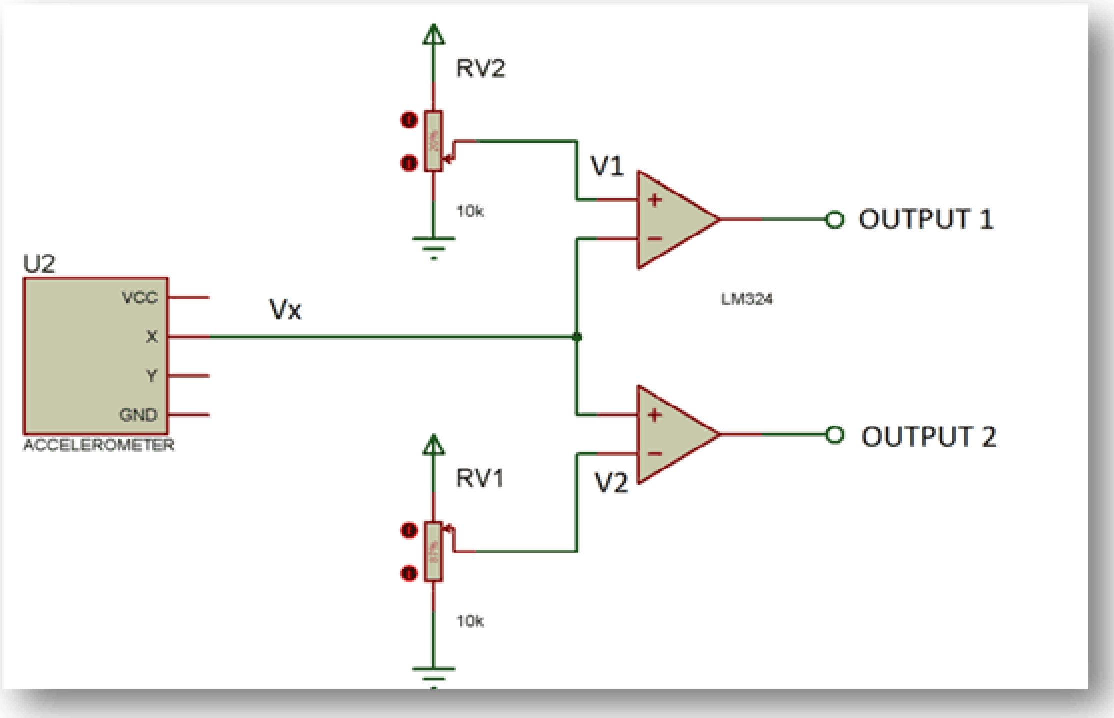
At -1 g level (negative Y direction)

- ➔ Input X1=1.80 V
- ➔ V1 (reference voltage at positive terminal) = 1.6 V
- ➔ Output at pin number 1= 0.02 V

- ➔ Input X2=1.80 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 7= 0.02 V

- ➔ Input Y2=1.40 V
- ➔ V2 (reference voltage at negative terminal) = 2 V
- ➔ Output at pin number 8= 0.02 V

- ➔ Input Y2=1.40 V
- ➔ V1 (reference voltage at positive terminal) = 1.6 V
- ➔ Output at pin number 14= 3.73 V



(Figure depicting operation of Comparator IC with references in place)

Conditions	Output 1	Output 2
Vx > V2	LOW	HIGH
Vx < V1	HIGH	LOW
V2>Vx>V1	LOW	LOW

ENCODER

Encoder here is a 12 bit series encoder i.e. it converts the four parallel outputs of the comparator into one serial output so that it can be transmitted wirelessly by the radio frequency module. The radio frequency module cannot transmit parallel data in this case.

We left first 8 pins of the encoder open and the 9th pin is grounded. The 7 pins were left open as these are the address pins as no address matching was required with the decoder.

Pin10 Pin11 Pin12 Pin13 are the input pins and receive the four outputs of the comparator.

Transmission enable pin which is pin 14 has to be logic low in order to make encoder work. It is hence grounded.

Pin 15 Pin 16 are internal oscillator Pin to provides internal clock. We have put suitable resistance of order of 750k.

Pin 17 is the Dout which has serial output.

Pin 18 is VCC.

RADIO FREQUENCY MODULE

A310 is the IC used. It successfully transmits the data over to the receiver module. Pin 17 output from the encoder is fed to the data pin of the A310. Its specified range depends on the power supply and the antenna. We have tested the pair to work at the range of 200 meter. Antenna usage enhances its capability.

DECODER (HT12D)

The wirelessly transmitted serial information is fed to the 14th pin of the decoder. The output is obtained on the 10th, 11th,12thand 13th pin . Pin 15 and 16 is the oscillator input and output where a resistor was required to make the oscillator work; the resistance has to order of 33k. We have used 33k in the circuit. A valid transmission pin 17 is given a 270 ohm resistance and further connected to a L.E.D. The glowing L.E.D. indicates the successful transmission of the data wirelessly. Pin 18 is VCC.

Pin 0 to pin 7 are left open as no address matching is required as earlier stated. Pin 9 is ground

MICROCONTROLLER

The output from the encoder is fed to the pin 36 37 38 39 40. The micro controller is programmed accordingly so that for every unique set of inputs at the receiver pins it generates a set of outputs at port A and port B.

ACTUATORS

We are using L293 D motor driver which can control two motors bi-directionally. The reason we use a motor driver is because circuits (most of them)/ microcontroller work at a different voltage level when compared to the motor and also they cannot provide enough current to the motors. L293D has 4 inputs and 4 output terminals.

Here is a table showing the input combinations and corresponding outputs.

INPUTS				MOTOR DIRECTION		ROBOT'S MOTION
I1	**I2**	**I3**	**I4**	**LEFT MOTOR**	**RIGHT MOTOR**	
1	0	0	1	Anti Clockwise	Clockwise	Forward
0	1	1	0	Clockwise	Anti Clockwise	BACKWARD
1	0	1	0	Anti Clockwise	Anti Clockwise	RIGHT
0	1	0	1	Clockwise	Clockwise	LEFT

RESULT

After the assembling of the entire project we were able to see the project working according to the desired outcome. We first tilted the bread board (housing the entire circuitry including accelerometer) in the forward direction, corresponding to the shift all four wheels of the robot started moving in the forward direction. When we tilted it in the reverse direction all wheels moved in the backward direction. When we tilted the bread board in the right direction the right hand side wheels moved in backward direction and left wheels moved in forward direction. Similarly when we tilted the bread board in the left direction the left wheels moved in backward direction and the right wheels moved in the forward direction creating a hard turn.

CONCLUSION

From the successful running of the hardware project we can conclude that we have been successful in implementing our project to desired level of expectation.

The design is simple and reliable and this technology can find use in many modern applications like automation for the disabled people in wheel chair etc, advanced control systems where too many controls are involved and the buttons are too confusing, automobile safety features etc.

Improvisation and future possible work

The first issue is that we get a crisp output from the comparator i.e. either zero or one. The robot either moves or stays still. We have no mechanism to control the speed this issue can be fixed by elaborate control system design which may include better voltage amplifiers or fuzzy logic circuits etc, also we can integrate obstacle avoidance and real time monitoring by using passive infrared sensors.

APPENDIX

It is the code we have used to program microcontroller to drive the motor IC's as per our signal coming from Accelerometer

```
#include<avr/io.h>
void main()
{
DDRA=0X00;
DDRB=0XFF;
char c;
while(1)
{
c=PINA;
if(c==0b00000000)
PORTB=0b00000000;
if(C==ob00000001)
PORTB=0b10101010;
if(c==0b00000010)
PORTB=0b01010101;
if(c==0b00000100)
PORTB=0b01011010;
if(c==0b00001000)
PORTB=0b10100101;
}
}
```

REFERENCES

- https://www.sparkfun.com/**datasheets**/Components/SMD/**adxl335**.pdf
- https://www.onsemi.com/pub/Collateral/**LM324**-D.PDF
- www.engineersgarage.com/electronic-components/**ht12e**-datasheet
- http://www.engineersgarage.com/electronic-components/ht12d-datasheet
- http://2embeddedrobotics.blogspot.in/2012/05/gesture-controlled-robot-is-kind-of.html
- http://en.wikipedia.org/wiki/RF_module
- www.ti.com/lit/ds/symlink/l293.pdf
- https://www.youtube.com/watch?v=KZVgKu6v808
- http://www.sensorwiki.org/doku.php/sensors/accelerometer
- http://www.ibtimes.com/how-does-accelerometer-work-smartphone-bill-hammack-engineer-guy-explains-full-text-699762