Embedded systems interfacing

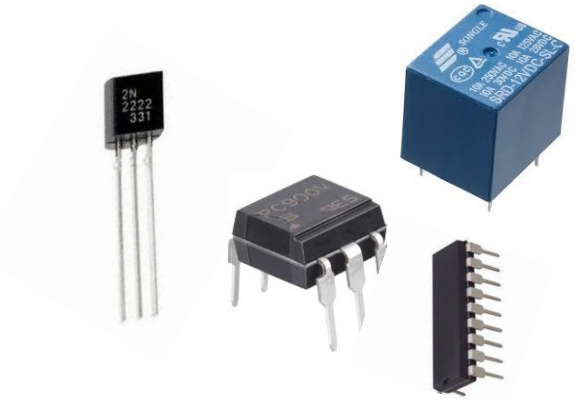
Lecture Five

Electronic switches

Electronic switches

What are electronic switches ?

The electronic switch is an electronic component that can switch an electrical circuit on or off with an electrical control signal.



Why electronic switches?

- ✓ Allow the Microcontroller to control the electrical circuits without human interaction
- ✓ Help in switching the power circuit on and off, the microcontroller plays the switching element not the driving element
- ✓ The Isolation between the control circuit and the power circuit.

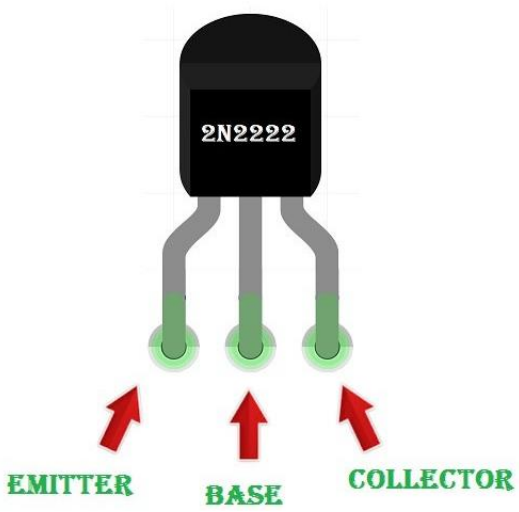
Transistors

Bipolar Transistor Basics:

Transistors are three terminal active devices made from different semiconductor materials that can act as either an insulator or a conductor by the application of a small signal voltage.

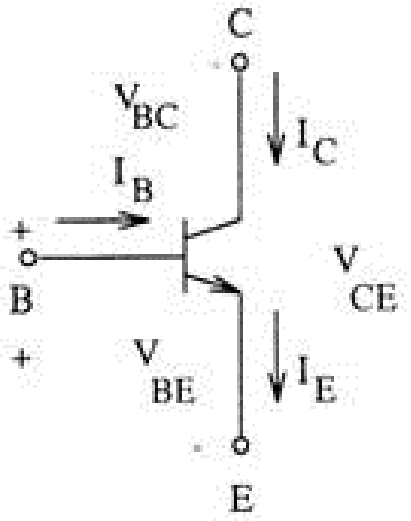
The transistor's ability to change between these two states enables it to have two basic functions: "***Switching***" (digital electronics) or "***Amplification***" (analogue electronics).

There are two basic types of bipolar transistor construction, NPN and PNP



Transistors

The bipolar transistors have the ability to operate within three different regions:



- **1. Active Region –**

Condition: **V**be = 0.7 v and **V**c > **V**b

Action: works as amplifier, **I**c = β **I**b , where β is the amplification factor

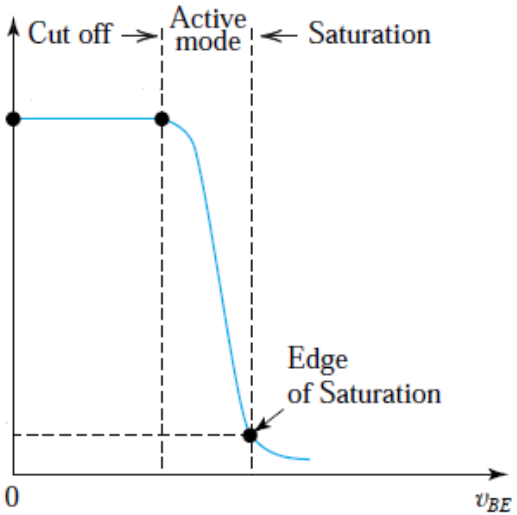
- **2. Saturation**

Condition: **V**be = 0.7 v and **V**c < **V**b

Action: - the transistor is "fully-ON" operating as a switch and **V**c approximately equals to **V**e

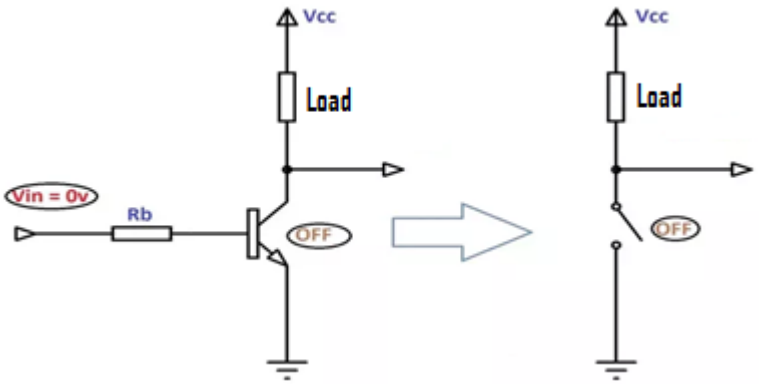
- **3. Cut-off**

Condition: - the transistor is "fully-OFF" operating as a switch and Ic = 0

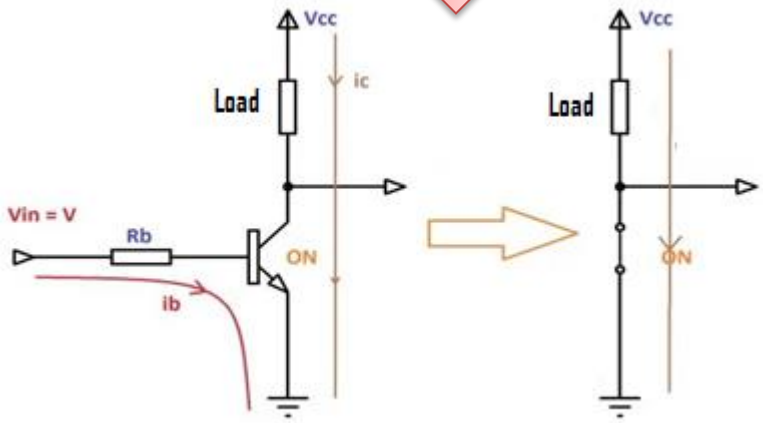


Transistor as a switch

When
Vin = 0V



When
Vin = 5V



Note :

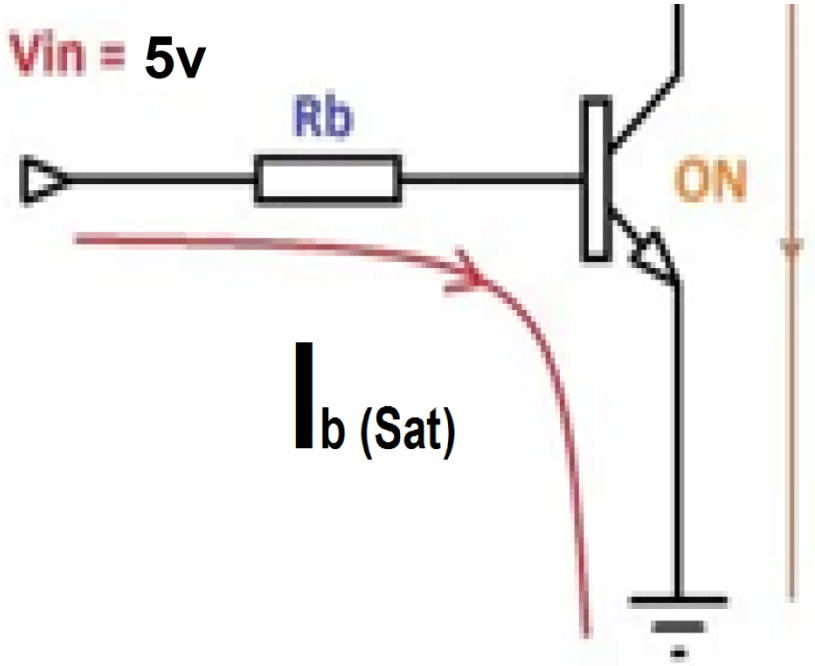
Rb is called a limiting resistor, which is used in order to keep the **Vbe** not exceeding 0.7 v.

Calculating Rb Value

We need to calculate the value of **R**b which achieve the ***saturation*** state when applying 5v on the base.

From the datasheet of the used transistor ***2n222***, the value of the saturation current at base is 15 mA.

By applying Ohm's law:



$$R = \frac{V}{I} = \frac{5v - 0.7v}{15\ mA} = 286\ ohm$$

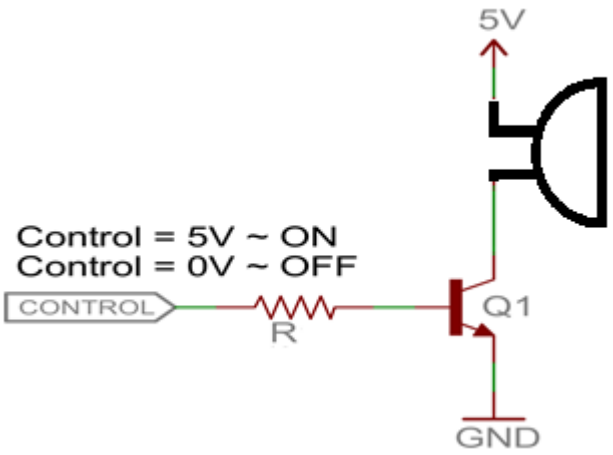
Transistor Interfacing

Simple lab :

Description :

We need to switch a buzzer On & OFF by 2n2222
With delay 1 sec.

Circuit Schematic :



Coding :

DDRA=0b00000001 ;

defined the first pin in port A as output .

PORTA=0b00000001 ;

Set the first pin in port A to 5v supply. "switch is on "

Delay

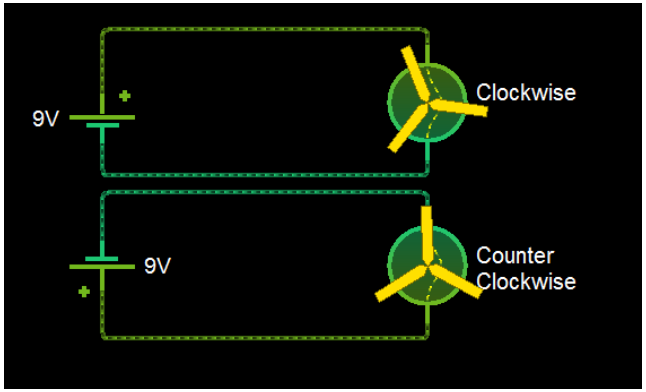
PORTA=0b00000000 ;

Set the first pin in port A as a 0v supply "switch is off"

lab 1

Description :

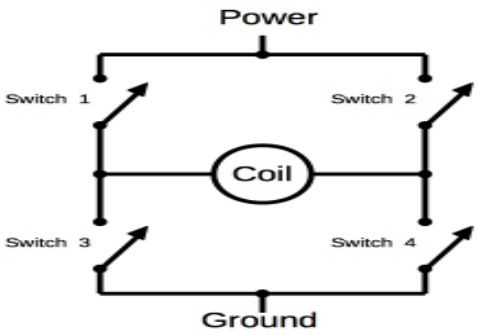
Write a C code to control a DC motor in one direction using a tactile switch. The switch shall act as a breaking the system, the motor shall rotate as long as the switch is not pressed.



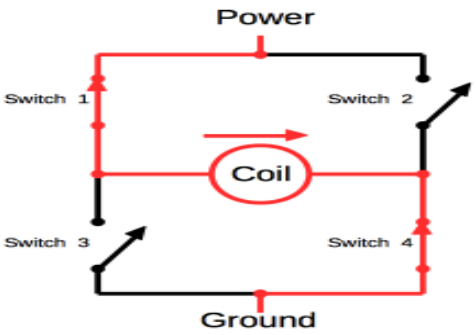
Transistor Interfacing

H-bridge

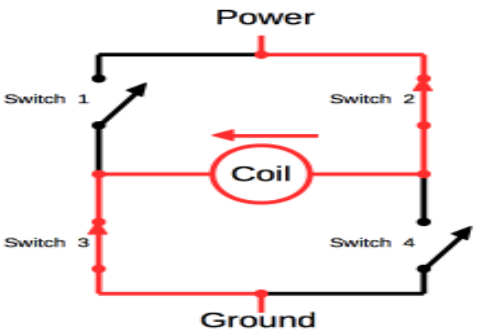
diagram :



Off



Forward



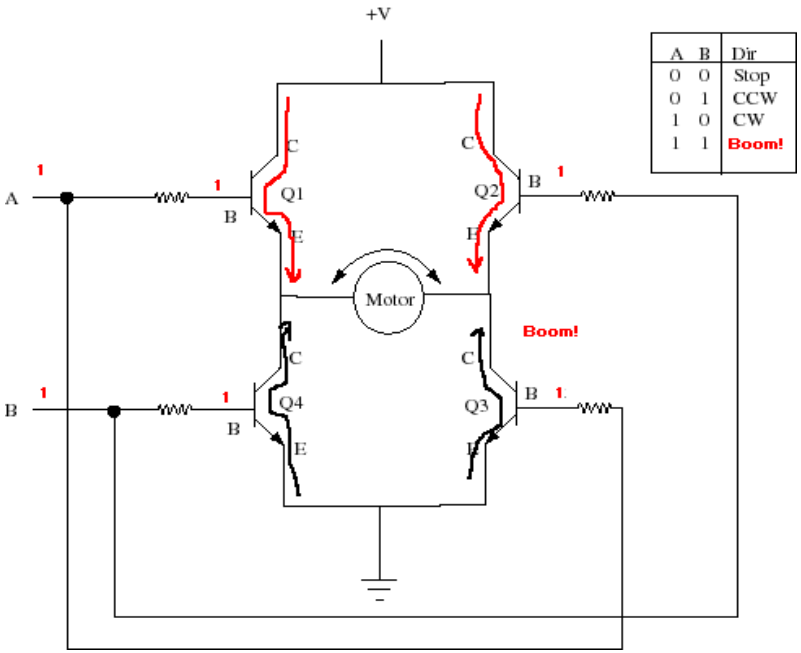
Reverse

Note :

What will happen if we close (S1 & S3) at the same time…?

Lab 2

Circuit schematic :



A	B	Dir
0	0	Stop
0	1	CCW
1	0	CW
1	1	Boom!

Coding :

DDRA=0b00000011 ;

define the first 2 pins in port A as an output **"A & B"** .

PORTA=0b00000001 ;

clockwise

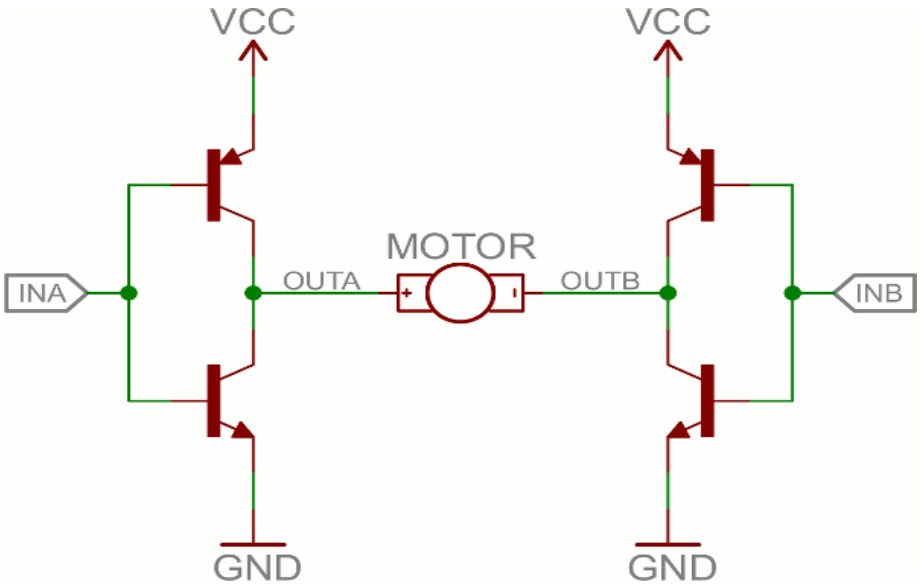
Delay

PORTA=0b00000010 ;

counter clockwise

Transistor Interfacing

We can prevent the danger of **S.C** of the H-bridge by using two NPN and 2 PNP transistors .



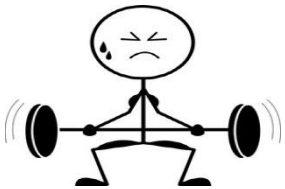
Pros and Cons

❑ *Advantages :*

- Low cost electronic switch
- Small base current controls larger collector current.
- High switching speed.

❑ *Disadvantages :*

- can’t use in switching for loads which need very high Power .
- No isolation between power circuit and control unit



Optocoupler

Optocoupler Basics:

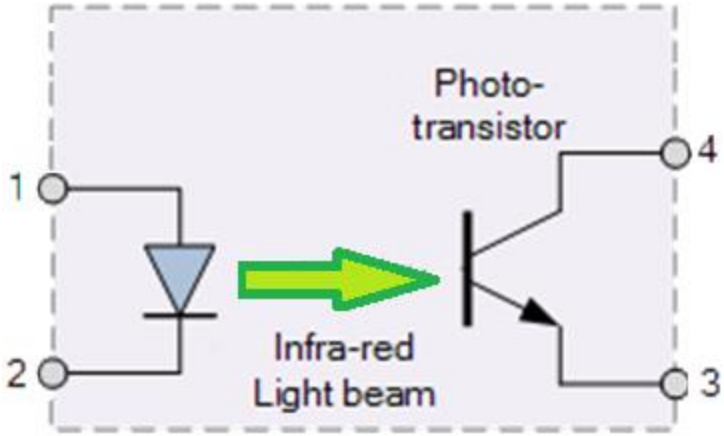
An ***Optocoupler*** (or an optoelectronic coupler) is basically an interface between two circuits which operate at (usually) different voltage levels.

the only contact between the input and the output is a ***beam of light***.

Optocoupler

Working concept:

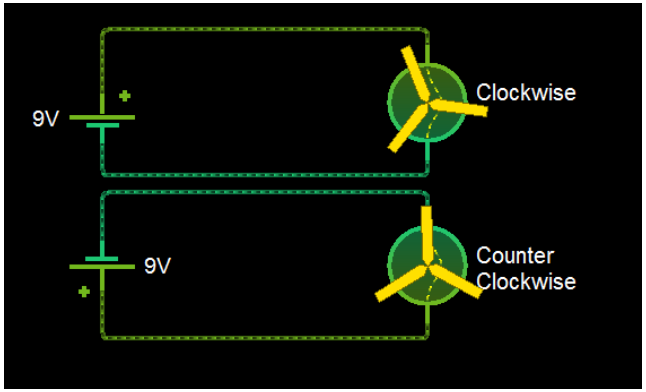
When applying a voltage difference between the LED terminal, a beam of light is generated towards the light sensor installed on the base of a transistor. The light sensor then generates an amount of current causes the transistor to enter a saturation mode. The optocoupler now is in the on state. If no voltage on the LED, then the transistor is on off state and the optocoupler too.



lab 3

Description :

Using Optocoupler, write a C code to control a DC motor in one direction using a tactile switch. The switch shall act as a breaking the system, the motor shall rotate as long as the switch is not pressed.



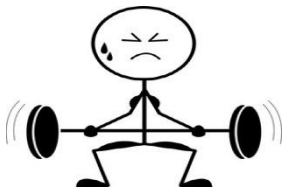
Pros and Cons

❑ *Advantages :*

- It is small size & light weight.
- Low power operation.
- well protected due to electrical isolation. (High isolation impedance).
- High switching speed.

❑ *Disdvantages :*

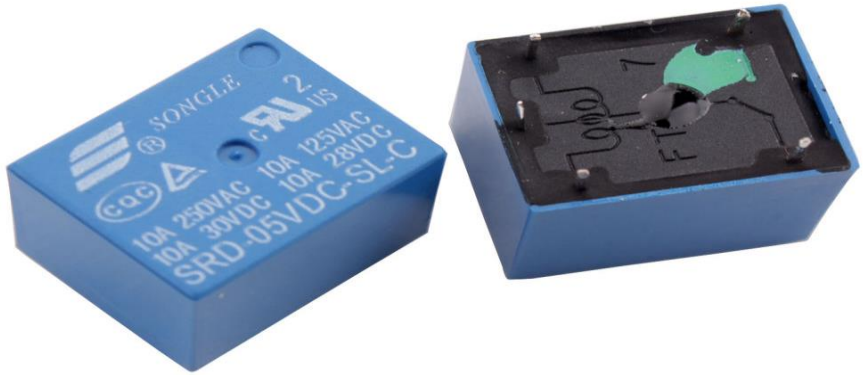
- can’t use in switching for loads which need high Power.
- High cost comparing to transistor



Relays

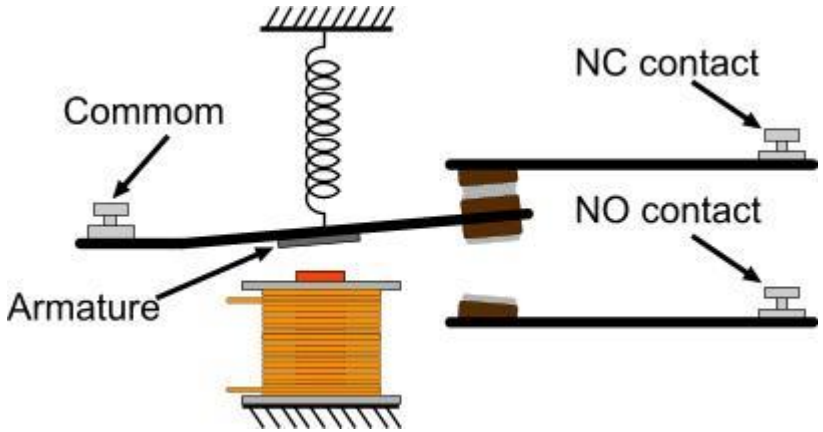
What are relays ?

Relays are electromechanical devices that use an electromagnet to operate a pair of movable contacts from an open position to a closed position.

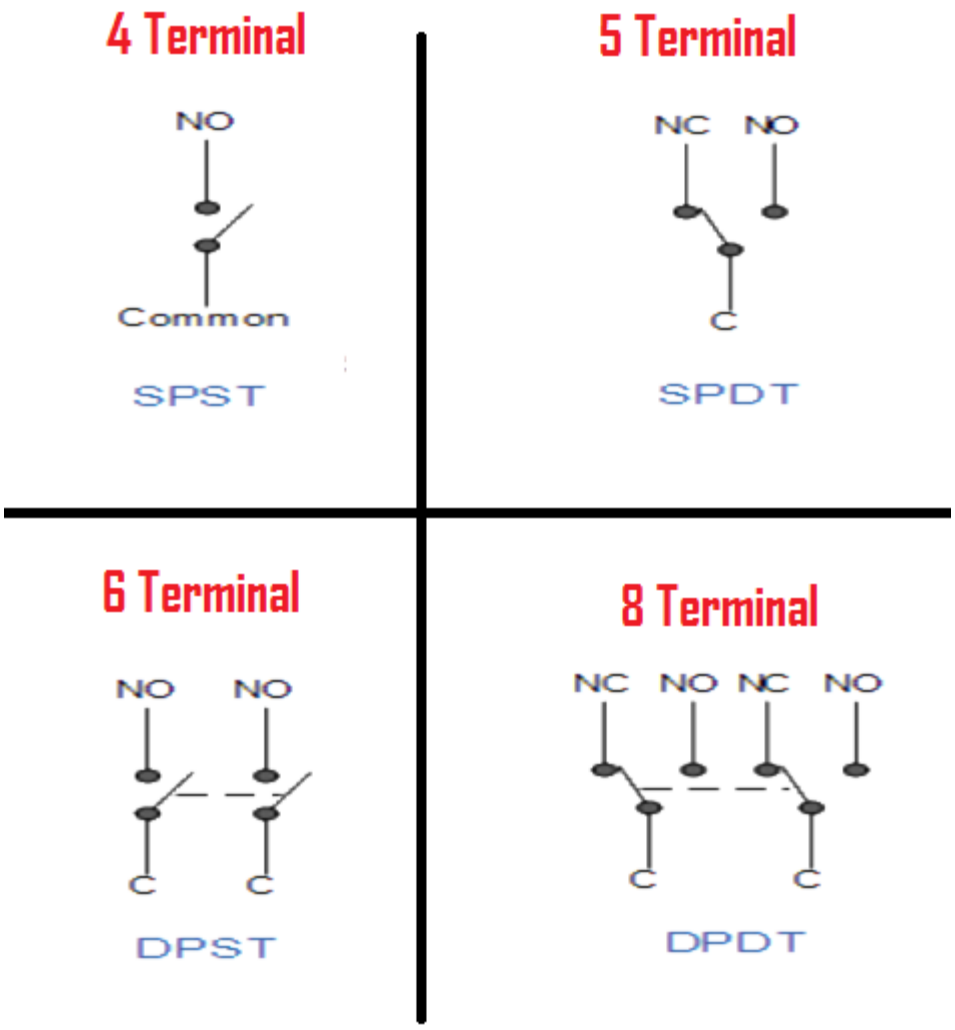


Concept of working :

Low Control Voltage is used to switch contacts of relays which are comparatively at high potential.



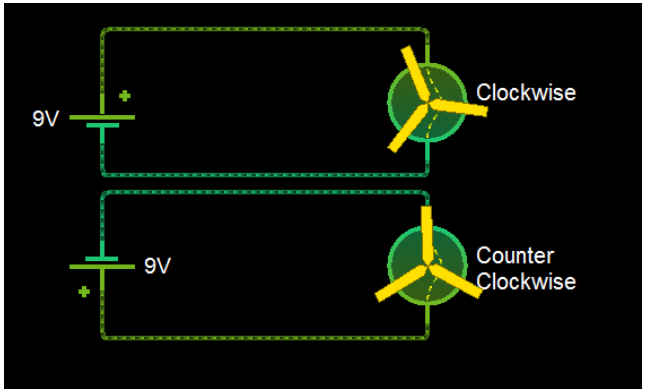
Relay Types


4 Terminal
NO
Common
SPST
5 Terminal
NC
NO
C
SPDT
6 Terminal
NO
NO
C
C
DPST
8 Terminal
NC
NO
NC
NO
C
C
DPDT

lab 4

Description :

Develop a H-bridge circuit using 2 SPDT relays. Rotate the dc motor in clockwise direction for 5 seconds and anti clock wise direction for another 5 seconds.



Pros and Cons

❑ ***Advantages :***

- Simple construction.
- Well protected due to electrical isolation.
- Can be used in switching for loads needs high Power.
- The ability of controlling a AC circuit using a DC control circuit

❑ ***Disdvantages :***

- High cost.
- High power consumption
- Limited speed of operation.
- Suffer from the effects of age.
- Produce magnetic interference.

The End …

Assignment

Using two tactile switches, control DC motor direction. One switch for rotating the motor clockwise and the other one for counter clockwise. The direction of the rotation shall be written on LCD.

IMT SCHOOL

www.imtschool.com

ww.facebook.com/imaketechnologyschool/