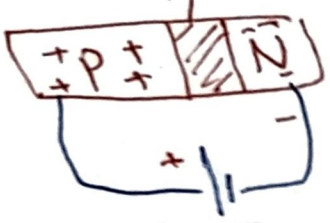
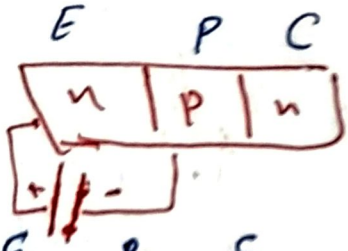
Switches ① Mechanical Switch
② Electrical Switch

① Transistor P-n Junction

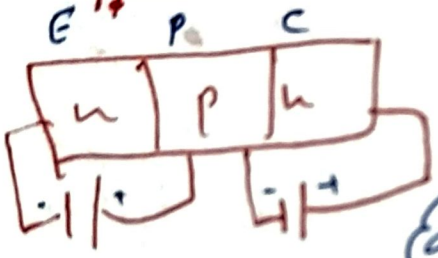


① npn Transistor



~ npn Trans.

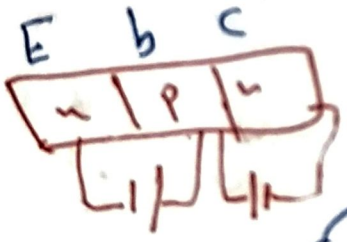
②



* Forward bias between E, B
* Reverse bias ~ b, C

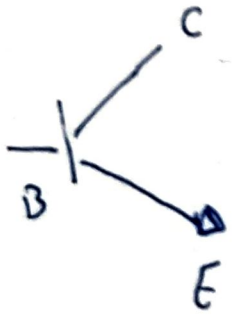
active Mode switch is on

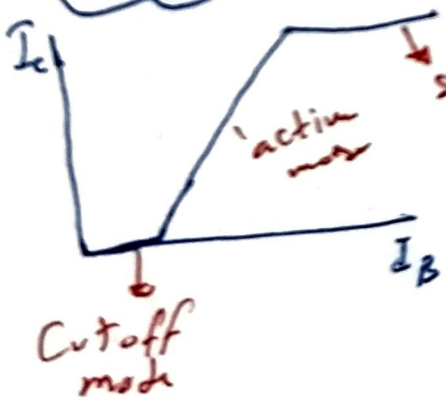
③



* Forward bias between E, b
* Forward bias between b, C

Saturation mode switch is on



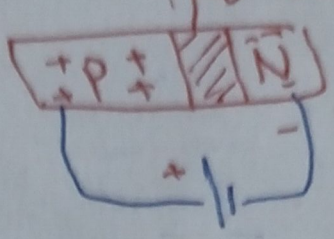


NPN Trans
Ic
2N2222

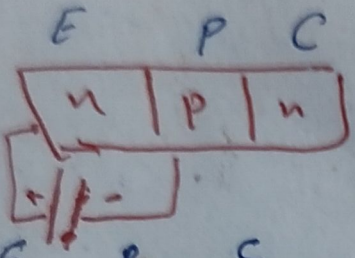
MC

Switches ① Mechanical Switch
② Electrical Switch

① Transistor P-n Junction

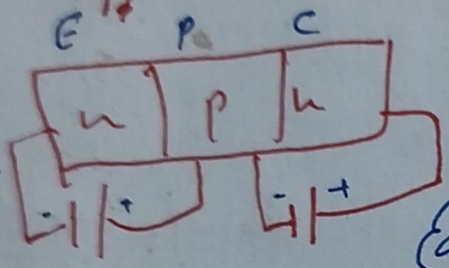


② npn Transistor



— npn Trans

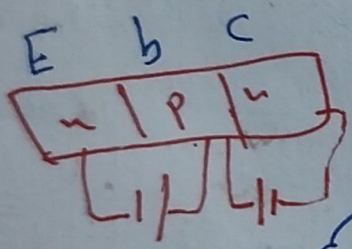
②



* Forward bias between E, B
* Reverse bias ~ b, C

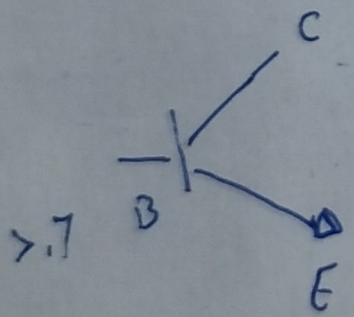
Active Mode switch is off

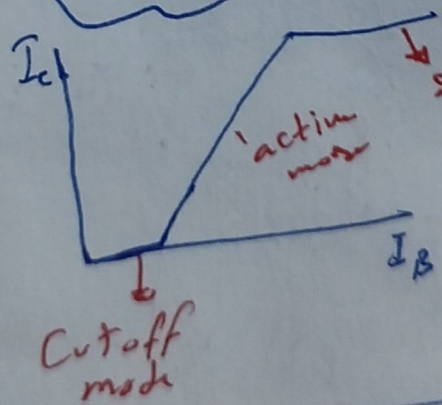
③



* forward bias between E, b
* forward bias between b, C

Saturation mode switch is on





NPN Trans
Ic

2N2222

MC

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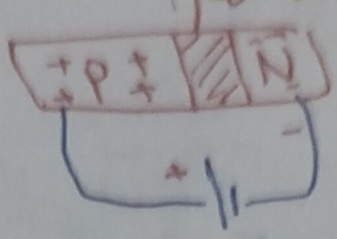
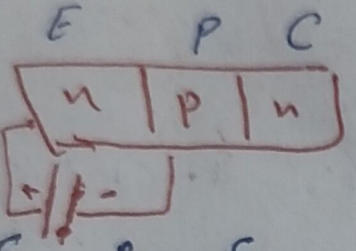
① Transistor P-n Junction

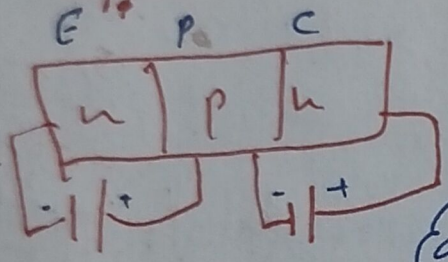


② npn Transistor



— npn Trans.

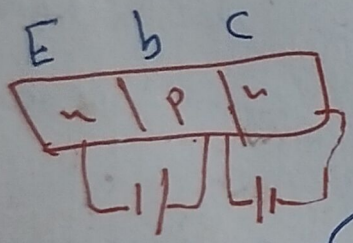
②



* Forward bias between E, B
* Reverse bias ~ b, C

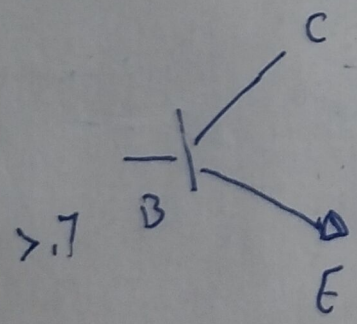
Cactive Mode switch is off

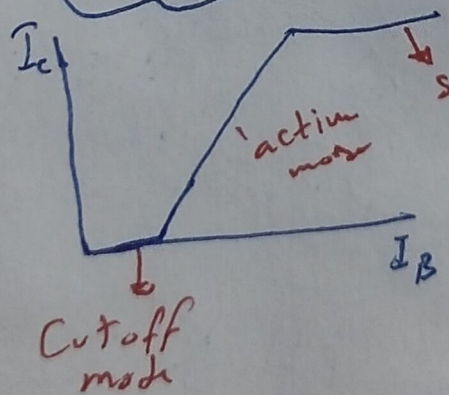
③



* Forward bias between E, b
* Forward bias between b, C

Saturation mode switch is on



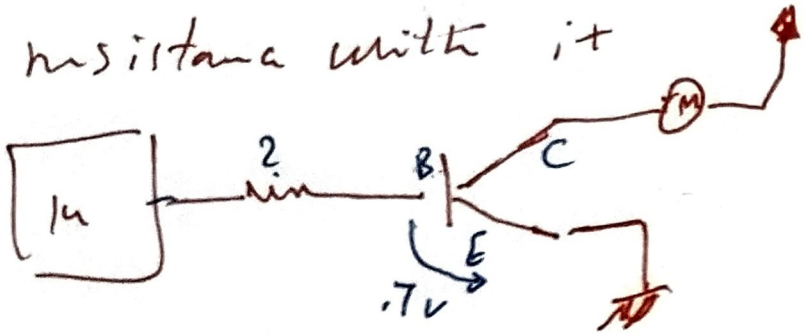


NPN Trans
I_C

2N2222

MC

The 2N2222 only need 15mA to be in saturation mode so we need to add resistance with it



$$R = \frac{\Delta V}{I} = \frac{5 - .7}{15mA} = \Omega$$

; 5v is volt from your Mc

Rule: Never use Mc as driving circuit use it as Control Circuit

---

Brushed DC Motor

Stator → magnet
Rotator → Coil

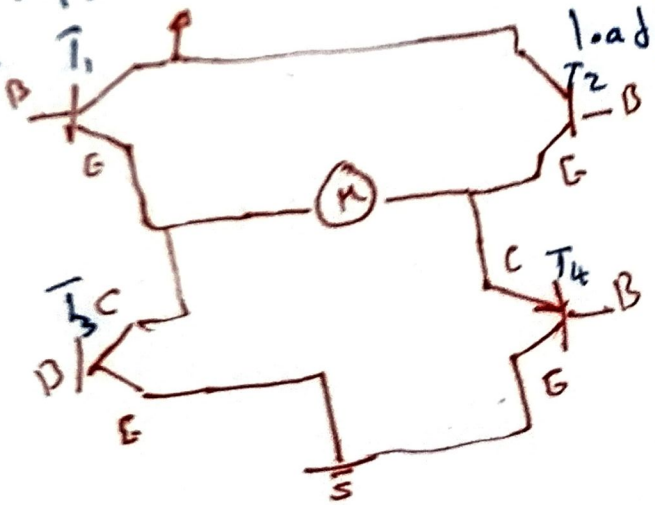
advantages

1. Small size
2. Simple Control
3. low power Cons

disadvantages

1. Control by H.w (change rotation dir)
2. RPM is not stable (depends on load)

H-bridge 4 Transistor NPN

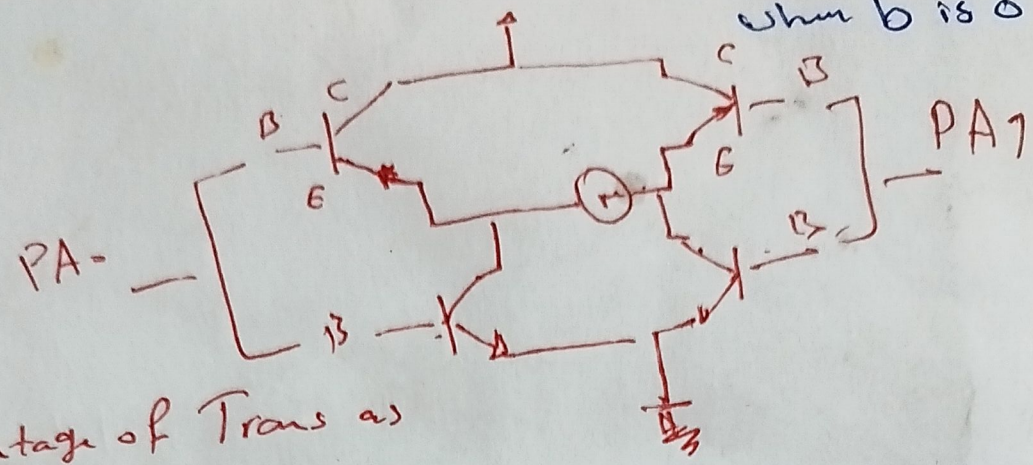


T_1	T_2	T_3	T_4	Motor
0	0	0	0	stop
0	0	0	1	rotate ↷
1	0	0	0	rotate ↶
0	1	1	0	stop
1	1	0	0	stop
0	0	1	1	stop
0	0	1	0	Short Circuit
1	0	1	1	~ ~
0	1	0	1	~ ~

This circuit has a problem That operator may enable or disable 2 Trans That are reverse each other To solve it

use H-bridge – 4 Trans npn & pnp

PNP only work when b is 0

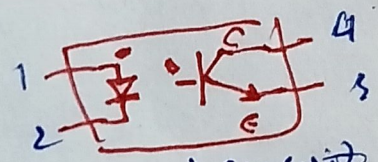


disadvantage of Trans as switch

① Can't use in switching for loads which need high power

② I/O isolation between power circuit & control unit

opto Coupler



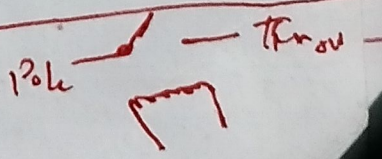
advantages

① Complete isolation between control circuit & load circuit
② low power consumption ③ High switch speed

disadvantages

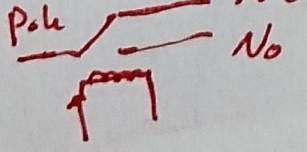
① High cost Compare to Transistor
② Can't use in Switching for high power loads

Relay



[1] Single Pole Single Throw (SPST)

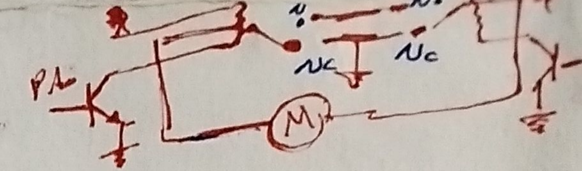
[2] SPDT



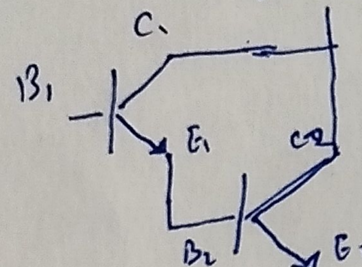
[3] DPST

[4] DPDT

Hbridge using 2 Relay



Darlington Pair — Type of Connection used to make ~~rests~~ Tran handle more Current Than usuall



for one Trans

- I_C = Amplification factor * I_B (β or hfe)

Assume $I_\beta = 20mA$ $\beta = 100$

max load can be handled by Trans

$I_C = 100 \times 20 = 2A$

- $I_E = I_C + I_B$

for Tr_1

$I_{E_1} = I_{\beta_1} + I_{C_1} \Rightarrow I_{E_1} \simeq I_{C_1}$ —①

$I_{C_1} = \beta_1 I_{\beta_1}$ —②

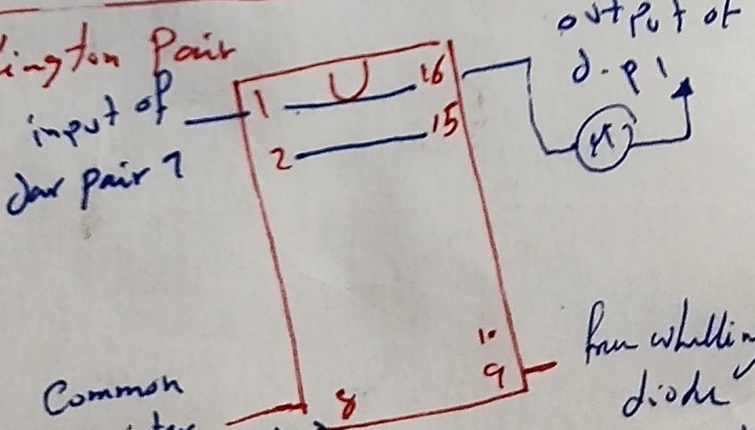
for Tr_2

$I_{C_2} = \beta_2 I_{\beta_2}$ —③ $\quad I_{B_2} = I_{E_1}$ —④

$I_{C_2} = \beta_2 I_{E_1}$ —from ① $\quad I_{C_2} = \beta_2 I_{C_1}$ —from ②

$I_{C_2} = \beta_2 (\beta_1 I_{\beta_1})$

Uln2003 → have 7 Darlington Pair
You can use it with 7 loads



This Connection is used for stepper Motor

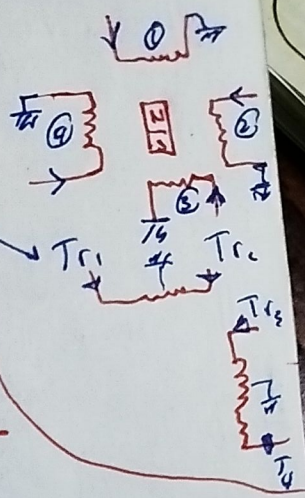
free whelling diode solve back emf problem
Can be connected to vcc or left free

Stepper Motors

Stator → Coils
Rotator → Magnet

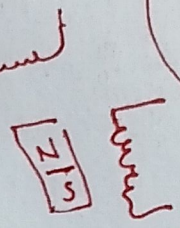
① Unipolar stepper Motor
Coils has only one dime

② Unipolar with 2 coils



2 Coils	4 Coils	
lower	higher	cost
lower	higher	torque

Bipolar Stepper Motor



	Unipolar 2 Coil	Bipolar
Cost	↑	↓
Control	low Control	H-bridge
torque	low	high
	Can operate in unipolar and bipolar	Bipolar only

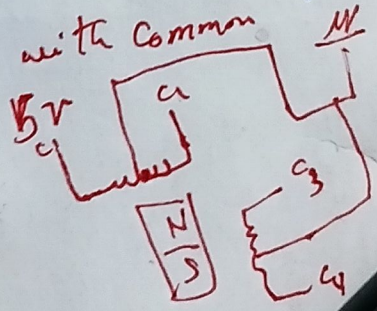
activation type

① full activation → only activate one Coil
② half step activation → activate 2 Coils against each other to get about 45°
④ Micro stepping → Control volt That used by Coil

how many degree per step?

Search for :- ① degree/step ② Resolution
③ stride angle (smallest angle) → angle/half step

Stepper motor is 28BYJ-48 is unipolar with Common connected to 5V



how to Calculate angle per step

Speed Variation

From DataSheet stride angle 5.625/64 = 0,08789°

angle per half step = ,08789°

" " full step = ,08789*2 = 0,1757

Number of steps to have full Cycle 360° = $\frac{360°}{,1757°}$ = 2048 step

Number of iteration of for loop = $\frac{2048}{4}$ = 512

360 → 2048

Xdg → ?

No. of steps = $\frac{(\text{degree needed} \times 2048)}{360}$

No. of iteration = $\frac{\text{No. of steps}}{4}$ = [ ]

Intrupt used in alot of peripheral like ADC

any peripheral That generate intrupt must have:-

① PIF (peripheral Intrupt Flag) ② PIE (Peripheral intrupt enable)

Intrupt types ① Maskable intrupt Can aquire (ADC - Timer - UART)

② Non Maskable ~~ Can't aquire by Processor (Reset button)

Int H.W Circuit ① Fixed vector table / priority → AVR

(programmable intrupt) PIC

any peripheral is connected to PIC by 2 wires PIE, PIF which are input to and gate and output of gate is Connected to PIC

GIE → global Intrupt Enable