Introductory Lecture

Electronics Club IITK

Hello!

We are team Electronics Club

We are here to give you a lecture on basic electronics and what to do and what not to.

Before we start ...

1. We assume you do not have ANY prior knowledge in electronics.
2. If you do not understand anything or want something more, feel free to interrupt.
3. Try to answer the questions posed during the lecture.
4. Don’t care about someone opinion on you (when asking questions/doubts or when answering to questions).
5. Most important instruction : Do follow the above four points.

Electronics Club has two rules:

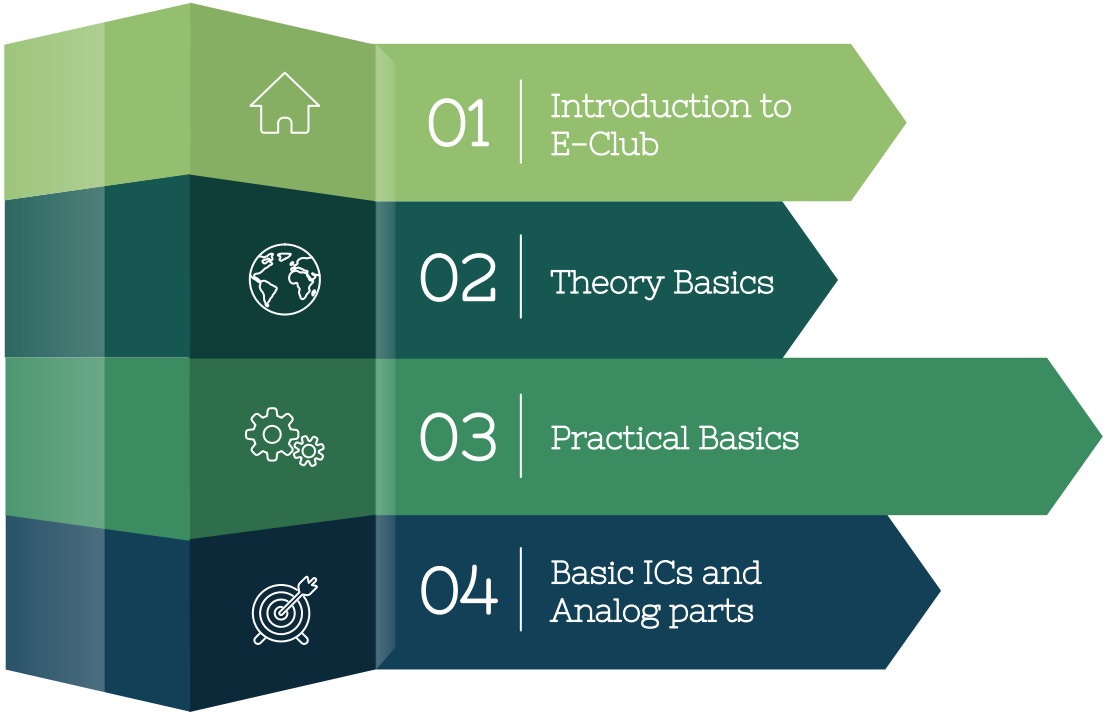
#1 Never Quit.

#2 Always remember rule #1

It always seems impossible until it's done.

–Nelson Mandela

Lecture Flow



1

Introduction and Previous Projects

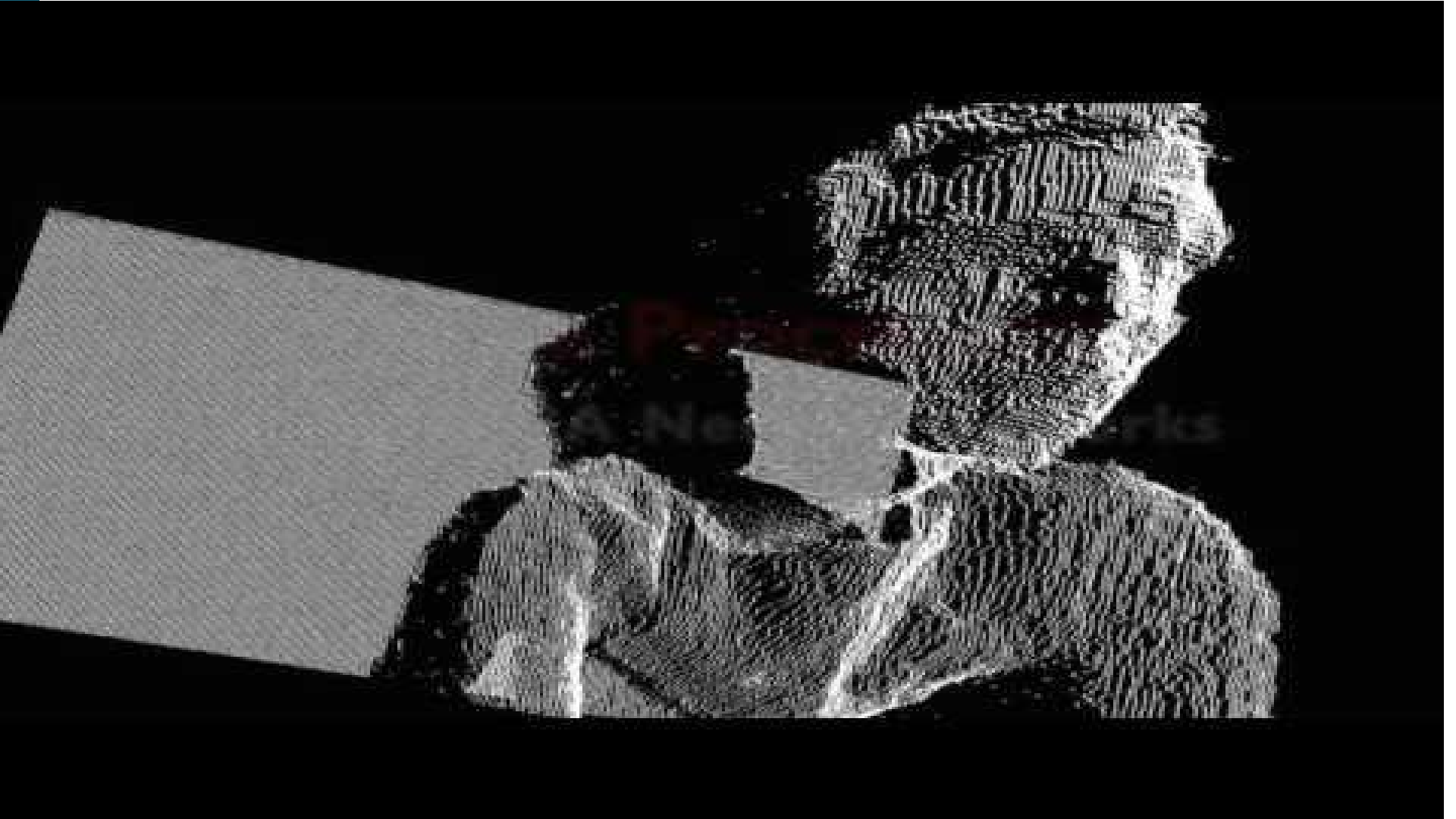
https://youtu.be/qD8iAxGxmFk

What the hell is Electronics about ???

What do we do ?

- We do everything !!!
- We make circuits, program ICs, make bots etc...
- Our main purpose is transform ideas to products.

Ex : Given distance sensors and motors, we make a obstacle avoiding robot.



Brain computer Interface

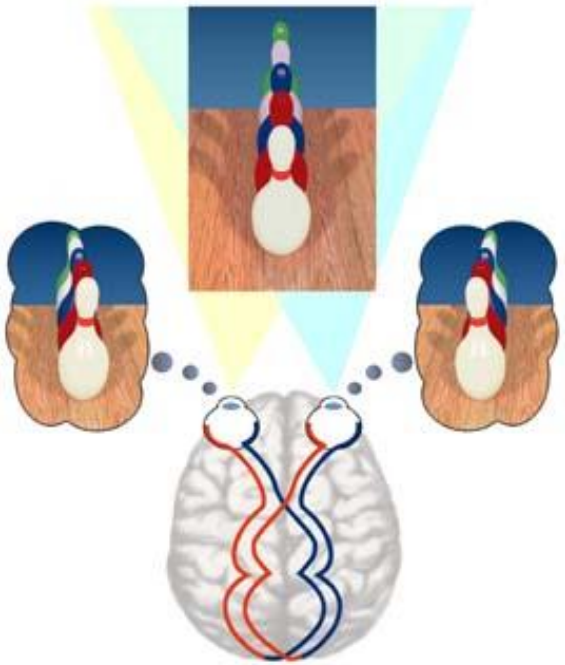
This project aims at classify your thoughts and using it to control different task on computer.

https://drive.google.com/file/d/0ByK8YhxIHcMQQmNfdEJIWjVwZGc/view

FPGA (Coding)

The objective was to implement a Convolutional Neural Network on FPGAs.

Stereo Vision (Coding + Circuit)



Stereo vision, just like human eyes, infers distance from two images taken from different views.

Swarm Robotics

Swarm robotics is an approach to the coordination of multirobot systems which consist of large numbers of mostly simple physical **robots**

Want to do something ?

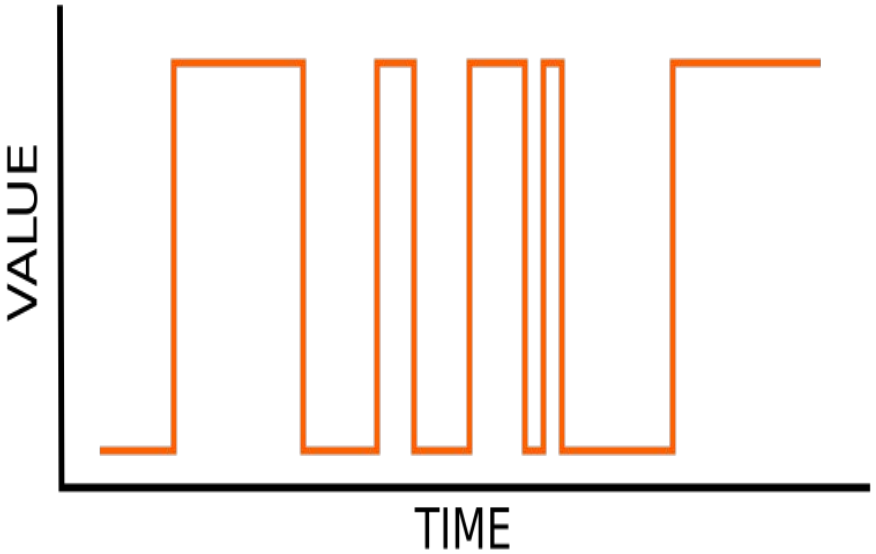
- Secy's and Coordinators are always there to mentor you - Contacts available in Club's Website
- Need some components ? We are a library for electronic components - get them issued free of cost.
- You can request for lectures (if many people want it) on a particular topics - Mail to us.

2

Some Basics (Theory)

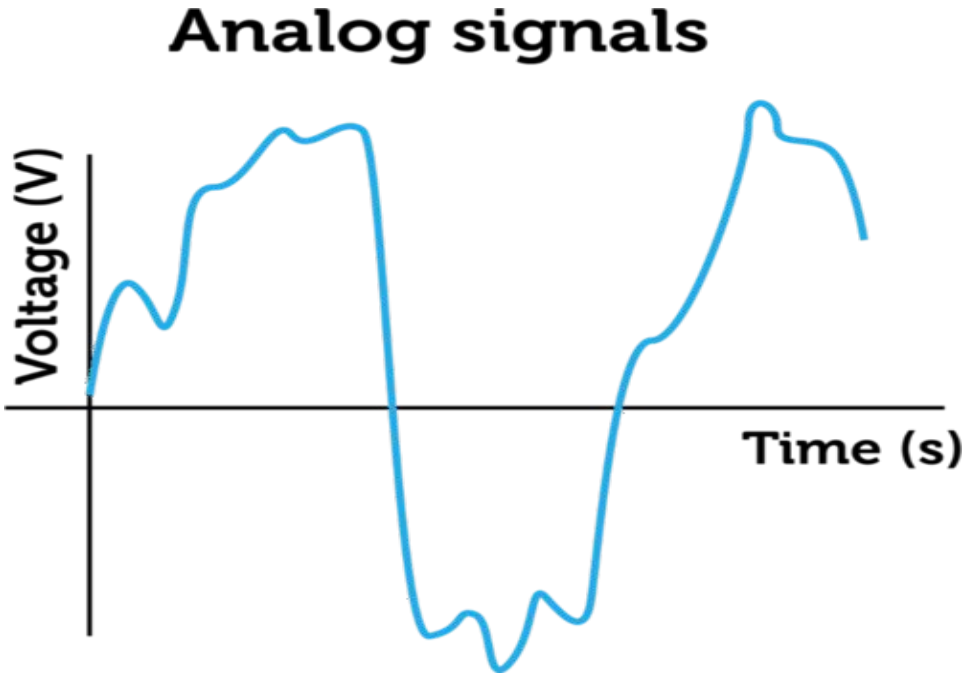
“ A journey of Thousand Miles begins with a single step “

Digital Signals



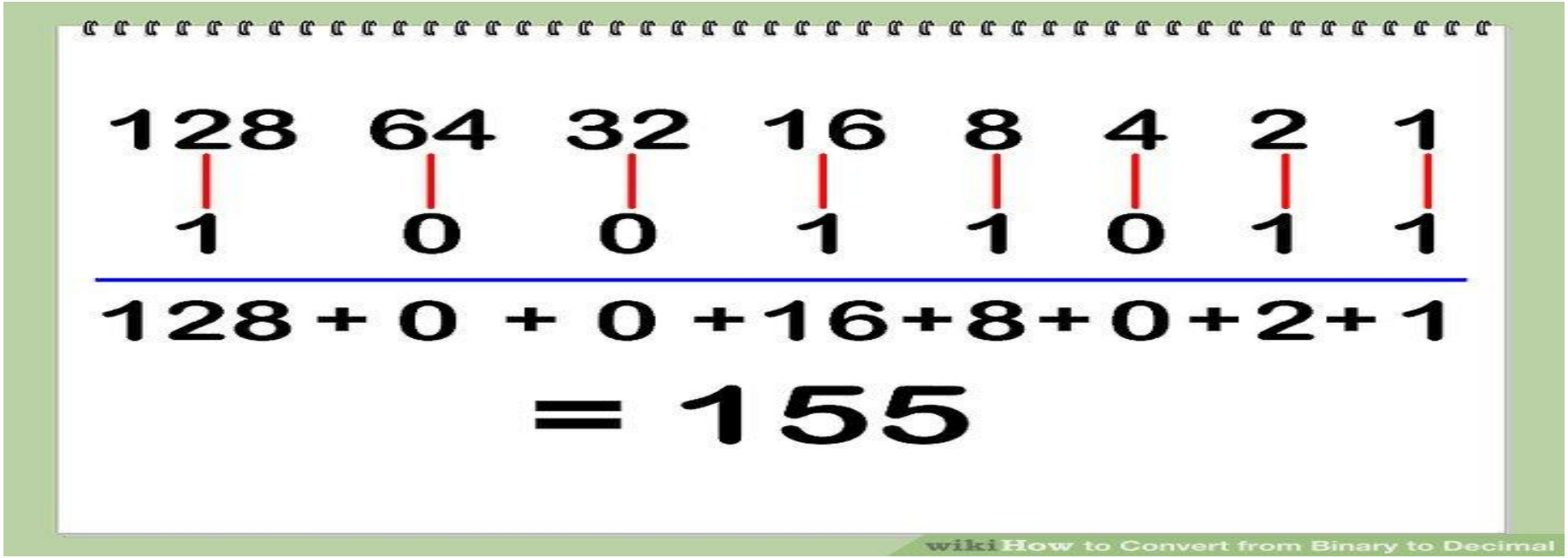
- Values are discrete.
- At any given point of time the possibilities are that voltage is either 5V or 0V.
- Intermediate values are not allowed.
- We denote 5V by the number “1” and 0V by the number “0”.

Analog Signals



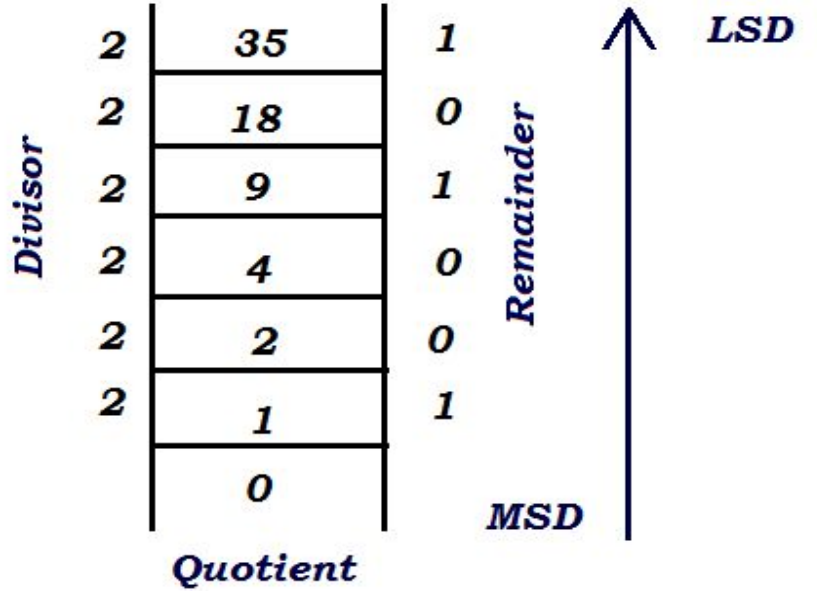
- Values are continuous.
- At any given point of time, the voltage can take any value.

Binary to Decimal



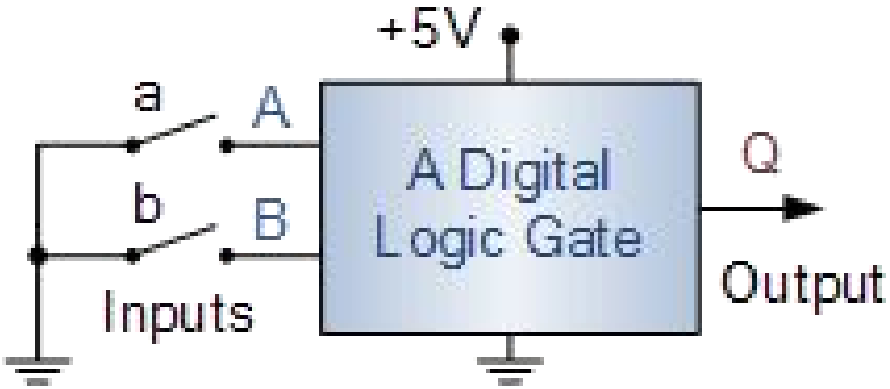
Decimal to Binary

Find the Binary equivalent for Decimal 35

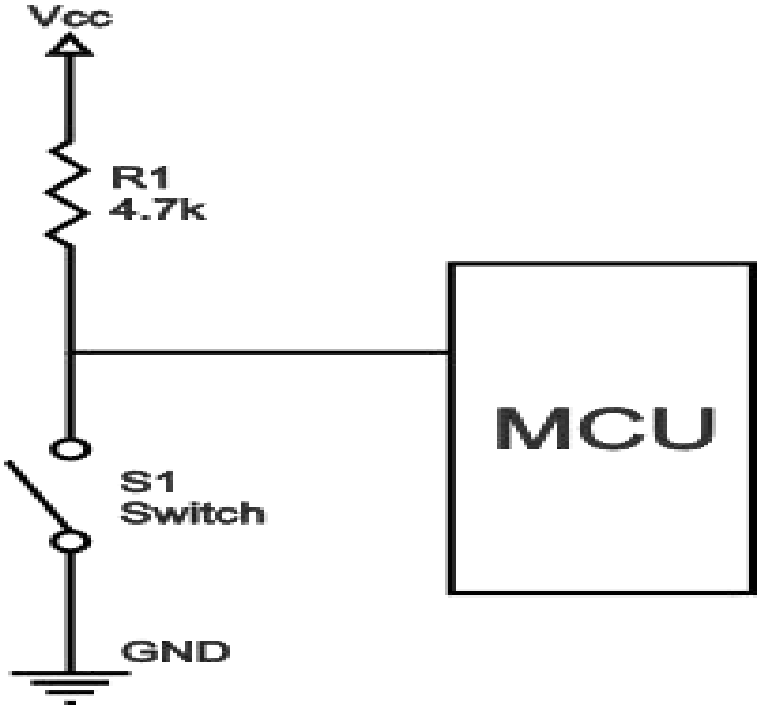


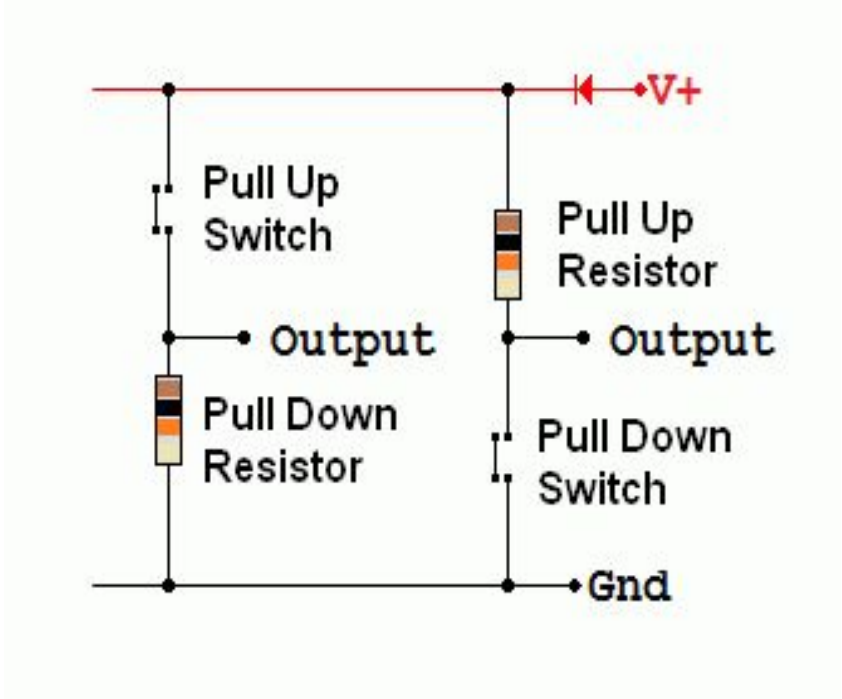
MSD - most significant digit
LSD - least significant digit
Therefore, the binary equivalent for 35 is 100101

Floating Voltages and Remedies



Pull-up and Pull-down



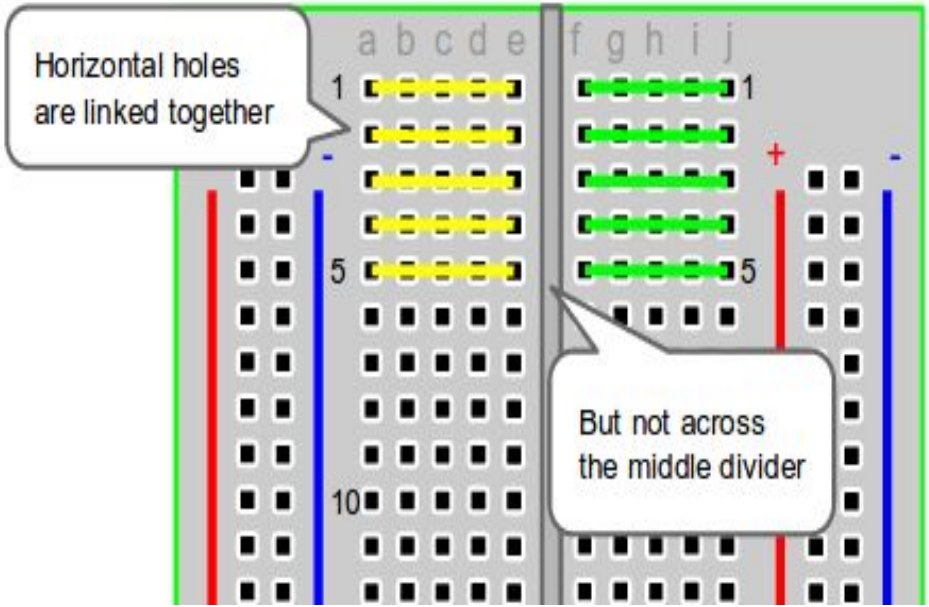


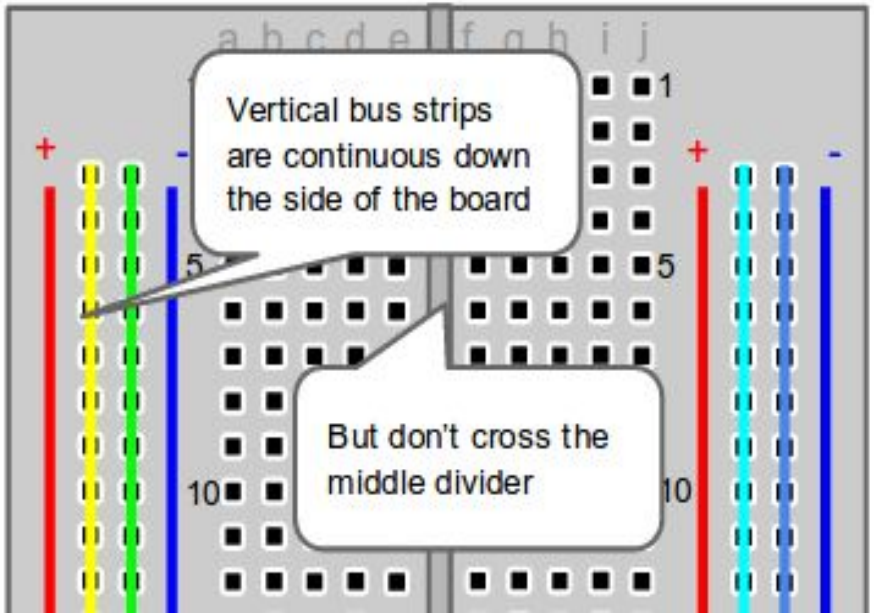
3

Some Basics (Practical)

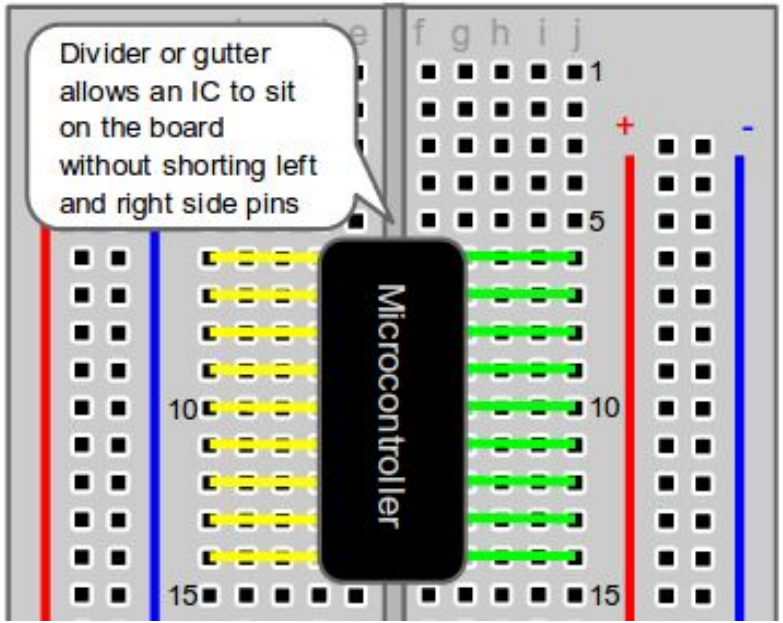
“ A journey of Thousand Miles begins with a single step “

Breadboard (BB)



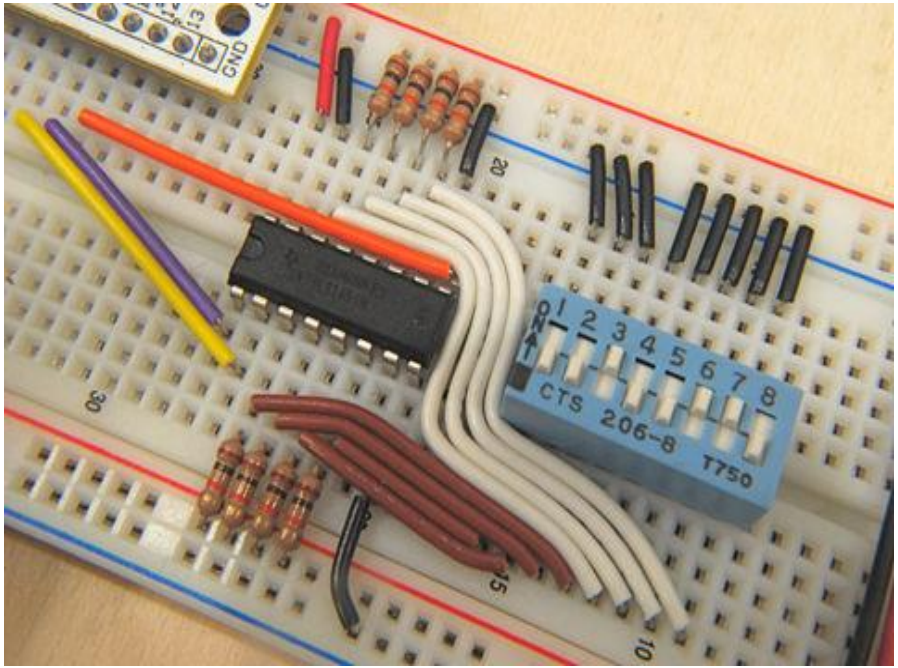


Breadboarding



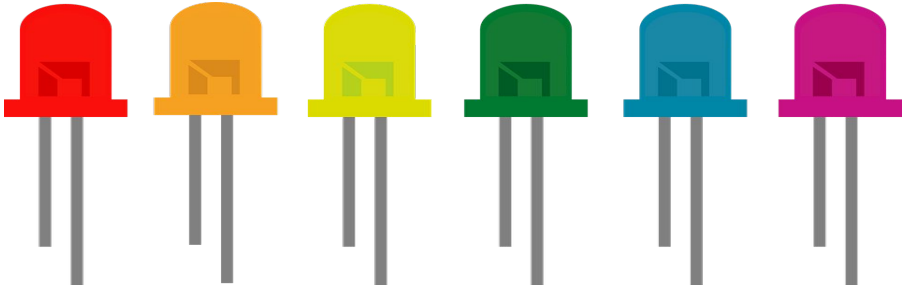
- Vertical long lines are generally used as power supply rails.
- ICs are placed as shown in the figure to avoid shorting.

Good practices



- Always use red and black coloured wires respectively when connecting to 5V supply and 0V (ground).
- Dangling wires is a bad breadboarding practice.
- The picture on the left is example of a good breadboarding.
- Why do we need a Breadboard and what are it's uses ?

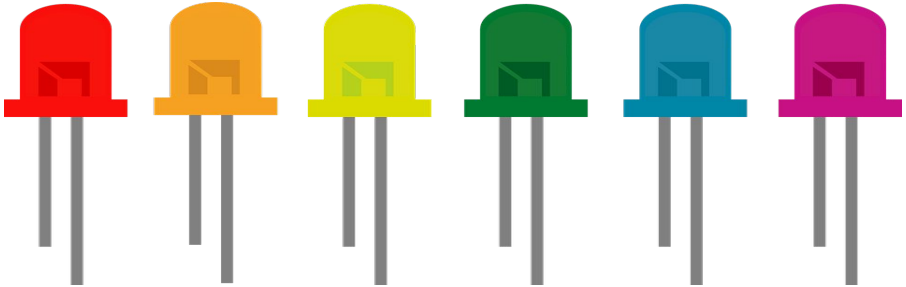
LEDs



- LEDs are special kind of diode that emit light when forward biased.
- Different kind of LEDs emit light of various colors.
- For LED to light, longer side must be at higher potential, and shorter one at lower potential.
- NOTE : Always use a resistance (~200 Ohms) in series with LED (Why ?).
- At which end of the LED should the resistance be connected ?
- What are the uses of LEDs ?

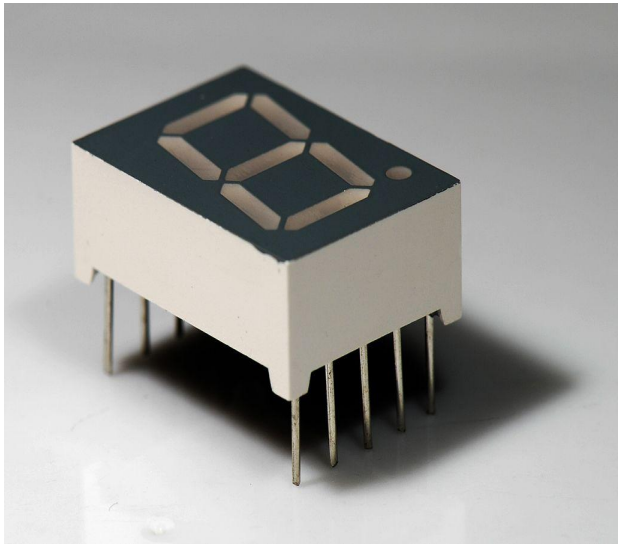
Debugging is like being the detective in a crime movie where you're also the murderer.

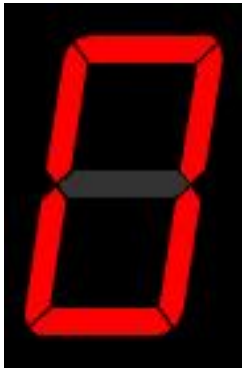
Uses of LEDs



- YES YOU GUESSED IT !!!
- LEDs are mostly used in debugging besides other uses.
- Other uses include lighting (as in your rooms) and indication of some process (indicative LEDs as in your computer/laptop).
- Another interesting use of LEDs is cheap and bright displays (as in Indian railways).
- “ Without LEDs, Electronics is hard and boring ”

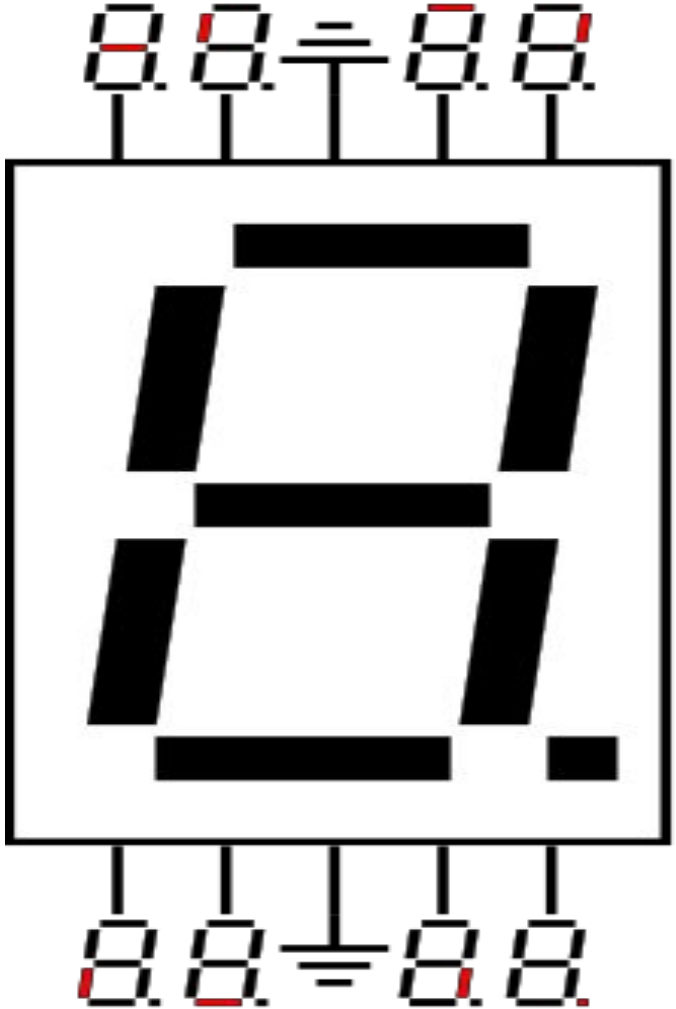
Seven Segment Display





- Seven segment display most commonly used to display numbers (in calculators) is just a set of 7 LEDs.
- There are two types:
- 1. All negative terminals of LEDs are connected together.
- 2. All positive terminals are connected together.
- Mostly used in combination with 7447 IC (explained later).

Common Cathode Type



Power Supply

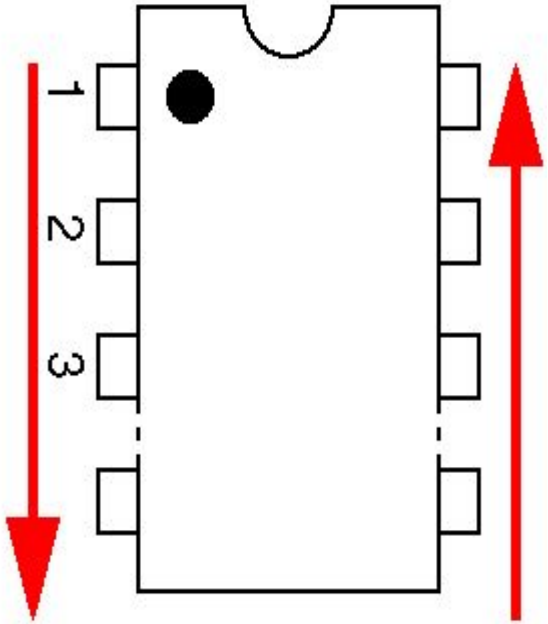
- Now comes the BAAP (I am not talking about Nokia), the power supply.
- The ICs we use operate at the 5V supply.
- It is difficult to find batteries of 5V.
- Hence we use phone chargers.
- There is (normally) 5V potential difference between inside and outside of the pin of chargers (old chargers).

4

Important ICs (Digital & Non Programmable)

“ A journey of Thousand Miles begins with a single step “

Important points



- IC stands for Integrated Circuit.
- For easy understanding consider it as a large number of transistors compressed into small space which serves a particular “Purpose”.
- The “Purpose” is generally to take input from some set of pins and output the processed input on some other pins.
- Any IC follows the numbering of pins as shown in the figure.

WORD OF CAUTION

From this point onwards we will treat ICs as black boxes which gives some output for a given input.

NOTE: We will NOT go into internal construction of the device.

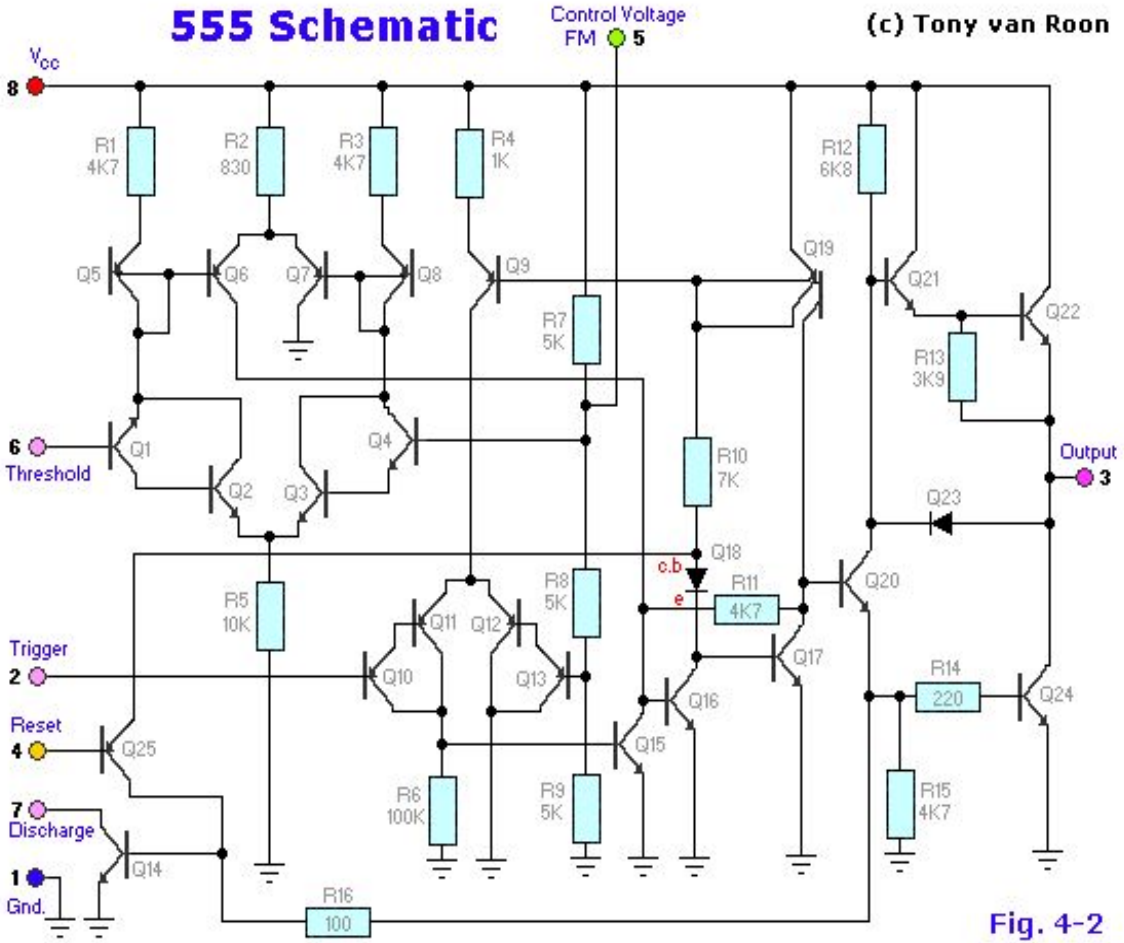
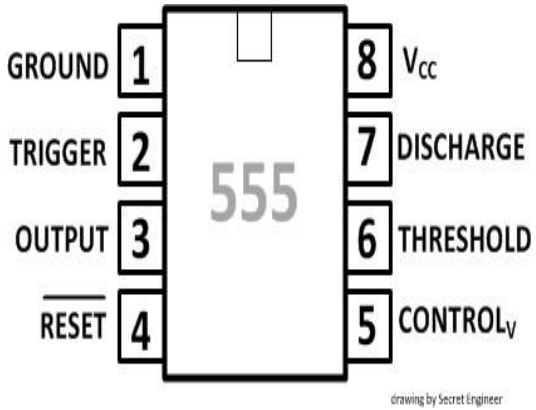
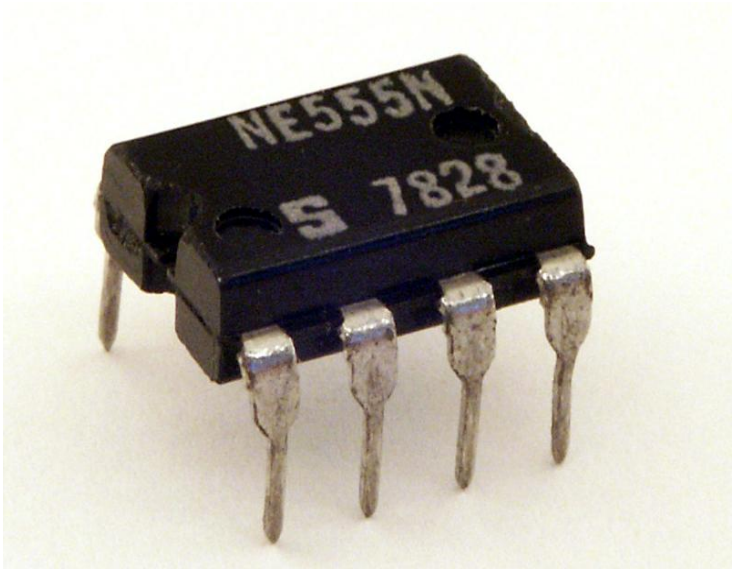

555 Schematic
Control Voltage
FM 5
(c) Tony van Roon
Vcc
8
R1
4K7
R2
830
R3
4K7
R4
1K
R12
6K8
Q5
Q6
Q7
Q8
Q9
Q19
Q21
Q22
R7
5K
R13
3K9
6
Threshold
Q1
Q2
Q3
Q4
R10
7K
Output
3
Q23
c.b
e
Q18
R11
4K7
Q20
R5
10K
R8
5K
Q11
Q12
Q10
Q13
Q17
Trigger
2
R14
220
Q24
Reset
4
Q25
Q16
Q15
7
Discharge
R6
100K
R9
5K
R15
4K7
1
Gnd.
Q14
R16
100

Fig. 4-2

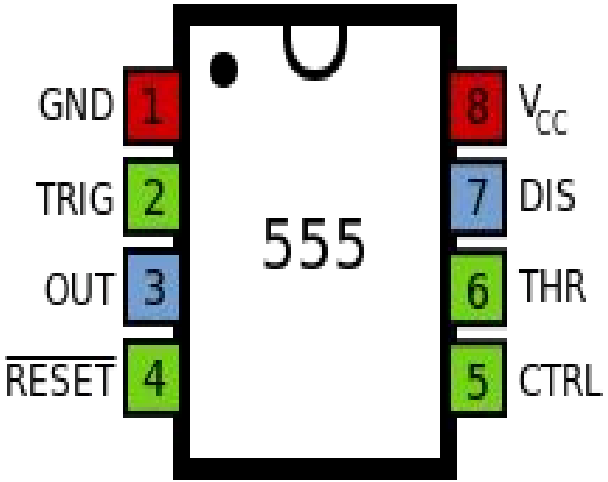

GROUND 1
TRIGGER 2
OUTPUT 3
RESET 4
555
8 Vcc
7 DISCHARGE
6 THRESHOLD
5 CONTROLV
drawing by Secret Engineer

555 Timer



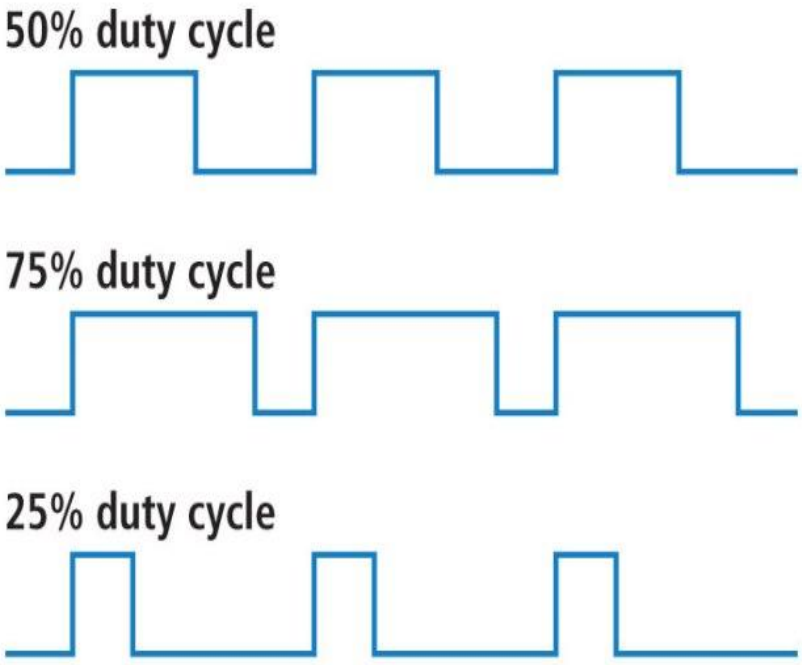
- 555 Timer is one of the most commonly used IC and is the heart of almost any real life appliance.
- Why is it called timer ?
- Because it is responsible for things to happen at given intervals, and synchronize various operations.
- There are three modes of operation of this IC viz
  - Astable
  - Monostable
  - Bi stable

Pin Out



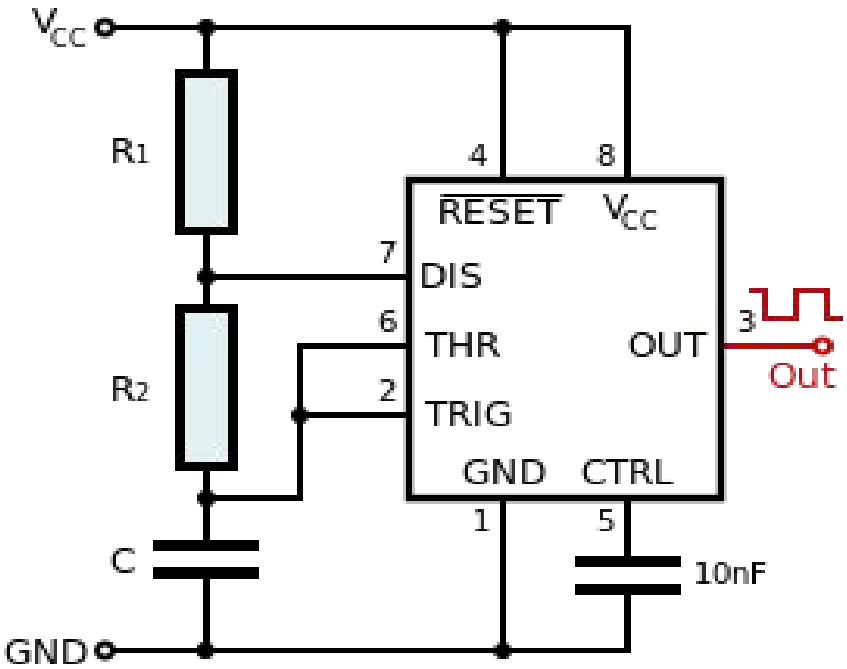
- The pin out diagram of 555 is shown in the figure.
- Pin number 5 is called control pin and by applying voltage here one can change timing characteristics of the IC.
- In most (all) cases this pin is not used and to avoid disturbance, it must be grounded via decoupling capacitor.
- To know more about the pins, please do visit wiki-page https://en.wikipedia.org/wiki/555_timer_IC

555 Timer - Astable



- In Astable mode, as the name suggests the output is not stable in either states i.e neither 0 nor 1.
- As a result it oscillates between 1 and 0 at a particular frequency determined some formulas given in next slide.
- Duty Cycle : Duty cycle of a pulse is defined as the percent of time High signal is present in the total duration of the pulse.
- You can also change duty cycle of the output pulse (Explained in next slide).

555 Timer - Astable



- Frequency of output pulse is given by:

$$f = \frac{1}{\ln(2) \cdot C \cdot (R_1 + 2R_2)}$$

- High time is given by :

$$\mathbf{high} = \ln(2) \cdot C \cdot (R_1 + R_2)$$

- Low time is given by :

$$\mathbf{low} = \ln(2) \cdot C \cdot R_2$$

- Note : C is in Farads and R1 and R2 are in Ohms.

555 Timer - Monostable

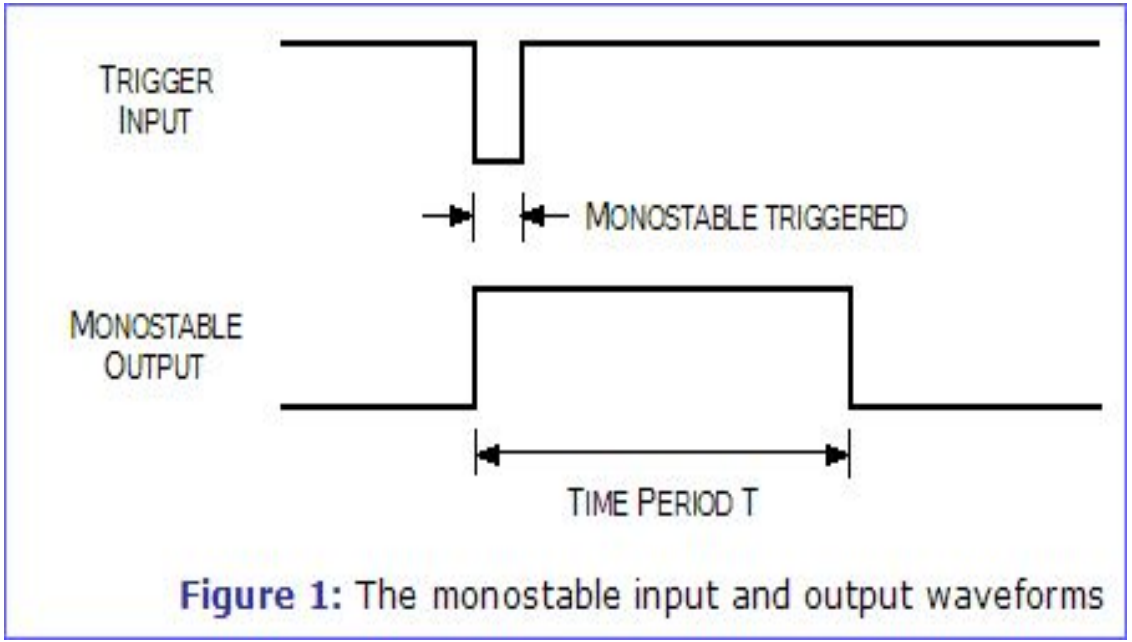
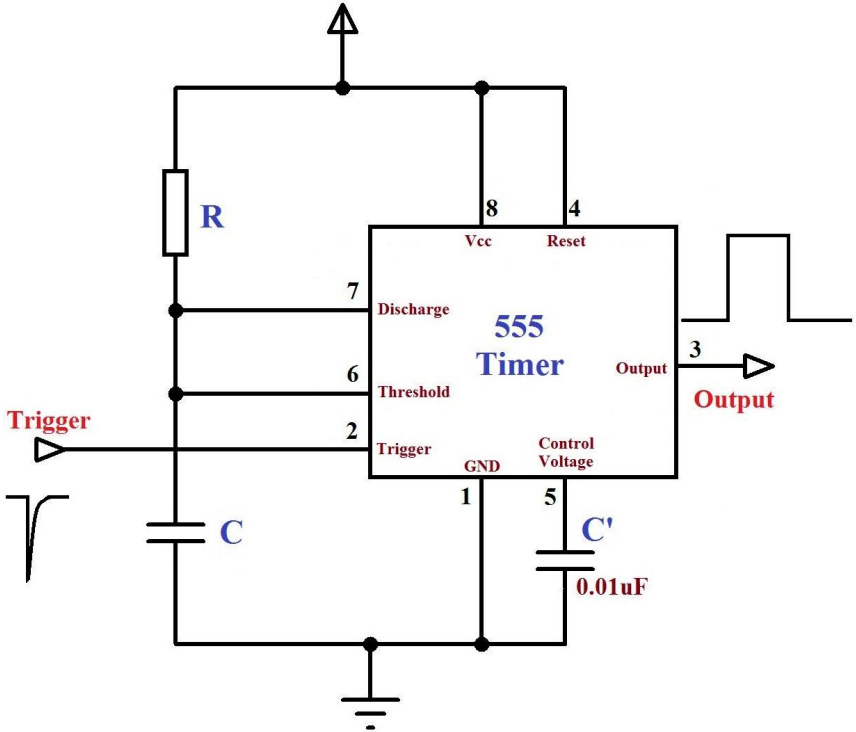


Figure 1: The monostable input and output waveforms

- As the figure suggests, when you want to trigger a output, the input signal must go low.
- Pull up should be done for proper working.

555 Timer - Monostable



- Monostable as the name suggests is stable at only one state 0.
- Mono Stable Mode can be viewed as a one-shot pulse generator.
- The pulse trigger is generally a push button though it can be anything.
- Pulse width depends on the time, capacitor C takes to get charged to ⅔ of the supply voltage.

$$t = \ln(3) \cdot RC \approx 1.1RC$$

555 Timer - Bistable

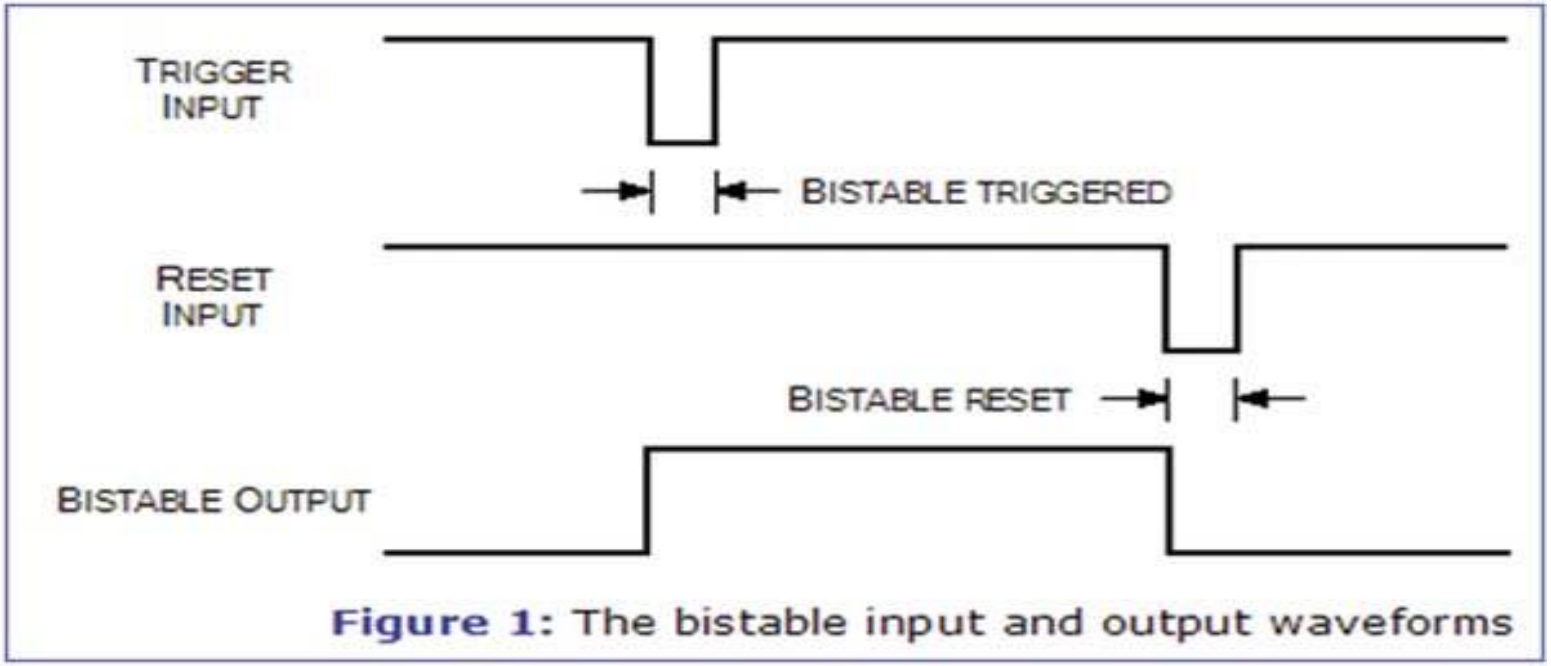
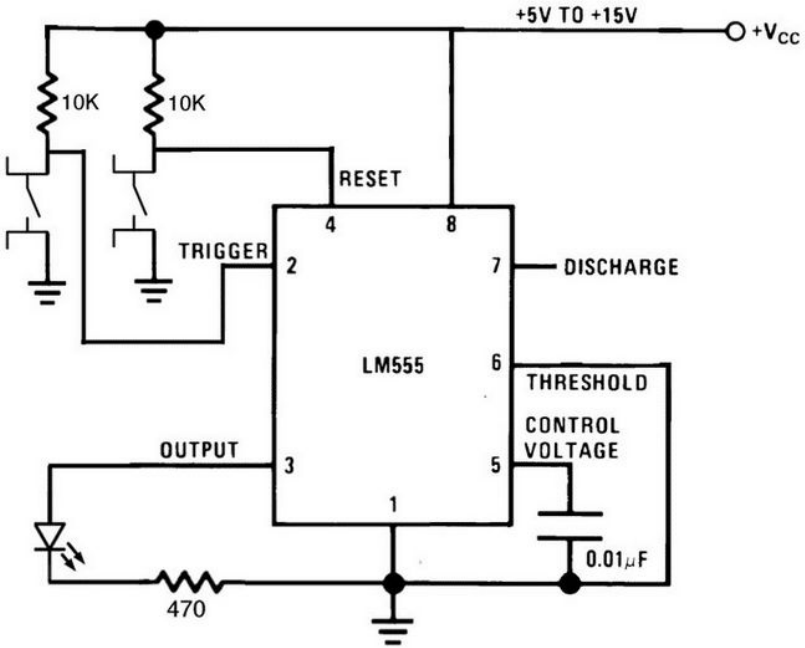
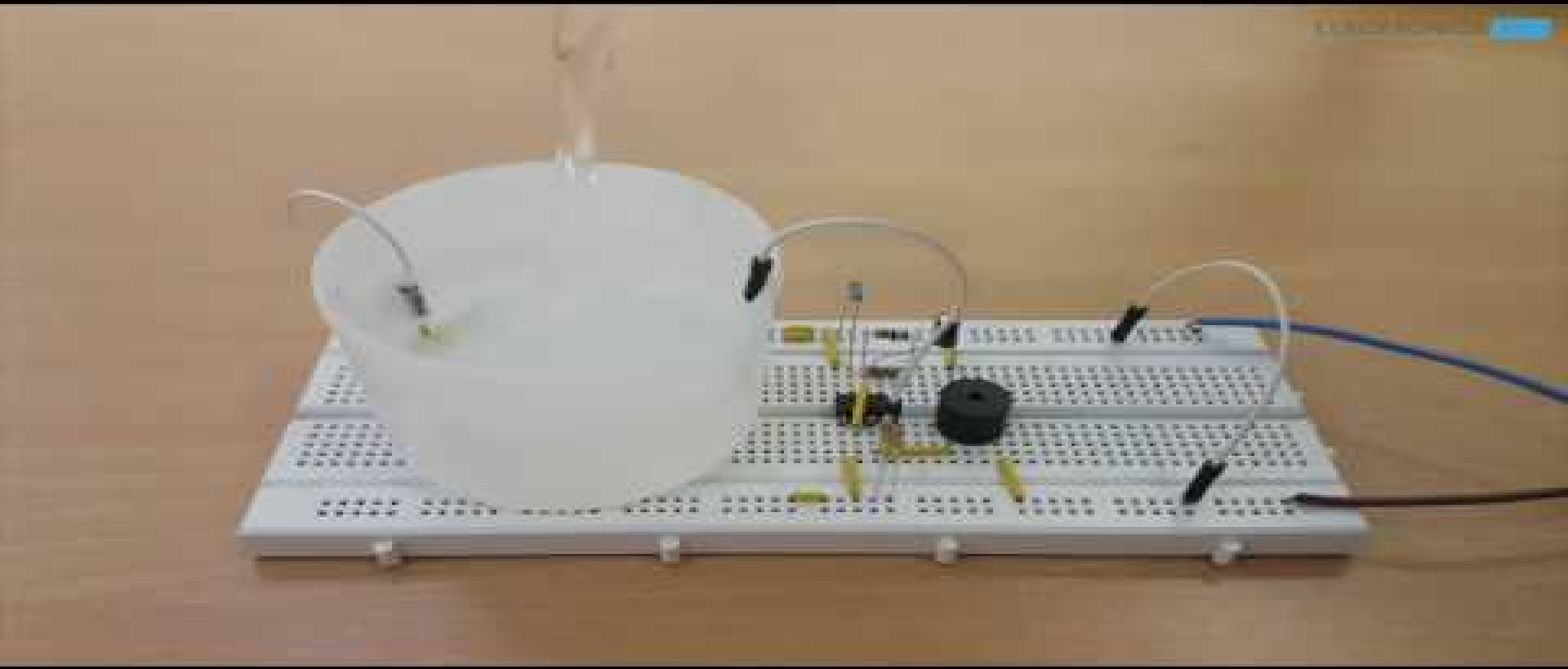


Figure 1: The bistable input and output waveforms

555 Timer - Bistable



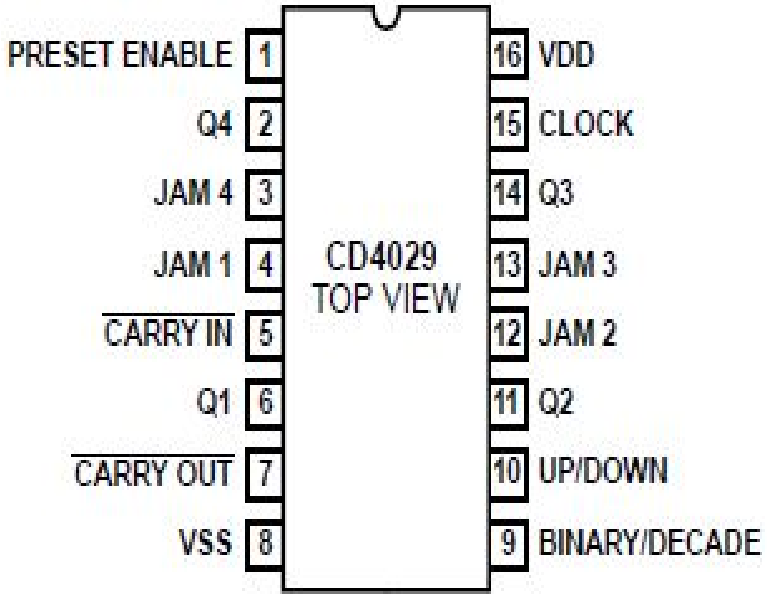
- Bistable as the name suggests is stable at both states i.e. 0 and 1.
- When Trigger pin is momentarily grounded, the output goes HIGH and stays there unlike monostable mode
- Reset pin as the name suggests, resets the output to GROUND.
- Construction of a simple water level alarm is shown in the next slide.



Is electronics all about ICs ?

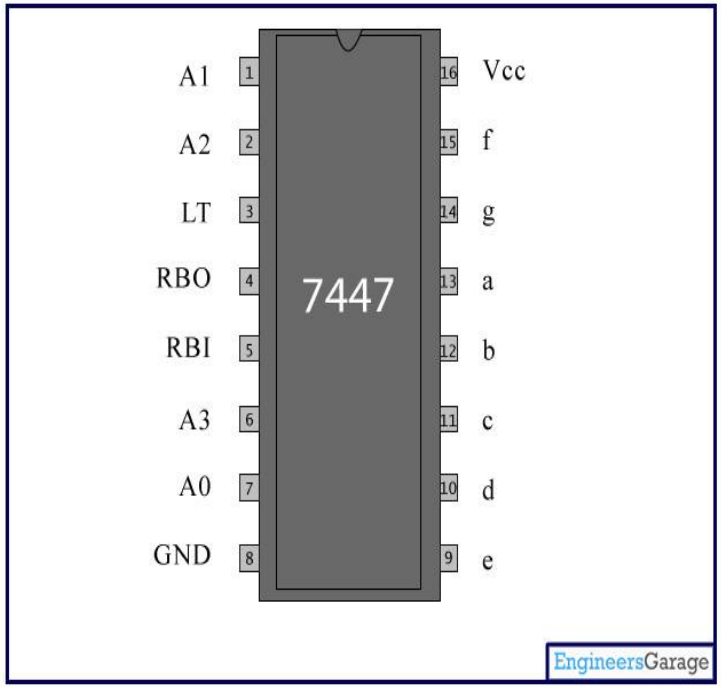
- No, all the operations we taught you till now can be implemented more easily on microcontrollers. But then why are we going the hard way?
- To decrease the cost !!! as well as to teach you the basics.
- A 555 IC costs ~Rs.10 while a microcontroller costs ~Rs.100.
- Do you need to do this all your life ?
- No !!! Once you get past takneek, we will teach you about programmable ICs (microcontrollers) and then you are free to use any IC / microcontroller you want. In Fact we rarely use “basic ICs” after takneek.

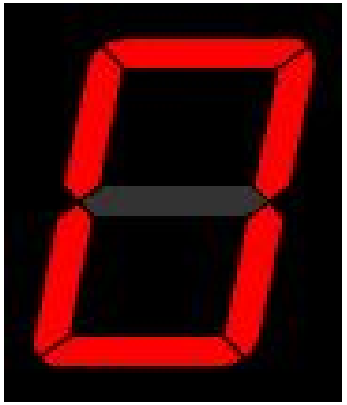
4029 Counter



- Counter as the name suggests this IC is a BCD decade up/down counter.
- What does it actually count ?
- It counts the number of ticks the 555 or any other IC sends to it.
- It outputs the result in binary of 4 digits (0 to 15 – 16 values).
- Pin 9 can be used to make it count till either 15 (binary) or 9 (decimal).
- After it reaches its full count, the Pin 7 is set to HIGH and output resets to zero.
- Pin 10 can be used to count up (0 to 9) or down (9 to 0).
- It is mostly used with 7447 Ic and a 7 segment display.

7447 & Seven segment display





- Consider it as a translator which translates the binary output of 4029 or any other IC to the language of 7 segment display.
- You might have seen this combination in many devices.

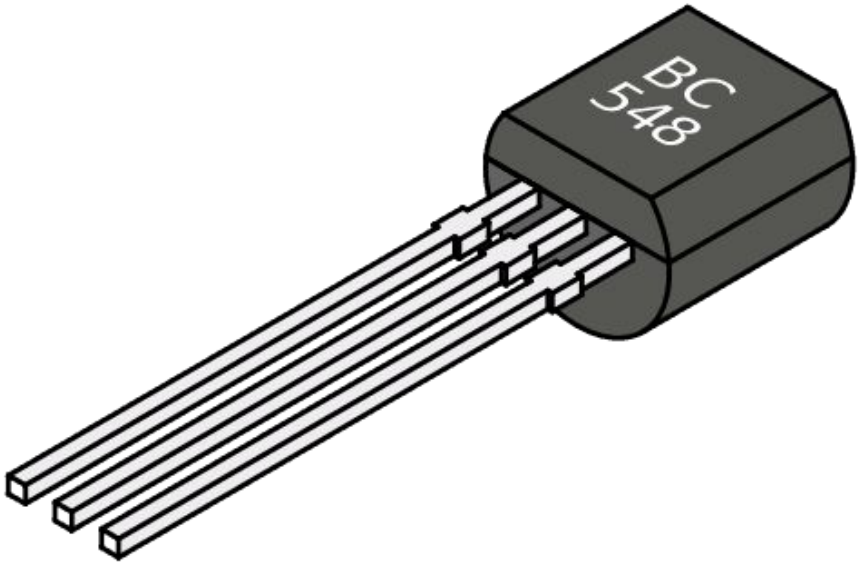
5

Important Analog Devices

“ A journey of Thousand Miles begins with a single step “

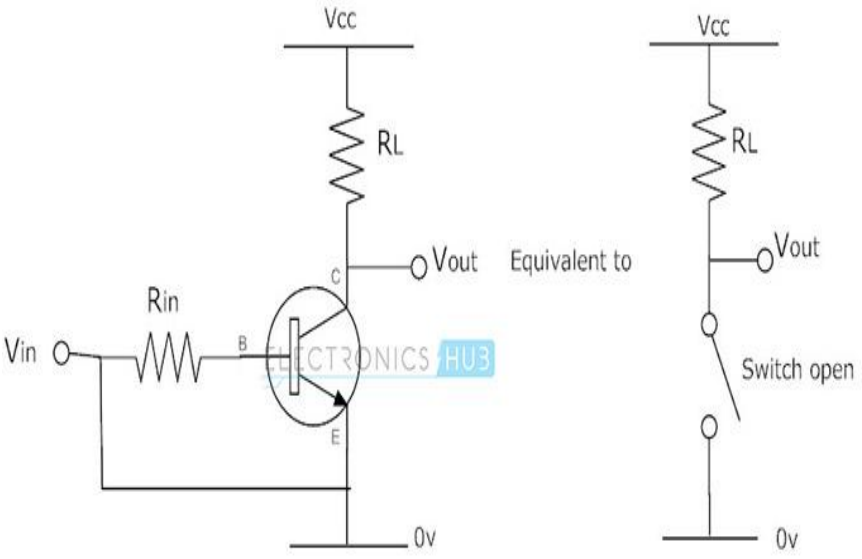
Transistor

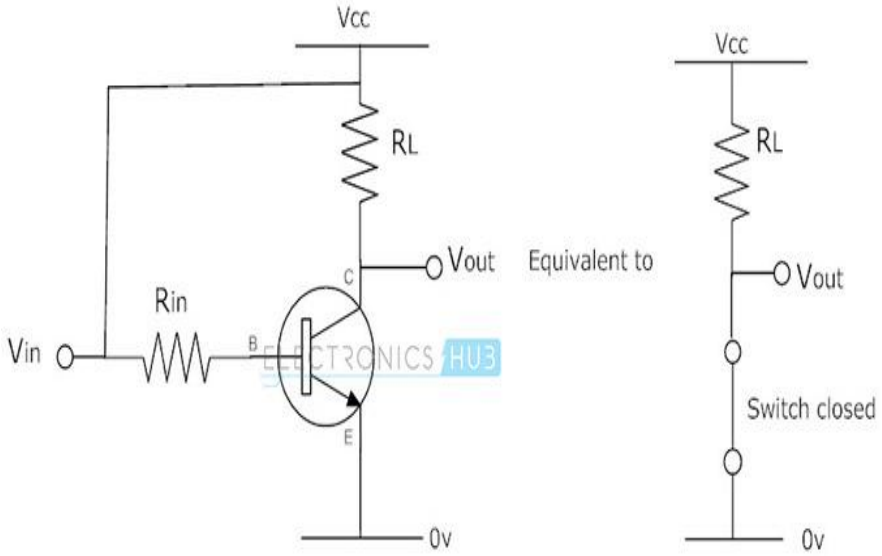
Transistor is the heart and soul of modern electronics



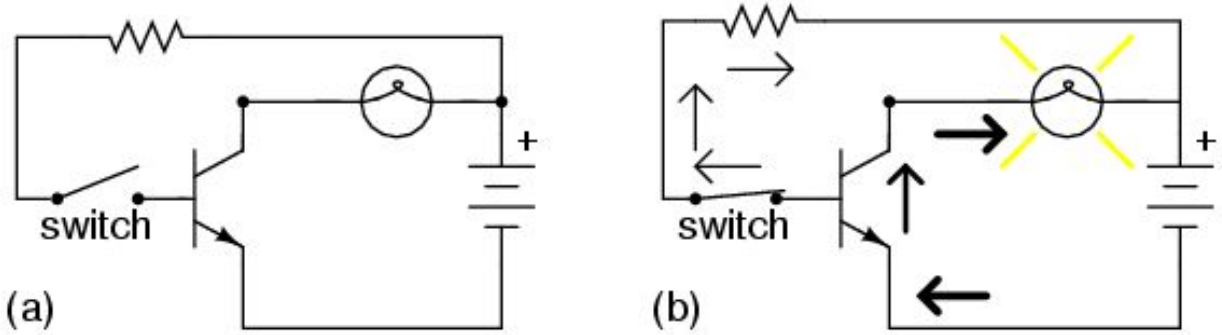
A **transistor** is a semiconductor device used to amplify or switch electric signals.

Transistor as Switch





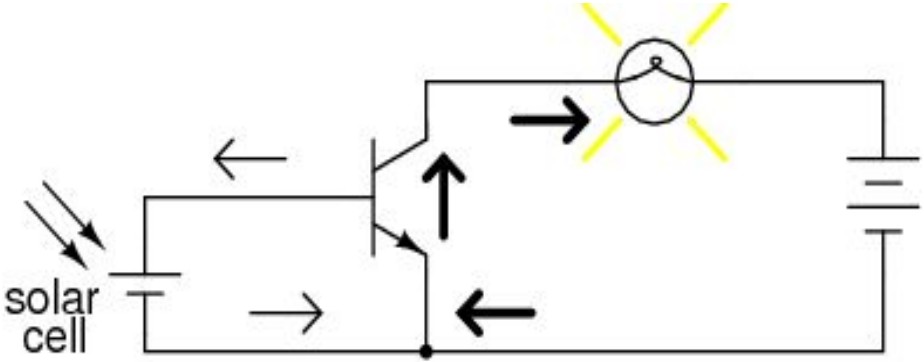
Transistor as Switch



Transistor: (a) cutoff, lamp off; (b) saturated, lamp on.

If we're still using a switch in the circuit, then what's the point of having a transistor as a switch.

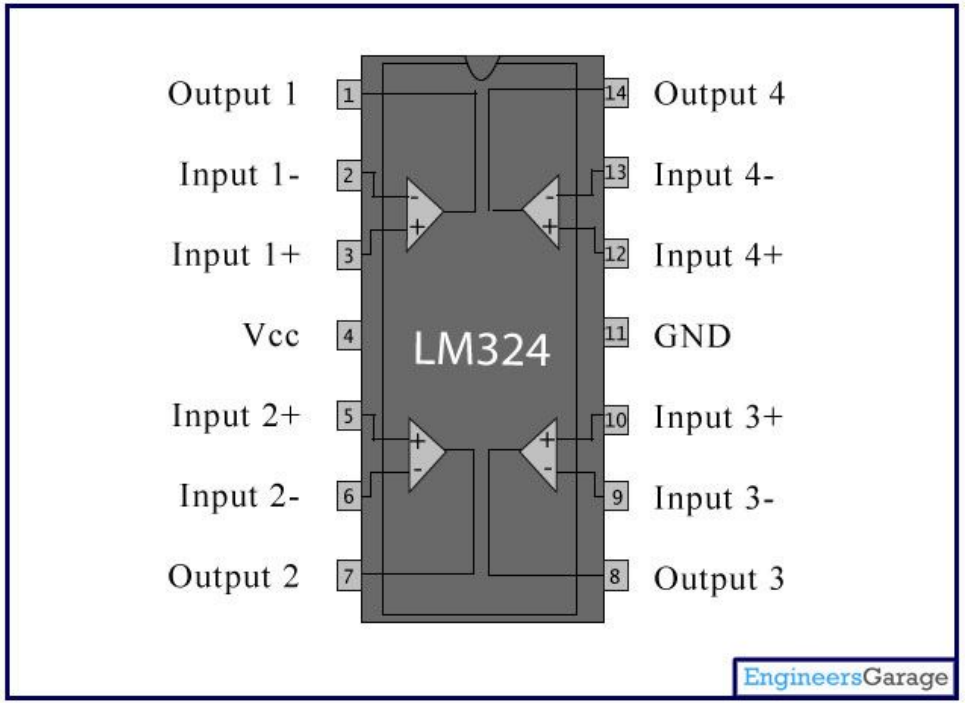
Transistor as Switch



Solar cell serves as light sensor.

- As in the figure suppose a particular device gives 1V when in one state and 0V in other state. Now we cannot operate a LED in this range.
- Transistor comes to our rescue in the sense that it actually acts like an “electronic” switch.
- As shown in previous slide, when 1V is applied to the corresponding pin, the transistor glows the bulb by giving it 5V.

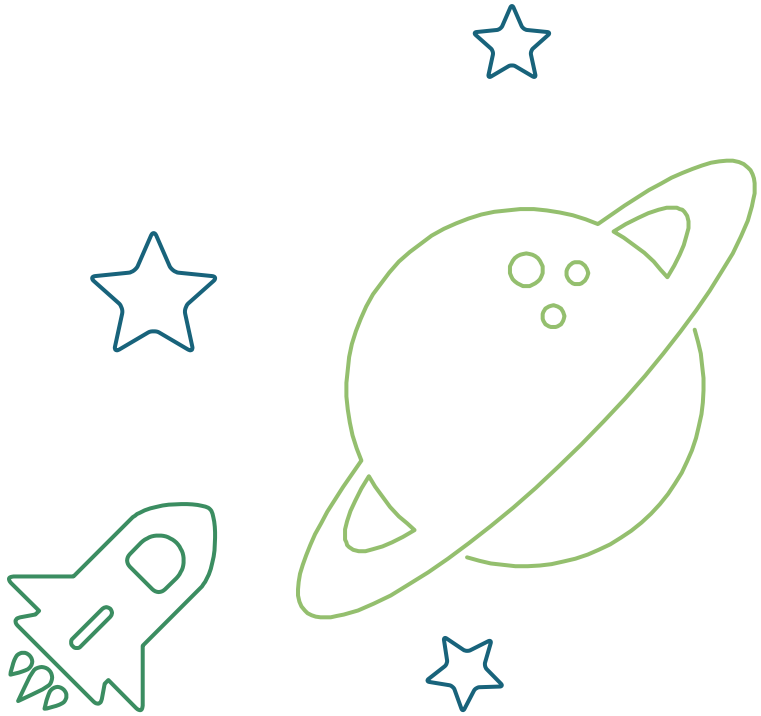
Operational Amplifier (LM324)



An operational amplifier (often **op-amp** or **opamp**) is a DC-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output.

BIG CONCEPT

Think of something interesting you can make from the basic ICs we taught you.



THANKS!

Any questions?

You can always reach us at facebook.com/electronicsclubiitk & eclub.iitk@gmail.com

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