OPTOCOUPLERS/OPTOISOLATORS:

- Opt couplers or Opt isolators is a combination of light source & light detector in the same package.
- They are used to couple signal from one point to other optically, by providing a completer electric isolation between them. This kind of isolation is provided between a low power control circuit & high power output circuit, to protect the control circuit.
- Depending on the type of light source & detector used we can get a variety of optocouplers. They are as follows,

(i) LED – LDR optocoupler
(ii) LED – Photodiode optocoupler
(iii) LED – Phototransistor optocoupler

Characteristics of optocoupler:

(i) Current Transfer Ratio (CTR)
(ii) Isolation Voltage
(iii) Response Time
(iv) Common Mode Rejection

(i) Current Transfer Ratio:

It is defined as the ratio of output collector current (Ic) to the input forward current (If)

$$CTR = I_c/I_f * 100\%$$

Its value depends on the devices used as source & detector.

(ii) Isolation voltage between input & output:

It is the maximum voltage which can exist differentially between the input & output without affecting the electrical isolation voltage is specified in K Vrms with a relative humidity of 40 to 60%.

(iii) Response Time:

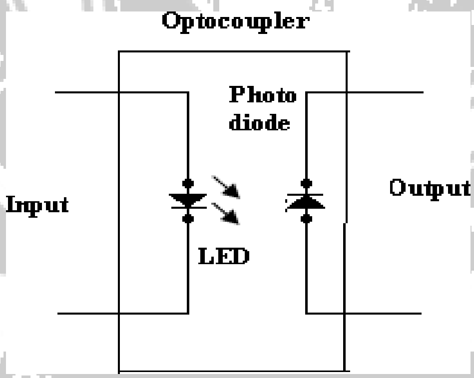
Response time indicates how fast an optocoupler can change its output state. Response time largely depends on the detector transistor, input current & load resistance.

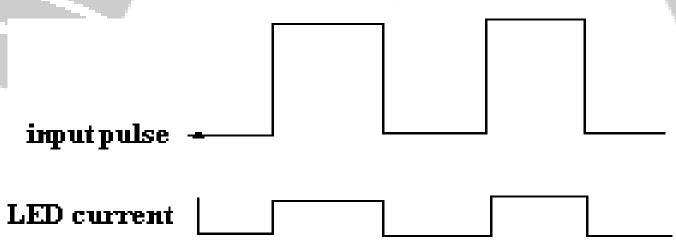
(iv) Common mode Rejection:

Eventhough the optocouplers are electrically isolated for dc & low frequency signals, an impulsive input signal (the signal which changes suddenly) can give rise to a displacement current Ic= Cf*dv/dt. This current can flow between input & output due to the capacitance Cf existing between input & output. This allow the noise to appear in the output.

Types of optocoupler:

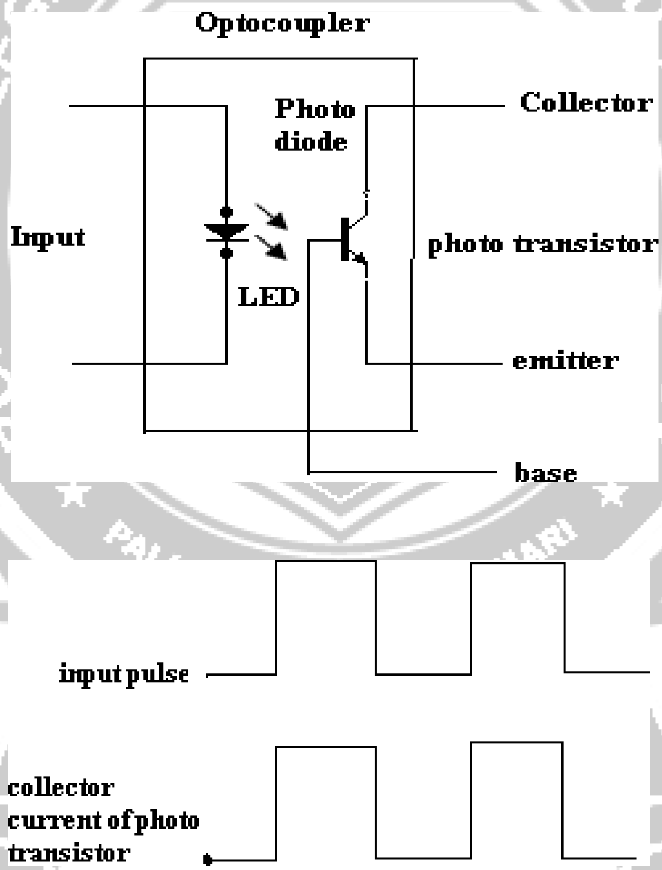
(i) LED – Photodiode optocoupler:





- LED photodiode shown in figure, here the infrared LED acts as a light source & photodiode is used as a detector.
- The advantage of using the photodiode is its high linearity. When the pulse at the input goes high, the LED turns ON. It emits light. This light is focused on the photodiode.
- In response to this light the photocurrent will start flowing though the photodiode. As soon as the input pulse reduces to zero, the LED turns OFF & the photocurrent through the photodiode reduces to zero. Thus the pulse at the input is coupled to the output side.

(ii) LED – Phototransistor Optocoupler:



- The LED phototransistor optocoupler shown in figure. An infrared LED acts as a light source and the phototransistor acts as a photo detector.
- This is the most popularly used optocoupler, because it does not need any additional amplification.
- When the pulse at the input goes high, the LED turns ON. The light emitted by the LED is

focused on the CB junction of the phototransistor.

- In response to this light photocurrent starts flowing which acts as a base current for the phototransistor.
- The collector current of phototransistor starts flowing. As soon as the input pulse reduces to zero, the LED turns OFF & the collector current of phototransistor reduces to zero. Thus the pulse at the input is optically coupled to the output side.

Advantages of Optocoupler:

- Control circuits are well protected due to electrical isolation.
- Wideband signal transmission is possible.
- Due to unidirectional signal transfer, noise from the output side does not get coupled to the input side.
- Interfacing with logic circuits is easily possible.
- It is small size & light weight device.

Disadvantages:

- Slow speed.
- Possibility of signal coupling for high power signals.

Applications:

Optocouplers are used basically to isolate low power circuits from high power circuits.

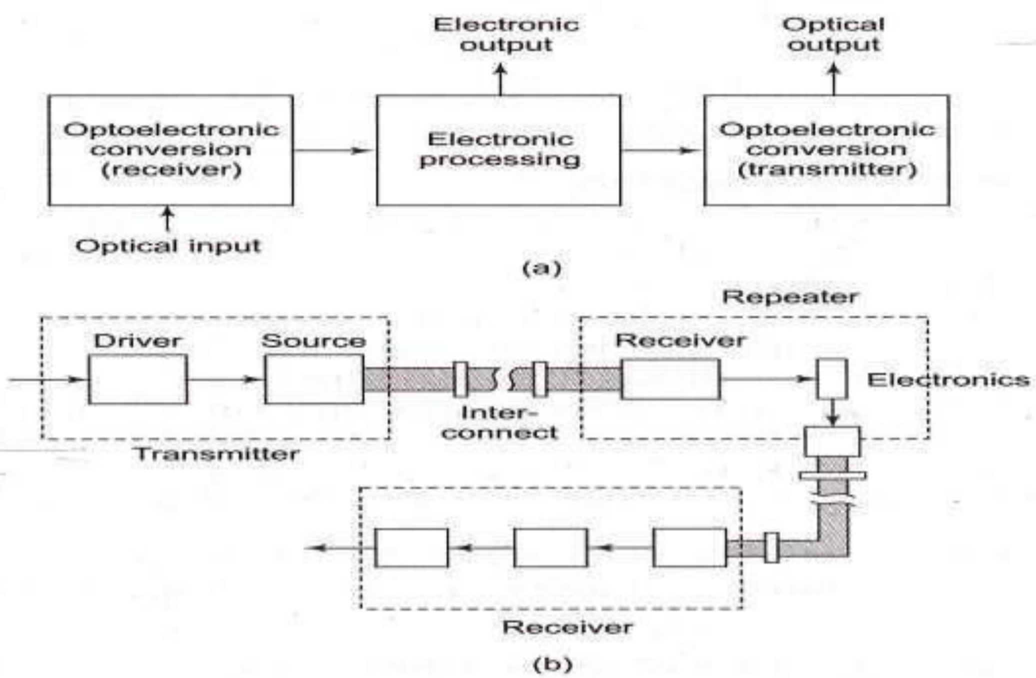
- At the same time the control signals are coupled from the control circuits to the high power circuits.
- Some of such applications are,
  - (i) AC to DC converters used for DC motor speed control
  - (ii) High power choppers
  - (iii) High power inverters
- One of the most important applications of an optocoupler is to couple the base driving signals to a power transistor connected in a DC-DC chopper.

- Note that the input & output waveforms are 180º out of phase as the output is taken at the collector of the phototransistor.

Optocoupler IC:

The optocouplers are available in the IC form MCT2E is the standard optocoupler IC which is used popularly in many electronic application.

- This input is applied between pin 1& pin 2. An infrared light emitting diode is connected between these pins.
- The infrared radiation from the LED gets focused on the internal phototransistor.
- The base of the phototransistor is generally left open. But sometimes a high value pull down resistance is connected from the Base to ground to improve the sensitivity.
- The block diagram shows the opto-electronic- integrated ciruit (OEIC) and the major components of a fiber-optic communication facility.



FUNCTION GENERATOR IC 8038:

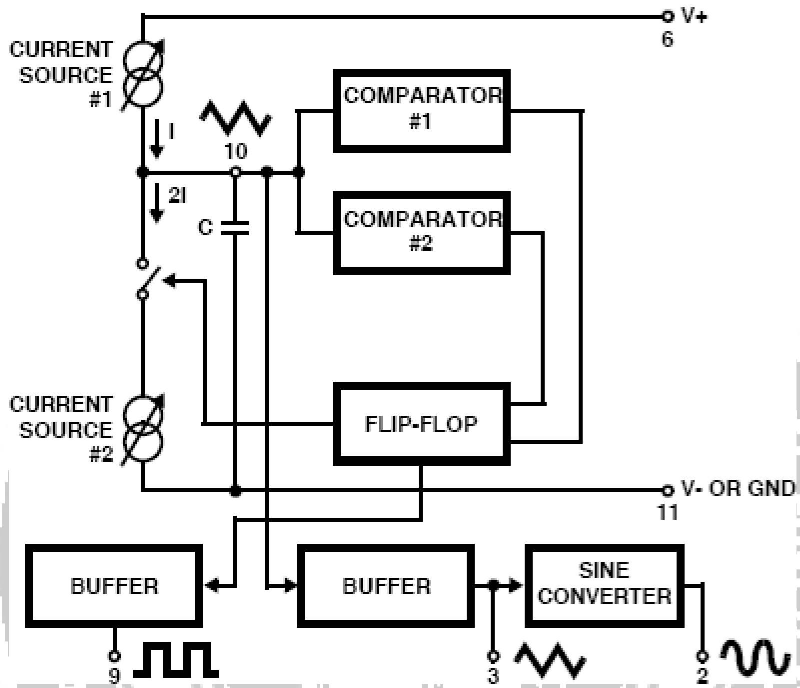
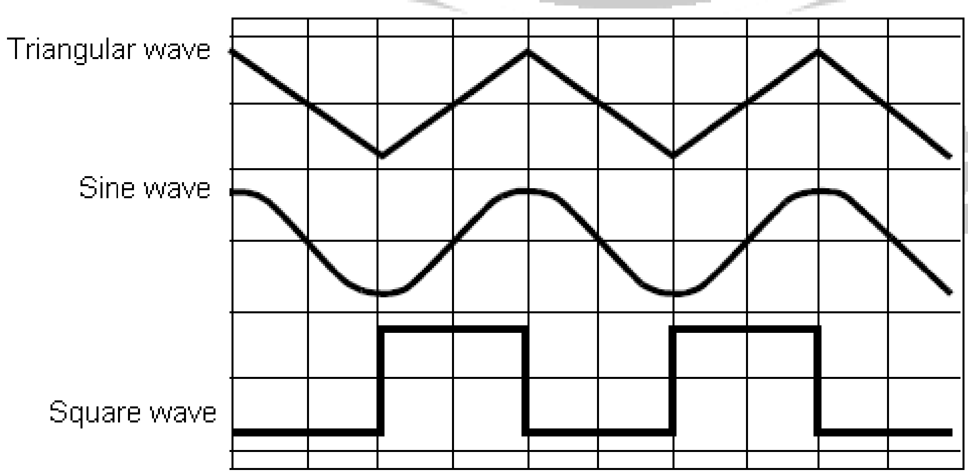


Fig: Functional block diagram of Function generator

Output Waveform:



It consists of two current sources, two comparators, two buffers, one FF and a sine wave converter.

Pin description:

Pin 1 & Pin 12: Sine wave adjusts:

The distortion in the sine wave output can be reduced by adjusting the 100KΩ pots connected between pin12 & pin11 and between pin 1 & 6.

Pin 2 Sine Wave Output:

Sine wave output is available at this pin. The amplitude of this sine wave is 0.22 Vcc. Where ± 5V ≤ Vcc ≤ ± 15 V.

Pin 3 Triangular Wave output:

Triangular wave is available at this pin. The amplitude of the triangular wave is 0.33Vcc. Where ± 5V ≤ Vcc ≤ ± 15 V.

Pin 4 & Pin 5 Duty cycle / Frequency adjust:

The symmetry of all the output wave forms & 50% duty cycle for the square wave output is adjusted by the external resistors connected from Vcc to pin 4. These external resistors & capacitors at pin 10 will decide the frequency of the output wave forms.

Pin 6 + Vcc:

Positive supply voltage the value of which is between 10 & 30V is applied to this pin.

Pin 7 : FM Bias:

This pin along with pin no8 is used to TEST the IC 8038.

Pin9 : Square Wave Output:

A square wave output is available at this pin. It is an open collector output so that this pin can be connected through the load to different power supply voltages. This arrangement is very useful in making the square wave output.

Pin 10 : Timing Capacitors:

The external capacitor C connected to this pin will decide the output frequency along with the resistors connected to pin 4 & 5.

Pin 11 : $-V_{EE}$ or Ground:

If a single polarity supply is to be used then this pin is connected to supply ground & if (±) supply voltages are to be used then (-) supply is connected to this pin.

Pin 13 & Pin 14: NC (No Connection)

Important features of IC 8038:

1. All the outputs are simultaneously available.
2. Frequency range : 0.001Hz to 500kHz
3. Low distortion in the output wave forms.
4. Low frequency drift due to change in temperature.
5. Easy to use.

Parameters:

(i) Frequency of the output wave form:

- The output frequency dependent on the values of resistors R1 & R2 along with the external capacitor C connected at pin 10.
- If $R_A = R_B = R$ & if R_C is adjusted for 50% duty cycle then

$$f_o = \frac{0.3}{RC}\ ; \quad R_A = R1,\ R_B = R3,\ R_C = R2$$

(ii) Duty cycle / Frequency Adjust : (Pin 4 & 5):

Duty cycle as well as the frequency of the output wave form can be adjusted by controlling the values of external resistors at pin 4 & 5.

- The values of resistors R_A & R_B connected between Vcc * pin 4 & 5 respectively along with the capacitor connected at pin 10 decide the frequency of the wave form.
- The values of R_A & R_B should be in the range of 1kΩ to 1MΩ.

(iii) FM Bias:

- The FM Bias input (pin7) corresponds to the junction of resistors R1 & R2.
- The voltage Vin is the voltage between Vcc & pin8 and it decides the output frequency.
- The output frequency is proportional to Vin as given by the following expression

For $R_A = R_B$ (50% duty cycle).

$$fo = \frac{1.5Vin}{CRAVcc}$$; where C is the timing capacitor

- With pin 7 & 8 connected to each other the output frequency is given by

$$fo = \frac{0.3}{RC}$$

where $R = R_A = R_B$ for 50% duty cycle.

- This is because $Vin = \frac{R1}{R1 + R2} Vcc$

(iv) FM Sweep input (pin 8):

- This input should be connected to pin 7, if we want a constant output frequency.
- But if the output frequency is supposed to vary, then a variable dc voltage should beapplied to this pin.
- The voltage between Vcc & pin 8 is called Vin and it decides the output frequency as,

$$f_o = \frac{1.5\, V_{in}}{C\, R_A\, V_{cc}}$$

A potentiometer can be connected to this pin to obtain the required variable voltage required tochange the output frequency.