1.5 TRIANGULAR WAVE GENERATOR

The two states of circuit are only stable for a limited time and the circuit switches between them with the output alternating between positive and negative saturation values. Figure 1.5.1 Shown is the circuit diagram for Triangular wave generator.

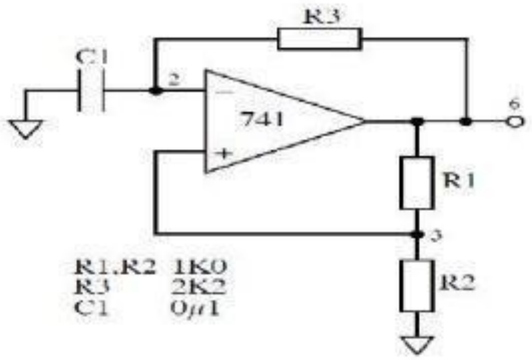

Figure 1.5.1 Triangular wave Generator circuit diagram

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Analysis of this circuit starts with the assumption that at time *t*=0 the output has just switched to state 1, and the transition would have occurred.An op-amp Astable multivibrator is also called as free running oscillator. The basic principle of generation of square wave is to force an op-amp to operate in the saturation region ($\pm V_{sat}$).A fraction $\beta = R_2/(R_1+R_2)$ of the output is feedback to the positive input terminal of op-amp. The charge in the capacitor increases & decreases up to a threshold value called $\pm\beta V_{sat}$. The charge in the capacitor triggers the op-amp to stay either at $+V_{sat}$ or $-V_{sat}$.

Asymmetrical square wave can also be generated with the help of Zener diodes. Astable multi vibrator do not require a external trigger pulse for its operation & output toggles from one state to another and does not contain a stable state.Astable multi vibrator is mainly used in timing applications & waveforms generators.

Design

1. The expression of f_o is obtained from the charging period t1 & t2 of capacitor as $T=2RC\ln (R_1+2R_2)/R_1$

2. To simplify the above expression, the value of R_1 & R_2 should be taken as $R_2 = 1.16R$ Such that f_o simplifies to $f_o = 1/2RC$.
3. Assume the value of R_1 and find R_2.
4. Assume the value of C & Determine R from $f_o = 1/2R\,C$
5. Calculate the threshold point from $\beta V_{SAT} = R_1 V_T / R1 - R_2\ l/\beta V_{SAT}$ w h e r e β is the feedback ratio.

MONOSTABLE MULTIVIBRATOR USING OP-AMP

circuit diagram:

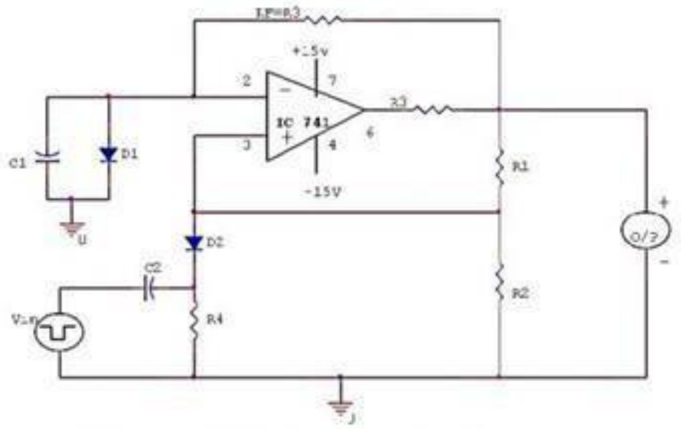

Figure 1.5.2.Monostable multivibrator using op-amp

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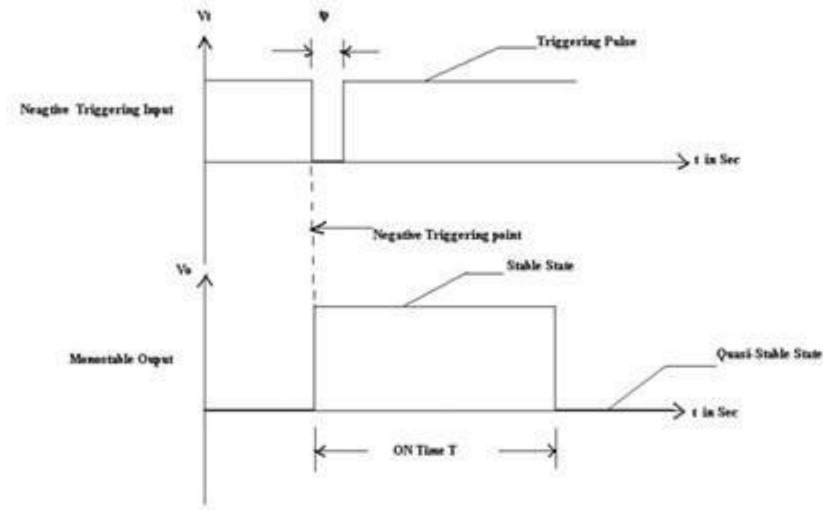

Figure 1.5.3 Input-output waveforms

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Monostable multivibrator using op-amp is shown in figure 5.2.2.A multivibrator which has only one stable and the other is quasi stable state is called as Monostable multivibrator or one-short multivibrator. This circuit is useful for generating signal output pulse of adjustable time duration in response to a triggering signal. The width of the output pulse depends only on the external components connected to the op-amp. Usually a negative trigger pulse is given to make the output switch to other state. But, it then return to its stable state after a time interval determining by circuit components. The pulse width T can be given as T = 0.69RC. For Monostable operation the triggering pulse width Tp should be less then T, the pulse width of Monostable multivibrator. This circuit is also called as time delay circuit or gating circuit. Input-output waveforms is shown in figure 5.2.3.

Design:

1. Calculating β from expression

$$\beta = \frac{R1}{R1 + R2}$$

2. The value of R and C from the pulse width time expression.

$$T = RC \ln \frac{(1 + V_D / V_{sat})}{1 - \beta}$$

$$T = RC \ln \frac{(1 + V_D / V_{sat})}{0.5}$$

$$T = 0.69RC.$$

3. Triggering pulse width T_p must be much smaller than T. $Tp < T$.

TRIANGULAR WAVE GENERATOR

A Triangular Wave Generator Using Op amp can be formed by simply connecting an integrator to the square wave generator.

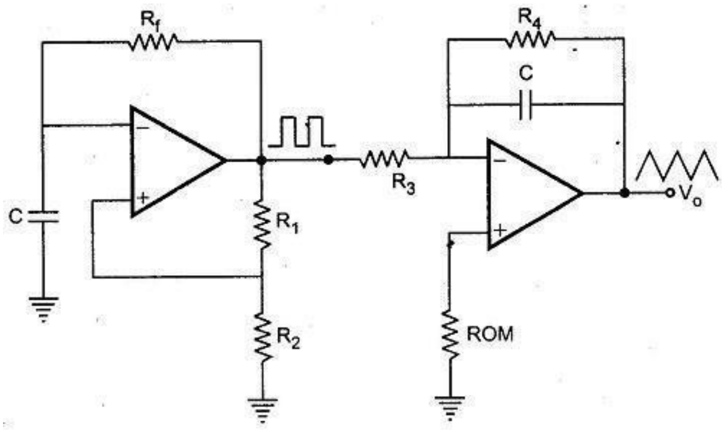

Figure 1.5.4.Circuit Diagram of Triangular wave Generator

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Triangular wave is generated by alternatively charging and discharging a capacitor with a constant current. This is achieved by connecting integrator circuit at the output of square wave generator as shown in the figure 1.5.4 above.

Assume that V' is high at $+V_{sat.}$ This forces a constant current ($+V_{sat}/R_3$) through C (left to right) to drive Vo negative linearly. When V' is low at —V_{sat}, it forces a constant current (— V_{sat} /R_3) through C (right to left) to drive Vo positive, linearly. The frequency of the triangular wave is same as that of square wave. This is illustrated in Figure 1.5.5 below.

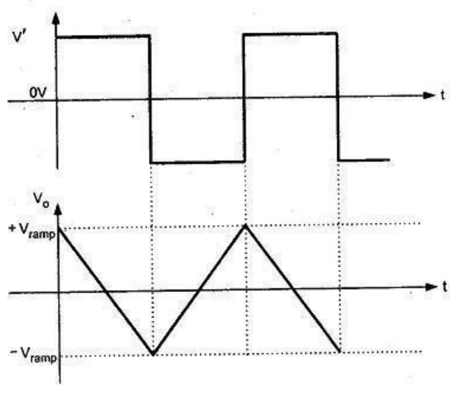

Figure 1.5.5 Input-output waveforms

[source: https://www.brainkart.com/subject/Linear-Integrated-Circuits_220/]

Although the amplitude of the square wave is constant (± V_{sat}), the amplitude of the triangular wave decreases with an increase in its frequency, and vice versa. This is because the reactance of capacitor decreases at high frequencies and increases at low frequencies. In practical circuits, resistance R_4 is connected across C to avoid the saturation problem at low frequencies as in the case of practical integrator as shown in the Figure 1.5.4 above.

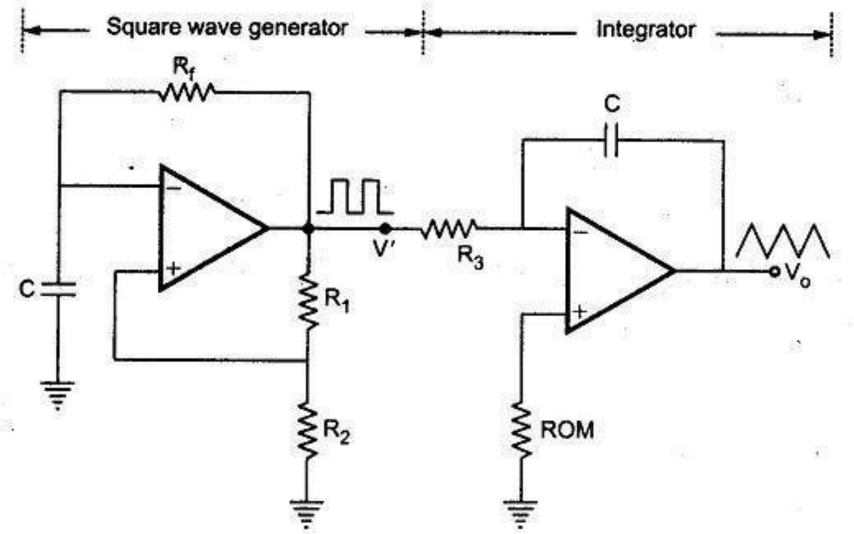

Figure 1.5.6 Triangular wave Generator using lessor components

[source: https://www.brainkart.com/subject/Linear-Integrated-Circuits_220/]

To obtain stable triangular wave at the output, it is necessary to have $5R_3 C_2 > T/2$, where T is the period of the square wave input. Triangular wave Generator using lessor components is shown in figure 1.5.6.

The time period of the output of the square wave generator is $T = 2 \times 2.303 R_f C \times \log((2R_2+R_1)/R_1)$ which is the same for triangular wave generator.

Frequency of the output f = 1/T