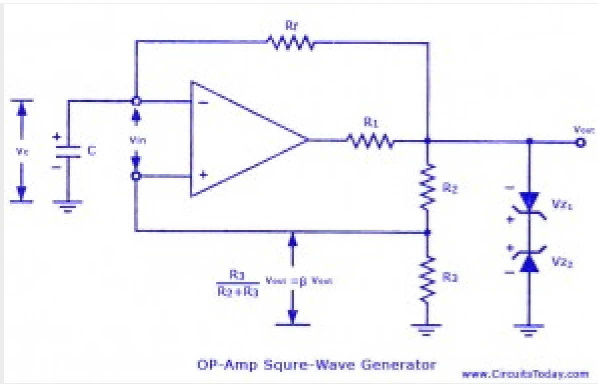
SQUARE WAVE GENERATOR USING OP-AMP

How to make an Astable or Free running Multi vibrator using 741 Op-Amp ?



op amp astable multi vibrator

The non-sinusoidal waveform generators are also called relaxation oscillators. The op-amp relaxation oscillator shown in figure is a square wave generator. In general, square waves are relatively easy to produce. Like the **UJT relaxation oscillator**, the circuit's frequency of oscillation is dependent on the charge and discharge of a capacitor C through feedback resistor R,. The "heart" of the oscillator is an **inverting op-amp comparator**

The comparator uses positive feedback that increases the gain of the amplifier. In a comparator circuit this offer two advantages. First, the high gain causes the op-amp's output to switch very quickly from one state to another and vice-versa. Second, the use of positive feedback gives the circuit hysteresis. In the op-amp square-wave generator circuit given in figure, the output voltage v_{out} is shunted to ground by two Zener diodes Z_1 and Z_2 connected back-to-back and is limited to either $V_{Z\ 2}$ or $–V_{Z\ 1}$. A fraction of the output is fedback to the non-inverting (+) input terminal. Combination of IL and C acting as a low-pass R-C circuit is used to integrate the output voltage v_{out} and the capacitor voltage v_c is applied to the inverting input terminal in place of external signal. The differential input voltage is given as $\mathbf{v_{in} = v_c - \beta\ v_{out}}$

When v_{in} is positive, $v_{out} = –\ V_{z1}$ and when v_{in} is negative $v_{out} = +\ V_z 2$. Consider an instant of time when $v_{in} < 0$. At this instant $v_{out} = +\ V_{z\ 2}$, and the voltage at the non-inverting (+) input terminal is $\beta\ V_{z\ 2}$, the capacitor C charges exponentially towards $V_{z\ 2}$, with a time constant $R_f\,C$. The output voltage remains constant at $V_{z\ 2}$ until v_c equal $\beta\ V_{z\ 2}$.

When it happens, comparator output reverses to – $V_{z\,1}$. Now v_c changes exponentially towards -V_{z1} with the same time constant and again the output makes a transition from -V_{z1} to + $V_{z\,2.}$ when v_c equals -$\beta V_{z\,1}$

Let $V_{z1} = V_{z\,2}$

The time period, T, of the output square wave is determined using the charging and discharging phenomena of the capacitor C. The voltage across the capacitor, v_c when it is charging from – B V_z to + V_z is given by

$$V_c = [1-(1+\beta)]e^{-T/2\tau}$$

Where $\tau = R_fC$

The waveforms of the capacitor voltage v_c and output voltage v_{out} (or v_z) are shown in figure.

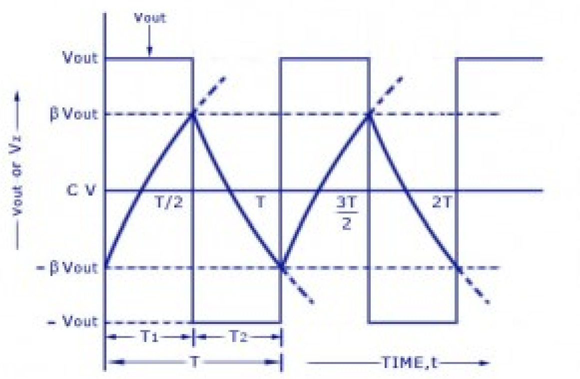
When t = t/2

$$V_c = +\beta V_{z\,or} + \beta V_{out}$$

Therefore $\beta V_z = V_z [1-(1+\beta)e^{-T/2\tau}]$

Or $e^{-T/2\tau} = 1- \beta/1+ \beta$

Or $T = 2\tau \log_e 1+\beta/1- \beta = 2R_f C \log_e [1+ (2R_3/R_2)]$



Output and Capacitor Voltage Waveforms

The frequency, f = 1/T , of the square-wave is independent of output voltage V_{out}. ***This circuit is also known as free-running or astable multivibrator because it has two quasi-stable states***. The output remains in one state for time $T_1$and then makes an abrupt transition to the second state and remains in that state for time T_2. The cycle repeats itself after time $\mathbf{T = (T_1 + T_2)}$ where T is the time period of the square-wave.

The op-amp square-wave generator is useful in the frequency range of about 10 Hz -10 kHz. At higher frequencies, the op-amp's slew rate limits the slope of the output square wave. The symmetry of the output waveform depends on the matching of two Zener diodes Z_1 and Z_2. The unsymmetrical square-wave (T_1 not equal to t_2) can be had by using different constants for charging the capacitor C to +V_{out} and -V_{out}

Source : http://www.circuitstoday.com/square-wave-generator-using-op-amp