

# Constant amplitude ramp generation with op amps

Generation of a constant amplitude ramp independent of frequency implies keeping the rate of increase of the ramp voltage in one period of the square wave, as a function of the frequency of the square wave itself. One method to obtain this involves a closed loop circuit of the type detailed in Fig. 1. This circuit comprises an operational integrator ( $A_0$ ) having a transfer function  $-1/s\tau$  where  $\tau = RC$ , a peak rectifier (RECT), a difference amplifier (A) of gain A, an electronic switch (Q) and a pulse generator (P.G.).

The output voltage  $V_o$  is fed

back to the input of the operational integrator and the constant amplitude of the ramp is set by the voltage reference  $V_r$ . At the end of every period of the input square wave (Fig. 2), the pulse generator provides an appropriate pulse to the switch (Q), to enable it to close and open instantaneously. Due to this action, the capacitor C discharges quickly and starts charging again.

If  $V_p$  is the peak value of the ramp voltage  $V(t)$ , then

$$V_o = A (V_p - V_r)$$

$$\text{and, } V(t) = -\frac{V_o}{s\tau}$$

Since,

$$V(t) = 0, \text{ for every } t = 0$$

$$V(t) = V_p, \text{ for every } t = T$$

$$V_p = -\frac{V_o T}{\tau}$$

and substituting for  $V_o$

$$V_p \left[ 1 + \frac{AT}{\tau} \right] = \frac{V_r AT}{\tau}$$

$$\text{or } V_p = V_r \cdot \frac{AT}{(\tau + AT)}$$

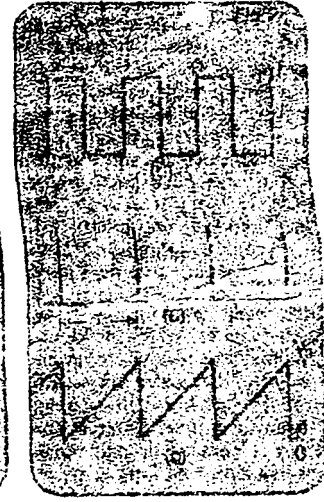
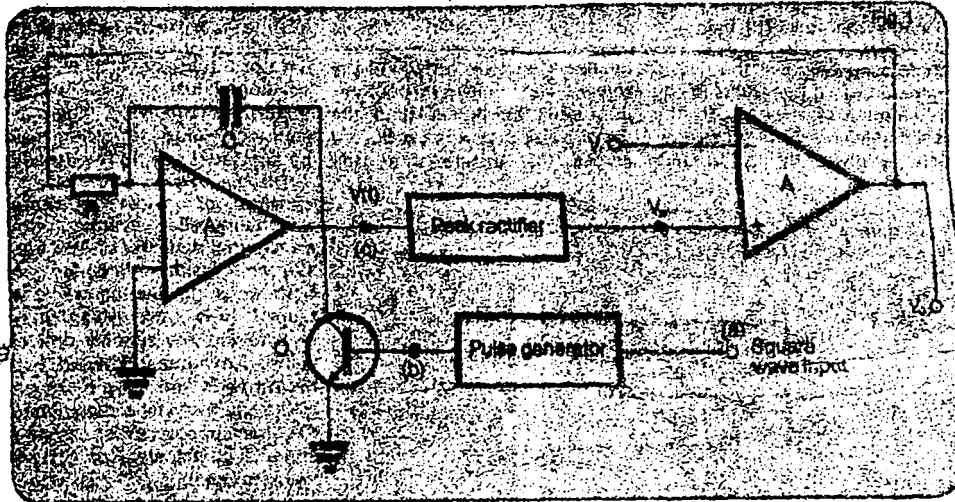
and when  $AT \gg \tau$ ,  $V_p = V_r$

Thus, the peak value of the ramp remains equal to the set-point voltage  $V_r$  independent of the frequency of the input square wave. Fig. 2 shows the wave

forms at points (a), (b) and (c) in Fig. 1.

A similar circuit, with a controlled constant current source charging a capacitor instead of the operational integrator is also possible. Such a circuit has been built and verifies the theory outlined here over a frequency range 5 kHz to 15 kHz. For a wider frequency range, it may be necessary to switch in different values of CR in the operational integrator.

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