SIMPLE INTEGRATOR

An op-amp and a capacitor can be used to implement, to a high degree of accuracy, the mathematical process of integration. In this case, current is summed over a period of time and the resultant voltage generated is the integral of that current as a function of time. What this means that if a constant voltage is inputted to the circuit, a ramp with a constant slope is generated at the output. When the input is positive, the output of the op-amp ramps negative.

In doing so it pulls the inverting terminal negative so as to maintain a 'virtual earth' condition. In fact the input current (Vin/R1) is being equalled by the current flowing through the capacitor, thus equilibrium is maintained. The equation governing the behaviour of a capacitor is C x dV/dt = i, where dV/dt is the rate of change of voltage across the capacitor.

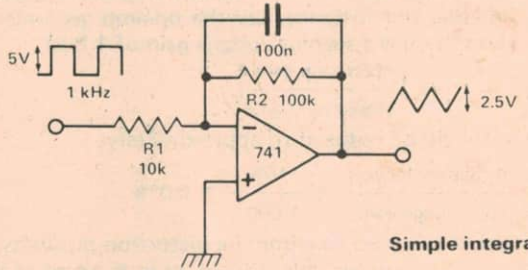
Therefore

$$\frac{dV}{dt} \quad \frac{i}{C}$$

Thus

$$\frac{dV}{dt} \quad \frac{Vin}{R1C}$$

So, when a square wave is applied to the circuit in Fig. 10, triangle waveforms are generated. R2 was added to provide DC stability. Its inclusion does slightly corrupt the mathematical processes, but not enormously. A good point about this integrator design is that it has a very low output impedance. You can put a load on the output and the op-amp will still generate the same waveform — that's what is so nice about negative feedback.



Simple integrator.

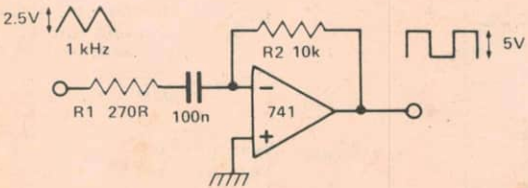


Fig. 11. Simple differentiator.

SIMPLE DIFFERENTIATOR

Mathematically, differentiation is the reverse process to integration. Thus, in the differentiator circuit the C and the R are reversed with respect to the integrator circuit.

The input waveform is a triangle with a constant rise and fall slope. This constant slope, when presented to a capacitor will generate a constant current. When the slope direction reverses, then so will the current flow. This current when passed through a resistor (R1), will then generate a square wave.