INTEGRATOR USING IC741 OP-AMP

Objective

To study the operation of the Integrator using op-amp and trace the output wave forms for sine and square wave inputs.

THEORY

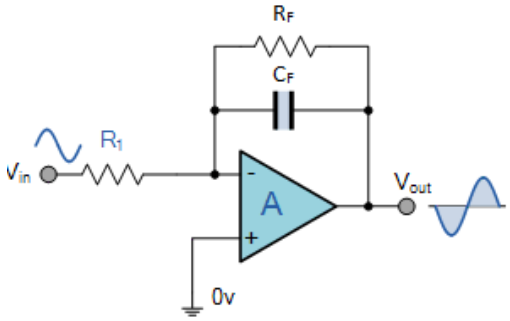

Figure 1

A circuit in which the output voltage is the integration of the input voltage is called an integrator.

$$V_o = -\frac{1}{R_1 C_F}\int V_{in}\, dt$$

In the practical integrator shown in Figure 1, to reduce the error voltage at the output, a resistor R_F is connected across the feedback capacitor C_F. Thus, R_F limits the low-frequency gain and hence minimizes the variations in the output voltage.

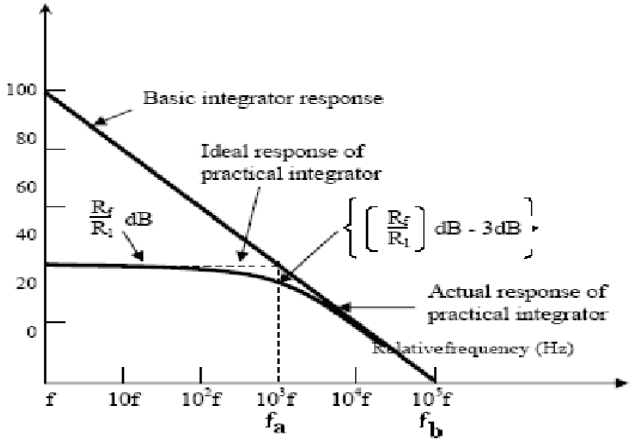

Figure 2

The frequency response of the integrator is shown in Figure 2. f_b is the frequency at which the gain is 0 dB and is given by:

$$f_b = 1/2\pi R_1 C_F$$

In this figure there is some relative operating frequency, and for frequencies from f to f_a the gain R_F/R_1 is constant. However, after f_a the gain decreases at a rate of 20 dB/decade. In other words, between fa and f_b the circuit of fig. 2.1 acts as an integrator. The gain limiting frequency f_a is given by

$$f_a = 1/2\pi R_F C_F.$$

Normally $f_a < f_b$. From the above equation, we can calculate R_F by assuming f_a & C_F. This is very important frequency. It tells us where the useful integration range starts.

- If fin < fa - circuit acts like a simple inverting amplifier and no integration results,
- If fin = fa - integration takes place with only 50% accuracy results,
- If fin = 10fa - integration takes place with 99% accuracy results.

In the circuit diagram of Integrator, the values are calculated by assuming f_a as 50 Hz. Hence the input frequency is to be taken as 500Hz to get 99% accuracy results. Integrator has wide applications in

1. Analog computers used for solving differential equations in simulation arrangements.
2. A/D Converters.
3. Signal wave shaping.
4. Function Generators.

Equipment:

1. Oscilloscope
2. AC Function Generator
3. Digital Multimeter

Components:

1. Resistors: 10kΩ, 22kΩ
2. Capacitor 0.1µF
3. Op-amp 741

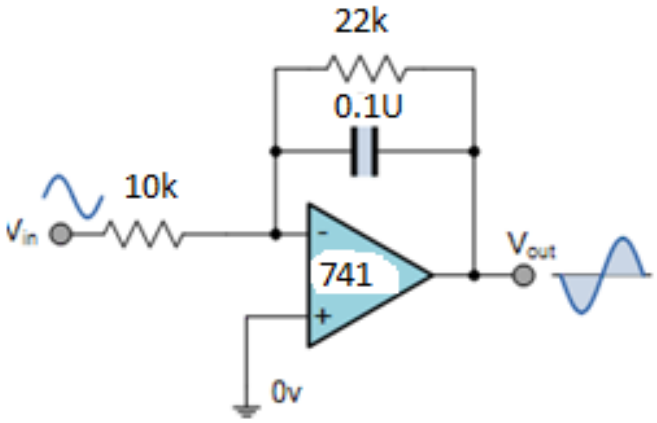

Figure 3

PROCEDURE:

1. Connect the components/equipment as shown in the circuit diagram Figure 3.
2. Switch ON the power supply.
3. Apply sine wave at the input terminals of the circuit using function Generator.
4. Connect channel-1 of CRO at the input terminals and channel-2 at the output terminals.
5. Observe the output of the circuit on the CRO which is a cosine wave (90o phase shifted from the sine wave input) and note down the position, the amplitude and the time period of Vin & Vo.
6. Now apply the square wave as input signal.

7. Observe the output of the circuit on the CRO which is a triangular wave and note down the position, the amplitude and the time period of Vin & Vo.
8. Plot the output voltages corresponding to sine and square wave inputs as shown in the Figure 4 below.

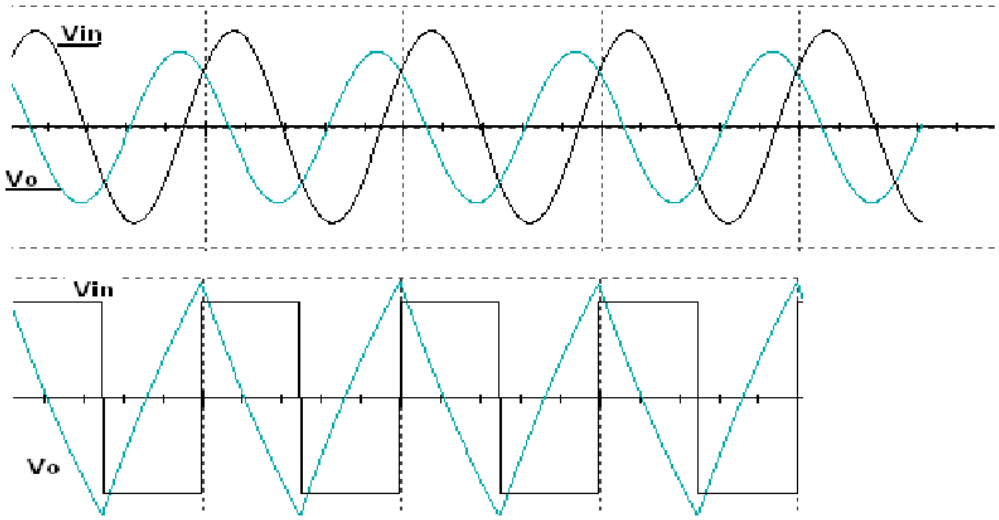

Figure 4