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Experiment- 7

VOLTAGE TO FREQUENCY CONVERTER

OBJECTIVE: Designing a voltage to frequency converter.

MATERIALS REQUIRED

Components :

Op-Amp : Two LM741.
Transistor : One 2N2222A
Diode : one 6.2V zener diode.
Resistance : One 330, One 1kΩ, two 2.2KΩ, one 3.9KΩ, one 5.6KΩ, two 10 kΩ, three 100 kΩ.
: Capacitor : One 10 μF.

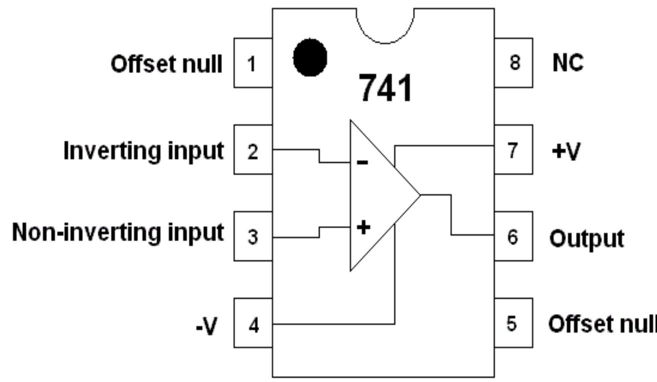

Fig 7.1

PRECAUTIONS AND GUIDELINES

1. The op-amp (Fig 7.1) generally works on split power supply (e.g. ±12 V). Both positive and negative power supplies must be present whenever op-amp is powered. The range of power supply is from ±5 V to ±15 V. Do not forget to connect the common terminal of the power supply to the *ground* on the breadboard.

2. Connecting only one side of power supply or interchanging positive and negative power supplies damages the op-amp.

3. While switching on the set-up, switch on the oscilloscope first, then the power supply to the circuit, and finally the function generator. When switching off, follow the sequence in reverse order.
4. For any IC, never exceed the input voltage beyond the power supply limits.

5. Keep ground terminals of the oscilloscope probes and function generator output, and power supply common connected together throughout the experiment.

The circuit shown in Fig. 7.2 is of Voltage to Frequency converter

Working Principle: Initially, the capacitor C gets charged at constant rate of (**V_i / R3**) amp. The output voltage **V_a** at point '**a**' drops linearly till this voltage is not less than the voltage **V_b** at point '**b**' which is approx. at about -5.0V. Note that, the comparator output voltage **V_C** is at approx. -12V when **V_a** is greater than -5.0V and the transistor is in 'off' state.

When the negatively increasing voltage Va becomes less than -5.0V, the comparator output Vc goes to approx. +12V. The transistor gets 'on' and hence the emitter voltage (also voltage at comparator '+' input) of the transistor is about at zero voltage. The transistor is in saturated state. The capacitor starts discharging. The discharging continues and Va increases positively, till Va becomes greater than zero voltage. The comparator output VC becomes about -12V and the transistor becomes 'off'. This charging and discharging process repeats again and again. Note that the discharging duration is same for any input voltage Vi and it should be much smaller than the charging time, which depends on the input voltage Vi.

Pre-experiment Reading:

(a) **Draw the waveforms at (i) V_a (ii) V_b and (iii) V_c**
(b) **Compute the charging time of the capacitor.**
(c) **Compute the discharging time of the capacitor. (Assume V_i= 4V for above)**

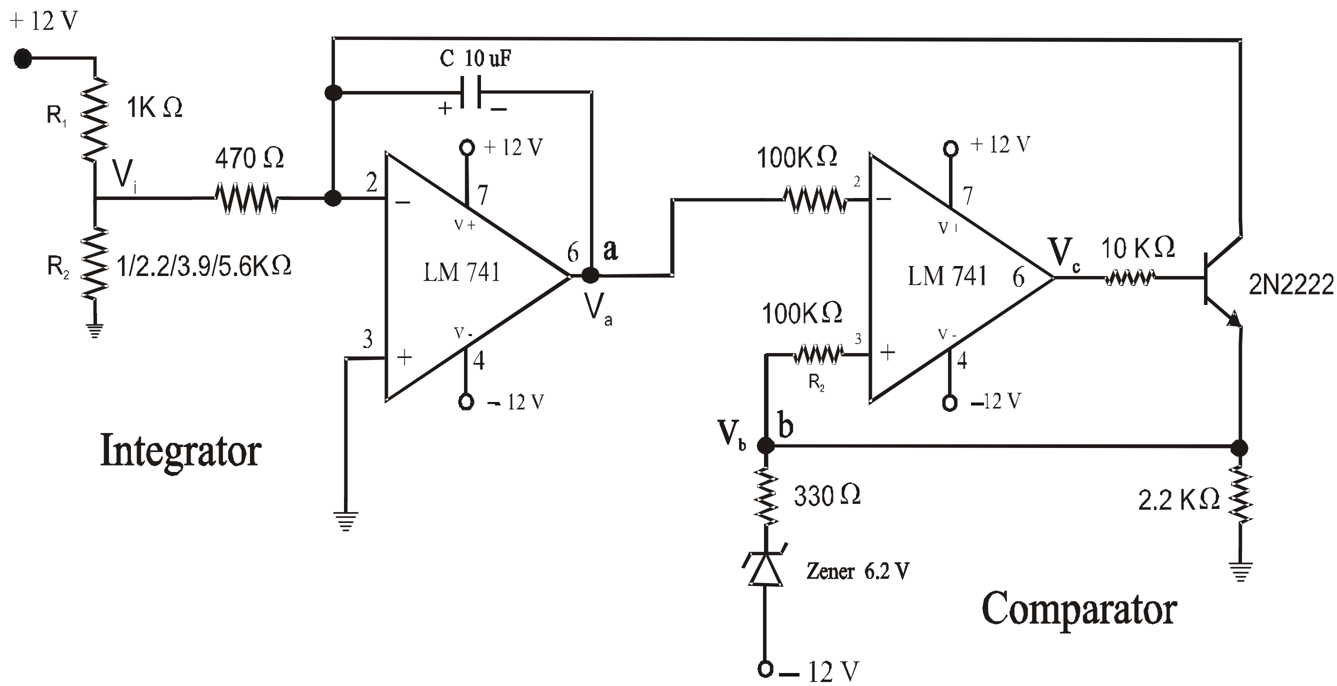

Fig 7.2 Voltage to Frequency Converter

OBSERVATIONS:

1. Connect the circuit as shown in Fig 7.2 with R_1 = 1 kΩ, and R_2 = 1 kΩ. Make sure the power supply ground is connected to the circuit ground.
2. Observe the waveform $\mathbf{V_a}$ at point '**a**' for
   (a) for R_2 = 1 KΩ
   (b) for R_2 = 2.2 KΩ
   (c) for R_2 = 3.9 KΩ
   (d) for R_2 = 5.6 KΩ
   and measure frequency form the output at point (Vc)
3. Similarly, observe the waveform V_b at point 'b' for all V_i as in step 2.
4. Remove the zener diode and replace it by a resistance so that V_b is approx. at -5.0V and observe V_b (both frequency and pulse width).