1. CHARACTERISTICS OF OP-AMP

AIM:

To measure the following parameters of op-amp

1. Input bias current
2. Input offset current
3. Input offset voltage
4. Slew rate

APPARATUS REQUIRED:

S.No.	APPARATUS	TYPE	RANGE	QUANTITY
1)	Op-Amp	µA741		1
2)	Resistors		4.7K, 100K, 1M	1
3)	Capacitors		0.01µF	1
4)	Signal Generator			1
5)	CRO			1
6)	Dual power supply			1
7)	Bread Board			1
8)	Connecting wires			

THEORY:

Input bias current: The inverting and noninverting terminals of an op-amp are actually two base terminals of transistors of a differential amplifier. In an ideal op-amp it is supported that no current flows through these terminals. However, practically a small amount of current flows through these terminals which is on the order of nA (typical and maximum values are 80 and 1500nA) in bipolar op-amps and pA for FET op-amps. Input bias current is defined as the average of the currents entering into the inverting and noninverting terminals of an op-amp. To compensate for bias currents a compensating resistor R_{comp} is used. Value of R_{comp} is parallel combination of the resistors connected to the inverting terminal. Input bias current $I_B = (I_{B1} + I_{B2})/2$, where I_{B1} and I_{B2} are the base bias currents of the op-amp.

Input offset current: The bias currents I_{B1} and I_{B2} will not be equal in an op-amp. Input offset current is defined as the algebraic difference between the currents into the inverting and non-inverting terminals. $I_{OS} = |I_{B1} - I_{B2}|$, Typical and maximum values of input offset current are 20nA and 200nA.

I**nput offset voltage:** Even if the input voltage is zero, output voltage may not be zero. This is because of the circuit imbalances inside the op-amp. In order to compensate this, a small voltage should be applied between the input terminals. Input offset voltage is

defined as the voltage that must be applied between the input terminals of an op-amp to nullify the output voltage. Typical and maximum values of input offset voltage are 2mV and 6mV.

Slew rate: Slew rate is the rate of rise of output voltage. It is the measure of fastness of op-amp. It is expressed in V/μsec. If the slope requirements of the output voltage of the op-amp are greater than the slew rate, distortion occurs. Slew rate is measured by applying a step input voltage.

PROCEDURE:

a) Input Bias Current

1. Connect the circuit as shown in Fig.1.1.
2. Measure the output voltage from which the inverting input bias current can be calculated as $I_B^- = Vo/R_f$.
3. Connect the circuit as shown in Fig.1.2.
4. Measure the output voltage from which the non-inverting input bias current can be calculated as $I_B^+ = Vo/R_f$.
5. Average of magnitude of both I_B^- and I_B^+ gives the input bias current.

b) Input Offset Current

1. Connect the circuit as shown in Fig.1.3.
2. Measure the output voltage using multimeter.
3. Calculate the offset current as $I_{os} = V_o/R_f$.

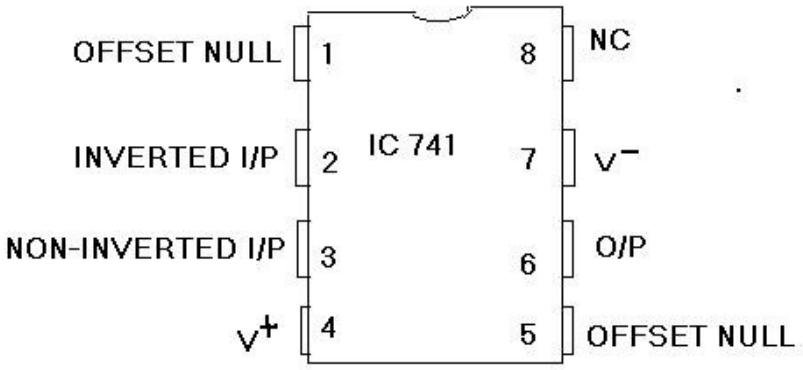
c) Input Offset Voltage

1. Connect the circuit as shown in Fig.1.4.
2. Measure the output voltage using multimeter
3. Calculate offset voltage as $V_{os} = V_o / (1+ R_f / R_1)$.

d) Slew Rate

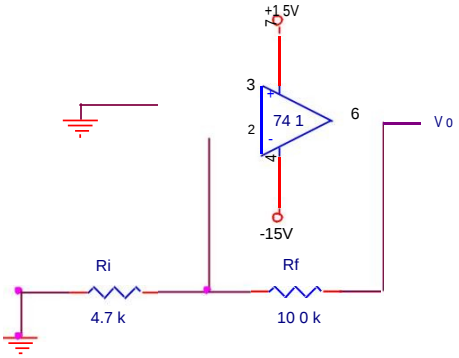
1. Connect the circuit as shown in Fig.1.5.
2. Give square wave input from the signal generator so that the output is a square wave at 1kHz.
3. Increase the frequency slowly until the output is just barely a triangular wave.
4. Calculate slew rate as $SR = (\Delta V / \Delta t)$.

PIN DIAGRAM:

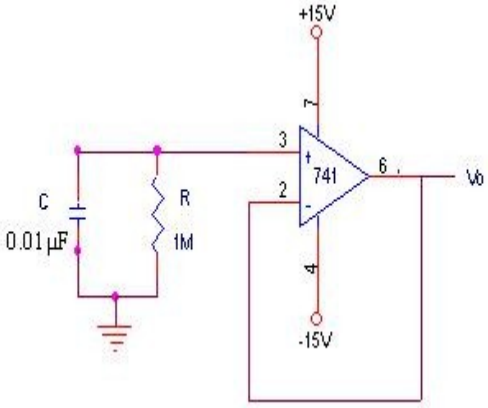


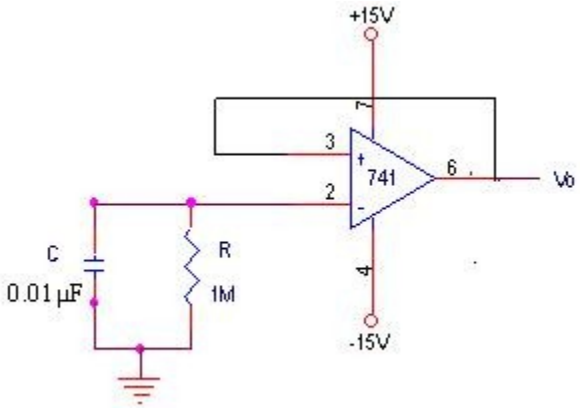
CIRCUIT DIAGRAM:

To measure input offset voltage

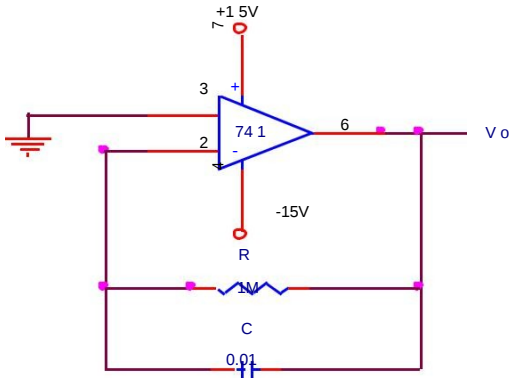


To measure input bias current

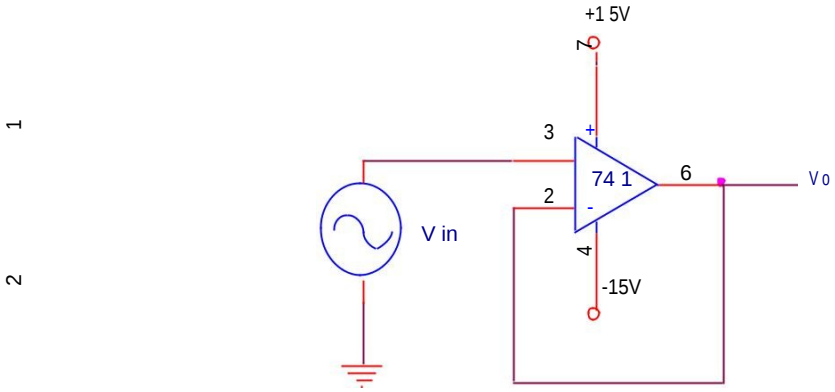




To measure input offset current



To measure slew rate



TYPICAL VALUES OF ELECTRICAL CHARACTERISTICS OF A741:

Input bias current = 80-500nA
Input offset current = 20-200nA
Input offset voltage = 1-5mV
Slew rate = <0.5 V/µs

RESULT:

The input bias current, input offset current, input offset voltage and slew rate of the op-amp were determined.

Input offset voltage = ……..mV
Input bias current = ……..A
Input offset current = ...…...A
Slew rate = ……..V/µs.