LAB REPORT-7

Non- Ideal characteristics of Op Amp Circuits

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Objective: Measurement of Offset Voltage, Bias Currents, Slew rate and Open-loop Gain of Op Amps.

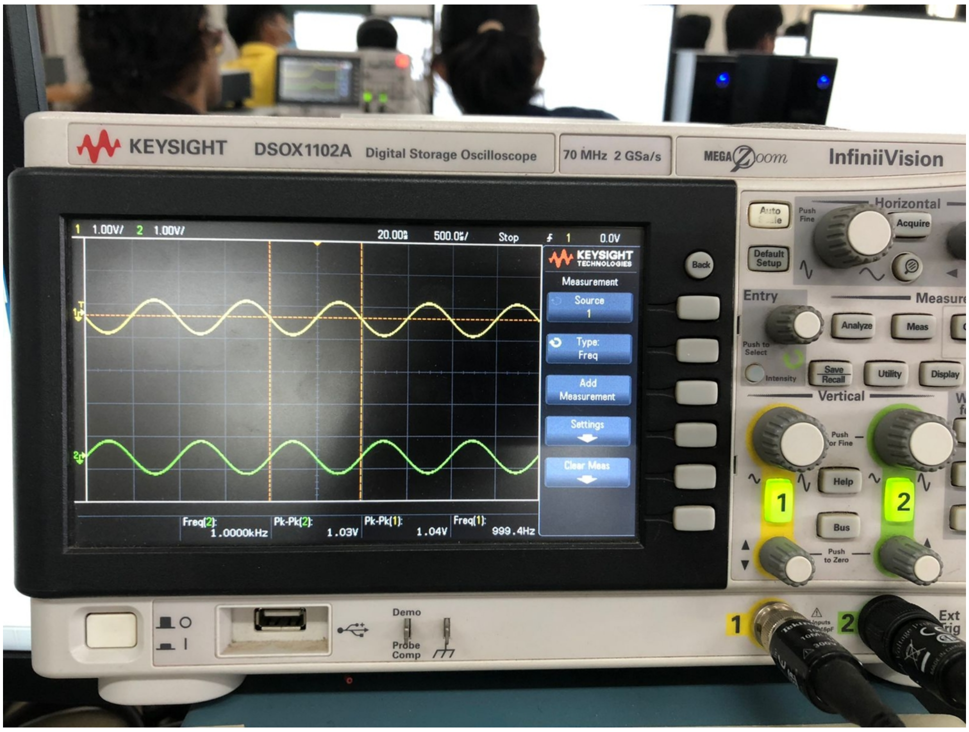
Equipment/Components Required:

1. Op-Amp µA 741
2. Resistors – 100 Ω,1MΩ,10kΩ
3. Regulated Power Supply
4. Variable Power Supply
5. Multimeter
6. Digital Storage Oscilloscope
7. Arbitrary Function Generator

Part A: Input offset voltage

Measured V_O = -3.7mV
Since, R1 = R2 = 10kΩ, A_V = -1
Therefore, $V_{OS} = V_O / A_V \Rightarrow V_{OS} = \frac{-3.7\,mV}{-1}$ = 3.7mV

⇒ Input offset Voltage = 3.7 mV



Part B: Input offset current

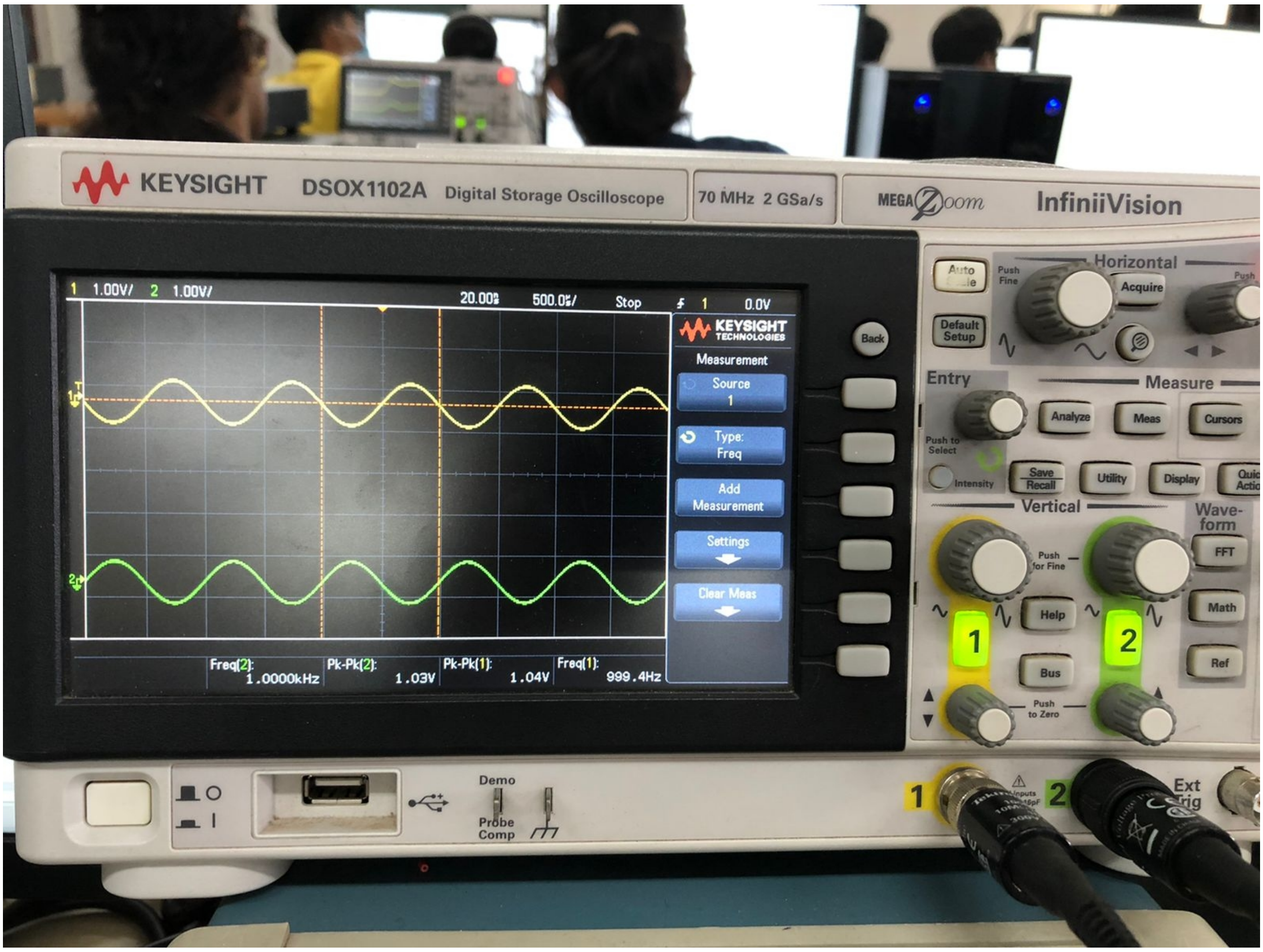
V_o (-ve teriminal inverting) = 0.348 V
V_o (+ve terminal non inverting) = -0.342 V

$$I_{B-} = \frac{0.348\,V}{10^7} = 0.0348\ \mu A$$

$$I_{B+} = \frac{-0.342\,V}{10^7} = -0.0342\ \mu A$$

$I_{bias} = I_{B+} + I_{B-} = 0.6$ nA

$I_{OS} = I_{B+} - I_{B-} = 70$ nA



Part C: Slew rate and Bandwidth measurement

Rising edge and falling edge measurements,

For 25 kHz,

ΔV = -950 mV
Δt = 1.9 μs

Slew rate = $\frac{-\Delta V}{\Delta t}$ = 0.5 V/μs

For 50 kHz,

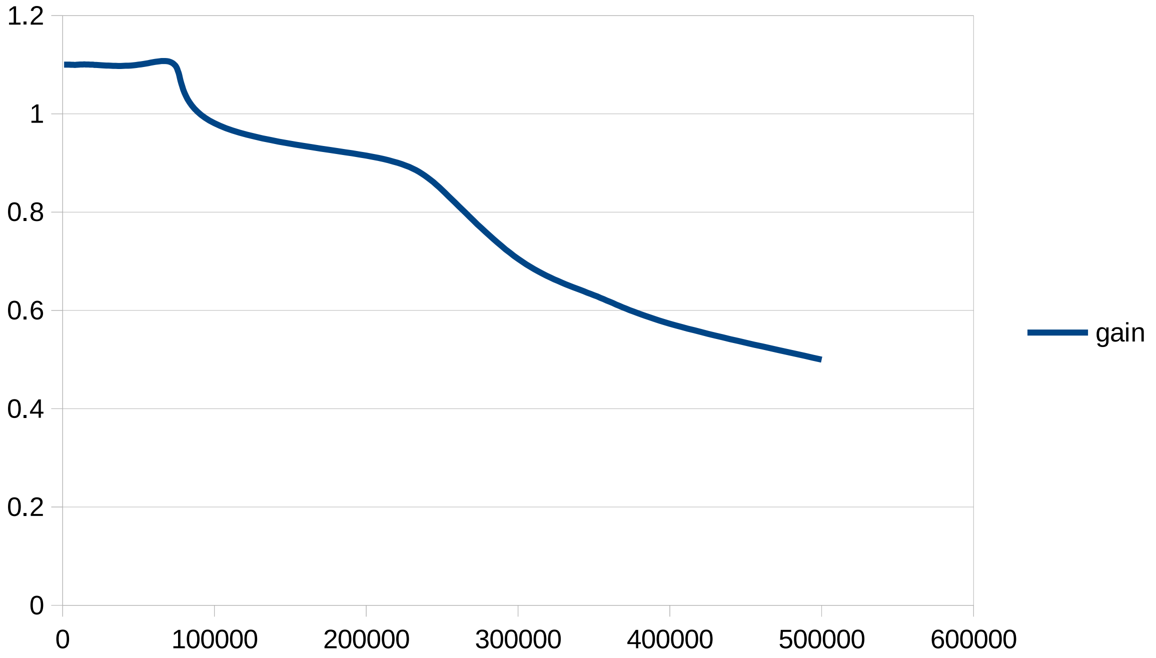
ΔV = -931.25 mV
Δt = 1.8 μs

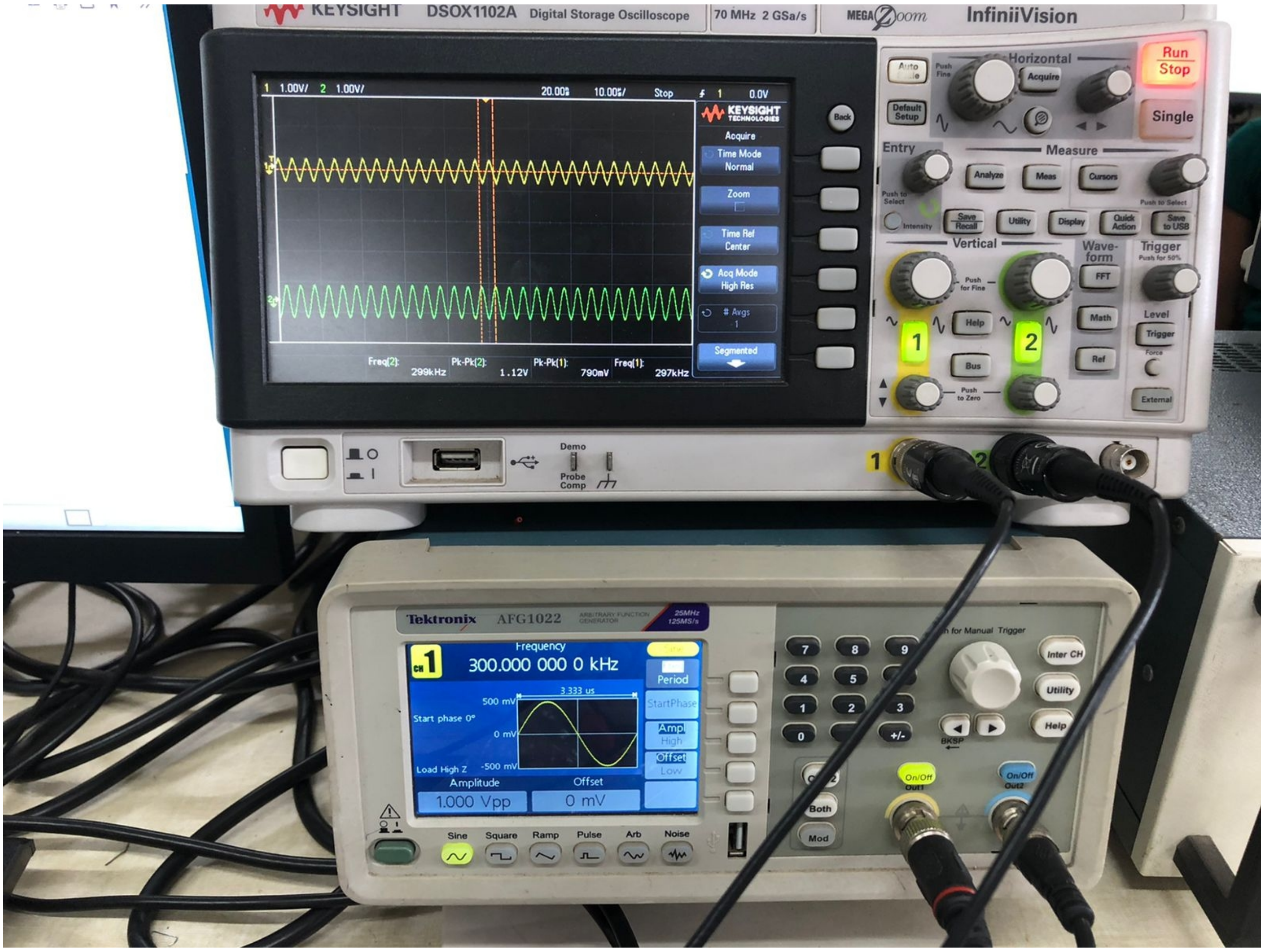
Slew rate = $\frac{-\Delta V}{\Delta t}$ = 0.517 V/μs

Part D: Bandwidth measurement

Frequency(in Hz)	Gain (for $V_{in} = 1V_{p\text{-}p}$)	Gain (in db)
1000	1.1	0.827853703164502
5000	1.1	0.827853703164502
10000	1.1	0.827853703164502
20000	1.1	0.827853703164502
50000	1.1	0.827853703164502
75000	1.095	0.788282383522743
100000	0.981	-0.16661985240103
200000	0.915	-0.771578118671034
250000	0.845	-1.46286582100615
300000	**0.705**	**-3.03621766017203**
350000	0.631	-3.99941281511731
400000	0.573	-4.8369075606522
500000	0.5	-6.02059991327962

Bandwidth of Op- Amp will be, **BW = 300 kHz**





Part E: Measurement of DC open-loop gain

From the circuit, R_2 = 100 Ω and R_3 = 1 MΩ.

V_o^A = 1.66 V
V_o^B = 1.68 V
V' = -270 mV

Using the equation given for A_{OL}, we have

$$\frac{R_2}{R_2 + R_3}(V_o^B - V_o^A) \times A_{OL} = -V'$$

A_{OL} (open loop DC gain) = 1.35×10^5

Gain in the Data sheet = 2×10^5

So, we have got a reasonably good gain for the Op – Amp in open loop configuration.

Discussion:

1. In this experiment, we explored non-ideal characteristics of Op Amp in contrary to the previous lab wherein we just verified the ideal characteristics of Op Amp.

2. We explored different non idealities such as offset currents and voltages, bias currents, Bandwidth of Op Amp, and DC open loop gain of Operational Amplifier, and also slew rate was measured for both positive edge and negative edge which is the rate of change of output voltage with respect to time, wherein we ideally expect Op Amp to give sharp increase and Decrease of output voltage.

3. Also the open loop gain is also limited due to fact that op-Amp gets saturated at its output at $+V_{CC}$ and $-V_{CC}$ even though the input voltage is small.

4. Also, in the ideal case, as the Op Amp is assumed to have infinite input impedance, the current going into terminals of Op Amp is zero. But, in real op-Amp, the input offset current and bias current have some, although very small currents in nA scale.