Analog Electronic Circuits – Lab 6

Sricharan Vinoth Kumar, Saikiran .S

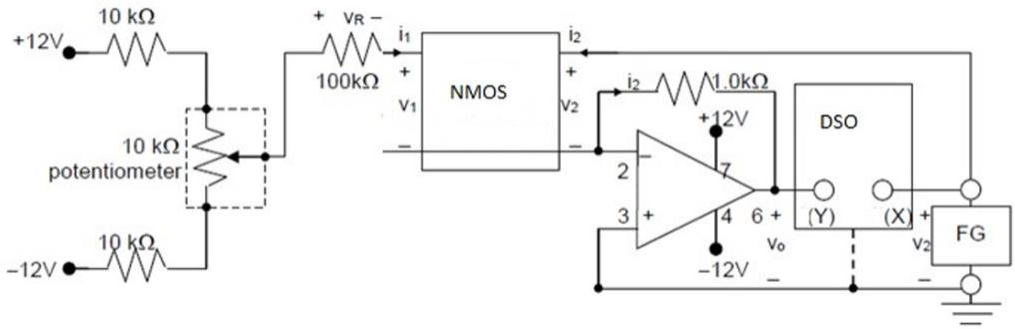
Roll No: 2024112022, 2024112007

Part 1:

- Objective:

  To determine the I_D vs V_{DS} characteristics of the given MOSFET.

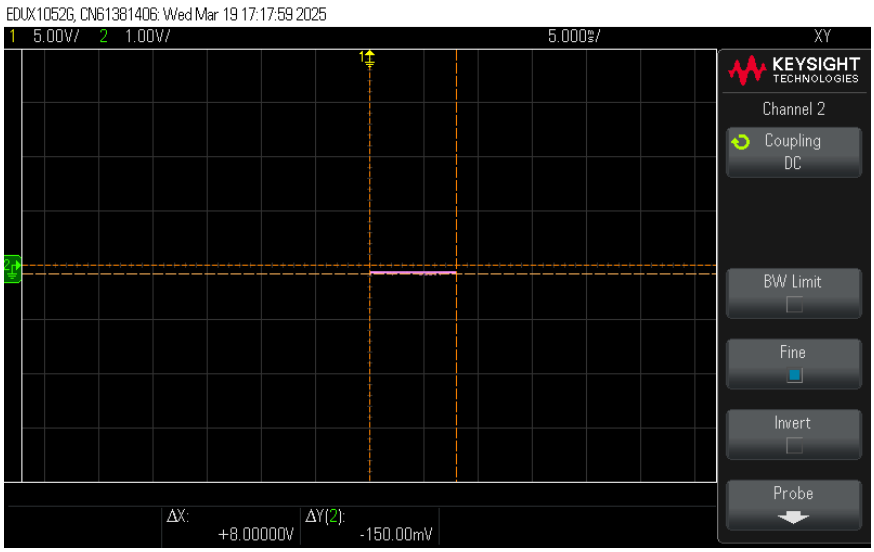
- Circuit:



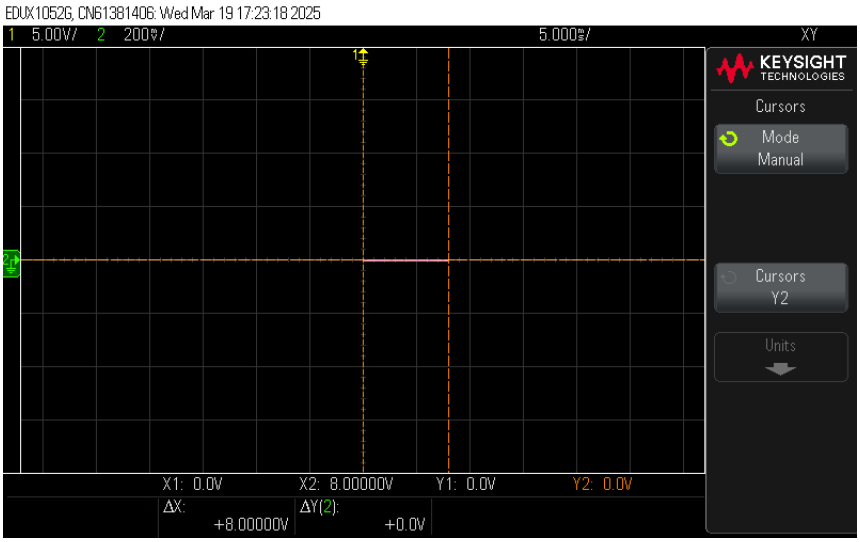
- Observations:
  - V_{DS} varies from 0 to 8V using a sinusoid.

V_{GS}	V_{DS} Max	V_o	I_D	I_D Corrected
0.2	8	-0.15	-0.00015	0.00015
0.4	8	0	0	0
0.6	8	0	0	0
0.8	8	0	0	0
1	8	0	0	0
1.2	8	0	0	0
1.4	8	-0.0175	-0.0000175	0.0000175
1.6	8	-0.0475	-0.0000475	0.0000475
1.8	8	-0.115	-0.000115	0.000115
2	8	-0.2725	-0.0002725	0.0002725
3	8	-1.43375	-0.00143375	0.00143375
4	8	-3.0645	-0.0030645	0.0030645

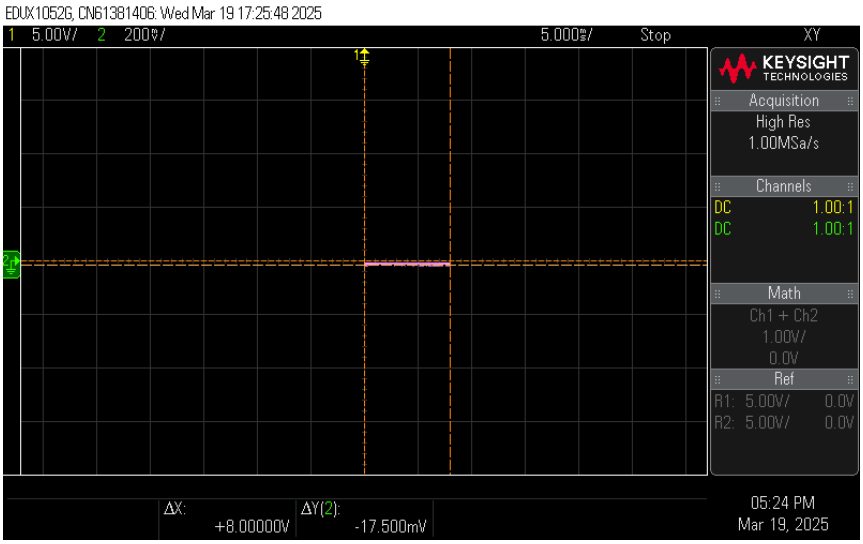
I_D correction is required since the op-amp is in **Inverted** mode of operation, so the current value is multiplied by -1.



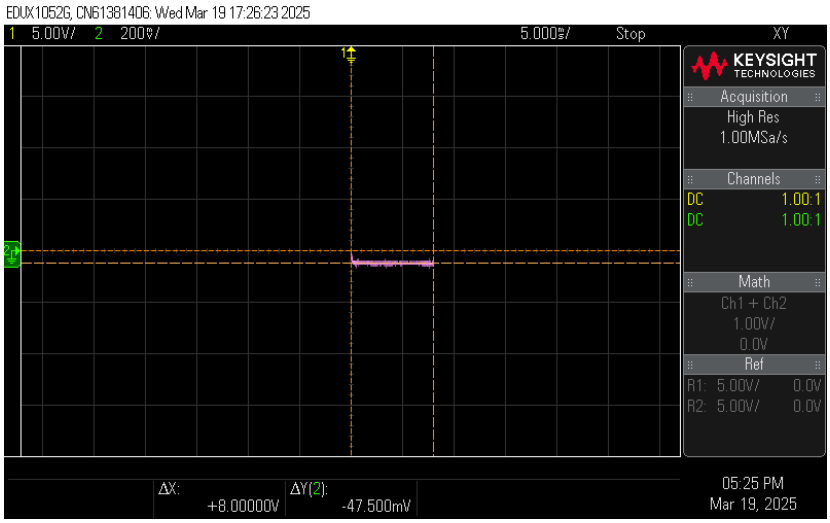
V_{GS} = 0.2V



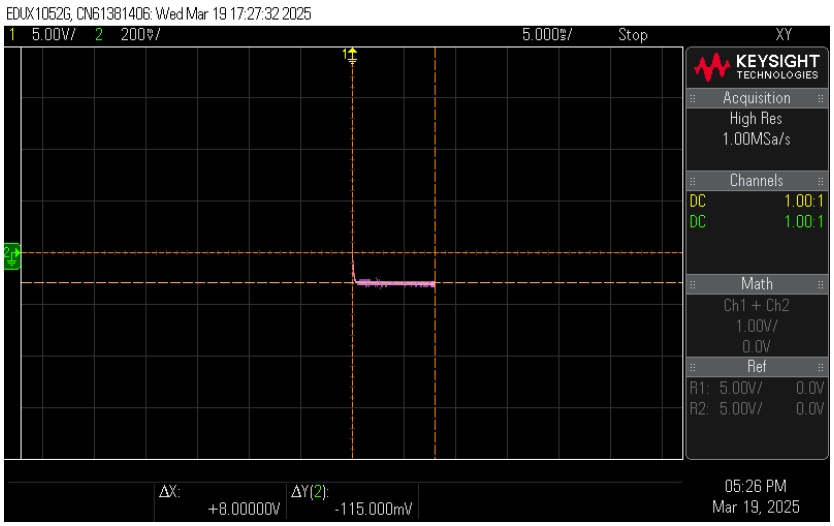
V_{GS} = 0.8V



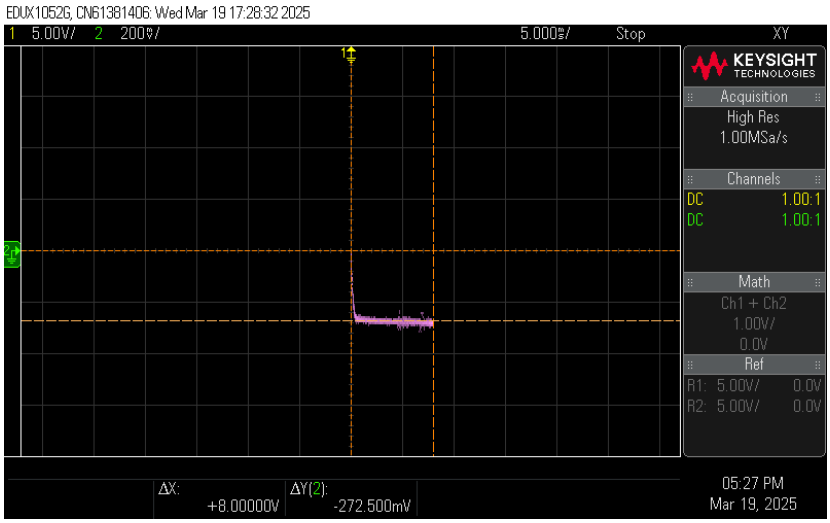
V_{GS} = 1.4V



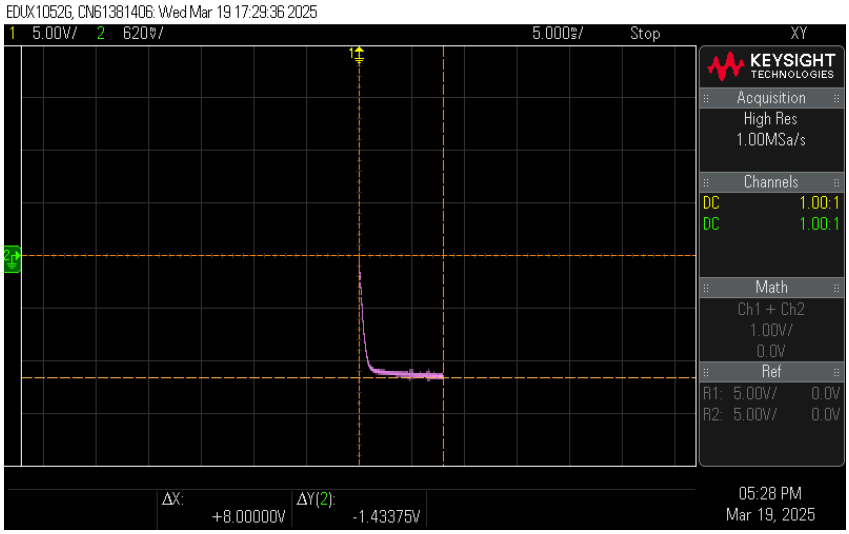
V_{GS} = 1.6V



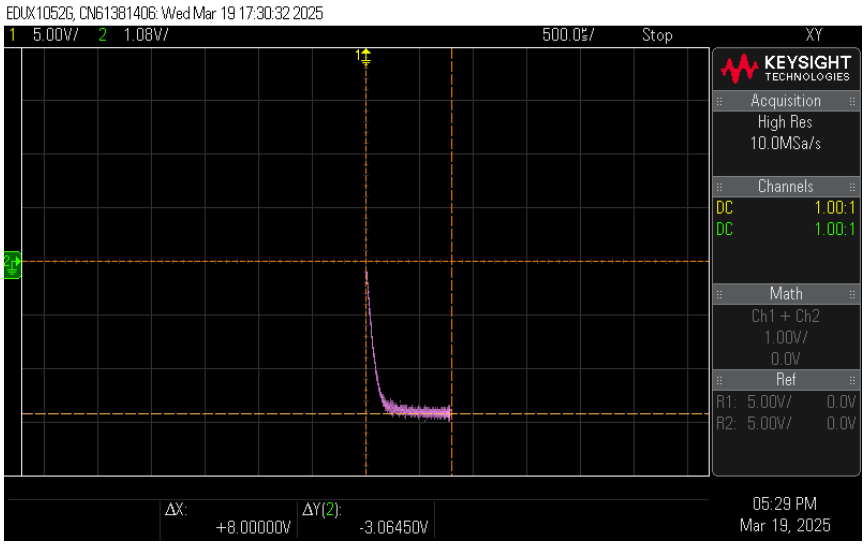
V_{GS} = 1.8V



$V_{GS} = 2V$



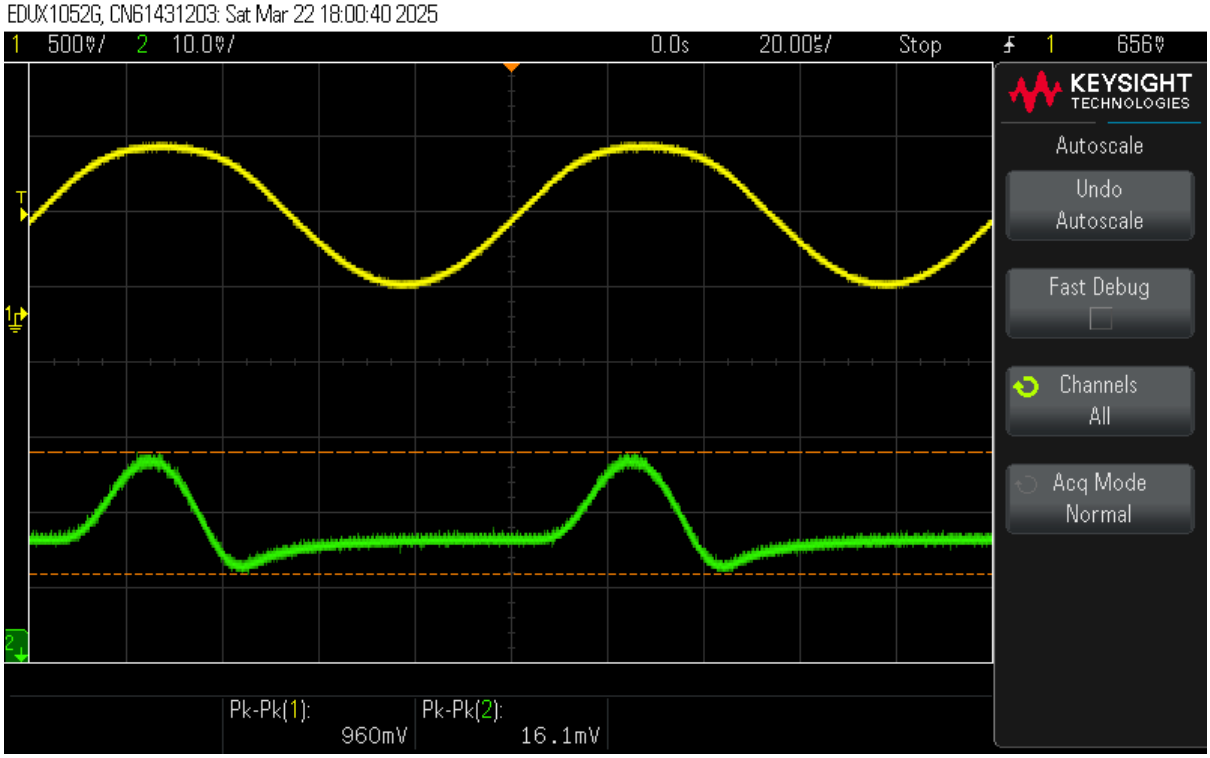
$V_{GS} = 3V$



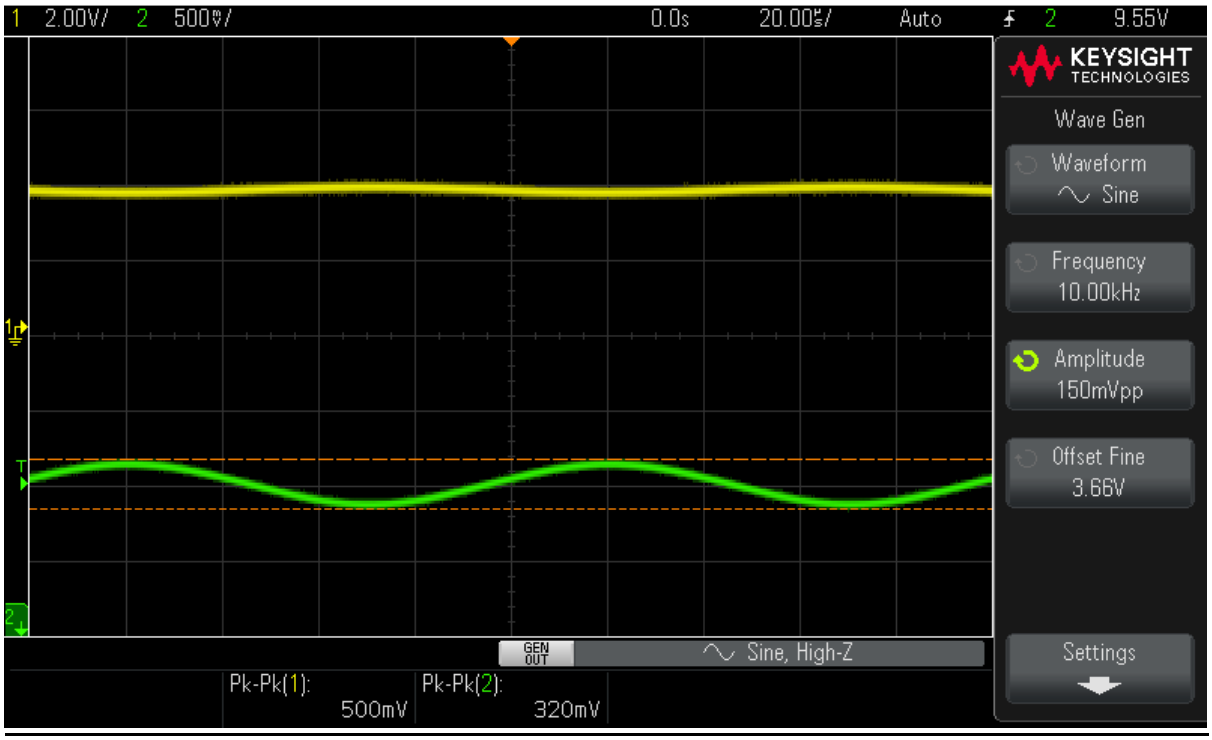
$V_{GS} = 4V$

- Inference:
    - The value of I_D begins to become significant at around V_{GS} = 1.4 V
    - Therefore, the Threshold Voltage of the given MOSFET can be approximated to be around 1.4V.

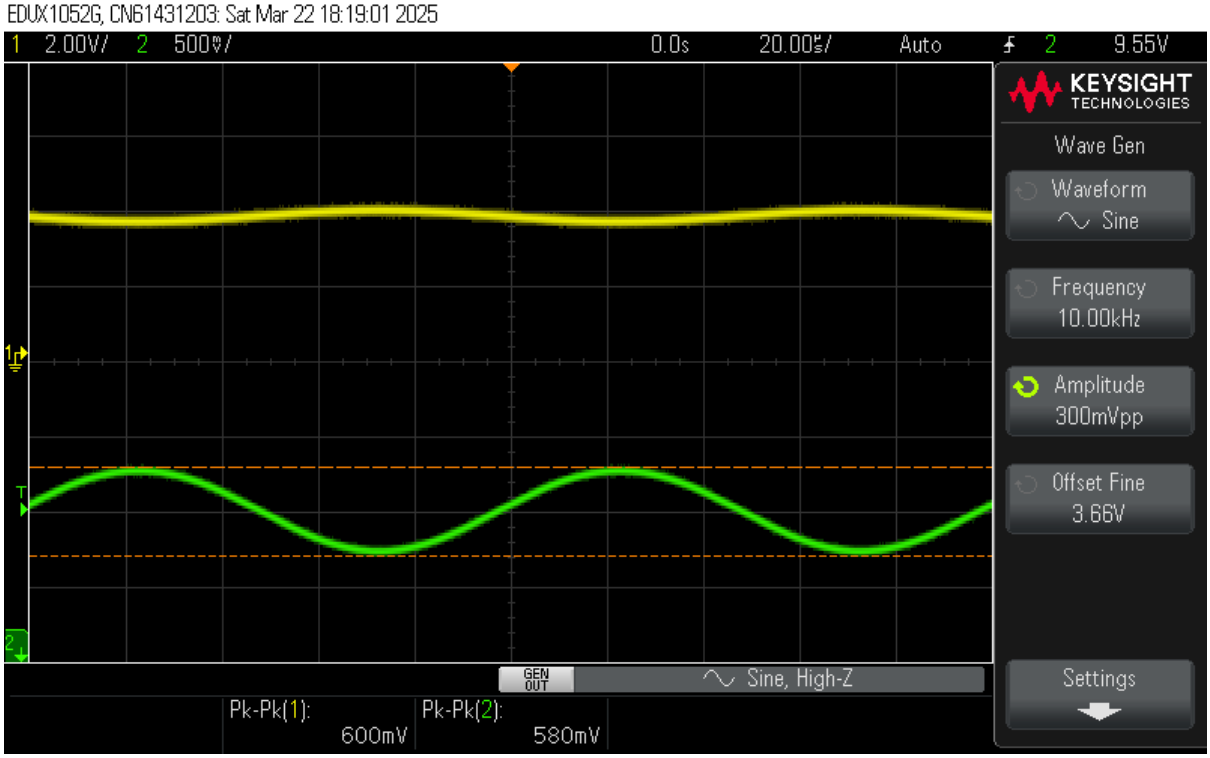
EDUX1052G, CN61431203: Sat Mar 22 18:00:40 2025



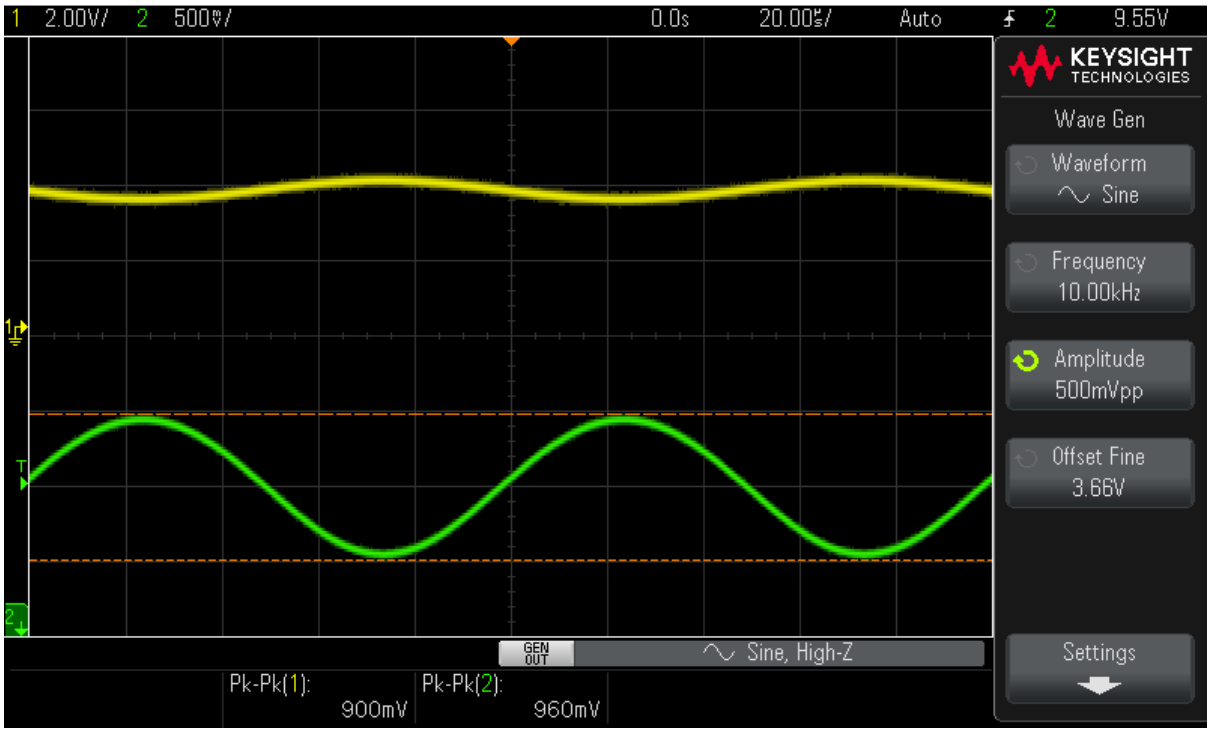
EDUX1052G, CN61431203: Sat Mar 22 18:18:27 2025

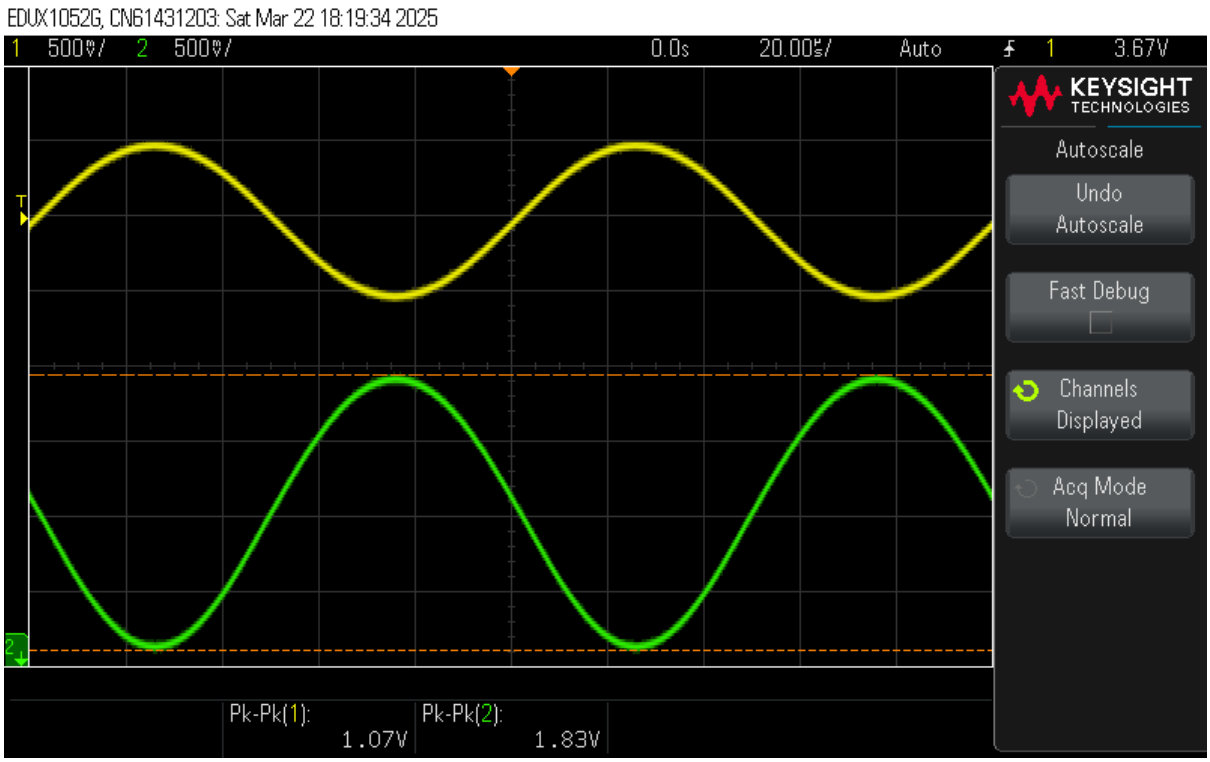


EDUX1052G, CN61431203: Sat Mar 22 18:19:01 2025



EDUX1052G, CN61431203: Sat Mar 22 18:19:15 2025





Part 2:

- ## Objective:

  To determine the I_D vs V_{GS} characteristics and calculate the value of $\mu C_{ox}\frac{W}{L}$ of the given MOSFET.

- ## Circuit Diagram:

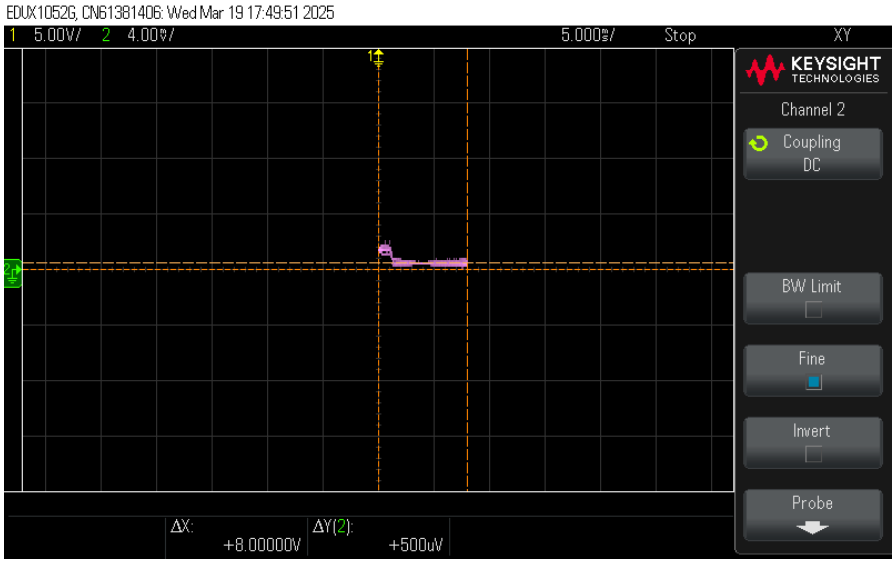
  In the previous circuit, connect the potentiometer to the drain and the function generator to the gate of the MOSFET.

- ## Observation:

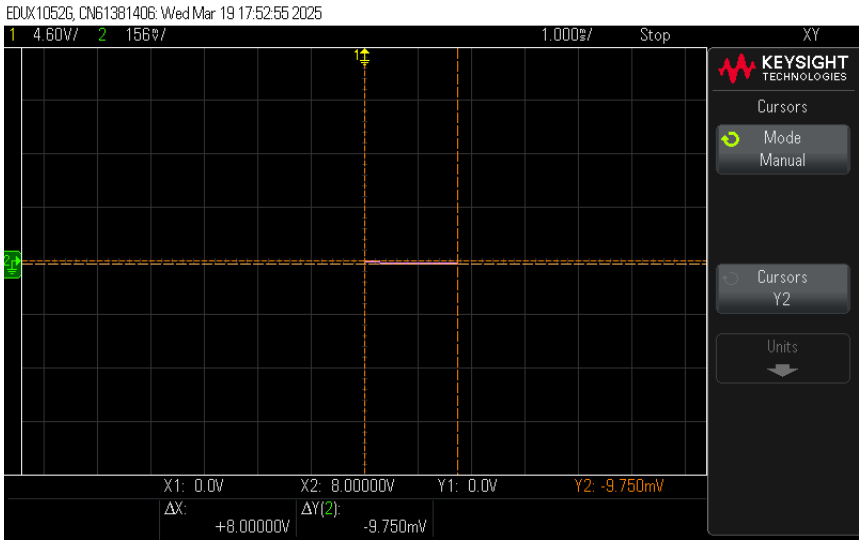
  - V_{GS} is varied from 0 to 8V using a sinusoid.

V_{DS}	V_{GS}	V_O	I_D	I_D Corrected
0.1	8	5.00E-04	5.00E-07	-5.00E-07
0.5	8	-0.00975	-9.75E-06	9.75E-06
1	8	-0.0156	-1.56E-05	1.56E-05
2	8	-0.017	-1.70E-05	1.70E-05
3	8	-0.026	-2.60E-05	2.60E-05
4	8	-0.0335	-3.35E-05	3.35E-05

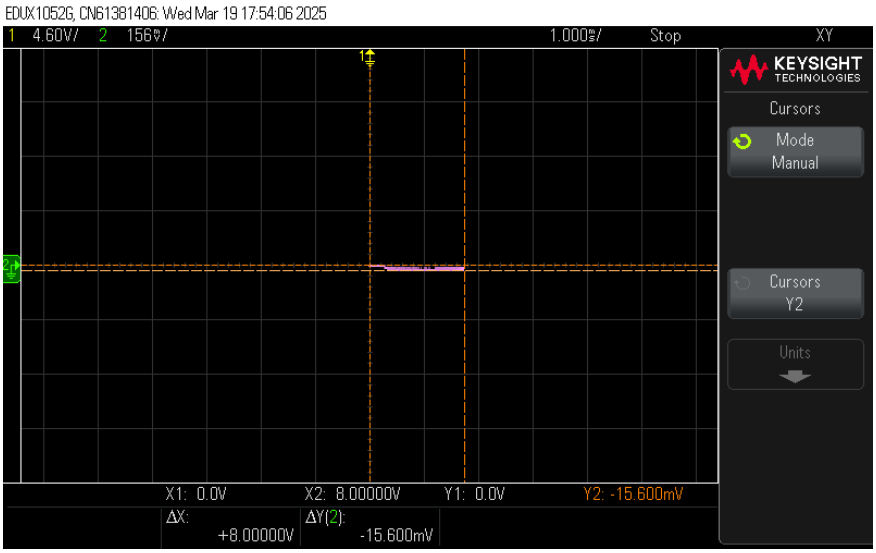
I_D correction is required since the op-amp is in **Inverted** mode of operation. So, we multiply the current value by -1.



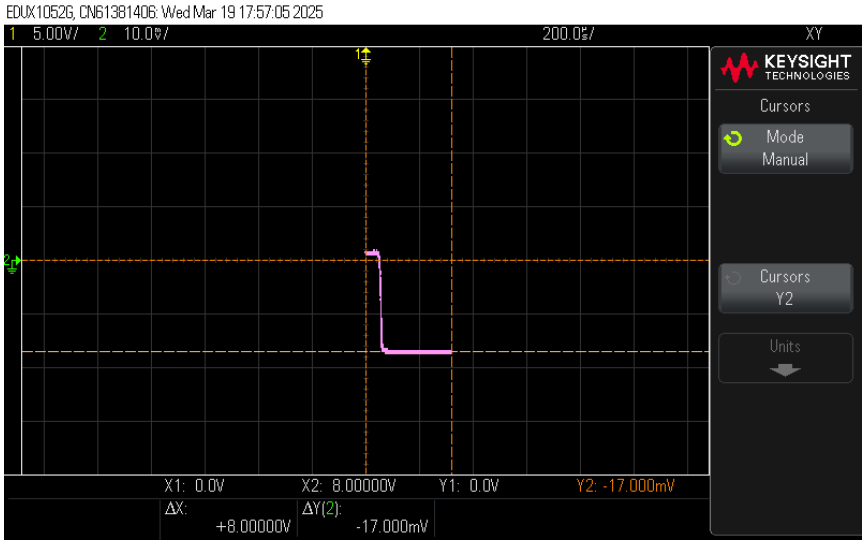
$V_{DS} = 0.1V$



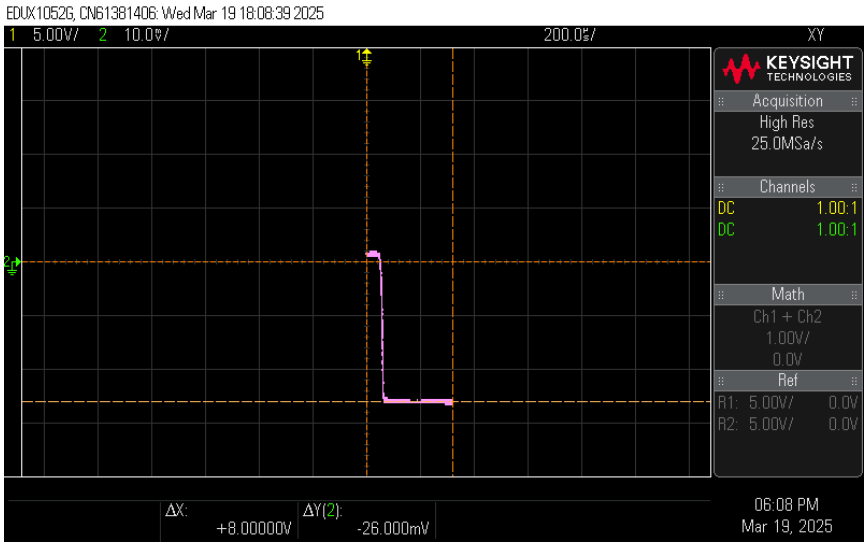
$V_{DS} = 0.5V$



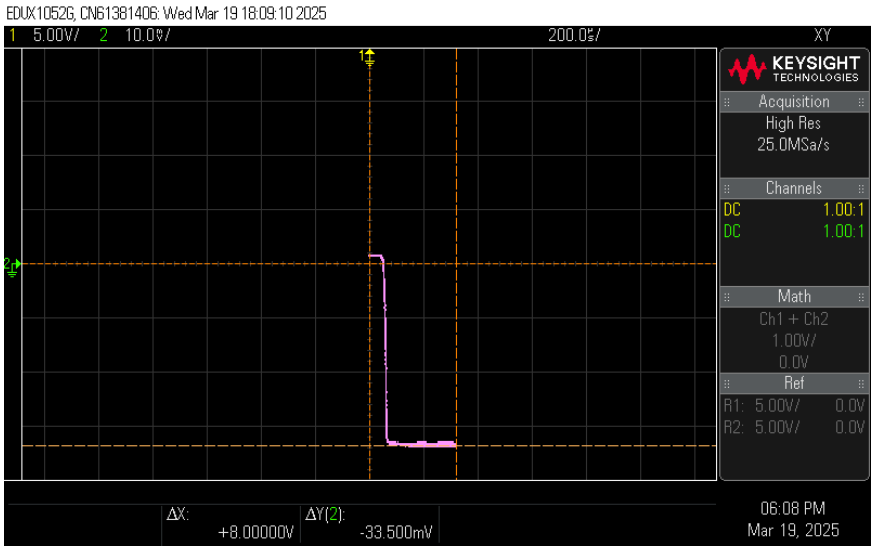
V_{DS} = 1V



V_{DS} = 2V



V_{DS} = 3V



$V_{DS} = 4V$

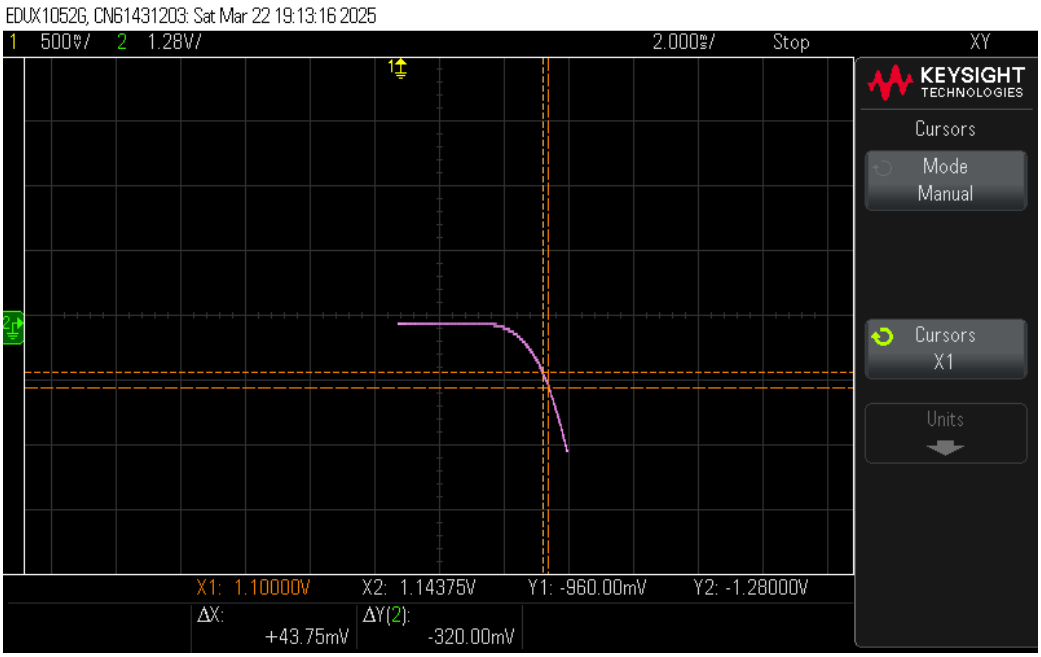
To find the parameters, we take $V_{DS} = 100$ mV, for linear region.

Point of Maximum Slope,

X (V_{GS}) = 1.14375 V

Y (I_D) = $(-1)\frac{-1.28}{1000} = 1.28mA$

Slope,



$$\text{m} = \frac{\Delta y}{\Delta x} = 0.007314$$

$$\Rightarrow (0 - I_D) = m(V_T - V_{GS})$$

$$\Rightarrow V_T = \frac{-I_D}{m} + V_{GS}$$

$$\Rightarrow V_T = \frac{-1.28x10^{-3}}{0.007314} + 1.14375$$

$$\Rightarrow \boldsymbol{V_T = 0.968743V}$$

We know that,

$$I_D \approx \mu C_{ox} \frac{W}{L} (V_{GS} - V_T) V_{DS}$$

$$\Rightarrow \mu C_{ox} \frac{W}{L} = \frac{I_D}{(V_{GS} - V_T) V_{DS}}$$

$$\Rightarrow \mu C_{ox} \frac{W}{L} = \frac{1.28x10^{-3}}{(1.14375 - 0.968743)(0.1)}$$

$$\Rightarrow \mu C_{ox} \frac{W}{L} = 0.07314\ A/V^2$$

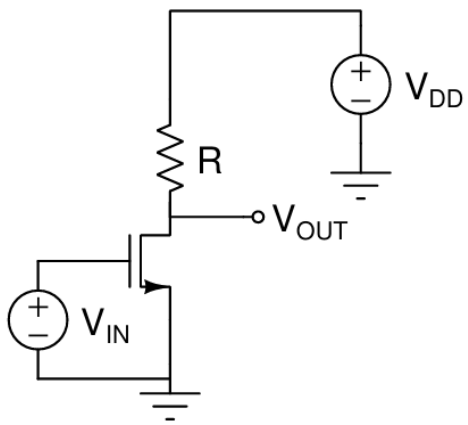
- Inferences:
  - $V_{TH} = 0.968743$ V
  - $\mu C_{ox} \frac{W}{L} = 0.07314\ A/V^2$

Part 3:

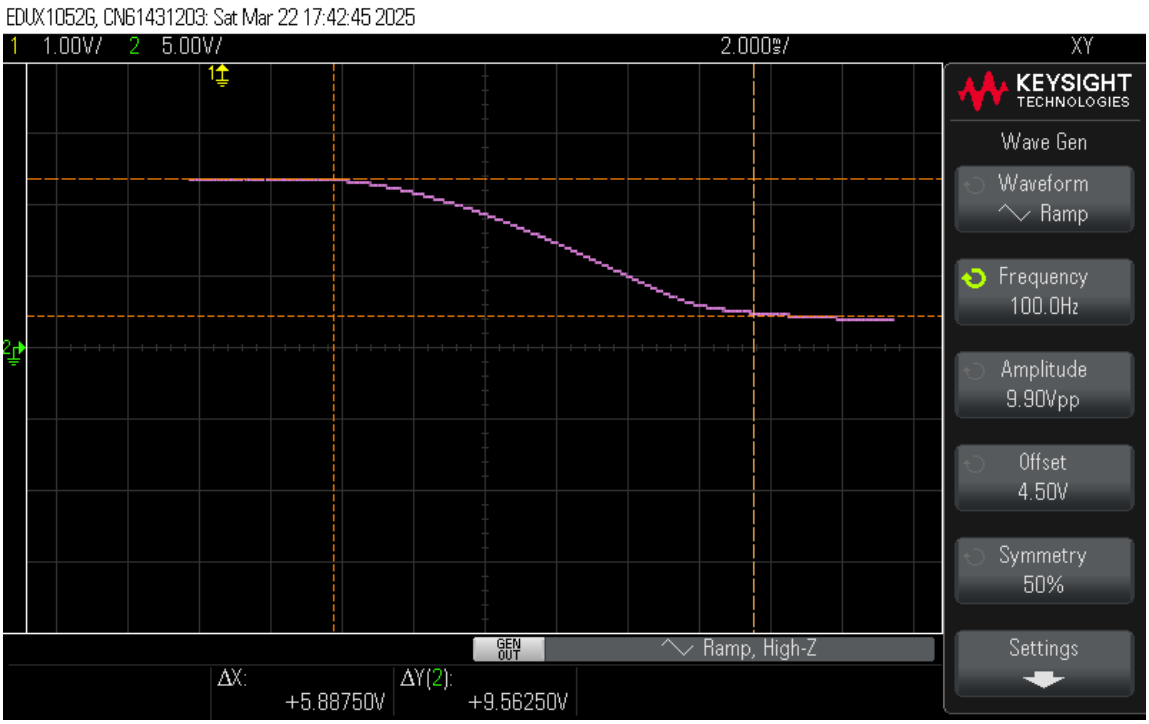
- Objective:

  To perform Large Signal Analysis and find Voltage Transfer Characteristic of a MOS based Amplifier.

- Circuit Diagram:

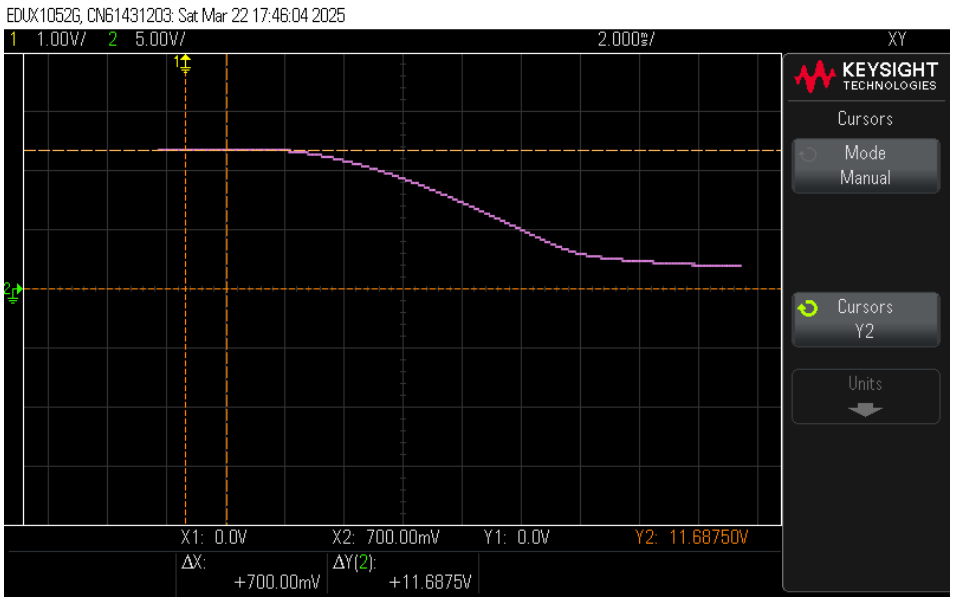


- Observation:

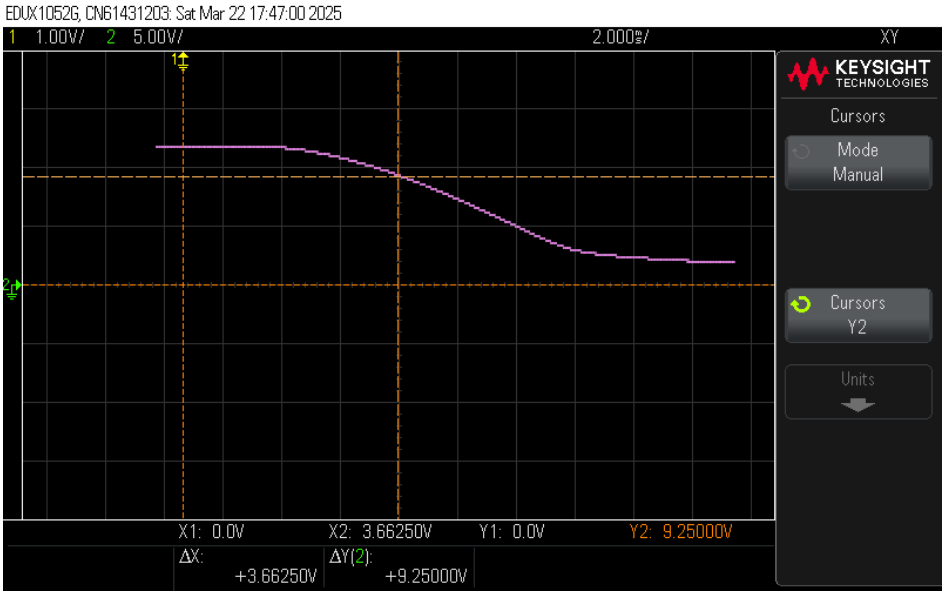


Cutoff Saturation Linear

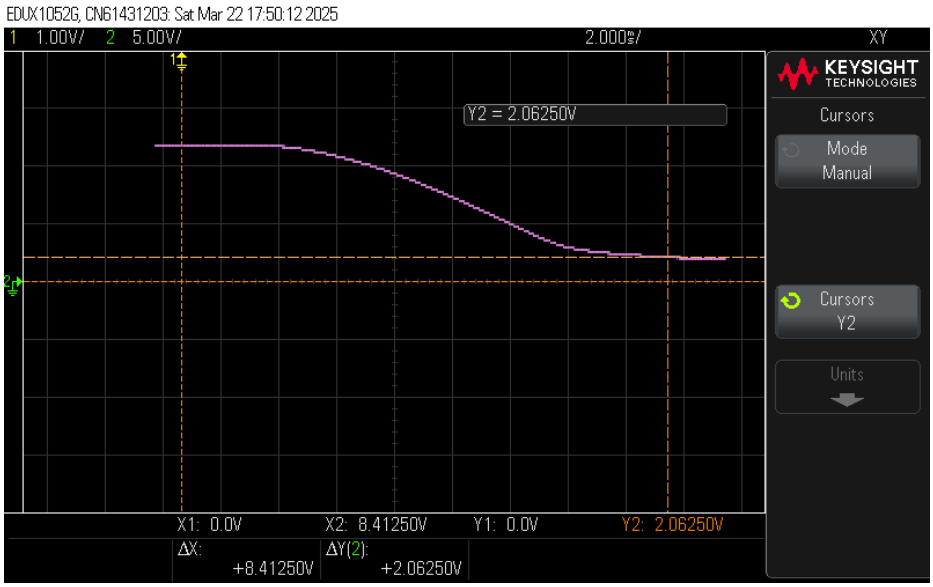
Mode	V_{in} (V)	V_{out} (V)
Cutoff	0.7	11.6875
Saturation	3.6625	9.25
Active	8.4125	2.0625



Cutoff



Saturation



Linear

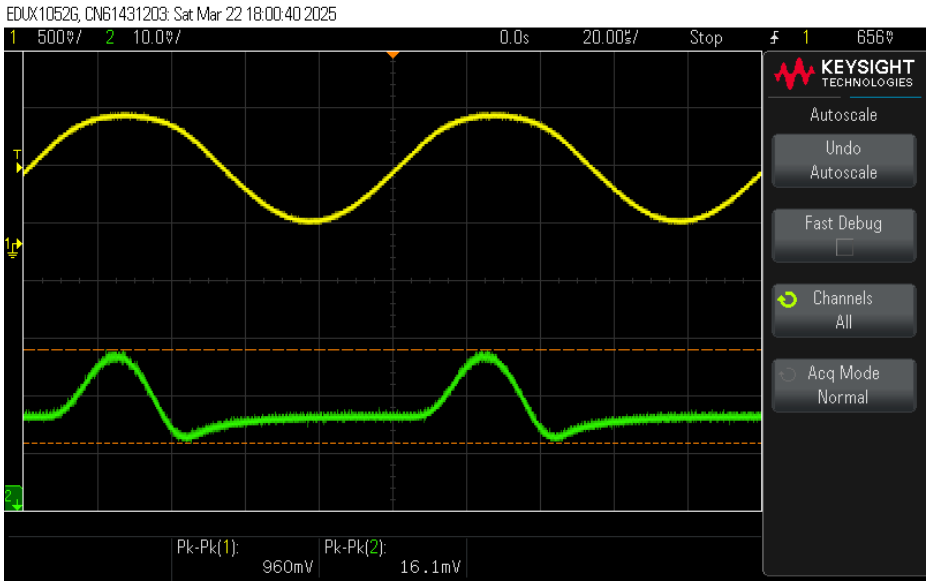
Applying Sinusoidal Signal with offset,

V_{DC}	V_{in}	V_{out}	Gain
0.7 (Cutoff)	0.05	0.6	12
0.7	0.1	0.6	6
0.7	0.5	0.6	1.2
0.7	1	0.0161	0.0161

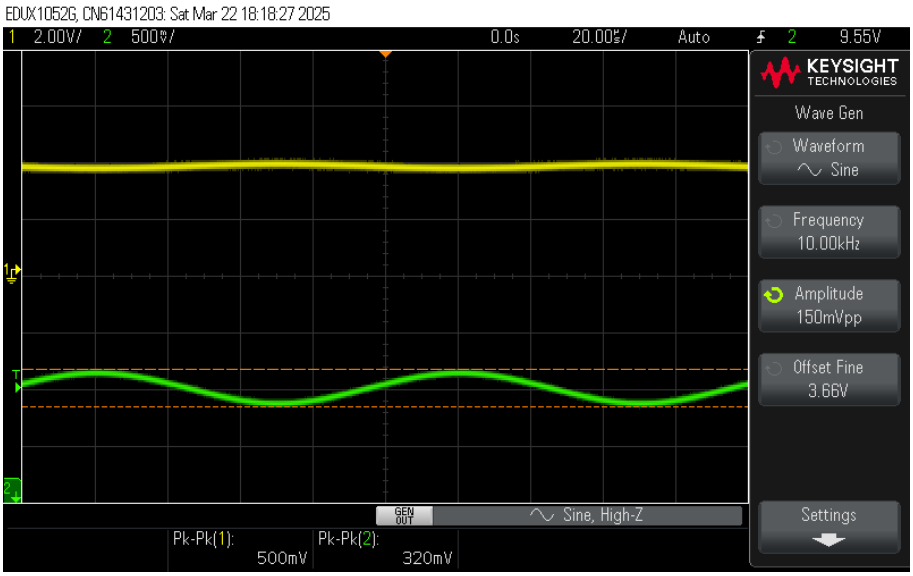
3.6625 (Saturation)	0.15	0.32	2.133333
3.6625	0.3	0.58	1.933333
3.6625	0.5	0.96	1.92
3.6625	1	1.85	1.85

The values marked in red are wrong, since the output signal is too small for the probes to detect anything, so the measurement option of the DSO just measures noise.

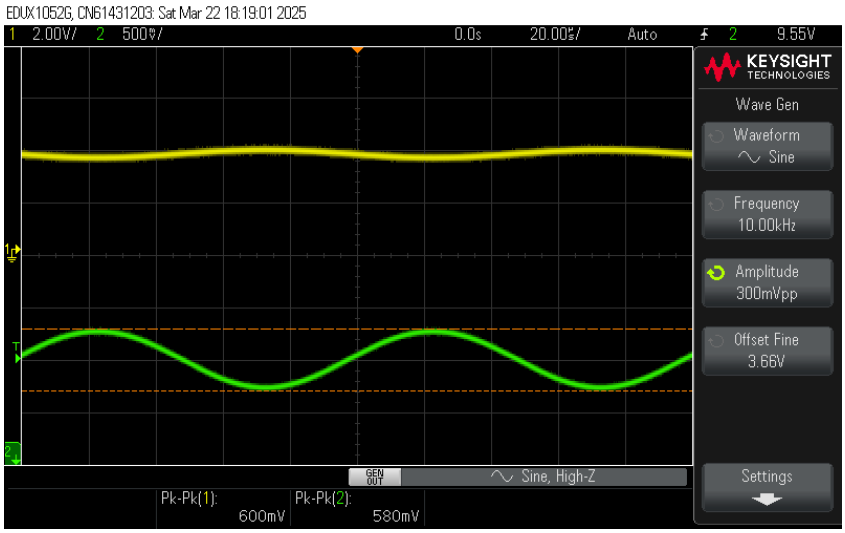
For Linear mode, the DC offset is too high to set reasonable signal amplitude in the DSO.



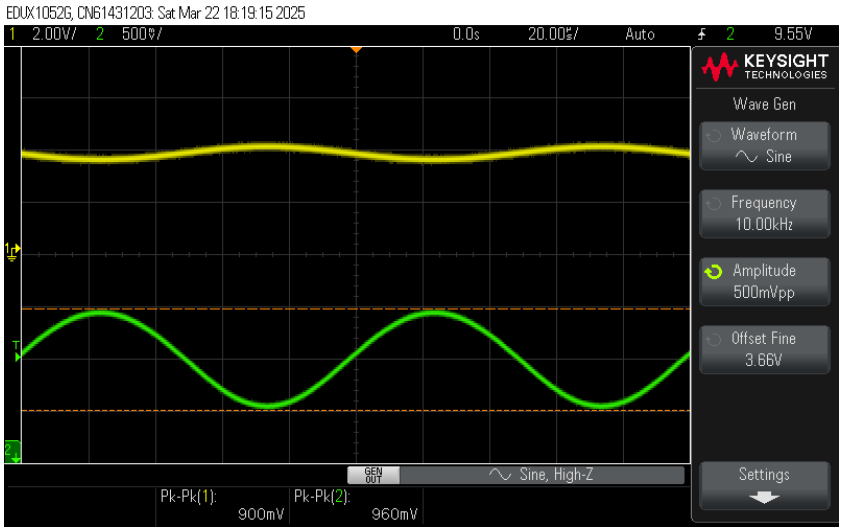
$V_{DS} = 0.7$, $V_{in} = 1$



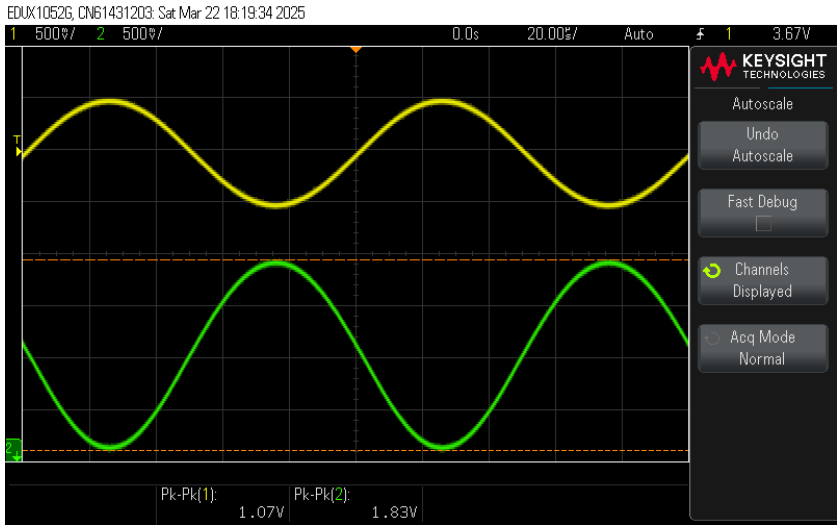
$V_{DS} = 3.6625, V_{in} = 0.15$



$V_{DS} = 3.6625, V_{in} = 0.3$



$V_{DS} = 3.6625, V_{in} = 0.5$



$V_{DS} = 3.6625, V_{in} = 1$

- <u>Inferences:</u>

  The gain of the amplifier in normal operation (Saturation mode) is around 2.