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Lab 01

8/29/24

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Section: 20008-009

Abstract

This lab's purpose was to demonstrate the uses of the lab equipment and the different functions each one has. It was also used to apply MOSFET knowledge to real circuits. The circuits were first created by following diagrams and instructions in the lab manual. The values were found using the lab equipment and estimated using the cursors and outputs on the lab equipment. It was found that the outputs matched the values from the datasheet. Lab equipment has many functions that can be used to analyze circuits.

Task 1

Objective

The objective of this task was to demonstrate the different functions on the oscilloscope.

Procedure

First the function generator was set to output the given value ($2\sin(2\pi 750t)$). Next, the output was hooked up to the oscilloscope's input and the trigger levels were varied from -4V to 4V. The trigger level changes the voltage level at which the oscilloscope looks for the wave. Afterwards, the horizontal and vertical offset were adjusted. The horizontal offset changes the time delay/phase of the wave while the vertical offset changes the vertical position of the wave or DC offset. The power supply (PSU) was connected to the digital multimeter (DMM) and set to 3.3V. The AC and DC RMS were recorded.

Results

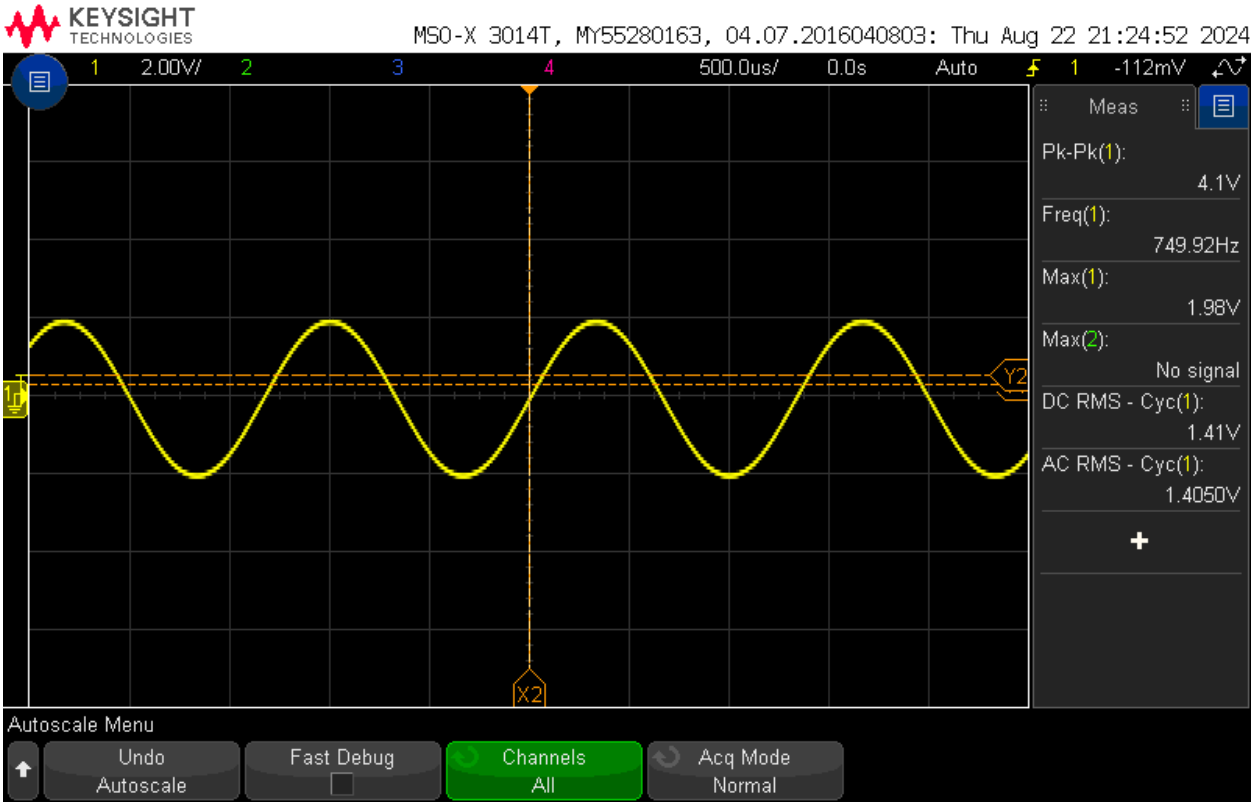


Figure 1.9.1.1: function generator wave

Value	RMS Voltage
$DC_{(RMS)}$	3.2997 V
$AC_{(RMS)}$	1.2 mV

Figure 1.9.1.10: AC and DC RMS values

Conclusion

This task was a success because the DC and AC RMS values displayed lined up with the DC and AC RMS values that were provided to the DMM.

Task 2

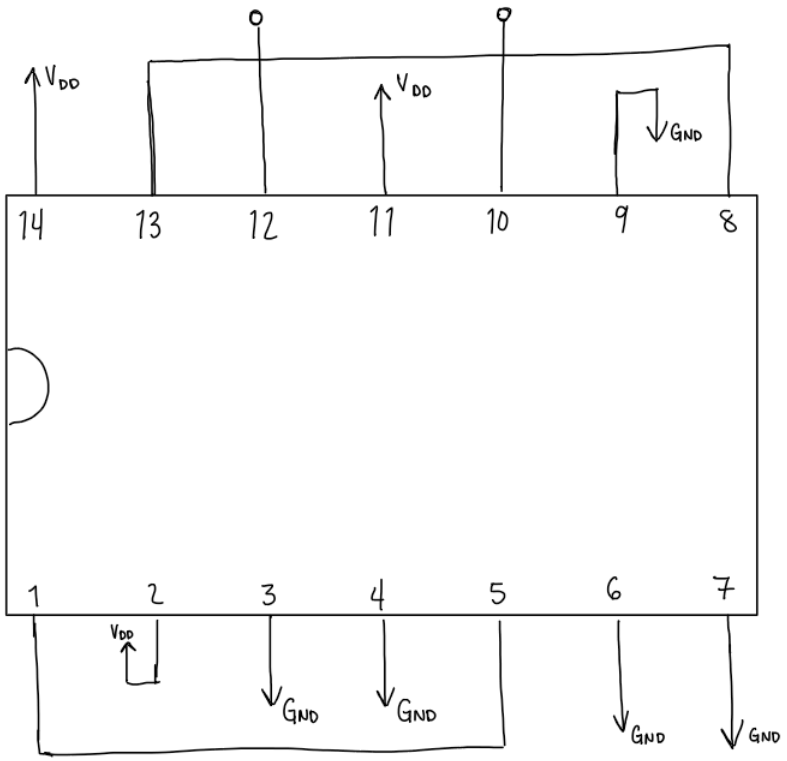
Objective

The objective of this task is to demonstrate the xy curve of a MOSFET in real life.

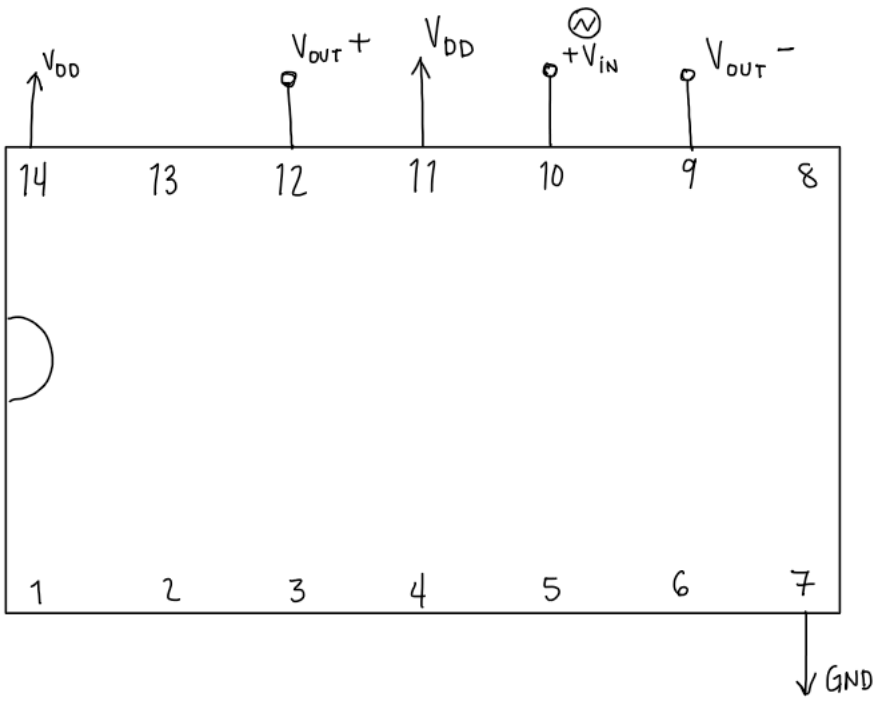
Procedure

First the circuit was built as the lab manual described. Next, the function generator and oscilloscope were attached to the circuit and the voltages were set using the PSU. The oscilloscope was set up to measure the XY characteristic, so the transition points were visible. The XY plot was also used to find the noise margins. Lastly, the noise margins on the datasheet were compared to those found.

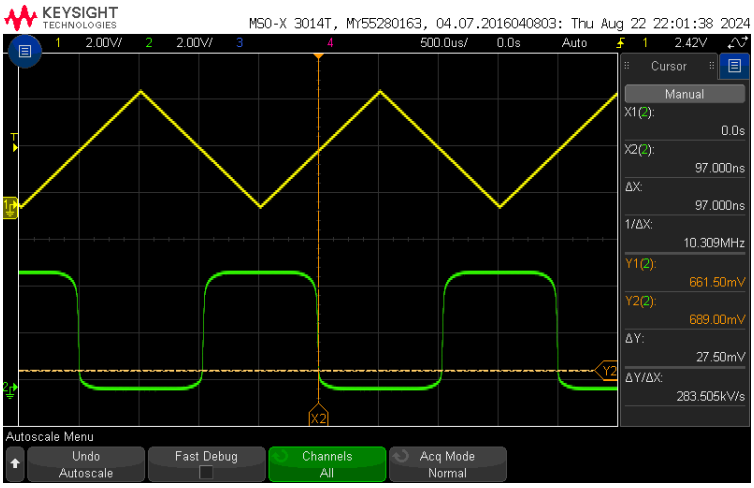
Results



Circuit used (figure 1.10 in manual)

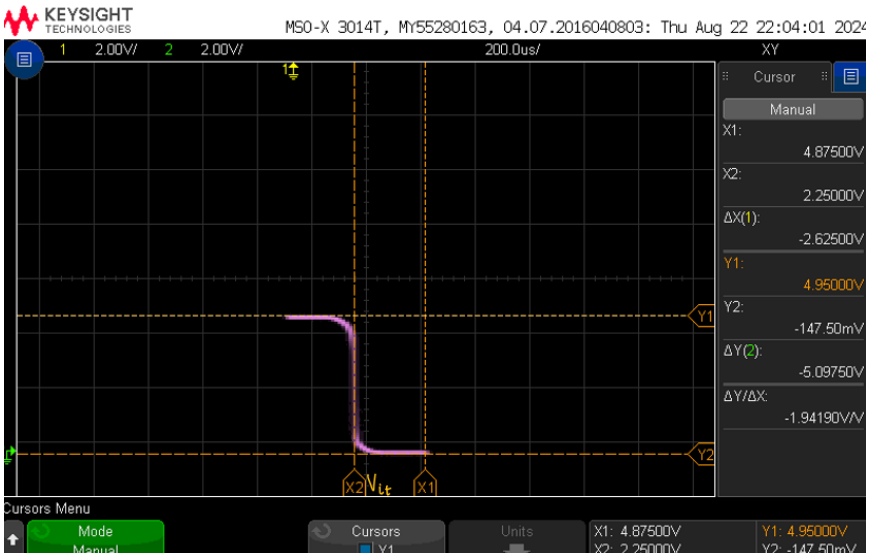


Circuit used with function generator (figure 1.11 in lab manual)

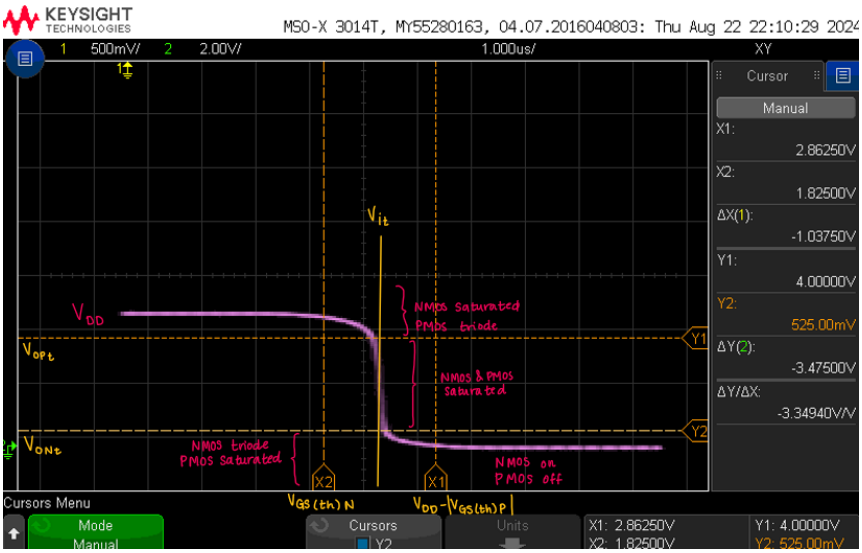


Vin and Vout function gen and MOSFET out

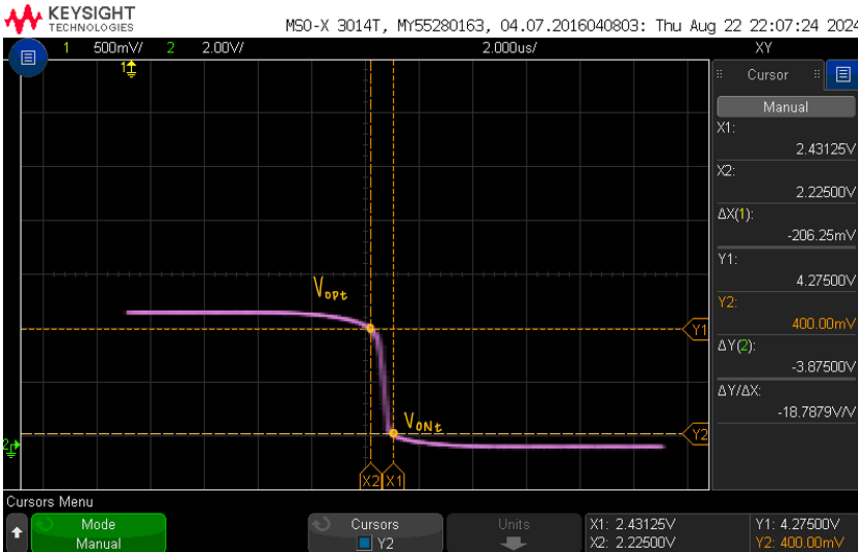
XY relationship Graphs:



V_{It}



Most values shown



V_{OPt} and V_{ONt}

Value	Measurement
V_{It}	2.25 V
$V_{GS(th)N}$	1.825 V
$V_{DD} - \lvert V_{GS(th)P} \rvert$	2.8625 V
V_{OPt}	4 V
V_{ONt}	.5 V
V_{DD}	4.95 V
V_{OLU}	4.275 V
V_{OHU}	.4 V
V_{OH}	5 V
V_{OL}	0 V
V_{IH}	2.225 V
V_{IL}	2.43125 V
NM_L (noise margin low) Estimation from graph	2.25 V
NM_L calculated from values	2.43125 V
NM_H (noise margin high) Estimation from graph	2.625 V
NM_H calculated from values	2.75 V

Values found from circuit

$$NM_L = V_{IL} - V_{OL}$$

$$NM_H = V_{OH} - V_{IH}$$

Formulas used to calculate the high and low noise margins

Value	Measurement
V_{IL}	1 V
V_{OL}	.05 V
V_{IH}	4 V
V_{OH}	4.95 V
NM_L calculated from equations	.95 V
NM_H calculated from equations	.95V

Noise margins from datasheet

Conclusion

The task was a success because the noise margin on the mosfet was found to be close to the datasheet's noise margin. It also demonstrated the xy curve function on the oscilloscope and the xy curve of the mosfet in real life

Task 3

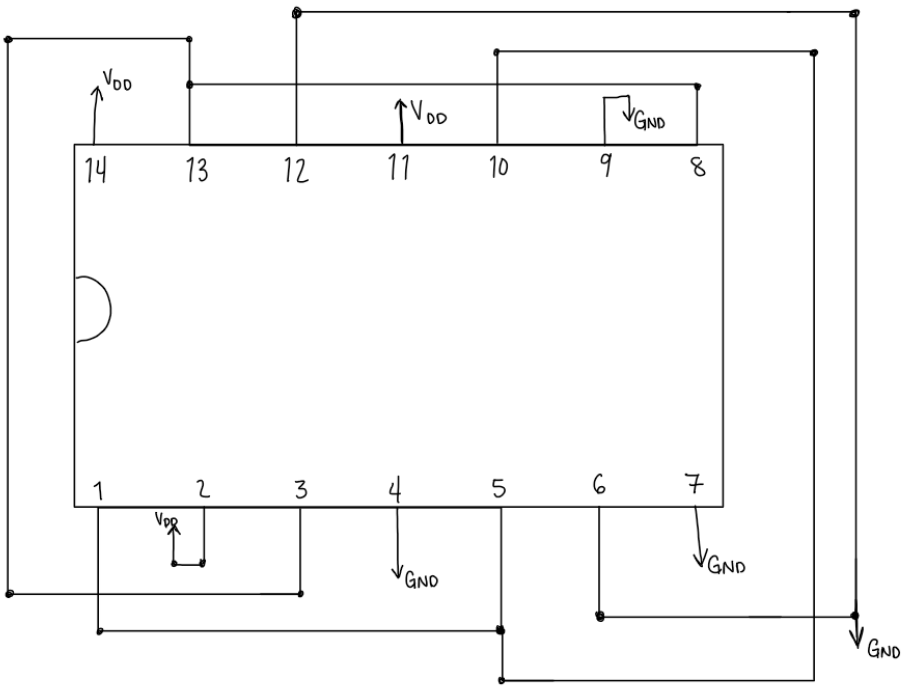
Objective

The objective of this task is to demonstrate a ring oscillator using 1 IC. It is also to show the different functions available to use on an oscilloscope.

Procedure

First the circuit was created according to the lab manual. It has 3 logic inverters in series driving each other, with the last driving the first. Next, the oscillation frequency was measured on the oscilloscope. Then, the propagation delays low to high and high to low were measured and compared to the datasheet.

Results



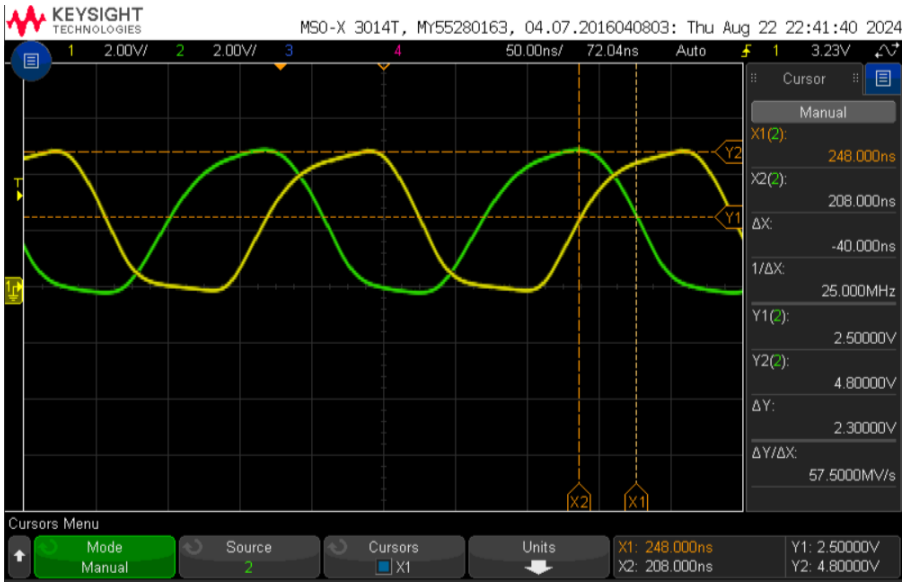
Ring Oscillator Circuit

Value	Time
T_{PLH}	40 nS
T_{PHL}	45 nS
t_{THL}	146 nS
Oscillation Frequency	4.58 MHz

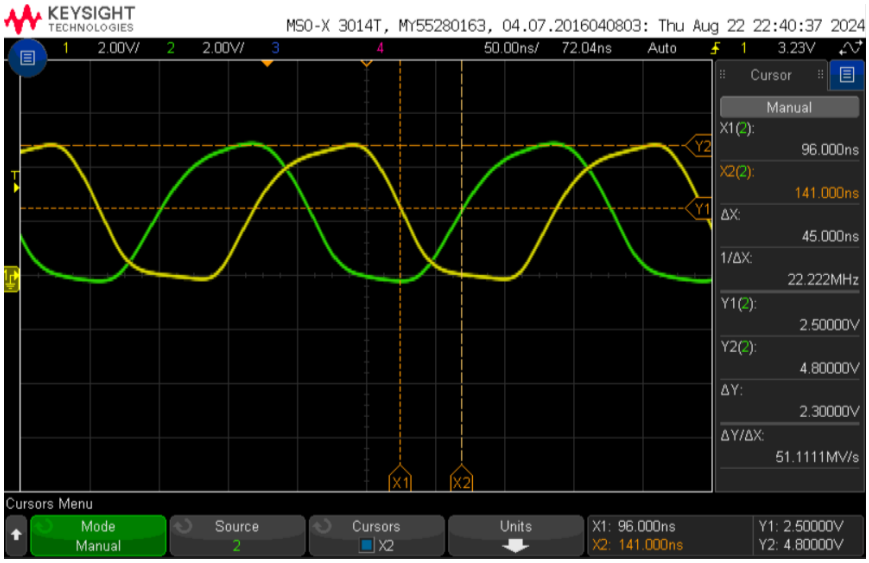
Times from circuit

Value	Time
T_{PLH}	55 nS
T_{PHL}	55 nS
t_{THL}	100 nS

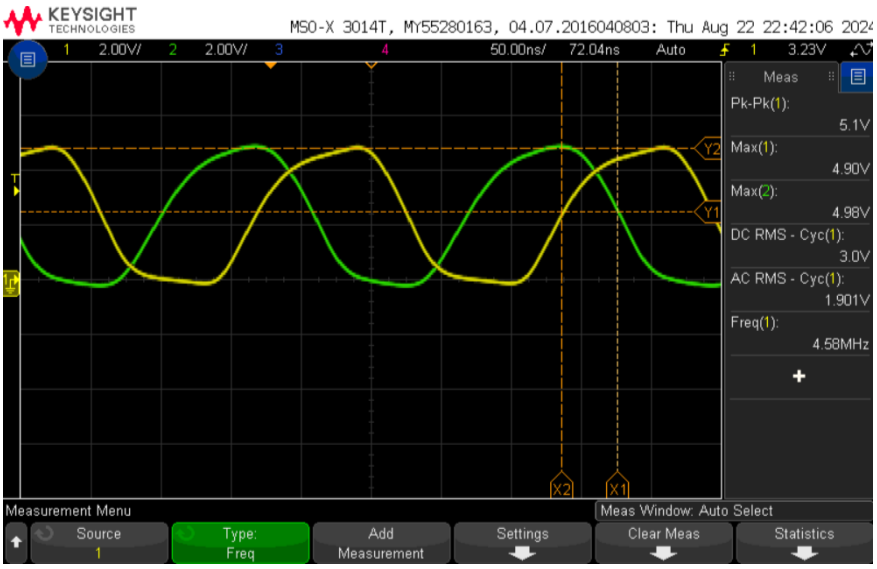
Times from CD4007UB datasheet



Propagation time (High Low) Δx



Propagation time (low high) Δx



Oscillation frequency

Conclusion

This task was a success since the propagation delay measured from the oscillator matched the propagation delay provided by the datasheet. The circuit was successfully created according to the lab manual.

References

https://www.ti.com/lit/ds/symlink/cd4007ub.pdf (CD40007UB datasheet)