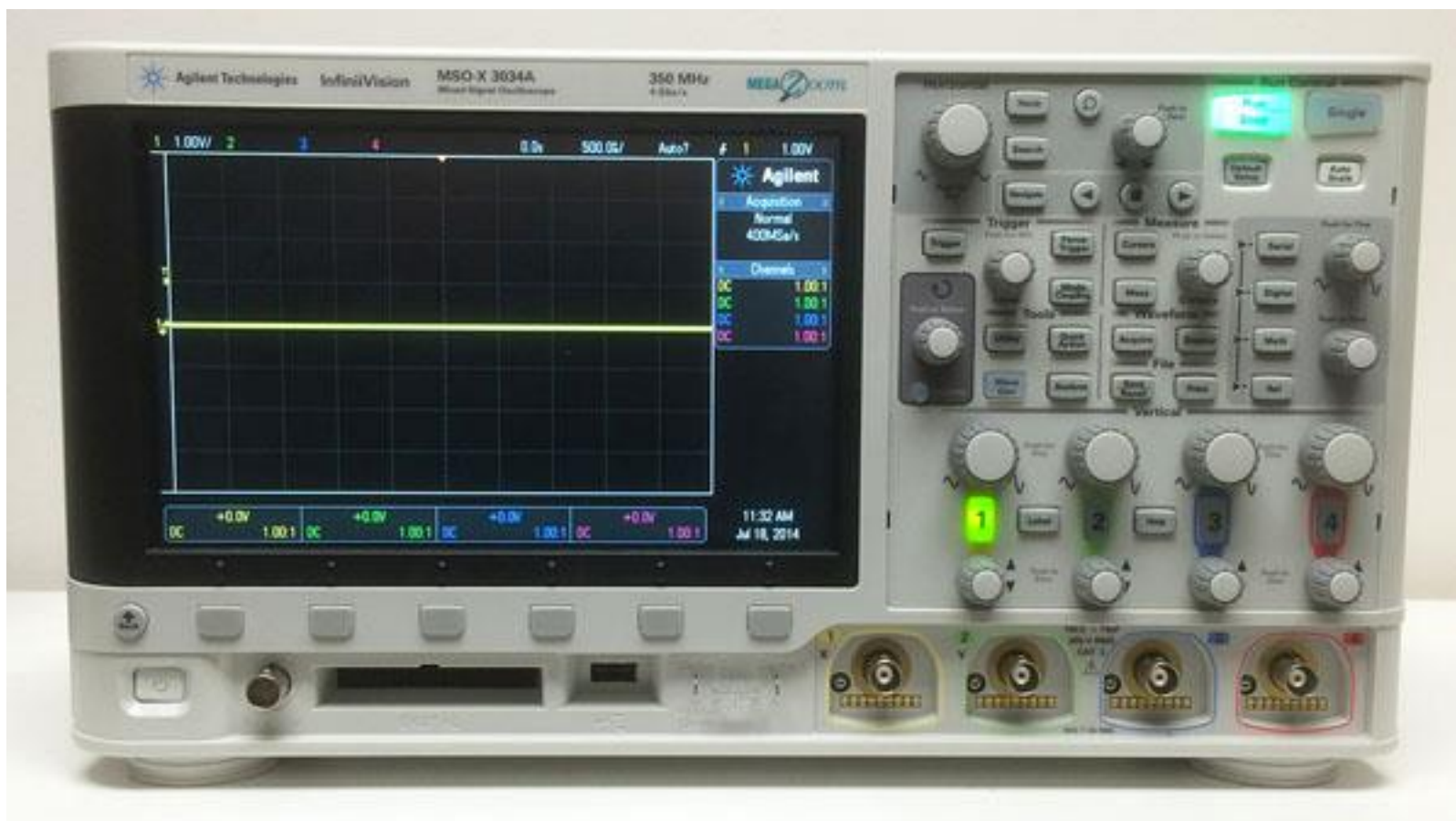


Oscilloscopes and Digital Circuits



Volts per vertical square for each of the four channels

Time per horizontal square common for all four channels



Reading Oscilloscope Signals

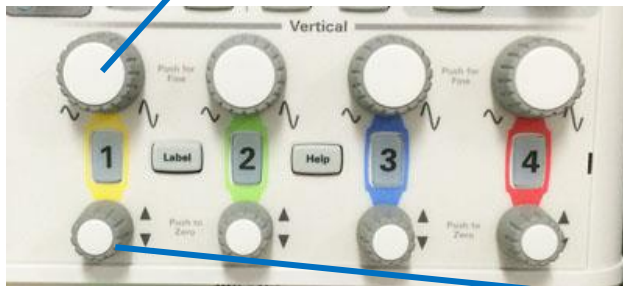
Horizontal (Time) Scale Controls



[..., 20 ns, 50 ns, 100 ns, ...,
 1 us, 2 us, 5 us, ...,
 1 ms, 2 ms, 5 ms, ...,
 1s, 2s, 5s, 10s]
 per division



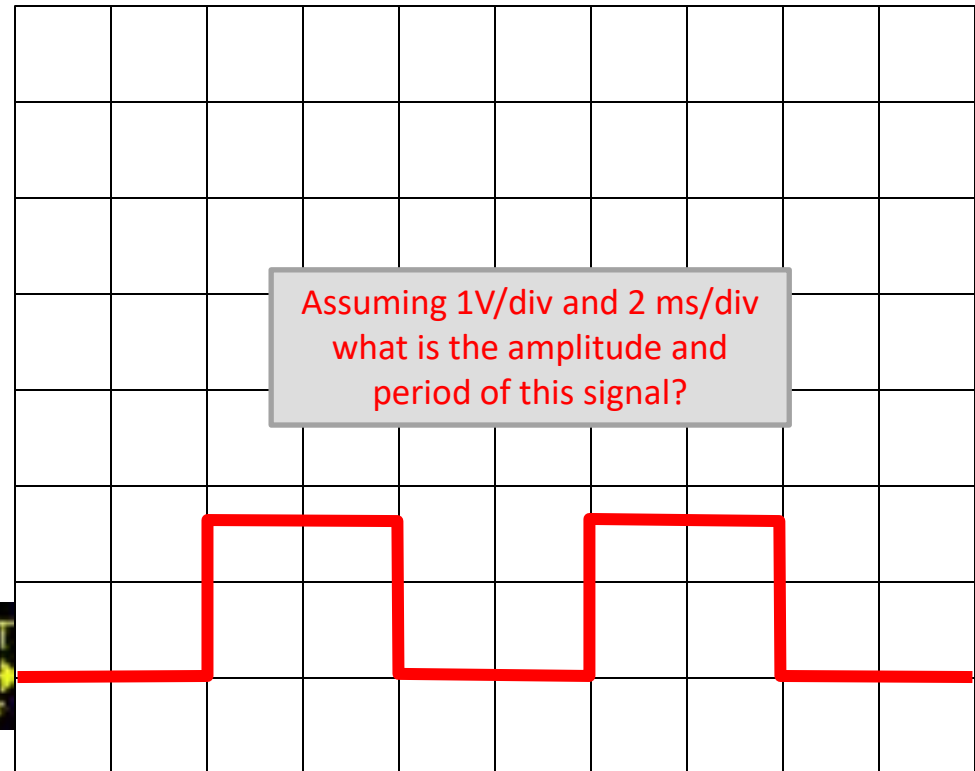
[..., 500mV, 1V, 2v, 5V, 10V, ...]
 per division



Vertical (Voltage)
 Scale Controls

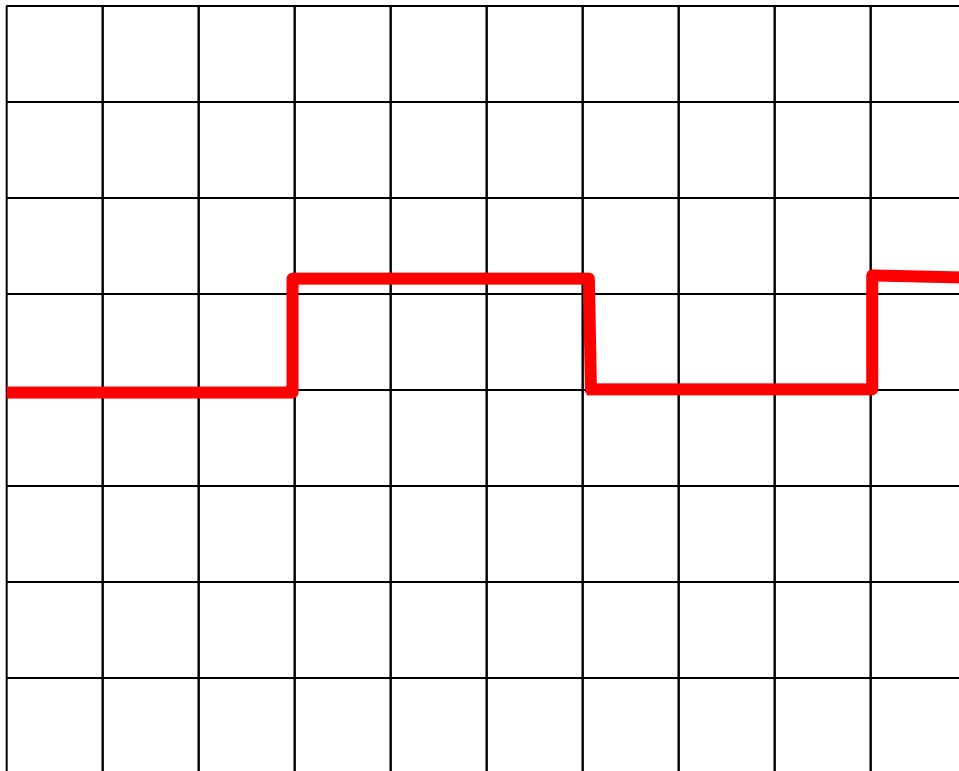
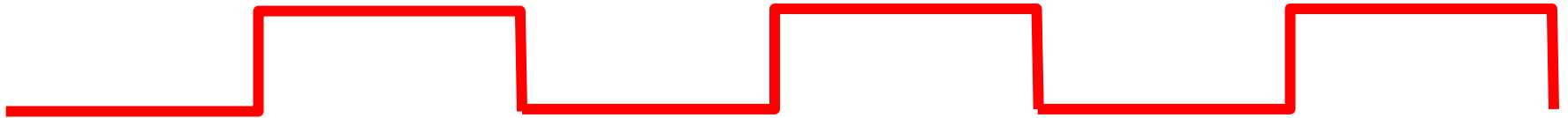
0V (GND)
 Level

Assuming 1V/div and 2 ms/div
 what is the amplitude and
 period of this signal?



Issue of Triggering (1)

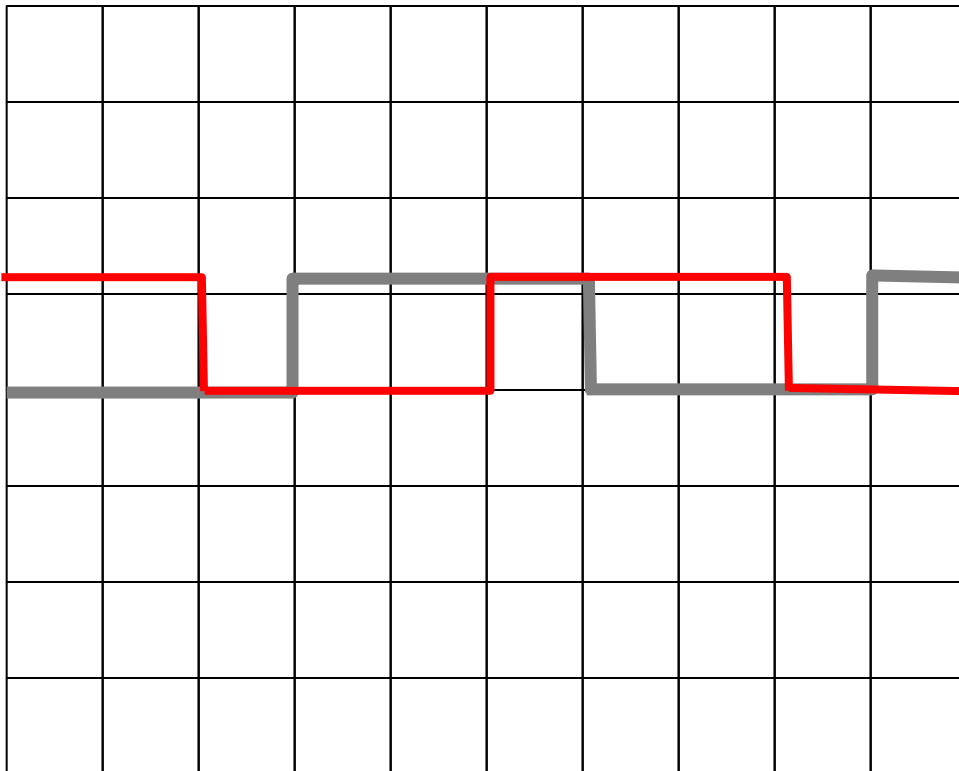
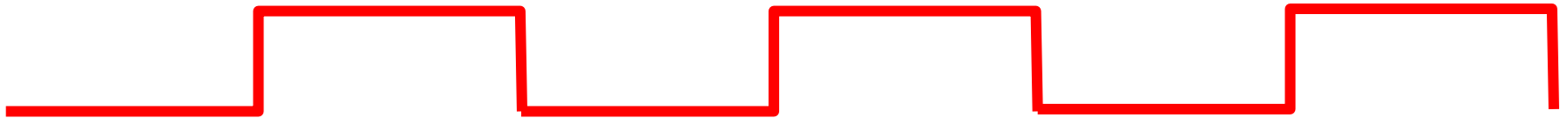
- Suppose this signal was plotted on the oscilloscope (realizing the scope wraps to the left after reaching the right-most edge). What would you see?



First left-to-right scan

Issue of Triggering (2)

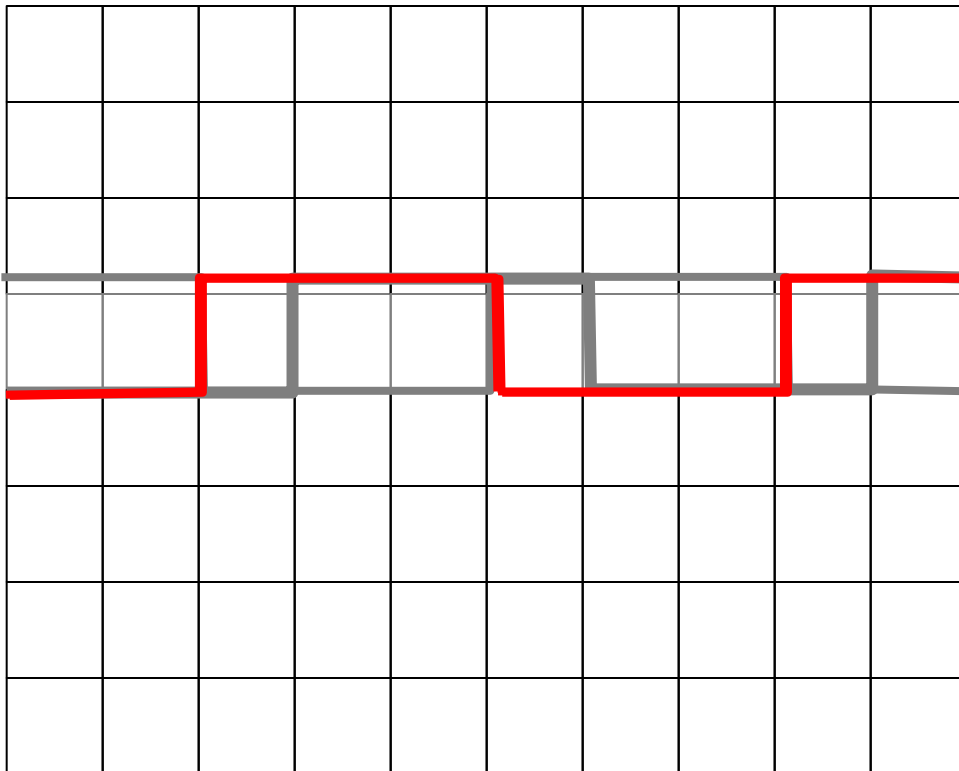
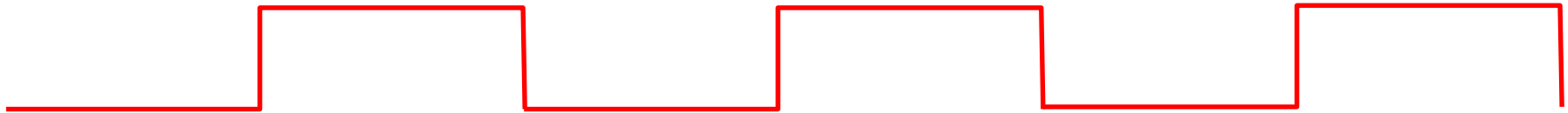
- Suppose this signal was plotted on the oscilloscope (realizing the scope wraps to the left after reaching the right-most edge). What would you see?



Second left-to-right scan

Issue of Triggering (3)

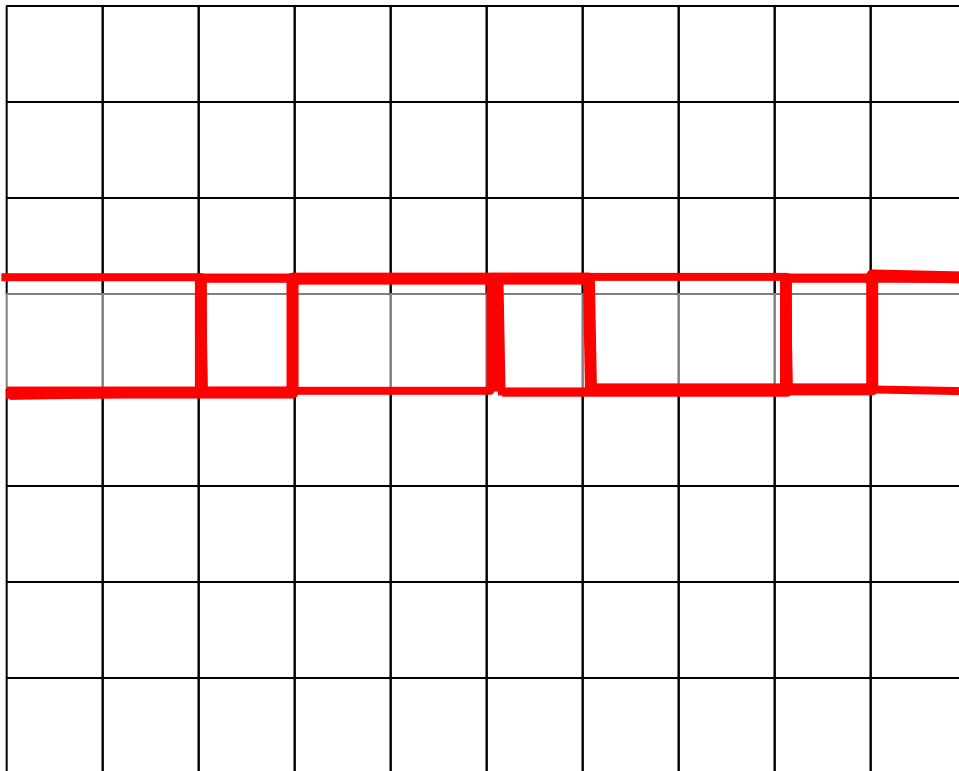
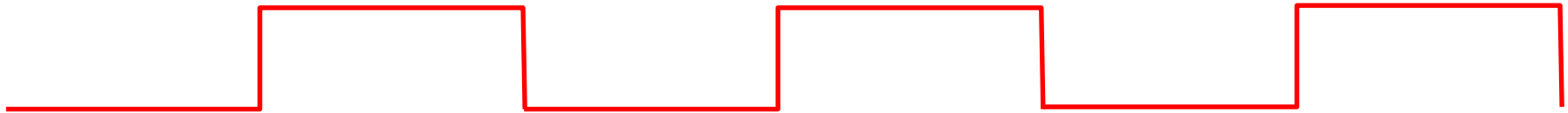
- Suppose this signal was plotted on the oscilloscope (realizing the scope wraps to the left after reaching the right-most edge). What would you see?



Third left-to-right scan

Issue of Triggering (4)

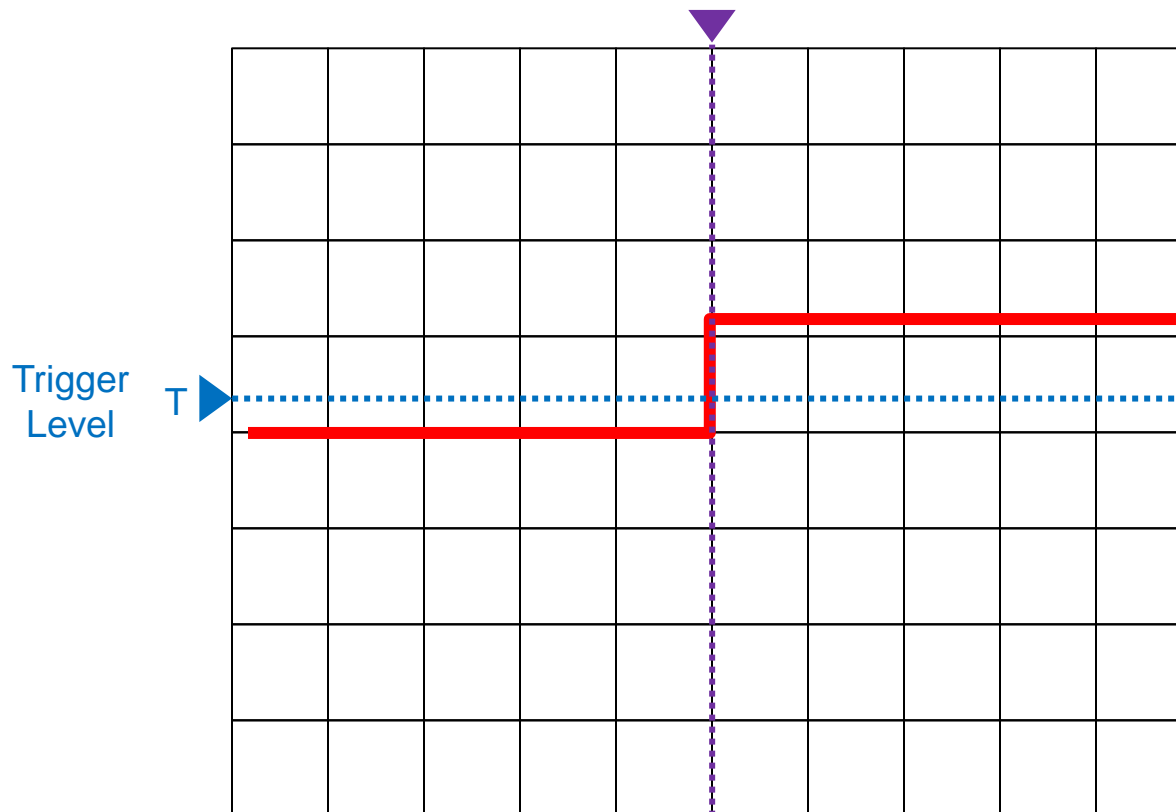
- Suppose this signal was plotted on the oscilloscope (realizing the scope wraps to the left after reaching the right-most edge). What would you see?



End Result

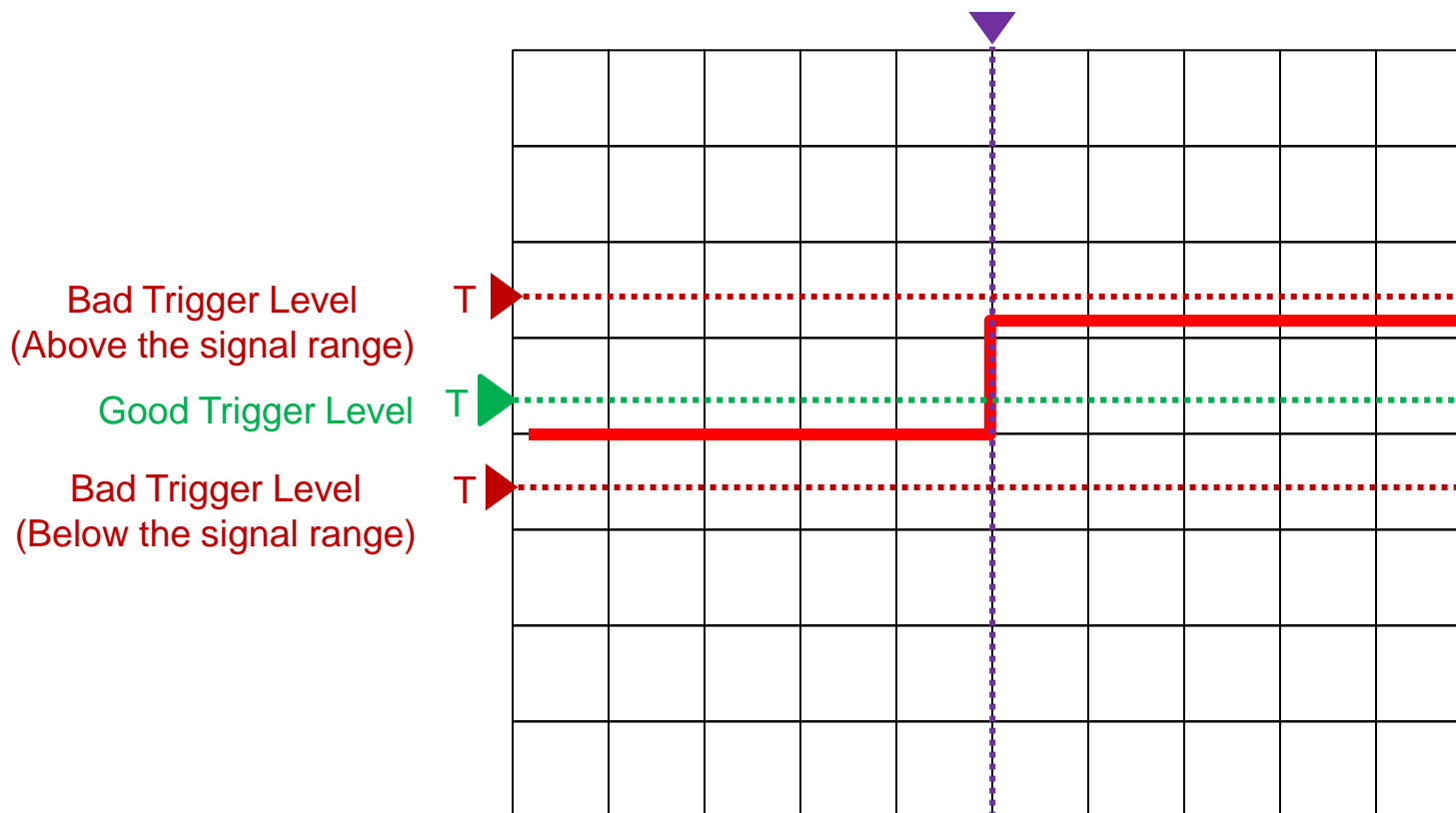
Adjusting the Trigger Level

- By adjusting the trigger level (i.e. threshold) near the middle of the voltage range of the actual signal the oscilloscope will align each left-to-right scan to the time when the signal crosses that trigger threshold



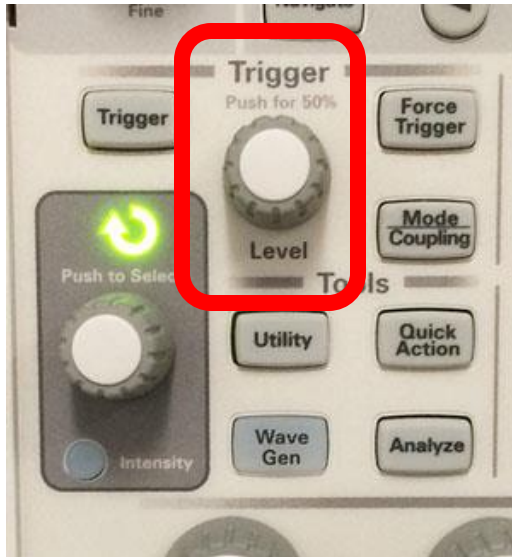
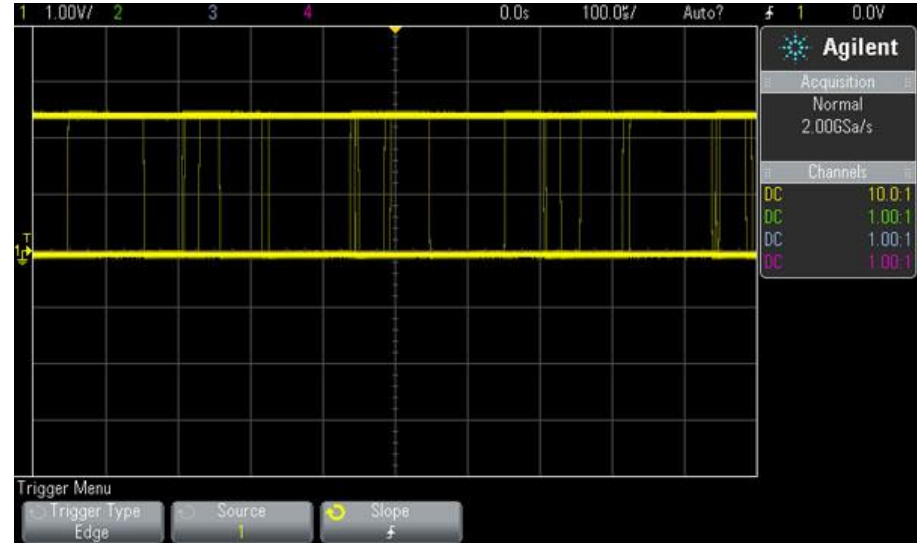
Adjusting the Trigger Level

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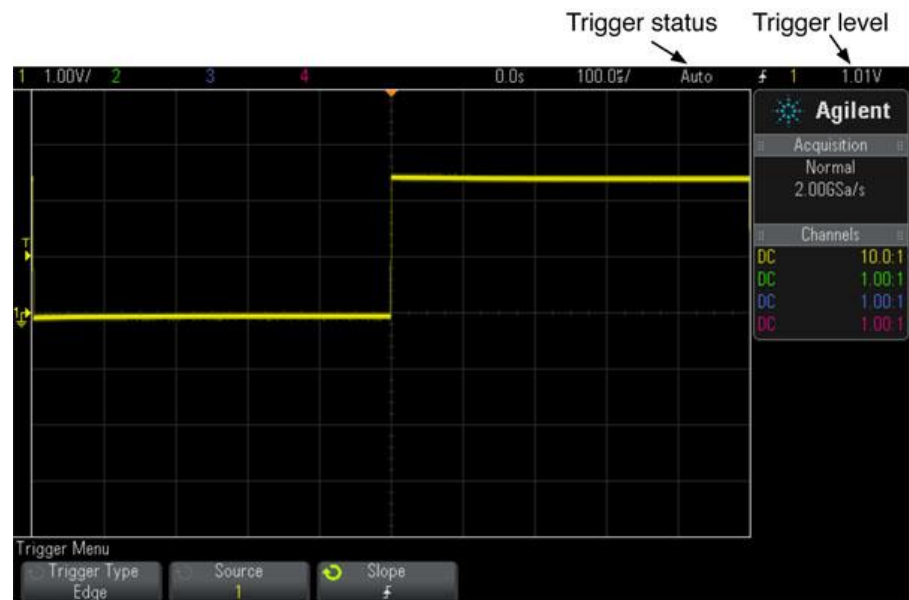


Triggering

Without trigger level adjusted

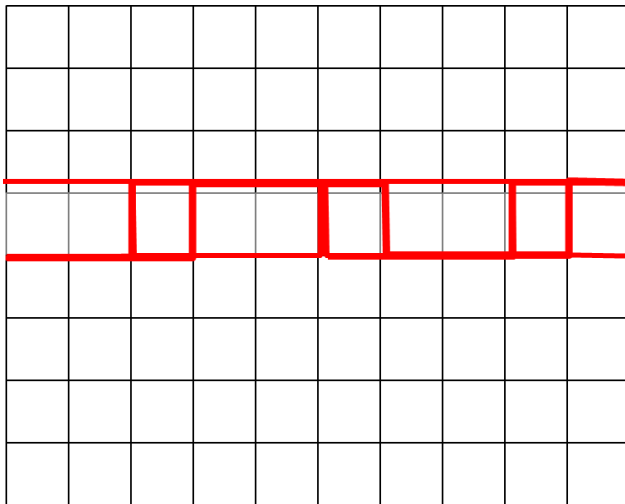


With trigger level adjusted



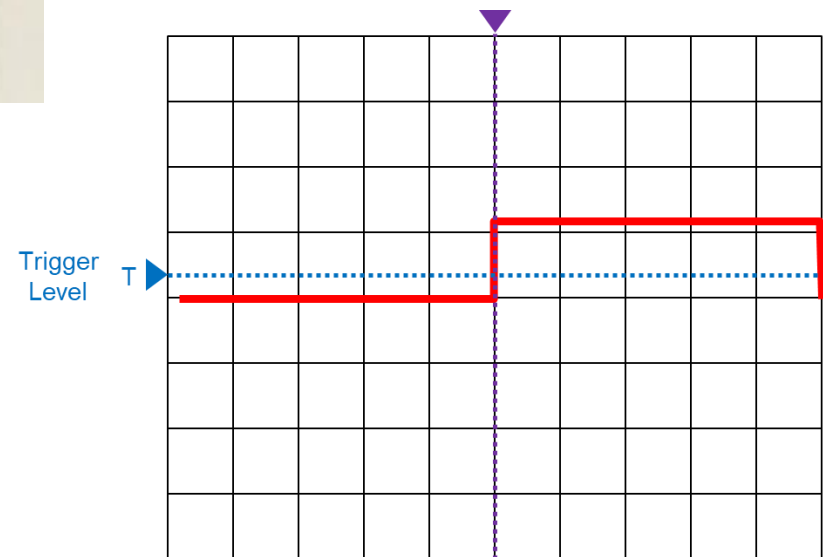


Single vs. Run Mode



Run Mode

- The oscilloscope draws the signal in "real-time" continuously scanning left-to-right
- Good for periodic signals



Single Mode

- The oscilloscope will capture a single "freeze-frame" of the signal when it detects the trigger condition.
- If the trigger is not setup or the condition is not met, nothing will be displayed
- Good for non-periodic signals or 1-time pulses

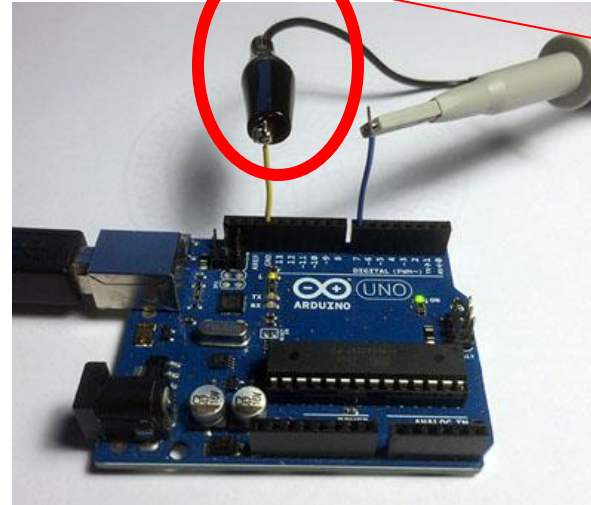
PROCEDURAL NOTES

Viewing Signals

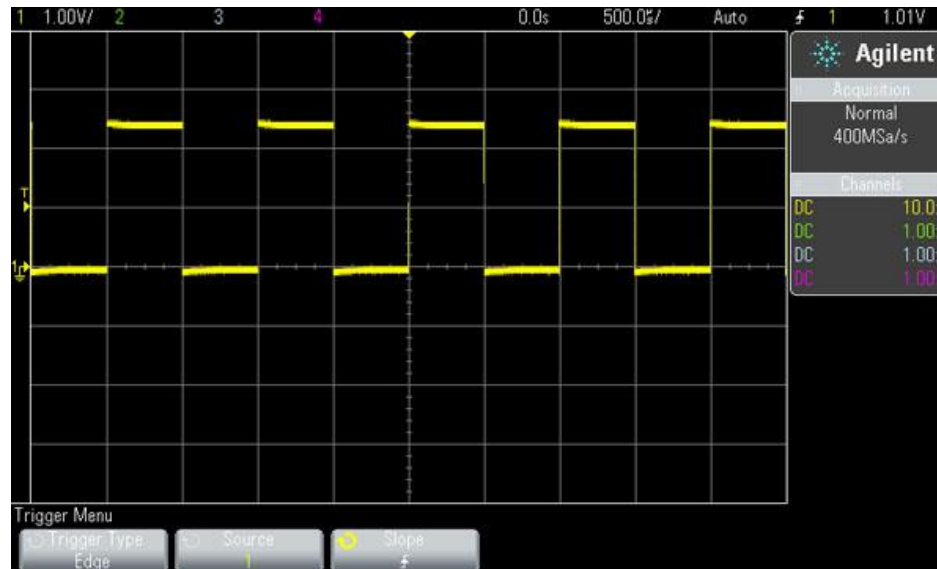
Ports D13 to D0



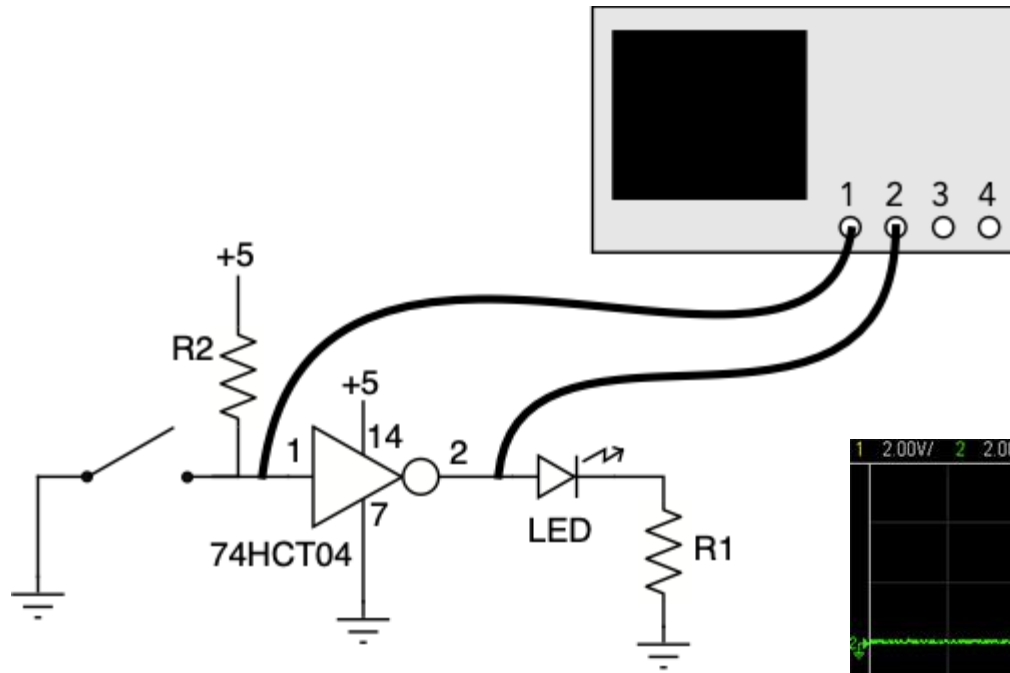
Ports A0 to A5



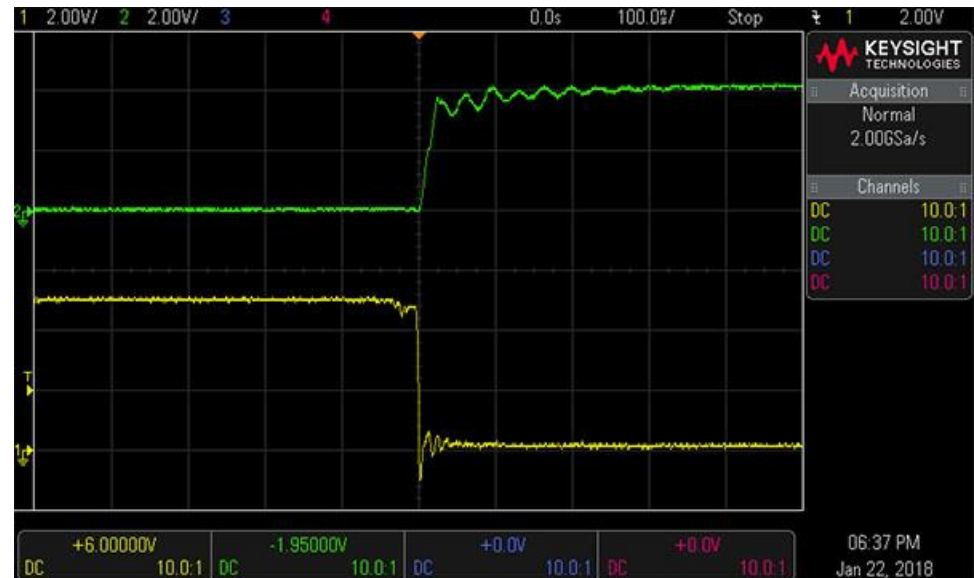
Remember voltage is measured across two points. You must attach the GND clip to a GND signal

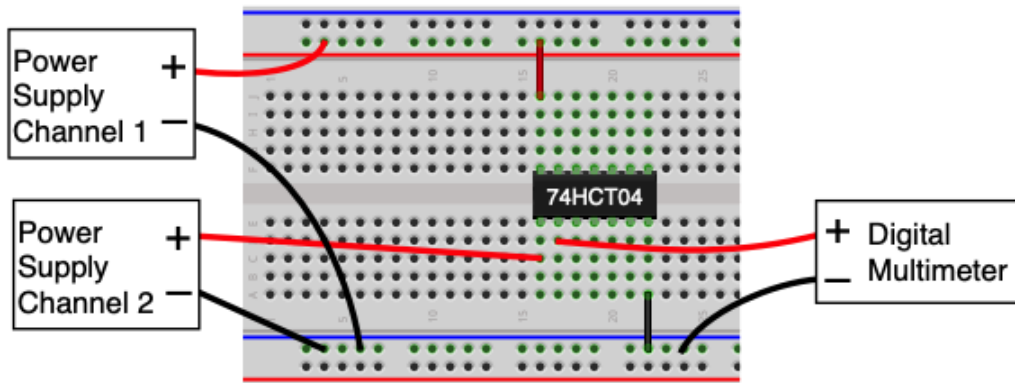


Digital Circuit

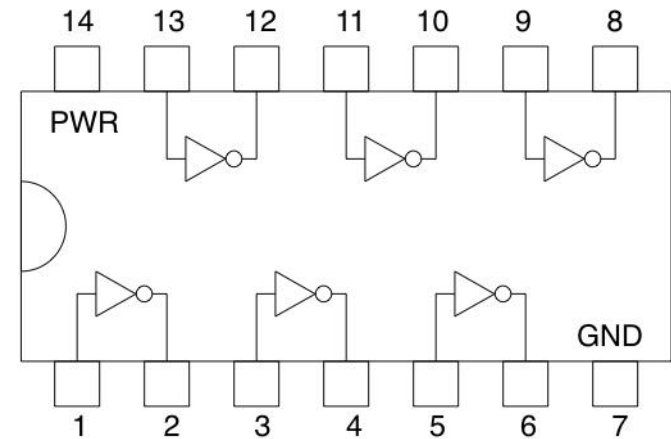


Scope connections to inverter circuit

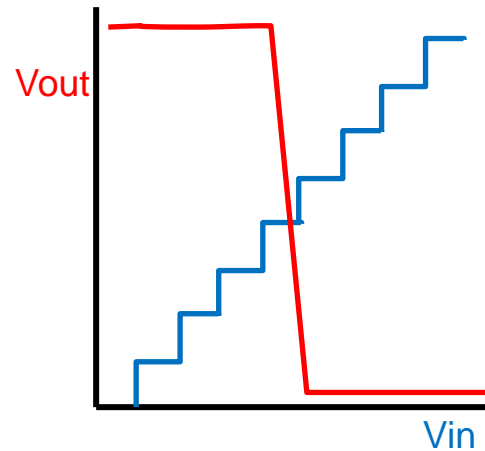




Measuring threshold with DMM



Pin diagram for the 74LS04



WHEN YOU ARRIVE

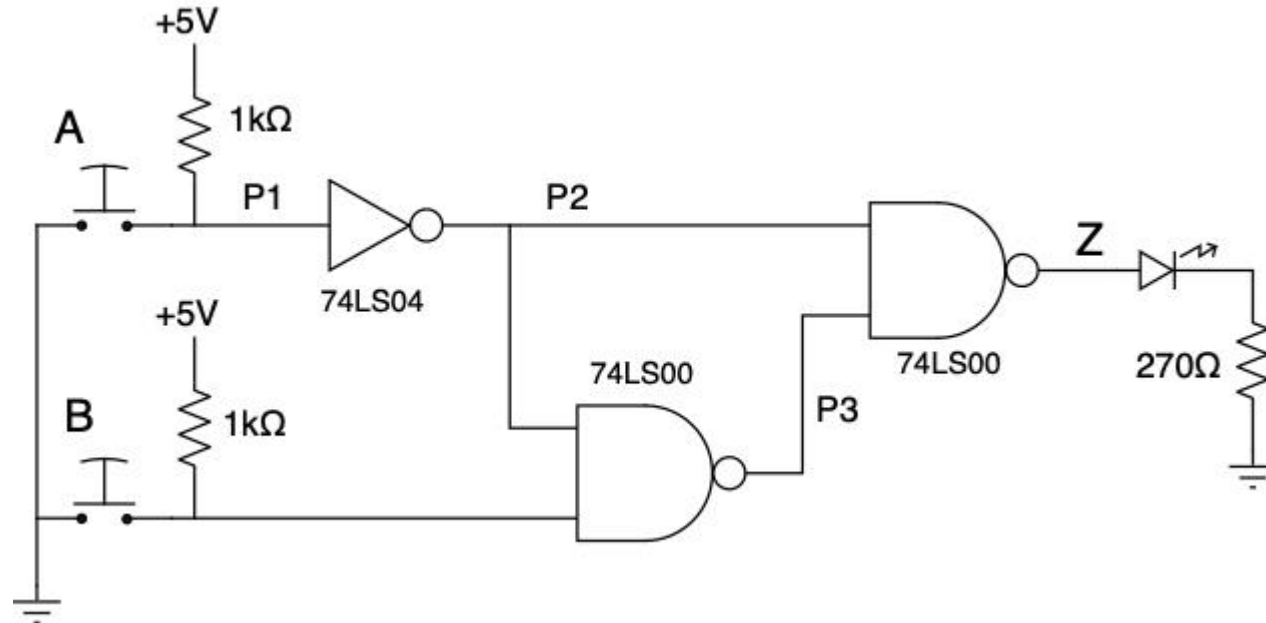
When You Arrive...

- For the part where we use the Arduino, be sure to update the `uscid.c` file with your USC ID and then recompile and download the code (using ``make`` and ``make flash``)
- For the combinational circuit you will need to demo a few aspects to your TA/CP. You should get their signature and keep your sheet as proof. We will enter the sign-off info in our own spreadsheet for our records

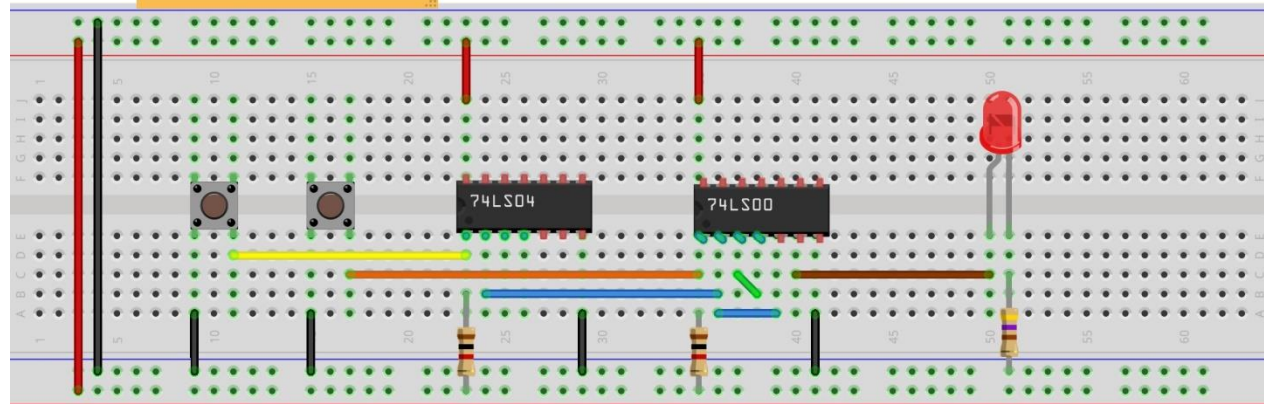
Version of slides before 2021

IGNORE!! – BEFORE 2021

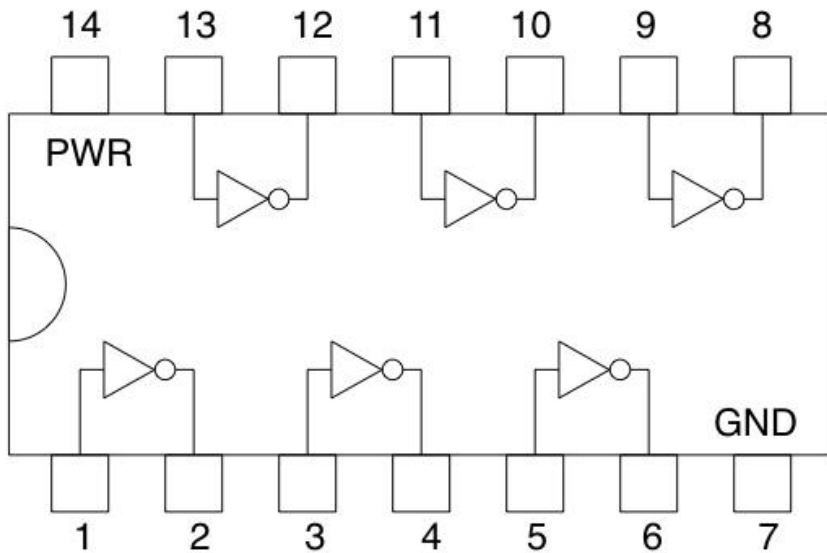
Digital Circuit



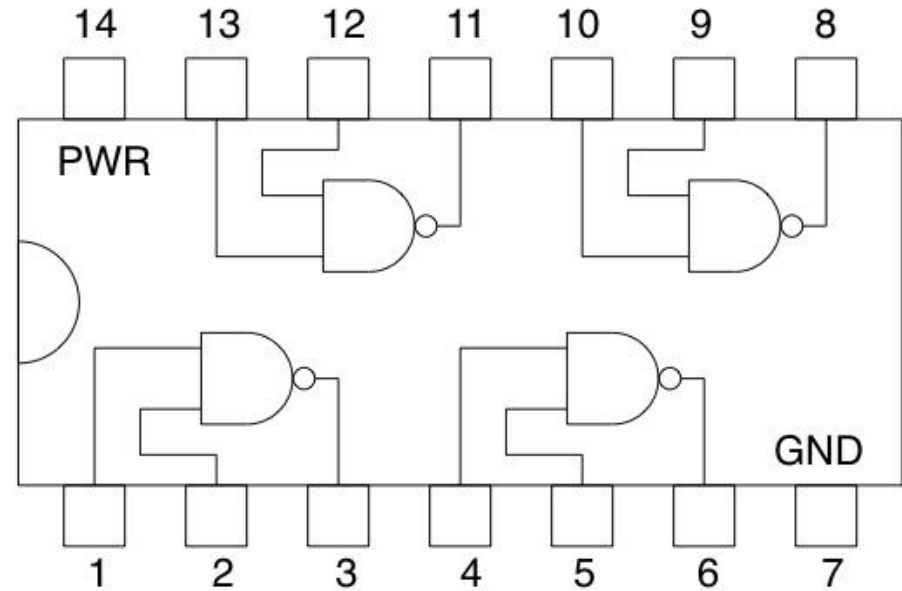
You will need to provide power and ground from your power supply.



IC Pin-outs

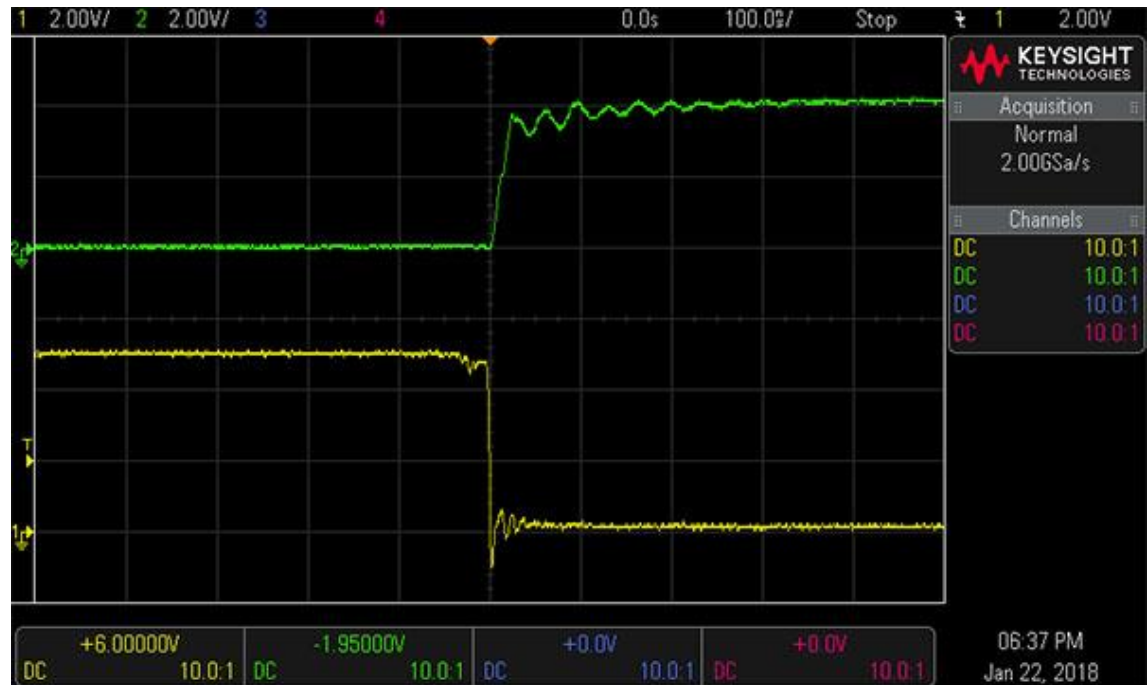
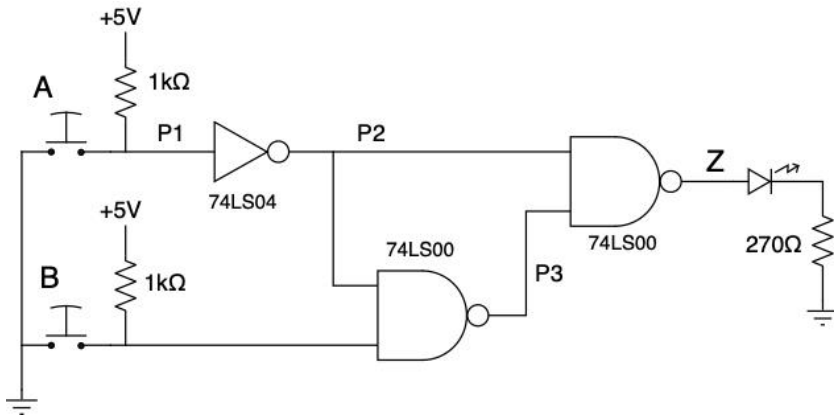


Pin diagram for the 74LS04

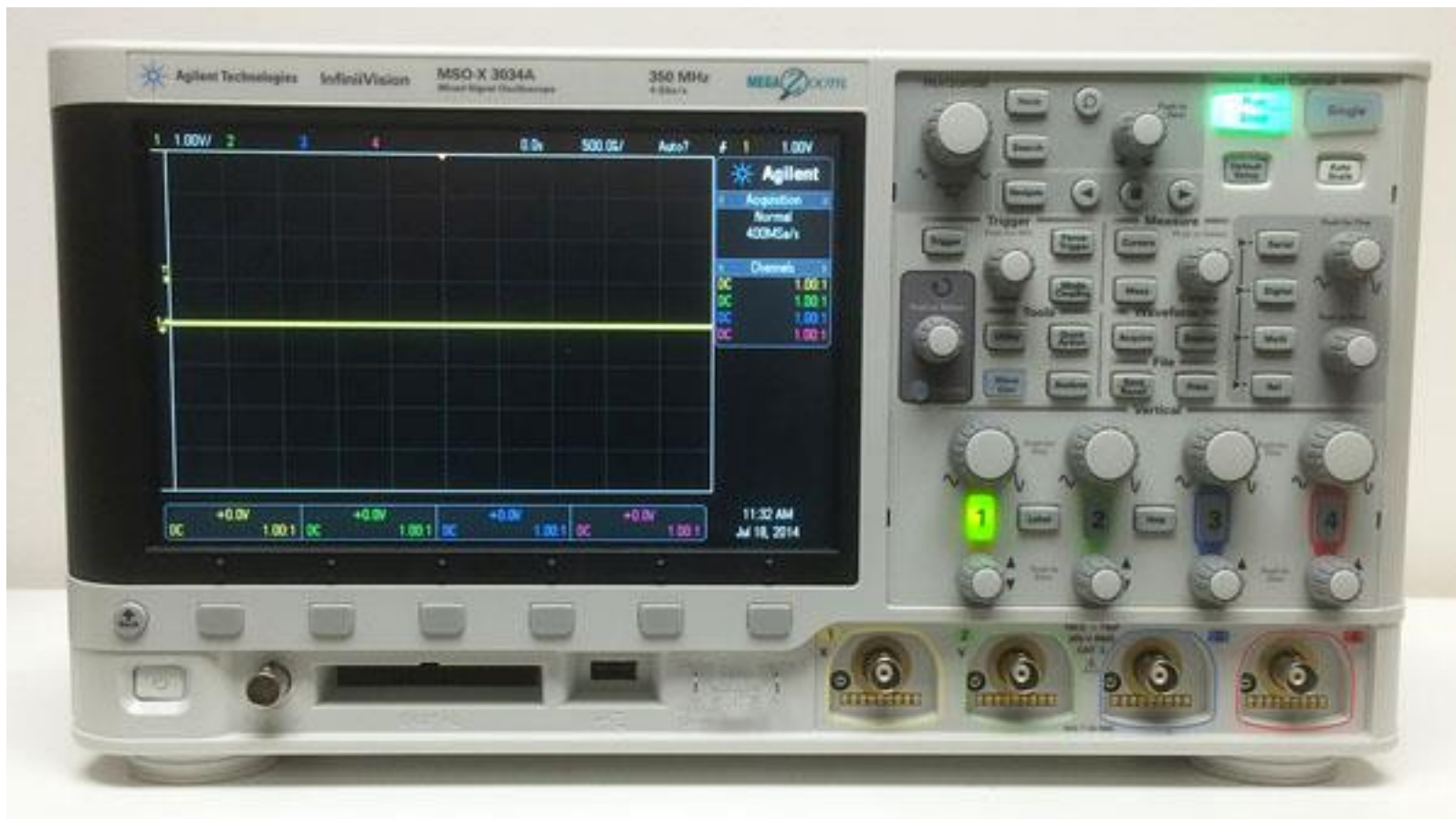


Pin diagram for the 74LS00

Measuring Propagation Delay

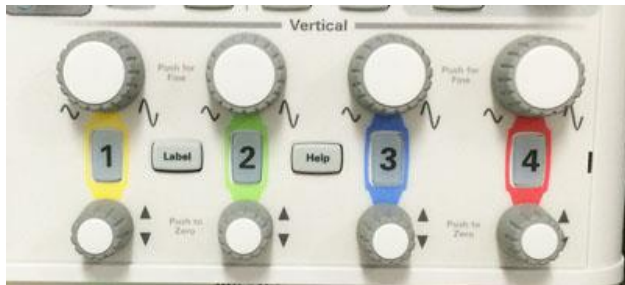


OSCILLOSCOPE TUTORIAL



Volts per vertical square for each of the four channels

Time per horizontal square common for all four channels



Reading Oscilloscope Signals

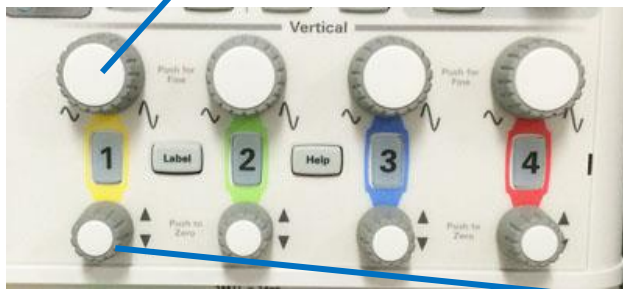
Horizontal (Time) Scale Controls



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 1 us, 2 us, 5 us, ...,
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 1s, 2s, 5s, 10s]
 per division



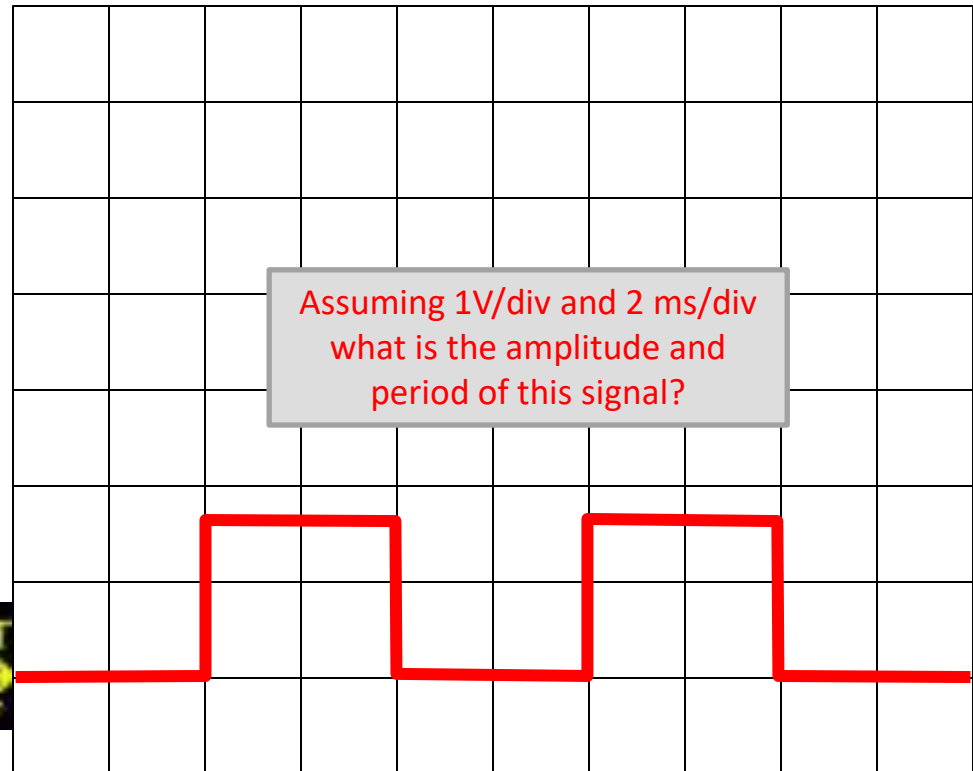
[..., 500mV, 1V, 2v, 5V, 10V, ...]
 per division



Vertical (Voltage)
 Scale Controls

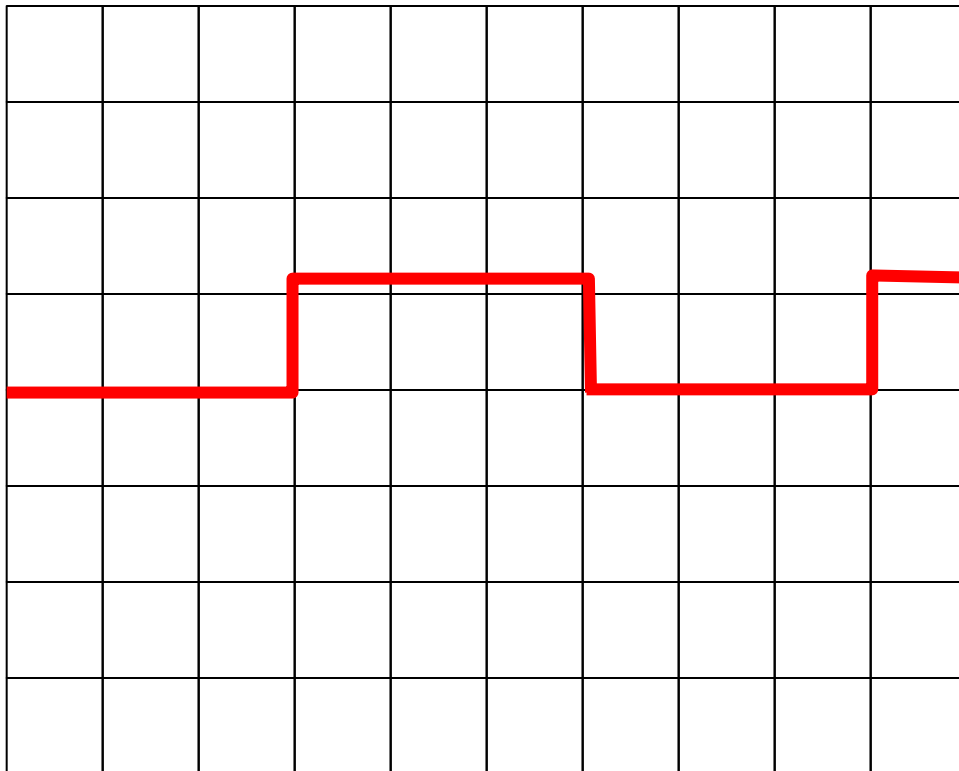
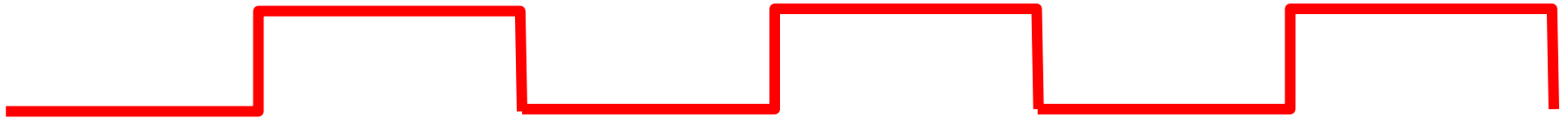
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 Level

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 what is the amplitude and
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Issue of Triggering (1)

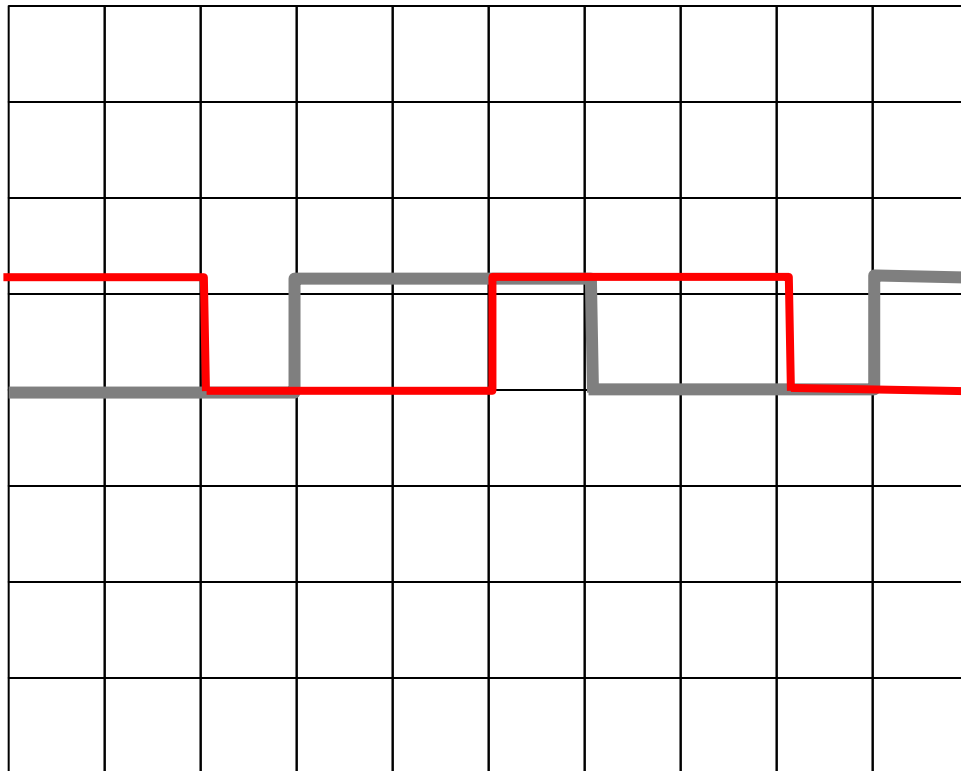
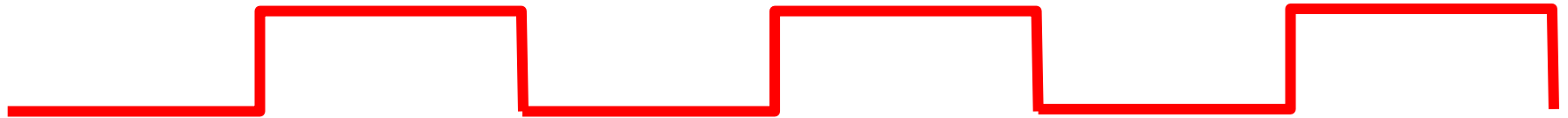
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First left-to-right scan

Issue of Triggering (2)

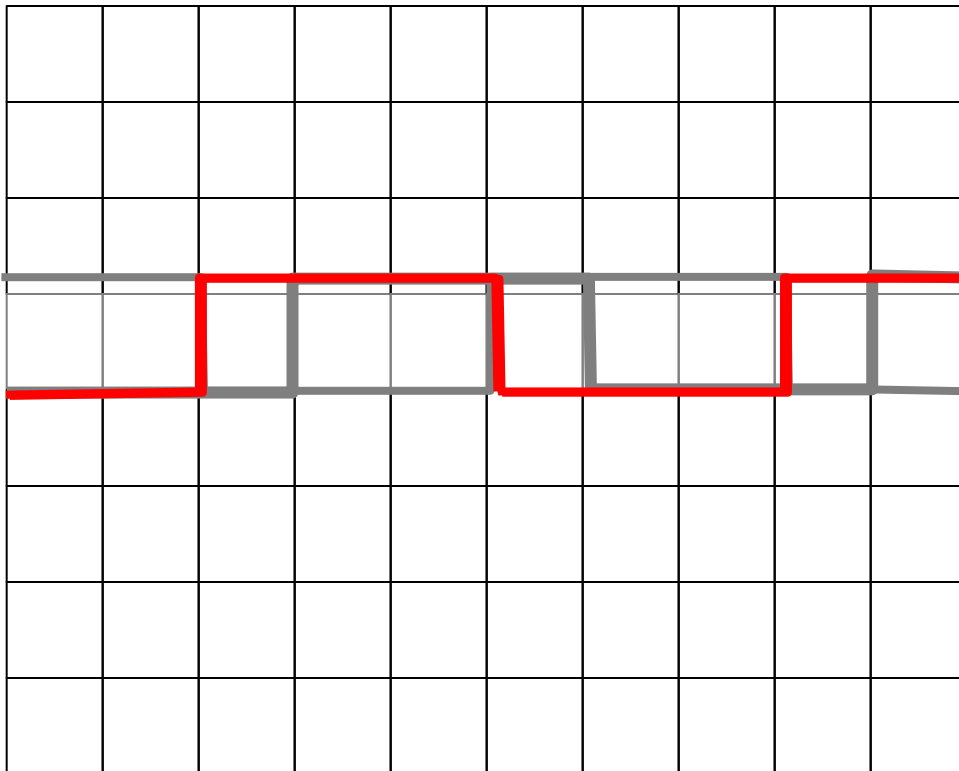
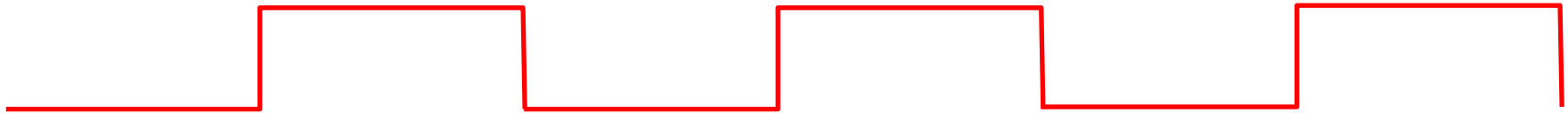
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Second left-to-right scan

Issue of Triggering (3)

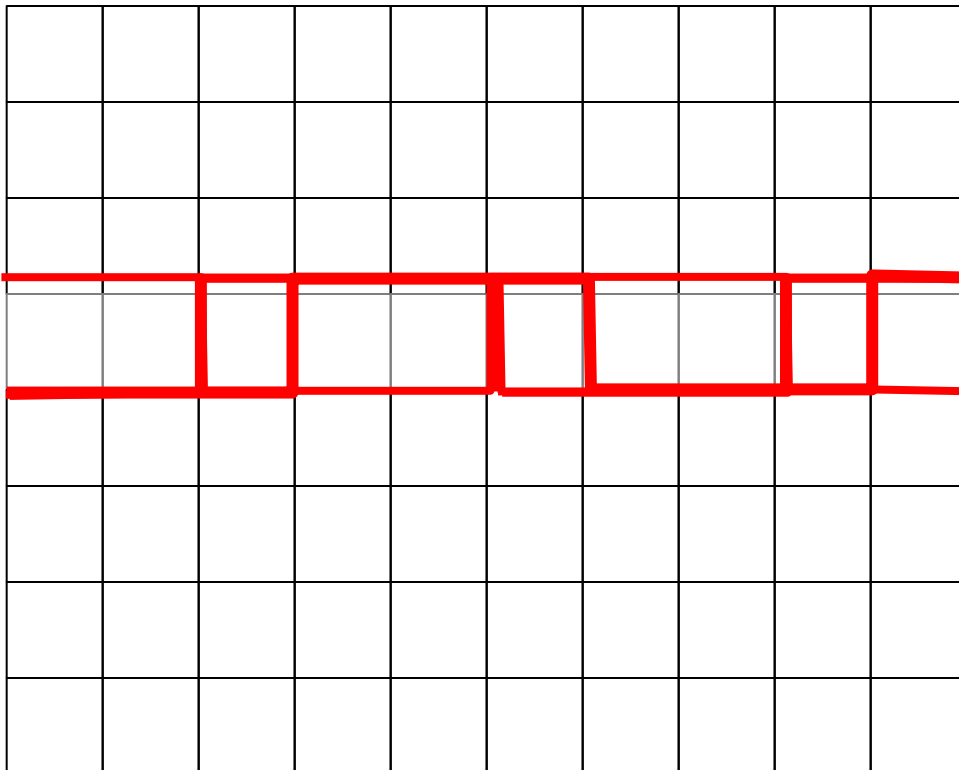
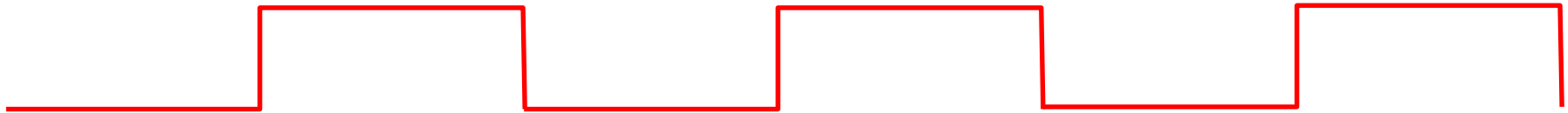
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Third left-to-right scan

Issue of Triggering (4)

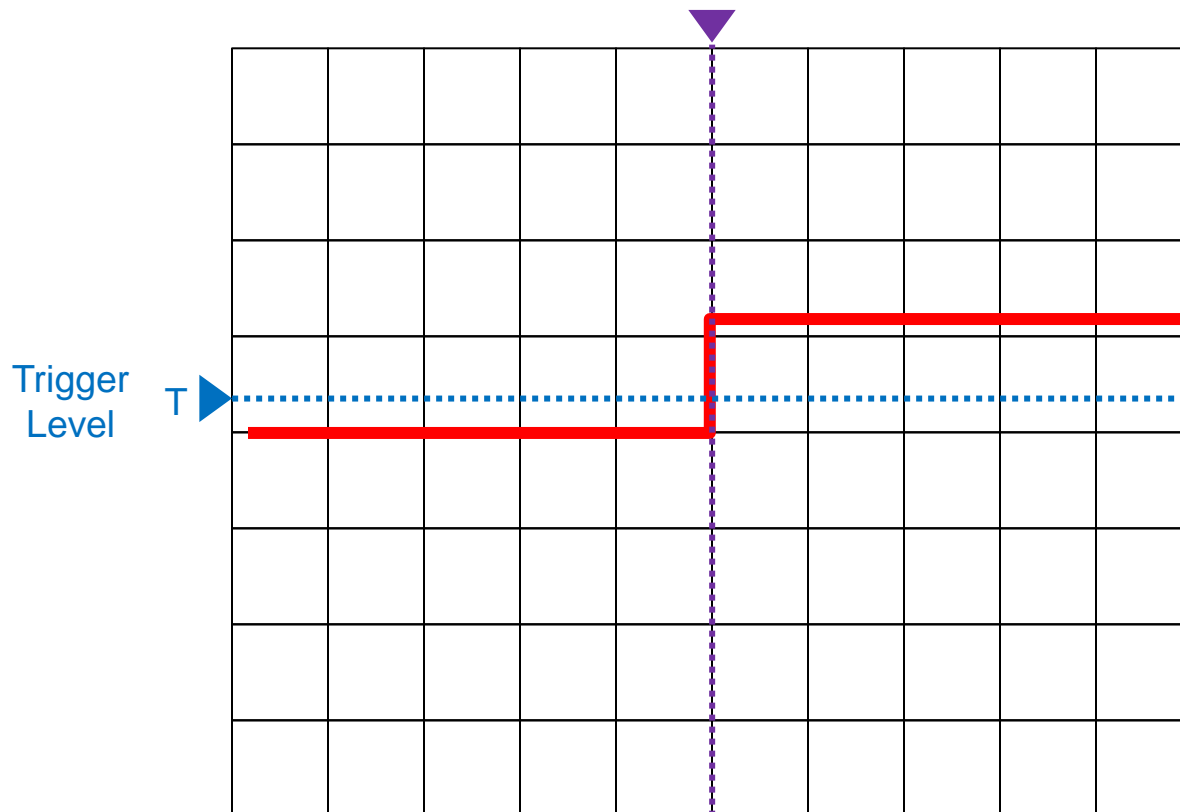
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End Result

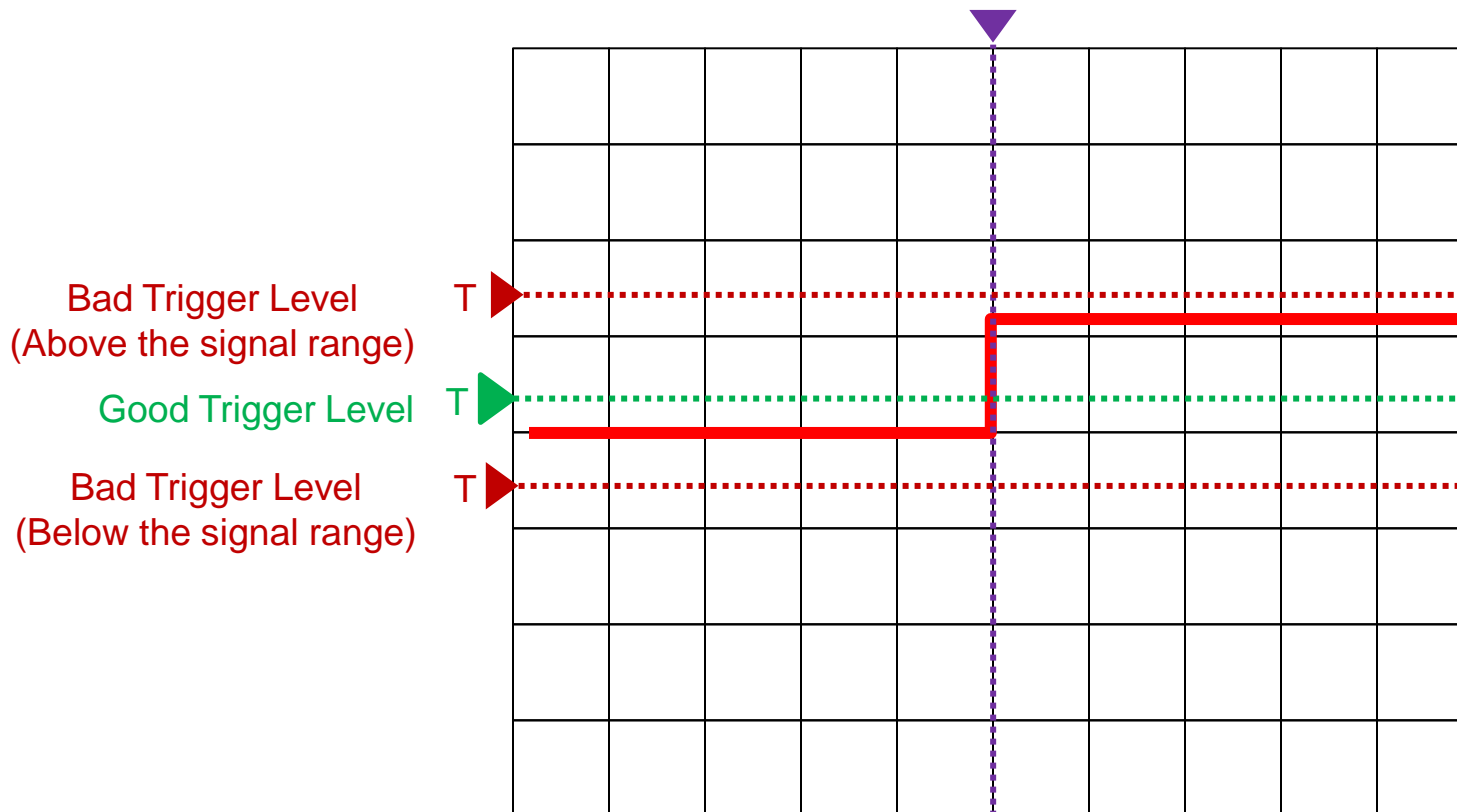
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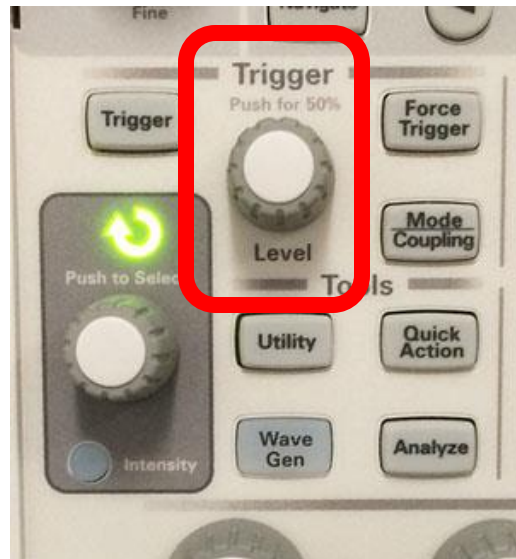
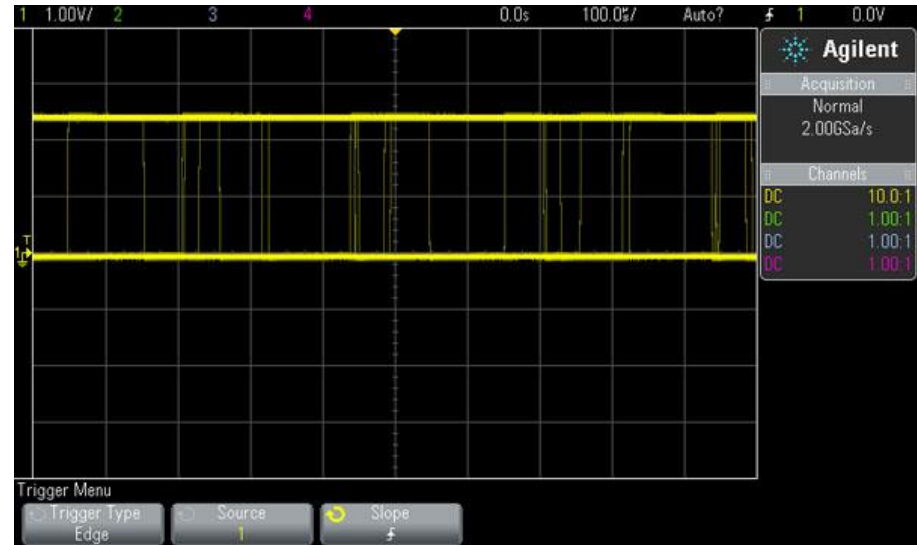
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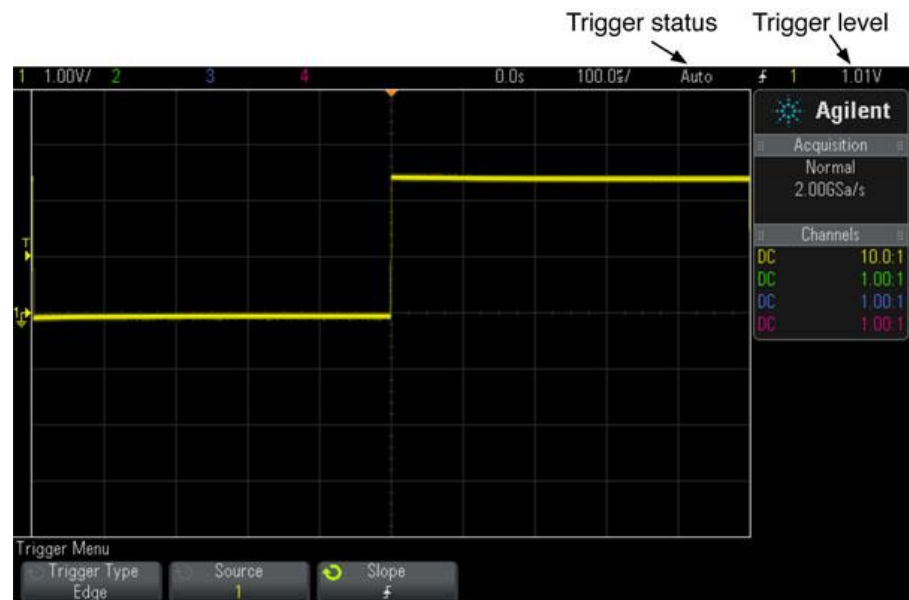


Triggering

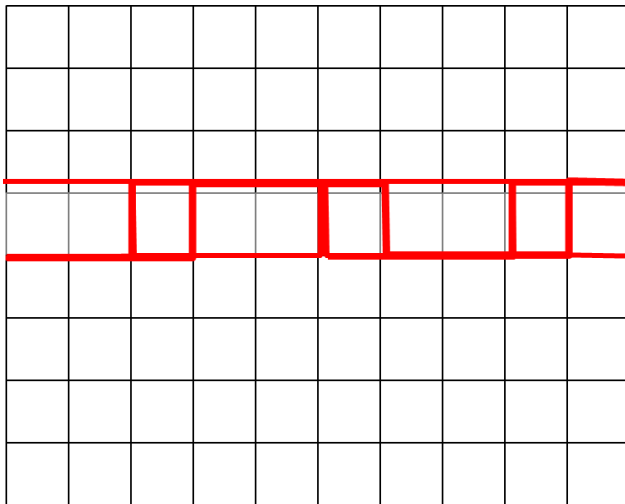
Without trigger level adjusted



With trigger level adjusted

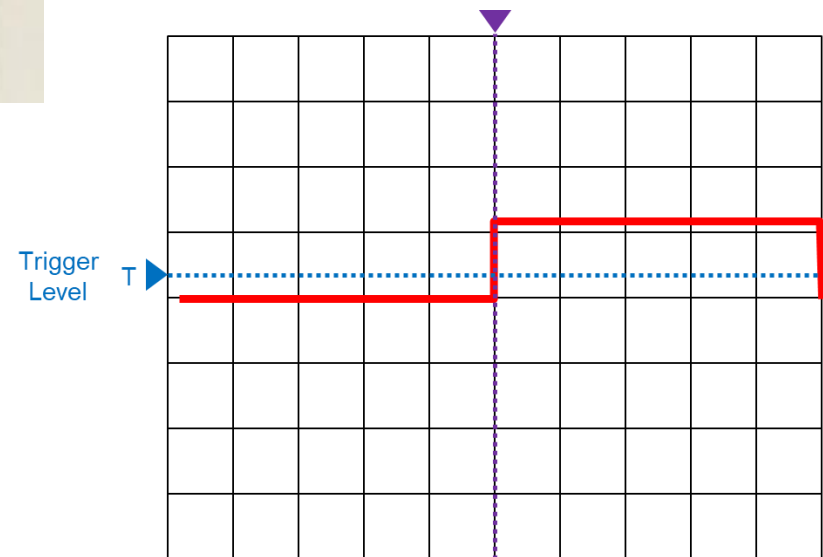


Single vs. Run Mode



Run Mode

- The oscilloscope draws the signal in "real-time" continuously scanning left-to-right
- Good for periodic signals



Single Mode

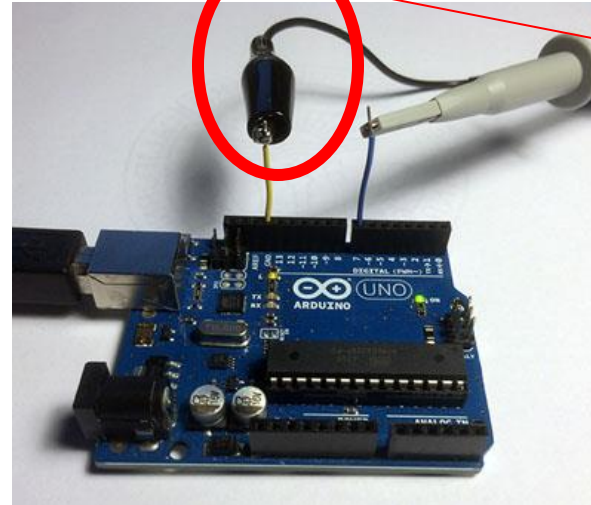
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Viewing Signals

Ports D13 to D0



Ports A0 to A5



Remember voltage is measured across two points. You must attach the GND clip to a GND signal

