Engr433 Lab #1

Digital Noise, Voltage Sources, and Capacitor Performance

Name ____________________________________

Partner (s)________________________________ **Grade** _______/10

Objective

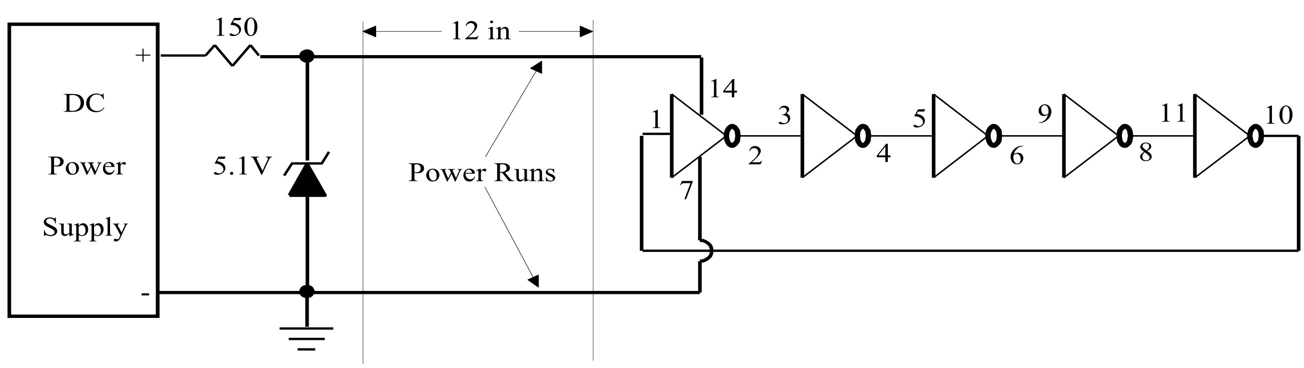
To familiarize you with digital switching noise, voltage sources, and performance of capacitors in noise and voltage sourcing situations.

Circuit Components Required

- 74ALS04 hex inverter;
- 5.1V zener diode;
- 150 Ω series resistor;
- 0.1 uF disc (ceramic) decoupling capacitor;
- 10 uF good quality (tantalum) electrolytic capacitor;
- 680 uF poorer quality (aluminum) electrolytic capacitor.

Circuit Design and Construction

Construct the circuit shown below. Use a 74ALS04 hex inverter chip. Any signal input or output should have a rather noisy square wave. Be sure that the leads from the DC power supply to the resistor are as short as possible (move the power supply down to bench level if necessary) and that there are 12" wires from the diode/resistor combination to the inverter chip. Set the DC power supply voltage to 10 volts.



Notes

- Keep the physical positioning of the 12" power runs constant throughout the experiment unless otherwise directed.
- Make accurate measurements - subtle differences will exist between certain measurements. Accurate peak-to-peak amplitude measurements for noise is essential.

Procedure

1. Calibrate the scope probe by connecting the probe and ground lead to the lower right side of the oscilloscope. Verify that the signal is a sharp square wave. Adjust the trim pot on the oscilloscope end of the probe if necessary.
2. Set Channel 1 on the oscilloscope to 10X to match the oscilloscope probe.
3. Verify that a square wave (will be a little noisy and rounded) exixts on one of the inverter outputs.

4. Measure and record the DC voltage on the positive side of the Zener diode: _________ V

5. Scope directly across the zener diode, keeping probe contacts as close as possible to the zener. Record noise riding the DC supply rail by choosing AC coupling. Sketch the approximate noise waveform shape with accurate peak-to-peak amplitude and frequency.

6. Connect the 10 uF tantalum capacitor (watch the polarity) across the zener diode and record the same information as in step 5.

7. Eliminate the zener regulated supply by removing the diode, resistor, and capacitor and connecting the circuit power runs directly to the DC power supply, set for the same voltage measured in step 4. Scope directly across the power supply output terminals. Record the same information as in step 5.

8. Install the same capacitor used in step 6 across the power supply output terminals and record the same information as in step 5.

9. Draw conclusions from steps 5 to 8 as to the relative performance between the zener supply and the DC power supply. Explain any differences observed when installing the capacitor across either supply configuration output.

10. In general, how does a capacitor affect the output impedance (to high frequency) of a (poor) voltage source? Why?

11. Where does the noise riding the DC rail come from?

12. Return the circuit to the original starting configuration shown on page 1. Scope pins 14 and 7 of the 74ALS04 chip, keeping probe contacts as close as possible to the chip. Record approximate noise waveform shape with accurate peak-to-peak amplitude.

13. Draw conclusions from steps 5 **and** 12 about the power distribution scheme explaining in general terms the differences observed at each end of the power runs.

14. Why is the noise amplitude different at one end of the power runs versus the other end?

15. Scope directly across the zener diode, keeping probe contacts as close as possible to the zener. Shunt the zener with a few different types and values of capacitors available to you. Find a capacitor which reduces the noise the most and record approximate waveform shape with accurate peak-to-peak amplitude.

16. Leaving the best capacitor shunted across the zener, scope pins 14 and 7 of the chip, keeping probe contacts as close as possible to the chip. Record waveform and amplitude as done earlier.

17. Still scoping the 74ALS04, move the decoupling capacitor from the zener to the chip. Install the capacitor across the chip with leads as close as possible to pins 14 and 7. Again, record waveform shape and amplitude.

18. Leaving the capacitor shunted across the chip, move the scope to the zener diode, keeping probe contacts as close as possible to the zener. Again record waveform shape and amplitude.

19. Draw conclusions from steps 15 through 18 as to the better location to install decoupling capacitors. Explain why one location is better than another.

20. Return your circuit to the starting configuration. Scope pin 8 on the 74ALS04, filling the oscilloscope screen with 1 or 2 cycles of the waveform. Keep probe ground as close as possible to pin 7. Record waveform shape and amplitude.

21. Add 18 inches or so of wire in series with the probe ground lead. As you observe the waveform, physically move the probe ground wire with respect to the signal probe. Try twisting or coiling the ground wire. Also, try wrapping the ground wire around the signal probe. Record your general observations.

22. Reposition the probe ground (with added wire) from pin 7 of the chip to the ground side of the zener. Repeat step 21 above.

23. Explain your observations of the preceding step. What are your recommendations regarding probe ground **lengths** and their **location** in the circuit with respect to the signal source?

24. Return the probe ground to normal. Coil the 12 inch power runs (both power and ground wires) around a pen or pencil. Repeat steps 5 **and** 8, recording approximate waveform shape with accurate peak-to-peak amplitude.

25. Did coiling the power runs change the original step 5 results? If yes, explain why.

26. Are you seeing all the circuit noise on the oscilloscope screen? Explain.