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Report – Equipment Demonstration

Introduction

Goals

The goal of the design was to learn to use industry standard computer engineering equipment including the function, generator, oscilloscope, power supply, and digital multimeter. These are demonstrations that were used: generating a 1kHz, +/-1V peak square wave with a +100mV offset using the function generator and using the +5V max channel of the power supply to determine the voltage needed to supply 100mA of current to a 10Ω resistor with the multimeter.

Background on Equipment for Lab

Oscilloscope

Measures in Volts/Time per Div with waveforms up to 16 Channels/ The Oscilloscope can also Decode SPI and UART. It also uses a BNC connector with probes that can be switched to have a larger impedance.

Function Generator

Also uses a BNC connector, but the function generator generated an AC power supply through a waveform. The waveform can also be configured on IO port 55555 to automate tests through importing sockets to form a connection in the internet.

Digital Multimeter

Can measure a point of circuit’s current, resistance, and/or Voltage through DC or AC supplies.

Power Supply

Supplies a DC voltage to a circuit. The Power supply has Positive and negative voltages: Known the reference point for it (The 0 Volts), and all the points of voltage are in reference to You. Also, a person can set the current or voltage limit is to protect some electronics.

Design

Wave Generation & Display

Tested how the function generator and the oscilloscope worked. In Lab, I generated a 1kHz, +/-1V peak square wave with a +100mV offset. On the Oscilloscope there at least two full periods that are on screen, and the trigger is on the rising edge of the waveform.

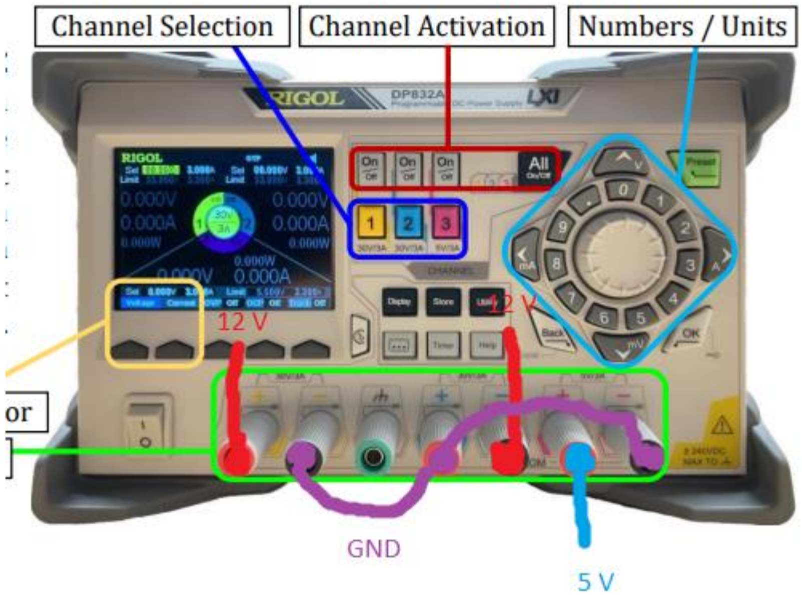
Voltage Test

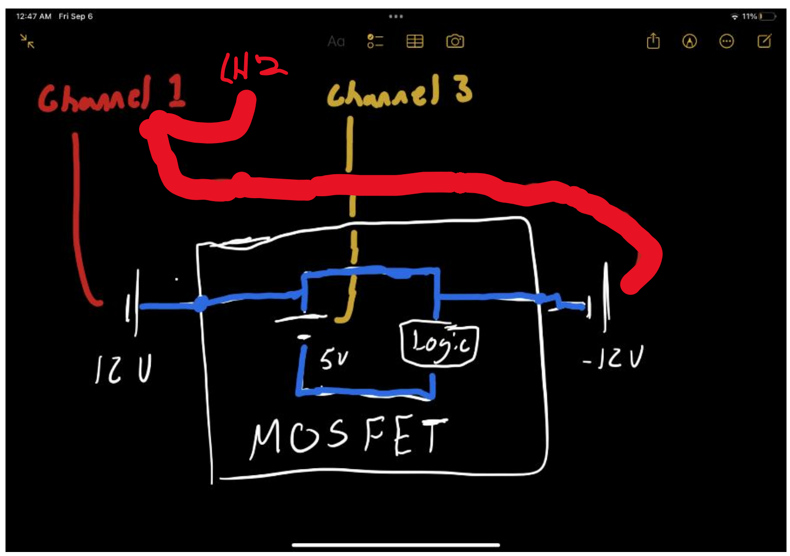
Tested how the Power Supply and the multimeter worked by creating a basic resistor in series with the multimeter circuit. The supply was on the +5V max channel with a 50 mA current limit. The resistor was found to need at least a voltage of 1V to be supplied.

Questions

<u>Warm-up</u>

1. Explain the terms volts per div and time per div as applied to an oscilloscope. Where are they indicated on the scope's display?
    a) Volts per div on an oscilloscope is the number of volts per the major grid lines of the oscilloscope on the y-axis. Time per div as applied to an oscilloscope is the amount of time per the major gridlines on the x-axis of the scope. On the display they are indicated as the horizontal axis with time (can be changed with the dark blue knob) and the vertical with voltage (can be changed with the channel knobs).
2. You are designing a class-D audio amplifier that needs a bipolar, +-12V DC power supply for the MOSFETs, as well as a 5V DC supply to power to logic circuitry. Make a labelled diagram showing how this could be done with power supplies available in our lab.





Scenario

3. Carsten received a synth PCB he designed by mail. He assembled the board and baked it in the reflow oven. He plugged it in and... pop! The power supply was reversed. Oops!
   a. Briefly describe how a programmable power supply and other equipment could detect which component(s) were damaged with minimal risk (hint: faulty components get hot).
      a) A programming power supply could detect which component(s) were damaged. Using the power supply, they could program the current limit and turn up the voltage to check if some of the faulty components get hot.

Then, use the multimeter to check the current going through the device when the voltage is supplied.

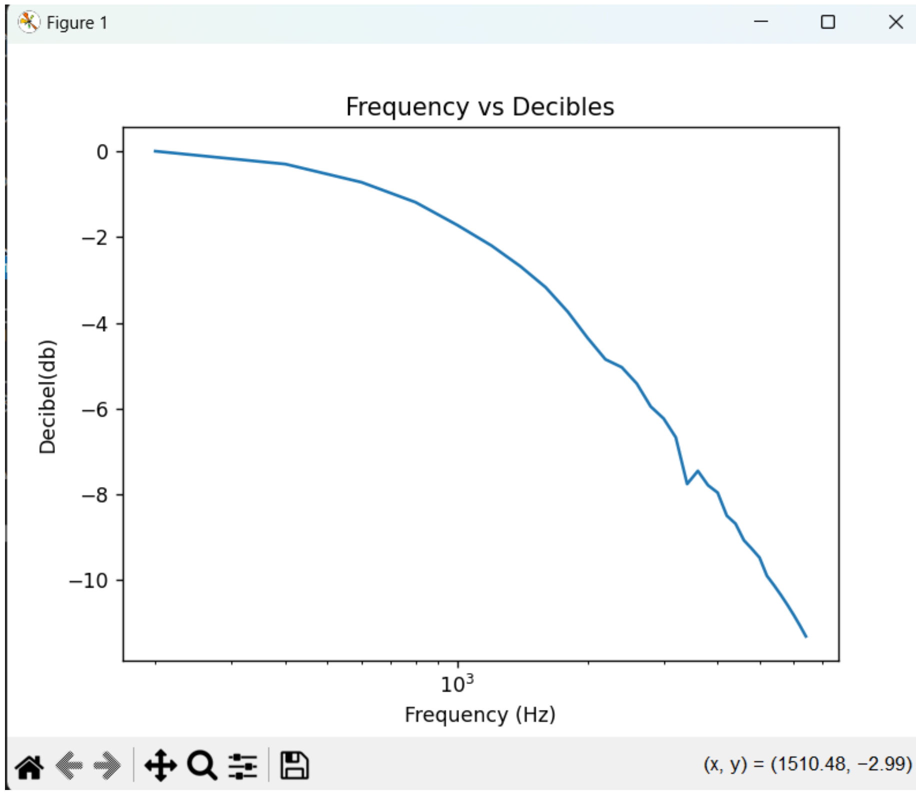
b. With your help, Carsten was able to find and replace the broken parts. He can program his microcontroller, but the SPI interfaced DAC isn't working as he thinks it should. Briefly describe a technique he could use to debug the circuit.
    a) A technique he could use to debug the circuit is to use the oscilloscope. The scope has a function on it where they can decode bits for SPI and UART to check if the packet on the SPI is sending the correct bits to the interface DAC after programming something very simple. This is done by first getting a probe and probing the pins that is the sending the packets and connect the other pin to ground, and then press the decode button on the scope to easily read the packets.

4. You are a test engineer for a drone manufacturer. The flight-ops team describes incidents where drones crash after an aggressive flight maneuver. You think the high motor load during maneuvers is causing the microcontroller to brown out. How could you test this hypothesis?
    a) I could test that the high motor load during the maneuver was causing the microcontroller to burn out by using the power supply and the multimeter. To test the hypothesis, after finding a reference voltage, connect the positive and negative leads to the load and set the current limit to the load to supply power. Turn up the voltage till the load browns out on the microcontroller with the multimeter hooked up to the controller. Finally check what the voltage that was supplied to the high motor load that could have caused that.

<u>Function Generator Scripting Exercise</u>

5. Construct this simple, passive low-pass filter on a breadboard.
    a. Calculate the theoretical cutoff frequency of this filter; Show your calculations.
        a) R = 1 kOhm
        b) C = 100 nF
        c) F0 = 1/(2*pi*R*C)
        d) F0 = 1/(2*pi*1*10^3*100*10-9)
        e) F0 = 1.59 kHz

b. Write a Python script to collect data on the frequency response of the filter. Starting below the cutoff frequency and ending above, use SCPI to iterate the function generator through a series of frequencies and acquire the attenuation from the oscilloscope. Capture at least 32 data points. Save the data in a file and use matplotlib to create a Bode plot for the circuit with labelled axes, a title, and a marker of the experimental cutoff frequency.
    a) See canvas for code
    b) Plot Bellow



Cutoff Frequency from Experiment is 1.51048 kHz

c. Manually measure the resistor and capacitor using the multimeter and use the values to recalculate the cutoff frequency. Does this match the frequency from the Bode plot? If not, what might account for discrepancies?
    a) Resistor: 989.6 ohm
    b) Capacitor: 101.2 nF
    c) F0 = 1/(2*pi*R*C) = 1,589 Hz
    d) The manually measured resistor and capacitor to calculate the cutoff frequency does match both the theoretical and the -3 db from the bode plot for their cutoff frequencies. The small

discrepancies are due to human error or manufacturing tolerances of the resistor and capacitors.

Conclusion

Difficulties

A difficult was that all of the equipment was very new to me, and I have never programmed in python before which was difficult

Results

In the question 5, the manually measured resistor and capacitor to calculate the cutoff frequency does match both the theoretical and the -3 db from the bode plot for their cutoff frequencies. The small discrepancies are due to human error or manufacturing tolerances of the resistor and capacitors. The other two demos where to get used to the equipment in the lab.