Lab 2 Report

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Introduction to AC Measurements

Physics 385L

**Abstract**: A brief introduction to measuring alternating currents through the use of a function generator, digital multimeter, and an oscilloscope. Using the function generator to produce various currents of different frequency and then using the oscilloscope and digital multimeter to measure the voltages of the circuit.

**Background**: Proper use of the oscilloscope, function generator, DMM, and how to interface the three pieces of equipment together to ensure accurate readings.

**Procedure**: The lab procedure provided in class is attached to the report.

**Presentation of Data**:

Section 2-2 AC Voltage Measurements

The voltage readings of the AC signal at a set DC offset.

AC Amplitude: 5V peak-to-peak

DC Offset: 0V

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sine Wave |  |  |  |  |  |  |
| Frequency | VDC Min | VDC Max | VDC Avg | VAC Min | VAC Max | VAC Avg |
| 10 Hz | -.68 V | 0.697 V | 0.000 V | 1.702 V | 1.736 V | 1.719 V |
| 20 Hz | -.109 V | 0.121 V | .007 V | 1.752 V | 1.752 V | 1.752 V |
| 50 Hz | .006 V | .006 V | .006 V | 1.763 V | 1.763 V | 1.763 V |
| 1 kHz | .006 V | .006 V | .006 V | 1.763 V | 1.763 V | 1.766 V |
| 2 kHz | .007 V | .007 V | .007 V | 1.756 V | 1.756 V | 1.756 V |
| 5 kHz | .007 V | .007 V | .007 V | 1.555 V | 1.555 V | 1.555 V |
| 10 kHz | .007 V | .007 V | .007 V | 1.104 V | 1.113 V | 1.108 V |
| 20 kHz | .007 V | .007 V | .007 V | .657 V | .682 V | .672 V |
| 50 kHz | .007 V | .007 V | .007 V | .353 V | .420 V | .392 V |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Square Wave |  |  |  |  |  |  |
| Frequency | VDC Min | VDC Max | VDC Avg | VAC Min | VAC Max | VAC Avg |
| 10 Hz | -.0869 V | 0.898 V | -0.031 | 2.455 V | 2.469 V | 2.463 V |
| 20 Hz | -0.131 V | 0.161 V | .0015 V | 2.480 V | 2.480 V | 2.480 V |
| 50 Hz | 0.015 V | 0.015 V | 0.015 V | 2.482 V | 2.482 V | 2.482 V |
| 1 kHz | 0.015 V | 0.015 V | 0.015 V | 2.411 V | 2.418 V | 2.415 V |
| 2 kHz | 0.015 V | 0.015 V | 0.015 V | 2.334 V | 2.348 V | 2.341 V |
| 5 kHz | 0.015 V | 0.015 V | 0.015 V | 2.005 V | 2.027 V | 2.016 V |
| 10 kHz | 0.015 V | 0.015 V | 0.015 V | 1.418 V | 1.456 V | 1.436 V |
| 20 kHz | 0.015 V | 0.015 V | 0.015 V | 0.869 V | 0.913 V | 0.889 V |
| 50 kHz | 0.015 V | 0.015 V | 0.015 V | 0.515 V | 0.592 V | 0.566 V |

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| --- | --- | --- | --- | --- | --- | --- |
| Triangle Wave |  |  |  |  |  |  |
| Frequency | VDC Min | VDC Max | VDC Avg | VAC Min | VAC Max | VAC Avg |
| 10 Hz | -0.555 V | 0.567 V | 0.041 V | 1.380 V | 1.413 V | 1.396 V |
| 20 Hz | -0.087 V | 0.100 V | 0.004 V | 1.430 V | 1.430 V | 1.430 V |
| 50 Hz | 0.007 V | 0.007 V | 0.007 V | 1.442 V | 1.442 V | 1.442 V |
| 1 kHz | 0.007 V | 0.007 V | 0.007 V | 1.444 V | 1.444 V | 1.444 V |
| 2 kHz | 0.007 V | 0.007 V | 0.007 V | 1.433 V | 1.433 V | 1.433 V |
| 5 kHz | 0.007 V | 0.007 V | 0.007 V | 1.264 V | 1.267 V | 1.265 V |
| 10 kHz | 0.007 V | 0.007 V | 0.007 V | 0.894 V | 0.905 V | 0.900 V |
| 20 kHz | 0.007 V | 0.007 V | 0.007 V | 0.532 V | 0.556 V | 0.545 V |
| 50 kHz | 0.007 V | 0.007 V | 0.007 V | 0.282 V | 0.342 V | 0.312V |

Section 2-4 Low-Pass and High-Pass Filters

Input and Output amplitudes as a function of frequency.

Low-Pass Filter

|  |  |  |
| --- | --- | --- |
| Frequency | Channel 1 Input Voltage | Channel 2 Output Voltage |
| 10 Hz | 8.160 V | 7.680 V |
| 20 Hz | 9.520 V | 8.600 V |
| 50 Hz | 10.000 V | 8.560 V |
| 100 Hz | 10.080 V | 7.440 V |
| 200 Hz | 10.080 V | 5.320 V |
| 500 Hz | 10.080 V | 2.640 V |
| 1000 Hz | 10.080 V | 1.360 V |
| 2000 Hz | 10.080 V | ~0.000 V |
| 5000 Hz | 10.080 V | ~0.000 V |
| 10000 Hz | 10.080 V | ~0.000 V |
| 20000 Hz | 10.080 V | ~0.000 V |
| 500000 Hz | 10.080 V | ~0.000 V |
| 100000 Hz | 10.080 V | ~0.000 V |

High-Pass Filter

|  |  |  |
| --- | --- | --- |
| Frequency | Channel 1 Input Voltage | Channel 2 Output Voltage |
| 10 Hz | 8.160 V | 0.000 V |
| 20 Hz | 9.460 V | 1.280 V |
| 50 Hz | 10.000 V | 3.200 V |
| 100 Hz | 10.000 V | 5.520 V |
| 200 Hz | 10.000 V | 7.840 V |
| 500 Hz | 10.000 V | 9.400 V |
| 1000 Hz | 10.000 V | 9.840 V |
| 2000 Hz | 10.000 V | 10.000 V |
| 5000 Hz | 10.000 V | 10.000 V |
| 10000 Hz | 10.000 V | 10.000 V |
| 20000 Hz | 10.000 V | 10.000 V |
| 500000 Hz | 10.000 V | 10.000 V |
| 100000 Hz | 10.000 V | 10.000 V |

**Discussion:**

The lab as a whole focused on bringing to light the differences between alternating and direct current circuits. In section 2-2 AC Voltage Measurements, both DC and AC voltage measurements were made and upon comparing them it can be seen that DC above frequencies of 20 Hz held a constant voltage, while the AC voltage measurements fluctuated throughout almost all of the frequencies. This held true for Sine, Square, and Triangle functions. The only differences between the three functions was the overall average voltages measured at each frequency and even then there were similarities between the DC measurements of the Sine and Triangle functions.

In section 2-3 Time/Frequency Measurements a comparison between the data measured by the Oscilloscope and DMM. Measuring the wave with both instruments netted the same answer on the oscilloscope it was 20.04 ms and the multimeter gave a reading of .02 seconds. While both readings are the same it the oscilloscope provides a more accurate and up to date reading. This is evident by the small fluctuations in the values reported by the oscilloscope and how often they were updated.

For section 2-4 Low-Pass and High-Pass Filters voltage input and output readings were compared between a low-pass filter and a high-pass filter. The breaking point in the both filters is somewhere between the 1000 Hz and 2000 Hz point. As can be seen in the tables above at the 2000 Hz reading the output either drops off completely or locks in at 10.00 V respectively. The fact that both the low-pass filter and high-pass filter have similar yet opposite behavior at similar frequencies highlights the different behavior of each circuit due to the simple rearrangement of the circuits components.

**Conclusion:** Overall the lab focused on showcasing the effects of an alternating current and its properties. This was done by using a function generator and recording voltages measured by a digital multimeter and an oscilloscope. Comparing the values between alternating and direct currents as well as different types of waves. Furthermore the differences between a low-pass and high-pass filter were investigated by measuring the input and output voltages of each circuit at different frequencies.

**What I learned:**  I was reminded of the importance of reading the instructions closely and thoroughly of the lab before jumping to conclusions and when trying to get something to work. From this I learned more about the use of an oscilloscope, more about what a function generator is capable of producing. The most significant hurdle my lab partner and I overcame was properly connecting all the equipment to get accurate voltage readings with the DMM. We initially weren’t using the banana connectors and instead were connecting things through a chain of connections this through off our voltage readings. Upon using a banana connector we finally got accurate readings that made sense.