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EEL3111C

Tuesday P.10-11

Lab 3-Write Up

Introduction

The goal of this lab is to introduce basic resistive circuits and the physical variation of tolerance in resistors. The fundamental properties of resistor ladders and R-2R ladder were revealed through LTSpice ideal simulations and the alternation that comes in the real-world were discovered with the physical circuit build. With independent measurements on each resistor the actual resistance can be exposed from the circuit.

Discussion

3.6.1 Resistor Tolerances

In this portion of the lab, the actual resistance of each resistors in the built circuits were gathered through independent measurement of each resistors with a multimeter.

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| Table 1: Resistor Ladder Resistance and Voltage | | | | |
| Measured Resistance (ohms) | Resistance Percent Error (%) | Node | Measured Voltage (V) | Voltage Percent Error (%) |
| 4.62k ohms | 1.732 % | A | 4.40279 V | 0.635 % |
| 9.82k ohms | 1.833 % | B | 3.1334 V | 1.208 % |
| 9.82k ohms | 1.833 % | C | 1.86401 V | 1.360 % |
| 9.80k ohms | 2.041 % | D | 0.597208 V | 1.394 % |
| 4.62k ohms | 1.732 % |  |  |  |

Table 1: The results of measuring of each resistor with a multimeter, the actual resistance of each resistors, and the re-calculate the ideal voltages using the measured resistances. Percent error is based on the prelab measured resistance and the ideal values calculated from the measured resistors.

The results demonstrate that there was no perfect resistor but resistors with tolerance about their specified value, as seen in the resistance percent error in the table. This slight variation in the resistance of the resistors ultimately leads to a voltage difference between the ideal values calculated from the independently measured resistors and the prelab measured values. As the resistors varied, the effect on the resistor ladder corresponds to change in the resistance where decreasing the resistance of the resistors will ultimately decrease the equivalent resistance thus increasing the voltage measured, following Ohm’s Law. The ideal voltages generated with the resistances that came from independently measuring each resistor led to a higher voltage than those measured in the prelab. However, the voltage percent errors are generally less than those of the resistance from the resistors.

Table 2: The results of measuring of each resistor with a multimeter, the actual resistance of each resistors, and the re-calculate the ideal voltages using the measured resistances. Percent error is based on the prelab measured resistance and the ideal values calculated from the measured resistors.

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| Table 2: R-2R Ladder Resistance and Voltage | | | | |
| Measured Resistance (ohms) | Resistance Percent Error (%) | Vout (V1,V0) | Measured Voltage (V) | Voltage Percent Error (%) |
| 465 ohms | 1.064 % | (0,0) | 0 V | 0 % |
| 966 ohms | 3.400 % | (0,5) | 1.25882 V | 0.094 % |
| 969 ohms | 3.100 % | (5,0) | 2.47715 V | 0.127 % |
| 965 ohms | 3.500 % | (5,5) | 3.73596 V | 0.187 % |

The results demonstrate that there was a greater tolerance with the resistors in the R-2R ladder than the resistor ladder, as seen in the resistance percent error. This variation in the resistance of the resistors also leads to a voltage difference between the ideal values calculated from the independently measured resistors and the prelab measured values. Following Ohm’s Law, the decrease in resistance in the R-2R ladder results in the decrease of resistance of the equivalent resistance thus increasing the voltage measured. This can be seen in the table as the ideal voltages generated with the resistances that came from independently measuring each resistor led to a higher voltage than those measured in the prelab. The voltage percent errors were also less than those of the resistance from the resistors but when compared to the resistor ladder, the resistance percent error was larger while the voltage percent error was much smaller. In the R-2R ladder, the value of 0 V being measure was within reason as with no voltage input there should not have been any voltage coming out. The max value reached in the R-2R ladder was when both input voltages was active, thus generating the largest amount of voltage to the circuit.

Conclusion

In conclusion, in the physical world, resistors have tolerance specified around a given value which might result in the resistance being greater or less than the stated values. As a result, the difference in resistance influences the resistor ladder and the R-2R ladder’s output voltages. This effect follow Ohm’s Law where the measure output voltage is proportional to the tolerance of the resistors, thus decreasing the resistor will increase the voltage and vice versa.