Feng Chia University

Electrical Engineering Fundamentals I Lab

Laboratory 6

Input/Output Resistance and Δ-Y Conversion

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1. Introduction
2. To learn to use the “proportional measurement method” for input and output resistance measurement
3. To learn the experimental measurement for Wheatstone bridge and the analysis and application of Δ-Y Conversion
4. Materials
   1. DC Power Supply
   2. Digital Multimeter
   3. Components
      1. 1.1 kΩ ×2, 2.2 kΩ×2, 3.3 kΩ×2, Variable Resistor RT ×1
      2. 1 kΩ ×2, 3 kΩ ×4, 6.2 kΩ ×1
5. Circuit diagram

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自動產生的描述

▲ Figure 1. Circuit of Experiment 6.a.1 Input Resistance

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▲ Figure 2. Circuit of Experiment 6.a.2 Output Resistance

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▲ Figure 3. Circuit of Experiment 6.a Input/Output Resistance Measurement

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▲ Figure 4. Circuit of Experiment 6.b Δ-Y Conversion

1. Methods

Determine the input/output resistance Rin/Rout of the circuit with Proportional Method and direct measurement.

1. Experiments data
   1. Experiment 6.a Input/Output Resistance Measurement
      1. Input Resistance

Table 1: Results of the Vin and Iin Measurements

|  |  |
| --- | --- |
| Vin | Iin |
| 12 V | 0.00245 A |

Table 2: Results of the Rin with proportional method

|  |  |  |
| --- | --- | --- |
| Rin(Proportional) | Rin(Theorem) | % Error |
| 4912.8 Ω | 4897.9592 Ω | 0.30% |

Table 3: Results of the Rin with direct measurement

|  |  |  |
| --- | --- | --- |
| Rin(Direct) | Rin(Theorem) | % Error |
| 4914.6 Ω | 4897.9592 Ω | 0.34% |

* + 1. Output Resistance

Table 4: Results of the Vout and Iout Measurements

|  |  |
| --- | --- |
| Vout(V) | Iout(A) |
| 2.187 V | 0.00089 A |

Table 5: Results of the Rin with proportional method

|  |  |  |
| --- | --- | --- |
| Rout(Proportional) | Rout(Theorem) | % Error |
| 2457.5 Ω | 2457.3034 Ω | 0.01% |

Table 6: Results of the Rin with direct measurement

|  |  |  |
| --- | --- | --- |
| Rout(Direct) | Rout(Theorem) | % Error |
| 2633.7 Ω | 2457.3034 Ω | 7.18% |

* 1. Experiment 6.b Δ-Y Conversion
     1. Based on Direct Measurement

Table 7: Measurement of practical resistance of the resistors and Rab

|  |  |  |
| --- | --- | --- |
|  | Measured | Theorem |
| R1 | 2975.8 Ω | 3000 Ω |
| R2 | 2964.7 Ω | 3000 Ω |
| R3 | 2960.1 Ω | 3000 Ω |
| R4 | 2983.5 Ω | 3000 Ω |
| R5 | 988.5 Ω | 1000 Ω |
| Rab | 2972.3 Ω | 3000 Ω |

* + 1. Based on Theoretical Calculation

Table 8: Calculation of equivalent resistance of R13, R15, and R35

|  |  |  |
| --- | --- | --- |
|  | Measured | Theorem |
| R13 | 1272.1197 Ω | 1285.7143 Ω |
| R15 | 424.8135 Ω | 428.5714 Ω |
| R35 | 422.5722 Ω | 428.5714 Ω |

Table 9: Calculation of equivalent resistance of Rab with different R4

|  |  |
| --- | --- |
| R4 | Rab |
| 1000 Ω | 2274.1442 Ω |
| 3000 Ω | 2975.1010 Ω |
| 6200 Ω | 3514.1398 Ω |

* + 1. Based on Current-Voltage Measurement

Table 10: Calculation of Rab by definition

|  |  |  |
| --- | --- | --- |
| R4 | Iab | Rab |
| 1000 Ω | 5.2971 mA | 2265.3905 Ω |
| 3000 Ω | 4.0415 mA | 2969.1946 Ω |
| 6200 Ω | 3.4217 mA | 3507.0287 Ω |

* + 1. Bridge Current Measurement

Table 11: Results of IR5 measurement based on different R4

|  |  |
| --- | --- |
| R4 | IR5(mA) |
| 1000 Ω | 0.9325 mA |
| 3000 Ω | 0.0087 mA |
| 6200 Ω | -0.4727 mA |

Table 12: Results of IR5 by applying Thevenin’s Theorem

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| R4 | VTh | RTh | IR5 | % Error |
| 1000 Ω | 3.0000 V | 2250.0000 Ω | 0.9231 mA | 1.021% |
| 3000 Ω | 0.0000 V | 3000.0000 Ω | 0.0000 mA | N/A |
| 6200 Ω | -2.0870 V | 3521.7391 Ω | -0.4615 mA | 2.418% |

1. Results

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▲ Figure 5. Experiment 6.a.1 Input Resistance Measurement

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▲ Figure 6. Experiment 6.a.2 Output Resistance Measurement

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▲ Figure 7. Experiment 6.b Δ-Y Conversion

1. Discussion

With applying Thevenin’s theorem to Wheatstone bridge, the calculation of resistance and current are easy to understand and calculate.

1. Conclusion

Once the equivalent resistances on both side of Wheatstone bridge are unbalanced, the current will flow through. Otherwise, the current won’t flow through resistance.