



Experiment 13 — Maximum Power Transfer Theorem

EL 111 - DC Fundamentals

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Objectives:

1. For the student to verify by measurement, that maximum power is developed in a load when the load resistance is equal to the internal resistance of the source.
2. For the student to construct a graph, using measured values of voltage, current and load resistance and calculated power to verify graphically Objective 1 above.

Equipment and parts:

Meters: Digital Multimeter (DMM)
Power Supply: Agilent E3631A DC power supply (0 to 20 V DC)
Resistors: 1-1 k Ω ; 1-1 k Ω potentiometer; 1-10 k Ω potentiometer.
Misc: Component Board

Information:

The maximum power transfer theorem states that when the load resistance is equal to the source's internal resistance, maximum power will be developed in the load. Since most low voltage DC power supplies have a very low internal resistance (10 ohms or less) great difficulty would result in trying to effect this condition under actual laboratory experimentation. If one were to connect a low value resistor across the terminals of a 10 volt supply, high power ratings would be required, and the resulting current would probably cause the supply's current rating to be exceeded. In this experiment, therefore, the student will simulate a higher internal resistance by purposely connecting a high value of resistance in series with the DC voltage supply's terminal. Refer to Figure 1 below. The terminals (a & b) will be considered as the power supply's output voltage terminals. The student will use a potentiometer as a variable size of load resistance. For various settings of the potentiometer representing R_L , the load current and load voltage will be measured. The power dissipated by the load resistor can then be calculated. For the condition of $R_L = R_i$, the student will verify by measurement that maximum power is developed in the load resistor.





Procedure:

1. Refer to Figure 2.
 - a. Using the DMM set the potentiometer to 100 ohms.
 - b. Connect the circuit of Figure 1. Measure the current through and the voltage across R_L . Record this data in Table 1 on page three.
 - c. Remove the potentiometer and set it to 200 ohms. Return it to the circuit and again measure the current through and the voltage across R_L . Record.
 - d. Continue increasing the potentiometer resistance in 100 ohm steps until the value 1 k ohms is reached, each time measuring the current and voltage and recording same in Table 1. Be sure the applied voltage remains at the fixed value of 10 volts.
 - e. Change to the 10 k Ω potentiometer. Continue measuring and recording the current through and the voltage across R_L . Increase the potentiometer value in 1 k Ω increments till 10 k Ω s is reached.
 2. For each value of R_L in Table 1, calculate the power input to the circuit using the formula:
 $P_{input} = E_{input} \times I_L = 10 \times I_L$, since E_{in} is always a constant 10 volts.
 3. For each value of R_L in Table 1, calculate the power output (the power developed in R_L) using the formula: $P_{out} = E_{RL} \times I_L$.
 4. For each value of R_L in Table 1, calculate the circuit efficiency using the formula:
 $\% \text{ efficiency} = P_{out}/P_{in} \times 100$.
 5. On linear graph paper, plot the curve of power output vs. R_L . Plot R_L on the horizontal axis (independent variable). Plot power developed in R_L on the vertical axis (dependent variable). Refer to the [What makes a Good Graph](#) handout if necessary. Label the point on the curve representing the maximum power.
 6. **At the point where the load dissipates maximum power, what is the relationship of R_L and R_i ?**
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Table 1

R_L (Ω)	I_L (mA)	E_{RL} (V)	P_{input} (mW)	P_{output} (mW)	% eff.
100					
200					
300					
400					
500					
600					
700					
800					
900					
1,000					
2,000					
3,000					
4,000					
5,000					
6,000					
7,000					
8,000					
9,000					
10,000					