1 Introduction

DC power sources are an essential part of circuits. The aim of the following experiments is to study the proprieties of these sources. Electromotive force, ideal-source current, open-circuit voltage, short-circuit current, and internal resistance will be studied for voltage sources.

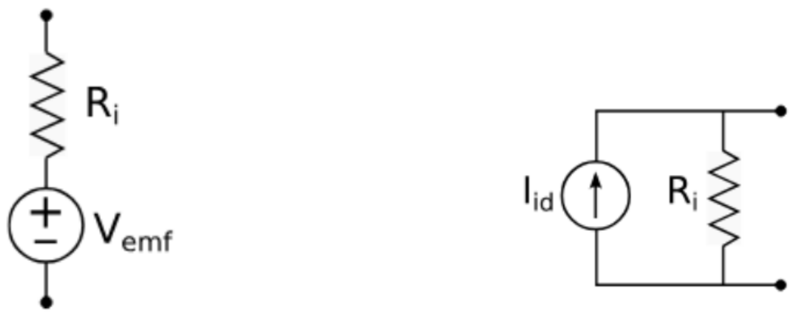
The behaviour of series and parallel source arrangements will also be studied.

2 Background/ Theory

DC power sources refer to either voltage or current sources of which the output does not diminish with time. A source is called an ideal voltage source when the output voltage does not change in relation to the load resistance. For current sources, the current remains constant regardless of the load resistor.

In physical applications however, the current or voltage will depend on the load resistance. Therefore, power sources will be represented as a combination between an ideal source and an internal resistance. For voltage sources, the resistance will be connected in series with the ideal source, whereas for current sources, the resistor will be connected in parallel. (book)

Figures 1(a) and 1(b) display the aforementioned representation of power sources, both for current and voltage sources.(lab text)



(a) Schematic representation of voltage source

(b) Schematic representation of current source

Figure 1: Schematic representation of power sources

2.1 Source characteristics

Using source transformation, all power sources can be represented as voltage sources with an internal resistance(book). Therefore, going forward, sources will be displayed as shown in Figure 1(a). This representation is called the voltage-equivalent circuit. By adding a load resistance to the power source, essential characteristics of the source can be discovered.

Figure 2 displays the circuit which will be used to determine these characteristics(labtext).

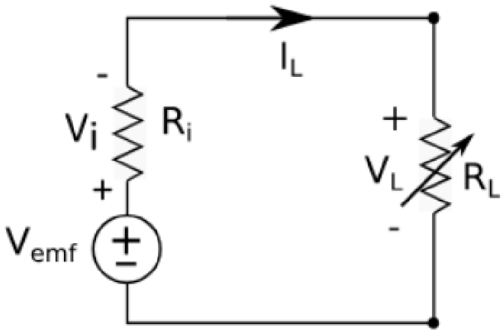


Figure 2: Simple load circuit of real voltage source

Firstly, the voltage of the ideal source is called the electromotive force, V_{emf}. By measuring the load current, this voltage can be related to the load voltage by observing that the same current passes through the internal resistance as well.

Equation 1 displays the relationship between current, load voltage, and electromotive force(labtext).

$$V_L = V_{emf} + I_L R_i \tag{1}$$

Since the internal resistance, R_i, is constant, the relationship between load voltage and current is a linear one.

Figure 3 displays this relationship for a real voltage source such as the one shown in Figure 1(a)(labtext).

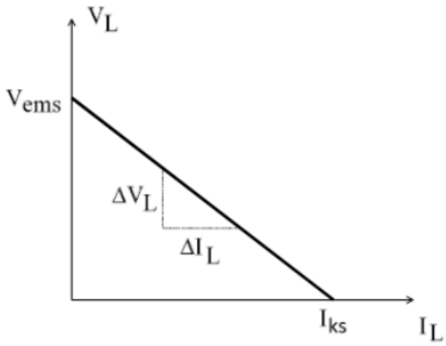


Figure 3: Typical V_L - I_L graph used to determine source characteristics

By determining the slope of the linear relationship between I_L and V_L, the internal resistance can be found(labtext):

$$R_i = -\frac{\Delta V_L}{\Delta I_L} \tag{2}$$

By looking at the x and y intercepts of the graph, both the electromotive force and the short circuit current can be found. Therefore, all of the sources characteristics can be found by analyzing the Voltage-Current graph.

A relationship between all of the characteristics is found equation 3(labtext):

$$I_{sc} = \frac{V_{emf}}{R_i} \tag{3}$$

2.2 Series and parallel sources

By connecting multiple voltage sources in series, higher V_{emf} values can be provided. The equivalent internal resistance will be equal to the sum of the individual sources internal resistances.

When connecting multiple sources in parallel, the equivalent internal resistance will be lowered. The lowering of the internal resistance will be governed by the parallel resistance equivalence(labtext):

$$R_i = \left(\sum_j \frac{1}{R_{i,\ j}} \right)^{-1} \tag{4}$$

Since sources should only be connected in parallel when they have the same electromotive force, the equivalent V_{emf} will be equal to that of one source(labtext).

2.3 Maximum power transfer

3 Method and materials