



## Common DC Circuit Theory Terms - An Empirical Study

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### Abstract

This paper looks at characteristic represented by a straight line. As with voltage sources, the current source can be either independent (ideal) or dependent (controlled) by a voltage or current elsewhere in the circuit, which itself can be constant or time-varying. Ideal constant current sources are represented in a similar manner to voltage sources, but this time the current source symbol is that of a circle with an arrow inside to indicate the direction of the flow of the current. The direction of the current will correspond to the polarity of the corresponding voltage, flowing out from the positive terminal. However as practical current sources have an internal source resistance, this takes some of the current so the characteristic of this practical source is not flat and horizontal but will reduce as the current is now splitting into two parts, with one part of the current flowing into the parallel resistance,  $R_p$  and the other part of the current flowing straight to the output terminals.

*Key words: Gustav Kirchhoff, Kirchhoff's Current Law, Kirchhoff's Voltage Law Ohms law*

### Introduction

$$I_1 + I_2 + I_3 - I_4 - I_5 = 0$$

The term **Node** in an electrical circuit generally refers to a connection or junction of two or more current carrying paths or elements such as cables and components. Also for current to flow either in or out of a node a closed circuit path must exist. We can use Kirchhoff's current law when analysing parallel circuits.

**Kirchhoffs Second Law** states that "in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop" which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero. This idea by Kirchhoff is known as the **Conservation of Energy**.

Starting at any point in the loop continue in the **same direction** noting the direction of all the voltage drops, either positive or negative, and returning back to the same starting point. It is important to maintain the same direction either clockwise or anti-clockwise or the final voltage sum will not be equal to zero. We can use Kirchhoff's voltage law when analysing series circuits.

When analysing either DC circuits or AC circuits using **Kirchhoffs Circuit Laws** a number of definitions and terminologies are used to describe the parts of the circuit being analysed such as: node, paths, branches, loops and meshes. These terms are used frequently in circuit analysis so it is important to understand them.

### Common DC Circuit Theory Terms:

- Circuit – a circuit is a closed loop conducting path in which an electrical current flows.
- Path – a single line of connecting elements or sources.
- Node – a node is a junction, connection or terminal within a circuit where two or more circuit elements are connected or joined together giving a connection point between two or more branches. A node is indicated by a dot.
- Branch – a branch is a single or group of components such as resistors or a source which are connected between two nodes.
- Loop – a loop is a simple closed path in a circuit in which no circuit element or node is encountered more than once.
- Mesh – a mesh is a single closed loop series path that does not contain any other paths. There are no loops inside a mesh.

### Objective:

1. When applying Kirchhoff's first rule, the junction rule, label the current in each branch and decide in what direction it is going.
2. When applying Kirchhoff's second rule, the loop rule, you must identify a closed loop and decide in which direction to go around it, clockwise or counterclockwise.

### Conclusion

Kirchhoff's Circuit laws are now known as Kirchhoff's Voltage and Current Laws. Since these laws apply to all electric circuits, understanding their fundamentals is paramount in the understanding of how an electronic circuit functions. These pair of laws that deal with the conservation of current and energy within electrical circuits. These

two laws are commonly known as Kirchhoff's Voltage and Current Law. These laws help in calculating the electrical resistance of a complex network or impedance in case of AC and the current flow in different streams of the network. In the next section, let us look at what these laws state. The voltage arrows and polarity signs are just reference directions for voltage. When the circuit analysis is complete, one or more of the element voltages around the loop will be negative with respect to its voltage arrow. The signs of the actual voltages always sort themselves out during calculations.

Although these laws have immortalised Kirchhoff in the field of Electrical Engineering, he has additional discoveries. He was the first person to verify that an electrical impulse travelled at the speed of light. Furthermore, Kirchhoff made a major contribution to the study of spectroscopy and he advanced the research into blackbody radiation.

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