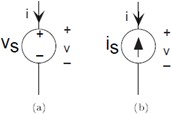
#### Sources

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**Figure 3.5 Sources** The voltage source on the left and current source on the right are like all circuit elements in that they have a particular relationship between the voltage and current defned for them. For the voltage source, v = vs for any current i; for the current source, i = −is for any voltage v

Sources of voltage and current are also circuit elements, but they are not linear in the strict sense of linear systems. For example, the voltage source's ***v-i*** relation is ***v*** = ***v***s regardless of what the current might be. As for the current source, ***i*** *=* ***−is*** regardless of the voltage. Another name for a constant-valued voltage source is a battery, and can be purchased in any supermarket. Current sources, on the other hand, are much harder to acquire; we'll learn why later.

### Ideal and Real-World Circuit Elements

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Source and linear circuit elements are **ideal** circuit elements. One central notion of circuit theory is combining the ideal elements to describe how physical elements operate in the real world. For example, the 1 kΩ resistor you can hold in your hand is

not exactly an ideal 1 kΩ resistor. First of all, physical devices are manufactured to

close tolerances (the tighter the tolerance, the more money you pay), but never have exactly their advertised values. The fourth band on resistors specifes their tolerance; 10% is common. More pertinent to the current discussion is another deviation from the ideal: If a sinusoidal voltage is placed across a physical resistor, the current will not be exactly proportional to it as frequency becomes high, say above 1 MHz. At very high frequencies, the way the resistor is constructed introduces inductance and capacitance efects. Thus, the smart engineer must be aware of the frequency ranges over which his ideal models match reality well.

On the other hand, physical circuit elements can be readily found that well approximate the ideal, but they will always deviate from the ideal in some way. For example, a fashlight battery, like a C-cell, roughly corresponds to a 1.5 V voltage source. However, it ceases to be modeled by a voltage source capable of supplying **any** current (that's what ideal ones can do!) when the resistance of the light bulb is too small.