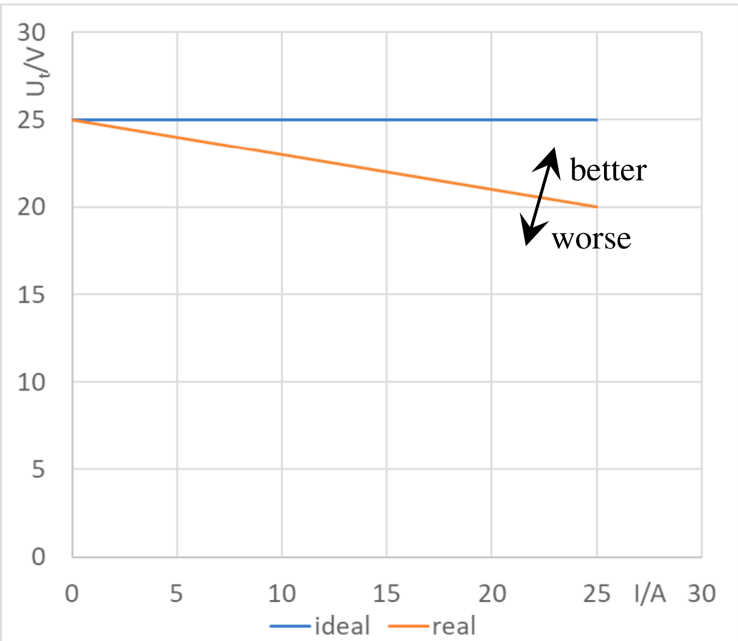
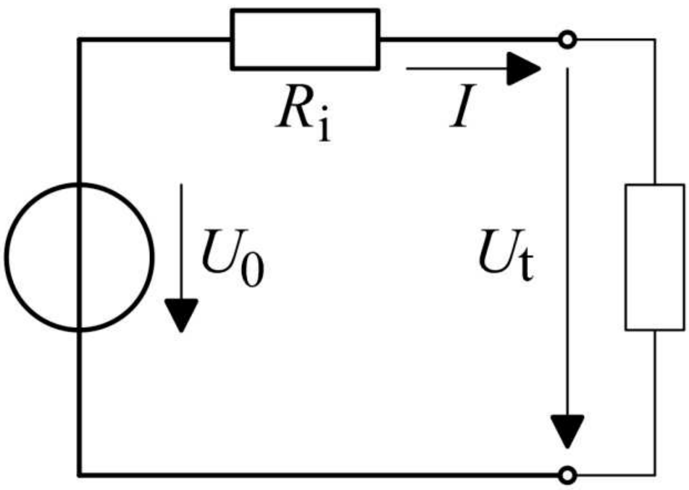
Voltage source

The following diagram shows the output curves of two voltage sources. The blue curve shows an ideal voltage source. In no-load operation (I=0A) it supplies U_t=25V. At full load (I=25A) it still supplies U_t=25V. The internal resistance R_i is 0Ω in this case.

The orange curve shows a real voltage source. In no-load operation (I=0A) it supplies also U_t=25V. At full load (I=25A), however, it supplies only U_t=20V. The internal resistance R_i in this case is $\Delta U/\Delta I$ = 5V/25A = 0.2Ω.

You can see that a voltage source is better when its internal resistance R_i is lower.



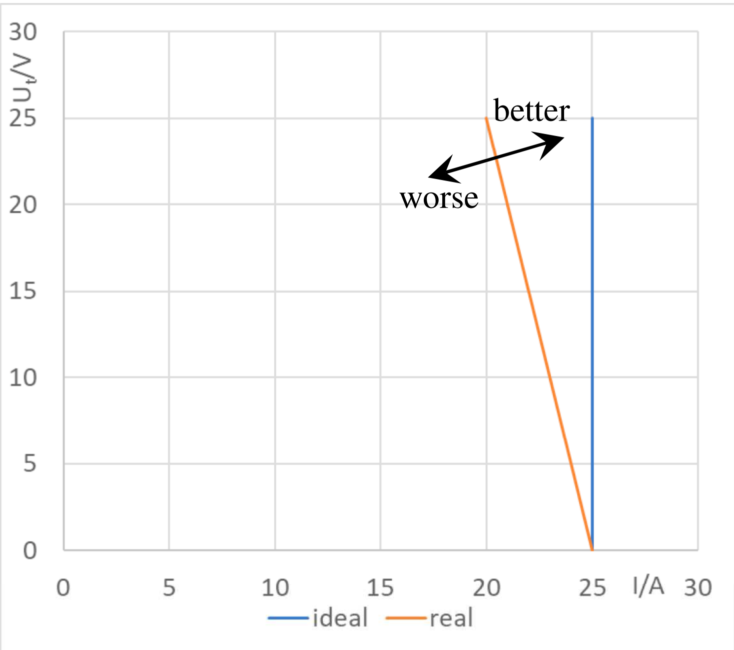


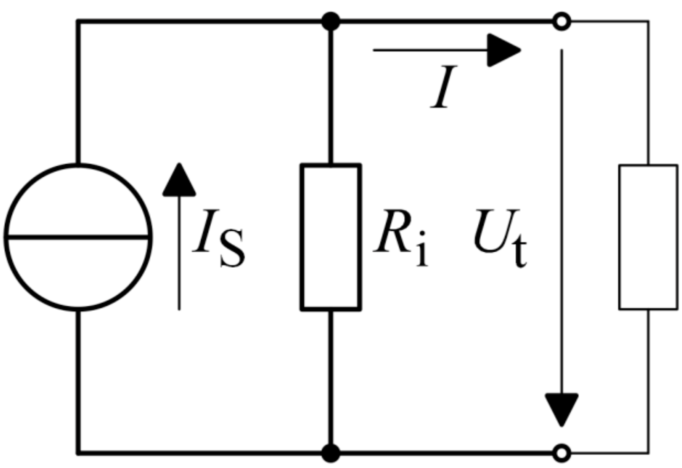
Current source

The following diagram shows the output curves of two current sources. The blue curve shows an ideal current source. In no-load operation it supplies 25A. For a current source, the short circuit is the no-load condition, that is U_t=0V. At full load (U_t=25V) it still delivers I=25A. The internal resistance R_i is infinitely high in this case (∞Ω), so R_i is not present.

The orange curve shows a real current source. In no-load operation (U_t=0V) it delivers also 25A. At full load (U_t=25V), however, it delivers only 20A. The internal resistance R_i in this case is $\Delta U/\Delta I = 25V/5A = 5\Omega$.

You can see that a current source is better if its internal resistance R_i is higher.





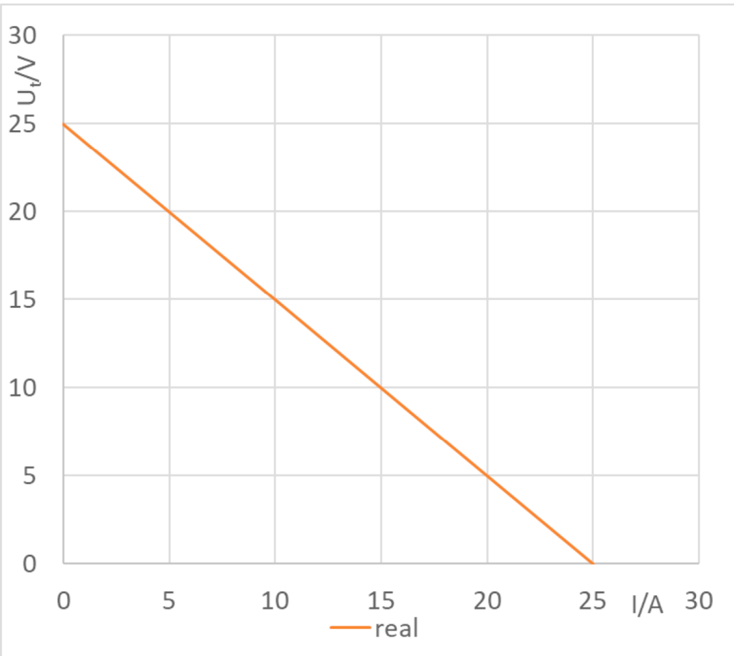
Real source

The following diagram shows the curve of a supply. But what is it? Is it a voltage source or a current source?

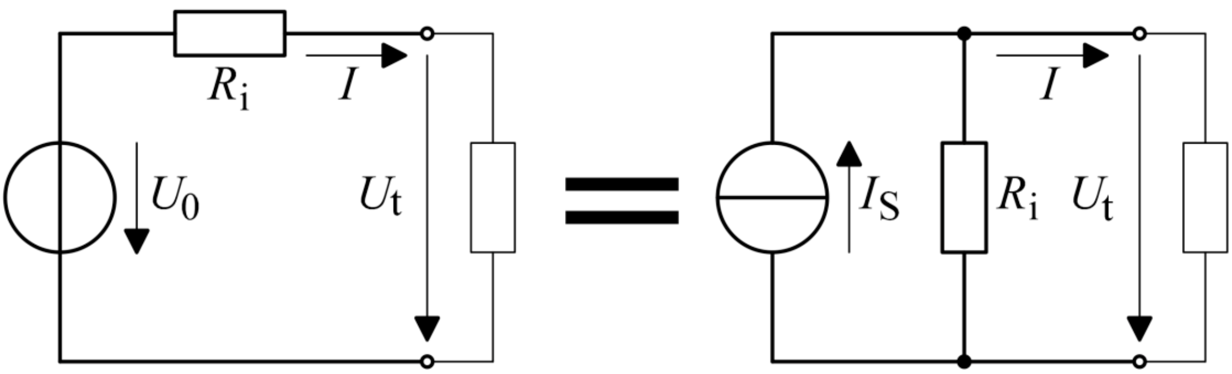
You can say it is a voltage source. U_0 is 25V. The internal resistance R_i is $\Delta U/\Delta I = 25V/25A = 1\Omega$.

But you can also say that it is a current source. I_S is 25A. The internal resistance R_i is $\Delta U/\Delta I = 25V/25A = 1\Omega$.

And both assumptions are correct! Because you can convert real current sources into real voltage sources, and vice versa. Therefore, you can consider a source to be whatever you like. If the internal resistance is much higher than the load resistance, one would rather speak of a current source. If the internal resistance is much smaller than the load resistance, one would rather speak of a voltage source.



?



The conversion is done according to the following formulas:

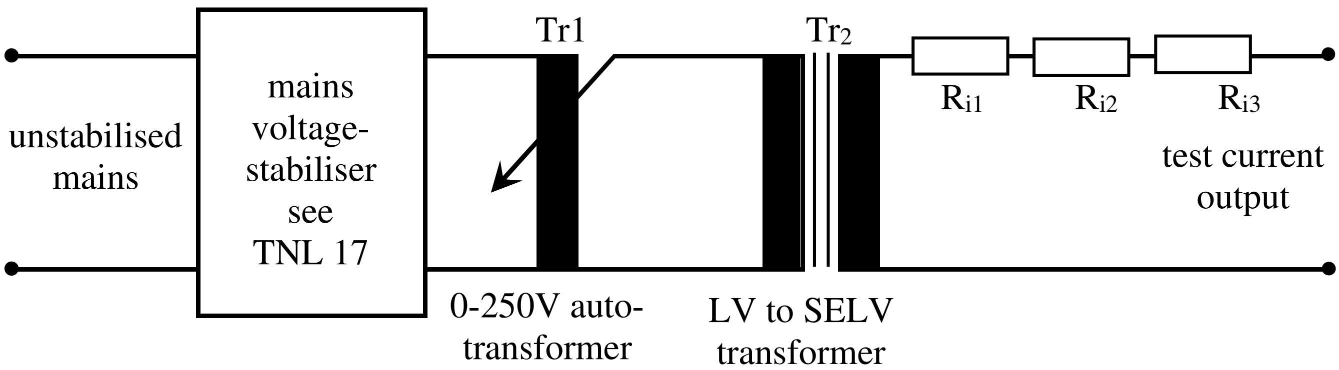
$$U_0 = I_S \cdot R_i \quad \Leftrightarrow \quad I_S = U_0 / R_i$$

Real current source

The following schematic shows a typical real current source.

At the left, it is connected to an unstabilised mains. This mains voltage is stabilised by a voltage stabilizer, see Technical Newsletter No. 17 for details. Afterwards, the voltage can be manually adjusted by means of an adjustable autotransformer. This voltage is then transformed down to a safe voltage by a LV (**L**ow **V**oltage) to SELV (**S**afety **E**xtra **L**ow **V**oltage) transformer.

Then you see 3 resistors. R_{i1} symbolises the internal resistance of the source, i.e. the voltage stabilisation and the two transformers. 100mΩ is a typical value. R_{i2} is an additional internal resistance that we will calculate later. R_{i3} is the resistance of the test setup. It includes not only the device under test but also the wiring. It is typically also around 100mΩ.



Is R_{i2} really needed?

Let's do an example calculation. Take R_{i1} with 100mΩ. We leave out R_{i2}, so it is 0Ω. Ri3 is 80mΩ at the beginning of the test (sample is cold). The test current should be 20A. Tr_1 must therefore be set so that Tr_2 supplies 20A · (100mΩ + 80mΩ) = 3.6V.

During the test, the test specimen changes as follows:

- Heating increases the resistance.
- As the temperature rises, the contact pressure decreases (relaxation), which also increases the resistance.

For example, the resistance R_{i3} increases from 80mΩ to 100mΩ. But this causes the current to drop from 20A to 3.6V / (100mΩ + 100mΩ) = 18A!

Now we use R_{i2} and select 5Ω. We have to set the voltage at the output of Tr_2 to 20A · (100mΩ + 5Ω + 80mΩ) = 103.6V at the beginning of the test. If the resistance of the test object now increases to 100mΩ, the current drops from 20A to 103.6V / (100mΩ + 5Ω + 100mΩ) = 19.92A. The current is therefore much more constant!