Safe Brake resistors
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Technical background with practical application

Introduction

In your daily routine you often encounter constructs that simplify your life. Whether it is a chair lift when skiing that enables you to get to the mountain top in comfort, an elevator which allows you to travel up and down stories within seconds, or a crane that makes it possible to transport heavy structures at construction sites. These examples have an electric motor in common which is a necessary component for dynamic plants.

When looking closer at these examples it is conspicuous that all of them are bound to intermittent velocity. Brake and acceleration processes are identifiers for the usage of this technology. Especially the brake process will be playing a rudimentary role in this document. This is the background of why the utilization of a brake resistor is required.

The goal is to be able to fully comprehend and understand brake resistors and why they are necessary.

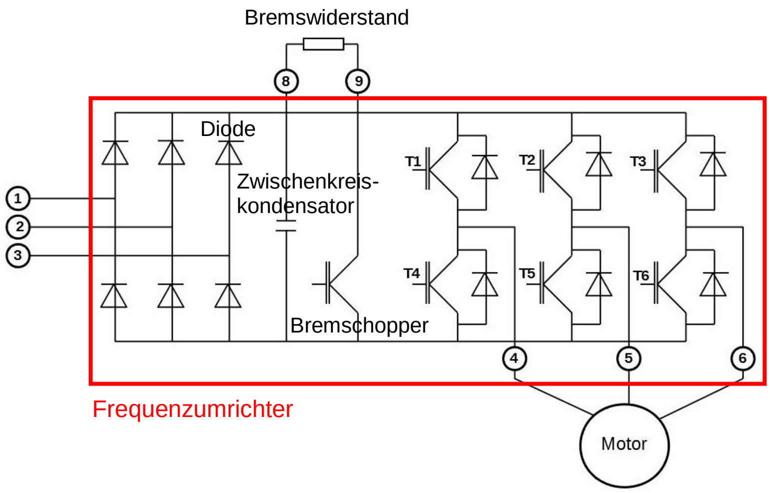
The role of the frequency inverter

This topic will be illustrated by means of an example. For this purpose, the previously mentioned elevator will be used due to its simplicity. Nevertheless, the concept can be transferred to any dynamic plant with an electric motor.

It is essential to mention that every electric motor must be connected to power in order to be functioning. Therefore, the elevator is also to be connected to the power grid. There is a uniform grid frequency in the German power grid of 50Hz. When connecting the elevator to the AC mains, the motor would accordingly rotate 50 times per second.

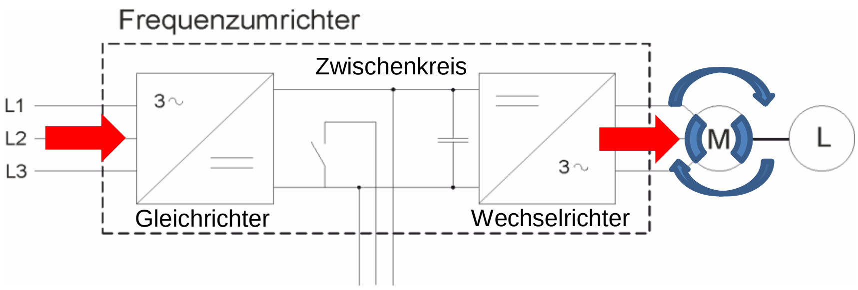
Nevertheless, the direct connection to the power grid is not always suitable for the usage of dynamic plants due to the fixed rotational frequency. It can lead to performance limitations. The application of the elevator also shows that in practice applications require variable AC voltages or a controllable speed, because the elevator does not move at a constant speed due to braking and acceleration processes.

Frequency converters are used to realize this. As the name implies, these are power converters that generate a variable AC voltage from the constant AC voltage supplied and thus make the speed of a motor controllable. This enables an adaptation of the frequency and voltage to the demand. Due to this the speed of the elevator is controllable, which prohibits an abrupt stop.

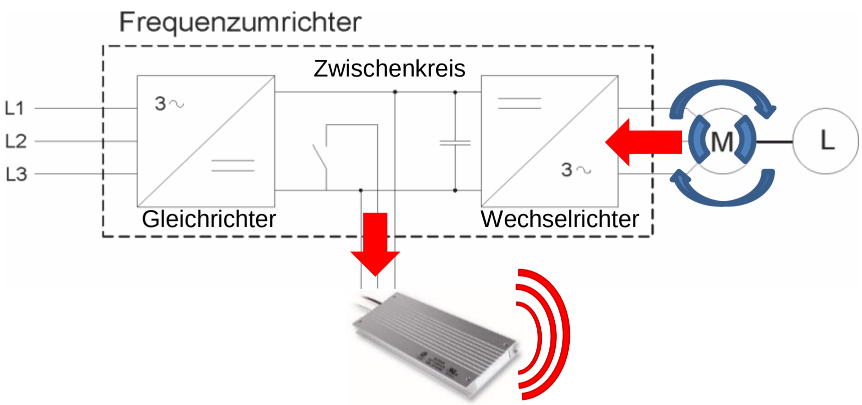


The graphic to the left shows the functionality of a frequency converter perfectly. It Is connected upstream of a motor to generate a variable AC voltage as required. As you can see in the illustration, it is no longer the power grid that generates the voltage and the frequency but the frequency inverter. This enables a smooth speed change of the motor, whereby an adaptation to required conditions can be realized optimally. Furthermore, the diodes symbolize that the current can only flow in one direction and therefore cannot return to the power grid.

The graphic below illustrates the acceleration process. In simplified terms, electrical energy is converted into kinetic energy to set the motor in motion. In relation to our example earlier, the elevator travels upwards.



In contrast, the following graphic shows the braking process. Related to the elevator, this moves downward.



In relation to this document, the braking process is decisive, because as can already be seen from the graphic, the use of a braking resistor is required. Basically, it should be mentioned that during the braking process, the motor acts as a generator. Accordingly, kinetic energy is converted into electrical energy. This causes current to flow in the intermediate circuit, which increases the voltage in the intermediate circuit.

Basically, too high voltages are problematic because they will disturb the sensitive electrical components. Accordingly, it is elementary to control the voltage to prevent it from rising above a certain threshold. At this point, the brake resistor is needed. In short, it is the reason why excess energy can be adequately dissipated and thus the voltage cannot reach dangerous heights.

Relationship between Brake Chopper and Brake Resistor

As mentioned before, the monitoring of the intermediate circuit voltage is elementary to prevent overvoltage and thus ensure the safety of the devices. This can be realized by brake chopper. These are programmed accordingly so that the brake choppers are switched on or off when a previously defined threshold is exceeded or undershot. The braking resistor is connected to this brake chopper, via which the excess energy in the intermediate circuit is converted into thermal energy. It should therefore be noted that the chopper ensures safety and this is implemented via the braking resistance.

At this point it should be added that this procedure is repeated as often as necessary. The braking resistor is therefore characterized as the limiting element. It is given a heavy load of energy to dissipate.

Brake Resistor – Closer Look

We now know that the brake resistor is used to adequately process brake energy. The speed of the motor may be reduced, resulting in braking. Braking resistors are therefore an essential component when it comes to the use of electrically driven machines. By effectively regulating the flow of energy, all components can be protected from destruction.

As a limiting element, however, it is crucial that the resistor can also dissipate the energy that is applied to it. The calculation regarding the correct design of the products is therefore of great importance and is absolutely necessary. The aim of this design is to ensure a high load capacity and a long service life.

In order to be able to absorb short but strong energy pulses corresponding to their resistance, the strength of the maximum energy pulses to be processed at given duty cycles is characterized as the decisive variable. In addition, the cycle time with its proportions of braking time and resting time is another important dimension in the design. As a result of the design process, a braking resistor with the correct ohm value and the appropriate nominal power crystallizes. If you have any questions, please do not hesitate to contact Michael Koch GmbH, located in Ubstadt-Weiher in the southwest of Baden-Württemberg. We will gladly take over the design of the required braking resistors through our professional sales team.

Furthermore, braking resistors face a wide range of applications due to wide spans of power and dielectric strength. Individual modules are designed in such a way that cascading can be carried out in order to realize higher outputs. In addition, machine-specific individual solutions can be formed on the basis of a modular system.

Various technologies have become established in accordance with the diversity of applications.

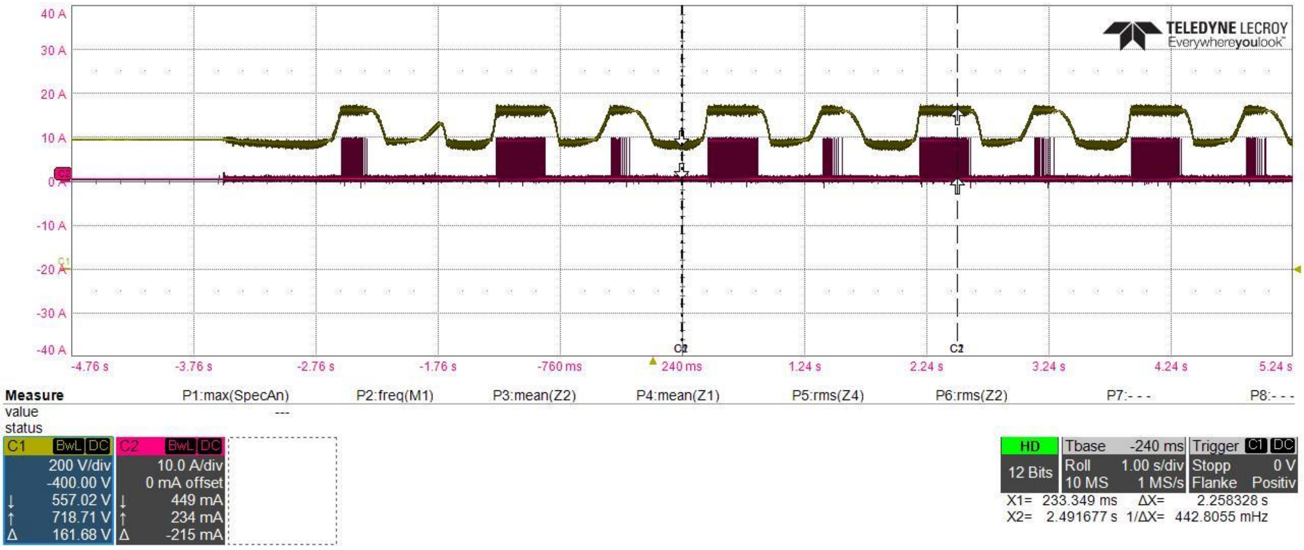
Wire-based resistors characterize themselves as the standard technology for small to medium power. The standard procedure is to wind the resistance wire (round or flat wire) around a ceramic carrier, usually a tube, and fix it in place using cement or glaze. In the case of impulse loads, the heat can therefore be dissipated quickly. However, very high surface temperatures occur for a short time. If the resistors are incorrectly designed or the brake chopper fails, the surface temperature can rise so high that there is a risk of fire. To avoid this, the use of wire resistors from Michael Koch GmbH is recommended. These have the property of self-protection due to an integrated predetermined breaking point.

The PTC ceramic resistor technology is particularly suitable for low power requirements. Due to their dynamic resistance value curve over the temperature, highest passive safety can be guaranteed in case of overload. If the temperature rises above about 140 degrees Celsius, the ohm value increases exponentially so that the power consumption approaches zero. Consequently, no further power consumption implies no further temperature increase. This systematically eliminates the risk of overload. This resistor therefore protects itself due to its high impedance. Misinterpretations and brake chopper failures can be intercepted in this way.

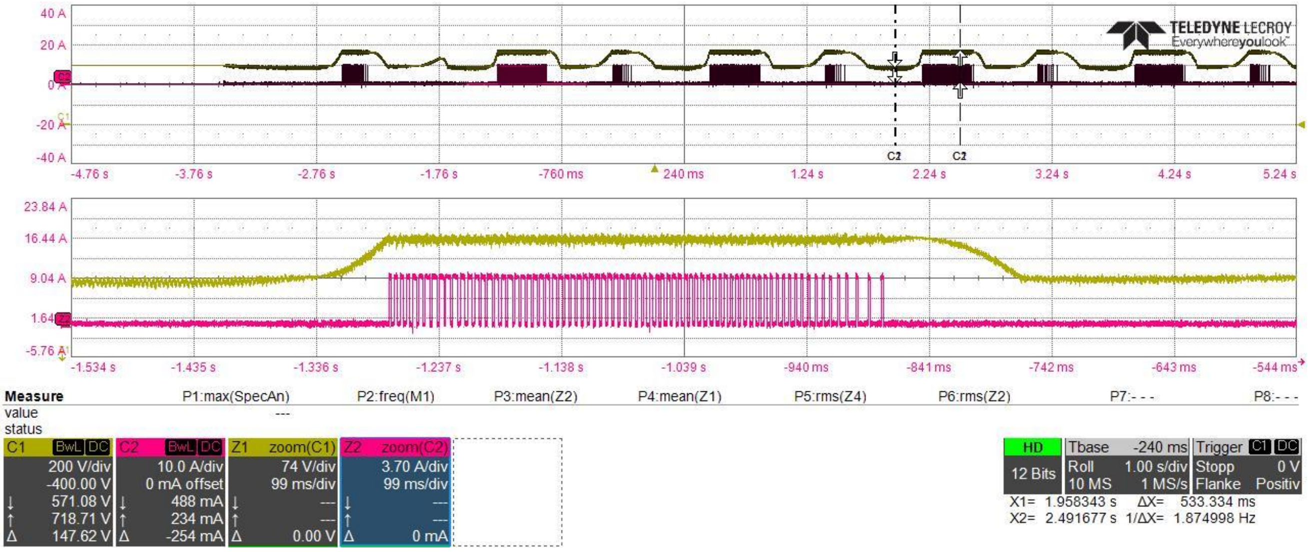
Practical Application

In order to illustrate this topic with a practical example, a corresponding experiment was set up and implemented in a very simple way. A brake resistor was installed in the intermediate circuit of a frequency converter, which was connected upstream of an electric motor, with the correct design with regard to the required conditions. In addition, an oscilloscope was connected to visually demonstrate the previously described subject matter.

This is an electronic measuring device that visualizes the time progression of electrical voltages and currents on a screen. The graph is displayed in a two-dimensional coordinate system. In our example, the x-axis shows the time, measured in seconds, and the y-axis shows the current, measured in amperes.



In the upper oscillogram you can see a recorded measurement. Two curves are displayed. The upper yellow curve shows the voltage in the intermediate circuit in volts, the lower pink curve shows the current in the braking resistor in amperes. Both of these curves are subject to interference due to real conditions. However, this is irrelevant for further consideration of this topic.



This oscillogram shows the intermediate circuit voltage. Here you can clearly see that when the voltage rises above a certain point, current flows into the resistor. If the voltage drops, the current flow stops.

The following oscillogram can be used to address the resistance issue in detail and to explain it adequately:

As already explained, too high voltages in the intermediate circuit are dangerous and must therefore be regulated. If the voltage exceeds a previously defined value, we now also know that the brake chopper is switched on, whereby the excess electrical energy is converted into thermal energy via the brake resistor. Accordingly, the voltage decreases to a defined point at which the brake chopper is switched off again and the brake resistor does not have to process any more energy. You can see exactly this scenario in the oscillogram above. If the voltage is at its highest point, in the example approximately 740 volts, the brake chopper is switched on and the resistor is activated. From this point on, the yellow line shows that the voltage decreases up to a certain point. If the voltage falls below approximately 715 volts in our example, the brake chopper is switched off and the resistor is deactivated. From this point on, however, the voltage increases again. This scenario repeats itself as often as required until the electric motor has completed its braking phase. This example is now also optimal to show why the duty cycle and rest time of the resistor is of decisive importance. The longer the duty cycle and the shorter the resting period, the more energy the resistor has to absorb and is therefore more heavily loaded.

It should be noted that the braking resistor makes a significant contribution to the smooth operation of dynamic machines. It ensures maximum safety and is therefore indispensable.

Wir freuen uns auf Ihre Kontaktaufnahme!

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