Thermal Circuit Breakers for Equipment

Considering the variables that influence the selection of rated current

Thermal circuit breakers for equipment (CBE) are particularly suitable for protection of motors and transformers against current overload. The circuit breaker trips when the internal bimetal is deflected. This deflection is caused by current flow that heats the bimetal, resulting in a thermal inertia of the bimetal. It is this thermal inertia that establishes the time-current characteristic of a thermal circuit breaker.

One of the advantages of using a thermal circuit breaker for equipment, over a fuse for instance, is that the circuit breaker is not as sensitive to the inrush currents associated with the start-up of motors and transformers. This means that it is not only the rated current of the load that determines the selection of a circuit breaker, but other parameters such as inrush current, overload capacity, operating duty, or ambient temperature that must also be taken into consideration. Many special types of motors can withstand short periods of overload. In these cases, the rated current of the circuit breaker can be selected with a wider tolerance to prevent the circuit breaker from tripping unnecessarily. The motor's specifications and/or the overload capacity of the protected load must be taken into account as well; these factors being strongly dependent on the equipment's operating mode. In many applications the equipment's operating mode and therefore the load current, which acts on the bimetal strip, is not the same. The heat generated by the load and thus the deflection of the bimetal (Fig. 1) in the circuit breaker depends to a large degree on the following three points:

- Load current characteristics
- Frequency of overload
- Switching frequency

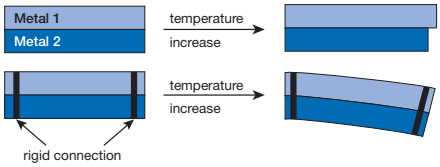

Fig. 1: Operating principle of a bimetallic strip

Below is a review of common applications for a thermal circuit breaker, with considerations to selecting the right breaker for each system.

Circular Saw Application

Let's consider a circular saw application. When turning on the power, the motor initially revs up to its idle state. The saw draws a high load current for a short period of time during this start-up period. This generates a great deal of heat on the bimetal strip. However, because of the wider tolerance of the specified current rating, the circuit breaker does not trip. The saw eventually reaches its idle state, and the bimetal strip cools down. This is because the load amounts to only a few percentages of the rated load. When the equipment is being used, the load related operating current increases. The increase varies depending on factors such as the type of wood, material thickness and the speed at which the wood is being fed to the circular saw blade. In manually operated machines, some of these factors are not consistent and may vary during operation. After a few seconds of operation, the load current decreases again back to a few percent of the rated current and the machine returns to its idle state. During this period, both the motor and the bimetal strip in the circuit breaker cool off again. The CBE should only trip when the machine is exposed to a sustained overload or a motor is even blocked.

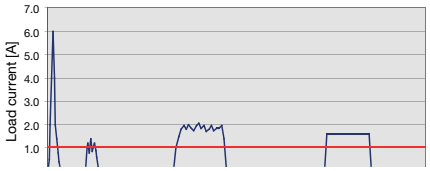

Fig. 2: Circular Saw

Automatic Motor Feeder Applications

In applications where the motor is frequently turned on, the rated current specification of the circuit breaker is critical due to the increased power consumption and the short intervals of down time for the system. For example. an automatic motor feeder application (Fig. 3), where the conveyor motor is operated every 10 seconds for a period of 6 seconds and only allows the bimetal 4 seconds to cool down. With these frequent start up currents, the bimetal, and the motor are increasingly heated, which will finally lead to the tripping of the power switch. The motor would be better served if it was operated less often and for a longer time, ultimately leading to longer breaks. In such an application it is therefore necessary to also monitor the frequency of insertions in addition to the overload.

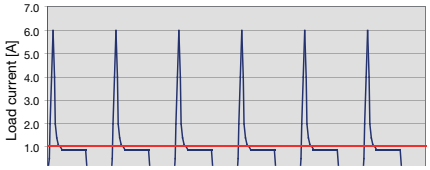

Fig. 3: Feeder

Fan Applications

It is a great deal simpler to determine the bimetal rated current at a constant load. As an example, the ventilator fan (Fig. 4) works for hours at a constant load and thus provides a constant current. However, with an application such as the ventilator fan, the in-rush current should also be taken into consideration to ensure it does not lead to nuisance tripping of the breaker.

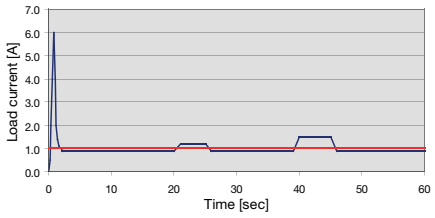

Fig. 4: Fan

Garden Shredder Applications

In all cases it is important to consider how well and how safe you want to protect a load. The higher protection of the load goes hand-in-hand with a higher likelihood of unwanted or nuisance tripping. Especially when working with irregular loads, such as a garden shredder (Fig. 5), the determination of the nominal current is difficult to define and time is needed to determine this nominal current accurately to prevent nuisance circuit breaker tripping.

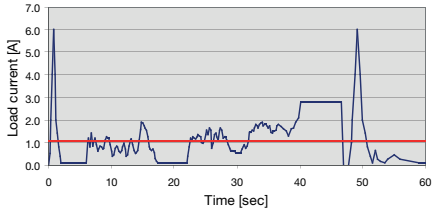

Fig. 5: Garden Shredder

Ambient Conditions

The most important factor directly influencing the trip characteristic of a circuit breaker is the ambient temperature. The tripping characteristic is partly specified by the international standard, IEC 60934, UL 1077 and CSA C22.2 235 and states the calibration takes place at +23 ° C. However, if the breaker is subjected to an ambient temperature of +60°C in an application, the bimetal is already significantly deflected before the load current flows, causing the breaker to trip too early. For applications in which the ambient temperature of the device's circuit breaker differs from the calibration of + 23 ° C, the rated current used for calculation must therefore be adjusted to the corresponding correction values provided in the product data sheets.

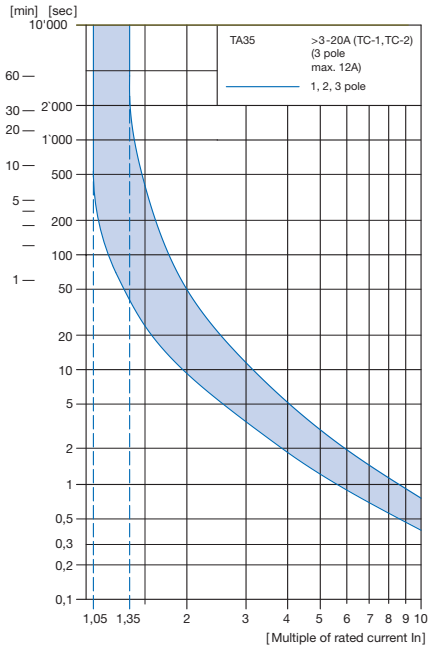

Fig. 6: Trigger characteristic Circuit Breaker TA35

Conclusion

For this reason, the maximum inrush current under normal conditions must be below the trip characteristic curve of the appropriate breaker (Fig. 6). Otherwise, with every switch-on the breaker would trip. Circuit breakers are in accordance with IEC 60934 and UL 1077. These standards are calibrated so that it does not cause a trip at the constant rated current of 105% while the switch is being minimally operated for one hour. In addition, these standards are also calculated where a trip will occur when the operation reaches a constant current rating of 135% after a maximum of one hour. Depending on the over-capacity of the load, a bimetal rated current can now be chosen as close to the rated value. Either it is chosen a little above or below this limit, according to the requirements of the system. For critical operating duty modes with frequent starts, large load fluctuation or elevated ambient temperatures, it is recommended to test the circuit breaker for the selected rated current under practical conditions.

Ambient temperature [°C]	Correction factor
-30	0.77
-20	0.81
0	0.90
+23	1.00
+40	1.03
+50	1.04
+60	1.06

Thermal derating of TA35

Headquarters in Lucerne

Company

SCHURTER continues to be a progressive innovator and manufacturer of electronic and electrical components worldwide. Our products ensure safe and clean supply of power, while making equipment easy to use. We offer a broad range of standard products including circuit protection, connectors, EMC products, switches and input systems, as well as electronic manufacturing services. Moreover, SCHURTER is ready to work with our customers to meet their application specific requirements, not covered in our standard range. You can rely on SCHURTER's global network of companies and partners to guarantee a high level of local service and product delivery.

Headquarters

Division Components
SCHURTER Group

SCHURTER AG
Werkhofstrasse 8-12
PO Box 4168
6002 Lucerne
Switzerland
schurter.com

Contact

Asia-Pacific
T +65 6291 2111
info@schurter.com.sg

Europe (Headquarters)
T +41 41 369 31 11
contact@schurter.ch

USA
T +1 707 636 3000
info@schurterinc.com

0165.0667/11.14/UD EN