NHP

TECHNICAL NEWS

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IN THIS ISSUE

DON'T FORGET THE MOTOR PROTECTION

The microprocessor has enabled the development of motor protection relays which offer sophisticated features designed to improve protection, communication and control of the three phase motor. But do these features actually improve motor protection.

Protection is of foremost importance

With the widespread use of microprocessors, it is often assumed that a protection relay using such technology automatically provides a high level of protection.

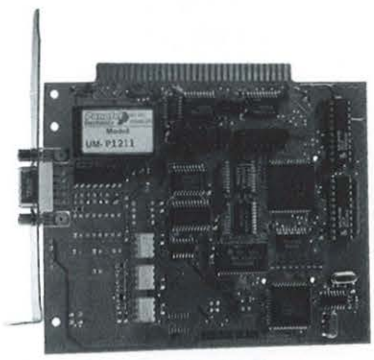
The extra features provided may not improve motor protection at all and in some cases, protection afforded by standard bi-metal thermal overload devices for instance, may be just as good. The main point here is not to assume that a relay based on microprocessor technology will automatically provide the best level of protection. Further evaluation of the device is recommended, after all, it is the primary function of a motor protection relay to provide high quality thermal overload protection for the motor.

The "bells and whistles" where available may be useful for functions other than motor protection.

Thermal models and memories

This is perhaps one of the least understood features of motor protection relays and each manufacturer will use jargon unique to the brand. For example, the feature *thermal model* can mean a number of things: To one manufacturer a thermal model could be a simple simulation of the motor temperature rise based on fixed heating and cooling parameters.

Electronic motor protection relay CET 4.



Typical CET 4 option card.

Thermal models and memories
(continued from page 1)

However, a true thermal model will automatically consider the dynamics of the motor and correctly calculate the heating and cooling of the motor under all conditions. In order to achieve this, it is necessary to consider the windings, surrounding iron, as well as the motor cooling at both run and standstill. Additionally, the relay may also take into account the coolant or ambient temperature to more accurately calculate the motor's final temperature. The "two body thermal model" of the Sprecher + Schuh CET 4 achieves this using a complex algorithm in the operating system. The term *memory* in this case would refer to the ability of the relay to memorise this thermal model and continue to correctly simulate the cooling, even when the control supply is lost.

Reset time is the key

Motors don't always take the same time to cool down. As can probably be understood, this would depend upon the temperature of the motor iron which will be influenced by the condition prior to tripping or switching off.

For example, a motor which has tripped on the first cold start due to a locked rotor, will cool down rather rapidly due to the relatively cold iron mass. On the other hand, the tripping of the motor due to an overload after operating at full load for a long period of time, would lead to a correspondingly longer cooling time. This is because the motor iron has reached a higher temperature.

A true thermal model takes this dynamic concept into account. What needs to be done here is to check the relay specific-ations. A fixed or set reset time does not suggest that the thermal model is correctly calculating motor heating and cooling under all conditions.

Accurate thermal models improve protection while enabling higher production

Correct thermal model techniques allow full use of the motor's thermal capacity without gross over or under protection. This has proved to be beneficial in many applications and allows in some cases an increase in the production output of the motor. In some cases, analogue meters can be used to give visual feed-back to the operator, often warning of an impending or approaching trip.

Will temperature sensors help?

The addition of Resistance Temperature Detectors (RTD) input capabilities into motor protection relays allows motor winding temperatures to be monitored, providing the RTDs have already been installed in the motor. For this to be practical, the RTDs need to be fitted in the windings during manufacture. It is not uncommon to have up to two RTDs per winding and each one needs to be separately monitored by the relay. With RTDs and unlike thermistors, these devices cannot be connected in series.

An RTD is a linear device whose resistance changes with temperature. By measuring this resistance, the protection relay can calculate and display the actual measured temperature and allow alarms and trip signals to be generated at certain set points.

Thermistors are another device which can also be used to detect a temperature limit being reached. However, they are unable to actually measure temperature. **(Figure 1)**.

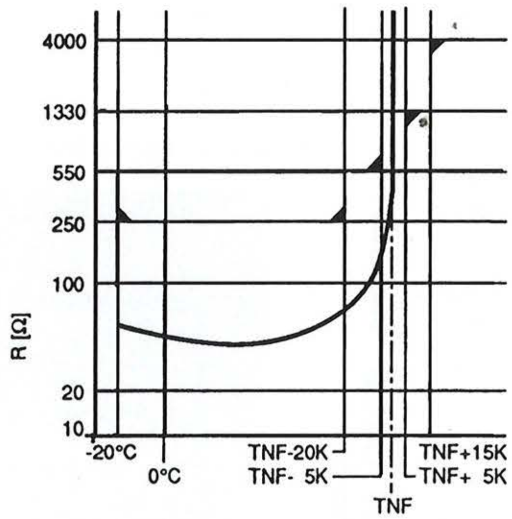


Figure 1. Thermistor characteristic.

Will temperature sensors help?
(continued from page 2)

Of course, temperature sensors can provide additional information about the winding temperatures. They are useful in detecting temperature changes caused by excessive load, asymmetrical supplies and varying ambient temperatures. Another example of how RTDs can be utilised is by measuring the cooling air around the motor to assist with determination of the maximum allowable motor load which is affected by the surrounding ambient. This information could also be fed into a thermal model to provide automatic compensation as is available with the Sprecher + Schuh CET 4 motor protection unit.

Thermal delay

A disadvantage of temperature sensors is that they are unable, in most cases, to detect rapidly rising temperatures caused by, for example, locked rotor conditions or heavy duty starting. This is because the sensors for obvious reasons need to be electrically insulated from the windings. This insulation is also a thermal insulator and thermal delays will cause errors in the temperature measurement. (**Figure 2**). Hence, the rapid temperature change of the windings during starting or motor locked rotor conditions needs to be calculated by the relay's thermal model, which responds instantly to the changes in the load current.

It can be seen that temperature sensors cannot protect the motor on their own.

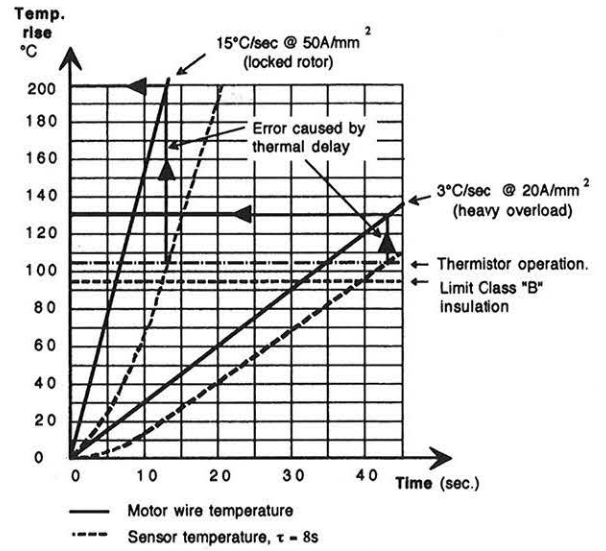


Figure 2. Thermal response with rapid heating.

Current evaluation and thermal models can do the work just as effectively under most operating conditions and the sensors should be considered as a back up device or as protective elements for bearings or mechanical parts.

In selecting a motor protection relay, evaluation needs to be made on the effectiveness of the thermal model, its range of adjustment to suit various motor types and the particular application. The added features where available may be used to provide additional controlling and monitoring functions.

"Bells and whistles" or not

Some additional features of the motor protection relay may be considered as "nice to have" whilst others may prove to be an extension of the motor protection features provided by the thermal model. The following are considered useful from a motor protection point of view.

a. Asymmetry or phase failure

This is mandatory on all good motor protection relays as asymmetrical currents and loss of phase will certainly cause additional heating. By having this feature fully adjustable, it is possible to first warn and then trip if the condition becomes critical.

b. Earth leakage/fault

An increase in the leakage current can be monitored using core balance current transformers and will warn or trip where unacceptable levels are reached. This is particularly useful where moisture ingress particularly in terminal boxes needs to be detected. In the case of an earth fault due to a damaged motor/cable the relay can only detect this occurrence and switch off the motor to avoid further damage. Prevention in such cases is obviously not possible.

"Bells and whistle" or not (continued from page 3)

c. Protection of mechanical parts

Stall detector

Detection of motor stalling is useful when mechanical problems occur and this could be during a start or while the motor is running. Such features are available on most electronic relays these days. **(Figure 3)**.

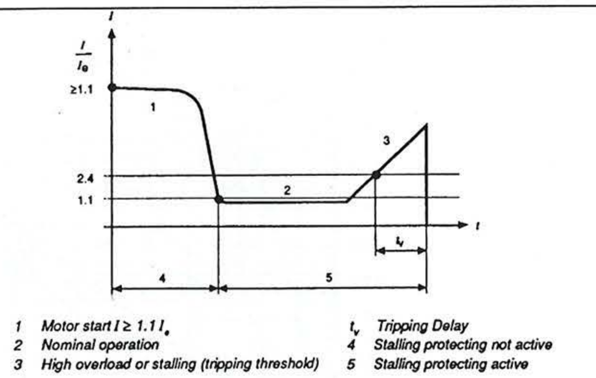


Figure 3. Function of high overload and stalling protection.

Underload

Loss of load can also indicate a plant problem and it is a relatively simple task to include this feature on the motor protection relay. This feature is considered particularly useful on pumping equipment, such as, submersible pumps, but can also be utilised on many other drives where loss of load may indicate a mechanical problem.

d. Additional features

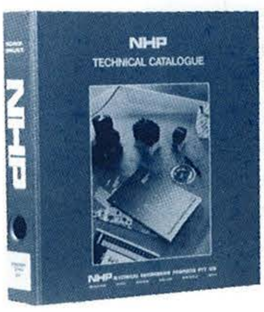
With the microprocessor it is also relatively simple to add many other features related to the motor protection. Such features would include monitoring the starting time, limiting the number of starts per hour, allowing hot start capability, emergency start routines etc. All of these features could be used to solve particular application requirements and are relatively simple "bells and whistles" to add to the motor protection relay.

More "bells & whistles"

We can add more and more features to the microprocessor controlled motor protection relay and it is easy to justify the usefulness of these extra features in many applications. One would trust that the selection of the relay is not made on these features alone.

For example, the recording of statistical data like the hours run, the cause of trips, when they happen etc. is useful in evaluating the history of the installation. Such features are readily available on many motor protection relays.

However, alone they are not much use if the basic protection concept is flawed. It may be useful to have all this information available but it's not very practical if it only tells you why the motor burned out in the first place. Obviously the answer is to provide high quality motor protection facilities to prevent such occurrences.



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