



Measurement of Electrical Variables Simple, yet effective, solutions



Introduction

The automation of today's complex industrial processes generally requires the use of specialised equipment, which needs to be managed by suitably qualified personnel. However, there are many applications where these requirements may not be necessary.

The solution to many industrial automation problems, can frequently be found in ingenious simple system designs, employing the use of monitoring relays. This short article explains how and why.

Monitoring Relays Explained

For those not *au fait* with the term 'monitoring relays', a short explanation is provided: A monitoring relay is simply a relay which monitors certain electrical parameters and provides a relay output signal (i.e. a switching contact) if the parameter reaches a predetermined condition. This predetermined condition is usually set by the user via a potentiometer adjustment

In order for any monitoring relay to operate, power must be supplied. This is usually mains (i.e. 240VAC) or phase-to-phase voltage (i.e. 415VAC), or a control voltage (eg. 24VDC). However, other supply voltages are also available.

The parameter to be monitored, for example, voltage, current, or frequency, must also be fed into the unit, usually via a separate input. However, certain units monitor the voltage or frequency of their own power supply.

Functions of Monitoring Relays

The primary function of a monitoring relay is the failsafe protection of industrial equipment being subjected to abnormal electrical conditions. This is usually achieved by the disconnection of the equipment via the monitoring relay, which de-energises when a fault condition is detected.

For instance, monitoring relays can provide for the detection of:

- Overvoltage and/or undervoltage conditions.
- Overload and/or underload conditions.
- Overfrequency and/or underfrequency conditions.
- Incorrect phase sequence, phase failure and/or phase asymmetry.

Brief explanations of these four monitoring functions, as well as other applications of each type of monitoring relay, follow.

Voltage Monitoring

Monitoring relays which are suitable for monitoring voltage conditions are commonly known as voltage monitors. They will detect when the power supply voltage has exceeded, or has dropped below, a certain set limit. These limits are usually adjustable by the user. Voltage monitors are available for all types of single or three phase AC power supplies (i.e. mains or generator) or DC power supplies (i.e. battery or isolated DC supplies). However, these units are not only designed to monitor the voltage of power supplies - other application examples could include the following:



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Automatic control for charging of batteries - monitoring the charging voltage.

Voltage monitoring on tachogenerators for overspeed conditions.

Monitoring the discrimination voltage between neutral and earth to ensure that the neutral does not float.

Monitoring of system trip circuits on high voltage switchgear.

Monitoring the conditions of fuses which are not accessible or easy to inspect.

Current Monitoring

Monitoring relays are also available for monitoring current. They will detect either overload or underload conditions. For instance, they may be used to protect motors, or any form of electrical equipment, against damage from an excess of current, usually due to equipment malfunction. An example of underload monitoring is to detect the slipping or tearing of a conveyor belt, since this occurs when the motor driving the belt, is suddenly driving a lesser load. Other applications could include the following:

Lift door control - responds to lift doors closing on foreign objects.

Monitoring of 4-20 mA control loops for short circuit or open circuit conditions.

Detection of mixture densities on a variety of industrial mixers.

Detection of any situation where a change in current can be detected.

Frequency Monitoring

Monitoring relays can also be used to monitor the frequency of an AC power supply (mains or generator driven), in order to protect any frequency-sensitive equipment connected to that power supply.

'Window' Monitoring

In all of the three types of monitoring relays described above, namely voltage, current and frequency monitors, each can be set up to respond to either an 'over' condition or an 'under' condition. However, there are monitoring relays available, sometimes referred to as 'window comparators', that respond to both 'over' and 'under' conditions. This means that as long as the parameter (voltage, current or frequency) is maintained within a set window, i.e. between the 'over' and 'under' limits, the unit will not detect a fault condition.

Phase Sequence, Phase Failure and Phase Asymmetry Monitoring

In a balanced and symmetrical three phase power supply, the voltage of the three phases are equal, the phases are in the correct sequence and are 120 degrees apart. When all three phases are perfectly balanced and symmetrical, the supply contains no negative phase sequence (NPS). However, an unbalanced or asymmetrical three phase power supply, generates a negative phase sequence (NPS) voltage component. The greater the imbalance or asymmetry, the greater the NPS component.

If the unbalanced three phase power supply is loaded, the resulting currents will also have an NPS component. On symmetrical loads, such as motors, a small imbalance in voltage may result in a significant imbalance in current. Furthermore, the heating effect of NPS current in motor windings, can be very severe. Therefore, a motor supplied by an asymmetrical three phase supply, may burn out, without activating any overload protection, since the rated phase current would not have been exceeded.

Detection of excess NPS voltage with a suitable monitoring relay, is thus the most effective method of protecting three phase equipment. It is very sensitive to voltage imbalance while not being affected by symmetrical voltage swings. Furthermore, it is insensitive to regenerated EMF, while providing high stability under harmonic distortion.



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Ease of Installation and Replacement

Convergent Water Controls Pty Ltd, the exclusive Australian agent for Rhombert Electronics, supplies monitoring relays, which are available in both 11-pin plug-in and DIN rail clip-on format. The nature of the 11-pin plug-in format allows for effortless unit installation and replacement, since the socket can be wired without the unit being plugged in. In an installation, the unit can simply be removed and plugged back in again, without interference to any of the wiring connections. This allows for simple unit replacement and fault finding. However, there are DIN rail units available that offer the same degree of ease of maintainability, due to their plug-in terminal blocks.

Conclusion

Monitoring relays provide simple, yet effective solutions for the failsafe protection of industrial equipment against abnormal electrical conditions. Monitoring relays, as their name suggests, monitor electrical variables and provide a switching relay output which can be used for applications, other than just equipment protection. The use of monitoring relays in single and three phase electrical systems, has provided for many industrial control solutions over the last few decades and will most likely provide the most cost-effective solution for many years to come.



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