MachineDesign

MONITORING RELAYS — TYPES AND APPLICATIONS

Production equipment is expensive and needs to be protected against input abnormalities such as voltage, current, frequency, and phase to stay online and in operation for the longest period.

Monitoring relays are essential to every safety system to protect from equipment failures. The primary functions of monitoring relays are to monitor input signals, determine their values against a set value or threshold, and output an alarm signal if there is an abnormality. These devices monitor motors for potential voltage, current, power, and frequency fluctuations in single-phase and three-phase power systems. They also monitor power supplies (voltage, current, power, phase), temperatures, and other analog signals. Further, monitoring relays can be used to detect abnormalities in machines and equipment through the same methods of operation. Upon detecting any abnormalities, the monitoring relay switches the piece of equipment off until a repair or maintenance routine is completed (see Figure 1).

Unlike a circuit breaker, monitoring relays are electronic devices that contain configurable measurement circuitry to a particular tripping point. Many of these devices come with a visual display that indicates the present operation. The visual display can also be used during manual setup. Onboard control circuitry is often available for remote programming by a higher-level device.

Figure 1: Upon detecting an abnormality in operation, monitoring relays switch equipment off until maintenance can be supplied.

Voltage Monitoring Relays

Common monitoring relays are used to identify over- and under-voltages in a wide variety of equipment, such as wind and solar power generation systems. These relays are connected to the line side of equipment and are sensitive to abnormal conditions that might occur in several ways, including a prestart situation. Voltage relays are one of the more straightforward products to install because they can be applied independently of the system load.

When used as an under-voltage device, the relay trips instantaneously once the voltage drops below a particular set point. The device recognizes a sustained under-voltage below the voltage rating of a generator, transformer, motor, or other device that could lead to equipment failure. The setpoint is adjustable and dependent on the equipment being protected. An example would be Altech's AMR-AP3U690V2D monitoring relay, which features undervoltage monitoring of three-phase circuits, phase sequence, and phase failure capabilities. These devices offer a compact design of only 22.5mm for industrial applications (see Figure 2).

Under-voltage monitoring is particularly valuable where the electrical load is an MVA (mega volt amp), such as uninterruptable power supplies, motors, and transformer applications. Under-Voltage monitoring is also necessary to protect motors from damage during abnormal conditions and to prevent some motors from reaccelerating after a restoration of voltage.

Figure 2: Voltage monitoring relays are ideal for use in motor control centers where motor operation is dependent on having the right input

When sensing for an over-voltage, the monitoring relay trips when the line voltage rises above a preprogrammed set point for a sustained period. Over-voltages can cause equipment failure or be caused by an equipment failure. These relays can operate instantaneously or be programmed as a time-delayed device dependent on the application's needs.

For safety purposes, a differential voltage relay can respond to the difference between the input and output voltages of the protected device. If the net between the circuits is zero, no fault is present, but if the net is not zero, an operating problem is in effect. These devices can be used at all points in a power system and are often used for protection. Whether an over-voltage, under-voltage, or differential voltage condition occurs, note that it can mean a system overload or equipment failure is possible.

Voltage-sensitive monitoring relays are incorporated in applications where it is critical to maintain voltage within safe limits, such as motor control centers, generators, HVAC systems, pump controls, solar and wind power installations, electrical distribution systems, and telecommunications equipment centers (see Figure 3).

Phase Monitoring Relays

Phase sensitive relays monitor phase sequence, phase reversal, ground or earth fault, power factor, phase failure or loss, and phase unbalance. These relays use voltage to discover if a phase sequence is incorrect or unavailable. Phases can be missing due to an open fuse, a mechanical failure of the switching equipment, or if there is an opening in one of the power lines. In a three-phase motor circuit, the motor won't start if a phase is missing, but it will continue operating if it drops offline. If you are only using a voltage monitoring relay, it might not protect the motor against a phase failure.

Reversals in phase are often caused by miswiring or during power restoration where a phase sequence that is different from before the power outage is evident. Phase reversal protection is a significant requirement on people transport systems such as escalators, airport treadmills, and elevators. Phase sequence relays ensure your three-phase circuit is not out of sequence (see Figure 4). When out of sequence, these relays will trip so that you cannot connect machinery incorrectly.

The power factor in an AC power transmission and distribution system is calculated as the cosine of the phase angle between the voltage and current, which indicates the difference in real and apparent power. A bad power factor leads to a distorted waveform, which results in higher power usage. Ground earth faults are detected when any undesired current path occurs with a different potential than ground.

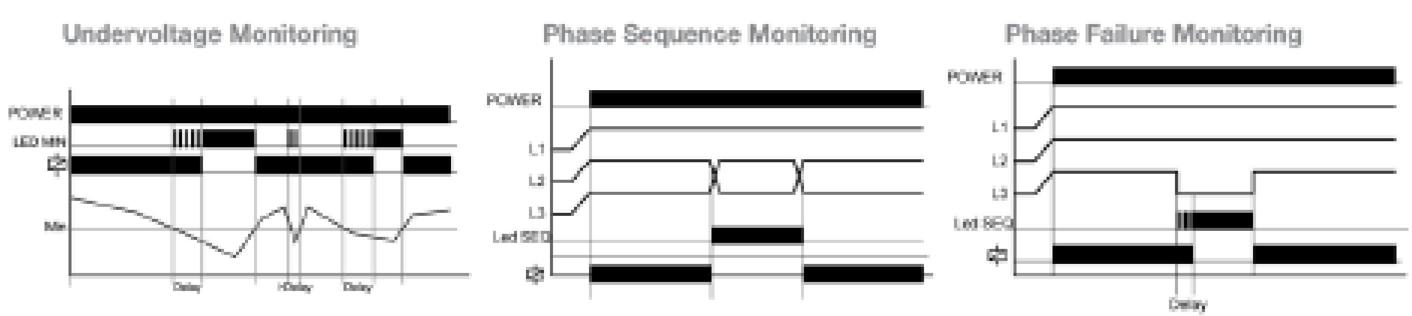

Figure 3: Example of voltage monitoring functions.

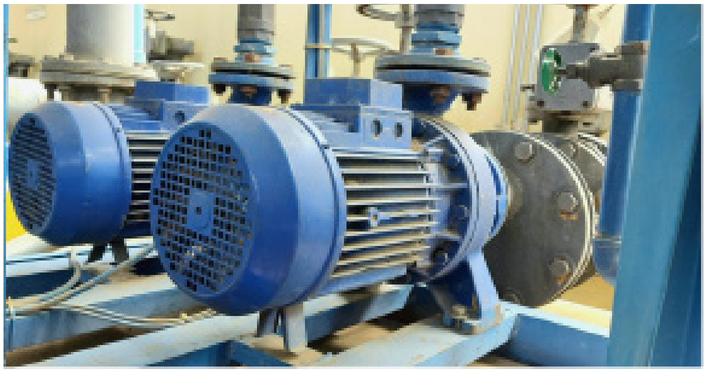

Figure 4: Phase sequence relays ensure that your three-phase circuit is not out of sequence, causing damage to equipment.

Current Monitoring Relays

The advantage of using a current sensing relay over a voltage sensing relay is that current sensing devices don't respond to back EMF (electromotive force), which is always present when there is a phase failure on a motor load. Current anomalies can be detected on the line side. Under-current relays trip when the current drops below a set point, which occurs if there is a power supply fault, or a loaded motor suddenly becomes unloaded. If an over-voltage situation causes the under-current, equipment damage can occur.

Like other monitoring relays, an over-current relay trips when a current rise is detected above a particular set point. Over-currents can be caused by the supply or load side, appearing as a sudden load increase. If caused by a drop in voltage, like the undercurrent situation, damage to your equipment can occur.

Like differential voltage relays, differential current relays trip based on the difference between input and output current. In this case, a fault occurs when the bus or generator input and output currents equal any value other than zero. This occurrence can happen due to a change in voltage, equipment failure, or a dropped line in a three-phase circuit.

Frequency Monitoring Relays

Like the other monitoring relays mentioned in this article, frequency sensitive relays detect frequency abnormalities. Variations in frequency occur when power is generated on-site from an inverter, backup power supply, or an alternative energy source such as solar or wind energy. Electronic controllers and systems rely on frequency for timing sequences — AC induction motor speed is determined by frequency — which means that a frequency increase or decrease can cause all sorts of industrial equipment malfunctions.

Frequency sensitive relays monitor variations that occur on any alternating electrical input and will trip instantaneously or through a time delay. As with voltage and current, a differential frequency relay detects differences between incoming and outgoing frequencies of protected equipment.

Time Delay Function in Monitoring Relays

We've mentioned time delays for each of the monitoring relay types. Time delay functions can operate according to the time a fault is detected, the time the relay trips, or in relation to the time a relay takes to reset. Several types of time delay functions are available, including ones where the relay operates from a programmable time delay feature, where the relay resets automatically once conditions return to normal, and where a visual indicator identifies system condition and latching controls. Latching functions are designed to maintain the last defined state before the power loss so that when the system is switched back on, the equipment can continue to operate from where it left off.

Monitoring relays are essential to any application and should be used properly. Many devices offer multiple capabilities that should be selected based on your specific needs. Each application is different, and each piece of equipment might be sensitive to varying types of input and output abnormalities. Regardless of your final decisions, be sure to work with a reputable company that can help with your selection based on their years of experience in a broad number of industries.