

Selecting the Right Three-Phase Voltage Monitoring Relay

The first four notes in this series examined phase sequence, phase loss, voltage imbalance, and undervoltage and overvoltage. This note brings those topics together for relay selection. It explains how to choose between three-wire and four-wire monitoring, match the detection functions to the equipment, and decide how the control system should respond when a fault occurs and when the supply recovers.

Introduction

A pump starter, a lift control panel and a refrigeration compressor may all be supplied from the same three-phase distribution board. Each can need a different type of monitoring. The pump needs the correct direction of rotation. The lift panel may depend on a neutral for its 230 V auxiliaries. The compressor may need time to settle before it can restart after a supply interruption. These differences determine which voltages the relay should monitor, which faults should inhibit operation and when the equipment can return to service.

Decide whether the neutral needs monitoring

A **three-wire relay** connects to L1, L2 and L3 and measures the voltages between phases. On a nominal 400/230 V supply, that means selecting for 400 V phase-to-phase. This is appropriate for a feeder supplying a three-phase motor or other load that operates between phases, even if a neutral is available at the distribution board.

A **four-wire relay** also connects to N and measures each phase relative to neutral. On the same supply, that means selecting for 230 V phase-to-neutral. Use this arrangement where the equipment depends on that neutral, for example when a panel supplies a 400 V motor and 230 V control power supplies or auxiliaries. Specify neutral-loss detection explicitly. If a shared neutral opens upstream of unevenly loaded circuits, some phase-to-neutral loads can see a rise in voltage while others see a fall, even when the phase-to-phase voltages remain close to normal.

Choose the faults the relay needs to detect

Consider starting and running separately. A pump may need to be held off if the phase sequence is wrong after a panel is rewired or a temporary generator is connected. Once the pump is running, loss of a phase or sustained low voltage can reduce torque and increase heating. An incoming supply monitor can give the control circuit a signal in both cases, allowing it to inhibit a start or stop the equipment as appropriate.

Check whether a voltage window covers the concern. A voltage window compares each reading with the lower and upper limits. For example, 390 V, 400 V and 410 V would all be inside an illustrative 380–420 V window, yet the three voltages are unequal. If the equipment manufacturer specifies a maximum voltage imbalance, select a relay that measures it directly and check how the relay defines its percentage. The equipment limit and the relay setting need to use a compatible calculation.
The table below relates each monitoring function to the equipment and operating conditions it can help protect.

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Monitoring function	When it matters	What it helps protect
Phase sequence	The incoming phase order determines the direction of a directly connected motor.	Pumps, fans, conveyors and other machinery that could malfunction or suffer damage if driven in reverse.
Phase loss	A lost supply phase can prevent a motor from starting or cause it to continue running with excessive current in the remaining phases.	Motor windings and driven equipment exposed to reduced torque and overheating.
Voltage imbalance	Unequal voltages can produce unequal motor currents even while all three readings are within the permitted voltage window.	Motors and compressors that are sensitive to heating from voltage imbalance. Choose a model with a dedicated imbalance threshold when this is a selection requirement.
Undervoltage and overvoltage	The equipment must operate within a defined voltage range. An undervoltage-only relay suits applications where low voltage is the concern. A voltage window supervises both limits.	Motors that can lose torque at low voltage, contactors and controls that can drop out, and power supplies or other components that can be stressed by sustained high voltage.
Neutral loss	Single-phase loads share the neutral in a three-phase, four-wire circuit.	Phase-to-neutral control supplies and auxiliaries exposed to abnormal voltages if the shared neutral is lost.

Match the application to a Broyce relay

Application	Broyce relay	Why it fits
Three-wire or four-wire installation with a specified voltage imbalance limit	LPMP/2	Provides adjustable imbalance monitoring, fixed under- and overvoltage thresholds, phase-loss/sequence detection plus adjustable restart delay. Four-wire mode also detects neutral loss.
Three-wire machinery requiring both low- and high-voltage limits	LXPRC/S	Adds an adjustable overvoltage threshold to undervoltage, phase-loss/sequence monitoring.
Four-wire machine or building-services panel with 230 V auxiliaries	LXPRC/S-4W or LXPRC-4W	Both monitor phase-to-neutral voltage against adjustable limits, detect phase loss and neutral loss. Choose the LXPRC/S-4W when phase sequence also needs to be checked.
Three-wire compressor package where a pause is required before restarting	LXPRC/S/RD	Provides fixed under- and overvoltage thresholds relative to the selected nominal voltage, phase-loss and phase-sequence detection, and an adjustable restart delay.
Three-wire pump starter where low voltage, phase loss and incorrect rotation are the main concerns	LXPRT	Monitors phase sequence and phase loss and provides an adjustable undervoltage threshold and fault delay.

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Specify what happens after detection

Use the equipment manufacturer's voltage limits to select the thresholds. A **fault delay** determines how long a monitored fault must persist before the relay responds. It can allow short voltage dips to pass without interrupting the process. Check the model's function diagram because some faults can override the delay. A **restart delay** holds off the relay output after the supply has returned to acceptable conditions. This can help enforce a compressor's minimum off-time. The control circuit determines whether equipment restarts automatically or requires an operator reset.

Use the output contacts to signal a PLC, operate a suitable contactor control circuit or raise an alarm. Select the monitoring point to suit the fault you need to detect. For example, a relay monitoring the incoming side of a contactor supervises the supply at that point. A failed contactor pole downstream can still interrupt a phase at the motor, so the equipment's motor overload and short-circuit protection remain part of the protection scheme.

Conclusion

Before specifying the relay, confirm the supply connection and nominal voltage, the faults that could harm the connected equipment and the required response on fault and recovery. A three-wire LXPRC/S can supervise a motor feeder with an adjustable voltage window, while the LXPRC/S-4W suits a panel that also depends on a healthy neutral. The LPMP/2 covers applications that need a dedicated imbalance threshold and restart delay. During commissioning, verify that the relay and the control circuit together produce the intended alarm, stop and restart behaviour.

Related Engineering Guides

- Why Phase Sequence Matters
- Understanding Phase Loss
- Protecting Against Voltage Imbalance
- Undervoltage and Overvoltage Explained
- Selecting the Right Three-Phase Monitoring Relay *(this guide)*