Technical Letters

Why Switch 2 Poles In A 3 Phase Solid State Circuit

2 Pole or 3 Phase Solid State Circuit Switching

For many on/off and zero-fire applications on solid-state controls circuits, two-pole switching in three-phase circuits is the preferred power circuit configuration. Since we have just left an electromechanical world in which two-pole, three-phase switching for general purpose applications was uncommon, and the immediate reaction to an un-switched leg in a solid-state controls is most often a negative one. Viewed from a solid-state perspective, however, two-pole switching in three-phase applications has definite advantages.

An underground three-phase load can be controlled as readily with a two-pole device as with a three-pole one; in fact, early three-phase electromechanical controls only switched two legs to save on material costs and panel space. An inductive loads came into wider use designers discover that switching all three poles would extend contact life by sharing the drawn when breaking the load current. Three-pole, three-phase switching became the electromechanical standard not so much for any functional reason, but to extend the life of key component parts. Even today, "definite-purpose" contactors are available for three-phase applications that switch only two poles when initial cost is a more important consideration than operating life.

Why Switch Two Poles In A Three-Phase Solid State Control

Since solid state switching means the interruption of power by non-mechanical means, no arc is drawn when breaking the load current; without the arcing, there is no functional requirement to switch three-poles with a solid-state control. Since there are only two sets of power semiconductors instead of three, two-pole switching has several positive effects over both the design and application of solid-state controls.

A. Heat Generation: The heat generated by power relays is one of the most difficult problems designers encounter. Semiconductors fail when they get too hot. Reducing the number of semiconductors reduces the amount of heat generated, which in turn makes the design more efficient.

B. Simplicity of Design: Each power relay must be grated on during operation by the power circuit. The more semiconductors there are the more complex the control circuit has to be.

C. Overall Size: Eliminating the semiconductors in one pole means a smaller control that consumes less panel space. Each set of semiconductors must be mounted to an aluminum heat sink, and those heat sinks make up most of the physical size of any solid-state control. A two-pole three-phase device is about 1/3 smaller than an equivalent three-pole, three-phase device.

D. Efficiency: A two-pole three-phase solid-state control is 33% more efficient than a three-phase one, which means it consumes less energy and cost less to operate.

What About Safety?

The most common objection to two-pole, three-phase switching with solid-state controls is that it endangers equipment operators and maintenance personnel - with the implication that three-pole three-phase switching doesn't. But what are the regulatory requirements and practical considerations with regard to two-pole switching with solid-state controls?

A. The National Electric Code (NEC): The NEC clearly mandates certain procedures that should be followed with remote-actuated electrical devices regardless of the controls and technology being used to help ensure operator safety. According to Paragraph 430, Part H, Selections 101 and 103, any remote actuated device must have a physical disconnect regardless of how many poles are being switched by the control device.

B. Occupation Safety and Health Administration (OSHA): OSHA regulation 1910.309 is the same as NEC on this issue.

C. Practical Considerations: Line power must be assumed at the output terminals of any solid state control, for one very simple reason: solid-state switching by definition means that moving parts, and no moving parts means no air-gap to interrupt line voltage. From both regulatory and practical perspectives, there is no difference between two-pole and three-pole three-phase solid-state controls when it comes to safety. Both are equally unsafe when input power has not been removed.

The same can be said for electromechanical controls.

Summary:

A. There are positive advantages to two-pole three-phase switching with solid-state technology: smaller size, greater efficiency and simpler design.

B. There are no regulatory requirements to switch poles in a three-phase control. OSHA and the NEC both require that the output of any control, regardless of the switching technology be assumed to be unsafe unless and until a line-of-site disconnect is used to break the power going to the control.

C. There is no practical safety reason for switching three poles rather than two in a solid state control. Regardless of the number of switched legs, line voltage must be assumed at the output terminals and on the load as long as the input voltage has not been disconnected.

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