

TechTopics No. 13

Use of latched contactors to switch transformers

Medium-voltage controllers are synonymous with control of motors up to 7.2 kV. However, medium-voltage controllers are equally suitable as feeders for other types of loads, particularly transformers. For such loads, the contactor is often modified to incorporate a mechanical latch so that the contactor does not automatically open when system voltage collapses.

The latched contactor is essentially identical in construction to a magnetically-held contactor. However, instead of relying on a continuously energized main coil to keep the contactor closed, the latched contactor utilizes a mechanical latch to hold the contactor closed. In essence, the latched contactor emulates a medium-voltage circuit breaker. However, there are distinct differences between a contactor and a circuit breaker that must be kept in mind.

Control circuit considerations

A conventional magnetically-held contactor, once it is closed, remains closed as long as the main coil is energized. Most commonly, the control supply for the main coil circuit is a control power transformer supplied as an integral part of the complete controller. Thus, for motor loads, the motor is automatically disconnected when system voltage collapses, thus preventing damage to the motor.

By contrast, the latched contactor remains closed when the system voltage collapses. This is particularly desirable when the loads are of a type where it is desirable that the load be automatically reenergized when the system voltage returns, such as lighting transformers.

A magnetically-held contactor opens when a contact in the main coil control circuit opens. On the other hand, a latched contactor is unlatched by the closing of a contact in the latch circuit, allowing the contactor to open. Thus, the control required for a latched contactor somewhat resembles that of a medium-voltage circuit breaker.

The latched contactor requires a reliable source of control power for tripping. A dc (battery) source is preferred, but if the only source of control power is a control power transformer connected to the primary voltage source, an ac capacitor trip device is appropriate.

The close circuit should use a momentary contact pushbutton, so that the main coil is energized only during closing. Similarly, the trip (latch release) circuit should use a momentary contact pushbutton. For automatic tripping from the protective relays, a normally open contact should be connected in the trip (latch-release) circuit, and a normally closed contact from the protective relay should be connected in the close circuit. The purpose of the normally closed relay contact in the close circuit is to assure that the main coil circuit is de-energized during tripping. It is also desirable to include a lockout (86) relay function, either by means of the 86 function incorporated in some multifunction microprocessor relays, or by means of a separate lockout relay.

It is important that the user's external control circuit not include a maintained contact in the close circuit. A latched contactor operates in the same manner as a magnetically-held contactor, and in addition, includes a mechanical latch. If the main coil circuit is continuously energized, the contactor will remain closed even if the trip latch is operated.

Sources vary in the estimates of the amount of time that must be allowed between interruption of the fault and the subsequent reenergizing. Most of the sources indicate there must be at least six cycles between arc interruption (on opening) and contact make on the subsequent closing operation.

Short-circuit and overload considerations

A contactor used to supply a transformer differs from a contactor used to supply a motor only in the characteristics of the current-limiting fuses. Fuses used to protect motor circuits are Class R fuses, with protective characteristics tailored to the application needs of motors. For transformer feeders, the fuses should be Class E fuses, designed to provide proper protection for transformers.

Contactors, without fuses, have only a limited interrupting capacity. Therefore, the contactor must always be used in combination with current-limiting fuses. Complete overcurrent and short-circuit interruption capability is provided by the combination of the contactor for interrupting normal load currents and moderate overload currents, and the current-limiting fuses for interrupting currents above the capabilities of the contactor alone.

Overcurrent relays should be used to provide protection for moderate overload currents, so that unnecessary fuse operation is avoided. This protection must be coordinated with the continuous current-carrying ability of the fused contactor. Since fuses generate a considerable amount of heat, it is not uncommon for the fuses to be sized somewhat larger than the continuous current would suggest. Therefore, overcurrent relays not only provide overload protection for the transformer, but also provide overload protection for the fused contactor. This is appropriate, since the function of the fuses is to provide short-circuit protection, not overload protection.

Single-phase protection

Modern motor overload protective devices often incorporate protection to automatically disconnect a motor in the event that one phase of the incoming supply is lost. However, for non-motor feeders, this "single-phase protection" may not be necessary or desirable. For example, capacitors or lighting loads are usually not harmed by single phasing. Nevertheless, the user should consider whether single-phase protection is appropriate. The most common way to achieve this function is to provide blown-fuse trip accessory, which is mechanically actuated by a plunger on the current-limiting fuse. With this option, when any single primary current-limiting fuse operates, the indicator plunger on the fuse actuates the tripping bar, which causes the contactor to open.

Other application considerations

The latched contactor shares many of the application characteristics of magnetically-held contactors. Unlike a circuit breaker, a contactor is designed for frequent operation, and latched contactors provided in Siemens SIMOVAC and SIMOVAC-AR controllers are suitable for 200,000 electrical operations. The size of transformer that can be fed from a contactor is, of course, limited by the available fuses (especially at 7.2 kV), as well as by the continuous current capability of the contactor.

Contactors are designed to have low-energy control power requirements. As a result, they may operate relatively slowly. For the contactors used in Siemens SIMOVAC and SIMOVAC-AR medium-voltage controllers, the typical closing time is 40 ms for 400 A and 70 ms for 720 A and the opening time is 90 ms for 400 A and 35 ms for 720 A. While these times are much longer than the operating times for circuit breakers, they generally do not require any special consideration in control circuits or with respect to system operating procedures.

Latched contactors are integrated in the design of the medium-voltage controllers, avoiding the need for transition sections and large switchgear enclosures as would be needed with circuit breakers.

Since the latched contactor uses fuses for short-circuit protection, in the event of a heavy fault, the fuses may operate. If this occurs, the downtime associated with replacement of the fuses is longer than that required if a circuit breaker is used. However, experience suggests that heavy faults are relatively rare, so it is unlikely that this will be a major issue.

For additional discussion on the comparative aspects of contactors and circuit breakers, refer to TechTopics No. 42.

Summary

Latched contactors have been used for decades to feed transformer and other non-motor loads, and their use has grown significantly in recent years. Use of latched contactors is particularly appropriate when transformers are fed from medium-voltage controllers.

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