Application Note AN2013-18

Fail-Safe Tripping in SEL-700 Series Relays

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INTRODUCTION

SEL-700 series relays provide protection and control solutions for motors, feeders, transformers, and generators in small, economic packages. The relays share a common user interface, as shown in Figure 1, and can be customized via the programmable liquid crystal display (LCD) screen, pushbuttons, light-emitting diodes (LEDs), and labels. The relays include the ability to swap or add hardware cards in the field for added functionality and capability. The cards available depend on the relay. Additional analog or digital inputs and outputs, resistance temperature detector (RTD) support, voltage and synchronism channels, and other additional features are provided with specific cards.

The logic engine in each SEL-700 series relay allows the user to program custom equations that can be used for automation and protection, such as the conditions for tripping a circuit breaker. This application note explains situations where fail-safe tripping may be preferred and describes the logic to implement it in the SEL-700 series relays.

Figure 1 SEL-700 Series Relays

Tracking of reliability and quality data shows that the mean time between failures (MTBF) of SEL relays continues to increase with each passing year. Each SEL relay, including the SEL-700 series relays, continually performs self-diagnostic testing to detect the rare occurrence of a failure. If the relay detects that it is unfit for protection, it will disable all protection and control elements, extinguish the **ENABLED** front-panel LED, de-energize all output contacts, and latch the hardware failure bit alarm **HALARM** to alert the user of the failure. Depending on the relay, it may restart itself several times in an attempt to clear the failure.

When a relay disables itself, it prevents an undesired trip of the circuit breaker when the protection is no longer reliable. The system must run on backup protection until the failed relay is replaced or repaired. This is the desired outcome for most utilities and industrial facilities where system availability is paramount for production or customer needs.

However, there are several situations where the user may want the circuit breaker to trip during a relay failure, including the following:

- Backup protection is slow or inadequate to prevent equipment damage.
- A failed relay on a feeder trips to prevent the possibility of the main bus breaker tripping on backup protection.
- It is deemed acceptable for a failed relay to trip a circuit breaker and prevent an increase in the arc-flash hazard rating for unaware downstream workers.

"Fail-safe tripping" is the phrase used to describe a relay that will, on failure, trip a circuit breaker or contactor.

FAIL-SAFE TRIPPING SOLUTION

The following actions are required to implement a fail-safe tripping solution in SEL-700 series relays:

- Add the tripping bit into the output equation for a normally closed b contact. Each SEL-700 series relay comes standard with a normally open and normally closed contact for Output 103 that is collectively designated as a Form C output contact. Adding additional hardware cards can increase the number of Form C contacts for a relay.
- In the relay settings, set the fail-safe setting for the trip output contact to **Y**. See Figure 2 for details.
- Wire the trip contact to trip the circuit breaker. Ensure the normally closed contact is used between Pins 07 and 09, as shown in Figure 3.

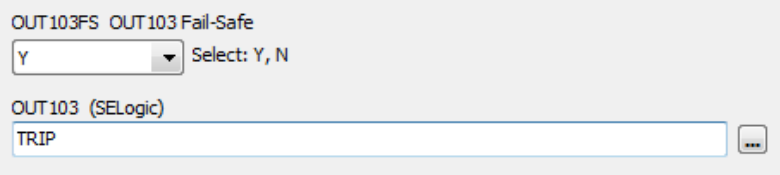

Figure 2 Example SEL-751A Feeder Protection Relay Fail-Safe Logic

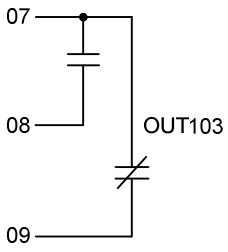

Figure 3 Example SEL-751A Form C Output Contact

When the fail-safe setting is enabled on a contact, the following occurs:

- The relay coil is energized when the relay is turned on and operational. A normally closed contact will be held open under healthy conditions when the trip bit is not asserted.
- The relay coil is de-energized under the following conditions: the logic equation for the output contact is satisfied, the power supply is removed from the relay, or the relay fails its self-test and disables protection.

When the normally closed contact becomes de-energized, it closes and provides a path for the trip coil to become energized, as shown in Figure 4. Note that in this example, the breaker will immediately trip free if it is closed while the output contact is de-energized.

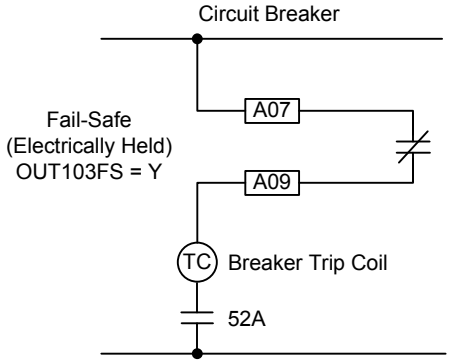

Figure 4 Relay Trip Contact Wiring

FAIL-SAFE USE IN MOTOR STARTING CIRCUITS

Fail-safe outputs are also commonly used in motor starting circuits with motor protection relays, such as the SEL-749M Motor Relay and SEL-710 Motor Protection Relay. In Figure 5, the contactor will close when coil CR is energized.

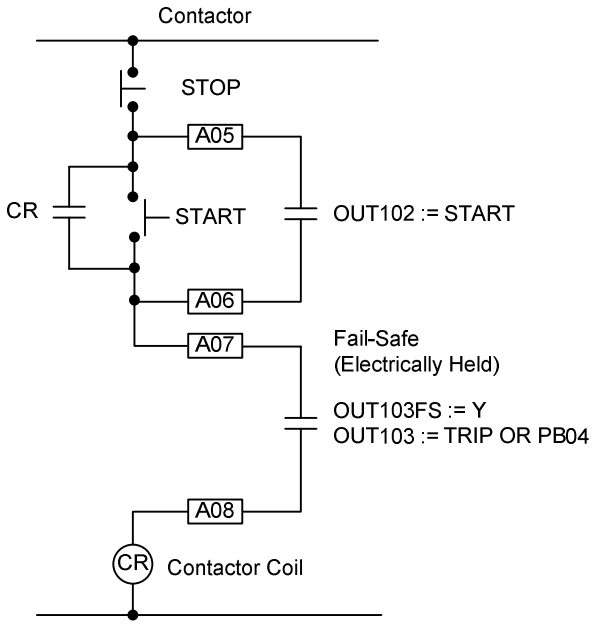

Figure 5 Motor Control Circuit

In Figure 5, the fail-safe output contact OUT103 is a normally open contact, and it will be closed when the relay is turned on and operational. Pressing the external **{START}** pushbutton or sending a **START** command to the relay will energize CR and start the motor, and a small seal-in contact will keep the circuit energized. The motor is stopped by either the external **{STOP}** pushbutton (**{PB04}** in Figure 5) being pressed or the relay trip bit asserting. The assertion of the logic equation for OUT103 causes the output to open and de-energizes coil CR so the contactor can open and stop the motor. If the protective relay loses power or is no longer able to provide protection, then OUT103 will open, forcing the contactor to stop the motor.

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