SEL-849 Fail-Safe and Nonfail-Safe Tripping

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INTRODUCTION

The SEL-849 Motor Management Relay is a versatile product suited for both industrial and utility applications. It offers current-, voltage-, and thermal-based motor protection; current- and voltage-based feeder protection; arc-flash detection; and power metering.

The relay provides the option for fail-safe or nonfail-safe tripping mode. Motor applications typically use the nonfail-safe mode, but fail-safe mode may be preferred for other applications. Each output can be set for either mode.

This application note will describe these modes and how to use them specifically for the SEL-849. See application note AN2013-18 for a detailed explanation of fail-safe tripping in the SEL-700 series relays.

DEFINITIONS

- **Fail-safe** is an output contact that is energized during normal relay operation and is de-energized when relay power is removed or if the relay fails.

- **Nonfail-safe** is an output contact that is not energized during normal relay operation. When referring to a trip or stop-output contact, the protected motor remains in unprotected operation when relay power is removed or if the relay fails.

- **Fail-safe tripping** describes a relay that will, on failure, trip a circuit breaker on contact.

When the fail-safe mode is enabled on an output contact:

- The relay coil is energized continuously if the relay is powered and operational. A normally closed contact stays 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 relay power supply voltage is removed, or the relay fails (self-test status is FAIL).

SEL-849 FAIL-SAFE AND NONFAIL-SAFE SETTINGS

The default setting for Outputs 01, 02, and 03 is nonfail-safe, while the default for Output 04 is fail-safe.

The fail-safe and nonfail-safe settings can be viewed and changed using QuickSet or the relay's browser-based settings page under **Settings** > **Protection** > **Output Settings**. See Figure 1.

Figure 1   Default Output Settings

Output 01 is the default trip output and is hidden unless the factory logic setting (FACTLOG) is changed from the default setting of Y to N. Open **Settings** > **Protection** > **Configuration Settings** and change **Y** to **N**, as shown in Figure 2.

Figure 2   Factory Logic (FACTLOG) Setting

Once FACTLOG is set to **N**, OUT01 becomes visible and the fail-safe setting can be set to **Y**, as shown in Figure 3.
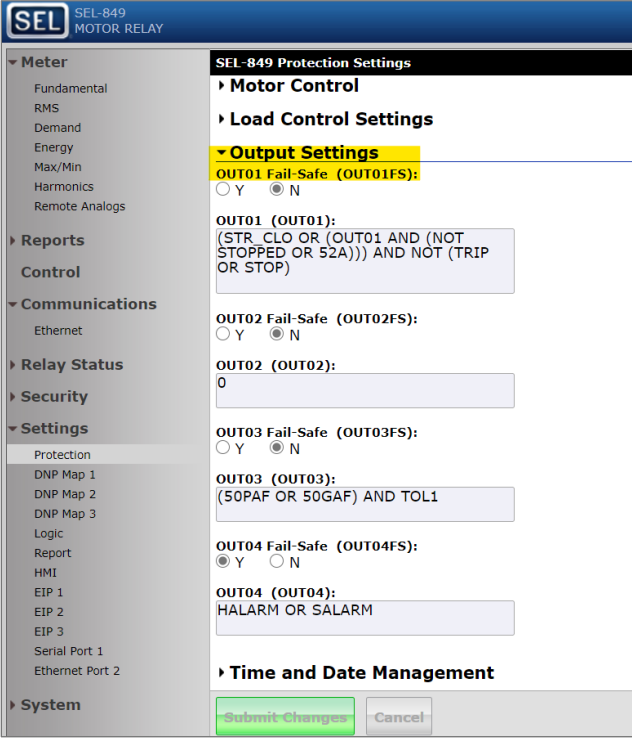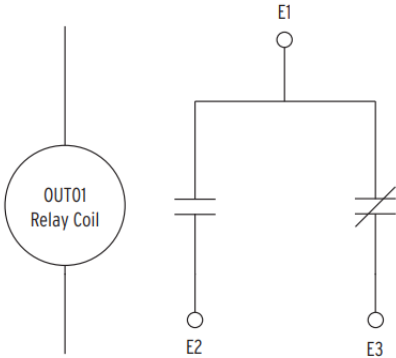

Figure 3   Output Settings with FACTLOG Set to N

SEL-849 FAIL-SAFE AND NONFAIL-SAFE TRIPPING FUNCTIONALITY

Figure 4 shows the OUT01 relay coil and Form C contact. When the relay coil is de-energized, the contact between E1 and E2 is open, while the contact between E1 and E3 is closed.

Contacts are shown with the OUT01 relay coil de-energized.

Figure 4   OUT01 Relay Output Contact Configuration (Figure 2.7 in the Instruction Manual)

Table 1 provides the state of the contacts when in fail-safe and nonfail-safe modes, defined by the power status of the relay.

Table 1   OUT01 Fail-Safe and Nonfail-Safe Contact State

	Relay is Not Powered		Relay is Powered and Operational	
OUT01 Mode	**E1-E2 Contact State**	**E1-E3 Contact State**	**E1-E2 Contact State**	**E1-E3 Contact State**
Fail-Safe	opened	closed	closed	opened
Nonfail-Safe	opened	closed	opened	closed

Examples of traditional fail-safe and nonfail-safe wiring methods used to control breakers and contacts are shown in Figure 5. Although the diagrams are shown using SEL-849 OUT01 contacts, the use of SELOGIC® control equations (Table 2) are not to be considered in these depictions.
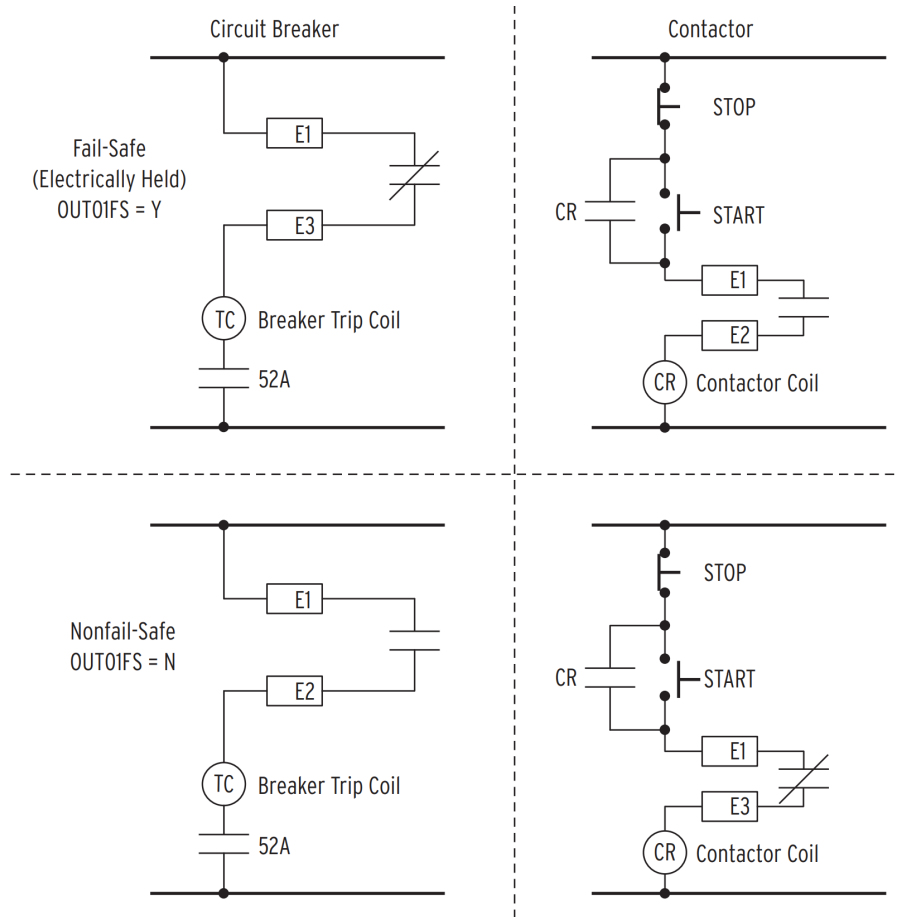

Figure 5   OUT01 Contact Fail-Safe and Nonfail-Safe Options (Figure 2.8 in the Instruction Manual)

OUTPUT SETTINGS

Table 2 shows the factory default settings for the four relay outputs. Only OUT04 has fail-safe enabled by default.

With the factory default logic (FACTLOG = Y), the SEL-849 achieves fail-safe functionality using SELOGIC control equations.

In the relay's default settings, OUT01 is configured as the trip output with fail-safe set to N. Fail-safe tripping is functionally achieved by using OUT01 for the motor applications (APP is set to MOTOR or VFD).

OUT01 = (STR_CLO **OR** (OUT01 **AND** (**NOT** STOPPED **OR** 52A))) **AND NOT** (TRIP **OR** STOP)

where:

- **STR_CLO** is the start/close command
- **STOPPED** is the motor-stopped Relay Word bit
- **52A** is the breaker/contactor status SELOGIC control equation
- **TRIP** is the output of trip logic
- **STOP** is the stop/open command

Refer to the instruction manual for further details.

Table 2   Control Output Equations and Contact Behavior Settings (Table 4.41 in the Instruction Manual)

Setting Prompt	Setting Range	Setting Name = Factory Default[a]
OUT01 Fail-safe	Y, N	OUT01FS = N
OUT01	SELOGIC	OUT01 = (STR_CLO **OR** (OUT01 **AND** (**NOT** STOPPED **OR** 52A))) **AND NOT** (TRIP **OR** STOP)
OUT02 Fail-safe	Y, N	OUT02FS = N
OUT02	SELOGIC	OUT02 = 0
OUT03 Fail-safe	Y, N	OUT03FS = N
OUT03	SELOGIC	OUT03 = (50PAF **OR** 50GAF) **AND** TOL1
OUT04 Fail-safe	Y, N	OUT04FS = Y
OUT04	SELOGIC	OUT04 = HALARM **OR** SALARM

[a] Default settings shown are for FACTLOG = Y, APP = MOTOR, and STARTRTY = FVNR. The relay automatically changes the default settings when the APP and/or STARTRTY setting is changed:
- When STARTRTY = FVR or 2SPEED,
  - OUT01 = ((STR_CLO **AND NOT** SPEED2) **OR** (OUT01 **AND** (**NOT** STOPPED **OR** 52A))) **AND NOT** (TRIP **OR** STOP)
  - OUT02 = ((STR_CLO **AND** SPEED2) **OR** (OUT02 **AND** (**NOT** STOPPED **OR** 52A))) **AND NOT** (TRIP **OR** STOP)
- When APP = FEEDER,
  - OUT01 = TRIP **OR** STOP
  - OUT02 = STR_CLO
- When STARTRTY = STAR_D,
  - OUT02 = DELTA **AND** 52A
  - OUT03 = STAR **AND** 52A

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