



## *Monitoring the Health of SEL Relays*

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### INTRODUCTION

One of the many advantages of SEL protective relays is their automatic self-testing capability. SEL relays include automated self-testing to determine the health of the device. Self-test mechanisms measure and verify that power supply voltages are within range, validate checksums of data, check the ability to read and write to memory, ensure that analog-to-digital conversion is correct, and monitor watchdog timers. A watchdog timer is normally designed to time out when a critical process, like protection, does not complete in its allocated time. For example, if a relay has a 4-millisecond processing interval, the watchdog timer might be designed to expire in 5 milliseconds. Thus a processor stall or other failure is rapidly detected and alarmed immediately.

### ALARM CONTACTS AND ENABLE LIGHTS

SEL relays come standard with a dedicated or programmable alarm output contact. These contacts may be Form A, Form B, or Form C. The alarm contact is held in its energized position when the relay is functional and powered correctly. If the relay fails or is powered down, the alarm contact safely falls to its de-energized position. Form A contacts are open in the relay de-energized or failed state; Form B contacts are closed in the relay de-energized or failed state. All alarm contacts are supervised by a watchdog timer. If the relay fails to update the watchdog timer, the alarm contact falls to its de-energized position.

SEL relays also include a light on the front panel that indicates that the relay is enabled. The **ENABLED** light is intended to indicate that supply voltage is present, the device is healthy, and protection is enabled. The **ENABLED** light logic does not necessarily behave the same as the alarm contact and should **not** be depended on to determine if the relay is in service.

In some designs and failure scenarios, it is possible that the **ENABLED** light and the self-test alarm contact may not agree because the **ENABLED** light is not controlled by the watchdog timer. Thus the **ENABLED** light may not extinguish if the processor stalls, for instance.

### SEL RECOMMENDED BEST PRACTICES

1. If the **ENABLED** light is off, the relay is disabled and protection is out of service. While it is possible that the **ENABLED** light itself may fail while the relay is functional, this is rare. For improved safety, assume that when the **ENABLED** light is off, protection is disabled. To check the **ENABLED** light status, press the relay **TARGET RESET/LAMP TEST** pushbutton.
2. If the **ENABLED** light is on, the relay is likely enabled, but because of the explanation above, this cannot and should not be assumed to be true.
3. If the normally closed or Form B alarm contact is closed (or if a normally open or Form A alarm contact is open), then the relay is disabled and protection is out of service.

4. Regardless of relay health, there may be other problems in the protection scheme, such as a failed instrument transformer or an open breaker trip coil, which may not cause the **ENABLED** light or alarm contact to indicate trouble. The protective relay, while critical, is just one component in the overall protection system. All components should be monitored, tested, and verified to ensure proper and safe operation of the protection system.
5. SEL strongly recommends that every installation monitor the state of the self-test alarm contact and other critical protection system statuses via a local annunciation panel and/or remote supervisory control and data acquisition (SCADA) system that is continuously monitored.
6. In some newer relays, the alarm function is not dedicated to a fixed output contact. Relays ship from the factory with one output configured as an alarm contact. Relay settings allow the user to reassign the alarm to one or many outputs. While it is acceptable to move or duplicate the alarm function, it should not be eliminated entirely.
7. Most power system applications are critical. Especially in applications that involve live-line work or work in or around high arc-flash hazard switchgear, SEL strongly recommends redundancy, not simply backup protection, and manual relay status checks, as described in Number 1 of the “Monitoring Relay Status” section.
8. There are typically many devices in a substation, so automation and visualization tools should be used to provide a complete picture to operators, technicians, and engineers.
9. The relay should be polled using a SCADA system or a communications or automation controller. Incorporate a watchdog timer in the serial or Ethernet communications link; if the relay fails to respond to repeated polls, consider the communications loss as a failed relay.
10. Manual checking of lights and meters is not as reliable or as fast as automation; it is also more expensive.
11. Communications to view metering and status or to change settings and perform controls are password protected. When access attempts fail, when any second access level is attained, or when settings are changed, the alarm contact operates momentarily. Monitor and investigate momentary alarm contact operations.
12. Event reports should be automatically retrieved and promptly reviewed to ensure proper protection system performance.

## MONITORING RELAY STATUS

The following are five different ways to monitor status, in increasing levels of performance:

1. Perform an entirely manual process. Check the **ENABLED** light, alarm contact status, metering data, and self-test status. Look for and analyze new event reports.
2. Wire alarm contacts to an annunciator.
3. Wire alarm contacts to a continuously monitored SCADA system.
4. Use additional logic and alarm outputs to indicate trouble not indicated by the alarm contact; monitor the health of the entire protection system.
5. Incorporate synchrophasor measurements into an automated monitoring scheme, which, for example, compares redundant voltage information and calculates Kirchoff’s current law to check voltages and currents.

## SUMMARY

**ENABLED** lights provide a convenient means to monitor relay performance. However, do not depend on them as the sole indicator of relay health. SEL relays provide many tools to indicate device health, including alarm contacts, **ENABLED** lights, metering, communications, annunciation, event reports, automation systems, and more. Use multiple indicators, when possible, to make a comprehensive and timely assessment of device performance.

Please contact SEL at +1.509.332.1890 if you have any concerns or if you wish to learn more about the suggestions outlined in this application note.

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