



Asset Optimization With Monitoring Capabilities in the SEL-487E

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INTRODUCTION

Substation assets, such as transformers and circuit breakers, are valuable and need to be monitored and maintained for longevity. Damaged assets can be extremely costly; therefore, asset optimization is essential.

Asset optimization tools are conveniently built into many SEL relays and monitoring devices, eliminating the need for extraneous devices. The SEL-487E Transformer Protection Relay has monitoring capabilities to optimize asset performance and reduce maintenance costs.

PROBLEM

Without asset monitoring, costly and irreparable damage may occur.

1. **DC battery failure** – When substation dc power systems fail, circuit breakers are unavailable, protective relays are out of service, and communications are stopped altogether. Under these conditions, there is a high risk of catastrophic failure.
2. **Through-fault damage** – Through faults on transformers reduce the life of the supporting structures within the transformer and may accelerate damage to transformer insulation systems. These factors lead to a decrease in the transformer's overall lifetime. Most transformers have no means of monitoring the through-fault energy that has accumulated over their lifetime. Transformers may fail without warning if severe damage from accumulated through faults occurs. Numerous through faults may indicate problems in other parts of the system, such as improper vegetation control or incorrectly set reclosers.
3. **Thermal damage** – Transformers are insulated using cellulose materials, which have a lifetime measured in decades when immersed in nonconductive oil and kept within thermal design limits. However, when transformers are overloaded for extended periods of time, the excessive heat causes this insulation to degrade, becoming brittle and more susceptible to failure. A failed insulation system results in internal transformer faults and damage that is very expensive to correct.
4. **Breaker failure** – Breaker contact replacement is one of the leading maintenance operations at most utilities. Breaker charging system failures may prevent correct operation of the breaker. Failure of a breaker to operate is one of the most critical failures that can occur in a substation and has far-reaching effects on the power system.

SEL SOLUTION

The SEL-487E has dc battery, through-fault, thermal, and breaker failure monitoring built into the relay. At no additional cost, the SEL-487E provides not only excellent transformer protection but also monitoring tools for asset optimization that can be applied today.

The dc monitoring in the relay measures the dc voltage, ac ripple, and voltage between each battery terminal and ground. The relay can be programmed to generate a wide range of alarm indications for local or remote annunciation of alarm conditions, allowing time for maintenance before a disastrous failure occurs. Apply the MET BAT command in a communications window to view battery system voltages and time stamps for voltage excursions.

Through-fault monitoring in the relay calculates the cumulative mechanical stress on the transformer windings by recording the number of through faults that have passed through a particular winding, the number of faults per phase, and the total accumulated percentage of the transformer's through-fault capability, as well as when the faults occurred and their duration and magnitude. Use the TFE command in the communications window to view a report of these values. This monitoring device helps prevent costly damages before they occur.

The transformer thermal model within the relay monitors key thermal indicators and calculates an insulation aging factor that shows the decay rate of the transformer insulation based on IEEE standards. The thermal element uses winding hot-spot temperatures to calculate the insulation aging acceleration factor, daily rate of loss of life, and total loss of life. The THE command generates reports monthly, daily, hourly, or even every minute to supply valuable data that track the overloading effects over the life of the transformer. Alarm outputs can be programmed to indicate problems that require immediate attention.

Breaker monitoring uses easy-to-set curves that measure the amount of current interrupted during each operation and provides alarms if the accumulated interrupted current exceeds the breaker manufacturer's recommendations. Breaker monitoring also records electrical and mechanical operate times, which can indicate failing mechanisms within the breaker. In addition, the charging motor or compressor run times are monitored as a means of indicating a damaged or failed energy storage system. Apply the BRE command to access vital information about the condition of substation circuit breakers and preset or reset circuit breaker monitor data. Comprehensive breaker monitoring in SEL relays saves time and money and provides peace of mind that breakers will operate properly when the time comes.

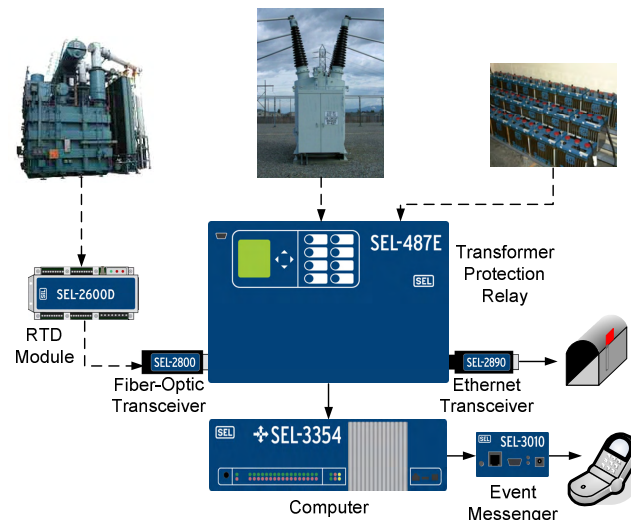


Figure 1 Asset optimization example—conveniently receive an alarm by email or mobile phone when metered dc battery, through-fault, thermal, or breaker indicators exceed user-specified thresholds

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