Recommended use of LSIG-equipped circuit breakers in UPS applications

**Background**

LSIG (long time, short time, instantaneous, ground) -equipped circuit breakers are often required by code in the application of larger UPS systems. Specifically, UPS systems fed by 480 volts (up to 1000V) and protected by circuit breakers of 1000 amps or greater, must generally have a means of ground fault protection in the service or feeder for that UPS. Note that certain exceptions in the NEC allow for non-LSIG circuit breakers to be used. An example is shown below:

**NEC 215.10**  
Exception No. 2: The provisions of this section shall not apply if ground-fault protection of equipment is provided on the supply side of the feeder and on the load side of any transformer supplying the feeder.

Keep in mind that different ground fault protection requirements may be required in specific applications such as healthcare (517.17) or emergency power (700.31). Consider all relevant sections of the code. See NEC 210.13, 215.10, 230.95, 240.13, 517.17, and others.

In addition to its primary function of protection from faults, the adjustability of an LSIG trip unit allows coordination of the breakers in the electrical path during a fault event. This ensures that the breaker closest to the fault will trip first, before, or instead of, the upstream protection. This isolates the fault without unnecessarily shutting down unaffected equipment.

**UPS considerations**

Modern UPSs are used almost exclusively in mission critical applications, which may include datacenters, medical imaging, or factory floor automation, among others. A UPS with an input or output isolation transformer, may require LSIG breakers upstream and downstream of the UPS for effective fault protection. But any UPS that does not include an isolation transformer in its power train is protected by the single LSIG incorporated in its feeder through its output until the first isolation transformer which may be in a PDU (Power Distribution Unit). The LSIG in the feeder or service provides protection for the downstream equipment as there is no isolation transformer in a transformerless UPS. A downstream fault will pick up the LSIG in the feeder or service source, thus limiting the need for additional LSIG as fault protection on the UPS output.

In fact, the presence of LSIG devices in the other circuit breakers surrounding the transformerless UPS may create issues with unintended breaker tripping, interrupting the operation of mission critical processes or equipment. The section below describes some of these issues and recommends methods of mitigating the risk of nuisance trips.
Parallel connected UPS

Two or more UPSs in parallel constantly make small adjustments in the phase of their inverters to facilitate precise load sharing between the UPS modules. These adjustments can allow the back-feeding of one or more of the UPS module output breakers, or MOBs (see figure 1). If these breakers are equipped with LSIG, they may sense the unbalanced current and trip, depending on the sensitivity of their settings. These backfeed currents are brief, but may have significant magnitude, making current pickup level adjustments less effective.

Recommendation or solution

Do not use ground fault sensing circuit breakers in the MOB positions

Transfer from bypass source onto UPS inverter

When a UPS is transferred from bypass to inverter operation, the inverter is controlled to shift its phase with respect to the bypass source to ensure a smooth transfer, while the two sources are briefly paralleled. Again, this action can be seen by the feeder for the bypass as an unbalance or back feed, tripping the breaker unnecessarily.

Recommendation or solution

Set the time delay to maximum (typically 500 msec), on the bypass feeder breaker

Maintenance or “wrap around” bypass breakers

These breakers are downstream of the main UPS feeder or service, and are usually labeled as shown below (see figure 1):

- **BIB**: bypass isolation breaker; isolates the UPS internal static bypass for de-energized service
- **MBP**: maintenance bypass breaker; wraps around the UPS power conversion circuits, providing power to the critical load while the UPS is being serviced
**MIS or MIB:** maintenance isolation breaker; in series with the UPS output, isolating the UPS output bus from load power.

If LSIG trip is used on any of these breakers, during transitions from UPS-to-bypass, or static bypass-to maintenance bypass, there is the possibility for false positives and nuisance tripping.

**Recommendation or solution**

- For BIB: Set the time delay to maximum, typically 500 msec.
- For MBP and MIS: Set the time delay to at least 100 msec.

**UPS rectifier input breaker trips during battery test**

When the UPS performs an automatic or manual battery test, it back feeds current (watts) back into the breaker that feeds the UPS rectifier, sometimes labeled RIB. The level of current varies depending on how much load is on the output of the UPS, and the duration of the test (minutes), makes time delay adjustment unlikely. Solution

- Disable the battery test or change the setting to run the test with output load only.

**Summary**

The use of LSIG trip features with transformerless UPSs requires consideration and planning beyond what was previously necessary with isolation transformer-based UPS systems. However, the utilization of a single LSIG in the main feeder or service to the UPS will save money and reduce complexity, while still meeting the national electrical code requirements for fault protection on larger feeders. During the design and planning stages, consultation with the circuit breaker vendor and the UPS vendor is strongly recommended.