Considerations for Implementing a Zone-Selective Interlocking Scheme on Medium and Low Voltage Systems

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Zone-Selective Interlocking

Used when time-overcurrent delay is unacceptable. “Chronometric coordination”
Zone-Selective Interlocking

Some form of Inter-IED signaling is required. Chronometric coordination + location logic.
Zone-Selective Interlocking - Hardwiring

Mechanical relay contacts can take approximately 4 ms to 10 ms to operate.

Solid-state contacts can take approximately 0.1 ms to operate but have leakage current. Beware false-positives!
Zone-Selective Interlocking - Hardwiring

Implemented in relays, failure mode is selectable

Fails into fast, non-selective (protective) mode.
LV trip units always fail this way!

Fails into slow but selective mode.
Additional logic can become cumbersome with hardwiring.

M1 TRIP

M1 51

M1 52a

TD

M1 50

50 – F1 (disconnected position shown)

F1 TOC

50 – F2 (disconnected position shown)

F2 TOC

Time Delay Relay

+DC

-DC
• Communications can be used to simplify wiring.
• Count on 4ms delay for priority GOOSE messages.
• Tripping device has a finite # of devices to which it can subscribe.
Zone-Selective Interlocking - Comms

Downstream IED’s publish block & TOC status via GOOSE.
Zone-Selective Interlocking - Comms

Upstream IED subscribes to block statuses via GOOSE.

Default states are chosen to choose failure mode. ON = Slow/Selective OFF = Fast/Non-Selective
Zone-Selective Interlocking - Comms

IED logic is created.

Logic is applied to fast-tripping element.
Zone-Selective Interlocking - Pickups

Upstream pickup must not be more sensitive than any downstream pickup. “Tolerance”

Upstream pickup must not pick up for charging current, inrush, etc.

Downstream pickup must not have any delay!

Beware excessively high pickup settings – DSP clamping
Zone-Selective Interlocking - Timing

Tripping can be set with an intentional delay to allow time for restraint signal to be active, OR a relay’s inherent inverse time/current characteristic can be used to time-coordinate.

Precise timing requires detailed info from manufacturer.

Even “instantaneous” has an inverse time/current characteristic.
Zone-Selective Interlocking - Timing

Tripping delay can be set more generally based on readily available manufacturer info.

Always weigh the benefits and risks when setting the delay. When reduction of clearing time is of utmost importance, attention to timing detail is extremely important.
ZSI Challenge #1: Transformer In-zone

This implementation will only expedite tripping for F1. This scheme will not help F2.

Beware inrush!
MV IED can be blocked for a period of time immediately after energization, but this solution is deficient in two ways:
1) Faults during energization would be slow to clear.
2) Doesn’t account for transient recovery inrush.

This solution seems sort of silly to me. Why are we discussing this at all?
ZSI Challenge #1: Transformer In-zone

2nd Harmonic detection can be used to address inrush.

This solution seems sort of silly to me. Why are we discussing this at all?
This implementation can expedite tripping for F1.

It is important for the LV IED CT’s to be removed from the F1 protected area.
Stress of 1 fault can cause a simultaneous fault.

Under very specific circumstances, the blocking relay would prevent the tripping relay from operating fast.

Normally, fault current would be re-directed into upstream fault so block would be removed.

Can we drop this discussion? Or do you think it is very important?
Conclusions

• ZSI is a longstanding technology that can be used to expedite otherwise slow time-overcurrent protection.

• The scheme can be implemented in many different ways. Consider the failure mode of the scheme.

• Transformer inrush and simultaneous faults offer challenges to ZSI implementation.

• Choose your ZSI timing carefully.
Thank You

Questions?