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.
Zone-Selective Interlocking

Some form of Inter-IED signaling is required.
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!
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Fails into fast, non-selective mode.

Fails into slow but selective mode.
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Zone-Selective Interlocking - Hardwiring

Additional logic can become cumbersome with hardwiring.
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
IED logic is created.

Logic is applied to fast-tripping element.
Upstream pickup must not be more sensitive than any downstream pickup.

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
Tripping must be delayed to allow restraint signal.

Precise timing requires detailed info from manufacturer.

Even “instantaneous” overcurrents have a time/current characteristic.
Tripping delay can be set more generally based on readily available manufacturer info. Always weigh the benefits and risks when setting the delay. Cost of false-operation vs. Benefit of reduced 20 ms clearing time?
Beware inrush!

This implementation will only expedite tripping for F1. This scheme will not help F2.
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.
ZSI Challenge #1: Transformer In-zone

2nd Harmonic detection can be used to address inrush.
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.
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?