Substation Engineering
Lecture 14: Auto-Reclosers (Part 2 of 2)

Milav Dabgar

Auto-Recloser Coordination

- Substation Engineering (DI04009011)
- Lecture 14: Auto-Reclosers (Part 2 of 2)
- Coordination Strategies and Network Application

Agenda

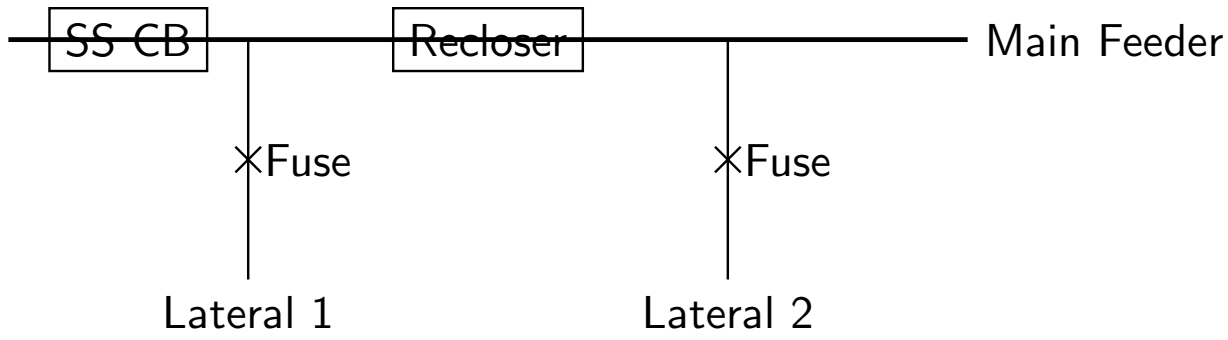
- What is Protection Coordination?
- Distribution Network Layout
- Time-Current Curves (TCC)
- Recloser-Fuse Coordination
- Strategy 1: Fuse Saving Scheme
- Strategy 2: Fuse Blowing Scheme
- Comparison of Schemes

What is Protection Coordination?

- Coordination is the process of selecting protective devices and their settings so that only the faulted part of the system is disconnected.
- Goal: Minimize the number of customers affected by a fault.
- Principle: The protective device CLOSEST to the fault should operate FIRST.
- If the closest device fails, the upstream device should act as a backup.

Typical Distribution Network Layout

- Substation Breaker: Protects the entire feeder.
- Main Feeder Recloser: Installed along the main line to segment it.
- Lateral Fuses: Installed where small lateral branches tap off the main feeder.
- Most faults occur on the lateral branches (due to trees, animals in residential areas).



Time-Current Curves (TCC)

- A TCC is a log-log graph showing the time it takes for a device to operate at various fault currents.
- X-axis: Current (Amps).
- Y-axis: Time (Seconds).
- Reclosers have adjustable TCCs (Fast curves and Slow/Delayed curves).
- Fuses have fixed TCCs (Minimum Melting Curve and Total Clearing Curve).

Recloser Operating Characteristics

- A typical recloser sequence uses a combination of Fast and Slow operations.
- Example Sequence: 2 Fast Trips, followed by 2 Slow (Delayed) Trips.
- Fast Curve (e.g., 'A' curve): Trips almost instantaneously. Intent is to clear transient faults BEFORE a downstream fuse can begin to melt.
- Slow Curve (e.g., 'C' curve): Trips with a time delay. Intent is to give a downstream fuse enough time to blow if the fault is permanent.

Fuse Saving Scheme: Concept

- Objective: Prevent lateral fuses from blowing during transient faults.
- How it works:
- 1. Fault occurs on lateral branch.
- 2. Recloser 'Fast Curve' operates FASTER than the fuse's minimum melting time.
- 3. Recloser trips, arc clears, recloser closes.
- 4. If fault was transient, the line is restored and the fuse is SAVED.

Fuse Saving Scheme: Permanent Faults

- What if the fault is permanent?
- 1. Recloser does its fast trips (e.g., 2 times). The fault remains.
- 2. Recloser switches to its 'Slow Curve'.
- 3. Recloser stays closed long enough for the fault current to melt and blow the lateral fuse.
- 4. Fuse clears the faulted lateral branch.
- 5. Main feeder remains energized.

Pros and Cons of Fuse Saving

Pros	Cons
Saves truck rolls for transient lateral faults.	Every customer on the main feeder experiences a momentary blink during the fast trips.
Excellent SAIDI (duration) metrics.	Poor MAIFI (momentary interruption) metrics.
Reduces permanent outage costs.	Power quality complaints from sensitive commercial loads (blinking clocks, computer reboots).

Fuse Blowing Scheme: Concept

- Objective: Never blink the main feeder for a fault on a lateral branch.
- How it works:
- 1. All recloser operations are set on a 'Slow Curve'.
- 2. If a fault occurs on a lateral branch, the fuse ALWAYS blows before the recloser can trip.
- 3. The recloser does nothing for lateral faults. It only acts on main line faults.

Pros and Cons of Fuse Blowing

Pros	Cons
Perfect power quality for main feeder customers (no blinks).	EVERY lateral fault (even transient) causes a permanent outage for that branch.
Excellent MAIFI metrics.	Poor SAIDI metrics.
Simpler coordination logic.	High maintenance costs (many truck rolls to replace blown fuses).

Hybrid Schemes

- Modern digital relays allow for adaptive or hybrid schemes.
- Weather-dependent: Use Fuse Saving during a lightning storm (high transients), switch to Fuse Blowing on a clear day.
- Load-dependent: If a critical customer (hospital, data center) is on the main line, use Fuse Blowing.
- Trip-saving (Trip-to-Save): Recloser trips fast once. If fault persists, it stays closed and lets the fuse blow.

Summary

- Coordination ensures only the faulted section is isolated.
- Reclosers use Fast and Slow Time-Current Curves to coordinate with fuses.
- Fuse Saving uses fast trips to clear transients without blowing fuses (causes blinks).
- Fuse Blowing forces the fuse to clear all lateral faults (prevents blinks, increases outages).
- The choice of scheme depends on utility goals: minimizing outages vs. maximizing power quality.