

Substation Engineering

Lecture 13: Auto-Reclosers (Part 1 of 2)

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Auto-Reclosers in Power Systems

- Substation Engineering (DI04009011)
- Lecture 13: Auto-Reclosers (Part 1 of 2)
- Principles and Fault Characteristics

Agenda

- Nature of Power System Faults
- Transient vs. Permanent Faults
- What is an Auto-Recloser?
- Why use Auto-Reclosers?
- The Operating Sequence
- Key Terminology
- Dead Time and Reclaim Time

The Nature of Faults on Overhead Lines

- Overhead lines are exposed to the environment (weather, trees, animals).
- Studies show that 80% to 90% of faults on overhead networks are TRANSIENT.
- Transient faults disappear quickly if the line is temporarily de-energized.
- Only 10% to 20% of faults are PERMANENT, requiring physical repair.

Examples of Transient Faults

- Lightning strikes causing a temporary arc across an insulator.
- A bird or squirrel bridging the gap between a phase and ground, which is then vaporized or falls away.
- Wind blowing branches into a line, which then swing clear.
- Ice loading causing lines to gallop and briefly touch.

Examples of Permanent Faults

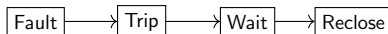
- A broken conductor falling to the ground (downed line).
- A tree falling entirely across the lines and remaining there.
- A shattered insulator.
- A vehicle crashing into and breaking a utility pole.

The Problem with Manual Restoration

- Historically, if a line tripped, it locked out.
- A crew had to be dispatched to patrol the line, which could take hours.
- If they found it was just a transient fault (like a lightning strike), they would just close the breaker.
- Result: Hours of power outage for customers due to a fault that lasted milliseconds.

What is an Auto-Recloser?

- A self-contained device with the necessary intelligence to sense overcurrents, time and interrupt fault currents, and automatically re-energize the line.
- If a fault is detected, it trips (opens).
- It waits a brief moment to allow the transient fault arc to clear (de-ionize).
- It then automatically re-closes.
- If the fault is gone, power is restored instantly. If not, it tries again or locks out.



Benefits of Auto-Reclosing

- Drastically reduces outage duration for customers (SAIDI improvement).
- Maintains system stability on transmission networks by quickly restoring parallel paths.
- Reduces operational costs by minimizing unnecessary line patrols.
- Allows for unmanned operation of remote substations.

The Reclosing Sequence

- A typical recloser is programmed for multiple 'shots' (attempts) before it locks out.
- Example sequence: Trip → 1st Reclose → Trip → 2nd Reclose → Trip → Lockout.
- Fast Trips: The first trip is usually very fast to clear temporary faults quickly before damage occurs.
- Delayed Trips: Subsequent trips are delayed to allow downstream fuses to blow if the fault is permanent and localized.

Key Terminology: Dead Time

- Dead Time (or Reclosing Time): The duration between the clearing of the fault (breaker open) and the reclosing of the breaker contacts.
- Purpose: Must be long enough to allow the arc path at the fault location to de-ionize.
- If Dead Time is too short: The arc will re-strike immediately upon reclosing.
- If Dead Time is too long: Motors stall, and system stability is compromised.

Key Terminology: Reclaim Time

- Reclaim Time (or Reset Time): The time following a successful reclose before the recloser resets its internal counter back to zero.
- Purpose: To distinguish between a single permanent fault and a series of independent transient faults.
- If another fault occurs BEFORE the reclaim time expires, the recloser considers it part of the same sequence.
- If another fault occurs AFTER the reclaim time expires, it treats it as a brand new fault.

Key Terminology: Lockout

- Lockout: The final state of a recloser after it has exhausted all programmed reclosing attempts.
- The breaker remains permanently open.
- Signifies that the fault is highly likely to be permanent.
- Requires human intervention (local or remote SCADA) to reset and close the breaker.

Single-Phase vs. Three-Phase Reclosing

Feature	Single-Phase Reclosing	Three-Phase Reclosing
Fault Type	Used for Single Line-to-Ground faults.	Used for all faults (multi-phase).
Breaker Mechanism	Each phase operates independently.	All three phases trip and close together.
System Stability	Better (2 phases still transmit power).	Worse (all power flow stops).
Complexity	High (complex relays and mechanisms).	Lower.
Application	EHV Transmission Lines.	Distribution and Sub-transmission.

Summary

- 80-90% of overhead line faults are transient and clear themselves if briefly de-energized.
- Auto-reclosers automatically trip and reclose to restore power after transient faults.
- Dead Time is the wait period to allow the arc to clear.
- Reclaim Time is the wait period to reset the sequence counter.
- Lockout occurs when all attempts fail, indicating a permanent fault.