Reclosers & FLISR Applications in Modern Microgrids

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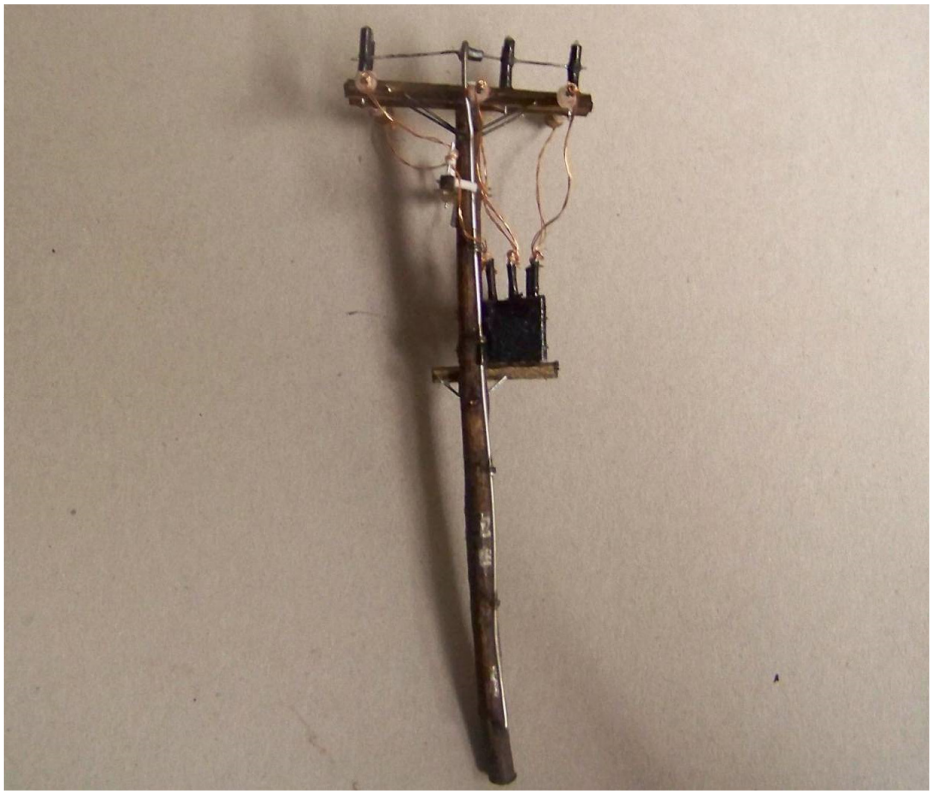
Reclosers: A Brief History

- In the early 1940s reclosers were invented with limited mechanical capabilities by the Kyle Corporation in the US.
- Modern microprocessor based digital relays have unlocked quicker response times and allowed for more dynamic responses to dynamic operating conditions

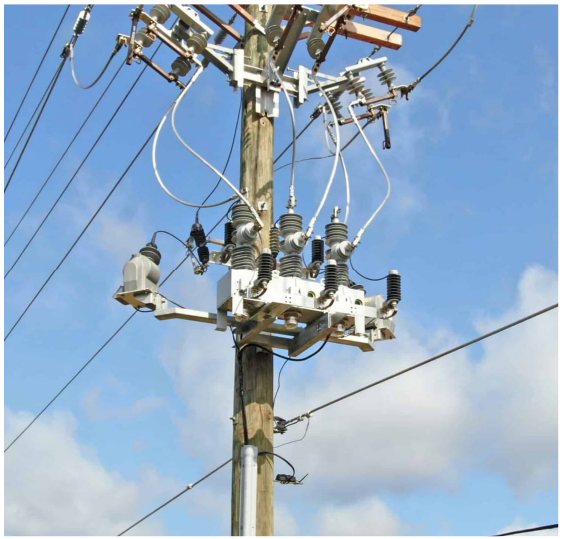


Operational Terminology

- ANSI/IEEE Code: 79 – Automatic Reclosing
- Dead-Time: The open interval between reclosing attempts.
- Lockout State: After exhausting all reclosing attempts with the persistence of a fault. The recloser no longer attempts to automatically reclose and contacts remain open until manual reset.

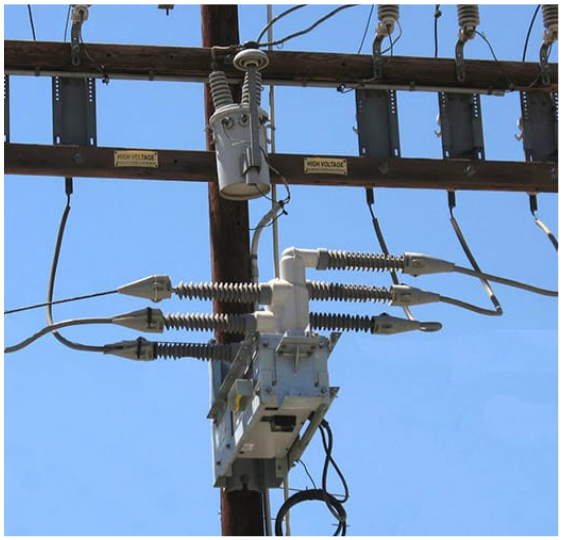
Recloser Suppliers

Southern States



Siemens

G&W



Complimentary Relaying Devices and Suppliers

- Besler (BE1-79M, Multi Shot Reclosing Relay)
- Beckwith (M-7679 R-PAC)
- GE (Multilin R650)
- SEL (SEL-651R)
- Siemens (7SR224)

Protection & Control

Most protection devices allow segments of the larger grid to be isolated from the rest of the network. Usually this takes place during the occurrence of faults.

A level of controllability is always needed and goes together with the protection capabilities of protective circuit equipment that is constantly on the lookout for mis-operations, faults, or unintended behavior.

Reclosing States

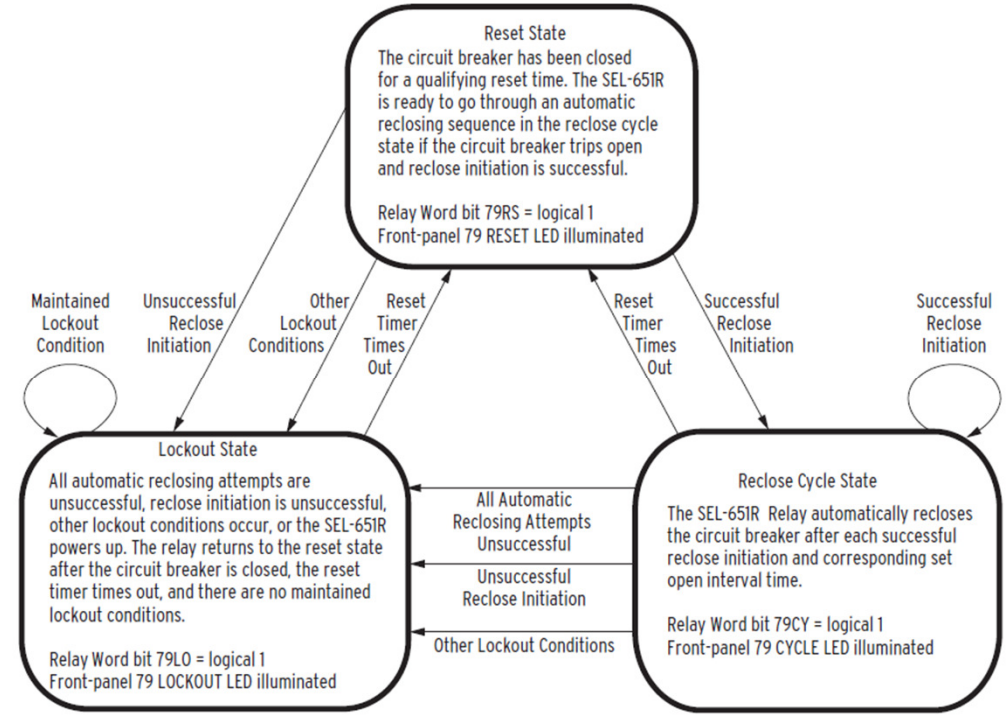
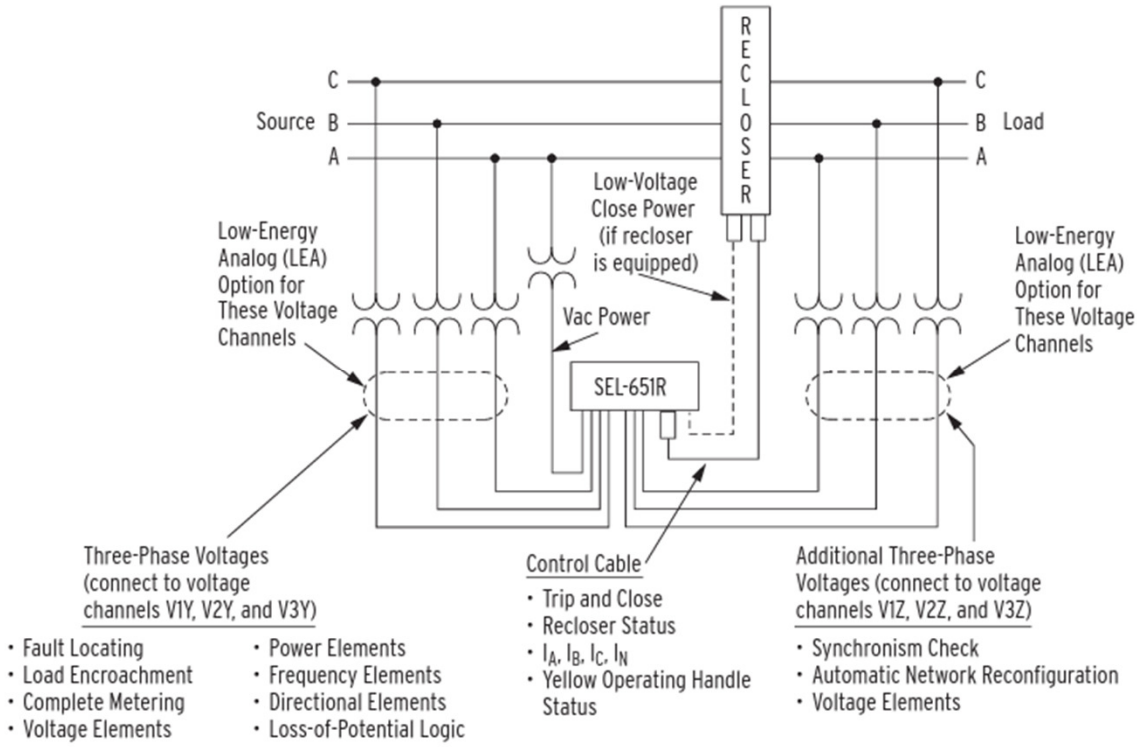
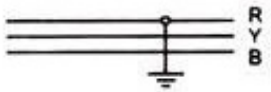
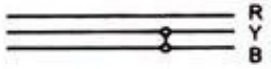
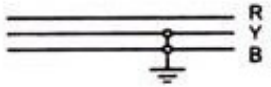
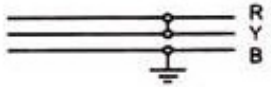
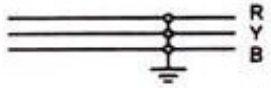
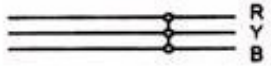


Figure 6.9 Reclosing Relay States and General Operation

System Topology



Faults on Distribution Networks

S.No.	Type of Short-Circuit Fault	Representation	Percentage Occurrence
1.	Single phase to ground (L-G)		70
2.	Phase to phase (L-L)		15
3.	Two phases to ground (L-L-G)		10
4.	Phase to phase and third phase to ground		2 or 3
5.	All the three phases to ground (L-L-L-G)		2 or 3
6.	All the three phases shorted		2 or 3

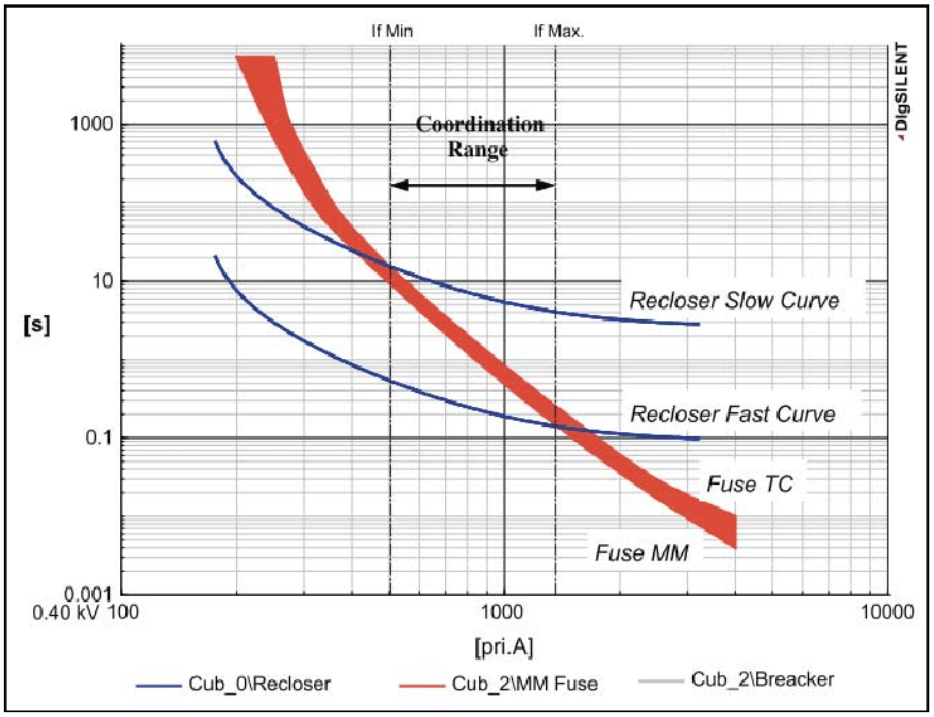
IEEE C37.100

- *Three-phase faults:* The first reclosing attempt should be made after a time delay of 0.5 to 2 seconds.
- *Single-phase-to-ground faults:* The first reclosing attempt should be made after a time delay of 2 to 8 seconds
- *Phase-to-phase and phase-to-phase-to-ground faults:* The first reclosing attempt should be made after a time delay of 8 to 30 seconds.

Fuse Saving Scheme

By aligning the time-current characteristics of these devices, faults can be cleared more efficiently, reducing downtime, minimizing damage, and extending the lifetime of equipment within the system.

Overall, coordinating a circuit breaker or recloser with a fuse improves fault response time, selective fault clearing, and equipment longevity



FLISR – Fault Location Isolation & System Restoration

- For a permanent fault the fault location will easily be isolated and neighboring circuits have restored power successfully since no overcurrent is detected
- It is important to note that FLISR does not avoid outages but works to minimize their impacts on customers when they do occur.

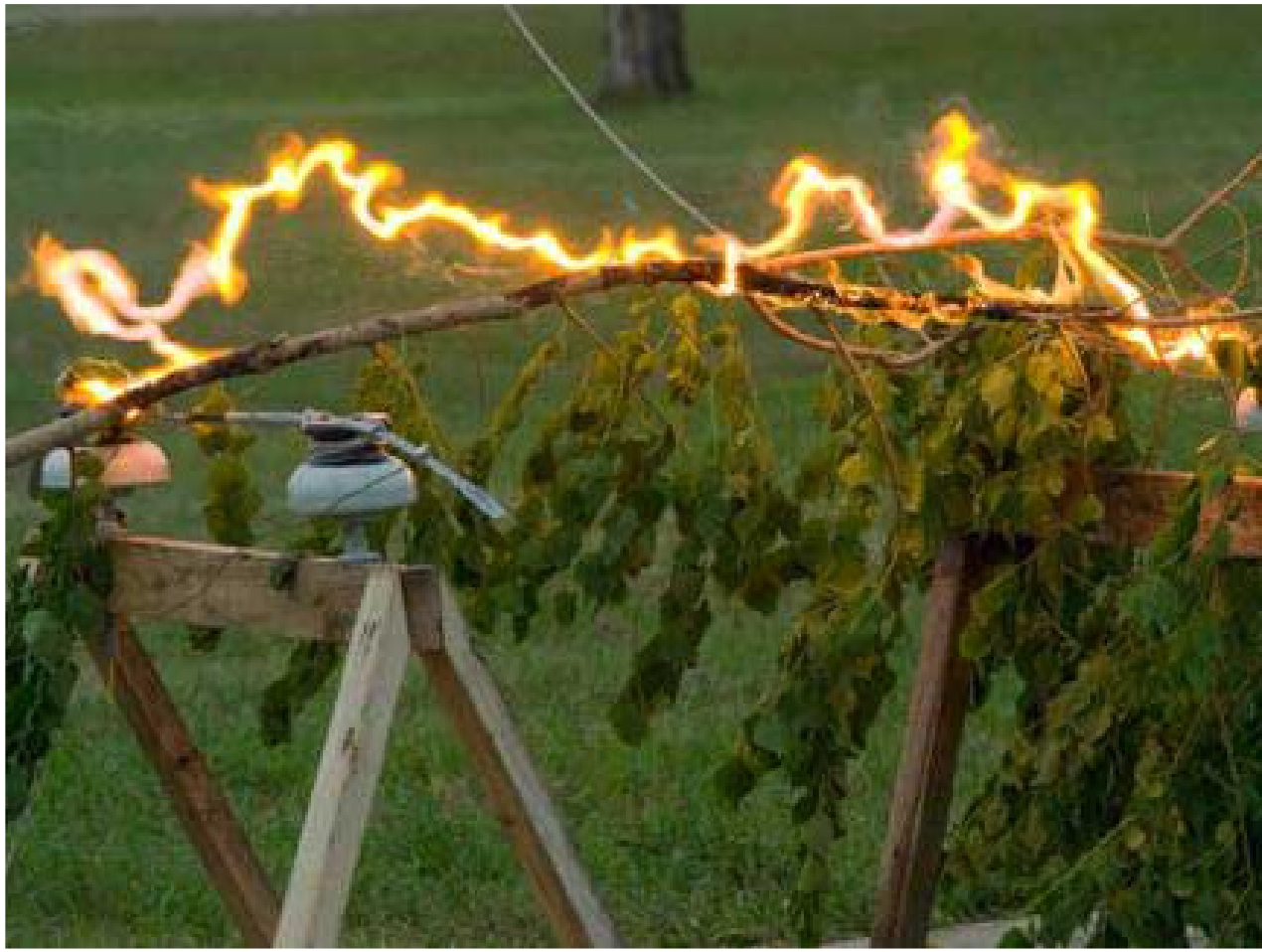
Typical Recloser Operation: Stage 1

Prefault Scenario

Steady state operation on a Distribution Network/Microgrid with power flowing in the forward direction

Stage 2: Fault

1. Vegetation encounters an OH conductor and interrupts the flow of power by drawing current through it.
2. After a few cycles, the branch either falls or burns off.
3. Relay detects a fault and recloser trips.



Stage 3: Response Stage

- Once healthy voltage is detected on the source side of the relay, the reclosing attempt is initiated and successively will be done until the circuit segment that is faulted is reached where overcurrent is detected and only there does the recloser trip since it is operating on a fast curve.
- Some rerouting occurs to deliver power to neighboring circuits and thanks to SCADA and FLISR. Faulted segmented is identified and proper response is in effect in a timely manner.

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Inherent Benefits of Reclosers

- Lifetime of equipment: on average, modern reclosers are designed to have a service life ranging from 20 to 30 years.
- Ease of O&M: timely replacement of components can extend the recloser's lifespan.
- Capital Costs: between $50,000 and $65,000

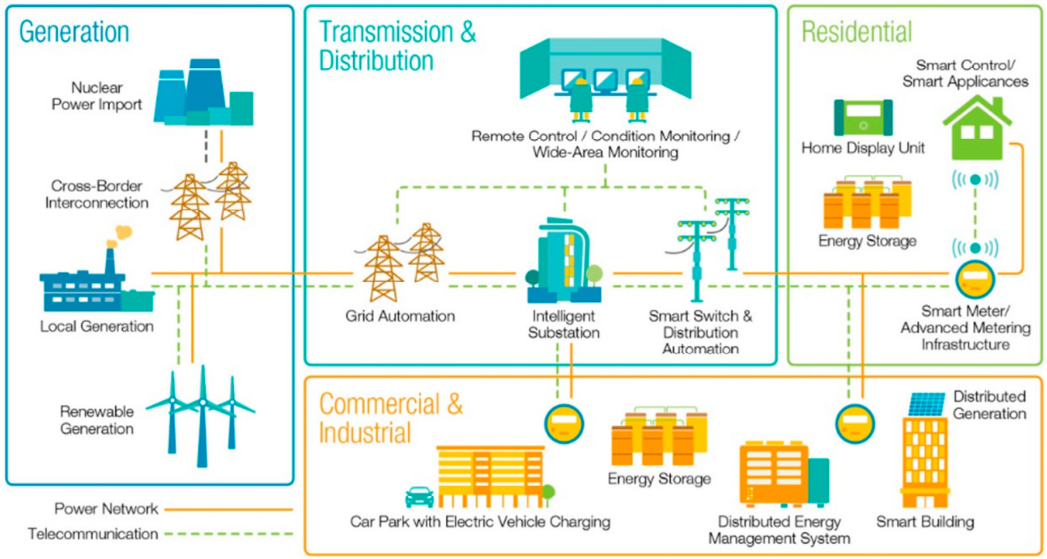
Result and Summary

- Reduced number of customers interrupted: About 270,000 fewer customers suffered interruptions (of >5 minutes) compared to estimated outcomes without FLISR.
- Reduced outage impact: Customers experienced about 38 million fewer minutes of interruption compared to estimated outcomes without FLISR.
- On average during this period, FLISR solutions reduced the number of customers interrupted (CI) by up to 45% and reduced the customer minutes of interruption (CMI) by up to 51% for an outage event.

Communication Infrastructure (IEC 61850)

Communications network must have sufficient coverage and capacity to interface and interoperate with a wide variety of technologies and systems, including various field devices and DMS, OMS, and SCADA systems.

Devices with bidirectional communication capabilities, can significantly improve system reliability indices such as SAIDI (System Average Interruption



Utility Implementation Versus Microgrid Penetration

- In microgrid applications, reclosers serve as key components to enhance resilience and fault management within localized energy systems.
- Reclosers in utility distribution networks are typically employed as a part of the larger power grid infrastructure. Their primary function is to enhance grid reliability by quickly isolating and restoring power to faulted sections.

Thank You!

Questions?