

Protection Application Handbook



Autoreclosing



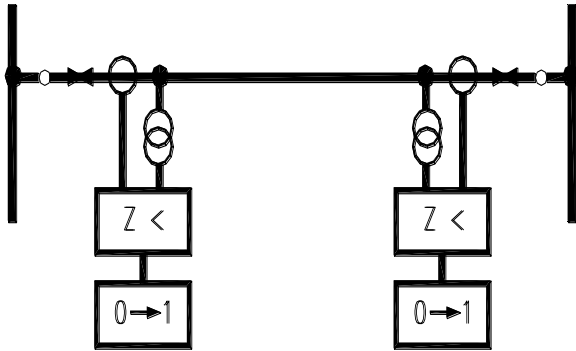
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Auto Reclosing Principles

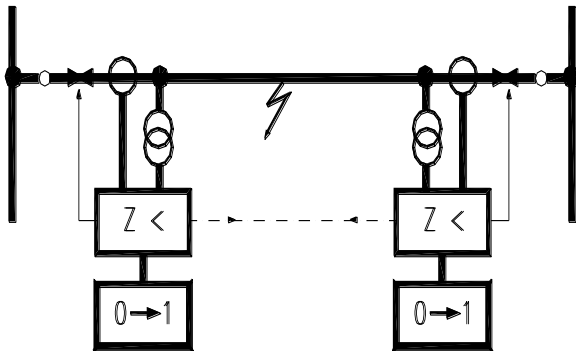


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Auto reclosing Cycle



OH-lines
High fault-rate
(80-90%)

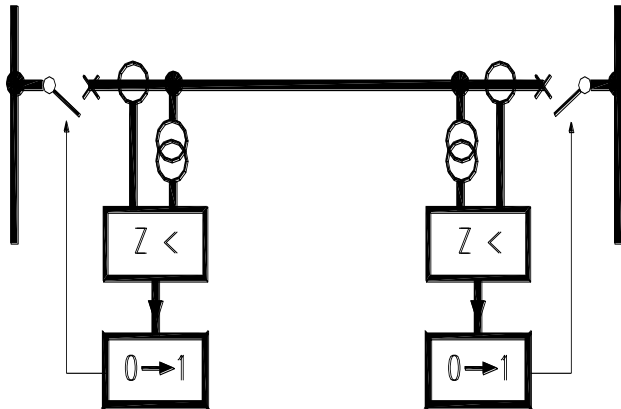
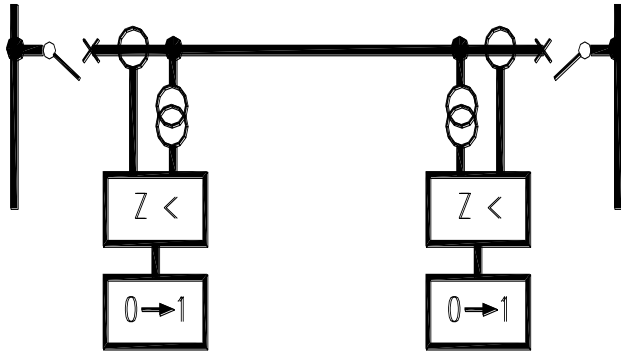


Fast
simultaneous
Fault clearing



Autoreclosing

AUTORECLOSING CYCLE



OH-lines
Intermittent faults
(80-90%)



Successful
AR-rate :
High (80-90%)



Autoreclosing

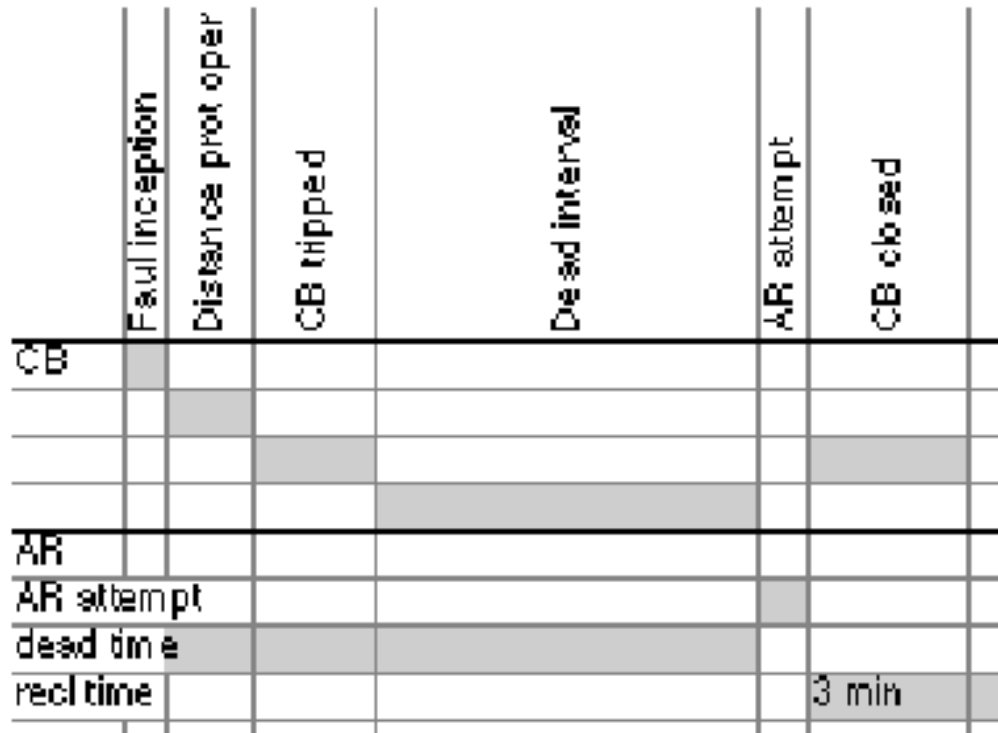
Auto reclosing principles

- 95% of faults are transient type
- 3 Ph autoreclosing synchrocheck is used
 - Helps verify phase angles are not out of phase e.g: due to heavy power swing
- 1 Ph autoreclosing needs identification of faulty phase
 - Phase identification is difficult for high resistance faults



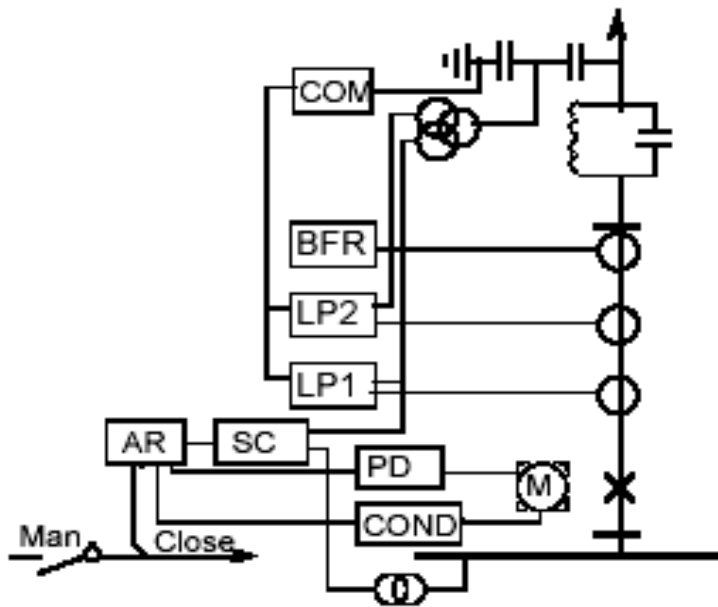
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Auto reclosing principles



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Autoreclosure in a Line bay



AR- Autorecloser
BFR- Breaker failure
relay
COM- Communication
COND-CB condition
DLC SC-Dead line check
and synchronism check
LP- Line protection
MAN- Manual CB control
PD- Pole discordance
relay

Autoreclosing

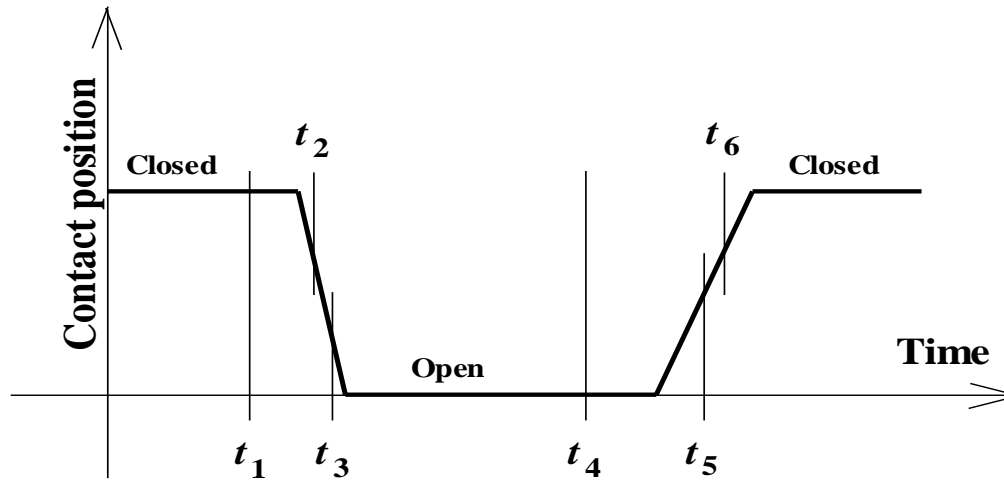
Auto reclosing principles

- Protections that start autoreclosing
 - Main 1 protection
 - Main 2 protection
- Protections that block autoreclosing
 - CB fail detected by Breaker fail relay & Pole discrepancy relay
 - CB not ready
 - Delayed tripping (Zone2 or3 of distance relay , Back up relay)
 - Manual CB operation
 - Communication fail
 - Direct transfer trip receive , BB protection , O/V protection, Reactor protection



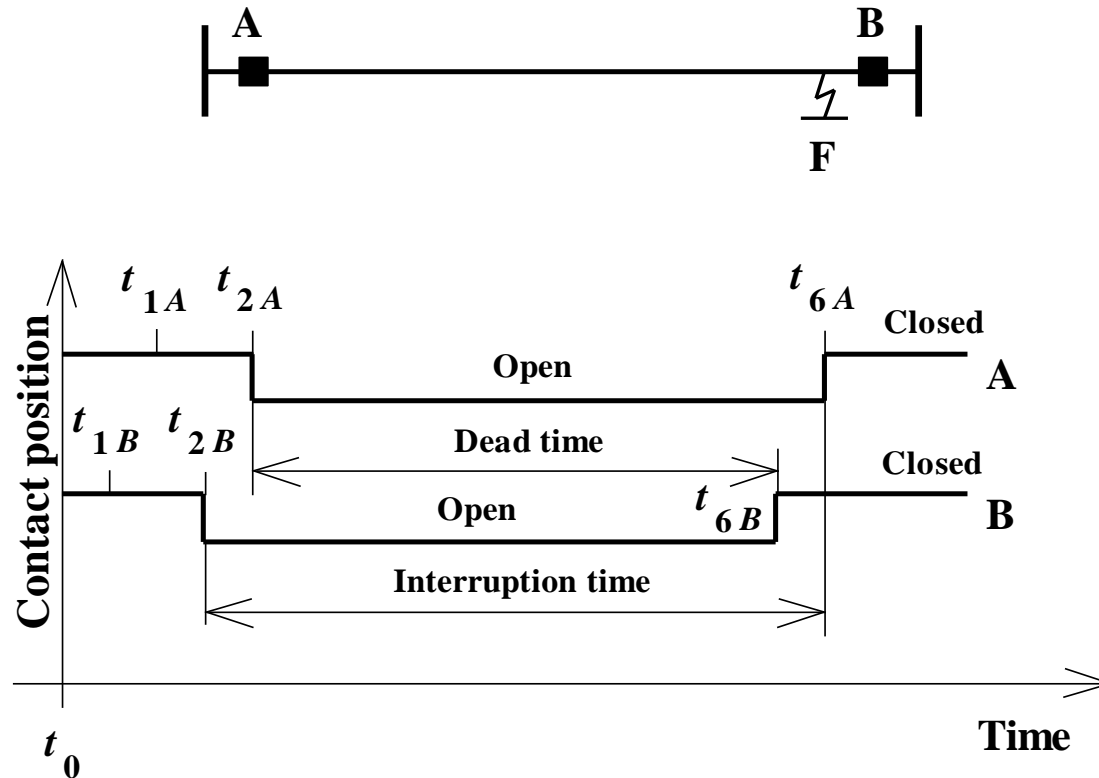
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Circuit-breaker Contact Travel



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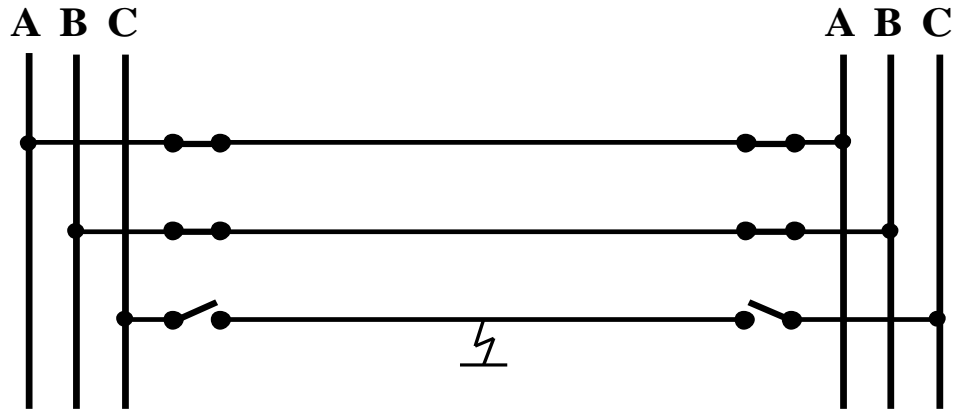
Dead time for Automatic Reclosing Equipment



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Single-pole Reclosing

Single-Pole Reclosing



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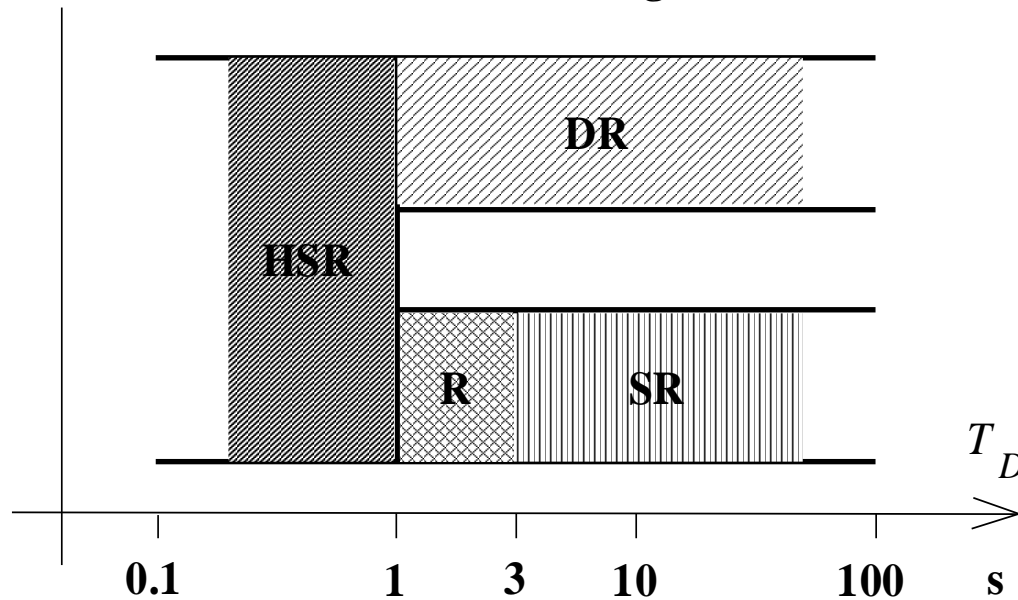
Temporal Description of Automatic Reclosing

HSR = High-Speed Automatic Reclosing

DR = Delayed Automatic Reclosing

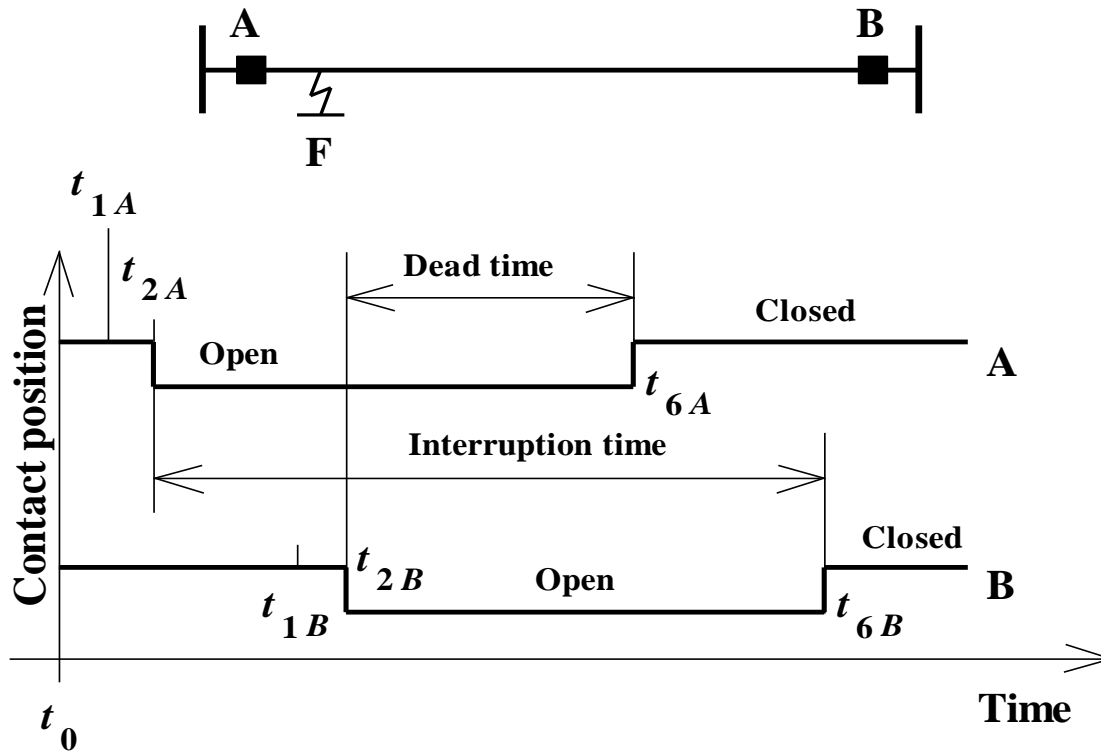
R = Automatic Reclosing

SR = Slow Automatic Reclosing



Autoreclosing

Classical Three-pole Reclosing



Autoreclosing

Factors affecting extinction of Primary Arc

- Fault current magnitude
- Fault clearance time
- Coupling from energized conductors
- Closing or opening of resistors
- Magnitude of reenergizing voltage
- Point of wave for reenergizing
- Magnetic forces on the fault current
- Length of insulating string
- Weather conditions
- Shape of grading ring



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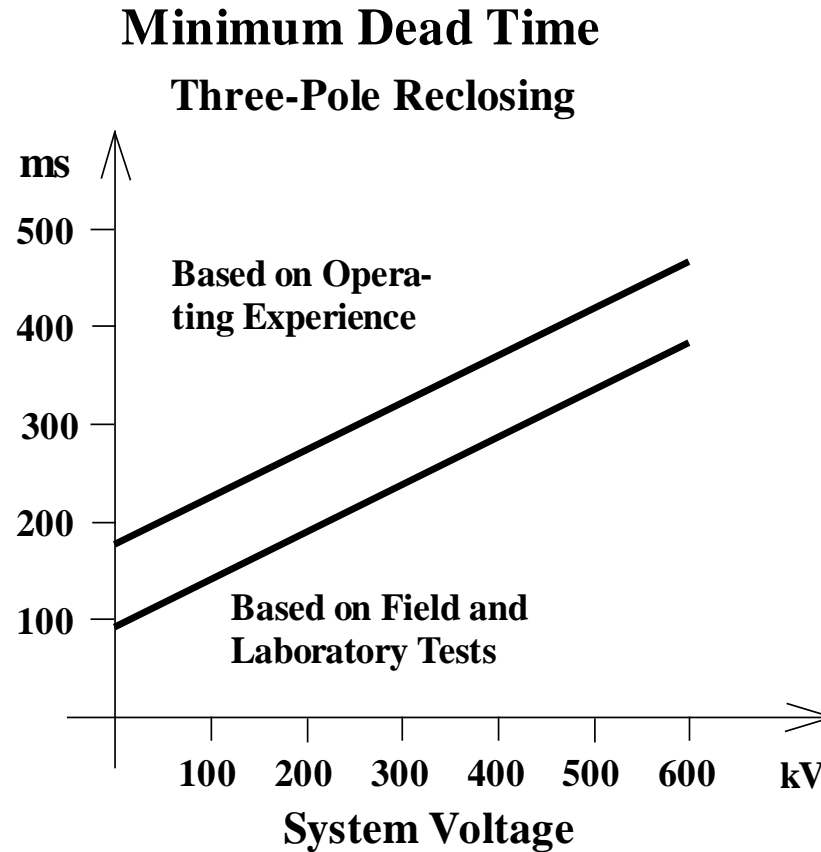
Minimum Dead Time (IEEE)

System Voltage kV	Minimum deionization time [ms]	
	Based on Field and Laboratory Tests	Based on Operating Experience
23	110	180
46	120	200
69	130	210
115	150	230
132	160	240
230	210	280
345	260	340
400	280	370
500	330	420



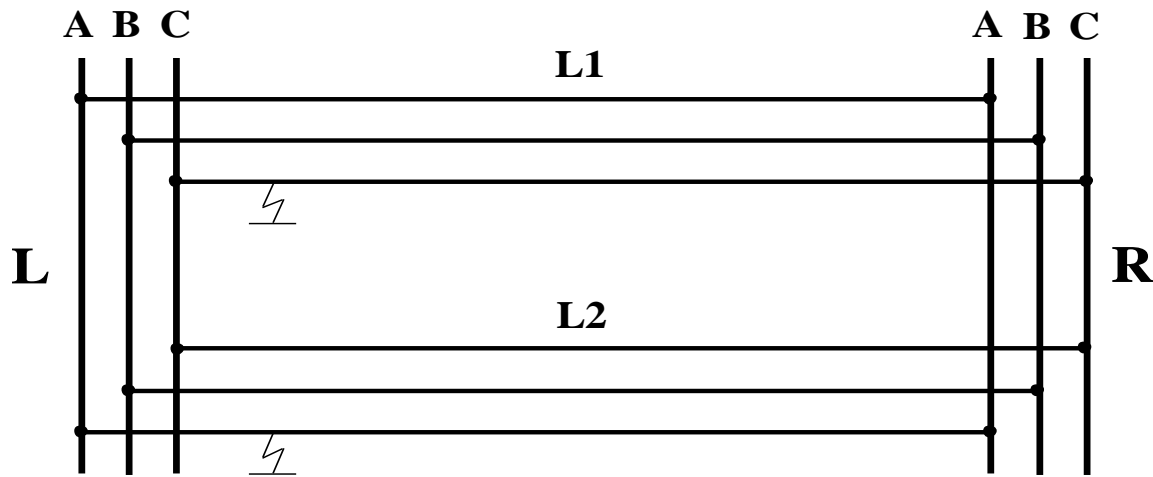
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Minimum Dead Time for Three-pole Reclosing



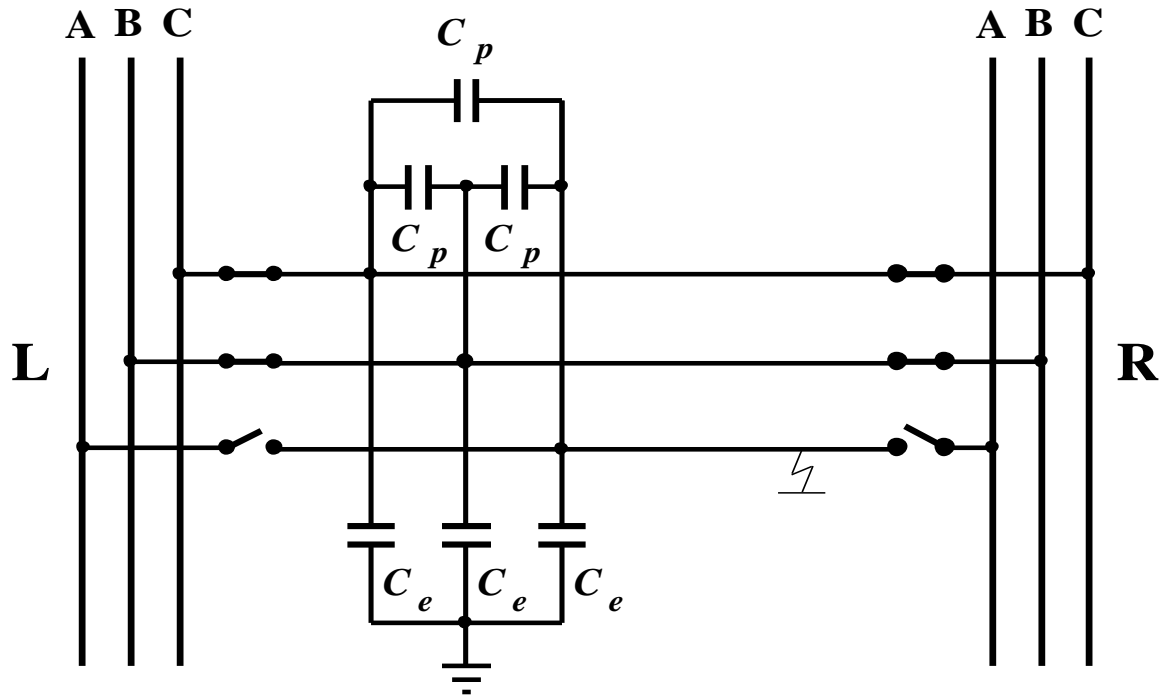
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Double Fault on a Double-circuit Line



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Capacitive Coupling and Single-pole Tripping



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Secondary arc

- Secondary arc is phasor sum of currents maintained by capacitive and inductive coupling from the energised phase conductors



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Critical Line Lengths for Single-pole Reclosing

System Voltage kV	Critical Line Length [miles]	
	Successful Range	Doubtful Range
230	0-300	300-500
345	0-140	140-260
500	0-60	60-100
765	0-50	50-80



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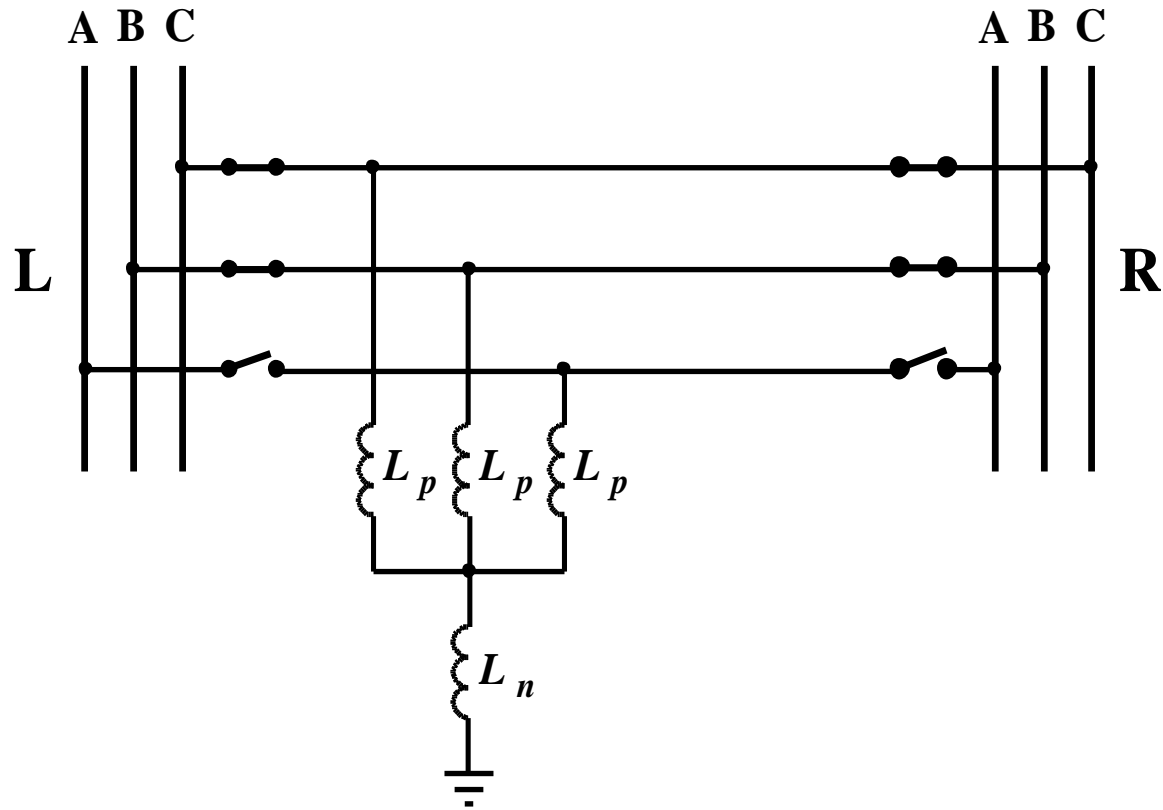
Artificial extinction of secondary arc

- Where high-speed automatic reclosing is to be implemented, secondary arcs must be artificially extinguished since they would otherwise last too long.
- There are several methods to extinguish artificially the secondary arc:
 - Fixed Four-Reactor Scheme
 - Switched Four-Reactor Scheme
 - High speed Earthing Switch Scheme



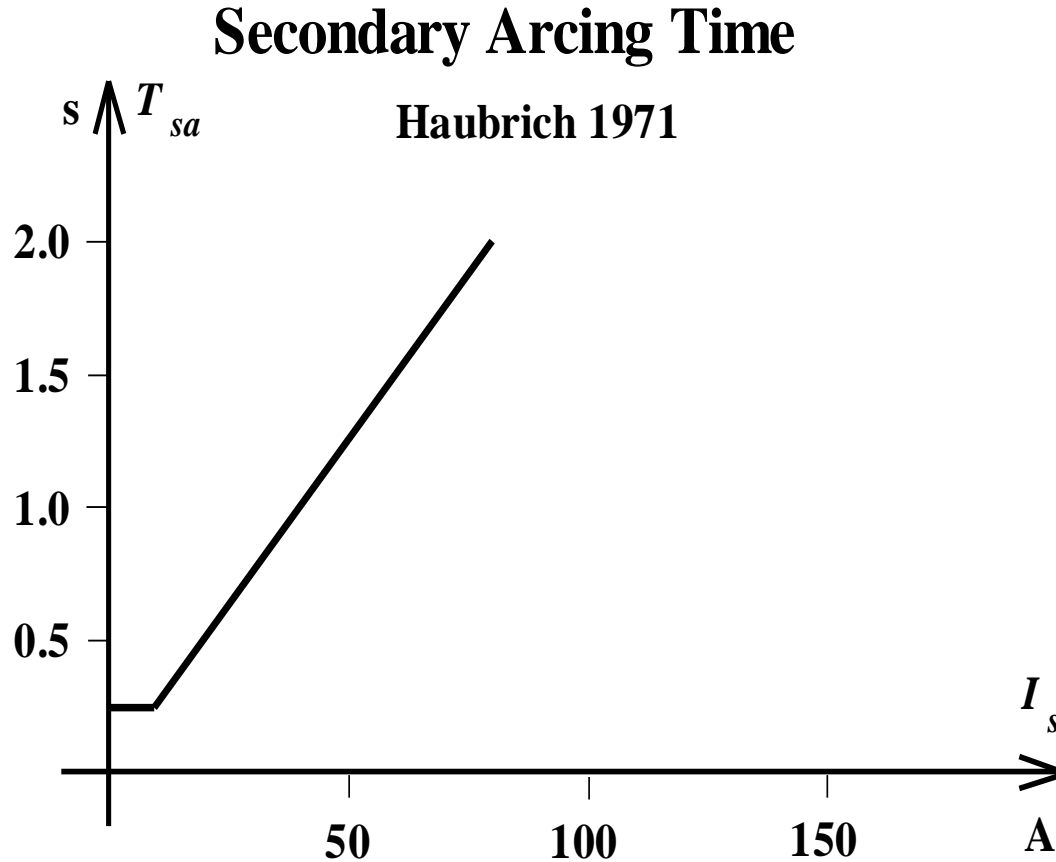
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Fixed Four-reactor Scheme



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Secondary Arcing Time (Haubrich)



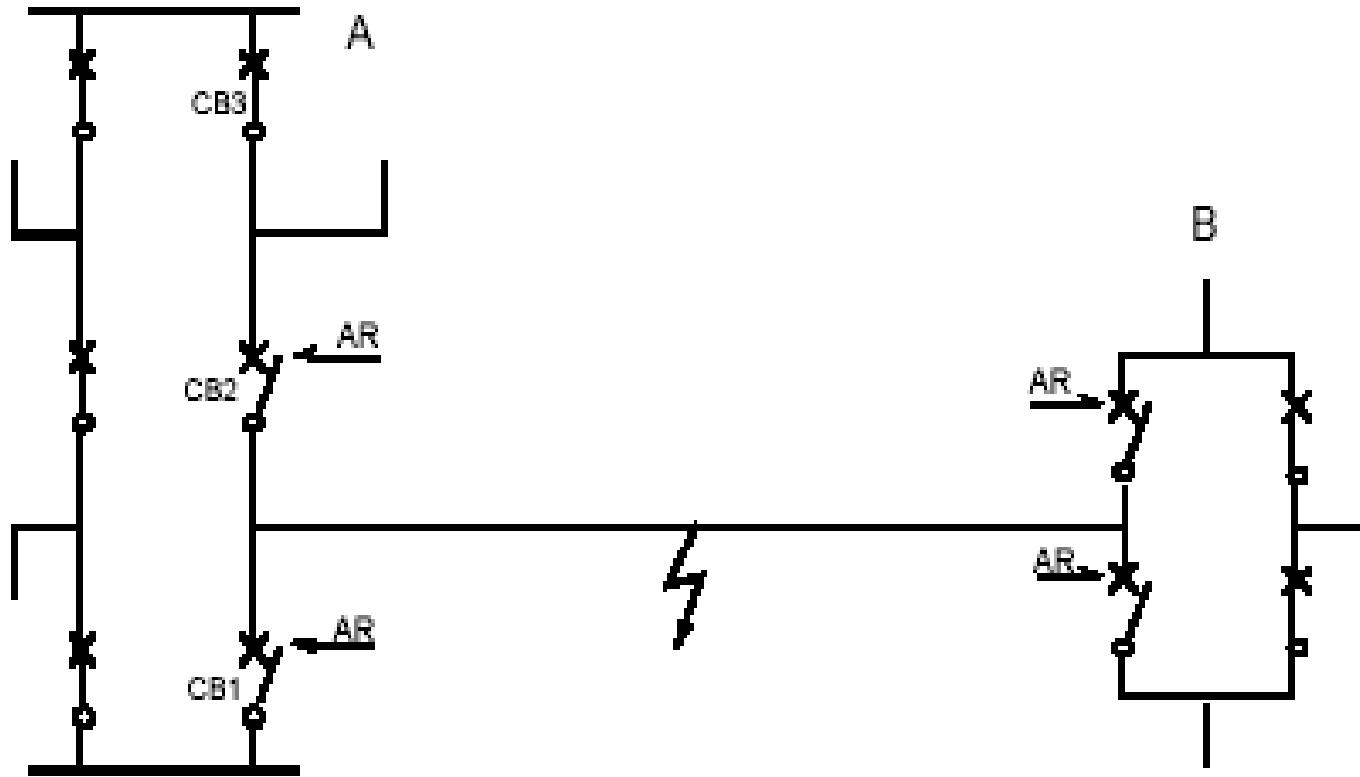
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Auto Reclosing in one and half CB system



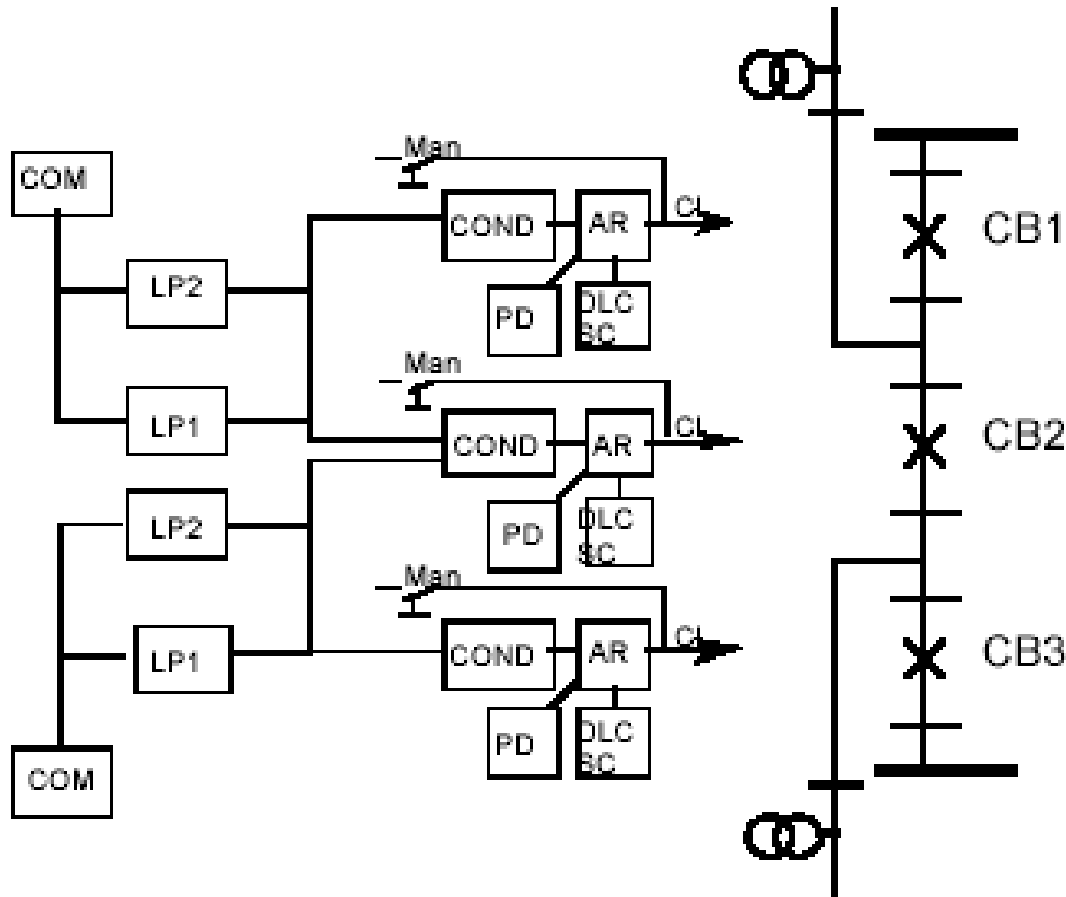
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Auto reclosing in one and a half breaker system



Autoreclosing

Auto reclosing in one and a half breaker system



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Special problems

- Memory Circuit
- Priority circuit
- Autoreclosure out of service



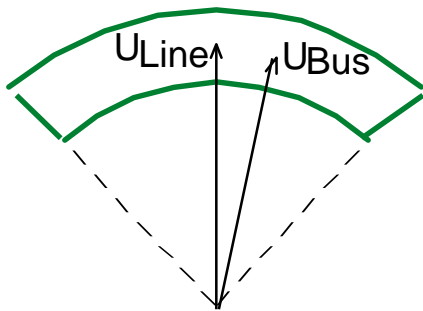
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Synchrocheck Device



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Synchronism and Energizing check



$$Freq_{Diff} < 50-300 \text{ mHz}$$

$$Phase_{Diff} < 5-75$$

$$U_{Diff} < 5-50\% U_r$$

$$U_{High} > 50-120\% U_r$$

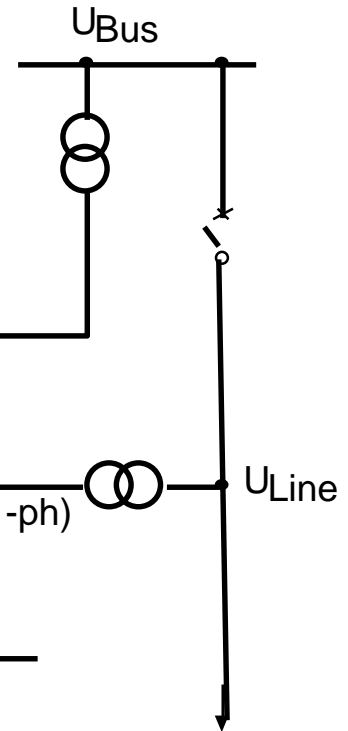
$$U_{Low} < 10-100\% U_r$$

SYNC-BLOCK

U_{Bus} ← 1-ph

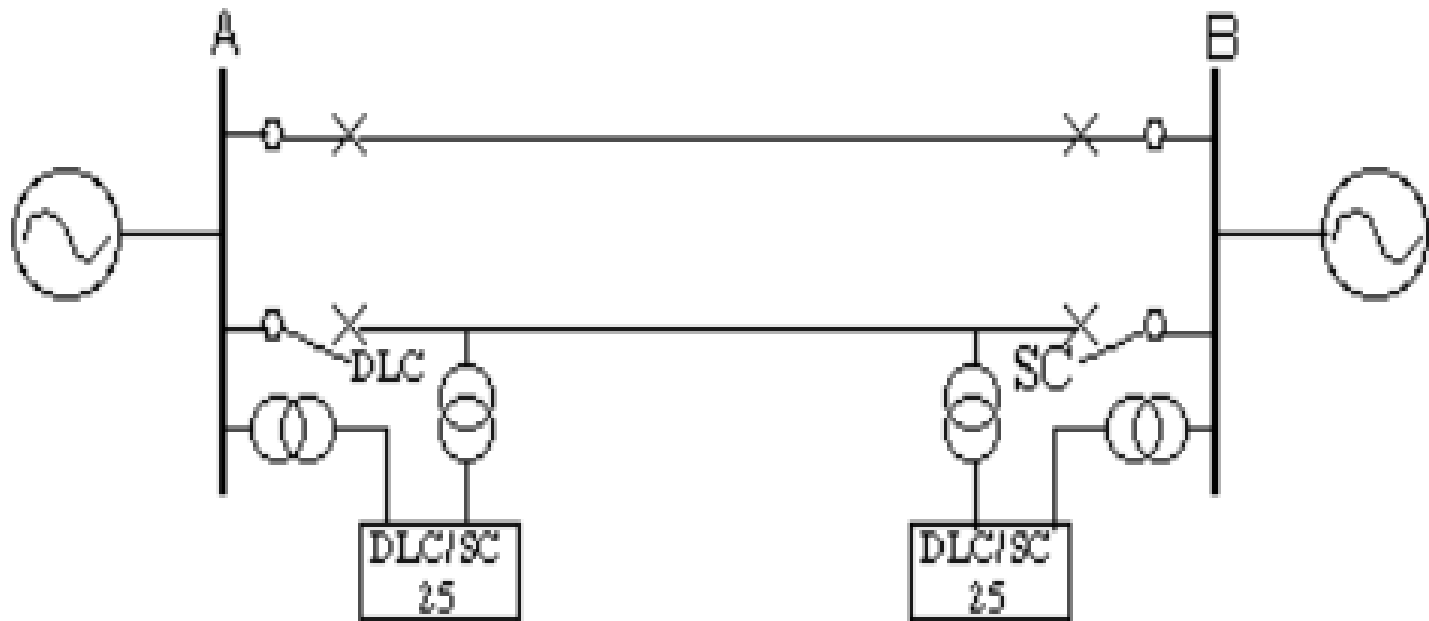
U_{Line} ← 3-ph (or 1-ph)

Fuse fail



Autoreclosing

DLC and SC at Auto reclosing



**CBIP manual on Protection
of Generators, generator
transformers and 220kV
and 400 kV networks**



Auto Reclosing



Autoreclosing

1.0 GENERAL

- The auto-reclosing of power lines has become a generally accepted practice.
- Reports from different parts of the world show that in certain networks in region subject to a high lightning intensity only about 5% of the faults are permanent.
- Auto reclosing therefore provides significant advantages.
- Outage times will be short compared to where station personnel have to re-energize the lines after a fault.
- In interconnected networks auto-reclosing helps in maintaining system stability



Autoreclosing

1.1 Recommendations for provisions of auto-reclosing

- Presently 1 phase high speed auto-reclosure (HSAR) at 400kV and 220kV level is widely practised including on lines emanating from Generating Stations and the same is recommended for adoption.
- If 3-phase auto-reclosure is adopted in future the application of the same on lines emanating from generating stations should be studied and decision taken on case to case basis.



Autoreclosing

2.0 SETTING CRITERIA

2.1 Dead Time

- **Auto- reclosing requires a dead time which exceeds the de-ionising time**
- **Time required for the de-ionising of the fault path depends on:- arcing time, fault duration, wind conditions, circuit voltage, capacitive coupling to adjacent conductors, etc.**
- **Single phase dead time of 1.0 sec is recommended for both 400kV and 220kV system.**



Autoreclosing

2.2 Reclaim Time

- The time during which a new start of the auto-reclosing equipment is blocked.
- If reclosing shot has been carried out and the line is energized and a new fault occurs before the reclaim time has elapsed, the auto-reclosing equipment is blocked and a signal for definite tripping of the breaker is obtained.
- After the reclaim time has elapsed, the auto-reclosing equipment returns to the starting position and a new reclosing sequence can occur.
- The reclaim time must not be set to such a low value that the intended operating cycle of the breaker is exceeded, when two faults incidents occur close together.



Autoreclosing

- **If the breaker is closed manually, the auto reclosing equipment is blocked and cannot start again until the reclaim time has elapsed.**
- **For the breaker to be used for auto-reclosing, it is essential that it has the operating mechanism and breaking capacity necessary for it to be able to perform the auto-reclosing sequences required.**



Autoreclosing

2.3 Circuit Breaker Requirement

- According to IEC Publication 56.2, a breaker must be capable of withstanding the following operating cycle with full rated breaking current:

O + 0.3 s + CO + 3 min + CO

- The recommended operating cycle at 400kV and 220kV is as per the IEC standard.
- Reclaim time of 25 sec is recommended.



ABB