

AUTO-RECLOSE SCHEME IN A RING CONFIGURATION SUBSTATION

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- Equipment technical problems derived from auto-reclose
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ISA - INTERCOLOMBIA's General Information and Businesses



ISA carries out important projects in **Linear Infrastructure Systems** that lead development in the continent. In order to achieve this, it focuses its activities on **Electric Power Transmission, Road Concessions, Telecommunication Transmission and Management of Real-time Systems.**

ISA is recognized today as a Multi-Latin leader with broad technical experience who carries out its activities within the framework of corporate sustainability. Directly and through its 33 affiliates and subsidiaries, it is currently implementing important infrastructure projects that boost the continent's progress and contribute to the advancement of the inhabitants of **Colombia, Brazil, Peru, Chile, Bolivia, Ecuador, Argentina, Panama and Central America.**

<http://www.isa.co/>

ISA-INTERCOLOMBIA's General Information and Businesses



INTERCOLOMBIA is one of the ISA's company dedicated to transport high voltage electricity in Colombia, which arises as a result of a separate process in ISA from its role focused on strategic issues.

INTERCOLOMBIA is a mix of public services. It is organized as a corporation and responsible for managing, operating and maintaining electrical assets owned by ISA in Colombia. It is the largest energy transporter in the country with national coverage. These energy transport networks extend through the diverse national territory, contributing to the development and competitiveness of Colombians. www.intercolombia.com

COLOMBIA - ELECTRIC INFRASTRUCTURE				
	Operational infrastructure		Infrastructure under construction. Approximate investment USD 240 million	
Companies	Transmission (circuit km)	Transformation (MVA)	Transmission (circuit km)	Transformation (MVA)
ISA-INTERCOLOMBIA	10,538	13,840	1,356	4,535

RECENT ELECTRIC INFRASTRUCTURE CONSTRUCTION	
Project	Benefits
UPME 02 - 2013: Expansion Copey 500/220 kV (450 MVA) substation	Installation of second transformer at the substation to increase electric system reliability in the Colombian northern region
Expansion UPME: Termocol 220 kV substation	Installation of capacitive compensation module (35 MVar)
Expansion UPME: El Bosque 220 kV substation	Substation expansion in 1 1/2 circuit breaker configuration to connect a 220/66 kV transformer belonging to Electrocaribe
Expansion UPME: FACTS device STATCOM type	Installation of a static synchronous compensator (STATCOM) at Bacata substation at 500 kV with a reactive power supply capacity of 200 MVar
Expansion UPME: Reforma 230 kV substation	Substation expansion in 1 1/2 circuit breaker configuration to connect the third 230/115 kV (150 MVA) transformer belonging to EMSA
Expansion UPME: Betania-Mirolindo 230 kV line	Installation of a line second circuit (206 km) including construction of associated bays. The work will improve network availability in the country's southwestern region
Connection: Expansion Chivor 230 kV substation	Construction of a new substation at 115 kV and increase of transformation capacity 230/115 kV (150 MVA), in order to supply Casanare Province's increasing energy demand

Auto-reclose Scheme in a Ring Configuration Substation

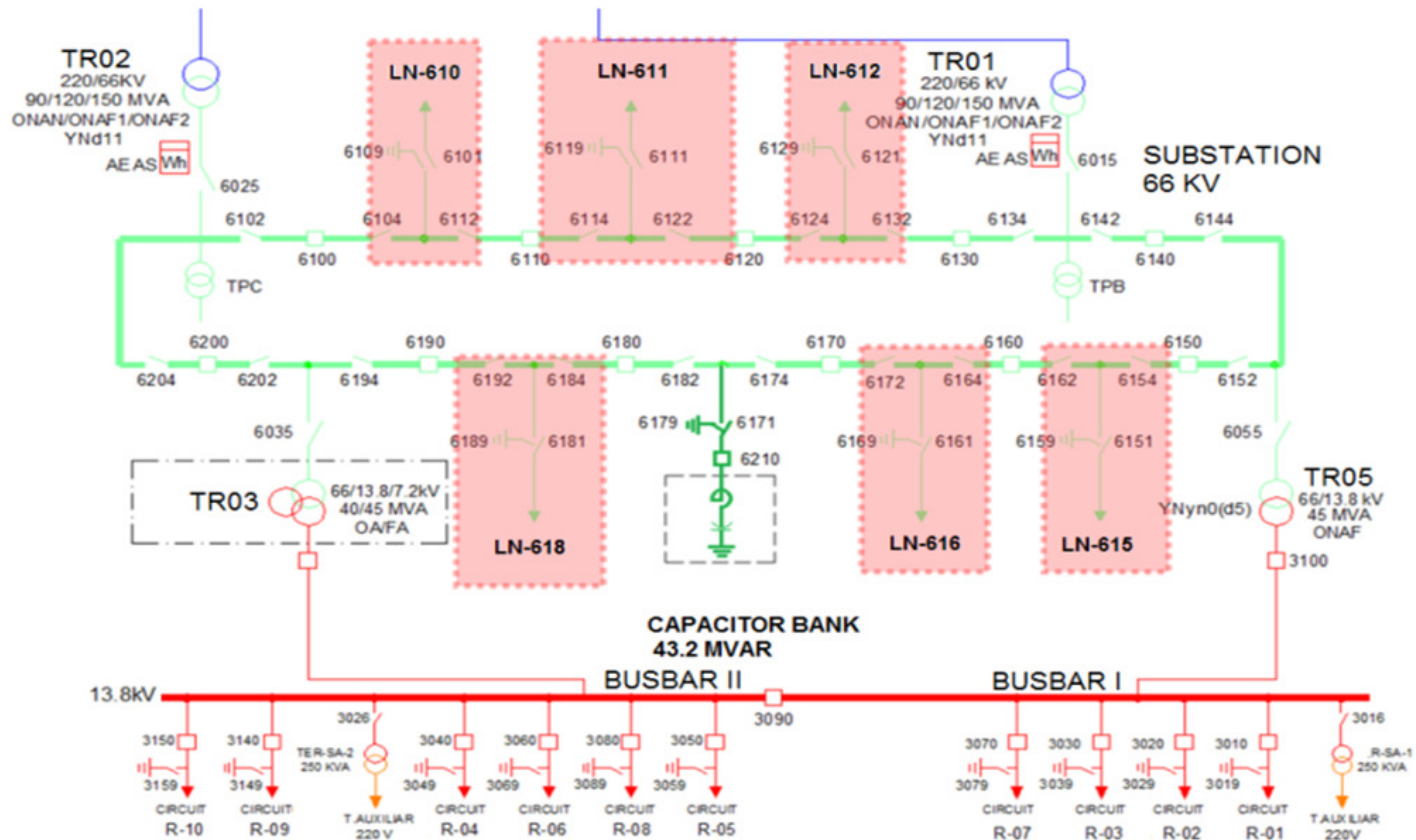


OBJECTIVES

Implement an automatic reclose scheme in a ring substation configuration at 66 kV in order to reduce reestablishing times.

- **Analyze** impacts over power equipment during reclosing condition on an overhead transmission or sub-transmission line.
- **Develop** criteria and logic to design control schemes to make a an safe auto-reclose
- **Implement** solutions on the auto-reclose relays based on the criteria and experience of reclose schemes.

ELECTRICAL SYSTEM INVOLVED



- Ring substation configuration at 66 kV interconnected to 220 kV
- Five overhead sub-transmission lines
- Four three phase transformers
- One capacitive bank compensator

Historical background:

- **Users complains** as a reaction of several events on the lines concerning three pole tripping.

- ✓ Social situations
- ✓ Fares kept increasing
- ✓ Long reestablishment times



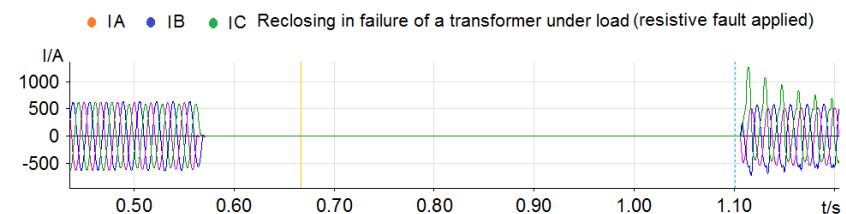
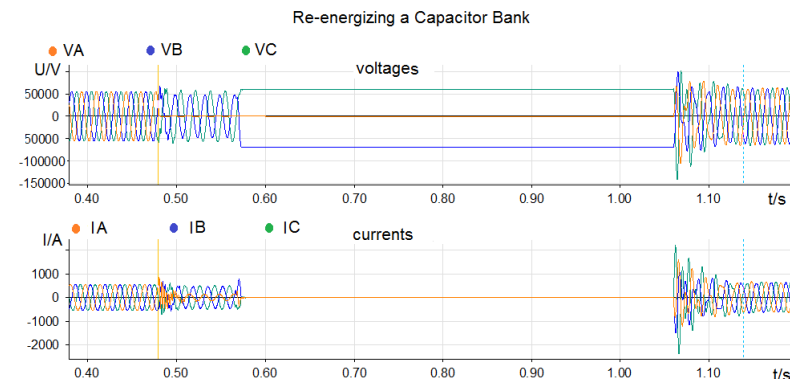
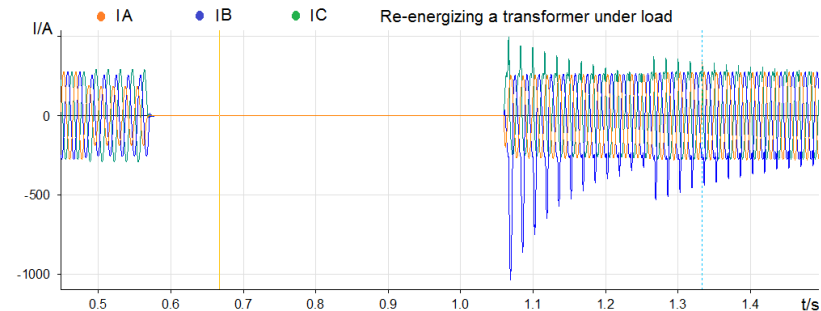
- **Old protection and control systems** limits to apply advanced development.

- ✓ Relays made up by ancient technology.
- ✓ Control system was reduced to voltage selection and manual switching.
- ✓ Difficulties to implement logics to make automatic control



Impact:

- **Re-energizing transformers and capacitor bank compensators generating overvoltages and overcurrents phenomena.**
- **Reclosing onto fault transformers and capacitor bank compensator** due to unsuccessful auto-recloses of CBs shared between line and this sort of equipment.
- **Re-energizing two lines by reclosing a common CB between them.** This could change the system topology and cause alterations of voltages and currents in the area.



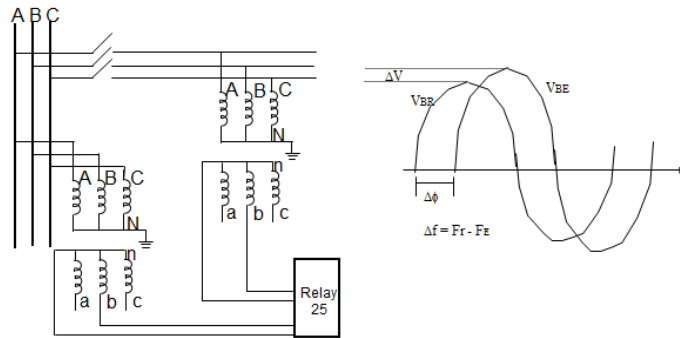
CRITERIA TO DESIGN OF THE AUTO-RECLOSE SCHEME



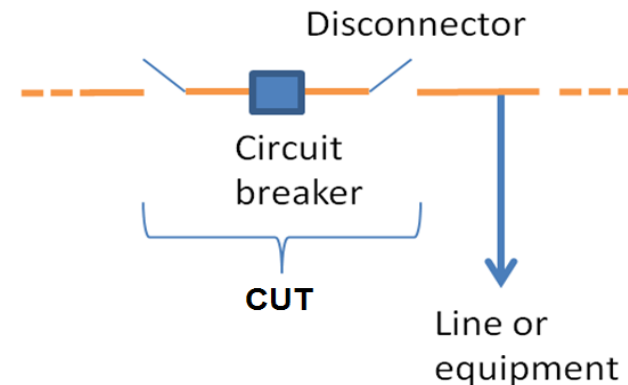
Fundamental criteria considered: circuit-breaker-ready signal which is supervised by the reclosing relay at the end of the cycle; voltage selection and synchronism check signals, which are monitored by synchronism relays permitting the auto-reclose relay to release the close command.

Complementary criteria:

Trips and auto-reclose are held three pole with synchronism check.



CUTs considered in a ring substation

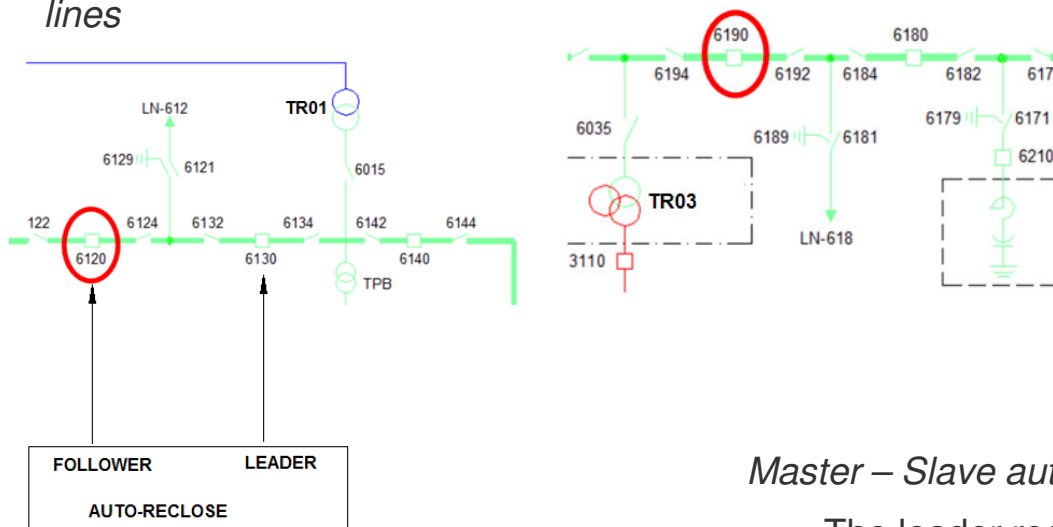


CRITERIA TO DESIGN OF THE AUTO-RECLOSE SCHEME

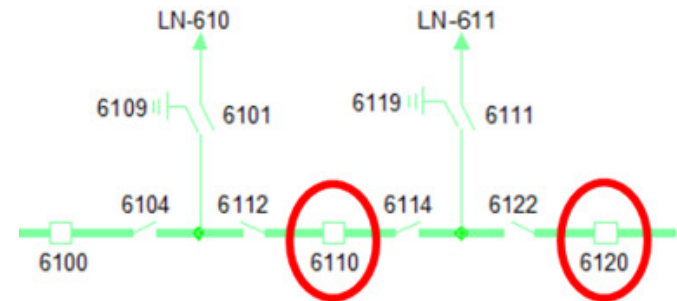


Complementary criteria:

Automatic reclosing of a circuit breaker (CB) shared between a line and a transformer or a capacitor lines



Automatic reclosing of a circuit breaker (CB) shared between two lines



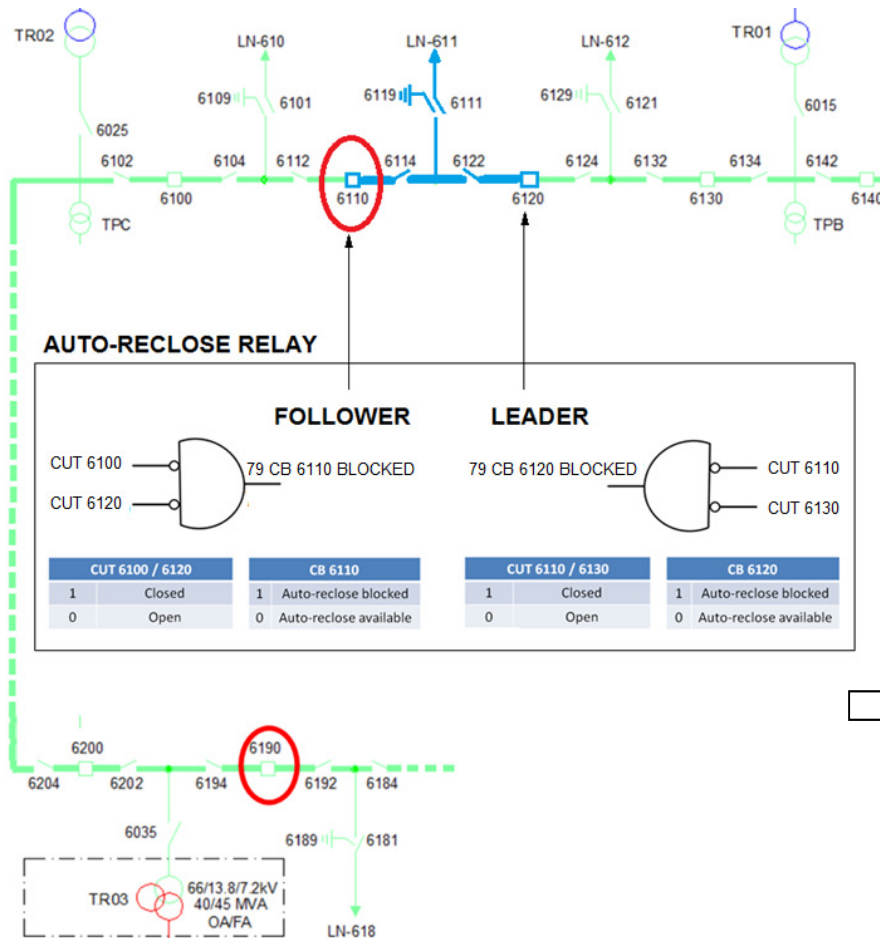
Master – Slave auto-reclose scheme could be modified

- The leader recloses after 60 seconds, the follower will reclose 200 ms later.
- If leader recloses in failure, the follower will not be reclosed.
- If leader could not reclose, the follower will be able to reclose.

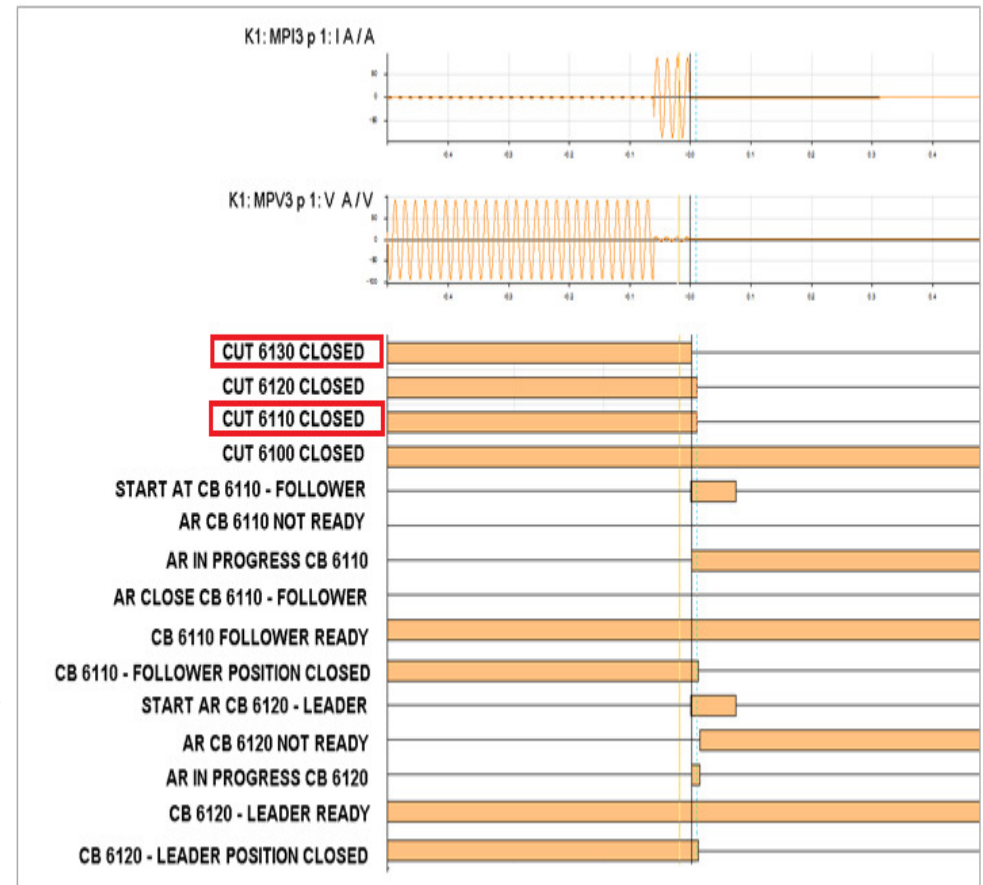
BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME



Bay LN-611



Fault condition test result of the bay LN-611. Both auto-recloses *CB 6110* and *CB 6120* start cycle as a consequence of external tripping. Conversely, reclosing in progress of *CB 6120* became unlatched quickly.

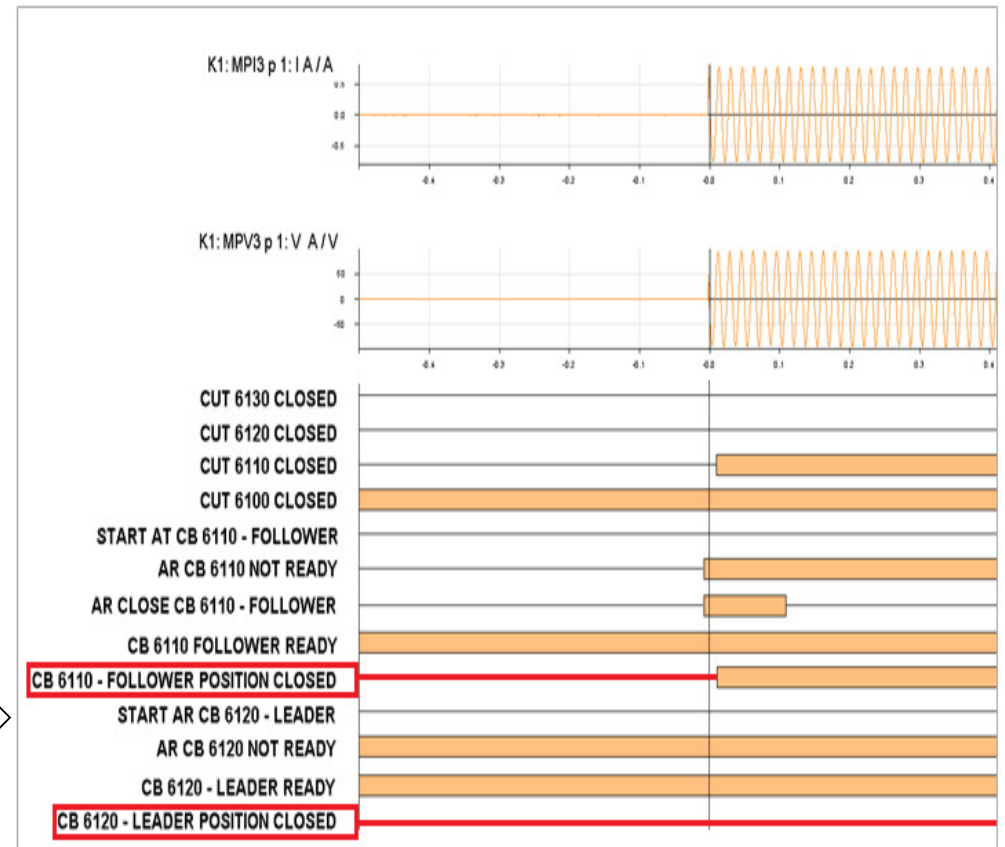
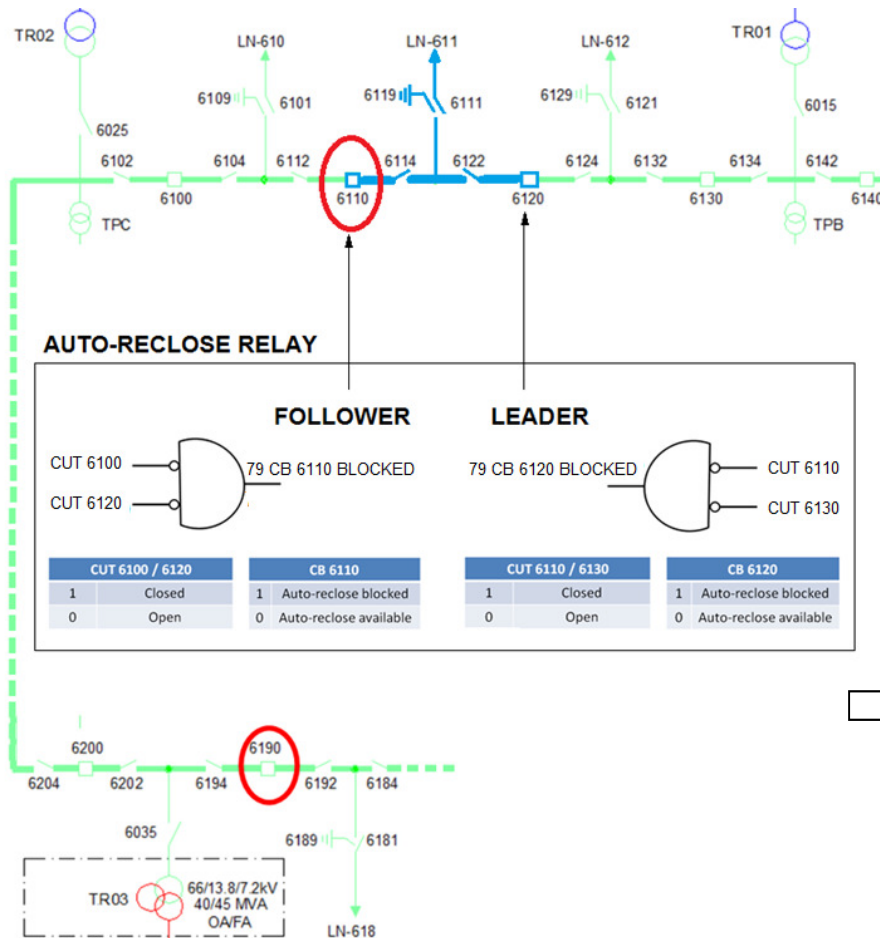


BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME



Bay LN-611

Auto-reclose scheme test result of the bay LN-611 handling CB 6110. The CB 6120 did not reclose

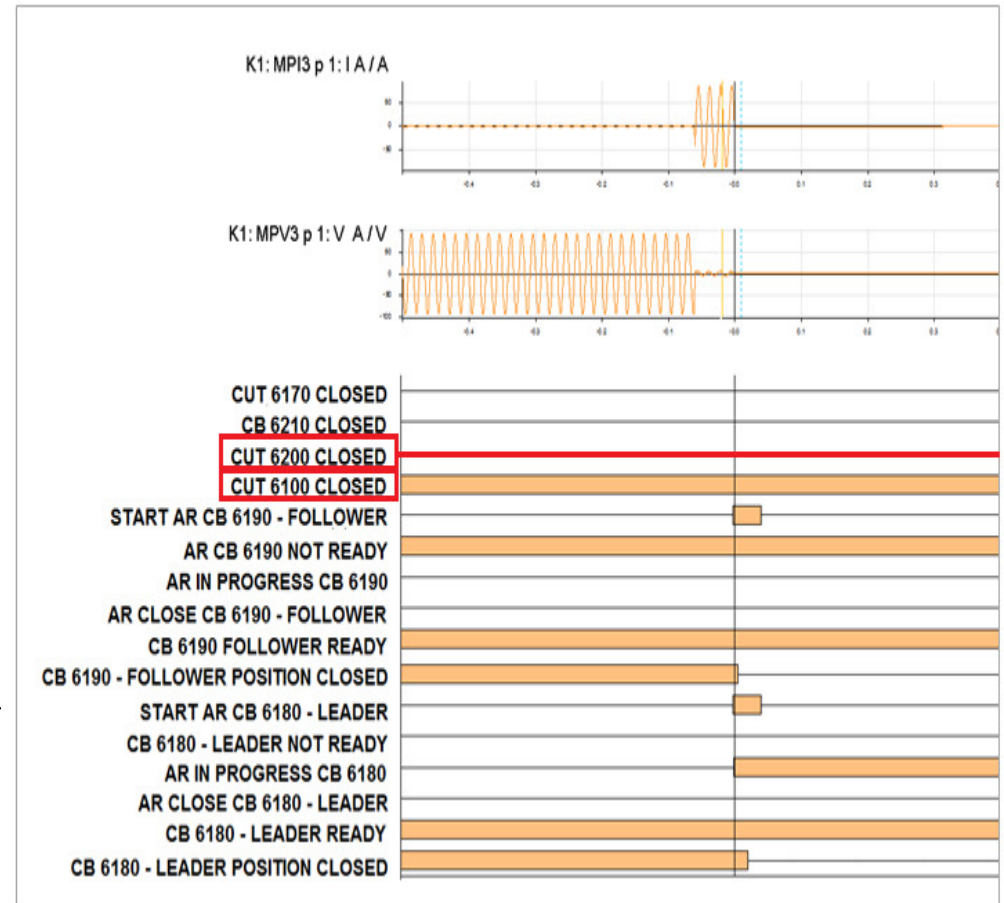
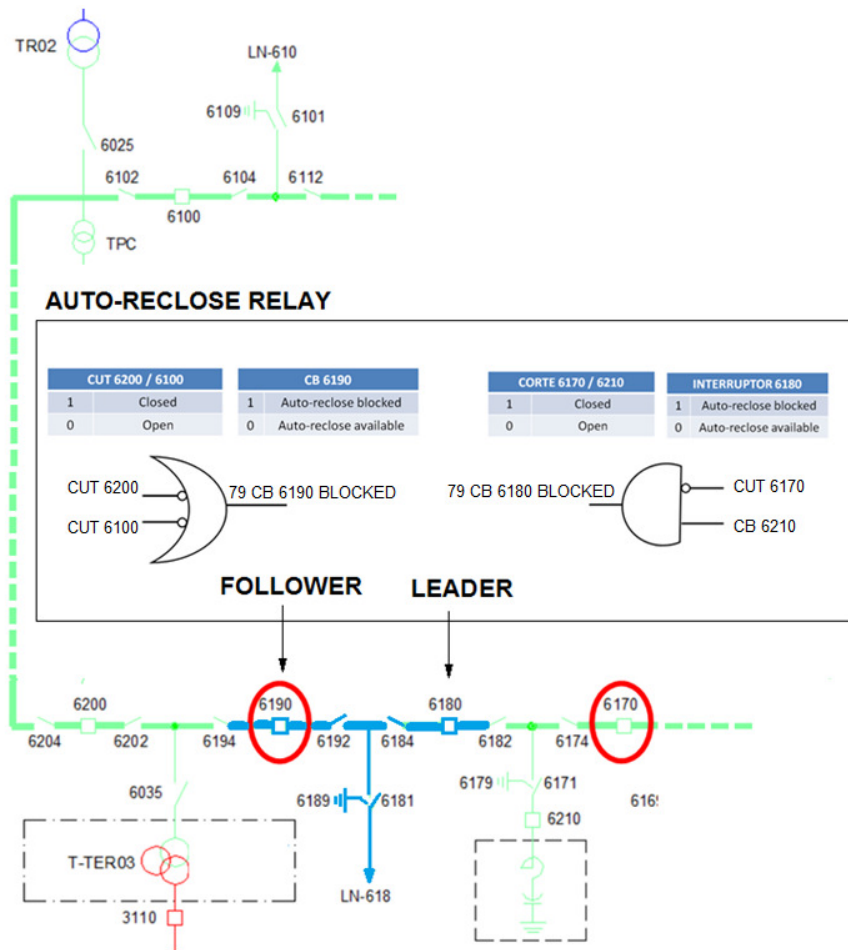


BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME



Bay LN-618 reclosing CB 6180

Fault condition test result of the bay LN-618 with CB 6210, and CUTs 6200 and 6170 open. The auto-reclose cycle of CB 6190 never started.

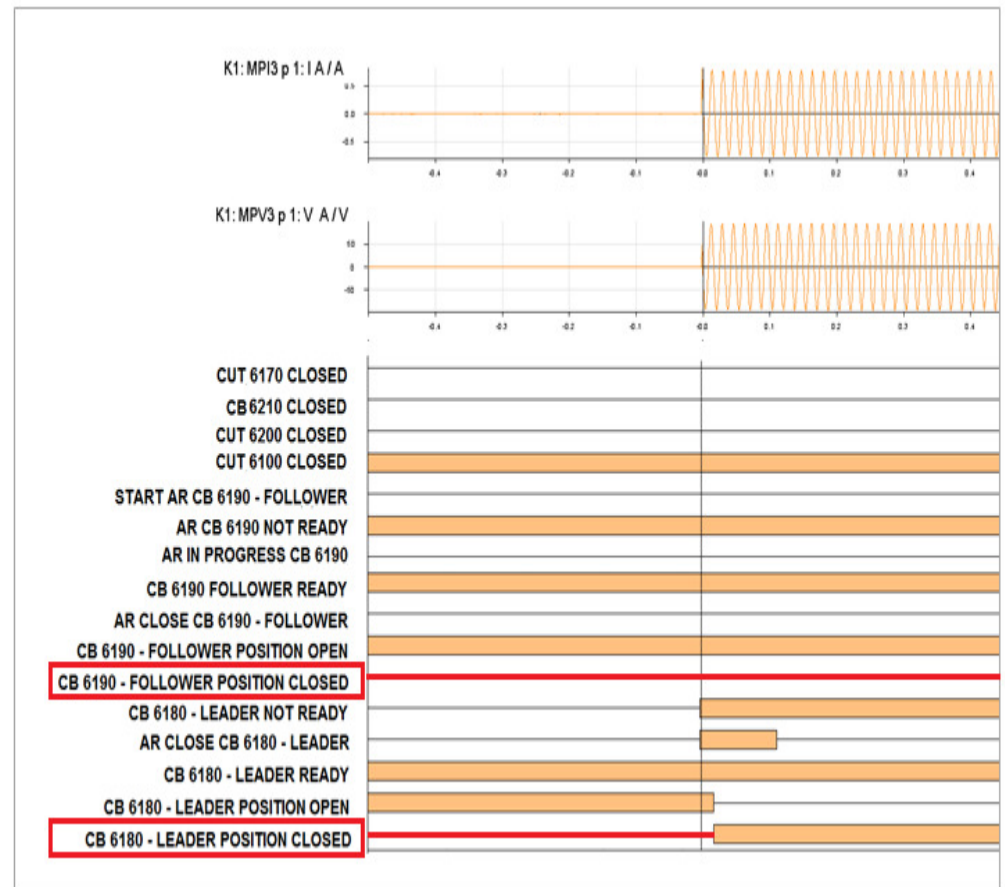
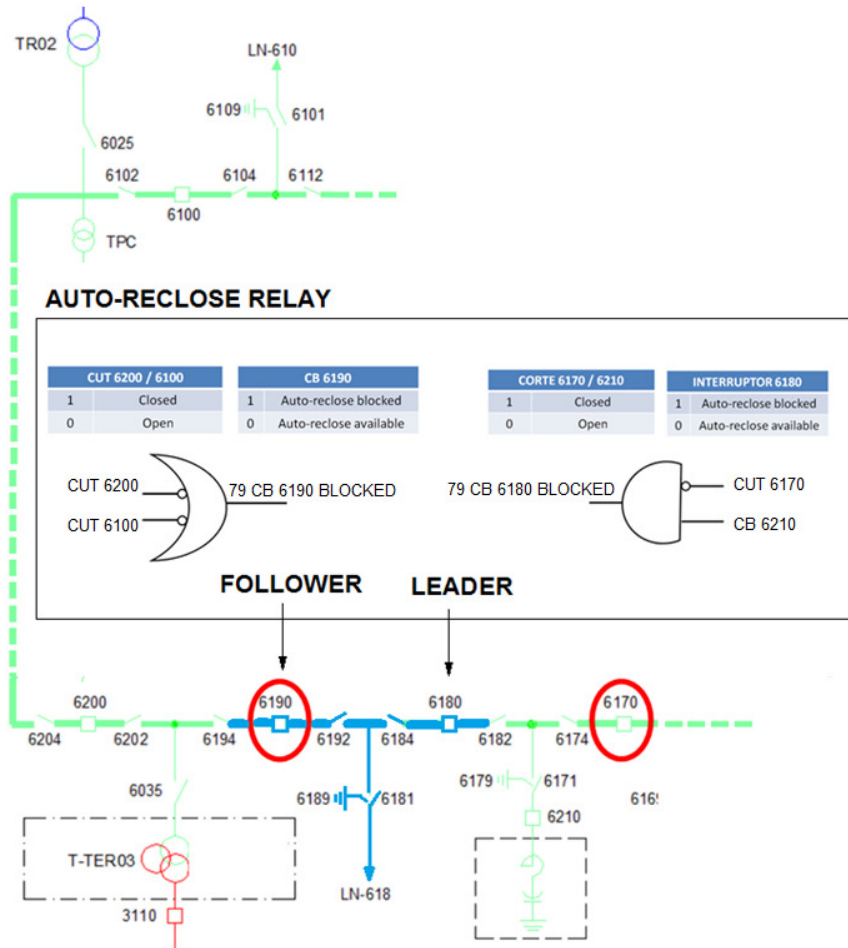


BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME



Bay LN-618 reclosing CB 6180

Auto-reclose scheme test of the bay LN-618 handling CB 6180. The CB 6190 did not reclose.

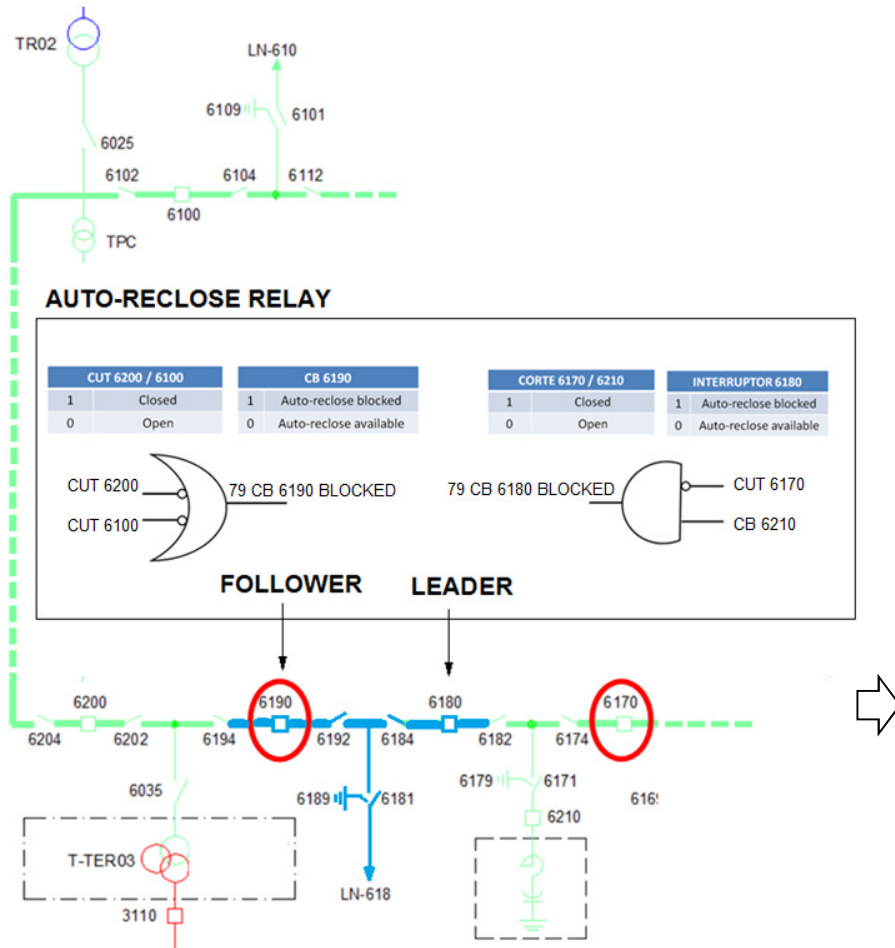


BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME



Bay LN-618 reclosing CB 6190

Fault condition test result of the bay LN-618 with CUT 6170 open and CB 6210 closed. After auto-reclosing starting, AR IN PROGRESS CB 6180 signal was never latched.

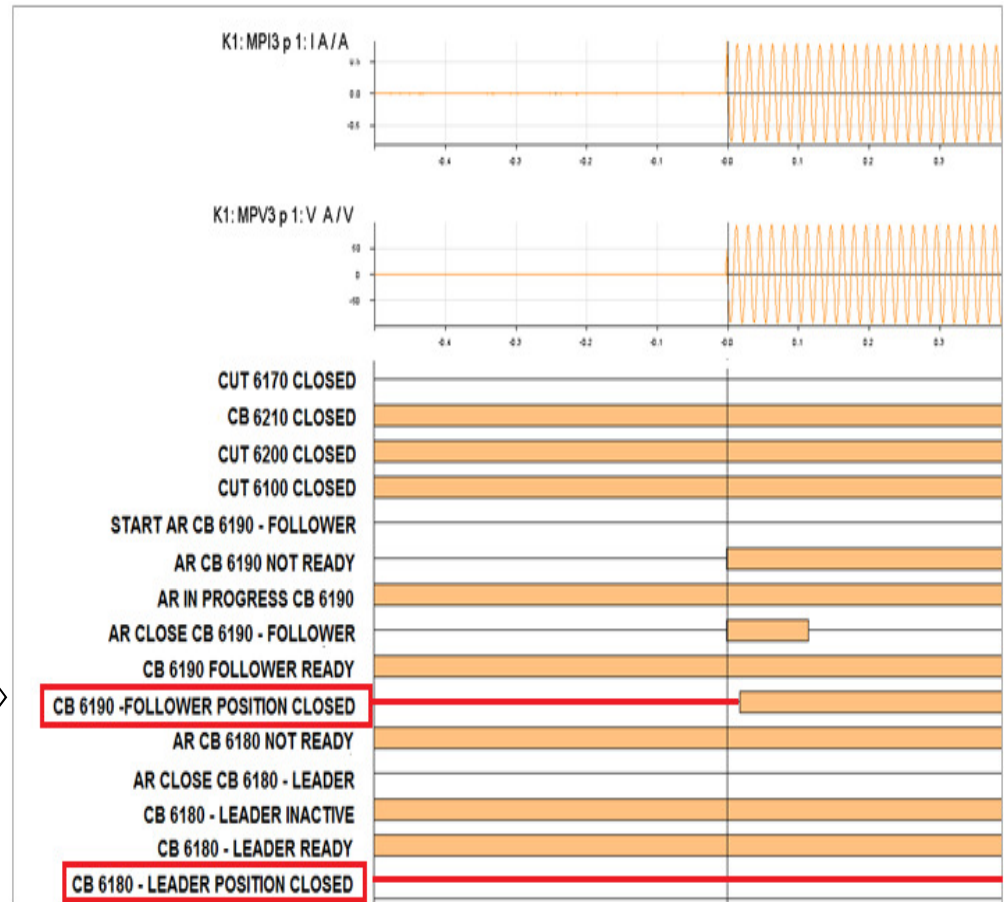
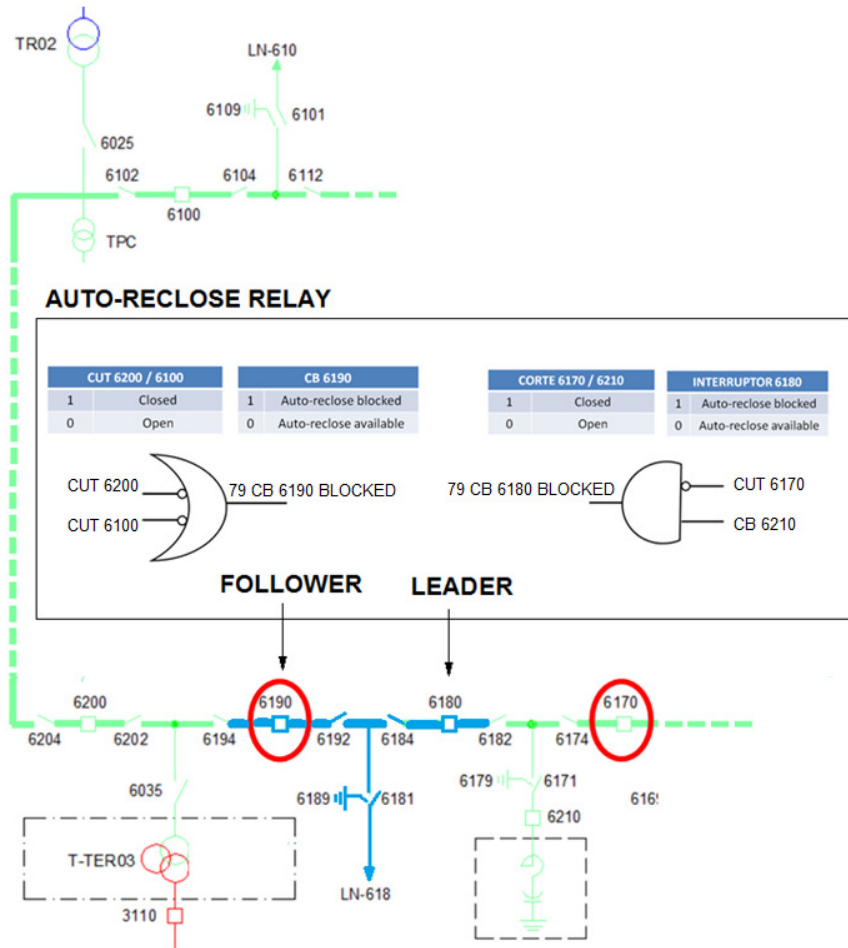


BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME



Bay LN-618 reclosing CB 6190

Auto-reclose scheme test result of the bay LN-618 handling CB 6190. The CB 6180 did not reclose.

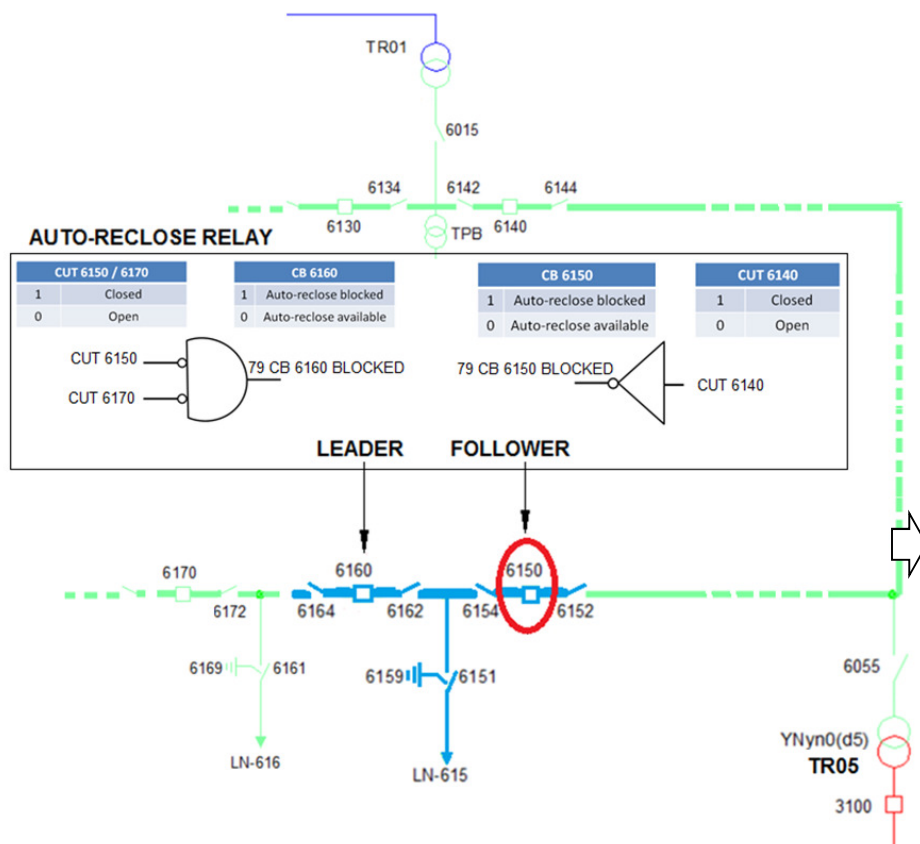


BLOCK CONDITIONS AND TEST RESULTS OF THE AUTO-RECLOSE SCHEME

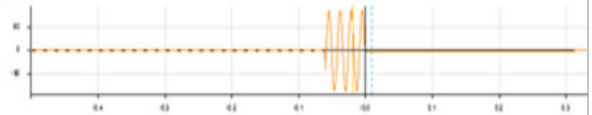


Bay LN-615

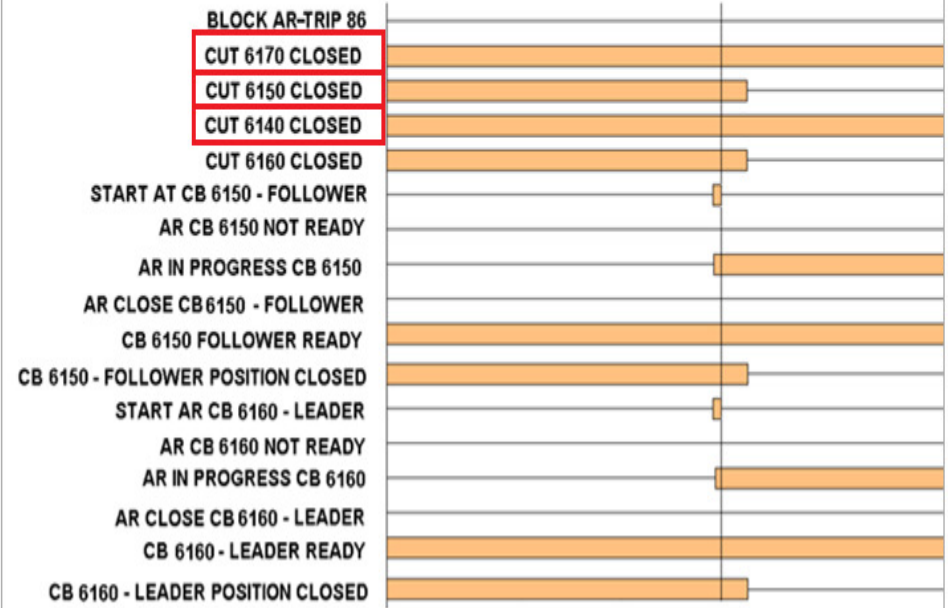
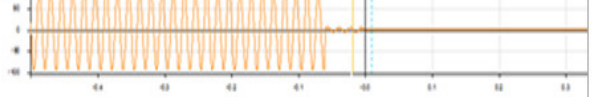
Fault condition test result of the bay LN-615. Both auto-recloses CB 6150 and CB 6160 start cycle as a consequence of external tripping. Additionally, their reclosing in progress signals became latched.



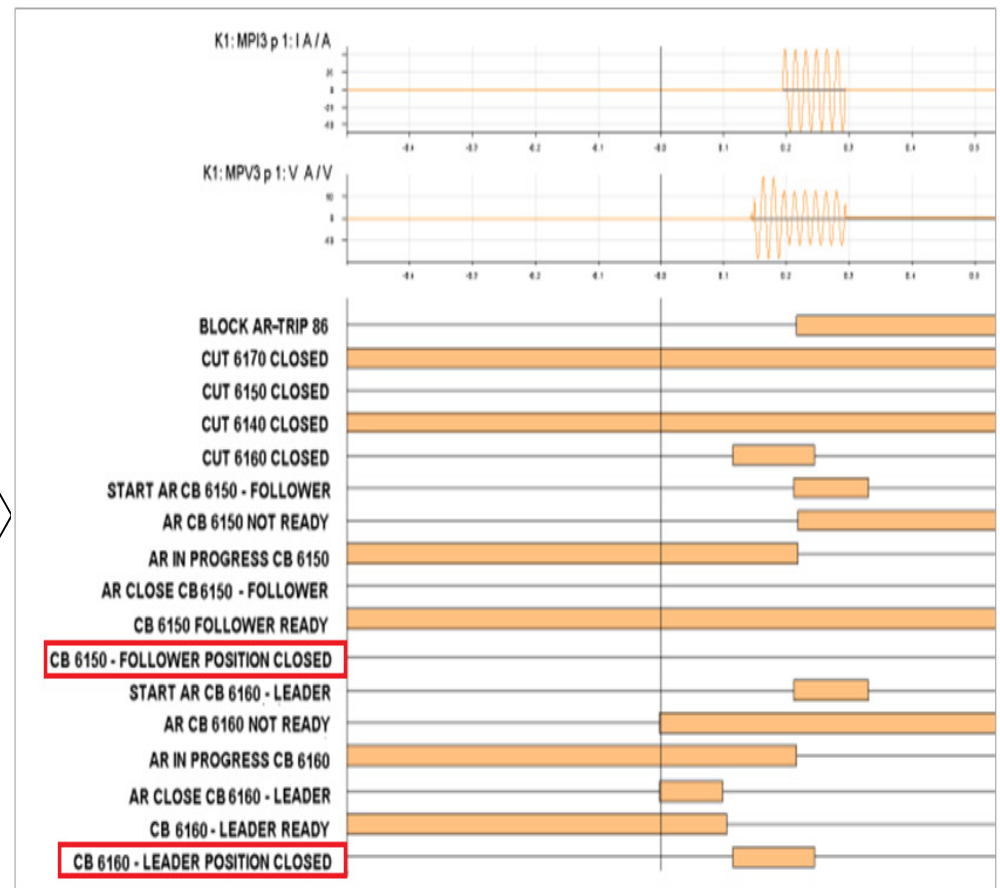
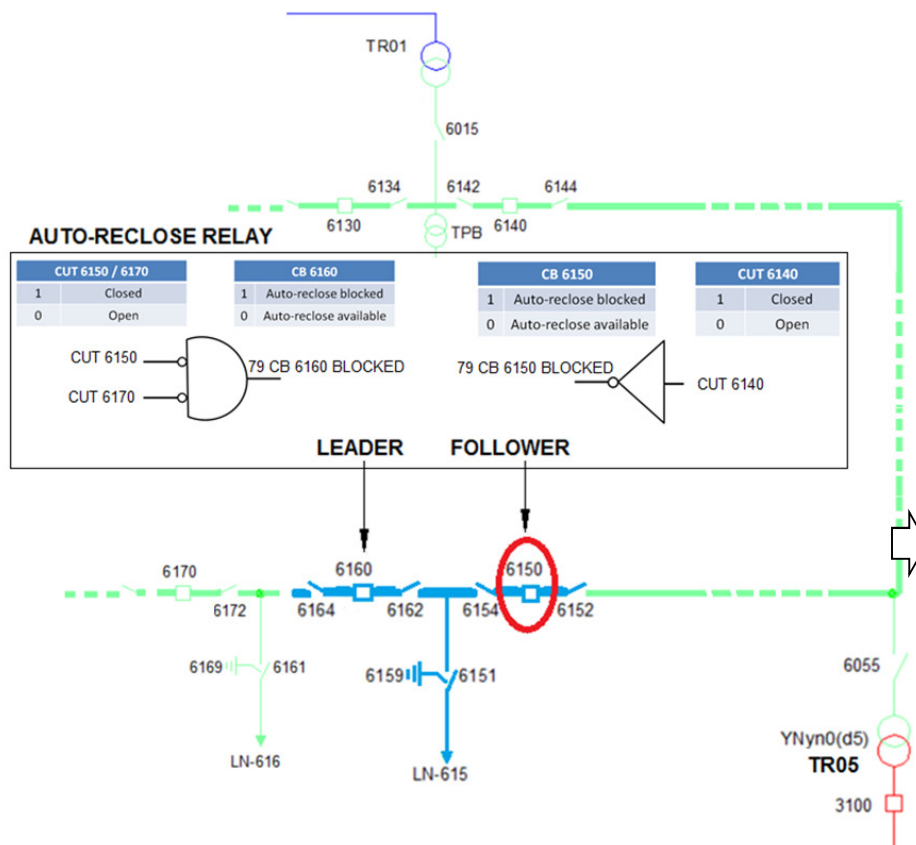
K1: MPI3 p 1: I A/A



K1: MPV3 p 1: V A/V



Soft condition test result of the bay LN-615- A reclosing in failure of CB 6160 was made



- **The scheme proposed by this document increases the reliability** of the energy service given to customers, and also avoids problems related to overvoltages, overloads and blackouts in the power system.
- This work was conducted according to **three important conditions**: the automatic reclosing of a circuit breaker shared between a line and a transformer, the automatic reclosing of a circuit breaker shared between a line and a capacitor bank, and the automatic reclosing of a circuit breaker shared between two lines.
- The block conditions of the auto-reclose schemes considers not only the circuit breaker ready and synchronism check signals, but also the **position of the adjacent CUTs and leader and follower CBs** on pre-fault, fault and auto-reclose cycle steps. The scheme offers a total control of both CBs, even during reclosing in failure
- **Every fault recorder proved how logic implementations were accomplished satisfactorily.** The scheme proposed makes the general auto-reclose scheme safer for equipment of the ring substation at 66 kV. This methodology and criteria employed in this work should be extended to other levels of ring and breaker-and-half substations with other equipment such as generators, FACTS o motors in order to obtain a successful automatic reclose saving the power equipment from harm.

Thank you!

German Gutierrez

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