Improving automatic reclosing “KONGIK-jord” in compensated systems

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Introduction

Important factors in the power system:

- Increasing demand for electrical energy
- Stability and reliability is important
- Automatic recloser must function optimally

A problem has been observed where the automatic recloser is undesirably interrupted. Upon closer investigation, it has been concluded that the problem lies in the logic "Kongik-Jord", which is part of the automatic recloser sequence.

Problem Definition

The "Kongik-Jord" logic was originally designed to avoid reconnecting after a double earth fault while there still is an earth fault on one side of the circuit breaker, by cancelling the automatic recloser. However it has been found that the time the measured earth fault voltage 3U0 takes to reach steady state, can in some rare cases interrupt the automatic reclosers in other types of faults. Since the AR gets canceled, the overhead lines will not be operational until the system control center manually reconnect the faulted lines. The time they use to reconnect can take anywhere from just a few seconds to several minutes. This can possibly creates other errors to be overlooked. Figure 1 shows a simplified sketch of the original logic provided by Statnett.

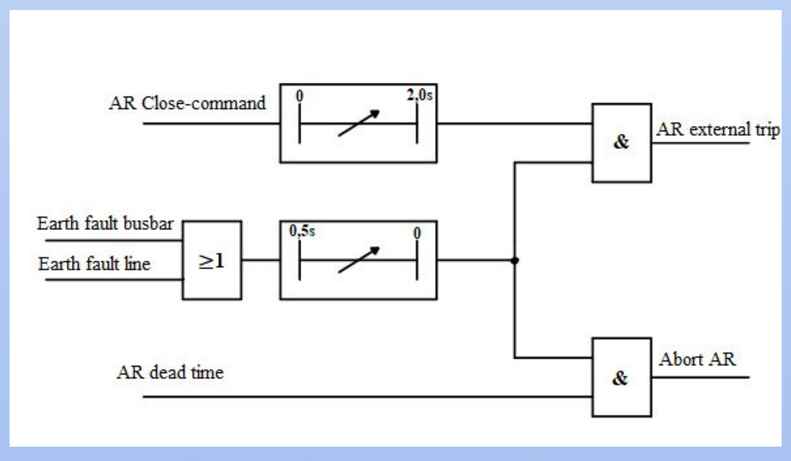

Figure 1. Simplified original logic

Case Study

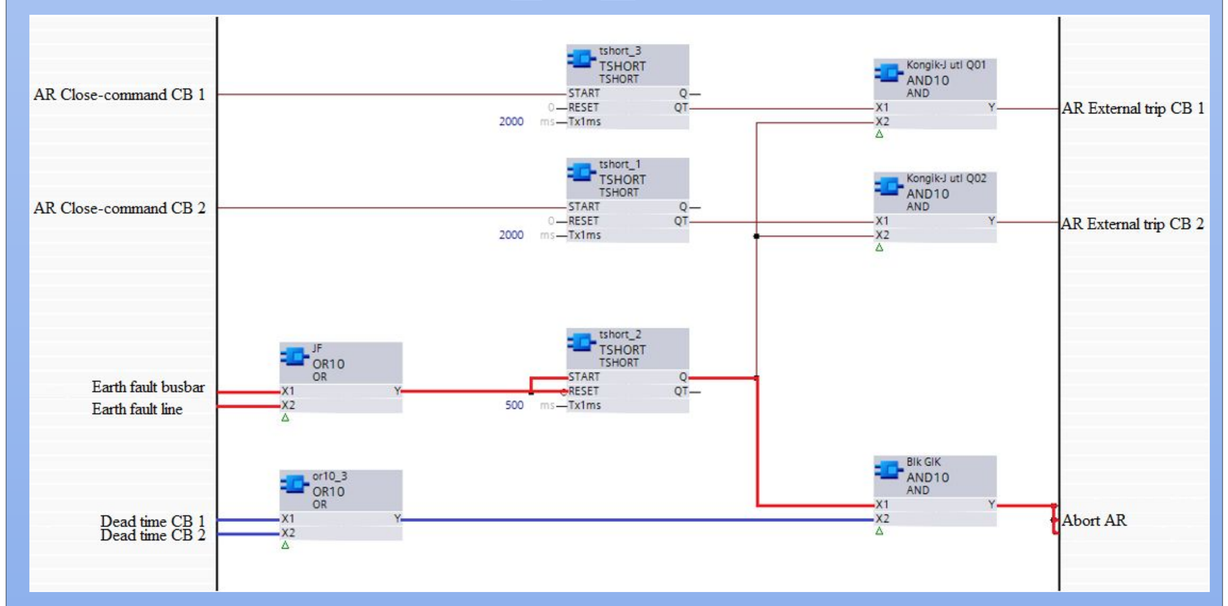

Figure 2. Original logic

The original logic seen in figure 2, it operates as follows:

1. After clearing a fault, measuring 3U0 voltage
2. Timer "tshort_2" will delay the 3U0 voltage signal for 500ms
3. The dead time is set to be 10 seconds
4. "Blk GIK" block will get two high inputs
5. Abort the AR-logic.

First option was to increase the the existing timer block to 1000ms, but after feedback from Statnett it was apparent that changing this to 1000ms, could disturb other blocks outside this specific logic.

To ensure that the other blocks would not be affected by the timer, it was decided to split the 3U0 signal into two separate timers.

- "tshort_2", 500ms
- “tshort_4”, 1000ms

The logic can be seen in figure 3.

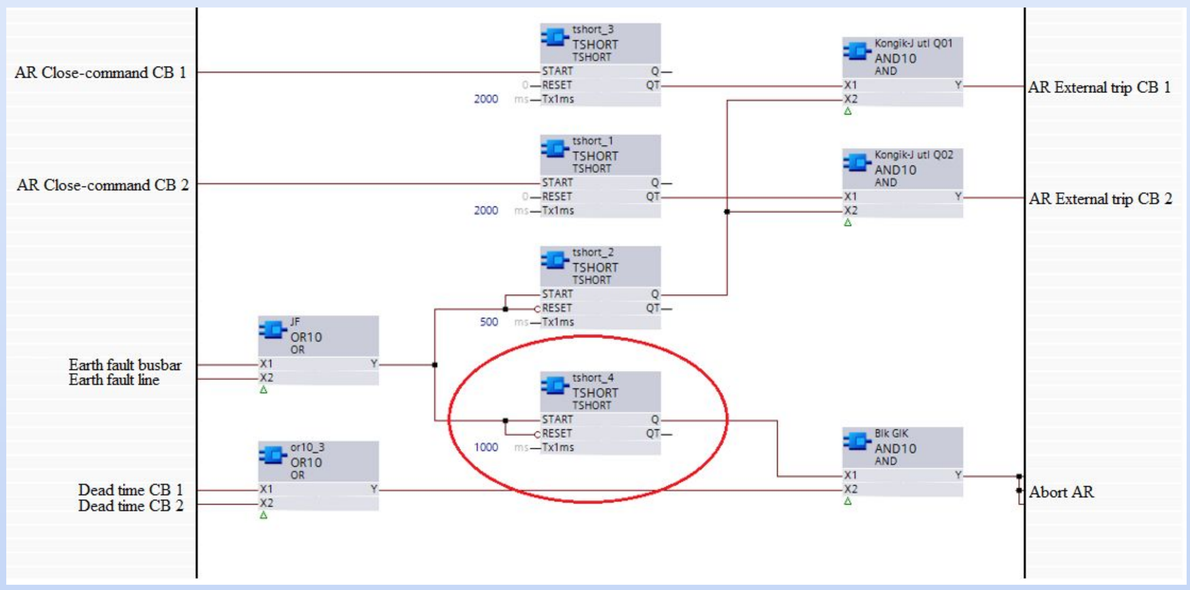

Figure 3. Second option

After further consultation with Statnett, it was clear that with temporary faults, the 3U0 voltage signal could still abort the logic early in the dead time. In order to prevent interruption too early, it was decided to make the logic check for 3U0 voltage later in the dead time. To achieve this:

- The "tshort_4" timer was moved and changed to 8 seconds
- Delay "Blk GIK", so no cancelation of AR

This would appear to be a possible way of solving the problem, which the consultant from Statnett agreed with. The final logic is pictured in figure 4, where the red circle indicates the delayed timer "tshort_4".

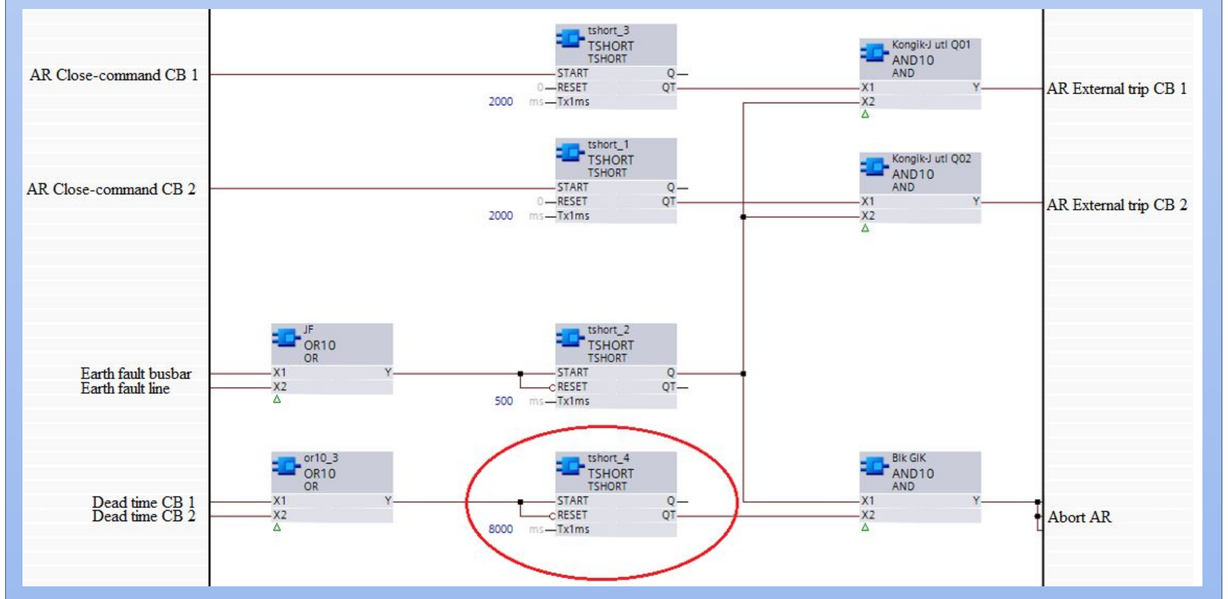

Figure 4. Proposed option

Conclusions

To be able to propose a solution, a broad understanding of power system organisation, grid distribution and fault treatment had to be established. It is important to know how the power grid is structured and how it is composed to understand the complexity. Power is produced in different types of power plants and distributed to consumers and the quality of the power is important to the consumers. The modified logic includes a timer that will force the logic to wait until the end of the dead time to check the conditions, and then decide if the auto recloser should be aborted or not.

This thesis propose a solution to a very specific problem in the Norwegian power grid, but operational reliability is important for every country. It is not unlikely that other countries are facing the same issues.

Topics for further analysis can be:

- 3U0 voltage level. This value is today at 30% of nominal voltage, but can be between 20-70%.
- Dead time is set at 10 seconds, and it can be further analysed if this value is at an optimal level.
- AR-cycle. One cycle is being used and adding multiple cycles may lead to safety problems.

Supervisors

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