INTEGRATED SOLUTIONS TO ACHIEVE RESERVE TRIGGERING ON BREAKER FAILURE IN DOUBLE BUSBAR SUBSTATIONS

Prof. Eng. **Gheorghe HAZI** PhD[1], Prof. Eng. **Aneta HAZI** PhD[1]

[1]„Vasile Alecsandri" University of Bacau.

REZUMAT. În lucrare se prezintă câteva soluţii de realizare pentru DRRI într-o staţie de transformare cu bară dublă, în situaţia utilizării protecţiilor digitale. Se arată schema logică pentru fiecare variantă şi diagrama de evenimente.. Soluţiile prezentate asigură o durată totală de funcţionare a DRRI redusă, ceea ce reduce efectele termice ale curenţilor de scurtcircuit. Se prezintă modul de integrare a DRRI local în schema DRRI pe staţie. Variantele prezentate se diferenţiază în funcţie de modul în care este pornit DRRI pe staţie, de controlul curentului din celulele declanşate şi în funcţie de modul de declanşare a întrerupătorului cuplei transversale. Se face o analiză critică a variantelor şi se trag concluzii privind avantajele, dezavantajele, precum şi riscurile pentru fiecare dintre acestea.

Cuvinte cheie: declanşare de rezervă la refuz de întrerupător (DRRI), protecția la refuz de întrerupător, protecție numerică, stație cu bară dublă.

ABSTRACT. This paper presents a few breaker failure (BF) implementation solutions in a double busbar substation, when using digital protections. For each option the logical and the events diagrams are shown. The solutions presented provide a reduced BF total operational duration, which reduces the thermal effects of short circuit currents. The paper presents the way to integrate a local BF in the BF station diagram. The presented alternatives differ depending on how the station BF is triggered, on the control current in the triggered cells and on how the transverse coupling breaker is triggered. A critical analysis of the alternatives is performed and conclusions are drawn regarding the advantages, disadvantages, and risks of each.

Keywords: breaker failure (BF), breaker failure protection (BFP), numerical protection, double busbar diagram.

1. INTRODUCTION

Use of the breaker failure protection is necessary when isolating a failure by the nearest breaker is not achieved due to its failure. We define breaker failure protection as an event caused by a failure to open the main contacts or by a failure to interrupt current after receiving the trip command.

Modern digital protections [1], [2], [3] have implemented the 50BF function which ensures either triggering of the same breaker through the second coil or triggering of adjacent breakers. The same function can be implemented through an independent digital terminal [4].

Figure 1 shows the conceptual diagram for the BFP at the bay level. The start signal is activated by the Breaker Failure Initiate input signal (BFI), ie by the triggering command given by the bay breaker. Operation is conditioned by the 50BF signal (Breaker failure detector), that is, by contacts remaining closed or/and by the high value of the current in the circuit.

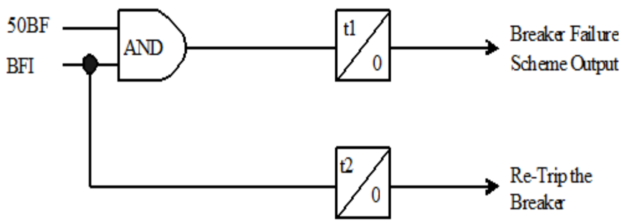

Fig. 1. Breaker failure schematic drawing

After a delay, t_2, the trip command is sent again, using both trigger coils. If the fault persists after a total time $t_1 > t_2$ a command for tripping all nearby breakers is sent (figure 2) [5], [6].

In double busbar substations the remote trip has to command only the breakers connected to the same bar as the breaker that refused tripping. Equipment manufacturers do not provide relays that perform this function. This paper proposes two options for remote trip.

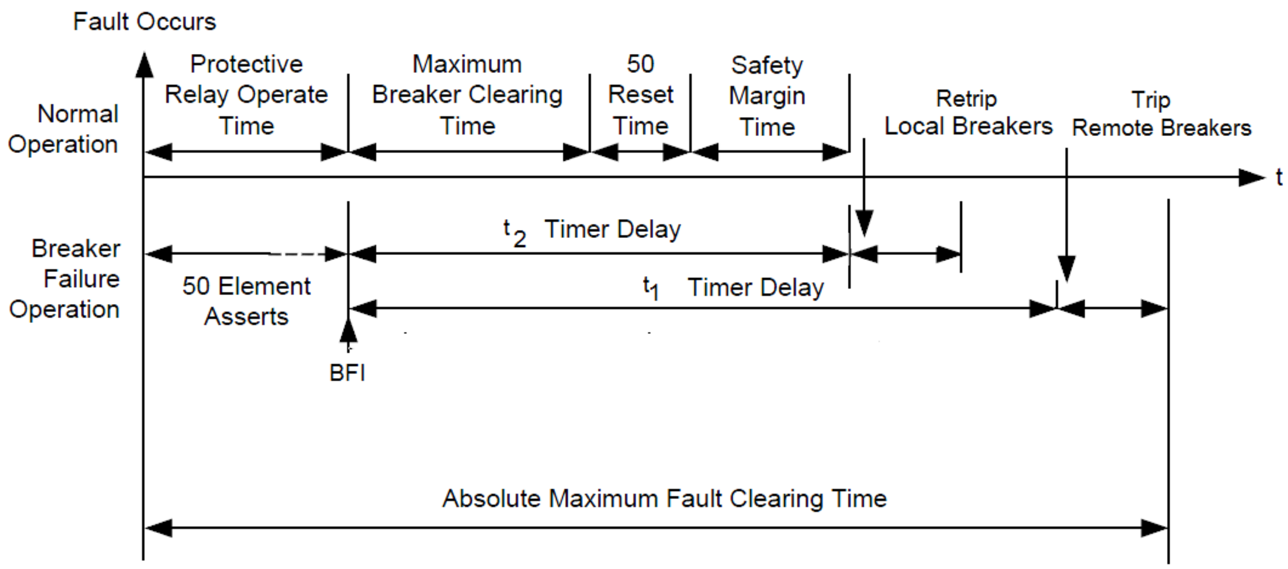

Fig. 2. Breaker Failure Scheme Time Chart

2. USING A DEDICATED DIGITAL TERMINAL

In this case the BFP at the bay level ensures the local reserve triggering, and the remote triggering is performed through the central relay. The solution is shown in figure 3.a. Figure 3.b shows the single line installation diagram. As opposed to conceptual diagram 2, in this alternative the delay for remote triggering (Δtc) is started after the local retripping command. The local delay (Δt) is controlled through the bay digital terminal, while the delay for reserve remote triggering (Δtc) is controlled through the central protection relay.

The cross coupling is disconnected on any breaker failure from another bay. It is well that, in such situations, the cross coupling is disconnected in advance of other disconnections from the busbar. On refusal to trigger the cross coupling the breakers for the departures from both busbar systems will be triggered.

This alternative has the advantage that it is more flexible, allowing a different setting in the case of the reserve remote triggering. It has the disadvantage that it requires an independent digital terminal containing 3 binary inputs and one binary output for each bay.

Using a properly configured programmable automaton would be appropriate.

3. ADDITIONAL CONFIGURATION OF DIGITAL PROTECTION TERMINALS FOR ALLOWING RESERVE TRIPPING

In this solution a reserve tripping loop is made for each of the two bars. Loop activation is performed by the local BFP output (figure 4). Compared to the local protection in figure 3, this alternative has added the delay element for external retripping (Δtc).

Figure 5 shows the hardware structure for the local implementation of the remote breaker failure protection.

Figure 5 shows that the digital terminal which ensures the basic protection receives information regarding the busbar breakers positions from the reserve protection. Upon receipt of a remote BF triggering command through BI1 or BI2, the basic protection will trigger its own breaker if the busbar separator corresponding to the received command (bar 1 or bar 2) is closed.

The remote protection is started if the local BFP is activated (see figure 4, variable BFK). The BFP loop will be remotely activated, depending on the position of the local busbar separators (through BI3, BI4).

Solution 2 has the advantage that it requires only one additional digital terminal, but the flexibility is reduced. In addition, the basic local protection must make available 4 binary inputs and 2 binary outputs.

In this solution, also, the cross coupling is disconnected on any BF from another bay, ie on activation of the loop corresponding to busbar 1 or activation of the loop corresponding to busbar 2.

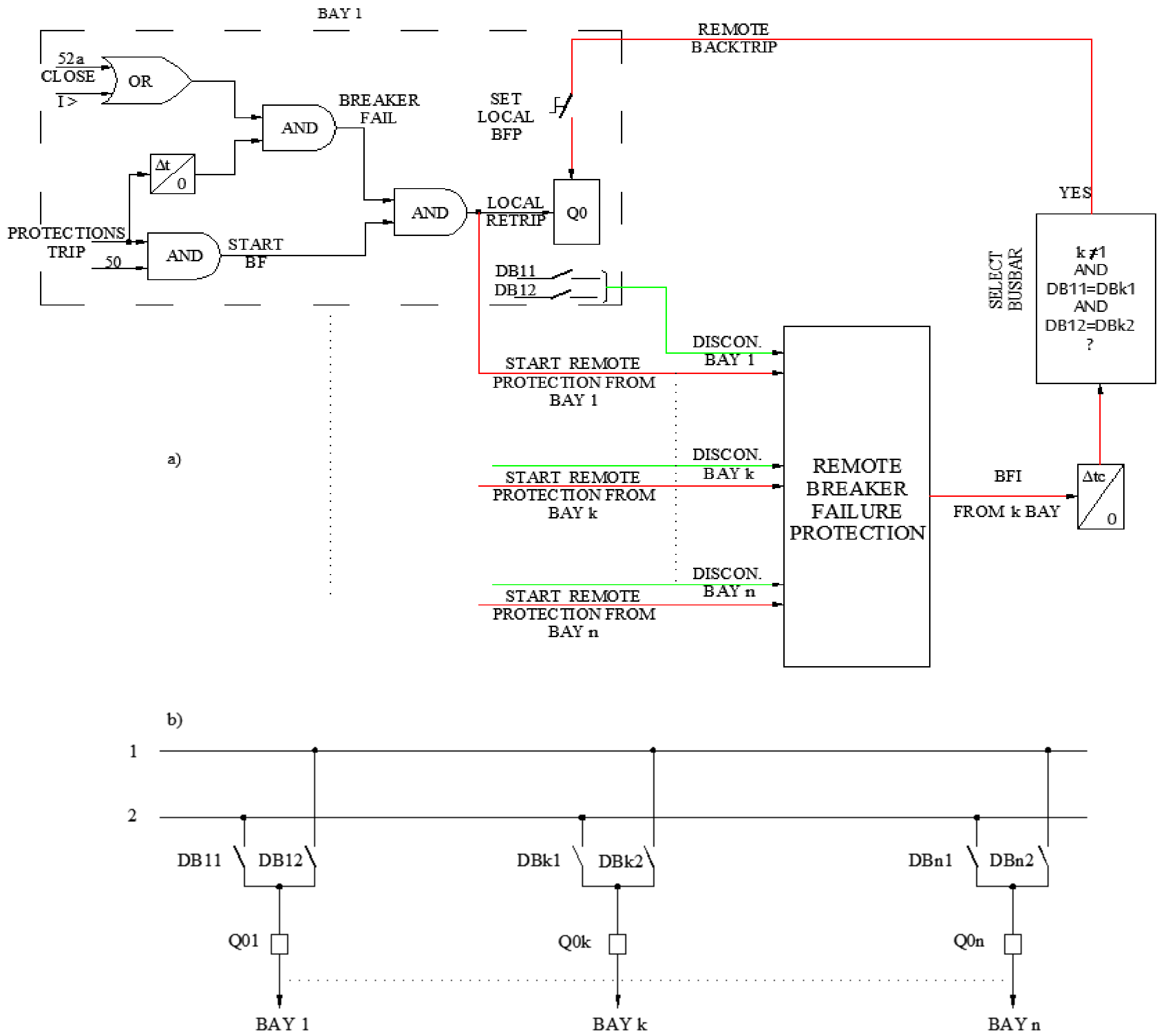

Fig. 3. Remote breaker failure protection with a separate numerical protection

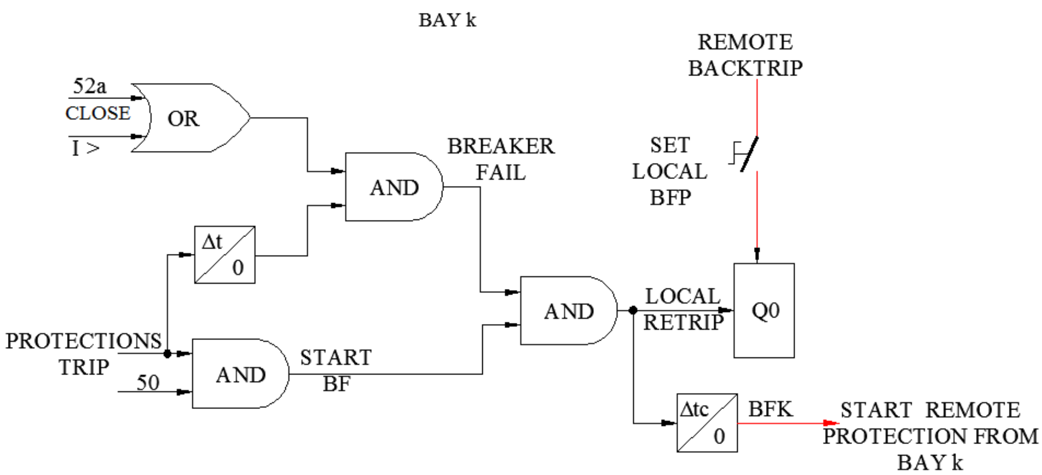

Fig. 4. Local breaker failure protection in 2nd solution

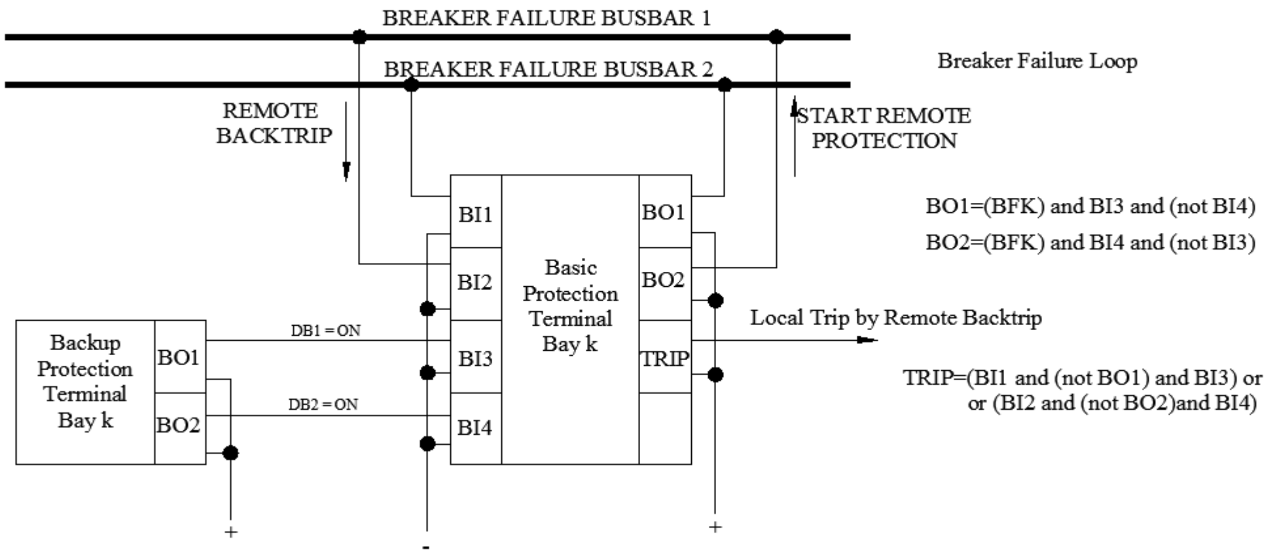

Fig. 5. Remote breaker failure protection without a separate numerical protection

4. CONCLUSIONS

This paper has presented two BFP solutions for double busbar substations:

- The first solution uses an independent digital terminal which triggers the BFPs for bays situated on the same bar as the failed breaker.
- The second solution is made up of two loops for reserve external triggering. Timing is provided locally, before loop activation. A loop is activated on a local breaker failure, according to the position of the busbar separators. Remote triggering is performed after checking the position of the local busbar separators in relation to the command received.

Both solutions have advantages and disadvantages:

- Solution 1 is more flexible, allowing different configurations for remote tripping. It is more expensive, requiring an independent digital terminal.
- Solution 2 is cheaper.

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About the authors

Prof. Eng. **Gheorghe HAZI,** PhD
“Vasile Alecsandri” University of Bacau
email:gheorghe.hazi@ub.ro

Graduated at the „Gh.Asachi”University of Iasi, Faculty of Electrotechnics, study program – Electro Power Engineering in 1982. In 1997 obtained the scientific title of doctor engineer of the „Gh.Asachi”University of Iasi, specialization Electro Power Engineering.

Prof. Eng. **Aneta HAZI,** PhD
“Vasile Alecsandri” University of Bacau
email:ahazi@ub.ro

Graduated at the „Gh.Asachi”University of Iasi, Faculty of Electrotechnics, study program - Industrial Power Engineering in 1982. In 1999 obtained the scientific title of doctor engineer of the “Politehnica”University of Bucharest, specialization Thermo Power Engineering.