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Booklets

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Title: Development of busbar differential protection algorithm on PSCAD

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Introduction (Differential Protection Concept)

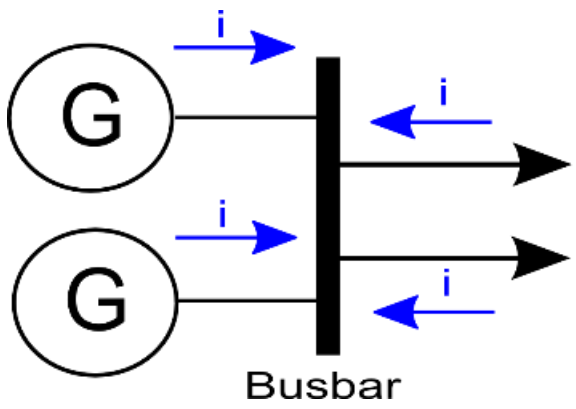

Figura 1 Busbar protection scheme. *Own elaboration.*

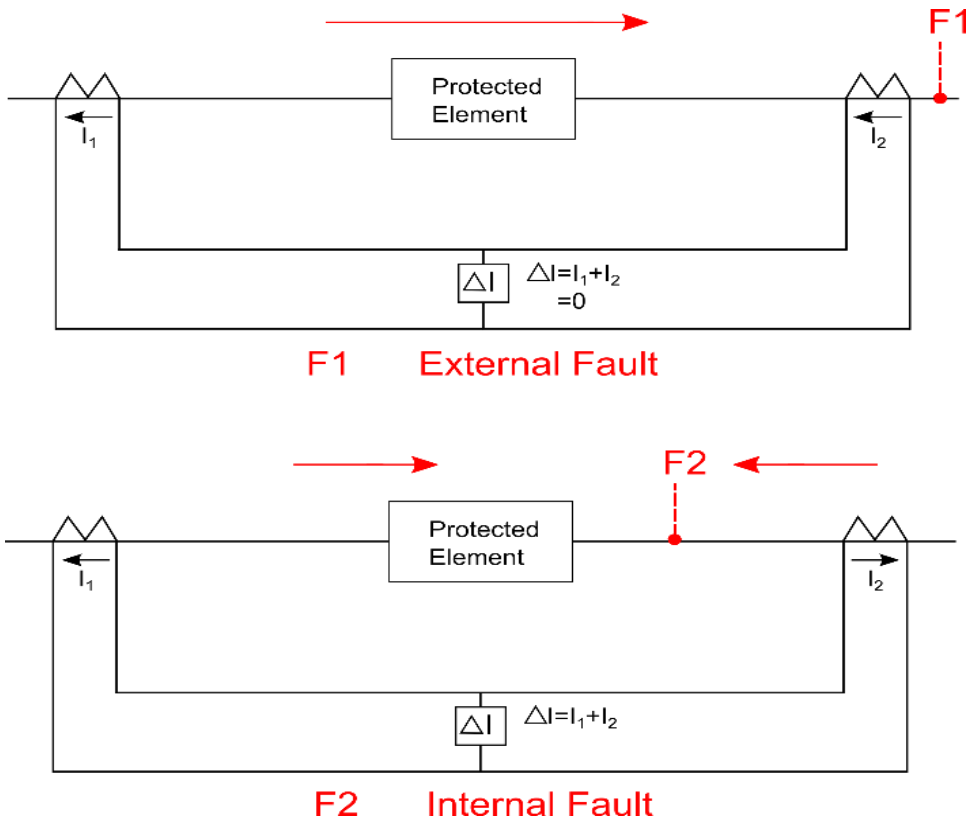

Figura 2 Differential protection internal and external faults. *Own elaboration.*

Objectivo

To develop an academic numerical Busbar Differential Protection on PSCAD (Power System Computer Assisted Design) and analyze the operation and behavior of this protection for the different types of faults, whether internal or external.

Justification

The developed Busbar Differential Protection can be used as simulation exercises for the undergraduate engineering students to better comprehend the operation of differential protection when there is an internal or external fault.

Hypothesis

The developed numerical Busbar Differential Protection on PSCAD should be sensitive enough to operate only for internal faults, in this case, faults on busbar. Whereas the algorithm should discriminate and not operate for any external faults whether they are single-phase, double-phase or even three-phase.

Methodology

$$I_{op_{me}} = |\bar{I}_1 + \bar{I}_2 + \bar{I}_3 \dots \bar{I}_n| \quad (1)$$

→ The measured tripping current

$$I_{rest} = |\bar{I}_1| + |\bar{I}_2| + |\bar{I}_3| \dots |\bar{I}_n| \quad (2)$$

→ The restraint current

$$I_{diff} = 1\ A \quad (3)$$

→ The differential current

$$I_{op_{cal}} = I_{diff} + k\ I_{rest} \quad (4)$$

→ The calculated tripping current

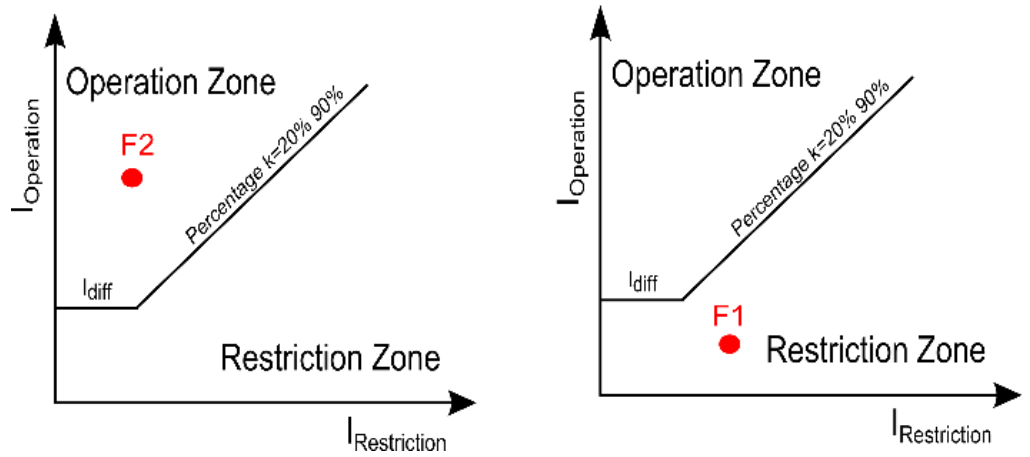

Figura 3 Differential protection characteristics: tripping zone and restraint zone.

Own elaboration.

Methodology

$$I_{op_{me}} > I_{op_{cal}} \quad (5)$$

→ Internal fault (Tripping operation)

$$I_{op_{me}} < I_{op_{cal}} \quad (6)$$

→ External fault condition or load (No tripping operation)

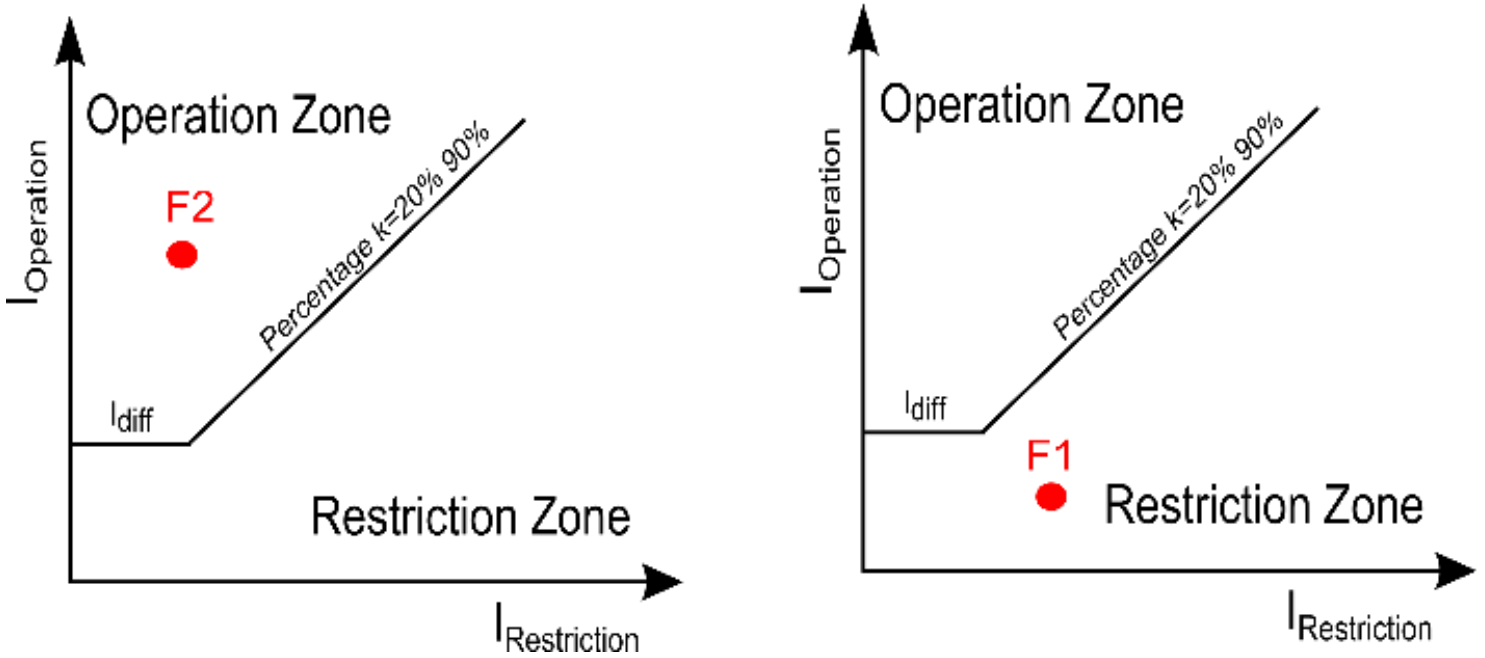

Figura 3 Differential protection characteristics: tripping zone and restraint zone.

Own elaboration.

Simulación

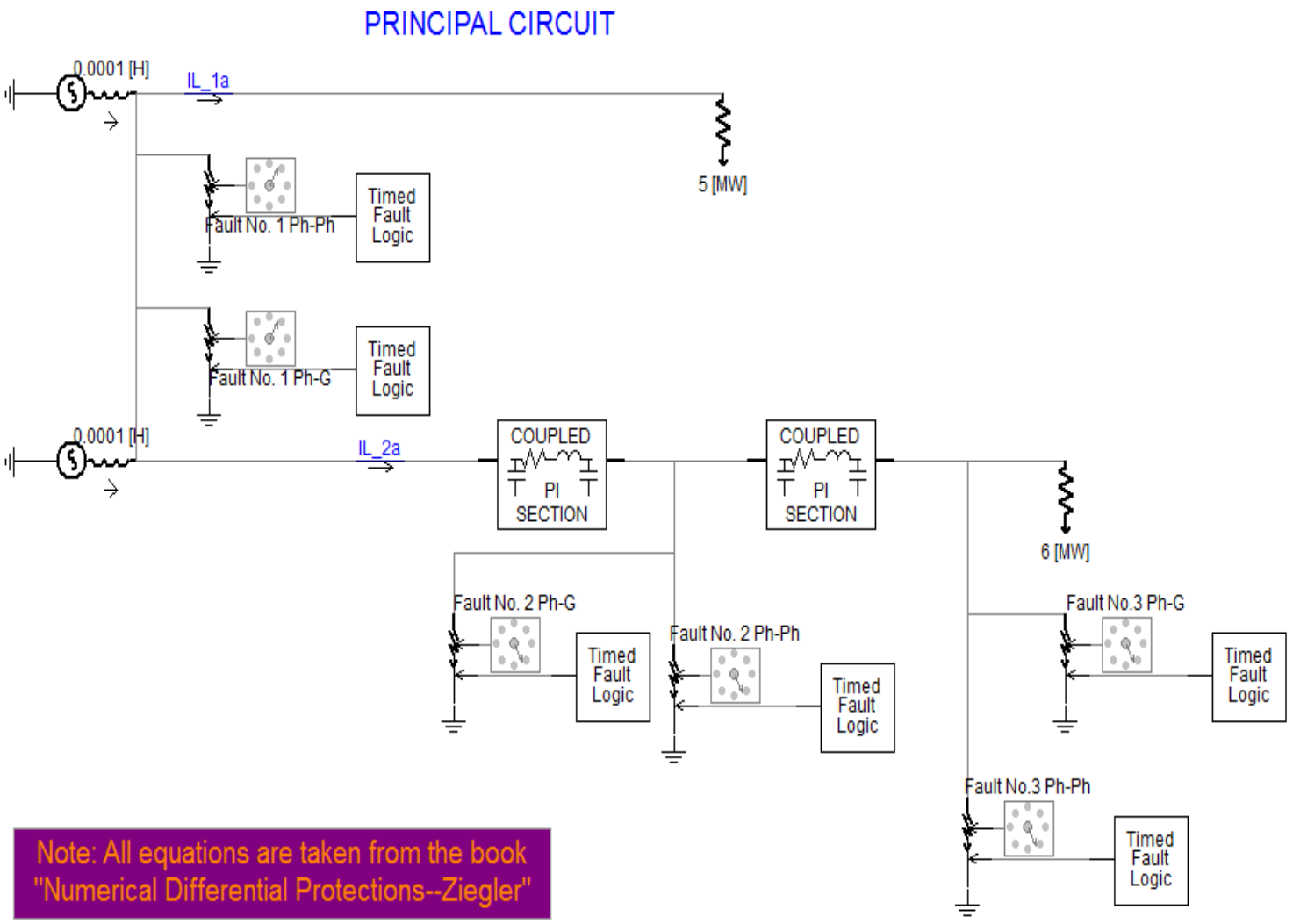

Figure 4 Principal circuit under study in PSCAD.

Own elaboration.

Parámetros	Valores
Gen 1 and 2	10 MVA
Internal Gen L	0.1 mH
Line 1	< 80 km
Line 2	> 240 km
Load 1	5 MW
Load 2	6 MW

Table 1 Test system data. *Own elaboration.*

Simulation

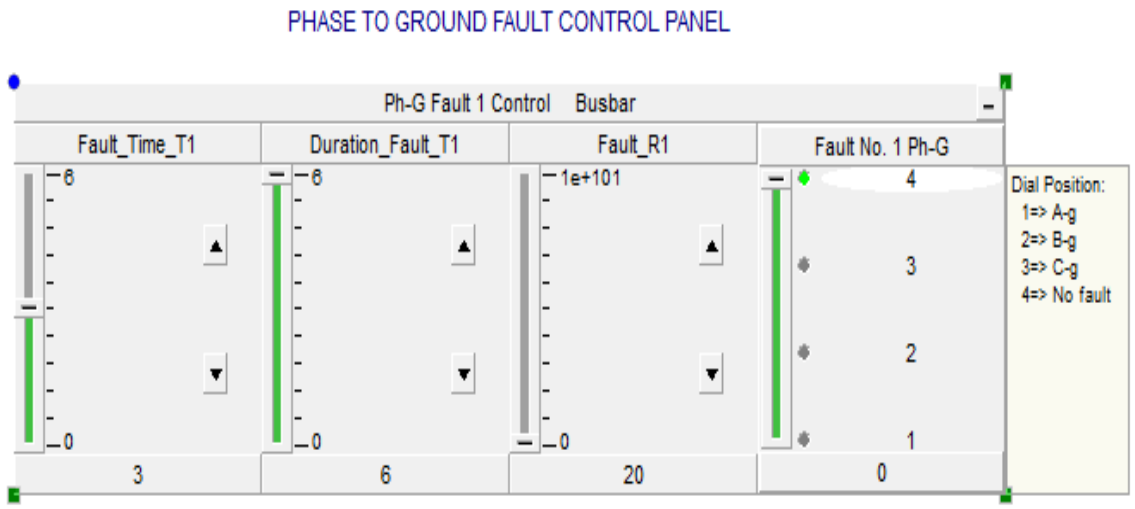

Figure 5 Phase to ground fault control in the protected zone (busbar).

Own elaboration.

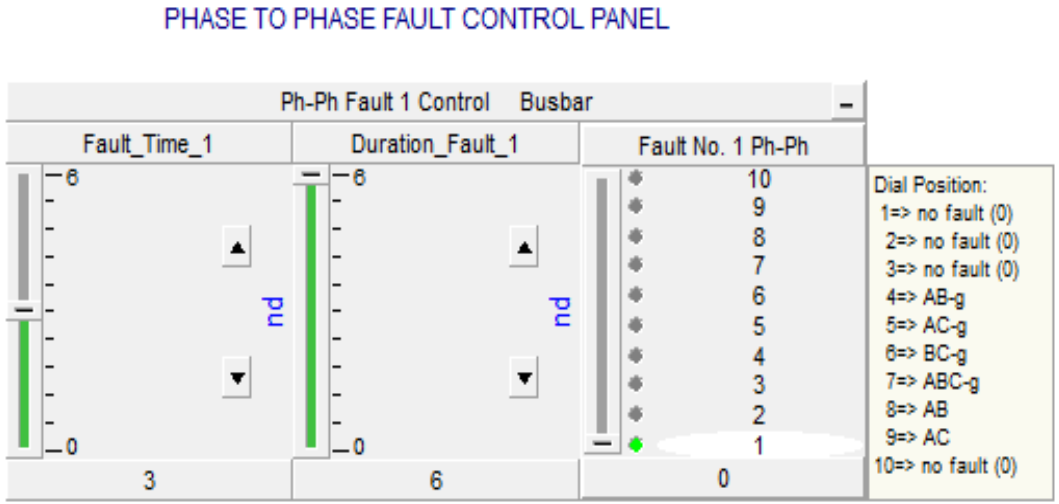

Figure 6 Phase to phase fault control in the protected zone (busbar).

Own elaboration.

Simulation

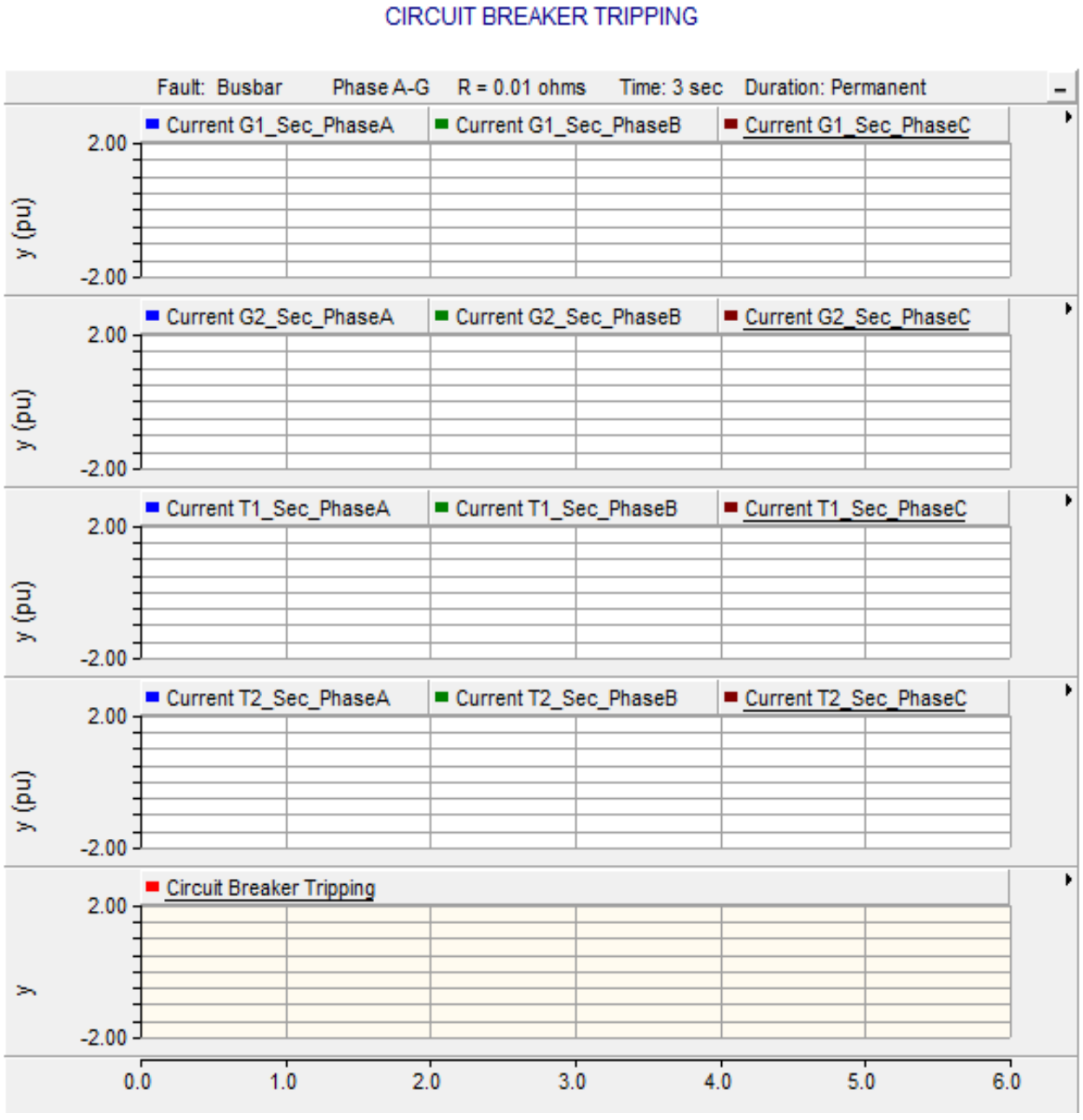

Figure 7 (a) Generator 1 currents. (b) Generator 2 currents. (c) 5 MW load currents. (d) 6 MW load currents. (e) Display of open or closed breakers: a “0” for closed breakers and a “1” for opened breakers.

Own elaboration.

Results Case 1.- Internal fault of phase A to ground in the principal busbar (R = 0.01 ohms).

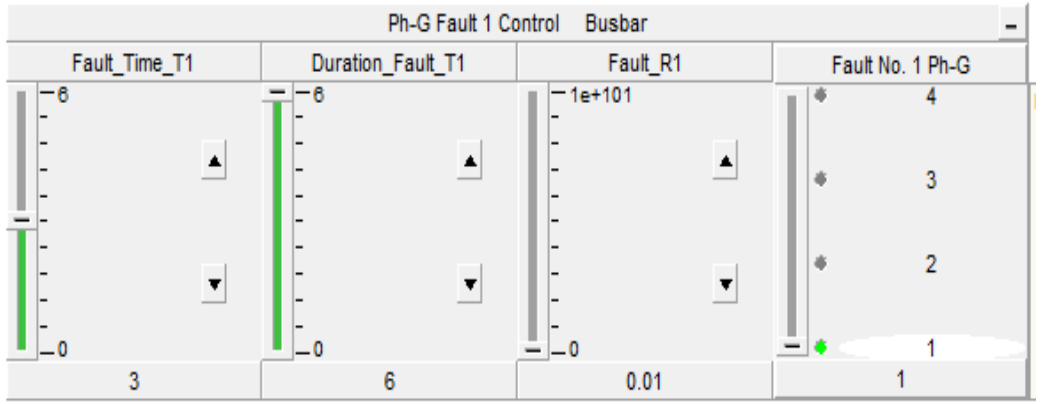

Figure 8 A-g fault adjustment (0.01 ohms), in the fault control panel..
Own elaboration.

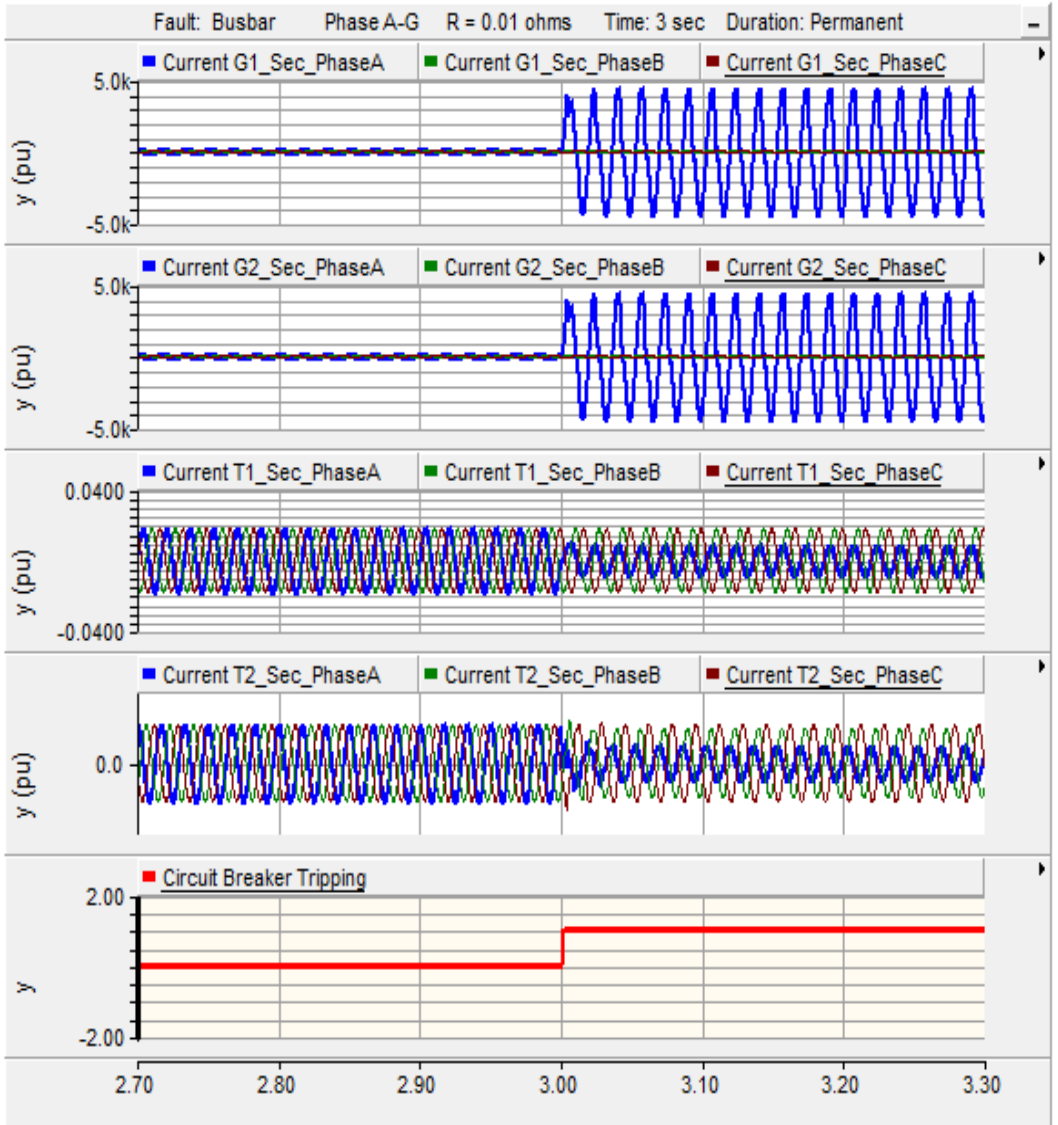

Figure 9 Fault graphs (Phase A-g R = 0.01 ohms). Internal fault. *Own elaboration.*

Results Case 2.- Internal fault of phase A to ground in the principal busbar (R = 20 ohms).

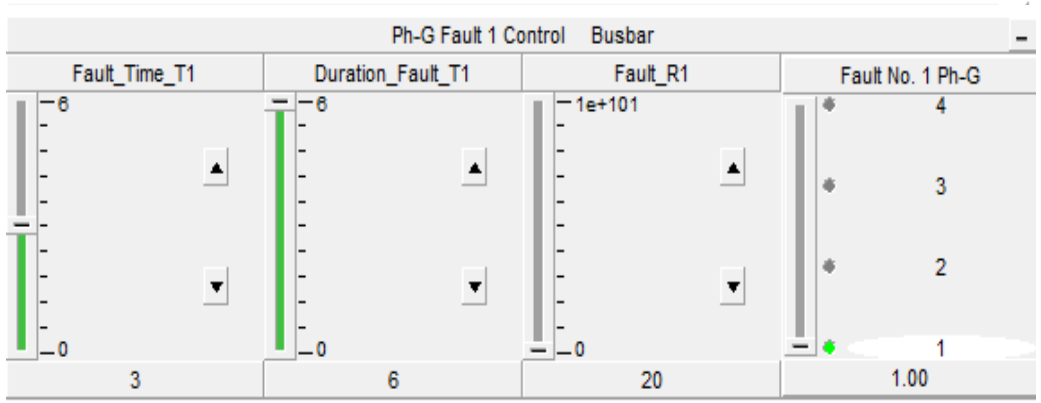

Figure 10 A-g fault adjustment (20 ohms), in the fault control panel. *Own elaboration.*

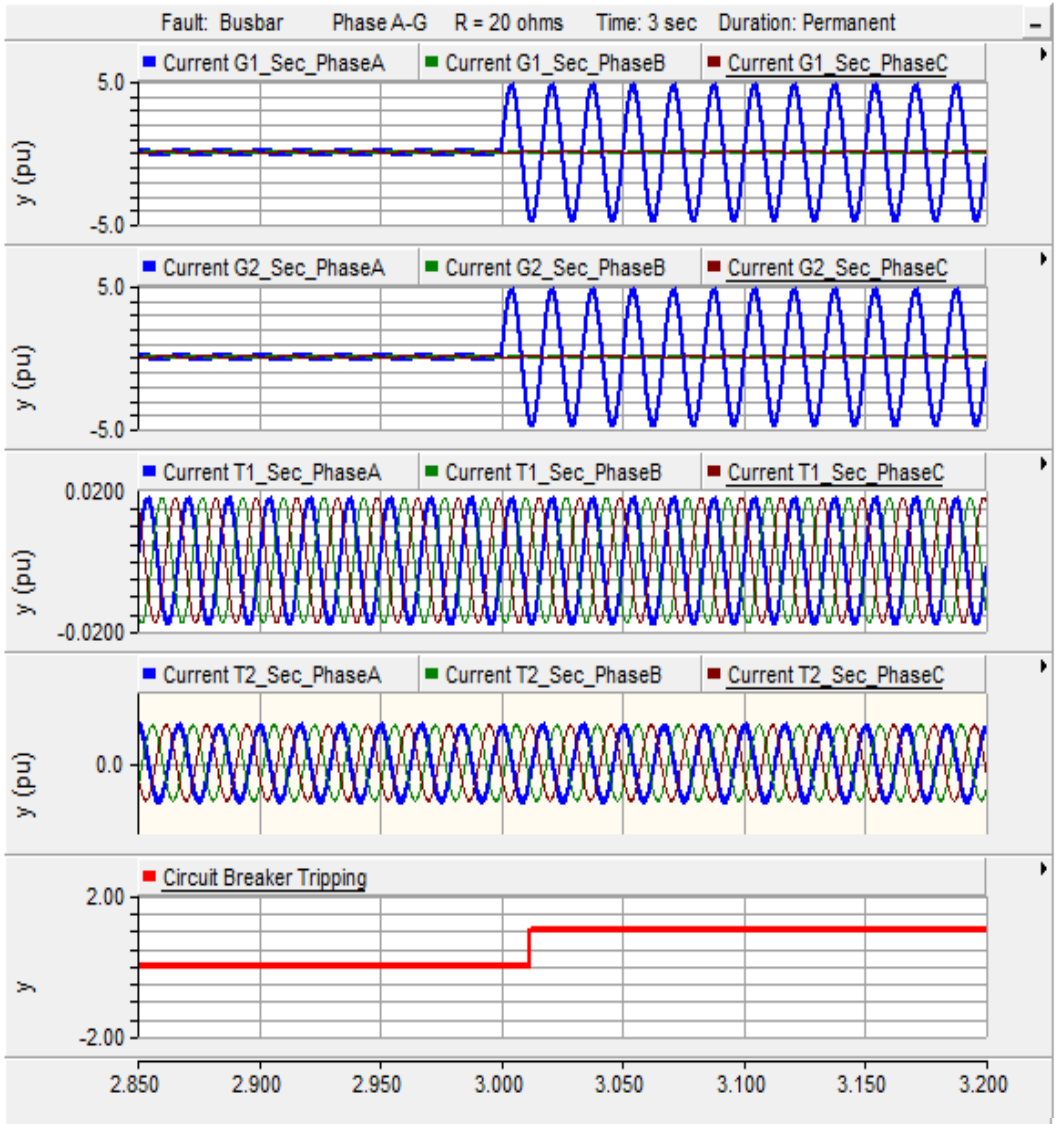

Figure 11 Fault graphs (Phase A-g R = 20 ohms). Internal fault. *Own elaboration.*

Results Case 3.- External fault phase A to phase B, distance 250 km.

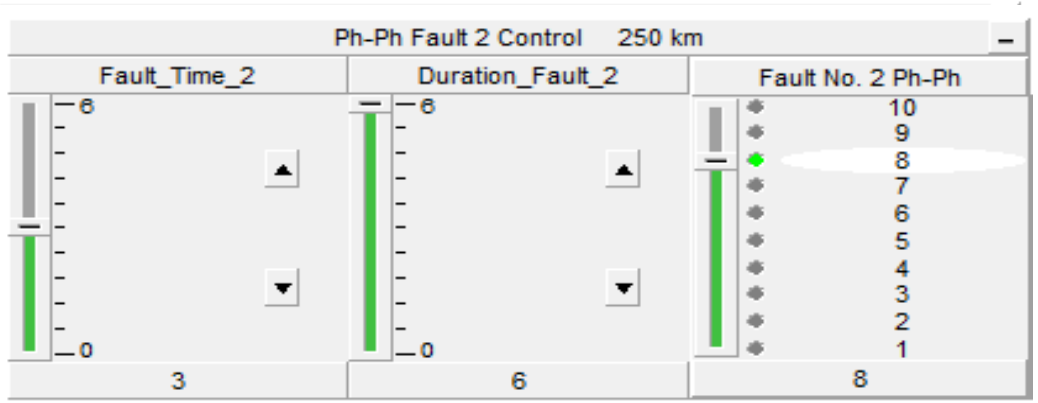

Figure 12 A-B fault adjustment. *Own elaboration.*

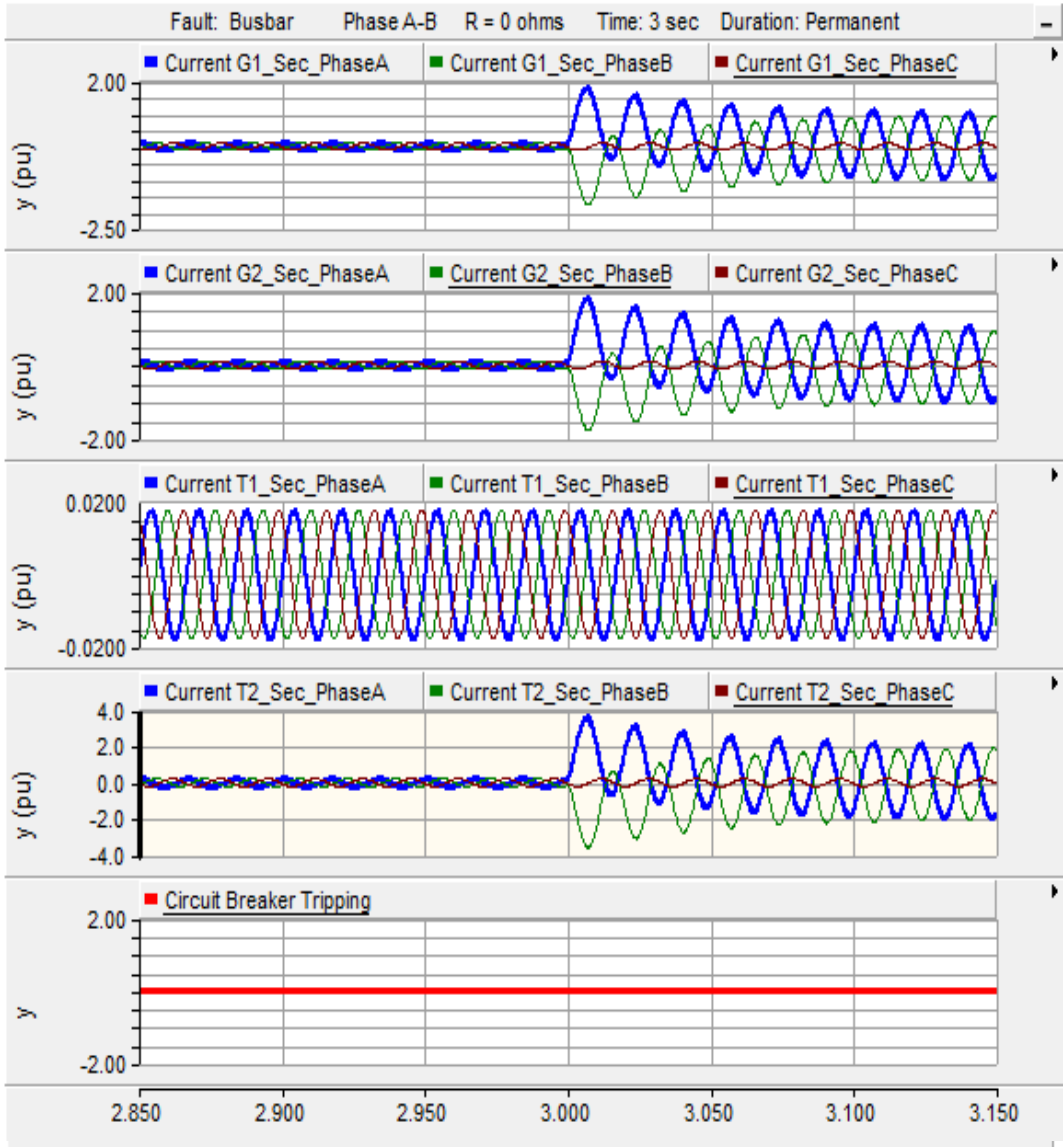

Figure 13 Ph-ph fault graphs (A-B). External fault.. *Own elaboration.*

Conclusions

Differential Protection Overview Responses				
Cases	Internal Fault	External Fault	Protection Operation	Correct
F=A-g R=0.01	✓		Yes	Yes
F=A-g R=20	✓		Yes	Yes
F=A-B 250km		✓	No	Yes

References

- Blackburn J. L. & Domin T. J. (2006). *Protective relaying, principles and applications*. (3rd edition). CRC Press Taylor & Francis Group.
- Chen G., Liu Y. and Yang Q. (2020). Impedance Differential Protection for Active Distribution Network, *IEEE Transactions on Power Delivery*, 35 (1), 25-36. DOI: 10.1109/TPWRD.2019.2919142
- Elmore W. (2003). *Protective relaying theory and applications*. (2nd edition). CRC Press Taylor & Francis Group.
- IEEE/PES Power System Relaying Committee (1979). *IEEE Guide for Protective Relay Application to Power System Buses*. ANSI/IEEE C37.97-1979. DOI: 10.1109/IEEESTD.2009.5325912
- Kasztenny B. & Finney D. (2005). Generator protection and CT-saturation problems and solutions, *IEEE Transactions on Industry Applications*, 41 (6), 1452-1457. DOI: 10.1109/CPRE.2005.1430427
- Saleh S. & Ozkop E. (2021). Digital Differential Protection for 3φ Solid-State Transformers, *IEEE Transactions on Industry Applications*, 57 (4), 3474-3486. DOI: 10.1109/TIA.2021.3072877
- Tavares K. & Silva K (2014). Evaluation of Power Transformer Differential Protection Using the ATP Software, *IEEE Transactions on Latin America*, 12 (2), 161-168. DOI: 10.1109/TLA.2014.6749533
- Ziegler G. (2005). *Numerical Differential Protections*, Editorial Siemens.

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