[[1]](#footnote-1)

Three-phase-two-wire rural distribution network: modeling the short-circuit and protection scheme

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# I. INTRODUCTION

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# II. THREE-PHASE TWO-WIRE DISTRIBUTION SYSTEM

The system proposed by [1] is composed of two overhead wires in which the ground is a conductor and part active in the system, o TPTWS uses an isolation transformer to connect the two-wire system to the network. The transformer isolator and costumer transformer are connected to the ground, using the grounding structures. The ground interface can design according to the local soil and the safety requirements. For this work, ground interface is simplified as a single impedance for the analysis.

For the equivalent circuit of system is modify the capacitances between cables and between cables to the ground, so that the short circuit is represented by its intrinsic model in the Fig. 1.

Diagrama

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**Fig. 1.** Model of short circuit in TPTWS.

The impedance Zs, is the result of the series association of the isolating transformer grounding resistance (Rt1) and the equalization series impedance (Ze), that is,

|  |  |
| --- | --- |
|  | (1) |

The model of the short circuit is characterized for three fault resistances (*Raf*, *Rbf* and *Rcf*). For the solid faults, it is possible to calculate the fault current considering the following criteria,

TABLE

Criteria used of fault values

|  |  |  |  |
| --- | --- | --- | --- |
|  | Raf (Ω) | Rbf (Ω) | Rcf (Ω) |
| Three-phase fault | 0 | 0 | 0 |
| Two-phase fault AB | 0 | 0 | ∞ |
| Two-phase fault AC | 0 | ∞ | 0 |
| Two-phase fault BC | ∞ | 0 | 0 |

The analysis of faults with the presence of fault resistance can be performed by changing the value of the resistance Rcf. To simplify the equations, it is possible to obtain the following series impedances:

|  |  |
| --- | --- |
|  | (2) |
|  | (3) |
|  | (4) |

***Fig. 1*** shows the equivalent circuit of the TPTWS network with the equivalent impedances.

Diagrama

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**Fig. 2.** Short circuit diagram: model with reduced replacement.

Applying Kirchhoff's Voltage Law, we have,

|  |  |
| --- | --- |
|  | (5) |
|  | (6) |

Solving equation (6) for the current I2, we have,

|  |  |
| --- | --- |
|  | (7) |

Substituting equation (7) into (5), we get,

|  |  |
| --- | --- |
|  | (8) |

Making the distribution in the third term of equation (8), we obtain,

|  |  |
| --- | --- |
|  | (9) |

Solving equation (9) for the current I1, we arrive at,

|  |  |
| --- | --- |
|  | (10) |

Substituting equation (10) into (7), we obtain:

|  |  |
| --- | --- |
|  | (11*)* |

Therefore, it is possible to equate the phase currents resulting from the fault, that is,

|  |  |
| --- | --- |
|  | (12*)* |
|  | (13*)* |
|  | (14*)* |

So, we define the short circuit equations for the TPTWS system.

# III. STUDY OF CASE

The maximum value of the short-circuit current during the transient period, in the simulation is the application of (15), so we can define the values of short-circuit current in each of its topologies different from the case studies.

|  |  |
| --- | --- |
|  | (15*)* |

On is a current measure on the circuit of TPTWS.

We approach the comparisons of short circuits with equations in relation to simulations and models of short circuits in lines, the models are a simple analysis with construction accuracy equal to the real model.

For the short-circuit study at the end of the line, a fault resistance of 40 Ω was considered. TABLE II presents the values of the resistors Raf, Rbf, Rcf used in the simulation.

TABLE II

Fault impedance values

|  |  |  |  |
| --- | --- | --- | --- |
| Type of fault | *Raf* (Ω) | *Rbf* (Ω) | *Rcf* (Ω) |
| Three-phase fault | 0 | 0 | 40 |
| Two-phase fault AB | 20 | 20 |  |
| Two-phase fault AC | 0 |  | 40 |
| Two-phase fault BC |  | 0 | 40 |

1. *Short Circuit in end of line.*

Diagrama, Esquemático

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**Fig. 3.** Model for end of line fault.

## B. Internal short circuit to the Line

Diagrama, Esquemático

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**Fig. 4.** Model for internal of line fault.

The test system is the same as shown in **Fig. 3**. In **Fig. 4** it is possible to see the fault model inserted at the end of the test system line.

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# V. Conclusion

## A conclusion section is not required. Although a conclusion may review the main points of the article, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

References

[1] P. R. de O. Borges, “REPOTENCIALIZAÇÃO DE SISTEMAS DE DISTRIBUIÇÃO RURAIS MONOFÁSICOS POR MEIO DE DOIS CABOS AÉREOS E O SOLO COMO A TERCEIRA,” 2017.

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