Detection of broken neutral conductor in LV networks to ensure customer safety

João Campos/ Guilherme Freire // **ENEIDA.IO, Portugal**   Anish Babu / Shafiqa Keddar / Ibrahim Abdulhadi // **PNDC, Scotland**

Introduction

//A broken neutral conductor can cause significant safety hazards, such as abnormal voltages that may damage household appliances or make exposed metallic parts live. This paper presents a new LV Broken Neutral detection algorithm developed by ENEIDA.IO and tested at PNDC for different earthing systems, load configurations, and fault locations.

Methodology

//The experimental setup at PNDC included an 11kV/230V substation, three junction boxes, and a configurable three-phase load. Tests were conducted for three types of earthing system (TT, TN-S, TN-C-S) with broken neutral faults emulated at three different locations. Voltage and current waveforms were acquired at three measurement points, sampled at 3.75kHz

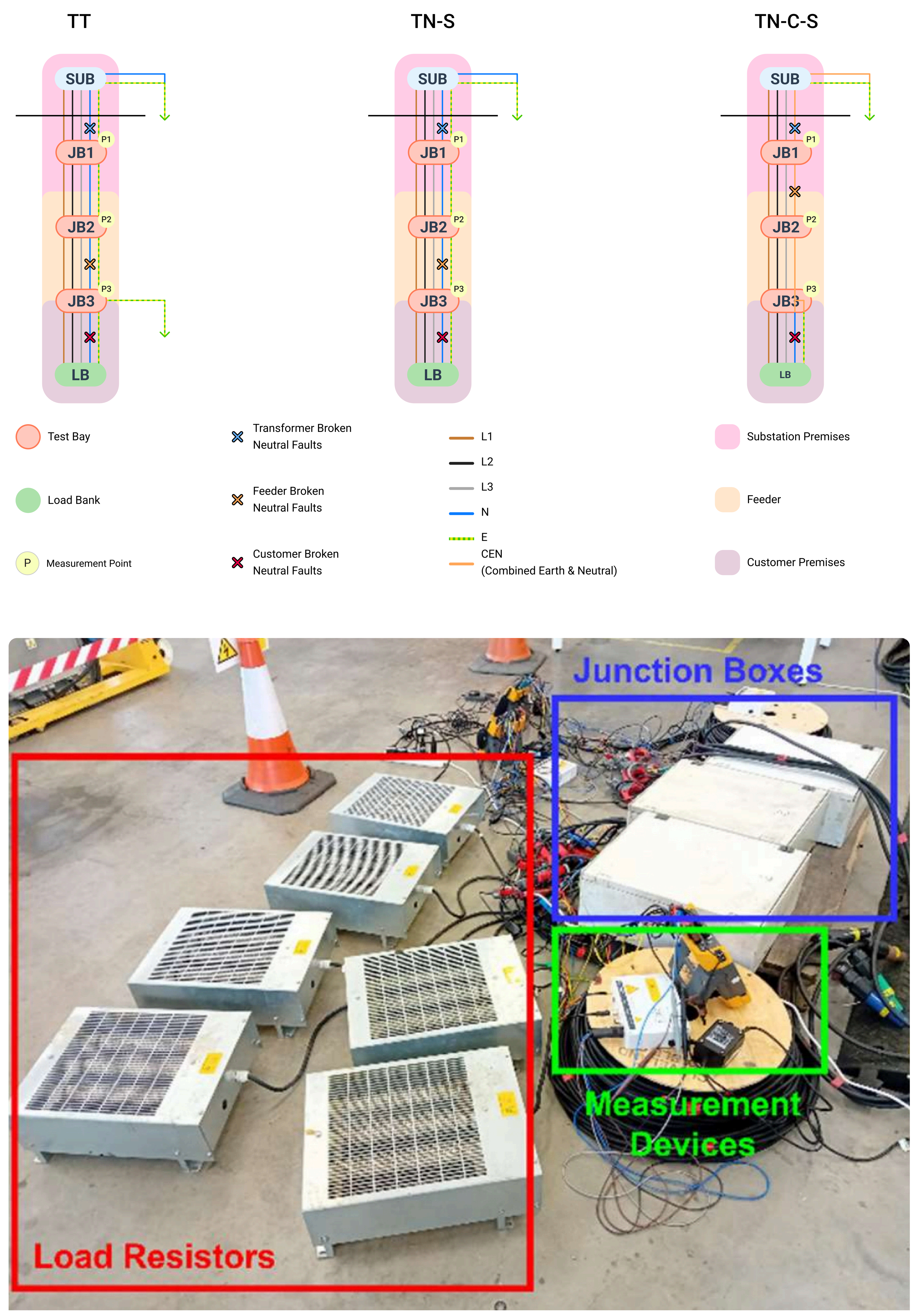

Figure 1. Experimental setup diagrams and picture

Results

//The analysis focused on the harmonic content of the current. The fault could be detected by observing a clear change in this harmonic content. The method showed high accuracy (99.2%) in detecting broken neutral faults across different earthing system types and load configurations. There is, however, room for improvement, as a small number of false positives was observed.

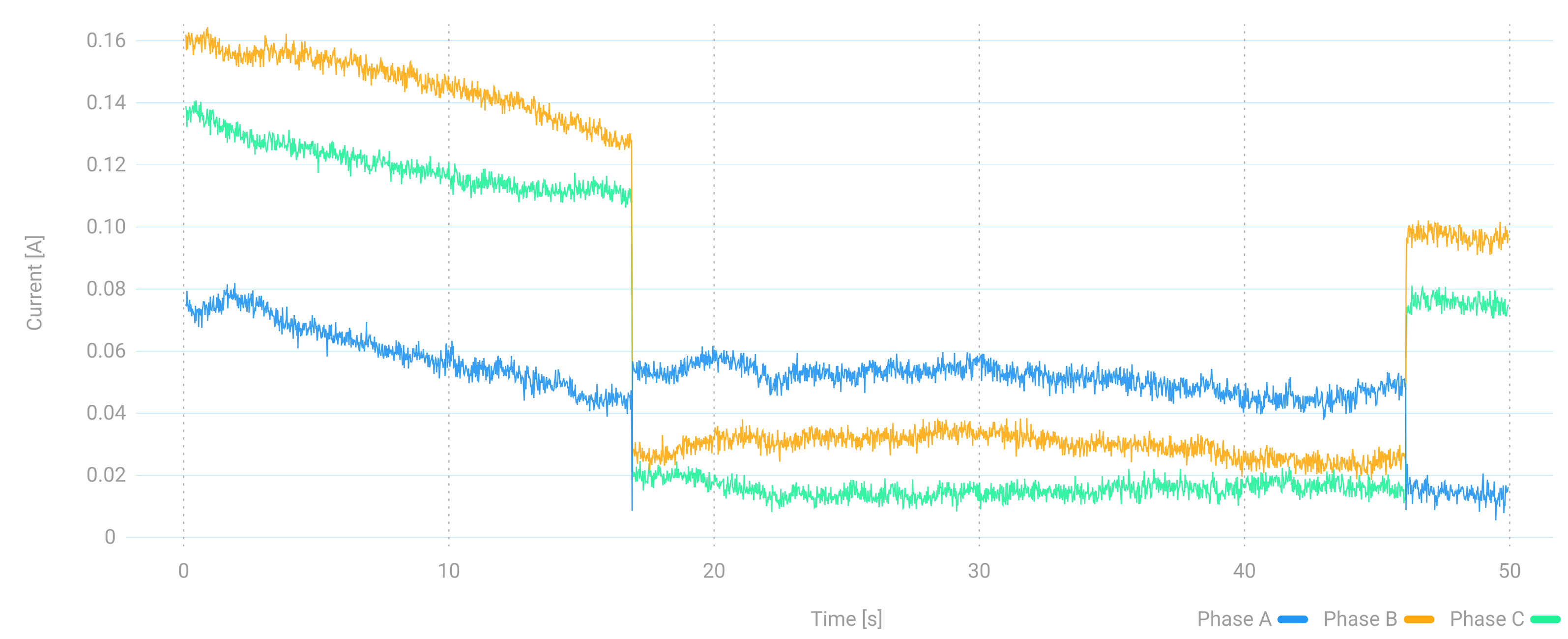

Figure 2. Change in harmonic content of the current during a Broken Neutral fault

	TP	TN	FP	FN	A
TT	45	45	0	0	100%
TN-S	45	44	1	0	98.9%
TN-C-S	45	44	1	0	98.9%
Total	**135**	**133**	**2**	**0**	**99.2%**

Table 1. Broken Neutral fault detection performance metrics. ***TP:*** True Positives; ***TN:*** True Negatives; ***FP:*** False Positives; ***FN:*** False Negatives; ***A:*** Accuracy

Conclusions

//The study confirms the potential of analyzing the harmonic content of line currents, especially the 3rd harmonic, to identify broken neutral faults. The method proved resilient across different variables but needs further refinement to reduce false positives while ensuring no false negatives.

Acknowledgements

//This work was supported by ATE – Aliança para a Transição Energética (Grant Agreement No. C644914747-00000023), funded under Plano de Recuperação e Resiliência (Portuguese Recovery and Resilience Plan - PRR). The research was also supported by the ERIGrid 2.0 project (Grant Agreement No. 870620), funded by the European Union's Horizon 2020 Research and Innovation Programme.

ENEIDA.IO
www.eneida.io
gfreire@eneida.io