CONTACTLESS EARTH FAULT INDICATOR

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ABSTRACT

This paper describes using of known methods for earth fault (short circuits) detection in 22kV rural network with Petersen compensated coil. Fault indicators are placed along the MV lines outside the transformer station and measure electric and magnetic field below the MV lines. The earth fault tests were done in choosen network in E.ON Czech republic company. The main purpose was ability check-out of earth fault indicators by various types of earth fault.

1. INTRODUCTION

The operation of the network with a ground fault belongs to states with an increased risk of the origination of heavy failures which would result in the interruption of electricity supply to customers. Although many methods for localizing the ground fault are available, there exists no universal method which could be applied in all types of non-solidly grounded networks and to all types of ground faults. However, even appropriately chosen methods do not guarantee a sufficiently accurate localization, mainly in the case of high-impedance and/or arcing ground faults. Great stress is therefore laid on a high reliability of indicating or measuring instruments. A good sensitivity can be achieved by installing indicating equipment as closely to the place of the failure as possible. This is also a reason for the expansion of indicators operating on principle of the measurement and analysis of electromagnetic fields. The contactless earth fault indicator is cost effective equipment, which implements as much as possible methods for earth fault detection.

2. CONTACTLESS EARTH FAULT INDICATOR

The earth fault indicator analyses the electromagnetic fields of individual phase conductors in as close distances of phase conductor as possible. The indicator consists of electromagnetic field sensors and evaluation unit (Figure 1). The influence of neighboring phases by computation of zero-sequence component U0 and I0 is corrected, because the distance between phase conductors is known and the distance between phase conductor and sensor is also known.

When a earth fault has been detected, the faulty record is written into internal memory and relay contact is made. Both of them (record and binary signal) can be transmitted to the control centre.

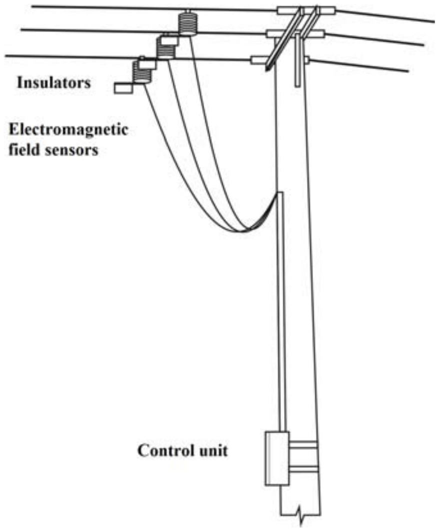


Figure 1: Contactless earth fault indicator

2.1. METHODS OF INDICATING THE EARTH FAULTS

The following methods are applied :

- Method of the zero-sequence current ($I0>I0_{limit}$)
- Method of the fifth harmonic of the ground current
- Admitance principle of the zero-sequence component
- First half-wave method (transient phenomenon)
- Connection of the resistor
  - A change of active component
  - A change of phase U0 and I0 (φ0)
  - A change of admitance active component (G0)
- Over current detection
- Short-circuit detection
- Unsuccessful reclosing detection

2.2. EARTH FAULT TESTS

Testing of correct implementation of used methods in indicator was made in network near Žďár nad Sázavou (owner E.ON Czech republic company) on the 27.11.2008. Variety of types of earth faults were realized. There where simulated metal earth fault, low-resistance earth fault (400 Ω), high-resistance earth fault (1600Ω) and arcing earth fault in 25km distance from transformer station.
Figure 2 shows connections diagram in the place of earth fault.
The operation of earth fault indicator was controled during testing. The following methods were monitored : first half wave method, fifth harmonic, connection of the resistor. Results are shown in the Table 1. When the first half-wave method was indicated the methods G0 and

φ0 were suppressed. In the test number 5 was only higher U0 detected, but no methods was indicated earth fault. Indicator 2 always detected higher U0, but never detected earth fault.

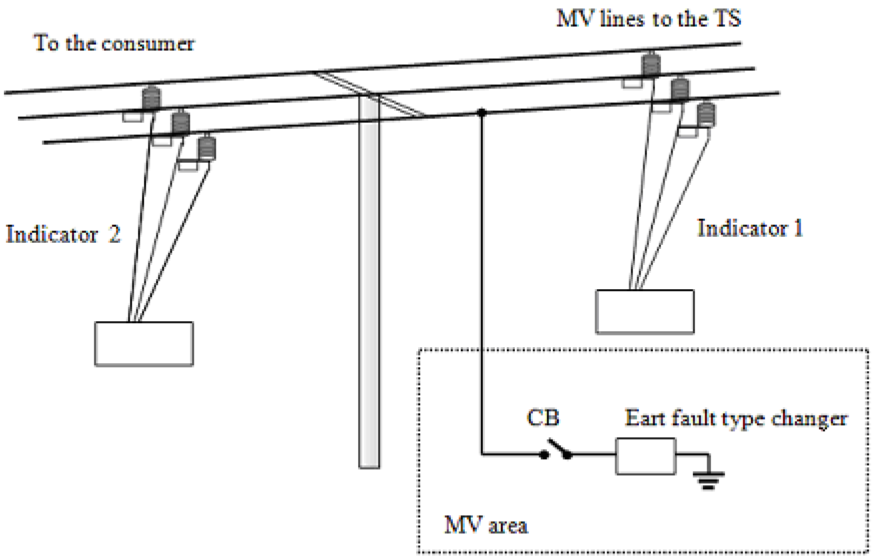


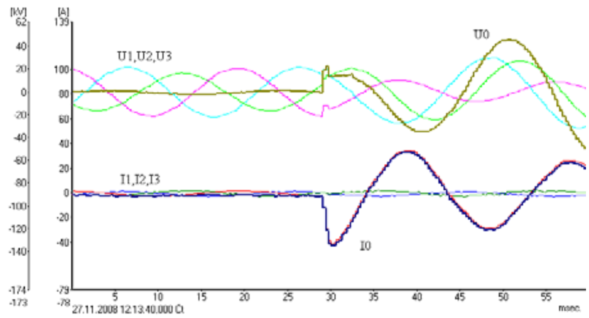
Figure 2: Connections diagram for testing earth faults

Test	Type of earth fault	FHW	5th harm.	Resistance			
				Connection	U0,I0	G0	φ0
1	Metal,compensated	-	-	Y	Y	Y	-
2	Metal,below-compensated	Y	-	Y	Y	S	S
3	Metal,over-compensated	Y	-	Y	Y	S	S
4	R=1600 Ω,compensated	-	-	Y	-	Y	-
5	R=1600 Ω,below-compensated	-	-	-	-	-	-
6	Arcing,discharger, compensated	-	-	Y	Y	Y	-
7	Arcing,discharger, below-compensated	-	-	Y	-	Y	Y
8	Arcing,cabel, compensated	Y	-	Y	Y	S	S
9	Arcing,cable, below-compensated	Y	-	Y	-	S	S
10	R=400 Ω, compensated	-	-	Y	Y	Y	-
11	R=400 Ω, below-compensated	-	-	Y	-	Y	Y
12	Bracket, compensated	Y	-	Y	Y	S	S
13	Bracket, below-compensated	Y	-	Y	Y	S	S

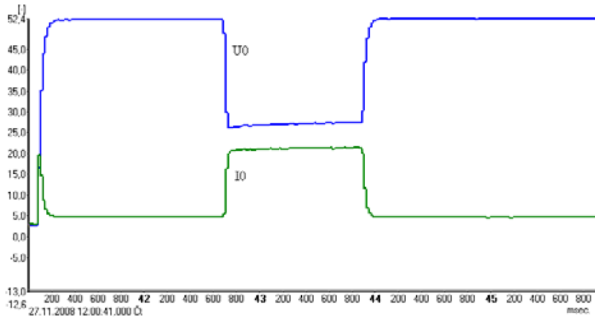
FHW – First Half Wave method, Y-Yes, '-' – no detection, S-suppressed method

Table 1: Types and detections of earth fault, indicator 1

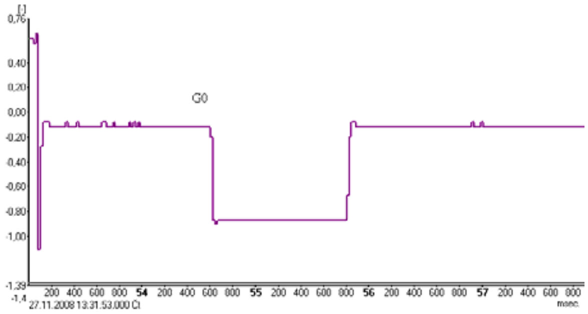
Figure 3 shows samples of fault records.



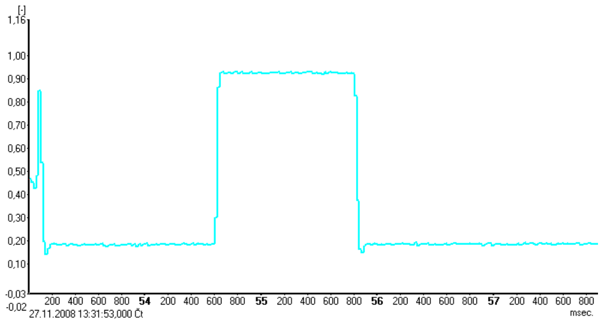
Test No.2, oscillogram



Test No.2, RMS values U0,I0, 5sec



Test No.7, value G0, 5sec



Test No.7, value cos(φ0)

Figure 3: Samples of fault records

3. CONCLUSION

Thanks to the combination of methods implemented in this contactless earth fault indicator it is possible to detect earth faults more reliably and more precisely in comparison with earth fault indicators with less applied methods.
The correct operation of contactless earth fault indicator consists in good parameterization which can be change according to the MV network wiring.
Some mistakes are probably in implemented method of the fifth harmonic of the ground current, because there wasn't any detections.
By using the telecommunication it will read out the data from individual indicators automatically and collect them into a data base according to requirements of the operator.
When such a complex data base will be available, it will be possible to evaluate the places with the most frequent occurrence of failures and, even based on faulty transient indications which are not used at present, it will be possible to predict electrically weak places in the network. This will decrease the frequency of outages of electricity supply to consumers and the quality of supplied electricity will thus increase.

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