THE ALGORITHM DEVELOPMENT FOR THE DAMAGE LOCATION SEARCH ON THE ELECTRIC LINE USING AN AMPLITUDE-PHASE COORDINATE CHARACTERISTIC

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Introduction

Main methods for determination of damage location in power lines:

**Remote methods**
- Pulse technique
- Wave method
- Oscillatory discharge method

**Topographical methods**
- Loop test
- Capacitance method
- Induction method
- Acoustical method
- Potential method
Introduction

The main disadvantages of existing methods:

• Complexity of technical implementation
• Insufficient accuracy in determining the location of damage
The idling conditions and short-circuit modes of the line.

\[ \hat{U}_1 \]
\[ \hat{i}_{1IDL} \]
\[ \hat{i}_{1SCT} \]

\( X \) – is the coordinate of the possible damage location; \( \hat{U}_1 \) – is the line input voltage; \( \hat{i}_{1IDL} \) and \( \hat{i}_{1SCT} \) – are the line complex currents into the idling conditions and short-circuit modes respectively.
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Methods and Investigation Strategy

Ratios for complex currents an undamaged line:

\[ \dot{I}_{1IDL} = \frac{\dot{U}_1}{Z_w \cdot \cosh(\gamma l)} \quad \dot{I}_{1SCT} = \frac{\dot{U}_1}{Z_w \cdot \sinh(\gamma l)} \]

After changing the constant \( l \) to the variable coordinate \( X \):

\[ \dot{I}_{1IDL}(jX) = I_{1mIDL}(X) \cdot e^{j\psi_{1IDL}(X)} \quad \dot{I}_{1SCT}(jX) = I_{1mSCT}(X) \cdot e^{j\psi_{1SCT}(X)} \]

Amplitude-phase coordinate (APhCC) characteristics of a damaged line
Results and Discussion

$l = 10 \text{ km};$

$R_0 = 20.5 \Omega/\text{km};$ $L_0 = 0.6 \cdot 10^{-3} \text{ H/km};$

$C_0 = 35.2 \cdot 10^{-9} \text{ F/km};$ $G_0 = 0.7 \cdot 10^{-6} \text{ S/km};$

$U_{1m} = 10 \text{ V}, \Psi_m = 0^\circ, f = 20 \cdot 10^3 \text{ Hz}$

Figure 1. (APhCC)$_{IDL}$ characteristics

Figure 2. (APhCC)$_{SCT}$ characteristics
Moved on from the complex \((\text{APhCC}_{\text{IDL}})\) according to Fig. 1 to coordinate-dependent \((\text{ACC})\) and \((\text{PhCC})\) characteristics.

\[(\text{ACC})_{\text{IDL}}\] characteristics

\[(\text{PhCC})_{\text{IDL}}\] characteristics

The presented graphs are ambiguous due to the periodicity of these functions.
Results and Discussion

\[ \lambda = \frac{V_{\text{ph}}}{f} \]

- \( V_{\text{ph}} \) is the phase velocity of the current and voltage waves circulation in the line

\[ \lambda = 40 \text{ km} \]
\[ V_{\text{ph}} = 1.7 \cdot 10^5 \text{ km/s} \]
\[ f_{\text{max}} = 4250 \text{ Hz} \]

(ACC)\(_{\text{IDL}}\) characteristics with \( f = 4000 \text{ Hz} \)

(PhCC)\(_{\text{IDL}}\) characteristics with \( f = 4000 \text{ Hz} \)

The similar result can be obtained for the case of a short circuit into the line.
Conclusion

• The obtained characteristics make it possible to unambiguously determine the desired coordinate of the break X of the power transmission line using the measured values of the current of the line.

• Further research on this topic is aimed at conducting a cycle of not only laboratory but also industrial tests of the proposed algorithm for determining the damage location to an electric line.
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