THE VOLTAGE DEPENDENCE OF CONTROL CURRENT SYMETRICAL COMPONENTS ON THE OUTPUT OF THE DISTANT CURRENT'S SONDE

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In this paper the influences of symmetrical components of control primary current are observed according to values of secondary voltage of current transformator. Especially, the influences of symmetrical components are expressed to current's values in secondary circuit of current donor for protection.

Keywords: Distant current , Symmetrical components, Current donor

1. INTRODUCTION

In this paper the influences of symmetrical components of control primary current are observed according to values of secondary voltage of current transformator. Especially, the influences of symmetrical components are expressed to current's values in secondary circuit of current donor for protection.

It is necessary to define voltage on the output of donor in different modes of short contacts for checking sensitivities and seletivities of measurement equipments.

During evaluating of values of voltage on the output donor when the form of short contact is present it is possible to apply the method's symmetrical components and to find out the voltage's expressions. The voltage is the function of symmetrical components measurment primary current and the values which donor characterizes.

All practical methods have exactly values of symmetrical components for analyze modes of short contacts in the electrical networks using computers.

If we want to use current's donor as filter's element of symmetrical components we need to make relation between output voltage and symmetrical components of measurement current.

2 THE ANALYSIS OF ELECTRICAL NETWORK

Every device presents filter of symmetrical components combined which has input triphase voltage on the primary side.

In the next part of the paper, the distant current donor is analized as filter of symmetrical components combined.

Equivalent model of donor is present on the figure 1. The voltages E_A, E_B and E_C are consequence of induction phases *A*, *B* and *C*.

$$\begin{aligned} E_A &= -j \cdot x_{mA} \cdot I_A = i_a \cdot (R_0 + jx_0 + R_d + jx_d) \\ E_B &= -j \cdot x_{mB} \cdot I_B = i_b \cdot (R_0 + jx_0 + R_d + jx_d) \\ E_C &= -j \cdot x_{mC} \cdot I_C = i_c \cdot (R_0 + jx_0 + R_d + jx_d) \end{aligned} \quad (1)$$

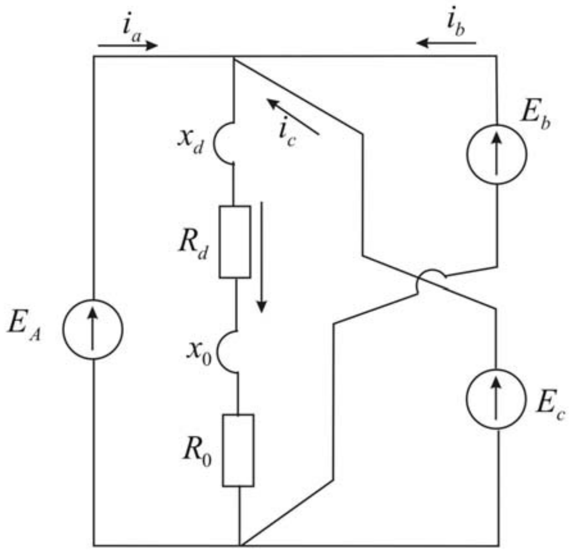

Fig. 1. Equivalent model of donor

From equitation (1) it can be obtained currents s i_a, i_b, i_c - secundary current's donor, which are inductive from primary currents individual phases:

$$\begin{aligned} i_a &= -\frac{j \cdot x_{mA} \cdot I_A}{R_0 + jx_0 + R_d + jx_d} \\ i_b &= -\frac{j \cdot x_{mB} \cdot I_B}{R_0 + jx_0 + R_d + jx_d} \\ i_c &= -\frac{j \cdot x_{mC} \cdot I_C}{R_0 + jx_0 + R_d + jx_d} \end{aligned} \quad (2)$$

The marks x_{mA}, x_{mB} and x_{mC} are reactances from mutual inductive conductors of primary phases *A, B* and *C* and donor:

R_0, R_d - load's active resistances and donor

x_0, x_d - load's reactive resistances and donor.

The load's impedance is $Z_0 = R_0 + jx_0$ and the total load's impedance and donor is $Z_p = R_0 + R_d + j(x_0 + x_d)$.

Using the method substitution we obtain real value of the current in the load's donor circuit:

$$i_R = i_a + i_b + i_c \quad (3)$$

The voltage on the backside is equal to the voltage of load:

$$u_R = i_R(R_0 + jx_0) = -j\,\frac{(x_{mA} \cdot I_A + x_{mB} \cdot I_B + x_{mC} \cdot I_C)(R_0 + jx_0)}{R_0 + R_d + j(x_0 + x_d)} \quad (4)$$

The transmission function depends on the short contact's mode and also depends on the reactances that appear from mutual inductivites:

$$W_{RP} = \frac{U_R}{I_{A,B,C}} \tag{5}$$

The voltage is shown over phase's currents on the filter's backside:

$$\begin{aligned} u_R &= k_A I_A + k_B I_B + k_C I_C = \\ &= -j\frac{x_{mA} Z_0}{Z_p} I_A - j\frac{x_{mB} Z_0}{Z_p} I_B - j\frac{x_{mC} Z_0}{Z_p} I_C \end{aligned} \tag{6}$$

In this case the phase's coeficients of donor are:

$$\begin{aligned} k_A &= -j\frac{x_{mA} Z_0}{Z_p} \\ k_B &= -j\frac{x_{mB} Z_0}{Z_p} \\ k_C &= -j\frac{x_{mC} Z_0}{Z_p} \end{aligned} \tag{7}$$

The voltage can be obtained from symmetrical components of primary current I_1, I_2 and I_0 and their coefficients k_1, k_2 and k_0.

According to formulas Fortesque known, relation between coefficients k_1, k_2, k_0 and k_A, k_B, k_C is:

$$\begin{aligned} k_1 &= k_A + a^2 k_B + a k_C \\ k_2 &= k_A + a k_B + a^2 k_C \\ k_0 &= k_A + k_B + k_C \end{aligned} \tag{8}$$

Changing k_A, k_B, k_C from (8) in (7) it is obtained:

$$\begin{aligned} k_1 &= -j\frac{Z_0}{Z_p}(x_{mA} + a^2 x_{mB} + a x_{mC}) \\ k_2 &= -j\frac{Z_0}{Z_p}(x_{mA} + a x_{mB} + a^2 x_{mC}) \\ k_0 &= -j\frac{Z_0}{Z_p}(x_{mA} + x_{mB} + x_{mC}) \end{aligned} \tag{9}$$

The voltage on the filter's backside is:

$$u_R = k_1 I_1 + k_2 I_2 + k_0 I_0 \tag{10}$$

3 RESULTS

Using the method substitution it is obtained in the case when the current goes through conductors next expression:

$$i_R = \frac{u_R}{Z_0} = \frac{k_1 I_1 + k_2 I_2 + k_0 I_0}{Z_0} \tag{11}$$

The values of i_R, u_R and W_{RP} are given in Table 1, which are evaluated in (5), (6), (9) i (10) for all forms of short contacts.

Short contact's mode	*1f*
Relation between primary currents	$I_{A_2}^{(1)} = I_{A_1}^{(1)}$ $I_0^{(1)} = I_{A_1}^{(1)}$ $I_B = 0;\ I_C = 0$
$i_p = \frac{k_1 I_1 + k_2 I_2 + k_0 I_0}{Z_p}$	$-3j \cdot I_{A_1}^{(1)} \frac{x_{mA}}{Z_p}$
$u_p = i_R Z_0$	$-j \cdot I_{A_1}^{(1)} x_{mA} \frac{Z_0}{Z_p}$
$W_{RP} = \frac{U_R}{I_{A,B}}$	$-j \cdot x_{mA} \frac{Z_0}{Z_p}$

Table 1 The values of i_p, u_p and W_{RP} for form of short contats 1f

Short contact's mode	*2f*
Relation between primary currents	$I_{A_2}^{(2)} = -I_{A_1}^{(2)}$ $I_A^{(2)} = 0$ $I_B^{(2)} = j\sqrt{3} \cdot I_{A_1}^{(2)}$ $I_C^{(2)} = -j\sqrt{3} \cdot I_{A_1}^{(2)}$
$i_p = \frac{k_1 I_1 + k_2 I_2 + k_0 I_0}{Z_p}$	$\sqrt{3} \cdot I_{A_1}^{(2)} \frac{(x_{mB} - x_{mC})}{Z_p}$
$u_p = i_R Z_0$	$\sqrt{3} \cdot I_{A_1}^{(2)} (x_{mB} - x_{mC})$
$W_{RP} = \frac{U_R}{I_{A,B}}$	$\frac{Z_0}{Z_p}(x_{mB} - x_{mC})$

Table 2. The values of i_p, u_p and W_{RP} for form of short contats 2f

Short contact's mode	*2f + Z*
Relation between primary currents	$I_{A_2}^{(1,1)} = -I_{A_1}^{(1,1)} \dfrac{x_{0\Sigma}}{x_{2\Sigma} + x_{0\Sigma}}$ $I_{0}^{(1,1)} = -I_{A_1}^{(1,1)} \dfrac{x_{2\Sigma}}{x_{2\Sigma} + x_{0\Sigma}}$ $I_{B}^{(1,1)} = I_{A_1}^{(1,1)} B^{**}$
$i_p = \dfrac{k_1 I_1 + k_2 I_2 + k_0 I_0}{Z_p}$	$j \cdot I_{A_1}^{(1,1)} \dfrac{A^*}{Z_p (x_{2\Sigma} - x_{0\Sigma})}$
$u_p = i_R Z_0$	$j \cdot I_{A_1}^{(1,1)} \dfrac{Z_0 \cdot A^*}{Z_p (x_{2\Sigma} - x_{0\Sigma})}$
$W_{RP} = \dfrac{U_R}{I_{A,B}}$	$j \cdot \dfrac{Z_0 \cdot A^*}{Z_p (x_{2\Sigma} - x_{0\Sigma}) B^{**}}$

Table 3. The values of i_p, u_p and W_{RP} for form of short contats 2f+Z

Short contact's mode	*3f*
Relation between primary currents	$I_{A}^{(3)} = I_{A_1}^{(3)}$ $I_{2}^{(3)} = 0$ $I_{0}^{(3)} = 0$
$i_p = \dfrac{k_1 I_1 + k_2 I_2 + k_0 I_0}{Z_p}$	$-j \dfrac{I_{A_1}^{(3)}}{Z_p} C^{***}$
$u_p = i_R Z_0$	$-jI_{A_1}^{(3)} \dfrac{Z_0}{Z_p} C^{***}$
$W_{RP} = \dfrac{U_R}{I_{A,B}}$	$-j \dfrac{Z_0}{Z_p} C^{***}$

Table 4. The values of i_p, u_p and W_{RP} for form of short contats 3f

Where are:

$$A^* = x_{mB}[(a^2 - 1)x_{2\Sigma} - j\sqrt{3}x_{0\Sigma}] + x_{mC}[(a-1)x_{2\Sigma} + j\sqrt{3}x_{0\Sigma}]$$

$$B^{**} = a^2 - \frac{x_{2\Sigma} + a \cdot x_{0\Sigma}}{x_{2\Sigma} + x_{0\Sigma}}$$

$$C^{***} = x_{mA} + a^2 \cdot x_{mB} + a \cdot x_{mC}$$

4. CONCLUSION

The paper proposes a new method for investigation influence voltage dependence on the output of distant current's transformer symmetrical components in the control conductor with primary current.

The influeces of different short contacts are examined and the values of the currents through distant relay and input voltage of relay are determined as well as the values of primary functions for all modes of short contacts.

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