Current Instrument Transformers In MATLAB Program Modeling

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ABSTRACT: *Using some literary base, we have studied the processes in the current instrument transformers. We have utilized the MATLAB program for modelling the current instrument transformers. The issues and limitations in the use of this model and the corresponding parameters are not documented. We primarily intend to model the CIT in MATLAB with the help of the available parameters and measurements.*

Keywords: Current Instrument Transformers (CIT), Model, Power Systems, Relay Protection

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1. Introduction

Normal operation of the equipment in power systems depends on the proper functioning of the control circuits and protection. It is essential to measure the regime parameters for relay protection, automation, commercial metering and others.

There are different technical solutions for measuring of regime parameters. The most widespread are Current Instrument Transformers (CIT) in Bulgaria.

They are devices with nonlinear characteristics and to provide the required accuracy of the measurements has strict rules for their selection. From the work of instrument transformers depends not only the accuracy of measurements, but also the reliability and proper operation of relay protection and automation. The model of Current Instrument Transformer must accurately reflects the relationship between the primary and secondary current Model Study of the Processes In Current Instrument Transformers is presented in various literary sources [1], [2].

Model of the Current Instrument Transformers is developed in MATLAB. Problem in using of this model is that there are not the required parameters in the catalogs of CIT.

The purpose of this paper is to determine the parameters needed for modeling of CIT in MATLAB based on the known catalog parameters and made measurements.

2. Preparation of the Information for the Model

The paper is designed in two sections. The first section relates to the preparation of the information for the model based on the known catalog parameters and measurements.

The second section presents the results of the model study of a particular CIT.

Catalogue information about CIT are nominal currents of primary and secondary coil (I_{1n}, I_{2n}) nominal voltage (U_n), nominal secondary power (S_{2n}), accuracy class, and the coefficients of dynamic and thermal sustainability.

CIT model in MATLAB requires a knowledge of: nominal power (S_n), VA; nominal frequency f_n, Hz; primary and secondary winding voltages (U_1, U_2), V; active resistance (R_1, R_2) and inductance (L_1, L_2) of the primary and secondary winding, pu; active component of magnetization resistance (R_m), pu and magnetization characteristic i_μ*(n)=f(Ψ*(n)).

Algorithm to determine the required input parameters of CIT is as follows:

1) Determination of the nominal power S_n

$$S_n = S_{2n},\ VA \tag{1}$$

2) Determination of the nominal frequency f_n

$$f_n = 50Hz \tag{2}$$

3) Determination of U_2 and U_1

$$U_2 = \frac{S_{2n}}{I_{2n}}, V \qquad U_1 = \frac{U_2}{K_{CIT}}, V \tag{3}$$

$K_{CIT} = \frac{I_{1n}}{I_{2n}}, V$ coefficient of transformation

4) Determination of *R and L* of the windings [3]

The active resistance R_2 is determined by the experience of a short circuit when supplied with DC voltage and short circuit impedance Z_k, when supplied with power frequency voltage.

$$Z_{k*(n)} = \frac{Z_k}{Z_{b2}} \qquad Z_{b2} = Z_{2n}\frac{Z_{2n}}{Z_{2n}^2} \tag{4}$$

$$R_{2win*(n)} = \frac{R_{2win}}{Z_{b2}} \qquad R_{2win*(n)} = \frac{R_{2win}}{Z_{b2}}$$

$$Z_{2win*(n)} = \frac{\sqrt{Z_{k*(n)}^2 - 4R_{2win*(n)}^2}}{2}$$

$$X_{1win*(n)} = X_{2win*(n)} = L_{1win*(n)} = L_{2win*(n)}$$

5) Determination of R_m

$$R_{m*(n)} = \frac{100}{accuracy\ class} \tag{5}$$

6) Determination of magnetization characteristic

$$I_{\mu*(n)} = f(\psi_{*(n)}) \tag{6}$$

The magnetization characteristic most frequently is asked in the form $B = f(H)$ (B-magnetic induction; H-magnetic field).

The following dependencies are used to obtain the required description of the model:

$$i_{\mu*(n)} = \frac{l_m}{w_1.I_{1n}}.H \tag{7}$$

$$\psi_{*(n)} = \frac{w_1.S}{\psi_{b1}}.B \qquad \psi_{b1} = \frac{\sqrt{2.U_1}}{\omega} \tag{8}$$

l_m - average length of the magnetic line, m;

W1,W2 - number of turns of the primary and secondary windings;

S - cross section of the magnetic core, m^2;

ω - frequency, rad.

3. Results of the Model Study of a Particular CIT

The following cases are investigated: normal operation; switching the breaker Q1 at 0.02 seconds from the beginning of the simulation (the presence of the aperiodic component); three phase short-circuit (current is shown for one of the faulty phase); open secondary winding.

Change of the regime parameters is shown for the investigated cases: primary and secondary current; magnetic flux, magnetizing current; coefficient of transformation and voltage of the secondary winding. Figure 2 shows the results obtained for normal operation. These results confirm the adequacy of the model.

The results for the other examined situations are shown in Figure 3 - Figure 5.

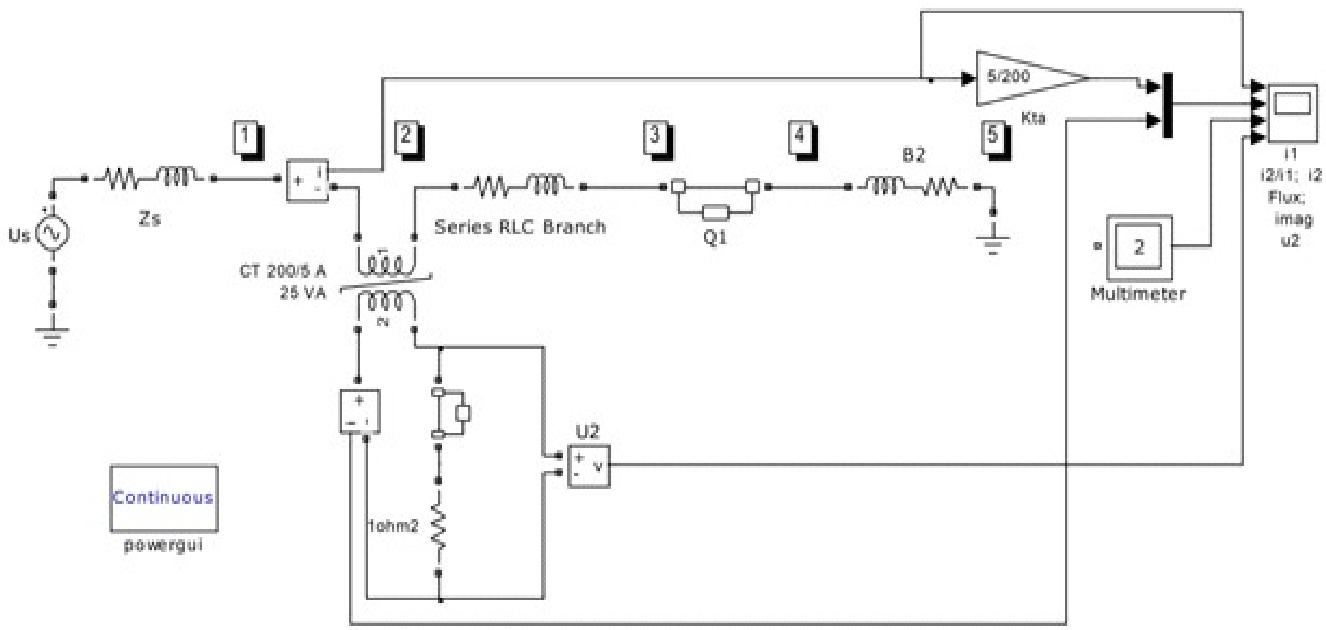

Figure 1. Shows the model of research CIT, type TKC 200/5

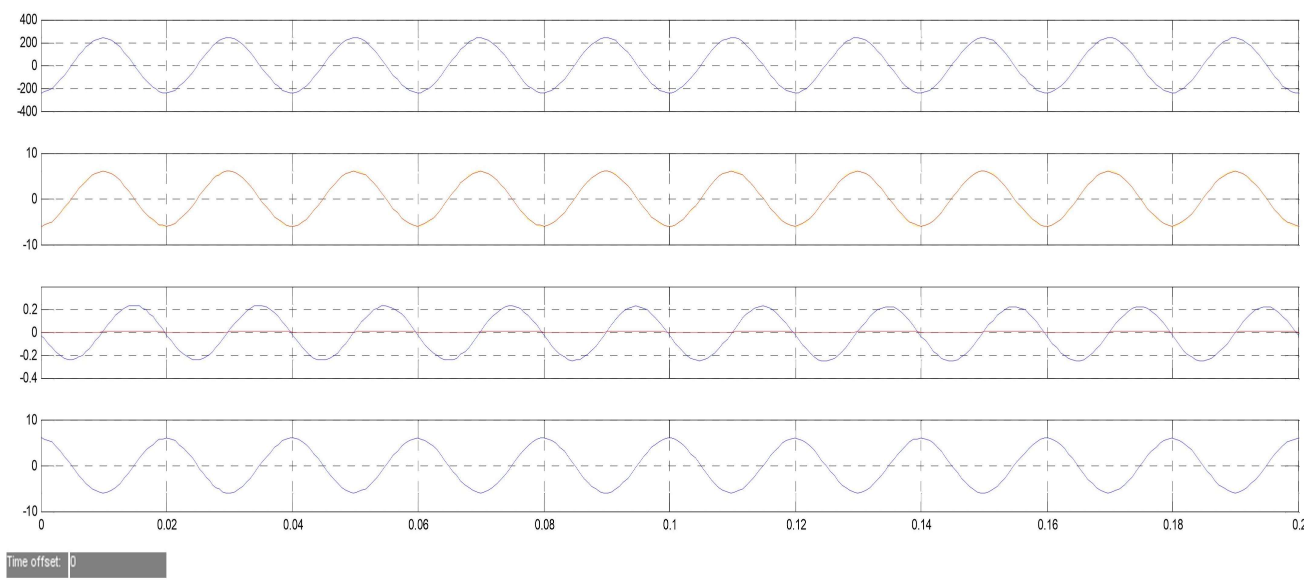

Figure 2. Primary current (a); coefficient of transformation and secondary current (b); magnetic flux and magnetizing current (c); voltage of the secondary winding (d) for normal operation

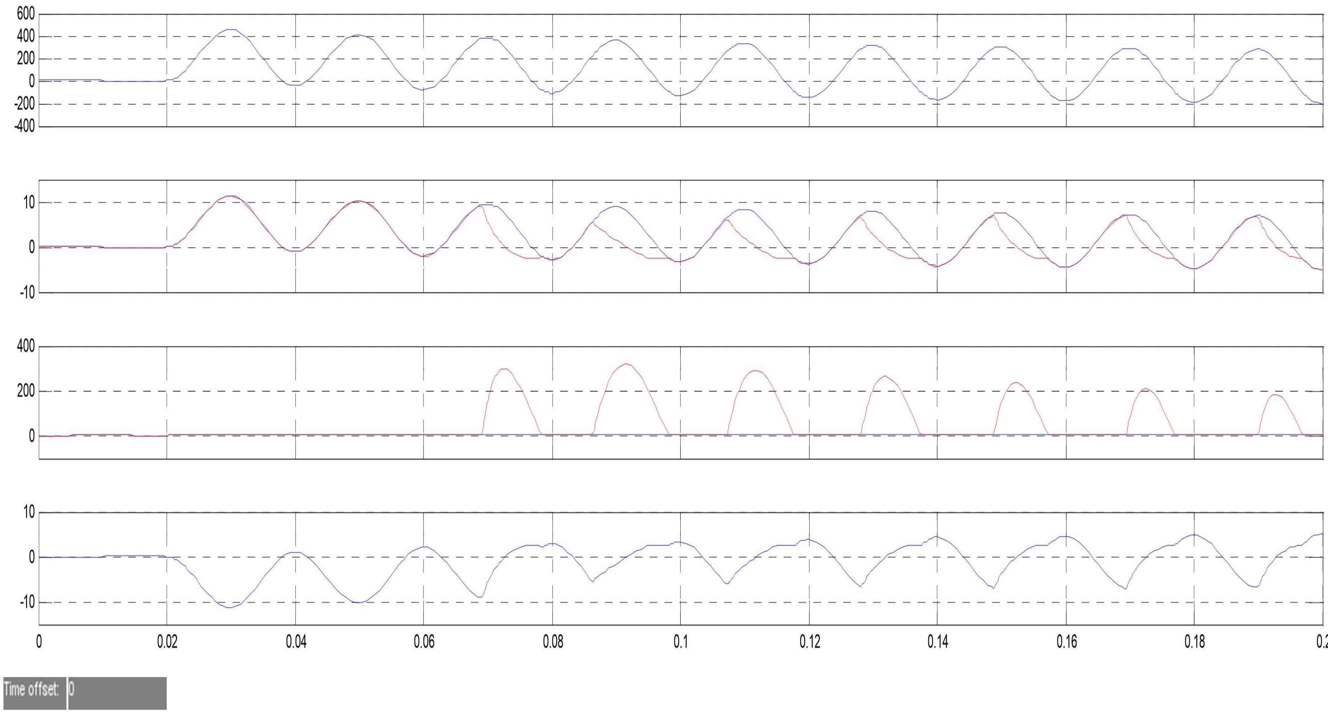

Figure 3. Primary current (a); coefficient of transformation and secondary current (b); magnetic flux and magnetizing current (c); voltage of the secondary winding (d) on the presence of the aperiodic component

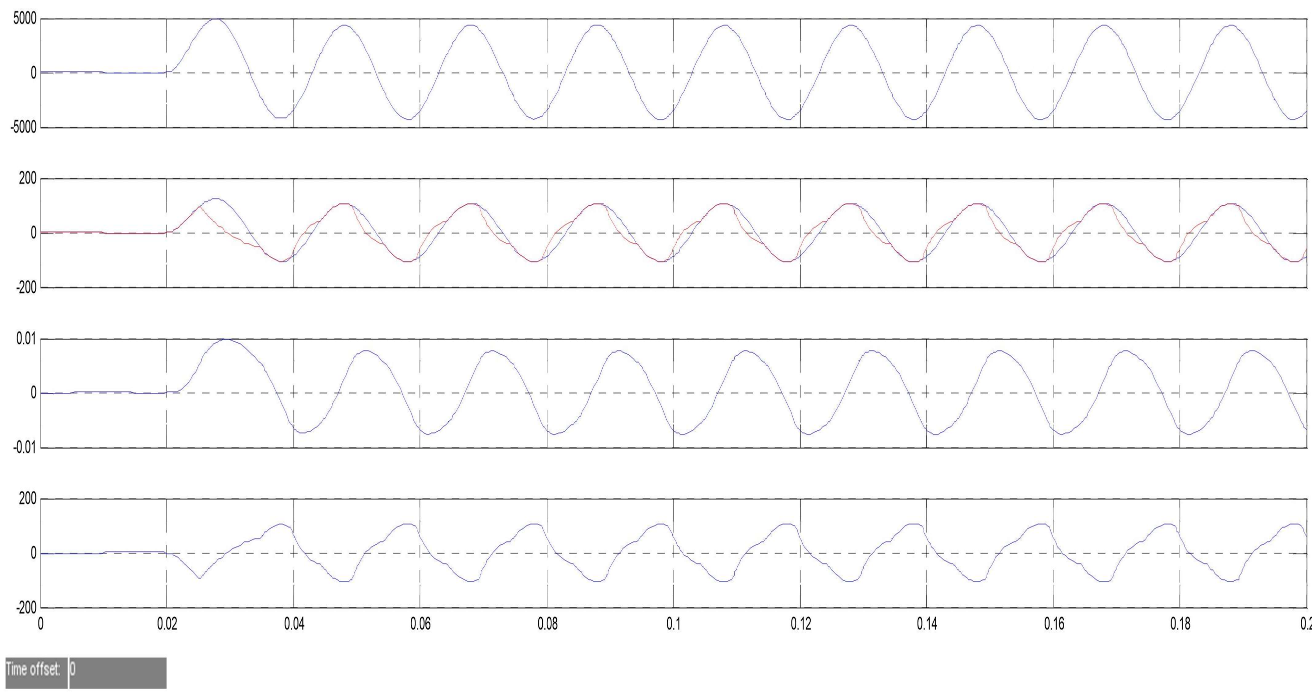

Figure 4. Primary current (a); coefficient of transformation and secondary current (b); magnetic flux and magnetizing current (c); voltage of the secondary winding (d) on two phase short-circuit

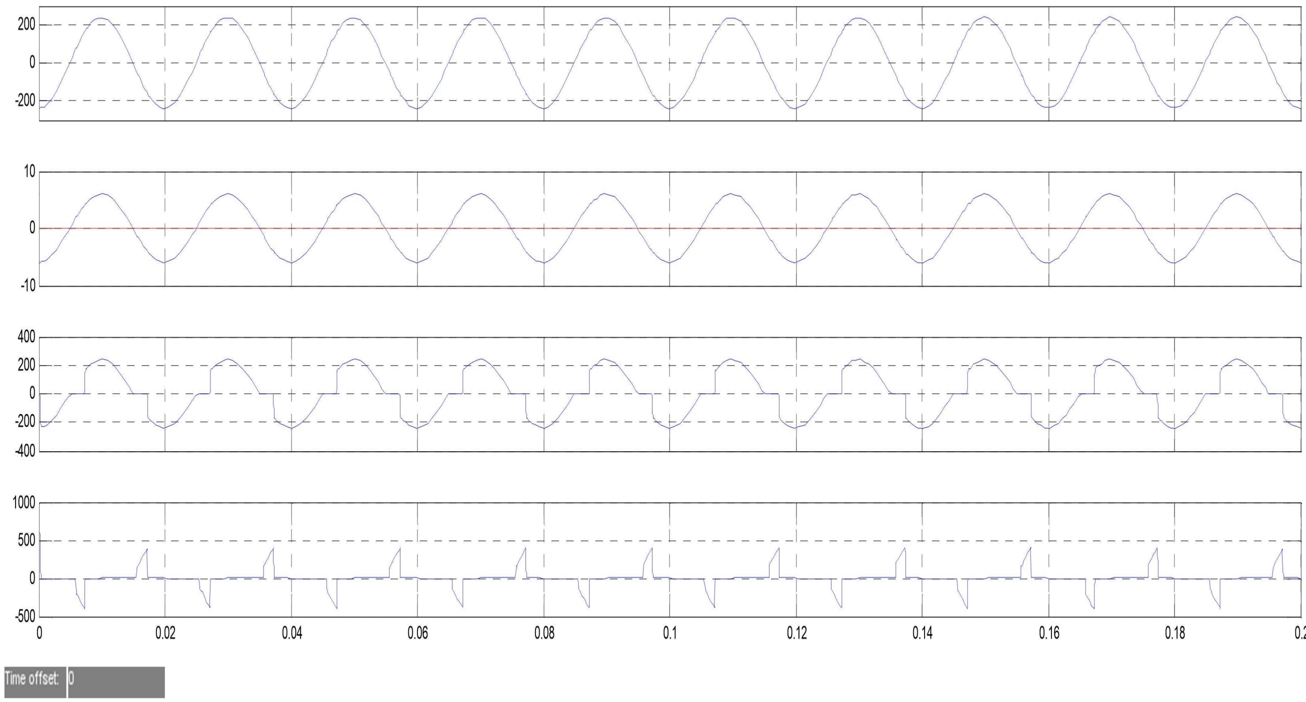

Figure 5. Primary current (a); coefficient of transformation and secondary current (b); magnetic flux and magnetizing current (c); voltage of the secondary winding (d) on open secondary winding

4. Conclusion

Based on the Model Investigation can be the following conclusions:

1) With the information available from catalogs and measurements can be obtained detailed model of CIT.

2) The adequacy of the created model are confirmed for the study regime parameters (Figure 2 – Figure 5).

3) Due to the presence of the aperiodic component can not obtain an accurate transformation of the current (Figure 3).

The developed CIT model allows making a number of researches related to their work in different types of shortcircuit for the purpose of relay protection.

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