IJIREEICE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

NCAEE 2017

National Conference on Advances in Electrical Engineering

NMAM Institute of Technology, Nitte

Vol. 5, Special Issue 2, April 2017

MATFORM: Tool for Modelling of Transformer in MATLAB

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Abstract: MATLAB software widely used for the simulations of electrical distribution network. It meets all the necessary requirements for power system simulations. But most of the users make use of default values available in the blocks in their model. This document gives the information about the tool developed for the modelling of the transformer in MATLAB which is named MATFORM.

Keywords: MATFORM, MATLAB, MATHWORK, Transformer, Modelling.

I. INTRODUCTION

Power system simulation is one of the essential things to do for the validation of any system circuit model. There are different software in which it is done. MATLAB is the most preferred one. There are many blocks present in MATLAB which can be used to develop the required model. But most of the times the difficulty lies in modelling of the components.

The parameters present in MATLAB blocks are difficult to understand and change. And hence many people tend to use default parameters. The MATFORM tool is developed so that person can use the transformers real manufacturing data to insert in MATLAB models. By doing this we can make MATLAB model as real as possible to the actual network.

II. ELECTRICAL POWER SYSTEM

Electrical power system consists of many segments right from the generation, transmission to distribution. Protection of this system is very vital and now as nation is heading towards the Smart Grid the development in power system networks is getting more focused.

A. Power system simulator

MATLAB is an acronym for MATrix LABoratory and is a high-performance language for technical computing integrating computation, visualization, and the programming environment. MATLAB's broader platform gives a better degree of simulation and because of more components to choose while making the models, multiple test cases are possible.

MATLAB updates its software database regularly and significantly providing the users with additional packages which are an obvious advantage.

B. Modelling in MATLAB

The modeling here is done using the SimPowerSystems® Library. The models made are meant to represent the transient conditions of an actual system. But the simulation results vary from the actual results. This occurs due to use of default parameters in simulation blocks hence modeling have to be done. This modeling normally is very difficult due to the parameters which are present in blocks.

Hence for modeling of the transformer we have developed a tool by using visual basic tool of Microsoft excel.

III. MATFORM

In simulation of a distribution network many components and blocks are present. We have developed the tool taking transformer into consideration. The description of the tool is given in detail. The tool is developed by using the visual basic coding tool in Microsoft excels. It consists of 5 parts which are the 5 sheets which covers the transformer block parameters in detail.

A. Introduction of MATFORM

The introduction sheet gives the details of how to use the tool what all are the input and outputs. This programmed is developed to generate MATLAB transformer block parameters from the manufactures data. The block parameters which we have to insert in MATLAB are not available from the manufacture's data. So it has to be calculated using different formulae. This GUI is made by making use of all those formulae. In the first sheet there are also keys to navigate to and fro. (Refer Figure 1)

B. The Tool GUI

The tool GUI gives the interface to put inputs and it gives output. The inputs which GUI ask are no load loss, no load

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voltage no, load current load loss load loss current and turns ratio. This parameters are available on the transformer test certificate the output of the GUI is the magnetising resistance, magnetising inductance, inductance of HV side and inductance of LV side. The formulae which are required to do the calculation are running into background. These parameters can be inserted into MATLAB model and the model can be made close to actual model. Figure 2 shows the GUI page of the MATFORM.

C. Parameters

The third page of the tool gives information about the parameters which transformer block requires. It shows transformer parameter block. The parameters required are power of the transformer, frequency of the transformer, Magnetising inductance, magnetising resistance, voltages, and resistance of both the windings and inductances of both the windings. There are also provisions to simulate saturation characteristics of transformer. Figure 3 shows tool interface for parameters detailing

D. Test Certificate

The tools works on the inputs which can be obtained from the transformer test certificate. The test certificate is present with all the transformers. And the tests which are carried out are the routine test as per the standards. The standard followed is IEC 60075-1 Clause 11.4 and 11.5. Open circuit test and the short circuit test are conducted on the transformer. In open circuit test the HV side winding is kept open and rated voltage at rated frequency is applied at the LV winding side. For short circuit test the LV winding is short circuited and the rated current is applied to HV side. Page three of the tool shows the example of transformer test certificate and is shown in Figure 4.

E. Saturation characteristics

The transformer block parameters can be changed in order to simulate saturation of transformer core. For simulation of saturation of core we need to put saturation characteristics. This can be obtained by B-H curve of the transformer core. But parameters which MATLAB requires are in terms of current (I) and magnetic flux (phi). After searching for the relation between the B-H curve and the I–phi curve on the MATHWORK website we came on conclusion that this two curves coincide with each other. This is explained in page 5 of the tool as showed in Figure 5

F. B-H curve

As I-Phi curve is coinciding with the B-H curve we tried to find more relation and in next page of the tool we have given B-H curve for different materials which are been used in distribution network so that user can use them for further simulation. Figure 6 shows the B-H curve page of the tool

G. Validation

The open circuit test was developed and run successfully with help of this tool and the result where within 5% of the required value the model image is shown in Figure 7.

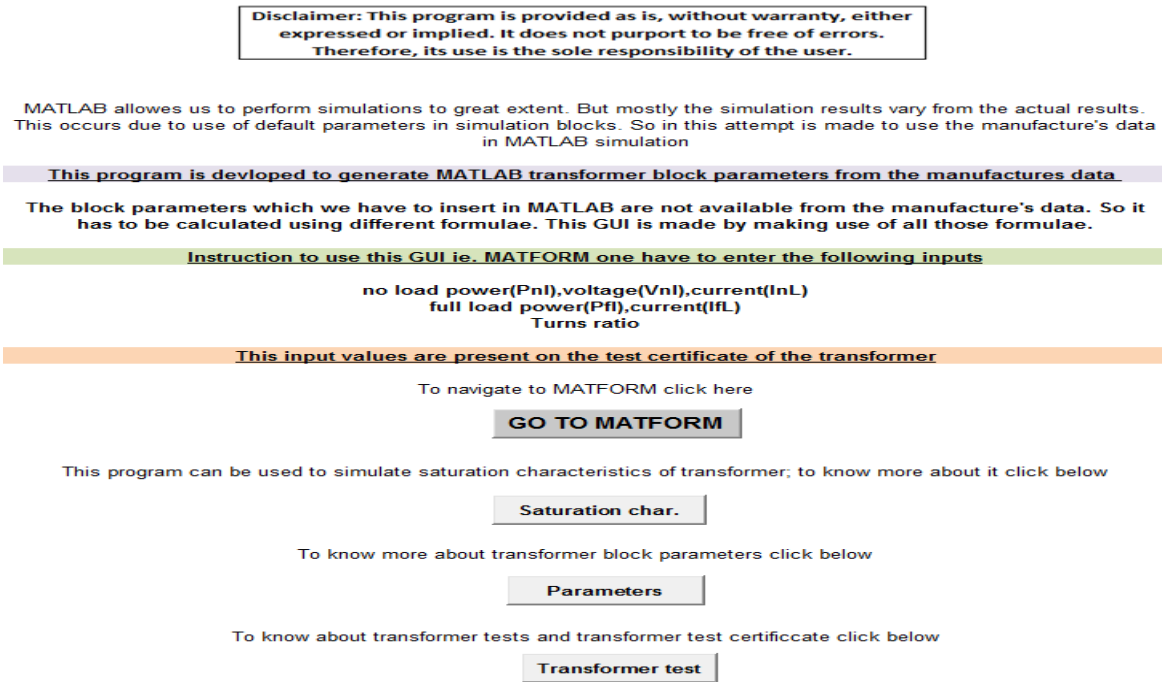

Figure1: Introductory Page of the MATFORM tool

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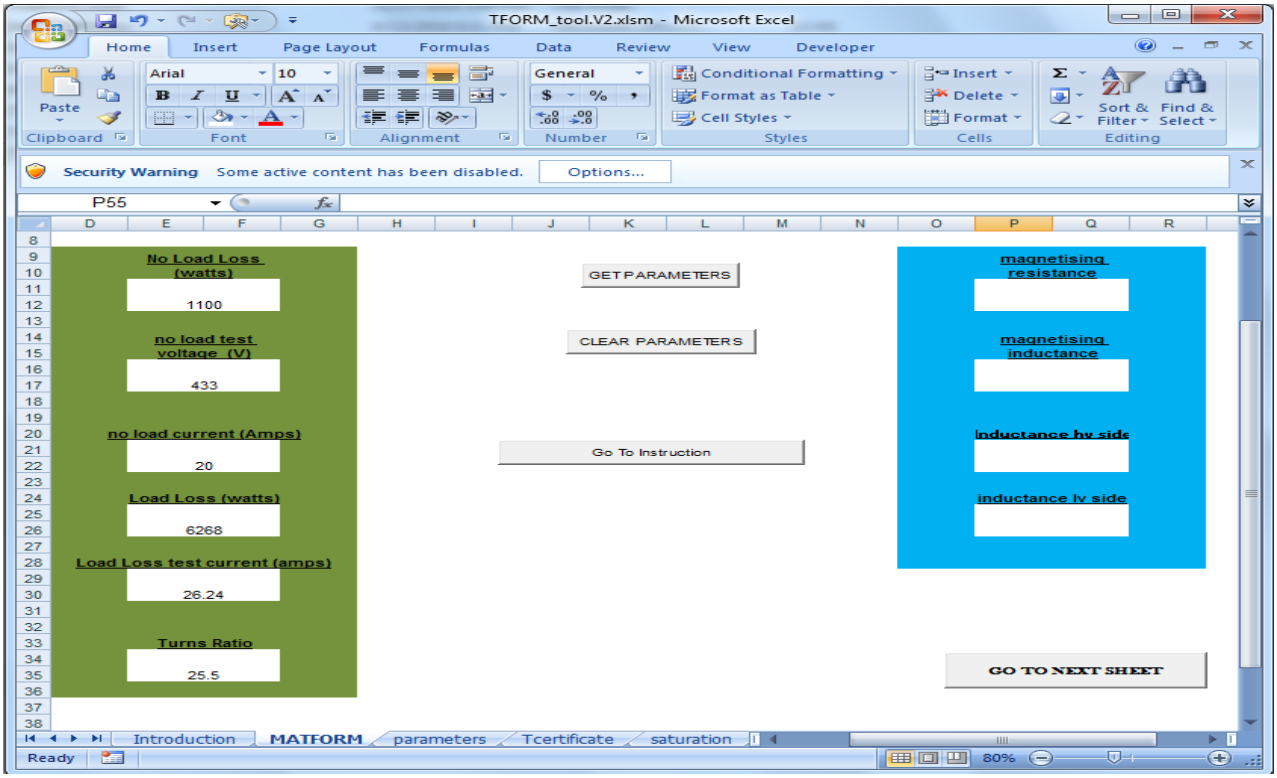
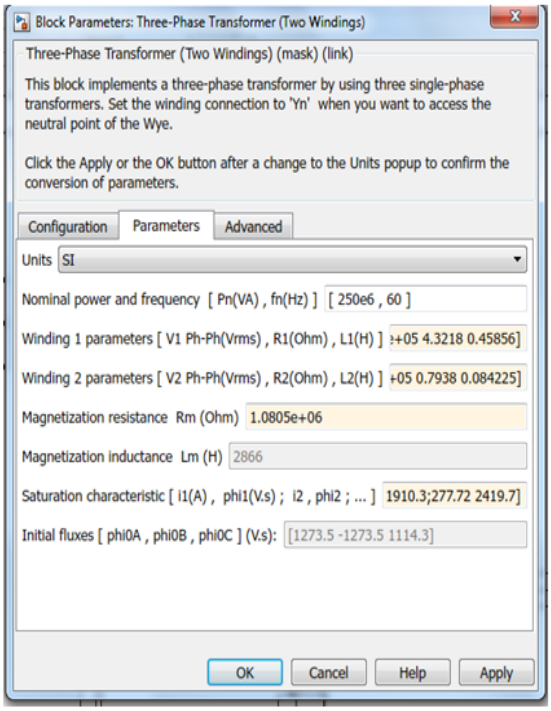


Figure2: MATFORM GUI

Block parameters of transformer

The dialogue box of matlab block parameters of transformer is shown below:



the requirements of the matlab block are:

power and frequency

voltages

resistance and inductance of winding

and magnetizing inductance.

resistance and inductance are not specified directly hence to calculate them formulas are used

saturation characteristic can be changed by use of B-H curve, to know more about it click here

saturation char.

Go To Instruction

GO TO NEXT SHEET

GO TO PREVIOUS SHEET

Figure3: Transformer Parameters

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The example of test certificate used is shown in this sheet

from this test certificate we will get the data which is required to be entered in MATFORM.

The tests which are carried out in the test certificate are routine tests. From these tests we will get the required data to be entered

The standard followed is IEC 60075-1 Clause 11.4 and 11.5.

open circuit test and the short circuit test are conducted on the transformer

In open circuit test the HV side winding is kept open and rated voltage at rated frequency is applied at the LV winding side

for short circuit test the LV winding is short circuited and the rated current is applied to HV side

Go To Instruction

GO TO NEXT SHEET

GO TO PREVIOUS SHEET

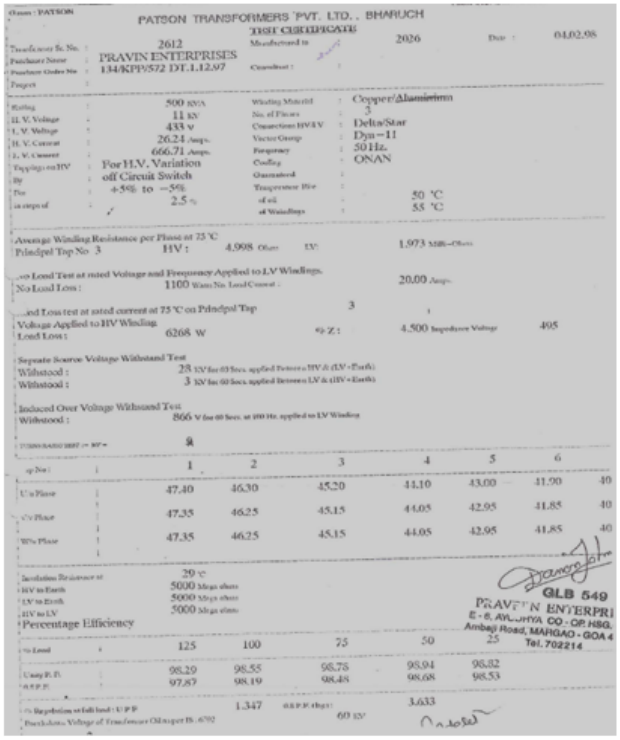
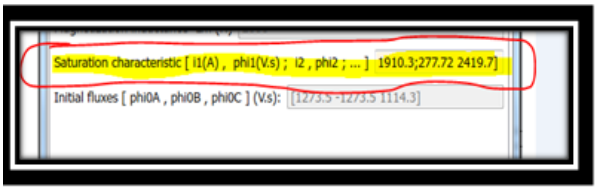
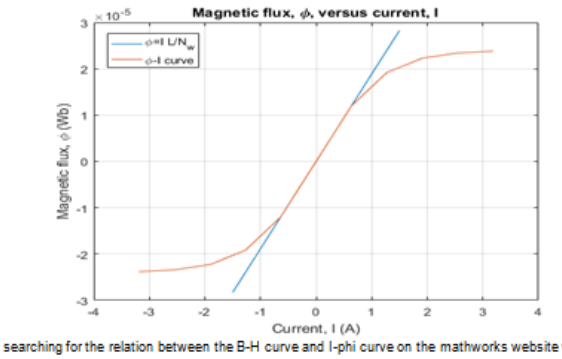


Figure 4: Test Certificate

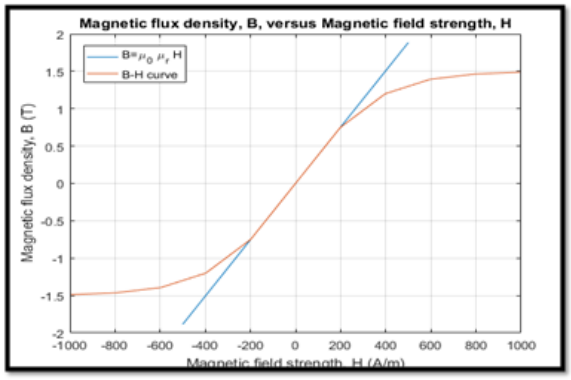
But parameters which MATLAB requires are in terms of current(I) and magnetic flux (phi).

For simulation of saturation of core we need to put saturation characteristics

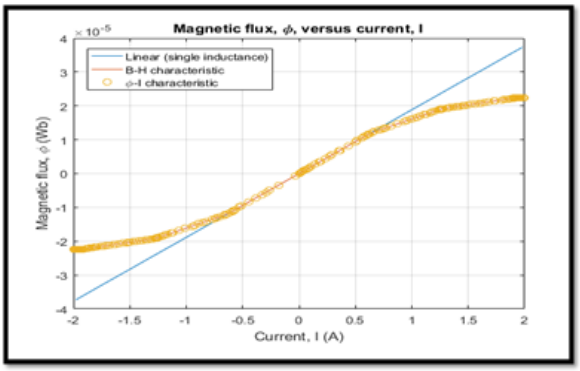




This can be obtain by B-H curve of the transformer core.



After searching for the relation between the B-H curve and I-phi curve on the mathworks website we came on conclution that this two curves coincide with each others.



To know more abt B-H curve click here

Go To Instruction

GO TO PREVIOUS SHEET

GO TO NEXT SHEET

Figure 5: Saturation Characteristics

IJIREEICE

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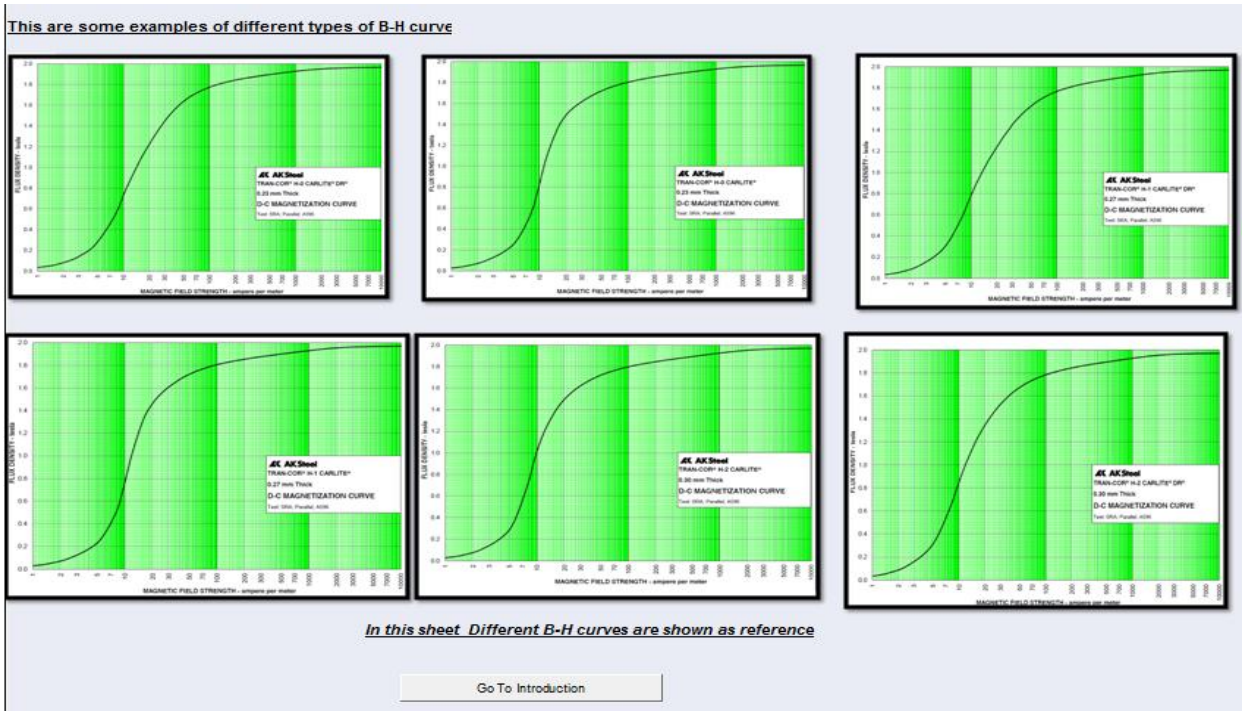

Figure 6: BH Curve

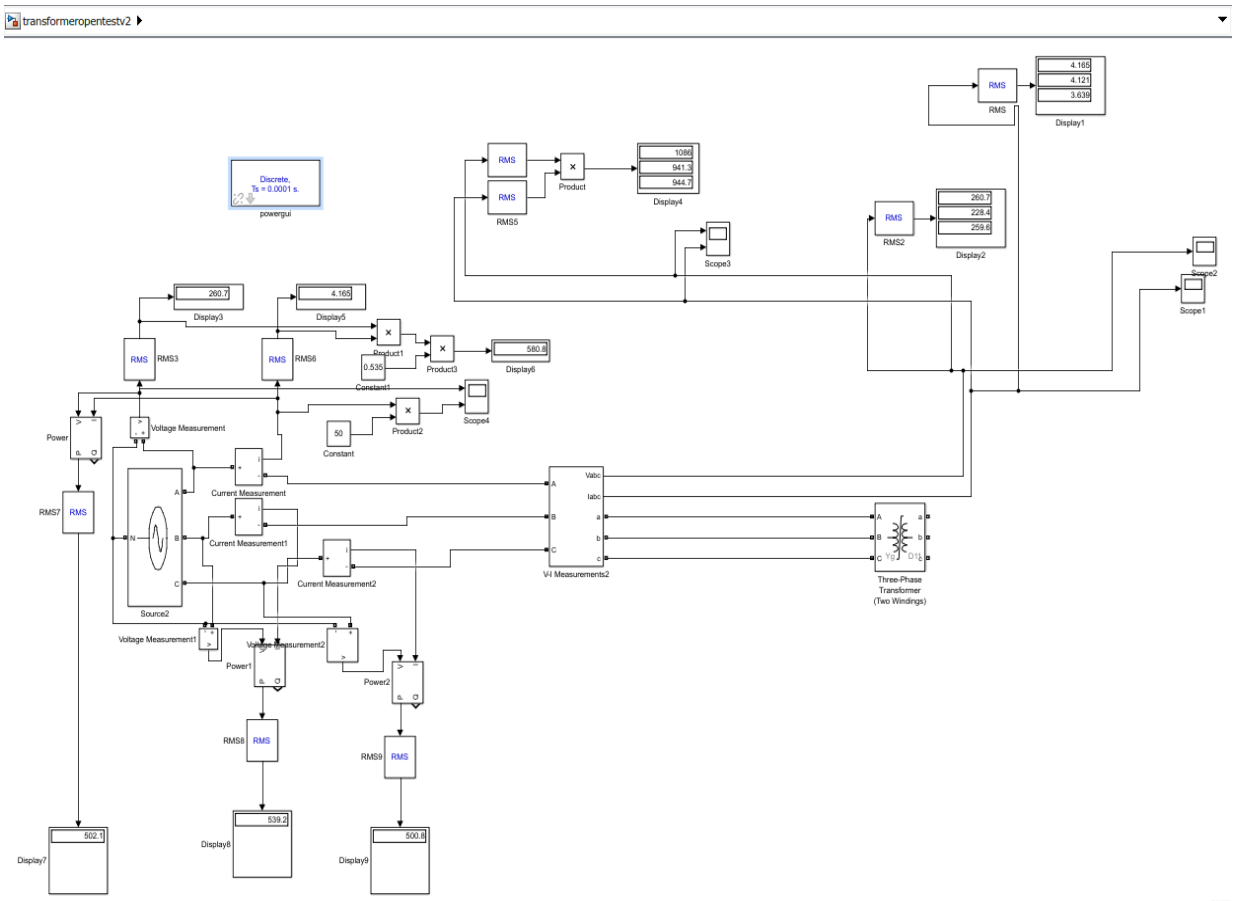

Figure 7: Open Circuit Test Model

IJIREEICE

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IV. DISCUSSION

Further the tool can be developed for the transmission line and CT and all other components which are used in distribution network.
The tool can be directly merged with the MATLAB so that the values can be directly changed

V. CONCLUSION

The output parameters obtain from the tool was used in conducting the open circuit test and short circuit test and the results obtain can be crossed checked with the test certificate value

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BIOGRAPHY

Ruturaj Ulhas Gauns Gaonkar received the Bachelor of Engineering degree in Electrical and Electronics Engg from Goa Collage of Engineering, Goa University. Currently pursuing M.E. in Power and Energy from Goa Collage of Engineering, Goa University, Goa. Carrying out project and undergoing internship in Siemens LTd. Goa. Interest in protection systems and Electrical Engineering area.