

# Modelling and Simulation of Transformer Tests under Dynamic Testing

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**Abstract:** Large power transformers are the most important equipment for the power grid. Their reliability not only affects the availability of electricity in the supply area, but also affects the economic functioning of an energy supplier. The main objective of this work of the development of the transformer testing simulation model on the MATLAB/SIMULINK environment. The designing aspect shall comprise the generator-based and grid-based testing of the transformer and associated results on the same in the SIMULINK. And the methodology shall study the impacts on the grid-connected devices due to testing of the transformers in the grid-based method. The study concluded that there is effectively no effect on the parameter evaluation of OC and SC tests by either source. However, the practical conditions would require grid-based testing that allows a greater range of transformers of various ratings to be tested with high current capability. The impact of fault on the grid can be easily evaluated through location of fault, duration of fault, and dip if occurred. The testing should follow proper timing to avoid such disturbances on the grid. This leads to the rescheduling of the other approved outages or Short Circuit tests.

**Keywords:** Short Circuit Tests, Open circuit Tests, Transformer, AC.

## I. INTRODUCTION

If the transformers are taken from the factory or moved from another place, it is necessary to ensure that each transformer is dry, that no damage has occurred during transport, that the internal connections have not been loosened, that the transformation ratio, the polarity and the impedance of the transformer matches the nameplate, its main insulation structure is intact, the cable insulation has not been bridged, and the transformer is operational. The size, the voltage class and the rated power in kVA are the main factors that determine the

amount of preparation required for commissioning the transformers. The size and power in kVA also determine the type and number of auxiliary devices needed by the transformer. All of these factors affect the amount of testing required to confirm that a transformer is ready to be powered and put into service. When mounting a transformer in a substation, various checks and tests are carried out. The test engineer does not have to directly perform all of the following tests and inspections, but must be certain that they are performed satisfactorily to make the final decision as to whether the converting bench is ready to be fired. Some tests and procedures can be performed by specialists during the assembly phase. Special tests other than those listed may also be required. Many require special equipment and skills that construction electricians don't have and aren't expected. Some tests are performed by an assembly team, while other tests are performed by the people who perform the final electrical tests on the transformers. BPA has installed hundreds of power transformers throughout the system, only some of which are identical. The following information is not intended to describe or include details on how to perform all the tests necessary to prepare the transformers for operation, but only the tests that field service personnel are authorized to perform. Although the details are limited, the descriptions should allow the field worker to perform or assist in performing any basic tests that may be required. The procedures and tests are described in fairly general terms, but they somehow apply to most transformers.

Short and Open circuit tests are performed on a transformer to determine the:

- Equivalent circuit of transformer
- Voltage regulation of transformer
- Efficiency of transformer

The power required for no-load and short-circuit tests on a transformer is equal to the dissipated power that occurs in the transformer.

## II. LITERATURE REVIEW

Manohar Singh et al. [1] In this article, a simulation offline was performed to survey the effect of online kind testing on the Indian public organization. In this article, a web-based test plot has been introduced that permits the public lattice administrator to dissect the present status of the organization and afterward decide the security grade of the force transformer for web-based testing. The simulated results are compared to the results in the field and it is determined that the simulated results are close to the actual results in the field. The combination of simulation and field results made it possible to successfully commission the test laboratory.

Wenli F et al. [2] In this presented study, we propose a cascade failure of model based on the complex network theory by combining node congestion failures and hidden transmission line failures during power outages. The model deals with electrical properties that were not included in the existing cascade failure model when modeling nodal loads. Cascade failure simulations in central China's 500 kV power grid and the IEEE 300 bus test system show that the proposed cascade failure of model with node load based on electrical properties can provide a better invulnerability network than the model with a model based on a pure structure topology.

Parasnath et al. [3] Transformers make up the main electrical network of the equipment. Failure of a transformer leads to loss of income and affects the reliability of the power supply for consumers. In order to ensure a long and trouble-free operation of the transformers, various diagnostic tests are performed and corrective actions are initiated throughout their lifetime. There are many methods to access the residual life of transformers, such as using transformers and making timely decisions on transformer refurbishment/ replacement.

Geibler D et al. [4] A test bench is presented to evaluate the resistance to radial instability of the power transformer windings under the influence of electromagnetic forces. The resulting deformation of the conductor can be measured in parallel with the sinusoidal test current. The proposed test results focus on the occurrence of forced twist for continuously inverted conductors (CTC), which is a special type of conductor commonly used in power transformer windings.

## III. OBJECTIVES

The work objective shall cover the following key points:

- Development of the transformer testing simulation model on the MATLAB/SIMULINK environment.
- The designing aspect shall comprise of the generator based and grid based testing of the transformer and associated results on the same in the SIMULINK.
- The methodology shall study the impacts on the grid connected devices due to testing of the transformers in the grid based method.
- Deriving a comparison the testing methods and practical layout of the testing process.

## IV. METHODOLOGY

The developed model in MATLAB/simulation. Its matrix of high level / array language by the control of flow instruction, data structure, and function, I/O function, and the object-oriented program. And follow of main function.

- High level language for scientific and technical informatics
- Desktop environment designed for iterative exploration, design, and troubleshooting
- Charts to visualize data and tools to create custom charts
- for the curve fitting Applications, the classification data, analysis of signal, and the control system tuning and many other tasks
- Complementary of the toolkit for a wide of variety of technical and scientific applications
- Tools for creating applications with custom user interfaces
- Royalty-free implementation options to share MATLAB programs with end users

In this model goal of good design is to the reduce losses in the transformer. Once of the transformer is designed, engineers build a prototype and then the measure of the losses through the open and the short circuit tests. These are the tests also to allow of engineers to create the equivalent circuit for the transformer. Once you have the equivalent wiring diagram of a transformer, it is very easy to replace the transformer with its equivalent wiring diagram and run a system-level simulation.

In this thesis the simulation of the model of the open circuit test and of the SC test of transformers is designed. The analysis focuses on running the simulation in SIMULINK once by taking the generator as the source and then selecting the grid to be tested. The essential parameters of the SC and SC tests are also calculated during modeling. This chapter discusses the different design and implementation phases that take place in the implementation of MATLAB.

The analysis first looked at the equivalent circuit for open and short circuit and its parameter evaluation requirements for testing a transformer. The chapter also describes how to simulate and implement generator-based tests for testing, then network-

based testing and implementing its components with the authoritative equations that make each component work.

**A. Open circuit Tests**

The quiescent test for the calculation of the parameters can be performed with Fig.1 The linear transformer block in the Simulink diagram as shown in the figure can be modeled according to the values as shown in the table below:

Table 1:Transformer test parameters		
Sno.	Parameters	Values
1	Rating	25 KVa
2	Frequency	50 Hz
3	Winding 1 resistance (R1)	4.3218 ohms
4	Winding 2 resistance (R2)	2.3814 ohms
5	Winding 1 inductance (L1)	0.45856 H
6	Winding 2 inductance (L2)	0.25267 H
7	Magnetization resistance (Rm)	1.0805 x10 <sup>6</sup> ohms
8	Magnetization inductance (Lm)	2866 H

The measurements either from experimental or simulation enables us to compute resistance (Rc) and reactance (Xm) approximately of the pathogenic branch based on the primary side [4]. The excitation amplitude of the impedance of the OC voltage and of the current is calculated as:

$$|Z_E| = R_c + jX_m = \frac{V_{oc}}{I_{oc}}$$

where Rc is the core resistance and Xm is the magnetizing reactance. The admittance phase angle can be calculated from the knowledge of the power factor. The power factor PFOC is given by,

$$PF_{oc} = \frac{P_{oc}}{V_{oc}} * I_{oc}$$

Once the power factor is computed, angle φ is known, Rc and Xm can to be the computed as the follows [4]:

$$R_c = |Z_E| * \cos\phi$$

$$X_m = |Z_E| * \sin\phi$$

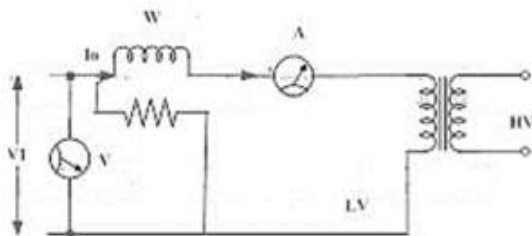


Fig. 1 Open circuit test circuit diagram implementation

**B. Short Circuit Tests**

The transformer short circuit test can be performed with the Simulink model shown in Fig. 4.2 [4]. The linear transformer block in the Simulink diagram can be modeled according to the parameters shown in Table 2.

The transformer copper losses can be determined by the transformer short circuit test. The transformer cut off displayed in Fig. 2 is performed by shorting the auxiliary terminal of the transformer and afterward applying a diminished voltage to the essential side. At the point when the appraised current moves during that time windings, the essential side information voltage is Vsc, the essential side windings input current is Isc, the info dynamic force is Psc, and the info responsive force is Qsc.

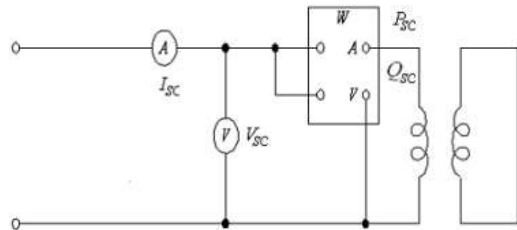


Fig. 2 the short-circuit resistance Rsc and the short-circuit reactance Xsc

Figure 2 the SC resistance Rsc and the SC reactance Xsc can be calculated as follows.

$$R_{sc} = P_{sc} / (I_{sc}^2)$$

$$X_{sc} = Q_{sc} / (I_{sc}^2)$$

The inductance Lsc is

$$L_{sc} = X_{sc} / (2 * \pi * f)$$

**C. Source of Short Circuit Current for Testing**

The simulation method for transformer SC testing is the useful for the studying is the operating principle and the characteristics of the transformers. And there are many types of software to complete the simulations; and the MALAB/ SIMULINK is the one of the most popular software used in this field.

Based on source of short circuit power there are two types of short circuit testing [3].

1. Generator based transformer testing
2. Grid connected transformer testing

During their lifetime, transformers can be exposed to a variety of system faults with different short-circuit currents (SC), which transformers must withstand. Therefore, they must be tested appropriately to ensure the efficiency of the design, quality and manufacturing process. For this reason the short-circuit test of transformers has been modified by the regulation of the Central Electricity Authority (Technical standard for the construction of power plants and power lines), 2010. Mandatory.

**D. Generator based transformer testing**

The motors drive the generators in the generator based short circuit test. Due to the inherent decrease in power output, generator-based laboratories have to overtake in advance to supply currents for a specified period of time. This can cause equipment wear. Network-based short circuit tests support availability when required and retest.

Generator-based tests have limited current ratings for test equipment, while grid-connected laboratories can provide high currents. Current switching or starting devices for generator short circuit testing are generally designed for generator output voltages of approximately 15 kV. At this voltage, the power failure occurs very quickly, which prevents significant damage to the transformer under test during a fault. In the laboratory connected to the network, the power failure lasts several tens of ms.

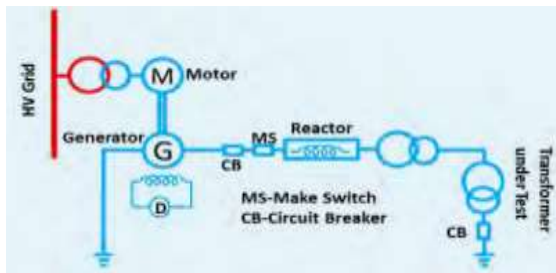


Fig. 3 Generator based short circuit testing

During simulation in the matlab the generator designed is modeled with the specifications mentioned in the table 2. The analysis is conducted by subjecting the transformer under test to this generator as a source for producing the required input for the primary.

Table 2: Generator chosen for fault analysis in transformer testing		
Sno.	Parameters	Values
1	Connection type	4-wire
2	Power rating	2000 KVA
3	L-L voltage	220 V
4	Frequency	50 Hz
5	Internal impedance (R)	0.0036 p.u
6	Internal impedance (X)	0.16 p.u

7	Pole pairs (p)	2
8	Inertia (H)	0.6 sec
9	Damping factor (Kd)	0.0 pu_T

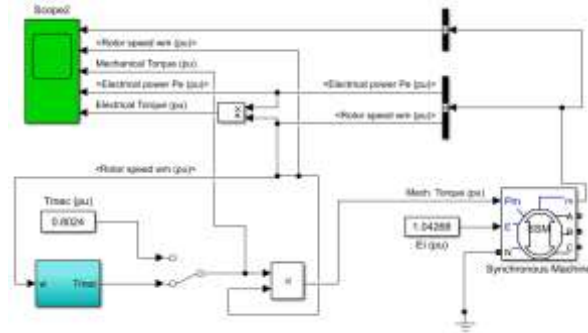


Fig. 4 MATLAB/SIMULINK model selected for feeding the transformer under test

three-stage, four-wire alternator evaluated 2000 kVA, 1600 kW, 0.8 force factor, 220 V, 1800 rpm. The stator unbiased point is grounded. The interior impedance of the generator ( $Z_g = 0.0036 + j*0.16$  pu) addresses the armature winding obstruction  $R_a$  and direct hub transient reactance  $X'd$ . The complete inactivity consistent of the generator and central player is  $H = 0.6$  s, comparing to  $J = 67.5$  kg.m<sup>2</sup>. Speed guideline is demonstrated with SIMULINK blocks carrying out a PI controller. The machine is energized with a consistent voltage.

**E. Grid connected transformer testing**

Unlike other utilities connected to the grid, the laboratory does not consume real electricity. During the test, reactive power is consumed for the time the test device is exposed to the short circuit. The duration can be on the order of 250 milliseconds. During the short-circuit test, the required short-circuit current is drawn from the 400 kV power line or the 765 kV power line, depending on the rated voltage of the transformer.

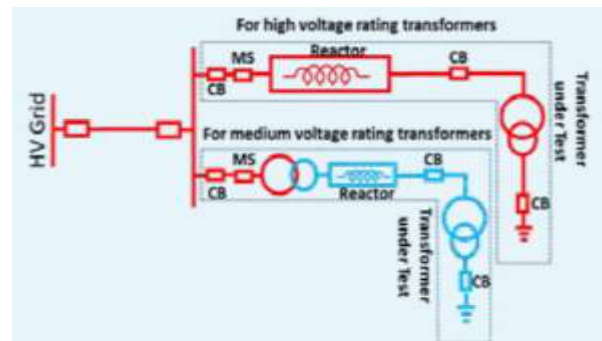


Fig. 5 Grid connected short circuit testing

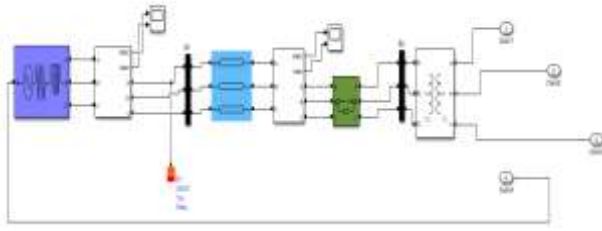


Fig. 6 Grid designing in the SIMULINK to act as source for transformer testing

Short-circuit currents range from kA to several tens of kA. In view of the risk of unwanted tripping during the short-circuit test, it was necessary to coordinate the protection system at the source and adjacent substations.

The organization is displayed as an appropriation organization. It comprised of two 25 kV electrical cables and a comparing 120 kV transmission framework. The three-stage current source block understands a balanced three-stage voltage source with an inside impedance R-L. Each of the three voltage sources are associated with Y with an impartial conductor, which can be grounded inside or made open. The inner obstruction and inductance of the source can be determined straight by entering the R and L qualities, or by implication by indicating the inductive short out level of the source and the X/R proportion. The inner association of the three interior voltage sources is Yn.

The inward inductance L (in H) is determined from the three-stage inductive short out power Psc (in VA), the base voltage Ubase (in Vrms stage to-stage) and the source recurrence f (in Hz) as follows:

$$L = \frac{v_{base}^2}{P_{sc}} \cdot \frac{1}{2\pi f}$$

The internal resistance R (in Ω) is computed from the source reactance X (in Ω) at specified frequency, and X/R ratio as follows:

$$R = \frac{X}{X/R} = \frac{2\pi f L}{X/R}$$

The designing involves utilization of a three phase breaker as well. he Three-Phase Breaker block implements a three-phase circuit breaker where the opening and closing times can be controlled either from an external Simulink® signal (external control mode), or from an internal control timer (internal control mode). The transmission line has been selected as simulink block to represent a 100km line whose supply is used for transformer testing after passing though a transformer.

The "Distributed Parameter Line" block executes a N-stage model of the dispersed boundary line with concentrated misfortunes. In this model, the lossless appropriated LC line is described by two qualities (for a solitary stage line): the trademark impedance  $Z_c = \sqrt{\frac{L}{C}}$  and the wave propagation speed  $v = \frac{1}{\sqrt{LC}}$ . l and c are inductance and capacitance per unit of length. The illustration shows the two-port model of a single-phase line.

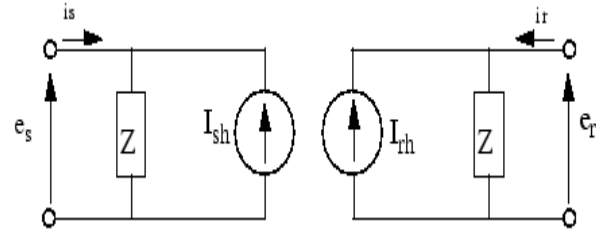


Fig.7 Model of Two-port of a single-phase line

For the lossless line ( $r = 0$ ), the quantity  $e + Zci$ , where  $e$  is the mains voltage at one end and the input mains current at the same end must arrive unchanged at the other end after a transport delay  $\tau$ .

$$\tau = \frac{d}{v}$$

where  $d$  is the line length and  $v$  is the propagation speed.

The model equations for a lossless line are:

$$e_r(t) - Z_c i_r(t) = e_s(t - \tau) + Z_c i_s(t - \tau)$$

$$e_s(t) - Z_c i_s(t) = e_r(t - \tau) + Z_c i_r(t - \tau)$$

knowing that:

$$I_{sh}(t) = \frac{2}{Z_c} e_r(t - \tau) - I_{rh}(t - \tau)$$

$$I_{rh}(t) = \frac{2}{Z_c} e_s(t - \tau) - I_{sh}(t - \tau)$$

When the account losses are taken, new equations for  $I_{sh}$  and  $I_{rh}$  are obtained by lumping  $R/4$  at both ends of the line and  $R/2$  in the middle of the line:

$$R = \text{total resistance} = r \times d$$

The current sources  $I_{sh}$  and  $I_{rh}$  are then computed as follows:

$$I_{sh}(t) = \left(\frac{1+h}{2}\right) \left(\frac{1+h}{Z_c} e_r(t - \tau) - h I_{rh}(t - \tau)\right) + \left(\frac{1-h}{2}\right) \left(\frac{1+h}{Z_c} e_s(t - \tau) - h I_{sh}(t - \tau)\right)$$

$$I_{rh}(t) = \left(\frac{1+h}{2}\right) \left(\frac{1+h}{Z} e_s(t - \tau) - hI_{sh}(t - \tau)\right) + \left(\frac{1-h}{2}\right) \left(\frac{1+h}{Z} e_r(t - \tau) - hI_{rh}(t - \tau)\right)$$

Where

$$Z = Z_c + \frac{r}{4}$$

$$h = \frac{Z_c - \frac{r}{4}}{Z_c + \frac{r}{4}}$$

$$Z_c = \sqrt{\frac{l}{c}}$$

$$\tau = d \sqrt{LC}$$

$r, l, c$  are the per unit length parameters, and  $d$  is the line length. For a lossless line,  $r = 0, h = 1$ , and  $Z = Z_c$ .

In multiphase network models, modal transformation is used to convert network variables from phase values (mains currents and voltages) to mutually independent modal values. Previous calculations are performed in the modal domain before being converted back to phase values. Compared to the PI cut line model, the distributed line represents wave propagation phenomena and end-of-line reflections with much better accuracy.

### V. SYSTEM DESIGN AND IMPLEMENTATION

For open circuit and short circuit tests, a variable AC voltage source is required to power the transformer. In fact, the independent variable of all the properties that can be drawn from these two tests is either the primary voltage or the primary current. This variable voltage source should gradually change in size from zero over time, with the supply frequency remaining constant throughout the testing process. In the no-load test, the final value of the input voltage is the rated voltage; During the short circuit test, the input voltage is increased until the primary and secondary rated currents of the transformer pass.

This subsystem which forms the source of variable alternating voltage is constructed as follows. In MATLAB, two main types of sinusoidal voltage sources were created, one generator-based model for laboratory tests and the other, a mains-powered model, for test execution.

The symmetrical three-phase voltage source is an ideal current source that is selected as the power supply when modeling the network. Its size is fixed at 25KV line to line. The primary and secondary conductors each have three conductors. Their lengths and impedances are every 100 km and 0.01273 / km respectively.

The line parameter was chosen during modeling at 0.9337 mH / km and then provided for testing.

The rated power of the three-phase transformer is 100 kVA, which is used at the end of the test. The nominal voltages on the primary and secondary are 2000 V and 220 V chained. In order to receive information on bus voltages, line currents and power flows, some measuring elements are defined in the test system.

- Voltmeter
- Ammeter
- Wattmeter
- Math operation SIMULINK blocks

For making the structure of the test system clear, the adopted measuring elements are all hidden inside the primary and secondary buses. The chapter discusses the analysis of a transformer under open circuit test and then under short circuit test whose output parameters are evaluated by first using a generator as a source and then using the modeled grid energy source as supply for carrying out each tests.



Fig. 8 Equivalent circuit of transformer drawn during evaluation

For the analysis the variables and circuit for evaluation of open circuit and short circuit parameters is drawn as in figure . this circuit is modified according to the OC and SC tests that shall be discussed later in this chapter.

Case 1: Open circuit test on the transformer using two sources.

Figure 5 shows the transformer identical circuit at no-load (open-circuit) test. To affirm the proposed recreation models, the same circuit boundaries that determined from commonsense association are contrasted and those from reproduction results.

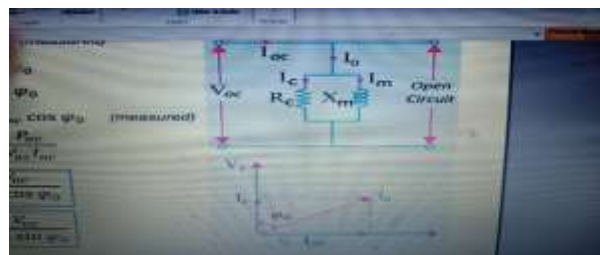


Fig. 9 Circuit for OC parameters identification

$I_o=I_{oc}$  =evaluated by using the RMS value of the voltage in the software

$$I_c=I_0 \cos(\Phi_o)$$

$$I_m=I_0 \sin(\Phi_o)$$

$P_{oc}= V_{oc}I_{oc} \cos (\Phi_o)$  = Evaluated by the power measurement block in the simulation

From the above equation the  $\cos (\Phi_o)$  which is referred to as no load power factor was determined in the MATLAB using the SIMULINK blocks by using the formula:

$$\cos (\Phi_o)=\frac{P_{oc}}{V_{oc} \times I_{oc}}=0.6447.$$

therefore,  $R_m$  is then identified as :

$$R_m=\frac{V_{oc}}{I_{oc} \cdot \cos(\Phi_o)}$$

$$=\frac{221.8}{0.0003206 \times 0.6447} \approx 1.073 \times 10^6 \Omega$$

$$X_m=\frac{V_{oc}}{I_{oc} \cdot \sin(\Phi_o)}$$

$$=\frac{221.8}{0.0003206 \times 0.7644} \approx 9.05 \times 10^5 \Omega$$

The evaluated parameters are being calculated using the formulas mentioned and the values observed for each quantity in the display block after simulation run time 10 seconds. Output power of transformer in open circuit test is zero because other side of transformer is open circuited.

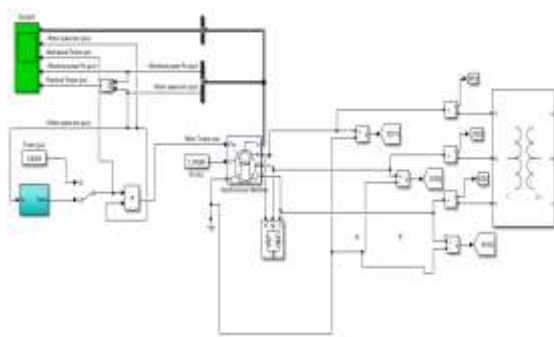


Fig. 10 Generator based Open circuit testing of transformer MATLAB/SIMULINK implementation

The analysis of OC test in the software used a synchronous machine working as a generator to supply power to the transformer under test. The work followed evaluation of certain open circuit parameters during the analysis which are accumulated in table 5.1. The evaluation included parameters

calculation such as  $R_m$ ,  $L_m$  and thereby  $X_m$  which is depicted in figure.

Sno.	Parameters	Values
1	$R_m$	$1.073 \times 10^6 \Omega$
2	$X_m$	$9.049 \times 10^5 \Omega$
3	$L_m$	2880 H

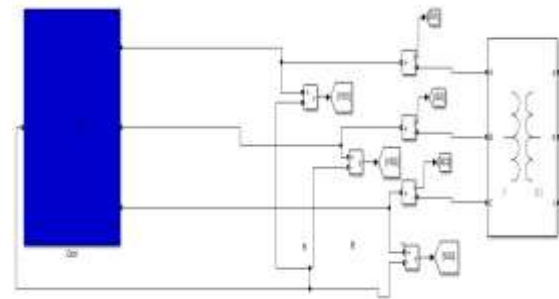


Fig. 11 Grid based Open circuit testing of transformer MATLAB/SIMULINK implementation

The analysis followed the implementation of grid system feeding the transformer under test with the required input parameters. The grid has been modeled as a three phase voltage source with frequency 50 hz assuming it to be a line of 25 KV being fed by various renewable and non renewable energy resources.

Sno.	Parameters	Values
1	$R_m$	$1.081 \times 10^6 \Omega$
2	$X_m$	$9.004 \times 10^5 \Omega$
3	$L_m$	2866 H

These parameters are evaluated using two sources of the transformer tests i.e generator and grid based testing. It was observed that the no load parameter evaluation was approximately same in both the cases of study and was concluded that there was almost negligible variation in the parameters depending upon the sources chosen.

During calculation of the percentage change with respect to the grid based testing, it was calculated that the value of  $R_m$  varied by only 0.07% change, the difference in the evaluation of  $X_m$  with respect to generator based testing model was only 0.04% and that of  $L_m$  it was also 0.04%. It can be concluded that these effects are negligible and therefore any sources for the testing purpose selected would not affect the efficiency of OC test procedure even by 1%.

Case 1: Short circuit test on the transformer using two sources

Copper losses calculated based on short-circuit test transformer which shown in Figure 7, the secondary winding of the transformer is shorted, after that a low voltage supply will connect to the primary side. As the maximum is flowing in the secondary windings,  $V_{sc}$ ,  $I_{sc}$  represent the short circuit voltage and current as respect to the primary side. The analysis follows the similar approach as of OC test and the equivalent circuit parameters considered during the analysis has been shown in figure:

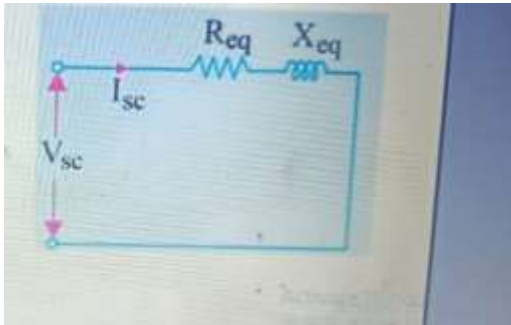


Fig. 12 Circuit for SC parameters identification

This test is performed to find series branch parameters of an equivalent circuit such as equivalent impedance  $Z_{eq}$ , total winding resistance  $R_{eq}$  and total leakage reactance  $X_{eq}$ . In Short Circuit (SC) test, the primary or HV winding is connected to the AC supply source through voltmeter, ammeter, wattmeter during the simulation time and parameters are then evaluated.

$$P_{sc} = I_{sc}^2 \cdot R_{eq}$$

From this formula we can calculate  $R_{eq}$  as:

$$R_{eq} = \frac{P_{sc}}{I_{sc}^2}$$

$$= 223.5$$

$$|Z_{eq}| = \frac{|V_{sc}|}{|I_{sc}|} = \sqrt{R_{eq}^2 + X_{eq}^2}$$

Hence:

$$\wedge X_{eq} = \sqrt{\left(\frac{|V_{sc}|}{|I_{sc}|}\right)^2 - R_{eq}^2}$$

$$= \sqrt{\left(\frac{220.2}{0.985}\right)^2 - 223.5^2}$$

$$= 223.4 \Omega$$

$$L_{eq} = \frac{X_{eq}}{2 \cdot \pi \cdot f}$$

$$= \frac{223.4}{2 \cdot \pi \cdot 50} \Omega$$

$$= 0.7112 \text{ H}$$

The parameters evaluation is done in both the cases where the feeding is done by generator and grid for short circuit test. The current flowing through the windings of transformer is rated current. The analysis has focused on the two types of sources that depicted almost similar results irrespective of their sources.

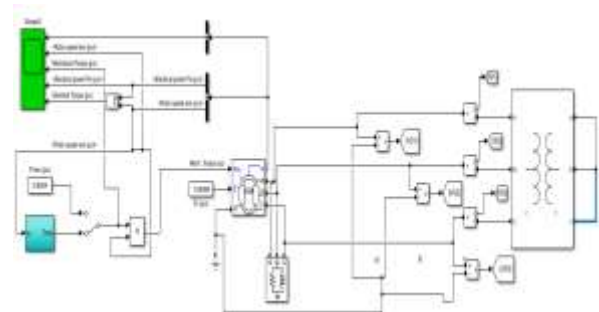


Fig. 13 Generator based Short circuit testing of transformer MATLAB/SIMULINK implementation

The analysis of SC test in the software used a synchronous machine working as a generator to supply power to the transformer under test. The work followed evaluation of certain short circuit parameters during the analysis which are accumulated in table 5.

Table 5 Parameters evaluation from SC test using generator.		
S no.	Parameters	Values
1	Rms voltage	220.2 V
2	$R_{eq}$	223.5 $\Omega$
3	$X_{eq}$	223.4 $\Omega$
4	$L_{eq}$	0.7112 H

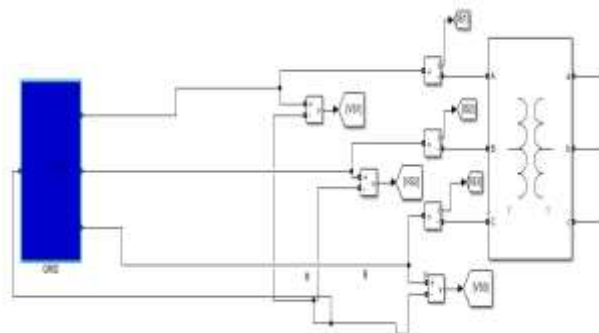


Fig. 14 Grid based Short circuit testing of transformer MATLAB/SIMULINK implementation

The grid based testing involves utilization of heavy current from the grid which is more practical way of drawing heavy current to be fed into transformers of high rating while they are short circuited. The similar short circuit test parameters are evaluated and represented in table.

S no.	Parameters	Values
1	Rms voltage	220.8 V
2	$R_{eq}$	223.5 $\Omega$
3	$X_{eq}$	223.4 $\Omega$
4	$L_{eq}$	0.7112 H

The parameters which are evaluated using two sources of the transformer tests i.e generator and grid based testing. It was observed that the short circuit test parameter evaluation was approximately same in both the cases of study and was concluded that there was almost negligible variation in the parameters depending upon the sources chosen.

The work concludes that the grid based testing is more practical approach of transformer testing when compared with the generator based testing. Also we have seen that it has no effects on the parametric evaluation so this has to be preferred over the other during testing. The grid offers current to be drawn in wide range while testing transformers of various rating.

## VI. CONCLUSION

The role of the manufacturer in designing the transformer for a particular application is very important. A detailed review of the design calculations for various parameters, including adequate design margins for strong electromagnetic forces during a short circuit, is very important before production begins. Transformers are subject to a variety of system failures during their life cycle. They must be suitably tested to ensure effectiveness of design and quality.

This work shares the experience of open circuit and short circuit testing in the MATLABSIMULINK environment subjected to generator based and grid based testing in facilitating transformer tests.

Two different modes of operation, connected to the grid and powered by a generator, were examined and the different requirements and results of the simulation were discussed. Grid-forming systems have been found to have the potential to meet the same short-circuit requirements as current-regulated systems, but offer an inherent rapid response to failures. The study concluded that there is effectively no effect on the parameter evaluation of OC and SC tests by either sources. However the practical conditions would require grid based

testing that allows greater range of transformers of various rating to be tested with high current capability.

The impact of fault on grid can be easily evaluated through location of fault, duration of fault and dip if occurred. The testing should follow a proper timing to avoid such disturbances on the grid. This leads to rescheduling of the other approved outages or Short Circuit tests.

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