academic publishers
INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE (ISSN: 2692-5206)
Volume 04, Issue 07, 2024
Published Date: 04-10-2024

DEVELOPMENT OF AN INTELLIGENT MONITORING SYSTEM FOR POWER TRANSFORMERS IN POWER SUPPLY

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Keywords: transformer, voltage, transformation, winding, circuit, diagram, efficiency, single phase, load, ratio, value, isolating transformers, autotransformer, simulation.

Abstract: The article concern with the study of transformers especially single phase transformers through efficiency assessment parameters with ohmic load for automatic control and regulation of quality indicators using electrical devices and controllers. As a result of the experiments, it was revealed that a single-phase transformer and simulation of wave parameters in secondary voltage observed with a help of changing in the different Voltage parameters. The simulation allows you to control the electrical devices through a controllers, by simulating the signals of primary and secondary coils; you can control and monitor the transformer parameters when the AC to DC converters circuit and automatic control in every electrical devices.

Introduction

One of the significant advantages of alternating current, including three-phase current, compared to direct current is that this type of electrical energy can be economically generated in large power plants, transmitted over long distances at high voltages with relatively low losses, and ultimately transformed to consumer level voltage. This all became possible thanks to transformers. All types of transformers are designed to convert power from less than one watt to over gigawatt. Three-phase transformers are used exclusively for large-scale power needs, and for smaller ones, single-phase designs are often used. To demonstrate the principle of operation of transformers, we will first consider single-phase transformers. The fundamental operating principle of a transformer is the law of induction. According to this law, a coil that is exposed to a periodically varying magnetic field will induce a voltage. Since a transformer is usually used to connect two different voltage levels, it is necessary that both sides be identified with unambiguous suffixes. Typically, the side intended for input is the primary side and is designated by suffix 1. The side of the transformer to which the load is connected is called the secondary side and is designated by suffix 2.

According to the law of induction, if the number of turns in the windings is represented by N1 and N2, then the relationship between the corresponding voltages for an ideal transformer will be:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

The most important indicator for a transformer is the voltage conversion ratio.

Ignoring transformer losses, the apparent power should be the same on both sides. This can be used to obtain the current ratio as follows:

$$\frac{I_1}{I_2} = \frac{N_2}{N_1}$$

The higher the transmission voltage, the lower the current will be for the same amount of power conducted. This principle allows the use of high-voltage lines with a smaller conductor cross-section, which is a more economical solution.[1]

In addition to the transformation ratio of the transformer, there are other factors that also determine the performance characteristics of the transformer. These include rated fixed power, no-load current, short-circuit voltage and efficiency.

The experiments conducted here will use one laminated core transformer and one toroidal core transformer with two secondary windings.

The operating characteristics of both types will be similar, they will differ only in the short circuit voltage and no-load current.

Research objectives:

After conducting the experiments, we will be able to:

-Connect a single-phase transformer, and then demonstrate the meaning of the concepts “voltage transformation”, “current transformation” and “no-load current” using the corresponding experimental diagrams.

-Assemble a measuring circuit to determine the short-circuit voltage and steady-state short-circuit current and measure their values.

-Consider the behaviour of the transformer voltage when connected to an ohmic load and determine its efficiency under the influence of the load.[2]

-Study and explain the behaviour of voltage when connected to an inductive or capacitive load.

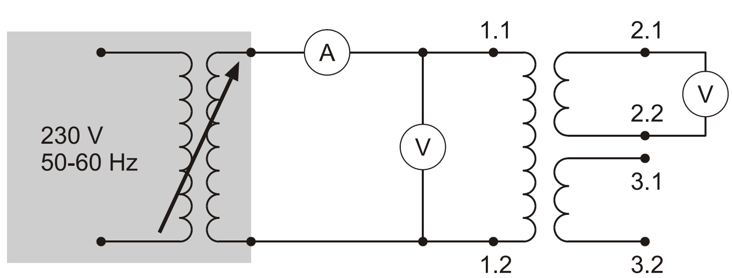
As an alternative to root mean square (RMS) voltmeters:

2 voltmeters 0 ... 400 V

1 ammeter 0 ... 1 A

1 ammeter 0 ... 2.5 A

Circuit for measuring voltage transformation in a single-phase transformer



To do this, the transformer under study must operate without load. Turn on the circuit and, on the control transformer feeding the circuit, set the voltage V1 = 230 V. Measure the no-load current I0 of the object under test and the voltage on each of the secondary windings V2 and V3 (between terminals 2.1 and 2.2 and 3.1 and 3.2, respectively).

Also measure the voltage V2,3 between terminals 2.1 and 3.2 when the two secondary windings are connected in series (connecting terminal 2.2 to terminal 3.1)

$$I_0 = 0.18A, V_2 = 121V, V_3 = 121V, V_{2,3} = 243V$$

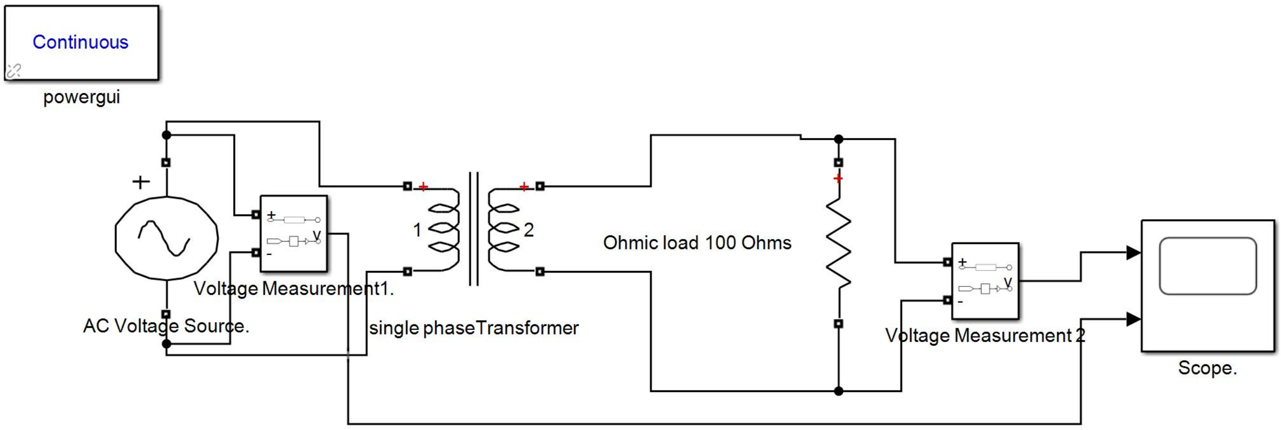
Make the ratios of voltages V1, V2 and V3 to the number of turns N1, N2 and N3 of their corresponding windings:

$$\frac{V_1}{N_1} = 0.564, \frac{V_2}{N_2} = 0.565, \frac{V_S}{N_S} = 0.565$$

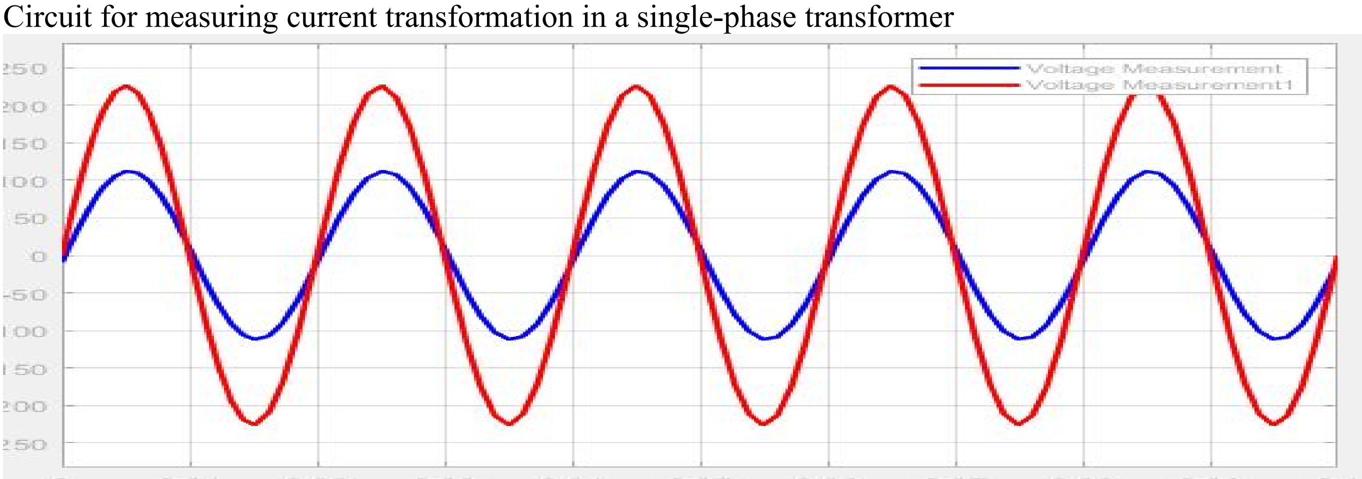
Create an equation for the voltage transformation ratio from the above data:

$\frac{V_1}{V_2} = \frac{N_1}{N_2}$ and $\frac{V_1}{V_S} = \frac{N_1}{N_S}$

To determine the current transformation ratio, change the circuit in accordance with Figure 2:



Circuit for measuring current transformation in a single-phase transformer



Set the ohmic load to 100% and turn on the circuit. Turn on the circuit and, on the control transformer feeding the circuit, set the voltage back to 230 V. Reduce the value of the load resistance so that the rated current flows through the secondary side of the test item (see Specifications on the front panel). Measure the corresponding current on the primary side.[3]

$I_1 = 0.72$ A, $I_2 = 1.36$ A,

Make up the ratios of currents I1 and I2 to the number of turns N2 and N1 of their corresponding windings:

$\frac{I_1}{N_2}$ =3.36mA, $\frac{I_2}{N_1}$ =3.33mA

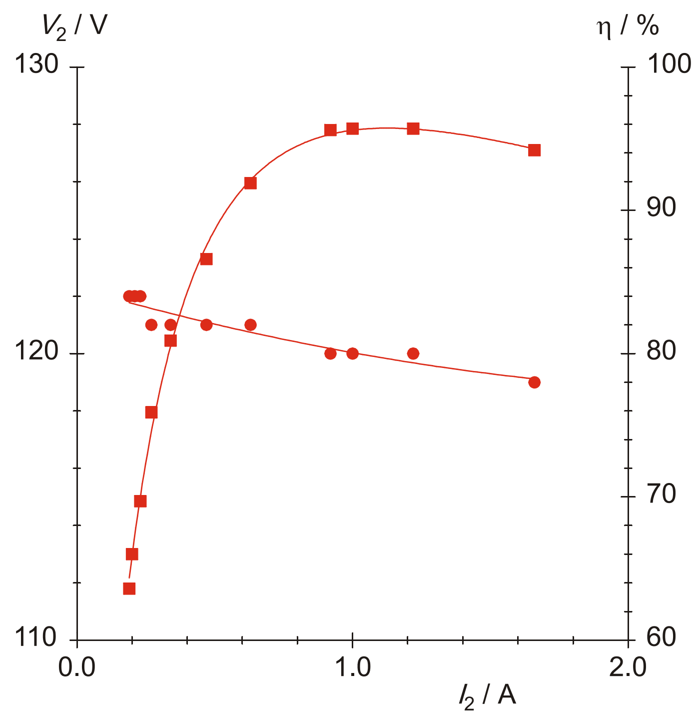
Create an equation for the current transformation ratio from the above data:

$$\frac{I_1}{I_2} = \frac{N_2}{N_1}$$

The power factor is about 96%.

	R / %	100	90	80	70	60	50	40	30	20	15	10
measured	I_1 / A	0,24	0,24	0,25	0,26	0.28	0.34	0,41	0.54	0,58	0,70	0,94
	cos	0,66	0,67	0,70	0,72	0,79	0.84	0,88	0.93	0,94	0,95	0,97
	V_2 / V	122	122	122	121	121	121	121	120	120	120	119
	I_2 / A	0,19	0,20	0,23	0,27	0.34	0,47	0,63	0.92	1,00	1,22	1,66
calculated	P_1 / W	36,4	37,0	40,3	43,1	50,9	65,79	83,0	115,5	125,4	153,0	209,7
	P_2 / W	23,2	24,4	28,1	32,7	41,1	56,9	76,2	110,4	120,0	146,4	197,5
	/ %	63,6	66,0	69,7	75,9	80,9	86,6	91,9	95,6	95,7	95,7	94,2

Draw a single graph of the measured values of voltage V2 and efficiency versus load current I2



Secondary voltage (●) and efficiency (■) depending on the load current of a single-phase transformer with an ohmic load.

When does efficiency reach its maximum?

With an ohmic load, the efficiency has a rather flat maximum. It is located in the secondary currents between 1 and 1.3 A.

In addition, it is necessary to know the differences in the physical structure of "isolating transformers" and "autotransformer". Separating transformers have virtually no galvanic connection between their windings, while an autotransformer is formed by two parts of one winding connected in series. One part of the winding, called the common winding, is the common winding for both sides. The other part of the winding, called the auxiliary or series winding, together with the common winding, forms the high voltage side.[4]

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