Simulation Analysis and Application of Three-Phase Alternating Circuits by Multisim 10 Software

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Abstract—The paper introduces simulation analysis and application of three-phase alternating current circuit by Multisim 10 software. As a well-known software in circuit simulation analysis, Multisim shows many advantages, such as friendly user interface, powerful functions and easily to operate. The paper takes several examples using Multisim software on application of three phase alternating circuit, and its visualization provides very good practical effects.

Keywords- Simulation analysis; Three-Phase alternating circuits; Multisim10 software

I. INTRODUCTION

Multisim 10 offers many visual components to utilize simulation to produce the data for the analysis we want to perform. These analyses can range from quite basic to extremely sophisticated, and can often require one analysis to be performed (automatically) as part of another.

II. SIMULATION ANALYSES OF THREE-PHASE CIRCUITS FEATURE

A. Creation of three-phase A.C. sources

Three-phase circuits must involve three-phase A.C. sources. We can only consider a balanced three-phase source, which consists of three sinusoidal voltages that have identical amplitudes and frequencies but are out of phase with each other by exactly 120° . [1]We can use three single-phase A.C. sources to combine a balanced three-phase source by Multisim 10 software as shown in Fig.1. This is also replaced by three-phase voltage source as shown in Fig.2.
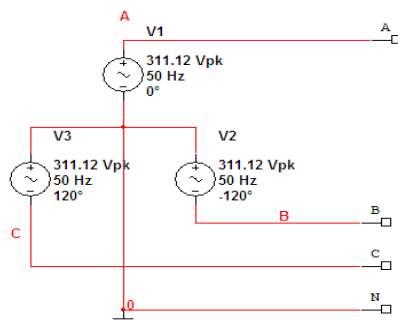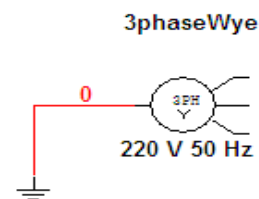

Figure 2. Three-phase A.C. source

B. Determination of phase sequence

In some cases it is necessary to identify phase sequence for three-phase A.C. source. Only two possible phase relationships can exist between the a-phase and b-phase and c-voltages. One possible phase sequence is for the b-phase voltage to lag the a-phase voltage by 120° , in which case c-phase voltage must lead the a-phase voltage by 120° . This phase relationship is known as the abc or positive phase sequence. Adversely, b-phase voltage leads the a-phase voltage by 120° , in which case the c-phase voltage must lag the a-phase voltage by 120° .This phase relationship is known as the acb or negative phase sequence.[2] To determine an unknown phase sequence of three- phase source, a capacitor with set value is connected to the a-phase with two sets of bulbs connected to b-phase and c-phase. Compared with their luminance of the two sets of bulbs, we judge which phase is b- or c-phase.

Using Simulink 10 software, create a model to simulate the circuit as shown in Fig.3.

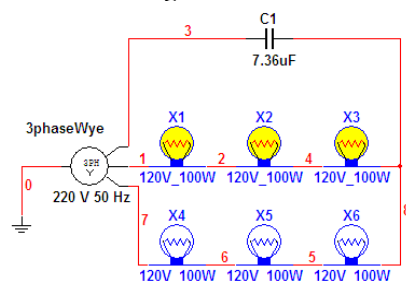Figure 1. Combined three-phase A.C. source

Figure 3. Determination of phase sequence for three-phase source

The simulate result shows the phase with more brilliant light is b-phase and the rest phase is c-phase.

C. Analysis of three-phase A. C. circuit features on load

There are two ways of interconnecting three-phase load which is either a wye(Y) or a delta (△). Fig.4 shows simulation circuit of three-phase balanced loads with each phase two lamps series connection in a wye configuration with neutral conductor. The simulation circuit of three-phase balanced or unbalanced loads (△ connected) with two or more lamps series connection is shown in Figure5.
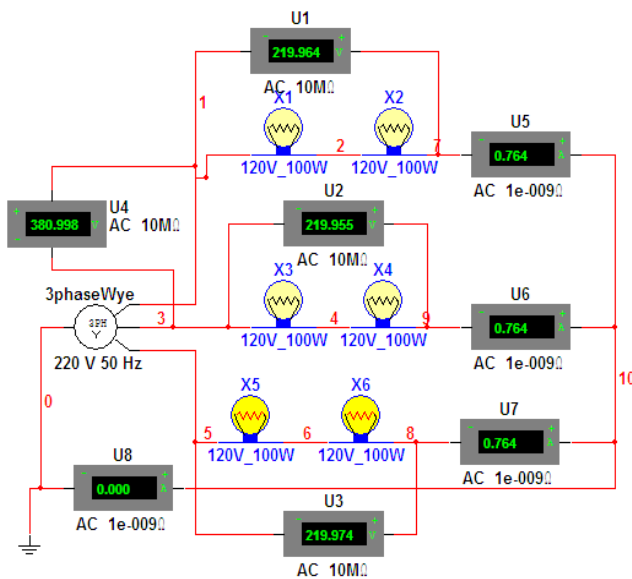

Figure 4.   Simulation circuit of three-phase balanced loads in a wye configuration with neutral conductor
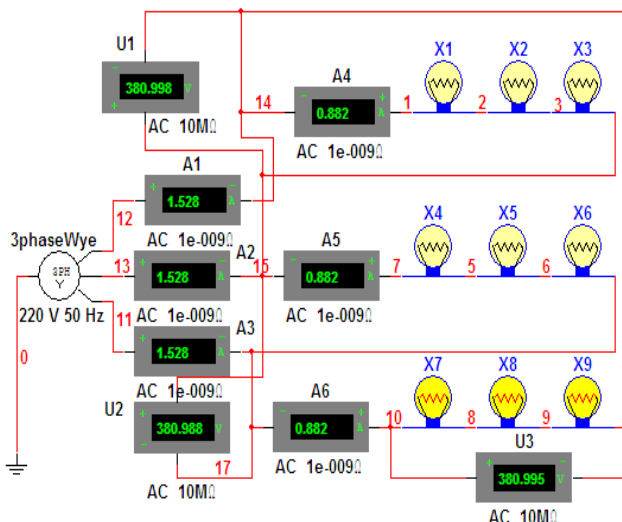

Figure 5.   Simulation circuit of three-phase balanced loads in a delta configuration with neutral conductor

The simulation results of three-phase balanced or unbalanced loads (Y-connected) with two or more lamps series connection in the case of connection and disconnection of neutral conductor show as follows below in Table.1(see page 3). According to these simulation data, we derive that in these cases each line-to-line voltage is balanced with neutral conductor or without neutral conductor , line-to-neutral voltage and current are balanced with neutral conductor, the magnitude of the line-to-line voltage is √3 times the magnitude of the line-to-neutral voltage and neutral node without neutral conductor is offset in the case of unbalanced loads.

The simulation results of three-phase balanced or unbalanced loads (△ -connected) with three or more lamps series connection is shown in Table.2. (see page 3). From simulation result, we derive that line voltage, line current and phase current are balanced when loads are balanced, and the magnitude of line current is √3 times the magnitude of the phase current, and line current and phase current are unbalanced in the case of unbalanced loads.

Thus, there are many three-phase AC circuits models built by multisim 10 in order to perform the result same as the real experiment.

D. Measurement of three-phase power

We measure total three-phase power by three power meters means which is shown in Fig6. After assuming motor parameter R1,R2 and R3 as 200, the sum of three power meter shown is 726.111, which is 3 times the show data of single power meter. Two- meters method can be used in some cases. We select three-phase motor as load shown in Fig.7. When the simulation switch button closes, the analysis is run and we read the data from power meter. The sum of data two meter shown is 726.09W, which is the total power consumed by three-phase motor and power factor of three-phase motor is 0.867 [3].Above two methods both adapt for measuring the total power of three-phase circuits. The three-phase motor can be replaced by other loads.
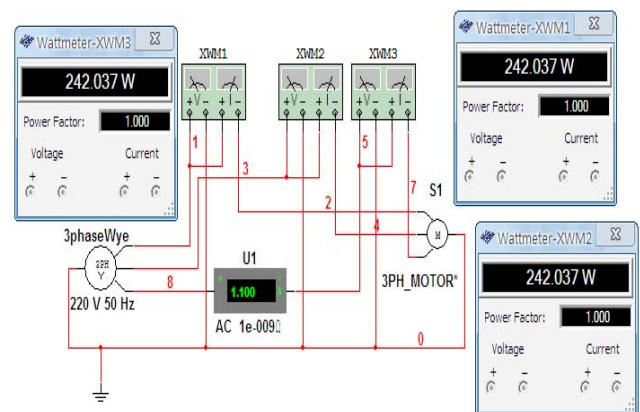

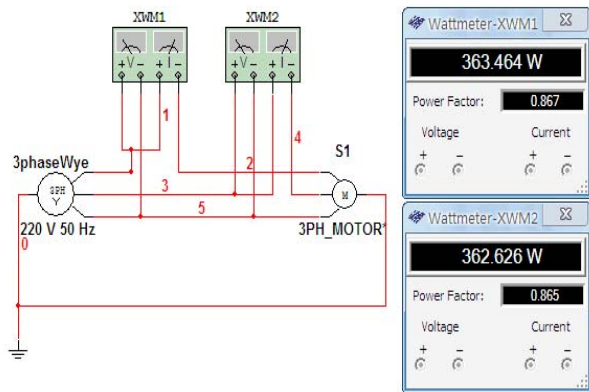Figure 6.   Three-meters method for measurement of three-phase power

Figure 7. Two-meters method for measurement of three-phase power

III. SUMMARIES

Multisim 10 simulation software on computer can provide the all kinds of design models to achieve test data and test images for principle experiments and expanded experiments. In addition to get the correct results，it can also be used for development and study of the experiment. The simulation results can determine whether the circuit design to achieve the desired goal to improve the students the analysis and solving problem skills. Meanwhile, Multisim 10 simulation software using computer as an experiment platform for different types of experiments, the laboratory can decrease the costs for construction and consumed raw materials and increase the operating efficiency because the components and apparatus used in the experiments are not limited.

TABLE I. SIMULATION DATA FOR THREE-PHASE LOADS(Y- CONNECTED)

	Lamps connection mode	U_{AB} (V)	U_{BC} (V)	U_{CA} (V)	U_A (V)	U_B (V)	U_C (V)	I_A (A)	I_B (A)	I_C (A)	I_N (A)	U_{NN}' (V)
With neutral conduct-or	Each phase with two lamps series connection	381	381	381	220	220	220	0.764	0.764	0.764	0	\
	Phases with two-three-two series connection	381	381	381	220	220	220	0.764	0.509	0.764	0.255	\
	A-phase is broken under above condition	381	381	381	220	220	220	0	0.509	0.764	0.674	\
With no neutral conduct-or	Each phase with two lamps series connection	381	381	381	220	220	220	0.764	0.764	0.764	\	0
	Phases with two-three-four series connection	381	381	381	178.3	232.6	255.5	0.619	0.538	0.444	\	0.019
	A-phase is broken under above condition	381	381	381	331.1	163.3	217.7	0	0.378	0.378	\	113.3
	A-phase is short (same as above condition)	381	381	381	0	381	381	1.341	0.882	0.662	\	220

TABLE II. SIMULATION DATA FOR THREE-PHASE LOADS(Δ -CONNECTED)

Lamps connection mode	U_{AB} (V)	U_{BC} (V)	U_{CA} (V)	I_A (V)	I_B (V)	I_C (V)	I_{AB} (A)	I_{BC} (A)	I_{CA} (A)
Each phase with three lamps series connection	380.998	380.998	380.995	1.528	1.528	1.528	0.882	0.882	0.882
Phases with three-four-three series connection	381.031	380.989	380.992	1.528	1.341	1.341	0.882	0.661	0.882
Phases with four-three-four series connection	381.031	381.020	381.024	1.146	1.341	1.341	0.662	0.882	0.662

REFERENCES

[1] James W. Nilsson; Susan A. Riedel. Introductory Circuits for Electrical and Computer Engineering, Publishing of Electronics Industry [M], 2002, PP:310-312

[2] NI Dian; HUANG Pei-gong. Application of Multisim 10 in the Design of Electronic Circuit ,Publishing of Electronics Industry[M], 2007. PP259-261.

[3] National Instruments Corporation. Multisim 10 User Guide [M] 2007.01, PP461-463