Simulation Model of Single-Phase AC-AC Converter by Using MATLAB

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***Abstract*— The current research sheds light on the electronic power devices that work as transformers and are named according to the function. A model of a single-phase transformer AC-AC type with half-wave and full-wave quality has been proposed. Its output is controlled by power, voltage and current, which is considered an input to the load. The fixed input transformer has a variable output according to the required power, voltage and current. Inverters of this type have so many uses that they are used in many different applications, including industrial, induction motor speed control, military, medical and household, including low-light circuits, among others. A simulation involving different types of single-phase AC transformers is proposed. The models were built in two ways, the first using a diode as an electronic switch, and the second using a thyristor. Different values for the load were chosen by adopting three values of 30 ohms, 40 ohms, and 50 ohms. An alternating power supply with an RMS value of 222 volts. Simulation was carried out after modeling to test the performance of the proposed transformer and its various modes of operation. Simulation models confirmed and reinforced the working theories of the proposed structures. From the results, we can reach the possibility of changing the voltage and power values using the electronic transformer by using the frequency of closing and opening the electronic keys within specific periods according to the proposed model, which can be represented or modified.**

Keywords—Single-phase AC-AC converter; Half Wave Converter (H. W. C); Full Wave Converter (F. W. C).

I. INTRODUCTION

Using transformers in protection, a single-phase (1-phase) AC-AC transformer was used to solve the problem of high voltage and current. The transformer works to prevent current and voltage surges by adopting safe switching [1-5]. A single-phase transformer was used in power transmission systems with IPT and SMC systems to control the current of transient states, and it was indicated that it is suitable in its applications for electric vehicles with battery charging systems [6-10]. The efficiency of a single-phase transformer AC-AC buck-boosting type was improved. The desired efficiency was achieved with a buck mode of 91.5% - 95.5% at a power of 200 watts. It can also have applications such as running alternating motors and connecting to the grid for wind turbines, this type of transformer and others [11]. The AC-AC single-phase transformer is built using IGBTs electronic switches. The switching process of electronic switches needs to be adopted to control the opening and closing state of the electronic switches. SPWM technology is employed with the transformer to reduce the harmonics of power and current [12-16]. The single-phase transformer type was built and designed in many studies, including in electrical traction applications. Using a cycloconverter to convert AC-AC to control the speed motor with frequency conversion with different values and with different load as resistors R [17-20].

AC-AC Converter it means the system has AC source and AC load. In constant source with variable load to solve this problem by add the AC-AC converter [21-23]. There are two types first 1-phase H.W.C. Second 1-phase F.W.C [24-26]. 1-phase H.W.C, it means the switch electronic number is one diode or thyristor. It works in half wave of voltage source when switch electronic is ON [27-29]. 1-phase F.W.C, it means the switch electronic number is four diodes or thyristors [30-32]. They work in 1-phase F.W.C of voltage source when switch electronic is ON [33-35]. In this type two diode like (d1&d3) are ON work every 1-phase H.W.C in the second time the diodes another work (d2&d4) is ON [34-36]. When conducting a search for this type of converter, we find a group of studies. They were written on different topics, including theoretical and applied types [37-39]. The types that included simulation for each type separately and other studies [40-42]. Somewhat different, according to our estimation, as it makes the simulation a method for presenting the review in a form acceptable to researchers [43-46].

The simulation included a review of alternating current circuits of both types, single and three phases, with different loads, including fixed and variable ones [47-50]. It also highlighted the fact that it has a 1-phase H.W.C or 1-phase F.W.C transformer, as will be mentioned later [51-55]. The current review will include the following electronic circuits: First, a 1-phase transformer, 1-phase H.W.C without control, second, the same type, first, with control, third, 1-phase F.W.C, without control, fourth, the same type, third, with control [56-60].

Researchers are interested in writing the most important topics in terms of appropriate applications. It is possible to identify the required behavior for any system to be dealt with. Electronic transformers are extremely important in the fields of various industrial applications, including protection and control systems, heating and cooling, power stations, transmission and distribution, etc.

The current research deals with one of the most important electronic transformers, the alternating current transformer[61-63]. Where its importance is through what it performs as it works to give a variable output from a source with a fixed input of the same type of supply to alternating current. Some applications require a variable frequency or variable voltage and so on. Electronic transformers are built from one or more electronic switches. Electronic keys during opening and closing by controlling the output of the electronic transformer according to the required design [64-66].

In the simulation there are many types that show in section two include 2. Simulation of AC-AC Converter. 2.1 Simulation of 1-phase of AC-AC Converter. 2.1.1 Simulation of uncontrolled single phase of AC-AC Converter. 2.1.1.a Simulation of uncontrolled 1-phase H.W AC-AC Converter. 2.1.1.b Simulation of uncontrolled 1-phase F.W AC-AC Converter. 2.1.2 Simulation of controller 1- phase of AC-AC Converter. 2.1.1.a Simulation of controlled 1-phase H.W AC-AC Converter. 2.1.1.b Simulation of controlled 1-phase H.W AC-AC Converter. 2.2 Also the simulation result for these models shows in section three include, 3. Simulation result for AC-AC Converter. 3.1 Simulation result for 1- phase of AC-AC Converter. 3.1.1 Simulation result For uncontrolled 1- phase of AC-AC Converter. 3.1.1.a Simulation result for uncontrolled 1-phase of H.W AC-AC Converter. 3.1.1.b Simulation result For uncontrolled 1- phase of F.W AC-AC Converter. 3.1.2 Simulation result For controller 1- phase of AC-AC Converter. 3.1.1.a Simulation result For controlled 1-phase H.W AC-AC Converter. 3.1.1.b Simulation result for controlled 1-phase F.W AC-AC Converter. 3.2.

The transformer is an electronic switch that conducts the electronic switching of the switches and we get a change in the opening and closing state with a certain frequency. Its drivers are being designed. Transformers are built using diode, transistor (MOSFET, IGBT) and thyristor with control devices such as pulse width regulators of different types.

Single Phase AC-AC Converter, there are two types for 1-Phase AC-AC Converter. First, single phase of half wave (1- phase of H. W.) AC-AC Converter. Second, single phase of full wave (1- phase of F. W.) AC-AC Converter [67-70]. the current simulation puts in the hands of readers many electronic circuits that shed light on one of the types of electronic systems. They have used in many electronic control systems. They are using electronic power devices represented by electronic switches [71-73]. Sources of alternating current, including single-phase and for loads also, such as the same source they can be of another type. It is the sources of direct current and the food can be different from the quality of the loads, which requires converting it to suit the load [74-76]. Therefore, we need electronic switches to build electronic switching systems, which studies have proven [77-79].

The possibility of using it to perform this purpose. Use the Matlab program to perform a simulation of all the proposed circuits to conduct the current review through computer simulation to show the results and display them with the forms of simulation models [80-82]. It included single-phase circuits for an electronic transformer, alternating current, constant input, variable output, as needed, that is, according to what is required by the load [83-87]. Fig. 1 show the 1- phase of AC-AC Converter.

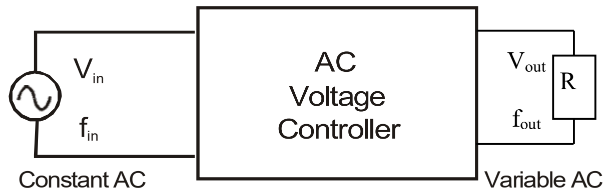


Fig. 1. Single phase of AC-AC Converter

Single phase of H.W AC-AC Converter, this type of electronic transformer consists of a single electronic switch that may be a diode, a transistor or a thyristor that acts as an electronic switch. It conducts the switching state electronically simulating the opening and closing of the switches. The frequency of opening and closing at different periods of time makes it possible to control the output of the transformer. Fig. 2 show the 1-phase of H. W. AC-AC Converter.

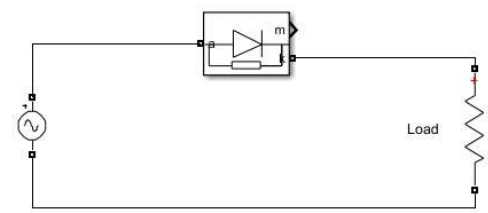


Fig. 2. Single phase of half wave AC-AC Converter.

Single phase of full wave AC-AC Converter, this type of electronic transformer consists of four electronic switches that may be diodes, transistors, or thyristors that act as electronic switches. It works on conducting the switching state electronically simulating the opening and closing of the switches. Repeated opening and closing at different periods of time makes it possible to control the output of the transformer. Fig. 3 show the 1- phase of F. W. AC-AC Converter.

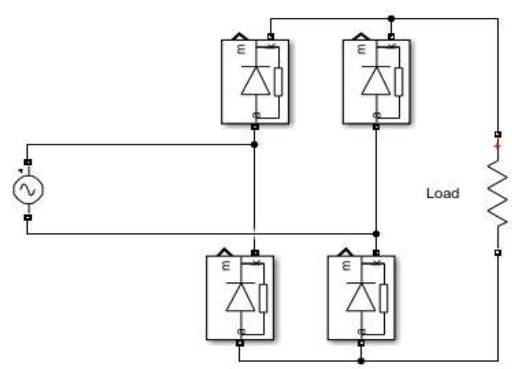


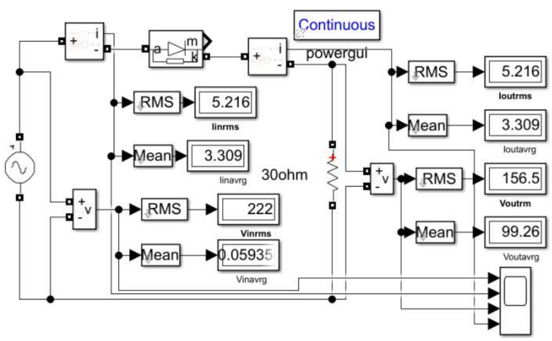
Fig. 3. Single phase of full wave AC-AC Converter.

II. Simulation Model For AC-AC Converter

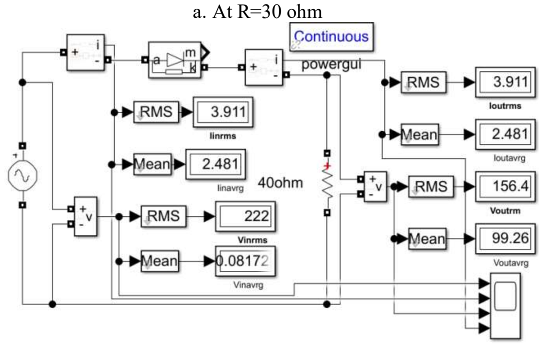
In this section there are two parts simulation first part by using the Simulation of uncontrolled 1- phase of AC-AC Converter. Second part by using the Simulation Model For controlled 1-phase of AC-AC Converter. It is suggested to use a variable resistor load with three values of 50-ohm, 40 ohm and 30 ohms. The cases are tested for various circuits such as a 1-phase H. W. transformer with a single electronic switch using a diode. The test reveals the control condition of the voltage and current between the input and the output with different load conditions. It also shows the input and output signals. The same test is repeated for a F. W. transformer also using the diode. Both cases are repeated by adopting the electronic switch with the gate such as the thyristor, that is, by adopting the control condition.

Uncontrolled single phase of AC-AC Converter, in this section there are two parts simulation first part by using the Simulation of uncontrolled single phase of H.W AC-AC Converter. Second part by using the Simulation Model for uncontrolled 1-phase of F. W. AC-AC Converter

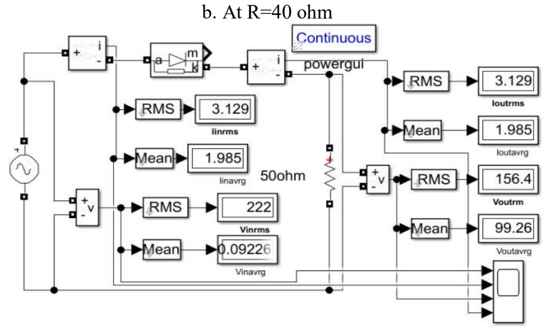
Uncontrolled 1-phase of H. W AC-AC Converter, in this section, there are three parts in simulation model. First part AC source voltage 50Hz, 222Vrms. Second parts half wave converter by using one diode. Third part is resistance load in ohm. The simulation model of uncontrolled 1-phase of H. W. AC-AC Converter as show in Fig. 4.



a. At R=30 ohm



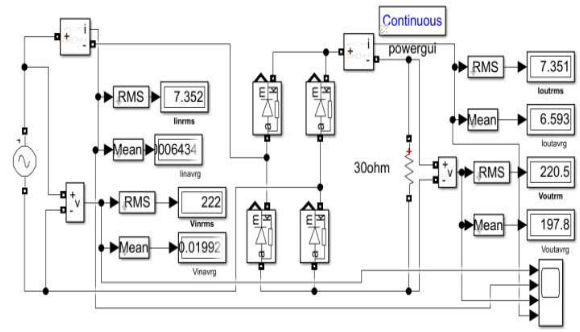
b. At R=40 ohm



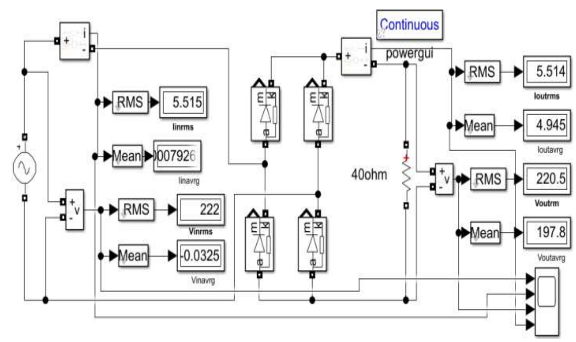
c. At R=50 ohm

Fig. 4. Sim. model of uncontrolled 1-phase of H. W. AC-AC Converter

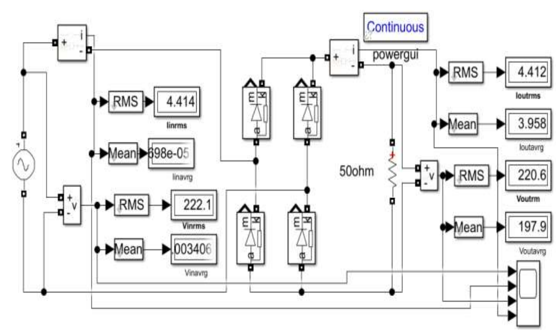
Uncontrolled 1-phase of F. W. AC-AC Converter, in this section, there are three parts in simulation model. First part AC source voltage 50Hz, 222Vrms.Second parts full wave (F.W.) converter by using four diode. Third part is resistance load in ohm. The simulation model of uncontrolled single phase of full wave (1-phase of F. W.) AC-AC Converter as show in Fig. 5.



a. At R=30 ohm



b. At R=40 ohm

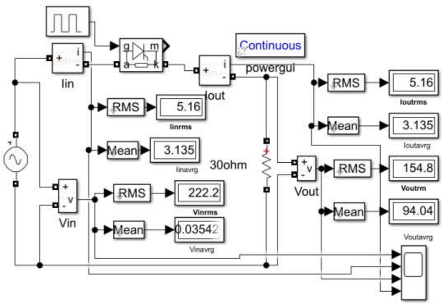


c. At R=50 ohm

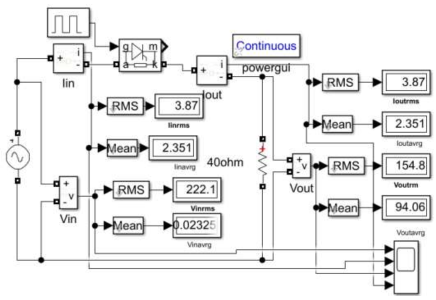
Fig. 5. Sim. model of uncontrolled 1-phase of F. W. AC-AC Converter

Controller single phase of AC-AC Converter, in this section there are two parts simulation first part by using the Simulation Model for controlled single phase of half wave AC-AC Converter. Second part by using the Simulation Model For controlled single phase of full wave AC-AC Converter.

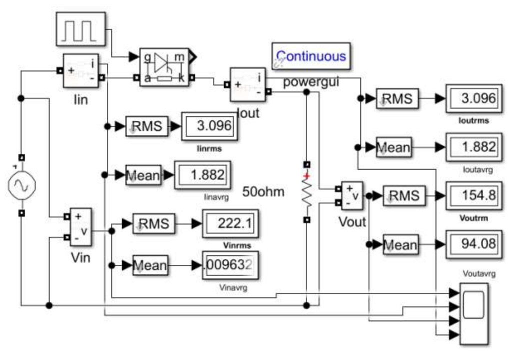
Controlled 1-phase of H. W. AC-AC Converter, in this section, there are three parts in simulation model. First part AC source voltage 50Hz, 222Vrms.Second parts H. W. converter by using one Thyristor. Third part is resistance load in ohm. The simulation model of controlled 1-phase of H. W. AC-AC Converter as show in Fig. 6.



a. At R=30 ohm



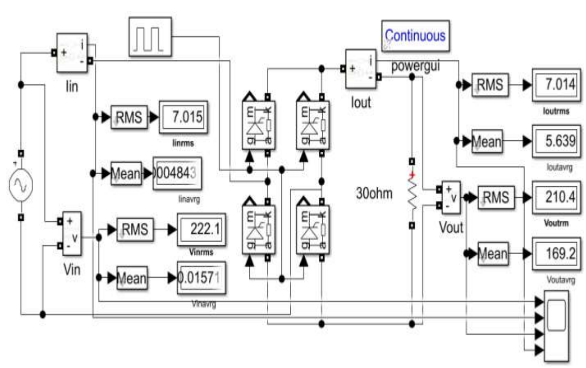
b. At R=40 ohm



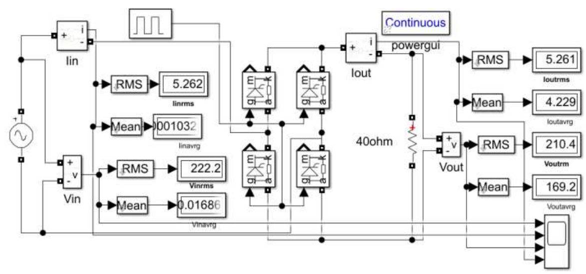
c. At R=50 ohm

Fig. 6. Sim. model of controlled 1-phase of H. W AC-AC Converter

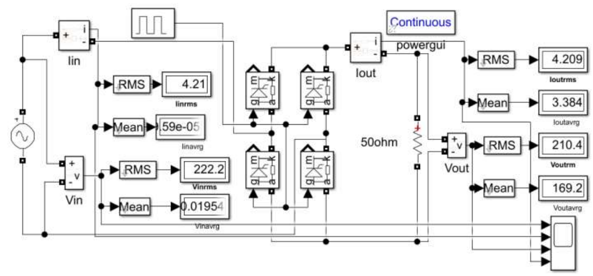
Controlled 1-phase of F. W. AC-AC Converter, in this section, there are three parts in simulation model. First part AC source voltage 50Hz, 222Vrms.Second parts F.W converter by using four thyristors. Third part is resistance load in ohm. The simulation model of controlled 1-phase of F. W. AC-AC Converter as show in Fig. 7.



a. At R=30 ohm



b. At R=40 ohm



c. At R=50 ohm

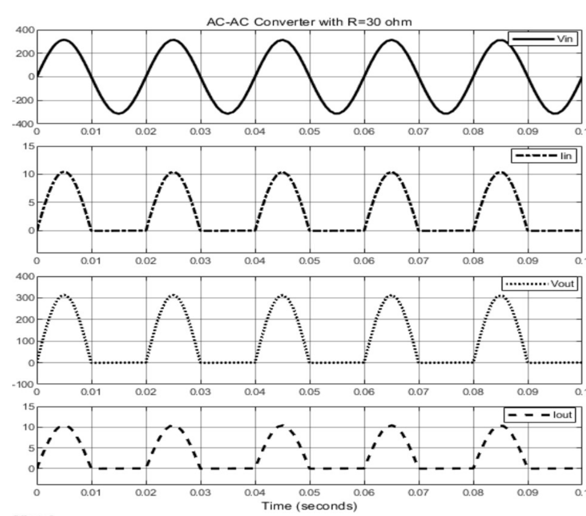
Fig. 7. Sim. model of controlled 1-phase of F.W AC-AC Converter

III. SIMULATION RESULT FOR 1-PHASE OF AC-AC CONVERTER

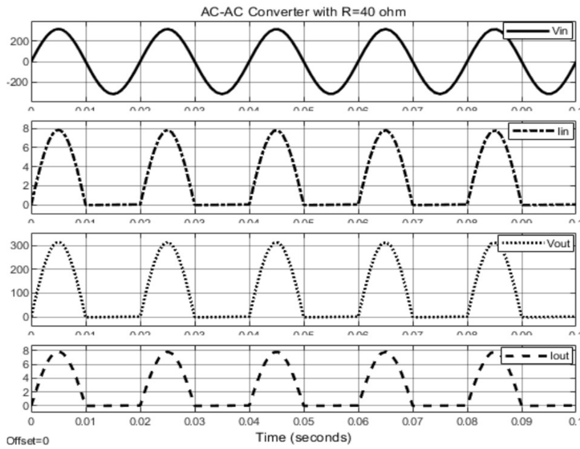
In this section there are two parts simulation result, first part Simulation result for uncontrolled single phase of AC-AC Converter. Second part Simulation result for controlled single phase of AC-AC Converter.

Uncontrolled single phase of AC-AC Converter, in this section there are two parts simulation result, first part Simulation result for uncontrolled half wave single phase of AC-AC Converter. Second part Simulation result for full wave uncontrolled single phase of AC-AC Converter.

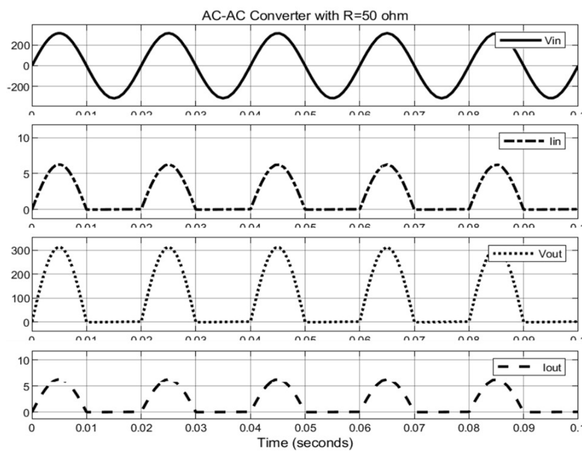
Uncontrolled 1-phase of H.W AC-AC Converter**,** In this section there are two parts simulation result, first part Simulation result For uncontrolled half wave single phase of input voltage, current, output voltage and current AC-AC Converter as show in Fig. 8.



a. At R=30 ohm



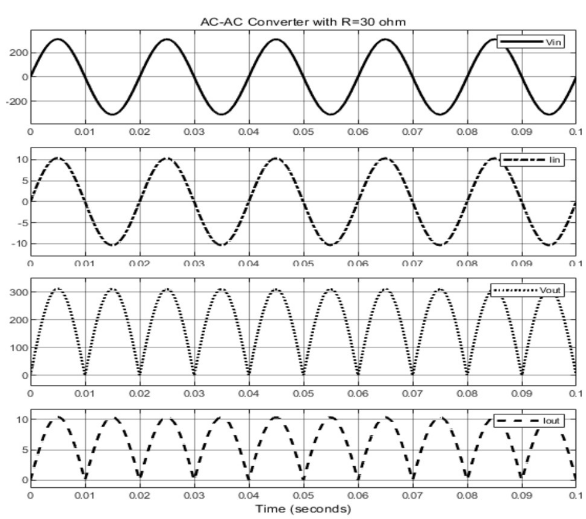
b. At R=40 ohm



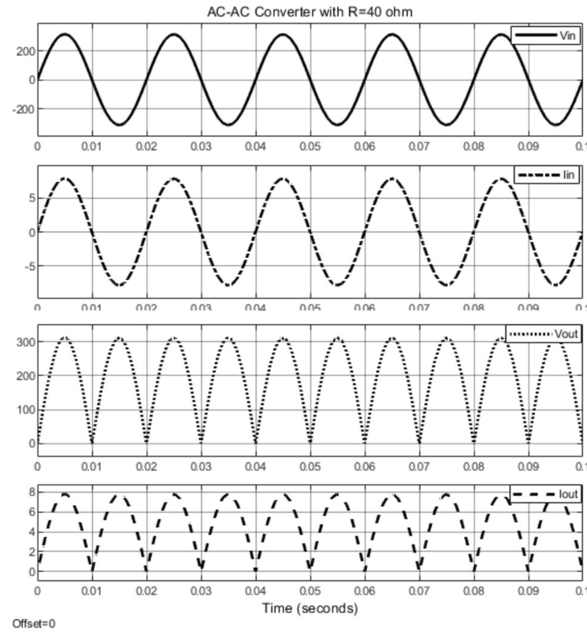
c. At R=50 ohm

Fig. 8. Simulation response for uncontrolled 1-phase of H.W

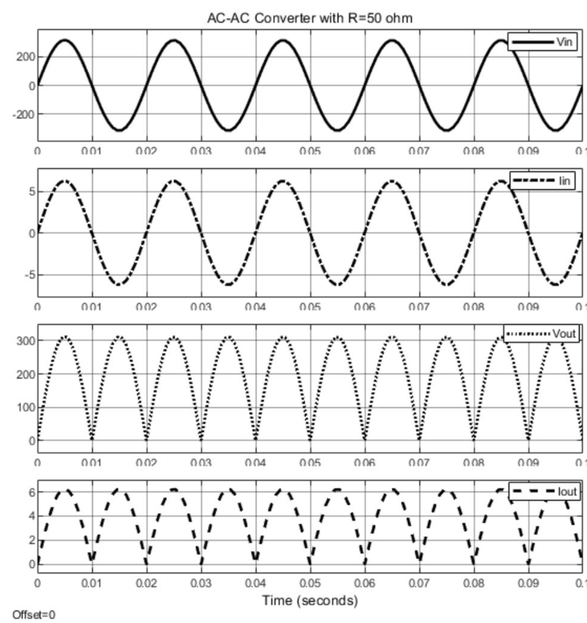
Uncontrolled 1-phase of F. W AC-AC Converter, in this section there are two parts simulation result, first part Simulation result for uncontrolled 1-single phase of F. W. for input voltage, current, output voltage and current AC-AC Converter as show in Fig. 9.



a. At R=30 ohm



b. At R=40 ohm

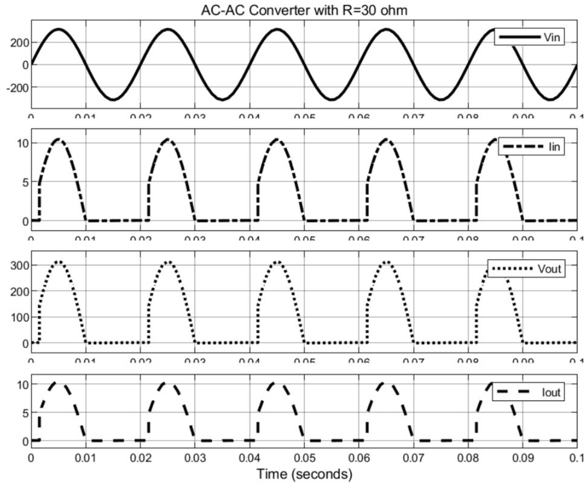


c. At R=50 ohm

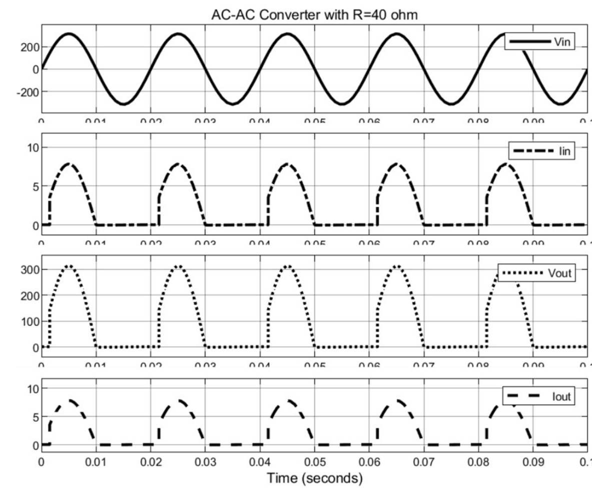
Fig. 9. Simulation response for uncontrolled 1-phase of F.W

Controller 1-phase of AC-AC Converter, in this section there are two parts simulation result, first part Simulation result for controlled half wave single phase of AC-AC Converter. Second part Simulation result for full wave controlled single phase of AC-AC Converter.

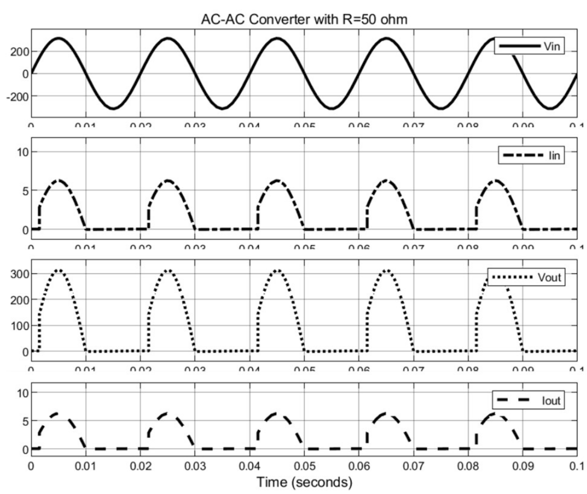
Controlled 1-phase of H. W. AC-AC Converter, in this section there are two parts simulation result, first part Simulation result for controlled 1-phase of H.W for input voltage, current, output voltage and current AC-AC Converter as show in Fig. 10.



a. At R=30 ohm



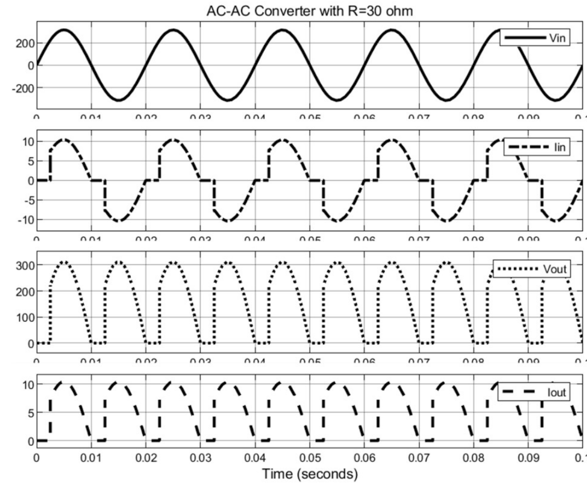
b. At R=40 ohm



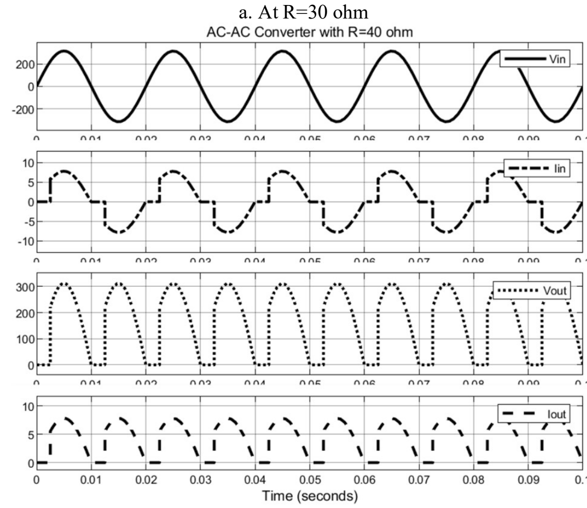
c. At R=50 ohm

Fig. 10. Simulation response for controlled 1-phase of H.W

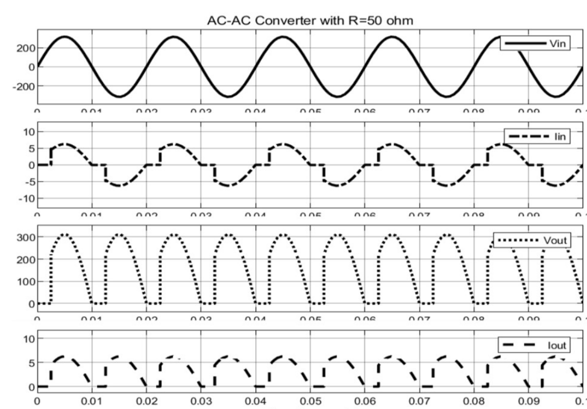
Controlled 1-phase of F. W. AC-AC Converter, in this section there are two parts simulation result, first part Simulation result for controlled full wave single phase of input voltage and current, output voltage and current AC-AC Converter as show in Fig. 11.



a. At R=30 ohm



b. At R=40 ohm



c. At R=50 ohm

Fig. 11. Simulation response for controlled 1-phase of F.W

After these simulation parts state many values and information in table and paragraph that show the discuses behavior of 1-phase of AC-AC Converter. Table 1 show the different value of input and output for voltage and current with constant input and change in load.

TABLE I. BEHAVIOR OF 1-PHASE OF AC-AC CONVERTER

Type of AC-AC Converter	RL (ohm)	I/P Vrm (V)s	I/P Irms (A)	O/P Vrms (V)	O/P Irms (A)
1-ph H.W Uncont.	30	222	5.216	156.5	5.216
1-ph H.W Uncont.	40	222	3.911	156.4	3.911
1-ph H.W Uncont.	50	222	3.129	156.4	3.129
1-ph H.W Cont.	30	222.2	5.16	154.8	5.16
1-ph H.W Cont.	40	222.1	3.87	154.8	3.87
1-ph H.W Cont.	50	222.1	3.096	154.8	3.096
1-ph F.W Uncont.	30	222	7.352	220.5	7.351
1-ph F.W Uncont.	40	222	5.515	220.5	5.514
1-ph F.W Uncont.	50	222.1	4.414	220.6	4.412
1-ph F.W Cont.	30	222.1	7.015	210.4	7.015
1-ph F.W Cont.	40	222.2	5.262	210.4	5.261
1-ph F.W Cont.	50	222.2	4.21	210.4	4.20

The simulation response shows the behavior of 1-phase of AC-AC Converter. In first type, H.W Uncontrolled. The input current equal output current at 5.216A. The value of the input equal output current with change the load that show in Table 1. whenever change the load to 40 ohm and 50 ohm the voltage is constant in input 222v and output 156.4v but the current in input and output is change with load that show in Table 1. In second type, H.W controlled. The input current equal output current at 5. 16A. The value of the input equal output current with change the load that show in Table 1. whenever change the load to 40 ohm and 50 ohm the voltage is constant in input 222.1v and output 154.8v but the current in input and output is change with load that show in Table 1. In third type, F.W Uncontrolled. The input current equal output current at 7.351A. The value of the input equal output current with change the load that show in Table 1. whenever change the load to 40 ohm and 50 ohm the voltage is constant in input 222v and output 220.5v but the current in input and output is change with load that show in Table 1. In fourth type, F.W controlled. The input current equal output current at 7.015A. The value of the input equal output current with change the load that show in Table 1. whenever change the load to 40 ohm and 50 ohm the voltage is constant in input 222.1v and output 210.4v but the current in input and output is change with load that show in Table 1.

IV. CONCLUSIONS

The present paper contains a computer simulation to verify and enhance the theories by contributing to the construction of the proposed simulation models. The present work contains the construction of models for each of the AC transformer to feed a resistive load of different values in order to observe the performance with cases of adoption of different types of AC transformers. The need for different values for each of the voltage and capacity that addresses the change in the behavior of the system needs control systems. Controlling the current through the adoption of electronic switches has become the solution. Controlling the current by adopting the closing and opening states of the electronic switches and thus it is possible to control and control the effort and output capacity. When conducting simulations for the four cases Suggested: The possibility of making the required adjustment for each case and obtaining the appropriate values for each case. The diode and thyristor were chosen to build the electronic transformer for both a half-wave and a full-wave single-phase AC transformer. Undoubtedly, the simulation leads to the possibility of predicting the behavior of the system by building more than one model in a short time and without economic cost and obtaining the best design for any system being simulated. A simulation model was proposed, and to verify the validity of the system, the simulation was conducted, and the results showed the possibility of using the proposed system effectively that suits its specifications. The current study was conducted to verify the possibility of simulating electronic devices to build electronic transformers using the diode as a single-phase circuit without half-wave and full-wave control, and thyristors with half-wave and full-wave control. It is also possible to conduct another study on the three phases in the same way.

The researchers plan to add other techniques to improve the performance of the current model, such as conventional and expert control systems and optimizing the change in the frequency of the pulse width that triggers the electronic key gate.

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