Utilizing the power controller, enhance the operation of a single-phase AC to DC converter

Raghad Hameed Ahmed[1], Mohammed Taha Yunis[2], Basima Taresh Dawood[2]
[1]Department of Technical Electronic, Technical Instructors Training Institute, Middle Technical University, Baghdad, Iraq
[2]Department of Technical Electrical, Technical Institute in Nasiriya, Southern Technical University, Basra, Iraq

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ABSTRACT

Smooth switching technology with a single-phase converter from AC to DC is existing in this work. A study of implementing a buck-batch converter was explored and the implementation details assessed. The system explaining the versatile balanced power control (VPBC) has advantages, the suggested boost buck processor is charged during the downtime; the voltage is relieved via the MOSFET switch. It has enhanced the power factor to 0.9715 at full load in further development. The advanced model of the AC to DC converter design will maintain stability and its reliability will depend on the average "charge" and "discharge" with the help of the VPBC-controlled current of the inductor, compensate automatically. Because of this process, a linear construction between line current and voltage is achieved by running normal work at regular intervals. As a result, they almost realized the PF at the input source. The output voltage of the planned for any load condition in the transformer model is always constant (0-1,000) watts. Suggested circuit has a great dynamic reaction. Suggested PFC circuit is usable for a range of loads. From the simulation, the efficiency of the suggested transformer is 91.11% upper at the rated load. Designed by MATLAB.

Corresponding Author:

Raghad Hameed Ahmed
Department of Technical Electronic, Technical Instructors Training Institute, Middle Technical University
Baghdad, Iraq
Email: raghad.hammed@mtu.edu.iq

1. INTRODUCTION

When noting a frequent change procedure, a full-wave range rectifier beside a channel capacitor or smoothing circuit has been regularly related among the data AC major and the DC yield critical. Regardless, it brings about a below power factor in the AC source and top-line current harmonics [1]. Having been presented conforming to this concern, suggested pattern has a full augmentation correction and beat width a regulation-based buck-help transformer, which is executed in additional fostering the power element in the entering grid [2]. The single-stage converter has several benefits, overwhelmingly transformer less AC-DC change and monitored buck-support processor, which may show a decrease in the wave voltage and high power factor in the DC-DC converter [3]. To restrict the system expense and partly uses, suggested it executed converter structure for an undeniable level control guideline method with a considered information power and the subsequent burden assortment [4]. The pulse width modulation (PWM) balance, the bridge rectifier, and the buck-boost converter are used in the current segment, as in Figure 1. For the change of the data besides the store network, a sensible PWM premised is need a controller for the buck-support converter [5]. Commitment extent of metal-oxide-semiconductor field-effect transistor (MOSFET) is relentless in the ordinary working situation, throughout the sporadic operation state, the buck-help inductor current isn't continuous in the complete assignment proportion, and it in addition arrives at zero level previously even before the completion of the commitment cycle [6]. We know this arranging pattern as the self-power factor control property or the voltage-lover power factor regulation technique. Although utilization is a nonlinear burden, the data power factor has various for its stable purpose. Needed harmonic current to the DC-DC converter, therefore generating an approximately unity power factor of the sinusoidal current, supplied the converter circuit [7]. In such a procedure, PFC and its following impact on the voltage besides current waveforms are sinusoidal by adjusting circuits to allow advanced techniques, i.e., to enhance the entering current and voltage, expecting to improve results [8]. The design factor, review, and dynamics of the progressive AC-DC converter with the easy-changeover technics introduced in this network. The speculative analysis supported the simulation results [9].

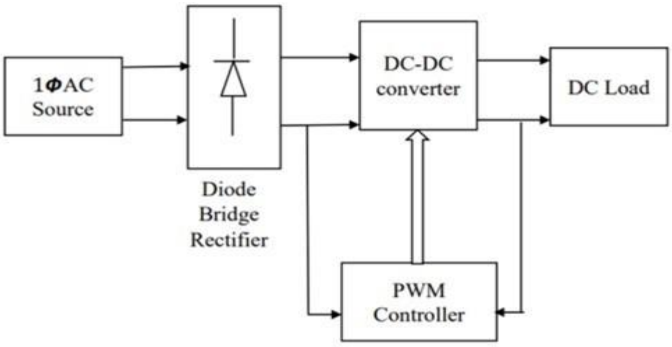


Figure 1. Operational block diagram for 1Φ AC-DC converter

2. METHOD

This project explains the working of the suggested 1 Φ AC to DC converter for reducing the number of needed active switches used in a buck-boost converter and enhancement in the power factor on the source side, the stabilization of the output power [10]. The transformer is low, less converter significantly and is lower cost to build in the system. Another benefit is the reparation of the input power factor with higher efficiency and introduce a developed duty ratio for the DCDC converter transition, which will stable the output voltage [11]. The combined functioning of both the buck-boost converter and Bridge rectifier has a profit of system security and dependability for the suggested pattern. We perform a thorough study of AC to DC converter in simulation, and its completion is checked [12], [13]. Results the efficiency of the proposed versatile power balanced control (VPBC) controlled algorithm.

In this configuration Figure 2 multiple looked loop control blocks are employed. The voltage stabilization and the switching pulse producer are both present in the control block, as well as the switching pulse producer [11]. All of these controllers were primarily used to evaluate the converter circuit's converter input power and output load differences and to provide a signal to the controller [14], [15]. A VPBC controller generates a duty cycle for the switch based on the signal. Due to this switching process, It shows that the output voltage may be balanced line and load variances using the VPBC control technique. The load will receive the required power from the DC to DC converter [16], [17]. For any variation in input voltage and load, the inherent capacity of the whole system is maintained for high power factor rectification [18]. The simulation of the AC-DC converter and its operating parameters are shown; the theoretical analysis will confirm its accuracy [19].

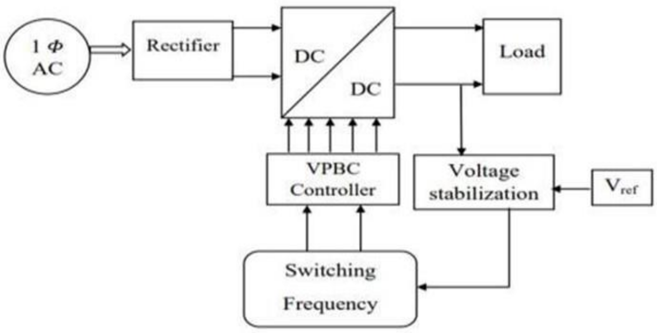


Figure 2. Suggested a block outline for the 1Φ AC-DC converter

2.1. Modelling of single-phase AC-DC converter and analysis

The concerted synchronous functioning of the single-phase converter from AC to DC is mentioned in this part. The purpose of the projected converter is to adjust the DC voltage to the load system and enhance the power quality in a condition of power factor stabilization at the source site [20], [21]. The transformers transformation takes major advantages to have lower cost and weight of the system. Additionally, an advanced switching approach makes an equilibrium outcome voltage under different the load and the source power [22].

Figure 3 shows the circuit diagram for the suggested AC-DC converter. The mentioned circuit diagram Figure 3 shows that the suggested converter will be carried out by the same components just. Buck-boost converter MOSFET switch "S", they are D1, D2, D3, D4 for the full-bridge rectifier and inductor L, filter capacitor C, the load resistance R and diode D. The input power Vac is straight linked to the rectifier diodes (D1, D2, D3, and D4). The rectification process of this diode depends upon the negative and the positive cycle of the AC source [23], [24]. During the negative half cycle, the voltage will flux through D2 and D3. For the positive half cycle, the voltage will cross through the diode D1 and D4 [25]. For this reason, this component of the circuit effectively provides the continuous rate of the DC output voltage [26].

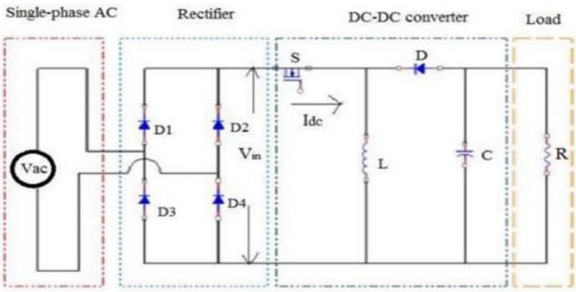


Figure 3. Patterning of single-stage AC to DC converter scheme

We give the corrected DC output voltage as;

$$Vin = Idc\ R = 2ImaxR/\pi \tag{1}$$

$$Vin = 2Vac \max R[Rf + R] \tag{2}$$

$$Vin = \left[\frac{2Vacmax}{\pi}\right] - Idc\ Rf \tag{3}$$

where:
Vin=voltage flux in DC circuit.
Idc=current flux in dc circuit.
R=load resistance.
RF=diode forward resistance.
Vac=input source voltage.

In Figure 4 during the one situation of the MOSFET "S," the current transient across the inductor is high. During the off situation of the MOSFET "S," the inductor current flows through a diode D. As shown in Figure 4. this condition represents the variance of the diode, and the inductor current will drop from the output [27].

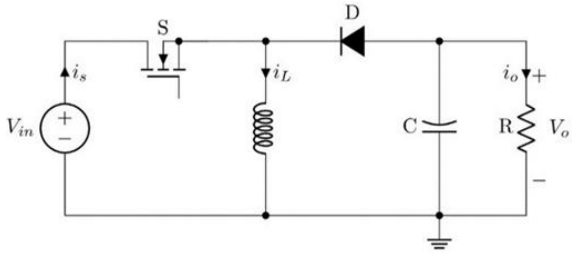


Figure 4. Buck-boost converter circuit

The determination of zero-volt for the inductor in the normal state is signified as,

$$VacDSW = -Vout\ (1 - D)$$

hence, the voltage ratio of the converter is,

$$= \frac{Vout}{Vac} = -\frac{D}{1 - D}$$

the product voltage of the converter V_{out} has a negative sign of reverence to the ground. The existing amplitude can be various with the limit of (D=>0.5) for the source voltage [28]. The inductor rate that will limit the uninterrupted and discontinued types of action.

$$L = \frac{(1-D)R}{2F}$$

2.2. Synchronizing the AC-DC converter with method VPBC

A VPBC is used to synchronize the proposed ACDC converter's power value augmentation VPBC premised controllers and the processes are examined in this part. Figure 5. express the tabled converter with the VPBC controller, which meaningfully optimizes the fault instant in the AC-DC conversion network. In this part, the suggested model has reviewed dynamic functionality of the suggested converter. By improving the AC-DC conversion in pattern, the DC values, phase angle shifts, voltage ripples, and fixed voltage of the buck-boost transformer are improved by utilizing the VPBC maximization technique [29].

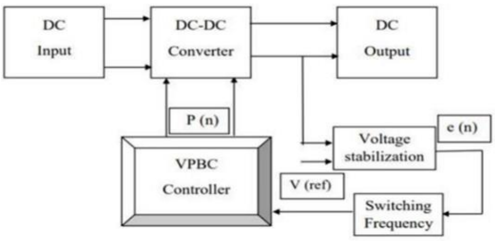


Figure 5. Block diagram for VPBC technique

3. RESULTS AND DISCUSSION

The simulation consequence of the single suggested phase AC-DC converter with closed-loop control of VPBC technique is introduced in this unit. The general system is planned in MATLAB 2017b Somalian situation. Figure 6 corresponds to the projected simulation for 1 Φ AC-DC converter usage Versatile Power balanced control (VPBC) development, which meaningfully develops the accomplishment of the AC-DC converter Exemplary. Table 1 depicts the design limits and their limits for the designed converter pattern. In this system, fewer elements are used to produce an energy-efficient process through the power transition process. Figure 6 illustrates the reference voltage and current waveform. Together are in phases with each other below the different periods. The waveforms corroborate the power factor is unity for several burdens. Figure 7 the source voltage and source current waveform under different loads: Figure 7(a) source voltage and current waveform-100 watt, Figure 7(b) source voltage and current waveform-500 watts, and Figure 7(c) source voltage and current waveform-1000 watts.

Table 1. Ranges of parameters for suggested AC-DC converter

parameters	Values
Vin (RMS)	230±10%V
V_{out}	48 V
Maximum load power	1,000 W
MOSFET switching frequency	5 KH
Input power factor targeted	Unity
Inductor	100e-4H
Capacitor	400e-8 Farad
Diode (forward voltage)	0.8 V
MOSFET (internal diode resistance)	1e-6 ohms

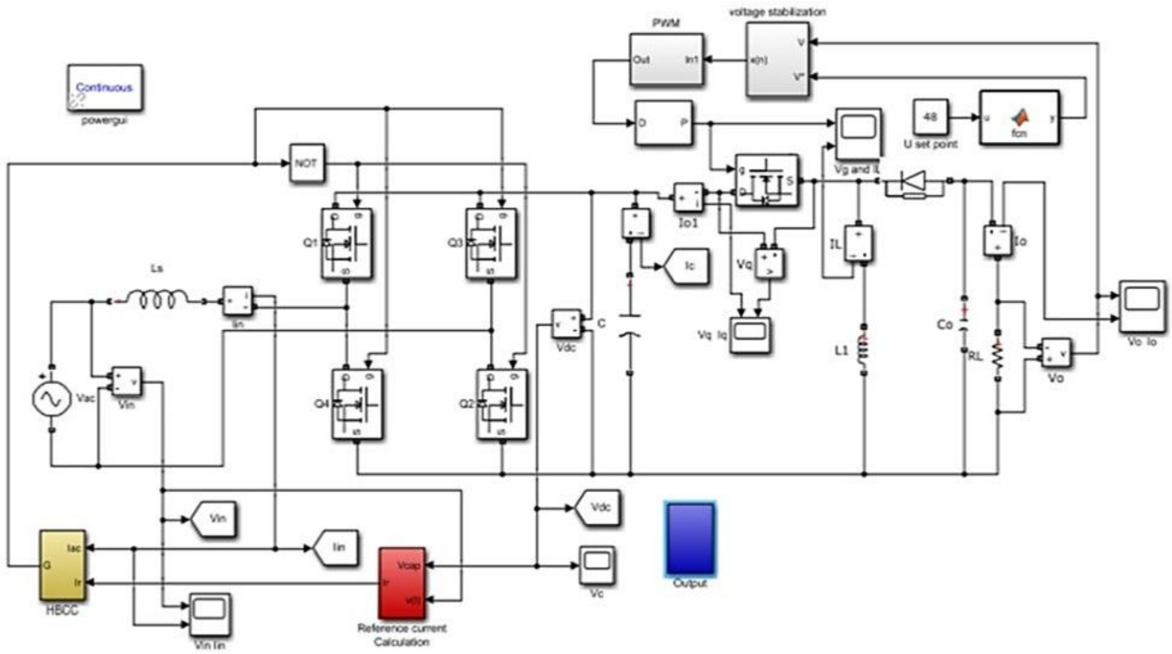
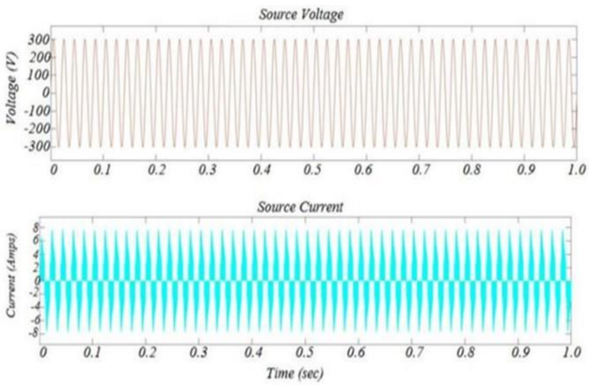
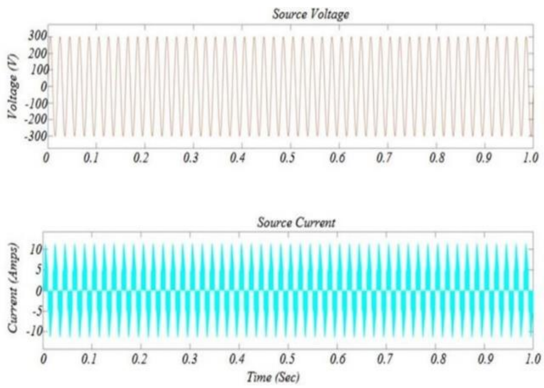


Figure 6. Simulation model of the suggested AC to DC converter



(a)



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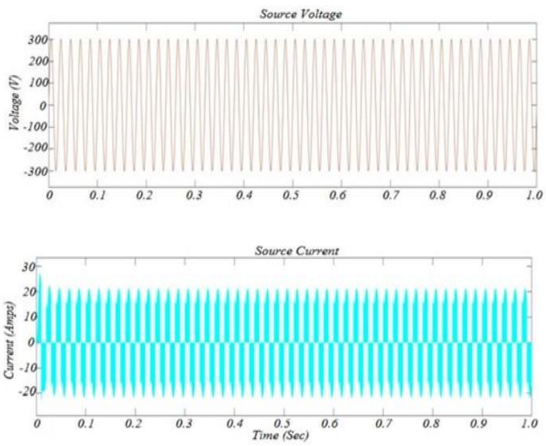

(c)

Figure 7. The source voltage and source current waveform under different loads: (a) source voltage and current waveform-100 watt (b) source voltage and current waveform-500 watts, and (c) source voltage and current waveform-1000 watts

Figure 8 the y-axis displays the converted DC voltage=48 V for time and the output voltage to a 0 W load from an AC-DC converter. Figure 9 signifies the waveform of the saturated current limit of the inductor through the Buck-boost converter working. Through the power balance procedure, the inductor current wave is kept among the least potential limits. Table 2 shows the comparison of power factor fluctuation in an AC-DC single juncture converter per a suggested VPBC technique. During different load conditions, the VPBC gives a near unity power factor.

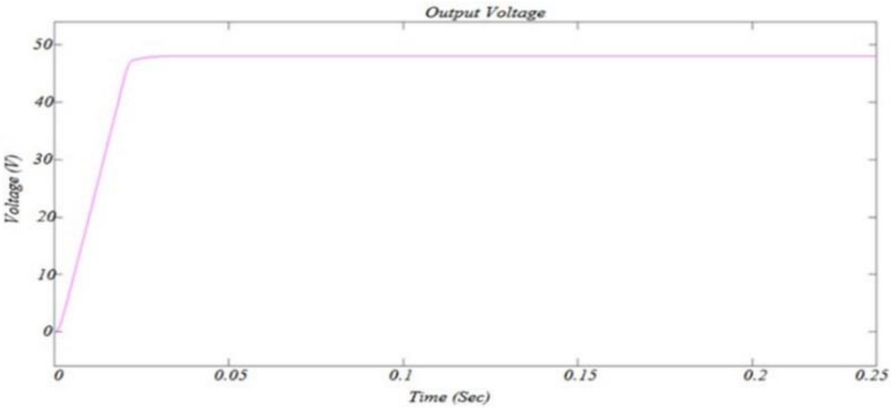

Figure 8. AC-DC converter output voltage

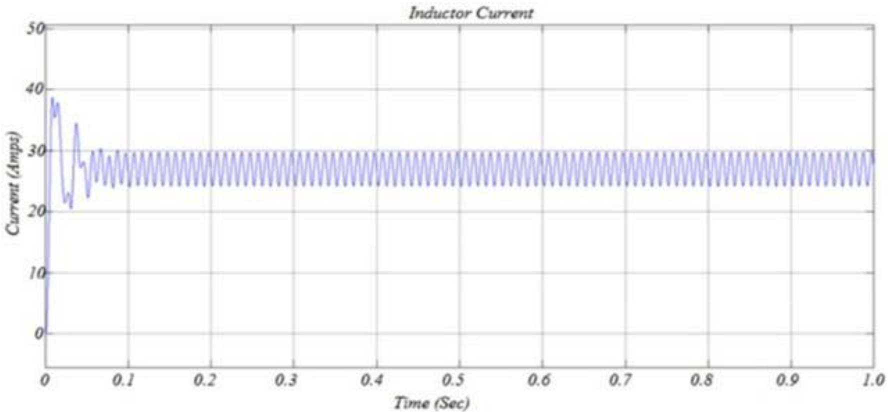

Figure 9. Inductor current waveform

Table 2. Power factor variation for VPBC controller for 1-Φ AC-DC converter structure

S.No	Controller Used	Power factor (P.F)	Load(W)
1	VPBC	0.9989	0
		0.9910	200
		0.9886	400
1	VPBC	0.9823	600
		0.9775	800
		0.9715	1000

Figure 10 exposits the relative study for the planned VPBC technique-based power factor analysis with different load conditions. In that graph, the X-axis shows the load variable up to (0-1000) watts, and the Y-axis represents the power factor quantity. The submitted VPBC method supplies active results. Table 3 demonstrates the projected model's efficiency study for different load power in watts. The designed VPBC controller manufactured an active consequence of 91.11% of efficiency for whole load conditions. Figure 11 the effectiveness study of the proposed converter model is visible. The waveform provides information on the exemplar's efficiency development for load powers between 0 and 1,000 watts.

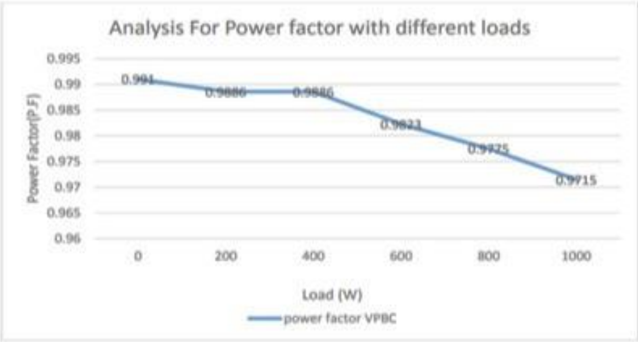

Figure 10. Power factor analysis proposed VPBC technique

Table 3. Efficiency of proposed AC-DC converter at different load

Load (watts)	Efficiency (VPBC)
0	0
100	55.55%
200	67.69%
300	73.88%
400	77.27%
500	80.08%
600	85.00%
700	85.55%
800	85.71%
900	90.69%
1000	91.11%

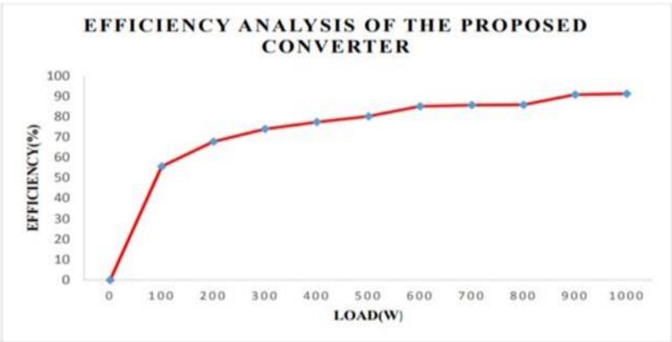

Figure 11. Efficiency of the proposed system for different loads

4. CONCLUSION

This project has received a smooth-switching technique with a single-phase AC to DC converter. The buck-boost converter's implementation has been fully analysed, and the execution details have been evaluated. For the computation of the system, several gains are made. First, the voltage stress across the MOSFET switch is improved in the proposed buck-boost converter that is accused of operating during the off time. At full load, greater growth improves the power factor to 0.9715. The average "charging" and "discharging" current of an inductor, which will automatically make up for it with the aid of the VPBC controller, will determine the dependability and stability of the offered model of AC to DC converter design. As a result of this action, the relationship between the current and line voltage through the normal working running is achieved at intervals regular time. As a result, nearly unity PF is achieved in the input source. Constant the output voltage for any load condition (0-1000) watts. The dynamic response is excellent in the proposed technique. For differential loads, the PFC circuit is valid. The efficiency of the planned converter model is being higher than 91.11% at the rated burden. In the future, the converter can supply for improving the overall efficiency with permanent magnet direct current (PMDC) motor control.

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BIOGRAPHIES OF AUTHORS

Raghad Hameed Ahmed born in mosul, Iraq, hold a Bachelor´s degree in Electrical Engineering from the Mosul University. Engineering College/Mosul/Iraq, completed a masters degree in electrical engineering in 2017 from Acharya Nagerjuna University. Engineering College/India, Faculty of Technical Instructors Training Institute, Middle Technical University/Iraq, currently works as a lecture in the Department of Technical Electronic, published several scientific researches specializing in electrical power in international refereed journals and Scopus in electrical engineering. Participation in Publishing scientific research in many local and international conferences. Participation in the evaluation of many research at international conferences. Supervising the projects of graduate students at the Middle Technical University/Iraq. She can be contacted at email: raghad.hammed@mtu.edu.iq.

Mohammed Taha Yunis received the B.E degree in Electrical power from Middle Technical University (Iraq) in 2005 and pursuing an M.Tech degree in Power Systems from Acharya Nagarjuna University, Guntur, Andhrapradesh state, India in 2017. Teaching Assistant of the department at the Technical Institute in Nasiriyah, affiliated to the Southern Technical University, Basra, published several scientific researches specializing in electrical power in international refereed journals and Scopus in electrical engineering. Participation in Publishing scientific research in many local and international conferences. Participation in the evaluation of many research at international conferences. Supervising the projects of graduate students at the Southern Technical University, Basra/Iraq. He can be contacted at email: mohammed.taha@stu.edu.iq.

Basima Taresh Dawood received the B.E degree in University of Technology-Baghdad/Electrical Engineering and Education/Technical in 2002 and pursuing an M.Tech. degree in University of Technology-Baghdad Electromechanical systems Engineering Form Electromechanical Engineering Department in 2018 teaching assistant of the Department at the Technical Institute in Nasiriyah, affiliated to the Southern Technical University, Basra, published several scientific researches specializing in electrical power in international refereed journals and Scopus in electrical engineering. Participation in Publishing scientific research in many local and international conferences. She can be contacted at email: b.t.alabide@stu.edu.iq.