Novel Single-Phase Ac-Ac Converter For Circuit Breaker With Power Factor Correction

[1]G. Sravanthi Asst.Prof,[2]G. priyanka (15891A0218), [3]D.Anilkumar(15891A0215)

Priyankagudipalli98@gmail.com

Vignan institute of technology and science

Abstract-This paper represent a novel single–phase ac-ac converter for circuit breaker with power factor correction. Output current control for circuit-breaker testing according to the IEC 60898 standard. The main advantages of the converter circuit fast response and low componentcount the wide range of output current the buck or boost converter are used as a single phase ac-ac converter and satisfying the ramping and step current the control circuit consists of two parts ac output control operating and dc voltage control of dc –link capacitor . in this simulation result of the circuit breaker with power factor correction is demonstrated in this paper

Key words:circuit breaker ,power factor correction (PFC),single phase ac-ac converter ,buck- boost capability ,continuous current mode (CCM) ,current control.

I.INTRODUCTION

In industrial, commercial residential the circuit breaker equipment is used .the damages caused by short circuit and overload are protected by designed electric circuit. The circuit breaker have capacity to interrupt the current flow to protect devices.to quality control IEC 6089 are detailed test producer and time tripping characteristics. The higher efficiency and higher current rating capability has ben improved in the single phase ac-ac converter, to get sinusoidal wave shape which is unity power factor from input current the power factor correction(PFC) is used in this paper.

The converters has two legs ,three legs and four legs (two full bridge converters).this paper have mainly a single phase inverter and a control rectifier ,power factor controller ,boost converter .To get the desired output voltage the buck or boost converter are operated . The input frequency can set a different value and output frequency is controllable. The electromagnetic interference produces switching loss so it hard to operate the two leg and three legs of single phase ac-ac converter.at the dc-link capacitors a high ripple voltage are produced when two leg single phase converter are used. The modified sinusoidal pulsed-width modulations (SPWM) control the ac output voltage. Due to the buck type the output voltage is limited to the input voltage is less then. the output voltage at zero –crossing the distortion take place

The low harmonics distortion and high input power factor of ac-ac converter for circuit testing a wide range of output voltage. It can operate in the buck and boost mode for required step and ramp current rate. The single phase ac-ac converter application is electric welding, voltage stabilizer, industrial application etc

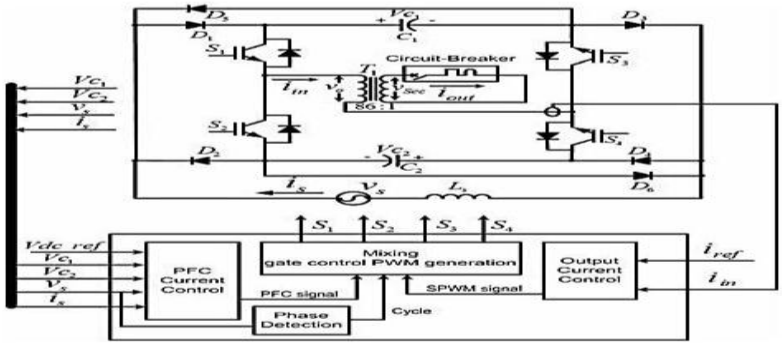


Fig 1:Ac-Ac Converter with Dc-Link Voltage And Ac Output Current Controllers.

II SYSTEM DESCRIPTION

A. Integrated Rectifier/Boost Converter

The integrated rectifier and boost converter has three functions they are:

1. The input voltage to output dc voltage signal are rectified
2. The dc voltage is boosted
3. The input current to sinusoidal waveform shaping

During positive half cycle the switch s_1 and s_2 are operated and input voltage(V_s) to the voltage of dc-link capacitor c_1 is boosted. For shaping of the inductor current the input voltage waveform is taken as reference (i_s).the input current and input voltage should be in phase for unity power factor. The constant value is a maintained at capacitor voltage Vc_1.

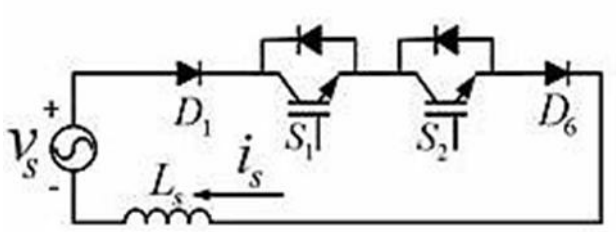


Fig 2: Charging Inductor Current during Positive Cycle

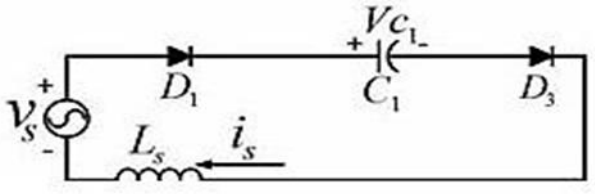


Fig 3: Discharging Inductor Current during Positive Cycle

The charging and discharging cycles of the inductor current as shown in fig 2and3.The inductor current increases when switch S_1 and S_2 are turned on during positive half cycle. Depending on the output pulses the switch S_1 and S_2 are turned off and inductor current is decrease to complete the boost cycle.

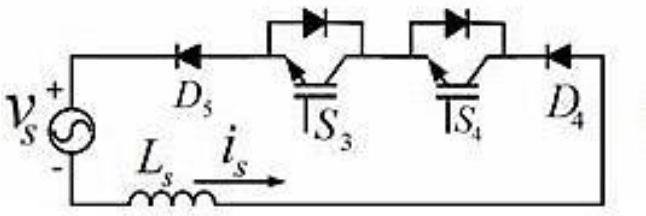


Fig 4: Charging Inductor Current during Negative Cycle

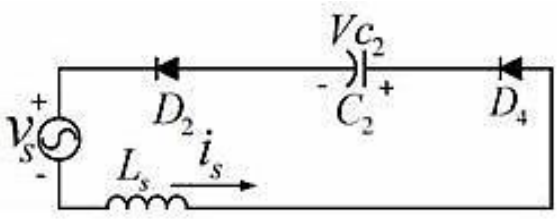


Fig 5: Discharge Inductor Current during Negative Cycle

Similarly during the negative half cycle operation charging and dis charging inductor and S_3 and S_4 are repeated at input voltage

B. DC-AC converter

In this section dc-ac converter is described.to the converter the positive pulse to output from the dc-link voltageVc_1 the switch S_1 and S_3 are turned on as shown in fig 6 When the switch S_2 and S_3 are turned on the negative pulses to converter output from the dc-link voltage, Vc_2 fig 7. The primary winding of the transformer $T_1$is directly connectedoutput of the dc-ac converter. And the secondary winding of the transformer is short circuited to circuit breaker.at the secondary side of transformer the low distortion sinusoidal current take place. The output voltage is given as

$$v_o = \frac{m_o}{\sqrt{2}}.Vc_1$$

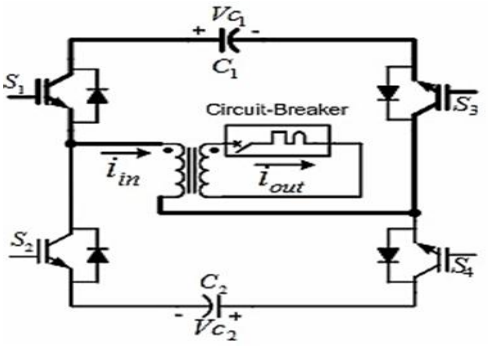


Fig6: Positive Pulses of the dc link voltage

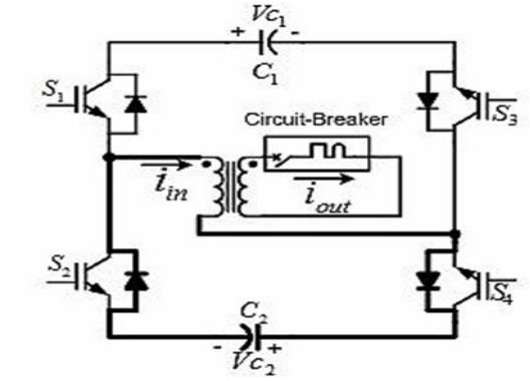


Fig 7:Negative pulse of the dc link voltage

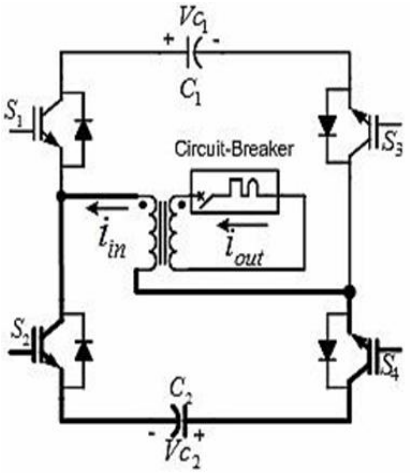


Fig 8:Negative pulses of bipolar SPWM operation

C. Power Transformer

In this section transformer is described. A hundred of amperes range is requires for testing of circuit breaker. To get the desired output current the transformer is used for two purposes they are current amplification and low-pass filter circuitry. The low pass filter circuit is given as

$$f_c = \frac{R_{eq}}{2\pi L_{eq}}$$

The current amplification capability used for switching the devices in the converter for low current rating. The transformers get the bipolar SPWM signal from the converter. the iron core transformer is used and the transformer current in the line frequency The secondary transformer is open when circuit breaker became zero

.in no load condition small amount of current is supplied. Using the current gain amplifier the power transformer is designed in the turn ratio of 86.

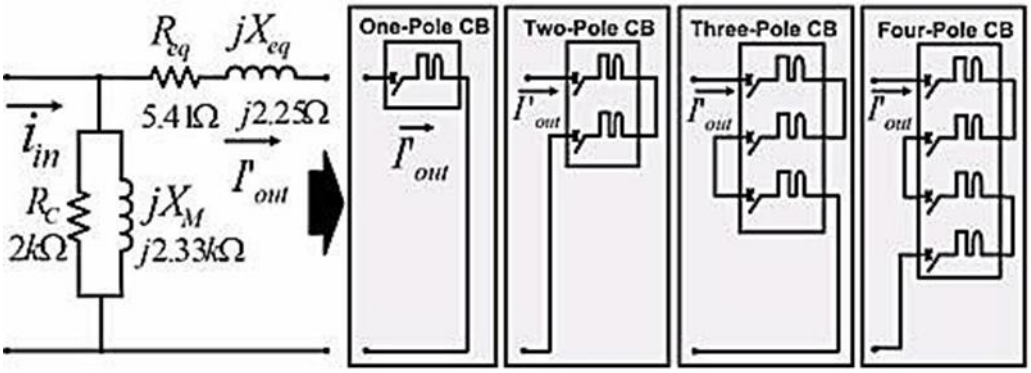


Fig 9: Equivalent Circuit of Power Transformer

The one pole ,two pole ,three pole and four pole are categorized in the circuit breaker.by using series contact connected time–current operating characteristics is tested in the circuit breaker.as show fig 9.

D. Controller

In this section controller are described. The controllers are divided into two parts they are:-

The first partis dc–link capacitor voltage control and ac input current control for power factor correction the block diagram is shown in fig 10.

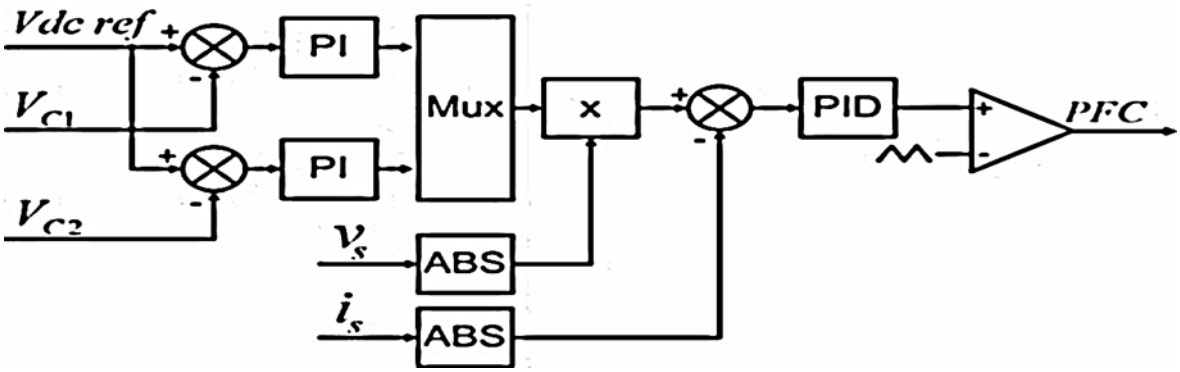


Fig 10: Block Diagram for PFC Current Control

For shaping the input current the input voltage is obtained in the form of reference signal. The PI controller measured by the dc-link capacitor.Alternately with cycle of input voltage the two outputs of PI controllers. To generate reference signal for the input current the ac input voltage is multiplied by the output of multiplex block. And the PID controller receives the input current error. For the power factor correction part the triangular signal to PWM signalThe second part of the control is output current control is shown in fig 11 .

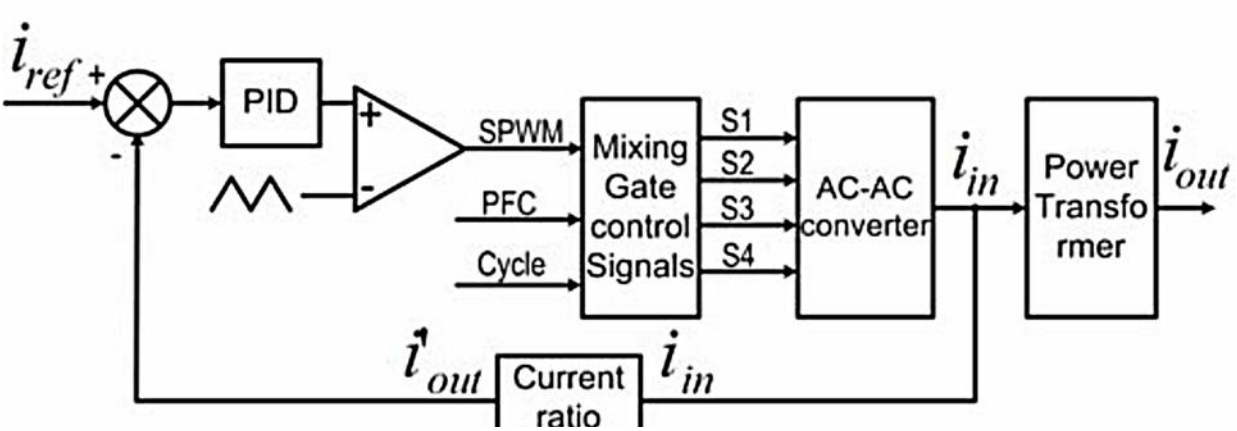


Fig 11: Block Diagram for Output Current Control.

The switching S_1,S_2,$S_3$and S_4 are control by the PID controller is used a control signal to generate PWM signal as shown in fig 1. The primary winding of the transformer T1 is connected to the output of dc-ac converter. The primary current transformer through the current control. The secondary current control properly compensate by the current transformer ratio. the SPWM and PFC signal are the two mixing gate control block for the input current control .the mixing of gate control signal is given as:

$$S_1 = SPWM\ or\ (PFC\ and\ cycle)$$

$S_2 = \overline{SPWM}$ *or (PFC and cycle)*

$$S_3 = SPWM\ or\ (PFC\ and\ \overline{cycle})$$

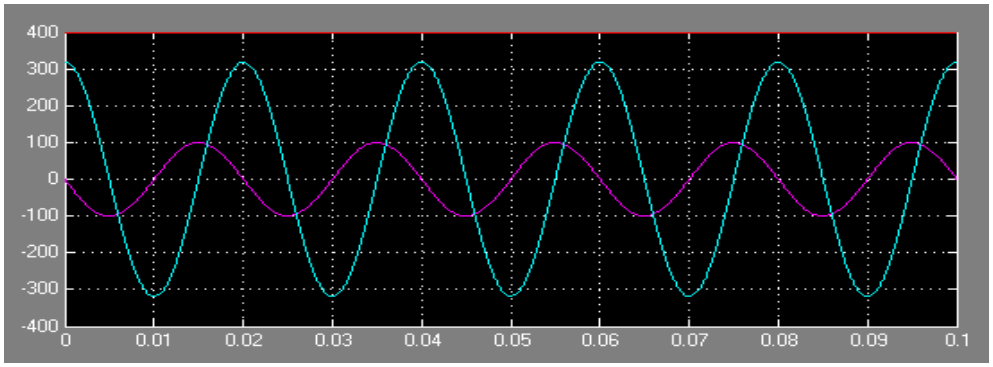
$$S_4 = \overline{SPWM} or (PFC\ and\ \overline{cycle})$$

When the SPWM logic status is high the switch S_1 and S_3 deliver positive pulse to the output.to drive the switchS_3 and S_4 for negative pulses for the output signal the SPWM is active low. The switching operation the desired input power factor the cycle logic dictate and PFC logic.to control input current for the positive cycle of the input voltage the signal is high and the switches S_1 and $S_2$are employed. For the switching $S_3$and S_4 the cycle is active low for the negative cycle of the input voltage.

III.SIMULATION RESULTS

The simulation result includes power factor correction, input current control; output current control and dc-link voltage control .the parameter are shown in the table

Parameters	**Value**	**Parameters**	**Value**
L_s	1.5mH	V_s	220Vrms/50Hz
C_1	6,000µF	i_{out}	0-600A/50, 60 Hz
C_2	6,000µF	V_{c1}	400V
f_s	20kHz	V_{c2}	400V



 ISBN: 978-93-84893-19-4

Fig12: dc-link voltage Vs,Is,Vc1,Vc2.

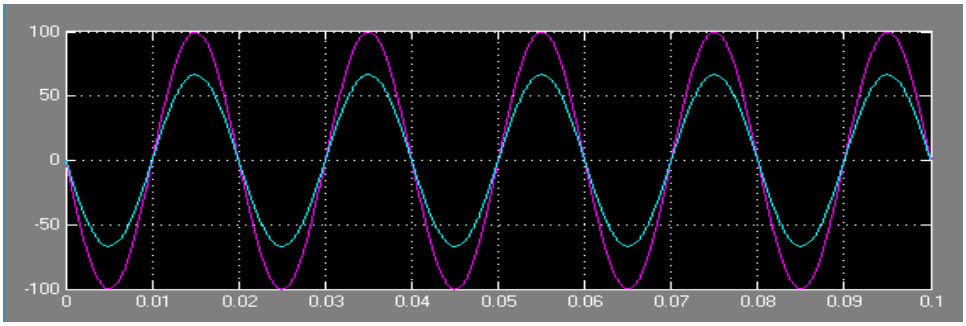


Fig 13: Output of the wave form of power factor in phase

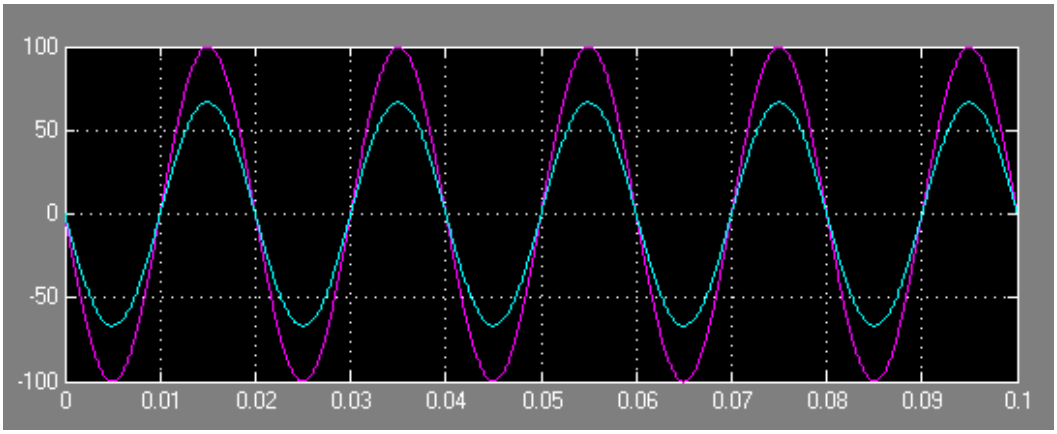


Fig 14:Input of the wave form of power factor in phase

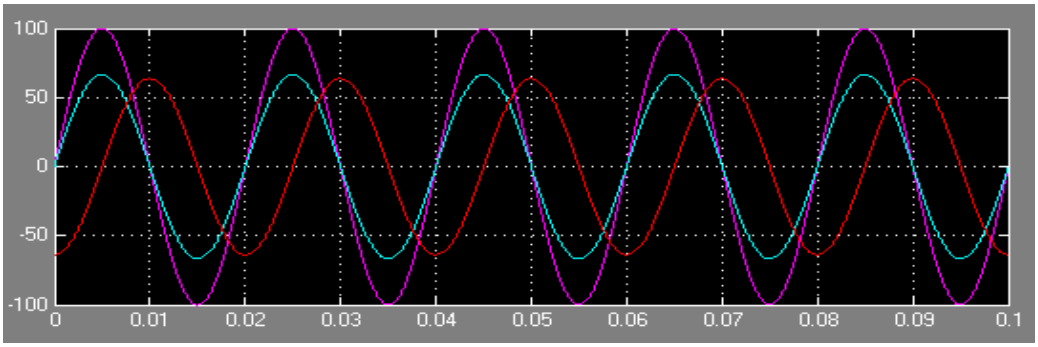


Fig 15:Output current at 100 amps with frequency at 60hz

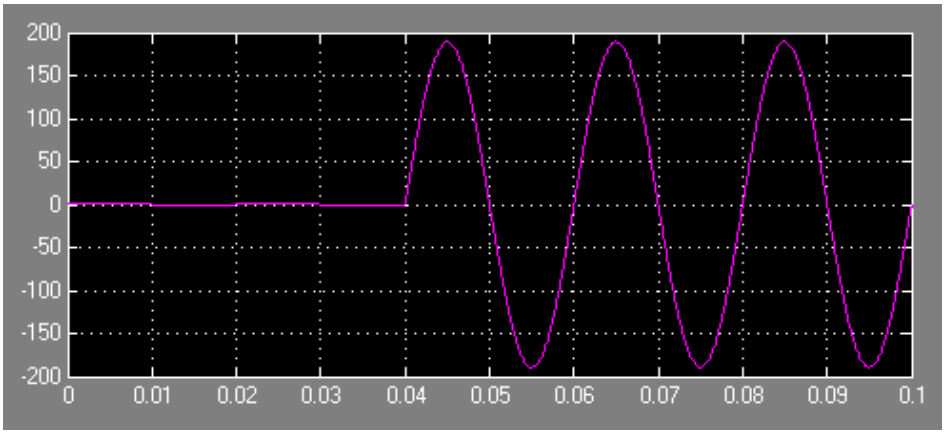


Fig 16:Ramped current for the test case

 ISBN: 978-93-84893-19-4

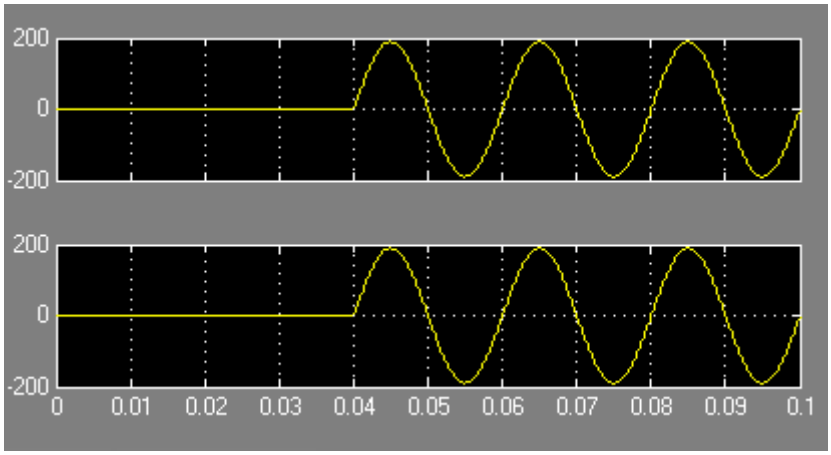


Fig 17: Step response of output current at 400amps

IV.CONCLUSIONS

In this paper a novel single-phase ac-ac converter for circuit breaker with power factor correction are implemented according to the circuit breaker testing standard (IEC60898)

The system having minimum number of switches so it low cost and simple .the boost power factor correction with dual dc link voltage controls the system. Thee output current at 600a(rms) in the system the step response of output current and sinusoidal input line current with unity power factor and power factor correction.

V. REFERENCES

[1] Circuit-breaker for over current protection for household and similar installations, IEC 60898-1, 2003-2007.
[2] S. Kitcharoenwat, , M. Konghirun, A. Sangswang, "A Controlled Current AC-AC Converter for Circuit Breaker Testing," in Proc.Electrical Machines and Systems Conf. (ICEMS), 2012, pp. 1-6
[3] S. Kitcharoenwat, , M. Konghirun, A. Sangswang, "A DigitalImplementation of Novel Single Phase AC-AC Converter with PowerFactor Control," in Proc. Electrical Machines and Systems Conf.(ICEMS), 2012, pp. 1-6
[4] S. B. Bekiarov and A. Emadi, "A New On-Line Single-Phase to Three-Phase UPS Topology with Reduced Number of Switches," in Proc,IEEE PESC, 2003, pp.451-456.
[5] J.-H. Choi, J.-M. B. kwon, j.-H. jung, and B.-H. Kwon, "High-Performance Online UPS Using Three-Leg-Type Converter," IEEETrans. Ind. Electron., vol. 52, no.3, pp. 889-897, Jun. 2005.