A Novel Integrated Power Quality Conditioner for BLDC Drive Applications

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Abstract-In recent years brushless DC motors (BLDC) are the research hotspot in speed precision and household applications due to its high reliability, simple frame, high efficiency, fast dynamic response, compact size, low maintenance, etc. It is an electronically commutated motor. The active power control approach is used to compensate voltage sag/swell and is integrated with theory of power angle control of UPQC to coordinate the load reactive power between the two inverters. Since the series and shunt inverter simultaneously delivers active and reactive powers, this concept is named as PQC. The topology uses a capacitor in series with the interfacing inductor of shunt active filter to match dc-link voltage requirement. Detailed design aspects of the series capacitor and VSI parameters have been discussed in this work. The obtained results are presented to demonstrate an improved power quality (PQ) at AC mains of the BLDC Motor drive system. The proposed topology enables PQ to compensate voltage sags, voltage swells and current harmonics with a reduced DC-link voltage without compromising its compensation capability by implementing. The proposed concept can be implemented to Brushless DC motor Applications by using Matlab/ Simulink software.

Index Terms— Micro grid, over current, power flow, power quality, transformer, variable reactor, Multilevel Inverter.

I. INTRODUCTION

The energy is neither be created nor destroyed but it can be converted from one form to another. The generation of an electrical energy is nothing but the conversion of various other forms of energy into an electrical energy. The electrical power is generated in bulk at the generating stations which are also called power stations. The generated electrical energy is demanded by the consumers. This cause due to power losses and power quality problems in the transmission lines FACTS device is introduced to reduce such problems. Micro grid leads to effective distribution in rural area all distribution includes effective power processor to control and monitor the power exchange between the grids [1-3]. When such processor get fully exploited it leads to high power quality problems and power consumption by developing narrow

band communication and local control algorithm full micro grid is exploited with marginal investment. A 48 pulse multilevel inverter was developed by cascading several units of three level diode clamped multilevel inverter with the help of phase shifting transformer. It leads to high cost and lengthy delays this cause serious deficiency in power transmission capacity while distribution [4].

Interline Power Flow Controller is one of the advanced controller in Flexible AC Transmission System controller it only compensates series and manages power flow in the system [5]. To simultaneously control the power flow two converter model d-q orthogonal was introduced in the microgrid. By means of transmission angle variation series voltage is inject in the control region and the system gets over compensated [6]. Microgrid leads to effective distribution in rural area all distribution includes effective power in the control region processor to control and monitor the power exchange between the grids. When such processor get fully exploited it leads to high power quality problems and power consumption by developing narrow band communication and local control algorithm full micro grid is exploited with marginal investment and mainly micro grid can be able to disconnect from the microgrid loads from the disturbance and protects the transmission from harmonics [7]. By grid interfacing converter system the conventional series and parallel structure is adapted.

Two three phase four leg inverters is tend to construct grid interfacing system to compensate harmonic current it increases the complication and losses in the system [8]-[9]. Distributed generator not only inject power to the grid it also enhance power quality. By means of droop control technique it autonomously compensates voltage unbalances active and reactive droop control [10].A flexible AC distribution system aims to improve the power quality and reliability in microgrid, the design of control algorithms and extended kalman filters is meant for frequency tracking and to extract harmonic in grid voltage and load current in micro grid. By minimizing the

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total system planning and operation cost and cost of load shedding co- optimization of power system is taken over to increase the economic and reliability of the grid [11].

The main advantage of multilevel inverters is that the output voltage can be generated with a low harmonics. Thus it is admitted that the harmonics decrease proportionately to the inverter level. For these reasons, the multilevel inverters are preferred for high power applications [12].

However, there is no shortage of disadvantages. Their control is much more complex and the techniques are still not widely used in industry.

In this paper, modeling and simulation of a multilevel inverter using Neutral Point-Clamped(NPC) inverters have been performed with motor load using Simulink/ MATLAB program. In the first section multilevel inverter control strategies are presented before to detail a study of seven-level inverter in the second section. Total Harmonic Distortion (THD) is discussed in the third section. The aim is to highlight the limit at which the multilevel inverters are no longer effective in reducing output voltage harmonics [13, 14].

II PRINCIPLE OF THE VARIABLE REACTOR

A) System Configuration: Fig. 1 shows the single-phase system configuration of the novel variable reactor based on magnetic flux control. Suppose that the turns of primary and secondary winding of the transformer are N_1 and N_2, respectively. The turns ratio is represented by $k= N_1/N_2$. A transformer with air gap is selected, and its primary winding AX can be connected in series or in parallel with power utility. The secondary winding ax is not connected with a normal load but a voltage-sourced inverter. The voltages of the primary and secondary windings are u_1 and u_2, respectively. The primary winding current $i1$ of the transformer is detected and functions as the reference signal i_{ref}. h is the gain of the current sensor. U_d is the voltage of dc side of the inverter. C_d Stands for the capacitance of the dc capacitor. α is a controllable parameter, which will be explained later. The voltage-sourced inverter and the current control are applied to yield a controlled current i_2, which has the same frequency as i_1. i_2 is inversely in phase injected to the secondary winding ax
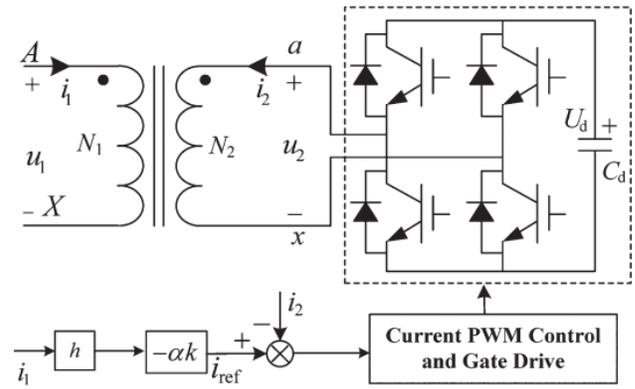

Fig.1.System configuration of the novel variable reactor

B) Equivalent T-Circuit of The transformer: The magnetically coupled circuit of the transformer is central to the operation of the novel variable reactor, which is shown in Fig.2. The flow of currents in the two windings produces magneto motive forces (MMFs), which, in turn, set up the fluxes.
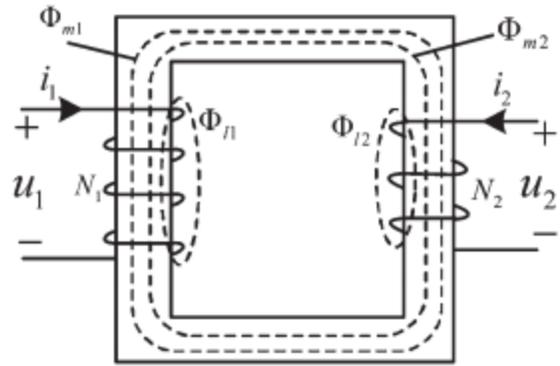

Fig.2. magnetically coupled circuit of the transformer

The total flux linking each winding may be expressed as

$$\Phi 1 = \Phi l1 + \Phi m1 + \Phi m2 = \Phi l1 + \Phi m \qquad (1)$$
$$\Phi 2 = \Phi l2 + \Phi m2 + \Phi m1 = \Phi l2 + \Phi m \qquad (2)$$

Herein, $\Phi l1$ and $\Phi l2$ are the leakage fluxes of the primary and secondary windings. $\Phi m1$ is the magnetizing flux produced by the primary winding, and it links all turns of the primary and secondary windings. $\Phi m2$ is the magnetizing flux produced by the secondary winding, and it links all turns of the primary and secondary windings. Φm denotes the resultant mutual flux. The voltage equations of the transformer can be expressed as

$$u1 = r1 i1 + d\lambda 1/dt \qquad (3)$$
$$u2 = r2i2 + d\lambda 2/dt \qquad (4)$$

Where $r1$ and $r2$ are the resistances of the primary and secondary windings, respectively. $\lambda 1$ and $\lambda 2$ are the flux linkages related to the primary and secondary windings, respectively. If saturation is neglected and the system is linear, the following equations can be achieved.

$$\lambda_1 = L_{l1} i_1 + L_{m1} \left(i_1 + \frac{N_2}{N_1} i_2 \right) \qquad (5)$$

$$\lambda_2 = L_{l2}i_2 + L_{m2}(\tfrac{N_1}{N_2}i_1 + i_2) \qquad (6)$$

Here in, L_{l1} and L_{l2} are the leakage inductances of the primary and secondary windings, respectively. L_{m1} And L_{m2} are the magnetizing inductances of the primary and secondary windings, respectively. $L_{m1}/N_1^2 = L_{m2}/N_2^2$ According to, when the

quantities of the secondary winding are referred to the primary winding, (3) and (4) become

$$u_1 = r_1 i_1 + L_{l1}\tfrac{di_1}{dt} + L_{m1}\tfrac{d}{dt}(i_1 + i'_2) \qquad (7)$$

$$u_1 = r'_2 i'_2 + L'_{l2}\tfrac{di'_2}{dt} + L_{m1}\tfrac{d}{dt}(i_1 + i'_2) \qquad (8)$$

Here, the prime denotes referred quantities of secondary winding to primary winding. Equations (7) and (8) can be expressed as the following equations in phasor form:

$$U_1 = r_1 I_1 + j\omega L_{l1} I_1 + j\omega L_{m1}(I_1 + I'_2) \qquad (9)$$

$$U'_2 = r'_2 I'_2 + j\omega L'_{l2} I'_2 + j\omega L_{m1}(I_1 + I'_2) \qquad (10)$$
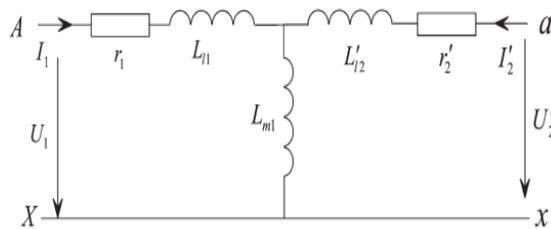

Fig.3 Equivalent T-circuit of the transformer

The voltage equations in (9) and (10) with the common L_{m1} suggest the equivalent T-circuit shown in Fig.3 for the two winding transformer. Note that, in some equivalent T-circuit of the transformer, a core loss resistance r_m, which accounts for the core loss due to the resultant mutual flux, is connected in parallel or in series with the magnetizing inductance L_{m1} (in the later analysis, a series core loss resistance r_m is taken into account in the equivalent T-circuit of the transformer).

Let $Z_1 = r_1 + j\omega L_{l1}$ which is the leakage impedance of the winding. $Z'_2 = r'_2 + j\omega L'_{l2}$, which is the leakage impedance of the secondary winding ax referred to the primary winding. $Z_m = r_m + j\omega L_{m1}$, which is the magnetizing impedance of the transformer. Here, ω is the fundamental angular frequency. Then, (9) and (10) become

$$U_1 = Z_1 I_1 + Z_m(I_1 + I'_2) \qquad (11)$$

$$U'_2 = Z'_2 I'_2 + Z_m(I_1 + I'_2) \qquad (12)$$

C) *Principle of the Variable Reactor:* In Fig.1, the primary winding current is detected and functions as the reference signal, and the voltage-sourced inverter is applied to track the reference signal to yield a controlled current i_2. When controlled current i_2 and the primary current i_1 satisfy

$$I'_2 = -\alpha I_1 (i.e., I_2 = -\alpha k I_1) \qquad (13)$$

Herein, α is a controllable parameter. The transformer is double side energized, and then, the following equations can be obtained:

$$U_1 = Z_1 I_1 + (1 - \alpha)Z_m I_1 \qquad (14)$$

$$U'_2 = Z'_2 I'_2 + (1 - 1/\alpha)Z_m I'_2 \qquad (15)$$

In terms of (14), from the terminals AX, the equivalent impedance of the transformer can be obtained, i.e.,

$$Z_{AX} = \tfrac{U_1}{I_1} = Z_1 + (1 - \alpha)Z_m \qquad (16)$$

In terms of (16), the equivalent impedance of the primary winding of the transformer is a function of the controllable parameter α. When α is adjusted, the primary winding exhibits consecutively adjustable impedance. Equation (16) can be also achieved in terms of the resultant. MMFs of the two windings acting around the same path of the core. When a controlled current i_2 produced by a voltage sourced inverter is injected into the secondary winding of the

Table.I: Equivalent Impedance of the Primary Winding of the Transformer

α	The equivalent impedance of terminal AX	Impedance charateristic
$\alpha < 0$	$Z_{AX} > Z_1 + Z_m$	resistive and inductive
$\alpha = 0$	$Z_{AX} = Z_1 + Z_m$	
$0 < \alpha < 1$	$Z_1 < Z_{AX} < Z_1 + Z_m$	
$\alpha = 1$	$Z_{AX} = Z_1$	
$1 < \alpha < 1 + Z_1/Z_m$	$Z_1 < Z_{AX} < 0$	
$\alpha = 1 + Z_1/Z_m$	$Z_{AX} = 0$	0
$\alpha > 1 + Z_1/Z_m$	$Z_{AX} < 0$	resistive and capacitive

Transformer and $i_2 = -\alpha k i_1$, the resultant MMF is $N_1 I_1 + =N_2 I_2 (1 - \alpha)N_1 I_1$. Then, the resultant flux set up by the MMF of the two windings is $(1 - \alpha)\Phi_m$. Then, the induced voltage produced by the resultant flux can be expressed in phasor form as

$$E_1 = (1 - \alpha)j\omega L_m I \qquad (17)$$

The primary voltage equation can be achieved as (14). In terms of (16), the relation between the equivalent impedance of the primary winding and the parameter α is shown in Table I. The variable reactor features hardly producing harmonics, simple control scenario, and with consecutive adjustable impedance. Many flexible ac transmission systems (FACTS) devices can be implemented in terms of the novel principle. The variable reactor can be used in unified power flow controller to change the line impedance between the sending and receiving ends to control the power flow; it can also substitute the thyristor-controlled reactor of the thyristor-

controlled series capacitor; however, the proposed variable reactor does not produce any harmonics; fault current limiter can be also implemented in terms of the novel principle of the variable reactor. Reactive power compensation can be all realized by the novel variable reactor. In addition, it has been successfully applied the hybrid series active power filter based on fundamental magnetic flux compensation.

D) Dynamic Analysis of the Variable Reactor: One of the key techniques of the novel variable reactor based on the magnetic flux control is current control. Nowadays, the widely used current control technique includes the hysteresis current control, the ramp comparison current control, and the predictive and deadbeat control. In the digital control system based on DSP, the most widely used current control is the ramp comparison current control with the proportional–integral (PI) controller. In this case, the system block diagram of the variable reactor system is shown in Fig.4. Herein, h is the gain of current sensor; the combined transfer function of the sample and delay is represented as $G_{di}(s) = 1/(1 + sT_{di})$; the transfer function of the voltage-sourced inverter is denoted by $G_{PWM}(s) = k_{PWM}/(1 + sT_{PWM})$. The transfer function of the PI controller is denoted by $G_{PI}(s) = k_i/(1 + sT_i)/sT_i$.
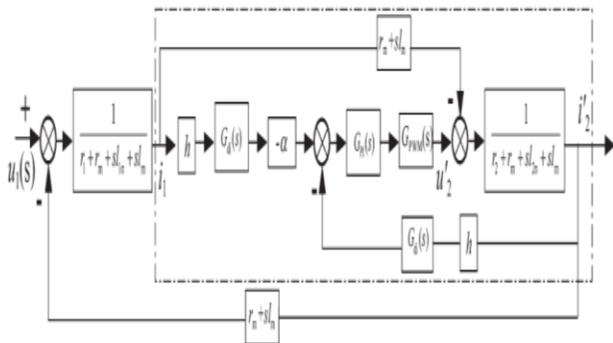

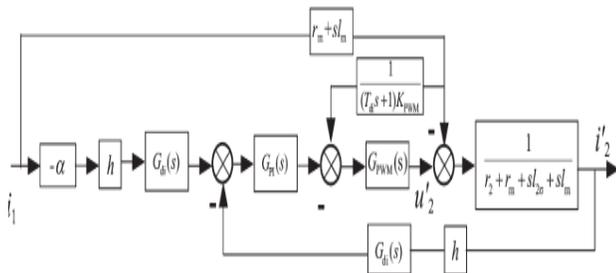Fig.4. System block diagram of the variable reactor

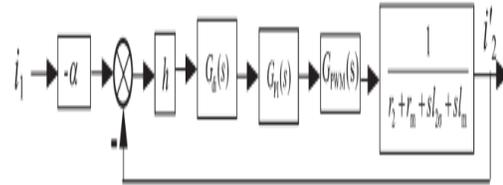Fig.5. Block diagram of current control with feed forward

Fig.6. Block diagram of current control

The system admittance transfer function can be derived as (18), shown at the bottom of the page, which means that the overall system is a five-order system. The current control component is in dash-dotted frame shown in Fig.4. In order to improve the system anti-interference performance in low-frequency band, a feed forward element is designed in the block diagram of the current control component, which is shown in Fig.5. In this case, the block diagram of the current control component becomes Fig.6. The open-loop transfer function of the current control block in Fig.6 is

$$G_Y(s) = \frac{i_1(s)}{u_1(s)}$$

$$= \frac{hk_i(1+T_i s)K_{PWM} + (r_2+r_m+sl_{2\sigma}+sl_m)(1+T_{di}s)sT_i(1+T_{PWM}s)}{hk_i(1+T_i s)K_{PWM}[r_1+r_m+sl_{1\sigma}+sl_m-\alpha(r_m+sl_m)]+[(r_1+sl_{1\sigma})(r_2+sl_{2\sigma})+(r_m+sl_m)(r_1+r_2+sl_{1\sigma}+sl_{2\sigma})](1+T_{di}s)sT_i(1+T_{PWM}s)} \quad (18)$$

$$G_{open}(s) = \frac{hk_i(1+sT_i)K_{PWM}}{(1+T_{di}s)sT_i(1+T_{PWM}s)(r_2+r_m+sl_{2\sigma}+sl_m)} \quad (19)$$

Let $T_i = (l_{2\sigma} + l_m)/(r_2 + r_m)$ and $T_{PWM} \approx 0.5T_{di}$, when combining the two elements with little time delay, (16) becomes

$$G_{open}(s) = \frac{\frac{hK_{PWM}k_i}{(r_2+r_m)}}{(1+1.5T_{di}s)sT_i} \quad (20)$$

$$k_i = T_i(r_2+r_m)/(3T_{di}K_{PWM}h)$$

Here, when the current control system performance will be approximately optimum.
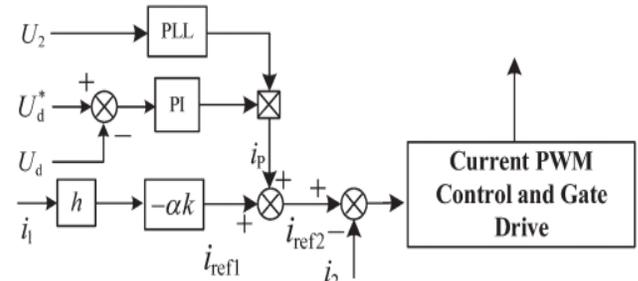

Fig.7. DC-link voltage control schematic

E) Dc-Link Voltage Control of The Variable Reactor: There must be some losses when the novel variable reactor system with inverter operates normally, and the inverter will absorb active power to maintain the dc voltage constant. Fig.7shows the dc-link voltage control

schematic of the variable reactor system. Herein, $U_d^{\bullet}$ and U_d represent the inverter dc reference and pi_{ref} to achieve a new reference signal $i$ref2. A dc-link voltage PI controller is applied to make the inverter dc practical voltage U_d follow thedc reference voltage$U_d^{\bullet}$. The output of the voltage PI controller is multiplied by the phase-locked loop (PLL) output of u_2 to yield the active current referencei_p.
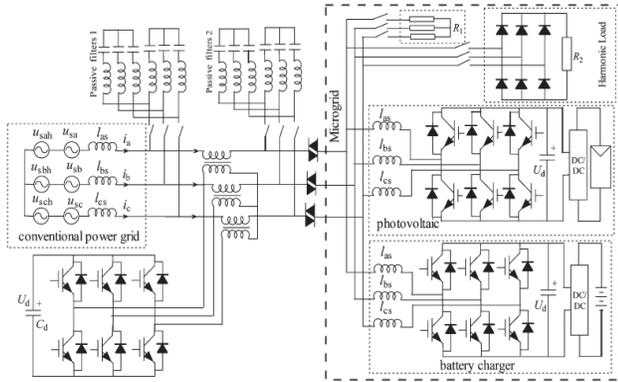

Fig.8. Circuit of the Proposed IPQC

III. PRINCIPLE OF THE IPQC

a) System Configuration: The novel IPQC can be installed in series and parallel in microgrid or point of common coupling (PCC). For simplicity, the IPQC is installed in PCC. Fig. 8 shows the three-phase detailed system configuration of the IPQC with transformer and inverter. U_s and L_s represent the source voltage and impedance of conventional power supply, respectively. The passive filters, which have the function of absorbing the harmonics, are shunted in both sides. The primary winding of a transformer is inserted in series between the conventional power utility and the microgrid, whereas the secondary winding is connected with a voltage-source PWM converter.

U_d is the voltage of the dc side of the inverter. The microgrid contains a harmonic load, a photovoltaic cell system, a battery storage system, and a normal load. The proposed IPQC has the following functions.

b) Power flow Control: When the power flow control and the fault current limiter are of concern, only the fundamental is taken into account. In terms of the preceding analysis, the primary winding exhibits adjustable impedance $Z_1 + (1 - \alpha)Z_m$. With the change in coefficient α, the equivalent impedance of the primary winding can be achieved, which is shown in Table I. Therefore, when the primary winding is connected in series in circuit, it can be applied to control the power flow between the conventional power utility and the microgrid or the internal power flow of the microgrid.

The schematic of power flow control is shown in Fig. 9 when the novel variable reactor is connected in series between the sending and receiving ends. Suppose that the equivalent impedance $Z_1 + (1 - \alpha)Z_m$ of the variable reactor is $R + jX$. In terms of the vector diagram in Fig.9, the following equations can be obtained:

$$U_m \cos \varphi = U_s \cos(\varphi - \delta) + RI \quad (21)$$

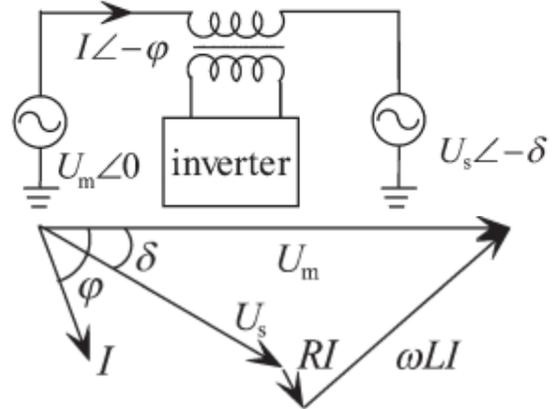$$U_m \sin \varphi = U_s \sin(\varphi - \delta) + XI \quad (22)$$

Fig.9. Power flow control principle and its vector diagram.

Multiply $\cos \phi$ in both sides of (21) and multiply $\sin \phi$ in both sides of (22), then the following equation can be obtained by adding them:

$$U_m(U_m - U_s \cos \delta) = PR + QX \quad (23)$$

Multiply $\sin \phi$ in both sides of (21) and multiply $\cos \phi$ in both sides of (22), then the following equation can be obtained by subtracting them:

$$U_s \sin \delta = PX - QR \quad (24)$$

In terms of (23) and (24), the active and reactive power from U_m to U_s are

$$P = \frac{U_m}{R^2 + X^2}[R(U_m - U_s \cos \delta) + XU_s \sin \delta] \quad (25)$$

$$Q = \frac{U_m}{R^2 + X^2}[-RU_s \sin \delta + X(U_m - U_s \cos \delta)] \quad (26)$$

In the power system with high voltage level, the inductive reactance component of the transmission line is much more than the resistance component of the transmission line, (25) and (26) become

$$P = \frac{U_s U_m}{X} \sin \delta \quad Q = \frac{U_m}{X}(U_m - U_s \cos \delta) \quad (27)$$

In microgrid with low voltage level, when the resistance component of the transmission line is much

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more than the inductive reactance component of the transmission line, (25) and (26) can be expressed as

$$P = \frac{U_m}{R}(U_m - U_s \cos\delta) \quad Q = -\frac{U_m U_s}{R}\sin\delta \qquad (28)$$

In terms of (28), there is a striking difference in power flow control and voltage regulation between microgrid and conventional power grid.

c) Fault Current Limiter: When the terminal AX is connected in series in circuit, in the normal operation state, the coefficient α can be controlled as $\alpha = 1 + Z_1/Z_m$, and the equivalent impedance of the primary winding AX is zero. Hence, the series transformer does not have any influence on the power system normal operation. The maximum system current i_{smax} of the three phases is obtained by a current-detecting circuit and compared with a reference current. In case of a short-circuit fault, maximum system current i_{smax} reaches the reference current, the coefficient α can be controlled between -1 and 1 in terms of the requirement of fault current, and the equivalent impedance of the primary winding AX is controlled between $Z_1 + Z_m$ and Z_1 to limit the system current to a desired value.

d) Voltage Compensation: In order to compensate the voltage fluctuation, the primary winding of the transformer is connected in series between the power electric utility and the load. When the load voltages higher than the desired voltage, the coefficient α can be controlled between 0 and $1 + Z_1/Z_m$, and the primary winding exhibits inductive impedance. When the load voltage is lower than the desired voltage, the coefficient α is controlled more than $1 + Z_1/Z_m$, and the primary winding exhibits capacitive impedance. Therefore, the load voltage can be controlled as a stable voltage.

e) Harmonic Isolation: The preceding function of power flow control, fault current limiter, and voltage compensation is concerned with the fundamental. If there exits harmonic in the power utility, the primary current contains the fundamental current and nth order harmonic currents, that is to say, $i_i = i_1^1 + \Sigma i_1^n$
The fundamental component i_1^1 rather than harmonic is detected from the primary winding current i1 and functions as a reference signal. A voltage source inverter is applied to track the fundamental reference signal i_1^1 to produce a fundamental compensation current i_1^2, which has the same frequency as i_1^1. i_2^1 is inversely in phase injected to the secondary winding ax. When $\alpha = 1 + Z_1/Z_m$, the fundamental equivalent impedance of primary winding AX is zero, which is shown in Fig. 10. Meanwhile, for the

nth- order harmonic, since only a fundamental current is injected to the secondary winding of
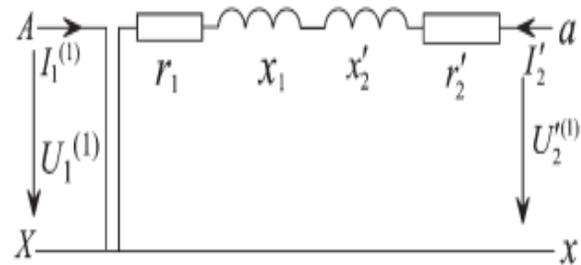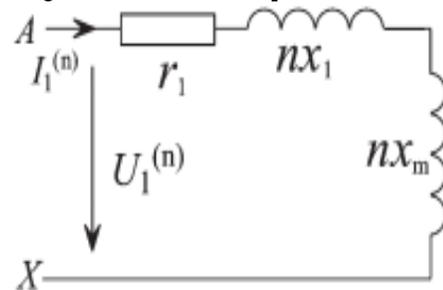

Fig.10. Fundamental equivalent circuit

Fig.11.Harmonic equivalent circuit

The transformer i_2 does not include any order harmonic current other than the fundamental current, which means that the transformer is open circuit to harmonic current. Therefore, the equivalent circuit of the transformer to the nth-order harmonic is shown in Fig.11. Then, the harmonic equivalent impedance of the transformer is $Z_{AX}{}^{(n)} = (r_1 + jnx_1) + jnx_m \approx nZ_m{}^{(1)}$. From the primary winding, the series transformer exhibits very low impedance at the fundamental and simultaneously exhibits high impedance to harmonics to act as a "harmonic isolator." Then, the harmonic currents are forced to flow into the passive LC filter branches in both sides.

e) IPQC: When integrating the preceding functions of variable reactor, power flow control, fault current limiter, voltage compensation, and harmonic isolation, a novel IPQC can be achieved. For fundamental and harmonic, the primary winding of the series transformer exhibits the impedance of $Z_1{}^{(1)} + (1 - \alpha)Z_m{}^{(1)}$ and $nZ_m{}^{(1)}$ respectively.

That is to say, the primary winding of the series transformer exhibits adjustable impedance, which plays the role of power flow control, fault current limiter, and voltage compensation to fundamental. Meanwhile, the primary winding of the series transformer exhibits high impedance $nZ_m{}^{(1)}$ to harmonic, which can greatly improve the source impedance to harmonics, and really acts as a harmonic isolator. Therefore, it can mitigate the harmonic high penetration.

IV. MULTILEVEL INVERTERS BLDC MOTOR

BLDC engine comprises of the perpetual magnet rotor and an injury stator. The brushless engines are controlled utilizing a three stage inverter. The engine obliges a rotor position sensor for beginning and for giving legitimate compensation arrangement to turn on the force gadgets in the inverter extension. In light of the rotor position, the force gadgets are commutated consecutively every 60 degrees. The electronic compensation takes out the issues connected with the brush and the commutator plan, in particular starting and destroying of the commutator brush course of action, along these lines, making a BLDC engine more rough contrasted with a dc engine. Fig.4 demonstrates the stator of the BLDC engine and fig.5 shows rotor magnet plans.

. BLDC motor stator construction

BLDC motor Rotor construction.

The brush less dc engine comprise of four fundamental parts Power converter, changeless magnet brushless DC Motor (BLDCM), sensors and control calculation. The force converter changes power from the source to the BLDCM which thus changes over electrical vitality to mechanical vitality.

One of the remarkable highlights of the brush less dc engine is the rotor position sensors, in view of the

rotor position and order signals which may be a torque charge, voltage summon, rate order etc; the control calculation s focus the entryway sign to every semiconductor in the force electronic converter.

The structure of the control calculations decides the sort of the brush less dc engine of which there are two principle classes voltage source based drives and current source based drives. Both voltage source and current source based commute utilized for perpetual magnet brushless DC machine. The back emf waveform of the engine is demonstrated in the fig. 6. Be that as it may, machine with a non sinusoidal back emf brings about diminishment in the inverter size and lessens misfortunes for the same influence level.
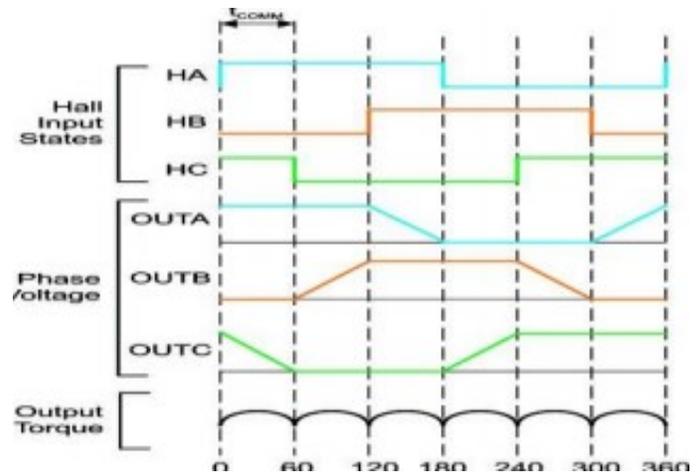

Fig.12. Hall signals & Stator voltages.
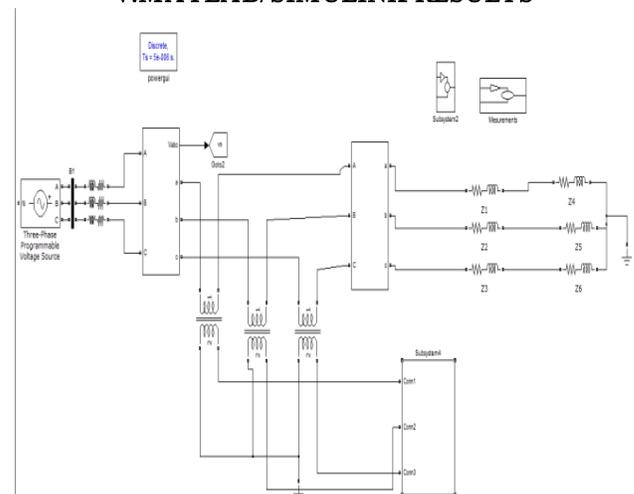
V.MATLAB/SIMULINK RESULTS
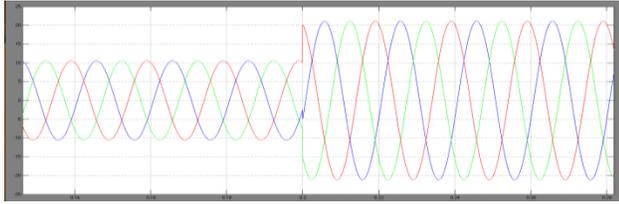

Fig 13 Conventional diagram for IPQC

Fig 14 Current waveforms of the primary winding when α suddenly changes from 0.1 to 0.6
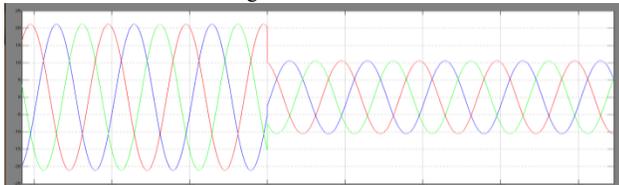

Fig 15 Current waveforms of the primary winding when α suddenly changes from 0.6 to 0.1

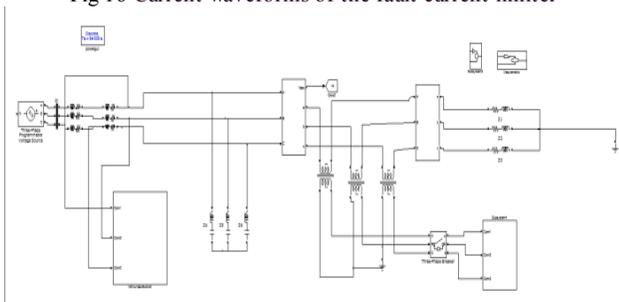Fig 16 Current waveforms of the fault current limiter

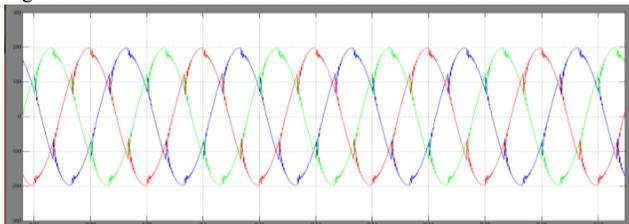Fig 17 Simulation circuit for harmonic isolation in the first condition

Fig 18 System voltage waveforms when the IPQC is not applied
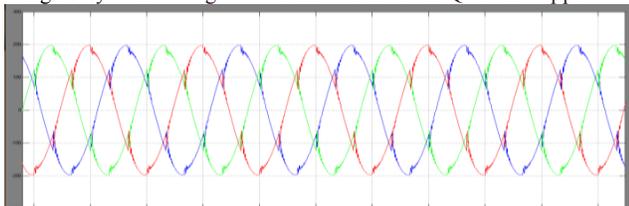

Fig 19 System current waveforms when the IPQC is not applied
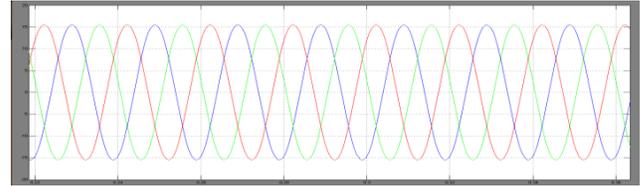

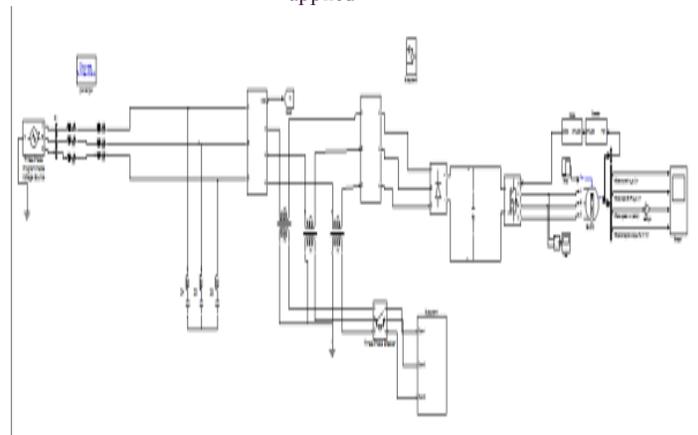Fig 20 Current waveforms at microgrid side when the IPQC is applied

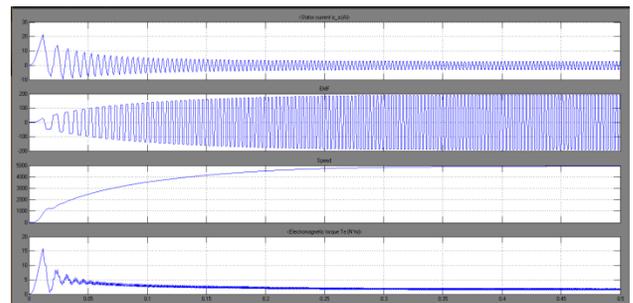Fig 21 Matlab/simulation Proposed circuits for BLDC motor drives

Fig 22 simulation wave form of BLDC motor drive stator current, EMF, speed and electromagnetic torque

VI. CONCLUSION

The BLDC motor drive characteristics of stator current, EMF, speed and electromagnetic torque it provides a dynamic performance under transient and steady state conditions, THD analysis also within the IEEE standards. Instantaneous real-power theory based cascaded multilevel inverter based IPQC is connected in the distribution network at the PCC through filter inductances and operates in a closed loop. A cascaded multilevel voltage source inverter based IPQC using instantaneous real power controller is found to be an effective solution for power line conditioning to compensate harmonics, reactive power and power factor with the IRP controller reduces harmonics and provides reactive power compensation due to non-linear load currents; as a result source current(s) become sinusoidal and unity power factor is also achieved under both transient and steady

state conditions. This paper has presented a novel variable reactor based on the magnetic flux control. A transformer with air gap is selected, and the primary winding current of the transformer is detected. A voltage-sourced inverter is applied to follow the primary current to produce another current, which is injected to the secondary. When the injected current is adjusted, the equivalent impedance of the primary winding of the transformer will change continuously. In terms of the novel variable reactor, a novel IPQC suitable for microgrid is proposed.

The primary winding exhibits adjustable impedance, which plays the role of power flow control, fault current limiter, and voltage compensation to fundamental.

REFERENCES

[1] B. Lasseter, "Microgrids [distributed power generation]," in Proc. IEEE Power Eng. Soc. Winter Meet., 2001, vol. 1, pp. 146–149.

[2] C. Marnay, F. J. Robio, and A. S. Siddiqui, "Shape of the microgrid," in Proc. IEEE Power Eng. Soc. Winter Meet., 2001, vol. 1, pp. 150–153.

[3] R. H. Lasseter et al., Integration of Distributed Energy Resources: The CERTS Microgrid Concept. Berkeley, CA, USA: Consortium for Electric Reliability Technology Solutions, 2002.

[4] C. Marnay and O. Bailey, "The CERTS micro grid and the future of the macrogrid," Lawrence Berkeley National Laboratory, Berkeley, CA, USA, Rep. LBNL-55281, Aug. 2004.

[5] N. Hatziargyriou, H. Asano, R. Iravani, and C. Marnay, "Micro grids," IEEE Power Energy Mag., vol. 5, no. 4, pp. 78–94, Jul./Aug. 2007.

[6] R. H. Lasseter, "Smart distribution: Coupled micro grids," Proc. IEEE, vol. 99, no. 6, pp. 1074–1082, Jun. 2011.

[7] H. Akagi, E. H. Watanabe, and M. Aredes, Instantaneous Power Theory and Applications to Power Conditioning. Piscataway, NJ, USA: IEEE Press, 2007, pp. 1–17.

[8] C. Sankaran, Power Quality. Boca Raton, FL, USA: CRC Press, 2002, pp. 133–146.

[9] R. C. Dugan, Electrical Power Systems Quality. New York, NY, USA: McGraw-Hill, 2003, pp. 167–223.

[10] A. Baggini, Handbook of Power Quality. Hoboken, NJ, USA: Wiley, 2008, pp. 187–257.

[11] B. Singh, K. Al-Haddad, and A. Chandra, "A review of active filters for power quality improvement," IEEE Trans. Ind. Electron., vol. 46, no. 5, pp. 960–971, Oct. 1999.

[12] F. Z. Peng, "Application issues of active power filters," IEEE Ind. Appl. Mag., vol. 4, no. 5, pp. 21–30, Sep./Oct. 1998.

[13] K. M. Smedley, L. Zhou, and C. Qiao, "Unified constant-frequency integration control of active power filters—Steady-state and dynamics," IEEE Trans. Power Electron., vol. 16, no. 3, pp. 428–436, May 2001.

[14] H. Rudnick, J. Dixon, and L. Moran, "Delivering clean and pure power," IEEE Power Energy Mag., vol. 1, no. 5, pp. 32–40, Sep./Oct. 2003.