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Effective Current Management Style and Analysis of Single Phase Electrical Converter for Power Quality Improvement

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ABSTRACT:

Using a good prophetical Current management strategy to one part voltage supply electrical converter and to analysis it's performance for varied parameters variations is that the main objective of this paper. associate degree improved performance of the proposed prophetical current management methodology hasbeen analyzed with varied conditions is dispensed like steady state, transient state, non curved references, input frequency variations, frequency variations, current reference amplitude variations and filter inductance variations, that gives wonderful reference trailing with less current harmonic distortion for all conditions.

The management rule and electrical

converter model was developed in Matlab/Simulink software package.

INTRODUCTION

Nowadays, the voltage source inverter is common topologies have been used in wide diversity of applications and give more attention of the researchers to control and conversion of power. For a grid connected inverter, the power quality mainly depends on performance of the current controller's in inverter. The development of PWM techniques is the most popular control technique for grid-connected inverters. As compared with the open loop voltage PWM converters, the current-controlled PWM has several advantages such as fast dynamic response and inherent over-current protection [1]. Several control technique that has been developed till now to control the current in inverter. In the Ref [1-16] a Varity of available current control techniques and its advantages and disadvantages are discussed. Nowadays, Predictive current control technique has been used for control the current of three phase inverter[27], three phase four-leg inverter[24], threephase two-level and three-level neutral-point-clamped inverter[29],[30], cascaded H-Bridge inverter[31], single phase boost rectifier[32],multilevel converter[33],matrix converter[34] and corresponding their application such as Active-Front-End Rectifier[18],[19], Distributed Generation Systems[20], Active Filters and Power Conditioning[23, 24], Non-Conventional Renewable Energy[20], uninterruptible power supplies (UPS) [25], drives [22], and power factor correction [26]. This current control method used in various wide power converters and the control scheme is to predict the future load current in terms of the measured actual load current and predicted load voltages. Compared with the Classic Linear PI-PWM the MPC offers many advantages such as good reference tracking and minimum output distortion [24, 22].In the all above mentioned strategies are only considering three phase inverter, multilevel inverter , matrix converter for various conditions is described. But the detailed investigation of single phase two level two-leg inverter for various conditions is not being described. In this paper, we use improved current controller used to control the current of single phase inverter for

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various condition are evaluated through simulation results.

CONVERTER BASED CLASSIFICATION

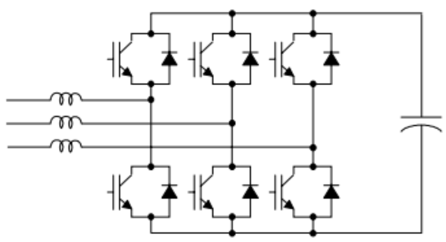

Fig.1. Basic diagram for VSI

(i)VOLTAGE SOURCE INVERTER

The voltage source inverter topology uses a diode rectifier that converts utility/line AC voltage (60 Hz) to DC. The converter is not controlled through electronic firing like the CSI drive. The DC link is parallel capacitors, which regulate the DC bus voltage ripple and store energy for the system. The inverter is composed of insulated gate bipolar transistor (IGBT) semiconductor switches. There are other alternatives to the IGBT: insulated gate commutated thyristors (IGCTs) and injection enhanced gate transistors (IEGTs). This paper will focus on the IGBT as it is used extensively in the MV VSI drives market. The IGBT switches create a PWM voltage output that regulates the voltage and frequency to the motor. The design in a neutral point clamped (NPC) Three-level inverter topology. The IGBT switching devices are cascaded to achieve a 4160V system rating.

- Self-supporting dc voltage
- Lighter, cheaper
- Expandable to multilevel

(ii) CURRENT SOURCE INVERTER

The way each of the drive building blocks operates defines the type of drive topology. The first topology that will be investigated is the current source inverter (CSI). The converter section uses silicon-controlled rectifiers (SCRs), gate commutated thyristors (GCTs), or symmetrical gate commutated thyristors (SGCTs). This converter is known as an active rectifier or active front end (AFE). The DC link uses inductors to regulate current ripple and to store energy for the motor. The inverter section comprises gate turn-off thyristor (GTO) or symmetrical gate commutated thyristor (SGCT) semiconductor switches.

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These switches are turned on and off to create a pulse width modulated (PWM) output regulating the output frequency.

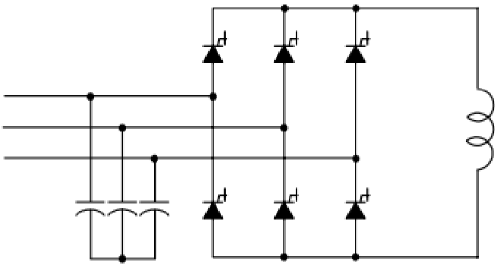

Fig 2..Basic diagram for CSI

• Switching frequency is restricted

• Higher losses

• Cannot be used in multilevel

Converter-based classification

• VSI (Voltage Source Inverter) bridge structure

• CSI (Current Source Inverter) bridge structure

Topology-based classification

• Shunt APF

• Series APF

• UPQC : Shunt APF + Series APF

• Hybrid APF : Shunt or Series Active Filter + Passive Filter

Supply-system-based classification

• Two-wire APF

• Three-wire APF

• Four-wire APF

2.7.1 CONVERTER BASED CLASSIFICATION

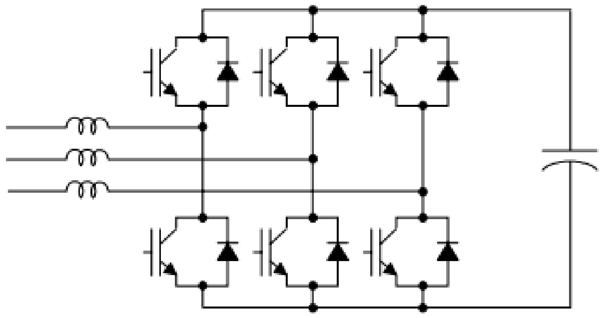

Fig.2.6. Basic diagram for VSI

(i)VOLTAGE SOURCE INVERTER

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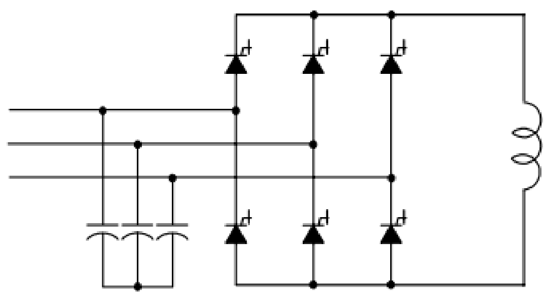

Fig 2.7 .Basic diagram for CSI

- Switching frequency is restricted
- Higher losses

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• Cannot be used in multilevel

2.7.2 TOPOLOGY BASED CLASSIFICATION

(i) SHUNT APF STAND-ALONE

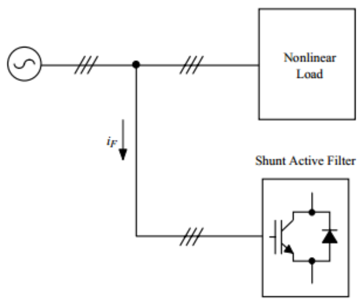

Fig 2.8 basic diagram for shunt active power filter stand-alone

• Eliminate current harmonics

• Reactive power compensation

• Balancing unbalanced current

(ii)SERIES APF STAND-ALONE

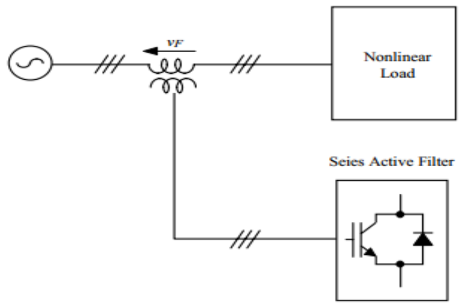

Fig 2.9 .basic diagram for series active power filter stand-alone

• Eliminate voltage harmonics

• Regulate and balance the terminal voltage

• Damp out harmonic propagation

(iii)UPQC (UNIFIED POWER QUALITY CONDITIONER)

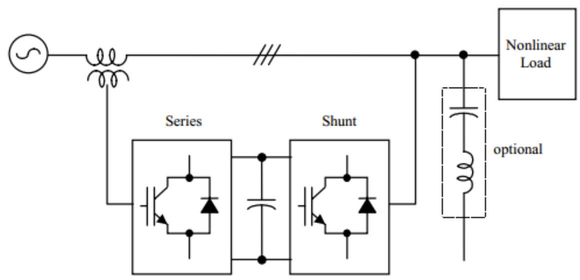

Fig 2.10.basic diagram for Shunt APF + Series APF

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(iv) HYBRID APF (COMBINATIONS OF PASSIVE-ACTIVE)

Parallel combination of shunt-APF and shunt passive filter

• Current source vs. Harmonic sink

Series combination of series-APF and series passive filter

• Voltage source vs. Harmonic damping

Hybrid of series-APF and shunt passive filter

• Harmonic isolation vs. Harmonic compensation

• Reduced size and cost : Quite popular

Hybrid of shunt-APF and series passive filter

• Harmonic isolation vs. Harmonic blocking

Series combination of shunt-APF and shunt passive filter

• Resonance damping vs. Harmonic compensation

Parallel combination of series-APF and series passive filter

• Enhancing passive filter vs. Harmonic blocking

Parallel Combination Of Shunt-Apf And Shunt Passive Filter

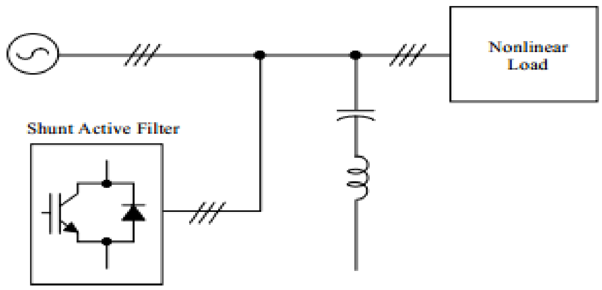

Fig 2.11 basic diagram for parallel combination of shunt-apf and shunt passive filter

• Harmonic cancellation

• Q control

• Optimal sharing is needed

• Commercialized

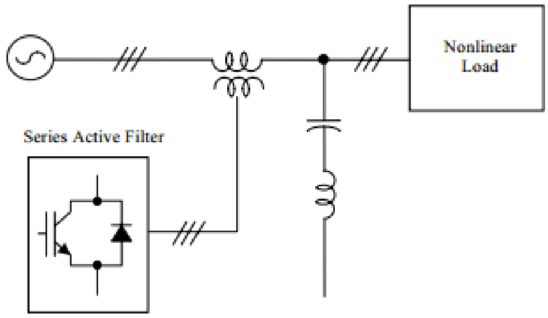

Fig 2.12 .basic diagram for parallel combination of series-apf and shunt passive filter

• Harmonic damping

• Existing passive filter

• Low power

• More circuit for Q control

• Over current protection is difficult

SERIES COMBINATION OF SERIES-APF AND SHUNT PASSIVE FILTER

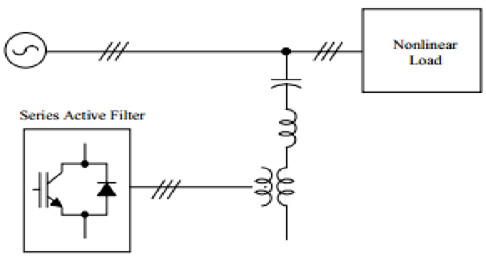

Fig 2.13 basic diagram for series combination of series-apf and shunt passive filter

• Harmonic cancellation and damping

• Series-APF enhanced existing passive filter

• Easy protection is possible

• Current Transformer is minimized

• No Q control

• Under developed

2.7.4 SUPPLY-SYSTEM BASED CLASSIFICATION

Two-wire APF

• Single-phase nonlinear loads, such as domestic appliances

• Smaller rating

Three-wire APF

• Three-phase nonlinear load without neutral, such as ASD's

Four-wire APF

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- Single-phase nonlinear loads fed from four-wire supply system, such as computers, commercial lighting
- Eliminate excessive neutral current and unbalance Capacitor midpoint four-wire shunt APF
- Used in smaller ratings, because entire neutral current flows through dc bus capacitor

Capacitor midpoint four-wire shunt APF

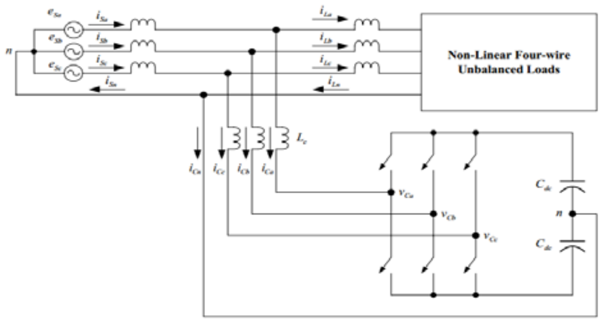

Fig 2.14 .Capacitor midpoint four-wire shunt APF

(i) FOUR-POLE FOUR-WIRE SHUNT APF

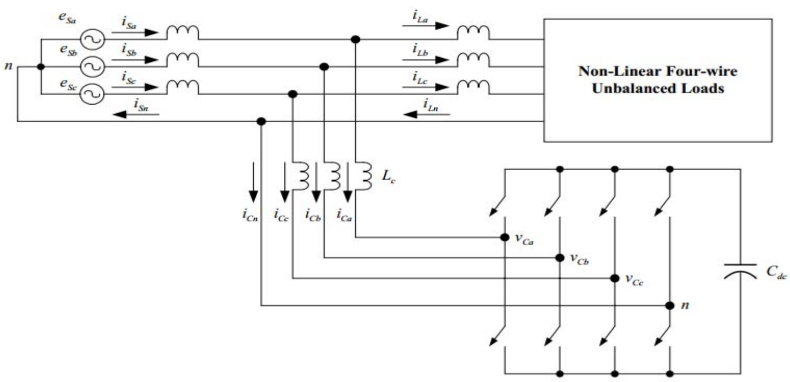

Fig 2.15 .Four-pole four-wire shunt APF

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(ii) THREE-BRIDGE FOUR-WIRE SHUNT APF

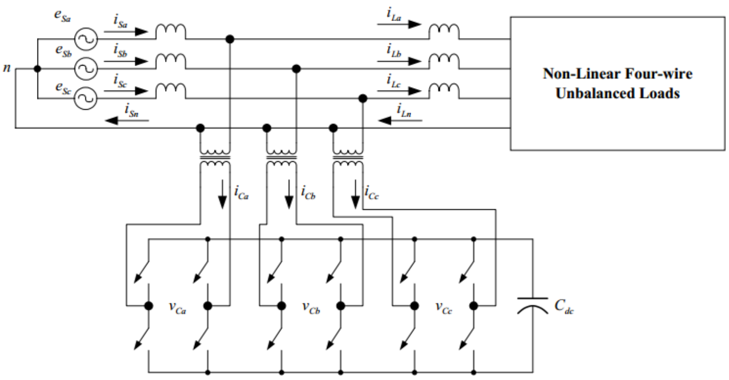

Fig 2.16 .Three-bridge four-wire shunt APF

2.8 APF CONTROL STRATEGIES

First stage : Signal conditioning

- Sensing system information by PT, CT, Isolation amplifiers
- Monitor, measure, record
- THD, power factor, active/reactive power, crest factor…

Second Stage: Derivation of compensating signal

- Current level and/or voltage level
- Frequency domain
- Based on Fourier transformation
- Cumbersome computation, large response time
- Time domain

Based on instantaneous derivation pq theory, synchronous dq reference frame method, synchronous detection method, flux-based controller, notch filter method…

Third stage : Generation of gating signal

- Hysteresis, PWM, SVPWM, sliding mode, fuzzy-logic…

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2.9 COMPONENT CONSIDERATIONS OF APF

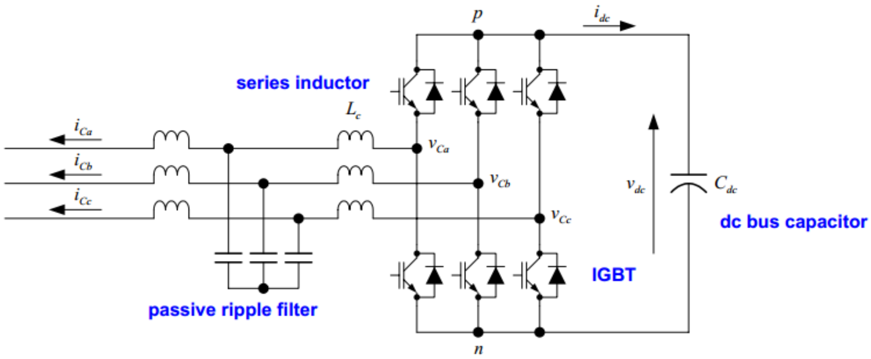

Fig 2.17 .series inductor and passive ripple filter

Series inductor: buffer between supply and PWM voltage

Passive ripple filter: suppress switching harmonic and improve source THD

DC bus capacitor: reduces dc ripples

2.10 BASIC CONCEPT OF ACTIVE FILTER CONTROL

2.10.1 Active Filter as a "Harmonic Canceller

(i) Harmonic Current Detection and Current Control Method"

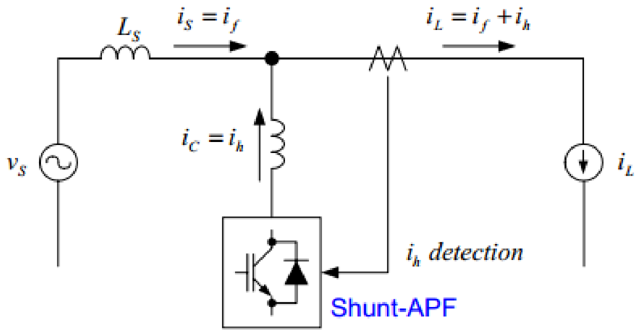

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fig 2.18.harmonic current detection and current control

(ii) Harmonic Voltage Detection And Voltage Control Method

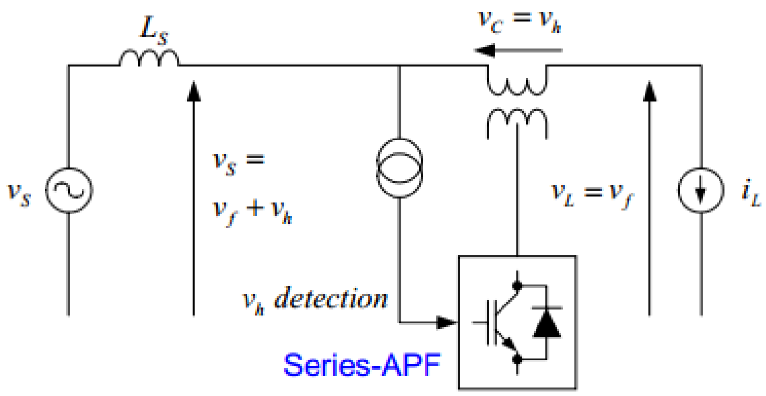

fig 2.19 .harmonic voltage detection and voltage control

2.10.2 ACTIVE FILTER AS A "HARMONIC DAMPER

(i) Harmonic voltage detection And Current control method

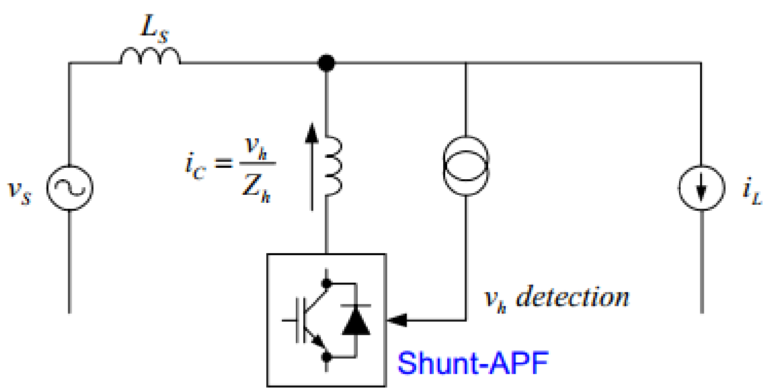

Fig 2.20. Harmonic voltage detection And Current control

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(ii)harmonic current detection and voltage control method

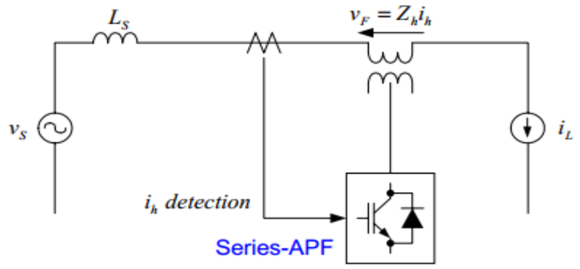

Fig 2.20 .harmonic current detection and voltage control

2.11 INSTANTANEOUS POWER THEORY

Among the several methods, PQ Theory is one of the most common and probably it is widely used method. This section is organized as to describe succinctly the PQ method. The nonlinear load considered is a three-phase diode bridge rectifier. Fig.2.21 shows the basic configuration of p-q theory. The load current signals are transformed into the conventional rotating frame d-q. If theta is the transformation angle, the transformation is defined by:

$$\begin{bmatrix} x_d \\ x_q \\ x_0 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos(\theta) & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta - \frac{4\pi}{3}\right) \\ -\sin(\theta) & \sin\left(\theta - \frac{2\pi}{3}\right) & -\sin\left(\theta - \frac{4\pi}{3}\right) \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \begin{bmatrix} x_a \\ x_b \\ x_c \end{bmatrix}$$

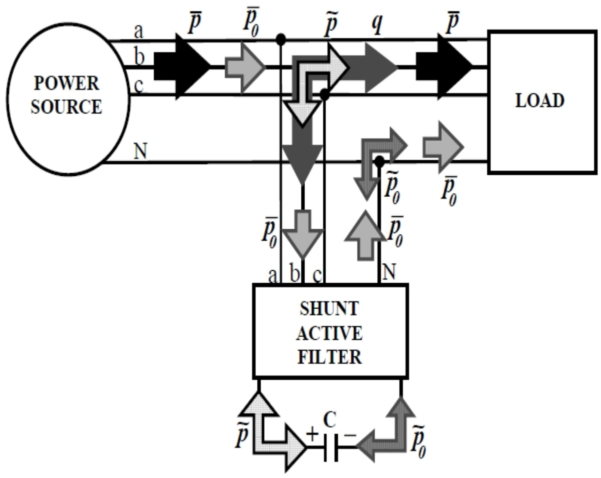

Figure. 2.21 Basic principal of p-q theory

MODEL PREDICTIVE CURRENT CONTROL

a) Predictive current control technique The proposed current control scheme is shown in Figure-3. It uses the discrete-time model of inverter and load for predicting the load current at a future sample instant for each of the available output voltage vector that can be generated by the inverter. The quality function or cost function or error between the reference and predicted values is calculated. The switching state that minimizes g is selected and applied during the next sampling period. The model need input voltage and actual load currents at instant of k. By using the system` input voltage to generate voltage vectors, which is given to the predictive model to predict the inverter future current. The current references are generated according to the application we are using. In this system a simple designing and analysis of the inverter. So that the references are user defined. By changing the reference it can be used for any applications.

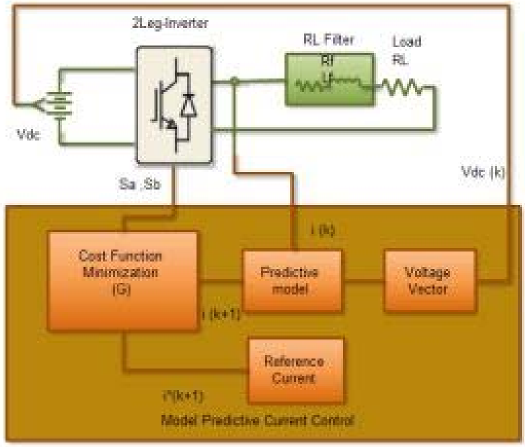

Figure-4. Configuration of MPC current control.

CONCLUSIONS

In this paper the current control of single phase two-level two-leg voltage source inverter has been presented. The control algorithm has been evaluated with seven different cases through simulation results. The result shows that good performances of the current tracking ability in all conditions with less harmonic distortion and the advantage of proposed technique are related to simplicity, design and modeling. With this the current control technique is a very good alternative solution to classical current control techniques. In further research on control technique with cost function values variations in control algorithm and to compare with conventional current controllers.

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