# COMBINATION OF CPS –IPD TECHNIQUE FOR THE CARRIER RECONSTRUCTION OF H-BRIDGE INVERTER

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***Abstract—***To overcome the deficiencies occurred in H-bridge inverter. There are two Techniques are introduced to solve the problems occurring in H-bridge inverter such as Carrier Phase Shift and Carrier In-Phase Disposition. Carrier Phase Shift Technique is used to change the phase of the carrier signal by varying the sine and cosine inputs. Carrier In-Phase Disposition is used to compensate all the carrier signals have the same frequency and amplitude. Both the techniques are applied to H-bridge Inverter. The advantages of two techniques are combined with H-bridge Inverter. The aforementioned technique uses the carrier component in the half carrier phase of the IPD-PWM technique as the basic unit and optimizes the modulation performance by periodically adjusting its arrangement in the vertical direction. When CHB Inverter adopts Hybrid multi carrier Technique and along with CPS-PWM technique, the output power balance between the cascaded H-bridge cells is achieved naturally. The harmonic characteristics of the output line voltage of the inverters are effectively improved. In this paper we discuss about the carrier signals in the cascaded h-bridge inverter to reconstruct the inverter to increase the efficiency and lowered the unwanted harmonics present in the inverter.

***Keywords—Hybrid multi carrier PWM, Power balance, cascaded H-bridge Inverter, Harmonic analysis.***

# 1. Introduction

In the last few years, multilevel inverters have several advantages of less power semiconductor device stress, good harmonic characteristics of the output voltage and low switching loss. In the fields of medium and high voltage speed regulation, high voltage direct current transmission has been widely used. In the multilevel converters, CHB multilevel inverter has being commonly used topology because of its nearly sinusoidal waveforms, simple controlling and easy assembling. The modulation technique of multi- level inverter is the key link for generating an output of superior multilevel waveforms, which directly determines the waveform of the output voltage and the output power distribute between the cascaded H-bridge cells.

There are two types of modulation techniques applied to CHB Inverters. They are

i) Low frequency

ii) High Frequency

These modulation techniques depends upon the device Switching frequency. Low- frequency modulation techniques mainly include staircase wave synthesis and Selective Harmonic Elimination. Although the low-frequency modulation technique has lower switching losses, the quality of output waveforms and dynamic response performance are poor. High-frequency modulation techniques such as IPD-PWM and Space Vector Modulation techniques. Among them, CPS-PWM technique can achieve output power balance naturally between cascaded H-bridge cells.

Total Harmonic Distortion of line voltage is higher with this technique, especially at low amplitude modulation index. IPD-PWM technique can minimize harmonic content of line voltage, but can't naturally balance the output power between cascaded H-bridge cells because of Total Harmonic Distortion. The imbalanced output power between cascaded H-bridge cells will cause the discharging characteristics of DC source to be inconsistent, resulting in deviation of DC source voltage, at the same time, the service life of DC source will be greatly different, and the maintenance cost will be increased.

# 2. Literature Review

**1. V. Jammala, S. Yellasiri, and A. K. Panda** describes single-phase cascaded transformer based multilevel inverter with a modified carrier-based level shift sinusoidal pulse width modulation (LS-SPWM) technique. The developed topology has two bridges with individual low frequency transformers. The bridges can give rise to quasi-square waveform and pulse width modulated waveform independently and energized the two transformers whose secondary terminals are cascaded to attain 19-level output voltage waveform across the load. The anticipated configuration has the least number of components to reduce the cost and enhance the reliability of the converter for medium power applications with inbuilt isolation. Moreover, this review establishes the most common LS-SPWM technique with a new carrier to enhance the fundamental magnitude and shifts the dominant harmonics into three times of the traditional strategy for the same modulation indices. The performance of the proposed topology is validated with experimental results.

**2) S. K. Sahoo and T. Bhattacharya** analyzes synchronization strategy for cascaded H-bridge multilevel inverter (CHBMLI) topologies with a carrier-based sinusoidal phase-shifted pulse width modulation (PSPWM) technique. In the PSPWM technique, a separate carrier is used for each H-bridge cells. With the carrier frequency being an integer (odd/even) multiple of the fundamental frequency, it is observed that the positions of zero crossings of the carriers with respect to the zero crossings of voltage references play an important role for maintaining quarter-wave symmetry among multilevel inverter pole voltage waveforms. This paper analytically shows the conditions for half-wave symmetry and quarter-wave symmetry and experimentally verifies those conditions for the PSPWM technique with a five-level CHBMLI laboratory prototype.

**3) C. Oates** describes the modular multilevel converter (MMC), originally proposed by Professor Marquardt, has made it practical to realize converters with ratings up to 1000 MW by using standard components developed for variable speed drives. With the power electronics packed into individual submodules, realizing a converter where the ac and dc voltages are under direct control and have very little distortion appears to be ideal; although there have been several papers published covering the design considerations required to ensure these converters operate correctly from an academic perspective, the method specifying the design of a fully rated MMC, where several hundred submodules may be required for each valve to meet all conditions in service has not been discussed. This paper outlines a procedure for calculating the values of the transformer turns ratio, the transformer reactance, and the valve reactance before considering how the ripple that appears on the sub module voltage affects the operating performance of the converter. This ripple limits the submodules from being able to fully use their capability, so the principal operators that affect the ripple voltage are considered. The main independent variables available are the sub module capacitor value, the number of submodules per valve, and the average capacitor voltage setting, which is set as a servo demand within the control. All these inputs have an effect on all aspects of the converter performance and so must be set together while considering other system variables such as the variation in the ac voltage.

**4) A. Ghias, P. Jose, and V. G. Agelidis** presents a transformer less static synchronous compensator (STATCOM) system based on multilevel H-bridge converter with star configuration. This proposed control methods devote themselves not only to the current loop control but also to the dc capacitor voltage control. With regards to the current loop control, a nonlinear controller based on the passivity-based control (PBC) theory is used in this cascaded structure STATCOM for the first time. As to the dc capacitor voltage control, overall voltage control is realized by adopting a proportional resonant controller. Clustered balancing control is obtained by using an active disturbances rejection controller. Individual balancing control is achieved by shifting the modulation wave vertically which can be easily implemented in a field-programmable gate array. Two actual H-bridge cascaded STATCOMS rated at 10 KV 2 MVA are constructed and a series of verification results are executed. The experimental results prove that the H-bridge cascaded STATCOM with the proposed control methods has excellent dynamic performance and strong robustness.

**5) M. Ye, L. Kang, Y. Xiao, P. Song, and S. Li** establishes **a** Comparison between the traditional cascaded H-bridge multi-level inverters, the hybrid cascaded multi-level inverters have been receiving attention because they can generate more levels with the same number of power cells. However, with the general hybrid pulse width modulation (PWM), the output power distribution between the high-voltage and low-voltage H-bridge cells is extremely uneven in low amplitude modulation, and it may appear that the high-voltage cell feeds power into the low-voltage cell in some modulation ratio intervals causing the low-voltage cell capacitor voltage boost. To avoid this problem, a method of a modified hybrid PWM strategy with power balance control is proposed. It has achieved the output power balance of H-bridge cells in full amplitude modulation.

**6) M. Perez, S. Kouro, J. Rodriguez, and B. Wu** describes that the Cascaded H bridge multilevel inverters are traditionally controlled using phase shifted PWM. This method allows an even power distribution among the different cells of the converter, which enables input current harmonic cancellations due to the isolation multi pulse transformer and rectifier system. For high power application, a selective harmonic elimination based method, also known as staircase modulation, has been proposed.

# 3. Existing System

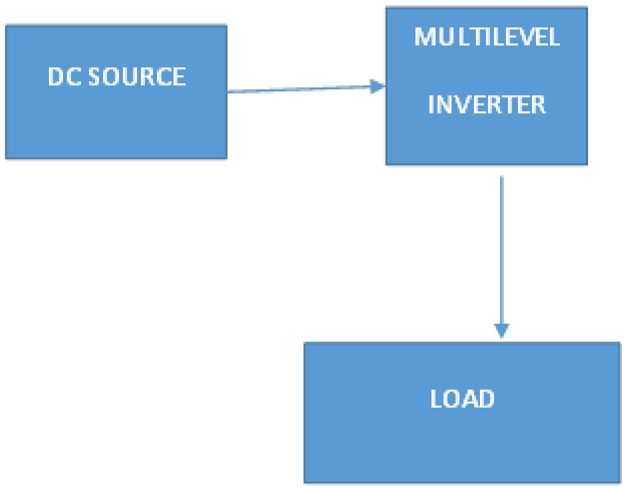
In the existing system, we use the 11–level inverter with a normal PMW technique or Otherwise pulse generator. PWM technique use to control the output voltage and to reduce the harmonic content. PWM technique is used for voltage control.

*A. Disadvantages*

By using PMW technique that is fine, but using different types of PMW techniques but that is not suitable for all types of inverters.

Though it will create a huge loss in the multilevel inverter side such as high rate of harmonic content ,large amount of power dissipation..

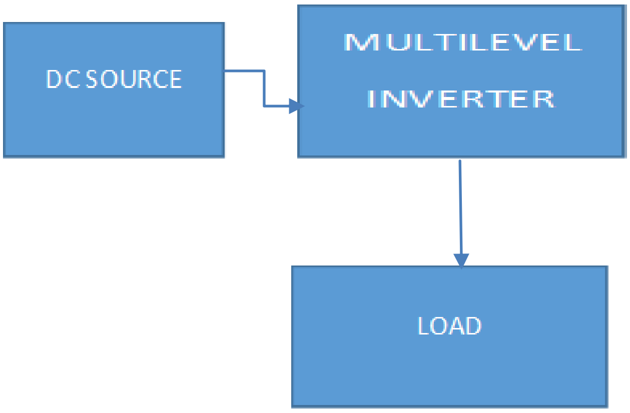
*B. Block-Diagram*



# 4. Proposed System

In the proposed system we use the PWM technique Carrier Phase Shift (CPS-PWM) and Carrier In-Phase Disposition (IPD-PWM) modulation techniques are applied to Cascaded H-bridge (CHB) multilevel inverters, combined with the advantages of the two techniques, a Hybrid Multi-carrier PWM technique based on carrier reconstruction is proposed.

*C. Block Diagram*




*1) Applications: DC-AC CONVERTERS, PI CONTROLLER,* PID CONTROLLER, AC-DC CONVERTER, MULTILEVEL INVERTERS.

*2) Advantages:* When CHB multilevel inverter adopts Hybrid Multi-carrier PWM technique, as with CPS-PWM technique, the output power balance between the cascaded H-bridge cells is achieved naturally; at the same time, the harmonic spectrum of the output voltage is identical with that of the IPD-PWM technique, that is to say, the harmonic characteristics of the output line voltage of the inverters are effectively improved.

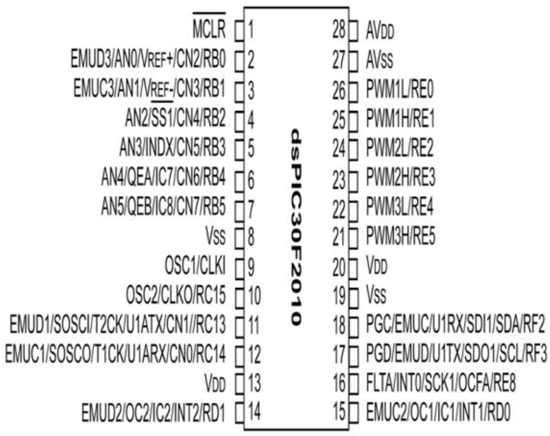
# 5. Hardware Requirement

*D. Transformer:* A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit .It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in current. It works with the principle of mutual induction. In our project, we are using a step -down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230v ac into 110v ac and 230v ac into 12v ac.

*E.* ***Filter:***In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output& a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

*F.* ***Pin Description***

*1)* ***Pin diagram of dsPIC30F2010***This controller contains 28 pins in that six pins are PWM pins. Mainly controllers used in this project to generate gating pulses for switches.




This controller contains 28 pins in that six pins are PWM pins. Mainly controllers used in this project to generate gating pulses for switches. Pulse Width Modulation (PWM) is a technique in which the width of a pulse is modulated keeping the time period of the wave constant. The ON time and OFF time can have any different values in the wave cycles, but the sum of the ON time and OFF time remains same for the entire cycles. With the help of the modulation of the width of a pulse in a period of the wave, they can generate any required voltage with the help of a proper filter circuits. The filter circuits are used for generating the voltage corresponding to a modulated wave.

This feature of the PWM wave is making use in so many digital systems like DC motor control, audio devices, simple decoration light controls etc. The PIC30F2010 has an inbuilt PWM module which can generate continuous PWM waves.

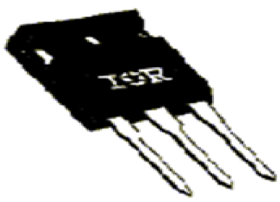
*2) OPTOCOUPLER:* Optocoupler is also termed as OptoIsolator. OptoIsolator a device which contains a optical emitter, such as an LED, neon bulb, or incandescent bulb, and an optical receiving element, such as a resistor that changes resistance with variations in light intensity, or a transistor, diode, or other device that conducts differently when in the presence of light. These devices are used to isolate the control voltage from the controlled circuit.

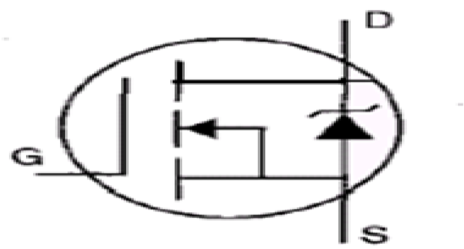
Driver performs three operations.
1: Amplification
2: Isolation
3: Impedance matching

The buffer IC used here IC 4050 is used for pulse generation to generate triggering pulse. There are pull up resistors to provide a resistance in series with the microcontroller which acts as a current source here. This IC acts as an impedance improvement buffer IC. Voltage follower concept is used and the signal is getting inverted. Now it is given to the isolator.

Since the microcontroller is a sensitive device and MOSFET carries high current, in order to provide isolation between the two, isolation is being provided by the Optocoupler.


*3) MOSFET:-* The component that is used as the switch in the inverter unit is the MOSFET which is a voltage controlled device. They are the power semiconductor devices that have a fast switching property with a simple drive requirement.




Vdss= 500 V
Rds (on) = 0.27 ohm
Id= 20 A

This mosfet provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness. This package is preferred for commercial and industrial applications where higher power levels are to be handled.

*G. Software Requirements*

*1) MATLAB System:* Consists of five main parts: Desktop Tools and Development Environment This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, an editor and debugger, a code analyser and other reports, and browsers for viewing help, the workspace, files, and the search path. The MATLAB Language This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object- oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create large and complex application programs.

*2) Graphics:* MATLAB has extensive facilities for displaying vectors and matrices as graphs, as well as annotating and printing these graphs. It includes high-level functions for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level functions that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

The MATLAB External Interfaces/API This is a library that allows you to write C and Fortran programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files

*3) MATLAB Documentation:* MATLAB provides extensive documentation, in both printed and online format, to help you learn about and use all of its features.

If you are a new user, start with this Getting Started book. It covers all the primary MATLAB features at a high level, including many examples. The MATLAB online help provides task-oriented and reference information about MATLAB features. MATLAB documentation is also available in printed form and in PDF format. MATLAB Online Help to view the online documentation, select MATLAB Help from the Help menu in MATLAB. The MATLAB documentation is organized into these main topics.

*4) The Role of Simulation in Design:* Electrical power systems are combinations of electrical circuits and electro mechanical devices like motors and generators. Engineers working in this discipline are constantly improving the performance of the systems. Requirements for drastically increased efficiency have forced power system designers to use power electronic devices and sophisticated control system concepts that tax traditional analysis tools and techniques. Further complicating the analyst's role is the fact that the system is often so nonlinear that the only way to understand it is through simulation. Land- based power generation from hydroelectric, steam, or other device is not the only use of power systems. A common attribute of these systems is their use of power electronics and control systems to achieve their performance objectives. Sim Power Systems is a modern design tool that allows scientists and engineers to rapidly and easily build models that simulate power systems. Sim Power Systems uses the Simulink environment, allowing you to build a model using simple click and drag procedures. Not only can you draw the circuit topology rapidly, but your analysis of the circuit can include its interactions with mechanical, thermal, control, and other disciplines. This is possible because all the electrical parts of the simulation interact with the extensive Simulink modelling library. Since Simulink uses MATLAB as its computational engine, designers can also use MATLAB toolboxes and Simulink block sets. SIM Power Systems and SIM Mechanics share a special Physical Modelling block and connection line interface.

# 6. Conclusion

Based on the analysis of the modulation principle of CPS-PWM and IPD-PWM techniques, this paper proposes a Hybrid Multi-carrier PWM modulation technique based on carrier reconstruction, which is applied to CHB seven-level inverter, Through theoretical, simulation and experimental analysis, the results show that:

1) The proposed Hybrid Multi-carrier PWM technique utilizes the redundant switching function states of the inverter to cyclically adjust the arrangement of the carrier in the vertical direction, so that the fundamental components of the output voltage of each cascaded H-bridge cell are equal. Therefore, the output power balance between cascaded H-bridge cells can be effectively realized, and the time required for power balance is one reconstructed carrier period.

2) Under IPD-PWM and the proposed Hybrid Multi-carrier PWM technique, the fundamental component and harmonic spectrum of the inverter output voltage are exactly the same, that is, Hybrid Multi-carrier PWM technique proposed in this paper has the optimal harmonic characteristics of the output line voltage.

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