Implementation of Multi-Carrier Spwm for Modified H-Bridge Multilevel Inverter using LabVIEW

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Abstract- **The simulation of the sinusoidal Pulse Width Modulation (SPWM) is performed using the Phase Opposition Disposition (POD) technique. SPWM POD technique is implemented for the multilevel H-bridge inverter. This paper presents the generation of the SPWM by using the NI LabVIEW and the NI myRIO hardware. The H-bridge multilevel inverter is a five level output voltage inverter. The H-bridge multilevel inverter is mainly used in transformer less grid connected photovoltaic system applications. SPWM POD technique is a multi-carrier PWM technique which has reduced leakage current.**

Index Terms – Total Harmonic Distortion (THD), Sinusoidal Pulse Width Modulation (SPWM), Lab VIEW, Phase Opposition Disposition

I. INTRODUCTION

Modified Multilevel Inverters are used in the grid connected systems as the number of output voltage levels are high and the output voltage is very near to a sinusoidal waveform. Grid connected PV systems are emerging at a very fast rate. The inverter topologies to be used in grid connected PV systems should have very low leakage current [1].The leakage current is low in the modified multilevel inverters when compared to the other topologies of inverters. Single phase transformer less topology of multilevel H-bridge inverter is used with an active bidirectional switch to clamp the first leg in the H-bridge circuit [5]. Total Harmonic Distortion (THD) is reduced in the multilevel H-bridge topology [3]. For the inverter topology, the pulse generation is carried out by using the Sinusoidal Pulse Width Modulation (SPWM) –Phase Opposition Disposition Technique (POD). Sinusoidal Pulse Width Modulation is carried out by using the multicarrier technique. The hardware implementation of the pulse width modulation is carried out using the NI LabVIEW and the NI myRIO Kit. The simulation is carried out using the NI LabVIEW software. A single sinusoidal waveform is compared with the four triangle waves and the resultant waveforms are obtained.

II.INVERTER TOPOLOGY

Figure (1) is a modified multilevel inverter. It consists of H-bridge configuration and a bidirectional switch to obtain half the level of input DC voltage. In the mode1 operation of the H-bridge inverter figure (2a), the switches S1 and S4 turned ON and the S2, S3, S5, S6, D1 and D2 are turned OFF in this condition. In the positive semi-period the generated voltage is Vpv and Vpv/2.In the mode2 operation figure (2b), the switch s1 is turned OFF whereas the switches S4, S6 and D1are turned ON, and the remaining switches S1, S2, S3, S5 and D2 are turned OFF. The generated output voltage is positive and the voltage rises to Vpv/2.
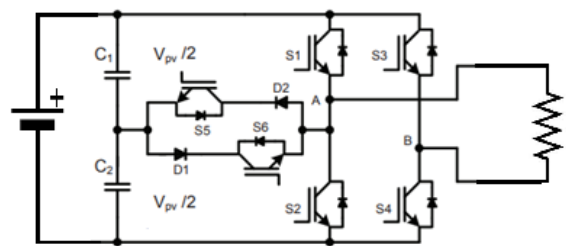

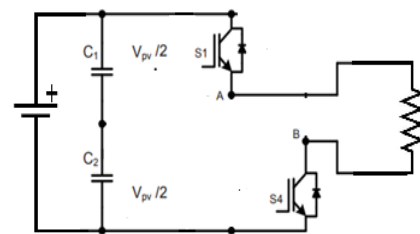Figure 1: Modified Multilevel inverter

Figure 2a: Mode 1

In the mode3 operation for the switching configuration Figure (3a), which is during the negative semi-period the switches S2 and S3 are turned ON, and the switches S1, S4, S5, S6, D1 and D2 are turned OFF.
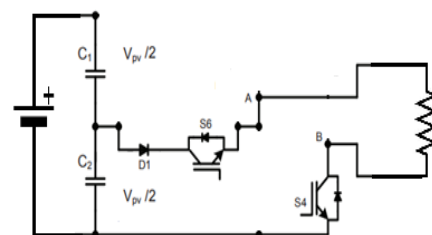

Figure 2b: Mode 2

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The output voltage is negative and the generated voltage levels are –Vpv and -Vpv/2.In the mode4 operation figure (3b) the switches S3, S5 and D2 are turned ON and the remaining switches S1, S2, S4, S6 and D1 are turned OFF. The output voltage is negative and the generated voltage is –Vpv/2.
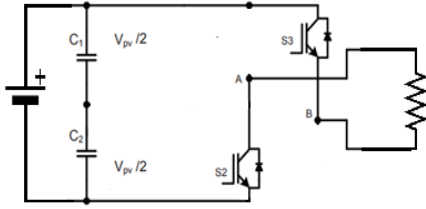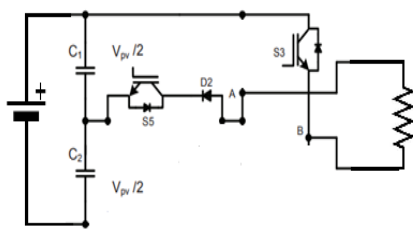

Figure 3a: Mode 3

Figure 3b: Mode 4

Mode5 and Mode6 operation is the null states operation. In mode5 the switches S1 and S3 are turned ON at the same time and the remaining switches are turned OFF, and in the other case which is mode6 the switches S2 and S4 are turned ON at the same time and the remaining switches are in OFF position. The switches S5 and S6 get saturated at the same time, and there is possibility of short-circuiting, therefore dead time must be included between the switches S2 and S6 [1].

III. CONTROL STRATEGIES

PWM techniques are classified into two types Level Shifted (LS-PWM) and Phase Shifted (PS-PWM). Level Shifted PWM is employed. Carrier signals used are vertically shifted to each other. This Level Shifted PWM is classified into three types. They are Phase Disposition (PD-PWM), Phase Opposition Disposition (POD-PWM) and Alternative Phase Opposition Disposition (APOD-PWM). From the classification of LS-PWM, Phase Opposition Disposition (POD-PWM) technique is more suitable for our topology. In POD PWM technique four carriers are used in such a way that the carrier signals above the zero reference are in phase and below the zero reference are shifted by 180° . For the five level inverter two signal above zero reference are in phase while, the other two are below zero are having phase shift of 180°. Pulse Width Modulation provides a way to decrease the Total Harmonic Distortion of load current [3]. In PWM, the amplitude of the output voltage can be controlled with the modulating signals. H-bridge inverter produces output voltage of Vdc, Vdc/2, -Vdc, -Vdc/2 and 0 [5]. In the unipolar switching for Pulse Width Modulation, output is switched either from high to zero or from low to zero. Unipolar switching is considered to reduce rate of change of voltage.
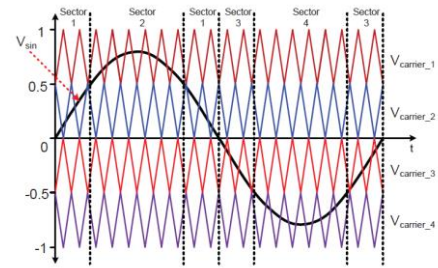

Figure4: Modulation strategy

IV. ALGORITHM

Step 1: Generate the sine wave, Triangle wave and square wave with the required parameters.
Step 2: Compare the sine wave and triangle waves by using the greater than and less than operations.
Step 3: Add the resultant outputs of comparison.
Step 4: Connect the resultants of addition operation to myRIO analog output block.
Step 5: Connect the outputs to the analog output according to the connection diagram of myRIO.
Analog output PIN A2 – S1, Analog output PIN A4 – S2, Analog output PIN B2 – S3, Analog output PIN B4 – S4, Analog output PIN C0 – S5, Analog output PIN C1 – S6

V. LABVIEW PROGRAM FOR MULTI-CARRIER SPWM

Simulation in LabVIEW is carried out in two parts as Front panel and Block diagram. Front panel consists of all the inputs and outputs as controls and indicators. Block diagram consists of the program [4]. All the outputs and indicators are in Front panel only. According to our application we design our program in the block diagram. The program in the block diagram consists of the generation of waveforms and the outputs of comparison. The front panel consists of the graph indicators to display the various pulse waveforms generated. Input parameters are given in the block diagram through constant blocks. The input parameters include the amplitude, phase, frequency and offset. Offset is specified by adding a constant value with the waveform output. The design parameters to generate SPWM for Supply frequency-50Hz, Carrier Frequency- 1 KHz.
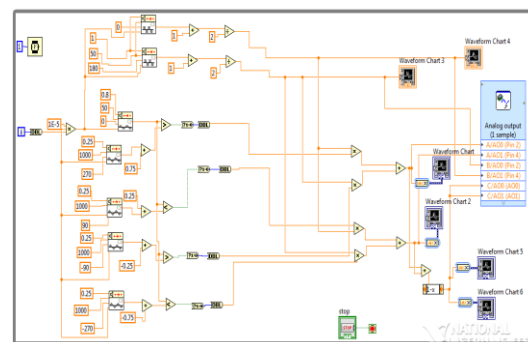

Figure 5: Lab view Program

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VI. HARDWARE IMPLEMENTATION USING NI MyRIO

In the employed SPWM technique, we are producing PWM signals for six switches of this topology. Those are digital signals, as we know PWM technique produces digital output. This output cannot be given directly to the proposed topology as there may be any signal discrepancy. So we can use signal conditioners (MAX1452, MAX1455, MAX6603 etc.,) for amplification.

Figure 6: Hardware setup

The signal is generated using NI LabVIEW software as this handles Data Processing. NI myRIO-1900is an external input-output device used here for connecting Lab VIEW with inverter hardware. We use the Lab VIEW software via MyRIO kit for giving control signals. Before using there are some installation procedures which include basically two steps of installation.

Firstly install LabVIEW software, modules and toolkits. Second part is to install NI device drivers.NI myRIO is connected to the computer over USB and wireless802.11 b.g.n[2]. We have to do the connectivity check for myRIO to check device compatibility with our system. Now add project .vi file under myRIO projects. In .vi file add respective output connection blocks which corresponds to taking signals out of myRIO. Check output using a Digital Oscilloscope. Continuously run program and graphs can be viewed in the front panel window.
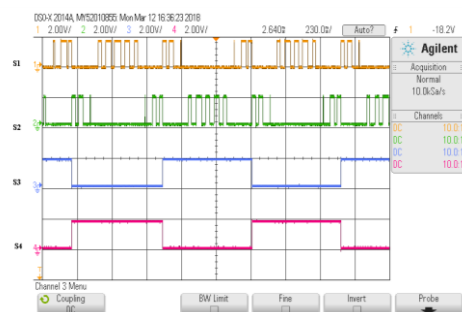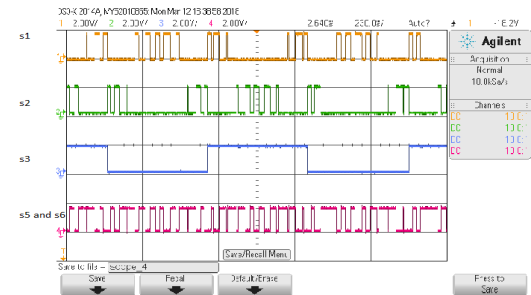

Fig. 6. Trigger pulse for S1, S2, S3 and S4

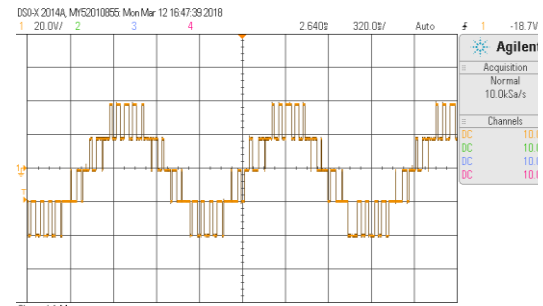
Fig. 7. Trigger pulse for S1, S2, S3, S5 and S6

Fig. 8. Output Voltage

VIII.CONCLUSION

By using LabVIEW, programming has become easy. Because programs developed for microcontroller have some tedious process and preparations to go through. Also it involves several steps like debugging, burning the program etc. So LabVIEW will be a better option due to its tremendous advantages such as graphical user interface, drag-and-drop built in functions, multiple high level development tools, easy hardware implementation using devices like NI myRIO, DAQ(Data acquisition) etc. In this project NI myRIO is used as an interface between software and driver circuits used for switches.

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