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Implementation of Cascaded H-Bridge Multilevel Inverter for Single Phase Induction Motor by Using Labview-Myrio

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Abstract
This work includes modeling for multilevel converter connected to induction motor for controlling speed by using LabVIEW. LabVIEW is strong graphical interface, flexibility of its programming language combined with built-in tools designed specifically for testing, measuring and controlling. MOSFET's are used as power switches. Pulse width modulation techniques (PWM) are the most commonly used methods to control voltage, frequency of AC machines. This paper proposes a new switching scheme for cascaded single phase H-Bridge multilevel inverter. Gating signals are generated using NI My RIO along with driver circuit. The single phase induction motor speed is controlled by using v/f control method by varying the slider which is connected to myRIO. A hardware setup is also done partially by giving the gating pulses using NI My RIO to cascaded H-Bridge inverter.

Keywords: *inverter, induction motor, multilevel inverter, LabView, MyRio*

1. Introduction

Multilevel are important for development of high power medium voltage AC drives
Neutral Point Clamped Multilevel Inverter.

a. Flying capacitor Multilevel Inverter.
b. Cascaded Multilevel Inverter.

Maynard and Foch has proposed a flying-capacitor-based inverter in 1992. This converter is similar to diode-clamped inverter. Instead of using clamping diodes, it uses capacitors. The cascaded single phase inverters offer more than two voltage levels. The output voltage waveform is obtained from 5 voltage levels with less distortion, at lower switching frequency, high efficiency. An important question is effective single phase multilevel converter is to reduces total harmonic distortion (THD) in the output voltage waveform should be less. At all switching angles the required fundamental voltages, lower order harmonics are eliminated.

DC sources are equal. Harmonics are eliminated from the multilevel converter since the DC sources does not have equal voltage levels. Usually each phase of a single phase cascaded multilevel converter requires n DC sources for 2n+1 level. In many of the applications, for obtaining several separate DC sources it is difficult as many DC sources are required.

In this paper, the lower order harmonics are eliminated by using two equal DC voltages for H- bridges, for reduction in the number of DC sources. Use of two equal DC sources is generated by a five level equal step single phase multilevel inverter output. Multilevel Inverter has been recognized as attractive topology for high voltage DC-AC conversion.

Multilevel Inverter

This inverter is used instead of two level VSI for various high voltage applications. Voltage amplitude can be increased which decreases stress in switching devices [6][7]. This intern reduces the harmonics. cascaded multilevel inverter is one of the popular topology used to exhibit simple circuit layout, less components counts, modular structure and can avoid unbalance capacitor voltage[8]-[13].

If the output level is increased when the connection area becomes complex and when it is applied to induction

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motors for variable speed applications. Induction motor control is expressed in terms of torque developed. Hardware implementation is done here by using *LabVIEW*. This can be also implemented by using microcontroller methodology for single phase induction motor

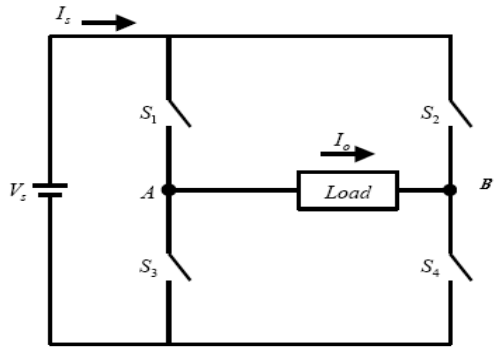
The pulse to MOSFET'S is given by coding in LABVIEW. The pulses obtained from that are given to NI MYRIO [5]. The hardware is completely worked under closed loop environment. The closed loop control is done by using a slider in the front panel obtained from block diagram. This enables us to control the speed of the induction motor [3,4].

LABVIEW enables the mathematical model in the block diagram and it displays in the front panel.

2. Multilevel Inverter

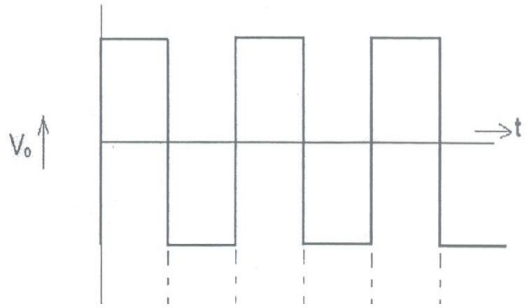
Single H-bridge

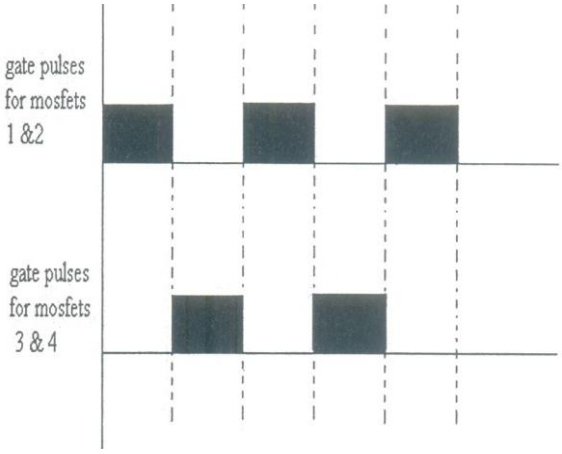
The single level is obtained by connecting MOSFETs as shown in the figure. MOSFETs are numbered for easy identification. The applied source is a low voltage DC supply (say 15V) and the load may be a resistive one (1000 ohms).



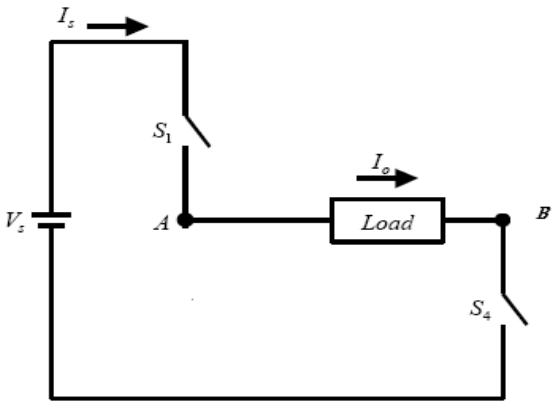
The voltage across the load and gating signals for the MOSFETs are as shown.

MOSFET's conducted for duration of its gate pulse is present and is commutated when the pulse is taken away. Therefore no need of any extra commutating circuitry. The duration for which the gating signal is to be given for a particular MOSFET is shown as shaded portion.

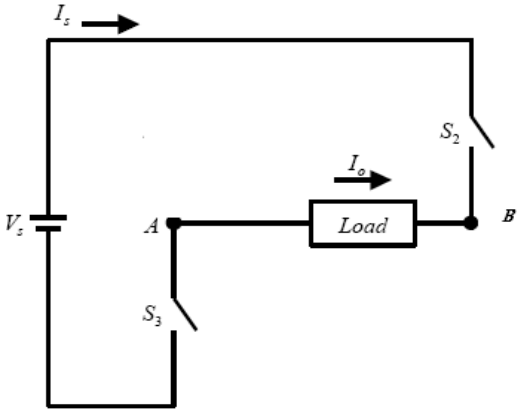




In the first half cycle in which the MOSFETs 1&2 are given firing pulse and the voltage, across the output is positive where the equivalent circuit is shown. (the MOSFET s that are not conducting during the interval are not seen).



In the other half cycle, MOSFETs 3&4 conducts, the voltage across load is negative (opposite to the previous) and the equivalent circuit is seen below.



In practical to obtain a gating signal in this manner Arduino can be used. When a 12V voltage source with a load is applied to H-bridge.

Multilevel Inverter

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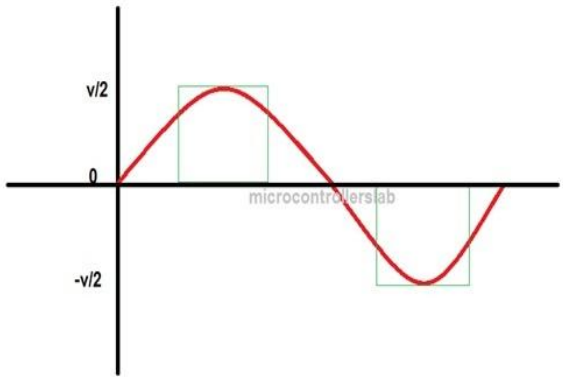
- A full H-Bridge multilevel inverter is connected in series produce an inverted AC from a separate DC source. The DC sources can be of any source like natural.
- This arrangement does not require any capacitors.
- The wave is sinusoidal and does not require any filter.
- These inverters are widely use in various applications for variable speed drives.
- The usage of multilevel inverters is to give a high output power from low voltage source. The multi-level inverter has several switches.
- High voltage is generated using the devices of lower rating.
- By increasing the number of voltage levels better voltage waveform is obtained.
- Switching losses are reduced for PWM operation

How Multilevel Inverter Works?

Single phase inverter gives a variable AC voltage from a DC input voltage. In a two level inverter the inverter gives out two half cycles where one is a positive half cycle with +V/2 and there a negative half cycle with –V/2. For building the proposed inverter, two dc sources are required with equal voltages. The type of single phase inverter can also be used with different DC input voltages.



The normal single phase output voltage with two level creates disturbances in the output like noise, harmonics, distortions. This can be overcome by the concept of a multilevel inverters. This MLI can convert two level voltages to different level of voltage levels but the complexity in the circuit becomes more and can be overcome by using different switching operations. When the output voltage level is increased the above mentioned disturbances can be reduced.

3. Software Requirements

Labview:

LABVIEW could be a system engineering software applicant in testing, measurement, and control with rapid access to hardware and data.

Laboratory Virtual Instrument Engineering Workbench is a platform for a visualized programming, from National Instruments.

The graphical language is known as "G";

Dataflow Programming

Programming is employed in LABVIEW, sometime as called G, supported the data available. If there's an enough data available to the sub VI or a function, the sub VI where the function is executed. This flow is set by the block diagram (the LABVIEW-source code) where the programmer can connect different function and nodes by drawing with connecting wires. This might be the case for multiple nodes. LABVIEW can be executed inherently in parallel. Multi-processing is an extra feature of this software. Once the execution takes place the built-in scheduler, that multiplexes the multiple OS is prepared for execution.

Graphical Programming

LABVIEW is a user interface.

LABVIEW programs virtual instruments (VIs). Each VI has three components: a diagram, a front panel, and a connector panel. This VI is represented in the form of block diagram and calls the other sub VI's. There can be n number of states according to the complexity of the problem. The front panel uses these controls and indicators obtained from the bock diagram.

Controls are inputs:

These controls and inputs provide information of the designed problem and are given to the logic.

Indicators are outputs:

These indicate and display the outputs obtained through the inputs connected to VI

The block diagram is just like a back panel contains blocks which appears in the front panel. The blocks are connected with nodes and wires .these wires are not displayed in the front panel .the front panel indicates only the controls and indicators ie inputs and outputs. The logic on the block diagram is built in the form of structures. The structures are present in the pallete box and are connected to inputs and outputs which are displayed in the front panel.

There is a condition in connecting wires that two controls cannot be connected and two indicators cannot be wired.

Thus a virtual instrument is often a run than a program, with the front panel serving like interface, the front panel defines the inputs and outputs in the node through the panel connector.

This implies each VI are often easily tested before being embedded as a subroutine into a bigger program.

The graphical approach allows non-programmers to create programs by picking and dropping the virtual representations of lab equipment.

The LABVIEW programming environment, with the included examples and documentation, makes it

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simple to make small applications. This is a benefit on one side, but there's also a particular danger of underestimating the expertise needed for high-quality G programming.

For complex algorithms or large-scale code, a programmer must possess an in depth knowledge in LABVIEW syntax.

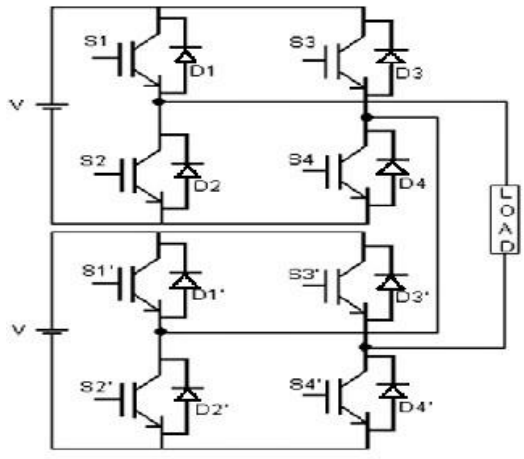
The most advanced LABVIEW development systems offer the power to create stand-alone applications.

4. Cascaded H Bridge Multilevel (5 LEVEL) Inverter

The DC input voltage is given in the form of modules. There are two modules on the proposed multilevel inverter. Each module consists of four switches and the total H-bridge multilevel inverter consists of eight switches. Each module is given with a dc source of same voltage.

Single phase full bridge inverter gives a variable AC voltage from a DC input voltage. In a two level inverter the inverter gives out two half cycles where one is a positive half cycle with +V/2 and there a negative half cycle with –V/2.

Each single phase H-bridge consists of a three-level converter. The four switches S1, S2, S3 and S4 are controlled by giving pulses through NI Myrio which gives discrete outputs with levels at +V, 0 and -V. When S1 and S4 are on, the output is +V and when S2 and S3 are on, the output is -V; when either pair S1 and S2 or S3 and S4 are on, the output is 0. The configuration of the proposed inverter is given below with the switching operations of the two modules. The operation of all the eight switches are shown in the table.

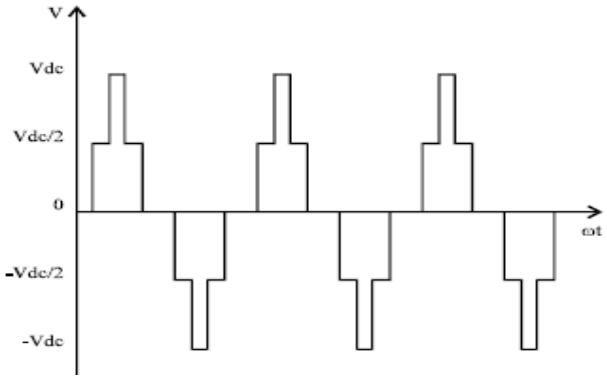


Five Level Cascaded Multilevel Inverter

The switching logic to obtain various output levels 0, +V, +2V, -V, -2V are shown in the following table

IGBT Nos	Ports	0V	+V	+2V	-V	-2V
S1	RC0	0	0	1	0	0
S2	RC1	1	1	0	1	1
S3	RC2	1	0	0	1	1
S4	RC3	0	1	1	0	0
S1’	RC4	1	1	1	1	0
S2’	RC5	0	0	0	0	1
S3’	RC6	0	0	0	1	1
S4’	RC7	1	1	1	0	0
Hex code		96H	9AH	99H	56H	66H

Load voltage waveform of the 5 level inverter is shown within the following waveform. A step waveform are often generated by combining specified output levels, which is shown below.



Load voltage waveform

The generation of pulses is completed by building the diagram within the LabVIEW program. Then the program is dumped into the myRIO by using female to male jumpers. Within the LabVIEW the program for respective pulses is made such the pulses having an magnitude of three .3 volts is boosted with the assistance of driver circuit such the output pulses from the driving force circuit will have an magnitude of 12 volts [2]. The pulses are then driven to the gate terminals of the IGBTs such they trigger consistent with the logic and therefore the induction motor is formed to run [1]. An sensor called IR sensor is attached to the blades of fan which is connected to the shaft of single phase induction motor such it acts as an feedback the sensor measures the amount of rotations and sends the worth to myRIO there it calculates the amount of rotations in RPM and it's displayed within the LCD screen which is attached to myRIO with the assistance of female to female jumpers. A slider is connected to myRIO such it are often wont to vary the speed of single phase induction motor. The program in LabVIEW is as follows: Block Diagram of LabVIEW Fig: Voltage outputs

The program in LabVIEW is as follows:

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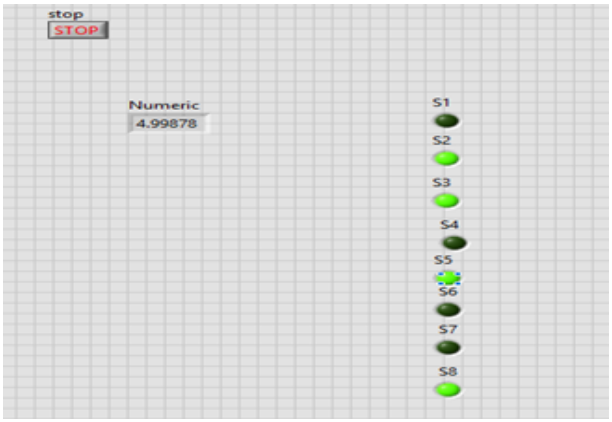
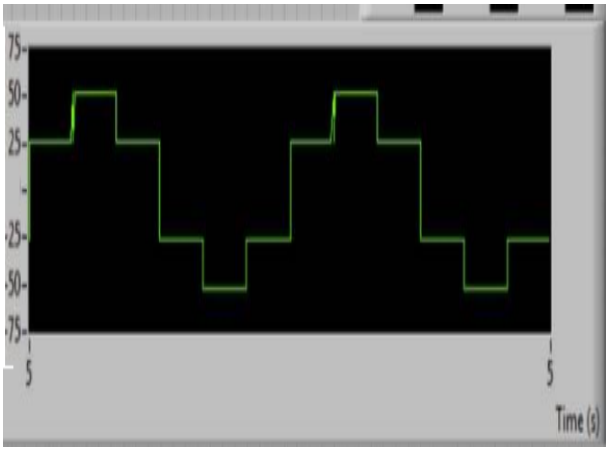


Block Diagram of LabVIEW



Voltage outputs

5. Conclusion

The software for cascaded H bridge five level multilevel inverter is fed to induction motor so as to regulate its speed by using Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is completed. By using Pulse width modulation techniques (PWM), the width of the pulses given to the gate terminals of MOSFETs is modified by using v/f control method and therefore the MOSFETs have less switching frequency. thanks to this the efficiency of output voltage is increased. In NI MyRIO it's easy to convert the analog value to digital or the other way around such by using the slider the speed of single phase induction motor is controlled. The hardware model is developed partially.

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