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DESIGN AND SIMULATION OF 3-PHASE 5- LEVELCURRENT SOURCE INVERTER FEEDS TOINDUCTION MOTORDRIVE USING INDUCTOR CELL AND H-BRIDGE TOPOLOGY

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Abstract:

The importance of multi-level inverter become a necessity that is used in industrial applications because it provides high energy in addition to it reduces the harmonics in the forms of AC wave.This paper includes the study of 3-phase 5- level which fed IM (IM) drive.The 5- level inverter is form of one H-bridge and one inductor cell and also increase number of levels in waveform output by increasing the number of inductor cells. Quality of low voltage and current in the traditional inverters that fed the IM as well as to the existence of harmonics so thereare significant loss of energy. Multi-level current source inverter (CSI) used to minimize the harmonics in output waveform.Simulation of 3-phase 5- level inverter fed IM drive is done by using Matlab/Simulink.

Key Words: Current Source Inverter (CSI), 3-Phase Five-Level Inverter, IM Drive& Total Harmonic Distortion (THD).

Introduction:

A 3-phase IM is widely used in the industry because it has the ability to adjustable wide range of the speed in applications, as well as being has easy in install and requires less maintenance. In recent years, the industry has started to require high equipment devices. The direct current of the megawatt voltage is directly connected to the intermediate voltage ring (2.4, 3.4, 4.6/ 7.4 Kv). A novel design of multi-level has a solution to work with high voltage levels [1]. The most distinguish characteristics of multi-level inverters are generating output voltage or current waveform with less harmonics, takes input current with less distortion, generating less common mode voltagethen reduce the stress in the motor tolerance and using tidy modulation manners common mode voltages can be eliminated, as well as working with a less switching frequency. Multi-level inverter performs an important function in many applications as well as a signal near to a sinusoidal wave with less harmonic should be created. This inverter is applied to applications that use huge power due to preferable harmonics and proper output waveform [2]. Most applications of multi-level inverter have been used for high power converters for stability improvement and voltage ampere reactive compensation, high voltage IM drive, effective filtering, high voltage dc transmission and lately for medium voltage or current IM adjustable speed drives. Moremulti-levelinverter application concentrate on industrial intermediate voltage or current motor drives, usefulness interface for photovoltaic systems, dragging drive systems and FACTS [3]. The less number of level in multi-level current and voltage waveform fed for IM which has more harmonics. The existence of considerable value of harmonics makes the motor to afford torque from dangerous pulses, particularly at lower speed, which roster them-selves in control of the shaft [4]. The decrease in harmonics demands for big sized filters, producing a raised in the size and price of the system. These daysmulti-level inverters committed alternative and add influential result for applications with huge voltage and huge power. Multi-level design helps increasing the power treating ability of the system in strong and methodical manner. The progress in the field power-electronics and micro-electronics whichallows to less the value of harmonics with multi-level inverters, so that the number of the inverters levelsare increased instead of raising the size of the filters [5]. The effectiveness of multi-level inverters consolidates with increase the level in output of waveform.

Converter Description:

Single Phase 5- Levels CSI:

5- levelCSIwaveform composed of a main H-bridge CSI is operating as a essential inverter equips five-level current source waveform ininterconnection with one inductor cell in parallel as subaltern circuits.Inductor cell is generating the inter-mediate level of the multi-level current waveform with no extra outerpower sources.The output currents of the 5- level CSI are (+I, +I/2, 0, −I/2, and –I). This topology increases levels by Increasing the number of inductor cells be depending on the correlation between the level number of a five-level output current waveform (M) and the number of inductor cells (N) [6-9].

$$M = 2^{(N+1)} + 1$$

When N= 1, we get output waveform of5- levelCSI and nth number inductor cell ILc (i) expressed as:

$$ILc(i) = \frac{I}{2^i} \text{ Where } i = 1,2,3\ldots\ldots..N$$

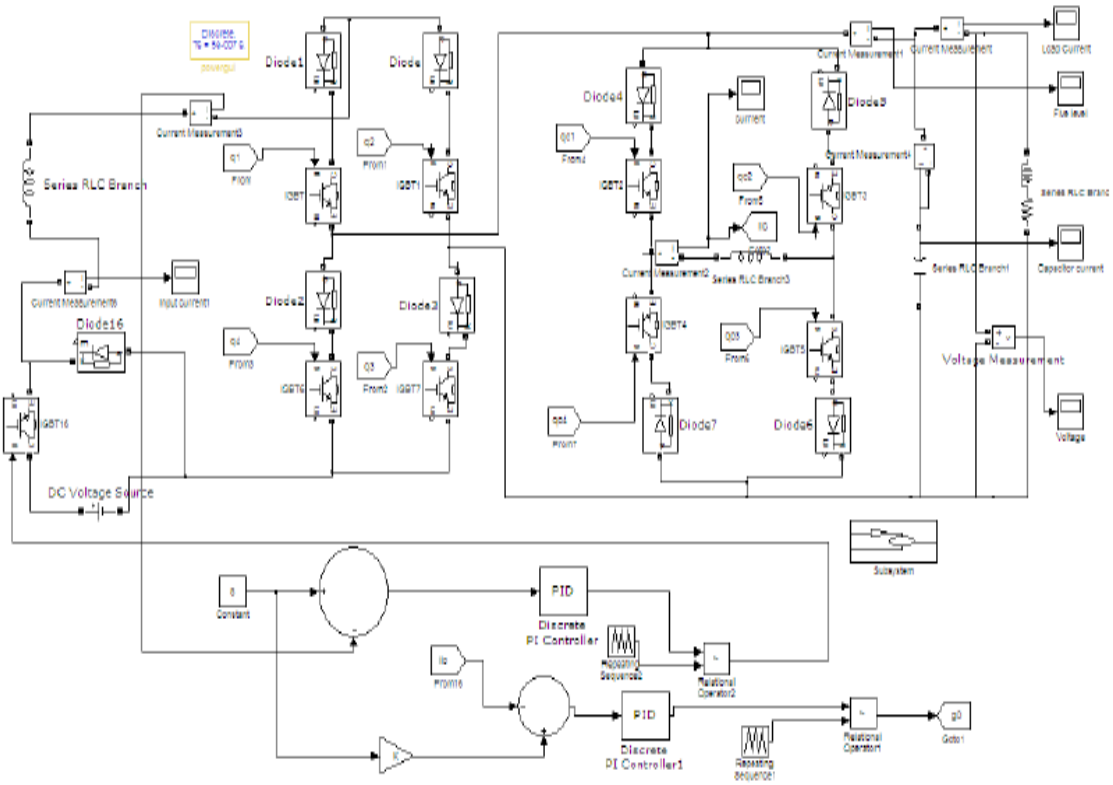

Figure 1: Single leg of 3-phase 5- levelMulti-level Inverter

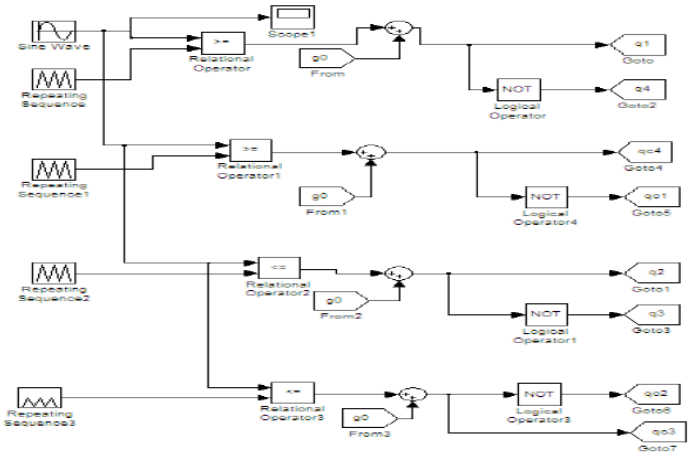

Figure 2: Subsystem of 5- levels CSI

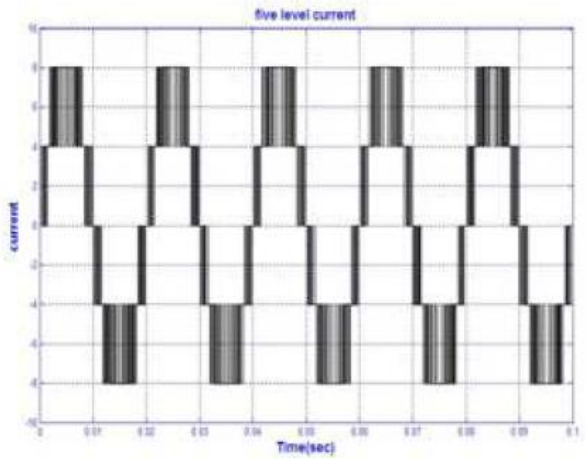

Figure 3: Output of 5- levels CSI

Figure 4: FFT Analysis for 5- level CSI

Operation Principle of new multi-level CSI:

The operation of Inductor cell explainedby three cases:

Charging Case of Inductor Cell:

Charging case happens when (Qc1 and Qc3) areswitch on and (Qc2 and Qc4) are switch off and the current is passing from H-bridge to the load.The amountof current equal to 1/2I.

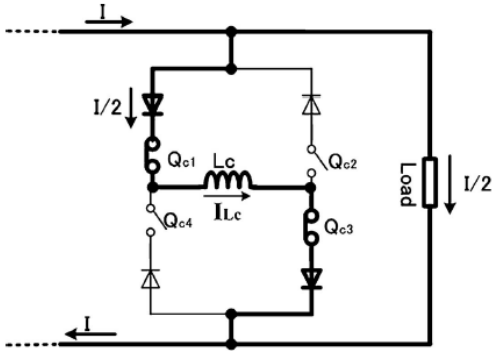

Figure 5: Charging case

Discharging Case of Inductor Cell:

Discharging mode happens when (Qc2, Qc4) are switch on and (Qc1, Qc3) are switch off and the power saving in the inductor ispassing to the load. The amount of current equal to 1/2I.

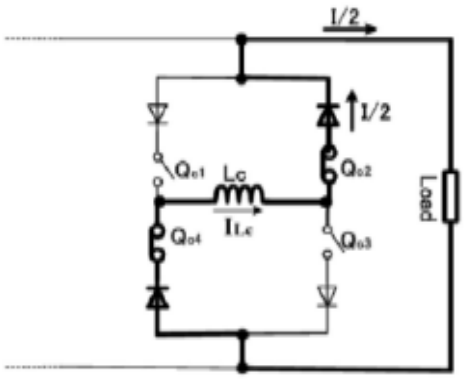

Figure 6: Discharging case

Circulating Case of Inductor Cell:

Circulating case happens when (Qc1, Qc2) are switch on and (Qc3, Qc4) are switch off and it use to save less current at the inductor.The current is passing from H-bridge to the load.The amount of current equal to I [12].

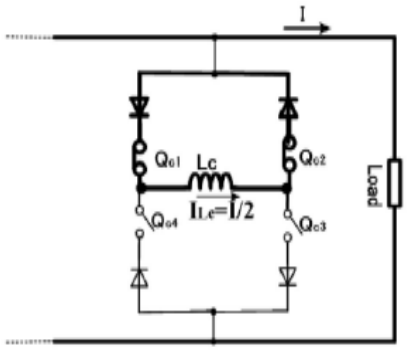

Figure 7: Circulating case

Table 1: Ratings

Smoothing inductor (Li) and inductor-cell(Lc)	1mH and 5mH
Power source voltage (Vin)	160V
Inverter switching frequency	22KHz
Filter capacitor Cf	5μ*f*
Load	R=8 , L=1.2 mH
Output current frequency	50

Improve:

IMis the generallyused in intermediateand hugepower industrial application, due tolessprice and rising reliability. The enhancement of hugevoltage or current and lessprice power-electronic elementsat past provided a many application in a.c. drives. A.c. drives like IM drives with power- electronic converters replaced thed.c. motor drives in many industries[13-14].Hardness in using a.c. drives with selection of appropriate power-electronic converter. The non- linear dynamic representation of the induction motor, withextra non- linearity's in the switching performance and converter dynamics, Control task are hardness also, especially when PWM used in control for the power- electronic converter, the duty ratio is necessary to be restricted in a specified domain, this can creat stability cases. Multi-level inverter may be a fantastic option for substituting conventional VSI or CSI. Minimizing voltage stress, Increase the power ratings and quality of output current or voltage are some of the advantages of Multi-level inverter [15].

Matlab Results:

Multi-level inverter fed IMdrive executed by using MATLAB SIMULINK as in Figure 8. Figure 1 represent single leg5- level model using H-bridge CSI and inductor cell configuration. Figure 3 representThe single phase 5- level inverter output and Figure 4 representFFT analysis for 5- level CSI. Figure 9 representThe 3-phase 5- level inverter output phase current to IM. Figure 10 represent the stator current. Figure 11 representVariation of speed. Figure 12 represent torque variation.

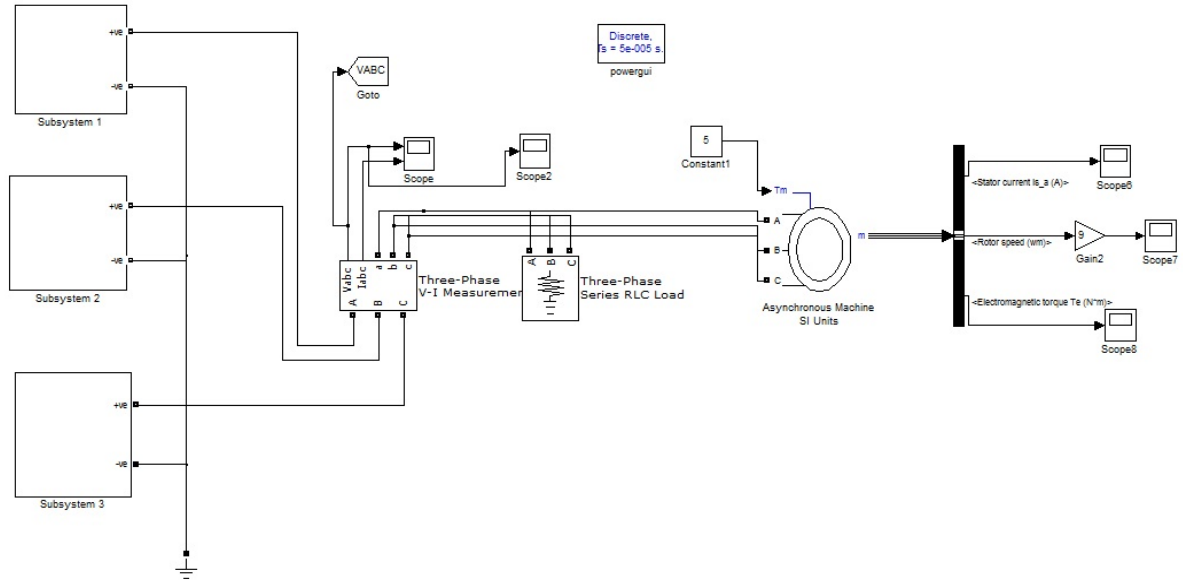

Figure 8: Multi-level CSI FedIMdrive

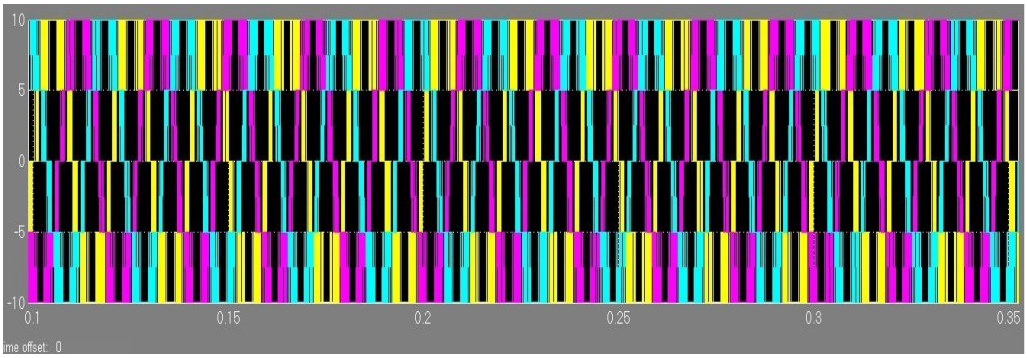

Figure 9: 3-phase 5- level inverter output waveform

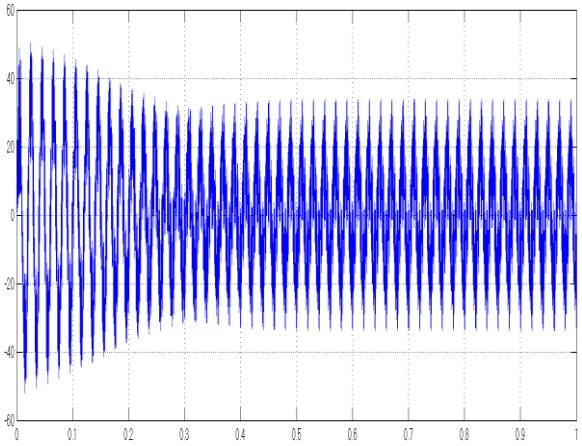

Figure 10: stator current output

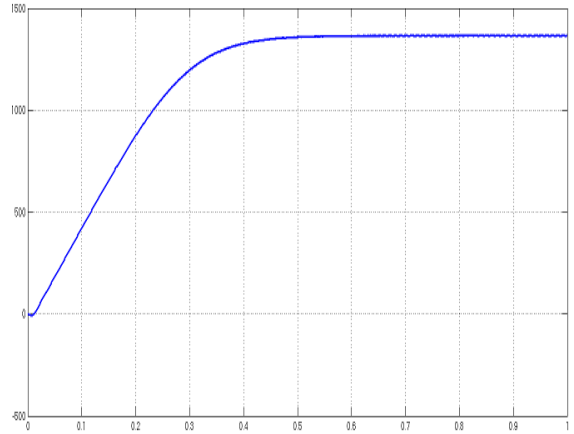

Figure 11: Variation in speed

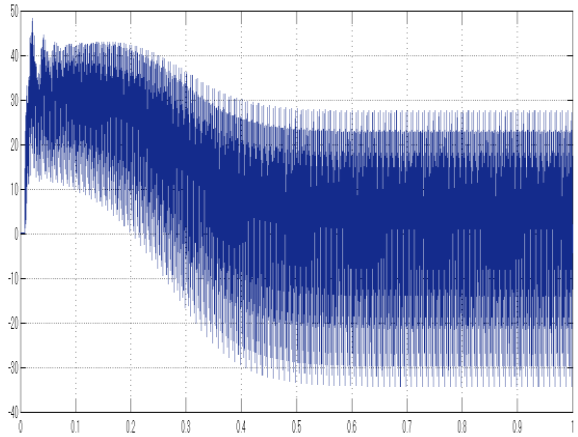

Figure 12: Variation in Torque

Conclusions:

In this paper a new five-level inverter fed IMdrive topology has been implemented. The present topology also has been generated less distortion of the output due to connecting inductor cells (one or more)towards the H-bridge CSI, the results reduction in di/dt then reduced switching stresses on devices, smaller size of filter capacitor, and lower EMI. It needs only single d.c. power source to generate multi-level without any additional external d.c. power sources. Simplicity in control circuit for the inter-mediate level current, inductors with small size. This topology has been realized high power applications and reduces the total harmonics distortion.

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