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Novel modulation technique for Asymmetry Diode Clamped Multilevel Inverter

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Abstract— *High power equipment are utilized in each power transmission and plentiful industrial applications. it's Mickey Mouse to use typical power convertor, thanks to its power rating. A construction power convertor structure was introduced to cut back the disadvantage in typical power convertor. To get a top quality output voltage with minimum quantity of ripple content, they need high switch frequency along side advance pulse dimension modulation ways. This paper presents a completely unique modulation technique for imbalance diode clamped multi-level electrical converter to provide a curving output. the most objective of the planned modulation theme is that the reduction of switch losses with smart harmonic performance. The principle of 3 Reference Modulations seven level curving Pulse dimension Modulation (TRM - SPWM) is analyzed well. This paper is especially converges on seven level electrical converter for single section system. The modulation technique will be simply extended to 3 section system. Simulation work is completed exploitation the MATLAB code. an in depth analysis is completed on diode clamped seven level electrical converter and experimental results ar conferred to demonstrate the prevalence of the planned system. That dissects the frequency spectrums of the traditional and therefore the planned schemes ar compared with one another through simulation.*

Keywords— **Multilevel Inverter, TRM-SPWM, MATLAB.**

I. INTRODUCTION

In recent years, the electrical and machinery industries have begun to demand for power conversion instrumentality within the vary of many Megawatts. Typical applications are the electrical train, heavy ac drives, conveyer belts, and unified power-flow controllers, that ar used DC to AC convertor usually referred to as electrical converter. typical electrical converter produces the sq. wave output, that contain a lot of harmonics. For increase the facility rating the quantity of switch device utilized in the convertor conjointly exaggerated. To eliminate the drawbacks of typical inverters construction structure were enforced. construction electrical converter is associate array of power semiconductor switches and electrical condenser voltage sources, that is switched {in a|during a|in associate exceedingly|in a very} manner that an output voltage of stepped wave shape is generated. construction inverters ar finding exaggerated attention in industries as a selection of electrical power conversion for medium voltage and high power applications, as a result of to boost the output wave shape of the electrical converter reduces its various harmonic content. The deviation of the voltageand current waveforms from curving is expressed as harmonic distortion. Power converters ar the most important supply of harmonic distortion, that can't be eliminated simply by filters. the most important blessings of exploitation construction inverters embrace high voltage capability with restricted range of switch devices, low harmonic distortion, reduced switch losses, exaggerated potency, and smart magnetic attraction compatibility.

In multi level electrical converter common topologies embrace the diode-clamped, flying electrical condenser and cascaded H-bridge inverters. during a single section system, the diode-clamped electrical converter has been wide applied thanks to the actual fact that it's fewer switch parts than different topologies and uniformly voltage sharing across the electrical condenser. uneven structure is principally accustomed scale back switch part and scale back the capacitors with exaggerated potency. Diode clamped construction converters ar utilized in high-octane ac motor drive applications like conveyors, pumps, fans, and mills. they're conjointly used in oil, gas, metals, power, mining, water, marine, and chemical industries. For ancient construction inverters increase the voltage levels with the assistance of increase the voltage level with the assistance of switch devices and electrical condenser. therefore it'll increase the switch losses, the value becomes high and therefore the circuit can becomes advanced.

Various switch techniques and PWM algorithms ar enforced to cut back the switch losses and total harmonic distortion. sort of topologies for multi-level inverters had been planned over the years. consequently, multi-carrier primarily based construction SPWM ways appropriate for diode-clamped electrical converter. Most of the on the market works on PWM schemes for a construction electrical converter cowl either multi carrier-based PWM or house vector PWM schemes. For a multi carrier primarily based PWM technique carrier frequency is high, therefore it tough to implement. On the idea of the thought of single carrier and multi modulations of construction SPWM, this paper proposes a completely unique TRM-SPWM, that could be a technique to cut back the extra part compare to a standard single carrier curving PWM theme. In typical three-modulation and one carrier primarily based seven-level SPWM theme used an equivalent waveforms within the positive and negative [*fr1] cycles of the modulations. It generates the positive [*fr1] cycle management signals solely. For the negative [*fr1] cycle, the signals ar reconfigured to provide a needed gate signals. within the negative [*fr1] cycle of the reference

modulation, the comparison logics between the 3 [*fr1] cycles and therefore the carriers have to be compelled to be inversed to implement construction output PWM waveforms. however planned schemes inverse the modulation signal within the negative [*fr1] cycle to provide the specified gate signals, that is a lot of convenient than typical strategies.

II. ASYMMETRIC DIODE CLAMPED MULTILEVEL INVERTER TOPOLOGY

To solve the drawbacks in typical diode clamped construction electrical converter uneven structure was planned. uneven structure is principally accustomed scale back the quantity of switches and clamping diodes. during a single section system, the diode clamped electrical converter has been wide applied thanks to the actual fact that it's fewer switch parts than different topologies. A schematic diagram of a single-phase seven-level imbalance diode clamped electrical converter is shown in Figure.1

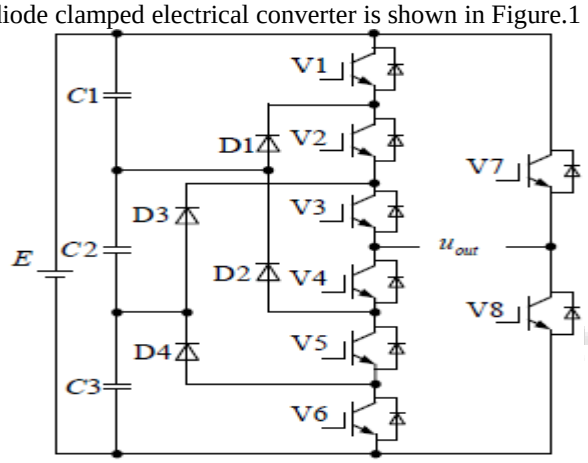

Fig.1. Schematic diagram of asymmetry diode clamped seven-level inverter

For the seven level imbalance diode clamped electrical converter carries with it eight switches and 4 clamping diodes. The capacitors ar accustomed share the input voltage equally. The left bridge arm combined with five-level leg, that carries with it six switches. Right bridge arm combined with two-level leg, that carries with it 2 switches. the overall operate of this construction electrical converter is to synthesize a desired voltage from the dc sources, which can be obtained from batteries, fuel cells, or ultra-capacitors. Single dc supply is employed to provide a seven level output. In PWM technique the dead time ought to be set to provide a continual wave shape which may be set with the combine of complementary switches, v1 and v4, v2 and v5, v3 and v6, v3 and v8.

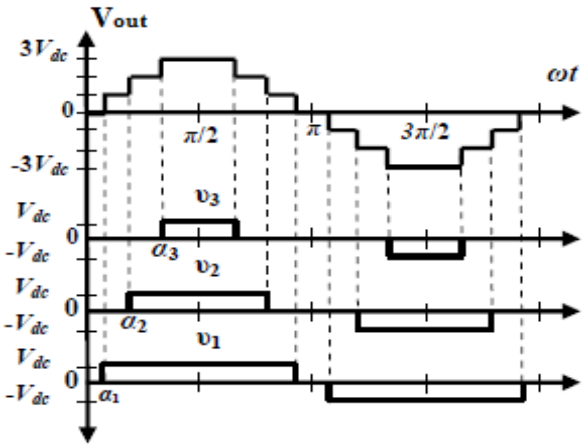

Fig.2: Output waveform of seven level Asymmetric diode clamped multilevel inverter

An 'm' level inverter needs

Number of switching devices $N_{sd} = m+1$ (1)

Number of clamping diodes $N_{cd} = (m+1)/2$ (2)

Number of DC bus capacitors $N_c = (m-1)/2$ (3)

III. PROPOSED TRM-SPWM SCHEME

To solve the traditional TRM-SPWM issues a completely unique TRM-SPWM theme is planned and therefore the principle is shown in Fig.3. The 3 modulations ar compared with an equivalent carrier. to get the seven-level SPWM wave shape while not inverting the comparison logic, the 3 modulations in their negative [*fr1] cycles ar all inverted and offset with totally different DC values (related to the amplitude of the carrier). The comparison results of u_r1 and therefore the carrier is employed because the management signal of V1, wherever logic inversion is employed because the management signal of V4. The comparison results of u_r2 and therefore the carrier is employed because the management signal of V2, and its logic inversion is used because the management signal of V5. The comparison results of u_r3 and therefore the carrier is used because the management signal of V3, and its logic inversion is employed because the management signal of V6. within the positive [*fr1] cycle, V8 is on, and V7 is off. within the negative [*fr1] cycle,

V8 is off and V7 is on.

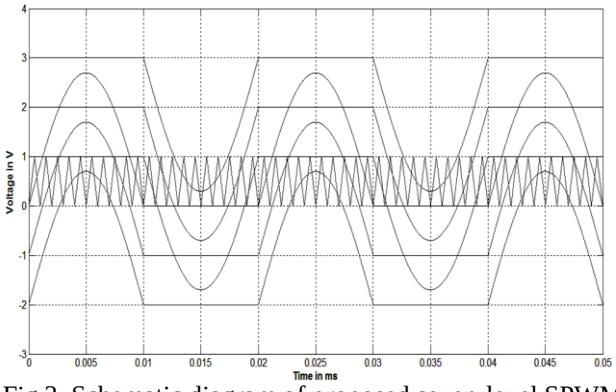

Fig.3. Schematic diagram of proposed seven-level SPWM

The functions of the three modulations are as follows. Assuming that the amplitude of the carrier is U_{tr}, the normal modulation is:

$$u_{nom} = U_{nom}\sin(\omega_s t) \quad (4)$$

Where u_{nom} and ω_s are the amplitude and the angular frequency of the normal modulation respectively.

The function of u_{r1} in the positive half cycle is:

$$u_{r1p} = U_{nom}\sin(\omega_s t) - 2U_{tr} \quad (5)$$

The function of u_{r1} in the negative half cycle is:

$$u_{r1n} = U_{tr} + U_{nom}\sin(\omega_s t) \quad (6)$$

The function of u_{r2} in the positive half cycle is:

$$u_{r2p} = U_{nom}\sin(\omega_s t) - U_{tr} \quad (7)$$

The function of u_{r2} in the negative half cycle is:

$$u_{r2n} = 2U_{tr} + U_{nom}\sin(\omega_s t) \quad (8)$$

The function of u_{r3} in the negative half cycle is:

$$u_{r3n} = 3U_{tr} + U_{nom}\sin(\omega_s t) \quad (9)$$

The amplitude of the modulation ratio of the proposed TRM-SPWM scheme is:

$$M = U_{nom} / 3U_{tr} \quad (10)$$

If the modulation ratio is varied the corresponding output voltage and THD level also varied

IV SIMULATION STUDY

The simulation of single section seven level imbalance diode clamped construction electrical converter was done exploitation Simulink. during this planned modulation strategy used, solely constitutional module gift within the advance controller to provide needed gate signals. a lot of switches ar needed to realize an equivalent output voltage within the symmetrical kind wherever equal dc sources ar used. the most advantage of the construction electrical converter over typical 2 level electrical converter is that the voltage stress on every switch is reduced thanks to series association of the switches. just in case of the symmetrical kind, the voltage of every switch is restricted to the worth of DC supply. Since the planned construction electrical converter uses unequal dc sources the voltage stress among the switches are going to be unsymmetrically distributed. therefore care ought to be taken whereas choosing power switches for this sort of configuration.

The MATLAB simulation circuit was developed for the traditional TRM-SPWM primarily based seven-level diode clamped electrical converter and therefore the imbalance construction electrical converter with novel modulation technique. The simulation of imbalance diode clamped construction electrical converter is shown in figure.4.

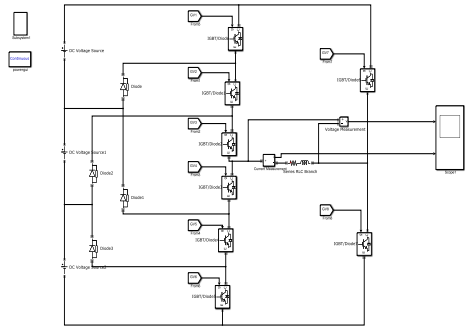

Fig.4. Simulation of asymmetry diode clamped multilevel inverter

The simulation model diagram for the planned circuit is shown in figure ten.It has solely eight switches used for seven-level electrical converter. Gate pulses ar generated by the mixture of XOR gates and pulse generators. typical imbalance diode clamped multi-level electrical converter consists of eight IGBT switches with three equal dc sources. The gate pulses ar generated by exploitation SPWM technique, that ar exploitation eighteen logic gates. For each complementary switch need gate pulses. Among all switches every switch is activate just one time during a complete cycle.

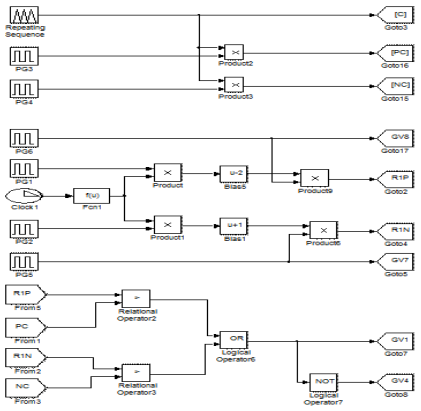

Fig.5. Simulation diagram of proposed TRM-SPWM scheme

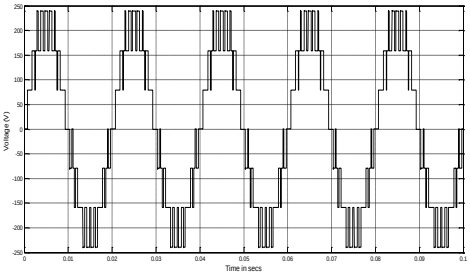

Fig.6. Output voltage waveform for asymmetry diode clamped Multilevel Inverter

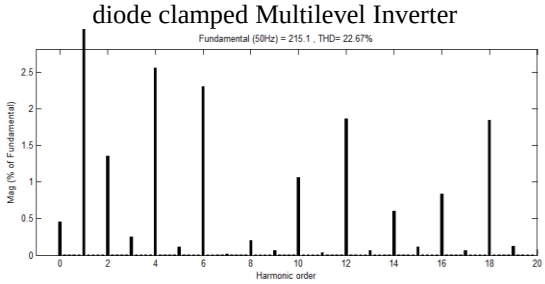

Fig .7.Harmonic spectrum of asymmetry diode clamped multi level inverter

THD level of TRM-SPWM based asymmetry diode clamped multilevel inverter is 22.67%.

V.EXPERIMENTAL RESULTS

To by experimentation validate the planned construction electrical converter output voltage, hardware of single section imbalance diode clamped construction electrical converter has been engineered exploitation MOSFET because the switch devices. A multi conversion cell consists of 3 half dozen V batteries. a true time variable output voltage, variable frequency electrical converter managementler supported ATmega16 Microcontroller is employed to implement the control rule. associate ATmega16 Microcontroller is employed because the main processor, that provides gate signals. in step with microcontroller management signal, MOSFET gate terminal is turned on and off. Output of the electrical converter terminal is connected to RL load. The hardware diagram and experimental setup of seven level electrical converter shown in Fig.8 and Fig.9. Hardware results of planned construction electrical converter is exposed in Fig.10.and Fig.11. The output voltage of seven level is fifteen V, with frequency of fifty cycle per second.

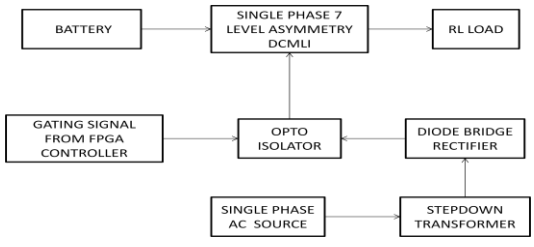

Fig.8. Block diagram of asymmetry diode clamped multilevel inverter

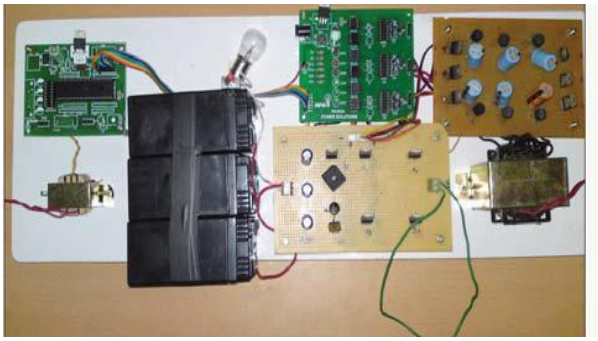

Fig.9. Experimental setup

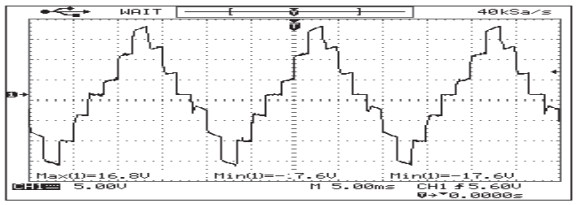

Fig.10. Output voltage of seven level asymmetry diode clamped multilevel inverter

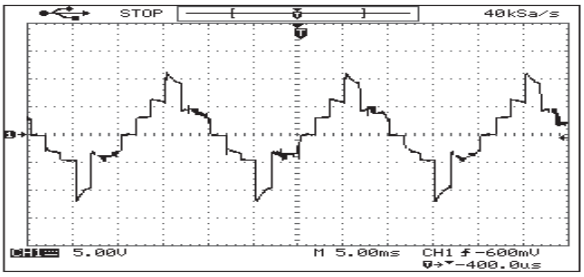

Fig.11. Output current of seven level asymmetry diode clamped multilevel inverter

V. CONCLUSION

Compared to totally different topologies and typical PWM switch schemes, elementary switch can cause lower the switch losses for the construction electrical converter. PWM switch schemes ar wide used thanks to its simplicity and harmonic reduction in multiple switch schemes. As a result, exploitation the construction first harmonic switch theme can cause exaggerated potency.

Proposed novel modulation technique for scale back the harmonics during a construction electrical converter utilizing the basic frequency switch theme. The planned topology reduces the quantity of logic gates and therefore the ThD level. therefore the switch losses and harmonic distortions ar reduced. The planned construction electrical converter will be used for industries wherever the adjustable speed drives ar needed and vital quantity of energy will be saved because the planned system has low harmonics.

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