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NEW ISOLATED MULTILEVEL INVERTER BASED ON CASCADED THREE-PHASE CONVERTER BLOCKS

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ABSTRACT— This paper displays another topology of an isolated multilevel inverter that can be utilized for high voltage and high power applications, for example, coordinating battery stockpiling system sand elective vitality sources to power network. With reduced number of segments the proposed fell multilevel inverter requires one and only dc source by falling high frequency transformers. The center building hinders in the multilevel inver terare the six-switch three-stage converters that are controlle dusing PWM stage moved plan for symphonious reduction.Discussions have been given to contrast the proposed cascadedmultilevel inverter and run of the mill existing fell inverters.Simulation and correlation examines have been completed toverify the execution of the proposed multilevel inverter.Index Terms- Cascaded converter, isolation, multilevelinverter, single DC source, three-phase converter.

I INTRODUCTION

To address the perpetually expanding interest for vitality andthe earnest ecological effect issues brought on by humanactivities identified with vitality creation and utilization, oneof the most encouraging arrangements is to jolt transportationfor enhanced fuel productivity and lessened outflow, and toimplement perfect, renewable vitality frameworks for electricitygeneration on a huge scale with high entrance. The marketshare of electric drive vehicle (EDV) in the US has beenincreasing relentlessly from 0.14% of new auto deals in 2011 to0.72% in 2014 [1], which could achieve a more critical levelof infiltration sooner rather than later. Renewable PortfolioStandards (RPS) [2] went in a larger part of states in the U.S.and the new fuel proficiency models of a normal fueleconomy of 35.5 miles for every gallon (mpg) by 2016 [3] providesupports in approach to Batteries have been distinguished by the DOE as one of thecritical advancements for EDV s that incorporate cross breed electricvehicles (HEVs), module crossover electric vehicle (PHEVs), andbattery electric vehicles (BEVs) [4]. A surge of resigned EDVbatteries will be seen as more EDVs hit the road.identified as the empowering advances toaccommodate renewable sources into future force systems(e.g., Smart Grids, Microgrids, or their mix withconventional power systems) [8]. Sandia NationalLaboratories discharged a report on the specialized and economicfeasibility of such methodologies quite a long while back [5]. However,management of huge scale battery stockpiling systems,particularly with utilized EDV batteries, is exceptionally testing taskand likewise requires more research on force electronicconverters and control methods.Multilevel inverters have gotten to be workhorse in gridconnected applications at medium and/or high voltage levelsbecause by and large it is difficult to interface a solitary powersemiconductor change straightforwardly to the brace [18]. Thesetechnologies are utilized to furnish power with low cost,reduced all out consonant twisting (THD), lessened dv/dt,optimal size, and low electromagnetic impedance (EMI)without disseminating a lot of force [9-18]. In general,multilevel inverter topologies can be grouped into four maingroups: 1) diode-clipped, otherwise called unbiased pointclamped (NPC) inverters; 2) capacitor clasped inverters (moreover called flying capacitor inverters); 3) fell H-bridgemultilevel inverter with discrete dc sources; and 4)interconnected three stage inverters, for example, Hexagramconverter [13, 15, 16, 18]. Additionally, different sorts of topologieshave likewise rose, for example, the one that is executed bymeans of falling the essential structures called hybridinverters [9, 11, 18]. A decent synopsis on different multilevelconverters can be found in [16].The diodes in a NPC inverter clasp the voltage and thecapacitors at the yield are in arrangement to share the high voltage.As an outcome, every switch stands just with one capacitor voltage[16]. Be that as it may, the inverter experiences capacitor unbalancevoltage issue and unfavorably huge number of cinching diodeswhen the quantity of voltage level is substantial [15]. Likewise, thereverse recuperation of clasping diodes turns into a noteworthy designchallenge if the inverter

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keeps running under heartbeat width modulation(PWM) for high-voltage high-control applications [18] H-span module will need to manage throbbing power.'2"(a the Hexagramconverter not appropriate for huge battery stockpiling framework thatrequire power administration on every battery module.This paper displays another topology of a fell multilevelinverter for high voltage and high power applications such asgrid associated battery stockpiling frameworks and other alternative2energy sources to power network. With lessened number ofcomponents the proposed fell multilevel inverterrequires one and only dc source by falling high frequencytransformers. Entrenched control techniques can be usedfor this multilevel converter. The PWM stage moved plan, an exceptionally prevalent technique in modern applications, is utilized forthe proposed inverter to lessen the sounds in the outputvoltage. Reproduction and examination ponders have been carriedout to check the execution of the proposed inverter.

II. CASCADED TRANSFORMERS TOPOLOGIES WITH ONE DCSOURCE

The cascaded multilevel inverter becomes one of the mostsingle dc power voltage source. This construction is used topile output voltage levels up by increasing number oftransformers instead of increasing number of dc voltagesources. Moreover, the HBCT inverter provides filtering effectof harmonic components due to the leakage reactance thecascaded transformers [9] and also provides electric isolationbetween output and source [13].In the HBCT inverter, the primary terminals of the transformers winding are connected to the H-bridge inverters to synthesize output voltage of +Vdo 0 V and -Vdc while theterminals of the secondary winding are connected in series toelevate the output voltage. The amplitude of the output voltage is determined by the turn ratios of the cascaded transformersand the input dc voltage. Hence, this inverter can operate ineither symmetric or asymmetric modes to synthesize steps of output voltage [9]. The maximum number of phase voltage levels in a symmetric HBCT inverter is given by: m=2K +l (1)where m, K are number of voltage levels and number of cascaded transformers, respectively. The output voltage can be obtained by summing the voltages across the secondary terminals of the cascadedtransformers.Vo = L.�=1 Vk (2) synthesize steps of output voltage [9]. The maximum number of phase voltage levels in a symmetric HBCT inverter synthesize steps of output voltage [9]. The maximum number of phase voltage levels in a symmetric HBCT inverter

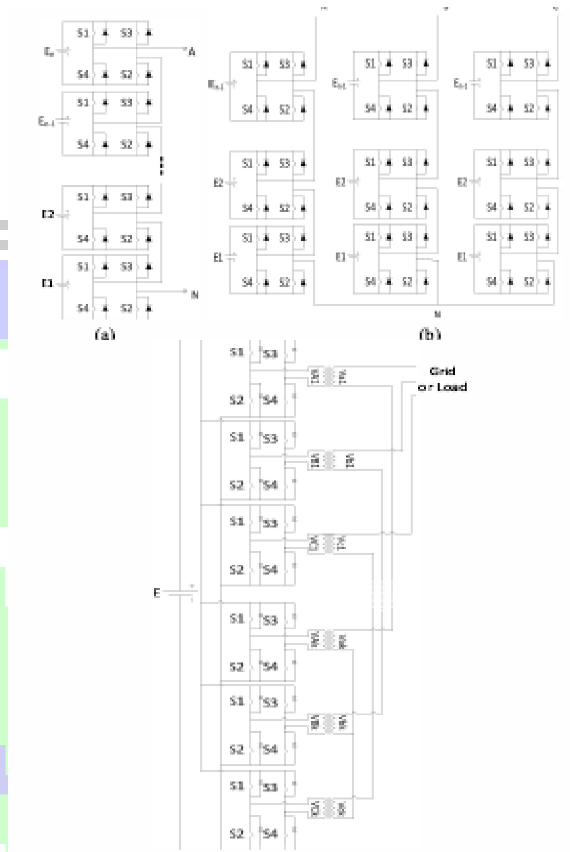

Fig. 2. Topology of a three phase H-bridge cascaded transformer (HBCT) multilevel inverter [12]

III. PROPOSED SIX-SWITCH CASCADED TRANSFORMERMULTILEVEL INVERTER

A new cascaded transformer based multilevel invertertopology with one single dc source is proposed in this paper.The building blocks in the proposed multilevel inverter aresix-switch three phase inverters, not the single phase H-bridgeconverters used in the HBCT shown in Figs. 1 and 2. Fig. 3shows the initial circuit topology of the six-switch cascadedtransformer (SSCT) multilevel inverter, based on which thenew topology will be developed. One of the advantages ofusing three-phase converters as building blocks is that dqframe based control can be used, which is simpler and canto the primary terminals of a high frequency transformer togenerate three voltages at the output side: +Vdc, 0 V and -VdC.The two inverters are controlled by a 12-pulse

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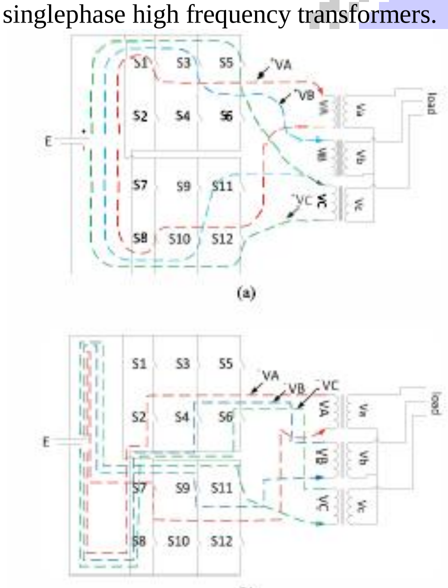
PWMtechnique (unipolar PWM drive technique of three-phaseinverter) where the upper inverter is driven by the first 6pulses while the remaining pulses are used to control thesecond inverter. The pulses are generated by comparing atriangular carrier waveform with two sinusoidal modulatingwaves for each phase which are of the same magnitude andfrequency but ISOo out of phase. For example, pulses 1, 2, 7and S are used to drive the corresponding switches which areconnected to phase A where S2 and SS are complementaryswitches for S 1 and S7, respectively. As a result, S 1 and SSwork together to perform +Vdc and 0 while S2 and S7 are usedto provide -Vdc and 0 at output terminals. In other words, thetwo inverters work together as a complementary device foreach other, making it easy to connect them to three singlephase high frequency transformers.



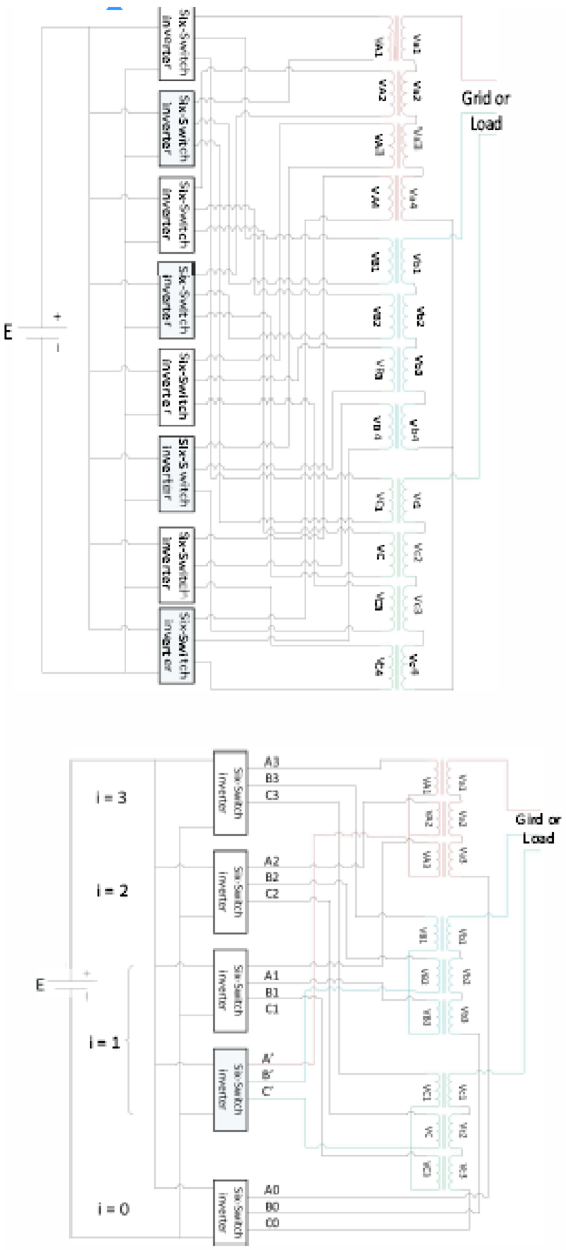
g. 4. Basic cell of the proposed inverter in the initial circuit topology: (a) ree phase positive level, and (b) three phase negative level.

Fig. 4. Basic cell of the proposed inverter in the initial circuit topology: (a)three phase positive level, and (h) three phase negative level.Well established carrier based PWM modulation techniques(such as phase-shifted or level-shifted modulation) formultilevel inverter can be used for the SSCT inverter. In thispaper, the phase-shifted scheme, a very popular method in ,industrial applications, is used to control the SSCT inverter toreduce harmonics in the output voltage [IS]. All the six-switchbuilding blocks are connected to the same dc source in paralleland all secondary terminals of the basic units are connected inseries to elevate the output voltage. As a result, the voltagelevel is increased by cascading more transformers. The peakof the output voltage is determined by the tum ratios of thecascaded transformers, the number of voltage levels and theinput dc voltage. The SSCT inverter can operate in eithersymmetric or asymmetric mode. If all the tum ratios are thesame, the inverter is known as symmetric multilevel inverterand the resulting output ac voltage could swing from +KaVdcto -KaVdC where K, a are the number of the cascadedtransformers and the tum ratio, respectively. The output phasevoltage can be determined by summing the voltages across thesecondary terminals of the cascaded transformers, which canbe described by (2) as well. The number of phase voltagelevels in the symmetric SSCT inverter. it is noticed that the proposed SSCT inverter acts similarlyto the three phase HBCT multilevel inverter while theproposed inverter has ability to reduce the number ofsemiconductor switches. One six-switch inverter block in thelast stage in the cascaded string can be removed. Moreover, inthe other stages, certain six-switch inverter blocks can beremoved as well. For the other stages (other than the laststage), one six-switch block can be removed for each stageexcept one stage that still needs to have two inverter blocks toprovide a complementary path (e.g., block A'B'C' in Fig.5(b)) for all the remaining six-switch inverter blocks, asshown in Fig 5 (b). The transformer at the last stage can beremoved if electric insolation is not needed and theshows a nine-levelSSCT inverter of its initial version with 8 six-switch inverterswhile Fig. 5(b) shows the compact SSCT inverter with only requirements, size and manufacturing cost.

IV. SIMULATION AND COMPARISON STUDIES

In multilevel inverter topologies, number of systemcomponents normally has a proportional relationship with thenumber of output voltage levels. Increased number of systemcomponents will increase the size of inverter, weight and costand also imposes higher requirement of insulation andcomplicates the control.

Moreover, these drawback factorswill challenge system reliability by means of the voltage levelgoes up. So, as discussed earlier, a new inverter topology isproposed to have more output voltage levels with less systemcomponents.Table I presents the number of components required toimplement a nine-level inverter with different topologiesincluding the proposed inverter. The proposed inverterachieves a 36% reduction in the number of systemcomponents required and uses only thirty switches comparedsymmetric converter underresistive load.



(b)

Fig. 5. The proposed inverter: (a) The initial SSCT inverter, (b) The compact SSCT inverter with component number reduced.

TABLE I
COMPARISON OF TOTAL COMPONENT REQUIREMENT FOR A NINE-LEVEL INVERTER UNDER DIFFERENT TOPOLOGIES.

	Cascaded H-bridge [18]	HBCT inverter [12]	CHBCT inverter [13]	Sub-Multilevel inverter [9]	Proposed inverter
Trans-formers	0	4	4	2	3
Switches	48	48	36	36	30
dc source	12	1	1	2	1
Diodes	48	48	36	36	30
Total #	108	101	77	76	64
% of reduction	0%	6.5%	28.7%	29.6%	40.7%

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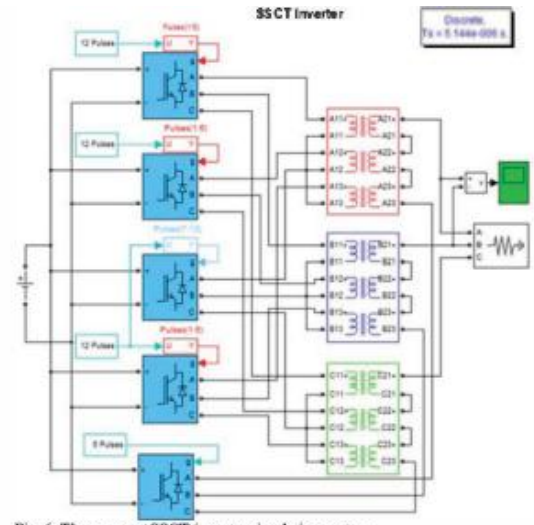
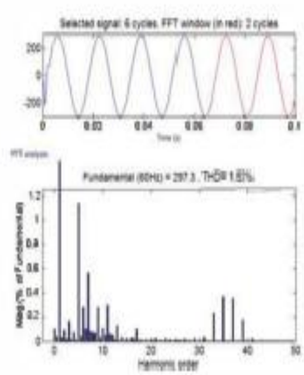


Fig. 6. The compact SSCT inverter simulation system.

fig. 7 and 8 show the output voltage waveforms and thecorresponding THD% for both the proposed and the HBCTmultilevel inverters. The carrier frequency is set to 1080 Hzand the high frequency transformers also have the same ratedfrequency. The result shows that the traditional topology stillhas better performance in THD%. Nevertheless, it isinteresting to note that the proposed inverter has smaller low order (below 16th) harmonic components though the totalTHD% is higher. It is relatively easier to filter high frequencyharmonics than low order ones. As shown in Figs. 7(b) and8(b), the output THD% of the proposed inverter is close to theHBCT with a 0.5 kVar capacitive load added



(b)

Fig. 8. Output voltage waveforms of the HBCT inverter: (a) Output voltage without filtering; and (b) Output voltage with 0.5 kVar capacitor.

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V. CONCLUSION

This paper presents a new topology of isolated multilevelinverter which has a single de source with the help of cascadedhigh frequency transformers. The proposed isolated multilevelinverter consists of three phase six-switch converters withreduced number of power components compared with theexisting topologies. The proposed inverter can be used forhigh voltage and high power applications such as gridconnected battery storage and alternative energy systems.Using three-phase converters as building blocks enables dqframe based simple control and eliminates the issues of singlephasepulsating power, which can cause detriment a limpactson certain de sources. Simulation studieshave been carried outto compare the proposed multi-level inverter with an H-bridgecascaded inverter. The simulation results verified theperformance of the proposed inverter. Though the proposedtopology does not show advantage in reducing the totalamount of harmonics, the lower order of harmonics in theproposed inverter have been significantly reduced, whichmakes it easier to filter out high order harmonics.

REFERENCES

[I] 1. Cobb, "December 2014 Dashboard: A total of I 18,682 plug-in electriccars were sold in 2014, consisting of 63,325 all-electric cars and 55,357plug-in hybrids," HybridCars.com and Baum & Associates.RetrievedRenewablePortfoliohttp://www. dsireusa.orgllibrary/includes/topic.cfin?TopicCategoryID=6&CurrentPageID= I O&EE= I &RE= I /.Standards.

[2] Fuel Economy, online: http://www.fueleconomy.gov/feg/smOildep.shtmJ/, April 13, 2009.

[3] Energy Storage Research and Development 2009 ProgressReport,http://wwwl.eere.energy.gov/vehiclesandfuels/resources/fcvt reports.html.

[4]E.Cready,1.Lippert,1.Pihl,I.Weinstock,anP.Symons,"TechnicalandEconomicFeasibilityofApplyingUsedEVBatteriesinStationaryApplications.AStudyfortheDOEEnergyStorageSystemsProgram,"SandiaNationalLabs.,Albuquerque, NM, Report: SAND2002-4084;SENTECH-068-006, J30p, Mar 2003.

[5] Chevy Volt Batteries For Neighborhood Energy Storage,Online,http://www.forbes.com/sites/uciliawang/20 I1/08/08/chevy-voltbatteries-for-neighborhood-energy-storage/.6

[6] Nissan Using Old LEAF Batteries in New Solar Charging Stations,Online, http://nissan-Ieafnet/2011/08/1 3/nissan-using-old-Ieaf-batteriesin-new-solar-charging-stationsl.

[7] Bottling Electricity: Storage as a Strategic Tool for ManagingVariability and Capacity Concerns in the Modern Grid, DOE report,Electricity Advisory Committee, Dec., 2008.

[8] M. R. Banaei and E. Salary, "A new family of cascaded transformer sixswitches sub-multilevel inverter with several advantages," J ElectrEngTechnol, vol. 8, no.5, 2013.

[9] K.N.V. Prasad, G. Ranjith kumar, T.Vamsee kiran, and G. SatyaNarayana, "Comparison of different topologies of cascaded H-Bridgemultilevel inverter," ICCCI, Jan. 04-06, 2013.

[10] Y. Suresh, and A. K. Panda, "Investigation on hybrid cascadedmultilevel inverter with reduced dc sources," Renewable and Sustainable Energy Reviews, 26, 2013.

[11] Y. Suresh, A. K. Panda, and Matada Mahesh, "An improvedperformance of cascaded multilevel inverter with single DC source byemploying three-phase transformers," 2010 9th International Power &Energy Conference (lPEC 2010), pp. 1088-1093, 2010.

[12] H. k. jahan, M. R. banaei, and S. T. Mobaraki, "Combined H-bridgecells cascaded transfonners multilevel inverter" PEDSTC, Feb. 5-6,2014.