International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 3 March 2023, pp: 283-291 www.ijaem.net ISSN: 2395-5252

Centralized Control Strategy of Three Port Bidirectional Converter

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Date of Submission: 25-02-2023 Date of Acceptance: 05-03-2023

ABSTRACT:
This will simply select the number of turns of the winding. Due to load changes, lack or excess powerappears. The converter adjusts this additional power flow from the energy storage element. Thisconverter demonstrates two-way power flow capabilities that are suitable for charging the batteryduring the playback braking of electric vehicles or hybrid electric vehicles. Battery and fuel cells aretwoenergycausesforproposedtopologies.Three-portisolated(TPI)BidirectionalDC/DCtransducers have proposed the advantages of the two energy ports and the advantages of largevoltage gains, galvanic insulation and high power density. Converters are suitable for connectingvarious power sources and loads in electric and hybrid vehicles. Bidirectional TPI DC/DC convertercontrolcircuittosuppressswitchingharmonicpeaksinthespectrumandreduceconductedelectromagneticinterference (EMI).
Keywords— bidirectionalDC/DCconverter,battery,fuelcell,voltage

I. INTRODUCTION

NowadayEV andHEVsaregaining extraattentionbecauseofincreasingissuesoffemission from oil/gasoline powered car and alsolowering availability of fossil gas.EVs and HEVsnolongermosteffectivestorefossilfuel,butadditionally acquire low gasoline emissions forenvironmental protection. In EVs and HEVs, thebidirectional DC/DC converter is an outstandingchoice to trade strength among the low-voltagepowergaragedeviceandthehigh-voltageDCbus of the traction motor. A bidirectional DC/DCconverter is used to exchange energy betweenthebatteryandtheexcessive-voltageDCbusconnected in series with HEV in a such mannertheDChyperlinkvoltageiskeptstrongregardless of voltage changes in the battery andcargoversionwithinthetractionmotor.Theexcessive-frequencytransformernotonlyintegrates and exchanges the electricity from allports, but also offers complete isolation amongstallportsandfitstheexceptionalportvoltageranges.Abidirectionalstrengthdriftmaybe managed with the aid of adjusting the section-shift angle between the excessive-frequency acvoltagesgeneratedthroughthetotal-bridgecellularateachport.

Anewmulti-inputbidirectionalDC/DCconverterthatusesacombinationofDCcircuitry and magnetic coupling to connect fuelcells,storageandloads.Step-updoublehalf-bridgesandbidirectionaldirectconnectedswitching cells are used. The load and source areelectrically isolated. This system is suitable formediumpowerapplicationswheresimpletopology, autonomy,miniaturizationandlowcostarerequired.BidirectionalisolatedHalfBridgeDC/DCconvertercombiningCurrentSourceandVoltageSourceconverters.a bidirectional isolated dc-dc converter based onhalf-bridge topology, that is supposed for fuel-cellularandbatteryapplications.Thelow-voltagesideisahalf-bridgeconverterwithacurrent source acting as a boost converter andinverter.Thehighvoltagesideisahalfbridge converter with a voltage source. A 10kHz highfrequency transformer isolates the low voltagesidefromthehighvoltageside.Poweristransferredusingasimplephase-shiftingschemesimilarto afull-bridgeDC/DCconverter.
andcontrolpowerflowandotherfunctionsthroughcentralizedcomplexmanagementstrategies. The power flow is monitored by thephaseshiftandthepowerflowcanbeadjustedtotheworkcycle.TheDCLINKsidemust

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Ithasthesameoveralldeviceratingsasthefull operatethefixedworkcycleatalevelof50%t bridge topology, and acceptable DC ripple on thelowvoltageside.Adisadvantageofthehalf-bridge topology is that the switching device isexposedtotwicetheDCbatteryvoltage.Forbatteryvoltagesaslowas48V,itmaymakesensetousethistopology.However,theHalfbridgetopologymaynotbesuitableforconnectingwithahigherbatteryvoltage.BecausetheMOSFETisrequiredtoahigherblockingvoltage,the lossofthedeviceincreases.

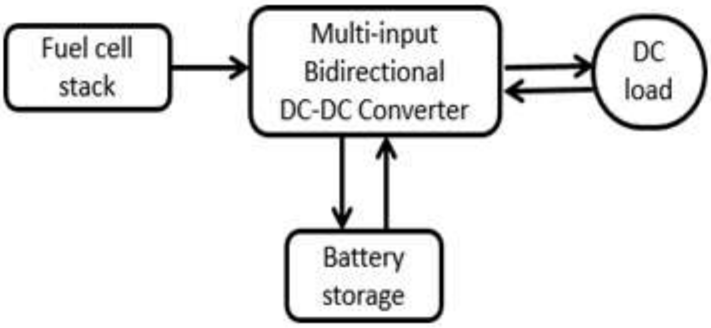

Fig 1: System evaluation: A multi-inputbidirectionalconvertermanagesthepowerflowbetween the fuel cell generator, storage andload.

II. MULTIPLE INPUT CONVERTER

Multiportableconverterscombinevarioussourcesand controlpowerflowandotherfunctionsthroughcentralizedcomplexmanagementstrategies.Thepowerflowis monitored by the phase shift and the power flowcan be adjusted to the work cycle. The DC LINKside must operate the fixed work cycle at a levelof50%togenerateasphericalwave.Tointegrate thesourceinto aDCLink systemorsize, depends on the isolation requirements andvoltagelevels.Fuelcells,photoelectricaccessories,batteries,preferences,andloadsmustbeintegratedwithmultipletwo-wayconverters. Bidirectional DC/DC TPI Converter,anInsulatingDC/DCConverter,hasahigh-qualityvoltageandafeatureofvoltageconversionofanelectricalinsulator.SiftedPhase-basedtiltcontrolsaredisplayedtocontrolthepowerofbidirectionalTPIMulti-portableconverterscombinevarioussources generate a square wave. To integrate the sourceinto a DC Link system or size, depends on theisolation requirements and voltage levels. Fuelcells,photoelectricaccessories,batteries,preferences, and loads must be integrated withmultiple two-way converters. Bidirectional DC /DCTPIConverter,anInsulatingDC/DCConverter,hasahigh-qualityvoltageandafeatureofvoltageconversionofanelectricalinsulator.SiftedPhase-basedtiltcontrolsaredisplayed to control the power of bidirectionalTPIbidirectionalDC/DC.Acombination ofDCLINKandmagnetic-couplingmethodsallowsyoutoconnectmoresourcesthatcanbeconsidered asourceofloadand storage.

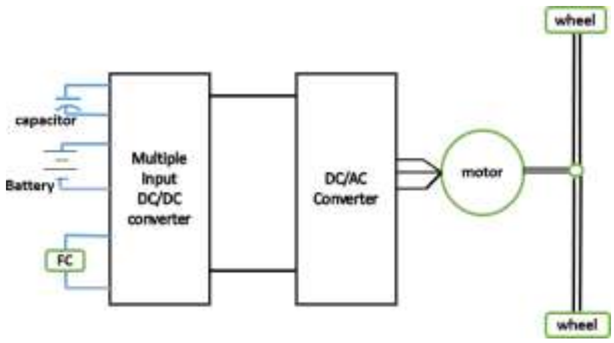

Fig2:Systemconfigurationofelectricvehiclesusingmulti-input DC/DCconverter.

Bidirectional dc-dc converters can be dividedintoisolatedandnon-isolatedconverters.Theisolatedconverterenhancessystemsafety,reliability, and flexibility, although it is costlierandcomplicatedthanthenon-isolatedconverter.Typically,full-bridgetopologyispreferred in high-power applications because ofits minimal voltage and current stress, minimumvolt-ampereratingofthehigh-frequencytransformer,andlowripplecurrentsattheoutput filter. Nevertheless, half-bridge topologyhas also been considered, particularly for fuel-cellelectricvehicles.Thissectionprovidesanoverview ofthebidirectionalisolateddcconverters that are employed with static energystorage devices. Isolated converters can achievehuge-varietyvoltageconversionandelectricisolationbyusingtheuseofhigh-frequencytransformers.exceptionalfromtwo-port

bidirectionalDC/DCconverters,multi-portDC/DCconvertersarederivedtoalternatestrength amongstacoupleofDCports.Non-Isolatedconverterscommonlyhavesimpletopologies and less additives, however they facechallenges in high-advantage voltage conversionand galvanic isolation. The transformer-remotedgreenback-enhanceconverterisknownastheflyback. and powers starting from milliwatts tomore than one hundred watts. these convertersaren't always used for excessive-energy circuits.The ahead converter is derived from the buckconverter.it'smilesusedforlowtomediumpowerfull-bridgeconverter.Theremotedcomplete-bridgeconverteristhedesiredtopologyformediumtoexcessiveenergyusedonmotorsforchargingtheexcessive-voltagebattery and powering the low-voltage auxiliaryload. The relative voltage and current stresses ofthe full-bridge converter are lower than those ofthe forward converter the full bridge has twicethe power for the same current ratings, half thevoltageontheswitches,andtwicetheripplefrequency.

III. PRINCIPLES OF OPERATION

Three power sources are connected to a 3-porthigh-frequencytransformerwithaDC/DCbridgeconverter. u1,u2andu3aretheconverter output voltages of the three ports andi1, i2 and i3 are the input currents of the threeports. L1,L2,L3are theleakage inductanceofthethreeportsandLmistheself-inductance.L12 and L13 are equivalent inductances L2 andL3asviewedfromport1.L12isequivalentinductance between port1 and port2, and L13 istheequivalentinductancebetweenport1andport3,andL23istheequivalentinductancebetween port2and port3[4].

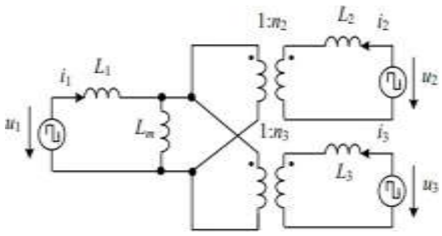

Fig 3: a) Original equivalent model withmagneticinductance.

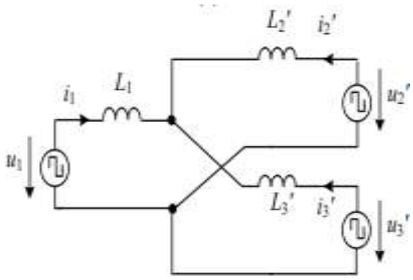

Fig 3: b) simplified Y-type equivalent modelobserved from port 1 without magneticinductance.

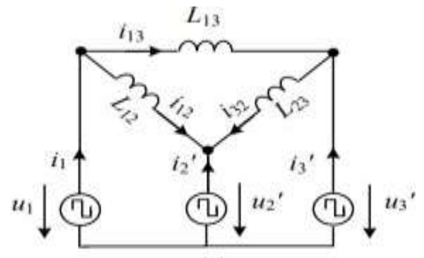

Fig3:(c)simplifiedΔ-typeequivalentmode.

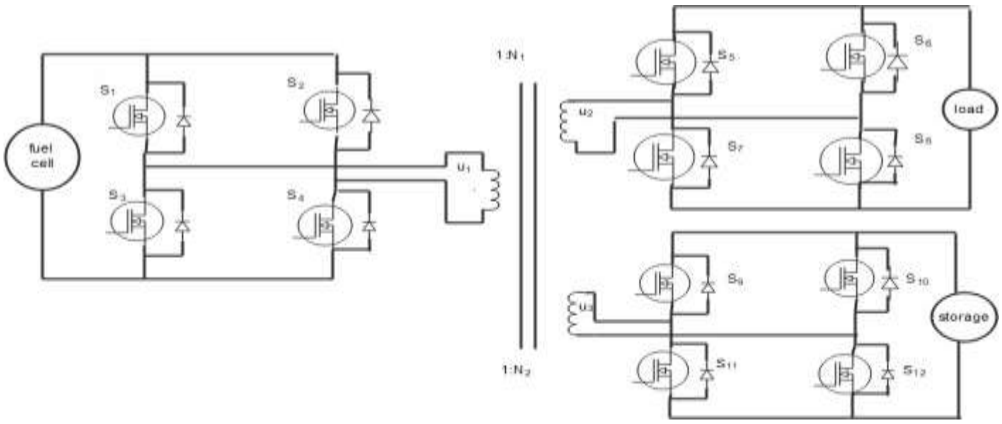

Fig4:circuitdiagramofthreeportbidirectionalDC/DCconverter

PWMcontrolcanP1,P2andP3areactivepowerofport 1,port2andport3,respectively.those aboveequationsmaybebeincorporatedwithin

$$P_{12} = \frac{V_1V_2'}{\omega L_{12}} \text{Ø}_{12}\left((1\text{-}\frac{\text{Ø}_{12}}{\pi}\right)$$

$$P_{13} = \frac{V_1V_3'}{\omega L_{13}} \text{Ø}_{12}\left((1\text{-}\frac{\text{Ø}_{13}}{\pi}\right)$$

$$P_{23} = \frac{V_2'V_3'}{\omega L_{23}} \text{Ø}_{12}\left((1\text{-}\frac{\text{Ø}_{23}}{\pi}\right)$$

$$P_1 = P_{12} + P_{13}$$

$$P_2 = P_{12} + P_{32}$$

$$P_3 = P_{13} - P_{32}$$

$$L_2' = \frac{L_2}{n_2^2} \qquad L_3' = \frac{L_3}{n_3^2}$$

$$L_{12} = L_1 + L_2' + \frac{L_1L_2'}{L_3'}$$

$$L_{13} = L_1 + L_3' + \frac{L_1L_3'}{L_2'}$$

$$L_{23} = L_2' + L_3' + \frac{L_1L_3'}{L_1}$$

□ 12 is the segment attitude among port 1 andport 2, □ is the shifted-phase mind-set betweenport 1 and port 3,and□ 32 is the shifted-segmentangle among port 2 and port 3, respectively. P1,P2 and P3 are active power of port 1, port 2 andport3, respectively. These above equations can beobservedthattheexchangedpowercanbecontrolled bytheshifted-phaseanglesbetweendifferent energy ports. By assuming L12 = L13 =L32anddefiningd12=u12/V1andd13=u13/V1, the soft-switching operation conditionscan be determined by the voltage gains d12 andd13 and

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shifted-phase angles φ12 and φ13. Toextendtheclean-switchingoperationlocation,the theshifted-phaseattitudemanage,andthesegment-shiftedPWMcontrolisacquired.Thisphase-shifted PWM control scheme can lower thecirculatingcontemporaryandgrowththeefficiency ofthe DC/DCconverter.

IV. DESIGN OF ANISOLATED BIDIRECTIONAL CONVERTER

DC/DCConverter'sBidirectionalOperating DC machine allows the engine or generator to beoperatedasanengineorgenerator.Whiledriving, current flows from the battery to the DCcar, so the converter acts as a boost converter.During regenerative braking, current flows fromthe DC machine to the battery and the converteractsasa buckconverter.

Theoutputvoltageofthefuelcellisstronglyinfluencedbyloadandenvironmentalconditions,toopowermanagement and still difficult. Different fuel cellstacks need to choose different fuel cell DC / DCpower supply topologies. High accuracy and fastresponse are key requirements f or Fuel cell DC-DC control supply power, but the control systemstillneedstobeupgradedaccordingly variousapplicationstoimplementoperationaldesignconversionindicators.DC/DCpowersupplyhasaveryhighengineeringapplicationvalue.Thecurrent power supply of DC/ DC fuel cell has thefollowingdevelopmentguidelines.

(1) Highperformance

At present, fuel cell vehicles are on the rise.Likepowerfultraditionalcars,gasolinecellularvehicles need a lot of control and must respondappropriately to a variety of situations. Becausethe fuel cell has soft discharge features and a lowoutput voltage, it cannot be driven directly. as asourceofenergy.Thisrequiresaddingamoreefficient DC/DCtoconverttheoutputfuelcellfeatures. This will jointly build a power source topowerthecarandconvertittoastableandreliableDC powersource.

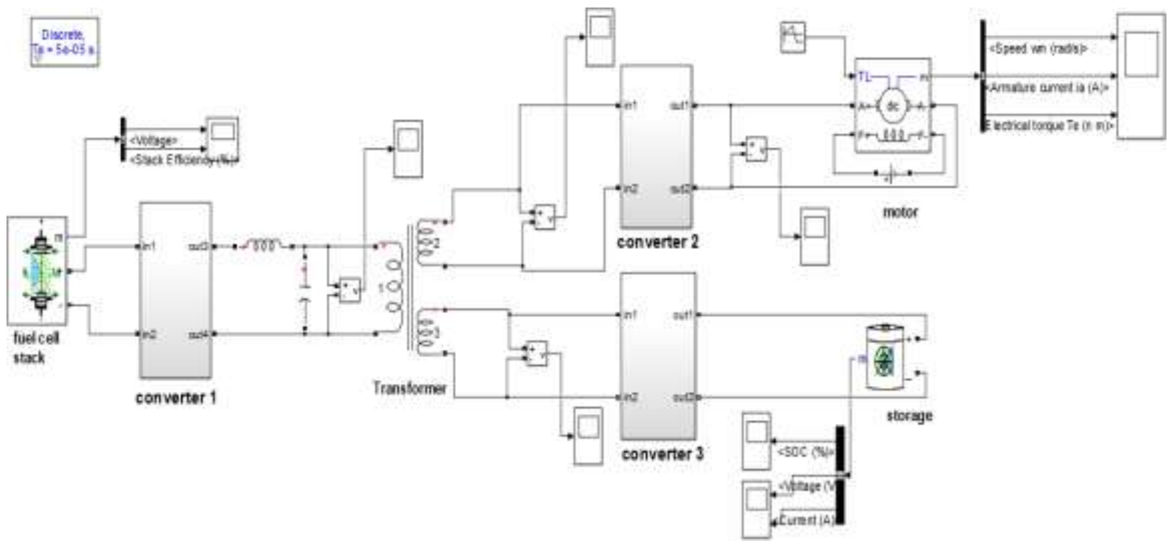

Fig5:Simulinkmodelof threeport bidirectionalDC/DCconverter

(2) High frequency

Using Mosfet canenableit to withstand lowpressureandfastswitchingspeed.Inaddition,andcanreduceswitchinglossesandoperatinglosses,andimprovefuelcellefficiencyDC/DCpower supply. With the continuous developmentof the device, it can operate at high voltages andtemperatures, and be strong and achieve long life.Moreover,itsconversionspeedismuchfasterthantraditionalsemiconductordevices.Atpresent,thefrequencyofchangewaspresentgradually expanded into megahertz. This helps toreduce the volume of the magnetic field and toimprove it total fuel cell capacity DC / DC. ThebidirectionaloperationoftheDC/DCconverterallows the DC machine to work either as a motoror as a generator. During motoring, the currentwill flow from the battery to the DC machine, andsotheconverterwillactasaboostconverter.During regenerative braking, the current will flowfrom the

DC machine to the battery, and then theconverterwill act asabuck converter.

The5-kWprototypehasbeenemployedforpower conversion between the 48-V battery busand the 240-V bus. During battery charging, themaximum efficiency of the converter is 95%, andtheconverterefficiencyisabove90%between400 W (8%) and 5 kW (100%). During batterydischarging,themaximumefficiencymeasure data battery voltage of 46 V is 94%. However, theefficiencydeterioratesasthepowertransferincrease s.Oneofthedisadvantagesistherequirementofalargecl ampingsnubbercapacitortowithstandhighcurrentathi ghfrequencyduetothesignificantdifferenceincurrent betweenthedc-linkandtransformerleakage inductors. In addition, the MOSFET in theclampingsnubberisswitchedatthefullloadpower and at twice the operating frequency of theconverter.

Parameter	**Value**
L_1	21
L_2'	0.84
L_3'	5.2
Motorvoltage	240V μH
Speed	1750rpm
Power	5kw
Ratiooftransformer :	1:5:2
Batteryvoltage	48V
switchingfrequencyf	10KHz

V. SIMULATION RESULT

An isolated bidirectional transducer is simulatedusing Simulink. Batteries, DC/DC converters, andmotorsaremodeledinMATLABandincludedin Simulink models.The resultsof starting the its rated speed at 50% of its rated voltage. The DCbus voltage is changed. When the reference speeddecreases,regenerativebrakingoccursandcurre nt flows from the motor to the battery (thecurrentreachesanegativevalue).Inthethird motoratratedloadareshowninFig6.DCbus test,themotorisstartedatratedloadandafter3 voltageis240V,butvoltageripplededependsoncurrent consumption. More current consumptioncauses more pulsation. Sliding movement can beestimated in the battery waveform. Fig.6 showstheperformanceofthemotordeceleratingfrom secondstheloadisreduced.Theresultofthistorqueconv ersionisreproducedinFig7.Thecurrent consumption decreases the load torque.DC bus adjustment of the DC bus is done despiteload perturbation.

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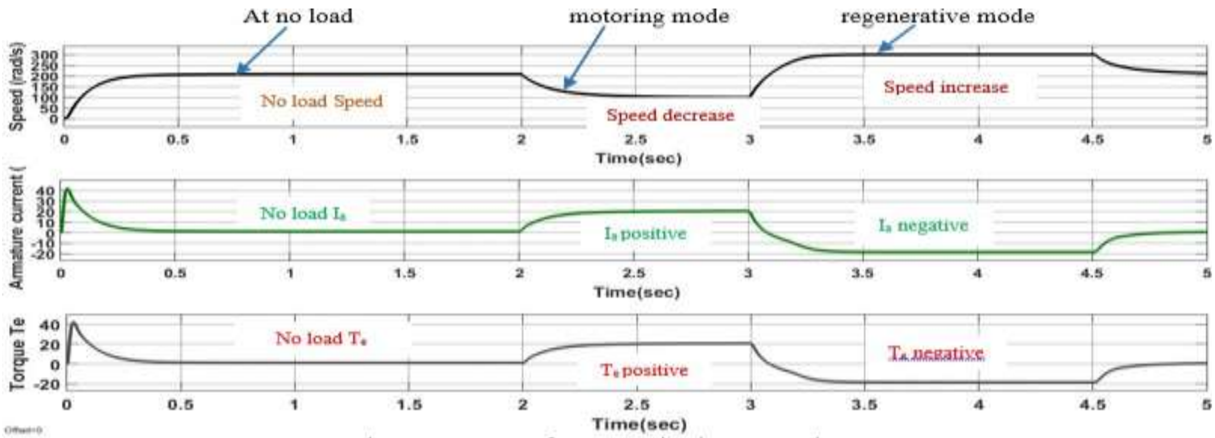
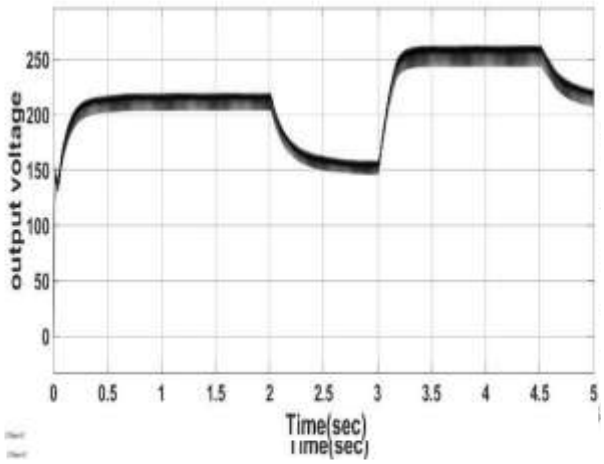


Fig6:motorwaveformatnoload,20Nmand-20Nm



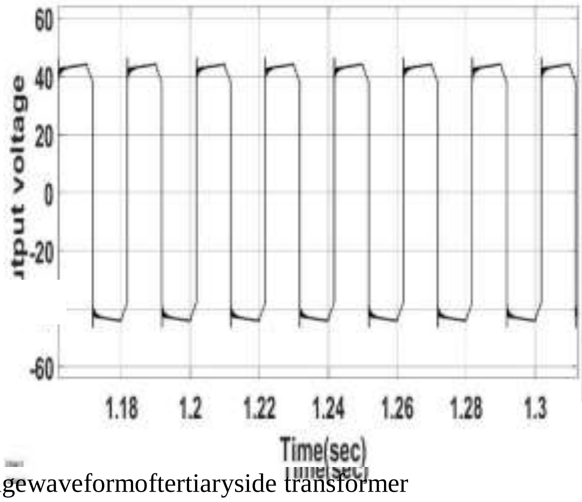


Fig7:outputvoltageofsecondconverter Fig8:voltagewaveformoftertiaryside transformer

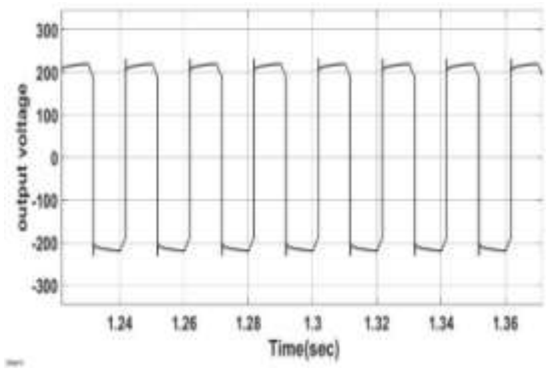


Fig9:voltagewaveformofsecondaryside transformer

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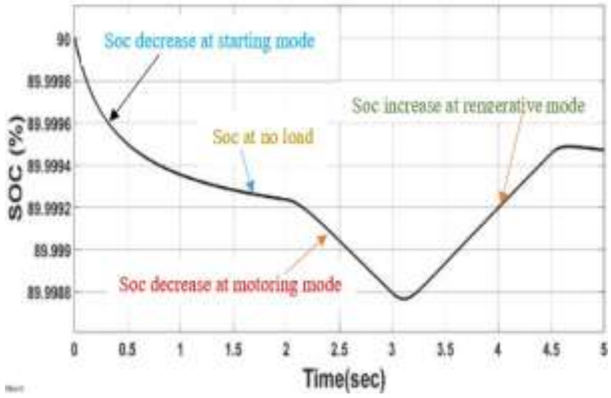

Fig10:stateofchargeofbattery

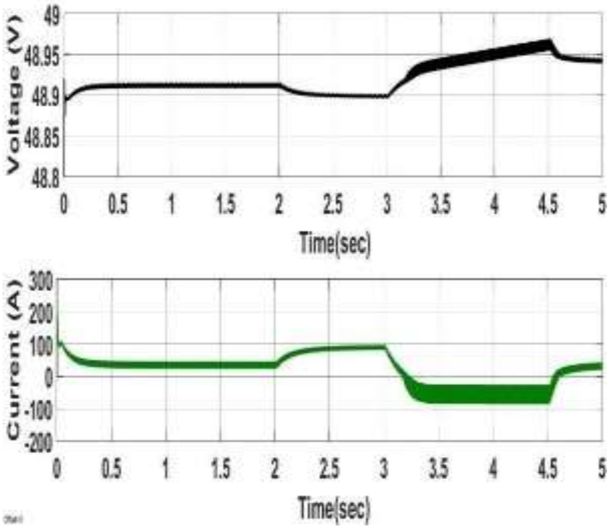

Fig11:waveformofvoltageandcurrentof battery

CONCLUSION

Thisarticlepresentsthedesignofabidirectional DC/DC converter. It is characterizedbycontrollingabidirectionalDC/DCconverterusing only one sliding control law. After designandcontrol,theconverterwasmodeledandsimulated along with the rest of the EV tractionsystem: motor and load. The results summarizedin the previous section confirm the performanceofbidirectionalDC/DCconverters.Thestudiedsliding surface is successfully used to manipulatethe DC/DC converter operation, each within thecourseofthemotoringandtheregenerativebrakingofthe device. TheslidingsurfaceunderstudyhasbeensuccessfullyusedtocontroltheoperationofDC/DCconvertersduring motionandregenerativebrakingofvehicles.

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