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SINGLE-PHASE BIDIRECTIONAL EDROCFOR ELECTRIC VEHICLES USING ARDUINO

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Abstract---*In this paper we propose a single phase bidirectional EDROC for electric vehicles using ARDUINO. With the advancement of technology, several techniques are being introduced to improve and simplify the human life. With that being considered, here we put forward a methodology which will both benefit the environment and the economy. The proposed system modifies the existing hardware without the need of an extra equipment. The proposed EDROC on comparison with the traditional EDROC possess advantages suchas reduction in cost and volume. The proposed EDROC generates unity power factor in the charging mode and discharges the stored energy to drive the motor in the driving mode. A prototype model is being designed to depict the operation in the charging mode and the driving mode.*

Keywords-Electric Drive ReconstructedOnboard Converter (EDROC)

I. INTRODUCTION

In this era, electric vehicles play a major role in transportation sector and in the conservation of fossil fuels. Plug-in electric vehicle (PEV) sales are predicted to rise in the future due to their cleanliness and environmental preservation. Because the electric drive system and charging system in PEVs can achieve zero emissions, they will replace the conventional internal combustion engine (ICE) drive system. The charging system and the drive system are usually separate components in a PEV. The charging system, which consists of two stages bi-directional converters is a crucial component of the electric powertrain. The motor and driver circuit are part of the driving system. The system is huge in size and expensive [1].

By combining the drive system and charging system in a PEV, the electric-drive- reconstructed onboard converter (EDROC) has been proposed to minimize size and boost power density [2]. As a result, the converter can work in either drive or charging mode.

A innovative and simple electric-drive- reconstructed onboard converter is proposed in this work. The suggested converter makesuse of a traditional PEV motor that is reconstructed using a switching network [3]. The proposed converter's topology circuit can be implemented onboard without the use of an additional AC inductor. The proposed converter can be used directly in a socket power outlet at work or at home. The systemcan use the current driving system without having to be specially constructed, and it hasthe advantages of being simple to construct and affordable in cost. Simulation and experimental findings are used to validate the proposed EDROC's performance.

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II. LITERATURE REVIEW

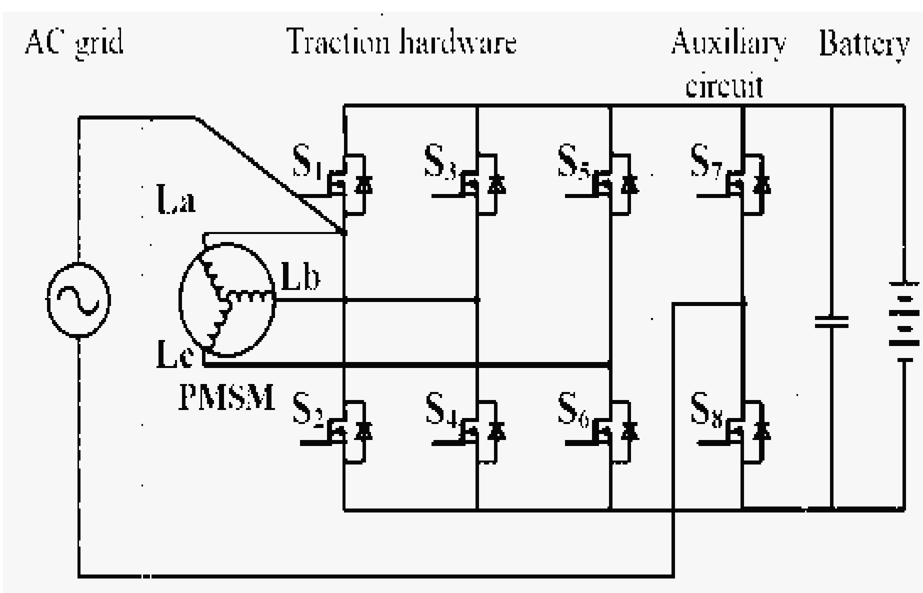
Electric cars now play a significant part in the transportation industry. Many academicsare now working on various sorts of electric car charging systems. An integrated quick battery charger for electric vehicles was discussed in S. Lacroix, E. Laboure, and M. Hilairet's work[4]. A low-cost digitally-controlled charger for plug-in hybrid electriccars was shown by Tang and G.-J. Su[5]. Also noted in an August 1994 magazine was the development of a "Combined motor driving and battery recharging system[6].

METHODOLOGY

the suggested electric-drive-reconstructed onboard converter in PEV is implemented by connecting an auxiliary circuit between the battery and traction hardware. To reconstruct the converter, the auxiliary circuit and the inverter of the traction hardware form a switching network. Furthermore, the proposed control system is suitable to any traction hardware with a three-phase inverter, and no particular motoris required. On the AC side, the converter merely utilizes a single-phase power source and no additional equipment such as inductance or a relay. The system operatesin two modes: charging mode and driver mode [7].

Here the EDROC with a split-winding AC motor was proposed. In the charging mode, the motor winding and 3 H-bridge inverters are reconfigured as two 3-phase boost converters sharing a DC bus. The AC power supply is connected to the stator winding's middle point. In the driving mode, this converter is difficult because it must control three independent currents. a motor with two sets of three-phase windings has been used. The motor functions as a three-phase motor in driving mode and as a transformer in charging mode. The triggering pulses to the mosfets in each mode is provided with ARDUINO MEGA [8].

a)



CHARGING MODE

The switches S3–S8 are enabled during charging mode. The switches S1 and S2 are both turned off. , The switching states are separated into eight categories. The system operates in states I – IV when the grid voltage is positive. The system operates in states V – VIII when the grid voltage is negative.

In state 1, the switch S7 is off and the switch S8 is on; in state 2, the switches S4 and S5 are on and the switches S3 and S6 are off. Instates II, the switches S_3, S_6, and S_8 are turned on, and the switch S_4, S_5, and S_7 are turned off. The switches S4, S6, and S8 are turned on in state III, whereas the switches S3, S5, and S7 are turned off. In states IV, the switches S_3, S_5, and S_8 are turned on, andthe switches S_4, S_6 and S_7 are turned off.

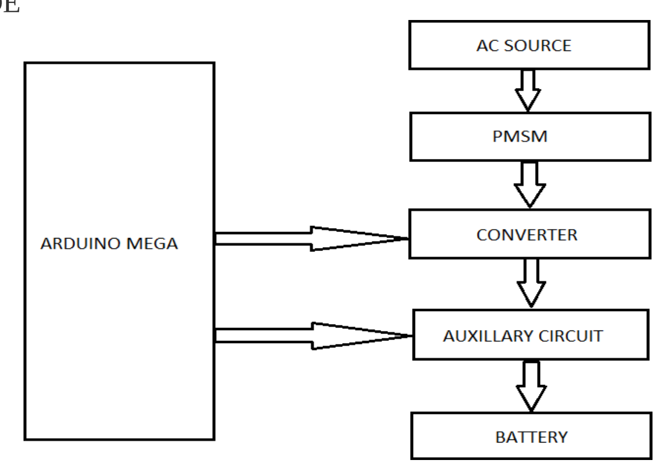
The proposed converter has two modes of operation when the grid voltage is positive, depending on the duty cycle(D) of switches S4&S6. When 0 <D <0.5, the switching sequence in the circuit is states I-states III - states II - states III - states I. The switching sequence shifts to states I - states IV - states II - states IV - states I when 0.5 D 1 is reached. When the grid voltage is negative, the working action is the same as when the grid voltage is positive.

b) DRIVING MODE

In driving mode, there are six different switching modes. Switches S7 and S8 will be switched off in driving mode, preventing the fourth leg from working. Only the switches S1 through S6 will be activated. It functions similarly to a standard three-phase inverter. A three-phase converter transforms a single-phase DC input into three-phase ACoutput. To generate a three-phase AC supply, its three arms are generally delayed by an angle of 120°.Each inverter switch hasa 50 percent ratio, and switching happens every T/6 of the time T.

A.BLOCK DIAGRAM

a) .CHARGING MODE

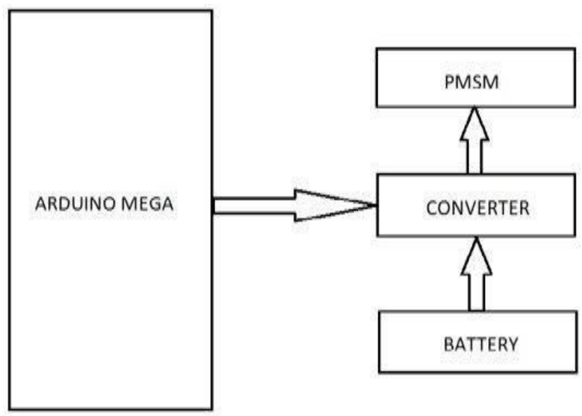


The supply in charging mode comes from an ac source. The converter uses the inductor coils of a pmsm motor in charging mode. Traction hardware and auxiliary circuit are the two components of this bidirectional circuit. Two switches, S7 and S8, make up

the auxiliary circuit. These two switches are enabled during charging mode. Switch S8 controls the positive half cycle, while switch S7 controls the negative half cycle. Arduino MEGA provides the control pulses for these switches. The battery is charged byfollowing this switching method.

b) DRIVING MODE

In driving mode, the action is inverted. As a result, the dc voltage is transformed to three-phase ac voltage. As a result, the battery's stored energy is converted back to ac. The mosfet switching pulses are given by the Arduino Mega 2560 R3. The voltage obtained from the switching network powersthe motor. Each leg of this network functions as a single-phase supply.



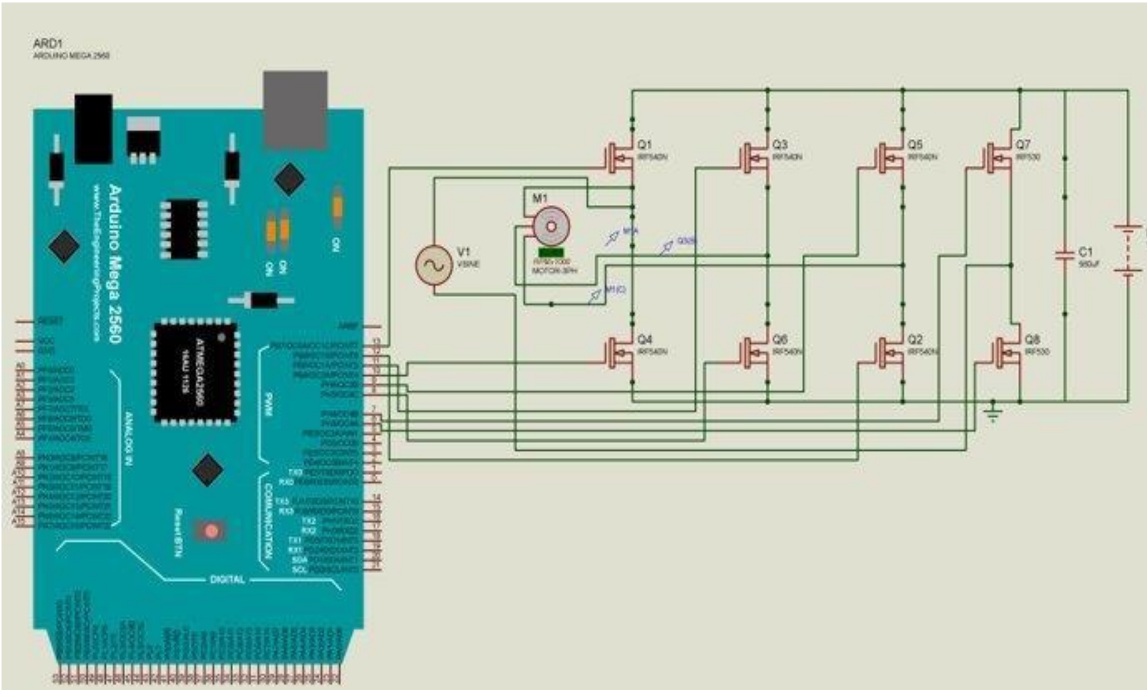
B.SOFTWARE

The project's main component is a MOSFET, with ARDUINO MEGA software controlling the switching signals. The PROTEUS programme is used to simulate and generate various waveforms for the driving and charging modes. The ARDUINO MEGA is programmed with the Arduino IDE and many sensor libraries.

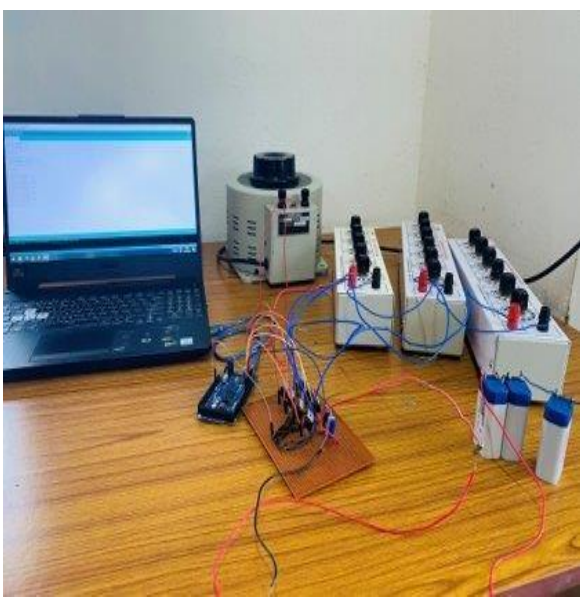
Proteus is a programme that allows you to simulate, design, and draw electroniccircuitsCircuit design on the proteus requires less time than circuit assembly in practice.Proteus allows you to find different parents of circuits at any time, such as current, the voltage value of each component, and resistance, which is quite difficult in practice.

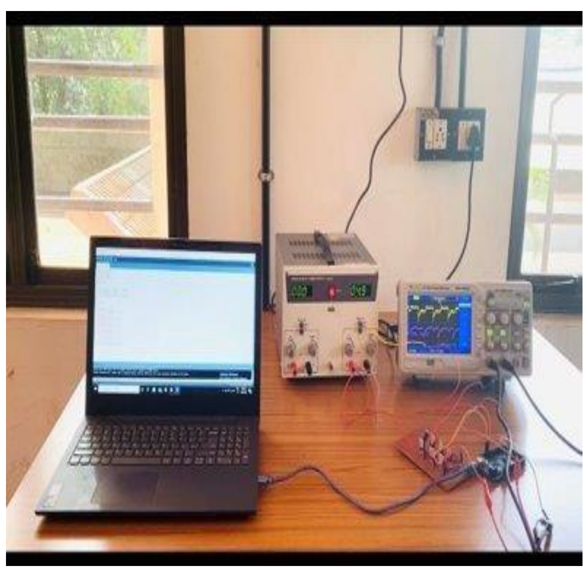
C.SIMULATION

Proteus design suite is used to simulate the entire driving mode and charging process. Each mode's output waveform is created. The simulation findings are used to implement hardware. The simulation diagram of the actual system is shown in:


ARD1
Arduino Mega 2560
Q1
Q3
Q5
Q7
Q4
Q6
Q2
Q8
V1
M1
C1
DIGITAL
ANALOG IN
PWM
COMMUNICATION

D.**HARDWARE**





An autotransformer is used to scale down the ac supply voltage in the hardware assembly of the proposed system. To obtain the 1mH inductance required for the system, an inductance box is employed. The traction hardware and auxiliary circuit require a switching pulse, which is provided by the Arduino mega. As a result, the ac voltage is converted to the necessary dc voltage to charge the battery. The energy is stored using a 12-volt battery.

The charge contained in the battery is dissipated while charging. The Arduino mega is used to provide the firing pulse for the switching network. We get three phases from each leg of the switching network. Each leg serves as a single-phase power source.

a) **Autotransformer :** The working principle and construction of an auto transformer are identical to that of a traditional two-winding transformer. It differs, however, in the way the primary and secondary are interconnected. It has a rotational moveable contact and only one winding coiled on a laminated magnetic core. A step-down or step- up transformer can be made from the same auto transformer.

b) **MOSFET:**Ametal–oxide– semiconductor field-effect transistor (MOSFET, MOS-FET, or MOS FET) is a field-effect transistor (FETwith an insulated gate) in which the conductivity of the device isdetermined by the voltage applied to it. It's utilized for signal switching and amplification. Electronic signals can be amplified or switched usingthe capacity to vary conductivity with the amount of applied voltage. MOSFETs are increasingly morewidespread in digital and analoguecircuits than BJTs.

c) **ARDUINO MEGA2560 R3** : The ATmega2560 is the basis for the Arduino Mega 2560 microcontroller board. It contains 54 digital input/output pins, 16 analogue inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It comes with everything you'll need to get started with the microcontroller; simply plug it into a computer with a USB cable or power it with an AC- to-DC adapter or battery. Most shields created for the Uno and previous boards Duemilanove or Diecimila are compatible with the Mega 2560 board.

IV. RESULT ANALYSIS

A workbench is developed to validate the suggested topology and control technique. The power switches are made up of eight identical MOSFETs that must match both the charging and driving system's technical requirements. 100V is the nominal voltage.

The waveforms obtained in various modes are displayed in the following diagram. In the charging mode, MOSFET 1,3,5,7 is shown in Fig 1. The charging mode of MOSFET 4,2,6,8 is shown in the diagram. MOSFETs 1 and 4 do not activate in the charging state, resulting in a straight line.The output waveform obtained in thedriving mode is shown in Fig 2. MOSFETs 7 and 8 do not operate in this mode. Each phase has a 180-degree phase shift from each other as shown in Fig 3.

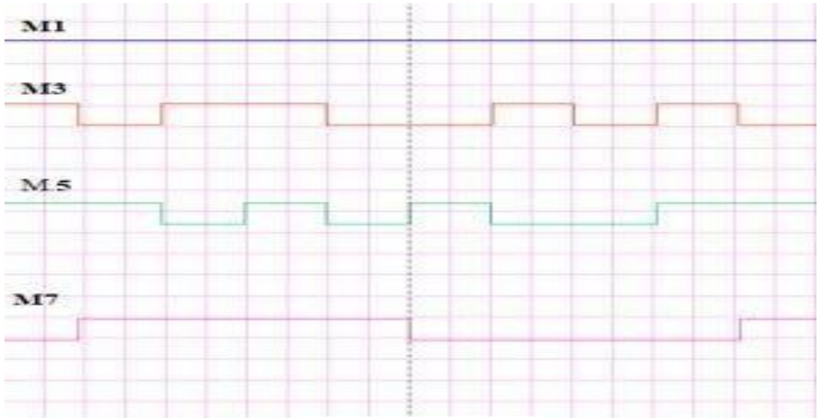


Fig1

V.

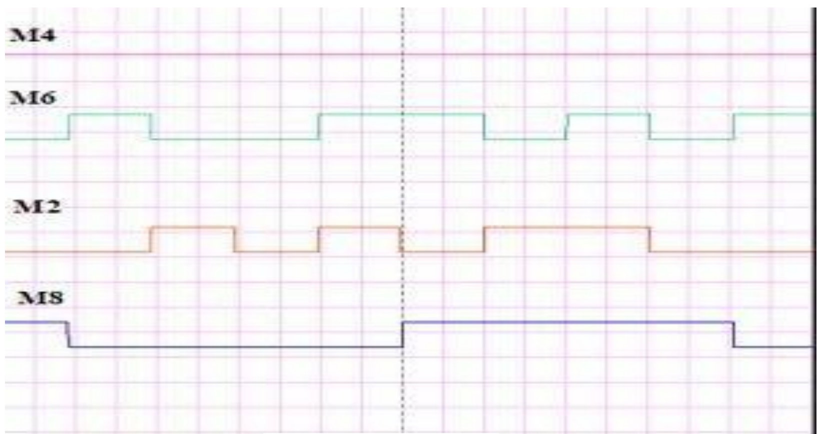


Fig2

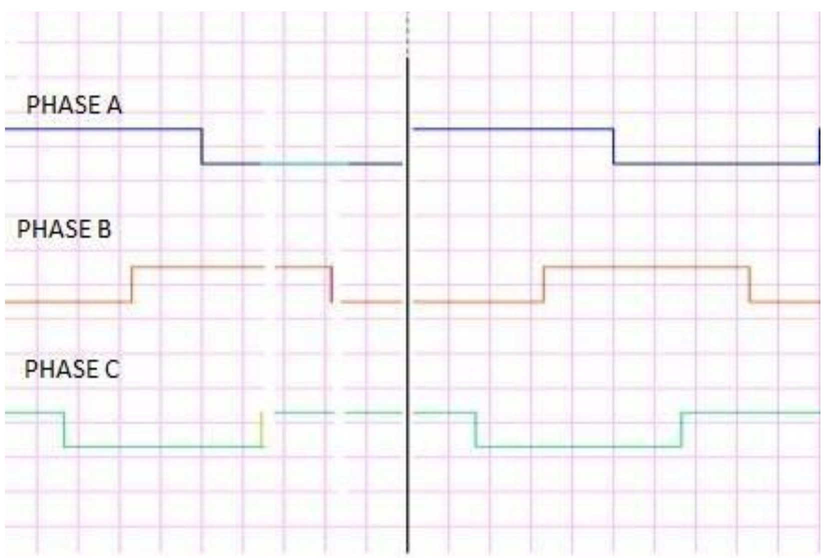


Fig3

CONCLUSION

An electric-drive-reconstructed onboard converter for PEVs is proposed in the paper. Without a particularly built motor or other extra equipment, the proposed reconstructed converter is simple. The proposed converter is a three-phase motor drive converter that has been updated. Only a few auxiliary switches are required on the DC side. Without any additional power supply equipment, the proposed EDROC can be linked to a power outlet in the office or at home. The suggested EDROC offers some advantages over existing EDROCs, including small size and low cost. The suggested EDROC is tested on a workbench, and the motor driving and charger functionalities are achieved.

VI. REFERENCES

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