Automotive Electronic System Controlling the Range Extended Electric Vehicle

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Abstract **- The main objective of this work is to make an automotive electrical and electronics system of an electric vehicle. Microcontroller is used for the controlling and monitoring the electric vehicle. A motor controller is used for controlling the motor which runs the vehicle which also uses serial peripheral interface for transmitting data to the display. The sensors are used for monitoring the vehicle parameters and give information to the microcontroller for the safety and control of the vehicle. The graphics liquid crystal display is used to display the parameter of the vehicle which is necessary for the driver. A current sensor is used to monitor the output current of the generator which a temperature sensor is used for checking the temperature of the engine by which the throttle angle is determined, and fuel level is determined by the fuel level sensor. The vehicle speed is calculated by wheel speed sensor. Contactors and relays are used for on/off operation which is controlled by the microcontroller. The battery parameters are measured by the battery management system which is transmitted through control area network. The vehicle consists of 12-volt and 48-volt circuits which are supplied by two different 48v and 12v battery. A dc-dc convertor is used for the charging the 12v battery using 48v battery.**

Keywords: Fuel level sensor, Current sensor, Temperature sensor, Contactors, Relay, Controller.

I. INTRODUCTION

In current society the usage of petrol/diesel vehicle causes many problems like rapid reduction of natural resources. Oil companies predict that there is limited amount of oil remaining, their estimates may still be large exaggeration according to the Common dreams. Since gasoline may run out in the next century, it is imperative to begin making changes in the fuel based world. The environment is polluted when gasoline combustion releases the end products of carbon dioxide, carbon monoxide, and nitrogen oxides, which may contribute to climate change. The electric vehicle's range is limited where the charging time is more than the run time in most of the electric vehicles. Hybrid electric vehicles use the generated power during the operation of the vehicle, which can also be operated by petrol. The plug-in hybrid electric vehicle is charged externally and uses engine when battery charge is depleted were as safety is the major issue in these vehicles. The cost of the electric vehicle is high, where in most of the population can't afford it. To overcome these problems a new system has been developed. The main scope of this work is to design and develop an Automotive Electrical and Electronics system of the electric vehicle with safety that focuses on hybrid technology extends the range of driving.

The Automotive Electronic system controlling the Range Extended Electric Vehicle is controlled by Microcontroller presumed as the heart of the vehicle. This Electric vehicle uses auxiliary power unit
known as a 'Range Extender'. Range Extender drives an electric generator which charges a battery and supplies electricity to vehicle's electric motor. This arrangement is known as Series Hybrid drivetrain. Vehicles nowadays uses fuel that affects the environment and natural resources are reducing rapidly. So this range extended electric vehicle is designed to reduce the consumption of fuel (gasoline) by using the primary fuel (battery), while still maintaining the driving range of a single fuel vehicle. This vehicle can be used for travelling in the near future, as the next generation is changing to electric vehicle. Although electric vehicle has many advantages, it also has certain limitations such were a range extended electric vehicle generate the power from the engine after the battery SOC is below 40%. The range extended electric vehicle is controlled by the Renesas RH850f1l Microcontroller and Arduino mega 2560. And safety measures are also not compromised for the driver. Vehicle's parameters are displayed in the dashboard in front of the driver. Current sensor is used to monitor the output current of the generator. Temperature sensor is used for checking the temperature of the engine by which the throttle angle is determined. Fuel level is determined by the fuel level sensor. Vehicle speed is calculated by wheel speed sensor. Contactors and relays are used for on/off operation which is controlled by the microcontroller. Battery parameters are measured by the Battery Management System, which is transmitted through Control Area Network.

2. CONCEPTUAL CIRCUIT DESIGN

The circuit is designed and categorized into two types, 12v circuit and 48v circuit. Both the circuits are controlled by the microcontroller which is operated at 5v. The

LM7805 IC is used for the conversion of 12v to 5v. Some sensors work in 12v and some work in 5v. There is an emergency kill switch circuit for safety. And display shows the parameters of the vehicle.

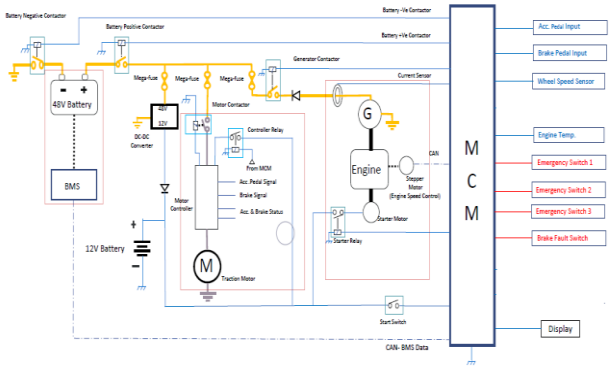

Fig 2.1.MCM block diagram

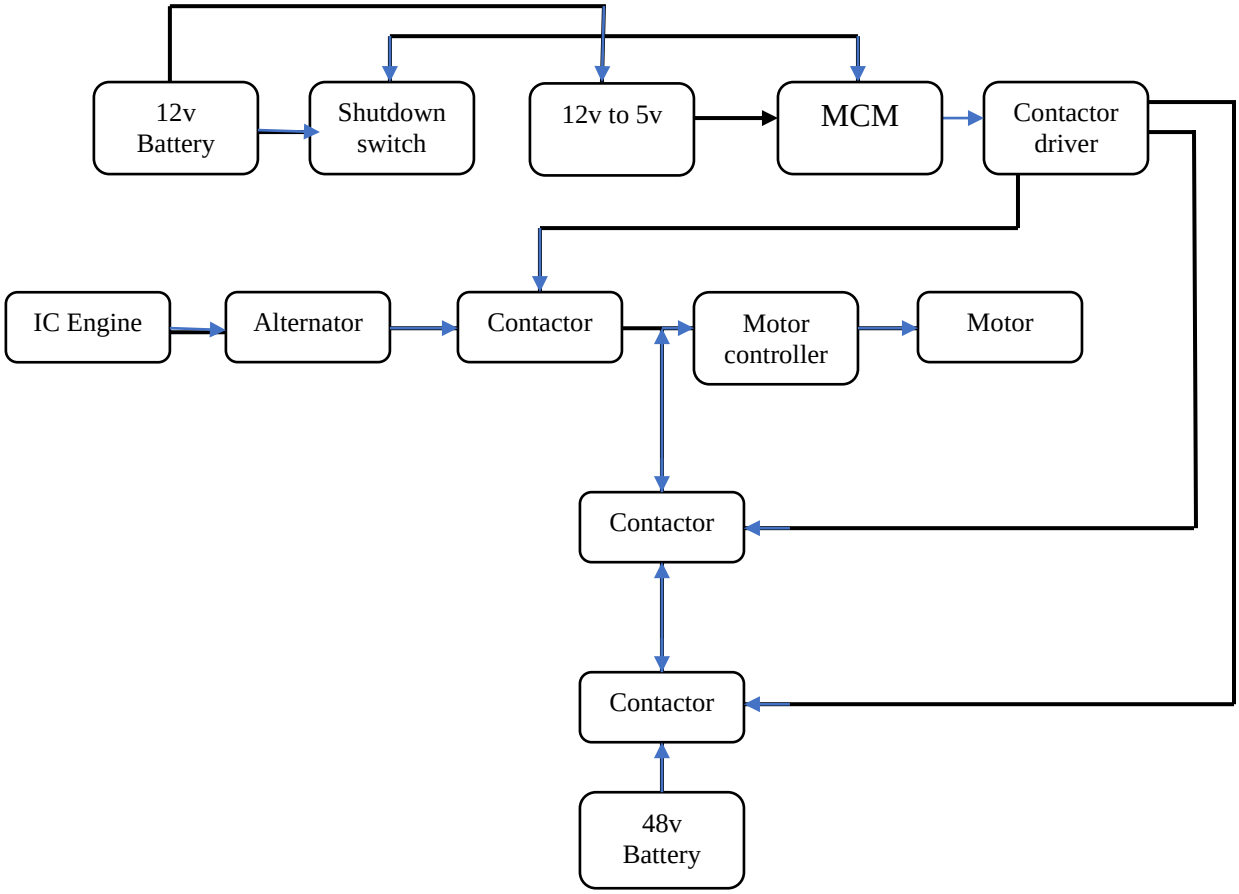

Fig. 3.1 Electrical block diagram

The vehicle is controlled by the `microcontroller which is part of the 12v circuit. Contactors and relay are used for the on/off function in the vehicle. MCM is the main part of the vehicle which controls the vehicle system. The MCM block diagram above gives the connection details. The MCM gives output and gets input from various sensors and provides the output control to many systems of the vehicle.

The system of the range extended electric vehicle is controlled by the MCM. The architecture specifies MCM block diagram that explains the system operation which is very important for the vehicle conceptual design. Motor controller is connected to the MCM for the input given for on and off function of the system operation. The MCM block diagram also shows the places where the other components are placed like fuses, contactors, stepper motor, starter motor and other components.

3. ELECTRICAL BLOCK DIAGRAM

MCM and relay drivers get their power supply from 12 V Battery. When MCM gets supply, signal is transmitted from MCM to Contactor Driver. Then supply is given to Motor Controller by battery. After that Motor controller gives supply to Motor. When battery charge drops below 50% of its value, the engine is turned on. When the engine is turned on, generator starts working and produces Electrical energy which is given to battery Which stores the electrical energy and supplies it to motor.

4. POWER SUPPLY DIAGRAM OF 12V

The power supply from the battery is transferred to the switches.

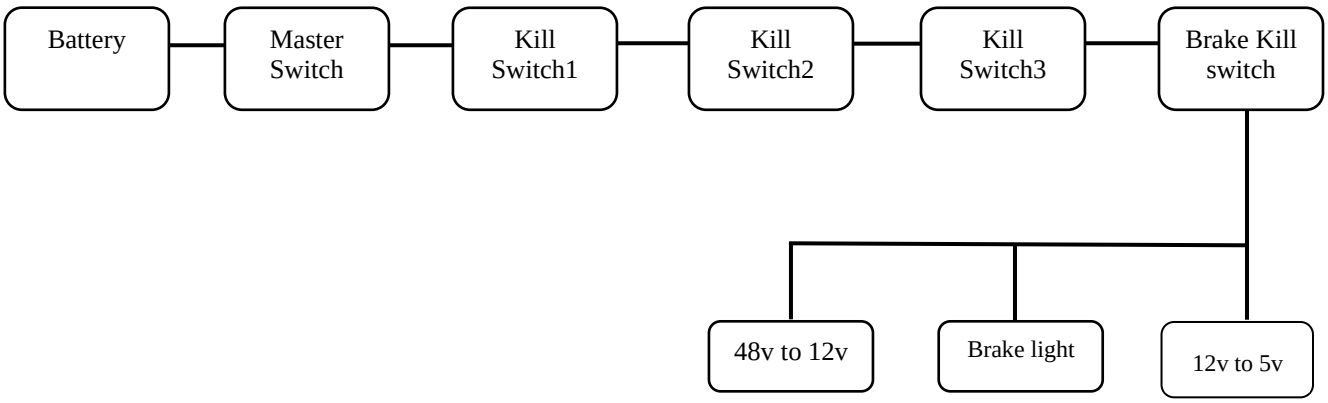

Fig. 4.1 Power supply diagram of 12v

5. POWER SUPPLY DIAGRAM FOR 48V

When the battery is discharged to 50% to the total charge, the MCM will turn on the engine.

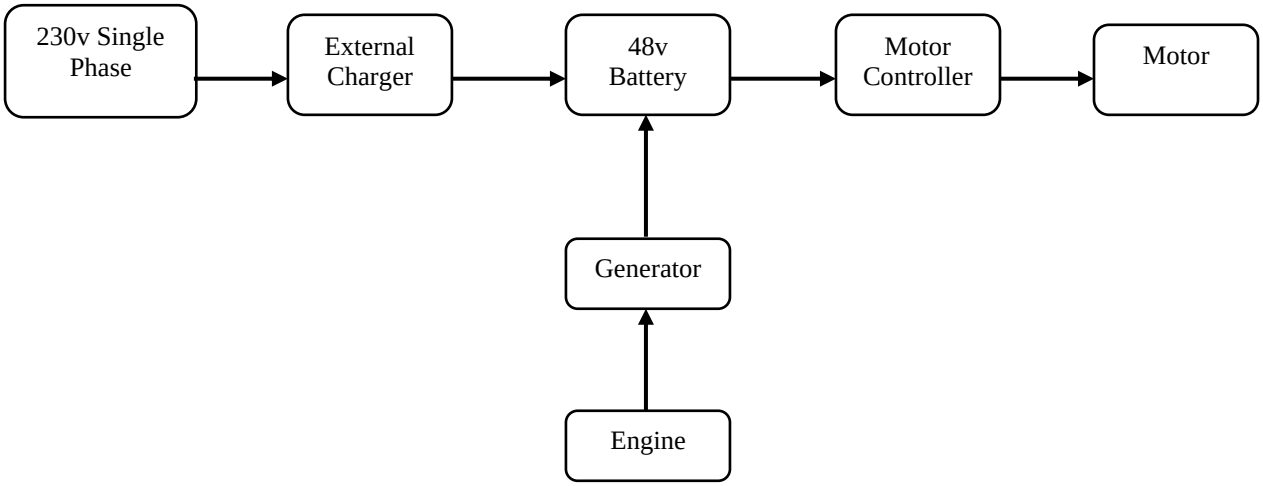

Fig. 5.1 Power supply diagram for 48v

6. RESULTS AND DISCUSSION

It mainly involves the different operations involved in the assembly and the sequence of its operation. Problems were identified in relation to the project, literatures were reviewed with respect to the automotive electronic system control for range extended electric vehicle. Required basic information and data were collected from the literatures

The power supply from the brake light switch is transferred to the 48v to 12v convertor, 12v coil sensor brake light and 12v to 5v converter.

The engine produces efficient energy that is coupled with generator to charge the battery.

6.1. Electric components assembly

Electric components like motor, generator were assembled according to their work in the vehicle

Fig. 6.1 Motor Assembly

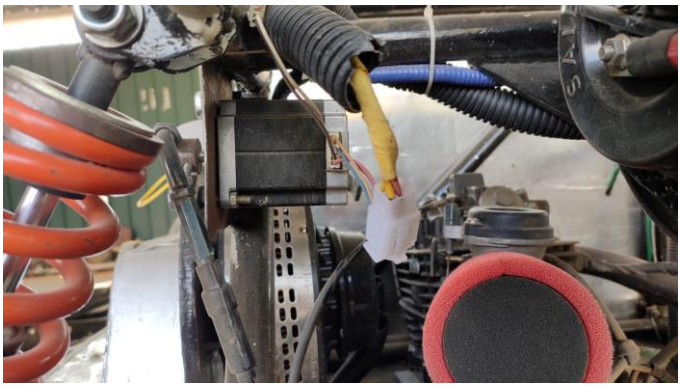

Fig. 6.2 Stepper motor and Generator Assembly

6.2 Electronic components assembly

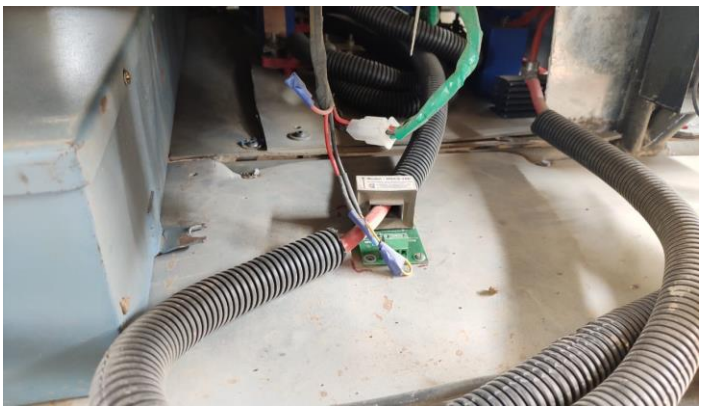

Fig. 6.3 Current sensor assembly

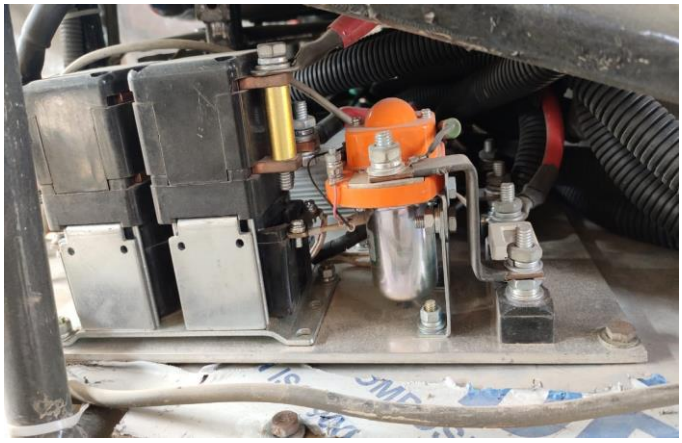

Fig. 6.4 Motor controller assembly

Fig. 6.5 Stepper Motor assembly

6.3. Complete assembly

Fig. 6.6 Complete assembly

6.4. Sequence of operation

- ✓ When the vehicle is switched ON MCM is ON.
- ✓ MCM gives command to battery contactors to ON.
- ✓ MCM gives command to Motor controller relay to ON.
- ✓ Battery temperature, voltage and SOC were checked.
- ✓ If the battery SOC is below 40% then fuel level and engine temperature is checked to meet the condition of engine starter motor and engine supply to be made ON.
- ✓ After the engine is ON stepper motor is initialized, throttle angle is adjusted to the speed required for generation of current.
- ✓ MCM gives command to generators contactor to ON, current output is monitored, if the current exceeds the limit then engine is stopped

7. CONCLUSIONS

Thus an automotive electronic system control for Range Extended Electric Vehicle is designed and assembled. The vehicle was tested in both hybrid and electric mode. The vehicle reached the range of 220 km in full charge and additionally with a liter of petrol. The vehicle can be operated by any licensed driver.

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