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DESIGN AND IMPLEMENTATION OF ULTRA CAPACITOR BASED ENERGY MANAGEMENT SYSTEM IN HYBRID ELECTRIC VEHICLE

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ABSTRACT

This paper shows another financially savvy technique for utilizing vitality stockpiling parts (battery and ultra capacitor) together with a specific end goal to develop the life of the battery. A ultra-capacitor based vitality administration framework for electric/hybrid electric vehicle is proposed to enhance its transient execution. The structure uses a DC-DC control converter which is related between ultra-capacitor and essential battery unit. Additionally, a vitality administration system of ultra-capacitor in light of PI controlling is proposed. With this technique the condition of charge of ultra-capacitor is measured and is kept at appropriate level as per diverse rates of vehicle.

Keywords: hybrid electric vehicle, DC-DC power converter, ultra-capacitor.

1. INTRODUCTION

Due to increasing fuel costs and the rising governmental restrictions on pollutants, automobiles have become increasingly more sophisticated and expensive. One of the more recent advances in the automobile industry is the current push for hybrid power within the vehicle. Many automobile manufacturers are attempting to compete in this new arena by implementing an Energy Storage System (ESS) and an electric motor alongside the common-place Internal combustion engine (ICE). This approach is commonly termed the Hybrid Electric Vehicle (HEV). During a typical driving cycle the HEV efficiently uses energy from both the gasoline, through the ICE, and the ESS, through the electric motor. A current progress inside the HEV segment is the hybridization of the ESS. The development used depends on upon the targets set for the vehicle, which fuses fuel capability, control, driving scope, or reduced ozone hurting substance releases. The achievement of any of the methodologies will be reliant on vitality stockpiling unit (batteries, ultra capacitors) abilities that are power, thickness, life, and cost. Batteries, ultra capacitors are vitality stockpiling gadgets. Ultra capacitors utilize electrolytes and design different measured cells into modules to meet the power, vitality, and voltage necessities for an extensive variety of uses. Be that as it may, batteries store charges synthetically, while ultra capacitors store them electro statically. As of now, ultra capacitors are more costly (per vitality unit) than batteries. The greater part of these vehicles right now advertised to purchasers have both regular fuel and electric engines, with the capacity to control the vehicle by it is possible that one autonomously or couple. Customer situated cross breed vehicles, which have been available for around ten years, are normally tuned for diminished outflows and driving extent. Corporate and government armadas that have been in administration for a long time or more are generally tuned for fuel effectiveness, regularly at the cost of driving reach, power, and hydrocarbon outflows. Joining the cleaner vitality of the electric engine with the long-extend energy of the gas motor yields a half and half vehicle with lower lethal emanations with better efficiency some of the time up to 30 miles a gallon or more than customary autos. Furthermore, the uplifting news is these HEVs (hybrid electric vehicles) execute too if not superior to non-cross breeds and are as protected, solid and agreeable as any conventional auto. Furthermore, they are intensely evaluated! Every auto proprietor should decide if the aces of half breed autos warrant their eagerness to spend somewhat more on the underlying buy, for lower costs later on.

2. BENEFITS OF ELECTRIC/HYBRID ELECTRIC VEHICLES

An electric vehicle has many points of interest over vehicles using an interior ignition motor. An electric vehicle is perfect. There are no vaporous emanations. Additionally dispensed with are other issue contaminations, for example, oil, transmission liquid and radiator liquid. In some EV's, the main hydrocarbon based substance utilized is the oil which greases up direction.

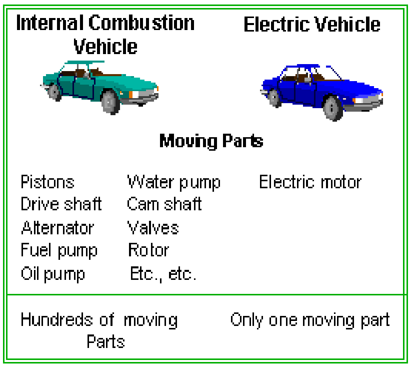

Figure-1. ICE vs. electric vehicle.

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Figure-1 shows comparison of IC vehicle & electric vehicle. Electric vehicles are exceptionally oversimplified. The impetus framework in an ICE vehicle has many moving parts. Notwithstanding lessening upkeep expenses and saving money on ointments and oils, the diminishment in grating misfortunes adds to the vitality effectiveness of electric vehicles.

Difference between hybrid EV and normal vehicle

Table-1. Difference between hybrid electric vehicle & normal vehicle.

S.NO	Hybrid electric vehicle	Normal vehicle
1.	Uses two or more distinct power system to operate.	Uses one power system to operate, however, only few normal vehicles are capable of using two power systems.
2.	Pollution free. Heat emission and smoke level are considerably low.	Heat emission and smoke level are high.
3.	Less expensive	Expensive.
4.	Energy or electricity or refilling stations of hybrid electric vehicles are not widely available in every country.	Many CNG/LNG and other filling stations are available for normal vehicles.
5.	Hybrid electric vehicles contain batteries up to ten.	Normal vehicle carry one to two batteries

3. PROPOSED MODEL PROPOSED BLOCK DIAGRAM

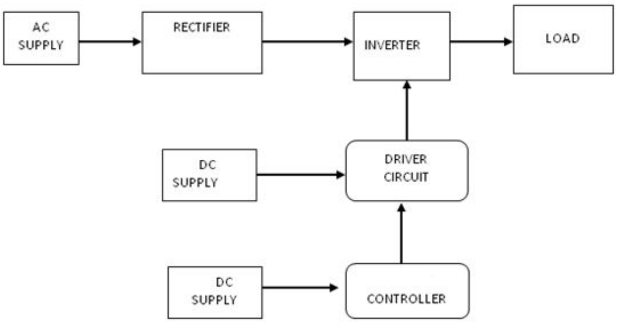

Figure-2. Proposed model.

Figure-2 indicates proposed model. Here, AC supply used to plug in the Hybrid electric vehicle. The AC power is converted into DC power by using rectifier circuit & which is stored in battery of hybrid electric vehicle. The inverter helps to convert the DC power to AC power to meet the required load in the vehicle when it gets started. Controller circuit provides gating pulses to driver circuit when required.

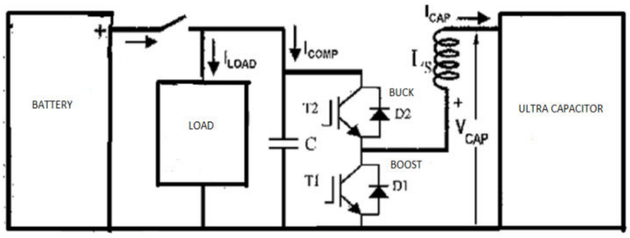

Figure-3. Proposed demonstrate.

Figure-3 demonstrates an outline of the framework executed into the vehicle. It has three principle parts: the bidirectional DC-DC converter in light of insulated gate bipolar transistors (IGBTs), the smoothing inductor LS, and the ultra capacitor. The gear is associated in parallel to the primary battery.

Modes of operation

Low voltage mode (LVM)

The operation of the vehicle explained in two modes, during low voltages the required energy can be supplied to the DC/DC converter alone, the working mode is low-voltage mode (Mode I) showed up in Figure-4.

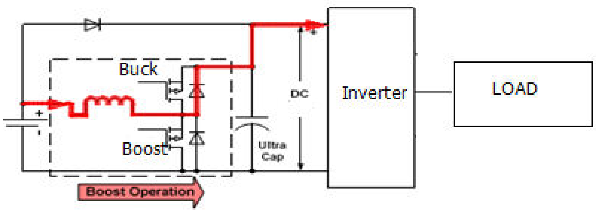

Figure-4. Energy flow in LPM.

High voltage mode (HVM)

In this mode, the required voltage is higher than the supply voltage, applies to the Buck Boost converter, the voltage of the ultra-capacitor can at no time later on be kept up. The essential power diode will be forward uneven. The battery is supplying voltage direct to the DC associate transport through the diode or controlled switch. Figure-5 represents the high voltage mode.

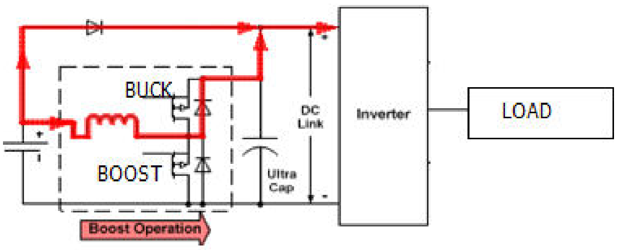

Figure-5. Energy flow in HPM.

Boost mode (Accelerating mode)

Amid boost operation (increasing speed), the IGBT T1 is turned on and off at a controlled obligation cycle, to exchange the required measure of vitality from the capacitor to the battery pack. At the point when T1 is

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ON appeared in Figure-6(a), vitality is taken from the capacitor and put away in the inductor LS. WhenT1 is turned OFF; the vitality put away in LS is moved into C, through D2, and after that into the battery pack as appeared in Figure-6 (b)

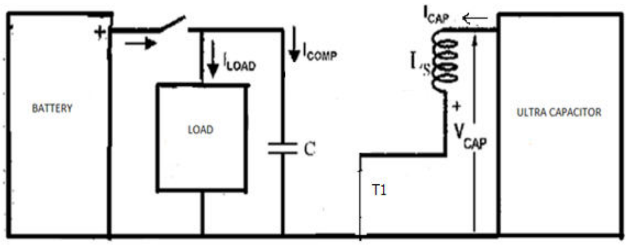

Figure-6. (a) T1 is switched ON during boost mode.

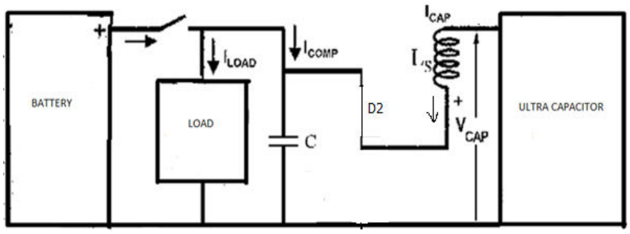

Figure-6. (b) T1 is OFF & D2 is ON during boost mode.

Buck mode (Deceleration mode)

Amid buck operation, the converter acquaints vitality from the battery with the ultra capacitor. That operation is refined with a controlled operation on T2. At the point when T2 is exchanged ON as appeared in Figure-7(a), the vitality goes from the battery pack to the ultra capacitor, and LS stores some portion of this vitality. At the point when T2 is turned OFF as appeared in Figure-7(b), the rest of the vitality put away in LS is exchanged inside the ultra capacitor through D1.

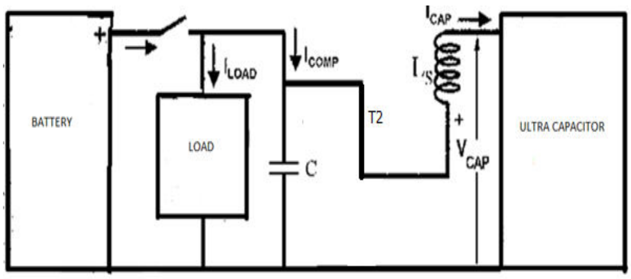

Figure-7. (a) When T2 is on during buck mode.

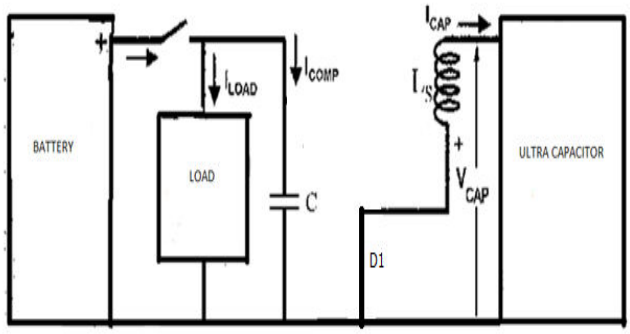

Figure-7. (b) When T2 is off & D1 is ON in buck mode.

4. SOFTWARE AND HARDWARE IMPLEMENTATION OF PROPOSED SYSTEM

Software implementation

The PC helped recreations are performed to demonstrate the capacity of proposed framework. A ultra-capacitor based vitality administration framework for electric/hybrid electric vehicle is proposed to enhance its transient execution. The framework utilizes a DC-DC control converter which associated between ultra-capacitor & principle battery unit. additionally, a vitality administration system of ultra-capacitor in view of PI controlling is proposed. With this technique the condition of charge of ultra-capacitor is measured and is kept at legitimate level as indicated by various velocities of vehicle.

Simulation model of boost converter

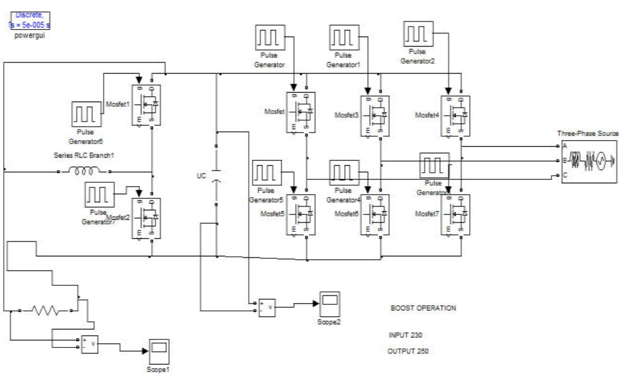

Figure-8. Simulation of boost converter.

Table-2. Ratings of boost converter.

S. No	PARAMETER	RATING
1.	Input voltage	230V
2.	Output voltage	250V
3.	Duty cycle	80%

The ratings of parameters shown in Table-2 are incorporated in simulation model of boost converter shown in Figure-8.

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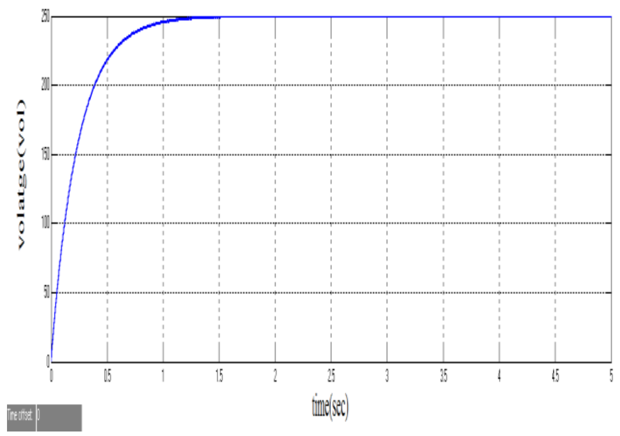

Figure-9. Simulation result of boost converter.

In the boost operation shown in Figure-8 the applied input voltage is 230V which is boosted up to 250V during accelerating mode of hybrid electric vehicle as shown in Figure-9.

Simulation model of buck converter

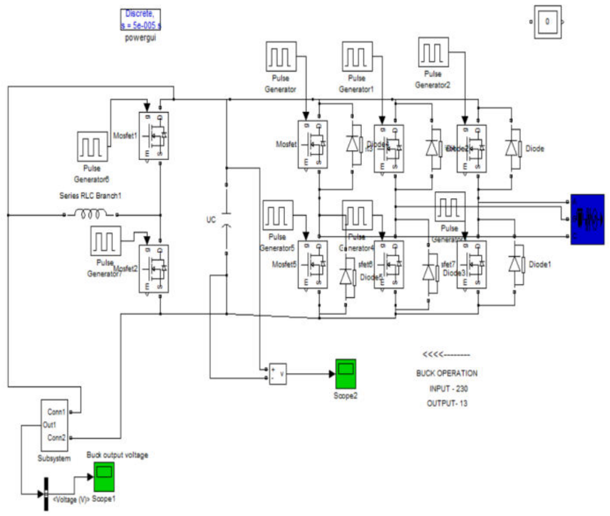

Figure-10. Simulation model of buck converter.

Table-3. Ratings of buck converter.

S. No	Parameter	Ratings
1	Input Voltage	230V
2.	Output Voltage	13V
3.	Duty Cycle	20%

The ratings shown in Table-3 are incorporated in the simulation model shown in Figure-10.

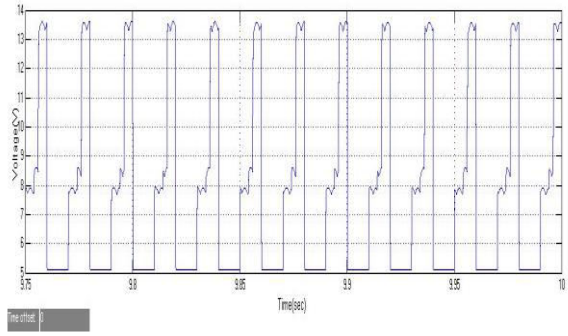

Figure-11. Simulation result of buck converter.

The circuit model of Buck operation is shown in Figure-10. Here the applied input voltage is 230V which is reduced to 13V by the buck converter during deceleration mode of Hybrid Electric Vehicle as shown in Figure-11.

Simulation model of proposed system

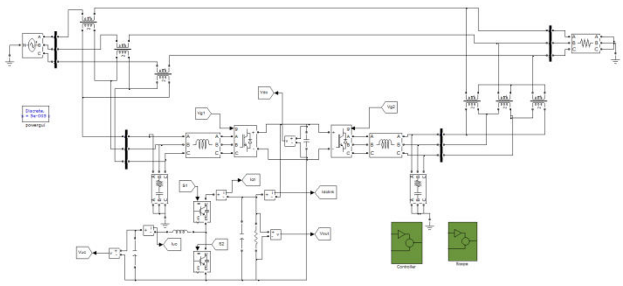

Figure-12. Simulation model of proposed system.

Simulation result of proposed system

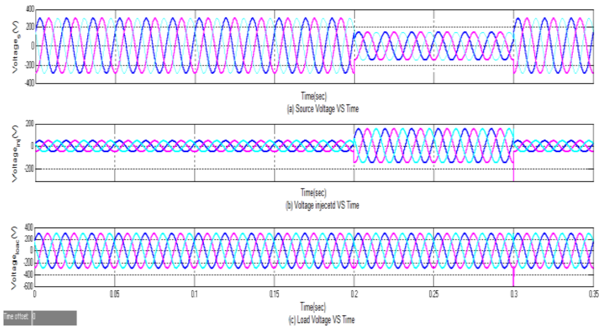

Figure-13. Simulation result of voltage vs time for proposed system.

Figure-13 represents simulation result of voltage vs time for the proposed system. Here, the source voltage which is reduced at some time say from 0.2 seconds to 0.3 seconds as shown in Figure. It is compensated by the injected voltage shown in Figure. The injected voltage is obtained by ultra capacitor. Thus the load gets sufficient voltage to meet its demand as shown in Figure 14.

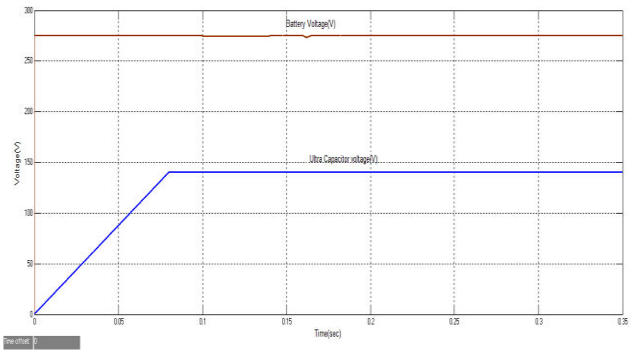

Figure-14. Simulation result of ultra capacitor & battery voltage for proposed system.

The voltage of battery is around 280V and the voltage across ultra capacitor is 144V which is shown in Figure-14. Figure-15 represents current of battery & ultra capacitor. Plot (a) represents battery current and Plot (b) represents ultra capacitor current. Here, there are different modes of operation. During start of vehicle the current drawn is zero up to 0.02 sec. After that the vehicle is in accelerating mode up to 0.2sec. During this mode the current increases up to 9 Amps. When the vehicle reaches its desired speed the current drawn by it becomes constant (around 8Amps) & this is known as freewheeling mode.

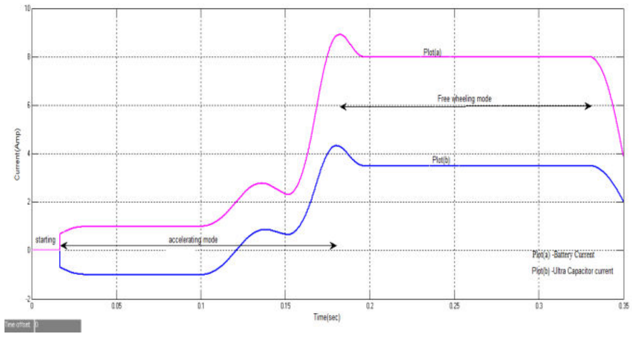

Figure-15. Simulation result of ultra capacitor & battery currents of proposed system.

During braking mode the current reduces and becomes zero resulting in stop of electric vehicle.

Hardware implementation

To confirm the operational standards of the proposed display, a model is executed. A model of having 6v sun based board; 4v battery is appeared in Figure-16.

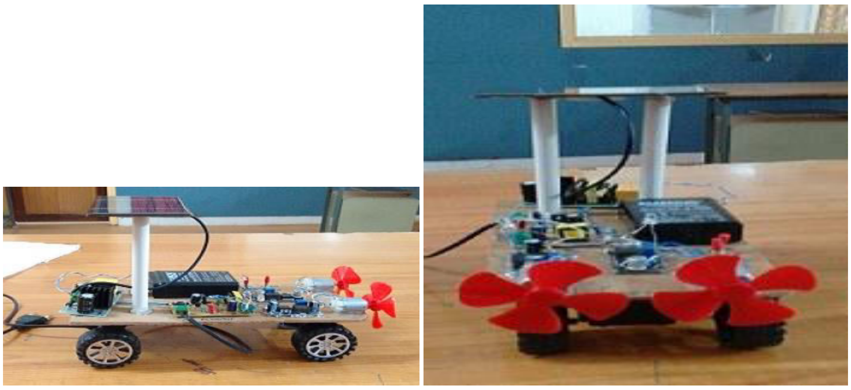

Figure-16. Hardware implementation of hybrid electric vehicle.

In the prototype a 6V solar panel, 4V, 4.5 Ah batteries is used to provide DC power for the Hybrid Electric Vehicle. The drives are connected to fans in order to indicate the operation of vehicle in different modes.

The prototype developed mainly operates in two different modes of operation.

1. Boost mode (or) Accelerating mode.
2. Buck mode (or) Deceleration mode.

Boost mode (OR) accelerating mode

Figure-17. Hardware model of boost converter.

The above Figure-17 demonstrates the operation of Boost Converter. In a lift converter or controller yield voltage of the converter is more noteworthy than info voltage of the converter circuit that implies it boosting the information voltage that is way its name is "Lift" controller.

The change proportion is given by

$$\frac{V_0}{V_{in}} = \frac{I_{in}}{I_0} = \frac{1}{1-D}$$

Where, D is the Duty cycle of the converter.

$$V_{in} = V_0(1-D)$$

$$I_{in} = \frac{I_0}{1-D}$$

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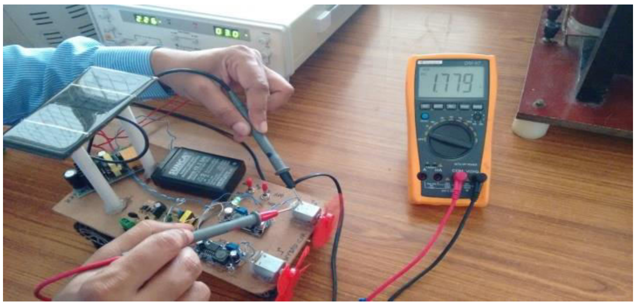

Figure-18. Implementation of boost converter.

In the above boost operation shown in Figure-18 the input applied is 2.409V. The output drawn at the boost operation is 17.79V.

Buck mode (or) decelerating mode

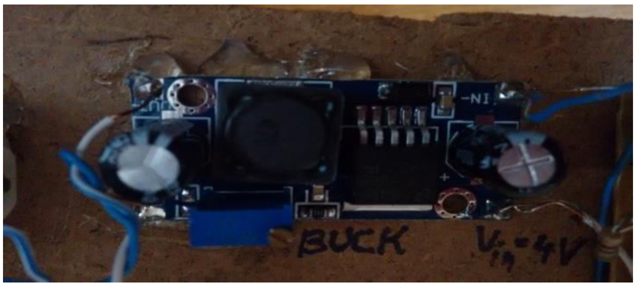

Figure-19. Hardware model of buck converter.

The Figure-19 demonstrates the operation of buck converter .In this converter yield voltage is littler than info voltage and yield current is more prominent than information current.

The transformation proportion is given by

$$\frac{V_0}{V_{in}} = \frac{I_{in}}{I_0} = D$$

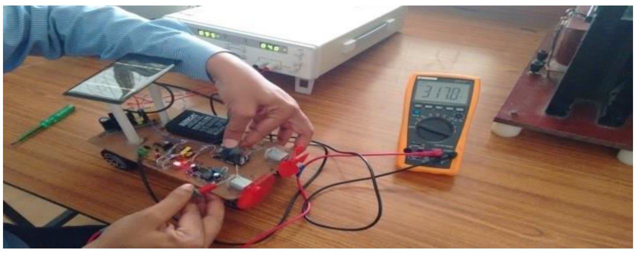

Figure-20. Implementation of boost converter.

In the Figure-20 Buck operation, the input applied is 3.604V. The output drawn at the buck operation is 317.0mV. So, the duty ratio is 0.087.

5. CONCLUSIONS

The further development of automobiles is important due to rising fuel costs. While many advances in the automotive industry have taken place since the invention of the internal combustion engine, it is clear that the advancement presented by the HEV is one of the most important. This research has focused on advancement in the energy storage medium of the HEV. The advancement of an enhanced hybrid UC - battery energy storage system where the UC can be charged to hi voltage than the battery. This expands the life of the battery. Exploratory outcomes gotten from the model electric vehicle, effectively exhibited the ability of parleying the vitality use of different vitality frameworks.

FUTURE SCOPE

In the vehicle vitality administration the future work required is to concentrate the capability of coordinating ideas of energy administration and vitality administration of Electric/Hybrid Electric Vehicle. For a battery a more exact Battery SoC estimation utilizing consolidated strategies might be fused in its Energy Management. The MOSFETS were chosen in the last form of usage structure. This paper exhibited reproduction and examinations that showed the conceivable advantages of numerous vitality frameworks in an EV application. Be that as it may, facilitate experimentation is expected to test more situations.

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