# Circuit Design Consideration in Solar Powered Electric Vehicle

Gowtham Rajan N,
Department Of Mechanical Engineering,
Hindusthan College Of Engineering And Technology,
Coimbatore - 641 032, Tamil Nadu, India.

Arun Kumar M
Department of Electronics and Instrumentation Engineering,
Hindusthan College Of Engineering And Technology,
Coimbatore - 641 032, Tamil Nadu, India.

Chandrasekar M G
Department of Electronics and Instrumentation Engineering,
Hindusthan College Of Engineering And Technology,

Asir Jonathan Beniro T
Department of Electronics and Instrumentation Engineering,
Hindusthan College Of Engineering And Technology,
Coimbatore - 641 032, Tamil Nadu, India.

***Abstract*— In recent days, the world has improved a lot particularly in transportation sector as it is required for the movement of troops. The process of oil production decreases, but the utilization of oil on our planet increases. The usage of coal, oil, diesel exudes a lot of debased gasses and this outcomes in foolish equality of O3 improvement, an earth wide temperature boost and climatic changes etc. So now the world is trading their transportation structure absolutely reliant on electrical and electronic as a power source. This foreseen need to contribute environmentally friendly power energy; considering this condition we could improve and utilize sun powered energy to charge electric vehicles by using sun light-based boards that are executed in the vehicle. This paper is completely equipped with explanations, for instance; progressed auxiliary structure, examination, their ability, weaknesses of this development and profitability of our vehicle.**

**All things considered, most of the business electric vehicles are available in substituting flow (air conditioning), it is trivial concerning battery accumulating, and need to do a great deal of assignments to store, anyway misfortunes are seen as extra. Inbuilding direct current drive sway efficiency. Realizing BLDC engine needs less thought and low help.**

***Keywords*— *BLDC Motor, Controller, Hybrid Technology, Solar Panel, Performance Experiment.***

## I. INTRODUCTION

Energy is the most essential need for human continuance. Individuals are dependent upon energy and converting energy from petroleum derivatives. We use energy from these hotspots for making power, running cars, etc. Regardless, to be pretty much it has different insults, that they are not eco-accommodating and they are superfluous. To manage these issues of fossil fuel, we have to invite a non-conventional source of energy. Solar powered vehicles are electric vehicles which are controlled by sun-oriented energy that is received by solar panels which are embedded on the outside of the vehicle. Fundamentally, photovoltaic cells and modules convert the solar energy straightforwardly into electrical energy. Solar panels are made up of semiconductors, usually silicon, that absorb the light. The sun's energy liberates electrons in the semiconductors, making a progression of electrons. This flow produces electricity that controls the battery and the particular motor in solar vehicles. These vehicles can be worked interestingly for a few detachments without sun, so they are not considered as a sensible kind of transportation these days. Considering all of these factors gives us another innovative idea. We have organized and created an electrical vehicle that abrupt spikes sought after for sun powered energy.

## II. DESIGN AND ANALYSIS

The preeminent motivation behind the plan is to accomplish less complicated and achieve ideal execution without settling on the driver's safety, reliability and durability. With respect to the plan, driver's security and ergonomics have been given top priority. This calls for weight decrease and better vehicle execution to the detriment of expanded expenses. During the conceptualizing stage, several design ideas were considered and the optimum solution at every stage was pursued, Various design and analysis software such as Solidworks Electrical, MATLAB were utilized to visualize into an effectively usable advanced medium that is appropriate for design creation, analysis and optimisation [6].

Consideration includes that Hybrid Electric Vehicles (HEV) have developed to modern development, and spoken a sensible answer for significant issues[2], for example, the decrease of vaporous contamination in urban drive just as the energy sparing necessities the level of charge of the armada is relied upon to develop essentially in one years from now [1].

BLOCK DIAGRAM

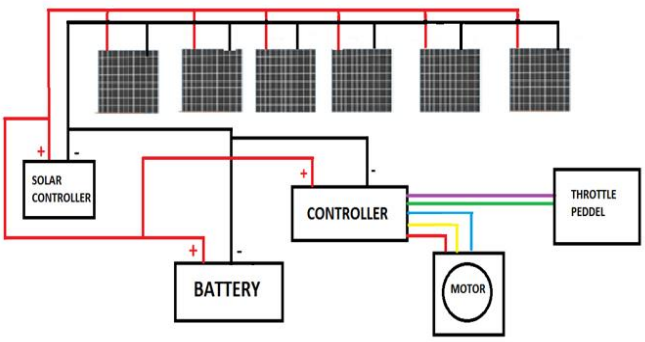


Fig. 1 Overall Block Diagram

The above block diagram shows the outline of working of solar vehicles. Sun is the fundamental wellspring of energy

for the vehicle. Photograph voltaic cells use sunshine as a wellspring of energy and produce direct current. Varieties of photovoltaic system have been an effortless capacity to electrical hardware. The electrical energy is taken care of as batteries for later use through the MPPT controller. Batteries deftly flexibly the ability to the controller which spits the essential force for the BLDC engine. The pole of the engine is associated with the back wheel of the vehicle using chain sprocket. From the outset batteries are totally empowered and from there on they are charged by boards. This guides in completing the charging-releasing example of the batteries, which is huge for real working of batteries.

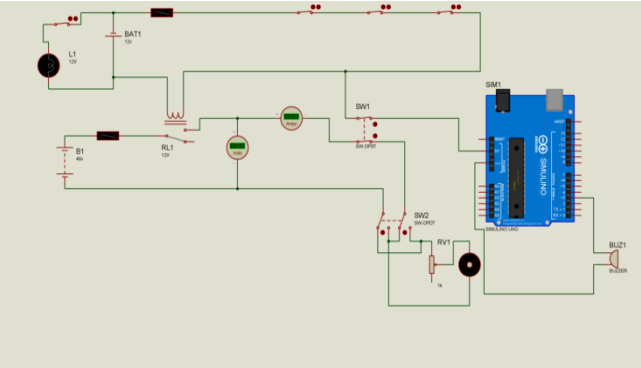


Fig. 2 Circuit diagram

The above given circuit diagram of a solar vehicle is presented as MATLAB design which shows the absolute electrical design except panel circuits. Electrical rating of the parts is point by point in the following table. Working phase of the vehicle starts from the battery (B1-48V), which is coordinated to the controller utilizing a breaker to guarantee security. Transfer is presented between the circuit for simplicity of availability and safe practice. Controller drives the BLDC engine by giving and appropriating the necessary force gracefully. Speed of the engine is changed by utilizing the choke pedal which is inbuilt in the controller circuit to fluctuate the opposition. Forward and Reverse of the vehicle is accomplished by exchanging the controllers FNR circuit. Voltmeter and Ammeter are associated over the essential circuit to look at the voltage and current utilization of the vehicle. Ringer is an electrical gadget used to modify when the vehicle begins. Bell is totally constrained by the Arduino board which stops the ringer sound inside 3 seconds after caution.

Also, all the electrical parts other than the tractive framework are fueled by an optional battery (BAT1-12V). This optional battery is utilized to gracefully capacity to the hand-off (RL1), ammeter, voltmeter, signal, horn, heat light and other lighting frameworks. Circuit is additionally utilized in the auxiliary association with guarantee wellbeing and are given ON/OFF alongside the three off buttons at the shifted area in the vehicle for crisis stop.

## III. ELECTRICAL COMPONENTS

Various types of electrical segments were actualized in the sun based fueled electric vehicle. A once-over of these parts' use with their range and the particular amounts that were required for making a sunlight-based vehicle is examined in the accompanying table.

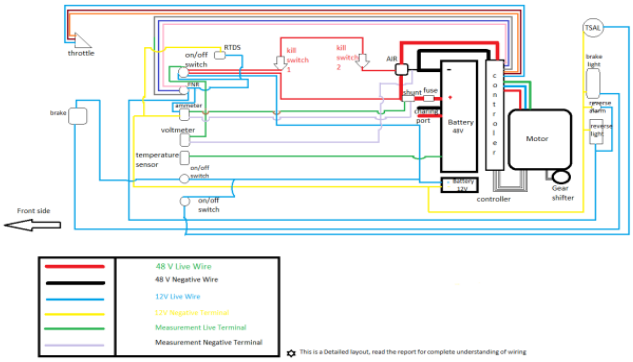


Fig. 3 Detailed diagram

TABLE I

| Components | Range | Quantity | Type |
|---|---|---|---|
| Battery | 48V, 100Ah | 1 | Li-ion |
| Motor | 48V,2kW | 1 | BLDC |
| Controller | 24-72V, 0-180A | 1 | Closed loop |
| Solar Controller | 48V, 40A | 1 | MPPT |
| Solar module | 150Wp<br>70Wp<br>35Wp<br>20Wp | 2<br>1<br>2<br>2 | Flexible Mono-crystalline |
| Relay | 48VDC, 200Ah | 1 | 2Z contact form |
| Wire Harnesses | 16mm² (High voltage) 2mm² (Low voltage) | Approx. 5meter<br>Approx. 8meter | copper |
| Battery | 12V | 1 | Lead acid |

Furthermore, some other electrical components were used in the vehicle some are.

- Voltmeter, Ammeter to measure the voltage and current consumption,
- Brake light, Buzzer, Horn were used for driver comfort and safety.

## COMPONENTS IN DETAIL

*Battery:*

A battery is a gadget involving in any event one electrochemical cell with an outside association that offered capacity to electrical gadgets. Exactly when a battery is giving electric power, its positive terminal is the cathode and its negative terminal is the anode [8].

TABLE II

| **Terms** | **Range** |
|---|---|
| Number of cells in battery | 546 cells |
| Cells in parallel connection | 42 cells |
| Cells in series connection | 13 cells |

| | |
|---|---|
| Number of cells in rows | 42 cells |
| Number of cells in columns | 13 cells |
| Current rating of single cell | 2.4 amps |

Charging and Discharging time:
V=48V, I=100Ah
Charging time = rated current/applied current
= 100/15
= 6.6 hours (approx.).

Discharging:
Motor power consumption=2000watts
Discharging time = total power/motor power
= 4800/2000
= 2.4 hours (approx.)

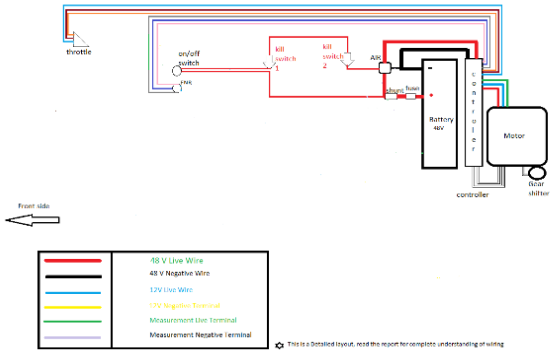

Fig. 4 Battery Circuit diagram

*Motor:*
A brushless DC electric motor, otherwise called coordinated DC engine, are concurrent engine filled by direct stream (DC) power by methods for an inverter or trading power deftly which produces power through subbing stream (AC) to drive every time of the engine by methods for a shut circle controller. The controller gives the beat of current to the engine windings that control the speed and force of the engine [7].

TABLE III

| Terms | Range/Type |
|---|---|
| Maximum Tractive System Voltage: | 54.6V |
| Nominal Tractive System Voltage: | 48V |
| Grounded Low Voltage System Voltage: | 12V |
| Number of Accumulator Containers: | 1 |
| Total Accumulator Capacity: | 1 |
| Motor Type: | BLDC NORMAL |
| Number of Motors: | 1 |
| Maximum Combined Motor Power: | 1 |

*Motor Controller:*
A controller is a gadget which control the presentation of an electric engine. An engine controller may join a manual or modified suggests for starting and stopping the motor, picking forward or pivot a turn, picking and dealing with the speed, coordinating or confining the force, and making sure about against over-load and electrical issues.

TABLE IV

| Terms | Range/Type |
|---|---|
| Make | Kelly |
| Available Battery Voltage | 48V |
| Available Motor Power | 2000W |
| Phase Peak Current | 80A (for 30 seconds) |
| Rated Current | 42A |
| Throttle Input Voltage | 5V |
| Operating Temperature Range | 0-60ºC |

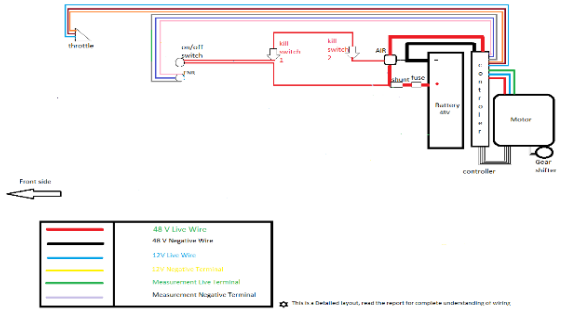

Fig. 5 Motor and Controller Circuit

*Fuse:*
A circuit is an electrical security device that can prevent flow from streaming on the off chance that it gets over-load, or a gadget that is utilized to light an unstable.
Wire is required between the battery and charge controller in light of the fact that the wire must be estimated to convey the biggest conceivable current in any case. A distinction, which might be a breaker, is required for administration and a ground flaw breaker that likewise detaches the battery gracefully is required by the NEC.
Safety system includes sensing speed of vehicle approaching to perform safe cuts and lane change over. This also includes sensing objects in the proximity of the vehicle which helps in parking and driving in heavy traffic.

TABLE V

| Fuse Location | Current Rating | Voltage Rating |
|---|---|---|
| Controller | 150A | 48V |

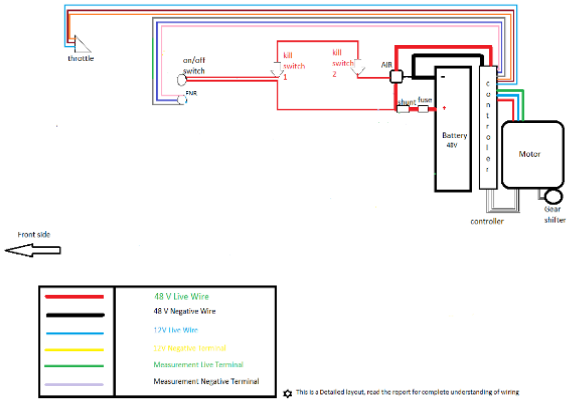

Fig. 6 Fuse Circuit

*Relay:*
A relay contactor is an electrically-controlled switch utilized for exchanging an electrical power circuit. A contactor is regularly controlled by a circuit which has much lower power

level than the exchanged circuit, for example, a 12-volt curl electromagnet controlling a 48-volt motor switch [9].

- Insulation resistance: 100Mohm Min
- Dielectric strength between contacts: 200VAC
- Between coil and contacts: 1500VAC

*Solar controller*

A MPPT charge controller, or greatest force point tracker is an electronic DC to DC converter that improves the match between the sun based (exhibit) bunch (PV boards), and the battery bank. To spread it out evidently, they convert a higher voltage DC yield from sunlight-based boards and down to the lower voltage expected to charge batteries similarly as relatively give power to the engine using a controller to drive a vehicle [5].

*Solar module*

Photovoltaic modules use light energy (photons) from the Sun to deliver power through the photovoltaic impact. A sun-based module is commonly a game plan related with, a satisfactory number of sun-based cells to give required standard voltage and force. A solitary sun powered module can be evaluated from 3 watts to 300 watts. Indeed, a single PV cell delivers an outstanding little total that is around 0.1 watt to 2 watts. Regardless, it is not useful to use such a low force unit as a structure square of a system. In this way, the necessary number of such cells are combined to outline a sensible monetarily available sun-based unit which is known as sun-based module or PV module.

The examples for the profitability of photovoltaic cells have showed up. By far most of today PV boards, with multi-crystalline silicon advancement, have efficiencies some place in the scope of 11% and 18%, while the usage of mono-crystalline silicon licenses to extend the changing profitability of about 4%. The reaction to multi-convergence cells, with the usage of materials as Gallium Arsenide and to concentrating progressions, has allowed to show up at 40% of cell profitability. Anyway, the cost of these last game plans is still preposterously high for a mass application on vehicles [3].

The vehicle is completely planned reliant on the driver's prosperity anyway most extreme need given to use the upper surface of the vehicle to accumulate sunlight-based shafts. The board should be mounted so that it can get the best sunbeams with the objective that it gives its most extraordinary capability. The vehicle is mounted with a sun-based board in 360 degrees of the vehicle, it helps with getting the most outrageous proportion of force, a journeying course of the vehicle won't be a genuine arrangement to assemble sun-controlled energy. Considering the constrained and smoothed out structure, versatile boards were recommended to use, conveniently it gives a weight abatement to the vehicle. As the vehicle has a board power rating of 480wp with a moved voltage evaluated board. Boards in a vehicle are related with a course of action and equivalent way to deal with get a perfect yield of 48V, affiliations are explained as a pictorial depiction in underneath [4].

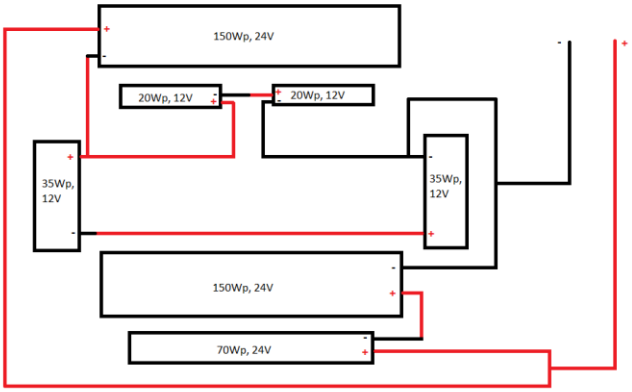


Fig. 7 Panel Connection

## IV. CONCLUSION

The coordination of photovoltaic boards in sun oriented controlled vehicles is getting dynamically down to earth, due to the extending task force charge, to the development in fuel costs, to the advances with respect to PV board advancement, and to the abatement in their cost. Sunlight based electric vehicles give a significant answer to face both energy sparing and natural issues. Obviously, these vehicles can't speak to a general arrangement, since the best amicability among favorable circumstances and costs would depend upon mission profile: explicitly, immense reductions in fuel use and outpourings can be procured during normal use in urban conditions during working days. Also, the joining with sun powered energy would in like manner add to decrease battery resuscitating time, a fundamental issue for plug-in vehicles, and to add an impetus for Vehicle to Grid applications. Putting a sun-based board on a current electric vehicle may be just the underlying stage: in order to extend their focal points, rethink and improvement of the whole vehicle-powertrain system would be required. Explicit thought must be paid in enhancing the net power from sun-based boards, and in grasping pushed answers for power equipment. In addition, these vehicles would require express responses for energy the executives and control, with further created look-ahead capacities. The gathering of moving housetops for leaving stages and the usage of sun-oriented boards on windows and even sides would overhaul sun powered duty, past the conventional fixed load up on the vehicle roof. In addition, these courses of action would diminish the opening between sun powered responsibility at low and high extensions, so extending the normal market of these vehicles. Interesting open entryways are in like manner related to possible reconversion of common vehicles to Solar Powered Electric Vehicles, by strategies for packs to be scattered in the affiliate's trade. The perspectives about cost issues of sun-oriented vehicles are engaging. Anyway, as it happens for certain, improvements, full fiscal feasibility couldn't be instant, and a cash related assistance from governments would irrefutably be fitting. In any case, the continuous business accomplishment of solar electrical vehicles exhibits the purposes of customers such as saving money as well as the planet from pollution, climate changes and resource fatigue.

ACKNOWLEDGEMENT

This paper is a complete researched, real time project designed and fabricated by the students of Hindusthan College of Engineering and Technology, Coimbatore. The research, vehicle design, analysis, fabrication and testing was made possible with the help and assistance provided by Dr. Y. Ras Mathew, Managing Director of Hi-Racing Motor Sports, and Associate Professor in Hindusthan College of Engineering and Technology, Coimbatore. The project was taken by a team of 5 members namely Arun Kumar M, Chandrasekar M G, Asir Jonathan Beniro T, Dhanish Mohammed Abdulla Y, Gowtham Rajan N.

Fig. 8 Equipped Vehicle

REFERENCES

[1] Fischer R. (2009), AVL List GmbH, *The Electrification of the Powertrain* – from Turbohybrid to Range Extender, 30. Internationales Wiener Motorensymposium 2009.

[2] Guzzella L. and Amstutz A. (1999), *CAE Tools for Quasi-Static Modeling and Optimization of Hybrid Poweretrains*. IEEE Transactions on Vehicular Technology, vol. 48, no. 6, November 1999.

[3] Smil V., (2006*), Energy at the Crossroads*, Global Science Forum Conference on Scientific Challenges for Energy Research, Paris, May 17-18, 2006.

[4] Yogesh Sunil Wamborikar, Abhay Sinha, "*Solar Powered Vehicle*" Proceedings of the World Congress on Engineering and Computer Science 2010 Vol II WCECS 2010, October 20-22, 2010, San Francisco,USA.

[5] Gianfranco Rizzo, Ivan Arsie and Marco Sorrentino, "Solar Collectors and Panels, Theory and Applications" https://www.researchgate.net/publication/221905597. 23 May 2014.

[6] Manivannan S, Kaleeswaran E, "First International Conference on Sustainable Green Buildings and Communities" (SGBC) 18-20 Dec. 2016.

[7] Refrangible Society of Technophile Engineers, "Saur Urja Vehicle Challenge" rule book september 2018.

[8] Segal A., Epstein M., Yogev A., (2004), Hybrid concentrated photovoltaic and thermal power conversion at different spectral bands, Solar Energy 76 (2004) 591–601.

[9] Thilagam, A., Singh, J., Stulik, P., (1998), Optimizing Gallium Arsenide multiple quantum wells as high-performance photovoltaic devices, Solar Energy Materials and Solar Cells, Vol: 50, 1-4, January, 1998 pp. 243-249, Elsevier