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# Designing Basic Regenerative Braking System Circuit for Electric Go-kart

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**ABSTRACT:** Electric vehicles have been attracting a lot of attention in light of the volatile market prices and prospect of finishing supplies of fuel. Advancements in electrical motor efficiency and battery technologies have made electric vehicles better alternatives. Now days these electric vehicles are extensively used especially for short distance or city commuting. The Permanent magnet BLDC motors are being used more frequently in electric vehicles due to their robustness, reliability and high efficiency. One of a best advantage of a Permanent magnet BLDC motor is that it can produce a higher voltage at lower rpms than other motors or generators. This will help to use this motor as a generator in the regenerative braking system. In an electric vehicle, regenerative braking system helps to charging the battery by conserving energy, thus extending the range of the vehicle.

**KEYWORDS:** Electric vehicles, regenerative braking, transmission, electric motor, regenerative circuit.

### I. INTRODUCTION

Now days, electric vehicles (EVs) are gaining much attention as an alternative to conventional vehicles powered by internal combustion engines running on non-renewable fossil-based oil fuels. The main reason of trying to find a better alternative are because of the economic and environmental concerns linked to the use of fossil fuel in internal combustion engine (ICE) powered vehicles. But with the increasing interests of the big automobile bands in the market they are getting successful in in making the technological advancements in the electric vehicle systems which are enabling the vehicles to cover larger distances. They are certainly achieving more and more by increasing their distance to charge interval ratio. EVs have a battery system which can be recharged from standard power outlets. Since performance characteristics of electric vehicles have become comparable to, if not better than those of traditional vehicles, EVs feels a realistic alternative. There is more advancement in the electric vehicle technology for recovering the lost energy. For example regenerative braking can be used in an EV as a way harvesting the lost energy during braking. Regenerative braking is the process of feeding energy from the drive motor. This can be done because when the car is freewheeling the motor can be used as a generator and the lost energy can be fed back into the battery during the braking process. When the vehicle is freewheeling the motor is driven with the wheels as the vehicle is already in motion. Due to this inertial momentum the motor acts as a generator. When the vehicle is moving, the batteries are seen as a load. This load creates a resistance in the motor which acts as brakes and tend to slow down the vehicle. But the braking system cannot only rely on this braking system as a result for the driver's safety the traditional mechanical brakes are also require to stop the vehicle. It is seen that if this regenerative system is optimized and used properly the driving range of the vehicle can be increased by about 15%.

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## II. RELATED WORK

### 1. Energy wasted in Braking:

A very large amount of energy is consumed by braking. When vehicles are driving with a stop-and-go pattern in urban areas, a significant amount of energy is consumed. This happens because of frequent braking. This results in high fuel wastage. The braking energy in city areas may reach up to more than 20% of the total energy. In large cities, such as Mumbai/Pune, it may reach up to 65%. It is clear that effective regenerative braking system can significantly improve the fuel economy of Electric vehicles.

### 2. Distribution of brake energy on Front and Rear Wheels:

The braking power and braking energy used by the rear and front wheels are directly proportional to the braking forces on them respectively. A full analysis of the braking power, braking force, and braking energy consumed by the front and rear wheels in various driving conditions is helpful in the design of regenerative braking systems.

But as when brakes are applied the weight transfer of the vehicle is more towards the direction of the vehicle that is the front side of the vehicle. The front wheels consume about 65% of the total braking power and energy. Thus, regenerative braking on front wheels is more effective than on rear wheels.

But in this case the go-kart will be powered by a brushless electric DC motor from the rear axle. Hence, the regenerative braking of the go-kart is from the rear side of the vehicle. But this might not affect much because the front brakes are eliminated because of the weight optimisation of this electric vehicle.

### 3. How regenerative braking works in the go-kart

The basic question that comes while considering regenerative braking in electric vehicles is that how to distribute the total braking forces required between the regenerative brake and the mechanical friction brake so as to recover the kinetic energy of the vehicle as much as possible. Hence, with some analysis, the best solution for the regenerative braking system type is to use series braking. It consists of the regenerative braking first and later mechanical braking.

The principle of the series braking system is to recover the braking energy as much as possible in the condition of meeting the required braking force demanded for the given deceleration. This principle is as illustrated. When the vehicle is braked, the braking forces on the rear wheels vary in a certain range. The variation should be in a way that for nominal braking the driver should achieve the braking without using the mechanical brakes. In this case, regenerative braking should only be used first and not with mechanical braking. This will allow the system to recover the losing energy in an efficient way. If, on the same road, the effect of available regenerative braking force is less than the braking required by the driver, then mechanical braking can be used to reduce the braking distance.

## III. THE COMPONENTS OF THE REGENERATIVE CIRCUIT

The main components of the system can be split into two parts

### i. The driving system.

- Batteries
- Motor controller
- Accelerator
- Electric motor

### ii. Add-ons for the Regenerative braking system.

- Motor controller cut-off switch
- Voltage rectifier
- Voltage regulator

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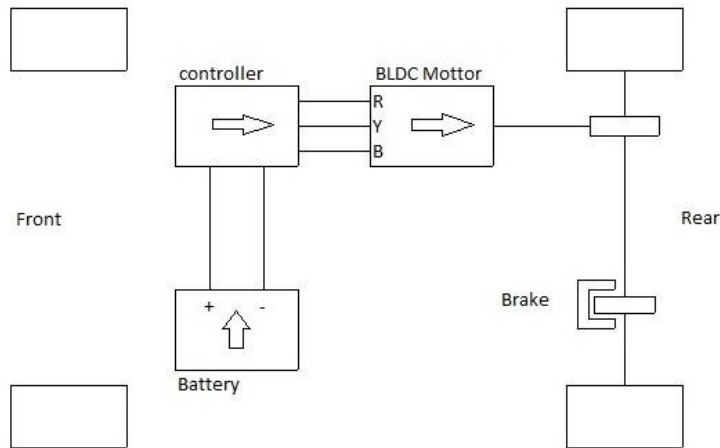


Fig. 1 Conventional EV powertrain and its circuit

The above figure (1) shows the conventional power train of an electric vehicle with rear wheel drive and rear wheel braking. The flow of voltage is as shown why the arrows when the vehicle is accelerated. The motor speed is controlled with the help of an accelerator and for braking purpose conventional hydraulic brakes are used. In this system, the motor controller used is a simple conventional type, thus the energy during braking is wasted and cannot be recovered in any form.

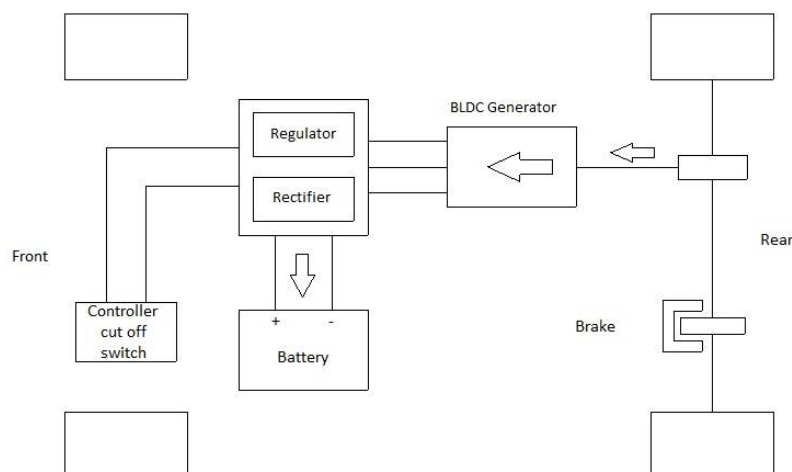


Fig. 2 Regenerative braking system powertrain and its circuit.

The above figure (2) shows the implementation of the regenerative braking system of an electric vehicle with rear wheel drive and rear wheel braking.

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In this type of regenerative circuit the resistance of the motor is used as the brake which in turn also acts as a generator thus charging the battery on the expense of slowing down the vehicle. But for effective braking the mechanical brakes are to be used by the driver.

The brake lever in the go-kart is as made that it first actuates a controller cut-off switch and later it actuals the mechanical brake if needed. The function of the cut-off switch is to cut-off the main current supply from the controller to the BLDC Motor. When the current is cut-off the controller can no more control the motor in any way. But at the same time the BLDC Motor acts as a generator and uses the momentum of the vehicle to rotate the shaft of the motor. In the motor an opposing force is generated as it produces current. This opposing force acts as a brake which helps slow down the vehicle. The flow of current is shown in the figure (2). When the vehicle is accelerating the current flow is as shown in the figure (1)

At the same time the motor produces an AC voltage. But this AC voltage cannot be fed directly to the batteries. Hence, this regenerative braking motor controller is embedded with a voltage rectifier circuit. This rectifier circuit converts AC voltage to DC voltage. The charging system doesn't end here. As the motor is powered by a 48v battery pack, a minimum if 55v is needed to charge the batteries. As the regeneration system will not only work at high speeds but also at lower speeds. And it's not possible for a generator to produce a same voltage with a varying rpm of the shaft. Hence, a voltage regulator circuit is also included in the controller circuit which will regulate the voltage and help charge the battery even in low vehicle speeds with a constant voltage of 55v.

#### IV. RESULTS AND CONCLUSIONS

Analysing all the parameters and with the help of the experimental values from the reference papers it is clear that only 5% to 8% of the total lost energy can be recovered from this system. There are more ways to optimise the energy recovery with the help of more advanced circuits. Using a regenerative circuit, the range of the vehicle increases. The decision to go full electric was due to the ill effects of IC engines such as air pollution, global warming and also the depleting oil reserves. The Government of India has recently passed a new resolution that no IC engine cars will be sold in the country from the year 2030 onwards. Also, with better technology now being available, it is economically feasible to run a vehicle on electrical power.

#### V. FUTURE SCOPE

Electric vehicles are the future of transport, there is no denying this. This project has been successfully completed according to the needs of the company and will be delivered to them. EV technology is still a relatively new concept and there is a lot which will be improved in the future. With new developments in battery and motor technology, the vehicle will be further enhanced down the line in the future.

#### REFERENCES

- [1] MehrdadEhsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory and Design", ISBN 0-8493-3154-4, 2008
- [2] Xiaohong Nian, "Regenerative Braking System Of Electric Vehicle Driven By Brushless Dc Motor", 2014.
- [3] James Larminie and John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd ISBN: 0-470-85163-5, pp 191, 2003
- [4] James Larminie and John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd ISBN: 0-470-85163-5, pp 183-189
- [5] Sathish Kumar N, Vighnesh A, "DESIGN AND ANALYSIS OF AN ELECTRIC KART", April 2015.
- [6] Kirpal Singh, "Automobile Engineering", Standard Publisher Distributors, 7th Edition 1995.
- [7] Albert Hartman and Wendy Lorimer, "Design Equations for BLDC Permanent Magnet Generators", Performance Magnetics, vol. 1, no. 2, 2013.
- [8] DidiIstardi, "MODELING AND ENERGY CONSUMPTION DETERMINATION OF AN ELECTRIC GO-KART", (2009)
- [9] Guoqing Xu, Weimin Li, Kun Xu and Zhibin Song, "An Intelligent Regenerative Braking Strategy ForElectric Vehicles", (2011)
- [10] Permanent Magnet Synchronous and Brushless DC Motor Drives, Ramu Krishnan, CRC Press, 25-Sep-2009
- [11] <http://www.revolt.org.il/rv-120-model/rv-120-regular/>
- [12] <http://www.flyelectric.com/ans.kv.html>