

# A Study Report on Fabrication of Hitech-Highway

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**ABSTRACT:** The effects of vehicular pollution are felt at many levels. This type of pollution does not just affect one particular area of the environment, but several other areas as well. The elimination of vehicular pollution is simply not going to happen. Instead there have been other attempts made in the prevention of vehicular pollution. One such method is explained here in the project work called as the hi-tech highway.

The hi-tech highway consists of an overhead catenary system that will run along the outside lanes of both sides of the road, sort of like the overhead wires that provide power to electric buses, trolleys, trains, etc in cities. Specially outfitted hybrid or all-electric trucks can attach to the system using automated current-transfer devices. Once connected, the vehicles will pull all their power from the overhead lines, effectively becoming emission-free vehicles. Hi-tech highway vehicle turns the future of electric-driven freight transport into reality. In normal operation, hi-tech Highway vehicle draws electric energy from a catenary system using an adaptive established contact with the overhead wire. Wherever if there is no overhead line, the hi-tech Highway vehicle will automatically switch over to their diesel-hybrid drive system. This means that they can be used just as flexibly and universally as conventional vehicle.

The demo model of the project is constructed with a four wheel chassis (vehicle) and is driven by a DC motor. Once the start button is pressed, the mechanical structure will be lifted that is driven by suitable electro mechanical components to make contact with the hi-tech highway line. The vehicle diesel drive mechanism is demonstrated by driving the vehicle through the battery. Once the hi-tech highway mechanism is started, supply from the battery to the motor is disconnected and is connected from the hi-tech highway lines to run the vehicle. The running motor condition of conventional drive or the hi-tech highway drive will be displayed in the LCD that is interfaced to the microcontroller. Depending on the connection establishment with the hi-tech highway, an input is fed to the controller by which the controller switches the supply to the motor through a relay contact automatically. The vehicle is equipped with obstacle detecting sensors in front to stop the vehicle automatically when any obstacle is detected.

In addition, the hi-tech highway line is powered through solar energy with automatic highway lighting system using sensors. The highway lights are automatically controlled depending on the vehicle movement and by sensing the natural light (day or night) to save the precious energy.

**KEYWORDS:** Hi-tech highway, vehicular pollution, automated current-transfer devices, DC motor, solar energy.

## I. INTRODUCTION

With most major auto manufacturers now actively developing electric vehicles, the drive towards a zero emission personal electric transportation future seems very much on the horizon. Road pollution doesn't just come from cars of course; freight vehicles are also major players in choking our highways and byways. Siemens is currently testing a possible solution in Germany that's based on proven railway and tram technology but has been adapted for trucks on roads. Heavy goods vehicles have been fitted with a newly-developed pantograph that can automatically rise to meet overhead cables and transfer electric power to hybrid diesel/electric power trains. Energy recovered from regenerative braking can also be fed back into the system for re-use by other vehicles.

The hi-tech Highway concept is a two part system. The first involves the rollout of a two pole catenary system along one or more lanes on freight transport routes that caters for two-way electricity transmission and ensures a reliable power supply by feeding the overhead wire via container substations. The substations used in the current test project feature a medium-voltage DC switching system, a power transformer, a rectifier and a controlled inverter (for the feedback of the electric energy generated by regenerative braking for real time).

The field trial in Germany is reported to have confirmed full performance potential, independent of weather, conditions and load. The concept proved to be at least as flexible as existing fuel-based road freight transport solutions thanks to the maneuverability of the mobile pantographs, with reduction in carbon dioxide, nitrogen oxide, soot and noise pollution and added fuel efficiency benefits. Keeping up with the flow of traffic doesn't appear to have been a problem

either, with speeds of up to 90 km/h (55 mph) being reached without difficulty under direct transmission of electric power.

For the first time ever, electric trucks powered by overhead cables will run to reduce carbon dioxide emissions. The hitech-highwayelectrifies selected traffic lanes using an overhead cable system. As a result, trucks can be supplied with electricity in the same way as trams. The "e-trucks" are equipped with a hybrid drive system and intelligent current collectors. Powered by electricity from overhead cables, they produce no emissions when operating in the local area. On roads without overhead cables, the vehicles use an electric drive system which can be powered by diesel, compressed natural gas, a battery or with other energy sources. The current collector allows the vehicles to overtake and automatically dock and undock at speeds of up to 90 kilometers per hour.

## II. RELATED WORK

The hi-tech-highway concept is particularly effective from an environmental and economic point of view on heavily used and relatively short truck routes, e.g. between ports, industrial estates, freight transport centers and central transshipment terminals. The intention is to set up a "zero emission corridor" for shuttle traffic between the two sea ports and the inland rail transshipment centers around 30 kilometers away. This will help to ease the pressure on the environment in a region which is plagued by smog. The aim is to eliminate local emissions completely, reduce the use of fossil fuels, cut operating costs and establish a basis for using the system on a commercial basis in the future.

The mechanical transmission section can be designed with DC motors or stepper motors, depending up on the load, suitable motors can be selected. Here instead of using stepper motors, high speed reduction gear mechanized DC motors are used, the advantage of using these types of motors is a) increased torque b) consumes less power.

In the present system 12V DC motors are used in which one is used for the vehicle movement and the other for the catenary system lifting mechanism i.e., up and down to dock and undock with the electric lines. These motors are built in with reduction gear mechanism; the maximum speed of the motor is 60 RPM, so that the vehicle runs at low speed for demo purpose.

Motors are controlled depending on the input signals provided to the controller through the push buttons. The enable signals produced by the microcontroller are fed to L293D, specifically designed to drive DC motors. Each motor driver consists of four transistors in an H-bridge configuration, controlled by the microcontroller IC. In each section (out of four switching circuits) two transistors are used to increase the current rating. The L293D is capable of driving the motor at a maximum current of 600 milli-amps. The H – Bridge IC designed to operate from 5V DC to 30V DC, hence any DC motor with in this range can be interfaced with this chip. Description of the project work and the components is provided in the further chapters.

The H – Bridge chip is called as a DC motor driver and a single chip can drive two DC motors. In this project work one motor is used to drive the catenary system thorough the H – Bridge IC and the vehicle driving motor is operated by a relay to switch supply between the electric lines and the battery of the vehicle. To control these motors, four switches (push buttons) are connected in the input of the controller.

## III. METHODOLOGY

Let's start with the name, H-bridge. Sometimes called a "full bridge" the H-bridge is so named because it has four switching elements at the "corners" of the H and the motor forms the cross bar. The basic bridge is shown in the figure above. The key fact to note is that there are, in theory, four switching elements within the bridge. These four elements are often called, high side left, high side right, low side right, and low side left (when traversing in clockwise order).

The switches are turned on in pairs, either high left and lower right, or lower left and high right, but never both switches on the same "side" of the bridge. If both switches on one side of a bridge are turned on it creates a short circuit between the battery plus and battery minus terminals. If the bridge is sufficiently powerful it will absorb that load and your batteries will simply drain quickly. Usually however the switches in question melt. To power the motor, turn on two switches that are diagonally opposed. The current flows and the motor begin to turn in a "positive" direction. Switch off these two switches and switch on other two switches diagonally in other direction then the motor starts rotating in opposite direction. Actually it is quite simple, the tricky part comes in when we decide what to use for switches. Anything that can carry a current will work, from four SPST switches, one DPDT switch, relays, transistors, to enhancement mode power MOSFET's.

One more topic in the basic theory section is quadrants. If each switch can be controlled independently then we can do some interesting things with the bridge, some folks call such a bridge a "four quadrant device" (4QD). If we built it out of a single DPDT relay, we can really only control forward or reverse. We can build a small truth table that tells us for each of the switch's states, what the bridge will do. As each switch has one of two states, and there are four

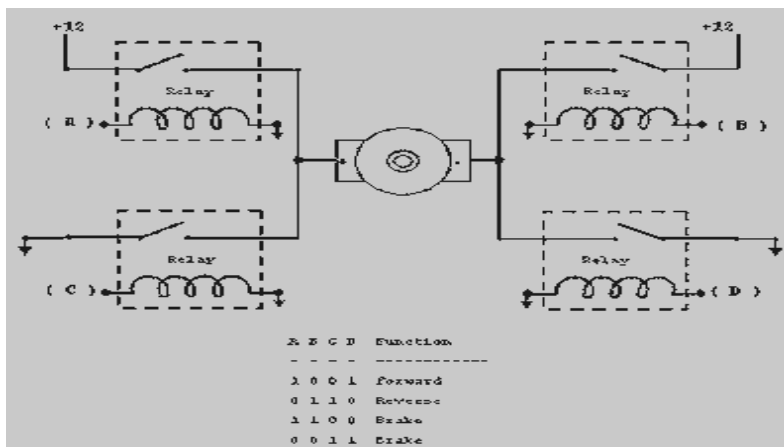
switches, there are 16 possible states. However, since any state that turns both switches on one side on is "bad", there are in fact only four useful states (the four quadrants) where the transistors are turned on.

High Side Left	High Side Right	Low Side Left	Low Side Right	Quadrant Description
On	Off	Off	On	Forward Running
Off	On	On	Off	Backward Running
On	On	Off	Off	Braking
Off	Off	On	On	Braking

In the above table the last two rows describes condition about short circuit the motor that causes the motors generator effect to work against it. The turning motor generates a voltage, which tries to force the motor to turn the opposite direction. This causes the motor to rapidly stop spinning and is called "braking" on a lot of H-bridge designs. Of course there is also the state where all the transistors are turned off. In this case the motor coasts freely if it was spinning and does nothing if it was doing nothing.

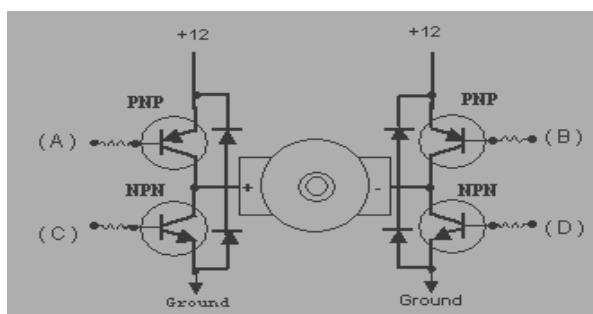
**1. Using Relays:**

A simple implementation of a H Bridge using four SPST relays is shown. Terminal A is High Side Left, Terminal B is High Side Right, Terminal C is Low Side Left and Terminal D is Low Side Right. The logic followed is according to the table above. **Warning:** Never turn on A and C or B and D at the same time. This will lead to a short circuit of the battery and will lead to failure of the relays due to the large current.



**2. Using Transistors:**

We can better control our motor by using transistors or Field Effect Transistors (FET's). Most of what we have discussed about the relays H-Bridge is true of these circuits. See the diagram showing how they are connected. We should add diodes across the transistors to catch the back voltage that is generated by the motor's coil when the power is switched on and off. This fly back voltage can be many times higher than the supply voltage. Don't turn on A and C or B and D at the same time.





Transistors, being a semiconductor device, will have some resistance, which causes them to get hot when conducting much current. This is called not being able to sink or source very much power, i.e.: Not able to provide much current from ground or from plus voltage.

MOSFET's are much more efficient, they can provide much more current and not get as hot. They usually have the fly back diodes built in so we don't need the diodes anymore. This helps guard against fly back voltage frying our ICs.

To use MOSFET's in an H-Bridge, we need P-Channel MOSFET's on top because they can "source" power and N-Channel MOSFET's on the bottom because they can "sink" power. It is important that the four quadrants of the H-Bridge circuits be turned on and off properly. When there is a path between the positive and groundside of the H-Bridge, other than through the motor, a condition exists called "shoot through". This is basically a direct short of the power supply and can cause semiconductors to become ballistic, in circuits with large currents flowing. There are H-bridge chips available that are much easier, and safer, to use than designing our own H-Bridge circuit.

L293D Dual H-Bridge Motor Driver

**L293D** is a dual **H-Bridge** motor driver, so with one IC we can interface two DC motors, which can be controlled in both clockwise and counter clockwise directions. Since the device is having four half 'H' Bridges, thereby if required four motors can be driven through this single device, moreover the task is to run all four motors in one direction only. **L293D** has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made **L293D** a best choice for DC motor driver.

#### IV. EXPERIMENTAL RESULTS

In this IC there are two different power supplies (Vcc1 and Vcc2). Vcc1 is for logic input circuit while Vcc2 is supply for the output circuit. This means that we should apply about 5V to Vcc1 and whatever voltage required by the motor (up to 36V max for this IC) to Vcc2. Each Half H-Bridge has an individual Ground. So we must ground the terminal corresponding to the Half H-Bridge, depending up on the circuit design, if required all four terminals of bridges can be connected to the ground.

Each Half H-Bridge has an Input (A) and output (Y). Also there are enable pins to turn on the Half H-Bridges. Once a Half H-bridge is enabled, then the truth table is as follows:

INPUT A	OUTPUT Y
L	L
H	H

So we just give a High level when we want to turn the Half H-Bridge on and Low level when we want to turn it off. When the Half H-Bridge is on, the voltage at the output is equal to Vcc2.

If we want to make a Full H-Bridge, we must connect the motor (or the load) between the outputs of two Half H-Bridges and the inputs will be the two inputs of the Half H-Bridges.

Suppose we have connected Half H-Bridges 1 and 2 to form a Full H-Bridge. Now the truth table is as follows:

INPUT 1A	INPUT 2A	OUTPUT 1Y	OUTPUT 2Y	Description
L	L	L	L	Braking (both terminals of motor are Gnd)
L	H	L	H	Forward Running
H	L	H	L	Backward Running
H	H	H	H	Braking (both terminals of motor at Vcc2)

## V. CONCLUSION

We have designed and implemented a prototype module; and the results are found to be satisfactory. Since it is a prototype module, a simple moving vehicle is constructed. In future this can be implemented not only on highways but also on the normal roads with the electric line.

While designing and developing this proto type module, we have consulted few experts those who are having knowledge in Mechatronics, and these professionals working at different organizations belongs to Hyderabad helped us while fabricating this project work. Since it is a prototype module, much amount is not invested. The whole machine is constructed with locally available components, especially the mechanical components used in this project work are procured from mechanical fabricators and they are not exactly up to the requirement. Some of the modifications must be carried out in design to make it as real working system.

## REFERENCES

- [1]. BOOK: Highway Engineering, by S.K Khanna, CEG Justo.
- [2]. WEB PAGES AND ONLINE MATERIALS
  - [www.solarroadways.com](http://www.solarroadways.com), details about solar panel and the working method, founder of the solar roadway.
  - [www.futureenergy.com](http://www.futureenergy.com), concept of renewable energy
- [3]. JOURNAL PAPERS
  - Mechanical properties of rubber- an overview. Bulletin of the Transylvania University of Brasov • Vol. 3 (52) – 2010 Series I: Engineering Sciences.
  - Mechanical Properties of Industrial Tire Rubber Compounds Article in Journal of Applied Sciences · December 2010 DOI: 10.3923/jas.2010.1345.1348 · Source: DOAJ.
  - Solar Roadways-The future of roadways, Ayushi Mehta, Neha Aggarwal, Anjali Tiwari, IMS Engineering College, Ghaziabad.
  - “Solar Roadways” – Rebuilding our Infrastructure and Economy, Alark A. Kulkarni, Director, Orbit Consultants Pvt. Ltd., Pune.