Project Phase - I Report on

Design of an Embedded System for Electric Drives with R.B.S Using CAN protocol

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Department of E&TC Engg.
Advancing Humanity through Technology
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CERTIFICATE

This is to certify that,

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Design of an Embedded System for Electric Drives with R.B.S Using CAN protocol

The said work is completed by putting the required number of hours as per prescribed curriculum during the academic year 2016 – 17. The report is submitted in partial fulfillment of the requirements for the Seventh Semester of the Degree of Bachelor of Engineering in Electronics & Telecommunication Engg. of Savitribai Phule Pune University

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Abstract

With the rising problem of global pollution and the decrease in world oil resources electric vehicles are becoming a necessity. This project focuses on designing an Ancillary system for a proposed electric vehicle (eV) which will be used for system diagnostics of every subsystems involved along with smart Regenerative Braking System technology And check the feasibility of the system with a real world application.The main components of the project are Battery Management System which aims to make efficient use of batteries by preventing it from overcharging and discharging,Regenerative Braking System, a method of braking of an electric vehicle which helps in efficient utilization of the battery power to increase the range of the vehicle and CAN protocol which is a serial bus communications protocol minimizing the wiring complexities.

Acknowledgment

As we successfully completed the decided task for this semester,many people come to our mind because of whom we could actually implement this project. Firstly we would like to thank our project guide Bhairavi Savant who guided us on every step. We are thankful to our HoD. Sandip Lokhande who is always there for our help. We would also like to thank all the teachers of EmSys domain who have been of great help throughout this project. A very special thanks of Vinayak Karne for helping us in hardware implementations. Lastly, I want to thank everyone who helped us directly or indirectly. Thank you.

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Chapter 1

Introduction

The Indian automotive industry is today amongst the fastest growing automotive industries globally. It is expected that, by 2020, the annual demand for passenger vehicles, commercial vehicles and two wheelers in India will be 10 million, 2.7 million and 34 million units respectively, thereby making India the third largest vehicle market in the world.

In an "As is" case scenario, the increase in vehicular population will lead to sharp rise in demand for fossil fuels and have an undesirable impact on the environment as per International Energy Agency(IEA) estimates,globally the transportation sector accounts for 30 percent of world wide energyu consumption and is the second largest source of carbon dioxide emissions contributing to 20% of global GHG. Three quarters of the projected increase in all demand in future will be from transportation sector with the highest growth from China and India.

India depends largely on oil imports to meet its energy needs. The percentage of oil imported by India has risen from 57% in 1997 to 85% in 2010.this is likely to reach 92% of total demand by 2020.High import dependence along with continuosly increasing prices of oil poses a serious challenge for India's future energy security.

According to previous research , 18% of the suspended particulates, 27% of the volatile organic compounds, 28% of Pb, 32% of nitrogen oxides, and 62% of the CO of air-borne pollution in America are produced by vehicles with internal combustion engines. In addition, 25% of energy-related Carbon dioxide (the principle cause for the greenhouse effect) of all the Carbon dioxide in the atmosphere are released from traditional vehicles. As an increasing number of people use public and personal transportation, the amount of air pollution increases every single day. Consequently, electric vehicles are becoming more and more popular.

An electric vehicle generally contains the following major components:

- An electric motor
- A motor controllerl
- A traction battery
- A battery management system
- A regenerative braking system
- A vehicle body and a frame

literature survey

1.1 National Electric Mobility Mission Plan 2020

The Indian automotive industry is today amongst the fastest growing automotive industries globally. It is expected that, by 2020, the annual demand for passenger vehicles, commercial vehicles and two wheelers in India will be 10 million, 2.7 million and 34 million units respectively, thereby making India the third largest vehicle market in the world India depends largely on oil imports to meet its energy needs. The percentage of oil imported by India has risen from 57 in 1997 to 85 in 2010; this is likely to reach 92 of the total demand by 2020. High import dependence along with continuously increasing prices of oil poses a serious challenge future energy security.

NEMMP MISSION "To encourage reliable, affordable and efficient xEVs that meet consumer performance and price expectations through Government -Industry collaboration for promotion and development of indigenous manufacturing capabilities, required infrastructure, consumer awareness and technology; thereby helping India to emerge as a leader in the xEV Two Wheeler and Four Wheeler market in the world by 2020, with total xEV sales of 6-7 million units thus enabling Indian automotive Industry to achieve global xEV manufacturing leadership and contributing towards National Fuel"

1.2 Electric Vehicles around the world

The first electric vehicles of the 1830s used non-rechargeable batteries. Half a century was to elapse before batteries had developed sufficiently to be used in commercial

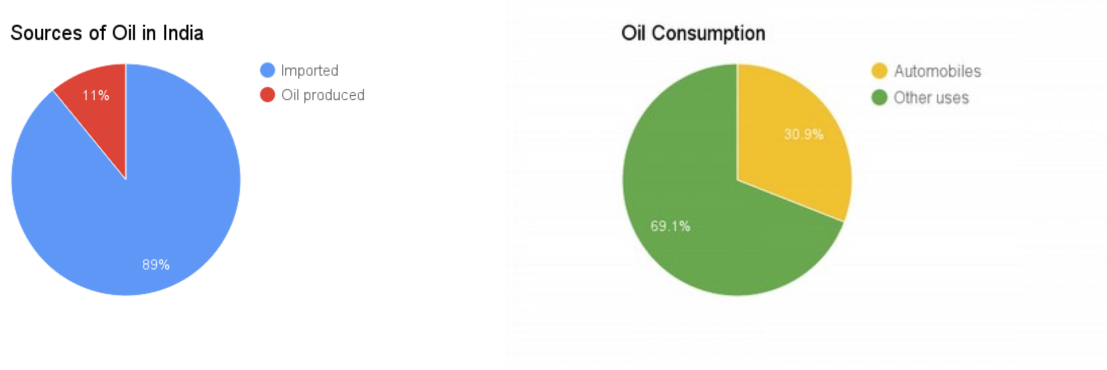

Figure 1.1: Sources And Consumption Of Oil In India

Figure 1.2: Electric vehicles around the world

electric vehicles. By the end of the 19th century, with mass production of rechargeable batteries, electric vehicles became fairly widely used. Private cars, though rare, were quite likely to be electric, as were other vehicles such as taxis. An electric New York taxi from about 1901 is shown, with Lily Langtree alongside.

1.3 Tesla Motors And Zero Motorcycles

In 2008 tesla motors came up with the roadster which goes to 0-60 in 3.2 seconds,in 2010 zero motor cycles a canadian start-up came up with zero motor SR a high end electric motorcycle,which goes to 317 km in a single charge

1.4 Comparison to IC engine vehicles

Chapter 2

Battery Management System

2.1 Introduction

An electric vehicle generally contains the following major components: an electric motor, a motor controller, a traction battery, a battery management system, a plug-in charger that can be operated separately from the vehicle, a wiring system, a regenerative braking system, a vehicle body and a frame. The battery management system is one of the most important components, especially when using lithium-ion batteries.

Currently, three types of traction batteries are available: the lead-acid, nickel-metal hydride and lithium-ion batteries. Lithium-ion batteries have a number of advantages over the other two types of batteries, and they perform well if they are operated using an effective battery management system.

2.2 Lithium Ion Battery

Lithium is the lightest metal with the greatest electrochemical potential and the largest energy density per weight of all metals found in nature. Using lithium as the anode, rechargeable batteries could provide high voltage, excellent capacity and a remarkably high-energy density.

However, lithium is inherently unstable, especially during charging. Therefore, lithium ions have replaced lithium metals in many applications because they are safer than lithium metals with only slightly lower energy density. Nevertheless, certain precautions should be made during charging and discharging. The Sony Corporation was the first company to commercialize the lithium-ion battery in 1991, which has since become popular and remains the best choice for rechargeable batteries.

The lithium-ion battery requires almost no maintenance during its lifecycle, which is an advantage that other batteries do not have. No scheduled cycling is required, and there is no memory effect in the battery. Furthermore, the lithium-ion battery is well suited for electric vehicles because its self-discharge rate is less than half of the discharge rate of lead-acid and NiMH batteries.

Despite the advantages of lithium-ion batteries, they also have certain drawbacks. Lithium ions are brittle. To maintain the safe operation of these batteries, they require a protective device to be built into each pack. This device, also referred to as the battery management system (BMS), limits the peak voltage of each cell during charging and prevents the cell voltage from dropping below a threshold during discharging. The BMS also controls the maximum charging and discharging currents and monitors the cell temperature.

2.3 Lithium Ion Battery Challenges

The operating temperature and voltage are the most important parameters that determine the performance of lithium-ion cells. Figure shows that the cell operating voltage, current and temperature must be maintained within the area indicated by the green box labeled Safe Operation Area (SOA) at all times. The cell could be permanently damaged if it is operated outside the safety zone. The batteries could be charged above its rated voltage or be discharged under the recommended voltage.

If the recommended upper limit of 4.2 V was exceeded during charging, excessive current would flow and result in lithium plating and overheating. On the other hand, overly discharging the cells or storing the cells for extended periods of time would cause the cell voltage to fall below its lower limit, typically 2.5 V. This could progressively break down the electrode.

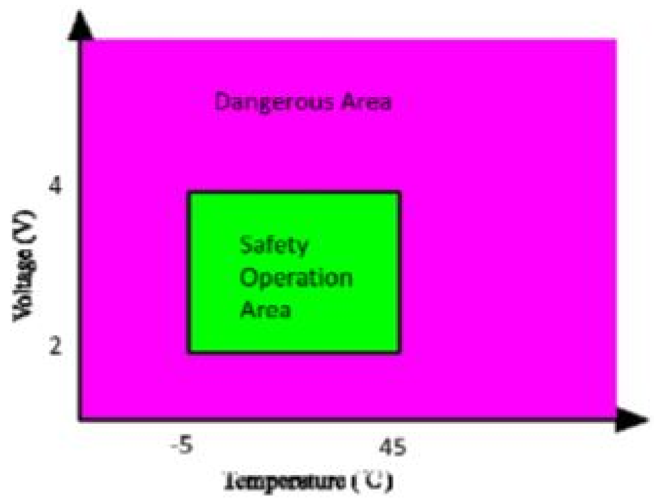

Figure 2.1: Lithium Ion Cell Operation Window (Voltage)

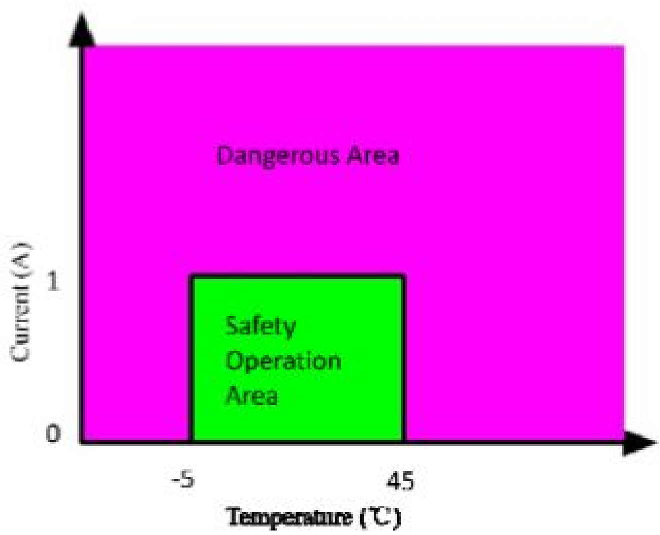

Figure 2.2: Lithium Ion Cell Window (Current)

The operating temperature of lithium-ion cells should be carefully controlled because excessively high or low temperatures could damage the cell. Temperature-related damages could be grouped into three types: low-temperature operational impact, high temperature operational impact and thermal runaway. While the effects of voltage and temperature on cell failures are immediately apparent, their effects on the lifecycle of the cells are not as obvious. However, the cumulative effects of these digressions may affect the lifetime of the cells.

The lifecycles of the cell would be reduced if its operating temperature falls below approximately 10 C. Similarly, their lifecycles would be reduced if the cells were operated above 40 C. Furthermore, thermal runaway would occur when the temperature reached 60 C. The thermal management system, which is part of the BMS, must be designed to keep the cells operating within its limitation at all times.

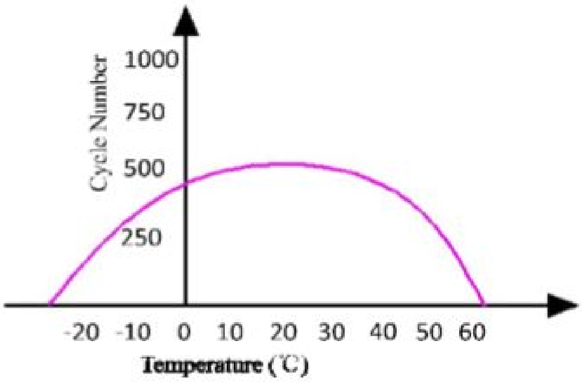

Figure 2.3: Lifecycle versus Operating Temperatute of LI Cells

It is clear from the discussion above that the goal of the BMS is to keep the cells operating within their safety zone; this could be achieved using safety devices such as protection circuits and thermal management systems.

2.4 Battery Management System(BMS)

There are different types of BMSs that are used to avoid battery failures. The most common type is a battery monitoring system that records the key operational parameters such as voltage, current and the internal temperature of the battery along with the ambient temperature during charging and discharging. The system provides inputs to the protection devices so that the monitoring circuits could generate alarms and even disconnect the battery from the load or charger if any of the parameters exceed the values set by the safety zone.

The battery is the only power source in pure electric vehicles. Therefore, the BMS in this type of application should include battery monitoring and protection systems, a system that keeps the battery ready to deliver full power when necessary and a system that can extend the life of the battery. The BMS should include systems that control the charging regime and those that manage thermal issues. In a vehicle, the BMS is part of a complex and fast-acting power management system. In addition, it must interface with other on-board systems such as the motor controller, the climate controller, the communications bus, the safety system and the vehicle controller.

2.4.1 Definition of the BMS

While the definition of a BMS could differ depending on the application, the basic task of the BMS could be defined in the following manner, according to [3]: It should ensure that the energy of the battery is optimized to power the product; It should ensure that the risk of damaging the battery is minimal; It should monitor and control the charging and discharging process of the battery.

2.4.2 Objective of the BMS

According to the definition, the basic tasks of the BMS are identical to its objectives. Although different types of BMS have different objectives, the typical BMS follows three objectives:

- It protects the battery cells from abuse and damage
- It extends the battery life as long as possible

- It makes sure the battery is always ready to be used

2.5 Functions of the BMS

2.5.1 Discharging and Charging Control

The primary goal of a BMS is to keep the battery from operating out of its safety zone. The BMS must protect the cell from any eventuality during discharging. Otherwise, the cell could operate outside of its limitations.

Batteries are more frequently damaged by inappropriate charging than by any other cause. Therefore, charging control is an essential feature of the BMS. For lithium-ion batteries, a 2-stage charging method called the constant current constant voltage (CC-CV) charging method is used. During the first charging stage (the constant current stage), the charger produces a constant current that increases the battery voltage. When the battery voltage reaches a constant value, and the battery becomes nearly full, it enters the constant voltage (CV) stage. At this stage, the charger maintains the constant voltage as the battery current decays exponentially until the battery finishes charging.

2.5.2 State of Charge Determination

One feature of the BMS is to keep track of the state of charge (SOC) of the battery. The SOC could signal the user and control the charging and discharging process. There are three methods of determining SOC: through direct measurement, through coulomb counting and through the combination of the two techniques.

To measure the SOC directly, one could simply use a voltmeter because the battery voltage decreases more or less linearly during the discharging cycle of the battery. In the coulomb-counting method, the current going into or coming out of a battery is integrated to produce the relative value of its charge. This is similar to counting the currency going into and out of a bank account to determine the relative amount in the account.

In addition, the two methods could be combined. The voltmeter could be used to monitor the battery voltage and calibrate the SOC when the actual charge approaches either end. Meanwhile, the battery current could be integrated to determine the relative charge going into and coming out of the battery.

2.5.3 State of Health Determination

The state of health (SOH) is a measurement that reflects the general condition of a battery and its ability to deliver the specified performance compared with a fresh battery. Any parameter such as cell impedance or conductance that changes significantly with age could be used to indicate the SOH of the cell. In practice, the SOH could be estimated from a single measurement of either the cell impedance or the cell conductance.

2.5.4 Cell Balancing

Cell balancing is a method of compensating weaker cells by equalizing the charge on all cells in the chain to extend the overall battery life. In chains of multi-cell batteries, small differences between the cells due to production tolerances or operating conditions tend to be magnified with each charge-discharge cycle. During charging, weak cells may be overstressed and become even weaker until they eventually fail, causing the battery to fail prematurely.

To provide a dynamic solution to this problem while taking into account the age and operating conditions of the cells, the BMS may incorporate one of the three cell balancing schemes to equalize the cells and prevent individual cells from becoming overstressed: the active balancing scheme, the passive balancing scheme and the charge shunting scheme.

In active cell balancing, the charge from the stronger cells is removed and delivered to the weaker cells.

In passive balancing, dissipative techniques are used to find the cells with the highest charge in the pack, as indicated by higher cell voltages. Then, the excess energy is removed through a bypass resistor until the voltage or charge matches the voltage on the weaker cells.

2.5.5 Communications

The communications function of a BMS may be provided though a data link used to monitor performance, log data, provide diagnostics or set system parameters. The function may also be provided by a communications channel carrying system control signals.

The choice of the communications protocol is not determined by the battery; instead, it is determined by the application of the battery. The BMS used in electric vehicles must communicate with the upper vehicle controller and the motor controller to ensure the proper operation of the vehicle.

There are two major protocols used by the BMS to communicate with the vehicle: through the data bus or the controller area network (CAN) bus. Data buses include the RS232 connection and EIA-485 (also called the RS485 connection). The industry standard for on-board vehicle communications is the CAN bus, which is more commonly used in vehicle applications.

2.6 BMS Topology

There are various BMS topologies that are currently used in electric vehicles but one that we are going to use is Centralized Topology.

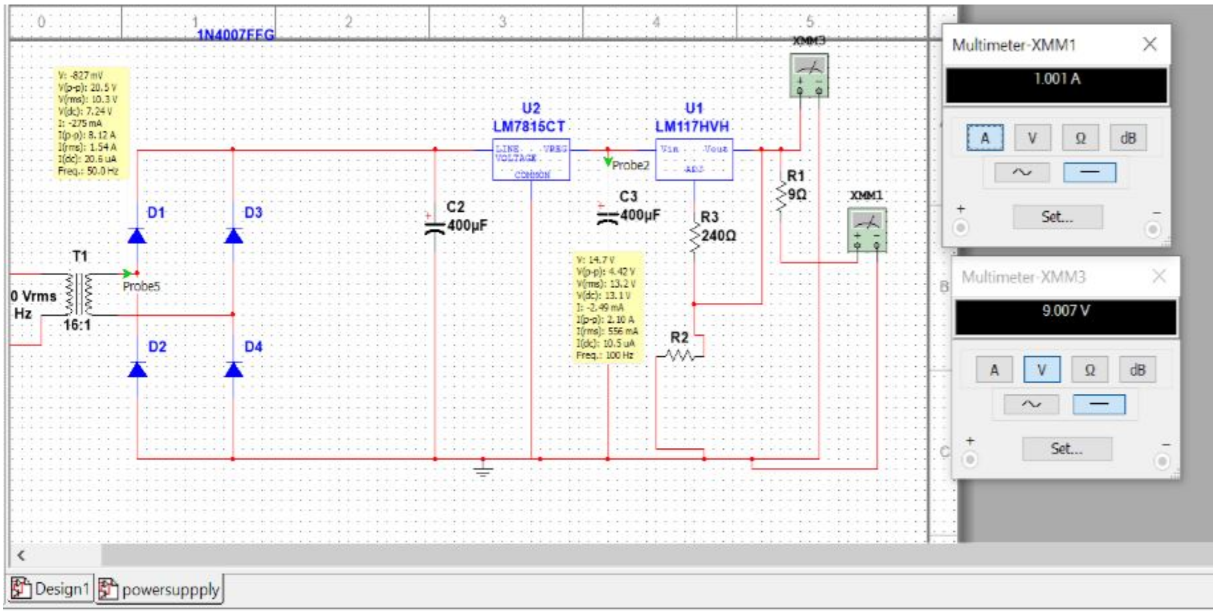

Figure 2.4: Wall charger for BMS

2.6.1 Centralized Topology

In centralized topology, a centralized master control unit is directly connected to each cell of the battery pack. The control unit protects and balances all cells while providing various other functions.

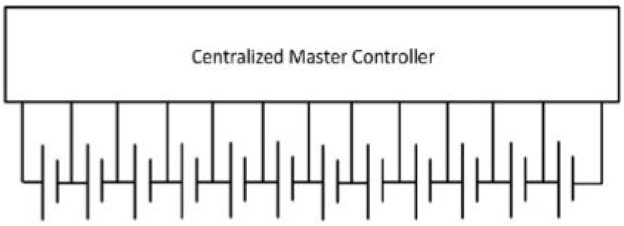

Figure 2.5: Centralized Topology

Using this topology only requires a single installation point and no complex inter-vehicle communications. However, excess heat could be generated because the controller is the only source for cell balancing. In addition, the cells are distributed within various locations of the vehicle, which requires wiring to a central location.

Chapter 3

Regenerative Braking System

3.1 Introduction

Regenerative method of braking of an electric vehicle helps in efficient utilization of the battery power to increase the range of the vehicle.When a conventional vehicle applies its brakes, kinetic energy is converted to heat as friction between the brake pads and wheels. This heat is carried away in the airstream and the energy is effectively wasted The total amount of energy lost in this way depends on how often, how hard and for how long the brakes are applied.

Regenerative braking refers to a process in which a portion of the kinetic energy of the vehicle is stored by a short term storage system. Energy normally dissipated in the brakes is directed by a power transmission system to the energy store dnring deceleration. That energy is held until required again by the vehicle, whereby it is converted back into kinetic energy and used to accelerate the vehicle.

Regenerative braking is a braking method that utilizes the mechanical energy from the motor by converting kinetic energy into electrical energy and fed back into the battery source.Regenerative braking system can convert a good fraction of its kinetic energy to charge up the battery, using the same principle as an alternator.It uses the motor to slow down the car when the driver applies force to the brake pedal then the electric motor works in reverse direction thus slowing the car. While running backwards, the motor acts as the generator and recharge the batteries.

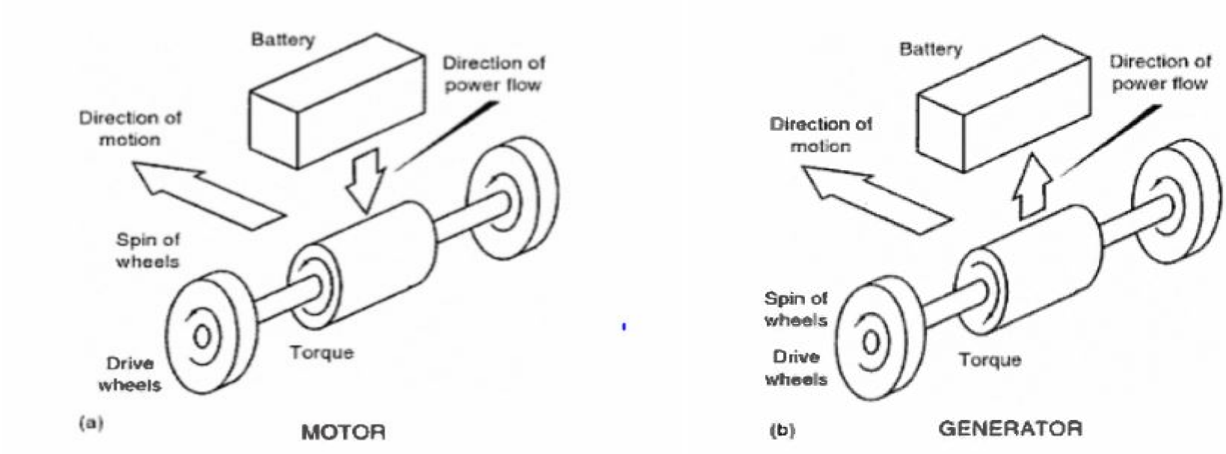

Figure 3.1: Normal forward driving condition and Regenerative action during braking

In the regenerative braking system, the braking controller is the heart of the system because it controls the overall process of the motor. The functions of the brake controller are monitor the speed of the wheel, calculate the torque, rotational force and generated electricity to be fed back into the batteries. During the braking operation, the brake controller directs the electricity produced by the motor into the batteries or capacitors

In additional, the advanced algorithms in the motor controller give a complete control over the motor torque for both driving and regenerative braking. A torque command is derived from the position of the throttle pedal. The motor controller converts this torque command into the appropriate 3-phase voltage and current waveforms to produce the commanded torque to the motor in the most efficient way. The torque command can be positive or negative. When the torque serves to slow the vehicle then energy is returned to the battery, regenerative is achieved.

3.2 Control circuit of Regenerative Braking

When the controller receives a brake signal; the motor operation changes from the normal mode into the energyregenerative mode. Thus, the operating principle of the energy regenerative mode for the duration of the state I is analyzed by the controller. By switchingS_2 and S_3 on, it change the switching sequence to the energy regenerative mode and the back EMF eab becomes a voltage source. During the

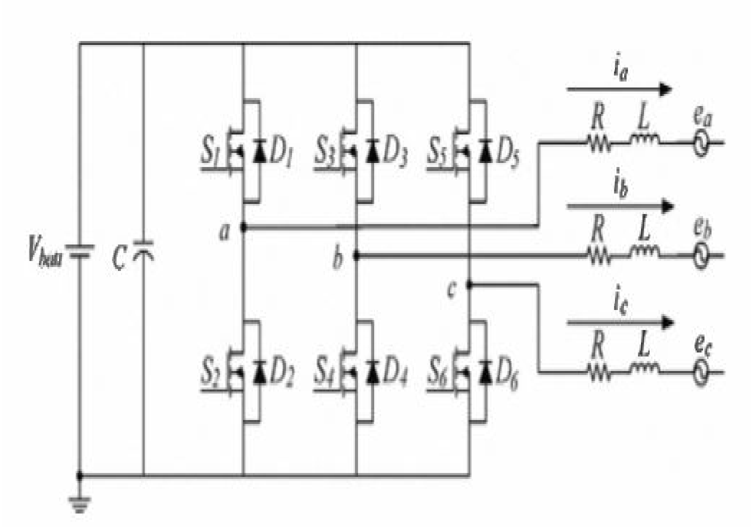

Figure 3.2: Control circuit of Regenerative Braking

tum-on period of S_2 and S_3, the winding will be energized. Therefore the voltage VL is equal to V batt + eab, and the current iin is equal to -iab,or ion. On the other hand, during the tum-off period of S_2 and S_3, the current iim which flows through the freewheeling diodes D_J and D_4, is equal to iab. It creates a current path ioff and this current fed to the battery.

During the normal mode, the high side switches S_1, S_3, and S_5 are operated in pulse width modulation (PWM) switching mode; the low side switches S_2, S_4, and S_6 are operated in normal high or low. To the contrary, all the switches are operated in PWM switching mode during the energy-regenerative mode. During state I the conduction mode, it switches S_l and S_4 on simultaneously. The inductor current iab would be increased by the energized current loop ion of the winding. When the magnetic field of the winding is increased due to iab increase, a reverse induction voltage eab has to resist the variation of the magnetic field according to Lenz's Law. This is represented by the armature back EMF of the motor. During freewheeling mode, the switch S_1 is turned off, and S_4 is still on, in such condition the inductor current will flow into the freewheeling diode D_2 and the switch S_4, which makes a discharging current path ioff. The corresponding sequences of S_1, S_4, input current iin and phase current iab are shown in the figure.

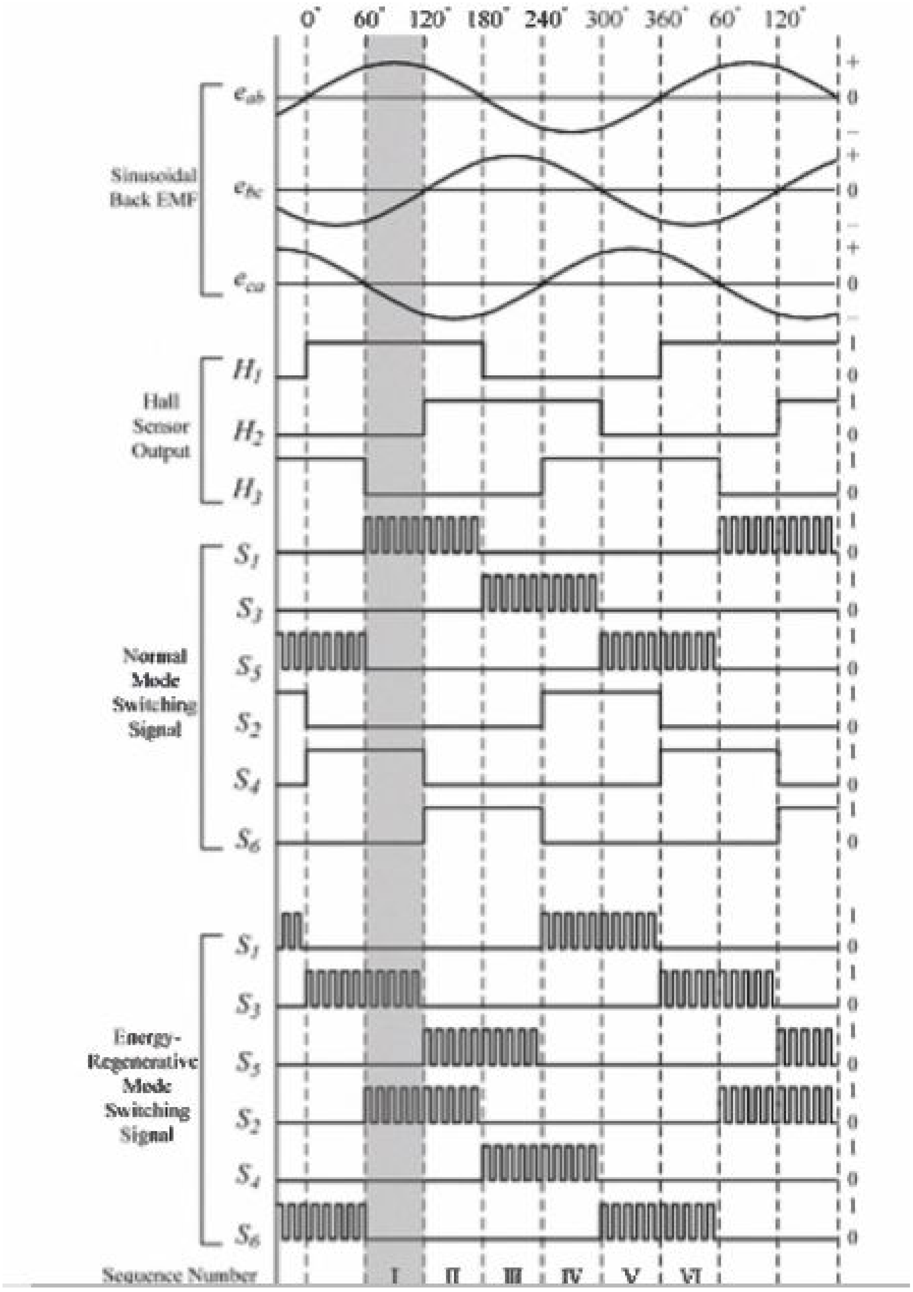

Figure 3.3: The characteristics of Hall sensor signals, back EMFs, and switching signal sequences of normal and energy-regenerative modes

3.3 Brushless DC motor

3.4 Introduction

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. In this context, AC, alternating current, does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform. Additional sensors and electronics control the inverter output amplitude and waveform (and therefore percent of DC bus usage/efficiency) and frequency (i.e. rotor speed).

A typical brushless motor has permanent magnets which rotate around a fixed armature, eliminating problems associated with connecting current to the moving armature. An electronic controller replaces the brush/commutator assembly of the brushed DC motor, which continually switches the phase to the windings to keep the motor turning. The controller performs similar timed power distribution by using a solid-state circuit rather than the brush/commutator system.

3.4.1 Usage and Advantages

Brushless motors offer several advantages over brushed DC motors, including high torque to weight ratio, more torque per watt (increased efficiency), increased reliability, reduced noise, longer lifetime (no brush and commutator erosion), elimination of ionizing sparks from the commutator, and overall reduction of electromagnetic interference (EMI). With no windings on the rotor, they are not subjected to centrifugal forces, and because the windings are supported by the housing, they can be cooled by conduction, requiring no airflow inside the motor for cooling. This in turn means that the motor's internals can be entirely enclosed and protected from dirt or other foreign matter.

3.4.2 Working

The rotor is a permanent magnet.The stator has the coil arrangement as shown in the figure.By applying DC power, the coil will energize to form electromagnet.The operation of the BLDC motor is due to the interraction between the permanent magnet and electromagnet.

3.4.3 Conclusion

Regenerative braking is one of the important systems in electric vehicle since it has the ability to save the wastes energy up to 8-25Furthermore, the regenerative braking system has been improved by the advanced power electronic component such as ultracapacitor, DC-DC converter (Buck-Boost) and flywheel.

The ultracapacitor that helps in improving the transient state of the car during starting, provide a smoother charging characteristic for the battery and boost up the overall performance of the electric vehicle system. The Buck-Boost converter helps maintaining the power management in the regenerative braking system such as boosting the acceleration. Finally, the flywheel is used to enhance the power recovery process thru the wheel of the car. In conclusion, the regenerative braking is a tremendous concept that has been developed by the automotive engineers. In the near future, if this system is fully utilized and further improve, a new generation of electric vehicle will be fully on the road.

Chapter 4

CAN Protocol

4.1 Introduction

The Controller Area Network (CAN) is an attractive alternative in the automotive and automation industries due to its ease in use, low cost and provided reduction in wiring complexity.[1] The priority based message scheduling used in CAN have a number of advantages, some of the most important being the efficient bandwidth utilization, flexibility, simple implementation and small overhead. CAN is a serial bus communications protocol developed by Bosch (an electrical equipment manufacturer in Germany) in the early 1980s. Thereafter, CAN was standardized as ISO-11898 and ISO-11519, establishing itself as the standard protocol for in vehicle networking in the auto industry. By networking the electronics in vehicles with CAN, however, they could be controlled from a central point, the Engine Control Unit, thus increasing functionality, adding modularity, and making diagnostic processes more efficient. CAN offer an efficient communication protocol between sensors, actuators controllers, and other nodes in real-time applications and is known for the simplicity, reliability and high performance.

The CAN protocol is based on a bus topology, and only two wires are needed for communication over a CAN bus. The bus has a multi master structure where each device on the bus can send or receive data. Only one device can send data at any time while all the others listen. If two or more devices attempt to send data at the same time, the one with the highest priority is allow to send data while the other returns to the receive mode

4.2 Standard CAN and Extended CAN

The CAN communication protocol is a carrier-sense, multiple-access protocol with collision detection and arbitration on message priority (CSMA/CD+AMP). CSMA means that each node on a bus must wait for a prescribed period of inactivity before attempting to send a message. CD+AMP means that collisions are resolved through a bit-wise arbitration, based on a preprogrammed priority of each message in the identifier field of a message. The higher priority identifier always wins bus access. That is, the last logic-high in the identifier keeps on transmitting because it is the highest priority. Since every node on a bus takes part in writing every bit "as it is being written," an arbitrating node knows if it placed the logic-high bit on the bus. The ISO-11898:2003 Standard, with the standard 11-bit identifier, provides for signaling rates from 125 kbps to 1 Mbps. The standard was later amended with the extended 29-bit identifier. The standard 11-bit identifier field in Figure 2 provides for 211, or 2048 different message identifiers, whereas the extended 29-bit identifier in Figure 3 provides for 229, or 537 million identifiers.

4.2.1 Bit Fields of Standard CAN and Extended CAN

can.JPG

Figure 4.1: Standard CAN:11 Bit Identifier

- SOF : The single dominant start of frame (SOF) bit marks the start of a message, and is used to synchronize the nodes on a bus after being idle.
- Identifier : The Standard CAN 11-bit identifier establishes the priority of the message. The lower the binary value, the higher its priority.

- RTR : The single remote transmission request (RTR) bit is dominant when information is required from another node. All nodes receive the request, but the identifier determines the specified node. The responding data is also received by all nodes and used by any node interested. In this way, all data being used in a system is uniform.

- IDE : A dominant single identifier extension (IDE) bit means that a standard CAN identifier with no extension is being transmitted.

- r0 : Reserved bit (for possible use by future standard amendment).

- DLC : The 4-bit data length code (DLC) contains the number of bytes of data being transmitted.

- Data : Up to 64 bits of application data may be transmitted.

- CRC : The 16-bit (15 bits plus delimiter) cyclic redundancy check (CRC) contains the checksum (number of bits transmitted) of the preceding application data for error detection.

- ACK : Every node receiving an accurate message overwrites this recessive bit in the original message with a dominate bit, indicating an error-free message has been sent. Should a receiving node detect an error and leave this bit recessive, it discards the message and the sending node repeats the message after rearbitration. In this way, each node acknowledges (ACK) the integrity of its data. ACK is 2 bits, one is the acknowledgment bit and the second is a delimiter.

- EOF : This end-of-frame (EOF), 7-bit field marks the end of a CAN frame (message) and disables bit-stuffing, indicating a stuffing error when dominant. When 5 bits of the same logic level occur in succession during normal operation, a bit of the opposite logic level is stuffed into the data.

- IFS : This 7-bit interframe space (IFS) contains the time required by the controller to move a correctly received frame to its proper position in a message buffer area.

can.JPG

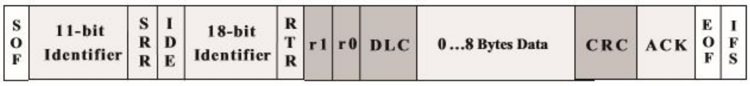

Figure 4.2: Extended CAN:29 Bit Identifier

The Extended CAN message is the same as the Standard message with the addition of:

- SRR : The substitute remote request (SRR) bit replaces the RTR bit in the standard message location as a placeholder in the extended format.
- IDE : A recessive bit in the identifier extension (IDE) indicates that more identifier bits follow. The 18-bit extension follows IDE.
- r1 : Following the RTR and r0 bits, an additional reserve bit has been included ahead of the DLC bit.

4.3 CAN in automobiles

CAN is a LAN (Local Area Network) controller CAN bus can transfer the serial data one by one. Fig 2 shows a typical architecture from an automotive. All participants in the CAN bus subsystems are accessible via the control unit on the CAN bus interface for sending and receiving data. CAN bus is a multi-channel transmission system. When a unit fails, it does not affect others. The data transfer rate of CAN bus in a vehicle system is different. For example, the rate of engine control system and ABS is high speed of real-time control fashion of 125Kbps to 1M bps. While, the rate of movement adjustment is low-speed with transmission rate of 10 to 125K bps. Others like multimedia systems use medium-speed rate between the previous two. This approach differentiates various channels and increases the transmission efficiency.

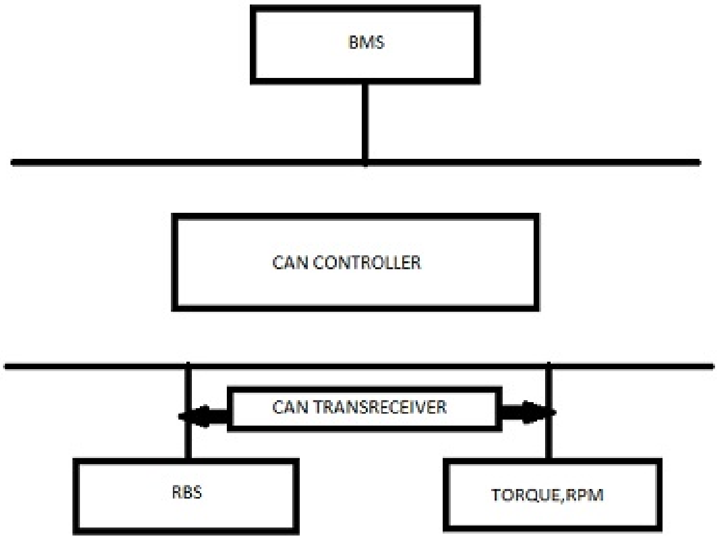

Figure 4.3: CAN in automobiles

4.4 Main Module

4.4.1 ARM Architecture

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles. It is the first RISC microprocessor designed for low-budget market. One of the typical products is ARM 7 family that is the most streamlined RISC. Therefore, it's relatively cheap, and the core of ARM7TDMI-S is a low budget- oriented, emphasizing the control of the system. The ARM7TDMI-S processor also employs a unique architectural strategy known as Thumb, which makes it ideally suited to high-volume applications with memory restrictions. It can be used in a variety of areas, such as embedded control, multimedia, DSP and mobile applications. The LPC2119/LPC2129 are based on a 16/32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, together with 128/256 kilobytes (kB) of embedded high speed bash memory.

A 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at maximum clock rate. It contains a 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package. With their compact 64 pin package, low power consumption, various 32-bit timers,4-channel 10-bit ADC, 2 advanced CAN channels, PWM channels, Real Time Clock and Watchdog and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for automotive and industrial control applications as well as medical systems and fault-tolerant maintenance buses. It does not contain MMU (memory management unit). But because of its low price, reliability and other factors, it is widely used in various industrial controllers.

4.4.2 Host Processor

The host processor decides what the meaning of received messages is and which messages it wants to transmit itself. Sensors, actuators and control devices can be connected to the host processor.

4.4.3 CAN controller

The CAN controller stores received bits serially from the bus until an entire message is available, which can then be fetched by the host processor. The host processor stores its transmit messages to a CAN controller, which transmits the bits serially onto the bus.

4.4.4 Transreceiver

It adapts signal level from the bus to level that the CAN controller expects and has protective circuitry that protects the CAN controller. It converts the transmit-bit signal received from the CAN controller into a signal that is sent onto the bus. MCP2515 implements the CAN specification, version 2.0B. It is capable of transmitting and receiving both standard and extended data and remote frames with 0 8 byte length of the data field. The MCP2515 has two acceptance masks and six

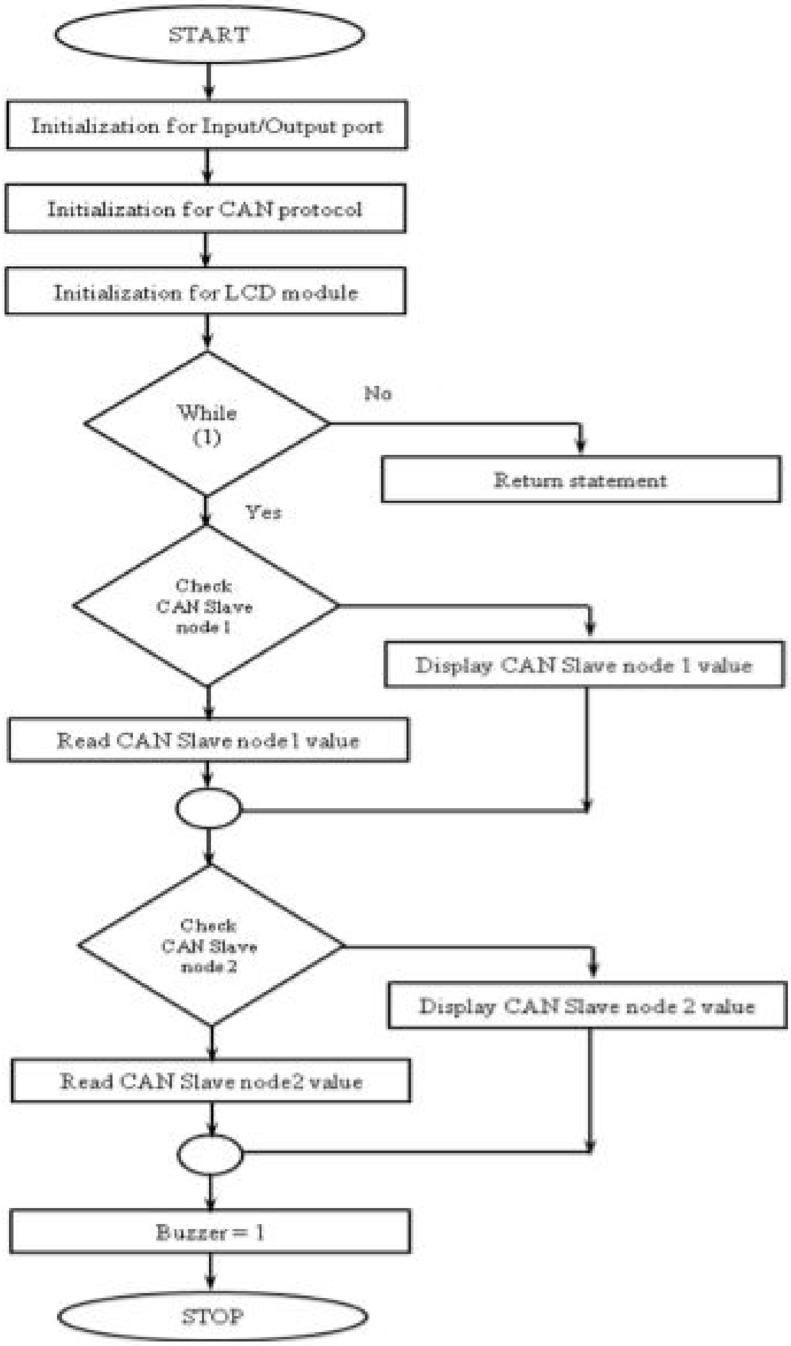

Figure 4.4: Flowchart

acceptance filters that are used to filter out unwanted messages, thereby reducing the host MCUs overhead. The MCP2515 is interfaced with microcontroller (MCU) via an industry standard Serial Peripheral Interface (SPI). MCP2515 has two receive buffers with prioritized message storage and three transmit buffers with prioritization and abort features.

The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller.

Chapter 5

Results

5.1 ADVISOR

ADVISOR, NRELs ADvanced VehIcle SimulatOR, is a set of model, data, and script text files for use with Matlab and Simulink. It is designed for rapid analysis of the performance and fuel economy of conventional, electric, and hybrid vehicles. ADVISOR also provides a backbone for the detailed simulation and analysis of user defined drivetrain components, a starting point of verified vehicle data and algorithms from which to take full advantage of the modeling flexibility of Simulink and analytic power of MATLAB.

ADVISOR uses basic physics and measured component performance to model existing or future vehicles. Its real power lies in the prediction of the performance of

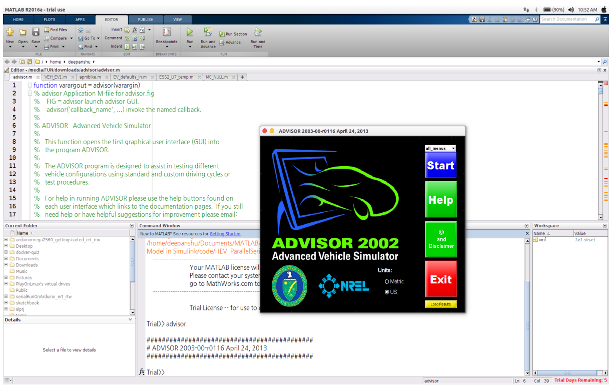

Figure 5.1: ADVISOR IS A MATLAB BASED SIMULATION FOR VEHICLES

vehicles that have not yet been built. It answers the question what if we build a car with certain characteristics? ADVISOR usually predicts fuel use, tailpipe emissions, acceleration performance, and gradeability.

In general, the user takes two steps:

Define a vehicle using measured or estimated component and overall vehicle data.

Prescribe a speed versus time trace, along with road grade, that the vehicle must follow.

ADVISOR then puts the vehicle through its paces, making sure it meets the cycle to the best of its ability and measuring (or offering the opportunity to measure) just about every torque, speed, voltage, current, and power passed from one component to another.

5.2 Getting familiar with the GUI

The ADVISOR GUI can be started using one of the two following methods.

Method 1

Start MATLAB 5.3 (or higher) and using the path browser, remove any previous ADVISOR paths. Then change the current (active) directory to be the top-level ADVISOR directory (the folder containing the extracted files). To run ADVISOR, type advisor at the command prompt in MATLAB. This will update the MATLAB path for the current MATLAB session and start running ADVISOR. If the directories needed for ADVISOR have not been saved to the path for future sessions, a window will popup and ask if you want to save the path for future sessions. It may be necessary to save the path for other programs to have access to ADVISOR.

Method 2 Creating ADVISOR shortcut icon to launch ADVISOR and MATLAB

In the GUI directory, find the ADVISOR shortcut icon to launch ADVISOR and MATLAB. Right click on the file and choose properties. Click on the shortcut tab. Do a search for the MATLAB executable file. Under Target modify it to point to

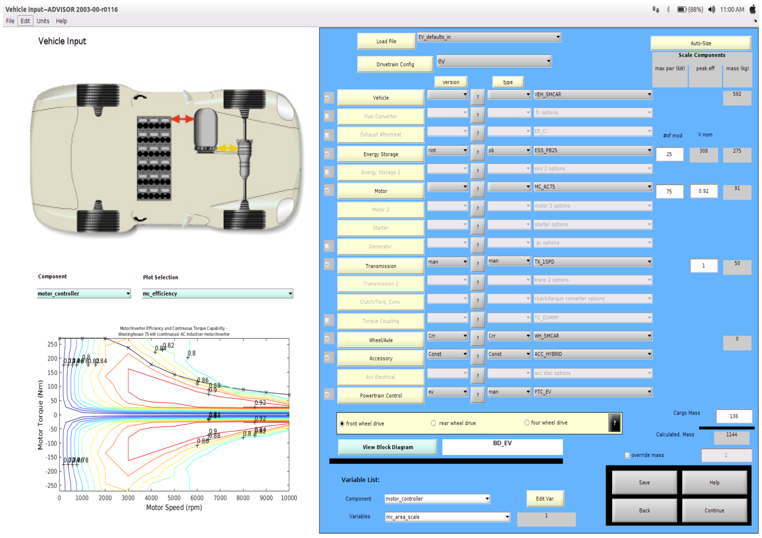

Figure 5.2: ADVISOR GUI

your MATLAB.EXE file, followed by -r advisor. Under Start in enter in the main ADVISOR directory. Hit the change icon button, then hit browse and find the ADVISOR.bmp file, not the shortcut file, in the GUI directory. Enter Ok, and double-click on the icon to launch ADVISOR.

5.3 Drive cycle

It is well known that the range of electric vehicles is a major problem. In the main this is because it is so hard to efficiently store electrical energy. In any case, this problem is certainly a critical issue in the design of any electric vehicle. There are two types of calculation or test that can be performed with regard to the range of a vehicle.

The first, and much the simplest, is the constant velocity test. Of course no vehicle is really driven at constant velocity, especially not on level ground, and in still air, which are almost universal further simplifications for these tests. However, at least the rules for the test are clear and unambiguous, even if the test is unrealistic. It can be argued that they do at least give useful comparative figures.

The second type of test, more useful and complex, is where the vehicle is driven,in

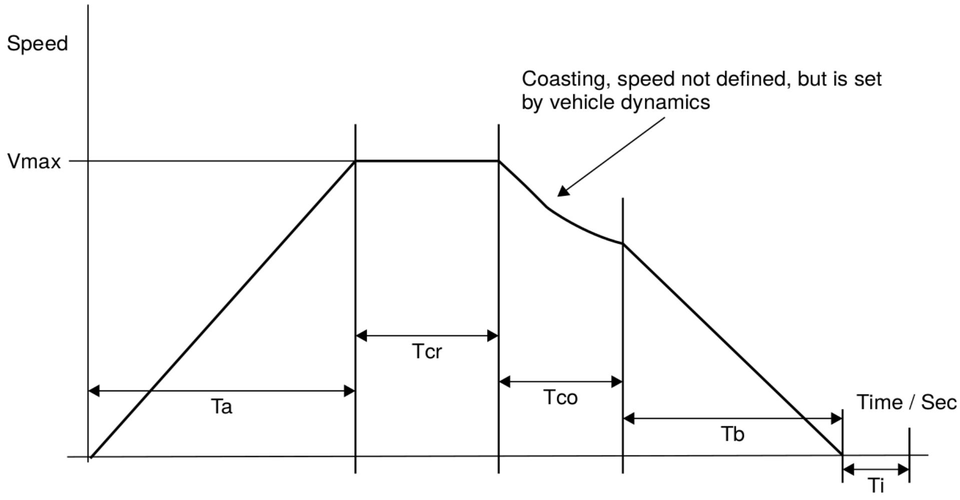

Figure 5.3: DRIVE CYCLE

Parameter	Unit	Cycle A	Cycle B	Cycle C	Cycle D
Maximum speed	$Km.h^{-1}$	16	32	48	72
Acceleration Time Ta	s	4	19	18	28
Cruise time Tcr	s	0	19	20	50
Coast time Tco	s	2	4	8	10
Brake time Tb	s	3	5	9	9
Idle time Ti	s	30	25	25	25
Total time	s	39	72	80	122

Figure 5.4: Nominal Parameters

reality or in simulation, through a profile of ever changing speeds. These test cycles have been developed with some care, and there are (unfortunately) a large number of them. The cycles are intended to correspond to realistic driving patterns in different conditions. During these tests the vehicle speed is almost constantly changing, and thus the performance of all the other parts of the system is also highly variable, which makes the computations more complex. These driving cycles (or schedules) have primarily been developed in order to provide a realistic and practical test for the emissions of vehicles.

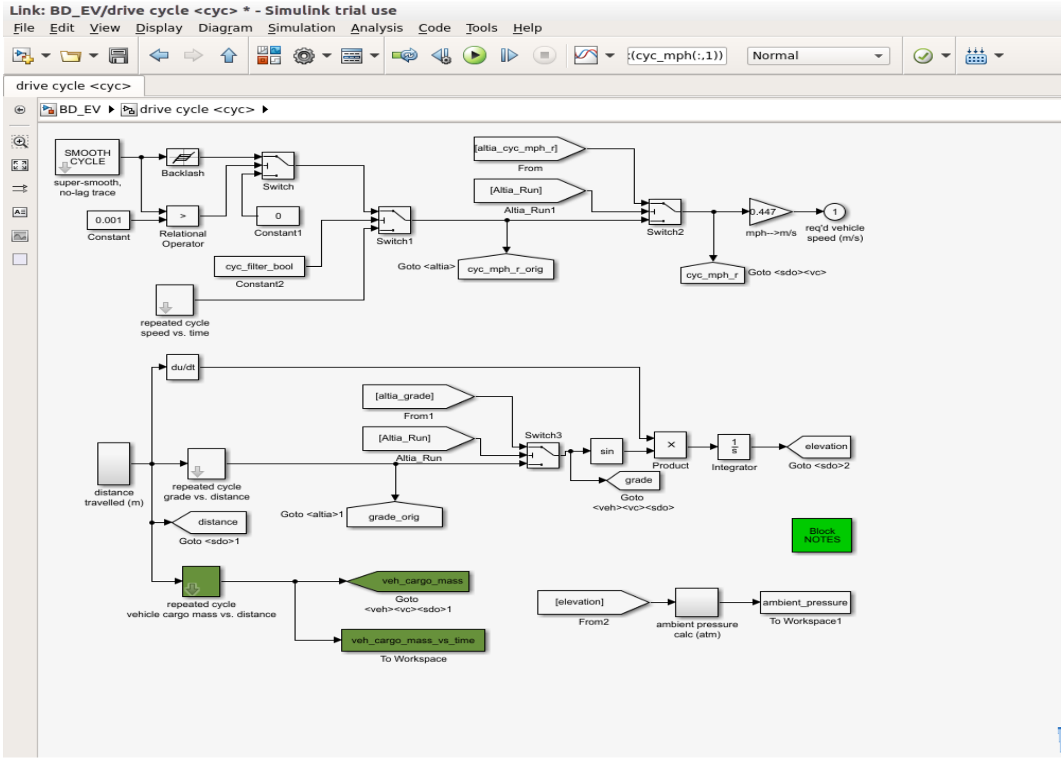

Figure 5.5: Simulink model of a generic Drive Cycle

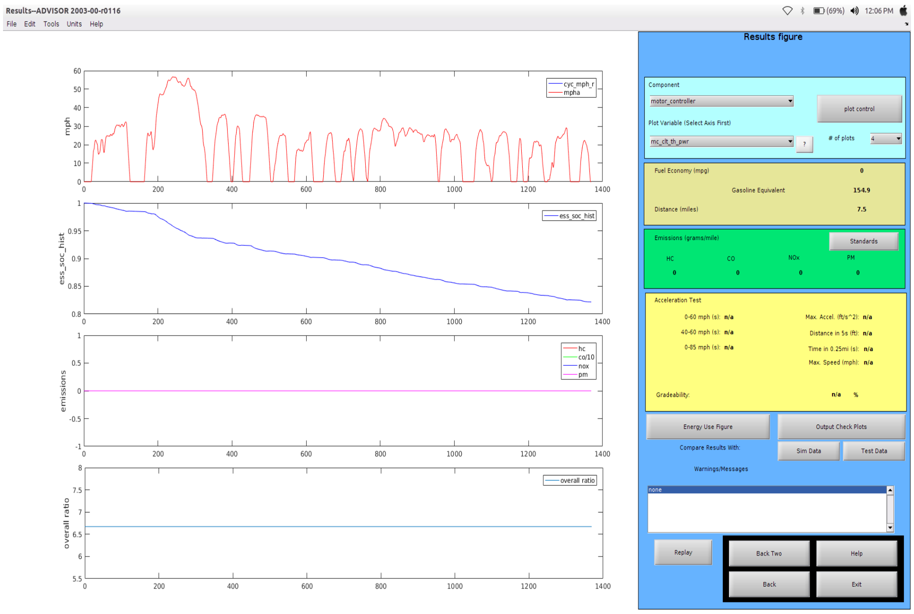

Figure 5.6: Final Result of Proposed System

Chapter 6

Conclusion

6.1 Conclusion

In this project we are designing an embedded system for an electric drive with Regenerative Braking System using CAN (Controller Area Network) Protocol which was purposely designed for automobiles. With the growing popularity of electric vehicles electric seems to be a future.

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