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INDEX

As the electrification of cars rapidly advances towards achieving a decarbonized society, the development of electric powertrain systems that are more efficient, compact, and lightweight is currently progressing. Hence the Students have to be exposed in this EV Technology. The following Products for setting up a EV Lab have been introduced for conducting Lab Experiments, doing UG/PG Projects and pursuing PhD Works.
To Offer an in-depth understanding of system-wide challenges in vehicles electronics and software

2 WHEELER ELECTRIC VEHICLE TRAINING SYSTEM

1.i EV Cycle Training System (View-2wc)

This Electric Vehicle Trainer is shown in the figure it consists of a rear wheel fixed with 250W BLDC motor. The dsPIC33CH based controller drive the MOSFET inverter which in turn drives the BLDC motor. Housing under the seat contains the Li-ion battery which will supply the power to the inverter. The dsPIC Controller is housed on the Back Seat of the Cycle with many test signal terminations for student experimentations.

Two wheeler Electric Bicycle

SPECIFICATIONS

Rated Voltage	:	48Vdc
Rated Current	:	20A
Speed	:	25 Km/hr

* Temperature sensor : IR sensor used to read temperature of the motor.
* Distance measurement : Magnetic proximity switch based sensor/ feedback from motor hall sensor.
* Display : 7-inch TFT display with touch screen for monitoring.

Hall sensor based motor current sensing.
Hall sensor based motor position sensing.
Hall Effect sensor is used to measure the speed.

* CAN protocol for data transferring in between dsPIC33CH controller and display.
* Test points are provided to see the various waveforms. (For Study purpose),

6 --PWM signals
3 --CAPTURE signals (CAP1, CAP2, and CAP3)
4 --Current sensor output (Idc, Ir, Iy, Ib)
1—Battery voltage
1—Ground

An external Battery charger is provided to charge the 48V Li-ion Battery. The specifications are given below.

Battery Charger

- Input Voltage 230 VAC
- Output Voltage 48 VDC
- Output Current 6 A

This **Electric Bicycle** vehicle consists of the following Components.

* Rear wheel fixed with 250W BLDC Hub Motor.
* Front Wheel, Head Light, a starting switch.
* Microcontroller (Raspberry-Pi) Based Dash Board with 7” TFT Display
* dsPIC33CH Based Controller
* MOSFET Based Inverter.
* Li-ion battery with 48V-20AH/7AH
* Temperature, current and speed Sensors.

BLDC HUB motor for Electric Wheel

Specifications

- Sleek 2 wheel frame
- 250W BLDC Motor
- 48V/20AH/7AH Li-ion Battery
- 25KM per hour speed
- We can ride up to 35KM for every complete charge.

DUAL CORE dsPIC33CH BASED PWM CONTROLLER (Nano - 33CH)

The Nano - 33CH Board, based on Dual Core dsPIC33CH DSP Controller, is developed for advanced closed-loop control applications for Power electronics, smartgrid, Power Systems, etc.

- MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics,Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.
- dsPIC33CH512MP508 dual core
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave

ON Board Features:

- 4 user LEDs, 4 Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- External Pickit3 programmer/debugger.
- Opto -isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector.
- 8 Channel ADC inputs & 2 DAC/Analog Compare outputs

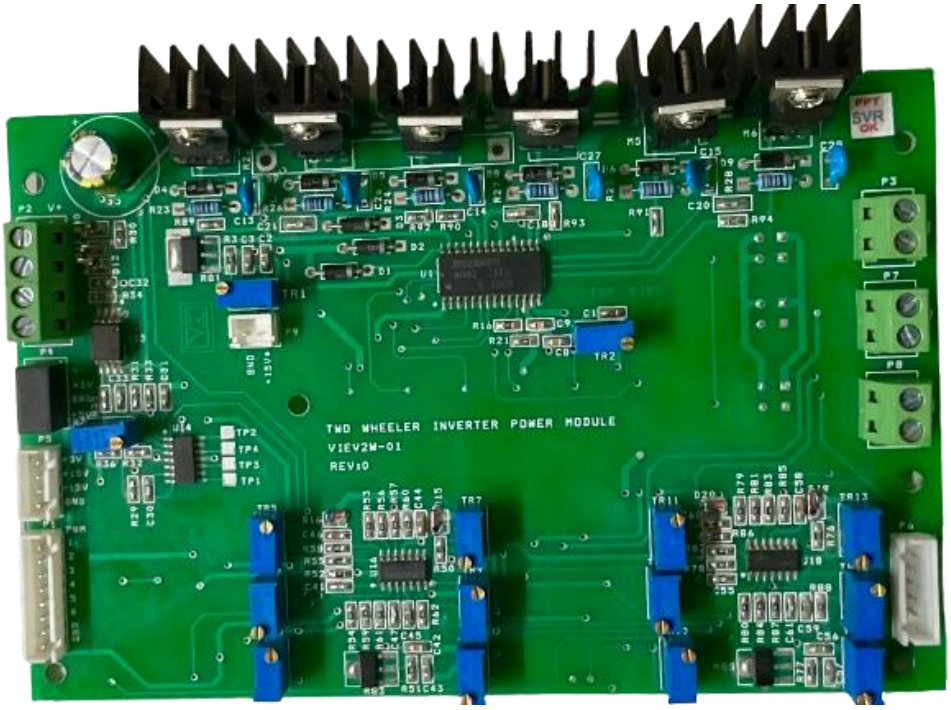
MOSFET Based Power Module

The power module consists of following aspects.

- 6 nos if MOSFET with driver -100V/50A MOSFET
- DC-DC convertor for drive current and signal conditioner current

* 4 No of current and one no of voltage sensor used to sense the voltage, current and protect the power module.
* Separate connectors provided to voltage input and output.
* Indicator LED provided for the getting pulse.
* Gate Pulse drive from on board controller based on the command pulse coming from the auxillator
* Output power maximum 300W.

 # Output Voltage : 48V
 # Output Current : 10A



The EV Controller, Power Module, Sensors etc are housed in a sleek Box with many Test Points Terminated at connectors, as shown below.

The dashboard communicates with the dsPIC33CH508 embedded controller through CAN bus. It is a 7” inch TFT display placed on the handlebar of the EV. The display shows the following parameters.

- Temperature input reading shows on Temp °C
- Motor current such as current R, current Y, current B
- Monitoring Battery Voltage in **BAT VOLTAGE**

- Monitoring Battery current in **BAT CURRENT**
- Speed Km/hr
- Total distance travelled in Kilometres.

For safety purpose to avoid crash of software and proper shut down hardware, we provide ON/OFF button on dash board display

List of experiments

- Control of speed Variation on potentiometer /throttle
- Control of different speed
- Control of electrical Braking system
- Control of Forward and reverse operation
- Set desired Speed of the BLDC Motor and Display it in the Dashboard
- To find out the maximum and minimum speed of the Cycle.
- Set the speed at 50% & 25%, apply break and note down the speed.
- Measure temperature and Display it in the 7" TFT Display.
- Measure battery voltage & battery current and Display it in the 7"TFT Dashboard
- Measure 3 Phase currents using Hall Effect Current Sensors.
- Measure the DC link current, voltage & battery Voltage using Hall effect Sensors
- Measure the battery charging and battery level identification
- Using CAN Bus send data from the controller and Display it on the 7" TFT dashboard

1.ii. EV Scooter Training System (View-2ws)

This Electric Vehicle Trainer is shown in the figure it consists of a rear wheel fixed with 1000W BLDC motor. The dsPIC33CH based controller drive the MOSFET inverter which in turn drives the BLDC motor. Housing under the seat contains the Li-ion battery which will supply the power to the inverter. The dsPIC Controller is housed on the Back Seat of the Scooter with many test signal terminations for student experimentations.

Two wheeler Electric Scooter

SPECIFICATIONS

Rated Voltage	:	48Vdc
Rated Current	:	20A
Speed	:	60 Km/hr
Battery	:	3.3 KWLiFePO4 Battery

* Temperature sensor : IR sensor used to read temperature of the motor.
* Display : 7-inch TFT display with touch screen for monitoring.
* Hall sensor based motor current sensing.
* Hall sensor based motor position sensing.
* Hall Effect sensor is used to measure the speed.
* CAN protocol for data transferring in between dsPIC33CH controller and display.
* Test points are provided to see the various waveforms. (For Study purpose),
  - 6 --PWM signals
  - 3 --CAPTURE signals (CAP1, CAP2, and CAP3)
  - 4 --Current sensor output (Idc, Ir, Iy , Ib)
  - 1—Battery voltage
  - 1—Ground

The dsPIC33CH508,Dual core controller is used here as PWM controller for the BLDC Inverter,gets feedback to capture input for the speed control of the EV Scooter.

Peripherals

The dsPIC333CH has many peripherals.It allows the device to be interfaced into the external world.The peripherals includes

* I/O Ports
* Timers, Input Capture Module
* Quadrature Encoder Interface (QEI)
* 12-bit A/D Converter
* UART Module, SPI Module
* I2C Module, CAN Module

An external Battery charger is provided to charge the 48V Li-ion Battery. The specifications are given below.

Battery Charger

- Input Voltage 230 VAC
- Output Voltage 48 VDC
- Output Current 6 A

BLDC HUB motor for Electric Wheel

Specifications

- Sleek 2 wheel frame
- 1000W BLDC Motor
- 60V,3.3KW Li-ion Battery
- 60KM per hour speed
- We can ride up to 60KM for every complete charge.

DUAL CORE dsPIC33CH BASED PWM CONTROLLER (Nano - 33CH)

The Nano - 33CH Board, based on Dual Core dsPIC33CH DSP Controller, is developed for advanced closed-loop control applications for Power electronics, smartgrid, Power Systems, etc.

- MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics,Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.
- dsPIC33CH512MP508 dual core,
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave

ON Board Features:

- 4 user LEDs, 4 Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- External Pickit3 programmer/debugger.
- Opto -isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector.
- 8 Channel ADC inputs & 2 DAC/Analog Compare outputs

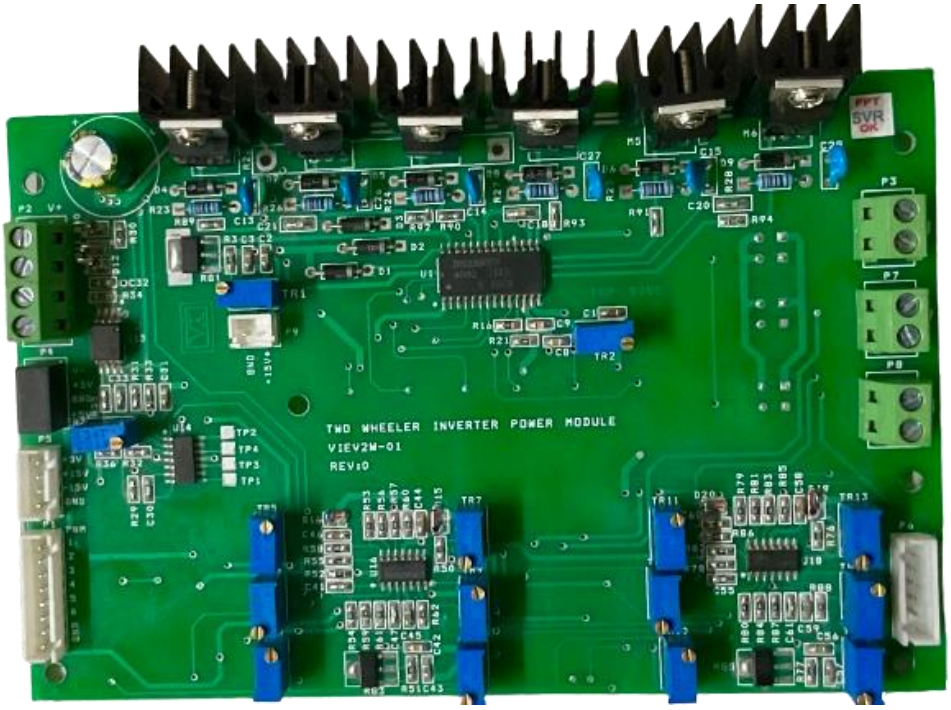
MOSFET Based Power Module

The power module consists of following aspects.

- 6 nos if MOSFET with driver -100V/100A MOSFET
- DC-DC convertor for drive current and signal conditioner current

* 4 No of current and one no of voltage sensor used to sense the voltage, current and protect the power module.
* Separate connectors provided to voltage input and output.
* Indicator LED provided for the getting pulse.
* Gate Pulse drive from on board controller based on the command pulse coming from the auxillator
* Output power maximum 1000W.

 # Output Voltage : 60V
 # Output Current : 20A peak



The EV Controller, Power Module, Sensors etc are housed in a sleek Box with many Test Points Terminated at connectors, as shown below

The dashboard communicates with the dsPIC33CH embedded controller through CAN bus. It is a 7” inch TFT display placed on the handlebar of the EV. The display shows the following parameters.

- Temperature input reading shows on Temp °C
- Motor current such as current R, current Y, current B
- Monitoring Battery Voltage in **BAT VOLTAGE**

- Monitoring Battery current in **BAT CURRENT.**
- Speed Km/hr
- Total distance travelled in Kilometres.

For safety purpose to avoid crash of software and proper shut down hardware, we provide ON/OFF button on dash board display

List of experiments

- Control of speed Variation on potentiometer /throttle
- Control of different speed
- Control of Forward and reverse operation
- Set desired Speed of the BLDC Motor and Display it in the Dashboard
- To find out the maximum and minimum speed of the scooter.
- Set the speed at 50% & 25%, apply break and note down the speed.
- Measure temperature and Display it in the 7" TFT Display.
- Measure battery voltage & battery current and Display in the 7"TFT Dashboard
- Measure 3 Phase currents using Hall Effect Current Sensors.
- Measure the DC link current, voltage & battery Voltage using Hall effect Sensors
- Measure the battery charging and battery level identification
- Using CAN Bus send data from the controller and Display it on the 7" TFT dashboard

2. TRICYLCLE / AUTO EV DEVELOPMENT SYSTEM (Viev-3w)

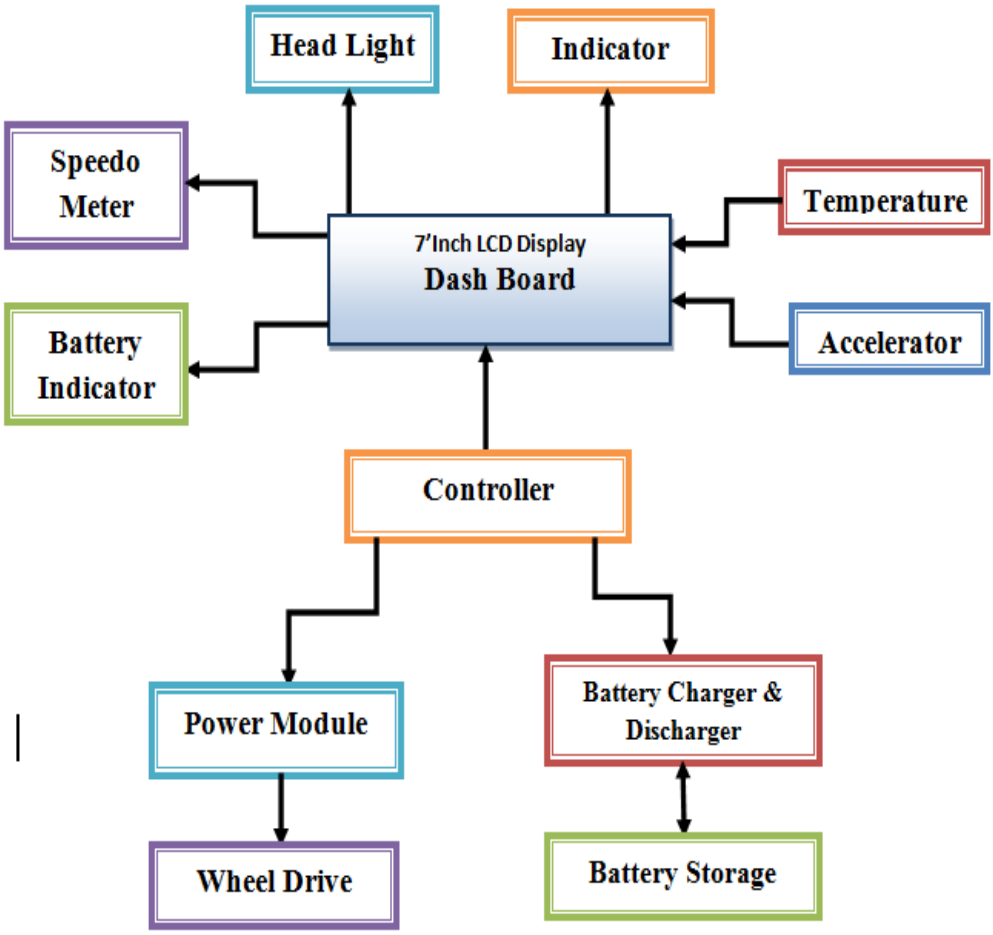
Electrical Vehicle technology, one of the fastest growing technologies at present. In 21st century, EV saw resurgence, due to technology development in power modules, embedded controllers for control applications, software evolvement like MATLAB, NX for chassis design. More & More Tri Cycle based EV being used for solid waste Management, Transportation like AUTO RICKSHAW Etc.

We are proud to introduce an Electrical Vehicle - Tricycle with BLDC Motor, DSP/FPGA Based Controller and Lithium ion Battery fixed on the tricycle /auto rickshaw frame for hands on experience with Three Wheeler E-Vehicle developments.

3Wheeler Frame

- Range of 35 Km on a single charge with maximum load
- Top Speed 25 KMpH.
- Powerful 3000 Watts BLDC Motor
- Long lasting 3.12kWHr, 48V, 65Ah Battery Lithium ion
- Charging time 4.5 Hours
- CAN Bus Interface

Electric Vehicle Components



Battery

- Lithium Ion Battery.
- Power 3.12 kWHr
- Voltage 48 VDC
- Current 65 Ah
- Battery Pack
- 48 VDC/65AH

Battery Charger

- Input Voltage 230 VAC
- Output Voltage 48 VDC
- Output Current 10 A

Drive Specification

- Output Power : 3000 W
- Output Voltage : 48 VDC
- Output Current : 65A max
- 100 Amps MCB Protection
- 3 Ph Half Bridge formed by 6 MOSFET as 3 Ph Inverter Power Module.
- BLDC Motor Controller using a Powerful DSP/FPGA Controller to generate the required PWMs for the power module and acts as Electric Speed Controller

Motor Specification

Brushless DC Motor

- 48 V DC, 62.5 A
- Power : 3000W

DUAL CORE dsPIC33CH BASED PWM CONTROLLER (Nano - 33CH)

The Nano - 33CH Board, based on Dual Core dsPIC33CH DSP Controller, is developed for advanced closed-loop control applications for Power electronics, smartgrid, Power Systems, etc.

- MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics,Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.
- dsPIC33CH512MP508 dual core,
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave

ON Board Features:

- 4 user LEDs, 4 Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- External Pickit3 programmer/debugger.
- Opto -isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector.
- 8 Channel ADC inputs & 2 DAC/Analog Compare outputs

7” inch TFT dashboard Display

The dashboard communicates with the DSP/FPGA through CAN bus. It is a 7” inch TFT display placed on the handle bar of the EV. The display shows the following parameters.

- Temperature input reading shows on Temp °C
- Motor current such as current R, current Y, current B
- Monitoring Battery Voltage in **BAT VOLTAGE**
- Monitoring Battery current in **BAT CURRENT**

- Speed Km/hr
- Total distance travelled in Kilometres.
- we provide ON/OFF button on dash board display.

Three Wheeler EV TRAINING MODULE EXPERIMENTS

- STUDY OF ELECTRIC VEHICLE COMPONENTS
- STUDY OF dsPIC33CH508 PWM Controller.
- CONTROLLER BASED PULSE GENERETION FOR FORWARD ACCELERATION.
- STUDY OF PULSE PATTERN FOR BREAKING.
- STUDY OF SENSORS AND DATA AQUISITION SYSTEM.
- STUDY OF VEHICLE STRUCTURE DESIGN using NX(cad/cam/mcd) Software.
- STUDY OF POWER TRAIN MODULE
- STUDY OF EFFIECIENCY OF POWER TRAIN MODULE.
- STUDY OF EFFICIENCY OF BATTERY CHARGING MODULE .
- STUDY OF LOAD Vs TORQUE CHARACTERITICS OF ELECTRIC VEHICLE.

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3.4 WHEELER EV DEVELOPMENT SYSTEM (Viev-3w)

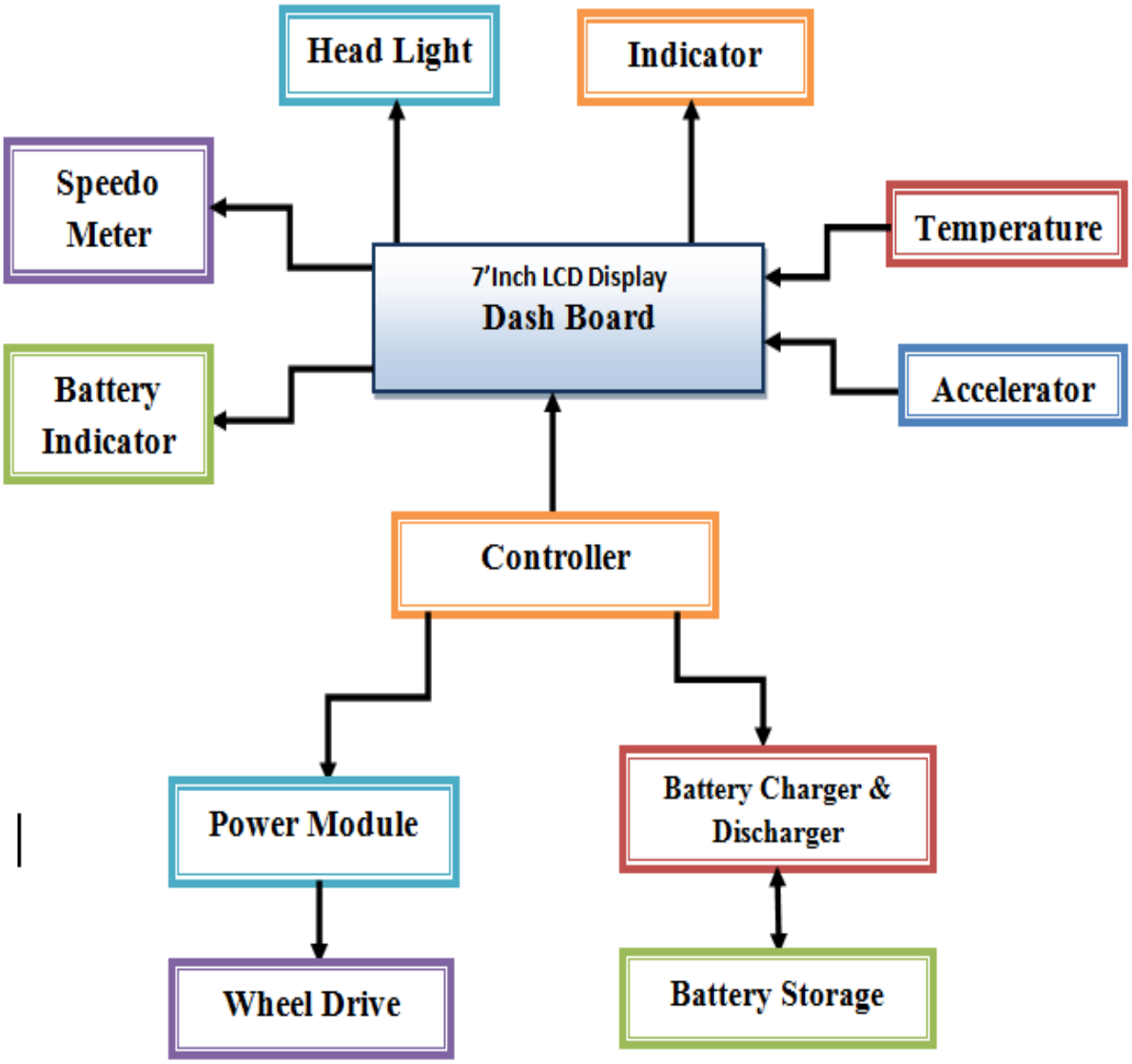
i. 4Wheeler EV Golf Development System (Viev-4wg)

Electrical Vehicle technology, one of the fastest growing technologies at present. In 21st century, EV saw resurgence, due to technology development in power modules, embedded controllers for control applications, software evolvement like MATLAB, NX for chassis design. More & More 4 Wheeler based EV being used for solid waste Management, Transportation like Airport & Railways Electric Shuttle Cart Etc,.

We are proud to introduce an Electrical Vehicle – 4 Wheeler with BLDC Motor, DSP/FPGA Based Controller and Lithium ion Battery fixed on the 4 Wheeler frame for hands on experience with three Wheeler E-Vehicle developments.

- Range of 35Km on a single charge with maximum load
- Top Speed 25 KMpH.
- Powerful 3000Watts BLDC Motor
- Long lasting 3.12kWHr, 48V, 65Ah Battery Lithium Ion
- Charging time 4.5Hours
- CAN Bus Interface

Electric Vehicle Components



Battery

- Lithium ion Battery
- Power 3.12 kWHr
- Voltage 48 VDC
- Current 65 Ah
- 48 VDC/65AH
- Battery Pack

Battery Charger

- Input Voltage 230 VAC
- Output Voltage 48 VDC
- Output Current 10 A

Drive Specification

- Output Power : 3000 W
- Output Voltage : 48 VDC
- Output Current : 65A max
- 100 Amps MCB Protection
- 3 Ph Half Bridge formed by 6 MOSFET as 3 Ph Inverter Power Module.
- BLDC Motor Controller using a Powerful DSP/FPGA Controller to generate the required PWMs for the power module and acts as Electric Speed Controller

Motor Specification

Brushless DC Motor

- 48 V DC, 62.5 A
- Power : 3000W

DUAL CORE DELFINO BASED DSP TMS320F28377D CONTROLLER

The Trainer kit should be a useful development of advanced closed-loop control applications for Power electronics, Smart grid, Drives, Electrical Vehicle, Process Control System etc.., It should be designed to learn the multi-processor architecture and the inter processor communication mechanisms, purpose built Intelligent Peripherals like CLA, Trignomatric Block, Veterbi Block etc.

Features:

* Based on Dual- Core 32-bit Delfino fixed point Processor TMS320F377D
* Operating Speed: 200MHz (For each core)
* 32-bit floating-point unit (FPU) which supports floating point operations
  - Trignometric Math Unit (TMU) to speed up the execution of trignometric operations
  - Viterbi, Complex Math, and CRC Unit II (VCU-II) to accelerate the performance of FFT's and communications-based algorithms
  - Two CLA real-time control co-processors that run at the same speed as the main CPU's
* 1MB (512KW) of onboard flash memory
  - 16 Channels (16-bit/12-bit at 1.1 MSPS/3.5 MSPS) Successive Approximation ADCs
* 16 Enhanced PWM outputs, 6 Enhanced Capture Inputs
* 3 (12-bit) Buffered DACs

ON Board Features:

- 16 Numbers of user LEDs, 256MB of SDRAM
- 2 Numbers of Limit Switches for user interface
- 4 Numbers of Push-Button Micro Switches
- 1 SPDT Switch for user interface
- 20 × 4 Alphanumeric LCD
- Opto-isolated USB Interface, Quadrature Encoder Interface
- Opto-isolated USB to Serial Interface
- Opto-isolated on board USB to JTAG Emulator
- PWM Outputs and Capture Inputs should be terminated at good quality 34-pin FRC connector for easy use for student.
- 16 Channel ADC inputs should be terminated at good quality 26-pin FRC connector with buffered and protection
- DAC outputs and sigma Delta ADC inputs should be terminated in screw type connector.
- **This board should have good support for MATLAB SIMULINK**
- **This Board Should be configured or many types of Control algorithm ON/OFF, PID, Fuzzy Logic, Model Predictive Algorithm, Reinforcement Learning Control. These algorithm should be able to run on this DSP Board.**

b. 100Amp IGBT Based EV INVERTER

The Power Circuit of this Trainer consists of Six Numbers of IGBT with gate driver. & PWM isolator IC'S. The PWM signals are given from DSP/ FPGA PWM Controller to drive the BLDC / PMSM Motor.

* 1200V/ 200A Peak, Infineon based IGBT module
* 6 Nos of IGBT's provided in 3nos of IGBT module
* 6 Nos driver WITH VCE SATURATION PROTECTION with inbuilt opto isolator
* Snubber capacitor provided for dv/dt protection for IGBT module
* Proper heat sink provided for all the IGBTs with cooling fan provision
* Temperature sensor provided for over temperature Protection
* Over current protection and short circuit protection provided for all individual IGBT Module
* PWM Inputs are brought out on Front Panel, you may connect any controller.
* Reset circuit provided and terminated to clear the fault
* Filter circuit available for power circuit input.
* 4 Nos Current sensor provided for DC link current and Output line current
* 4 Nos Voltage sensor provided for DC link voltage
* Input Voltage : 12V – 72V
* Output Voltage : 12V – 72V
  Output Current : 100A, AC
* One no of 34 pin connector & one no of 26 pin connectors provided in the front panel for PWM Input and feedback signals to Controller.

7” inch TFT dashboard Display

The dashboard communicates with the DSP/FPGA through CAN bus. It is a 7” inch TFT display placed on the handle bar of the EV. The display shows the following parameters.

- Temperature input reading shows on Temp °C
- Motor current such as current R, current Y, current B
- Monitoring Battery Voltage in **BAT VOLTAGE**
- Monitoring Battery Current in **BAT CURRENT**

- Speed Km/hr
- Total distance travelled in Kilometres.
- we provide ON/OFF button on dash board display.

Four Wheeler EV TRAINING MODULE EXPERIMENTS

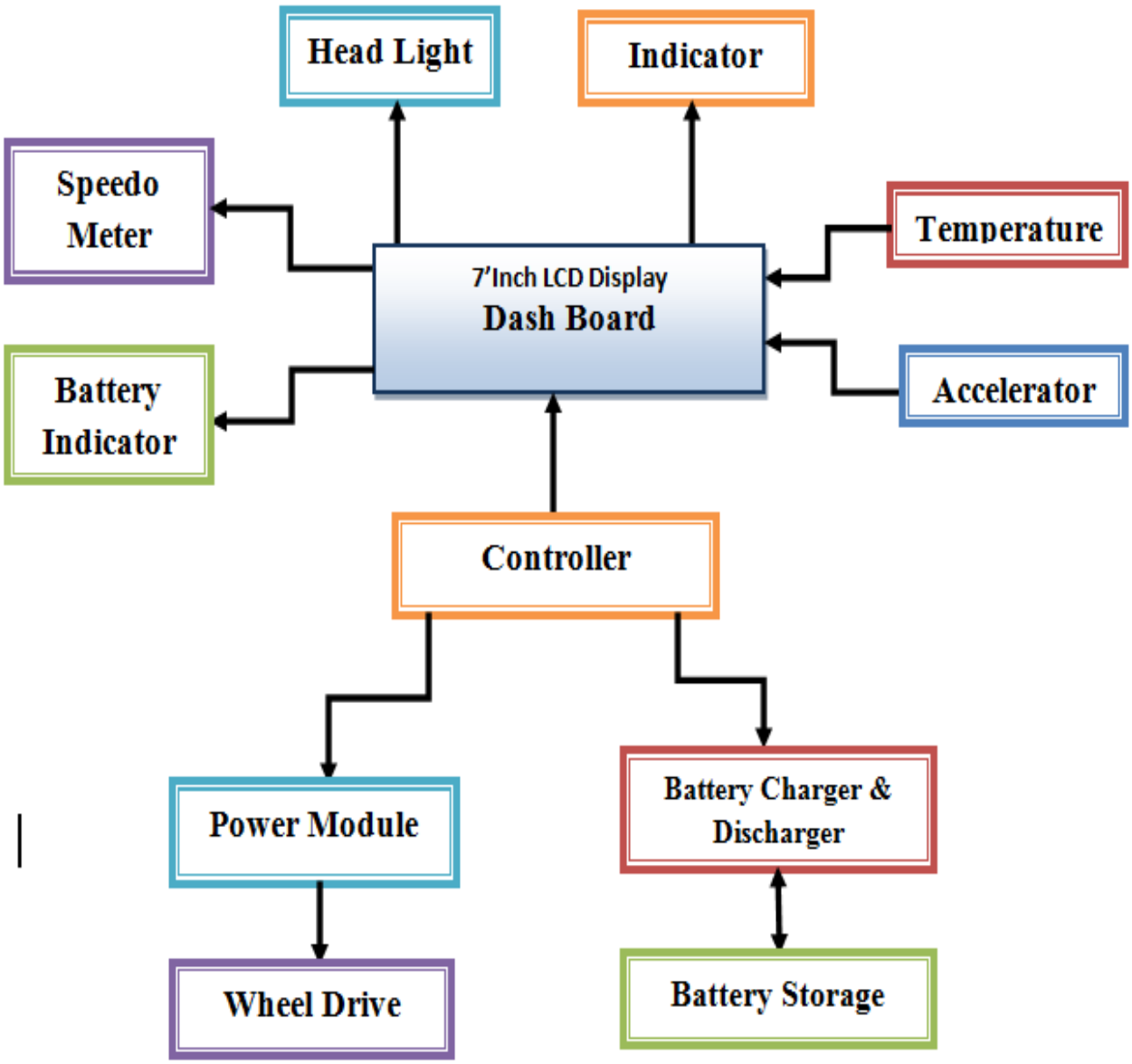
- STUDY OF 4 Wheeler ELECTRIC VEHICLE COMPONENTS
- STUDY OF TMS320F28377D PWM Controller.
- CONTROLLER BASED PULSE GENERETION FOR FORWARD ACCELERATION.
- STUDY OF PULSE PATTERN FOR BREAKING.
- STUDY OF SENSORS AND DATA AQUISITION SYSTEM.
- STUDY OF VEHICLE STRUCTURE DESIGN using NX (cad/cam/mcd) Software.
- STUDY OF POWER TRAIN MODULE
- STUDY OF EFFICIENCY OF POWER TRAIN MODULE.
- STUDY OF EFFICIENCY OF BATTERY CHARGING MODULE .
- STUDY OF LOAD Vs TORQUE CHARACTERISTICS OF ELECTRIC VEHICLE.

3.ii. 4Wheeler EV Car Development System (Viev-4wc)

We are proud to introduce an Electrical Vehicle – 4 Wheeler Car with PMSM Motor, DSP/FPGA Based Controller and Li-Ion Battery fixed on the 4 Wheeler frame for hands on experience with 4 Wheeler E-Vehicle developments.

- Range of 35 Km on a single charge with maximum load
- Top Speed 25 KMpH.
- Powerful 3000Watts PMSM Motor
- Long lasting 3.12 kWHr, 48V, 65Ah Battery Lithium ion
- Charging time 4.5 Hours
- CAN Bus Interface

Electric Vehicle Components



Battery

- Lithium Ion Battery.
- Power 3.12 kWHr
- Voltage 48 VDC
- Current 65 Ah
- 48 VDC/65AH
- Battery Pack

Battery Charger

- Input Voltage 230 VAC
- Output Voltage 48 VDC
- Output Current 10 A

Drive Specification

- Output Power : 3000 W
- Output Voltage : 48 VDC
- Output Current : 65A max
- 100 Amps MCB Protection
- 3 Ph Half Bridge formed by 6 MOSFET as 3 Ph Inverter Power Module.
- BLDC Motor Controller using a Powerful DSP/FPGA Controller to generate the required PWMs for the power module and acts as Electric Speed Controller

Motor Specification

Brushless DC Motor

- 48 V DC, 62.5 A
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  - Trignometric Math Unit (TMU) to speed up the execution of trignometric operations
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  - Two CLA real-time control co-processors that run at the same speed as the main CPU's
* 1MB (512KW) of onboard flash memory with error correction code (ECC)
  204KB (102KW) of SRAM
  - 16 Channels (16-bit/12-bit at 1.1 MSPS/3.5 MSPS) Successive Approximation ADCs
* 16 Enhanced PWM outputs, 6 Enhanced Capture Inputs
* 3 (12-bit) Buffered DACs

ON Board Features:

- 16 Numbers of user LEDs, 256MB of SDRAM
- 2 Numbers of Limit Switches for user interface
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- 1 SPDT Switch for user interface
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* 1200V/ 200A Peak, Infineon based IGBT module
* 6 Nos of IGBT's provided in 3nos of IGBT module,
* 6 Nos driver WITH VCE SATURATION PROTECTION with inbuilt opto isolator
* Snubber capacitor provided for dv/dt protection for IGBT module
* Proper heat sink provided for all the IGBTs with cooling fan provision
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* 4 Nos Current sensor provided for DC link current and Output line current
* 4 No Voltage sensor provided for DC link voltage
* Input Voltage : 12V – 72V
* Output Voltage : 12V – 72V
  Output Current : 100A, AC
* One no of 34 pin connector & one no of 26 pin connectors provided in the front panel for PWM Input and feedback signals to Controller.

7” inch TFT dashboard Display

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- Monitoring Battery Voltage in **BAT VOLTAGE**
- Monitoring Battery current in **BAT CURRENT**

- Speed Km/hr
- Total distance travelled in Kilometres.
- we provide ON/OFF button on dash board display.

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- STUDY OF EFFICIENCY OF POWER TRAIN MODULE.
- STUDY OF EFFICIENCY OF BATTERY CHARGING MODULE .
- STUDY OF LOAD Vs TORQUE CHARACTERISTICS OF ELECTRIC VEHICLE.

4.Motor Test bed set up

4.i. 100A ELECTRICAL VEHICLE INVERTER WITH dsPIC33CH CONTROLLER(Viev- IN-33ch)

This Inverter with Controller will be used in the PMSM & Induction Motor Test Bed for Performance Analysis of these Motors.

a. DUAL CORE dsPIC33CH BASED PWM CONTROLLER (Nano - 33CH)

The Nano - 33CH Board, based on Dual Core dsPIC33CH DSP Controller, is developed for advanced closed-loop control applications for Power electronics, smartgrid, Power Systems, etc.

- MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics,Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.
- dsPIC33CH512MP508 dual core,
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave

ON Board Features:

- 4 user LEDs, 4 Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- External Pickit3 programmer/debugger.
- Opto -isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)

- ❖ 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector.
- ❖ 8 Channel ADC inputs & 2 DAC/Analog Compare outputs

d. 100Amp IGBT Based EV INVERTER

The Power Circuit of this Trainer consists of Six Numbers of IGBT with gate driver in a Single Chip Called Mini Intelligent Power Module. & pwm isolator IC'S. The PWM signals are given from dsPIC33CH/ DSP/ FPGA PWM Controller. It can be used for high voltage single phase / Three phase Inverter, chopper, motor control applications

* 1200V/ 200A Peak, Infineon based IGBT module
* 6 Nos of IGBT's provided in 3nos of IGBT module
* 6 Nos driver WITH VCE SATURATION PROTECTION with inbuilt opto isolator
* Snubber capacitor provided for dv/dt protection for IGBT module
* Proper heat sink provided for all the IGBTs with cooling fan provision
* Temperature sensor provided for over temperature Protection
* Over current protection and short circuit protection provided for all individual IGBT Module
* PWM Inputs are brought out on Front Panel, you may connect any controller.
* One common +15V Power supply for all the driver circuit, Inbuilt isolated power supply provided.
* Reset circuit provided and terminated to clear the fault
* Filter circuit available for power circuit input.
* 4 Nos Current sensor provided for DC link current and Output line current
* 4 No Voltage sensor provided for DC link voltage

* Input Voltage : 12V – 72V
* Output Voltage : 12V – 72V
  Output Current : 100A, AC
* One no of 34 pin connector & one no of 26 pin connectors provided in the front panel for PWM Input and feedback signals to Controller.

All Performance Parameters like

i. Speed
ii. 3 Phase Current
iii. 3 Phase Voltage
iv. Temperature of the Motor Body.

Safety Features:

i. Emergency Stop Button for immediate shut down. ii. Electrical Isolation
iii. Protection: Overvoltage, Overcurrent, Overheating protection.

4.ii. BLDC Hub Motor Test bed Set Up (Viev-TB-Hub)

This experimental set up consists of a HUB MOTOR fixed on mechanical set up with spring load arrangement for loading mechanically the Hub Motor for various performance test. A MOSFET Based Inverter and a dual core dsPIC33CH Controller provided

3 ϕ MOSFET based Inverter with built in Controller

This trainer consists of a MOFET Based Power Module and a built in PWM Controller and can be used to build a Test Set Up to conduct performance test.

DUAL CORE dsPIC33CH BASED PWM CONTROLLER (Nano - 33CH)

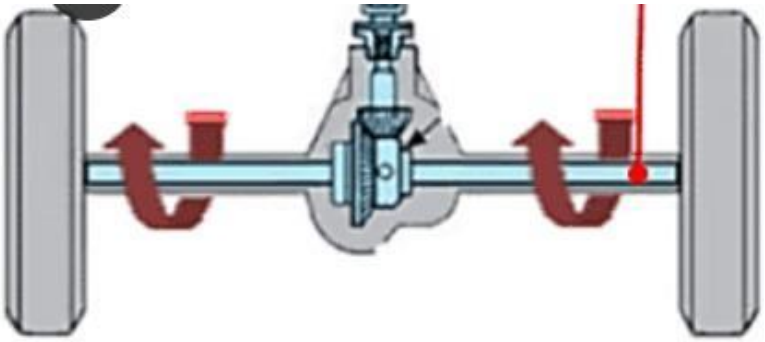
The Nano - 33CH Board, based on Dual Core dsPIC33CH DSP Controller, is developed for advanced closed-loop control applications for Power electronics, smartgrid, Power Systems, etc.

- MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics,Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.
- dsPIC33CH512MP508 dual core,
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave

ON Board Features:

- 4 user LEDs, 4 Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- Opto -isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector.
- 8 Channel ADC inputs & 2 DAC/Analog Compare outputs

DIFFERENTIAL DRIVE



3ϕ MOSFET Based Power Circuit.

The Power Circuit of this Trainer consists of Six Numbers of MOSFET with gate driver in a Single Chip Called Mini Intelligent Power Module & pwm isolator IC'S. The PWM signals are given from the dsPIC33CH PWM Controller.

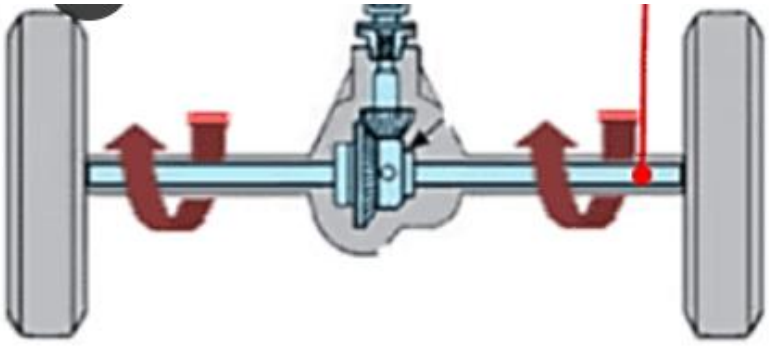
- **Six Numbers of High speed opto - isolator provided for PWM isolation**
- **Power Circuit: One Number of MOSFET based power module - with suitable snubber circuit & Heat sink provided .**
- **Rating of device is 600V@ 20AMP**
- **Isolated +15 Vdc@1amp provided for control ic's**
- **One number of Single phase diode rectifier (600V, 35Amp) with filter capacitor provided for input ac rectification and for power circuit input with fuse protection**
- **One number of Analog voltmeter provided for DC-Link voltage measurement.**
- **Four Number of Hall Effect current sensors provided for output current & DC-Link Current Measurement & Protection**
- **Four number of op-amp signal conditioner circuit provided for all current sensors & output terminated in front panel for current wave form measurement.**
- **Over current Trip circuit provided for Over Load protection.**
- **One number of LED provided to indicate TRIP Status**
- **One number of Reset Switch provided to reset the Trip Function**
- **Six Numbers of banana connector termination provided in power circuit Input & external load interface**
- **12 Numbers of test points provided in control section for waveform measurement in CRO**
- **All are mounted in attractive powder coated cabinet with front panel sticker with mimic diagram indication.**
- **230V AC input, one number of power on / off switch with indication.**

List of experiments

- Study of PWM signals for BLDC motor
- Study of position feedback signals
- Study of speed control of BLDC motor in open loop.
- Study of speed control of BLDC motor in closed loop.
- Study of current waveform of input DC current and output currents
- Study of load Vs Speed curve
- Study of Load Vs Current curve
- Study to develop a BLDC Motor based drive system
- Study of MATLAB based PWM generator
- Study of inverter power circuit

4.iii. 60V PMSM Motor Load SET UP (Viev-LS-60PMSM)

This experimental set up consists of a PMSM fixed on mechanical set up with spring load arrangement for loading mechanically the PMSM Motor for various performance test. A 100A IGBT Based Inverter and a Dual core dsPIC33CH Controller provided for conducting this experiment. (Item 4.i)



List of experiments

- Study of PWM signals for PMSM motor
- Study of position feedback signals
- Study of speed control of PMSM motor in open loop.
- Study of speed control of PMSM motor in closed loop.
- Study of current waveform of input DC current and output currents
- Study of load vs Speed curve
- Study of Load vs Current curve
- Study to develop a PMSM Motor based drive system
- Study of MATLAB based PWM generator
- Study of inverter power circuit

4.iv. 48V EV Induction Motor Test bed (Viev-LS-ACIM)

This experimental set up consists of a 48V EV Induction Motor fixed on mechanical set up with spring load arrangement for loading mechanically the Motor for various performance test.

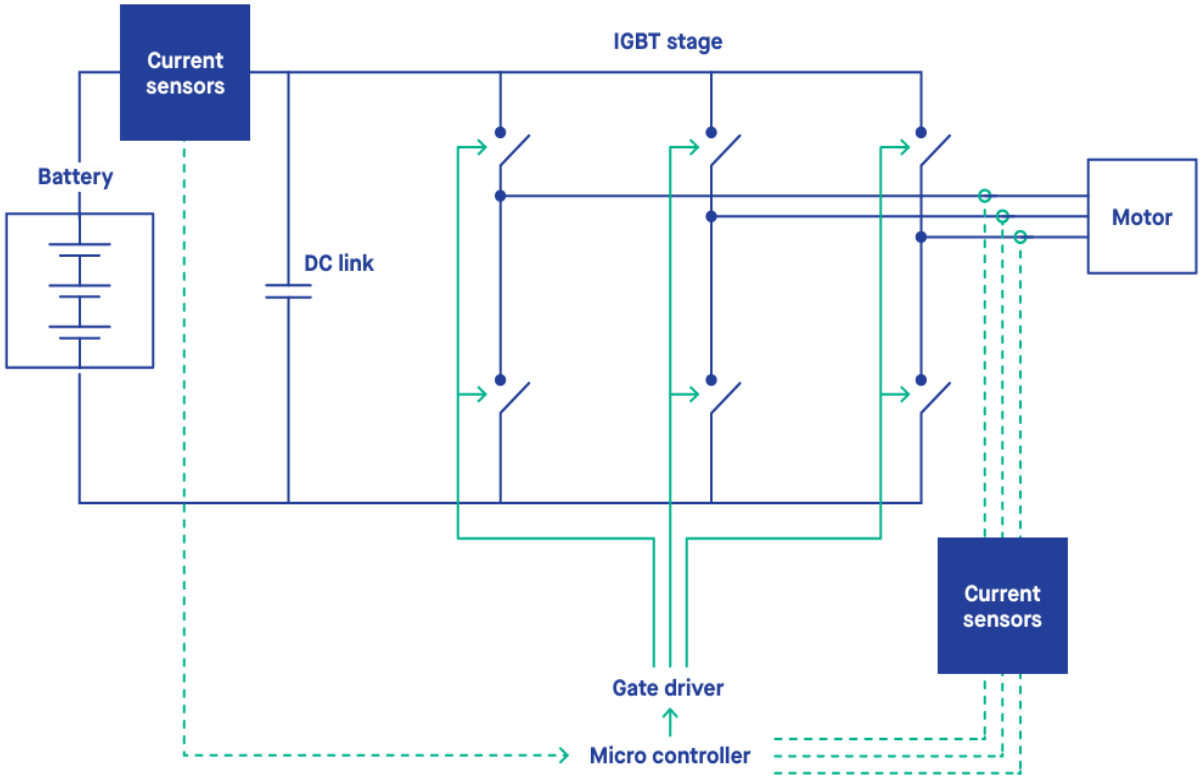
The IGBT Based 100Amp Inverter and the dsPIC33CH/DSP/FPGA Controller will be used for Driving the Motor (Item 4.i).

5.100A Electric Vehicle Inverter

Generally a Electrical Vehicle is powered by a 48V, 50-100A BLDC / PMSM/ AC IM. This Inverter is designed for this type of EV Motors.

This inverter can be driven by Controllers like Micro-33CH, Micro-377D, VPE-Cyclone4, VPE-Spartan6, Zynq – 7020, Zynq - Ul

Motor inverter architecture



MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics, Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.

* 1200V/ 200A Peak, Infineon based IGBT module
* 6 Nos of IGBT's provided in 3nos of IGBT module
* 6 Nos driver WITH VCE SATURATION PROTECTION with inbuilt opto isolator
* Snubber capacitor provided for dv/dt protection for IGBT module
* Proper heat sink provided for all the IGBTs with cooling fan provision
* Temperature sensor provided for over temperature Protection
* Over current protection and short circuit protection provided for all individual IGBT Module
* PWM Inputs are brought out on Front Panel, you may connect any controller.
* One common +15V Power supply for all the driver circuit, Inbuilt isolated power supply provided.
* Reset circuit provided and terminated to clear the fault
* Filter circuit available for power circuit input.
* 4 No Current sensor provided for DC link current and Output line current
* 4 No Voltage sensor provided for DC link voltage
* Input Voltage : 12V – 72V
* Output Voltage: 12V – 72V
  Output Current: 100A, AC
* One no of 34 pin connector & one no of 26 pin connector provided in the front panel for PWM Input and feedback signals to Controller.

Dual Core dsPIC33CH Based PWM Controller Module (Nano - 33CH)

The Nano - 33CH Trainer , based on Dual Core dsPIC33CH DSP Controller, is intended and developed for advanced closed-loop control applications for Power electronics, Smart grid etc., It is also focused for students to learn the multi-processor – Dual Core- architecture and the inter processor communication mechanisms. The inbuilt intelligent peripherals of this processor lead to complicated design for the developers in the emerging electric technology.

MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics, Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.

- PROCESSOR: dsPIC33CH512MP508 dual core,
  16-Bit Digital Signal Controllers, Master/Slave Core Operation
- Core Frequency: Slave Core :100MIPS @ 200MHz.
- Core Frequency: Master Core: 90MIPS @ 180MHz,
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave
  4 CAPTURE INPUT SIGNALS at 5 PIN RMC

ON Board Features:

- 4 Numbers of user LEDs
- 4 Numbers of Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- External Pickit3 programmer/debugger.
- Opto-isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector for easy use for the students.
- 8 Channel ADC inputs & 2 DAC/Analog Compare outputs are terminated at good quality connector with buffered and protection
- 12 BIT RESOLUTION, 3.5 MSPS SAMPLING RATE
- 1 no of SPI Interface Terminated at 6 pin RMC Connector.
- 1 no of I2C Interface Terminated at 4 pin RMC Connector.

List of Experiments

- Study of 3ϕ input full bridghe rectifier
- Study of active power factor corection
- Study of H-bridge inverter

- Study of LLC resonant converter
- Study of high frequency rectifier
- Study of synchronous rectifier
- Study of input PWM signals for PFC,H bridge inverter and bridge inverter and bridge rectifier and synchronous rectifier

6. Battery Management Systems

6.i. 12 BATTERY CELLS MANAGEMENT SYSTEM

Lithium-ion batteries, particularly the higher power versions with nickel-based cathodes (positive electrodes), can suffer damage if they are overcharged or undercharged or get too hot during operation. Monitoring the charge level of each cell, actively balancing that level between cells, and protecting against excessive temperature buildup are some tasks assigned to this BMS.

A smart battery management has been designed as Development System for the students to understand the concept and further research work on this.

It consists of i. Multicell Battery monitoring section ii. Multicell battery cell balancer iii. Charger iv. Embedded Controller

The LTC3300-1 multicell battery cell balancer is a key component in a high performance battery management system (BMS) for series-connected Li-ion cells.

It is designed to operate in conjunction with a Battery monitoring Section using LTC6803, a charger, and an Embedded Controller, as shown in the figure below.

The Embedded Controller which communicates directly with the balancer, monitor, and charger to receive voltage, current, and temperature information and to implement a balancing algorithm.

There is no single balancing algorithm optimal for all situations. For example, during net charging of the overall stack, it may be desirable to discharge the highest voltage cells first to avoid reaching terminal charge on any cell before the entire stack is fully charged. Similarly, during net discharging of the overall stack, it may be desirable to charge the lowest voltage cells first to keep them from reaching a critically low level. Other algorithms may prioritize fastest time to overall balance. The LTC3300-1 implements no algorithm for balancing the stack. Instead it provides maximum flexibility by imposing no limitation on the algorithm implemented as all individual cell balancers can operate simultaneously and bidirectionally.

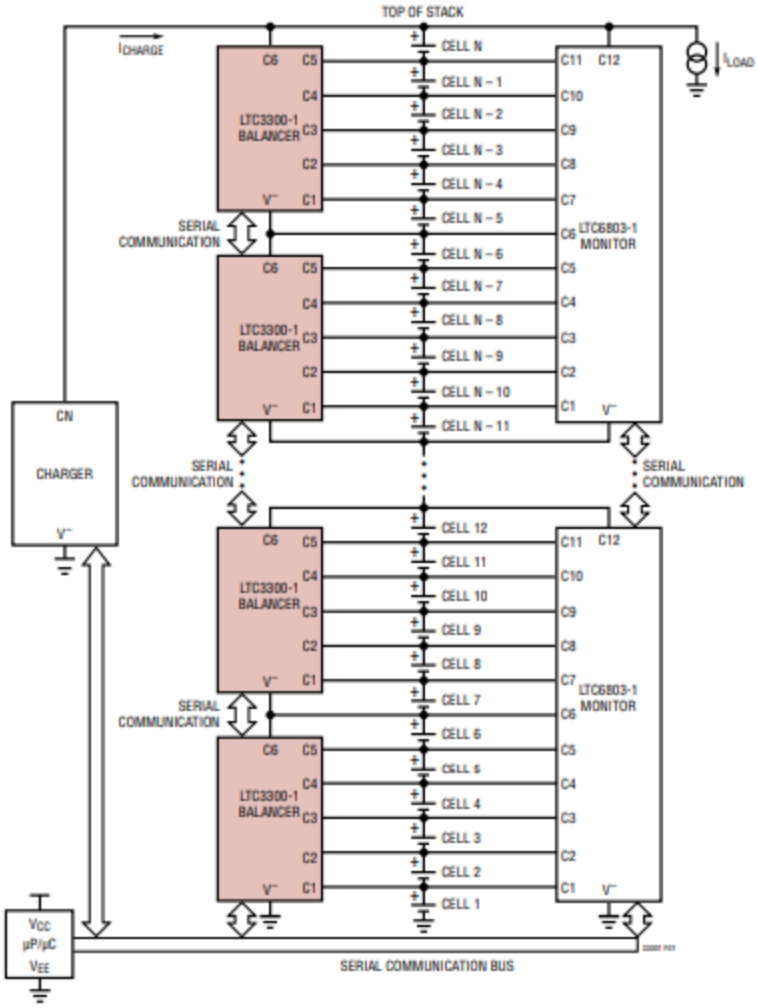
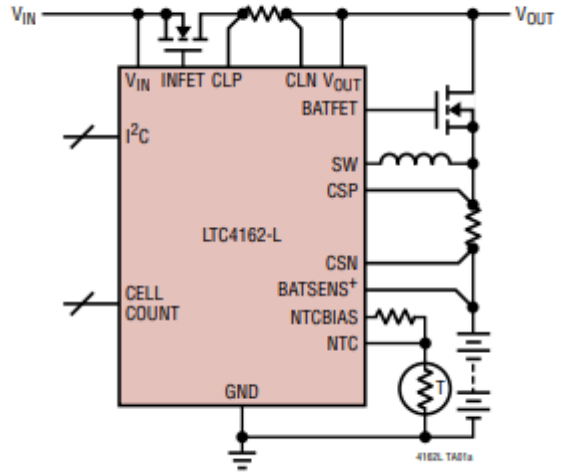


Figure 1. LTC3300-1/LTC6803-1 Typical Battery Management System (BMS)

1-8 Cell, 3.2A Step-Down Switching Battery Charger with PowerPath



Multicell Battery Monitoring Using LTC6803

The LTC®6803 is a 3rd generation multicell battery stack monitor that measures up to 12 series connected battery cells with a total measurement error of less than 1.2mV. The cell measurement range of 0V to 5V makes the LTC6803 suitable for most battery chemistries. All 12 cell voltages can be captured in 290µs, and lower data acquisition rates can be selected for high noise reduction.

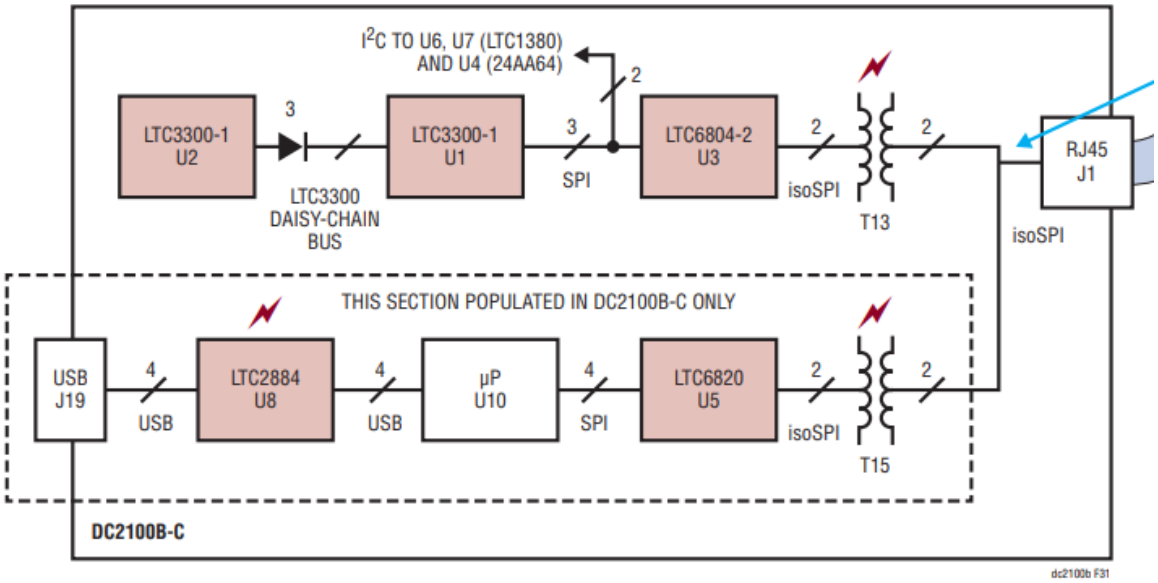
- Measures Up to 12 Battery Cells in Series
- Stackable Architecture Supports 100s of Cells
- Built-In isoSPI™ Interface
- 1Mbps Isolated Serial Communications
- Uses a Single Twisted Pair, Up to 100 Meters
- Low EMI Susceptibility and Emissions
- 1.2mV Maximum Total Measurement Error
- 290µs to Measure All Cells in a System
- Synchronized Voltage and Current Measurement
- 16-Bit Delta-Sigma ADC with Frequency Programmable 3rd Order Noise Filter
- Engineered for ISO26262 Compliant Systems
- Passive Cell Balancing with Programmable Timer
- 5 General Purpose Digital I/O or Analog Inputs
- Temperature or other Sensor Inputs
- Configurable as an I^2C or SPI Master
- 4µA Sleep Mode Supply Current

Balancer using LTC3300-1

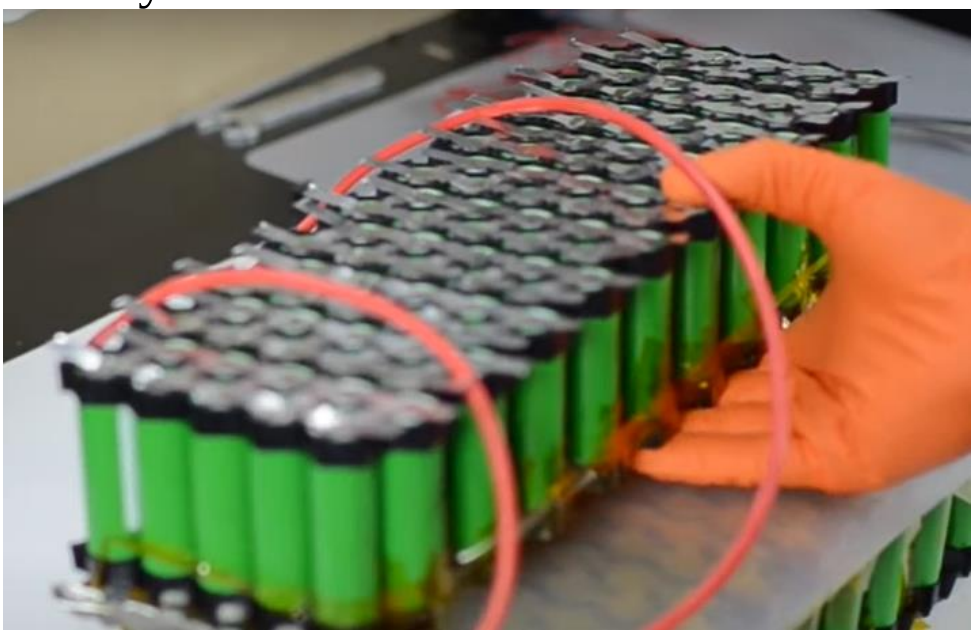
The LTC®3300-1 is a fault-protected controller IC for transformer-based bidirectional active balancing of multicell battery stacks. All associated gate drive circuitry, precision current sensing, fault detection circuitry and a robust serial interface with built-in watchdog timer are integrated

- Bidirectional Synchronous Flyback Balancing of Up to 6 Li-ion or $LiFePO_4$ Cells in Series
- Up to 10A Balancing Current (Set by Externals)
- Integrates Seamlessly with the LTC680x Family of Multicell Battery Stack Monitors
- Bidirectional Architecture Minimizes Balancing Time and Power Dissipation
- Up to 92% Charge Transfer Efficiency
- Stackable Architecture Enables >1000V Systems
- Uses Simple 2-Winding Transformers
- 1MHz Daisy-Chainable Serial Interface with 4-Bit CRC Packet Error Checking
- High Noise Margin Serial Communication
- Numerous Fault Protection Features
- 48-Lead Exposed Pad QFN and LQFP Packages
- AEC-Q100 Qualified for Automotive Applications

A development board has been developed to connect 12 nos of Li-ion Batteries, Multicell Battery Monitoring is being done Using LTC6803, Active Balancing is being done by using LTC3300 and a PIC Embedded Controller has been used to connect to PC. A powerful GUI has been developed for multiple action. A Calibration Data window to calibrate cell and balancer characteristics, an Error Log window to display logged errors, and a Graph View window to graphically display characteristics of the stacked system over time.



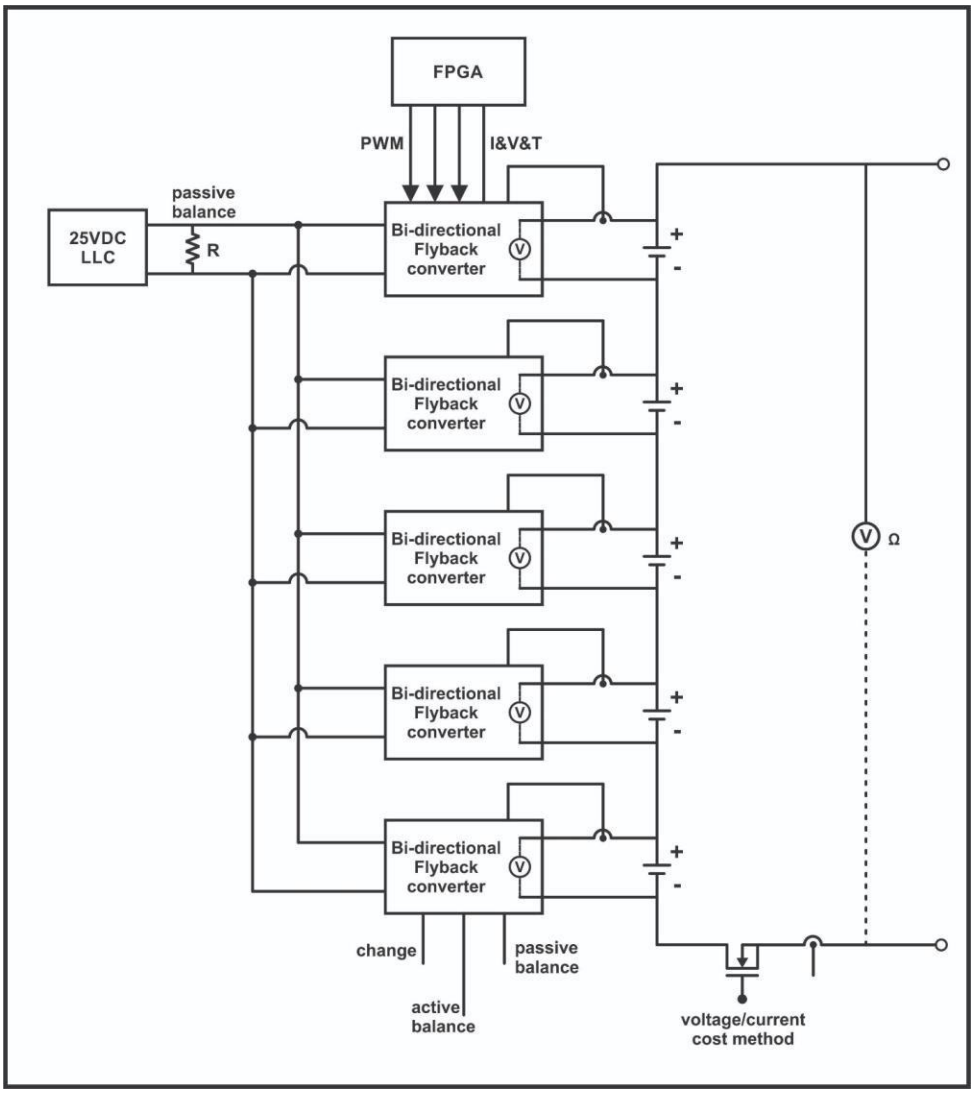
Li-ion Battery Pack

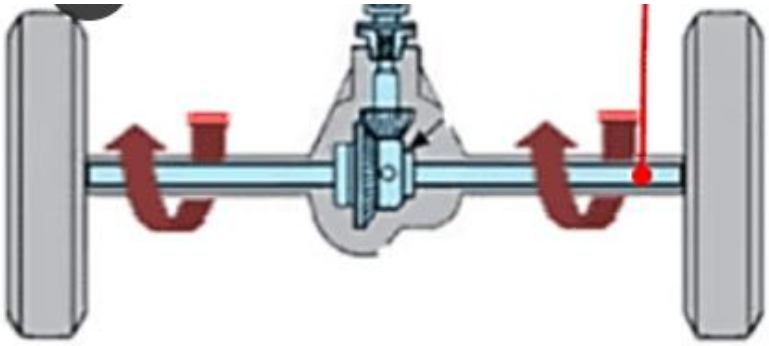


6.ii. FPAG BASED BATTERY MANAGEMENT SYSTEM

A smart battery management has been designed as Development System for the students to understand the concept and further research work on this.
It consists of i. Multicell Battery monitoring section ii. Multicell battery cell balancer using Bi-Directional Fly Back Converters iii. Charger (LLC Based or SMPS Based) iv. FPGA Controller

The Multicell Battery Cell Balancer, based on the FPGA Controller Cyclone-IV and Bidirectional Flyback Converters, is a key component in a high-performance battery management system (BMS) for series-connected Li-ion cells.
It is designed to operate in conjunction with a Battery Monitoring Section- Data Acquisition Board, a charger, and an FPGA Embedded Controller, as shown in the figure.
The FPGA Embedded Controller, which communicates directly with the balancer, Data Acquisition Board for monitoring, and charger to receive voltage, current, and temperature information and to implement a balancing algorithm.
There is no single balancing algorithm optimal for all situations. For example, during net charging of the overall stack, it may be desirable to discharge the highest voltage cells first to avoid reaching terminal charge on any cell before the entire stack is fully charged. Similarly, during net discharging of the overall stack, it may be desirable to charge the lowest voltage cells first to keep them from reaching a critically low level. Other algorithms may prioritize fastest time to overall balance. The FPGA implements no algorithm for balancing the stack. Instead it provides maximum flexibility by imposing no limitation on the algorithm implemented as all individual cell balancers can operate simultaneously and bidirectionally.


FPGA
PWM
I&V&T
passive balance
25VDC LLC
R
Bi-directional Flyback converter
Bi-directional Flyback converter
Bi-directional Flyback converter
Bi-directional Flyback converter
Bi-directional Flyback converter
Ω
change
passive balance
active balance
voltage/current cost method



ADVANCED CYCLONE - IV FPGA CONTROLLER (VPE-CYIVAD)

- Based on Altera family Cyclone - IV
- 8 User LEDs & Switches
- 20 x 4 Alphanumeric LCD display
- One isolated USB to serial port
- 2 limit switches are provided for general purpose usage in the software
- Termination of 84 PWMs at 5V level in 2nos of 50 pin FRC connector.
- PE & Drives compatible signals terminated at 34 pin FRC connector
  - PWM outputs are terminated at 34 pin FRC connector
  - 16 motor control PWM with programmable dead band signals
  - 8 captures input signals / 1 quadrature encoder interface
- ADC signals terminated at 26 pin FRC connector
  - 16 Channel ADC inputs
  - 1 MSPS sampling rate
  - Input Range: ±IOV, ±5V programmable
- DAC outputs terminated at J801 connector
  - 4 channel DAC output
  - Output range: ±IOV, ±5V programmable
- On board isolated USB to JTAG port
- On board USB 2.0 interface
- Unique Features
  - 100 PWMs
  - Isolated USB 2.0 (12mbps)
  - 6 Channel ADC with Bipolar Interface

- Measures Up to 5 Battery Cells in Series
- Synchronized Voltage and Current Measurement
- Temperature of each cell through Thermistor.
- 12-Bit ADC
- Passive Cell Balancing with Programmable Timer
- Thermistor based Battery Temperature Measurement or other Sensor Inputs

Passive and Active Balancer

This is a fault-protected controller for transformer-based bidirectional active balancing of multicell battery stacks. All associated gate drive circuitry, precision current sensing, fault detection circuitry and serial interface with built-in watchdog timer

A development board has been developed to connect 5 nos of Li-ion Batteries, Multicell Battery Monitoring is being done by a seperate Voltage, Current and Temperture Board for each cell. Active Balancing is being done by using Cyclone IV FPGA and used to connect to PC. A powerful MATLAB-SIMULINK GUI has been developed for multiple action. A Calibration Data window to calibrate cell and balancer characteristics, an Error Log window to display logged errors, and a Graph View window to graphically display characteristics of the system over time.

Li-Ion Battery Pack

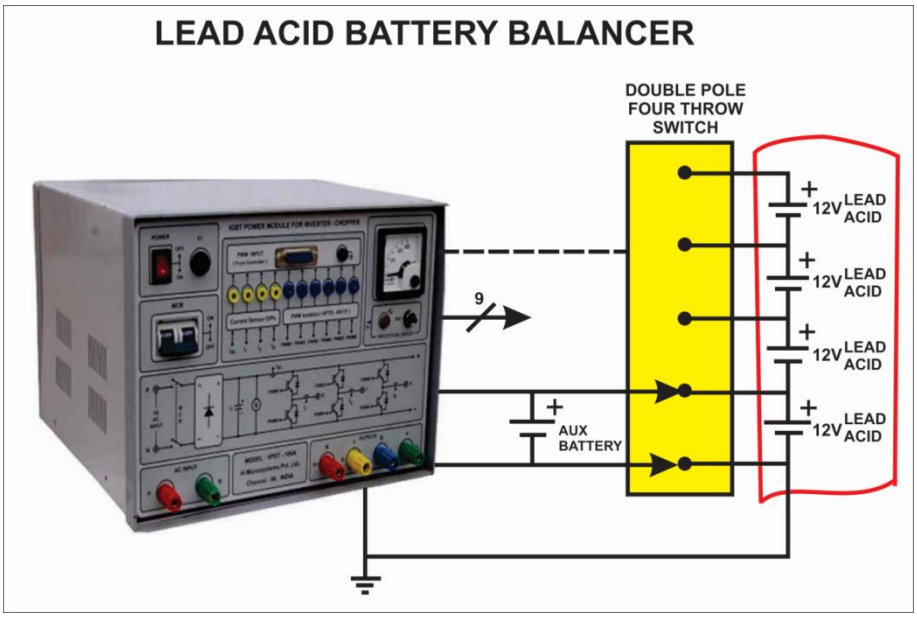
- One Bank of Li-ion Battery Consists of 5 nos of Li-ion battery.
- Each li-ion Battery @3.6Voltage,6Amp
- One Leg consists of 6 nos(5x3.6V= 18V)

List of experiments

- Study of bidirectional fly back converter
- Study of active balancing
- Study of passive balancing
- Study of charging in CC mode
- Study of charging in CV mode
- Study of PWM signals for active, passive discharging and charging
- Study of feedback signals from current and voltage sensor and how to control charging and discharging.

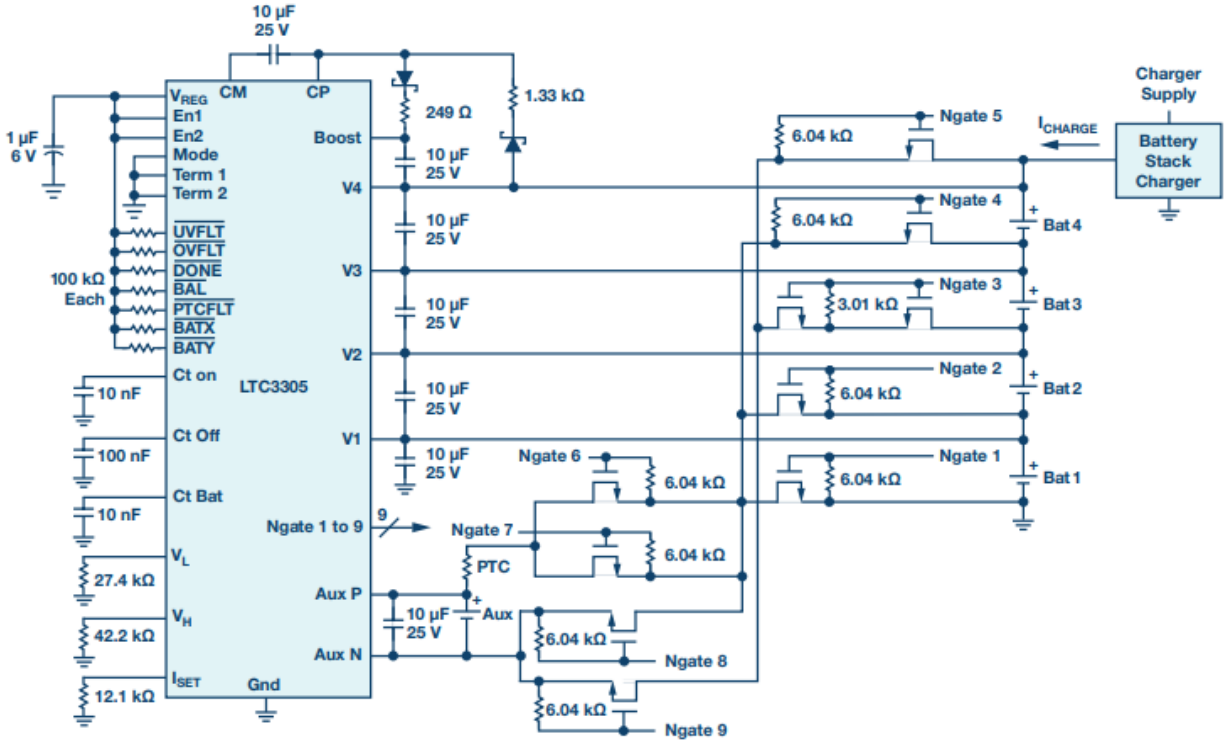
6.iii. LEAD ACID BATTERY BALANCING BMS TRAINER

With passive and active cell balancing, each cell in the battery stack is monitored to maintain a healthy battery state of charge (SoC). This extends battery cycle life and provides an added layer of protection by preventing damage to a battery cell due to deep discharging, because of overcharging. Passive balancing results in all battery cells having a similar SoC by simply dissipating excess charge in a bleed resistor; it does not, however, extend system run time. Active cell balancing is a more complex balancing technique that redistributes charge between battery cells during the charge and discharge cycles, thereby increasing system run time by increasing the total useable charge in the battery stack, decreasing charge time compared with passive balancing, and decreasing heat generated while balancing.



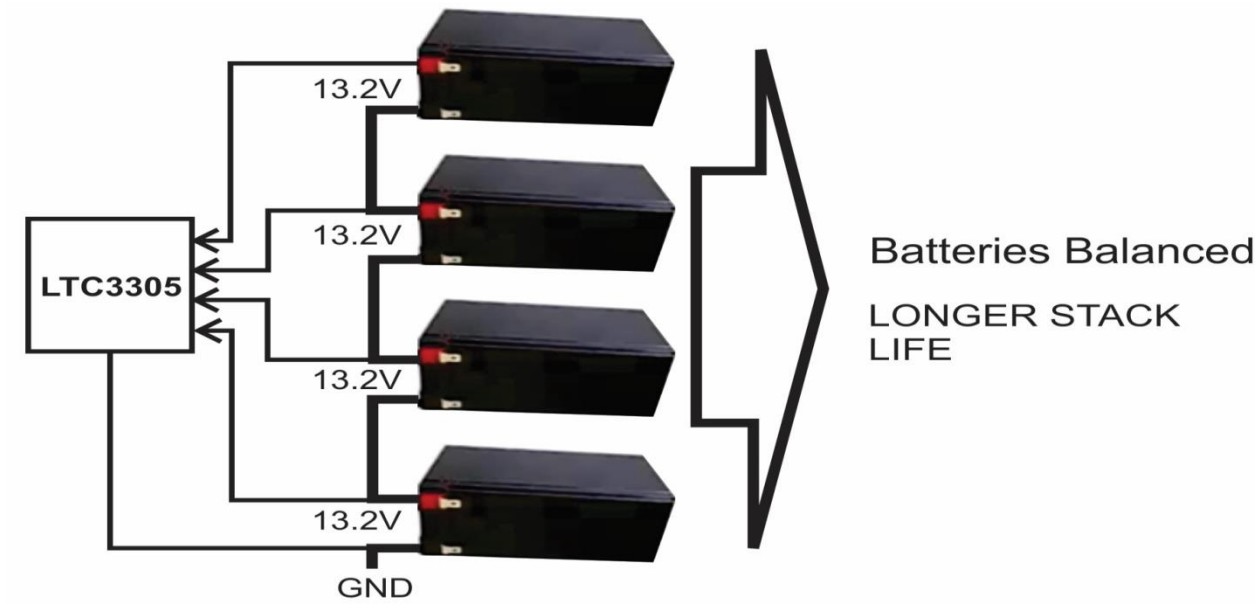
This Trainer based on the LTC3305 is lead acid battery balancer for up to four cells. This lead-acid battery balancer uses an auxiliary battery or an alternative storage cell (AUX) to transfer charge to and from individual batteries within a series-connected stack. The balancer controls external NMOS switches to sequentially connect the auxiliary battery to each battery in the stack with PTC as current limiting device.

This trainer balances up to 4 lead acid batteries connected in series. All voltage monitoring, gate drive, and fault detection circuitry is Integrated.



Key Features :

- **2.5V/6mA regulated output**
- **2-,3-, or 4-Battery balancing**
- **Continuous Mode or Timer Mode**
- **Selectable Termination Thresholds 25mV/50mV/100mV/200mV**
- **Balancing Status and Fault Indicators**
- **Programmable Battery/Stack Timing**
- **Programmable UV & OV Faults 4V-20V**



List of experiments

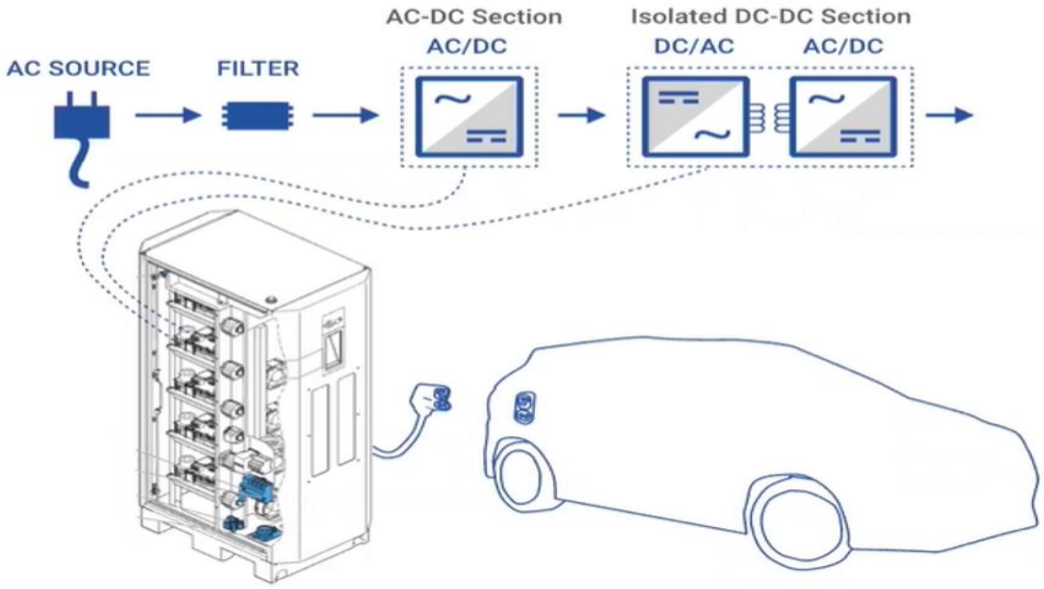
- Study of bidirectional fly back converter
- Study of active balancing
- Study of passive balancing
- Study of charging in CC mode
- Study of charging in CV mode
- Study of PWM signals for active, passive and charging
- Study of feedback signals from current and voltage sensor and how to control charger and discharging.

7. 5KW LLC CONVERTER BASED ELECTRICAL VEHICLE QUICK CHARGER WITH FRONT END PFC CORRECTION

Fast-charging:

Fast-charging station require EV chargers be small, rugged, reliable, and highly efficient w**hile also delivering less-than-6**0-minute charge times. The typically 3- to 7-kW on-board chargers take four hours or more to charge today's EVs. To reduce charging time, fast off-board chargers must deliver much higher power.

Such fast chargers are modular in design with 5-kW to 20-kW blocks and paralleled for High Capacity.



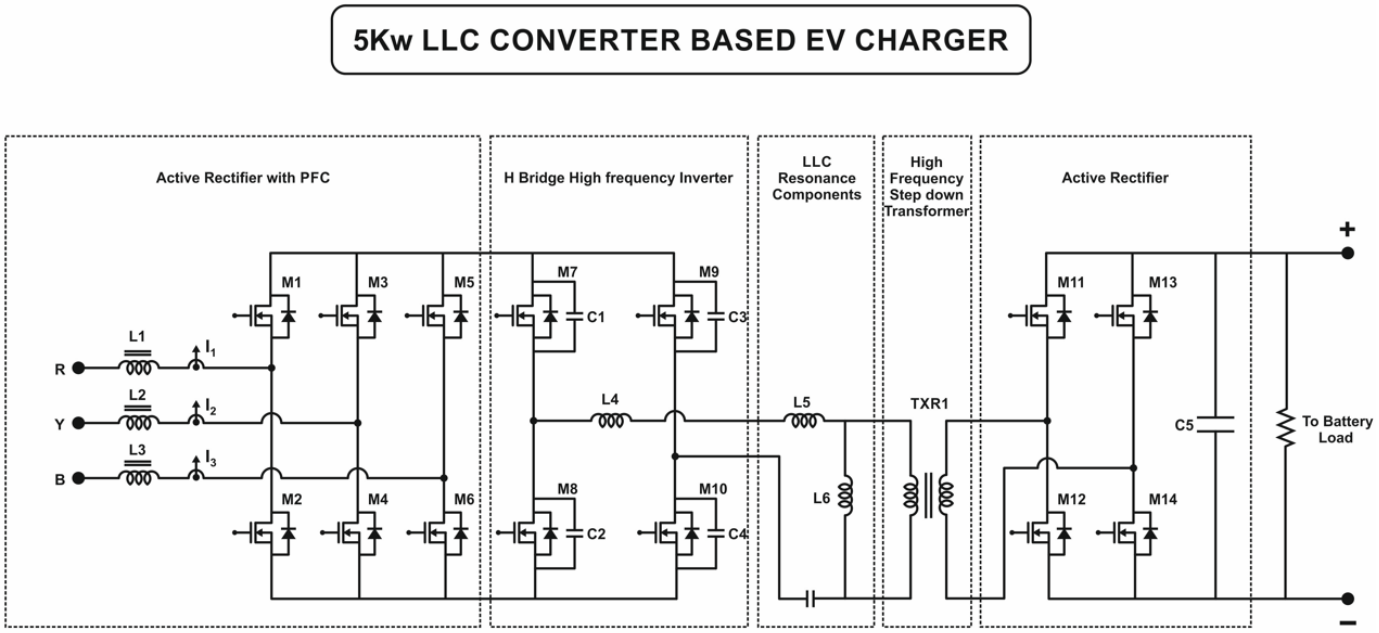
Quick LLC Based EV chargers comprise 5 main blocks, the Ist Block is an Active AC/DC -Front end PFC-Rectifier-Bi Directional DC/DC Converter. This AC/DC converter gets the three-phase power from the grid to DC intermediate voltages. The 2nd Block forms the High Frequency Inverter, which converts the intermediate DC Voltage to HF AC.

The 3rd Block forms the LLC Resonate Circuit and then the step down transformer-4th Block and then the 5th Block converts HF AC to DC voltage required for fast charging the EV batteries.

The following figure shows the implementation, which consists of a FILTER INDUCTOR, a AC/DC converter and a DC/AC – AC/DC conversion with Isolation.

The input could be 1 or 3 phase with power factor correction and filtered and applied to the AC/DC section with a fixed DC Output. Then it is applied to a DC/AC section and coupled to a AC/DC section for isolation. The final DC output can be configured to the need of battery to be charged up to 100V. This design builds a 5 KW Charger which can be paralleled for more power rating like 20 to100 KW.

Block Diagram for QUICK CHARGER WITH PFC



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SiC based 5KW PFC Bi-Directional Isolated Quick EV Charger

- An Advanced Dual Core DSP controller TMS320F28377D will be used for control algorithm and PWM implementation

SiC MOSFETs Power Devices are used for the following Advantages

- Highest efficiency
- miniaturization
- Improved power density
- Very high ruggedness and reliability
- Bi-Directional energy flow for smart grid enable

POWER CIRCUIT HARDWARE

1st Bock : ACTIVE Rectifier with PFC

 # 3 Inductors provided at the 3ϕ Power Input.
 # 6 SiC MOSFETS 1200V/55A with Driver Provide For Power Factor Correction
 # Active AC to DC (Selectable) Conversion Acts as Bi Directional Converter

2nd Block : HF INVERTER

 # 4 nos of SiC MOSFETS 1200V/55A provided to Form High frequency Inverter

3rd Block : LLC Resonant Circuit

 # Inductance Inductance Capacitance Provided to form the LLC Resonant Circuit
Resonate the DC to AC and Converts Square Wave Into Sine waveform

4th Block : HF Step down Transformer.

 # A HF step Down Transformer Provided To deduce the HF Inverter voltage and Isolation

5th Block : Active HF AC to DC Converter (Active Rectifier)

 # 4 nos of SiC MOSFETS 1200V/55A Provided to form as Bridge Rectifier
to provide required DC Output Voltage.
 # Selectable up to 100V, 50A

→ Cyclone-IV EP4CE30F484 FPGA

* 28848 Logic Elements
* 594 K bits Embedded Memory
* 66 Nos of 18 x 18 Embedded Multipliers
* 4 Nos of General purpose PLL
* 20 Nos of Global clock Networks
* 328 user I/O lines and 124 LVDS lines

- → Flash Memory EPCS16 used to configure the FPGA at power OFF & Reset condition.
- → On-Board Isolated USB-Blaster used to configure the flash memory & FPGA device.
- → Two number of 4-channel 12-bit SPI Bipolar ADC to convert the analog signal into digital signal. ADC channels inputs are terminated at 26 pin connector.
- → One number of 4 channel 12 bit SPI Bipolar DAC used to convert the digital signal into analog signal.
- → One 20 x 4 LCD display to display the alpha numeric character outputs
- → 8 PWM output signals are generated through level translator IC.
- → FPGA receives external 8 capture input signals through level translator IC
- → 8 I/O lines are available with voltage level translation.
- → One 8-bit DIP switch to give binary input to FPGA.
- → 8 LEDs to display the 8-bit binary output
- → 4 Micro switches are used to give binary input to FPGA.
- → 2 Limit switches are used to give binary input to FPGA.
- → 3 Nos of 20-pin connectors are available & each having 18 I/O lines.
- → On-Board Isolated RS232 communication used to communicate with PC.

List of Experiments

- Study of 3ϕ input full bridge rectifier
- Study of active power factor corection
- Study of H-bridge inverter
- Study of LLC resonant converter
- Study of high frequency rectifier
- Study of synchronous rectifier
- Study of input PWM signals for PFC,H bridge inverter and bridge inverter and bridge rectifier and synchronous rectifier

8. NX (CAD/CAM/CAE/MCD) SOFTWARE FOR ELECTRICAL VEHICLE

The Siemens Xcelerator portfolio enables uninterrupted workflow by having design integrated into NX, making for a seamless to the next stage: the manufacturing engineering process. NX CAD, NX Additive and NX CAM software, work in tandem with the latest machine tool technologies to create an end-to-end digital manufacturing solution by converting a 3D part model into a real part installed on an Electrical Vehicle

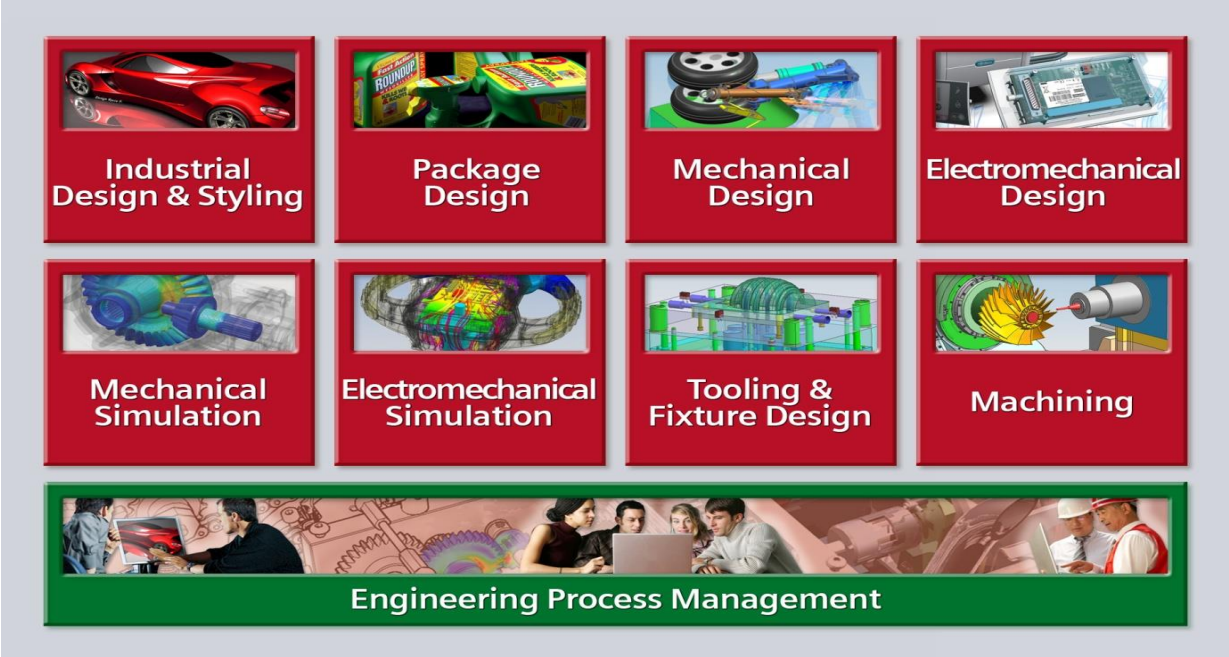
Electric automotive manufacturer uses Simcenter and NX to move from concept to finished product in a short period. Then they use Simcenter Simulation software to optimize and validate the performance of the all-electric. Finally, using NX CAM and 3D printing, Electrical Vehicle can be built.

NX (CAD/CAM/CAE) PLM Software

It develops Products Faster with NX Software.

Siemens NX software is an integrated product design, engineering and manufacturing solution that helps you deliver better products faster and more efficiently.

It is integrated CAD/CAM/CAE: Smarter Decisions, Better Products



NX for Design (CAD)

NX for Design is an integrated product design solution that streamlines and accelerates the product development process for engineers who need to deliver innovative products in a collaborative environment.

- Sophisticated freeform shape modelling, surface continuity, analysis and visualization tools
- Comprehensive 3D design ability including wireframe, surface, solid and synchronous modelling
- Create rendered images with break-through quality and accuracy
- Knowledge capture and automation tools

NX for Manufacturing (CAM)

NX for Manufacturing provides you with a complete solution set for part manufacturing - from CAM to CNC controller.

- Reduce NC programming and machining time
- Produce better quality parts
- Maximize use of manufacturing resources

Some examples of Manufacturing machine

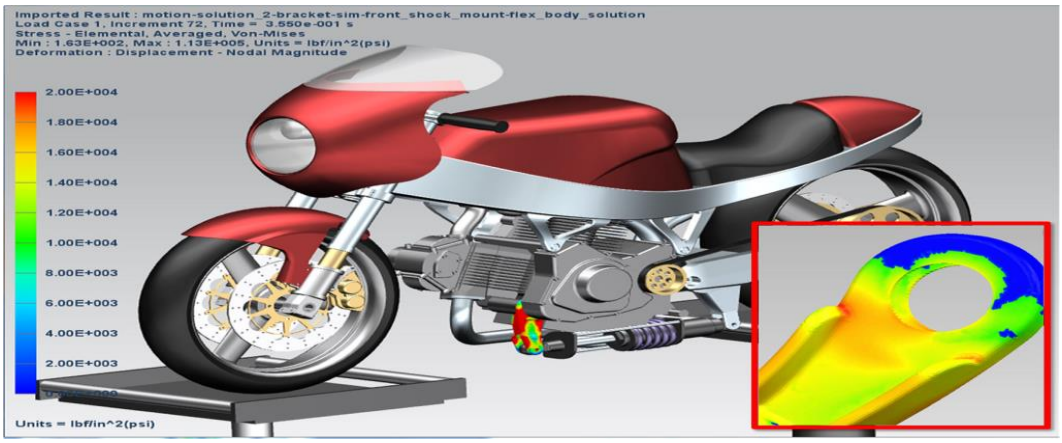
- 2 ½-, 3- and 5-Axis Milling
- Turning
- Wire EDM
- Feature based machining
- NC Simulation

NX for Simulation (CAE)

Simcenter 3D

Simcenter 3D delivers a unified, scalable, open and extensible environment for 3D CAE with connections to design, 1D simulation, test, and data management. Simcenter 3D speeds the simulation process by combining best-in-class geometry editing, associative simulation modeling and multi-discipline solutions embedded with industry expertise. Fast and accurate solvers power structural, acoustics, flow, thermal, motion, and composites analyses, as well as optimization and multi-physics simulation. It has FEA analysis of a material by FEM.

Simcenter 3D is available as a standalone simulation environment. It is also available completely integrated with NX delivering a seamless CAD/CAE experience.

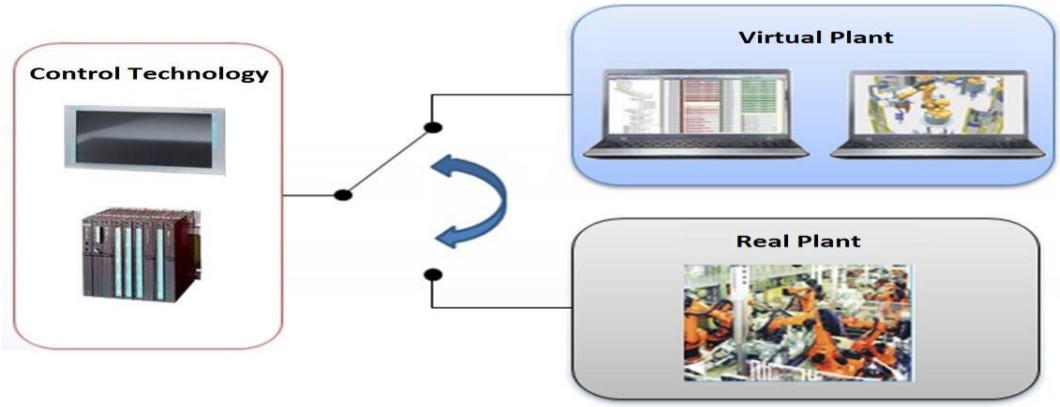


- Linear and non-linear structural analysis
- Durability / fatigue analysis
- Thermal and flow analysis
- Motion analysis

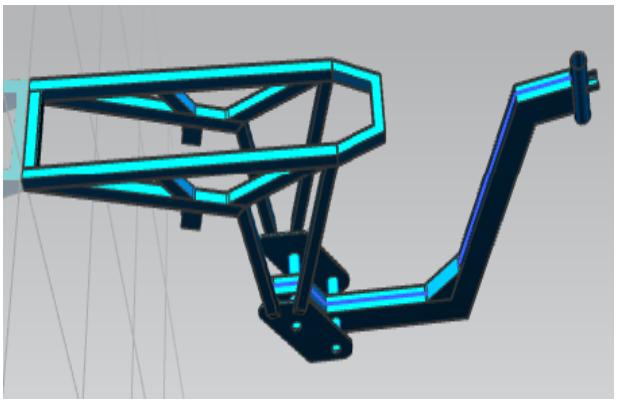
NX Academic Modules are available only to accredited academic institutions such as universities, technical colleges, trade schools and high schools. The software is intended for classroom training and research projects.

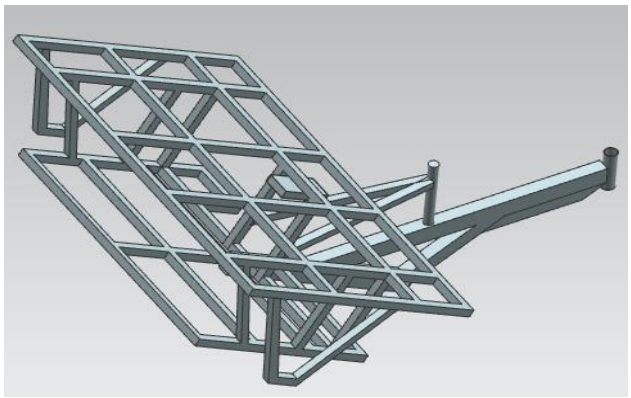
Mechatronics Concept Designer

- Virtual startup without a physical prototype
- Mechatronics Concept Designer brings teams together by facilitating the integration of engineering departments, including requirements management, concept design, mechanical design, electrical design and software/automation engineering.
- Enhance collaboration among mechanical, electrical and automation designers
- Identify devices and assemblies in electronic computer-aided design (ECAD) and mechanical computer-aided design (MCAD)
- Simulate the real machine behavior, including PLC, CNC, Actuators and Sensors



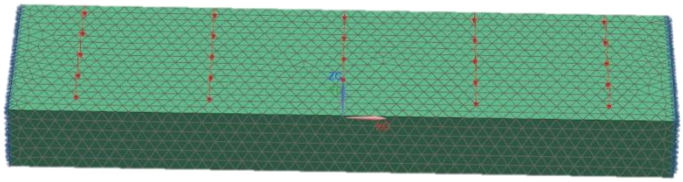
SOME OF CHASIS DESIGN ARE DONE BY NX and MANUFACTURED FOR E- VEHICLE

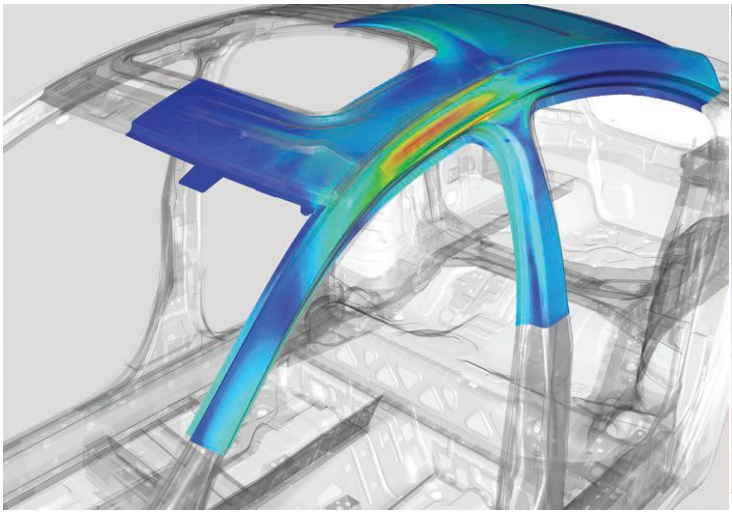


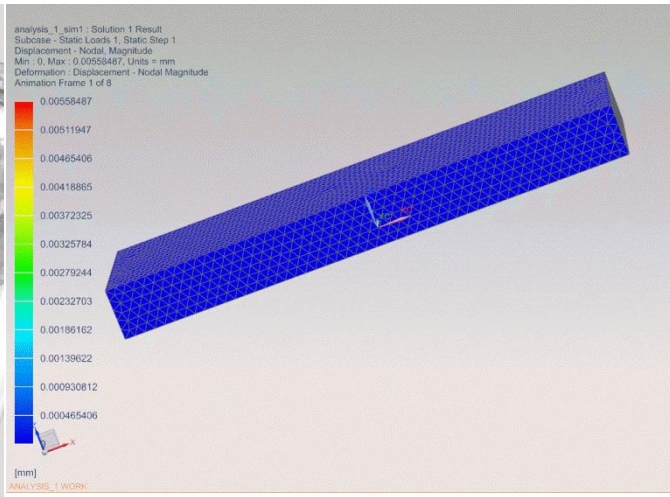


ANYALSIS OF E-VECHICLE DESIGN AND MANUFACTURING ARE DONE USING NX AND FEA ANLYSIS OF MATERIALS ARE ALSO DONE BY THE NX CAE.

CAE ANLYSIS OF MATERIALS ARE GIVEN BELOW







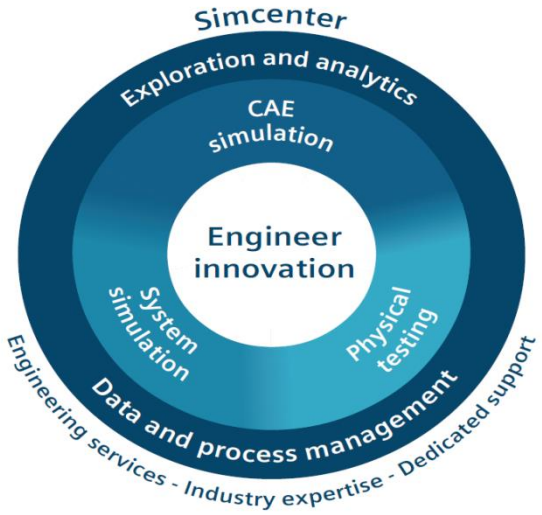
9. SIEMENS SIMCENTER AMESIM SOFTWARE FOR ELECTRIC VEHICLE

Using 3D simulation tools, we don't have to build an actual prototype, which saves us considerable time and money. Siemens Simcenter Amesim is one simulation tool to design and validate a Electrical vehicle, Li-ion battery etc.

Many Electric bus manufacturer uses Simcenter Amesim for system simulation to optimize battery design and thermal management

AMESIM

- **A**dvanced **M**odeling **E**nvironment for performing **Sim**ulations of engineering systems.
- AMESim is a **1D lumped parameter time domain** simulation platform.
- **Simcenter Amesim** is a Multi Domine mechatronics **system simulation** platform
- Many component libraries (45+ standard libraries covering all the domains of physics
- Simcenter Amesim is a **mechatronics system simulation platform**
- System simulation allows engineers to **characterize the dynamic** (and static) **behavior** of a **system** or a **component**
- Mathematical representation uses **time derivatives equations**



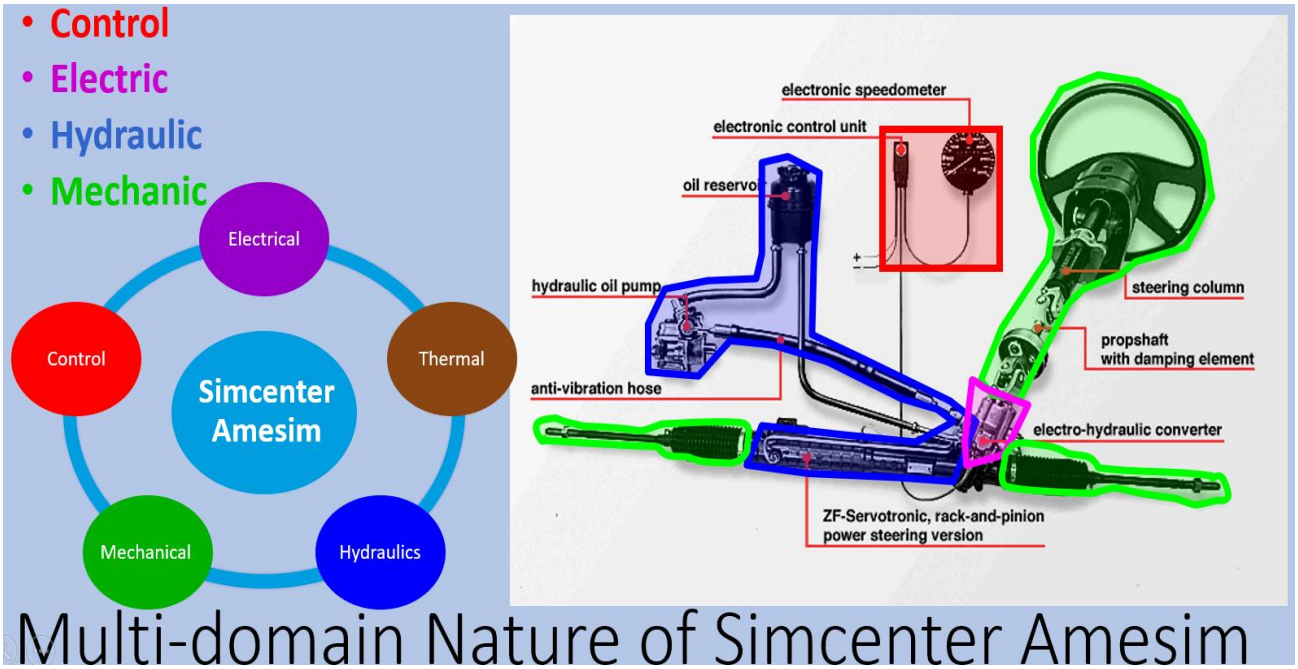
LIBRARIES IN AMESIMS

- 3D Mechanical
- Aeronautics and Space
- Air-Conditioning
- Aircraft Electrics
- Aircraft Fuel System
- Automotive Electrics
- Cams and Followers
- CFD1D
- Cooling System
- Discrete Partitioning
- Electric Motors and Drives
- Electric Storage
- Electrical Basics
- Electrical Static Conversion
- Electro Mechanical
- Engine Signal Generator
- Filling
- Gas Mixture
- Gas Turbine
- Heat Exchangers Assembly Tool
- Hydraulic
- Hydraulic Component Design
- Hydraulic Resistance
- IFP Drive
- IFP Engine
- IFP Exhaust
- Liquid Propulsion
- Mechanical
- Moist Air
- Planar Mechanical
- Pneumatic
- Pneumatic Component Design
- Powertrain
- Signal, Control
- Thermal
- Thermal Hydraulic
- Thermal Hydraulic Component Design
- Two Phase Flow
- Vehicle Dynamics

System simulation

System simulation supports design, manufacturing and maintenance across industries by enabling

- Predict the behavior of mechatronic systems
- Balance conflicting performance attributes
- Benchmark multiple design options to improve your product
- Reduce physical prototyping and testing to a strict minimum

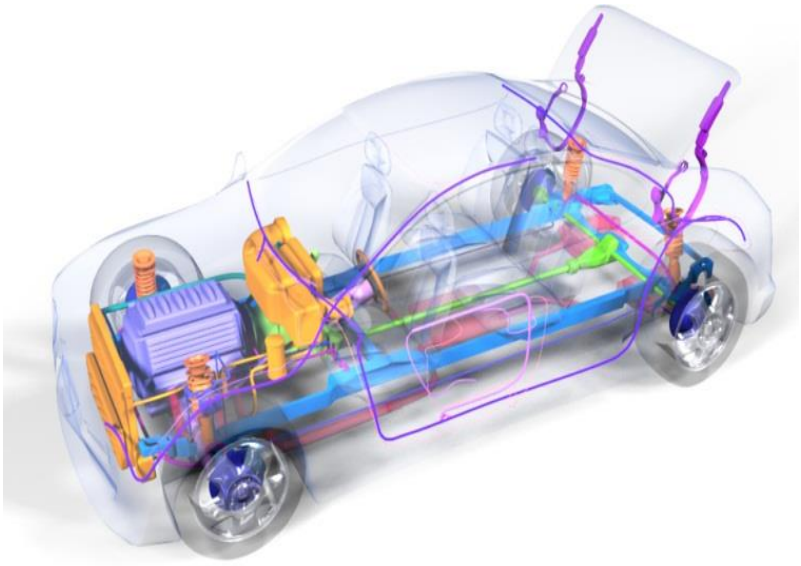


IT CAN LINK WITH MANY SOFTWARES TO SIMULATION ARE

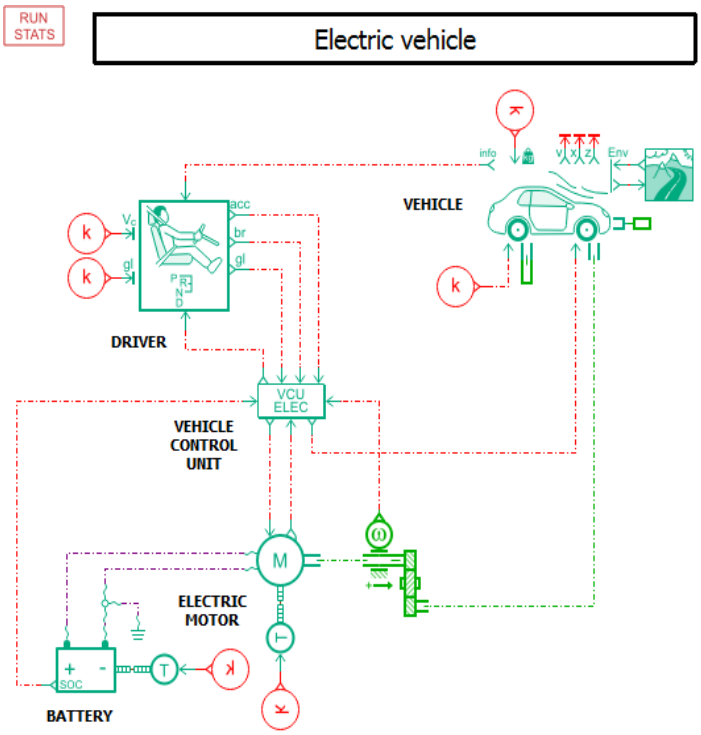
- NX
- PLCSIM ADVANCED
- DCS
- PLC
- MATLAB

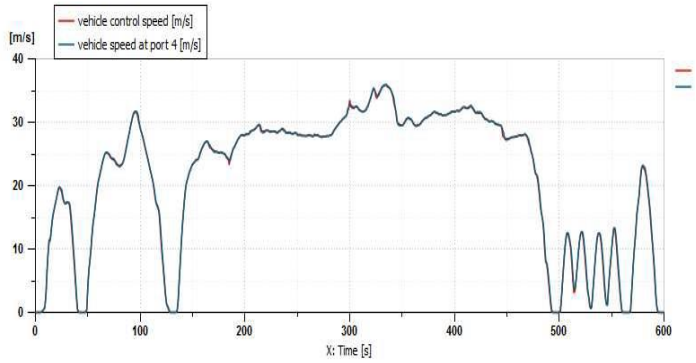
E-VEHICLE IN AMESIM

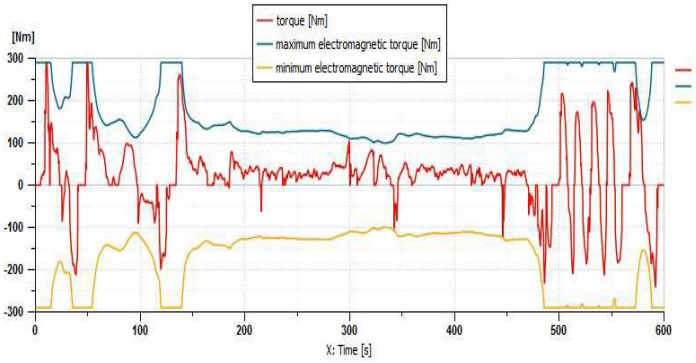
E-VEHICLE CAN BE SIMULATED IN AMESIM THRPOUGH VARIOUS LIBRARY TO FORM A SYSTEM AND EVALUVATE THROUGH GRAPHS BY TIME.



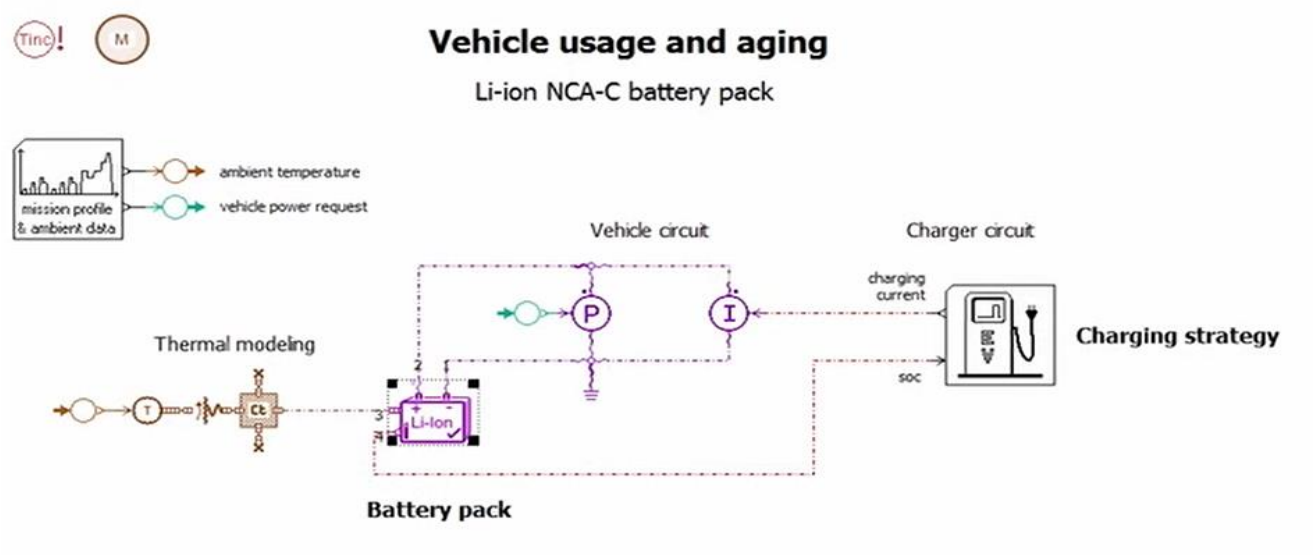
AMESIM CIRCUIT DIAGRAM WITH RESULTS FOR EXAMPLES

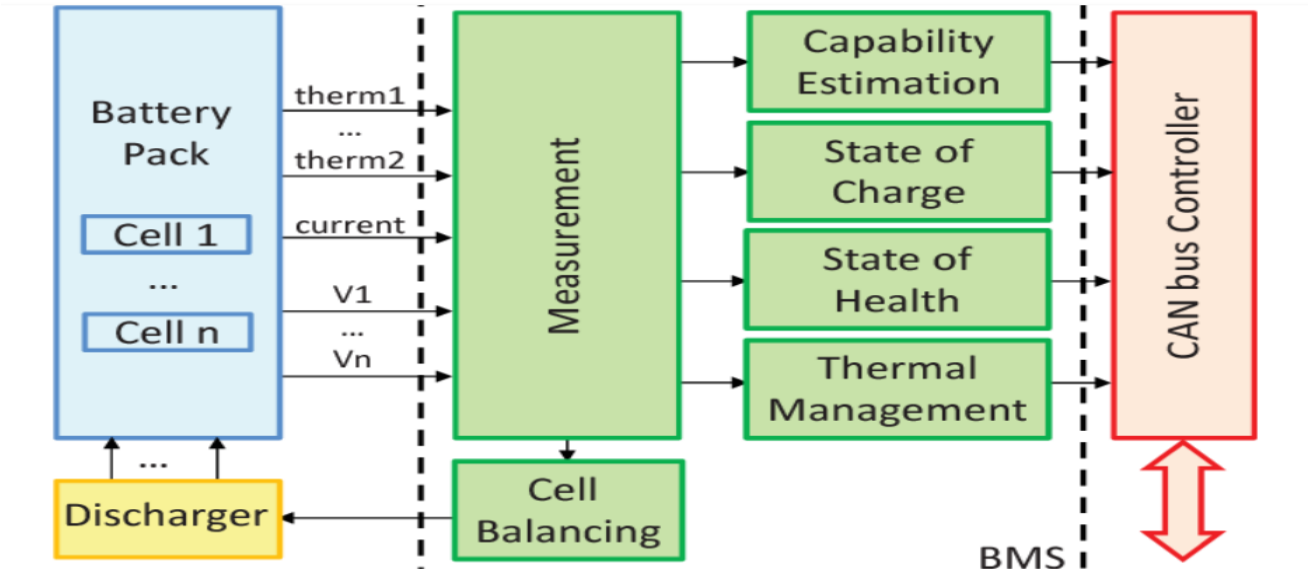




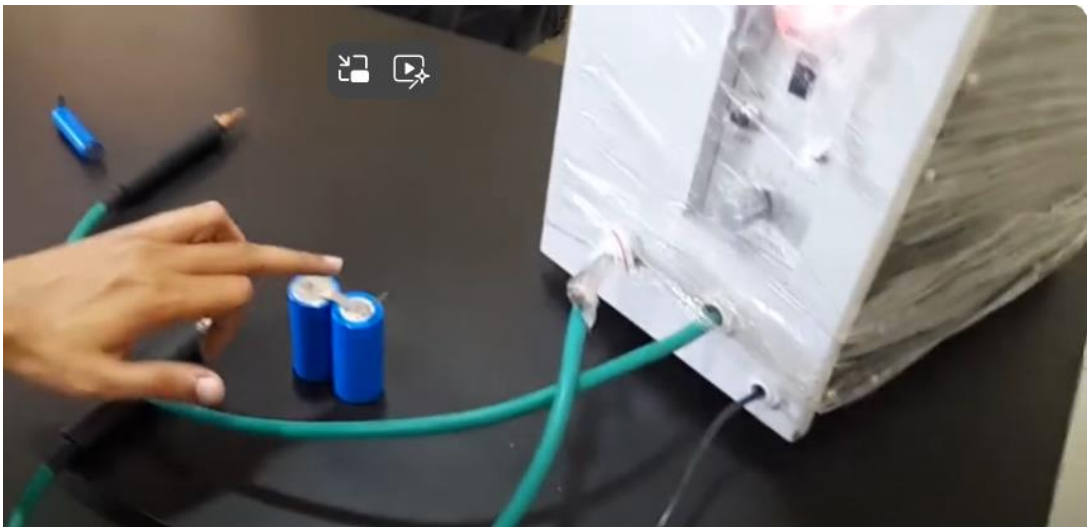


In amesims there is a battery management also available to test the life of battery & analysis in that.





10. Li-Ion Battery Spot Welding Machine



SPECIFICATION:

- Type : Lithium Battery Spot Welding
- Rated Input Power : 4KVA
- Usage/Application : Industrial
- Voltage : 220V, AC
- Automation Grade : Manual
- Weight : 20Kg
- Frequency : 50Hz
- Nickel Thickness : 0.05 – 0.4mm
- Is it Portable : Portable

11. Electric Vehicle Chassis Testing Bed System

11.i Chassis Testing System for EV 2 Wheeler Cycle, Scooter & Bike

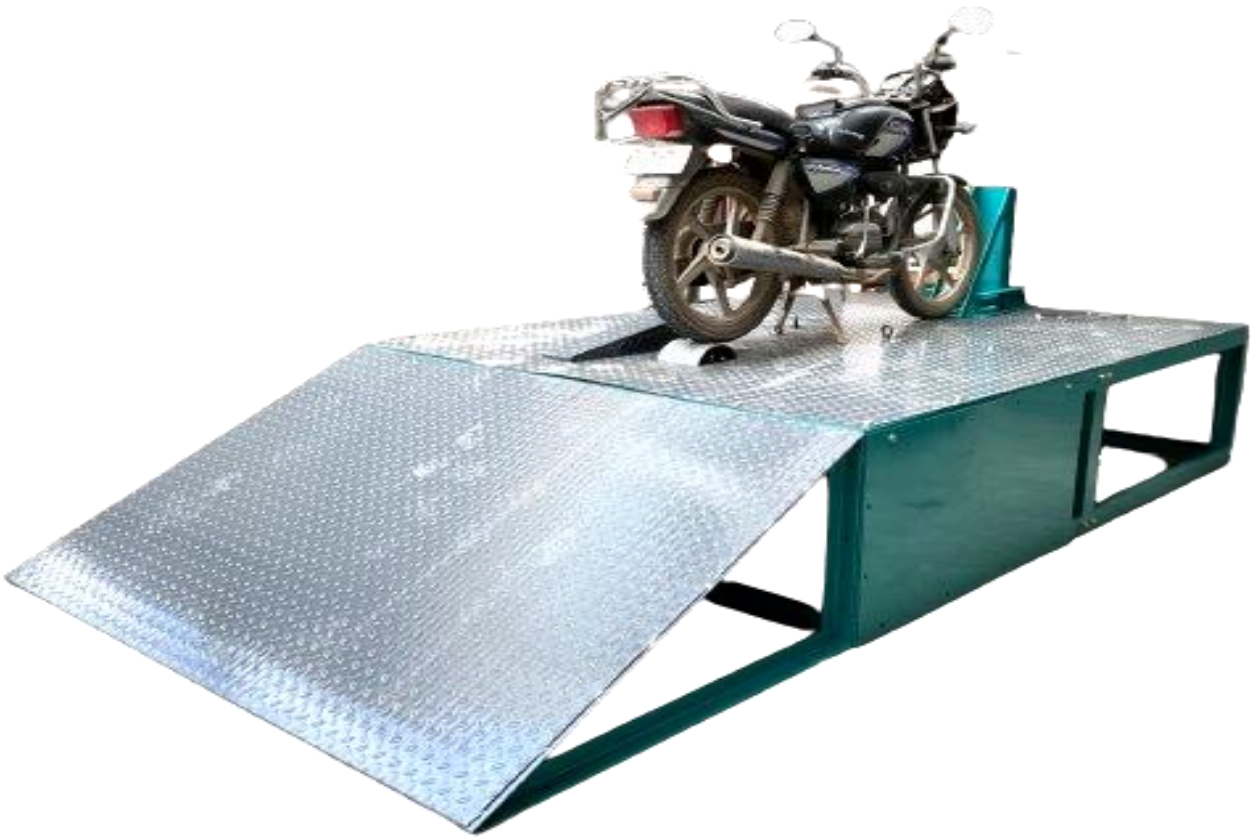
Chassis dynamometer:

Chassis dynamometer is device which simulates the Road Load Condition. RWD i.e., Rear wheel drive (Two-wheeler) vehicles can be tested .To perform these tests on lab level, a roller is being used according to the size and the weight of the vehicle on which the vehicle runs. This roller is connected to PMSG machine, which is called as Dynamometer.
There are various types of tests carried out on vehicle level testing which are mentioned as follows

1.Performance, Range Test & Durability
2. Maximum Speed: up t o 40 km/h
3. Roller surface: Textured Coating as per EPA Compliance
4. Road load simulation
5. CAN Bus interfaces

LOAD SETUP FOR ELECTRIC BICYCLE

LOAD SETUP FOR ELECTRIC SCOOTER



LOAD SETUP FOR ELECTRIC BIKE

11.ii Chassis Testing System for EV 3 & 4 Wheeler Auto & Car.

Chassis dynamometer is device which simulates the Road Load Condition. RWD i.e., Rear wheel drive (Three/Four-Wheeler) vehicles can be tested on this system. To perform these tests on lab level, rollers are being used according to the size and the weight of the vehicle on which the vehicle runs. This roller is connected to a PMSG with Torque Controller for applying load on the vehicle under test.

There are various types of tests carried out on vehicle level testing which are mentioned as follows,

1. Performance, Range Test & Durability
2. Inertia Simulation range: 150 to 2500 kg
3. Maximum Speed: up to 40 km/h
4. Roller surface: Textured Coating as per EPA Compliance
5. Road load simulation
6. CAN Bus interfaces

The below experiments can be done(with optionally purchase EV vehicle)

List of Experiments

- Study of motor load vs torque characteristics
- Study of current at maximum load characteristics
- Waveformetric study of motor current signals and data logging.
- Waveformetric study of battery current and voltage signals and data logging.
- Study of battery with range.
- Speed,distance travelled by the vehicle can be study.