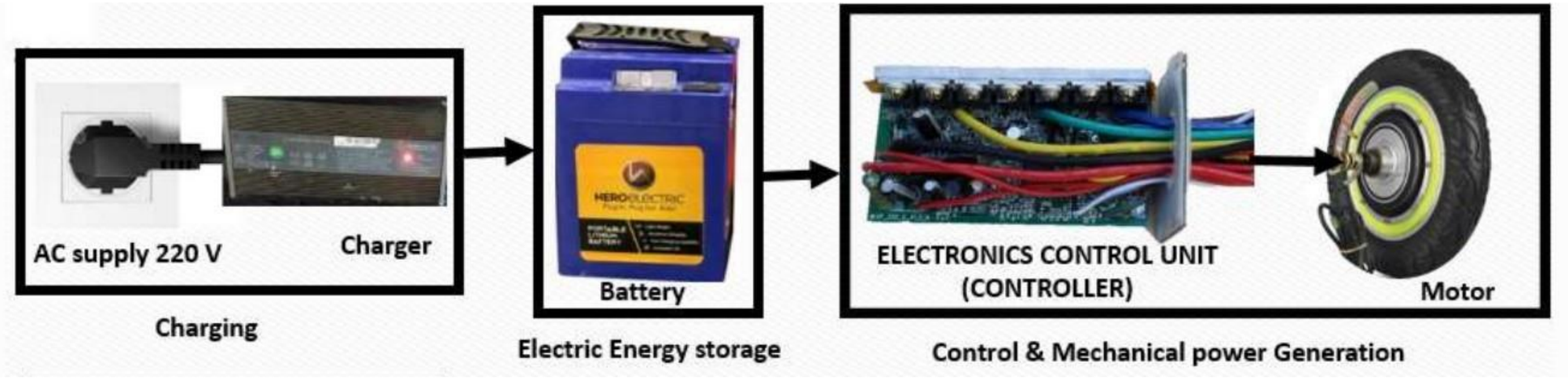
ELECTRIC SCOOTER POWER-TRAIN AND ITS WORKING

Introduction to EVs

A vehicle Powered (Derived) by an electric motor, rather than a traditional petrol or diesel engine. The electric motor is powered by rechargeable batteries that can be charged using household mains electricity via an EV charge point at home or at a more powerful EV charge station at work or in the street.



Main Parts of an E-Vehicle

Electrical

- Battery
- Charger
- Motor
- Controller
- DC to DC converter
- Throttle
- Wiring Harness
- Speedometer
- All switches

Mechanical

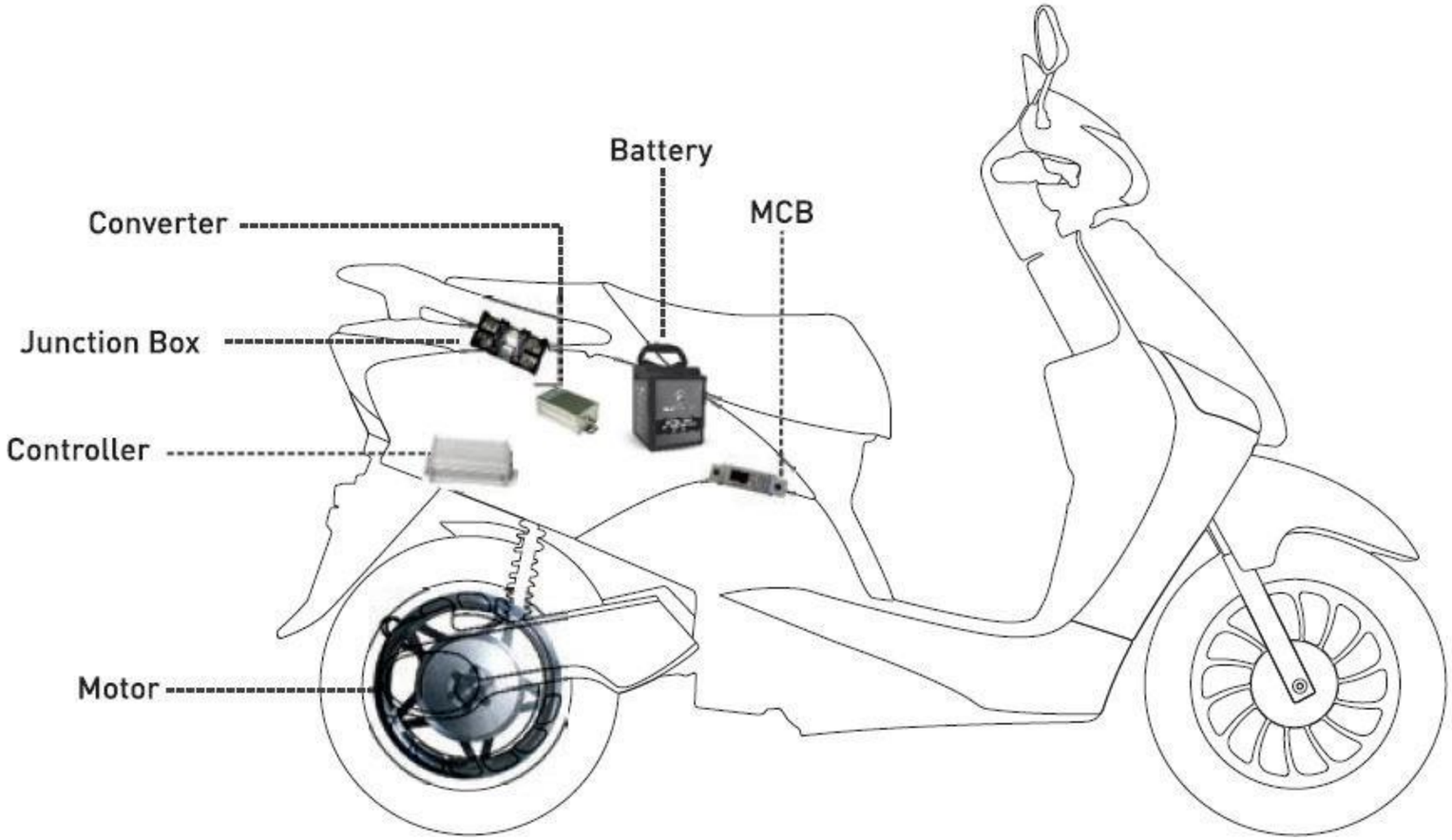
- Chassis
- Brakes
- Wheel
- Suspension
- Plastic parts

Main Parts of an E-Vehicle

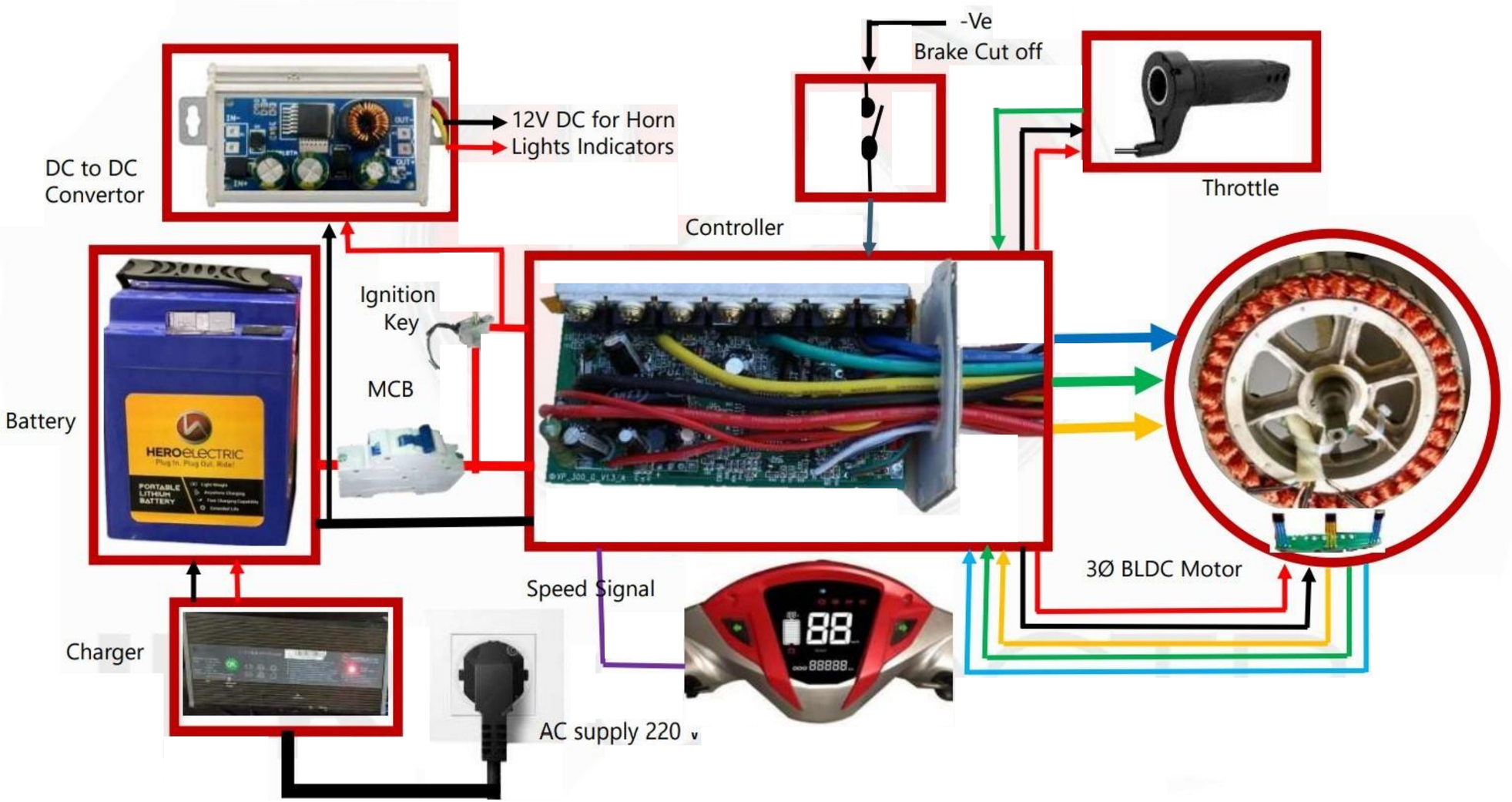
Vehicle LHS view

Vehicle RHS view

Main Parts of an E-Vehicle



Subsystems of Electric Vehicle



Electrical Parameters

ELECTRICAL PARAMETERS AND THEIR MEASUREMENT

- Voltage
- Current
- Electrical Power
- Electrical Energy

Electrical Parameters Measurement

Electrical Power (W) = Voltage (V) x Current (I)

48V x 10A = 480 W 72V x 10A =720 W

Conversion in kW

480W /1000=.48 kW

720W/1000= 0.72 kW

Electrical Energy = Power x Time

Unit of Electrical energy = Wh or kWh

(1kWh = 1000Wh)

Battery & Battery Terminology

- Battery
- Battery Terminology
  - Nominal Voltage
  - Ah (Ampere-Hour)
  - On load / Terminal Voltage
  - NO Load/ Open-circuit voltage (V)
  - Charge Cut Off Voltage
  - Discharge Cut Off Voltage
  - Battery Energy

Battery Energy is calculated by = Voltage of battery x Ah of battery

48 V x 28 Ah = 1344 Wh 72 V x 25 Ah =1800 Wh

1344 Wh/1000 =1.344 kWh 1800 Wh / 1000= 1.8 kWh

Battery Energy is also calculated by = Discharge Power(W) x Time (h)

Types of Batteries

Li-Ion

- LFP with PVDF & Super conducting Carbon Black
- NMC
- LMO
- LMO +NMC

Lead Acid

- **VRLA** (Valve regulated lead Acid battery) - sometimes called sealed lead acid (SLA) or maintenance free batter

Advantages of LI-ION Battery

- **High specific energy and high load capabilities with Power ells**
- **Long cycle and extend shelf-life; maintenance-free**
- **High capacity, low internal resistance, good columbic efficiency**
- **Simple charge algorithm and reasonably short charge times**
- **Low self-discharge (less than half that of NiCd and NiMH)**
- **Portable**
- **High life cycle**
- **Less charging time**
- **Low Maintenance - no periodic discharge is needed; there is no memory**
- **Specialty cells can provide very high current to applications such as power tools**

FOR BATTERY

Don’t drop the battery

Don’t throw the battery

Don’t puncture the battery

Don't stack on each other & goods on the battery

Don't Keep Step on the Battery

Avoid charging immediately after long drive

FOR BATTERY

- Only specified charger should be used.
- Whether you use the bike or not, charge the battery once in 30 days.
- Whenever vehicle is not used for more than 4 days then MCB must be turn Off & discharging connector to be disconnected.
- When charge the battery out side the vehicle battery must be kept in ventilated area .
- Batteries must be kept as cool as possible to ensure the long life and good performance
- Keep batteries at room temperature
- Allow time for cooling before charging a battery that is still warm from usage and using a battery that is still warm from charging.
- Handle with care .

Battery

Battery Specifications

Specification	VRLA		LI –ION		
	Each Battery	48V/ 24AH	72 V /28Ah	48V /28Ah	51V /28Ah
Charging time	6 to 8 Hours		4 to 5Hours		5 to 6 Hours
Nominal voltage	12.0V	48.0V	72V	48.0V	51 V
Charge cut off voltage	14.4V	57.6V	84V	54.4V	58.4 V
Float voltage	13.5	54.0v			
Discharge Cut off voltage	10.5	42.0V	63V	42.5	42.5 V.
Charger use		3A /48V	84.0	54.2v 6A	58.4 V ,6A
Maximum charging current		3A +/- 0.3A		6A	6A

Charger

Charger parameters

Parameters	Lead Acid	Li – ion		
	48V/2.7A	48V/6A	84V/5A	58V /6A
AC input voltage	180V to 300V or 180V to 260V	180V to 260V		
Charging voltage	58.8 +/-0.2 V 58.6V to 59.0V	54.6 +/- 0.2V	84.0V +/-.2V	58.4V +/- .2V
Charging current	2.7A to 3.0A	6A	**5A**	6A
Led indication on Charging time	RED Blinking	RED	RED	All status LED Glow RED and 100% LED Glow with blink RED
Battery full charge LED indication	Green	Green	Green	All Level indication Glow RED and 100% LED Glow Green.
LED indication without load	Green	Green	Green	Only 100% LED Glow Green

MOTOR

E2W Motor Comparison (based on Location)

	Hub Motor	Off Hub Motor(Mid Drive Motor)
Controlling Mechanism	An ECU (Electronic Control Unit) is required which is based on MOSFETS for power control with the help of programming based automotive micro controller	An ECU (Electronic Control Unit) is required which is based on MOSFETS for power control with the help of programming based automotive micro controller
Sensor Mechanism	Hall Sensor Based & Sensor less(Based on Back EMF)	Hall Sensor Based & Sensor less(Based on Back EMF)
Magnet Type	Permanent Magnet	Permanent Magnet
Power Rating	Generally of the order of 3KW	Generally of the order of Greater than 4KW
Application	Electric Cycle , E-bike , Push Scooter , E-scooter and some electric motorcycle	High power and High Speed electric scooter and electric Motor Cycle
Transmission Mechanism	No transmission Mechanism	CVT , Belt drive , chain drive , Gear Transmission
Efficiency	Approx. 85%	less than that of Hub motor due to transmission losses
Motor Type	Usually BLDC,SRM	BLDC , Induction motor , SRM
Maintenance	Very less maintenance	Maintenance required due to transmission
Regenerative Braking	Yes	Yes
Gradient	Approx 10 degree	Greater than 10 degree
Voltage	Usally 24V,36V,48V,60V,72V	48V , 60V , 72V
Controlling Principle	Trapazoidal & Sinusoidal	Trapezoidal & Sinusoidal
No. of Phases	Single Phase & Three phase	Single Phase & Three phase
Size & Weight	Small and Light Weight	Comparatively heavy
Life	Long Life	Comparatively low due to transmission impact
Noise & EMI	Low	Comparatively High
RPM Reduction	RPM of motor = RPM of Wheel	RPM of motor >RPM of Wheel (Subject to gear Ratio)
Losses	Low	Comparatively High
Protection Standard	IP67	IP67

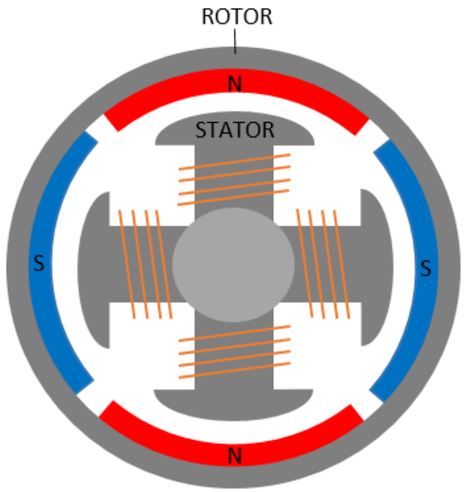
Hub Motor

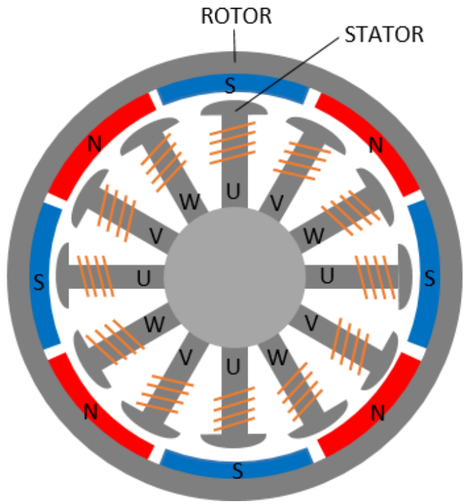
Mid Drive Motor

How Does a PM BLDC Motor Work?

whatch video on

click here



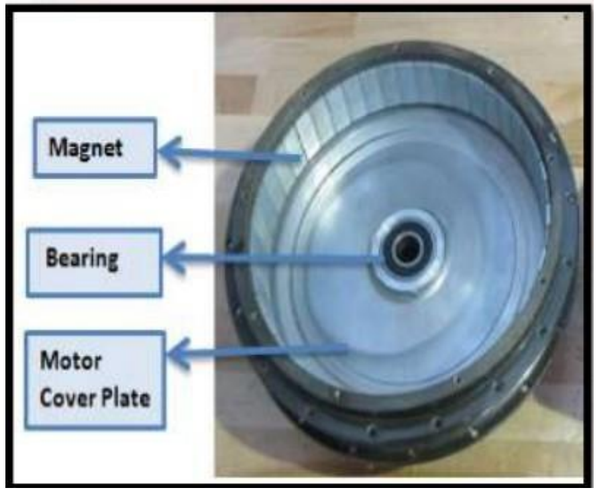


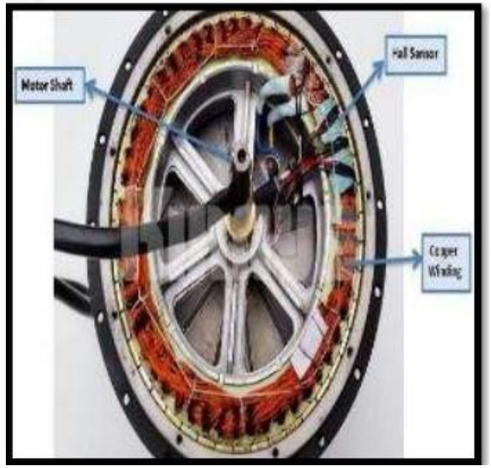
Motor

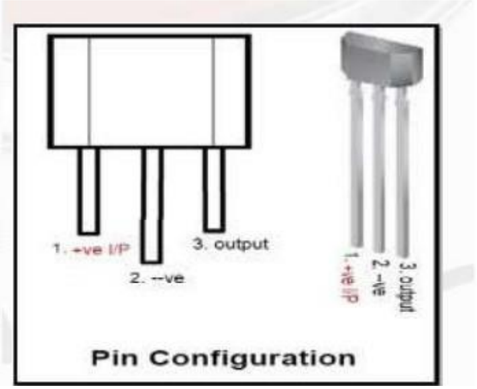
Advantages of BDLC Motor
❑ It has no mechanical Commutator and associated problems
❑ High efficiency due to the use of permanent magnet rotor
❑ High speed of operation even in loaded and unloaded conditions due to the absence of brushes that limits the speed
❑ Smaller motor geometry and lighter in weight than both brushed type DC and induction AC motors
❑ Long life as no inspection and maintenance is required for commutator system
❑ Higher dynamic response due to low inertia and carrying windings in the stator
❑ Less electromagnetic interference
❑ Quite operation (or low noise) due to absence of brushes

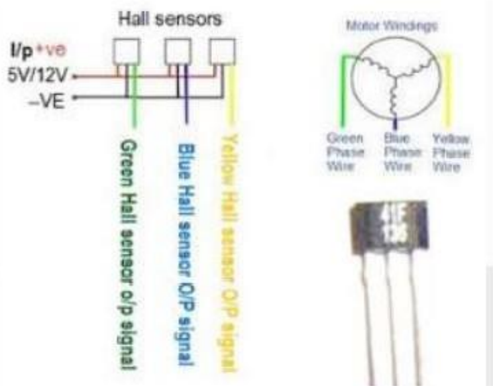
Motor

Motor and their parts









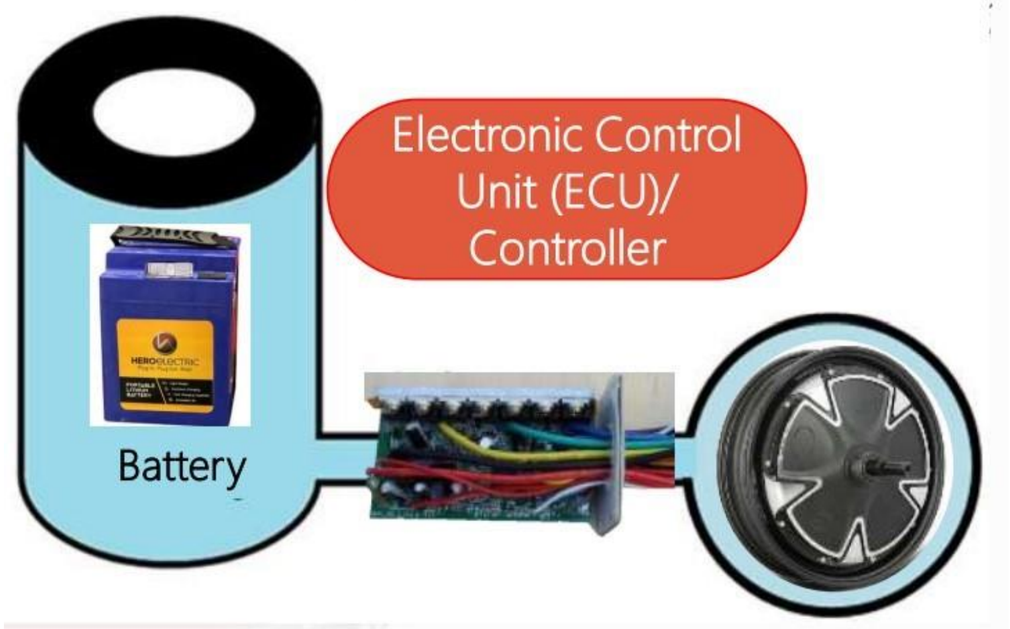
Hall sensor

hall sensor detailed blog

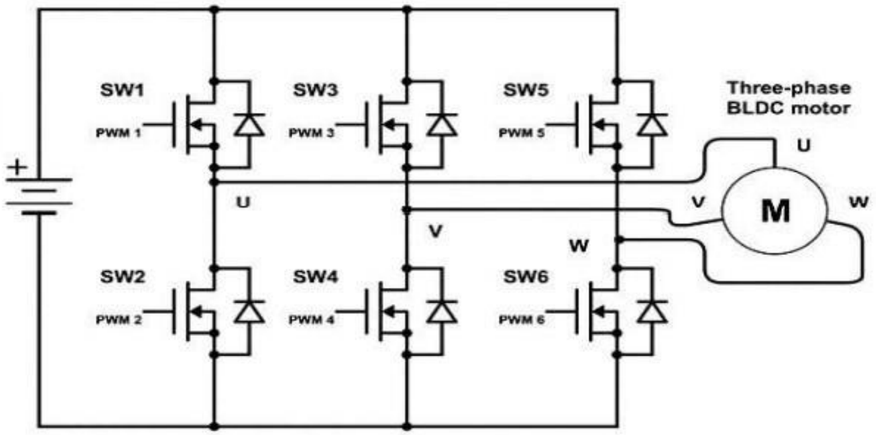
click here

CONTROLLER

Controller (Electric Control unit)



Electric Power controlled by Electronic Control unit (ECU) /Controller



A typical 3 phase bi-directional MOSFET switch setup for a 3 phase load or in this case a BLDC motor. This configuration is often called a 3 phase H-Bridge.

Controller

Controller Coupler details

36V500W Brushless Motor Controller Wiring Diagram

1. 3 big wires, color: yellow,green,blue
   to motor phase wire (motor power supplier)
2. 2 big wires, color: red, black
   to battery (red to +, black to -)
3. 5 small wires, color: red, black, yellow, green, blue
   to motor hall sensor
4. 3 small wires, color: gray,orange,brown
   to alarm
5. 1 small wire, color: gray
   signal wire, to odometer
6. 2 small wires, color: red, black
   alarm power supply(red+, black-)
7. 3 small wires, color: red&white,black,brown&white
   to 3-speed switch(red&white:fast, brown&white:slow, black:"-")
8. 3 small wires, color: red,black,green&white
   to throttle/speed governor
9. 2 white wires, color: white
   self-learning wire, normally disconnected
10. 2 small wires, color: yellow&white, black
    to reverse switch
11. 1 small wire, color: purple
    High level brake(another wire connect to red wire 13)
12. 2 small wires, color: black, purple&white
    low level brake, to brake switch
13. 1 small wire, color: red
    to key ignition (another wire connect to battery+, 2 red wire)

Motor

Motor and Controller connections

Motor Phase Wires

- Connect Motor phase wire to controller phase wire
- Yellow to yellow
- Green to Green
- Blue to Blue

Motor Hall sensor wires

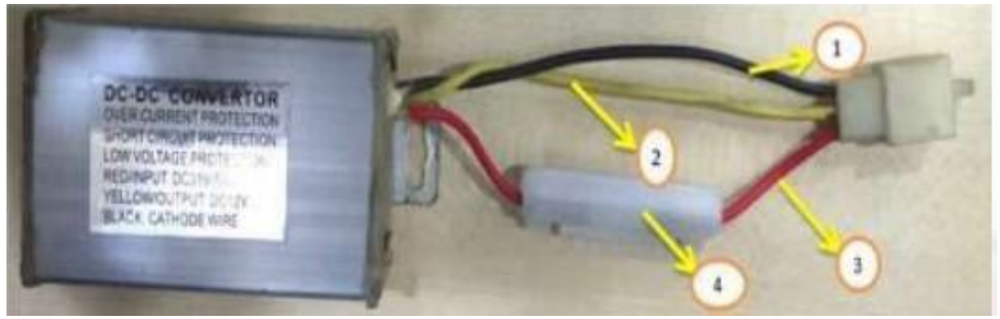
- Connect Motor Hall sensor coupler to controller Hall sensor coupler and match wire
- Red to RED
- Black to Black
- Yellow to yellow
- Green to Green
- Blue to Blue

DC TO DC CONVERTOR , THROTTLE & Speedo Meter

Convertor

DC to DC convertor

converts 72V or 48V into 12 Volts DC , it is used for lights, indicators and Horn.



1. Negative input & output common wire (Black)
2. 12V DC output (Yellow)
3. Battery Voltage input (Red)
4. 5 A Glass fuse

Testing DC to DC convertor

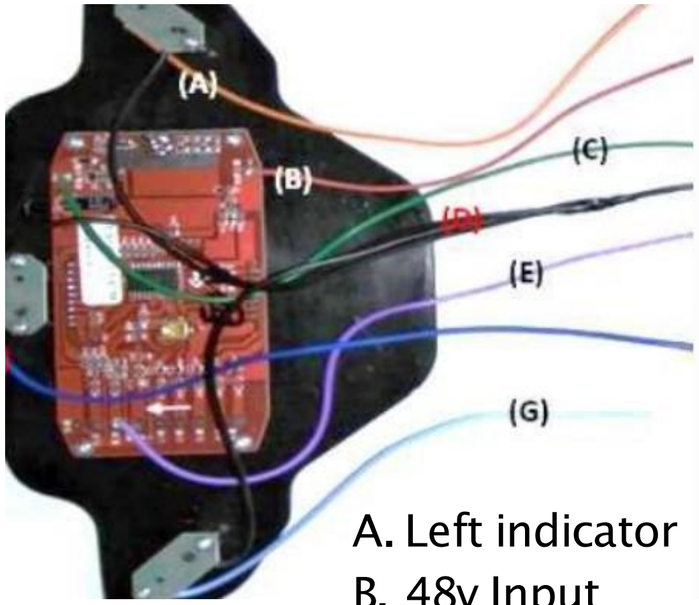
- Select the Multimeter in DC voltage Mode
- Scooty ignition key switch ON
- Check input voltage of Convertor between Red and black wire it should
- be 48V /72 V/ Battery Voltage.
- Check output voltage between Yellow and black wire it should be 12V DC .

Throttle

Throttle testing through DMM

- Check input voltage between Red and Black wire , it should be 5V DC approx
- If input voltage is ok then give throttle and check output voltage in green wire, it should be 0.8V DC +ve to 3.8V DC +ve as per throttling

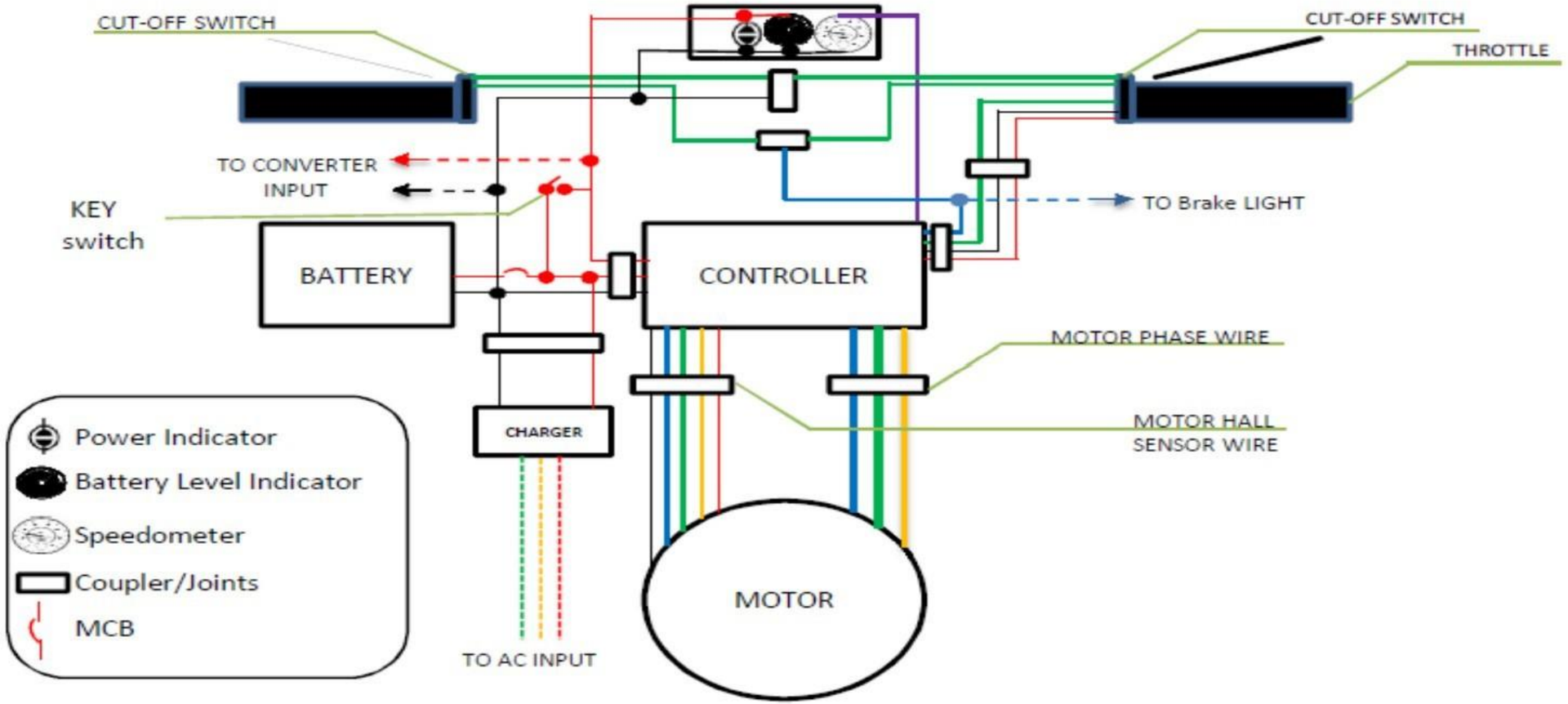
Speedo meter



A. Left indicator
B. 48v Input
C. PCB ground
D. 12V +ve (for upper dipper and LH and RH indicator)
E. Speed signal
F. Upper dipper indicator
G. Right indicator

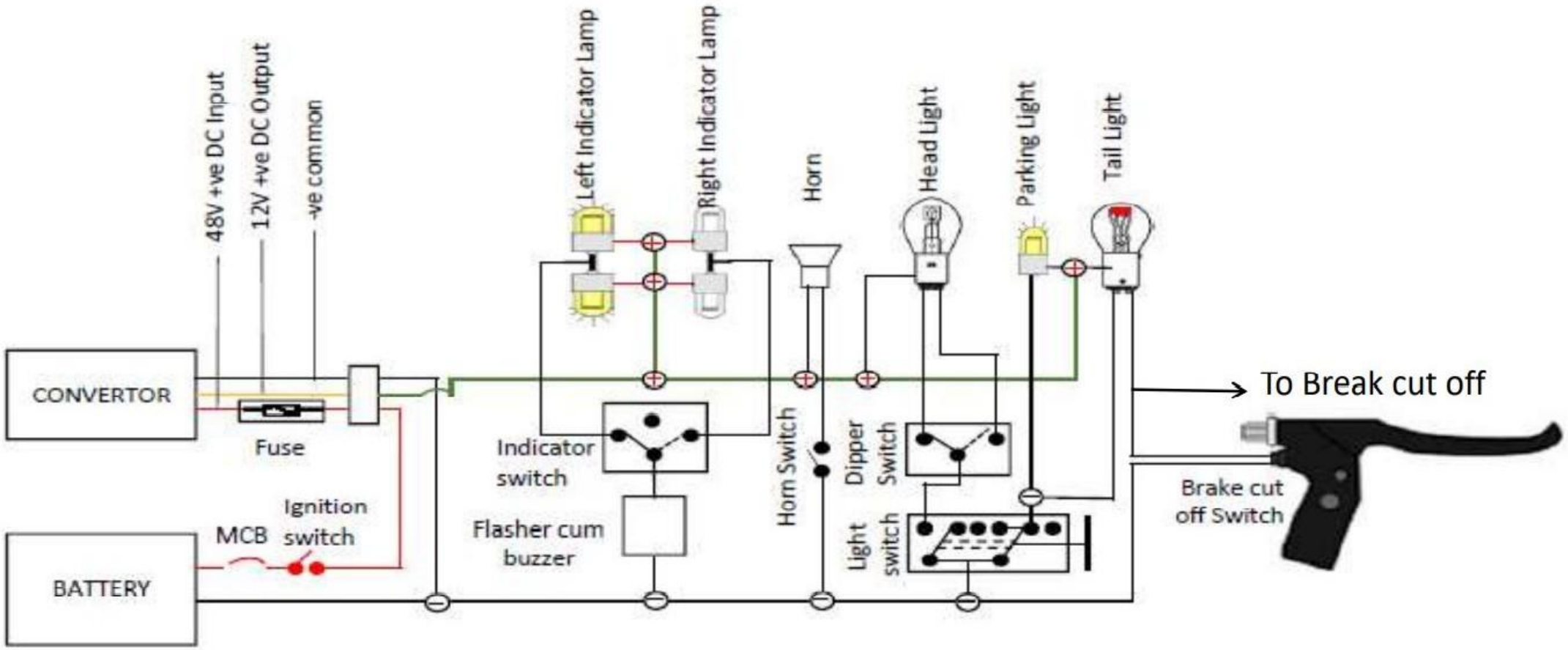
Line Diagram

Line Diagrams Of Power Train

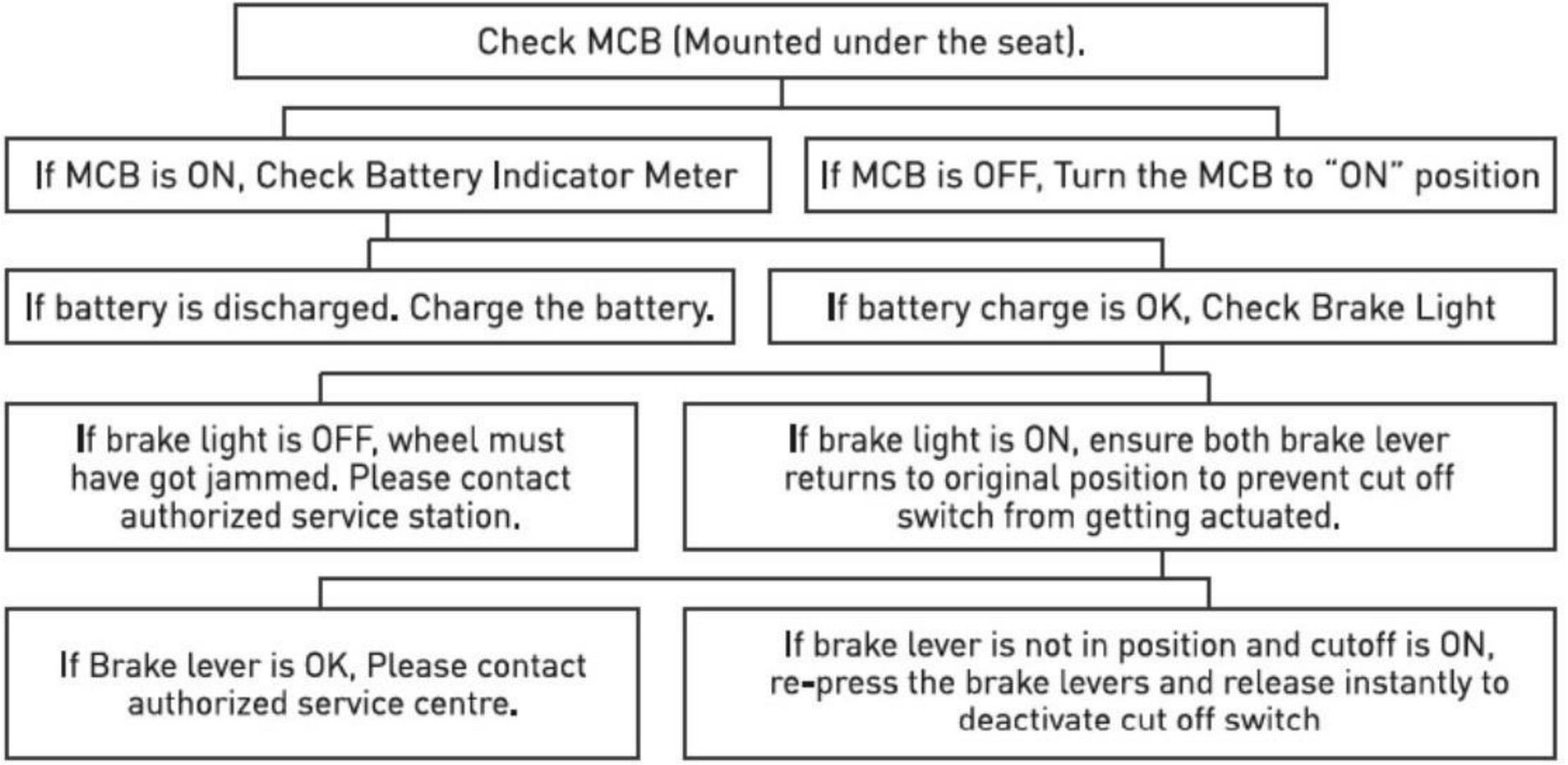


Line Diagram

Line Diagrams Of Lights ,Indicators and Horn



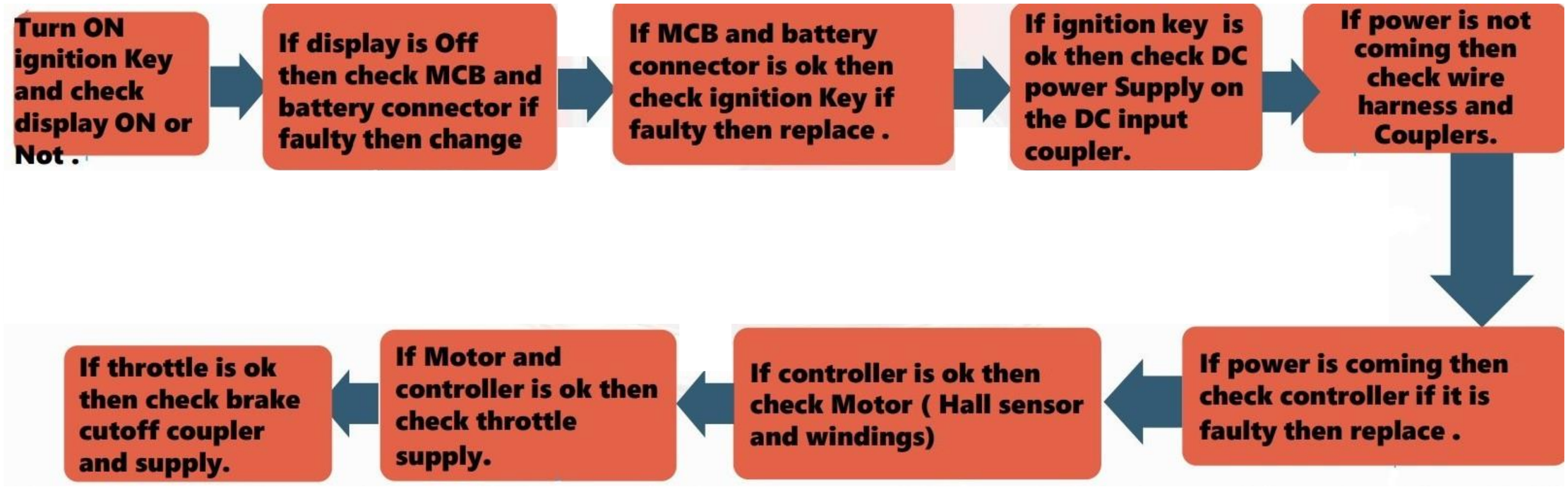
E-Bike stops suddenly while driving or does not start initially



FAULTS FINDING & REMEDIES

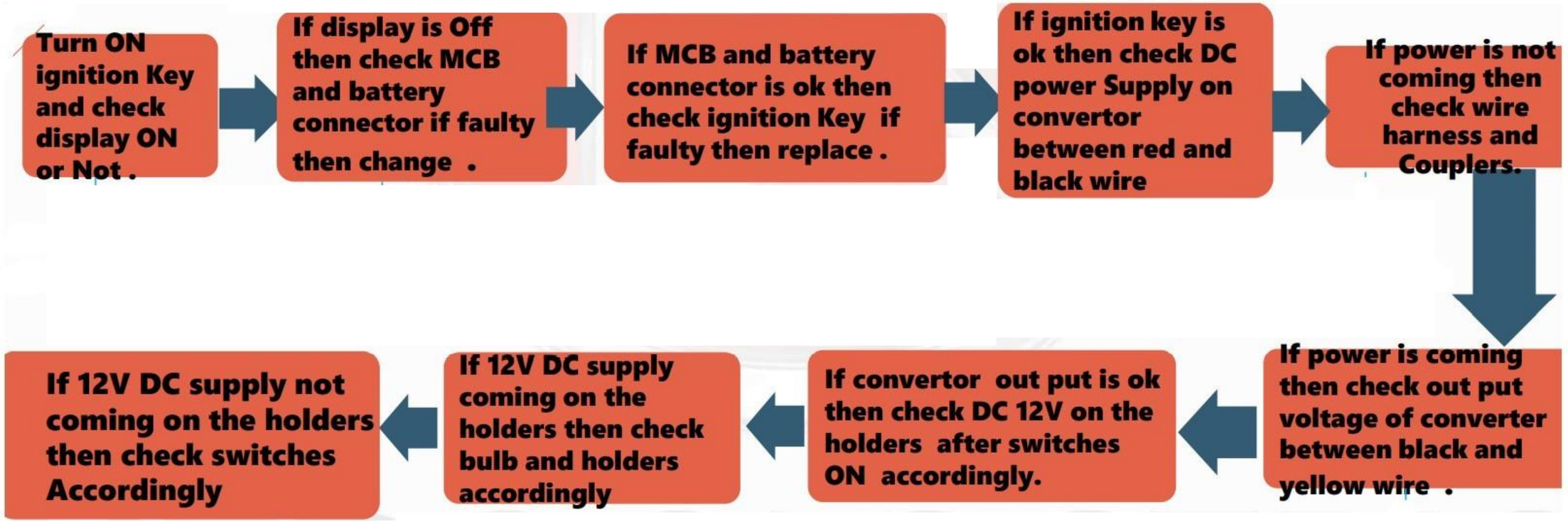
Faults finding & Remedies

Trouble shooting steps for power train



Faults finding & Remedies

Trouble shooting steps for Horn, light Indicator



Thank You