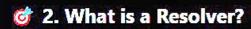


1. What is BMS?

BMS (Battery Management System) is an electronic system that manages a rechargeable battery by:

- Monitoring its state (SoC, SoH)
- Protecting the battery from operating outside its safe limits
- Controlling the charging and discharging process
- Balancing the cells
- Communicating data to other systems



A resolver is an analog rotary position sensor that converts the mechanical angle of a rotating object into an electrical signal. It's commonly used in electric motors to:

- Measure rotor position
- Provide speed feedback
- Ensure accurate motor control

A. Series Hybrid

- Working: Engine → Generator → Electric Motor → Wheels
- Advantages:
 - Simple mechanical layout
 - Good at low-speed, stop-and-go traffic
- Disadvantages:
 - Inefficient at high speed
 - Requires large motor and battery
- Applications: Chevrolet Volt (mode), some buses

B. Parallel Hybrid

- Working: Engine and Motor both connected to drivetrain
- Advantages:
 - Better efficiency at highway speeds
 - Smaller motor and battery needed
- Disadvantages:
 - Complex transmission
 - Less regenerative braking efficiency
- Applications: Honda Civic Hybrid, Hyundai Ioniq

C. Series-Parallel Hybrid

- Working: Combines both series and parallel operation
- Advantages:
 - Flexible and efficient across speed ranges
 - Optimized fuel economy
- Disadvantages:
 - Complex powertrain and control
- Applications: Toyota Prius, Ford Fusion Hybrid

4. Types of Batteries & Their Cell Voltages

Battery Type	Nominal Cell Voltage	
Lead Acid	2.0 V	
Nickel-Cadmium (NiCd)	1.2 V	
Nickel-Metal Hydride (NiMH)	12 V	
Lithium-ion (Li-ion)	3.6 – 3.7 V	
Lithium-Polymer (Li-Po)	3.7 V	
Solid-State Battery	~3.7 V	
Sodium-ion (emerging)	~2.3—3.0 V	

Motor Type	Working Principle	Specs (Typical)	
BLDC (Brushless DC)	Electronic commutation via inverter	High efficiency, 2kW-100kW, 90-95% efficient	
PMSM (Permanent Magnet	Uses rotor with permanent magnets	High torque density, used in EVs	
Synchronous Motor)	& sinusoidal back EMF		
Induction Motor (AC)	Induced current in rotor due to	Rugged, less costly, 50kW-150kW	
	stator's magnetic field		
SRM (Switched Reluctance Motor)	Reluctance torque generation via	Simple & robust, noisy, under	
	switched stator	development	
DC Motor (Brushed)	Commutator & brushes supply	Simple control, low cost, lower	
	current to armature	efficiency	

6. Full Forms

- DoD: Depth of Discharge
- SoC: State of Charge
- SoH: State of Health
- RUL: Remaining Useful Life
- ERG: Exhaust Gas Recirculation (usually EGR, check spelling)
- CRDi: Common Rail Direct Injection
- LVDT: Linear Variable Differential Transformer

7. Sensors and Actuators Used in HEVs

Sensors:

- Current Sensor (Hall-effect)
- Voltage Sensor
- Temperature Sensor
- Speed Sensor
- Position Sensor (Encoder, Resolver)
- Accelerometer
- Gyroscope
- Fuel Level Sensor
- O2 Sensor (Lambda Sensor)
- Battery SoC/SoH Sensor
- Brake Pedal Position Sensor
- Throttle Position Sensor

Actuators:

- Electric Motor
- Fuel Injector
- Throttle Actuator
- Relay / Contactor
- Cooling Fan
- Electric Brake Actuator
- Transmission Solenoid