SURFACE VEHICLE INFORMATION REPORT

J1715 OCT2014

Issued 1994-04
Revised 2014-10

Superseding J1715 FEB2008

(R) Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology

RATIONALE

The document is being updated a) to intersperse previously separated hybrid and electric terms for easier reading, b) to add additional diagrams and tables as well as several definitions, c) to clean up minor editing items called out by the SAE Publications group, and d) to coordinate removal of specialized battery terms to a companion document J1715/2, issued by the Battery Terminology Committee.

FOREWORD

This document is an ongoing effort to provide the technical community with the terminology used most frequently in the Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) industry.

1. SCOPE

This SAE Information Report contains definitions for HEV and EV terminology. It is intended that this document be a resource for those writing other HEV and EV documents, specifications, standards, or recommended practices.

1.1 Purpose

The purpose of this document is to provide a record of commonly used terminology established by the technical community involved with writing practices and information reports for HEVs and EVs.

1.2 Field of Application

This SAE Information Report pertains to HEVs and EVs.

1.3 Product Classification

Information Report.

1.4 Product Description

Information Report containing commonly used terminology in the HEV and EV industry.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/J1715_201410

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 NFPA Publication

Available from the National Fluid Power Association, 3333 N. Mayfair Road, Suite 211, Milwaukee, WI 53222-3219, Tel: 414-778-3344, www.nfpa.com.

NFPA 30 Flammable and Combustible Liquids Code

2.1.2 Federal Publication

Available from The Government Printing Office, www.access.gpo.gov/nara/cfr.

40 CFR paragraph 86.115-78 Control of Emissions from New and In-Use Highway Vehicles and Engines

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1634 Electric Vehicle Energy Consumption and Range Test Procedure

SAE J1711 Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles

SAE J1715/2 Battery Terminology

SAE J670 Vehicle Dynamics Terminology, latest revision

2.2.2 IEEE PUBLICATIONS

Available from IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

ANSI/IEEE 100 Standard Dictionary of Electrical and Electronic Terms, latest revision

2.2.3 Japanese Electric Vehicle Society Publication

Available from Japanese Electric Vehicle Association, evinfo@gw.jeva.or.jp.

JEVS Z 805 Glossary of Terms Relating to Electric Vehicles, latest revision

2.2.4 NIST PUBLICATIONS

Available from NIST, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070, Tel: 301-975-6478, www.nist.gov.

For definitions of SI units of measurement - mass, EMF, current, power, etc.

2.2.5 National Highway Traffic Safety Administration Publication

Available from The Government Printing Office, www.access.gpo.gov/mara/cfr.

49 CFR Ch V, Section 571 Federal Motor Vehicle Safety Standards

2.2.6 SAND Publication

Available from Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185, www.sandia.gov.

SAND88-2852 * UC-212 Glossary of Testing Terminology for Rechargeable Batteries, latest revision

2.2.7 USABC Publication

Available from USCAR, 1000 Town Center Drive, Suite 300, Southfield, MI 48075, Tel: 248-223-9000, www.uscar.org.

USABC Test Procedures Manual, latest revision

3. HYBRID ELECTRIC (HEV) AND ELECTRIC VEHICLE (EV) TERMINOLOGY

3.1 ADEQUATE VENTILATION

As defined in NFPA 30, ventilation is adequate if it is sufficient to prevent accumulation of hydrogen vapor-air mixtures in concentrations over one-fourth of the lower flammability limit.

3.2 AIR CLEARANCE

The shortest distance through air between two conductive parts.

3.3 ALL ELECTRIC RANGE

The distance a vehicle can drive in all electric mode without engaging the Hybrid Power Unit (HPU) or Auxiliary Power Unit (APU) on a specific cycle.

3.4 AUXILIARY POWER UNIT (APU)

A device that converts consumable fuel energy into mechanical or electrical energy. Compared to the HPU, the APU is a secondary energy or propulsion source. Some examples of auxiliary power units are internal combustion engines, gas turbines, or fuel cells.

3.5 BATTERY ELECTRIC VEHICLE (BEV)

A vehicle that receives its on-board propulsion power solely from batteries, unlike a hybrid vehicle that may receive a portion of its power from a separately-fueled power source, such as an internal combustion engine.

3.6 BREAKDOWN

The failure of the dielectric of an insulation due to the effects of an excessive electric field and/or physical or chemical deterioration of the dielectric material.

3.7 CHARGE CONNECTOR

A conductive or inductive device that establishes an electrical connection to the electric vehicle for the purpose of charging and information exchange.

3.8 CHARGE DEPLETING (CD) MODE

An operating mode of an HEV in which the vehicle runs by consuming only electric energy from the RESS charged from an external power source, or along with the fuel energy, simultaneously or sequentially, until the charge-sustaining (CS) mode state is obtained.

3.9 CHARGER (BATTERY)

The component that supplies the power required for battery charging.

3.10 CHARGE SUSTAINING (CS) MODE

An operating mode where the HEV runs by consuming fuel energy while sustaining the electric energy of the RESS.

3.11 CHASSIS GROUND

The conductor used to connect the non-current-carrying metal parts of the vehicle high voltage system to the vehicle ground system.

3.12 CONDUCTIVE

Having the ability to transmit electricity through a physical path (conductor).

3.13 CONNECTION CYCLES

Refers to connect and disconnect cycles of connectors. One insertion and withdrawal operation is a connection cycle.

3.14 CONNECTOR

A component which terminates conductors for the purpose of providing connection and disconnection to a suitable mating component.

3.15 CONTACT

The part of a switch, relay or connector that carries current.

3.16 CONTACT FORCE (N)

The force which two contacts exert against each other in the closed position under specified conditions.

3.17 CONTACT RESISTANCE (Ω)

The electrical resistance of a single mated set of contacts under specified conditions.

3.18 CONTROL PILOT

An electrical signal sourced by the Electric Vehicle Supply Equipment (EVSE). It performs several functions including assuring that the vehicle is present and connected, permits energizing/de-energizing of the supply, transmits the supply equipment current rating to the vehicle, monitors the presence of the equipment ground, and establishes vehicle ventilation requirements. See SAE J1772™ for a complete description.

3.19 COOPERATIVE REGENERATIVE BRAKING

Maximizes energy recovery by actively controlling the friction braking in coordination with the regenerative braking system.

3.20 COUPLER

A device connected to the electric vehicle supply equipment that transfers power to the electric vehicle for charging the energy storage system and permits the exchange of information between the electric vehicle and the electric vehicle's supply equipment (see Charge Connector and EV Connector).

3.21 DC (Direct Current) CHARGING

The Electric Vehicle Supply Equipment provides direct current to the vehicle to be used to charge the vehicle RESS. This method is also sometimes known as fast charging. DC charging is under development and will be defined in a follow on to SAE J1772™ JAN2010.

3.22 DRIVING PROFILE

A vehicle speed-versus-time schedule that is used to test vehicle and battery characteristics.

3.23 ELECTRIC VEHICLE (EV)

A vehicle powered solely by energy stored in an electrochemical device.

3.24 ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE)

The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, and other components intended to deliver energy to an electric vehicle.

3.25 EQUIPMENT GROUND (Grounding Conductor)

A conductor used to connect the non-current-carrying metal parts of the EV supply equipment to the system grounded conductor, the grounding electrode conductor, or both at the service equipment.

3.26 EV CHARGING SYSTEM

The equipment required to condition and transfer energy from the constant frequency, constant voltage supply network to the direct current, variable voltage EV traction battery bus for the purpose of charging the battery and/or operating vehicle electrical systems while connected.

3.27 EV CONNECTOR

Off-board component used to interface with the vehicle-mounted EV inlet to supply power and provide communication interface.

3.28 EV INLET

Vehicle-mounted component which interfaces with the EV connector to receive power and provide communication interface (also called a charge port).

3.29 FEDERAL URBAN DRIVING SCHEDULE (FUDS)

The Environmental Protection Agency (EPA) urban dynamometer driving schedule, as defined in 40 CFR, paragraph 86.115-78. A velocity-versus-time profile defined by the EPA to test for vehicle emissions and city fuel economy. This schedule is also referred to as 'UDDS' and 'LA4".

3.30 FUEL CELL HYBRID ELECTRIC VEHICLE (FCHEV)

An electric vehicle with a RESS and a fuel cell power system as power sources for vehicle propulsion.

3.31 FUEL CELL VEHICLE (FCV)

A vehicle that receives propulsion energy from an onboard fuel cell power system.

3.32 HIGH VOLTAGE

Any wiring system which contains one or more circuits operating between 60 V DC or AC RMS and 600 V DC or AC RMS.

3.33 HYBRID VEHICLE

A vehicle with two or more energy storage systems, both of which must provide propulsion power – either together or independently.

3.34 HYBRID ELECTRIC VEHICLE (HEV)

A road vehicle that can draw propulsion energy from both of the following sources of stored energy: 1) a consumable fuel and 2) an RESS that is recharged by an electric motor-generator system, an external electric energy source, or both.

3.35 HYBRID POWER UNIT (HPU)

A non-RESS energy propulsion system (e.g., internal combustion engine, fuel cell, etc.).

3.36 HYDRAULIC HYBRID

A hybrid vehicle where hydraulic fluid is used as the coupling between propulsion elements and energy storage.

3.37 INDUCTIVE CHARGING SYSTEM

A charging system that transfers power across a two part transformer and rectifies that power into DC voltage to the batteries.

3.38 INSERTION FORCE (N)

The force required to fully insert a set of mating components.

3.39 LEVEL 1 CHARGING (AC)

A charging method that allows the vehicle to be connected to the most common grounded electrical receptacles (NEMA 5-15R or 5-20R). Also known as AC Level 1 Charging. See SAE J1772™ for a complete description.

3.40 LEVEL 2 CHARGING (AC)

A method that uses dedicated Electric Vehicle Supply Equipment to provide single phase alternating current to the vehicle at a nominal voltage of 208 to 240 volts and a maximum current of 80 amperes. Also known as AC Level 2 Charging. See SAE J1772™ for a complete description.

3.41 LEVEL 3 CHARGING (AC)

Also known as AC Level 3 Charging; this term should not be used to refer to DC Charging. A method that uses dedicated Electric Vehicle Supply Equipment to provide single phase alternating current to the vehicle at a nominal voltage of 208 to 240 volts and a maximum current of 400 amperes.

3.42 NET AMPERE-HOURS (A•h)

For a discharge test including both negative (discharge) and positive (regen) current or power steps, the difference between the A•h removed from the battery during discharge steps and the A•h returned to the battery during regen steps, regardless of battery charge acceptance.

3.43 OFF-VEHICLE CHARGE CAPABLE

The capability to charge a battery from an off-vehicle electric energy source that cannot be connected or coupled to the vehicle in any manner while the vehicle is being driven.

3.44 OPERATING TEMPERATURE (°C)

The temperature range in which a component is designed to operate under normal conditions.

3.45 OVERCURRENT PROTECTION DEVICE

A fuse, circuit breaker, intelligent contactor, or other device placed in an electrical circuit to provide current overload protection.

3.46 PLUG-IN ELECTRIC VEHICLE (PEV)

An electric vehicle that can be recharged with an off-board source of electricity; it includes both battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV).

3.47 PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV)

A hybrid electric vehicle with an RESS that is designed to be recharged from an external (off-vehicle) electric energy source, typically an alternating current (AC) electrical power supply system.

3.48 POWER ASSIST

A hybrid mode in which the HPU power output is augmented by energy drawn from the RESS.

3.49 POWER-SPLIT TRANSMISSION

A transmission providing continuously variable torque/speed ratios by the use of differential gearing connected with at least one electric motor-generator.

3.50 POWERTRAIN

The elements of a propulsion system that convert electrical energy from a battery to mechanical energy at the wheels of an electric vehicle. It includes all drivetrain components plus an electrical power inverter and/or controller, but not the battery system. For a hybrid-electric vehicle, the hybrid power unit is also included.

3.51 PROPULSION SYSTEM

The combination of the powertrain and energy supply system.

3.52 RANGE (km)

The maximum distance that an electric vehicle can travel on a single battery charge over a specified driving cycle. Alternatively, the distance reached when a specified minimum level of performance or other characteristic (such as battery depth of discharge) is attained.

3.53 RANGE EXTENDER

A small engine-powered generator or auxiliary power unit (APU) added to a battery electric vehicle to produce a plug-in electric vehicle (PEV). This generator sustains vehicle operation beyond the range provided by the batteries alone.

3.54 RATED VOLTAGE (V)

Voltage range at which a device is designed to operate.

3.55 REGENERATIVE BRAKING

A conversion of vehicle retardation force into energy stored in the RESS. Also known as “regen” braking.

3.56 RESS (Rechargeable Energy Storage System)

Any energy storage system that has the capability to be charged and discharged. (Examples: batteries, capacitors, and electro-mechanical flywheels).

3.57 RESS AVAILABLE ENERGY

Energy available at the connection point of the RESS to the system.

3.58 RESS DRIVING

Ability to drive the vehicle using only the energy from the RESS.

3.59 RESS LAUNCH

Capability to launch the vehicle using only the energy from the RESS.

3.60 SERIES HYBRID

A hybrid vehicle in which both sources of energy go through a single propulsion device.

3.61 SMART GRID

A modernization of the (present) electricity delivery system so that it monitors, protects and automatically optimizes the operation of its interconnected elements. It will be characterized by a two-way flow of electricity and information to create an automated, widely distributed energy delivery network. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level.

3.62 START/STOP

Engine is automatically turned off when power demand is zero or negative, such as during vehicle stop, and then restarted automatically. This is sometimes referenced in the industry as a Micro Hybrid.

3.63 VEHICLE TO GRID CONNECTION (V2G)

Concept that allow bi-directional energy exchange between the vehicle and grid.

4. FUNCTIONAL POWERTRAIN ARCHITECTURE DIAGRAMS

Hybrid Systems can be assembled in a variety of different configurations using the HPU, E-machine and Gearing. This section provides a block-diagram overview of the major types in the market today, but does not cover all of the possible configurations.

Power-Split:

A transmission providing continuously variable torque/speed ratios by the use of differential gearing connected with at least one electric motor-generator. Examples: 2008 Toyota Prius, 2008 Ford Escape Hybrid

Power-Split Mode:

A mechanical arrangement within a power-split transmission having a fixed linear combination of engine speed, output speed, and the speed of the motor-generator(s) that directly control(s) the speed ratio through the power-split.

Should the speed(s) of the controlling motor-generator(s) equal zero, this condition is a “mechanical point or mechanical ratio” of the system.

Mechanical Point or Mechanical Ratio:

A ratio at which one of the motor-generators that controls the speed ratio through the transmission has come to a stop, and therefore power is transmitted mechanically through the differential gearing, but not electrically through that motor-generator.

Power-Split design options:

Input split: The input is connected separately to differential gearing. The power flow through the transmission is split by using differential gearing at the input.

A Power-Split with gearing at the transmission input is shown here:

Output split: The output is connected separately to differential gearing. The power flow through the transmission is split by using differential gearing at the output. A Power-Split with gearing at the transmission output is shown here:

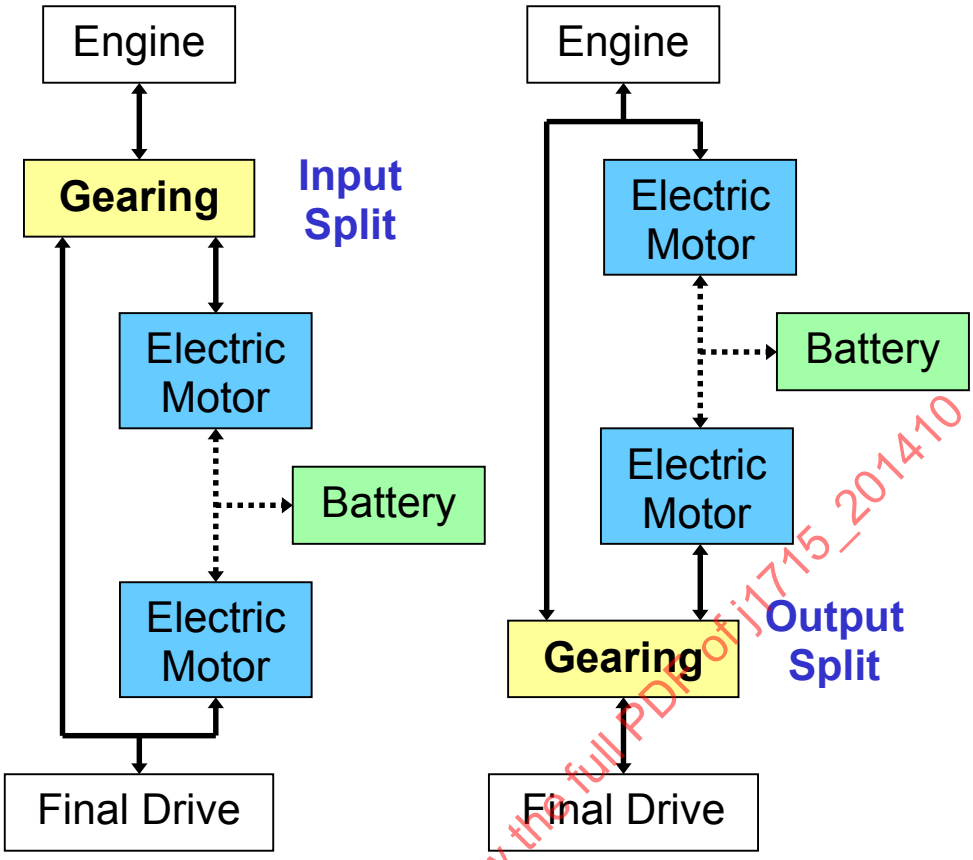


FIGURE 1 - INPUT AND OUTPUT SPLIT

Compound split: Both the input and output are connected separately to differential gearing. The power flow through the transmission is split by using differential gearing at both the input and the output.

A Power Split with gearing at both input and output is shown here:

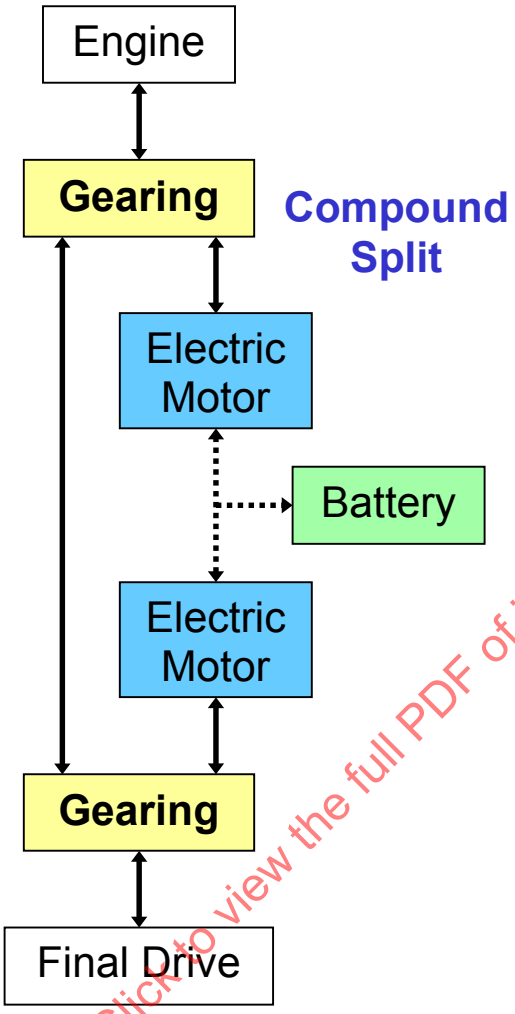


FIGURE 2 - COMPOUND SPLIT

One-Mode or Single-Mode:

There is only one, fixed linear combination of the input speed, output speed, and the speed of the motor-generator(s) that directly control(s) the speed ratio through the power-split transmission.

Multi-Mode (e.g., 2-Mode):

The power-split transmission can mechanically select from among more than one fixed, linear combination of input speed, output speed, and the speed of the motor-generator(s) that directly control(s) the speed ratio through the power-split transmission. For example, a two-mode power-split transmission may have an input-split mode when one clutch alone is closed and a compound-split mode when another clutch alone is closed. Examples: 2008 Chevrolet Tahoe Hybrid, 2009 Mercedes Benz ML450 Hybrid, and 2009 BMW X6 Active Hybrid.

Series

A hybrid vehicle in which both sources of energy go through a single propulsion device. Example: Orion Hybrid Bus

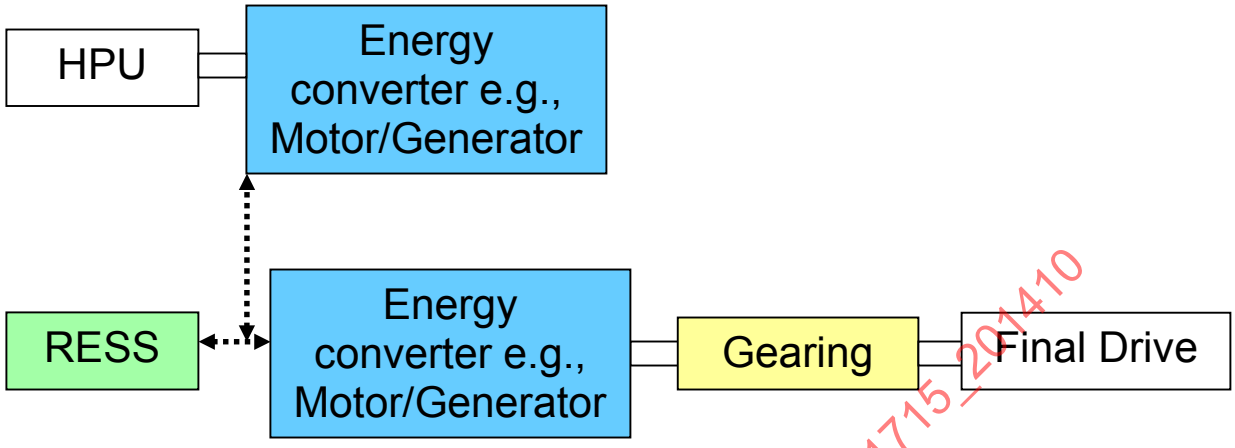


FIGURE 3 - SERIES HYBRID

Parallel

A hybrid vehicle which has multiple propulsion systems that can be operated independently or together.

Example: 2008 Honda Civic Hybrid

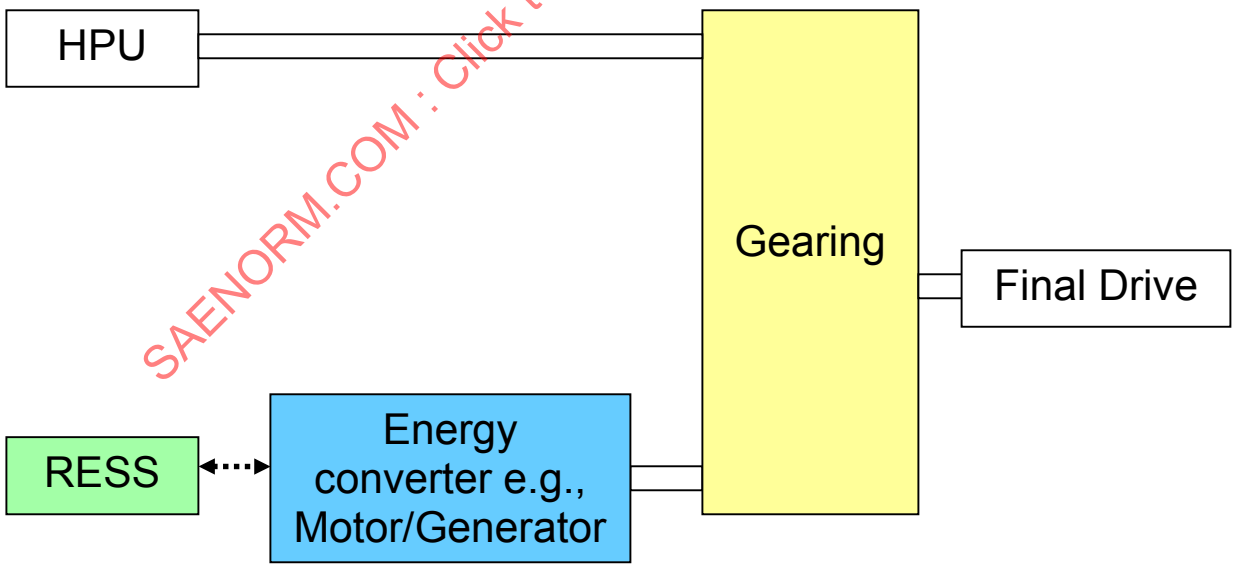
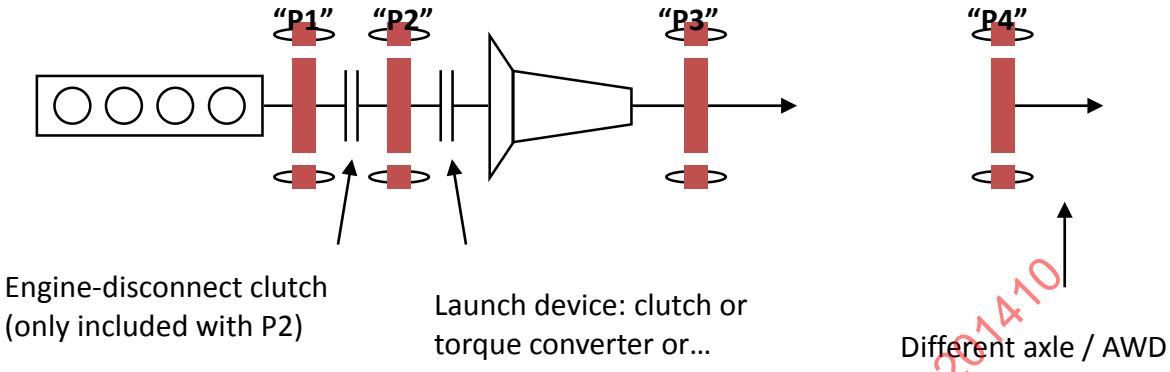


FIGURE 4 - PARALLEL HYBRID

Parallel Hybrid numbering convention for a single motor in numbered position:

e.g., P1. Combinations denoted with "/" e.g., P1/P2/P4.



Examples:

Parallel - P1

A hybrid system that is connected directly to the crankshaft of the engine with some type of Clutch/Fluid Coupling between the Electric Motor and the Gearing.

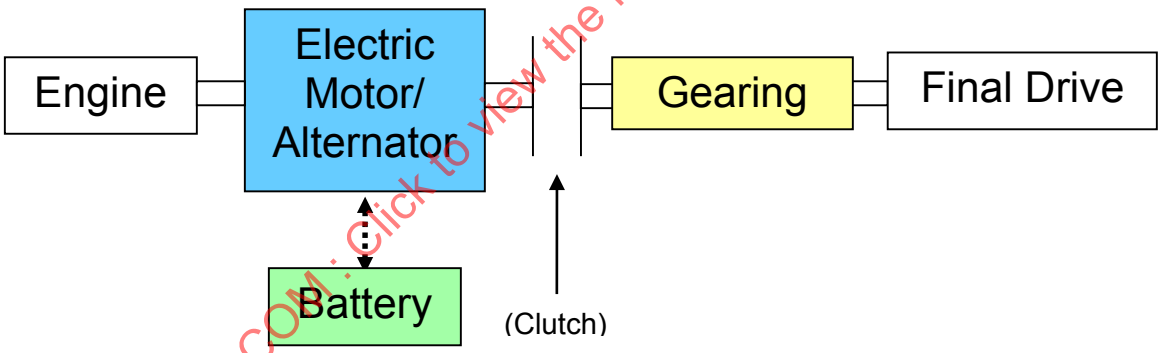


FIGURE 5 - P1 HYBRID

Parallel - P2

A hybrid system with one Clutch/Fluid Coupling between the HPU and the Electric Motor and a second Clutch/Fluid Coupling between the Electric Motor and the Gearing.

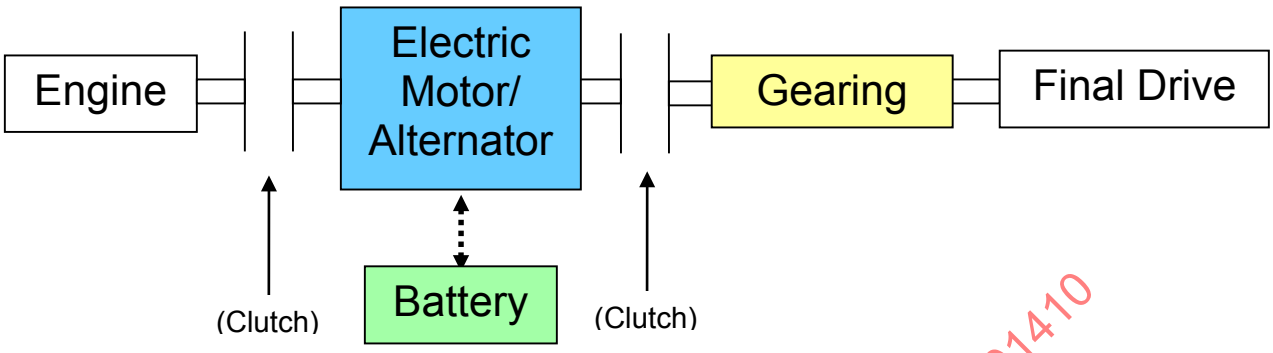


FIGURE 6 - P2 HYBRID

Crankshaft Motor Generator (Also know as Integrated Motor Generator (IMG), Integrated Motor Assist (IMA), Flywheel Assist System (FAS)

Electric Machine is coupled to the engine crankshaft and can provide the hybrid functions of assist and regeneration.

Example: 2006 Silverado Hybrid Pick Up, 2008 Honda Civic Hybrid.

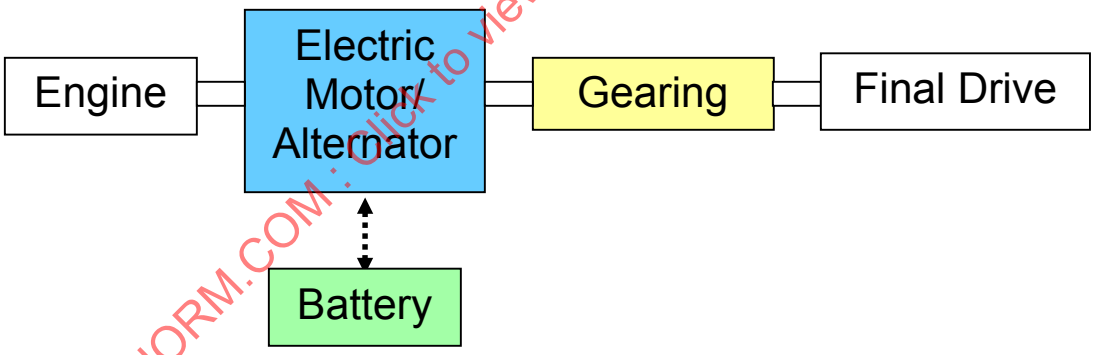


FIGURE 7 - CRANKSHAFT MOTOR GENERATOR

Belt-alternator-starter (BAS)

Electric motor generator is coupled to the engine through a belt that can provide the function (but not necessarily take the place) of the alternator and starter as well as hybrid functions of assist and regeneration. Example: 2008 Saturn VUE Greenline

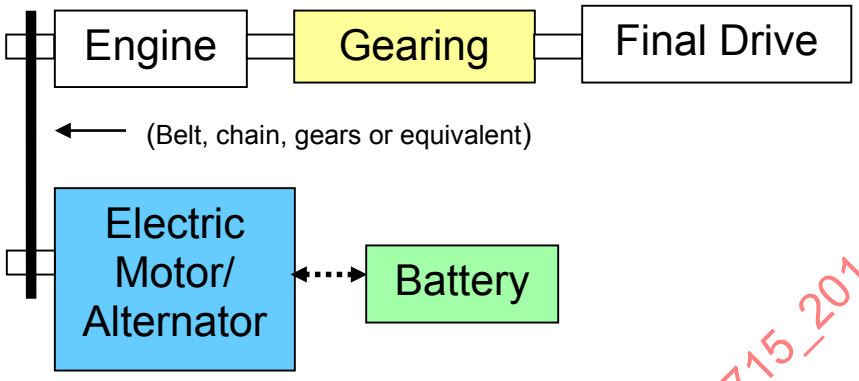


FIGURE 8 - BELT-ALTERNATOR-STARTER

Through-the-Road Parallel

A 4WD configuration where the RESS-powered propulsion system powers one axle and the HPU powers the other axle. No other connection between power sources exist.

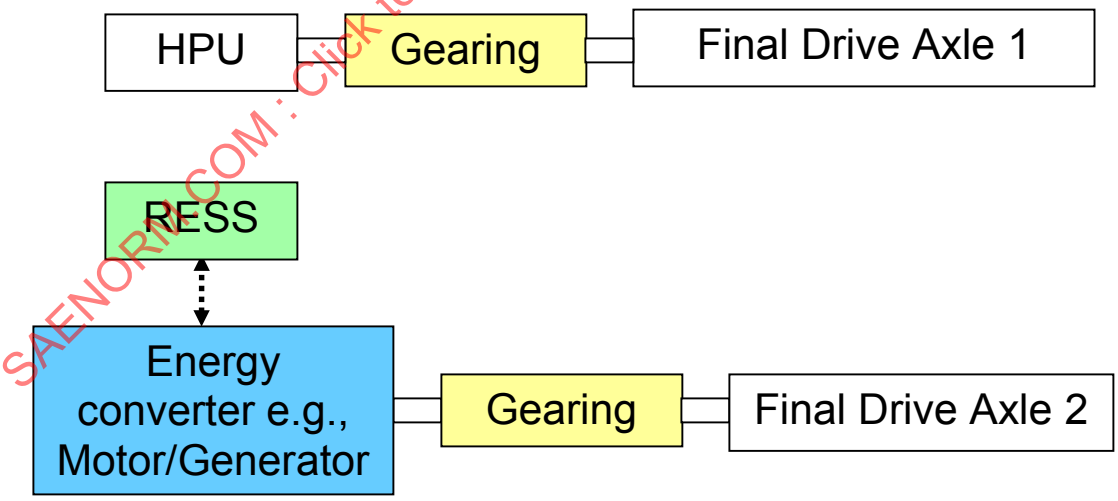


FIGURE 9 - THROUGH-THE-ROAD PARALLEL