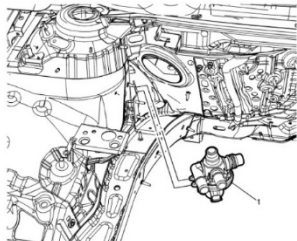

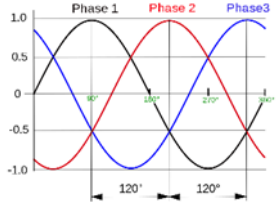
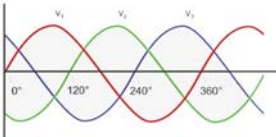
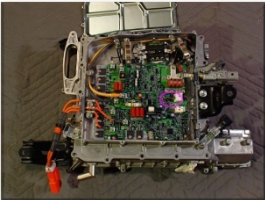

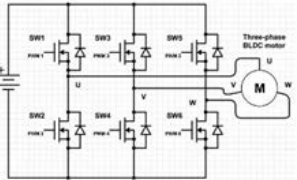
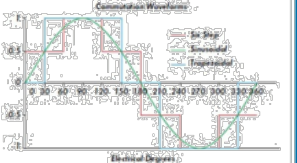
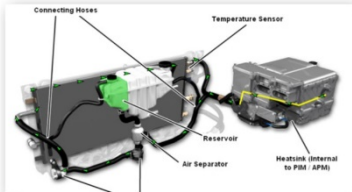



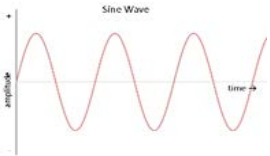

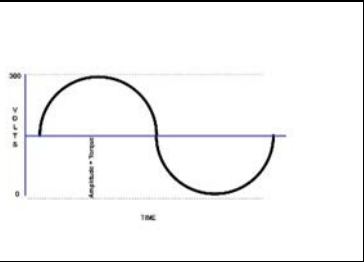
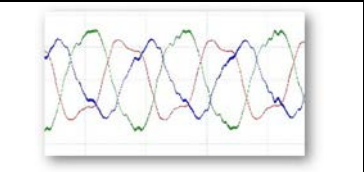
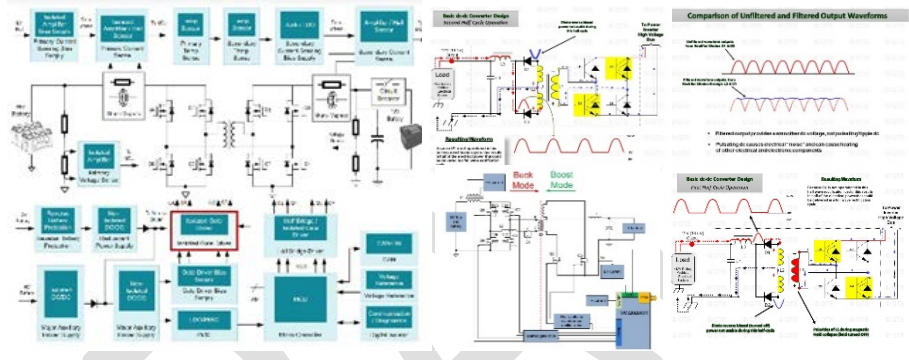
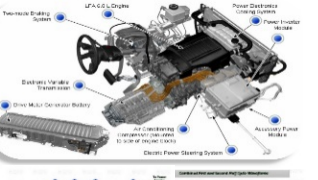


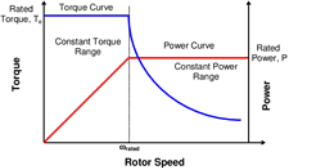


Abbr/ Acronym	Name	Description/Definition	Symbol	Picture
	2/3/4 Way Valve		<p>Drive Motor Battery Coolant Flow Control Valve Replacement</p> 	
	3-Phase	<p>Three Phases are the number of conductor circuits within a motor or generator that are connected in a Wye or Delta configuration.</p>		
	3-Phase Alternating Current	<p>Three-phase electricity consists of three AC voltages of identical frequency and similar amplitude. Each of the three AC voltage phases is separated by 120°.</p>		
	3-Phase Power Inverter	<p>A power electronic unit that converts dc electrical power to 3-Phase ac electrical power output for the purposes of operating and electric machine or other device.</p>		


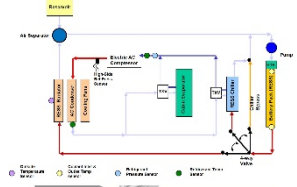
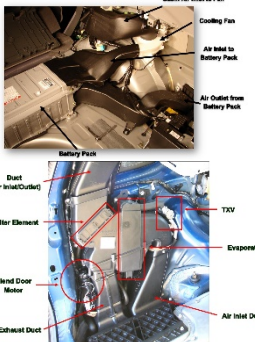
	50/50 Glycol-Deionized Water Mixture	<p>The cooling system is designed to transfer heat from a component to the coolant so it can be delivered to the radiator and the heat can be removed by way of air movement passed the radiator core tubes. Coolant will operate most efficiently to absorb heat when blended with the proper amount of (deionized) water. A mixture percentage based on the lowest temperatures typically seen in your climate. Most regions are best suited to a 50/50 water-antifreeze mixture which will provide protection from a low of -34°F to a high of 265°F. In addition, maintaining proper freeze point protection ensures corrosion inhibitors remain at intended levels.</p>		
	6-Pack Motor Drive	<p>A 6-Pack motor drive circuit contains 6 transistor (typically IGBT) circuits that connect to a source (battery pack) and a 3-Phase electric machine. The 6-Pack drive circuit will be controlled with a sine or 6-step waveform strategy to control the torque and speed of the electric machine</p>		
	6-Step	<p>The 6-Step (overmodulated) waveform is a derivative of a sine waveform that is used in electric machine control to provide conditions that will permit higher speed operation</p>		
	Actual Battery Capacity	<p>The engineered maximum energy storage capacity of a battery pack when it at 100% SOC</p>		

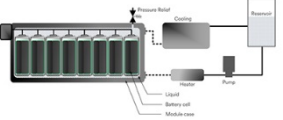
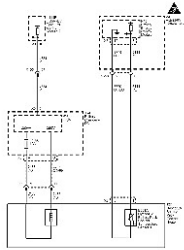
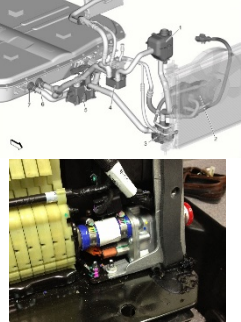
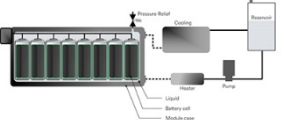
AFS	Air Flow Sensor	Sensor that measures the flow of air entering or within a component		
	Air Separator	The air separator is designed to purge air from the power electronics cooling system. The component separates air from the coolant returning from the heat exchanger, and passes the air to the reservoir, avoiding air going to the pump inlet by slowing the coolant flow down, without adding a pressure drop in the system.	 	
	Air-to-Air PTC Heater	A PTC heating unit that utilizes the vehicle HVAC blower motor to force air past the heating elements of the heating unit, thereby forcing warm/hot air into a vehicle cabin to warm it. The PTC Air heater can be placed behind a vehicle heater core to increase/add the air temperature to the cabin air being forced into the vehicle cabin.	 	
ATS	Air Temperature Sensor	Sensor that measures the temperature of incoming or ambient air of a component		
AC	Alternating Current	A type of electrical current in which, the direction of the flow of electrons switches back and forth at specified intervals or cycles. The cycles per second (Hz) can be variable or fixed.		
AC/DC	Alternating Current to Direct Current	A circuit within a battery charger system that changes alternating current (AC) to direct current (DC). The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry, and the global location.		


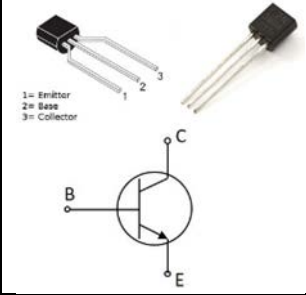
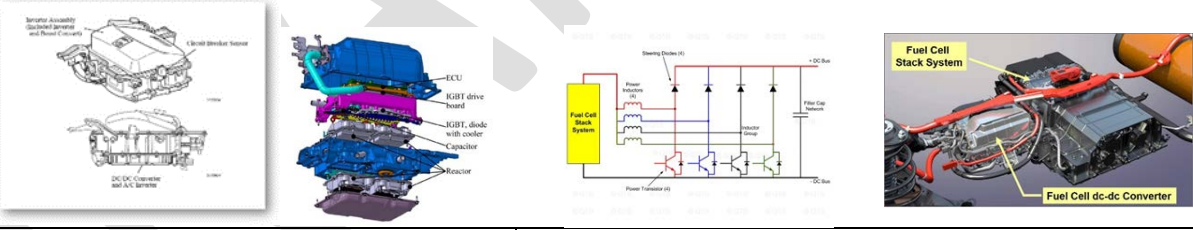
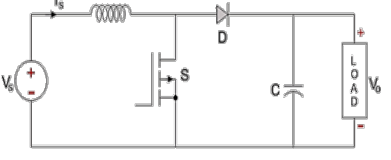
	Amp (Current) Clamp			
A-h	Amp-Hour	The amperage that can be delivered by energy storage device (i.e. battery) for a period of 1 hour		
	Amplitude	Amplitude of a waveform is a direction indication of how much voltage or current is being supplied from a Power Inverter to an electric motor (whether single phase or 3-Phase electric machines). Amplitude of Voltage or Current correlates, in a linear sense, to how much torque can be developed within an electric machine		
ACL	Apparent Capacity Loss	A failure mode of NiMH battery technology that places portions of the battery cell in a dormant state and causes capacity loss. ACL is reversible by cycling the cell.		
	Asymmetrical Waveform	Having parts or aspects that are not equal or equivalent; unequal in some respect. Example: 3-Phase sine waves that are not equal in shape, height, width, etc.		

<p>DC-DC; APM</p>	<p>Automotive BEV/FCEV/HEV/PHEV DC-DC Converter</p>	<p>A Direct-Current to Direct Current (DC-DC) converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another (higher to lower or lower to higher voltage). It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission). A DC-DC converter can also be known as an Accessory Power Supply (APM)</p> 	  
<p>BEMF</p>	<p>Back Electromotive Force</p>	<p>Back Electromotive Force (Counter-electromotive force or CEMF), also known as back electromotive force (EMF), is the electromotive force or "voltage" that opposes the change in current which induced it. CEMF is the EMF caused by magnetic induction</p>	
	<p>Base Speed</p>	<p>It is the maximum speed at which motor can operate under constant torque characteristics or the minimum speed to operate at rated power.</p>	

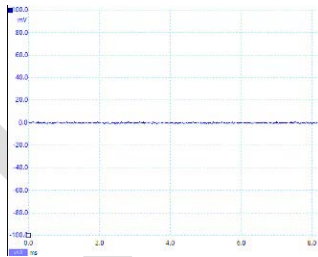
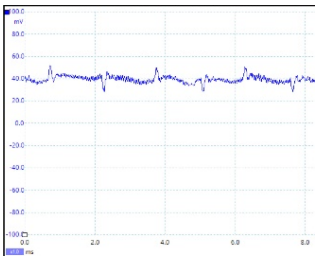
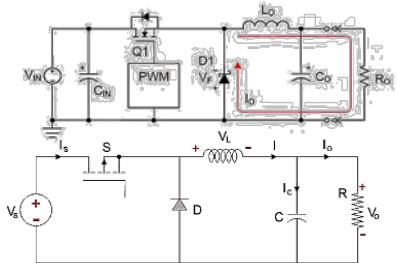
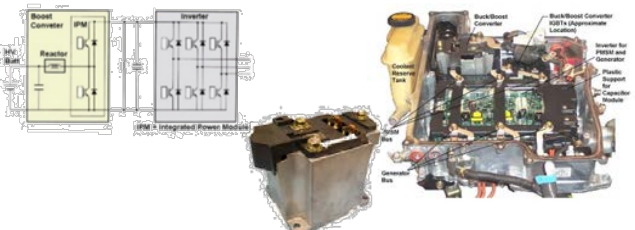


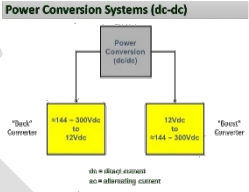
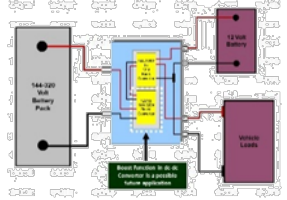
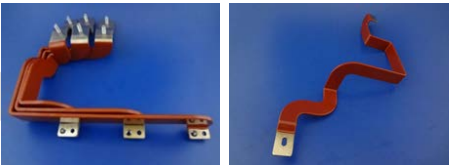

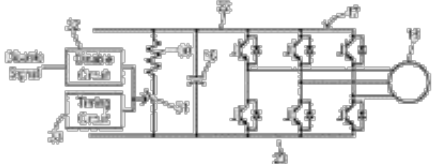
BCM	Battery Control Module	The electronic controller that controls the operation of a high voltage battery pack		
BEV	Battery Electric Vehicle	A battery electric vehicle (BEV) is an electric vehicle that utilizes chemical energy that is stored in a rechargeable battery pack. Electric vehicles use electric motors instead of an engine system to propel the vehicle.		
BMS	Battery Management System	A control system software/firmware within the BCM that manages the control and balancing of a battery pack		
BP	Battery Pack	An electric-vehicle battery pack is a battery system comprised of multiple battery cells or modules used to power the electric motors of a battery electric vehicle or hybrid electric vehicle. These batteries are usually rechargeable batteries and are typically lithium-ion batteries. These batteries are specifically designed for a high ampere-hour capacity.		
	Battery Pack Cooling System	A thermal (cooling) system that ensures that battery modules or cells do not exceed a temperature in which permanent (irreversible) cell damage would occur. The cooling system is designed to ensure that the battery modules/cells operate within the optimal temperature band that will result in high operating efficiencies, high capacity & power, while safeguarding long service life.		

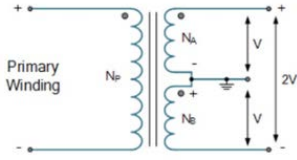
	<p>Battery Pack Immersion Cooling System</p>	<p>A battery pack heating system that utilizes an immersion type of battery cooling system to the battery modules/cells. By immersing the battery cells in a chilled oil or glycol-based liquid, battery cell temperature gradients can be mitigated thus, increasing battery performance, extending battery performance during the service life, and performance in hot operating conditions.</p>		 <ul style="list-style-type: none"> <li>• <a href="#">US Patent Fully Submerged Battery Cells for Vehicle Energy-Storage Systems.pdf</a></li> <li>• <a href="#">XingMobility Immersion Cooled Modular Battery System.pdf</a></li> </ul>
	<p>Battery Pack Heater</p>	<p>A heating unit that heats the coolant that is transferred to the battery pack by an electric pump. The coolant is transferred to a hollow cooling plate that will heat the modules/cells by conduction or, the coolant is routed through cooling tubes/plates that are located adjacent to the modules/cells and will conduct heat from them by circulating a liquid coolant.</p>		
	<p>Battery Pack Immersion Heater</p>	<p>A battery pack heating system that utilizes an immersion type of battery heating system to heat the battery modules/cells. By immersing the battery cells in heated oil or glycol-based liquid, battery cell temperature gradients can be mitigated thus, increasing battery performance, extending battery performance during the service life, and performance in cold operating conditions.</p>		 <ul style="list-style-type: none"> <li>• <a href="#">US Patent Fully Submerged Battery Cells for Vehicle Energy-Storage Systems.pdf</a></li> <li>• <a href="#">XingMobility Immersion Cooled Modular Battery System.pdf</a></li> </ul>

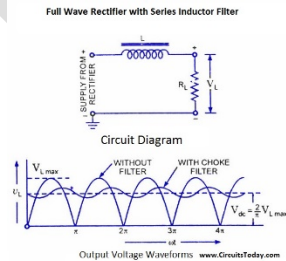
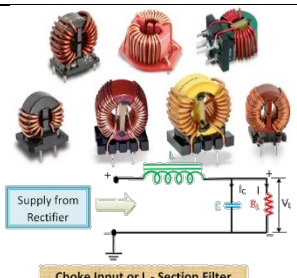
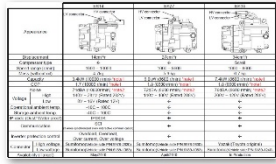

<p>BAS</p>	<p>Belted Alternator Starter</p>	<p>A configuration of HEV that places the electric machine on the front of the engine where it drives or is driven by a serpentine drive belt to provide/receive torque, through the engine vibration damper. The BAS system provides torque in parallel with the engine.</p>	
<p>NPN; PNP</p>	<p>Bipolar Transistor</p>	<p>A bipolar junction transistor is a type of transistor that uses both electrons (negative) and holes (positive) charge carriers. Unipolar transistors, such as field-effect transistors, use only one kind of charge carrier.</p>	
<p>DC-DC; APM (Accessory Power Module)</p>	<p>Boost Converter (DC-DC Converter)</p>	<p>A DC-DC converter used in a Fuel Cell system is utilized to Boost the voltage from the Fuel Cell Stack before transferring it to the input of the electric propulsion system.</p>	
<p>DC-DC; APM (Accessory Power Module)</p>	<p>Boost Converter (DC-DC Converter)</p>	<p>A DC-DC converter used in a Fuel Cell system is utilized to Boost the voltage from the Fuel Cell Stack before transferring it to the input of the electric propulsion system.</p>	


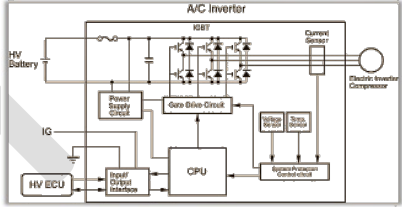
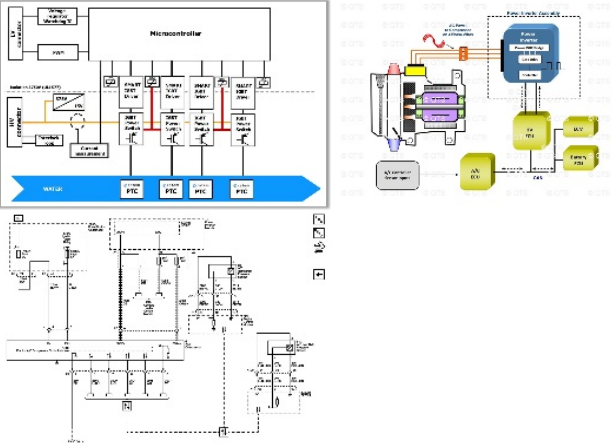


	<p>Boosting Current</p>	<p>The initial current injected into the phases of an electric machine stator to magnetize (provide an instantaneous strong magnetic field) in the stator necessary to overcome the internal load of the rotor (i.e., magnetic field needed to begin rotating the rotor) and any other loads that would load the rotor (i.e., A/C pressure, hydraulic pressure, etc.). Boosting current is typically injected for a specified millisecond duration and the amplitude can be 7-15 times that of normal operating current.</p>		
	<p>Buck Converter</p>	<p>A buck converter is a DC-to-DC power converter which steps down voltage from its input to its output. It is a class of switched-mode power supply typically containing at least two semiconductors and at least one energy storage element, a capacitor, inductor, or the two in combination.</p>		
<p>Buck/Boost Converter (Boost Reactor)</p>		<p>An inductor that uses self-induction to boost battery voltage to a higher level for the purpose of increasing electric machine rpm, torque, and horsepower. The inductor is also used to buck (reduce) electric machine voltage that is transmitted to the battery pack during Regenerative Braking</p>		

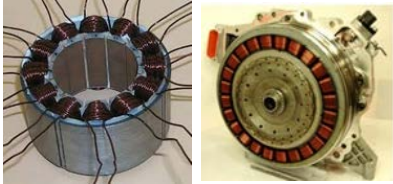
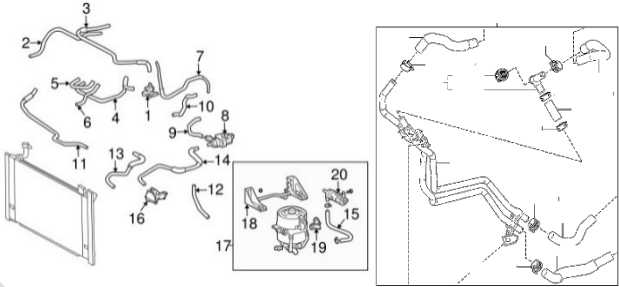
	Buck-Boost Converter	The buck–boost converter is a type of DC-to-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage. It can increase or decrease its output voltage, irrespective of the input voltage that is supplied to it	 	
	Bus Bar	A copper or copper alloy bar, with a specified thickness and width that, is bent into a form that will serve as a medium to transfer electrical current from one device/circuit to another		
	Bus Capacitor	The dc bus capacitor is the most important passive component in a traction motor drive. Conventional designs have been using a set of electrolytic bulk capacitors to smooth dc bus voltage, reduce waveform harmonics, and increase power factor		
	Bus Discharge Circuit	An electronic circuit that discharges the energy stored in the Bus Capacitors each time the power inverter system is powered OFF (i.e., each time vehicle powered OFF, collision detection or, the opening of the safety interlock circuit when the vehicle is powered ON		
"C" Rate	Capacity Rate	The rate that an energy storage device is charged or discharged within a 1-hour period		
	Cabin Heater (Vehicle) (See PTC Immersion & Air-to-Air Heaters)	An electric heater, typically comprised of PTC materials that, can be used to heat a liquid or air, to heat the interior (cabin) of a BEV, PHEV, or HEV. PTC Heaters typically have more than one heating element, with each element independently		

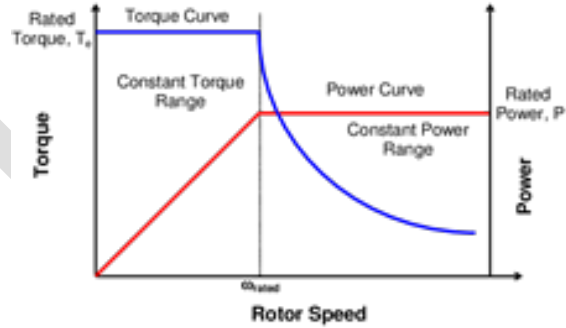

		controlled. The heating capability can range from 1.2kW to 10kW. The cabin heater can be located within the interior of the vehicle or in the front compartment (i.e., engine compartment).		
CT Xformer	Center-Tapped Transformer	In electronics, a center tap (CT) is a contact made to a point halfway along a winding of a transformer. Unlike other transformers, this is a kind of transformer in which a wire is taken from the midpoint of the secondary coil and is used as a ground reference		
CHAdEMO	Charge de Move	CHAdEMO is the trade name of a quick charging method for battery electric vehicles delivering up to 62.5 kW by 500 V, 125 A direct current via a special electrical connector. A revised CHAdEMO 2.0 specification allows for up to 400 kW by 1000 V, 400 A direct current. It uses a proprietary charging connector system.		
CP	Charge Port	The component of an electric vehicle that functionally serves to permit the connection of a charging station connector to the vehicle for the purpose of charging the high voltage battery pack.		
	Charge Port Connector (J1772)	The component of a charging station that permits an electrical connection between the charging station and an electrified vehicle with a battery pack that can be charged with electrical energy from a local utility power company.		

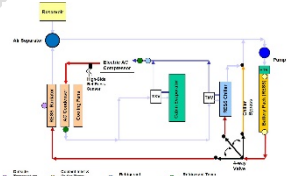

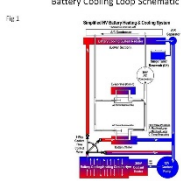
Gnd; G	Chassis Ground	A chassis ground is a common link between different metallic parts of a component to ensure an electrical connection between them. Examples include electronic instruments and motor vehicle chassis or body.		
	Choke	In electronics, a choke is an inductor used to block higher-frequency while passing direct current (DC) and lower-frequencies of alternating current (AC) in an electrical circuit. The name comes from blocking—"choking"—high frequencies while passing low frequencies.	 <p>Full Wave Rectifier with Series Inductor Filter</p> <p>Circuit Diagram</p> <p>Output Voltage Waveforms: <a href="http://www.CircuitsToday.com">www.CircuitsToday.com</a></p>	 <p>Supply from Rectifier</p> <p>Choke Input or L-Section Filter</p>
C.O.P.	Coefficient of Performance	The coefficient of performance or COP of a heat pump, refrigerator or air conditioning system is a ratio of useful heating or cooling provided to work required. Higher COPs equate to lower operating costs		
	Coil Turns (i.e., 4 Turn Coil)	The number of times a group of wires in hand is turned (wound into a loop) and then inserted into a stator slot		
CCS	Combined Charging Station (SAE Standard)	A vehicle charging connection system that combines Level 1, Level 2, and Level 3 charging configuration into one charge port connection to permit the transfer of electrical power from a power utility to the vehicle for the purposes of charging the high voltage battery. Its charging connector provides a standard for all transportation manufacturers.		

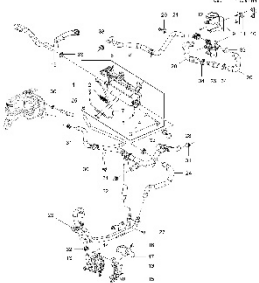

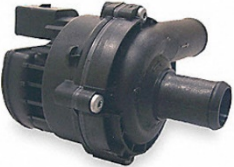

	Compound Planetary Gear Set		
	Compressor Drive System	<p>The electrical and electronic system that controls the speed and torque of the air conditioning compressor. The system commences from the high voltage battery pack (where it receives its operating energy) and completes the circuit at the air conditioning compressor stator windings.</p>	
	Compressor Control System	<p>An electronic and software/firmware system that controls the operation of an air conditioning compressor. The control system will use software/firmware to command or change electronic and electrical signals to transmit varying amplitude and frequency 3-Phase waveforms transferred to the stator windings of the air conditioning compressor. The control system uses pressure sensor, ambient temp, cabin temp, vehicle speed, etc. to determine air conditioning speed. Compressor speed, along with other air conditioning components (i.e., orifice tube, expansion valve, etc.). Compressor speed determines refrigerant circulation speed that determines how quickly heat can be removed from the refrigerant (and the vehicle cabin).</p>	



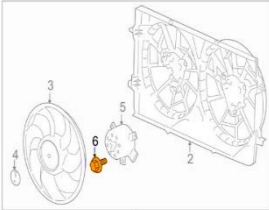

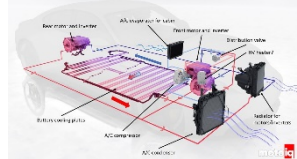


	Concentrated Winding	A singular winding that is wound around an iron (ferrite) that concentrates a magnetic field within a confined area. Concentrated winding provides a very high torque/amp.		
	Connecting Hoses	Hoses, of various sizes, that connect the heat exchanger, pumps, and control system in a series or series-parallel flow pattern permit liquid coolant to flow between the components in the cooling system circuit.		
CC/CV	Constant Current / Constant Voltage Charging	The Constant Current (CC) / Constant Voltage (CV) charging strategy will charge a battery at a specified CC until the battery reaches 90% of its capacity. The charger will then switch to a CV charging mode and begin to charge the battery at a lower rate until the maximum battery terminal voltage is achieved. It will then switch to a lower charging current until it reaches maximum battery terminal voltage. This will continue until the final CV charging step has been achieved.		

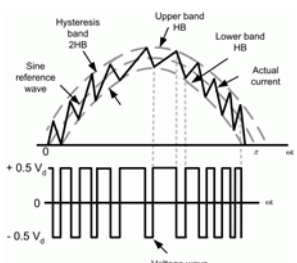
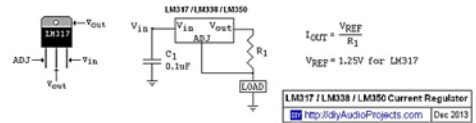
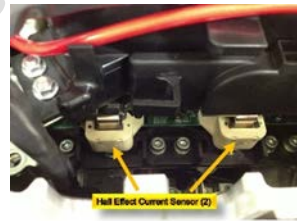
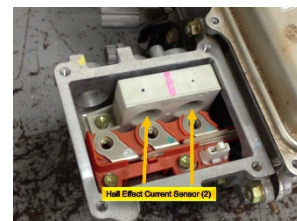
	Constant Power	The region on a graph that indicates that an electric machine is no longer in the rpm region for constant torque and indicates the rpm region where the electric machine is controlled with constant power (V x A). The constant power rpm region succeeds the constant torque rpm region.		
	Constant Torque	The region on a graph that indicates that an electric machine is in the rpm region where it will provide constant torque irrespective of the rpm. The constant torque region precedes the constant power rpm region on a graph.		
CP	Control Pilot (J1772)	The J1772 Pilot is a 1kHz +12V to -12V square wave, the Duty cycle (ratio high state to low state) determined the maximum available current. The EVSE sets the duty cycle the EV must comply to original setting or changes to the duty cycle.		
	Controller (DC-DC Converter)	A DC-DC Converter controller is an integrated circuit microcontroller that controls the output of the converter, to a commanded level, dictated by embedded Firmware		


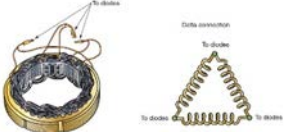
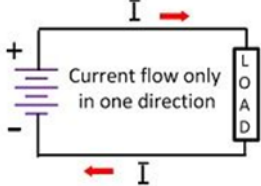
CAN	Controller Area Network	<p>A Controller Area Network (CAN) bus is a communication system made for vehicle intercommunication. This bus allows many microcontrollers and different types of devices to communicate with each other in real time and without a host computer. A CAN bus, unlike Ethernet, does not require any addressing schemes, as the nodes of the network use unique identifiers. This provides the nodes with information regarding the priority and the urgency of the transmitted message.</p>		
Coolant Chiller		<p>A device used to cool the temperature of a liquid that is passed through it. In the case of an electric vehicle system, a Chiller can be used to cool (chill) liquid entering a battery pack to ensure the modules/cells maintain an optimal operating temperature.</p>		 <p>Battery Cooling Loop Schematic</p> 

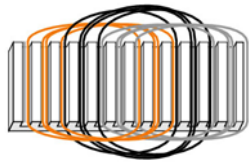
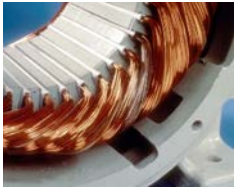
	Coolant Control Valve	An electrically controlled valve that directs coolant to various components of a system depending on the mode that the system is operating, by moving a valve or door. The control valve may be designed to move in two or more positions for directing the coolant.		
	Coolant Pump	A device that is used to transport coolant through components for the purpose of absorbing the heat of the components and transferring the warm/hot coolant to a heat exchanger, so the heat can be removed. The pump is typically electrically powered and controlled with a PWM signal. A system can utilize more than one coolant pump.		
	Coolant Pump (Electric)	Electric coolant pump for automotive products is a pump that driven by a 12v, 24v or 48v and is typically a series or permanent magnet brush dc motor. However, more recent designs are placing 3-Phase brushless 12V pump motors into the cooling circuits. The pump is powered by dc source (battery). It pressurizes the coolant to and has a high flow rate ensure the coolant circulates properly to components in the cooling system		

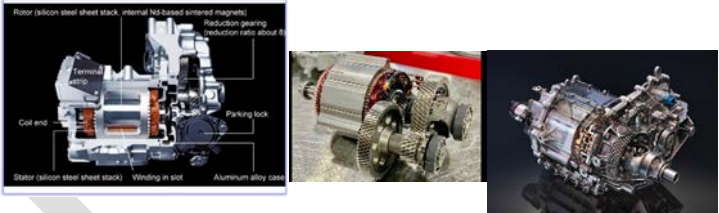


	Coolant Reservoir	The coolant reservoir is a container that holds the excess or overflowing coolant which is used in the system. The coolant reservoir is usually pressurized, is attached to the radiator and the engine with hoses, and is a central component in the system	
CTS	Coolant Temperature Sensor	A device that senses the temperature of a liquid by using a corresponding change in resistance with a change in temperature. Typically, a CTS uses a negative temperature coefficient design to decrease resistance as the temperature of the liquid increases.	
	Cooling Fan (Radiator)	An electrical radiator cooling fan is device that assists in regulating engine temperature by pulling or pushing air through a radiator. Electrical cooling fans traditionally use DC motors that utilizes energy from the vehicle electrical system	  <p><small>Only one part or sub-assembly in diagram included. See Item Specifics for Reference #. Diagram may not be specific to your vehicle. See Compatibility for vehicle specific diagram.</small></p>
	Cooling Loop	A phrase to describe how and where a cooling system is routed, and the components connected to the loop, throughout a system that uses air or liquid for the cooling medium.	
C	Coulomb	SI unit of electric charge, equal to the quantity of electricity transferred in one second by a current of one ampere.	

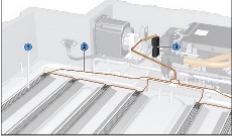

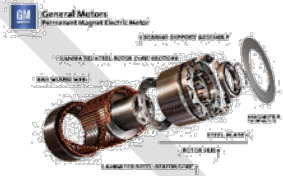

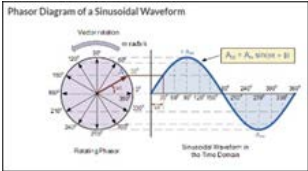


CEMF	Counter Electromotive Force	See BEMF		
	Current Regulation	3-Phase current from the Power Inverter to an electric machine is regulated within the 3-Phase sine waves delivered or received from the electric machine to ensure that current does not exceed the current commanded by the electric machine controller		
	Current Regulation	Current regulation control will perform constant adjustments while comparing it to the voltage in a circuit to ensure voltages are not affected while changes occur in load current		<p>LM317 / LM338 / LM350 Configured as a Current Regulator  <a href="http://diyAudioProjects.com/Technical/Current-Regulator/">http://diyAudioProjects.com/Technical/Current-Regulator/</a></p>  <p>LM317 / LM338 / LM350 Current Regulator  <a href="http://diyAudioProjects.com">http://diyAudioProjects.com</a> Dec 2013</p>
	Current Sensor (Power Inverter)	A current sensor is a device that detects electric current in a wire (typically Hall Effect design) and generates a signal proportional to that current. The generated output signal could be analog voltage, analog current or digital	 	
DCFC	DC Fast Charging	See Level 3 Charging		

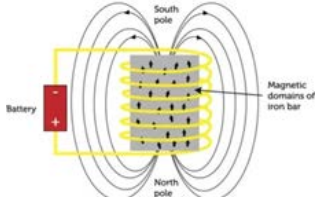

DI Coolant	Deionized Coolant	Deionized water can also be referred to as DI Water and simply means all the ions have been removed. This is important for applications where the highest purity water needs to be used. Deionized water has many applications where it is favored due to its high purity. In industrial situations involving machining or high temperatures, deionized water helps by having low conductivity, and in turn, this helps lower the temperatures during manufacturing. Automotive applications such as coolant systems see the benefit of using deionized water by increasing the lifespan of the motor. The reason deionized water is preferred is due to its resistance to electricity from it not having charged ions to carry a charge.		
	Delta Wound Stator	A 3-Phase stator design in which all 3 phases are connected in a Delta (triangle) shape that electrically connects them in parallel.		
DTC	Diagnostic Trouble Code	A specific hexadecimal code assigned to a specific vehicle system and component that identifies when an abnormal operating condition is occurring.		
	Differential			
DC	Direct Current	Direct current is the unidirectional flow of an electric charge. A vehicle 12V is a prime example of DC power. Direct current may flow through a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams		





DC-	Direct Current -	An electrical current which flows consistently in one direction. The current that flows in a flashlight or another battery powered appliance is direct current. DC- indicates the ground or negative polarity of the circuit.		
DC+	Direct Current +	An electrical current which flows consistently in one direction. The current that flows in a flashlight or another battery powered appliance is direct current. DC+ indicates the ground function of the circuit.		
	DC Bus	Battery powered systems have a positive and negative bus. A Direct Current (DC) bus is a term to define if a component is connected to the positive or negative side of a DC system.		
DC/AC	Direct Current to Alternating Current	A circuit within a battery charger system that changes direct current (DC) to alternating current (AC). The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry, and the global location.		
	Distributed Winding	A stator winding configuration that, places round wire windings in the stator slots that are spanned (Distributed) to a specific number of slots between each winding bundle, to widen the magnetic field that will interact with the rotor magnetic fields for smooth rotation.		


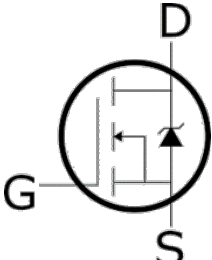
DU	Drive Unit	A gear reduction unit used to house an electric vehicle electric machine that typically does not include hydraulic clutches.		
	eAxle	A drive axle that is designed with the electric machine integrated as part of the axle assembly		
η	Efficiency	The efficiency of a system in electronics and electrical engineering is defined as useful power output divided by the total electrical power consumed (a fractional expression), typically denoted by the Greek small letter eta ( $\eta$ – ἥτα)		
	Electric Air Conditioning Compressor Assembly	The mechanical and electrical components that comprise an electric air conditioning compressor assembly		
	Electric Axle	See eAxle		

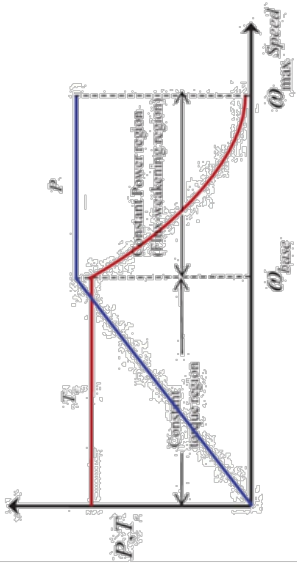
	Electric Grid Heater	A type of heater that utilizes a material, configured in a series or parallel pattern, that heats a component by transmitting an electric current through the material creating heat.		
EM	Electric Machine	A generic term that describes a unit that can provide both motoring and generating electrical power.		
EVSE	Electric Vehicle Supply Equipment	Electric vehicle supply equipment (EVSE) supplies electricity to an electric vehicle (EV). Commonly called charging stations or charging docks, they provide electric power to the vehicle and use that to recharge the vehicle's batteries. EVSE systems include the electrical conductors, related equipment, software, and communications protocols that deliver energy efficiently and safely to the vehicle. EVSE equipment is classified as Level 1 (120 volts AC), Level 2 (240 volts, AC), and DC Fast Charger (480 volts DC and higher).		
	Electrical Degrees	Vector (rotational) and sinusoidal (sine) wave cycles are constructed of 360° increments that comprise 1 cycle		

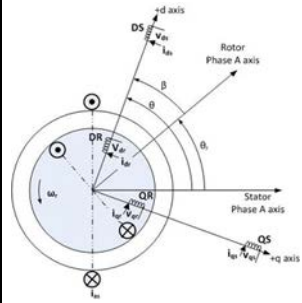

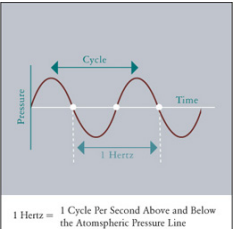


EMC	Electromagnetic Compatibility	A method of ensuring that electronic components that produce electrical (magnetic) noise are operationally compatible when the components are within a close or moderate proximity		
EMI	Electromagnetic Interference	Electrical signal noise generated from components that produce magnetic fields that can interfere with the operation of other electronic components that are in an immediate area		
EMI	Electromagnetic Interference (Gasket)	Electromagnetic shielding is the practice of reducing the electromagnetic field in a space by blocking the field with barriers made of conductive or magnetic materials. EMI shielding is utilized in power electronics gaskets, connectors, wires or, cables		
	Electromagnetic Pole	Each of the two points or regions of an artificial or natural magnet to and from which the lines of magnetic force are directed.		 <p>The diagram shows a battery connected to a solenoid. Magnetic field lines are shown as loops passing through the solenoid. Labels include 'South pole' at the top, 'North pole' at the bottom, and 'Magnetic domains of iron bar' pointing to the interior of the solenoid.</p>
EMF	Electromotive Force	See BEMF		
	Encapsulated Rotor	A manufacturing process for Induction Machines that has rotor bars covered (encapsulated) by a sleeve so no further diameter machining processes need to be performed after the rotor is cast.		 <p>The photograph shows a cylindrical rotor assembly. A red arrow points to a sleeve on the rotor. The label 'Steel Sleeve' is at the bottom.</p>

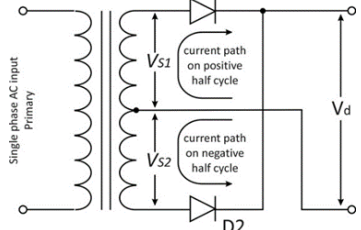
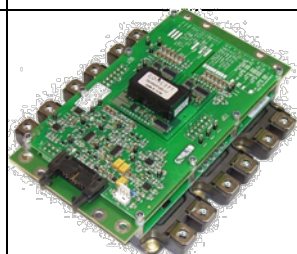
	Enclosure (Case)	An electrical enclosure is a cabinet for electrical or electronic components to mount internal parts and to prevent electrical shock to equipment users and protect the contents from the environment. The enclosure is the only part of the equipment which is seen by users		
	Encoder	 A digital sensor that senses the position and speed of an electric machine rotor but, does not provide absolute position of the rotor		
	End Turn	End turns are the area of electric machine windings which extend out from the slots at either end of a motor and appear as wire bundles that are held in place by dipping the stator in a varnish or poly material and wrapping the end turns in a Nomex-Mylar string to reduce the movement caused by the Lorentz Force		
Wh/L	Energy Density (Watt-Hours/Liter)	The watt-hours of energy stored within a specified volume area.		
ESS	Energy Storage System	A system that stores energy and is non-rechargeable (i.e., an onboard hydrogen storage tank for an FCEV)		

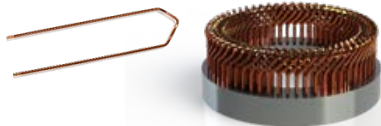
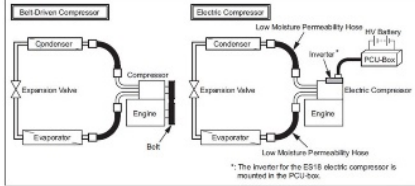
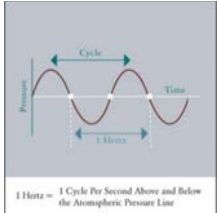
EREV	Extended Range Electric Vehicle	A small engine-powered generator or auxiliary power unit (APU) added to a battery electric vehicle to produce a plug-in electric vehicle (PEV). This generator sustains vehicle operation beyond the range provided by the batteries alone.		
	Faraday Shield	A container comprised of copper or other alloy material that will block magnetic fields from exiting or entering the container		
FET	Field Effect Transistor	The field-effect transistor is a type of transistor which uses an electric field to control the flow of current. FETs are devices with three terminals: source, gate, and drain		



	<p>Field Weakening</p>	<p>As a motor rotates, it creates a back-EMF voltage across its coils proportional to the speed of rotation. In order to force current into the coils, the applied voltage must exceed this voltage. The limitation comes when the speed of rotation is such that the required applied voltage is greater than the voltage available from the inverter electronics. At this point, the inverter can no longer supply current to the stator coils and the motor will not generate any torque. If the rotor is externally forced to rotate faster, the back-EMF voltage will exceed the power supply voltage, and current will attempt to flow from the coils into the power supply, producing a torque counter to the direction of rotation. In practical terms, this means that for a given power supply voltage, and a required coil current, there is a maximum speed of rotation obtainable before inverter saturation occurs preventing more coil current from flowing into the coil. This speed is referred to as the base speed. In order to exceed the base speed, the back-EMF voltage must be reduced. Since the back-EMF is also a function of the magnetic flux between rotor permanent magnets and stator coils, reducing this magnetic flux will reduce the back EMF voltage. The inverter then does not enter saturation, current can flow into the stator coils, and the motor can rotate faster, although at the expense of reduced maximum torque. The basic principle of field weakening, as its name suggests, is to weaken the magnetic field strength of the rotor magnets, by applying an opposing magnetic field on the stator coils in phase with the rotor field. This is the direct axis (d-axis) in field-oriented control, and acts to reduce the back EMF generated by the motor as it rotates. Without field weakening, a motor drive can only operate the machine up to base speed in the plot below. That's the constant torque region, you can achieve full torque in all that speed region, and then torque suddenly drops to zero.</p>	 <p>The graph plots Power (P) on the vertical axis against Speed (<math>\omega</math>) on the horizontal axis. A horizontal line represents the constant power supply voltage. The region where the motor operates at constant torque is shown as a blue line with a constant vertical height, extending from the origin to a speed labeled <math>\omega_{base}</math>. Beyond <math>\omega_{base}</math>, the motor enters the field weakening region, shown as a red curve that rises to meet the constant power supply voltage line at a speed labeled <math>\omega_{max\ speed}</math>. The area between the constant power supply voltage line and the red curve is labeled 'Constant Power region (field weakening region)'. The area under the blue line is labeled 'Constant Torque region'. The maximum torque in the constant torque region is labeled <math>T_{max}</math>, and the maximum torque in the field weakening region is labeled <math>T_{max}'</math>.</p>
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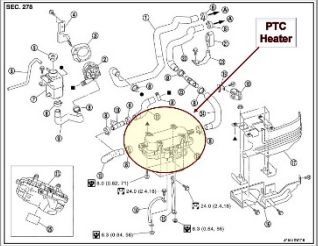
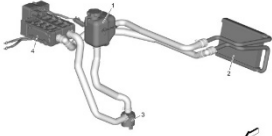


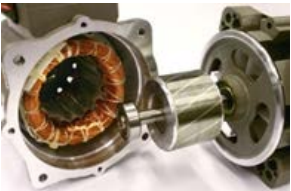
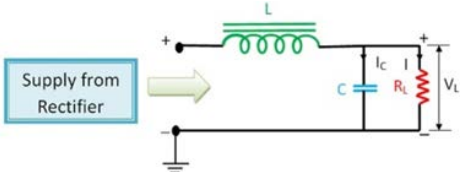
	Flux Vector	Vector control, also called field-oriented control (FOC), is a variable-frequency drive (VFD) control method in which the stator currents of a three-phase AC electric motor are identified as two orthogonal components that can be visualized with a vector. One component defines the magnetic flux of the motor, the other the torque. The control system of the drive calculates the corresponding current component references from the flux and torque references given by the drive's speed control.		
FAS	Flywheel Alternator Starter	A configuration of HEV that places the electric machine in series between the engine and transmission but, the torque is supplied in parallel with the powertrain driveline		
	Fractional Slip	The relative rpm speed difference between an Induction Machine rotor and stator given in a percentage unit.		
Hz	Frequency (Hertz)	The SI unit of frequency, equal to one cycle per second.		 <p>1 Hertz = 1 Cycle Per Second Above and Below the Atmospheric Pressure Line</p>


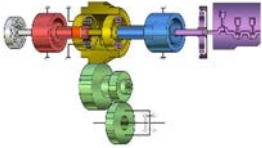
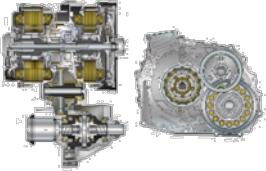



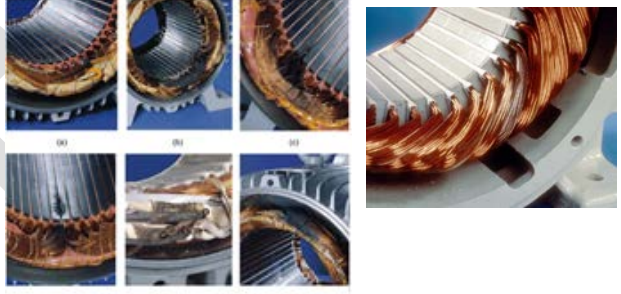
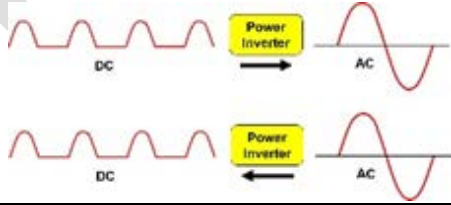
FCEV	Fuel Cell Electric Vehicle	A vehicle containing a fuel cell using stored hydrogen gas and oxygen pumped into the fuel cell to create electricity that is transferred to an electric propulsion system for propelling a vehicle		
	Full Wave Rectifier	A full wave rectifier is an efficient mechanism for converting alternating current into direct current. A full wave rectifier is a device that converts an alternating signal, with positive and negative signal components, to one in which all parts of the signal are positive.		
FWRB	Full Wave Rectifier (Bridge)	Full wave bridge rectifier. A Full wave rectifier is a circuit arrangement which makes use of both half cycles of input alternating current (AC) and converts them to direct current (DC). The classical use of a full wave rectifier bridge is the use a transformer that is attached to 4 diodes arranged as a bridge to rectify AC to DC. This arrangement is known as a Bridge Rectifier.		
	Gate Driver	A gate driver is a power amplifier that accepts a low-power input from a controller IC and produces a high-current drive input for the gate of a high-power transistor such as an IGBT or power MOSFET. Gate drivers can be provided either on-chip or as a discrete module		

Gnd; G	Ground (Utility Ground)	<p>Electrical grounding, otherwise known as earthing, primarily provides a measure of safety against electric shocks by acting as a safety line to redirect electric current in the event of short circuits. For household appliances, this is accomplished by a three-pronged electrical outlet with a dedicated grounding prong. Grounding is also a way of providing a current return path in some electrical transmission systems. Since the earth is an electrically neutral body, it is said that the ground, or earth, is at zero electric potential, and all other voltages are determined relative to this ground potential. This allows the ground to function as an extended neutral line in that it completes the transmission electric circuit by acting as a source of electrons for the electric generator and as an endpoint for electrons after the electrical load. This means that instead of a wire that provides a current return path from the load back to the voltage source as seen in most simple circuits, the ground acts as that return path.</p>	
	Hairpin (Bar) Wound Stator Winding	<p>A stator winding comprised of square or rectangular wire that, provides much higher slot copper fill than traditional round wire, and results in higher electric machine torque.</p>	
HVAC	Heating Ventilation & Air Conditioning	<p>HVAC stands for Heating Ventilation and Air Conditioning. Its purpose in a vehicle is to clean, cool, heat, regulate, ventilate and dehumidify the air entering the cabin, depending on the inputs of the operator as well as electronic sensors.</p>	 <p>The diagrams show two HVAC systems. The left diagram is a 'Belt Driven Compressor' where the compressor is mechanically connected to the engine via a belt. The right diagram is an 'Electric Compressor' where the compressor is powered by an inverter connected to the battery. Both diagrams show the refrigerant cycle components: Condenser, Compressor, Expansion Valve, and Evaporator. Labels include 'Low Moisture Permeability Hose' and 'PCU/Inverter'.</p>
Hz	Hertz	<p>The SI unit of frequency, equal to one cycle per second.</p>	 <p>The graph shows a sine wave with 'Amplitude' on the vertical axis and 'Time' on the horizontal axis. One full cycle is marked with a double-headed arrow and labeled '1 Cycle'. Below the graph, it states: '1 Hertz = 1 Cycle Per Second Above and Below the Atmospheric Pressure Line'.</p>



HV	High Voltage	Per the SAE, high voltage is defined as a DC voltage that is $\geq 60V$ or 30VACRMS		
hp	Horsepower	A unit of measurement of power (equal to 550 foot-pounds per second or 745.7 watts), or the rate at which work is done, usually in reference to the output of engines or motors. ... The term was adopted in the late 18th century by Scottish engineer James Watt to compare the output of steam engines with the power of draft horses. 1 hp = 746W		
	HVAC Controller	An electronic, dedicated microcontroller that controls the operation of the HVAC system. The HVAC controller is typically located in the HVAC control head electronic assembly. For the Power Electronics Cooling Loop, the HVAC Controller or the PCM could control the speed of the electric coolant pump position of coolant control valve.		
HEV	Hybrid Electric Vehicle	A vehicle that uses a combination of an engine and electric propulsion system to propel a vehicle		
	Hydraulic Clutch	Hydraulic clutches use incompressible fluids such as oil to transfer input movement from one transmission gear member to another.		 <small>Car Reversing Clutch Automatic Transmission Drum Assembly</small>

	<p>Immersion PTC Heater</p>	<p>The PTC immersion heater is designed to be immersed in a liquid, heat the liquid, and an electric fluid pump transfers the hot liquid to a heater core where the liquid heat can be extracted by blowing air over the heater core tubes and into the vehicle cabin. Its resistance technology will increase of resistance and decrease heater power at elevated temperatures. This characteristic of the PTC heaters makes them self-regulating, as their output power saturates at a fixed temperature.</p>	 	 
<p>IM</p>	<p>Induction Machine</p>	<p>A brushless 3-Phase electric machine used in electric vehicles that uses mutual induction to magnetize the rotor using the magnetic field from the stator field that results in electric machine rotor rotation. It does not use permanent magnets.</p>		
	<p>Input Current</p>			
	<p>Input Filter</p>	<p>An Input Filter will filter electrical signals to ensure a reduction of electrical noise that enters a component to system. This will reduce electrical losses, increase efficiencies, and enhance reliability of an electronic system</p>	 <p>Choke Input or L - Section Filter</p>	
	<p>Input voltage</p>	<p>The voltage that is supplied from utility or other source to an electrical component.</p>		

IGBT	Insulation Gate Bipolar Transistor	Insulated Gate Bipolar Transistor is a power transistor that has characteristics of both MOSFET and bipolar junction transistors (BJTs). Introduced in the 1980s, the IGBT handles high current, a characteristic of BJTs, but enables fast switching with greater ease of control. IGBTs are found in home appliances, electric cars and digital stereo power amplifiers. Modules with multiple IGBTs can support very high voltage and amperage.		
	Integrated (Electric Machine) Architecture	A powertrain design that places the electric machines inside design of a transmission, transaxle, or eAxe with all other transmission internal components		
IPM	Interior Permanent Magnet Machine	A brushless 3-Phase electric machine used in electric vehicles that uses permanent magnets mounted below the surface of the rotor to interact with the stator magnetic field that results in rotor rotation. The magnets can be single or double row		 <p>Magnet Slots (8 Pole Rotor)</p> <p>Laminations Outer = 6.3112" Diameter</p>

	Inter-turn Winding Short	The short circuit occurs between the same phase winding wires or when the fault occurs between the same winding turns. This results in the total current circulation in the number of turns (ampere turns) become reduces. It affects the total flux produced in winding depending upon the fault location of the winding). This type of failure is also known as an in turn short.		
	Invert (an electrical signal)	The inverting of a signal means that it can be changed from one type of signal to another. Example: An AC signal can be inverted from AC to DC or, DC to AC. A Power Inverter changes AC to DC or DC to AC by the use of IGBTs and Rectifier Diodes.		
	J1772 Charge Receptacle	SAE J1772 (IEC Type 1), also known as a J plug, is a North American standard for electrical connectors for electric vehicles maintained by the SAE International and has the formal title "SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler".		
J	Joule	One joule is the equivalent of one watt of power radiated or dissipated for one second		
kW-h	Kilowatt-Hour	A measure of electrical energy equivalent to a power consumption of 1,000 watts for 1 hour.		
kW	Kilowatts	1kW = 1,000 Watts; 1kW = 1.34hp; 103kW/0.746 = 138hp; (138hp)(0.746) = 103kW		






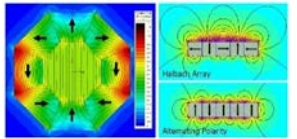
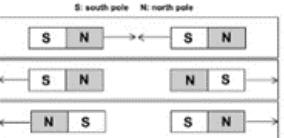
kW/kg	Kilowatts/Kilogram	A unit of specific energy commonly used to measure the density of energy in batteries and capacitors (i.e., the mass of battery and the number of watts that it can deliver)		
	Laminations	Thin wafers (0.015" - 0.030") of electrical grade silicon steel used in the rotor and stator (also known as the lamination stack). Stator laminations reduce eddy current by insulating the core. Thin silicon steel plates are stacked on top of one another around the center, preventing eddy current flow. With the eddy current reduced, the stator core can maintain higher efficiency. Silicon steel has the advantage of high saturation flux density	 	
	Lead and Lag (i.e., Vector Lead and Lag)	Lead is the number of sine wave degrees (up to +80°) electrical that the stator magnetic field will lead the rotor magnets speed (rpm) to provide propulsion positive torque. +80° provides the maximum torque. Lag is the number of sine wave degrees (up to -80°) electrical that the stator magnetic field will lag the rotor magnet speed (rpm) to provide regenerative braking torque. -80° provides the maximum negative torque.		
	Level 1 Charging	Level 1 equipment provides charging through a 110V/120 volt (V), alternating-current (AC) plug and requires a dedicated circuit. Generally speaking, Level 1 charging refers to the use of a standard household outlet. Level 1 charging equipment is standard on vehicles and therefore is portable and does not require the installation of charging equipment. On one end of the provided cord is a standard, three-prong household plug. On the other end is a J1772 connector, which plugs into the vehicle.		

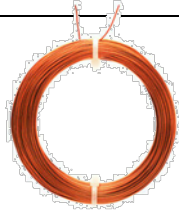


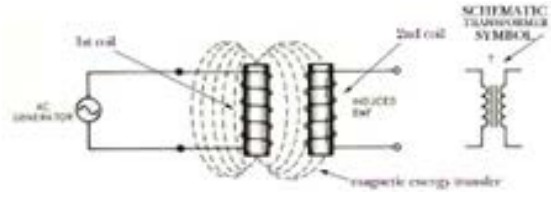
	Level 2 Charging	Level 2 equipment provides charging through a 220/240 volt (V), alternating-current (AC) plug and requires a dedicated circuit. Level 2 charging equipment is wall or pedestal mounted and therefore, requires installation by a professional. The charging equipment utilizes a J1772 connector to interface (connect) to the vehicle.	
	Level 3 Charging	DC fast chargers are the highest-powered EV chargers on the market. Most DC fast chargers on the market charge at rates of 25-50 kW but, can perform higher charging rates. At current charging speeds, they are ideal for places where a person would spend 15 minutes to an hour, such as restaurants, recreational areas and shopping centers. DC fast chargers require inputs of 480+ volts and 100+ amps (50-60 kW) and can produce a full charge. New generations of DC fast chargers are gaining traction and can produce 150-350 kW of power. It is important to note that not every EV model is capable of DC fast charging, and therefore, they cannot be utilized by every EV driver. DC fast chargers have multiple standards for connectors, whereas there is only one common standard for Level 1 and 2 charging (SAE J1772). DC fast chargers have three types of connectors: CHAdeMO, CCS or Tesla.	
L1	Line 1 (Utility Hot Black Wire)	The hot line (also known as a phase line) is a wire in the latter stages of the distribution grid (like inside your house) that has a non-zero average voltage relative to the Earth (also called ground), as opposed to neutral lines, which are ideally at ground potential. Since hot lines carry electricity that has a high potential energy, they are shock hazards. Many electrical devices minimize this risk by taking advantage of polarized electrical outlets to ensure that the on/off switch is on the hot line, effectively limiting the length of the hot line, which minimizes the risk of shock as only a relatively small segment of the wiring (the wire before the switch, as opposed to the whole device) is considered "hot" when the circuit is open. The hot wire color is Black and has a distinct slot in electrical outlets.	

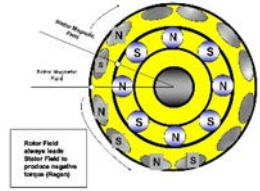
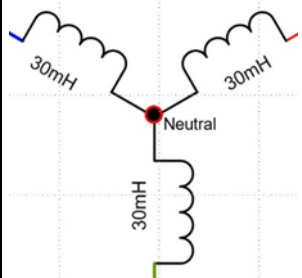


L2	Line 2 (Utility Neutral White)	Neutral lines are at zero potential relative to the ground, meaning that ideally, they do not pose a shock hazard. This is because neutral lines are wires connected deep in the ground. That means that the neutral side of the outlet would carry most of the electric energy directly into the ground and very little current would go through a person touching the device. The neutral wire color is White and has a distinct slot in electrical outlets		
LCO	Lithium Cobalt Oxide	A type of Lithium battery containing Cobalt Oxide as its main reactive chemical components		
LiFePO	Lithium Iron Phosphate (LiFePO <sub>4</sub> )	A type of Lithium battery containing an Iron Phosphate as its main reactive chemical components		
LMO	Lithium Manganese Oxide	A type of Lithium battery containing Manganese Oxide as its main reactive chemical components		
NCA	Lithium Nickel Cobalt Aluminum Oxide	A type of Lithium battery containing a Nickel, Cobalt, & Aluminum as its main reactive chemical components		
NMC	Lithium Nickel Manganese Cobalt Oxide	A type of Lithium battery containing Nickel, Manganese, & Cobalt as its main reactive chemical components		
LTO	Lithium Titanate	A type of Lithium battery containing Titanate as its main reactive chemical component		

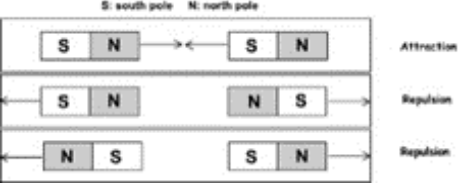
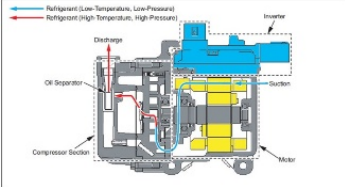




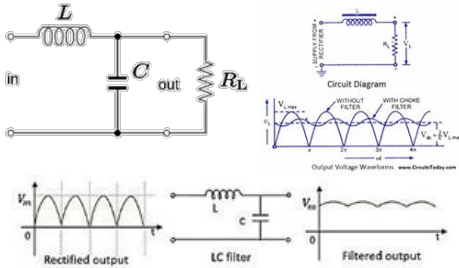
	Load Tester	A load tester is comprised of system that will permit it to simulate a load on the low voltage electrical system (using carbon discs) so the performance of a DC-DC Converter can be measured and analyzed to determine its overall state-of-health and capability.		
LIN	Local Interconnect Network Bus	LIN is a serial network protocol used for communication between components in vehicles. The need for an inexpensive serial network arose as the technologies and the facilities implemented in the vehicle increased, while the CAN bus was more expensive to implement for every component in the car.		
	Magnet "V" Shape	Rotor interior magnets that are configured in the shape of the alphabetical letter "V" that permits a smoother BEMF sine wave		
	Magnet Halbach Array	A concept or reorienting magnets to optimize magnetic field strength that exceeds traditional magnet North & South orientation		
	Magnet Pole	Each of the two points or regions of an artificial or natural magnet to and from which the lines of magnetic force are directed.		


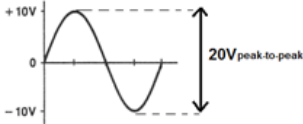
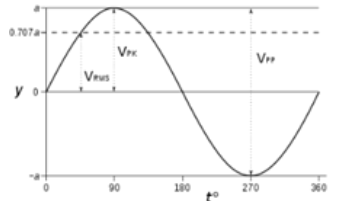
	Magnet Wire	Wire used in electric machines, transformers, relays, etc. that is a copper alloy core and covered by a coating, so the windings are electrically isolated but, not magnetically isolated from each other	
MOSFET	Metal Oxide Semiconductor Field Effect Transistor	The metal–oxide–semiconductor field-effect transistor, also known as the metal–oxide–silicon transistor, is a type of insulated-gate field-effect transistor that is fabricated by the controlled oxidation of a semiconductor, typically silicon.	
MC	Microcontroller	See Motor Controller	
MCA	Motor Circuit Analysis	An electric machine testing process in which DC Resistance, Inductance, Impedance, Capacitance, Phase Angle, Current to Hz Ratio, Dissipation Factor, and insulation Resistance metrics are used to determine electric machine state of health	
	Motor Controller	A microprocessor-based system (mounted on a printed circuit board with signal conditioning) that controls the torque and speed of an electric machine in HEV, PHEV, BEV, and FCEV	
	Mutual Induction	The concept of placing two separate winding groups within close proximity (or winding one group over the top of another). The result is if one (primary) winding has an expansion or collapsing of its magnetic fields, induced voltages and currents will be generated the adjacent (secondary) winding but, will be out of phase with the primary winding.	

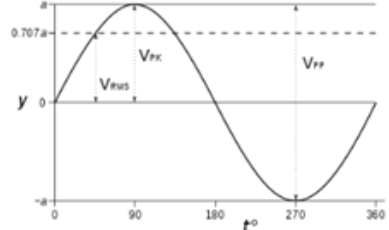
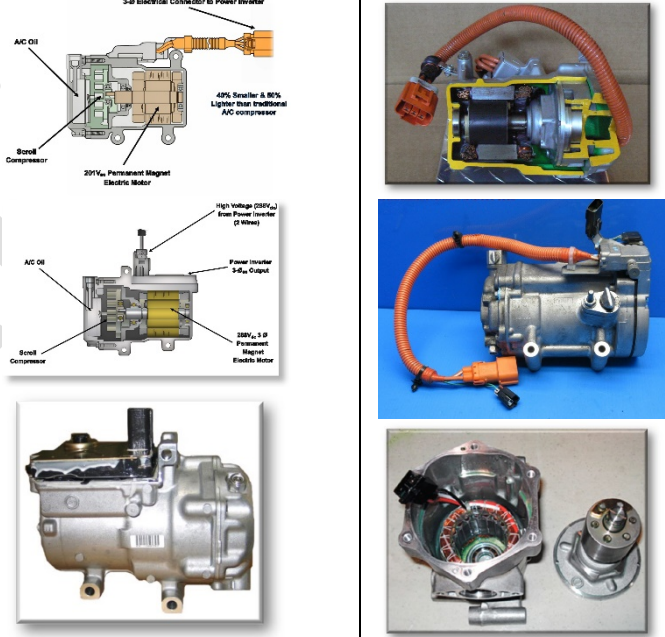

	Negative Slip%	Slip% is an alternative term for Torque. The percent of speed (Hertz) that the stator field is being switched slower than the rotational rpm of the rotor. When the stator field Hz is slower than rotor rotational speed, the Slip% is Negative (vehicle being driven in reverse or during regenerative braking mode). Example: If the stator frequency speed is an equivalent of 90rpm and the rotor is rotating at 100rpm then, the Slip is -10%. Maximum Negative Slip% for an Induction Machine is -15% before torque breakdown occurs		
	Neutral (electric machine)	The common point at which the 3-Phases of an electric machine are connected within a Wye or Delta wound stator		
NiMH	Nickel Metal Hydride	A battery chemistry that utilizes a Nickel Metal Hydride as its primary storage material		


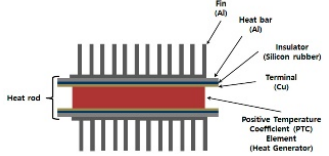

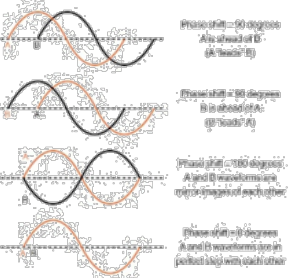


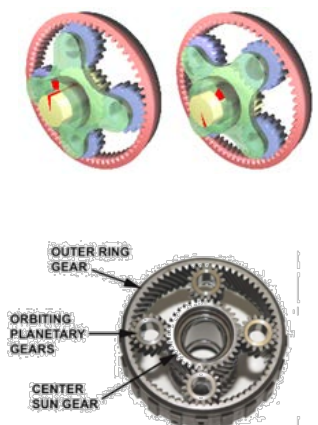
	<p>North Pole (Magnet or Electromagnet)</p>	<p>1. A permanent magnet is a piece of iron (or an ore, alloy, or other material) that has its component atoms so ordered that the material exhibits properties of magnetism, such as attracting other iron-containing objects or aligning itself in an external magnetic field. A magnet consists of a North and South Pole that can be used to cause electrical or mechanical movement within a component</p> <p>2. An electromagnet is a soft metal core made into a magnet by the passage of electric current through a coil surrounding it and will act as a permanent magnet but, it does need electrical current to activate the magnetic fields</p>		
	<p>(Compressor) Oil Separator</p>	<p>The oil separator is capable of separating oil from the refrigerating gas mixture so as to improve the performance of refrigerating air conditioning system and save energy.</p>		
<p>OBC; OBCM</p>	<p>On-Board Battery Charger Module</p>	<p>An on-board charging module (OBCM) is used in an electric vehicle (EV) or plug-in hybrid electric vehicle (HEV) to charge the high voltage traction battery. The On-Board charger system converts the AC input from the grid to a DC input which charges the battery.</p>		

	Open Slot Rotor	A manufacturing process for Induction Machines where the rotor bars are not covered by a sleeve but, would require machining processes to be performed after the rotor is cast to acquire the correct rotor diameter	
	Oscilloscope	a device for viewing oscillations, as of electrical voltage or current, by a display on the screen of a cathode ray tube or by digital conversion	
	Output Current	The rated output current is the maximum load current that a power source can provide at a specified ambient temperature. A power source can never provide more current than its rated output current unless there is a fault, such as short circuit at the load	
LC	Output Inductor Capacitor Filter	An LC circuit, also called a resonant circuit, tank circuit, or tuned circuit, is an electric circuit consisting of an inductor, represented by the letter L, and a capacitor, represented by the letter C, connected together	

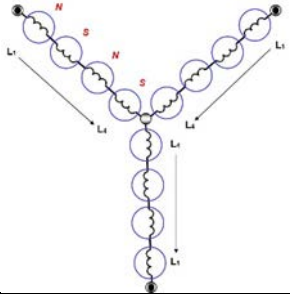
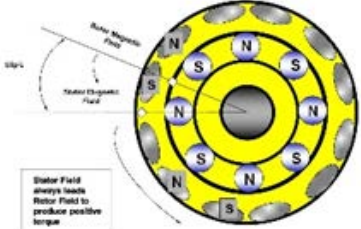
	Output Power	Output electrical power is the power supplied by the power producing device (up to its maximum rated output) to an external circuit		
PID	Parameter Identification	OBD-II PIDs (On-board diagnostics Parameter IDs) are codes used to request data from a vehicle, used as a diagnostic tool. ... All on-road vehicles and trucks sold in North America are required to support a subset of these codes, primarily for state mandated emissions inspections.		
PD	Partial Discharge	A partial discharge (PD) is an electrical discharge or spark that bridges a small portion of the insulation between two conducting electrodes. Partial Discharge can happen at any point in the insulation system, where the electric field strength exceeds the breakdown strength of that portion of the insulating material.		
Pk	Peak (Sinusoidal Waveform)	One half (180°) of a full 360° alternating current sine wave		

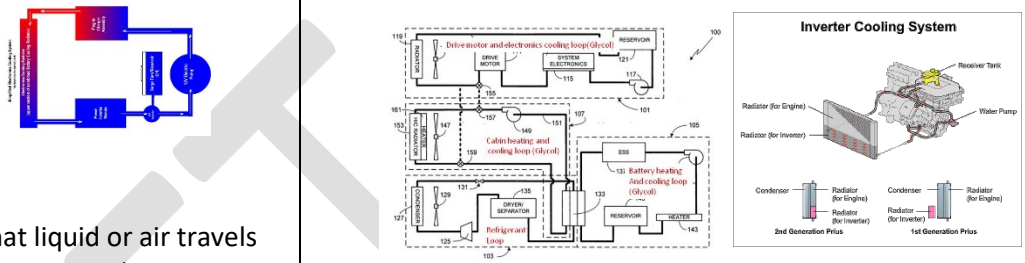
Pk-Pk	Peak-to-Peak (Sinusoidal Waveform)	Peak-to-peak (pk-pk) is the difference between the maximum positive and the maximum negative amplitudes of a waveform, as shown below. If there is no direct current ( DC ) component in an alternating current ( AC ) wave, then the pk-pk amplitude is twice the peak amplitude.		
	Permanent Magnet A/C Compressor	An Electric machine that, utilizes permanent magnets that are located on the surface or interior of the rotor, for coupling the magnetic field of the rotor magnets to the magnetic field of the stator causing the rotor to rotate		
PAG	Polyalkylene Glycol Oil	PAG oil, or Polyalkylene Glycol, is a fully synthetic hygroscopic oil specifically designed for automotive air conditioner compressors. It is used in automotive air conditioning systems to lubricate the compressor.		

POE	Polyol Ester Oil	Polyol ester oil is a type of synthetic oil used in refrigeration compressors that is compatible with the refrigerants R-134a, R-410A and R-12. It is recommended by experts as a replacement for hydrofluorocarbons		
PTC Heater	Positive Temperature Coefficient Heater	Positive Temperature Coefficient (PTC) heaters are self-regulating heaters that run open loop without any external diagnostic controls. As its temperature increases, the electrical resistance of the material also increases, thus limiting the current flow.		
PM	Permanent Magnet Machine	An Electric machine that, utilizes permanent magnets that are located on the surface or interior of the rotor, for coupling the magnetic field of the rotor magnets to the magnetic field of the stator causing the rotor to rotate		
$\phi$ ; $\phi$	Phase Angle (Phase Shift)	Describes the phase shift between total voltage and total electric current. In the voltage triangle this matches the phase shift between total voltage and active voltage. For the resistance triangle the phase shift lies between the impedance and effective resistance vector. When voltage and current waveforms are superimposed Power Factor is Unity (perfect)		

	Planetary Gear Set	An epicyclic gear train (also known as planetary gear) consists of two gears mounted so that the center of one gear revolves around the center of the other. A carrier connects the centers of the two gears and rotates to carry one gear, called the planet gear or planet pinion, around the other, called the sun gear or sun wheel. The planet and sun gears mesh so that their pitch circles roll without slip. A point on the pitch circle of the planet gear traces an epicycloid curve. In this simplified case, the sun gear is at the center (sun gear) and the planetary gear(s) rotate and revolve around the sun gear.		
PHEV (PHV)	Plug-In Hybrid Electric Vehicle	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).		
PHEV/PHV	Plug-In Hybrid Vehicle	A PHEV is defined as a vehicle with an engine combined with an electric propulsion system that utilizes stored energy from a battery with a capacity of at least four kilowatt-hours, is capable of being charged from an external source		


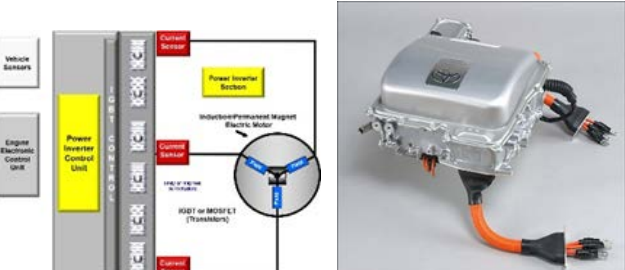



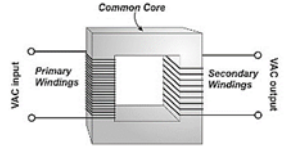
Poles/ $\phi$	Poles Per Phase	The number of stator winding for each phase of an electric machine. If each phase of an electric machine has 4 windings for each phase of a 3-Phase electric machine then, it is considered to be a 3-Phase - 4 pole machine (or a total of 12 poles for the entire machine)		
	Positive Slip%	Slip% is an alternative term for Torque. The percent of speed (Hertz) that the stator field is being switched faster than the rotational rpm of the rotor. When the stator field Hz is faster than rotor rotational speed, the Slip% is Positive (or, vehicle traveling in the forward direction in propulsion mode). Example: If the stator frequency speed is an equivalent of 100rpm and the rotor is rotating at 90rpm then, the Slip is 10%. Maximum Positive Slip% for an Induction Machine is 15% before torque breakdown occurs		
	Power Density	Power density is the amount of power per unit volume. In energy transformers including batteries, fuel cells, motors, etc., and power supply units or similar, power density refers to a volume. It is then also called volume power density, which is expressed as $W/m^3$		
W/L	Power Density (Watts/Liter)	Watts of electric power that can be stored in the volume (area) of 1 liter		

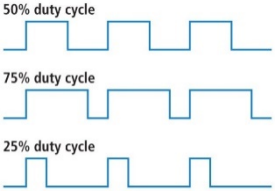

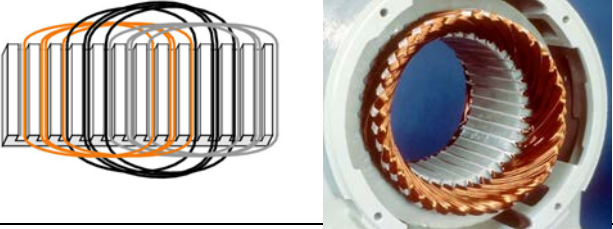
	<p>Power Electronics Cooling Loop</p>	<p>A cooling loop is the route that liquid or air travels throughout a connected system to cool components that are part of the loop.</p>	
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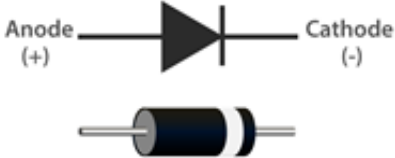
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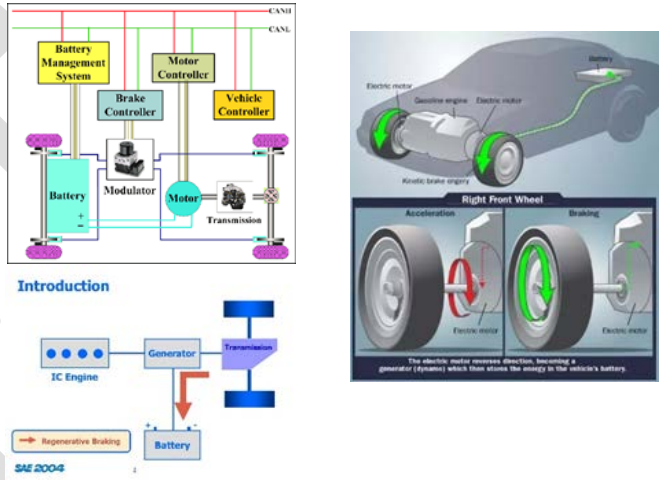
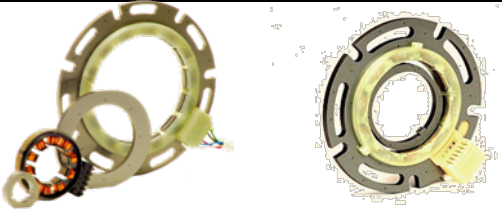
<p>PF</p>	<p>Power Factor Correction</p>	<p>Power factor is an expression of energy efficiency. It is usually expressed as a percentage—and the lower the percentage, power usage is less efficient. Poor Power Factor means that the system needs to consume more electrical power to do the same amount of work. This will reduce the range of an electric vehicle or reduce fuel economy of a hybrid/plug-in vehicle. Low Power Factor can also cause higher component temps and can reduce the service life of the component. Power factor (PF) is the ratio of working power, measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA). Apparent power, also known as demand, is the measure of the amount of power used to run machinery and equipment during a certain period. It is found by multiplying (kVA = V x A). The result is expressed as kVA units. PF expresses the ratio of true power used in a circuit to the apparent power delivered to the circuit. A 96% power factor demonstrates more efficiency than a 75% power factor. PF below 95% is considered inefficient in many regions.</p>	 <p><b>Making sense of power factor: The beer analogy</b></p> <p>Beer is a fine drink (kW)—the useful power, or the useful beer, is the energy for cooking with. This is the part you want.</p> <p>Foam is reactive power (kVAR)—the foam is wasted power, or bad power, as the energy being produced that isn't doing any work, such as the production of heat or alcohol.</p> <p>The mug is apparent power (kVA)—the mug is the container power, or the power being delivered by the utility.</p> <p>If a circuit were 100% efficient, demand would be equal to the power available. When demand is greater than the power available, a class is placed on the utility system. Many utilities add a demand charge to the bills of large customers to offset differences between supply and demand when supply is more than demand. For most utilities, demand is calculated based on the average load placed within 15 to 30 minutes. To comply with requirements and to regulate the utility meter have more accurate capacity available than if load was measured over a longer interval.</p>
	<p>Power Inverter</p>	<p>A power electronic unit that converts dc electrical power to AC electrical power in single or multi-phase systems</p>	

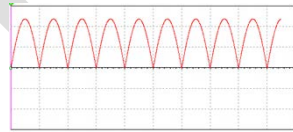
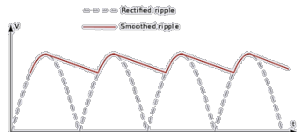
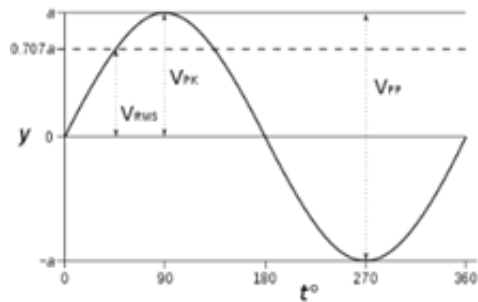
	Power Inverter Module	See Power Inverter		
PCM	Powertrain Control Module	A power-train control module, abbreviated PCM, is an automotive component, a control unit, utilized in vehicle control systems. Its operation is to control engine functions but, can also control transmission functions. For the Power Electronics Cooling Loop, the HVAC Controller or the PCM could control the speed of the electric coolant pump position of coolant control valve.		
	Primary Transformer Winding	The primary winding is the coil that draws power from the source. The secondary winding is the coil that delivers the energy at the transformed or changed voltage to the load		
	Proximity Detection	A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation, and looks for changes in the field or return signal		

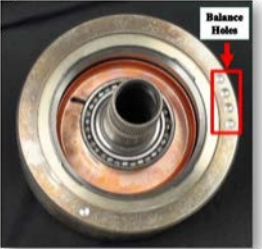
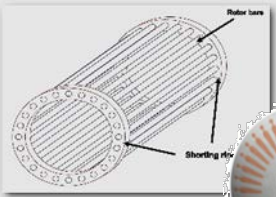
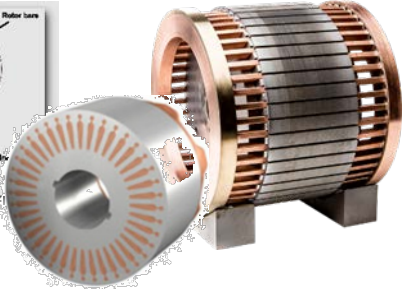
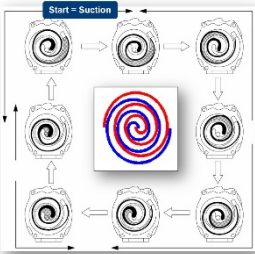
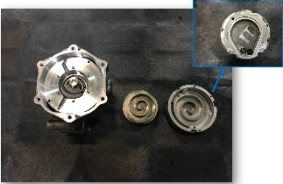
<p>PWM</p>	<p>Pulse Width Modulation</p>	<p>Pulse-width modulation (PWM) is a modulation process or technique used in most control systems for encoding the amplitude of a signal right into a pulse width or duration of another signal, usually a carrier signal, for transmission. The purpose of PWM is to control the power that is supplied to various types of electrical devices, most especially to inertial loads such as AC/DC motors. PWM is also known as duty cycle</p>	
	<p>Radiator (Heat Exchanger)</p>	<p>A heat exchanger is a system used to transfer heat between two or more fluids. Heat exchangers are used in both cooling and heating processes. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact</p>	
	<p>Random Wound Stator Winding</p>	<p>A stator manufacturing process in which magnet wire is placed in each stator slot by a winding machine that will place each wire of a coil in the slot in a random position</p>	

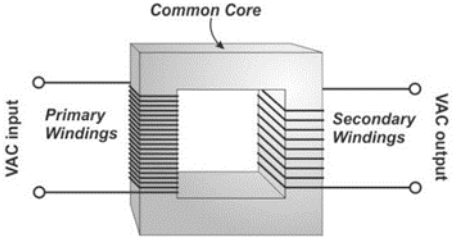
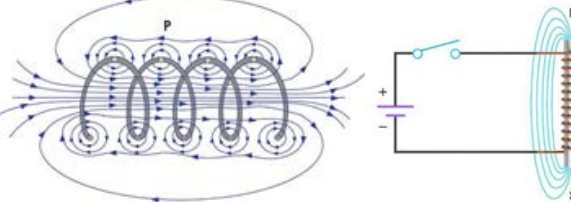

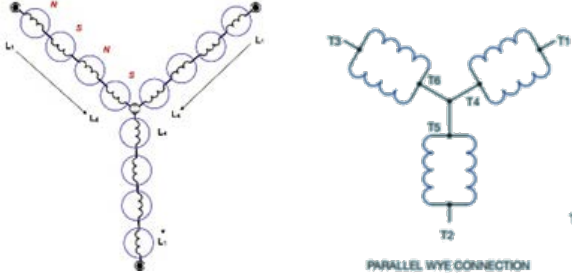
	Rare Earth Magnet	<p>The rare earth magnet family is derived from what is called rare earth which is an ore from which both Neodymium &amp; Samarium are extracted. These 2 elements listed as lanthanides on the periodic table are the namesakes of the 2 most powerful permanent (can't turn them on and off like electromagnets) magnets on the planet.</p> <p>Neodymium is the strongest with Samarium cobalt is a very close 2nd place in terms of strength. Neodymium the strongest and most affordable type of rare-earth magnet. Invented in the 1980s, it's made of a combination of neodymium, iron and boron</p>	
RESS	Rechargeable Energy Storage System	An alternative name for a Battery Pack	
D	Rectifier Diode	<p>A diode allows current in only one direction. It can be used to "rectify" AC current into a DC current (i.e., an alternator operates with positive and ground or 0V negative to charge a 12V vehicle battery). Such a diode can also be used to prevent current from flowing in the "wrong" direction in a circuit.</p>	

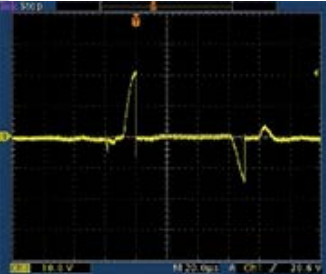
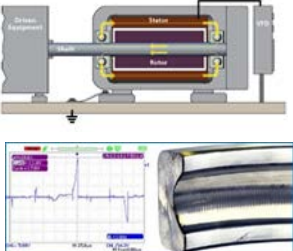
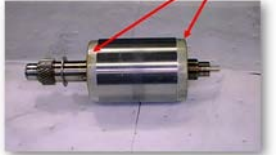
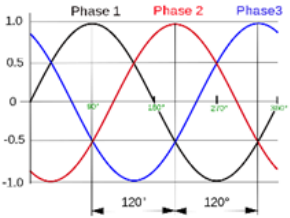
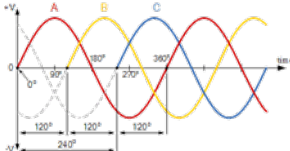


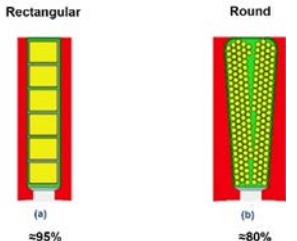
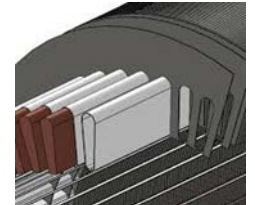
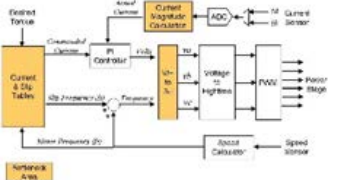
<p>Regen</p>	<p>Regenerative Braking</p>	<p>Regenerative braking uses an electric vehicle's motor as a generator to convert much of the vehicle kinetic energy lost when decelerating back into stored energy in the vehicle's battery. The generation of electrical power results in negative torque on the vehicle axle causing its speed to slow (braking effect). The rate of vehicle speed reduction is determined by a significant number of factors in the powertrain and battery pack system. The next time the car accelerates, it uses much of the energy previously stored from regenerative braking instead of tapping in further to its own energy reserves.</p>	 <p>The diagrams illustrate the regenerative braking system. The top diagram shows a powertrain layout with components: Battery Management System, Motor Controller, Vehicle Controller, Battery, Modulator, Motor, and Transmission. The middle diagram, titled 'Introduction', shows an IC Engine connected to a Generator, which is connected to a Transmission and a Battery. A red arrow indicates 'Regenerative Braking' from the Transmission to the Battery. The bottom diagram shows a car with an 'Electric motor' and 'Gasoline engine'. A 'Right Front Wheel' section shows 'Acceleration' where the 'Electric motor' is driven by the 'Battery', and 'Braking' where the 'Electric motor' acts as a generator, sending energy back to the 'Battery'.</p>
	<p>Reluctance Torque</p>	<p>A secondary Electric machine rotor torque that is generated by specifically shaping the stator magnetic field around the rotor magnets in such a way that there is a secondary torque developed from stator magnetic fields that are curved by the magnets on the rotor</p>	
<p>Resolver</p>		<p>An electric machine rpm (speed) and position sensor that is connected to the shaft of an electric machine rotor that measures absolute speed and position changes in finite rotational degree increments to ensure that a controller can trigger phase coils at the correct time</p>	 <p>The images show two views of a resolver sensor. The left image is a perspective view of the metal housing and internal components. The right image is a top-down view of the stator core with its slots and windings.</p>

rpm	Revolutions Per Minute	Revolutions per minute is the number of turns in one minute. It is a unit of rotational speed or the frequency of rotation around a fixed axis		
	Ripple Current	Ripple in electronics is the residual periodic variation of the DC voltage within a power supply which has been derived from an alternating current source. This ripple is due to incomplete suppression of the alternating waveform after rectification.		
RMS	Root-Mean-Square	A calculation of an average used in statistics and engineering, abbreviated as RMS. To find the root mean square of a set of numbers, square all the numbers in the set and then find the arithmetic Mean of the squares. Take the square root of the result. This is the root mean square. It is also amount of AC power that produces the same heating effect as an equivalent (or useable) DC power. RMS is calculated as $RMS = (P-P)(.3535)$ or $RMS = (P)(0.707)$		
	Rotor	The rotor is a moving component of an electromagnetic system in the electric motor or electric generator. Its rotation is due to the interaction between the windings and magnetic fields which produces a torque around the rotor's axis.		

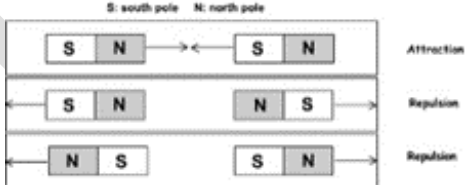
	Rotor Balancing	High speed balancing of an electric machine rotor by removing rotor material (i.e., drill holes) to ensure that the rotor balance is achieved to ensure low noise and vibration operation		
	Rotor Bar	A copper or aluminum alloy bar within the structure of an electric machine rotor (i.e., one of 40, 50, 60, etc. bars) that are analogous to the secondary windings of a transformer that, serve to circulate currents to generate magnetic fields to interact with stator magnetic fields to cause the rotor to rotate		
	Scroll Compressor	A scroll compressor is a specially designed compressor that compresses gases by rotating in a circular motion, as opposed to vertical/horizontal piston action. Scroll compressors provide in HVAC systems, as they are more reliable and efficient than reciprocating compressor types.		

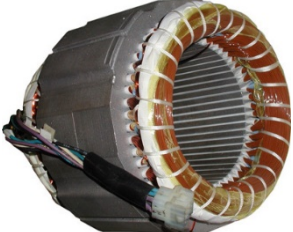
	<p>Secondary Transformer Winding</p>	<p>A secondary winding is the winding of a transformer that receives its energy by electromagnetic induction from the primary winding. A secondary winding is the winding of a transformer that receives its energy by electromagnetic induction from the primary winding.</p>	
	<p>Self-Induction</p>	<p>The property of the coil due to which it opposes the change of current flowing through it. Inductance is attained by a coil due to the self-induced emf produced in the coil itself by changing the current flowing through it.</p>	
	<p>Serial Data Tool (DC-DC Converter PIDs)</p>		
	<p>Series and Parallel Connected Stator Windings</p>	<p>Series coils are stator coil windings that are connected in series while Parallel coils are stator coil windings that are connected in parallel.</p>	


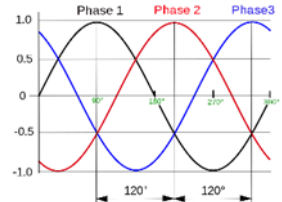
	Shaft Currents	Shaft circulating currents are caused from "dissymmetry's" in the magnetic paths through the stator and rotor iron. As the rotor rotates within the stator and as the stators magnetic field rotates, small differences in the magnetic "reluctance" of the core parts generate small voltages between the ends of the shaft.		
	Shorting Ring	Induction machine rotors have two rings cast at each end of the rotor that connect and hold all of the rotor bars that, serve as the collection point to carry current from each of the rotor bars		
	Sine Wave (3-Phase)	A circuit, system, or device that magnetically energizes or is energized by three electromotive forces that are separated by 120° sine wave cycles.		
	Sinusoidal Waveform	See Sine Wave		


	Slot Fill	The percentage of materials that fill the stator winding slots		
	Slot Liner	Typically, is a Nomex-Mylar material that is placed in each stator slot to physically and electrically insulate the stator windings from the		
SAE	Society of Automotive Engineers	SAE International, previously known as the Society of Automotive Engineers, is a U.S.-based, globally active professional association and standards developing organization for engineering professionals in various industries		
	Software Control Table	Data arranged in 2 or more dimensions that serve as a location for control software to access in how a system should be controlled for a specific rpm, current load, pressure, etc. Microsoft Excel is an example of how a control table could be arranged in a 2-dimensional format (x and y).		

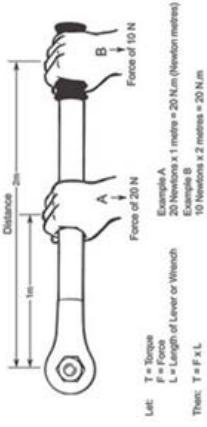
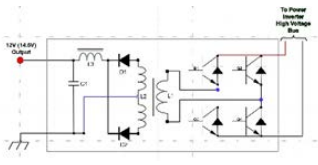
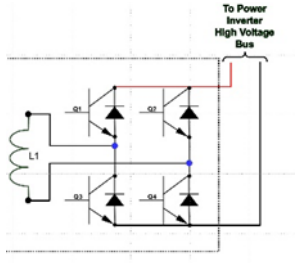




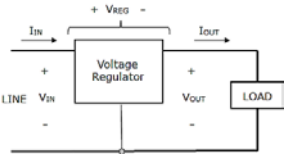
	South Pole (Magnet or Electromagnet)	<p>1. A permanent magnet is a piece of iron (or an ore, alloy, or other material) that has its component atoms so ordered that the material exhibits properties of magnetism, such as attracting other iron-containing objects or aligning itself in an external magnetic field. A magnet consists of a North and South Pole that can be used to cause electrical or mechanical movement within a component</p> <p>2. An electromagnet is a soft metal core made into a magnet by the passage of electric current through a coil surrounding it and will act as a permanent magnet but, it does need electrical current to activate the magnetic fields</p>		
Wh/kg	Specific Energy (Watt-Hours/Kilogram)	Stored Watts of power, with a given mass, that can be delivered for a period of 1 hour		
W/kg	Specific Power	Watts of electric power with a specific mass that can deliver electric power to a load		
	Speed (rpm) Sensor	See Resolver and Encoder		
	Spin Loss	The loss of rotational energy that is lost/wasted with an electrical machine is freely spinning without being electrically powered in in propulsion or regenerative braking modes		

SOC	State-of-Charge	<p>The state of charge is a measurement of the amount of energy available in a battery at a specific point in time expressed as a percentage (100% energy full or 0% energy empty). The SOC provides the user with information of how much longer the battery can perform before it needs to be charged or replaced or need to be recharged.</p>		
SOH	State-of-Health	<p>The State of Health is a "measurement" that reflects the general condition of a battery and its ability to deliver the specified performance compared with a new battery. It takes into account such factors as charge acceptance, internal resistance, voltage and self-discharge. It is a measure of the long-term capability of the battery and gives an "indication" not an absolute measurement, of how much of the available "lifetime energy throughput" of the battery has been consumed, and how much remains.</p>		
	Stator	<p>The stator is the stationary part of a rotary system, found in electric generators and electric motors. Electric Current flows through stator windings that create magnetic sequentially switched fields that will interact with the rotor magnetic fields that causes the rotor to rotate (spin).</p>		



	Stator Core	A stack of laminations that is typically welded together that comprises the material that will permit a magnetic field core to be highly concentrated when electrical current is transmitted through each stator coil that will magnetize the windings and core (laminations)		
Stator Hz	Stator Frequency	The frequency in which the electric machine stator phases are switched (triggered) to determine the rpm of the rotor		
	Step Down Transformer	A transformer that decreases the voltage from primary to secondary (fewer secondary winding turns than primary winding turns) is called a step-down transformer.		
	Step-Up Transformer	A transformer that increases the voltage from primary to secondary (more secondary winding turns than primary winding turns) is called a step-up transformer.		
Hz	Switching Frequency (Hertz)	The SI unit of frequency, equal to one cycle per second.		
	Symmetrical (Waveform)	Similarity or exact correspondence between different things. With respect to 3-Phase AC waveforms, symmetry would indicate that all 3 waveforms within one cycle would be identical (symmetrical shape)		

	Tesla Supercharger	<p>A Tesla Supercharger is a 480-volt DC fast-charging technology built by American vehicle manufacturer Tesla Inc. for their all-electric cars. The Tesla Supercharger network of fast-charging stations was introduced beginning in 2012</p>		
	Thermal Grease	<p>Thermal grease is printed onto the IGBT or, other power modules or the cooling fin, and the force exerted by tightening the screws that secure the IGBT module to the cooling fin causes the thermal grease to spread out and fill the gap between the IGBT module and cooling fin. The thermal grease will transfer heat from a power electronic device to the mounting surface. The heat sink system is either a mounting surface utilizes heat sink fins or liquid coolant routed through an enclosure to remove high temperatures from the power electronic device</p>		

	Torque	<p>A mechanical system that produces or tends to produce torsion or rotation. The newton-meter (also newton meter; symbol N·m or N m) is a unit of torque (also called moment) in the SI system. One newton-meter is equal to the torque resulting from a force of one newton applied perpendicularly to the end of a moment arm that is one meter long. One newton is the force needed to accelerate one kilogram of mass at the rate of one meter per second squared in direction of the applied force. Pound-Feet is the English unit of torque measurement. As a unit of energy, one foot-pound is the energy it takes to push with one pound-force one pound for a distance of one foot</p>		 <p>Distance = 2m Force of 10 N Force of 20 N</p> <p>Example A 20 Newtons x 1 meter = 20 Nm (Newton meters) 10 Newtons x 2 meters = 20 Nm</p> <p>Let: T = Torque F = Force L = Length of Lever or Wrench Then: T = F x L</p>
	Totem Pole (Push-Pull) Driver	<p>The connection of four (or more) transistors that form a network to drive (power) the primary of a transformer primary winding. The transistors will be pulsed in pairs to alternately change the polarity on a primary winding that results in an alternating current output used to create an AC waveform that will be transferred an AC power waveform to the transformer secondary. The secondary waveform will eventually get rectified to DC for power lower voltage DC circuits and charging a lower voltage battery.</p>		

	Transmission	A transmission is a machine in a power transmission system, which provides controlled application of the power. The term transmission refers simply to the gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device.	
	Transaxle	See transmission	
	Usable Battery Capacity	The energy capacity of a battery pack that is accessible to an electric propulsion system (which is less than the maximum) to ensure a long service life of a battery cell (battery pack). For Example, traditional Lithion Ion battery pack usable capacity state-of-charge range is $\approx 20\% - 90\%$ (or 70% of total capacity).	
VR	Voltage Regulation	Voltage regulation is a measure of change in the voltage magnitude between the component transmitting an electrical power signal and the device receiving it such as, a vehicle alternator/generator and 12V battery	



	Wires in Hand	<p>The number of wires (conductors) that will be used to make a coil turn. The Wires (conductors) in Hand, combined with the Coil Turns, determine the magnetic field strength within the span of a distributed winding electric machine. Example: If 6 conductors of 18-gauge wires are used to wrap a stator coil then, this would be 6 wires in hand</p>		
	Wye Wound Stator	<p>A 3-Phase stator design in which all 3 phases are connected at a central point in the configuration of the alphabet letter "Y" that electrically connects them in parallel.</p>		
	Zero Slip%	<p>Slip% is an alternative term for Torque. The percent of speed (Hertz) that the stator field is being switched at the same speed as the rotational rpm of the rotor. When the stator field Hz is the same as the rotor rotational speed, the Slip% is Zero. Zero slip speed is used for vehicle coasting or Traction Control. Example: If the stator frequency speed is an equivalent of 100rpm and the rotor is rotating at 100rpm then, the Slip is 0% and no Negative or Positive torque is produced</p>		