

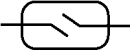

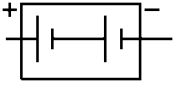
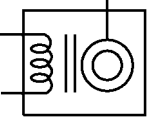

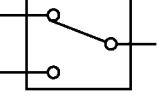
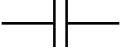







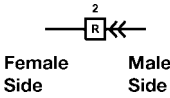

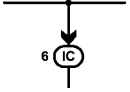


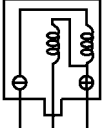
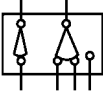


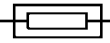

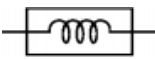
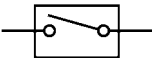

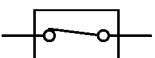
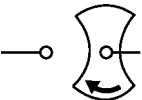

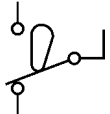
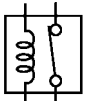

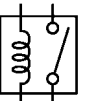
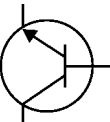
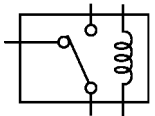






Appendix A

Toyota Wiring Diagram Symbols

	<p>ANALOG METER Current flow activates a magnetic coil which causes a needle to move, thereby providing a relative display against a background calibration.</p>		<p>DIODE A semiconductor which allows current flow in only one direction.</p>
	<p>ANALOG SPEED SENSOR Uses magnetic impulses to open and close a switch to create a signal for activation of other components.</p>		<p>DIODE, ZENER A diode which allows current flow in one direction but blocks reverse flow only up to a specific voltage. Above that potential, it passes the excess voltage. This acts as a simple voltage regulator.</p>
	<p>BATTERY Stores and converts chemical energy into electrical energy. Provides DC current for the auto's various electrical circuits.</p>		<p>DISTRIBUTOR (I.I.A.) Channels high-voltage current from the ignition coil to the individual spark plugs.</p>
	<p>BIMETALLIC THERMOSWITCH An automatic switch which opens or closes, depending on temperature.</p>		<p>DOUBLE-THROW SWITCH A switch which continuously passes current through one set of contacts or the other.</p>
	<p>CAPACITOR (Condenser) A small holding unit for temporary storage of electrical current. Capacitors with a ground connection are frequently called Condensers.</p>		<p>FUSE A thin metal strip which burns through when too much current flows through it, thereby stopping current flow and protecting a circuit from damage.</p>
	<p>CIGARETTE LIGHTER An electric resistance heating element.</p>		<p>FUSIBLE LINK A heavy-gauge wire placed in high amperage circuits which burns through on overloads, thereby protecting the circuit.</p>
	<p>CIRCUIT BREAKER Basically a reusable fuse, a circuit breaker will heat and open if too much current flows through it. Some units automatically reset when cool, others must be manually reset.</p>		<p>GROUND The point at which wiring attaches to the chassis, thereby providing a return path for an electrical circuit; without a ground, current cannot flow.</p>
	<p>CONNECTORS Male connectors typically have extended pins which engage sockets in the female connector. Toyota wiring diagrams show harness connectors from the open end.</p>	<p>Single Filament</p> 	<p>HEADLAMPS Current flow causes a headlamp filament to heat up and cast light. A headlamp may have either a single filament or a double filament.</p>
	<p>CONNECTOR, HARNESS TO HARNESS A connector in the wiring harness which joins two harness sections. This symbol refers to pin 2 of connector R.</p>	<p>Double Filament</p> 	
	<p>CONNECTOR, TO JUNCTION BOX A connection of a wire harness to a junction block. This symbol refers to pin 6 of connector C at junction block 1.</p>		<p>HORN An electric device which sounds a loud audible signal.</p>
	<p>DIGITAL METER Current flow activates one or many LED's, LCD's or fluorescent displays, which provide a relative or digital display.</p>		<p>IGNITION COIL Converts low-voltage DC current into high-voltage ignition current for firing the spark plugs.</p>

	<p>IGNITION SWITCH A key operated switch with several positions which allow various circuits to become operational, including the primary ignition circuit.</p>		<p>SENSOR (Thermistor) A resistor which varies its resistance with temperature.</p>
	<p>LAMP Current flow through a filament causes a lamp to heat up and cast light.</p>		<p>SHORT PIN Used to provide an unbroken connection within a junction block.</p>
	<p>LED (LIGHT EMITTING DIODE) Upon current flow, these diodes cast light without emitting the heat of a comparable lamp. Used in instrument displays.</p>		<p>SOLENOID An electromagnetic coil which creates its own mechanical movement or force upon current flow.</p>
<p>Normally Open</p> 	<p>MANUAL SWITCH Opens and closes circuits, thereby stopping or allowing current flow.</p>		<p>SPEAKER An electromechanical device which creates sound waves from current flow.</p>
<p>Normally Closed</p> 			<p>SWITCH, WASHER TIMER SWITCH Controls the intermittent operation of the windshield washer jets.</p>
	<p>MOTOR A power unit which converts electrical energy into mechanical energy or rotary motion.</p>		<p>SWITCH, WIPER PARK Automatically returns wipers to the stop position when the wiper switch is turned off.</p>
<p>Normally Closed</p> 	<p>RELAY Basically, an electrically operated switch which may be normally closed or normally open. Current flow through a small coil creates a magnetic field which either opens or closes an attached switch.</p>		<p>TAPPED RESISTOR A resistor which supplies two or more different non-adjustable resistance values.</p>
<p>Normally Open</p> 			<p>TRANSISTOR A solid-state device typically used as an electronic relay; stops or passes current depending on the applied voltage at "base."</p>
	<p>RELAY DOUBLE THROW A relay which passes current through one set of contacts or the other.</p>	<p>Not Connected</p> 	<p>WIRES Wires are always drawn as straight lines on wiring diagrams. Crossed wires, without a black dot at the junction, are not joined; crossed wires with a black dot at the junction, are spliced (joined) connections.</p>
	<p>RESISTOR An electrical component with a fixed resistance, placed in a circuit to reduce voltage to a specific value.</p>	<p>Spliced</p> 	
	<p>RESISTOR, VARIABLE or RHEOSTAT A controllable resistor with a variable rate of resistance. Also called a potentiometer or rheostat.</p>		

Glossary of Terms

A

A - Abbreviation for ampere, the unit of measurement of current.

Active Materials - The metals and acids used in a storage battery which cause a chemical reaction to occur and voltage potential to be developed.

Afterglow - The time the glow plugs remain activated after fuel in a diesel engine starts to self-ignite. The added heat is used to reduce white smoke and improve slow idle.

Alternating Current (AC) - An electric current whose polarity is constantly cycling between positive and negative. (Reverse direction or flow at regular intervals.)

Alternator - A type of generator used in automobiles to produce electric current. Its A.C. (Alternating Current) output is internally rectified (changed) to D.C. (Direct Current) through the use of diodes.

Ammeter - An electrical meter used to measure the amount of current flowing in a circuit. It reads amperes of current flow. The ammeter must be connected in series with the circuit ... red lead toward the voltage source, black lead toward ground.

Amperage - The amount of current (amperes) flowing in a circuit.

Ampere - The unit of measure for the flow of electrons, or current, in a circuit. The amount of current produced by one volt acting against one ohm of resistance.

Ampere Hour - Unit used to rate batteries. The quantity of electricity delivered by a current of one ampere flowing for one hour.

Ampere-Hour Rating - A battery rating based on the amperes of current that a battery can supply steadily for 20 hours, with no battery cell falling below 1.75 volts. Also called a 20-hour discharge rating.

Ampere Turn - The amount of magnetism or magnetizing force produced by a current of one ampere flowing around a coil of one turn. The product of the current flowing through a coil multiplied by the number of turns or loops of wire in a coil.

Analog - Method of transmitting information through an electrical circuit by regulating or changing the current or voltage.

Anode - Positive terminal or electrode through which current flows in a semiconductor.

Armature - Conductor or coil of wire moved through a magnetic field to produce current. In an alternator, the rotor is a magnetic field that rotates inside the stator coils to induce voltage in them. In a motor, it is the rotating electromagnetic field interacting with the stationary magnets to produce a turning motion.

B

Armature Circuit Tests - Tests used to determine if there are any short circuits or opens and grounds in the armature of a starter motor.

Atom - The small particles which make up all matter. An atom is made up of a positive-charged nucleus with negative-charged electrons orbiting around it.

Ballast (Primary) Resistor - A resistor in the primary circuit that stabilizes ignition system voltage and current flow.

Bar Magnet - A straight permanent magnet.

Base - The center layer of semiconductor material in a transistor.

Battery - A group of two or more cells of a lead-acid (storage) battery connected together. It produces an electric current by converting chemical energy into electrical energy. Also, a dry cell.

Battery Acid - Mixture of sulfuric acid and water used in a storage battery. Also called the battery electrolyte.

Battery Cell - Group of positive and negative plates, covered with electrolyte, in a compartment of the battery case separate from other elements. A cell of an automotive battery has a voltage of about 2.2 volts.

Battery Charge - Reverse chemical reaction that takes place when current is reversed through a battery to restore the metal in the plates and the electrolyte to their original condition.

Battery Charger - Rectifier used to change alternating current into direct current to send a reverse current through the plates of a battery to restore the chemical imbalance needed to produce electrical energy.

Battery Element - Group of positive and negative plates with separators and covered with electrolyte and contained in a battery cell.

Belt Tension - The tightness of a drive belt.

Biasing - Applying voltage to a junction of semiconductor materials.

Bimetal - Sensing device made from two metals with different heat expansion rates. Temperature changes cause the device to bend or distort. Activates another component.

Bimetallic - A substance made up of two metals bonded together.

Bonding - Process by which the electrons in the valence ring of one atom are shared with those of another.

Bound Electrons - Five or more tightly held electrons in an atom's outer ring.

Breakdown Voltage - Voltage applied to a diode or a transistor in the reverse direction from that in which it passes current. The voltage is large enough to cause a massive failure to hold back current. Breakdown voltage is also that applied to a zener diode to allow a reverse current flow through the diode.

Brushes - Bars of carbon, or other conductive material, that make an electrical connection with the rotating commutator or slip rings.

Buss Bar - A solid metal strip, or bar, used as a conductor in a fuse panel.

C

Cable - Conductor made from a number of wires twisted together.

Capacitance - The ability of two conducting surfaces, separated by an insulator, to store an electric charge.

Capacitor - Electrical component used to store and release a current through a secondary circuit. Can be used to protect a circuit against surges in current, store and release a high voltage, or smooth out current fluctuations. Also called a condenser.

Capacity Test - Test of a battery's condition by applying a heavy load (300 amp) to the battery for a brief time (15 seconds) then measuring the voltage.

Carbon Pile - A pile, or stack, of carbon disks enclosed in an insulating tube. When the disks are pressed together, the resistance of the pile is decreased.

Cathode - The negative terminal of a semiconductor toward which the current flows.

Cell - A dry cell, e.g., a flashlight battery. In a storage (wet cell) battery, one of the sets of positive and negative plates which, with electrolyte (sulfuric acid and water), produces electricity. Each cell can produce about 2.2 volts.

Cell Gassing - The emission of hydrogen gas from battery cells during charging.

Central Processing Unit (CPU) or Microprocessor - The processing and calculating portion of a microcomputer.

Charge (Recharge) - To restore the active materials in a battery cell by electrically reversing the chemical action.

Charging System - Components to restore electrical potential in the battery and supply the current needed to meet the electrical demands of the vehicle.

Circuit - A combination of elements physically connected to provide an unbroken flow of electrical energy from a power source through a conductor to a working device, and through a return conductor, back to the power source.

Circuit Breaker - Device used to open an electric circuit when overheated to prevent damage by excess current flow.

Circuit Diagram - Drawing showing the wires, connections and components (loads) in an electric circuit.

Closed Circuit - A circuit which is uninterrupted from the current source and back to the current source.

Cold-Cranking Rating - A battery rating based on the amperes of current that a battery can supply for 30 seconds at 0°F, with no battery cell falling below 1.2 volts.

Collector - The area of a transistor which collects emitted electrons and then passes them on through a conductor completing a circuit.

Color Coding - The use of colored insulation on wire to identify an electrical circuit.

Commutator - That part of a starter motor where current is sent to the rotating coils in the armature. It is the rotating connector between the armature windings and the brushes. It consists of copper bars at one end of the starter motor armature electrically insulated from the shaft and insulated from each other by mica.

Compound Motor - A motor that has both series and shunt field windings. Often used as a starter motor.

Computer Control - Control of any automotive system using solid state devices and operating with a preprogrammed set of commands (program), sensors to monitor various engine conditions (input), and signals set to affect the function of some component (output). Also holds commands in memory for later use.

Condenser - Electrical component used to store and release a current through a secondary circuit. Can be used to protect a circuit against surges in current, store and release a high voltage, or smooth out current fluctuations. Also called a capacitor.

Conductivity - Measure of how easily an electrical component conducts current.

Conductor - Any material that allows electric current or heat to flow. Current flows easily through a conductor because there are many free electrons.

Constant Voltage Charging - Method of charging battery in which a constant voltage is applied and the current decreases as the battery approaches the charged condition.

Continuity - Continuous, unbroken. Used to describe a working electrical circuit or component that is not open.

Control Circuit Resistance Test - Test used to determine if there is high resistance in the control circuit that will reduce current flow through the starter solenoid or relay windings and cause improper operation of the starter circuit.

Conventional Theory - The current flow theory which says electricity flows from positive to negative. Also called the positive current flow theory.

Copper - A metal used for electrical conductors because it has less resistance than most other metals.

Counterelectromotive Force - An induced voltage that opposes the source voltage and any change (increase or decrease) in the charging current. Abbreviated: CEMF.

Cranking - The act of engaging the starter by turning the ignition switch to make the engine turn over.

Cranking Circuit - Motor feed and ground circuits required to supply heavy current to the cranking or starter motor.

Cranking Circuit Resistance Test - Test used to determine if there is excessive electrical resistance in the cranking circuit preventing full power from reaching the starter motor.

Current - Flow of electrons through a circuit, measured in amperes.

Cutout Relay - A relay that keeps the battery from discharging when the engine is off or idling. It acts as a circuit breaker to open the circuit between the battery and alternator.

Cycle - Any series of events repeating continuously. In electrical system the flow of current alternates first in one direction and then in the opposite direction.

Cycling - Battery electrochemical action. One complete cycle is the operation from fully charged to discharged and back to fully charged.

D

D'Arsonval Movement - A small, current-carrying coil mounted within the field of a permanent horseshoe magnet. Interaction of the magnetic fields causes the coil to rotate. Used as a measuring device within electrical gauges and test meters.

Defective Device - A type of circuit malfunction in which a component of electrical circuit does not work as it should. This could be a worn-out battery, corroded switch, burned-out lamp bulb, or broken connector.

Delta-Type Winding - An alternator stator design in which the three windings of a 3-phase alternator are connected end-to-end. The beginning of one winding is attached to the end of another winding. Used in alternators that must give high-amperage output.

Dielectric - The insulating material between the two conductive plates of a capacitor.

Digital - Method of sending information through an electrical circuit by switching the current on or off.

Digital Computer - A computer that uses numbers to perform logical and numerical calculations, usually in a binary (two digits) numbering system. Faster and superior performance to an analog computer.

Digital Readout - A display of numbers or a combination of numbers.

Diode - A semiconductor device made of P.-material and N-material bonded at a junction. It permits current to flow in one direction only, and is used in rectification (changing alternating current to direct current).

Diode Trio - Six diodes, arranged in pairs front to back, each at the end of a stator winding in an alternator. Used to rectify both phases of an alternating current cycle to direct current.

Direct Current (DC) - A steady flow of current moving continuously in one direction along a conductor from a point of high potential to a point of lower potential.

Doping - Addition of a small amount of a second element to a semiconductor element to change its electrical characteristics.

Drive Belt - A flexible belt connecting the fan and the alternator, causing both to turn through a pulley system at the end of the crankshaft.

Dry Cell - Voltage source consisting of three elements: a zinc cylinder, a paste of electrolyte, and a carbon rod or electrode.

E

Eddy Current - Currents in armatures, pole pieces, and magnetic cores induced by changing electromotive force. It is wasted energy and creates heat.

Effective Resistance - All electrical and inductive losses of a cd

Electrical Balance - An atom or an object in which positive and negative charges are equal.

Electrical Charge - Property of electrons and protons that give a substance its electrical characteristics. A deficiency of electrons in the outer ring of atoms of a substance will give it a positive charge. An excess will give the substance a negative charge.

Electrical Symbols - Simple drawings used to represent different parts of an electrical circuit.

Electrical System - Parts of the vehicle that crank the engine for starting, furnish high voltage sparks in the cylinders, operate lights and accessories, and charge the battery. Electrical systems of a diesel include circuits to operate the glow plug system.

Electricity - The controlled movement of electrons in a conductor.

Electrochemical Device - A device that operates on both electrical and chemical principles (a lead-acid storage battery, for example).

Electrochemistry - In a battery, voltage caused by the chemical action of two dissimilar materials in the presence of a conductive chemical solution.

Electrolyte - A solution of sulfuric acid and water used in a storage battery that through chemical reaction produces electric potential.

Electromagnet - Coil of current-carrying wire usually wound around a soft iron core that becomes magnetized when current passes through the wire and demagnetized when the current stops.

Electromagnetic Field - The invisible field of force which surrounds a charged conductor or coil.

Electromagnetic Induction - The creation of a voltage within a conductor when relative motion exists between the conductor and a magnetic field.

Electron - Those parts of an atom which are negatively charged and orbit around the nucleus of the atom.

Electron Flow Theory - Belief that current flow consists of electrons flowing from a point with a high potential of free electrons (negative) to a point with fewer electrons (positive).

Electronic - Any system using integrated circuits or semiconductors to control the flow of current. As opposed to electrical that describes systems in which there are no solid state components and devices are controlled by current applied to such components as motors, solenoids, and relays.

Electron Theory - States that all matter is made up of atoms which are made up of a nucleus and orbiting electrons. The “free” electrons can move from one atom to another, producing electricity.

Electrostatic Field - The area around an electrically charged body resulting from the difference in voltage between two points or surfaces.

Element - A substance that cannot be further divided into a simpler substance. In a battery, a group of positive and negative plates, separated by insulators that make up each cell.

Emitter - Region in a transistor that emits (NPN) or collects (PNP) large number of electrons as a small number of electrons are taken from or added to the base.

Energize - To put energy into. The iron core of an electromagnet is energized by passing current through the coil.

Equivalent Resistance - The total resistance of a parallel circuit. The single mathematical equivalent of all the parallel resistances.

F

Farad - The unit of measurement of capacitance.

Feedback System - Electronic system in which sensors monitor the output of various automotive systems and provide input to control the operation of the system and change the output. It is a self-correcting system.

Feed Circuit - Line supplying all the branch circuits with the main supply of current. Generally used to refer to the hot (not grounded) feed from the battery to the electrical components of a vehicle.

Field Coil - Winding of current-carrying conductors used in a starter motor to produce a magnetic field.

Field Magnet - A magnet for producing and maintaining a magnetic field especially in an alternator or electric motor.

Field Relay - A magnetic switch used to open and close the alternator field circuit, or in a charging circuit with a warning lamp, to control the lamp circuit.

Field Strength - The density of magnitude of the magnet lines of force. The denser the magnetic field, the more lines of force will extend from pole to pole in the magnet and the stronger the field will be.

Field Windings - Insulated wire wrapped around an iron or steel core. When current flows through the windings, a strong magnetic field is created.

Filament - A resistance in an electric light bulb which heats up and glows, producing light, when an adequate current (bombardment by electrons) is sent through it.

Flux - The lines of magnetic force flowing in a magnetic field.

Flux Density - The number of flux lines in a magnetic field area. The more flux lines in a unit of area the stronger the magnetic field at that point.

Forward Bias - The application of a voltage to produce current flow across the junction of a semiconductor.

Free Electron - An electron in the outer orbit of an atom, not strongly attracted to the nucleus, and can therefore be easily forced out of its orbit into orbit around the nucleus of another atom.

Frequency - Number of times every second an alternating current goes through a complete cycle. Now measured in units of hertz (Hz) but previously measured in cycles per second (cps).

Full-Wave Rectification - A process by which all of an A.C. voltage wave is rectified and allowed to flow as D.C.

Fuse - A device containing a soft piece of metal which melts and opens, or breaks, the circuit when it is overloaded. Similar in function to a "circuit breaker," but must be replaced after circuit problem is corrected.

Fusible Link - A short piece of wire soldered into a heavy feed circuit, designed to melt when an overload occurs. Performs the same function as a fuse or circuit breaker. Like the fuse, it must be replaced after the circuit problem is corrected.

G

Gassing - Escape from a battery of highly explosive hydrogen gas formed during charging.

Generator - An apparatus that produces an electric current through magnetism. Its A.C. (Alternating Current) output is internally changed to D.C. (Direct Current) through the commutator. The alternator, a type of generator, changes its A.C. output to D.C. through the use of diodes.

Germanium - A metalloid element used as a semiconductor material in transistors.

Glow Plug - A resistance heater, shaped somewhat like a spark plug, heated by low voltage current. Used to heat compressed air in a diesel engine until the heat of combustion reaches the temperature to cause self-ignition without assistance.

Grid - Frame of a storage battery plate having spaces in which the active material in paste form is pressed.

Ground - The return path for current flow in a circuit. In automotive use, the circuit ground path is usually the vehicle frame and metal body parts.

Ground Cable - The battery cable that provides a ground connection from the vehicle chassis to the battery.

Grounded Circuit (Unintentional) - A type of circuit malfunction in which the current in the circuit is accidentally shunted, or diverted to ground. Usually, this condition bypasses a load. If a load is bypassed, it reduces the resistance of the circuit and can cause wiring to overheat, fuses to blow, etc.

Ground-Seeking - A test method using a 12-volt test light where one lead is connected to a known power source and the other lead is touched to various points of a circuit to seek a point where the circuit is grounded.

Ground Terminal - The terminal of the battery connected to the metal frame and chassis of the vehicle for the return path of current flow back to the battery, usually to the negative terminal.

H

H₂O - Chemical symbol for water.

H₂SO₄ - Chemical symbol for sulfuric acid.

Half-Wave Rectification - A process by which only one-half of an A.C. voltage wave is rectified and allowed to flow as D.C.

Heat Sink - Device to absorb heat from one medium by transferring it to another. Diodes in alternators are mounted on heat sinks to prevent the diodes from overheating,

High Rate Discharge Test - Battery test in which the battery is discharged at a high rate of current while cell voltages are checked.

High Resistance - A type of circuit malfunction in which a loose, dirty or corroded connection limits current flow below specifications. The result can be dimmed lamps, flickering lamps, or even inoperative devices.

Hold-In Winding - The coil of small-diameter wire in a solenoid that creates a magnetic field to hold the solenoid plunger in position inside the coil.

Hole - The space in a valence ring where another electron could fit.

Hydrogen - (H) Colorless, odorless, highly flammable gas. Simplest and lightest element having only one electron orbiting around the nucleus.

Hydrometer - Device used to measure the weight of a liquid, or its specific gravity. Used to measure the acid content of electrolyte in batteries or the ethylene-glycol content of coolant.

I

Ignition - Action of the spark in starting the burning of the compressed air/fuel mixture in the combustion chamber.

Ignition Coil - An induction coil used to produce a high voltage current to jump the gap in a spark plug and ignite the air/fuel mixture in the combustion chamber. A small voltage turned on and off in the primary windings induces a much larger voltage as the output from the secondary winding.

Ignition Resistor - A resistance in the primary ignition circuit to reduce the amount of battery voltage available at the coil.

Ignition Switch - Switch used to open and close the circuit to the primary ignition coil. Also used to open and close accessory circuit on the vehicle.

Ignition System - System to furnish high voltage sparks to the cylinders to ignite the compressed air/fuel mixture at the right time. Consists of the battery, ignition coil, distributor, ignition switch, wiring and spark plugs.

Impurities - The doping elements added to pure silicon or germanium to form semiconductor materials.

Indicator - Device used to make some condition known by use of a light or gauge.

Indicator Light - An illuminated warning or indicator to the driver of a vehicle of some condition, such as when the alternator is not supplying current or when the coolant temperature is close to overheating.

Induced Voltage - The voltage which appears in a conductor when relative motion exists between it and magnetic flux lines.

Induction - Producing a voltage in one conductor or coil by moving the conductor or coil through a magnetic field or by moving the magnetic field past the conductor or coil.

Infinite Reading - A reading () on an ohmmeter that indicates an open circuit - broken wire, defective component.

Infinite Resistance - Very high resistance, a value higher than can be conceived. No current can move through. Usually, circuit is broken with no complete path for current flow.

Initial Charge Rate - The current a battery will accept at the start of charging. Charging current decreases as charging progresses.

Input - Generally used to refer to the data or instructions given or fed into a micro-computer.

Insulated Cable - The battery cable that conducts battery current to the automotive electrical system.

Insulators - Materials that will not conduct electron flow because of their many bound electrons.

Integrated Circuit - (IC) An electronic circuit containing transistors, diodes, resistors, and capacitors along with electrical conductors processed and contained entirely within a single chip of silicon.

Ion - An atom which has become unbalanced by losing or gaining an electron. It can be positively or negatively charged.

Ionize - To break up molecules into two or more oppositely charged ions. The air gap between the spark plug electrodes is ionized when the air/fuel mixture is changed from a nonconductor to a conductor.

J

Jump Starting - Using a booster battery to start a vehicle in which the battery does not have sufficient charge to start the vehicle itself.

Jumper Wire - A test device or tool used by technicians to create a temporary bypass for current in a circuit. A jumper wire may be used to ground a circuit, to bridge a broken wire or switch, or to complete a circuit for test purposes.

Junction - The area where two types of semiconductor materials (P- and N-material) are joined.

K

K - Prefix used in the metric system of measurement to mean 1000 times the stated value. Abbreviation for kilo.

Kilowatt - Unit of power in the metric system. One kilowatt is equal to about 1.341 horsepower. Also used to describe 1000 watts of electrical power.

Knock Sensor - An acoustical device used to sense engine vibrations caused by self-ignition, or knock, and signal an electronic control module to adjust spark timing and reduce detonation.

L

Lead-Acid Battery - A common automotive battery in which the active materials are lead, lead peroxide, and a solution of sulfuric acid and water.

Lead Dioxide - Lead oxide material used in the positive plates of storage batteries.

Lead Sulfate - Hard, insoluble layer that slowly forms on the plates of a discharged battery and can only be reduced by slow charging. Caused by the chemical reaction of the acid in the electrolyte acting on the lead peroxide and sponge lead of the active material in the plates.

Leakage Current - Unwanted current flowing through a semiconductor or capacitor.

Left-Hand Rule - A method of determining the direction of the magnetic flux lines surrounding a current-carrying conductor when the electron theory of current flow is used (- to +). If the conductor is grasped with the left hand so the thumb points in the direction of current flow, the fingers will point in the direction of magnetic flux.

Light Emitting Diode (LED) - A semiconductor diode designed so light is emitted when forward current is applied to the diode.

Light-Load Test - A test applied to storage batteries during which the voltage is measured while the battery is subjected to a light load, such as the car headlights.

Linear Integrated Circuit - An integrated circuit designed to amplify signals rather than switching.

Lines of Force - Imaginary lines representing the direction of magnetism around a conductor or from the end of a magnet.

Liquid Crystal Display (LCD) - Uses a polarized light principle and a liquid crystal to display numbers and characters.

Loss of Power - A type of circuit malfunction in which the voltage source for the circuit or device is lost. This could be a worn-out or defective battery or an OPEN CIRCUIT on the battery side of the electrical load.

M

Magnet - Any body with the property of attracting iron and steel. Temporary magnets are made by surrounding a soft iron core with a strong electromagnetic field. Permanent magnets are made with steel.

Magnetic Circuit - Paths taken by lines of force in going from one end of the magnet to the other.

Magnetic Field - The area near a magnet where the property of magnetism can be detected. Also the flow of magnetic force between opposite poles of a magnet.

Magnetic Flux - The invisible, directional lines of force which make up a magnetic field.

Magnetic Flux Density - Strength of the magnetic lines of force. The denser the magnetic flux, the more lines of force will extend from pole to pole in the magnet.

Magnetic Induction - Producing magnetism in a magnetic body by bringing it near a magnetic field.

Magnetic Pole - Point where the lines of force enter and leave a magnet.

Magnetic Saturation - The condition when a magnetic field reaches full strength and maximum flux density.

Magnetic Shunt (Magnetic Bypass) - A piece of metal on a voltage regulator coil that controls voltage output at varying temperatures by affecting the coil's magnetic field.

Magnetism - A form of energy caused by the alignment of atoms within certain materials. The ability of a metal to attract iron.

Maintenance-Free Battery - Battery that does not require the addition of water during its normal service. Grids in maintenance-free batteries are made of metals other than antimony to produce less gassing and therefore, less chance of pushing electrolyte from the battery.

Matter - The substance of which a physical object is composed.

Memory - Part of a microprocessor or microcomputer in which instructions or data are stored as electrical impulses.

Micro - Prefix of measurement meaning one millionth of a part.

Microprocessor - Set of integrated circuits that can be programmed with stored instructions to perform given functions. A computer in the lowest range of size and speed containing a central processing unit (CPU), instructions stored in a read only memory (ROM), and a random access memory (RAM) for receiving data and instructions. Also called a microcomputer.

Milli - Prefix of measurement meaning one thousandth of a part.

Millisecond - Unit of measurement for time, meaning one thousandth of a second.

Module - A self-contained, sealed unit that houses the solid-state circuits needed to control certain electrical or mechanical functions.

Molecule - Two or more atoms joined together to form an element or a chemical, compound.

Motor - An electromagnetic device used to convert electrical energy into mechanical energy.

Mutual Induction - Creation of voltage in one conductor by the rise and collapse of the magnetic field surrounding another conductor. Magnitude or strength of Induced voltage depends on the ratio of turns between one coil and the other and the strength of current causing the induced voltage.

N

Nanosecond - One billionth-of a second. A unit of measurement usually referring to the speed the circuit in a microcomputer can work.

Electricity, traveling at the speed of light, will travel about 11.8 inches in one nanosecond. In comparison the same electricity will travel about 930 feet in one microsecond (millionth of a second).

Negative Polarity - Also called ground polarity. A correct polarity of the ignition coil connections. Coil voltage is delivered to the spark plugs so that the center electrode of the plug is negatively charged and the grounded electrode is positively charged.

Negative Pole - The point to which the electrons forming an electric current return from a circuit. Also referred to as the south pole in magnetism.

Negative Temperature Coefficient - The property of any substance in which the electrical resistance increases as the temperature of the substance decreases.

Negative Terminal - The battery terminal closest to the negative potential in the battery.

Neutral Junction - Center connection of the three windings in a Y-type alternator stator.

Neutron - A particle in an atom that has no charge and is electrically neutral.

N-Material - A semiconductor material that has excess free electrons because of the type of impurity added. It has a negative charge and will repel additional electrons.

No-Load Test - A cranking-motor test in which the cranking motor is operated without load; the current draw and armature speed at the specified voltage are noted.

North Pole - The area of a magnet from which the lines of force are said to leave the magnet. The end of a magnet that will point toward the north if freely suspended.

NPN Transistor - Transistor with two layers of N-type material separated by a layer of P-type material. Base circuit must be positive relative to the emitter for current to flow through the collector circuit.

N-Type Material - Semiconductor material with an excess of free electrons because of some impurity added. It has a negative charge and will repel additional electrons.

Nucleus - The center core of an atom that contains the protons and neutrons.

O

Ohm - The standard unit for measuring the resistance to current flow. One ohm of resistance will limit current flow to one ampere when one volt of pressure is applied.

Ohm's Law - The mathematical relationship between voltage, current, and resistance. The pressure of one volt applied to one ohm of resistance will cause one ampere of current to flow. Amps equal volts divided by ohms ($I = E/R$). Volts equal amps times ohms ($E = I \times R$). Ohms equal volts divided by amps ($R = E/I$).

Ohmmeter - An electrical meter used to measure the resistance to current flow in a circuit or working load. It reads ohms of electrical resistance. The ohmmeter can only be connected across a circuit or device with the power removed. This meter has its own battery and will be damaged if connected to a circuit that has power applied.

Open Circuit - A type of circuit in which there is an incomplete path for current flow. The open circuit may be caused deliberately, by a switch that is in the OFF position, or it may be caused by a break in the conductor. An open circuit can occur on either side of the load; however, an open circuit in the ground side of the circuit is usually referred to as a LOSS OF GROUND.

Open-Circuit Voltage - The voltage across the battery terminals with no load applied.

Oscilloscope - An electric instrument producing, on a screen, a visual display or trace of voltage changes in an electrical circuit.

Overcharging - Continued charging of a storage battery after it has reached the fully charged state. This damages the battery and shortens its life.

Overload - Carrying a greater load than the device, machine, or electric circuit is designed to carry.

P

Parallel Circuit - A circuit in which the components are arranged so that there is a separate current path to each component. In a parallel circuit, the components are connected positive-to-positive and negative-to-negative.

Peak Inverse Voltage - Highest reverse bias voltage that can be applied to a junction of a diode before the semiconductor material breaks down and allows current to flow in the opposite direction.

Permanent Magnet - Piece of metal that holds its magnetism without the use of continuing electric current to create a magnetic field.

Permeability - A measure of the ease or difficulty with which materials can be penetrated by magnetic flux lines. Iron is more permeable than air.

Photoelectricity - Voltage caused by the energy of light as it strikes certain materials.

Piezoelectricity - Voltage caused by physical pressure applied to the faces of certain crystals.

Plate - Material in a storage battery that reacts with the acid in electrolyte to produce a voltage for current flow. Usually made of a soft porous lead compound supported by a harder metal grid. If the plate is sponge lead it has a positive charge; if it is made of lead peroxides, it has a negative charge.

Plate Group - The positive and negative plates in one cell of a battery, connected together to produce approximately 2.2 volts.

PN Junction - Dividing line in a semiconductor between P-type material and N-type material. Electrons can flow from N to P but not from P to N.

PNP Transistor - Transistor with two layers of P-type material separated by a layer of N-type material. Base circuit must be negative relative to the emitter for current to flow through the collector circuit.

Polarity - The quality or condition in a body that has opposite properties or directions. A collective term applied to the positive (+) and negative (-) ends of a magnet or electrical component such as a battery or coil.

Polarize - The process of establishing positive and negative polarity across alternator fields and thus determining the direction of current flow.

Polarizing - A method of maintaining the electrical and magnetic polarity of the pole shoes and field in an alternator.

Poles - Positive and negative terminals of a cell or battery. Also, the ends of a magnet (north and south).

Pole Shoes - Magnetic iron cores, or poles, that provide the magnetic field in an alternator or motor and strengthen the electromagnetic field of the field windings.

Positive Charge - The electrical characteristics of a substance with a deficiency of electrons in the outer ring of its atoms.

Positive Plate - The dioxide of lead plate in a lead-acid storage battery.

Positive Polarity - Also called reverse polarity. An incorrect polarity of the ignition coil connections. Coil voltage is delivered to the spark plug so that the center electrode of the plug is positively charged and the grounded electrode is negatively charged.

Positive Pole - The point from which the electrons forming an electric current enter a circuit as defined by the "Conventional Theory." Also referred to as the north pole in magnetism.

Positive Temperature Coefficient (PTC) - Resistor or heating element in which the resistance increases with temperature, heat created by current flowing through it. Eventually the resistance will get so high that it will oppose all current flow. Then, the resistor or heating element will cool down until current can begin to flow again, increasing the temperature.

Positive Terminal - The battery terminal from which electrons flow in a complete electrical circuit. Generally the side of the circuit not connected to ground.

Potential - The pressure (voltage) existing between two points available to force electrons through the circuit as current.

Potentiometer - Electrical component that can vary the amount of resistance placed in a circuit by turning or sliding a contact on the resistance wire windings.

Power - Rate at which work is done. Common unit of measure for power is horsepower. Power is also measured by kilowatt (kW). About three-fourths of a kilowatt equal one horsepower.

Power Feed Circuit - Wires that carry current from the positive terminal of the battery to the electrical components of the vehicle.

Power-Seeking - A test method using a 12-volt test light where one lead is connected to a known ground and the other lead is touched to various points of a circuit to seek a point where power is present.

Power Supply - Sources of voltage in a circuit.

Preglow - The time it takes a glow plug to reach a temperature at which it will cause ignition of the mixture in the cylinder.

Primary Winding - Winding of relatively heavy wire in an ignition coil that receives current from the battery to create a magnetic field and induce a voltage in the secondary windings of the coil.

Primary Wiring - The low-voltage wiring in an automobile electrical system.

Printed Circuit - An electrical circuit made by etching a conductive material on an insulated board into a pattern to provide current paths between components mounted on the board.

Programmable Read-Only Memory (PROM) - Part of a microprocessor or computer in which instructions or data are semipermanently located. PROM data can be changed (like a RAM) but are not volatile memory (they do not erase when the power is turned off but are permanently configured as part of the electronic circuit).

Proton - One of the positive-charged particles in the nucleus of an atom.

P-Type Material - Semiconductor material with holes as part of its basic structure. It has a positive charge and will attract additional electrons.

Pull-In Winding - The coil of large-diameter wire in a solenoid that creates a magnetic field to pull the solenoid plunger into the coil.

Q

Quick Charger - Battery charger used to produce a high charging current to boost the charge of a battery in a short time.

R

Random Access Memory (RAM) - Part of a microprocessor or computer into which information can be written and from which information can be read.

Reactance - Property of an electrical device or conductor to impede change in current passing through it or voltage exerted on it.

Read-Only Memory (ROM) - Part of a microprocessor or computer where information and instructions are permanently integrated into the circuits and can only be read by the processor. Usually used to store the program or instructions for the processing unit to act on.

Rectifier - Device used to change alternating current to direct current.

Regulator - Device in the charging system used to control alternator output to prevent excessive voltage from being fed to the battery or to the electrical components in a vehicle.

Relative Motion - Movement of a conductor in relation to magnetic flux lines or movement of magnetic flux lines in relation to a conductor.

Relay - An electromagnetic switch. A relay uses a small amount of current flow to control the flow of a larger amount of current through a separate circuit.

Reluctance - The tendency of some materials to resist penetration by magnetic flux lines.

Required Voltage - Voltage needed to fire a spark plug.

Reserve Capacity Rating - A battery rating based on the number of minutes a battery at 80°F can supply 25 amperes, with no battery cell falling below 1.75 volts.

Resistance - The opposition to the free flow of an electric current, measured in ohms.

Resistor - A device made of carbon or wire that presents a resistance to current flow. Any device in a circuit that produces work, loads the circuit, and causes a voltage drop acts as a resistor.

Resistor Plug - A spark plug with a resistor in the center electrode to reduce the inductive portion of the spark discharge. Used to minimize radio and television interference caused by spark plugs.

Resistor Wire - Conductor of a given diameter and length that adds resistance, usually a low value, to a circuit.

Reverse Bias - Polarity of voltage applied to the junctions of a diode or transistor so normally no current will flow across the junction.

Reverse Breakdown Voltage - The reverse voltage beyond which a diode cannot hold back reverse current.

Reverse Current - Amount of current flowing from cathode to anode when a given reverse voltage is imposed on a diode or transistor.

Rheostat - A resistor for regulating a current by means of variable resistances.

Right-Hand Rule - A method of determining the direction of magnetic flux lines surrounding a current-carrying conductor, when the conventional theory of current flow is used (+ to -). If the conductor is grasped with the right hand so the thumb points in the direction of conventional current flow, the fingers will point in the direction of magnetic flux.

Rotor - Revolving part of a device, such as an alternator rotor, distributor rotor, or rotary combustion engine rotor.

S

Schematic Diagram - A drawing of a circuit, or any part of a circuit, that shows how it works.

Secondary Circuit - High voltage circuit of the ignition system consisting of the coil, rotor, distributor cap, spark plug cables, and spark plugs.

Secondary Winding - The coil winding made of many turns of a fine wire, in which voltage is induced by the rise and collapse of the magnetic field of the primary winding.

“See-Saw” Rule - An easy way to remember and use Ohm’s Law in your work. If voltage stays the same, but current is above specs, **resistance must be down** - possibly a short circuit. If voltage stays the same, but current is below specs, **resistance must be up** - possibly a bad connection.

Self Discharge - Chemical activity in a battery causing the battery to discharge even though it is not supplying a circuit or component with current.

Self-Induced Voltage - Voltage created in a conductor by the magnetic lines of a current through that same conductor.

Self-Powered Test Light - Used to check for continuity in a circuit or load device. Test unit uses a low voltage battery (1.5 volts) and bulb, and test leads.

Semiconductor - Popular name associated with almost any solid state circuit or component. Materials with four electrons in the outer ring of the atom which show the properties of a conductor or a nonconductor under different conditions.

Sending Unit - Sensor in the engine at a convenient point of an oil gallery or coolant passage to send a signal to a gauge or light indicating the pressure or temperature of the oil or coolant.

Series Circuit - A circuit in which the parts are connected end to end, positive pole to negative pole, so that only one path is available for all current flow.

Series Motor - A motor that has only one path for current flow through the field and armature windings. Commonly used for starter motors.

Series-Parallel Circuit - The connection of several loads in a circuit in such a way that current must flow through some loads, but can flow to one or more other loads without affecting the rest of the circuit. A series-parallel circuit is simply a circuit containing elements of both a series circuit and a parallel circuit.

Short Circuit - A type of circuit malfunction in which two or more wires touch each other accidentally, in such a way that the circuit(s) are completed wrong. A short circuit between two different circuits interconnects the two in such a way that if either circuit is electrically energized, both will function.

Shunt - Parallel. An electrical connection or branch circuit in parallel with another branch circuit or connection.

Shunt Motor - A motor that has its field windings wired in parallel with its armature. Not used as a starter motor, but often used to power vehicle accessories.

Silicon - Element commonly used in making semiconductor material.

Sine Wave Voltage - The constant charge, first to a positive peak and then to a negative peak, of an induced alternating voltage in a conductor.

Single-Phase Current - Alternating current caused by a single-phase voltage.

Single-Phase Voltage - The full wave voltage induced within one conductor by one revolution of an alternator rotor.

Slip Rings - Parts of an alternator forming a rotating connection between the field coil windings and the brushes.

Solenoid - Electromechanical device used to produce mechanical movement by drawing a plunger into a coil when current is applied to the coil. Used to control a valve, switch contacts, or control other moving parts.

Solenoid-Actuated Starter - A starter that uses a solenoid both to control current flow in the starter circuit and to engage the starter motor with the engine flywheel.

Solid State - Electronic components consisting mainly of silicon chips and similar conductive materials.

Solid State Regulator - Voltage regulator made from semiconductor components mounted in the alternator.

Solid Wire - A conductor made of one piece instead of being made from a number of smaller wires.

South Pole - Area of a magnet where the magnetic lines of force converge and enter the magnet.

Spark Plug - Device used to provide the heat or flame to ignite compressed air/fuel mixture in the combustion chamber. Consists of two accurately spaced electrodes and a threaded outer shell to screw into the cylinder head.

Specific Gravity - Weight of a substance compared to the weight of water. Any substance with a specific gravity of less than 1.00 is lighter than water; more than 1.00 is heavier than water. The amount of another substance (such as battery acid or antifreeze) in water can be determined by measuring the specific gravity of the mixture.

Sponge Lead - Porous lead used as the active material of the negative plate of a lead-acid storage battery.

Starter Motor - Electric motor used to crank the engine for starting.

Starter Motor Load Test - Test used to identify internal problems in the starter motor.

Starter No-Load Test - Test used to uncover such faults as open or shorted windings, rubbing armature, and bent armature shaft.

Starter Relay - Electrical switch on the starter motor that uses a smaller current from the ignition circuit to control a larger current from the battery to the starter motor.

Starter Solenoid - An electrically operated plunger mechanism on the starter motor used to engage the starter pinion gear with the ring gear on the flywheel. Also used to control the current to the starter motor.

Starting Bypass - A parallel branch circuit that bypasses the primary ballast resistor during cranking.

Starting Control Circuit Test - Test used to determine whether failure to crank is due to open circuits, defective wiring, or poor connections causing excessive resistance in the starter control circuit.

Starting Safety Switch - A neutral start switch. It keeps the starting system from operating when a car's transmission is in gear.

Starting System - Components in the electrical system used to crank the engine until it can begin running on its own.

State-of-Charge - A measurement of a battery's internal condition in relation to a fully charged unit, usually expressed as a percentage of full charge.

Static Electricity - Voltage resulting from the transfer of electrons from the surface of one material to the surface of another material. The electrons are "static," meaning at rest.

Stator - In an alternator, it is the part which contains the conductors within which the field rotates.

Storage Battery - Device used to change chemical energy into electrical energy. Part of the electrical system acting as a reservoir for electrical energy, storing it in a chemical form.

Stranded Wires - Wires or cables made of a number of smaller wires twisted or braided together.

Sulfation - The crystallization of lead sulfate on the plates of a constantly discharged battery.

Sulfuric Acid - Highly corrosive chemical compound used in a diluted form as the electrolyte in storage batteries.

Switch - A device used for opening, closing, or changing the connections in an electric circuit.

Symmetrical - The same on either side of center. In a symmetrical high-beam headlamp, the light beam is spread the same distance to either side of center.

System Diagram - A drawing that shows all of the different circuit diagrams in a complete electrical system.

T

Temperature Correction - The amount that must be added to or deducted from a reading taken at one temperature to make it comparable with the same reading taken at a standard temperature.

Terminal - A device attached to the end of a wire or to an apparatus for convenience in making electrical connections.

Test Lamp - A 12-volt lamp with leads (wires) attached so that the lamp can be temporarily inserted in an electrical circuit, either in series or in parallel with it. It is used to confirm that voltage is available to a specific point in a circuit.

Thermistor (Thermal Resistor) - A resistor especially built to reduce its resistance as the temperature increases.

Thermoelectricity - Voltage resulting from an unequal transfer of electrons from one metal to another, when one of the metals is heated.

Three Phase Current - Combination of three alternating current cycles, each starting one-third of a cycle apart so each of the cycles in the resulting combined wave is 120 degrees out of phase from the others. Provides a smoother direct current flow when rectified because voltages of each alternating cycle are not allowed to decay completely before the next cycle begins to rise.

Thyristor - A silicon-controlled rectifier (SCR) that normally blocks all current flow. A slight voltage applied to one layer of its semiconductor structure will allow current flow in one direction while blocking current flow in the other direction.

Transducer - A device that changes one form of energy into another. In an ignition system, it may sense a mechanical movement and change it to an electrical signal.

Transformer - Device used to change alternating current from one voltage to another. Consists of two coils, one with more windings than the other, that induce voltage in one coil when current flows to the other. Can increase or decrease applied voltage.

Transistor - A semiconductor device with three connections. A small current at the control junction between semiconductor materials is used to control a larger current between two rectifying junctions.

Trickle Charge - A low rate of charge given to a storage battery over a long period of time.

Twenty Hour Rate - Battery rating measuring the amount of current a battery can deliver for 20 hours with an electrolyte temperature of 80°F (27°C) before the cell voltage drops to 1.75 volts.

V

V - Abbreviation for volt, a unit of measurement for electrical potential.

Vacuum Fluorescent Display (VFD) - Process of displaying numbers and letters by using free electrons from a heated filament striking a phosphor-coated material emitting a blue-green light. Used in many electronic display devices.

Valence Ring - The outermost electron shell of an atom.

Volt - The unit for measuring current pressure in a circuit. One volt of pressure causes one ampere of current to flow against one ohm of resistance.

Voltage - The electromotive force that causes current flow. The potential difference in electrical force between two points when one is negatively charged and the other is positively charged.

Voltage Drop - The difference in potential (voltage) between one point in a circuit and another; typically the voltage difference from one side of a component to the other.

Voltage Leak - The loss of charge in a capacitor because of the imperfect insulating characteristics of the dielectric, allowing voltage to “leak” across, neutralizing the electrical charge,

Voltage Loss (Also Called Voltage Drop) - Reduction in voltage across an electrical device or circuit because of the resistance to current flow of that device or circuit.

Voltage Regulator - A relay that limits an alternator’s voltage output.

Voltmeter - An electrical meter used to measure the difference in voltage between two points in a circuit. It reads volts of electrical pressure. The voltmeter must be connected across the load or circuit — red lead on the battery side of the circuit, black lead on the ground side of the circuit.

W

W - Abbreviation for watt, a unit of measurement for power.

Warning Light - Light that illuminates to alert the driver to some condition in the vehicle such as battery charging rate, high coolant temperature, or low oil pressure,

Watt - The unit of measurement for electric power. One way to measure the rate of doing work. Watts equal volts times amperes.

Watts Rating - A method of rating the available cranking power of a battery. The rating can be found by multiplying the current available from the battery by the battery voltage at 0°F.

Wire Gauge - Wire size numbers based on the cross section area of the conductor. Larger wires have lower gauge numbers.

Wiring Diagram - A schematic. The representation of an electrical circuit by a drawing. A wiring diagram may contain electrical symbols for various loads and components.

Wiring Harness - A bundle of wires enclosed in a plastic cover and routed to various areas of the vehicle. Most harnesses end in plug-in connectors. Harnesses are also called looms.

Y

Y-Type Winding - An alternator design in which one end of three windings is connected at a neutral junction.

Z

Zener Diode - A semiconductor made so it will allow reverse current flow without damage at a voltage above a specific value.