NEW

PETERBILT ESSENTIALS

MODULE 10

Electrical Systems

Peterbilt

CLASS PAYS

Introduction

Quality materials and sound assembly techniques go into the manufacture of every Peterbilt electrical system. In addition, the system is designed to provide for timely analysis of trouble and ease of repair. The result: a minimized chance of electrical problems.

How To Use New Peterbilt Essentials

1. Print the module and study the information. To print, click the printer icon on your browser. Highlight material that is new to you, or complex.
2. When you are ready to take the online test, click the "Begin" button in the "Test" column for the desired module. When the test is completed, it will automatically be scored and the results will be entered in the Peterbilt training records database.
3. Upon successful completion of all modules, you will receive a personalized certificate.

It is recommended that you complete these training modules in sequence since each succeeding module builds on the previous module.

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Electrical Systems

The Peterbilt electrical system features sealed electrical connectors for maximum protection from dirt and water contamination. The wires are protected by the most durable insulation available, and wire harnesses are carefully supported to help prevent chafing. There are 11 colors in the Peterbilt electrical color code. Every color has a specific electrical purpose. For example, red = protected 12 volts and white = ground. Each wire is marked every four inches or less with its corresponding circuit number for identification. The circuit numbers are grouped into electrical categories. For example, any circuit number between 7000-7999 is related to the heating and A/C system. These measures ensure that system maintenance and troubleshooting can be performed quickly and easily.

Numbered Wires/Sealed Electrical Connectors

At the end of the frame, Peterbilt offers an unwired junction box to which additional wiring can be routed. This option is designed to make body installation easier. The "body connections" option simplifies body installation even further. It provides two junction boxes, one with four power circuits and another that is set up for the installation of the body's lighting system.

The traditional model electrical system is divided into six separate harnesses that are connected to each other by means of hard shell connectors:

- Main cab
- Hood
- Trailer
- Engine
- Chassis
- Sleeper
- Roof

Cab Harness

The cab harness can be considered the main distribution harness, since most of the other harnesses connect to it. The cab harness begins at the feed-through connectors and goes to the fuse/circuit breaker panel, which is located inside the cab in the lower left-hand forward corner. A relay panel and a 12-space accessory block are located behind the tachometer and speedometer panel. The hood, trailer, engine and chassis harnesses are "cab feed through" harnesses. They enter the cab through two connectors on the lower left-hand side of the cab firewall and one on the top drivers' side corner.

Roof Harness

The roof harness connects to the main cab harness behind the glove box. It is routed up the right A-post to the header, where it splits and branches across the header to the left side of the cab roof and above the right door frame to the rear of the cab.

Sleeper Harness

The sleeper harness connects to the cab's roof harness at the left rear corner of the cab. The sleeper harness also connects to the sleeper fuse relay panel under the left-hand side of the bed. All electrical devices in the sleeper receive power from a branch of this harness. The wiring system design incorporates the wiring for many commonly specified options within the standard wiring harnesses. Even if they are not specified, most accessories are pre-wired; this simplifies future customer/dealer-installed options.

The sleeper fuse/circuit breaker panel, or sleeper load center, is located inside the sleeper with easy access under the left-hand side of the bed.

The sleeper load center has 12 fuse locations and 6 relay locations to separate sleeper electrical needs from the cab. This design provides more dependable operation and easy maintenance or repair. The load center also includes 5 spare circuits with fuse locations and 1 spare relay location to simplify installation of customer-added electrical devices. Optional auto-resetting circuit breakers are available in place of fuses in some applications.

Kick Panel Door Concealing Fuse/Circuit Breaker Panel

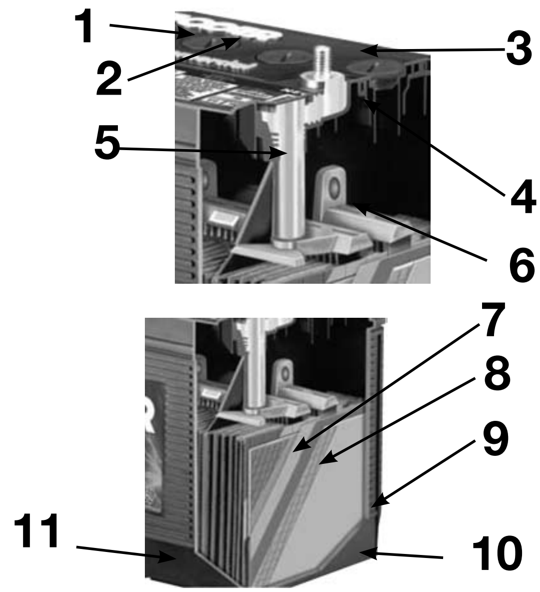
Fuse/Circuit Breaker Panel

Peterbilt features easily removable dash panels for quick access to instrument wiring.

Starting and Charging

The starting and charging system consists of three major components:

- Battery
- Alternator
- Starter



1. Leak-resistant, maintenance-free flush cover keeps battery top clean and dry.
2. Screw-in caps permit maintenance if needed.
3. Stainless steel terminal studs resist corrosion.
4. Forged terminal bushings resist leakage and corrosion.
5. Heavy duty internal posts deliver highest current flow.
6. Heavy duty "straight through partition" connectors reduce resistance.
7. Compu-cast grids resist internal shorts.
8. High density oxides deliver dependable "high cycling" service.
9. Fiberglass-wrapped envelope separators lock active material to the plates.
10. Anchor-locked elements resist pounding vibration.
11. Reinforced case bottom resists punctures by stones and foreign objects.

PACCAR Battery Design and Construction

Battery

A battery is an electrochemical device for converting chemical energy into electrical energy. The battery has three main purposes:

- To provide electrical energy to start the vehicle and power to operate electrical accessories when the engine is not running.
- To provide energy to the electrical system when demand exceeds alternator output when the engine is running.
- To stabilize the system by acting as a reservoir where large amounts of current can be removed (drawn) quickly during starting and replaced gradually by the alternator during charging.

How Batteries Work

The battery produces electricity by a chemical reaction that releases large amounts of electrical current at a sustained voltage for a specified period of time. The battery is recharged while the vehicle is operating and the electrical demand is low. If the recharging is inadequate, the battery will eventually fail to crank the engine.

A battery's electrical output is measured in amps of direct current (DC) at the battery terminals. Inside the battery case are six cells (for a 12-volt battery). Each cell has positive and negative plates separated by a small space. Each positive and negative plate is constructed on a framework, or grid, made primarily of lead. Battery grids provide the electrical pathways for the current created in the plate.

Direct Current (DC)

When electrical current constantly flows in the same direction, we refer to it as direct current. It is generally accepted that in vehicle applications, electrical current flows from areas of positive charge to those of negative charge. All electrical equipment used in heavy-duty vehicles operates on DC.

A battery cell produces voltage because the plates are immersed in an electrolyte solution of sulfuric acid and distilled water. The chemical reaction between the acid and the dissimilar plate materials produces approximately 2.11 volts per cell. Since a standard 12-volt battery contains six cells connected in series, it will produce a total full charge voltage of approximately 12.66 volts (6 x 2.11 = 12.66V). As the plate material in the cells slowly interacts with the electrolyte solution, the chemical reaction of the electrolyte maintains the voltage imbalance between the negative and positive plates. This prevents electrical charges inside the battery from being rapidly lost while the battery is being stored.

Battery Capacity

A battery's ability to deliver starting power, especially at very low temperatures, is generally the most important indicator of its capacity. This ability is measured in cold cranking amperes (CCA). In a test to determine CCA, the temperature of the battery electrolyte is brought to 0°F in the center cell. The current drawn from the battery for 30 seconds at a terminal post voltage of not less than 7.2 volts (1.2V per cell) is the CCA rating of the battery.

For example, if a battery is rated at 625 CCA, it can deliver 625 amps of current for 30 seconds at 0°F while maintaining a terminal post voltage of at least 7.2 volts. A heavy-duty vehicle starting system might use three such batteries. If they were each rated at 625 CCA, they would provide a total output of 1,875 CCA.

A battery with a shorted cell would register from 10.45 to 10.65 volts. In this case, there would be only five cells to produce the terminal post voltage (2.11 x 5 = 10.55V). A short occurs when the negative and positive plates in one cell make contact with each other and electrically remove the cell from contributing to the total battery voltage.

Why Batteries Fail

Here are some common reasons batteries fail.

- **Condition of Battery –** Vibration from an improperly installed battery can dislodge material from the plates and reduce battery life. Flakes from the lead plates can fall to the bottom of the cell, causing a short and ruining the battery.
- **Insufficient Electrolyte** – Portions of the plates become exposed, causing the coating on the plates of the battery to sulfate. The sulfate on the plate surface then hardens, making recharging difficult or impossible.
- **Extended Discharged State –** When a battery is allowed to remain discharged too long, the accumulated lead sulfate in the plate material solidifies and cannot re-enter the electrolyte.
- **Overheating –** When the electrolyte temperature reaches 125 degrees Fahrenheit, increased chemical reaction causes corrosion of the plates and reduces battery life.
- **Freezing –** When electrolyte freezes, the ice formed dislodges active material from the plates. Also, the battery case may crack and the electrolyte will leak out when it thaws. It is especially important to keep a battery at full charge in cold weather; the high specific gravity of a fully charged battery helps it resist freezing.
- **Corrosion** – Dirt and corrosion around battery terminals and on the top cover of the battery can form deposits that can conduct electricity and cause battery drain.
- **Overcharging** – Prolonged overcharging generates excessive heat inside the battery, which buckles the plates and can destroy the battery.

Alternator

An alternator converts mechanical energy into electrical energy and has two purposes. First, it must charge the batteries, and second, it must provide sufficient current at the proper voltage to operate the vehicle's electrical and electronic systems.

A rotor in the alternator is turned by the engine by a belt and drive pulley. The rotor becomes an electromagnet that turns inside three stationary windings mounted on a common circular frame (called the stator). As the rotor turns inside the stator, current is induced into the wire windings. The induced current is the alternator's output, but it is an alternating current (AC) because of the magnet's alternating poles.

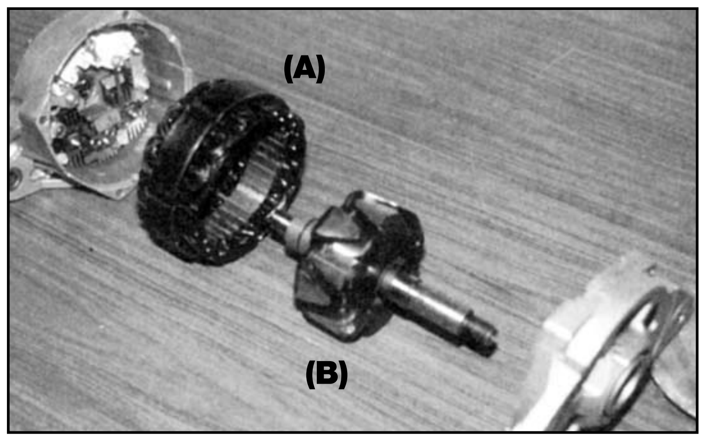
Alternating Current (AC)

In contrast to what happens in direct current electricity, the flow of electrons in alternating current (AC) electricity constantly changes direction in a cycle of positive to negative, then negative to positive. This is because the source of the current is a rotating magnet whose poles alternate. AC is common in houses but not in automobiles and heavy-duty vehicles.

The electrical equipment in a heavy-duty vehicle operates on DC. Therefore, the AC output of the alternator must be rectified (converted) to DC before the vehicle can use it. The current induced in the stator winding connects to diodes (one-way electrical check valves) that permit the electrical current to flow in only one direction. The diodes couple the AC waveforms to the battery, and this results in a pulsating DC output current.

The output voltage and current of an alternator depend on three factors:

1. **Speed of rotation –** Alternator output is increased with alternator rotational acceleration to its maximum possible ampere output. Alternators normally rotate two to three times faster than engine speed, depending on pulley sizes used for the belt drive.
2. **Number of conductors –** The more turns of wire in the stator windings, the higher the output of the alternator.
3, **Strength of the magnetic field –** The stronger the magnetic field, the higher the output that is possible, because the current generated by electromagnetic induction is dependent on the lines of magnetic force.



Alternator. Note the Stator (A) and the Rotor (B)

The voltage regulator (V/R) regulates the charging voltage by controlling field current (magnetic field strength). When a battery has reached full charge, the voltage regulator switches the field current off or reduces it dramatically. As the battery charge drops, the voltage regulator turns on the field current to recharge the battery. This cycle occurs many times per second and controls the flow of current. The voltage regulator also disconnects battery voltage from the field winding when the ignition key is turned to the OFF position.

Alternator Specification

Peterbilt offers alternators in a wide range of amperage ratings up to 270 amps. The PACCAR 130-amp is standard on most configurations.

Will a standard equipment alternator be adequate, or should the vehicle be spec'ed with an optional higher-amperage alternator? The answer depends on the electrical load. A two-stage process, illustrated below, is used to determine whether an alternator will be sufficient to handle the vehicle's electrical loads. In the first stage, the vehicle's demand for electrical current is measured.

1. All electrical components to be used during a specified period must be identified along with their loads.
2. The sum of all the loads of the identified electrical components is multiplied by the number of hours in the specified period. This yields a measurement of total current demand in ampere-hours.

Table 1 lists electrical loads and the time period during which they will be used. Notice that a 20% reserve factor has been added to the total number of amp-hours to account for intermittent loads, such as turn signals and the battery's need to recharge after a starting cycle.

Table 1. Electrical Loads for Specified Time Period

Electrical Loads per Working Shift	Amperes Draw	Hours Used	Amp-Hour Load
Gauges	2.00 x	8	= 16.00
Air Conditioner	22.00 x	8	= 176.00
Headlights-high beam	11.00 x	6	= 66.00
Tail lights (2)	1.20 x	6	= 7.20
Cab marker lights (5)	1.20 x	6	= 7.20
Fog lights (2)	6.70 x	6	= 40.20
Semitrailer lights	6.60 x	6	= 39.60
Total load, amp-hrs.	**50.70**		**352.20**
Reserve (20% x load)			**70.44**

In the second stage, the alternator's output capacity for the same period is determined as follows:

3. Find alternator output at idle rpm and at road speed. The Peterbilt standard alternator has an idle speed output of 60 amps and a road speed output of 130 amps. Now estimate idling time and the time spent at road speed for the period. Table 2 shows the output based on an estimate of 1 hour at idle speed and 7 hours at road speed.
4. Multiply the hours spent in each mode by the alternator's corresponding output.

Table 2. Alternator Output for Specified Period

Engine Speed	Amperes Output	Operating Hours	Amp-Hour Output
Idle Speed	60	1.00	60
Road Speed	130	7.0	910
Output			**970**

A quick comparison of the electrical demand listed in Table 1 (about 352 amp-hours) and the alternator output listed in Table 2 (970 amp-hours) shows the standard alternator is more than adequate to handle the electrical demand for this vehicle during the period specified.

Starting

In an earlier module we learned that the combustion phase of engine operation is the period during which the high-pressure diesel fuel is injected into the compressed air mass within the cylinder. The fuel ignites to produce both a high temperature and a high pressure rise within the combustion chamber.

The pressure created by the expanding gases forces the piston down the cylinder. The chemical energy released from the burning diesel fuel and air mixture is then converted to mechanical energy through the piston, the connecting rod and the crankshaft.

Starter Motor

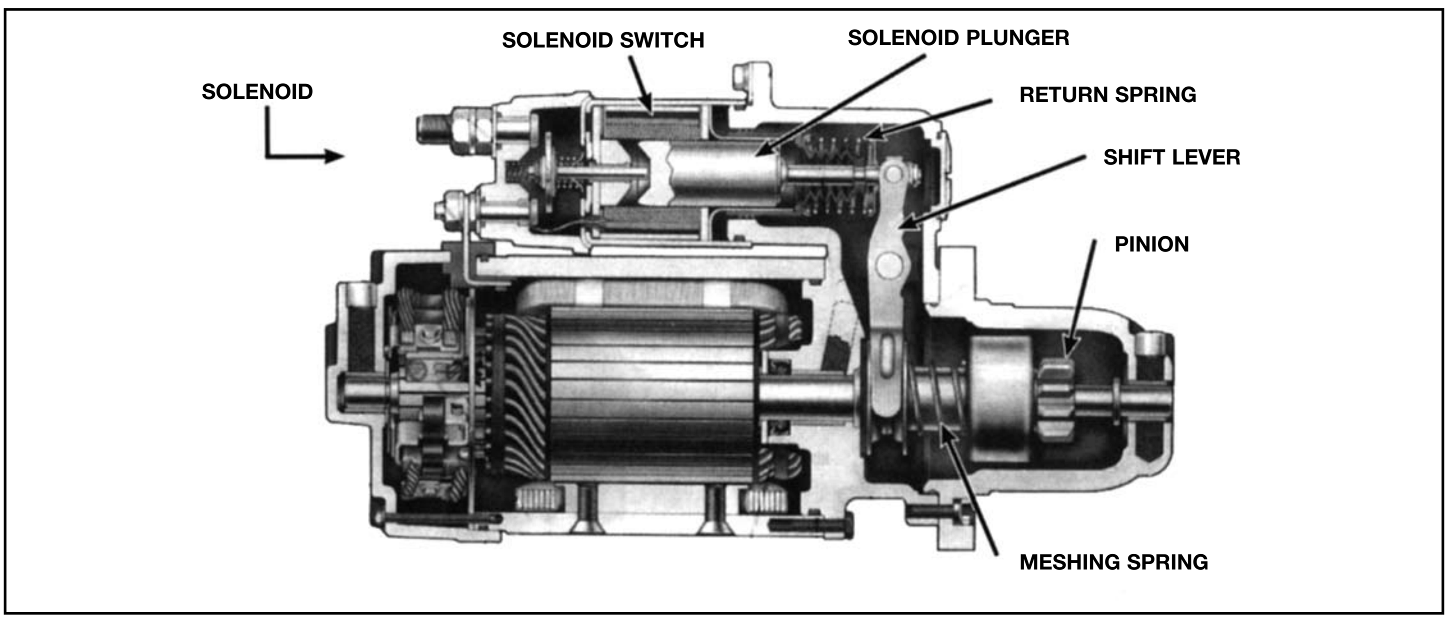
The starter motor assembly is required to crank the engine at a speed high enough to initiate combustion within the engine cylinders so the engine will run. This is achieved by using battery power to rotate the starter motor, which in turn spins a pinion gear. This gear engages with the engine flywheel ring gear teeth to cycle the engine for starting purposes.

Starter motors found on medium- or heavy-duty trucks vary in physical size and design, although their principle of operation is the same. Each model of starter motor is rated for a specific output, which is generally listed in kilowatts or horsepower.

Higher output starter motors are generally used on diesel engines because diesel engines have a much higher compression ratio than gasoline engines. The engine's displacement, or size, will also impact the required starter output.

The initial starting of the engine is accomplished by turning the key to "START." This allows power to flow from the batteries to the starter-mounted solenoid switch. Providing power to the solenoid activates the solenoid plunger, which shifts the pinion gear into mesh with the ring gear. Once engagement of the pinion and the ring gear takes place and the ignition switch is "ON," the solenoid contacts close, allowing full battery power to the starter motor. Power to the starter turns the crankshaft, which causes the pistons to move in the cylinders. The piston's movement toward Top Dead Center (TDC) in the cylinder compresses the air, causing it to get hot. Fuel is injected, combustion occurs and the engine begins to run.

Once the engine starts and the key switch is returned to the "RUN" position, an internal return spring forces the solenoid plunger back to its released position, effectively breaking the contact disk away from the starter motor switch terminals. This also disengages the pinion gear, preventing an overrun condition.



Starter Motor Assembly