Section 3

The Battery

The Battery

The battery is the main source of electrical energy on Toyota vehicles. The battery powers these major electrical systems:

- Starting
- Ignition
- Charging
- Lighting
- Accessories

The Battery

The battery is the main source of electrical energy in the vehicle.

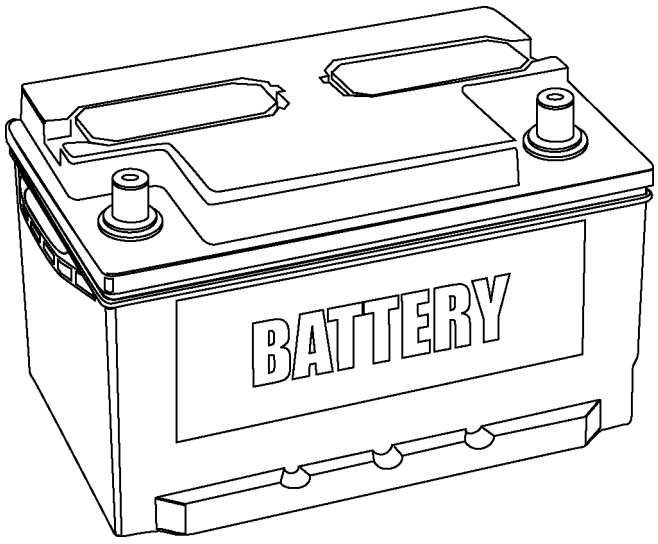

Fig. 3-01
TL623f301

Battery Functions

Engine off - The battery provides energy to operate lighting and accessories.

Engine starting - The battery provides energy to operate the starter motor and ignition system during starting.

Engine running - The charging system provides most of the energy required with the engine running; the battery acts as a voltage stabilizer to protect voltage sensitive circuits, particularly digital circuits.

Battery Functions

The battery provides energy to operate lights and accessories and to start the engine. It also serves as a voltage stabilizer.

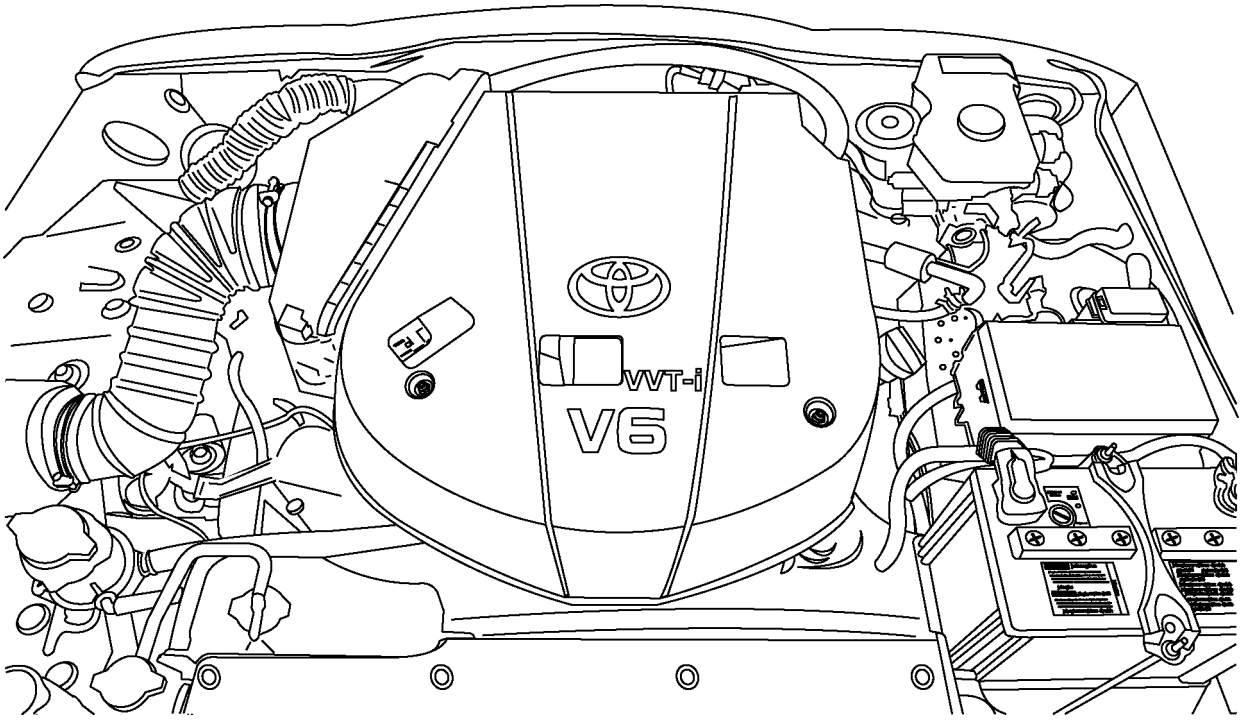

Fig. 3-02
TL623f302

Battery Type

Lead-Acid - Virtually all automotive batteries are lead-acid batteries. Two different metals, both lead compounds, are immersed in an acid electrolyte. The chemical reaction produced provides electrical energy.

Low Maintenance/No Maintenance - Some manufacturers use this terminology. “Low maintenance” means that electrolyte can be added. “No maintenance” means that the battery is sealed.

Vented - Most batteries have removable vented caps that are used to check electrolyte level and add distilled water as necessary to restore the level. The caps also allow hydrogen gas, a byproduct of battery charging, to escape during charging.

Sealed - Some lead-acid batteries are sealed, that is, there are no removable caps to check electrolyte or replenish it. Some of these batteries have a small “eye” to indicate charge level. Still others are sealed, but include connections to external vent tubes.

NOTE For all types of batteries, always follow the manufacturers’ recommendations for charging and testing.

Lead-Acid Battery

Lead-acid batteries are called by different names: vented, sealed, low maintenance, and no maintenance.

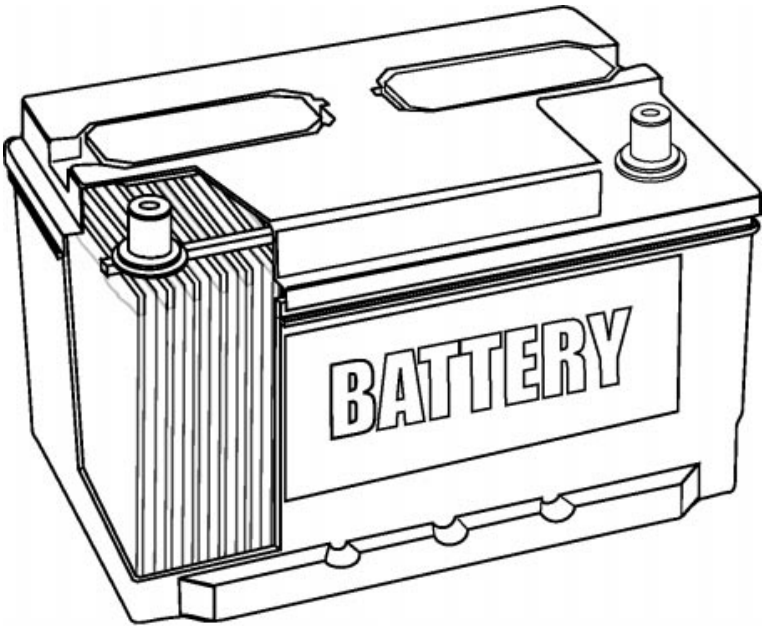

Fig. 3-03
TL623f300

Battery Construction

Battery Case

The battery case holds and protects all of the internal components and contains the electrolyte.

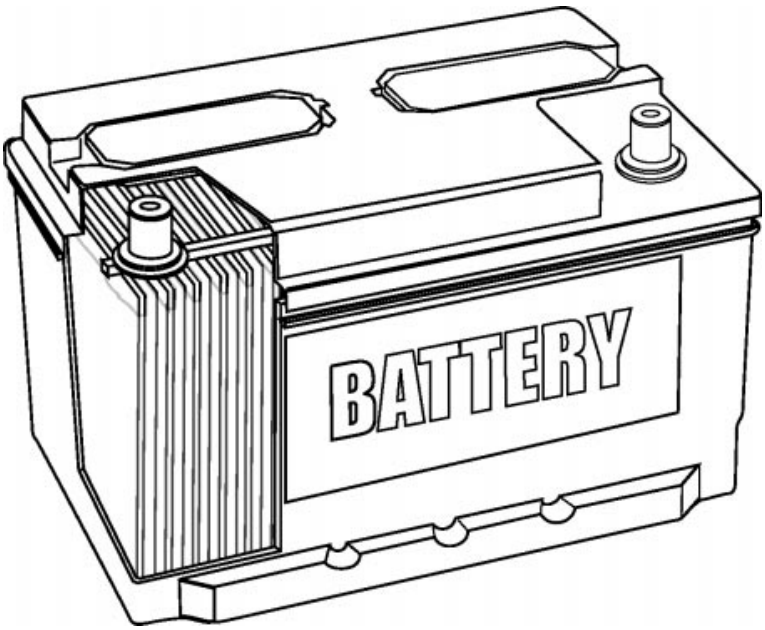

Fig. 3-04
TL623f300

Battery Case

The battery case and cover...

- Form a sealed container.
- Protect the internal parts.
- Keep the internal parts in proper alignment.
- Prevent electrolyte leakage.

Plates

Two types of plates are used in a battery: positive and negative.

Positive - Positive plates are made of antimony covered with an active layer of lead dioxide (PbO2).

Negative - Negative plates are made of lead covered with an active layer of sponge lead (Pb).

Only the surface layers on both plates take part in the chemical reaction.

Plate surface area - As the surface area of the plates increases, so does the current capacity of the battery. Surface area is determined by the size of each plate, as well as the total number of plates in a battery. Generally speaking, the larger the battery, the higher is its current capacity.

Surface area has no effect on battery voltage.

Positive and Negative Plates

Positive plates are covered with lead dioxide (PbO2); negative plates are made of lead (Pb).

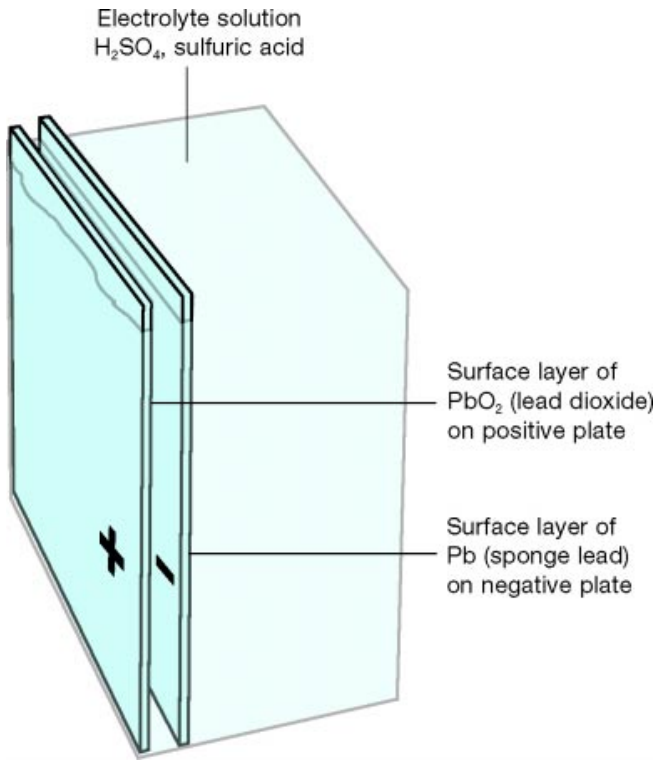

Fig. 3-05
TL623f305c

Separators

The plates are separated by thin porous insulators. These allow electrolyte to pass freely between the plates, but prevent the plates from touching each other and shorting out.

Insulators

Insulator plates keep positive and negative plates from touching each other and shorting out.

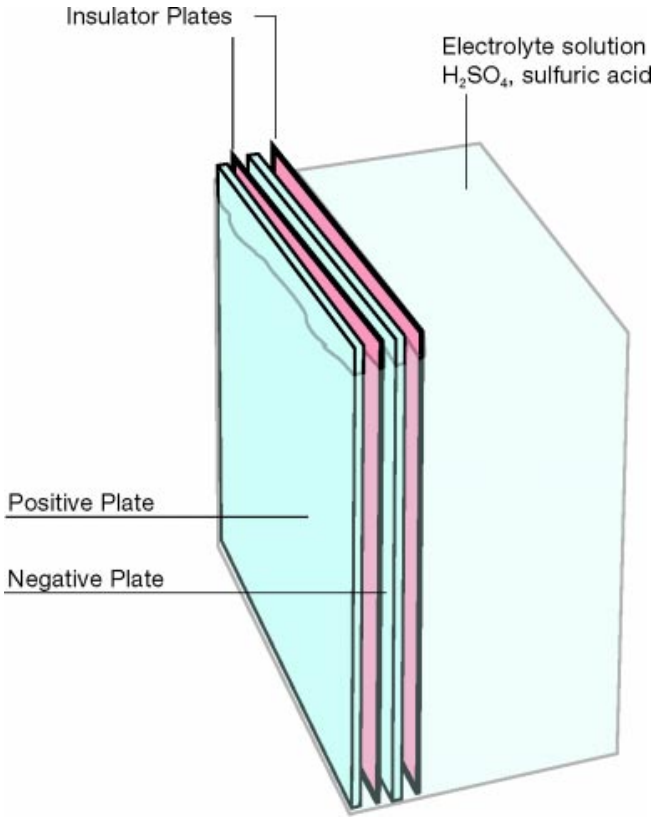

Fig. 3-06
TL623f306c

Cells

A typical lead acid battery is organized into cells.

Each cell ...

- Consists of multiple positive and negative plates immersed in their own electrolyte reservoir.
- Produces about 2.1 volts, regardless of battery size.

Automotive batteries are rated at 12 volts. To make up this voltage, six cells, each producing 2.1 volts, are connected in series.

6 x 2.1 volts = 12.6 volts

As a result, actual battery voltage is typically closer to 12.6 volts.

Cells are connected in series with heavy internal straps.

A positive and a negative terminal post provide connection points for the vehicle's battery cables.

Battery Cells

A typical automotive battery contains six cells connected in series. Each cell produces 2.1 volts.

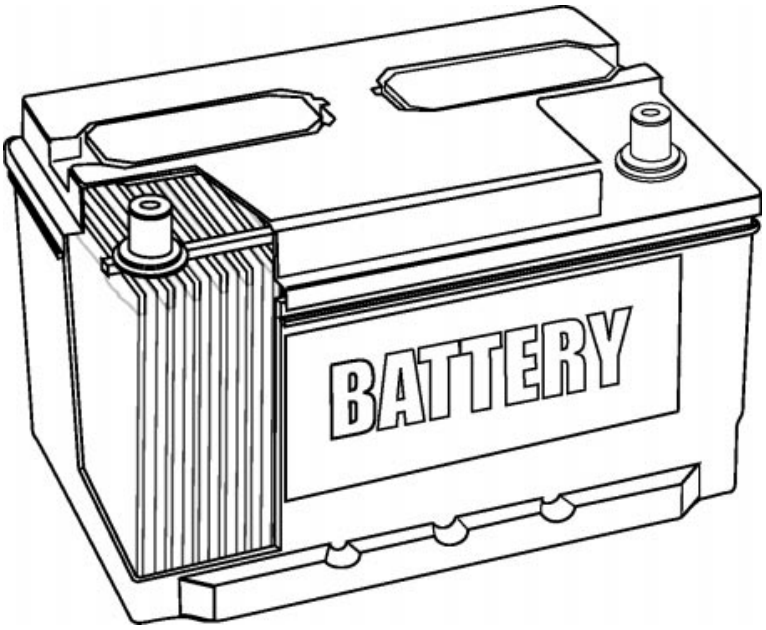

Fig. 3-07
TL623f307

Venting System

On some batteries, vent caps allow a controlled release of hydrogen gas. This gas forms naturally during battery recharging, whether by the vehicle's alternator or by an external charger.

Battery Vent Caps

Vent caps allow the controlled release of hydrogen gas as the battery charges.

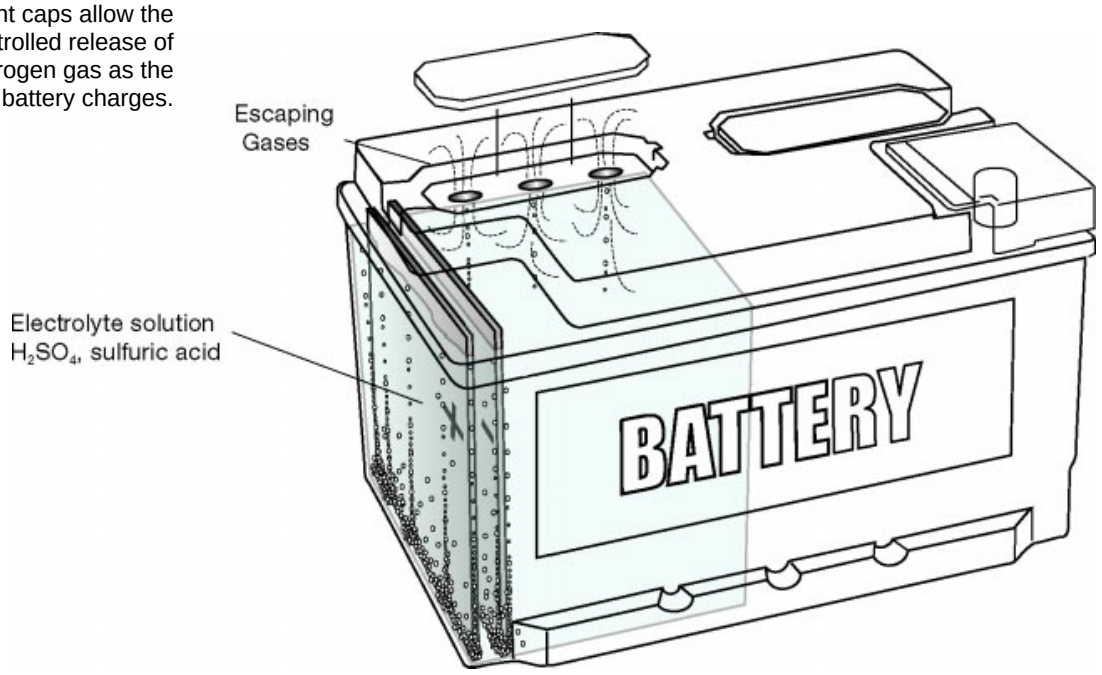

Fig. 3-08
TL623f308c

Electrolyte

The electrolyte is a mixture of sulfuric acid (H_2SO_4) and water (H_2O). The electrolyte reacts chemically with the active material on the plates to produce a voltage (electrical pressure).

Battery Electrolyte

Acid in the electrolyte reacts chemically with the positive plate's lead oxide (PbO_2) and the negative plate's sponge lead (Pb) to produce a voltage.

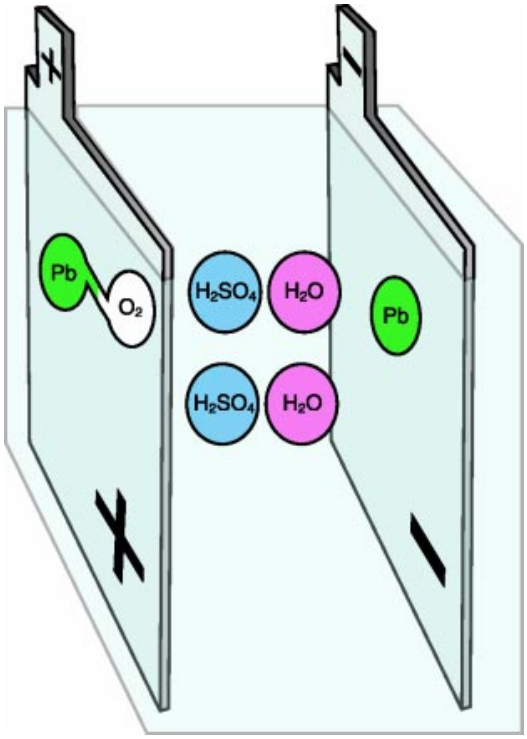

Fig. 3-09
TL623f309c

How Batteries Work

The function of a lead acid cell is based on a simple chemical reaction. When two dissimilar metals are immersed in an acid solution, a chemical reaction produces a voltage. Using this reaction, a lead-acid battery can be discharged and charged many times.

There are four stages in the discharging-charging cycle:

Fully Charged

- Positive plate covered with lead oxide (PbO_2).
- Negative plate covered with sponge lead (Pb).
- Electrolyte contains water (H_2O) and sulfuric acid (H_2SO_4).

Discharging

- Current flows in the cell from the negative to the positive plates.
- Electrolyte separates into hydrogen (H_2) and sulfate (SO_4).
- The free sulfate combines with the lead (both lead oxide and sponge lead) and becomes lead sulfate ($PbSO_4$).
- The free hydrogen and oxygen combine to form more water, diluting the electrolyte.

Fully Discharged

- Both plates are fully sulfated.
- Electrolyte is diluted to mostly water.

Charging

- Reverses the chemical reaction that took place during discharging.
- Sulfate (SO_4) leaves the positive and negative plates and combines with hydrogen (H_2) to become sulfuric acid (H_2SO_4).
- Hydrogen bubbles form at the negative plates; oxygen appears at the positive plates.
- Free oxygen (O_2) combines with lead (Pb) at the positive plate to become lead oxide (PbO_2).

Lead Acid Chemical Reaction

The charging-discharging cycle has four distinct stages, all based on a reversible chemical reaction with lead and sulfuric acid.

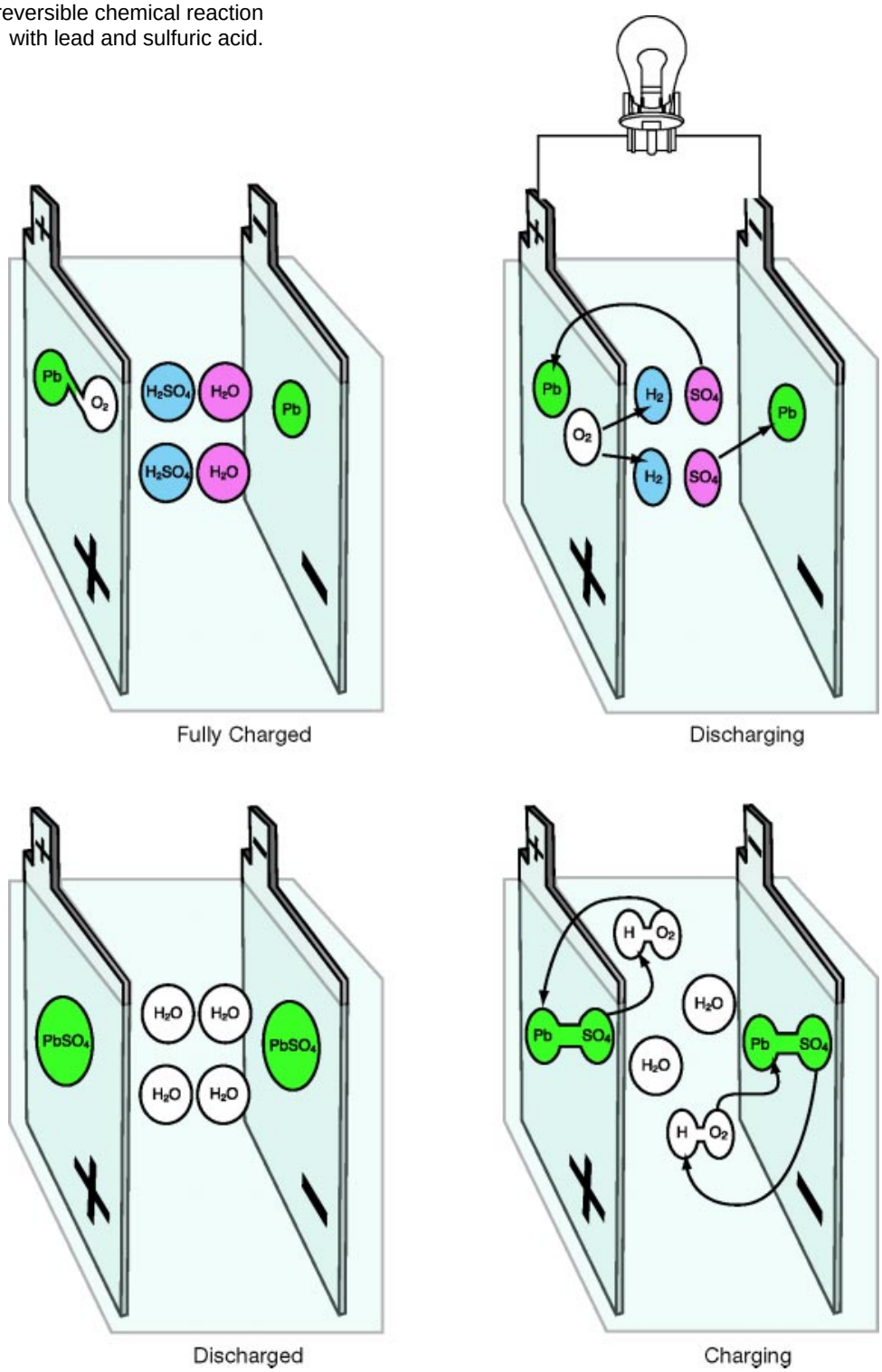

Fig. 3-10
TL623f310c

Capacity Ratings

An automotive battery must be able to crank the engine for starting and still have enough reserve capacity to operate the vehicle systems once the engine starts.

Battery capacity is:

- The amount of electrical energy the battery can deliver when fully charged.
- Determined by the size and total number of plates and the volume and strength of the electrolyte.

Refer to the manufacturer's specification for information specific to a particular Toyota vehicle.

Cold-Cranking Amperes

While it is operating the starter, the battery experiences a large discharge current.

The measure of a battery's ability to provide this current is expressed as Cold-Cranking Amperes, or CCA Rating.

The CCA Rating specifies (in amperes) the discharge current a fully charged battery can deliver ...

- at 0° F (-18° C),
- for 30 seconds,
- while maintaining at least 1.2 volts per cell (or 7.2 volts total for a six-cell, 12-volt battery).

Batteries in Toyota vehicles typically have a CCA rating between 350 to 560 amperes, depending on vehicle model. Refer to TIS to obtain information for specific Toyota vehicles.

Reserve Capacity (RC)

The battery must provide reserve energy for the ignition system and for lights and accessories if the charging system fails.

The Reserve Capacity rating measures (in minutes) the amount of time a fully charged battery can ...

- discharge at 25 amperes, while maintaining a voltage of at least 1.75 volts per cell (total of 10.5 volts for a 6-cell, 12-volt battery).

Batteries in Toyota vehicles typically have an RC rating between 55 and 115 minutes, depending on vehicle model. Refer to TIS to obtain information for specific Toyota vehicles.

Ampere-Hours (AH)

The Ampere-Hours, or AH rating, is another important measure of a battery's design performance.

The AH rating expresses the discharge current a fully charged battery can deliver for 20 hours ...

- at 80° F (27° C),
- while maintaining a voltage of at least 1.75 volts per cell (total of 10.5 volts for a 6-cell, 12-volt battery).

EXAMPLE A battery that can deliver 4 amps for 20 hours is rated at 80 amp-hours.

Batteries in Toyota vehicles typically have an AH rating between 40 and 80 amp-hours, depending on vehicle model. Refer to TIS to obtain information for specific Toyota vehicles.

Visual Inspection

Battery service should always begin with a thorough visual inspection. Such an inspection may reveal simple, easily corrected problems or problems that require battery replacement without further testing.

Include these steps in a visual inspection:

1. Check for cracks in the battery case. Check particularly around battery terminals. These are sometimes overstressed when removing and installing battery cables. Replace the battery if there is any evidence of cracking.
2. Check for cracked or broken cables or connections. Replace cables or connectors as necessary.
3. Check for corrosion on terminals and dirt or acid on the case top. Clean the terminals and case top with a mixture of water and baking soda. Wire brush heavy corrosion on the terminals.
4. Check for a loose battery hold-down and loose cable connections. Tighten as needed.
5. On batteries with removable vent caps, remove the caps and check the electrolyte level. Add distilled water to each cell to restore the level if necessary. Avoid overfilling and never add additional acid. Tap water adds contaminants, and will reduce battery efficiency.

Visual Inspection

A visual inspection can reveal easy-to-correct problems with the battery and conditions that will require battery replacement.

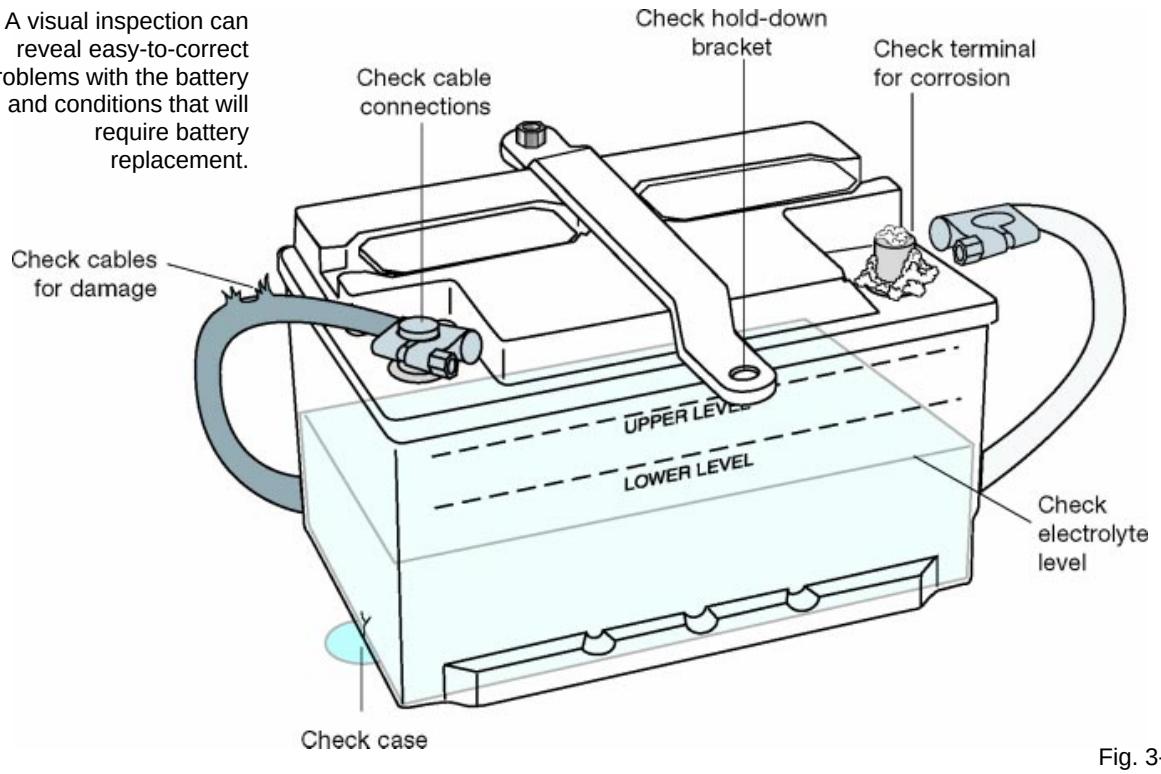

Fig. 3-11
TL623f311c

Battery Indicator Eye

The battery indicator eye can give a quick indication of battery condition.

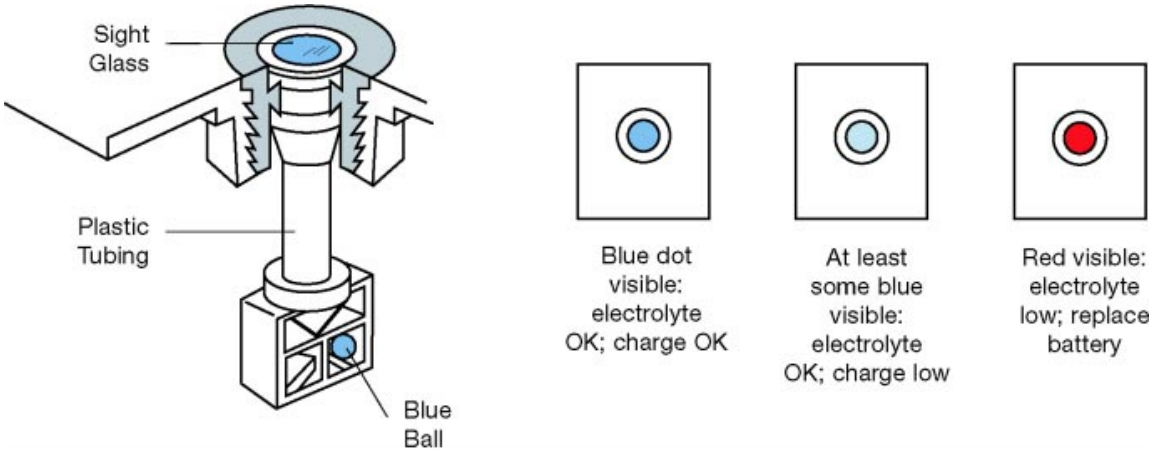

Fig. 3-12
TL623f312c

6. Check the indicator eye. A red eye indicates the battery is severely discharged or the electrolyte is low. The electrolyte level is sufficient and the battery is at least 25% charged if at least some blue is showing.
7. Check for cloudy or discolored electrolyte. This can be caused by overcharging or excessive vibration. Correct the problem and replace the battery.

Safety First

Safety should be your first consideration whenever you inspect, test, or replace a lead acid battery. The electrolyte contains sulfuric acid. This acid can burn your skin, injure your eyes, and damage the vehicle, your tools, or your clothing.

If you splash electrolyte onto your skin or into your eyes, immediately rinse it away with large amounts of clean water. Contact a doctor immediately.

If you spill electrolyte onto any part of the vehicle, neutralize the acid with a solution of baking soda and water, then rinse liberally to remove any residue.

When a battery is charging, the electrolyte may release gasses (hydrogen and oxygen). Hydrogen gas is explosive, and oxygen supports combustion. A flame or spark near a charging battery can cause an explosion.

Precautions

Take the following precautions when working with automotive batteries:

- Wear gloves and safety glasses.
- Never use spark-producing tools near the battery.
- Never lay any tools on the battery.
- If it is necessary to remove the battery cables, always remove the ground first.
- When connecting battery cables, always connect the ground cable last.
- Do not use the battery ground terminal when checking for ignition spark.
- Take care not to spill electrolyte into your eyes, onto your skin, and onto any part of the vehicle.
- If you mix electrolyte, pour the acid into the water (not the water into the acid).
- Always follow the recommended procedures for battery testing, charging, and for connecting jumper cables between two batteries.

Battery Drain Tests

There are two tests for battery drain:

1. Parasitic load
2. Surface discharge

A parasitic load is created by a device that draws current even when the ignition switch is turned to "Off." Even a small current can discharge the battery, if the vehicle is not used for an extended time.

Check for a parasitic load as follows:

1. Connect an ammeter in series between the battery negative terminal and the ground cable connector.
2. Select the appropriate scale and read the current draw.
3. Toyota vehicles typically draw between 20 and 75 milliamps (this is current used to maintain electronic memories).
4. Any reading higher than 100 milliamps is unacceptable. Locate and correct the cause of the excess parasitic drain.
5. Make sure that you wait a few minutes before checking for parasitic load. After the vehicle is shut down or a door is opened, parasitic load may be 50-75 milliamps, depending on model, for a few minutes.

Surface discharge is a small current that runs between the two battery terminals, across the surface of the battery. This can occur only when that surface is dirty.

Check for surface discharge as follows:

1. Connect a voltmeter, black test lead (negative) to the battery's negative terminal; red test lead (positive) to the top of the battery case.
2. Select an appropriate scale and read the voltage.
3. If the meter reading is higher than 0.5 volts, clean the case top with a solution of baking soda and water.

Two Tests for Battery Drain

Parasitic load current and battery surface discharge can cause batteries to discharge over time.

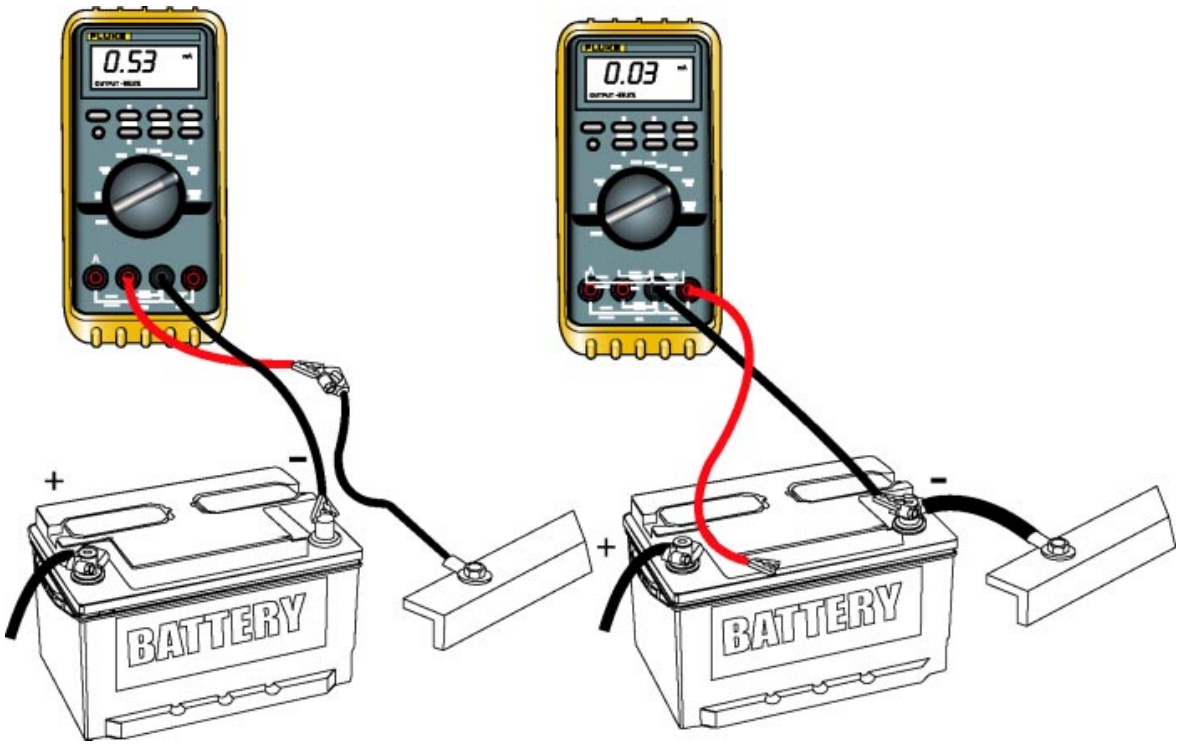

Fig. 3-13
TL623f313c

Micropro 815 Battery Analyzer

You can use a battery analyzer to obtain an indication of battery condition that is more accurate than just its state of charge. The Midtronics Micropro 815 Battery Analyzer uses conductance testing to evaluate the condition of the plates inside the battery.

There are several advantages of using this battery analyzer:

- Battery can be tested even when it's not fully charged.
- No need to charge battery before testing; can be tested as soon as vehicle arrives for service.
- Information from analyzer lets you make a quick decision.
- Reduces costly mistakes.

Micropro 815 Battery Analyzer

A battery analyzer can help you make a quick and accurate determination of battery condition.

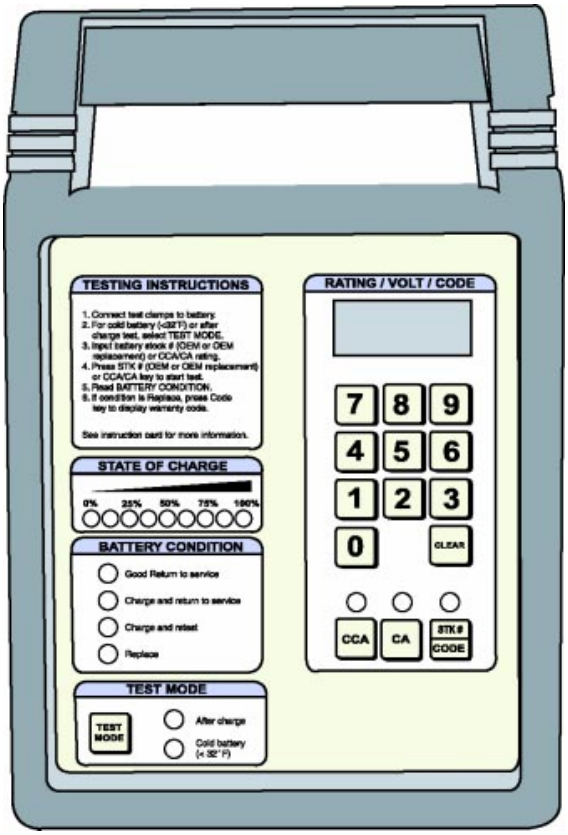

Fig. 3-14
TL623f314c

Preparing the Battery for Analyzer Tests

Prepare the battery for testing:

- Remove the battery's surface charge.
- Disconnect the battery from the vehicle.
- Make sure the terminals are clean and free of corrosion.
- If the battery has removable vent caps, check the electrolyte level. Top up with distilled water if needed.

To remove a battery's surface charge, turn on the headlights with the engine off. Leave the lights on for one minute.

You can test batteries either connected to or disconnected from the vehicle. In general, you get more reliable results with the battery disconnected. If you do leave the battery connected for testing, turn off all lights and accessories and set the ignition switch to the OFF position.

Preparing the Battery

To get the most accurate results, make sure the battery terminal posts are clean for testing.

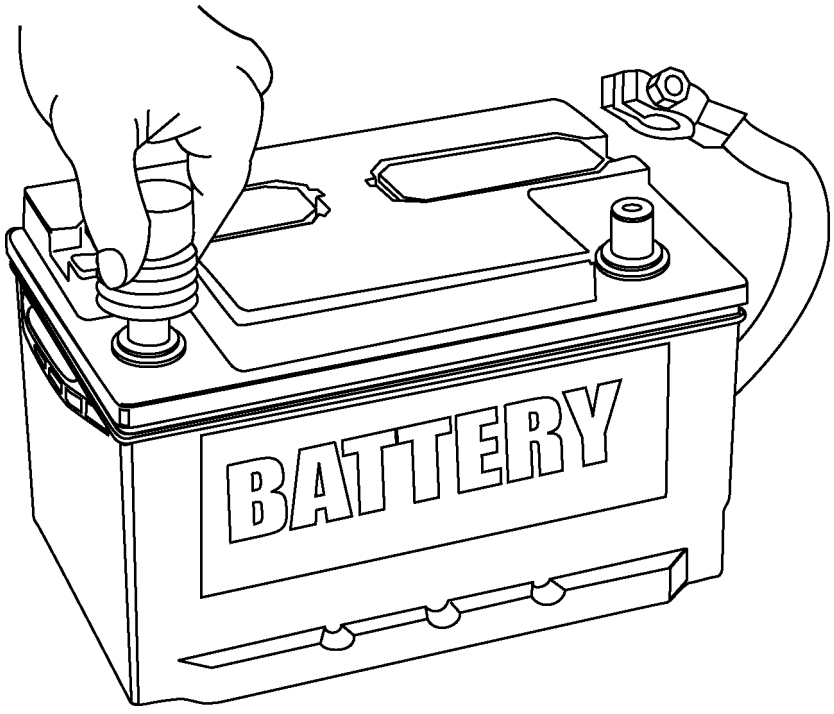

Fig. 3-15
TL623f315

Setting Up the Battery Analyzer

Set up the battery analyzer as follows:

1. Connect the analyzer's red lead to the positive battery terminal.
2. Connect the black lead to the negative battery terminal.
3. Check the analyzer's display. It should illuminate and show four zeros to indicate a good connection. The analyzer's display will not illuminate if there is a poor connection.

   Connections - The teeth on both sides of each clamp must contact the battery terminal. Rock both clamps back and forth to ensure a good electrical connection.
4. Proceed to Testing the Battery (on the next page) if you have not charged the battery before test.
5. Press the Test Mode key once if you charged the battery before the test. The "After Charge" LED will light.

   Press the Test Mode key twice if battery temperature is 32° F (0° C) or lower. The "Cold Battery" LED will light.

Analyzer Test Connections

The battery analyzer's clamp teeth must contact the battery terminal post on both sides.

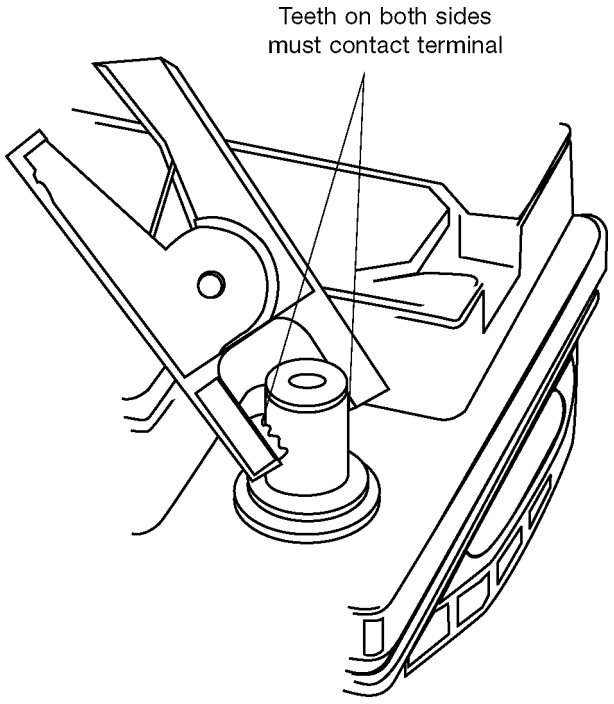

Fig. 3-16
TL623f316

Testing the Battery

Use these steps to test an original equipment battery or OE replacement:

1. Select the correct STK# from the chart included with the tester (in the flap of the soft case).

NOTE A valid STK# is a requirement for warranty testing. Updated charts can be found on TIS.

2. Use the analyzer's keypad to enter the 4-digit STK#.
3. Press the STK# key to start the test.

Testing the Battery

This table is enclosed with the Midtronics Battery Analyzer.

TOYOTA

BATTERY TESTING INSTRUCTIONS

MIDTRONICS

To test a Toyota OE or Toyota Interstate OE Replacement battery, input the STK# listed below and press the ***STK#/Code*** key to begin test. To test all other batteries, locate the battery's CCA or CA rating located on the battery label, and input the number using the keypad. Begin the test by pressing the ***CCA*** key if using the CCA rating or ***CA*** key if using the CA rating. If testing a Lexus OE or Lexus Interstate OE Replacement battery, refer to the testing instructions on the reverse side of this card.

TOYOTA OE BATTERY					INTERSTATE OE REPLACEMENT			
Model	OE STK#	CCA	Group Size	Supplier	REPL STK#	CCA	Group Size	Supplier
Avalon	2458	582	80D26L	JCI, GNB	2460	575	24F	INTERSTATE
Avalon	5523	356	55D23L	JCI, GNB	3560	550	35	INTERSTATE
Camry (USA)	2458	582	80D26L	JCI, GNB	2460	575	24F	INTERSTATE
Camry (Japan) ≤ 2001	5523	356	55D23L	JCI, GNB	3560	550	35	INTERSTATE
Camry (Japan)	8026	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
Celica ≤1999	5523	356	55D23L	PANASONIC	3560	550	35	INTERSTATE
Celica ≤1999	6523	420	65D23L	PANASONIC YUASA	3560	550	35	INTERSTATE
Celica	5020	306	50D20L	PANASONIC	3560	550	35	INTERSTATE
Celica (cold pkge)	5523	356	55D23L	PANASONIC	3560	550	35	INTERSTATE
Corolla (Canada) ≤ 2002	3531	356	55D23L	DELCO / DELPHI	3560	550	35	INTERSTATE
Corolla (NUMMI) ≤ 2002	3531	356	35	DELCO / DELPHI	3560	550	35	INTERSTATE
Corolla	3531	356	55D23L	DELPHI	3560	550	35	INTERSTATE
Corolla / Matrix	3531	356	55D23L	DELPHI	3560	550	35	INTERSTATE
Paseo	5020	306	50D20R	PANASONIC	2560	550	25	INTERSTATE
Paseo (cold pkge)	5523	356	55D23R	PANASONIC	2560	550	25	INTERSTATE
Tercel	5020	306	50D20R	PANASONIC	2560	550	25	INTERSTATE
Tercel (cold pkge)	5523	356	55D23R	PANASONIC	2560	550	25	INTERSTATE
Supra A/T	8026	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
Supra M/T	7526	490	75D26L	PANASONIC	2460	575	24F	INTERSTATE
Echo	5020	306	50D20R	PANASONIC	2560	550	25	INTERSTATE
Echo (cold pkge)	6523	420	65D23R	PANASONIC	2560	550	25	INTERSTATE
Tacoma 4X2	3531	356	55D23L	DELCO	3560	550	35	INTERSTATE
Tacoma 4X2 (cold pkge)	2455	582	80D26L	DELCO	2460	575	24F	INTERSTATE
Tacoma 4X4	2455	582	80D26L	DELCO	2460	575	24F	INTERSTATE
Tacoma 4X4	3531	356	55D23L	DELCO	3560	550	35	INTERSTATE
Tacoma 4X4 (cold pkge)	2455	582	80D26L	DELCO	2460	575	24F	INTERSTATE
4Runner	8026	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
4Runner (cold pkge)	9531	622	95D31L	PANASONIC	2761	675	27F	INTERSTATE
4Runner	5523	356	55D23L	PANASONIC	3560	550	35	INTERSTATE
4Runner (cold pkge)	8026	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
Highlander	8026	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
Land Cruiser (cold pkge)	0531	710	105D31L	PANASONIC	2771	710	27F	INTERSTATE
Land Cruiser	2455	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
MR2 Spider	5524	433	55B24L	PANASONIC	3560	550	35	INTERSTATE
Previa	5523	356	55D23L	PANASONIC	3560	550	35	INTERSTATE
Previa S/C	8026	582	80D26L	PANASONIC	2460	575	24F	INTERSTATE
Prius	3420	272	S34B20L	GS NIPPON DENCHI	NONE	NONE	NONE	NONE
T100	2455	550	80D26L	DELCO	2460	575	24F	INTERSTATE
RAV4	4624	325	46B24L	FURUKAWA	3560	550	35	INTERSTATE
RAV4 (cold pkge)	5523	356	55D23L	FURUKAWA, YUASA	3560	550	35	INTERSTATE
Sequoia	0531	710	105D31L	JCI, GNB	2771	710	27F	INTERSTATE
Sienna	2458	582	80D26L	JCI, GNB	2460	575	24F	INTERSTATE
Solara	2458	582	80D26L	JCI, GNB	2460	575	24F	INTERSTATE
Solara	5523	356	55D23L	JCI, GNB	3560	550	35	INTERSTATE
Tundra 5VZ-FE	5523	356	55D23L	JCI, GNB	3560	550	35	INTERSTATE
Tundra 5VZ-FE (cold pkge)	2458	582	80D26L	JCI, GNB	2460	575	24F	INTERSTATE
Tundra 2UZ-FE	2458	582	80D26L	JCI, GNB	2460	575	24F	INTERSTATE
Tundra 2UZ-FE (cold pkge)	0531	710	105D31L	JCI, GNB	2771	710	27F	INTERSTATE

Updated: May 2002

MIDTRONICS P/N 168-475C-T

Fig. 3-17
TL623f317

Use these steps to test a non-OE battery.

For battery with CCA rating:

1. Find the CCA (cold-cranking amps) rating on the battery label.
2. Enter the rating number via the keypad.
3. Press the CCA key to start the test.

For battery with a CA (cranking amps) rating:

1. Find the CA rating on the battery label.
2. Enter the rating number via the keypad.
3. Press the CA key to start the test.

Use this procedure if you cannot determine any usable rating for a battery to be tested:

1. Find an STK# on the chart that is recommended for the vehicle in which the battery is installed.
2. Use the analyzer's keypad to enter the 4-digit STK#.
3. Press the STK# key to start the test.

Interpreting the Results

The results will be displayed in the Battery Condition area of the panel.

Good return to service - The battery is in good condition and ready to return to service.

Charge and return to service - The battery is good, but must be fully charged before returning to service.

Charge and retest - The test result is inconclusive. “Quick Charge” the battery and retest using the After Charge test mode.

Replace - The battery must be replaced. Press the STK#/CODE key to show the warranty code for the repair order.

Interpreting the Results

The battery analyzer lights one of these LED’s to tell you the battery condition.

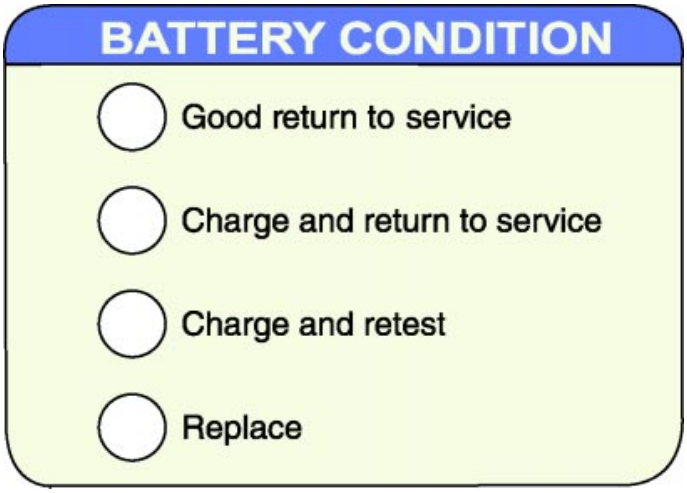

Fig. 3-18
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Fast Charging

Fast charging is used to charge the battery for a short period of time with a high rate of current. Fast charging may shorten battery life. If time allows, **slow charging is preferred.** Some low maintenance batteries cannot be fast charged.

1. Preparation for charging:
   - Clean dirt, dust, or corrosion off the battery; if necessary, clean the terminals.
   - Check the electrolyte level and add distilled water if needed.
   - If the battery is to be charged while on the vehicle, be sure to disconnect both (-) (+) terminals.
2. Determine the charging current and time for fast charging:
   - Some chargers have a test device for determining the charging current and required time.
   - If the charger does not have a test device, refer to the chart to determine current and time.

Typical Charging Rates for Fully Discharcled Batteries

Reserve Capacity Rating	20-Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes
75 Minutes or less	50 Ampere-Hours or less	10 Hours	5 Hours	2½ Hours	2 Hours	
Above 75 to 115 Minutes	Above 50 to 75 Ampere-Hours	15 Hours	7½ Hours	3¼ Hours	2½ Hours	2 Hours
Above 115 to 160 Minutes	Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2½ Hours
Above 160 to 245 Minutes	Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7½ Hours	5 Hours	3½ Hours

3. Using the charger:
   - Make sure that the main switch and timer switch are OFF and the current adjust switch is at the minimum position.
   - Connect the positive lead of the charger to the battery's positive terminal (+) and the negative lead of the charger to the battery's negative terminal (-).
   - Connect the charger's power cable to the electric outlet.
   - Set the voltage switch to the correct battery voltage.
   - Set the main switch at ON.
   - Set the timer to the desired time and adjust the charging current to the predetermined amperage.

4. After the timer is OFF, check the charged condition using a voltmeter.
   - Correct Voltage: 12.6 volts or higher.

If the voltage does not increase, or if gas is not emitted no matter how long the battery is charged, there may be a problem with the battery, such as an internal short.

5. When the voltage reaches the proper reading,
   - Set the current adjust switch to minimum.
   - Turn off the main switch of the charger.
   - Disconnect the charger cable from the battery terminals.
   - Wash the battery case to clean off the acid emitted.

Slow Charging

High charging rates are not good for completely charging a battery. To completely charge a battery, slow charging with a low current is required.

Slow charging procedures are the same as those for fast charging, except for the following:

1. The maximum charging current should be less than 1/10th of the battery capacity. For instance, a 40 AH battery should be slow charged at 4 amps or less.
2. Set the charger switch to the slow position (if provided).
3. Readjust the current control switch, if needed, while charging.
4. As the battery gets near full charge, hydrogen gas is emitted. When there is no further rise in battery voltage for more than one hour, the battery is completely charged.
   - Battery Voltage: 12.6 volts or higher.

Jump Starting

Jump starting requires proper battery connecting procedures to prevent sparks. Jump start a vehicle using the following procedure:

1. Connect the two positive cables using the positive jumper leads.
2. Connect one end of the negative jumper lead to the booster battery.
3. Connect the other lead of the negative jumper lead to a good ground on the vehicle with the dead battery. This location could be:
   - The vehicle frame.
   - The engine block.

Using this method ensures that any possible sparks occur away from the battery.

NOTE Battery jumper leads should be high quality and have a large wire gauge (such as 4 gauge) to safely carry the current necessary to jump start a vehicle.

CAUTION Never try to jump start a vehicle with a visibly damaged battery or if no battery is present. Vehicle damage and risk of battery explosion are possible.

Jump Starting

Jump start as follows:
1. Positive to positive,
2. Negative to good battery,
3. Negative to good ground of vehicle with dead battery.

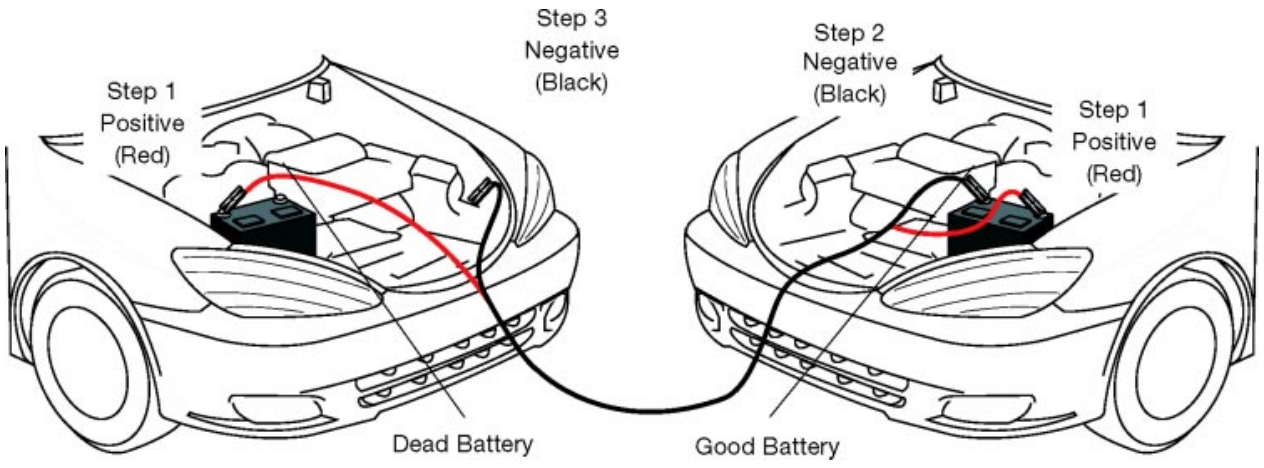

Fig. 3-19
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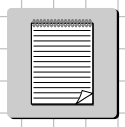

Notes