Technical Manual

Powersports Batteries

YUASA

Consumer Products

Yuasa 12V, 1 AMP Automatic Battery Charger & Maintainer

Part No. YUA1201000

- 3 stage charge cycle
- Easy-to-use, simply attach to battery & plug it in
- Charges and maintains your battery
- 3 color LED displays your charge status at a glance
- Reaches 14.4 volt peak then automatically switches to maintenance mode
- Designed to prevent overcharging
- Includes quick connect adapter and alligator clips

Jumper Cables

Part No. YUA00ACC07

- Easy to use, easy to store
- Convenient storage bag
- Heavy duty, 8 ft., 8-gauge cables won't stiffen or freeze
- Tangle resistant, encased rubber grips for safer use

Battery Charger Lead

Part No. YUA00ACC04

- Simple, bolt-on connection with fuse
- Can be used with Yuasa's chargers for applications ranging from motorcycles, automobiles and personal watercraft to ATVs, snowmobiles and riding mowers

Table of Contents

1 About

About Yuasa

Yuasa Battery, Inc. has been producing batteries in the U.S.A. to uncompromisingly high standards since 1979. Today Yuasa Battery is one of the largest American manufacturers, distributors and original equipment (OE) suppliers of batteries for motorcycles, all-terrain & utility vehicles, snowmobiles and personal watercraft in North America. Yuasa supplies batteries to more powersports OE manufacturers than all other competitors combined.

Most of the large capacity powersports batteries are manufactured in our Laureldale, Pennsylvania plant. All other powersports batteries are produced in a Yuasa state-of-the-art manufacturing facility in various countries throughout the world. Each Yuasa facility follows the same rigorous manufacturing processes to ensure the high quality standards set by Yuasa are met.

We provide our customers world-class quality products and services through ISO-9000 (International Organization for Standardization) registration at all Yuasa manufacturing facilities. Through employee involvement, teamwork, design/process innovation, waste elimination and supplier partnerships Yuasa's commitment to quality is an on-going process. At Yuasa we are proud of our products and customer support. More information about Yuasa can be found at yuasabatteries.com or by calling 800-431-4784.

About This Manual

Working on all types of powersports vehicles, technicians and owners are often faced with battery related questions: how do I activate a new battery, how do I charge a battery, what type of battery charger should I use, what's the difference between AGM and Conventional batteries, how do I test or install a battery and more.

Whether you are a professional technician working in a motorcycle dealership, or an avid powersports enthusiast, Yuasa's Technical Manual will provide you with in-depth information on how a battery operates, new battery activation, maintenance, installation tips and how to get maximum power and life from Yuasa batteries. We'll take a close look at battery charging and chargers, as well as several methods to accurately test a battery and determine its state-of-health. Throughout this manual information that is highlighted in **Bold Text** is especially noteworthy. In addition, at the end of each section *Important Points to Remember* are listed as bullet points. If you, or your customers need information about Yuasa's battery line and its powersports applications, or if you have questions regarding Yuasa battery chargers and testers, this manual will provide the answers you're looking for.

The Lead Acid Battery

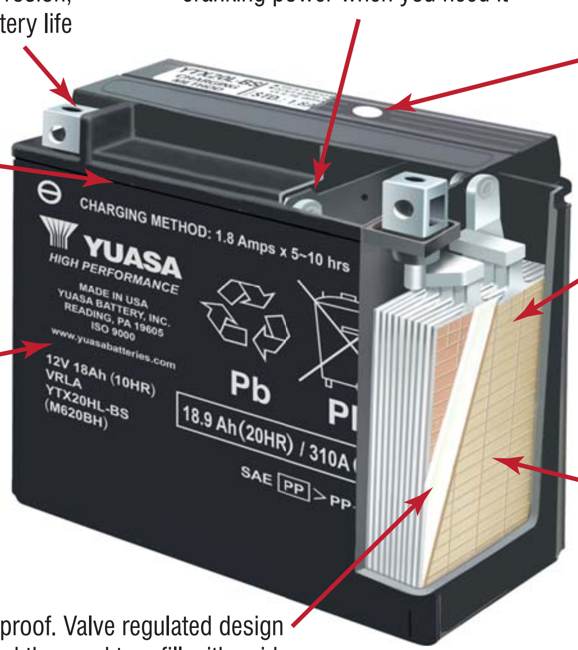
What Does a Battery Do?

Powersports—depending on your interests, the term can bring to mind many vehicles. Street-ridden motorcycles, off-road bikes, sport & utility ATVs or watercraft—all very different but all with one thing in common—they all have a battery. Most enthusiasts don't give the battery in their vehicle much thought until the engine won't start—then the battery becomes the center of attention. We'll take a close look at the how and why of batteries, but first it's easier to understand how a battery works if you know what it is supposed to accomplish. **Batteries have three jobs:**

1. **To provide electrical power to start the engine.** A battery's primary job is engine starting. Engine size, or displacement is the determining factor for amperage requirements and battery capacity for a specific application. A battery's capacity is rated in two ways; amp-hour (AH) and cold cranking amps (CCA). The amp-hour rating is the battery's ability to deliver current for an extended period of time. Cold cranking amps is the battery's ability to produce current in low temperatures. A battery's CCA rating for a specific application is directly proportional to engine size which determines the minimum level of amperage for starting. CCA must be met or exceeded by the battery's capacity. Batteries with less capacity are capable of starting a large displacement engine, but they may not do so reliably, especially in colder climates. How batteries are rated is covered later in this manual.

2. **To supply additional current when the charging system can't keep up with electrical demand.** A battery's second job is to supply current when the charging system is overworked. This usually occurs (though not always) when the engine is being run at lower than normal operating speeds. Electrical components including: lights, fuel pump, ignition & fuel injection systems use most of the charging system's capacity. If aftermarket electrical accessories have been added (heated clothing or extra lighting for example) the charging system may not keep up with the added electrical demand and the battery supplies the additional current to power these components.

3. **To act as a voltage stabilizer for the charging system.** The third job of a battery is to act as a voltage stabilizer for the charging system. Powersports charging systems need something to *push* against to keep from producing excessive voltage. In addition, high voltage spikes may be produced when turning on, or off certain electrical circuits. These fluctuations in voltage are partially absorbed by the battery, which protects solid-state components, including computers and ignitions systems from damage.



Battery Construction and Chemistry

Technically speaking, a battery is a device that converts chemical energy to electrical energy. It's important to understand that a battery does not "store" energy, or electricity, it stores a series of chemicals, and through a chemical reaction electricity is produced.

What's Inside the Battery Case? To understand the process of chemical to electrical energy conversion, let's take a look inside a battery. The battery case is divided in sections called cells with a 12-volt battery having six cells that produce 2.2 volts each (depending on battery type) for a total of 13.2 volts. A 6-volt battery has only three cells with a total voltage of just over 6 volts.

How Battery Cells Work. The cells consist of lead plates, half of which have a positive charge and the other half with a negative charge. Within each of the cells the plates are stacked alternately: negative, positive, negative. Insulators or separators (usually made from fiberglass or treated paper) are placed between the plates to prevent contact. The alternating plates in each cell are connected at the top to form two groups, one positive and one negative. Each cell's groups of plates are then connected in series (positive to negative) to those in the next cell. The "active material" in these positively and negatively charged groups of plates produce electricity when immersed in an electrolytic solution that is made up of sulfuric acid and water, sometimes called battery acid. When an electrical load is placed across the battery's terminals, a chemical process starts inside the battery that produces electrical energy.

Battery Capacity. The size and number of plates within each cell have a direct relationship to battery capacity, or its ability to start engines of various sizes. Cranking current capacity (or flow of electrical energy) increases as the plate surface area increases. Directly related to plate size, is the amount of active material on each plate (lead peroxide on the positive plate and metallic sponge lead on the negative plate). The battery's current producing capacity is directly related to the amount of active material on its plates.

Battery Chemistry. Batteries are constantly either discharging or charging, and during either process, ions (both positively or negatively charged) are transferred from the positive and negative groups of cell plates. The plates are insulated from each other with a permeable, non-conductive material which allows this transfer of ions. At the same time as the ions are moving from one plate to another, the ratio of battery acid to water is changing as well. However, as the battery discharges, the ratio of acid to water changes so that there is less sulfuric acid and more water; thus, the specific gravity (SG) of the electrolyte solution is lowered as well. SG can be used to measure a battery's state-of-charge. For example, an SG of 1.160 indicates a battery with only a 50% charge. The process is reversed when the battery is charged.

Here is what an AGM Yuasa battery looks like with the cover removed. The case is divided into 6 cells each, containing plates and separators. Cells are inner connected by lead lugs on top of each cell. With the cover in place, only the positive terminal (right side) and negative terminal are visible. At the lower right is the strip of sealing caps that will be installed when the battery is filled with electrolyte. Once installed, never remove the sealing caps to add water or electrolyte to the battery during its service life.

The SG becomes higher as the ratio of acid to water changes back to mostly acid. Measuring SG can only be performed on a Conventional battery because it has filler caps that allow access to the electrolyte. Other types of batteries without filler caps require a different method to determine state-of-charge.

When a battery discharges, and the SG changes to more water and less acid, a chemical by-product called lead sulfate is produced and starts the process of coating the cell plates reducing the surface area over which chemical reactions producing current occur. This is the reason that an engine's starter motor can't be cranked indefinitely, as well as other electrical loads left on for long periods of time without the battery going dead. Although this process is normal within the battery during discharge, a timely recharge is required to reverse the process and increase the usable surface area of the plates. Without battery charging, the lead sulfate will continue to develop and it becomes difficult, if not impossible, to break down. If the battery becomes too discharged, total failure of the battery is likely as the lead sulfate cannot be removed no matter how much the battery is charged.

Corrosion and Freezing. Besides sulfation concerns, many other detrimental actions are taking place inside the battery while in a discharged condition. The corrosive effect, caused by acid on the lead plates and connections within the battery, is greatly increased due to the reduced specific gravity of the electrolyte. In addition, the corrosion of the plates can result in a gradual reduction in battery performance over time. Corroded connectors may have sufficient integrity to support low drain accessories such as lights and instruments, but may lack the necessary strength to provide a pathway for the high discharge current required to start an engine. If the corrosion is bad enough, it may cause the inter-cell connectors and the connecting welds to fail. This creates an open circuit within the battery resulting in sudden battery failure. Another condition that frequently occurs in a discharged battery is freezing of the electrolyte. In a deeply discharged battery, the electrolyte has a reduced specific gravity resulting in a higher percentage of water than sulfuric acid. During this condition, the battery may freeze at temperatures as high as 32° F (0° C). The electrolyte in a fully charged battery will not freeze in temperatures well below 0° F, even down to -75° F. In fact Yuasa batteries have a suggested operating temperature range between: 14° F to 140° F (-10° C to 60° C).

Battery Safety

Any device that stores energy can be dangerous. There is a lot of explosive power in a gallon of gasoline, but when handled with some knowledge its use can be made relatively safe. Batteries are no different in that with the proper precautions and safety practices, they can be handled in a safe manner. Working with batteries poses two hazards: potentially explosive gases that are given off during discharging and charging, and sulfuric acid, which is highly corrosive. The following is an 8-point safety list that will help keep these two hazards under control:

1. **ABSOLUTELY NO SMOKING, SPARKS (FROM STATIC ELECTRICITY OR OTHER SOURCES) OR OPEN FLAMES AROUND OR NEAR BATTERIES.** Batteries can produce hydrogen gas that is highly flammable when combined with oxygen; if these gases ignite the battery case can rupture or explode.

2. **On Conventional batteries, loosen vent caps when charging and ventilate the entire charging area.** A build-up of hydrogen and oxygen levels within the battery, or in the area where it's being charged, can create a fire hazard.

3. If a battery feels hot to the touch during charging, stop charging and allow it to cool before resuming. Excessive heat damages the plates, and a battery case that's too hot during charging can rupture.

4. On Conventional batteries, **REMOVE THE RED SEALING CAP FROM THE VENT ELBOW**. Never put the red sealing cap back on the battery once it is removed. If sealing cap is left on, gases trapped inside the battery can explode. For the same reason, make sure the vent tube isn't kinked or blocked. See illustration on page 15.

5. Properly connect battery chargers leads to the battery: positive to positive, negative to negative. Unplug the charger, or turn it off before connecting or disconnecting the leads. This will minimize the chance of creating sparks when connecting or removing the leads from the battery.

6. **Always wear eye protection, protective gloves and protective clothing when handling a battery.**

7. Clean up acid spills immediately, using a water and baking soda solution to neutralize battery acid (1 lb. baking soda in 1 gal. water).

8. Make sure battery acid fill containers are clearly marked and work areas are well lighted. **If sulfuric acid is swallowed or splashed in the eyes, take immediate action.** Sulfuric acid in the eyes can cause blindness. While the diluted sulfuric acid used as electrolyte can burn the skin, this type of injury is generally less serious. Ingesting, or swallowing sulfuric acid can cause serious internal injuries or death.

Remedies for contact with sulfuric acid:

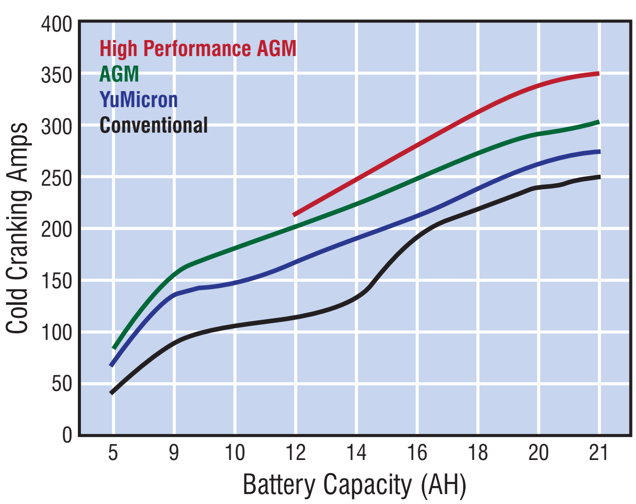
- **External** – flush with water
- **Internal** – drink large quantities of milk or water, followed by milk of magnesia, vegetable oil or raw, beaten eggs. Call a poison control center or doctor immediately
- **Eyes** – flush for several minutes with water, get immediate medical attention

Battery Types

Each Yuasa line of batteries has its unique features that account for differences in price and performance. We'll take a closer look at the two basic types of batteries that Yuasa manufactures. These two battery types are: Conventional and Absorbed Glass Mat, or AGM. Conventional batteries have filler caps that allow distilled water to be added to the battery periodically. AGM batteries do not have filler caps and are sometimes referred to as maintenance-free batteries or VRLA (valve regulated lead acid) batteries. In this manual, AGM will refer to all types of these non-Conventional batteries.

AGM Batteries

AGM batteries look different than other battery types. They are more compact because there is no free electrolyte making them more "volume efficient" in that they take up less space for their energy storing capacity. Because they are filled with electrolyte only one time during activation there are no filler caps. Instead a sealing plug permanently covers the filler ports. Also there is no vent tube. AGM batteries are ideal for long term storage on vehicles that include: riding mowers, personal watercraft, scooters and motorcycles that are not ridden in winter. In addition, an AGM battery is an excellent choice for use in vehicles where acid spills could occur (ATVs, watercraft and motorcycles).



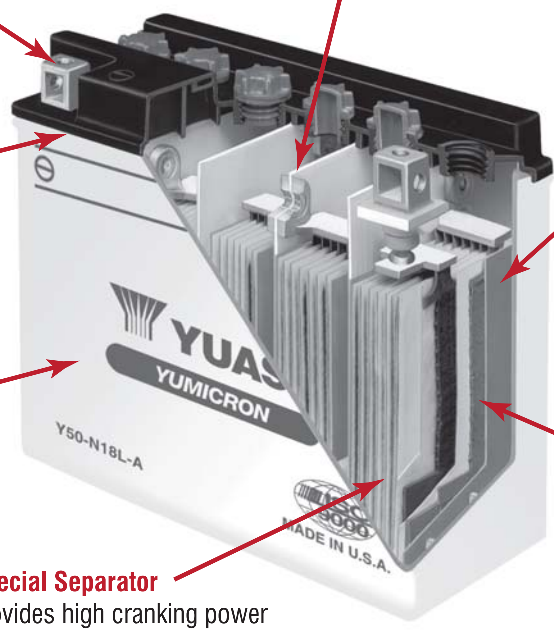
Battery design as well as materials used in construction give each type of Yuasa battery different performance ratings. This chart shows the relationship between battery capacity in amp hours and cold cranking amps.

Yuasa's AGM battery does not vent gasses to the atmosphere during the charge/discharge process. The construction of the AGM battery causes internal freed gas to recombine inside the battery so no vent tube is required. This technology is referred to as valve regulated lead acid (VRLA) or a sealed VRLA battery. The terms, AGM and VRLA are sometimes used interchangeably however in this manual AGM will be used. An AGM battery can be sealed because inside the battery the negative plates are never fully charged and therefore don't produce hydrogen gas. The positive plates create oxygen during the discharge process but instead of the oxygen being forced out a vent tube, it reacts with the charged active material on the plates to become water until the battery is charged and the water is transformed into acid. This process is called recombinant technology and this design is what makes Yuasa's AGM batteries unique.

Inside an AGM battery, the separators between the negative and positive plates are made of a special fiber that is resistant to heat and acid. This design makes the AGM battery less prone to spilling acid in that there is less liquid acid contained inside the battery. In addition, an internal safety valve is used in case of accidental overcharging. The safety valve opens if gas pressures inside the battery reach a critical point venting the gasses to the outside. The valve also includes a flame arrestor disk that minimizes the risk of explosion. Some of the benefits of an AGM battery include:

- No topping off with water or having to check the acid level
- Reduced self-discharge because the plate grids are manufactured from a special lead-calcium alloy that holds a charge longer than other battery types
- Easy, instant activation using the "one-push" electrolyte acid container

Most Yuasa AGM batteries are available either "factory activated" or as a dry battery with an acid pack. A "factory activated" battery does not require filling before installation. An extensive activation process ensures complete absorption of the electrolyte so no liquid acid is contained within the battery. This process allows these batteries to be shipped from the factory ready to install. The GYZ and YTZ series batteries are only available as "factory activated".



Yuasa batteries are also available as a dry battery with an acid pack. The part numbers for these batteries end with "-BS" to signify "bottle supplied" (i.e. YTX14-BS, YTX20HL-BS). Because the battery is shipped dry, it has an indefinite shelf life before it is activated as long as the foil covering the cells remains intact, undamaged and air-tight.

Because AGM batteries are different than Conventional batteries, it is important to keep these points in mind:

1. **There are important differences in the activation of an AGM battery versus a Conventional battery.** Be sure to follow the instructions for activating AGM batteries.

2. **While Yuasa AGM batteries dramatically reduce the need for maintenance, they do need periodic charging.** It's important to remember this and use the correct charging method and battery charger.

3. **When considering upgrading to an AGM battery that was not original equipment on a vehicle, check to make sure the charging system has a regulated output between 14.0 and 14.8 volts.** In general, older vehicles have a charging rate that produces lower voltages and a Conventional battery will be the only battery option for these vehicles.

Conventional Batteries

Unlike AGM batteries, Yuasa's Conventional designs have filler caps and vent tubes. Not all vehicles require an AGM battery and the Conventional batteries offer good performance and longevity but at a lower price point. Yuasa manufactures several designs of these batteries: Conventional (YuMicron) and High Performance Conventional batteries (YuMicron CX). They have features in common that Yuasa uses for all their batteries. Sealed posts to resist corrosion, tough polypropylene covers and containers and heat sealed construction for a strong, bonded unit. In addition, they share design features, like special separators and through-partition construction.

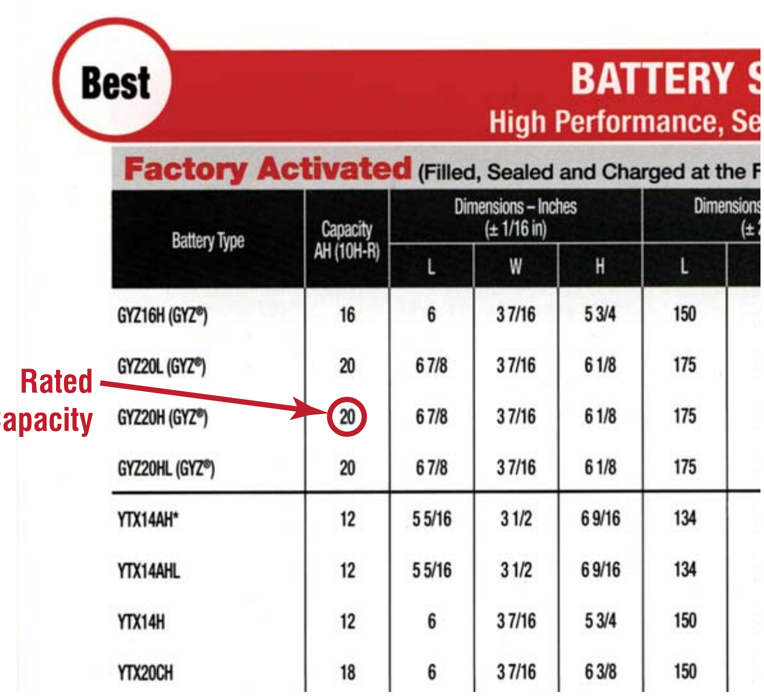
Yuasa YuMicron batteries have more cranking power (up to 30%) for their physical size than a standard Conventional battery. The plate surface area in the YuMicron is increased by the use of thin, high-tech separators that make room for extra plates within each cell. The YuMicron batteries also use a special inter-cell connector that minimizes internal resistance and further maximizes starting capacity, plus a special glass mat that resists vibration damage. The difference between the YuMicron and the YuMicron CX is the material used in the plates. Conventional and YuMicron batteries both use lead-antimony plates while the YuMicron CX uses lead-calcium. The use of lead-calcium technology provides increased cold cranking amps, reduced water loss (up to 66% when compared to a Conventional design) and has reduced self-discharge properties resulting in a battery that will hold a charge longer.

Do all the features offered by the YuMicron design make it a better choice than a Yuasa Conventional battery? Not necessarily as it depends on the vehicle and application. While a Conventional battery is an ideal choice for a lawn tractor it may not be for an ATV, watercraft or motorcycle. Space limitations, engine vibration, terrain (on-the-water vs. off-road vs. mowing the lawn) all affect battery choice and how well a battery will perform over its lifetime.

Battery Ratings

Because a battery's basic job is to power the starter motor while maintaining sufficient voltage to also run the ignition and fuel systems, there has to be a way to rate its ability to perform these jobs. Powersports batteries are rated in ampere-hours (AH) and/or cold cranking amps (CCA). **A battery's ability to discharge a given amount of current over a specific length of time is the AH rating.**

The AH rating is based on a fully charged battery with an open circuit voltage of 13.0 that is considered fully discharged when the voltage reaches 10.5 volts at 77° F (25° C). The **Amp Hour** ratings are printed on the battery case in two ways: 10 hour and 20 hour ratings. The following is an example of the 10-hour rating designation for a battery that has an 18 AH rating.



Battery Type	Capacity AH (10H-R)	Dimensions – Inches (± 1/16 in) L	W	H	Dimensions (± L
GYZ16H (GYZ®)	16	6	3 7/16	5 3/4	150
GYZ20L (GYZ®)	20	6 7/8	3 7/16	6 1/8	175
GYZ20H (GYZ®)	20	6 7/8	3 7/16	6 1/8	175
GYZ20HL (GYZ®)	20	6 7/8	3 7/16	6 1/8	175
YTX14AH*	12	5 5/16	3 1/2	6 9/16	134
YTX14AHL	12	5 5/16	3 1/2	6 9/16	134
YTX14H	12	6	3 7/16	5 3/4	150
YTX20CH	18	6	3 7/16	6 3/8	150

The Yuasa Battery Specifications & Applications guide lists information including: Battery Type, Dimensions and Capacity in Amp Hours (AH).

Printed on the front of the battery case is *18 Ah (10HR)*. This means that the battery can be discharged at a rate of 1.8 amps for 10 hours (18/10 = 1.8) before it becomes fully discharged.

The larger the battery plate area, the greater the ampere-hour rating. Temperature also has an effect on AH because low temperatures slow down the chemical reaction inside a battery. A battery will have a lower AH capacity in cold temperatures than in warm ones.

CCA rates how well a battery can be expected to produce current at low temperatures. Just like AH, the CCA rating depends on the number of plates and their total surface area. CCA represents the discharge load in amps that a new, fully-charged battery at 0° F can continuously deliver for 30 seconds while maintaining 7.2 volts. In general, as engine size increases so does the starter motor cranking current required to start the engine and thus CCA battery requirements. For example, a battery with a CCA rating of 270 will start a large displacement engine under most conditions. A battery with a rating of 310 CCA, and used in the same application, would start the engine more reliably especially in cold weather. Because starter motor requirements differ by year, make and model of vehicle it's best to check the Yuasa Battery Specifications & Applications guide to select the correct original equipment replacement battery. If a special application demands higher cranking power, select an appropriate upgraded battery from the Yuasa battery line. Try to match battery features to vehicle requirements. For example, a cold start rating is important in a snowmobile but not on a lawn tractor—unless it's used to plow snow.

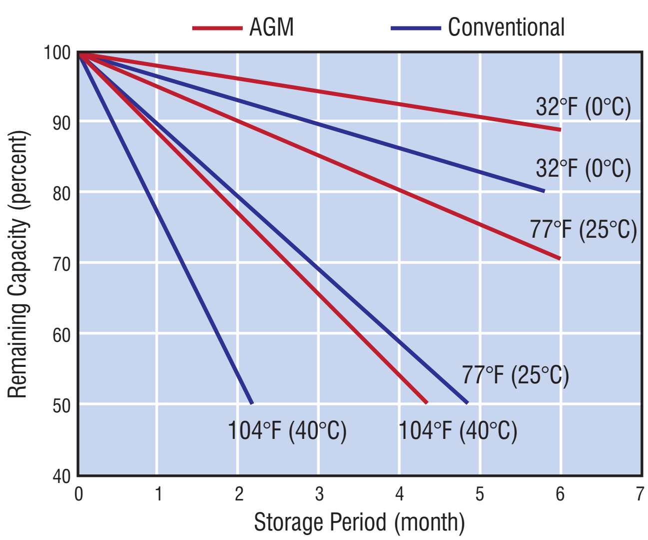
POINTS TO REMEMBER

- A battery converts chemical energy to electrical energy
- Each cell has approximately 2 volts: a 12-volt battery has 6 cells; a 6-volt battery has 3 cells
- Inside each cell are electrically charged positive and negative lead plates, isolated from each other by separators
- Current, or amperage is the flow of electricity
- Always ventilate battery charging area
- On Conventional batteries, always remove the red sealing cap from the vent elbow and discard it
- Charging produces flammable gasses—no smoking, sparks or flames
- Always wear safety glasses, or face shields when working with batteries
- Battery acid in eyes, or swallowed requires immediate antidotes and medical care
- Battery safety considerations are important... review them frequently

Battery Discharging

One of two chemical processes is always occurring inside a battery at any given time—discharging or charging. Here is how the discharge process works. The electrolyte solution contains charged atomic particles called ions, made up of sulfate and hydrogen. The sulfate ions are negatively charged, while the hydrogen ions have a positive charge. When an electrical load is placed across a battery's terminals (starter motor, headlight, horn, etc.) the sulfate ions travel to the negative plates and give up their negative charge, causing the battery to discharge or produce electrical energy. This excess electron flow out of the negative side of the battery, through the electrical device, and back to the positive side of the battery is what creates DC current. Once the electrons arrive back at the positive battery terminal, they travel back into the cells and re-attach themselves to the positive plates. The discharge process continues until the battery is dead and there is no more chemical energy left.

Discharge Chemistry. In addition to the electron flow within the battery as it discharges, the ratio of sulfuric acid to water in the electrolyte solution is also changing to more water and less acid. A chemical byproduct of this process is lead sulfate that coats the battery plates within each cell reducing its surface area. With less area available on the cells to produce electrical energy, the production of amperage, or current is also reduced. If the discharge process continues, even more lead sulfate is deposited on the cell plates and eventually the chemical process that produces current is no longer possible. The lead sulfate deposits on the plates is the reason that a battery can't supply energy indefinitely. For example, lights left on for several days or extensive cranking of the starter motor. In fact, **prolonged discharge causes harmful sulfation and the battery may not recover** no matter how long it's charged.



This chart illustrates how temperature and type of battery effects battery capacity. Colder storage temperatures are best for long-term storage. For example, an AGM battery stored at 32ºF holds 90% of its capacity for about 6 months. The same battery stored at 104ºF loses 50% of its capacity in 4 months. These temperatures can be reached if the battery is stored in garage or shed in hot weather.

Besides not being able to produce enough current to start an engine, **a dead battery is also prone to freezing in cold temperatures** because the battery's electrolyte is mostly water instead of acid. When temperatures drop below freezing the electrolyte may freeze and permanently damage the battery. A charged battery won't freeze until the temperature drops well below -75° F. The suggested operating temperature range for all Yuasa Batteries is 14° F to 140° F (-10° C to 60° C).

Battery Self-Discharge. It's a fact that a battery's ability to produce electricity will decrease from just sitting around. Self-discharge is always taking place even if the battery is not connected to anything. How rapidly batteries self-discharge depends on ambient temperature and battery type. At temperatures above 130° F self-discharge is even more rapid. These temperatures can be reached if the battery is stored in a garage or shed in hot weather.

Speaking of discharging, a common misconception about battery storage is that if one is left on a concrete floor it will self-discharge rapidly. This was true over thirty-five years ago, when battery cases were made of hard rubber—the moisture from concrete caused this type of battery to discharge directly into the concrete floor. However, modern battery cases are made of polypropylene plastic and can be stored on concrete without any concern for excessive self-discharge.

Reasons for Self-Discharge

Short Charging Time. Low state-of-charge can be caused by short trips that aren't long enough for the vehicle's charging system to recharge the battery. Engine operation of less than 15 or 20 miles and occasional use of a vehicle only a couple of times

Current Drain (Y50-N18L-A)

Discharging Ampere	Days From 100% Charged to 50% Discharged	Days From 100% Charged to 100% Discharged
7 mA	60 Days	119 Days
10 mA	42 Days	83 Days
15 mA	28 Days	56 Days
20 mA	21 Days	42 Days
30 mA	14 Days	28 Days

On-board computers, clocks and other accessories can drain a battery over time. This chart shows the amperage draw in milliamps and the number of days until the battery is 50% to 100% discharged.

per week may not keep the battery charged enough to start the engine. The vehicle's charging system will not be able to keep up with the use of the starter motor and electrical accessories (lights, ignition, fuel injection) over time. To keep the battery's capacity high enough to operate the starter it will have to be charged with a battery charger when the vehicle is not in use—about once per month for a Conventional battery depending on temperature. An AGM battery will discharge at a slower rate than a Conventional battery and does not need to be recharged as often.

Battery Charging

Chemistry. Charging a battery reverses the chemical process that occurred during discharge. The sulfate and hydrogen ions basically switch places. The electrical energy used to charge a battery is converted back to chemical energy and stored inside the battery. Battery chargers, including alternators and generators, produce a higher voltage (higher "electrical pressure") than the battery's open circuit voltage. For example if a battery charger that outputs 14-volts is connected to a 12-volt battery, current flow will be from the charger into the battery. This high electrical pressure, or voltage, is required to push electrical current back into the battery, overcoming its open circuit voltage and thus providing charging current. The charging device (alternator, generator, or battery charger) produces excess electrons at the negative battery plates where positive hydrogen ions are then attracted to them. The hydrogen ions combine to form sulfuric acid and lead, which ultimately reduces the amount of water in the electrolytic solution and increases the battery's specific gravity during the charging process.

How Many Amps? Applying a charging current to a battery, without overheating it, is called the "natural absorption rate." Because of their smaller size, when compared to automotive types of batteries, powersports batteries are more sensitive to how much current they can safely absorb. **When charging a motorcycle or other small battery, the battery charger should not exceed 3 amps.** Most automotive types of battery chargers are not suitable for charging a motorcycle battery because they output current above 3 amps. For the correct charge rate a rule of thumb is to divide the battery's amp hour rating by 10. For example a 14 AH battery should be charged at 1.4 amps (14AH ÷ 10 = 1.4 amps). See the section on "Choosing a Battery Charger" for more details.

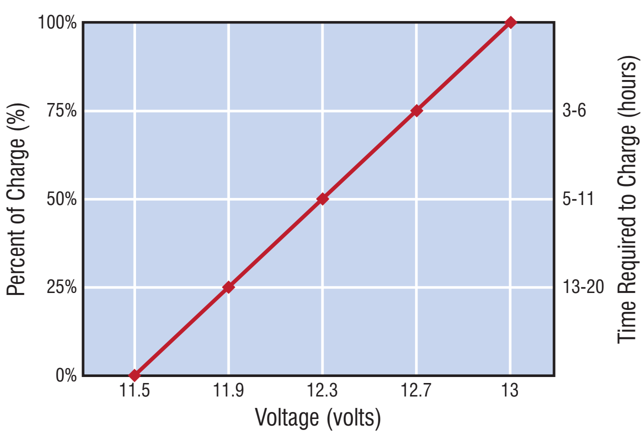
When charging amperage exceeds the level of the natural absorption rate, the battery may overheat, causing the electrolyte solution to bubble creating flammable hydrogen gas. Hydrogen gas, when combined with oxygen from the air, is highly explosive and can easily be ignited by a spark. Consequently, **always remember to turn the power off before connecting or disconnecting a battery charger to prevent a spark at the battery terminals!** Many "Smart" solid-state battery chargers, that are designed for use with small batteries, have a "no spark" feature, when being connected or disconnected from the battery. In addition to excessive out gassing during charging, a battery that has been rapidly discharging (cranking an engine over until it's dead for instance) may also produce excessive hydrogen gas.

Checking a Battery. A routine should be established by which a battery is checked for state-of-charge and charged if necessary. Because access to the battery may be difficult on some vehicles, a permanent, quick connect/disconnect connector can be installed allowing the battery charger to be connected to the vehicle's battery externally. When charging

Charging Times

State of Charge	Battery Types: YB14	YB30L	YTX14	YTX20HL	YIX30L	GYZ20L
Approximate Charge Times (Hours) Using a "Trickle" (0.25 Amp) Charger						
75%	18	38	15	23	38	25
50%	35	75	30	45	75	50
25%	53	113	45	68	113	75
0%	70	150	60	90	150	100
Approximate Charge Times (Hours) Using a 1 Amp Taper Charger						
75%	8	17	7	10	17	11
50%	14	30	13	18	30	20
25%	20	42	18	25	42	28
0%	27	56	23	33	56	37
Approximate Charge Times (Hours) Using a 1 Amp Constant Current Charger						
75%	4	9	4	6	9	6
50%	9	19	8	11	19	13
25%	13	28	11	17	28	19
0%	18	38	15	23	38	25

The relative charging times are shown for several types of batteries using three types of battery chargers; Trickle, Taper and Constant Current.



The approximate charging times are shown using a constant current charger (smart charger) at the amps specified on the battery.

a battery, always refer to the instructions that came with the battery charger. While maintaining a battery at its full state-of-charge will insure optimum life, overcharging may significantly reduce it. Any of the Yuasa automatic "smart" chargers will maintain both Conventional and AGM types of batteries without overcharging them. Use the following guidelines for charging AGM and Conventional batteries. Always verify battery state-of-charge before charging, and 30 minutes after charging. a battery charger has been disconnected from the battery for one to two hours, a fully charged Conventional battery should read 12.6 volts (12.8 volts with Sulfate Stop) or higher. AGM batteries may have slightly higher voltage readings after a full charge

Do Not Overcharge. Because of the characteristics of an AGM battery, too much of a boost charge, or overcharge will decrease the volume of electrolyte. The longer the overcharge time, the greater the drop in electrolyte and starting power. Because the battery is sealed, water can't be added to make up the difference in the loss of electrolyte. In addition, overcharging can warp cell plates making future charging difficult or impossible. To prevent over charging, track charging times carefully, or ideally, use one of Yuasa's Automatic Chargers. Always stop charging if the battery case becomes too hot to touch. Let it cool down 6 to 12 hours and resume charging. Charging times will vary depending on type of charger and the size of the battery.

Caution: Always wear safety glasses when handling batteries and charge them in a well-ventilated area.

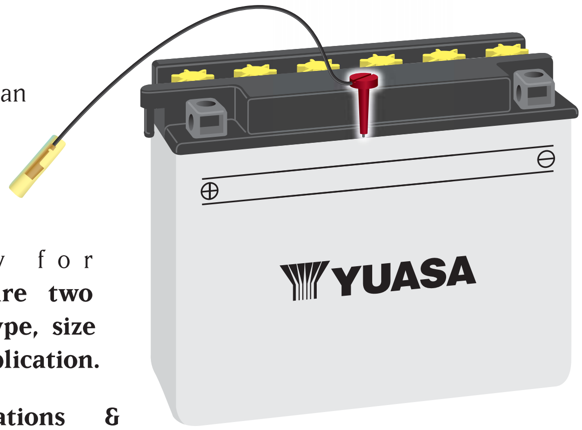
Charging a Deeply Discharged Battery

Batteries with an open circuit voltage below 11.5 volts may require a special charger and procedures to recharge. Deeply discharged batteries will have high internal resistance, making normal battery charging difficult. It may be necessary to use a charging voltage higher than normal to get the battery to accept a charge. The Yuasa Automatic 12V 4 Amp Battery Charger is capable of charging at a rate of 20 volts and has two current settings. With either charger, charge the battery for 30 minutes and then measure the open circuit voltage. If the voltage reading has not increased (indicating that charging has taken place) the battery must be replaced. If the battery is accepting a charge, continue charging. During this process the battery's case temperature should be checked for excessive heat. If the case temperature becomes too high (about 140° F) charging should be stopped or charging current should be reduced. The process of charging a deeply discharged battery may take up to 20 hours or more.

POINTS TO REMEMBER

- Prolonged discharge causes harmful sulfation and may damage a battery
- Discharged (dead) batteries are prone to freezing in cold temperatures
- Short trips may not provide enough battery charging time
- Always verify the state of charge 30 minutes after charging
- Storing batteries in high temperatures will cause damage to the battery
- Never exceed 3 amps when charging a motorcycle, or other small battery

Selecting a Battery



Selecting the right battery is an important decision as it will ultimately affect customer satisfaction. Often times battery issues, or problems are caused by the wrong battery for a specific application. **There are two sources to find the correct type, size and capacity battery for an application.**

1. **Yuasa Battery Specifications & Applications guide (also online at www.yuasabatteries.com)**
2. **The original equipment (OE) microfiche or online parts look up data.**

Be careful just matching a new battery with what's installed in the vehicle—make sure that it is the correct battery or the same "problem" may be repeated causing the battery to be replaced over again.

Yuasa may list more than on battery for a specific vehicle. For example, this page from the Yuasa Battery Specifications and Applications guide shows battery replacement information for a 1983 to 1986 Honda, V65 Magna. Here is how to read the chart. First find the Motorcycle Applications section and then Honda. Find the engine size (1100cc). Look through the list until the VF1100C V65 Magna '83-'86 is located. There are three battery selections for this motorcycle:

- High Performance AGM—YTX20H-BS*
- AGM—YTX20-BS*
- YuMicron—YB18-A

MOTORCYCLE APPLICATIONS

CC	Model	Year	High Performance Maintenance Free	Maintenance Free VRLA AGM	YuMicron	Conventional
HONDA						
1100	CB1100F Super Sport	'83	YTX14AHL-BS*	–	YB14L-A2*	–
	CB1100	'10-'12	YTZ14S	–	–	–
	CBR1100XX	'01-'04	YTZ12S	–	–	–
	CBR1100XX	'97-'00	–	YTX12-BS	–	–
	GL1100 Gold Wing	'80-'83	YTX24HL-BS*	–	Y50-N18L-A-CX*	Y50-N18L-A
	ST1100, ABS-TCS, 1100A	'91-'02	YTX14H-BS*	YTX14-BS	–	–
	VF1100C V65 Magna	'83-'86	YTX20H-BS*	YTX20-BS*	YB18-A	–
	VF1100S V65 Sabre	'84-'85	YTX20HL-BS*	YTX20L-BS*	YB18L-A	–
	VT1100C2 Shadow Sabre	'00-'07	YTX14H-BS*	YTX14-BS	–	–
	VT1100C, C3, T Shadow (Spirit, Aero, A. C. E. Tourer)	'01-'07	YTX14H-BS*	YTX14-BS	–	–

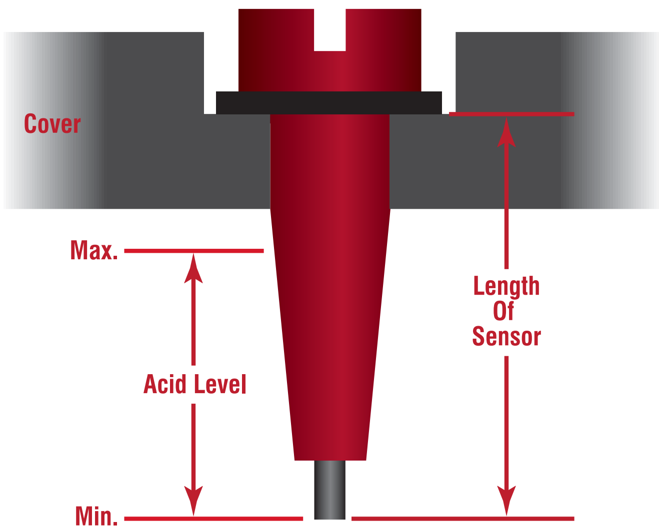
Yuasa's Battery Specifications & Applications guide shows that three types of batteries are available for a mid-'80s Honda V65 Magna.

Battery sensors indicate low electrolyte level inside a battery via a warning light. When the light comes on, it's time to top off the battery with distilled water. AGM batteries do not use battery sensors.

There is no Conventional battery for this application. Two of these batteries have an asterisk (*) at the end of the part number. In the guide, this refers to the Battery Supplier Cross Reference charts where other branded batteries may be substituted for the Yuasa battery part number. Which battery is the best for this application? Any of these batteries are a good choice for the Magna, however here are some things to consider. If the engine has been modified, higher compression or larger displacement, a battery with more starting capacity like the High Performance AGM would work well. If the bike will not be operated for long periods of time the AGM or YuMicron batteries are a good choice. If there is any question about which battery is best for a specific application consult the Yuasa website (www.yuasabatteries.com) or contact Yuasa toll-free at **800-431-4784.**

About Sensors

Many powersports vehicles that use Conventional batteries come equipped from the factory with battery sensors. The sensors indicate battery electrolyte level by flashing a warning light on the vehicle's instruments panel—similar to a low fuel warning light. When the battery sensor light flashes it's time to add water to the battery. Battery sensors are matched to each



The length of the sensor is important because it determines when it turns on the low battery water level warning light. Sensors are specific for each battery and cannot be interchanged.

battery and are not interchangeable. **Even if the battery sensor is original equipment (OE) it must be changed when replacing the battery because it may not match the new battery.** This is true even if the replacement battery is the same brand as the OE battery. Sensor plugs that are installed into one of the battery's cells come in many different lengths and diameters. A sensor plug that's too long can cause electrical system problems. If the plug is too short, the warning light will flash when the electrolyte level is not low. Yuasa's sensor batteries are not interchangeable as they have different vent locations, sensor wire lengths and diameters. **When replacing a battery always replace the sensor.** The correct sensor and battery can be determined by using the Yuasa Battery Specifications & Applications guide.

Activating a Battery

Yuasa batteries come from the factory in one of two ways: **Factory Activated (FA)** where the battery is filled with electrolyte, sealed and charged at the factory. These batteries must be used within a period of time and cannot be stored indefinitely. The other type of battery is shipped dry and can be either a Conventional or AGM type of battery. These batteries are sometimes referred to as **Bottle Supplied (BS)** because they are shipped with the electrolyte stored in a plastic container. The battery is filled with electrolyte from the container when it's ready to be activated. These types of factory sealed, dry batteries have an indefinite shelf life as long as they remain sealed (filler caps and red sealing cap in place on a Conventional battery and foil sealing strip in place on an AGM battery). Once it's unsealed, a battery should be activated, charged and installed. The plates of an unsealed battery will begin to oxidize making it more difficult to charge later.

Choosing a Battery Charger

A battery charger brings a new battery, or a battery that has been discharged, to full capacity. Battery chargers send direct current (DC) into the battery flowing in the opposite direction of current when the battery discharges. In addition, charging a battery reverses the destructive chemical process that takes place as the battery is discharged. The lead plates and electrolyte, which transform into lead sulfate and water during discharge are changed back to lead antimony (Conventional battery), or lead calcium (AGM battery). The charging process reverts the lead sulfate and water to its original state.

Types of Battery Chargers. There are three types of battery chargers that are commonly used for powersports-sized batteries.

1. **Trickle or Taper Chargers.** The least effective are the "trickle" and automatic taper types of battery chargers. Both are similar in that their charging voltage is fixed. The taper charger reduces charging current while the trickle charger keeps both voltage and current constant. These types of chargers are slow in charging even moderately discharged batteries and are not safe to leave connected to a battery for long periods of time as they can over charge the battery possibly causing damage.
2. **Constant Current Charger.** By contrast, a professional-quality Constant Current Battery Charger makes charging simple. It maintains a constant supply of current to the battery at all levels of charging. As the battery's internal voltage increases with the amount of charge, the charger automatically increases the charging voltage to maintain the current output.

Smart Battery Charger. The best chargers combine both types of designs. The strong charging characteristics of a constant-current charger are used to initially charge the battery; then the charger automatically switches to a constant voltage mode to float-charge or maintain the battery. This type of charger is also known as a Smart Battery Charger because they use a micro-chip (computer) in their circuits to determine when to switch from charging mode to maintenance, or "float" modes of charging.

Smart chargers monitor the battery's state-of-charge and will automatically start charging when the battery falls below a specific voltage. This smart technology is also used to keep batteries from being over-charged, causing excessive water loss in Conventional batteries. **Yuasa Smart chargers can be left on an AGM battery indefinitely, but cannot be left for extended periods of time on a Conventional battery without checking water levels.** In addition, these chargers are capable of reaching 12.8 or more volts required to activate AGM batteries. Some smart chargers have diagnostic features that indicate if a battery is worn out and needs replacing. In addition to these features, many smart chargers will not spark when connected to a battery and will indicate that they are connected backwards (reverse polarity).

The current output of a battery charger, used to provide a maintenance charge for powersports-sized batteries, should not exceed 3 amps. Automotive or high-rate types of battery chargers should not be used as they can overcharge and damage small batteries. Always match Conventional or AGM batteries to the correct battery charger. The wrong type of charger, or a charger that outputs too much amperage, can cause poor performance or even permanent damage. **Do not use a high-amperage charger to reduce charging time as it will void the battery warranty.**

Current Output. To find the recommended charger current output in amps for a specific battery, divide the battery amp hour rating by 10. For example a 14 AH battery should be charged at 1.4 amps (14 AH ÷ 10 = 1.4 amp current). Select a battery charger that comes closest to the value of that figure. Yuasa AGM batteries have the amp hours printed on the front of the battery case. If unsure about a battery's rating, refer to the Yuasa Battery Specifications & Applications guide. Yuasa offers a complete line of chargers to activate and maintain batteries to factory specifications and all of them are discussed in the next section.

1 AMP Automatic Battery Charger & Maintainer

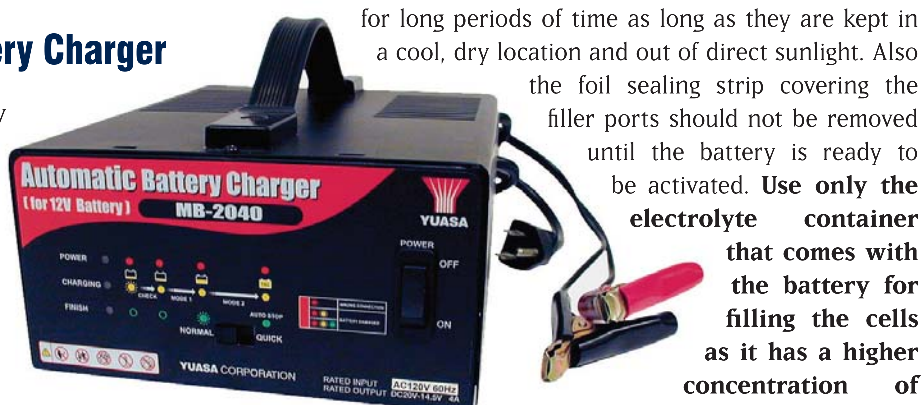
Designed for long term use, Yuasa's 1 AMP Automatic Battery Charger & Maintainer uses "smart" battery charger technology, is fully automatic and features a three level charge cycle. These include:

- **Bulk Charge**—concentrated charging power in the constant current mode
- **Float Charge**—maintains a fully charged battery
- **Pulse Mode**—peaks battery capacity which enhances battery life

When the initial charging mode reaches 14.4 volts the charger switches to float mode. If a load is applied to the battery (turning on the vehicles ignition or lighting) during charging, the charger automatically switches back to "charge" mode, then to a maintenance float charge. The 1 AMP Automatic Battery Charger & Maintainer is designed for use with both AGM and Conventional types of batteries, plus it will not overcharge even if left connected for long periods of time. It also features an AC power LED indicator, full charger indicator, battery fault indicator, reverse polarity protection and spark-free operation. The charger plugs directly into a wall outlet and comes with a 12-foot output cord, battery accessory lead and fused ring connector. The charger has a 5-year warranty. (For more information, see page 2.)

Automatic 12V 4 Amp Battery Charger

The Yuasa Automatic 12V 4 Amp Battery Charger can charge up to 20-volts to aid in recovering deeply discharged, sulfated batteries. It features a "Quick Mode" for faster vehicle setup and "Normal Mode" for smaller batteries. The diagnostic function provides information indicating that the battery is damaged and will not accept a charge. In addition, a reverse polarity connection is indicated on the panel. (For more information, see page 27.)



10-Bank Battery Maintainer

For shop use where multiple batteries have to be maintained the Yuasa 10-Bank Battery Maintainer is ideal. It will charge and maintain 10 batteries (both Conventional and AGM) at one time. The charger uses a 5-stage maintenance/float charge cycle that includes:

- **Pre-Qualification**—determines battery condition
- **Bulk Charge**—concentrated charging power
- **Absorption**—equalizes battery's cell charge
- **Float Mode**—safely maintains proper charge condition
- **28-Day Charge Recycle**—re-evaluates battery status for long term storage

It also features a built-in timer for extra battery protection. Each charging port has LED indicators for charging status. (For more information, see page 27.)

Activating AGM Batteries

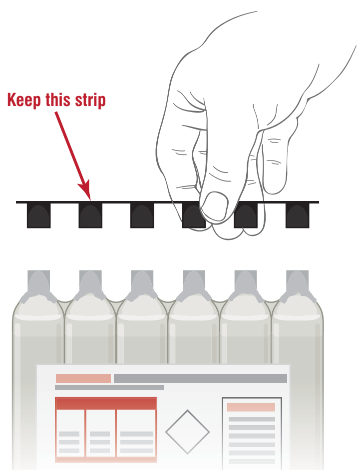
Activating an AGM battery is a simple process and differs from activating a Conventional battery (covered later in this section). Un-activated, AGM batteries can be stored for long periods of time as long as they are kept in a cool, dry location and out of direct sunlight. Also the foil sealing strip covering the filler ports should not be removed until the battery is ready to be activated. **Use only the electrolyte container that comes with the battery for filling the cells as it has a higher concentration of sulfuric acid than the acid used for Conventional batteries.**

The electrolyte container that is shipped with a dry AGM battery contains the correct amount of battery acid and is more concentrated that the electrolyte used in a conventional battery.

All AGM battery electrolyte containers are not the same. Each contains the proper amount of electrolyte for its specific battery. Before filling, read the electrolyte handling instructions and precautions on the label. Do not smoke when activating a battery or handling battery acid. Always wear plastic gloves and protective eyewear and be sure to read the Battery Safety section in this manual. The following seven steps should be used to activate an AGM battery:

1. The battery must be out of the vehicle and placed on a level surface.

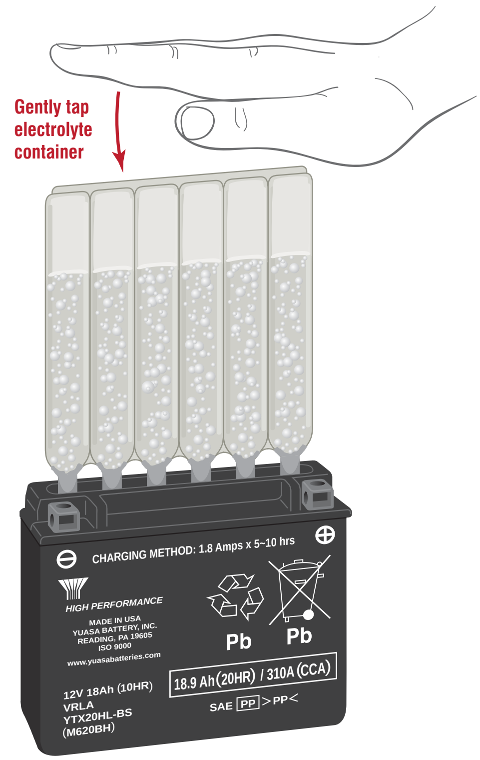
2. Remove electrolyte container from the plastic storage bag. Remove the strip of caps. **Put the strip aside as you will use it later to seal the battery cells.** For battery filling use only the dedicated acid container that comes with the battery as it contains the proper amount of electrolyte for that specific battery. This is important to service life and battery performance. **Do not pierce, or otherwise open the foil seals on the electrolyte container. Do not attempt to separate the individual electrolyte containers.**



Do not puncture the foil seal or remove it prior to filling a dry AGM battery.

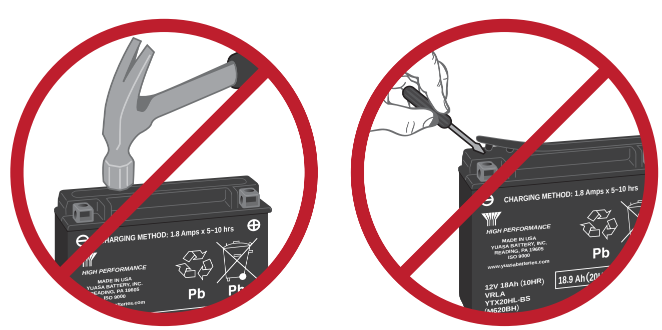
3. Place the electrolyte container with the foil seals facing down into the cell filler ports on the battery. Hold the container level and push down to break the foil seals. Electrolyte will start to flow into the battery and air bubbles will be seen inside the container. **Do not tilt the electrolyte container.**

4. Check the electrolyte flow. **Keep the container in place for 20 minutes or longer until it empties completely.** If no air bubbles are coming up from the filler ports, or if container cells haven't emptied completely after 20 minutes, tap the container and/or battery case a few times to cause the electrolyte to flow into the battery. Do not remove the acid container from the battery until it is completely empty. The battery requires all of the electrolyte from the container for proper operation.



Bubbles will appear as the electrolyte container fills the battery indicating the flow of battery acid. Tap the container periodically to keep the electrolyte flowing until the container is completely empty. **Never puncture the top of the acid container to speed up the filling process.**

5. Remove the empty electrolyte container from the battery. Fully insert the strip of sealing caps (previously removed from the electrolyte container) into the battery filling ports. Make sure the strip of caps is fully inserted and flush with the top of the battery. Insert the caps by hand, do not use

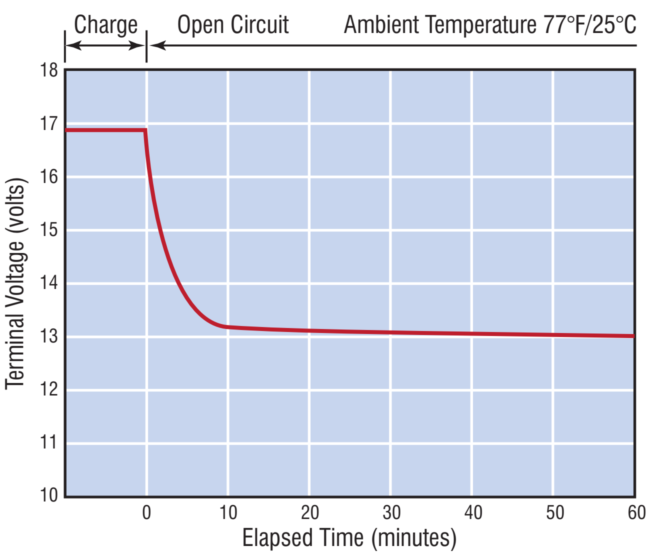


After filling, the sealing caps should be installed using hand pressure only. The sealing cap should never be removed once the battery is activated.

a hammer or excessive force. **Never remove the strip of caps or add water or electrolyte to the battery during its service life.**

6. **For batteries with ratings of less than 18 AH, let the battery stand for 20 to 60 minutes.** For batteries with higher AH ratings, and/or having the **High Performance rating (designated by an "H" in the part number/ name) allow the battery to stand for 1 to 2 hours.** Yuasa AGM batteries have the amp hour (AH) printed on the front of the battery case. The stand, or rest period, allows the electrolyte to permeate into the plates for optimum performance.

7. **Newly activated AGM batteries require an initial charge.** After adding electrolyte, a new battery is approximately 75-80% charged. After the "stand" period (step 6), charge the battery to bring it to a full state-of-charge. The battery charger used for initial charging should be able to charge at 12.8+-volts for an AGM battery. All Yuasa battery chargers are capable of reaching this minimum voltage and initializing/activating an AGM battery.



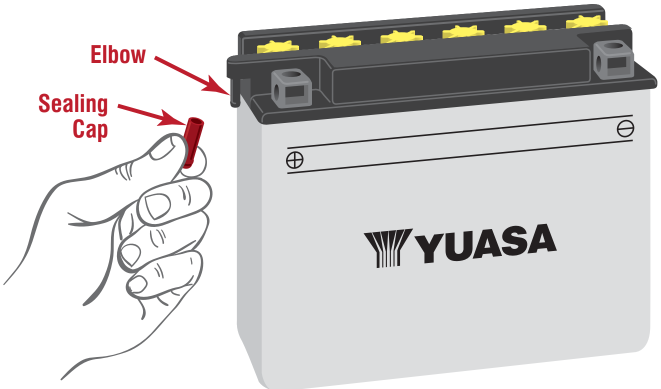
During the initial charging period, battery voltage may reach over 16-volts. Open circuit voltage should be checked after the battery is allowed to stand between 1 and 2 hours.

Activating Conventional Batteries

Sealed at the factory, a new Yuasa Conventional battery has an indefinite shelf life as long as it remains sealed (filler caps and red vent cap installed) and is stored at room temperature. Once the battery is unsealed, it should be activated and put into service. The cell plates on an unsealed, uncharged battery will oxidize making charging difficult and reducing the service life of the battery. The following eight steps explain the process of activating Yuasa's Conventional, YuMicron and YuMicron CX batteries:

1. The battery must be out of the vehicle and placed on a level surface. Remove filling caps (red, yellow or green colored battery caps).

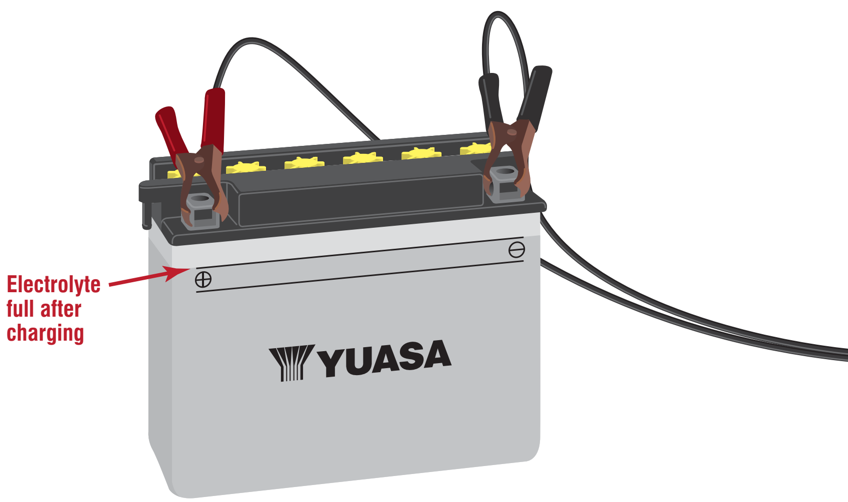
2. **REMOVE THE RED SEALING CAP FROM THE VENT ELBOW**. If the battery has a red cap on the vent elbow remove it and throw it away. Never put this cap back on the battery after it is filled with acid as the buildup of internal gas pressure can cause the battery case to rupture.



Always remove the red sealing cap from the vent elbow before filling and activating the battery.

3. If using the acid bottle supplied with the battery, place the container upright on a flat surface. Carefully cut off the tip of the bottle's spout and attach the short tube provided. **Caution, Do not squeeze the bottle when cutting the fill tip**.

4. Fill the battery with electrolyte supplied with the battery or from a bulk container. Do not use water or any other liquid to activate a battery. Electrolyte should be between 60° F and 86° F before filling. If electrolyte is stored in a cold area, it should be warmed to room temperature before



Make sure that the acid level is to the upper mark after the battery is initially charged. If the level is low fill with electrolyte.

filling. Fill to the UPPER LEVEL as indicated on the battery. NOTE: Never fill/activate a battery installed in a vehicle as electrolyte spillage can cause damage.

5. Fill each battery cell slowly and carefully to the highest level line.

6. Let the battery stand for at least 30 minutes after filling. Move or gently tap the battery so that any air bubbles between the plates will be expelled. If the acid level has fallen, refill with acid to upper level.

Post-Fill Stand Time

Amp-Hour	Stand Time
<18	30-60 minutes
>18	1-2 hours
High Performance	1-2 hours

7. Filling a Conventional battery with electrolyte will bring it to 75-80% of a full charge. **A battery must be charged to 100% before putting it into service**. To find recommended charging current requirements in amps for a specific battery, divide battery ampere-hour capacity rating by 10. For example a 14 AH battery should be charged at 1.4 amps (14 AH 10 = 1.4 amps). The specific gravity of the electrolyte should rise to at least 1.260 on 12N series batteries. On all High Performance batteries (YB Series) a minimal reading of 1.270 should be observed.

   During initial charging check to see if the electrolyte level has fallen, and if so, fill with acid to the UPPER LEVEL. After adding acid, charge for another hour at same rate as above to mix the water and acid together. Note: This is the last time electrolyte should be added to the battery. If the level is low during use, distilled water should be added as required.

8. When charging is complete, replace filler cap plugs and tighten by hand—do not use a screwdriver or pliers. Wash off spilled acid with a water and baking soda solution, paying particular attention that any acid is washed off the terminals. Dry the battery case and install the battery.

POINTS TO REMEMBER

- Newly activated AGM and Conventional batteries require an initial charge before being placed into service
- Yuasa Smart Battery Chargers use constant current and pulse technology and can activate, charge and maintain all Yuasa batteries
- High-rate, automotive types of chargers can cause damage to powersports batteries
- High performance batteries (designated by an "H" in the part number) must stand 1 to 2 hours after initial charging
- Never remove the strip of caps on an AGM battery to add water or electrolyte during its service life
- Before activation of Conventional batteries remove the red sealing cap from the vent elbow and discard it

5 Installation, Testing and Maintenance

Battery Installation

In most applications, batteries should be installed in an upright position, If there is any question regarding a particular vehicle/battery/installation please contact us for our specific recommendations before installation.

Yuasa AGM batteries that come with separate acid packs that are used to fill and activate the battery should not be installed in any position other than upright, as possible electrolyte leakage may occur. Also, **Conventional and YuMicron batteries should never be installed in any position other than upright as their liquid electrolyte will leak from the battery case causing damage to the vehicle.**

Disclaimer:

Yuasa batteries are to be mounted in a position identical to the position in which they were mounted in the vehicle by the manufacturer. Any position other than the "0°" position (upright) requires a "non-spillable" "Factory Activated" battery.

Yuasa Battery assumes no responsibility for damages and/or injuries incurred due to a battery being mounted in a position other than what was originally used in the vehicle by the manufacturer. All "-BS" and Conventional "Flooded" batteries are to be mounted in the "0°" (upright) normal/center position.

POINTS TO REMEMBER

- The Yuasa Battery Specifications & Applications guide and OE microfiche, or online parts look up data are the best sources for battery applications information
- When replacing a battery that uses an original equipment sensor, always replace the sensor
- Conventional and YuMicron batteries should never be installed in any position other than upright as their liquid electrolyte will leak from the battery case causing damage to the vehicle
- Yuasa batteries are to be mounted in a position identical to the position in which they were mounted in the vehicle by the manufacturer

Any position other than the "0°" position (upright) requires a "non-spillable" "Factory Activated" battery While it may seem obvious that testing a battery before replacing it would be a good idea, often times a battery is unnecessarily replaced only to find that the charging system, or a loose battery cable connection is the reason for the discharged battery. For example, a motorcycle's battery is discharged, or dead. The owner (or dealer) replaces the battery and the engine easily starts. The battery must have been the problem as bikes starts consistently for a week. Eventually the battery becomes discharged again and the owner is facing the same problem. If the charging system on the motorcycle is weak, or there is a loose connection in the electrical system, the new battery only temporarily solved the discharge problem. Batteries should be tested to avoid unnecessary replacement.

There are several methods used to test a battery. Measuring state-of-charge after charging a battery can determine if the battery is good. For Conventional batteries, a hydrometer can be used to measure specific gravity and thus state-of-charge. For both Conventional and AGM batteries, a voltmeter can measure state-of-charge. Load testing is another method to determine if a battery is good. All of these tests require that the battery be fully charged before testing. The only method that does not require a fully charged battery is using the Yuasa Digital Powersports Battery Tester. This tool will be covered later in this section.

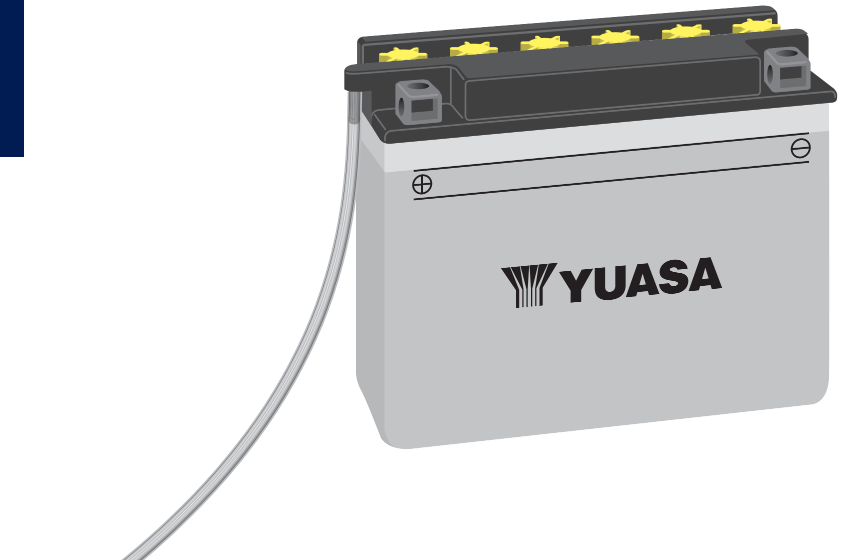
Inspecting a Battery

Battery testing should begin with an inspection of the battery using the following steps:

1. **Make sure the top of the battery case is clean and dry.** If the case of a battery is dirty it can cause the battery to discharge through the grime on top of the case. Use a soft brush and water and soap or a solution of baking soda and water to clean the battery case or terminals. On a Conventional battery, make sure filler cap plugs are finger tight so cleaning materials will not enter the cells and neutralize the acid.

2. **Inspect battery terminals, screws, clamps and cables for problems including: breakage, corrosion or loose connections.** Clean the terminals and clamps with a wire brush. Once battery cables are installed, dielectric grease (available at most auto parts stores) or clear lacquer from a spray can applied to the terminals will help prevent oxygen from causing corrosion on the battery terminals.

3. **Inspect the battery case for obvious damage such as cracks or leaks;** look for discoloration, warping or raised battery case top, which may indicate that battery has overheated or been overcharged.



4. **For Conventional batteries, check electrolyte level and add distilled water if necessary. Don't add acid—only distilled water.** Before any testing, charge the battery so the water and acid mix.

5. **If equipped, check the battery vent tube. Make sure it's not kinked, pinched or otherwise obstructed.** On a motorcycle, it should exit away from the drive chain and from below the swing arm. Small cuts in the tube near the battery vent are OK; they form an emergency escape for trapped gas in case the vent tube becomes obstructed.

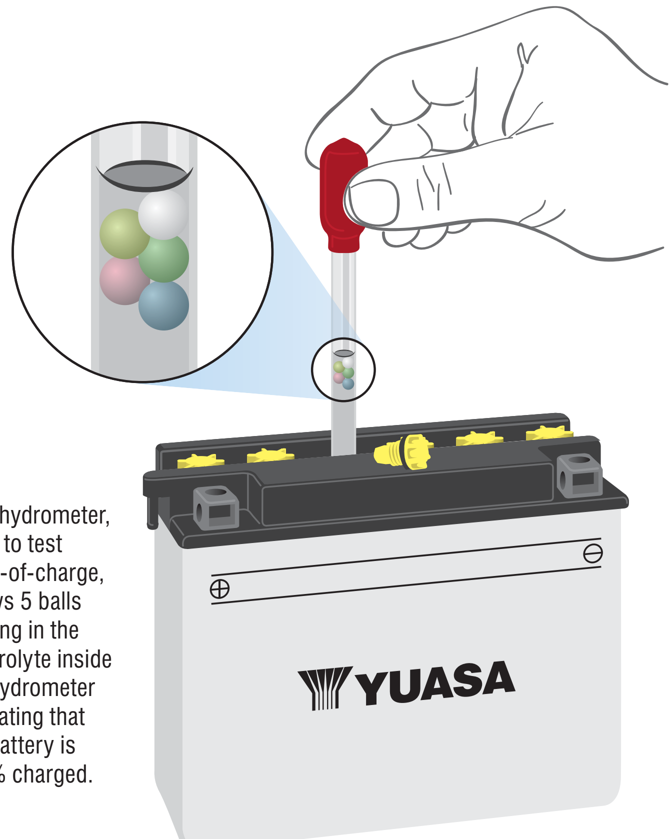
Battery Testing — Hydrometer

Because Conventional batteries have filler caps their state-of-charge can be checked using a hydrometer by measuring specific gravity. If after charging, the battery's specific gravity does not increase to indicate a full charge, the battery should be replaced.

A hydrometer measures the ratio of sulfuric acid to water, or the specific gravity (SG) of the electrolyte. The SG for pure water is 1.000 and sulfuric acid has an SG of 1.835. Combined, their SG is between 1.265 to 1.280. In general, an SG reading between 1.265 to 1.280 indicates a fully charged battery. A reading of 1.230 to 1.260 indicates the battery should be charged before testing.

Yuasa YuMicron batteries use Sulfate Stop, a chemical additive that increases battery life by reducing sulfate buildup. Sulfate Stop may cause a slight increase in SG readings for these types of batteries. **A battery's specific gravity changes with temperature.** Ideally, readings should be taken at 77° F. If the temperature is much colder, or hotter a conversion factor can be used to obtain an accurate reading. Add .001 to the SG for every 3° F above 77° F and subtract .001 from the SG for every degree below 77° F. SG has a direct relationship to battery cell voltage. By adding .84 to the SG number, the cell voltage can be calculated. For example, an SG of 1.265 + .84 = 2.105 volts. Multiply 2.205 volts x 6 (six cells for a 12-volt battery) and the result is 12.63 volts—indicating a fully charged battery.

There are two types of hydrometers used to measure SG: calibrated float and floating ball. The calibrated float provides an exact SG reading, however due to the amount of electrolyte needed to cause the float to rise inside the hydrometer they are impractical for use on small powersports batteries. The floating ball type hydrometer is much smaller in size and easy to use on small batteries. Instead of reading specific gravity directly, it uses colored balls to indicate state-of-charge. After drawing in enough electrolyte to cover the balls inside the hydrometer, the number that float are counted. One floating ball equals 25% charge, two balls—50%, three balls—75% and four balls indicate 100% state-of-charge (see chart page 19). Again, if after charging, the battery's specific gravity does not increase to indicate a full charge, the battery should be replaced as it may have an open/shorted cell or excessive sulfation.



This hydrometer, used to test state-of-charge, shows 5 balls floating in the electrolyte inside the hydrometer indicating that the battery is 100% charged.

Methods of Checking Battery Condition

State of Charge	Syringe Hydrometer	Digital Voltmeter	5-Ball Hydrometer
100% Charged (w/Sulfate Stop)	1.280	12.80v	5 Balls Floating
100% Charged	1.265	12.60v	4 Balls Floating
75% Charged	1.210	12.40v	3 Balls Floating
50% Charged	1.160	12.10v	2 Balls Floating
25% Charged	1.120	11.90v	1 Balls Floating
0% Charged	< 1.100	< 11.80v	0 Balls Floating

Three methods of determining state-of-charge are shown; Syringe Hydrometer, Digital Voltmeter and 5-Ball Hydrometer.

Battery Testing — Voltmeter

Unlike Conventional batteries, AGM types cannot be tested using a hydrometer because they are sealed. Instead a voltmeter can be used to perform an open circuit voltage test. The test can be used for both Conventional and AGM batteries. The test is used to determine the following: battery state-of-charge, ability to hold a charge and shorted or open battery cells. It is possible that a battery can pass the open circuit voltage test and still be unable to start a vehicle and battery load testing will be required to determine if the battery needs replacement. **Before performing an open circuit voltage test the battery must be fully charged.**

Charging a battery using the vehicle's charging system or a battery charger creates a "surface" charge across the battery's cells. The surface charge needs to be removed before an accurate test for open circuit voltage can be performed. To remove the surface charge, turn on the ignition key for about three minutes then turn it off. Now let the battery sit for about 10 minutes. This step is not necessary if the battery has been sitting for 1 hour after charging is complete. Connect a digital voltmeter to the battery, red lead to positive and black lead to the negative battery terminals. Open circuit voltage indicates what percent of charge the battery has reached after charging. Open circuit voltage for a fully, 100% charged AGM battery is 12.8 to 13.0 volts. AGM batteries that are 75% to 100% charged will measure 12.5 to 12.8 volts. Conventional batteries have slightly lower open circuit voltages: 12.6 volts (12.8 volts with Sulfate Stop) for 100% charge and 12.4 for 75% charge..

If after charging, and the open circuit voltage indicates that the battery is less than 75% charged, the battery is probably no good and should be replaced. Before the battery is condemned, try charging it again. If the battery is still not close to 100% charged it needs to be replaced. The open circuit voltage test is not conclusive. It is possible to have a 100% charged battery as indicated by the open circuit voltage test that will not start a powersport vehicle reliably. A load test must be performed to determine actual battery performance after charging.

Charging System Quick Check

A quick check of a powersport vehicle's charging system can be performed using a digital voltmeter. Connect the voltmeter leads directly to the battery (red to positive and black to the negative terminals). Read the open circuit voltage and start the engine. Operate the engine between 3000 to 4000 rpm while watching the reading on the voltmeter. If the vehicle's charging system maintains voltage between 13.0 and 14.5 volts, the charging system is probably working properly. If voltage is the same as open circuit voltage (usually less than 13 volts) the charging system is not working and further diagnosis will have to be performed. Installing a new battery in a powersports vehicle with a faulty charging system will eventually result in a dead battery and an unhappy customer. Always use the OE service manual as a guide for further testing and diagnosis of the charging system.

Battery Load Testing

Once the battery is charged and passes the open circuit voltage test its time to determine if it can really perform its main job—starting the engine. It might seem obvious that if the starter button is pressed and the engine starts, the battery must be OK. While a marginal battery might start an engine a few times, it may not reliably start it in the future—especially in cold weather.

There are two tools that can be used for load testing: a dedicated battery load tester, or a digital voltmeter. The load tester can be used when the battery is not installed in a vehicle. The load tester simulates the electrical load of a starter motor to load-test the battery. These testers are usually used by dealerships and are able to adjust the load applied to the battery under test. Always follow the instructions that apply to the specific battery load tester. In general, apply a load of three times the ampere-hour rating. After 10 seconds check the battery voltage with the load still applied. A good 12-volt battery will not drop below 9.5 volts (ambient temperature of 70° F). A 6-volt battery should drop no more than 5.25 volts. If the voltage reading is below these minimums replace the battery.

As an alternative to the load tester, the vehicles starter motor can be used to provide the load to test the battery. To load test the battery, cranking voltage must be measured. Low cranking voltage will indicate that the battery is getting tired and should be replaced. Following are the steps for performing a battery load test using a digital voltmeter and the vehicle's starter motor.

Connect a digital voltmeter directly to the battery—red lead to the positive terminal and black lead to negative. While watching the voltmeter, press the start button and crank the engine's starter (it's OK if the engine starts). Just before the engine starts, note the voltmeter reading. As the starter motor places an electrical load on the battery, cranking voltage will normally drop. **If battery voltage drops below 9.5 volts (at 70° F) while the engine is cranking over, the battery needs to be replaced.** If the engine starts too quickly to read cranking voltage, the ignition or fuel injection computer fuse can be removed. This will allow the starter motor to operate (without the engine starting) and cranking voltage can be measured.

Yuasa Digital Powersports Battery Tester

The previous battery testing methods required the battery to be fully charged before testing. Yuasa's Digital Powersports Battery Tester (part number YUA00BTY01) can test a battery, in or out of the vehicle even if the battery is discharged. The tester measures a battery's internal resistance regardless of its state-of-charge. Internal resistance is an indication of a battery's ability to deliver current, or amperage. The more capacity a battery has to produce current, the lower its internal resistance.

Yuasa's digital tester uses single load dynamic resistance technology to calculate battery performance. A modified DC load is momentary applied to the battery while measuring the instantaneous voltage drop across all cells. The load is then removed and voltage across the cells is measured again after a recovery period. These analog measurements are converted into digital information—the tester calculates the dynamic internal resistance in order to evaluate overall battery condition. The entire process takes about two seconds and current drain on the battery is minimized. The tester provides information on open circuit voltage, state-of-charge and battery health and condition. This tester can also test a partially charged or fully discharged battery on or off a vehicle.

To use the tester:

1. Connect it directly to the battery terminals. When the connection is made battery voltage will be displayed.
2. Program what type of battery you are testing. There are three selections—**VRLA/MF/AGM/SLA** (valve regulated lead acid/ maintenance free/absorbed glass mat (AGM) lead acid) or **SLI** (starting, lighting and ignition) and **Conventional** batteries.
3. "SET CAPACITY" is displayed and arrow keys are used to select the amp hour rating of the battery being tested.
4. Press the "ENTER" button to begin testing. In less than two seconds the open circuit voltage is displayed with test results that include: Good & Pass, Good & Recharge, Recharge & Retest, Bad & Replace and Bad Cell & Replace.
5. After testing, pressing the up/down arrow keys displays State-of-Charge and Battery Health, both listed as a percentage.

Battery Maintenance

AGM Batteries. AGM batteries do not have to be checked as often as Conventional batteries—about every three months, or three months from the date of battery activation at the factory if stored at room temperature. Higher storage temperatures cause faster self-discharge and and requires that batteries be checked more often. The battery will last longer if it is 100% charged most of the time and any of the Yuasa automatic chargers will maintain a battery for optimum performance and long service life. AGM batteries have a predetermined quantity of electrolyte added at the factory or in the field specified for the battery. Once activated, the battery is permanently sealed and must never be opened. The addition of water is never required for an AGM battery. **The single most important aspect to maintaining an AGM battery is to not let it sit discharged for long periods of time—keep it fully charged for peak performance.**

Conventional Batteries. Conventional batteries should be checked for state-of-charge about once per month if not used on a regular basis. Recharging may be required if the vehicle is not used for more than two weeks or if the starter turns slower than usual when starting the engine. A Conventional battery requires the periodic addition of distilled water when the electrolyte level becomes low. Water loss is normal in these batteries through the process of electrolysis and evaporation. Low electrolyte levels that expose the lead plates to the air will result in permanent damage to the battery. Maintain the electrolyte levels above the minimum fill lines on the battery and at or below the maximum line. Clean terminals and connectors as necessary and make sure the vent tube is free of kinks or clogs. Always replace filler caps and finger-tighten only.

Battery Storage

If the vehicle is in storage or used infrequently, disconnect the battery cable to eliminate current drain from electrical equipment. Check the battery every month (for Conventional types) and every three months for AGM batteries. If open circuit voltage indicates a low state-of-charge, charge the battery. **Temperatures below 60° F or above 80° F may require more frequent inspections and/or charging.**

Sulfation and Freezing

The two most common reasons that batteries can become damaged are sulfation and freezing. These are not a problem if the battery is properly charged, and for Conventional batteries the water level is maintained. Battery sulfation takes place for two reasons: continuous discharging, or low electrolyte levels. When a battery discharges the lead in the plates turn into lead sulfate. The lead sulfate is actually a crystal which grows larger when the discharge is continuous and uninterrupted. In a Conventional battery, low electrolyte levels expose the cell plates to air causing the lead material to oxidize and form sulfates. In either case it doesn't take long before the battery won't hold a charge. Low electrolyte levels cause another problem because the acid in the electrolyte becomes more concentrated, causing the active material to corrode and fall to the bottom of the battery case. If this conditions takes place over a long enough time period the process will internally short out the battery.

Electrolyte Freezing Points

Specific Gravity of Electrolyte	Freezing Point
1.265	-75°F
1.225	-35°F
1.200	-17°F
1.150	+5°F
1.100	+18°F
1.050	+27°F

A battery that is fully charged can be stored at low temperatures without freezing. This chart shows that as specific gravity (state-of-charge) decreases, the battery will freeze at a higher temperature.

For added protection, YUASA's YuMicron and AGM batteries are treated with a special chemical formula called "Sulfate Stop." This dramatically reduces sulfate crystal buildup on cell plates resulting in longer battery life. For example, Yuasa conducted a test on two batteries; one with Sulfate Stop, and the other without. Both batteries were under the constant discharge of a 10-watt bulb for a week. The battery with Sulfate Stop was charged with a 90% recover rate. The untreated battery could not be charged enough to put it back into service.

Freezing is not a problem with a fully charged battery. However if the battery becomes discharged (and the acid in the electrolyte turns into mostly water) the electrolyte will freeze. Freezing can cause a condition called "mossing" which is indicated by small red lines on the battery plates. Freezing can also crack the battery case and buckle the plates permanently damaging the battery. A fully-charged battery can be stored at subfreezing temperatures with no damage. As the chart on this page indicates a fully charged battery will not freeze unless the temperature drops below -75° F. By contrast a discharged (dead) battery will freeze at only 27° F. That's a difference of more than 100 degrees between the low temperatures a charged and discharged battery can withstand.

POINTS TO REMEMBER

- Inspect battery terminals, screws and cables for breakage, corrosion or loose connections
- Inspect the battery case for damage including cracks or leaks
- Check electrolyte level on Conventional batteries and add water if necessary
- Never add water to an AGM battery
- State-of-Charge can be tested on a fully charged battery using a voltmeter
- A vehicle's starter motor can be used for battery load testing
- For peak performance never let a battery sit discharged for long periods of time

Acid—Sulfuric acid, used to describe the electrolyte or liquid contained in a battery's cells. Pages 6, 7.

Active Materials—Materials in a battery that react chemically to produce electrical energy; lead peroxide (positive plates) and sponge lead (negative plates).

Activation—Adding electrolyte to a dry battery. Pages 8, 14, 23.

AGM—Absorbed glass mat. Page 6, 8, 9, 14, 16.

AGM Battery—A battery that does not contain any liquid electrolyte. The electrolyte is absorbed in glass mat material located in each of the battery's cells. AGM and VRLA (Valve Regulated Lead Acid) batteries are the same design. Page 8, 16.

Ampere—The amount of electrical that a battery produces. Page 10, 11.

Ampere-Hour—A measure of the volume of electricity (one amp per hour). Pages 10, 19.

Ampere-Hour Capacity—The number of ampere-hours that can be delivered by a battery under specific conditions. Page 19.

Antimony—A hard, brittle, silver-white metal with a high luster from the arsenic family. Pages 9, 15.

Cadmium—A metallic element highly resistant to corrosion used as a protective plating on battery components.

Capacity Test—A test that discharges a battery using a constant current at room temperature until voltage drops to 1.75 per cell.

Charged—A battery cell's maximum ability to deliver current (amps). The positive plates contain a maximum of lead oxide and a minimum of lead sulfate, and the negative plates contain a maximum of sponge lead and a minimum of sulfate. The electrolyte is at maximum specific gravity. Pages 6, 8, 10, 11, 12.

Charged and Dry—A battery assembled with dry, charged plates and no electrolyte.

Charged and Wet—A fully charged battery containing electrolyte (ready to be installed).

Charging—The process of converting electrical energy to stored chemical energy. Pages 5, 6, 7, 9, 11.

Charging Rate—The current (amps) in amperes at which a battery is charged. Page 9.

Cold Cranking Amps—The number of amps a battery can produce at 0° F for 30 seconds without cell voltage falling below 7.2 volts. Pages 5, 8, 10.

Constant Current Charge—A battery charger that produces a constant current (amps) during the charging process. Pages 12, 13, 15.

Conventional Battery—Same as a standard battery or any YuMicron or YuMicron CX battery. Page 7, 9, 13, 14, 15, 18.

Current—The flow of electrical energy normally expressed as amperes or amps. Pages 5, 6, 7 , 10, 11, 12.

Deep Discharge—Removal of up to 80% of the rated capacity of a battery's cell.

Discharge—Conversion of a battery's chemical energy into electrical energy. Pages 6, 7, 8, 10, 11.

Discharge Rate—Any specified amperage rate at which a battery is discharged.

Dry Charged—Battery cell plates that have been subjected to the dry charging process.

Electrolyte—In a battery electrolyte is a diluted solution of sulfuric acid and water. Pages 6, 7, 8, 11, 12, 14, 15, 17, 18, 20.

Float Charge—Recharge voltage rate that is slightly higher than the open circuit voltage of a battery. Pages 15, 16.

Glass Mat—Fabric made from glass fibers with a polymeric binder such as styrene or acrylic which is used to help retain positive active material. Glass mats also absorb electrolyte in an AGM battery. Pages 8, 9.

Hydrometer—A device used to measure specific gravity of electrolyte in a battery. Pages 20, 21.

Lead—Sometimes listed as Pb is a chemical element used in lead acid batteries. Pages 5, 6, 7, 8, 15 .

Lead Antimony—A commonly used alloy in battery castings or plates. Pages 15.

Lead Calcium—A lead base alloy that is sometimes used for battery components in place of antimonial lead alloys. Also know as lead calcium. Pages 8, 9, 15.

Lead Oxide—A general term for any of the lead oxides used to produce battery plates.

Lead Peroxide—A brown lead oxide which is the positive material in a fully formed positive battery plate. Page 6.

Lead Sponge—The chief component of the active material of a fully-charged negative battery cell plate.

Lead Sulfate—A compound that results from the chemical action of sulfuric acid on oxides of lead within a battery cell. Pages 7, 11, 15, 24.

MF—Maintenance-Free, VRLA sealed absorbed glass mat battery and AGM are all the same type of battery and do not have fill caps, nor do they need to be filled with water. Page 8.

Milliampere—One thousandth of an ampere or amp.

Modified Constant Voltage Charge—A charge in which charging voltage is held constant while a fixed resistance is inserted in the battery charging circuit causing a rising voltage as charging progresses.

Negative Plate—The grid and active material that current flows to from the external circuit when a battery is discharging. Pages 6, 8, 11.

Negative Terminal—The battery terminal from which current flows through an external circuit to the positive terminal when a battery discharges. Pages 6, 22.

Open Circuit Voltage—The voltage at a battery's terminals when no current is flowing. Pages 10, 12, 13, 18, 22.

Positive Terminal—The battery terminal that current flows toward in an external circuit when the battery is discharging. Pages 6, 22.

Rated Capacity—Amp hours of discharge that can be removed from a fully-charged battery at a specific, constant discharge rate. Page 10.

Self-Discharge—Gradual loss of electrical energy when a battery is stored. Pages 8, 9, 11, 23.

Sponge Lead—A porous mass of lead crystals and the chief material contained in a fully-charged negative battery plate. Page 6.

Standard Battery—Any conventional, YuMicron or YuMicron CX battery.

State-of-Charge—The amount of electrical energy contained in a battery. Pages 7, 11, 12, 15, 20.

Sulfation—Formation of lead sulfate on a battery's plates as a result of discharge. Pages 7, 11, 21, 24.

Sulfuric Acid—The principal acid compound of sulfur, sulfuric acid in diluted form is the electrolyte of a lead acid battery. Pages 6, 7, 11, 12, 16.

Trickle Charge—A low-rate continuous charge approximately equal to a battery's internal losses and capable of maintaining a battery in a fully-charged state. Page 15.

Vent Plug or Vent Cap—The seal for the vent and filling well of a cell cover or a small hole for the escape of gases. Pages 7, 18.

Volt—The unit of measure of electromotive force or the electrical pressure of a circuit or battery. Pages 6, 9, 10, 12, 13, 15, 21, 22.

Voltage—The difference in electrical potential that exists between the terminals of a battery or any two points in an electrical circuit. Pages 20, 21, 22.

Voltmeter—Instrument used for measuring voltage. Pages 20, 21, 22, 24.

VRLA—Valve Regulated Lead Acid. Sealed batteries which feature a safety valve vent system designed to release excessive internal pressure while maintaining sufficient pressure for recombination of oxygen and hydrogen into water. VRLA and AGM refer to the same type of battery design. Pages 8, 17.

Professional Shop Products

Yuasa MB-2040 Battery Charger

Part No. YUA1202040

- High Output charging current (4 amps)
- High Voltage capable (20 volts) – designed to improve recovery of sulfated batteries
- Switchable Mode operation
  - "Fast Mode" – for quick vehicle set-up
  - "Normal Mode" – ideal for smaller batteries, initial activation, and deeply discharged batteries
- Commercial Grade – perfect for Dealer / Shop use
- Suitable for all battery types – Conventional, as well as MF (AGM),including YTZ
- Automatic Shut-Off
- Reverse Polarity Protection / Spark-free Operation (UL / CUL) approved)
- Durable construction for longer life
- 3 year limited warranty

Digital Battery Tester

Part No. YUA00BTY01

- Developed exclusively for the Powersports industry
- Determines accurate battery status in seconds
- Single load, dynamic resistance technology minimizes battery drain during test
- Tests both charged and discharged batteries accurately
- 1 year limited warranty

With Protective Rubber Boot and Amp Hr Guide

10-Bank Battery Maintainer

Part No. YUA120027 - Battery Maintainer with 3 Ft. Leads
Part No. YUA122500 - Battery Maintainer with 25ft Leads
Part No. YUA00AC25F - 10 Pack of 25 Ft. Leads

- Maintain up to 10 batteries at a time
- 5-stage maintenance / float charge
- Prequalification battery test
- Built-in timer for battery protection
- 250 mA per channel
- 1 year warranty

2901 Montrose Avenue, Laureldale, PA 19605-2752
Phone: 610.929.5781 Fax: 610.929.1295
yuasabatteries.com