HOW CAN I TELL IF MY BATTERY IS CHARGED OR NOT?

SIMPLE ANSWER, WELL, MAYBE NOT SO SIMPLE:

The simplest method requires that you use a voltmeter to measure the voltage between the positive (+, red) and negative (-, black) posts (lugs, or terminals). For this method to work at all, the battery should sit idle for at least a couple of hours. When the battery is not being charged and not delivering charge to a load, this is the rule of thumb. For a 12 volt, lead-acid battery, the voltage measured between these two points should be between 11 and 13 volts. The closer the voltage is to 13 volts, the closer the battery is to being fully charged. The closer the voltage is to 11 volts, the closer the battery is to being “dead”. The exact value or the voltage that you measure will be different depending upon the style of battery, and the age of the battery.

MORE DETAILED ANSWER:

Lead acid batteries are made up of cells. Each cell is approximately 2 volts, so a 12-volt battery has 6 individual cells. It turns out that a fully charged 2-volt cell has a voltage of approximately 2.15 volts. Oddly enough, a fully discharged 2-volt cell has a voltage of 1.9 volts. That’s only a difference of 0.25 volts on each cell from fully charged to fully discharged. So a 12-volt battery will measure at about 12.9 volts when it’s fully charged and about 11.4 volts when it is fully discharged. That’s a total of 1.5 volts that represents the full range of charge on a 12-volt battery. To make a good guess at how much charge your battery has left, you can assign a percentage of charge remaining that is directly proportional to the battery voltage. Let’s see how we can do that.

If the battery voltage is 12.15 volts, how much charge is left? Beginning with 11.4 volts representing no charge or 0% charge available, subtract 11.4 volts from the voltage that you read. So 12.15 – 11.4 = 0.75 volts. Since there are only 1.5 volts above 11.4 volts that represents the full range of charge, we can divide the difference that we just calculated by 1.5 volts to get the percentage of charge remaining. 0.75 volts / 1.5 volts = 0.5 or when expressed as a percentage, multiply by 100 and get 50%.

Here’s the procedure written as a formula that is applicable to 12 Volt Batteries:

OPEN CIRCUIT BATTERY STATE OF CHARGE (SOC) CALCULATION

% Charge = SOC

% Charge = ((Measured Battery Voltage – 11.4 volts) / 1.5 volts) x 100

Equation 1

That seems easy enough. So what’s the catch? In order for this formula to work, the battery must be in a rest state. In other words, the battery should not be supplying power to any type of load. The experts say that the battery should remain at rest for at least 24 hours to get an accurate measurement, but in a pinch a couple of hours are good enough to make a reasonable guess.

The only way to be absolutely sure that your battery is fully charged is to do a load test. It is best to have the battery dealer do this for you. We only mention it here because it is possible for a battery to indicate a good voltage, but then immediately when you try to use it, it acts like it’s dead. This doesn’t happen very often, but it is a possibility.

HOW LONG WILL IT TAKE TO CHARGE A BATTERY?

We can make a pretty good guess by just dividing two numbers:
Equation 2: Approximate Recharge Time Calculations

(Battery Capacity) / (Charger Current) = Hours
(Amp-Hours) / (Amps) = Hours

Let's say I have a 50 Amp-Hour battery and a 10 Amp charger. These are fairly typical sizes for an automotive engine start type battery and an automotive battery charger. The dash that normally appears between Amp and Hours has been replaced by the multiplication sign (*) to emphasize the behavior of these 2 items in a mathematical equation.

If the battery is fully discharged then the first approximation for the charge time is **(50 Amps*Hours) divided by (10 Amps) = 5 Hours.** Truthfully, this is a rough estimate and it usually tells us how long it will take to recharge the battery to about 80% of its capacity.

To complete the recharge of a battery to 100% with a 3 or 4-step charger, it turns out that it will probably take an equal amount of time, or another 5 hours to recharge the last 20% of the battery capacity. A 4-step charger may get to 100% charge a little faster than a 3-step charger, but there is absolutely no guarantee. It actually could take longer. There is no definitive answer to this question.

HOW CAN I TELL IF MY BATTERY NEEDS TO BE REPLACED?

Referring back to the discussion of how you can calculate the charge level of your battery, we know that about 1.5 volts represent the full range of charge on a 12-volt battery. Now it is possible to over-discharge a battery, well beyond its intended design. It is possible to take the battery voltage on a 12-volt battery down to 3 or 4 volts, or even to almost ZERO under load. That would constitute a severe over-discharge. Many lead acid batteries will not respond kindly to such abuse. Some batteries may recover to 8 or 9 volts without recharging. However that is still a very low voltage and it does not represent any real charge storage, rather only a 'surface charge' that cannot do any useful work. Assuming that there are no other usage issues with the battery it may be possible to restore to full charge if it is recharged within a few hours of experiencing the severe over-discharge.

The battery may also not recover, in which case it is safe to say that the battery is defective. If after using a Deltran Battery Tender® battery charger, a battery in this condition does not recover to at least 12.6 volts, then the battery should probably be replaced.

HOW IS THE BATTERY TENDER® PLUS BATTERY CHARGER DIFFERENT FROM A TRICKLE CHARGER?

The BatteryTender® Plus (BT Plus) battery charger has microprocessor controlled power electronic circuitry which enables it to perform and safely control a number of sophisticated charging functions, well beyond the capability of inexpensive trickle chargers.

After connecting the BT Plus to a battery and then applying AC power, it first conducts a number of checks during Initialization Mode to ensure that the battery functioning normally. Then it will deliver its full charge at a constant rate of 1.25 amperes. This is called the Bulk Charge Mode. The battery voltage will rise and when it reaches a predetermined

level the BT Plus will hold the battery charge voltage constant at that level, allowing the charge current amplitude to drop. This is the Absorption Charge Mode. The Absorption Charge Mode is complete when the battery charge current drops below a very low value, usually below ¼ ampere. Some BT Plus models have timers to limit the duration of the Absorption Charge Mode.

After the current drops or the allotted time expires (typically several hours), the BT Plus automatically switches to a Float / Maintenance Charge Mode. The purpose of the Float / Maintenance Charge Mode is to maintain the battery voltage just slightly (typically between 1/10 and ½ volt) above where it would be if it were fully charged and sitting at rest. This keeps the battery topped off at voltages well below the gassing voltage of a lead acid battery.

Based on price alone, trickle chargers often appear to be a better economic choice for the typical consumer, but trickle chargers do not have the advantage of sophisticated electronic control. Therefore, as they allow the value of charge current to trickle down to what appears to be safe levels, the output voltage of the charger may very well rise to an unacceptably high level, sometimes even going higher than 16 VDC depending on the charger type and the battery that is connected to it. This magnitude of voltage is far above the gassing voltage of a lead acid battery. If the battery remains connected to this high level of voltage for an extended period of time, extreme damage may be done to the battery. Without Battery Tender® type electronic safety controls, what appears to be an initial cost savings for the charger may actually cost several times the charger price in replacement batteries.

HOW IS THE BATTERY TENDER® JR. BATTERY CHARGER DIFFERENT FROM A TRICKLE CHARGER?

The Battery Tender® Junior (BTJR) battery charger has microprocessor controlled power electronic circuitry which enables it to preform and safely control a number of sophisticated charging functions, well beyond the capability of inexpensive trickle chargers. Some legacy marketing literature refers to the BTJR as a “Trickle Charger with a Brain”. That description was based in context on two parts, first the relatively low output current, and second, the reduced level of charge control sophistication on earlier BTJR models relative to the BT Plus. Since mid-2006 the only major functional difference between the BTJR and the BT Plus is the maximum amplitude of the charger current, 0.75 and 1.25 amperes, respectively. Even though the marketing description may still be applicable, again, in a limited context, we can say now that the BTJR has a larger brain that enables it to create maximum charge effectiveness with minimal output current amplitude.

After connecting the BTJR to a battery and then applying AC power, it first conducts a number of checks during Initialization Mode to ensure that the battery functioning normally. Then it will deliver its full charge at a constant rate of 0.75 amperes. This is called the Bulk Charge Mode. The battery voltage will rise and when it reaches a predetermined level the BTJR will hold the battery charge voltage constant at that level, allowing the charge current amplitude to drop. This is the Absorption Charge Mode. The Absorption Charge Mode is complete when the battery charge current drops below a very low value, usually below 1/8 ampere. Some BTJR models have timers to limit the duration of the Absorption Charge Mode.

After the current drops or the allotted time expires (typically several hours), the BTJR automatically switches to a Float / Maintenance Charge Mode. The purpose of the Float / Maintenance Charge Mode is to maintain the battery voltage just slightly (typically between 1/10 and ½ volt) above where it would be if it were fully charged and sitting at rest. This keeps the battery topped off at voltages well below the gassing voltage of a lead acid battery.

Based on price alone, trickle chargers often appear to be a better economic choice for the typical consumer, but trickle chargers do not have the advantage of sophisticated electronic control. Therefore, as they allow the value of charge current to trickle down to what appears to be safe levels, the output voltage of the charger may very well rise to an unacceptably high level, sometimes even going higher than 16 VDC depending on the charger type and the battery that

is connected to it. This magnitude of voltage is far above the gassing voltage of a lead acid battery. If the battery remains connected to this high level of voltage for an extended period of time, extreme damage may be done to the battery. Without Battery Tender® type electronic safety controls, what appears to be an initial cost savings for the charger may actually cost several times the charger price in replacement batteries.

HOW ARE THE BATTERYTENDER® PLUS AND JUNIOR BATTERY CHARGERS DIFFERENT FROM OTHER AUTOMATIC BATTERY CHARGERS?

Many automatic battery chargers simply turn off when the battery voltage rises to a preset level or when the charge current falls below a certain level. With the battery sitting idle, its internal losses will consume much of its stored charge. Depending upon the age and condition of the battery, it may only take a couple of months before the battery loses more than 90% of its charge. The amount of charge lost tracks pretty well with the reduction in battery terminal voltage.

Some automatic chargers will restart when they sense that the battery voltage is too low. As a battery goes through these types of cycles of repeated charging and idle self-discharge to low capacity levels, the useful battery life may be dramatically reduced.

Both the BatteryTender® Plus & Junior battery chargers do not turn off after they charge the battery. They automatically switch to a safe float voltage level that keeps the battery charged and yet does not do any harm to the battery. In fact, in most cases, this type of charge maintenance will extend the battery's useful life by at least 50%.

Some customers have reported battery life increases of more than double what they had before using the Battery Tender® Plus or Battery Tender® Junior battery chargers.

IS THE BATTERY TENDER® PLUS BATTERY CHARGER MORE EXPENSIVE THAN A TRICKLE CHARGER?

In simple terms, comparing only the "off-the-shelf", retail price dollars, probably yes. However, in terms of the total cost of ownership, including the likely dramatic reduction in battery life resulting from using a trickle charger, then the answer is ABSOLUTELY NO. The Battery Tender® Plus will more than make up the difference in price by extending the useful life of only one engine start battery. Multiply this savings over the 10 year Deltran warranty period and you will save enough in battery cost to more than pay for the Battery Tender® Plus battery charger.

IS THE BATTERY TENDER® JR. BATTERY CHARGER MORE EXPENSIVE THAN A TRICKLE CHARGER?

There is a good chance that the Battery Tender® Jr (BTJR). will cost no more or maybe even less than some trickle chargers presently on the market. Even if the Battery Tender® Jr. does cost more, it will not be much more. With the performance improvements designed into the BTJR since 2006, the total cost of ownership should be much less. The BTJR is now essentially a lower power version of the Battery Tender® Plus. Considering that you will avoid the likely dramatic reduction in battery life resulting from using a trickle charger, the BTJR will more than make up the difference in price by extending the useful life of only one engine start battery. The Battery Tender® Jr. comes with a 5 year limited warranty.

HOW LONG CAN I LEAVE THE BATTERY TENDER® PLUS BATTERY CHARGER CONNECTED TO A BATTERY?

In theory, you can leave the Battery Tender® Plus battery charger connected to a battery forever. That's a really long time. Sales people like to say, "Just plug it in and forget about it!" However, practically speaking, it is a good idea to check on the battery at least once every couple of weeks. Strange things can happen. Sometimes a battery can have a weak cell that won't show up until the worst possible time. Of course, that time is usually when the battery is connected to a charger, and you are out of town on vacation.

If something goes wrong, then you have to deal with the question of the chicken and the egg. Which came first? Did the battery fail because it was connected to the charger or did the charger fail because it was connected to the battery? Good luck sorting that one out.

With a battery and a charger connected together, it's a much better idea to be proactive and anticipate problems, however unlikely they may be. In more than 99.9% of cases, nothing will go wrong. That still leaves about 0.1% where something might. Learn to respect electricity. A little common sense can go a long way.

Also consider this. No matter how good a product is, anything can break. In fact, everything will break, eventually. There are only 2 questions to be answered. 1) When will it fail? & more importantly 2) How will it fail? If a product is designed and built well, a manufacturer will set a long warranty period, usually several years, to support that notion. Deltran, and other responsible manufacturers, invest a tremendous amount of time, effort, and money to ensure that their products will fail in a relatively safe manner. For electronic products, at the very least that means no electrical shock or fire hazard.

The Battery Tender® Plus battery charger has a 10 year limited warranty, which is unprecedented among battery charger manufacturers. And it is listed with Underwriter's Laboratories to comply with both US and Canadian electrical product safety standards for battery chargers used with engine start batteries.

HOW CAN THE BATTERY TENDER PLUS BATTERY CHARGER THAT IS RATED AT 1.25 AMPERES RECHARGE A BATTERY AS FAST AS ANOTHER CHARGER THAT IS RATED AT 3 AMPERES?

SHORT ANSWER:

Deltran's claim that the 1.25 amp Battery Tender Plus battery charger will charge a battery in the same amount of time as a typical 3 amp charger is based on the fact that the Battery Tender Plus charge current is very nearly constant during the bulk charge period, while a typical 3 amp charger, configured like so many chargers on the market, is not.

DETAILED ANSWER:

You would think that a 3 amp charger would recharge a battery roughly 3 times faster (actually only 2.4 times faster) than a 1.25 amp charger. There are 2 main reasons why this is not true.

First, the way a battery reacts to charge current is complex. The simplest approximate calculations for recharge time only work for about the first 75 or 80% of the charge and only if the charge current is nearly constant. Returning the last 20 to 25% of the charge to the battery is also a complex and time consuming process. It may very well take as long to return the last 20% of the battery charge as it took to return the first 80%.

Second, and just as important, is the way that battery charger manufacturers rate the output current of their charger products. Let's say that the 3 amp rating is based on a peak current value during the initial charge phase and the 1.25 amp rating is nearly constant for entire time that it takes to return 80% of the battery charge. Let's also say that the 3 amp current only exists long enough to return 10% of the battery charge and then it tapers down to 1 amp for the next 70%.

The dimensions or units describing electrical charge are the Coulomb or, more conveniently in the context of battery charging, the Amp-Hour. The abbreviation for amp hour is Ah.

A battery charger delivers charge (amp-hours) to the battery by using an electrical current (Amps) at its output over a period of time (Hours). The numerical product of the electrical current and time period is the amount of charge delivered. This is true in a general sense for any charger.

Now let's do some math. For a 100 Ah battery, 10% = 10 Ah, 70% = 70 Ah, and 80% = 80 Ah.

10 Ah / 3 A = 3.3 Hours, 70 Ah / 1 A = 70 Hours, So this particular 3 amp charger takes 73.3 hours to return 80% of the charge to a 100 Ah battery that was fully discharged.

80 Ah / 1.25 A = 64 Hours, so a nearly constant 1.25 amp charger (that would be the Battery Tender® Plus) takes only 64 hours to return 80% of the charge to a 100 Ah battery that was fully discharged.

Marketing and sales people like big performance numbers because they believe that those numbers enhance the perception of value. The truth is that the best value for a battery charger should be based on the total cost of ownership for both the charger and the batteries that it is charging and maintaining. If a charger has a smaller output current rating, but recharges the battery in less time, and if it maintains the batteries in a full state of charge by employing a float / maintenance function those are both good things help to make the batteries last longer. Of course, the Battery Tender® Plus does both of those things very well.

CAN I LEAVE THE BATTERY TENDER PLUS® BATTERY CHARGER CONNECTED TO A BATTERY WHILE I'M USING THE BATTERY TO POWER ANOTHER APPLIANCE LIKE A RADIO?

Actually, this is basically the same situation that exists by default on many of today's complex, computer controlled vehicles that have a wide range of on-board electronic devices, many of which consume electric power even when the vehicle is not running. So the short answer is 'Yes, you can leave the Battery Tender® Plus (BT Plus) battery charger connected to a battery even when it is being used to provide power to another appliance. However, this is definitely not a simple yes or no type of question. There are definitely some things to consider that may limit this type of usage.

Think about how consumer electronic products are used and consequently, how they are designed. To keep the price low and competitive, it is important to limit the battery charger applications to a realistic, manageable portion from the vast number of ways in which a battery charger may be used.

The simplest applications involve charging and maintaining vehicle engine start batteries. The advantage in this application is that there is almost always another, larger source of electric power to charge the battery while the vehicle is running. So the off-line engine start battery charger need not normally supply the full amount of charge stored by the battery. One common exception would be when the vehicle battery is drained because lights were left on.

The point is that the engine start battery charger is not normally expected to deliver its maximum charge current for extremely long, extended periods of time.

IS THERE ANY DANGER THAT THE BATTERY TENDER® PLUS BATTERY CHARGER CAN CAUSE ANY DAMAGE TO OTHER AUTOMOTIVE ELECTRONIC SYSTEMS WHILE IT IS CONNECTED TO THE BATTERY IN MY AUTOMOBILE?

No. As long as the automotive electronics system is functioning properly, there should be no problem. Typical automotive electronic systems run on the alternator output of approximately 14 to 15 volts. The maximum charge voltage output of the Battery Tender® Plus battery charger is in the same range and less than 15 volts. For the majority of the time, the Battery Tender® Plus will be operating in float / maintenance mode so the maximum voltage output will be less than 14 volts.

HOW IS THE BATTERY TENDER PLUS BATTERY CHARGER DIFFERENT FROM THE BATTERY TENDER BATTERY CHARGER?

OVERVIEW and COMPARISON: The Battery Tender and Battery Tender Plus battery chargers are both designed to provide a quick, economical means to recharge motorcycle and engine start batteries used in other power sports equipment. Typically, power sports engine start batteries are in the 12 Ah to 20 Ah capacity ranges. Both chargers are constant voltage type with precisely regulated output current limits. Both chargers have a regulated, nearly constant 1.25-ampere output charge current during the bulk charge phase. Physically, there is virtually no difference between these 2 chargers. Both the Battery Tender and the Battery Tender Plus operate in 3 charge modes, bulk charge, absorption charge, and float charge.

Both the Battery Tender® and the Battery Tender® Plus are 4-step chargers meaning that they operate in 4 charge distinct modes: initialization, bulk charge, absorption charge, and float / maintenance charge. The legacy marketing literature and the operating instructions do not identify the original Battery Tender® as having an initialization mode. Therefore there is a lot of old literature that refers to Battery Tender® chargers as 3-step chargers. However the basic initialization functionality was present but there was no LED status indication; the Battery Tender® simply would not allow output voltage to activate unless a battery was properly connected to the charger. The Battery Tender® Plus does have an LED indication to indicate a faulty battery connection, which, with a little extra software and battery checks, completes the mechanization of ‘initialization’, the 4th charging step, even though time sequentially it is actually the 1st step.

RECHARGING AGM BATTERIES: The Battery Tender® has an absorption charge mode, but the the Battery Tender® Plus has a different absorption mode maximum charge voltage and a timer to hold the absorption voltage longer. These specific changes were made to accommodate the charging requirements of Absorbed Glass Mat (AGM) style lead acid batteries.

CAN THE BATTERY TENDER® PLUS BATTERY CHARGER BE USED TO CHARGE MORE THAN 1 BATTERY SIMULTANEOUSLY IF THE BATTERIES ARE CONNECTED IN PARALLEL?

Yes, but with restrictions. A parallel connection means that positive posts of each battery are electrically connected together and the negative posts of each battery are electrically connected together. The voltage of a parallel connected battery pack is exactly the same as the voltage of each battery in that pack.

If the nominal battery voltages (i.e. 12V, 8V, 6V) are the same on each battery, and if the batteries are the same lead

acid type (flooded, AGM, or Gel Cell), then yes, the Battery Tender® Plus battery charger can be used to charge more than 1 battery simultaneously when those batteries are connected in parallel. Just remember that 2 batteries in parallel behave like one large battery. The charge storage capacity of each battery simply adds together. Two 12 volt batteries, each with 25 amp hour capacities, will look like one 12 volt battery with a 50 amp hour capacity. You may be able to charge more than 1 battery simultaneously, but it will take longer to do it.

CAN THE BATTERY TENDER PLUS BATTERY CHARGER BE USED TO CHARGE MORE THAN 1 BATTERY SIMULTANEOUSLY IF THE BATTERIES ARE CONNECTED IN SERIES?

Yes, but series connections have more restrictions than parallel connections. A series connection means that positive post of one battery is electrically connected to the negative post of the next battery, and the positive post of that battery is connected to the negative of the next battery and when all the connections are made, the positive post of the last battery and the negative post of the first battery becomes the connection point for the entire battery pack. The voltage of a series connected battery pack is sum of the voltage of each battery in that pack. So if two 6 volt batteries are connected in series, then the voltage of the battery pack is 12 volts.

There are more restrictions on charging battery packs connected in series than there are for parallel connected battery packs. The nominal battery voltages (i.e. 12V, 8V, 6V, 4V, 2V) must be the same on each battery, and the batteries must be the same lead acid type (flooded, AGM, or Gel Cell). Also the batteries must be close to the same size in terms of amp hour capacity, and they must be close to the same level of discharge. It is also a good idea that the batteries be approximately the same age and that they be in relatively the same general condition.

If all 4 of these conditions are met, and if the total voltage of the pack is 12 volts (or 8 volts, or 6 volts depending upon the BT Plus model), then yes, the Battery Tender® Plus battery charger can be used to charge more than 1 battery simultaneously when those batteries are connected in series. This will not work if the total battery voltage is greater than the voltage of the Battery Tender® Plus (12V, 8V, or 6V).

CAN I CHARGE BATTERIES WITH DIFFERENT VOLTAGES ON A SINGLE CHARGER, EITHER A 12-VOLT OR A 6-VOLT CHARGER?

One of the answers to this question is a special case of the general question asked earlier about charging more than one battery at a time. That specific answer is that if the total nominal battery voltages of all of the batteries connected in series equals the nominal voltage output of the battery charger then you can use a single charger. For example, two 6-volt batteries connected in series can be recharged with a single 12-volt charger. Of course, all of the previous restrictions about charging batteries connected in series apply to this case.

To this question answer more directly for single batteries, NEVER use a charger on a single battery unless the nominal output voltage of the charger matches the nominal battery voltage. For example, only use a 12-volt charger with a 12-volt battery. Do not use a 12-volt charger on a 6-volt battery or a 6-volt charger on a 12-volt battery. If the nominal charger voltage is larger than the nominal battery voltage, then the situation can become dangerous.

The reason that this situation is dangerous is because the battery cannot develop a voltage high enough to allow the charger to complete the different phases of its charge cycle. That means that the charger will be “stuck” in the bulk charge mode, continually delivering electrical current to the battery for as long as AC power is applied to the charger, or until the charger safety mechanisms engage. In this case, the only type of safety mechanism that would work properly would be one designed to sense a battery voltage increase over a specific period of time. Even then, depending on the specific design parameters, that type of charger safety mechanism may not be sufficient to prevent serious damage to the battery or even a potential fire hazard, or even worse, a risk of explosion.

If the nominal charger voltage is smaller than the nominal battery voltage, then one of two things will happen: nothing, or the battery will be discharged.
The reason that nothing may happen is that many chargers are protected from reverse current. Usually a semiconductor-switching device called a diode provides this protection. A diode only allows electrical current (charge) to flow in one direction. For a battery charger that direction is out of the charger and into the battery. If a 6-volt charger is connected to a 12-volt battery, the 12 volt battery will try to deliver current to the 6 volt charger because electrical charge always moves in the direction from the higher voltage to the lower one. If the charger is protected from reverse current, then no current will flow, and nothing will happen.Of course, the battery will not be recharged, and if it is deeply discharged, then remaining in that condition may result in permanent damage to the battery. If the charger is not protected from reverse current, then the battery will be discharged. Likewise in this case, the battery may be damaged severely from being over discharged.

WHAT HAPPENS IF THE AC POWER IS REMOVED FROM THE BATTERY TENDER PLUS BATTERY CHARGER WHILE IT IS CONNECTED TO A FULLY CHARGED BATTERY?

If the battery is fully charged, then the Battery Tender Plus battery charger's green light will be on. Once the AC power is removed from the Battery Tender Plus battery charger, the green light will go out and the charger not have any effect on the battery. The Battery Tender Plus battery charger is protected from reverse current, so it will not discharge the battery. Of course, like we said earlier when discussing nominal voltage mismatches between a battery and a charger, the battery will not be recharged either.

When AC power is restored to the Battery Tender Plus battery charger, it will restart its charge cycle. The sequence of events should go something like this. The red light will come on for a few minutes. Then the green light will start flashing while the red light stays on. The next thing that happens is what may confuse some people who use the Battery Tender Plus battery charger. Remember, the battery was fully charged, so you may ask, "Why doesn't the green light just come right back on?"

The reason that the green light doesn't come on immediately is that when the charger first comes on, the battery is sitting there, fully charged, at a voltage of about 12.9 volts. The charger immediately tries to bring the battery voltage up to about 14.5 volts. This takes a finite amount of time, although it should only be a few minutes if the battery is fully charged. Then, when the battery reaches 14.5 volts, the charger will hold it there until one of two things happen. Either the battery charge current will drop to less than 0.1 amp (from an initial value of 1.25 amps) or, if the current does not drop below 0.1 amp, then the charger will hold the battery voltage at 14.5 volts for 6 to 8 hours.

There are a couple of reasons why the battery current may not drop below 0.1 amp. First, on a larger battery, like an automotive SLI battery, the internal losses of the battery may consume more than 0.1 amp. Second, if the vehicle or the system that the battery is connected to has appliances that consume electricity, then that consumption of electricity, coupled with the battery internal losses may very likely exceed the 0.1 amp limit. This second cause is very common and its result is that the Battery Tender Plus battery charger's timer circuits will be fully engaged. So it will take 6 to 8 hours for the green light to come on. Fortunately, the Battery Tender Plus has the ability to continue to supply its full current even after it has switched over to the lower, float, maintenance charge voltage of 13.2 volts. When the charger turns the green light back on, it also drops its output voltage to this float, maintenance charge level of 13.2 volts.

Note: It only takes a momentary AC power outage to cause the Battery Tender Plus battery charger to reset.

WHAT IS TEMPERATURE COMPENSATION AND HOW IMPORTANT IS IT?

While a battery is being charged, it is important that the charger absorption and float, maintenance voltages closely match the recommendations of the battery manufacturer. The absorption voltage match is important for quick charging. The float, maintenance voltage match is important for long term, storage charging.

Batteries are sensitive to temperature. Recall the number of TV ads showing how tough a battery is when it can start a vehicle in sub-zero temperatures. Cold temperatures tend to reduce a battery's ability to deliver current to a load. High temperatures not only increase a battery's ability to deliver current to a load, but also increase a battery's internal losses. Temperature compensation is a way to change a charger's output voltage to maintain optimum compatibility with the battery's charging requirements. The way it works is that the charger senses the ambient temperature. Then it increases the charge voltage when it is cold and decreases the charge voltage when it is hot. Typical values for temperature compensation for a lead acid battery are minus 0.0025 to minus 0.004 volts per degree Centigrade per 2-volt cell. For a 12-volt battery, that would be minus 0.015 volts to minus 0.024 volts per °C. The reference temperature requiring zero charge voltage compensation is 25 °C or 77 °F.

How important is temperature compensation? Like with most everything else about batteries, it depends on the application. For industrial, critical load, standby power applications, where the batteries may be connected to a live charger for a number of years, then temperature compensation can have a significant influence on battery life. In many consumer applications like SLI, deep cycle marine, etc., temperature compensation will increase long-term battery performance, but it is probably not essential in all applications. Where it is most beneficial is in helping to minimize the negative impact of a battery's self-discharge characteristics in high temperature environments. Deltran Battery Tender Plus Battery Chargers Overcome the Negative Impact of High Temperature on Battery Performance.

The self-discharge rate of a battery is directly dependent upon the ambient temperature of the battery environment. At higher temperatures, the chemical reaction rates that determine self-discharge will also increase.

When a battery sits idle, its self-discharge characteristics will reduce its ability to deliver power on its next use. If the battery either sits long enough, or if the ambient temperature rises high enough, then the battery may become fully discharged. In fact, it is possible for the battery to be over-discharged to the point where it cannot be recovered.
The Deltran Battery Tender Plus battery chargers overcome the negative impact of higher ambient temperature and battery self-discharge in two ways. First, the Deltran Battery Tender Plus battery charger applies a safe, float, maintenance voltage level to the battery to overcome its internal losses and counteract the self-discharge phenomena. Second, the Battery Tender Plus battery charger automatically compensates the amplitude of its charge voltages for changes in ambient temperature. It reduces the amplitude of the float, maintenance voltage as the ambient temperature increases and it increases the amplitude of the charge voltages in colder temperatures. In mathematical terms, this type of compensation scheme is called a "Negative Temperature Coefficient".

The temperature compensation ratio employed by the Deltran Battery Tender Plus battery chargers is approximately minus 3.67 millivolts per battery cell per degree Centigrade of temperature rise above 25 °C. Stated another way, the output voltage of the Deltran Battery Tender Plus battery charger will drop 0.022 volts, or 22 millivolts, for every degree Centigrade temperature rise, when it is connected to a 12-volt battery.
In the event that the temperature would rise enough so that the Deltran Battery Tender Plus battery charger voltage output drops below the what would be considered a normal operating voltage for a 12 volt battery, then the Deltran Battery Tender Plus battery charger automatically disconnects itself from the battery via an internal solid state mechanism, affording an extra measure of safety in a very high temperature environment.

CAN THE BATTERY TENDER PLUS SUCCESSFULLY PERFORM THE INITIAL CHARGE ON A NEW, FLOODED, MOTORCYCLE BATTERY?

Background: The motorcycle dealers receive batteries from the manufacturer in a dry state. The plates are dried out,

and there is no acid in the cell compartments. (Do not confuse this with a dry-cell battery.) The dealer must fill the individual battery cells with acid and then put them on a shop charger to pre-charge prior to selling them to a customer. As the batteries arrive from the manufacturer, the plates are approximately 80% "formed". The initial pre-charge, post-formation charge, or more correctly, formation-finishing charge, must be conducted at a specific power level and for a specific time period. Each manufacturer has its own recommendations, for example one manufacturer recommends that the charger deliver a constant current equal to 10% to 15% of the battery amp-hour capacity and that the charge current be applied to the battery for a period of 5 to 10 hours.

Answer 1) Certainly if the dealer has properly pre-charged the battery after filling it with acid, then the answer is ABSOLUTELY YES.

Answer 2) If the dealer has not properly pre-charged the
newly filled battery prior to the sale, then the answer is YES, WITH SOME QUALIFICATIONS:

Qualification A) The Battery Tender® Plus should be left on the new battery for a minimum of 24 hours on float, in addition to whatever amount of time it takes for the charger to get to the float stage. It is not clear how to correlate the 80% formed plates with a given state of charge once the cells are filled with acid. To be safe, assume that the batteries require a full 100% charge after the cells are filled.

For example, a 16 Ah battery will take about 13 hours to get to the absorption voltage (constant 14.4 Volts). It may take another 6 to 8 hours to reach the float voltage (constant 13.2 Volts). This may sound awkward; because what happens is that the battery charge current drops while the absorption voltage is held constant. When the battery current drops to 0.1 amp, or if 6 to hours have elapsed at the absorption voltage, the charger automatically switches its output from 14.4 V to 13.2 V. So it may take the better part of 20 hours to reach the float stage. Add another 24 hours to that and you are at 44 hours. Throw in another 4 hours for good measure and you get a nice round, even 48 hours, or 2 days.

Qualification B) Although there are probably several charging methods that will be equally effective, regardless of who manufactures the battery, in the interests of technical consistency, they will not officially sanction any initial charging method other than those published in their technical applications literature.

WHAT IS THE EXPECTED LIFE OF A H-D BATTERY?

Proper care is the key to battery longevity. Laboratory tests have shown that consistent use of any Deltran Battery Tender can add as much as three to four times normal battery life (five to seven years is not unusual). What the lab tests can not prove is how vigilant one is about battery maintenance (if watering is required) and how much shake, rattle, heat, and cold the battery has been subjected.

If it were me, and I had five years of good service out of my battery, I would be hunting for a new one. What would I replace it with? Our theory is "if you have to fill it, forget it." In other words, stay with sealed maintenance free, most of the new maintenance free AGM (Absorbed Glass Mat) batteries like the new Harley original equipment batteries are excellent. They never require watering and they come from the Harley dealer fully charged.