CARE AND FEEDING OF A K2 BATTERY
By Bob Lewis (AA4PB)

The Power-Sonic PS-1229A Sealed Lead Acid (SLA) battery, commonly called a "gel cell" because of its gelled electrolyte, is supplied with the K2 internal battery kit. This battery, like all SLA batteries, requires a certain amount of care in order to obtain the maximum service life. With proper care, this battery should provide 4 or 5 years of dependable service life in back-up service or between 200 and 1000 charge/discharge cycles depending on the average depth of discharge. In most cases, failure to properly maintain the battery does not result in sudden death, but rather a gradual deterioration of its ability to hold a full charge and a shortened service life.

A New Battery

Power-Sonic recommends that a new battery be left on a continuous float charge for several months in order to bring it to its full rated capacity. Alternately the battery can be cycled several times by discharging it and then recharging with an automatic charger.

Deep Discharge

The K2 battery should never be permitted to discharge below 10.5 volts. How much damage is done depends upon how low you permit the voltage to go and how often you permit it to happen. Discharging below this level also runs the risk of reverse charging and damaging a weaker cell. Once the battery voltage reaches 11.5 volts the voltage begins to drop very rapidly and must be watched closely.

Under Charging

With the K2's internal float charge circuit, you do not need to be concerned with overcharging the battery. It is however quite possible to shorten the service life by continuous under charge. When the charge voltage is too low, the charging current will essentially stop before the battery is brought to a full charge. This results in the electrodes building up a deposit of lead sulfate that gradually reduces the capacity and shortens the service life. A proper float charge voltage for the K2 battery is 13.7 to 13.8 volts in normal room temperatures. Because there is a reverse polarity diode in the K2 power line, this added 0.4 volt drop requires that 14.1 to 14.2 volts be applied to the K2 in order to provide an adequate float charge to the battery. When operating the K2 from a lower voltage such as a 13.8 volt power supply, the battery switch on the rear panel should be turned off in order to disconnect the battery.

The K2 battery should not be left in a discharged condition. SLA batteries experience a "self-discharge" when not in use. Power-Sonic recommends that unused batteries be charged every 6 to 9 months in order to avoid a reduction in capacity resulting from lead sulfate deposits.

Automatic Chargers

Under no circumstances should an automatic charger or a solar charge controller be connected to the normal power input connector of the K2. These chargers depend upon being connected directly across the battery in order to provide the proper charge. The K2's reverse polarity diode and 6.2 ohm charging resistor will cause a voltage drop between the charger and the battery that will result in improper charging. There is also a potential for the charger to apply excessive voltage and damage the K2.

In order to avoid the above limitations, some K2 users have added a charging connector to the rear panel. The 6.2 ohm charging resistor is removed (the diode is left in place) and the battery is wired via an additional 3-amp poly fuse directly to the connector. The poly fuse protects the battery and wiring in case of a short between the pins of the charging connector. The charging connector now provides direct battery access for an automatic charger or solar charge controller.

Over Charging

With the addition of a direct battery connection in lieu of the original K2 circuit, we now have the potential for over charging the battery. There are two basic categories of over charging, high rate over charge and low rate over charge.

An example of high rate over charging would be connecting a solar panel rated for several amps to the charging connector without a regulator or controller of some type. The maximum charge rate for the K2 battery is 560 mA. Some type of circuit must be used to limit this current because a discharged battery will draw considerably more if it is permitted to do so. This type of high rate over charging causes the battery to heat up which causes it to draw more current which causes it to heat up even more. This thermal runaway condition can render a battery useless in a matter of hours. It also has the potential for cracking the plastic housing and leaking corrosive electrolyte inside the K2 (a really ugly death for a K2).

Small solar charge controllers generally do not provide any type of current limiting. The solar panel size should be selected so that the panel is not capable of supplying more than the 560 mA that the K2 battery can handle. AC powered automatic chargers often do have a built in current limiter. A charger should be selected that provides as much current as possible without exceeding the 560 mA maximum.

A second example of high rate over charging would be connecting a solar panel of the proper current rating to the charging connector without a regulator or controller of some type and letting the battery voltage climb to the solar panel's maximum output of 16 or 17 volts. While most solar charge controllers depend on the solar panel itself for current limiting, they do limit the maximum voltage to about 14.5 volts.

Low rate over charging is a case where the battery voltage is brought to 14.5 volts or so and left there after the battery has obtained a full charge. Low rate over charging does not cause excessive heat and thermal runaway but it does cause the generation of oxygen and hydrogen gasses at a rate greater than they can be recombined back into water for the electrolyte. This causes excessive pressure inside the battery. Plastic cased batteries such as the PS-1229A used in the K2 have a pressure release valve which opens at a couple of PSI in order to release the excess gasses into the atmosphere (hydrogen and oxygen are not corrosive and should not damage the K2). This results in a gradual drying of the electrolyte and a shortened service life for the battery.

Automatic 3-State Charger Caution

Many automatic chargers are 3-state or 3-mode devices which sense current drain to determine when the battery has received a full charge. They will not work reliably with a battery that is under load because they have no way of telling how much of the current is going to the battery and how much is going to the load. The small Power–Sonic series of charges are of this type. The charger applies a voltage source to the discharged battery and limits the maximum current to 500 mA. This is called the "bulk" mode. As the battery charges, its voltage begins to rise. When the battery voltage reaches about 14.5 volts, the charger then limits the voltage at that level. At this point the battery has received 80 to 90 percent of its full charge. This is called the "absorption" or "overcharge" mode. As the battery continues to charge at this constant voltage, the current begins to drop. When the current drops to 29 mA, the charger switches to the "float" mode and applies a constant 13.8 volts to the battery. The battery can be left on a float charge indefinitely.

Now for the problem. When a load in excess of 29 mA is placed across a fully charged battery (the K2 receiver for example) the charger sees this current and is tricked into thinking that the battery needs recharging. The charger switches to "overcharge" mode and applies a continuous 14.5 volts. This will result in low rate overcharging of the battery. Being in this condition for very long or very often will result in a shortened service life due to the loss of water in the electrolyte. Chargers using the UC3906 SLA charger IC use current to determine when to switch from overcharge to float but they switch from float to overcharge by sensing voltage rather than current. This means that they will not switch out of float mode until the battery has discharged to a particular voltage, usually about 12.4 volts. However, once they have come out of float mode they will not return until the load has been removed, regardless of the condition of the battery. The end result is the same; the charger eventually gets locked into an overcharge condition.

Of course if the load is always equal to or greater than the maximum charger current (500 mA in this case) then the battery will not be overcharged because all of the available current is going to the load. This is not the case for the K2 however because the receiver draws a maximum of about 220 mA. This leaves 280 mA available to overcharge the battery.

If you use one of these 3-mode chargers, it is wise to remove the charger when operating the K2.

Solar Charge Controllers

Most small solar charge controllers operate by sensing voltage rather than current. They automatically adjust to varying load conditions and are ideal for maintaining the K2 battery provided that you limit the maximum current to 560 mA. The Micro-M+ charge controller by Sunlight Energy Systems is interesting because it uses a series mode switch that runs cool at 500 mA and has no high frequency switching circuits that can generate RFI.