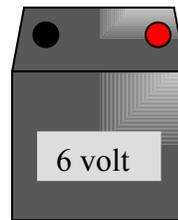


Adding Batteries To Your RV

A Discussion of Series / parallel battery arrangements

. The purpose of this article is to help you understand how to wire multiple batteries together properly in various series and parallel configurations, to supply your coaches electrical needs. We will not discuss the relative merits of 6-volt vs. 12-volt batteries, or flooded cell vs. AGMs here.

Years ago, life on the road was pretty simple, at least electrically speaking. Each car had one 6-volt battery that supplied all the power needed to start lights, and play the radio. The engine had a generator that battery through a voltage regulator, and all was well... you remembered to put water in the battery occasionally, regulator contacts didn't burn or pit, and the generator short out and leave you stranded on some desolate road the night. But that was then, and now we are faced with brought on by our ever-increasing need for more power. Today's motor coaches carry with them some of the most modern electrical and electronic devices made, and most all of them require power, sometimes huge amounts of it. So how do we feed these hungry beasts of the open road when their engines and generators have been caged for the night? With batteries!



Today, almost every automobile, truck, and recreational vehicle designed for our everyday use will come equipped with at least one twelve (12) volt battery, which is used to power the starter motor, interior and exterior lighting, radio, etc. This is not always the case, however. Some RVs may be equipped with 2, 4, or more (usually in multiples of two) six (6) volt batteries instead of one or more twelve (12) volt batteries. In order to supply your electrical power needs over a greater span of time between charges, the simplest way to do this is by adding more batteries to the existing system. To do so correctly, you need understand (1) how your existing battery system is designed; single or multiple batteries, battery type, voltage, how they're wired together, etc., and (2) how to add more batteries to it properly; what type of batteries to use, how many, their voltage, do I use a series or parallel wiring scheme or a combination of both, etc. We'll answer these questions and more, but first an explanation of the terms we use is in order. Bear with me if some of this sounds pretty basic. While some may not be exactly scientifically accurate, they're close enough for our purposes.

VOLT or VOLTAGE

A *VOLT* is the unit of measure of the **pressure** of electricity traveling through a wire. The wire is like a garden hose connected to a water source. Voltage is the same as the pressure of the water stream coming out the end when the spigot is turned on. The higher the pressure, the higher the force the water stream will exert on an object placed in front of it.

AMPERE or AMPERAGE

An *AMPERE* is the unit of measure of the **amount** of electricity flowing through a wire. Using our garden hose example above, it's the amount of water that will come out the end of the hose over a given period of time, say one second, at a given pressure (voltage). Let's say we have a hose of one inch in diameter, and another that is only one-quarter inch in diameter. It's pretty obvious that if both hoses were connected to the same pressure water source, the larger one will pass much more water (no pun intended) than the smaller one.

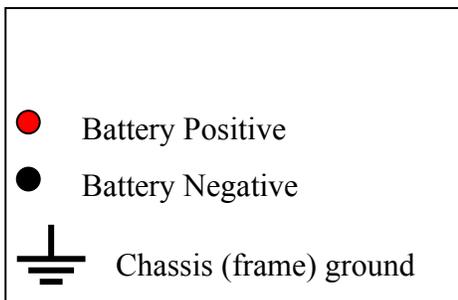
BATTERY

In the *BATTERY* typically found in cars and RVs, there are a number of individual **CELLS** connected in series, and mounted together in the same container, and serves as our water source used in the examples above. That is, it provides both pressure (volts) and amount (amperes). A *CELL* is composed of many individual (usually) rectangular shaped metal grids, half the number of them are covered with a paste of Lead (Pb), and the other half of them with Lead Oxide (PbO₂).

When these **plates**, as they're called, are submerged in a mixture of sulfuric acid and water, a chemical reaction occurs which causes the generation of electricity. For this type of battery, the individual cells will have a potential of about 2.1 volts when fully charged, so a 6 volt battery will contain three cells (3 times 2.1 volts = 6.3 volts) in the same container, and a 12 volt battery will contain six of them (6 times 2.1 volts = 12.6 volts). Voltage is rounded down for simplicity.

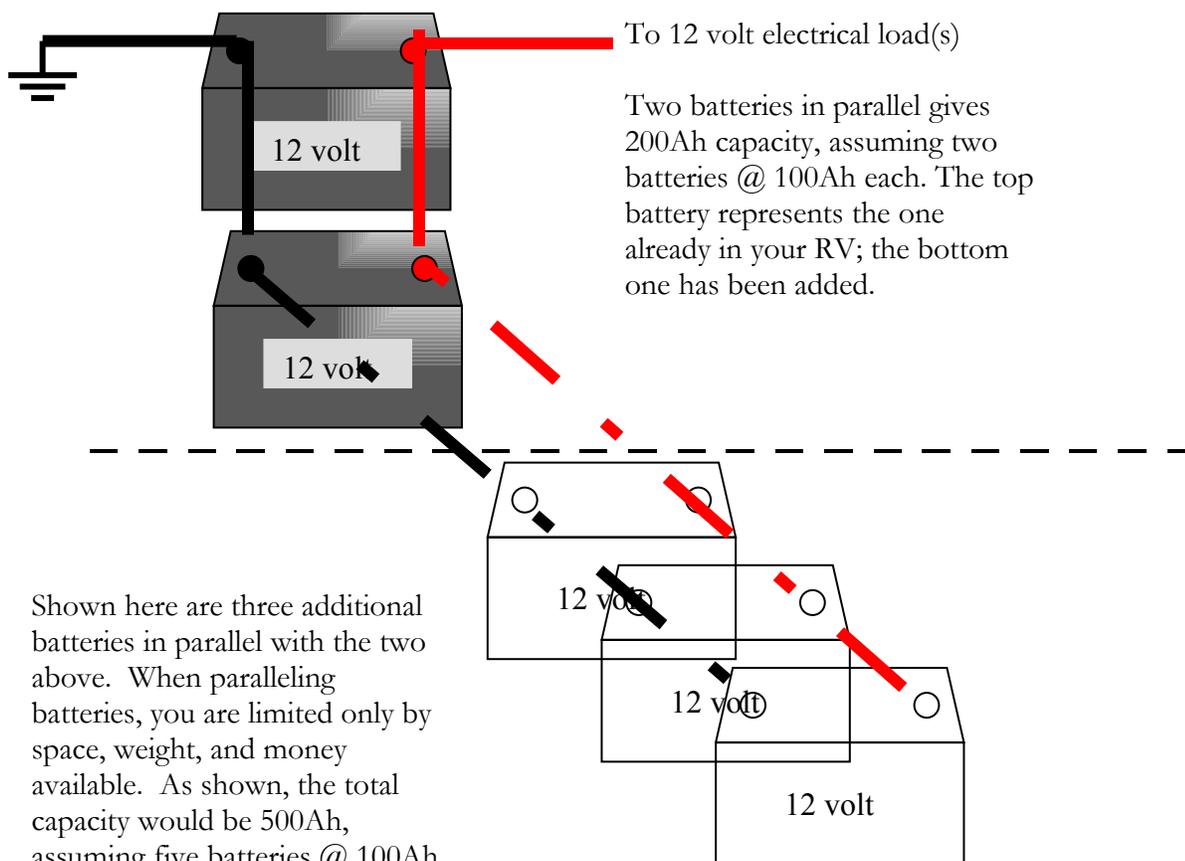
AMPERE HOUR (shortened to Ah)

Batteries are normally rated in both voltage and *AMPERE HOURS*. An *AMPERE HOUR* (Ah) is the unit of measurement of the **amount** of energy in a battery that will allow one *ampere* to flow for one *hour*. Using our water analogy, let's take an ordinary coffee cup and fill it with water. Now let's drill a small hole in the bottom to allow the water to drip out. If it takes one hour to empty the cup, we can say that the cup had a capacity of one *water-hour*. Batteries are the same as the cup, but their capacity is in ampere-hours rather than water-hours. We can then say that if you put a load of 1 ampere on a battery and it takes one hour for it to be drained (discharged), it has a capacity of one Ah. RV batteries are, of course, much larger and have a capacity ranging from about 60 to 200 or more Ah. The higher the number, the longer an electric light bulb, for example, will stay lit before the battery is discharged. In normal use, batteries hardly ever discharge completely, but the voltage drops to a point where it will no longer provide the necessary energy (pressure) to do any meaningful work. For a 12-volt battery, that will be at about 10.5 volts when it is considered 'dead'. Batteries should NOT be discharged to this level however, because it will shorten their life dramatically. A 'safe' discharge level is roughly 50-60% of full charge before recharging, but this is dependent on battery type, condition, temperature, and other factors. It's always best to check and follow the manufacturers recommendations.



Batteries In Parallel

To increase the total amperage available while maintaining the same voltage, you would place 2 or more batteries in parallel, as shown below. Simply connect all the negative battery terminals to each other, and all the positive battery terminals to each other.

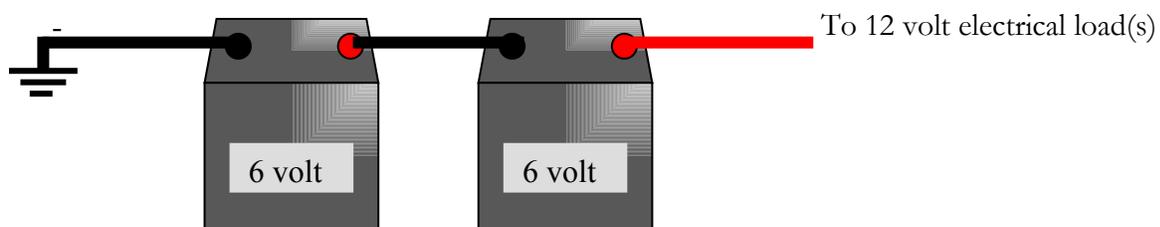


Shown here are three additional batteries in parallel with the two above. When paralleling batteries, you are limited only by space, weight, and money available. As shown, the total capacity would be 500Ah, assuming five batteries @ 100Ah each.

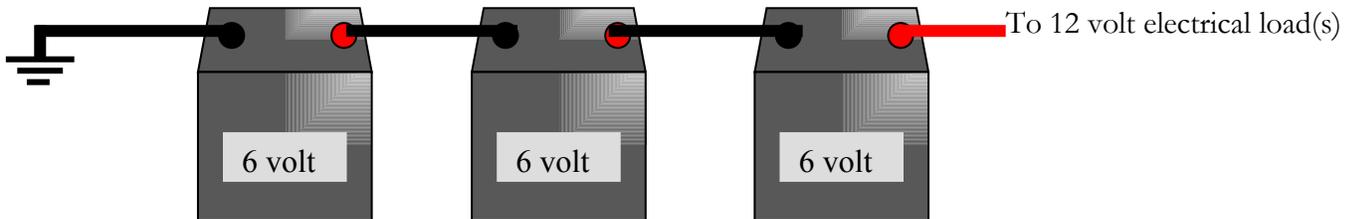
CAUTION! When wiring batteries together in parallel, certain rules MUST be followed. Never try to put a six (6) volt battery in parallel with a twelve (12) volt battery under any circumstances. The result can be both dangerous and very expensive. You also should never try to parallel different battery types, i.e. flooded cell batteries (lead/acid batteries with filler caps on top) and AGM (Absorbed Glass Mat) batteries, even though they may have the same voltage and ampere hour ratings. The reasons for these cautions will be explained later in this article, along with some other helpful hints and suggestions.

Batteries In Series

We mentioned earlier that some RVs might come equipped with two 6-volt batteries. Unless it is a very, very old RV (think 1940's), we can be pretty sure that they are wired in series to produce twelve volts. The positive (+) terminal of the left battery is connected to the negative (-) terminal of the one on the right. Again assuming each battery is capable of outputting 100 ampere-hours, you might think that the total capacity would be 200Ah, but that would not be correct. When batteries are wired in series, only the voltages of the individual batteries are added together ($6 + 6 = 12$ volts), not their capacity. The capacity remains at 100Ah.



So, how do we add more capacity?

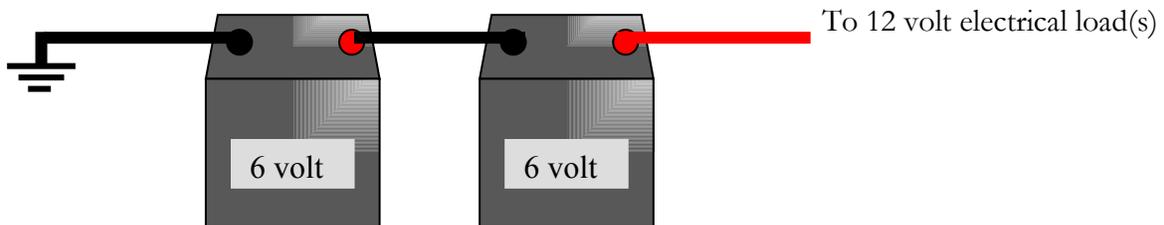


NOT LIKE THIS! Adding a third battery in series with the other two would give us the same 100Ah, but at **18 volts**, and 18 volts would burn out every 12-volt light bulb, motor, and battery operated appliance in your RV! Don't do it. What you need is not a series connection or a parallel connection, but a *combination of the two*, shown next.

Batteries In A Series / Parallel Combination

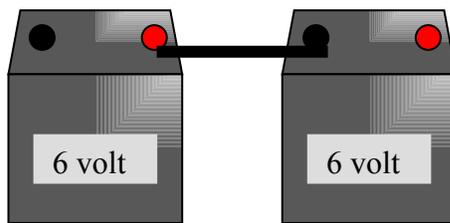
Many RVs come equipped with two 6 volt, deep-cycle batteries, similar or exactly like those commonly used in golf carts and other electric powered vehicles. Their relative merits and shortcomings are explained in detail elsewhere in our library. If you have them, they will be wired exactly as in our example of Batteries In Series, above. To increase your capacity, you simply add additional pairs of 6-volt batteries in series, to the existing batteries, but you hook this new **series** string of batteries in **parallel** to the existing ones. Sound complicated? It's not, really.

Let's look at an example. First are our existing two 6 volt batteries in series.

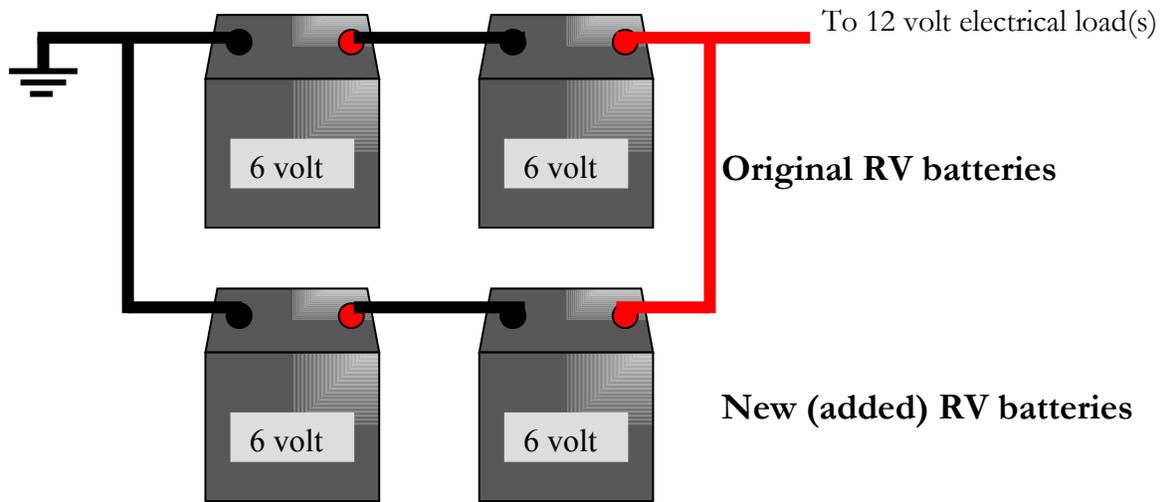


Look familiar? Good

Now let's hook up a second, new pair of 6 volt batteries.



As you can see, they too are in series (positive terminal of one battery to the negative terminal of the other), but they don't connect to anything yet. Let's do that now, just as we did when we hooked up two 12-volt batteries in parallel.



This is what we get. Because we added the two new batteries in parallel to the existing two batteries, we have doubled our Ah capacity from 100 to 200, yet kept the voltage at 12 volts. Pretty neat, isn't it?

You can easily add more pairs of batteries the very same way – wire them in series first, then wire the pair of them in parallel with the existing banks of batteries.

There is one final way to connect batteries together, but it is **NOT RECOMMENDED** for a permanent installation; as will be explained later. It is only mentioned here because some of you may have used this feature; perhaps without even realizing it. It's called the **EMERGENCY START** or **AUX. (Auxiliary) START** button found on the dashboard of some self-propelled RVs. Typically, they will have two separate batteries or sets of batteries. One for starting the engine and running the headlights, taillights, and accessories associated with driving the vehicle called the **CHASSIS BATTERY**, and a second for running all the twelve-volt lights and accessories inside the RV called the **HOUSE BATTERY**. Maybe you've left the parking lights on by mistake, and find you can't start your engine in the morning. Push the button, and that will energize a large electrical contactor that will place your house battery in parallel with the chassis battery, allowing you to start the motor. The switch and contactor don't really care which battery, chassis or house, is dead, so if you've

fallen asleep with the TV on or the furnace drained your house batteries, you can push that same button to start your generator (if you have one), to recharge your house batteries.

In the above example, we've not added any batteries; merely connected the house and chassis battery together briefly for a single purpose – to start the engine, or start the generator.

Some Does and Don'ts

DO mount batteries securely, preferably in a compartment away from heat, sources of ignition, other electronics (fumes can damage them), and with adequate ventilation.

DO mount them as close to the original batteries as possible, using the largest cable available to minimize voltage drop. Welding cable (size 0000) is ideal. Keep cables away from heat sources and sharp edges. Use rubber grommets, insulation, etc. where necessary.

DO make sure all connections are clean, tight, and corrosion free. Check often. Apply dielectric grease to prevent corrosion. WD-40 also works well, but must be re-applied occasionally.

DO check water levels frequently. If necessary, add distilled water ONLY - never regular tap water, and NEVER top off with more battery (sulfuric) acid. AGM's and other sealed batteries don't require topping off – never try to open one.

DO purchase new, name brand batteries. So-called bargain batteries are usually someone else's seconds, and aren't a bargain at all.

DO purchase a good battery charger capable of at least three charge levels – BULK; for quickly bringing up a battery from the 50-60% level to about 80%, ACCEPTANCE; a slower rate to take it from there to full or nearly full charge, and FLOAT; to maintain the battery at its' optimal charge state.

DON'T mix battery types. Flooded cell, AGM's, and gelled electrolyte batteries all have different charging requirements, and what works for one type may well damage another.

DON'T parallel wire additional batteries with existing ones if (1) they are not the same voltage rating (lots of sparks, overheated cables, possible battery explosion!), (2) the existing batteries are not in good to excellent condition (the old batteries can drain and reduce the efficiency of the new ones and shorted cells could damage them), and (3) they are not of the same or nearly the same ampere-hour rating. Similar Ah ratings, like 100 Ah and 120Ah mixes are probably o.k. That's because they will discharge at about the same rate, and will take a recharging at about the same rate. If the difference is too great (200Ah batteries

added to 100Ah batteries), the smaller battery will discharge below the recommended 50-60% level much quicker than the larger one. Similarly, the smaller battery will reach the 80-90% charge level sooner than the larger one. At this point, the charger should 'throttle back' to a lower rate, but won't because it believes the larger battery is still well below the 80-90% level, possibly resulting in damage to the smaller one due to overcharging and boiling away of the water/electrolyte.

DON'T wire the house batteries to the chassis battery. While it may *seem* like a logical thing to do, it's not. The chassis battery is most likely one with a very high Cold Cranking Amperes (CCA) rating, up to 1000 Amperes or more, designed to provide a lot of power in a short period of time. The house batteries on the other hand, are usually designed for low amperage loads over a long period of time, and are called Deep Cycle batteries. Besides the vast technical differences and charge/discharge characteristics, you could easily find yourself with ALL batteries drained with no way to start the engine or the generator!

DON'T waste your money on battery additives. Most are useless. Some will seem to rejuvenate a battery, but it's only temporary. Nothing will save a dead and/or dying battery that's been subjected to abuse, or has just outlived its' usefulness.

DON'T be tempted to buy "Marine/Deep Cycle" batteries for use as your house batteries. At best, they are a compromise between a starting battery and a deep cycle battery. While some do a fairly good job both, none can match the performance and longevity of a true deep cycle battery.

In summary, adding additional battery capacity is not terribly difficult, but a thorough knowledge of your existing battery system, understanding what is required to correctly install and wire your new batteries, and planning for it are essential. Hopefully, this article has removed some of the mystery surrounding batteries and their wiring; the rest is up to you.

More Power To You!