WHITE PAPER

Selecting and Installing a Battery Backup System for Your Sump Pump

Executive Summary

Your sump pump is your home's first line of defense against flooding, but what happens when the power goes out? Without battery backup during a power outage, your sump pump will stop working and your home will be placed at risk. You could buy a battery backup system from your plumber, but these proprietary systems are very expensive to purchase, install and maintain. For anyone with a little mechanical aptitude, a DIY system consisting of an inverter/charger and one or more batteries provides an outstanding sump pump backup system with lower initial costs, lower maintenance costs and greater flexibility than proprietary backup systems.

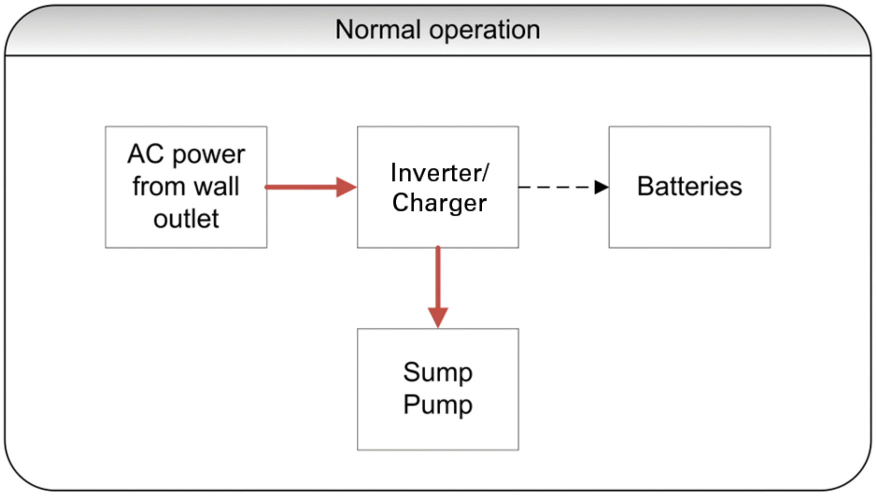
Contents

WARNING: Potentially lethal voltages exist within an inverter/charger as long as the battery supply and/or AC input are connected. Please consult the manuals that came with your inverter/charger and batteries for important safety information.

Battery Backup System Overview

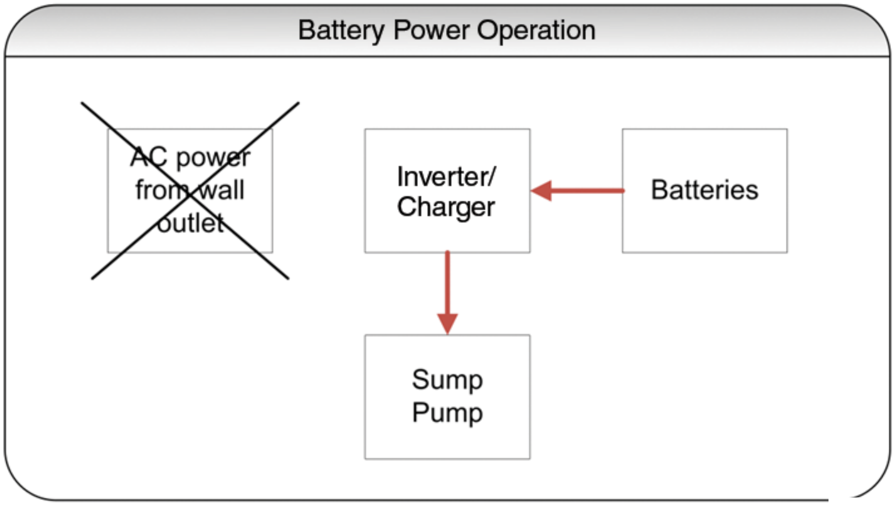
The basic setup

A battery backup system for a sump pump consists of two main components: an inverter/charger and one or more batteries. The inverter is responsible for converting the power stored in the batteries into a form that can be used by your sump pump. It is also responsible for keeping the batteries fully charged at all times. You plug the inverter/charger into your wall outlet and then plug your sump pump into the inverter/charger, like this:



Note the red arrows showing the flow of electricity. During normal operation, the inverter/charger just passes the electricity coming from your wall outlet straight through to the sump pump as though the sump pump was plugged directly into the outlet. While it is doing that, it will also automatically charge the batteries and keep them fully charged as long as it continues to receive power from the wall outlet.

When your power goes out, the system will automatically send power from the batteries to the sump pump, like this:



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Inverter/chargers vs. UPS systems

The inverter/charger is the heart of the system, and is responsible for three jobs:

1. Charging the batteries and keeping them fully charged at all times
2. Sensing when the power has gone out and automatically switching to battery power
3. Converting the power stored in your batteries from "direct current" (DC) into "alternating current" (AC), which runs your sump pump

This description of an inverter/charger sounds an awful lot like the description of an uninterruptible power supply (UPS), which might lead you to wonder, "Why can't I just install a UPS and be done with it?" Well, it basically boils down to the fact that a UPS is just not designed to do the job.

Although inverter/chargers and UPS systems work in very similar ways and perform similar functions, the battery in a UPS is not large enough to run a sump pump for any significant length of time. Most UPS systems are also not designed to provide enough power to start a sump pump. In addition, UPS systems have smaller battery chargers.

An inverter/charger also allows you more flexibility to decide how much power you need. You can think of it like buying stereo equipment: you can buy the "all in one" model, which is inexpensive and easy to assemble but offers less powerful sound (the UPS), or you can buy individual modular components, which gives you increased flexibility and more powerful sound (the inverter/charger). And if your needs change in the future, you can expand the system without starting over again.

The advantages of GFCI outlets

We recommend that you select an inverter/charger with GFCI outlets in this situation, such as Tripp Lite's "UT" family. GFCI outlets protect against electrical shocks near a water source.

What kind of batteries will I need?

An inverter/charger doesn't do anything unless you hook it up to a battery, which is sold separately. These aren't the kind of batteries you put in a flashlight. Instead, we're talking about 12-volt deep-cycle lead-acid batteries similar to the battery in your car. "Deep-cycle" means that they can be almost completely discharged without losing their ability to produce their specified output. Although they are similar to the battery in your car, the batteries that you use with an inverter/charger are not quite the same. Instead, they are the kind of batteries that you might use in a golf cart, boat or RV.

All deep-cycle batteries are rechargeable, so it's not like buying AA batteries where you have to choose between disposable and rechargeable. The main decision you have to make is whether to get sealed or unsealed. Sealed batteries are often called "maintenance-free" because you don't have to periodically top them off with distilled water, which makes life much easier.

How many batteries will I need?

The more batteries you connect to your inverter/charger, the longer you can keep your sump pump running. This is one of the advantages of the modular nature of an inverter/charger versus a UPS system—you get to decide how big the system needs to be and how much money you want to spend. Theoretically, you can connect an unlimited number of batteries and get an unlimited runtime, but there are practical limitations including cost, space, weight and charger size, so you will likely end up with just a few batteries. You can get by with just one battery if you really need to, but chances are good that you are going to want at least two.

You also have the option of using 6-volt batteries instead of 12-volt batteries, but you are going to have to connect them properly. For instance, four 6-volt batteries can provide the same amount of power as two 12-volt batteries if they are connected correctly. The key thing to understand is that you must provide a total of 12 volts to the inverter/charger regardless of the voltage of your batteries, so it will be simpler if you just use 12-volt batteries.

Please refer to the ***Planning the Battery Backup System*** section for specific instructions about how to calculate the number of batteries you will need.

What other components will I need?

(Note: Please also refer to the ***Installing the Battery Backup System*** section for more information about components, tools and materials required.)

Fuse and fuse holder

You must install a fuse between the batteries and the inverter/charger. This is an important safety feature, and it is <u>not</u> optional. Please note that the fuse and fuse holder are not included with either the inverter/charger or the battery. They are separate items that you must purchase on your own.

We recommend a 200-amp DC fuse, which is not a normal fuse like you might have in the fuse box in your home. It is much bigger and intended for DC current instead of AC current. One of the easiest types of fuses to use in this situation is an "ANL" fuse that can be spliced into the positive wire coming from your battery pack. ANL fuses are often used in high-end car stereos and you can buy them from electronics stores and other places that sell high-end car audio equipment.

You will also need to buy a fuse holder, which is the part that actually connects the fuse to the wire coming from the battery. Many vendors offer combo packs that include both a fuse and a fuse holder, but you can also buy them separately. Either way, make sure that you get both the fuse and a fuse holder because neither one will do you any good without the other.

Battery enclosure

Although it is not absolutely required, it is a good idea to get some sort of enclosure for your batteries. An enclosure will help keep the batteries clean and prevent accidental short circuits. Tripp Lite makes a two-battery enclosure that is perfect for this job: model number **BP-260**. The **BP-260** also comes with all of the cables you need to connect the batteries to each other and to the inverter/charger. If you don't purchase the **BP-260** battery enclosure, you may need to provide the cables on your own.

Heavy-duty storage rack

When fully assembled, the battery backup system is going to be fairly large and very heavy, so it's a good idea to get a rack or shelving unit to keep everything off the floor and away from any water that might end up there. (Since the battery backup system will be around plumbing, water on the floor is a distinct possibility.)

Planning the Battery Backup System

There are several decisions you have to make while designing and planning your new system:

- Select an inverter/charger
- How long do I want my sump pump to run?
- Calculate how many batteries you need
- Select a battery enclosure
- Select a fuse and fuse holder
- Other considerations

Select an inverter/charger

The first thing you need to do is pick an inverter/charger based on the wattage of your sump pump.

Step	Instructions	Your Value
1	**Determine Total Watts Required** The wattage rating of your sump pump is usually listed in the manual or on the product nameplate. If your sump pump power is rated in amps, multiply that number times AC utility voltage, which is 120V in North America, to determine watts. *Example: 6 amps x 120 volts = 720 watts*	
2	**Adjust for Maximum Efficiency** Your inverter/charger will operate at higher efficiencies at about 88% - 94% of the nameplate rating, so divide the number you calculated in Step 1 by 0.90. This is the minimum number of watts that your inverter/charger must support for continuous operation. *Example: 720 watts ÷ 0.90 = 800 watts*	
3	**Adjust to Compensate for Higher Starting Current** Your sump pump draws more power (watts) when it starts up, usually around 2-3 times the amount of power that it needs to continuously run. Check the nameplate rating on the sump pump for a start-up current or call your dealer to verify the start-up current. We will use the highest start-up current scenario in our example by multiplying the number you calculated in step 1 by 3. *Example: 720 watts x 3 = 2160 watts*	**Inverter/ Charger Wattage Required**

Now that you have the peak wattage, you can pick an appropriate inverter/charger. Choose an inverter/charger that supports the start-up current (peak wattage) of your sump pump, such as the Tripp Lite models listed below:

- **UT750UL** (750 watts continuous/ 1500 watts peak)
- **UT1250UL** (1250 watts continuous/ 2500 watts peak)
- **UT2012UL** (2000 watts continuous/ 4000 watts peak)

How long do I want my sump pump to run?

It's important to understand that "power," in this case, is defined in terms of "amp-hours,"which can be calculated as follows:

Step	Instructions	Your Value
4	**Determine DC Amperage** Divide the total watts required (from step 1, above) by the DC voltage to determine the DC amps required. (The DC voltage will always be 12 when using an inverter/charger with a 12-volt battery system, even if you decide to use 6-volt batteries.) *Note: Do not use the wattage from Step 3. That's the start-up wattage and does not apply to ongoing operation.* *Example: 720 watts ÷ 12 DC volts = 60 DC amps (This is the DC amp-hours required to run the system for one hour)*	
5	**Determine Active Runtime Required** First, decide the total number of hours you want the sump pump to be operational during a power outage, which is the total runtime. (The more runtime, the more battery capacity required. Four hours of total runtime should provide a good balance between protection and cost.) Next, determine how much of the time the sump pump actually pumps during a storm. Even when it's raining, the sump pump doesn't run constantly. When the water rises to a certain level, the pump turns on, it pumps water for a while, then it turns off until the water rises again. Everyone's situation is different, so it may be worthwhile to observe your sump pump during a big storm. Record the total time you observe the pump and how long it actively pumps during that time. When you have those numbers, plug them into the formula below, along with the desired total runtime in hours, to estimate the active runtime requirement. Active runtime required = minutes of pumping ÷ minutes of observation x total runtime (in hours). *Example: 5 min. pumping ÷ 10 min. observation x 4 hours total runtime = 2 hours active runtime.* *Note: If you don't have the time or inclination to observe your sump pump during a storm, just assume that it runs constantly (10 minutes on during 10 minutes total observation). This may give you more runtime than you need, but that's better than having too little.*	
6	**Estimate Battery Amp-Hours Required** To get a rough estimate of the battery amp-hours required, multiply the DC amperage (from Step 4, above) by the active runtime required, in hours (from Step 5, above), then multiply by 1.2 to adjust for inefficiency (energy lost as heat). **This is the minimum number of amp-hours that your batteries must supply.** *Example: 60 DC amps x 2 hours active runtime x 1.2 = 144 amp-hours*	**Battery Amp-Hours Required**

Battery Recharge Time

You can estimate the time required to completely recharge the batteries after an outage by dividing the required battery amp-hours (from Step 6, above) by the inverter's rated charging amps. (If the batteries weren't completely discharged during the outage, the recharge time will be reduced proportionally.)

Example: 144 amp-hours ÷ 40 amps inverter charge rating (UT1250UL) = 3.6 hours recharge

Calculate how many batteries you need

Most batteries are rated for a certain number of amp-hours. If the battery you choose supplies fewer amp-hours than the total required from Step 6, above, you'll need to get as many as it takes to add up to the requirement.

For example, Tripp Lite's 12-volt sealed maintenance-free battery (model **98-121**) is rated for 82 amp-hours. In order to supply the 144 amp-hours calculated in the example, you would either need to get two batteries or settle for the proportionally shorter total runtime supplied by one battery.

Select a battery enclosure

Although it's not absolutely required, it's a good idea to get some sort of enclosure for the batteries to keep them safely tucked out of the way and prevent accidental short circuits, especially considering that the system is going to be operating near water.

Tripp Lite's metal battery enclosure (model **BP-260**) is designed to hold two model **98-121** batteries. It also includes all of the cables that you will need to connect your system components, which is convenient.

Select a fuse and fuse holder

You are required to install a 200-amp DC fuse between the batteries and your inverter/charger. This is an important safety feature, and it is not optional. The fuse and fuse holder are not included with either the inverter/charger or the battery pack, so you must purchase them separately. The best type of fuse to use for this is an "ANL" fuse in an appropriate fuse holder that can be spliced directly into the positive wire between the batteries and the inverter/charger.

The Kicker ANL fuse 2-pack (model #09ANL200/AFS200) with the Kicker AFS/ANL fuse holder (model #09FHA/FHS) works well, although there are many other brands and models available that are just as good. Some manufacturers sell combo packs that include both the fuse and the fuse holder, but it's important to check and make sure that you are getting both parts.

Other considerations

Think carefully about exactly where you are going to install your system and how much space it is going to take up because it is likely to be larger than you were expecting. It's also going to be very heavy (the batteries alone weigh 50 pounds each), so it will be hard to move after you are done.

(Considering the Tripp Lite models mentioned, the battery enclosure is the largest component. Its dimensions are 10.5 inches high x 10.5 inches wide x 17.75 inches deep, so it's roughly the size of a medium-sized microwave. The inverter/charger is almost a perfect cube with each side measuring about 12 inches.)

It's a good idea to get some sort of shelf or rack to keep the batteries and inverter/charger off the floor, especially considering that they're going to be near water. Three-shelf wire "bread rack" models sold at most home improvement stores work well. They stand about 30 inches tall and can support up to 250 pounds on each shelf, so the weight of the system components is no problem. Putting the battery enclosure on the middle shelf and the inverter/charger on the top shelf keeps everything off the floor and away from the water.

Installing the Battery Backup System

Component list

This is a list of all of the components needed for a typical installation. Your installation may be different.

Item	Manufacturer	Part #	Description	Qty
Inverter/ charger	Tripp Lite	UT750UL	750-watt utility/work truck inverter/charger with 2 outlets.	1
Battery enclosure	Tripp Lite	BP-260	Sturdy metal battery cabinet for two 12-volt batteries, such as 98-121. Includes heavy gauge cabling, nut/bolt connectors and battery terminal isolators for user installation.	1
Batteries	Tripp Lite	98-121	12-volt DC, sealed, maintenance-free battery. Works with all inverter/chargers that accept 12-volt DC battery connections.	2
Fuse	Kicker	09ANL200/AFS200	Kicker 200-amp ANL fuse (2-pack).	1
Fuse holder	Kicker	09FHA/FHS	Kicker AFS/ANL fuse holder.	1
Shelving unit	Perfect Home	31424PS-YOW	3-shelf steel commercial shelving unit (24 x 30 x 14 inches).	1

Tools and materials needed

The list below includes the tools and materials that you will need to complete this job.

Required:

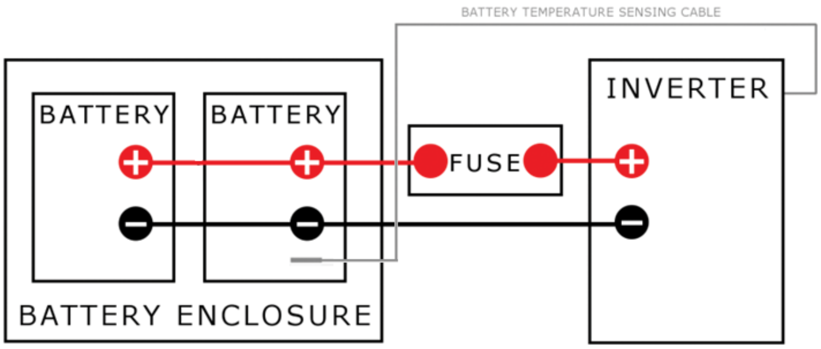
- Socket wrench
- Phillips-head screwdriver
- Flat-head screwdriver
- Wire/cable cutters (ideally heavy-duty, able to cut at least 1/0 AWG cable)
- Electrical tape
- Utility knife (for stripping the cables)
- Allen wrench
- Super glue

Optional (but very handy):

- Rubber mallet (for assembling the shelving)
- Plastic zip ties (for keeping everything neat and orderly)
- Ballpoint pen or awl for setting DIP switches

Overview

The conceptual drawing below shows how the components will be connected when we're done. (The drawing shows the logical connections between the components. It does not represent the physical setup of the system, and it is not to scale.)



Step 1: Set up shelves and double-check placement

- Assemble your shelving unit and make sure it fits in the space next to your sump pump. The assembled system is going to be very hard to move, so make sure that you will not have to move it after everything has been set up.
- Make sure the battery enclosure and the inverter/charger fit on the shelves of your shelving unit.

Step 2: Prepare lead cables

The lead cables are the long red and black cables that came with the battery enclosure, which will connect your batteries to your inverter/charger. They have "ring terminals" on each end that you use to bolt the cable to the unit. Before you can connect the cables, you need to modify them as follows:

- Cut the long red cable about three-quarters of the way from the smaller end, then strip about a half-inch of insulation from each of the cut ends:

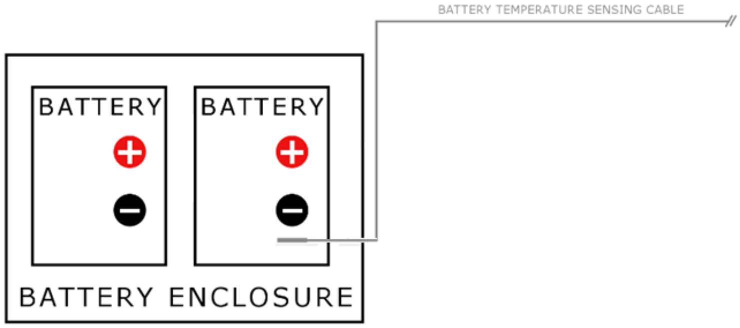
- Screw the fuse into the fuse holder, and then connect the fuse holder to the cut ends of your cable:

- Cut off the small ring terminal on the end of the cable that's closest to the fuse, and then strip about a half-inch of insulation from the cut end, like this:

- Now cut the small ring terminal off the end of the black cable, and strip it just like you stripped the red cable.
- Wrap heat-shrink tubing around the stripped ends of the two cables to prevent short circuits while you finish the installation.

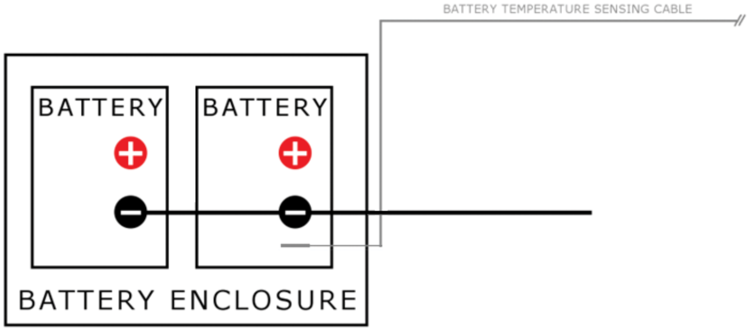
Step 3: Install the batteries in the battery enclosure

- Remove the cover from the battery enclosure and remove the cables and wires that came with it.
- Remove the top shelf from your shelving unit and put the empty enclosure, with the top removed, on the middle shelf.
- Place one battery in the battery enclosure making sure that the positive ("+") and negative ("-") terminals on the battery line up with the holes on the end of the enclosure marked "+" and "-".
- Attach the temperature sensing cable near the negative battery post with a small amount of cyanoacrylate adhesive (super glue).
- Snake the other end of the temperature sensing cable out of one of the holes in the end of the battery enclosure, then place the second battery in the enclosure next to the first.
- When you are done, the system should look like this:



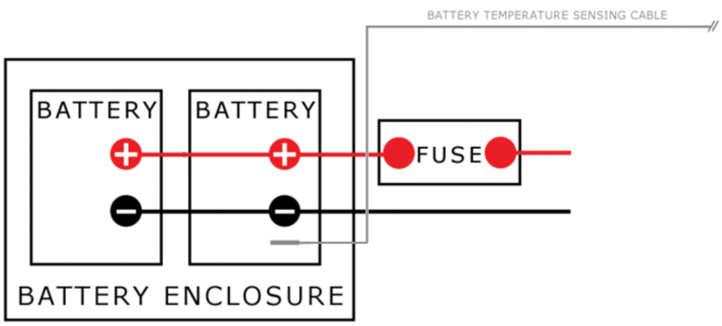
Step 4: Connect the negative terminals of the two batteries

- Connect the short black cable that came with the battery enclosure to the negative ("-") terminal of the battery farthest away from the openings in the battery enclosure (put the ring terminal down first, followed by the flat washer, then the lock washer, and finally the bolt).
- Thread the long black cable through the opening on the end of the battery enclosure marked "-" with the ring terminal inside the battery enclosure and the stripped end outside the enclosure.
- Connect the free end of the short black cable along with the black lead cable that you just threaded through the hole to the negative terminal of the other battery. Again, put the ring terminals down first, then the flat washer, followed by the lock washer, and finally the bolt.
- **It is very important that you avoid connecting the negative terminal of one battery to the positive terminal of the other, so be careful!**
- When you are done, the svstem should look like this:



Step 5: Connect the positive terminals of the two batteries

- Connect the short red cable that came with the battery enclosure to the positive ("+") terminal of the battery furthest away from the openings in the battery enclosure (put the ring terminal down first, followed by the flat washer, then the lock washer, and finally the bolt).
- Thread the long red cable through the opening on the end of the battery enclosure marked "+" with the ring terminal inside the battery enclosure and the fuse outside the enclosure.
- Connect the free end of the short red cable along with the red lead cable that you just threaded through the hole to the positive terminal of the other battery. Again, put the ring terminals down first, then the flat washer, followed by the lock washer, and finally the bolt.
- **It is very important that you avoid connecting the positive terminal of one battery to the negative terminal of the other, so be careful!**
- When you are done, the system should look like this:



Step 6: Close the battery enclosure

- Double-check your connections and then put the red plastic terminal covers that came with the battery enclosure over the positive battery terminals. You may need to cut additional openings in the terminal cover using your utility knife in order to get them to fit snugly. If you do not have terminal covers, use heat-shrink tubing over each battery terminal.
- Put the cover back on the battery enclosure and secure it with the screws you took out when you removed it.
- Put the top shelf on your shelving unit, and place the inverter/charger on it.

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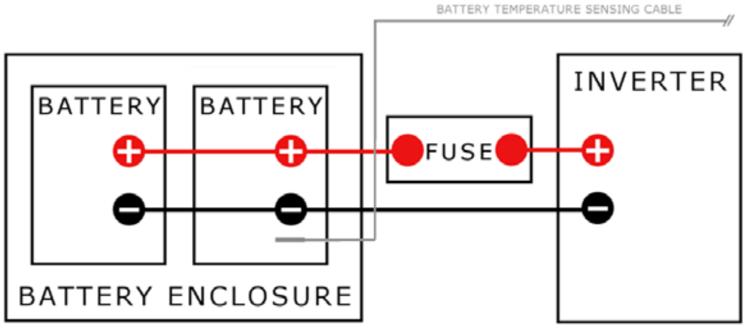
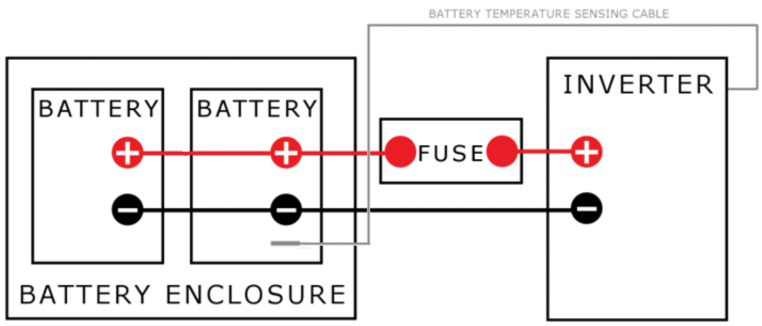
Step 7: Attach the leads to the inverter/charger

- Remove the electrical tape from the stripped end of the black lead and connect it to the negative ("-") terminal on the inverter/charger, then connect the stripped end of the red lead to the inverter/charger's positive ("+") terminal.
- **It is very important that the black cable is connected to the negative ("-") terminal and the red cable is connected to the positive ("+") terminal, so be careful!**
- You may see some sparks when you touch the red lead to the terminal on the inverter/charger. This is normal because you are completing the circuit between the batteries and the inverter/charger, but it can be surprising if you are not expecting it.
- When you are done, the system should look like this:



Step 8: Connect the battery temperature sensing cable

- Connect the battery temperature sensing cable to the jack on the back of the inverter/charger labeled "Remote Temp. Sense." Ideally, the temperature sensor should be as close to a negative terminal as possible.
- When you are done, the system should look like this:



Step 9: Configure the inverter/charger

There are some DIP switches on the front panel of the inverter/charger that control important settings that affect the way it works. You should refer to the owner's manual that came with your inverter/charger for more information about exactly which settings to select.

Step 10: Connect the inverter/charger to utility power and the sump pump

- Plug the inverter/charger into your wall outlet (note that you may hear a slight humming coming from the unit as the batteries start charging; this humming will stop once the batteries are fully charged).
- Plug the sump pump into your inverter/charger.

Step 11: Testing the system

It's important that you test your system to make sure it's operating correctly. The most thorough way to test the system is to use a hose or a bucket to fill your sump well with water until the sump pump activates. Do this once with the inverter/charger plugged into utility power and then again with the inverter/charger disconnected from utility power, which will force the sump pump to run off of the batteries. If the sump pump operates normally in both situations, you have successfully installed your battery backup system!

Step 12: Battery maintenance

Batteries must be maintained and tested to ensure optimal performance. The average battery life is 5 years. Batteries should be tested on an annual basis, before you need to rely on them during an outage.

About Tripp Lite

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