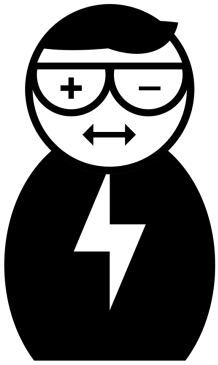
Installation & User Manual

BankManager™ 1.X



BANK MANAGER™

Battery Bank
Management System

The most up-to-date version of this manual can be found at

www.EmilyAndClarksAdventure.com/BankManager

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Welcome

Thank you for buying a ***BankManager™*** battery bank management system (BBMS).

This experimental device will help you combine a bank of LiFePO4 (lithium) batteries with a bank of lead batteries, in a system that gives you the advantages of both chemistries. This device was built with the design point of making it easy and inexpensive to add a lithium battery bank to an existing lead-based power system, and letting you take advantage of the new lithium chemistry without throwing away your existing investment. The BankManager™ can accept power from any charge source, be that solar panels, wind, an alternator, shore AC charger or anything that can push amps into your off-grid battery system.

Adding lithium batteries to a lead system provides long cycle life and very efficient operation. Even battery systems that are predominantly based on lithium benefit from lead's durability and dependability. A hybrid battery system that uses the *BankManager™* will benefit from better charge control for the lithium batteries.

Other available charge controllers that have a Lithium setting are just lead charge controllers with the absorption time set to 0. Only the BankManager™ can sense the needs of the bank of lithium batteries it's managing and calculate when they are fully (as defined by the user) charged. It then removes the lithium bank from further charge until the li bank has been significantly discharged. The BankManager™ reconnects the lithium bank when your system requires their power.

This is the only way to truly protect lithium batteries from overcharging damage. Lithium batteries can be damaged by subjecting them to charge current at any voltage over 13.48 volts after they are fully charged. Lithium batteries cannot be safely charged to a voltage or floated.

System Requirements

The *BankManager™* will work on a 12-, 24-, 36-, or 48-volt system. It should work with any existing lead-based off-grid power system, provided the lead batteries are in good health and there is at least minimal control of the charging voltages.

Supported Battery Types

You may use the *BankManager™* to add LiFePO4-chemistry batteries to any system based on standard lead-chemistry batteries (i.e., flooded, AGM, gel, or carbon foam). The *BankManager™* is NOT for combining lead batteries with other Lithium Ion (Li-ion) battery chemistries.

Battery Type	Compatible?	
	YES	NO
Flooded Lead-acid	✔️	
Absorbent Glass Mat (AGM)	✔️	
Gel	✔️	
Carbon-Foam	✔️	
Lithium Iron Phosphate (LiFePO4)	✔️	
~~**Lithium Ion (Li-ion)**~~		❌

Fig. 1.a Battery types compatible with the BankManager

The *BankManager™* is a BBMS (NOT a BMS)

It is expected that any lithium battery you choose for your hybrid system will be protected with its own battery management system (BMS). The BMS is responsible for monitoring and protecting *individual cells* within the lithium battery. The *BankManager*, on the other hand, is responsible for managing the *lithium battery's use within a hybrid system*. This is why we call it a battery bank management system (BBMS).

Either drop-in or self-assembled LiFePO4 batteries are supported by the *BankManager*, as long as the BMS in the batteries is up to the task.

Understanding Battery Systems

Typical Lead System

Let’s start by looking at the schematic of a typical off-grid lead battery system:

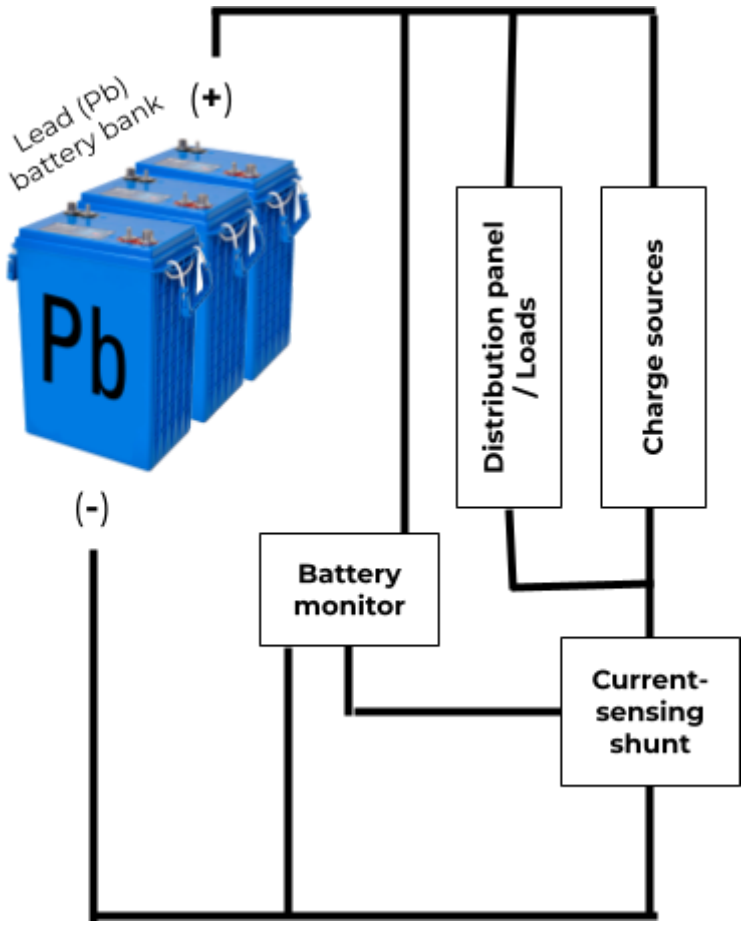


Fig. 1.b: a typical off-grid lead battery system

Simple Lead-Lithium Hybrid System

Adding lithium batteries to a typical lead system looks something like this:

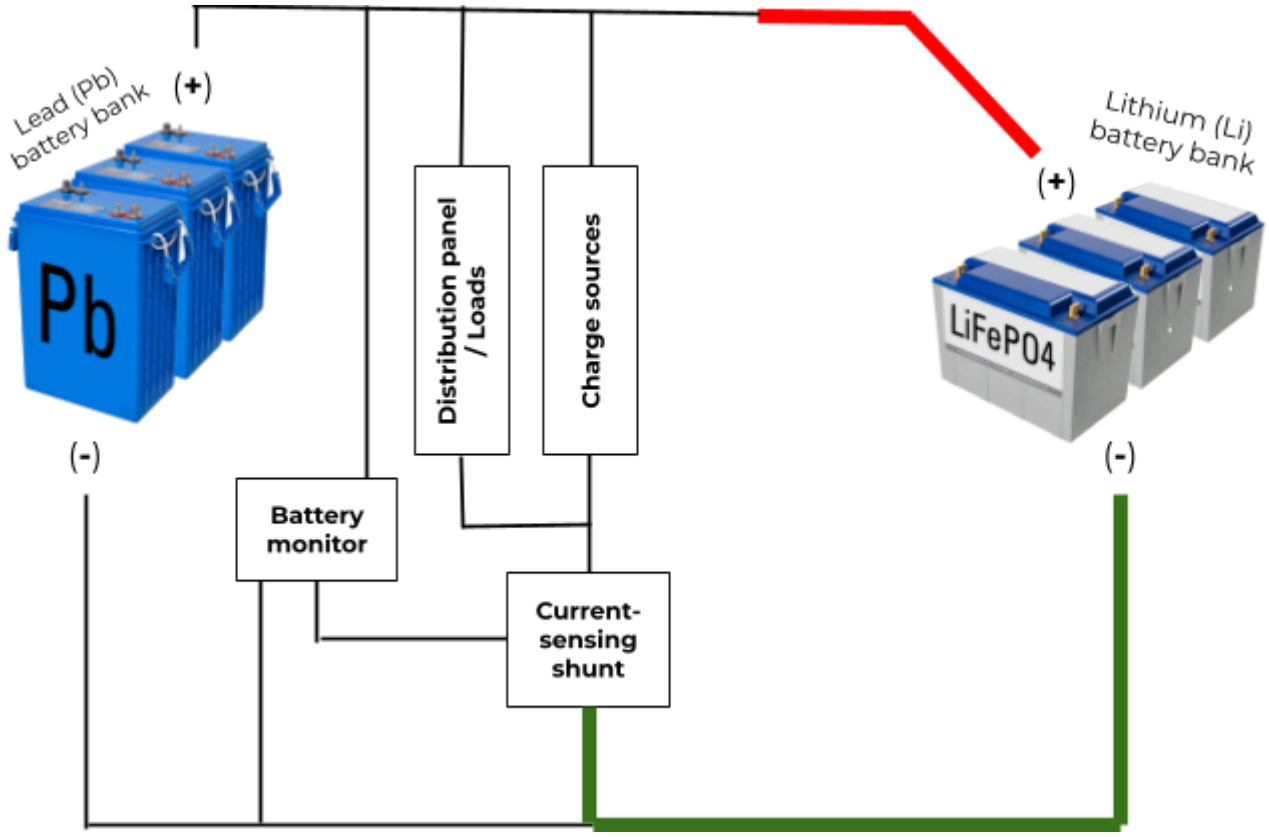


Fig. 1.c : example of a hybrid lithium-lead battery system

⚠	**Adding lithium into a lead-based system requires careful wiring and fusing practices to install batteries safely.** (Imagine someone welding. The power running through the wires connecting the batteries in this system is much, much higher than what welding equipment requires to melt steel!) Whenever you are working with this type of wire, if you aren't absolutely certain you can do this safely, you should seek help from a professional to avoid starting a fire.

BankManager™ Hybrid System

While your installation will be somewhat different, the drawing below should give you a general idea of how a *BankManager™* should be installed within a hybrid system.

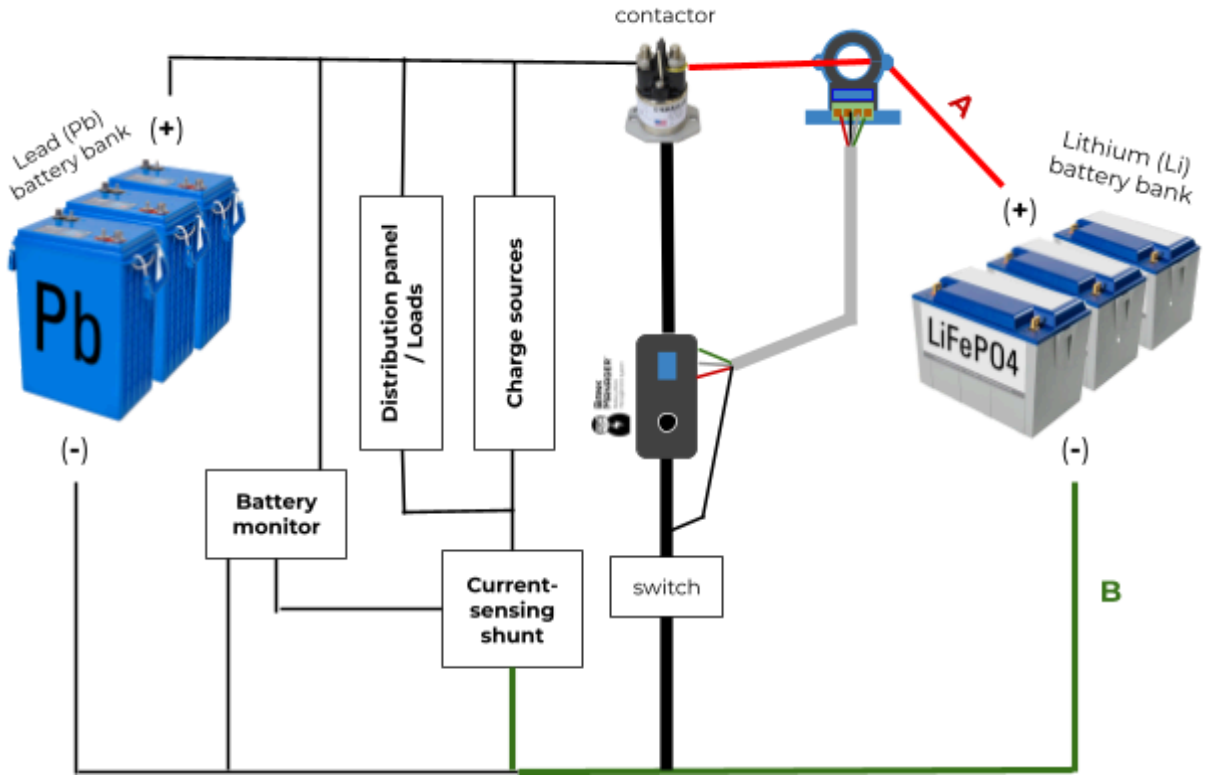


Fig. 1.d : example hybrid battery system with a BankManager™ and contactor

Note there is a section in the wiring where **the lithium battery's ground (-) is not affected by any other component** (**B**). Also note that there is a section where **the lithium battery's positive side (+) is connected to the lead battery's positive side (+) and the charge/load system** (**A**). These two parts of the drawing represent where you should connect your *BankManager™* and its contactor. It is important that the *BankManager™* sensor wires can "see" the true voltage of your lithium battery. Things like shunts and switches cause a voltage drop and will report incorrect voltages to the *BankManager,* preventing it from working optimally.

⚠	**Warning: Some MOSFET-based switches used by some external BMS installations have been known to cause high frequency pulses of power that have been known to destroy sensitive boat electronic devices like the BankManager.** If your installation uses this kind of switch, use an oscilloscope to verify that the power passing through it is clean, or simply change it to a simple relay-type contactor. This is especially recommended if there is an excessive voltage drop across the switch.

Prepare for Installation

Tools & Parts Needed for Installation

To install the *BankManager*, you will need the following tools:

- ☐ **Small screwdrivers,** flat and philips
- ☐ **Wrench and/or torx set** for contactor terminals
- ☐ **Wire cutters, strippers, and crimping tools**

You will also need the following parts:

- ☐ **1 SPST switch** (to turn the *BankManager™* off and on). You will also need a way to mount the switch. A SPST switch is a simple off/on switch with two terminals. Basically any switch that can handle 5 amps will work.
- ☐ **A Contactor** of adequate power to handle the largest charging and discharging loads expected for your lithium batteries. This can be Normally Closed, Normally Open, or bistable (latching) low side triggered. ⚠️**WARNING:** ***A normally-closed contactor is NOT recommended as failure conditions would cause immediate connection of the lithium batteries, possibly causing over current conditions.***
- ☐ **14- and 12-* gauge wire**
- ☐ **4-part twisted pair cable** for current sensor
- ☐ **3 inline fuses**
- ☐ **Ring terminals**
- ☐ **Mounting hardware**

**If a particularly long run is required, larger wire might be needed. See note on page <13>.*

Choose the Installation Site

First, decide where you would like to physically install your *BankManager™* and its contactor.

***BankManager™* location:** You might choose to install the *BankManager™* where you can easily see it, so you can access its controls and its voltage/current display. Alternatively, you may decide to install it out of the way and close to its contactor. (Note that once set up and tested, there should be little need to change the settings on the *BankManager™* very frequently, though it is still important to monitor the system voltage to verify the *BankManager™* is working properly.

Contactor location: The contactor should be installed where you have already run the large wire connecting the lithium battery bank to the rest of your electrical system. (Adding length to this large wire is not only needlessly expensive, it will waste energy due to added resistance.)

Install the Contactor

Let's start by installing the contactor. Install it into a break in the positive wire (see Fig. 1.d on page <6> for a reference).

⚠	**WARNING: If you are using a bistable contactor, verify that the contactor is in the "off" state before installing.** A check with your multimeter should show an open circuit between the large terminals of the contactor. If the contactor is in "on" mode, momentarily power the OFF coil to action the contactor and test again.

Contactor Installation Diagram

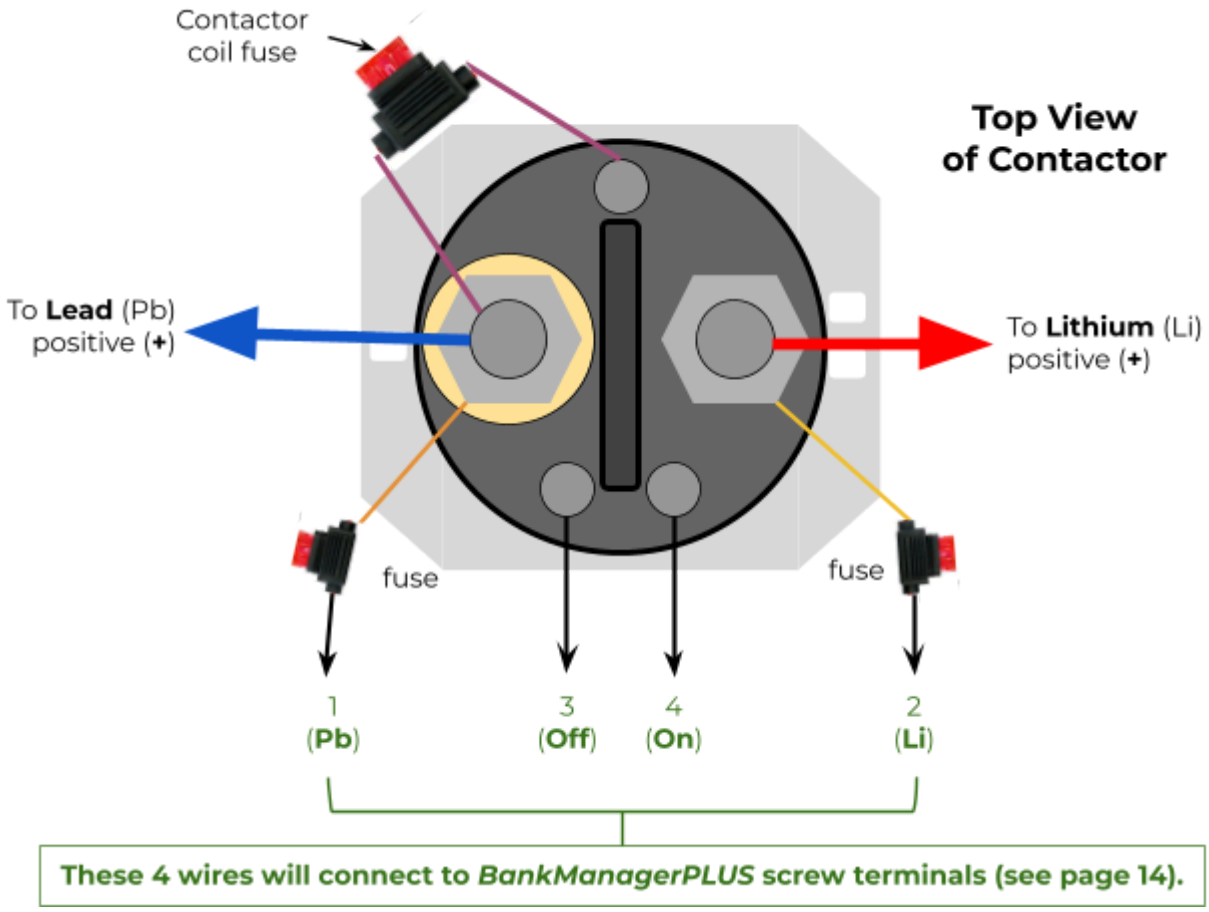


Fig. 2.a : The bistable contactor (included with your BankManager) with proper placement of wires and fuses.

Steps for Installing the Contactor

1. **Mount the contactor securely, in a safe place where no grounded conductors can touch it.** As with any high-current-potential connection, adding insulated boots to the wires is recommended. If you are using a large contactor, it might be preferable to mount it on a rubber pad. (These contactors can make a rather loud “click” when they operate and if you are annoyed by this kind of noise, it is better to minimize it now during installation.)

⚠️	**WARNING: If you choose to use a normally closed contactor (NOT recommended) it’s likely that you will need a heavy disconnect switch in this circuit to disconnect your lithium batteries when you shut down the *BankManager*.**

2. **Connect the heavy power wires to the contactor.** Again verify your contactor is in the “off” state. Only do this if you are absolutely certain you know how to do it safely. Consider de-powering these wires before connecting them. Don’t drop these wires on a grounded conductor. The Lead side of the contactor should connect to the positive terminal (+) or your Lead (Pb) battery bank. The Lithium side of the contactor should connect to the positive terminal (+) of your Lithium (Li) battery bank.

3. **Run a fused wire from the contactor's Lead side power terminal to the common coil terminal (contactor coil fuse).** The fuse should be enough to activate the contactors coil. For the 300A Shallco bistable contactor (included with most *BankManager™* orders) a 5A fuse should be sufficient. For normally open or normally closed contactors, much lower values (1A) would be appropriate. Check your manufacturer's requirements.**Mount the *BankManager™* and a SPST switch** where you would like them.

4. **Install the current sensor around the lithium battery’s positive wire** as it travels from the contactor to the lithium battery bank. (See Fig. 1.d on page <6> for reference.) Then mount it securely, with its arrow pointing in the direction of the Lithium battery bank. (Note that this sensor can be opened and closed to more easily attach it around the wire. When closing the contactor, make sure it closes completely—otherwise, it won’t be accurate.)

Install the *BankManager*

To wire all this together, use 14 gauge wire for all connections, unless otherwise noted.

You will need a twisted pair wire to run from the *BankManager™* to its current sensor. Since there will be 4 wires running from the current sensor, it's most convenient to use a cable of 4 wires, at least 2 of which are a twisted pair. These wires can be quite small (20 gauge or so). Many people have successfully used a length of ethernet wire with the ends cut off for this.

If the run is especially long, or if the cable runs parallel to high-current carrying wires, it might be best to choose a cable with a shield around the twisted pair. But for normal installs most any wire will work well. If you choose to use regular single wires just take a moment to manually twist them around each other so there is about one twist per inch.

1. Wire the Sensor

Use a 4-part cable (described above) to wire the sensor's 4 terminals:

1 **(+5v)**	Connect this terminal to a wire that you will use for **positive voltage** (**A**). . *This will connect to BankManager™ screw terminal 8* ***(+5).***
2 **(0v)**	Connect this terminal to a wire that you will use for **negative voltage** (**B**)
3 **(Vout)**	Connect this terminal to **one of the wires** in the twisted pair (**C**). *This will connect to BankManager™ screw terminal 7* ***(HiC)****.*
4 **(Vref)**	Connect this terminal to the **other wire** in the twisted pair (**D**). *This will connect to BankManager™ screw terminal 6* ***(LowC)****.*

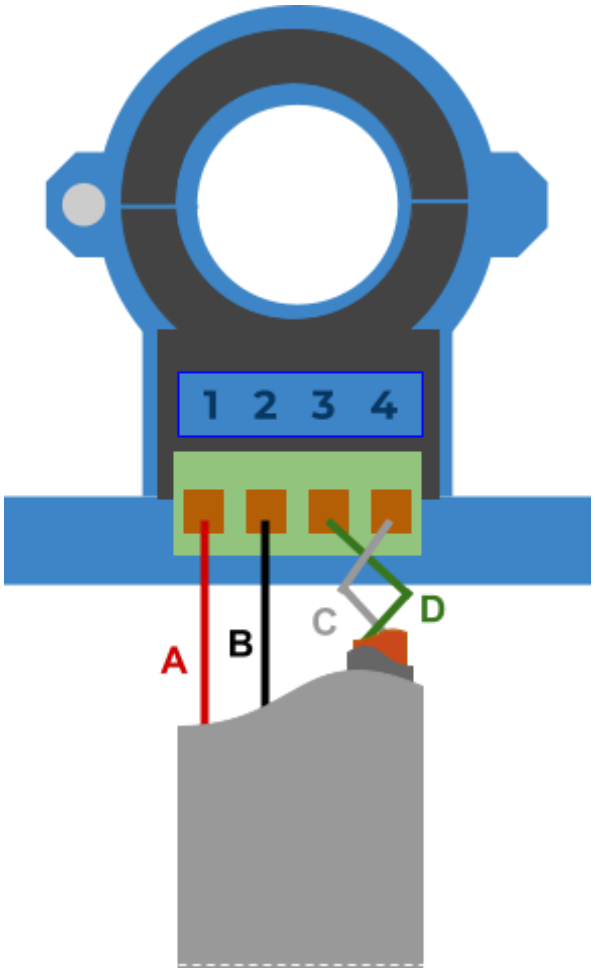


Fig. 3.a: sensor, wired to a 4-part cable

Note: If you are using shielded wire, let the shield float (do not connect it to anything) on the sensor end of the cable.

2. Wire the *BankManager*

⚠️	***Ensure that the wires enter the screw terminals cleanly, with no strands shorting between terminals.*** *Tighten the screws well enough to make very good contact. As in any electrical installation, it's best to use ferrules, and to check your connections for tightness again later.*

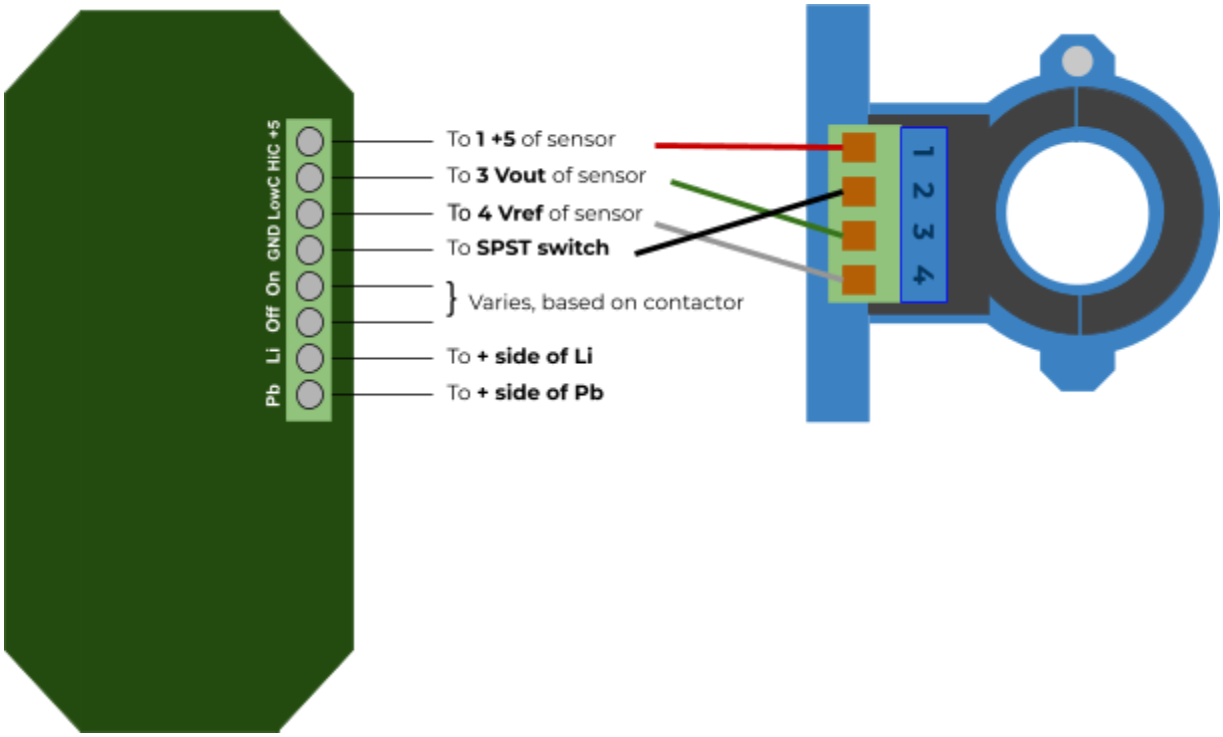


Fig. 3.b: Labeled *BankManager™* screw terminals, and corresponding sensor pins.

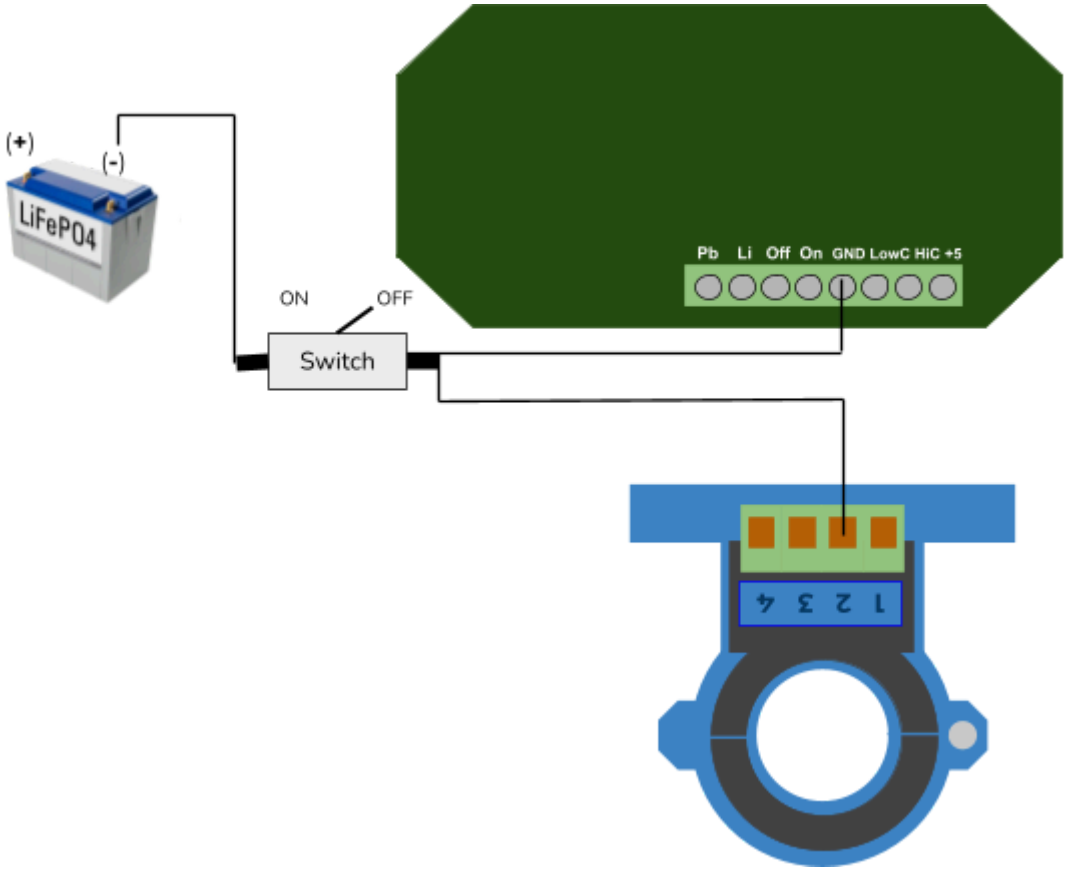


Fig. 3.c: Ground wires and switch

Run wires from the *BankManager*, starting with the leftmost screw terminal (1):

1 **Pb**	Run a wire from here to the positive side (+) of your lead (Pb) batteries. Use a 1-amp fuse in this wire. It is best to run this wire **to the lead power terminal of your contactor.**
2 **Li**	Run a wire from here to the positive side of your lithium (Li) batteries. Use a 1-amp fuse in this wire. It is usually best to run this wire **to the lithium power terminal of your contactor.**
3 **Off**	• **bistable contactor**: wire this to the “off” coil terminal of the contactor. • **normally open contactor**: ignore this terminal. • **normally closed contactor**: wire this to your contactor’s coil terminal.
4 **On**	• **bistable contactor**, wire this to the “on'' coil terminal of the contactor. • **normally open contactor**, wire this to your contactor’s coil terminal. • **normally closed contactor**, ignore this terminal.

5 **GND**	1. Turn the SPST switch off 2. Using 12-gauge* connect the **negative side (-) of your lithium (Li) bank** to one terminal of the SPST switch (lets call it the battery terminal of the switch) (see New FIG. for switch). 3. Run a 14-gauge wire from the other terminal of the SPST switch (lets call it the BankManager™ terminal of the switch) to the GND screw terminal of the BankManager. 4. Connect the negative wire and the shield (if you are using one) from the sensor cable to the BankManager™ side of the switch. (This is the wire that goes to terminal "**2 0V**" of the sensor),
6 **LowC**	Connect this screw terminal to the twisted pair wire coming from the sensor terminal "**4 Vref.**"
7 **HiC**	Connect this screw terminal to the other twisted pair wire, coming from the sensor terminal "**3 Vout.**"
8 **+5**	Connect this screw terminal to the sensor terminal "**1 +5v.**" (It's vital that battery terminal positive wires are never connected to either of these terminals. That will instantly destroy the BankManager.)

**If this wire has a long run, use a larger size. A voltage drop in this wire will affect the BankManager' voltage reading. 12-gauge wire should be sufficient for most runs. If using a monostable contactor, it's particularly important that this wire be large enough.*

Close the lid of the *BankManager™* (being careful not to pinch any of the wires) and secure it with ½-inch screws.

Now you're ready to power up your *BankManager*.

Power Up Your *BankManager*

Before you turn on the *BankManager*, there are 2 important things to know:

1. **For your first power-up, remove the contactor coil fuse (in the wire running from the lead side of the contactor to its common coil terminal).** With the fuse removed, the *BankManager™* cannot operate its contactor. Once you have everything set properly, and configured, you can turn off your *BankManager*, replace this fuse, and turn your *BankManager™* back on for full operation.

2. **Note that your system must be running at correct nominal voltage before turning on your *BankManager*.** The voltage of the lead side of your system at the time you turn on your *BankManager™* will define what voltage system the device expects it is installed in:

lead voltage at time of startup	expected system voltage
<15 V	nominal 12V
15-30 V	nominal 24V
30-45 V	nominal 36V
45-60 V	nominal 48V

Fig. 4.a. Expected system voltage, based on lead voltage at time of startup

With the fuse removed, turn on the switch for the first time. In a few seconds, you should be greeted by the *BankManager™* splash screen. Then you should see a display showing the lithium voltage, and either the lead voltage or the amps flowing to/from the lithium battery bank.

Configure Your *BankManager*

Let's go through each menu item and configure your *BankManager™* to your needs.

Opening the Menu

To configure your BankManager, first power up the device using the SPST switch you installed. Wait until the splash screen goes away then **push the knob once.** You will see the Configuration Menu. Note that whenever you enter the Configuration Menu, your *BankManager™* will disconnect your lithium bank. You can use this as a quick way to disconnect your lithium batteries—just push the knob to enter the Configuration Menu, and the contactor will open.

Factory Reset

There is a factory reset option. This should have already been chosen during testing, but you may wish to start by choosing this option. Selecting "factory reset," then "yes" to set everything to a good starting position.

Navigating the Menu

To navigate through the menu, twist the knob left and right to make your selection. Then push the knob once to select your choice.

In most cases, you will only need to adjust the following 2 important menu items. (These 2 items appear with an asterisk (*) on page 18.)

- **Lithium Bank Size**
- **Contactor Type**

For the other options, the factory defaults will probably serve most users well. It is recommended that most users operate their system with the default settings for a while before changing these. Then change only one at a time. These setting give you great power but remember "with great power comes great responsibility". The menu items and available options are described in detail on the following pages:

CHARGE TO

This tells the *BankManager™* **when to stop charging your lithium battery bank**. Once this charge point is reached the display will show an ASTERISK after the li voltage. When the ASTERISK is showing the lithium battery isn't a candidate for further charging.

> 💡 **Note from the inventor:** *Deciding how best to charge your Lithium batteries is a bit of a "religious" topic. Everyone has a different opinion on the subject. We are still in the early days of lithium batteries, and these batteries last a long time in the field, so I think the best answer is...we just don't know yet. I have made every attempt to allow users to choose what method they like best. I am going to give my opinion, since I'm sure many users would be interested, but feel free to set this up any way you like. We are all captains of our own ships and are free to use our equipment as we choose.*

Your *BankManager™* gives the choice of very different charging methods. It can be told to charge to a percentage of full charge, or it can be told to charge to a set voltage.

First, let's talk about the difference between these two methods.

- The **charge to percentage of full charge** method is a very unique and useful way to charge your batteries. It can protect your lithium bank from overcharging at low voltages that happen when your charge source is slow or variable, as when using solar panels especially on a cloudy day.

  In these situations lithium batteries can become overcharged at voltages as low as 13.48 volts (for a 12V system). If overcharged in this way, some lithium metal undergoes a permanent change that renders it unable to hold a charge ever again. To protect your batteries from this, your *BankManager™* can sense your batteries filling up by noticing that they are entering a state of "taper current" where further charging will result in either a drop in current or a rise in voltage.

- When the *BankManager™* is told to **charge to a set voltage**, this overcharge protection is not available, but some users may prefer to charge to a set voltage method for their own reasons. This mode could be useful for certain maintenance reasons (like balancing cells), or just because that is how you want to charge your batteries.

From within the "Charge To" menu, you can choose from the following options:

100%	In this mode, the *BankManager™* tries to fully charge your lithium bank. For all of the percent charge settings the *BankManager™* uses some multidimensional math to decide when the battery is adequately charged. For 100% it also watches for any un-forecast rise in voltage as an extra safety to end the charge cycle. This is the most accurate setting.

98.5%	This setting is very similar to 100%. Maybe a version for the timid. It's probably the second most accurate setting.
95%	These percent settings tell the BankManager™ to take its best shot at stopping the charge cycle at the number chosen. These points aren't exact but I guess they don't really need to be. Trust that 90% is less than 95% but more than 85%. But expect them all to be off by at least a few percent.
90%	
85%	
80%	
50%	
Use Volts	This setting is very different from the percent settings. This is the approach that most charge controllers use today, and what is in many battery manufacturers' manuals. (I don't think this is the best way to charge lithium but we all live in a free world and can make our own choices!) I have added features to this setting that could make it safer than what I have seen other controllers do. If you choose this option, you will find some new settings in your Configuration Menu (shown in gray, below). This method doesn't use the current sensor, so if you have a problem with your current sensor, you could switch to this mode until you get it sorted out.
	Max Charge Voltage. When your lithium batteries reach this voltage, the *BankManager™* is triggered to either stop charging or start a soak timer.
	Soak Time. Once the set voltage has been reached, the *BankManager™* will continue allowing the lithium battery bank to charge for this many minutes. If you don't want this feature just set it to 0. *Note: As your charge controllers are set to a higher voltage than the MaxChargeVoltage expect the voltage the lithium battery bank sees to be higher as well. If you use this feature, you must make sure your highest regulator setting is safe for your lithium batteries.*
	Soak Interval. If you like the idea of soaking your lithium batteries but don't want to soak them every charge cycle, you can use this setting to have your *BankManager™* only soak occasionally. If you set this value to 1/1, it will soak your batteries every time. If you set this value to 1/X, it will soak them every X number of times (e.g., setting it to 1/5 will soak your batteries every 5th cycle.)

💡 **Note from the inventor:** *I personally think charging to 100% is the best choice. I didn't always think so, but I came around to the idea that charging to full not only gives the most capacity to your bank of lithium but it avoids the "memory effect" that can happen when lithium batteries are only partially charged. As testing progressed and I started trusting my device to stop the charge when it should I went with this option. I now just let it do its thing at 100%.*

****LITHIUM BANK SIZE****

It is very important that you tell the *BankManager™* the size of the lithium battery bank it is managing. You can choose any bank size from 10Ah to 2,550Ah, in increments of 10Ah. If you need to round, round up to the next higher setting.

RESET FULL BATTERY

The *BankManager™* has a built-in feature that keeps it from charging a lithium battery bank that it believes is already charged (when it shows an ASTERISK on the screen). When your bank drops below this voltage for a period of time, it is marked as no longer fully charged (the ASTERISK is removed), and is a candidate for another charge cycle.

💡 **Note from the inventor:** With *clever use of this setting, you can set up a large lithium battery bank to only charge every few days. Some people believe that will give your lithium batteries a longer life.*

MAX FULL BATTERY VOLT

Once the BankManager has determined that the lithium battery bank is fully charged (indicated by an ASTERISK on the display), the *BankManager™* will not allow additional current to enter the lithium bank as long as the lithium battery's voltage is above the value chosen in this setting (the default value for this setting is 13.4V for 12v systems). 12V lithium batteries are usually considered safe from overcharge damage when at, or below, 13.48V. Therefore, choosing a value for this setting at or below 13.48 volts will protect the lithium bank from overcharge damage. Because of this feature, you might hear your contactor "click" a bit when your lithium bank is full and charge conditions are changing (e.g., solar charging on a cloudy day) as the *BankManager™* brings the li in and out as charging stops and starts.

****CONTACTOR TYPE****

As stated earlier, **this is a very important setting.**

Monostable	Use this setting with a monostable (e.g., normally open) contactor.
Bistable	Use this setting with a bistable contactor.

⚠️	**The Contactor Type setting must be set correctly.** If you connect your *BankManager™* to a bistable contactor with this setting set to Monostable, you will burn out the contactor. Because this is so important, there is a small '**b**' or '**m**' displayed on the main operating screen to verify the *BankManager™* is set correctly

MAX AMPS

If you choose to use this feature you may set this value to the maximum number of amps you wish to allow your system to draw from your lithium bank. If a higher number of amps is requested the *BankManager™* will disconnect the lithium bank from your system. The bank manager will not reconnect the lithium until the lead side voltage comes close to the lithium bank voltage.

You may want to use this feature to protect a small lithium bank from large loads like starting an engine or as a software fuse to protect your system from a short circuit. This device may be used for convenience but is not a replacement for a true fuse or circuit breaker.

MIN POC

Set this to the minimum percent of charge (POC) you want to allow your lithium bank to fall to. For example if you wish your lithium batteries to stop discharging once they reach 20% set this to 20% and when your lithium bank falls to 20% full the BankManager™ will disconnect the lithium bank and cause your system to run on your lead batteries until a charge source comes on line.

SENSOR TYPE

Your *BankManager™* can work with an assortment of current sensors, from **50A** to **600A**, depending on your charging and load requirements. It's important that you choose the correct sensor type. Factory reset will change this setting to 200A, which is the sensor that came with your *BankManager™* by default.

FACTORY RESET

Choosing "yes" under this setting causes all features and functions of the *BankManager™* to return to the original factory settings.

RESUME OPERATION

Clicking on this choice exits the Configuration Menus and returns the *BankManager™* to normal operating mode.

💡 **Note from the inventor:** Remember that while you are in the Configuration Menu, your lithium bank is disconnected. Your lithium bank will not be reconnected until the *BankManager™* deems it safe to do so. In some cases, you might have to charge your lead batteries or turn off your chargers for just a bit to get the *BankManager™* to reconnect. **For this reason, *it's best not to use the Configuration Menu after you are done charging for the day.*** *If you do and the sun is down, you might have to start your engine for a few minutes to bring your lead voltage up for reconnection.*

Normal Operation

⚠️	**The first time you power up your BankManager, it was recommended to remove the contactor coil fuse. After configuring your device properly be sure to replace the fuse before normal operation.**

Reading the Display

Under normal operation, you will see 1 of 2 screens presented:

When Lithium bank is *disconnected:*

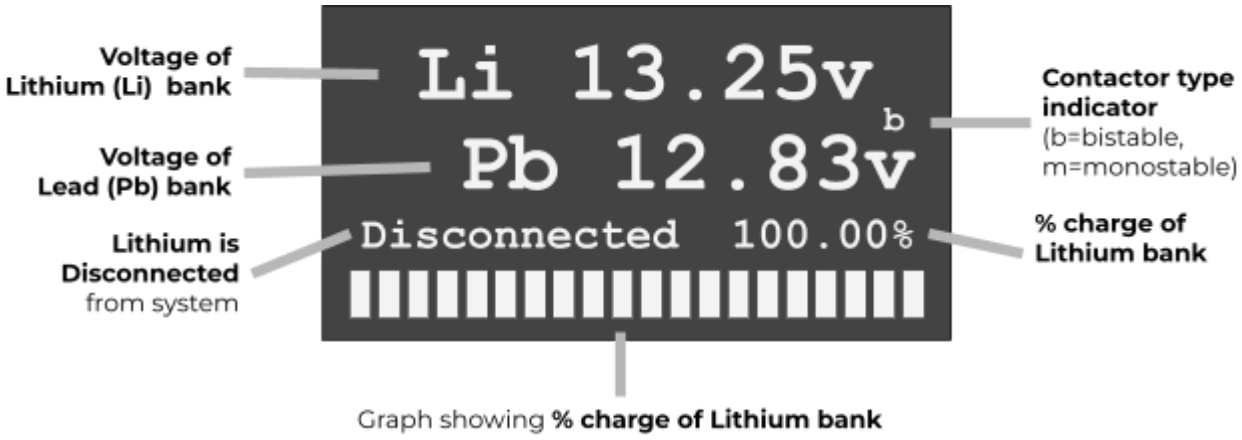


Fig. 6.a: BankManager™ OLED display when Lithium is disconnected from system.

When Lithium bank is *connected:*

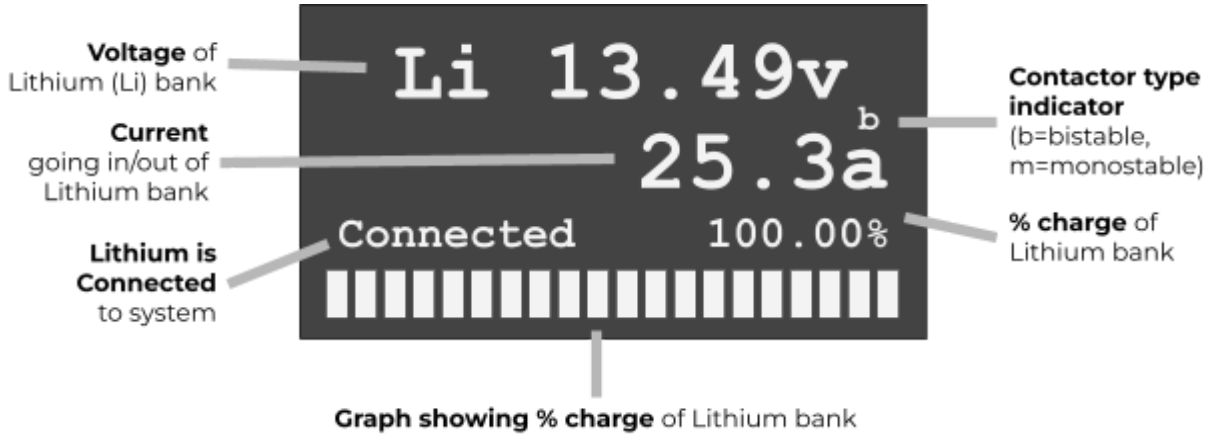
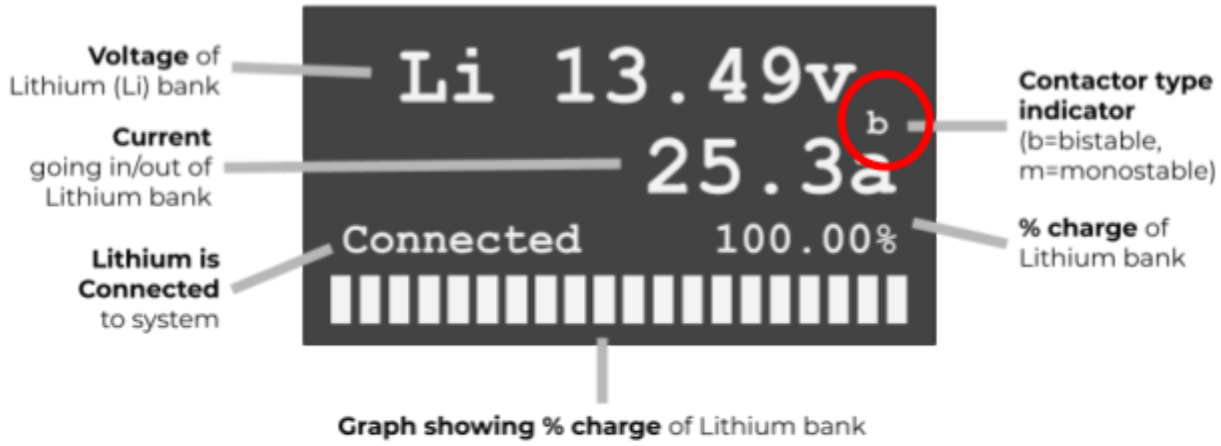


Fig. 6.b: BankManager™ OLED display when Lithium is connected to system.

Contactor Type Indicator

Both screens also display a small '**b**' or '**m**' on the right side of the display, indicating the contactor type that is currently configured (**b**=**bistable**, **m**=**monostable**).



⚠️	**It is vitally important that your contactor type be set correctly.** If the *BankManager™* is set for 'm' while connected to a bistable contactor, it will burn out that contactor. (And of course, operation will simply be wrong if the settings are incorrect.)

The screen also has:

- fields that plainly say whether the lithium bank is **connected** or **disconnected**
- a field that tries to guess the **state of charge** of the lithium bank
- a bar graph showing the state of charge.

💡 **Note from the inventor:** Notes about "percent of charge". Whenever the BankManager™ is turned on with its switch it will default to 100% POC. The POC reading will not be accurate until the first charge cycle has finished and the first asterisk is displayed.

Once this happens you will likely find that your other percent of charge meters don't agree. Most likely the BankManager™ is more correct simply because it can reset itself at every full charge cycle.

Even if you feel the BankManager™ POC number is inaccurate, rest assured that this number is only used to display on the screen and to decide when MIN POC is reached if you made that setting. All really important functions use a much more reliable signal based on voltage, current, time and other secret internal sauces.

Testing

⚠️	**Before trusting your *BankManager™* and your installation to run autonomously, it's important that you verify its operation.**

For the first couple of charge cycles, you should watch the operation of the *BankManager™* to verify it is operating as you expect:

1. **Check for proper disconnection.** Make sure that it stops the charge cycle of your lithium battery bank when it should, and that the contactor actually opens and disconnects the lithium battery bank from the rest of the system (this is easily done with a clamp-on amp meter).

2. **Check for proper reconnection.** Verify that the *BankManager™* only reconnects the lithium battery bank to the rest of your system when its voltage is very close to the rest of the system's voltage.

The BankManager™ will decide when your lithium bank is fully charged. Depending on several factors, especially charge rate this can happen at various voltages. It's likely this will happen between 13.7v and 14.2v in most solar charging installations.

Configuring Your Regulators

One of the basic design points for the *BankManager™* was that it should allow you to drop it, and some lithium batteries, into an existing, functional system with healthy lead batteries, and it will simply work. There should be no need to replace charge controllers as long as they can be set to reasonable voltages.

If you choose to configure your *BankManager™* to charge to a percentage then you are free to choose where to set your charge controllers. It's important, of course, to not let your charge controllers overcharge your lead batteries, so the top charging voltage should be what your lead can handle. It's probably a good idea to keep that voltage below **14.5 volts**. If you are charging very fast and the voltage gets too high, either the *BankManager™* or your lithium battery's BMS might stop the charge cycle early. If you set your charge controller voltage too high, it can actually take longer to charge your system, especially if your lithium cells get out of balance.

Clicking If your BankManager™ is connecting and disconnecting your lithium bank a lot especially on cloudy days this can be greatly minimized by setting the "float" setting on your charge controllers to a voltage lower than what **MAX FULL BATTERY VOLT** is set for. A setting of 13.4v for a 12v system is usually a good choice.

Equalizing your lead bank. Technically, you can run an equalization cycle on your lead if you want. You should verify that the *BankManager™* disconnects your lithium battery bank before voltage gets over 14.6 volts, at least the first time.

⚠️	**IMPORTANT: For 48V installations, take care not to subject the BankManager™ to over 60 volts.** If you must equalize your lead batteries, first verify your lithium bank is disconnected (push the knob if necessary) and turn off the BankManager. After equalizing the batteries, you can turn the BankManager™ on again.

💡 **Note from the inventor:** If you have enough lithium capacity in your system that your lead batteries seldom get used overnight, you should consider lowering the soak time for your lead batteries. Why? Because in this situation, your lead batteries really aren't being used. So they will likely reach full voltage just seconds after the *BankManager™* removes the lithium battery bank from your system. And there is never a need to charge a full battery, even for lead—it just wastes water.

If you use your lead over a cloudy period, then yes—the lead might not get fully charged during the next cycle. But it would likely charge back up before it was needed again. Just something to think about.

Adding Manual Control to a Bistable Contactor

If you would like manual control over your bistable relay, it can be easily done with two momentary switches and some operator care.

To do this, simply wire 2 momentary switches from the “on” and “off” terminals of the *BankManager™* to the ground of the lead bank. It is usually best to use a SPDT ((momentary)on-off-(momentary)on) switch for this so that only one coil can be powered at once. Do not use non-momentary switches as the risk of destroying the contactor is high.

To operate the contactor this way, first turn off the *BankManager*. Then use the switch to power one of the coils. (If you power the “off” coil, the contactor will turn off. if you power the “on” coil, the contactor will switch on.)

⚠️	**Take great care not to turn on the contactor unless the two battery types are at the same voltage**, **or else extreme current could flow through your system.** In a well-designed system, your BMS and fusing should protect you from any real damage, but it’s not worth the risk. Also, **never power the coil for very long.** The *BankManager™* only powers the coils for 150 milliseconds. Anything over a half second is dangerous to the contactor, and could burn out its coils, rendering the device inoperable.

Reliability Features

Your BankManager™ has been designed with features to help it survive in a tough corrosive environment. It’s not waterproof but all its circuits have been coated with a military type conformal coating to protect it from corrosion and shorting due to condensation.

Every effort has been made to make the BankManager™ run reliably. But in the off chance that it were to fail there is a hardware “watchdog” timer that will automatically reboot the device and resume normal operation.

If there were ever a problem with the current sensor or its cable the BankManager™ can be configured to run in “charge to voltage” mode until the problem can be addressed.

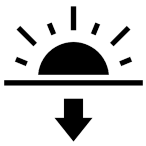
How the BankManager™ “Thinks”

Don’t be fooled by its size—your *BankManager™* has a lot of complex logic running inside of its little microprocessor. But it has been designed to be easy to configure and use. In fact, most users should just set their lithium battery bank size and contactor type and go.

Since most users nowadays charge with solar panels, we will discuss a day in the life of the *BankManager™* device in terms of solar power. But no matter where your system gets its power from, operation will be basically the same, even if multiple sources are used.

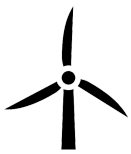
A “Day in the Life” of the *BankManager*

Generally, the *BankManager™* will start its day with the lithium connected to the rest of your system. It has spent the night allowing the lithium battery bank to supply your power systems needs, and even float your lead batteries. If the lithium battery bank’s voltage dropped enough to be marked as “no longer full” (i.e., it dropped to the level you set under “Reset Full Battery”), then once charging starts, most of your system's power will go into your lithium battery bank. Your lithium will continue charging until your lithium battery bank reaches the point at which you configured the *BankManager™* to stop charging (the specifications you set under “Charge To”). Then the *BankManager™* will disconnect the lithium battery bank from your system, allowing your charge controllers to continue charging your lead batteries and supplying power.



Upon completion of the lead charging cycle (or the end of sun for the day), your system's voltage will start to go down. Once the voltage of your system reaches the same voltage as your lithium batteries, the *BankManager™* will reconnect your lithium battery bank with your system. At this point, your lithium batteries will run your power system.

It’s possible—and likely, on a cloudy day—that the *BankManager™* might connect and disconnect the lithium battery bank several times. (You will hear a “click” noise each time it connects or reconnects.) This is normal, because the *BankManager™* is very careful never to charge a fully charged lithium battery. Eventually, the system voltage will drop below the level you set as the point where your lithium batteries can no longer accept power (“Max Full Battery Volt”) and the clicking will stop.



If a different charge source starts producing power (perhaps a wind generator or your engine's alternator) the *BankManager™* will not allow power to go into your lithium battery bank as long as it considers your lithium batteries are “fully charged” (the level you set for “Reset Full Battery”).

BANK MANAGER™
Battery Bank
Management System

Support & Inquiries

For more information about the BankManager™ and BBMS technology, contact:

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💡 **Note from the inventor:** Special thanks to Conrad Grillo for his help testing the Battery Bank Management System (BBMS) and pushing me to add one feature after another until the *BankManager™* became the device it is today.