HIGH DESERT AMATEUR RADIO CLUB

INSTRUCTION MANUAL

Assembly of LiFePO4 Battery Unit for Mobile Amateur Radio Use

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Prepared by: John R. Dodd (KJ5KUF)

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Overview

This instruction manual provides a step-wise assembly procedure for the cost-effective build of an 8-cell LiFePO4 (Lithium Iron Phosphate) battery unit, from this point forward generically referred to as a **LiFe Battery**. The purpose of the manual is to provide the builder with a mobile power source that supplies power for long-term operation of amateur radio equipment in a mobile environment.

Members of the HDARC refer to this LiFe Battery by multiple names, such as, Ammo Can Battery or Ammo Can LIPO Battery, but it's all the same. When you complete this instruction, conceptually you will produce something that looks like Figure 1. **(Note, the contents of the ammo can are much more extensive than just the LiFe batteries pictured in the figure.)**

Your final battery assembly will be an enclosed container with charger and power cables inputs and outputs. The power comes from an external AC/DC power source and outputs to your HAM radio equipment. This is a fun project. You will accumulate valuable knowledge and learn valuable skills along the way.

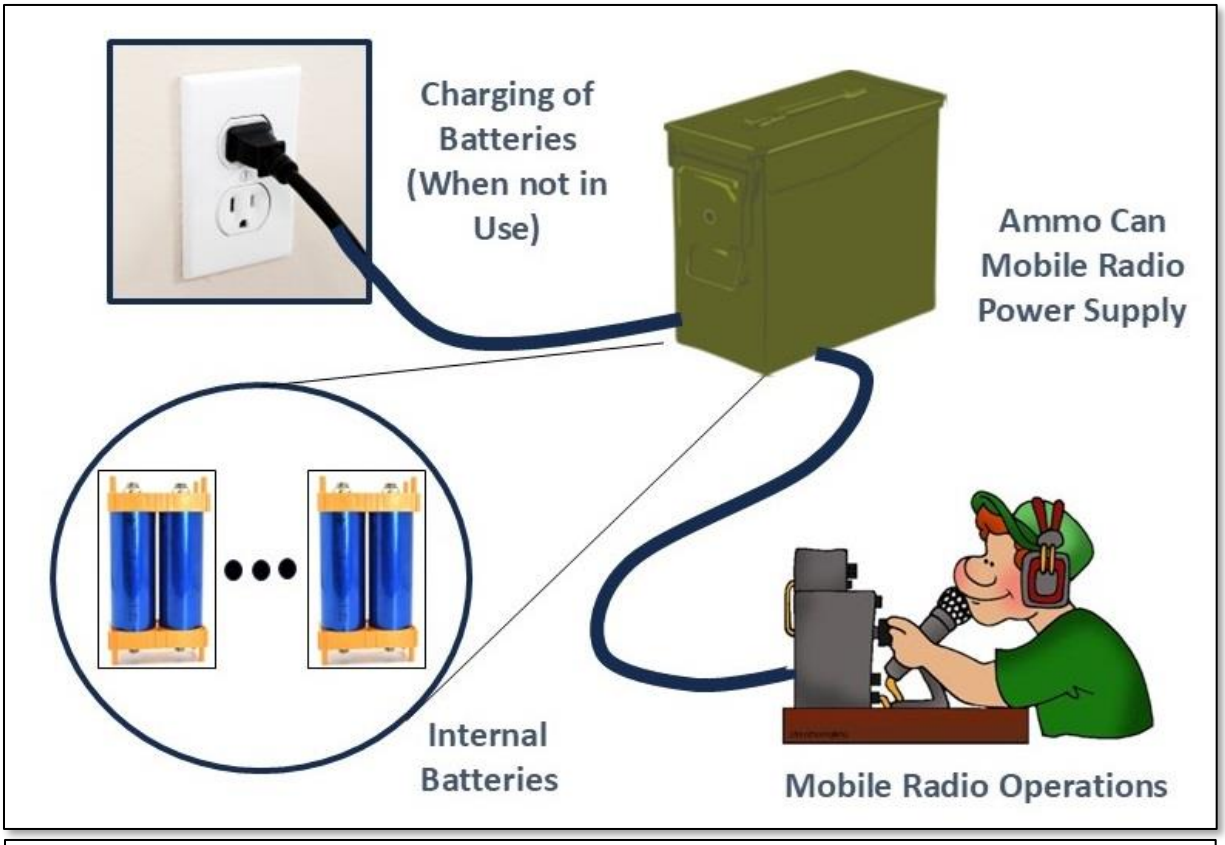


Figure 1: The LiFe Battery End-Product

Credits and Thanks

The LiFe battery build described in this document is derived from a variety of YouTube, Google, vendor, and HDARC expert designs, in particular Rob Summerhill (KI5NBN) provided the primary design and motivation for this build activity. This manual accompanies an exhaustive list of components compiled by Mark Tibbett [KJ5ITL]. Bob Watson [KJ5GMA] provided alternate approaches for satisfaction of parts of this build. John R. Dodd (KJ5UF) compiled all of their wisdom into this collective offering. Critical review and editing were provided by Don Shoemaker (N9DCS).

Document Structure

In addition to the main instruction, this document provides several supplemental appendices that are critical to a an undertaking and understanding of the assembly process. Appendix A provides a required component list. Appendix B provides the Air8 Battery Charger System charging and operation settings for a 4-cell LiFe battery unit. Finally, Appendix C provides an alternative 4-cell LiFe battery build developed by Bob Watson (K9GMA).

As indicated in Appendix A, components may be purchased from a variety of sources and vendors. Participation by builders at HDARC 2 Night radio chat sessions and at our monthly meetings is greatly encouraged. These group sessions will provide the builder with opportunities for discussing questions, comments, and/or other suggestions. Please see the HDARC Dispatch newsletter for our meeting schedule, which can be found at the HDARC website: www.nm5hd.org.

Introduction

The assembly of a LiFe Battery unit is analogous to building a WWII Liberty ship. That is, we will build individual modules and then assemble them into a final end-product. Like the Liberty ship, first build the bow structure. Then build the aft, all the midship sections, and the bridge. Finally, weld all the sections together and launch it – and hopefully the ship floats. This manual provides directions for the assembly of individual battery modules, and then brings them together into an integrated battery assembly. (However, please do not expect the final LiFe Battery unit to float.)

Throughout the assembly, builders are reminded to adhere to safety procedures, such as wearing eye protection or separation of any potentially reactive battery leads and wires. The instruction will provide tips and tricks to facilitate the build process. The potential builder should read through this entire manual before proceeding with the LiFe Battery build, in order to establish a working familiarity with the overall process and to gauge their capability to safely complete the end product.

Cautionary Note

> Please know that HDARC assumes no liability for any personal injury. It is the responsibility of the builder to determine if they possess the necessary mechanical and electronic skills to undertake this battery project.

The LiFe Battery Build

The LiFe battery instructs 7 major assemblies. The initial assembly of components will focus on support for a single rechargeable 4-cell LifePo4 unit. The 4-cell LiFe unit alone is sufficient to support HAM radio operations in the field. The 8-cell configuration will connect two 4-cell units, and thus double the amperage hour operation of a single 4-cell configuration.

The 7 major component assemblies of the LiFe Battery system are:

1. Power supply charger with connector,
2. Basic 4-cell LiFe Battery unit,
3. Battery Charger System (BCS),
4. Battery Management System (BMS),
5. Integrated 4-cell LiFe Battery unit
6. Integrated two 4-cell units into an 8-cell unit configuration, and
7. Packaging into a portable configuration.

Component Assembly #1: Power Supply Charger with Connector

For the LiFe battery build we have elected to use an iSDT Air8 battery charger. This charger requires an external power source. Although the charger itself will power on through a USB micro port, this is not sufficient to provide output power to the LiFe battery unit when under charge. Therefore, a more robust power source is required, which can be provided by attaching an old laptop power supply. The laptop power supply output links to the battery charger via a pre-made, purchased adapter, or by modifying the output power cable with an adapter appropriate for input to the battery charger. Figure 2 provides an image of a laptop power supply with output power cable.

Figure 2: Candidate Laptop Power Supply

Adaptation of the power supply requires splicing the laptop output power plug (not the input AC plug) from the power supply unit to a male XT60 pigtail adapter. **(Note, the builder may choose to assemble this adapter through individual wire and plug components, as well.)**

When cut, the exposed power supply will have 2 or 3 wires, which will require soldering the hot and common wires of the power supply to the XT60 pigtail connector.

The laptop supply listed in Appendix A has 3 wires, a black, a white, and a blue wire. The blue wire is used as a laptop sense wire, so it can just be cut short and ignored. That leaves the white and the black wires for splicing to the black and red wires of the XT60 pigtail, as follows:

1. Strip the two power-supply wire ends to expose the internal metal cores.
2. Strip the corresponding ends of the XT60 pigtail.
3. Separate both sets of wires in order to provide for the insertion of shrink wrap tubing.
4. Tin the exposed wire ends of both the power supply and pigtail with solder and then connect the soldered ends using a soldering iron: **(Note,**
    a. **The positive side of the XT60 connector is the square-shaped side – not the pointed side, which is the common).**
    b. **Use a volt meter to verify the 19-19.5 voltage and polarity of the white and black power supply wires. This will involve temporarily powering on the power supply for measurement with the meter probes. Be careful not to allow the stripped wire ends to touch!**

c. **19-19.5V with positive polarity indicates which wires of the power supply (white or black) should be connected to the red (positive) and black (common) wires of the XT60 pigtail.**

5. Once the two sets of wires are connected, slide the heat shrink tubing over the joins and seal.
6. Wrap the entire assembly in electrical tape or heat a second, larger heat-shrink tube over the spliced assembly. **(Note, in order to apply a second heat-shrink tube, it needs to have been inserted over the originally cut laptop power supply wire.)**

The finished laptop output power cable connects to the left-side power-input to the Air8 battery charger. When you connect the adapted laptop power supply to AC power, the Air8 will power on. This standalone configuration allows for programming of the Air8 unit as described in Appendix B.

Figure 3: XT60 Female-to-laptop power supply adaptor

Figure 3 provides an image of a power supply to XT60 adapter, which may be purchased from various vendors as identified in Appendix A.

Component Assembly #2: Assembly of Basic 4-Cell LiFe Battery Unit

The basic 4-cell LiFe-battery unit, as the name suggests, consists of 4 independent LiFePO4 batteries (as show in Figure 4) and arranged in an assembled plastic carrier case.

Figure 4: Single LiFePO4 battery

Cautionary note to the builder: The individual batteries hold a 3.3-volt charge, which you will subsequently verify. Therefore, for safety reasons it is extremely important to:

1. **Wear protective eye-wear,**
2. **Avoid accidentally or inadvertently connecting battery terminals that may cause an arching electrical spark, such as two terminals of the same polarity, and**
3. **Follow safety procedures for proper handling of batteries.**

Sled Assembly

The 4-cell LiFe battery unit binds 4-battery pillars with two sets of plastic sleds, one sled on the top and one on the bottom. Each TOP and BOTTOM sled assembly consists of 2 individual plastic sleds. Two sleds lock together to form a single 4-hole piece sled.

Figure 5 provides an example of two TOP sled assemblies.

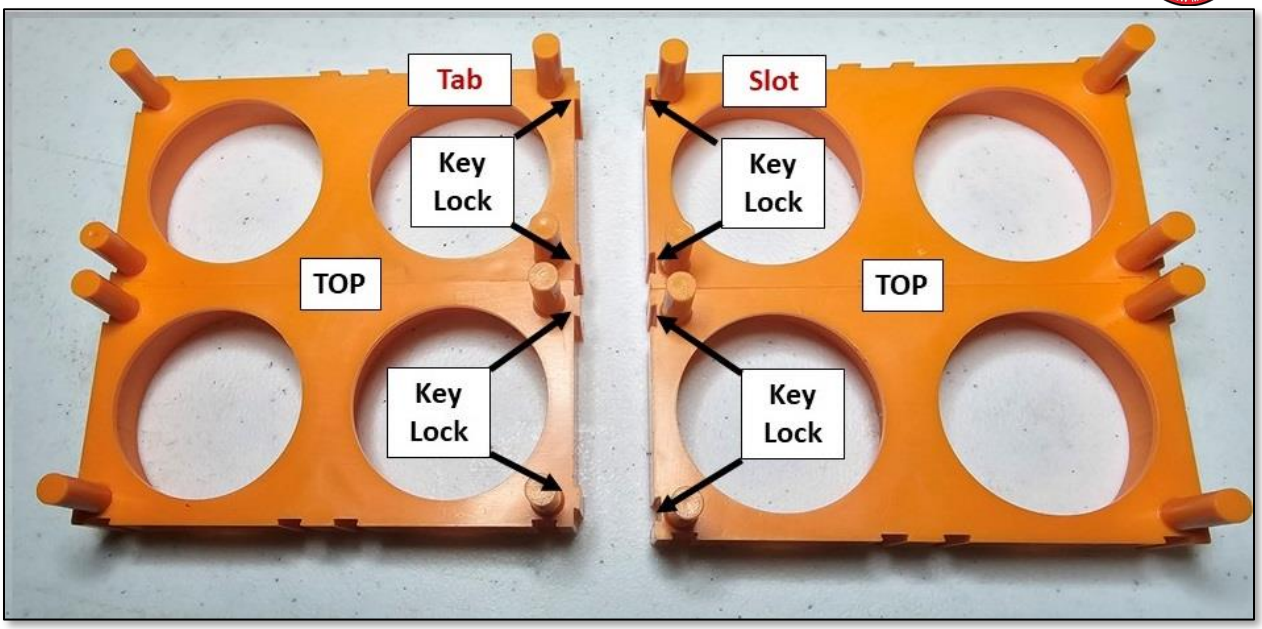


Figure 5: Orientation of Battery Sled Assemblies with Key Locks.

Assembly of the sleds should follow a couple of guiding factors, in order to avoid problems downstream:

1. The join between two individual, plastic, 2-holed sleds should be horizontal. **(Note, there is a seam running underneath the TOP labels in Figure 5.)**
2. If building an 8-cell battery unit, or if you have any intention of linking two 4-cell battery units together, assemble the TOP and BOTTOM sleds of the left-hand unit such that their key locks will mate with the left-hand unit's sled, That is, one side's key lock is a tab and the other side's key lock is a slot.

(Note, there are locking keys on the sides of the sleds such that when assembled there are no air gaps.) See Figure 6 for a side view of a completed batteries-in-sled assembly.

Battery and Cap Assembly

The LiFe batteries slide into the sled assemblies. Place 4 batteries in the bottom sled (two sleds assembled horizontally) in alternating positive to negative ends. Starting at bottom left, insert the positive-end down of the battery. **(Note, the positive end of the LiFe battery is the multi-holed metal terminal.)**

Figure 6: Side View of a 4-Cell LiFe Battery Unit

Next in the upper right corner, insert another LiFe battery, negative-end down. Moving to the upper right, insert another battery positive-side down. Finally, in the lower right, insert the fourth battery negative side down. **(Note, the sled openings may be rather tight, so make sure you insert and shove down the batteries until they seat properly and level.)** Now, place another assembled sled unit on top of the 4 LiFe batteries.

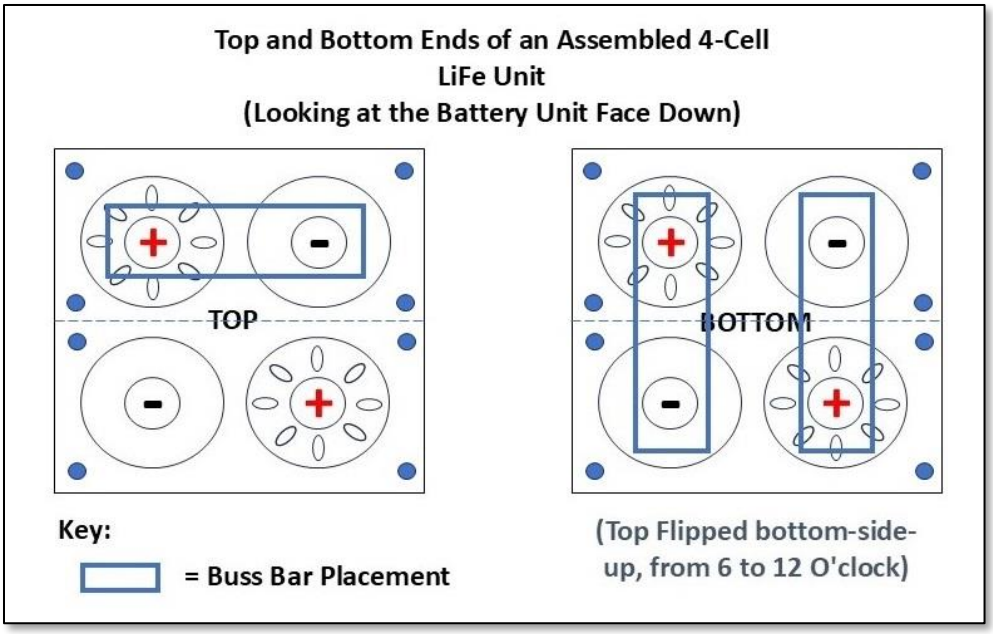


Figure 7: TOP and BOTTOM Sled View of 4-LiFe-Battery Unit

The top and bottom of the 4-unit LiFe battery assembly should look like Figure 7.

Procedure

To summarize, your assembly steps are:

1. Assemble two 2-holed plastic sleds in a side-by-side configuration for your bottom receptacle.
2. Do the same thing for the top receptacle.
3. Insert 4 LiFe batteries in an alternating-terminal clock-wise fashion as described above into the bottom sled assembly.
4. Cap the sled assembly with an assembled top plastic unit.
5. Label the attached sled units as Top and Bottom, per Figure 7.

Testing

Before getting to far down the build path, it is a good idea to test the voltage of the individual batteries and their combined voltage. Individual testing can be done straight out of the box using a multimeter. Set the meter to DCV and put the positive and negative probes to each end of the battery, matching polarity. Each battery should measure approximately 3.3V. With the buss bars attached, measure the voltage of the two open (no buss bar) terminals on the top assembly. The measured voltage should be approximately 13.2V. **(Note, although rare with new batteries, if the individuals do not add up to the desired voltage, or the unit in total does not add up to the overall desired voltage, then replace any faulty batteries before proceeding with the build.)**

Connection-Point Numbering

OK, now it's time to label sides and number specific terminal posts of the battery unit with connection points, so we can later attach wires form the Battery Charger System (BCS) and the Battery Management System (BMS). Figure 7 provides the numbering scheme for these connection points.

With a magic marker, annotate the TOP, BOTTOM, and terminal number labels on the assembled top and bottom plastic sleds, as shown in Figure 8.

Buss Bar Attachment

With the numbering completed, it's time to install the buss bars. Place a lock washer and terminal bolt on each battery terminal. Now, as noted in Figures 6 and 7, install buss bars on the TOP-side across the upper two terminals, and across the BOTTOM-side along the two pairs of side terminals, linking the left pair of terminals and the right pair of terminals, respectively. **(Note, as previously mentioned, do not allow the accidental electrical arching of buss bars to incorrect terminals. If you are anxious about these connections, you could use non-conductive tape to temporarily isolate a terminal or bar end.)**

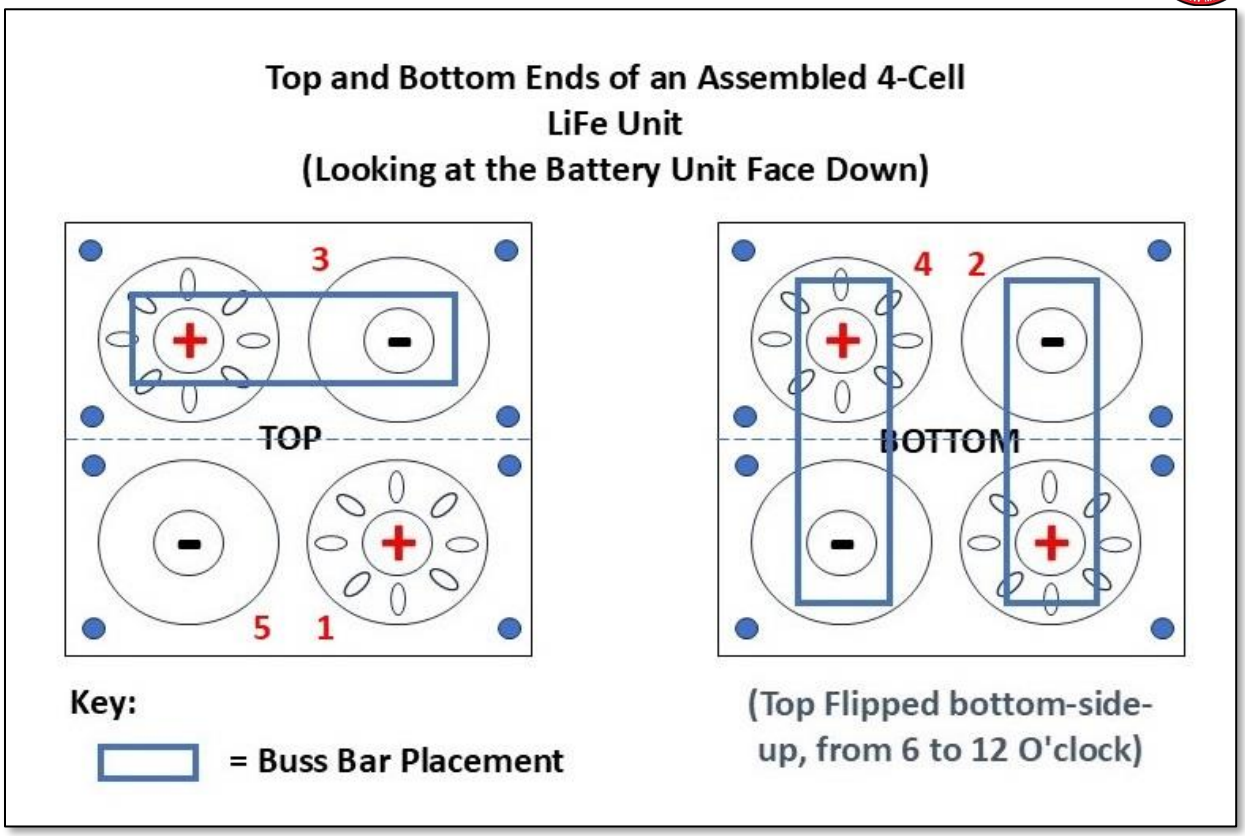


Figure 8: Battery Connection Labels

The abbreviated procedure for installation of the buss bars follows:

1. Obtain 6, M6-1.0 x 8mm bolts and locking washers, along with 3 buss bars.
2. With the bolts and lock washers secure a buss bar between terminals as shown in Figure 7.

Figure 9 provides images of the assembled basic 4-cell LiFe battery with labeling.

Figure 9: The Assembled Basic 4-cell LiFe Battery Unit with Labeling

Component Assembly #3: Battery Charger System (BCS) with Cables

As previously mentioned, the selected Battery Charger System (BCS) is an iSDT Air8, as shown in Figure 10. The charger

has connector ports on the left and right side. On the left side are the input power connector port and a micro-USB port. The input power port accepts an XT60 connector. The USB port provides for laptop connection of local unit power (not sufficient for charging) to the BCS for unit programming and firmware upgrades.

On the right side of the Air8 BCS are the output power port (to the LiFe battery unit) and the charger's battery sense port. The output power connector is an XT60 female type, while the charger sense connector is a single 5-wire JST-XH connector cable. Subsequently, we will install an adapter cable (bought or DIY built) that converts the output power XT60 port to an Anderson-Power-Pole adapter. **(Note, the Air8 output sense cables will be used with an extension cable.)**

The Air8's sense port can also accept an iSDT proprietary connector for insertion of a Bluetooth adapter (Air8-to-BattAir-JST-XH). Use of the Bluetooth capability will also require a proprietary iSDT app on your cell phone. For this build, however, we will ignore the Bluetooth capability and connect a JST-XH connector directly to the sense port.

Figure 10: iSDT Air8 Battery Charger System (BCS)

The output sense port cable is a 5-pin JST-XH type for 4S battery operation, with crimped ring connectors that will attach to specific battery unit terminals. (More on that below.)

Figures 11 and 12 provide images of the Air8 output cables. Figure 11 is an XT60-to-Anderson-Power-Pole output power cable. Figure 12 is an Air8 sense cable, which will be spliced to ring connectors for attachment to the 4-cell battery unit.

Figure 13 provides a top-down view of the Air8 BCS with notional cabling and labeling. The right-side sense port uses a numbering scheme that labels 8 pins from left to right, if looking into the port, or bottom to top, when looking at the Figure. This numbering scheme runs 2S, 3S, 4S, 5S, …

8S, and corresponds to the order of pins that are used to charge a LiFe battery unit. Our LiFe battery unit is a 4-cell, which corresponds to a 4S nomenclature (S stands for cell).

Figure 11: XT60-to-Anderson-Power-Pole Adapter Cable

Thus, our sense cable is a type 4S configuration and has 5-pins of 22AWG wiring. We subsequently will label the individual wires for our sense cable as 1,2, 3, 4, and 5, at the ring connector ends.

The following step-wise instruction provides for the assembly of the charger's output power cable and connectors. As follows:

Figure 12: 5-Pin Air8 Sense Cable

1. Beginning with a male XT60 pigtail connector, strip the red and black wires for adaption to a similar Anderson-Power-Pole pigtail connector. **(Note, the builder has the option of assembling these connectors with wires from scratch or by purchasing of a single XT6-to-Andrson-Power-Pole adapter cable.)**
2. Separate both sets of wires in order to provide for the insertion of shrink wrap tubing.

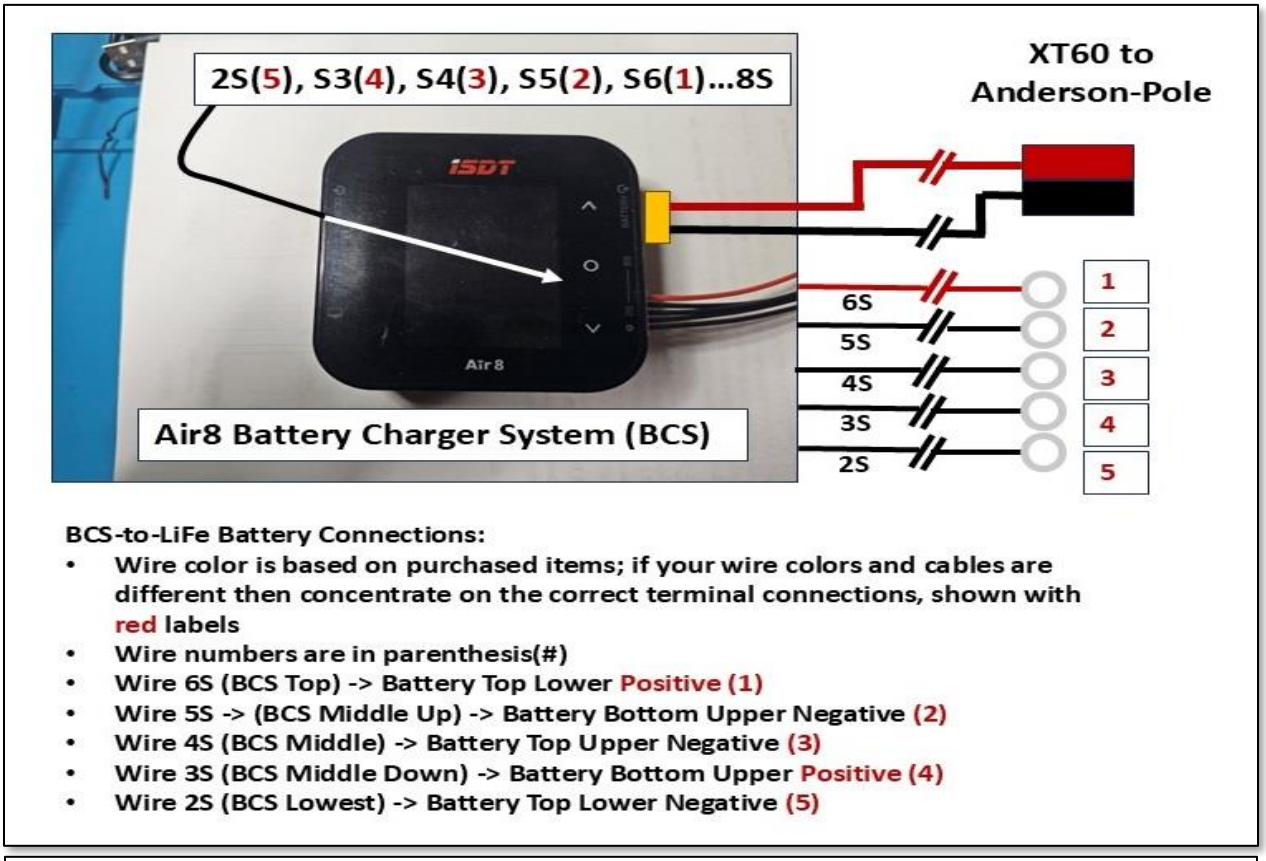


Figure 13: Air8 Battery Charger System (BCS) with Notional Cabling

3. Tin the exposed wire ends with solder and then connect the soldered ends using a soldering iron. **(Note, the positive side of the XT60 female connector is the square side of the connector. not the pointed side (common).**
4. Slide the heat shrink tubing over the joins and seal.

The following step-wise instruction provides for the assembly of the output 5-pin JST-XH sense cable and connector (Note, use of a 4S JST-XH cable and alignment with the Air8 port is only possible in one direction, left to right.

(Note, ignore the color coding of the sense cable wires. Different vendors use whatever wires that are available to them, without regard to any overall standard (4 black wires to a single red wire.) It is for this reason that our assembly concentrates on wire number and labelling.)

Figure 14: BCS Extension Sense Cable

As follows:

1. Strip the ends of the 5 wires extending from the JST-XH connector, and tin them with solder. It is likely these will be approximately 22 AWG wire.
2. Slide heat-shrink tubing of the correct size over each end-stripped wire, in order to accommodate the ring connector identified in the next step. **(Note, some ring connectors already have a heat-shrink sheath.)**
3. Sequentially, insert and crimp (or solder and crimp) a metal ring connector on each of the 5 wires.
4. (Slide and) Heat the shrink in place and seal to the joined ends of the ring connectors.
5. With an indelible marker, label each ring connector with a number 1 through 5, as indicated in Figure 10.
6. Attach the newly built sense cable to the 4S JST-XH extension cable, and insert the extension cable (Figure 14) into the Air8 sense port.

Figure 15 provides an image of a standalone BCS with output cabling. **(Note, in the Figure the final sense ring-end cable is not shown, as it would be connected to the JST-XH extension cable. Also, a JST-XH gender-bender provides for the correct port interface.)**

Component Assembly #4: The Battery Management System (BMS)

Figure 16 depicts the Battery Management System (BMS) and its associated cable. The BMS is a printed circuit board, which performs multiple functions, but most importantly, it protects and balances the charging of the batteries, resulting in their longer life.

Similar to the BCS, the BMS has a 5-pin JST-XH cable, which will connect to specific terminals of the LiFe battery unit. We will label the individual wires of this sense cable as 1, 2, 3, 4, and 5. Depending on the manufacturer's nomenclature, however, on the circuit board the corresponding pins may be labelled B-, B1, B2, B3, B+. P-, and C-, or something similar. We will use a subset of these pins.

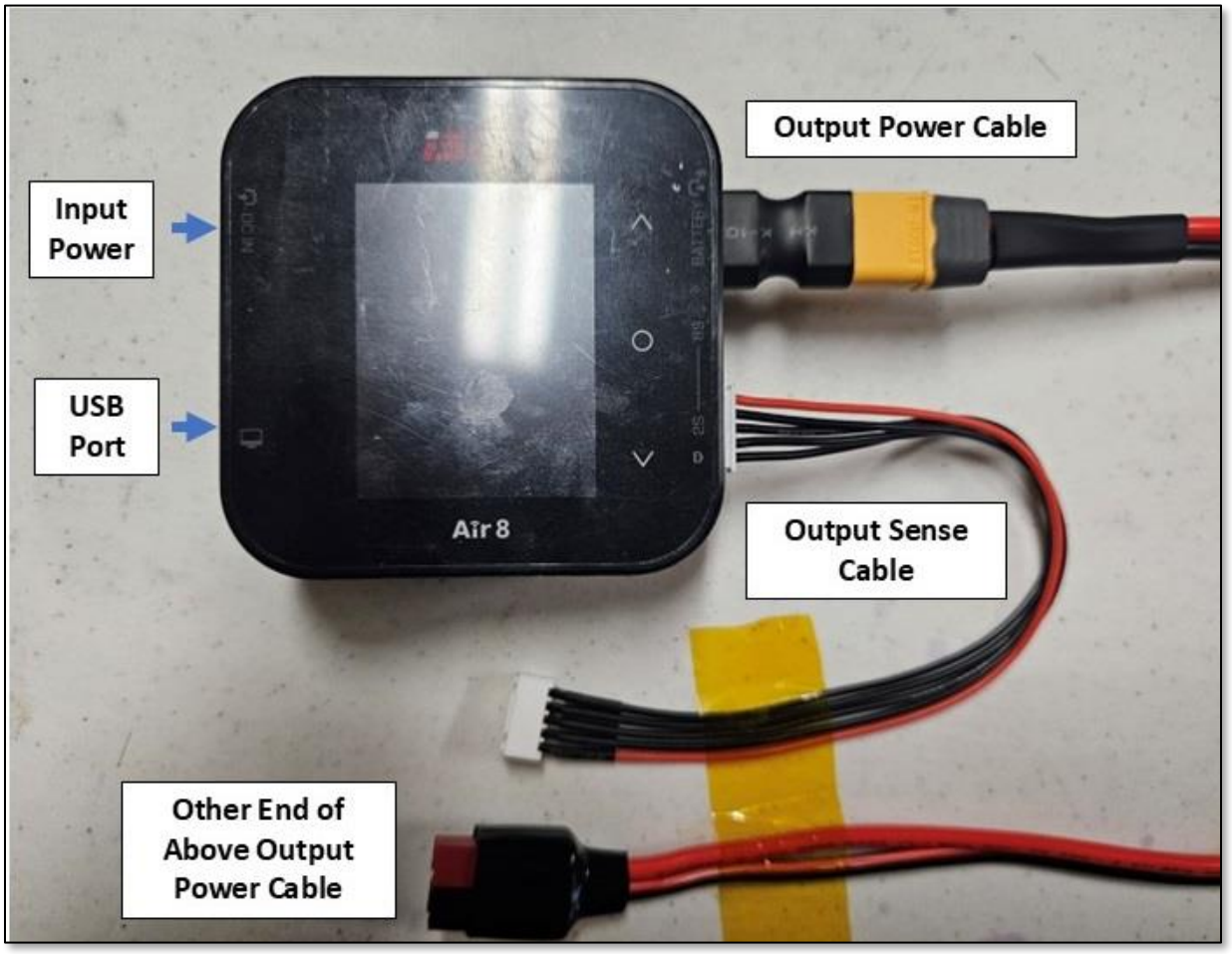


Figure 15: Standalone BCS with Output Cabling

Figure 16 highlights the wires and their labeling. A ring will terminate each of the 5-wires comprising the sense cable of the BMS. The sense cable wires are size 22 AWG (thin wire). Wires B- and P- are 14 AWG (thick) and are soldered to the battery unit. Wires B- and P- connect to the power unit (such as the radio) or battery charger via an adaptable cable harness. (More on that down-stream connections later.)

Note, the BCS and power unit are never connected at the same time, but this connection is transparent to the BMS.

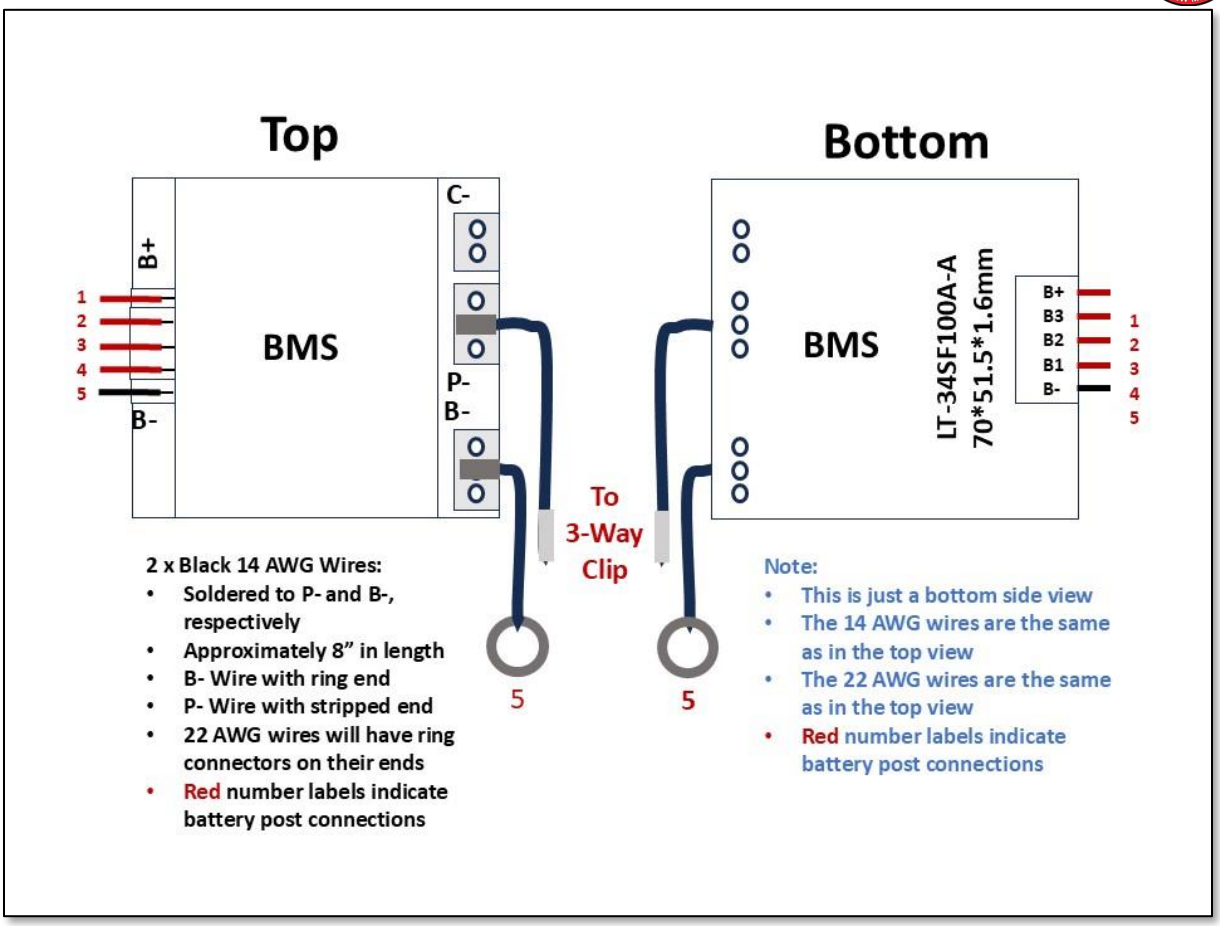


Figure 16: The Battery Management System (BMS) and cabling

It is important to observe that the BMS manages current to the power unit through the negative side of the circuit, that is, the common side of the circuit. This will become apparent when installing the BCS/power unit harness.

The following step-wise instruction provides for the assembly of the BMS sense cable:

1. Beginning with the 5-pin JST-XT pigtail connector that plugs into the circuit board, strip the opposite ends of the wire.
2. If needed, separate the wire ends in order to provide for the insertion of shrink wrap tubing.
3. Tin the exposed wire ends with solder.
4. Attach ring connectors to each of the five wires, and heat the inserted shrink wrap or existing shrink wrap collar of the ring connector.
5. With an indelible marker, label each ring connector with a number 1 through 5, as it corresponds to the numbering in Figure 16. Write the label numbers on the wires or upside of the rings. See Figure 17 for an example of labeled ring connectors. **(Note, the**

Figure 17's example shows two separate ring connectors that will attach the third wire of the BCS and BMS sense cables to the labeled terminals of the LiFe battery.)

Figure 17: Example of Labeled Ring Connector.

The following step-wise instruction provides for the assembly of the BMS B- and P- minus wires:

1. Cut two 8" 14-AWG lengths of wire, both black.
2. Strip about 4mm (~.125 = 1/8 inch) of wire from the ends of the wires.
3. Tin the exposed wire ends with solder.
4. Attach a ring connector to one of the wires.
5. Slide heat-shrink onto the wire with the ring, push the shrink down over the end of the ring, and apply heat to the shrink to secure it in place over the ring ends.
6. Solder the ring-ended wire to the B- plate of the BMS
7. Solder one end of the remaining bare-ended black wire (the one with no ring) to plate P-.
8. Temporarily wrap the other bare end of the remaining wire with tape, to prevent any accidental arching. **(Note, you can attach the bare end of the remaining wire to the end slot of a 3-way WAGO 221 connector, to provide the same protection. The WAGO will subsequently be used as part of the BCS/power unit harness.)**

Set the completed BMS aside for connection to the 4-cell LiFe battery unit in the next assembly.

Component Assembly #5: Integrate 4-Cell LiFe Battery Unit

Now it's time to integrate the basic 4-cell LiFe battery unit with the BCS sense cable and the BMS. Once this assembly is completed, the builder may choose to forgo assembly into a full 8-cell unit system, and attach the BCS/power unit harness. The 4-cell assembled unit with harness is sufficient to power radio operation. The length of operation time will be dependent of the average hourly draw of the target radio and the current available in the battery system.

Attach the BMS

With stringed tie-wraps, electrical tape, hot glue, or any combination of these, attach the BMS to the front side of the 4-cell battery unit. Ensure that the BMS sense connector points upwards. **(Note, it may be easier to first detach the sense cable from the BMS, in particular to facilitate testing of the wires when connected to their respective battery terminals.**

Loosen, if tight, the TOP battery terminal screws. Using Figures 8 and 16 as guides, attach the ring connectors of sense wires 5, 1, and 3 to their corresponding labeled terminals on the battery by placing the rings under the terminal screws with lock washers. Recall, terminal 5 is TOP lower-left **negative**. Terminal 1 is TOP lower-right **positive**. Terminal 3 is TOP upper right. Attach wire 3 to the top of the buss bar.

Now, flip the battery unit from 6 o'clock to 12 o'clock, in order to bring the BOTTOM upwards into view. Again, using Figures 8 and 16 as guides, attach ring connectors of sense wires 4 and 2 to their respective battery terminals. Recall, the BOTTOM battering terminals are connected length-wise on the left and the right with buss bars.

Temporarily tighten the battery terminal screws in order to provide secure circuit connections for measurement of the sense cable to verify voltages, as follows:

1. With a multi-meter, touch/insert the positive probe to wire number 1 of the BMS 5-pin JST-XH connector.
2. Touch/inset the positive probe (red) to wire number 1 of the BMS JST-XH connector. **(Note, pins 5 and 1 are the outer pins.)**
3. Verify in sequence that the voltage measurements read approximately 13.2V for pins 1 and 5, and subsequently by holding the red probe to pin 1 and moving the black probe that:
    a. Pin 2 measures 3.3V,
    b. Pin 3 measures 6.6V, and
    c. Pin 4 measures 9.9V.

4. Re-insert the BMS sense cable into the BMS board.

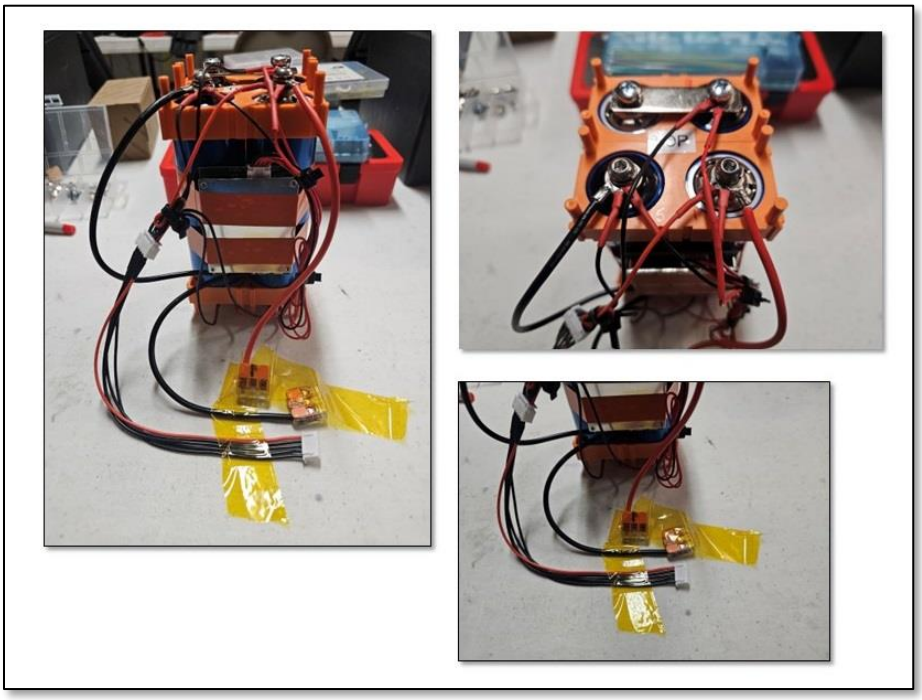


Figure 18: Assembled 4-cell Battery with all cables

To tidy up the assembly, use tie-wraps to group the excess sense cable wires into a shortened loop assembly. Figure 18 provides an image of this growing battery assembly. **(Note, the Figure also displays the B- and P- wire attachments described below, along with the attached BCS sense cable.**

Proceeding to the B- 14 AWG wire, attach its ring connector to battery terminal labeled number 5.

At this point, it is expedient to make a red 8" 14-AWG wire with ring connector for connection to the BCS/power unit harness, as follows:

1. Cut one 8" 14-AWG lengths of red wire and strip the isolation off the ends.
2. Strip about 4mm (~.125 = 1/8 inch) of wire from the ends of the wires.
3. Tin the exposed wire ends with solder.
4. Attach a ring connector to one end of the wire.
5. Slide heat-shrink onto the wire with the ring, push the shrink down over the end of the ring, and apply heat to the shrink to secure it in place over the ring ends.
6. Temporarily wrap the bare end of the red wire with tape, to prevent any accidental arching. **(Note, you can attach the bare end of the red wire to the end slot of a 3-way WAGO 221 connector, to provide the same protection. The WAGO will subsequently be used as part of the BCS/power unit harness.)**

Attach the BCS

Disconnect the BCS extension sense cable as previously shown in previous Figure 15 (Output Sense Cable) from the BCS unit. Attach the extension sense cable to the 5-pin JST-XH cable with ring connectors, as previously prepared in Assembly #3. Now loosen, if tight, the TOP battery

terminal screws 5, 3, and 1 on the LiFe battery unit. Likewise, loosen BOTTOM battery terminal screws 2 and 4 on the battery unit.

Using Figures 8 and 13 as guides, attach the BCS sense cable ring connectors to TOP battery terminals 5, 1, and 3. Ensure that the ring and wire connectors face downward from the TOP battery terminals (that is, toward the front face of the battery unit), similar to the downward direction of the sense cable ring connections of the BMS on the TOP. **(Note, the battery terminals will each now share multiple wire connections. Terminals 5, 1, and 3 will now have two sense wires, one from the BCS and one from the BMS, respectively. The third black, thicker gauge wire on terminal 5 is from the B- connection of the BMS. The third red, thicker gauge wire on terminal 1 is from the lead to the battery harness 3-clip connector.).**

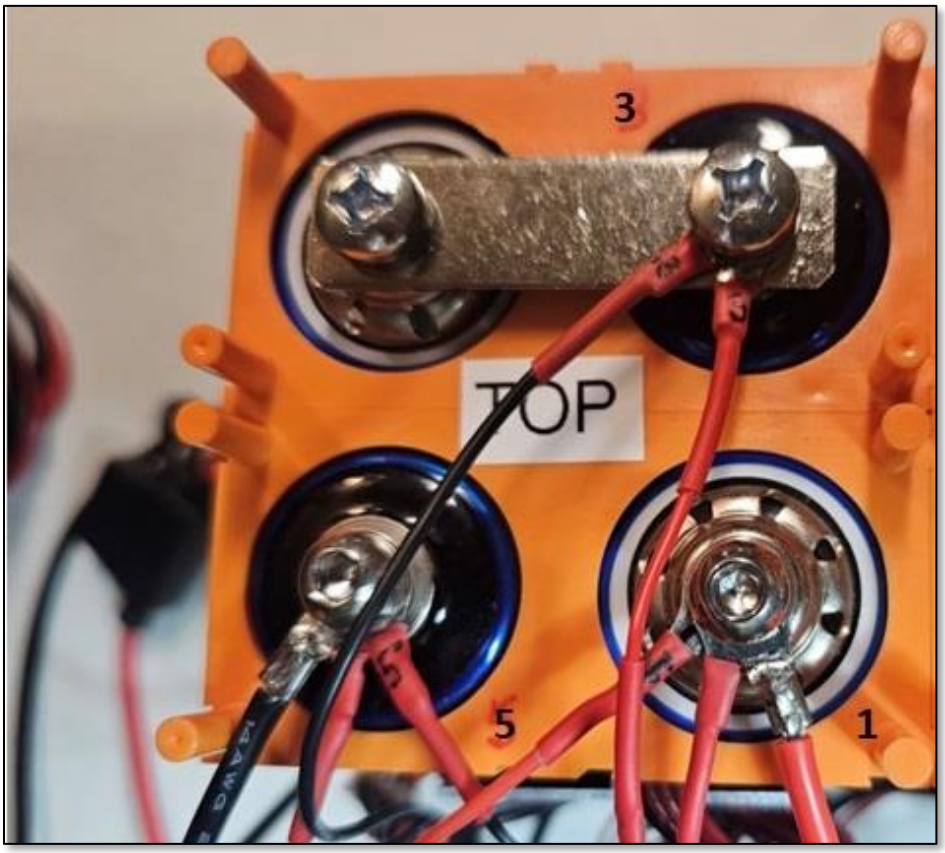


Figure 19 BCS and BMS Dual-Wire Connections to the TOP of the Battery Unit.

Figure 19 presents the dual connections of the BCS and BMS sense wires to the TOP of the battery unit, as well as the thicker gauge wires on terminals 5 and 1 previously mentioned.

Now, flip the battery unit from 6 o'clock to 12 o'clock, in order to bring the BOTTOM upwards into view. Again, using Figures 8 and 13 as guides, attach ring connectors of sense wires 4 and 2 to their respective battery terminals. **(Note, these battery terminals will each share two wire connections (terminals 4 and 2) to the BCS and BMS sense cables.)**

Cation: Before flipping or moving the battery unit ensure there are no exposed wires that may come into contact with each other, thus causing an electrical arch/discharge.

Tighten the battery terminal screws in order to provide secure circuit connections for measurement of the sense cable to verify voltages, as follows:

1. With a multi-meter, touch/insert the positive probe to wire number 1 of the BCS 5-pin JST-XH connector.
2. Touch/inset the positive probe (red) to wire number 1 of the BCS JST-XH connector. **(Note, pins 5 and 1 are the outer pins.)**
3. Verify in sequence that the voltage measurements read approximately 13.2V for pins 1 and 5, and subsequently by holding the red probe to pin 1 and moving the black probe that:
    a. Pin 2 measures 3.3V,
    b. Pin 3 measures 6.6V, and
    c. Pin 4 measures 9.9V.
4. Use tie wraps to tidy up any excessively long sense wires into a compact bundle.

Again, verify that the assembled 4-cell battery unit with BMS, BMS cables, and BCS sense cables (with extension) look similar to Figure 16. **(Note, the BCS unit itself is not re-attached.)**

Attach the BCS/Power Unit Harness

At this point, we are getting very close to the finish of the LiFe battery build. One of the last items to fabricate is a connecting-harness that provide for either 4-cell or 8-cell (2x 4-cell) interface to the BCS or power unit (such as a radio).

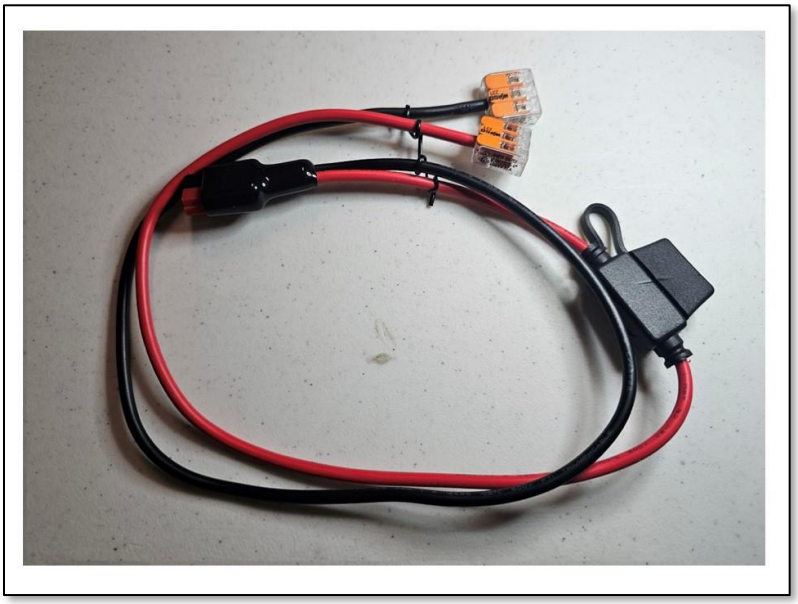


Figure 20: LiFe Battery Build Harness

The battery harness is a pre-built Anderson-Power-Pole cable with in-line 30–40-amp fuse on the **red** (positive) wire, and assembled around a 12-AWG wire structure. The harness is terminated with 2 WAGO 221 3-way connectors, with the stripped 12-AWG wire of the harness inserted into the center slot of the WAGO connector. Figure 20 provides an image of the completed harness.

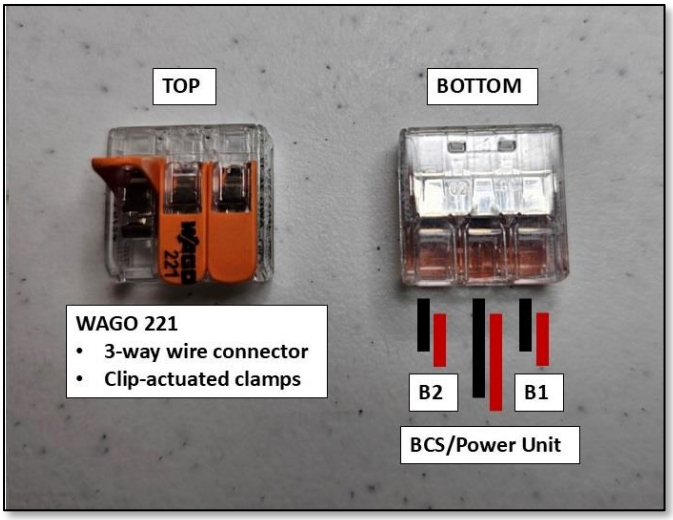


Figure 21: WAGO Connectors of the LiFe Battery Harness

A noticeable feature of the harness is its use of a single 30–40-amp fuse, rather than dual fuses for each 4-cell LiFe batter unit. This provides for externalization of the fuse from the ammo box container, and ease of maintenance in the event of any fuse failure.

Figure 21 presents a WAGO 221 3-way connector. These connectors bind the harness to the battery(s). **(Note, these WAGO connectors are the same ones that were temporarily used in Figure 16 to protect the exposed battery wires off BMS P- and terminal 1 from accidentally arching.)**

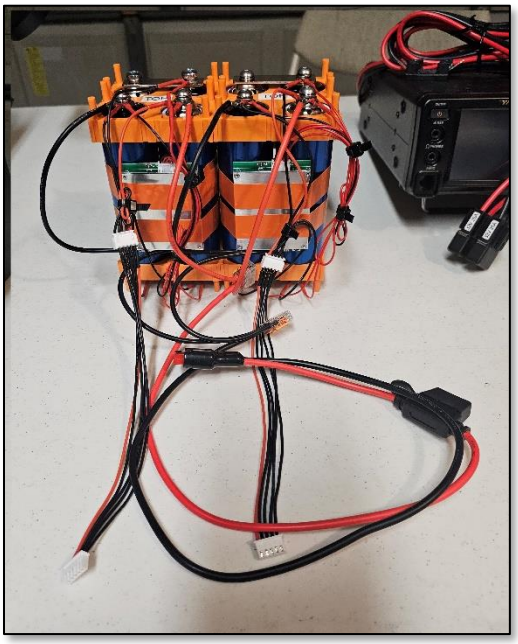
As a convention, we place two 4-cell batteries next to each other, one on the left and one on the right. At this time, do not connected the batteries together through the sled notch bindings. The battery on the left will be Battery #1, and the Battery on the right will be Battery #2.

Insert the BMS P- (**black**) wire of Battery #1 into the left side of the WAGO connector with the **black** (negative) center wire of the harness. Insert the BMS P- (**black**) wire of Battery #2 into the right side of the WAGO connector with the **black** (negative) center wire of the harness. **(Note, if there is no Battery #2, then the right side of the WAGO connector remains empty, which means that the builder desires to construct a 4-cell LiFe battery unit.)**

Insert the terminal 1 (**red**) wire of Battery #1 into the left side of the WAGO connector with the **red** (positive) center wire of the harness. Insert the terminal 1 (**red**) wire of Battery #2 into the right side of the WAGO connector with the **red** (positive) center wire of the harness. **(Note, if there is no Battery #2, then the right side of this second WAGO connector remains empty, which means that the builder desires to construct a 4-cell LiFe battery unit.)**

At this point, the build of the single 4-cell LiFe battery unit has everything needed to either charge the battery unit or operate a radio with the unit. Final connection of the BCS or the radio is made through the Anderson-Power-Pole connectors of the harness. **(Note, the BCS sense cable must also be connection to the 4-cell LiFe battery unit to complete the charging circuit. See Appendix B for BCS set-up and operation.)**

Component Assembly #6: Integrate Two 4-Cell LiFe Battery Units into an 8-Cell Configuration



Now the assembly you all have been waiting for: the integration of two 4-cell LiFe battery units into a single 8-cell unit. The builder will require two separate 4-cell LiFe battery units. If a second unit is unavailable, then build another following the 5 previous assembly and testing steps.

With two units placed side-by-side and avoiding wire entanglement and pinching of wires, slide the second battery unit's sled into the first unit's sled, such that both sets of TOP and BOTTOM sleds without gaps. (Note, the join may take a little bit of effort but it is achievable.) Figure 22 depicts a complete 8-cell LiFe battery unit with harness, but no connection to a BCS or power unit.

Figure 22: 8-cell Battery Unit with Harness

At this point, you may initiate a charge of the right-most unit, following the procedure in Appendix B. When that charge is complete, unplug the BCS, attach the left-side BCS cable of the left 4-cell LiFe unit. Connect the BCS to its power supply, and start the second charge.

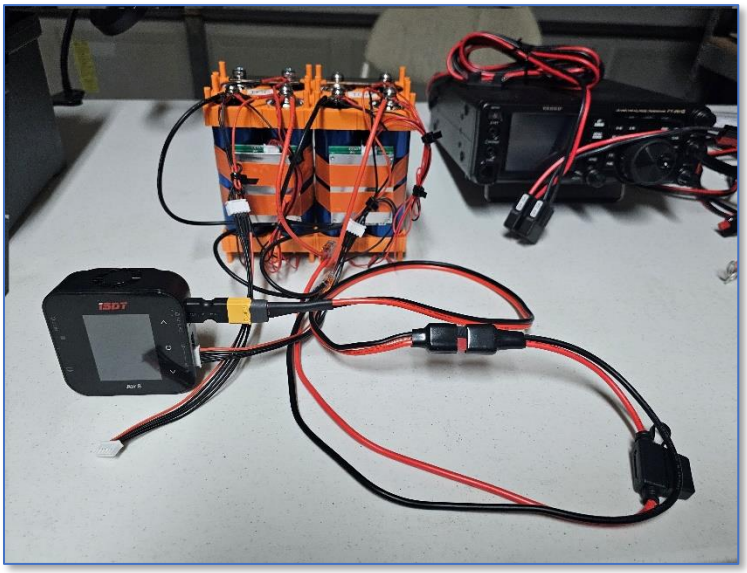


Figure 23 depicts the addition of a BCS unit attached to the right-most 4-cell LiFe battery unit. **(Note, always power down the BCS before switching cables or performing any re-connection of the unit.)**

Figure 23: 8-Cell Battery Unit with BCS Attached

With charged batteries the builder (now operator) can proceed with connection to a radio unit and verify its operation. Connect the radio to the harness cable, which has been disconnected from the BCS, along with its sense cable. Turn on the radio and verify powered operations, as shown in Figure 24.

Component Assembly #7: Packaging into a Portable Configuration

The last assembly is, of course, placing the 8-cell Life battery unit in an ammo can or any selected transporting case that fits the builders need. The plastic 30-gallon ammo can provided in Appendix A is convenient in that:

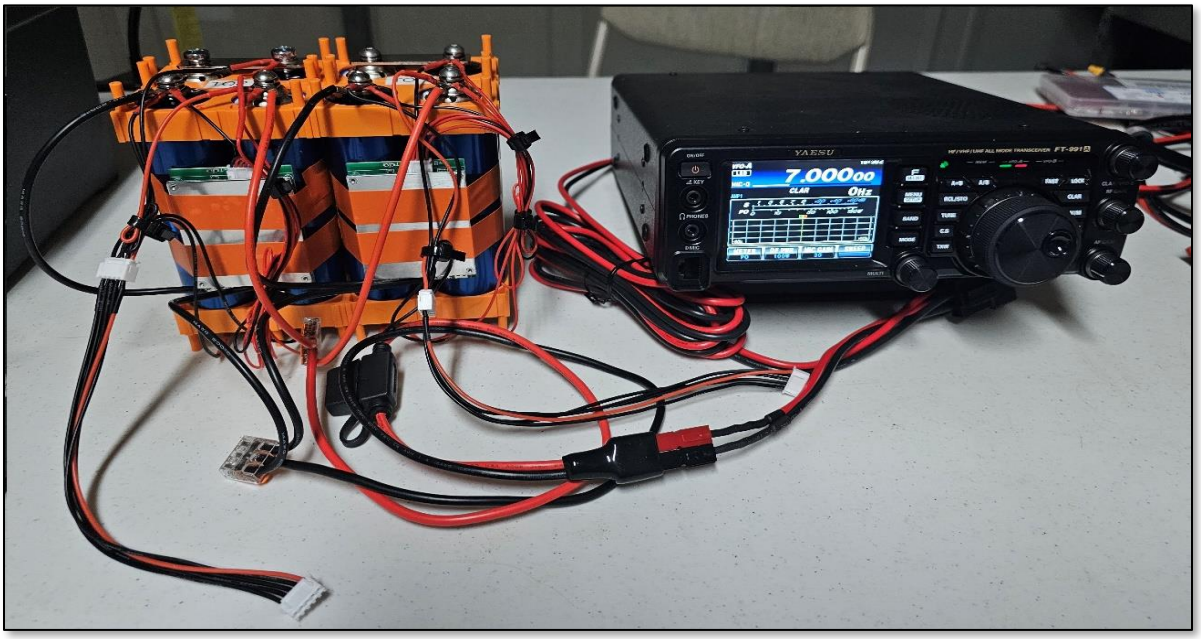


Figure 24: 8-Cell Battery with Connected Radio

1. It's the right size,
2. It's waterproof,
3. It has a little bit of extra storage for the BCS and cables, and
4. It's easy to drill holes into it.

The packaging of the LiFe battery into the ammo can is a bit of an artform combined with user preference. As shown in Figure 25, there are several suggested opportunities for final containment of the battery unit.

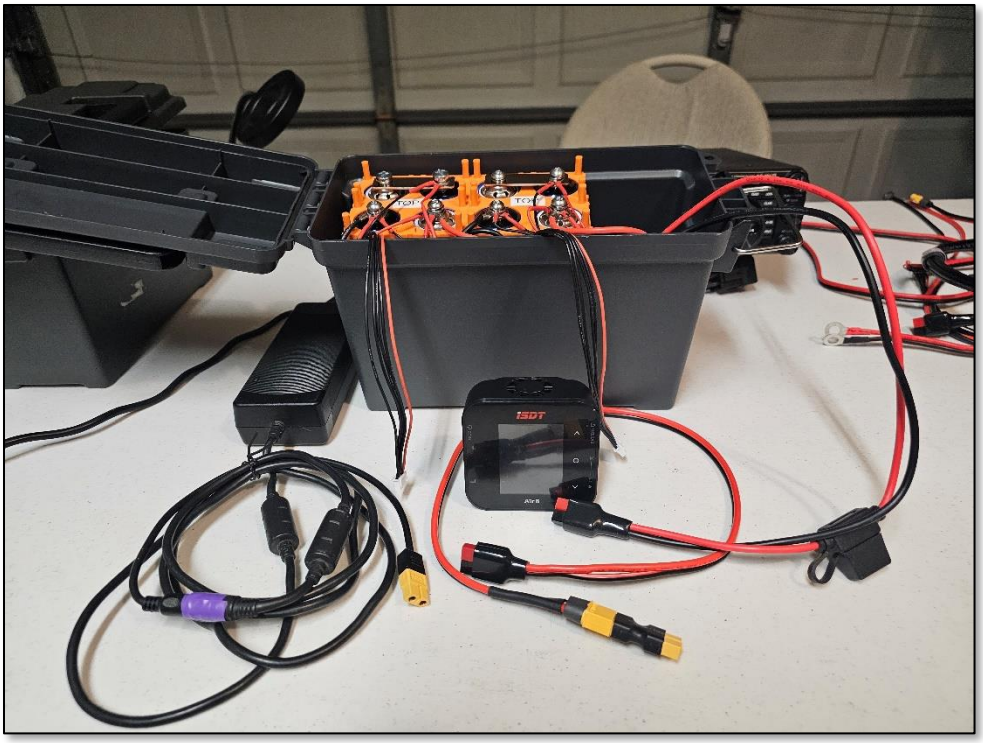


Figure 25: 8-Cell Battery Unit in an Ammo Can

Likely, the shown ammo can could benefit from holes drilled on the front side or right side for throughput of cables. It is apparent that another set of BCS sense extension cables would be convenient, and externalization of the harness fuse would also be convenient for charging and radio-powered operations. If the builder elects to drill holes in the ammo can container, then use of rubberized grommets is probably a wise investment.

At this point, packaging of the portable configuration is left as an exercise for the builder. **(Note, I used to hate it when math books pulled the same verbal trick for the development of mathematical proofs by the reader.)**

Conclusion

This brings us to the end of the LiFe battery unit build. It is likely the builder will find some errors and have suggestions for improvement of the instruction manual, but it is the best we have for now. Any comments provided to the High Desert Amateur Radio Club (HDARC) would be greatly appreciated, and that contact information is provided below.

There may be future revisions based on the comments to this document or other changes that the HDARC feels are necessary. Also, it is the intention of HDARC instructors to construct a set of presentation materials from this document for use at future build sessions. And, for those of you who cannot attend any future sessions, well, you always have this manual to assist you.

Again, HDARC will like to thank everyone who contributed to the development of this instruction manual. If anything, it has been a learning experience. I hope you had fun, I did, the author, John Dodd KJ5KUF.

High Desert Amateur Radio Club (HDARC) Contact Information

- HDARC is a 501(c)(3) non-profit charity.
- Our website is https://www.nm5hd.org.
- We are an official affiliate of the Amateur Radio and Relay League (ARRL).
- Our contact email is NM5HD@ARRL.NET.
- We hold in-person meetings on the 3rd Saturday of every month from 10:00a to 2:00p:
    - Please see the HDARC website for the "live" meeting location.
    - The last two hours is for extra activities, so don't worry about sticking around for the whole thing.
- We operate several radio repeaters and radio sessions. Please see the website for repeater frequencies and a schedule of events.
- Sign up for the newsletter, *The Dispatch*, at our website.
- Everyone is welcome.
- Membership has its benefits.

Appendix A: The Parts List

This Appendix provides links and approximate costs for source vendor products that are used in the LiFe battery build. **(Note, these links were active at the time of publication of this document, so hopefully none have turned invalid in the interim of publication to your access. The builder will need to perform Google searches for any "broken" link searches. An electronic version of this Appendix will be provided by contacting the HDARC authors, and is anticipate to be on the HDARC website, which will avoid a heck of a lot of typing. Or, just show up at a HDARC meeting and ask for it!)**

As follows:

1. **Headway 38120S LiFePo4 Battery Cells 8 Pack 3.2V 10Ah (1 set of 8) $70.00:**
https://www.ebay.com/itm/234917121323?chn=ps&norover=1&itemid=234917121323&targetid=4580496739019530&device=c&mktype=&googleloc=&poi=&campaignid=603247656&mkgroupid=1230354555785701&rlsatarget=pla-458049673901953O&abcId=9316139&merchantid=51291

2. **1x2 Headway 38120 Double Cell Holders Spacers x8 $12.00:**
https://batteryhookup.com/products/1x2-headway-38120-single-cell-holders-spacers?variant=39502739931298

3. **Li-ion/Lifepo4 4s 30a BMS With Balance, for battery protection and proper charging. $16.00:**
https://batteryhookup.com/products/li-ion-lifepo4-3s-20s-30a-bms-with-balance

4. **Alternate BMS on Amazon:**
https://www.amazon.com/dp/B07511RJ9S?ref=ppx_yo2ov_dt_b_fed_asin_title

5. **Sensing cable needed to go to the charger. The charger will monitor each cell:**
https://www.amazon.com/dp/B08L6QFXRT?ref=ppx_yo2ov_dt_b_fed_asin_title

6. **Extension for sensing cables for charger:**
https://www.amazon.com/dp/B07Q29TG24?ref=ppx_yo2ov_dt_b_fed_asin_title

7. **Copper bus bars, 100 amp rated x14 $20.00: (Buss bars need to have a 40mm/1.56" spacing / pitch row.):**
https://www.amazon.com/dp/B0DSLT4JXS?ref=ppx_yo2ov_dt_b_fed_asin_title&th=1

8. **Bolts and washers for bus bars x16 $4.00 (Bolts for Headway 38120 Cells - M6-1.0 x 8mm):**

https://batteryhookup.com/products/bolts-for-headway-38120-cells-m6-1-0-x-8mm?variant=43212217057442

9. **Flat Washer x16:**
https://www.amazon.com/Washer-0-24x0-7in-Stainless-Washers-Silver/dp/B0F66LMTHR/ref=sr_1_1_sspa?content-id=amzn1.sym.918a99dd-4826-4c0a-be33-a6705d69c4cf%3Aamzn1.sym.918a99dd-4826-4c0a-be33-a6705d69c4cf&crid=2M7TC0DSEVOYT&dib=eyJ2IjoiMSJ9.REg9R_E0SpkZJhPxmLoE02_IqP5eytmnYZ6xpEQRgj5Qsf78PMdhc1YoK_FIL77jMsiV-ceNIzy7bDVxtSO4HfVUVt88M3M48XfEProDDf634Jk_XK5Q7hUi39YFMwoEhTv9-HIlYgcwzPEYLbQSepjXneOMu1OnzQvFWEmltsk2ZMG0Wy_5LQI7TlvhmIXp-lm5miu5_RwKAq0dwVzJ3zLs9biK2bDSquImp8gATWKBpgehkBb5dbkXuY7uhNZ6PfiomsBSha3o8ewEzjkuxBs8r1vq8Bbnqp8LBbBKMmE.5C-IeuskHvMr_DeH51E0VRZFF7yeP5J1Fyy2J9_7vXs&dib_tag=se&keywords=Washers&pd_rd_r=a89d88aa-460a-4f15-a3e8-5aec3773d7d5&pd_rd_w=fc0Lq&pd_rd_wg=IhDOT&pid=hGk9B3v&qid=1750041469&s=industrial&sprefix=flat%2Bwasher%2Bfor%2Bm6-1.0%2Bx%2B8mm%2Caps%2C246&sr=1-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1

10. **Lock Washers x16:**
https://www.amazon.com/Washer-Stainless-Spring-Elastic-Gasket/dp/B0C1YXFDDQ/ref=sr_1_3?dib=eyJ2IjoiMSJ9.0SsWHX9yQlASWH1TiKMQQcLBwaC6mHaJPtxsPXUV8sYtv5bJBirl5FYnUVM7dF5RC2KUj3WYVNpfKQSSjlCQWt4UO8nQNdSkWOPUkklZFIKuBUnmQebP7PboByEqSP2P9X_dQG1tS9mq-ZwdEQqKSkqp30fCVd2D3nmRhiogKLVI4_zlViFuCxIRvkzfMDtG5Xgt3awHTn4AMc12_YXaALLfnI3K5NIDkTmNHYoVTLZZfk_pwuJFc56EnEb-kLNdPVDhbVLjnbdcVxoSxMhwQvFuL5s2ztUtnDYxmDtdRmk.bZb7P5u9r2K1vZtOyA4ifccfeLAzCd_LQMNh7q41-hE&dib_tag=se&keywords=lock%2Bwashers%2Bfor%2BM6-1.0%2Bx%2B8mm&qid=1750041842&refinements=p_n_feature_three_browse-bin%3A17420954011&rnid=17420897011&s=industrial&sr=1-3&th=1

11. **60-amp connectors rather than Anderson-Power-Poles:**
https://batteryhookup.com/collections/accessories/products/10-pairs-of-xt60-connectors-male-female-20-pcs-total?variant=37888601096354

12. **A fuse block with two 30 Amp fuses (DC volts, not AC): You will need to purchase the fuses separately:**
https://www.amazon.com/COOPER-BUSSMANN-S-8202-2-R-BLOCK-BOLT/dp/B0195UTF06/ref=sr_1_48_sspa?crid=23ET0N61I3U5W&dib=eyJ2IjoiMSJ9.4pSRHmLOH7Z8sycYEGO1pAaYPxfT0l_FJ_buxwO4kfVjjOrdhcP9Asf1G5qhmeLv3J2r_0eLl--jQQdC30z8wKpWRl5rf8lfkjx9BlE8BuF8LjfMXmcx_NSfkEGENx3B5nXK944NfWfaGt0BolcKL520Tp2DdRCKcjrtiJGNI2OW3_MdudF9vOuOmRgmvutc7Y0geadtVZE9iQhFGrrnKdkWcwO1T32WFn97TOSbmjcuqbzSCNisrdcDPeUo4f5OJMRS5fzlQB9gasTc1WcVhzIhN2M_ucnxLVuPVJ7KsiM.uo4fCm0A4odRhVsa414x5rf4O8vTRHhdQWe9s4dhgUk&dib_tag=se&keywords=du

al+inline+fuse+block&qid=1753583751&s=industrial&sprefix=dual+inline+fuse+block%2Cindustrial%2C141&sr=1-48-spons&xpid=axRzaqs93cwO5&sp_csd=d2lkZ2V0TmFtZT1zcF9idGY&psc=1

13. Inline fuses can also be used
https://www.amazon.com/Waterproof-Standard-Automotive-Lighting-Electrical/dp/B0D9JP7PL4/ref=sr_1_9?crid=23ET0N61I3U5W&dib=eyJ2IjoiMSJ9.2B3XHvHsyAhpKqNtuw5zem7sgKzjde3UwUo5cvOW5TiqU8nK4r_KQhFZ80j8MWYrakT1ftsGYw9IBrrJtAjd92x6Mw2Zo6AXpkJAANlJxXo4oL8L1vtCNJoSWAhmWmhbqsMwEmK-ngFlvN0haWUlLv0Ks6HuZ9h8BYMOXVER0HqiyakyMgEyUWv0Pclxkt7OngNKYu6q-RjaUrYRYX4_Bpd-Jf10Q5Jo9r8uWNL9EY341oUPzq5-rL17yfYuGCrIuDsS-tS7ax0h7e_v27lWQOe2bMuEwEe9JMNV_oMcbvE.cQhkiI_GyJ2rAvV3YAcACUIRUxtF_HcwC3-1Tdqgph4&dib_tag=se&keywords=dual%2Binline%2Bfuse%2Bblock&qid=1753583543&s=industrial&sprefix=dual%2Binline%2Bfuse%2Bblock%2Cindustrial%2C141&sr=1-9&th=1

14. Automotive wire terminals for 10- and 14-gauge wiring:
- https://www.amazon.com/dp/B07QB6233R?ref=ppx_yo2ov_dt_b_fed_asin_title&th=1
- https://www.oreillyauto.com/detail/c/dorman-conduct-tite/lighting---electrical/connectors---terminals/wire-terminals/389c357f2202/dorman-conduct-tite-22-10-gauge-blue-red-yellow-terminal-assortment/cti0/85694?pos=3
- https://www.amazon.com/Zoostliss-Electrical-Connectors-Insulated-Connector/dp/B074Y31S2Z/ref=sr_1_10?crid=3NGQBUL4OLISY&dib=eyJ2IjoiMSJ9.zSPV0O_ngzBm4llZq0S9I8TpSdeAd1G_c9bMN9vnzi7enOcIKRFp9YWDcuxeHil-hxWCHAf_kXjL4FP0-v4fVmRIu2E9jAJcheGewrUf5gdeGjVGD01Dd2svS-r_HF6c5B5jhcRaP95IDG7NdCe5rV6cqPYhBgwAWg5E6d7PdPU9lZ9bGZVv259MuJfSk2H6BMBhRi8sLyAa0o95eCAdr0pPmw4kxEqgfvOEf208TnzfE0HwqAlzeRKZxdanpokjv0YaG3BXo2sqxRJATZM1EvXm3fBQBTLB6hg69fNr2ag.tsHozevggER6ilP525Ejsh6rRNtZQyUSlLoOzeXx-jE&dib_tag=se&keywords=Assorted+lugs&qid=1749527081&refinements=p_n_feature_nine_browse-bin%3A18644577011&rnid=18644573011&s=industrial&sprefix=assorted+lugs%2Caps%2C149&sr=1-10

15. WAGO Wire Connectors:
https://www.amazon.com/Compact-Splicing-Connector-Assortment-221-2401/dp/B0CJ5QF3VX/ref=sr_1_2_sspa?crid=13ABP7OETMC4V&dib=eyJ2IjoiMSJ9.iHu73kiXn9ahDe-Ed0bRqyzxqb7La7_Xm3Zb7SL7ftv51wMi6lEWh_rE3BPJs9oeglTz_FCY_sRKAkX9YR5YHkRC_kdqnOKGwFgKY07uG_FfE8tOo_eguNE0bfIcd9vzipyLED4nx9iF381NOvy6qOr9G5Fnhzk1ISaBdzOIS34_pm1P8UtGuO_AL8-5ScF1yTVBH4SwUuZ19POaW43pftVFlNiSS34qyYbPgt3B6zIvgk50vYncEqL0MpIrfXgajFu5Ep1o0-ouVMXeGYw-

DEGVqXZcooV49UB2sn_v36k.znyti8xtHjVVAXkT2jWKeXM7M_0ToCL7toaswiOBaSE&dib_tag=se&keywords=wago%2B221&qid=1754702800&sprefix=wago%2Caps%2C234&sr=8-2-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&th=1

16. Miscellaneous wire. Suggestion: purchased 10- & 14-gauge wire at a local O'Reilly's

- **10-gauge wire Amazon search**: https://www.amazon.com/s?k=10+Guage+Wire&crid=2093QS7A23VGW&sprefix=10+guage+wire%2Caps%2C183&ref=nb_sb_noss_2

- **14-gauge wire O'Reilly search**: https://www.oreillyauto.com/detail/c/dorman-conduct-tite/dorman-conduct-tite-black-14-gauge-copper-primary-wire/cti0/85778?q=14+gauge+wire&pos=9

- **Red 10-gauge wire (O'Reilly)**: https://www.oreillyauto.com/detail/c/dorman-conduct-tite/dorman-conduct-tite-red-10-gauge-copper-primary-wire/cti0/85700?q=10+Guage+wire&pos=0

- **Black 10-gauge wire (O'Reilly)**: https://www.oreillyauto.com/detail/c/dorman-conduct-tite/dorman-conduct-tite-black-10-gauge-copper-primary-wire/cti0/85702?q=10+Guage+wire&pos=1

- **Red 14-gauge wire (O'Reilly)**: https://www.oreillyauto.com/detail/c/dorman-conduct-tite/dorman-conduct-tite-red-14-gauge-copper-primary-wire/cti0/85776?q=14+gauge+wire&pos=2

- **Black 14-gauge wire (O'Reilly)**: https://www.oreillyauto.com/detail/c/dorman-conduct-tite/dorman-conduct-tite-black-14-gauge-copper-primary-wire/cti0/85778?q=14+gauge+wire&pos=9

17. Battery Charger:
https://www.amazon.com/ISDT-Touchscreen-Battery-Charger-Discharger/dp/B0823DGJXS

18. Ammo Can: Bunker Hill Security 0.30 Caliber Ammo Box (Harbor Freight):
https://www.harborfreight.com/030-caliber-ammo-box-63135.html

Appendix B: Air8 Programming and Operation

Air8 BCS Set-Up

Table 1 provides a list of charge-settings for the Air8 battery charger for a 4-cell LiFe battery unit.

Table 1: Air8 Charge Settings, 4-cell LiFe Battery Configuration

No.	Setting	State	Comment
1	Task	Charge	This is likely the only setting you will use
2	Chemistry	LiFe	Not LiPo
3	Condition	3.65V	The max voltage for the batteries
4	Cells	4S	This mean a 4-cell battery unit
5	Current	1.0A	This is the charge rate, which is low, to ensure maximum battery life

To set up the Air8 Charger, first connect it to a power source. This connection can occur either via the micro-USB port or the XT60 input power port (which is connected to an adapted AC laptop power supply).

Figure 26: Air8 Power-On Display

The unit will power on with the screen displayed in Figure 26.

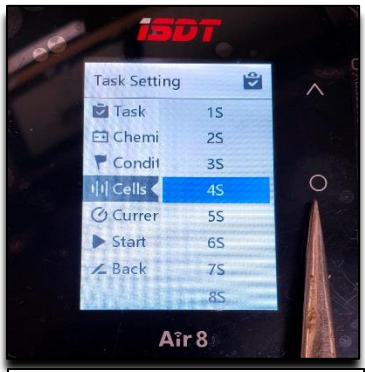


*Figure 27: **Air8 Settings Display, Cells***

Depress the "circle" on the right-edge of the touch-display of the Air8 charger. This will display the charger's main menu, as shown in Figure 27. Continue the selection of settings with the following procedure:

1. Using the circle touch-display option and the up/down arrows, highlight Cells and select 4S for a 4-cell LiFe battery unit.
2. Select Battery Condition and set to 3.65 VDC maximum. This setting will fully charge the batteries and increase the life of each cell.
3. Select Chemistry and set to LiFe.

4. Select Task and set to Charge. **(Note: Never select Destroy! It will do just that, and erase all your settings, as well as the battery charge.)**
5. Select Current and set to 1.0 Amp, which is the charge rate. Charging the batteries at a 1A rate will enhance battery life, possibly up to 10 years of usage.

The Air8 charger automatically saves the programmed settings, so no other keying function is necessary.

Figure 28 depicts all the final setting of the Air8 BCS.

Figure 28: Air8 Settings Display, All Options Set

Air8 BCS Charging

To begin charging the LiFe battery unit, turn the charger off and connect the battery pack power cord to the charger (if not already done so). Connect the 5-wire sense cable to the bottom of the Air8 charger. (Note, the lower portion of the sense cable connects to the corresponding 2S to 6S pin terminals, with the JST-XH plug guides facing downward. By design, the sense cable can only be inserted in this fashion in alignment with the 5 pins. Continue as follows:

1. Power on the Air8 charger and the main meu will reappear.
2. Push the Circle button and the settings display appears as in Figure 29.
3. Select the Start option via the up/down arrow buttons, and press the Circle button. The display will turn Orange and begin charging, per Figure 26.

Figure 29: Air8 Charge-In-Progress Display

At this point, the Air8 will charge, increasing the amp load to 1 amp max, as it senses the battery state/voltage. Do not worry about the battery voltage per cell at this time, as they will be balanced by the charger.

The charger will operate for several hours depending on the battery voltage and capacity on each cell. When complete, the screen will turn Green and show the battery pack's full potential in mAh. Figure 30 provides an example of this end-charge state, along with the charge time at the top.

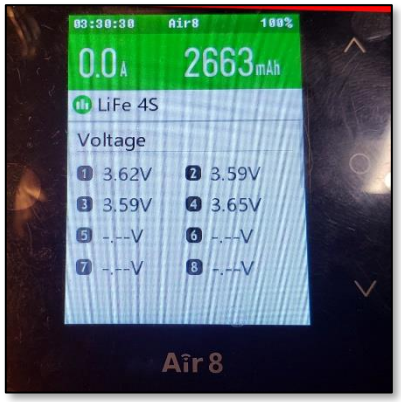


*Figure 30: **Charge-Completed Display***

Appendix C: Alternate 4-Cell Build Configuration, Bob Watson

This Appendix provides an alternate 4-cell LiFe-battery-build developed by Bob Watson (K9GMA), presented in his own words. We have Bob's word that this configuration works. However, no independent verification of operations has yet been undertaken by the author of this document. Please address any questions or discussions regarding this build to Bob. **(Note, Figure numbers were inserted for document continuity and readability, but no other edits or changes have been added to this appendix.)** As follows:

Alternative Battery Build Design
Bob Watson, K9GMA

Figure 31: Completed 4-Cell Battery Build, Bob Watson

This battery build is similar to Rob's [KI5NBN] original design, with one important difference. Since the **iSDT 608AC** battery charger is a "*smart charger*", then a separate (duplicate) BMS circuit board is not needed. (Note: the **iSDT AIR8** is also a "smart charger"). The cell balancing is done inside of the "smart charger". I upgraded from the originally-specified **AIR8** charger (which requires a separate battery of higher voltage to charge the one you are building), to the **iSDT 608AC** charger which plugs into a 120V wall plug for convenience.

Figure 32: Bottom View, 4-Cell Battery Build, Bob Watson

I bought the pre-made XT60 charging cable from Amazon with lugs already attached. Amazon also supplied the output power (load) cable with attached lugs at one end and Anderson-Power-Pole connectors on the other end that connect to my multiple radios.

CAUTION: I bricked my iSDT 608AC charger when I left the fully-charged, 4-cell battery pack connected to the iSDT charger for an extended period of time. After about ½ hour I went back to the charger and picked it up. It was very hot and I had to drop it. This should not have happened, and after it cooled off, I tried to get it to work again. But, it was damaged and was acting

badly. I think the excess heat ruined it. So, the takeaway is…unplug your charged battery from the charger *as soon as possible* after reaching full charge!

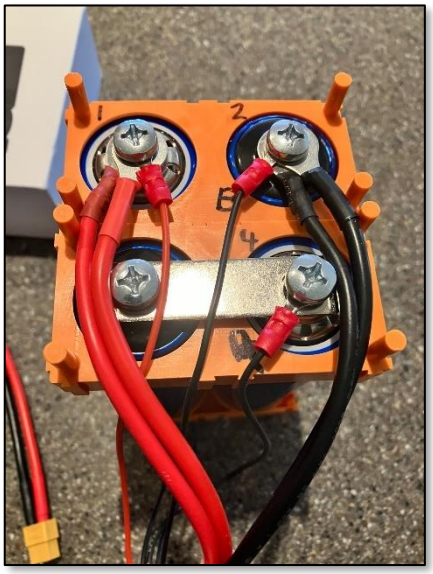


Figure 34: Top View, 4-Cell Battery Build Bottom-View, Bob Watson

UPDATE: I upgraded my battery charger to an **iSDT Dual Charger "D2 Mark II"**. It can charge two separate battery packs simultaneously, with independent BMS control circuits. This charger is a 200 W charger (12 A), and it also plugs into the wall. I used it to charge both 4-cell battery packs, and it never got hot (it has much bigger, dual cooling fans). It costs about twice as much as an **iSDT AIR 8**, however. But, it's a much more rugged unit that should last longer.

Figure 33: iSDT Dual-Battery Charger, 4-Cell Battery Build Bottom-View, Bob Watson

[Bob Watson Update:] I extended the BMS sensor (voltage) wires by about 10" over the previous build. This used the pair of extension cables that I mentioned in my last email. Now, the 5-pin white connector for the BMS balancing wires easily reaches the charger sitting on the table top.

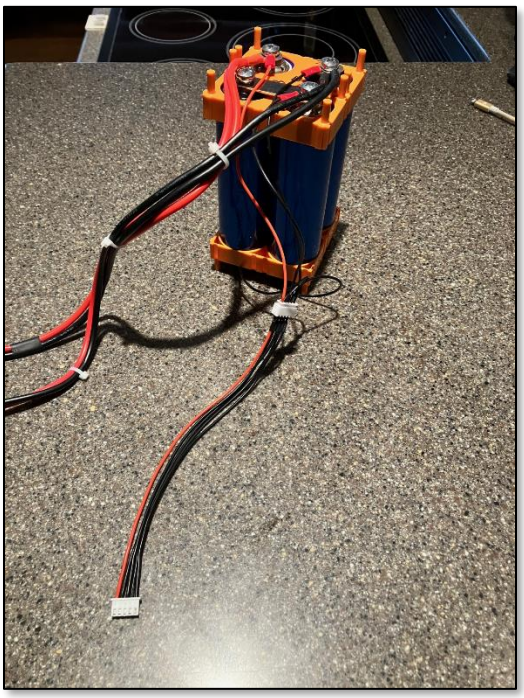


Figure 35: Updated Completed 4-Cell Battery Build Bottom-View, Bob Watson