KC1IKA, Charlie "Smitty" Smith

Battery Power and Portable Operations

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Hampden County Radio Association

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Introduction

First thing you should do before building a go box or battery system is figure out how and where you want to use it as well as how you will transport it. Vehicle vs man portable (carry it all). How long do you plan to operate, will a battery charge last or will you need to charge them while in the field? Which modes and bands will you be operating?

I am heavily involved in emergency communications, EmComm for short. For the most part I will either be working out of my ham shack at home or I will drive to a remote site. I won't be hiking anywhere with my radio gear so I don't need to be "man-portable". Man-portable you need to be concerned with making everything as light as possible and as efficient as possible. You will be carrying your radio gear and possibly food, water, and shelter. I do have an IC-705 HF/VHF/UHF radio in a backpack so I could set up short distances from my car but I don't plan on traveling any distance.

I also decided to go modular. As you will see, I have multiple go boxes and will bring what I need for the situation at hand. Even though I am transporting my equipment by car, I still have to carry it down stairs and out to the car and back. One big box with everything in it would be a bit much to carry if I only needed VHF/UHF operations that day.

My biggest priority is being able to operate from my ham shack in any weather conditions for extended grid down situations. With the setup I will show you I can operate for as long as needed, as long as the sun comes out a few times a week.

This presentation will show you what I built for portable operations as well as continuous off grid operations from my home shack.

What I will be showing in this presentation:

Go boxes:

- VHF/UHF boxes with internal batteries, two designs
- HF/VHF/UHF Backpack radio with battery
- HF box with batteries
- Battery box
- FRS/GMRS box, no batteries
- Power distribution boxes, two versions
- Cable and adapter box
- Antennas
- Solar panels

Ham shack power system:

- Batteries for radios
- Batteries for computer related items
- Commercial power usage
- My battery charging options

Other stuff:

- Transmitting power and how it relates to operating time
- My battery choice and why
- Low power lighting options

VHF/UHF boxes, version 1

Ammo Can VHF/UHF go box with battery

My first attempt at creating a go box. Very portable and self contained.

Features

10 Amp Hour Lithium Iron Phosphate (LiFePO4) battery

Dual USB charging ports

Dual Anderson PowerPole 12 VDC output

Voltage and current draw display

External charging and 12 VDC ports

Compact mobile VHF/UHF radio

Coax jumper to make it easy to hook up antenna

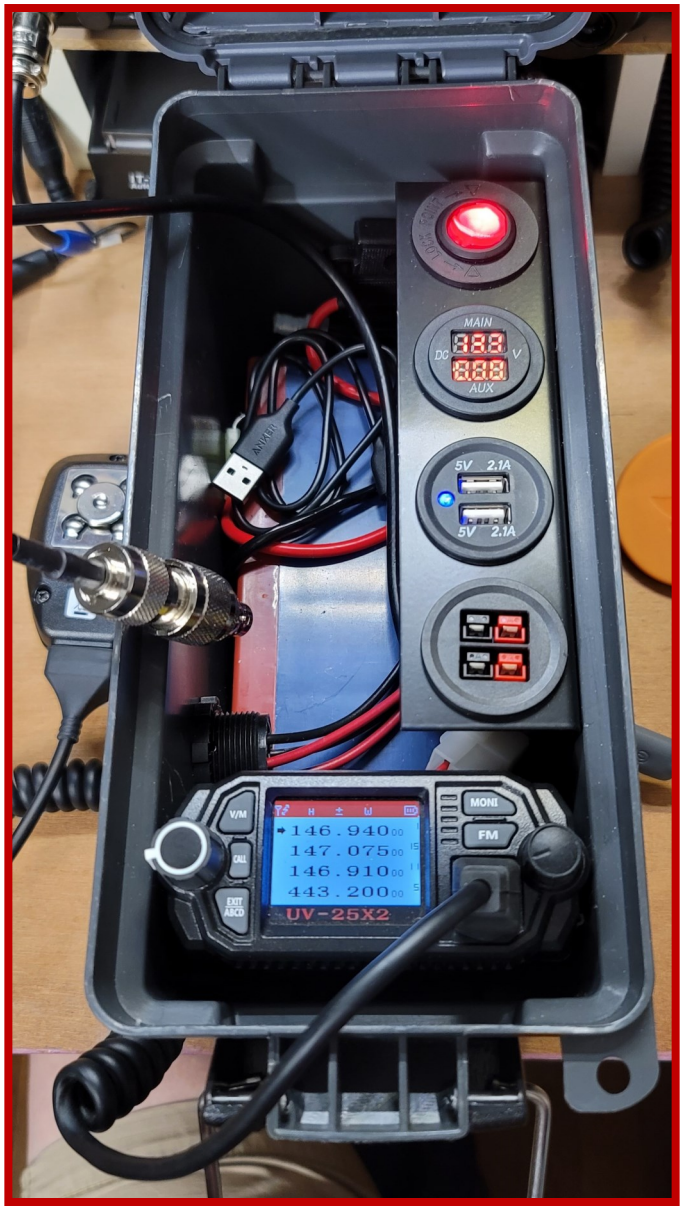
Lollipop USB light for portable lighting, will show this later in the presentation

Storage space for microphone and two J-pole antennas

Water resistant case, when closed, to protect gear

Very lightweight and portable

Can use as power source to power other equipment, even when closed



VHF/UHF boxes, version 2

VHF/UHF go box with 14 Ah battery and Bluetooth

My second UHF/VHF go box. Very portable, self contained with more battery power. Simpler construction.

Features

Dual 7 Amp Hour Lithium Iron Phosphate (LiFePO4) batteries, 14 Ah total.

Voltage and current draw display

External charging and 12 VDC in ports

Icom IC-2730 mobile VHF/UHF radio with Bluetooth option

Right angle adapter to make it easy to hook up antenna

Just remove antenna, unplug microphone, flip upside down and stow in box

Lined storage space for microphone and Bluetooth earbuds

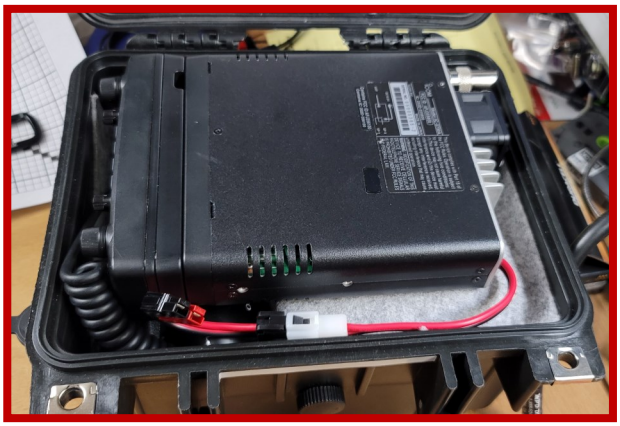
Water resistant case, when closed, to protect gear

Very lightweight and portable

Can use as power source to power other equipment, even when closed

Can choose to run on internal battery or external power

Bluetooth allows you to monitor signal on a second receive frequency while transmitting without risk of feedback



HF/VHF/UHF backpack radio

Icom IC-705 QRP radio with battery, solar charge controller, and tuner

The Icom IC-705 is a great portable QRP (low power) radio and uses the same battery as my Icom ID-51A handheld. I also purchased their backpack that was designed for it with plenty of room for the radio, a battery, a tuner, and an external plate to mount an antenna. The radio transmits with 5 watts using just the attached battery or 10 watts with an external power source. It has built in WiFi and can connect wirelessly with a phone, laptop or tablet to control the radio.

Features

10 Amp Hour Lithium Iron Phosphate (LiFePO4) battery

USB charging port

Dual Anderson PowerPole 12 VDC output

Voltage and current draw display

Solar charge controller

Compact mobile HF/VHF/UHF radio

Coax jumper and BNC mount to make it easy to hook up antenna

Lollipop USB light for portable lighting, will show this later in the presentation

Extra storage space for tablet, QRP amplifier and cables

Very lightweight and portable

Can use radio while walking with speaker/mic, tablet or phone

HF radio with batteries

HF Discovery Lab599

If any of you saw the show and Tell in 2021 you saw the HF radio box I created while under quarantine for Covid in February, 2021. Fortunately the symptoms were very mild but it gave me the time in isolation to complete my HF project. This box is the biggest go box I will make and contains some extra features such as built in computer control and the ability to monitor DTV broadcasts during an event. I am already planning on a major modification to replace the Raspberry Pi computer with a micro Windows unit. The Raspberry Pi is fine for a shack computer but has too many software compatibility issues to depend on in a real event.

Features

21 Amp Hour Lithium Iron Phosphate (LiFePO4) battery

Four USB charging ports, two internal and two external

Four Anderson PowerPole 12 VDC outputs

Solar charge controller

External access to battery charge, 12 VDC out, solar input and external 12 VDC input

DTV and computer monitor built in

External access to HF and DTV antenna ports

External storage pouch for headset and DTV antenna

Lined internal storage for mic, cables, keyboard and micro computer

Water resistant case

Battery Box

LiFePO4 Battery, 28 Ah

For times when more power is required or I'm using some of the equipment that doesn't have internal batteries I have a box with just batteries and connectors. This can be charged from an AC charger or from a solar charge controller.

This was a very quick and easy build. Just three holes to drill in the case for the switch, meter and Anderson connectors then build a wire harness to put the four 7 Ah batteries in parallel configuration. Pack in some dense foam to keep things in place and close the lid.

I could have used 10 Ah batteries for a total of 40 Ah but there was a deal on the 7 Ah batteries.

Features

28 Amp Hour Lithium Iron Phosphate (LiFePO4) battery

External Volt meter display

External power switch

One Anderson PowerPole 12 VDC output

External access to battery charge, 12 VDC out and external 12 VDC input

Water resistant case

FRS/GMRS Box, no batteries

FRS/GMRS mobile radio and four hand helds

This is about as easy a build as you can get. Just had to figure out the right size box to fit all the items and the best way to put them in the box. No drilling or cutting. Just print a couple of labels and you are done.

Works well with the battery box from the previous page to power the radio. The drop in chargers are USB powered so the power bricks I will show later are a great match.

GMRS license is required if using the GMRS frequencies. FRS frequencies can be used without a GMRS or ham license. Great for medical units without radio licenses.

Features

Two dual drop-in chargers

Four handheld units

Mobile unit with Anderson PowerPole connector

Longer range folding tactical antenna

Water resistant case

Power Distribution Box, version 1

DC power distribution box with some storage

I quickly came to realize the wide variety of connector types would prevent me from having every battery being able to connect to or charge every item in my kits. The best solution I came up with was to have a minimum of connectors on the batteries and create a distribution box I could share between power sources.

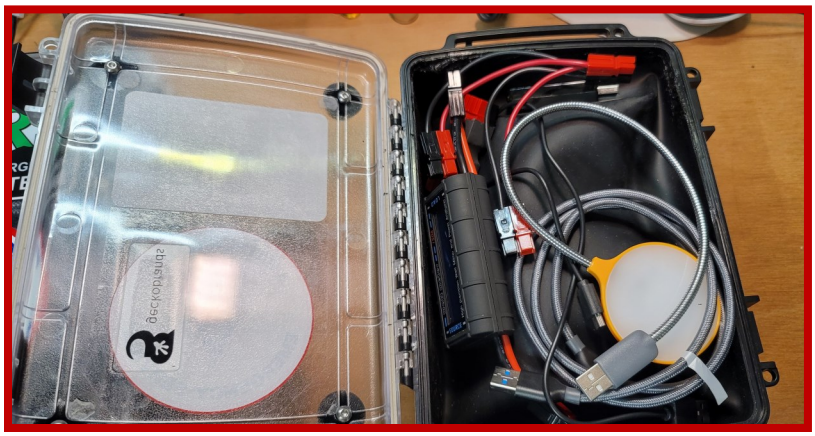
This is the first version I came up with. It works really well but I didn't document the build. So, I designed a second one and took pictures as I went along. Those build instructions wil be uploaded to the HCRA web site.

Features

Choose what connections you want, up to eight items

Storage in lid

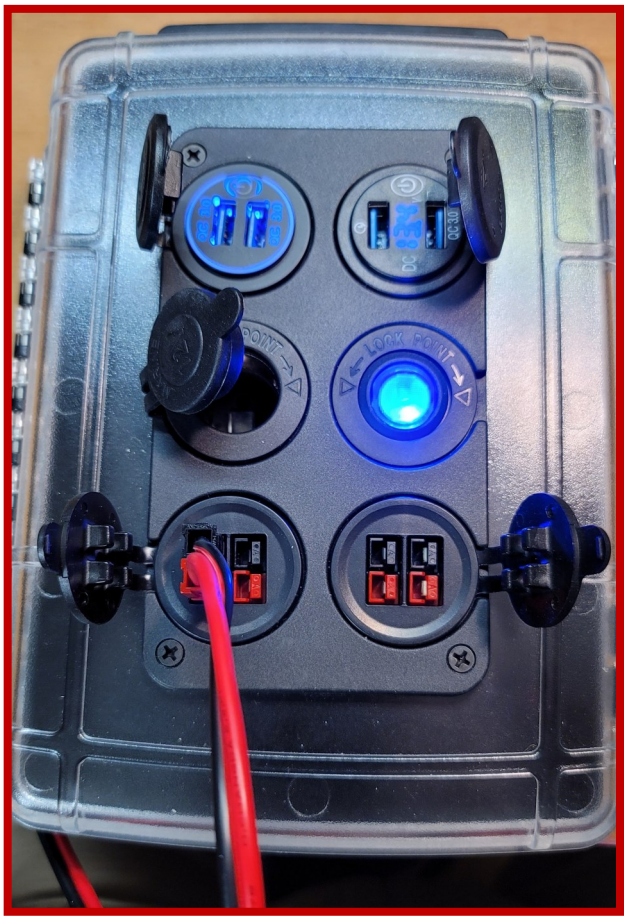
Water resistant case



Power Distribution Box, version 2

DC power distribution box with storage

This box was a lot easier to build. It has six instead of eight positions to fill. I also put the connectors in the lid instead of the base. This avoids having to cut and re-glue the rubber liner in the base of the box. Wih the first box I discovered the liner when I drilled the holes in the bottom. It looked like it was painted on but it is only glued to the top quarter inch.



I haven't covered the inside of the wiring harness yet as I wanted to show the interior space. With fewer wires than version 1 there is more storage available in the box for cables and adapters.

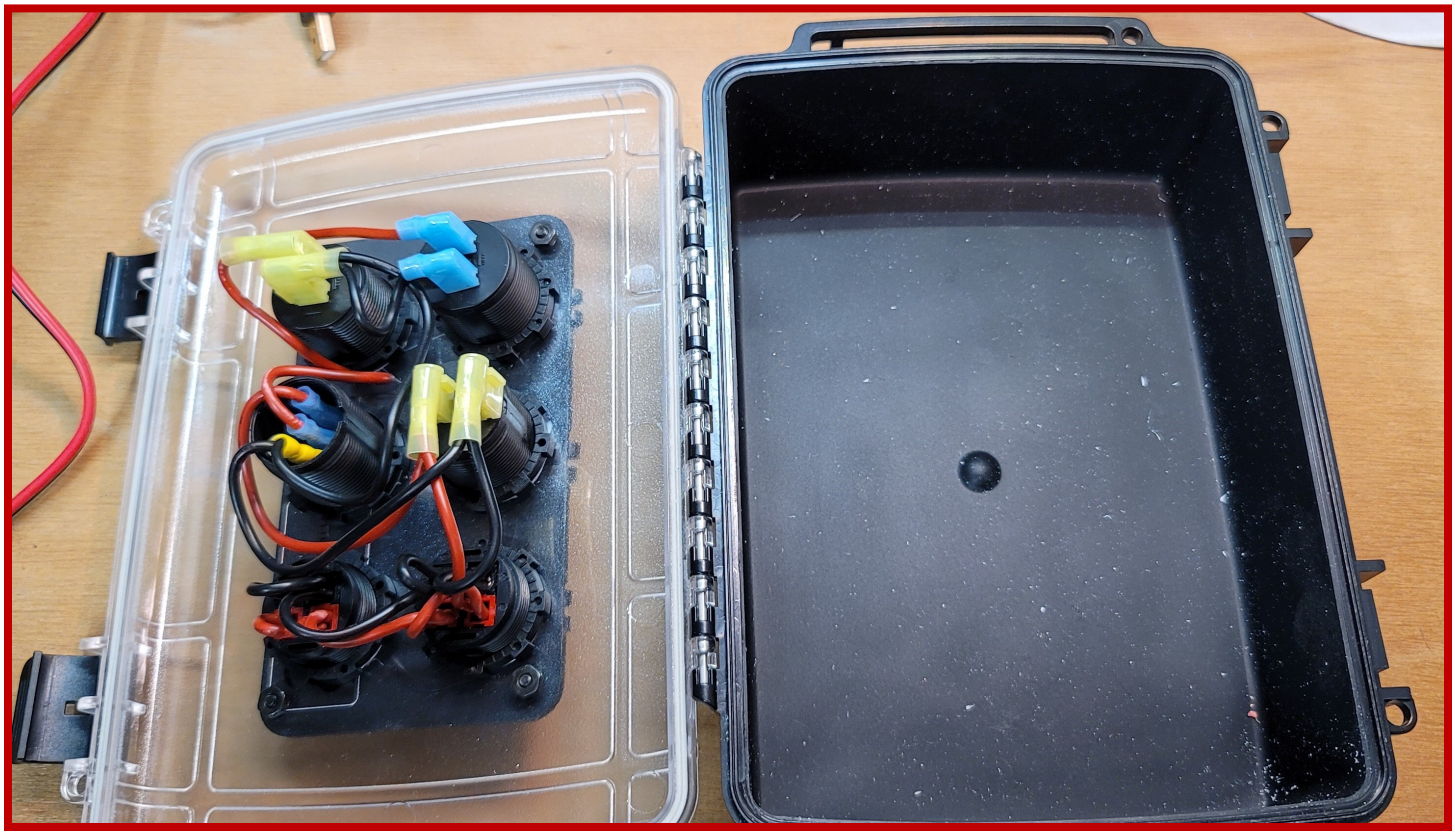
Features

Choose what connections you want, up to six

Easier to build than the first version

Storage in bottom

Water resistant case



Cable and Adapter box

Cables and more cables

This box was also a very easy box. It only required labels and feet to be added. I put the feet on the lid to avoid the liner in the bottom and to match the first power distribution box. This type of box can be used to store anything that will fit and you want to keep dry or organized.

Just make appropriate labels and it's good to go.

Features

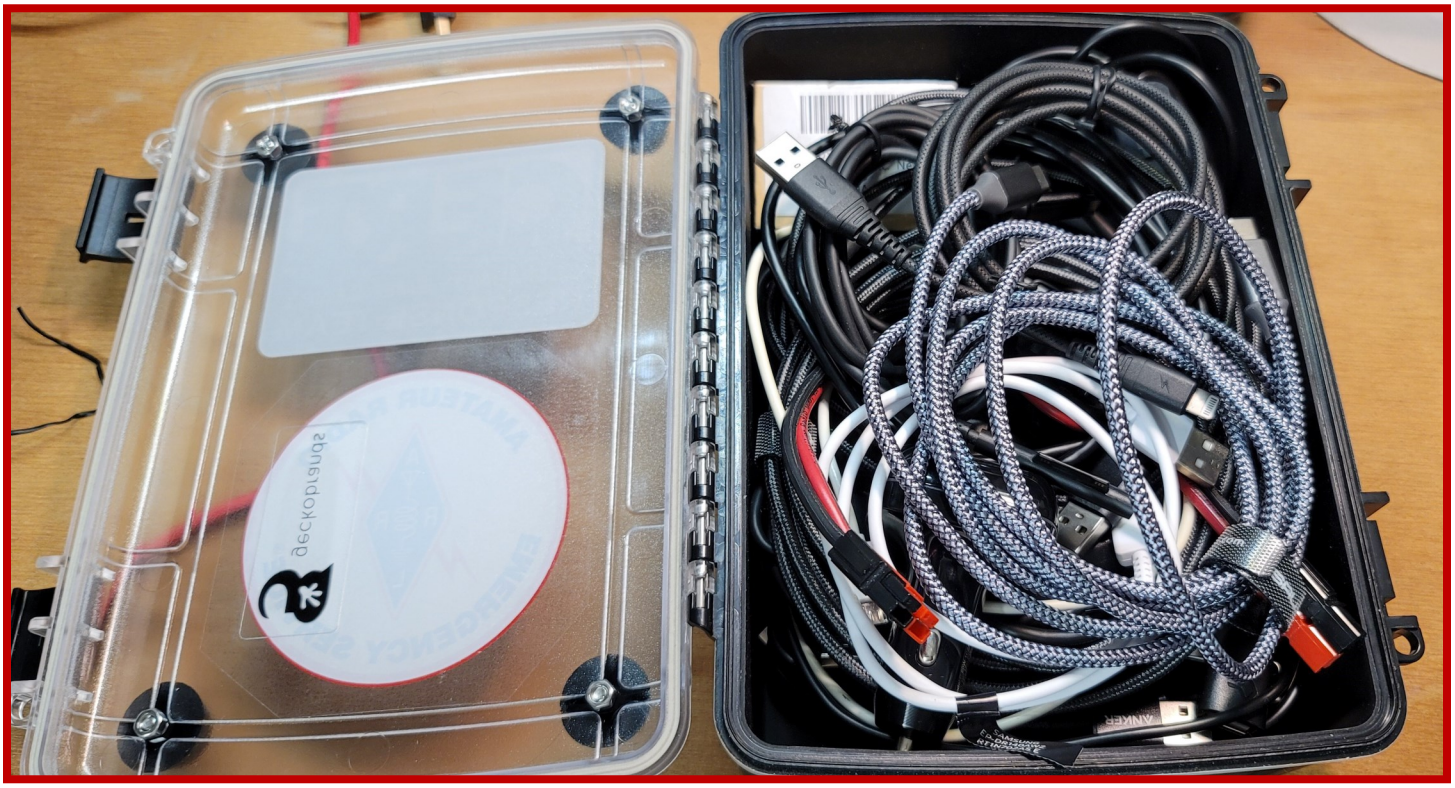
A place for all your USB cables

Also store extra 12 VDC cables

Power monitors and mini lights can also be stored here

Basically anything that will fit in the box can be stored here

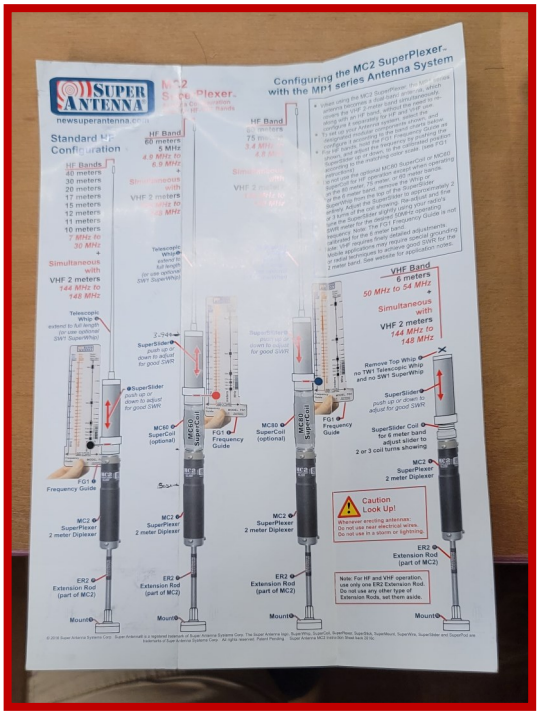
Water resistant case



Antennas

HF/ UHF/ VHF antenna and coax

Which antenna I bring depends on which modes and bands I will be operating on. I have a vertical Super Antenna that works well on HF and VHF. I have an assortment of mounts for it as well as the 80 and 2 meter adapter coils. Using the supplied template for setting the sliding coil height gets me close to resonance. The meter will get me to 1.2 SWR or better.



The parts and cables for the Super Antenna are in the bag shown below. It is easy to carry and not too heavy.

I also have an assortment of tuned dipoles as well as whip antennas for other radios in another bag. It has some 50 foot sections of LMR-400 coax that I can use for UHF and VHF without too much loss.

In the shack I cannot have outside antennas so all my operating antennas are in the attic. Fortunately I live in an old Victorian so I can have a 10' UHF/VHF vertical, an 8' UHF/VHF vertical and a HF random wire end fed up there.

There are lots of good books and videos on antennas and too many options to discuss here.

Solar Panels

Charging 12 Volt and 5 Volt batteries

There are solar panels for 12 volt systems and 5 volt systems. I have two 20 watt panels in my shack window as well as folding panels for operating remotely. The top picture shows a folding panel for charging USB powered devices. These are handy for phones or tablets as well as HT drop in chargers.

Ham Shack Power System

Batteries and charge controller for radios

The two 20 watt panels feed into the Budipole Powermini. The Powermini controls and monitors the charge and draw from my two batteries behind the small monitor. The tool box on the right contains seven 10 Ah Dakota Lithium LiFePO4 batteries. The ammo can on the left contains two 10 Ah LiFePO4 batteries. This gives me a total of 70 Ah total for operating the radios. On a sunny day I can get 2 Ah in from the solar panels

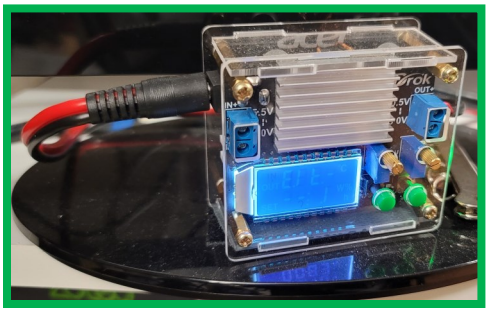
Batteries and charge controller for computer related items

Behind my larger monitor are eight 7.2 Ah Sealed Lead Acid (SLA) batteries, totaling 57.2 Ah. These are backup power for the computer and monitors if commercial power is interrupted.

Commercial power powers the 12 VDC power supply that feeds into the West Mountain Radio Epic PWRgate. The PWRgate is also fed by the solar panels and the SLA batteries. If commercial power is interrupted the PWRgate switches to batteries fast enough that the Raspberry Pi that I use doesn't even notice.

The smaller monitor operates off 12 VDC but the larger one had an AC transformer. I replaced the transformer with a DC to DC converter so it also operates on 12 VDC, lower left picture..

There is also a USB power buss for eight circuits to charge or power USB devices.



Ham Shack Power System

Comercial power usage

With the battery power supplied to the radios from the LiFEPO4 batteries and the computers and monitors supplied by the DC power supply and backup SLA batteries I usually don't notice commercial power failing. One of the pictures below was taken with the DC power supply turned on and the other picture I turned off the power supply to simulate a power failure.

Can you see the only two indications from loss of commercial power? The green light and the meter backlight on the power supply are out. Also the green light is out on the PWRgate, top center. Those are the only indications from loss of commercial power other than loosing internet.

Ham Shack Power System

Battery Charging Options

I have multiple choices for charging various batteries. If there is a chance that we could lose power and my main radio batteries have not returned to full charge due to lack of sunshine I would use an AC powered charger to top them off as a precaution.

If there are a lot of mostly cloudy days I can hang a 160 watt solar panel out the shack window as well as a 100 watt panel out the attic window, I also have another 50 watt panel I can hang out another attic window if really needed. This gives me a total of 350 watts of solar input. I would only need a brief amount of sunshine to charge all my radio and go box batteries.

If I need to charge cell phones or other USB powered devices I have four 28,500 mA hour charging bricks that can be recharged from the two 5 VDC folding solar chargers. I also have a 35 Ah SLA battery in my car that runs my mobile radio and is charged by the alternator when the car is running. If the car is not putting out 14 VDC the battery is isolated from the car so it won't drain the car battery. I can use that system to charge the other SLA batteries for the computers, if needed.

Other Stuff

Transmitting power and how it relates to operating time

How much power your radio is transmitting directly affects how much power you draw with the radio. The more power you draw with the radio the less time your batteries will last.

Being a Net Control Station for the ARES nets I have plenty of opportunity to record power usage under various situations. These are examples of real measurements during multiple nets.

Radio used for testing: Icom IC-2730. Power draw for full 50 watt output: 8.9 amps. Power draw for mid, 15 watt output: 4.7 amps. Power draw for low, 5 watt output: 2.75 amps. Listening: .47 Amps

Working net as Net Control Station, 65% transmit, 35% receive. Just signing into nets, 6% transmit, 94% receive.

Drawing from 14 Ah battery in go box as NCS I could operate about 2.25 hours on high, 4.25 on mid and 7 hours on low power. Just checking into nets I could operate about 14 hours on high, 18.75 on mid, and 22.5 hours on low power.

Using all the batteries in the shack I could operate as NCS on full power for 25.5 hours, mid for 45 hours or 76.5 hours on low power. Just checking into nets I can operate about 153 hours on high, 204 hours on mid and 240 hours on low. All without recharge.

I have been operating for months on the low power setting , 5 watts transmit, as both NCS and just signing in. On a sunny Sunday morning as NCS the 40 watt solar panels can keep up with the battery draw with about 2 amps solar input per hour. If I was just signing in they could recharge a partially discharged battery while I was listening to the nets.

My battery choice and why

When I first started looking into solar and battery power for emergency communications I checked out a few brands and chemistry options.

I first tried a 35 Ah SLA battery but I could watch the voltage drop as I operated my IC-7300 on HF. After looking at the flat voltage output of LiFePO4 batteries I decided to try a couple. The voltage stayed constant for the full Ah draw of the battery. It also had 80 to 90 percent of its capacity available for use. SLA batteries only have about 50 percent of their rated capacity actually usable. I could also recharge a LiFePO4 battery a couple of thousand times compared to a couple of hundred times for a SLA.

Dakota Lithium was the only brand that I could start with a battery or two and add batterie as funds allowed. Most of the other manufacturers did not advise putting their batteries in parallel to increase amp hours. Dakota Lithium had no issues with that and testimonials from actual users who did just that. One sailboat owner had twenty batteries in one bank.

All in all the Dakota Lithium batteries were a lot more expensive but they last longer, 11 year warranty, and perform longer, recharge many more time and can be run in parallel. This allowed me to start small and add battery capacity as I could afford it instead of having to start with a big battery.

Other Stuff

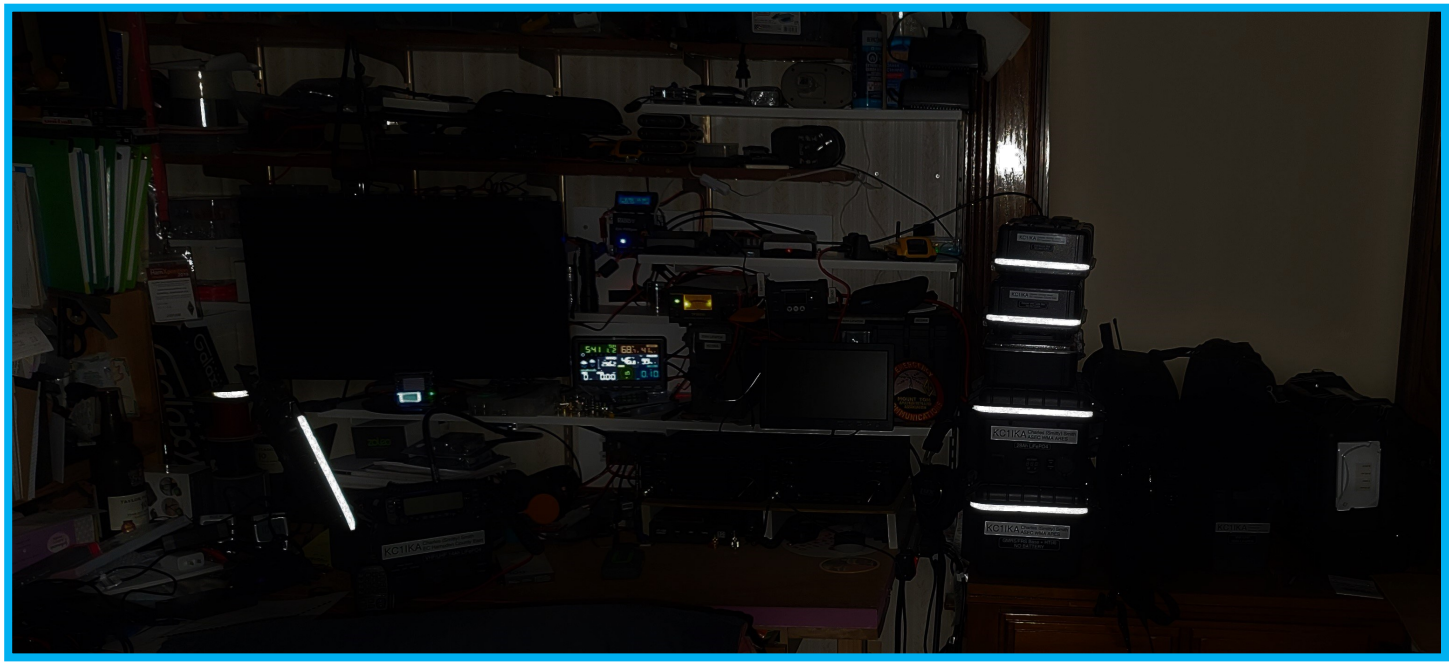
Low power lighting options

Being able to see what you are doing is also important. There are many choices for off grid lighting. When I'm not in the shack I prefer USB powered "popsicle" lights. I am now using the second generation and the color is not as harsh as the first version. I can still dim them down to such low power consumption the power brick won't recognize it and it will shut off. In my shack I use one of those lights and I also have some LED strip lights on the underside of two shelves. They generate a lot more light but draw about an amp when on. This isn't a big deal if there is frequent sunshine to recharge my batteries. In a true, prolonged grid down event, I would only operate the minimum lighting needed to operate to conserve battery power for the radios. There are some pictures below of the light strip, the USB light at full power, and the USB light at very low power.

Other Stuff

Finding a black box in a dark room

As you can see from the picture below, all the boxes I build I put a strip of reflective tape around the box so I can find a black box in the dark. You can clearly see the stack of go boxes, the slanted open lid of the VHF/UHF box and the roll of tape to the left of the open box. This would also be a big help at night outside during a deployment or at Field Day.



Communicating without cell service

Another helpful device is a Zoleo personal communicator. If you are at a remote location without cell service you would still be able to text anyone in your contact list on your phone. It connects via Bluetooth to your phone and attempts to use your phone wifi connection first to communicate. If wifi fails it tries your phone data connection. If that also fails it uses the Iridium satellite system to communicate. You can send texts and the checkmark is to send an automated “I’m okay” message with your location information. You can have it automatically send position updates at an interval you select. This is good for groups to know where everyone is or for loved ones to see you are still alive and moving. There is also an emergency SOS button that is monitored 24/7/365. It is inexpensive to purchase and the monthly subscription cost is very low. Just another piece of backup equipment.