EMERGENCY BACKUP POWER FOR HAM STATIONS

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WHY DISCUSS EMERGENCY BACKUP POWER?

The recent winter and tornadic weather outages of 2021 in Lincoln County, TN caused me to realize that I need emergency (back-up) power for my ham station – Why?

• To facilitate local/statewide emergency communications
• To continue to operate and make contacts with other amateur radio operators
• Power outages had shut me down and I could not operate or assist in the statewide emergency net (Tennessee Phone/CW nets)

After much thought, I decided to research this subject and add backup power to my station
STEPS TO IMPLEMENTATION OF EMERGENCY BACKUP POWER

- Assess station requirements – How much power is needed?
- Design backup power system – Battery, Generator, or Solar cells?
- Purchase & Install the necessary essential equipment – Components are available from ham radio dealers, junk stores, junk box, etc.
- Test Monthly – To determine function of backup power system
WHAT EQUIPMENT MUST BE POWERED?

- You must make a decision as to which equipment you must provide backup power

AC4G’s Ham Shack

AC4G’s Power Cabinet w/ 2m VHF Yaesu Rig (bottom)
DETERMINE STATION POWER REQUIREMENTS

- How much auxiliary power do I need during a power outage?
  - Duration and duty cycle: SSB, CW, RTTY, FT8, and other modes which determines battery life (battery & solar backup power)
  - Power for Computer equipment (Desktop or Laptop); displays; and other peripherals
  - Consider other household needs such as antenna switches, antenna rotator, CW keyer, desk lights, etc.?
ITEMIZE EQUIPMENT NEEDING TO BE POWERED WITH BACKUP SYSTEM

- Begin by listing all equipment to be powered
  - Transceivers/tuners/interfaces
  - Computer & monitor
  - Room Lighting
  - Etc.
- For each component, determine:
  - Voltage requirements
  - Peak current consumption
  - Duty cycle Requirements (How long to stay powered?)
## TYPICAL TRANSMIT AND RECEIVE POWER CONSUMPTION

<table>
<thead>
<tr>
<th>Item</th>
<th>Transmit Current</th>
<th>Receive Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF Transceiver (100W)</td>
<td>22A</td>
<td>1.5A</td>
</tr>
<tr>
<td>HF Tuner</td>
<td>1.0 A plus</td>
<td></td>
</tr>
<tr>
<td>VHF/UHF Mobile Rig (50W)</td>
<td>12A</td>
<td>1.0A</td>
</tr>
<tr>
<td>Desktop/Laptop PC</td>
<td>2.5A@120VAC</td>
<td></td>
</tr>
<tr>
<td>Desktop Monitor</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Other Components</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

Check your equipment ratings! Each component may have differing ratings and can be found in the manual or measured.
MUST DECIDE ON TYPE OF BACKUP POWER SYSTEM (1 OF 2)

- Generator
  - Equipment to be plugged-in (Extension chord?)
  - Power Supplies to operate 12V equipment
  - Maintain generator (gas, oil, etc.)
- Battery (Indoor or Outdoor)
  - Use 12V directly vice Power Supplies (120VAC electrical power)
  - Inverter to be used for 120V equipment
  - Requires batteries to be charged
  - Batteries to be replaced every 3 to 5 years
MUST DECIDE ON TYPE OF BACKUP POWER SYSTEM (2 OF 2)

- Solar
  - Requires solar components: charge controller, deep cycle batteries, and solar cells
  - Generates lots of noise affect HF transceivers
  - Cells are currently expensive (Not an option for AC4G)
  - Requires space for solar cells

AC4G selected second option: Battery backup system
INDOOR BATTERY BACKUP SYSTEM MUST:

- Seamlessly auto-switch if AC power (120VAC) is lost in the ham shack
- Provide sufficient voltage and run time to facilitate ham radio operations (Backup run time is based on battery size & condition & operating time)
- Must trickle charge battery to keep it charged and ready for instantaneous use at any time
HOW TO CALCULATE BATTERY RATING

- The amp-hour is a unit of battery energy capacity equal to the amount of continuous current multiplied by the discharge time that a battery can supply before exhausting its internal storage of chemical energy.

\[
\text{Amp-hour} = I(\text{continuous}) \times t(\text{discharge}) \Rightarrow \text{[Results in discharge of battery]}
\]

- Peukert’s Law (states the capacity of a battery in terms of the rate at which it is discharged) - as the discharge rate increases, the battery’s available capacity decreases. [Note: A factor of 1.1 is perfect (10%).]

An increase in a battery’s discharge rate results in a decrease of a battery’s capability to provide power.
HOW TO CALCULATE BATTERY RATING

- An amp-hour is one amp for one hour OR 10 amps for 1/10 of an hour (~6 minutes)

- Transmit: Assume a rig drawing 20A and running 20 minutes: Amp-hours used would be 20A X .333 hours (1/3 hour or 20 minutes) = 6.67 AH

- Receive: Receiving 20% of the time on HF:
  - 1.5A X .66 hours (2/3 hour or 40 minutes) = 1.0 amp-hours

- You need 6.67AH + 1.0 AH = 7.67 AH

- Factoring Peukert’s Factor yields 7.67AH + 10% Peukart factor = 7.67AH + (7.67AH X .10) = 8.437 AH battery capacity per hour
CONSTRUCTION OF THE AC4G’S BATTERY BACKUP SYSTEM

- Use the components described on the following slide
- Powerpoles make a neat looking project
- Use the correct wire size
- Try using cables less than 6 feet long
- Install fuses at the battery (battery box has this feature built-in)
Types of Commercial Battery Backup Modules

SAMLEX BBM-1225 or BBM-12100

Manufacturer's Part Number: BBM-1225
Part Type: Automatic Battery Backup Switch Devices
Product Line: Samlex Battery Backup Modules
DVE Part Number: SXA-06151
UPC: 62269001514
Maximum Output Current: 25A
Charging Circuit Type: Smart charger
Fused Input: No
Fuses Included: No
Width (in): 3.900 in.
Height (in): 1.900 in.
Depth (in): 4.600 in.
Weight: 0.800 lbs
Quantity: Sold Individually.

Samlex Battery Backup Modules are connected to the output of a power supply and a battery to provide automatic battery backup capabilities. When the AC power fails, these silent, solid-state modules instantaneously switch the DC power connection of your electronic devices from the power supply to the battery, keeping your essential DC powered electronics working! While the AC power is on, these modules regulate the DC power supply output voltage and current to recharge the backup batteries while supplying the DC load. There are no relays to fail and no contacts to clean.

Functional from well under 12 Vdc up to 26 Vdc and capable of handling 25A or 100A output depending on model, these units are used to create uninterruptible power supplies that are used in essential communications, automotive, marine, RV, aviation and other applications. Especially well-suited for Emergency Communications and in generator powered systems, and anywhere AC to DC supplies provide crucial power service, Samlex Battery Backup Modules from DX Engineering will keep your electronics up and running!

Others available or homemade?
AC4G’S BATTERY BACKUP BATTERY SYSTEM - COMPONENTS

- West Mountain Radio 4008 Battery Box: $139.95
- Samlex Battery Backup Module (BBM-1225 or BBM-12100) Auto switcher and trickle charger: $59 - $137
- Blue or Yellow Top AGM Battery: $268
- Miscellaneous power cables: $30
- PWRCheck (measures Volts, Amps and alternates between AH and WH. Takes guesswork out of power measurements. Makes it easy to read power consumption and capacity: $184.95

Powerpoles make installation easy and neat!
FUNCTION OF THE BATTERY BOX

- West Mountain Radio 4008 Battery Box: $139.95
- Contains any explosion particles (just in case)
- Makes it easier to move and transport if needed for use in other projects or portable operation
- Powerpoles make connecting devices much easier

Note: Powerpole connectors and fuses
The Samlex module is a passive interface between the ham station power supply, the battery, and the DC load (HF transceiver, etc.)

- When power supply is operational, the load is provided with voltage & a float charge to the battery
- When the power supply fails, the battery will supply voltage to the load (HF transceiver, etc.); however, the battery begins discharging
- Once power is provided to the power supply (120VAC), the power supply takes over and the re-charging of the backup battery resumes (up to 4A charging current)
SECTION 2 | Layout and Dimensions

2.1 LAYOUT

LEGEND:
1. Positive Input Terminal
2. Negative Input Terminal
3. Common Negative Output Terminal for Load and Battery
4. Positive Output Terminal for Load
5. Positive Output Terminal for Battery

NOTE: All input and output terminals: Hole size 5mm / 0.2”, Set Screw: #10, 24 TPI, 5/16” long

2.1 DIMENSIONS

Excerpt from Samlex Power Battery Backup Module Model: BBM-1225
Voltage is fed through isolating D1 to load and current limiting resistors R1 & R2 (.6 Ohm-Parallel). D1 isolates the power supply & battery. D1 has a voltage drop of 0.5V. Trickle charging voltage is 0.5V lower than the power supply.

If the power supply fails, the load will be supplied by the battery thru D2 with a voltage drop of 0.5V. Since D2 is connected in parallel with R1 & R2, D2 bypasses R1 & R2 when the battery discharges thru the load.

R1 & R2 are 1.2 Ohm, 25 W
MAXIMUM CHARGING CURRENT

- Maximum battery charging current
  \[ I_b = \frac{(V_p - V_d) - V_b}{R_s} \]
- \( V_p \) = Output voltage of the power supply (13.8V for 12V battery)
- \( V_d \) = Forward voltage drop across Schottky Diode D1 (up to 0.5V)
- \( V_b \) = Battery voltage
- \( R_s \) = Equivalent series resistance. R1 (1.2 Ohm) and R2 (1.2 Ohm) in parallel = 0.6 Ohm.

- Assuming the voltages of fully discharged 12V batteries to be 11.1V (at Discharge Rate of around C/10 (0.1C) Amps), the maximum charging currents will be as follows:
  - \( (13.8V - 0.5V - 11.1V) \) divided by 0.6 Ohm = 3.67 A
AC4G’S INDOOR BATTERY BACKUP SYSTEM (BATTERY)

- Backup Battery is Absorbed Glass Mat (AGM) (Uses GEL electrolyte)
  - Designed for indoor use
  - Non-spill electrolyte
  - Does not emit hazardous, explosive gases inside ham shack
  - AGM batteries can take more abuse than Gel-type battery
  - Gel-type battery must be charged at a lower rate otherwise, heat damage can occur

AC4G’s battery backup system uses a battery box with this battery
BLOCK DIAGRAM OF THE AC4G BATTERY BACKUP SYSTEM

HF Equipment

Samlex BBM-12100 Battery Backup Module

AGM Battery (in Battery Box)

Power Supply

Optional PWR Check to make measurements
MAINTAINING THE BACKUP SYSTEM

- Test the Charge/Discharge cycle routinely
  - Test under load
  - Record data
  - Compare with previous test results
- Clean dirty contacts
- Inspect cables
  - Check for corrosion
  - Look for signs of overcharging and venting
- Keep spare fuses on hand
There are many articles covering many designs on the internet discussing emergency and backup power for amateur radio stations.

- Many designs from the past use discreet electrical components, while modern equipment provides an easy solution to build an emergency and backup power solution for the ham radio station.

A backup power system enables the radio amateur to participate in emergency events.

- AC4G’s design is simple and makes use of modern equipment to switch from local power utilities to battery backup.

- Although generator, battery, and solar power backup systems can be designed and built, each ham operator must decide which is best for their situation.
REFERENCES

- AGM Batteries: www.windsun.com
- Battery Box: Westmountainradio.com
- Powerpole: www.powerwerx.com
- Dxengineering: www.dxengineering.com
- Gigaparts: www.gigaparts.com
- ARRL: www.arrl.org
QUESTIONS?