



GETTING STARTED WITH SOLAR BACKUP POWER IN THE SHACK

Jack Weaver – AA5VZ

GETTING STARTED...

MOVING FORWARD

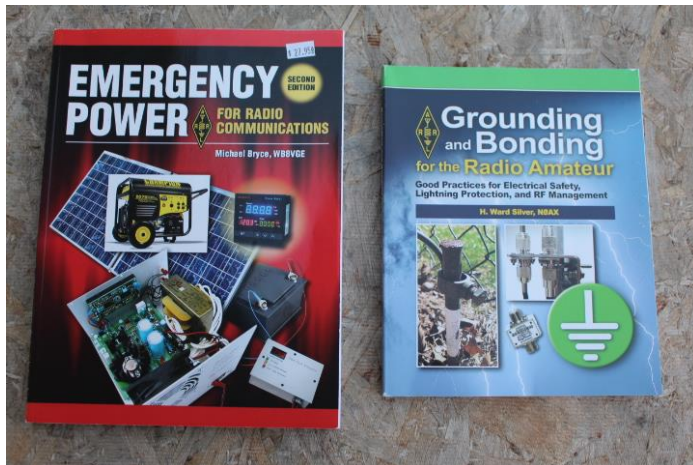
▶ RECOMMENDED READING:

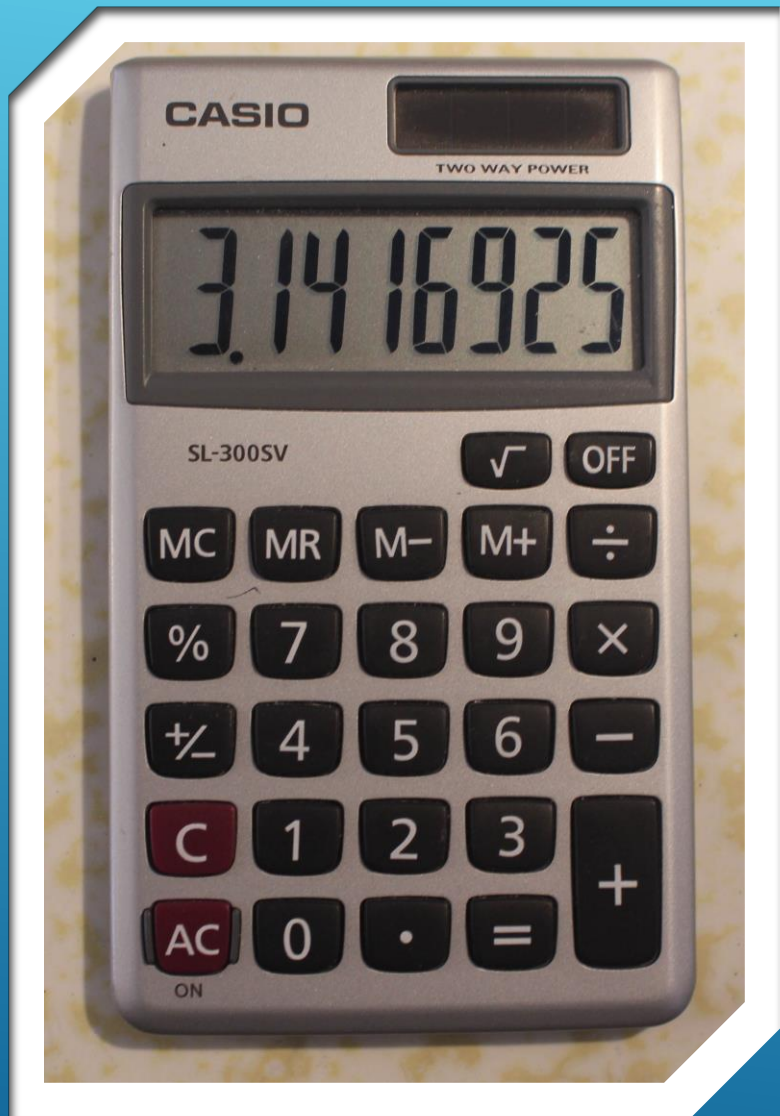
▶ Emergency Power for Radio Communications

Michael Bryce – WB8VGE

▶ Grounding and Bonding for the Radio Amateur

H. Ward Silver – N0AX





HARNESSING SOLAR ENERGY



HARNESSING SOLAR ENERGY



HARNESSING SOLAR ENERGY

- ▶ Specific Use
- ▶ Battery-powered Light
- ▶ Solar Battery Charger

HARNESSING SOLAR ENERGY

- ▶ Principle – Adaptable - i.e.:
- ▶ Battery-powered Radio
 - ▶ 12Vdc, 7AH SLA Battery
- ▶ Solar Battery Charger

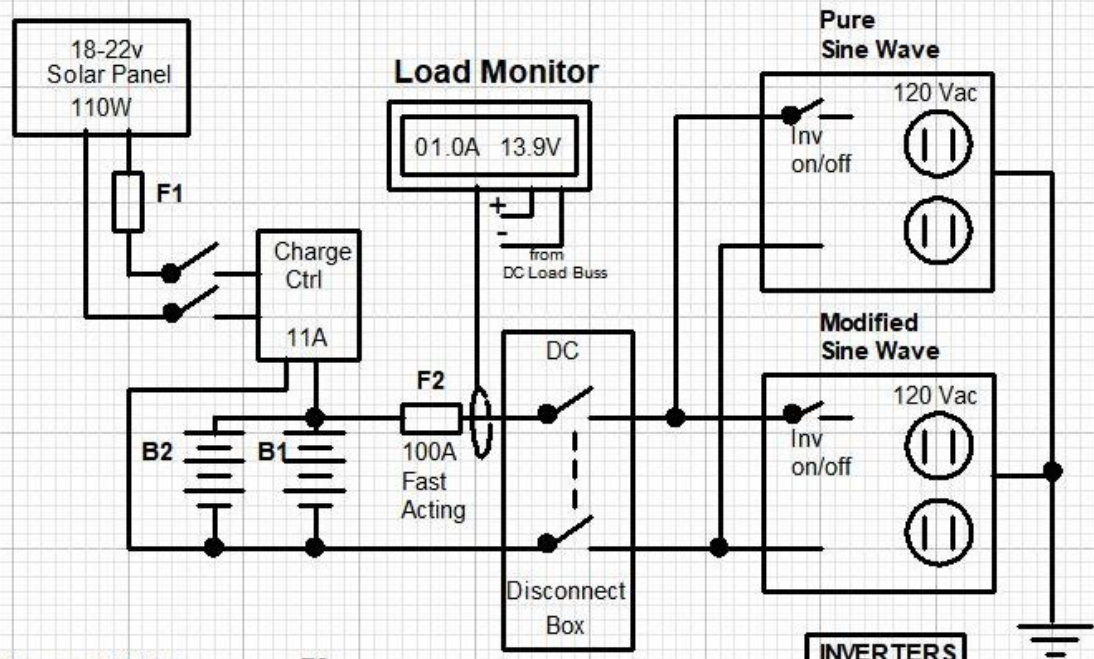




HARNESSING SOLAR ENERGY

- ▶ Off-Grid AC Power
- ▶ Battery Derived – Inverter Generated
- ▶ Solar Charged – (charge controller)
- ▶ Short-Term Use
- ▶ Limited Loads
- ▶ Basic Backup or Specific Purpose

MY SYSTEM

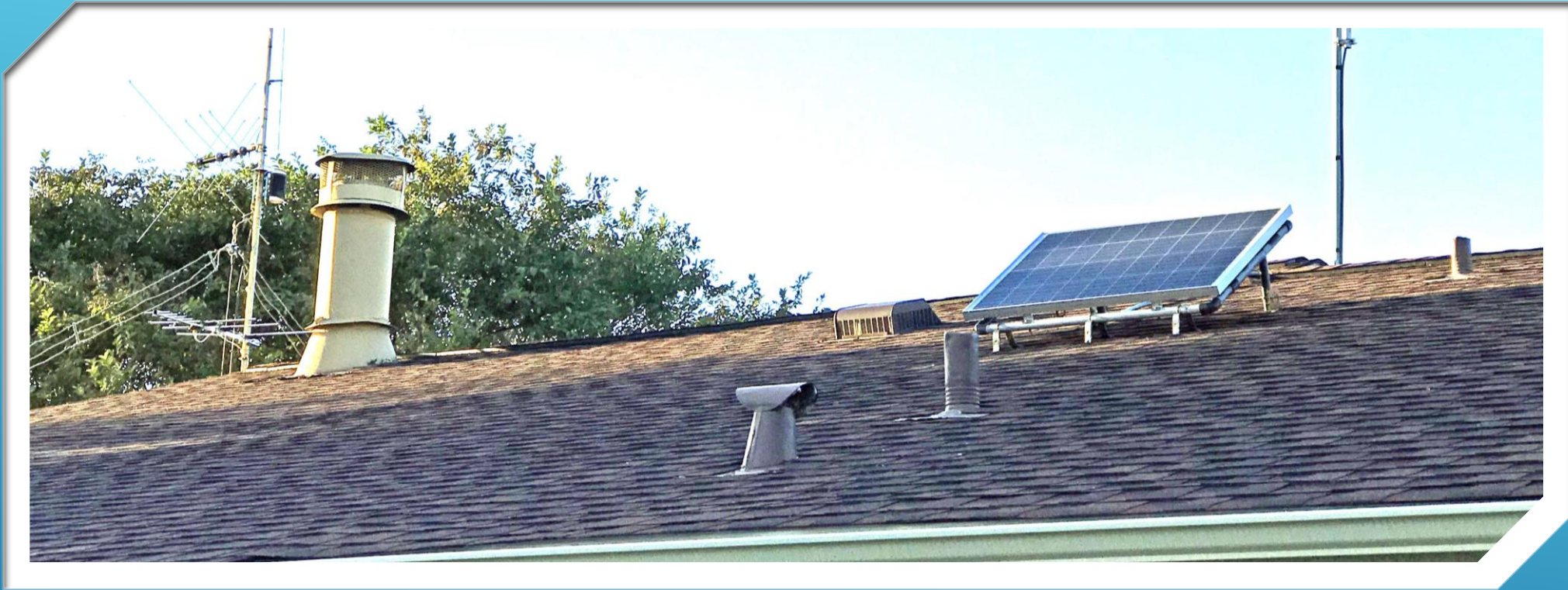


Battery B1 / B2
 Lead Acid
 Marine - Deep Cycle
 12Vdc 90ah

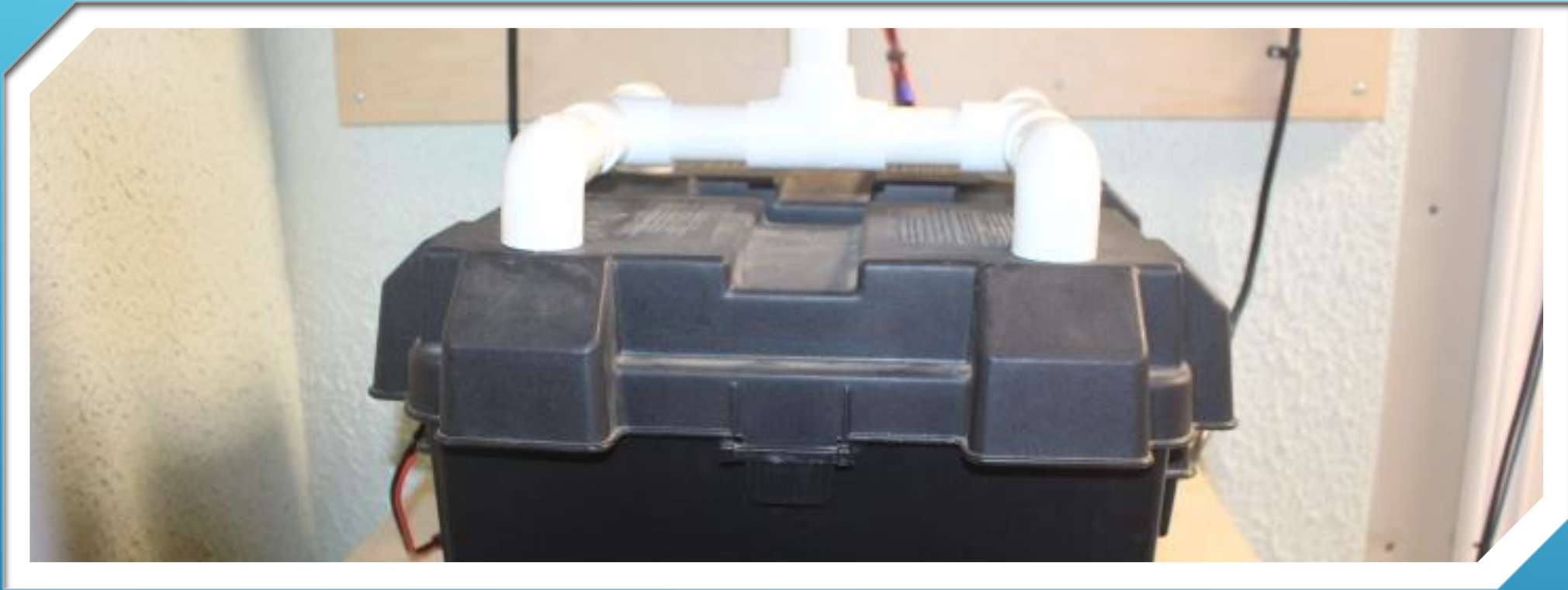
F2
 T8-Semiconductor
 Inverter Rated

Solar Battery Charging System
 With Inverters

SCHEMATIC



ROOF VIEW

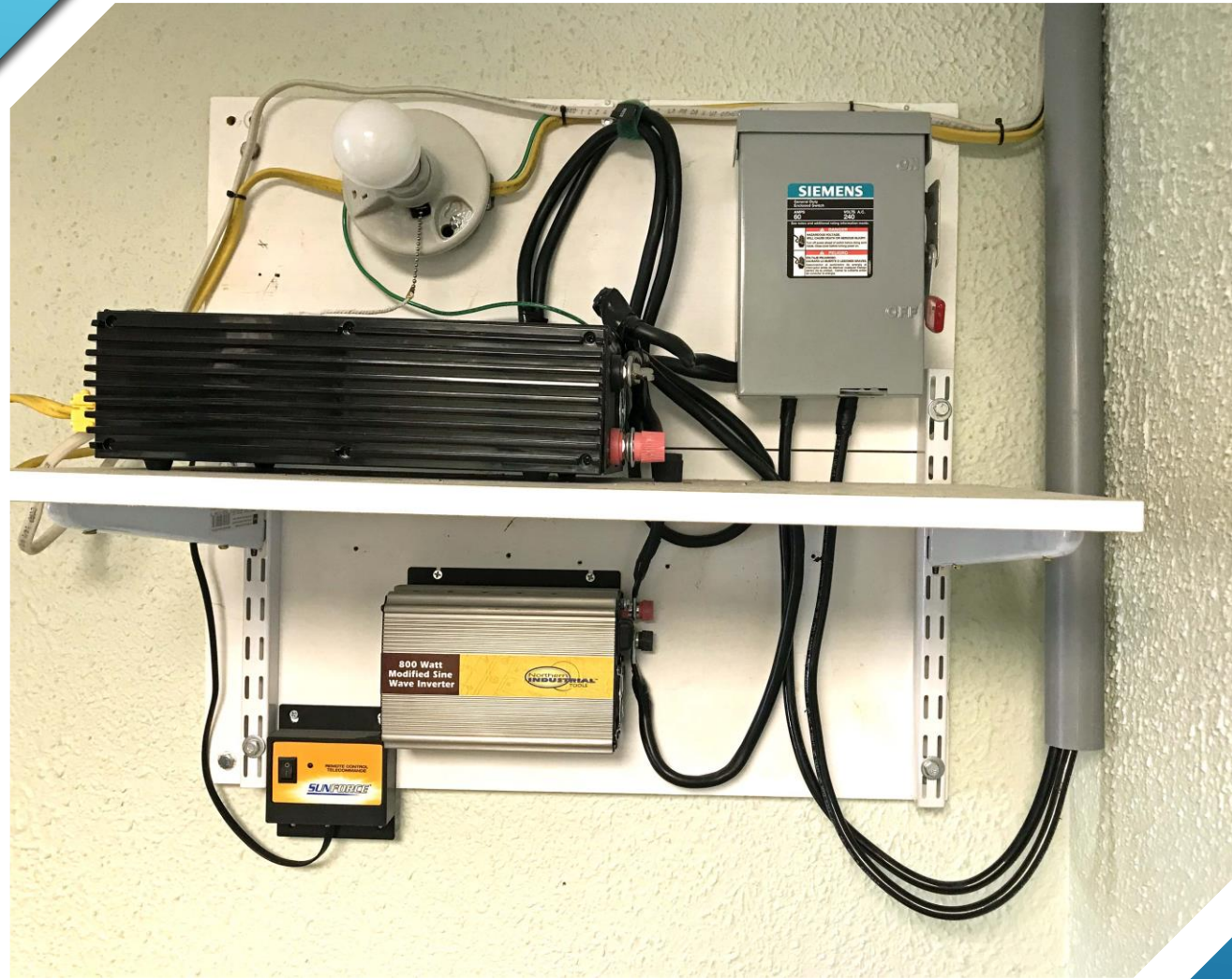


BATTERY STORAGE

DC INTERFACE PANEL



INVERTER PANEL



OFF-GRID LIGHT / AC FIXTURES





TYPICAL USE





OFF-GRID AC WALL OUTLET

NEVER connected to AC
house power

ALWAYS identifiable using
unique color (red preferable)

GETTING STARTED

WHAT DO I NEED?

- ▶ Budget
 - ▶ Solar Panel (s)
 - ▶ Proper Battery (s)
 - ▶ Charge Controller
 - ▶ Proper Ventilation
 - ▶ Inverter
 - ▶ Cables (Properly Sized)
 - ▶ Fuses (Proper Size and Type)
 - ▶ Utilize Proper Grounding (Per Manufacturer)
 - ▶ External Battery Charger (optional/recommended)
 - ▶ Ensure compliance with applicable codes (local/electrical)
- ▶ **ALWAYS THINK SAFETY !!!**

ALWAYS THINK SAFETY

Low Voltage-High Current Devices...

Do the Research Up Front

Think before you Act

Avoid Working Alone

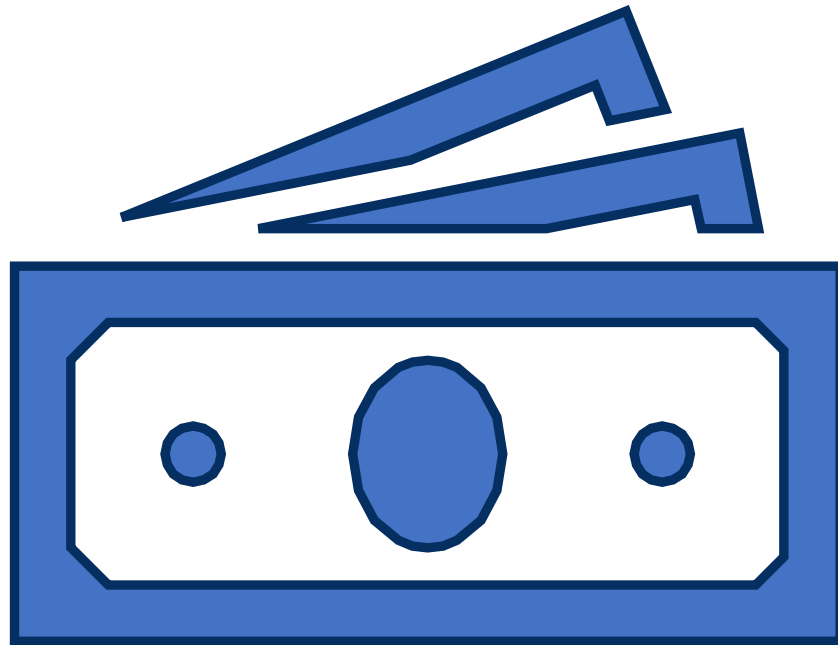
Utilize Personal Protective Equipment (PPE)
Eye/Face Protection (flash or spill)
Protective Clothing

Select Proper Tools – Use them Safely
Short-handled Wrenches
Insulate accordingly to prevent shorts
Avoid Clutter

Properly Sized and Type of Fire Extinguisher

First Aid items on hand for acid contact,
cuts, or burns

Telephone close by



BUDGET

Amps

Watts

Amp-Hours

Watt-Hours

BUDGET

- ▶ Power Demand
- ▶ Operational Time
- ▶ What is necessary?
- ▶ What is wasteful?



- ▶ Inverter Alone
- ▶ 2.9 DC Amps (continuous)
- ▶ 36.8 W
- ▶ $180\text{aH (Batt)}/3\text{aH (Stby)} = 60 \text{ Hrs Available}$

BUDGET



- ▶ Inverter + Yaesu P.S. (unloaded)
- ▶ 4.2 DC Amps (continuous)
- ▶ 52.9W
- ▶ $180\text{aH (Batt)}/4\text{aH (Stby)} = 45 \text{ Hrs Available}$

BUDGET



- ▶ Inverter + Yaesu P.S. + Rx
- ▶ 8 DC Amps (continuous)
- ▶ 100 W
- ▶ $180\text{aH (Batt)}/8\text{aH (Rx)} = 22.5 \text{ Hrs Available}$

BUDGET



- ▶ TS-590 Transmitting 5W FT-8
- ▶ 19.9 DC Amps (continuous)
- ▶ 244 W
- ▶ $180\text{aH (Batt)}/20\text{aH (active)} = 9$ Hrs Available

BUDGET



- ▶ TS-590 Transmitting 60W FT-8
- ▶ 38.4 DC Amps (continuous)
- ▶ 464 W
- ▶ $180\text{aH (Batt)}/40\text{aH (Active)} = 4.5 \text{ Hrs Available}$

BUDGET



BUDGET

Plan use of low power loads whenever possible.

Examples:

SDR Play (wide band Rx)

MFJ-Cub (3W)

PSK-20 (4W)

MFJ 20m / 40m SSB Xcvr (<10W)

HT (5W)

SOLAR COLLECTORS

SOLAR PANEL

- ▶ **Amorphous**
- ▶ Polycrystalline



SOLAR MODULE

- ▶ Amorphous
- ▶ **Polycrystalline**





MOUNTING

- ▶ Install panels facing Southward
- ▶ Allow path for rainwater to drain
- ▶ Set angle to local latitude
 - ▶ 32 deg. for DFW
 - ▶ Level and Protractor or
 - ▶ Smart phone with protractor app
- ▶ Use proper sealant to ensure water tightness and protect roof

PROPER BATTERY



BATTERY



BATTERY

CHARGE CONTROLLER

CHARGE CONTROLLER



VENTILATION



VENTILATION

- ▶ Lead-Acid Batteries produce Hydrogen gas when charging
- ▶ Use proper enclosure
- ▶ Keep away from sparks or flames
- ▶ Ensure proper ventilation



VENTILATION



VENTILATION

VENTILATION





VENTILATION

INVERTER



INVERTER

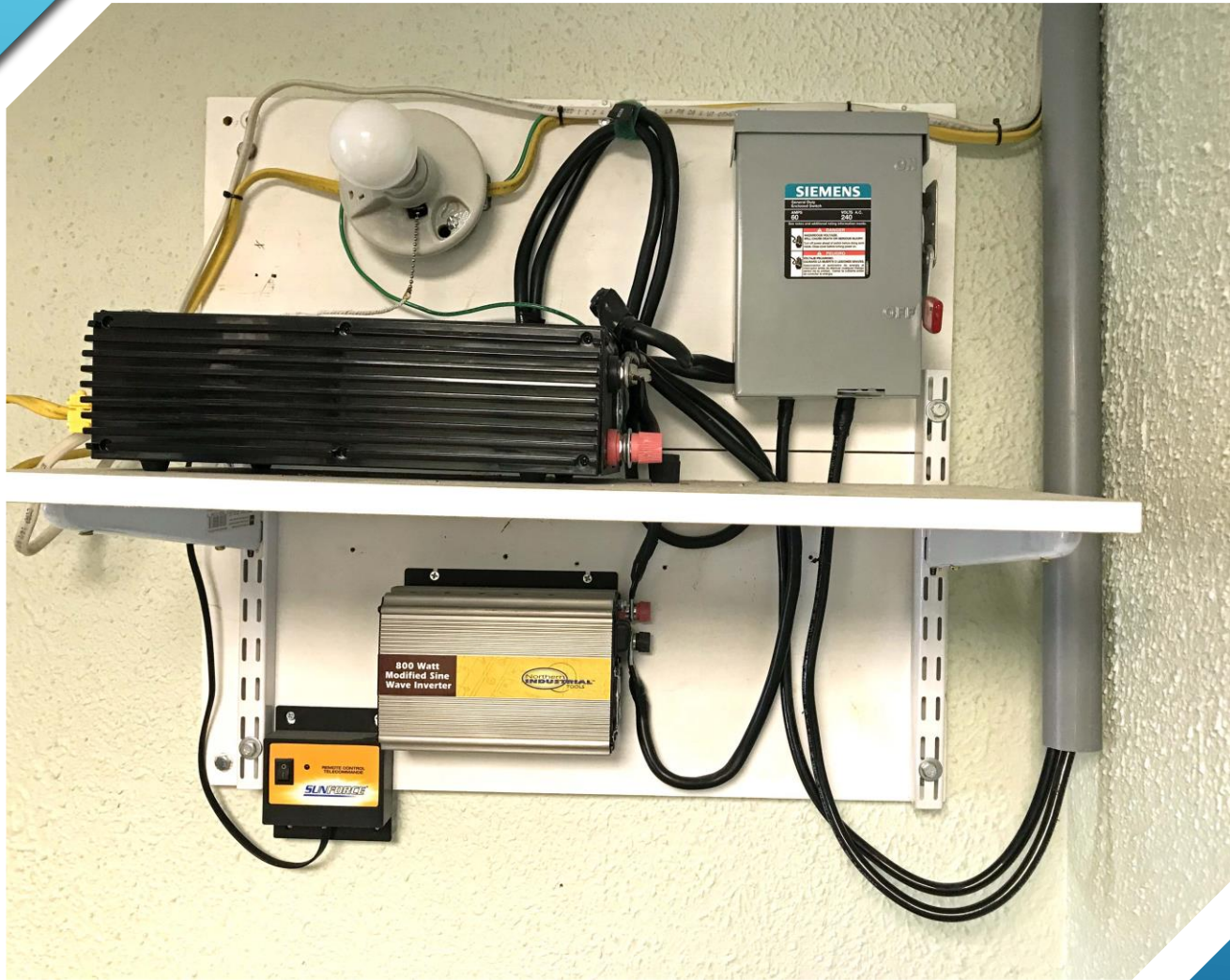


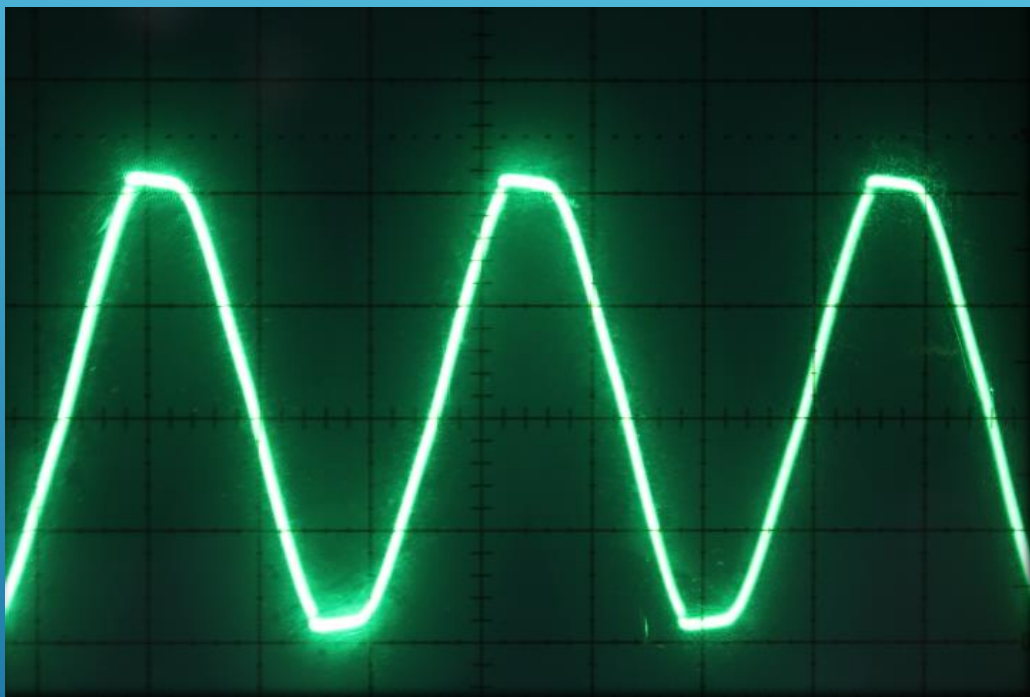
INVERTER

- ▶ !!! Use Properly Sized Input Cables !!!
- ▶ Install and Use a DC Disconnect Box
 - ▶ Always disconnect battery power before loosening or moving cables

INVERTER TYPES

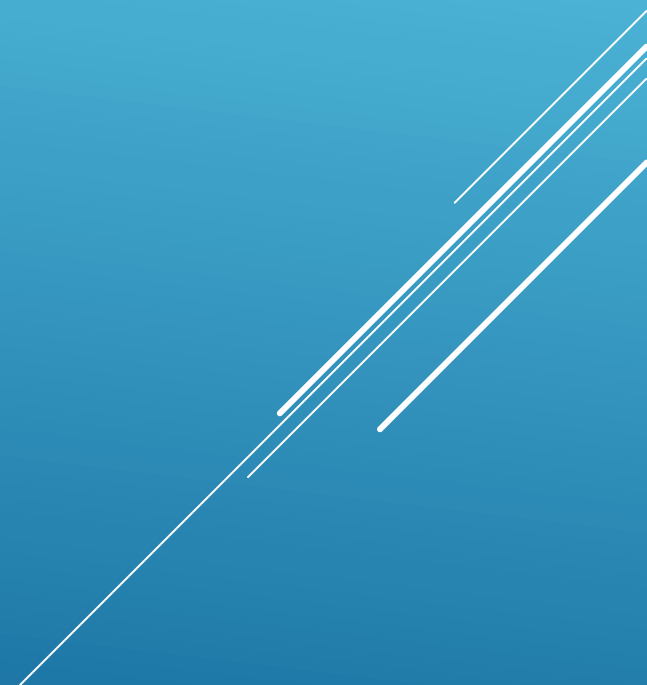
- ▶ Pure Sine Wave (Top)
 - ▶ More expensive option
 - ▶ Linear AC (Sine-Wave) Output
- ▶ Modified Sine Wave (Bottom)
 - ▶ Less expensive option
 - ▶ Non-Linear AC Output
 - ▶ Some devices may not accept

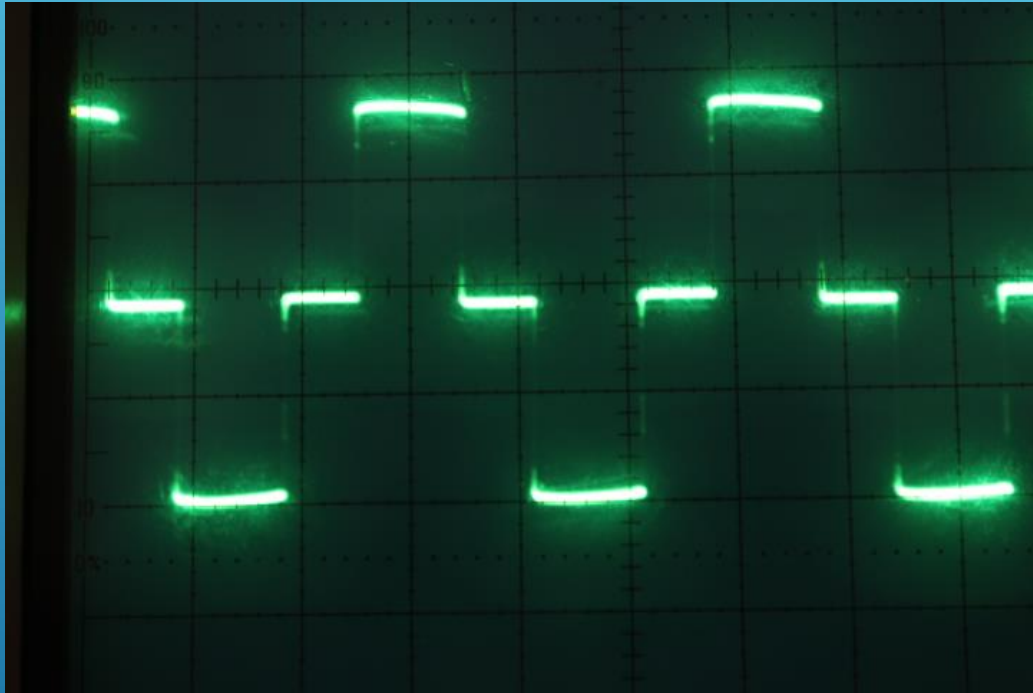




My AC House Power

~~INVERTER~~



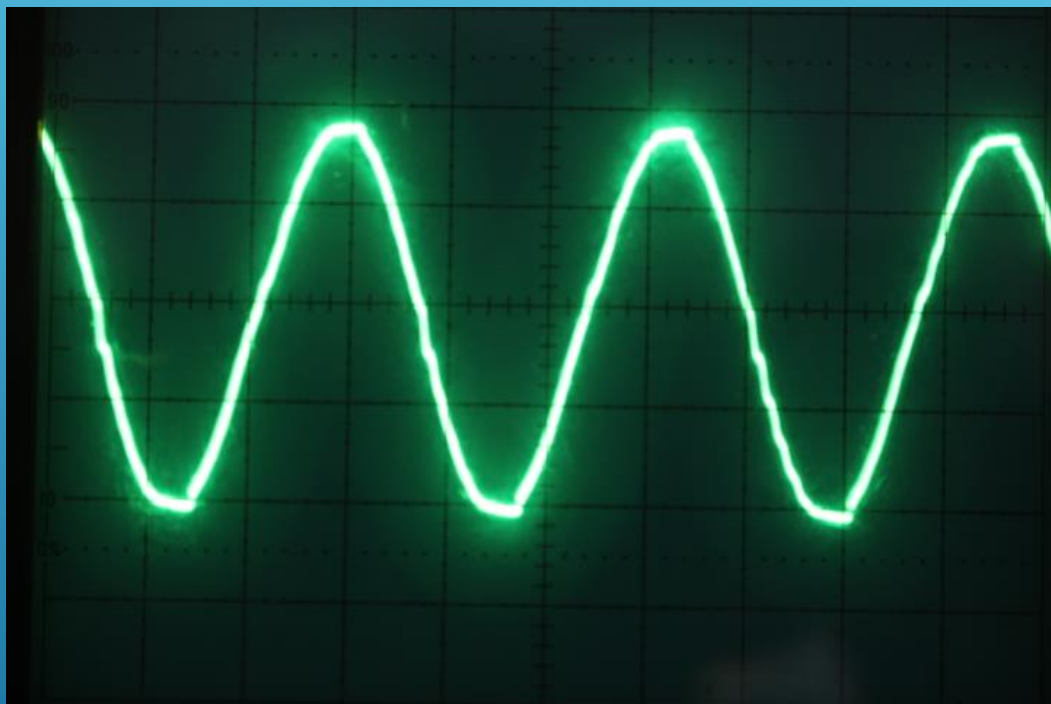


Inverter AC Output

Modified Sine Wave Model

Will not operate some devices

INVERTER



Inverter AC Output
Pure Sine Wave Model

INVERTER



CABLE SIZE

Conductor Size for 3% Drop in Voltage

Current (Amps)	Round-Trip Length of Conductor (Feet)								
	10	20	30	40	60	80	100	120	140
	Minimum Wire Size (AWG)								
1	16	16	16	16	16	14	14	14	12
2	16	16	16	14	14	12	10	10	8
5	16	14	12	10	10	8	6	6	6
10	14	10	10	8	6	6	4	4	2
15	12	10	8	6	6	4	2	2	1
20	10	8	6	6	4	2	2	1	0
25	10	6	6	4	2	2	1	0	2/0
30	10	6	4	4	2	1	0	2/0	3/0
40	8	6	4	2	1	0	2/0	3/0	4/0
50	6	4	2	2	0	2/0	3/0	4/0	
60	6	4	2	1	2/0	3/0	4/0		
70	6	2	1	0	3/0	4/0			
80	6	2	1	0	3/0	4/0			
90	4	2	0	2/0	4/0				
100	4	2	0	2/0	4/0				

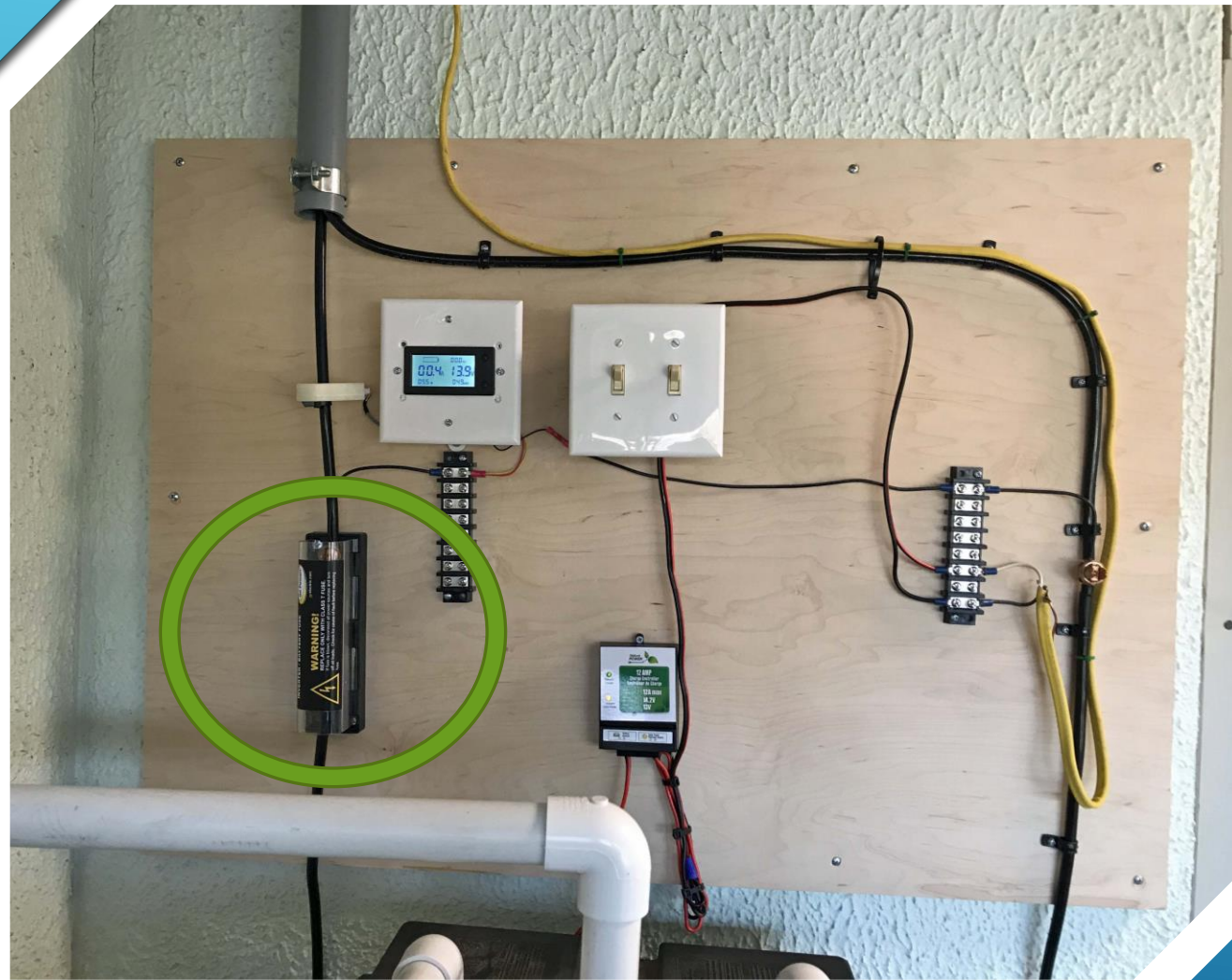
CABLE CHART

BATTERY CIRCUIT PROTECTION



BATTERY CIRCUIT PROTECTION

BATTERY CIRCUIT PROTECTION



BATTERY CIRCUIT PROTECTION





CIRCUIT PROTECTION

GROUNDING



AC GROUNDING

- ▶ AC Ground Source – house wiring
- ▶ Home built in 1978
- ▶ May be different in homes now
- ▶ Inverter grounding requirements vary
- ▶ Follow Mfgr. directions for grounding your inverter.

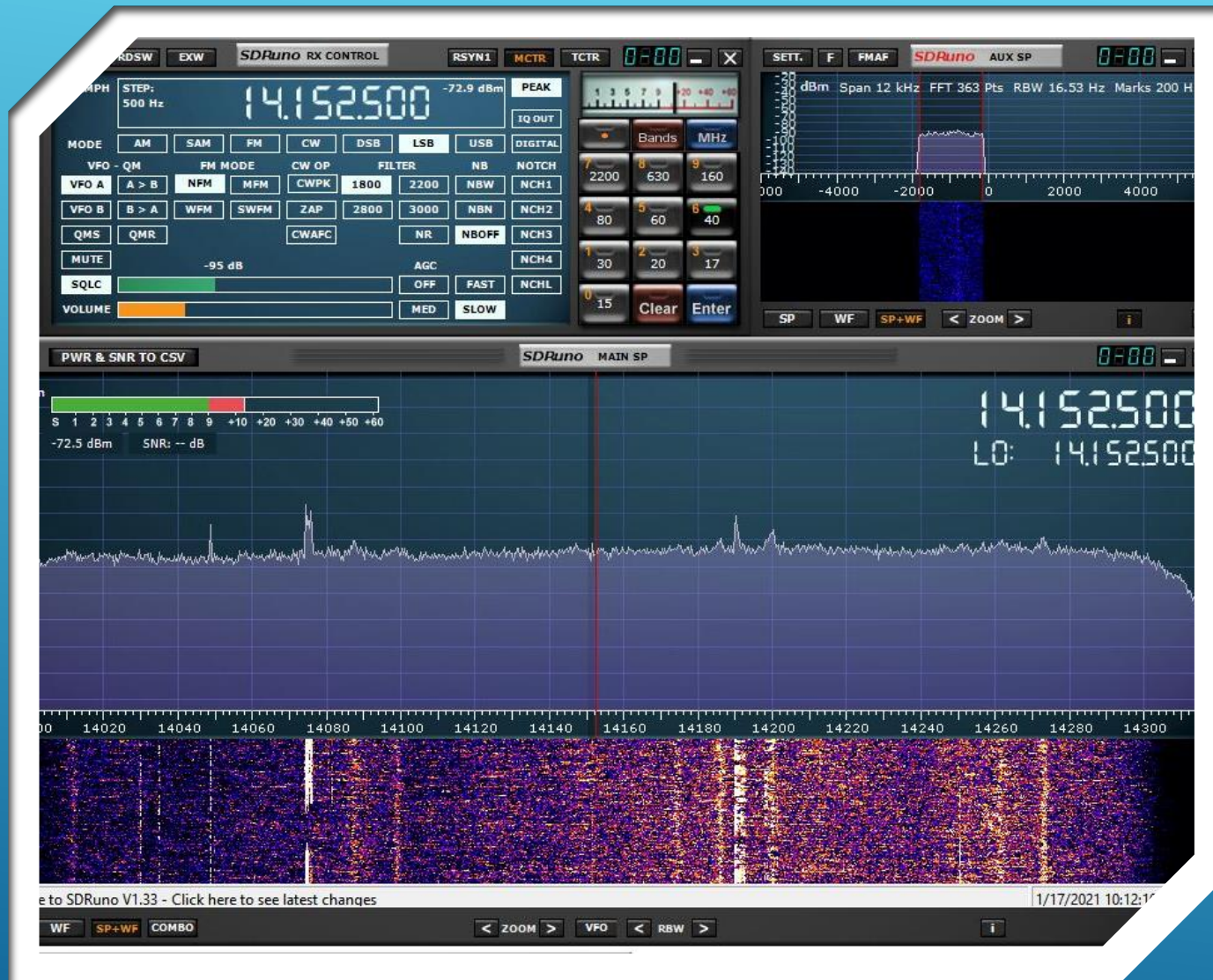
(OPTIONAL)

EXTERNAL
CHARGER

OPTIONAL BATTERY CHARGER

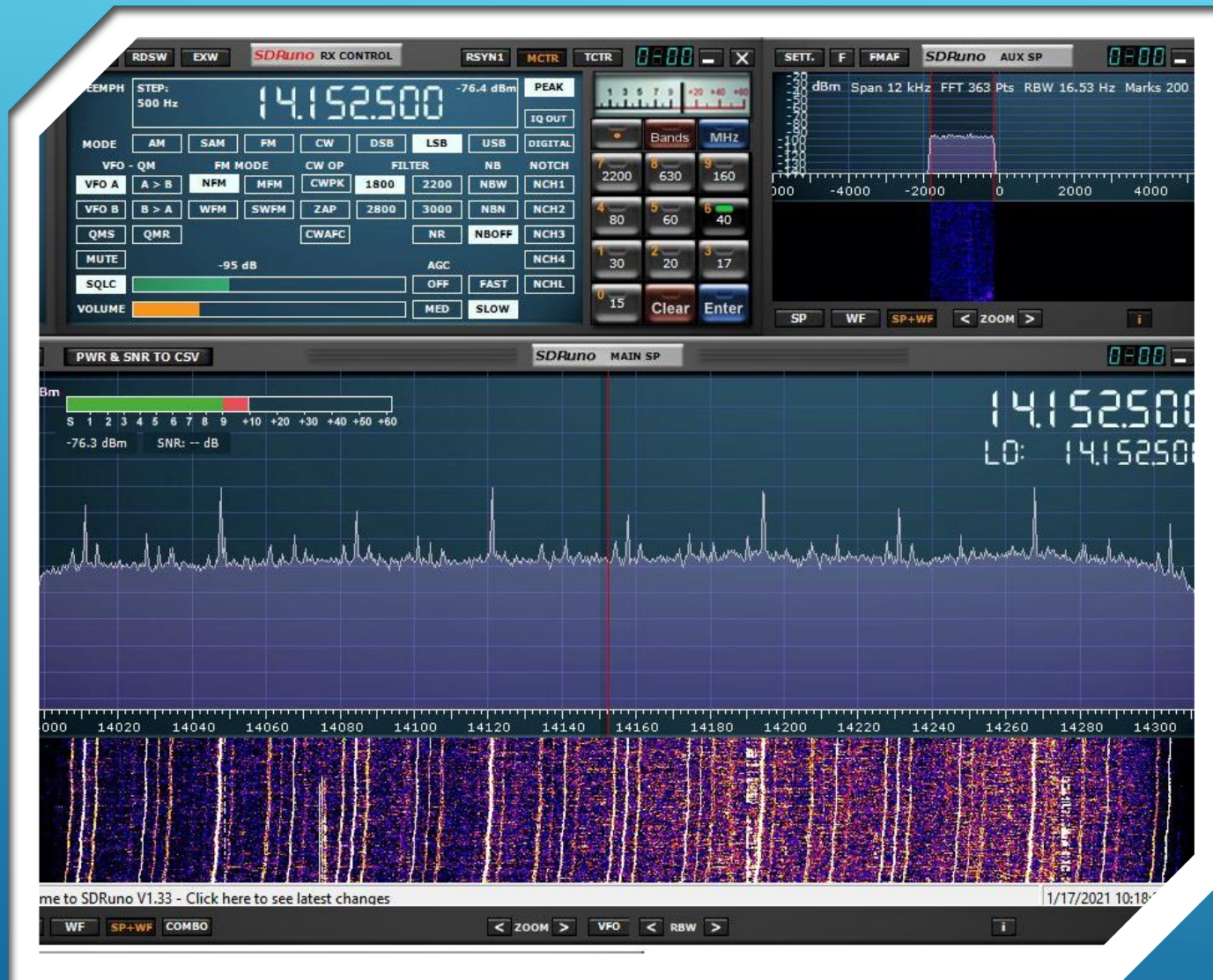


RF NOISE



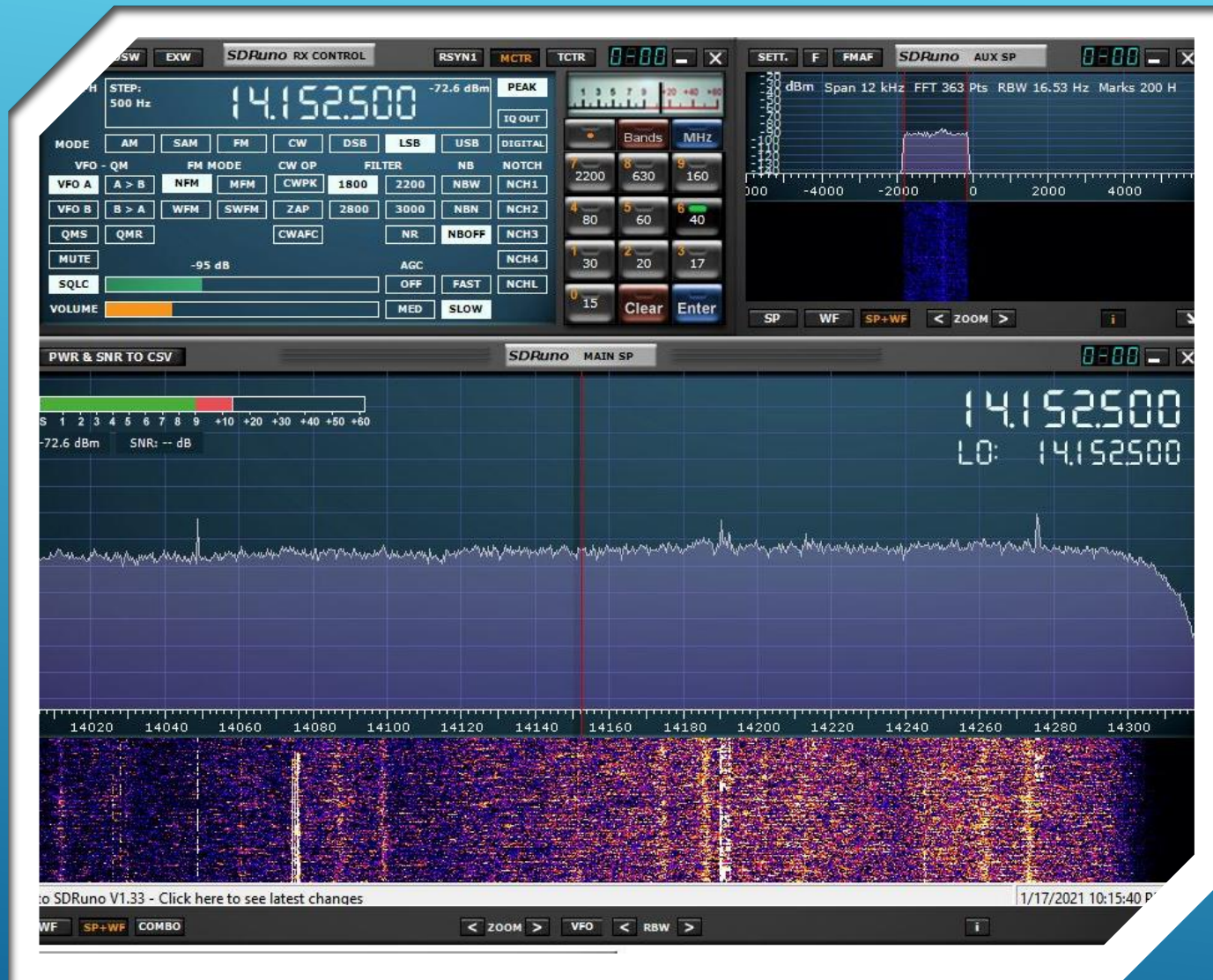
RF NOISE

- ▶ 20m Band
- ▶ AC House Power Source
- ▶ No appreciable noise



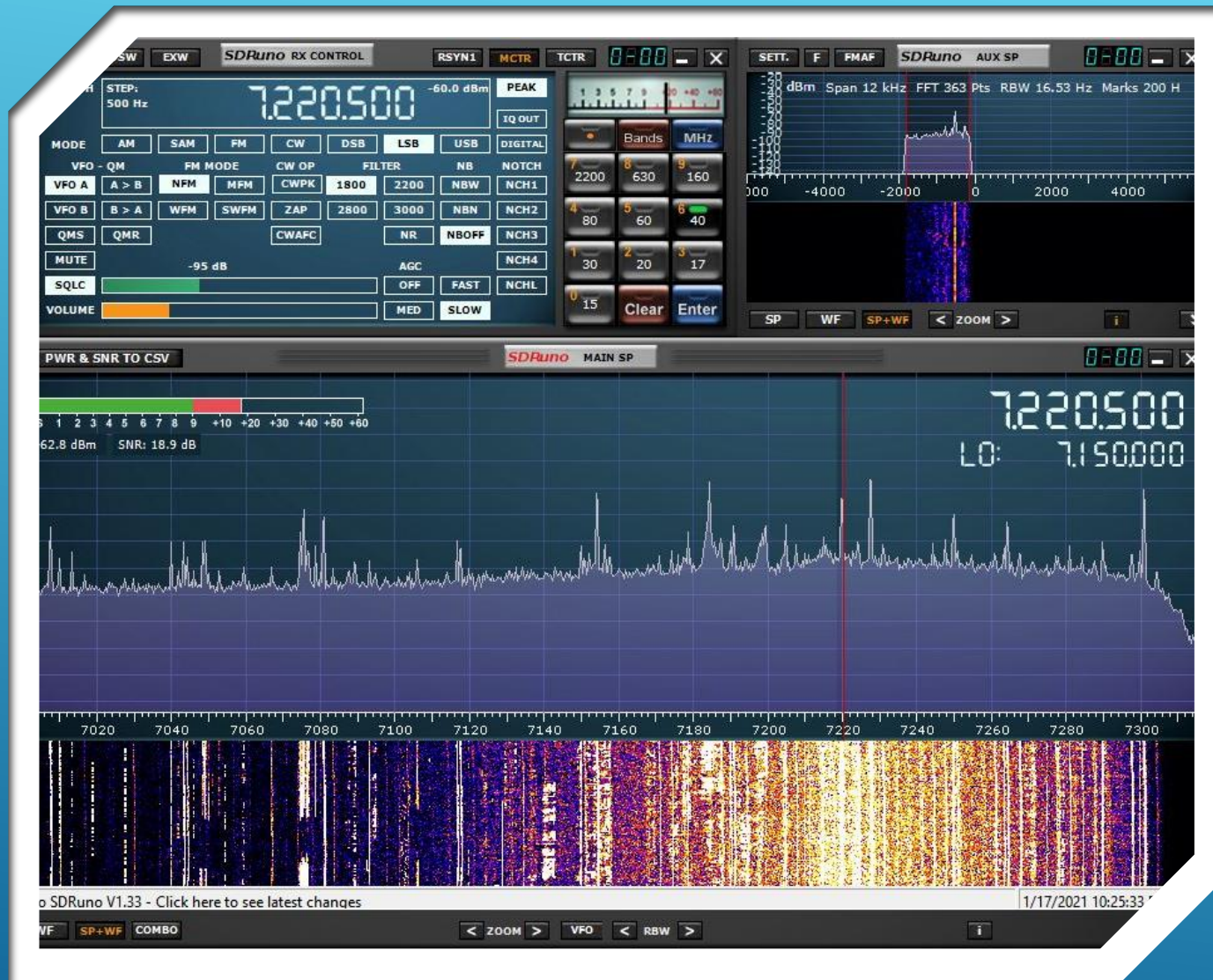
RF NOISE

- ▶ 20m Band
- ▶ Pure Sine Wave Inverter
- ▶ Significant RF noise across entire band
- ▶ Area between noise products useable



RF NOISE

- ▶ 20m Band
- ▶ Modified Sine Wave Inverter
- ▶ Increased RF noise
- ▶ Entire band still useable



RF NOISE

- ▶ 40m Band
- ▶ Pure Sine Wave Inverter
- ▶ Noticeable RFI in Phone Band
- ▶ Cleaner on Lower End

RF NOISE

- ▶ 40m Band
- ▶ Pure Sine Wave Inverter
- ▶ Successful FT-8 QSO

The screenshot displays the WSJT-X software interface. At the top, a wide graph shows a spectrum of RF noise across the 40m band (approximately 7.0 to 7.3 MHz). Below the graph, a 'Band Activity' window lists various stations and their frequencies. The main interface shows the current frequency set to 7.074000 MHz, with a '40m' band selection and a 'Log QSO' button. The interface also displays a signal strength indicator (S-meter) and a digital display showing the date and time: 2021 Jan 18 00:19:22.

UTC	dx	dt	Freq	Message	UTC	dx	dt	Freq	Message		
001705	-7	0.5	978	CQ W4WKA EM10	U.S.A.	031030	0	0.5	976	CQ W4WKA EM10	U.S.A.
001730	-12	0.1	813	CQ W4WY DM15	U.S.A.	031030	-7	0.2	919	CQ N4RAG EL96	U.S.A.
001738	-14	0.5	876	CQ W4WVW EM20	U.S.A.	031030	-7x	0.2	919	N4RAG AASVZ EM12	U.S.A.
001739	-18	0.1	864	CQ KMSLY EM12	U.S.A.	001690	-12	0.4	925	CQ N4RAG EL96	U.S.A.
001804	-13	0.5	917	CQ W4WVW EM20	U.S.A.	005715	-1x	0.0	928	N4RAG AASVZ EM12	U.S.A.
001809	-11	0.2	1283	CQ DK K4MFM EM22	U.S.A.	001738	-11	0.4	901	N4RAG AASVZ EM12	U.S.A.
001809	-15	0.2	815	CQ W4WY DM15	U.S.A.	001745	-7x	0.0	918	N4RAG AASVZ R-12	U.S.A.
001809	-15	0.3	1159	CQ N4WYT EM08	U.S.A.	001809	-12	0.3	917	N4RAG AASVZ EM12	U.S.A.
001809	-15	1.2	1082	CQ VV7WA EK00	Venezuela	001815	-7x	0.0	918	N4RAG AASVZ R-12	U.S.A.
001809	-20	0.2	1683	CQ KMSLY EM12	U.S.A.	001820	-12	0.3	918	N4RAG AASVZ EM12	U.S.A.
001830	-6	0.2	813	CQ W4WY DM15	U.S.A.	031841	-1x	0.0	918	N4RAG AASVZ EM12	U.S.A.
001830	-18	1.3	1082	CQ VV7WA EK00	Venezuela	031900	-15	0.3	920	CQ N4RAG EL96	U.S.A.
001830	-7	0.3	1158	CQ W4WYT DM15	U.S.A.						
001830	-17	0.0	500	CQ CD7GZ FL11	Cuba						
001900	-15	0.0	500	CQ N4RAG EL96	U.S.A.						
001900	-18	2.6	1002	CQ VV7WA EK00	Venezuela						

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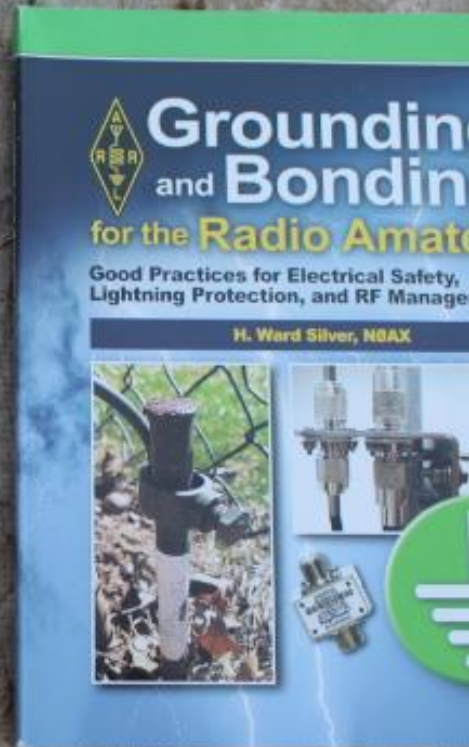
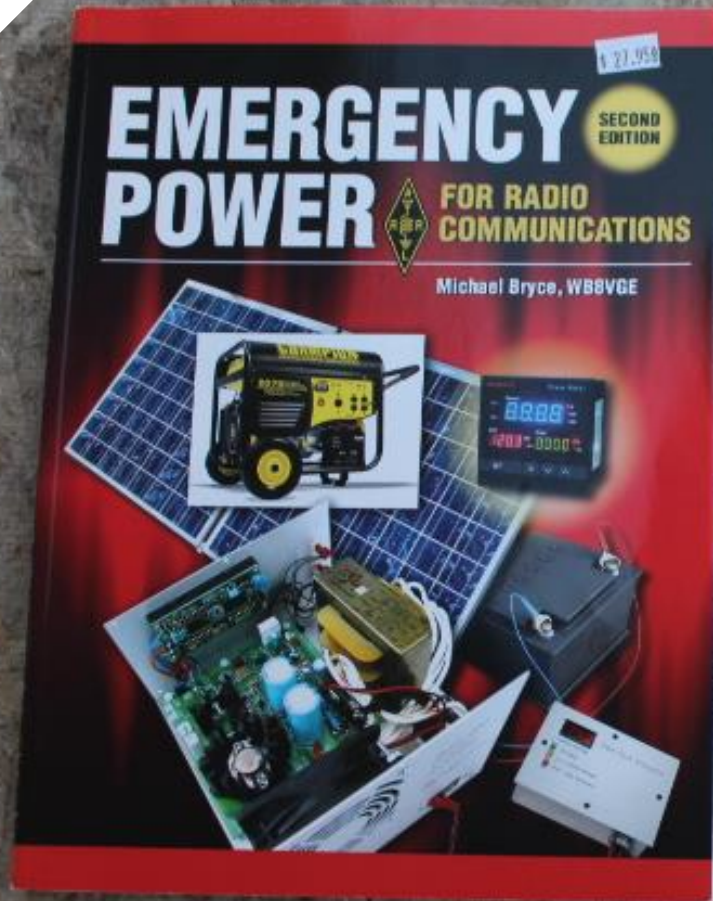
RECOMMENDED READING

- ▶ **Emergency Power for Radio Communications**

Michael Bryce – WB8VGE

- ▶ **Grounding and Bonding for the Radio Amateur**

H. Ward Silver – N0AX



QUESTIONS OR TESTIMONIALS





GETTING STARTED WITH SOLAR BACKUP POWER IN THE SHACK

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