



# Building a Solar Generator

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# Why Build a Soar Generator

- Field Day – AARL
- Winter Field Day
- Jamboree-on-the-Air (BSA)
- Portable Operation
- Emergency Power

# Why Build a Soar Generator



# Comparing Solar and Gasoline Generators

## Solar Generators

- Clean and quiet
- No fuel to store
- Weather dependent
- Low upkeep
- Higher initial cost

## Gasoline Generators

- Easily available
- More power for lower cost
- Need to store fuel
- Difficult to start
- Carbon monoxide



# Components of a Solar Generator

- Solar Panel
- Charge Controller
- Battery
- DC/AC Power Inverter



# Solar Panels

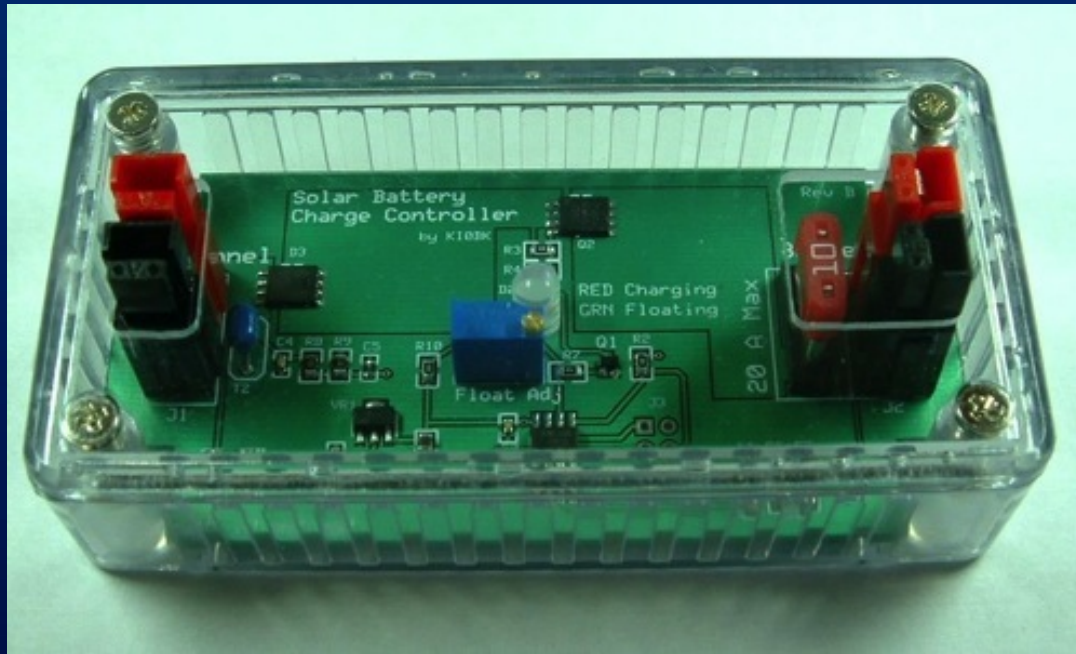
- PV panel should be sized to match the capacity of battery and charge controller
- Capacity of battery in AH divided by 5
- Example:  $40 \text{ AH} / 5 = 8 \text{ A}$
- 100W panel = 5.5 A
- 1 - 100W solar panel for a 40 AH battery



# Solar Charge Controllers

- Regulates the power going from the solar panels to the batteries
- PWM: More simple circuitry; less efficient; less expensive; light weight
- MPPT: High voltage panels can be used to charge a 12v battery bank; converts excess voltage into amperage; 95+ percent efficient; heavier; more expensive

# PWM Solar Battery Charge Controller (FlintHills Radio)





# MPPT Solar Battery Charge Controller (Newegg)



# Deep-Cycle Batteries

- Sealed Lead-Acid (SLA)
  - Gel Cell
  - AGM (Absorbent Glass Matt) batteries
- $\text{LiFePO}_4$  (lithium-iron-phosphate)
- $\text{LiFeMgPO}_4$  (lithium-iron-magnesium-phosphate)



# Benefits of AGM Batteries

- Good option for Ham radio use
- Sealed - low maintenance
- Heavy
- Less expensive



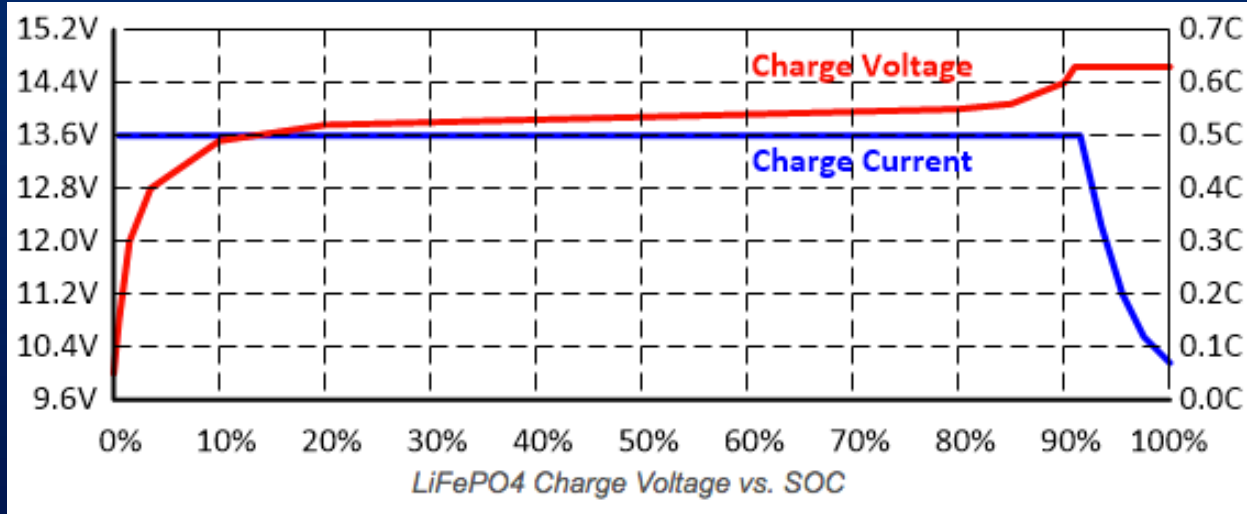
## Benefits of $\text{LiFePO}_4$ Batteries

- Twice the run-time and a third the weight of a comparatively sized lead-acid battery
- Handles high loads better, less voltage drop
- May last as long as 3,000 cycles
- Nearly maintenance-free
- Mounts any orientation; up recommended
- Less fire danger than earlier lithium designs

# Charging a $\text{LiFePO}_4$ 12V Battery

- Bulk/Absorb: 14.2 – 14.6 Volt; 0 – 2 hours
- High charge rate: Capacity/2 (40AH/2 = 20A)
- Float: 13.6 Volt or less
- Best to stored at a partial charge

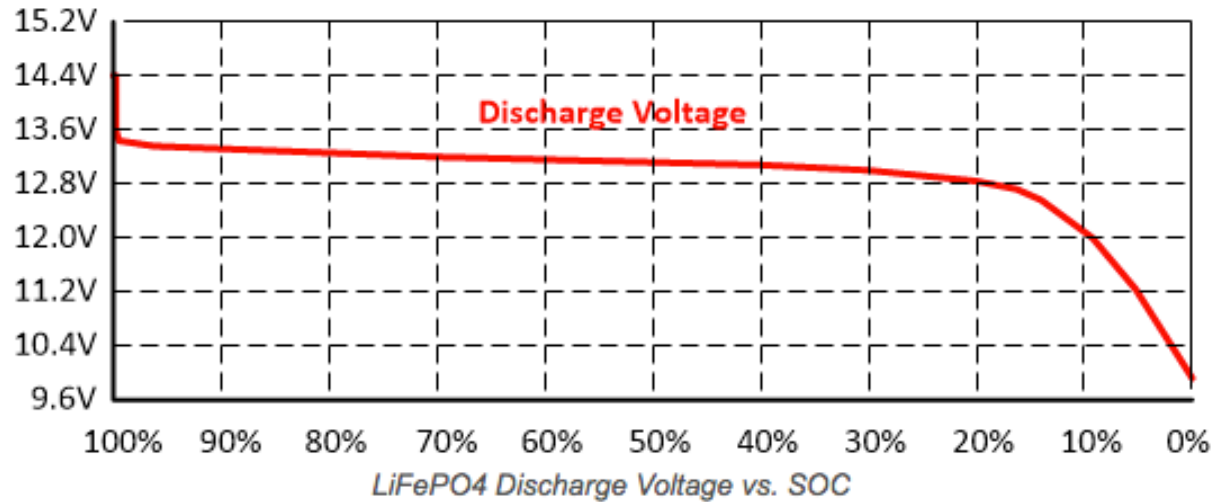
# Charging a LiFePO<sub>4</sub> 12V Battery



# Discharging a 40AH LiFePO<sub>4</sub> Battery

- Maximum continuous discharge: 30 A
- Maximum 30 second current pulse: 80 A
- Cut-off Voltage: 10V
- Run-time @ 10A: 240 minutes
- Run-time @ 30A: 80 minutes
- Run-time @ 23A: 100 minutes
- 100W HF radio: 180 minutes

# Discharging an $\text{LiFePO}_4$ Battery







# Built-in Battery Management System

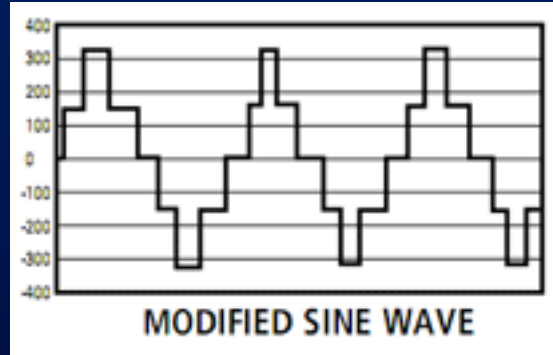
- Protects from over charge/discharge
- Limits charge/discharge currents
- Monitors cell temperatures
- Balance the cells during charging

## For long $\text{LiFePO}_4$ battery life

- Keep the battery temperature under  $30^\circ\text{C}$
- Keep charge/discharge currents under 50% capacity; 20% preferred
- Charge battery above  $0^\circ\text{C}$
- Do not cycle battery below 10-15% SOC
- Do not float the battery at 100% SOC

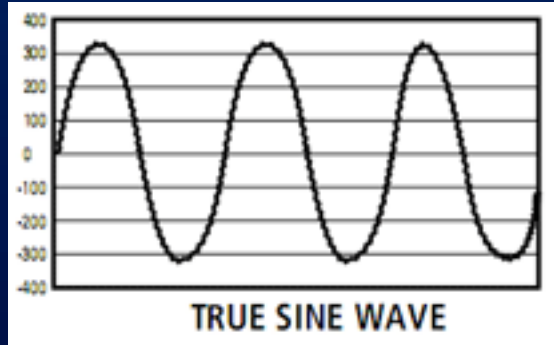
# Power Inverters Converts DC to AC current

- Modified Sine Wave
  - Simulates sine wave
  - Not compatible with many devices
  - Less expensive



# Power Inverters - Convert DC to AC current

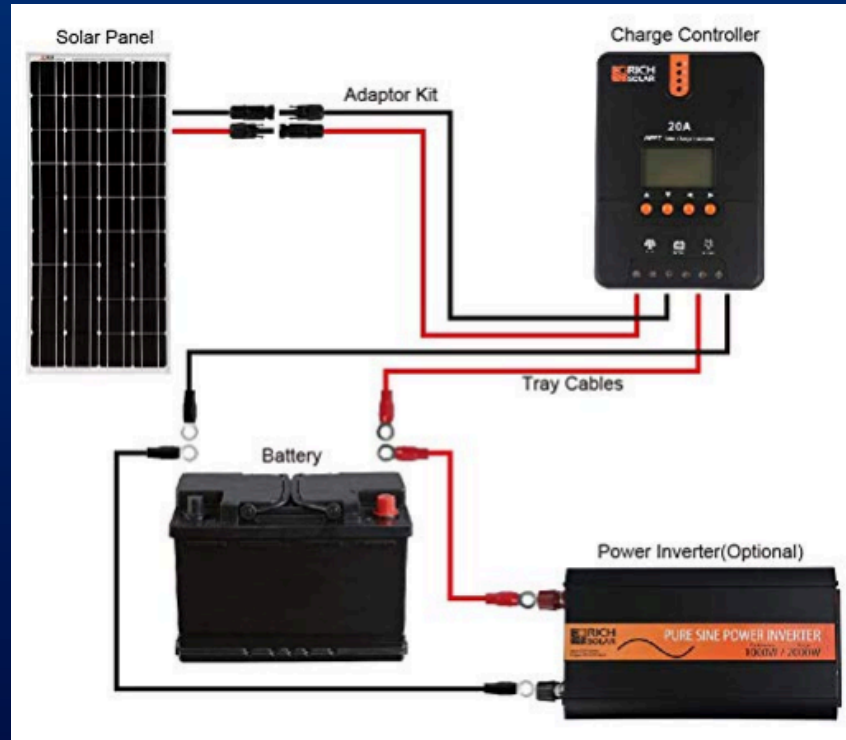
- Pure Sine Wave
  - Clean power; household AC
  - Better for motors and electronics
  - Greater efficiency



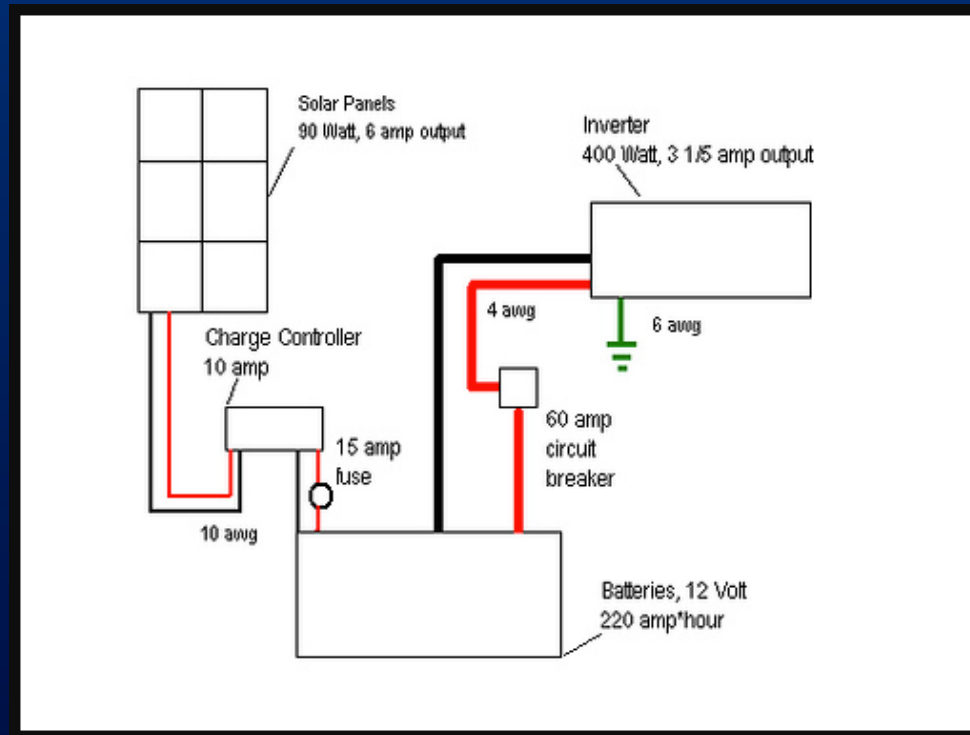
# Common electronic devices that should not be used with a modified sine inverter

- Battery chargers
- Variable speed tools
- Electric shavers
- Newer TV's
- Some laptops
- Induction cooktops
- Items with brushless motors
- Coffee makers
- Electric blankets
- Microwaves
- Audio equipment
- Laser printers
- Many digital clocks
- Medical equipment

# Non Grid-Tied PV/Solar System



# Solar Generator Block Diagram



# Costs to Build Your Solar Generator

COMPONENT	COST
100 Watt 12V Solar Panel	\$110.00
40AH Valence Battery (eBay)	\$100.00
Solar Charge Controller (FlintHills Radio)	\$40.00
300W BELTTT Pure Sine Wave Inverter	\$50.00
TOTAL	\$300.00



# Resources

- <https://sunelec.com/home/>
- <http://ki0bk.no-ip.com>
- <https://www.solacity.com/how-to-keep-lifepo4-lithium-ion-batteries-happy/>
- <https://lithiumwerks.com/valence-batteries/standard-modules/rt-modules/>
- Craigslist, eBay, Amazon, Newegg, etc.



The End