# Battery Power

for HF radio

and
laptop computer

# Project Goal

- Run my 100 Watt HF radio and laptop computer using battery power during *Field Day*.
- Encourage all UVARC Field Day stations to use battery power so we don't need to run a noisy stinky gasoline-powered generator.

# Best way to power radio?

- Direct connection to 12V battery
- AC inverter + DC power supply
- DC to DC converter

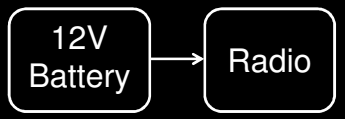
# Direct Battery Connection

Power Consumption in Watts

| Receive | Transmit |
|---|---|
| 15-13.4 | 240-220 |

Power decreases as the battery discharges

## Direct Battery Connection

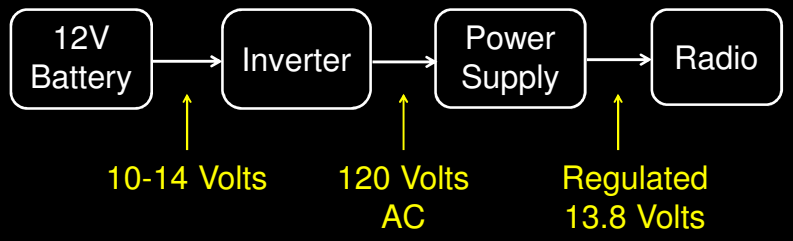



- Efficient power transfer
- Works well at first…
- HF radio malfunctions during *transmit* when the battery is less than half discharged
- Must compensate by increasing battery size

## The Transmit Problem

- Battery voltage sags about 0.5 Volt when HF radio transmits full power.
- Radio power requirement: 13.8 Volts +/- 10%. Radio malfunctions when the battery drops below 12 Volts during transmit.
- Less than half of the battery energy can be used before battery drops below 12V during transmit.
- Cable loss makes the problem worse.

## Solution 1: Inverter + Power Supply




## Inverter + Power Supply

- Regulation cures the TX low voltage problem
- Multiple conversions ruin efficiency

  My 30 Amp switching power supply consumes 14 Watts with no load

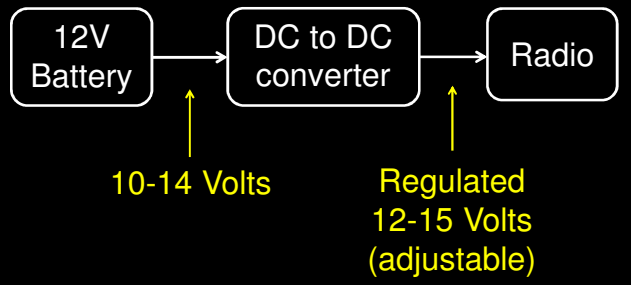
  Inverter consumes 4-10 Watts with no load
- Inverters often generate unwanted HF noise

## Inverter + Power Supply

Power Consumption in Watts

| Radio Off | Receive | Transmit |
|---|---|---|
| 18 | 36 | 320 |

## Solution 2: DC to DC Converter




## DC to DC Converter

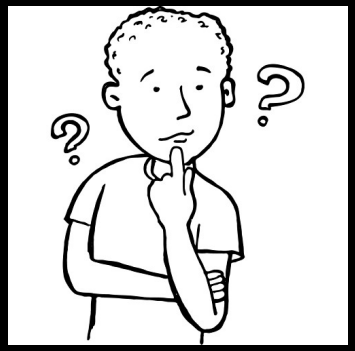
- Allows ALL of the battery energy to be used. Transmit works fine with battery as low as 9V.
- Conversion efficiency is 90%.
- Can adjust output voltage to reduce radio power consumption by 10%.
- 25 Amp converter costs $150.

## DC to DC Converter

Power Consumption in Watts

| | Receive | Transmit |
|---|---|---|
| 13.8 V | 16.8 | 259 |
| 12.5 V | 14.5 | 231 |
| No RX boost | 14-12.4 | |

## What is this magic box?



## MFJ-4416B Battery Booster


RF sense input on back side, not visible

## Radio problem solved!

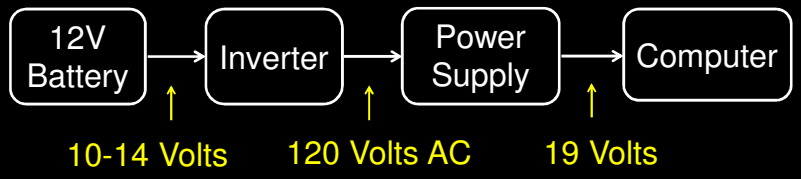
## How about the computer?

## Laptop Computer

- Requires 19 Volts DC, up to 5 Amps
- Impossible to power directly from battery
- Two methods to power via 12 Volt battery:
  - Inverter + laptop's AC power supply
  - DC to DC converter

## Computer Power Consumption

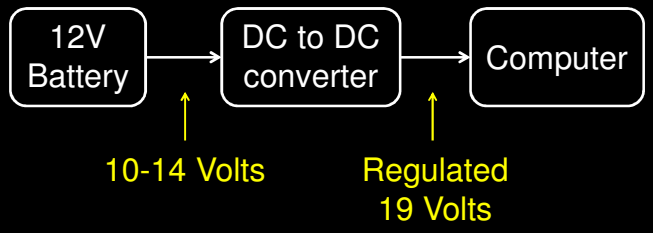
### 22 Watts




My 110 Watt inverter consumes 3.5 Watts with no load

## Computer Power Consumption

### 18 Watts




## Laptop Computer DC to DC converter


Version sold by HP: $100

Aftermarket version: $22

## Power Comparison, Watts

| | Receive | Transmit | Computer |
|---|---|---|---|
| Direct to battery | 15-13.4 | 240-220 | impossible |
| Inverter + P.S. | 36 | 320 | 22 |
| DC-DC converter | 14-12.4 | 231 | 18 |

# What I Learned

- Direct battery connection doesn't allow a 100 Watt HF transceiver to use all of the battery energy.
- Efficiency is poor if you use inverter + power supply.
- DC to DC converter offers the lowest power consumption and maximum usable battery energy.
- Cost of DC to DC converter may be similar to cost of doubling battery capacity. Less weight!

Handout for March presentation

# DC to DC Converters

MFJ 4416B
supplies regulated
12.5V to radio


PWR+ 12V adapter
supplies regulated
19V to computer


Will my battery last for Field Day?

To find out, I need to compare
battery energy
and
energy needed

# Battery

Sealed Lead Acid (SLA)

- 12 Volt
- 100 Amp-hour
- 59 pounds
- $ 200


SLA costs twice as much as deep cycle wet battery, but is safe to use indoors

# Discharge How Low?

No lower than 11.9 Volts for maximum cycle life

11.6 Volts is okay, but will shorten cycle lifetime

Measure voltage after NO LOAD for 5 minutes

Voltage rises 0.12 Volt after turning off radio

| State of Charge | 12 Volt battery |
|---|---|
| 100% | 12.7 |
| 90% | 12.5 |
| 80% | 12.42 |
| 70% | 12.32 |
| 60% | 12.20 |
| 50% | 12.06 |
| 40% | 11.9 |
| 30% | 11.75 |
| 20% | 11.58 |
| **10%** | **11.31** |
| **0** | **10.5** |

# Measured Battery Energy

| | |
|---|---|
| Above 12V during TX: | 450 Watt-hours |
| Discharge to 11.9 Volts: | 936 Watt-hours |
| Discharge to 11.6 Volts: | 1130 Watt-hours |

# Energy Needed for Field Day

| | |
|---|---|
| Receive | 10 hours |
| SSB Transmit | 2 hours |
| Computer | 12 hours |

## Direct 12V Connection

| | | |
|---|---|---|
| Receive | 10 hours | 145 Watt-hours |
| SSB Transmit | 2 hours | 230 Watt-hours |
| Computer | 12 hours | 264 Watt-hours |
| **Energy Needed:** | | 639 Watt-hours |

**Battery Energy:** 450 Watt-hours

Before battery sags below 12V during transmit

## Inverter + Power Supply

| | | |
|---|---|---|
| Receive | 10 hours | 360 Watt-hours |
| SSB Transmit | 2 hours | 320 Watt-hours |
| Computer | 12 hours | 264 Watt-hours |
| **Energy Needed:** | | 944 Watt-hours |

**Battery Energy:**

| | |
|---|---|
| Discharge to 11.9 Volts: | 936 Watt-hours |
| Discharge to 11.6 Volts: | 1130 Watt-hours |

## DC to DC Converters

| | | |
|---|---|---|
| Receive | 10 hours | 135 Watt-hours |
| SSB Transmit | 2 hours | 231 Watt-hours |
| Computer | 12 hours | 216 Watt-hours |
| **Energy Needed:** | | 582 Watt-hours |

**Battery Energy:**

| | |
|---|---|
| Discharge to 11.9 Volts: | 936 Watt-hours |
| Discharge to 11.6 Volts: | 1130 Watt-hours |

## DC to DC Converters Win!

- Lowest energy consumption
- Maximum available battery energy

## Result:

- Longest possible operating time
- Radio guaranteed to work properly
- Less weight than doubling battery size