Amateur Radio and PIE

WA4YIH – Ed Woodrick

P=IE

- P = Power (Watt)
- I = Current (Amp)
- E = Electromotive Force (aka V – Voltage) (Volt)

- Commonly known as P=VI
- Also equivalent to I=P/V or V=P/I

Simplest Use

- How much current does my 50W radio pull?

FT-8800R Guesstimate

- 50 Watts Output
- 13.8VDC Power
- 50W / 13.8V = 3.7Amps minimum
- Amplifiers are not 100% efficient
- Don’t forget the fan and light bulbs

FT-8800R Specifications

- GENERAL
  - Antenna Impedance: 50 Ohms
  - Supply Voltage: 13.8 VDC (±15%)
  - Current Consumption: RX: 0.5 A (Squelched)
  - TX: 8.5 A (144 MHz), 8.0 A (430 MHz)
- TRANSMITTER
  - Output Power: 50/20/10/5 W (144 MHz),
  - 35/20/10/5 W (430 MHz)
- RECEIVER
  - Maximum AF Output: 2 W @ 8 Ω for 5% THD

Something Bigger
500 W Amplifier

- Plugged into house
  - 120V
  - 500W
  - 500W/120V = 4.2A
- Plugged into car
  - 12V
  - 500W
  - 500W/12V = 42A

Batteries

- Batteries have a specified voltage
- Battery capacity in Amp-Hours (AH)
  - 1 AH Battery will supply 1A for 1 Hour

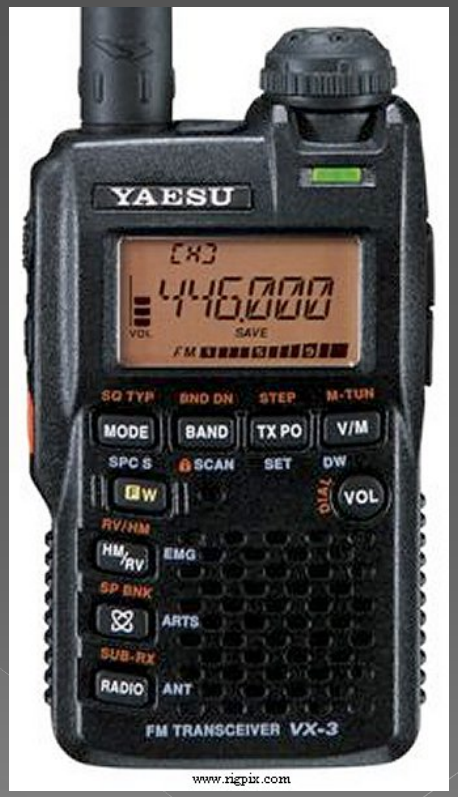
VX-3R Specifications

- **Antenna Impedance**: 50 Ohms
- **Supply Voltage**: Nominal: 3.7 V DC, Negative Ground
- Operating: 3.5 ~ 7 V, Negative Ground (**EXT DC** Jack)
- 5.0 ~ 7 V, Negative Ground (**EXT DC** Jack with Charging)
- **Current Consumption**: 120 mA (Receive)
- 60 mA (Standby, Saver Off)
- 30 mA (Standby, Saver On, Save Ratio 1:2)
- 50 mA (Radio Band Receive)
- 100 µA (Auto Power Off)
- 1.3 A (1.5 W Tx , 144 MHz) 3.7 V DC
- 1.6 A (3 W Tx , 144 MHz) 6 V DC
- 1.2 A (1 W Tx , 430 MHz) 3.7 V DC
- 1.8 A (2 W Tx , 430 MHz) 6 V DC
- **Transmitter**
- **RF Power Output**: 1.5 W (@ 4.5 V AA x 3 or 3.7 V FNB-82LI 144 MHz)
- 3 W (@ 6 V or EXT DC 144 MHz)
- 1 W (@4.5 V AA x 3 or 3.7 V FNB-82LI 430 MHz)
- 2 W (@ 6 V or EXT DC 430 MHz)
- Low 0.1 W (@ 4.5 V AA x 3 or 3.7 V FNB-82LI)
- Low 0.3 W (@ 6 V or EXT DC)
- **Receiver**
- **AF Output**: 50 mW @ 8 W for 10 % THD (@ 3.7 V)
- 100 mW @8 W for 10 % THD (@ 6 V)
- FNB-82LI – 1000 mAH, 3.7V

VX-3R Calculations

- Receive
  - 1000mA/Hr / 50mA = 20Hrs
- Transmit
  - 1000mA/Hr / 1300mA = 0.76Hrs

- How Much Do You Transmit?
- How Much Do You Receive?

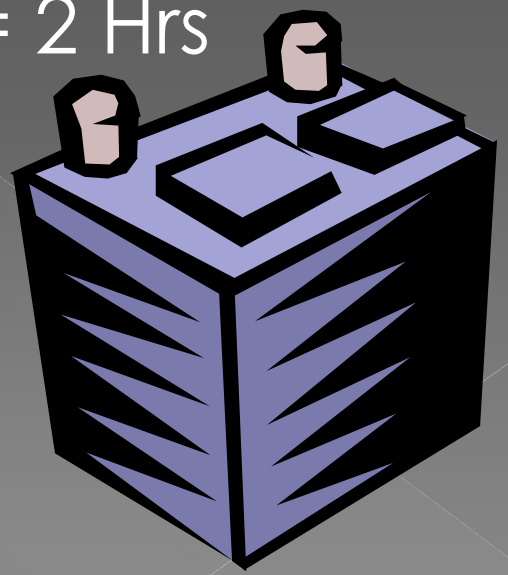


Go-Kit Calculations

- Determine Duty Cycle
- Add all current requirements
- Determine adequate battery size
- Determine battery charging requirements

How big of a battery…..

- 40 Watt Mobile Radio
- 40W/12V = 3.5A
- 80 A-H Battery = 80AH / 3.5A = 22 Hrs
- 7 A-H Battery = 7AH / 3.5A = 2 Hrs



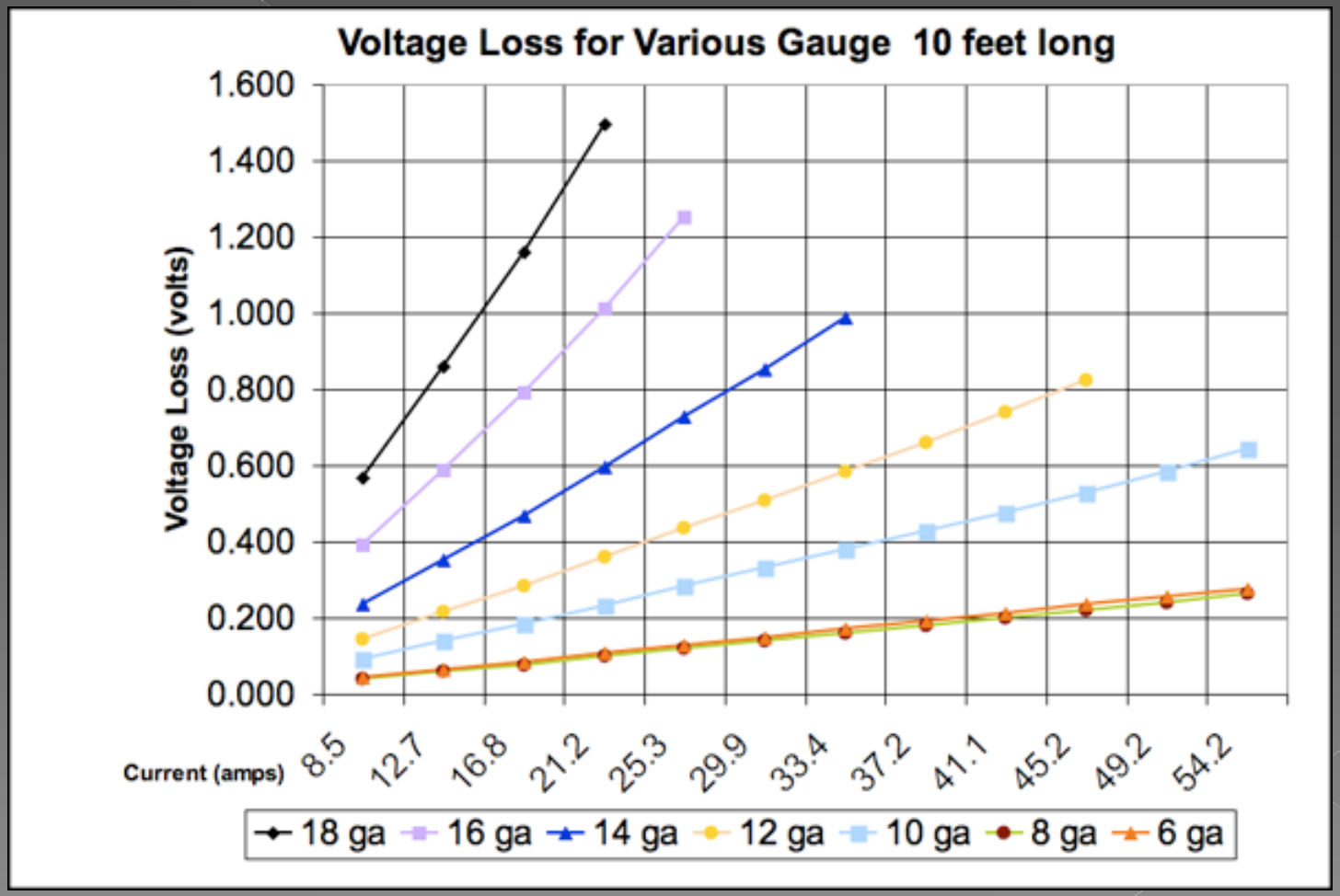
How long does it take to charge…..

- West Mountain Super Power Gate
- 1, 4, 7, and 10A multi-stage charging
- Example 80 A-H Battery
  - 1A charge rate – 80AH / 1A = 80 hours
    - Batteries can take 130% of capacity to charge
    - 80 hours x 130% = 4.4 days
  - 10A charge rate – 80AH / 10A = 8 hours
    - 8 hours x 130% = 11 hours
- Batteries must be charged at rated current

Does Wire Size Matter?

Why use big wire instead of small wire?
Isn't zip cord good for everything
Fuses

Voltage Loss @ 10 ft



Recommended Wire Gauge

General Purpose Thermoplastic (GPT)

AWG	Diameter Inches	Approximate Ohms per 1000 feet	Allowable Ampacity 140°F	Max Fuse or Circuit Breaker Size (Amps)	Permissible Load 80% (Amps)
6	0.162"	0.4	80	80	65
8	0.129"	0.63	55	50	44
10	0.102"	1.0	40	40	32
12	0.081"	1.6	25	25	20
14	0.064"	2.5	20	20	16

AC Power is Weird!

- AC Power isn't DC
- Voltage switches from + to –
- Resistance turns into Reactance
- AC current flows on the outside of the wire!
- A hollow wire carries as much AC as a solid core does.
- High Tension Power Lines are hollow to reduce cost and weight

What to Watch Out For

Places Where Power Becomes an Issue

Coax

- RG-58 has small center conductor
- Max Power 250W at 150MHz

Ohms Law

- V=IR
  - V = Voltage (Volts)
  - I = Current (Amps)
  - R = Resistance (Ohms)
- AWG 6
  - 0.4 Ohms / 1000ft
  - 80% Load = 65A
  - Voltage Drop = 0.4 x 65 = 26V
  - Not suitable for 12V application

Extension Cables

- 100ft cord drops twice the Voltage as a 50ft cord
- To compensate, the longer the cord, the lower the gauge to carry the same current.
- $P=I^2R$
- When current passes through a cable that has a resistance, power is converted to heat

Fuses

- Fuses can have relatively high internal resistance
- Fuse resistance can increase over time and abuse
- Typical 0.2V drop across fuse

Voltage Inverters

- Convert 12V DC to 120V AC
- Large Units becoming inexpensive
- 1000W Unit Example
  - Full Power 1000W
  - Output 120V AC
  - Input 12V DC
  - Output Current = 1000W / 120VAC = 8.3A
  - Input Current = 1000W / 12VDC = 83A

Inverter Cabling

- Output
  - 8.5A
  - #14+ Gauge Wire
  - Voltage drop / 100ft = 2.5 Ohms/1000ft/10ft x 8.5A = 2.125V / 100ft
- Input
  - 85A
  - Not on chart – at least #4 Gauge
  - Voltage drop / 100ft = 0.3 Ohms/1000ft/10ft x 85A = 2.125V / 1000ft = 0.03V / 100ft

Car Jumper Cables

- Starter can use 500A when first energized
- After initial on-rush, currents are 50-100A
- Good Jumper Cables are 4 gauge and larger

JUMPER CABLES

Advertising is misleading…..

JUMPER CABLES

Don’t be Fooled by Thick Insulation

JUMPER CABLES

2 Gauge Jumper Cables

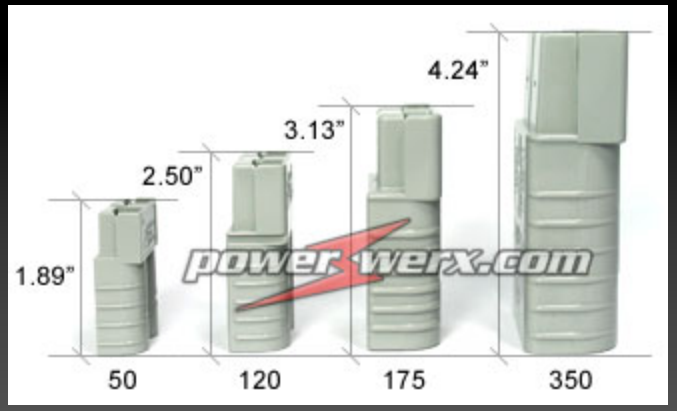
JUMPER CABLES

Cables with PowerPoles!

Anderson PowerPoles

- ARES Standard
- 15, 30, and 45A connectors all use the same size shell
- Pins are different for each model
- Don't put 45A through a 15A connector!
  - 15A for 16-18 gauge wire
  - 30A for 14-12 gauge wire
  - 45A for 10 gauge wire

POWERPOLE CONNECTORS



They look the same from the outside (except bigger) but the pins are different.

AC Plugs

	15A	20A
125V		
250V		

Conclusions

- Too small of wire can cause fires
- Cables have voltage drop, this can sometimes be significant
- Use the right size cable for the job
- PowerPoles are not all the same!
- Good Jumper Cables can mean starting a car immediately