

POWER DISTRIBUTION WIRING IN THE SHACK; WHAT'S YOUR VOLTAGE DROP?

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TOPICS FOR DISCUSSION

- Introduction & Overview
- What is voltage drop?
- DC Power Supplies
- Batteries
- Power Supply-to-Battery Auto-Switching Devices
- Power Distribution
- Branch Circuit Wiring
- Overcurrent Protective Devices

INTRODUCTION & OVERVIEW

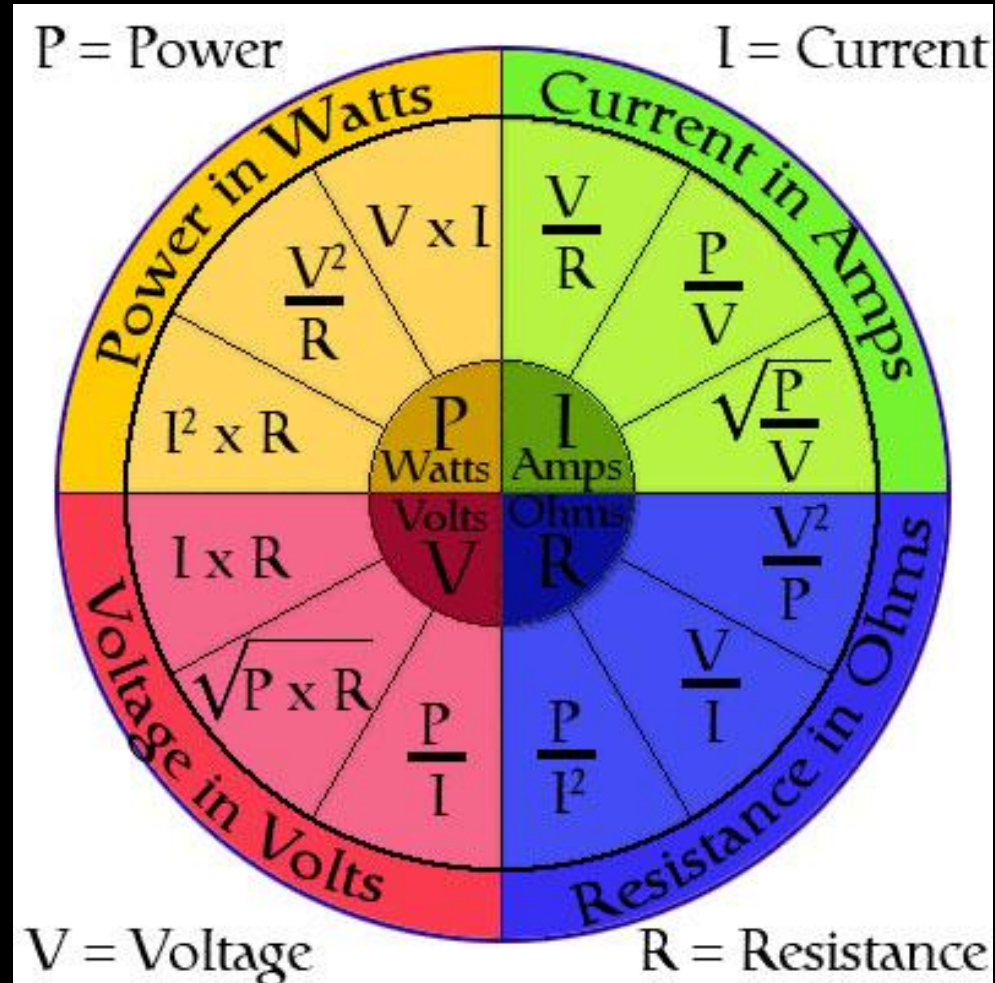
- Many station components today operate on an AC powered 12V dc supply
 - HF radios
 - VHF/UHF radios
 - RF power amplifiers
 - Station peripherals - lighting, computers, controls, receivers, interfaces, etc.
- Batteries may also be used in lieu of AC powered sources
- Power must be controlled and branch circuits protected
- Voltage drop should be factored into branch circuits
- **This tutorial is intended to raise your awareness about installing DC power distribution circuits in your station**

WHAT IS VOLTAGE DROP?

- Voltage drop is the difference in supply voltage between any two points in an electric circuit that is carrying current
- It's caused by the circuit resistances, mainly wiring, between the power source and the equipment served
- Effects of excessive voltage drop
 - Insufficient power to equipment
 - Unreliable equipment operation
 - Potential for overheated wiring

YOU CAN USE OHM'S LAW TO EASILY WORK VOLTAGE DROP PROBLEMS!

Google "Ohms law wheel" to find a graphic.



EXAMPLE OF THE EFFECTS OF EXCESSIVE VOLTAGE DROP

- Nominal dc input to an FT-950 HF/6M radio 13.8V +/- 10% = 12.4 – 15.2V
- Radio requires 22 amps
- A run of 12.5 feet of AWG #14 wiring to radio is used



13.5V



12.0V

Voltage Drop



Yaesu FT-950
100W OUT 22 Amps

DC POWER – POWER SUPPLIES

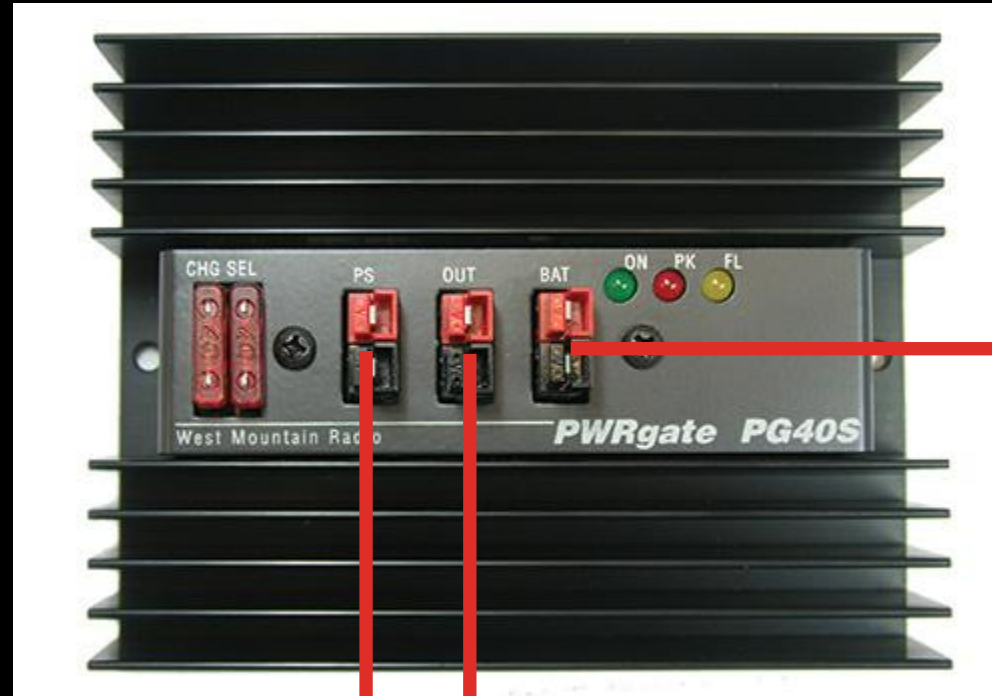
- Most dc power supplies in use today are voltage *regulated*
- As output current increases, the output voltage remains constant throughout the designed operating range of the power supply
- Voltage regulation not withstanding, there will be voltage drop at the load

DC POWER - **BATTERIES**

- There are additional circuit considerations when operating a station on battery power
 - Battery voltage does not remain constant like a power supply
 - There is a specific amount of time the battery can provide adequate voltage to the equipment
 - Voltage drop tolerance is critical here
- Remember, as battery voltage drops during discharging, voltage at the equipment will drop proportionately
- **It is suggested that you keep all wiring as short as practical and as large as you can comfortably manage to keep voltage drop to a minimum when batteries are being employed in your station**

- There is inherent voltage drop in the PG40S
- The amount varies based on the load imposed on the unit
- If you own one and are having trouble with the radio shutting down, refer to the PG-40S manual

POWER SUPPLY / BATTERY SWITCHING



POWER DISTRIBUTION CIRCUITS

- Two things are needed to safely distribute power to equipment
 - Overcurrent protection, i.e., fuses or circuit breakers
 - Adequately sized branch circuit wire
 - Equipment performance
 - Safety
- Example Problem
 - Yaesu FT-8800 dual band transceiver
 - **8.5 amps** - high power 2M
 - **13.8 VDC** +/- 15% (11.73 – 15.87 VDC)
 - Radio requires **10 feet** of wire from power supply
 - Operator wants to use **AWG #14** wire

VOLTAGE DROP & WIRE SIZE CALCULATIONS

- **Calculate drop with known wire size**

- #14 wire = 4110 cm**
- $13.8 - .46 = 13.34$ at radio

$$\frac{11.1 \times \text{loop conductor} \times \text{current}}{\text{wire size}}$$

$$\frac{11.1 \times 20 \times 8.5}{4110}$$

.46V drop

- **Calculate wire size with allowable drop**

- .46V
- 4102 cm = #14 wire

$$\frac{11.1 \times \text{loop conductor} \times \text{current}}{\text{voltage drop}}$$

$$\frac{11.1 \times 20 \times 8.5}{.46}$$

4102 cm

**The non-SI unit for measuring the cross-sectional area of an electrical conductor: 1 CM= area of a circle having diameter of 0.001

AWG TO CM CONVERSION TABLE

Size (AWG MCM)	Area circle (mils)
18	1620
16	2580
14	4110
12	6530
10	10,380
8	16,510
6	26,240
4	41,740
3	52,620
2	66,360
1	83,690
0	105,600
00	133,100
000	167,800
0000	211,600

WIRE SIZES AND AMPACITIES

For Reference Only

Generally, rated “ampacity” of wire is a function of...

- Its insulation temperature rating
- Ambient temperature of 86° F
- Max 3 conductors in conduit
- Source: 2011 NEC

Size	Temperature Rating of Conductor. [See Table 310.104(A).]						Size
AWG or kcmil	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	AWG or kcmil
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE- 2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RH, RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	Copper			Aluminum or Copper-Clad Aluminum			
	18	—	—	14	—	—	
16	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0

OVERCURRENT PROTECTION SIZING

- Fuses and circuit breakers are intended to protect wiring from overheating and fire
- Contrary to popular belief they are not intended to protect the equipment
- All circuits should be protected at the source like the distribution panel



FUSES & CIRCUIT BREAKERS

- Common Types
 - Blade
 - 3AG glass or ceramic
 - Resettable push-on/push-off breakers
- Operation
 - Fast acting
 - Slow-blow
 - Delay trip breakers



NOTES ON SIZING FUSES AND BREAKERS

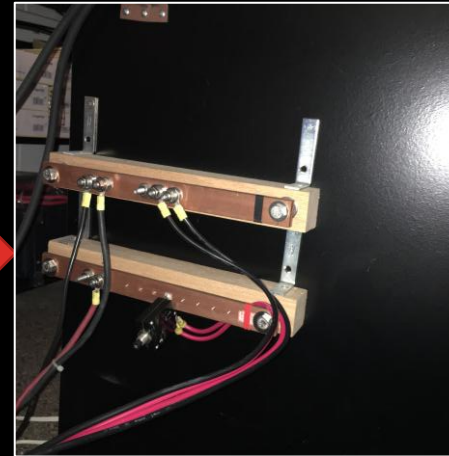
- ⚠ A fuse or breaker should not have the same current rating as the requirement for equipment it will serve
- ⚠ Nuisance tripping of breakers or blowing of fuses will occur
- ⚠ A general rule of thumb is to use a breaker or fuse rated no higher than 20% above the equipment rating. In other words, don't use a 30 amp device for a 5 amp circuit
- ⚠ If an application calls for a slow blow or delay trip breaker – USE IT
- ⚠ If you're not sure what to do in a specific case, contact the equipment maker
- ⚠ Remember, a lot of equipment has fusing built-in but you still need to protect the supply branch circuit feeding it

WA3UOO STATION POWER

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Battery 2 x 12V



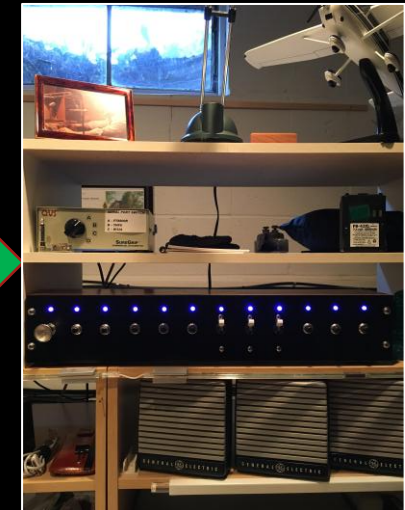
Battery / DC Bus



Station Power & Boost Charger



Meter & Control Panel



Breaker & Distribution Panel

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