




POWER SUPPLIES FOR HAM
RADIO

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OVERVIEW

- Basics of a Power Supply
- Types of Power Supplies
- Batteries & power supplies
- Safety Features
- Suggested Power Supplies

Types of Power Supplies

- Powering VHF/UHF/HF Transceivers
 - Analog (“Linear”)
 - Switching
- Bench Experiments / Development
- Battery Charging
- Safety Features
 - Overvoltage Protection
 - Current Limiting

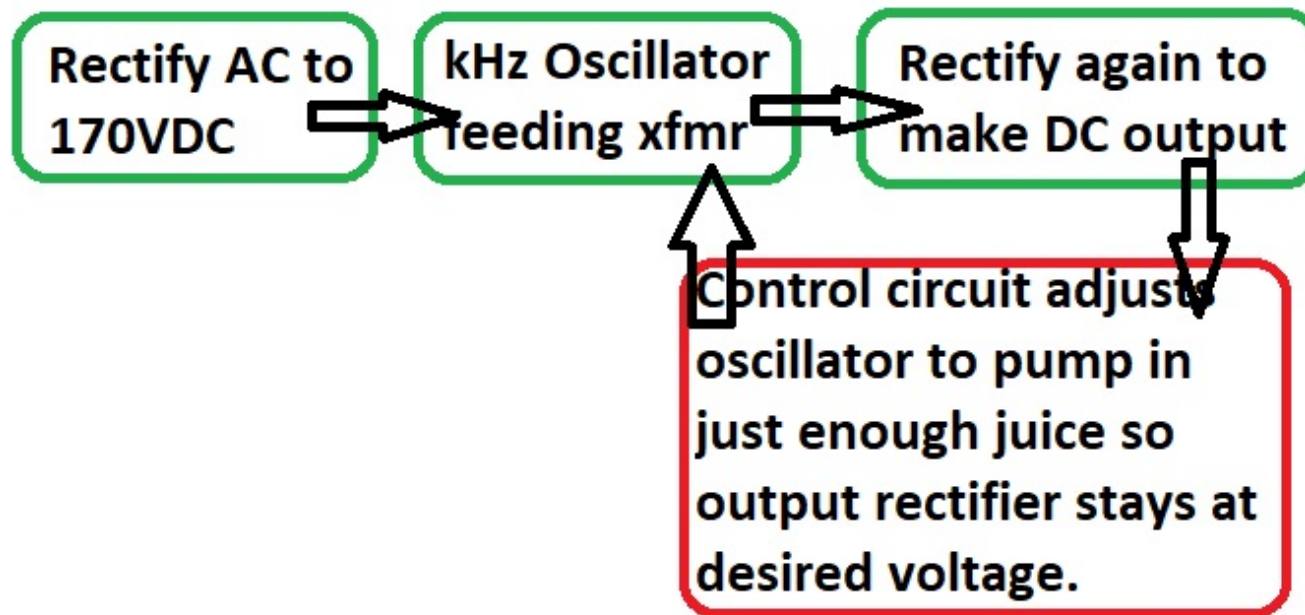
MARKETING/RETAIL

- Modern Ham Radio Transceivers
 - GENERALLY DO NOT COME WITH POWER SUPPLIES!!
 - Users may power them so many different ways
 - Directly from battery in vehicle
 - From AC-powered supply at home
 - From battery at home or portable
- MOST modern radios need 13.8VDC
- OLDER vacuum tube radios – multiple voltages, including “Filament” (6.3/12.6VAC), “low” voltage (300 VDC) High Voltage (700/800 VDC) and possibly Bias (-150VDC)

Common to ALL direct current power supplies: rectification and filtering

- Rectification takes alternating current and converts to one-way (but not at all steady!) direct current
 - Half Wave rectification (only used for very low current supplies at absolutely minimum cost) – gives positive wave for 50% of the time
 - Full Wave rectification (almost universally used, whether “linear” or “switching” –creates 120Hz one-direction waves. Literally a frequency doubler! (Can be used in transmitter doubler circuits)
 - LINEAR supplies – rectify to produce slightly higher than 13.8VDC output then regulate downward with pass transistor
 - SWITCHING supplies – **rectify to 170VDC**...then run oscillator feeding an isolation transformer to low-voltage repeat rectification and pulse-width regulation of output voltage.

Switching Power Supply



Halfwave rectifier

- 1N4007 diode (\$0.10) 1-amp max, tolerates 1000 inverse volts

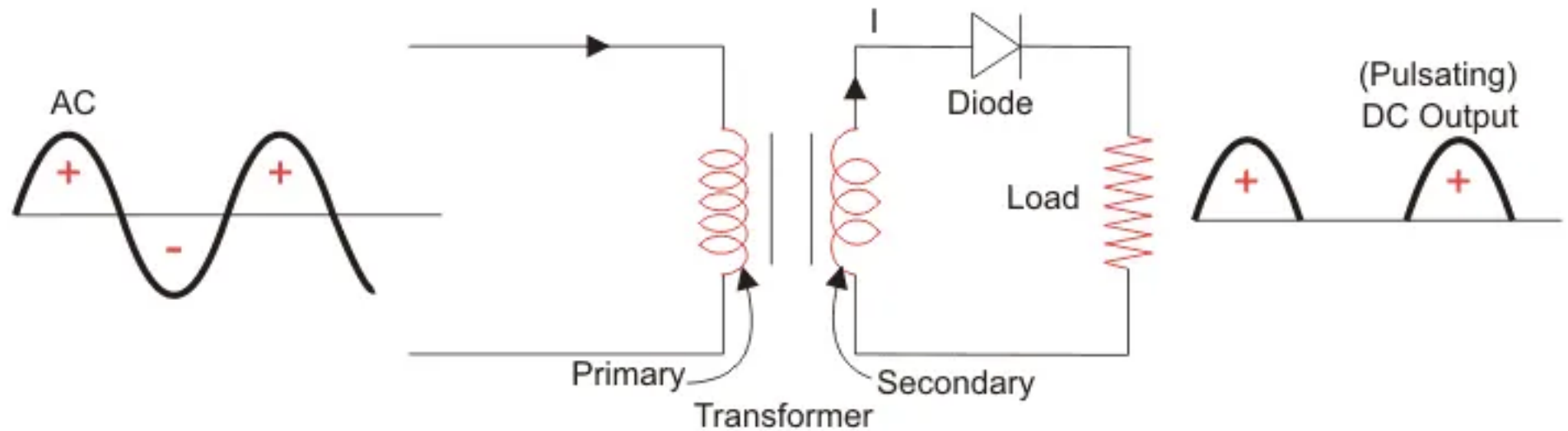


Figure - 3

<https://www.electrical4u.com/half-wave-rectifiers/#:~:text=A half wave rectifier is,bloc king the other half-cycle.&text=A rectifier is a device,or a group of diodes.>

ARRL Handbook

- Excellent discussion in section 7.4.1 Half-Wave Rectifier

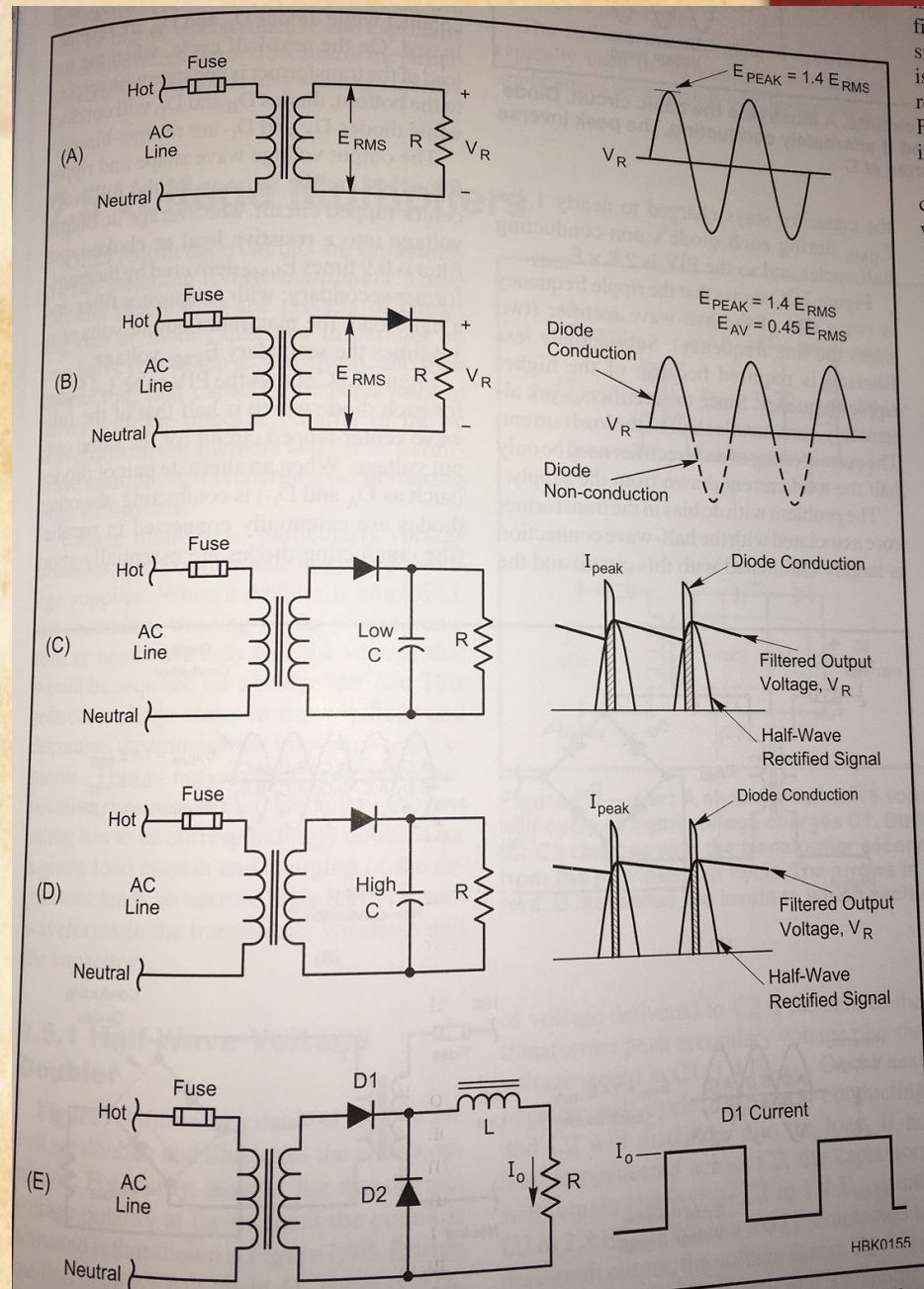


Figure 7.6 — Half-wave rectifier circuits. A illustrates the voltage waveform at the output without a rectifier. B represents the basic half-wave rectifier and the output waveform. C and D represent the output waveforms with large filter capacitors on the output. E represents the output waveform with an inductor filter.

Full wave rectifier

- Typically a “bridge” rectifier (other types exist) of 4 diodes. Make of 4 diodes, or buy ready-made package.
- EXACT same circuit is a DSB modulator or demodulator.

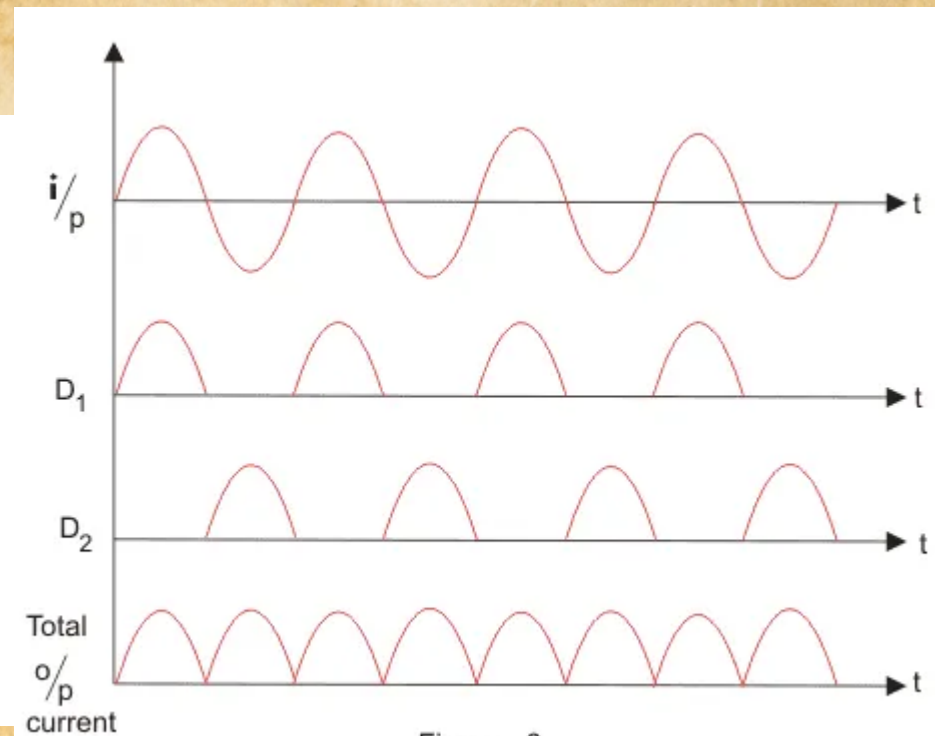
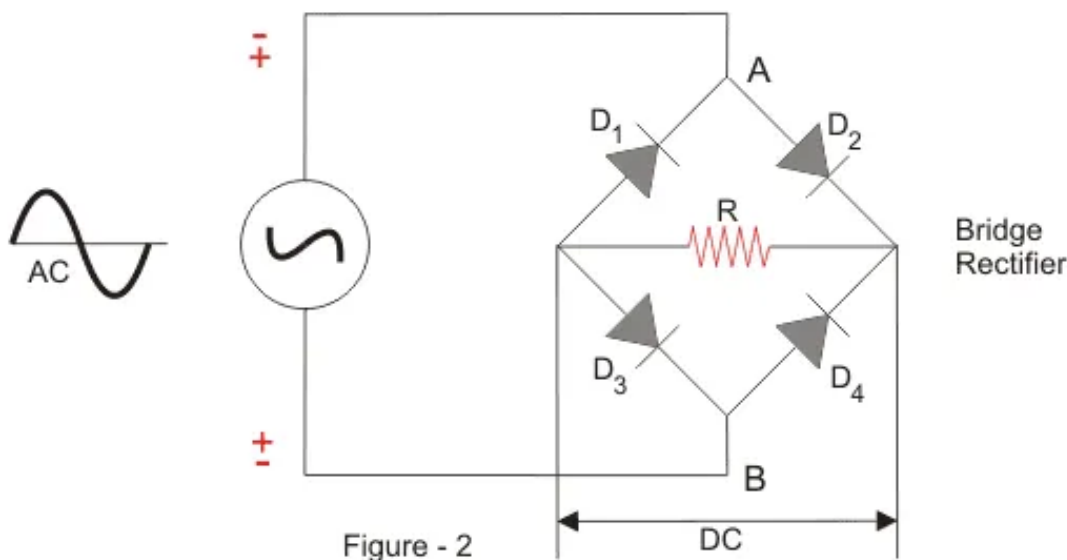
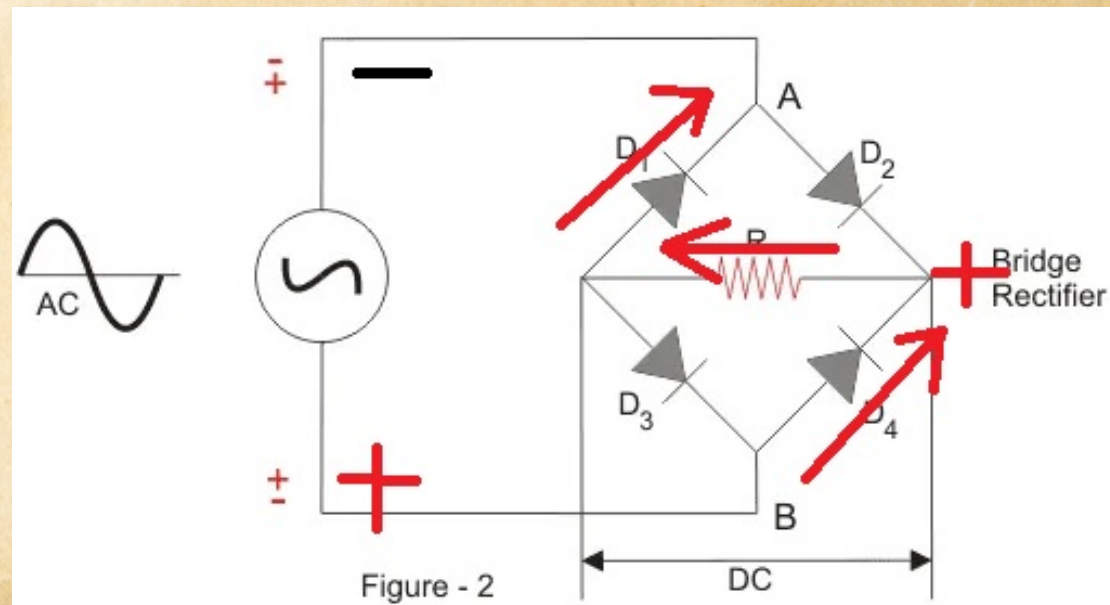
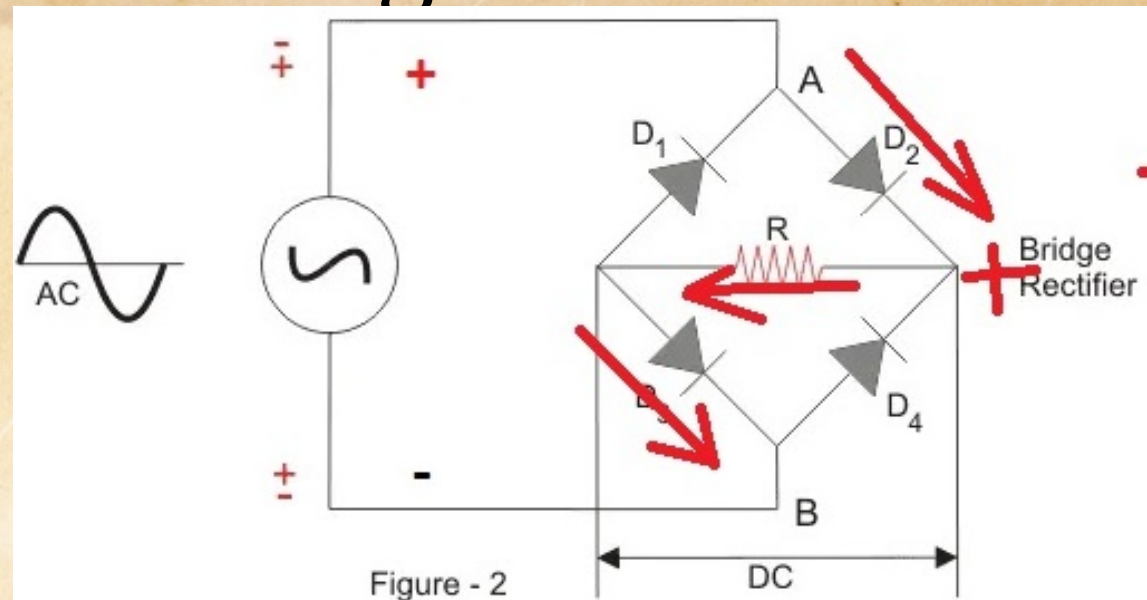


Figure - 8

Bridge always keeps current unidirectional through load

ARRL Handbook has larger discussion including the traditional full wave center tap rectifier circuit.

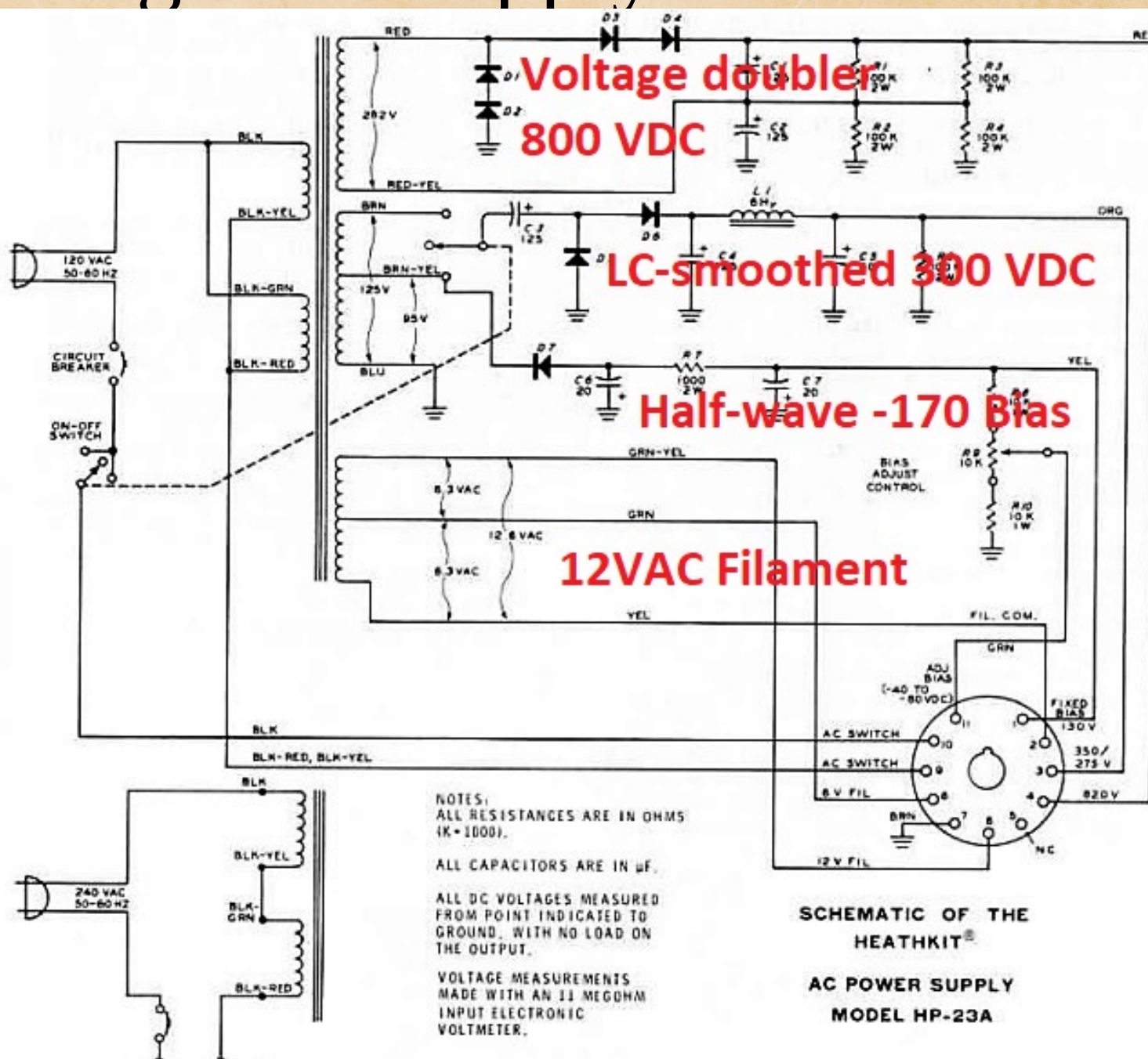
This is an EXCELLENT resource for people to learn more electronics.



FILTERING

- The easiest filtering is to use a huge capacitor. THOUSANDS of microfarads are now readily available.
- Capacitor charges on the peaks, and fills in the “valleys” to smooth out the RIPPLE.
 - Bit of math with definition of capacitors $C=Q/V$ can predict the amount of “droop” at any current....
- RIPPLE on your transmitter can be heard as 60 or 120 Hz “hummmmmm” on your signal.

Vintage DC Supply



Regulation

- Voltage Regulation also tends to reduce RIPPLE – because the ripple appears as an “error” and the voltage regulator (whether linear or switching) will mitigate it.
- Typically we want way less than 1% ripple. Older high voltage supplies for vacuum tube rigs struggled to get there....

BATTERIES

- Large batteries have very low “source impedance”
- Hence can deliver HUGE currents
- Connecting DC supply off by tenths of volt → huge currents possible....
- Hence charger systems are often current limited.
- Batteries should have FUSING sufficient to avoid melting wiring – and CLOSE TO THE BATTERY
- LiFePO₄ include a management system to help with these issues....limits the output and charging currents.

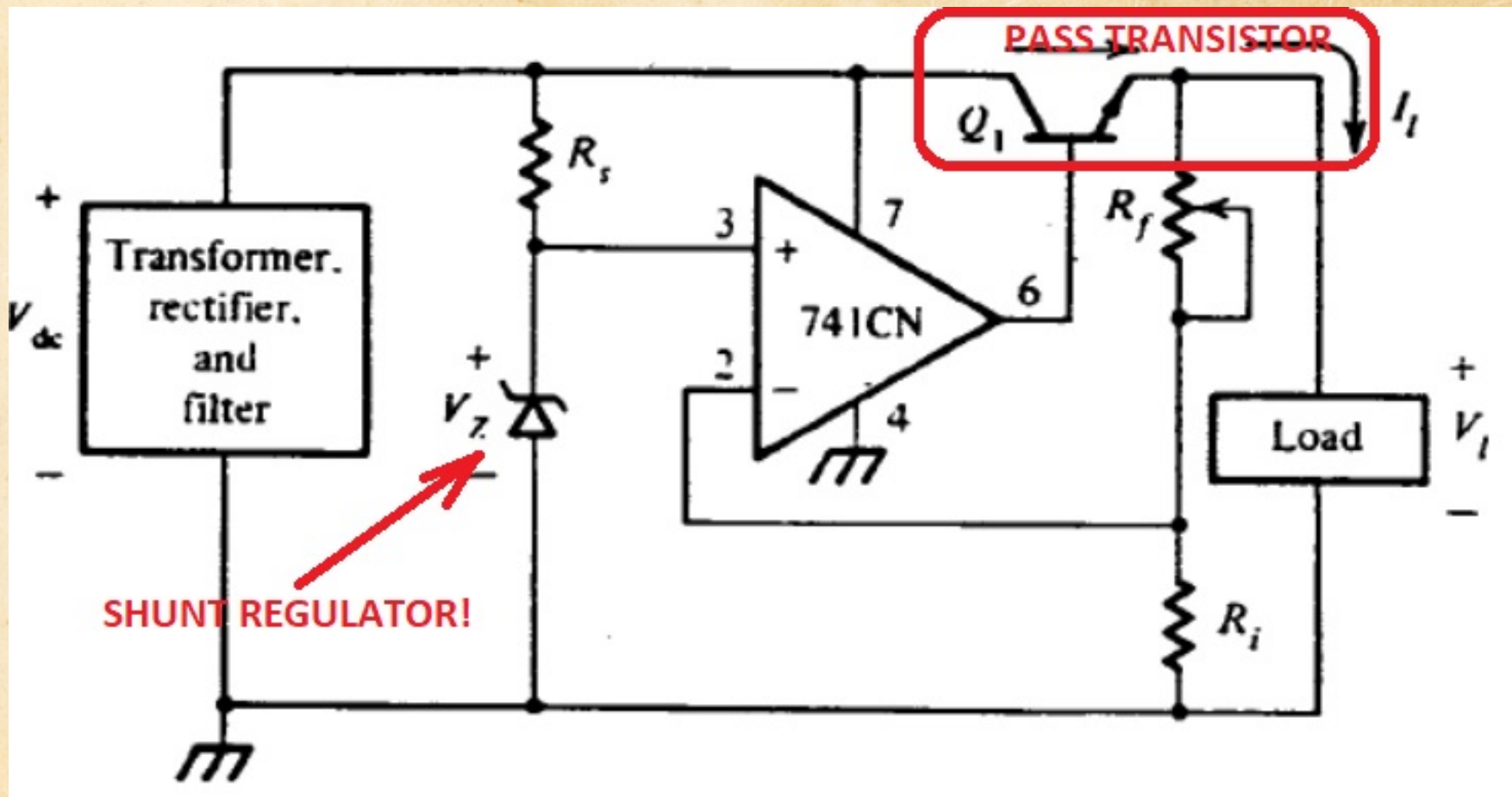
Ham radio Transceiver Supplies

- Multiple vendors
- Expect to add proper connectors
- CAREFUL!! with the polarity!!!
- Quality is important: power supply can destroy your radio!
-

OVER-VOLTAGE PROTECTION

- Linear Power Supplies – Pass Transistor Shorting
 - Will send full rectified voltage to the transceiver!
 - Good reason not to over-stress linear power supplies!
 - Better supplies will include “crowbar” that shorts output when overvoltage detected
 - Watch for fried PCB traces afterwards.....
 - Depends on CURRENT LIMITING to work.....

Linear Supply: Pass Transistor



If too much current pulled, the pass transistor may SHORT OUT....and then the FULL rectified voltage gets applied to the radio being powered...

<https://people.eecs.ku.edu/~callen58/501/LinearRegulators.pdf>

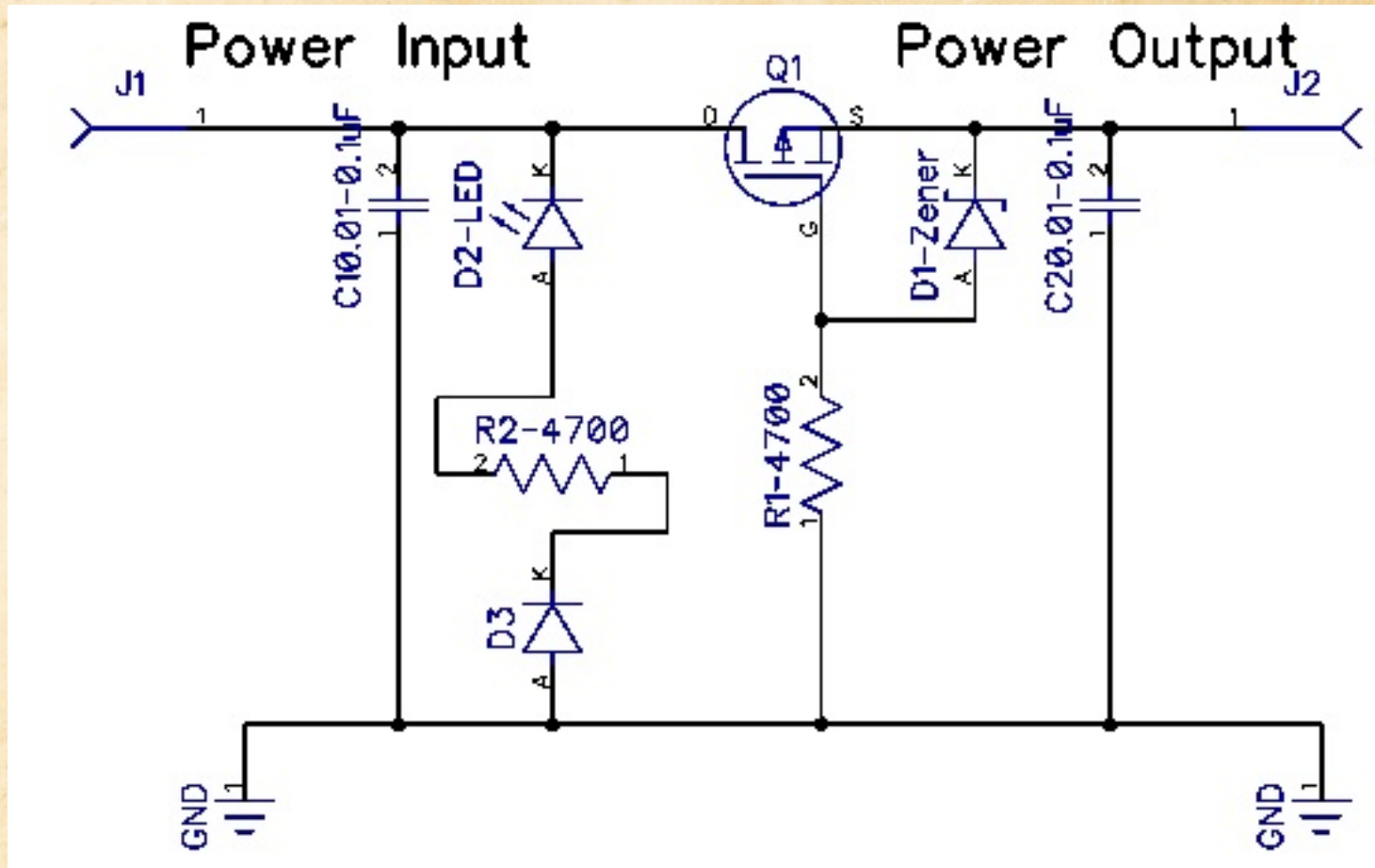
CURRENT LIMITING

- Absent in MOST transceiver-aimed power supplies
- Important for bench work experimenting – best if ADJUSTABLE

Polarity Protection

- Polarized connectors (“Power Pole” etc)
- Series Diode (difficult if high current)
- Shunt diode to blow fuse
- P-Channel Pass MOSFET (ideal solution!)

P-Chan Enhancement MOSFET



W285350ASJ14

INPUT

+13.8

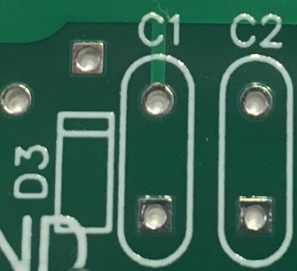
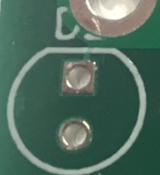
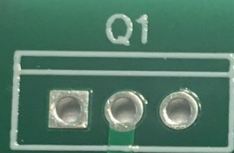
POSITIVE
OUTPUT

REVERSE

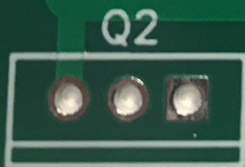
GROUND

GROUND

POLARITY
GLG V1.0



ZENER

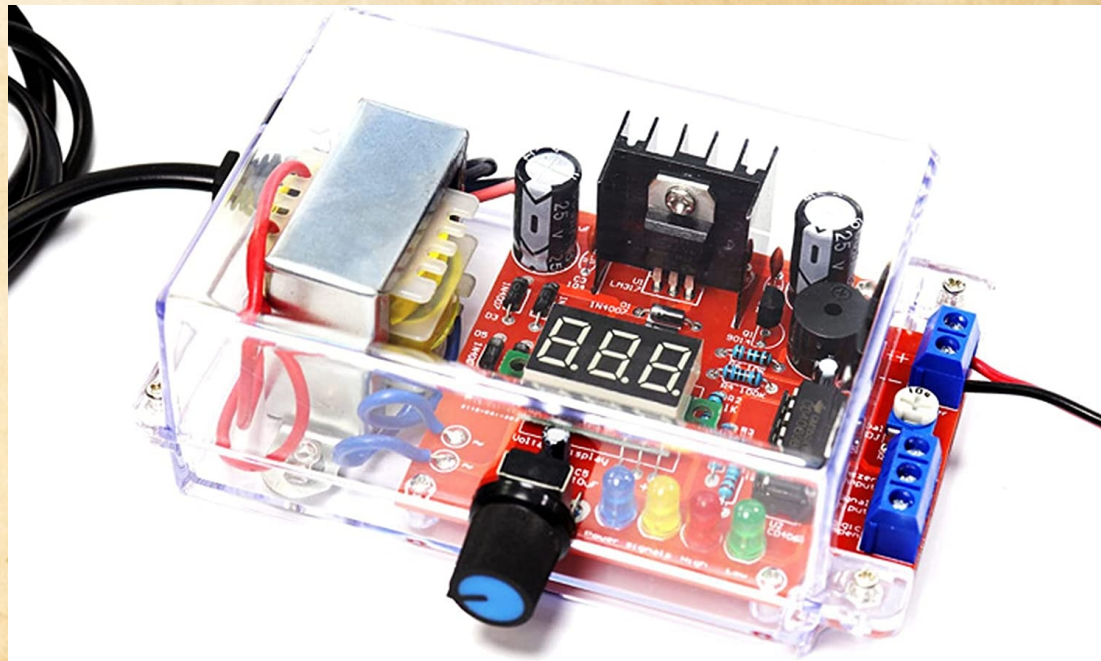


Surge / Transient Protection

- MOV on 120VAC primary
- zener/back-to-back zener on outputs
- Gas Discharge possibility for EMP
- SCR crowbar circuits to protect from power supply failure

Inexpensive bench power

- Limited current
- <https://www.amazon.com/Adjustable-Regulator-PE-MENOL-Electronic-Multifunctional/dp/B07SDLRSGD>
- Includes useful function generator (square waves, etc)

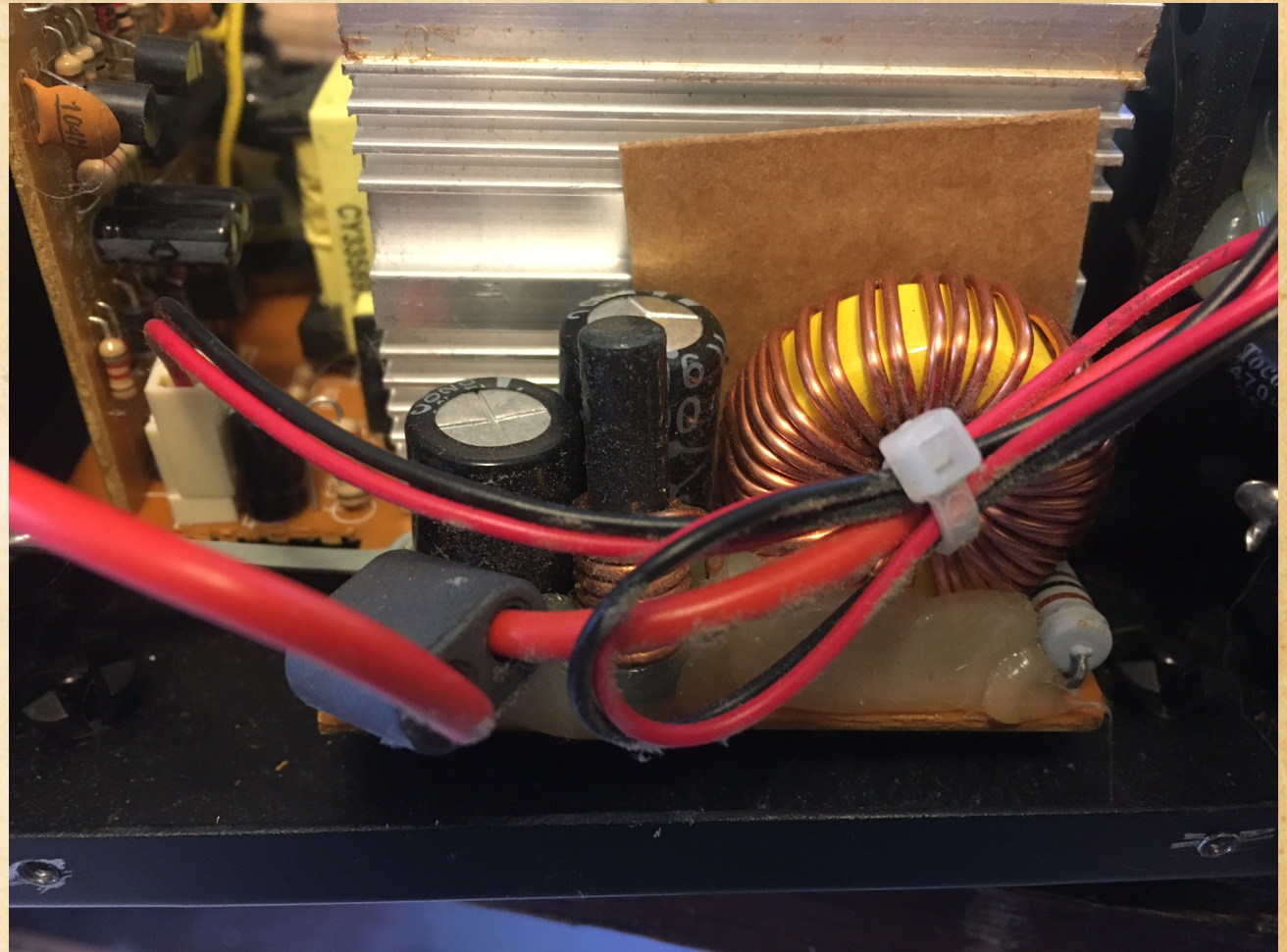


Purchasing ham radio supply

- LINEAR supplies – heavier, more expensive, less load regulation.....but zero RFI hash
- SWITCHING supplies – lighter, less expensive, often better load regulation....but cheap “computer supplies” often are WIDEBAND HASH GENERATORS.
- Some mfr’s literally include an oscillator adjustment so you can move the hash away from your operating freq...
- Others do extensive FILTERING.

High current DC Power Supplies

- Switching RF Hash a real concern for HF operations, occasionally VHF



Items to consider

- Linear versus Switching
- Reputation of vendor
- Over voltage protection?
- Over current protection?
- Transient protection?
- RFI generation?
- Metering / Measurement?

Suggestions for more study

- ARRL Handbook is great!
- Simple voltmeter can help you see output voltage of your power supplies and sag under load (“load regulation”)
- Inexpensive oscilloscope or even a capacitor in series with your \$5 digital voltmeter on AC scale, can let you see “ripple”
- Strongly recommend GREAT CARE on polarity!!





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