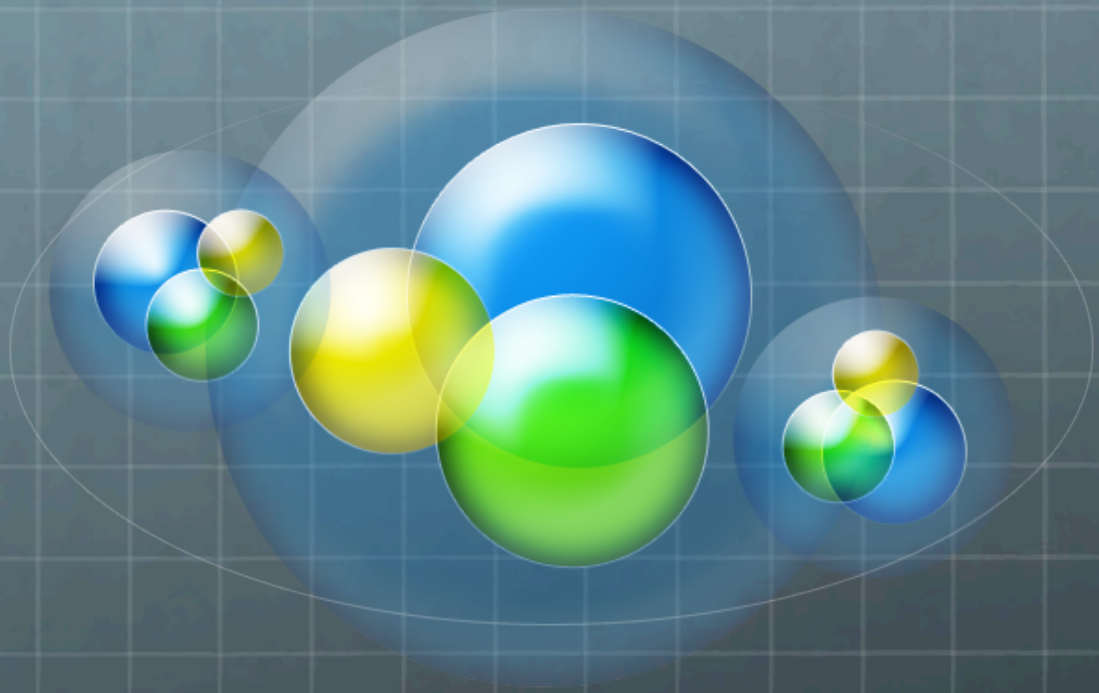


Theory and Repair of Astron Linear Power Supplies

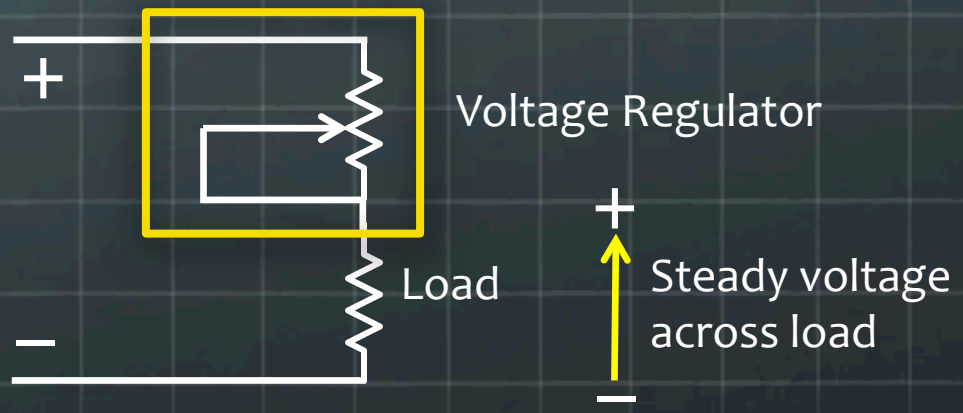
George K1IG

Topics

- Linear Power Supplies
- Astron Observations
- Block Diagrams
- Components
- Electrical Safety
- Troubleshooting & Repair
- Test & Calibration
- Efficiency & Noise Measurements

Linear Power Supplies

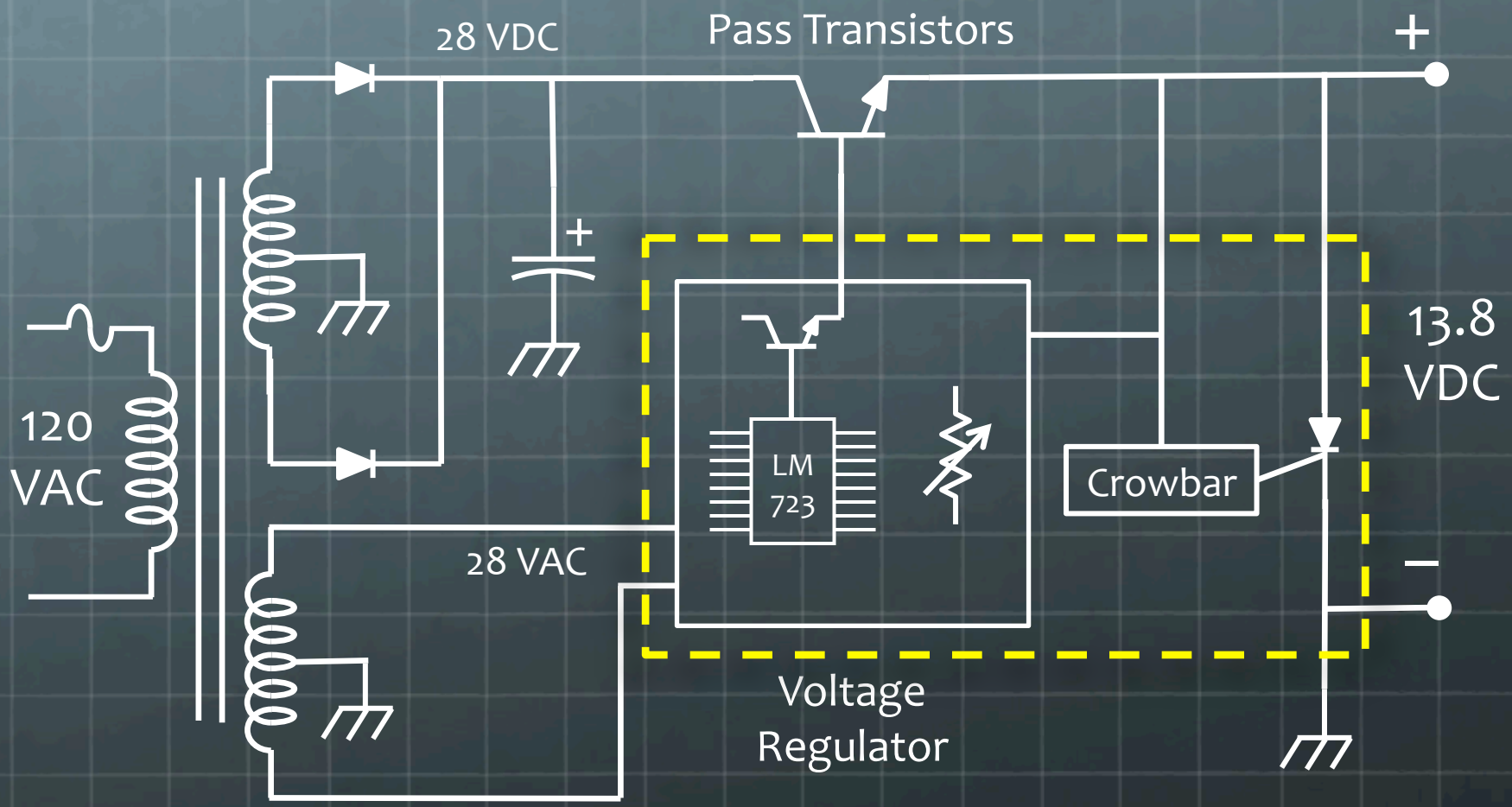
- Convert AC to DC and maintain steady voltage with a linear regulator
- The regulator acts as a variable resistor in a voltage divider circuit
- The linear regulator varies its resistance in accordance with the load to maintain a constant output voltage



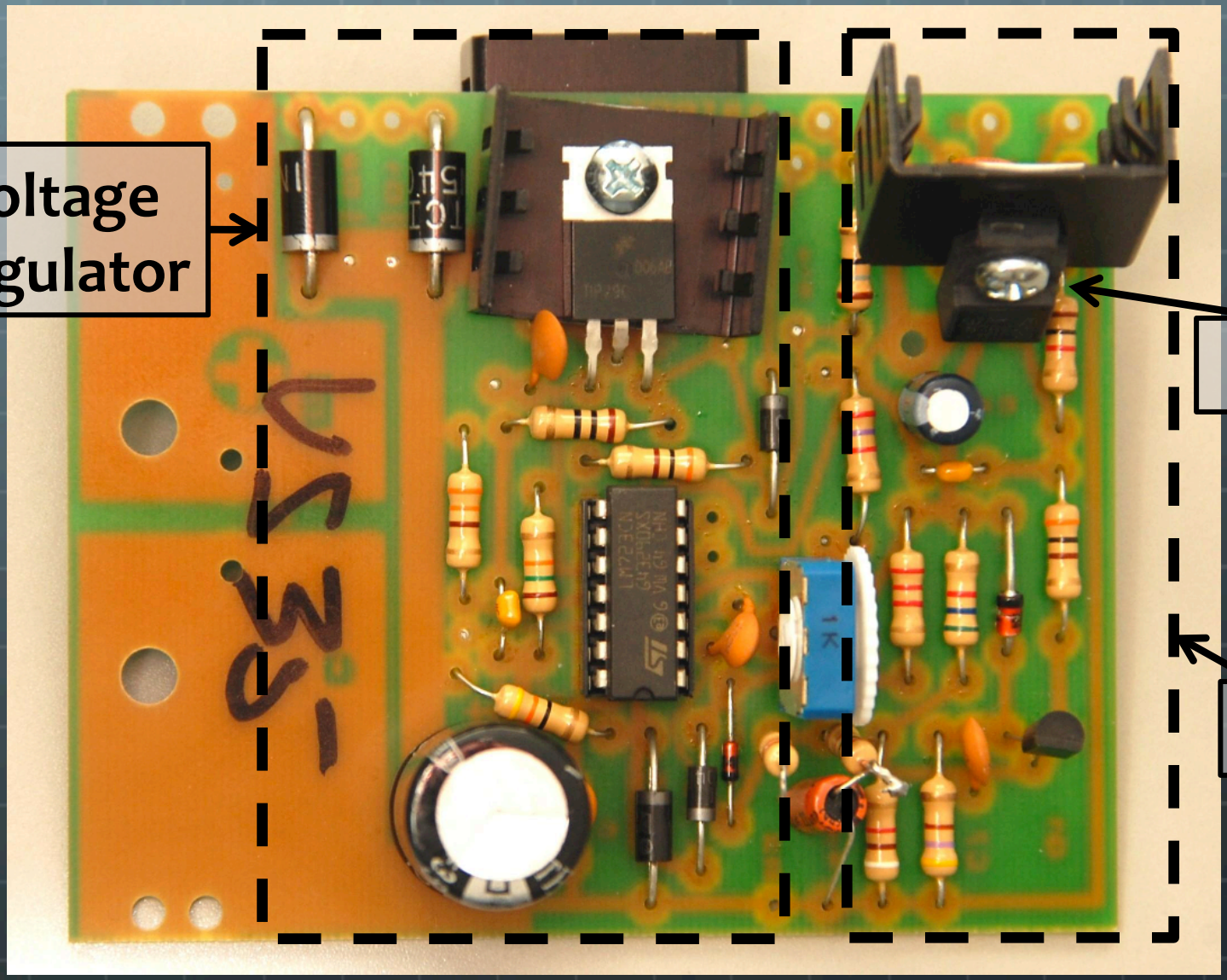
Astron Observations

- Longevity
- Family of RS supplies – all the same design
- Simple and inexpensive to repair
- No configuration control; circuit diagrams are often incorrect
- No help on Astron web site
- Lots of help on www.repeater-builder.com
- Early models have electrical safety hazards

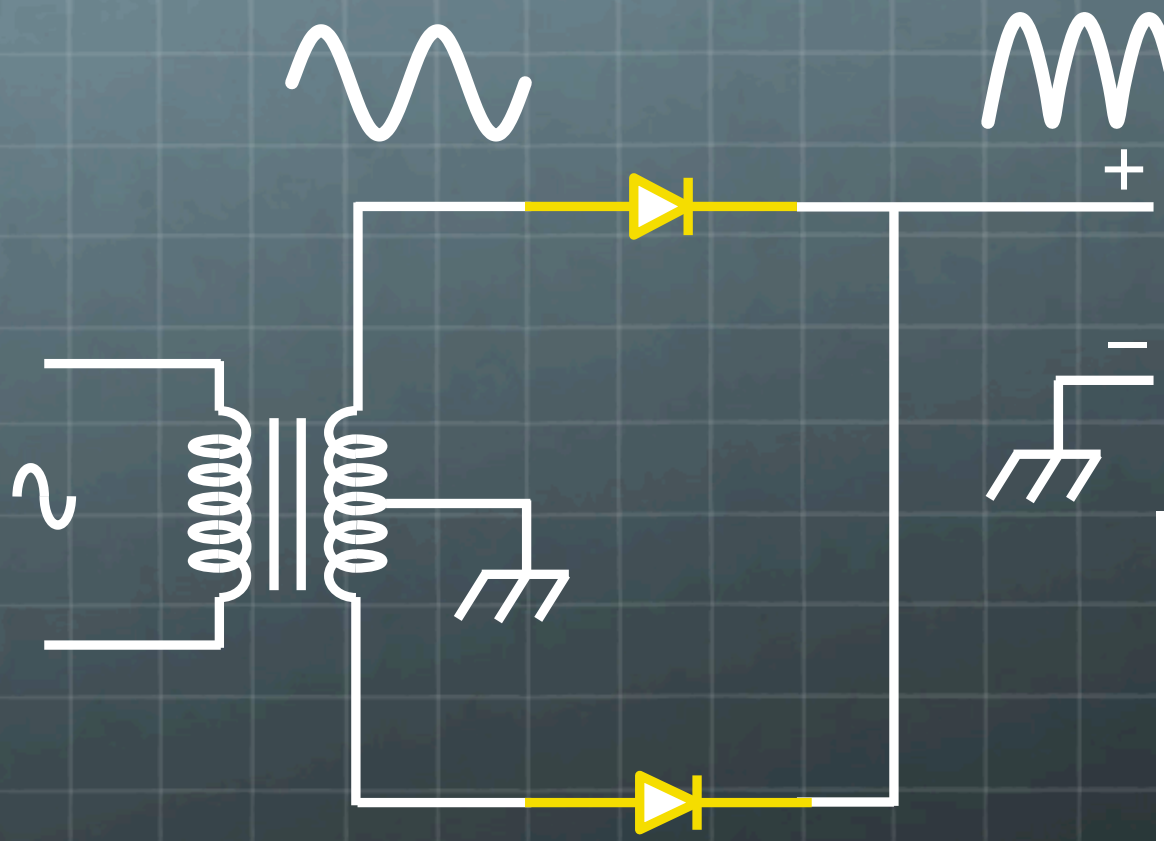
Astron RS Block Diagram



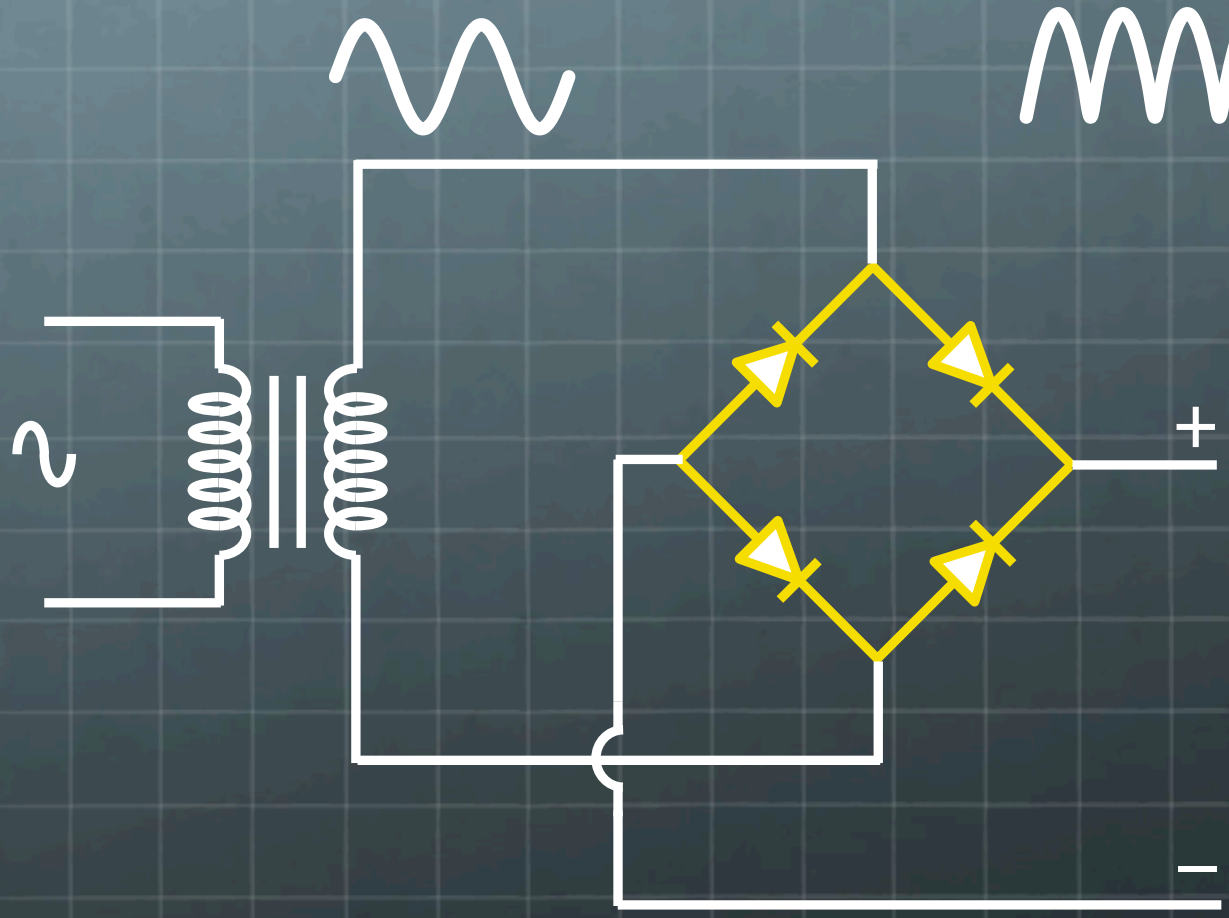
Regulator Board

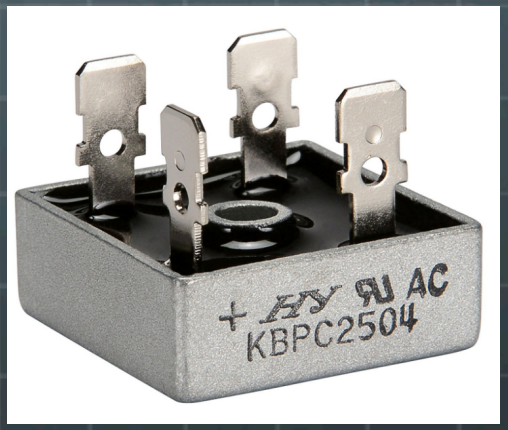


Two Diode Rectifier

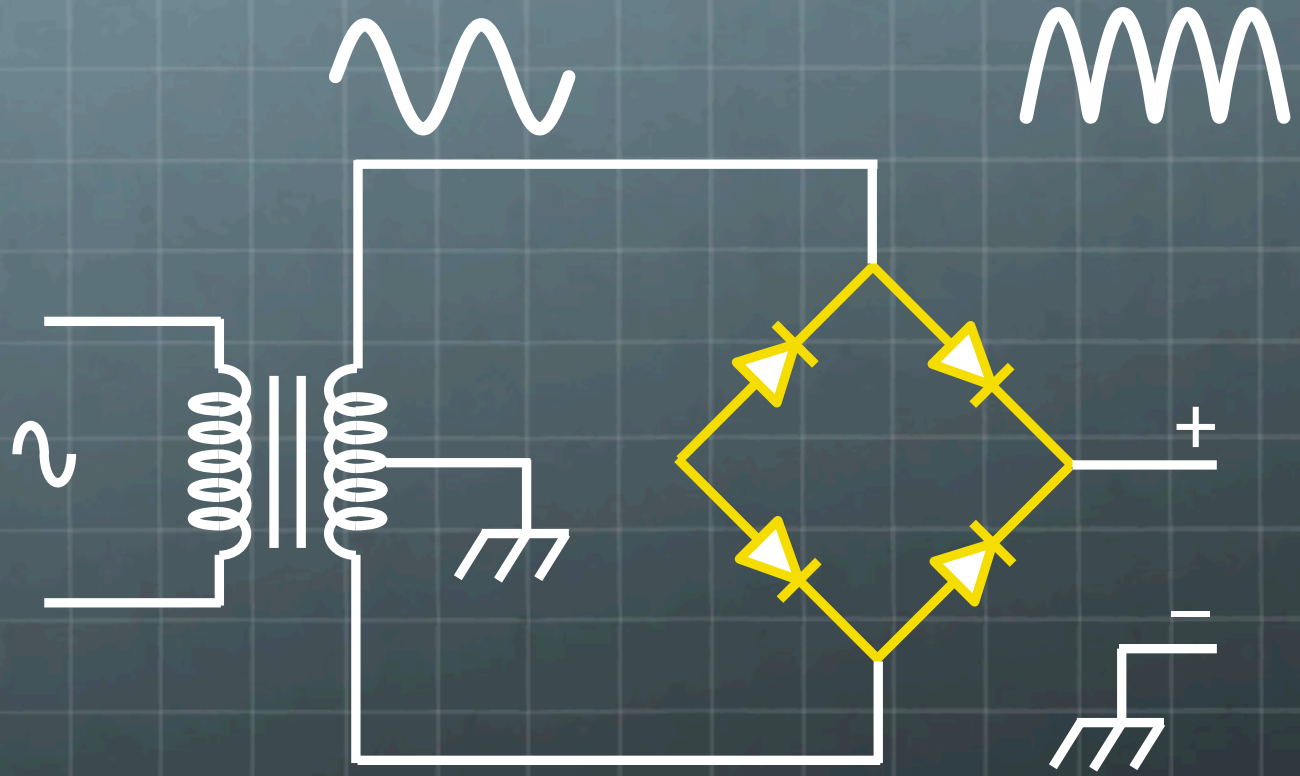


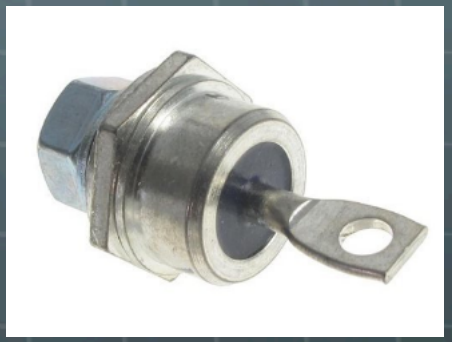
Bridge Rectifier



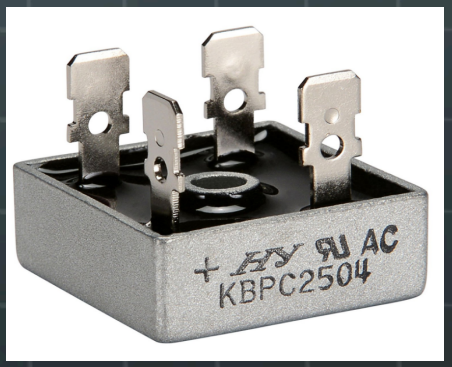


Astron Rectifier



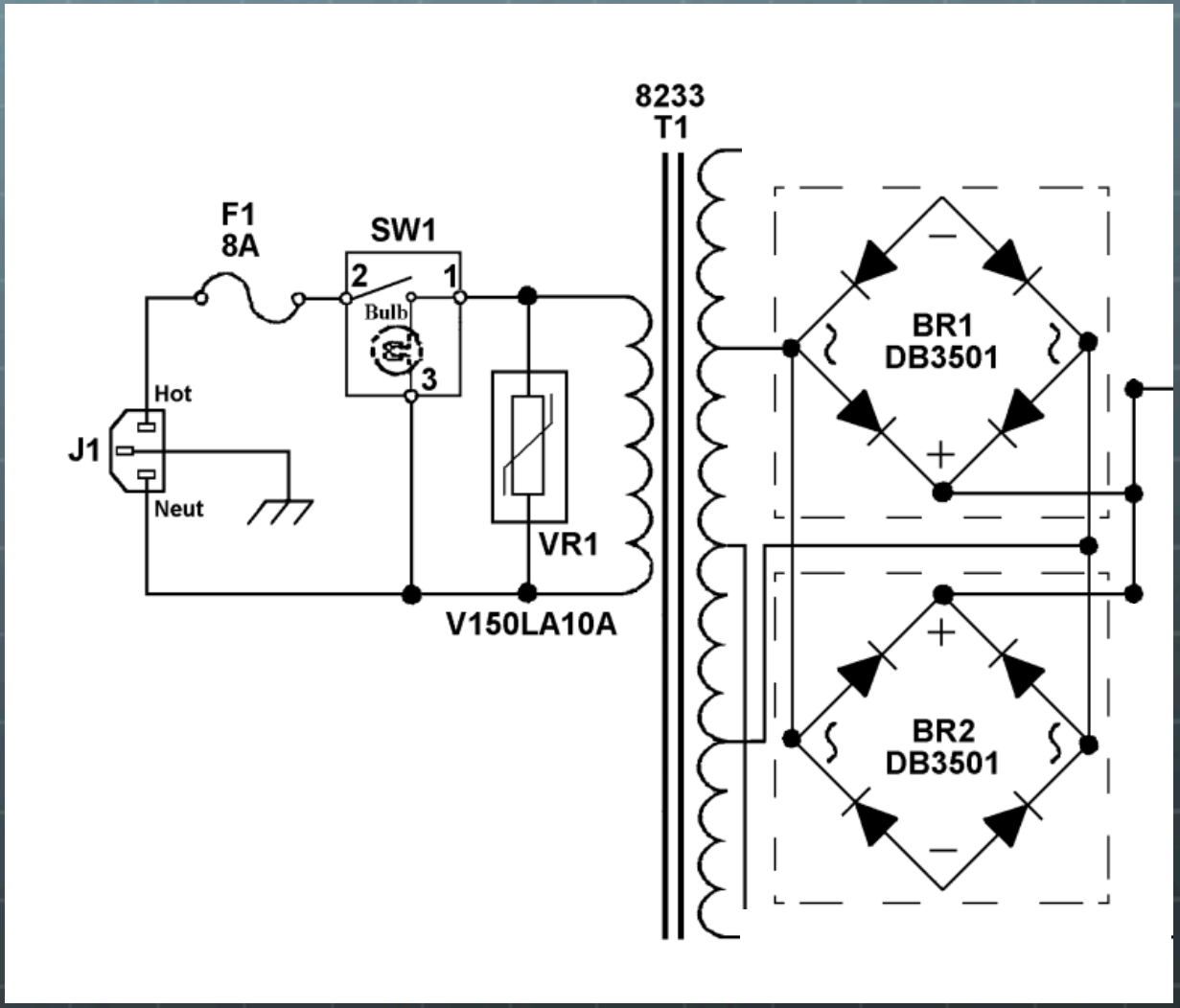


$7.00 x 2



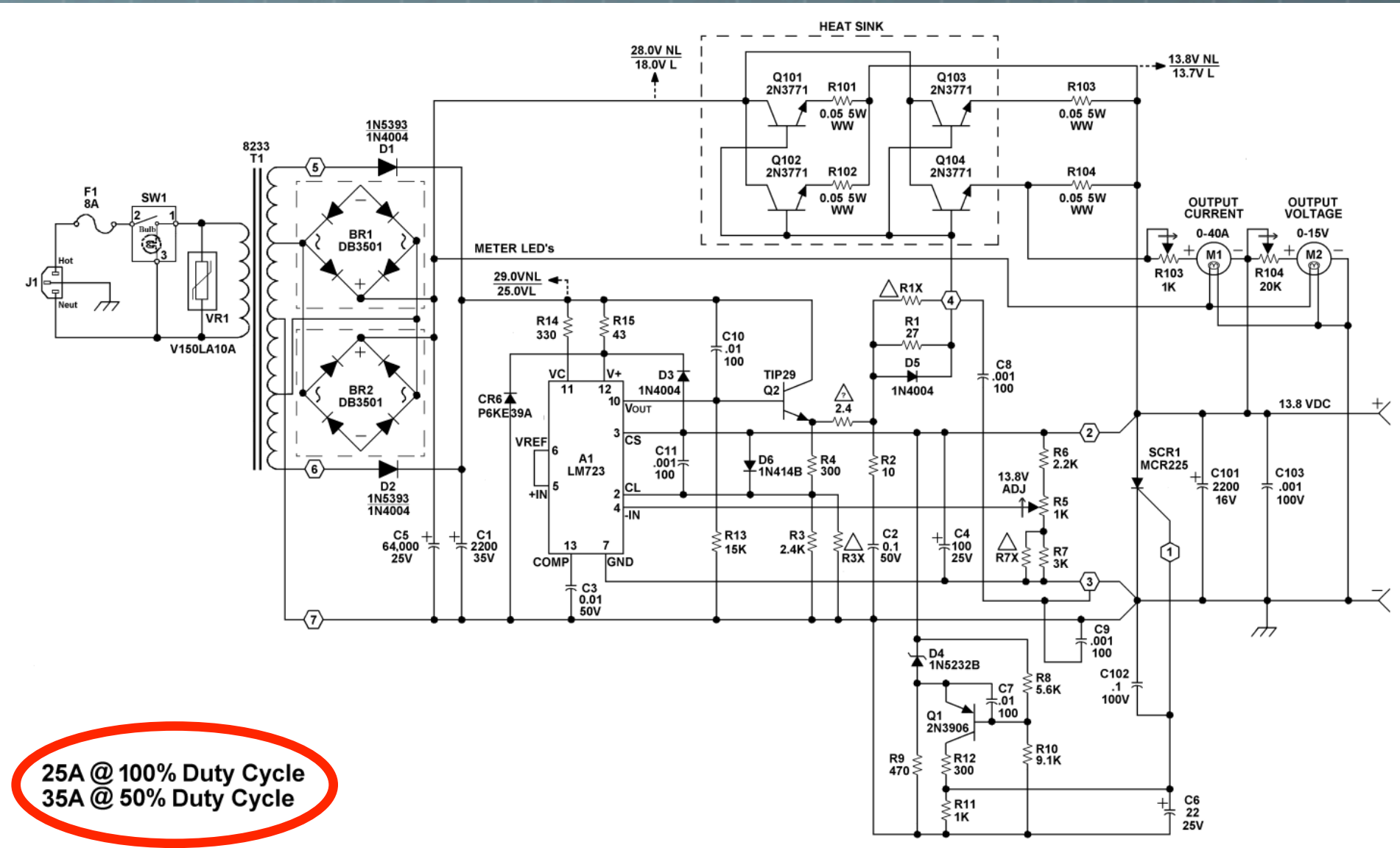
$5.00

Astron RS-35 Rectifier



The RS-35 uses two 35 amp bridge rectifiers in parallel

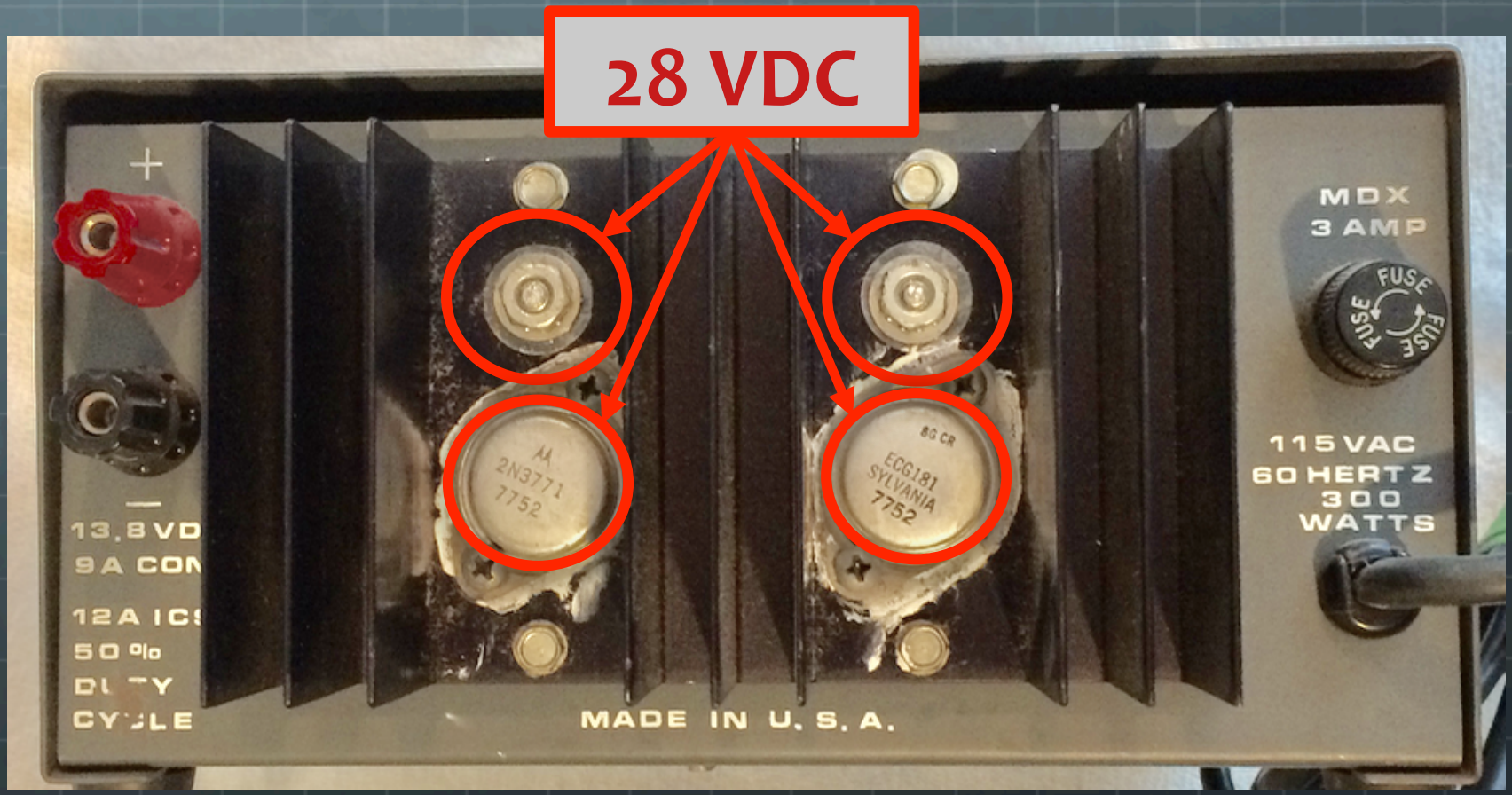
Astron RS-35M



25A @ 100% Duty Cycle
35A @ 50% Duty Cycle

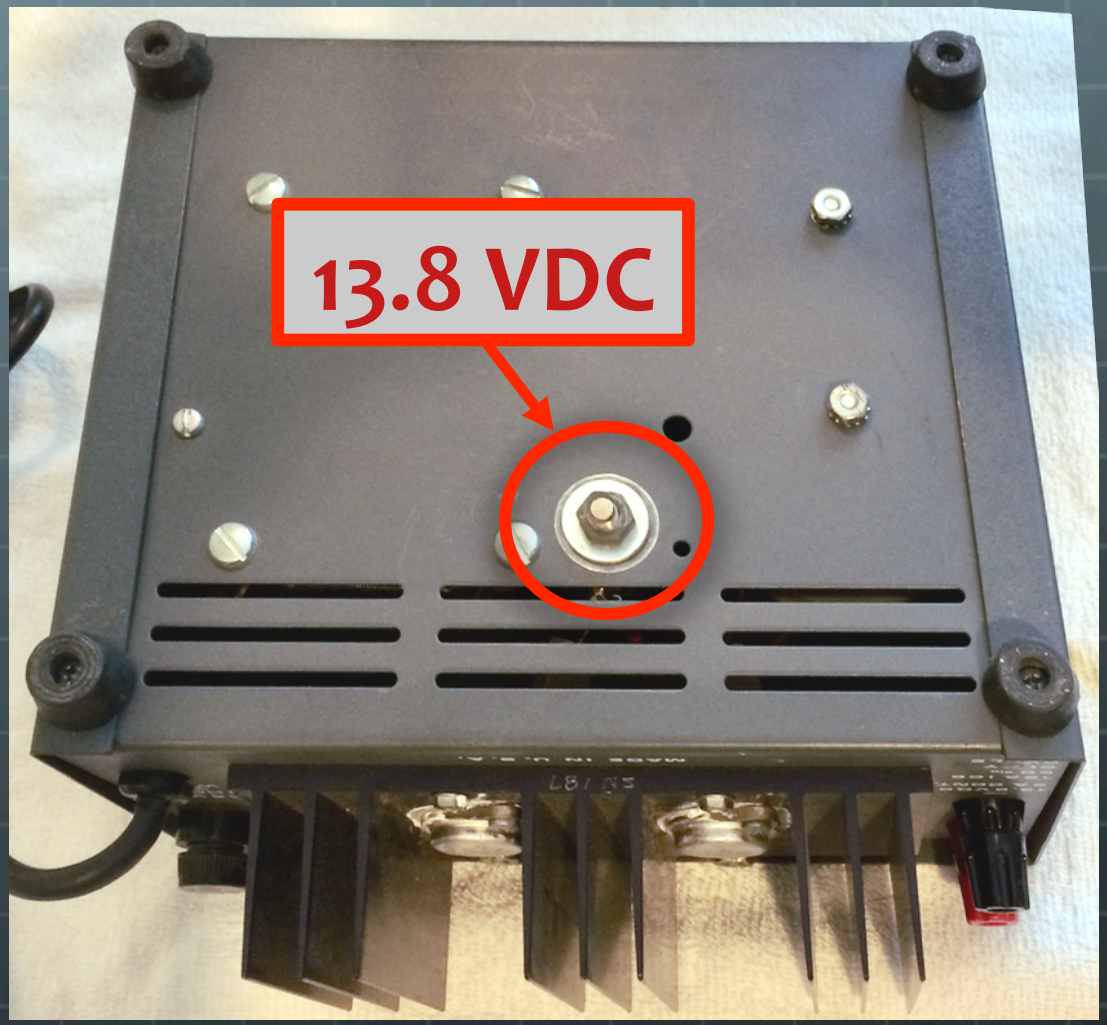
Electrical Safety

Exposed voltages



Electrical Safety

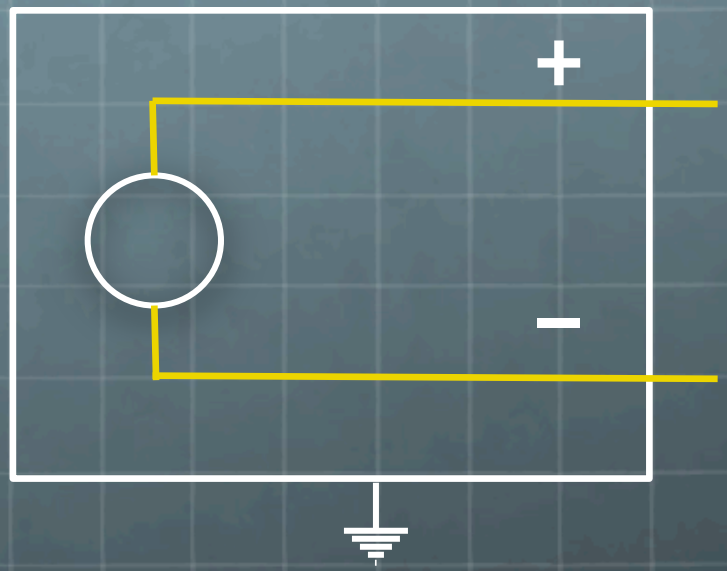
Exposed voltages



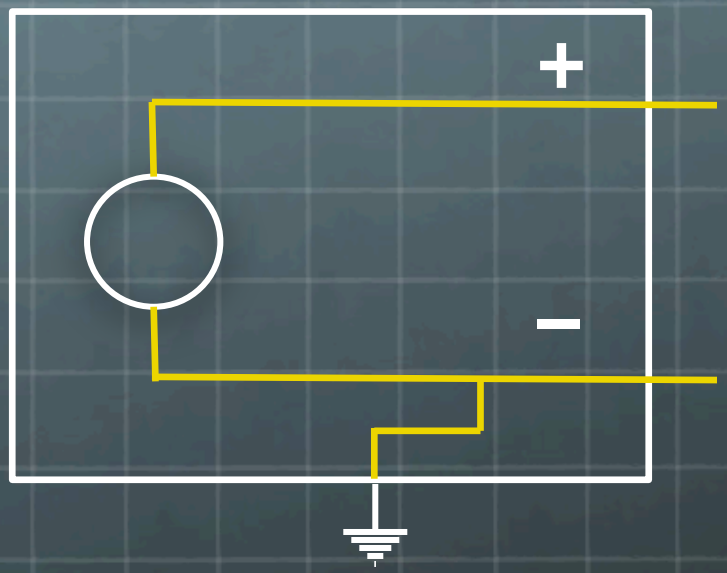
Fixes

- Relocate diodes and SCR to the inside of the cabinet
- Cover them up
  - Tape
  - Heat shrink

Floating Ground?



Floating



Non-Floating

- Astron is inconsistent – some do, and some don't
- Don't rely on the circuit diagram; check it yourself
- Does it matter?

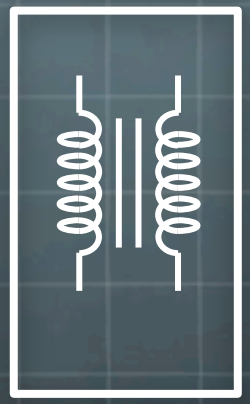
Floating Ground

- Elecraft: “We don't recommend a floating ground. If you insist on trying it, at the minimum you should fuse the + and – leads with 25 Amp fast blow fuses.”
- Icom: “The issue is most devices that have a floating ground will short out if the negative lead touches its chassis or create a ground loop. The radio negative DC IN wire is also at the chassis (not floating) so if you tie the power supply chassis with floating ground and the radio chassis to ground you could be shorting out the power supply letting the smoke out of it and possibly the radio also.”

Don’t Float

Troubleshooting

Think of the power supply as five modules

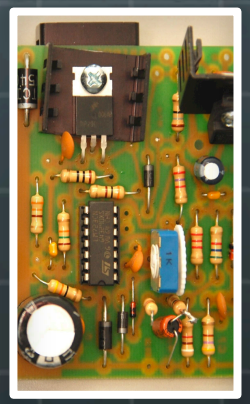


Transformer

Rectifier

Filter Capacitor

Pass Transistors



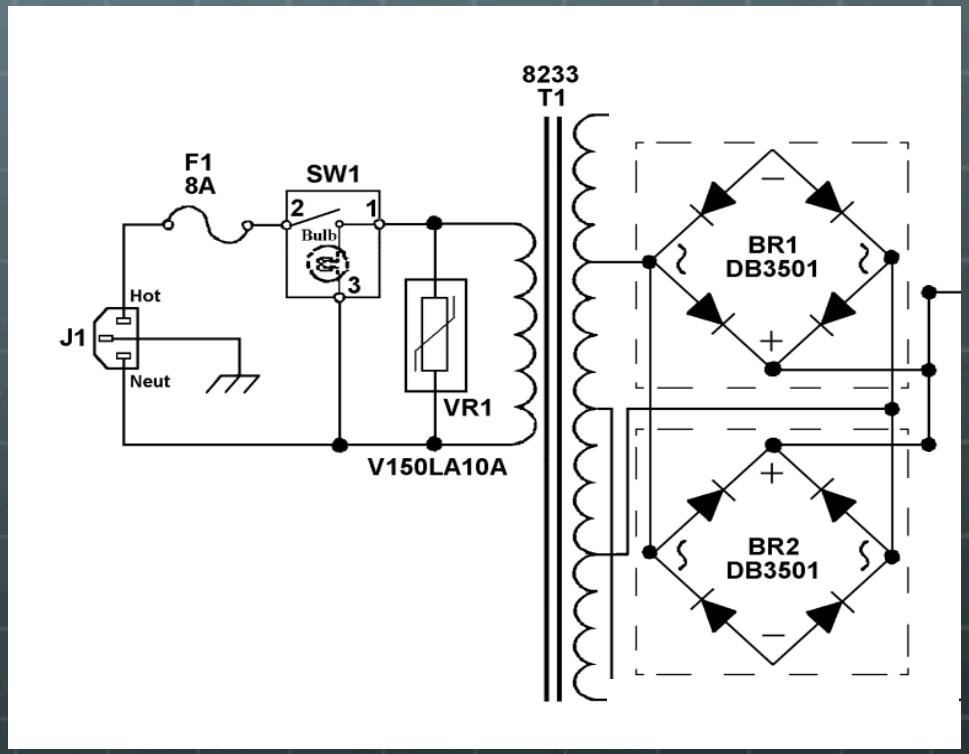
Regulator Board

Troubleshooting

- Just two symptoms
  1. It blows a fuse when you turn it on
  2. The output isn't what it's supposed to be
     - Too high
     - Too low
     - Drops under load
     - Hum
- We'll only look at most common causes
- Only a volt-ohmmeter for test equipment

Blows A Fuse

- The most common problem in the RS-35
- Design flaw



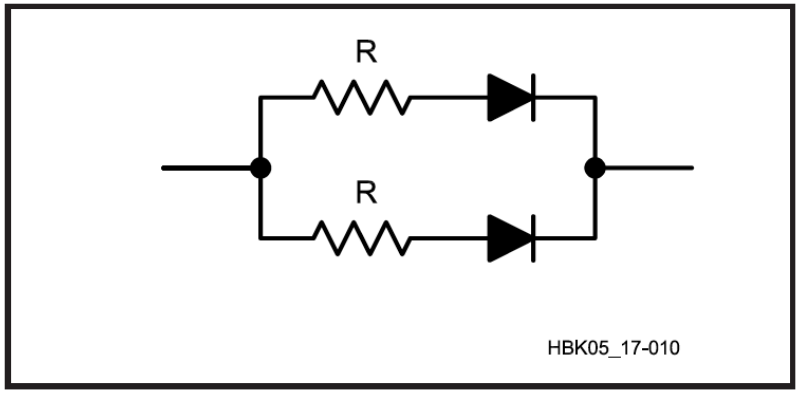
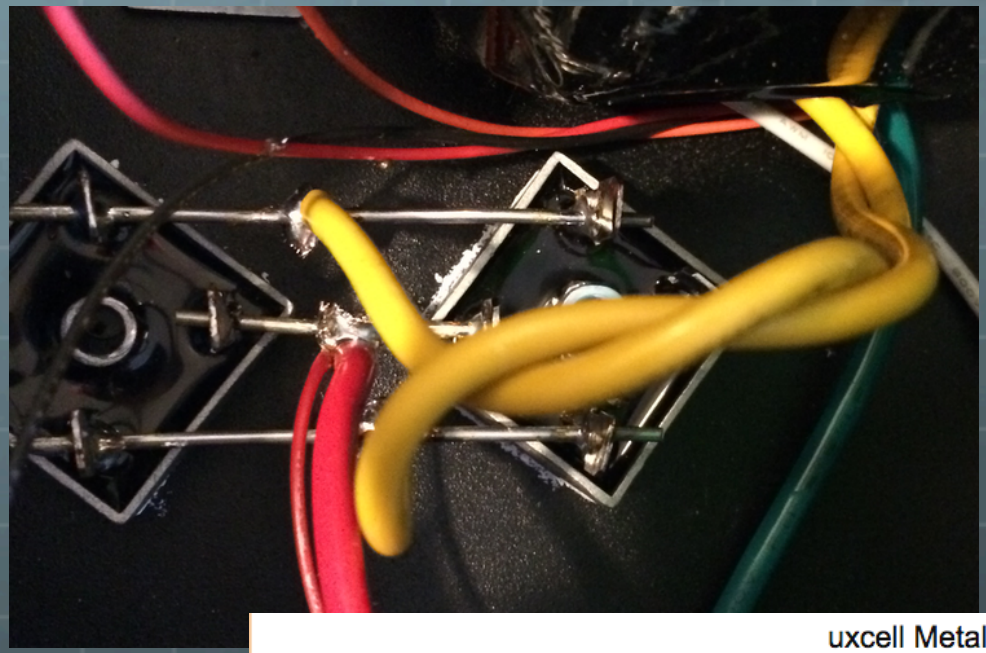


Fig 17.10 — Diodes can be connected in parallel to increase the current-handling capability of the circuit. Each diode should have a series current-equalizing resistor, with a value selected to provide a few tenths of a volt drop at the expected current.

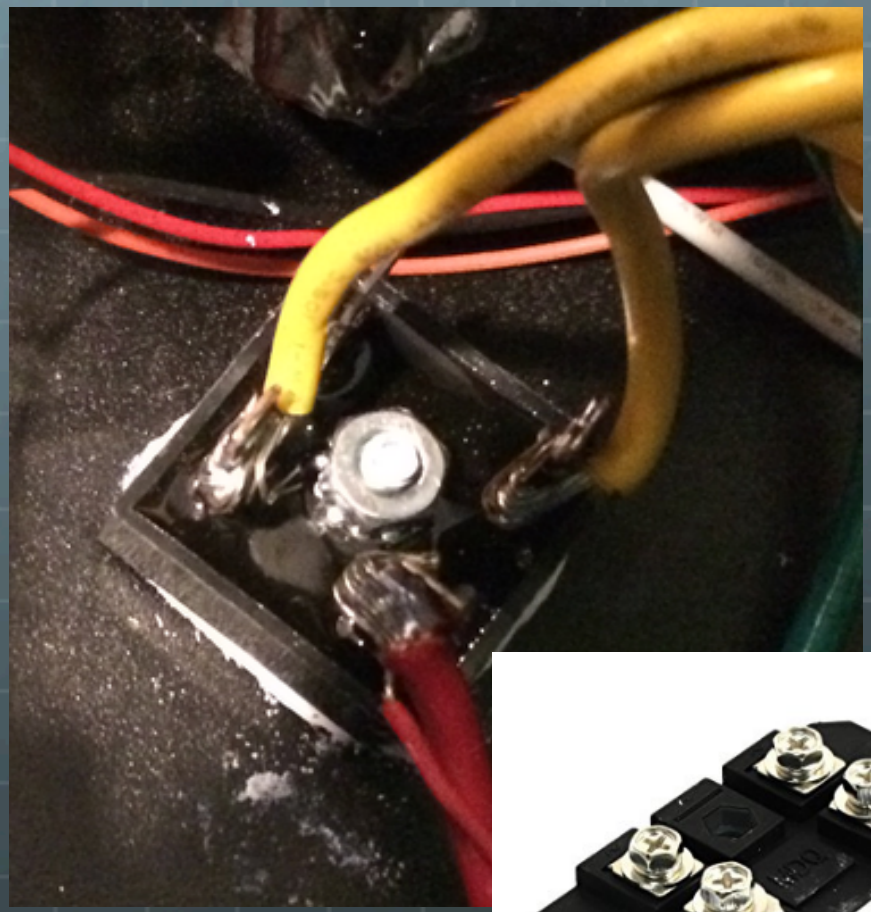
Blows A Fuse



Troubleshooting

- Disconnect wires
- Test resistance
- Replace with a single bridge rectifier

Blows A Fuse



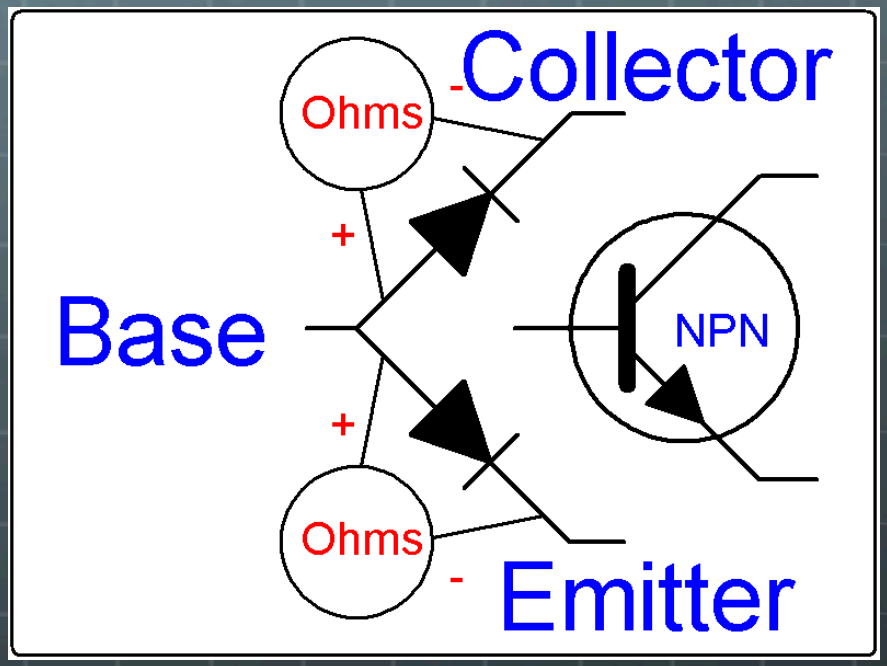
Replacing

- Verify polarity
- Use thermal compound

Bad Output

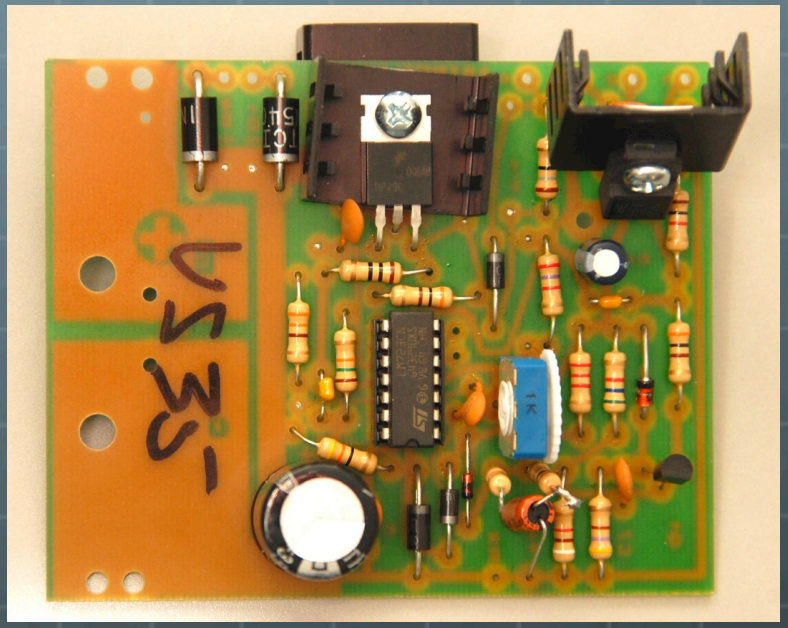
- Could be:
  - Filter capacitor (rare)
  - Pass transistor(s)
  - Regulator board

Pass Transistors



- Take off transistors and test with ohmmeter
- Positive lead of ohmmeter to base; should read ≈10Ω across other two terminals
- Replace all if one is bad

Regulator Board



- If rectifiers, filter capacitor, and pass transistors are good, all that's left is the regulator board
- Try replacing LM723 first
- Easiest fix: call Astron and order a new board: $20 + $7 shipping. They will send you the latest model board.

Regulator Board Replacement

- Label all the wires and mark the connections on the old and new boards before you remove the old board. Don't rely on the circuit diagram.
- Take pictures before unsoldering the old board
- Don't mess with the potentiometer
- If your power supply has the SCR off the board, consult "Installing a New Regulator Board in an Old Astron Power Supply" on the Repeater-Builder website

Test and Calibration

- The Prime Directive: *Do not use your transceiver as a dummy load !*
  - Dummy load can be auto headlight (caution) or resistor load bank.

- Turn on power supply (no load) and measure output voltage. Adjust regulator board output voltage potentiometer if necessary.
- Run power supply for about an hour at one amp or less. Check for hot and cold components.

Warning: If using your finger to check temperatures, turn off the power supply first!

Test and Calibration

- Run power supply at increased loads for a few minutes.
  - Check for hot/cold components at each load increment
  - Check voltage stability
  - Check power supply voltmeter and ammeter calibrations. Adjust with plastic tool.
- GET ON THE AIR!

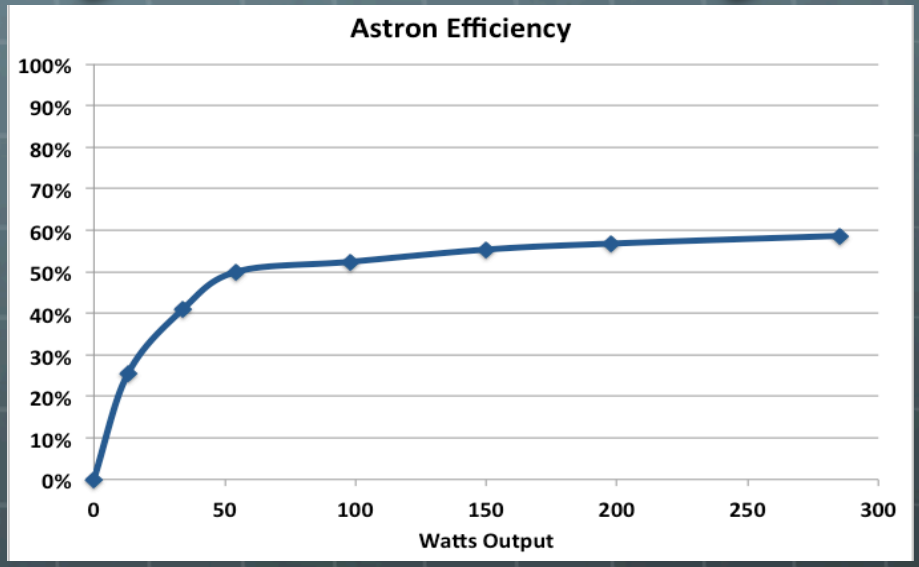
Power Supply Efficiency

$$\text{Efficiency} = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

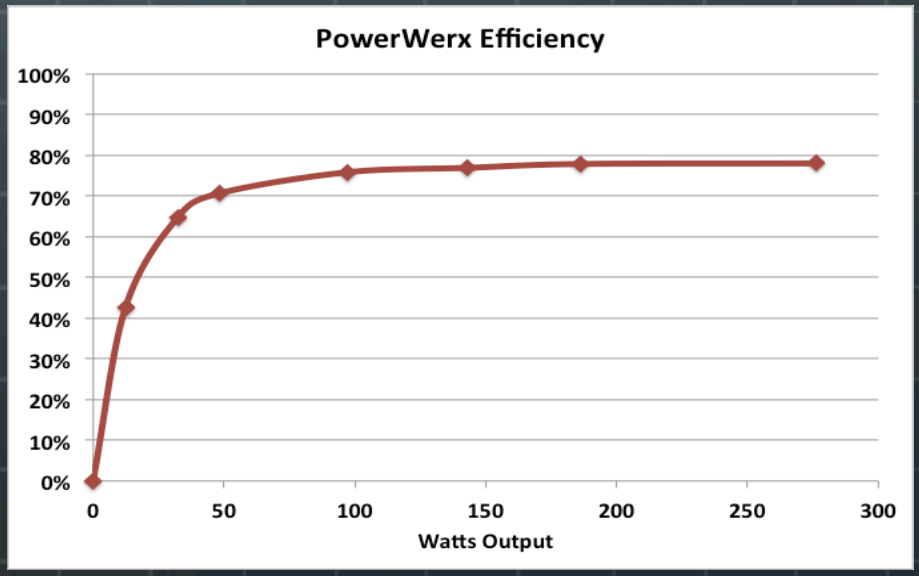
We can compare efficiency of the linear versus switched-mode power supplies

Power Supply Efficiency

Astron			
Watts In	Watts Out	Efficiency	Loss (Watts)
29	0	0%	29
51	13	25%	38
83	34	41%	49
109	55	50%	55
187	98	52%	89
271	150	55%	121
348	198	57%	150
486	285	59%	201



PowerWerx			
Watts In	Watts Out	Efficiency	Loss (Watts)
12	0	0%	12
29	12	43%	17
50	32	65%	18
68	48	71%	20
128	97	76%	31
186	143	77%	43
239	186	78%	53
354	276	78%	78



QST Product Review

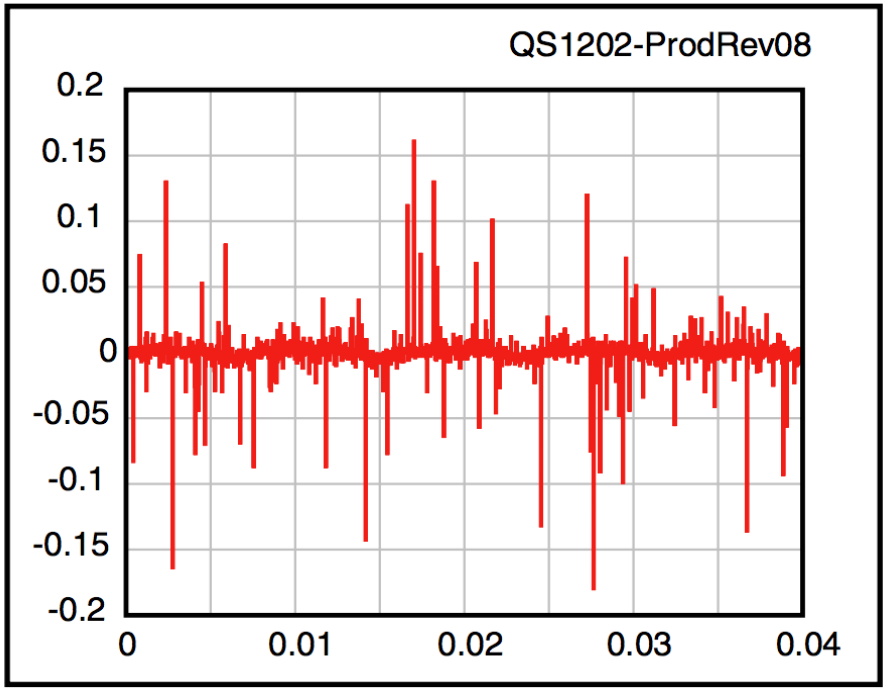


Figure 8 — An oscilloscope trace of the dc output of the Powerwerx SS-30DV under 20 A load. The vertical scale is 50 mV/div and the horizontal scale is 5 ms/div. The level of the dc ripple is approximately 30 mV p-p. Spikes due to switching measure about 350 mV p-p.

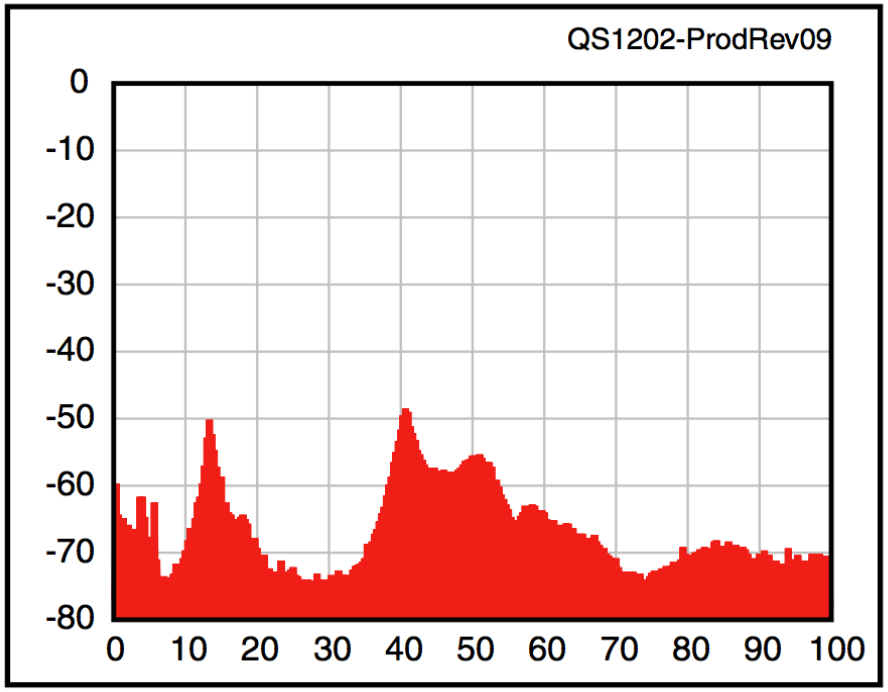
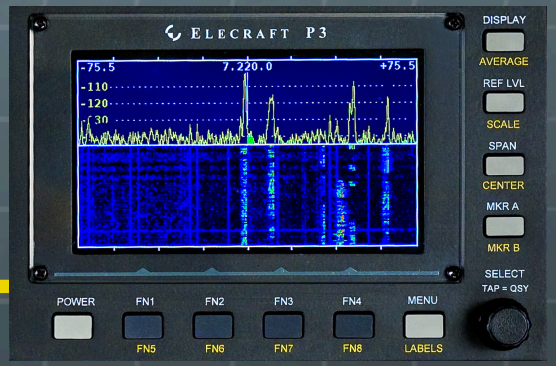
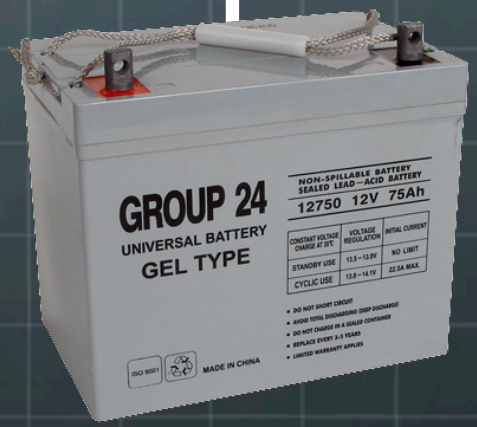


Figure 9 — Spectral plot (0-100 MHz) of the output of the Powerwerx SS-30DV under 20 A load. The reference level is 0 dBm and the vertical scale is 10 dB/div.

QST, Feb 2012

Noise Measurements





Switching PS Noise