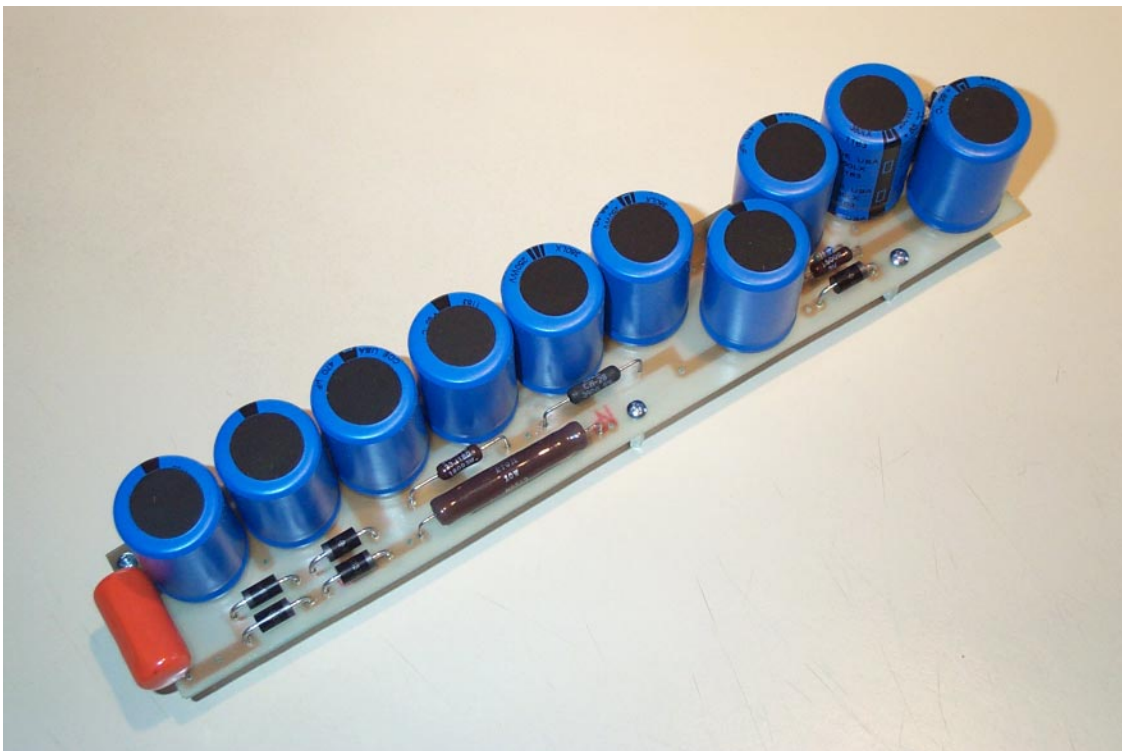




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## Harman Kardon Citation V Capacitor Board



Harman Kardon Citation V Power Supply Capacitor Board

This board replaces the 4 large can capacitors in the power supply section of the Harman Kardon Citation V amplifier. Exact replacements for the original can capacitors are impossible to find. The values needed can be built up with various replacement caps, but the installation of all the needed capacitors tends to make the amplifier very messy. This circuit board uses readily available circuit board mounted capacitors. There is a large range of values and voltages available in this form factor. The board easily holds similar capacitor values to the original can caps with room to spare. The capacitor values can be increased substantially and still fit on the board and in the amplifier. As an added bonus, the cost of all the caps needed is almost the same as two modern twist lock capacitors. The high voltage and bias diodes are also contained on the board.

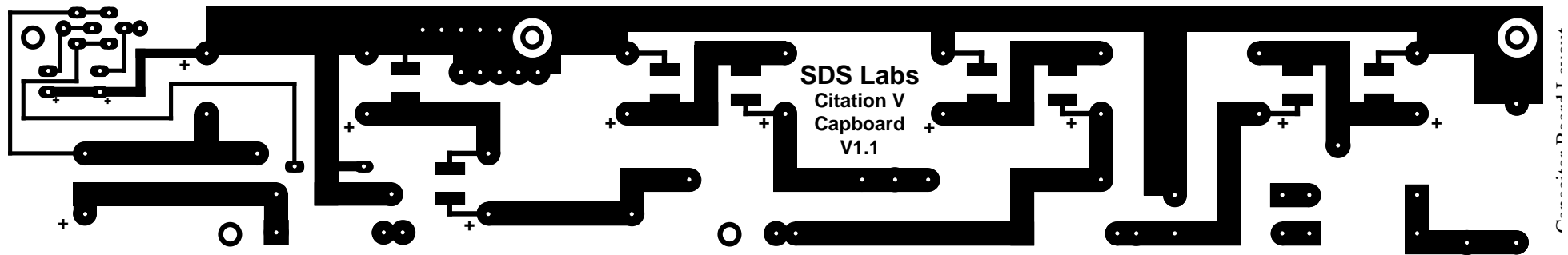
This board bolts to the support rail where the original can capacitors were attached. The board is attached to 5 existing bolt holes using 3/4" 4-40 standoffs. The wiring to the board is solder through the existing holes where the quad cap terminals extended through the support rail. The board is exactly 10 inches wide by 1.625 inches high.

On the trace side of the board are provisions for surface mount resistors to balance the voltages across the series capacitors which make up the 4 high voltage sections. Mouser does not sell surface mount resistors that are larger than 1/8 watt. In order to get enough current through these parts to make the divider effective, those parts should really be 1/4 watt or higher. These parts are available from digikey or other sources, or pairs of resistors can be used in parallel. The balancing resistors (RB) specified here are to be used in pairs, and produce a 500 K $\Omega$  1/4 watt resistors.

This board also adds the ability to adjust the bias voltage for the pairs of output tubes. This amplifier includes AC and DC balance controls, but a bias control is consciously missing. In typical Harman Kardon style, the output tubes are driven very hard. The plate dissipation for each of the 7581 output tubes is just a hair under 35 watts. This is right on the ragged edge of acceptable for these tubes, and over the limit for the more common 6L6GC tubes. This bias control will allow the bias to be dialed back a bit for longer tube life and the ability to use other 6L6 variants. There is a bias pot for each channel. The pot is adjusted while measuring the voltage across the 3.3  $\Omega$  cathode resistors on the output tubes. A good sounding and safe bias point is a quiescent current of about 54 mA, which is a voltage across the cathode resistor of 0.18 volts, and a plate dissipation of 25 watts.

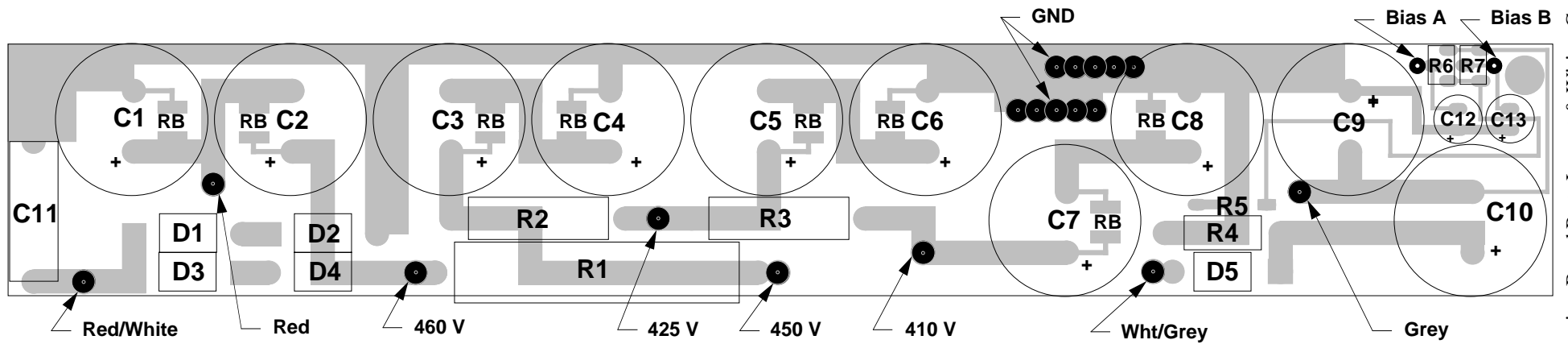
Part No.	Description	Mouser Part Number	Cost
C1	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C2	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C3	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C4	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C5	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C6	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C7	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C8	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C9	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C10	470 $\mu$ F 250 V	5985-85-250V470	\$4.08
C11	0.01 $\mu$ F 1600 V	75-715P1600V0.01	\$1.33
C12	22 $\mu$ F 100 V	75-517D100V22	\$0.28
C13	22 $\mu$ F 100 V	75-517D100V22	\$0.28
D1	3A 1000 PIV	625-1N5408	\$0.18
D2	3A 1000 PIV	625-1N5408	\$0.18
D3	3A 1000 PIV	625-1N5408	\$0.18
D4	3A 1000 PIV	625-1N5408	\$0.18
D5	3A 1000 PIV	625-1N5408	\$0.18
R1	270 $\Omega$ 10 Watt	588-20J-270	\$1.50
R2	180 $\Omega$ 3 Watt	588-23J-180	\$0.89
R3	390 $\Omega$ 3 Watt	588-23J-390	\$0.89
R4	1.5 K $\Omega$ 3 Watt	588-23J-1.5K	\$1.33
R5	49.9 K $\Omega$ 1/4 Watt	271-49.9K	\$0.09
R6	10K Potentiometer	652-3266X-1-103	\$2.94
R7	10K Potentiometer	652-3266X-1-103	\$2.94
RB	1 M $\Omega$ 1/8 Watt (16 Needed)	263-1M	\$1.28
		Total:	\$55.45

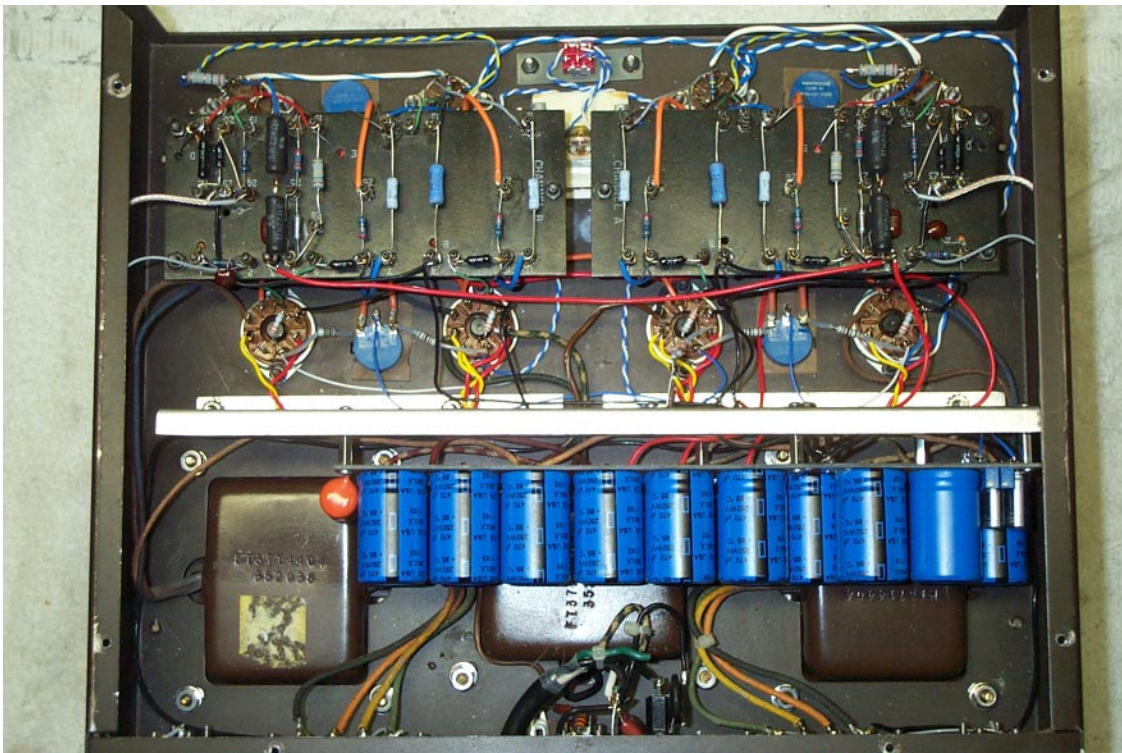
Capacitor Board Parts List



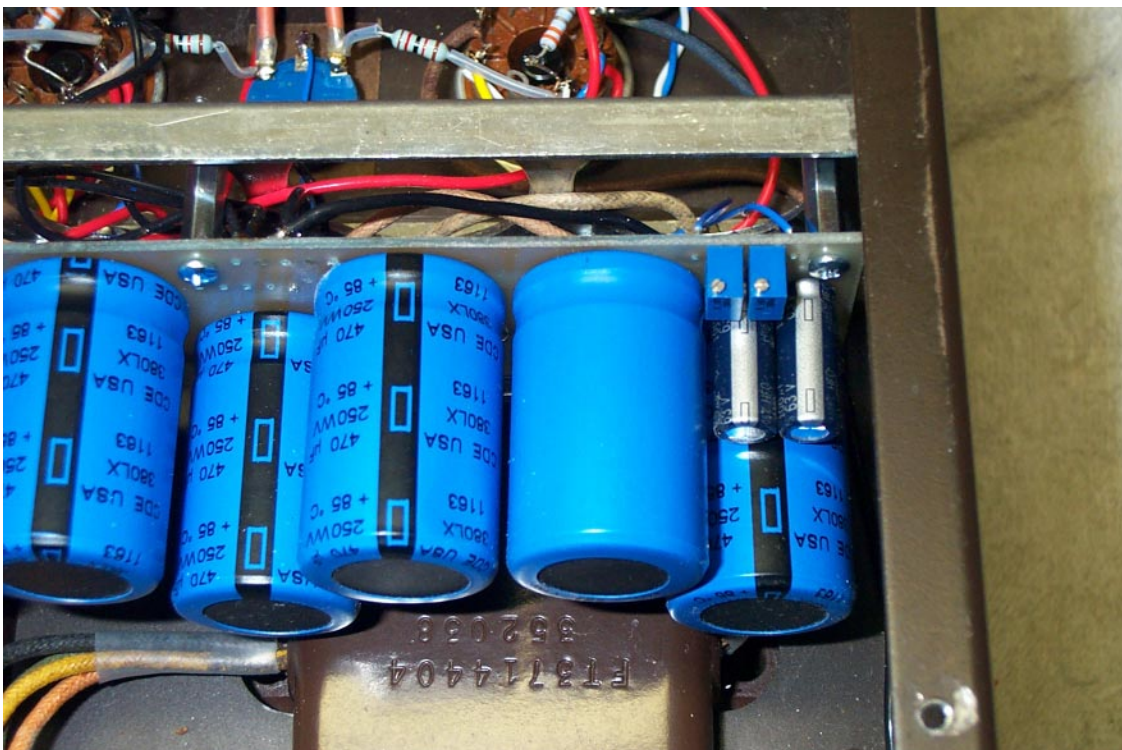
SDS Labs  
Citation V  
Capboard  
V1.1

COURTESY: SDS LABS

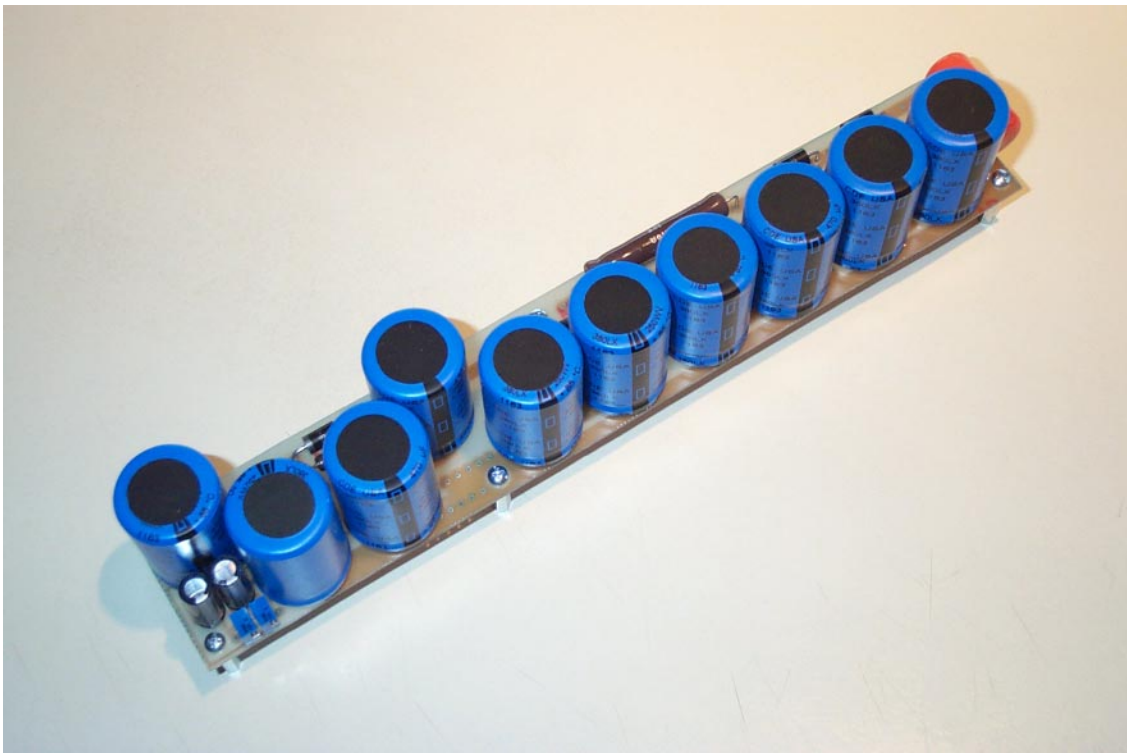




Capacitor Board Installed in Amplifier



Two Potentiometers For Bias Adjustment



Harman Kardon Citation V Power Supply Capacitor Board



## Board Etching Tips

The artwork is printed onto transparency film from a laser printer, print it three times. Cut out two of the prints with about a quarter inch of clear space around the circuit board image. Then carefully tape these two copies to the uncut one after carefully aligning the traces of the overlay to the uncut sheet's traces. When finished, there should be three perfectly stacked copies. This increases the contrast of the final image. When a transparency is printed with a laser printer, there are usually holes in the black printed parts. And the blacks aren't all that black when it is held up to the light. Overlaying makes the blacks much more black, and gets rid of the holes. Now the artwork is ready to use. For double sided boards, the two sheets of artwork can be taped securely together on three sides after carefully aligning the traces on each side. This forms an envelope which the circuit board gets slid into. It's helpful to tape the board in place inside the envelope with a single piece of tape. This will prevent the board from shifting when it is flipped over to expose the second side.

This method uses GC positive sensitized boards and developer. The FR-4 fiberglass 1 Oz. grade board works very well (they can be gotten local electronics stores). The board emulsion is sensitive to UV light, A good source of UV to expose the board is a GE sunlamp. The sunlamp is hung so the bottom of the bulb is about 12" above the board. The exposure time is 9 minutes. With a yellow incandescent bug light-bulb on, pull the protective coating off the board and carefully align the artwork on top of the board. Then cover the artwork with a piece of glass to hold the artwork against the board (just like making a contact print in photography). Then turn the sun lamp on for 9 min. If a sunlamp is unavailable, the sun at noontime (on a clear day) can be used exposing the board for about 20 minutes.

The exposed board gets dumped into the developer which has been mixed up beforehand. The developer says to use a 1:9 concentration of developer to water, but a 1:5 mix can be used, which works faster and can yield slightly better results. However the timing is more tricky, so it is not recommended for the first time. Submerge the board into the developer (A photography developer tray works very well), and rock the solution back and forth over the board. The exposed parts will start to dissolve. The emulsion is green and it will wash away exposing the copper underneath. This is the tricky part. The board must be removed when all the emulsion is off the exposed areas. If the board is removed too soon, the emulsion won't be completely dissolved off the exposed areas and it won't etch, if the board is in the developer too long all the emulsion dissolves and all that is left is a bare board. With the 1:9 solution this time window is about a minute, with a 1:5 solution it's about 20 seconds. The board is removed from the developer and washed off with room temperature water, then scrape at an exposed area and see if there is any emulsion left there. If there is, place the board back in the developer for a few seconds. Repeat this as necessary until the exposed areas clear. With a little practice, it's pretty obvious when it's time to pull the board out. Do all the developing using the yellow bug light. When the board is done, wash it off and let it dry. Be careful of the emulsion, it's easily scratched, especially when fresh from the developer.

Next, drop the board into an etching solution. Ferric Chloride is available from the same electronic outlets where the GC boards and developer are purchased or from Radio Shack. Ferric Chloride is a nasty smelling, iodine looking, serious staining stuff. Pour out the developer from the tray, wash it out and add the etchant. Then put the board into the etchant and rock gently back and forth for about a half hour or so, until all the exposed areas are clear. Then remove the board and wash it clean. The emulsion can then be removed with acetone or alcohol.

Then all the holes need to be drilled in the board. A Dremel moto tool works well for drilling the small holes, a small drill press would also work.