

Easy DENTRON MLA-2500 Conversion using SVETLANA 3CX400A7 3CX800A7



**PERFORMANCE CHART
TWO 3CX400A7/8874 IN MLA-2500 (B)**

Operating Freq MHz	28.5	24.9	21.3	18.15	14.2	10.1*	7.2	3.8	1.9
Bandswitch	28	21	21	14	14	7	7	3.5	1.9
Power Output Watts	820	1020	920	920	1000	940	1000	1050	800
Drive Power Watts	115	115	120	120	110	60	80	85	60
Plate Voltage	2000	1950	2000	2000	1950	2000	1950	2000	2000
Plate Current Amps (single tone)	.800	.930	.880	.920	.930	.740	.950	.900	.860
Grid Current mA	70	95	75	80	80	95	90	90	100
Input VSWR (Auto Antenna-ON)	1.2	1.2	1.5	1.3	1.3	1.1	1.2	1.1	1.1
Tune Control	21	27	18	25	12	23	6	3.8	6
Load Control	7.	7.5	6.2	7	3	10	3	6.4	10

* Maximum RF Power Output in U. S. is 200 watts at present. Operation from DX locations should be governed by local regulations.

Conditions: Primary Power = 119V AC
Exciter = ICOM 765; Auto Antenna Tuner On
RF Load = 50 ohm Antenna
RF Power Meter = Bird 43 1 KW element

Figure 1
Plenum Fabrication

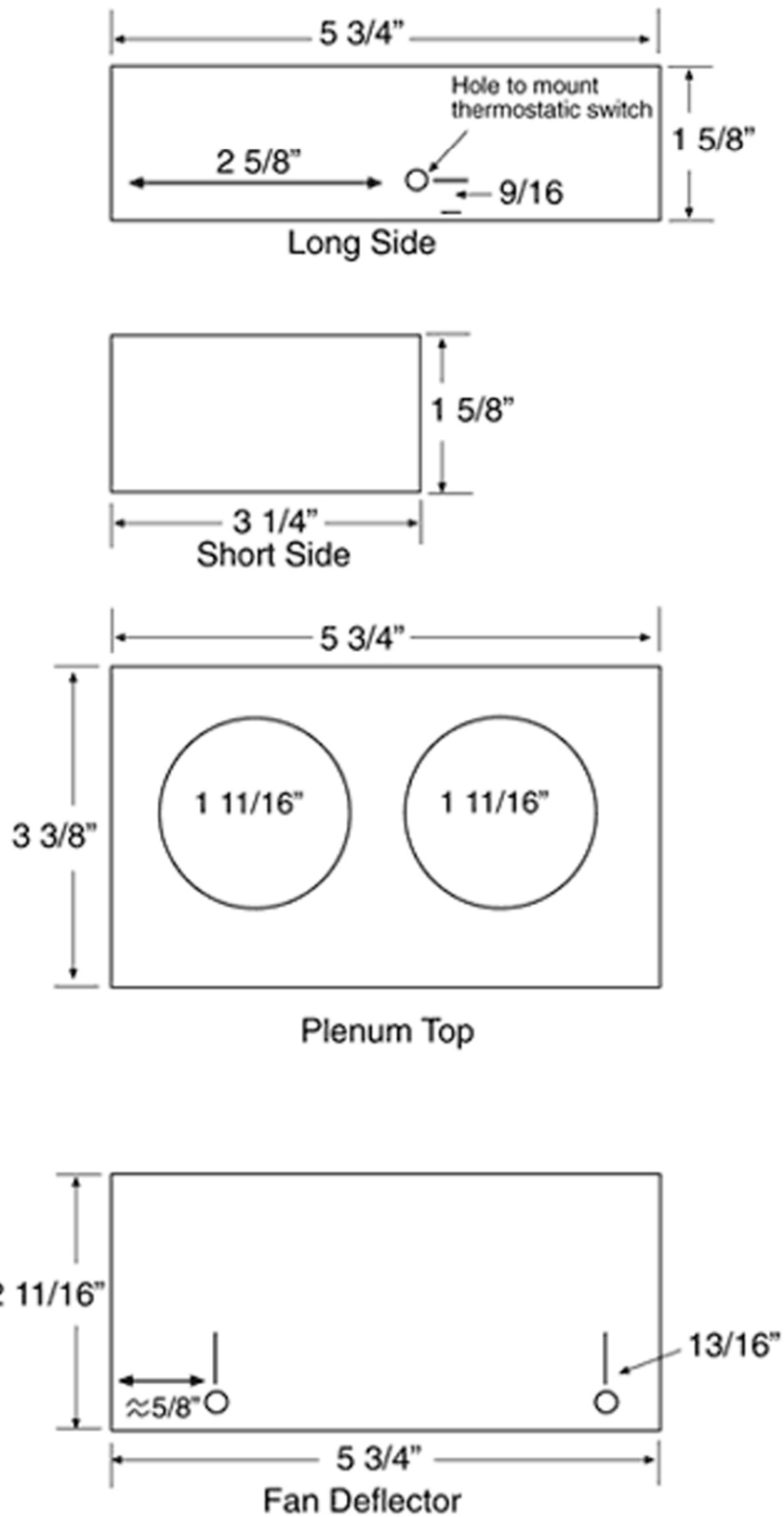
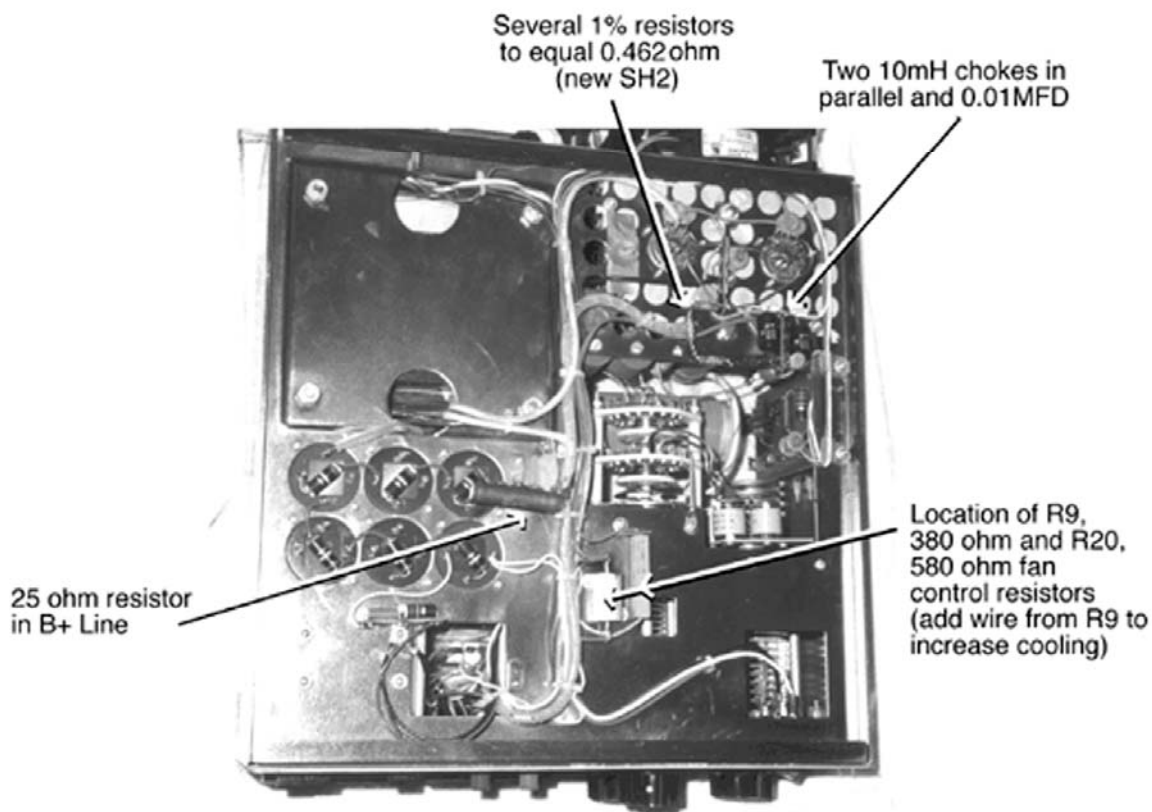
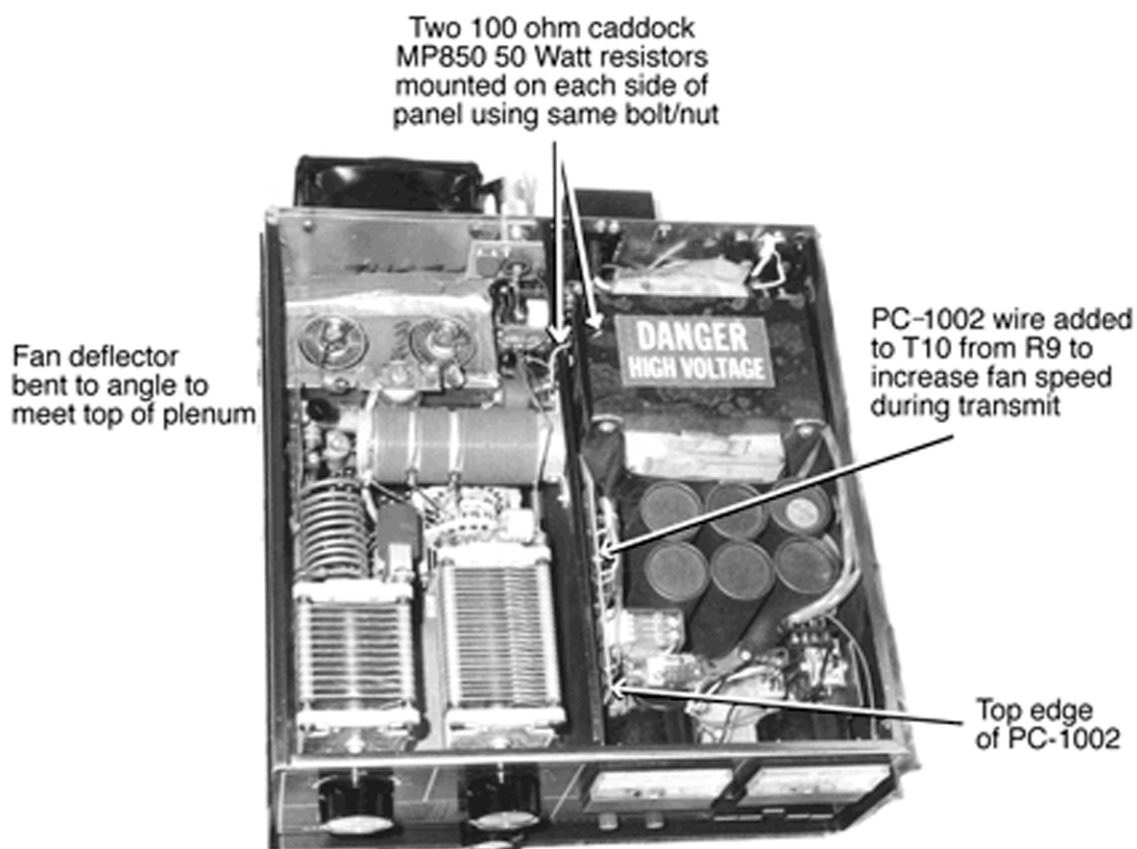


Fig 1



Bottom View Without Cover

Photo A.



Top View without cover

Photo B.

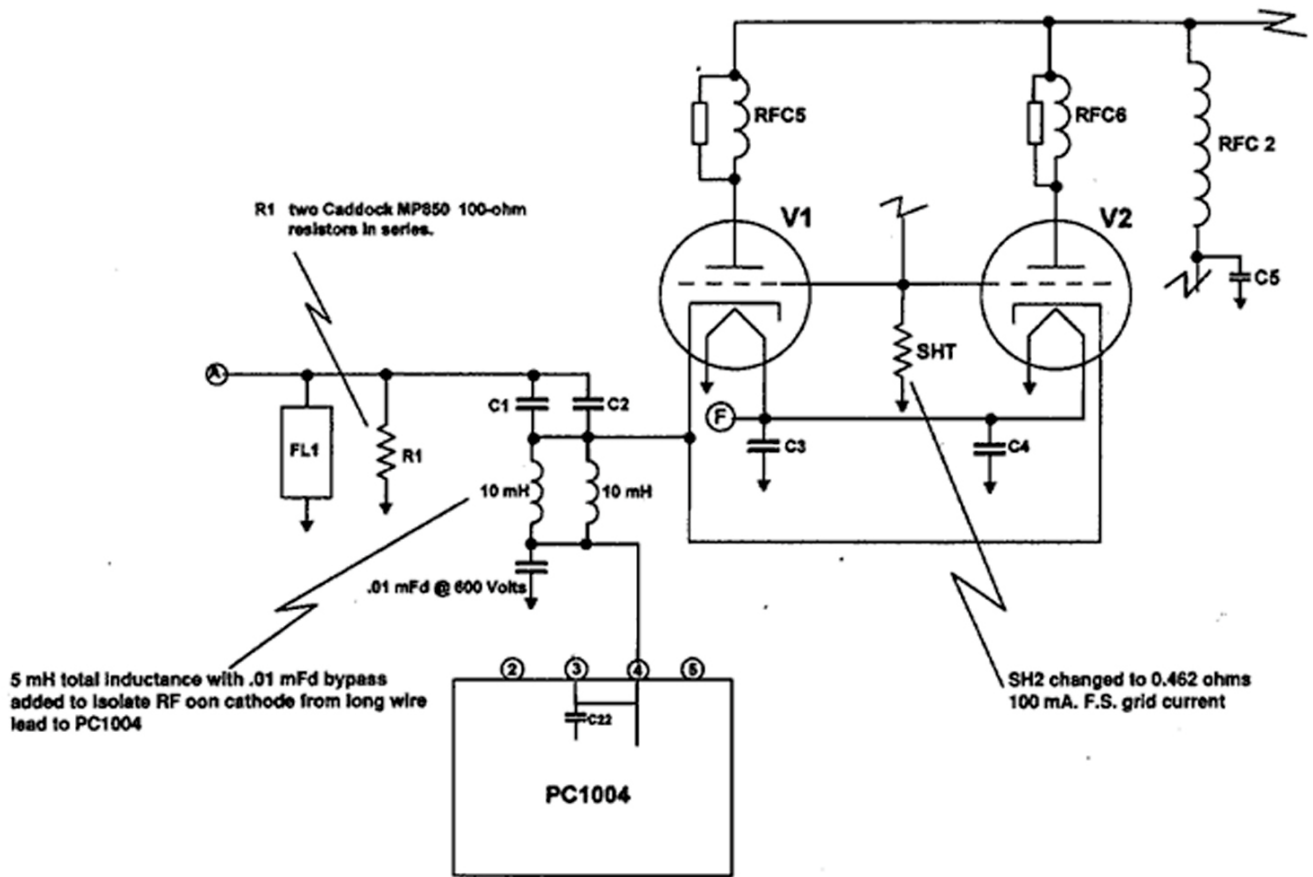


Fig 2.

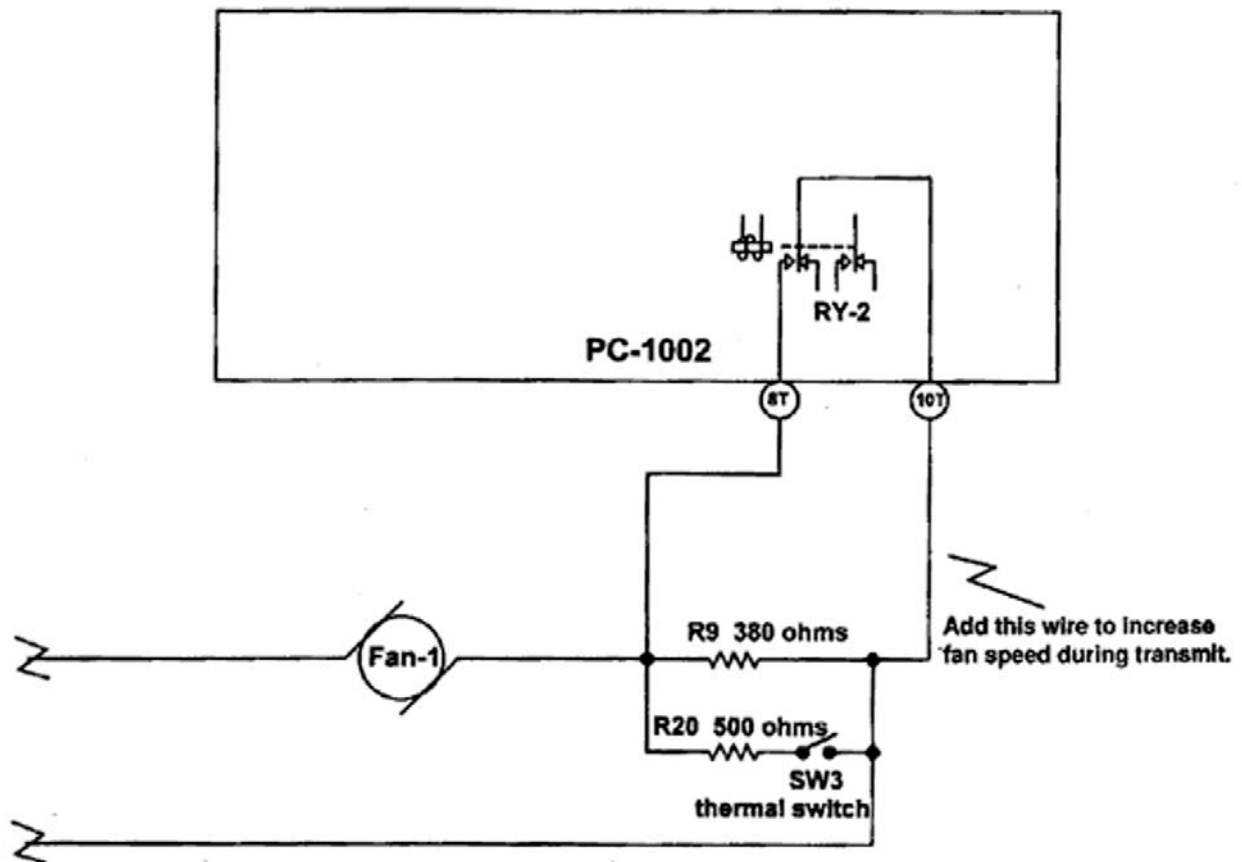


Fig 3.



No.44

Amateur Radio

3CX400A7 & 3CX800A7

TECHNICAL BULLETIN

The Easy MLA-2500 Conversion

By: B-N. Bob Alper



The MLA-2500 power amplifiers that are available for purchase have become scarce since the articles for conversion to more popular tubes appeared in QST and Communications Quarterly. Also, the 8875 tubes are in demand less and less because, except for amateur use, there is little industrial/commercial use for the tube. As the demand decreases, we can expect the price of a new 8875 to climb further from its present level, which is near \$450.

The MLA-2500 series is one of the most compact linear amplifiers of its power class. Its intermod performance at 1250 watts RF output, with 100 watts of drive to 8875 tubes, as measured by the ARRL (3rd and 5th order distortion products of 35 and 37 dB, respectively) is relatively good by the standards of modern amplifier designs. Therefore, it seems reasonable for MLA-2500 owners to try to find an alternate more economical and available replacement power tube.

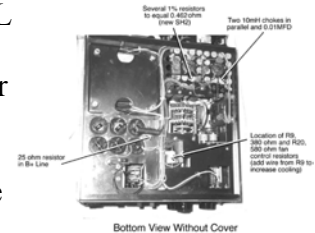
REPLACEMENT TUBE SOLUTION

The 3CX400A7 and the 3CX800A7 are both candidates for consideration. Neither is nearly as economical as the tetrode tubes of previously published conversions. However, these tube types are both very similar to the original 8875. The 3CX400A7 is electrically identical to the 8875. Both the 3CX400A7 and the 3CX800A7 use the same socket, so this conversion is very easy. There is reasonable confidence that both tubes will be available for sometime in the future, as they are both used in numerous types of commercial, industrial, and medical equipment. The continuous and on-going use of these tubes will maintain the demand, resulting in a reasonable supply and price stability. At today's prices, the 3CX400A7/8874 is about \$100 less than the 8875, and the 3CX800A7 is about \$80 less. Therefore, to re-tube the amplifier, at current prices, there is a net saving of \$150 to \$200. In the future, as demand for the 8875 increases and availability decreases, the savings may be more.

If you have recently purchased your MLA-2500 or MLA-2500B, you will want to check out the power supply portion so that you know the starting point. Prior to turn-on, make a visual inspection for dirt, loose wires, or damaged components. Ideally, you would have done this prior to purchase.

Since many of these amplifiers will be available without tubes or with weak or bad tubes, some additional precautions should be taken. Remove the top and remove any existing tubes. Make certain the plate connections are not near or touching anything. The initial turn-on should be at less than full-line voltage. I prefer to use a variac or a 150-watt lightbulb in series with the primary power line. Half-voltage may easily be achieved by strapping the PA primary power for 220 VAC operation and using 110 VAC primary power. A low voltage/soft start is a good idea in case the MLA-2500 has not been operated for some time. This will allow the electrolytic capacitors to "form" and not destroy themselves. Depress the Plate Voltage Meter switch and depress the Tune/Operate switch to Tune position.

EXTREME CAUTION must now be observed, as there is access to **LETHAL VOLTAGES**. With the amplifier connected to a primary power source, turn the power switch to "on"; nothing should happen. With one hand behind your back, and using only one finger of the other hand, momentarily close the micro switch (interlock) at the top right rear of the PA and observe the plate voltage meter. It should rise to 1000-1500 volts if there are no problems. The fan will also operate. If there is no arcing or other problems, again close the micro switch and hold it in place for a minute or so to assure operation



After the above-described initial turn-on, the amplifier should be operated at full voltage for a longer period of time in order to verify power supply performance. The micro switch should be temporarily closed. I used a plastic bag tie wrap. Carefully make needed measurements now to verify that all the appropriate voltages are available.

If you desire to try operation with tubes received with your amplifier, this is the time to do so.

THE 3CX400A7 CONVERSION

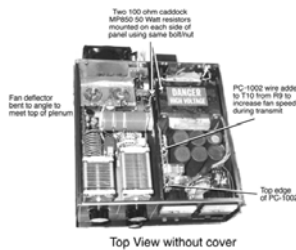
The 3CX400A7/8874 is electrically identical to the 8875. There are two mechanical differences. First, and of most importance to us, the 3CX400A7 cooling air must be applied axially through the radial anode cooling fins, like the famous 4CX250 series. The 8875 cooling air is applied in a transverse manner across horizontal fins. Second, the plate power dissipation of the 3CX400A7 is 400 watts, while the 8875's is 300 watts. The additional 100 watts per tube provides additional margin for cooling. It does not provide additional RF power output.

We need to construct a plenum or other device to change the direction of the air flow from parallel to the chassis to a vertical direction, and through the cooling fins of the 3CX400A7/8874 anode. A similar change in direction of the air flow was necessary to use the 4CX400A conversion. That solution also involved making a plenum.

The holes in the bottom of the chassis must be sealed. I used duct tape, as was used for the 4CX400A conversion. It should be possible to use a very thin fiberglass material; however, I found the duct tape to be satisfactory.

Next, the side panels of the plenum must be fabricated. G-10 is an ideal material, although I used a good grade of Masonite for the 4CX400A conversion, and it has now been operational for two years. [Figure 1](#) shows the approximate dimensions of the side panels. When cutting the two pieces for the side panels, leave an extra 1/8 inch in each dimension, in order to file them to fit. Two "L" brackets were fabricated from soft aluminum strips about 1/2 inch wide. Install these brackets to hold the side panels and to assure that there will be metal to drill holes for mounting to the bottom of the MLA-2500 chassis. By moving the thermostatic switch to approximately the center of the long panel, it will respond equally to both tubes. The hole vacated by the stud holding the switch now provides a convenient mounting hole for one of the "L" brackets to hold the long panel in place. A second long panel "L" bracket and the new horizontal mounting position of the thermostatic switch may be

combined and uses the same screw that holds the solder tiepoint. Since the mounting position on the plenum long side is now very close to the plate RF choke, be certain to use a nylon screw to mount the thermostatic switch (I didn't, and I had to repair the RF choke; see further discussion on the plate RF choke below).



The plenum top is made from thin G-10 material. The approximate size is shown in [Figure 1](#). The dimensions should be custom fitted to the plenum. Your dimensions may be slightly different from mine. Locate the centers of the two tubes and cut two holes in the G-10 material top to fit the anode coolers of both tubes.

With the two tubes in their sockets, adjust the height of the side panels to make certain the tubes' cooling jackets project above the G-10 plenum top by at least 1/8 of an inch. This will force the cooling air through the anode cooler of each tube. Also, check to verify that the tubes can be individually removed from their sockets, with the plenum in place. There should be enough room in the plenum top to allow a limited rocking motion to remove each tube. The pin contacts of the 11-pin socket should be loose enough to allow tube removal. If not, a small pointed object may be used to release the tension of the socket pin contacts, if necessary.

Mount the fan thermostatic switch in the hole on the long side-panel so that it is approximately centered with respect to both tubes. The thermostatic switch wiring, when re-routed, will reach the new mounting position.

Bolt the plenum to the floor of the amplifier chassis, using existing holes, and to screws holding capacitors or other components to the under side of the amplifier. Alternately, new mounting holes may be drilled. Seal all plenum joints with duct tape. A larger seal will be necessary to close the opening between the fan deflector and the G-10 top plate. I used another piece of G-10 material mounted to the screws holding the fan. I bent it out slightly to meet the plenum top plate. The dimensions of this piece are also shown in [Figure 1](#). The openings are now sealed with duct tape to force all of the air from the fan through the tube cooling fins. PLATE RF-CHOKE

My experience with the MLA-2500, when performing the 4CX400A conversion, prompted me to check the resonance of the plate RF choke in the 17-meter band. I have found the Grid Dip Oscillator to be a reliable (but not perfect) instrument for this check. Some interpretation of the data is necessary. A high "Q" resonance (deep dip of grid current) is almost always a sign of trouble. The resonance of the plate RF choke in my MLA-2500B was about 17 MHz. I prefer about a 2 MHz separation between the resonance and the band edge. To move the resonance down in frequency to the 16 MHz point, I made a capacitor by adding three turns of #20 Teflon-insulated wire on top of the RF choke winding at/near the top of the RF choke. These three turns are spread out over about an inch, and the two ends are not to be shorted. The ends of these turns are twisted together to hold them in place. Several attempts at positioning the over-winding were required to make certain that high Q (deep) resonances do not occur in any HF amateur band. Fasten the turns in place with low-loss adhesive. While working on the plate choke, make certain the primary power is completely disconnected.

The minimum amount of air required for the 3CX400A7 at 400 watts anode dissipation is 8.6 CFM. The MLA-2500 (not the "B" version) has two fan speeds, slow and normal. The slow speed is used during standby. The keying line increases the speed to normal during transmit. The temperature sensor, when activated, will also increase the speed to normal. The MLA-2500B normally operates at the slower speed and only the temperature sensor activating will increase the fan speed. Applying K6GT's idea of using a plastic bag of known volume, I roughly measured/estimated the MLA-2500B's fan's capacity. Running at its slow speed, it produces about 4 CFM with the back-pressure caused by the plenum. This is adequate air for 200 watts anode dissipation. Again, using the plastic-bag method, I roughly estimated 8-9 CFM cooling at normal speed. I therefore decided to activate

the fan to the higher speed when transmitting. This is accomplished by paralleling the unused contacts of RLY-2 with the thermostat switch SW-3. A single wire from pin 10T (top) on PC 1002 to the 380-ohm resistor is all that is necessary.

The MLA-2500 manual did not specify a typical grid current rating; the only comment made is that 200 mA should not be exceeded. The Svetlana 3CX400A7 data sheet shows five watts maximum grid dissipation. It does not have a specified maximum grid current limit. The 3CX400A7 has about 80% of cathode area of the 3CX800A7, which is rated at 60 mA grid current (CCS). Thus, 50 mA is a conservative maximum grid current for the 3CX400A7. A higher grid current during brief tune-up and for voice and CW is reasonable; however, 100 mA average for both tubes during operation should not be exceeded. Therefore, for my conversion, I changed the MLA-2500 grid shunt from 0.0462 ohms (F.S.=1A) to 0.462 ohms (F.S.=100 mA). This modification serves several purposes; the two-tube grid current limit is now full scale, causing the operator to exercise more care when tuning, and it eliminates the 10% of full-scale maximum value of the original meter shunt, which was difficult to monitor and, therefore, put the tubes at risk.

Another worthwhile addition is a series resistor in the HV B+ lead to limit current due to an internal arc in the tube. A 20-to-50-ohm 50-watt resistor is adequate for this protection. In the event of an arc, the power supply energy is dissipated in the resistor instead of the tube. This is an important addition to the MLA-2500. I mounted one end of this resistor with one lead on the top electrolytic capacitor, after unsoldering the heavily insulated B+ lead to the RF choke (see [PhotoA](#), bottom view). I made a well-insulated solder tiepoint from a scrap of G-10 material and an aluminum angle bracket. I mounted the other end of the 25-ohm resistor between the tiepoint and the connection to the RF choke.

Most modern power amplifiers use a tuned circuit of some sort between the exciter and the cathodes in a grounded-grid configuration. Several benefits derive from the tuned circuit, in addition to lower RF-drive requirement and improved IMD. One benefit is that it provides a good termination/load for the exciter and provides isolation from the variation of input impedance to the cathodes due to plate tuning and loading. The lack of isolation becomes obvious with exciters having an automatic antenna tuner. With the auto tuner out of the circuit, the VSWR may be high, causing the power fold-back protecting circuit of the exciter to protect and reduce RF output. With the auto tuner in the circuit, it is difficult to optimize the RF output of the amplifier. Adding a tuned circuit for each of the nine amateur bands, while nice, is not practical in the case of the MLA-2500. I made an improvement in input VSWR by adding an RF choke and a bypass capacitor near the tube socket cathodes (see [PhotoA](#)). This reduces the adverse effect of the long cathode connection running to PC 1004, the ALC board. Another improvement is to replace the existing 75-ohm load resistor, which is supposed to be non-inductive (but is not) with a true non-inductive resistor. I used two Caddock 100-ohm, 50-watt resistors, type MP 850, in series to realize 200 ohms, 100-watts. These resistors are mounted on each side of the solid wall near the antenna change-over relay ([PhotoB](#), top view without cover). Use plenty of heat-conducting compound to assure heat removal from these compact devices. The input VSWR performance would be improved by placing the resistors closer to the cathodes, except there is no solid surface there to mount them for conducting the heat away. These two additions do improve the input VSWR and provide sufficient isolation so that the antenna tuner in my ICOM 765 matches the input of the MLA-2500 on all bands.

We are now ready for initial testing.

TESTING

Before applying power carefully, inspect around the plenum. It will be necessary to close the safety micro switch at the right rear of the chassis. Initial turn-on should be without tubes. If all is satisfactory, after full safety precautions are taken, including removing the primary power plug, and after the plate voltage meter reads zero, and shorting the B+ supply to ground, place the 3CX400A7

tubes in their sockets. Use care, because the top and bottom are open and the safety switch is disabled. Set the amplifier multi-meter switch to Plate Voltage and the Tune/CW switch to Tune. Reapply primary power. B+ should be about 1700 on the MLA-2500B. B+ should read about 2200V DC on the MLA-2500.

After an initial warmup period of five-ten minutes (I prefer a longer-than-normal initial warm-up period for an out-of-the-box new tube), close the keying line without RF drive. The grid current should read zero, and the zero signal plate current should be about 10 mA. The MLA-2500 fan should increase in speed. This is now true for both models, provided the MLA-2500B was modified as above.

Connect a watt-meter and a dummy load to the RF output connector. Set the band switch to 10 meters. With the keying line closed, rotate the plate-tuning control completely (360 degrees), first with the load control at minimum, and then at maximum capacity. Ensure there are no settings of the tune-and-load controls where there is change in plate or grid current. Perform the same test for each of the band-switch positions.

With the amplifier band switch again set to 10 meters, connect the RF exciter, set for 10 meter CW and 10-watts RF output. Now key-up the combination, and adjust the amplifier plate-tuning and load controls for maximum RF output. Follow the MLA-2500 instruction manual.

With the amplifier and exciter unkeyed, increase the B+ on the "B" version to 2400 VDC by placing the Tune/CW-SSB switch in the CW-SSB position. Depress the multi-meter switch for the grid-current position. Again key the amplifier-exciter combination. Re-check plate tuning. There should be little change.

Increase the RF drive, alternately adjusting the tuning and load control to increase power output and keep the grid current below 100 mA. Watch the plate current occasionally, as a check; however, the most important parameter to observe is the grid current. On the higher HF bands, you may operate the exciter at full 100 watts RF output. On the lower bands, exciter RF output must be reduced to maintain the grid current below 100 mA and the plate current below 1 A. I operate the tune-and-load controls--where the RF power output is at peak, the grid current is no more than 100 mA and plate current is less than 1 A.

The MLA-2500 manual may be used as a guide for tune-up, but follow this article for adjustment of grid current. This parameter must NEVER exceed 100 mA. A tuning chart is very handy.

[Table 1](#) shows the performance of my MLA-2500. Operation from 220 volts AC primary power will undoubtedly yield higher RF output, providing better regulation and stable B+ voltage. A schematic of the modified MLA-2500B appears in Figures 2 and 3.

[Figure 1 - Plenum Fabrication](#)

[Figure 2 - Modified MLA-2500B schematic](#)

[Figure 3 - Modified MLA-2500B schematic, continued](#)

[PhotoA](#) - Bottom View, without cover

[PhotoB](#) - Top view, without cover

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