Dentron MLA-2500/GI7B Tuned Input
By N3OC

Overview

The Dentron MLA-2500 linear amplifier was designed in produced in an era when the exciter that was attached to it contained tube finals. This allowed the exciter to have a much wider matching range, and the lack of a tuned input circuit in the MLA-2500 did not cause a problem.

When a solid state exciter is used, the reflected power is monitored by the rig to ensure safe operation of the PA transistors. Any reflected power seen by the rig, be it from an impedance mismatch with the MLA-2500, or harmonics coming back to the rig from the cathode of the tubes, will cause the rig to see SWR and begin to reduce its power output.

Some rigs are better than others. Mobile rigs, for example, will begin to reduce power much sooner because of their limited cooling ability. Typically those rigs start to reduce power as low as 1.5:1 or 2:1. Other rigs may tolerate up to 3:1 SWR before reducing power significantly.

This article will discuss this problem as it relates to the conversion of these amplifiers to the Russian GI-7B tubes.

The Problem

Just use an auto-tuner, you say. Not so fast! Many auto-tuners tune at five watts output from the rig. The input impedance of a grounded-grid amplifier changes significantly according to output power and plate tuning. So when you tune at five watts, then operate the amplifier with the rig producing 60 or 70 watts, you are no longer tuned. You can't hit a moving target with an auto-tuner. (Some auto-tuners that can tune at full output power may work. Your mileage will vary.)

The lack of a tuned input shows up as a problem in three areas. First is the obvious possibility of an impedance mismatch between the rig and the amplifier. The second, and often overlooked area, are the harmonics generated by the tube (usually the 3rd harmonic is the strongest) and these harmonics will travel back up the coax to the exciter and often be seen as SWR by the exciter's directional coupler.

This can cause a solid state exciter to go crazy, with dramatic and rapid shifting of the output power up and down. It thinks the impedance is good briefly, and it increases power. That causes the impedance to change, and also harmonics to become stronger, which is sees as SWR and decreases the power. The whole cycle then repeats itself rapidly as seen by the power output and SWR meters on the exciter rapidly fluctuating.

Back in the day, with tube finals, the rig was tuned into the amplifier at full power, and that was the end of it. There was nothing changing after the initial tuning, and the harmonics couldn't get through the rig's tank circuit to cause mischief in the rig's PA.

The rig's tank circuit also provided the means to store a little exciter energy as the tube went through its class AB2 impedance swings, where it is normal for the cathode impedance to vary in a grounded-grid amplifier as it is also in the same path that the plate current is flowing. You may have heard of flywheel effect in the tank (output) circuit of the amplifier, but there also is a flywheel effect occurring on the input side too.

So we have to fix all of these issues in order for a modern solid state exciter to be happy. We have to roughly match the impedance, we have to isolate it from the normal harmonics produced by the tube, and we have to provide some energy storage to isolate it from the flywheel effect.

After converting an MLA-2500 to a pair of GI-7B tubes, I measured the following input impedances:

10m	55+j0
15m	55+j0
20m	55+j0
40m	60+j31
75m	20+j30
80m	10+j28
160m	7+j9

We can see from this data that the GI-7B does not like the low bands for some reason. The overall input impedance from a single GI-7B appears to be 110 ohms and 55 ohms for a pair of them in parallel. From 40m and lower, the input impedance drops rapidly.

I am not sure if this is the nature of the tube (unlikely) or if it is the minimal design of the MLA-2500 tank circuit causing this. Inefficiencies and mismatch in the output tank circuit will cause changes in the input impedance. However, when I measure the tank circuit it seems to match well enough on the low bands although little tuning range remains due to the large amount of parallel switched capacitance they use with a small value of air tuning capacitor for the plate and load adjustments.

So I am a little baffled by this data, but I went with it to design the tuned input circuits.

The Solution

After consulting with some experts in the field, I learned that you really need a pi network to provide the tuned input circuit. A simple L network might provide a match, but it won't do a good job of stopping the harmonics from reaching the exciter.

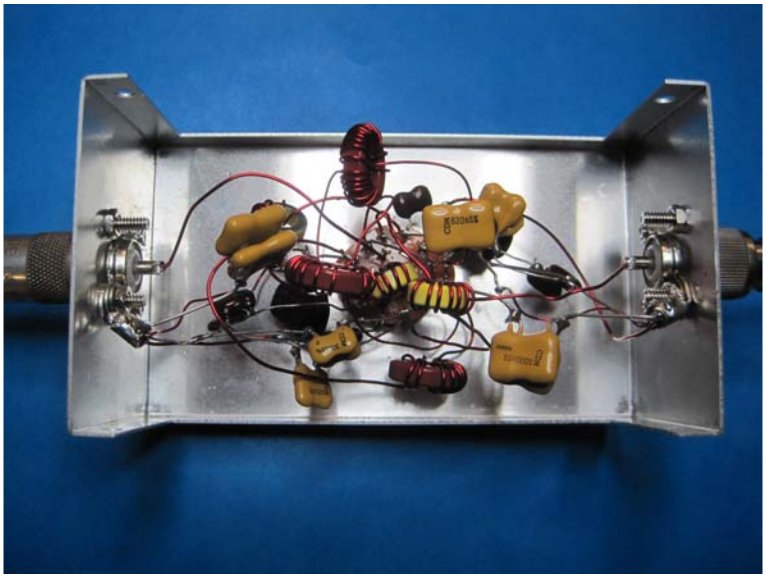
You will also note that in some cases we will be matching 50 ohms to 50 ohms. This may seem strange, but remember we need to provide some energy storage to isolate the exciter from the flywheel effect and also isolate it from the harmonics, so there is more to this than simply matching the impedances.

Dentron briefly made a box called a CM-1 or a CM-2, which was a simple six-band selectable tuned input circuit box. It connected between the rig and the amplifier input. While not ideal as the circuit needs to be connected as close to the cathode as possible (particularly on 10m) it is probably close enough.

So my solution is to make my own CM-1, with components calculated to match the GI-7B input impedances I measured. You can also purchase a tuned input circuit board from WD7S that will allow you to use relay switching to select the tuned input circuit. His board comes without the silver mica caps as he can't know what your individual matching requirements are and also requires a source of +12VDC to operate the relays.

I chose to make my own CM-1 by mounting two six-position selector switches and two SO-239 connectors on an aluminum project box. One switch selects the input side of the filter to be used, and the other switch selects the output side of the filter to be use. The box is connected to the MLA-2500 by as short a piece of coax as practical, and the torroids are "tuned" to that particular length of coax to provide an excellent match.

You will need to obtain a supply of 500v silver mics caps (available from Mouser) and a supply of Amidon T68-2 and T50-6 torroid cores with some #22 and some #20 enameled wire to wind them with.



Here are the values that worked for me. They were calculated using one of the many on-line pi-network calculators, and then fine tuned using the actual exciter:

10 meters
Input – 160pf
Inductor – 4 turns #20 on T50-6 core
Output – 160pf

15 meters
Input – 200pf
Inductor - 7 turns #20 on T50-6 core
Output – 200pf

20 meters
Input – 320pf
Inductor – 8 turns #20 on T50-6 core
Output – 320pf

40 meters
Input – 520pf
Inductor – 12 turns #20 on T68-2 core
Output – 620pf

80 meters (tune at 3.675)
Input – 2000pf

Inductor – 14 turns #22 on T68-2 core
Output – 2000pf

160 meters (1.83)
Input – 4700pf
Inductor – 18 turns #22 on T68-2 core
Output – 4700pf

Tune the coils for minimum exciter SWR as you build the circuit. Connect the tuned input box output to the MLA-2500 input with as short a cable as is practical (6” if possible) and tune the torroids with this cable, and always use the same cable as you tuned the pi networks with.