OUTPUT TANK CIRCUIT ADJUSTMENTS WITH NETWORK ANALYSER

Original text by William Smith, some complements by F1FRV

Borrow or buy a network analyzer like the MINIVNA (or Agilent / HP).

1. Hook it up to the output of the amp. Amp is off and unplugged !!

2. Leave the tube or tubes connected but install a carbon resistor equaling the input impedance of the tube or tubes from the plate connection to the chassis. 1/2 watt carbon resistor (must be carbon so it is non-inductive). This simulates the output impedance of the tube or tubes.

3. Mechanically or electrically (use a small external power supply) activate the T/R relay

4. Set amp's bandswitch to whatever band you want to check.

5. Set the tune and load knobs to about 1/3 positions.

6. Set the frequency fed from the antenna analyzer into the amp to where ever you want it. I begin mid band and go on either side of that.

7. Adjust the antenna analyzer until you see these 3 things happen all at the same time:
a. 1:1 SWR or as low as you can get it.
b. 50 ohms impedance (Rs)
c. Reactance or Xs of zero or as close as you can get it.
d. Move the taps around on the tank coil as required to get the values above.

8. Now adjust the tune and load capacitors around and see how much range you have. If you can tune the amp ok this way and maintain low SWR and 50 ohms resistance don't change the tank coil tap. If not move it around until you get the correct match. Markers placed at -3dB return loss will let you know the "Q" of the circuit

9. Do this with all the bands. The most important: Check also in amplifier full range (1.5 – 30 MHz) for parasitic resonances of the DC plate choke. If any near amateur bands (less than 2 MHz), modify your plate choke design to avoid STRONG, SMOKY AND NOISY DESTRUCTION…
A well designed DC plate choke should not have ANY resonance between 1 and 32 MHz.
Plate chokes can be made with ferrit rod inside the coil.

When done put the T/R relay back in it's normal state and remove the resistor!!
This works well and saves you a lot of hard work.

10, 12 and 15 meters can take a lot of experimenting to find the best match.

TUNED INPUT ADJUSTMENTS FOR GROUNDED GRID TUBES

Leave tubes plugged in sockets and connected.

1. **No power at amplifier (Amp is unplugged !!)**

2. **Solder a carbon ½ watt resistor who's value equals the cathode impedance of the tube from the tube's cathodes to the chassis. This will simulate the input impedance of the tube or tubes. As an example a single 3-400Z tube equals 120 ohms of cathode impedance. My amp uses two in parallel so I used a 60 ohm carbon resistor.**

3. **Connect the network analyser to the input of the amplifier, RF IN.**

4. **Use the same coax jumper you will use when the radio is reconnected to the amplifier. It's length will be critical if you are not able to obtain a good match.**

5. **Mechanically or electrically (use a small external power supply) activate the T/R relay.**

6. **Adjust the analyser frequency to what ever frequency you are using. I used 7.225 for 40 meters because that is about the midway point where I operate.**

7. **Now adjust the tuned input inductor or capacitors. I recommend leaving Cin (radio side) alone and adjust the inductor and Cout (tube side).**

8. **Go for a SWR of 1:1 or as close as you can get it, Rs of 50 ohms and a Xs or zero or as close as you can get it.**

9. **Remove the carbon resistor from the tube's cathode.****

10. **When done with all bands you can expect to have to do some minor tuning of the tuned input after RF is applied.**

11. **Be patient it can take some time!!**

TUBE	Ep (V)	Ip (mA)	Cathode ohms for <u>one tube</u>
811A	1250	175	320
	1700	160	320
572B/T160L	2400	250	215
813	2000	200	270
	2500	200	270
3-400Z/8163	2000	400	120
	2500	400	120
	3000	333	120

3-500Z	**2000**	**400**	**115**
	2500	**400**	**115**
	3000	**370**	**115**
3-1000Z	**2500**	**800**	**65**
	3000	**670**	**65**
	3500	**750**	**65**
4-125A	**2000**	**105**	**340**
	2500	**110**	**340**
	3000	**115**	**340**
4-400A	**2000**	**265**	**160**
	2500	**270**	**150**
	3000	**330**	**140**
4-1000A	**3000**	**700**	**104**
	4000	**675**	**106**
	5000	**540**	**110**

INDIRECTLY HEATED CATHODES

3CX1000A7 is ~42 Ohms

3CX1500A7 is ~50 Ohms

GS-35B is ~72 Ohms

GI-7B is ~100 Ohms

6LQ6 is ~104 Ohms

EL-509/6KG6 is ~56 ohms

TUNE INPUT COMPONENT VALUES FOR THE EL-509/6KG6 TUBES (FOUR TUBES IN PARALLEL) Capacitors are 500 volt Silver Mica types

Band	SWR	CAP IN	Core uh	CAP/OUT	# of Turns	Toroid Core
3.75	**1:1.2**	**1200pf**	**1.5uh**	**1100pf**	**18**	**T-50-2**
7.5	**1:1.1**	**590pf**	**.8uh**	**560pf**	**13**	**T-50-2**
14.3	**1:1.2**	**300pf**	**.4uh**	**280pf**	**10**	**T-50-6**
21.15	**1:1.3**	**200pf**	**.27uh**	**180pf**	**8.5**	**T-50-6**
28.3	**1:1.15**	**100pf**	**.2uh**	**81pf**	**7**	**T-50-6**

#18 AWG enameled wire was used for winding the inductors.

NOTES:

Calculating Tank Q, Tune C (C1), and Optimal Anode Load Resistance (R_L)

Tank Q, the reactance of C1, and the optimal anode load resistance for linear operation (R_L) are inter-related. Tank Q is defined as the capacitive reactance of C1 (X_{C1}) at the frequency of operation, divided into R_L ---i.e., $Q = R_L/X_{C1}$.....and $X_{C1} = R_L/Q$. Note: C1 includes the anode (output) capacitance (Ca) of the amplifier tube. At 29MHz, Ca may be a sizeable fraction of C1.

$R_L = E_{supply}/2*I_{An}$ where I_{An} is the average anode current in amperes.

(Note: There is some variation in the constant in the denominator of the R_L formula. For tubes with minimal anode-cathode potential at peak anode-current, like the 8877, a constant of 1.6 should give more accurate results. However, for tetrodes, which use a high screen potential (reduces anode AC peak-V), a constant of 2 seems to be more accurate.

Thus, for a tube operating from 2500v @ 1A, whose anode capacitance (Ca) is 10pF:

R_L = 2500v/2*1A = 1250 ohms.

Calculating C1

For a Q of 12.5, X_{C1}=1250 ohms/12.5 = 100 ohms.

The needed tune capacitance, $C1 = 1/(2*Pi*f*X_{C1})$. For 14MHz, $C1 = 1/(6.28*14*10^6 Hz*100$ ohms) = 113.7pF. However, since part of C1 is comprised of Ca, the net tune C is 113.7pF - 10pF = 103.7pF. At 28MHz, the tune C would be roughly: 57pF -10pF = 47pF.

You can also use the EXCEL calculation sheet available at:

http://f1frv.free.fr/main3d_pi.html