T.A.P. Version 2.0 (C) 1989-1996
(Triode Amplifier Program)

FREEWARE

Courtesy of KD9JQ

T.A.P. Version 2.0 (Triode Amplifier Program) provides the Amateur with a new
Tool in Designing Triode Power Tube Amplifiers for Grounded Grid Service.
This Program should be considered as a designers aid only and does not represent
all facets of High Power Amplifier design. It is left to the user to verify
correct Filament Voltages and Currents for the frequency of operation, to verify
the correct plate voltage and dissipations per operating class, and as well as
the proper cooling and mounting methods recommended by the tube vendor. The user
does not need to have to Plate/Grid-Voltage/Current Plots to use this program
unless a new device data file is required.

The following information will guide the designer with Menus and Prompts.

Start:

1. Press <CR> to pull up the Library files of typical triodes.

2. Type in the file name (.TUB extension assumed) and press <CR>

3. A menu will pop up indicating 4 possible design selections or Exit.

   F1 will find IBdc, RL Given PO, VDC, VBmin

   F2 will find IBdc, PO Given RL, VBmin, VDC

   F3 will find VBmax, PO Given IBdc, RL, VBmin, VDC

   F4 will find VBmin, PO Given RL, IBdc, VDC

   F9 Exit "Ends Program"

4. A series of prompts will appear requesting input from the designer.
   Enter the requested information at this time. The program utilizes
   Data from the Tube Library File to simulate the Tube Characteristics
   at VBmin (Plate Voltage at full IB).

   VDC = DC Plate Voltage @ no load.

   Guideline;
   Plate voltage should not exceed
   VDC (Maximum rated) - (.5 * Vp-p Drive)

   VBmax = Maximum Instantaneous Plate Voltage at IB @ cutoff.
   Should not exceed VDC.

VMmin = Minimum Instantaneous Plate Voltage at Peak Plate Current

** Hint ** Use 10% +/- 5% of VB to start.
Lower VMmin => higher Grid current, higher drive
Higher VMmin => lower Grid current, lower drive

Guideline;
VKmax < .75 * VBmin where VKmax = Peak Grid Voltage

VP = VBmax - VBmin (1/2 Plate Swing)

IBdc = DC Plate Current at Full Power

PO = Output Power Desired (Po to Load will reflect FeedThru Drive)

RL = Plate Load in Ohms (Final Load reflects FeedThru Drive)

FO = Operating Frequency (Mhz)

N = Number of Tubes used in Parallel (Not for Push Pull)

CLASS = C (165 Deg Conduction)
B (180 Deg Conduction)
AB1 (185 Deg Conduction
AB2 (~191 Deg Conduction)
USER (Conduction Angle or Bias)

USER Option:

You will be prompted for [A] Angle or [B] Bias.

The Angle allows the user to select a particular conduction angle from 140 to 220 Degrees. The corresponding Bias voltage will be calculated.

The Bias option allows you to enter a particular fixed voltage. The corresponding Conduction Angle will be calculated. This option is useful when using zero bias triodes. A bias of "0" volts must be entered as a small number such as .0001.

5. A list of the calculated Design parameters will now be displayed.
Any exceeded values will flash red.

6. To obtain Input/Output Matching circuit data press either the up or down arrow keys.

7. A display of matching circuits for input and outputs is now shown.
Input T or PI Matching circuit component values can be

obtained by
Toggling the TAB key.

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VG = Peak Cath Voltage Swing
IB = Peak Plate Current   IB(DC) = IB/Kb
IG = Peak Grid Current   IG(DC) = IB/Kg
CA = Conduction Angle (Radians)
VK = Cathode Bias Voltage   VK =(Cos(CA/2)*(VG+VBmin/U))+VDC/U)
Kb = PI^2/CA (Radians)   Kg is a function of VK/(VG+VK)
Expected efficiency ~= (1 - (1/Kb)) * 100 %
PDCinput = VDC * IBdc Po = VP^2/(2*RL)
PDISS = PDC - Po
N (efficiency) = Po/PDC * 100 %
Po to Load = Po + Pfdthru where Pfdthru = (VG+VK)^2/(2*RB)
PGDISS = (VG+VK)^2/(2*RG) Grid Dissipation
RB = 2*(VG+VK)/IB   RG = 2*(VG+VK)/IG
RK = 2*(VG+VK)/(IB+IG) Parallel Real component of Input Impedance
XP = -1 / (WO * CP)
CP = Cath-Grid Capacitance.
where WO = 2 * Pi * Fo

Converting to Series
RS = RP/((RK/XP)^2 + 1) XS = -RP*RS/XP
Zin = SQR(RS^2+XS^2) Magnitude of Zin
Phase Angle = 2*ATN(XS/(RS+Zin))

PIN = (VG+VK)^2/(2*Zin)

The Output is designed for a PI design with an additional C/L circuit for intermediate impedance step up Transformation. If only the PI circuit is desired, the user can input a new transformation Impedance equal to the Load (50 ohms). The Plate Tuning Capacitance has the RFC Plate Choke and Tube Capacitance reactance removed.

Items 1 thru 8 can be changed by the user at this time. Select the Item number to change and enter the new value. Enter a Negative number when entering Inductance, and a Positive number for Capacitance. Only used for RFC's. <CR> to update screen to new values.

Toggling the UP or Down Arrow Keys will alternately pop up the Data Display or Matching Circuits.

8. The center Menu allows for "Dynamic" design of the matching circuits. To use this option, you must have initially designed the amplifier at the low end of the Band of interest and at the highest expected output power with the F1 selection. Print out Data at this time.

Press "D" and the program will prompt you for new power output level (Lowest) and Upper Frequency end of the Band. The screen will now display Matching circuit values required while maintaining constant inductor values. Loaded Q and capacitance values are recalculated. Print out the new Data at this time.

MENU will return you to the main menu.
FILE will return you to the .Tub Library.
PRINT will output the Data to your Printer.
QUIT will exit program.

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Note: The designer should account for drive and bias current equalization of parallel devices. If there is adequate grid and plate dissipation then the problem may not pose a problem at HF.

Circuit component losses are not figured in to the Gain. Use of High Q components for low losses are required in high power amplifiers.

Example:
A QL of 12 to QU of 400 => (1-(QL/QU))*100% efficiency or .22dB Loss in the Tank Circuit. Subtract all Input & Output LC losses from calculated Gain.

REFERENCES

RADIO HANDBOOK 22ND ED By William I. Orr Section 7

RCA TRANSMITTING TUBE TECHNICAL MANUAL TT-5 10-62 Pages 46 - 62

CARE & FEEDING OF POWER GRID TUBES VARIAN 4TH PRINTING 1982