

Take a 300B single ended amplifier output stage.

Simple, right?

No, it is not that simple.

Here is a simple example of why it is not very simple:

#### Quiescent

A classical quiescent operating condition for a 300B is:

300V plate to filament; -61V grid to filament; 60mA plate current;

Gm 5500 microMhos;  $\mu = 3.85$ ; and 700 Ohms plate resistance,  $r_p$ .

#### Real output stage

Put some parts around the 300B, and we have an output stage.

Use RC coupling from the driver to the grid, R from grid to ground.

Let the 5V filament supply 'float' at the + 61V self bias voltage.

Self Bias resistor of  $61V / 0.06A = 1017$  Ohms.

Plate load,  $R_L$ , output transformer primary 3000 Ohms.

#### Bypass capacitor

$1/G_m = 182$  Ohms filament impedance to ground (filament

impedance to ground = "cathode" impedance to ground).

Plus  $3000 \text{ Ohms} / (1 + \mu) =$  increased filament impedance due to  $R_L$ .

$3000 / (1 + 3.85) = 619$  Ohms

$182 + 619 = 801$  Ohms, the impedance from the filament to ground.

801 Ohms is in parallel with 1017 Ohms = 448 Ohms.

A bypass capacitor has to bypass 448 Ohms at the lowest frequency we choose for it to be effective.

For -1 dB @ 20Hz, we need  $X_c = 44.8$  Ohms.

$X_c = 1/(2 \times \pi \times 20\text{Hz} \times C)$ ;  $C = 178\mu\text{F}$

#### Working results

The 300B stage gain is  $\mu \times (3000 / ((3000 + 700))) = 3.12$

The damping factor is  $R_L / r_p$ ;  $3000 / 700 = 4.29$  (a little less than that because of the output transformer insertion loss)

What happens if we want to "improve" that output stage?

Modifying to get rid of the bypass capacitor (some hate capacitors, so let's eliminate a capacitor).

Self bias has certain advantages; can we keep them without a bypass capacitor?

(fixed bias to the grid has other advantages and disadvantages).

Without the 178uF cap across the 1017 Ohm self bias resistor, The operating plate impedance,  $r_p$  is increased by the factor of: Self bias resistance x  $\mu$ .  $1017 \times 3.85 = 3915$  Ohms, additional plate impedance.  $700 + 3915$  Ohms = new plate impedance, 4615 Ohms. High plate impedance, not good.

Now, Gain is  $3.85 \times ((3000 / (3000 + 700 + 3915 \text{ Ohms})) = 3.85 \times (3000 / 7615) = 1.517$   
Very low gain, not good.

And because output power is dependent on Gain x 61V bias, the output power will be severely reduced.

And, damping factor is  $3000 / (700 + 3915) = 3000 / 4615 = 0.65$   
That is less than Unity ( $< 1.0$ )

It appears we need to change something, if we are not willing to use a bypass capacitor.

Eliminate the bypass capacitor, but fix the voltage from the 'floating filament' to ground to be 61V.

Use a series string of LEDs, rectifier diodes, Zeners, or series combinations of them to get 61V @ 60mA.

What are 3 disadvantages of doing that?

\* Suppose the B+ is not regulated, then when the power mains voltage changes, there is no self bias auto-adjustment to correct to 60mA.

\*\* Using 61V bias to the floating filament, unless the 300B tubes are matched, the left channel and the right channel will not both be at 60mA current.

Changing to a regulated B+ can fix \* above; but we have to increase the complexity of the amplifier, add parts, \$\$\$, bigger chassis, etc.

We still should use matched 300B if we want them at the same plate current. \*\*

\*\*\* LEDs, rectifier diodes, and Zeners have a non-linear impedance, they change voltage versus the changing current draw of the single ended amplifier output stage that varies from quiescent current to about 2 times quiescent current, and from quiescent current to very low current in the other direction of signal.  
This reduces the linearity of the output stage.

Are you still afraid to use a bypass capacitor and self bias resistor?  
Tradeoff one disadvantage, real or perceived; for another disadvantage, real or perceived.

That is enough discussion of the simple 300B output stage for now.