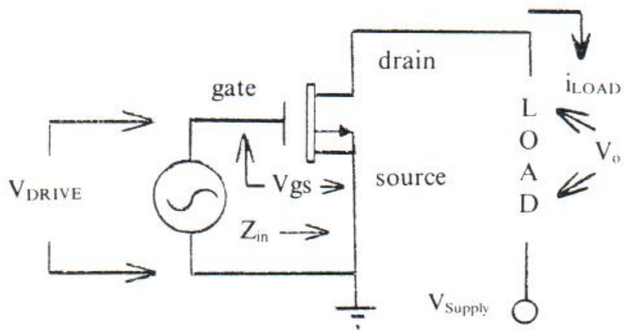
VSP Labs Trans Mos

MOSFET POWER AMP WITH TRANSCONDUCTANCE OUTPUT STAGE

What is a Transconductance Output Stage? It is an output topology whereby the output current is a direct function of the input voltage. It is the circuit topology used in the finest tube power amplifiers. To fully understand the differences between the VSP Trans Mos and the more conventional transistorized power amplifier a brief explanation follows. Fig. 1 shows a simplified diagram of one side of the complementary output stage. Fig. 2 shows the equivalent of a conventional transistorized power amplifier. Fig. 3 is for vacuum tube amplifiers.

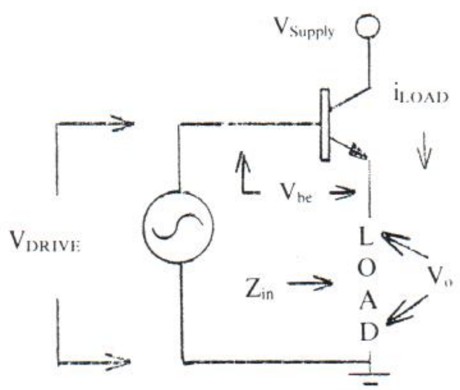


$V_o = i_{LOAD} \times Z_{LOAD}$

$i_{LOAD} = Gm \times Vgs$

$Z_{in} = \frac{V_{DRIVE}}{i_{gate}} = \frac{Vgs}{i_{gate}}$ — approaches an open circuit for low frequencies. Capacitive at high frequencies

Fig. 1 Transconductance Output - Mosfet



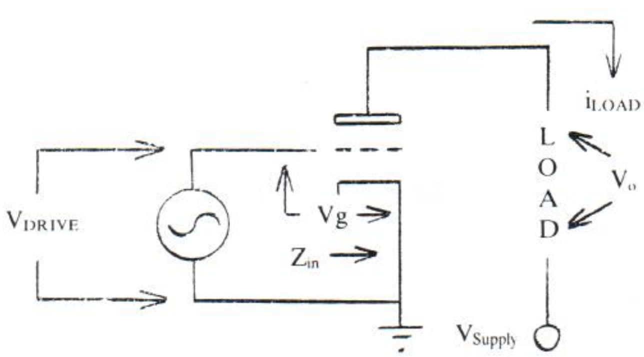
$V_o = i_{LOAD} \times Z_{LOAD} = V_{DRIVE} - V_{BE}$

$i_{LOAD} = \frac{V_{DRIVE} - V_{BE}}{Z_{LOAD}}$

$V_{DRIVE} = V_o + V_{BE}$

$Z_{in} = \frac{V_{DRIVE}}{I_{BASE}} = \frac{V_o + V_{BE}}{I_{BASE}}$

Fig. 2 Emitter Follower Output



$V_o = i_{LOAD} \times Z_{LOAD}$

$i_{LOAD} = Gm \times Vg$

$Z_{in} = \frac{V_{DRIVE}}{i_{grid}} = \frac{Vgs}{i_{grid}}$ — approaches an open circuit for low frequencies. Capacitive at high frequencies

Fig. 3 Transconductance Output - Tube type where:

Gm = Transconductance = Output Current (i Load)
Input Drive (volts)

Z_{in} = Input Impedance

V_{be} = Bipolar Base to Emitter Voltage

Ib = Base current

Vgs = Mosfet gate to source voltage

Vgrid = Tube grid to cathode voltage

From the circuit topologies of Figs. 1, 2, and 3 and its respective equation for output current, several conclusions can be arrived at:

a. The Trans Mos and vacuum tube amplifier (Figs. 1 and 3 respectively) have identical characteristics.

b. The output current for Figs. 1 and 3 are isolated from the input drive voltage.

c. In Fig. 2, the drive voltage is somewhat modulated by the instantaneous output voltage.

d. Under current limit conditions in the output stage, the input impedance of Fig. 2 goes through a severe change due to the term V_o in the Z_{in} equation. If V_o does not change due to current limit in the output stage this results in very low Z_{in} as compared when stage is not current limited. (Note: However small, this phenomenon is present even if stage is not current limiting due to changes in beta of transistor as function of collector current.)

Advantages/Disadvantages of Transconductance Mode: If the transconductance mode provides a better isolation of output from input, why wasn't it used before? As a matter of fact, almost all vacuum tube power amplifiers used this mode of operation for two reasons.

a. Voltage amplification existed between output voltage (i Load & Z load) and input voltage (V drive).

b. Simplicity of input drive.

Both reasons are also true for Mosfet versions. The main disadvantage is a degradation of the frequency response due to Miller Effect resulting in difficulty in maintaining stability in wideband feedback amplifiers. For a given output bipolar transistor, operation in a transconductance mode vs. emitter follower mode usually results in a reduction of bandwidth by about an order of magnitude. With the advent of Mosfets, this is no longer a problem since the bandwidth of a similarly rated Mosfet is about an order of magnitude better as compared to bipolars.

Conclusion: The availability of the power Mosfet with its excellent linearity and frequency response has enabled VSP Labs to bring to the audiophile an amplifier with an output topology identical to the best of vacuum tube amplifiers. To fully appreciate its advantages, we recommend you audition the Trans Mos and note its smoothness and ease in handling very quiet passages as well as powerful transients even during momentary overloads due to program peaks as indicated by front panel clip lights.

VSP labs
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