Thevenin Model of First Stage:
$R_o \approx 38k$ output resistance of stage

Next stage’s
Input Impedance
Effectively Infinite
\[ Z_1 = R_o + \frac{1}{sC_1} = \frac{sR_o C_1 + 1}{sC_1} \]

\[ Z_2 = \frac{\alpha R / sC_2}{\alpha R + 1/sC_2} \]

\[ Z_T = Z_1 + Z_2 = \frac{sR_o C_1 + 1}{sC_1} + \frac{\alpha R}{1 + \alpha RC_2 s} = \frac{(sR_o C_1 + 1)(1 + \alpha RC_2 s)}{sC_1(1 + \alpha RC_2 s)} + \frac{\alpha RC_1 s}{sC_1(1 + \alpha RC_2 s)} \]

\[ H(s) = \frac{(1-\alpha)R}{(1-\alpha)R + Z_T} = \frac{(1-\alpha)R}{(1-\alpha)R + \frac{(1+sR_o C_1)(1 + \alpha RC_2 s) + \alpha RC_1 s}{sC_1(1 + \alpha RC_2 s)}} \]

\[ = \frac{(1-\alpha)RsC_1(1 + \alpha RC_2 s)}{(1-\alpha)RsC_1(1 + \alpha RC_2 s) + (1+sR_o C_1)(1 + \alpha RC_2 s) + \alpha RC_1 s} \]
function bypassed_volume_pot(Ro,C1,C2,Rpot,beta)
    % bypassed_volume_pot
    % Computes and plots frequency response for a bypassed
    % volume pot in a tube
    amp.
    % Assumptions:
    % (i) previous stage modeled as output resistance Ro
    % (ii) next stage is modeled as infinite resistance
    %
    % Inputs:
    %   Ro = output resistance of previous stage (in ohms)
    %   C1 = coupling cap from previous stage (in uF)
    %   C2 = bypass cap (in pF)
    %   Rpot = volume pot resistance (in ohms)
    %   beta = "percent up" on volume pot (beta = 1 is full up)
    %
    % Output:  Plot of frequency response
    C1 = C1*1e-6;
    C2 = C2*1e-12;
    f=logspace(1,5,10000);
    w=2*pi*f;
    s=j*w;
    alpha = 1 - beta;

    %%%% Z1 = series combo of Ro and C1 impedance
    Z1 = Ro + 1./(s*C1);

    %%%% Z2w = parallel combo of alpha*Rpot and C2 impedance
    %%%% ("w" means "with" the bypass)
    Z2w = ( (alpha*Rpot)./(s*C2) )./( alpha*Rpot + 1./(s*C2));

    %% Now find freq response via voltage divider:
    Hw = (1-alpha)*Rpot./( Z_Tw + (1-alpha)*Rpot );
    Hwo = (1-alpha)*Rpot./( Z_Two + (1-alpha)*Rpot );
    semilogx(f,20*log10(abs(Hw)),'b',f,20*log10(abs(Hwo)),'r--')
end
$\alpha = 0.999$
Bypass Cap = 120 pF
Coupling Cap = 0.01 $\mu$ F
1st Stage $R_0 = 39k \, \Omega$

Almost Full Volume

1000 ohms above pot wiper

$\alpha = 0.5$
Bypass Cap = 120 pF
Coupling Cap = 0.01 $\mu$ F
1st Stage $R_0 = 39k \, \Omega$

“Half” Volume
Full Volume Without Bypass

Full Volume With Bypass (120 pF)
Low Volume Without Bypass

Low Volume With Bypass
(120 pF)
Full Volume Without Bypass

Full Volume With Bypass (1000 pF)
Low Volume
Without Bypass

Low Volume
With Bypass
(1000 pF)