

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
 CAMBRIDGE, MASSACHUSETTS 02139

Low Frequency Hybrid- π Equation Chart

TRANSISTORS

Characteristic	Common Emitter	CE with R_E	CC [E. Follower]	Common Base
Voltage Gain [if $r_o \gg R_L$]	$A_v = -g_m R_L$	$A_v \approx -\frac{R_L}{R_E}$	$A_v \approx 1$	$A_v = \frac{\beta_o R_L}{r_\pi // R_E + (\beta_o + 1)R_s}$
Current Gain	β_o	β_o	$\beta_o + 1$	$\frac{\beta_o}{\beta_o + 1}$
Input Impedance	$r_\pi // R_B$	$[r_\pi + (\beta_o + 1)R_E] // R_B$	$[r_\pi + (\beta_o + 1)R_E] // R_B$	$\frac{r_\pi}{\beta_o + 1}$
Output Impedance	R_L [if $r_o \gg R_L$]	R_L [if $r_o \gg R_L$]	$\left[\frac{(r_\pi + R_s // R_B)}{\beta_o + 1} \right] // R_E$	R_L [if $r_o \gg R_L$]
Phase Reversal?	Yes	Yes	No	No

JFET'S

Characteristic	Common Source	C Source with R_s	Common Drain [Source Follower]	Common Gate
Voltage Gain [if $r_{ds} \gg R_L$]	$A_v = -g_m R_L$	$A_v = \frac{-g_m R_L}{1 + g_m R_s}$	$A_v = \frac{g_m R_s}{1 + g_m R_s}$	$A_v = \frac{g_m R_L}{1 + g_m R_i + \frac{R_i}{R_s}}$ $R_i = \text{generator resistance}$
Current Gain	$\frac{I_D}{I_S}$ Very large!	$\frac{I_D}{I_S}$ Very large!	$\frac{I_D}{I_S}$ Very large!	$A_i = \frac{g_m R_s}{g_m R_s + 1}$
Input Impedance	R_G	R_G	R_G	$\frac{R_s}{g_m R_s + 1} = \frac{1}{g_m} // R_s$
Output Impedance	R_L [if $r_{ds} \gg R_L$]	R_L [if $r_{ds} \gg R_L$]	$\frac{R_s}{g_m R_s + 1} = \frac{1}{g_m} // R_s$	R_L [if $r_{ds} \gg R_L$]
Phase Reversal?	Yes	Yes	No	No