Common Source Amplifier With Fixed Bias

Figure 3.2.1 shows Common Source Amplifier With Fixed Bias. The coupling capacitor C1 and C2 which are used to isolate the d.c biasing from the applied ac signal act as short circuits for ac analysis.

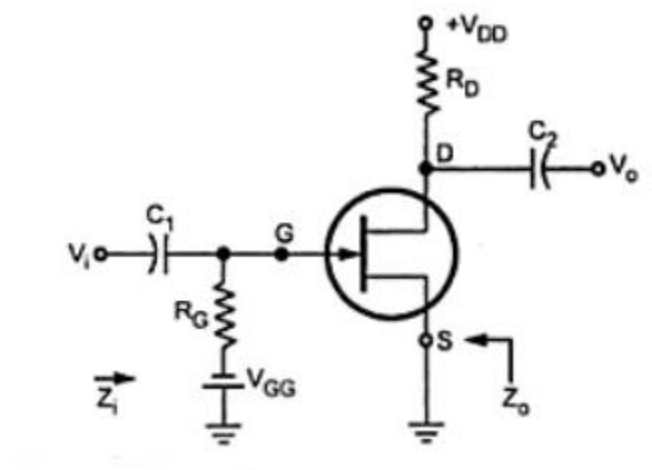

Figure 3.2.1 Common Source Amplifier With Fixed Bias

Diagram Source Electronic Tutorials

The following figure 3.2.2 shows the low frequency equivalent model for Common Source Amplifier With Fixed Bias. It is drawn by replacing all capacitors and d.c supply voltages with short circuit JFET with its low frequency a.c Equivalent circuit

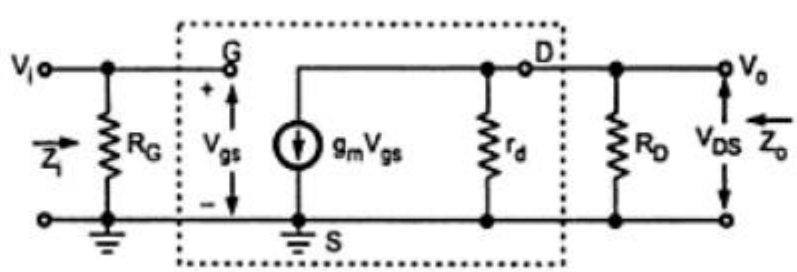

Figure 3.2.2 Common Source Amplifier With Fixed Bias

Diagram Source Brain Kart

low frequency equivalent model for Common Source Amplifier With Fixed Bias

Input Impedance Zi

$$Z_i = R_G$$

Output Impedance Zo

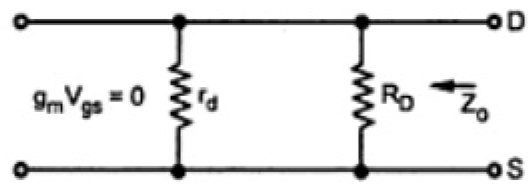

Figure 3.2.2

Figure 3.2.3 Equivalent Circuit model of JFET for output

Diagram Source Brain Kart

It is the impedance measured looking in figure 3.2.3 from the output side with input voltage Vi equal to Zero. As Vi=0,Vgs =0 and hence g_mVgs =0 . And it allows current source to be replaced by an open circuit. So,

$$Z_o = R_D \,||\, r_d$$

If the resistance rd is sufficiently large compared to R_D, then

$$Z_o \approx R_D \qquad \because r_d >> R_D$$

Voltage Gain A_v :

The voltage gain $A_v = \frac{V_{ds}}{V_{gs}} = \frac{V_o}{V_i}$

Looking at Fig. we can write

$$V_o = -g_m V_{gs} (r_d || R_D)$$

As we know $V_i = V_{gs}$ we can write

$$V_o = -g_m V_i (r_d || R_D)$$

$$\therefore \quad A_v = \frac{V_o}{V_i} = -g_m (r_d || R_D)$$

and if $r_d >> R_D$,

$$A_v \approx -g_m R_D$$

Table summarizes performance of common source amplifier with fixed bias.

Parameter	Exact	With $r_d >> R_D$
Z_i	R_G	R_G
Z_o	$R_D \| r_d$	R_D
A_v	$-g_m (R_D \| r_d)$	$-g_m R_D$

Common source amplifier with self bias (Bypassed Rs)

Figure 3.2.4 shows Common Source Amplifier With self Bias. The coupling capacitor C1 and C2 which are used to isolate the d.c biasing from the applied ac signal act as short circuits for ac analysis. Bypass capacitor Cs also acts as a short circuits for low frequency analysis.

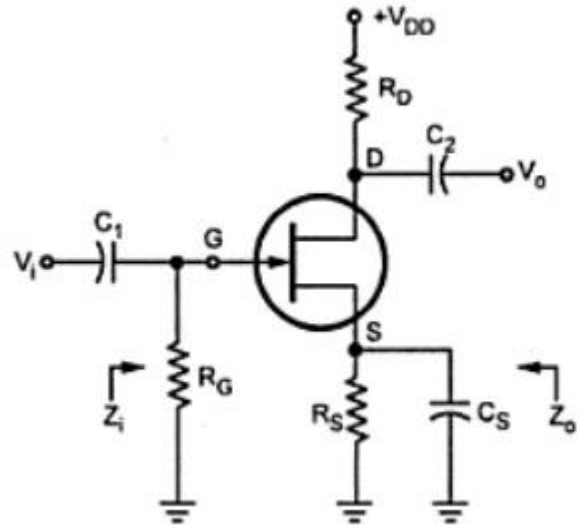

Figure 3.2.4 Common Source Amplifier With self Bias

Diagram Source Brain Kart

The following figure 3.2.5 shows the low frequency equivalent model for Common Source Amplifier With self Bias.

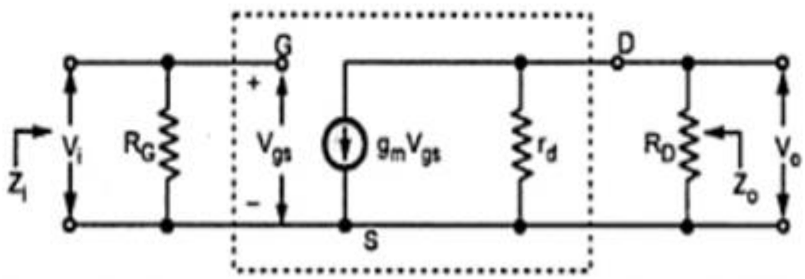

Figure 3.2.5 Common Source Amplifier With self Bias

Diagram Source Brain Kart

i) Input impedance Z_i :	$Z_i = R_G$
ii) Output impedance Z_o :	$Z_o = r_d \| \| R_D$
if $r_d >> R_D$	$Z_o \approx R_D$
iii) Voltage gain A_v :	$A_v = -g_m (r_d \| \| R_D)$
If $r_d >> R_D$	$A_v = -g_m R_D$

FigureThe low frequency equivalent model for Common Source Amplifier With self Bias.The negative sign in the voltage gain indicates there is a 180o phase shift between input and output voltages.

Common source amplifier with self bias (unbypassed R_s)

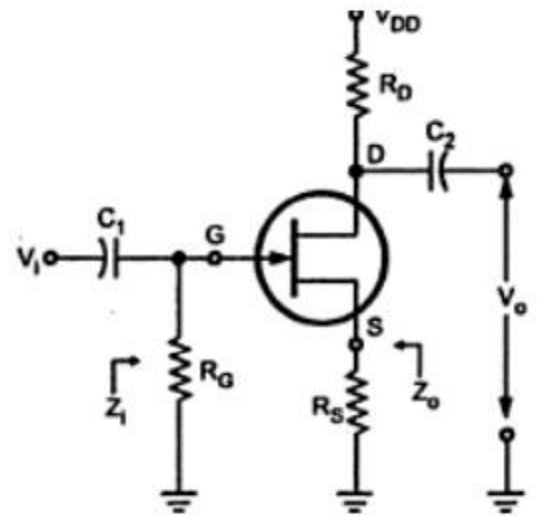

Fig3.7 **Common source amplifier** model of JFET

Figure 3.2.6 Common Source Amplifier model of JFET

Diagram Source Brain Kart

Now R**s** will be the part of low frequency equivalent model as shown in figure 3.2.6

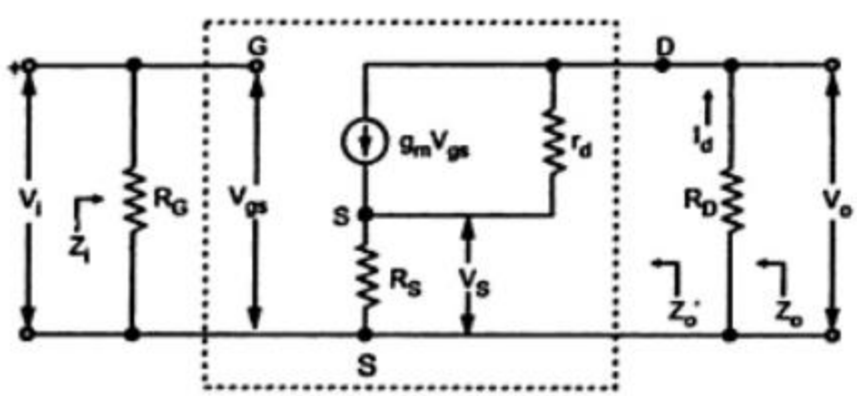

Figure 3.2.7 Small signal model for Common source amplifier model of JFET

Diagram Source Brain Kart

Figure 3.2.7 **Input Impedance Z_i**

$$Z_i = R_G$$

Output Impedance Z_o

It is given by

$$Z_o = Z_o' \| R_D$$

where $$Z_o' = \left.\frac{V_o}{I_d}\right|_{V_i=0}$$

$$Z_o = [\, r_d + R_s(\mu + 1) \,] \| R_D$$

$$Z_o = [\, r_d + R_s(g_m r_d + 1) \,] \| R_D$$

Voltage gain (A_v)

It is given by

$$A_v = \frac{V_o}{V_i}$$

We know that,

$$V_o = -I_d R_D$$

$$A_v = \frac{V_o}{V_i} = \frac{-g_m r_d R_D}{r_d + R_s + R_D + g_m R_s r_d}$$

Dividing numerator and denominator by r_d we get,

$$\therefore \quad A_v = \frac{V_o}{V_i} = \frac{-g_m R_D}{1 + g_m R_s + \frac{R_s + R_D}{r_d}}$$

If $r_d >> R_s + R_D$

$$A_v = \frac{V_o}{V_i} = \frac{-g_m R_D}{1 + g_m R_s}$$

Table summarizes performance of common source amplifier with self bias.

Parameter	Bypassed R_S		Unbypassed R_S	
	Exact	$r_d >> R_D$	Exact	$r_d >> R_D$
Z_i	R_G	R_G	R_G	R_G
Z_o	$R_D \parallel r_d$	R_D	$[r_d + R_S(g_m r_d + 1)] \parallel R_D$ or $[r_d + R_S(\mu + 1)] \parallel R_D$	$[r_d + R_S(g_m r_d + 1)] \parallel R_D$ or $[r_d + R_S(\mu + 1)] \parallel R_D$
A_v	$-g_m(R_D \parallel r_d)$	$-g_m R_D$	$\dfrac{-g_m R_D}{1 + g_m R_S + \dfrac{R_S + R_D}{r_d}}$	$\dfrac{-g_m R_D}{1 + g_m R_S}$

Common source amplifier with Voltage divider bias (Bypassed R_S)

Figure 3.2.8 shows Common Source Amplifier With voltage divider Bias. The coupling capacitor C_1 and C_2 which are used to isolate the d.c biasing from the applied ac signal act as short circuits for ac analysis. Bypass capacitor Cs also acts as a short circuits for low frequency analysis.

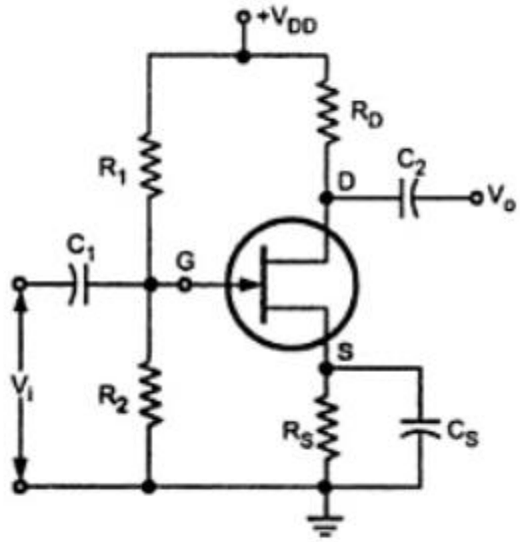

Figure 3.2.8 Common Source Amplifier With voltage divider Bias (Bypassede Rs)

Diagram Source Brain Kart

The following figure 3.2.9 shows the low frequency equivalent model for Common Source Amplifier With voltage divider Bias

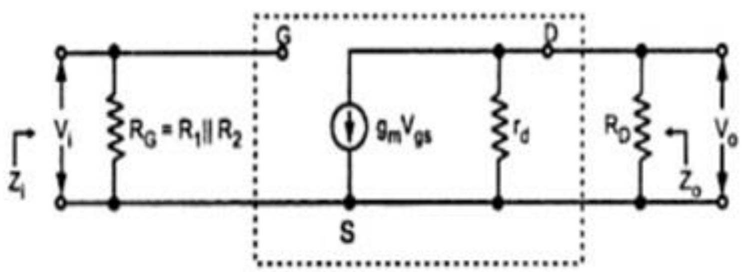

Figure 3.2.9 low frequency equivalent model for Common Source Amplifier With voltage divider Bias

Diagram Source Brain Kart

The parameters are given by

$$R_G = R_1 \parallel R_2$$

$$Z_i = R_G$$

$$= R_1 \parallel R_2$$

$$Z_o = r_d \parallel R_D$$

if $r_d >> R_D$

$$Z_o \approx R_D$$

$$A_v = -g_m (r_d \parallel R_D)$$

If $r_d >> R_D$

$$A_v = -g_m R_D$$

The negative sign in the voltage gain indicates there is a 180° phase shift between input and output voltages.

Common source amplifier with Voltage divider bias (unbypassed R_s)

Figure 3.2.10 shows small signal model of Common source amplifier with Voltage divider bias(without Bypassed Rs.

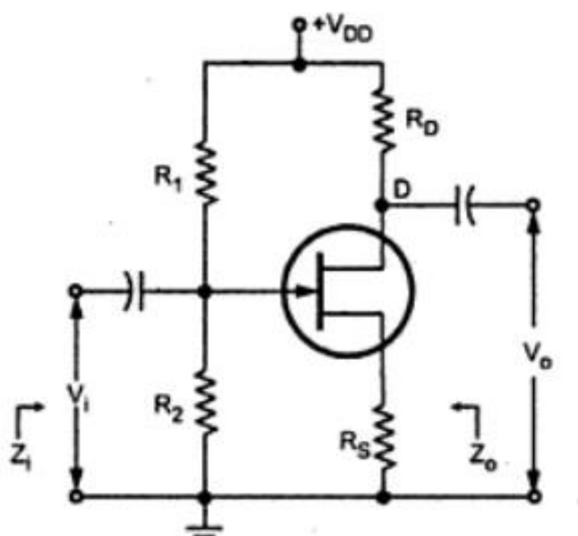

Figure 3.2.10 small model of Common source amplifier with Voltage divider bias(without Bypassed Rs

Diagram Source Brain Kart

Now Rs will be the part of low frequency equivalent model as shown in figure 3.2.11.

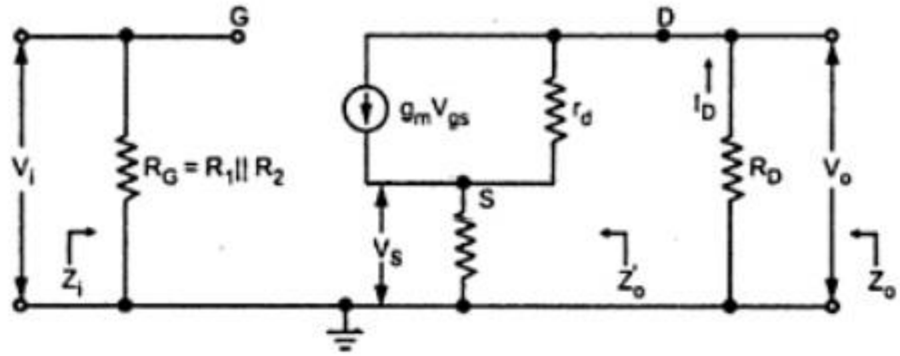

Figure 3.2.11 small model of Common source amplifier with Voltage divider bias(without Bypassed Rs

Diagram Source Brain Kart

It is important to note that, here, $R_G = R_1 || R_2$.

$$Z_i = R_G = R_1 || R_2$$

$$Z'_o = r_d + g_m R_s r_d + R_s$$

or

$$Z'_o = r_d + R_s (\mu + 1)$$

$$Z_o = [r_d + g_m R_s r_d + R_s] || R_D$$

or

$$Z_o = [r_d + R_s (\mu + 1)] || R_D$$

$$A_v = \frac{-g_m R_D}{1 + g_m R_s + \frac{R_s + R_D}{r_d}}$$

Where Av is the Voltage Gain.