

Common-emitter Amplifier with Resistor-capacitor Load

Schematic

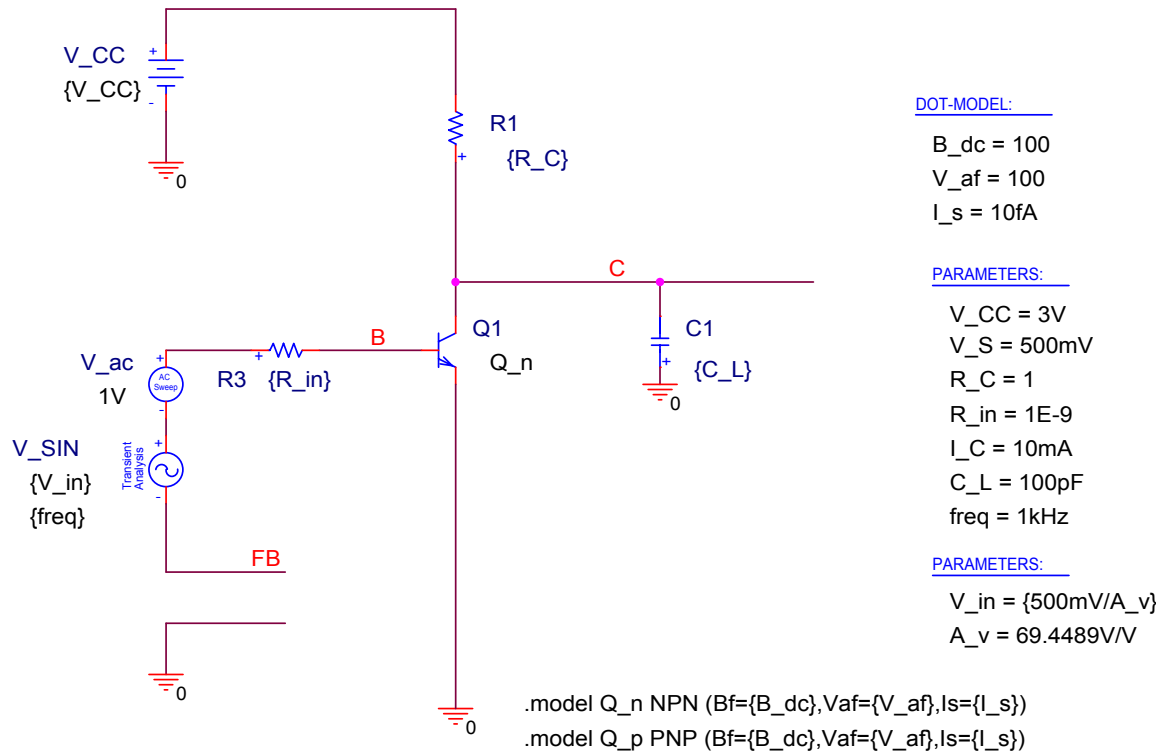


FIGURE 1
Common emitter amplifier with resistor –capacitor load

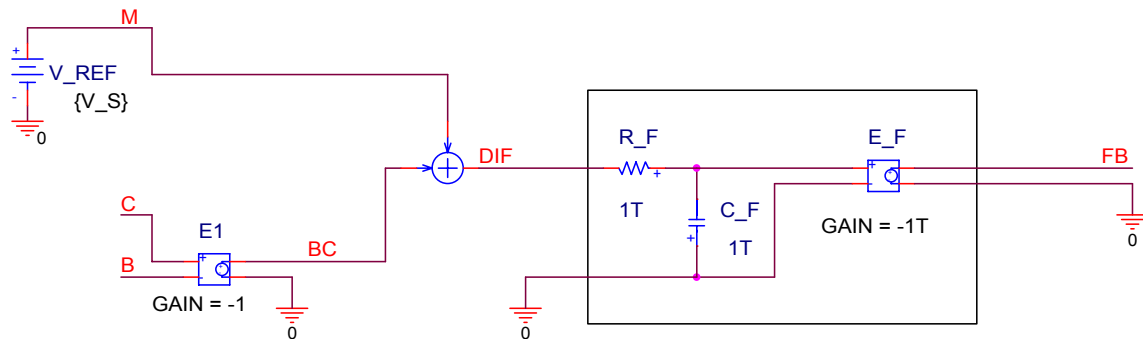


FIGURE 2
Feedback network to establish Q-point voltage $V_{CB} = V_S$

Specifications

Suppose that the maximum swing and the collector current are specified.

Example spreadsheet

Beta		=B_dc*(1+V_SW/V_af)		
	E	F	G	H
5	Common-Emitter Amplifier Design			
6				
7				
8				
9	Design variables	Collector current (mA)	IC(mA)	0.1
10		Output swing	V_SW	0.5
11				
12	Enter Data Here	pi	pi	3.1415926
13		Supply voltage	V_CC	3
14		Load C	C_L	1.00E-10
15		Source R	R_IN	0.00E+00
16		Max forward V_CB	V_sat	0
17				
18		DC beta	B_dc	100
19		Thermal voltage	V_th	0.025864
20		Scale current	I_s	1.00E-14
21		Early voltage	V_af	100
22				
23	Calculated	Output side V_CB	V_S	0.5
24		Output side beta	Beta	100.5
25		I_C (A)	I_C	0.0001
26		NPN	V_BE	0.595411611
27		Collector resistor	R_C	19045.88389
28		r_pi NPN	r_pi	25993.32
29		r_o NPN	r_ON	1005000
30		R_C/r_ON	RC_rON	18691.65592
31		g_m NPN	g_mN	0.003866378
32		Small-signal gain	A_v	72.26900682
33		Corner frequency	f_3dB	85147.59016
34		Gain bandwidth product	GBW	6153531.774

FIGURE 3
DESIGN POINT ON CHARTS worksheet

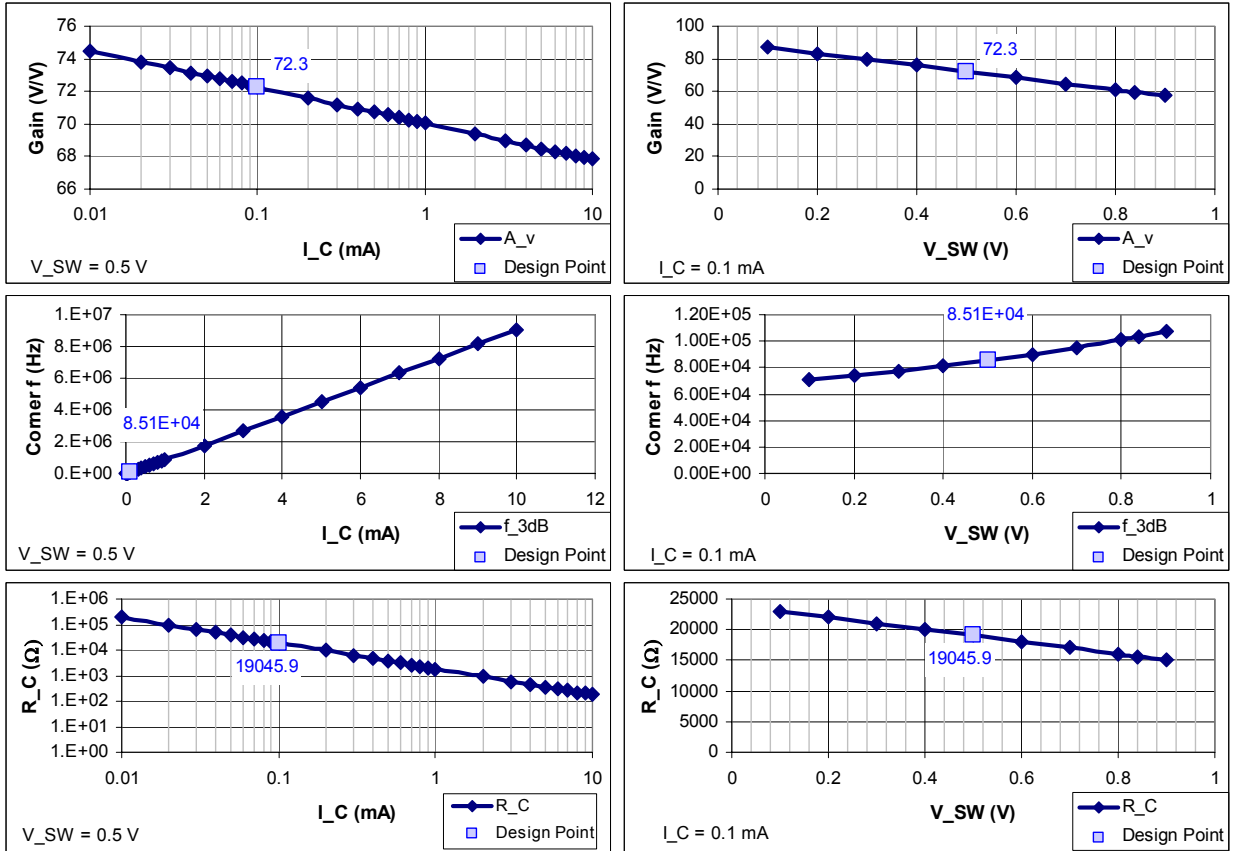


FIGURE 4
 Charts on the worksheet CHARTS; the DESIGN POINT is labeled and the value of the variable that is held fixed is labeled (for example, swing V_{SW} on the charts where I_C varies)

IC_mA = 0.01			R	S	T	U	V	W	X	Y	Z	AA	AB	AC
7	Label	V_SW = 0.												
8														
9	IC(mA)	V_SW	V_S	Beta	I_C	V_BE	R_C	r_pi	r_ON	RC_rON	g_mN	A_v	f_3dB	GBW
10	0.01	0.5	0.5	100.5	0.00001	0.535858	196414.2	259933.2	10050000	192649.2	0.000387	74.48545	8261.388	615353.2
11	0.02		0.5	100.5	0.00002	0.553785	97310.74	129966.6	5025000	95462.09	0.000773	73.8185	16672.06	1230706
12	0.03		0.5	100.5	0.00003	0.564272	64524.26	86644.4	3350000	63304.95	0.00116	73.42826	25141	1846060
13	0.04		0.5	100.5	0.00004	0.571713	48207.18	64983.3	2512500	47299.65	0.001547	73.15133	33648.23	2461413
18	0.09		0.5	100.5	0.00009	0.592687	21192.37	28881.47	1116667	20797.67	0.00348	72.37048	76525.38	5538179
19	0.1		0.5	100.5	0.0001	0.595412	19045.88	25993.32	1005000	18691.66	0.003866	72.26901	85147.59	6153532
20	0.2		0.5	100.5	0.0002	0.613339	9433.304	12996.66	502500	9259.478	0.007733	71.60129	171883.3	12307064
21	0.3		0.5	100.5	0.0003	0.623826	6253.913	8664.44	335000	6139.302	0.011599	71.21059	259239.5	18460595

FIGURE 5
 Segment of IC_VARIES worksheet showing IC_mA is column variable

Label	=CONCATENATE("I_C = ",I_C_mA," mA")													
D	E	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	
7	Label	I_C = 0.1 mA												
8														
9	I_C(mA)	V_SW	V_S	Beta	I_C	V_BE	R_C	r_pi	r_ON	RC_rON	g_mN	A_v	f_3dB	GBW
10	10	0.1	0.1	100.1	0.0001	0.595515	23044.85	25889.86	1001000	22526.26	0.003866	87.09502	70653.08	6153532
11		0.2	0.2	100.2	0.0001	0.595489	22045.11	25915.73	1002000	21570.53	0.003866	83.39984	73783.49	6153532
12		0.3	0.3	100.3	0.0001	0.595463	21045.37	25941.59	1003000	20612.86	0.003866	79.69711	77211.48	6153532
13		0.4	0.4	100.4	0.0001	0.595437	20045.63	25967.46	1004000	19653.23	0.003866	75.98683	80981.55	6153532
14		0.5	0.5	100.5	0.0001	0.595412	19045.88	25993.32	1005000	18691.66	0.003866	72.26901	85147.59	6153532
17		0.8	0.8	100.8	0.0001	0.595335	16046.65	26070.91	1008000	15795.21	0.003866	61.07024	100761.6	6153532
18		0.84	0.84	100.84	0.0001	0.595324	15646.76	26081.26	1008400	15407.69	0.003866	59.57194	103295.8	6153532
19		0.9	0.9	100.9	0.0001	0.595309	15046.91	26096.78	1009000	14825.82	0.003866	57.32222	107349.9	6153532

FIGURE 6
Segment of VSW_VARIES worksheet showing construction of chart label using CONCATENATE function

PSPICE results

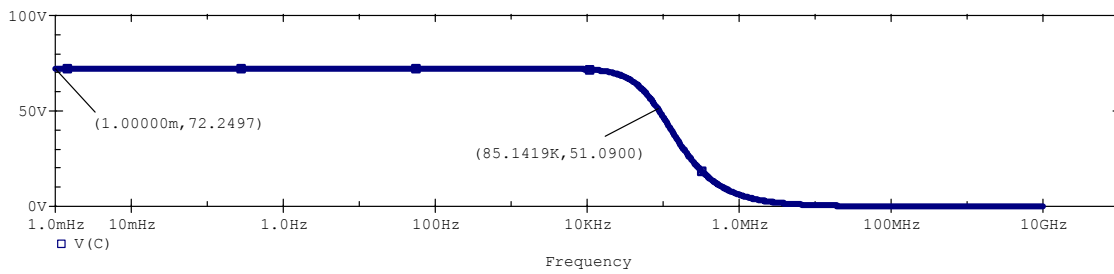


FIGURE 7
Gain vs. frequency showing f_{3dB}

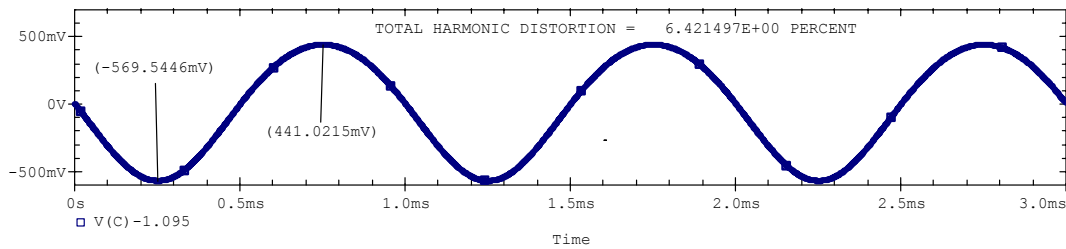


FIGURE 8
Transient output analysis for input voltage 500mV/A₀

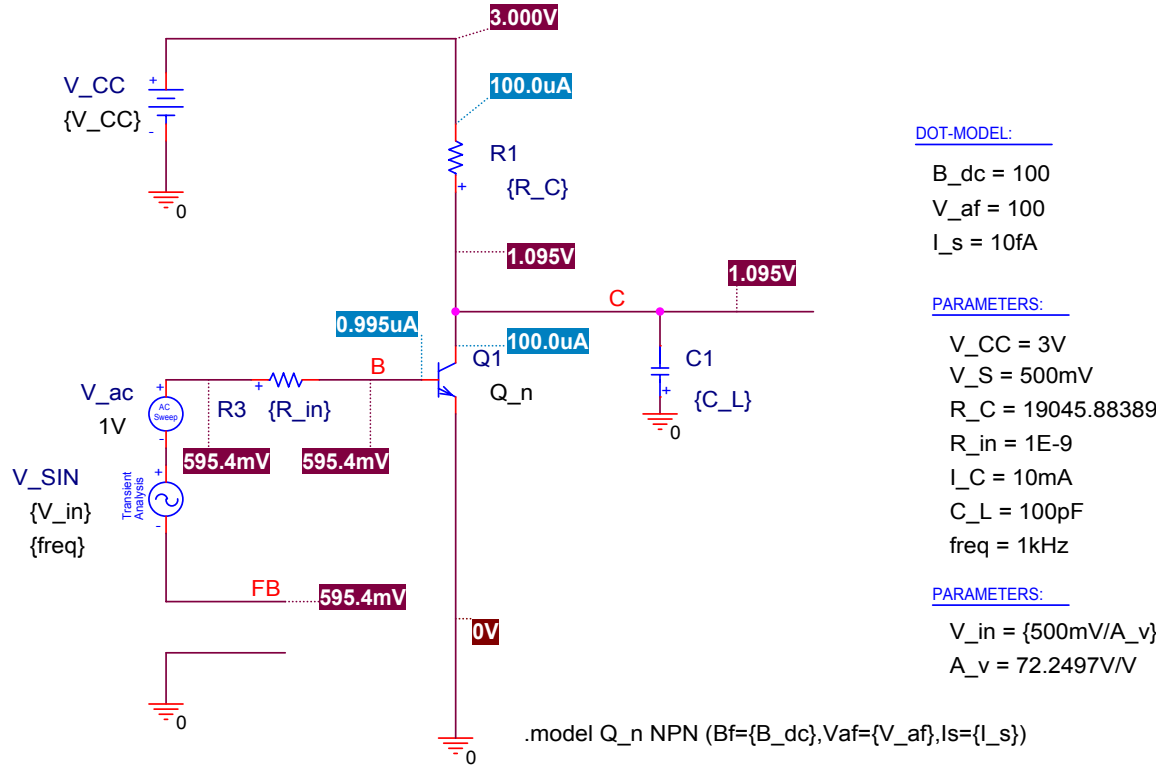


FIGURE 9
Q-point simulation for case corresponding to spreadsheet

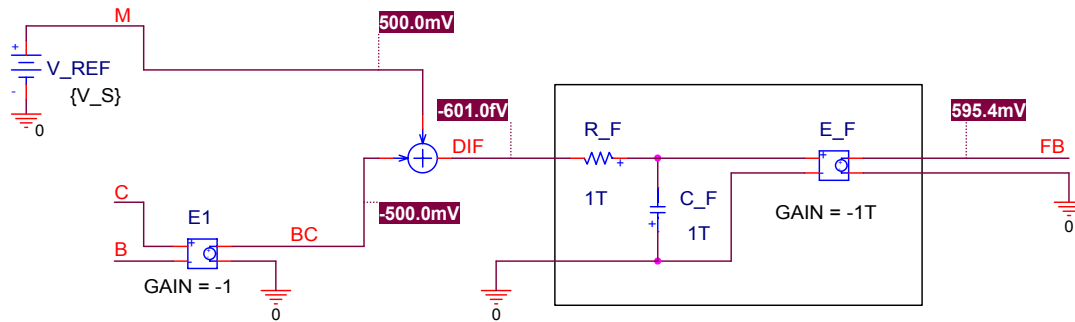


FIGURE 10
Feedback loop at Q-point for design of Figure 3.

The PSPICE results agree with the spreadsheet, showing that the design tool is working.