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2SC4416

Silicon NPN Epitaxial

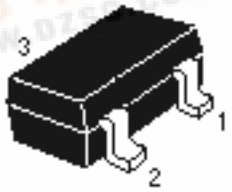
HITACHI

Application

UHF Frequency conversion, Wide band amplifier

Outline

MPAK



1. Base
2. Emitter
3. Collector

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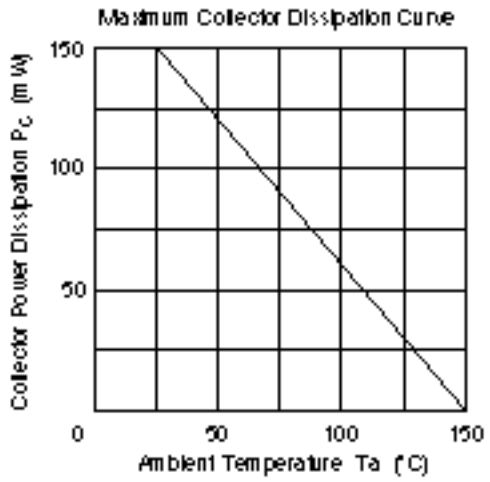
Absolute Maximum Ratings (Ta = 25°C)

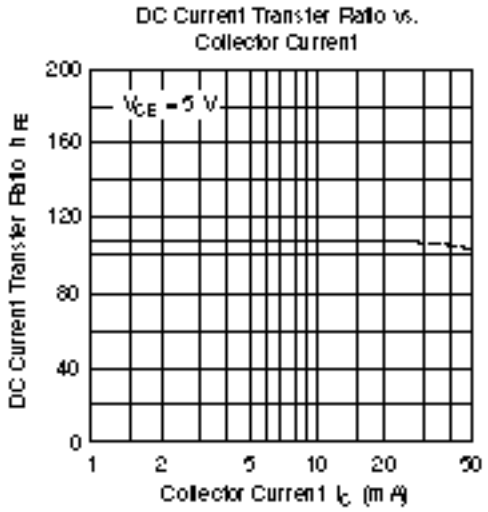
Item	Symbol	Ratings	Unit
Collector to base voltage	V_{CBO}	25	V
Collector to emitter voltage	V_{CEO}	13	V
Emitter to base voltage	V_{EBO}	3	V
Collector current	I_C	50	mA
Collector power dissipation	P_C	150	mW
Junction temperature	Tj	150	°C
Storage temperature	Tstg	–55 to +150	°C

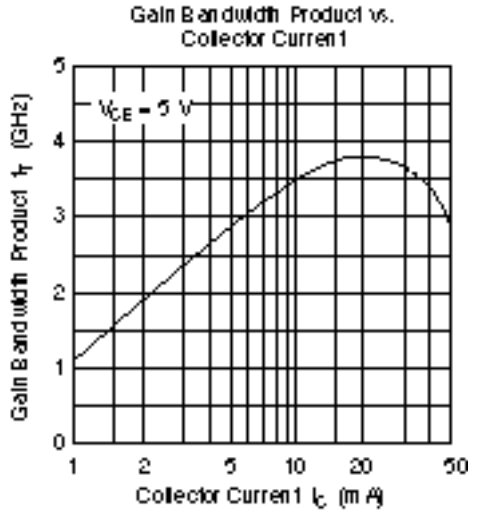
Electrical Characteristics (Ta = 25°C)

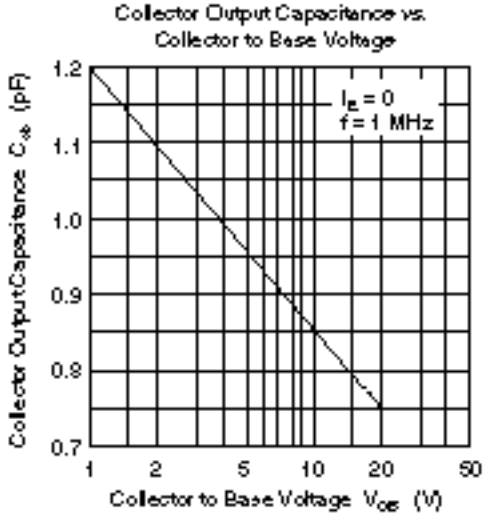
Item	Symbol	Min	Typ	Max	Unit	Test conditions
Collector to base breakdown voltage	$V_{(BR)CBO}$	25	—	—	V	I_C = 10 µA, I_E = 0
Collector cutoff current	I_{CBO}	—	—	0.1	µA	V_{CB} = 15 V, I_E = 0
	I_{CEO}	—	—	10	µA	V_{CB} = 13 V, R_{BE} = ∞
Emitter cutoff current	I_{EBO}	—	—	0.3	µA	V_{EB} = 3 V, I_C = 0
Collector to emitter saturation voltage	$V_{CE(sat)}$	—	—	0.3	V	I_C = 20 mA, I_B = 4 mA
DC current transfer ratio	h_{FE}	50	—	180		V_{CE} = 5 V, I_C = 5 mA
Collector output capacitance	Cob	—	0.85	1.3	pF	V_{CB} = 10 V, I_E = 0, f = 1 MHz
Gain bandwidth product	f_T	3.0	3.8	—	GHz	V_{CE} = 5 V, I_C = 20 mA
Conversion gain	CG	15	19	—	dB	V_{CC} = 5 V, I_C = 0.8 mA, f_{in} = 900 MHz, f_{OSC} = 930 MHz (–5dBm), f_{out} = 30 MHz
Noise figure	NF	—	8	1.2	dB	

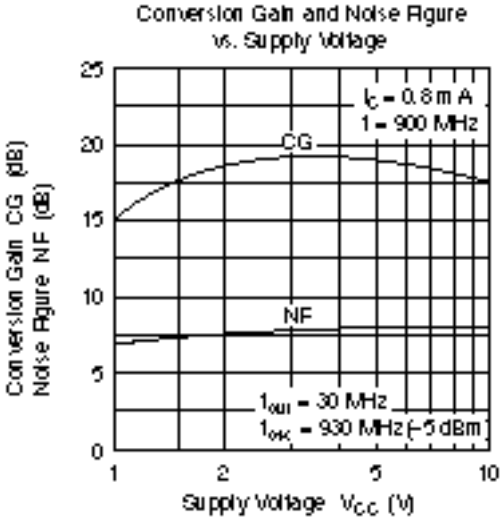
Note: Marking is “XB–”.

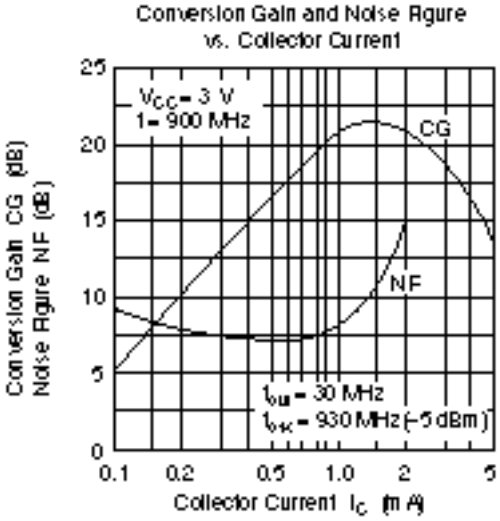

Maximum Collector Dissipation Curve
Collector Power Dissipation P_C (mW)
150
100
50
0
50
100
150
Ambient Temperature Ta (°C)

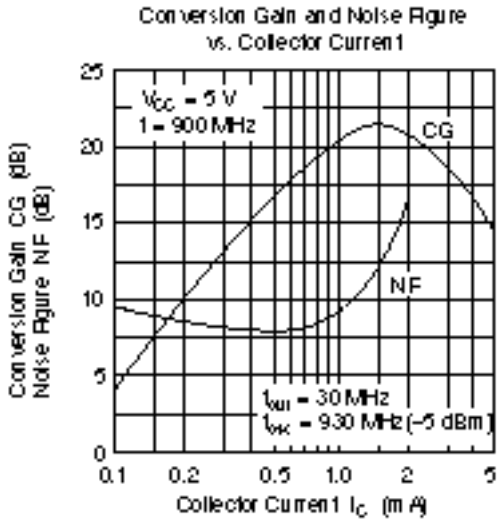

DC Current Transfer Ratio vs.
Collector Current
V_{CE} = 5 V
DC Current Transfer Ratio h_{FE}
200
160
120
80
40
0
1
2
5
10
20
50
Collector Current I_C (mA)


Gain Bandwidth Product vs.
Collector Current
V_{CE} = 5 V
Gain Bandwidth Product f_T (GHz)
5
4
3
2
1
0
1
2
5
10
20
50
Collector Current I_C (mA)


Collector Output Capacitance vs.
Collector to Base Voltage
I_E = 0
f = 1 MHz
Collector Output Capacitance C_{ob} (pF)
1.2
1.1
1.0
0.9
0.8
0.7
1
2
5
10
20
50
Collector to Base Voltage V_{CB} (V)


Conversion Gain and Noise Figure
vs. Supply Voltage
I_C = 0.8 mA
f = 900 MHz
CG
NF
f_{out} = 30 MHz
f_{osc} = 930 MHz (−5 dBm)
Conversion Gain CG (dB)
Noise Figure NF (dB)
25
20
15
10
5
0
1
2
5
10
Supply Voltage V_{CC} (V)


Conversion Gain and Noise Figure
vs. Collector Current
V_{CC} = 3 V
f = 900 MHz
CG
NF
f_{out} = 30 MHz
f_{osc} = 930 MHz (−5 dBm)
Conversion Gain CG (dB)
Noise Figure NF (dB)
25
20
15
10
5
0
0.1
0.2
0.5
1.0
2
5
Collector Current I_C (mA)

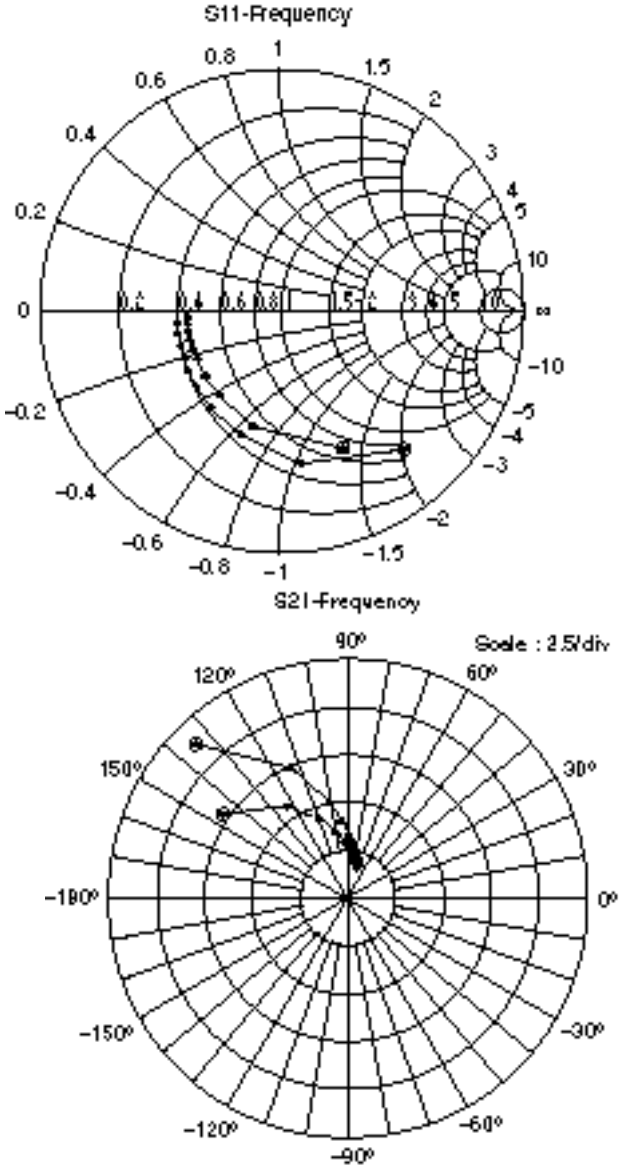

Conversion Gain and Noise Figure
vs. Collector Current
V_{CC} = 5 V
f = 900 MHz
CG
NF
f_{out} = 30 MHz
f_{osc} = 930 MHz (−5 dBm)
Conversion Gain CG (dB)
Noise Figure NF (dB)
Collector Current I_C (mA)
0
5
10
15
20
25
0.1
0.2
0.5
1.0
2
5

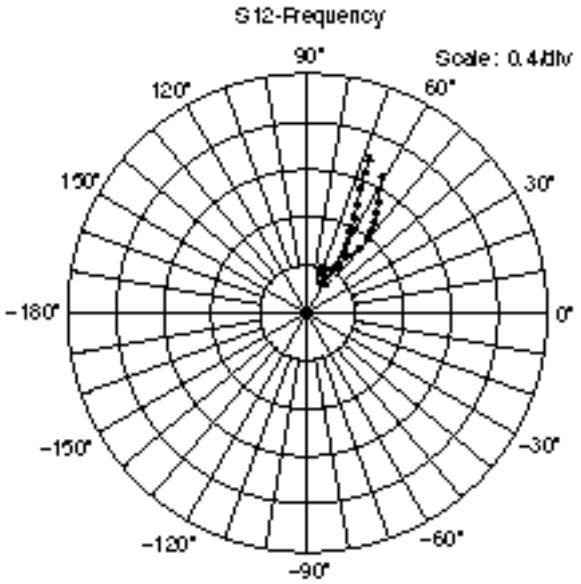
S Parameters (Emitter Common)

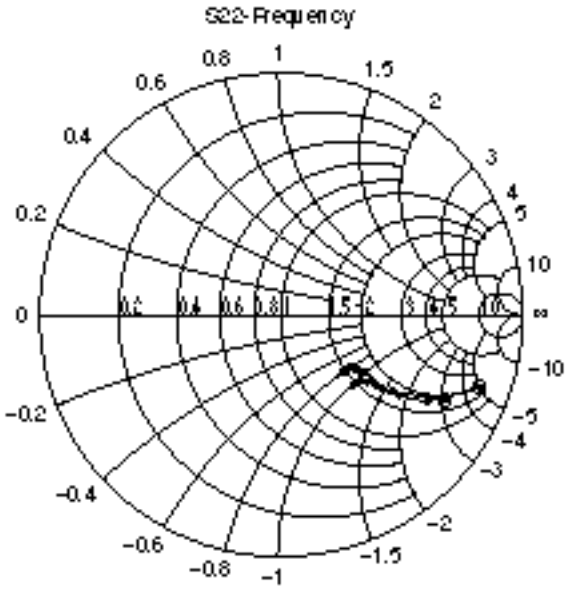
Test Condition V_{CE} = 5 V, 100 MHz to 1000 MHz (100 MHz STEP) , Z_O = 50 Ω

I_C = 5 mA

I_C = 10 mA




S12-Frequency
Scale : 0.4/div
90°
120°
60°
150°
30°
−180°
0°
−150°
−30°
−120°
−60°
−90°


S22-Frequency
0.8
1
0.6
1.5
2
0.4
3
4
5
0.2
10
0
∞
−10
−0.2
−5
−4
−3
−0.4
−2
−0.6
−1.5
−0.8
−1

S Parameters (Emitter Common)

Test Condition V_{CE} = 5 V, I_C = 5 mA, Z_O = 50 Ω

Freq.	S11		S21		S12		S22	
(MHz)	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
100	0.777	–47.6	12.318	146.4	0.037	66.8	0.878	–20.1
200	0.636	–82.6	9.212	124.5	0.058	55.3	0.702	–30.7
300	0.540	–107.9	6.901	110.6	0.071	51.0	0.586	–34.8
400	0.494	–125.0	5.480	101.6	0.079	50.7	0.520	–36.4
500	0.468	–138.0	4.547	94.5	0.087	52.0	0.480	–37.2
600	0.452	–147.7	3.859	89.0	0.095	53.7	0.452	–38.4
700	0.439	–155.4	3.374	84.2	0.103	55.7	0.436	–39.9
800	0.437	–162.0	2.982	80.0	0.112	57.5	0.427	–41.3
900	0.428	–167.9	2.691	76.1	0.122	59.6	0.419	–43.4
1000	0.429	–173.8	2.457	72.5	0.131	61.2	0.415	–45.0

Test Condition V_{CE} = 5 V, I_C = 10 mA, Z_O = 50 Ω

Freq.	S11		S21		S12		S22	
(MHz)	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
100	0.627	–64.8	17.938	135.2	0.032	63.2	0.766	–27.4
200	0.492	–102.5	11.621	113.8	0.047	56.4	0.560	–35.3
300	0.432	–125.3	8.190	102.4	0.058	57.2	0.460	–36.1
400	0.411	–139.4	6.332	95.1	0.069	59.6	0.412	–36.2
500	0.395	–150.3	5.168	89.5	0.079	61.7	0.385	–36.2
600	0.394	–157.4	4.350	84.8	0.090	63.7	0.366	–36.8
700	0.392	–163.5	3.784	80.9	0.102	65.2	0.356	–38.3
800	0.390	–168.7	3.333	77.1	0.113	66.5	0.351	–39.7
900	0.388	–173.1	2.995	73.8	0.127	67.3	0.347	–41.6
1000	0.387	–177.0	2.731	70.5	0.138	67.9	0.345	–43.5

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Y Parameters (Emitter Common)

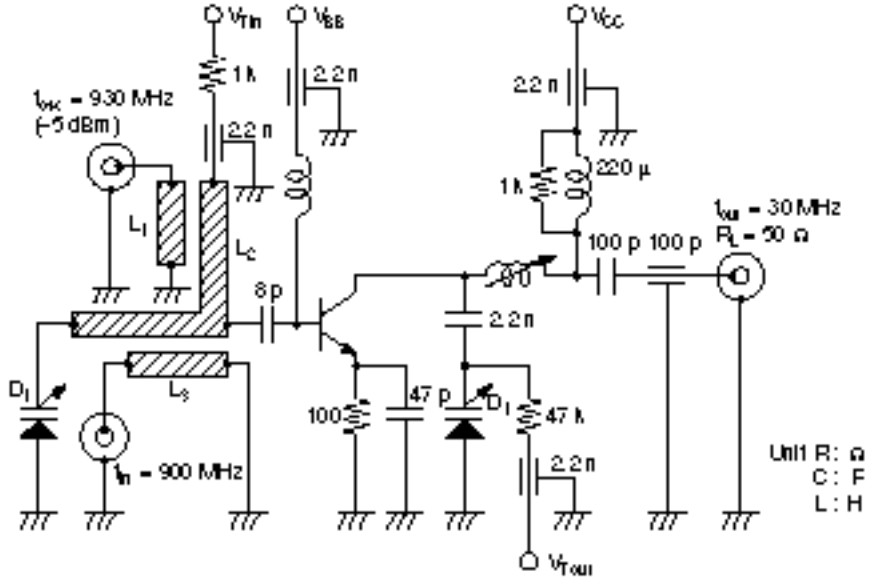
Test Condition V_{CE} = 5 V, I_C = 5 mA

Freq.	Yie (mS)		Yfe (mS)		Yre (mS)		Yoe (mS)	
(MHz)	REAL	IMAG.	REAL	IMAG.	REAL	IMAG.	REAL	IMAG.
100	2.182	5.286	149.226	–28.448	–0.004	–0.459	0.069	0.745
200	4.596	9.838	138.489	–53.561	–0.005	–0.941	0.137	1.465
300	8.314	13.395	121.525	–74.164	–0.025	–1.460	0.086	2.251
400	12.329	15.566	103.171	–87.811	–0.044	–1.955	0.111	3.025
500	16.310	16.548	83.990	–97.188	–0.068	–2.451	0.080	3.813
600	19.817	16.562	66.015	–100.594	–0.104	–2.958	0.154	4.618
700	22.727	15.707	49.791	–101.015	–0.136	–3.433	0.226	5.461
800	25.355	14.778	36.105	–98.928	–0.165	–3.943	0.246	6.241
900	27.058	13.073	23.869	–95.428	–0.192	–4.438	0.307	7.067
1000	28.966	11.370	13.481	–92.170	–0.260	–4.944	0.328	7.902

Test Condition V_{CE} = 5 V, I_C = 10 mA

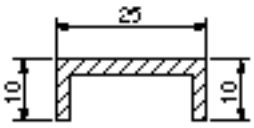
Freq.	Yie (mS)		Yfe (mS)		Yre (mS)		Yoe (mS)	
(MHz)	REAL	IMAG.	REAL	IMAG.	REAL	IMAG.	REAL	IMAG.
100	4.137	6.218	246.938	–82.680	–0.004	–0.462	0.139	0.754
200	7.995	10.306	193.805	–128.092	–0.015	–0.937	0.220	1.578
300	12.296	12.125	140.844	–144.955	–0.027	–1.432	0.322	2.338
400	15.691	12.521	100.830	–145.272	–0.024	–1.913	0.404	3.028
500	18.471	12.026	70.237	–139.959	–0.049	–2.396	0.410	3.817
600	20.418	11.618	48.828	–130.672	–0.032	–2.894	0.492	4.460
700	21.855	10.887	33.158	–121.649	–0.024	–3.394	0.474	5.196
800	23.059	10.127	20.494	–112.454	–0.017	–3.889	0.502	5.950
900	23.687	9.375	11.528	–103.839	–0.013	–4.418	0.446	6.699
1000	24.366	8.807	4.277	–96.921	–0.013	–4.905	0.471	7.486

Conversion Gain and Noise Figure Test Circuit

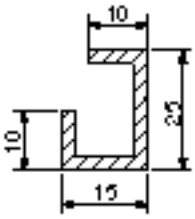


D_1 : 1SV188

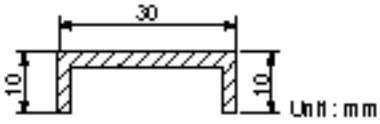
L_1 : φ1 mm Enameled Copper Wire.



L_c : φ1 mm Enameled Copper Wire.



L_s : φ1 mm Enameled Copper Wire.



L_4 : Inside Dia 3 mm, φ0.5 mm Enameled Copper Wire 1 Turn.

L_5 : Inside Dia 5 mm Bobin, φ0.2 mm Enameled Copper Wire 20 Turns Using Ferrite Core.

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