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# 2SC4416

Silicon NPN Epitaxial

# HITACHI

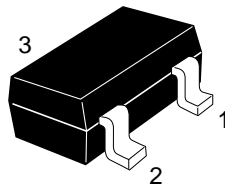
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## Application

UHF Frequency conversion, Wide band amplifier

## Outline

MPAK



1. Base
2. Emitter
3. Collector

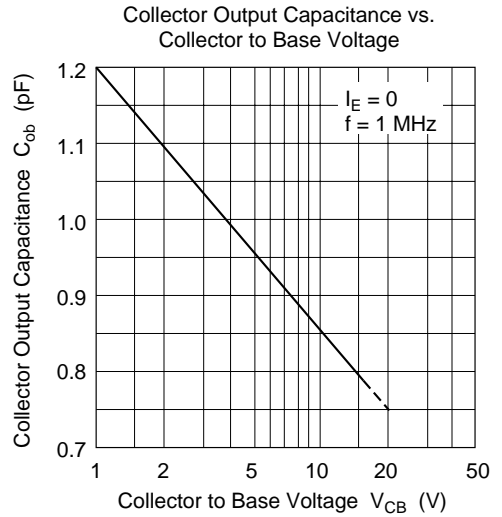
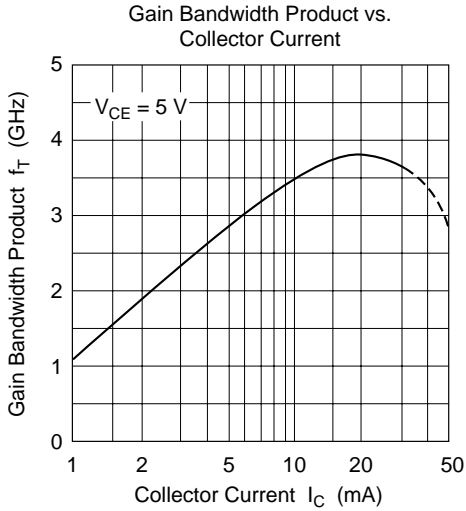
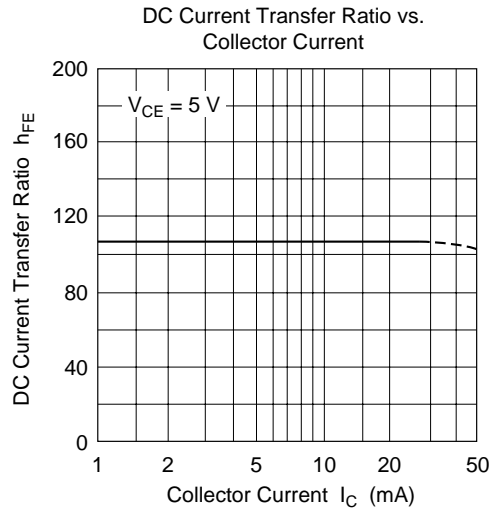
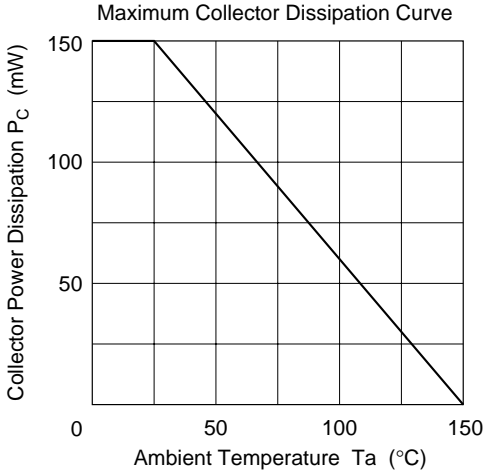
**Absolute Maximum Ratings** ( $T_a = 25^\circ\text{C}$ )

Item	Symbol	Ratings	Unit
Collector to base voltage	$V_{\text{CBO}}$	25	V
Collector to emitter voltage	$V_{\text{CEO}}$	13	V
Emitter to base voltage	$V_{\text{EBO}}$	3	V
Collector current	$I_{\text{C}}$	50	mA
Collector power dissipation	$P_{\text{C}}$	150	mW
Junction temperature	$T_{\text{j}}$	150	$^\circ\text{C}$
Storage temperature	$T_{\text{stg}}$	-55 to +150	$^\circ\text{C}$

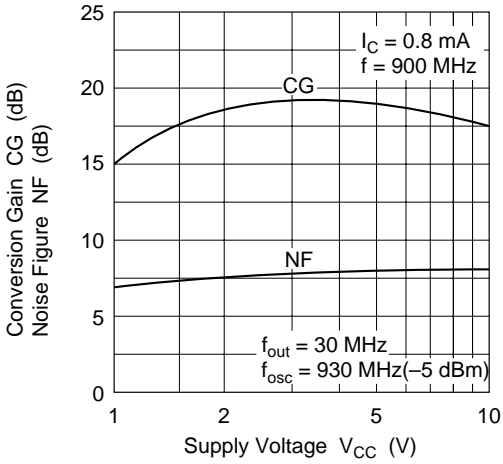
**Electrical Characteristics** ( $T_a = 25^\circ\text{C}$ )

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

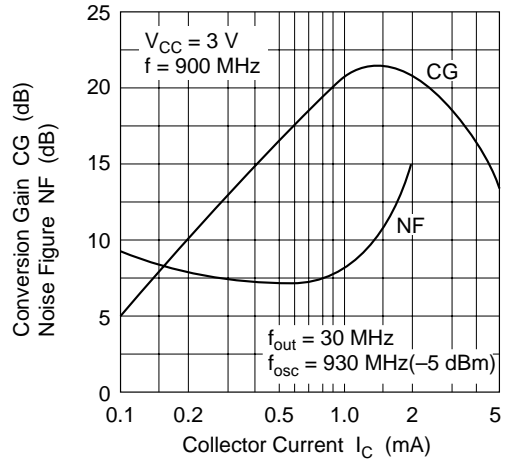
Note: Marking is "XB-".



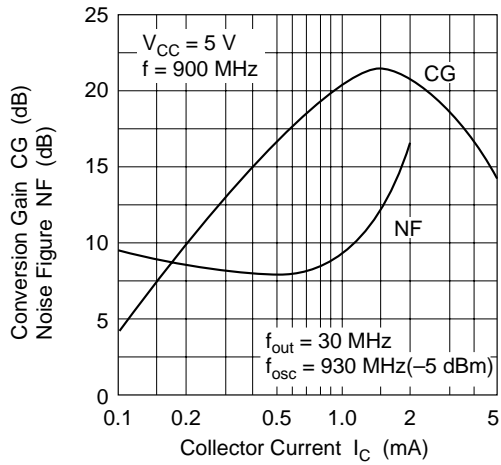
Conversion Gain and Noise Figure vs. Supply Voltage



Conversion Gain and Noise Figure vs. Collector Current



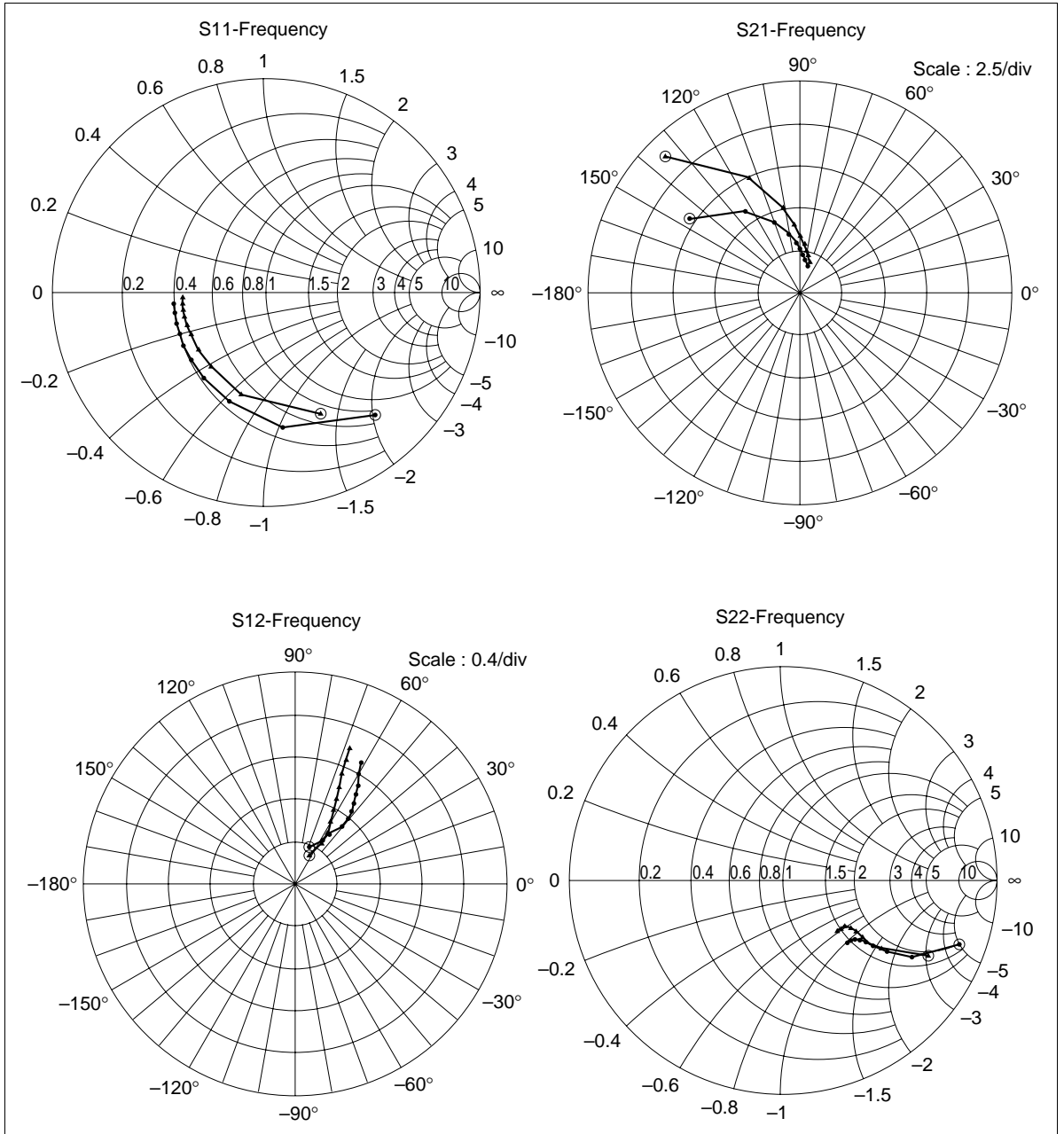
Conversion Gain and Noise Figure vs. Collector Current



**S Parameters (Emitter Common)**

**Test Condition**  $V_{CE} = 5\text{ V}$ , 100 MHz to 1000 MHz (100 MHz STEP),  $Z_O = 50\ \Omega$

$I_C = 5\text{ mA}$  ● ——— ●  
 $I_C = 10\text{ mA}$  ▲ ——— ▲



**S Parameters (Emitter Common)****Test Condition**  $V_{CE} = 5 \text{ V}$ ,  $I_C = 5 \text{ mA}$ ,  $Z_O = 50 \Omega$ 

Freq. (MHz)	S11		S21		S12		S22	
	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**  $V_{CE} = 5 \text{ V}$ ,  $I_C = 10 \text{ mA}$ ,  $Z_O = 50 \Omega$ 

Freq. (MHz)	S11		S21		S12		S22	
	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

## Y Parameters (Emitter Common)

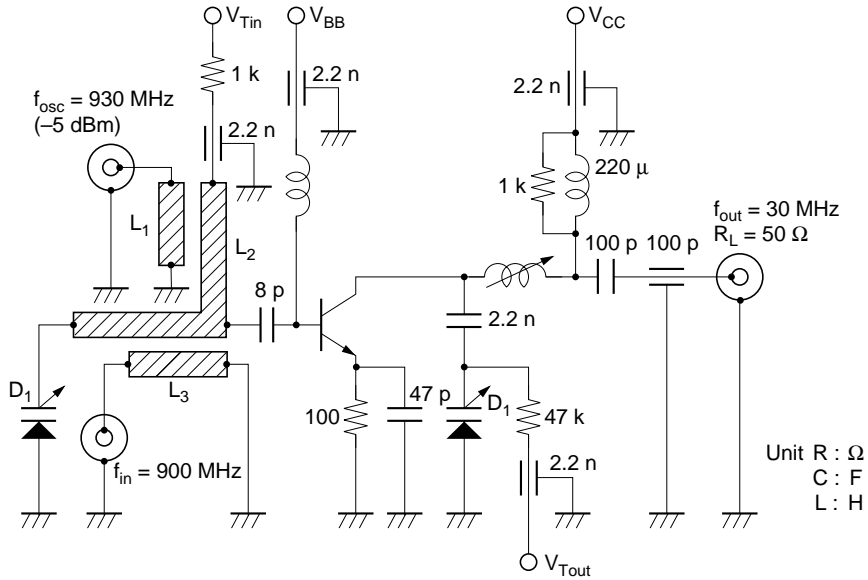
Test Condition  $V_{CE} = 5\text{ V}$ ,  $I_C = 5\text{ mA}$

Freq. (MHz)	Yie (mS)		Yfe (mS)		Yre (mS)		Yoe (mS)	
	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  $V_{CE} = 5\text{ V}$ ,  $I_C = 10\text{ mA}$

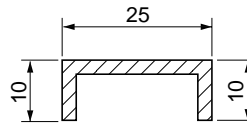
Freq. (MHz)	Yie (mS)		Yfe (mS)		Yre (mS)		Yoe (mS)	
	REAL	IMAG.	REAL	IMAG.	REAL	IMAG.	REAL	IMAG.
100	4.137	6.218	246.938	-82.680	-0.004	-0.462	0.139	0.754
200	7.995	10.306	193.805	-128.092	-0.015	-0.937	0.220	1.578
300	12.296	12.125	140.844	-144.955	-0.027	-1.432	0.322	2.338
400	15.691	12.521	100.830	-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

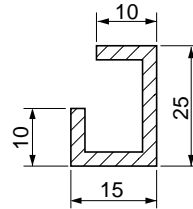


D<sub>1</sub> : 1SV188

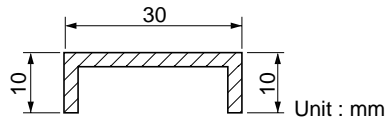
L<sub>1</sub> : φ1 mm Enameled Copper Wire.



L<sub>2</sub> : φ1 mm Enameled Copper Wire.



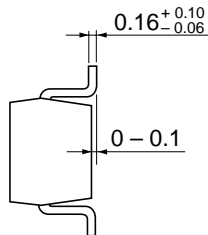
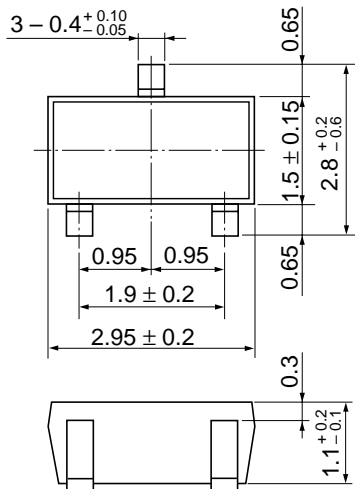
L<sub>3</sub> : φ1 mm Enameled Copper Wire.



L<sub>4</sub> : Inside Dia 3 mm, φ0.5 mm Enameled Copper Wire 1 Turn.

L<sub>5</sub> : Inside Dia 5 mm Bobin, φ0.2 mm Enameled Copper Wire 20 Turns Using Ferrite Core.





Hitachi Code	MPAK
JEDEC	—
EIAJ	Conforms
Weight (reference value)	0.011 g

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