

# HSG2004

## SiGe HBT High Frequency Medium Power Amplifier

REJ03G0484-0400

Rev.4.00

Jun 21, 2006

### Features

- High Transition Frequency  
 $f_T = 30$  GHz typ.
- Low Distortion and Excellent Linearity  
P1dB at output = +14.5 dBm typ.  $f = 5.8$  GHz
- High Collector to Emitter Voltage  
 $V_{CEO} = 5$  V
- Ideal for 2 GHz, 5 GHz Band applications. e.g. WLAN, Digital cordless phone.

### Outline

Renesas Package code: PWQN0008ZA-A  
(Package name: HWQFN-8 <TNP-8TV>)



1. Collector
2. Collector
3. Collector
4. Emitter
5. Emitter
6. Base
7. Emitter
8. Emitter
9. Emitter

Note: Marking is "2004".

### Absolute Maximum Ratings

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

Item	Symbol	Ratings	Unit
Collector to base voltage	$V_{CBO}$	12	V
Collector to emitter voltage	$V_{CEO}$	5	V
Emitter to base voltage	$V_{EBO}$	1.2	V
Collector current	$I_C$	200	mA
Collector power dissipation	$P_C$	1 <sup>Note</sup>	W
Junction temperature	$T_j$	150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to +150	$^\circ\text{C}$

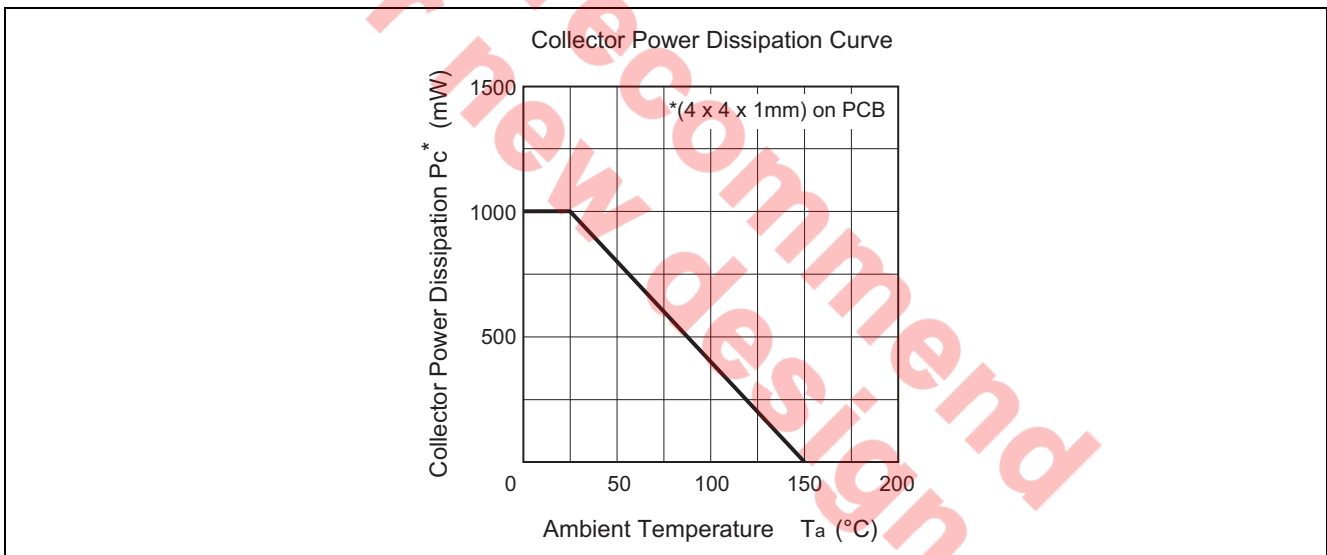
Note: Value on PCB (40 x 40 x 1.0 mm)

## Electrical Characteristics

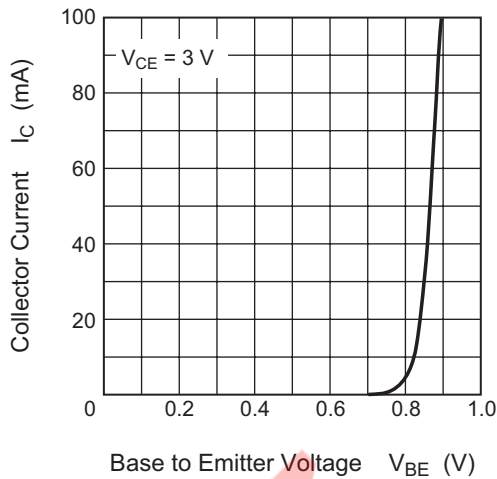
(Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
DC current transfer ratio	$h_{FE}$	170	240	320	—	$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$
Reverse Transfer Capacitance	$C_{re}$	—	—	0.6	pF	$V_{CB} = 3\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ , emitter grounded
Transition Frequency	$f_T$	—	30.0	—	GHz	$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 1\text{ GHz}$
Maximum Stable Gain	MSG	14	15.5	—	dB	$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 5.8\text{ GHz}$
Maximum Available Gain	MAG	—	21	—	dB	$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 2.4\text{ GHz}$
Maximum Available Gain	MAG	—	12	—	dB	$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 5.8\text{ GHz}$
Power Gain	PG	—	11.5	—	dB	$V_{CE} = 3.6\text{ V}$ , $I_{idle} = 30\text{ mA}$ , $f = 5.8\text{ GHz}$ , $P_{in} = +0\text{ dBm}$
1dB Compression Point at output	P1dB	—	+14.5	—	dBm	$V_{CE} = 3.6\text{ V}$ , $I_{idle} = 30\text{ mA}$ , $f = 5.8\text{ GHz}$
Saturation Output Power	Po(sat)	—	+22	—	dBm	$V_{CE} = 3.6\text{ V}$ , $I_{idle} = 30\text{ mA}$ , $f = 5.8\text{ GHz}$ , $P_{in} = +0\text{ dBm}$

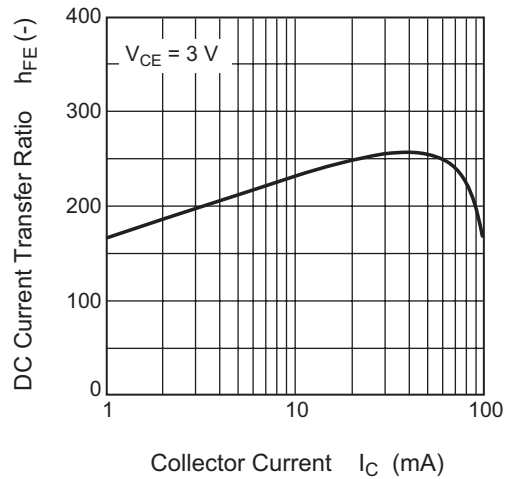
## Main Characteristics



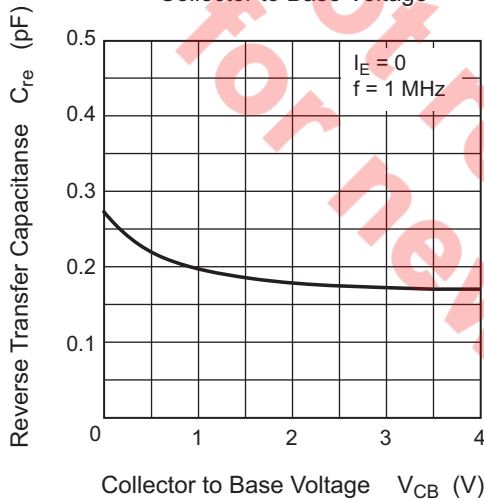
Typical Transfer Characteristics



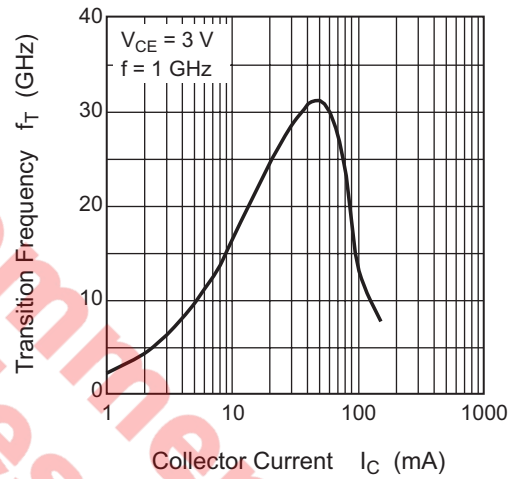
DC Current Transfer Ratio vs. Collector Current



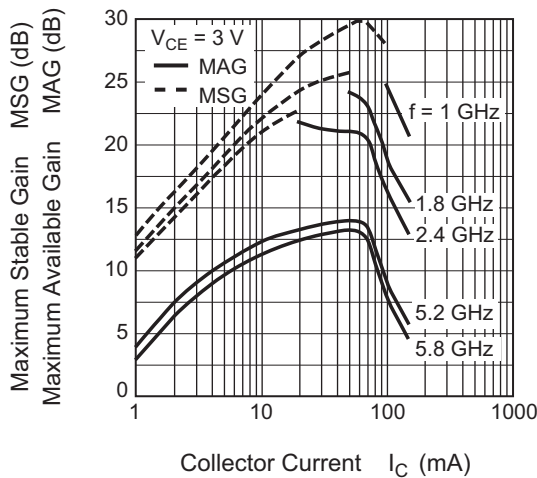
Reverse Transfer Capacitance vs. Collector to Base Voltage



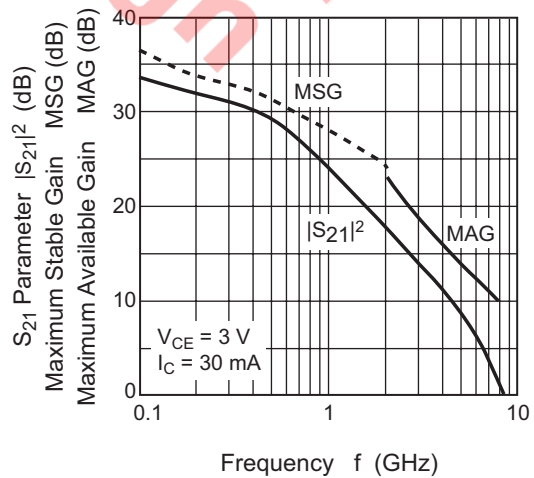
Transition Frequency vs. Collector Current



Maximum Stable Gain, Maximum Available Gain vs. Collector Current

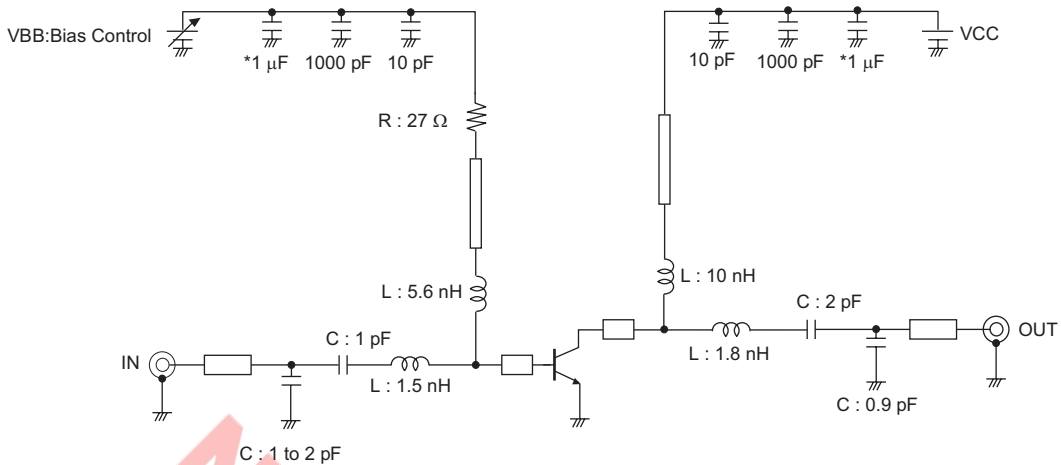


$S_{21}$  Parameter, Maximum Available Gain, Maximum Stable Gain vs. Frequency

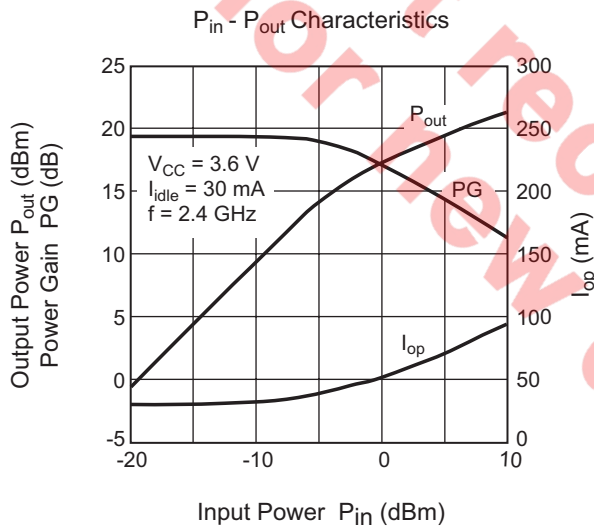


## 2.4 GHz Characteristics

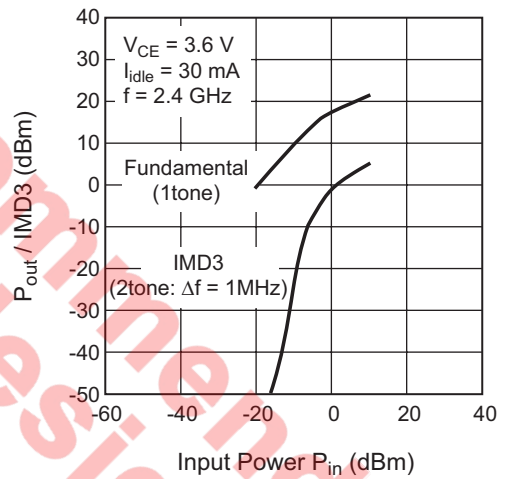
Evaluation Board Circuit



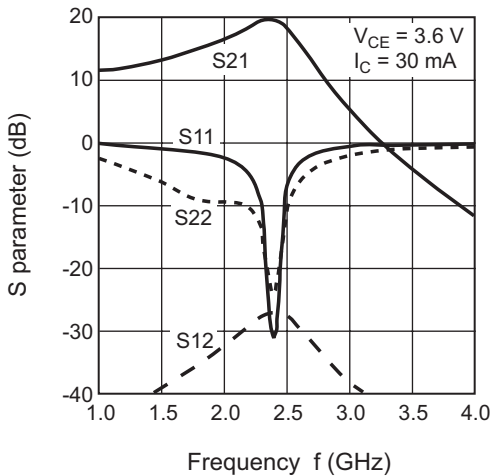
$P_{in} - P_{out}$  Characteristics



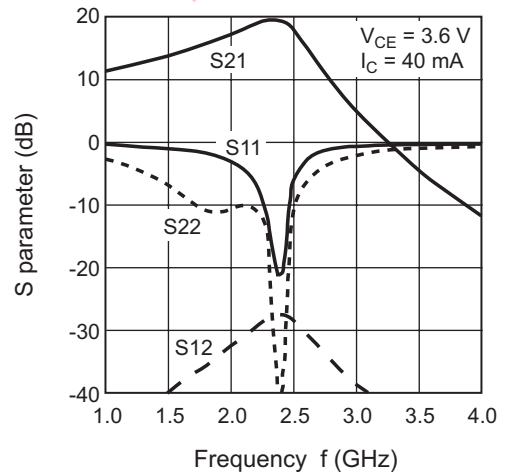
3rd. Order Intermodulation Distortion (IMD3)



S parameter vs. Frequency

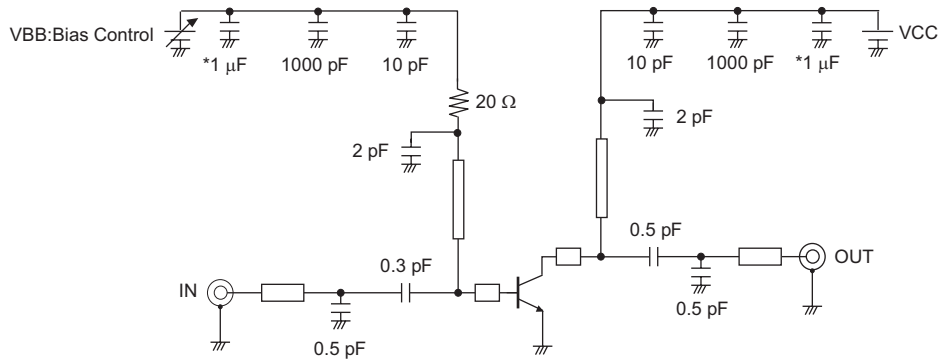


S parameter vs. Frequency

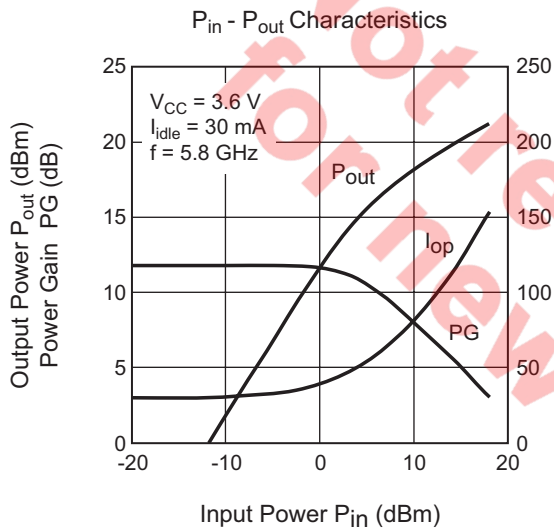


### 5.8 GHz Characteristics

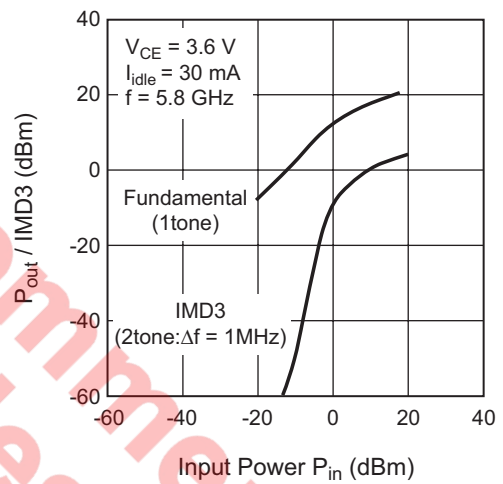
Evaluation Board Circuit



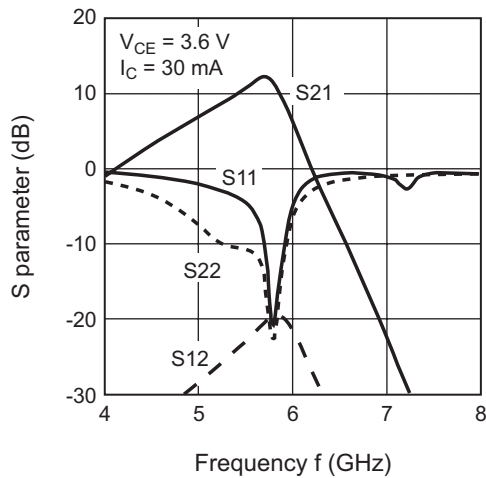
$P_{in}$  -  $P_{out}$  Characteristics



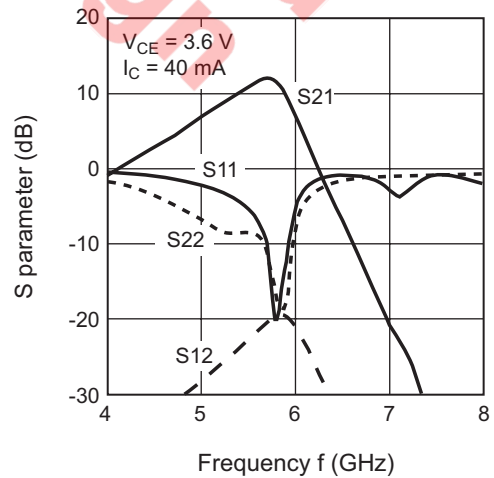
3rd. Order Intermodulation Distortion (IMD3)



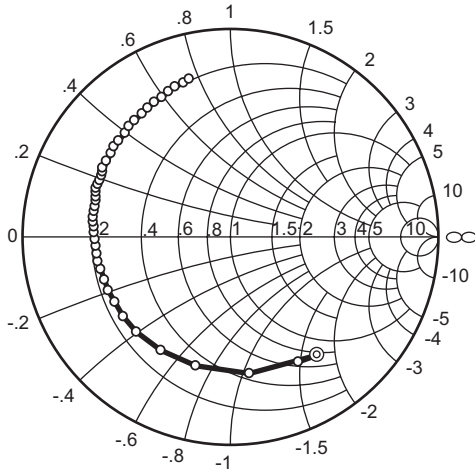
S parameter vs. Frequency



S parameter vs. Frequency

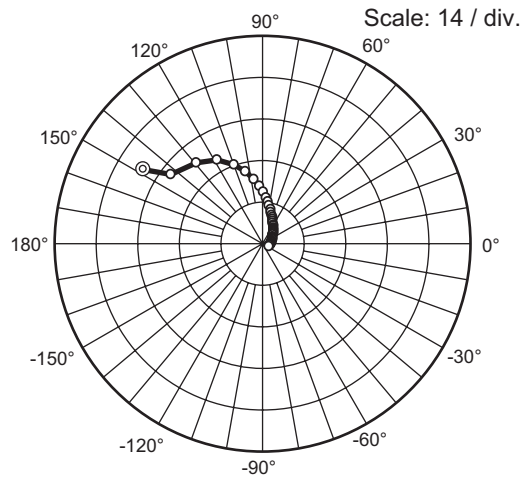


S<sub>11</sub> Parameter vs. Frequency



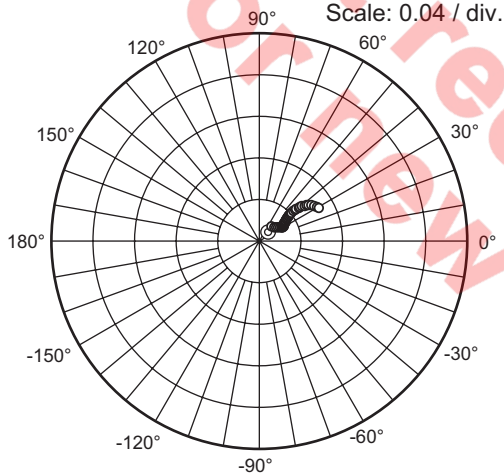
Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>21</sub> Parameter vs. Frequency



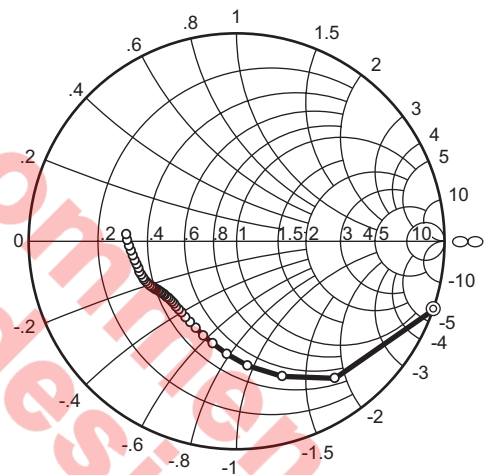
Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>12</sub> Parameter vs. Frequency



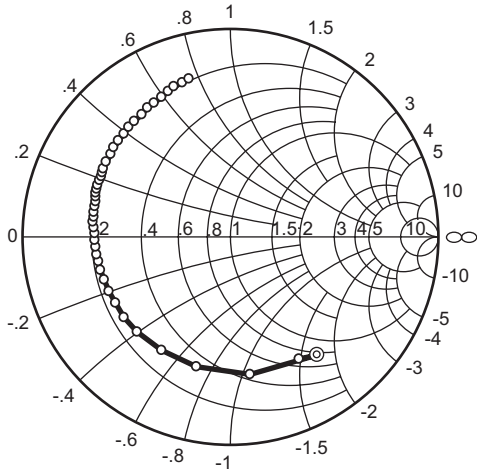
Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>22</sub> Parameter vs. Frequency



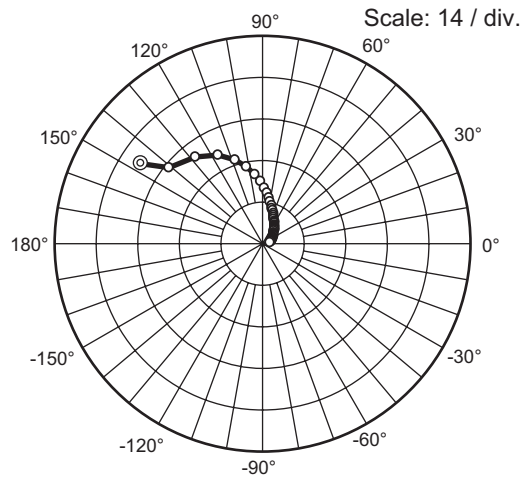
Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>11</sub> Parameter vs. Frequency



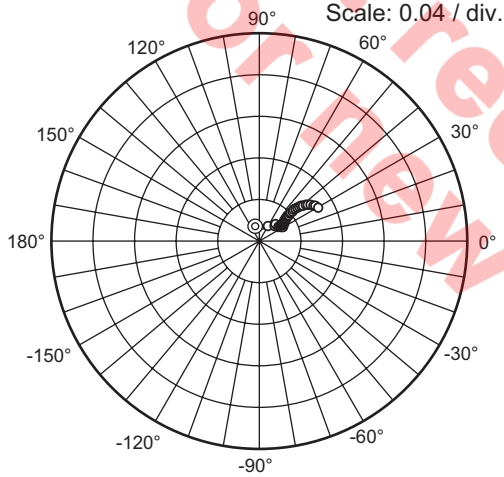
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>21</sub> Parameter vs. Frequency



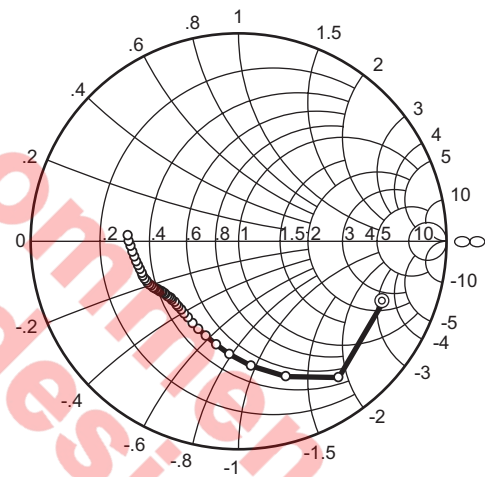
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>12</sub> Parameter vs. Frequency



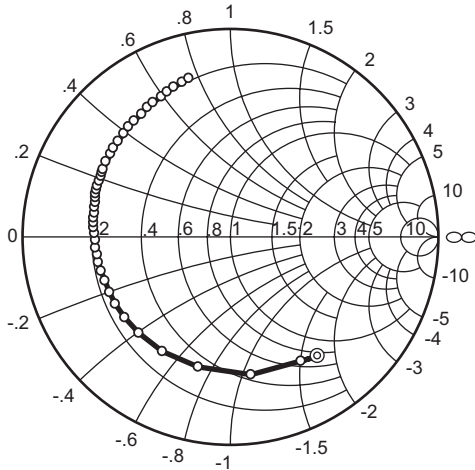
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>22</sub> Parameter vs. Frequency



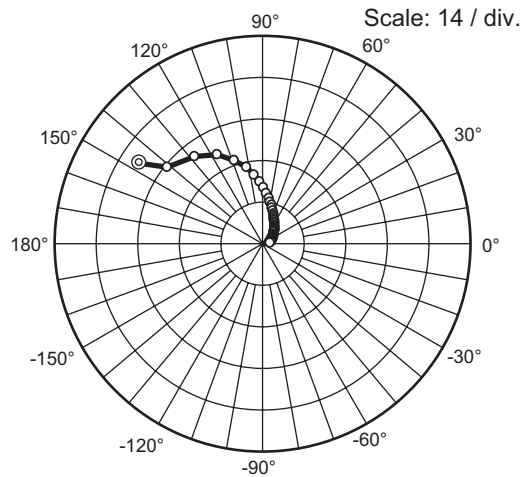
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>11</sub> Parameter vs. Frequency



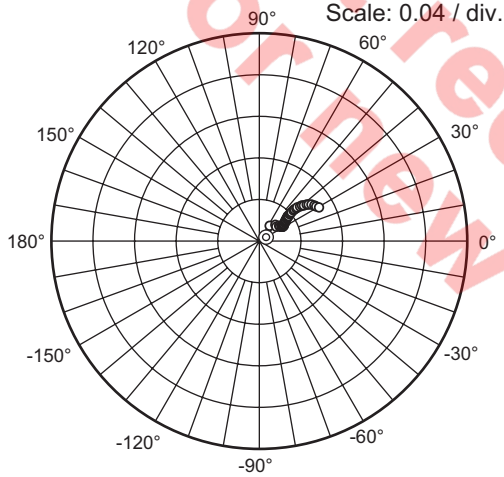
Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>21</sub> Parameter vs. Frequency



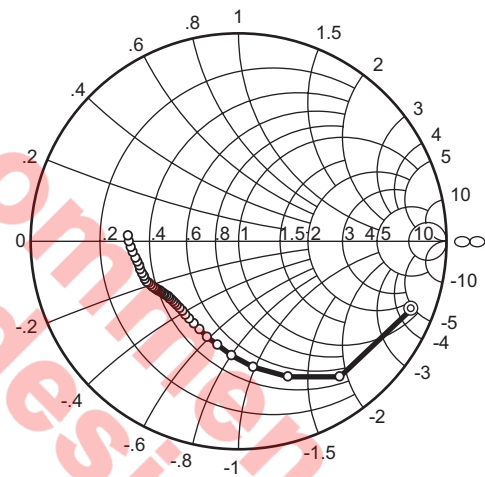
Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>12</sub> Parameter vs. Frequency



Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>22</sub> Parameter vs. Frequency



Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 30\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)



## S parameter

(V<sub>CE</sub> = 3 V, I<sub>C</sub> = 30 mA, Z<sub>o</sub> = 50 Ω)

f (MHz)	S11		S21		S12		S22	
	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)
100	0.684	-61.3	47.90	147.5	0.0103	39.8	1.006	-19.0
200	0.708	-53.6	39.45	142.1	0.0168	50.5	0.811	-53.9
300	0.664	-81.8	35.97	128.9	0.0180	41.9	0.685	-71.2
400	0.644	-105.0	32.90	117.8	0.0192	36.7	0.601	-84.9
500	0.638	-121.4	29.04	109.5	0.0214	34.3	0.543	-94.8
600	0.640	-134.8	25.80	102.8	0.0225	31.8	0.505	-102.7
700	0.640	-143.6	22.83	97.7	0.0240	29.2	0.480	-109.5
800	0.640	-150.6	20.30	93.4	0.0238	28.5	0.460	-115.0
900	0.641	-156.5	18.23	89.8	0.0242	30.5	0.447	-119.7
1000	0.641	-161.6	16.44	86.5	0.0249	30.4	0.437	-123.8
1100	0.644	-166.1	15.00	83.6	0.0250	27.9	0.431	-127.3
1200	0.648	-169.8	13.75	80.9	0.0252	29.1	0.427	-130.2
1300	0.649	-173.1	12.70	78.4	0.0258	29.4	0.425	-132.7
1400	0.651	-176.2	11.78	76.0	0.0262	29.7	0.423	-134.9
1500	0.651	-179.2	10.97	73.9	0.0263	30.7	0.423	-136.9
1600	0.656	-177.9	10.23	71.8	0.0270	32.4	0.424	-138.7
1700	0.660	-175.5	9.58	69.9	0.0274	33.0	0.425	-140.3
1800	0.665	-173.5	9.01	68.0	0.0282	33.6	0.427	-141.7
1900	0.667	-171.5	8.52	66.1	0.0285	34.5	0.429	-143.0
2000	0.668	-169.3	8.08	64.1	0.0294	34.3	0.432	-144.1
2100	0.669	-167.1	7.65	62.4	0.0297	35.2	0.435	-145.2
2200	0.673	-164.9	7.27	60.7	0.0304	35.9	0.438	-146.2
2300	0.678	-163.1	6.92	59.2	0.0310	36.5	0.441	-147.3
2400	0.683	-161.5	6.61	57.6	0.0318	37.7	0.444	-148.0
2500	0.687	-160.0	6.32	55.9	0.0327	38.0	0.448	-148.9
2600	0.687	-158.2	6.05	54.2	0.0337	37.6	0.450	-149.6
2700	0.688	-156.4	5.80	52.5	0.0339	38.8	0.454	-150.3
2800	0.689	-154.5	5.57	50.9	0.0348	38.8	0.457	-150.9
2900	0.693	-152.9	5.35	49.5	0.0359	39.4	0.460	-151.6
3000	0.698	-151.5	5.16	48.2	0.0364	39.9	0.463	-152.2
3200	0.702	-148.6	4.80	45.0	0.0381	40.5	0.468	-153.4
3400	0.703	-145.0	4.48	41.8	0.0399	40.5	0.473	-154.6
3600	0.709	-142.1	4.19	39.0	0.0418	40.7	0.477	-156.0
3800	0.712	-139.0	3.95	36.0	0.0436	40.1	0.480	-157.3
4000	0.715	-135.4	3.72	32.7	0.0453	39.9	0.483	-158.9
4200	0.723	-132.3	3.51	29.9	0.0477	39.2	0.485	-160.6
4400	0.726	-129.2	3.33	27.0	0.0489	39.3	0.487	-162.5
4600	0.730	-125.4	3.14	23.7	0.0511	38.3	0.490	-164.8
4800	0.742	-122.4	2.98	20.8	0.0531	37.1	0.493	-167.0
5000	0.747	-119.4	2.84	17.8	0.0555	36.5	0.497	-169.5
5200	0.753	-115.9	2.69	14.5	0.0571	35.1	0.503	-172.1
5400	0.765	-113.0	2.55	11.5	0.0592	33.4	0.509	-174.9
5600	0.773	-110.3	2.43	8.4	0.0612	31.6	0.517	-177.8
5800	0.779	-106.9	2.30	5.3	0.0628	30.0	0.525	-179.3
6000	0.790	-104.5	2.18	2.2	0.0643	28.2	0.534	-176.2

## S parameter

 $(V_{CE} = 3.3 \text{ V}, I_C = 30 \text{ mA}, Z_o = 50 \Omega)$ 

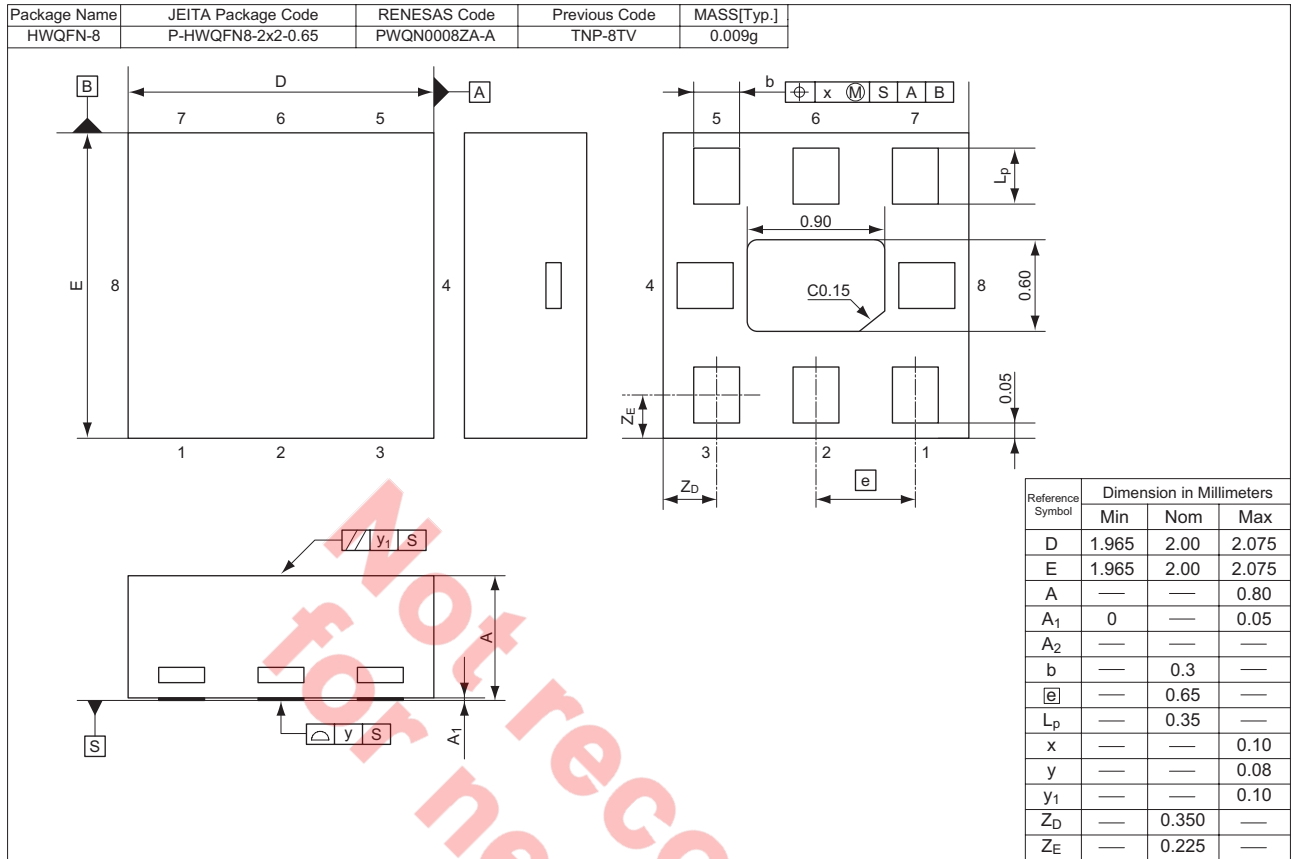
f (MHz)	S11		S21		S12		S22	
	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)
100	0.674	-60.3	48.82	147.33	0.0124	106.4	0.755	-22.6
200	0.708	-53.6	40.51	141.98	0.0146	57.5	0.814	-53.5
300	0.668	-81.6	36.68	128.82	0.0189	39.9	0.690	-70.4
400	0.646	-104.3	33.30	117.87	0.0211	42.3	0.598	-83.9
500	0.637	-121.1	29.33	109.63	0.0216	34.1	0.544	-94.1
600	0.638	-134.3	26.04	102.93	0.0229	32.8	0.506	-102.0
700	0.640	-143.1	23.01	97.82	0.0234	31.7	0.480	-108.7
800	0.639	-150.2	20.48	93.51	0.0239	29.8	0.460	-114.2
900	0.639	-156.1	18.38	89.85	0.0244	30.0	0.448	-119.1
1000	0.639	-161.2	16.56	86.63	0.0247	28.7	0.436	-123.2
1100	0.643	-165.7	15.11	83.71	0.0248	29.6	0.431	-126.6
1200	0.647	-169.5	13.85	80.95	0.0252	27.6	0.426	-129.5
1300	0.648	-172.8	12.80	78.44	0.0259	30.7	0.424	-132.0
1400	0.649	-175.9	11.87	76.09	0.0258	30.7	0.422	-134.3
1500	0.650	-178.9	11.05	73.89	0.0269	31.0	0.422	-136.4
1600	0.653	178.2	10.31	71.81	0.0273	32.5	0.423	-138.2
1700	0.658	175.8	9.66	69.89	0.0276	31.8	0.424	-139.8
1800	0.663	173.7	9.08	67.99	0.0281	33.4	0.426	-141.2
1900	0.665	171.7	8.58	66.10	0.0288	34.3	0.428	-142.5
2000	0.667	169.5	8.14	64.14	0.0294	35.0	0.431	-143.6
2100	0.667	167.3	7.71	62.39	0.0297	35.5	0.434	-144.8
2200	0.671	165.1	7.33	60.67	0.0305	35.8	0.437	-145.7
2300	0.676	163.3	6.97	59.20	0.0311	36.7	0.440	-146.7
2400	0.682	161.6	6.66	57.56	0.0318	37.6	0.443	-147.6
2500	0.685	160.1	6.36	55.90	0.0322	37.5	0.447	-148.4
2600	0.685	158.4	6.10	54.14	0.0337	39.1	0.450	-149.2
2700	0.687	156.5	5.85	52.44	0.0342	38.8	0.453	-149.8
2800	0.688	154.7	5.61	50.90	0.0348	39.2	0.456	-150.6
2900	0.692	153.1	5.39	49.52	0.0355	39.3	0.459	-151.2
3000	0.696	151.6	5.19	48.15	0.0361	39.5	0.462	-151.8
3200	0.701	148.7	4.84	44.97	0.0380	40.5	0.467	-153.0
3400	0.702	145.2	4.51	41.72	0.0397	40.5	0.472	-154.2
3600	0.708	142.3	4.22	39.02	0.0414	40.1	0.476	-155.6
3800	0.710	139.2	3.98	35.99	0.0437	41.0	0.479	-156.9
4000	0.714	135.5	3.75	32.71	0.0458	40.5	0.483	-158.5
4200	0.722	132.4	3.54	29.88	0.0477	39.9	0.484	-160.3
4400	0.724	129.4	3.35	26.99	0.0490	38.8	0.487	-162.2
4600	0.729	125.5	3.17	23.61	0.0509	38.5	0.489	-164.4
4800	0.740	122.4	3.01	20.69	0.0530	37.5	0.493	-166.7
5000	0.746	119.5	2.86	17.76	0.0554	36.7	0.497	-169.1
5200	0.752	115.9	2.71	14.45	0.0573	35.6	0.502	-171.7
5400	0.764	113.1	2.57	11.42	0.0592	33.8	0.509	-174.6
5600	0.773	110.4	2.45	8.38	0.0614	31.9	0.516	-177.5
5800	0.778	107.0	2.32	5.20	0.0623	30.6	0.524	179.6
6000	0.789	104.5	2.19	2.09	0.0639	28.1	0.534	176.6

## S parameter

 $(V_{CE} = 3.6 \text{ V}, I_C = 30 \text{ mA}, Z_o = 50 \Omega)$ 

f (MHz)	S11		S21		S12		S22	
	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)
100	0.686	-60.1	49.50	147.35	0.0070	30.5	0.897	-21.2
200	0.713	-53.6	41.32	141.93	0.0155	53.8	0.815	-52.9
300	0.669	-81.1	37.11	128.90	0.0200	42.6	0.690	-69.6
400	0.645	-103.8	33.55	118.06	0.0199	37.3	0.605	-83.3
500	0.637	-120.5	29.52	109.81	0.0221	34.8	0.546	-93.3
600	0.638	-133.6	26.17	103.15	0.0222	31.6	0.507	-101.4
700	0.638	-142.5	23.13	98.02	0.0238	30.5	0.481	-108.1
800	0.637	-149.7	20.59	93.66	0.0239	28.3	0.461	-113.7
900	0.638	-155.6	18.47	90.02	0.0243	28.8	0.447	-118.4
1000	0.638	-160.8	16.65	86.77	0.0245	29.0	0.437	-122.5
1100	0.642	-165.3	15.20	83.83	0.0251	29.2	0.431	-125.9
1200	0.645	-169.1	13.93	81.07	0.0256	29.2	0.427	-129.0
1300	0.645	-172.4	12.87	78.55	0.0253	30.2	0.424	-131.4
1400	0.648	-175.6	11.94	76.19	0.0263	30.9	0.423	-133.8
1500	0.648	-178.6	11.11	73.98	0.0268	30.6	0.422	-135.8
1600	0.652	-178.5	10.37	71.89	0.0271	32.1	0.423	-137.7
1700	0.657	-176.1	9.71	69.97	0.0274	32.5	0.424	-139.3
1800	0.662	-174.0	9.13	68.06	0.0279	33.0	0.426	-140.7
1900	0.664	-171.9	8.62	66.16	0.0287	33.5	0.428	-142.1
2000	0.665	-169.8	8.18	64.18	0.0292	34.2	0.431	-143.2
2100	0.666	-167.5	7.75	62.44	0.0298	34.7	0.433	-144.3
2200	0.670	-165.3	7.37	60.71	0.0306	35.9	0.436	-145.4
2300	0.675	-163.5	7.01	59.24	0.0310	36.8	0.439	-146.3
2400	0.680	-161.9	6.69	57.59	0.0316	36.8	0.443	-147.1
2500	0.684	-160.4	6.40	55.92	0.0322	37.7	0.446	-148.0
2600	0.683	-158.7	6.13	54.16	0.0335	38.0	0.450	-148.8
2700	0.684	-156.8	5.88	52.46	0.0338	39.0	0.453	-149.5
2800	0.686	-154.9	5.64	50.91	0.0345	39.3	0.455	-150.1
2900	0.691	-153.2	5.42	49.54	0.0349	39.4	0.459	-150.8
3000	0.695	-151.8	5.22	48.16	0.0364	39.8	0.462	-151.4
3200	0.700	-148.9	4.86	44.99	0.0383	40.4	0.467	-152.5
3400	0.700	-145.3	4.53	41.72	0.0399	40.5	0.472	-153.9
3600	0.706	-142.4	4.24	39.01	0.0420	40.3	0.476	-155.2
3800	0.709	-139.3	4.00	36.00	0.0430	40.9	0.479	-156.6
4000	0.713	-135.6	3.77	32.71	0.0452	40.3	0.482	-158.1
4200	0.721	-132.6	3.56	29.88	0.0471	40.2	0.485	-159.9
4400	0.723	-129.5	3.37	26.99	0.0489	39.2	0.487	-161.8
4600	0.728	-125.6	3.18	23.59	0.0510	38.4	0.489	-164.0
4800	0.739	-122.6	3.02	20.67	0.0527	37.6	0.492	-166.4
5000	0.745	-119.7	2.87	17.72	0.0551	36.4	0.496	-168.8
5200	0.751	-116.1	2.72	14.42	0.0573	35.6	0.502	-171.4
5400	0.762	-113.2	2.58	11.39	0.0590	33.7	0.509	-174.3
5600	0.771	-110.4	2.46	8.34	0.0610	32.0	0.516	-177.2
5800	0.777	-107.1	2.33	5.17	0.0624	30.4	0.524	-179.8
6000	0.788	-104.7	2.21	2.04	0.0638	28.5	0.533	-176.8

### Package Dimensions



### Ordering Information

Part Name	Quantity	Shipping Container
HSG2004TB-E	2000 pcs.	φ178 mm Reel, 8 mm Emboss Taping

Note: Therefore especially small contact area of terminal, miss contact may occur if inadequate soldering condition is applied.

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