

# NSF2250WT1

## NPN Silicon Oscillator and Mixer Transistor

The NSF2250WT1 NPN silicon epitaxial bipolar transistor is intended for use in general purpose UHF oscillator and mixer applications. It is suitable for automotive keyless entry and TV tuner designs.

The device features stable oscillation and small frequency drift during changes in the supply voltage and over the ambient temperature range.

### Features

- High Gain Bandwidth Product:  $f_T = 2000$  MHz Minimum
- Tightly Controlled  $h_{FE}$  Range:  $h_{FE} = 120$  to 250
- Low Feedback Capacitance:  $C_{RE} = 0.45$  pF Typical
- Pb-Free Package is Available

### MAXIMUM RATINGS

Rating	Symbol	Value	Units
Collector to Base Voltage	$V_{CBO}$	30	V
Collector to Emitter Voltage	$V_{CEO}$	15	V
Emitter to Base Voltage	$V_{EBO}$	3.0	V
Collector Current	$I_C$	50	mA
Electrostatic Discharge	ESD	HBM – Class 1C MM – Class A	

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	202 (Note 1) 310 (Note 2) 1.6 (Note 1) 2.5 (Note 2)	mW mW/ $^\circ\text{C}$
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	618 (Note 1) 403 (Note 2)	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Lead	$R_{\theta JL}$	280 (Note 1) 332 (Note 2)	$^\circ\text{C}/\text{W}$
Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$

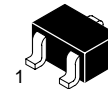
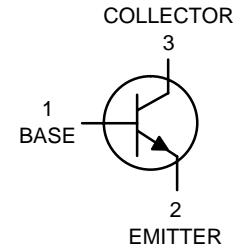
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. FR-4 @ Minimum Pad
2. FR-4 @ 1.0 x 1.0 inch Pad



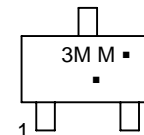
ON Semiconductor®

<http://onsemi.com>



SOT-323/SC-70  
CASE 419  
STYLE 3

### MARKING DIAGRAM



3M = Specific Device Code  
M = Date Code\*  
■ = Pb-Free Package

(Note: Microdot may be in either location)

\*Date Code orientation may vary depending upon manufacturing location.

### ORDERING INFORMATION

Device	Package	Shipping†
NSF2250WT1	SOT-323	3000/Tape & Reel
NSF2250WT1G	SOT-323 (Pb-Free)	3000/Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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## ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ )

Characteristic	Symbol	Min	Typ	Max	Unit
Collector Cutoff Current $V_{CB} = 12\text{ V}, I_E = 0$	$I_{CBO}$	–	–	0.1	$\mu\text{A}$
DC Current Gain $V_{CE} = 10\text{ V}, I_C = 5.0\text{ mA}$	$h_{FE}$	120	–	250	–
Collector Saturation Voltage $I_C = 10\text{ mA}, I_B = 1.0\text{ mA}$	$V_{CE(sat)}$	–	–	0.5	V
Gain Bandwidth Product $V_{CE} = 3\text{ V}, I_E = -5.0\text{ mA}$	$f_T$	2.0	2.3	–	GHz
Output Capacitance $V_{CB} = 3\text{ V}, I_E = 0\text{ mA}, f = 1.0\text{ MHz}$	$C_{OB}$	–	0.7	1.2	pF
Collector to Base Time Constant $V_{CE} = 3\text{ V}, I_E = -5.0\text{ mA}, f = 31.9\text{ MHz}$	$C_C \cdot r_{b'b}$	–	3.5	8.0	ps
Feedback Capacitance $V_{CB} = 10\text{ V}, I_E = 0\text{ mA}, f = 1.0\text{ MHz}$	$C_{RE}$	–	0.45	–	pF

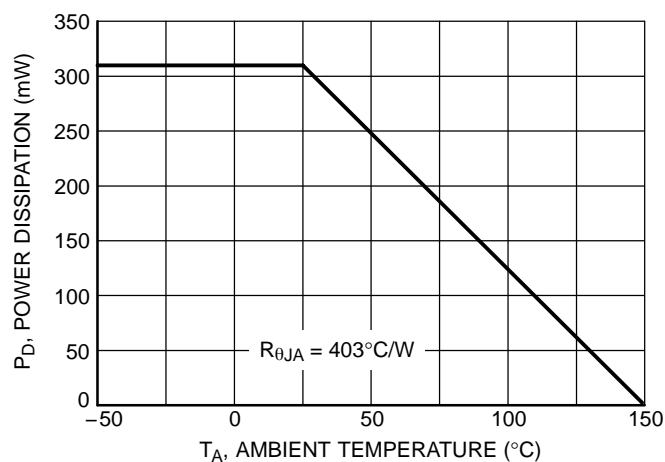
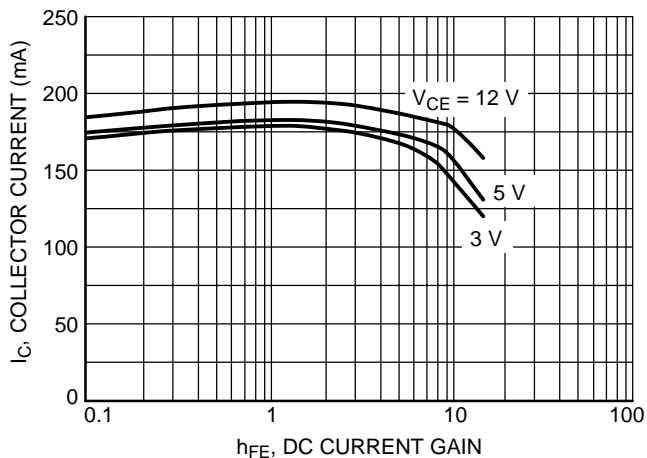
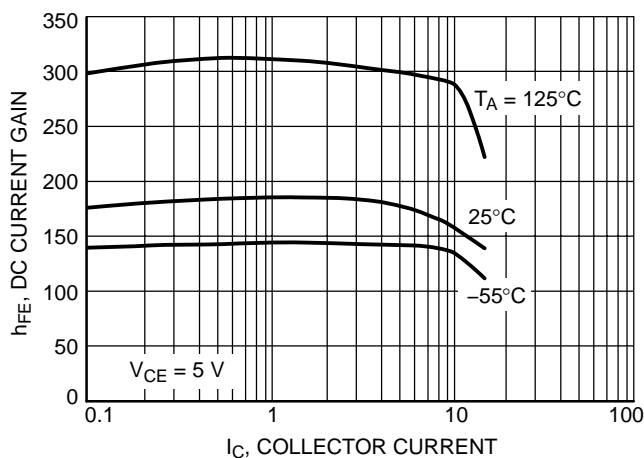


Figure 1. Derating Curve

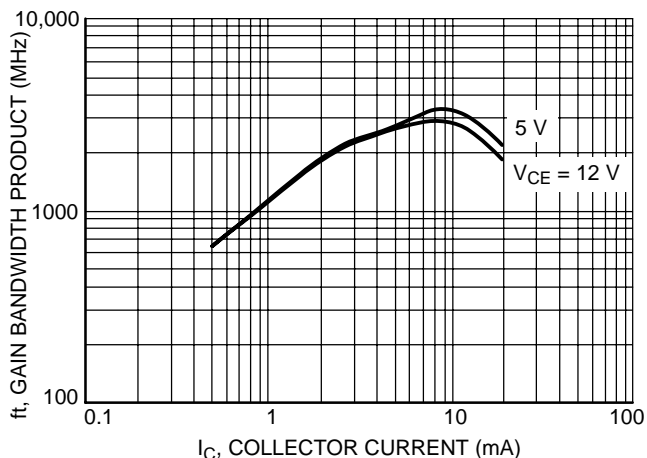
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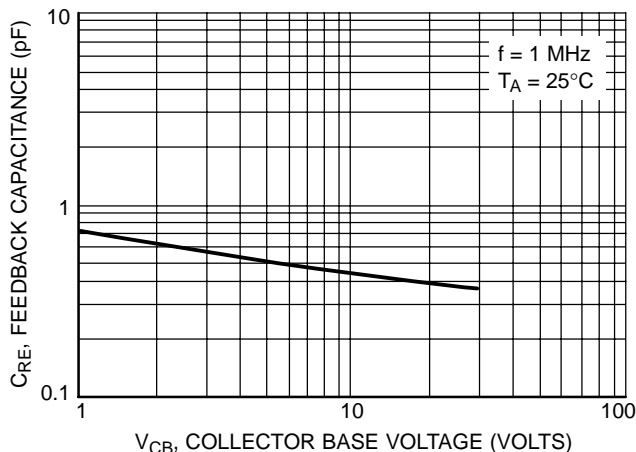
**Figure 2. DC Current Gain versus Collector Current**



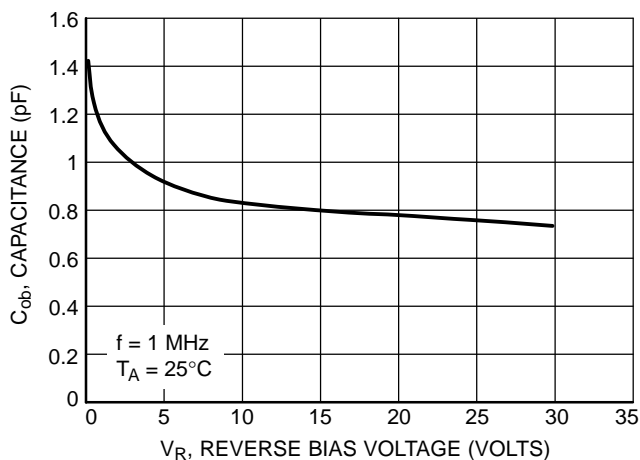
**Figure 3. DC Current Gain versus Collector Current**



**Figure 4. Gain Bandwidth Product versus Collector Current**



**Figure 5. Device Capacitance versus Collector Base Voltage**



**Figure 6. Output Capacitance**

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## TYPICAL COMMON EMITTER SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
$V_{CE} = 2.5\text{ V}, I_C = 2.5\text{ mA}$								
50	0.926	-14.124	6.803	162.639	0.018	82.792	0.973	-7.062
100	0.855	-26.794	6.224	148.649	0.034	73.296	0.921	-12.818
200	0.667	-47.287	5.033	126.317	0.058	62.292	0.807	-19.210
300	0.513	-60.931	4.072	110.981	0.074	58.641	0.736	-21.979
400	0.411	-70.342	3.326	100.524	0.090	57.333	0.694	-23.695
500	0.342	-77.461	2.831	92.771	0.104	56.067	0.670	-25.311
600	0.297	-84.335	2.445	86.222	0.117	55.166	0.651	-27.095
700	0.261	-90.986	2.154	80.493	0.131	53.800	0.637	-29.095
800	0.236	-97.798	1.935	75.382	0.144	52.087	0.627	-31.026
900	0.218	-104.905	1.755	70.672	0.155	50.745	0.617	-33.167
1000	0.205	-112.449	1.617	66.258	0.168	49.386	0.608	-35.352
1500	0.190	-147.224	1.200	48.079	0.219	42.418	0.575	-46.016
2000	0.215	-171.677	1.011	33.299	0.258	35.910	0.544	-58.267
2500	0.230	-172.291	0.889	20.271	0.294	31.024	0.510	-68.713
3000	0.236	-155.125	0.866	10.984	0.340	28.868	0.450	-81.517

## TYPICAL COMMON EMITTER SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
$V_{CE} = 3\text{ V}, I_C = 5\text{ mA}$								
50	0.858	-20.126	12.065	156.269	0.017	78.802	0.945	-10.278
100	0.733	-36.552	10.452	139.116	0.029	69.100	0.850	-16.656
200	0.493	-58.358	7.472	115.678	0.047	62.893	0.712	-20.497
300	0.362	-69.976	5.544	103.053	0.062	62.188	0.653	-21.545
400	0.288	-78.272	4.337	94.866	0.075	61.876	0.621	-22.551
500	0.242	-85.666	3.582	88.592	0.090	61.259	0.603	-23.975
600	0.212	-93.237	3.048	83.504	0.103	59.861	0.590	-25.526
700	0.190	-101.308	2.656	78.785	0.116	58.802	0.580	-27.405
800	0.177	-109.656	2.375	74.561	0.128	57.017	0.573	-29.334
900	0.167	-118.336	2.145	70.348	0.141	55.629	0.563	-31.402
1000	0.163	-127.188	1.968	66.700	0.153	53.851	0.555	-33.301
1500	0.176	-164.287	1.435	50.083	0.203	47.574	0.528	-43.164
2000	0.210	-174.155	1.187	35.998	0.246	41.767	0.501	-54.213
2500	0.226	-159.754	1.034	23.227	0.288	36.614	0.469	-63.689
3000	0.239	-144.224	0.995	14.088	0.340	34.458	0.413	-74.387

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## TYPICAL COMMON EMITTER SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
$V_{CE} = 3\text{ V}, I_C = 10\text{ mA}$								
50	0.643	-35.313	15.384	140.063	0.015	69.823	0.864	-14.048
100	0.459	-53.013	11.650	121.580	0.024	63.636	0.738	-17.013
200	0.289	-70.035	7.214	104.714	0.040	65.531	0.647	-17.265
300	0.225	-80.644	5.260	96.934	0.053	66.205	0.618	-18.444
400	0.192	-91.607	4.122	91.266	0.068	66.344	0.598	-20.216
500	0.172	-102.488	3.419	86.447	0.082	64.574	0.584	-22.273
600	0.161	-113.748	2.929	82.212	0.096	63.206	0.572	-24.418
700	0.156	-125.151	2.575	78.231	0.107	61.822	0.561	-26.828
800	0.155	-135.549	2.313	74.282	0.119	60.606	0.553	-28.821
900	0.156	-145.469	2.099	70.461	0.131	59.154	0.543	-31.132
1000	0.163	-153.718	1.925	67.004	0.141	57.409	0.536	-33.247
1500	0.201	-175.526	1.415	50.535	0.193	52.024	0.505	-43.365
2000	0.237	-159.398	1.173	36.726	0.240	46.396	0.477	-54.652
2500	0.247	-147.097	1.021	24.113	0.289	41.529	0.444	-64.094
3000	0.259	-133.925	0.982	15.023	0.346	38.491	0.382	-75.243

## TYPICAL COMMON EMITTER SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
$V_{CE} = 10\text{ V}, I_C = 5\text{ mA}$								
50	0.877	-17.278	11.972	157.707	0.012	81.580	0.972	-7.268
100	0.765	-31.274	10.386	140.944	0.022	72.099	0.900	-12.126
200	0.539	-49.213	7.575	118.277	0.037	66.849	0.803	-14.944
300	0.406	-57.758	5.678	105.478	0.049	66.104	0.757	-16.182
400	0.334	-63.347	4.464	97.467	0.062	65.473	0.729	-17.508
500	0.286	-68.461	3.698	91.347	0.073	64.460	0.717	-19.007
600	0.252	-73.828	3.159	86.264	0.085	63.014	0.706	-20.874
700	0.227	-79.612	2.766	81.745	0.095	62.100	0.697	-22.551
800	0.208	-86.135	2.474	77.803	0.106	60.785	0.690	-24.442
900	0.190	-93.121	2.237	73.571	0.116	59.532	0.682	-26.405
1000	0.179	-100.507	2.047	70.150	0.125	57.905	0.674	-28.385
1500	0.162	-139.494	1.495	53.949	0.169	52.604	0.652	-37.411
2000	0.185	-167.453	1.242	40.156	0.207	47.697	0.631	-47.834
2500	0.200	-175.534	1.082	27.306	0.247	44.045	0.609	-55.962
3000	0.208	-159.130	1.050	18.234	0.296	42.716	0.557	-65.696

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$V_{CE} = 2.5 \text{ V}$ ,  $I_C = 2.5 \text{ mA}$

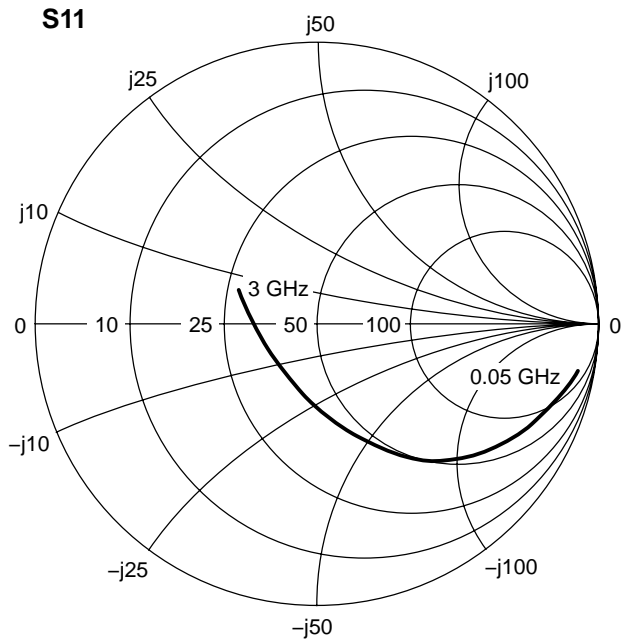


Figure 7. Input Reflection Coefficient

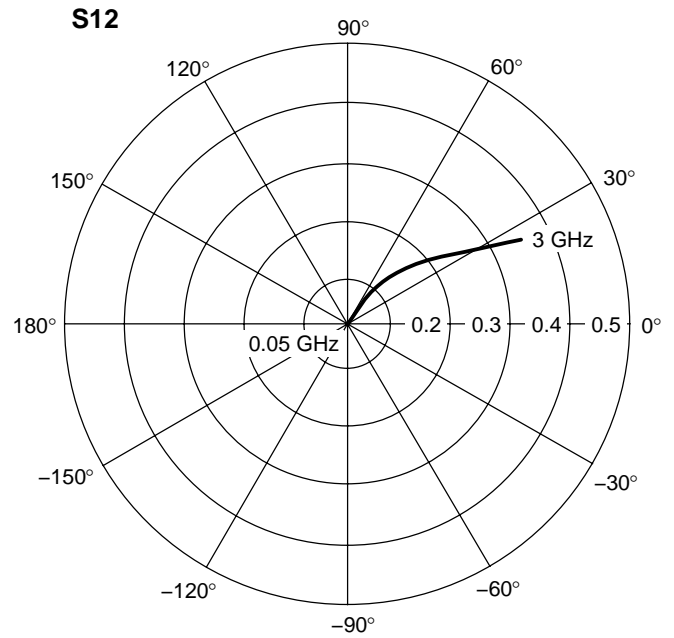


Figure 8. Reverse Transmission Coefficient

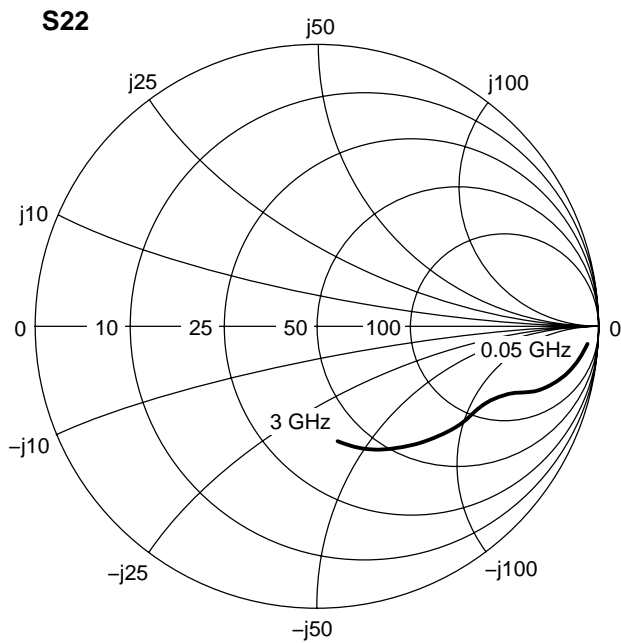


Figure 9. Output Reflection Coefficient

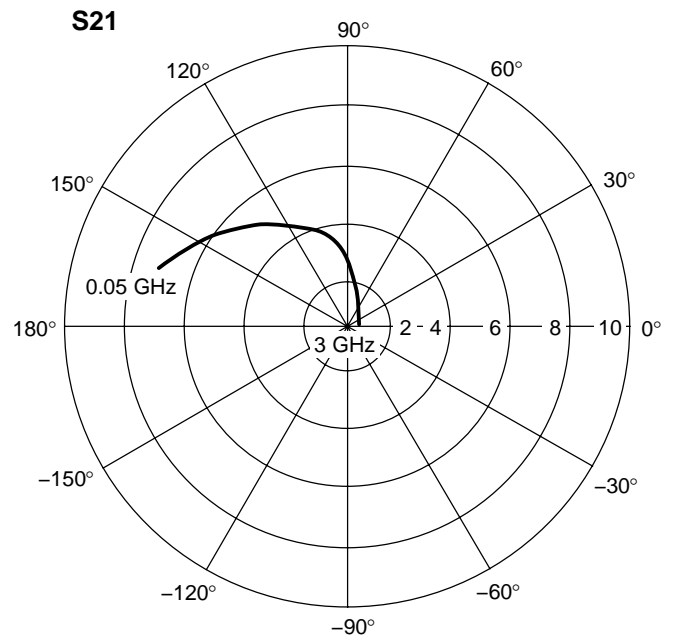


Figure 10. Forward Transmission Coefficient

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$V_{CE} = 3.0 \text{ V}$ ,  $I_C = 10 \text{ mA}$

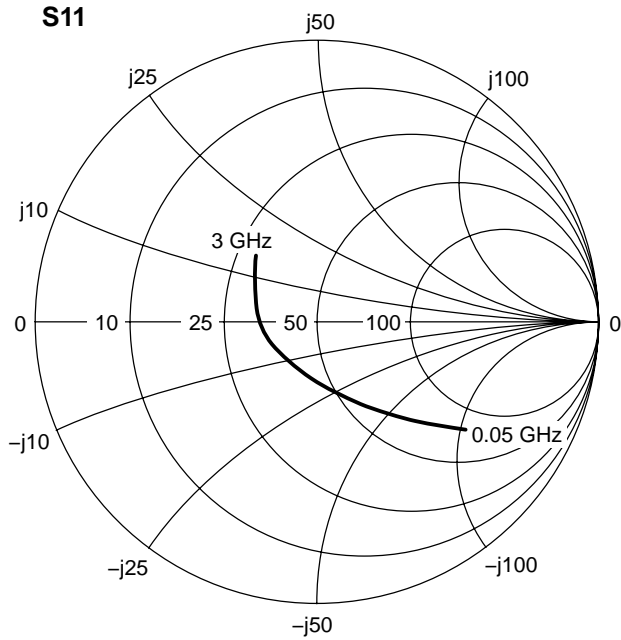


Figure 11. Input Reflection Coefficient

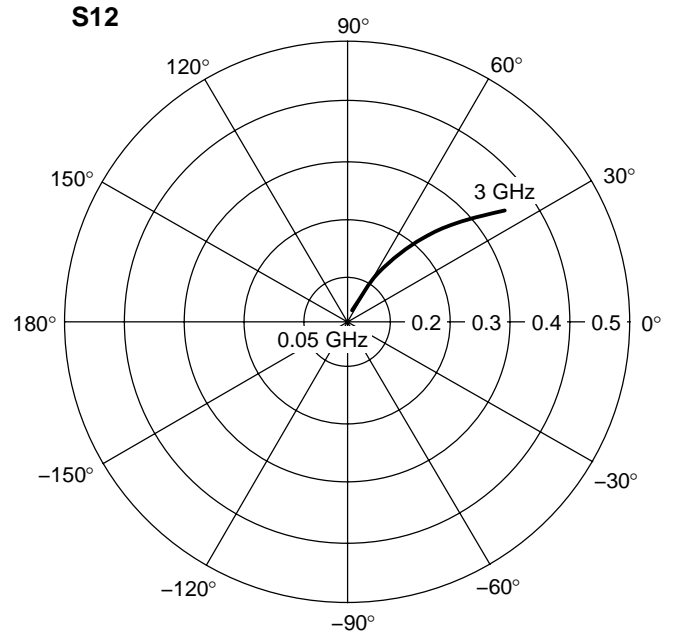


Figure 12. Reverse Transmission Coefficient

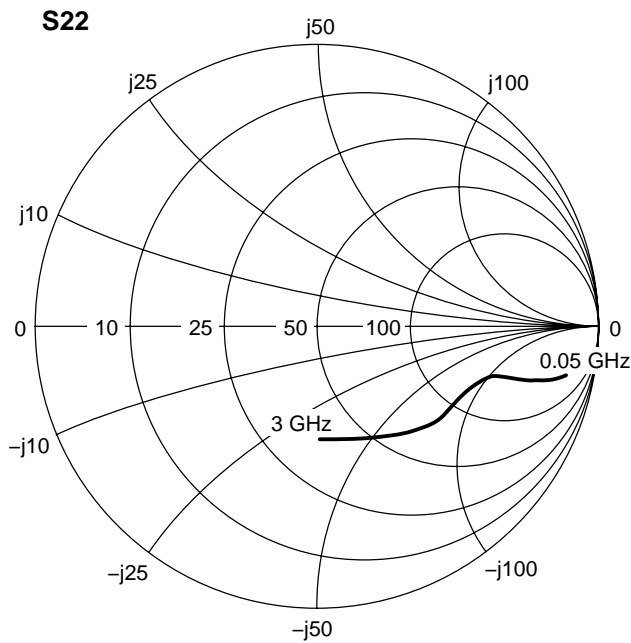


Figure 13. Output Reflection Coefficient

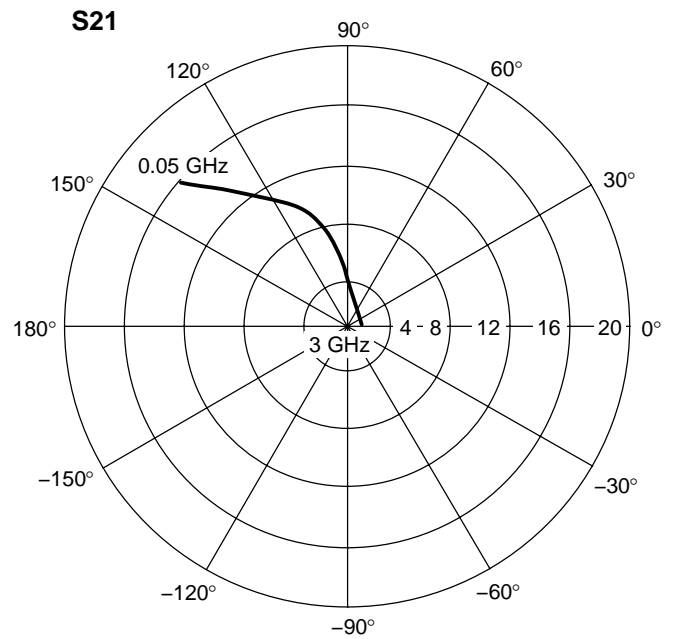


Figure 14. Forward Transmission Coefficient

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## TYPICAL COMMON BASE SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang

$V_{CE} = 2.5\text{ V}$ ,  $I_C = 2.5\text{ mA}$

50	0.627	176.455	1.6218	-3.3808	0.003	81.692	1.006	-1.7455
100	0.626	172.821	1.6153	-6.8404	0.008	87.954	1.002	-3.5734
200	0.622	165.583	1.6042	-13.205	0.014	92.620	1.005	-6.7806
400	0.608	151.867	1.5630	-26.289	0.031	96.834	1.006	-13.779
600	0.589	138.455	1.5099	-39.579	0.052	96.285	1.016	-21.141
800	0.566	126.103	1.4461	-52.382	0.076	94.675	1.022	-28.553
1000	0.541	114.811	1.3613	-65.315	0.102	90.577	1.026	-36.519
1500	0.476	89.445	1.1404	-98.892	0.170	78.774	1.014	-57.448
2000	0.397	68.206	0.8928	-133.58	0.233	68.003	0.922	-77.708

## TYPICAL COMMON BASE SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang

$V_{CE} = 3\text{ V}$ ,  $I_C = 5\text{ mA}$

50	0.781	176.95	1.7732	-3.0425	0.004	85.472	1.006	-1.6658
100	0.780	174.093	1.7625	-5.9870	0.006	88.871	1.002	-3.5604
200	0.776	168.012	1.7622	-11.733	0.013	94.408	1.004	-6.7723
400	0.759	156.688	1.7285	-23.541	0.029	100.70	1.006	-13.627
600	0.743	145.893	1.6911	-35.161	0.047	100.93	1.015	-20.799
800	0.725	135.660	1.6441	-46.886	0.071	98.938	1.024	-28.057
1000	0.709	126.241	1.5817	-58.697	0.095	95.803	1.031	-35.921
1500	0.674	103.465	1.4275	-90.316	0.172	85.633	1.037	-56.915
2000	0.620	81.3686	1.1968	-123.89	0.249	73.589	0.957	-77.953

## TYPICAL COMMON BASE SCATTERING PARAMETER ( $T_A = 25^\circ\text{C}$ )

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang

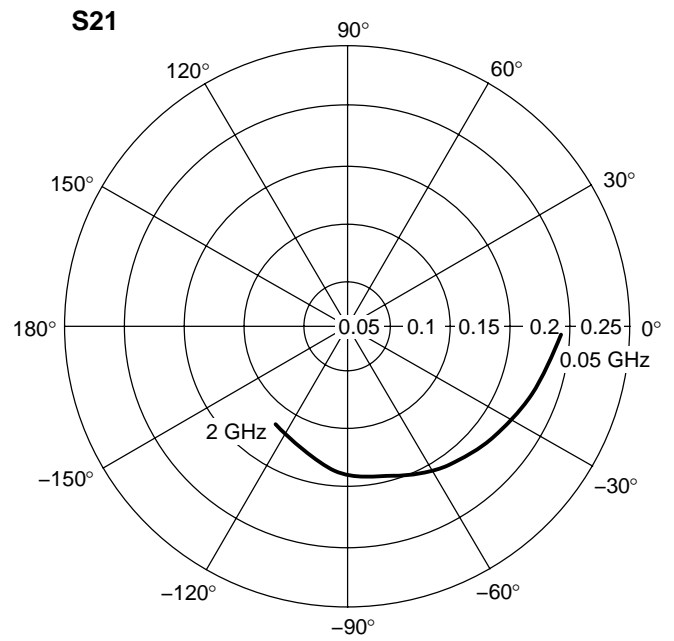
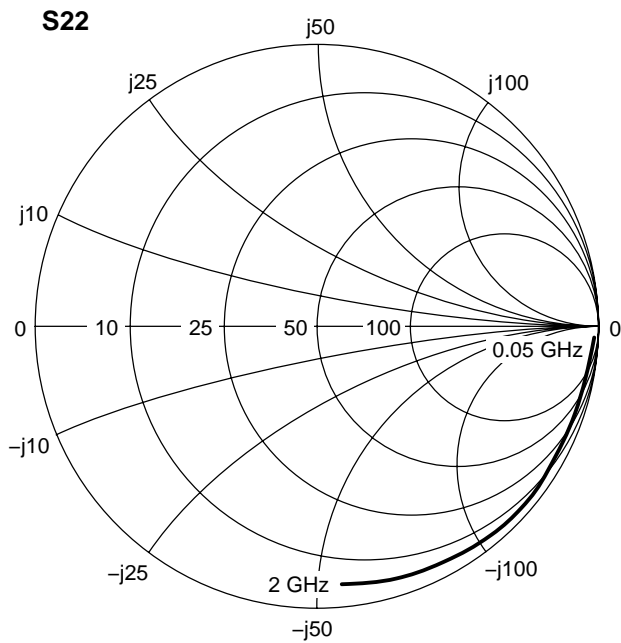
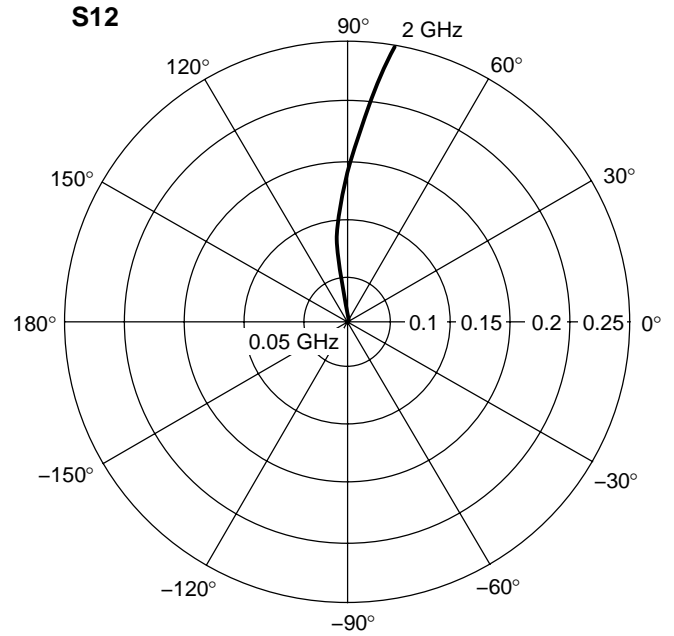
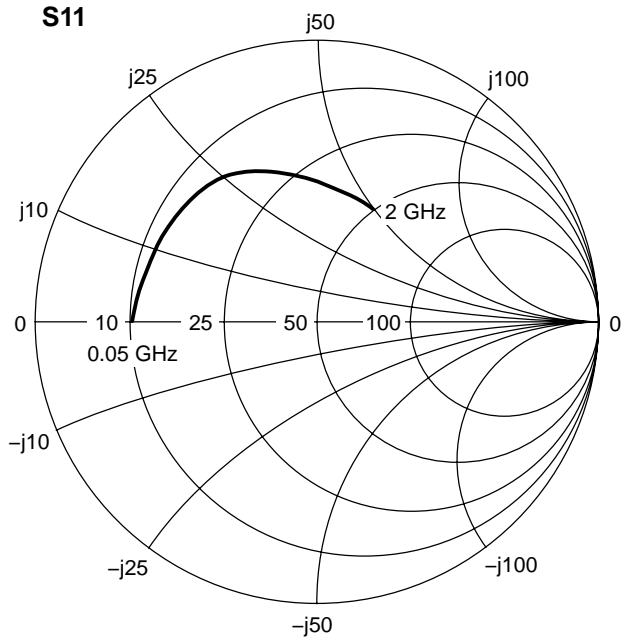
$V_{CE} = 3\text{ V}$ ,  $I_C = 10\text{ mA}$

50	0.867	176.898	1.8601	-3.2938	0.004	88.195	1.006	-1.7132
100	0.863	173.941	1.8432	-6.3479	0.007	90.044	1.001	-3.6916
200	0.851	167.942	1.8370	-12.359	0.014	91.598	1.003	-6.9503
400	0.821	157.527	1.7814	-23.95	0.029	96.128	1.003	-13.909
600	0.795	148.933	1.7303	-34.993	0.045	97.955	1.011	-21.082
800	0.782	139.487	1.6831	-46.443	0.067	98.521	1.018	-28.456
1000	0.773	131.501	1.6327	-57.916	0.091	96.532	1.024	-36.296
1500	0.765	110.253	1.4975	-89.11	0.169	88.005	1.031	-57.462
2000	0.730	87.937	1.2711	-123.21	0.253	76.070	0.950	-78.777



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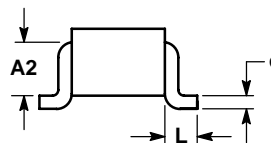
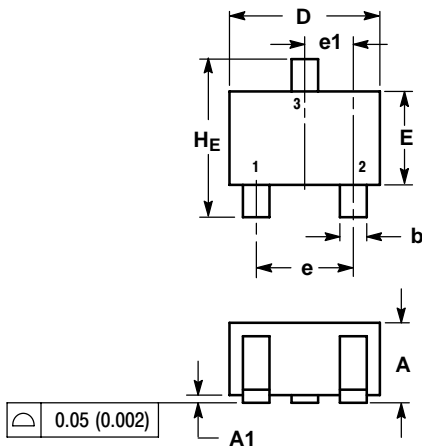
$V_{CE} = 2.5 \text{ V}$ ,  $I_C = 2.5 \text{ mA}$



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## PACKAGE DIMENSIONS

SC-70 (SOT-323)  
CASE 419-04  
ISSUE M

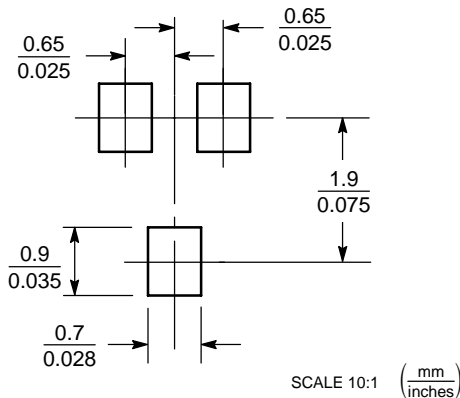


- NOTES:  
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.90	1.00	0.032	0.035	0.040
A1	0.00	0.05	0.10	0.000	0.002	0.004
A2	0.7 REF			0.028 REF		
b	0.30	0.35	0.40	0.012	0.014	0.016
c	0.10	0.18	0.25	0.004	0.007	0.010
D	1.80	2.10	2.20	0.071	0.083	0.087
E	1.15	1.24	1.35	0.045	0.049	0.053
e	1.20	1.30	1.40	0.047	0.051	0.055
e1	0.65 BSC			0.026 BSC		
L	0.425 REF			0.017 REF		
HE	2.00	2.10	2.40	0.079	0.083	0.095

- STYLE 3:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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