

# SILICON TRANSISTOR 2SC5180

## NPN EPITAXIAL SILICON TRANSISTOR IN SUPER MINI-MOLD PACKAGE FOR LOW-NOISE MICROWAVE AMPLIFICATION

#### **FEATURES**

- Low current consumption and high gain
   |S<sub>21e</sub>|<sup>2</sup> = 12 dB TYP. @ VcE = 2 V, Ic = 7 mA, f = 2 GHz
   |S<sub>21e</sub>|<sup>2</sup> = 11 dB TYP. @ VcE = 1 V, Ic = 5 mA, f = 2 GHz
- Supper Mini-Mold package

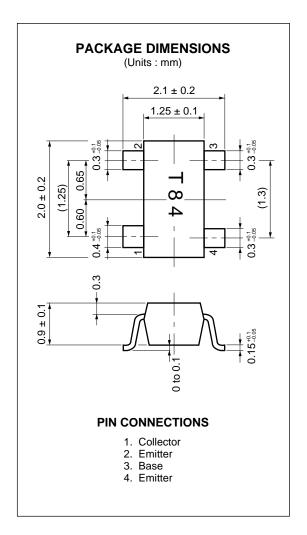
#### ORDERING INFORMATION

PART NUMBER	QUANTITY	ARRANGEMENT
2SC5180-T1	3 000 units/reel	Embossed tape, 8 mm wide, pins No. 3 (base) and No. 4 (emitter) facing the perforations
2SC5180-T2	3 000 uills/leel	Embossed tape, 8 mm wide, pins No. 1 (collector) and No. 2 (emitter) facing the perforations

<sup>\*</sup> Contact your NEC sales representatives to order samples for evaluation (available in batches of 50).

#### ABSOLUTE MAXIMUM RATINGS (TA = 25 $^{\circ}$ C)

Collector to Base Voltage	Vсво	5	V
Collector to Emitter Voltage	VCEO	3	V
Emitter to Base Voltage	VEBO	2	V
Collector Current	Ic	10	mA
Total Power Dissipation	Рт	30	mW
Junction Temperature	$T_j$	150	°C
Storage Temperature	$T_{stg}$	-65 to +150	°C



Caution; This transistor uses high-frequency technology. Be careful not to allow excessive current to flow through the transistor, including static electricity.



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

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Collector Cutoff Current	Ісво			100	nA	Vcb = 5 V, IE = 0
Emitter Cutoff Current	ІЕВО			100	nA	VEB = 1 V, IC = 0
DC Current Gain	hfe	70		140		VcE = 2 V, Ic = 7 mA*1
Insertion Power Gain (1)	S <sub>21e</sub>   <sup>2</sup>	10	12		dB	VcE = 2 V, Ic = 7 mA, f = 2 GHz
Insertion Power Gain (2)	S <sub>21e</sub>   <sup>2</sup>	8.5	11		dB	VcE = 1 V, Ic = 5 mA, f = 2 GHz
Noise Figure (1)	NF		1.5	2.0	dB	VcE = 2 V, Ic = 3 mA, f = 2 GHz
Noise Figure (2)	NF		1.5	2.0	dB	VcE = 1 V, Ic = 3 mA, f = 2 GHz
Gain Bandwidth Product (1)	fт	12	15.5		GHz	VcE = 2 V, Ic = 7 mA, f = 2 GHz
Gain Bandwidth Product (2)	fт	10	13		GHz	VcE = 1 V, Ic = 5 mA, f = 2 GHz
Feedback Capacitance	Cre		0.3	0.5	pF	VcB = 2 V, IE = 0 mA, f = 1 MHz*2

<sup>\* 1 :</sup> Measured with pulses : Pulse width  $\leq$  350  $\mu$ s, duty cycle  $\leq$  2 %, pulsed

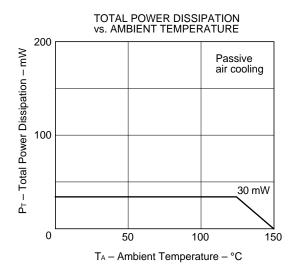
#### hee class

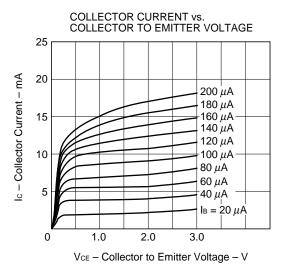
Class	FB
Marking	T84
hfE	70 to 140

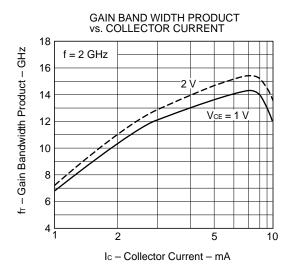
2

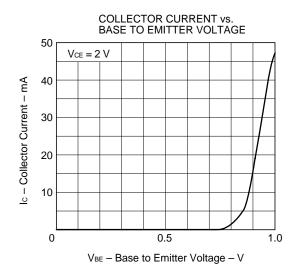
<sup>\* 2 :</sup> Measured with a three-terminal bridge. The emitter and case terminal are connected to the guard terminal of the bridge.

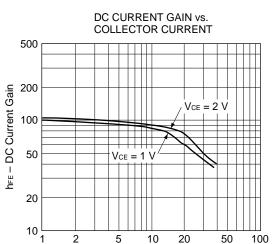
#### CHARACTERISTICS CURVES (TA = 25 °C)



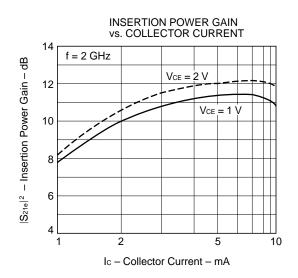


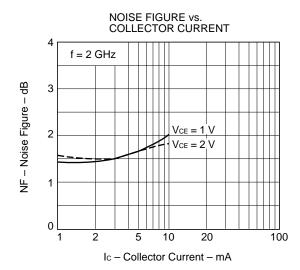


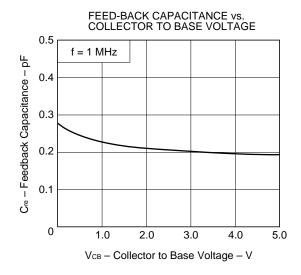




Ic - Collector Current - mA









#### **S-PARAMETER**

	A 7. FO (							
VCE = 1 V, IC = 1 m/s	$A, ZO = 50 \Omega$	2						
FREQUENCY		S11	S	21	S	12	S	22
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.916	-28.0	3.247	147.1	0.074	65.6	0.960	-21.2
800.00	0.816	-36.9	3.092	136.2	0.111	58.6	0.887	-26.2
1000.00	0.741	<b>-47.1</b>	2.929	125.5	0.140	54.4	0.810	-32.8
1200.00	0.691	-55.8	2.864	116.5	0.158	52.2	0.788	-39.3
1400.00	0.628	-63.3	2.762	109.6	0.179	48.2	0.744	-44.5
1600.00	0.558	-72.3	2.590	100.9	0.195	44.8	0.692	-49.2
1800.00	0.508	-80.9	2.505	93.4	0.199	43.7	0.647	-54.7
2000.00	0.444	-87.8	2.293	88.1	0.196	39.5	0.602	-58.2
2200.00	0.386	-94.3	2.111	81.8	0.201	35.8	0.575	-61.2
VCE = 1 V, IC = 3 m/	A, Zo = 50 <u>c</u>	2						
FREQUENCY		S11	S	21	S	12	S	22
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.694	-43.6	6.614	129.7	0.063	57.9	0.819	-30.4
800.00	0.557	-54.5	5.730	117.1	0.090	54.4	0.707	-35.6
1000.00	0.463	-63.1	5.054	106.4	0.113	52.6	0.609	-41.1
1200.00	0.394	-70.7	4.628	99.0	0.115	54.2	0.575	-45.5
1400.00	0.325	-78.9	4.123	92.2	0.123	52.5	0.526	-48.8
1600.00	0.269	-88.2	3.744	84.3	0.157	51.5	0.478	-52.5
1800.00	0.226	-96.9	3.488	79.4	0.160	52.5	0.441	-57.0
2000.00	0.220	-103.5	3.085	75.5	0.166	50.8	0.412	-57.0 -57.9
2200.00	0.146	-103.3 -111.9	2.776	73.5 70.5	0.174	48.1	0.412	-60.0
			2.770	70.5	0.174	40.1	0.401	-00.0
VCE = 1 V, $IC = 5 m$	A, $Z_0 = 50 \ \Omega$	2						
FREQUENCY	;	S11	S	21	S	12	S	22
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00				120.8	0.055	57.5		-33.5
	0.556	<del>-</del> 51.5	7.925	120.0	0.055		0.729	
800.00	0.430	-61.6	6.573	108.7	0.083	55.0	0.614	-37.4
800.00 1000.00	0.430 0.338	-61.6 -68.2	6.573 5.644	108.7 98.8	0.083 0.102	55.0 54.0	0.614 0.527	-37.4 -41.0
800.00 1000.00 1200.00	0.430 0.338 0.271	-61.6 -68.2 -75.3	6.573 5.644 5.047	108.7 98.8 92.4	0.083	55.0 54.0 57.7	0.614 0.527 0.498	-37.4 -41.0 -44.6
800.00 1000.00 1200.00 1400.00	0.430 0.338 0.271 0.217	-61.6 -68.2 -75.3 -84.1	6.573 5.644 5.047 4.409	108.7 98.8 92.4 86.0	0.083 0.102 0.117 0.133	55.0 54.0 57.7 56.5	0.614 0.527 0.498 0.451	-37.4 -41.0 -44.6 -47.5
800.00 1000.00 1200.00 1400.00 1600.00	0.430 0.338 0.271 0.217 0.171	-61.6 -68.2 -75.3 -84.1 -94.6	6.573 5.644 5.047 4.409 3.985	108.7 98.8 92.4 86.0 78.8	0.083 0.102 0.117 0.133 0.148	55.0 54.0 57.7 56.5 55.9	0.614 0.527 0.498 0.451 0.414	-37.4 -41.0 -44.6 -47.5 -50.0
800.00 1000.00 1200.00 1400.00 1600.00	0.430 0.338 0.271 0.217	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4	6.573 5.644 5.047 4.409 3.985 3.674	108.7 98.8 92.4 86.0 78.8 74.9	0.083 0.102 0.117 0.133 0.148 0.155	55.0 54.0 57.7 56.5 55.9 57.4	0.614 0.527 0.498 0.451 0.414 0.382	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9
800.00 1000.00 1200.00 1400.00 1600.00	0.430 0.338 0.271 0.217 0.171 0.137	-61.6 -68.2 -75.3 -84.1 -94.6	6.573 5.644 5.047 4.409 3.985	108.7 98.8 92.4 86.0 78.8	0.083 0.102 0.117 0.133 0.148	55.0 54.0 57.7 56.5 55.9	0.614 0.527 0.498 0.451 0.414	-37.4 -41.0 -44.6 -47.5 -50.0
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3	6.573 5.644 5.047 4.409 3.985 3.674 3.229	108.7 98.8 92.4 86.0 78.8 74.9 71.4	0.083 0.102 0.117 0.133 0.148 0.155 0.162	55.0 54.0 57.7 56.5 55.9 57.4 55.7	0.614 0.527 0.498 0.451 0.414 0.382 0.361	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897	108.7 98.8 92.4 86.0 78.8 74.9 71.4	0.083 0.102 0.117 0.133 0.148 0.155 0.162	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, IC = 7 m/s	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 S	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2
800.00 1000.00 1200.00 1400.00 1600.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA FREQUENCY	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 Q	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2
800.00 1000.00 1200.00 1400.00 1600.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA FREQUENCY MHz 600.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 S MAG 0.455	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3 2 S11 ANG -57.2	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2 22 ANG -34.1
800.00 1000.00 1200.00 1400.00 1600.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA FREQUENCY MHz 600.00 800.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 S MAG 0.455 0.335	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3 2 611 ANG -57.2 -67.4	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897 S MAG 8.518 6.873	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173 SAMAG 0.051 0.075	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357 S MAG 0.657 0.557	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2 22 ANG -34.1 -36.6
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, IC = 7 m/s FREQUENCY MHz 600.00 800.00 1000.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 G MAG 0.455 0.335 0.252	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3 2 611 ANG -57.2 -67.4 -73.2	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897 S MAG 8.518 6.873 5.825	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9 21 ANG 114.4 103.1 93.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173 SAMAG 0.051 0.075 0.095	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0 12 ANG 56.0 55.1 56.7	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357 S MAG 0.657 0.557 0.480	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2 22 ANG -34.1 -36.6 -39.2
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA FREQUENCY MHz 600.00 800.00 1000.00 1200.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 Q MAG 0.455 0.335 0.252 0.194	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3 2 611 ANG -57.2 -67.4 -73.2 -80.5	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897 S MAG 8.518 6.873 5.825 5.131	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9 21 ANG 114.4 103.1 93.9 88.3	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173 SAMAG 0.051 0.075 0.095 0.113	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0 12 ANG 56.0 55.1 56.7 59.7	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357 S MAG 0.657 0.557 0.480 0.453	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2 22 ANG -34.1 -36.6 -39.2 -41.8
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA FREQUENCY MHz 600.00 800.00 1000.00 1200.00 1400.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 G MAG 0.455 0.335 0.252 0.194 0.148	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3 2 611 ANG -57.2 -67.4 -73.2 -80.5 -91.1	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897 S MAG 8.518 6.873 5.825 5.131 4.447	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9 21 ANG 114.4 103.1 93.9 88.3 82.0	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173 SAMAG 0.051 0.075 0.095 0.113 0.129	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0 12 ANG 56.0 55.1 56.7 59.7 58.7	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357 S MAG 0.657 0.557 0.480 0.453 0.417	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2 22 ANG -34.1 -36.6 -39.2 -41.8 -44.6
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, IC = 7 mA FREQUENCY MHz 600.00 800.00 1000.00 1200.00 1400.00 1600.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 §  MAG  0.455 0.335 0.252 0.194 0.148 0.114	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3  S11  ANG -57.2 -67.4 -73.2 -80.5 -91.1 -105.9	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897 S MAG 8.518 6.873 5.825 5.131 4.447 4.018	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9 21 ANG 114.4 103.1 93.9 88.3 82.0 75.3	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173 SAMAG 0.051 0.075 0.095 0.113 0.129 0.145	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0 12 ANG 56.0 55.1 56.7 59.7 58.7 58.7	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357 S MAG 0.657 0.557 0.480 0.453 0.417 0.385	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2 22 ANG -34.1 -36.6 -39.2 -41.8 -44.6 -46.8
800.00 1000.00 1200.00 1400.00 1600.00 1800.00 2000.00 2200.00 VCE = 1 V, Ic = 7 mA FREQUENCY MHz 600.00 800.00 1000.00 1200.00 1400.00 1600.00 1800.00	0.430 0.338 0.271 0.217 0.171 0.137 0.100 0.079 A, Zo = 50 G MAG 0.455 0.335 0.252 0.194 0.148 0.114 0.087	-61.6 -68.2 -75.3 -84.1 -94.6 -104.4 -114.7 -125.3 2 611 ANG -57.2 -67.4 -73.2 -80.5 -91.1 -105.9 -119.5	6.573 5.644 5.047 4.409 3.985 3.674 3.229 2.897 S MAG 8.518 6.873 5.825 5.131 4.447 4.018 3.682	108.7 98.8 92.4 86.0 78.8 74.9 71.4 66.9 21 ANG 114.4 103.1 93.9 88.3 82.0 75.3 71.9	0.083 0.102 0.117 0.133 0.148 0.155 0.162 0.173 SAMAG 0.051 0.075 0.095 0.113 0.129 0.145 0.152	55.0 54.0 57.7 56.5 55.9 57.4 55.7 53.0 12 ANG 56.0 55.1 56.7 59.7 58.7 58.7 60.6	0.614 0.527 0.498 0.451 0.414 0.382 0.361 0.357  MAG 0.657 0.480 0.453 0.417 0.385 0.357	-37.4 -41.0 -44.6 -47.5 -50.0 -53.9 -55.0 -57.2  22  ANG -34.1 -36.6 -39.2 -41.8 -44.6 -46.8 -50.6



VcE = 1 V, Ic = 10 m	A, Zo = 50	Ω						
FREQUENCY	S	S11	S	21	S	12	;	S22
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.359	-65.9	8.500	108.9	0.048	54.8	0.603	-33.1
800.00	0.255	-78.2	6.731	98.1	0.071	56.3	0.516	-34.4
1000.00	0.177	-83.8	5.648	89.6	0.090	56.8	0.449	-35.9
1200.00	0.127	-96.6	4.927	84.4	0.109	61.7	0.431	-38.2
1400.00	0.098	-115.6	4.251	78.2	0.125	61.4	0.400	-40.5
1600.00	0.081	-141.9	3.839	71.9	0.143	61.2	0.377	-42.8
1800.00	0.072	-162.7	3.504	68.8	0.150	62.1	0.351	-46.1
2000.00	0.070	170.9	3.072	65.8	0.157	60.3	0.338	-47.5
2200.00	0.074	157.1	2.748	61.5	0.167	57.2	0.342	-50.4
Vce = 2 V, Ic = 1 mA	, Zo = 50 Ω	2						
FREQUENCY	S	S11	S	21	S	12	Ş	S22
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.927	-26.3	3.263	148.6	0.065	64.5	0.968	-19.5
800.00	0.827	-34.2	3.122	138.1	0.101	59.7	0.903	-24.1
1000.00	0.758	-43.7	2.962	127.7	0.129	54.9	0.828	-30.3
1200.00	0.712	-52.2	2.910	118.9	0.146	54.2	0.808	-36.5
1400.00	0.653	-59.1	2.825	112.3	0.165	50.6	0.769	-41.3
1600.00	0.581	-67.5	2.657	103.8	0.181	47.3	0.723	-46.0
1800.00	0.530	-75.7	2.578	96.3	0.185	46.0	0.673	-51.3
2000.00	0.469	-82.1	2.368	91.0	0.184	41.5	0.630	-54.7
2200.00	0.410	-87.5	2.184	84.7	0.188	38.2	0.607	-57.4
Vce = 2 V, Ic = 3 mA	$\Lambda$ , Zo = 50 $\Omega$	2						
		2 S11	S	321	S	12	;	S22
FREQUENCY	S	S11		321 ANG		12 ANG		S22 ANG
FREQUENCY MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
FREQUENCY MHz 600.00	MAG 0.727	ANG -39.7	MAG 6.761	ANG 131.7	MAG 0.057	ANG 58.1	MAG 0.841	ANG -27.8
FREQUENCY MHz 600.00 800.00	MAG 0.727 0.587	ANG -39.7 -49.7	MAG 6.761 5.910	ANG 131.7 119.4	MAG 0.057 0.084	ANG 58.1 55.8	MAG 0.841 0.737	ANG -27.8 -32.4
FREQUENCY  MHz  600.00  800.00  1000.00	MAG 0.727 0.587 0.490	ANG -39.7 -49.7 -57.4	MAG 6.761 5.910 5.229	ANG 131.7 119.4 108.8	MAG 0.057 0.084 0.104	ANG 58.1 55.8 54.2	MAG 0.841 0.737 0.645	ANG -27.8 -32.4 -37.5
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00	MAG 0.727 0.587 0.490 0.425	ANG -39.7 -49.7 -57.4 -64.5	MAG 6.761 5.910 5.229 4.812	ANG 131.7 119.4 108.8 101.3	MAG 0.057 0.084 0.104 0.120	ANG 58.1 55.8 54.2 55.7	MAG 0.841 0.737 0.645 0.608	ANG -27.8 -32.4 -37.5 -41.8
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00	MAG 0.727 0.587 0.490 0.425 0.354	ANG -39.7 -49.7 -57.4 -64.5 -70.8	MAG 6.761 5.910 5.229 4.812 4.314	ANG 131.7 119.4 108.8 101.3 94.8	MAG 0.057 0.084 0.104 0.120 0.135	ANG 58.1 55.8 54.2 55.7 55.3	MAG 0.841 0.737 0.645 0.608 0.562	ANG -27.8 -32.4 -37.5 -41.8 -45.1
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5	MAG 6.761 5.910 5.229 4.812 4.314 3.919	ANG 131.7 119.4 108.8 101.3 94.8 86.9	MAG 0.057 0.084 0.104 0.120 0.135 0.148	ANG 58.1 55.8 54.2 55.7 55.3 54.1	MAG 0.841 0.737 0.645 0.608 0.562 0.517	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00  1800.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5	MAG 6.761 5.910 5.229 4.812 4.314 3.919	ANG 131.7 119.4 108.8 101.3 94.8 86.9	MAG 0.057 0.084 0.104 0.120 0.135 0.148	ANG 58.1 55.8 54.2 55.7 55.3 54.1	MAG 0.841 0.737 0.645 0.608 0.562 0.517	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00  1800.00  2000.00  2200.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00  1800.00  2000.00  2200.00  VCE = 2 V, Ic = 5 mA	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164	58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω MAG	ANG  -39.7  -49.7  -57.4  -64.5  -70.8  -78.5  -85.1  -89.4  -93.9  ANG	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω  MAG 0.592	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9 ANG -46.3	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S MAG 0.052	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00  800.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω S MAG 0.592 0.457	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S MAG 8.189 6.849	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S MAG 0.052 0.074	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00  800.00  1000.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω S MAG 0.592 0.457 0.369	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1 -60.0	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S MAG 8.189 6.849 5.900	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9 101.1	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S MAG 0.052 0.074 0.096	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9  12  ANG 59.4 56.6 54.1	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655 0.564	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8 -37.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, Ic = 5 mA  FREQUENCY  MHz  600.00  800.00  1000.00  1200.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω MAG 0.592 0.457 0.369 0.305	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1 -60.0 -66.2	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S MAG 8.189 6.849 5.900 5.303	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9 101.1 94.7	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S  MAG 0.052 0.074 0.096 0.111	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9  12  ANG 59.4 56.6 54.1 58.0	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655 0.564 0.533	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8 -37.6 -40.7
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω S MAG 0.592 0.457 0.369 0.305 0.249	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1 -60.0 -66.2 -72.3	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S  MAG 8.189 6.849 5.900 5.303 4.651	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9 101.1 94.7 88.4	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S MAG 0.052 0.074 0.096 0.111 0.126	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9  12  ANG 59.4 56.6 54.1 58.0 58.2	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655 0.564 0.533 0.495	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8 -37.6 -40.7 -43.3
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω  MAG 0.592 0.457 0.369 0.305 0.249 0.198	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1 -60.0 -66.2 -72.3 -79.2	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S  MAG 8.189 6.849 5.900 5.303 4.651 4.202	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9 101.1 94.7 88.4 81.2	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S  MAG 0.052 0.074 0.096 0.111 0.126 0.139	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9  12  ANG 59.4 56.6 54.1 58.0 58.2 58.2	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655 0.564 0.533 0.495 0.460	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8 -37.6 -40.7 -43.3 -45.6
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  1800.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω  MAG 0.592 0.457 0.369 0.305 0.249 0.198 0.160	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1 -60.0 -66.2 -72.3 -79.2 -85.2	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S  MAG 8.189 6.849 5.900 5.303 4.651 4.202 3.888	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9 101.1 94.7 88.4 81.2 77.2	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S  MAG 0.052 0.074 0.096 0.111 0.126 0.139 0.146	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9  12  ANG 59.4 56.6 54.1 58.0 58.2 58.2 59.2	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655 0.564 0.533 0.495 0.460 0.425	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8 -37.6 -40.7 -43.3 -45.6 -59.3
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1800.00  2000.00  2200.00  VCE = 2 V, IC = 5 mA  FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00	MAG 0.727 0.587 0.490 0.425 0.354 0.295 0.251 0.203 0.167  A, Zo = 50 Ω  MAG 0.592 0.457 0.369 0.305 0.249 0.198	ANG -39.7 -49.7 -57.4 -64.5 -70.8 -78.5 -85.1 -89.4 -93.9  ANG -46.3 -55.1 -60.0 -66.2 -72.3 -79.2	MAG 6.761 5.910 5.229 4.812 4.314 3.919 3.662 3.243 2.924  S  MAG 8.189 6.849 5.900 5.303 4.651 4.202	ANG 131.7 119.4 108.8 101.3 94.8 86.9 81.8 77.9 73.0  21  ANG 122.9 110.9 101.1 94.7 88.4 81.2	MAG 0.057 0.084 0.104 0.120 0.135 0.148 0.151 0.156 0.164  S  MAG 0.052 0.074 0.096 0.111 0.126 0.139	ANG 58.1 55.8 54.2 55.7 55.3 54.1 54.8 52.9 50.9  12  ANG 59.4 56.6 54.1 58.0 58.2 58.2	MAG 0.841 0.737 0.645 0.608 0.562 0.517 0.478 0.449 0.441  MAG 0.763 0.655 0.564 0.533 0.495 0.460	ANG -27.8 -32.4 -37.5 -41.8 -45.1 -48.3 -52.4 -53.6 -55.6  S22  ANG -30.6 -33.8 -37.6 -40.7 -43.3 -45.6



VCE = 2 V, $IC = 7 m$	$A, Zo = 50 \Omega$	2						
FREQUENCY	5	S11	S	21	S	12	S	22
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.489	-50.8	8.917	116.7	0.045	58.5	0.701	-31.1
800.00	0.371	-58.8	7.266	105.4	0.070	57.0	0.601	-33.3
1000.00	0.287	-62.3	6.166	96.2	0.090	57.4	0.523	-35.7
1200.00	0.233	-67.2	5.456	90.6	0.106	61.2	0.501	-38.3
1400.00	0.181	-72.6	4.743	84.5	0.122	62.0	0.465	-40.4
1600.00	0.138	-80.1	4.283	77.7	0.137	61.2	0.436	-42.7
1800.00	0.105	-86.5	3.937	74.2	0.143	62.8	0.404	-45.9
2000.00	0.072	-91.2	3.456	71.1	0.149	60.2	0.389	-47.1
2200.00	0.052	-93.0	3.097	66.9	0.159	57.3	0.391	-49.2
VCE = 2 V, IC = 10	mA, Zo = 50	Ω						
Vce = 2 V, Ic = 10 FREQUENCY	,	Ω S11	S	21	S	12	S	22
•	,		S MAG	21 ANG	S <sup>2</sup> MAG	12 ANG	S: MAG	22 ANG
FREQUENCY	,	S11						
FREQUENCY MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
FREQUENCY MHz 600.00	MAG 0.404	ANG -55.4	MAG 9.236	ANG 111.8	MAG 0.039	ANG 55.3	MAG 0.660	ANG -30.2
FREQUENCY  MHz  600.00  800.00	MAG 0.404 0.298	ANG -55.4 -62.9	MAG 9.236 7.374	ANG 111.8 101.0	MAG 0.039 0.064	ANG 55.3 57.2	MAG 0.660 0.569	ANG -30.2 -31.4
FREQUENCY  MHz  600.00  800.00  1000.00	MAG 0.404 0.298 0.221	ANG -55.4 -62.9 -65.2	MAG 9.236 7.374 6.206	ANG 111.8 101.0 92.5	MAG 0.039 0.064 0.087	ANG 55.3 57.2 60.1	MAG 0.660 0.569 0.501	ANG -30.2 -31.4 -33.0
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00	MAG 0.404 0.298 0.221 0.169	ANG -55.4 -62.9 -65.2 -69.5	MAG 9.236 7.374 6.206 5.441	ANG 111.8 101.0 92.5 87.4	MAG 0.039 0.064 0.087 0.102	ANG 55.3 57.2 60.1 63.5	MAG 0.660 0.569 0.501 0.483	ANG -30.2 -31.4 -33.0 -35.3
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00	MAG 0.404 0.298 0.221 0.169 0.128	ANG -55.4 -62.9 -65.2 -69.5 -76.3	MAG 9.236 7.374 6.206 5.441 4.701	ANG 111.8 101.0 92.5 87.4 81.4	MAG 0.039 0.064 0.087 0.102 0.119	ANG 55.3 57.2 60.1 63.5 63.3	MAG 0.660 0.569 0.501 0.483 0.456	ANG -30.2 -31.4 -33.0 -35.3 -37.4
FREQUENCY  MHz  600.00  800.00  1000.00  1200.00  1400.00  1600.00	MAG 0.404 0.298 0.221 0.169 0.128 0.089	ANG -55.4 -62.9 -65.2 -69.5 -76.3 -86.1	MAG 9.236 7.374 6.206 5.441 4.701 4.244	ANG 111.8 101.0 92.5 87.4 81.4 75.0	MAG 0.039 0.064 0.087 0.102 0.119 0.134	ANG 55.3 57.2 60.1 63.5 63.3	MAG 0.660 0.569 0.501 0.483 0.456 0.430	ANG -30.2 -31.4 -33.0 -35.3 -37.4 -39.5

7

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NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.

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