



# NEC's MEDIUM POWER NPN SILICON HIGH FREQUENCY TRANSISTOR

## NE677M04

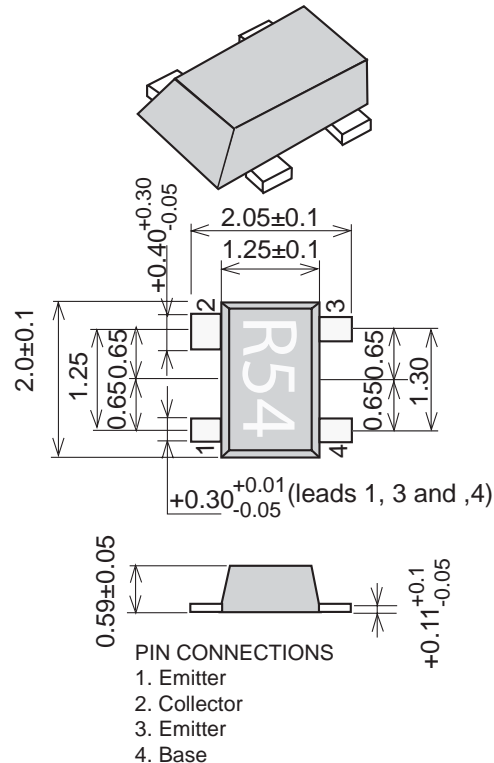
### FEATURES

- **HIGH GAIN BANDWIDTH:**  
 $f_T = 15 \text{ GHz}$
- **HIGH OUTPUT POWER:**  
 $P_{-1\text{dB}} = 15 \text{ dBm}$  at 1.8 GHz
- **HIGH LINEAR GAIN:**  
 $G_L = 15.5 \text{ dB}$  at 1.8 GHz
- **NEW LOW PROFILE M04 PACKAGE:**  
SOT-343 footprint, with a height of only 0.59 mm  
Flat lead style for better RF performance

### DESCRIPTION

NEC's NE677M04 is fabricated using NEC's HFT3 wafer process. With a transition frequency of 15 GHz, the NE677M04 is usable in applications from 100 MHz to 3 GHz. The NE677M04 provides P1dB of 15 dBm, even with low voltage and low current, making this device an excellent choice for the driver stage for mobile or fixed wireless applications.

NEC's NE677M04 is housed in NEC's new low profile/flat lead style "M04" package



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

PART NUMBER PACKAGE OUTLINE EIAJ <sup>3</sup> REGISTRATION NUMBER		NE677M04 M04 2SC5751				
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	
DC	ICBO	Collector Cutoff Current at $V_{CB} = 5 \text{ V}$ , $I_E = 0$	nA		100	
	IEBO	Emitter Cutoff Current at $V_{EB} = 1 \text{ V}$ , $I_C = 0$	nA		100	
	hFE	DC Current <sup>1</sup> Gain at $V_{CE} = 3 \text{ V}$ , $I_C = 20 \text{ mA}$		75	120	150
RF	P1dB	Output Power at 1 dB compression point at $V_{CE} = 2.8 \text{ V}$ , $I_{CQ} = 8 \text{ mA}$ , $f = 1.8 \text{ GHz}$ , $P_{in} = 1 \text{ dBm}$	dBm		15.0	
	GL	Linear Gain at $V_{CE} = 2.8 \text{ V}$ , $I_{CQ} = 8 \text{ mA}$ , $f = 1.8 \text{ GHz}$ , $P_{in} = -10 \text{ dBm}$	dB		15.5	
	MAG	Maximum Available Gain <sup>4</sup> at $V_{CE} = 3 \text{ V}$ , $I_C = 20 \text{ mA}$ , $f = 2 \text{ GHz}$	dBm		16.0	
	$ S_{21E} ^2$	Insertion Power Gain at $V_{CE} = 3 \text{ V}$ , $I_C = 20 \text{ mA}$ , $f = 2 \text{ GHz}$	dB	10.0	13.5	
	$\eta_c$	Collector Efficiency at $V_{CE} = 2.8 \text{ V}$ , $I_{CQ} = 8 \text{ mA}$ , $f = 1.8 \text{ GHz}$ , $P_{in} = 1 \text{ dBm}$	%		50	
	NF	Noise Figure at $V_{CE} = 3 \text{ V}$ , $I_C = 5 \text{ mA}$ , $f = 2 \text{ GHz}$ , $Z_s = Z_{OPT}$	dB		1.7	2.5
	$f_T$	Gain Bandwidth at $V_{CE} = 3 \text{ V}$ , $I_C = 20 \text{ mA}$ , $f = 2 \text{ GHz}$	GHz		15	
Cre	Reverse Transfer Capacitance <sup>2</sup> at $V_{CB} = 3 \text{ V}$ , $I_C = 0$ , $f = 1 \text{ MHz}$	pF		0.22	0.50	

Notes:

1. Pulsed measurement, pulse width  $\leq 350 \mu\text{s}$ , duty cycle  $\leq 2\%$ .
2. Collector to Base capacitance measured by capacitance meter (automatic balance bridge method) when emitter pin is connected to the guard pin of capacitance meter.
3. Electronic Industrial Association of Japan
4.  $MAG = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1})$ .

**ABSOLUTE MAXIMUM RATINGS<sup>1</sup>** (T<sub>A</sub> = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>CB0</sub>	Collector to Base Voltage	V	9.0
V <sub>CE0</sub>	Collector to Emitter Voltage	V	6.0
V <sub>EB0</sub>	Emitter to Base Voltage	V	2.0
I <sub>C</sub>	Collector Current	mA	50
P <sub>T</sub>	Total Power Dissipation <sup>2</sup>	mW	205
T <sub>J</sub>	Junction Temperature	°C	150
T <sub>STG</sub>	Storage Temperature	°C	-65 to +150

Note:

1. Operation in excess of any one of these parameters may result in permanent damage.
2. Mounted on a 1.08cm<sup>2</sup> x 1.0 mm thick glass epoxy PCB.

**ORDERING INFORMATION**

PART NUMBER	QUANTITY
NE677M04-T2	3k pcs./reel

**THERMAL RESISTANCE**

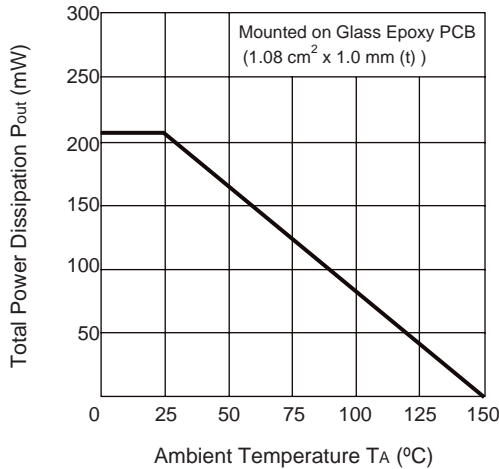
SYMBOLS	PARAMETERS	UNITS	RATINGS
R <sub>th j-a</sub>	Thermal Resistance from Junction to Ambient	°C/W	600

Note:

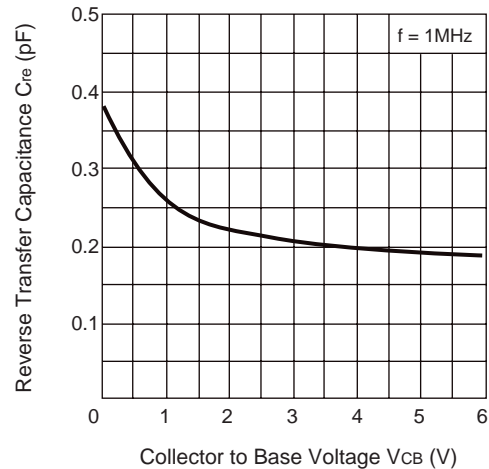
1. Mounted on a 1.08cm<sup>2</sup> x 1.0 mm thick glass epoxy PCB.

**TYPICAL PERFORMANCE CURVES** (T<sub>A</sub> = 25 °C)

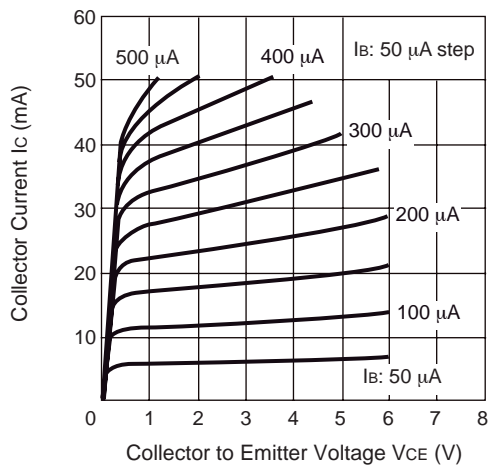
**TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE**



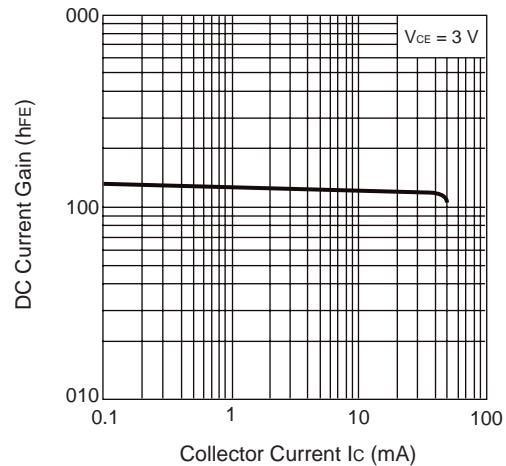
**REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE**



**COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE**

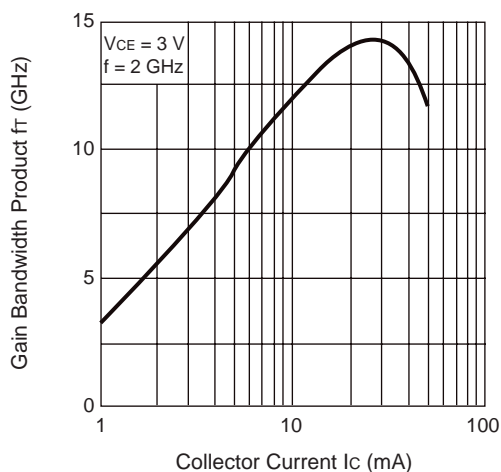


**DC CURRENT GAIN vs. COLLECTOR CURRENT**

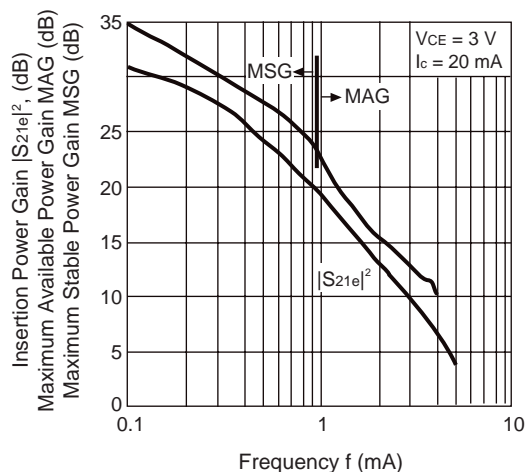


TYPICAL PERFORMANCE CURVES (TA = 25 °C)

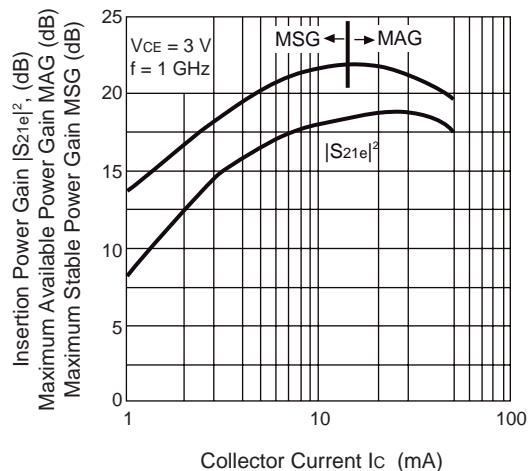
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



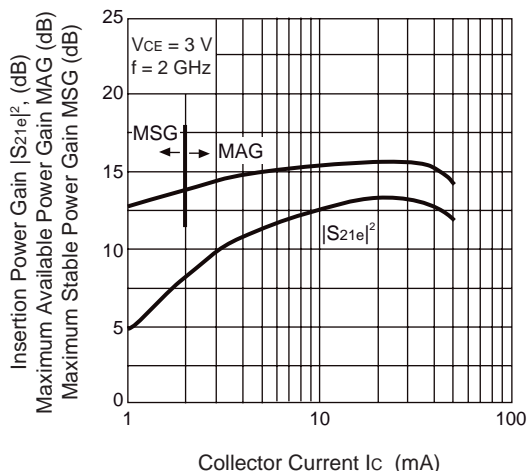
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



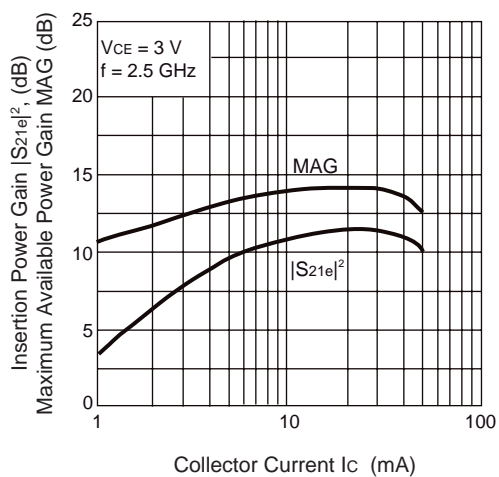
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



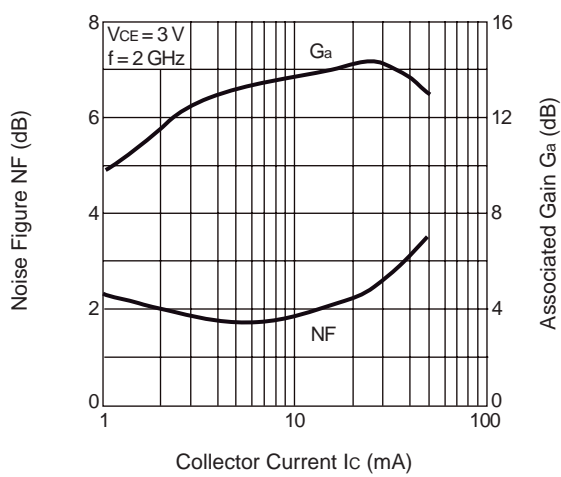
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



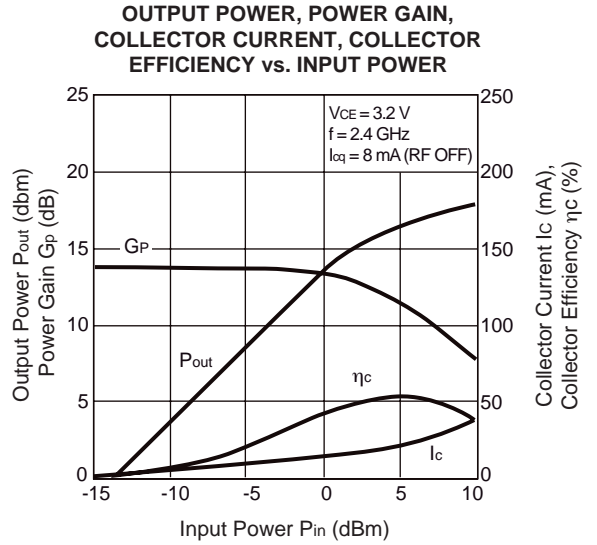
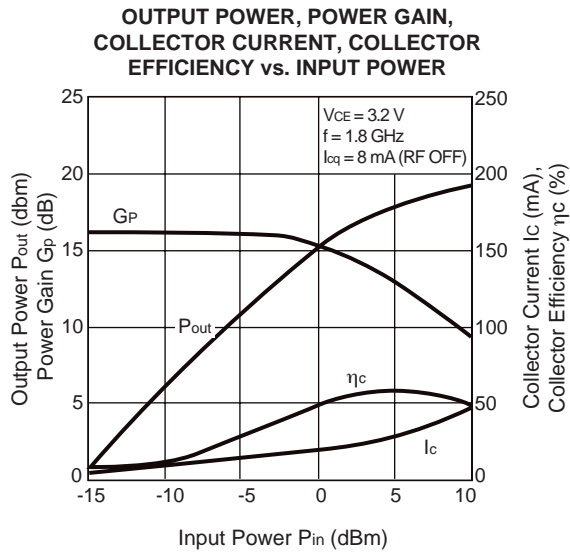
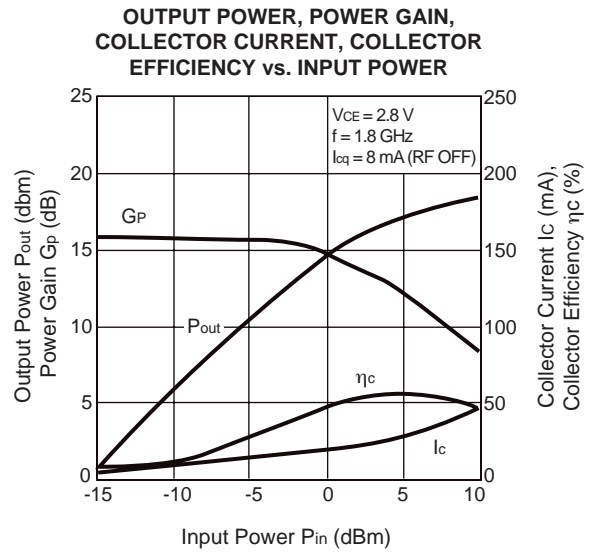
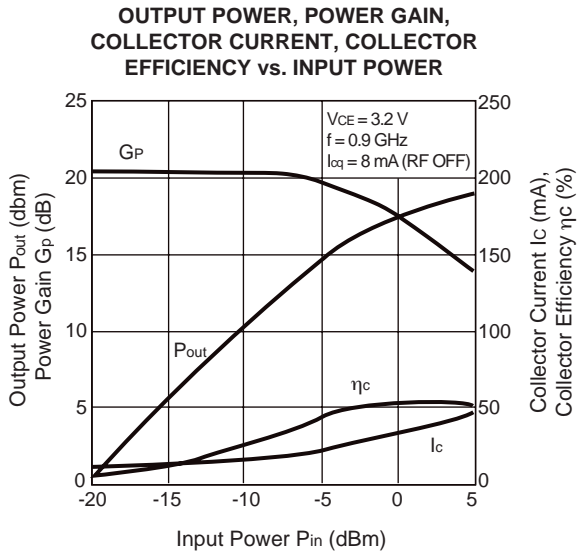
INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT



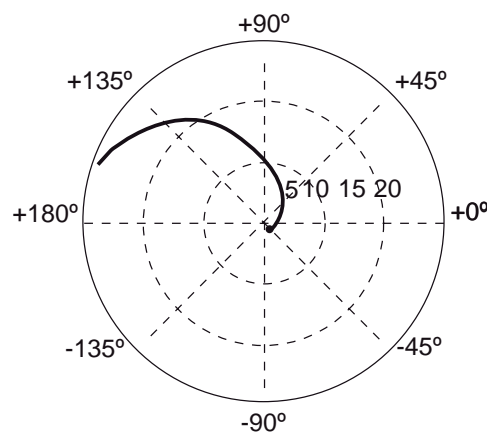
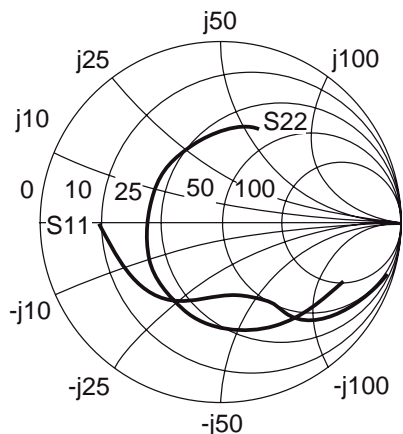
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



TYPICAL PERFORMANCE CURVES (T<sub>A</sub> = 25 °C)



**TYPICAL SCATTERING PARAMETERS** (TA = 25°C)



**NE677M04**  
**Vc = 2 V, Ic = 10 mA**

FREQUENCY GHz	S11		S21		S12		S22		K	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
0.100	0.72	-28.02	23.85	159.39	0.01	76.80	0.94	-17.17	0.11	32.34
0.200	0.67	-53.32	21.19	142.90	0.02	61.76	0.85	-30.90	0.22	29.46
0.300	0.62	-74.47	18.36	129.52	0.03	53.97	0.75	-41.48	0.30	27.71
0.400	0.57	-91.69	15.78	119.03	0.04	47.84	0.66	-49.21	0.38	26.40
0.500	0.54	-105.42	13.68	110.66	0.04	44.49	0.60	-55.01	0.46	25.44
0.600	0.50	-119.13	11.77	103.58	0.04	41.61	0.51	-57.12	0.62	24.54
0.700	0.48	-128.64	10.42	97.78	0.04	40.18	0.48	-61.53	0.69	23.81
0.800	0.47	-136.17	9.33	92.96	0.05	39.74	0.45	-63.91	0.75	23.13
0.900	0.46	-143.27	8.43	88.43	0.05	39.29	0.43	-66.99	0.82	22.51
1.000	0.46	-148.66	7.70	84.44	0.05	39.40	0.42	-69.40	0.87	21.95
1.500	0.44	-170.56	5.30	67.31	0.06	40.48	0.39	-82.07	1.10	17.66
1.800	0.43	179.75	4.47	58.55	0.06	41.76	0.39	-89.26	1.19	15.82
1.900	0.43	176.51	4.24	55.72	0.07	41.66	0.39	-91.76	1.20	15.33
2.000	0.43	173.63	4.04	52.97	0.07	42.00	0.40	-94.18	1.22	14.87
2.500	0.42	159.00	3.26	39.73	0.08	42.28	0.42	-105.45	1.26	13.00
3.000	0.42	144.48	2.73	27.19	0.10	40.73	0.46	-115.95	1.24	11.64
3.500	0.43	129.44	2.34	15.06	0.11	38.24	0.49	-125.23	1.18	10.67
4.000	0.45	115.14	2.04	3.42	0.13	34.92	0.53	-134.51	1.11	9.99
4.500	0.48	102.37	1.79	-7.89	0.14	30.39	0.56	-144.23	1.04	9.71
5.000	0.50	91.32	1.59	-18.83	0.16	25.33	0.59	-154.88	0.97	9.94
5.500	0.53	81.53	1.42	-29.44	0.18	19.49	0.62	-165.89	0.90	9.00
6.000	0.55	72.28	1.27	-39.61	0.20	13.49	0.66	-176.84	0.85	8.11

Note:

1. Gain Calculations:

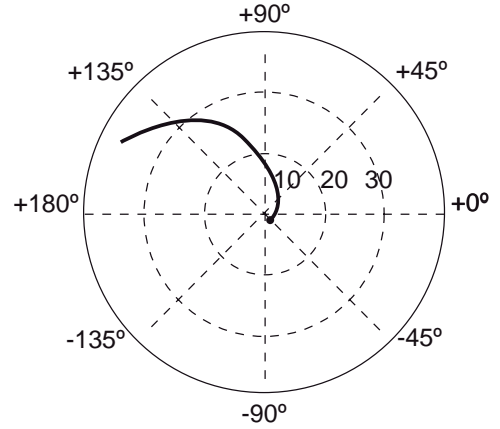
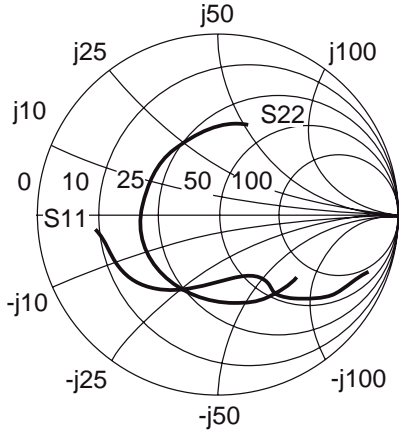
$$MAG = \frac{|S_{21}|}{|S_{12}|} (K - \sqrt{K^2 - 1})$$

When  $K \geq 1$ , MAG is undefined and MSG values are used.  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (TA = 25°C)



NE677M04

Vc = 3 V, Ic = 20 mA

FREQUENCY GHz	S11		S21		S12		S22		K	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
0.100	0.58	-36.91	34.82	154.30	0.01	65.53	0.91	-19.74	0.28	35.64
0.200	0.53	-67.97	29.03	135.74	0.02	59.98	0.78	-33.77	0.34	32.23
0.300	0.49	-91.49	23.80	122.19	0.02	55.05	0.67	-43.13	0.45	30.35
0.400	0.46	-108.88	19.70	112.29	0.03	51.06	0.58	-49.18	0.56	28.90
0.500	0.44	-121.87	16.66	104.71	0.03	49.50	0.52	-53.43	0.65	27.72
0.600	0.42	-135.00	14.16	98.54	0.03	48.74	0.45	-53.84	0.81	26.72
0.700	0.42	-143.29	12.41	93.35	0.03	49.30	0.42	-57.21	0.89	25.86
0.800	0.41	-149.68	11.03	89.03	0.03	50.12	0.40	-58.72	0.95	25.08
0.900	0.41	-155.84	9.91	84.93	0.04	50.69	0.39	-61.16	0.99	24.32
1.000	0.41	-160.23	9.01	81.35	0.04	51.41	0.38	-63.04	1.04	22.48
1.500	0.40	-178.96	6.14	65.55	0.05	53.28	0.37	-74.89	1.17	18.28
1.800	0.39	172.52	5.16	57.30	0.06	53.31	0.38	-82.12	1.20	16.70
1.900	0.39	169.64	4.90	54.62	0.06	53.31	0.38	-84.61	1.20	16.25
2.000	0.39	167.05	4.66	52.02	0.06	53.16	0.38	-87.15	1.21	15.82
2.500	0.39	153.59	3.75	39.33	0.08	51.37	0.42	-98.84	1.19	14.09
3.000	0.39	139.95	3.14	27.21	0.10	48.43	0.45	-109.77	1.15	12.83
3.500	0.41	125.64	2.68	15.39	0.11	44.68	0.49	-119.46	1.09	12.00
4.000	0.43	111.98	2.34	3.97	0.13	40.02	0.53	-129.07	1.02	11.72
4.500	0.45	99.88	2.06	-7.19	0.15	34.90	0.56	-139.11	0.95	11.48
5.000	0.48	89.38	1.83	-18.07	0.16	29.26	0.60	-150.00	0.88	10.49
5.500	0.51	80.01	1.64	-28.76	0.18	22.90	0.63	-161.27	0.82	9.55
6.000	0.53	71.10	1.47	-39.12	0.20	16.56	0.66	-172.54	0.77	8.69

Note:

1. Gain Calculations:

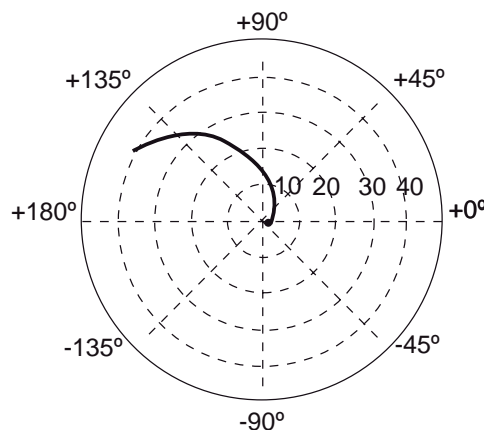
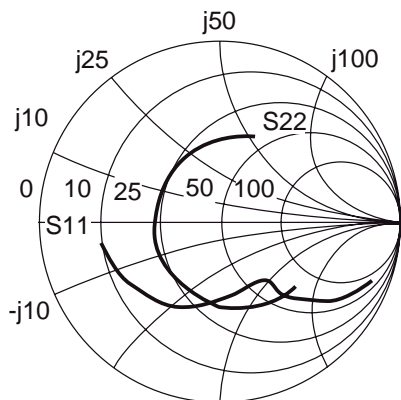
$$MAG = \frac{|S_{21}|}{|S_{12}|} (K - \sqrt{K^2 - 1})$$

. When  $K \geq 1$ , MAG is undefined and MSG values are used.  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

**TYPICAL SCATTERING PARAMETERS** (T<sub>A</sub> = 25°C)



**NE677M04**

V<sub>c</sub> = 5 V, I<sub>c</sub> = 30 mA

FREQUENCY GHz	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
0.100	0.53	-41.03	40.66	151.83	0.01	79.56	0.89	-20.30	0.21	36.62
0.200	0.48	-73.66	32.81	132.70	0.02	64.08	0.75	-33.75	0.39	33.32
0.300	0.44	-97.50	26.31	119.35	0.02	56.29	0.63	-42.07	0.53	31.43
0.400	0.42	-114.52	21.49	109.81	0.02	53.44	0.56	-47.07	0.66	30.03
0.500	0.41	-127.00	18.03	102.57	0.02	53.31	0.50	-50.52	0.75	28.75
0.600	0.39	-139.82	15.28	96.73	0.03	53.08	0.43	-50.09	0.90	27.65
0.700	0.39	-147.57	13.34	91.78	0.03	54.05	0.41	-52.99	0.98	26.75
0.800	0.38	-153.47	11.83	87.64	0.03	55.02	0.40	-54.21	1.02	24.98
0.900	0.38	-159.31	10.62	83.69	0.03	55.65	0.39	-56.48	1.06	23.55
1.000	0.38	-163.26	9.64	80.25	0.04	56.16	0.38	-58.27	1.09	22.49
1.500	0.37	-179.14	6.55	64.91	0.05	58.22	0.37	-70.16	1.18	18.69
1.800	0.37	-171.01	5.50	56.83	0.06	57.93	0.38	-77.47	1.19	17.16
1.900	0.37	-168.30	5.22	54.20	0.06	57.51	0.39	-80.11	1.20	16.71
2.000	0.37	-165.83	4.96	51.65	0.06	57.41	0.39	-82.71	1.20	16.30
2.500	0.37	-152.63	3.99	39.13	0.08	54.90	0.43	-94.79	1.17	14.62
3.000	0.37	-139.29	3.33	27.15	0.09	51.63	0.46	-106.02	1.12	13.43
3.500	0.38	-125.14	2.85	15.43	0.11	47.27	0.50	-116.01	1.05	12.75
4.000	0.40	-111.70	2.49	4.05	0.13	42.60	0.54	-125.90	0.99	12.91
4.500	0.43	-99.67	2.19	-7.08	0.15	37.08	0.58	-136.09	0.91	11.79
5.000	0.46	-89.42	1.95	-17.99	0.16	31.31	0.61	-147.22	0.84	10.78
5.500	0.49	-80.22	1.74	-28.73	0.18	25.13	0.65	-158.70	0.78	9.86
6.000	0.51	-71.38	1.56	-39.19	0.20	18.62	0.68	-170.08	0.73	8.98

Note:

1. Gain Calculations:

$$MAG = \frac{|S_{21}|}{|S_{12}|} (K - \sqrt{K^2 - 1})$$

When K ≥ 1, MAG is undefined and MSG values are used.  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

Life Support Applications

These NEC products are not intended for use in life support devices, appliances, or systems where the malfunction of these products can reasonably be expected to result in personal injury. The customers of CEL using or selling these products for use in such applications do so at their own risk and agree to fully indemnify CEL for all damages resulting from such improper use or sale.

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