

# NEC

## MEDIUM POWER NPN SILICON HIGH FREQUENCY TRANSISTOR

### NE678M04

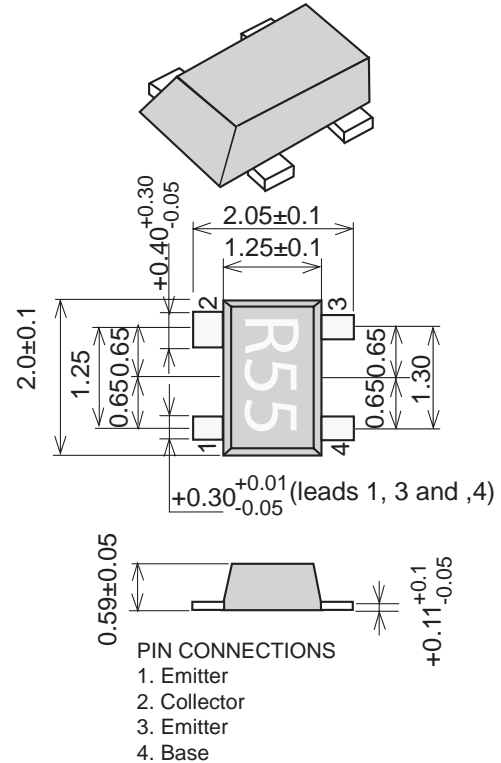
### FEATURES

- **HIGH GAIN BANDWIDTH:**  
 $f_T = 12 \text{ GHz}$
- **HIGH OUTPUT POWER:**  
 $P_{-1\text{dB}} = 18 \text{ dBm}$  at 1.8 GHz
- **HIGH LINEAR GAIN:**  
 $G_L = 13 \text{ dB}$  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

The NE678M04 is fabricated using NEC's HFT3 wafer process. With a transition frequency of 12 GHz, the NE678M04 is usable in applications from 100 MHz to 3 GHz. The NE678M04 provides  $P_{1\text{dB}}$  of 18 dBm, even with low voltage and low current, making this device an excellent choice for the driver stage for mobile or fixed wireless applications.

The NE678M04 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 EIAJ3 REGISTRATION NUMBER		NE678M04 M04 2SC5753				
	SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
DC	$I_{CBO}$	Collector Cutoff Current at $V_{CB} = 5\text{ V}$ , $I_E = 0$	nA			100
	$I_{EBO}$	Emitter Cutoff Current at $V_{EB} = 1\text{ V}$ , $I_C = 0$	nA			100
	$h_{FE}$	DC Current <sup>1</sup> Gain at $V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$		75	120	150
RF	$P_{1\text{dB}}$	Output Power at 1 dB compression point at $V_{CE} = 2.8\text{ V}$ , $I_{CQ} = 10\text{ mA}$ , $f = 1.8\text{ GHz}$ , $P_{in} = 7\text{ dBm}$	dBm		18.0	
	$G_L$	Linear Gain at $V_{CE} = 2.8\text{ V}$ , $I_C = 10\text{ mA}$ , $f = 1.8\text{ GHz}$ , $P_{in} = -5\text{ dBm}$	dB		13.0	
	MAG	Maximum Available Gain <sup>4</sup> at $V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 2\text{ GHz}$	dBm		13.5	
	$ S_{21E} ^2$	Insertion Power Gain at $V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 2\text{ GHz}$	dB	8.0	10.5	
	$\eta_c$	Collector Efficiency at $V_{CE} = 2.8\text{ V}$ , $I_{CQ} = 10\text{ mA}$ , $f = 1.8\text{ GHz}$ , $P_{in} = 7\text{ dBm}$	%		55	
	NF	Noise Figure at $V_{CE} = 3\text{ V}$ , $I_C = 7\text{ mA}$ , $f = 2\text{ GHz}$ , $Z_S = Z_{opt}$	dB		1.7	2.5
	$f_T$	Gain Bandwidth at $V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 2\text{ GHz}$	GHz		12.0	
$C_{re}$	Reverse Transfer Capacitance <sup>2</sup> at $V_{CB} = 3\text{ V}$ , $I_C = 0$ , $f = 1\text{ MHz}$	pF		0.42	0.7	

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 Industriail Association of Japan.

$$4. \text{MAG} = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right).$$

**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	100
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
NE678M04-T2	3k pcs./reel

**THERMAL RESISTANCE**

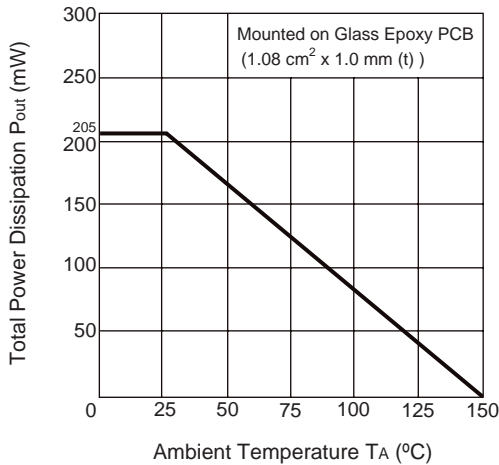
SYMBOLS	PARAMETERS	UNITS	RATINGS
R <sub>th j-a</sub>	Thermal Resistance from Junction to Ambient	°C/W	600

Note:

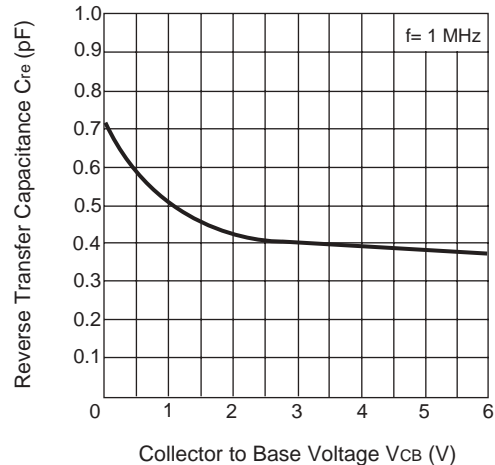
1. Mounted on a 1.08cm<sup>2</sup> x 1.0 mm thick glass epoxy PCB.

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

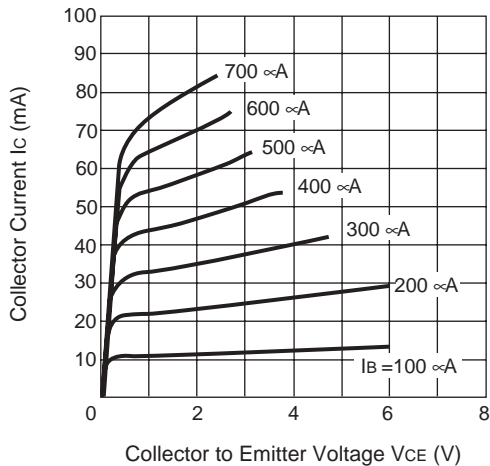
**TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE**



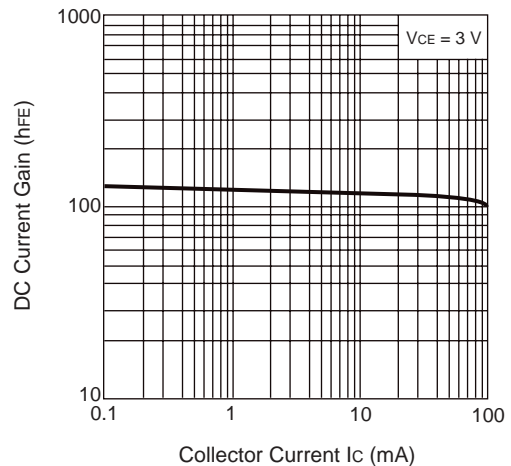
**REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE**



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

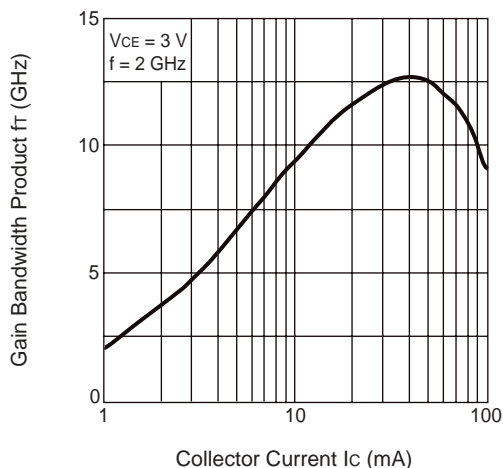


**DC CURRENT GAIN vs. COLLECTOR CURRENT**

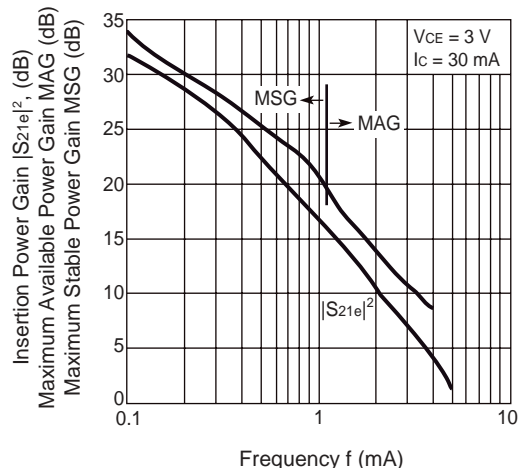


TYPICAL PERFORMANCE CURVES (T<sub>A</sub> = 25 °C)

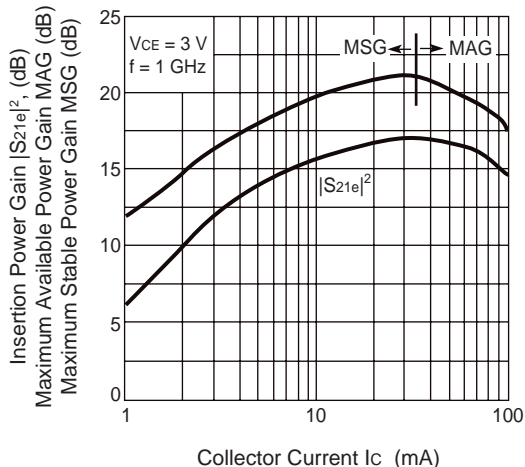
**GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT**



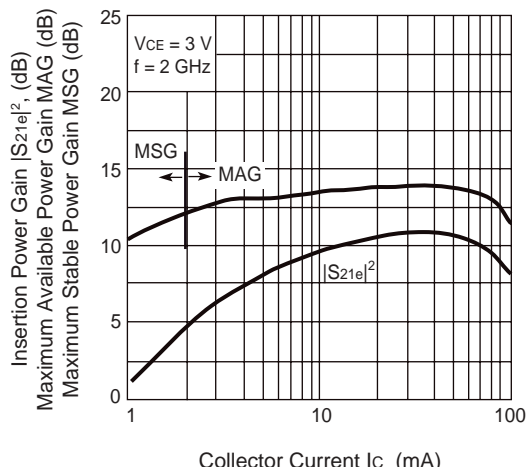
**INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY**



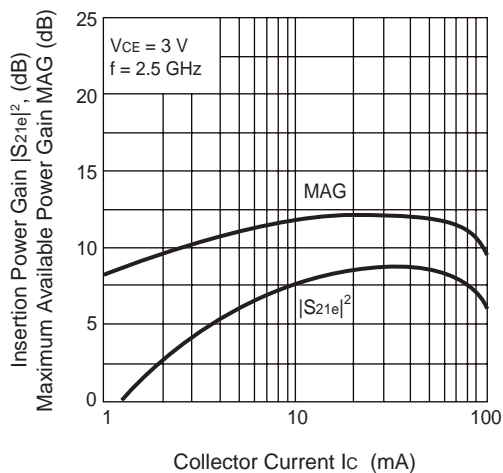
**INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT**



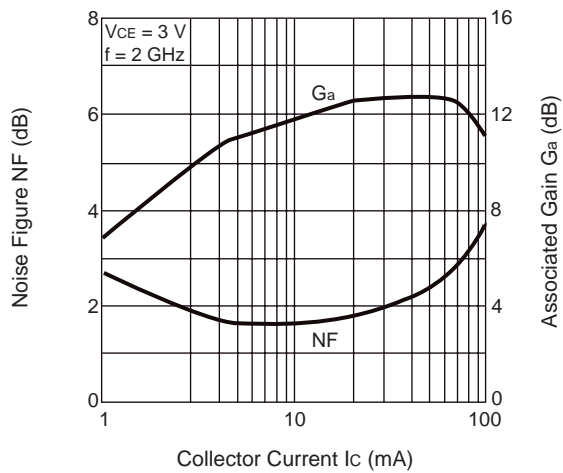
**INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT**



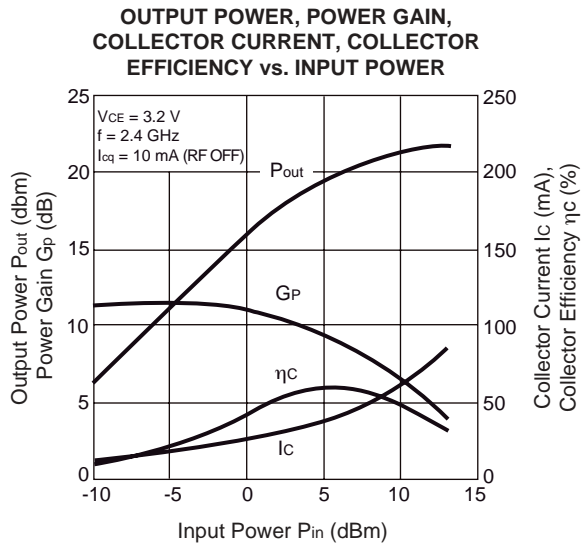
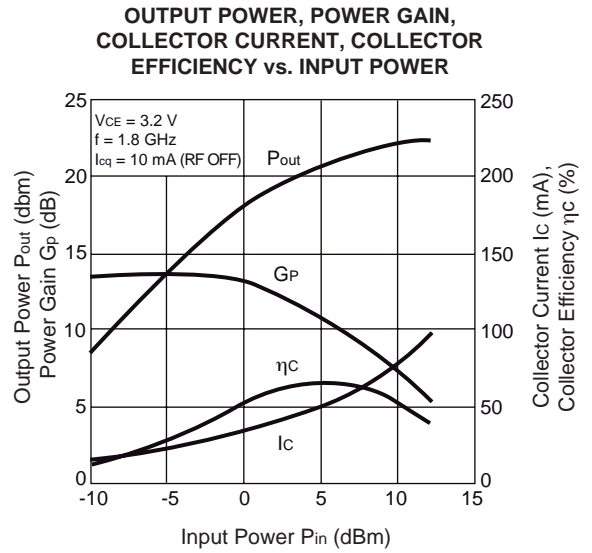
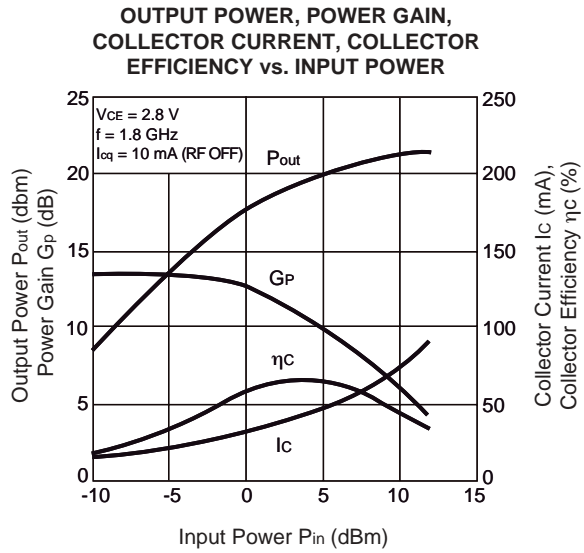
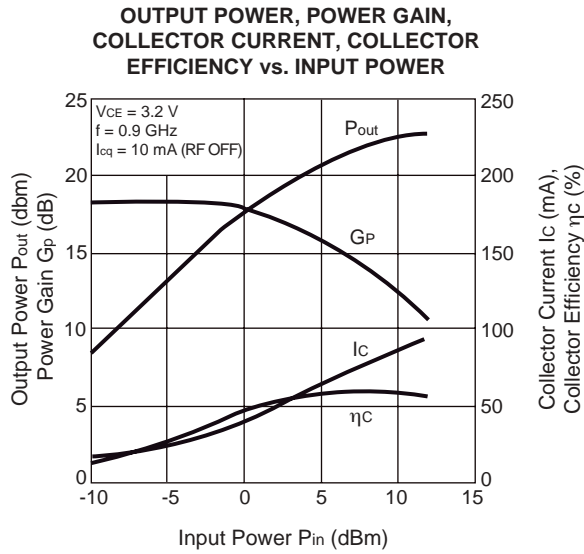
**INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT**



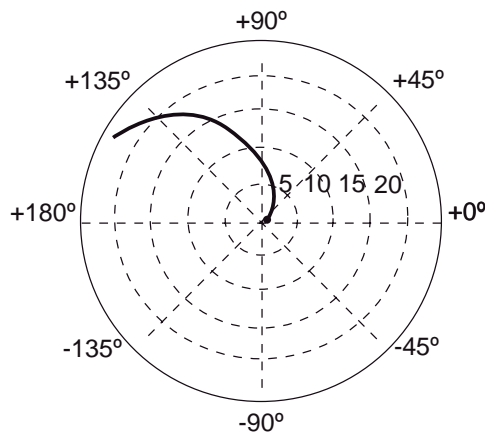
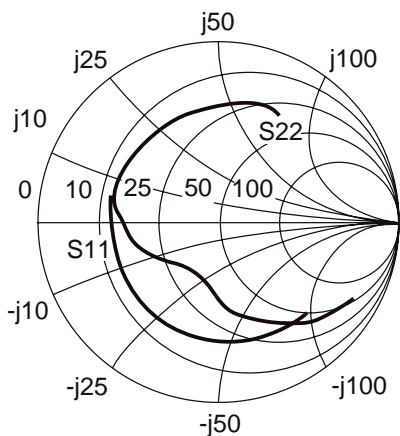
**NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT**



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



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



**NE678M04**

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	-45.97	23.42	152.40	0.02	65.62	0.90	-29.51	0.10	29.97
0.200	0.68	-81.43	19.17	132.28	0.04	52.02	0.74	-51.31	0.18	26.71
0.300	0.65	-106.66	15.41	118.19	0.05	42.17	0.61	-66.86	0.26	24.93
0.400	0.63	-124.06	12.56	108.21	0.05	37.11	0.52	-77.84	0.34	23.61
0.500	0.62	-136.69	10.53	100.63	0.06	33.66	0.46	-86.27	0.42	22.62
0.600	0.60	-148.20	8.85	94.98	0.06	32.53	0.38	-92.24	0.56	21.75
0.700	0.60	-155.78	7.72	89.80	0.06	31.81	0.36	-98.70	0.62	21.00
0.800	0.60	-161.77	6.86	85.45	0.06	31.70	0.34	-102.52	0.68	20.32
0.900	0.60	-167.38	6.15	81.38	0.07	31.29	0.33	-106.64	0.74	19.72
1.000	0.60	-171.69	5.59	77.66	0.07	31.31	0.32	-110.16	0.79	19.17
1.500	0.59	-170.30	3.81	61.44	0.08	33.17	0.31	-123.84	1.00	16.81
1.800	0.59	-161.69	3.21	52.84	0.09	33.52	0.32	-130.08	1.07	13.98
1.900	0.59	-158.90	3.05	50.05	0.09	33.69	0.32	-131.91	1.10	13.41
2.000	0.59	-156.19	2.90	47.32	0.09	33.45	0.33	-133.96	1.11	12.93
2.500	0.59	-142.62	2.35	33.99	0.11	32.55	0.36	-142.01	1.14	11.02
3.000	0.60	-128.82	1.97	21.32	0.13	29.86	0.39	-149.47	1.15	9.63
3.500	0.61	-114.69	1.69	9.12	0.14	26.40	0.43	-156.17	1.12	8.62
4.000	0.63	-101.16	1.47	-2.44	0.16	21.89	0.47	-163.41	1.07	7.95
4.500	0.65	-89.04	1.29	-13.44	0.18	16.66	0.50	-171.39	1.03	7.59
5.000	0.67	-78.45	1.15	-23.86	0.19	10.92	0.53	-179.62	0.98	7.69
5.500	0.69	-68.99	1.02	-33.79	0.21	4.77	0.57	-170.14	0.94	6.86
6.000	0.71	-59.90	0.92	-43.00	0.23	-1.43	0.60	-160.66	0.92	6.09

Note:

1. Gain Calculations:

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

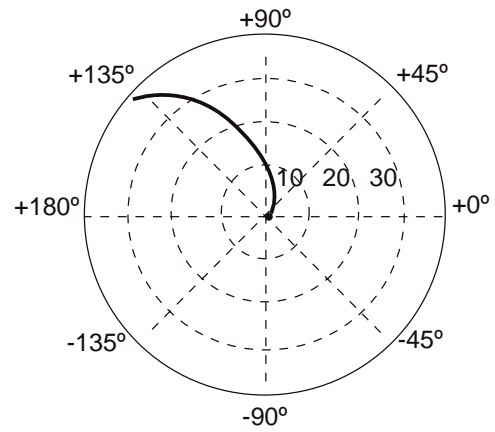
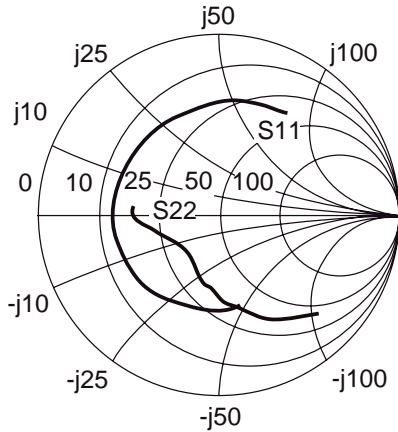
. When  $K \geq 1$ , MAG is undefined and MSG values are used.  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

# NE678M04

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



### NE678M04

Vc = 3 V, Ic = 30 mA

FREQUENCY GHz	S11		S21		S12		S22		K	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
0.100	0.52	-74.30	39.85	141.89	0.02	63.14	0.79	-43.24	0.22	33.48
0.200	0.55	-114.70	28.29	120.64	0.03	50.10	0.58	-69.59	0.37	30.30
0.300	0.56	-136.33	20.98	108.33	0.03	45.90	0.46	-86.51	0.49	28.27
0.400	0.56	-149.34	16.42	100.26	0.03	45.26	0.40	-97.94	0.61	26.78
0.500	0.56	-158.35	13.45	94.25	0.04	45.86	0.36	-106.44	0.69	25.46
0.600	0.56	-167.02	11.22	90.08	0.04	47.13	0.30	-115.48	0.83	24.40
0.700	0.57	-172.39	9.70	85.86	0.04	48.18	0.28	-121.83	0.88	23.43
0.800	0.57	-176.68	8.57	82.27	0.05	49.01	0.27	-125.22	0.92	22.51
0.900	0.57	179.14	7.66	78.87	0.05	49.82	0.27	-128.89	0.96	21.72
1.000	0.57	176.07	6.93	75.71	0.06	50.22	0.26	-131.89	0.98	20.95
1.500	0.57	161.30	4.70	61.65	0.08	49.69	0.27	-142.80	1.07	16.35
1.800	0.57	153.82	3.96	53.96	0.09	48.26	0.27	-147.21	1.09	14.70
1.900	0.57	151.23	3.76	51.43	0.09	47.59	0.28	-148.33	1.09	14.25
2.000	0.57	148.83	3.58	48.96	0.10	46.86	0.28	-149.67	1.09	13.81
2.500	0.57	136.19	2.90	36.74	0.12	42.26	0.31	-154.80	1.09	12.03
3.000	0.57	123.25	2.44	24.91	0.14	36.84	0.34	-159.87	1.08	10.71
3.500	0.58	109.78	2.10	13.41	0.16	30.78	0.37	-164.45	1.06	9.71
4.000	0.60	96.93	1.84	2.30	0.18	24.27	0.40	-170.06	1.04	9.03
4.500	0.62	85.43	1.63	-8.43	0.19	17.67	0.43	-176.72	1.01	8.78
5.000	0.64	75.45	1.46	-18.79	0.21	11.05	0.47	-175.39	0.98	8.46
5.500	0.65	66.54	1.32	-28.80	0.22	4.47	0.50	-166.91	0.95	7.72
6.000	0.67	57.90	1.19	-38.45	0.24	-2.21	0.53	-158.44	0.93	7.05

Note:

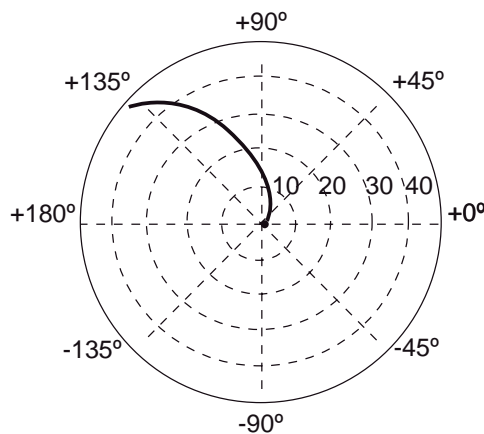
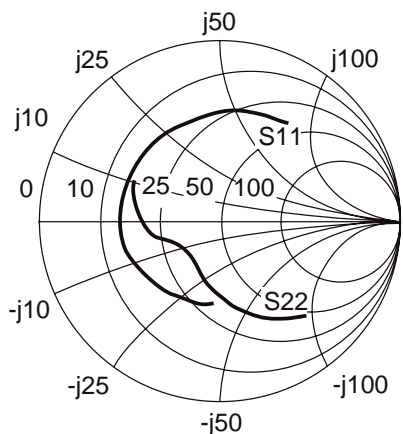
1. Gain Calculations:

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

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

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



**NE678M04**

Vc = 5 V, Ic = 70 mA

FREQUENCY GHz	S11		S21		S12		S22		K	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
0.100	0.46	-92.27	47.62	136.35	0.01	61.08	0.69	-50.06	0.35	35.14
0.200	0.51	-129.65	31.64	115.69	0.02	51.85	0.49	-77.41	0.51	31.73
0.300	0.53	-147.72	22.84	104.50	0.03	50.27	0.39	-94.24	0.65	29.60
0.400	0.54	-158.40	17.67	97.25	0.03	51.38	0.34	-105.50	0.76	27.89
0.500	0.55	-165.77	14.38	91.83	0.03	53.36	0.31	-113.55	0.84	26.43
0.600	0.55	-173.25	11.98	88.17	0.04	54.92	0.26	-123.64	0.94	25.20
0.700	0.56	-177.75	10.33	84.28	0.04	55.88	0.25	-129.49	0.98	24.08
0.800	0.56	178.53	9.12	80.93	0.04	56.52	0.25	-132.28	1.00	22.69
0.900	0.56	174.86	8.14	77.76	0.05	56.38	0.24	-135.41	1.02	21.26
1.000	0.56	172.16	7.36	74.77	0.05	57.10	0.24	-138.20	1.04	20.18
1.500	0.56	158.57	4.98	61.30	0.08	55.00	0.25	-147.24	1.08	16.43
1.800	0.55	151.40	4.19	53.86	0.09	52.53	0.26	-150.84	1.09	14.89
1.900	0.55	148.96	3.98	51.41	0.09	51.60	0.26	-151.75	1.09	14.44
2.000	0.55	146.64	3.79	49.00	0.10	50.56	0.27	-152.82	1.09	14.02
2.500	0.55	134.28	3.07	37.07	0.12	44.90	0.29	-157.03	1.09	12.29
3.000	0.56	121.53	2.58	25.46	0.14	38.56	0.32	-161.31	1.07	10.96
3.500	0.57	108.26	2.22	14.13	0.16	32.10	0.36	-165.52	1.06	9.97
4.000	0.58	95.62	1.95	3.18	0.18	25.40	0.39	-170.85	1.03	9.29
4.500	0.60	84.34	1.73	-7.49	0.20	18.42	0.42	-177.21	1.01	9.02
5.000	0.62	74.53	1.55	-17.79	0.21	11.57	0.45	175.01	0.98	8.67
5.500	0.64	65.76	1.40	-27.80	0.22	4.84	0.48	166.70	0.96	7.95
6.000	0.65	57.22	1.27	-37.47	0.24	-1.99	0.51	158.43	0.94	7.29

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

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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