



NEC's MEDIUM POWER NPN SILICON HIGH FREQUENCY TRANSISTOR

NE678M04

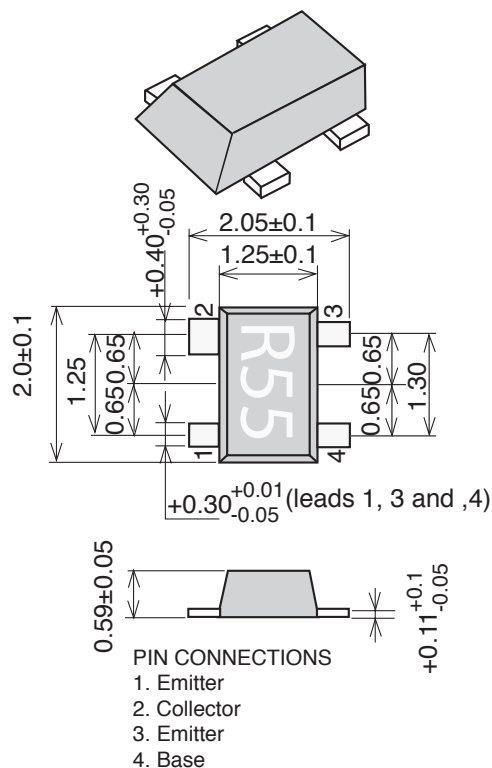
FEATURES

- **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

NEC's 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 EIAJ ³ 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 ¹ 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 ⁴ at $V_{CE} = 3\text{ V}$, $I_C = 30\text{ mA}$, $f = 2\text{ GHz}$	dBm		13.5	
	$ S_{21} / S_{12} ^2$	Insertion Power Gain at $V_{CE} = 3\text{ V}$, $I_C = 30\text{ mA}$, $f = 2\text{ GHz}$	dB	8.0	10.5	
	η_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 ² at $V_{CB} = 3\text{ V}$, $I_C = 0$, $f = 1\text{ MHz}$	pF		0.42	0.7

Notes:

1. Pulsed measurement, pulse width $\leq 350\text{ }\mu\text{s}$, 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 Industriall Association of Japan.

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

ABSOLUTE MAXIMUM RATINGS¹ (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V _{CB0}	Collector to Base Voltage	V	9.0
V _{CEO}	Collector to Emitter Voltage	V	6.0
V _{EB0}	Emitter to Base Voltage	V	2.0
I _C	Collector Current	mA	100
P _T	Total Power Dissipation ²	mW	205
T _J	Junction Temperature	°C	150
T _{STG}	Storage Temperature	°C	-65 to +150

- Note:
- Operation in excess of any one of these parameters may result in permanent damage.
 - Mounted on a 1.08cm² x 1.0 mm thick glass epoxy PCB.

ORDERING INFORMATION

PART NUMBER	QUANTITY
NE678M04-T2-A	3k pcs./reel

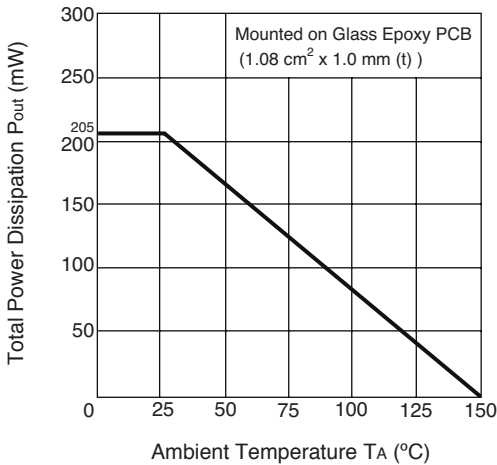
THERMAL RESISTANCE

SYMBOLS	PARAMETERS	UNITS	RATINGS
R _{th j-a}	Thermal Resistance from Junction to Ambient	°C/W	600

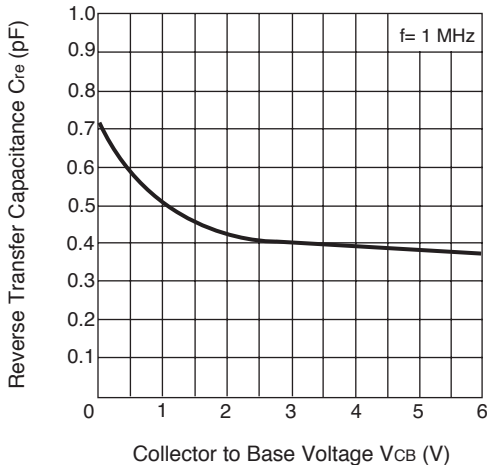
- Note:
- Mounted on a 1.08cm² x 1.0 mm thick glass epoxy PCB.

TYPICAL PERFORMANCE CURVES (T_A = 25 °C)

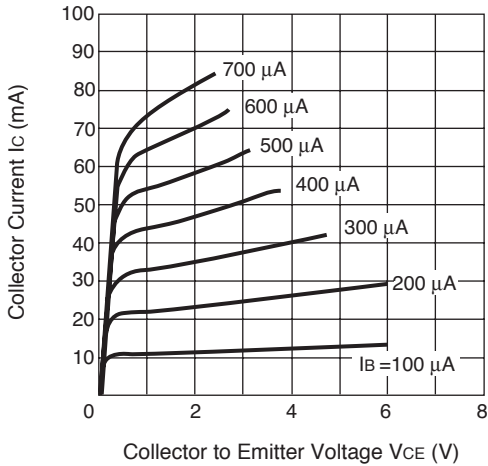
TOTAL POWER DISSIPATION
vs. AMBIENT TEMPERATURE



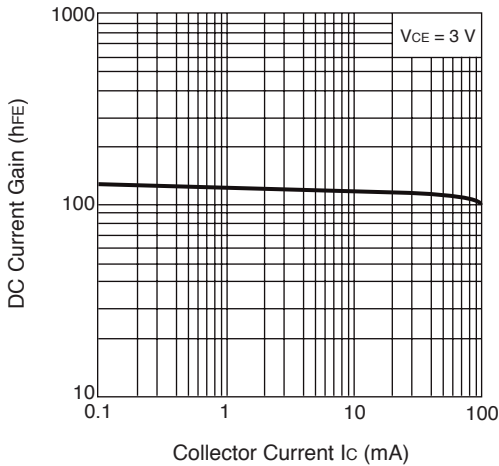
REVERSE TRANSFER CAPACITANCE
vs. COLLECTOR TO BASE VOLTAGE



COLLECTOR CURRENT
vs. COLLECTOR TO EMITTER VOLTAGE

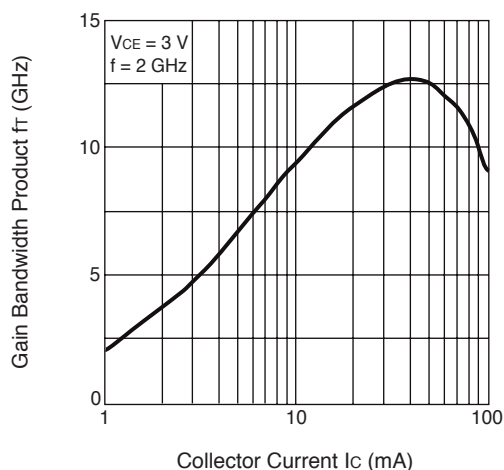


DC CURRENT GAIN
vs. COLLECTOR CURRENT

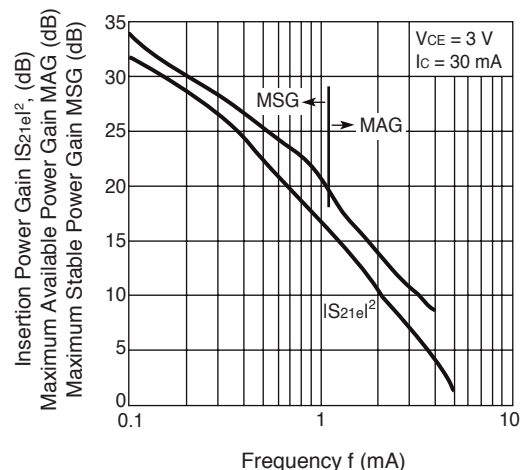


TYPICAL PERFORMANCE CURVES ($T_A = 25^\circ\text{C}$)

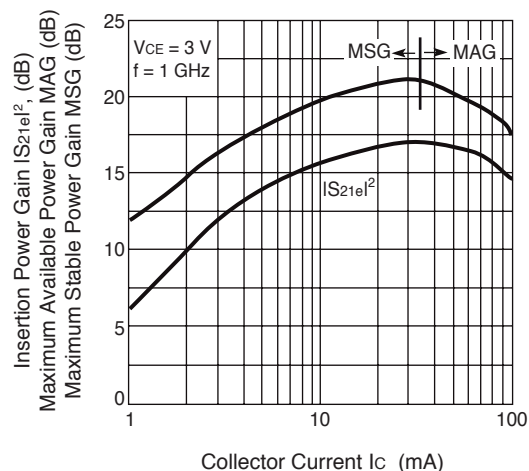
**GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT**



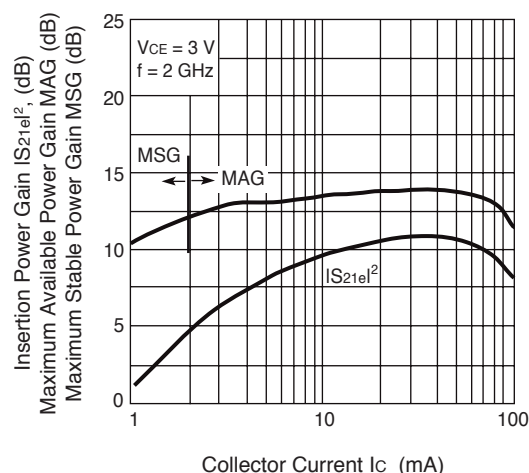
**INSERTION POWER GAIN,
MAG, MSG vs. FREQUENCY**



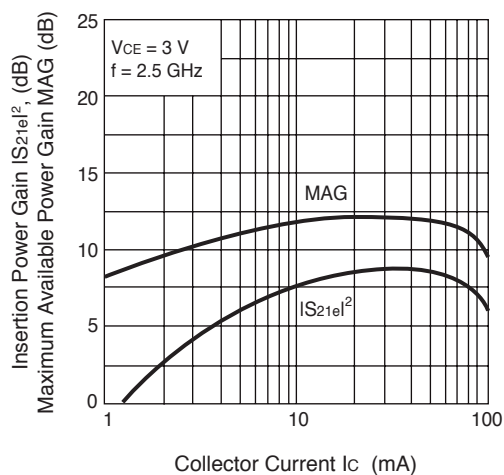
**INSERTION POWER GAIN,
MAG, MSG vs. COLLECTOR CURRENT**



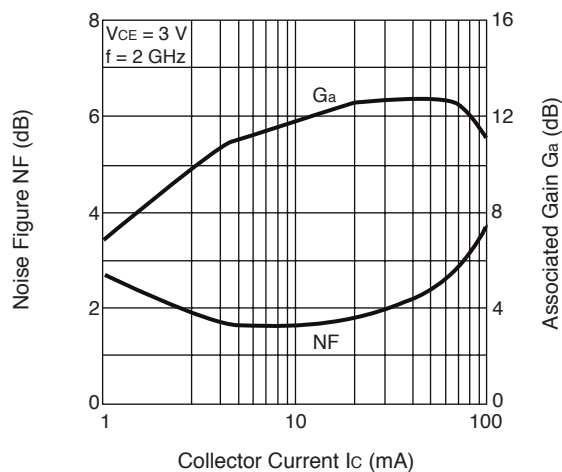
**INSERTION POWER GAIN,
MAG, MSG vs. COLLECTOR CURRENT**



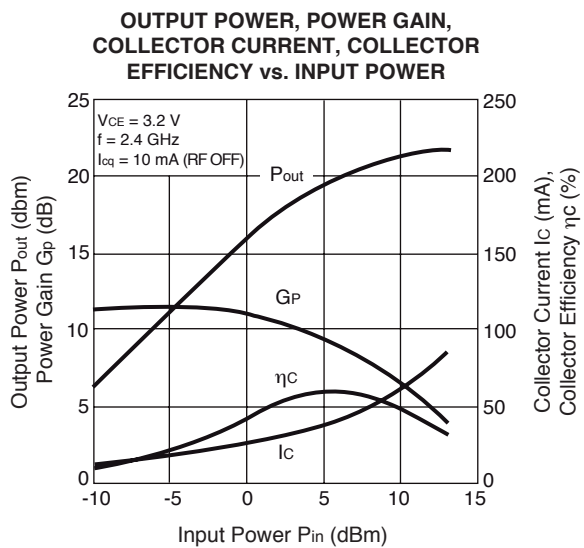
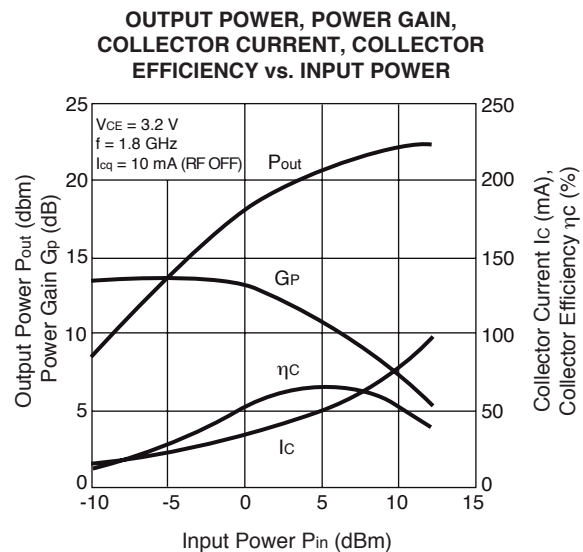
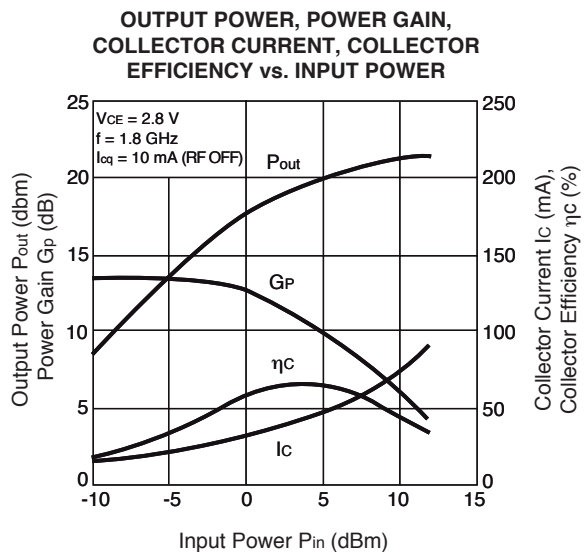
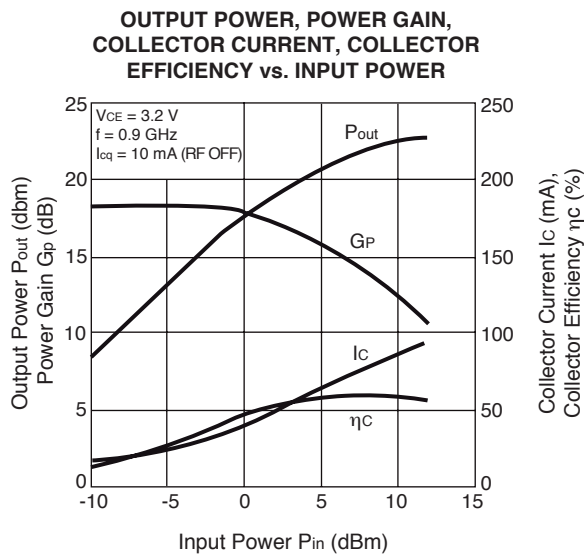
**INSERTION POWER GAIN,
MAG vs. COLLECTOR CURRENT**



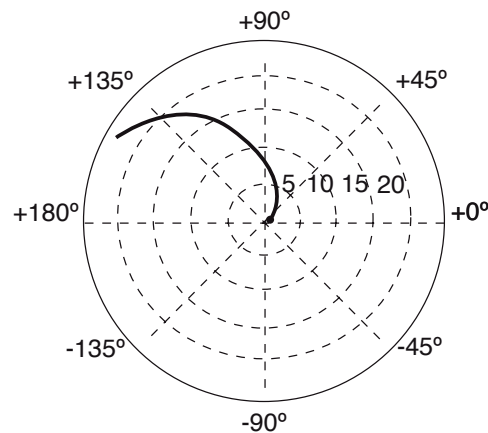
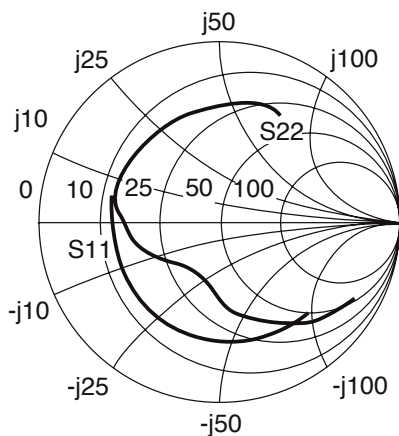
**NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT**



TYPICAL PERFORMANCE CURVES (T_A = 25 °C)



TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



NE678M04

V_c = 2 V, I_c = 10 mA

FREQUENCY	S ₁₁		S ₂₁		S ₁₂		S ₂₂		K	MAG ¹
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
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:

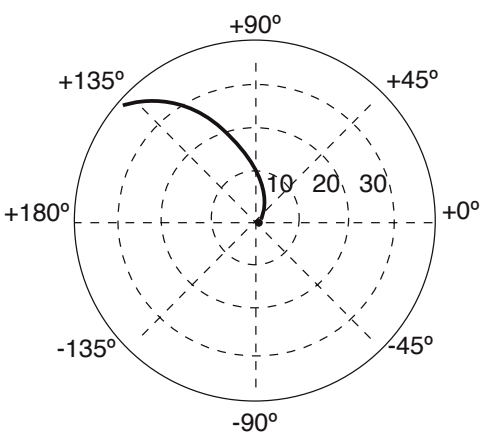
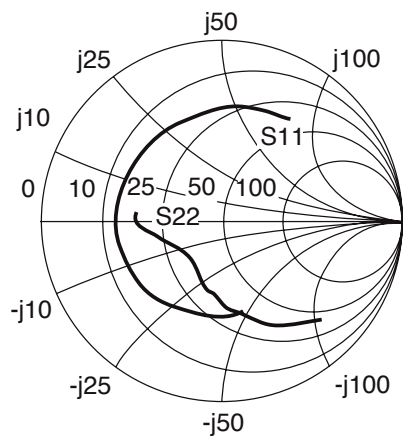
1. Gain Calculations:

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

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (TA = 25°C)

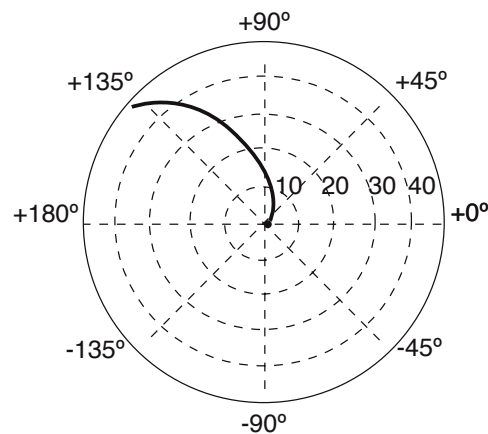
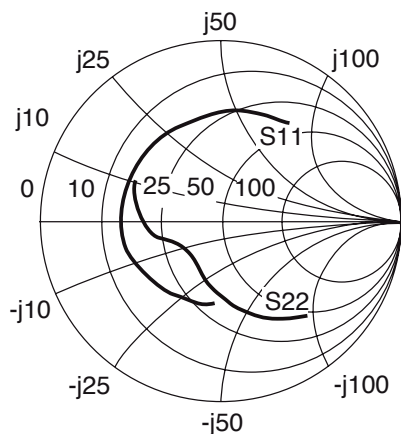


NE678M04
Vc = 3 V, Ic = 30 mA

FREQUENCY	S11		S21		S12		S22		K	MAG ¹ (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:
 $MAG = \frac{|S_{21}|}{|S_{12}|} \left(K - \sqrt{K^2 - 1} \right)$. 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_A = 25°C)



NE678M04

V_c = 5 V, I_c = 70 mA

FREQUENCY	S ₁₁		S ₂₁		S ₁₂		S ₂₂		K	MAG ¹
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
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:

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

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.

EXCLUSIVE NORTH AMERICAN AGENT FOR NEC RF, MICROWAVE & OPTOELECTRONIC SEMICONDUCTORS

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02/07/2002

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

Restricted Substance per RoHS	Concentration Limit per RoHS (values are not yet fixed)	Concentration contained in CEL devices	
		-A	-AZ
Lead (Pb)	< 1000 PPM	Not Detected	(*)
Mercury	< 1000 PPM	Not Detected	
Cadmium	< 100 PPM	Not Detected	
Hexavalent Chromium	< 1000 PPM	Not Detected	
PBB	< 1000 PPM	Not Detected	
PBDE	< 1000 PPM	Not Detected	

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

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