CEL

NEC's NPN SILICON TRANSISTOR NE687M13

FEATURES

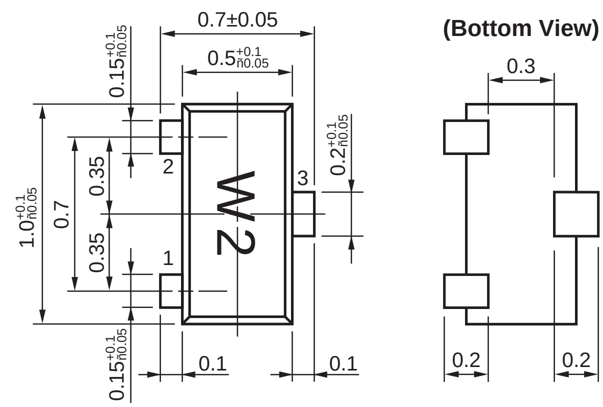
- **NEW MINIATURE M13 PACKAGE:**
  - Small transistor outline
  - 1.0 X 0.5 X 0.5 mm
  - Low profile / 0.50 mm package height
  - Flat lead style for better RF performance
- **HIGH GAIN BANDWIDTH PRODUCT:**
  f_T = 14 GHz
- **LOW NOISE FIGURE:**
  NF = 1.4 dB at 2 GHz

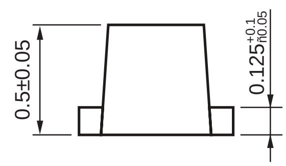
DESCRIPTION

NEC's NE687M13 transistor is designed for low noise, high gain, and low cost requirements. This high f_T part is well suited for very low voltage/low current designs for portable wireless communications and cellular radio applications. NEC's new low profile/flat lead style "M13" package is ideal for today's portable wireless applications.

OUTLINE DIMENSIONS (Units in mm)

PACKAGE OUTLINE M13





PIN CONNECTIONS

1. Emitter
2. Base
3. Collector

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE		NE687M13 2SC5618 M13			
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**
f_T	Gain Bandwidth at V_{CE} = 2 V, I_C = 20 mA, f = 2 GHz	GHz	9.0	14.0	
	V_{CE} = 1 V, I_C = 10 mA, f = 2 GHz	GHz	7.0	12.0	
NF	Noise Figure at V_{CE} = 2 V, I_C = 3 mA, f = 2 GHz, $Z_s = Z_{opt}$	dB		1.4	2.0
	V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz, $Z_s = Z_{opt}$	dB		1.5	2.0
$\|S_{21E}\|^2$	Insertion Power Gain at V_{CE} = 2 V, I_C = 20 mA, f = 2 GHz	dB	8.5	10.0	
	V_{CE} = 1 V, I_C = 10 mA, f = 2 GHz	dB	6.0	9.0	
h_{FE}	Forward Current Gain at V_{CE} = 2 V, I_C = 20 mA, Note 2		70		130
I_{CBO}	Collector Cutoff Current at V_{CB} = 5 V, I_E = 0	µA			0.1
I_{EBO}	Emitter Cutoff Current at V_{EB} = 1 V, I_C = 0	µA			0.1
C_{RE}	Feedback Capacitance at V_{CB} = 2 V, I_E = 0, f = 1 MHz, Note 3	pF		0.4	0.8

Notes:
1. Electronic Industrial Association of Japan.
2. Pulsed measurement, pulse width ≤ 350 µs, duty cycle ≤ 2 %.
3. Capacitance is measured with emitter and case connected to the guard terminal of the bridge.

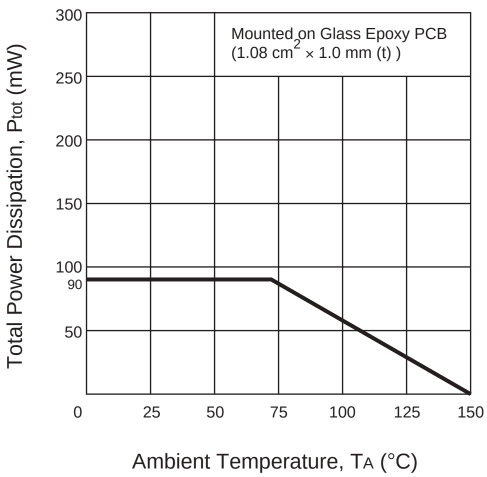
ABSOLUTE MAXIMUM RATINGS[1] (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{CBO}	Collector to Base Voltage	V	5.0
V_{CEO}	Collector to Emitter Voltage	V	3.0
V_{EBO}	Emitter to Base Voltage	V	2.0
I_C	Collector Current	mA	30
P_T	Total Power Dissipation[2]	mW	90
T_J	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to +150

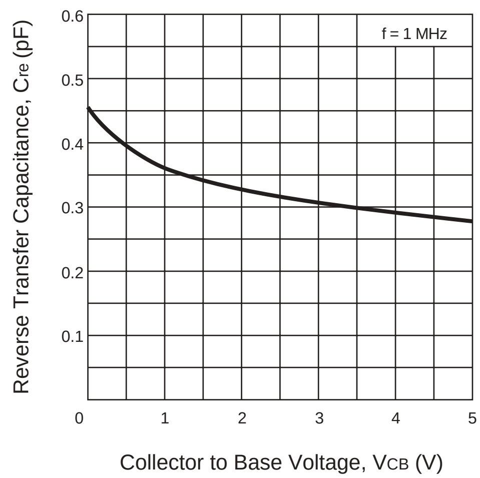
Notes:
1. Operation in excess of any one of these parameters may result in permanent damage.
2. With device mounted on 1.08 cm^2 X 1.2 mm glass epoxy board.

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

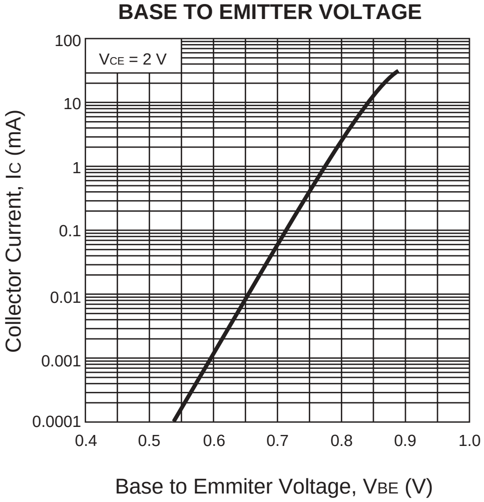
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



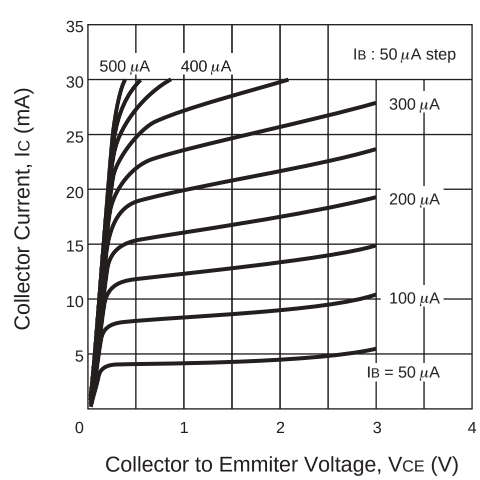
REVERSE TRANSFR CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE

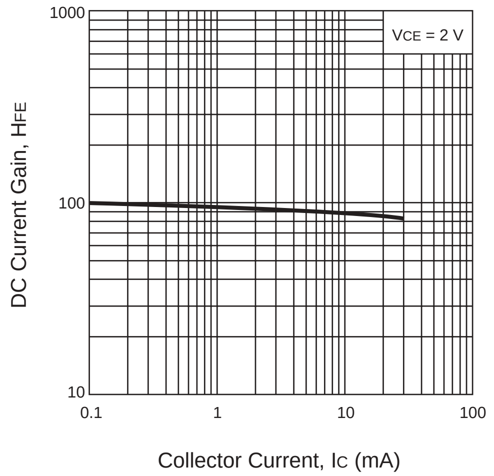


COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

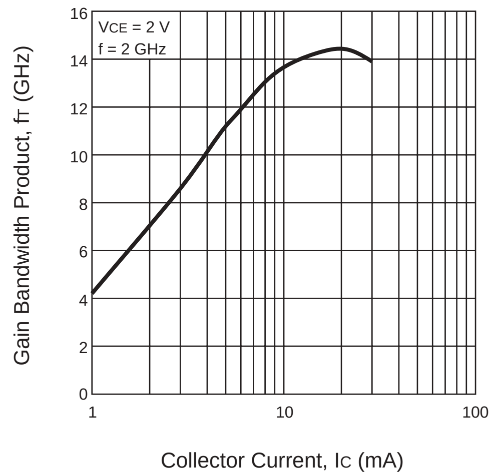


TYPICAL PERFORMANCE CURVES (TA = 25°C)

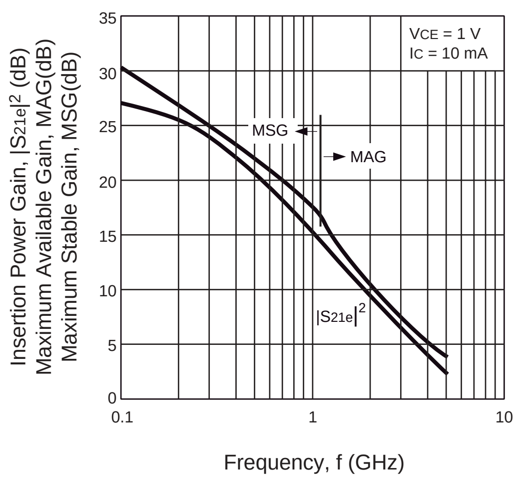
DC CURRENT GAIN vs. COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



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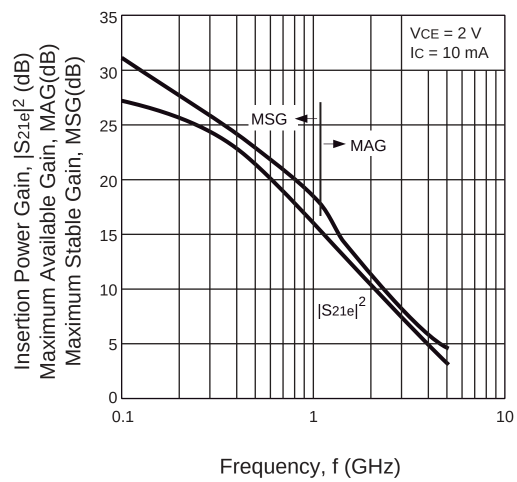
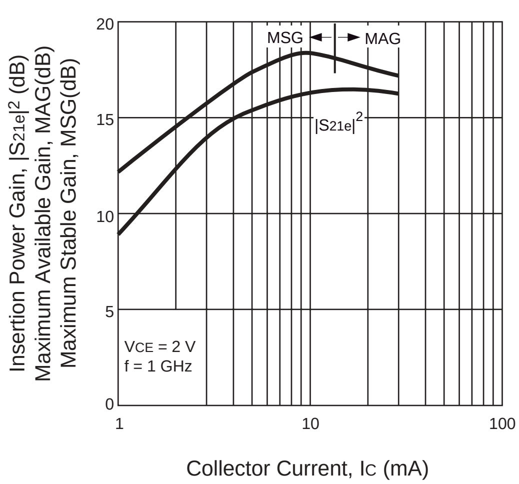
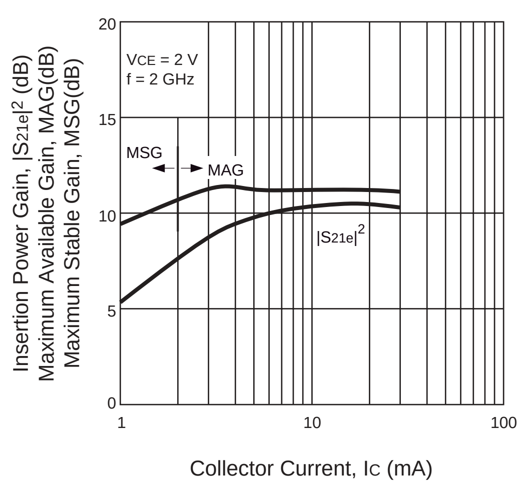


INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

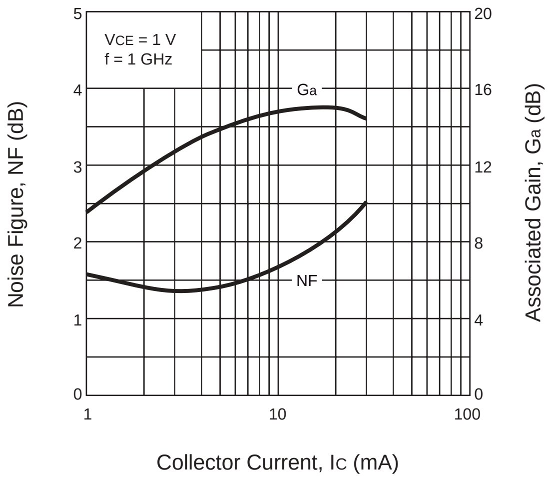


INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

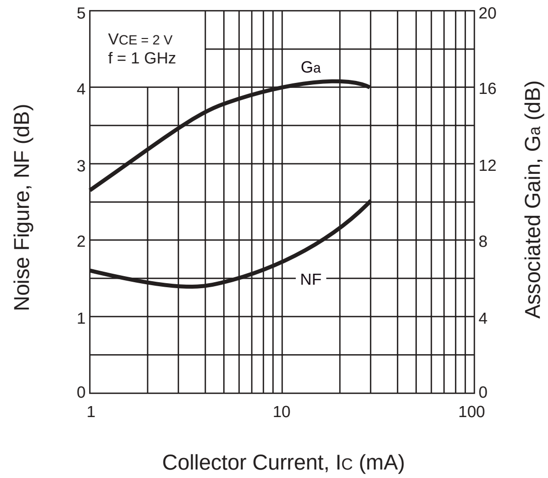


TYPICAL PERFORMANCE CURVES (TA = 25°C)

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



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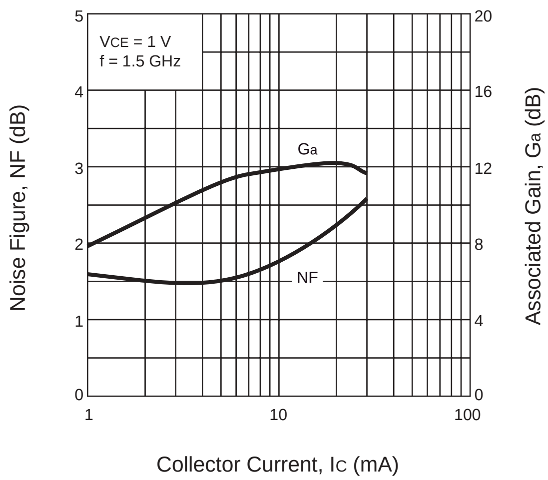
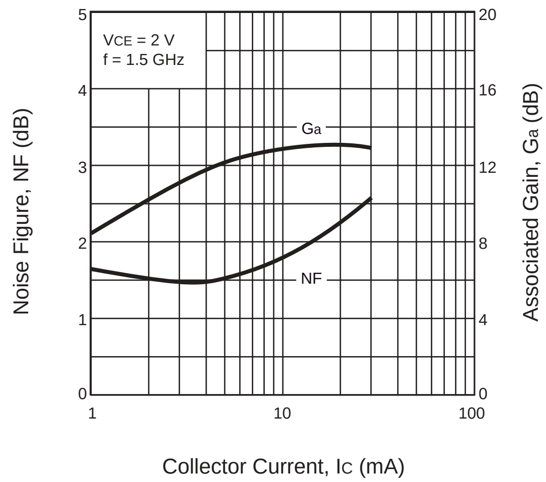


NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



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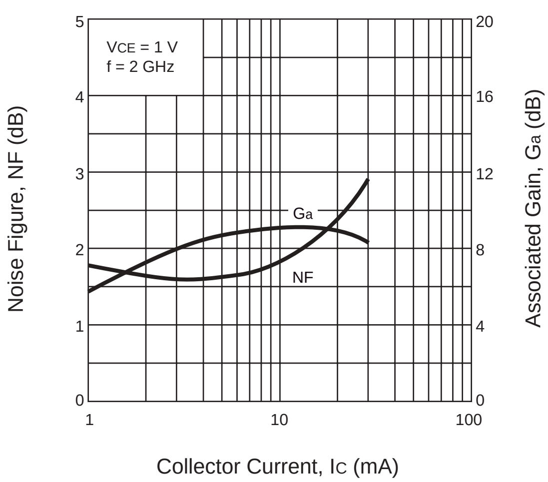
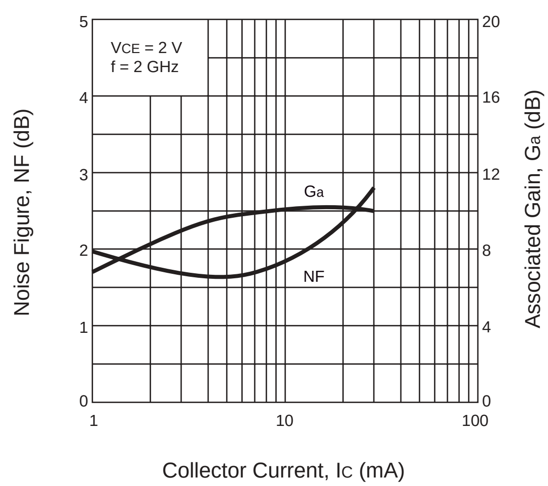
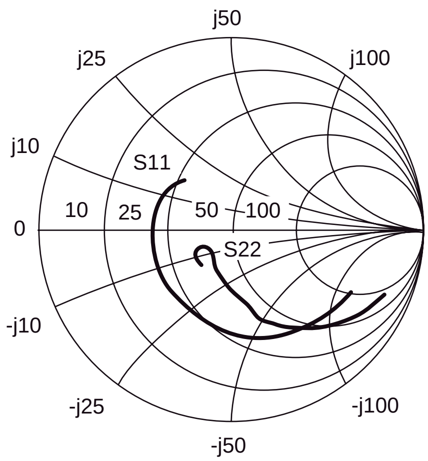
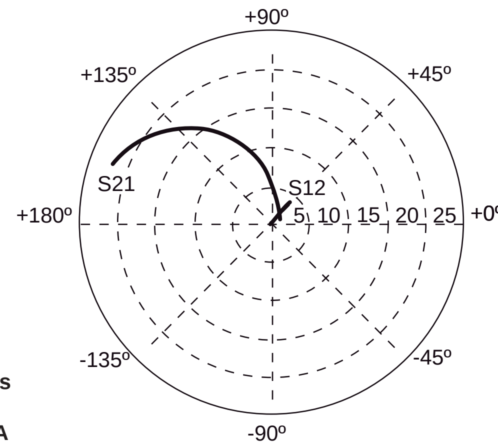


NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



TYPICAL SCATTERING PARAMETERS





Coordinates in Ohms
Frequency in GHz
V_{CE} = 1 V, I_C = 10 mA

NE687M13
V_{CE} = 1 V, I_C = 10 mA

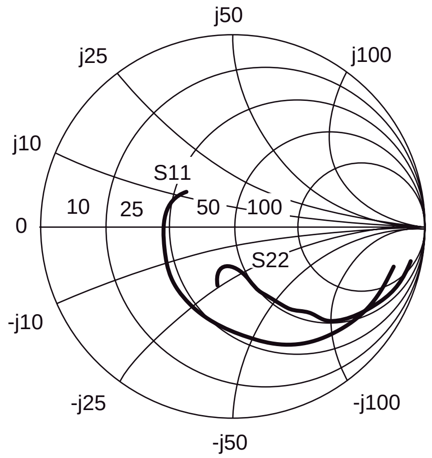
Frequency	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.71	-28.83	21.86	158.87	0.02	76.89	0.86	-22.59	0.19	29.94
0.200	0.64	-56.70	19.01	141.86	0.04	64.05	0.75	-40.78	0.28	27.02
0.300	0.57	-77.87	16.05	129.44	0.05	57.48	0.63	-54.59	0.37	25.16
0.400	0.53	-94.58	13.57	120.29	0.06	54.28	0.54	-64.96	0.46	23.79
0.500	0.49	-107.39	11.62	113.50	0.06	52.33	0.47	-72.99	0.54	22.68
0.600	0.45	-120.85	9.91	108.06	0.07	51.39	0.37	-78.86	0.68	21.71
0.700	0.44	-129.42	8.73	103.77	0.07	51.70	0.33	-85.54	0.74	20.83
0.800	0.44	-135.99	7.80	100.31	0.08	52.15	0.30	-90.17	0.79	20.04
0.900	0.43	-141.83	7.02	97.30	0.08	52.52	0.28	-94.31	0.83	19.34
1.000	0.43	-146.64	6.38	94.61	0.09	53.11	0.26	-99.34	0.88	18.67
1.200	0.42	-153.87	5.40	90.05	0.10	54.26	0.23	-106.29	0.94	17.49
1.400	0.42	-160.59	4.69	86.18	0.11	55.29	0.21	-113.29	0.99	16.45
1.600	0.42	-165.22	4.14	82.82	0.12	56.05	0.19	-118.74	1.03	14.43
1.800	0.42	-169.18	3.71	79.73	0.13	56.51	0.18	-123.68	1.06	13.15
2.000	0.41	-172.49	3.37	76.86	0.14	56.83	0.17	-128.17	1.08	12.13
2.500	0.40	179.29	2.76	70.23	0.16	56.91	0.16	-136.91	1.12	10.14
3.000	0.40	171.08	2.35	64.05	0.19	55.87	0.17	-143.47	1.14	8.61
3.500	0.39	161.33	2.05	58.49	0.21	54.71	0.18	-147.06	1.16	7.38
4.000	0.40	152.78	1.83	53.56	0.24	53.37	0.20	-147.25	1.16	6.41
4.500	0.39	146.02	1.66	49.23	0.26	52.04	0.22	-144.73	1.16	5.60
5.000	0.38	141.59	1.53	45.35	0.29	50.81	0.23	-140.61	1.15	4.94
5.500	0.36	138.25	1.44	41.63	0.31	49.38	0.23	-135.48	1.14	4.40
6.000	0.34	134.43	1.36	37.72	0.34	47.54	0.23	-133.06	1.13	3.90

Note:
1. Gain Calculations:

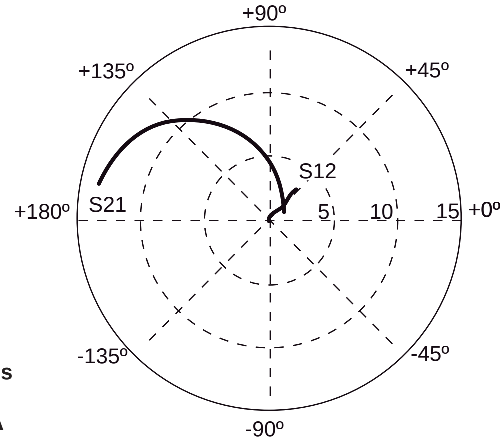
$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When K ≤ 1, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\ |S_{12}\ S_{21}|}$, $\Delta = S_{11}\ S_{22} - S_{21}\ S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS



Coordinates in Ohms
Frequency in GHz
V_{CE} = 2 V, I_C = 5 mA



NE687M13
V_{CE} = 2 V, I_C = 5 mA

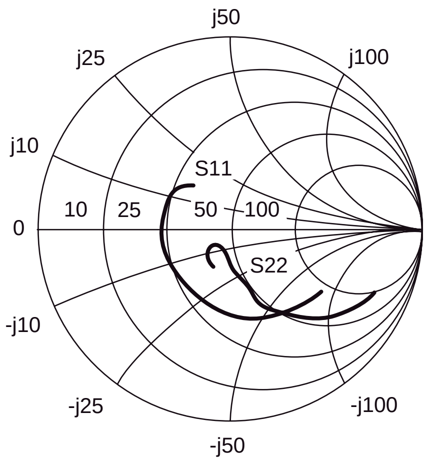
Frequency	S11		S21		S12		S22		K	MAG[1]
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)
0.100	0.86	-14.28	13.53	167.49	0.02	80.25	0.94	-11.88	0.14	28.47
0.200	0.81	-31.85	12.83	155.13	0.04	71.73	0.89	-22.74	0.17	25.34
0.300	0.76	-46.05	11.91	144.78	0.05	65.56	0.82	-32.21	0.22	23.61
0.400	0.70	-59.23	10.91	135.97	0.06	60.40	0.75	-39.96	0.28	22.37
0.500	0.65	-70.68	9.95	128.54	0.07	56.24	0.68	-46.33	0.34	21.38
0.600	0.58	-82.92	8.87	121.33	0.08	52.47	0.58	-49.51	0.47	20.54
0.700	0.54	-91.97	8.07	116.01	0.08	50.58	0.53	-54.17	0.52	19.81
0.800	0.52	-99.97	7.39	111.61	0.09	49.44	0.48	-57.43	0.57	19.16
0.900	0.49	-107.10	6.76	107.73	0.09	48.55	0.44	-59.80	0.62	18.56
1.000	0.48	-113.24	6.24	104.20	0.10	47.85	0.41	-63.07	0.66	18.02
1.200	0.45	-123.52	5.38	98.29	0.11	47.62	0.36	-66.56	0.75	17.05
1.400	0.43	-132.69	4.72	93.40	0.11	47.64	0.32	-70.62	0.82	16.19
1.600	0.41	-139.56	4.20	89.17	0.12	48.14	0.29	-73.13	0.88	15.41
1.800	0.40	-145.30	3.78	85.45	0.13	48.60	0.27	-75.54	0.94	14.70
2.000	0.39	-150.12	3.45	82.00	0.14	49.16	0.25	-77.78	0.98	14.05
2.500	0.37	-161.26	2.84	74.35	0.16	50.11	0.22	-83.87	1.07	11.05
3.000	0.36	-171.52	2.42	67.39	0.18	50.31	0.21	-91.33	1.12	9.30
3.500	0.35	176.69	2.12	61.12	0.20	50.27	0.22	-98.64	1.15	7.96
4.000	0.34	166.32	1.88	55.53	0.22	49.84	0.23	-104.18	1.17	6.92
4.500	0.34	158.42	1.70	50.63	0.23	49.50	0.26	-106.91	1.18	6.08
5.000	0.34	153.42	1.56	46.37	0.25	49.25	0.28	-106.70	1.17	5.40
5.500	0.32	150.03	1.46	42.49	0.27	48.86	0.30	-104.89	1.16	4.85
6.000	0.30	146.33	1.38	38.57	0.30	48.07	0.31	-104.37	1.15	4.35

Note:
1. Gain Calculations:

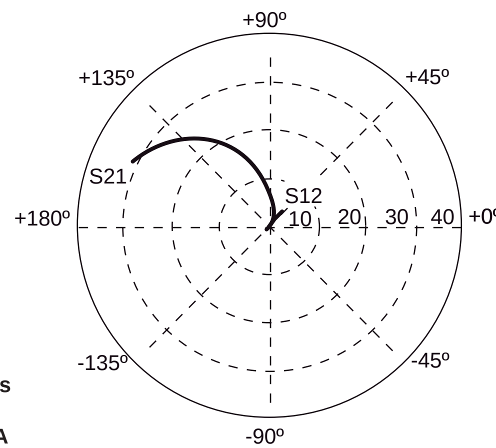
$MAG = \frac{|S_{21}|}{|S_{12}|}\left(K \pm \sqrt{K^2 - 1}\right)$. When K ≤ 1, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2\,|S_{12}\,S_{21}|}$, $\Delta = S_{11}\,S_{22} - S_{21}\,S_{12}$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS



Coordinates in Ohms
Frequency in GHz
V_{CE} = 2 V, I_C = 20 mA



NE687M13
V_{CE} = 2 V, I_C = 20 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	0.57	-36.15	31.49	154.52	0.01	71.95	0.81	-25.05	0.34	33.26
0.200	0.50	-67.88	25.71	135.92	0.03	66.14	0.67	-43.58	0.42	29.76
0.300	0.45	-90.13	20.68	123.67	0.03	60.45	0.54	-56.22	0.54	27.77
0.400	0.42	-106.56	16.96	115.24	0.04	59.44	0.46	-64.85	0.64	26.19
0.500	0.40	-118.50	14.25	109.26	0.05	59.55	0.39	-71.22	0.71	24.88
0.600	0.37	-131.65	12.07	104.60	0.05	60.02	0.30	-75.54	0.84	23.77
0.700	0.37	-139.21	10.55	100.88	0.06	60.94	0.26	-81.03	0.89	22.75
0.800	0.37	-144.73	9.37	97.86	0.06	61.83	0.24	-84.22	0.92	21.84
0.900	0.37	-149.66	8.41	95.24	0.07	62.31	0.21	-87.05	0.95	21.02
1.000	0.36	-153.80	7.62	92.90	0.07	62.97	0.20	-91.25	0.98	20.26
1.200	0.37	-159.66	6.43	88.88	0.08	63.94	0.17	-96.57	1.02	18.15
1.400	0.37	-165.38	5.56	85.48	0.09	64.61	0.15	-102.15	1.05	16.47
1.600	0.37	-169.31	4.90	82.45	0.10	64.72	0.14	-106.18	1.07	15.17
1.800	0.37	-172.61	4.39	79.67	0.11	64.87	0.13	-109.91	1.08	14.10
2.000	0.36	-175.37	3.98	77.07	0.13	64.81	0.12	-113.45	1.09	13.16
2.500	0.36	177.29	3.24	70.97	0.15	63.80	0.11	-121.12	1.11	11.27
3.000	0.35	169.69	2.75	65.26	0.18	62.10	0.12	-128.22	1.12	9.76
3.500	0.35	160.03	2.39	60.01	0.21	60.09	0.14	-133.08	1.12	8.53
4.000	0.36	151.53	2.12	55.28	0.23	58.20	0.16	-134.34	1.12	7.54
4.500	0.36	144.75	1.92	51.05	0.25	56.51	0.18	-132.06	1.12	6.71
5.000	0.35	140.37	1.76	47.24	0.28	54.88	0.20	-127.09	1.11	6.03
5.500	0.33	137.20	1.65	43.56	0.30	53.20	0.21	-120.86	1.10	5.48
6.000	0.31	133.76	1.55	39.78	0.33	51.20	0.21	-117.44	1.09	4.95

Note:
1. Gain Calculations:

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

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