

**NEC**

# LOW NOISE Ku-K BAND GaAs MESFET FOR HI REL APPLICATIONS ONLY

**NE67300**  
**NE67383**

## FEATURES

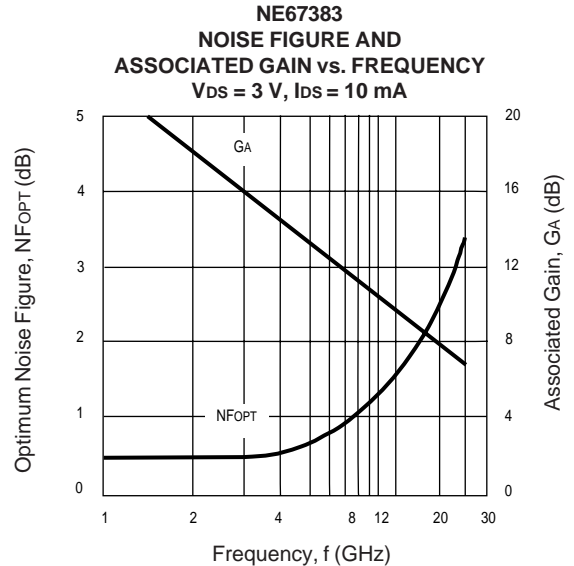
- **VERY HIGH  $f_{MAX}$ : 100 GHz**
- **LOW NOISE FIGURE**  
0.4 dB at 4 GHz  
0.8 dB at 8 GHz  
1.4 dB at 12 GHz  
1.9 dB at 18 GHz  
3.3 dB at 26 GHz
- **$L_G = 0.3 \mu\text{m}$ ,  $W_G = 280 \mu\text{m}$**
- **N+ CONTACT LAYER**  
(Triple Epitaxial Technology)
- **PROVEN RELIABILITY AND STABILITY**
- **SPACE QUALIFIED**

## DESCRIPTION

The NE673 features a low noise figure and high associated gain through K-band by employing a recessed 0.3 micron gate and triple epitaxial technology for industrial and space applications.

The device is available as a chip (NE67300). The chip's gate and channel are glassivated with a thin layer of  $\text{Si}_3\text{N}_4$  for mechanical protection only. The NE673 is in a rugged hermetically sealed metal/ceramic stripline package selected for  $N_{FOPT}$  performance at 12.0 GHz.

NEC's stringent quality assurance and test procedures assure the highest reliability and performance.



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

PART NUMBER EIAJ <sup>1</sup> REGISTERED NUMBER PACKAGE OUTLINE			NE67300 00 (CHIP)			NE67383 2SK407 83		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
$N_{FOPT}$	Optimum Noise Figure at $V_{DS} = 3 \text{ V}$ , $I_{DS} = 10 \text{ mA}$ , $f = 12 \text{ GHz}$	dB		1.4	1.6		1.4	1.6
$G_A$	Associated Gain at Optimum Noise Figure at $V_{DS} = 3 \text{ V}$ , $I_{DS} = 10 \text{ mA}$ , $f = 12 \text{ GHz}$	dB	8.5	10		8.5	10	
$P_{1dB}$	Output Power at 1 dB Compression Point at $V_{DS} = 3 \text{ V}$ , $I_{DS} = 30 \text{ mA}$ , $f = 12 \text{ GHz}$	dBm		14.5			14.5	
$I_{DS}$	Saturated Drain Current at $V_{DS} = 3 \text{ V}$ , $V_{GS} = 0$	mA	20	40	120	20	40	120
$V_P$	Pinch-off Voltage at $V_{DS} = 3 \text{ V}$ , $I_{DS} = 0.1 \text{ mA}$	V	-0.5	-1.1	-3.5	-0.5	-1.1	-3.5
$g_M$	Transconductance at $V_{DS} = 3 \text{ V}$ , $I_{DS} = 10 \text{ mA}$	mS	20	50	100	20	50	100
$I_{GS}$	Gate to Source Leakage Current at $V_{GS} = -5 \text{ V}$	mA		1	10		1	10
$R_{TH}(\text{CH-A})$	Thermal Resistance (Channel-to-Ambient)	$^\circ\text{C/W}$			190 <sup>2</sup>			450

Notes:

1. Electronic Industrial Association of Japan.
2.  $R_{TH}$  (Channel to Case) for chips mounted on an infinite heat sink.

California Eastern Laboratories

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

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>DS</sub>	Drain to Source Voltage	V	5
V <sub>GS</sub>	Gate to Source Voltage	V	-6
I <sub>DS</sub>	Drain Current	mA	I <sub>DSS</sub>
P <sub>IN</sub>	RF Input (CW)	mW	40
T <sub>CH</sub>	Channel Temperature	°C	175
T <sub>STG</sub>	Storage Temperature	°C	-65 to +175
P <sub>T</sub>	Total Power Dissipation NE67300	mW	400
	NE67383	mW	270

Note:

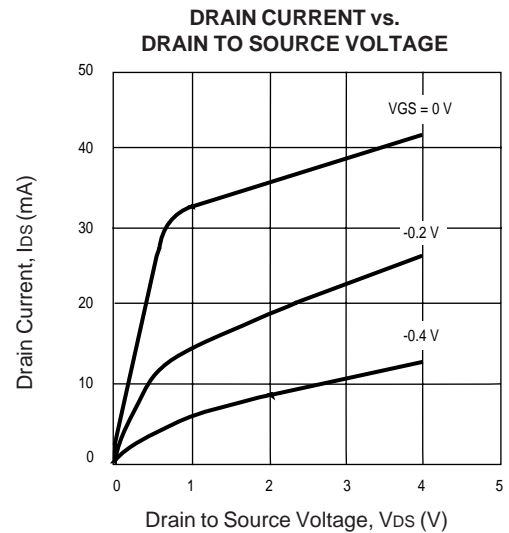
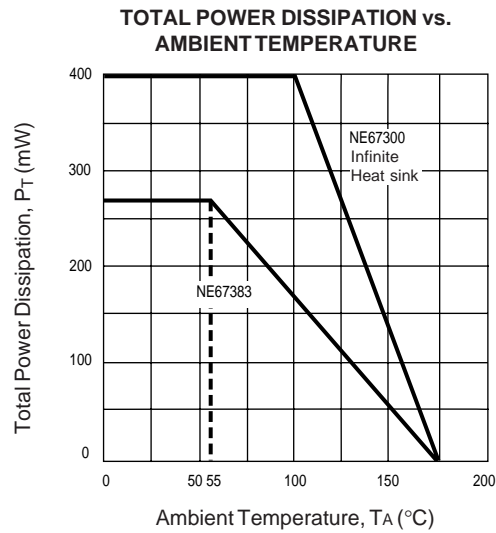
1. Operation in excess of any one of these parameters may result in permanent damage.

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

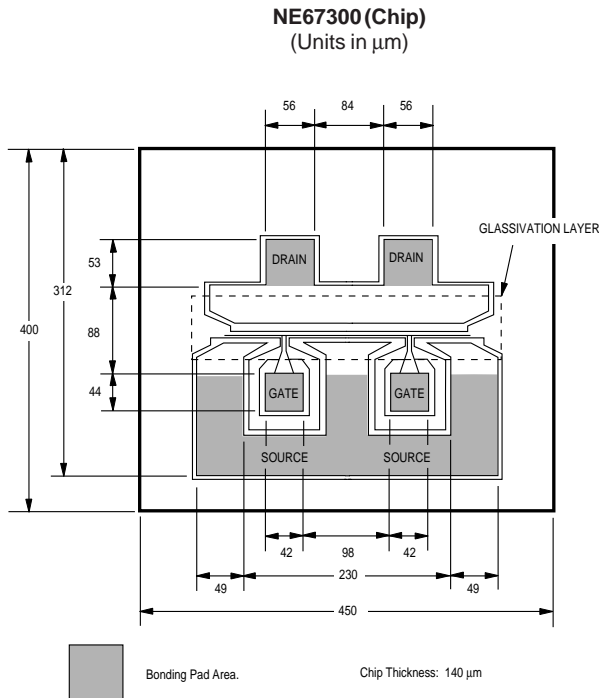
NE67383, V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 10mA

FREQ. (GHz)	NF <sub>OPT</sub> (dB)	G <sub>A</sub> (dB)	Γ <sub>OPT</sub>		R <sub>n</sub> /50
			MAG	ANG	
1.0	0.30	20.5	0.90	17	.65
2.0	0.35	17.5	0.84	40	.57
4.0	0.40	14.5	0.72	79	.48
6.0	0.55	12.5	0.62	112	.39
8.0	0.80	11.7	0.56	143	.33
10.0	1.1	10.5	0.50	168	.28
12.0	1.4	9.5	0.46	-165	.24
14.0	1.7	9.0	0.43	-140	.20
16.0	2.0	8.5	0.40	-112	.18
18.0	2.5	7.8	0.40	-84	.16

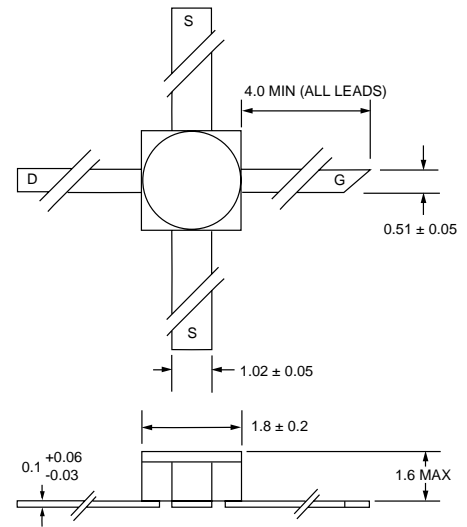
**TYPICAL PERFORMANCE CURVES** (T<sub>A</sub> = 25 °C)



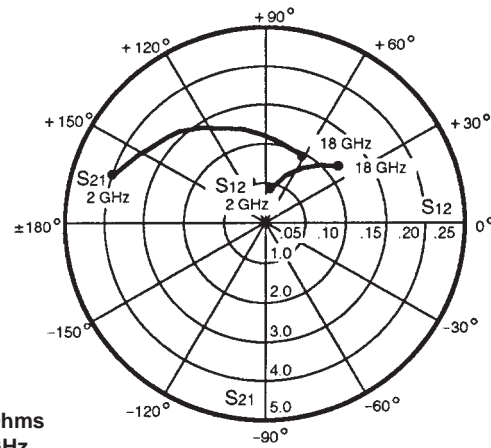
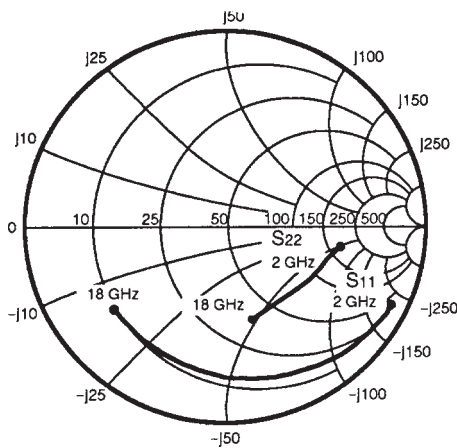
OUTLINE DIMENSIONS (Units in mm)



PACKAGE OUTLINE 83



TYPICAL COMMON SOURCE SCATTERING PARAMETERS (TA = 25°C)



NE67300  
Coordinates in Ohms  
Frequency in GHz  
(Vds = 3 V, Ids = 10 mA)

Vds = 3 V, Ids = 10 mA

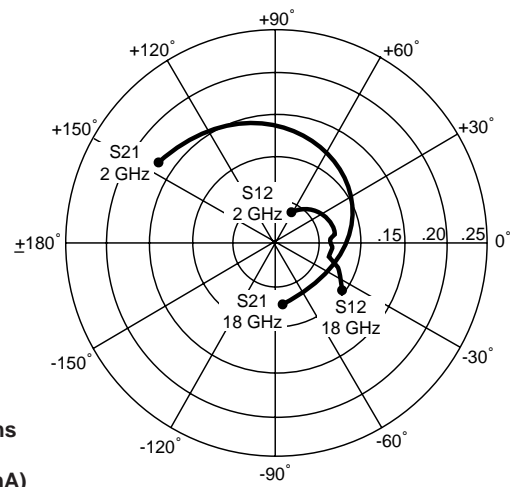
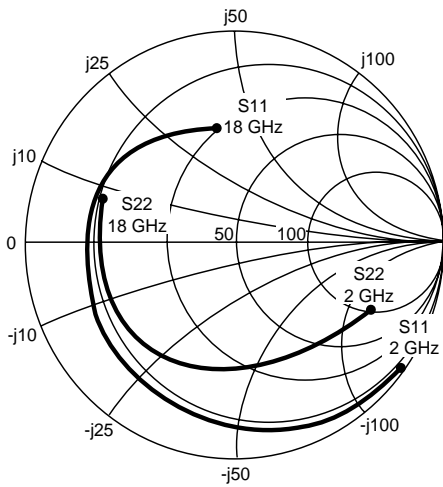
FREQ (GHz)	S11		S21		S12		S22		K	S21 (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	.95	-26	3.79	161	.04	79	.59	-13	0.20	11.6	19.8
4.0	.89	-50	3.26	141	.06	66	.58	-24	0.35	10.3	17.3
6.0	.82	-70	2.83	126	.08	56	.54	-33	0.51	9.0	15.5
8.0	.78	-88	2.55	114	.09	51	.50	-42	0.59	8.1	14.5
10.0	.73	-102	2.21	104	.10	48	.47	-48	0.75	6.9	13.4
12.0	.71	-114	2.16	93	.10	43	.45	-55	0.84	6.7	13.3
14.0	.71	-122	2.11	90	.11	44	.47	-62	0.70	6.5	12.8
16.0	.67	-128	1.92	76	.11	43	.49	-64	0.88	5.7	12.4
18.0	.66	-140	1.81	63	.11	40	.52	-70	0.90	5.1	12.2

Note:

1. Gain Calculation:

$$MAG = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right) . \text{ When } K \leq 1, MAG = MSG. \text{ MSG} = \frac{|S_{21}|}{|S_{12}|} , K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|} , \Delta = S_{11} S_{22} - S_{21} S_{12}$$

TYPICAL COMMON SOURCE SCATTERING PARAMETERS (TA = 25°C)



NE67383  
Coordinates in Ohms  
Frequency in GHz  
(Vds = 3 V, Ids = 10 mA)

NE67383  
Vds = 3 V, Ids = 10 mA

FREQUENCY (GHz)	S11		S21		S12		S22		K	S21 (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	.965	-43	3.248	141	.037	61	.658	-29	0.18	10.2	19.4
2.5	.939	-53	3.178	131	.045	53	.647	-36	0.28	10.0	18.4
3.0	.933	-61	3.022	124	.051	48	.643	-42	0.27	9.6	17.7
3.5	.921	-71	3.049	114	.058	41	.639	-49	0.29	9.7	17.2
4.0	.898	-80	2.882	106	.062	36	.629	-56	0.34	9.2	16.6
4.5	.876	-90	2.840	99	.067	31	.621	-63	0.35	9.1	16.3
5.0	.846	-98	2.640	91	.069	24	.608	-69	0.48	8.4	15.8
5.5	.833	-106	2.583	83	.071	20	.603	-74	0.51	8.2	15.6
6.0	.823	-113	2.504	75	.074	15	.603	-80	0.54	8.0	15.3
6.5	.807	-121	2.409	68	.076	9	.600	-86	0.58	7.6	15.0
7.0	.787	-128	2.315	60	.074	6	.600	-92	0.67	7.3	14.9
7.5	.771	-135	2.191	55	.072	4	.596	-97	0.74	6.8	14.8
8.0	.763	-141	2.167	48	.074	0	.597	-102	0.76	6.7	14.7
8.5	.762	-147	2.066	43	.073	-2	.607	-106	0.77	6.3	14.5
9.0	.746	-153	2.021	34	.073	-6	.608	-112	0.84	6.1	14.4
9.5	.743	-159	1.953	29	.071	-8	.616	-116	0.87	5.8	14.4
10.0	.726	-166	1.891	24	.071	-8	.614	-122	0.92	5.5	14.2
11.0	.709	-176	1.803	12	.069	-13	.617	-130	1.05	5.1	12.8
12.0	.682	172	1.767	-1	.071	-17	.621	-139	1.11	4.9	12.0
13.0	.649	161	1.658	-13	.070	-17	.625	-147	1.29	4.4	10.5
14.0	.627	149	1.593	-24	.073	-19	.628	-155	1.32	4.0	10.0
15.0	.607	138	1.563	-36	.078	-22	.633	-164	1.29	3.9	9.8
16.0	.585	125	1.531	-45	.086	-24	.639	-173	1.20	3.7	9.8
17.0	.563	112	1.513	-60	.091	-32	.646	178	1.18	3.6	9.7
18.0	.536	98	1.467	-71	.101	-37	.649	168	1.13	3.3	9.4

Note:

1. Gain Calculations:

$$MAG = \frac{|S21|}{|S12|} \left( K \pm \sqrt{K^2 - 1} \right) . \text{ When } K \leq 1, MAG = MSG. \text{ MSG} = \frac{|S21|}{|S12|}, K = \frac{1 + |\Delta|^2 - |S11|^2 - |S22|^2}{2 |S12 S21|}, \Delta = S11 S22 - S21 S12$$

MAG = Maximum Available Gain  
MSG = Maximum Stable Gain

# NE67300, NE67383

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

### NE67383

V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 20 mA

FREQUENCY (GHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	S <sub>21</sub> (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	.95	-45	3.99	139	.03	60.9	.61	-29.3	0.27	12.0	21.2
2.5	.93	-55	3.88	129	.04	54.2	.60	-36.5	0.31	11.8	19.9
3.0	.91	-64	3.68	122	.04	48.8	.59	-42.1	0.39	11.3	19.6
3.5	.90	-75	3.69	111	.05	42.2	.59	-49.0	0.36	11.3	18.7
4.0	.87	-84	3.47	103	.05	37.3	.58	-55.2	0.47	10.8	18.4
4.5	.85	-94	3.39	96	.06	33.5	.57	-62.3	0.43	10.6	17.5
5.0	.82	-102	3.14	88	.06	26.9	.56	-68.3	0.57	9.9	17.2
5.5	.81	-110	3.07	80	.06	24.0	.56	-73.8	0.59	9.7	17.1
6.0	.79	-118	2.93	72	.06	18.9	.55	-79.9	0.69	9.3	16.9
6.5	.78	-126	2.83	66	.07	14.0	.55	-85.2	0.63	9.0	16.1
7.0	.76	-133	2.71	58	.06	12.0	.55	-90.8	0.82	8.7	16.5
7.5	.74	-140	2.58	53	.06	11.0	.55	-95.8	0.89	8.2	16.3
8.0	.73	-146	2.52	46	.07	8.7	.55	-100.6	0.80	8.0	15.6
8.5	.73	-152	2.40	41	.06	7.1	.56	-105.1	0.95	7.6	16.0
9.0	.71	-159	2.35	32	.06	3.2	.57	-110.3	1.03	7.4	14.9
9.5	.70	-164	2.24	26	.06	2.0	.57	-115.4	1.11	7.0	13.7
10.0	.69	-171	2.20	22	.07	2.4	.58	-120.0	0.92	6.8	15.0
11.0	.67	178	2.07	10	.06	-1.2	.58	-128.3	1.24	6.3	12.4
12.0	.65	166	2.02	-2	.07	-4.9	.59	-137.0	1.09	6.1	12.8
13.0	.62	154	1.89	-13	.07	-4.7	.60	-144.4	1.23	5.5	11.5
14.0	.58	142	1.82	-25	.08	-8.6	.60	-152.6	1.21	5.2	10.8
15.0	.57	131	1.77	-37	.08	-12.6	.61	-161.2	1.24	5.0	10.5
16.0	.55	117	1.72	-46	.09	-16.3	.62	-170.4	1.13	4.7	10.6
17.0	.53	104	1.70	-60	.10	-24.9	.63	-179.5	1.03	4.6	11.2
18.0	.50	91	1.64	-72	.11	-32.0	.64	171.7	1.00	4.3	11.7

### NE67383

V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 30 mA

FREQUENCY (GHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	S <sub>21</sub> (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	.95	-46	4.37	138	.03	61	.60	-29	0.26	12.8	21.6
2.5	.92	-57	4.23	128	.04	53	.59	-36	0.34	12.5	20.2
3.0	.91	-66	4.02	121	.04	49	.58	-42	0.36	12.1	20.0
3.5	.89	-76	4.00	110	.05	43	.57	-48	0.39	12.0	19.0
4.0	.87	-85	3.74	102	.05	38	.57	-54	0.46	11.5	18.7
4.5	.84	-95	3.66	95	.05	34	.56	-61	0.52	11.3	18.6
5.0	.81	-103	3.39	87	.05	28	.55	-67	0.68	10.6	18.3
5.5	.79	-111	3.28	79	.06	25	.55	-72	0.64	10.3	17.4
6.0	.78	-119	3.18	71	.06	21	.54	-78	0.69	10.0	17.2
6.5	.76	-126	3.03	65	.06	15	.54	-83	0.78	9.6	17.0
7.0	.74	-133	2.90	57	.06	15	.54	-89	0.85	9.2	16.8
7.5	.73	-139	2.75	52	.06	13	.54	-94	0.90	8.8	16.6
8.0	.72	-145	2.71	45	.06	11	.55	-99	0.92	8.7	16.5
8.5	.71	-151	2.56	39	.06	10	.56	-103	0.97	8.2	16.3
9.0	.70	-157	2.51	31	.06	7	.56	-108	1.02	8.0	15.3
9.5	.70	-162	2.43	26	.06	7	.57	-113	1.01	7.7	15.5
10.0	.68	-169	2.35	21	.06	7	.57	-118	1.08	7.4	14.2
11.0	.66	-179	2.24	8	.06	3	.58	-126	1.19	7.0	13.1
12.0	.63	169	2.20	-4	.07	0	.59	-134	1.07	6.8	13.4
13.0	.59	158	2.03	-15	.07	0	.59	-141	1.27	6.1	11.5
14.0	.56	146	1.97	-27	.08	-4	.60	-149	1.18	5.9	11.4
15.0	.53	134	1.91	-40	.09	-9	.61	-158	1.11	5.6	11.3
16.0	.51	120	1.82	-50	.10	-12	.62	-167	1.04	5.2	11.4
17.0	.48	106	1.83	-66	.10	-21	.63	-176	1.07	5.2	11.0
18.0	.45	92	1.69	-75	.11	-31	.64	174	1.08	4.6	10.2

Note:

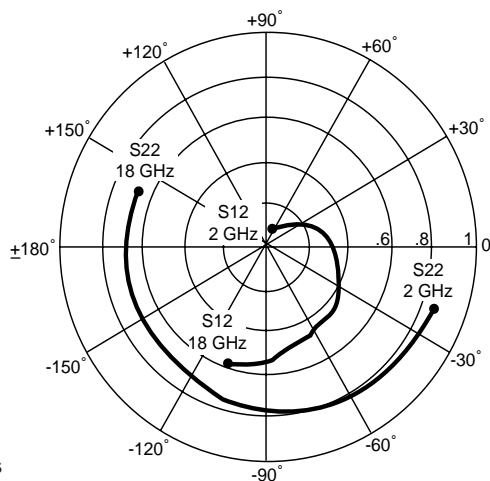
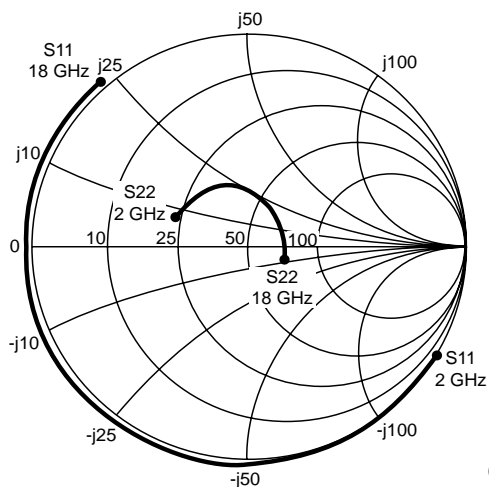
1. Gain Calculations:

$$\text{MAG} = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right) . \text{ When } K \leq 1, \text{ MAG} = \text{MSG}. \text{ MSG} = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12}| |S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL COMMON SOURCE SCATTERING PARAMETERS (TA = 25°C)



NE67383  
Coordinates in Ohms  
Frequency in GHz  
Vds = -3 V, Ibs = 10 mA

NE67383  
Vds = -3 V, Ibs = 10 mA

FREQUENCY (GHz)	S11		S21		S12		S22		K	S21 (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	1.01	-29	1.25	-22	.09	67	.37	160	-0.05	1.9	11.4
2.5	1.00	-35	1.26	-28	.11	61	.37	154	0.04	2.0	10.6
3.0	1.00	-41	1.22	-34	.13	56	.37	149	0.05	1.7	9.7
3.5	1.02	-49	1.26	-39	.15	48	.36	144	-0.02	2.0	9.2
4.0	1.02	-55	1.22	-44	.17	45	.36	139	-0.03	1.7	8.6
4.5	1.02	-63	1.23	-49	.19	39	.35	134	-0.02	1.8	8.1
5.0	1.01	-70	1.19	-57	.21	33	.35	130	0.05	1.5	7.5
5.5	1.01	-76	1.19	-60	.23	27	.34	124	0.05	1.5	7.1
6.0	1.02	-82	1.19	-67	.25	22	.33	121	0.05	1.5	6.8
6.5	1.03	-89	1.17	-72	.26	15	.32	116	0.03	1.4	6.5
7.0	1.04	-96	1.16	-79	.28	10	.30	112	0.02	1.3	6.2
7.5	1.03	-102	1.11	-81	.29	5	.29	108	0.03	0.9	5.8
8.0	1.04	-108	1.14	-87	.30	0	.28	103	0.02	1.1	5.8
8.5	1.04	-114	1.10	-93	.32	-5	.27	100	0.04	0.8	5.4
9.0	1.04	-120	1.11	-99	.33	-12	.26	95	0.06	0.9	5.3
9.5	1.05	-127	1.07	-104	.34	-17	.24	91	0.03	0.6	5.0
10.0	1.06	-133	1.08	-108	.35	-20	.24	85	-0.01	0.7	4.9
11.0	1.04	-143	1.03	-119	.38	-32	.21	75	0.07	0.3	4.3
12.0	1.06	-154	1.03	-130	.41	-44	.18	62	0.04	0.3	4.0
13.0	1.06	-165	1.01	-139	.41	-55	.16	57	0.05	0.1	3.9
14.0	1.04	-176	0.99	-152	.43	-64	.15	42	0.10	-0.1	3.6
15.0	1.05	172	1.01	-163	.45	-76	.15	28	0.09	0.1	3.5
16.0	1.05	160	1.00	-174	.48	-84	.16	11	0.08	0.1	3.2
17.0	1.04	148	0.99	174	.50	-99	.14	-6	0.11	-0.1	3.0
18.0	1.05	136	0.98	161	.53	-109	.16	-25	0.08	-0.2	2.7

Note:

1. Gain Calculations:

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

. When  $K \leq 1$ ,  $MAG = MSG$ .  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

MAG = Maximum Available Gain  
MSG = Maximum Stable Gain

**NE67300, NE67383**

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

NE67383

V<sub>DS</sub> = -3 V, I<sub>DS</sub> = 20 mA

FREQUENCY (GHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	S <sub>21</sub> (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	1.01	-28	1.35	-22	.09	68	.47	160	-0.04	2.6	11.8
2.5	1.00	-35	1.36	-28	.11	62	.47	154	0.03	2.7	10.9
3.0	1.00	-41	1.32	-34	.13	56	.47	149	0.05	2.4	10.1
3.5	1.02	-48	1.36	-39	.15	49	.46	144	-0.01	2.7	9.6
4.0	1.02	-55	1.32	-44	.17	46	.46	139	-0.02	2.4	8.9
4.5	1.02	-63	1.33	-49	.19	40	.45	134	-0.02	2.5	8.4
5.0	1.01	-70	1.29	-56	.21	34	.44	129	0.04	2.2	7.9
5.5	1.02	-76	1.29	-60	.23	28	.44	124	0.01	2.2	7.5
6.0	1.02	-83	1.29	-67	.25	23	.43	120	0.04	2.2	7.1
6.5	1.04	-90	1.27	-72	.26	16	.41	115	-0.01	2.1	6.9
7.0	1.04	-97	1.27	-79	.28	11	.40	111	0.02	2.1	6.6
7.5	1.04	-103	1.21	-81	.29	6	.40	106	-0.01	1.7	6.2
8.0	1.04	-109	1.25	-87	.31	0	.38	102	0.04	2.0	6.1
8.5	1.05	-115	1.20	-93	.32	-3	.37	98	0.01	1.6	5.7
9.0	1.06	-122	1.21	-99	.33	-10	.35	92	-0.01	1.7	5.6
9.5	1.06	-128	1.17	-104	.35	-15	.34	87	-0.01	1.4	5.2
10.0	1.07	-135	1.19	-108	.36	-19	.33	81	-0.04	1.5	5.2
10.5	1.06	-140	1.15	-116	.37	-24	.32	77	0.04	1.1	4.7
11.0	1.05	-145	1.14	-120	.39	-31	.31	70	-0.01	1.0	4.4
11.5	1.06	-151	1.13	-125	.40	-35	.30	63	-0.02	1.0	4.4
12.0	1.08	-156	1.13	-132	.41	-42	.27	57	0.06	0.9	4.1
13.0	1.08	-168	1.12	-140	.41	-53	.25	49	0.04	0.9	3.8
14.0	1.05	-179	1.10	-153	.43	-63	.25	36	0.04	0.8	3.4
15.0	1.06	168	1.11	-164	.46	-74	.26	23	0.05	0.7	3.3
16.0	1.06	156	1.10	-176	.50	-83	.27	7	0.04	0.7	3.0
17.0	1.06	145	1.09	173	.51	-97	.25	-7			
18.0	1.06	132	1.08	159	.54	-108	.27	-24			

NE67383

V<sub>DS</sub> = -3 V, I<sub>DS</sub> = 30 mA

FREQUENCY (GHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	S <sub>21</sub> (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
2.0	1.01	-28	1.38	-22	.09	68	.50	160	-0.03	2.8	11.9
2.5	1.00	-35	1.39	-28	.11	61	.50	155	0.05	2.9	11.0
3.0	1.00	-41	1.35	-34	.13	56	.50	149	0.05	2.6	10.2
3.5	1.02	-48	1.40	-39	.15	49	.49	144	-0.00	2.9	9.7
4.0	1.02	-55	1.35	-44	.17	46	.49	139	-0.02	2.6	9.0
4.5	1.03	-63	1.37	-49	.19	40	.48	134	-0.05	2.7	8.6
5.0	1.01	-70	1.32	-57	.21	34	.47	130	0.05	2.4	8.0
5.5	1.01	-76	1.32	-60	.23	28	.47	125	0.05	2.4	7.6
6.0	1.03	-83	1.32	-67	.25	23	.45	120	0.02	2.4	7.2
6.5	1.04	-90	1.29	-72	.27	16	.44	115	0.01	2.2	6.8
7.0	1.04	-97	1.30	-78	.28	11	.42	111	0.02	2.3	6.7
7.5	1.04	-103	1.24	-81	.30	6	.42	106	0.01	1.9	6.2
8.0	1.05	-109	1.28	-87	.31	0	.40	101	0.01	2.1	6.2
8.5	1.05	-115	1.23	-93	.32	-4	.39	97	0.01	1.8	5.8
9.0	1.06	-121	1.24	-99	.34	-11	.38	92	0.02	1.9	5.6
9.5	1.06	-127	1.20	-104	.35	-15	.36	87	0.01	1.6	5.3
10.0	1.07	-134	1.22	-108	.36	-19	.36	81	-0.03	1.7	5.3
11.0	1.06	-144	1.17	-119	.39	-32	.33	70	0.03	1.4	4.8
12.0	1.08	-156	1.16	-131	.42	-43	.30	56	-0.01	1.3	4.4
13.0	1.08	-167	1.16	-140	.42	-54	.28	48	0.01	1.3	4.4
14.0	1.06	-178	1.13	-153	.44	-64	.27	35	0.05	1.1	4.1
15.0	1.06	169	1.15	-164	.47	-76	.28	22	0.07	1.2	3.9
16.0	1.06	157	1.13	-176	.50	-83	.29	6	0.04	1.1	3.5
17.0	1.06	146	1.13	172	.51	-98	.28	-8	0.06	1.1	3.5
18.0	1.07	133	1.12	159	.55	-109	.29	-23	0.05	1.0	3.1

Note:

1. Gain Calculations:

$$MAG = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1}) \text{ . When } K \leq 1, MAG = MSG. \text{ } MSG = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

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