NEC®

LOW NOISE X-BAND GaAs MESFET

NE21800 NE21889

FEATURES

- **VERY HIGH fmax:** 60 GHz
- **LOW NOISE FIGURE**
  1 dB at 4 GHz
  1.7 dB at 8 GHz
  2.8 dB at 12 GHz
- **HIGH MAXIMUM AVAILABLE GAIN**
  16.5 dB at 4 GHz
  11.5 dB at 8 GHz
  9.5 dB at 12 GHz
- **PROVEN RELIABILITY AND STABILITY**
- **RUGGED 1 MICRON RECESSED GATE**
- **SPACE QUALIFIED**

DESCRIPTION AND APPLICATIONS

The NE218 is a 1 μm recessed gate gallium arsenide (GaAs) n-channel field effect transistor (FET). Offering low noise figure and high associated gain thru 8 GHz, the NE218 is ideal for 3.7 to 4.2 GHz ground station LNA applications.

The device is available as a chip (NE21800), and in a rugged hermetically sealed metal-ceramic stripline package (NE21889). The chip's gate and channel are glassivated with a thin layer of SiO_2 for mechanical protection only.

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

	PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE		NE21800 00 (CHIP)			NE21889 2SK281 89		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
f_{MAX}	Maximum Frequency of Oscillation at V_{DS} = 3 V, I_{DS} = 30 mA	GHz		60			60	
MAG	Maximum Available Gain[2] at V_{DS} = 3 V, I_{DS} = 30 mA (Typ. I_{DS} = 50% I_{DSS}) f = 4 GHz f = 8 GHz f = 12 GHz	 dB dB dB		 16.5 11.5 9.5			 16 11 9	
NF_{OPT}	Optimum Noise Figure[3] at V_{DS} = 3 V, I_{DS} = 10 mA (Typ. I_{DS} = 15% I_{DSS}) f = 4 GHz, Γ_{OPT} = .56∠103°, R_N = .25 f = 8 GHz, Γ_{OPT} = .31∠126°, R_N = .11 f = 12 GHz	 dB dB dB		 1 1.7 2.8	 1.2[4]		 1 1.7 2.8	 1.2
G_A	Associated Gain at Optimum Noise Figure at V_{DS} = 3 V, I_{DS} = 10 mA (Typ. I_{DS} = 15% I_{DSS}) f = 4 GHz f = 8 GHz f = 12 GHz	 dB dB dB		 13 10.5 7.5		 12	 13 10 7	
P_{1dB}	Output Power at 1 dB Compression Point at V_{DS} = 3 V, I_{DS} = 30 mA (Typ. I_{DS} = 50% I_{DSS}) f = 4 GHz	mW		50			50	

Notes:

1. Electronic Industrial Association of Japan.
2. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K \pm \sqrt{K^2 - 1})$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}|\,|S_{21}|}$, $\Delta = S_{11}S_{22} - S_{21}S_{12}$
3. Typical values of noise figures are those obtained when 50% of the devices from a large number of lots were individually measured in a circuit with the input individually tuned to obtain the minimum value. Maximum values are criteria established on the production line as a "go-no-go" screening test with the fixture tuned for the "generic" type but not for each specimen.
4. RF performance of chips is determined by packaging and testing 10 chips per wafer; wafer rejection criteria for standard devices is 2 rejects for 10 samples.

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ELECTRICAL CHARACTERISTICS (T_A = 25°C)

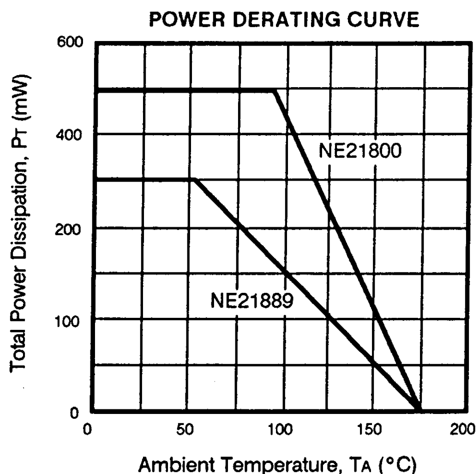
	PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE		NE21800 00 (CHIP)			NE21889 2SK281 83		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
I_{DSS}	Drain Current at V_{DS} = 3 V, V_{GS} = 0	mA	30	70	120	30	70	120
V_P	Pinch-off Voltage at V_{DS} = 3 V, I_{DS} = 0.1 mA	V	-0.8	-2.0	-6.0	-0.8	-2.0	-6.0
g_M	Transconductance at V_{DS} = 3 V, I_{DS} = 10 mA	mS	20	40	100	20	40	100
I_{GS}	Gate to Source Leakage Current at V_{GS} = –5 V	µA		1.0	10		1.0	10
R_{TH}	Thermal Resistance (Channel-to-Ambient)	°C/W			170[2]			400
P_T	Total Power Dissipation	mW			500[2,3]			300[4]

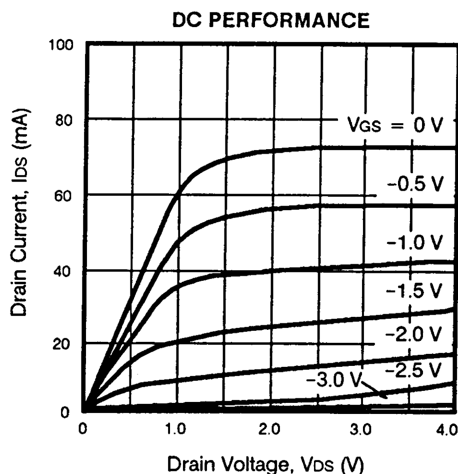
Notes:
1. Electronic Industrial Association of Japan.
2. R_{TH} (channel to case) for chips mounted on a copper heatsink.
3. T_A = 90°C
4. T_A = 55°C

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

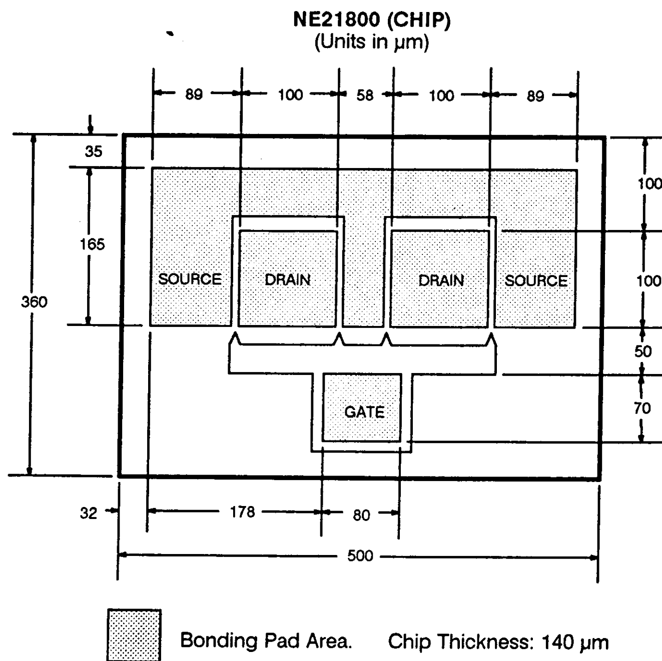
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{DS}	Drain to Source Voltage	V	5.0
V_{GS}	Gate to Source Voltage	V	-6.0
I_{DS}	Drain Current	mA	120
P_{IN}	RF Input Power	mW	40
T_{CH}	Channel Temperature	°C	175
T_{STG}	Storage Temperature	°C	-65 to +175

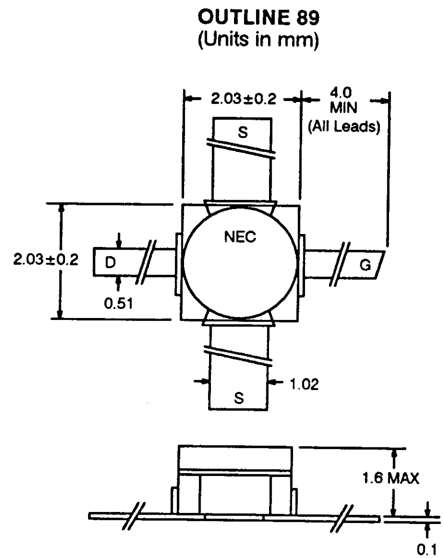
TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)





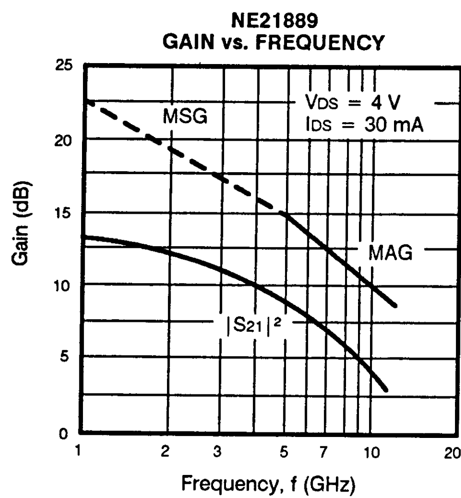
OUTLINE DIMENSIONS

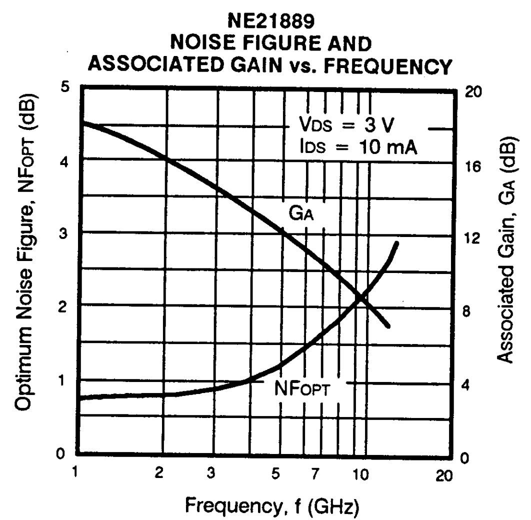




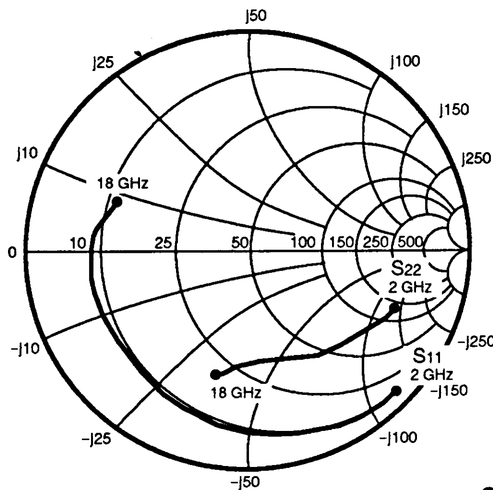
Bonding Pad Area. Chip Thickness: 140 μm

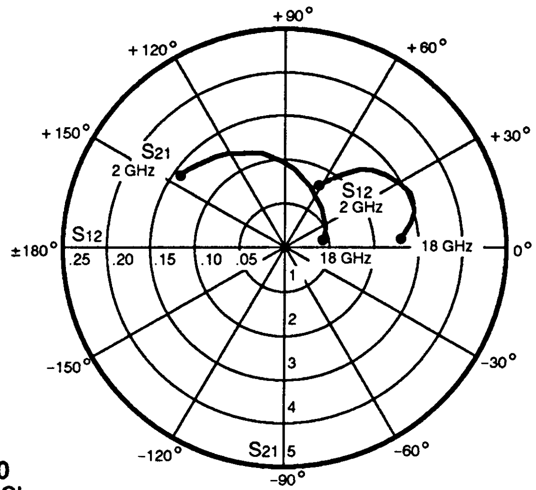
TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)





TYPICAL COMMON SOURCE SCATTERING PARAMETERS





NE21800
Coordinates in Ohms
Frequency in GHz
(VDS = 3 V, IDS = 10 mA)

S-MAGN AND ANGLES:

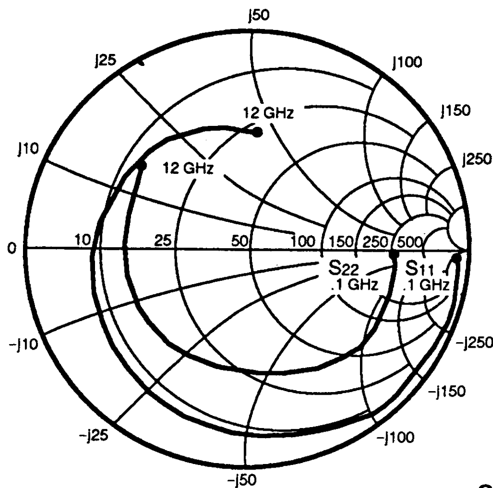
VDS = 3 V, IDS = 10 mA

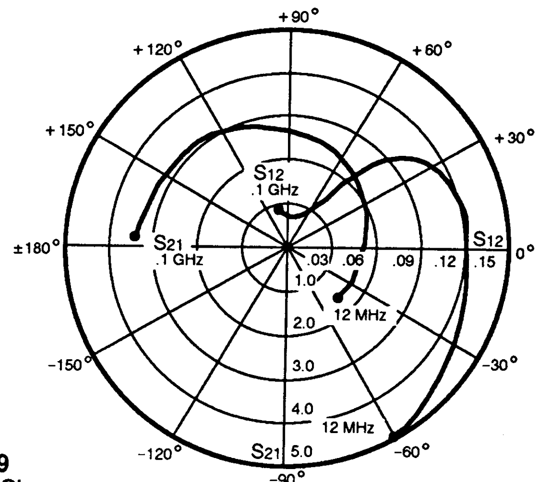
FREQUENCY (MHz)	S11		S21		S12		S22	
2000	.91	-44	2.95	144	.08	64	.71	-22
3000	.90	-63	2.81	132	.11	53	.68	-27
4000	.83	-81	2.47	113	.12	44	.62	-35
5000	.78	-96	2.27	105	.14	36	.58	-43
6000	.75	-108	2.08	97	.15	32	.56	-52
7000	.70	-119	1.83	87	.15	26	.55	-58
8000	.67	-130	1.65	79	.15	19	.55	-63
9000	.66	-140	1.49	72	.15	18	.56	-65
10000	.64	-152	1.37	64	.15	15	.56	-67
11000	.64	-158	1.24	59	.14	14	.54	-66
12000	.67	-165	1.18	54	.14	13	.54	-67
13000	.69	-168	1.11	49	.14	11	.51	-74
14000	.69	-175	1.11	44	.14	12	.54	-80
15000	.65	-178	1.05	38	.13	9	.55	-86
16000	.66	174	1.02	33	.14	9	.53	-90
17000	.63	164	.96	26	.13	8	.56	-95
18000	.64	160	.86	21	.13	9	.50	-97

VDS = 3 V, IDS = 30 mA

FREQUENCY (MHz)	S11		S21		S12		S22	
2000	.90	-49	3.61	143	.07	62	.65	-24
3000	.89	-70	3.39	130	.10	52	.61	-28
4000	.83	-88	2.91	117	.11	44	.55	-36
5000	.78	-103	2.63	104	.12	36	.51	-44
6000	.75	-116	2.37	97	.13	33	.49	-53
7000	.70	-126	2.08	87	.13	27	.49	-59
8000	.68	-137	1.87	79	.13	22	.49	-64
9000	.67	-148	1.67	73	.13	21	.51	-67
10000	.65	-158	1.53	65	.12	19	.51	-68
11000	.65	-164	1.37	60	.12	18	.49	-67
12000	.70	-171	1.32	55	.12	18	.47	-68
13000	.72	-174	1.23	51	.12	17	.47	-75
14000	.74	-180	1.22	46	.13	20	.49	-81
15000	.67	177	1.16	40	.12	17	.50	-87
16000	.69	169	1.12	36	.12	18	.50	-90
17000	.66	158	1.05	28	.13	18	.52	-96
18000	.67	156	.94	24	.12	20	.56	-98

TYPICAL COMMON SOURCE SCATTERING PARAMETERS





NE21889
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 3 V, I_{DS} = 10 mA)

S-MAGN AND ANGLES:

V_{DS} = 3 V, I_{DS} = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	1.00	-4	3.43	176	.02	109	.69	-2
200	1.00	-6	3.47	175	.01	77	.69	-3
500	1.00	-16	3.49	164	.01	80	.68	-9
1000	.98	-31	3.39	154	.03	73	.68	-20
2000	.92	-60	3.25	125	.06	53	.66	-39
4000	.75	-117	2.56	79	.12	15	.54	-78
6000	.67	-160	2.02	43	.11	-6	.50	-110
8000	.60	166	1.64	10	.12	-21	.50	-146
10000	.57	127	1.55	-18	.14	-38	.51	178
12000	.55	86	1.50	-52	.15	-60	.55	137

V_{DS} = 3 V, I_{DS} = 30 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	1.00	-3	4.57	175	.01	106	.65	-3
200	1.00	-7	4.65	174	.01	81	.66	-3
500	1.00	-18	4.66	163	.01	79	.64	-8
1000	.98	-34	4.50	152	.02	70	.64	-20
2000	.89	-66	4.17	122	.05	57	.61	-37
4000	.70	-127	3.14	76	.09	19	.47	-76
6000	.60	-171	2.34	37	.10	-10	.39	-113
8000	.55	158	1.95	9	.11	-5	.46	-148
10000	.52	121	1.79	-19	.13	-25	.49	173
12000	.51	82	1.72	-53	.15	-49	.57	131

NEC®

LOW NOISE Ku-K BAND GaAs MESFET

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
- **0.3 MICRON RECESSED GATE**
- **N^+ CONTACT LAYER**
  (Triple Epitaxial Technology)
- **PROVEN RELIABILITY AND STABILITY**
- **SPACE QUALIFIED**

DESCRIPTION AND APPLICATIONS

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

The device is available as a chip (NE67300). The chip's gate and channel are glassivated with a thin layer of Si_3N_4 for mechanical protection only. The NE67383 is in a rugged hermetically sealed metal-ceramic stripline package selected for NF_{OPT} performance at 12 GHz. The NE67383-4 is selected for NF_{OPT} performance at 4 GHz.

PERFORMANCE SPECIFICATIONS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE67300 00 (CHIP)			NE67383/ NE67383-4[2] 2SK407 83		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
f_{MAX}	Maximum Frequency of Oscillation at V_{DS} = 3 V, I_{DS} = 30 mA	GHz		100			100	
MAG	Maximum Available Gain[3] at V_{DS} = 3 V, I_{DS} = 30 mA f = 8 GHz f = 12 GHz f = 18 GHz	 dB dB dB		 15 12 8.5			 15 12 8.5	
NF_{OPT}	Optimum Noise Figure[4] at V_{DS} = 3 V, I_{DS} = 10 mA f = 4 GHz, Γ_{OPT} = .64∠69°, R_N = .38 f = 8 GHz, Γ_{OPT} = .55∠115°, R_N = .20 f = 12 GHz, Γ_{OPT} = .48∠-155°, R_N = .20 f = 18 GHz, Γ_{OPT} = .46∠-33°, R_N = .40 f = 26 GHz	 dB dB dB dB dB		 0.4 0.8 1.4 1.9 3.3	 1.6		 0.4 0.8 1.4	 0.6[2] 1.6
G_A	Associated Gain at Optimum Noise Figure at V_{DS} = 3 V, I_{DS} = 10 mA f = 4 GHz f = 8 GHz f = 12 GHz f = 18 GHz f = 26 GHz	 dB dB dB dB dB	 8.5	 14.5 11.5 10 8 6		 12[2] 8.5	 14.5 11.5 10	
P_{1dB}	Output Power at 1 dB Compression Point at V_{DS} = 3 V, I_{DS} = 30 mA f = 12 GHz	dBm		14.5			14.5	

Notes:

1. Electronic Industrial Association of Japan.
2. NE67383-4 is tested for NF_{OPT} at 4 GHz. The standard NE67383 is tested at 12 GHz.
3. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K \pm \sqrt{K^2 - 1})$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}|\,|S_{21}|}$, $\Delta = S_{11}S_{22} - S_{21}S_{12}$
4. Typical values of noise figures are those obtained when 50% of the devices from a large number of lots were individually measured in a circuit with the input individually tuned to obtain the minimum value. Maximum values are criteria established on the production line as a "go-no-go" screening test with the fixture tuned for the "generic" type but not for each specimen.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

	PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE		NE67300 00 (CHIP)			NE67383/ NE67383-4 2SK407 83		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
I_{DSS}	Drain Current at V_{DS} = 3 V, V_{GS} = 0	mA	20	40	120	20	40	120
V_P	Pinch-off Voltage at V_{DS} = 3 V, I_{DS} = 0.1 mA	V	-0.5	-1.1	-3.5	-0.5	-1.1	-3.5
g_M	Transconductance at V_{DS} = 3 V, I_{DS} = 10 mA	mS	20	50	100	20	50	100
I_{GS}	Gate to Source Leakage Current at V_{GS} = -5 V	μA		1	10		1	10
R_{TH}	Thermal Resistance (Channel-to-Ambient)	°C/W			190[2]			450
P_T	Total Power Dissipation	mW			400[2,3]			270[4]

Notes:

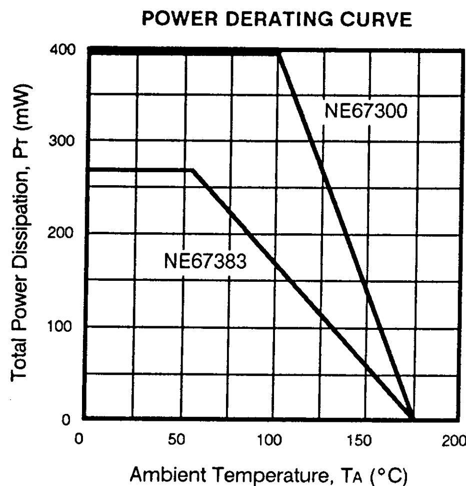
1. Electronic Industrial Association of Japan.
2. R_{TH} (Channel-to-Case) for chips mounted on a copper heatsink.
3. T_A = 100°C
4. T_A = 55°C

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

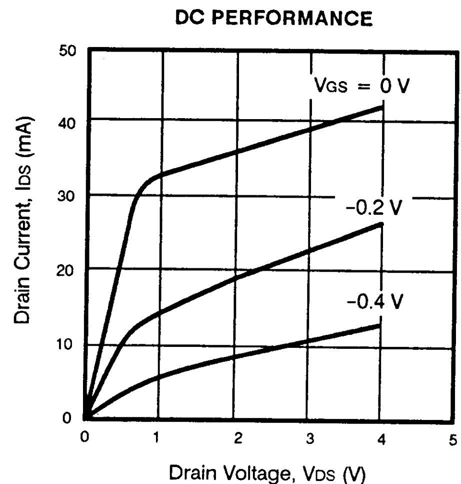
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{DS}	Drain to Source Voltage	V	5
V_{GS}	Gate to Source Voltage	V	-6
I_{DS}	Drain Current	mA	120
P_{IN}	RF Input Power	mW	40
T_{CH}	Channel Temperature	°C	175
T_{STG}	Storage Temperature	°C	-65 to +175

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

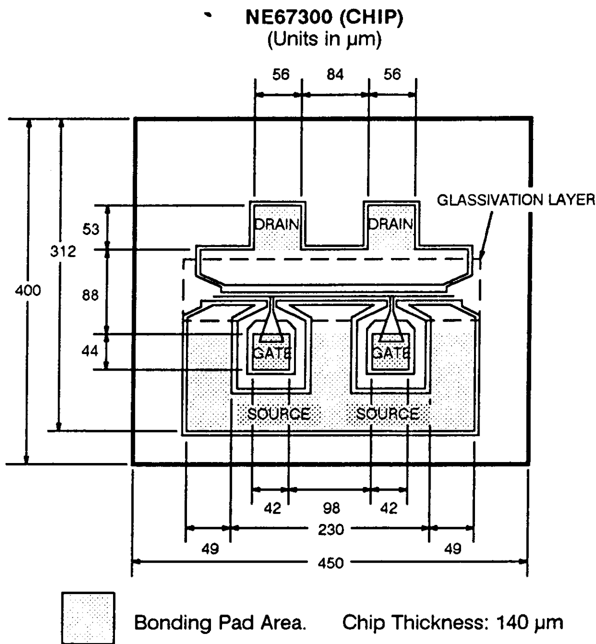
POWER DERATING CURVE

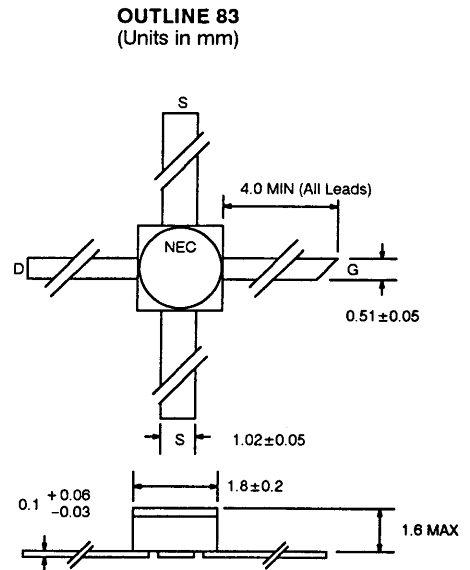


DC PERFORMANCE

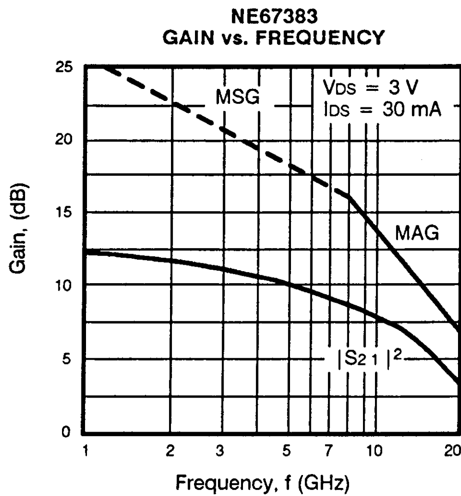


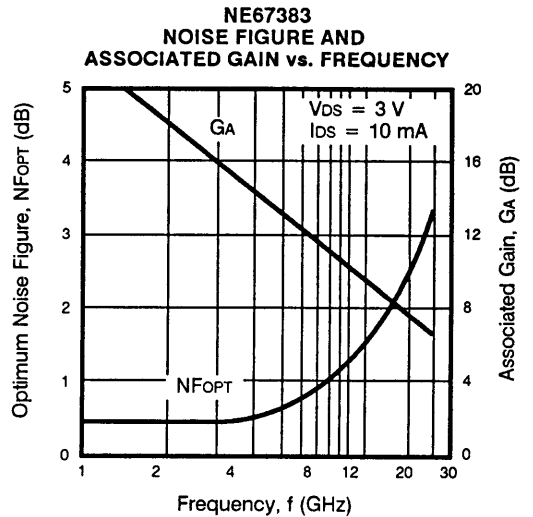
OUTLINE DIMENSIONS



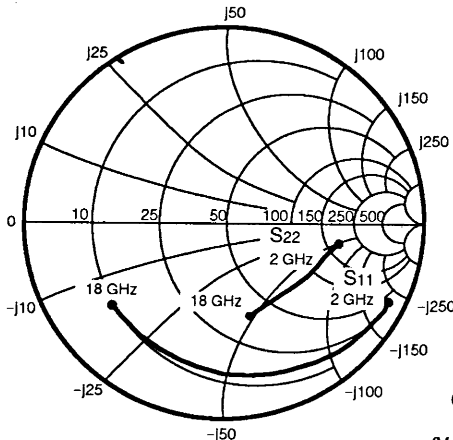


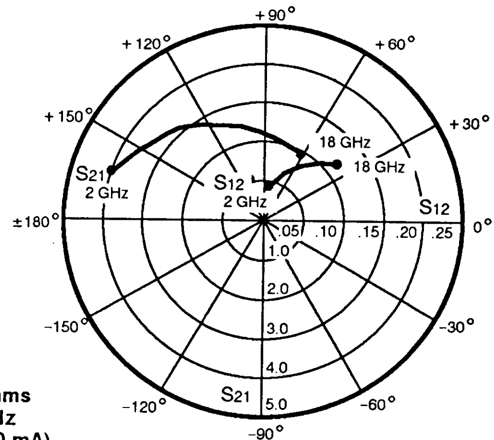
TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)





TYPICAL COMMON SOURCE SCATTERING PARAMETERS



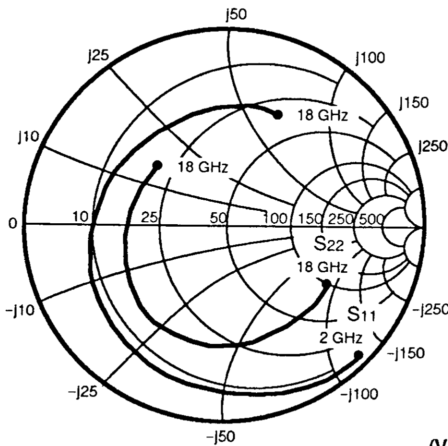


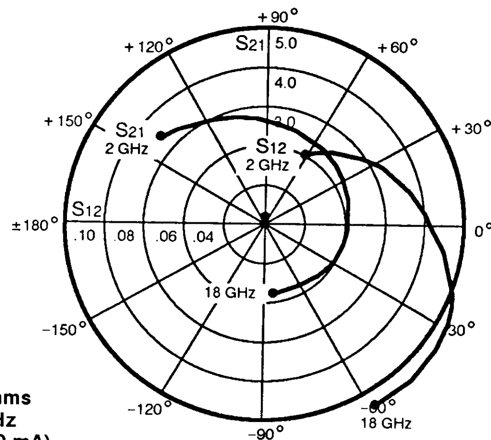
NE67300
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 3 V, I_{DS} = 10 mA)

S-MAGN AND ANGLES:

VDS = 3 V, IDS = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
2000	.95	-26	3.79	161	.04	79	.59	-13
4000	.89	-50	3.26	141	.06	66	.58	-24
6000	.82	-70	2.83	126	.08	56	.54	-33
8000	.78	-88	2.55	114	.09	51	.50	-42
10000	.73	-102	2.21	104	.10	48	.47	-48
12000	.71	-114	2.16	93	.10	43	.45	-55
14000	.71	-122	2.11	90	.11	44	.47	-62
16000	.67	-128	1.92	76	.11	43	.49	-64
18000	.66	-140	1.81	63	.11	40	.52	-70





NE67383
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 3 V, I_{DS} = 10 mA)

S-MAGN AND ANGLES:

VDS = 3 V, IDS = 10 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
2000	.97	-43	3.39	140	.04	61	.63	-32
4000	.88	-79	2.85	107	.06	35	.61	-58
6000	.84	-103	2.57	81	.07	20	.62	-77
8000	.78	-126	2.33	56	.07	12	.62	-94
10000	.71	-146	2.11	38	.07	4	.61	-107
12000	.64	-174	1.98	12	.08	-7	.60	-123
14000	.59	157	1.95	-11	.10	-15	.57	-139
16000	.57	111	1.83	-42	.11	-31	.47	-169
18000	.62	64	1.74	-84	.11	-58	.43	137