NEC

LOW NOISE Ku-K BAND GaAs FET | NE710 SERIES

FEATURES

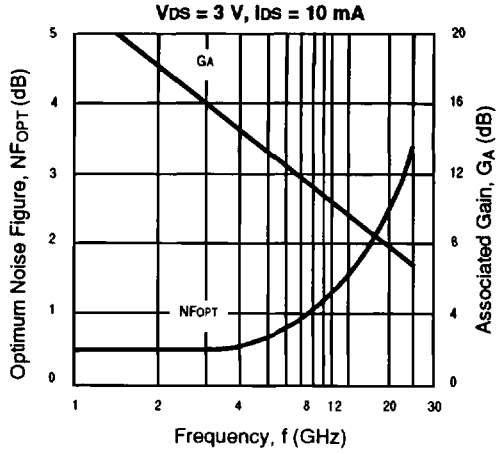
- **VERY HIGH f_{MAX}: 90 GHz**
- **LOW NOISE FIGURE**
- **HIGH ASSOCIATED GAIN**
- **L_G = 0.3 µm, W_G = 280 µm**
- **N+ CONTACT LAYER** (Triple Epitaxial Technology)
- **PROVEN RELIABILITY AND STABILITY**

DESCRIPTION

The NE710 series features a low noise figure and high associated gain through K-band by employing a recessed 0.3 micron gate and triple epitaxial technology.

The device is available in chip form (NE71000). The surface of the device, except for the bonding pads, is passivated with SiO_2 and SiN_4 for scratch protection as well as surface stabilization. The NE71083 is a low cost device for industrial applications, and the NE71084 is a low cost device for consumer applications.

NOISE FIGURE & ASSOCIATED GAIN vs. FREQUENCY
V_{DS} = 3 V, I_{DS} = 10 mA



ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER / EIAJ[1] REGISTERED NUMBER / PACKAGE OUTLINE			NE71000 CHIP			NE71083 2SK406 83			NE71084 2SK609 84		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
MAG	Maximum Available Gain[2] at V_{DS} = 3 V, I_{DS} = 20 mA,										
	f = 4 GHz	dB		17.0			17.0				
	f = 8 GHz	dB		15.0			15.0			10.0	
	f = 12 GHz	dB		12.0			12.0				
	f = 18 GHz	dB		8.5			8.5				
NF_{OPT}	Optimum Noise Figure[3] at V_{DS} = 3 V, I_{DS} = 10 mA,										
	f = 4 GHz	dB		0.6			0.6	0.7			
	f = 8 GHz	dB		1.0			1.0				
	f = 12 GHz	dB		1.5	1.8		1.5	1.8		1.6	1.8
	f = 18 GHz	dB		2.1							
	f = 26 GHz	dB		3.5							
G_A	Associated Gain Optimum Noise Figure at V_{DS} = 3 V, I_{DS} = 10 mA,										
	f = 4 GHz	dB		13.0		11.5	13.0				
	f = 8 GHz	dB		11.0			11.0				
	f = 12 GHz	dB	8.0	9.0		8.0	9.0		8.0	9.0	
	f = 18 GHz	dB		7.0							
	f = 26 GHz	dB		5.5							
P_{1dB}	Output Power at 1 dB Compression Point at V_{DS} = 3 V, I_{DS} = 10 mA,										
	f = 4 GHz	dBm					14.5				
	f = 12 GHz	dBm		14.5			14.5			14.5	

Notes:
1. Electronic Industrial Association of Japan.
2. Gain Calculations:

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

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER EIAJ[1] REGISTERED NUMBER PACKAGE OUTLINE			NE71000 CHIP			NE71083 2SK406 83			NE71084 2SK609 84		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I_{DS}	Saturated Drain Current at V_{DS} = 3 V, V_{GS} = 0	mA	20	40	120	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	-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	20	50	100
I_{GS}	Gate to Source Leakage Current at V_{GS} = -5 V	µA		1	10		1	10		1	10
$R_{TH\ (CH-C)}$	Thermal Resistance (Channel to Case)	°C/W			190[2]			450			450

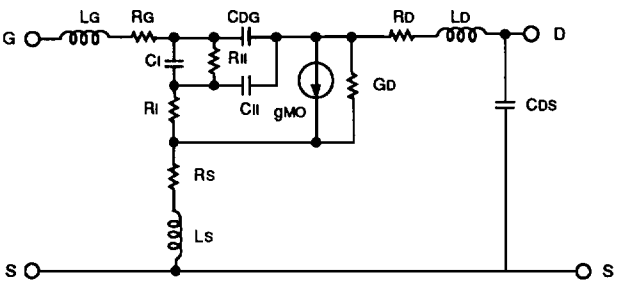
Notes:
1 Electronic Industrial Association of Japan.
2 R_{TH} for chip mounted on an infinite heat sink.

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

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{DS}	Drain to Source Voltage	V	5
V_{GSO}	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
P_T	Total Power Dissipation NE71000 NE71083 NE71084	 mW mW mW	 400[2] 270 270

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

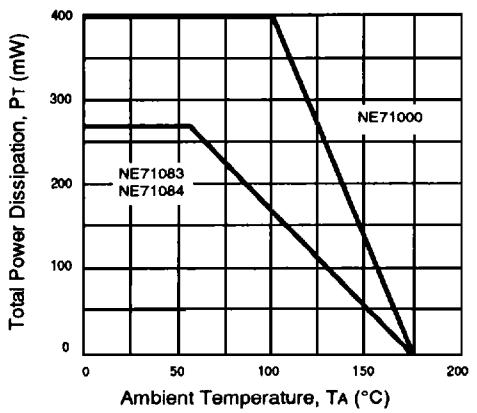
EQUIVALENT CIRCUIT



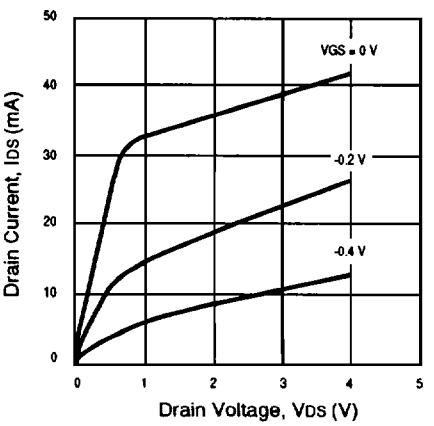
Components	Value
L_G	0.005 nH
R_G	2.00 Ω
C_I	0.28 pF
R_I	1.6 Ω
C_{II}	0.064 pF
R_{II}	1 MΩ
R_S	1.5 Ω
L_S	0.001 nH
C_{DG}	0.0033 pF
R_D	1.5 Ω
L_D	0.005 nH
C_{DS}	0.03 pF
g_{MO}	480 mS
G_D	1.5 mS

TYPICAL PERFORMANCE CURVES (T_A = 25 °C)

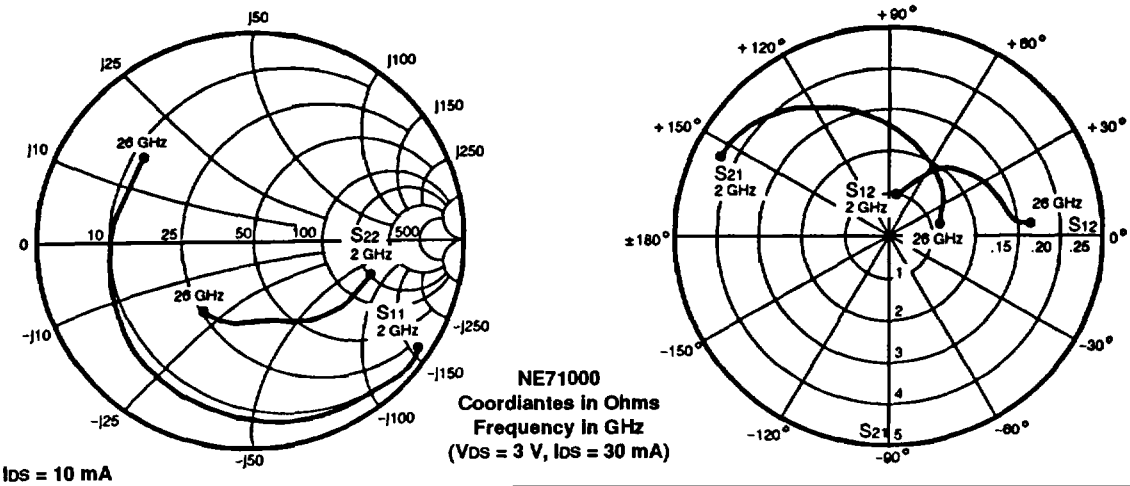
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



DC PERFORMANCE



TYPICAL COMMON SOURCE SCATTERING PARAMETERS



VDS = 3 V, IDS = 10 mA

FREQUENCY	S11		S21		S12		S22	
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
2.0	.98	-29	3.23	157	.06	72	.65	-16
3.0	.94	-43	3.14	145	.08	65	.64	-24
4.0	.92	-57	3.00	135	.10	56	.60	-32
5.0	.90	-70	2.84	125	.12	49	.59	-38
6.0	.89	-80	2.67	117	.14	43	.58	-44
7.0	.87	-91	2.53	108	.15	36	.57	-50
8.0	.84	-100	2.39	99	.16	30	.54	-55
9.0	.83	-107	2.23	92	.16	26	.54	-58
10.0	.82	-116	2.12	86	.17	23	.53	-64
11.0	.78	-124	2.01	78	.17	18	.50	-67
12.0	.77	-130	1.92	72	.17	17	.50	-70
13.0	.74	-138	1.82	65	.18	13	.48	-74
14.0	.73	-146	1.73	59	.18	10	.47	-78
15.0	.71	-154	1.68	54	.19	6	.48	-83
16.0	.69	-161	1.60	47	.19	4	.47	-90
17.0	.67	-167	1.51	43	.19	-1	.47	-96
18.0	.67	-172	1.47	39	.19	-3	.47	-99
19.0	.66	-176	1.41	35	.18	-6	.46	-103
20.0	.66	180	1.37	31	.18	-8	.47	-104
21.0	.66	176	1.32	26	.17	-7	.47	-106
22.0	.65	171	1.27	22	.17	-8	.48	-107
23.0	.64	167	1.21	19	.17	-7	.47	-109
24.0	.63	162	1.19	15	.18	-7	.47	-112
25.0	.63	155	1.14	11	.18	-7	.47	-115
26.0	.64	148	1.10	6	.19	-9	.46	-123
VDS 3 V, IDS 30 mA								
2.0	.97	-34	4.35	155	.05	70	.58	-18
3.0	.92	-50	4.14	142	.07	63	.56	-26
4.0	.90	-65	3.88	131	.09	55	.53	-35
5.0	.87	-79	3.61	121	.10	48	.51	-40
6.0	.87	-90	3.36	114	.12	42	.50	-47
7.0	.85	-101	3.14	105	.12	34	.49	-53
8.0	.81	-110	2.93	97	.12	30	.46	-57
9.0	.80	-118	2.71	89	.13	27	.46	-59
10.0	.80	-126	2.55	84	.13	24	.46	-65
11.0	.76	-134	2.40	77	.13	21	.43	-67
12.0	.74	-140	2.28	70	.13	20	.43	-70
13.0	.73	-148	2.14	64	.14	17	.41	-74
14.0	.71	-156	2.02	59	.14	16	.40	-78
15.0	.70	-163	1.94	54	.14	14	.42	-83
16.0	.69	-170	1.86	48	.15	12	.41	-90
17.0	.67	-176	1.74	44	.15	9	.41	-96
18.0	.66	-180	1.69	40	.15	6	.41	-99
19.0	.66	176	1.62	37	.15	5	.41	-103
20.0	.66	172	1.58	33	.15	5	.42	-104
21.0	.66	168	1.52	29	.14	5	.42	-106
22.0	.65	164	1.47	25	.15	5	.43	-106
23.0	.64	159	1.38	21	.14	7	.42	-109
24.0	.63	155	1.37	18	.16	8	.42	-111
25.0	.63	149	1.30	13	.16	8	.41	-114
26.0	.65	142	1.25	8	.17	4	.42	-122

Note: S-parameters include bond wires.
Gate: Total 2 wire (s), 1 per bond pad, 0.015" long each wire. Source: Total 4 wire (s), 2 per side, 0.008" long each wire.
Drain: Total 2 wire (s), 1 per bond pad, 0.011" long each wire.1-58 Wire: 0.0008" Diameter, Gold.

TYPICAL NOISE PARAMETERS

NE71000 V_{DS} = 3 V, I_{DS} = 10 mA

FREQUENCY (GHz)	MIN NF (dB)	Γ_{OPT}	Rn/50Ω
1.0	0.50	.90 ∠ 12	0.57
2.0	0.55	.85 ∠ 21	0.51
4.0	0.60	.75 ∠ 40	0.44
6.0	0.80	.69 ∠ 55	0.38
8.0	1.00	.62 ∠ 70	0.33
10.0	1.30	.56 ∠ 85	0.28
12.0	1.60	.52 ∠ 99	0.24
14.0	1.90	.49 ∠ 114	0.20
16.0	2.20	.47 ∠ 127	0.18
18.0	2.50	.45 ∠ 140	0.16

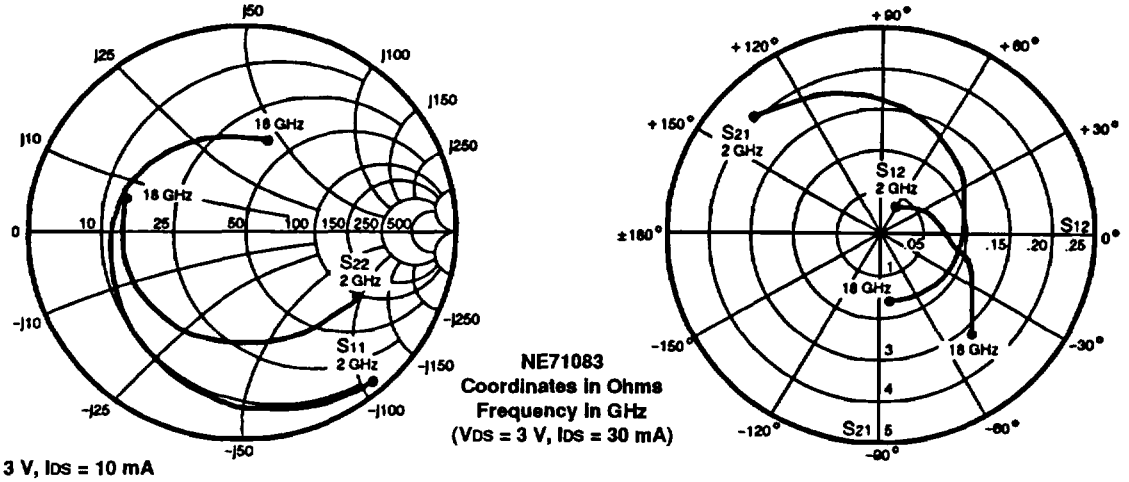
NE71083 V_{DS} = 3 V, I_{DS} = 10 mA

FREQUENCY (GHz)	MIN NF (dB)	Γ_{OPT}	Rn/50 Ω
1.0	0.45	.90 ∠ 17	0.65
2.0	0.55	.84 ∠ 40	0.57
4.0	0.60	.72 ∠ 79	0.48
6.0	0.80	.62 ∠ 112	0.39
8.0	1.00	.56 ∠ 143	0.33
10.0	1.35	.50 ∠ 168	0.28
12.0	1.60	.46 ∠ -165	0.24
14.0	1.90	.43 ∠ -140	0.20
16.0	2.10	.40 ∠ -112	0.18
18.0	2.70	.40 ∠ -84	0.16

NE71084 V_{DS} = 3 V, I_{DS} = 10 mA

FREQUENCY (GHz)	MIN NF (dB)	Γ_{OPT}	Rn/50 Ω
1.0	0.50	.90 ∠ 17	0.50
2.0	0.55	.85 ∠ 37	0.47
4.0	0.60	.71 ∠ 85	0.43
6.0	0.80	.61 ∠ 127	0.35
8.0	1.00	.54 ∠ 165	0.30
10.0	1.30	.52 ∠ -158	0.25
12.0	1.60	.51 ∠ -124	0.20

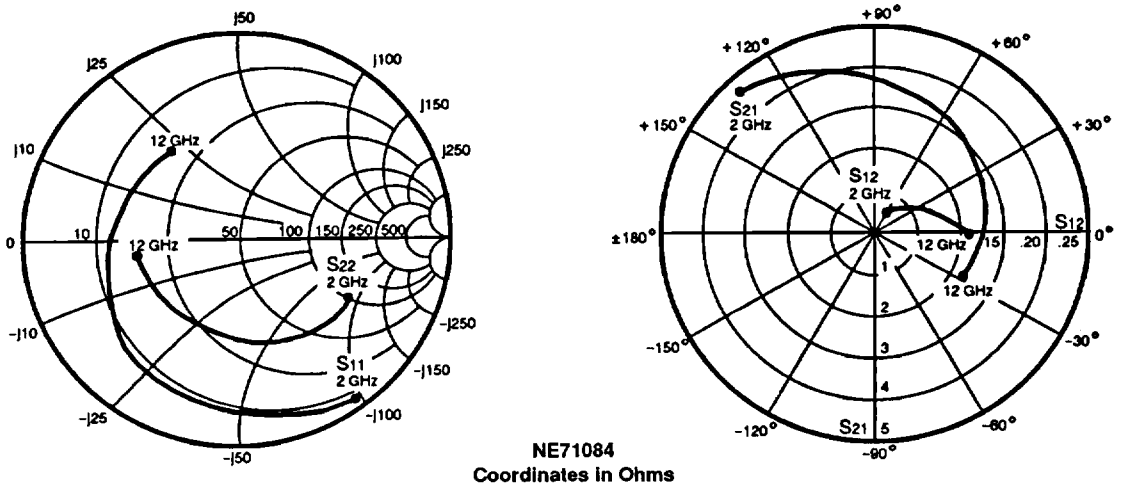
TYPICAL COMMON SOURCE SCATTERING PARAMETERS



VDS = 3 V, IDS = 10 mA

FREQUENCY	S11		S21		S12		S22	
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
2.0	.96	-45	3.20	138	.05	59	.68	-31
3.0	.92	-64	2.95	121	.06	46	.66	-45
4.0	.88	-84	2.77	101	.07	33	.64	-59
5.0	.82	-102	2.56	86	.08	21	.61	-72
6.0	.79	-118	2.37	69	.09	11	.60	-84
7.0	.75	-134	2.20	54	.09	2	.60	-96
8.0	.73	-148	2.04	41	.09	-3	.60	-106
9.0	.71	-160	1.92	27	.09	-10	.60	-116
10.0	.68	-173	1.78	17	.09	-12	.60	-126
11.0	.67	176	1.70	5	.09	-17	.61	-134
12.0	.64	163	1.65	-9	.09	-22	.61	-143
13.0	.61	152	1.56	-20	.09	-24	.61	-152
14.0	.59	140	1.51	-31	.10	-27	.61	-160
15.0	.57	128	1.47	-45	.10	-33	.61	-169
16.0	.54	114	1.47	-54	.11	-35	.61	-178
17.0	.52	99	1.45	-69	.12	-45	.60	172
18.0	.50	85	1.41	-81	.14	-52	.59	160
VDS = 3 V, IDS = 20 mA								
2.0	.95	-48	3.88	136	.04	59	.63	-32
3.0	.90	-68	3.52	119	.05	47	.61	-45
4.0	.85	-88	3.29	99	.07	35	.59	-59
5.0	.79	-106	2.98	84	.07	24	.56	-72
6.0	.76	-123	2.74	67	.08	16	.55	-84
7.0	.72	-138	2.53	52	.08	8	.55	-97
8.0	.70	-151	2.33	40	.08	4	.55	-107
9.0	.67	-164	2.17	26	.08	-2	.56	-117
10.0	.65	-176	2.01	16	.08	-3	.56	-128
11.0	.63	173	1.92	4	.08	-7	.57	-136
12.0	.60	160	1.84	-10	.09	-12	.57	-146
13.0	.57	149	1.75	-21	.09	-15	.58	-155
14.0	.55	137	1.69	-31	.10	-20	.58	-164
15.0	.53	125	1.63	-45	.11	-26	.59	-173
16.0	.50	111	1.64	-55	.12	-31	.59	178
17.0	.48	96	1.60	-69	.14	-42	.59	167
18.0	.47	82	1.58	-82	.15	-50	.59	155
VDS = 3 V, IDS = 30 mA								
2.0	.95	-49	4.18	136	.04	59	.62	-31
3.0	.89	-70	3.78	118	.05	47	.60	-45
4.0	.84	-91	3.49	98	.06	35	.58	-58
5.0	.78	-109	3.15	83	.07	26	.55	-71
6.0	.74	-126	2.91	66	.07	17	.55	-82
7.0	.71	-141	2.66	51	.07	11	.55	-94
8.0	.68	-155	2.45	39	.08	6	.55	-104
9.0	.66	-168	2.27	25	.08	2	.56	-114
10.0	.63	-180	2.10	15	.08	1	.56	-123
11.0	.62	169	2.00	3	.08	-3	.57	-131
12.0	.59	156	1.93	-11	.09	-8	.57	-140
13.0	.56	145	1.82	-22	.09	-10	.58	-149
14.0	.54	133	1.75	-33	.10	-16	.58	-157
15.0	.52	121	1.69	-47	.11	-22	.59	-165
16.0	.49	107	1.67	-56	.12	-27	.59	-174
17.0	.47	92	1.64	-70	.14	-38	.58	176
18.0	.46	78	1.61	-82	.15	-45	.58	164

TYPICAL COMMON SOURCE SCATTERING PARAMETERS



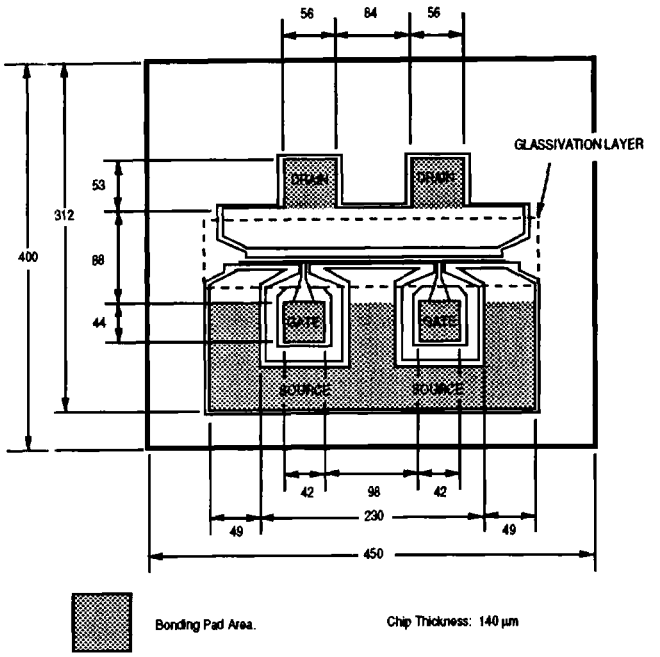
NE71084
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 3 V, I_{DS} = 30 mA)

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

FREQUENCY	S11		S21		S12		S22	
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
2.0	.94	-49	3.48	136	.04	59	.65	-31
3.0	.94	-70	3.36	118	.06	45	.64	-45
4.0	.86	-92	2.99	97	.07	33	.61	-61
5.0	.81	-108	2.71	82	.07	25	.57	-73
6.0	.79	-126	2.56	64	.08	15	.57	-86
7.0	.71	-142	2.40	48	.08	7	.53	-100
8.0	.66	-155	2.28	36	.08	4	.51	-110
9.0	.61	-171	2.19	23	.09	2	.49	-123
10.0	.59	172	2.17	8	.09	-3	.48	-139
11.0	.57	154	2.08	-9	.10	-11	.49	-157
12.0	.55	137	1.94	-23	.10	-11	.51	-173
V_{DS} = 3 V, I_{DS} = 20 mA								
2.0	.93	-52	4.29	134	.04	60	.60	-31
3.0	.92	-75	4.03	115	.05	47	.59	-45
4.0	.83	-97	3.51	94	.06	35	.55	-60
5.0	.78	-113	3.16	79	.06	29	.52	-73
6.0	.75	-131	2.94	62	.07	21	.52	-85
7.0	.67	-147	2.74	47	.07	16	.49	-98
8.0	.62	-161	2.58	34	.08	14	.47	-108
9.0	.57	-176	2.47	21	.08	12	.44	-119
10.0	.56	166	2.41	6	.09	8	.44	-135
11.0	.54	148	2.30	-11	.10	-1	.46	-154
12.0	.52	130	2.10	-24	.11	-3	.47	-169
V_{DS}=3 V, I_{DS} = 30 mA								
2.0	.92	-54	4.67	133	.03	60	.59	-31
3.0	.90	-77	4.40	114	.05	47	.57	-45
4.0	.81	-100	3.83	93	.05	37	.54	-60
5.0	.75	-116	3.43	77	.06	31	.51	-72
6.0	.72	-134	3.19	60	.06	24	.51	-84
7.0	.65	-150	2.93	44	.07	19	.48	-96
8.0	.60	-164	2.75	32	.07	18	.46	-105
9.0	.55	-180	2.60	19	.08	16	.45	-118
10.0	.54	163	2.52	4	.09	11	.44	-134
11.0	.53	145	2.38	-12	.10	1	.46	-153
12.0	.50	127	2.25	-26	.10	-1	.46	-168

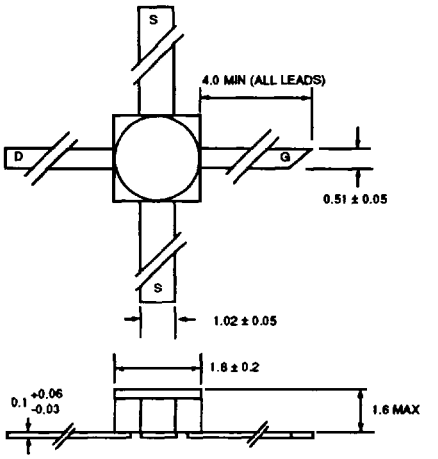
OUTLINE DIMENSIONS (Units in mm)

71000 (CHIP)
(Units in μm)



Note: All dimensions are typical unless otherwise specified.

PACKAGE OUTLINE 83
(Units in mm)



ORDERING INFORMATION

PART NUMBER	IDSS SELECTION
NE71000	Standard (IDSS = 20 - 120)
NE71000L	IDSS = 80 to 120 mA
NE71000M	IDSS = 50 to 80 mA
NE71000N	IDSS = 20 to 50 mA

PACKAGE OUTLINE 84-SL
(Units in mm)