



# LOW NOISE Ku-K BAND GaAs MESFET

# NE710 SERIES

## FEATURES

- VERY HIGH f<sub>MAX</sub>: 90 GHz
- LOW NOISE FIGURE
- HIGH ASSOCIATED GAIN
- 0.3 MICRON RECESSED GATE
- N+ CONTACT LAYER (Triple Epitaxial Technology)
- PROVEN RELIABILITY AND STABILITY

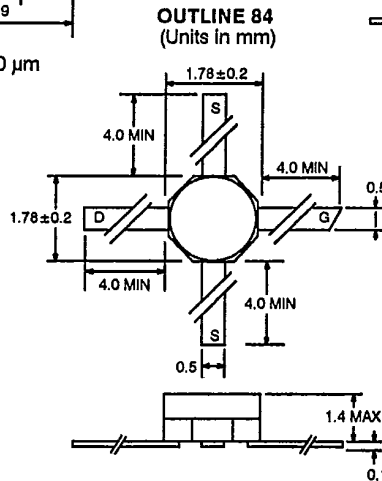
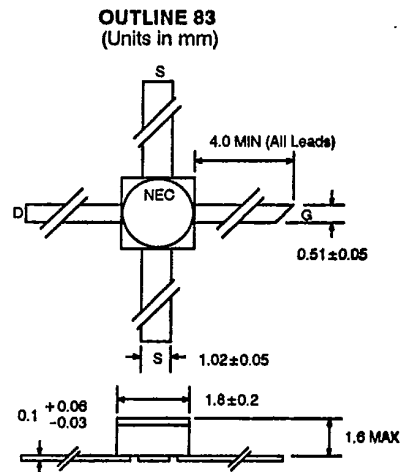
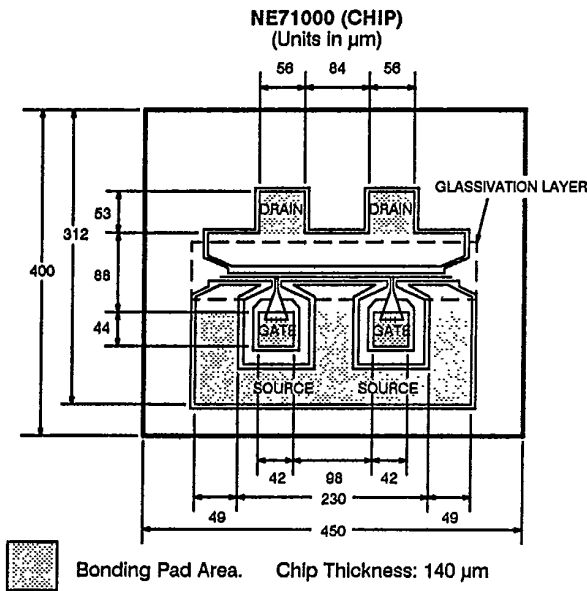
## DESCRIPTION AND APPLICATIONS

The NE710 series features a low noise figure and high associated gain thru 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<sub>2</sub> and SiN<sub>4</sub> for scratch protection as well as surface stabilization. The NE71083 is a low cost device for industrial and military applications, and the NE71084 is a low cost device for consumer applications.

Several versions of NE71083 and NE71084 are available. Noise figure and gain of the NE71083 and NE71084 are specified at 12 GHz. The noise figure and gain of the NE71083-06, -07, -08 and the NE71084-06, -08 are specified at 4 GHz.

## OUTLINE DIMENSIONS



**PERFORMANCE SPECIFICATIONS (TA = 25°C)**

SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	NE71000 CHIP		NE71083 2SK406 83		NE71083-06 2SK406-06 83		NE71083-07 2SK406-07 83		NE71083-08 2SK406-08 83		NE71084 2SK609 84		NE71084-06 2SK609-06 84		NE71084-08 2SK609-08 84		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP
f <sub>MAX</sub>	Maximum Frequency of Oscillation at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 30 mA	GHz	90			90			90			90			90			90	
MAG	Maximum Available Gain <sup>2</sup> at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 20 mA f = 4 GHz f = 8 GHz f = 12 GHz f = 18 GHz	dB dB dB dB	17 15 12 8.5			17 15 12 8.5									16.5			16.5	
NFOPT	Optimum Noise Figure <sup>3</sup> at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 10 mA f = 4 GHz f = 8 GHz f = 12 GHz f = 18 GHz f = 26 GHz	dB dB dB dB dB	0.6 1 1.5 2.1 3.5		1.8	0.6 1 1.5 1.8		0.6		0.7		0.8		1.6 1.8		0.45 0.6		0.6 0.8	
GA	Associated Gain at Optimum Noise Figure at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 10 mA f = 4 GHz f = 8 GHz f = 12 GHz f = 18 GHz f = 26 GHz	dB dB dB dB dB	13 11 9 7 5.5		1.8	11.5 13 11 9								8 9		13 14		13 14	
P <sub>1dB</sub>	Output Power at 1 dB Compression Point at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 10 mA f = 4 GHz f = 12 GHz	dBm dBm	14.5			14.5 14.5								14.5		14.5		14.5	

**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.



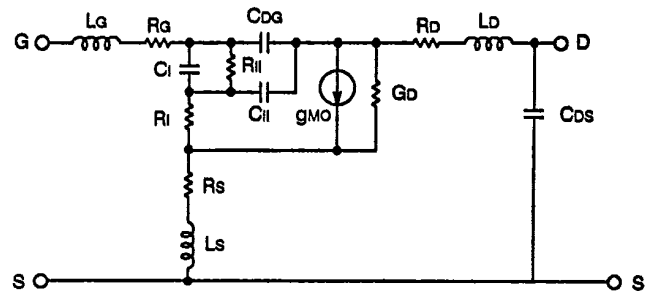
**ELECTRICAL CHARACTERISTICS** (TA = 25°C)

PART NUMBER EIAJ <sup>1</sup> 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 <sub>DS</sub>	Drain Current at V <sub>DS</sub> = 3 V, V <sub>GS</sub> = 0	mA	20	40	120	20	40	120	20	40	120
V <sub>P</sub>	Pinch-off Voltage at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 0.1 mA	V	-0.5	-1.1	-3.5	-0.5	-1.1	-3.5	-0.5	-1.1	-3.5
g <sub>m</sub>	Transconductance at V <sub>DS</sub> = 3 V, I <sub>DS</sub> = 10 mA	mS	20	50	100	20	50	100	20	50	100
I <sub>GS</sub>	Gate to Source Leakage Current at V <sub>GS</sub> = -5 V	μA		1	10		1	10		1	10
R <sub>TH</sub>	Thermal Resistance (Channel-to-Case)	°C/W			190 <sup>2</sup>			450			450
P <sub>T</sub>	Total Power Dissipation	mW			400			270			270

**Notes:**

1. Electrono Industrial Association of Japan.
2. R<sub>TH</sub> for chip mounted on a copper heatsink.

**EQUIVALENT CIRCUIT**

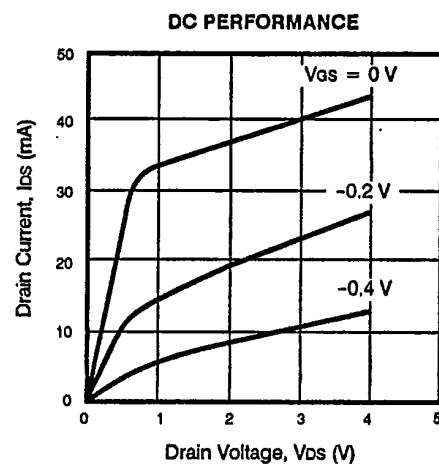
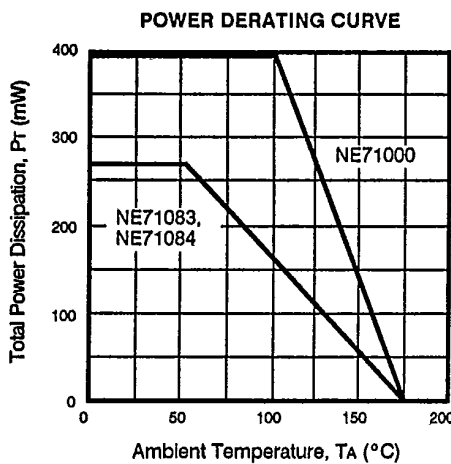


COMPONENT	VALUE
Lg	0.005 nH
Rg	2.00 Ω
Ci	0.28 pF
Ri	1.6 Ω
Cii	0.064 pF
Rii	1 M Ω
Rs	1.5 Ω
Ls	0.001 nH
Cdg	0.033 pF
Rd	1.5 Ω
Ld	0.005 nH
Cds	0.03 pF
gmo	48.0 mS
Gd	1.5 mS

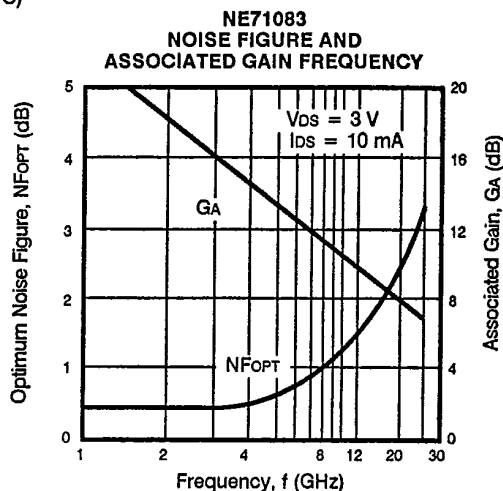
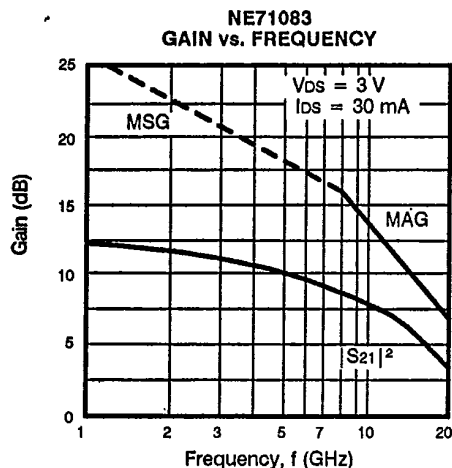
**ABSOLUTE MAXIMUM RATINGS** (TA = 25°C)

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	120
P <sub>IN</sub>	RF Input Power	mW	40
T <sub>CH</sub>	Channel Temperature	°C	175
T <sub>STG</sub>	Storage Temperature	°C	-65 to +175

**TYPICAL DEVICE CHARACTERISTICS** (TA = 25°C)



**TYPICAL PERFORMANCE CHARACTERISTICS** (TA = 25°C)



**TYPICAL NOISE PARAMETERS**

NE71000 V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 10 mA

FREQUENCY (GHz)	MIN NF (dB)	Γ <sub>OPT</sub>	Rn/50 Ω
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<sub>DS</sub> = 3 V, I<sub>DS</sub> = 10 mA

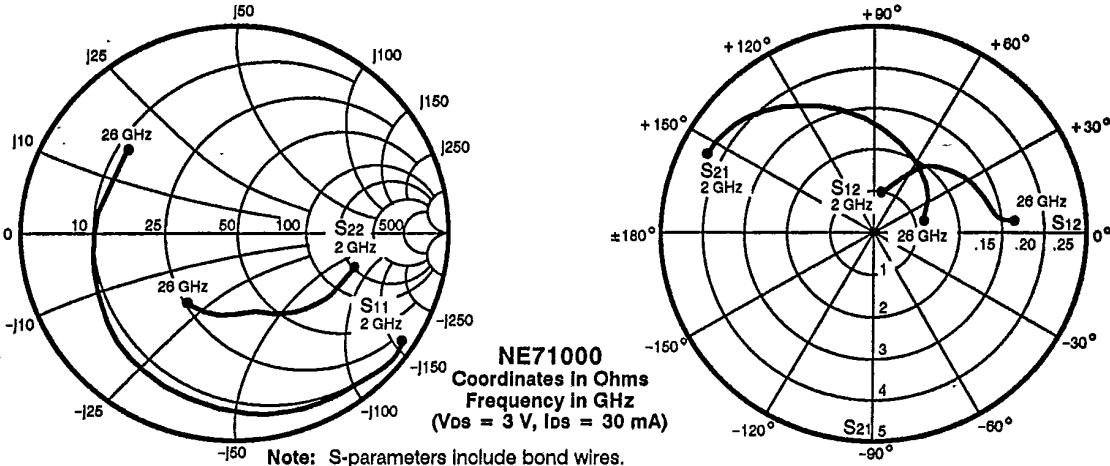
FREQUENCY (GHz)	MIN NF (dB)	Γ <sub>OPT</sub>	Rn/50 Ω
1.0	0.45	.90 ∠ 17	0.65
2.0	0.55	.84 ∠ 40	0.57
4.0	0.60	.72 ∠ 79	0.48
6.0	0.80	.62 ∠ 112	0.39
8.0	1.00	.56 ∠ 143	0.33
10.0	1.35	.50 ∠ 168	0.28
12.0	1.60	.46 ∠ -165	0.24
14.0	1.90	.43 ∠ -140	0.20
16.0	2.10	.40 ∠ -112	0.18
18.0	2.70	.40 ∠ -84	0.16

NE71084 V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 10 mA

FREQUENCY (GHz)	MIN NF (dB)	Γ <sub>OPT</sub>	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



NE71000  
Coordinates in Ohms  
Frequency in GHz  
(V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 30 mA)

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

S-MAGN AND ANGLES:

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

FREQUENCY (GHz)

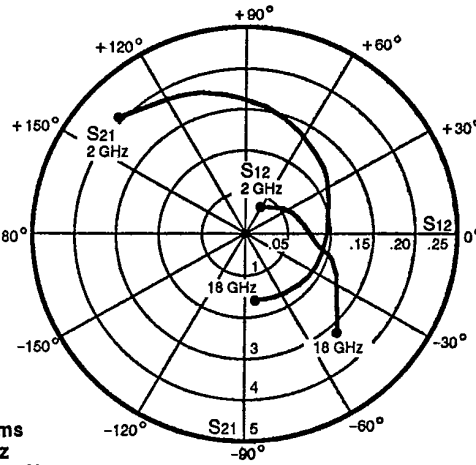
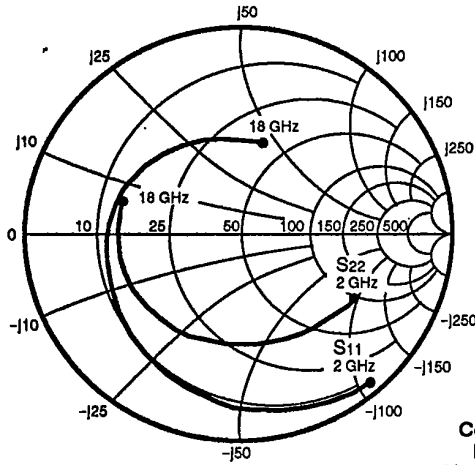
FREQUENCY (GHz)	S <sub>11</sub>	S <sub>21</sub>	S <sub>12</sub>	S <sub>22</sub>
2.0	.98 -29	3.23 157	.06 72	.65 -16
3.0	.94 -43	3.14 145	.08 65	.64 -24
4.0	.92 -57	3.00 135	.10 56	.60 -32
5.0	.90 -70	2.84 125	.12 49	.59 -38
6.0	.89 -80	2.67 117	.14 43	.58 -44
7.0	.87 -91	2.53 108	.15 36	.57 -50
8.0	.84 -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

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>
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

T-31-25

TYPICAL COMMON SOURCE SCATTERING PARAMETERS



NE71083  
Coordinates in Ohms  
Frequency in GHz  
(V<sub>DS</sub> = 3 V, I<sub>DS</sub> = 30 mA)

S-MAGN AND ANGLES:

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

FREQUENCY (GHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
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

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

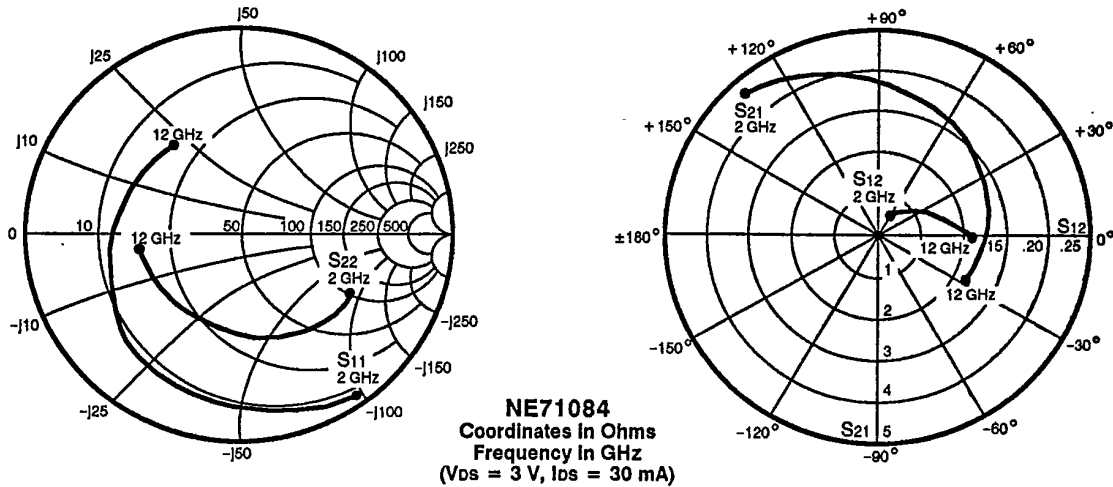
2.0	.95	-48	3.88	136	.04	59	.63	-32
3.0	.90	-68	3.52	119	.05	47	.61	-45
4.0	.85	-88	3.29	99	.07	35	.59	-59
5.0	.79	-106	2.98	84	.07	24	.56	-72
6.0	.76	-123	2.74	67	.08	16	.55	-84
7.0	.72	-138	2.53	52	.08	8	.55	-97
8.0	.70	-151	2.33	40	.08	4	.55	-107
9.0	.67	-164	2.17	26	.08	-2	.56	-117
10.0	.65	-176	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

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



S-MAGN AND ANGLES:

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

FREQUENCY (GHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
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<sub>DS</sub> = 3 V, I<sub>DS</sub> = 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<sub>DS</sub> = 3 V, I<sub>DS</sub> = 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