NEC®

C-BAND POWER GaAs MESFET

NE8004 SERIES

FEATURES

- **CLASS A OPERATION**
- **HIGH EFFICIENCY:** $\eta_{ADD} \geq 35\%$ TYP
- **BROADBAND CAPABILITY**
- **AVAILABILITY:**
  Chip
  Hermetic Package
- **PARTIALLY MATCHED INPUT FOR PACKAGED DEVICES**
- **PROVEN RELIABILITY**

DESCRIPTION AND APPLICATIONS

The NE800495 power GaAs FET covers the 3.5 to 8.5 GHz frequency range with five different Class A, 2 W partially matched devices. Each packaged device has an input lumped element matching network.

The NE800400 is the four-cell recessed gate chip used in "95" package. Recommended bias is 8 to 9 volts for CW operations and up to 13 volts for pulsed operation.

SELECTION CHART

PART NUMBER	TYPICAL PERFORMANCE		
	P_{1dB} (WATTS)	FREQUENCY RANGE (GHz)	G_{1dB} (dB)
NE800400	2	2 to 10	7
NE800495-4	2	3.5 to 4.5	7.5
NE800495-5	2	4.5 to 5.5	7.5
NE800495-6	2	5.5 to 6.5	7
NE800495-7	2	6.5 to 7.5	7
NE800495-8	1.8	7.5 to 8.5	6.5

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{DS}	Drain to Source Voltage	V	20
V_{GS}	Gate to Source Voltage	V	-14
I_D	Drain Current	A	1.6
I_G	Gate Current	mA	10
T_{CH}	Channel Temperature	°C	175
T_{STG}	Storage Temperature	°C	-65 to +175

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

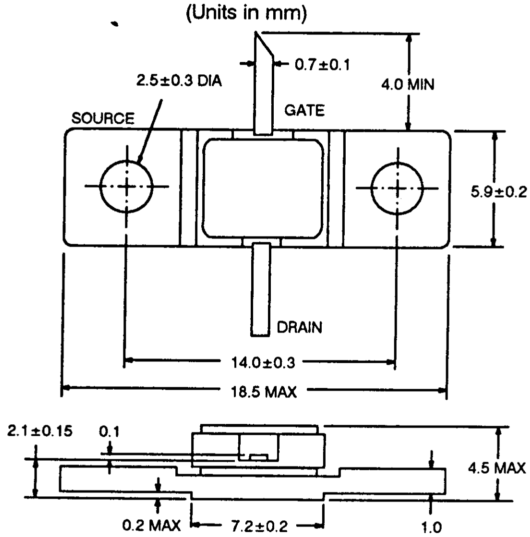
PART NUMBER PACKAGE OUTLINE			NE800400[1] 00 (CHIP)			NE800495-4,5 95			NE800495-6,7 95			NE800495-8 95		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I_{DSS}	Saturated Drain Current at V_{DS} = 2.5 V, V_{GS} = 0	A	0.9	1.2	1.6	0.9	1.2	1.6	0.9	1.2	1.6	0.9	1.2	1.6
V_P	Pinch-off Voltage at V_{DS} = 2.5 V, I_D = 8 mA	V	-5	-3.5	-2.5	-5	-3.5	-2.5	-5	-3.5	-2.5	-5	-3.5	-2.5
g_m	Transconductance at V_{DS} = 3 V, I_D = 0.4 A	mS		240			240			240			240	
R_{TH}	Thermal Resistance (Channel-to-Case)	°C/W		15	16		15	16		15	16		15	16
P_T	Total Power Dissipation	W			10			10			10			10
P_{TEST}[2]	Power Output at Test Point P_{IN} = 25 dBm, V_{DS} = 9 V, $I_D \leq$ 600 mA P_{IN} = 26 dBm, V_{DS} = 9 V, $I_D \leq$ 600 mA P_{IN} = 26.5 dBm, V_{DS} = 9 V, $I_D \leq$ 600 mA	dBm dBm dBm	32	33		32	33		32	33		32	33	
P_{1dB}[3]	Output Power at 1 dB Compression Point V_{DS} = 9 V, $I_D \leq$ 600 mA	dBm		33			33			33			32.5	
G_{1dB}[3]	Gain at 1 dB Compression Point V_{DS} = 9 V, $I_D \leq$ 600 mA	dB		7			7.5			7			6.5	
η_{ADD}[4]	Power Added Efficiency V_{DS} = 8 V, $I_D \leq$ 600 mA, P_{OUT} = P_{1dB}	%		37			40			37			35	

Notes:

1. Four-cell chip; all cells are good. RF performance of the chip is determined by packaging 10 chips per wafer. Wafer rejection criteria for standard devices are 2 rejects per 10 samples.
2. This is production test. Devices are measured in broadband amplifier circuit with the drain current between 400 to 700 mA. The gate current is limited to 10 mA max. Test frequencies are: -4 @ 4.2 GHz, -5 @ 5 GHz, -6 @ 6.5 GHz, -7 @ 7.2 GHz, -8 @ 8.4 GHz.
3. Amplifier performance in a circuit optimized at the test frequency.
4. $\eta_{ADD} = \dfrac{P_{1dB} - P_{IN}}{V_{DS} \times I_D} \times 100\%$

OUTLINE DIMENSIONS AND HANDLING

OUTLINE 95
(Units in mm)

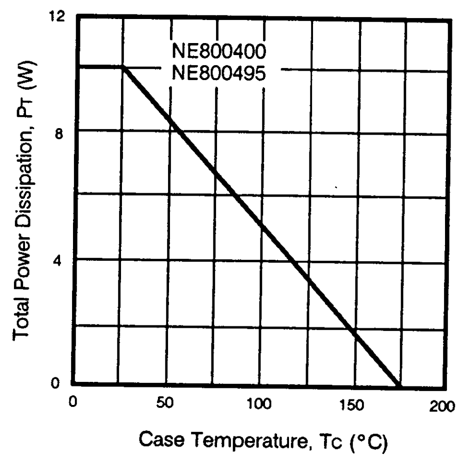


Flange Material: Copper
Flange Plating: Ni, Au

Lead Material: Kovar
Lead Plating: Ni, Au

TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

POWER DERATING CURVE



DIE ATTACHMENT

Die attach can be accomplished with either Au-Ge (390±10°C) or Au-Sn (290 ± 10°C) preforms in a forming gas environment. Epoxy die attached is not recommended.

BONDING

Gate and drain bonding wires should be minimum length, semi-hard gold wire (3-8% elongation) 30 microns or less in diameter. The source should be connected with gold ribbon or mesh.

Bonding should be performed with a wedge tip that has a taper of approximately 15°. Die attach and bonding time should be kept to a minimum. As a general rule , the bonding operation should be kept within a 300°C - 10 minute curve. If longer periods are required, the temperature should be lowered.

PRECAUTIONS

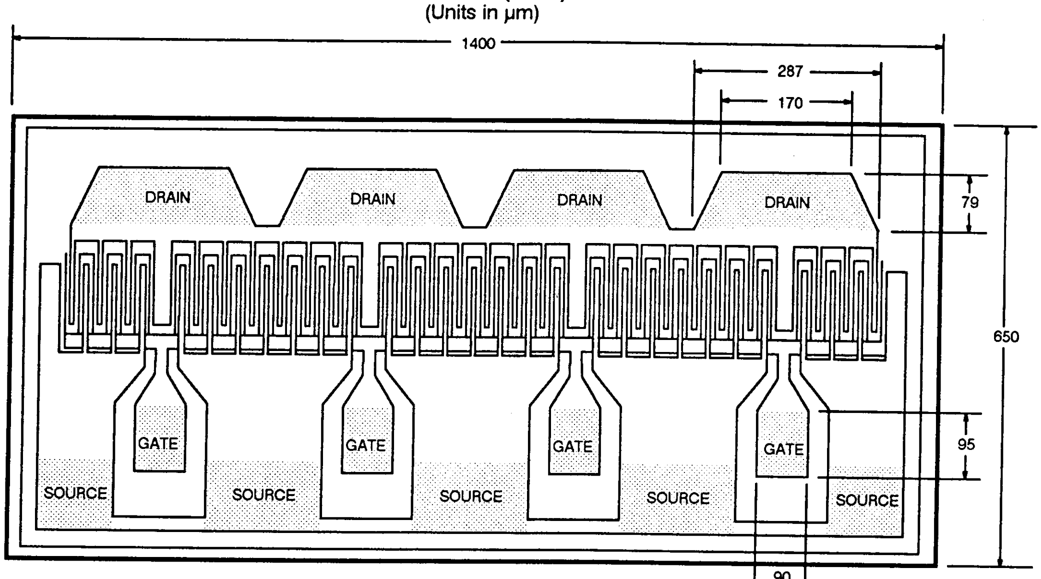
The user must operate in a clean, dry environment. The chip channel is glassivated for mechanical protection only and does not preclude the necessity of a clean environment.

The bonding equipment should be periodically checked for sources of surge voltage and should be properly grounded at all times. All test and handling equipment should be grounded to minimize the possibilities of static discharge.

See AN-1001 Recommended Handling Procedures for Microwave Transistor & MMIC Chips) for additional information.

3

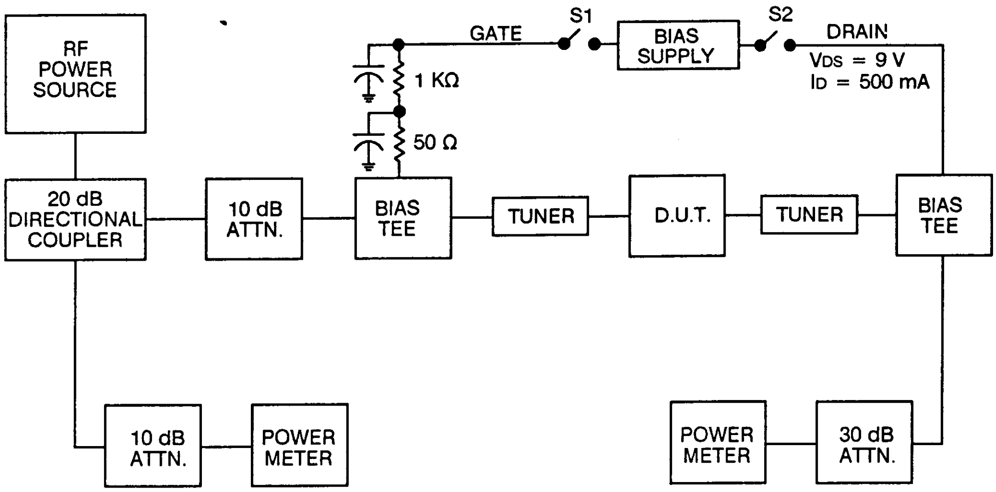
NE800400 (CHIP)
(Units in μm)



Recommended Bonding Area.

Die Thickness: 140 μm

RF TEST CIRCUIT

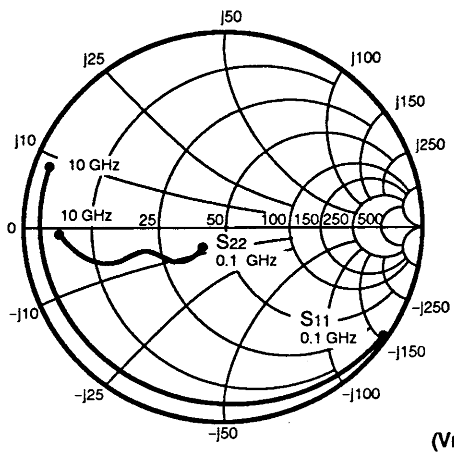


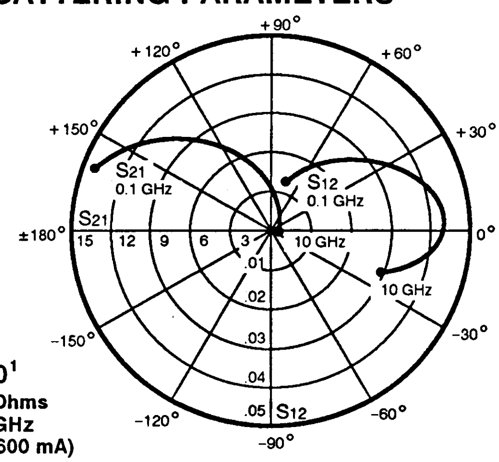
BIASING PROCEDURE

The proper bias sequence is to completely deplete the channel prior to application of the drain voltage. Next, decrease the gate voltage to obtain the required drain current. This bias sequence will prevent GUNN domains from forming in Power GaAs FETs.

Turn on the power supply. Make sure its voltage is 0 V. Turn on S1 and S2. Apply V_{GS} = –5, then apply V_{DS} = 9 V. Decrease V_{GS} to obtain the required drain current, I_D. Apply the RF input and adjust the gate voltage to maintain the desired drain current. Do not exceed a gate current of 10 mA (I_G = 10 mA max).

TYPICAL SMALL SIGNAL COMMON SOURCE SCATTERING PARAMETERS





NE800400[1]
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 9 V, I_{DS} = 600 mA)

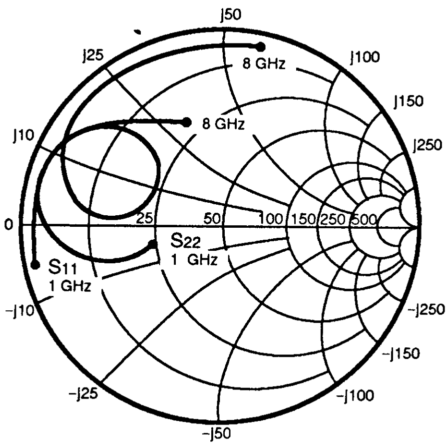
S-MAGN AND ANGLES:
V_{DS} = 9 V, I_{DS} = 600 mA

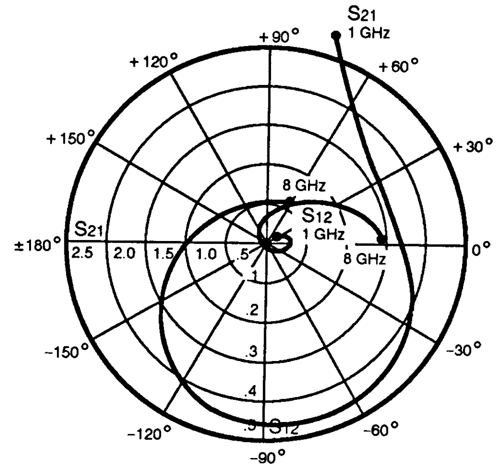
FREQUENCY (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	MAG (dB)[2]
.10	.99	–35	14.05	161	.014	69	.14	–125	.04	30.05
.20	.97	–64	12.20	145	.025	56	.23	–133	.07	26.96
.50	.94	–115	7.66	115	.037	30	.37	–150	.09	23.13
1.0	.93	–147	4.35	94	.043	11	.42	–160	.16	20.04
1.5	.92	–159	2.96	81	.044	3	.44	–161	.24	18.32
2.0	.92	–166	2.25	71	.043	–4	.46	–161	.32	17.19
2.5	.93	–171	1.83	63	.042	–7	.48	–160	.36	16.44
3.0	.92	–175	1.59	56	.041	–10	.50	–160	.49	15.87
3.5	.92	–177	1.28	48	.040	–13	.54	–160	.62	15.03
4.0	.92	–180	1.11	41	.039	–15	.56	–160	.74	14.52
4.5	.92	178	.94	35	.038	–18	.59	–161	.89	13.98
5.0	.92	176	.86	28	.036	–20	.62	–162	1.03	12.74
5.5	.92	174	.78	22	.033	–20	.64	–163	1.27	10.63
6.0	.92	172	.73	16	.034	–17	.66	–165	1.25	10.28
6.5	.92	171	.66	12	.034	–16	.68	–166	1.32	9.48
7.0	.92	170	.60	6	.037	–23	.70	–167	1.21	9.39
7.5	.92	168	.55	0	.033	–26	.72	–169	1.39	8.48
8.0	.93	167	.51	–5	.031	–25	.74	–171	1.43	8.22
8.5	.93	165	.47	–9	.029	–24	.76	–172	1.58	7.57
9.0	.93	164	.43	–15	.029	–22	.77	–174	1.63	7.09
9.5	.93	163	.41	–20	.029	–21	.78	–176	1.58	7.07
10.0	.93	161	.39	–23	.030	–21	.80	–177	1.50	7.01

Note 1: S-parameters include bond wires.
GATE: Total 4 wire (s), 1 per bond pad, 0.0278" (705 µm) long each wire.
DRAIN: Total 4 wire (s), 1 per bond pad, 0.0213" (540 µm) long each wire.
SOURCE: Total 15 wire (s), 3 per source area, 0.0063" (161 µm) long each wire.
WIRE: 0.0007" (17.8 µm) dia., gold.

Note 2:
Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K - \sqrt{K^2 - 1})$.
When $K \leq 1$, MAG = MSG

TYPICAL SMALL SIGNAL COMMON SOURCE SCATTERING PARAMETERS





NE800495-4
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 9 V, I_{DS} = 600 mA)

S-MAGN AND ANGLES:
V_{DS} = 9 V, I_{DS} = 600 mA

FREQUENCY (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	MAG (dB)[1]
.10	.99	-59	14.31	147	.009	65	.19	-146	.08	32.2
.20	.96	-98	10.72	126	.017	46	.25	-151	.16	28.0
.50	.93	-144	5.43	98	.025	28	.31	-161	.42	23.4
1.0	.94	-167	3.03	77	.028	26	.34	-164	.55	20.3
1.5	.94	-180	2.24	60	.031	27	.36	-162	.66	18.6
2.0	.92	172	1.86	45	.036	29	.41	-163	.88	17.1
2.5	.89	164	1.66	32	.041	28	.43	-164	1.08	14.4
3.0	.84	156	1.70	16	.048	26	.47	-161	1.16	13.0
3.2	.83	153	1.71	10	.050	24	.49	-160	1.15	13.0
3.4	.79	149	1.75	1	.053	18	.52	-160	1.16	12.8
3.6	.73	146	1.80	-7	.055	13	.55	-159	1.36	11.6
3.8	.71	144	2.08	-16	.056	7	.59	-159	1.02	14.9
4.0	.64	140	2.23	-27	.054	-1	.65	-160	1.04	14.8
4.2	.54	139	2.36	-42	.050	-14	.73	-162	1.16	14.4
4.4	.44	145	2.48	-60	.039	-32	.81	-167	1.34	14.5
4.6	.41	162	2.51	-79	.022	-58	.89	-174	1.83	15.3
4.8	.50	175	2.37	-97	.002	-147	.93	177	8.95	17.5
5.0	.64	176	2.08	-116	.025	132	.93	169	.34	19.2
5.5	.84	161	1.42	-153	.045	88	.82	154	.14	15.0
6.0	.92	146	.95	178	.080	67	.73	145	.04	10.7
6.5	.96	130	.70	151	.144	49	.66	138	.05	6.9
7.0	.95	114	.56	128	.176	38	.61	131	.26	5.0
7.5	.92	95	.50	101	.215	24	.57	123	.59	3.7
8.0	.93	73	.46	73	.257	8	.52	113	.60	2.6

Note:

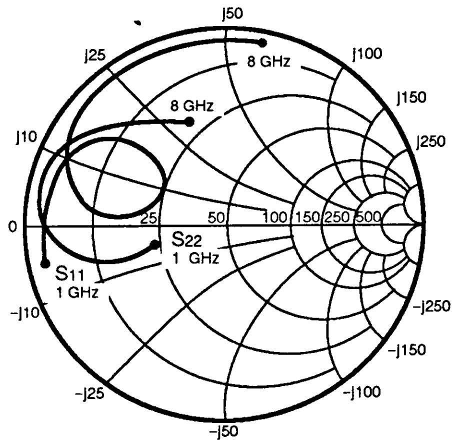
1. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K - \sqrt{K^2 - 1})$. When $K \leq 1$, MAG = MSG.

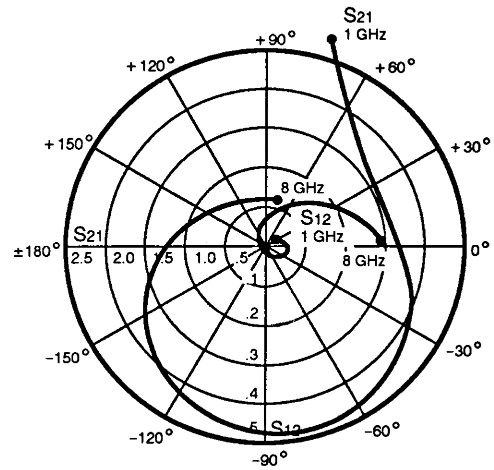
$$MSG = \frac{|S_{21}|}{|S_{12}|},\ K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}|\ |S_{21}|},\ \Delta = S_{11}S_{22} - S_{21}S_{12}$$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

3

TYPICAL SMALL SIGNAL COMMON SOURCE SCATTERING PARAMETERS





NE800495-5
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 9 V, I_{DS} = 600 mA)

S-MAGN AND ANGLES:
V_{DS} = 9 V, I_{DS} = 600 mA

FREQUENCY (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	MAG (dB)[1]
.10	.98	−58	15.06	148	.008	63	.16	−139	.08	32.6
.20	.97	−97	11.35	127	.016	48	.23	−146	.15	28.5
.50	.93	−143	5.75	98	.025	29	.29	−159	.41	23.7
1.0	.94	−166	3.19	76	.028	28	.32	−162	.58	20.5
1.5	.93	−179	2.33	60	.031	29	.34	−161	.71	18.7
2.0	.92	172	1.91	46	.036	33	.39	−163	.88	17.2
2.5	.89	165	1.67	32	.042	32	.42	−164	1.09	14.2
3.0	.86	157	1.63	17	.050	32	.44	−161	1.07	13.5
3.5	.83	150	1.70	2	.059	26	.49	−161	.95	14.6
4.0	.74	141	1.95	−17	.066	16	.56	−161	.88	14.7
4.2	.68	137	2.04	−27	.065	10	.61	−161	.94	14.9
4.4	.60	134	2.18	−40	.065	0	.67	−162	.95	15.3
4.6	.51	133	2.35	−53	.060	−8	.74	−165	.95	15.9
4.8	.41	139	2.48	−68	.050	−20	.81	−170	1.02	16.1
5.0	.37	156	2.48	−84	.031	−31	.89	−177	1.21	16.3
5.2	.44	171	2.38	−102	.012	−41	.94	175	1.92	17.5
5.4	.58	174	2.24	−121	.022	108	.95	166	.13	21.0
5.6	.71	169	2.03	−138	.040	96	.88	159	.11	17.0
5.8	.78	163	1.76	−153	.060	88	.83	152	.02	14.7
6.0	.82	157	1.47	−168	.087	76	.79	147	.02	12.3
6.5	.90	137	1.06	161	.136	54	.72	135	.04	8.9
7.0	.93	120	.80	137	.179	41	.65	126	.12	6.5
7.5	.94	102	.69	111	.231	26	.61	116	.20	4.8
8.0	.93	78	.61	81	.279	9	.54	103	.39	3.4

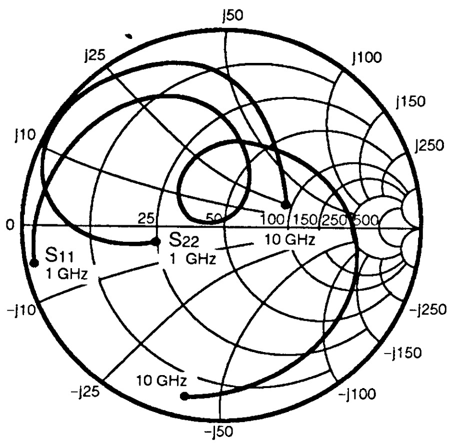
Note:

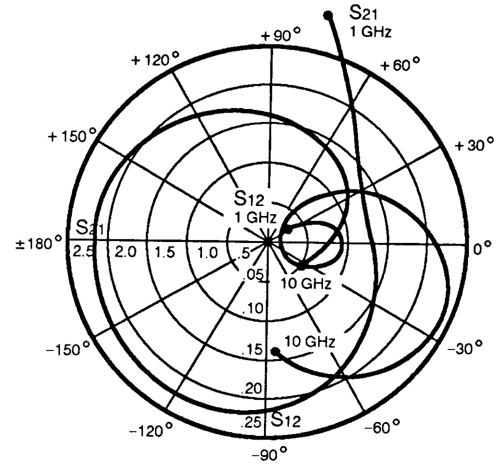
1. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K - \sqrt{K^2 - 1})$. When $K \leq 1$, MAG = MSG.

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

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SMALL SIGNAL COMMON SOURCE SCATTERING PARAMETERS





NE800495-6
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 9 V, I_{DS} = 600 mA)

S-MAGN AND ANGLES:
VDS = 9 V, IDS = 600 mA

FREQUENCY (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	MAG (dB)[1]
.10	.98	-62	14.81	146	.010	61	.21	-148	.12	31.8
.20	.96	-100	10.95	125	.017	45	.28	-153	.16	28.1
.50	.93	-146	5.45	97	.024	27	.34	-164	.41	23.5
1.0	.94	-169	3.00	76	.028	26	.36	-166	.57	20.3
1.5	.94	178	2.15	61	.031	30	.38	-165	.67	18.4
2.0	.93	170	1.74	46	.036	34	.42	-168	.87	16.9
2.5	.91	162	1.47	33	.042	35	.44	-169	1.02	14.5
3.0	.89	154	1.39	21	.050	35	.46	-170	1.07	12.8
3.5	.87	147	1.35	6	.059	30	.49	-171	.99	13.6
4.0	.84	136	1.44	-8	.070	26	.52	-172	.84	13.1
4.5	.79	124	1.50	-25	.079	18	.55	-174	.86	12.8
5.0	.71	109	1.68	-44	.088	9	.61	-176	.76	12.8
5.2	.65	101	1.74	-52	.090	3	.65	-177	.76	12.9
5.4	.59	93	1.86	-63	.093	-3	.69	-179	.71	13.0
5.6	.52	85	2.01	-74	.092	-10	.73	179	.65	13.4
5.8	.43	75	2.17	-86	.087	-15	.78	176	.61	13.9
6.0	.32	65	2.22	-99	.078	-24	.84	172	.58	14.6
6.2	.21	59	2.26	-114	.066	-31	.89	166	.56	15.4
6.4	.10	66	2.30	-128	.051	-35	.93	160	.53	16.6
6.6	.07	137	2.28	-143	.031	-23	.97	152	.49	18.6
6.8	.16	157	2.28	-157	.023	27	.99	145	.23	19.9
7.0	.25	148	2.27	-174	.042	50	.98	137	.08	17.3
7.5	.41	107	2.04	149	.126	37	.94	116	.01	12.1
8.0	.54	56	1.81	108	.192	12	.83	95	.10	9.8
8.5	.66	2	1.46	68	.233	-18	.66	73	.25	8.0
9.0	.77	-43	1.08	32	.217	-48	.50	53	.45	7.0
9.5	.85	-75	.78	1	.183	-70	.39	37	.59	6.3
10.0	.91	-98	.59	-23	.140	-85	.35	19	.67	6.2

Note:

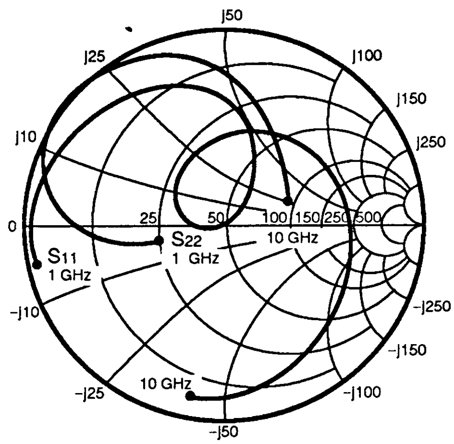
1. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K - \sqrt{K^2 - 1})$. When $K \leq 1$, MAG = MSG.

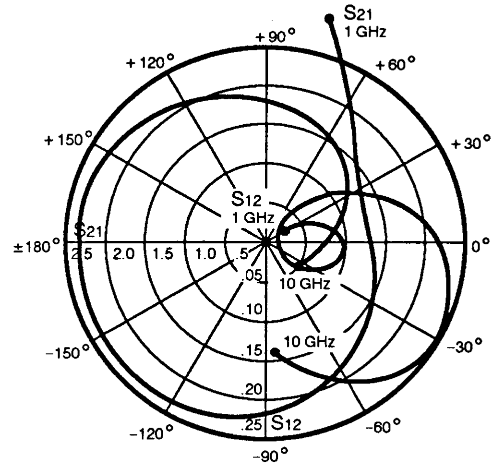
$$MSG = \frac{|S_{21}|}{|S_{12}|},\quad K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}|\,|S_{21}|},\quad \Delta = S_{11}S_{22} - S_{21}S_{12}$$

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

3

TYPICAL SMALL SIGNAL COMMON SOURCE SCATTERING PARAMETERS





NE800495-7
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 9 V, I_{DS} = 600 mA)

S-MAGN AND ANGLES:
VDS = 9 V, IDS = 600 mA

FREQUENCY (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	MAG (dB)[1]
.10	.99	−56	13.40	149	.008	65	.17	−147	.07	32.2
.20	.97	−94	10.27	128	.015	50	.23	−150	.14	28.3
.50	.94	−141	5.30	99	.023	29	.29	−159	.42	23.5
1.0	.95	−165	2.92	77	.027	26	.33	−161	.55	20.4
1.5	.95	−179	2.10	61	.028	29	.36	−159	.63	18.7
2.0	.94	172	1.69	47	.032	34	.41	−162	.80	17.2
2.5	.92	164	1.43	34	.038	37	.44	−163	.98	15.8
3.0	.91	156	1.35	21	.044	37	.47	−164	.98	14.8
3.5	.89	147	1.29	7	.053	35	.51	−166	.98	13.9
4.0	.85	138	1.36	-7	.063	32	.54	−167	.95	13.4
4.5	.81	126	1.43	-22	.075	26	.57	−169	.84	12.8
5.0	.74	110	1.63	-40	.086	18	.63	−171	.69	12.7
5.5	.60	90	1.88	-64	.094	3	.72	−175	.57	13.0
6.0	.37	62	2.21	-94	.084	−15	.85	177	.44	14.2
6.2	.26	49	2.28	−108	.074	−22	.89	172	.41	14.9
6.4	.14	35	2.35	−122	.060	−28	.95	166	.31	15.9
6.6	.01	20	2.38	−138	.041	−22	.98	159	.26	17.7
6.8	.10	−175	2.40	−153	.030	15	.99	152	.22	19.0
7.0	.20	166	2.38	−170	.040	50	.99	144	.04	17.7
7.2	.29	147	2.34	175	.065	54	.98	135	.02	15.6
7.4	.36	126	2.30	158	.115	48	.96	126	.02	13.0
7.6	.43	104	2.26	143	.153	39	.93	117	.02	11.7
7.8	.48	80	2.16	125	.187	27	.91	108	.02	10.6
8.0	.53	54	2.03	108	.213	14	.84	97	.07	9.8
8.5	.66	-8	1.60	62	.252	−20	.61	73	.27	8.0
9.0	.77	−54	1.11	27	.222	−50	.41	55	.52	7.0
9.5	.87	−85	.79	-5	.180	−70	.31	46	.64	6.4
10.0	.92	−108	.57	−29	.140	−85	.30	30	.68	6.1

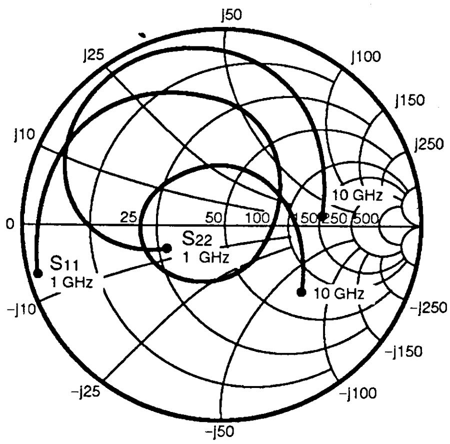
Note:

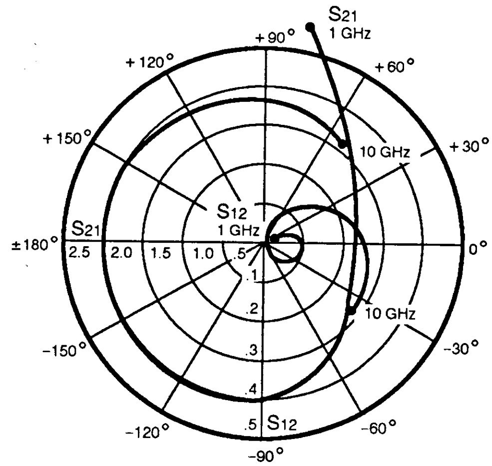
1. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K - \sqrt{K^2 - 1})$. When $K \leq 1$, MAG = MSG.

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

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL SMALL SIGNAL COMMON SOURCE SCATTERING PARAMETERS





NE800495-8
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 9 V, I_{DS} = 600 mA)

S-MAGN AND ANGLES:
VDS = 9 V, IDS = 600 mA

FREQUENCY (GHz)	S_{11}		S_{21}		S_{12}		S_{22}		k	MAG (dB)[1]
.10	.99	-54	12.92	150	.009	66	.18	-148	.09	31.4
.20	.97	-91	10.00	129	.017	50	.24	-150	.15	27.8
.50	.94	-140	5.23	100	.026	28	.31	-160	.38	23.1
1.0	.94	-165	2.89	78	.028	23	.34	-162	.50	20.1
1.5	.94	-179	2.06	62	.030	26	.37	-161	.66	18.4
2.0	.92	174	1.64	48	.033	23	.42	-164	.98	17.0
2.5	.92	166	1.37	35	.037	33	.45	-164	1.15	13.4
3.0	.91	159	1.27	24	.044	36	.48	-166	1.11	12.7
3.5	.90	152	1.20	10	.050	36	.51	-168	1.03	12.8
4.0	.87	143	1.23	-2	.062	32	.54	-170	.87	12.9
4.5	.84	132	1.23	-16	.072	28	.56	-174	.91	12.3
5.0	.79	119	1.33	-31	.085	22	.60	-177	.80	11.9
5.5	.71	102	1.49	-49	.099	10	.64	-180	.70	11.8
6.0	.59	78	1.72	-72	.105	-4	.72	175	.62	12.2
6.5	.39	40	1.87	-101	.103	-23	.80	167	.63	12.6
7.0	.26	-25	2.04	-130	.070	-42	.89	154	.64	14.6
7.2	.25	-61	2.05	-142	.052	-47	.92	148	.72	15.9
7.4	.28	-93	2.03	-157	.030	-43	.94	140	1.06	16.8
7.6	.32	-119	2.03	-168	.012	16	.94	133	2.46	15.4
7.8	.36	-140	2.02	177	.038	59	.94	126	.79	17.2
8.0	.39	-159	2.04	163	.069	59	.94	118	.46	14.7
8.2	.41	-177	2.03	150	.105	50	.94	108	.36	12.9
8.4	.41	164	1.99	136	.141	43	.91	99	.36	11.5
8.6	.39	144	1.96	121	.173	34	.88	88	.39	10.5
8.8	.36	121	1.90	106	.206	22	.83	76	.43	9.7
9.0	.33	94	1.84	90	.233	9	.78	64	.49	9.0
9.5	.36	15	1.60	50	.279	-20	.64	34	.58	7.6
10.0	.51	-38	1.28	17	.283	-48	.51	5	.68	6.6

Note:

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

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

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

NEC®

Ku-BAND POWER GaAs MESFET

NE9004 SERIES

FEATURES

- CLASS A OPERATION
- HIGH POWER ADDED EFFICIENCY
- EMPLOYS P.H.S. (PLATED HEAT SINK) AND VIA HOLE GROUNDING
- BROAD BANDWIDTH
- INPUT OF PACKAGED DEVICE PARTIALLY MATCHED TO 50 Ω
- AVAILABILITY:
  Hermetic Package
  Chip

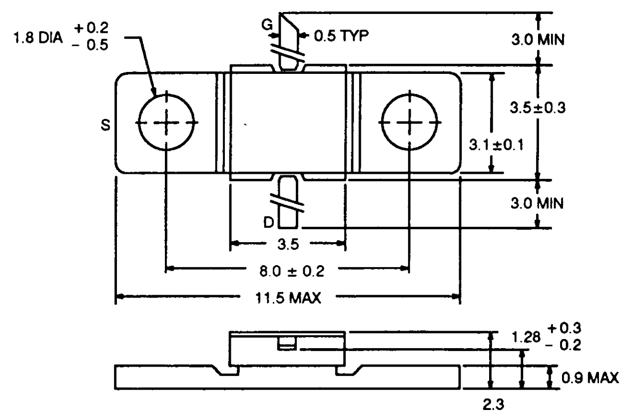
DESCRIPTION AND APPLICATIONS

The NE9004 is a 0.5 micron recessed gate GaAs power FET for commercial, military, space amplifier and oscillator applications to 20 GHz. This device is part of the NE900 series of Ku-Band power transistors which includes the NE9000, NE9001 and NE9002. They are described in separate data sheets.

The NE9004 incorporates silicon nitride passivation for surface stabilization, and silicon dioxide glassivation for superior scratch resistance and mechanical protection. It is a four cell die of 3000 µm gate width incorporating wrap-around source metallization and via hole source grounding for superior RF and thermal performance. The device is available in chip form and in a hermetic ceramic package. The series conforms to MIL-S-19500 and is space qualified.

OUTLINE DIMENSIONS (Units in mm)

OUTLINE 74



Flange Material: Copper
Flange Plating: Ni, Au

Lead Material: Kovar
Lead Plating: Ni, Au

SELECTION CHART

PART NUMBER	TYPICAL PERFORMANCE		
	P_{1db} (WATTS)	FREQUENCY RANGE (GHz)	G_{1db} (dB)
NE900400G[1]	1.25	up to 20	6
NE900474-13	1.25	9 to 13.5	6
NE900474-15	1.25	13 to 15.2	6

Note:
1. Unpackaged chip with sidewall metallization/via hole source grounding.

PERFORMANCE SPECIFICATIONS (T_A = 25 °C)

CHIP PART NUMBER / PACKAGE PART NUMBER / PACKAGE OUTLINE			NE900400G / NE900474-13 / 00G (CHIP), 74			NE900474-15 / 74		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX
P_{TEST}	Output Power at Test Point							
	P_{IN} = 25.0 dBm, V_{DS} = 8 V, I_D = 450 mA, f = 13.5 GHz	dBm	30.5	31				
	P_{IN} = 25.5 dBm, V_{DS} = 8 V, I_D = 450 mA, f = 15.2 GHz	dBm				30.5	31	
P_{1dB}	Output Power at 1 dB Compression Point							
	V_{DS} = 8 V, I_D = 450 mA, f = 13.5 GHz	dBm		31				
	V_{DS} = 8 V, I_D = 450 mA, f = 15.2 GHz	dBm					31	
G_{1dB}	Gain at 1 dB Compression Point							
	V_{DS} = 8 V, I_D = 450 mA, f = 13.5 GHz	dB		6			6	
	V_{DS} = 8 V, I_D = 450 mA, f = 15.2 GHz	dB		6			6	
η_{ADD}[1]	Power Added Efficiency							
	V_{DS} = 8 V, I_D = 450 mA, f = 13.5 GHz	%		26			26	
	V_{DS} = 8 V, I_D = 450 mA, f = 15.2 GHz	%		24			24	

Note:

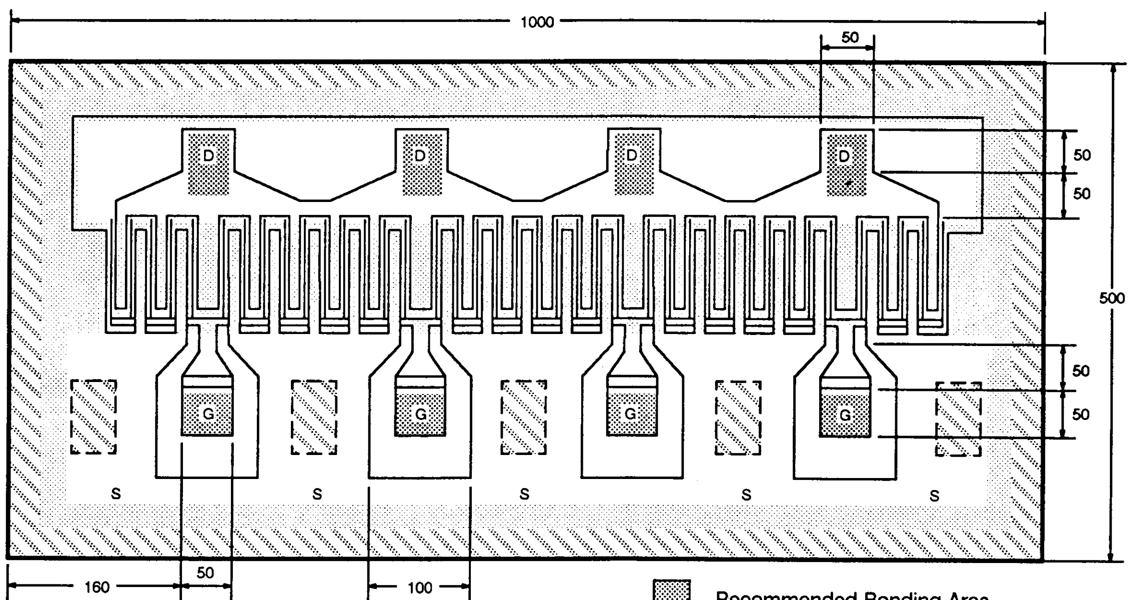
1. $\eta_{ADD} = \dfrac{P_{OUT} - P_{IN}}{V_{DS} \times I_D} \times 100\%$

ELECTRICAL CHARACTERISTICS (TA = 25°C)

CHIP PART NUMBER PACKAGE PART NUMBER PACKAGE OUTLINE			NE900400G NE900474-13, 15 00G (CHIP), 74		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
I_{DSS}	Saturated Drain Current at V_{DS} = 2.5 V, V_{GS} = 0	mA	600	900	1200
V_P	Pinch Off Voltage at V_{DS} = 2.5 V, I_{DS} = 20 mA		-2	-3.5	-5
g_M	Transconductance at V_{DS} = 2.5 V, I_{DS} = 300 mA	mS		200	
R_{TH}	Thermal Resistance (Channel-to-Case)	°C/W			20
P_T	Total Power Dissipation (T_{CASE} = 50°C)	W			7.5

CHIP DIMENSIONS AND HANDLING

NE900400G (CHIP)
(Units in μm)



Die Thickness: 40 to 80 μm

Recommended Bonding Area.

Glassivated Area

Plated Wraparound Area and Via Hole detail.

DIE ATTACHMENT

Die attach can be accomplished with a Au-Ge (390±10°C) preform in a forming gas environment. Epoxy die attach is not recommended.

BONDING

Gate and drain bonding wires should be minimum length, semi-hard gold wire (3-8% elongation) 30 microns or less in diameter.

Bonding should be performed with a wedge tip that has a taper of approximately 15°. Die attach and bonding time should be kept to a minimum. As a general rule, the bonding operation should be kept within a 300°C to 10 minute curve. If longer periods are required, the temperature should be lowered.

PRECAUTIONS

The user must operate in a clean, dry environment. The chip channel is glassivated for mechanical protection only and does not preclude the necessity of a clean environment.

The bonding equipment should be periodically checked for sources of surge voltage and should be properly grounded at all times. All test and handling equipment should be grounded to minimize the possibilities of static discharge.

See AN-1001 (Recommended Handling Procedures for microwave transistor & MMIC chips) for additional information.

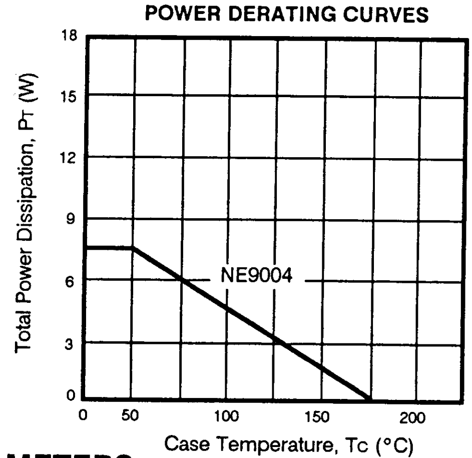
3

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

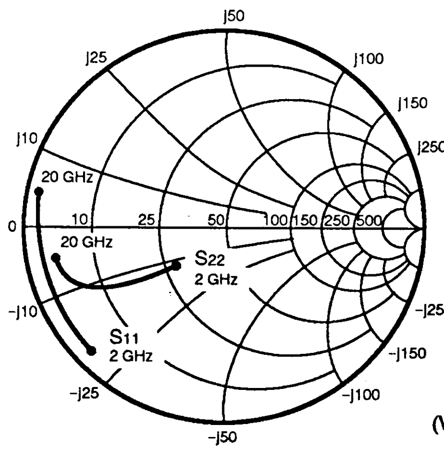
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{DS}	Drain to Source Voltage	V	20
V_{GS}	Gate to Source Voltage	V	-9
I_D	Drain Current	mA	1200
I_G	Gate Current	μA	10

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

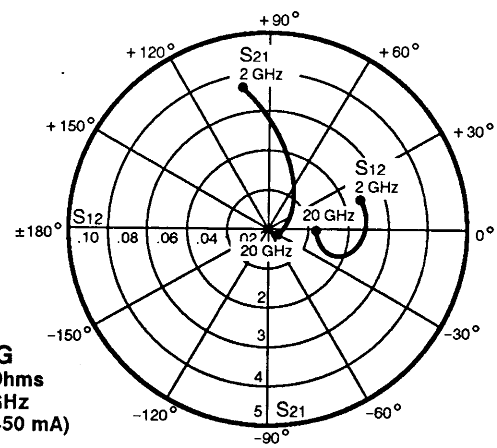
POWER DERATING CURVES



TYPICAL COMMON SOURCE SCATTERING PARAMETERS



NE900400G
Coordinates in Ohms
Frequency in GHz
(V_{DS} = 8 V, I_{DS} = 450 mA)



Note: S-Parameters include bond wires.

Gate:	Total 4 wire (s), 1 per bond pad, 0.0134" (340 μm) long each wire.
Drain:	Total 4 wire (s), 1 per bond pad, 0.0104" (264 μm) long each wire.
Source:	No bond wires. Gold plated wraparound to back side of chip.
Wire:	0.0007" (17.8 μm) diameter, gold.

S-MAGN AND PHASE:
V_{DS} = 8 V, I_D = 450 mA

FREQUENCY (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		K	MAG[1] (dB)
2000	0.92	-138	3.56	97	0.051	16	0.36	-146	0.180	18
3000	0.92	-151	2.47	81	0.050	7	0.39	-148	0.254	17
4000	0.92	-159	1.85	69	0.050	1	0.44	-148	0.328	16
5000	0.92	-164	1.46	60	0.049	-4	0.48	-149	0.403	15
6000	0.92	-168	1.21	52	0.050	-4	0.53	-149	0.444	14
7000	0.92	-171	1.03	45	0.047	-12	0.57	-151	0.552	13
8000	0.92	-172	0.90	37	0.045	-13	0.61	-152	0.622	13
9000	0.92	-174	0.78	29	0.041	-16	0.65	-153	0.763	13
10000	0.93	-176	0.69	23	0.040	-17	0.69	-154	0.765	12
11000	0.93	-179	0.62	16	0.038	-21	0.72	-155	0.844	12
12000	0.93	179	0.56	8	0.036	-22	0.75	-156	1.040	11
13000	0.93	178	0.49	3	0.032	-23	0.77	-157	1.239	9
14000	0.93	176	0.46	-2	0.030	-25	0.79	-158	1.451	8
15000	0.93	174	0.43	-7	0.028	-23	0.81	-159	1.577	7
16000	0.93	173	0.39	-12	0.027	-21	0.82	-161	1.659	7
17000	0.93	172	0.37	-16	0.025	-19	0.83	-162	1.888	6
18000	0.93	172	0.35	-20	0.024	-17	0.83	-164	2.066	6
19000	0.93	171	0.32	-26	0.024	-5	0.84	-166	1.960	6
20000	0.93	171	0.30	-29	0.025	-0	0.85	-169	1.839	6

Note:

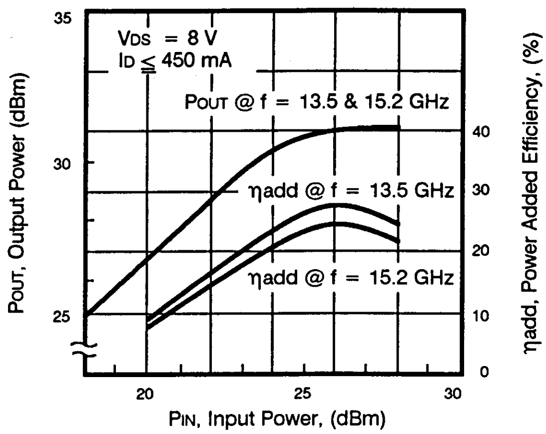
1. Gain Calculations: $MAG = \frac{|S_{21}|}{|S_{12}|}(K - \sqrt{K^2 - 1})$. When $K \leq 1$, MAG = MSG.

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

MAG = Maximum Available Gain
MSG = Maximum Stable Gain

TYPICAL DEVICE CHARACTERISTICS (T_A = 25°C)

NE900474-13, -15
OUTPUT POWER AND POWER ADDED EFFIECIENCY vs. INPUT POWER



3