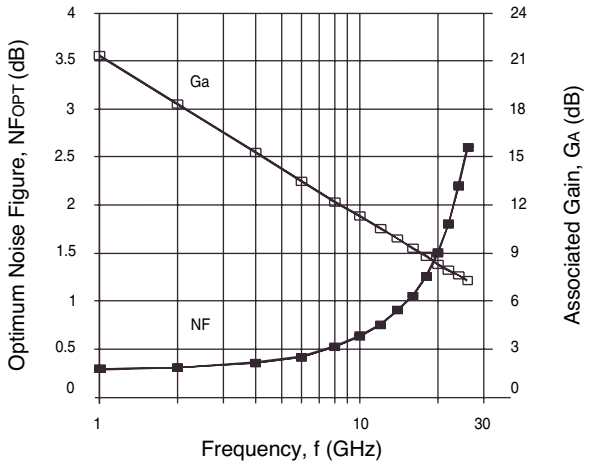
NEC

SUPER LOW NOISE HJ FET | NE33200

FEATURES

- **VERY LOW NOISE FIGURE:** 0.75 dB typical at 12 GHz
- **HIGH ASSOCIATED GAIN:** 10.5 dB Typical at 12 GHz
- **GATE LENGTH:** 0.3 μm
- **GATE WIDTH:** 280 μm

NOISE FIGURE & ASSOCIATED GAIN vs. FREQUENCY
V_{DS} = 2 V, I_{DS} = 10 mA



DESCRIPTION

The NE33200 is a Hetero-Junction FET chip that utilizes the junction between Si-doped AlGaAs and undoped InGaAs to create a two-dimensional electron gas layer with very high electron mobility. Its excellent low noise figure and high associated gain make it suitable for commercial and industrial applications.

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

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER PACKAGE OUTLINE			NE33200 00 (Chip)		
SYMBOLS	**PARAMETERS AND CONDITIONS**	**UNITS**	**MIN**	**TYP**	**MAX**
NF_{OPT}[1]	Noise Figure, V_{DS} = 2 V, I_D = 10 mA, f = 4 GHz f = 12 GHz	 dB dB		 0.35 0.75	 1.0
G_A[1]	Associated Gain, V_{DS} = 2 V, I_D = 10 mA, f = 4 GHz f = 12 GHz	 dB dB	 9.5	 15.0 10.5	
P_{1dB}	Output Power at 1 dB Gain Compression Point, f = 12 GHz V_{DS} = 2 V, I_{DS} = 10 mA V_{DS} = 2 V, I_{DS} = 20 mA	 dBm dBm		 11.2 12.0	
G_{1dB}	Gain at P_{1dB}, f = 12 GHz V_{DS} = 2 V, I_{DS} = 10 mA V_{DS} = 2 V, I_{DS} = 20 mA	 dB dB		 11.8 12.8	
I_{DSS}	Saturated Drain Current, V_{DS} = 2 V, V_{GS} = 0 V	mA	15	40	80
V_P	Pinch-off Voltage, V_{DS} = 2 V, I_D = 100 μA	V	-2.0	-0.8	-0.2
g_m	Transconductance, V_{DS} = 2 V, I_D = 10 mA	mS	45	70	
I_{GSO}	Gate to Source Leakage Current, V_{GS} = -5 V	μA		0.5	10
$R_{TH(CH-C)}$[2]	Thermal Resistance (Channel to Case)	°C/W			240

Notes:
1. RF performance is determined by packaging and testing 10 samples per wafer. Wafer rejection criteria for standard devices is 2 rejects for 10 samples.
2. Chip mounted on infinite heat sink.

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

SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{DS}	Drain to Source Voltage	V	4.0
V_{GS}	Gate to Source Voltage	V	-3.0
I_{DS}	Drain Current	mA	I_{DSS}
I_{GRF}	Gate Current	μA	280
P_{IN}	RF Input (CW)	dBm	15
T_{CH}	Channel Temperature	°C	175
T_{STG}	Storage Temperature	°C	-65 to +175
P_T[2]	Total Power Dissipation	mW	240

Note:
1. Operation in excess of any one of these parameters may result in permanent damage.
2. With chip mounted on infinite heat sink.

TYPICAL NOISE PARAMETERS[1] (T_A = 25°C)

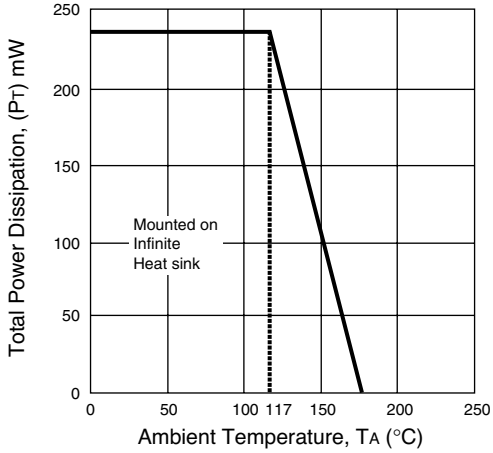
V_{DS} = 2 V, I_{DS} = 10 mA

FREQ.	NF_{OPT}	G_A	Γ_{OPT}		
(GHz)	(dB)	(dB)	MAG	ANG	Rn/50
1	0.29	21.3	0.82	8	0.39
2	0.31	18.3	0.81	17	0.36
4	0.35	15.3	0.76	41	0.33
6	0.42	13.5	0.71	63	0.30
8	0.52	12.2	0.64	77	0.27
10	0.63	11.3	0.55	95	0.24
12	0.75	10.5	0.48	112	0.22
14	0.9	9.9	0.41	130	0.19
16	1.05	9.3	0.37	144	0.18
18	1.25	8.8	0.35	164	0.15
20	1.5	8.3	0.37	180	0.13
22	1.8	7.9	0.38	-166	0.11
24	2.2	7.6	0.39	-154	0.10
26	2.6	7.3	0.40	-142	0.08

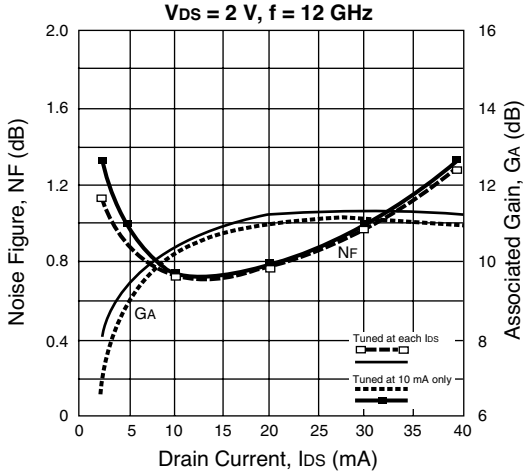
Note:
1. Noise Parameters include Bond Wires:
   Gate: Total 2 wires, 1 per bond pad 0.0129" (327 μm) long each wire.
   Drain: Total 2 wires, 1 per bond pad 0.0118" (300 μm) long each wire.
   Source: Total 4 wires, 2 per side, 0.0071" (180 μm) long each wire.
   Wire: 0.0007" (17.8 μm) dia. gold.

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

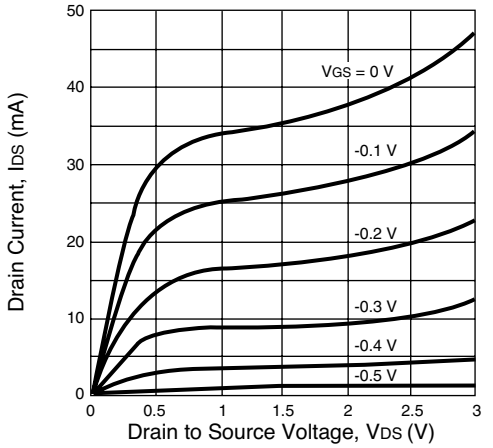
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



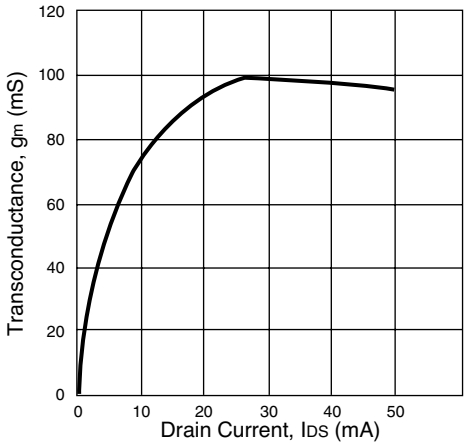
NOISE FIGURE and GAIN vs. DRAIN CURRENT
V_{DS} = 2 V, f = 12 GHz



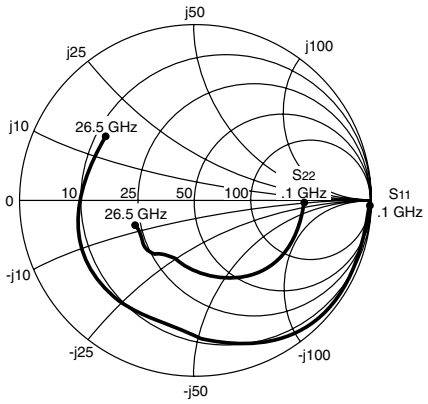
DRAIN CURRENT vs. DRAIN TO SOURCE VOLTAGE

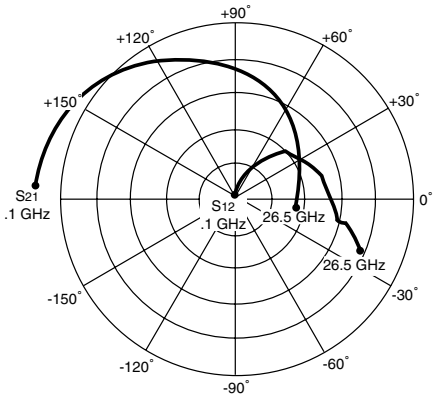


TRANSCONDUCTANCE vs. DRAIN CURRENT
V_{DS} = 2.0 V



TYPICAL COMMON SOURCE SCATTERING PARAMETERS[1] (T_A = 25°C)





V_{DS} = 2 V, I_{DS} = 10 mA

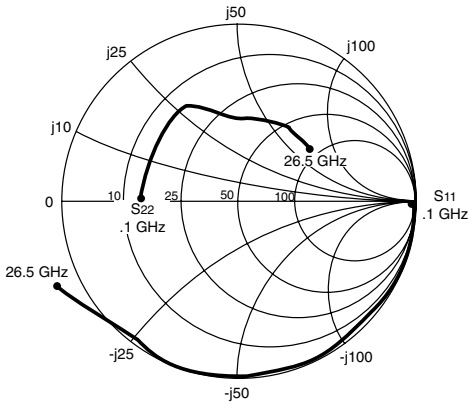
FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	S_{21}	MAG[2]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
0.1	.999	-1.8	5.854	178.8	.003	87.5	.631	-1.4	0.05	15.3	32.9
0.2	.999	-3.6	5.850	177.2	.005	86.2	.632	-2.5	0.04	15.4	30.7
0.5	.998	-8.9	5.846	173.5	.011	84.6	.632	-6.1	0.02	15.3	27.3
1.0	.994	-17.7	5.797	167.0	.022	82.0	.628	-12.1	0.00	15.3	24.2
2.0	.974	-34.6	5.614	154.1	.044	71.2	.618	-23.8	0.04	15.0	21.1
3.0	.940	-49.9	5.299	142.1	.063	62.4	.598	-34.9	0.09	14.5	19.2
4.0	.903	-63.2	4.919	131.1	.079	52.5	.578	-43.9	0.17	13.8	17.9
5.0	.861	-75.1	4.512	121.4	.089	46.4	.556	-51.5	0.23	13.1	17.0
6.0	.822	-85.9	4.210	112.5	.099	39.7	.532	-59.1	0.29	12.5	16.3
7.0	.798	-93.2	3.900	105.5	.103	35.2	.528	-60.8	0.35	11.8	15.8
8.0	.750	-102.2	3.642	97.8	.103	27.7	.495	-65.1	0.48	11.2	15.5
9.0	.728	-110.1	3.420	89.9	.104	23.9	.479	-69.1	0.55	10.7	15.2
10.0	.724	-117.8	3.304	83.8	.109	21.9	.468	-74.6	0.54	10.4	14.8
12.0	.722	-132.6	3.045	69.8	.115	14.7	.433	-86.7	0.56	9.7	14.2
14.0	.724	-146.6	2.876	57.2	.120	4.9	.398	-101.2	0.57	9.2	13.8
16.0	.714	-158.3	2.668	46.2	.125	-2.4	.376	-112.4	0.61	8.5	13.3
18.0	.695	-169.5	2.483	35.7	.132	-9.8	.373	-119.5	0.66	7.9	12.7
20.0	.676	-179.4	2.296	26.5	.143	-10.5	.394	-124.8	0.66	7.2	12.1
22.0	.665	168.5	2.115	13.7	.153	-14.9	.401	-130.3	0.68	6.5	11.4
24.0	.648	158.1	1.897	0.4	.163	-17.7	.388	-139.5	0.75	5.5	10.7
26.0	.632	147.8	1.817	-12.1	.167	-19.9	.378	-148.9	0.79	5.2	10.4
26.5	.641	145.0	1.832	-14.3	.168	-18.3	.372	-152.5	0.76	5.3	10.4

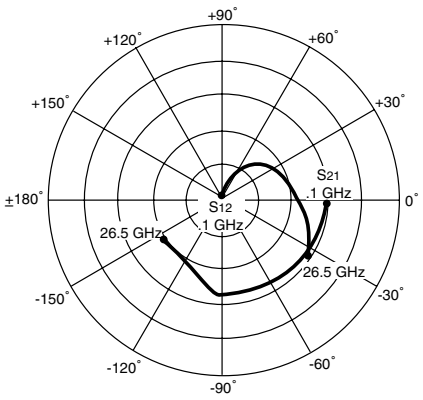
V_{DS} = 2 V, I_{DS} = 30 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K	S_{21}	MAG[2]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
0.1	.999	-2.0	7.441	178.7	.002	87.9	.484	-1.1	0.06	17.4	35.7
0.2	.999	-3.9	7.436	177.1	.003	86.5	.483	-2.7	0.04	17.4	33.9
0.5	.997	-9.5	7.422	173.1	.009	84.7	.483	-6.5	0.04	17.4	29.2
1.0	.991	-18.8	7.317	166.4	.017	82.2	.482	-12.8	0.04	17.3	26.3
2.0	.968	-36.6	7.041	153.1	.032	72.3	.472	-24.8	0.09	16.9	23.4
3.0	.929	-52.7	6.570	140.6	.047	63.9	.458	-36.3	0.16	16.3	21.4
4.0	.889	-66.4	6.058	129.9	.059	56.1	.447	-45.3	0.23	15.6	20.1
5.0	.846	-78.7	5.518	120.2	.067	50.5	.431	-52.3	0.31	14.8	19.1
6.0	.805	-89.3	5.083	111.5	.076	44.2	.411	-60.0	0.38	14.1	18.2
7.0	.777	-98.8	4.686	103.6	.083	39.5	.403	-64.1	0.44	13.4	17.5
8.0	.728	-107.8	4.335	96.3	.082	32.5	.375	-67.7	0.59	12.7	17.2
9.0	.709	-115.5	4.046	88.8	.084	30.6	.365	-70.9	0.65	12.1	16.8
10.0	.708	-123.2	3.879	82.9	.089	30.2	.359	-76.6	0.63	11.8	16.4
12.0	.707	-137.7	3.551	69.6	.097	23.8	.333	-89.5	0.64	11.0	15.6
14.0	.710	-151.1	3.293	57.0	.102	15.7	.311	-105.0	0.65	10.4	15.1
16.0	.704	-162.7	3.055	46.0	.110	8.8	.294	-117.1	0.67	9.7	14.4
18.0	.680	-173.2	2.835	35.9	.118	2.4	.300	-124.4	0.71	9.1	13.8
20.0	.667	177.0	2.598	27.1	.134	-0.5	.320	-128.7	0.69	8.3	12.9
22.0	.661	164.9	2.384	15.4	.149	-4.0	.336	-133.8	0.67	7.5	12.0
24.0	.654	153.8	2.141	3.1	.162	-6.8	.327	-141.0	0.70	6.6	11.2
26.0	.639	144.0	2.020	-9.2	.171	-10.4	.310	-150.5	0.75	6.1	10.7
26.5	.641	142.2	2.059	-11.6	.175	-11.7	.308	-156.2	0.72	6.3	10.7

See notes on back page.

TYPICAL COMMON SOURCE, REVERSE CHANNEL SCATTERING PARAMETERS[1] (T_A = 25°C)





V_{DS} = -2 V, I_{DS} = 10 mA

FREQUENCY	S11		S21		S12		S22		K	S21	MAG[2]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
0.1	0.998	-0.8	1.492	-0.5	.003	93.9	.586	179.5	0.25	3.5	27.0
0.2	0.999	-1.6	1.490	-1.3	.005	86.2	.587	179.3	0.12	3.5	24.7
0.5	0.998	-3.8	1.489	-3.1	.013	89.7	.585	177.7	0.05	3.4	20.6
1.0	1.000	-7.7	1.480	-5.9	.024	88.7	.588	175.6	-0.03	3.4	17.9
2.0	0.998	-15.3	1.480	-11.9	.051	80.6	.585	171.0	0.02	3.4	14.6
3.0	0.997	-22.	1.474	-17.9	.075	78.3	.582	167.0	0.01	3.4	12.9
4.0	0.992	-29.5	1.464	-23.8	.101	73.5	.577	162.7	0.04	3.3	11.6
5.0	0.987	-36.3	1.439	-29.2	.127	69.2	.573	158.5	0.06	3.2	10.5
6.0	0.979	-42.9	1.428	-34.7	.151	64.8	.575	154.5	0.09	3.1	9.7
7.0	0.965	-48.9	1.390	-40.2	.172	59.2	.573	151.1	0.15	2.9	9.1
8.0	0.960	-55.1	1.379	-46.4	.191	55.5	.573	147.3	0.17	2.8	8.6
9.0	0.955	-60.7	1.320	-52.2	.212	51.8	.574	143.4	0.18	2.4	7.9
10.0	0.954	-66.6	1.323	-56.2	.243	47.2	.577	137.8	0.16	2.4	7.4
12.0	0.968	-77.1	1.298	-66.4	.295	36.7	.578	125.1	0.13	2.3	6.4
14.0	0.982	-87.3	1.301	-75.6	.348	24.6	.571	111.9	0.11	2.3	5.7
16.0	0.986	-98.1	1.302	-85.8	.395	12.1	.530	99.8	0.14	2.3	5.2
18.0	0.970	-108.8	1.268	-95.9	.453	1.1	.493	90.0	0.21	2.1	4.5
20.0	0.962	-120.3	1.199	-104.0	.484	-7.5	.465	80.7	0.20	1.6	3.9
22.0	0.978	-130.6	1.119	-113.2	.518	-16.8	.467	67.9	0.14	1.0	3.0
24.0	1.039	-141.1	1.071	-123.5	.545	-23.7	.497	55.5	-0.00	0.6	2.9
26.0	1.109	-152.1	1.076	-137.0	.574	-33.5	.485	40.8	-0.11	0.6	2.7
26.5	1.112	-154.7	1.068	-140.6	.569	-36.8	.477	37.3	-0.11	0.6	2.7

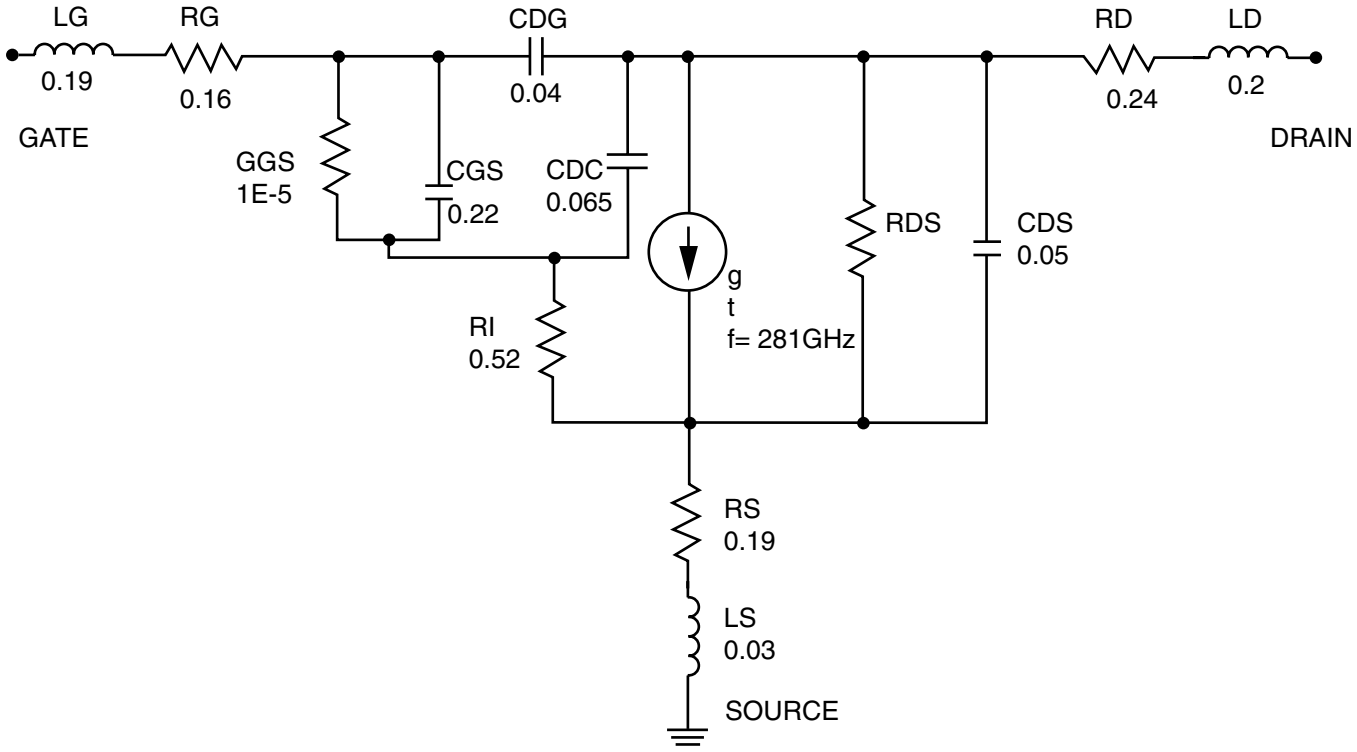
V_{DS} = -2 V, I_{DS} = 30 mA

FREQUENCY	S11		S21		S12		S22		K	S21	MAG[2]
(GHz)	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		(dB)	(dB)
0.1	0.999	-0.7	1.574	-0.3	.002	135.9	.687	179.7	-0.33	3.9	29.0
0.2	1.000	-1.5	1.575	-1.3	.005	96.9	.686	179.2	-0.09	3.9	25.0
0.5	0.998	-3.6	1.569	-2.9	.012	87.2	.687	177.8	0.06	3.9	21.2
1.0	0.997	-7.4	1.565	-6.1	.022	87.9	.685	175.9	0.02	3.9	18.5
2.0	0.998	-14.7	1.562	-12.0	.043	82.0	.684	171.3	0.01	3.9	15.6
3.0	0.998	-21.6	1.558	-17.8	.066	79.8	.685	167.5	-0.01	3.8	13.7
4.0	0.993	-28.3	1.550	-23.6	.087	75.1	.680	164.0	0.03	3.8	12.5
5.0	0.990	-34.8	1.525	-28.9	.110	71.7	.678	159.7	0.02	3.7	11.4
6.0	0.982	-41.3	1.518	-34.4	.132	67.0	.680	156.3	0.06	3.6	10.6
7.0	0.966	-48.0	1.472	-39.7	.155	61.7	.677	153.1	0.11	3.4	9.8
8.0	0.964	-54.4	1.463	-46.0	.172	57.8	.680	149.6	0.13	3.3	9.3
9.0	0.961	-59.9	1.395	-52.0	.193	55.0	.684	145.7	0.13	2.9	8.6
10.0	0.961	-65.9	1.401	-56.2	.220	51.0	.690	140.6	0.10	2.9	8.0
12.0	0.974	-76.3	1.376	-65.7	.268	40.8	.700	128.7	0.07	2.8	7.1
14.0	0.990	-86.5	1.378	-75.6	.319	28.9	.696	116.0	0.07	2.8	6.3
16.0	0.998	-97.1	1.383	-85.8	.364	17.1	.651	104.3	0.10	2.8	5.8
18.0	0.985	-107.9	1.350	-96.1	.417	6.0	.612	95.2	0.17	2.6	5.1
20.0	0.982	-119.1	1.273	-104.0	.448	-2.0	.582	87.1	0.15	2.1	4.5
22.0	0.995	-129.7	1.173	-112.5	.485	-11.7	.582	74.2	0.08	1.4	3.8
24.0	1.056	-140.0	1.121	-122.6	.513	-18.5	.611	61.8	-0.07	1.0	3.4
26.0	1.132	-150.8	1.118	-135.6	.537	-27.8	.606	48.3	-0.18	1.0	3.2
26.5	1.123	-153.5	1.119	-139.9	.539	-30.6	.584	45.2	-0.15	1.0	3.2

See notes on back page.

NE33200 LINEAR MODEL

SCHEMATIC



BIAS DEPENDENT MODEL PARAMETERS

Parameters	2 V, 10 mA	2 V, 20 mA
g	73 mS	96 mS
t	2.5 pSec	3.5 pSec
RDS	220 ohms	160 ohms

UNITS

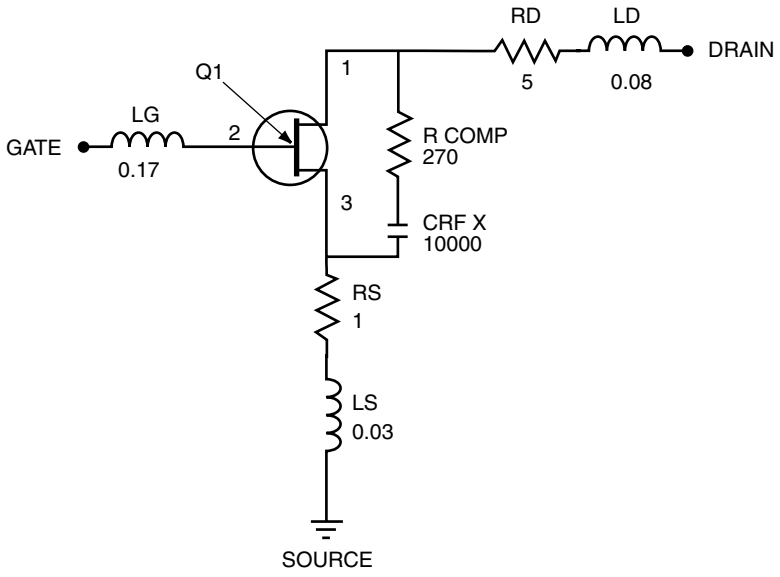
Parameter	Units
capacitance	picofarads
inductance	nanohenries
resistance	ohms
conductance	millisiemans

MODEL RANGE

Frequency: 0.1 to 26.5 GHz
Bias: V_{DS} = 2 V, I_D = 10, 20 mA
Date: 7/19/96

NE33200 NONLINEAR MODEL

SCHEMATIC



FET NONLINEAR MODEL PARAMETERS (1)

Parameters	Q1	Parameters	Q1
BETA	0.0989	CGD	0
VTO	-0.6	KF	0
ALPHA	8	AF	1
LAMBDA	0.2	TNOM	27
THETA[2]	0	XTI	3
TAU	4e-12	EG	1.43
VBR	Infinity	VTOTC	0
IS	8e-14	BETATCE	0
N	1	FFE	1
VBI	1		
FC	0.5		
RC	Infinity		
CRF	0		
RD	0		
RG	0		
RS	0		
RIN	0		
CGSO[3]	0.4e-12		
CGDO[4]	0.05e-12		
DELTA1	0.3		
DELTA2[5]	0.5		
CDS	0.16e-12		
CGS	0		

(1) Series IV Libra TOM Model
The parameter in Libra corresponds to the parameter in PSpice:

(2) THETA	B
(3) CGSO	CGS
(4) CGDO	CGD
(5) DELTA2	VDELTA

UNITS

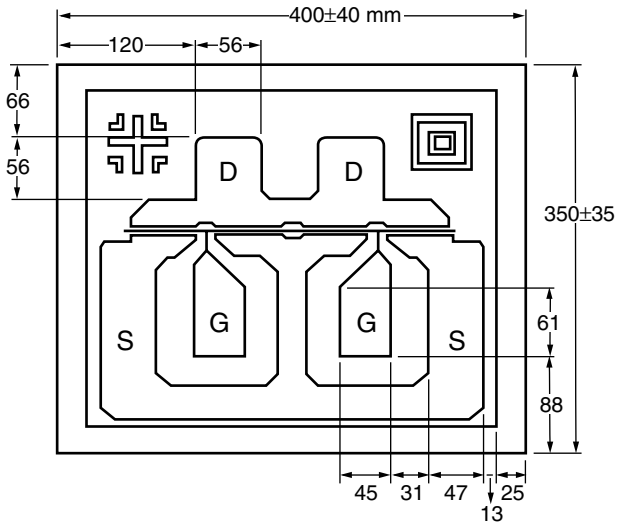
Parameter	Units
capacitance	picofarads
inductance	nanohenries
resistance	ohms

MODEL RANGE

Frequency: 0.1 to 10 GHz
Bias: V_{DS} = 2 V, I_D = 10 mA to 20 mA
Date: 8/6/96

CHIP DIMENSIONS (Units in µm)

NE33200 (CHIP)



Chip Thickness: 140 µm typical
Note: All dimensions are typical unless otherwise specified

ORDERING INFORMATION

PART NUMBER	IDSS RANGE (mA)
NE33200	Standard (15 - 80)
NE33200N	15 - 50
NE33200M	50 - 80

Notes:
1. S-Parameters include Bond Wires:
   Gate: Total 2 wires, 1 per bond pad 0.0129" (327 µm) long, each wire.
   Drain: Total 2 wires, 1 per bond pad 0.0118" (300 µm) long, each wire.
   Source: Total 4 wires, 2 per side, 0.0071" (180 µm) each wire.
   Wire: 0.0007" (17.8 µm) dia. gold.

2. Gain Calculations:

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

MAG = Maximum Available gain
MSG = Maximum Stable Gain