NEC

ULTRA LOW NOISE PSEUDOMORPHIC HJ FET

NE32400

FEATURES

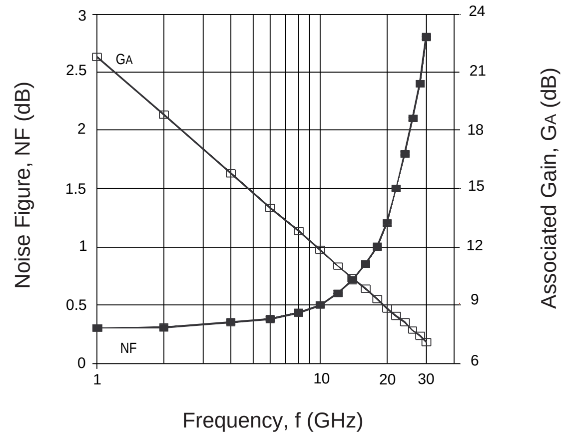
- **VERY LOW NOISE FIGURE:**
  NF = 0.6 dB typical at f = 12 GHz
- **HIGH ASSOCIATED GAIN:**
  G_A = 11.0 dB typical at f = 12 GHz
- **L_G = 0.25 µm, W_G = 200 µm**

DESCRIPTION

The NE32400 is a pseudomorphic 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. This device features mushroom shaped TiAl gates for decreased gate resistance and improved power handling capabilities. The mushroom gate results in lower noise figure and high associated gain for consumer and industrial applications.

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

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



ELECTRICAL CHARACTERISTICS (T_A = 25°C)

PART NUMBER PACKAGE OUTLINE			NE32400 00 (CHIP)		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
NF_{OPT}[1]	Optimum Noise Figure at V_{DS} = 2 V, I_{DS} = 10 mA f = 4 GHz f = 12 GHz	 dB dB		 0.35 0.6	 0.7
G_A[1]	Associated Gain at V_{DS} = 2 V, I_{DS} = 10 mA f = 4 GHz f = 12 GHz	 dB dB	 10.0	 16.0 11.0	
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		 9.5 11.0	
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 at V_{DS} = 2 V, V_{GS} = 0 V	mA	15	40	70
V_P	Pinch-Off Voltage at V_{DS} = 2 V, I_{DS} = 100 µA	V	-2.0	-0.8	-0.2
g_m	Transconductance at V_{DS} = 2 V, I_{DS} = 10 mA	mS	45	60	
I_{GSO}	Gate to Source Leakage Current at V_{GS} = -3 V	µA		0.5	10
$R_{TH\ (CH-C)}$[2]	Thermal Resistance (Channel-to-Case)	°C/W			260

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_{GSO}	Gate to Source Voltage	V	-3.0
I_{DS}	Drain Current	mA	I_{DSS}
I_{GRF}	Gate Current	µA	200
T_{CH}	Channel Temperature	°C	175
T_{STG}	Storage Temperature	°C	-65 to +175
P_T[2]	Total Power Dissipation	mW	200

Notes:
1. Operation in excess of any one of these parameters may result in permanent damage.
2. With chip mounted on an alumina heat sink (size: 3 x 3 x 0.6 mm thick)

TYPICAL NOISE PARAMETERS[1,2] (T_A = 25°C)

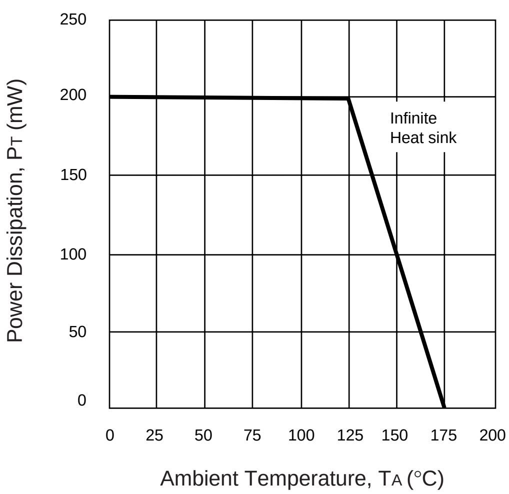
V_{DS} = 2 V, I_{DS} = 10 mA

FREQ. (GHz)	NF_{OPT} (dB)	GA (dB)	Γ_{OPT} MAG	ANG	Rn/50
1	0.30	22.0	0.81	10	0.39
2	0.31	19.0	0.79	17	0.36
4	0.35	16.0	0.75	31	0.33
6	0.38	14.2	0.72	45	0.30
8	0.43	12.9	0.70	59	0.27
10	0.50	12.0	0.68	77	0.24
12	0.60	11.0	0.66	92	0.22
14	0.71	10.6	0.64	108	0.19
16	0.85	10.0	0.62	126	0.18
18	1.0	9.5	0.58	140	0.15
20	1.2	9.0	0.55	153	0.13
22	1.5	8.6	0.52	164	0.11
24	1.8	8.3	0.49	175	0.10
26	2.1	7.9	0.48	-176	0.08
28	2.4	7.6	0.46	-168	0.07
30	2.8	7.3	0.46	-160	0.05

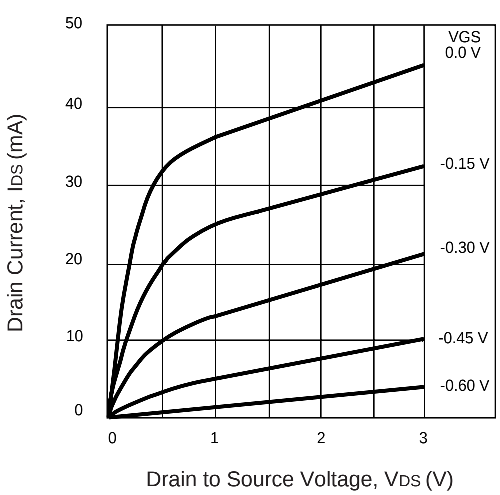
Notes:
1. Noise Parameters include Bond Wires.
   Gate: Total 2 wires, 1 per bond pad 0.0132" (335 µm) long each wire.
   Drain: Total 2 wires, 1 per bond pad 0.0094" (240 µm) long each wire.
   Source: Total 4 wires, 2 per side, 0.0070" (178 µm) long each wire.
   Wire: 0.0007" (17.8 µm) dia. gold.
2. Data at 28 and 30 GHz is extrapolated, not measured.

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

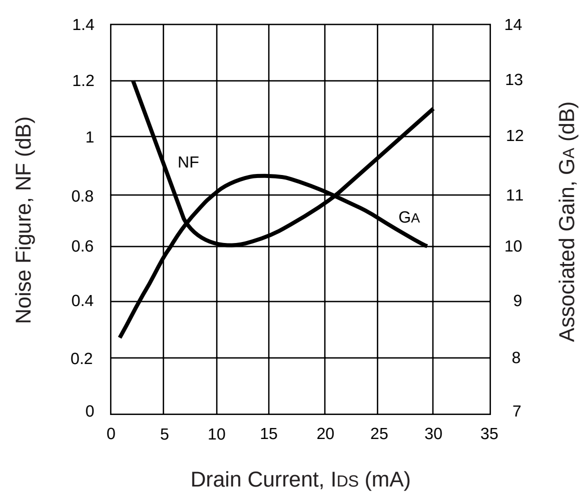
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



DRAIN CURRENT vs. DRAIN TO SOURCE VOLTAGE

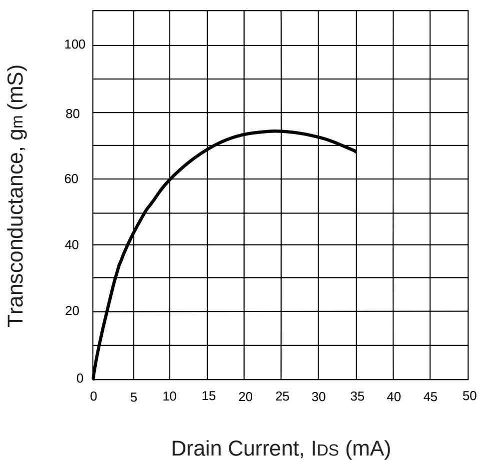


NOISE FIGURE & ASSOCIATED GAIN vs. DRAIN CURRENT VDS = 2 V, f = 12 GHz



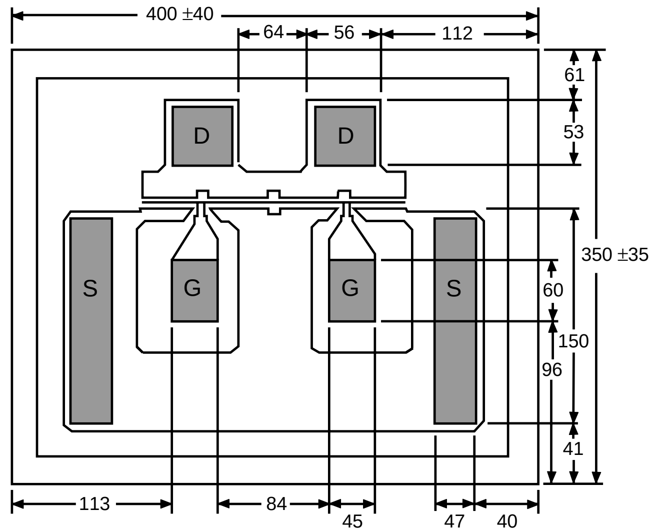
TYPICAL PERFORMANCE CURVES (T_A = 25°C)

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



OUTLINE DIMENSIONS (Units in µm)

NE32400 CHIP

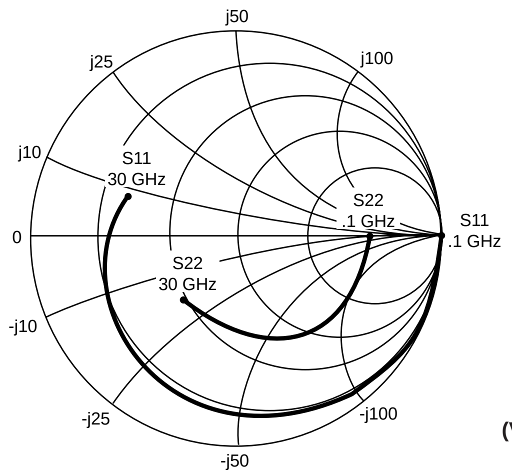


Chip Thickness: 140 µm
Note: All dimensions are typical unless otherwise specified.

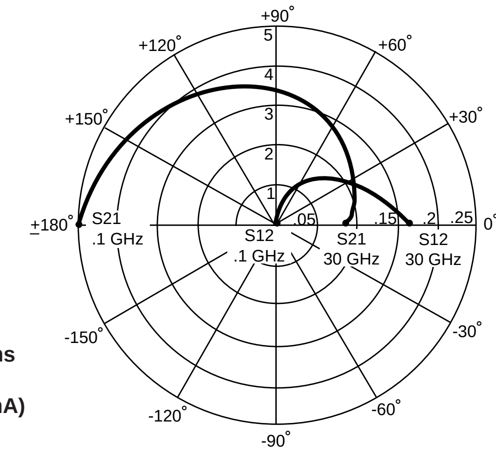
ORDERING INFORMATION

PART NUMBER	IDSS Range (mA)
NE32400	15-70 mA
NE32400N	15-45 mA
NE32400M	45-70 mA

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



Coordinates in Ohms
Frequency in GHz
(V_{DS} = 2 V, I_{DS} = 10 mA)



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	.999	-1.3	5.039	179.0	.002	89.2	.617	-0.7	.05	14.0	34.1
0.2	.999	-2.5	5.021	178.0	.004	88.6	.617	-1.4	.03	14.0	31.4
0.5	.999	-6.1	4.966	175.1	.008	86.7	.617	-4.2	.01	13.9	27.7
1.0	.997	-11.9	4.876	170.4	.016	83.6	.617	-8.4	.01	13.8	24.9
2.0	.989	-23.1	4.702	161.2	.030	77.3	.614	-15.4	.04	13.4	22.0
3.0	.978	-33.7	4.535	152.3	.042	70.9	.611	-22.4	.07	13.1	20.4
4.0	.967	-43.7	4.375	143.8	.052	64.7	.606	-29.4	.09	12.8	19.2
5.0	.947	-53.1	4.222	135.6	.062	58.8	.600	-36.0	.12	12.5	18.3
6.0	.927	-62.2	4.075	127.8	.071	53.1	.593	-41.2	.16	12.2	17.6
7.0	.909	-70.8	3.933	120.2	.079	47.8	.585	-46.1	.20	11.9	17.0
8.0	.891	-79.0	3.797	112.8	.086	42.9	.576	-51.0	.23	11.6	16.4
9.0	.873	-86.8	3.666	105.8	.092	38.3	.567	-55.8	.26	11.3	16.0
10.0	.856	-94.3	3.540	98.9	.099	34.2	.557	-60.5	.29	11.0	15.5
11.0	.838	-101.5	3.418	92.3	.104	30.4	.547	-65.1	.32	10.7	15.1
12.0	.820	-108.4	3.301	86.0	.109	26.9	.536	-69.6	.35	10.4	14.8
13.0	.803	-115.0	3.188	79.8	.114	23.8	.525	-73.9	.37	10.1	14.4
14.0	.786	-121.4	3.079	73.8	.119	20.9	.514	-78.2	.40	9.8	14.1
15.0	.769	-127.5	2.973	68.1	.123	18.4	.503	-82.4	.43	9.5	13.8
16.0	.753	-133.5	2.871	62.5	.127	16.1	.492	-86.6	.45	9.2	13.5
17.0	.736	-139.2	2.773	57.1	.131	14.0	.481	-90.6	.48	8.8	13.2
18.0	.721	-144.7	2.677	51.8	.135	12.1	.470	-94.5	.51	8.5	13.0
19.0	.705	-150.1	2.585	46.7	.138	10.4	.460	-98.3	.54	8.2	12.7
20.0	.691	-155.3	2.495	41.7	.142	8.9	.450	-102.0	.57	7.9	12.5
22.0	.662	-165.2	2.324	32.3	.148	6.3	.433	-109.1	.64	7.3	12.0
24.0	.635	-174.6	2.163	23.3	.153	4.2	.419	-115.9	.71	6.7	11.5
26.0	.610	176.5	2.011	14.8	.159	2.4	.410	-122.3	.76	6.1	11.0
28.0	.587	168.1	1.867	6.8	.163	1.0	.406	-128.3	.85	5.4	10.6
30.0	.565	160.0	1.732	0.8	.168	0.1	.407	-133.9	.92	4.8	10.1

Notes:
1. S Parameters include Bond Wires.
   Gate: Total 2 wire(s), 1 per bond pad 0.0132" (335 μm) long each wire.
   Drain: Total 2 wire(s), 1 per bond pad 0.0094" (240 μm) long each wire.
   Source: Total 4 wire(s), 2 per side, 0.0070" (178 μm) long 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 ≤ 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

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

V_{DS} = 2 V, I_{DS} = 20 mA

FREQUENCY (GHz)	S_{11} MAG	S_{11} ANG	S_{21} MAG	S_{21} ANG	S_{12} MAG	S_{12} ANG	S_{22} MAG	S_{22} ANG	K	$\|S_{21}\|$ (dB)	MAG[2] (dB)
0.1	.999	-1.4	6.161	178.9	.002	89.3	.554	-0.6	.007	15.8	35.6
0.2	.999	-2.7	6.156	177.8	.003	88.6	.553	-1.5	.01	15.8	32.8
0.5	.998	-6.7	6.121	174.5	.006	86.5	.550	-3.7	.03	15.7	29.9
1.0	.995	-13.2	6.030	169.2	.013	83.2	.545	-7.4	.06	15.6	26.6
2.0	.982	-25.6	5.811	159.3	.027	76.8	.535	-15.5	.09	15.3	23.4
3.0	.965	-37.1	5.579	149.9	.039	70.7	.525	-22.9	.13	14.9	21.6
4.0	.945	-47.9	5.345	141.0	.049	65.0	.516	-30.3	.16	14.6	20.4
5.0	.923	-58.1	5.120	132.6	.058	59.7	.507	-37.7	.19	14.2	19.5
6.0	.900	-67.6	4.902	124.6	.066	54.7	.498	-42.2	.23	13.8	18.7
7.0	.878	-76.5	4.692	117.0	.073	50.0	.489	-47.2	.27	13.4	18.1
8.0	.856	-84.9	4.493	109.7	.079	45.7	.481	-52.1	.31	13.0	17.6
9.0	.835	-92.8	4.303	102.8	.085	41.7	.473	-56.8	.34	12.7	17.1
10.0	.816	-100.2	4.122	96.1	.090	38.0	.465	-61.4	.37	12.3	16.6
11.0	.797	-107.3	3.951	89.7	.095	34.6	.457	-65.9	.40	11.9	16.2
12.0	.780	-113.9	3.788	83.6	.099	31.4	.450	-70.3	.43	11.6	15.8
13.0	.764	-120.3	3.634	77.7	.103	28.6	.443	-74.5	.46	11.2	15.5
14.0	.749	-126.3	3.488	72.0	.107	26.0	.436	-78.6	.48	10.8	15.1
15.0	.734	-132.1	3.350	66.5	.111	23.6	.429	-82.7	.51	10.5	14.8
16.0	.720	-137.7	3.219	61.1	.115	21.5	.423	-86.6	.54	10.1	14.5
17.0	.706	-143.1	3.095	56.0	.119	19.6	.417	-90.4	.56	9.8	14.2
18.0	.692	-148.2	2.977	51.0	.123	17.9	.411	-94.1	.59	9.5	13.8
19.0	.679	-153.3	2.865	46.2	.126	16.4	.405	-97.8	.61	9.1	13.6
20.0	.665	-158.2	2.759	41.5	.130	15.1	.399	-101.3	.64	8.8	13.3
22.0	.637	-167.7	2.562	32.5	.138	12.8	.389	-108.1	.70	8.2	12.7
24.0	.609	-176.9	2.384	23.9	.147	11.1	.380	-114.6	.75	7.5	12.1
26.0	.583	174.1	2.222	15.7	.157	9.6	.370	-120.8	.80	6.9	11.5
28.0	.562	165.2	2.076	7.7	.167	8.4	.362	-126.7	.84	6.3	10.9
30.0	.552	156.4	1.942	0.0	.180	7.1	.354	-132.2	.86	5.7	10.3

Notes:

1. S Parameters include Bond Wires.
   Gate: Total 2 wire(s), 1 per bond pad 0.0132" (335 µm) long each wire.
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   Source: Total 4 wire(s), 2 per side, 0.0070" (178 µm) long each wire.
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MAG = Maximum Available Gain
MSG = Maximum Stable Gain