

**NOT RECOMMENDED FOR NEW DESIGN**

### FEATURES

- **VERY LOW NOISE FIGURE:**  
0.5 dB typical at 12 GHz
- **HIGH ASSOCIATED GAIN:**  
11.5 dB Typical at 12 GHz
- **L<sub>G</sub> = 0.20 μm, W<sub>G</sub> = 200 μm**
- **LOW COST METAL CERAMIC PACKAGE**
- **TAPE & REEL PACKAGING OPTION AVAILABLE**

### DESCRIPTION

The NE32684A is a pseudomorphic Hetero-Junction FET that uses the junction between Si-doped AlGaAs and undoped InGaAs to create very high mobility electrons. The device features mushroom shaped TiAl gates for decreased gate resistance and improved power handling capabilities. The mushroom gate also results in lower noise figure and high associated gain. This device is housed in an epoxy-sealed, metal/ceramic package and is intended for high volume consumer and industrial applications.

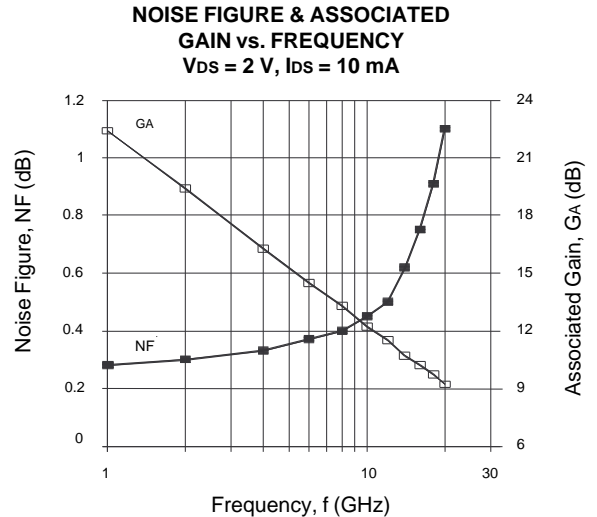
NEC's stringent quality assurance and test procedures assure the highest reliability and performance.

### ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C)

PART NUMBER PACKAGE OUTLINE			NE32684A 84AS		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
NF <sup>1</sup>	Optimum Noise Figure, V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 10 mA, f = 12 GHz	dB		0.5	0.6
GA <sup>1</sup>	Associated Gain, V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 10 mA, f = 12 GHz	dB	10.0	11.5	
P <sub>1dB</sub>	Output Power at 1 dB Gain Compression Point, f = 12 GHz V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 10 mA V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 20 mA	dBm dBm		8.5 10.75	
G <sub>1dB</sub>	Gain at P <sub>1dB</sub> , f = 12 GHz, V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 10 mA V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 20 mA	dB dB		11.0 11.5	
I <sub>DSS</sub>	Saturated Drain Current, V <sub>DS</sub> = 2 V, V <sub>GS</sub> = 0 V	mA	15	40	70
V <sub>P</sub>	Pinch-off Voltage, V <sub>DS</sub> = 2 V, I <sub>DS</sub> = 100 μA	V	-2.0	-0.8	-0.2
g <sub>m</sub>	Transconductance, V <sub>DS</sub> = 2 V, I <sub>D</sub> = 10 mA	mS	45	60	
I <sub>GSO</sub>	Gate to Source Leakage Current, V <sub>GS</sub> = -3 V	μA		0.5	10.0
R <sub>TH</sub> (CH-A)	Thermal Resistance (Channel to Ambient)	°C/W		750	
R <sub>TH</sub> (CH-C)	Thermal Resistance (Channel to Case)	°C/W			350

Note:

1. Typical values of noise figures and associated gain 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 tuned for the "generic" type but not for each specimen.



**ABSOLUTE MAXIMUM RATINGS<sup>1</sup>** (T<sub>A</sub> = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>DS</sub>	Drain to Source Voltage	V	4.0
V <sub>GS</sub>	Gate to Source Voltage	V	-3.0
I <sub>DS</sub>	Drain Current	mA	I <sub>DSS</sub>
I <sub>GRF</sub>	Gate Current	μA	200
T <sub>CH</sub>	Channel Temperature	°C	150
T <sub>STG</sub>	Storage Temperature	°C	-65 to +150
P <sub>T</sub>	Total Power Dissipation	mW	165

Note:

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

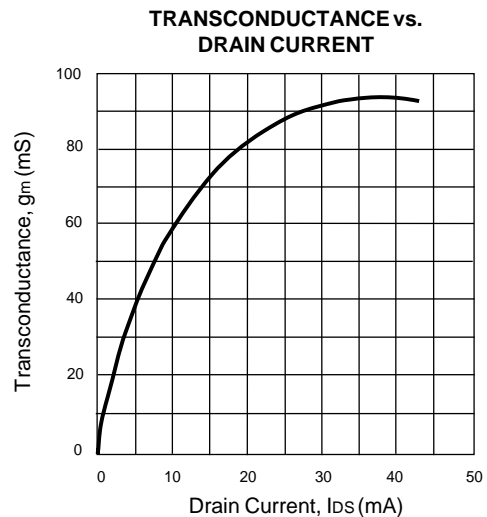
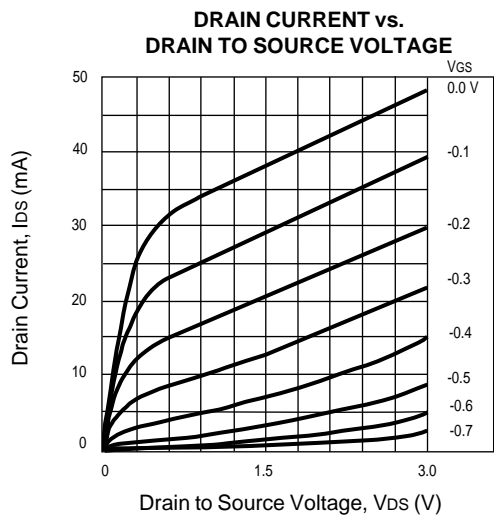
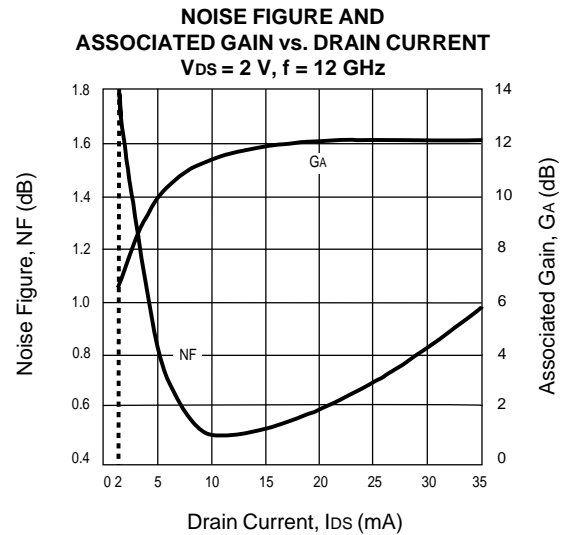
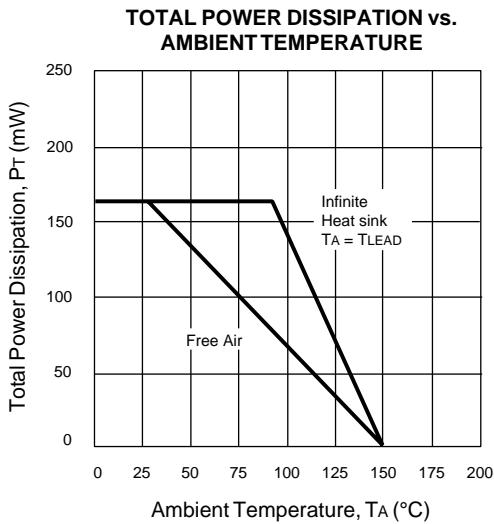
**TYPICAL NOISE PARAMETERS** (T<sub>A</sub> = 25°C)

FREQ. (GHz)	NF <sub>OPT</sub> (dB)	G <sub>A</sub> (dB)	Γ <sub>OPT</sub>		R <sub>n</sub> /50
			MAG	ANG	
1	0.28	22.4	.90	17	0.45
2	0.30	19.4	.85	32	0.37
4	0.33	16.3	.72	64	0.27
6	0.37	14.5	.62	91	0.21
8	0.40	13.3	.54	116	0.15
10	0.45	12.2	.48	138	0.10
12	0.50	11.5	.42	164	0.07
14	0.62	10.7	.38	-169	0.07
16	0.75	10.2	.34	-139	0.08
18	0.91	9.7	.34	-101	0.09
20 <sup>1</sup>	1.10	9.2	.38	-77	0.10

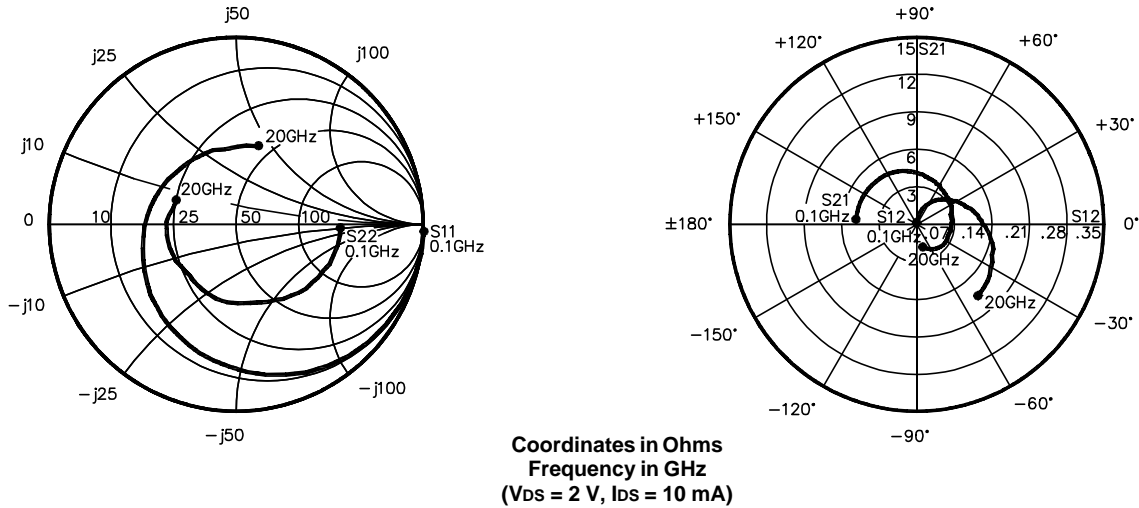
Note:

1. Data at 20 GHz is extrapolated, not measured.

**TYPICAL PERFORMANCE CURVES** (T<sub>A</sub> = 25°C)



**TYPICAL COMMON SOURCE SCATTERING PARAMETERS** (TA = 25°C)



**NE32684A**  
**Vds = 2 V, Ids = 10 mA**

FREQUENCY GHz	S11		S21		S12		S22		K	S21 (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
0.1	0.999	-2.0	4.879	178.4	0.002	88.8	0.555	-1.9	0.06	13.8	33.9
0.2	0.999	-3.6	4.872	176.7	0.003	88.1	0.554	-2.8	0.04	13.7	32.1
0.5	0.999	-9.0	4.859	171.5	0.008	85.9	0.556	-6.0	0.01	13.7	27.8
1.0	0.991	-17.6	4.796	162.2	0.015	77.7	0.552	-12.0	0.13	13.6	25.0
2.0	0.960	-33.9	4.750	146.0	0.029	70.4	0.541	-23.1	0.24	13.5	22.1
3.0	0.922	-49.4	4.618	130.4	0.042	60.0	0.520	-33.0	0.36	13.3	20.4
4.0	0.873	-64.5	4.370	115.8	0.054	52.4	0.505	-42.8	0.45	12.8	19.1
5.0	0.816	-79.0	4.179	101.5	0.062	45.2	0.478	-52.5	0.57	12.4	18.3
6.0	0.758	-92.9	3.962	87.9	0.070	38.9	0.454	-62.2	0.68	12.0	17.5
7.0	0.712	-106.0	3.720	74.7	0.077	32.5	0.437	-71.8	0.76	11.4	16.8
8.0	0.667	-117.2	3.527	63.3	0.084	27.9	0.425	-79.7	0.83	10.9	16.2
9.0	0.629	-128.8	3.348	51.3	0.090	22.7	0.421	-88.7	0.88	10.5	15.7
10.0	0.592	-140.1	3.218	39.9	0.095	18.5	0.418	-96.8	0.92	10.1	15.3
11.0	0.549	-152.4	3.104	28.3	0.103	13.5	0.410	-105.2	0.96	9.8	14.8
12.0	0.513	-165.5	2.994	17.1	0.110	8.1	0.396	-114.2	0.99	9.5	14.3
13.0	0.487	-179.2	2.901	5.8	0.115	3.4	0.382	-123.2	1.02	9.2	13.1
14.0	0.464	168.1	2.825	-4.5	0.121	-1.2	0.368	-132.4	1.03	9.0	12.5
15.0	0.443	154.0	2.763	-16.3	0.130	-7.7	0.369	-143.0	1.01	8.8	12.6
16.0	0.423	139.4	2.707	-27.6	0.138	-13.9	0.373	-154.5	0.99	8.6	12.9
17.0	0.415	123.9	2.638	-40.1	0.144	-22.2	0.374	-166.2	0.98	8.4	12.6
18.0	0.414	107.4	2.614	-52.5	0.152	-30.1	0.371	-176.5	0.95	8.3	12.3
19.0	0.413	89.2	2.581	-65.4	0.161	-38.6	0.360	171.9	0.93	8.2	12.0
20.0	0.432	74.1	2.528	-78.0	0.167	-49.2	0.341	158.7	0.91	8.1	11.8

Note:

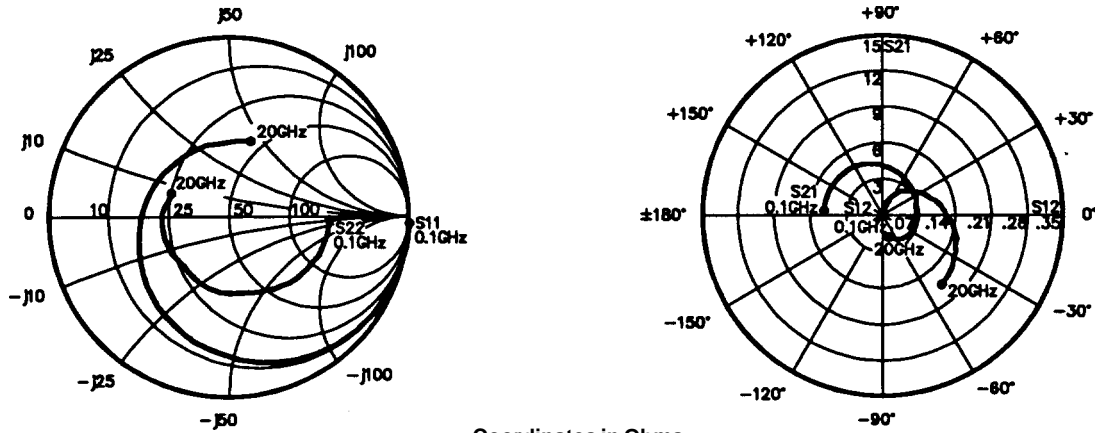
1. Gain Calculations:

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

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL COMMON SOURCE SCATTERING PARAMETERS (TA = 25°C)



Coordinates in Ohms  
Frequency in GHz  
(Vds = 2 V, Id = 20 mA)

NE32684A

Vds = 2 V, Id = 20 mA

FREQUENCY GHz	S11		S21		S12		S22		K	S21 (dB)	MAG <sup>1</sup> (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG			
0.1	0.999	-2.3	6.403	178.0	0.002	88.9	0.480	-2.0	0.06	16.1	35.0
0.2	0.999	-4.0	6.366	176.1	0.003	88.6	0.480	-2.9	0.04	16.1	33.3
0.5	0.998	-9.6	6.384	170.6	0.007	87.6	0.480	-5.9	0.03	16.1	29.6
1.0	0.986	-18.9	6.298	161.0	0.014	77.6	0.476	-11.5	0.17	16.0	26.5
2.0	0.948	-36.2	6.108	143.6	0.026	72.2	0.467	-22.0	0.30	15.7	23.7
3.0	0.894	-52.3	5.792	127.1	0.038	62.0	0.449	-31.2	0.46	15.3	21.8
4.0	0.833	-67.8	5.404	112.1	0.049	55.8	0.436	-40.4	0.56	14.6	20.4
5.0	0.766	-82.1	5.063	97.6	0.058	49.4	0.413	-49.2	0.68	14.1	19.4
6.0	0.703	-95.8	4.713	84.3	0.067	44.1	0.394	-58.3	0.77	13.5	18.5
7.0	0.653	-108.6	4.385	71.3	0.074	38.3	0.382	-67.4	0.85	12.8	17.7
8.0	0.607	-119.6	4.112	59.8	0.082	33.8	0.374	-74.9	0.90	12.3	17.0
9.0	0.569	-130.6	3.861	48.6	0.090	28.3	0.375	-83.3	0.93	11.7	16.3
10.0	0.529	-141.4	3.686	37.5	0.097	23.4	0.378	-90.8	0.96	11.3	15.8
11.0	0.487	-153.2	3.517	26.0	0.107	18.4	0.374	-99.4	0.98	10.9	15.2
12.0	0.554	-166.0	3.376	14.8	0.114	11.8	0.365	-108.0	1.00	10.7	14.4
13.0	0.428	-179.3	3.262	4.1	0.121	6.3	0.354	-116.8	1.01	10.3	13.6
14.0	0.407	167.8	3.165	-5.9	0.130	0.6	0.341	-125.5	1.01	10.0	13.3
15.0	0.387	154.5	3.081	-17.3	0.138	-5.4	0.345	-136.6	0.99	9.8	13.5
16.0	0.368	139.9	3.007	-27.9	0.146	-13.5	0.352	-148.4	0.97	9.6	13.1
17.0	0.359	124.4	2.934	-40.2	0.154	-21.6	0.353	-160.0	0.96	9.3	12.8
18.0	0.358	107.6	2.910	-52.3	0.160	-30.1	0.349	-170.6	0.94	9.3	12.6
19.0	0.361	89.4	2.865	-65.4	0.169	-39.1	0.337	-177.9	0.92	9.1	12.3
20.0	0.379	73.7	2.812	-77.8	0.174	-49.0	0.319	165.2	0.91	9.0	12.1

Note:

1. Gain Calculation:

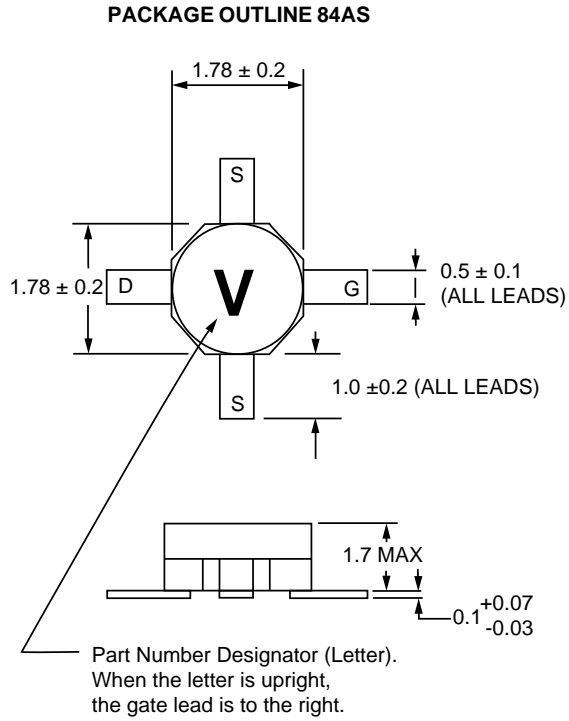
$$MAG = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right). \text{ When } K \leq 1, \text{ MAG is undefined and MSG values are used. } MSG = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12}| |S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

# NE32684A

## OUTLINE DIMENSIONS (Units in mm)



## ORDERING INFORMATION

PART NUMBER	AVAILABILITY	PACKAGE OUTLINE
NE32684AS	Bulk up to 1K	84AS
NE32684A-T1	1K/Reel	84AS

**Note:**

Long leaded (1.7 mm min.) 84A package available upon request in bulk quantities up to 1000 pcs. To order specify NE32684A-SL.

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