

# HETERO JUNCTION FIELD EFFECT TRANSISTOR

## NE32500, NE27200

### C to Ka BAND SUPER LOW NOISE AMPLIFIER N-CHANNEL HJ-FET CHIP

#### DESCRIPTION

NE32500 and NE27200 are Hetero Junction FET chip that utilizes the hetero junction between Si-doped AlGaAs and undoped InGaAs to create high mobility electrons. Its excellent low noise and high associated gain make it suitable for commercial systems, industrial and space applications.

#### FEATURES

- Super Low Noise Figure & High Associated Gain  
NF = 0.45 dB TYP.,  $G_a = 12.5$  dB TYP. at  $f = 12$  GHz
- Gate Length:  $L_g = 0.2 \mu\text{m}$
- Gate Width :  $W_g = 200 \mu\text{m}$

#### ORDERING INFORMATION

PART NUMBER	QUALITY GRADE
NE32500	Standard (Grade D)
NE27200	Special, specific (Grade C and B)

#### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ )

Drain to Source Voltage	$V_{DS}$	4.0	V
Gate to Source Voltage	$V_{GS}$	-3.0	V
Drain Current	$I_D$	$I_{DSS}$	mA
Total Power Dissipation	$P_{tot}^*$	200	mW
Channel Temperature	$T_{ch}$	175	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-65 to +175	$^\circ\text{C}$

\* Chip mounted on a Alumina heatsink (size:  $3 \times 3 \times 0.6^t$ )

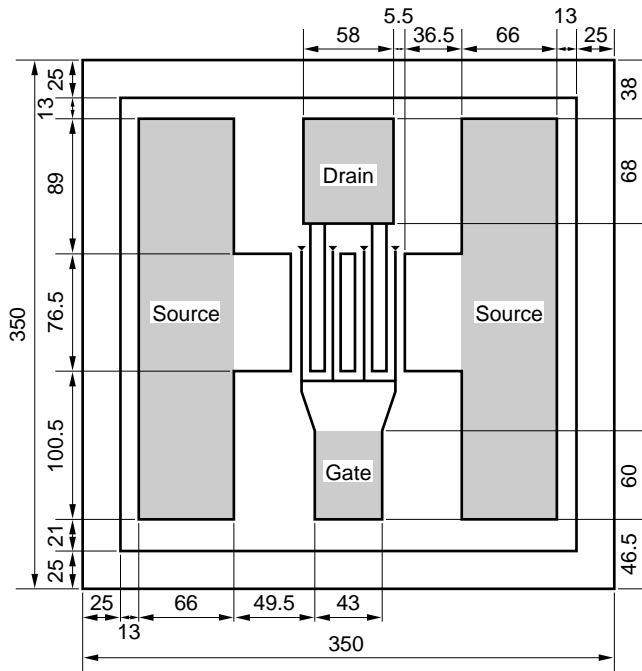
#### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ )

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Gate to Source Leak Current	$I_{GSO}$	-	0.5	10	$\mu\text{A}$	$V_{GS} = -3$ V
Saturated Drain Current	$I_{DSS}$	20	60	90	mA	$V_{DS} = 2$ V, $V_{GS} = 0$ V
Gate to Source Cutoff Voltage	$V_{GS(off)}$	-0.2	-0.7	-2.0	V	$V_{DS} = 2$ V, $I_D = 100 \mu\text{A}$
Transconductance	$g_m$	45	60	-	mS	$V_{DS} = 2$ V, $I_D = 10$ mA
Thermal Resistance	$R_{th}^*$	-	-	260	$^\circ\text{C}/\text{W}$	channel to case
Noise Figure	NF	-	0.45	0.55	dB	$V_{DS} = 2$ V, $I_D = 10$ mA, $f = 12$ GHz
Associated Gain	$G_a$	11.0	12.5	-	dB	

RF performance is determined by packaging and testing 10 chips per wafer.

Wafer rejection criteria for standard devices is 2 rejects per 10 samples.

CHIP DIMENSIONS (Unit:  $\mu\text{m}$ )

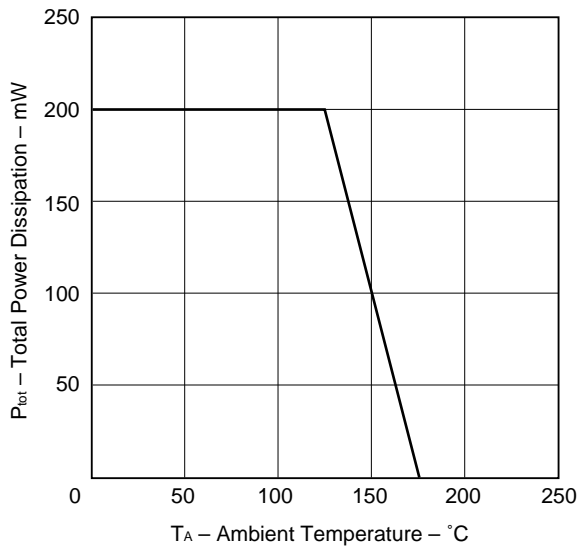


Thickness = 140  $\mu\text{m}$

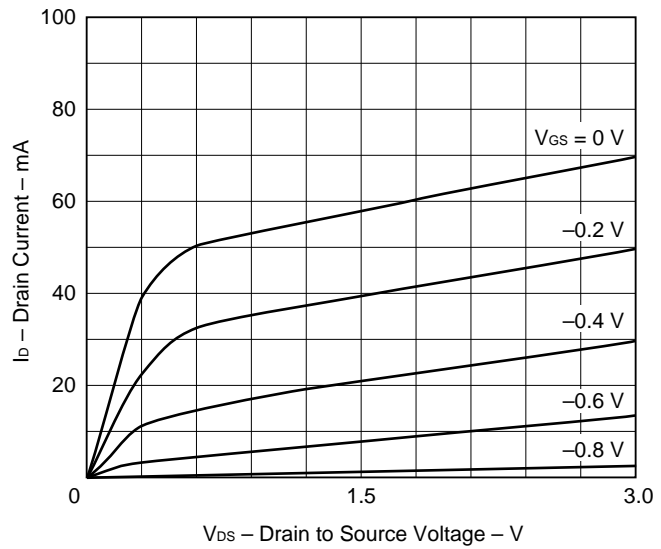
■ : BONDING AREA

TYPICAL CHARACTERISTICS ( $T_A = 25\text{ }^\circ\text{C}$ )

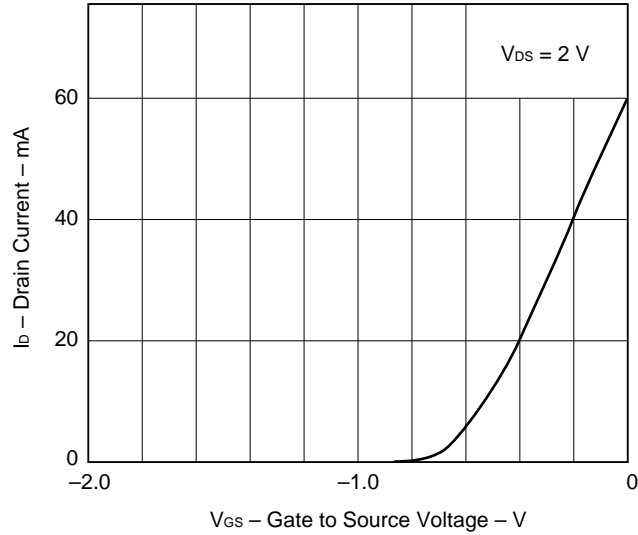
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



DRAIN CURRENT vs. DRAIN TO SOURCE VOLTAGE



DRAIN CURRENT vs. GATE TO SOURCE VOLTAGE



Gain Calculations

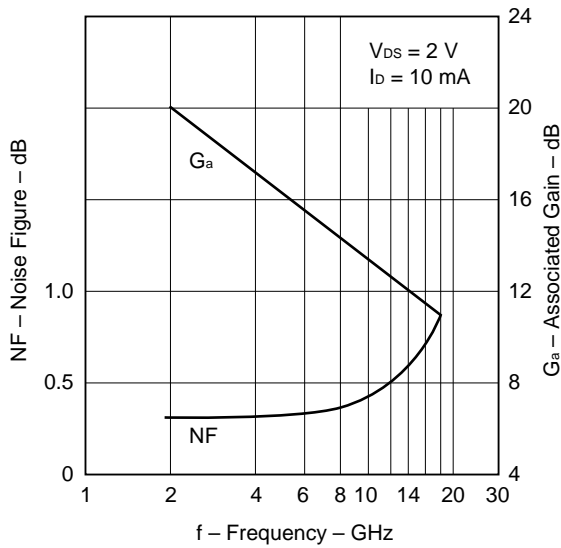
$$MSG. = \frac{|S_{21}|}{|S_{12}|}$$

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

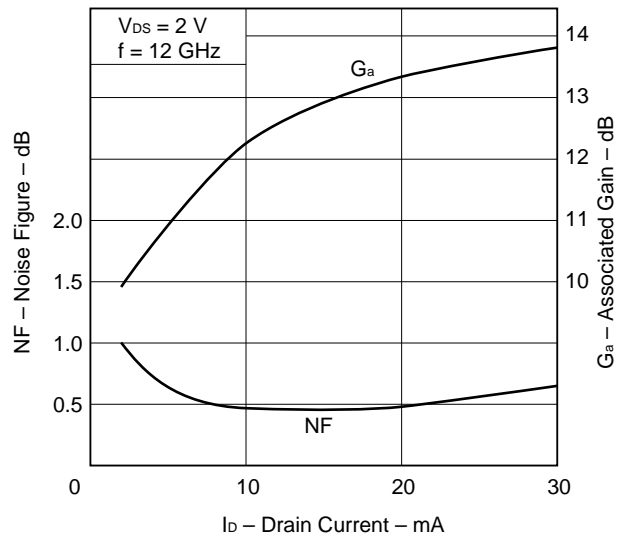
$$MAG. = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1})$$

$$\Delta = S_{11} \cdot S_{22} - S_{21} \cdot S_{12}$$

NOISE FIGURE, ASSOCIATED GAIN vs. FREQUENCY



NOISE FIGURE, ASSOCIATED GAIN vs. DRAIN CURRENT



**S-PARAMETERS MAG. AND ANG.**

$V_{DS} = 2\text{ V}$ ,  $I_D = 10\text{ mA}$

FREQUENCY (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)	MAG.	ANG. (deg.)
500	0.999	-4	4.34	177	0.006	82	0.564	-3
1000	0.998	-7	4.33	174	0.012	84	0.562	-6
2000	0.996	-14	4.28	168	0.025	81	0.559	-11
3000	0.992	-20	4.26	163	0.037	76	0.557	-17
4000	0.976	-28	4.24	158	0.048	71	0.551	-23
5000	0.962	-36	4.11	152	0.060	66	0.546	-29
6000	0.962	-42	4.06	148	0.070	62	0.539	-34
7000	0.943	-48	3.95	143	0.079	58	0.533	-40
8000	0.928	-55	3.83	139	0.087	55	0.526	-44
9000	0.920	-60	3.73	134	0.095	51	0.519	-49
10000	0.900	-67	3.58	129	0.104	47	0.508	-54
11000	0.881	-72	3.46	126	0.109	43	0.503	-58
12000	0.869	-77	3.34	122	0.114	40	0.494	-62
13000	0.856	-82	3.23	118	0.120	37	0.488	-66
14000	0.839	-86	3.11	115	0.123	34	0.483	-69
15000	0.831	-91	3.01	112	0.127	32	0.476	-72
16000	0.818	-96	2.88	108	0.131	29	0.472	-76
17000	0.804	-99	2.78	105	0.134	27	0.468	-79
18000	0.796	-103	2.68	103	0.137	24	0.464	-81
19000	0.784	-106	2.59	100	0.141	22	0.460	-84
20000	0.782	-111	2.49	96	0.142	20	0.456	-88
21000	0.772	-114	2.42	95	0.144	19	0.457	-90
22000	0.761	-117	2.33	93	0.147	17	0.450	-92
23000	0.758	-119	2.25	90	0.147	15	0.454	-94
24000	0.753	-122	2.20	88	0.148	14	0.453	-95
25000	0.748	-125	2.11	86	0.150	12	0.453	-98
26000	0.746	-127	2.06	84	0.152	11	0.460	-100
27000	0.750	-129	2.01	82	0.154	9	0.453	-101
28000	0.738	-133	1.93	79	0.151	7	0.453	-104
29000	0.744	-135	1.90	77	0.153	7	0.453	-105
30000	0.742	-138	1.84	75	0.156	4	0.454	-107

## CHIP HANDLING

### DIE ATTACHMENT

Die attach operation can be accomplished with Au-Sn (within a 300 °C – 10 s) performs in a forming gas environment.

Epoxy die attach is not recommend.

### BONDING

Bonding wires should be minimum length, semi hard gold wire (3-8 % elongation) 20 microns in diameter.

Bonding should be performed with a wedge tip that has a taper of approximately 15 %. Bonding time should be kept to minimum.

As a general rule, the bonding operation should be kept within a 280 °C, 2 minutes for all bonding wires.

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. In fact, all test and handling equipment should be grounded to minimize the possibilities of static discharge.

Avoid high static voltage and electric fields, because this device is Hetero Junction field effect transistor with shottky barrier gate.

## CAUTION

**The Great Care must be taken in dealing with the devices in this guide.**

**The reason is that the material of the devices is GaAs (Gallium Arsenide), which is designated as harmful substance according to the law concerned.**

**Keep the law concerned and so on, especially in case of removal.**

[MEMO]

[MEMO]

No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Corporation. NEC Corporation assumes no responsibility for any errors which may appear in this document.

NEC Corporation does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from use of a device described herein or any other liability arising from use of such device. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Corporation or others.

While NEC Corporation has been making continuous effort to enhance the reliability of its semiconductor devices, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC semiconductor device, customers must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.

NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.