



T-31-25

# ULTRA LOW NOISE K-BAND HETRO JUNCTION FET

**NE32100**  
**NE32183A**  
**NE32184A**

## FEATURES

- **SUPER LOW NOISE FIGURE:**  
NF = 1.0 dB TYP at f = 12 GHz
- **HIGH ASSOCIATED GAIN:**  
GA = 10.5 dB TYP at f = 12 GHz
- **GATE LENGTH:**  $L_g = 0.3 \mu\text{m}$
- **GATE WIDTH:**  $W_g = 200 \mu\text{m}$

## DESCRIPTION

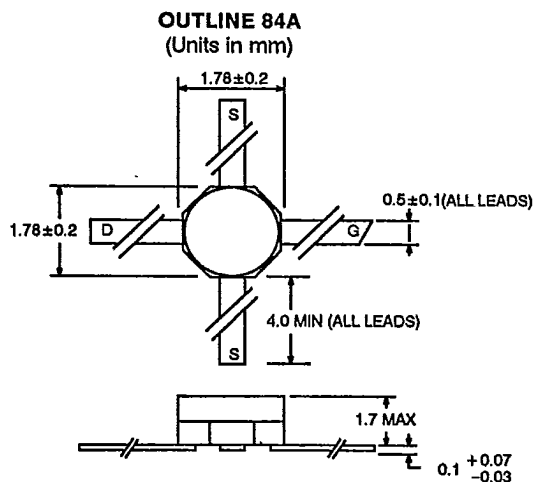
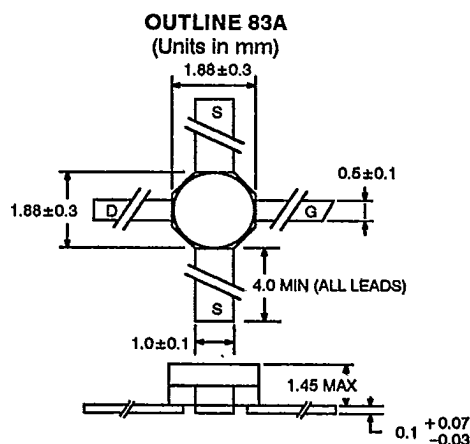
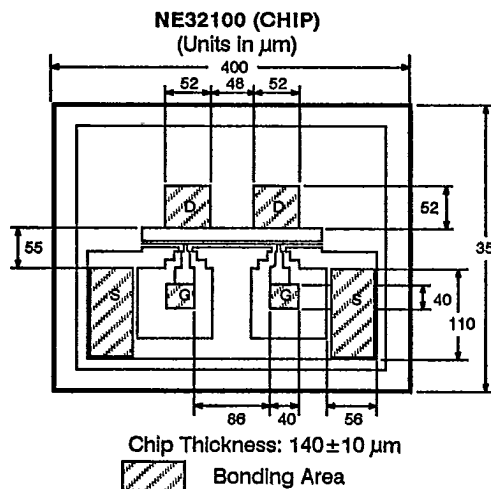
The NE321 is a Hetero-Junction FET that utilizes the junction between Si-doped AlGaAs and undoped GaAs to create a two-dimensional electron gas layer which has higher electron mobility than conventional GaAs MESFETs. The device features mushroom shaped TlAl gates for decreased gate resistance and improved power handling capabilities. The mushroom gate results in lower noise figure and high associated gain for satellite communications, narrow and broadband amplifiers (for military and commercial uses) as well as high volume consumer applications.

The surface of the device, except for the bonding pads, is passivated with layers of SiO<sub>2</sub> and SiN<sub>4</sub> for scratch protection as well as surface stability.

The NE321 device is available in chip form (00), a solder sealed hermetic, metal/ceramic package (83A) and an epoxy sealed metal/ceramic package (84A).

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

## OUTLINE DIMENSIONS



## ABSOLUTE MAXIMUM RATINGS (TA = 25°C)

SYMBOLS	PARAMETERS	UNITS	RATINGS
V <sub>DS</sub>	Drain to Source Voltage	V	4.0
V <sub>GS0</sub>	Gate to Source Voltage	V	-3.0
V <sub>GD0</sub>	Gate to Drain Voltage	V	-3.0
I <sub>DS</sub>	Drain Current	mA	60
T <sub>CH</sub>	Channel Temperature	°C	175
	NE32100	°C	175
	NE32183A	°C	175
	NE32184A	°C	150
T <sub>STG</sub>	Storage Temperature	°C	-65 to +175
	NE32100	°C	-65 to +175
	NE32183A	°C	-65 to +175
	NE32184A	°C	-65 to +150

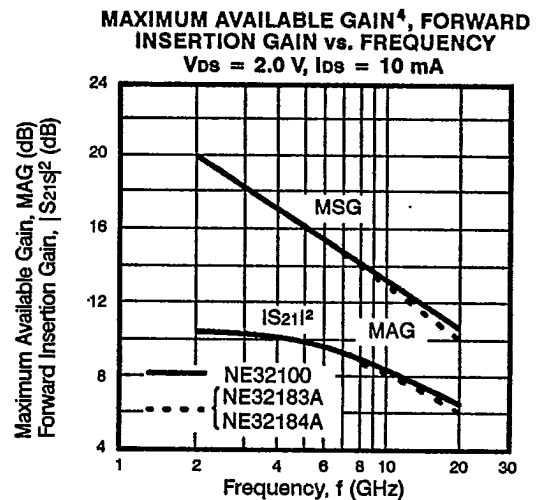
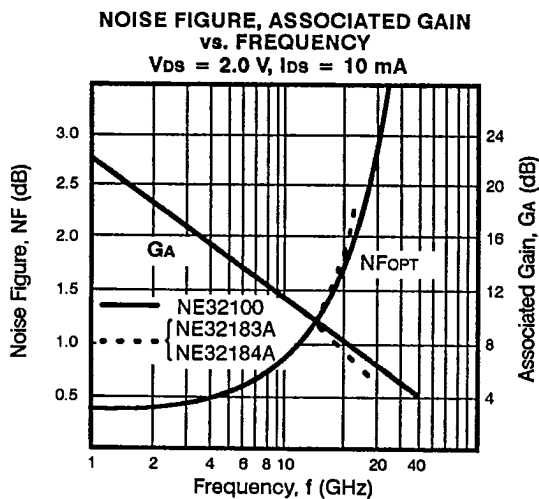
9000-1911

California Eastern Laboratories

**ELECTRICAL CHARACTERISTICS** (TA = 25°C)

PART NUMBER PACKAGE OUTLINE			NE32100 <sup>3</sup> 00 (CHIP)			NE32183A 83A			NE32184A 84A		
SYMBOLS	CHARACTERISTICS	UNITS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
I <sub>gso</sub>	Gate to Source Leak Current, V <sub>gs</sub> = -3 V	μA		1	10		1	10		1	10
I <sub>ds</sub>	Saturated Drain Current, V <sub>ds</sub> = 2 V, V <sub>gs</sub> = 0	mA	12	30	60	12	30	60	12	30	60
V <sub>gs (off)</sub>	Gate to Source Cutoff Voltage V <sub>ds</sub> = 2 V, I <sub>d</sub> = 100 μA	V	-2.0	-1.0	-0.2	-2.0	-1.0	-0.2	-2.0	-1.0	-0.2
g <sub>m</sub>	Transconductance, V <sub>ds</sub> = 2 V, I <sub>d</sub> = 10 mA	mS	30	40		30	40		25	40	
N <sub>F OPT</sub> <sup>2</sup>	Optimum Noise Figure, f = 12 GHz, V <sub>ds</sub> = 2 V, I <sub>ds</sub> = 10 mA	dB		1.0	1.2		1.0	1.2		1.0	1.2
GA	Associated Gain, f = 12 GHz, V <sub>ds</sub> = 2 V, I <sub>ds</sub> = 10 mA	dB	9.5	10.5		9.5	10.5		9.5	10.5	
P <sub>1dB</sub>	Output Power @ 1 dB Gain Compression V <sub>ds</sub> = 2.0 V, I <sub>ds</sub> = 10 mA, f = 12 GHz V <sub>ds</sub> = 2.0 V, I <sub>ds</sub> = 20 mA, f = 12 GHz	dBm dBm		9.0 10.5			9.0 10.5			9.0 10.5	
R <sub>TH</sub>	Thermal Resistance (Channel to Ambient)	°C/W			380 <sup>1</sup>			750			750
P <sub>T</sub>	Total Power Dissipation	mW			200			200			165

**TYPICAL PERFORMANCE CURVES** (TA = 25°C)



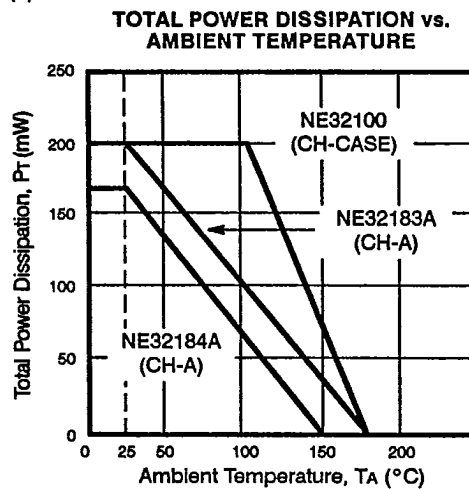
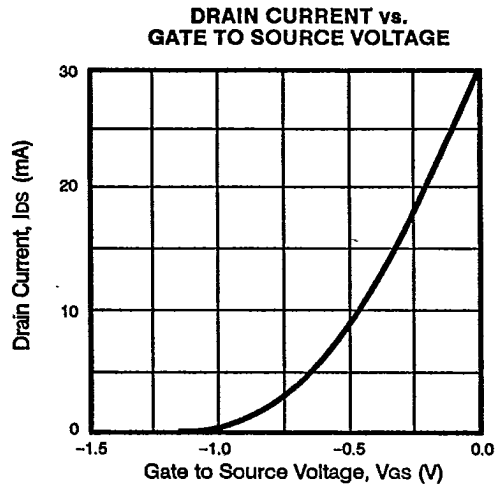
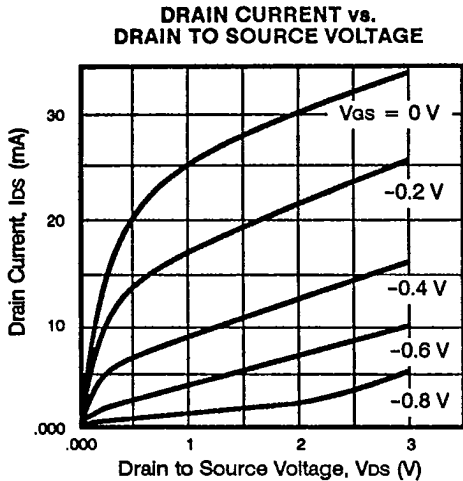
**Notes:**

1. R<sub>TH</sub> is (channel to case) for chips mounted on an infinite heat sink.
2. Typical values of noise figures 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.
3. RF performance is determined by packaging and testing 10 samples per wafer; wafer rejection criteria for standard devices is 2 rejects for 10 samples.
4. Gain Calculations:  $MAG = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1})$ . 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 PERFORMANCE CURVES** (TA = 25°C) (continued)



**TYPICAL NOISE PARAMETERS** (TA = 25°C)

V<sub>DS</sub> = 2.0 V, I<sub>DS</sub> = 10 mA

**NE32100**

FREQ. (GHz)	NF <sub>OPT</sub> (dB)	G <sub>A</sub> (dB)	Γ <sub>OPT</sub>		Rn/50
			MAG	ANG	
1	0.35	22.0	0.83	10	0.75
2	0.37	18.0	0.82	23	0.65
4	0.40	16.0	0.80	40	0.57
6	0.60	14.0	0.77	63	0.50
8	0.65	12.5	0.73	68	0.45
10	0.82	11.5	0.67	84	0.42
12	1.00	10.5	0.60	103	0.38
14	1.20	9.8	0.55	116	0.32
16	1.35	9.2	0.52	126	0.25
18	1.55	8.8	0.49	137	0.20
20	1.76	8.1	0.47	146	0.16
22	1.90	7.6	0.45	158	0.12
24	2.10	7.2	0.44	170	0.10
26	2.35	7.0	0.43	-176	0.09
28	2.60	6.5	0.44	-164	0.08
30	2.82	6.2	0.45	-153	0.08

- Notes:**
- Noise Parameters include Bond Wires:  
 Gate: Total 2 wires, 1 per bond pad 0.0126" (321 μm) long each wire.  
 Drain: Total 2 wires, 1 per bond pad 0.0116" (292 μm) long each wire.  
 Source: Total 4 wires, 2 per side, 0.0076" (194 μm) long each wire.  
 Wire: 0.0007" (17.8 μm) dia. gold.
  - Data at 28 and 30 GHz is estimated.

**NE32183A**

FREQ. (GHz)	NF <sub>OPT</sub> (dB)	G <sub>A</sub> (dB)	Γ <sub>OPT</sub>		Rn/50
			MAG	ANG	
1	0.35	22.0	0.80	9	0.65
2	0.37	19.0	0.72	29	0.51
4	0.40	16.0	0.71	62	0.36
6	0.50	14.0	0.67	89	0.27
8	0.65	12.5	0.62	108	0.15
10	0.82	11.5	0.59	137	0.11
12	1.00	10.5	0.55	156	0.07
14	1.20	9.8	0.48	175	0.06
16	1.35	9.2	0.42	-169	0.05
18	1.60	8.5	0.35	-142	0.04

**NE32184A**

FREQ. (GHz)	NF <sub>OPT</sub> (dB)	G <sub>A</sub> (dB)	Γ <sub>OPT</sub>		Rn/50
			MAG	ANG	
1	0.35	22.0	0.82	9	0.65
2	0.37	19.0	0.80	26	0.50
4	0.40	16.0	0.78	52	0.33
6	0.50	14.0	0.71	80	0.24
8	0.65	12.5	0.65	106	0.20
10	0.82	11.5	0.67	138	0.12
12	1.00	10.5	0.62	171	0.09
14	1.25	9.8	0.51	-134	0.08
16	1.40	9.2	0.52	-103	0.07
18	1.65	8.5	0.56	-77	0.06

TYPICAL SCATTERING PARAMETERS

NE32100<sup>1</sup>

V<sub>DS</sub> = 2 V, I<sub>DS</sub> = 10 mA

FREQ (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
100	.999	-1	3.48	178	.001	89	.63	0	0.15	34.0
200	.999	-2	3.48	178	.003	88	.63	-1	0.07	30.6
500	.999	-5	3.48	175	.009	87	.62	-4	0.02	26.1
1000	.998	-11	3.46	170	.017	83	.62	-7	0.04	23.2
2000	.988	-21	3.36	162	.032	76	.62	-14	0.09	20.2
3000	.976	-30	3.26	153	.046	70	.61	-20	0.13	18.5
4000	.958	-39	3.15	146	.059	64	.61	-26	0.19	17.3
5000	.945	-46	3.06	139	.071	60	.60	-31	0.21	16.4
6000	.932	-54	2.98	132	.083	55	.60	-36	0.23	15.6
7000	.919	-61	2.94	126	.093	50	.59	-40	0.25	15.0
8000	.908	-69	2.92	119	.104	47	.59	-45	0.24	14.5
9000	.886	-78	2.89	112	.115	42	.58	-52	0.26	14.0
10000	.864	-87	2.82	104	.126	37	.56	-58	0.29	13.5
11000	.841	-95	2.74	97	.134	31	.54	-65	0.32	13.1
12000	.821	-104	2.65	90	.141	26	.52	-71	0.35	12.7
13000	.805	-111	2.54	84	.148	20	.51	-77	0.39	12.3
14000	.795	-117	2.46	78	.148	16	.49	-82	0.42	12.2
15000	.779	-122	2.33	73	.153	12	.49	-85	0.46	11.8
16000	.776	-127	2.28	67	.152	8	.48	-89	0.48	11.7
17000	.764	-131	2.18	63	.153	5	.48	-91	0.52	11.5
18000	.752	-137	2.15	58	.150	4	.47	-92	0.56	11.6
19000	.730	-142	2.09	53	.147	1	.47	-93	0.64	11.5
20000	.712	-146	2.07	49	.147	2	.48	-93	0.66	11.5
21000	.701	-151	2.03	44	.157	1	.47	-96	0.65	11.1
22000	.702	-158	2.02	39	.156	2	.48	-100	0.61	11.1
23000	.686	-165	1.99	32	.169	-1	.48	-107	0.60	10.7
24000	.672	-174	1.91	27	.170	-7	.45	-113	0.66	10.5
25000	.655	-178	1.82	25	.167	-9	.43	-118	0.73	10.4
26000	.668	178	1.88	19	.183	-9	.42	-122	0.63	10.1

V<sub>DS</sub> = 2 V, I<sub>DS</sub> = 20 mA

FREQ (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
100	0.999	-1	4.24	178	.002	88	.57	-1	0.09	32.1
200	0.999	-2	4.24	178	.004	87	.57	-2	0.06	30.7
500	0.999	-6	4.23	175	.007	84	.57	-4	0.05	27.8
1000	0.996	-12	4.20	170	.015	81	.57	-9	0.05	24.5
2000	0.984	-23	4.07	160	.029	75	.57	-15	0.11	21.4
3000	0.971	-33	3.94	152	.042	70	.56	-21	0.15	19.7
4000	0.948	-42	3.78	144	.054	64	.55	-27	0.22	18.5
5000	0.931	-51	3.64	136	.064	60	.55	-31	0.24	17.6
6000	0.914	-59	3.52	130	.074	54	.54	-36	0.27	16.8
7000	0.897	-67	3.46	123	.083	50	.54	-42	0.29	16.2
8000	0.886	-75	3.42	116	.092	47	.53	-47	0.28	15.7
9000	0.861	-85	3.35	108	.102	42	.52	-53	0.31	15.2
10000	0.835	-94	3.24	101	.111	37	.50	-60	0.34	14.7
11000	0.813	-103	3.13	94	.116	32	.48	-66	0.38	14.3
12000	0.795	-112	2.99	87	.123	27	.46	-72	0.41	13.9
13000	0.779	-119	2.84	81	.128	22	.45	-78	0.45	13.5
14000	0.767	-125	2.73	76	.128	18	.44	-82	0.48	13.3
15000	0.759	-129	2.59	70	.130	15	.43	-86	0.51	13.0
16000	0.752	-134	2.52	65	.130	12	.43	-89	0.55	12.9
17000	0.737	-138	2.41	61	.132	10	.42	-91	0.60	12.6
18000	0.725	-143	2.35	56	.129	7	.42	-91	0.65	12.6
19000	0.703	-148	2.29	51	.127	7	.42	-91	0.72	12.5
20000	0.679	-153	2.26	47	.130	9	.43	-91	0.75	12.4
21000	0.673	-158	2.20	41	.141	9	.43	-94	0.72	11.9
22000	0.670	-165	2.18	37	.144	9	.45	-99	0.67	11.8
23000	0.662	-173	2.15	30	.156	5	.44	-106	0.65	11.4
24000	0.647	179	2.04	26	.155	0	.41	-113	0.73	11.2
25000	0.638	174	1.94	23	.154	-1	.39	-116	0.79	11.0
26000	0.655	171	2.01	18	.162	-1	.39	-121	0.69	10.9

Notes:

- S-Parameters include Bond Wires:  
 Gate: Total 2 wire(s), 1 per Bond Pad 0.0126" (321 μm) long each wire.  
 Drain: total 2 wire(s), 1 per Bond Pad 0.0115" (292 μm) long each wire.  
 Source: Total 4 wire(s), 2 per side, 0.0076" (194 μm) long each wire.  
 Wire: 0.0007" (17.8 μm) dia. gold.

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## TYPICAL SCATTERING PARAMETERS

NE32183A

V<sub>DS</sub> = 2 V, I<sub>DS</sub> = 10 mA

FREQ (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
100	.999	-1	3.23	179	.001	89	.61	-1	0.15	34.0
200	.999	-2	3.21	177	.003	88	.61	-2	0.08	30.3
500	.999	-8	3.22	172	.007	87	.61	-6	0.00	26.4
1000	.994	-16	3.20	164	.015	79	.61	-13	0.08	23.3
2000	.979	-32	3.15	148	.028	67	.61	-26	0.16	20.5
3000	.954	-47	3.07	133	.041	56	.60	-39	0.25	18.7
4000	.925	-63	2.94	118	.052	46	.59	-51	0.31	17.5
5000	.895	-77	2.82	103	.059	36	.58	-62	0.40	16.8
6000	.863	-91	2.69	89	.065	27	.57	-73	0.49	16.2
7000	.836	-103	2.53	76	.069	19	.57	-84	0.57	15.7
8000	.812	-115	2.38	64	.070	12	.57	-93	0.66	15.3
9000	.788	-125	2.25	53	.071	7	.58	-101	0.74	15.0
10000	.767	-135	2.16	42	.072	1	.58	-109	0.82	14.8
11000	.747	-146	2.11	31	.074	-4	.58	-117	0.88	14.6
12000	.728	-156	2.05	19	.075	-9	.58	-125	0.95	14.4
13000	.708	-166	1.99	8	.074	-12	.58	-132	1.03	13.2
14000	.690	-175	1.94	-2	.075	-16	.59	-139	1.07	12.5
15000	.673	176	1.92	-13	.077	-20	.60	-146	1.08	12.3
16000	.650	166	1.90	-24	.081	-25	.61	-152	1.08	11.9
17000	.619	156	1.89	-36	.087	-31	.61	-159	1.11	11.4
18000	.589	144	1.94	-47	.091	-37	.60	-166	1.11	11.3
19000	.563	131	1.99	-60	.097	-44	.59	-174	1.09	11.3
20000	.515	118	2.00	-74	.104	-55	.58	178	1.16	10.4

V<sub>DS</sub> = 2 V, I<sub>DS</sub> = 20 mA

FREQ (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
100	.999	-1	3.93	179	.001	89	.54	-1	0.14	34.8
200	.999	-3	3.92	177	.003	88	.54	-2	0.10	31.2
500	.999	-8	3.92	172	.007	83	.54	-6	0.04	27.6
1000	.993	-17	3.89	163	.014	79	.53	-13	0.11	24.5
2000	.972	-34	3.79	147	.026	68	.53	-26	0.21	21.6
3000	.941	-50	3.65	131	.037	58	.52	-38	0.31	19.9
4000	.908	-66	3.49	116	.047	48	.52	-50	0.39	18.7
5000	.870	-81	3.30	101	.054	39	.51	-62	0.50	17.8
6000	.834	-95	3.12	87	.059	31	.50	-72	0.60	17.2
7000	.802	-108	2.93	74	.063	24	.50	-82	0.69	16.6
8000	.773	-119	2.74	61	.066	19	.51	-91	0.79	16.2
9000	.747	-129	2.58	50	.068	14	.52	-99	0.87	15.8
10000	.725	-139	2.46	39	.071	9	.53	-106	0.92	15.4
11000	.700	-150	2.38	28	.074	4	.53	-114	0.98	15.1
12000	.679	-160	2.31	16	.076	-1	.53	-121	1.03	13.8
13000	.657	-170	2.23	5	.078	-6	.54	-129	1.09	12.8
14000	.640	-179	2.17	-5	.081	-9	.55	-135	1.10	12.4
15000	.619	172	2.13	-17	.085	-14	.56	-142	1.08	12.2
16000	.594	162	2.10	-28	.090	-21	.58	-148	1.07	12.0
17000	.562	152	2.08	-39	.096	-27	.58	-155	1.09	11.6
18000	.533	141	2.12	-51	.101	-35	.58	-162	1.08	11.5
19000	.501	127	2.15	-64	.108	-44	.58	-169	1.07	11.3
20000	.456	113	2.16	-78	.117	-54	.56	-177	1.10	10.7

NE32100, NE32183A, NE32184A

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## TYPICAL SCATTERING PARAMETERS

NE32184A

V<sub>DS</sub> = 2 V, I<sub>DS</sub> = 10 mA

FREQ (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
100	.999	-1	3.68	179	.001	89	.62	-1	0.12	34.2
200	.999	-2	3.68	177	.003	88	.62	-2	0.06	30.2
500	.999	-8	3.68	172	.010	85	.62	-6	0.02	25.6
1000	.991	-17	3.68	163	.019	78	.62	-12	0.12	22.9
2000	.969	-33	3.64	147	.037	68	.61	-23	0.19	19.9
3000	.939	-49	3.49	132	.054	57	.60	-34	0.27	18.1
4000	.895	-66	3.49	116	.069	47	.58	-45	0.36	17.1
5000	.839	-84	3.38	101	.081	37	.55	-56	0.46	16.2
6000	.782	-102	3.23	86	.092	27	.52	-67	0.56	15.5
7000	.728	-120	3.10	71	.099	17	.49	-78	0.65	15.0
8000	.686	-137	2.93	56	.103	9	.47	-87	0.73	14.5
9000	.648	-154	2.78	43	.106	1	.45	-96	0.81	14.2
10000	.618	-171	2.66	30	.111	-5	.44	-103	0.87	13.8
11000	.593	171	2.56	16	.113	-12	.41	-111	0.94	13.5
12000	.584	153	2.42	4	.114	-19	.38	-120	1.01	12.7
13000	.589	136	2.33	-9	.115	-25	.35	-129	1.05	11.8
14000	.598	121	2.22	-22	.116	-31	.34	-139	1.06	11.3
15000	.603	107	2.11	-34	.118	-38	.34	-148	1.09	10.7
16000	.609	94	2.02	-46	.120	-44	.32	-157	1.11	10.3
17000	.627	81	1.95	-58	.123	-52	.31	-166	1.10	10.1
18000	.653	67	1.91	-70	.125	-59	.29	-175	1.05	10.5

V<sub>DS</sub> = 2 V, I<sub>DS</sub> = 20 mA

FREQ (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>		K	MAG (dB)
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG		
100	.999	-1	4.41	179	.001	89	.591	-1	0.11	35.0
200	.999	-2	4.41	177	.003	88	.590	-2	0.07	31.7
500	.999	-8	4.40	172	.009	85	.588	-5	0.04	26.9
1000	.990	-16	4.40	163	.015	78	.585	-11	0.15	24.5
2000	.965	-34	4.37	147	.030	70	.574	-22	0.22	21.6
3000	.925	-51	4.26	131	.043	60	.558	-32	0.32	20.0
4000	.873	-67	4.10	115	.055	50	.539	-43	0.44	18.7
5000	.816	-84	3.94	100	.066	41	.515	-53	0.54	17.8
6000	.760	-101	3.77	85	.074	33	.490	-63	0.64	17.1
7000	.706	-117	3.57	70	.081	25	.467	-73	0.73	16.5
8000	.653	-133	3.34	57	.085	19	.450	-81	0.85	16.0
9000	.606	-148	3.15	44	.089	13	.437	-90	0.94	15.5
10000	.572	-164	3.01	32	.095	8	.423	-98	0.98	15.0
11000	.549	179	2.90	19	.099	1	.409	-107	1.01	14.0
12000	.534	161	2.79	6	.105	-5	.388	-116	1.04	13.1
13000	.527	145	2.64	-6	.107	-11	.372	-127	1.08	12.2
14000	.526	130	2.52	-18	.112	-16	.364	-136	1.08	11.8
15000	.533	116	2.43	-30	.116	-23	.360	-145	1.07	11.6
16000	.536	101	2.33	-43	.124	-30	.353	-156	1.04	11.5
17000	.546	87	2.26	-55	.129	-38	.344	-165	1.02	11.5
18000	.571	73	2.20	-68	.133	-48	.326	-177	1.00	12.2

EXCLUSIVE AGENT FOR NEC Corporation RF &amp; MICROWAVE SEMICONDUCTOR PRODUCTS—U.S. &amp; CANADA

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