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April 1st, 2010
Renesas Electronics Corporation

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RENESAS

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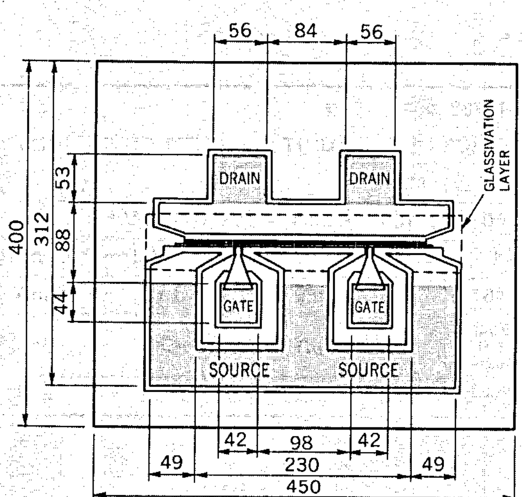
GaAs MES FET
NE137

LOW NOISE Ku-BAND GaAs FET
N-CHANNEL GaAs MES FET

PHYSICAL DIMENSIONS

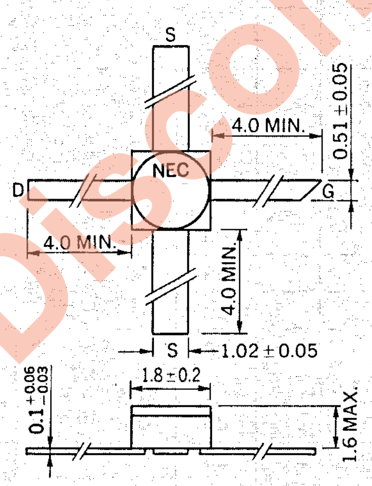
NE13700 (Chip) (Units in μm)



Bonding pad area. Chip Thickness : 140 μm

PACKAGE CODE-83

(Units in mm)



DESCRIPTION

The NE137 features exceptionally low noise figure and high associated gain through 18 GHz by employing a recessed 0.5 micron gate length. The device is available as a chip (NE13700) and in a hermetically sealed package (NE13783). The chip's gate and channel are glassivated with a thin layer of SiO_2 for mechanical protection. The NE13783 is a low cost packaged device for industrial and space applications. The NE13783-4 is selected for NF_{opt} performance at 4 GHz.

FEATURES

- Very high $f_{max.}$: 80 GHz
- Low noise figure :
  - NF 0.7 dB G_a 14.0 dB @f = 4.0 GHz
  - NF 1.2 dB G_a 11.0 dB @f = 8.0 GHz
  - NF 1.9 dB G_a 9.5 dB @f = 12.0 GHz
  - NF 2.5 dB G_a 7.5 dB @f = 18.0 GHz
- 0.5 μm recessed gate
- Proven reliability and stability

ORDERING INFORMATION

PART NUMBER	PACKAGE CODE
NE13700	00 (CHIP)
NE13783	83
NE13783-4	83

ABSOLUTE MAXIMUM RATINGS ($T_a = 25\,^\circ C$)

Drain to Source Voltage	V_{DS}	5.0	V	
Gate to Source Voltage	V_{GS}	-6.0	V	
Drain Current	I_{DS}	100	mA	
Total Power Dissipation	P_T	400 *1, *3	mW	(NE13700)
		270 *2	mW	(NE13783)
RF Input Power	P_{in}	40	mW	
Channel Temperature	T_{ch}	175	°C	
Storage Temperature	T_{stg}	-65 to +175	°C	

*1 $T_a = 100\,^\circ C$
*2 $T_a = 50\,^\circ C$
*3 R_{th} (channel to case) for chips mounted on a copper heatsink.

ELECTRICAL CHARACTERISTICS ($T_a = 25\,^\circ C$)

PART NUMBER		NE13700			NE13783			UNIT	TEST CONDITIONS
PACKAGE CODE		00 (CHIP)			83				
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
Saturated Drain Current	I_{DSS}	20	50	100	20	50	100	mA	$V_{DS} = 3$ V, $V_{GS} = 0$ V
Pinch-off Voltage	V_P	-0.5	-1.1	-6	-0.5	-1.1	-6	V	$V_{DS} = 3$ V, $I_{DS} = 0.1$ mA
Transconductance	g_m	20	45	100	20	45	100	mS	$V_{DS} = 3$ V, $I_{DS} = 10$ mA
Gate to Source Leakage Current	I_{GS}		1.0	10		1.0	10	µA	$V_{GS} = -5$ V
Thermal Resistance	R_{th}			190*3			450	°C/W	channel to case

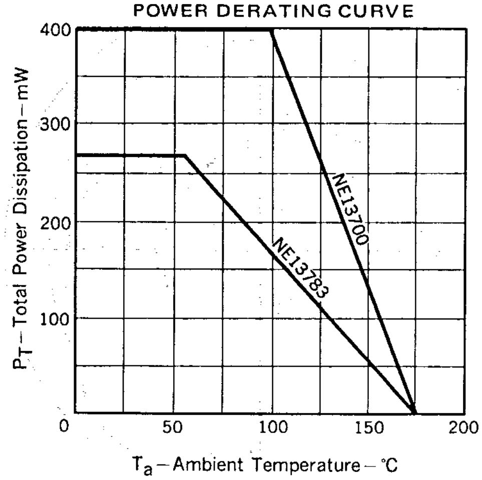
PERFORMANCE SPECIFICATIONS ($T_a = 25\,^\circ C$)

PART NUMBER		NE13700			NE13783			NE13783-4			UNIT	TEST CONDITIONS	
PACKAGE CODE		00 (CHIP)			83			83					
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.			
Maximum Frequency of Oscillation	$f_{max.}$		80			80			80		GHz	$V_{DS} = 3$ V, $I_{DS} = 30$ mA	
Maximum Available Gain *4	MAG		16			16			16		dB	$V_{DS} = 3$ V, $I_{DS} = 30$ mA	f = 8 GHz
			11			11			11		dB		f = 12 GHz
			8			8			8		dB		f = 18 GHz
Optimum Noise Figure	NF_{opt}		0.8			0.8			0.7	0.8	dB	$V_{DS} = 3$ V, $I_{DS} = 10$ mA	f = 4 GHz
			1.2			1.2			1.2		dB		f = 8 GHz
			1.9	2.3		1.9	2.3		1.9		dB		f = 12 GHz
			2.5								dB		f = 18 GHz
Associated Gain at Optimum Noise Figure	G_a		14.0			14.0			14.0		dB	$V_{DS} = 3$ V, $I_{DS} = 10$ mA	f = 4 GHz
			11.0			11.0			11.0		dB		f = 8 GHz
		8.0	9.5		8.0	9.0			9.0		dB		f = 12 GHz
			7.5								dB		f = 18 GHz
Output Power at 1 dB Gain Compression Point	$P_{O(1\,dB)}$		15.0			15.0			15.0		dBm	$V_{DS} = 3$ V, $I_{DS} = 20$ mA	

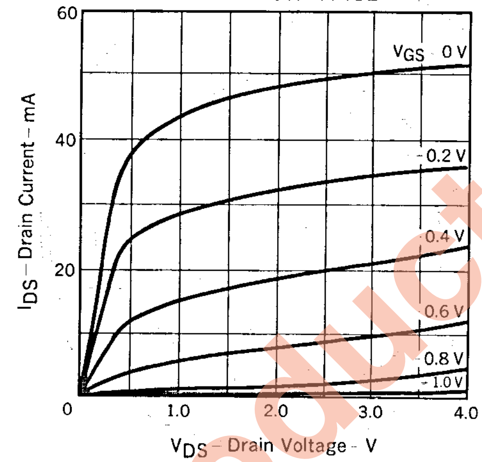
*4 Gain Calculations : $MAG = \frac{|S_{21}|}{|S_{12}|}(K \pm \sqrt{K^2 - 1})$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|}$, $\Delta = S_{11}S_{22} - S_{21}S_{12}$, $MSG = \frac{|S_{21}|}{|S_{12}|}$

DEVICE CHARACTERISTICS

POWER DERATING CURVE

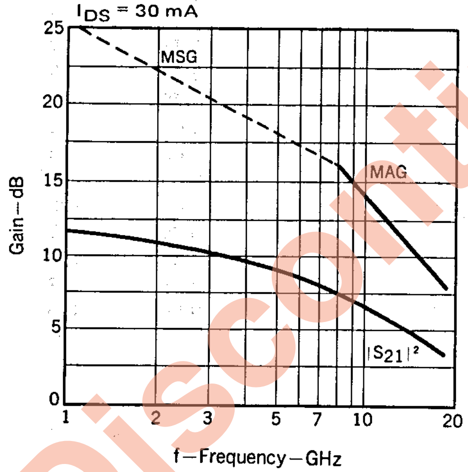


DC PERFORMANCE

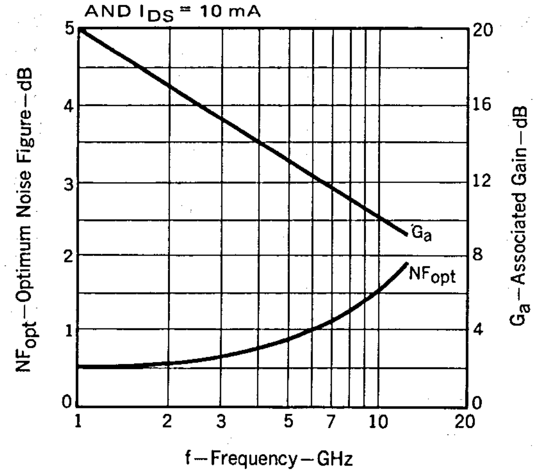


TYPICAL CHARACTERISTICS (T_a = 25 °C)

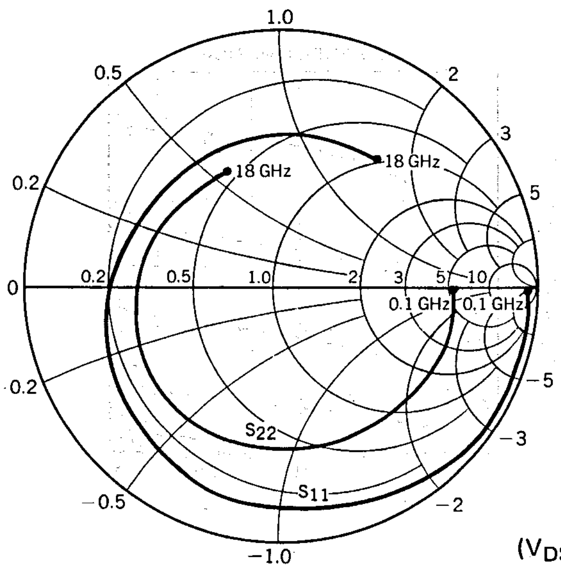
TYPICAL GAIN vs. FREQUENCY FOR THE NE13783 AT V_{DS} = 3 V AND I_{DS} = 30 mA

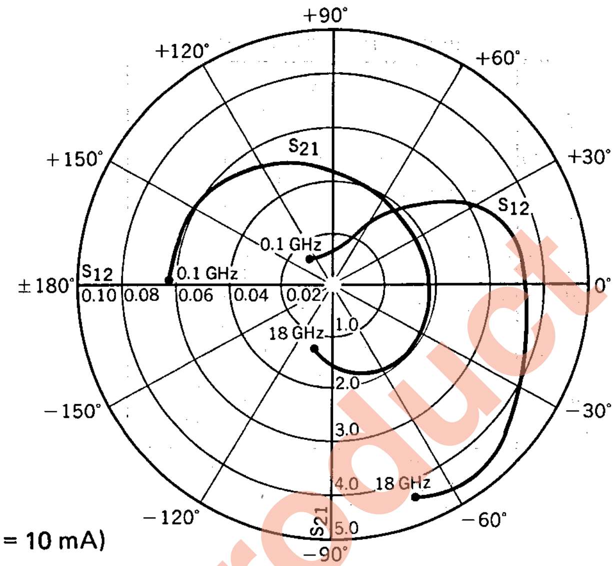


TYPICAL NOISE FIGURE AND ASSOCIATED GAIN vs. FREQUENCY FOR THE NE13783 AT V_{DS} = 3 V AND I_{DS} = 10 mA



NE13783 S-PARAMETERS





$(V_{DS} = 3\ V, I_{DS} = 10\ mA)$

S-MAGN AND ANGLES:

$V_{DS} = 3\ V, I_{DS} = 10\ mA$

frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	1.00	−3	3.07	176	0.01	134	0.74	−2
500	0.99	−11	3.14	167	0.01	76	0.74	−7
1000	0.99	−24	3.05	159	0.01	79	0.75	−17
1500	0.98	−35	2.97	147	0.02	60	0.74	−23
2000	0.97	−44	2.95	137	0.03	52	0.75	−32
4000	0.88	−76	2.40	108	0.06	33	0.66	−56
6000	0.84	−100	2.14	80	0.07	19	0.68	−76
8000	0.77	−124	1.93	54	0.07	6	0.66	−93
10000	0.68	−147	1.83	32	0.07	−4	0.63	−108
12000	0.58	180	1.83	1	0.07	−14	0.60	−125
14000	0.54	134	1.89	−28	0.08	−27	0.53	−150
16000	0.61	87	1.80	−63	0.09	−41	0.48	167
18000	0.65	49	1.36	−102	0.09	−68	0.50	109

$V_{DS} = 3\ V, I_{DS} = 30\ mA$

frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
100	1.00	−3	3.83	176	0.02	58	0.69	−3
500	0.99	−14	3.92	166	0.01	75	0.69	−6
1000	0.99	−25	3.80	158	0.01	76	0.70	−16
1500	0.97	−37	3.69	146	0.02	61	0.70	−23
2000	0.97	−48	3.64	135	0.02	64	0.70	−32
4000	0.89	−80	3.02	105	0.04	38	0.62	−55
6000	0.81	−103	2.62	78	0.05	25	0.63	−73
8000	0.73	−127	2.29	51	0.06	16	0.63	−90
10000	0.64	−148	2.15	29	0.06	11	0.61	−104
12000	0.52	178	2.10	−2	0.07	4	0.58	−119
14000	0.50	131	2.12	−32	0.09	−9	0.52	−141
16000	0.57	84	1.96	−66	0.11	−24	0.44	179
18000	0.64	46	1.48	−104	0.11	−54	0.44	118

CHIP HANDLING

DIE ATTACHMENT

Die attach can be accomplished with a Au-Sn (300±10 °C) preforms in a forming gas environment. Epoxy die attach is not recommended.

BONDING

Gate and drain bonding wires should be minimum length, semi-hard gold wire (3-8 % elongation) 20 microns or less in diameter.
Bonding should be performed with a wedge tip that has a taper of approximately 15 %. Die attach and bonding time should be kept to a minimum. As a general rule, the bonding operation should be kept within a 280 °C – 5 minute curve. 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.

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