

NPN SILICON RF TRANSISTOR NE661M04

NPN SILICON RF TRANSISTOR FOR LOW CURRENT, LOW NOISE, HIGH-GAIN AMPLIFICATION FLAT-LEAD 4-PIN THIN SUPER MINI-MOLD

FEATURES

- Low noise and high gain with low collector current
- $NF = 1.2 \text{ dB}$, $G_a = 16 \text{ dB TYP.}$ @ $f = 2 \text{ GHz}$, $V_{CE} = 2 \text{ V}$, $I_c = 2 \text{ mA}$
- Maximum stable power gain: $MSG = 22 \text{ dB TYP.}$ @ $f = 2 \text{ GHz}$, $V_{CE} = 2 \text{ V}$, $I_c = 5 \text{ mA}$
- $f_r = 25 \text{ GHz}$ technology
- Flat-lead 4-pin thin super mini-mold ($t = 0.59 \text{ mm}$)

ORDERING INFORMATION

Part Number	Quantity	Packaging Style
NE661M04	Loose product (50 pcs)	<ul style="list-style-type: none"> • 8 mm wide emboss taping • 1 pin (emitter), 2 pin (collector) feed hole direction
NE661M04-T2	Taping product (3 kpcs/reel)	

Remark To order evaluation samples, consult your NEC sales representative (available in 50-pcs units).

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Ratings	Unit
Collector to Base Voltage	V_{CBO}	15	V
Collector to Emitter Voltage	V_{CEO}	3.3	V
Emitter to Base Voltage	V_{EBO}	1.5	V
Collector Current	I_c	12	mA
Total Power Dissipation	P_{tot}^{Note}	39	mW
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	-65 to +150	°C

Note $T_A = +25^\circ\text{C}$ (free air)

THERMAL RESISTANCE

Item	Symbol	Value	Unit
Junction to Case Resistance	R_{th-j-c}	240	°C/W
Junction to Ambient Resistance	R_{th-j-a}	650	°C/W

Because this product uses high-frequency technology, avoid excessive static electricity, etc.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

ELECTRICAL CHARACTERISTICS (T_A = +25°C)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC characteristics						
Collector Cut-off Current	I _{CBO}	V _{CB} = 5 V, I _E = 0	–	–	100	nA
Emitter Cut-off Current	I _{EBO}	V _{EB} = 1 V, I _C = 0	–	–	100	nA
DC Current Gain	h _{FE} ^{Note 1}	V _{CE} = 2 V, I _C = 5 mA	50	70	100	–
RF Characteristics						
Reverse Transfer Capacitance	C _{re} ^{Note 2}	V _{CB} = 2 V, I _E = 0, f = 1 MHz	–	0.08	0.12	pF
Gain Bandwidth Product	f _T	V _{CE} = 3 V, I _C = 10 mA, f = 2 GHz	20	25	–	GHz
Noise Figure	NF	V _{CE} = 2 V, I _C = 2 mA, f = 2 GHz, Z _S = Z _{opt}	–	1.2	1.5	dB
Insertion Power Gain	S _{21e} ²	V _{CE} = 2 V, I _C = 5 mA, f = 2 GHz	14	17	–	dB
Maximum Stable Power Gain	MSG ^{Note 3}	V _{CE} = 2 V, I _C = 5 mA, f = 2 GHz	–	22	–	dB
Output Power at 1 dB Compression Point	P ₋₁	V _{CE} = 2 V, I _C = 5 mA ^{Note 4} , f = 2 GHz	–	5	–	dBm
Output Power at Third Order Intercept Point	OIP ₃	V _{CE} = 2 V, I _C = 5 mA ^{Note 4} , f = 2 GHz	–	15	–	–

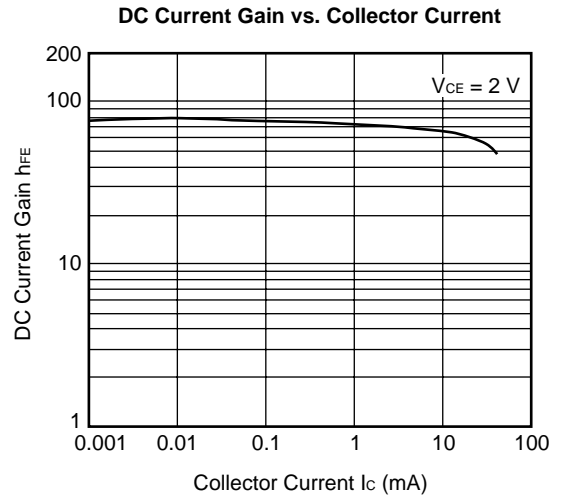
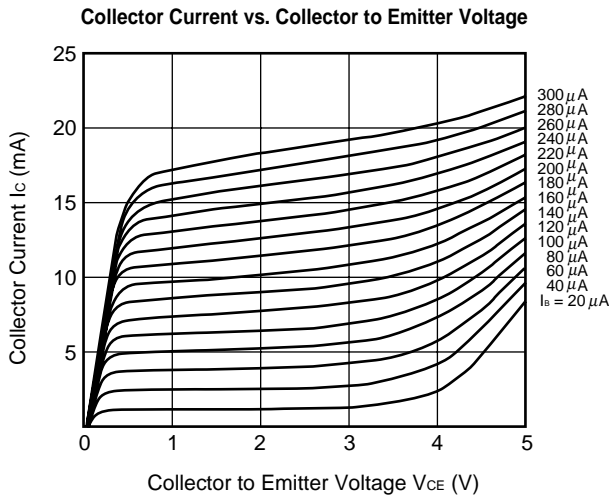
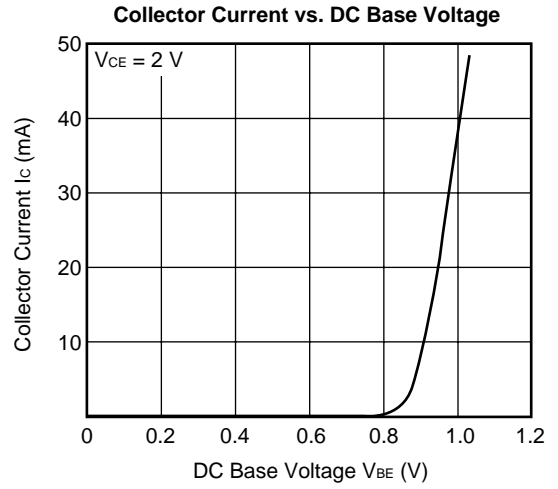
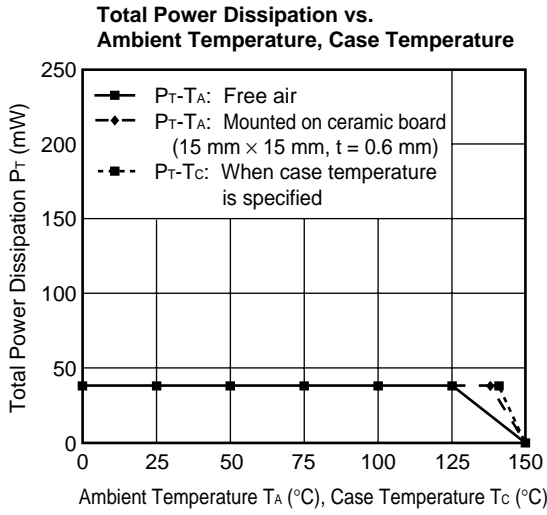
- Notes**
1. Pulse measurement PW ≤ 350 μs, Duty cycle ≤ 2%
 2. Emitter to base capacitance measured using capacitance meter (self-balancing bridge method) when the emitter is connected to the guard pin
 3. $MSG = \left| \frac{S_{21}}{S_{12}} \right|$
 4. Collector current when P₋₁ is output

h_{FE} CLASSIFICATION

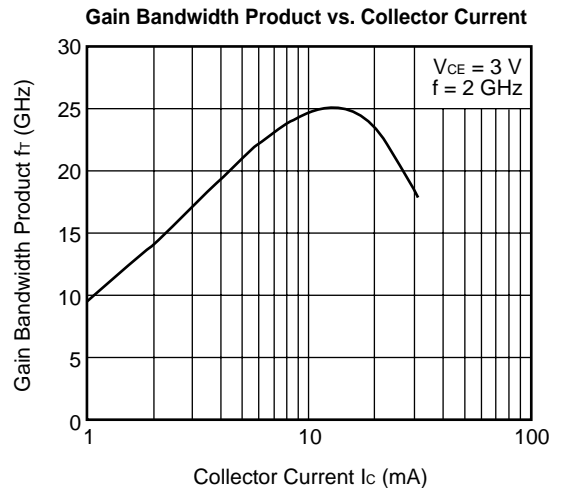
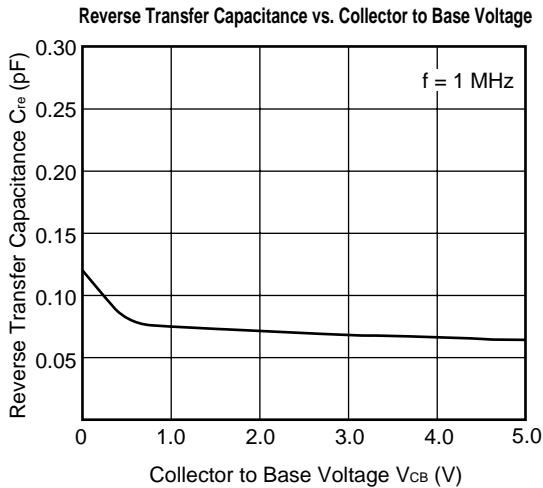
Rank	FB
Marking	T78
h _{FE}	50 to 100

TYPICAL CHARACTERISTICS (T_A = +25°C)

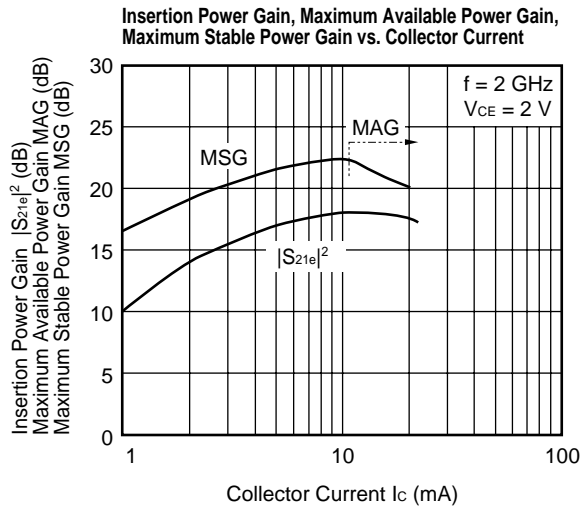
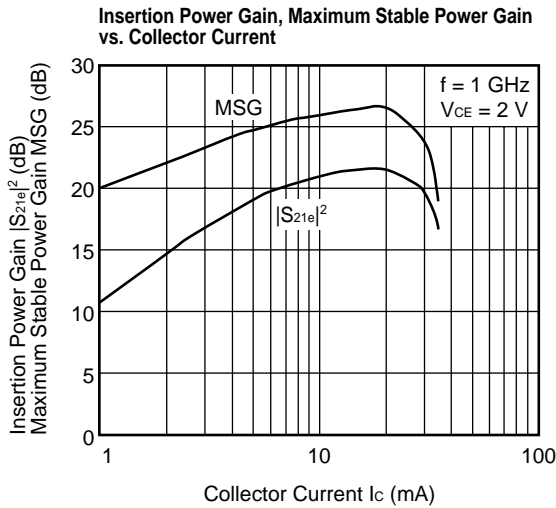
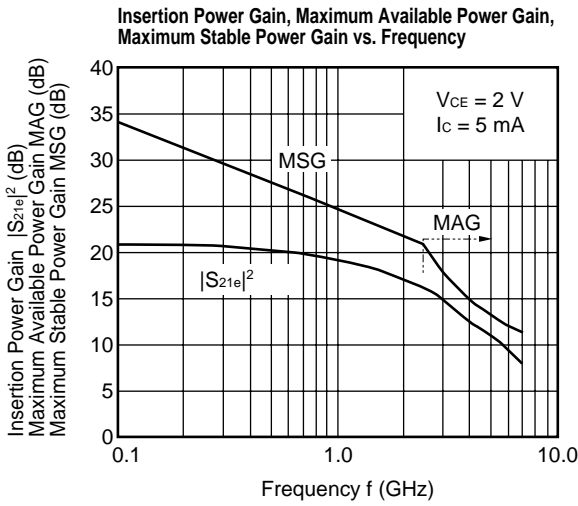
Thermal/DC Characteristics



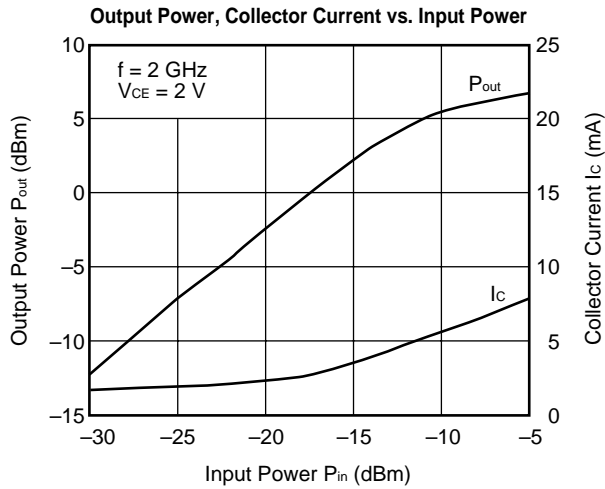
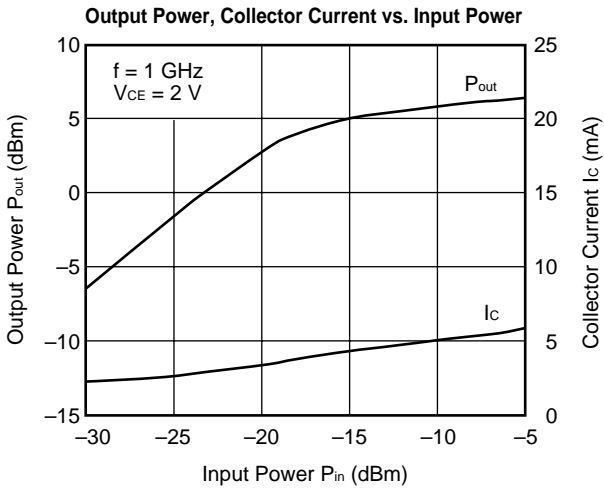
Capacitance/f_T Characteristics



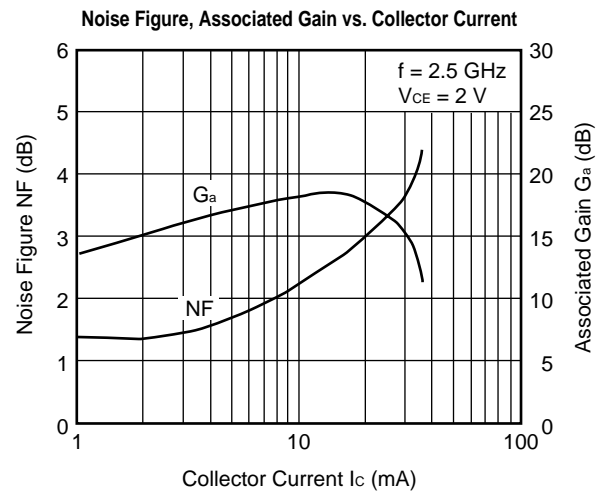
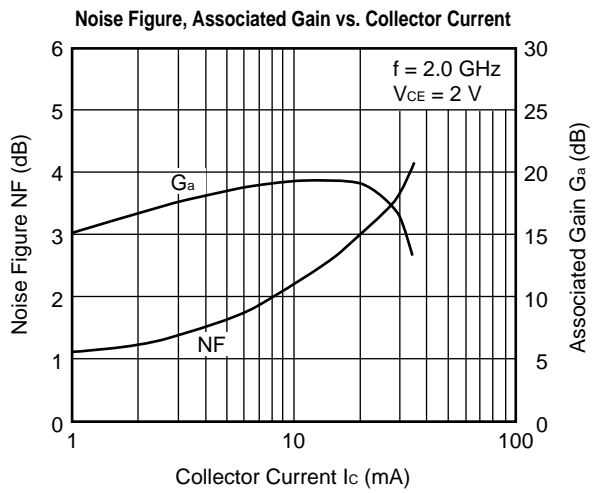
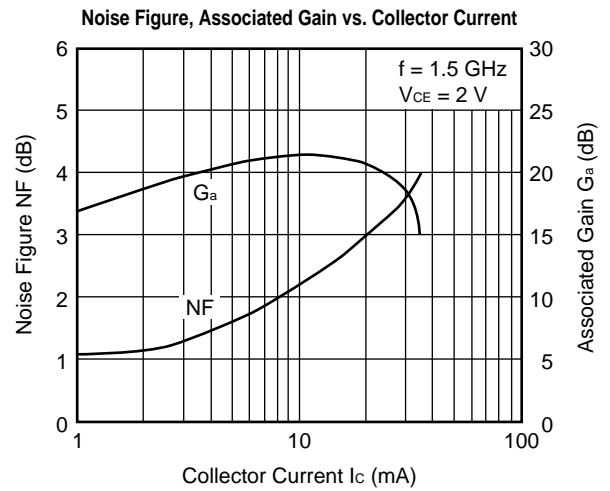
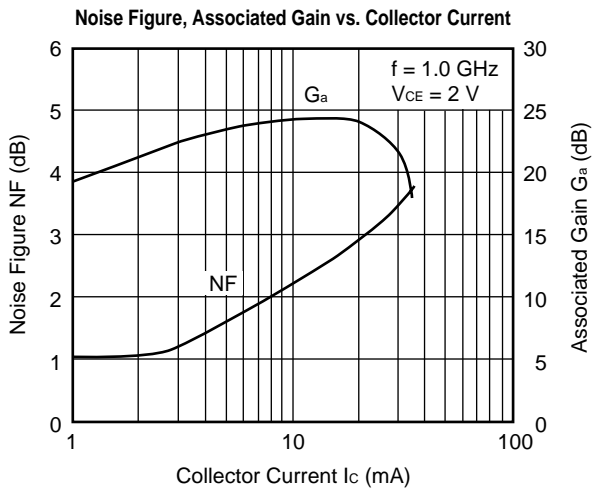
Gain Characteristics



Output Characteristics



Noise Characteristics



S PARAMETER

V_{CE} = 2 V, I_c = 2 mA

Frequency GHz	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
0.1	0.90	-3.7	6.45	174.8	0.00	81.9	0.98	-3.6
0.2	0.89	-7.1	6.25	170.8	0.01	77.9	0.95	-6.0
0.3	0.89	-10.6	6.12	167.2	0.01	75.5	0.94	-7.9
0.4	0.88	-14.2	6.02	163.6	0.02	75.7	0.92	-9.5
0.5	0.87	-17.6	5.96	160.2	0.02	74.1	0.91	-11.0
0.6	0.87	-21.0	5.87	156.9	0.02	72.4	0.90	-12.7
0.7	0.86	-24.6	5.79	153.4	0.03	70.0	0.89	-14.3
0.8	0.84	-28.0	5.69	150.3	0.03	68.7	0.88	-15.6
0.9	0.83	-31.5	5.64	147.1	0.03	66.9	0.87	-17.3
1.0	0.82	-35.0	5.54	143.8	0.03	65.2	0.86	-18.9
1.1	0.80	-38.6	5.50	140.7	0.04	63.3	0.84	-20.3
1.2	0.79	-42.0	5.42	137.7	0.04	62.2	0.83	-21.8
1.3	0.77	-45.8	5.37	134.5	0.04	60.1	0.82	-23.3
1.4	0.76	-49.4	5.28	131.6	0.04	58.4	0.81	-24.9
1.5	0.74	-53.4	5.25	128.5	0.05	57.0	0.80	-26.4
1.6	0.72	-57.1	5.19	125.2	0.05	55.0	0.78	-27.8
1.7	0.70	-61.0	5.14	122.4	0.05	53.1	0.77	-29.3
1.8	0.68	-65.0	5.06	119.2	0.05	52.1	0.76	-30.7
1.9	0.66	-69.2	5.04	116.1	0.06	50.9	0.75	-32.2
2.0	0.64	-73.3	4.98	113.0	0.06	49.1	0.73	-33.6
2.1	0.62	-77.7	4.91	109.9	0.06	46.6	0.72	-35.1
2.2	0.60	-82.1	4.82	106.9	0.06	45.6	0.71	-36.3
2.3	0.58	-86.9	4.78	103.6	0.06	43.8	0.69	-37.8
2.4	0.56	-91.8	4.68	100.6	0.06	42.2	0.68	-39.2
2.5	0.55	-97.1	4.62	97.5	0.07	40.5	0.66	-40.5
2.6	0.52	-102.5	4.53	94.1	0.07	39.0	0.65	-41.9
2.7	0.50	-108.7	4.46	90.8	0.07	37.0	0.63	-43.0
2.8	0.47	-115.5	4.29	87.5	0.07	34.8	0.62	-44.1
2.9	0.42	-120.2	4.11	85.2	0.06	34.7	0.61	-44.0
3.0	0.40	-119.0	4.06	84.6	0.06	38.1	0.61	-45.4
4.0	0.47	-159.3	3.24	66.5	0.07	33.4	0.51	-55.3
5.0	0.49	163.9	2.74	45.5	0.07	33.5	0.44	-69.8
6.0	0.56	141.2	2.34	26.7	0.08	35.9	0.40	-88.9
7.0	0.63	123.9	2.00	9.3	0.09	37.0	0.38	-112.9
8.0	0.69	111.6	1.70	-6.5	0.11	35.9	0.39	-138.6
9.0	0.74	102.1	1.44	-21.4	0.12	31.3	0.44	-163.4
10.0	0.79	95.1	1.19	-34.9	0.13	25.3	0.52	175.7

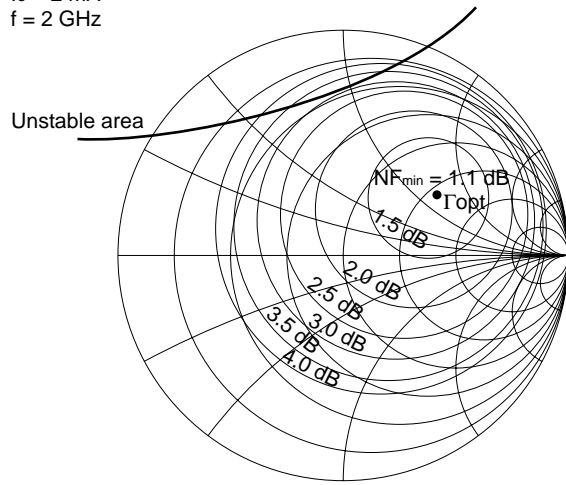
V_{CE} = 2 V, I_c = 5 mA

Frequency GHz	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
0.1	0.82	-4.7	10.44	173.8	0.00	80.8	0.97	-4.1
0.2	0.82	-9.2	10.28	168.8	0.01	75.3	0.94	-7.1
0.3	0.80	-13.8	10.09	164.2	0.01	75.0	0.92	-9.4
0.4	0.79	-18.0	9.89	159.8	0.01	74.1	0.90	-11.5
0.5	0.78	-22.4	9.73	155.6	0.02	72.2	0.88	-13.4
0.6	0.76	-26.6	9.55	151.5	0.02	70.4	0.87	-15.4
0.7	0.74	-31.1	9.36	147.4	0.02	68.0	0.85	-17.3
0.8	0.72	-35.3	9.19	143.5	0.03	66.6	0.84	-18.9
0.9	0.70	-39.4	9.01	139.6	0.03	64.9	0.82	-20.8
1.0	0.68	-43.6	8.82	135.8	0.03	63.3	0.80	-22.4
1.1	0.66	-47.9	8.67	132.0	0.03	61.2	0.78	-23.9
1.2	0.63	-51.9	8.46	128.6	0.04	60.7	0.77	-25.5
1.3	0.61	-56.2	8.27	124.8	0.04	58.7	0.75	-26.9
1.4	0.58	-60.3	8.07	121.5	0.04	57.8	0.73	-28.4
1.5	0.56	-64.7	7.91	117.9	0.04	56.3	0.72	-29.7
1.6	0.53	-68.9	7.72	114.5	0.04	55.5	0.70	-31.0
1.7	0.51	-73.3	7.54	111.3	0.05	53.8	0.69	-32.3
1.8	0.49	-77.6	7.35	108.2	0.05	53.4	0.67	-33.6
1.9	0.46	-82.0	7.18	105.0	0.05	51.9	0.65	-34.9
2.0	0.44	-86.7	7.00	102.0	0.05	51.6	0.64	-36.1
2.1	0.42	-91.6	6.83	98.9	0.05	49.6	0.62	-37.2
2.2	0.40	-96.5	6.66	95.9	0.05	49.6	0.61	-38.2
2.3	0.38	-101.9	6.49	92.9	0.05	48.3	0.60	-39.5
2.4	0.36	-107.6	6.32	90.0	0.05	47.4	0.58	-40.5
2.5	0.35	-113.6	6.16	87.0	0.06	46.2	0.57	-41.7
2.6	0.33	-120.2	6.00	84.1	0.06	45.3	0.55	-42.7
2.7	0.32	-127.9	5.82	80.9	0.06	44.6	0.53	-43.4
2.8	0.30	-137.3	5.59	77.9	0.06	42.5	0.52	-43.8
2.9	0.25	-144.7	5.29	76.3	0.06	44.1	0.52	-43.2
3.0	0.23	-142.4	5.22	76.0	0.06	48.2	0.52	-44.8
4.0	0.31	175.3	4.23	62.3	0.06	46.8	0.44	-48.3
5.0	0.42	147.1	3.50	41.8	0.08	45.6	0.36	-70.4
6.0	0.51	130.2	2.94	25.6	0.09	42.7	0.31	-89.6
7.0	0.58	116.8	2.52	9.8	0.10	38.6	0.29	-115.3
8.0	0.65	106.9	2.16	-5.0	0.12	34.4	0.31	-143.0
9.0	0.71	99.0	1.85	-19.3	0.13	28.7	0.36	-168.2
10.0	0.76	92.8	1.57	-32.6	0.14	22.9	0.44	172.1
11.0	0.78	89.2	1.36	-44.5	0.14	17.8	0.53	158.5
12.0	0.79	84.8	1.16	-55.1	0.15	13.4	0.60	149.8

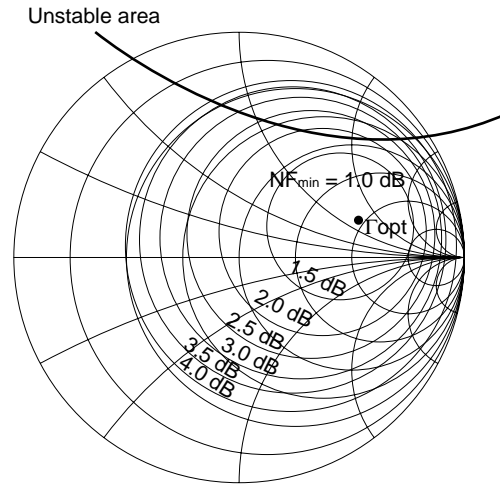
NOISE PARAMETER

<Equal NF circle>

$V_{CE} = 2\text{ V}$
 $I_C = 2\text{ mA}$
 $f = 2\text{ GHz}$



$V_{CE} = 2\text{ V}$
 $I_C = 2\text{ mA}$
 $f = 1\text{ GHz}$



$V_{CE} = 2\text{ V}, I_C = 2\text{ mA}$

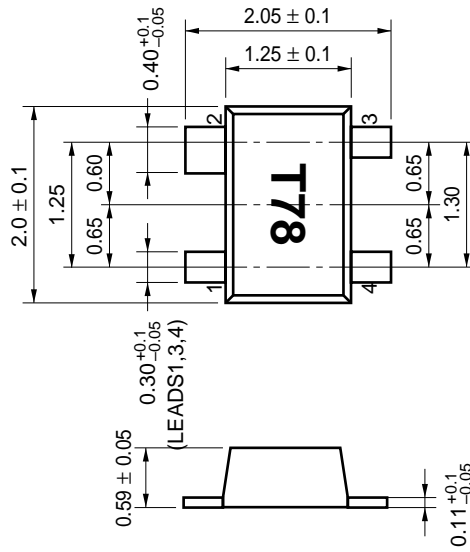
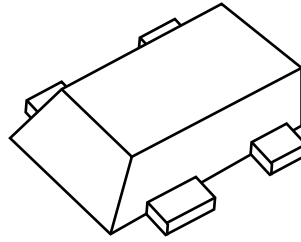
f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		R _n /50
			MAG.	ANG.	
0.8	0.93	22.9	0.54	13.3	0.47
0.9	0.95	22.2	0.54	14.9	0.47
1.0	0.97	21.6	0.54	16.4	0.47
1.5	1.08	18.8	0.53	24.6	0.45
1.8	1.14	17.5	0.51	30.3	0.43
1.9	1.16	17.1	0.50	32.4	0.42
2.0	1.18	16.7	0.49	34.6	0.41
2.5	1.29	15.2	0.44	47.7	0.35

$V_{CE} = 2\text{ V}, I_C = 5\text{ mA}$

f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		R _n /50
			MAG.	ANG.	
0.8	1.59	24.7	0.38	10.7	0.43
0.9	1.60	24.1	0.38	11.9	0.43
1.0	1.60	23.4	0.38	13.2	0.43
1.5	1.62	20.7	0.36	20.5	0.41
1.8	1.63	19.3	0.34	25.7	0.38
1.9	1.63	18.9	0.33	27.5	0.38
2.0	1.63	18.5	0.32	29.4	0.37
2.5	1.65	16.9	0.26	40.1	0.32

PACKAGE DRAWINGS

Flat-lead 4-pin thin super mini-mold (unit: mm)



Pin connections

- 1. Emitter
- 2. Collector
- 3. Emitter
- 4. Base

SOLDERING CONDITIONS

Solder this product under the following recommended conditions.

For soldering methods and conditions other than those recommended, consult NEC.

Soldering Method(s)	Soldering Conditions	Recommended Conditions Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 sec max. (210°C min.), Number of times: twice max., Maximum number of days: None ^{Note}	IR35-00-2
VPS	Package peak temperature: 215°C, Time: 40 sec max. (200°C min.), Number of times: twice max., Maximum number of days: None ^{Note}	VP15-00-2
Wave soldering	Solder bath temperature: 260°C, Time: 10 sec max., Number of times: once, Maximum number of days: None ^{Note}	WS60-00-1

Note Number of days in storage after the dry pack has been opened. The storage conditions are at 25°C, 65% RH MAX.

Caution Do not use two or more soldering methods in combination.

For details of the recommended soldering conditions, refer to information document **Semiconductor Device Mounting Technology Manual (C10535E)**.

[MEMO]

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- NEC semiconductor products are classified into the following three quality grades:
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 - "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)
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The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.

(Note)

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- (2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).