

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)	• 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 ($T_A = +25^\circ\text{C}$)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC characteristics						
Collector Cut-off Current	I_{CBO}	$V_{CB} = 5\text{ V}, I_E = 0$	—	—	100	nA
Emitter Cut-off Current	I_{EBO}	$V_{EB} = 1\text{ V}, I_C = 0$	—	—	100	nA
DC Current Gain	$h_{FE}^{\text{Note 1}}$	$V_{CE} = 2\text{ V}, I_C = 5\text{ mA}$	50	70	100	—
RF Characteristics						
Reverse Transfer Capacitance	$C_{re}^{\text{Note 2}}$	$V_{CB} = 2\text{ V}, I_E = 0, f = 1\text{ MHz}$	—	0.08	0.12	pF
Gain Bandwidth Product	f_T	$V_{CE} = 3\text{ V}, I_C = 10\text{ mA}, f = 2\text{ GHz}$	20	25	—	GHz
Noise Figure	NF	$V_{CE} = 2\text{ V}, I_C = 2\text{ mA}, f = 2\text{ GHz}, Z_S = Z_{opt}$	—	1.2	1.5	dB
Insertion Power Gain	$ S_{21e} ^2$	$V_{CE} = 2\text{ V}, I_C = 5\text{ mA}, f = 2\text{ GHz}$	14	17	—	dB
Maximum Stable Power Gain	$MSG^{\text{Note 3}}$	$V_{CE} = 2\text{ V}, I_C = 5\text{ mA}, f = 2\text{ GHz}$	—	22	—	dB
Output Power at 1 dB Compression Point	P_{-1}	$V_{CE} = 2\text{ V}, I_C = 5\text{ mA}^{\text{Note 4}}, f = 2\text{ GHz}$	—	5	—	dBm
Output Power at Third Order Intercept Point	OIP_3	$V_{CE} = 2\text{ V}, I_C = 5\text{ mA}^{\text{Note 4}}, f = 2\text{ GHz}$	—	15	—	—

Notes 1. Pulse measurement $PW \leq 350\text{ }\mu\text{s}$, Duty cycle $\leq 2\%$

2. Emitter to base capacitance measured using capacitance meter (self-balancing bridge method) when the emitter is connected to the guard pin

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

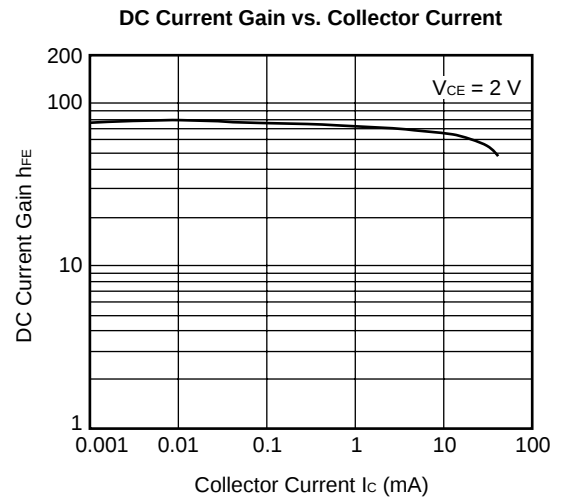
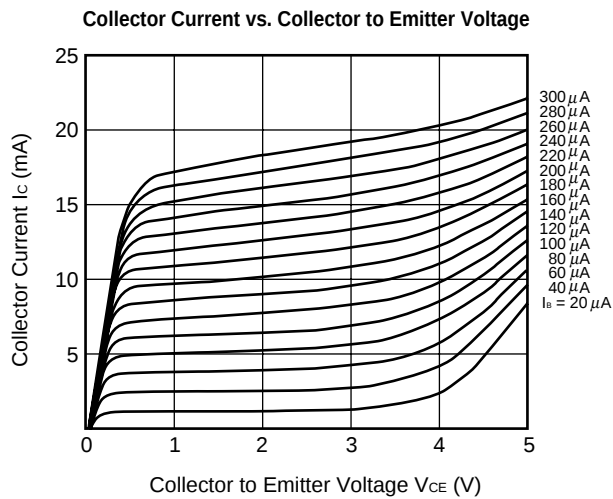
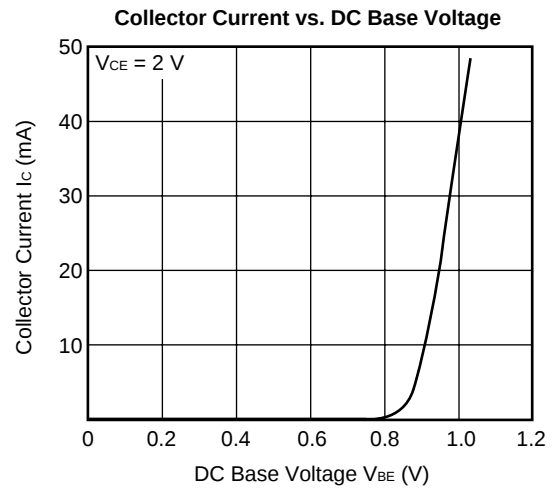
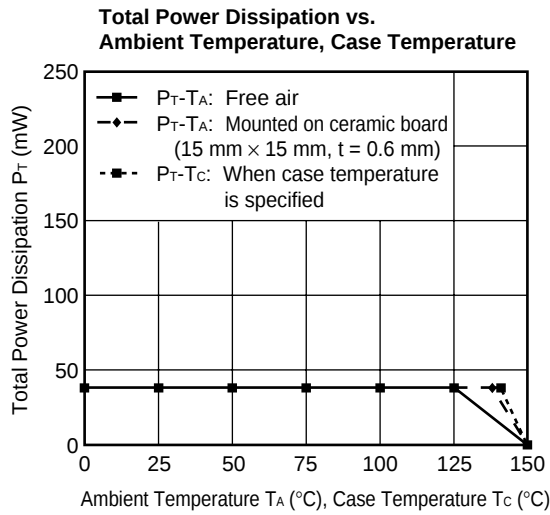
4. Collector current when P_{-1} is output

 h_{FE} CLASSIFICATION

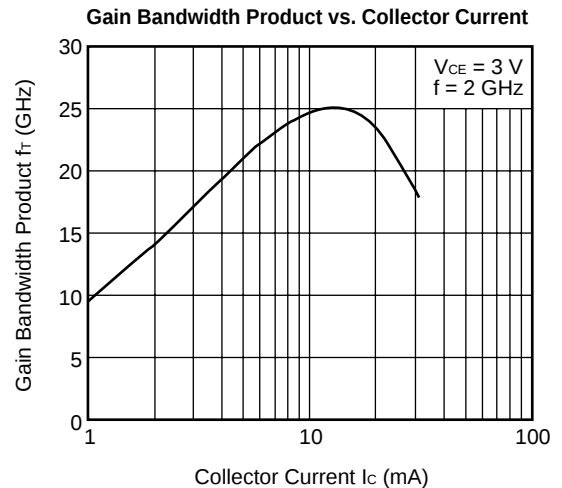
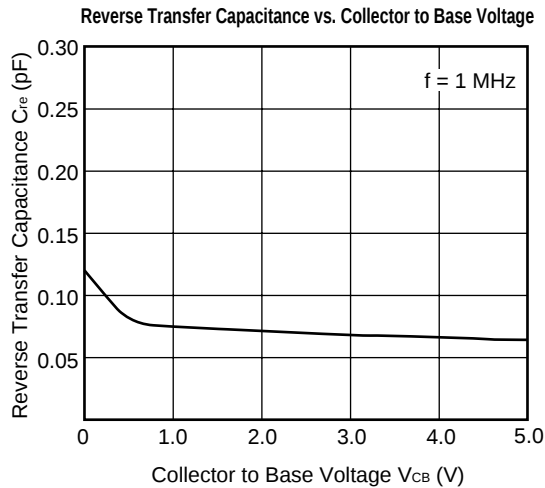
Rank	FB
Marking	T78
h_{FE}	50 to 100

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

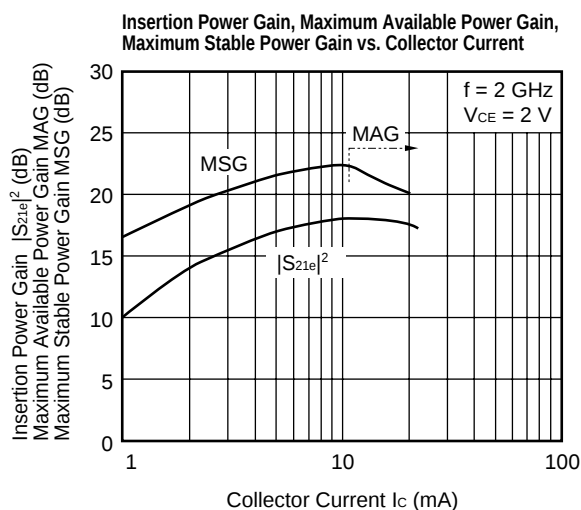
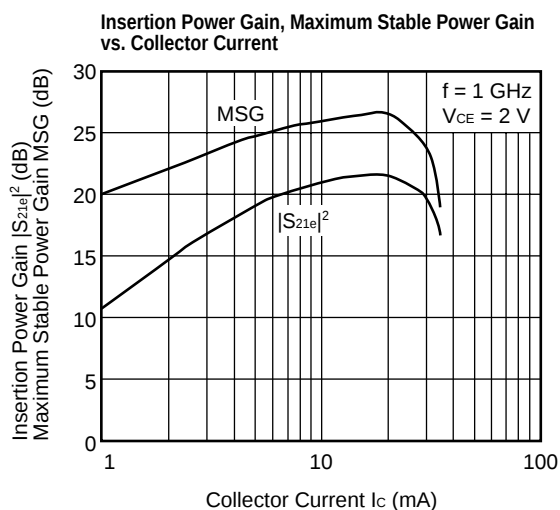
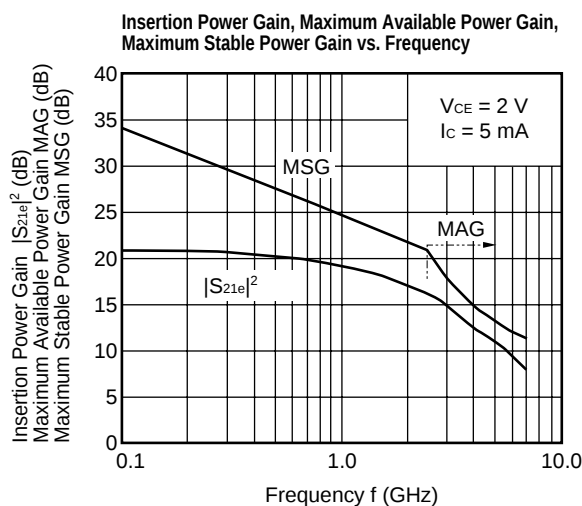
Thermal/DC Characteristics



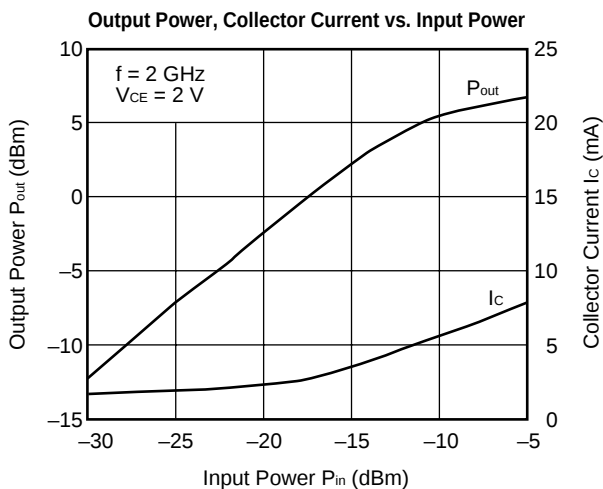
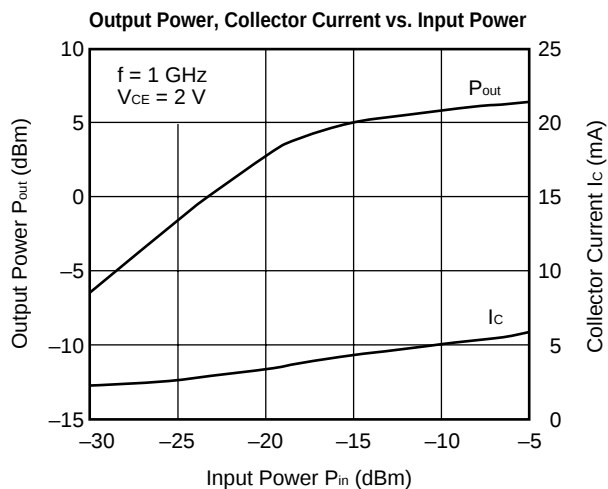
Capacitance/ f_T Characteristics



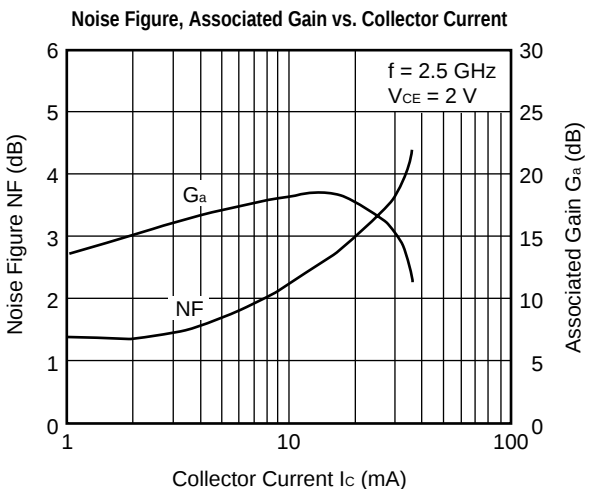
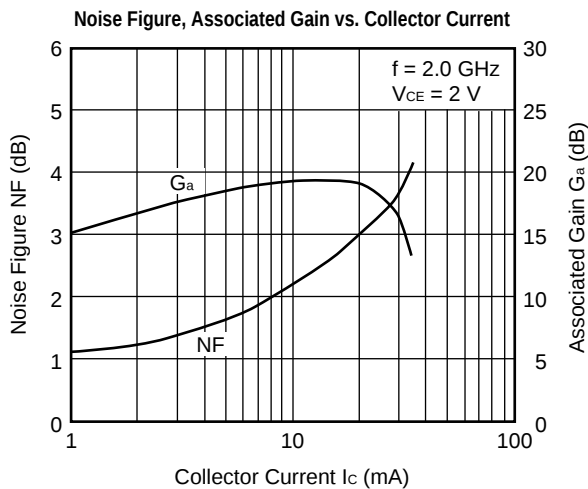
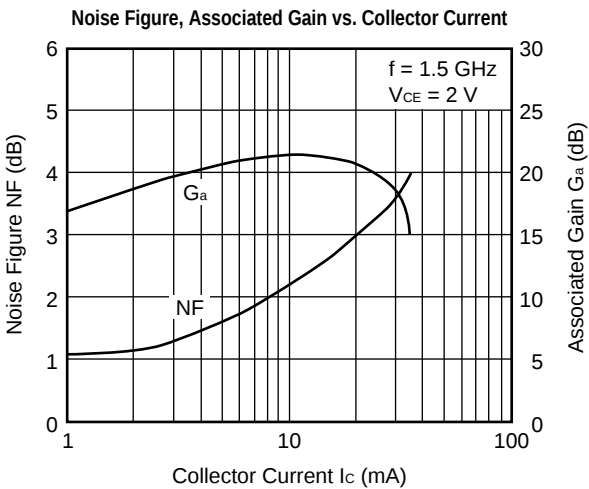
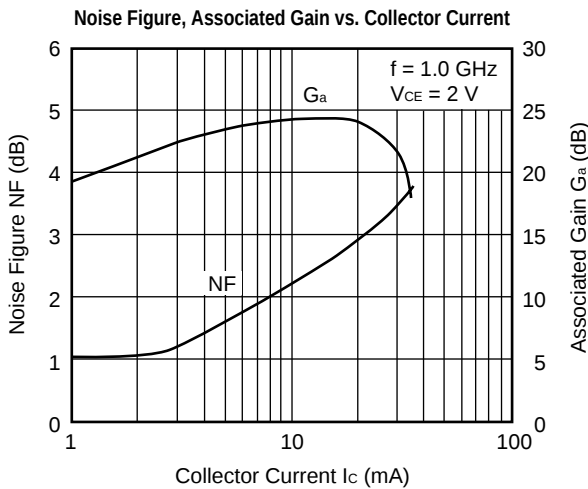
Gain Characteristics



Output Characteristics



Noise Characteristics



S PARAMETER

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

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

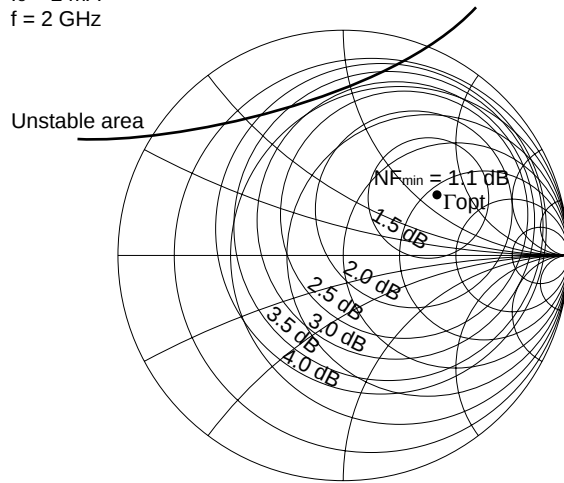
$V_{CE} = 2 \text{ V}$, $I_C = 5 \text{ mA}$

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

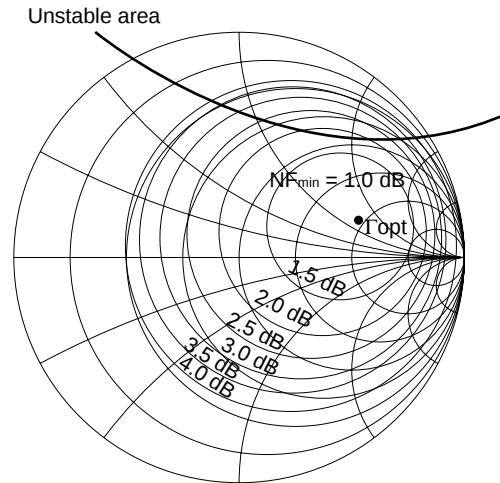
NOISE PARAMETER

<Equal NF circle>

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



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



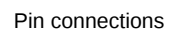
$V_{CE} = 2\text{ V}, I_C = 2\text{ mA}$

f (GHz)	NF _{min} (dB)	G _a (dB)	Γ _{opt}		Rn/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}		Rn/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

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



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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 "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": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.
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