DATA SHEET

NEC

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 dB, G_a = 16 dB TYP. @f = 2 GHz, V_{CE} = 2 V, I_C = 2 mA
- Maximum stable power gain: MSG = 22 dB TYP. @f = 2 GHz, V_{CE} = 2 V, I_C = 5 mA
- f_T = 25 GHz technology
- Flat-lead 4-pin thin super mini-mold (t = 0.59 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°C (free air)

THERMAL RESISTANCE

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

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

Document No. P14909EJ1V0DS00 (1st edition)
Date Published June 2000 N CP(K)
Printed in Japan

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

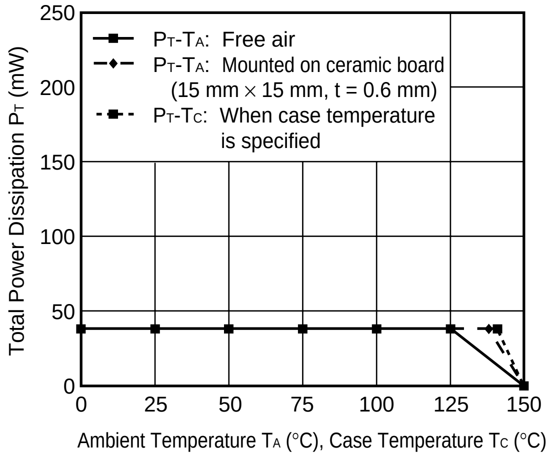
h_{FE} CLASSIFICATION

Rank	FB
Marking	T78
h_{FE}	50 to 100

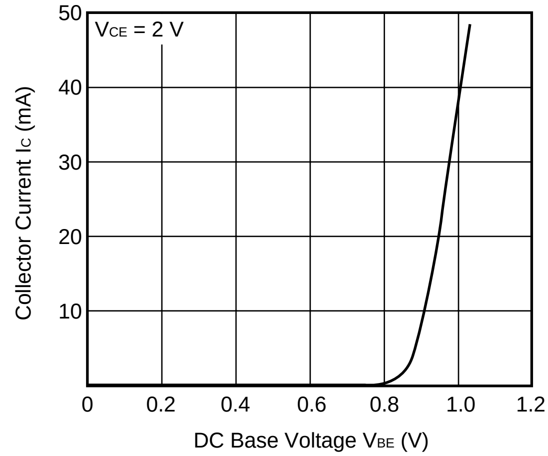
TYPICAL CHARACTERISTICS (T_A = +25°C)

Thermal/DC Characteristics

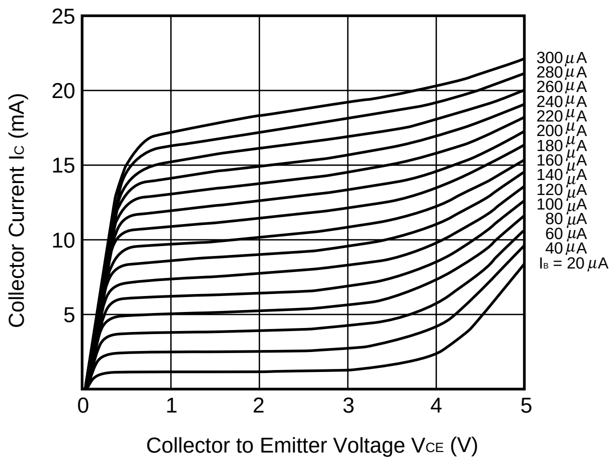
Total Power Dissipation vs. Ambient Temperature, Case Temperature



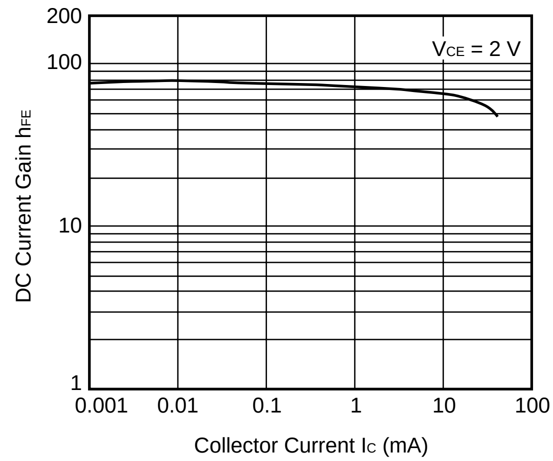
Collector Current vs. DC Base Voltage



Collector Current vs. Collector to Emitter Voltage

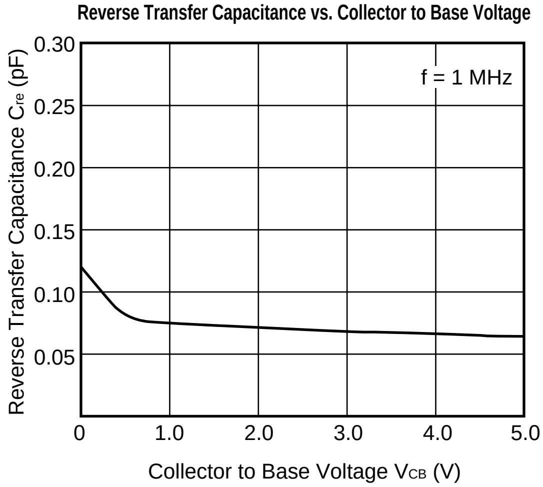


DC Current Gain vs. Collector Current

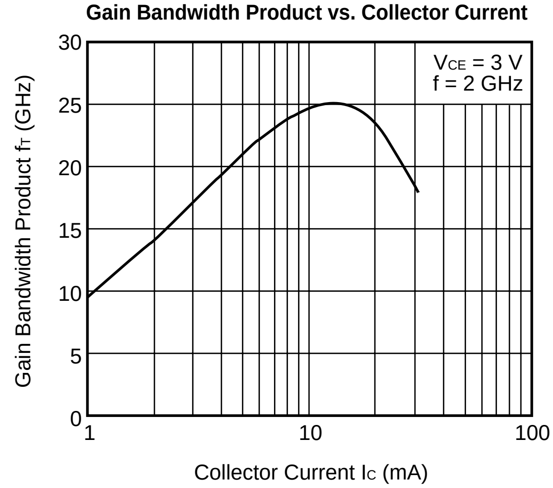


Capacitance/f_T Characteristics

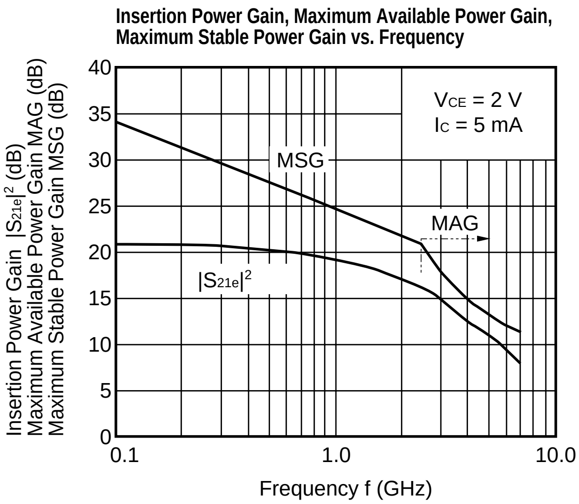
Reverse Transfer Capacitance vs. Collector to Base Voltage

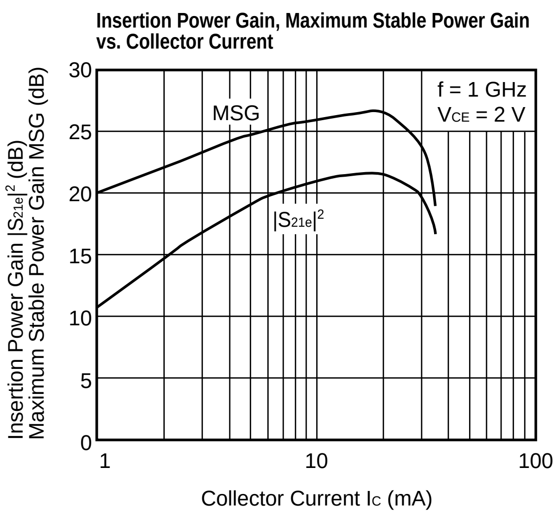


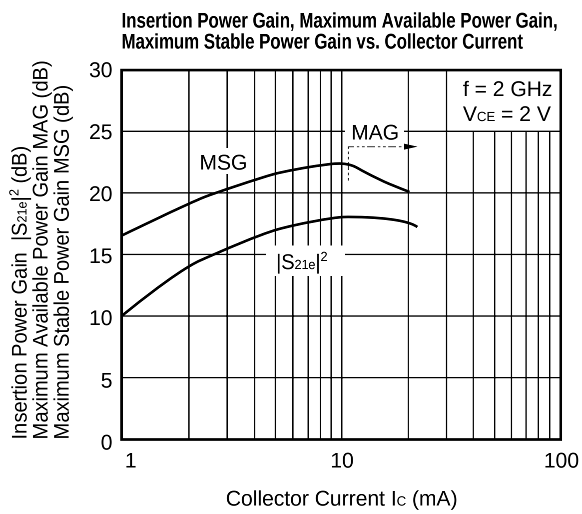
Gain Bandwidth Product vs. Collector Current



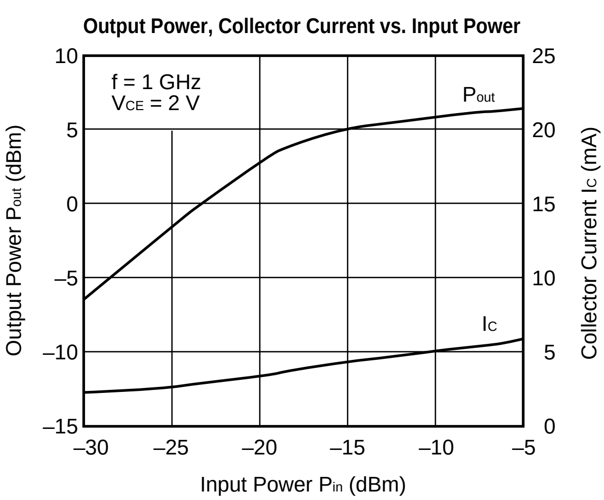
Gain Characteristics

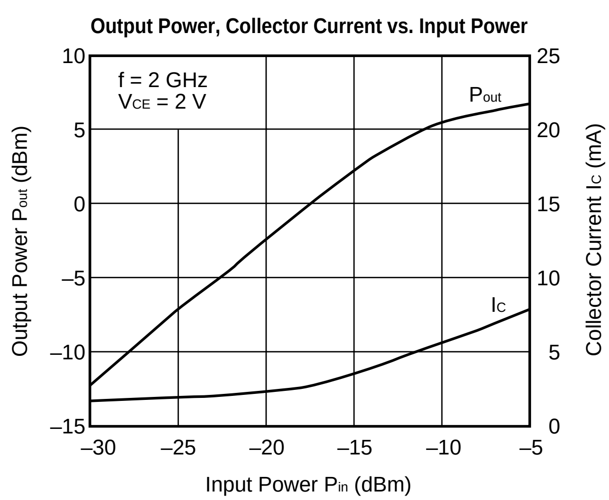




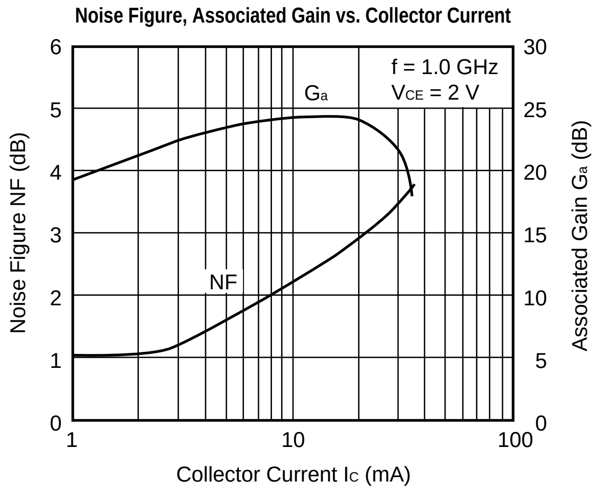


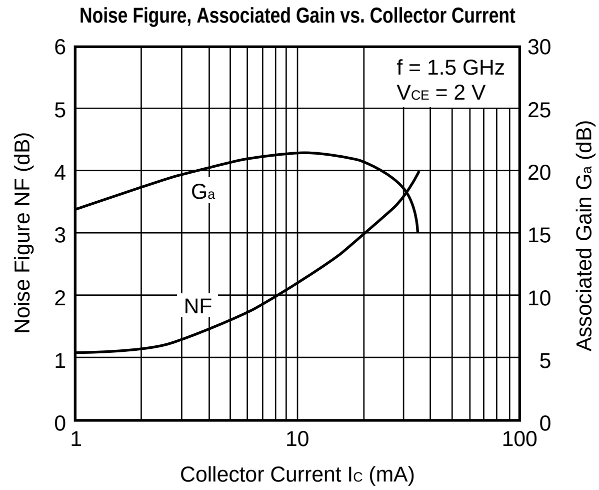
Output Characteristics

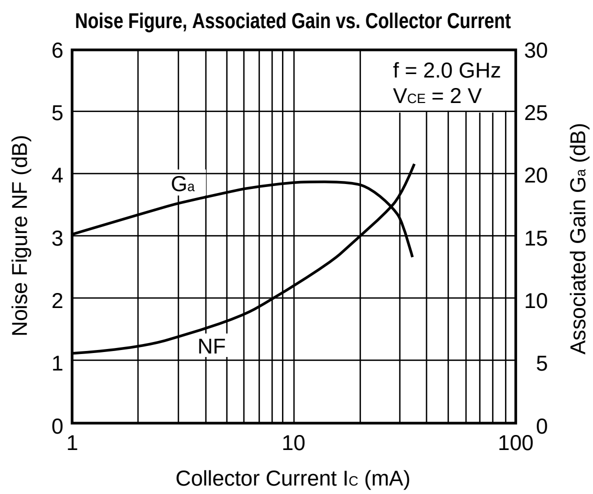


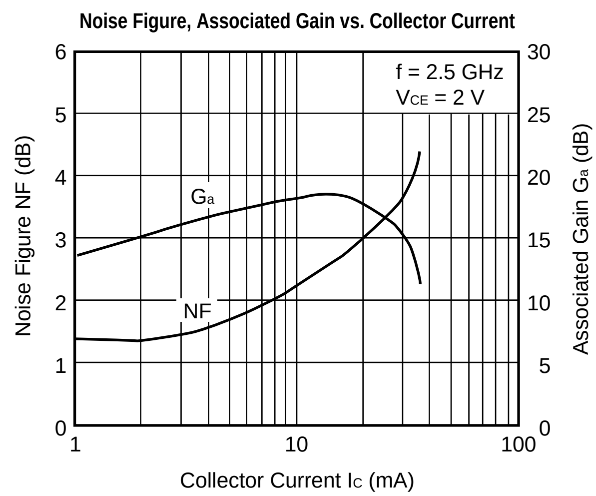


Noise Characteristics









S PARAMETER

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

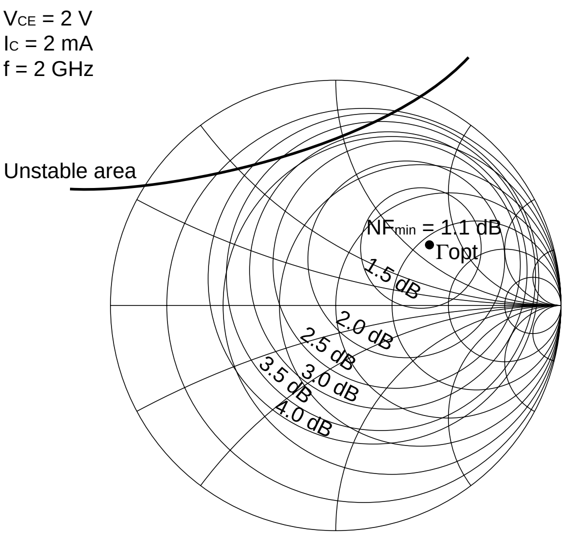
Frequency	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
0.1	0.90	–3.7	6.45	174.8	0.00	81.9	0.98	–3.6
0.2	0.89	–7.1	6.25	170.8	0.01	77.9	0.95	–6.0
0.3	0.89	–10.6	6.12	167.2	0.01	75.5	0.94	–7.9
0.4	0.88	–14.2	6.02	163.6	0.02	75.7	0.92	–9.5
0.5	0.87	–17.6	5.96	160.2	0.02	74.1	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

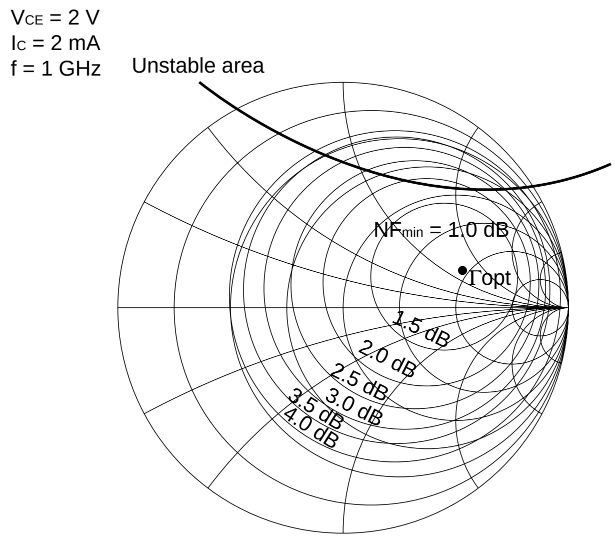
V_{CE} = 2 V, I_C = 5 mA

Frequency	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	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 V, I_C = 2 mA

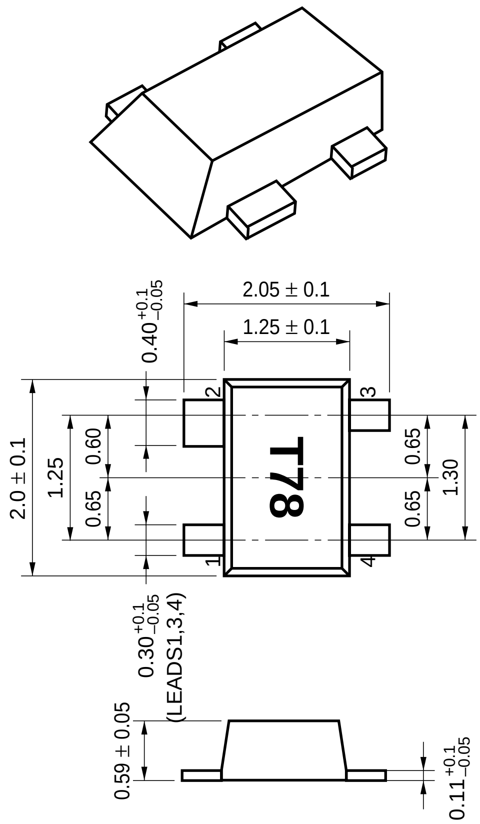
f (GHz)	NF_{min} (dB)	G_a (dB)	Γopt MAG.	Γopt ANG.	Rn/50
0.8	0.93	22.9	0.54	13.3	0.47
0.9	0.95	22.2	0.54	14.9	0.47
1.0	0.97	21.6	0.54	16.4	0.47
1.5	1.08	18.8	0.53	24.6	0.45
1.8	1.14	17.5	0.51	30.3	0.43
1.9	1.16	17.1	0.50	32.4	0.42
2.0	1.18	16.7	0.49	34.6	0.41
2.5	1.29	15.2	0.44	47.7	0.35

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

f (GHz)	NF_{min} (dB)	G_a (dB)	Γopt MAG.	Γopt ANG.	Rn/50
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]