

SILICON TRANSISTOR  
2SC5181

NPN EPITAXIAL SILICON TRANSISTOR IN ULTRA SUPER MINI-MOLD PACKAGE  
FOR LOW-NOISE MICROWAVE AMPLIFICATION

FEATURES

- Low current consumption and high gain  
 $|S_{21e}|^2 = 10.5 \text{ dB}_{\text{TYP.}} @ V_{CE} = 2 \text{ V}, I_c = 7 \text{ mA}, f = 2 \text{ GHz}$   
 $|S_{21e}|^2 = 9.0 \text{ dB}_{\text{TYP.}} @ V_{CE} = 1 \text{ V}, I_c = 5 \text{ mA}, f = 2 \text{ GHz}$
- Ultra Super Mini-Mold package

ORDERING INFORMATION

PART NUMBER	QUANTITY	ARRANGEMENT
2SC5181	50 units/box	Embossed tape, 8 mm wide, pin No. 3 (collector) facing the perforation
2SC5181-T1	3 000 units/reel	

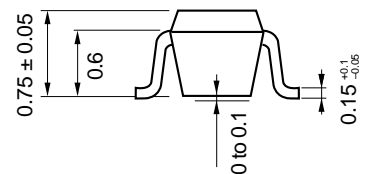
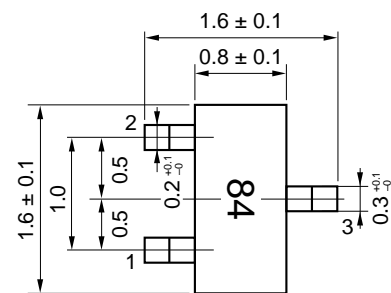
\* Contact your NEC sales representatives to order samples for evaluation (available in batches of 50).

ABSOLUTE MAXIMUM RATINGS ( $T_A = 25 \text{ }^\circ\text{C}$ )

Collector to Base Voltage	$V_{CBO}$	5	V
Collector to Emitter Voltage	$V_{CEO}$	3	V
Emitter to Base Voltage	$V_{EBO}$	2	V
Collector Current	$I_c$	10	mA
Total Power Dissipation	$P_T$	30	mW
Junction Temperature	$T_j$	150	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-65 to +150	$^\circ\text{C}$

PACKAGE DIMENSIONS

(Units: mm)



PIN CONNECTIONS

1. Emitter
2. Base
3. Collector

**Caution;** This transistor uses high-frequency technology. Be careful not to allow excessive current to flow through the transistor, including static electricity.

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

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Collector Cutoff Current	$I_{CBO}$			100	nA	$V_{CB} = 5\text{ V}, I_E = 0$
Emitter Cutoff Current	$I_{EBO}$			100	nA	$V_{EB} = 1\text{ V}, I_C = 0$
DC Current Gain	$h_{FE}$	70		140		$V_{CE} = 2\text{ V}, I_C = 7\text{ mA}^{*1}$
Insertion Power Gain (1)	$ S_{21e} ^2$	8.0	10.5		dB	$V_{CE} = 2\text{ V}, I_C = 7\text{ mA}, f = 2\text{ GHz}$
Insertion Power Gain (2)	$ S_{21e} ^2$	7.0	9.0		dB	$V_{CE} = 1\text{ V}, I_C = 5\text{ mA}, f = 2\text{ GHz}$
Noise Figure (1)	NF		1.5	2.0	dB	$V_{CE} = 2\text{ V}, I_C = 3\text{ mA}, f = 2\text{ GHz}$
Noise Figure (2)	NF		1.5	2.0	dB	$V_{CE} = 1\text{ V}, I_C = 3\text{ mA}, f = 2\text{ GHz}$
Gain Bandwidth Product (1)	$f_T$	10	13		GHz	$V_{CE} = 2\text{ V}, I_C = 7\text{ mA}, f = 2\text{ GHz}$
Gain Bandwidth Product (2)	$f_T$	8.5	12		GHz	$V_{CE} = 1\text{ V}, I_C = 5\text{ mA}, f = 2\text{ GHz}$
Feedback Capacitance	$C_{re}$		0.4	0.6	pF	$V_{CB} = 2\text{ V}, I_E = 0\text{ mA}, f = 1\text{ MHz}^{*2}$

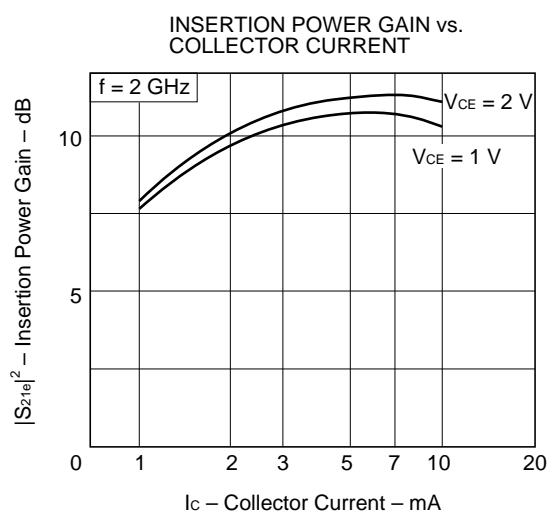
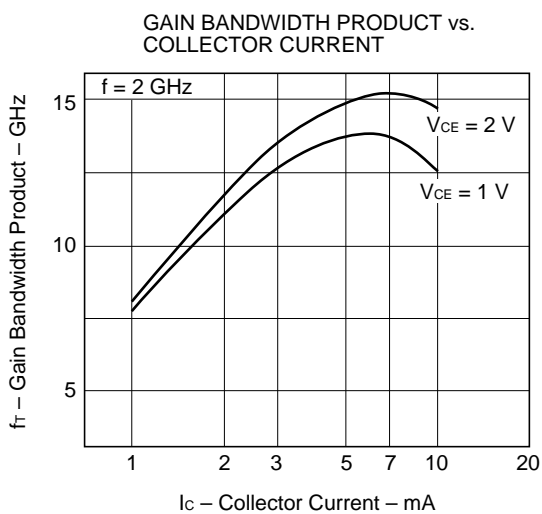
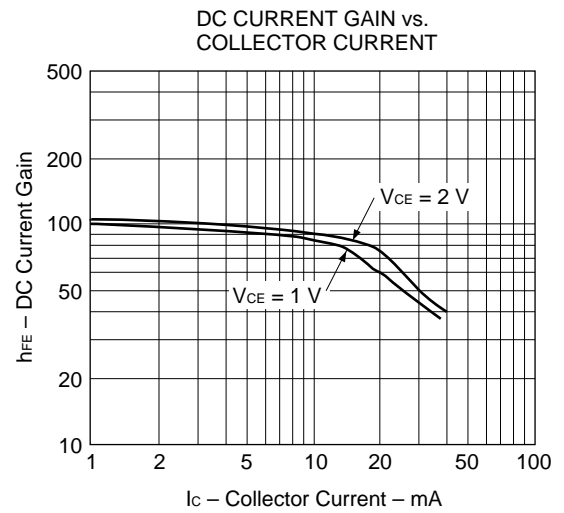
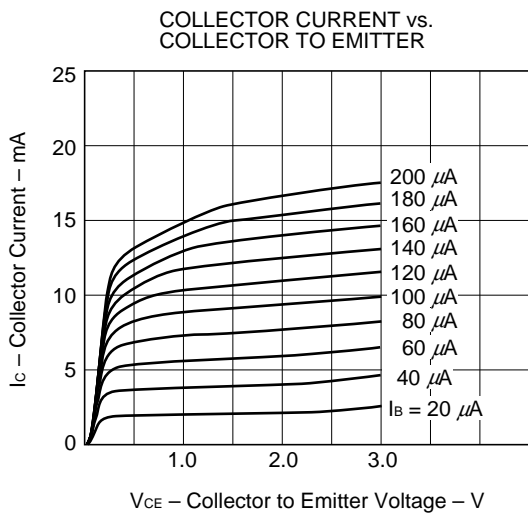
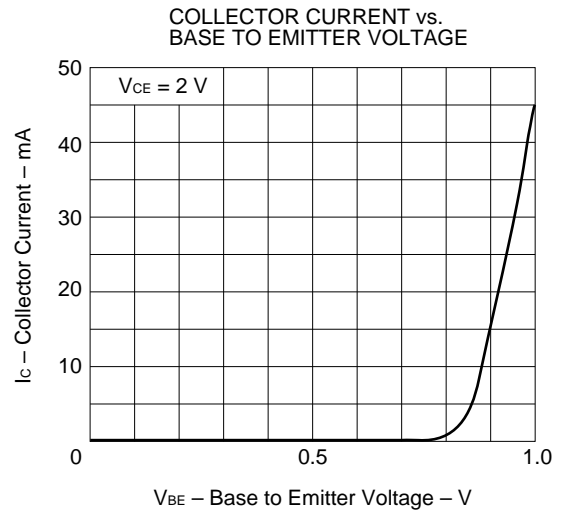
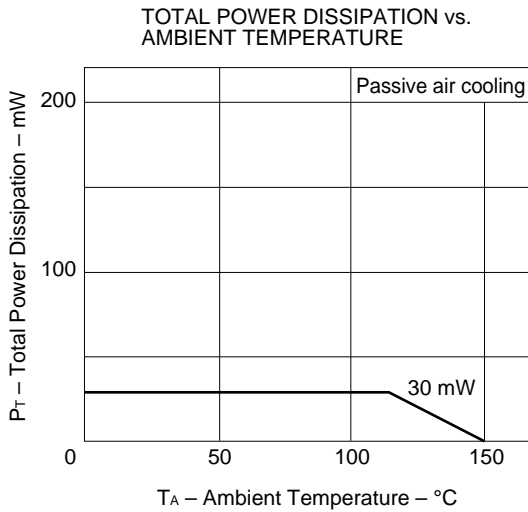
\*1. Measured with pulses: Pulse width  $\leq 350\ \mu\text{s}$ , duty cycle  $\leq 2\%$ , pulsed

\*2. Measured with a three-terminal bridge. The emitter and case terminal are connected to the guard terminal of the bridge.

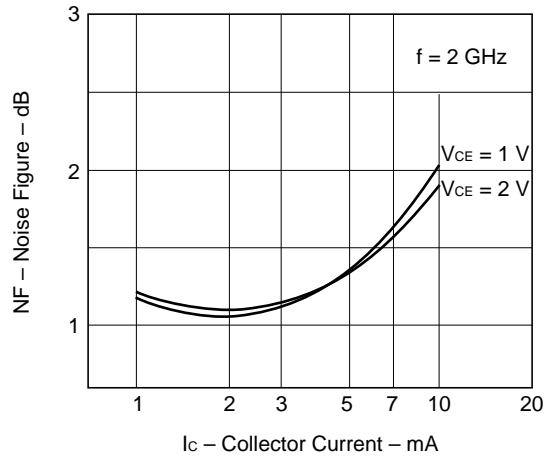
 **$h_{FE}$  Class**

Class	FB
Marking	84
$h_{FE}$	70 to 140

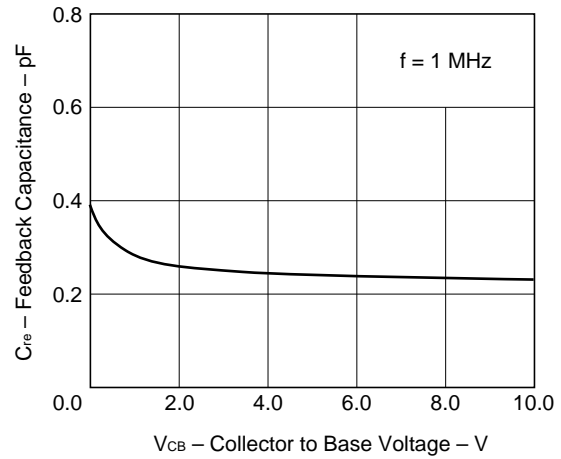
CHARACTERISTICS CURVES (T<sub>A</sub> = 25 °C)



NOISE FIGURE vs.  
COLLECTOR CURRENT



FEED-BACK CAPACITANCE vs.  
COLLECTOR TO BASE VOLTAGE



**S-PARAMETERS**

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 1 mA, Z<sub>o</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.892	-31.5	3.159	142.3	0.113	64.7	0.934	-25.9
800.00	0.795	-40.9	2.964	130.8	0.152	58.9	0.847	-32.1
1000.00	0.704	-50.9	2.762	119.7	0.180	53.0	0.759	-39.9
1200.00	0.653	-60.1	2.674	110.1	0.204	49.8	0.726	-47.4
1400.00	0.598	-66.6	2.590	103.0	0.228	45.9	0.688	-53.1
1600.00	0.524	-73.7	2.409	94.9	0.253	42.5	0.636	-58.2
1800.00	0.464	-80.6	2.285	87.2	0.265	41.3	0.575	-64.2
2000.00	0.415	-88.8	2.182	81.7	0.270	39.6	0.530	-68.9
2200.00	0.355	-97.7	2.032	74.6	0.278	35.7	0.495	-74.6

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 3 mA, Z<sub>o</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.653	-48.4	6.121	124.0	0.095	59.6	0.754	-37.3
800.00	0.517	-59.5	5.199	111.4	0.123	55.7	0.629	-43.1
1000.00	0.422	-68.5	4.502	100.6	0.143	53.0	0.533	-49.5
1200.00	0.362	-76.1	4.084	92.8	0.165	53.5	0.493	-54.2
1400.00	0.301	-81.4	3.661	86.8	0.183	51.6	0.448	-57.6
1600.00	0.245	-88.0	3.279	79.5	0.204	50.1	0.411	-61.1
1800.00	0.209	-92.7	3.024	74.1	0.220	49.7	0.369	-66.7
2000.00	0.175	-105.8	2.796	70.4	0.230	50.0	0.334	-69.5
2200.00	0.132	-121.6	2.535	64.5	0.244	46.8	0.311	-75.0

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 3 mA, Z<sub>o</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.514	-56.3	7.156	115.3	0.082	57.8	0.648	-40.3
800.00	0.389	-66.9	5.830	103.5	0.109	57.0	0.530	-44.6
1000.00	0.307	-73.5	4.939	93.6	0.131	56.4	0.446	-48.9
1200.00	0.253	-79.7	4.391	86.9	0.151	56.4	0.414	-52.5
1400.00	0.202	-85.5	3.865	81.4	0.175	55.2	0.379	-55.2
1600.00	0.157	-91.8	3.440	74.7	0.196	53.8	0.347	-58.4
1800.00	0.130	-96.2	3.155	70.1	0.213	53.5	0.313	-63.6
2000.00	0.108	-116.1	2.900	67.0	0.227	53.3	0.283	-65.6
2200.00	0.077	-142.5	2.614	61.5	0.241	50.7	0.268	-71.7

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 7 mA, Z<sub>o</sub> = 50 Ω

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.405	-61.9	7.590	109.4	0.077	59.1	0.570	-40.5
800.00	0.305	-72.5	6.043	98.4	0.101	59.0	0.469	-43.6
1000.00	0.229	-78.2	5.059	89.2	0.124	57.9	0.399	-46.6
1200.00	0.184	-84.9	4.454	83.2	0.145	59.2	0.374	-49.4
1400.00	0.141	-91.4	3.886	78.0	0.169	57.6	0.347	-51.8
1600.00	0.106	-98.8	3.455	71.6	0.191	56.2	0.322	-54.5
1800.00	0.086	-104.3	3.162	67.6	0.210	55.3	0.290	-59.5
2000.00	0.071	-136.6	2.898	64.6	0.224	55.9	0.264	-61.4
2200.00	0.060	-174.6	2.606	59.4	0.237	52.7	0.249	-67.2

$V_{CE} = 1\text{ V}$ ,  $I_c = 10\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.324	-71.3	7.550	104.5	0.069	62.8	0.526	-39.4
800.00	0.232	-82.5	5.924	94.2	0.096	61.0	0.434	-40.5
1000.00	0.167	-89.5	4.927	85.5	0.119	59.7	0.375	-42.1
1200.00	0.128	-98.6	4.307	80.0	0.141	61.4	0.355	-44.8
1400.00	0.094	-110.3	3.740	74.9	0.165	60.6	0.335	-47.0
1600.00	0.067	-127.3	3.326	68.7	0.187	58.2	0.314	-49.2
1800.00	0.055	-140.2	3.041	64.9	0.207	57.6	0.283	-54.0
2000.00	0.068	-176.6	2.781	62.2	0.219	57.4	0.262	-56.1
2200.00	0.083	153.2	2.498	56.9	0.235	54.8	0.247	-62.0

$V_{CE} = 2\text{ V}$ ,  $I_c = 1\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.901	-29.6	3.172	143.7	0.106	66.0	0.940	-24.4
800.00	0.811	-38.5	2.995	132.6	0.143	59.6	0.861	-30.3
1000.00	0.719	-47.8	2.797	121.7	0.172	55.0	0.778	-37.6
1200.00	0.671	-56.7	2.715	112.2	0.196	51.4	0.745	-45.0
1400.00	0.621	-62.9	2.646	105.3	0.220	47.9	0.712	-50.5
1600.00	0.549	-69.2	2.467	97.5	0.240	44.4	0.659	-55.0
1800.00	0.488	-75.6	2.343	89.8	0.255	43.6	0.601	-60.8
2000.00	0.438	-83.6	2.243	84.3	0.261	41.6	0.556	-65.6
2200.00	0.380	-91.1	2.095	77.3	0.268	37.8	0.522	-70.9

$V_{CE} = 2\text{ V}$ ,  $I_c = 3\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.678	-44.9	6.256	125.7	0.088	60.5	0.778	-34.8
800.00	0.543	-55.3	5.350	113.4	0.114	56.1	0.656	-40.4
1000.00	0.447	-63.1	4.650	102.7	0.137	54.8	0.563	-46.1
1200.00	0.388	-69.9	4.225	94.8	0.157	54.2	0.519	-50.7
1400.00	0.325	-74.0	3.809	88.9	0.176	53.1	0.481	-54.5
1600.00	0.270	-78.9	3.408	81.8	0.195	51.3	0.441	-57.3
1800.00	0.231	-82.5	3.144	76.3	0.214	51.5	0.397	-62.3
2000.00	0.193	-93.2	2.918	72.7	0.223	51.1	0.363	-65.0
2200.00	0.148	-103.1	2.647	66.8	0.236	48.8	0.343	-70.0

$V_{CE} = 2\text{ V}$ ,  $I_c = 5\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.539	-51.7	7.390	117.1	0.080	61.7	0.676	-37.8
800.00	0.415	-61.1	6.057	105.3	0.103	58.5	0.560	-41.6
1000.00	0.332	-66.2	5.136	95.5	0.125	57.5	0.478	-45.6
1200.00	0.280	-71.9	4.579	88.7	0.146	58.5	0.445	-49.2
1400.00	0.228	-74.8	4.043	83.3	0.168	57.3	0.413	-51.6
1600.00	0.183	-78.2	3.597	76.8	0.187	55.4	0.383	-54.0
1800.00	0.157	-80.9	3.298	72.2	0.207	55.4	0.345	-58.9
2000.00	0.123	-95.6	3.042	69.1	0.218	55.5	0.317	-61.2
2200.00	0.084	-108.3	2.746	63.7	0.232	52.6	0.301	-66.0

$V_{CE} = 2\text{ V}$ ,  $I_c = 7\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.442	-56.3	7.920	111.3	0.070	63.0	0.610	-38.1
800.00	0.331	-65.1	6.345	100.3	0.097	59.0	0.507	-40.7
1000.00	0.257	-67.8	5.311	91.1	0.118	57.7	0.434	-43.4
1200.00	0.213	-73.1	4.689	85.1	0.141	60.4	0.407	-45.9
1400.00	0.168	-74.5	4.103	80.1	0.162	59.5	0.386	-48.0
1600.00	0.132	-77.3	3.643	73.8	0.184	58.3	0.359	-50.5
1800.00	0.110	-79.7	3.335	69.8	0.204	57.4	0.323	-54.8
2000.00	0.081	-99.2	3.065	66.9	0.214	57.5	0.301	-56.9
2200.00	0.048	-123.7	2.760	61.7	0.231	54.8	0.286	-62.3

$V_{CE} = 2\text{ V}$ ,  $I_c = 10\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.358	-60.7	8.135	106.8	0.068	61.8	0.565	-36.5
800.00	0.264	-68.8	6.411	96.5	0.090	62.0	0.475	-38.3
1000.00	0.199	-70.8	5.335	87.8	0.113	61.6	0.414	-40.1
1200.00	0.158	-75.7	4.674	82.4	0.139	62.5	0.392	-42.2
1400.00	0.121	-77.9	4.068	77.5	0.157	61.1	0.377	-44.8
1600.00	0.089	-80.4	3.610	71.4	0.180	59.7	0.352	-46.6
1800.00	0.073	-82.4	3.301	67.8	0.198	59.3	0.321	-50.6
2000.00	0.052	-114.2	3.027	65.1	0.211	58.9	0.298	-52.5
2200.00	0.030	-166.0	2.724	59.9	0.228	56.0	0.286	-58.0

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NEC devices 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)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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Anti-radioactive design is not implemented in this product.