

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

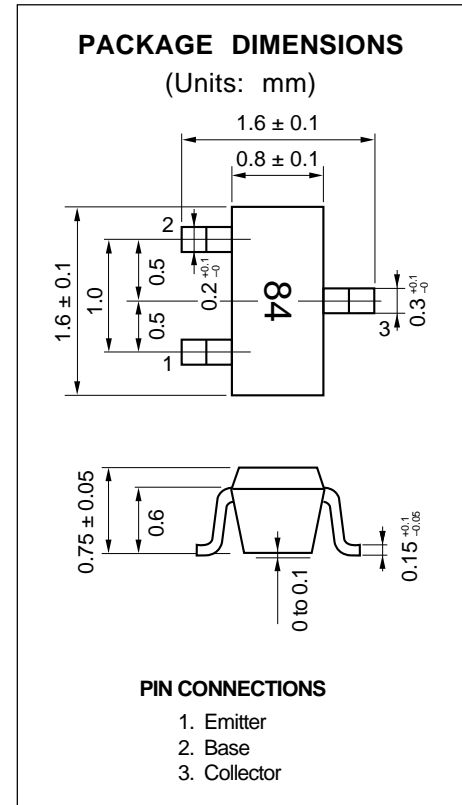
ORDERING INFORMATION

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	$^\circ\text{C}$



**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	$V_{CB} = 2\text{ V}, I_E = 0\text{ mA}, f = 1\text{ MHz}^{*2}$

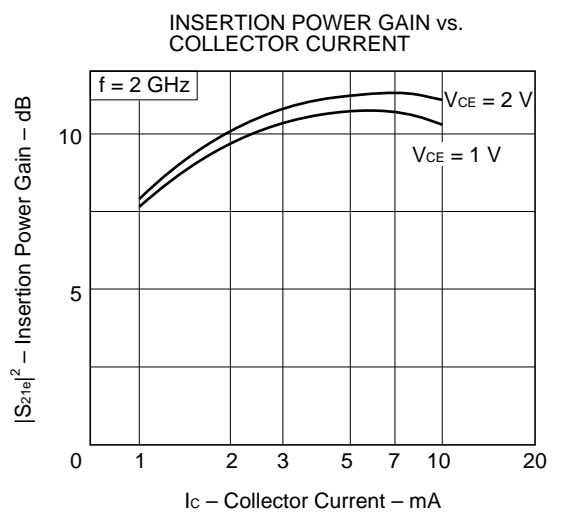
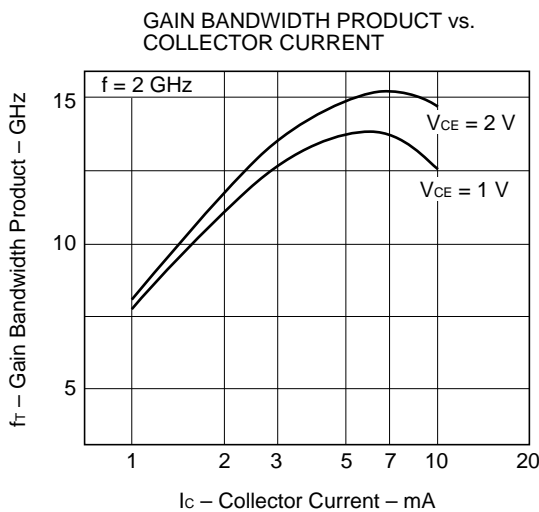
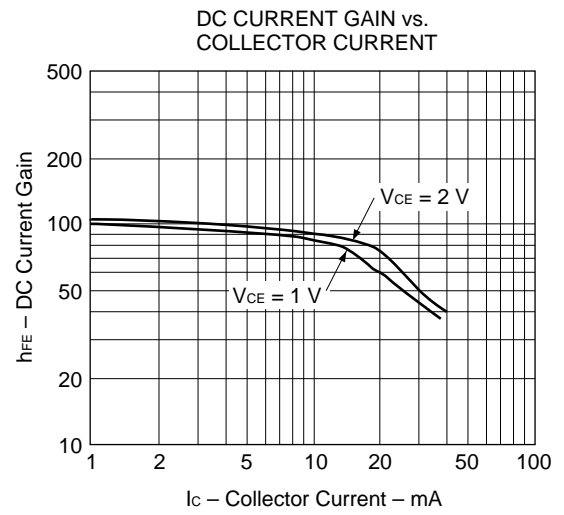
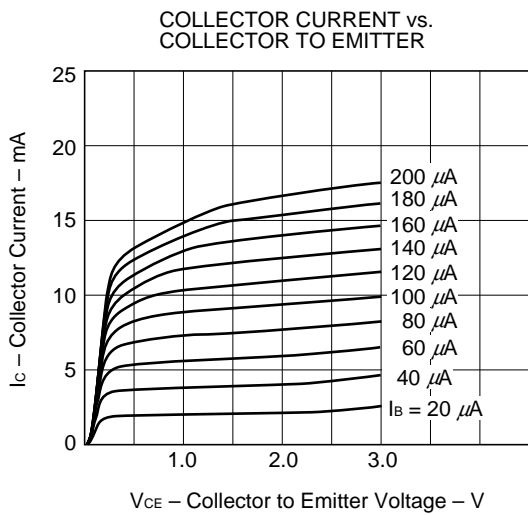
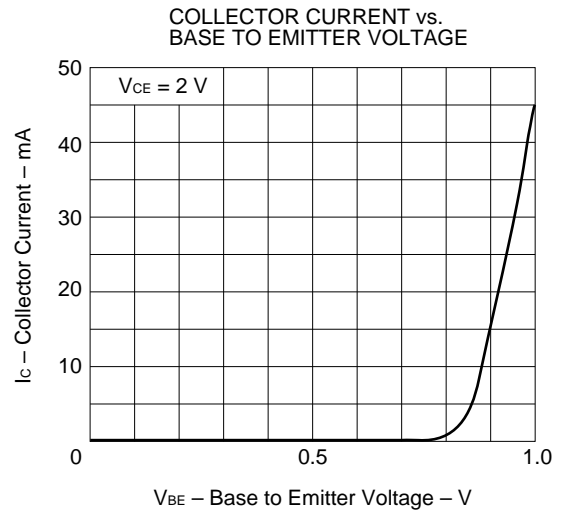
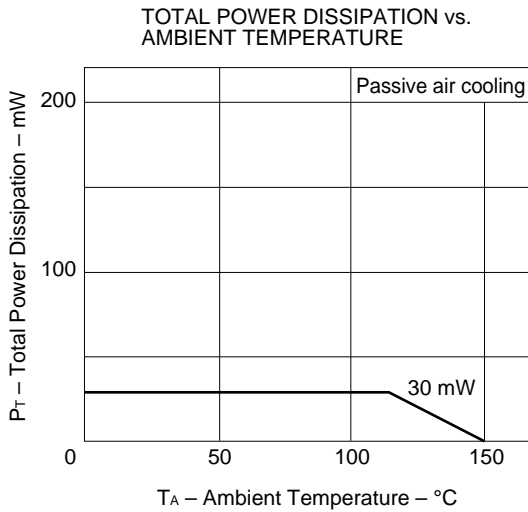
\*1. Measured with pulses: Pulse width  $\leq 350\ \mu\text{s}$ , duty cycle  $\leq 2\%$ , pulsed

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

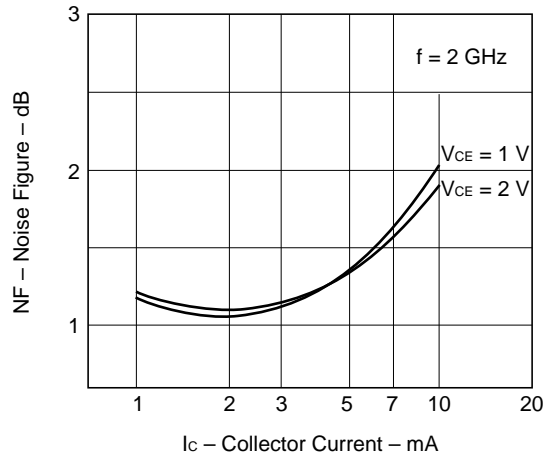
 **$h_{FE}$  Class**

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

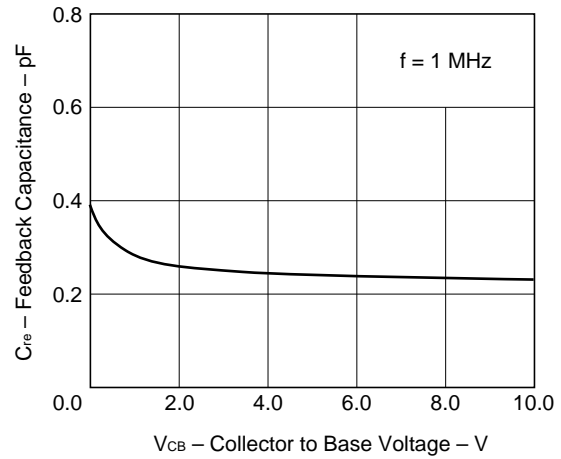
CHARACTERISTICS CURVES (T<sub>A</sub> = 25 °C)



NOISE FIGURE vs.  
COLLECTOR CURRENT



FEED-BACK CAPACITANCE vs.  
COLLECTOR TO BASE VOLTAGE



**S-PARAMETERS**

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

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.892	-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

$V_{CE} = 1\text{ V}$ ,  $I_c = 3\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.653	-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

$V_{CE} = 1\text{ V}$ ,  $I_c = 3\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.514	-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

$V_{CE} = 1\text{ V}$ ,  $I_c = 7\text{ mA}$ ,  $Z_o = 50\ \Omega$

FREQUENCY	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
600.00	0.405	-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:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

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.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.