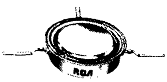
RCA
Solid State
Division

Power Transistors

2N6479 2N6481
2N6480 2N6482



(RADIAL)

H-1354

Radiation-Hardened Silicon N-P-N Power Transistors

Epitaxial-Planar Types for
Aerospace and Military Applications

Rated for Operation in Radiation Environments with Cumulative Neutron Fluence Levels to 1 x 10^{14} Neutrons/cm^2 and Gamma Intensity to 1 x 10^8 Rad(Si)/s

RCA types 2N6479, 2N6480, 2N6481, and 2N6482• are epitaxial silicon n-p-n planar power-switching transistors. They are designed for aerospace applications in which they might be subjected to extreme neutron and gamma-ray exposure.

The 2N6479, 2N6480, 2N6481, and 2N6482 are intended for use in 5-to-10 ampere high-frequency power inverter service. Types 2N6479 and 2N6481 differ from types 2N6480 and 2N6482, respectively, in voltage and power ratings. In types 2N6479 and 2N6480, the collector is isolated from the case.

• Formerly RCA Dev. Nos. TA8007, TA8007B, TA8100, and TA8100B, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

		2N6479	2N6480	2N6481	2N6482	
* COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	100	100	100	100	V
COLLECTOR-TO-EMITTER SUSTAINING VOLTAGE:						
* With external base-to-emitter resistance (R_{BE}) ≤ 100 Ω	$V_{CER}(sus)$	80	100	80	100	V
With base open	$V_{CEO}(sus)$	60	80	60	80	V
* EMITTER-TO-BASE VOLTAGE	V_{EBO}	6	6	6	6	V
* CONTINUOUS COLLECTOR CURRENT	I_C	12	12	12	12	A
* PEAK COLLECTOR CURRENT		25	25	25	25	A
* CONTINUOUS BASE CURRENT	I_B	5	5	5	5	A
* TRANSISTOR DISSIPATION:	P_T					
At case temperatures up to 25°C		87	87	117	117	W
At case temperatures above 25°C		See Figs. 1,2, and 4				
* TEMPERATURE RANGE:						
Storage and Operating (Junction)		-65 to +200				°C
* TERMINAL TEMPERATURE (During Soldering):						
At distance ≥ 1/32 in. (0.8 mm) from seating plane for 10 s max.		230				°C

* In accordance with JEDEC registration data format JS-6 RDF-1.

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ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C*

PRE-RADIATION

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS				UNITS
		VOLTAGE V dc		CURRENT A dc		2N6479 2N6481		2N6480 2N6482		
		V_{CE}	V_{EB}	I_B	I_C	MIN.	MAX.	MIN.	MAX.	
Collector Cutoff Current: With emitter open, V_{CB} = 100 V	I_{CBO}						1	–	1	mA
With base shorted	I_{CES}	60				–	200	–	200	μA
* With base-emitter junction reverse-biased	I_{CEV}	100	0			–	1	–	1	mA
* At T_C = 100°C		60	0			–	1	–	1	
* Emitter Cutoff Current	I_{EBO}		6			–	2	–	2	mA
Emitter-to-Base Voltage: I_E = 2 mA	V_{EBO}					6	–	6	–	V
Collector-to-Emitter Sustaining Voltage: * With base open	$V_{CEO}(sus)$				0.2[a]	60[b]	–	80[b]	–	V
With external base-to-emitter resistance (R_{BE}) = 100 Ω	$V_{CER}(sus)$				0.2	80[b]	–	100[b]	–	
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			1.2	12[a]		0.75	–	0.75	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			1.2	12[a]		1.5	–	1.5	V
* DC Forward Current Transfer Ratio	h_{FE}	2			12[a]	20	300	20	300	
Second Breakdown Collector Current: With base forward-biased, t = 1 s	$I_{S/b}$	12				7.3	–	7.3	–	A
Second Breakdown Energy: With base reverse-biased, R_{BE} = 100 Ω, L = 100 μH	$E_{S/b}$**				5	1.25	–	1.25	–	mJ
* Saturated Switching Time (V_{CC} = 30 V, I_{B1} = I_{B2}): Rise	t_r			1.2	12	–	400	–	400	ns
Storage	t_s			1.2	12	–	800	–	800	
Fall	t_f			1.2	12	–	200	–	200	
* Magnitude of Common Emitter Small-Signal Short Circuit Forward Current Transfer Ratio: f = 10 MHz	$\|h_{fe}\|$	5			1	10	-	10	–	
Collector-to-Base Feedback Capacitance: V_{CB} = 10 V, f = 1 MHz	C_{ob}					–	400	–	400	pF
						2N6479 2N6480		2N6481 2N6482		
Thermal Resistance: Junction-to-Case	$R_{\theta JC}$	10			5	–	2	–	1.5	°C/W

* In accordance with JEDEC registration data format JS-6 RDF-1.

[a] Pulsed; pulse duration ≤ 350 μs, duty factor ≤ 2%.

[b] CAUTION: The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ MUST NOT be measured on a curve tracer. These sustaining voltages should be measured by means of the test circuit shown in Fig.13.

POST-NEUTRON-RADIATION ELECTRICAL CHARACTERISTICS
AFTER EXPOSURE TO 5 x 10^{13} NEUTRONS/cm^2 (1 MeV equiv.), *At Case Temperature (T_C) = 25°C*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS				LIMITS		UNITS
		VOLTAGE V dc		CURRENT A dc		For all Types		
		V_{CE}	V_{BE}	I_C	I_B	MIN.	MAX.	
* Collector Cutoff Current: With base-emitter junction reverse-biased	I_{CEV}	100	0			–	1.2	mA
* Emitter Cutoff Current	I_{EBO}		−5			–	2.2	mA
* Collector-to-Emitter Sustaining Voltage: With base open	$V_{CEO}(sus)$			0.2 0.2	0.05 0.05	80[b] 60[c]	– –	V
* Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$			7[a]	1.4	–	1.5	V
* Base-to-Emitter Saturation Voltage	$V_{BE}(sat)$			7[a]	1.4	–	1.5	V
* DC Forward Current Transfer Ratio	h_{FE}	5		7[a]		12	–	
Magnitude of Common Emitter, Small-Signal Short Circuit Forward Current Transfer Ratio: Ratio (f = 10 MHz)	$\|h_{fe}\|$	5		1		10	–	
* Damage Constant	K▲					–	9 x 10^{-16}	

* In accordance with JEDEC registration data format JS-6 RDF-1.

a Pulsed; pulse duration ≤ 350 μs, duty factor ≤ 2%.

b For types 2N6480, 2N6482.

c For types 2N6479, 2N6481.

▲Damage constant $K = \dfrac{\dfrac{1}{h_{FE_2}} - \dfrac{1}{h_{FE_1}}}{\phi}$

Where h_{FE_1} = Beta prior to exposure
h_{FE_2} = Beta after exposure
ϕ = Neutron fluence (1 MeV equiv.)

Knowing K, h_{FE_2} may be calculated for other fluences using the relationship:

$$h_{FE_2} = \frac{1}{K\phi + \dfrac{1}{h_{FE_1}}}$$

TYPICAL CHARACTERISTIC DURING GAMMA EXPOSURE FOR DOSE RATES OF LESS THAN 1 x 10^8 RAD(Si)/sec

CHARACTERISTIC	SYMBOL	TEST CONDITIONS		LIMITS	UNITS
		VOLTAGE – V dc		For all Types	
		V_{CB}	V_{BE}	TYPICAL	
Collector-to-Base Charge Generation Constant	(C)	20	0	5x10^{-8}	Coulomb / Rad

The charge generated in the depletion region of a transistor is proportional to the volume of the depletion region, the total dose, and the energy of the gamma radiation.

The primary base-collector photo current $[I_{pp(base)}]$ = $(C)\dot{\gamma}$, where $\dot{\gamma}$ is the gamma dose rate in Rad(Si)/s.

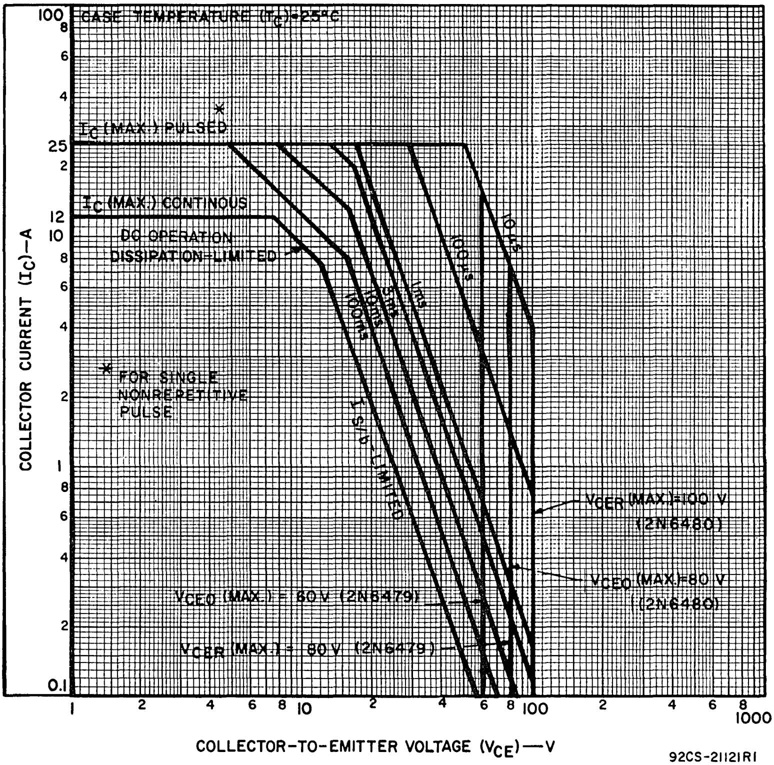


Fig.1 – Maximum operating areas for 2N6479 and 2N6480.

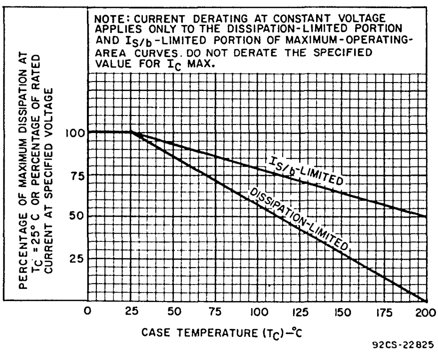


Fig.2 – Derating curves for all types.

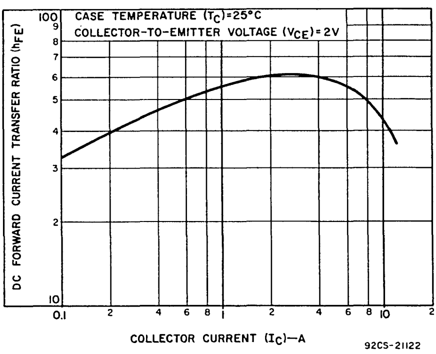


Fig.3 – Typical dc beta characteristic for all types.

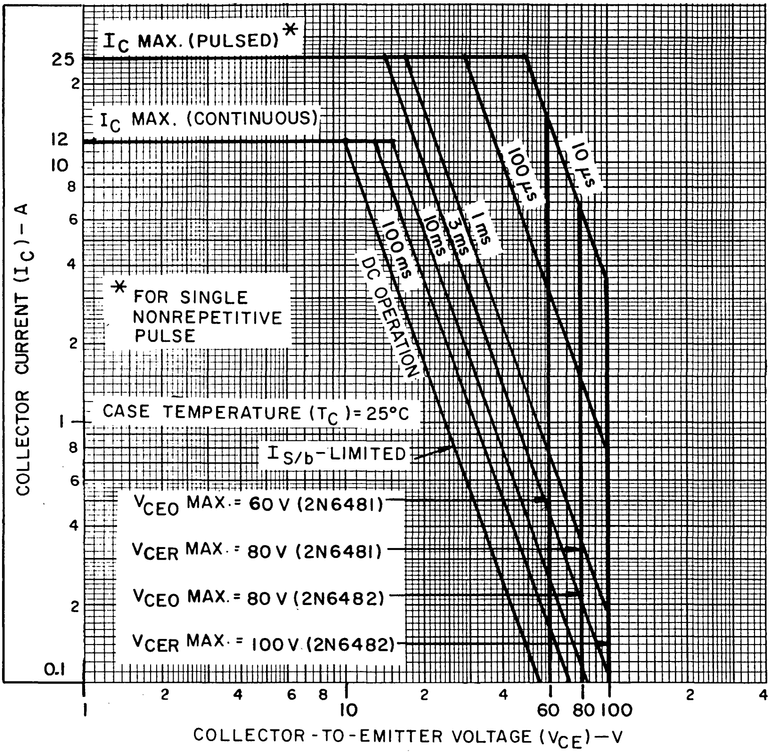


Fig.4 – Maximum operating areas for 2N6481 and 2N6482.

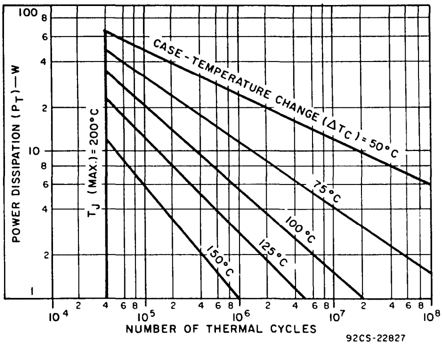


Fig.5 – Thermal-cycling rating chart for 2N6479 and 2N6480.

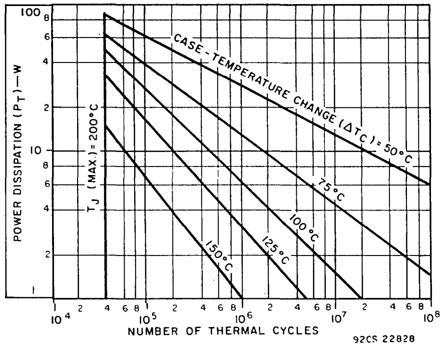


Fig.6 – Thermal-cycling rating chart for 2N6481 and 2N6482.

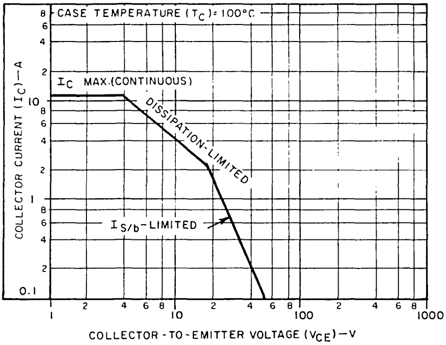


Fig.7 – Maximum operating area for 2N6479 and 2N6480 at 100°C case temperature.

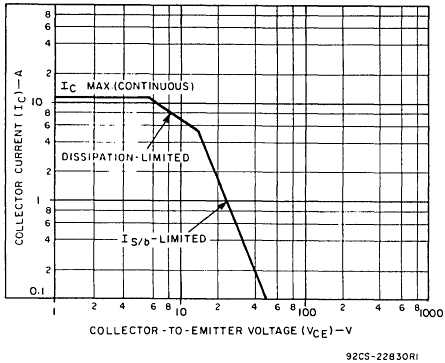
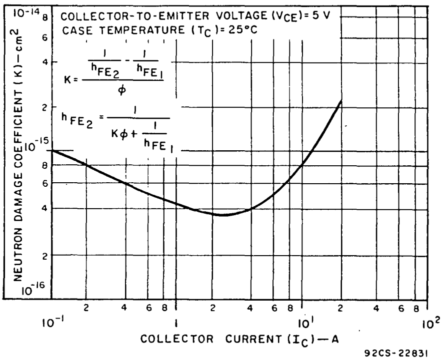


Fig.8 – Maximum operating area for 2N6481 and 2N6482 at 100°C case temperature.



$$K = \frac{\frac{1}{h_{FE_2}} - \frac{1}{h_{FE_1}}}{\phi}$$

$$h_{FE_2} = \frac{1}{K\phi + \frac{1}{h_{FE_1}}}$$

Fig.9 – Typical 1-MeV-equivalent neutron damage coefficient as a function of collector current for all types.

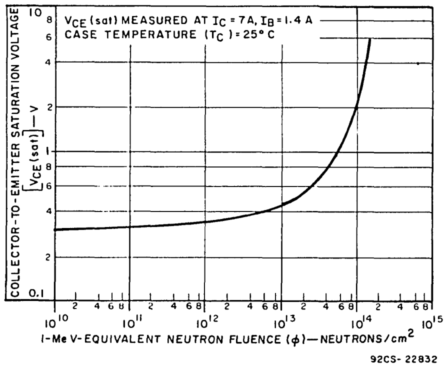


Fig.10 – Typical collector-to-emitter saturation voltage as a function of 1-MeV-equivalent neutron fluence for all types.

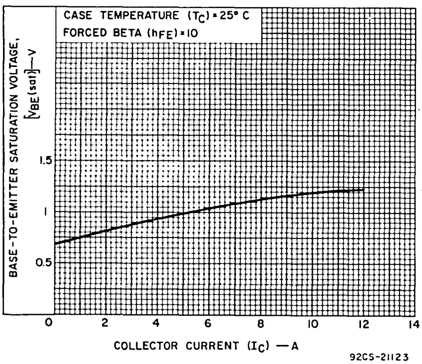


Fig.11 – Typical base-to-emitter saturation voltage characteristic for all types.

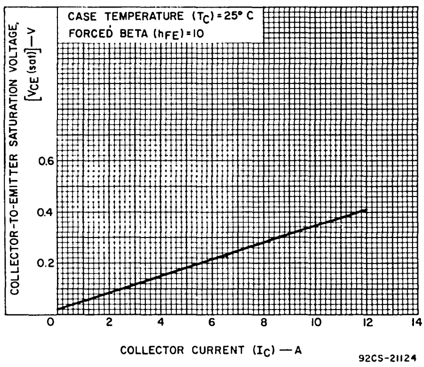


Fig.12 – Typical collector-to-emitter saturation voltage characteristic for all types.

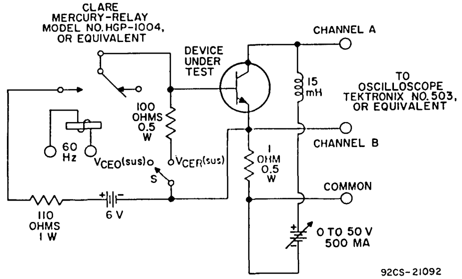
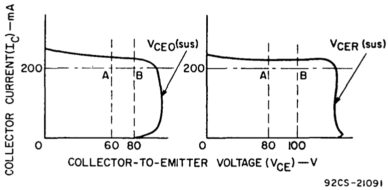


Fig.13 — Circuit used to measure sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$.



The sustaining voltages $V_{CEO}(sus)$ and $V_{CER}(sus)$ are acceptable when the traces fall to the right of point "A" for types 2N6479 and 2N6481. The traces must fall to the right of point "B" for 2N6480 and 2N6482.

Fig.14 — Oscilloscope display for $V_{CEO}(sus)$ and $V_{CER}(sus)$ measurement. (Test circuit shown in Fig.13).

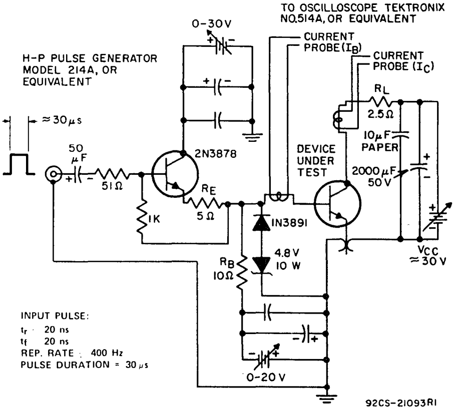


Fig.15 — Circuit used to measure saturated switching times.

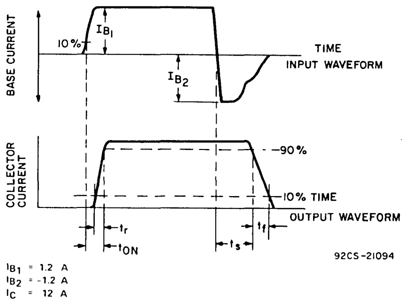


Fig.16 — Phase relationship between input and output currents showing reference points for specification of switching times. (Test circuit shown in Fig.15).

TERMINAL CONNECTIONS

	2N6479 2N6480	2N6481 2N6482
Terminal No. 1	Base	Base
Terminal No. 2	Collector	Collector, Case
Terminal No. 3	Emitter	Emitter