NPN SILICON POWER TRANSISTORS

RADIATION RESISTANT

20 AMPERES

FEATURES

HIGH POWER
RADIATION EXPOSURE LEVEL TO 5×10^{14} nvt
TOTAL NEUTRON FLUX GREATER THAN 10 KEV

APPLICATIONS

POWER AMPLIFIER
RADIATION ENVIRONMENTS
ULTRA HIGH FREQUENCY

TO-*61

*All leads isolated from case

ABSOLUTE MAXIMUM RATINGS

		2N5535 2N5536*	2N5537 2N5538*
V_{CBO}	COLLECTOR-BASE VOLTAGE	60 V	90 V
V_{CEO}	COLLECTOR-EMITTER VOLTAGE	50 V	75 V
V_{EBO}	EMITTER-BASE VOLTAGE	3 V	3 V
I_C	CONTINUOUS COLLECTOR CURRENT	20 A	20 A
I_B	CONTINUOUS BASE CURRENT	8 A	.8 A
T_J	OPERATING JUNCTION TEMPERATURE	−65°C to +200°C	
T_{stg}	STORAGE TEMPERATURE	−65°C to +200°C	
$R_{\theta JC}$	THERMAL RESISTANCE, JUNCTION TO CASE	3.5°C/W	
P_D	POWER DISSIPATION (25°C)	50 W	

8-83-3R

RADIATION RESISTANT NPN SILICON POWER TRANSISTORS

SOLITRON DEVICES INC

2N5535 2N5536 2N5537 2N5538

ELECTRICAL CHARACTERISTICS (T_C = 25°C UNLESS OTHERWISE NOTED)

CHARACTERISTICS		SYMBOL	MIN.	MAX.	UNITS
COLLECTOR EMITTER SUSTAINING VOLTAGE[1]		$V_{CEO(sus)}$			
(I_C = 50 mA)	2N5535, 2N5536		50		V
	2N5537, 2N5538		75		V
(I_C = 50 mA, NOTE 2)	2N5535, 2N5536		50		V
	2N5537, 2N5538		75		V
COLLECTOR-CUTOFF CURRENT		I_{CEX}			
(V_{CE} = 30V, V_{BE} = 0, T_C = 100°C)				1.0	mA
COLLECTOR-CUTOFF CURRENT		I_{CBO}			
(V_{CB} = RATED)				1.0	mA
(V_{CB} = RATED, NOTE 2)				1.0	mA
COLLECTOR-CUTOFF CURRENT		I_{CBO}			
(V_{CB} = 30V)				0.1	mA
(V_{CB} = 30V, NOTE 2)	2N55335, 2N55336			1.0	mA
(V_{CB} = 30V, NOTE 2)	2N55337, 2N55338			2.0	mA
COLLECTOR-CUTOFF CURRENT		I_{CEO}			
(V_{CE} = RATED)				50	mA
EMITTER CUTOFF CURRENT		I_{EBO}			
(V_{EB} = 3.0V)				1.0	mA
(V_{EB} = 3.0V, NOTE 2)				1.0	mA
EMITTER FLOATING POTENTIAL		V_{EBF}			
(V_{CB} = RATED, I_E = 0)				1.0	V
DC CURRENT GAIN[1]		h_{FE}			
(V_{CE} 5.0V, I_C = 0.5A)	2N5535, 2N5536		50		
(V_{CE} 5.0V, I_C = 5.0A)	2N5537, 2N5538		40		
(V_{CE} 5.0V, I_C = 10A)	2N5535, 2N5536		30	150	
(V_{CE} 5.0V, I_C = 10A)	2N5537, 2N5538		20	150	
(V_{CE} 3.0V, I_C = 20A)			3.33		
(V_{CE} 5.0V, I_C = 5.0A, NOTE 2)	2N5535, 2N5536		15		
(V_{CE} 5.0A, I_C = 5.0A NOTE 2)	2N5537, 2N5538		10		
COLLECTOR-EMITTER SATURATION VOLTAGE[1]		$V_{CE(sat)}$			
(I_C = 5.0A, I_B = 1.0A)				1.25	V
(I_C = 20A, I_B = 6.0A)				3.0	V
(I_C = 5.0A, I_B = 1.0A, NOTE 2)	2N5535, 2N5536			2.0	V
(I_C = 5.0A, I_B = 1.0A, NOTE 2)	2N5537, 2N5538			2.5	V
BASE-EMITTER SATURATION VOLTAGE[1]		$V_{BE(sat)}$			
(I_C = 5.0A, I_B = 1.0A)				1.5	V
BASE-EMITTER VOLTAGE		V_{BE}			
(V_{CE} = 5.0V, I_C = 5.0A)				1.5	V
MAGNITUDE OF SMALL SIGNAL GAIN		$[h_{fe}]$			
(V_{CE} = 28V, I_C = 0.5A, f = 25 MHz)			6.0		
SMALL SIGNAL GAIN		h_{fe}			
(V_{CB} = 5.0V, I_C = 5.0A, f = 1.0 KHz)	2N5535, 2N5536		25		
	2N5537, 2N5538		20		
OUTPUT CAPACITANCE		C_{obo}			
(V_{CB} = 30V, f = 1.0 MHz)				100	pF
PULSE DELAY TIME		t_d			
(V_{CC} = 55V, I_C = 10A, I_{B1} = $-I_{B2}$ = 1.0A)				25	nsec
PULSE RISE TIME		t_r			
(V_{CC} = 55V, I_C = 10A, I_{B1} = $-I_{B2}$ = 1.0A)				200	nsec

Note 1: Pulsed 300μsec, 1.8% Duty Cycle **Note 2: After exposure, 1×10^{14} nvt, FLUX ≥ 10 KEV**

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2N5535 2N5536 2N5537 2N5538

ELECTRICAL CHARACTERISTICS (T_C = 25°C UNLESS OTHERWISE NOTED)

CHARACTERISTICS	SYMBOL	MIN.	MAX.	UNITS
PULSE STORAGE TIME (V_{CC} = 55V, I_C = 10A, I_{B1} = $-I_{B2}$ = 1.0A)	t_s		300	nsec
PULSE FALL TIME (V_{CC} = 55V, I_C = 10A, I_{B1} = $-I_{B2}$ = 1.0A)	t_f		300	nsec
PROMPT PRIMARY PHOTO CURRENT ($\dot{\gamma}$ = 1×10^9 R/sec, $\in \geq$ 1 Mev, V_{CB} = 10V)	I_{ppc}		2.0	A(PK)

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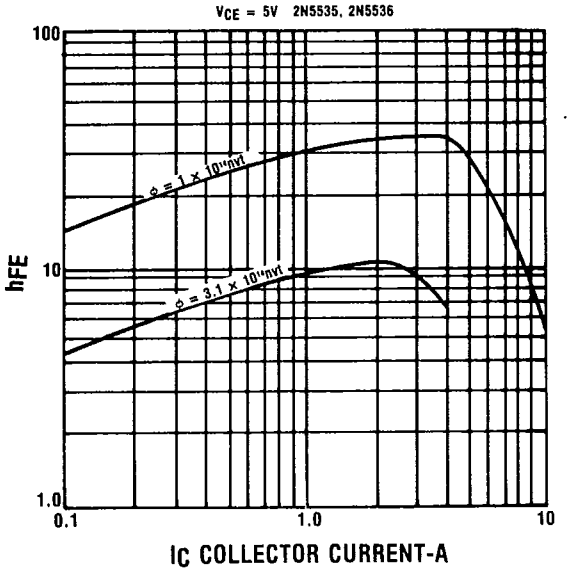
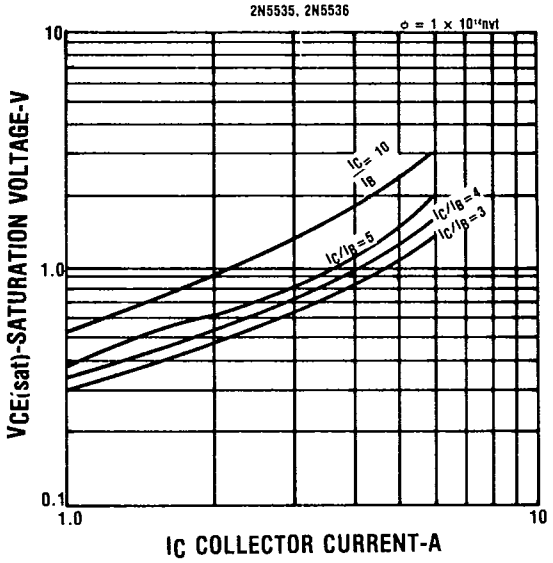
TYPICAL STATIC FORWARD CURRENT TRANSFER RATIO



TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE



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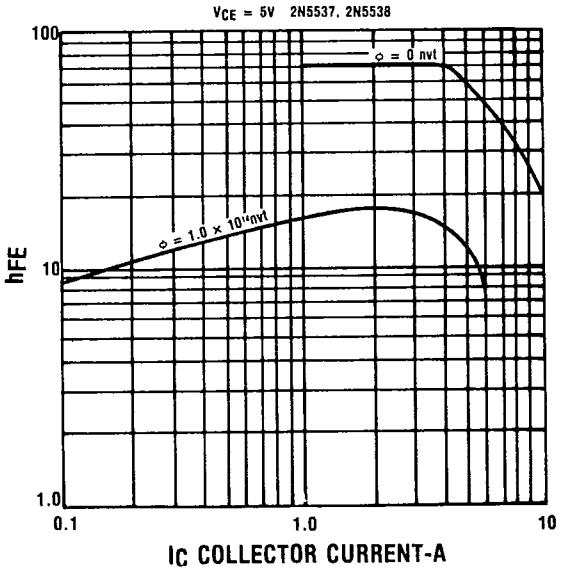

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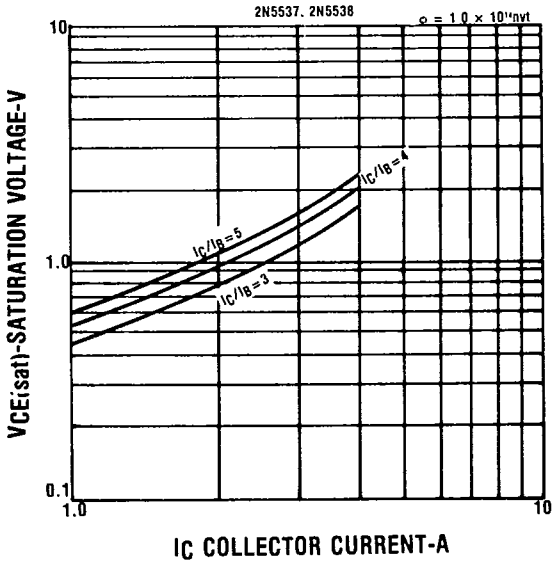

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2N5535 2N5536 2N5537 2N5538

SAFE OPERATING AREA (SOAR) INFORMATION

The Safe Operating ARea (SOAR) principle is a method of specifying the exact transistor to use in an amplifier, switching or DC application. SOAR defines the region which encloses all of the points representing simultaneous values of the collector current and the collector-to-emitter voltage which a transistor can safely handle under specified conditions for base current, time, junction temperature and average power dissipation. With transistors specified under the Solitron SOAR technique, secondary breakdown is virtually eliminated.

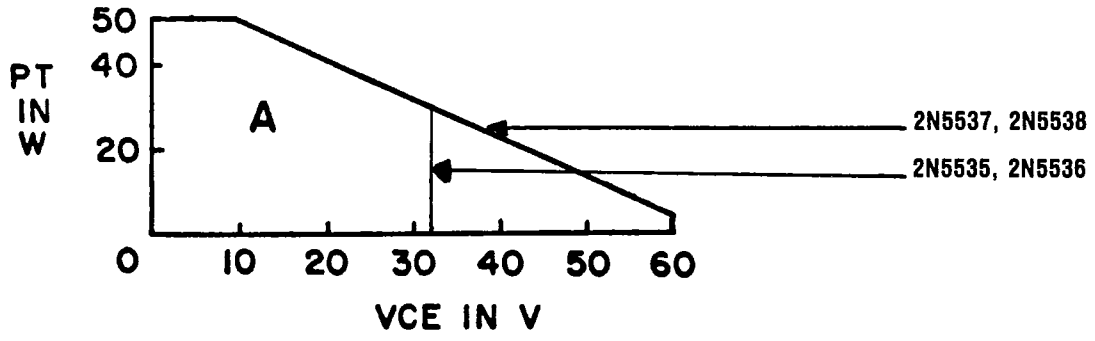
The suggested test circuits are shown for each type of SOAR operation. Any other thermally stable circuit may also be used as long as the SOAR conditions and maximum ratings are observed.

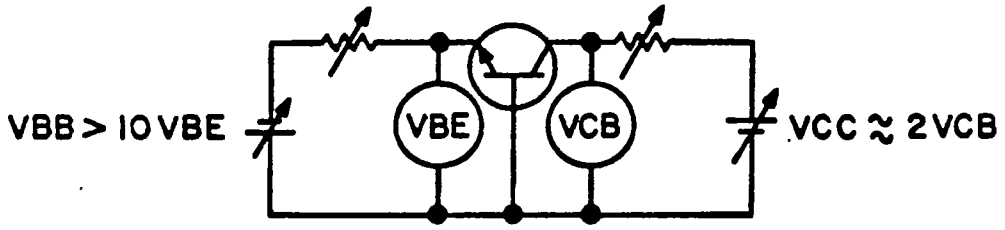
SOAR VALUES

TYPE NUMBER	V1 V	V2 V
2N5535	40	60
2N5536	40	60
2N5537	65	90
2N5538	65	90

CONTINUOUS DC OPERATION

Conditions: 1. $T_J = T_{CASE} + \Theta_{J-C}$ PDC $\leq$ 200°C
2. $V_{CE} \leq$ 0.8 V1 rating for specified transistor type
3. $P_T \leq P_T$ max rating for specified transistor type.
4. $I_C \leq$ 20A
5. $P_T \leq P_T = f(V_{CE})$ Area A



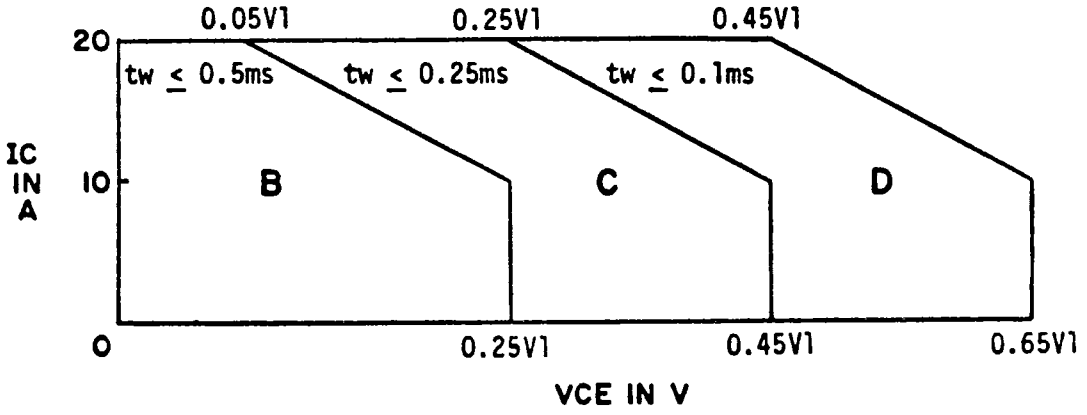


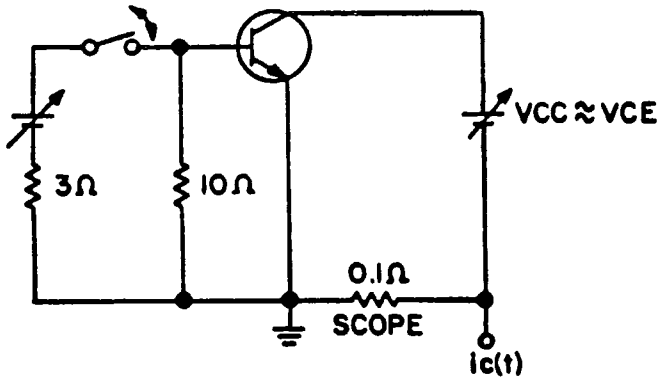
RADIATION RESISTANT NPN SILICON POWER TRANSISTORS

PULSED FORWARD BIASED OPERATION

Conditions:

1. $T_J = T_{CASE} + \Theta_{J-C}$ Pavg $\leq$ 200°C
2. Pavg $= \frac{1}{4\text{ ms}} \int_0^{4\text{ms}}$ ic vce dt $\leq$ the allowed continuous DC power dissipation for a V_{CE} equal to the highest v_{ce} applied to the transistor.
3. Operation in the active region should be limited to a maximum pulse width of t_W = 0.5 ms for Area B, t_W = 0.25 ms for Area C and t_W = 0.1 ms for Area D. $t_r \leq 5\mu s$ and $t_f \leq 5\mu s$ for Areas B-D.





SUGGESTED TEST FREQUENCY f•25Hz

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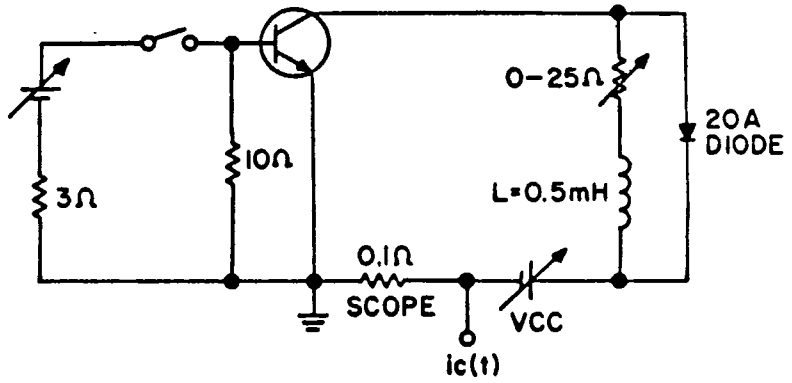
2N5535 2N5536 2N5537 2N5538

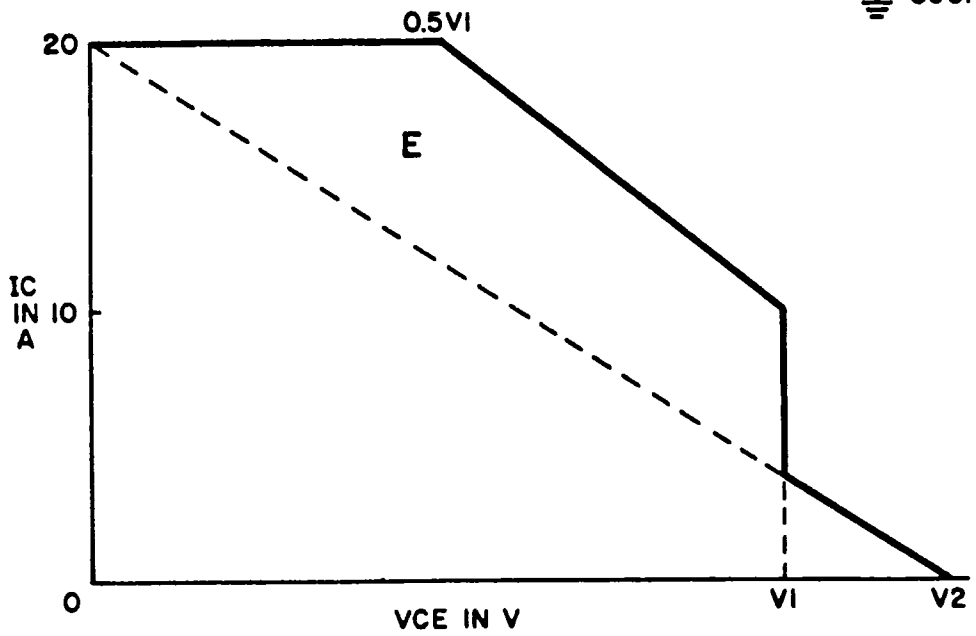
RESISTIVE AND CLAMPED INDUCTIVE SWITCHING

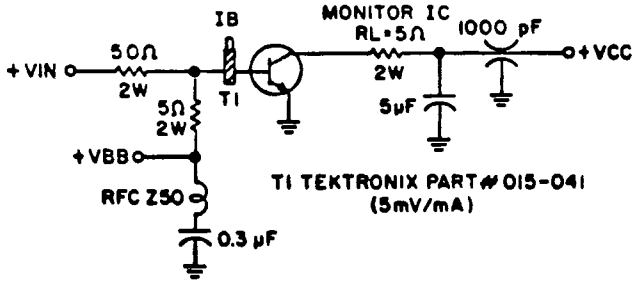
(Switching from saturation to cutoff)

Conditions:

1. $T_J = T_C + \Theta_{J-C}$ Pavg $\leq$ 200°C
2. Pavg $= \frac{1}{4ms} \int_0^{4ms}$ ic vce dt $\leq P_T$ max.
3. For the resistive loadline, L = 0 and V_{CC} = V2 in the given circuit
4. tr $\leq 2\mu s$, tf $\leq 2\ \mu s$ in Area E







SATURATED SWITCHING TEST CIRCUIT

Maximum Switching Times: $t_d \leq$ 25 ns:

$t_r \leq$ 200 ns; $t_s \leq$ 300 ns; $t_f \leq$ 300 ns

Test Conditions: V_{in} = 70 V when generator with 50Ω internal impedance is terminated in a 50 Ω load. V_{BB} = −5 V; V_{CC} = 55 V; $I_C \cong$ 10 A; IB_1 = 1 A, $IB_2 \cong$ 1 A; t_p = 400 ns; f = 720 Hz.

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UNCLAMPED INDUCTIVE SWITCHING

(Switching from saturation to cutoff)

Conditions:

1. $T_J = T_C + \Theta_{J-C}$ Pavg $\leq$ 200°C
2. Pavg $= \frac{1}{4ms} \int_0^{4ms}$ ic vce dt $\leq P_T$ of Area A at 0.8 V1
3. ½ $LIC^2 \leq$ 8 mWs