TYPES 2N4999, 2N5001, 2N5147, 2N5149
P-N-P SILICON POWER TRANSISTORS

TYPES 2N4999, 2N5001, 2N5147, 2N5149
BULLETIN NO. DL-S 7111493, SEPTEMBER 1971
REVISED NOVEMBER 1971

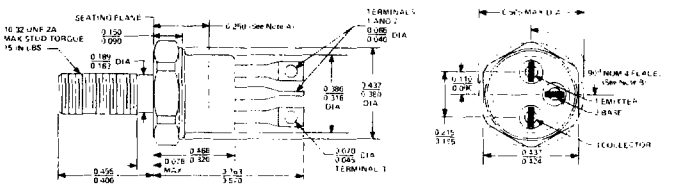
5

HIGH-FREQUENCY POWER TRANSISTORS WITH COMPUTER-DESIGNED ISOTHERMAL GEOMETRY

- For Complementary Use With 2N4998, 2N5000, 2N5148, and 2N5150
- 6 mJ Reverse Energy Rating with I_C = 5 A and 4 V Reverse Bias

*mechanical data

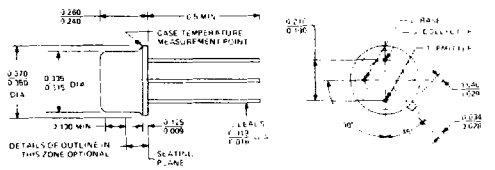
2N4999, 2N5001 — ALL TERMINALS ARE INSULATED FROM THE CASE



ALL JEDEC TO-59 DIMENSIONS AND NOTES ARE APPLICABLE

NOTES: A. Within this dimension, case diameter may vary.
B. Position of terminals with respect to hexagon is not controlled.
C. The case temperature may be measured anywhere on the seating plane within 0.125 inch of the stud.
D. All dimensions are in inches unless otherwise specified.

2N5147, 2N5149 — THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE



ALL JEDEC TO-39 DIMENSIONS AND NOTES ARE APPLICABLE

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	2N4999 2N5001	2N5147 2N5149
Collector-Base Voltage	← −100 V* →	
Collector-Emitter Voltage (See Note 1)	← −80 V* →	
Emitter-Base Voltage	← −5.5 V* →	
Continuous Collector Current	−2 A*	−2 A*
Peak Collector Current (See Note 2)	−5 A*	−5 A*
Continuous Base Current	−1 A*	−1 A*
Safe Operating Areas	See Figures 7* and 8	
Continuous Device Dissipation at 50°C Case Temperature (See Note 3)	30 W*	6 W*
Continuous Device Dissipation at 100°C Case Temperature (See Note 3)	20 W	4 W
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 4)	2 W	1 W*
Unclamped Inductive Load Energy (See Note 5)	← 6 mJ →	
Operating Collector Junction Temperature Range	−65°C to 200°C*	
Storage Temperature Range	−65°C to 200°C*	
Lead or Terminal Temperature 1/8 Inch from Case for 60 Seconds	← 300°C* →	

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. This value applies for $t_w \leq 8.3$ ms, duty cycle ≤ 1%.
3. For operation above (or below) 50°C case temperature, refer to Dissipation Derating Curves Figures 9 and 10.
4. Derate linearly to 200°C free-air temperature at the rate of 11.4 mW/°C for 2N4999 and 2N5001, 5.7 mW/°C for 2N5147 and 2N5149.
5. This rating is based on the capability of the transistors to operate safely in the unclamped inductive load circuit of Section 3.2 of the forthcoming JEDEC publication *Suggested Standards on Power Transistors*†. L = 0.48 mH, R_{BB1} = 20 Ω, R_{BB2} = 100 Ω, V_{BB1} = 10 V, V_{BB2} = 4 V, R_L = 0.1 Ω, V_{CC} = 10 V, I_{CM} = 5 A, Energy ≈ $I_C^2 L/2$.

*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

†This circuit appears on page 5-1 of this data book.

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 • DALLAS, TEXAS 75222

TYPES 2N4999, 2N5001, 2N5147, 2N5149
P-N-P SILICON POWER TRANSISTORS

*electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		2N4999 2N5147 MIN	2N4999 2N5147 MAX	2N5001 2N5149 MIN	2N5001 2N5149 MAX	UNIT
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	$I_C = -100$ mA, $I_B = 0$,	See Note 6	−80		−80		V
I_{CEO}	Collector Cutoff Current	$V_{CE} = -40$ V, $I_B = 0$			−50		−50	μA
I_{CES}	Collector Cutoff Current	$V_{CE} = -60$ V, $V_{BE} = 0$			−1		−1	μA
		$V_{CE} = -100$ V, $V_{BE} = 0$			−1		−1	mA
I_{CEV}	Collector Cutoff Current	$V_{CE} = -60$ V, $V_{BE} = 2$ V, $T_C = 150°C$			−500		−500	μA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = -4$ V, $I_C = 0$			−1		−1	μA
		$V_{EB} = -5.5$ V, $I_C = 0$			−1		−1	mA
h_{FE}	Static Forward Current Transfer Ratio	$V_{CE} = -5$ V, $I_C = -50$ mA	See Notes 6 and 7	20		50		
		$V_{CE} = -5$ V, $I_C = -1$ A		30	90	70	200	
		$V_{CE} = -5$ V, $I_C = -2$ A		15		30		
		$V_{CE} = -5$ V, $I_C = -3$ A		5		15		
		$V_{CE} = -5$ V, $I_C = -1$ A, $T_C = -55°C$		15		35		
V_{BE}	Base-Emitter Voltage	$I_B = -100$ mA, $I_C = -1$ A	See Notes 6 and 7		−1.2		−1.2	V
		$I_B = -200$ mA, $I_C = -2$ A			−1.5		−1.5	
		$V_{CE} = -5$ V, $I_C = -2$ A			−1.5		−1.5	
		$V_{CE} = -5$ V, $I_C = -3$ A			−3		−3	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_B = -100$ mA, $I_C = -1$ A	See Notes 6 and 7		−0.46		−0.46	V
		$I_B = -200$ mA, $I_C = -2$ A			−0.85		−0.85	
		$I_B = -600$ mA, $I_C = -3$ A			−5		−5	
h_{fe}	Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = -5$ V, $I_C = -0.1$ A, $f = 1$ kHz		20		50		
$\lvert h_{fe} \rvert$	Small-Signal Common-Emitter Forward Current Transfer Ratio	$V_{CE} = -5$ V, $I_C = -0.2$ A, $f = 20$ MHz		2.5		3		
C_{obo}	Common-Base Open-Circuit Output Capacitance	$V_{CB} = -10$ V, $I_E = 0$, $f = 1$ MHz			120		120	pF

NOTES: 6. This parameter must be measured using pulse techniques: $t_w = 300$ μs, duty cycle ≤ 1%.

7. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 0.125 inch from the device body.

*JEDEC registered data

thermal characteristics

PARAMETER		2N4999 2N5001 MAX	2N5147 2N5149 MAX	UNIT
$R_{\theta JC}$	Junction-to-Case Thermal Resistance	5	25	°C/W
$R_{\theta JA}$	Junction-to-Free-Air Thermal Resistance	87.5	175	

switching characteristics at 25°C case temperature

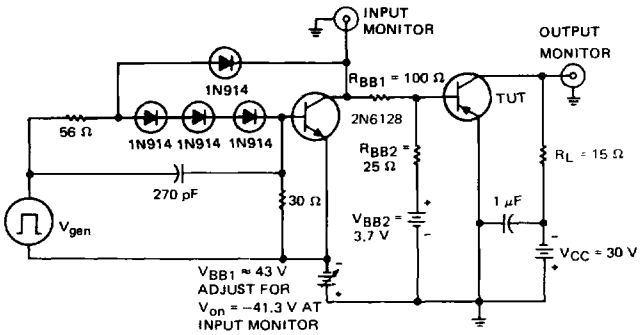
PARAMETER		TEST CONDITIONS†			ALL TYPES TYP	UNIT
t_{on}	Turn-On Time	$I_C = -2$ A,	$I_{B(1)} = -200$ mA,	$I_{B(2)} = 200$ mA,	0.2	μs
t_{off}	Turn-Off Time	$V_{BE(off)} = 3.7$ V,	$R_L = 15\ \Omega$,	See Figure 1	0.4	

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

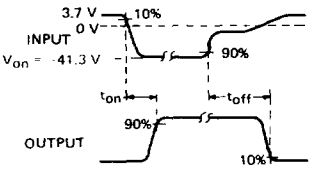
5

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 • DALLAS, TEXAS 75222

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. V_{gen} is a 30-V pulse (from 0 V) into a 50 Ω termination.
B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\ \Omega$, $t_w = 20\ \mu s$, duty cycle ≤ 2%.
C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10\ M\Omega$, $C_{in} \leq 11.5$ pF.
D. Resistors must be noninductive types.
E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1

TYPICAL CHARACTERISTICS

5

2N4999, 2N5147
STATIC FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT

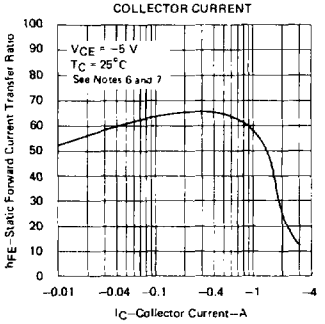


FIGURE 2

2N5001, 2N5149
STATIC FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT

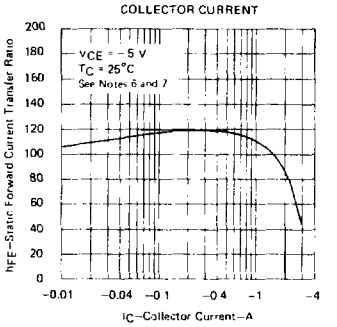


FIGURE 3

BASE-EMITTER VOLTAGE vs COLLECTOR CURRENT

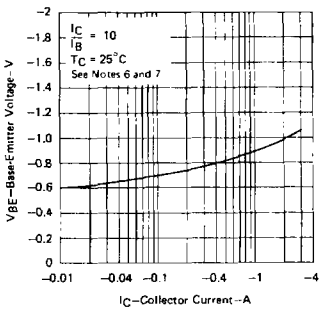


FIGURE 4

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

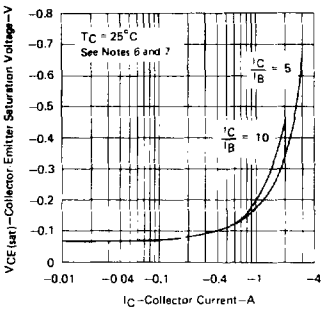


FIGURE 5

COMMON-BASE OPEN-CIRCUIT OUTPUT CAPACITANCE vs COLLECTOR-BASE VOLTAGE

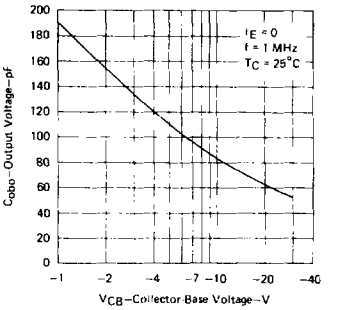


FIGURE 6

NOTES: 6. These parameters must be measured using pulse techniques. $t_w = 300\ \mu s$, duty cycle ≤ 1%.
7. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 0.125 inch from the device body.

MAXIMUM SAFE OPERATING AREAS

MAXIMUM COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE

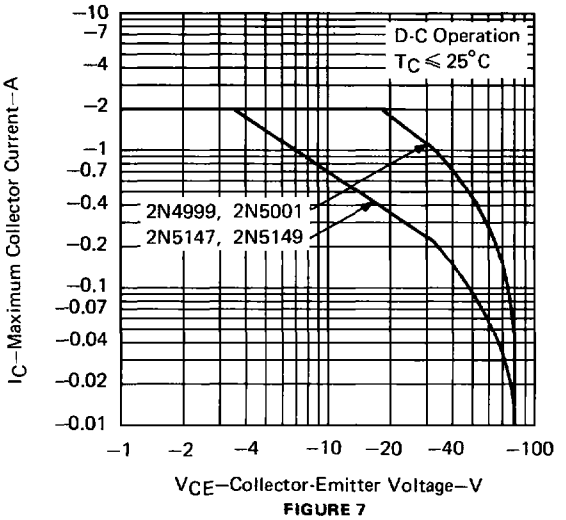


FIGURE 7

MAXIMUM COLLECTOR CURRENT
vs
UNCLAMPED INDUCTIVE LOAD

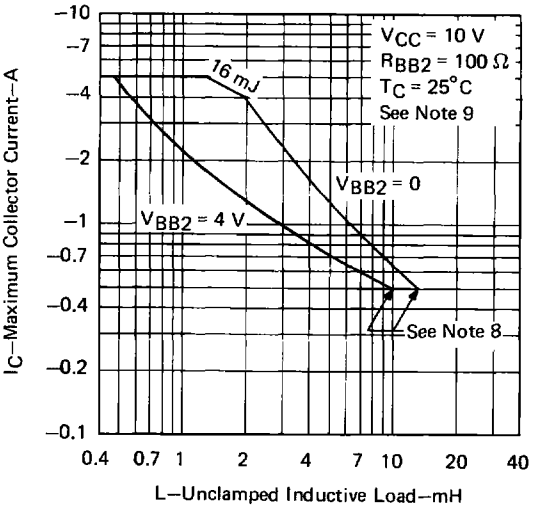


FIGURE 8

NOTES: 8. Above these points the safe operating areas have not been defined.

9. These curves are based on the capability of the transistors to operate safely in the unclamped inductive load circuit of Section 3.2 of the forthcoming JEDEC publication *Suggested Standards on Power Transistors.*† $R_{BB1} = 10 \cdot V_{BB1}/I_C$, $V_{BB1} = 10$ V, $R_L = 0.1\ \Omega$. Energy $\approx I_C^2 L/2$.

† This circuit appears on page 5-1 of this data book.

THERMAL CHARACTERISTICS

2N4999, 2N5001

DISSIPATION DERATING CURVE

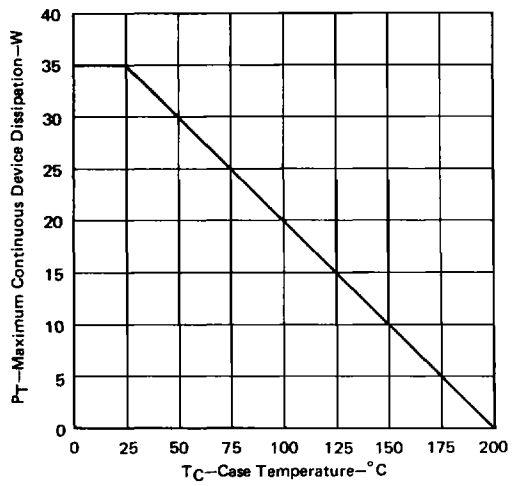


FIGURE 9

2N5147, 2N5149

DISSIPATION DERATING CURVE

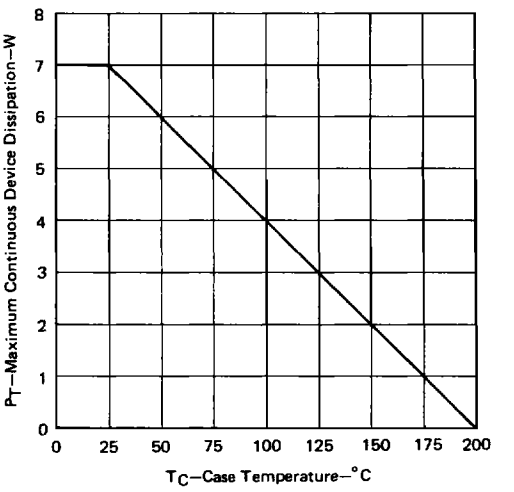


FIGURE 10

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 5012 • DALLAS, TEXAS 75222