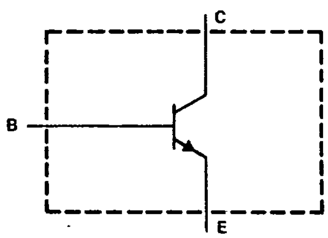
2N5301, 2N5302, 2N5303
N-P-N SILICON POWER TRANSISTORS

FEBRUARY 1969 – REVISED OCTOBER 1984

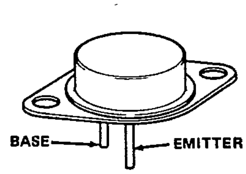
- **Designed for Complementary Use With 2N4398, 2N4399**
- **200 W at 25°C Case Temperature**
- **30 A Continuous Collector Current (2N5301, 2N5302)**
- **20 A Continuous Collector Current (2N5303)**
- **50 A Peak Collector Current**
- **Min f_T of 2 MHz at 10 V, 1 A**
- **Suitable for Use in Power Amplifier and High-Speed Switching Applications**

2 — 2N Devices

device schematic



TO-3 PACKAGE



THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE

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

	2N5301	2N5302	2N5303
*Collector-base voltage	40 V	60 V	80 V
*Collector-emitter voltage (V_{BE} = 0)	40 V	60 V	80 V
*Emitter-base voltage		5 V	
*Continuous collector current	30 A	30 A	20 A
*Peak collector current (see Note 1)		50 A	
*Continuous base current		7.5 A	
Continuous device dissipation at (or below) 25° C case temperature (see Note 2)		200 W	
Continuous device dissipation at (or below) 25° C free-air temperature (see Note 3)		5 W	
Safe operating region at (or below) 25° C case temperature		See Figures 7 and 8	
*Operating junction and storage temperature range		– 65° C to 200° C	

NOTES: 1. This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%.
2. Derate linearly to 200° C case temperature at the rate of 1.14 W/°C.
3. Derate linearly to 200° C free-air temperature at the rate of 28-6 mW/° C.

*JEDEC registered data.

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

PARAMETER	TEST CONDITIONS	2N5301 MIN	2N5301 TYP	2N5301 MAX	2N5302 MIN	2N5302 TYP	2N5302 MAX	2N5303 MIN	2N5303 TYP	2N5303 MAX	UNIT
$V_{(BR)CEO}$	$I_C = 0.2$ A, $I_B = 0$, See Note 5	40			60			80			V
I_{CBO}	$V_{CB} = 40$ V, $I_E = 0$			1							mA
	$V_{CB} = 60$ V, $I_E = 0$						1				
	$V_{CB} = 80$ V, $I_E = 0$									1	
I_{CEO}	$V_{CE} = 40$ V, $I_B = 0$			5							mA
	$V_{CE} = 60$ V $I_B = 0$						5				
	$V_{CE} = 80$ V, $I_B = 0$									5	
I_{CEV}	$V_{CE} = 40$ V, $V_{BE} = -1.5$ V			1							mA
	$V_{CE} = 60$ V, $V_{BE} = -1.5$ V						1				
	$V_{CE} = 80$ V, $V_{BE} = -1.5$ V									1	
	$V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$			10							
	$V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$						10				
	$V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$									10	
I_{EBO}	$V_{EB} = 5$ V, $I_C = 0$			5			5			5	mA
h_{FE}	$V_{CE} = 2$ V, $I_C = 1$ A, See Notes 4 and 5	40			40			40			
	$V_{CE} = 2$ V, $I_C = 10$ A							15		60	
	$V_{CE} = 2$ V, $I_C = 15$ A	15		60	15		60				
	$V_{CE} = 2$ V, $I_C = 20$ A							5			
	$V_{CE} = 2$ V, $I_C = 30$ A	5			5						
V_{BE}	$I_B = 1$ A, $I_C = 10$ A, See Notes 4 and 5			1.7			1.7			1.7	V
	$I_B = 1.5$ A, $I_C = 15$ A			1.8			1.8			2	
	$I_B = 2$ A, $I_C = 20$ A			2.5			2.5				
	$I_B = 4$ A, $I_C = 20$ A									2.5	
	$V_{CE} = 2$ V, $I_C = 10$ A									1.5	
	$V_{CE} = 2$ V, $I_C = 15$ A			1.7			1.7				
	$V_{CE} = 4$ V, $I_C = 20$ A									2.5	
	$V_{CE} = 4$ V, $I_C = 30$ A			3			3				
$V_{CE(sat)}$	$I_B = 1$ A, $I_C = 10$ A, See Notes 4 and 5			0.75			0.75			1	V
	$I_B = 1.5$ A, $I_C = 15$ A									1.5	
	$I_B = 2$ A, $I_C = 20$ A			2			2				
	$I_B = 4$ A, $I_C = 20$ A									2	
	$I_B = 6$ A, $I_C = 30$ A			3			3				
h_{fe}	$V_{CE} = 10$ V, $I_C = 1$ A, f = 1 kHz	40			40			40			
$\|h_{fe}\|$	$V_{CE} = 10$ V, $I_C = 1$ A, f = 1 MHz	2			2			2			

NOTES: 4. These parameters must be measured using pulse techniques, $t_w = 300\ \mu s$, duty cycle $\leq 2\%$.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

thermal characteristics

PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$			0.875	°C/W
$R_{\theta JA}$			35	°C/W

resistive-load switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_r	$I_C = 10$ A, $I_{B1} = 1$ A, $V_{BE(off)} = -2$ V, $R_L = 3\ \Omega$, See Figure 1			1	μs
t_s	$I_C = 10$ A, $I_{B1} = 1$ A, $I_{B2} = -1$ A			2	μs
t_f	$R_L = 3\ \Omega$, See Figure 2			1	μs

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

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PARAMETER MEASUREMENT INFORMATION

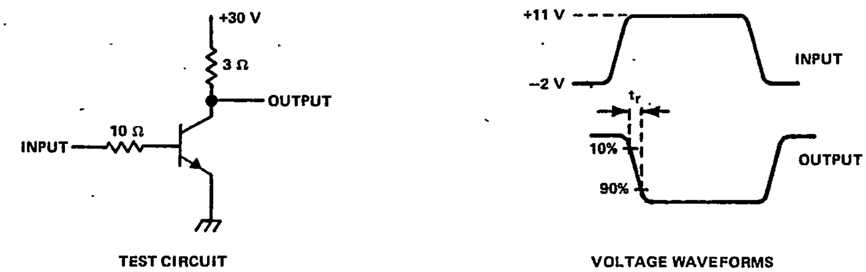

FIGURE 1. RESISTIVE-LOAD SWITCHING – RISE TIME

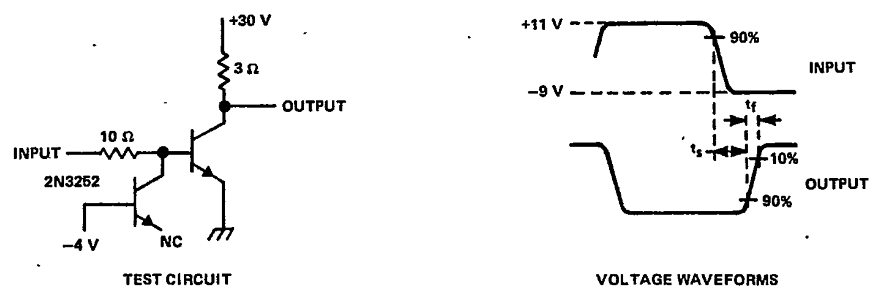

FIGURE 2. RESISTIVE-LOAD SWITCHING – STORAGE AND FALL TIMES

NOTES: A. The input waveforms are supplied by a generator with the following characteristics: $t_r \leq 20$ ns, $t_f \leq 20$ ns, $Z_{out} = 50\ \Omega$, $t_w = 10\ \mu s$ to $100\ \mu s$, duty cycle $\leq 2\%$.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 20$ ns, $R_{in} \geq 10\ k\Omega$, $C_{in} \leq 11.5$ pF.
C. Resistors must be noninductive types.
D. The d-c power supplies may require additional bypassing in order to minimize ringing.

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TYPICAL CHARACTERISTICS

2N5301, 2N5302
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

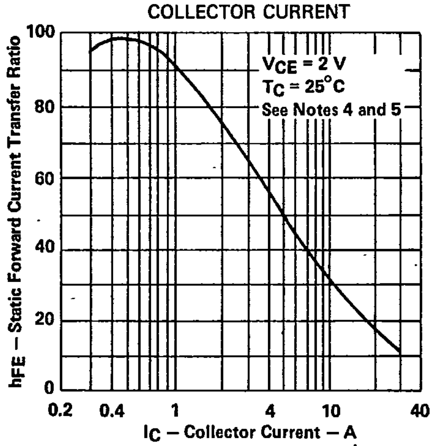

FIGURE 3

2N5303
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

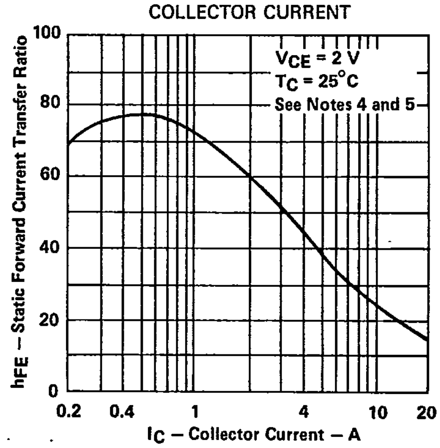

FIGURE 4

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

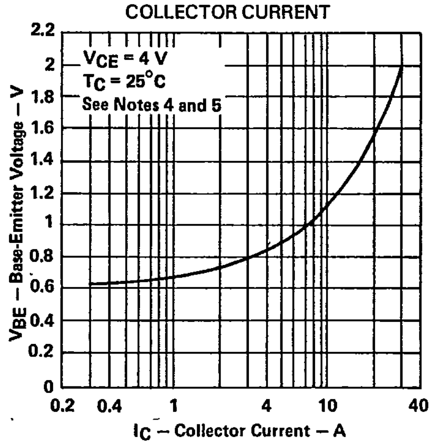

FIGURE 5

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

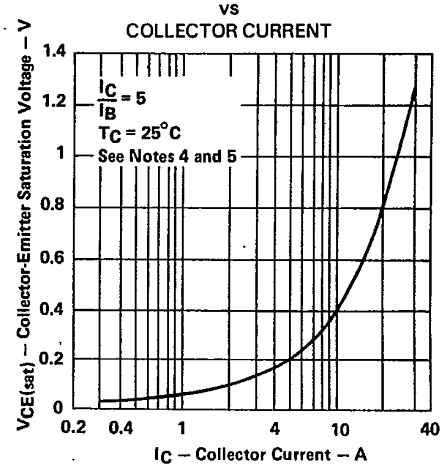

FIGURE 6

NOTES: 4. These parameters must be measured using pulse techniques, $t_w = 300\ \mu s$, duty cycle $\leq 2\%$.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

2
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MAXIMUM SAFE OPERATING AREA

2N5301, 2N5302
FORWARD-BIAS SAFE OPERATING AREA

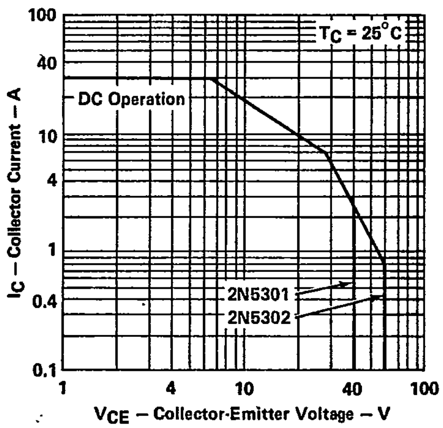

FIGURE 7

2N5303
FORWARD-BIAS SAFE OPERATING AREA

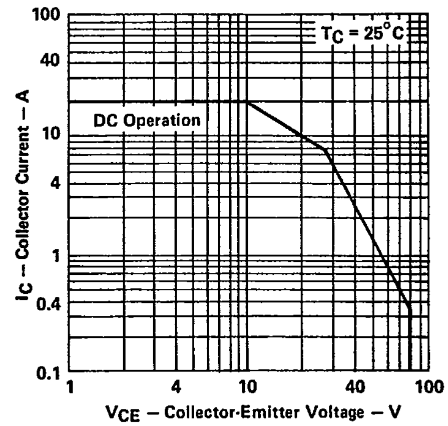

FIGURE 8

THERMAL INFORMATION

DISSIPATION DERATING CURVE

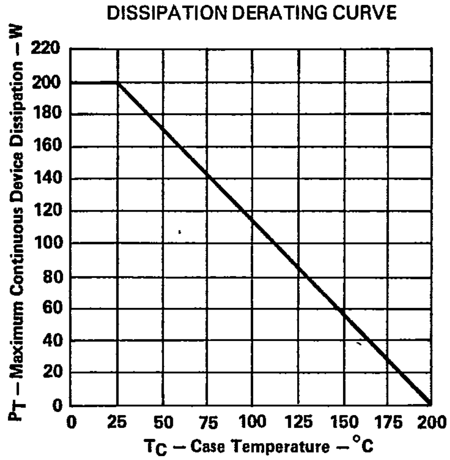

FIGURE 9

PEAK-POWER COEFFICIENT CURVE

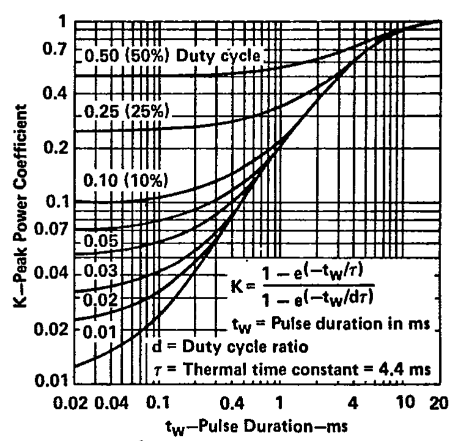

FIGURE 10

2N Devices