

**MAXIMUM RATINGS**

Rating	Symbol	PNP		NPN		Unit
		2N5415	2N5416	2N3439	2N3440	
Collector-Emitter Voltage	V <sub>CEO</sub>	200	300	350	250	Vdc
Collector-Base Voltage	V <sub>CBO</sub>	200	350	450	300	Vdc
Emitter-Base Voltage	V <sub>EBO</sub>	4.0	6.0	7.0	7.0	Vdc
Base Current	I <sub>B</sub>	0.5				Adc
Collector Current — Continuous	I <sub>C</sub>	1.0				Adc
Total Device Dissipation @ T <sub>A</sub> = 25°C Derate above 25°C	P <sub>D</sub>	—	—	1.0	5.7	Watts mW/°C
Total Device Dissipation @ T <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	10	57	5.0	28.6	Watts mW/°C
Total Device Dissipation @ T <sub>A</sub> = 50°C Derate above 50°C	P <sub>D</sub>	1.0	6.7	—	—	Watts mW/°C
Operating and Storage Junction Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	- 65 to + 200				°C

**2N3439, 2N3440 NPN  
2N5415, 2N5416 PNP**

**JAN, JTX, JTXV AVAILABLE  
CASE 79-02, STYLE 1  
TO-39 (TO-205AD)**

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**THERMAL CHARACTERISTICS**

Characteristic	Symbol	2N5415	2N3439	Unit
		2N5416	2N3440	
Thermal Resistance, Junction to Case	R <sub>θJC</sub>	17.5	35	°C/W
Thermal Resistance, Junction to Ambient	R <sub>θJA</sub>	150	175	°C/W

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted.)**

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector-Emitter Sustaining Voltage(1) (I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 0)	V <sub>CEO(sus)</sub>	200 300 350 250	— — — —	Vdc
*Collector Cutoff Current (V <sub>CE</sub> = 300 Vdc, I <sub>B</sub> = 0) (V <sub>CE</sub> = 200 Vdc, I <sub>B</sub> = 0)	I <sub>CEO</sub>	— —	20 50	μAdc
*Collector Cutoff Current (V <sub>CE</sub> = 450 Vdc, V <sub>BE</sub> = 1.5 Vdc) (V <sub>CE</sub> = 300 Vdc, V <sub>BE</sub> = 1.5 Vdc)	I <sub>CEX</sub>	— —	500 500	μAdc
Collector Cutoff Current (V <sub>CB</sub> = 175 Vdc, I <sub>E</sub> = 0) (V <sub>CB</sub> = 280 Vdc, I <sub>E</sub> = 0) (V <sub>CB</sub> = 360 Vdc, I <sub>E</sub> = 0) (V <sub>CB</sub> = 250 Vdc, I <sub>E</sub> = 0)	I <sub>CBO</sub>	— — — —	50 50 20 20	μAdc
Emitter Cutoff Current (V <sub>EB</sub> = 4.0 Vdc, I <sub>C</sub> = 0) (V <sub>EB</sub> = 6.0 Vdc, I <sub>C</sub> = 0)	I <sub>EBO</sub>	— —	20 20	μAdc
<b>ON CHARACTERISTICS(1)</b>				
DC Current Gain (I <sub>C</sub> = 2.0 mAdc, V <sub>CE</sub> = 10 Vdc) *(I <sub>C</sub> = 20 mAdc, V <sub>CE</sub> = 10 Vdc) *(I <sub>C</sub> = 50 mAdc, V <sub>CE</sub> = 10 Vdc)	h <sub>FE</sub>	30 40 30 30	— 160 150 120	—
Collector-Emitter Saturation Voltage (I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 4.0 mAdc)	V <sub>CE(sat)</sub>	—	0.5	Vdc
Base-Emitter Saturation Voltage (I <sub>C</sub> = 50 mAdc, I <sub>B</sub> = 4.0 mAdc)	V <sub>BE(sat)</sub>	—	1.3	Vdc

\*Indicates Data in Addition to JEDEC Requirements.

# 2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

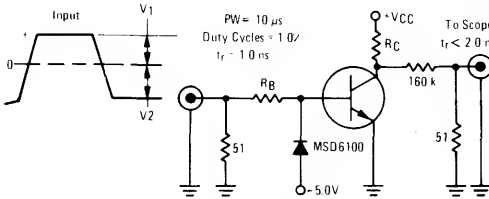
## ELECTRICAL CHARACTERISTICS (continued) ( $T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
<b>SMALL-SIGNAL CHARACTERISTICS</b>				
Current-Gain — Bandwidth Product ( $I_C = 10 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 50 \text{ MHz}$ )	$f_T$	15	—	MHz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{obo}$	—	15 10	pF
Input Capacitance ( $V_{EB} = 5.0 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )	$C_{ibo}$	—	75	pF
Small-Signal Current Gain ( $I_C = 5.0 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ ) ( $I_C = 10.0 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 5.0 \text{ MHz}$ )	$h_{fe}$	25	—	—
Real Part of Input Impedance ( $V_{CE} = 10 \text{ Vdc}$ , $I_C = 5.0 \text{ mA}$ , $f = 1.0 \text{ MHz}$ )	$\text{Re}(h_{ie})$	—	300	Ohms

(1) Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

CAUTION: The sustaining voltage *must not* be measured on a curve tracer. (See Fig. 15.)

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



NOTE:  $V_{CC}$  and  $R_C$  adjusted for  $V_{CE(\text{off})} = 150 \text{ V}$  and  $I_C$  as desired,  $R_B$  chosen for desired  $I_{B1}$ .  $V_1 \approx 10 \text{ V}$ ,  $V_2 \approx 8.0 \text{ V}$

For  $t_d$  and  $t_r$ , D1 is disconnected and  $V_2 = 2.0 \text{ V}$

For PNP test circuit, reverse all polarities.

PNP  
2N5415, 2N5416

NPN  
2N3439, 2N3440

FIGURE 2 — TURN-ON TIME

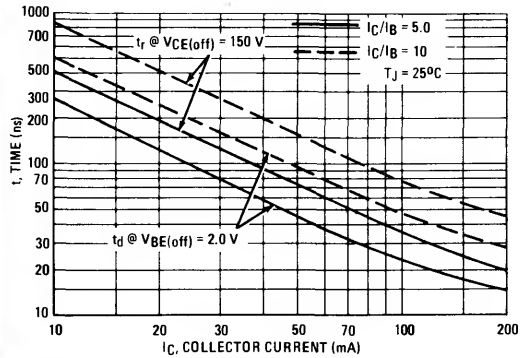
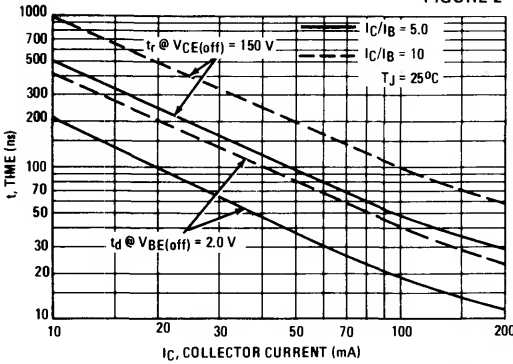
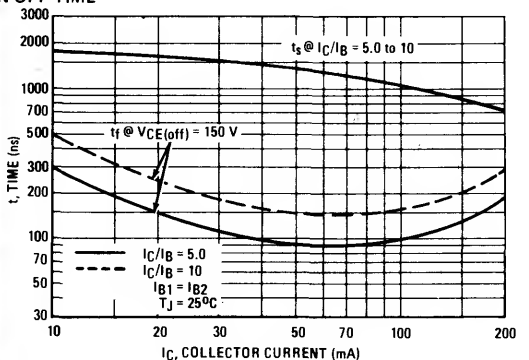
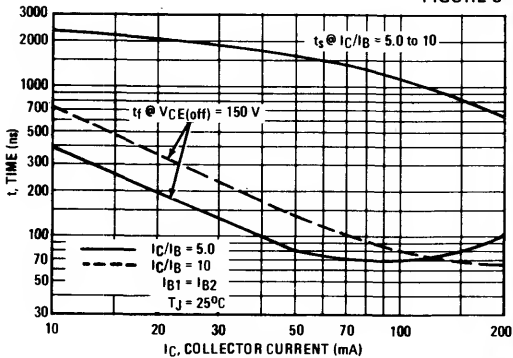


FIGURE 3 — TURN-OFF TIME



2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

FIGURE 4 – CURRENT-GAIN – BANDWIDTH PRODUCT

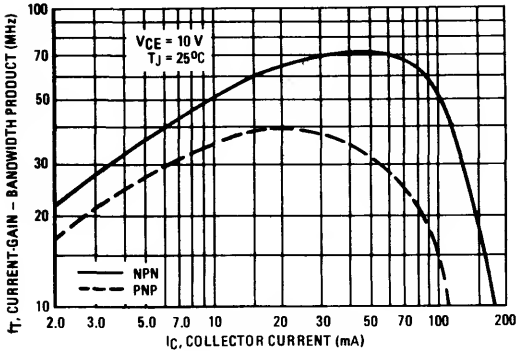


FIGURE 5 – CAPACITANCE

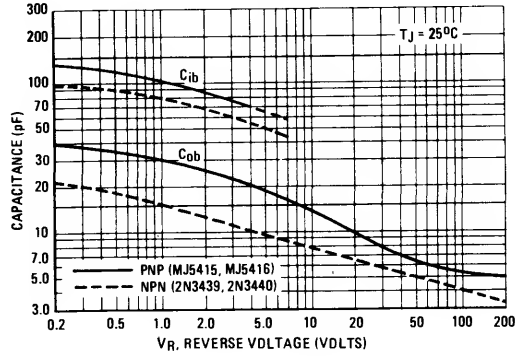


FIGURE 6 – THERMAL RESPONSE

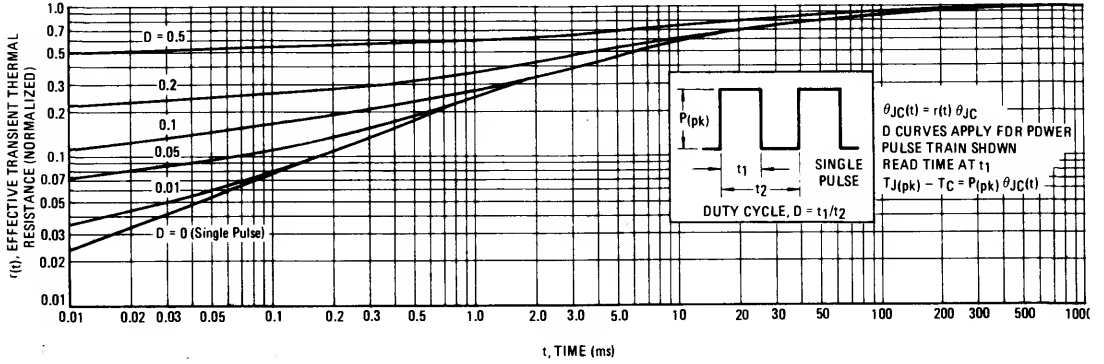
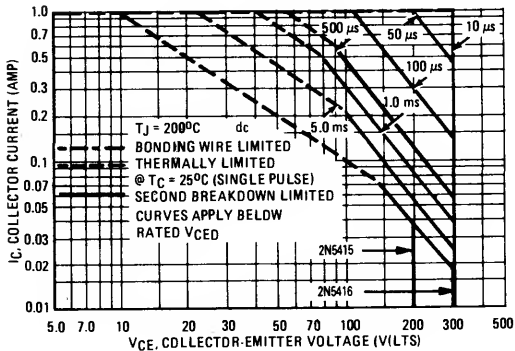
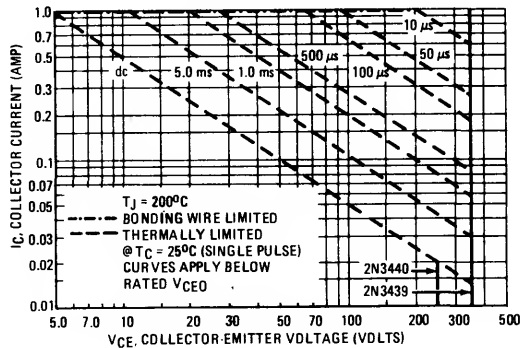


FIGURE 7 – ACTIVE-REGION SAFE OPERATING AREA

PNP – 2N5415, 2N5416

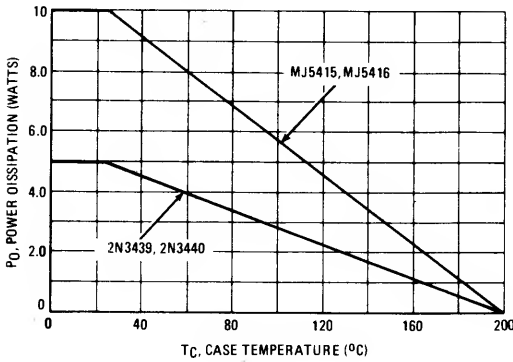


NPN – 2N3439, 2N3440



**2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP**

**FIGURE 8 – POWER DERATING**



There are two limitations on the power handling ability of a transistor, average junction temperature and second breakdown. Safe operating area curves indicate  $I_C$ - $V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

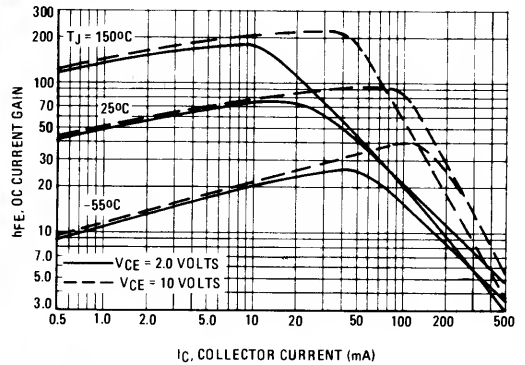
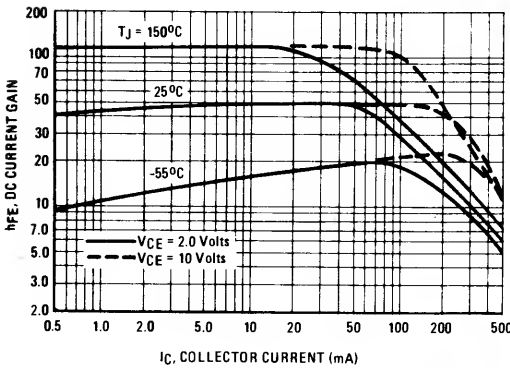
The data of Figure 7 is based on  $T_{J(pk)} = 200^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 200^\circ\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 6. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See AN-415).

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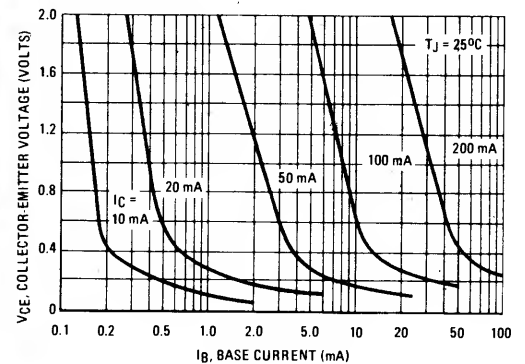
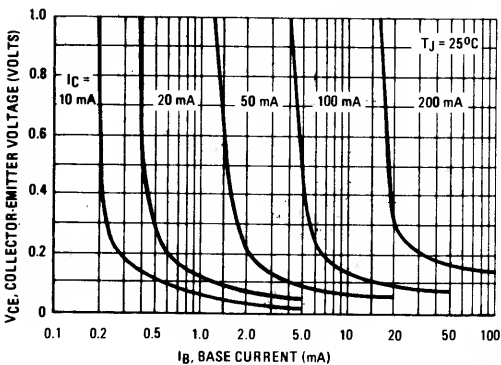
**PNP**  
**2N5415, 2N5416**

**NPN**  
**2N3439 2N3440**

**FIGURE 9 – DC CURRENT GAIN**

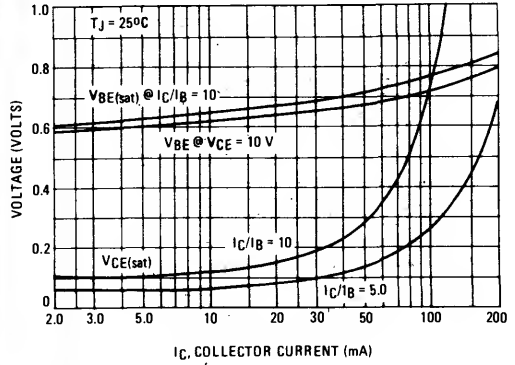
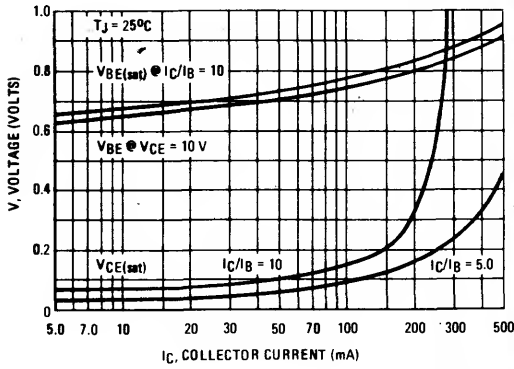


**FIGURE 10 – COLLECTOR SATURATION REGION**



2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

FIGURE 11 - "ON" VOLTAGES



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FIGURE 12 - TEMPERATURE COEFFICIENTS

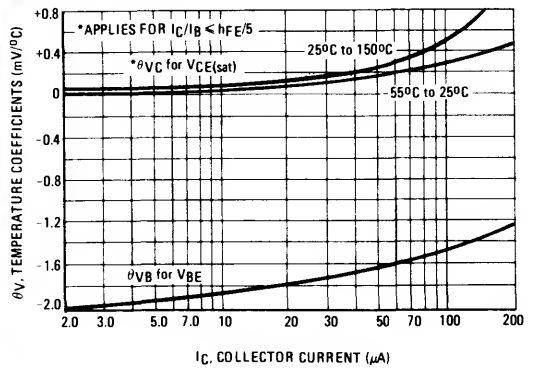
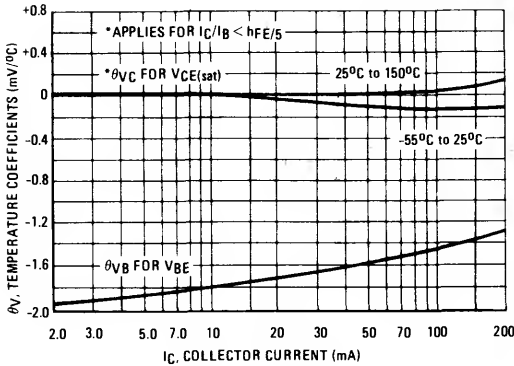
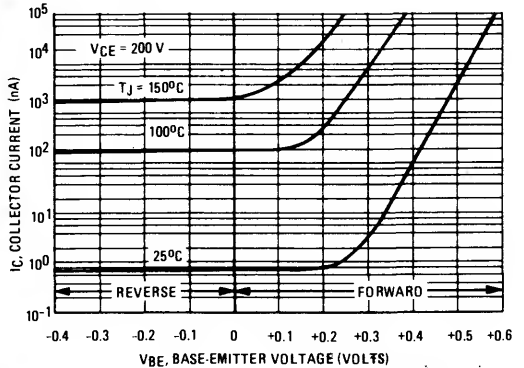
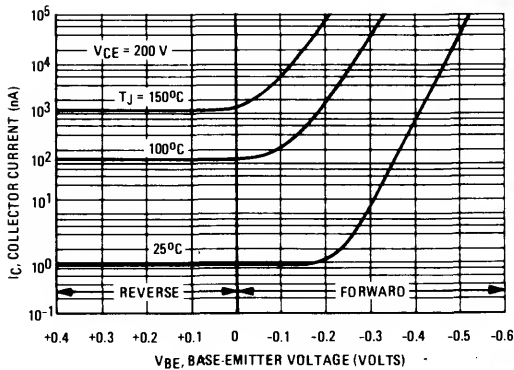


FIGURE 13 - COLLECTOR CUTOFF REGION



2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

FIGURE 14 - BASE CUTOFF REGION

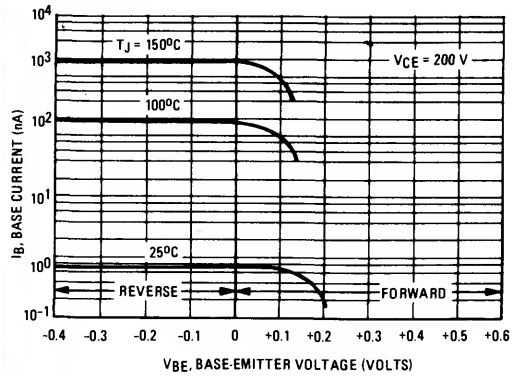
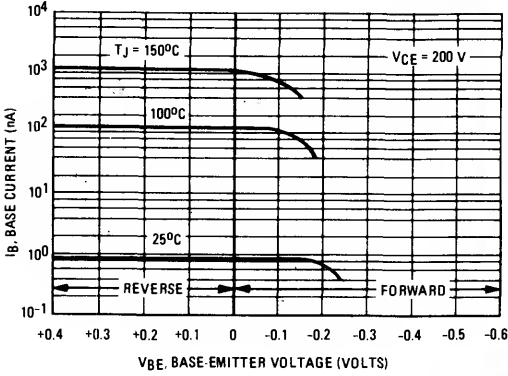


FIGURE 15 - CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES

