

# NPN – 2N6515, 2N6517; PNP – 2N6520

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

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Breakdown Voltage (Note 1) (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , I <sub>B</sub> = 0)	V <sub>(BR)CEO</sub>	250 350	– –	V <sub>dc</sub>
Collector–Base Breakdown Voltage (I <sub>C</sub> = 100 μA <sub>dc</sub> , I <sub>E</sub> = 0)	V <sub>(BR)CBO</sub>	250 350	– –	V <sub>dc</sub>
Emitter–Base Breakdown Voltage (I <sub>E</sub> = 10 μA <sub>dc</sub> , I <sub>C</sub> = 0)	V <sub>(BR)EBO</sub>	6.0 5.0	– –	V <sub>dc</sub>
Collector Cutoff Current (V <sub>CB</sub> = 150 V <sub>dc</sub> , I <sub>E</sub> = 0) (V <sub>CB</sub> = 250 V <sub>dc</sub> , I <sub>E</sub> = 0)	I <sub>CBO</sub>	– –	50 50	nA <sub>dc</sub>
Emitter Cutoff Current (V <sub>EB</sub> = 5.0 V <sub>dc</sub> , I <sub>C</sub> = 0) (V <sub>EB</sub> = 4.0 V <sub>dc</sub> , I <sub>C</sub> = 0)	I <sub>EBO</sub>	– –	50 50	nA <sub>dc</sub>

## ON CHARACTERISTICS (Note 1)

DC Current Gain (I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )	h <sub>FE</sub>	35 20	– –	–
(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )		50 30	– –	
(I <sub>C</sub> = 30 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )		50 30	300 200	
(I <sub>C</sub> = 50 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )		45 20	220 200	
(I <sub>C</sub> = 100 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )		25 15	– –	
Collector–Emitter Saturation Voltage (I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 1.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 20 mA <sub>dc</sub> , I <sub>B</sub> = 2.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 30 mA <sub>dc</sub> , I <sub>B</sub> = 3.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 50 mA <sub>dc</sub> , I <sub>B</sub> = 5.0 mA <sub>dc</sub> )	V <sub>CE(sat)</sub>	– – – –	0.30 0.35 0.50 1.0	V <sub>dc</sub>
Base–Emitter Saturation Voltage (I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 1.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 20 mA <sub>dc</sub> , I <sub>B</sub> = 2.0 mA <sub>dc</sub> ) (I <sub>C</sub> = 30 mA <sub>dc</sub> , I <sub>B</sub> = 3.0 mA <sub>dc</sub> )	V <sub>BE(sat)</sub>	– – –	0.75 0.85 0.90	V <sub>dc</sub>
Base–Emitter On Voltage (I <sub>C</sub> = 100 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )	V <sub>BE(on)</sub>	–	2.0	V <sub>dc</sub>

## SMALL–SIGNAL CHARACTERISTICS

Current–Gain – Bandwidth Product (Note 1) (I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 20 V <sub>dc</sub> , f = 20 MHz)	f <sub>T</sub>	40	200	MHz
Collector–Base Capacitance (V <sub>CB</sub> = 20 V <sub>dc</sub> , I <sub>E</sub> = 0, f = 1.0 MHz)	C <sub>cb</sub>	–	6.0	pF
Emitter–Base Capacitance (V <sub>EB</sub> = 0.5 V <sub>dc</sub> , I <sub>C</sub> = 0, f = 1.0 MHz)	C <sub>eb</sub>	– –	80 100	pF

## SWITCHING CHARACTERISTICS

Turn–On Time (V <sub>CC</sub> = 100 V <sub>dc</sub> , V <sub>BE(off)</sub> = 2.0 V <sub>dc</sub> , I <sub>C</sub> = 50 mA <sub>dc</sub> , I <sub>B1</sub> = 10 mA <sub>dc</sub> )	t <sub>on</sub>	–	200	μs
Turn–Off Time (V <sub>CC</sub> = 100 V <sub>dc</sub> , I <sub>C</sub> = 50 mA <sub>dc</sub> , I <sub>B1</sub> = I <sub>B2</sub> = 10 mA <sub>dc</sub> )	t <sub>off</sub>	–	3.5	μs

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

NPN – 2N6515, 2N6517; PNP – 2N6520

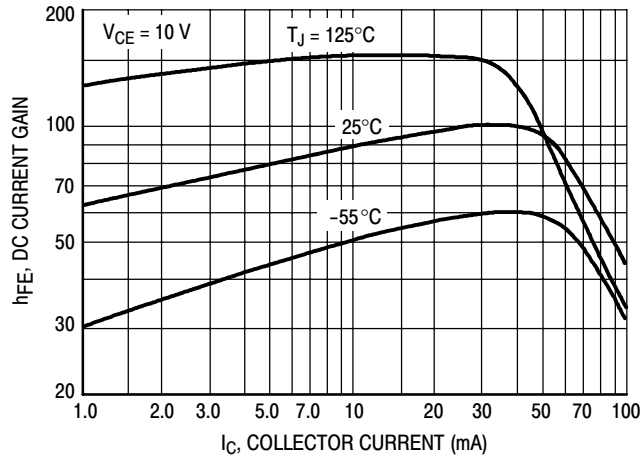


Figure 1. DC Current Gain  
NPN 2N6515

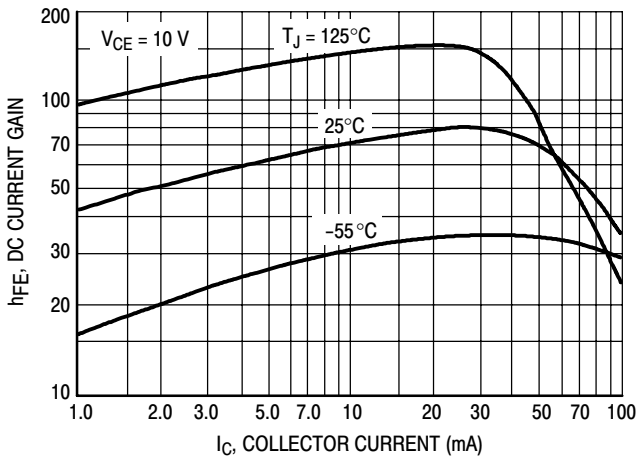


Figure 2. DC Current Gain  
NPN 2N6517

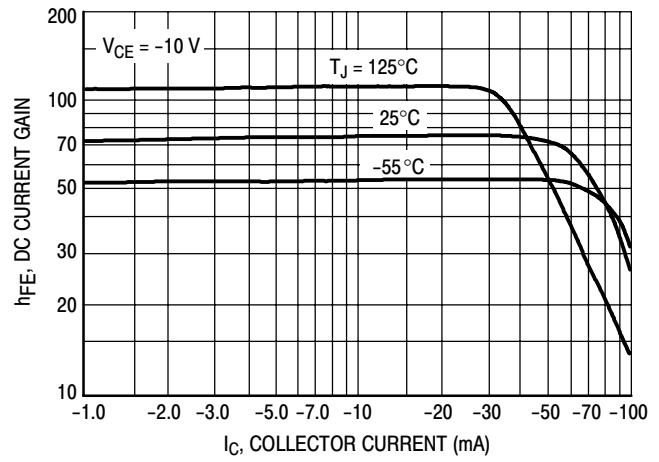


Figure 3. DC Current Gain  
PNP 2N6520

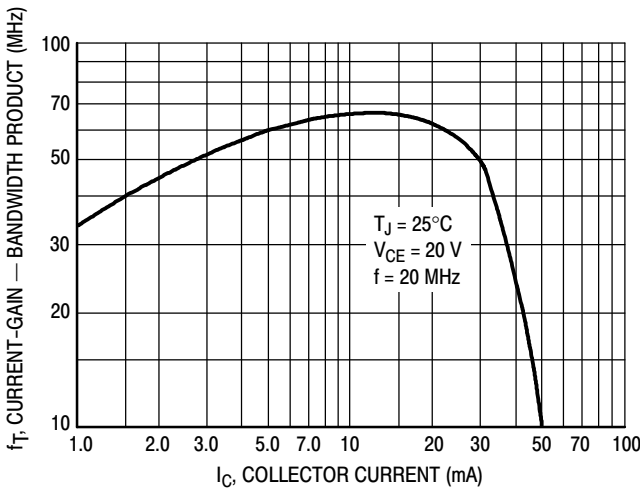


Figure 4. Current-Gain – Bandwidth Product  
NPN 2N6515, 2N6517

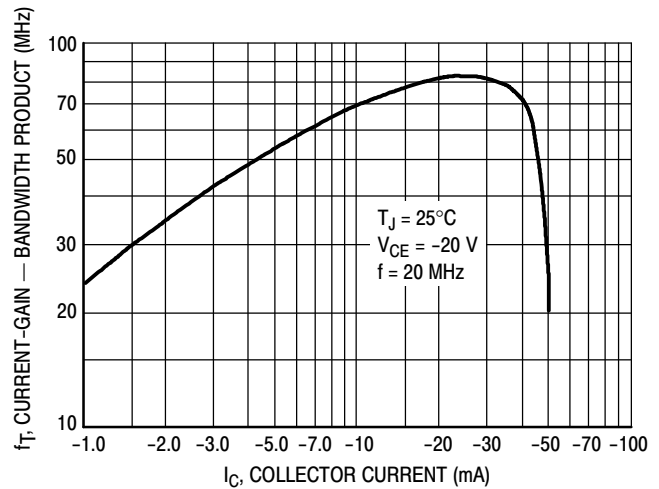


Figure 5. Current-Gain – Bandwidth Product  
PNP 2N6520

NPN – 2N6515, 2N6517; PNP – 2N6520

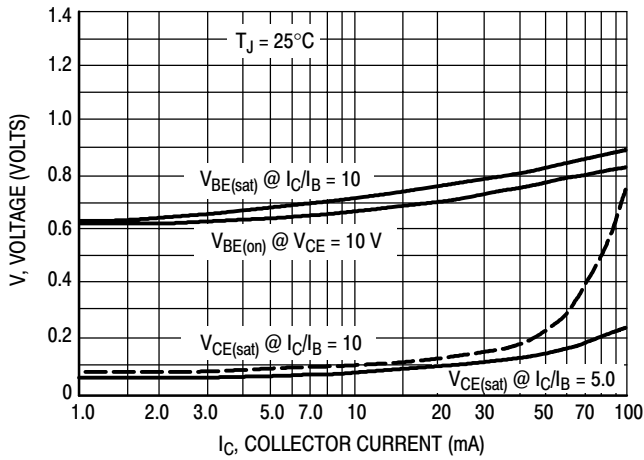


Figure 6. "On" Voltages  
NPN 2N6515, 2N6517

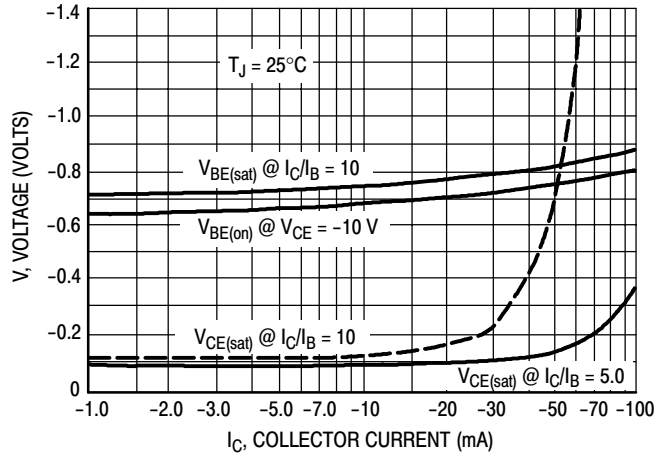


Figure 7. "On" Voltages  
PNP 2N6520

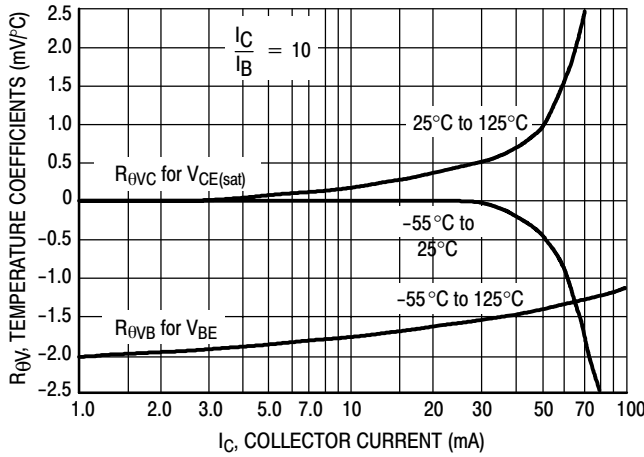


Figure 8. Temperature Coefficients  
NPN 2N6515, 2N6517

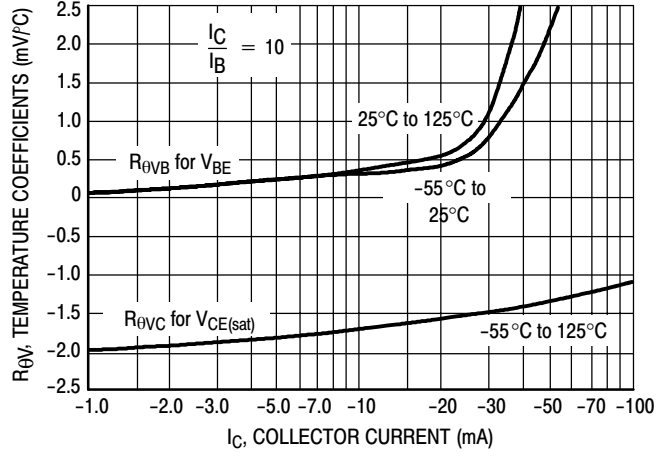


Figure 9. Temperature Coefficients  
PNP 2N6520

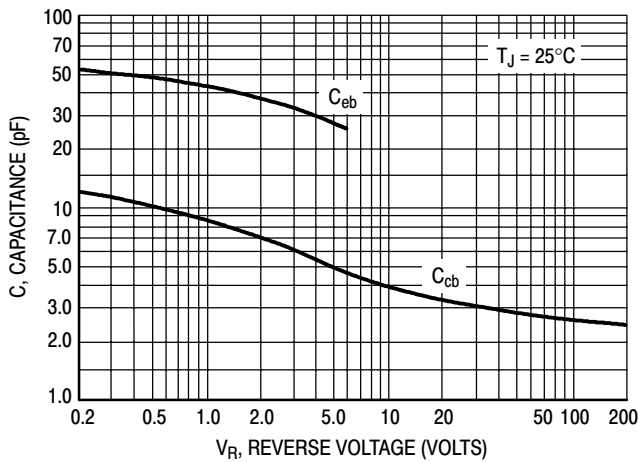


Figure 10. Capacitance  
NPN 2N6515, 2N6517

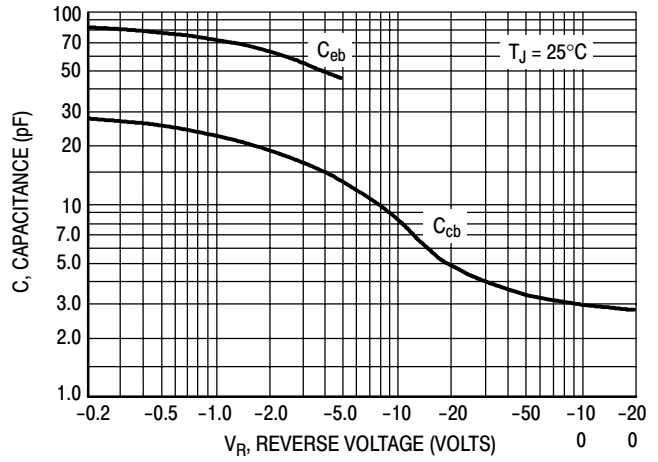
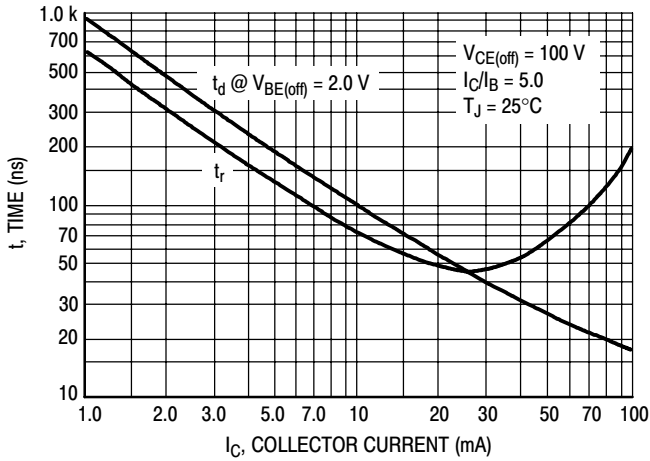
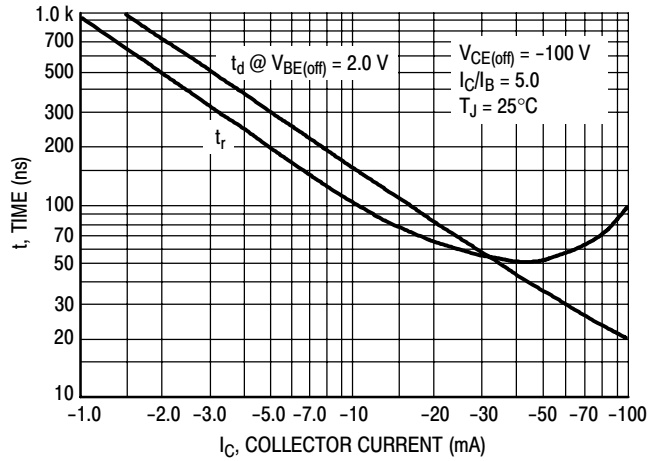


Figure 11. Capacitance  
PNP 2N6520

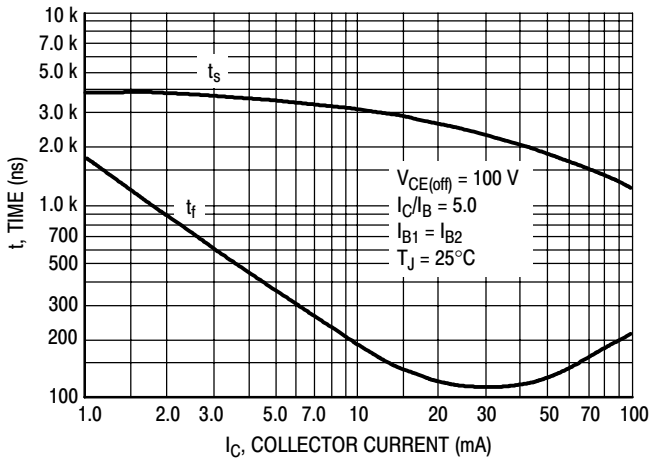
# NPN – 2N6515, 2N6517; PNP – 2N6520



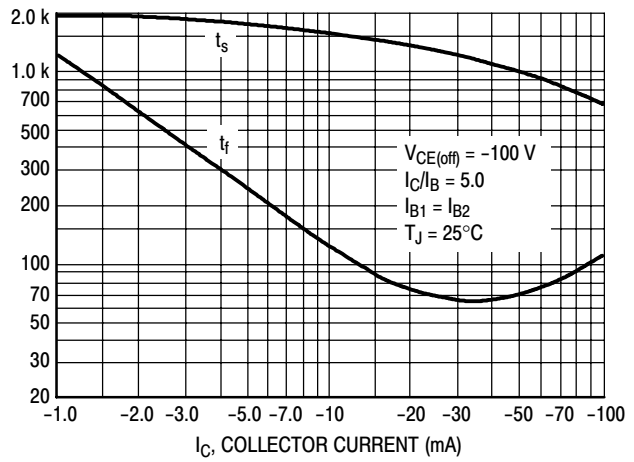
**Figure 12. Turn-On Time  
NPN 2N6515, 2N6517**



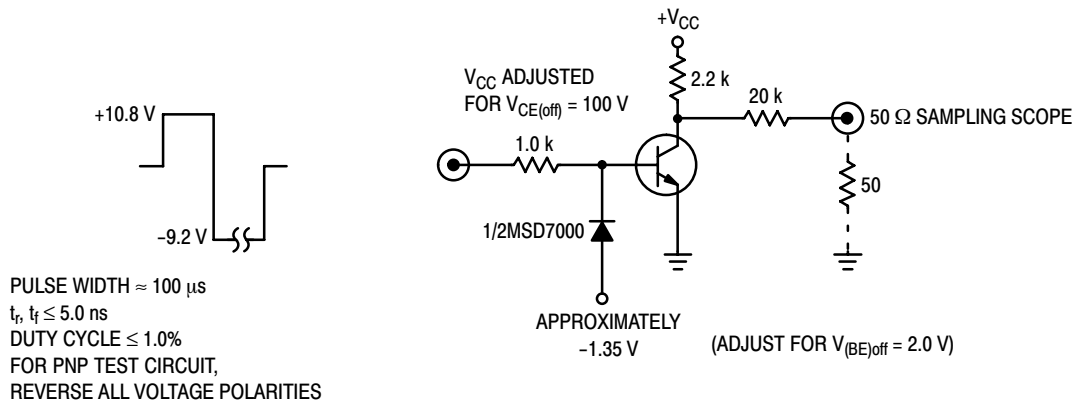
**Figure 13. Turn-On Time  
PNP 2N6520**



**Figure 14. Turn-Off Time  
NPN 2N6515, 2N6517**



**Figure 15. Turn-Off Time  
PNP 2N6520**



**Figure 16. Switching Time Test Circuit**

# NPN – 2N6515, 2N6517; PNP – 2N6520

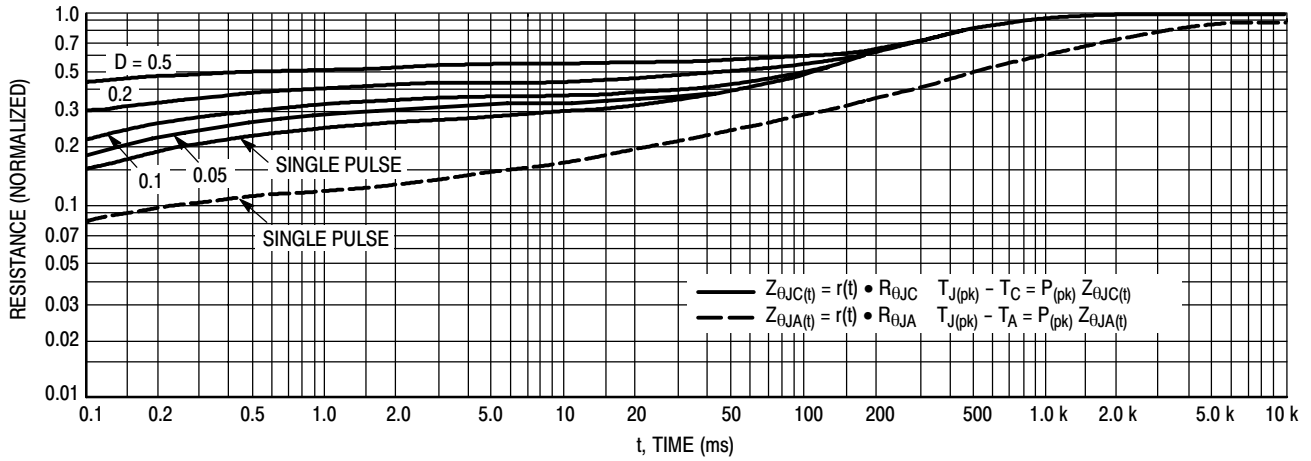


Figure 17. Thermal Response

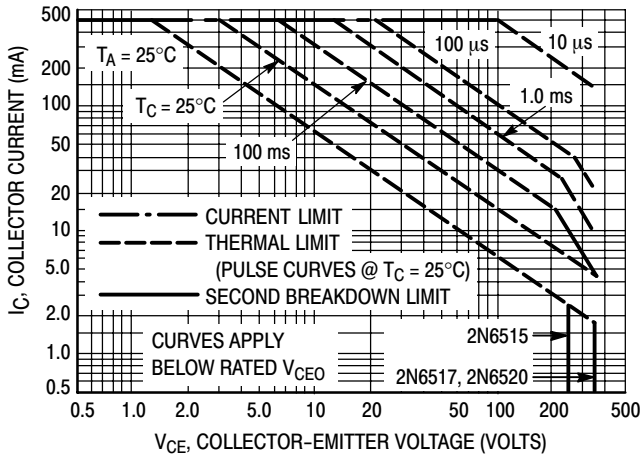
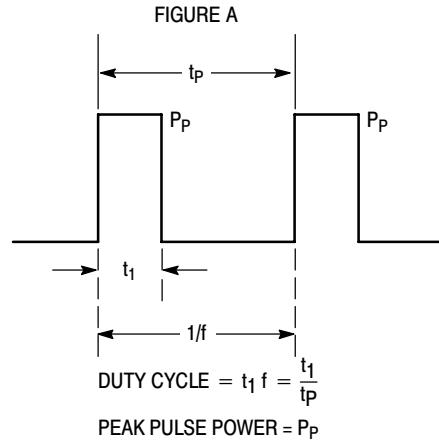


Figure 18. Active Region Safe Operating Area



Design Note: Use of Transient Thermal Resistance Data

## ORDERING INFORMATION

Device	Package	Shipping†
2N6515RLRMG	TO-92 (Pb-Free)	2000 Ammo Pack
2N6517G	TO-92 (Pb-Free)	5000 Unit / Bulk
2N6517RLRPG	TO-92 (Pb-Free)	2000 Ammo Pack
2N6520RLRAG	TO-92 (Pb-Free)	2000 Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®



SCALE 1:1



TO-92 (TO-226)  
CASE 29-11  
ISSUE AM

DATE 09 MAR 2007



STRAIGHT LEAD  
BULK PACK



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD  
TAPE & REEL  
AMMO PACK



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS	
	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

STYLES ON PAGE 2

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**TO-92 (TO-226)**  
**CASE 29-11**  
**ISSUE AM**

DATE 09 MAR 2007

STYLE 1:  
 PIN 1. EMITTER  
 2. BASE  
 3. COLLECTOR

STYLE 2:  
 PIN 1. BASE  
 2. EMITTER  
 3. COLLECTOR

STYLE 3:  
 PIN 1. ANODE  
 2. ANODE  
 3. CATHODE

STYLE 4:  
 PIN 1. CATHODE  
 2. CATHODE  
 3. ANODE

STYLE 5:  
 PIN 1. DRAIN  
 2. SOURCE  
 3. GATE

STYLE 6:  
 PIN 1. GATE  
 2. SOURCE & SUBSTRATE  
 3. DRAIN

STYLE 7:  
 PIN 1. SOURCE  
 2. DRAIN  
 3. GATE

STYLE 8:  
 PIN 1. DRAIN  
 2. GATE  
 3. SOURCE & SUBSTRATE

STYLE 9:  
 PIN 1. BASE 1  
 2. EMITTER  
 3. BASE 2

STYLE 10:  
 PIN 1. CATHODE  
 2. GATE  
 3. ANODE

STYLE 11:  
 PIN 1. ANODE  
 2. CATHODE & ANODE  
 3. CATHODE

STYLE 12:  
 PIN 1. MAIN TERMINAL 1  
 2. GATE  
 3. MAIN TERMINAL 2

STYLE 13:  
 PIN 1. ANODE 1  
 2. GATE  
 3. CATHODE 2

STYLE 14:  
 PIN 1. EMITTER  
 2. COLLECTOR  
 3. BASE

STYLE 15:  
 PIN 1. ANODE 1  
 2. CATHODE  
 3. ANODE 2

STYLE 16:  
 PIN 1. ANODE  
 2. GATE  
 3. CATHODE

STYLE 17:  
 PIN 1. COLLECTOR  
 2. BASE  
 3. EMITTER

STYLE 18:  
 PIN 1. ANODE  
 2. CATHODE  
 3. NOT CONNECTED

STYLE 19:  
 PIN 1. GATE  
 2. ANODE  
 3. CATHODE

STYLE 20:  
 PIN 1. NOT CONNECTED  
 2. CATHODE  
 3. ANODE

STYLE 21:  
 PIN 1. COLLECTOR  
 2. EMITTER  
 3. BASE

STYLE 22:  
 PIN 1. SOURCE  
 2. GATE  
 3. DRAIN

STYLE 23:  
 PIN 1. GATE  
 2. SOURCE  
 3. DRAIN

STYLE 24:  
 PIN 1. EMITTER  
 2. COLLECTOR/ANODE  
 3. CATHODE

STYLE 25:  
 PIN 1. MT 1  
 2. GATE  
 3. MT 2

STYLE 26:  
 PIN 1. V<sub>CC</sub>  
 2. GROUND 2  
 3. OUTPUT

STYLE 27:  
 PIN 1. MT  
 2. SUBSTRATE  
 3. MT

STYLE 28:  
 PIN 1. CATHODE  
 2. ANODE  
 3. GATE

STYLE 29:  
 PIN 1. NOT CONNECTED  
 2. ANODE  
 3. CATHODE

STYLE 30:  
 PIN 1. DRAIN  
 2. GATE  
 3. SOURCE

STYLE 31:  
 PIN 1. GATE  
 2. DRAIN  
 3. SOURCE

STYLE 32:  
 PIN 1. BASE  
 2. COLLECTOR  
 3. EMITTER

STYLE 33:  
 PIN 1. RETURN  
 2. INPUT  
 3. OUTPUT

STYLE 34:  
 PIN 1. INPUT  
 2. GROUND  
 3. LOGIC

STYLE 35:  
 PIN 1. GATE  
 2. COLLECTOR  
 3. EMITTER

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