

# BUL642D2

## High Speed, High Gain Bipolar NPN Transistor with Integrated Collector-Emitter and Built-in Efficient Antisaturation Network

The BUL642D2 is a state-of-the-art High Speed High Gain Bipolar Transistor (H2BIP). Tight dynamic characteristics and lot to lot minimum spread (150 ns on storage time) make it ideally suitable for Light Ballast Application. A new development process brings avalanche energy capability, making the device extremely rugged.

### Features

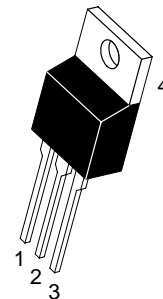
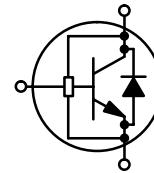
- Low Base Drive Requirement
- High Peak DC Current Gain (55 Typical) @  $I_C = 300 \text{ mA}/5 \text{ V}$
- Extremely Low Storage Time Min/Max Guarantees Due to the H2BIP Structure which Minimizes the Spread
- Integrated Collector-Emitter Free Wheeling Diode
- Fully Characterized Dynamic  $V_{CEsat}$
- "Six Sigma" Process Providing Tight and Reproducible Parameter Spreads
- Avalanche Energy 20 mJ Typical Capability
- Pb-Free Package is Available\*



ON Semiconductor®

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**3 AMPERES  
825 VOLTS  
75 WATTS  
POWER TRANSISTOR**



TO-220AB  
CASE 221A  
STYLE 1

### MARKING DIAGRAM



BUL642D2 = Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

Device	Package	Shipping
BUL642D2	TO-220	50 Units/Rail
BUL642D2G	TO-220 (Pb-Free)	50 Units/Rail

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Sustaining Voltage	$V_{CEO}$	440	Vdc
Collector–Base Breakdown Voltage	$V_{CES}$	825	Vdc
Emitter–Base Voltage	$V_{EBO}$	11	Vdc
Collector Current – Continuous – Peak (Note 1)	$I_C$ $I_{CM}$	3.0 8.0	Adc
Base Current – Continuous – Peak (Note 1)	$I_B$ $I_{BM}$	2.0 4.0	Adc
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$ *Derate above $25^\circ\text{C}$	$P_D$	75 0.6	W W/ $^\circ\text{C}$
Operating and Storage Temperature	$T_J, T_{stg}$	–65 to +150	$^\circ\text{C}$

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

## TYPICAL GAIN

Rating	Symbol	Value	Unit
Typical Gain @ $I_C = 1\text{ A}$ , $V_{CE} = 2\text{ V}$ Typical A, $V_{CE} = 1\text{ V}$	$h_{FE}$ $h_{FE}$	45 50	– –

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction–to–Case	$R_{\theta JC}$	1.6	$^\circ\text{C/W}$
Thermal Resistance, Junction–to–Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$
Maximum Lead Temperature for Soldering Purposes: 1/8 in. from Case for 5 seconds	$T_L$	260	$^\circ\text{C}$

1. Pulse Test: Pulse Width = 5.0 ms, Duty Cycle = 10%

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-Emitter Sustaining Voltage ( $I_C = 200\text{ mA}$ , $L = 25\text{ mH}$ )	$V_{CEO(sus)}$	440	-	-	Vdc	
Collector-Base Breakdown Voltage ( $I_{CBO} = 1\text{ mA}$ )	$V_{CBO}$	825	-	-	Vdc	
Emitter-Base Breakdown Voltage ( $I_{EBO} = 1\text{ mA}$ )	$V_{EBO}$	11	-	-	Vdc	
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CEO}$ , $I_B = 0$ )	$I_{CEO}$	@ $T_C = 25^\circ\text{C}$	-	-	200	$\mu\text{Adc}$
		@ $T_C = 125^\circ\text{C}$	-	-	1000	
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CES}$ , $V_{EB} = 0$ )	$I_{CES}$	@ $T_C = 25^\circ\text{C}$	-	-	100	$\mu\text{Adc}$
		@ $T_C = 125^\circ\text{C}$	-	-	1000	
Emitter-Cutoff Current ( $V_{EB} = 10\text{ Vdc}$ , $I_C = 0$ )	$I_{EBO}$	-	-	100	$\mu\text{Adc}$	

### ON CHARACTERISTICS

Base-Emitter Saturation Voltage ( $I_C = 0.5\text{ Adc}$ , $I_B = 100\text{ mAdc}$ $I_C = 1\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	$V_{BE(sat)}$	-	-	1.1 1.5	Vdc
Collector-Emitter Saturation Voltage ( $I_C = 0.5\text{ Adc}$ , $I_B = 50\text{ mAdc}$ $I_C = 2\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	$V_{CE(sat)}$	-	-	0.5 1.5	Vdc
DC Current Gain ( $I_C = 0.5\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$ $I_C = 0.5\text{ Adc}$ , $V_{CE} = 3\text{ Vdc}$ )	$h_{FE}$	16 18	-	-	-

### DYNAMIC SATURATION VOLTAGE

Dynamic Saturation Voltage:	$I_C = 0.5\text{ Adc}$ $I_{B1} = 50\text{ mAdc}$ $V_{CC} = 125\text{ Vdc}$	@ $1\ \mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$V_{CE(dsat)}$	-	2.0	-	V
		@ $3\ \mu\text{s}$	@ $T_C = 25^\circ\text{C}$		-	5.0	-	
	$I_C = 1\text{ Adc}$ $I_{B1} = 100\text{ mAdc}$ $V_{CC} = 300\text{ Vdc}$	@ $1\ \mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		-	0.2	-	
		@ $3\ \mu\text{s}$	@ $T_C = 25^\circ\text{C}$		-	1.3	-	
		@ $1\ \mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		-	4.5	-	
		@ $3\ \mu\text{s}$	@ $T_C = 25^\circ\text{C}$		-	10	-	
					-	1.0	-	
					-	3.0	-	

### DYNAMIC CHARACTERISTICS

Current Gain Bandwidth $I_C = 0.5\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1\text{ MHz}$	$f_T$	-	13	-	MHz
Output Capacitance @ $V_{cb} = 10\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$	$C_{ob}$	-	70	150	pF
Input Capacitance @ $V_{EB} = 8\text{ V}$ , $f = 1\text{ MHz}$	$C_{ib}$	-	500	1000	pF

### DIODE CHARACTERISTICS

Forward Diode Voltage ( $I_{EC} = 0.5\text{ Adc}$ ) ( $I_{EC} = 1.0\text{ Adc}$ )	$V_{EC}$	-	0.8 1.0	1.5 2.0	V
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### SWITCHING CHARACTERISTICS: Resistive Load (D.C. $\leq 10\%$ , Pulse Width = $70\ \mu\text{s}$ )

Delay Time	$I_C = 0.5\text{ Adc}$	$t_d$	-	60	400	ns
Rise Time	$I_{B1} = 45\text{ mA}$	$t_r$	-	160	1100	ns
Storage Time	$I_{B2} = 500\text{ mA}$	$t_s$	-	0.5	1400	$\mu\text{s}$
Fall Time	$V_{CC} = 125\text{ V}$	$t_f$	-	0.4	600	ns

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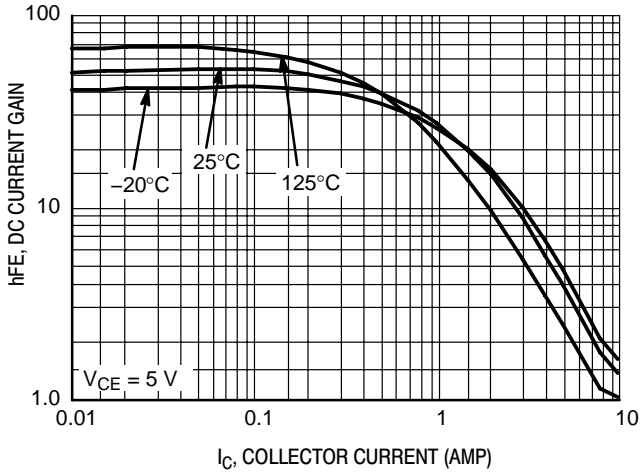


Figure 1. DC Current Gain

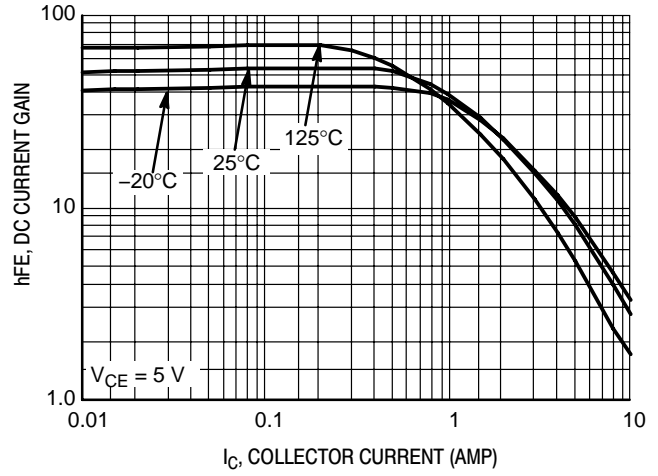


Figure 2. DC Current Gain

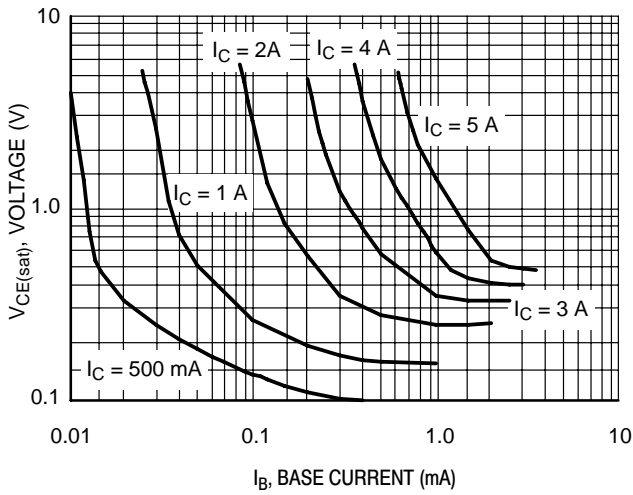


Figure 3. Collector Saturation Region

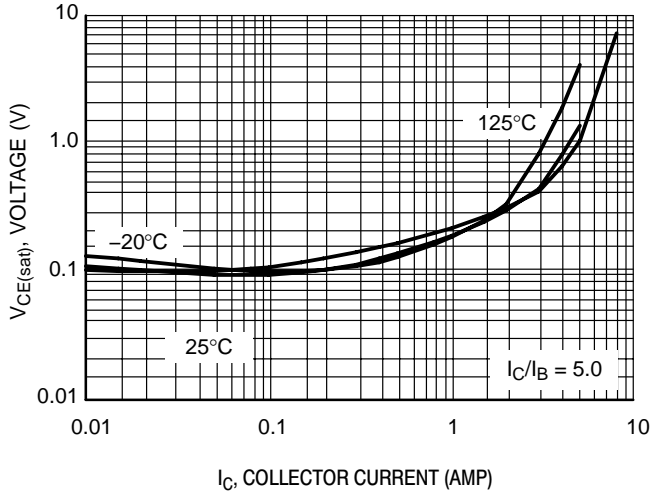


Figure 4. Collector-Emitter Saturation Voltage

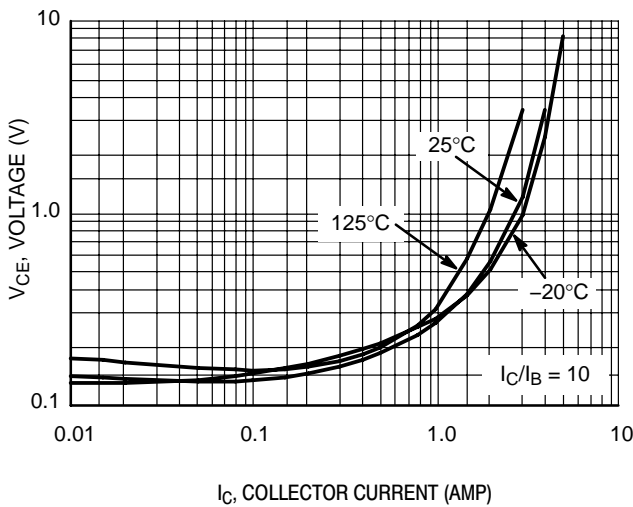


Figure 5. Collector-Emitter Saturation Voltage

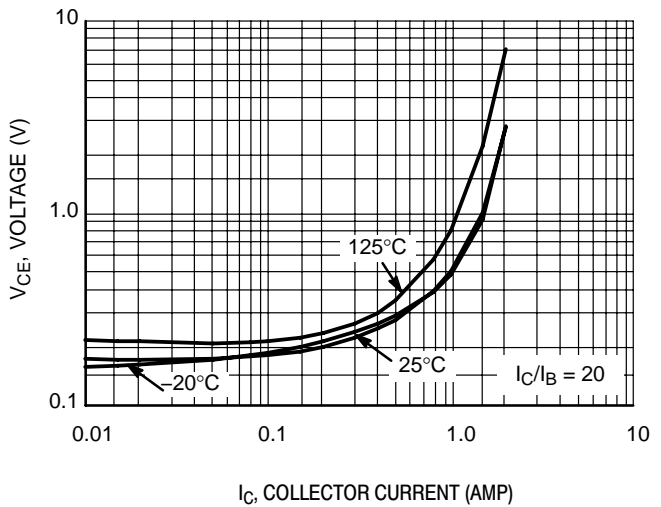
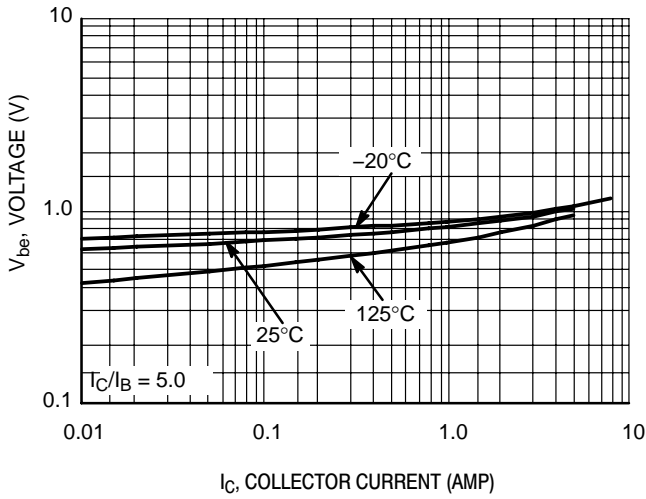
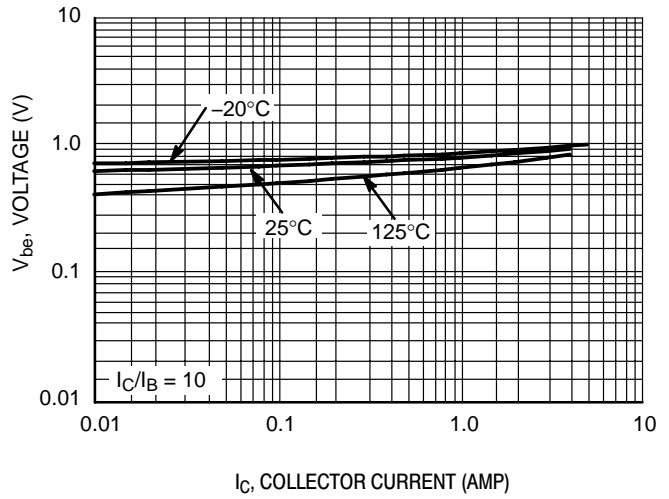


Figure 6. Collector-Emitter Saturation Voltage

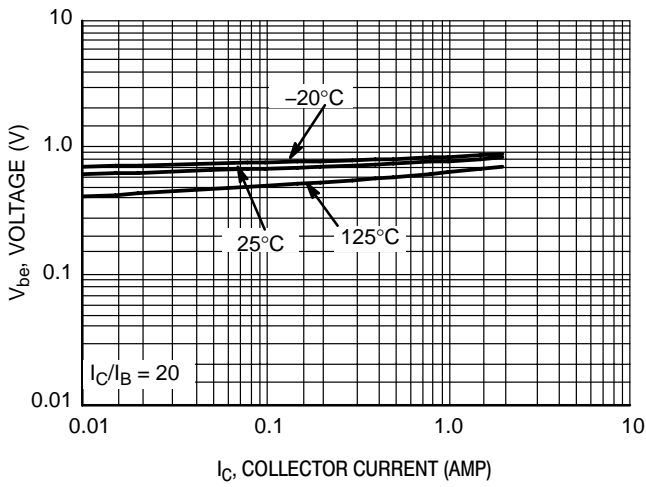
**BUL642D2**



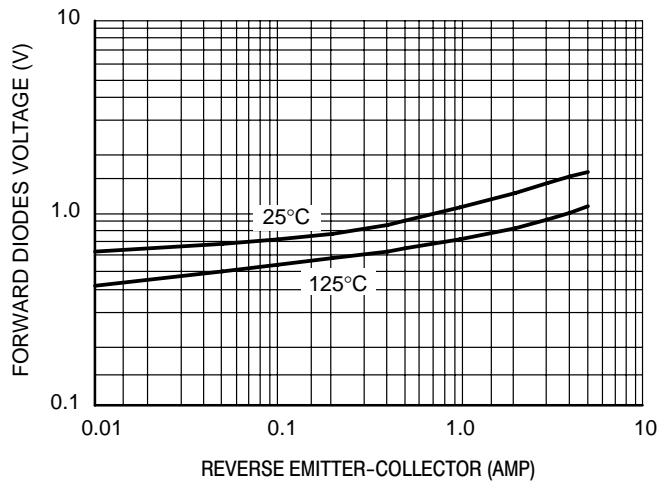
**Figure 7. Base-Emitter Saturation Voltage**



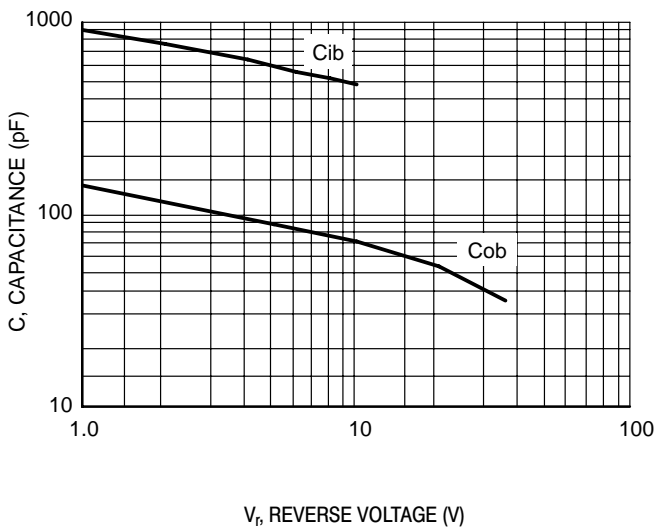
**Figure 8. Base-Emitter Saturation Voltage**



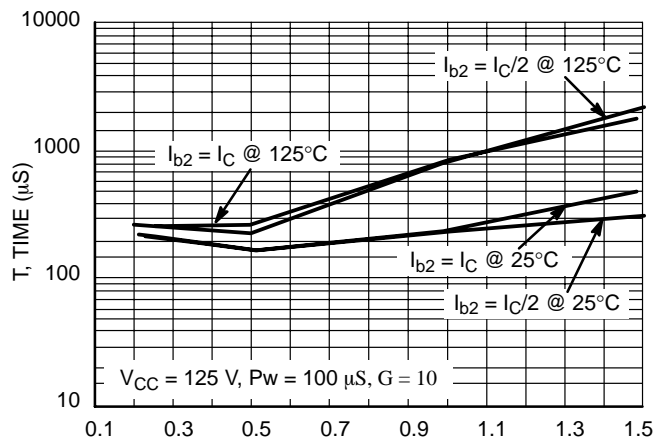
**Figure 9. Base-Emitter Saturation Voltage**



**Figure 10. Forward Diode Voltage**

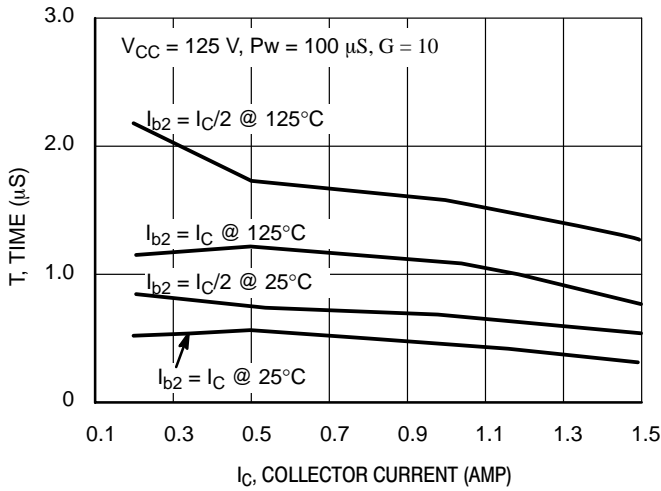


**Figure 11. Capacitance**

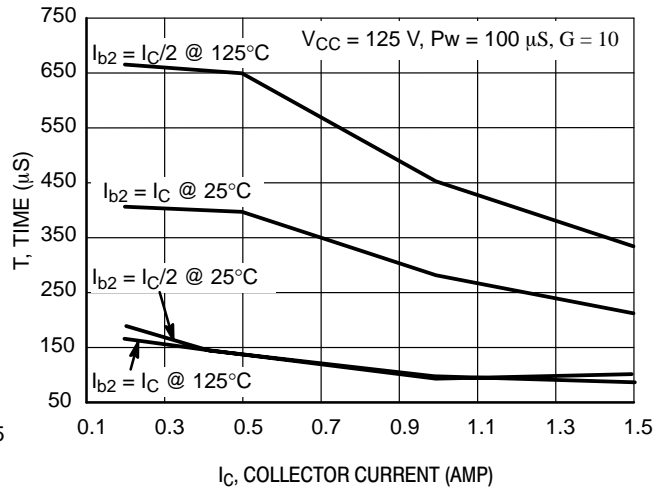


**Figure 12. Resistive Switch Time, Storage Time  $T_{ON}$**

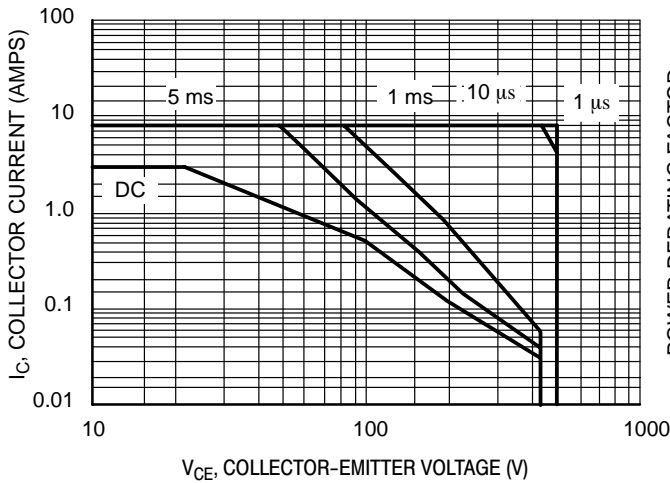
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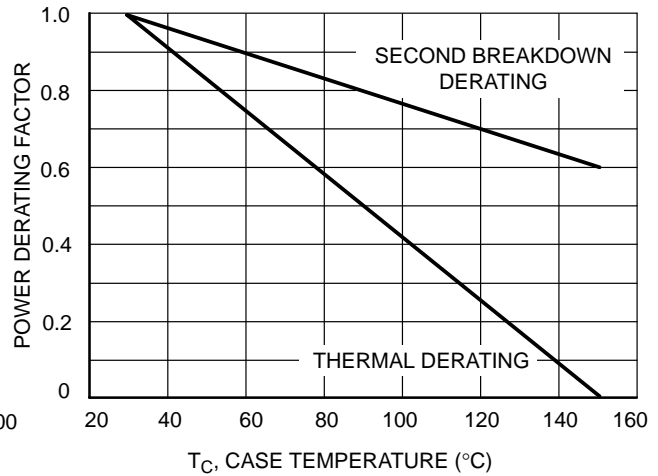
**Figure 13. Resistive Switch Time, Storage Time**



**Figure 14. Resistive Switch Time, Fall Time**



**Figure 15.**



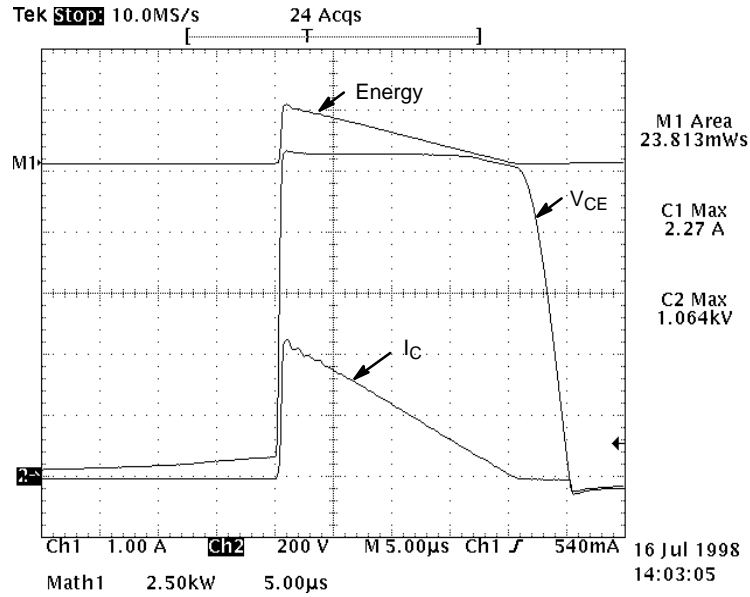
**Figure 16. Power Derating**

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 15 is based on  $T_C = 25^\circ\text{C}$ ;  $T_{j(pk)}$  is variable depending on power level. Second breakdown pulse limits do not derate like

thermal limitations. Allowable current at the voltages shown on Figure 10 may be found at any case temperature by using the appropriate curve on Figure 16.

$T_{j(pk)}$  may be calculated from the data in Figure 18. At any case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

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Figure 17. Typical Avalanche Energy Test/Waveforms

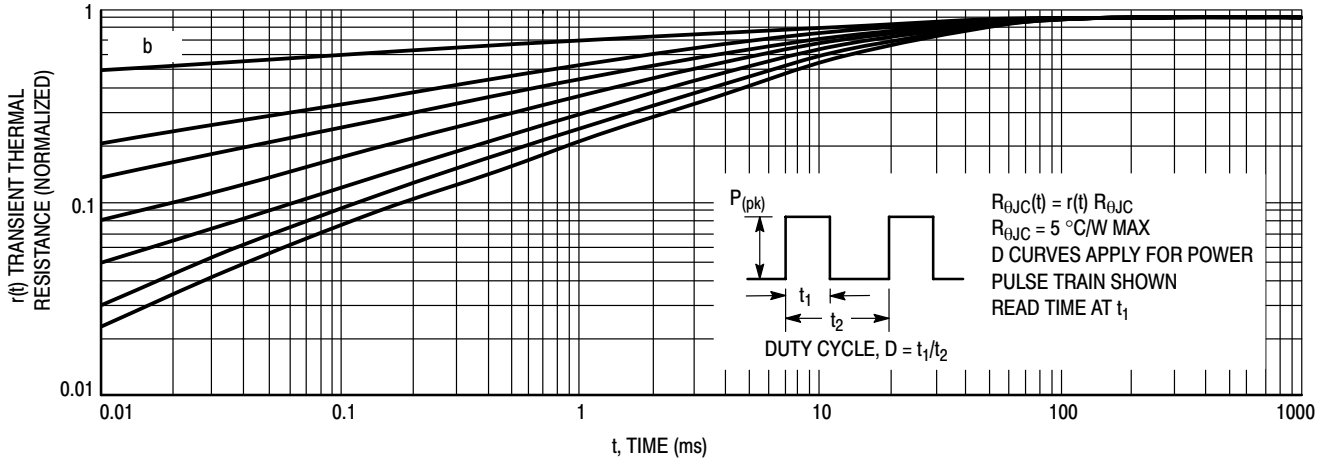
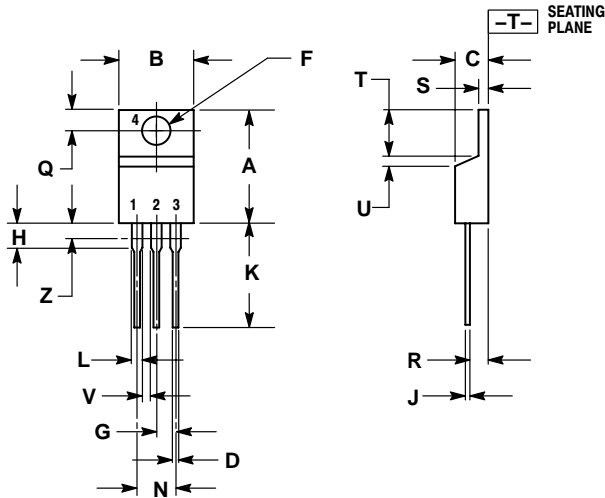


Figure 18. Thermal Response

# BUL642D2

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AA



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	---	1.15	---
Z	---	0.080	---	2.04

**STYLE 1:**

1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

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