

**BUH150**

*Designer's™ Data Sheet*  
**SWITCHMODE NPN Silicon**  
**Planar Power Transistor**

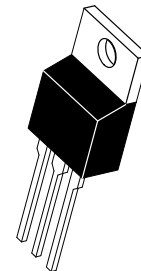
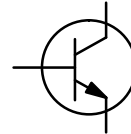
The BUH150 has an application specific state-of-art die designed for use in 150 Watts Halogen electronic transformers.

This power transistor is specifically designed to sustain the large inrush current during either the start-up conditions or under a short circuit across the load.

This High voltage/High speed product exhibits the following main features:

- Improved Efficiency Due to the Low Base Drive Requirements:
  - High and Flat DC Current Gain  $h_{FE}$
  - Fast Switching
- Robustness Thanks to the Technology Developed to Manufacture this Device
- Motorola "6 SIGMA" Philosophy Provides Tight and Reproducible Parametric Distributions

**POWER TRANSISTOR**  
**15 AMPERES**  
**700 VOLTS**  
**150 WATTS**



**CASE 221A-06**  
**TO-220AB**

**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Sustaining Voltage	$V_{CEO}$	400	Vdc
Collector-Base Breakdown Voltage	$V_{CBO}$	700	Vdc
Collector-Emitter Breakdown Voltage	$V_{CES}$	700	Vdc
Emitter-Base Voltage	$V_{EBO}$	10	Vdc
Collector Current — Continuous	$I_C$	15	Adc
— Peak (1)	$I_{CM}$	25	
Base Current — Continuous	$I_B$	6	Adc
— Peak (1)	$I_{BM}$	12	
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$	$P_D$	150	Watt
*Derate above $25^\circ\text{C}$		1.2	W/ $^\circ\text{C}$
Operating and Storage Temperature	$T_J, T_{stg}$	-65 to 150	$^\circ\text{C}$

**THERMAL CHARACTERISTICS**

Thermal Resistance			$^\circ\text{C}/\text{W}$
— Junction to Case	$R_{\theta JC}$	0.85	
— Junction to Ambient	$R_{\theta JA}$	62.5	
Maximum Lead Temperature for Soldering Purposes: 1/8" from case for 5 seconds	$T_L$	260	$^\circ\text{C}$

(1) Pulse Test: Pulse Width = 5 ms, Duty Cycle  $\leq 10\%$ .

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**Designer's Data for "Worst Case" Conditions** — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. SOA Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

# BUH150

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector–Emitter Sustaining Voltage ( $I_C = 100\text{ mA}$ , $L = 25\text{ mH}$ )	$V_{CEO(sus)}$	400	460		Vdc
Collector–Base Breakdown Voltage ( $I_{CBO} = 1\text{ mA}$ )	$V_{CBO}$	700	860		Vdc
Emitter–Base Breakdown Voltage ( $I_{EBO} = 1\text{ mA}$ )	$V_{EBO}$	10	12.3		Vdc
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CEO}$ , $I_B = 0$ )	$I_{CEO}$			100	$\mu\text{Adc}$
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CES}$ , $V_{EB} = 0$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $I_{CES}$			100 1000	$\mu\text{Adc}$
Collector Base Current ( $V_{CB} = \text{Rated } V_{CBO}$ , $V_{EB} = 0$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $I_{CBO}$			100 1000	$\mu\text{Adc}$
Emitter–Cutoff Current ( $V_{EB} = 9\text{ Vdc}$ , $I_C = 0$ )	$I_{EBO}$			100	$\mu\text{Adc}$

## ON CHARACTERISTICS

Base–Emitter Saturation Voltage ( $I_C = 10\text{ Adc}$ , $I_B = 2\text{ Adc}$ )	$V_{BE(sat)}$		1	1.25	Vdc
Collector–Emitter Saturation Voltage ( $I_C = 2\text{ Adc}$ , $I_B = 0.4\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $V_{CE(sat)}$		0.16 0.15	0.4 0.4	Vdc
( $I_C = 10\text{ Adc}$ , $I_B = 2\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$		0.45	1	Vdc
( $I_C = 20\text{ Adc}$ , $I_B = 4\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$		2	5	Vdc
DC Current Gain ( $I_C = 20\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $h_{FE}$	4 2.5	7 4.5		—
( $I_C = 10\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	8 6	12 10		—
( $I_C = 2\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	12 14	20 22		—
( $I_C = 100\text{ mAdc}$ , $V_{CE} = 5\text{ Vdc}$ )	@ $T_C = 25^\circ\text{C}$	10	20		—

## DYNAMIC SATURATION VOLTAGE

Dynamic Saturation Voltage: Determined 3 $\mu\text{s}$ after rising $I_{B1}$ reaches 90% of final $I_{B1}$ (see Figure 19)	$I_C = 5\text{ Adc}$ , $I_{B1} = 1\text{ Adc}$ $V_{CC} = 300\text{ V}$	@ $T_C = 25^\circ\text{C}$	$V_{CE(dsat)}$	1.5	V
		@ $T_C = 125^\circ\text{C}$		2.8	V
	$I_C = 10\text{ Adc}$ , $I_{B1} = 2\text{ Adc}$ $V_{CC} = 300\text{ V}$	@ $T_C = 25^\circ\text{C}$	2.4	V	
		@ $T_C = 125^\circ\text{C}$	5	V	

## DYNAMIC CHARACTERISTICS

Current Gain Bandwidth ( $I_C = 1\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1\text{ MHz}$ )	$f_T$		23		MHz
Output Capacitance ( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1\text{ MHz}$ )	$C_{ob}$		100	150	pF
Input Capacitance ( $V_{EB} = 8\text{ Vdc}$ , $f = 1\text{ MHz}$ )	$C_{ib}$		1300	1750	pF

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

Characteristic	Symbol	Min	Typ	Max	Unit	
<b>SWITCHING CHARACTERISTICS: Resistive Load</b> (D.C. $\leq 10\%$ , Pulse Width = 40 $\mu\text{s}$ )						
Turn-on Time	$I_C = 2 \text{ Adc}, I_{B1} = 0.2 \text{ Adc}$ $I_{B2} = 0.2 \text{ Adc}$ $V_{CC} = 300 \text{ Vdc}$	@ $T_C = 25^\circ\text{C}$	$t_{on}$	200	300	ns
Storage Time		@ $T_C = 25^\circ\text{C}$	$t_s$	5.3	6.5	$\mu\text{s}$
Fall Time		@ $T_C = 25^\circ\text{C}$	$t_f$	240	350	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$	$t_{off}$	5.6	7	$\mu\text{s}$
Turn-on Time	$I_C = 2 \text{ Adc}, I_{B1} = 0.4 \text{ Adc}$ $I_{B2} = 0.4 \text{ Adc}$ $V_{CC} = 300 \text{ Vdc}$	@ $T_C = 25^\circ\text{C}$	$t_{on}$	100	200	ns
Storage Time		@ $T_C = 25^\circ\text{C}$	$t_s$	6.1	7.5	$\mu\text{s}$
Fall Time		@ $T_C = 25^\circ\text{C}$	$t_f$	320	500	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$	$t_{off}$	6.5	8	$\mu\text{s}$
Turn-on Time	$I_C = 5 \text{ Adc}, I_{B1} = 0.5 \text{ Adc}$ $I_{B2} = 0.5 \text{ Adc}$ $V_{CC} = 300 \text{ Vdc}$	@ $T_C = 25^\circ\text{C}$	$t_{on}$	450	650	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{off}$	2.5 3.9	3	$\mu\text{s}$
Turn-on Time	$I_C = 10 \text{ Adc}, I_{B1} = 2 \text{ Adc}$ $I_{B2} = 2 \text{ Adc}$ $V_{CC} = 300 \text{ Vdc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{on}$	500 900	700	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{off}$	2.25 2.75	2.75	$\mu\text{s}$

**SWITCHING CHARACTERISTICS: Inductive Load** ( $V_{clamp} = 300 \text{ V}, V_{CC} = 15 \text{ V}, L = 200 \mu\text{H}$ )

Fall Time	$I_C = 2 \text{ Adc}$ $I_{B1} = 0.2 \text{ Adc}$ $I_{B2} = 0.2 \text{ Adc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{fi}$	110 160	250	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{si}$	6.5 8	8	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$	235 240	350	ns
Fall Time	$I_C = 2 \text{ Adc}$ $I_{B1} = 0.4 \text{ Adc}$ $I_{B2} = 0.4 \text{ Adc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{fi}$	110 170	250	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{si}$	6 7.8	7.5	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$	250 270	350	ns
Fall Time	$I_C = 5 \text{ Adc}$ $I_{B1} = 0.5 \text{ Adc}$ $I_{B2} = 0.5 \text{ Adc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{fi}$	110 140	150	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{si}$	3.25 4.6	3.75	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$	275 450	350	ns
Fall Time	$I_C = 10 \text{ Adc}$ $I_{B1} = 2 \text{ Adc}$ $I_{B2} = 2 \text{ Adc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{fi}$	110 160	175	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{si}$	2.3 2.8	2.75	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$	250 475	350	ns

TYPICAL STATIC CHARACTERISTICS

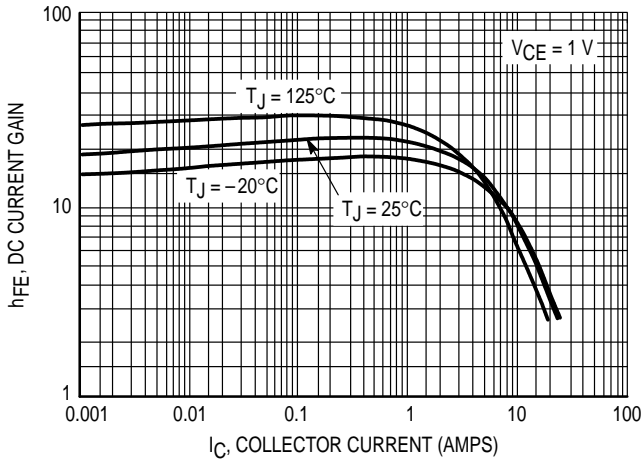


Figure 1. DC Current Gain @ 1 Volt

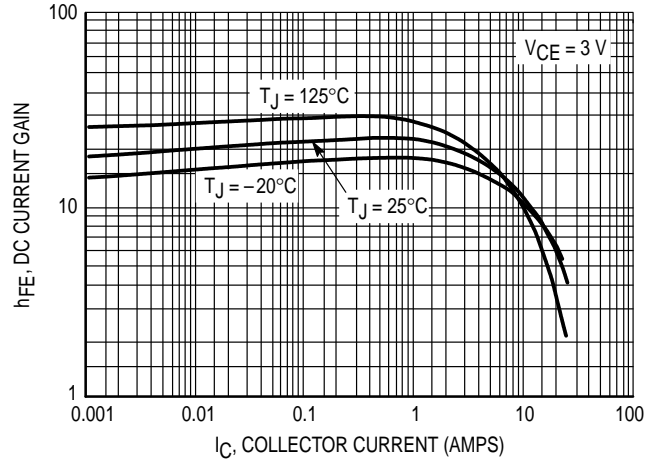


Figure 2. DC Current Gain @ 3 Volt

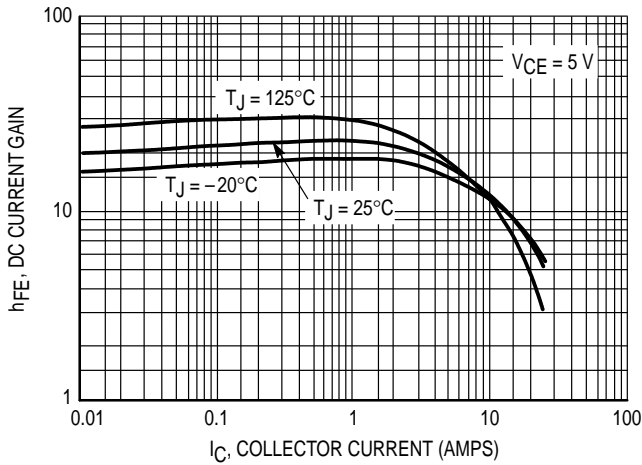


Figure 3. DC Current Gain @ 5 Volt

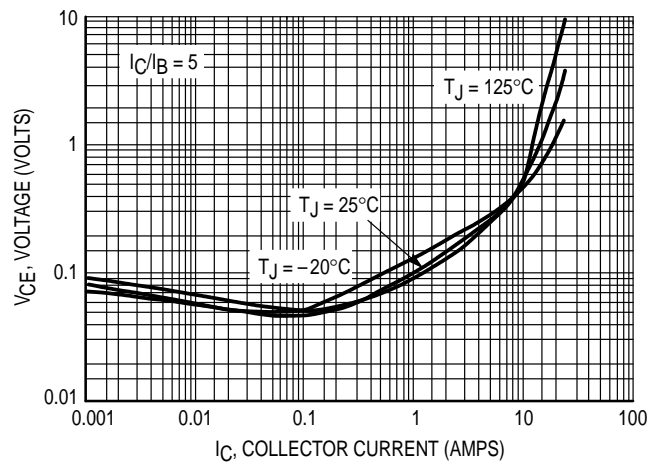


Figure 4. Collector-Emitter Saturation Voltage

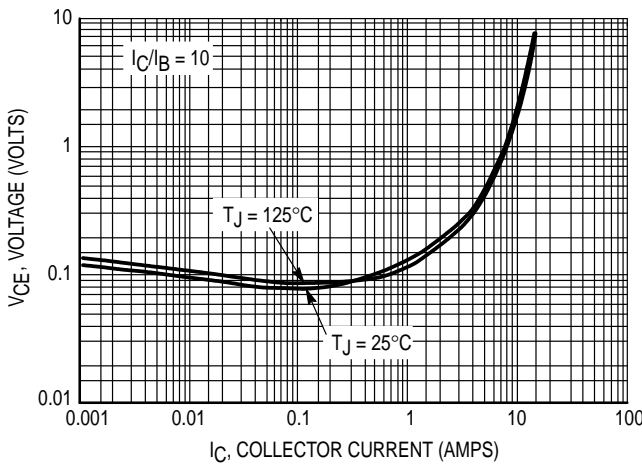


Figure 5. Collector-Emitter Saturation Voltage

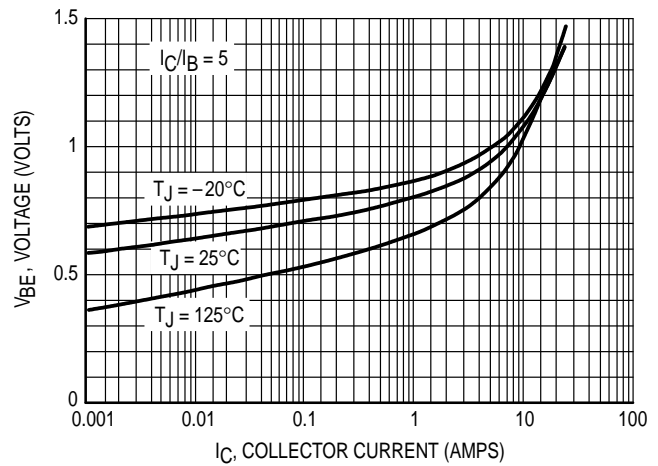


Figure 6. Base-Emitter Saturation Region

TYPICAL STATIC CHARACTERISTICS

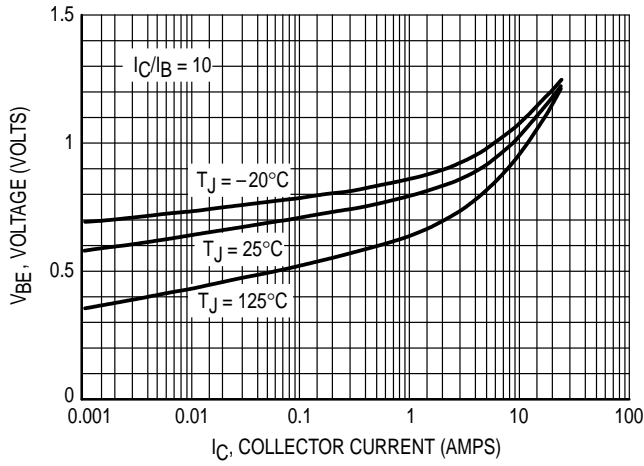


Figure 7. Base-Emitter Saturation Region

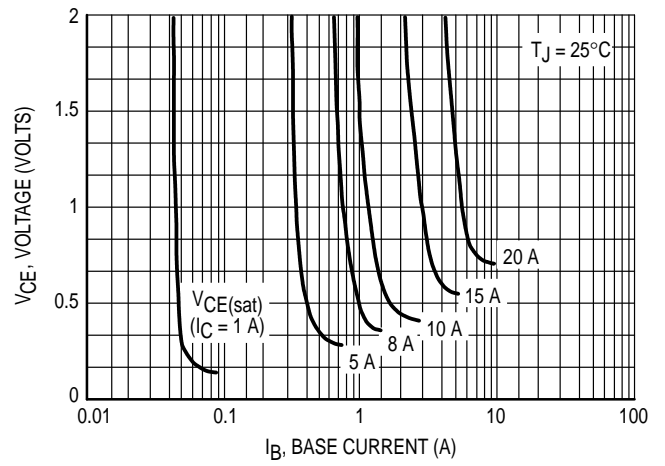


Figure 8. Collector Saturation Region

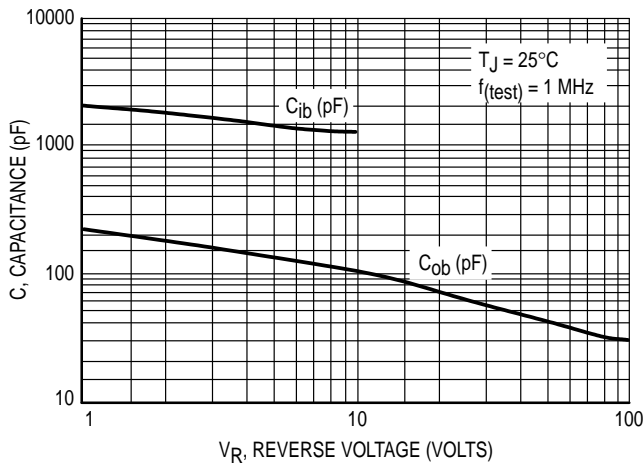


Figure 9. Capacitance

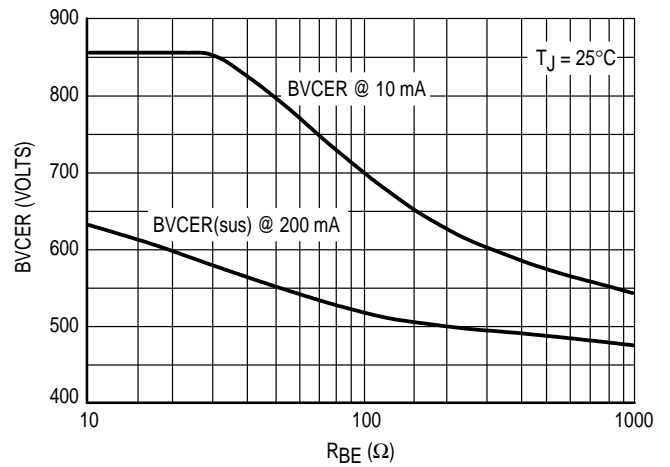


Figure 10. Resistive Breakdown

TYPICAL SWITCHING CHARACTERISTICS

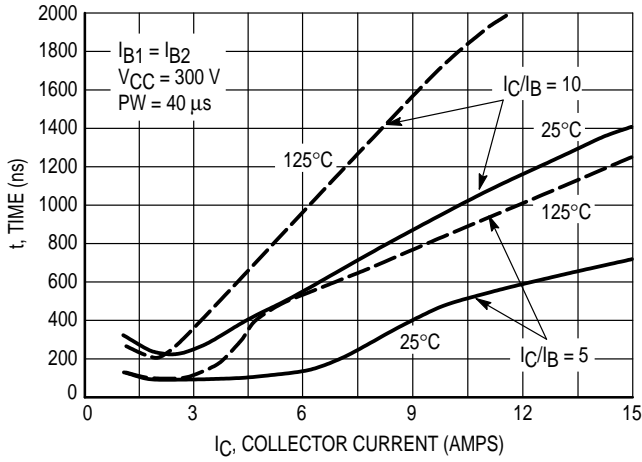


Figure 11. Resistive Switching,  $t_{on}$

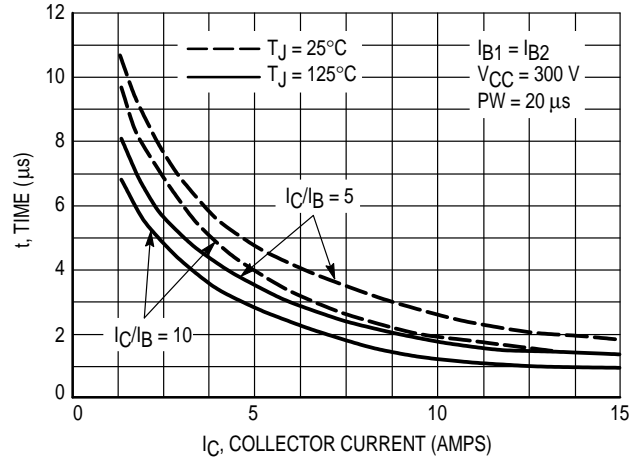


Figure 12. Resistive Switch Time,  $t_{off}$

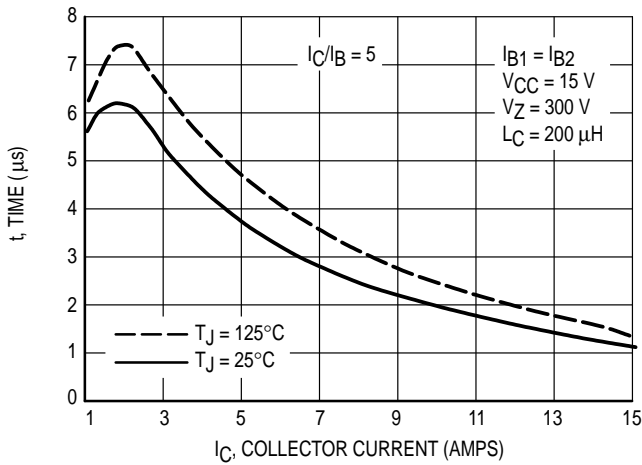


Figure 13. Inductive Storage Time,  $t_{sj}$

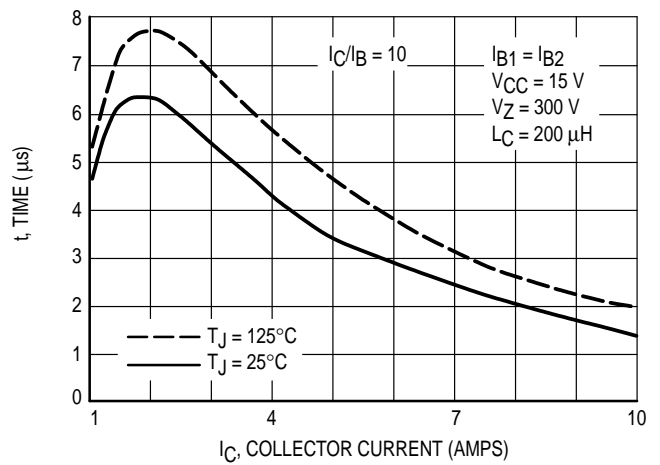


Figure 13 Bis. Inductive Storage Time,  $t_{sj}$

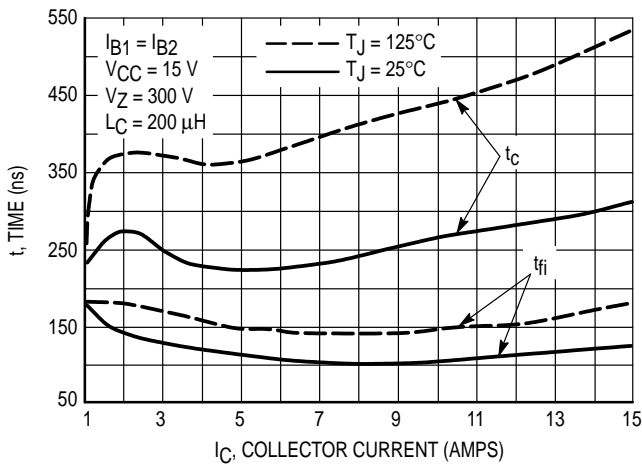


Figure 14. Inductive Storage Time,  $t_c$  &  $t_{fj}$  @  $I_C/I_B = 5$

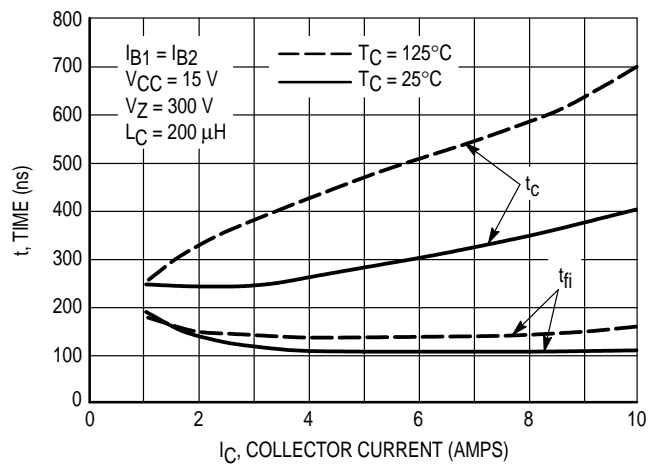


Figure 15. Inductive Storage Time,  $t_c$  &  $t_{fj}$  @  $I_C/I_B = 10$

TYPICAL SWITCHING CHARACTERISTICS

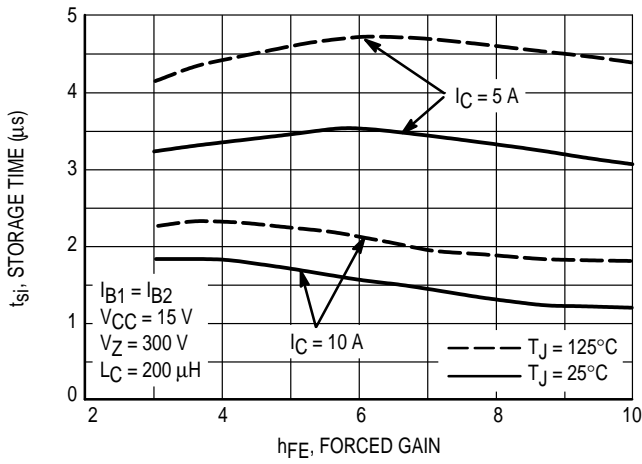


Figure 16. Inductive Storage Time

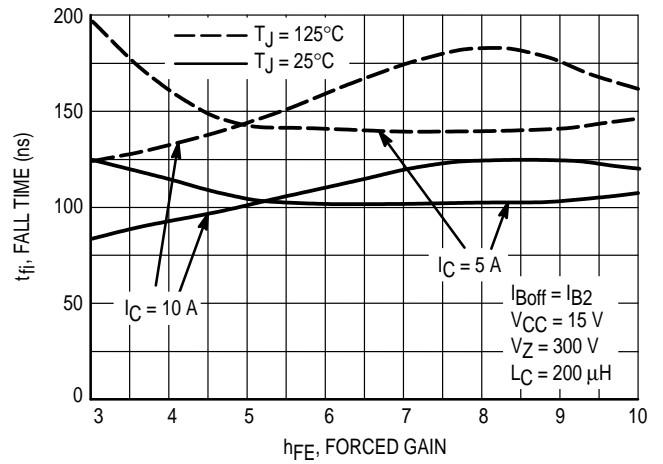


Figure 17. Inductive Fall Time

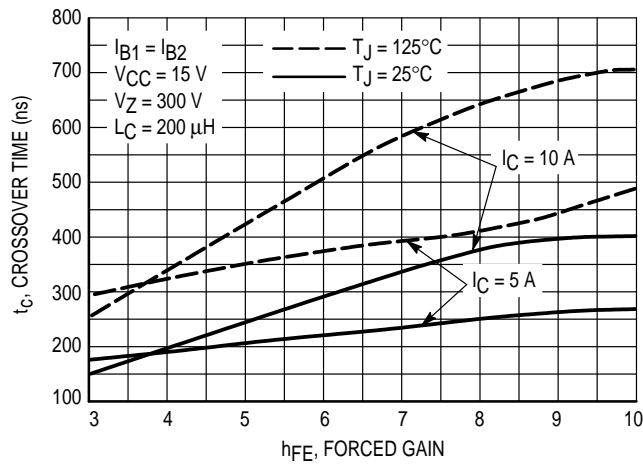


Figure 18. Inductive Crossover Time

TYPICAL SWITCHING CHARACTERISTICS

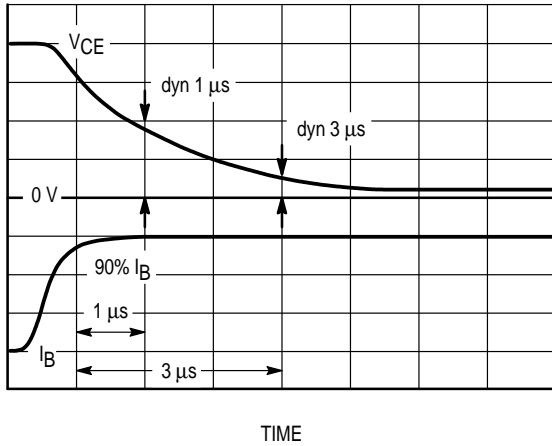


Figure 19. Dynamic Saturation Voltage Measurements

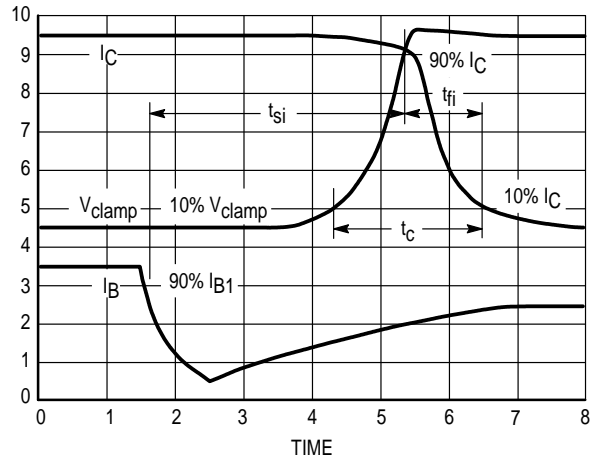
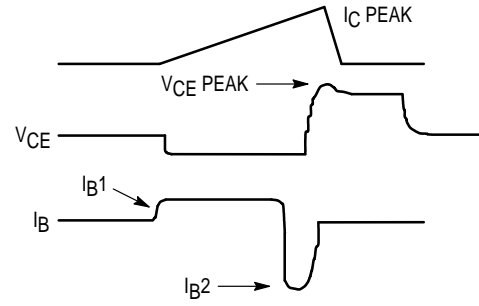
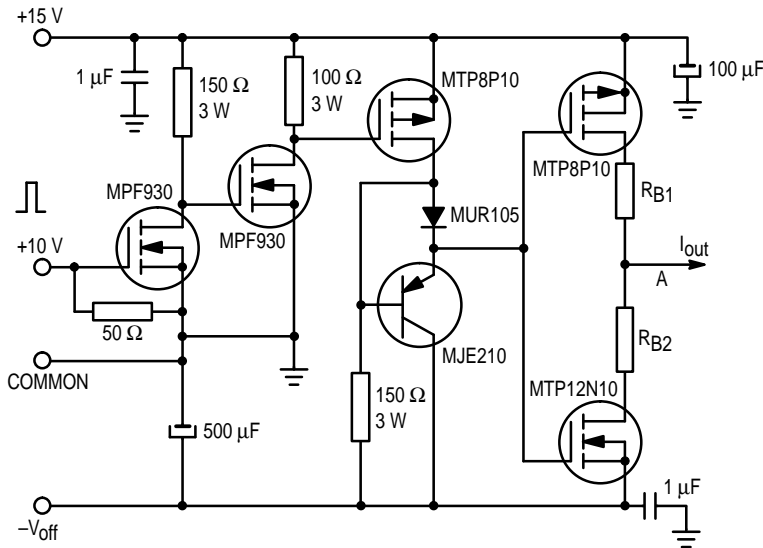


Figure 20. Inductive Switching Measurements

Table 1. Inductive Load Switching Drive Circuit



$V_{(BR)CEO(sus)}$   
 $L = 10 \text{ mH}$   
 $R_{B2} = \infty$   
 $V_{CC} = 20 \text{ Volts}$   
 $I_{C(pk)} = 100 \text{ mA}$

**Inductive Switching**  
 $L = 200 \mu\text{H}$   
 $R_{B2} = 0$   
 $V_{CC} = 15 \text{ Volts}$   
 $R_{B1}$  selected for desired  $I_{B1}$

**RBSOA**  
 $L = 500 \mu\text{H}$   
 $R_{B2} = 0$   
 $V_{CC} = 15 \text{ Volts}$   
 $R_{B1}$  selected for desired  $I_{B1}$

TYPICAL THERMAL RESPONSE

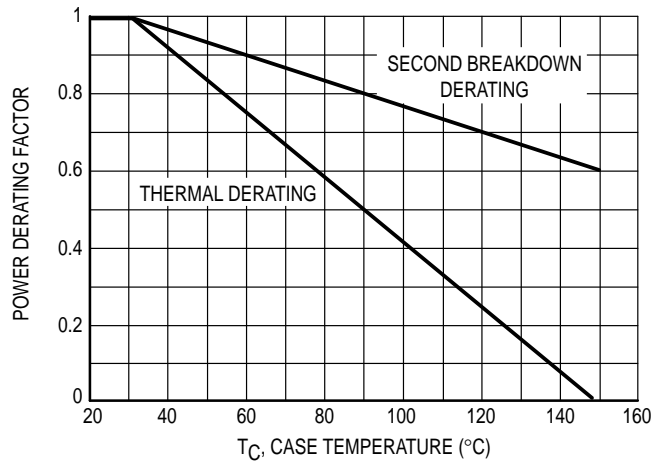


Figure 21. Forward Bias Power Derating



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 22 is based on  $T_C = 25^\circ\text{C}$ ;  $T_{J(pk)}$  is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when  $T_C > 25^\circ\text{C}$ . Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figure 22 may be found at any case temperature by using the appropriate curve on Figure 21.

$T_{J(pk)}$  may be calculated from the data in Figure 24. At any case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. For inductive loads, high voltage and current must be sustained simultaneously during turn-off with the base to emitter junction reverse biased. The safe level is specified as a reverse biased safe operating area (Figure 23). This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode.

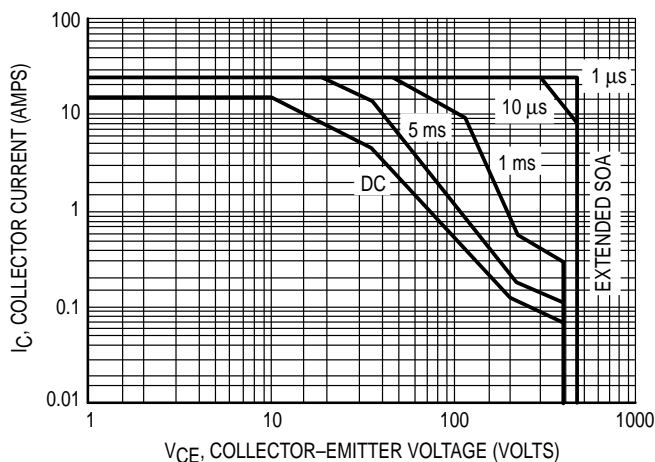


Figure 22. Forward Bias Safe Operating Area

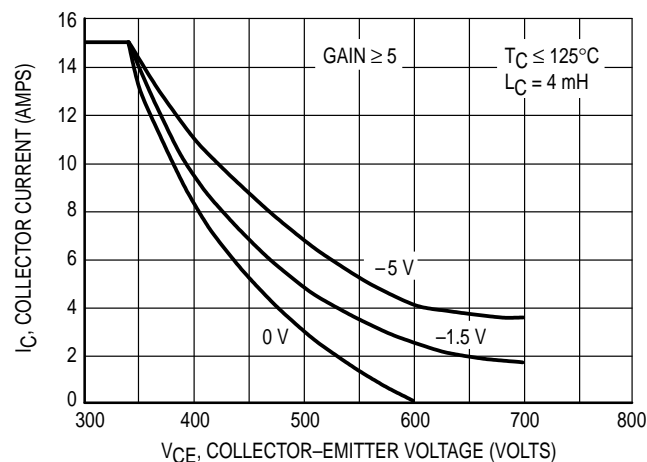


Figure 23. Reverse Bias Safe Operating Area

TYPICAL THERMAL RESPONSE

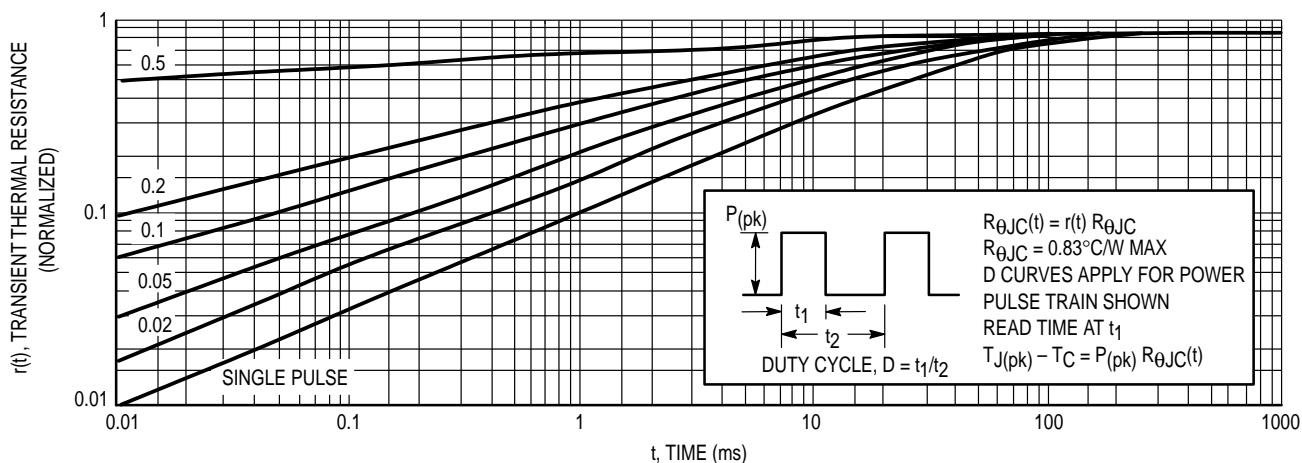
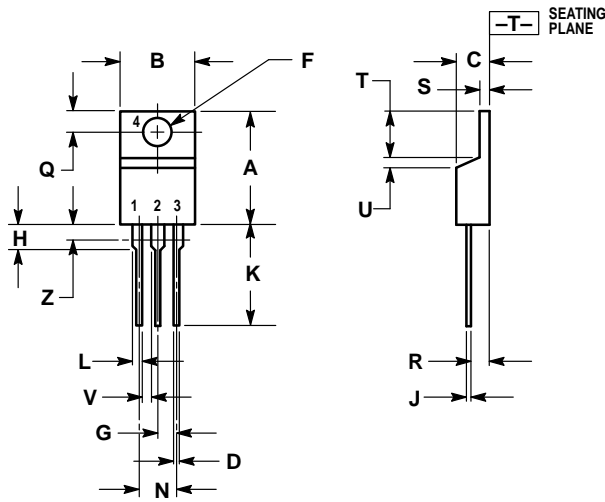


Figure 24. Typical Thermal Response ( $Z_{\theta JC}(t)$ ) for BUH150

PACKAGE DIMENSIONS



- 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:  
 PIN 1. BASE  
 2. COLLECTOR  
 3. EMITTER  
 4. COLLECTOR

CASE 221A-06  
 TO-220AB  
 ISSUE Y

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