BUH150

SWITCHMODE™ NPN Silicon Planar Power Transistor

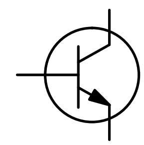
The BUH150 has an application specific state–of–art die designed for use in 150 Watts Halogen electronic transformers.

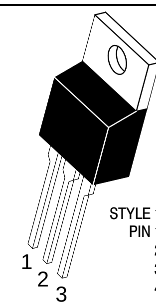
This power transistor is specifically designed to sustain the large inrush current during either the start–up conditions or under a short circuit across the load.

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
- ON Semiconductor Six Sigma Philosophy Provides Tight and Reproducible Parametric Distributions

POWER TRANSISTOR
15 AMPERES
700 VOLTS
150 WATTS





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

CASE 221A–09
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 — Peak (1)	I_C I_{CM}	15 25	Adc
Base Current — Continuous — Peak (1)	I_B I_{BM}	6 12	Adc
*Total Device Dissipation @ T_C = 25°C *Derate above 25°C	P_D	150 1.2	Watt W/°C
Operating and Storage Temperature	T_J, T_{stg}	–65 to 150	°C

THERMAL CHARACTERISTICS

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

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

April, 2002 – Rev. 3
Publication Order Number:
BUH150/D

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Sustaining Voltage (I_C = 100 mA, L = 25 mH)		$V_{CEO(sus)}$	400	460		Vdc
Collector–Base Breakdown Voltage (I_{CBO} = 1 mA)		V_{CBO}	700	860		Vdc
Emitter–Base Breakdown Voltage (I_{EBO} = 1 mA)		V_{EBO}	10	12.3		Vdc
Collector Cutoff Current (V_{CE} = Rated V_{CEO}, I_B = 0)		I_{CEO}			100	µAdc
Collector Cutoff Current (V_{CE} = Rated V_{CES}, V_{EB} = 0)	@ T_C = 25°C @ T_C = 125°C	I_{CES}			100 1000	µAdc
Collector Base Current (V_{CB} = Rated V_{CBO}, V_{EB} = 0)	@ T_C = 25°C @ T_C = 125°C	I_{CBO}			100 1000	µAdc
Emitter–Cutoff Current (V_{EB} = 9 Vdc, I_C = 0)		I_{EBO}			100	µAdc
ON CHARACTERISTICS						
Base–Emitter Saturation Voltage (I_C = 10 Adc, I_B = 2 Adc)		$V_{BE(sat)}$		1	1.25	Vdc
Collector–Emitter Saturation Voltage (I_C = 2 Adc, I_B = 0.4 Adc)	@ T_C = 25°C @ T_C = 125°C	$V_{CE(sat)}$		0.16 0.15	0.4 0.4	Vdc
(I_C = 10 Adc, I_B = 2 Adc)	@ T_C = 25°C			0.45	1	Vdc
(I_C = 20 Adc, I_B = 4 Adc)	@ T_C = 25°C			2	5	Vdc
DC Current Gain (I_C = 20 Adc, V_{CE} = 5 Vdc)	@ T_C = 25°C @ T_C = 125°C	h_{FE}	4 2.5	7 4.5		—
(I_C = 10 Adc, V_{CE} = 5 Vdc)	@ T_C = 25°C @ T_C = 125°C		8 6	12 10		—
(I_C = 2 Adc, V_{CE} = 1 Vdc)	@ T_C = 25°C @ T_C = 125°C		12 14	20 22		—
(I_C = 100 mAdc, V_{CE} = 5 Vdc)	@ T_C = 25°C		10	20		—

DYNAMIC SATURATION VOLTAGE

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Dynamic Saturation Voltage: Determined 3 µs after rising I_{B1} reaches 90% of final I_{B1} (see Figure 19)	I_C = 5 Adc, I_{B1} = 1 Adc V_{CC} = 300 V	@ T_C = 25°C	$V_{CE(dsat)}$		1.5		V
		@ T_C = 125°C			2.8		V
	I_C = 10 Adc, I_{B1} = 2 Adc V_{CC} = 300 V	@ T_C = 25°C			2.4		V
		@ T_C = 125°C			5		V

DYNAMIC CHARACTERISTICS

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

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic			Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS: Resistive Load (D.C. ≤ 10%, Pulse Width = 40 μs)							
Turn–on Time	I_C = 2 Adc, I_{B1} = 0.2 Adc I_{B2} = 0.2 Adc V_{CC} = 300 Vdc	@ T_C = 25°C	t_{on}		200	300	ns
Storage Time		@ T_C = 25°C	t_s		5.3	6.5	μs
Fall Time		@ T_C = 25°C	t_f		240	350	ns
Turn–off Time		@ T_C = 25°C	t_{off}		5.6	7	μs
Turn–on Time	I_C = 2 Adc, I_{B1} = 0.4 Adc I_{B2} = 0.4 Adc V_{CC} = 300 Vdc	@ T_C = 25°C	t_{on}		100	200	ns
Storage Time		@ T_C = 25°C	t_s		6.1	7.5	μs
Fall Time		@ T_C = 25°C	t_f		320	500	ns
Turn–off Time		@ T_C = 25°C	t_{off}		6.5	8	μs
Turn–on Time	I_C = 5 Adc, I_{B1} = 0.5 Adc I_{B2} = 0.5 Adc V_{CC} = 300 Vdc	@ T_C = 25°C @ T_C = 125°C	t_{on}		450 800	650	ns
Turn–off Time		@ T_C = 25°C @ T_C = 125°C	t_{off}		2.5 3.9	3	μs
Turn–on Time	I_C = 10 Adc, I_{B1} = 2 Adc I_{B2} = 2 Adc V_{CC} = 300 Vdc	@ T_C = 25°C @ T_C = 125°C	t_{on}		500 900	700	ns
Turn–off Time		@ T_C = 25°C @ T_C = 125°C	t_{off}		2.25 2.75	2.75	μs
SWITCHING CHARACTERISTICS: Inductive Load (V_{clamp} = 300 V, V_{CC} = 15 V, L = 200 μH)							
Fall Time	I_C = 2 Adc I_{B1} = 0.2 Adc I_{B2} = 0.2 Adc	@ T_C = 25°C @ T_C = 125°C	t_{fi}		110 160	250	ns
Storage Time		@ T_C = 25°C @ T_C = 125°C	t_{si}		6.5 8	8	μs
Crossover Time		@ T_C = 25°C @ T_C = 125°C	t_c		235 240	350	ns
Fall Time	I_C = 2 Adc I_{B1} = 0.4 Adc I_{B2} = 0.4 Adc	@ T_C = 25°C @ T_C = 125°C	t_{fi}		110 170	250	ns
Storage Time		@ T_C = 25°C @ T_C = 125°C	t_{si}		6 7.8	7.5	μs
Crossover Time		@ T_C = 25°C @ T_C = 125°C	t_c		250 270	350	ns
Fall Time	I_C = 5 Adc I_{B1} = 0.5 Adc I_{B2} = 0.5 Adc	@ T_C = 25°C @ T_C = 125°C	t_{fi}		110 140	150	ns
Storage Time		@ T_C = 25°C @ T_C = 125°C	t_{si}		3.25 4.6	3.75	μs
Crossover Time		@ T_C = 25°C @ T_C = 125°C	t_c		275 450	350	ns
Fall Time	I_C = 10 Adc I_{B1} = 2 Adc I_{B2} = 2 Adc	@ T_C = 25°C @ T_C = 125°C	t_{fi}		110 160	175	ns
Storage Time		@ T_C = 25°C @ T_C = 125°C	t_{si}		2.3 2.8	2.75	μs
Crossover Time		@ T_C = 25°C @ T_C = 125°C	t_c		250 475	350	ns

TYPICAL STATIC CHARACTERISTICS

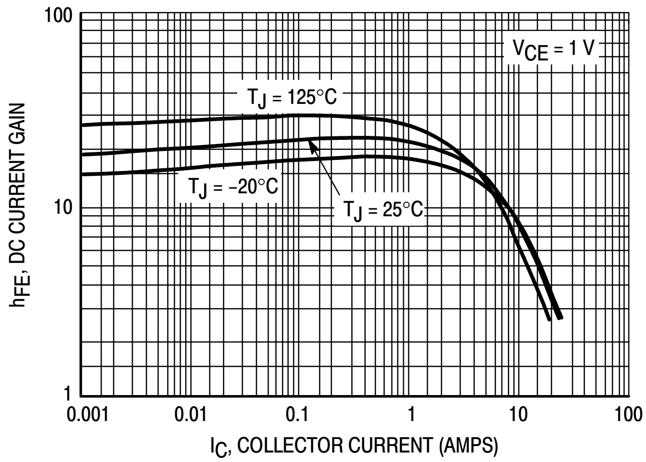


Figure 1. DC Current Gain @ 1 Volt

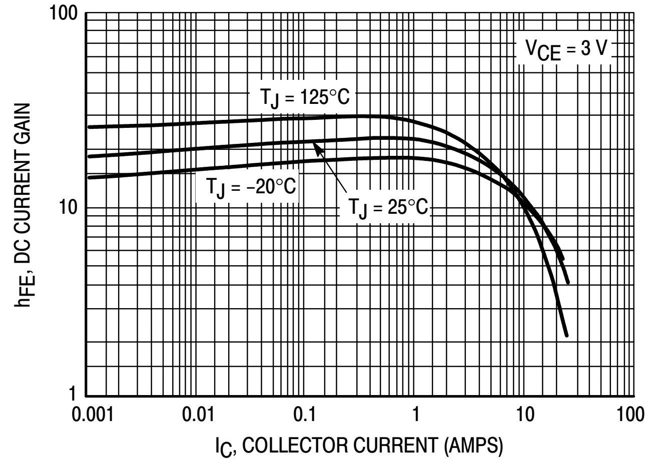


Figure 2. DC Current Gain @ 3 Volt

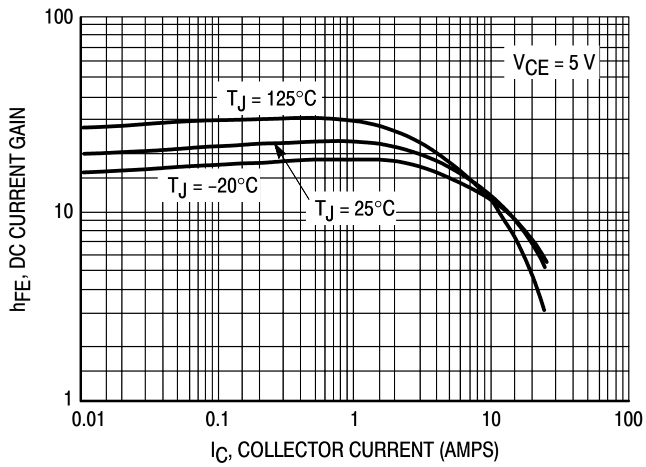


Figure 3. DC Current Gain @ 5 Volt

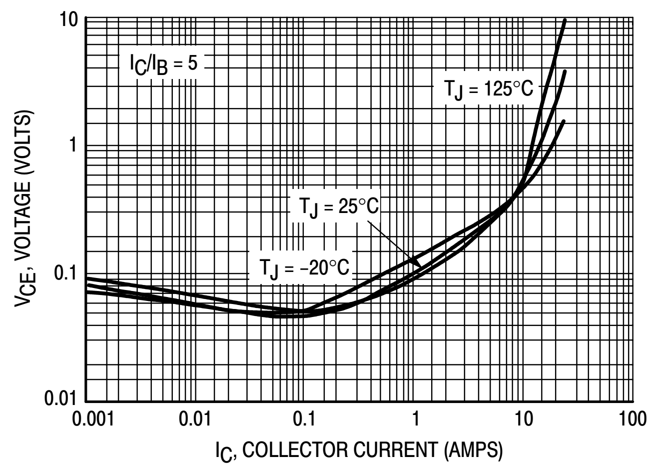


Figure 4. Collector–Emitter Saturation Voltage

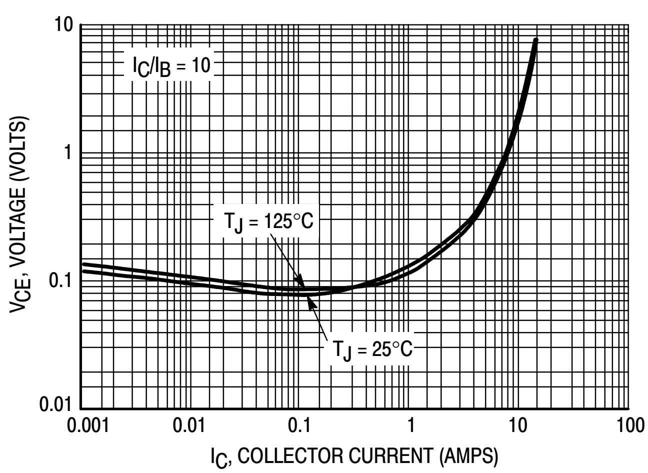


Figure 5. Collector–Emitter Saturation Voltage

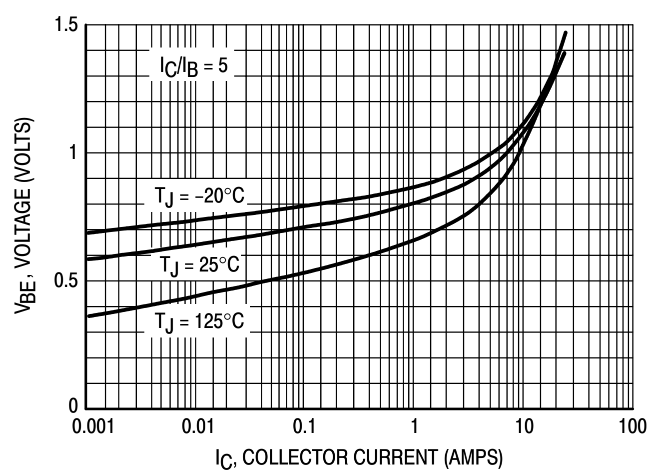


Figure 6. Base–Emitter Saturation Region

TYPICAL STATIC CHARACTERISTICS

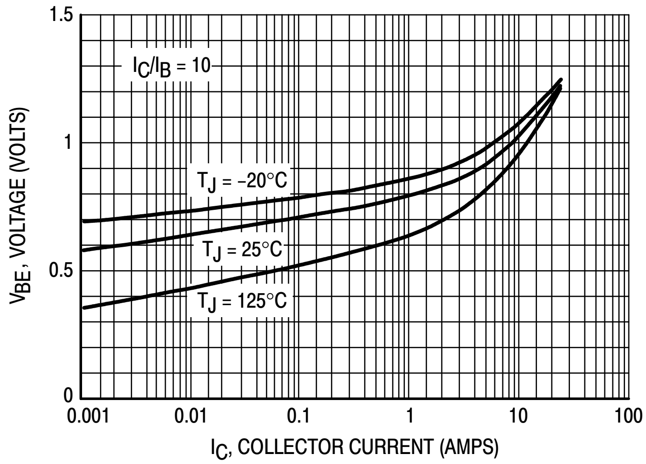


Figure 7. Base–Emitter Saturation Region

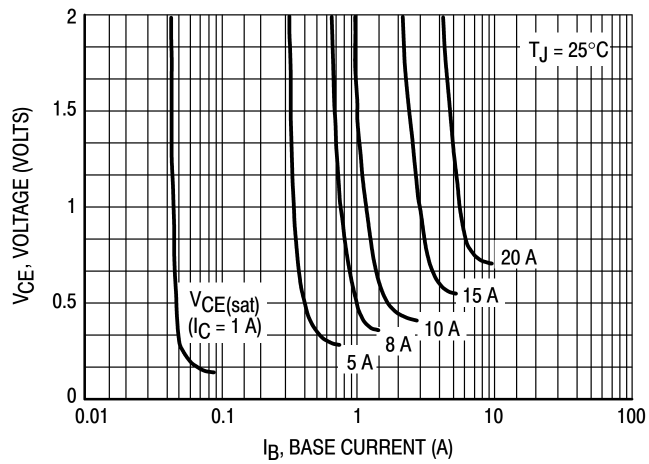


Figure 8. Collector Saturation Region

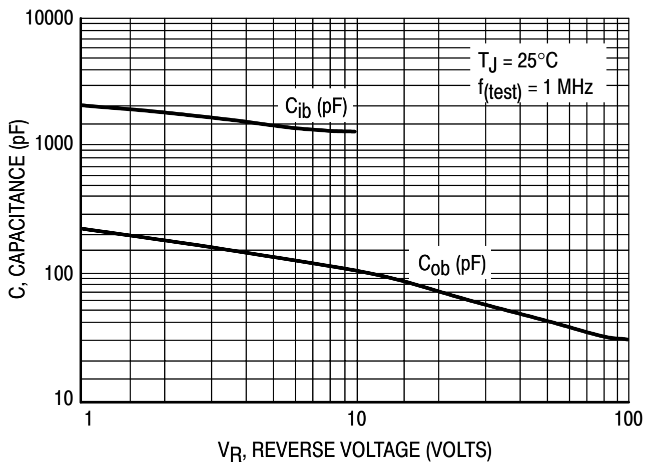


Figure 9. Capacitance

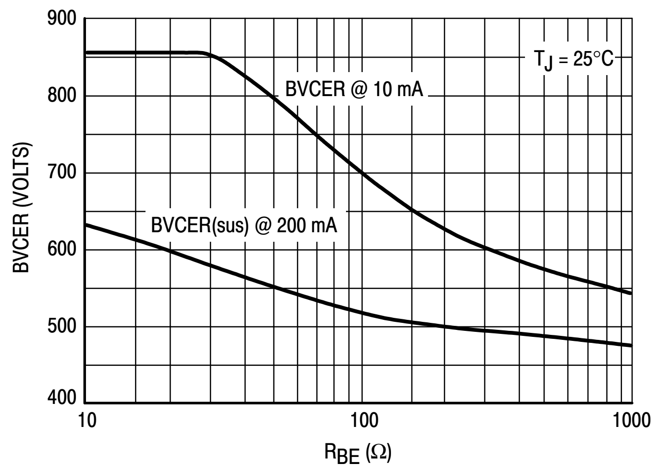


Figure 10. Resistive Breakdown

TYPICAL SWITCHING CHARACTERISTICS

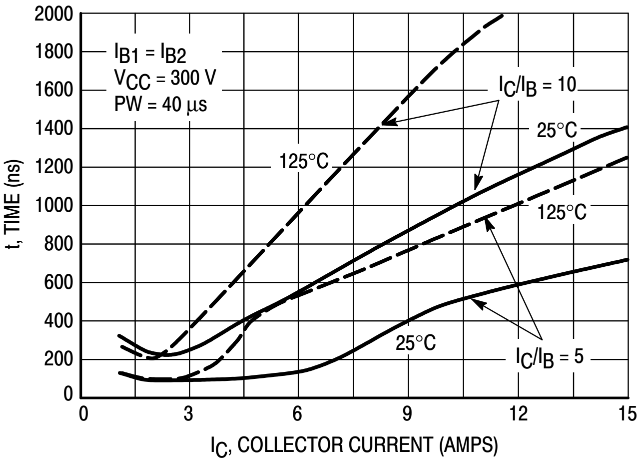


Figure 11. Resistive Switching, t_{on}

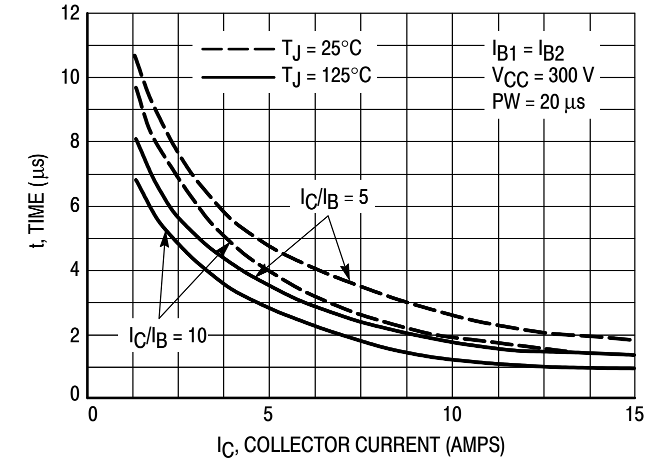


Figure 12. Resistive Switch Time, t_{off}

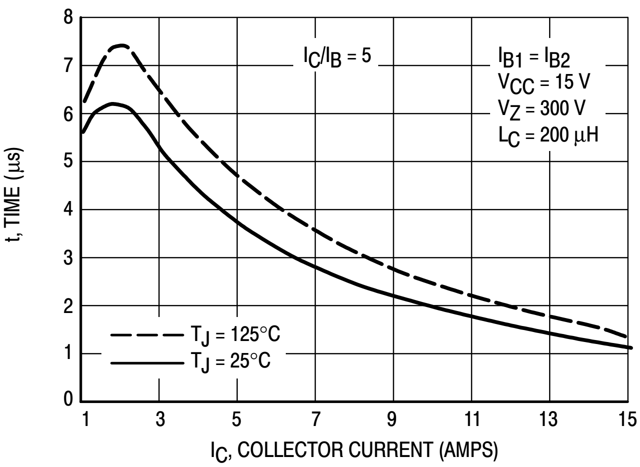


Figure 13. Inductive Storage Time, t_{si}

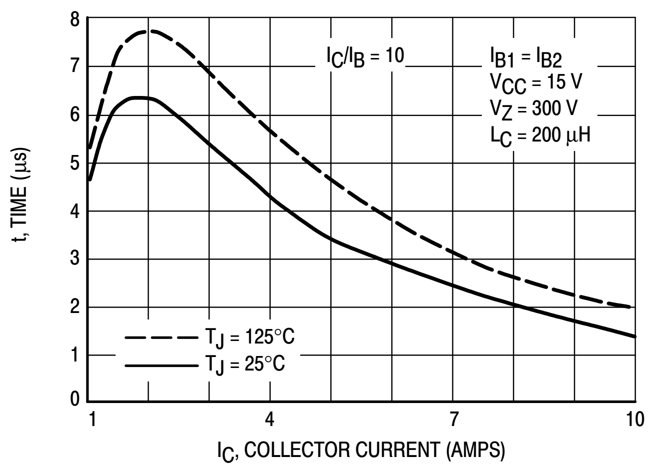


Figure 13 Bis. Inductive Storage Time, t_{si}

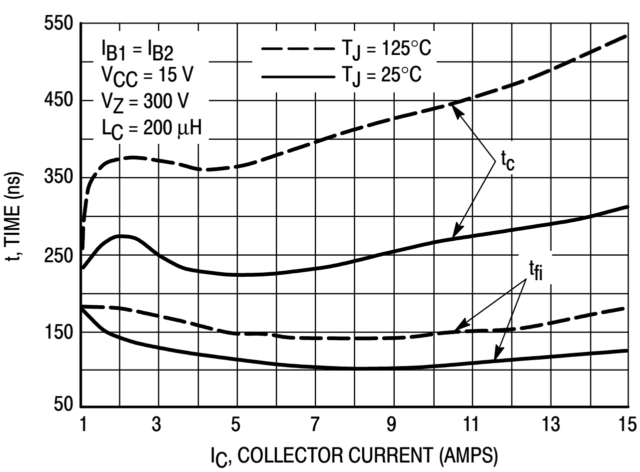


Figure 14. Inductive Storage Time,
t_c & t_{fi} @ I_C/I_B = 5

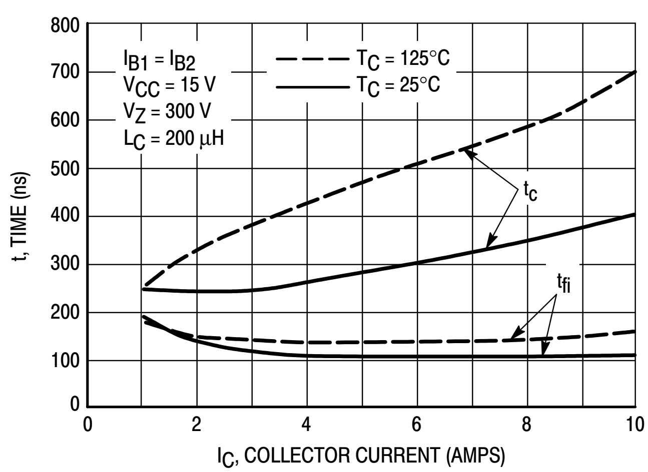


Figure 15. Inductive Storage Time,
t_c & t_{fi} @ I_C/I_B = 10

TYPICAL SWITCHING CHARACTERISTICS

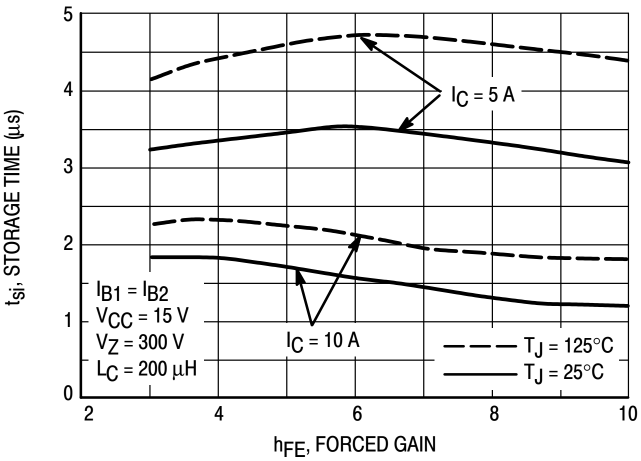


Figure 16. Inductive Storage Time

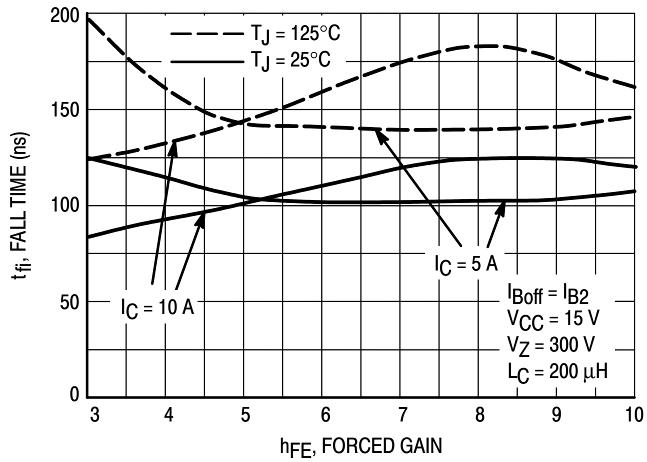


Figure 17. Inductive Fall Time

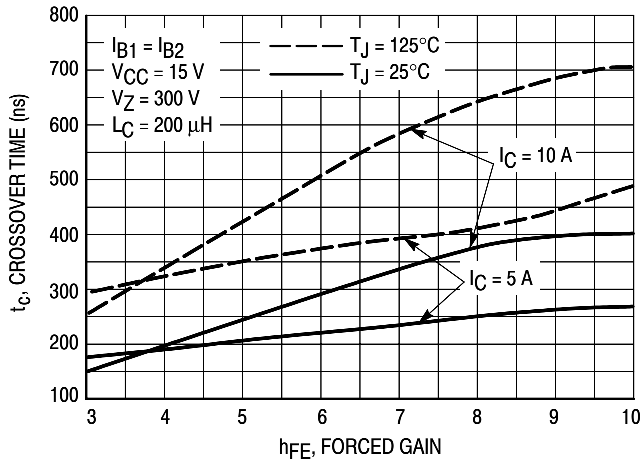


Figure 18. Inductive Crossover Time

TYPICAL SWITCHING CHARACTERISTICS

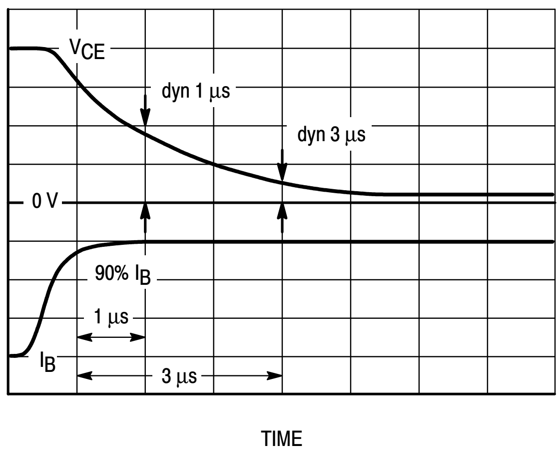


Figure 19. Dynamic Saturation Voltage Measurements

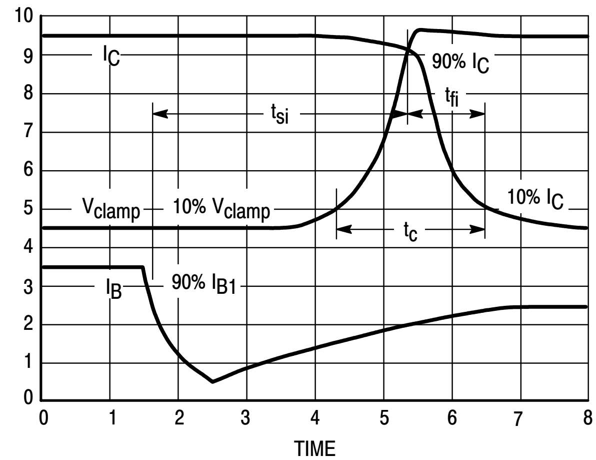
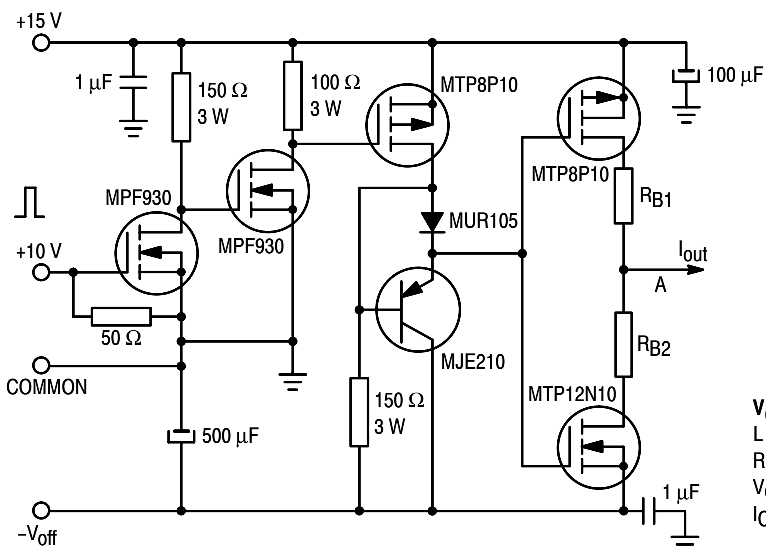
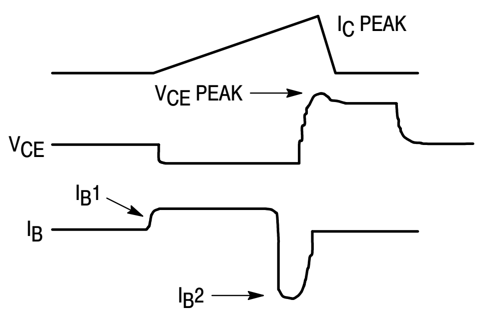


Figure 20. Inductive Switching Measurements

Table 1. Inductive Load Switching Drive Circuit





$V_{(BR)CEO(sus)}$	Inductive Switching	RBSOA
L = 10 mH	L = 200 μH	L = 500 μH
$R_{B2} = \infty$	$R_{B2} = 0$	$R_{B2} = 0$
V_{CC} = 20 Volts	V_{CC} = 15 Volts	V_{CC} = 15 Volts
$I_{C(pk)}$ = 100 mA	R_{B1} selected for desired I_{B1}	R_{B1} selected for desired I_{B1}

TYPICAL THERMAL RESPONSE

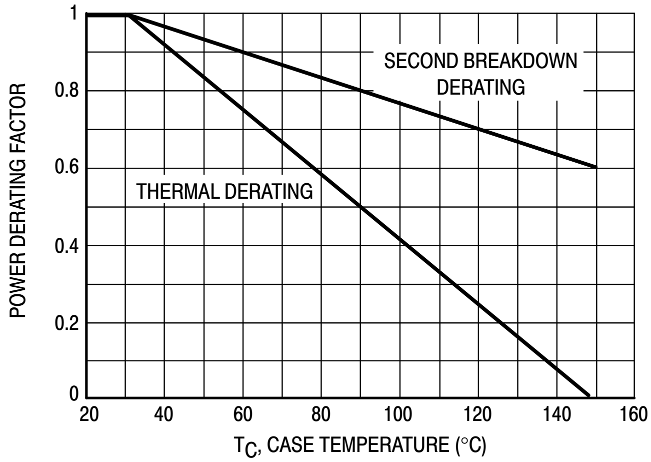


Figure 21. Forward Bias Power Derating

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 $T_C = 25°C$; $T_{J(pk)}$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when $T_C > 25°C$. 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.

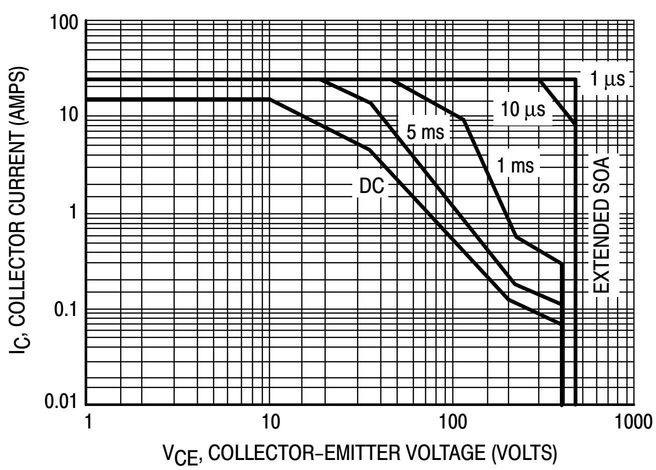


Figure 22. Forward Bias Safe Operating Area

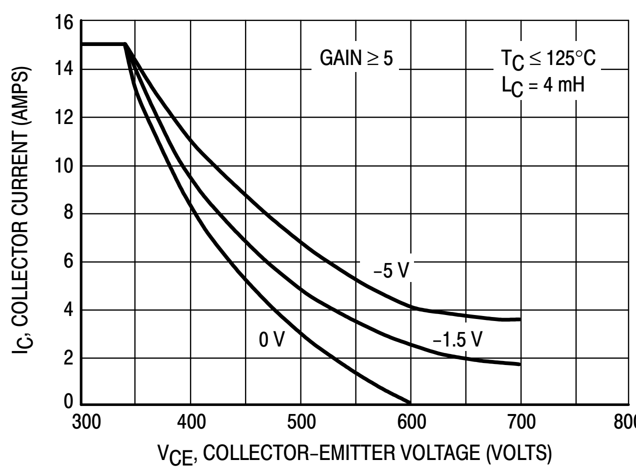


Figure 23. Reverse Bias Safe Operating Area

TYPICAL THERMAL RESPONSE

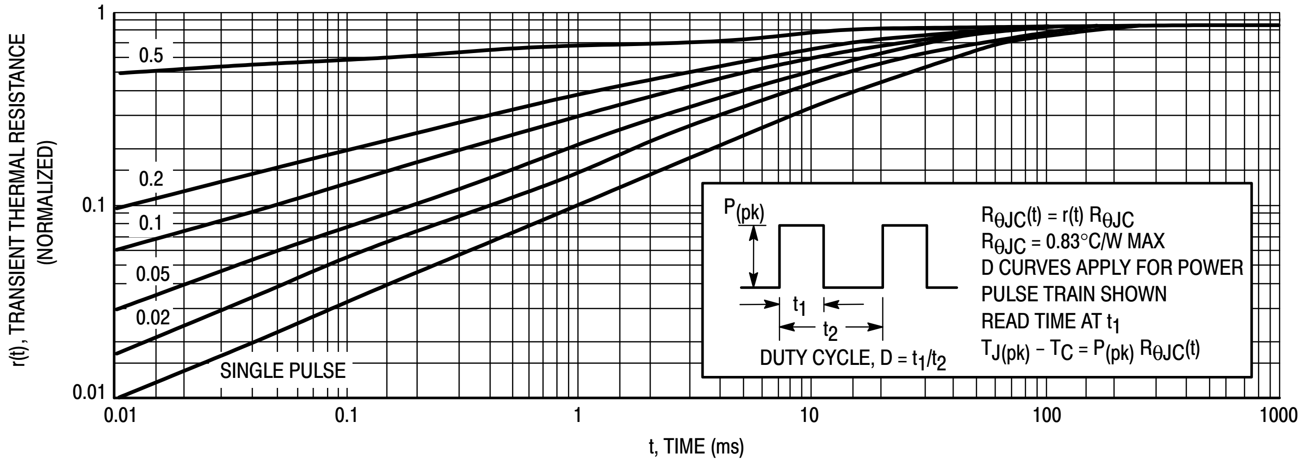
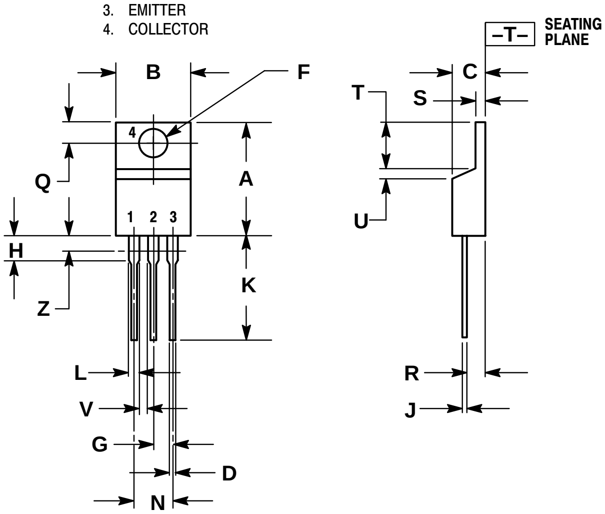


Figure 24. Typical Thermal Response ($Z_{\theta JC}(t)$) for BUH150

PACKAGE DIMENSIONS

TO–220AB
CASE 221A–09
ISSUE AA

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



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.

	INCHES		MILLIMETERS	
DIM	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

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Phone: 81–3–5740–2700
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