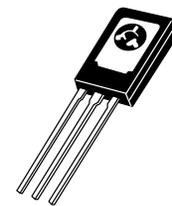
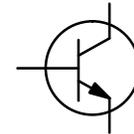


BUH51

POWER TRANSISTOR
3 AMPERES
800 VOLTS
50 WATTS



CASE 77-07
TO-225AA TYPE

Advance Information
SWITCHMODE NPN Silicon
Planar Power Transistor

The BUH51 has an application specific state-of-art die designed for use in 50 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 Providing Tight and Reproducible Parametric Distributions

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Sustaining Voltage	V_{CEO}	500	Vdc
Collector-Base Breakdown Voltage	V_{CBO}	800	Vdc
Collector-Emitter Breakdown Voltage	V_{CES}	800	Vdc
Emitter-Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	3	Adc
— Peak (1)	I_{CM}	8	
Base Current — Continuous	I_B	2	Adc
— Peak (1)	I_{BM}	4	
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$	P_D	50	Watt
*Derate above 25°C		0.4	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J, T_{stg}	-65 to 150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance			$^\circ\text{C/W}$
— Junction to Case	$R_{\theta JC}$	2.5	
— Junction to Ambient	$R_{\theta JA}$	100	
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%.

Designer's and SWITCHMODE are trademarks of Motorola, Inc.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

BUH51

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Sustaining Voltage ($I_C = 100\text{ mA}$, $L = 25\text{ mH}$)	$V_{CEO(sus)}$	500	550		Vdc
Collector–Base Breakdown Voltage ($I_{CBO} = 1\text{ mA}$)	V_{CBO}	800	950		Vdc
Emitter–Base Breakdown Voltage ($I_{EBO} = 1\text{ mA}$)	V_{EBO}	10	12.5		Vdc
Collector Cutoff Current ($V_{CE} = \text{Rated } V_{CEO}$, $I_B = 0$)	I_{CEO}			100	μAdc
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	μAdc
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	μAdc
Emitter–Cutoff Current ($V_{EB} = 9\text{ Vdc}$, $I_C = 0$)	I_{EBO}			100	μAdc

ON CHARACTERISTICS

Base–Emitter Saturation Voltage ($I_C = 1\text{ Adc}$, $I_B = 0.2\text{ Adc}$)	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $V_{BE(sat)}$		0.92 0.8	1.1	Vdc
Collector–Emitter Saturation Voltage ($I_C = 1\text{ Adc}$, $I_B = 0.2\text{ Adc}$)	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $V_{CE(sat)}$		0.3 0.32	0.5 0.6	Vdc
DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 1\text{ Vdc}$) ($I_C = 2\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$) ($I_C = 0.8\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$) ($I_C = 10\text{ mAdc}$, $V_{CE} = 5\text{ Vdc}$)	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ h_{FE}	8 6	10 8		—
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	5 4	7.5 6.2		—
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	10 8	14 13		—
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	14 18	20 25		—

DYNAMIC SATURATION VOLTAGE

Dynamic Saturation Voltage: Determined 3 μs after rising I_{B1} reaches 90% of final I_{B1}	$I_C = 1\text{ Adc}$, $I_{B1} = 0.2\text{ Adc}$ $V_{CC} = 300\text{ V}$	@ $T_C = 25^\circ\text{C}$	$V_{CE(dsat)}$	1.7	V
		@ $T_C = 125^\circ\text{C}$		6	V
	$I_C = 2\text{ Adc}$, $I_{B1} = 0.4\text{ Adc}$ $V_{CC} = 300\text{ V}$	@ $T_C = 25^\circ\text{C}$		5.1	V
		@ $T_C = 125^\circ\text{C}$		15	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}		34	100	pF
Input Capacitance ($V_{EB} = 8\text{ Vdc}$, $f = 1\text{ MHz}$)	C_{ib}		200	500	pF

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

Characteristic	Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS: Resistive Load (D.C. $\leq 10\%$, Pulse Width = 40 μs)					
Turn-on Time	$I_C = 1 \text{ Adc}, I_{B1} = 0.2 \text{ Adc}$ $I_{B2} = 0.2 \text{ Adc}$ $V_{CC} = 300 \text{ Vdc}$	@ $T_C = 25^\circ\text{C}$	t_{on}	110	ns
Turn-off Time		@ $T_C = 125^\circ\text{C}$		125	150
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}	700	ns
Turn-off Time		@ $T_C = 125^\circ\text{C}$		1250	1000
Turn-on Time	$I_C = 1 \text{ Adc}, I_{B1} = 0.2 \text{ Adc}$ $I_{B2} = 0.2 \text{ Adc}$ $V_{CC} = 300 \text{ Vdc}$	@ $T_C = 25^\circ\text{C}$	t_{off}	3.5	μs
Turn-off Time		@ $T_C = 125^\circ\text{C}$		4.1	4
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_{off}	1.75	μs
Turn-off Time		@ $T_C = 125^\circ\text{C}$		2.1	2

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

Fall Time	$I_C = 1 \text{ Adc}$ $I_{B1} = 0.2 \text{ Adc}$ $I_{B2} = 0.2 \text{ Adc}$	@ $T_C = 25^\circ\text{C}$	t_{fi}	200	ns	
Storage Time		@ $T_C = 125^\circ\text{C}$		320	300	
Crossover Time		@ $T_C = 25^\circ\text{C}$	t_{si}	3.4	3.75	μs
Storage Time	$I_C = 2 \text{ Adc}$ $I_{B1} = 0.4 \text{ Adc}$ $I_{B2} = 0.4 \text{ Adc}$	@ $T_C = 125^\circ\text{C}$		4		
Fall Time		@ $T_C = 25^\circ\text{C}$	t_c	350	500	ns
Storage Time		@ $T_C = 125^\circ\text{C}$		640		
Fall Time	$I_C = 1 \text{ Adc}$ $I_{B1} = 0.2 \text{ Adc}$ $I_{B2} = 0.2 \text{ Adc}$	@ $T_C = 25^\circ\text{C}$	t_{fi}	140	ns	
Storage Time		@ $T_C = 125^\circ\text{C}$		300	200	
Crossover Time		@ $T_C = 25^\circ\text{C}$	t_{si}	2.3	2.75	μs
Storage Time	$I_C = 2 \text{ Adc}$ $I_{B1} = 0.4 \text{ Adc}$ $I_{B2} = 0.4 \text{ Adc}$	@ $T_C = 125^\circ\text{C}$		2.8		
Fall Time		@ $T_C = 25^\circ\text{C}$	t_c	400	600	ns
Storage Time		@ $T_C = 125^\circ\text{C}$		725		

TYPICAL STATIC CHARACTERISTICS

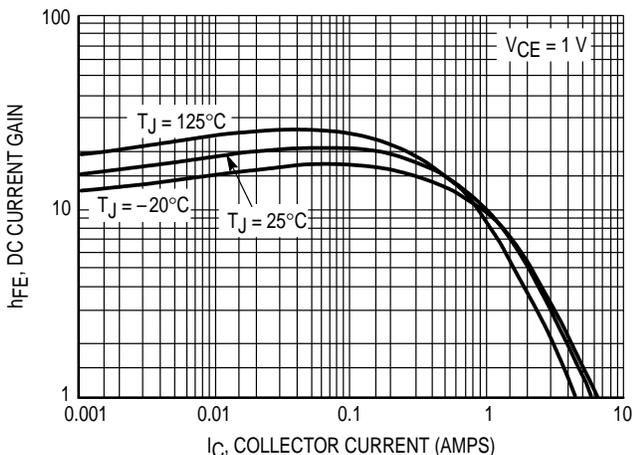


Figure 1. DC Current Gain @ 1 Volt

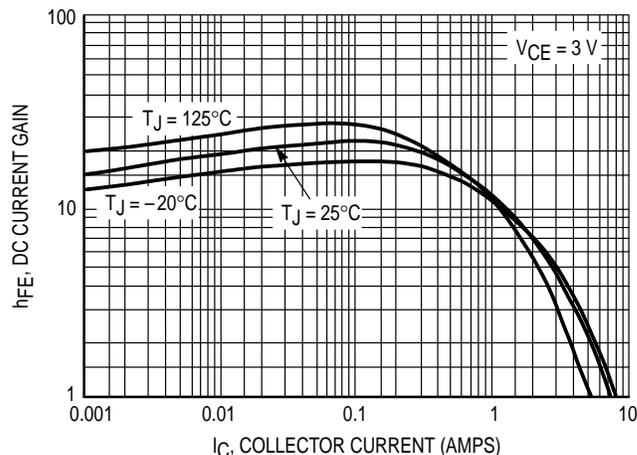


Figure 2. DC Current Gain @ 3 Volt

TYPICAL STATIC CHARACTERISTICS

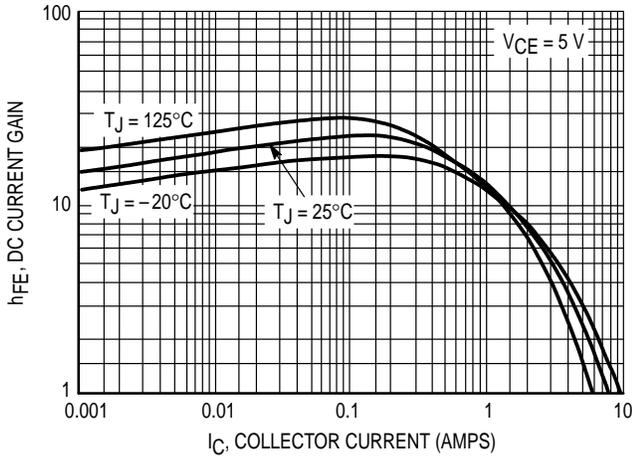


Figure 3. DC Current Gain @ 5 Volt

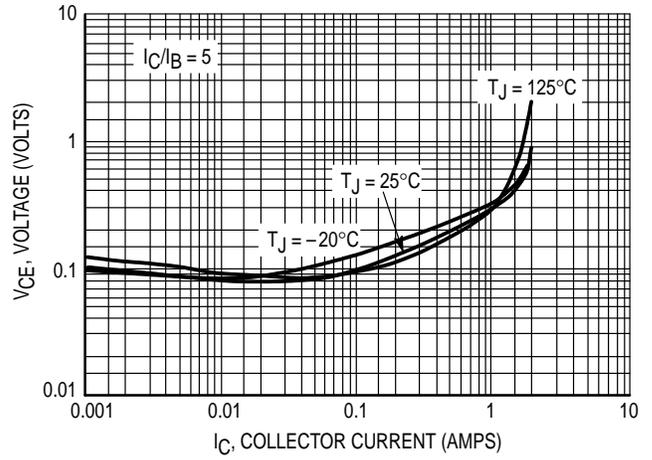


Figure 4. Collector-Emitter Saturation Voltage

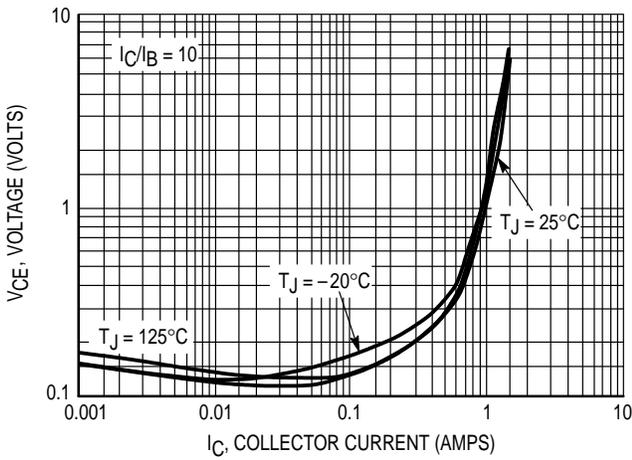


Figure 5. Collector-Emitter Saturation Voltage

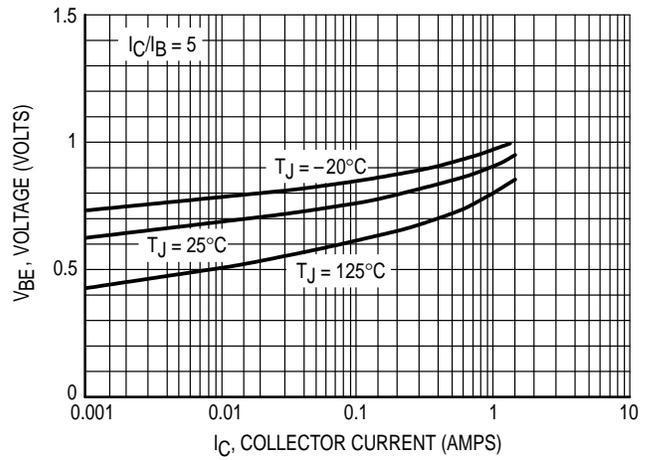


Figure 6. Base-Emitter Saturation Region

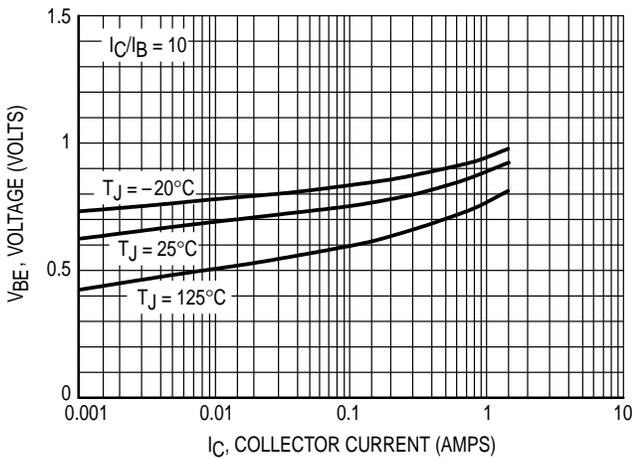


Figure 7. Base-Emitter Saturation Region

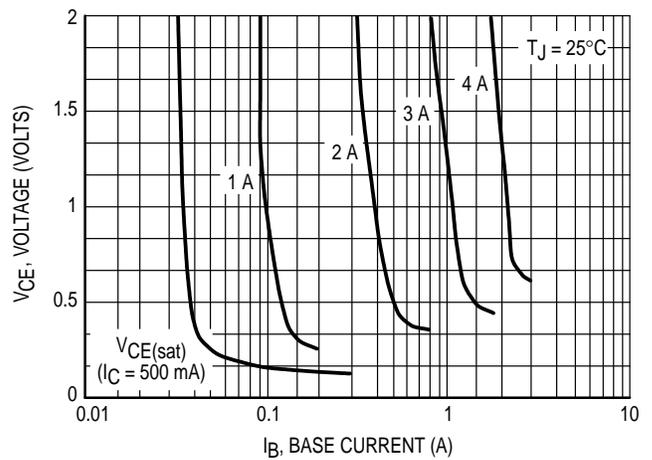


Figure 8. Collector Saturation Region

TYPICAL STATIC CHARACTERISTICS

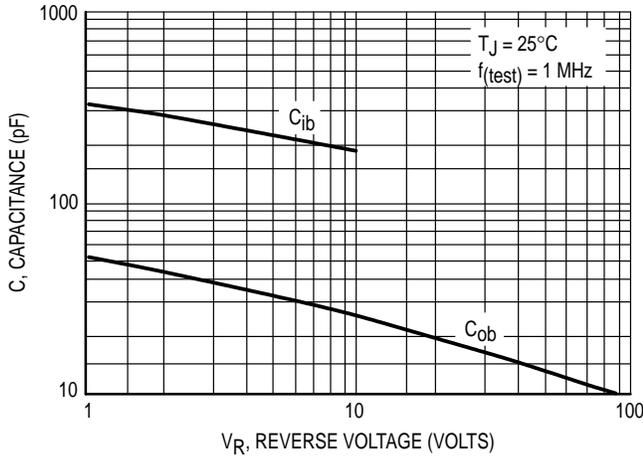


Figure 9. Capacitance

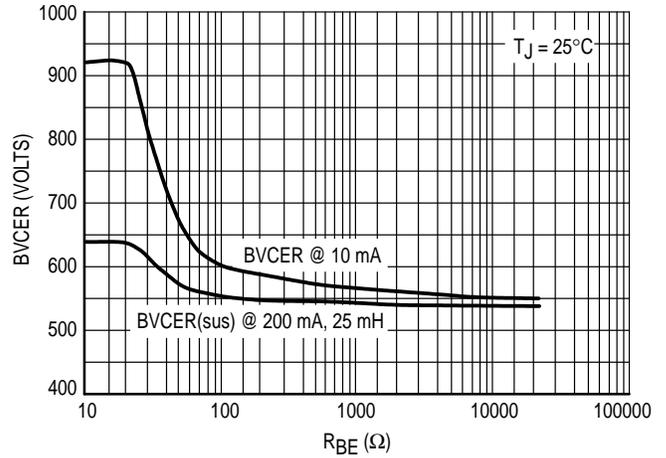


Figure 10. Resistive Breakdown

TYPICAL SWITCHING CHARACTERISTICS

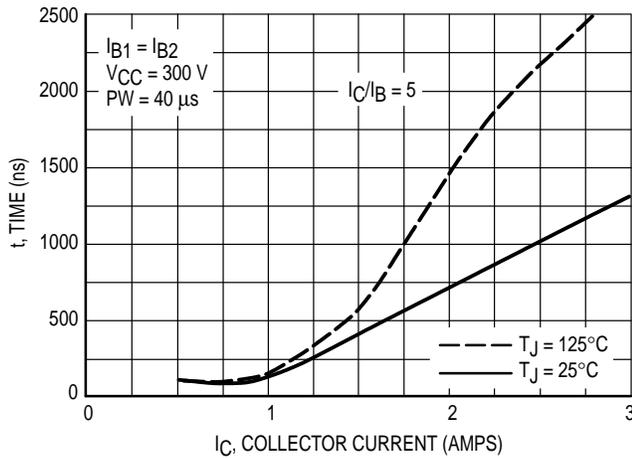


Figure 11. Resistive Switching, t_{on}

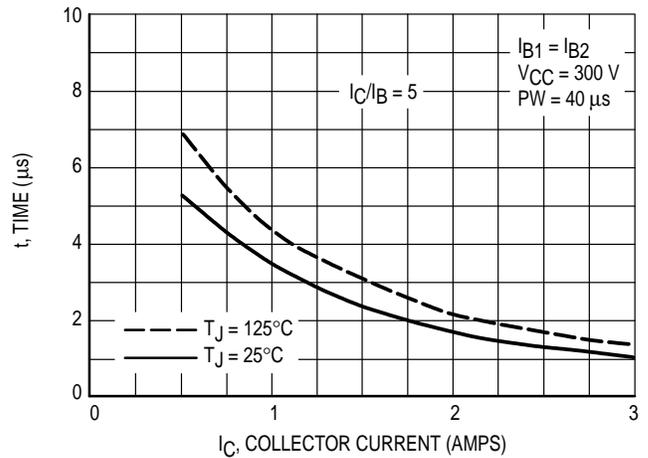


Figure 12. Resistive Switch Time, t_{off}

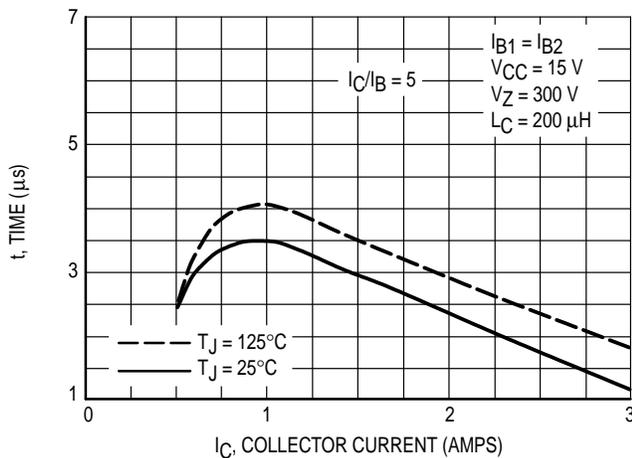


Figure 13. Inductive Storage Time, t_{si}

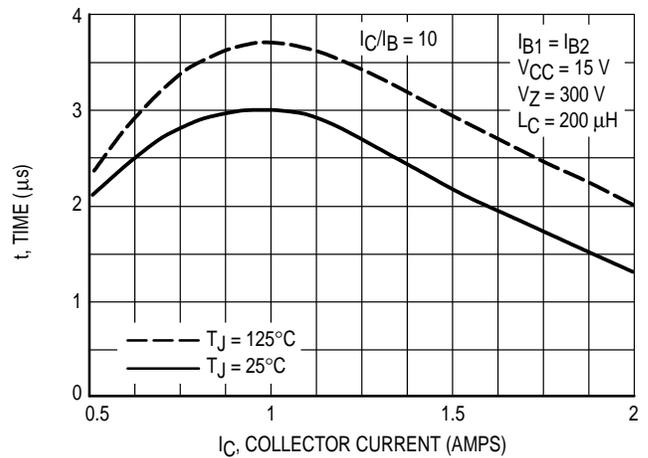


Figure 13 Bis. Inductive Storage Time, t_{si}

TYPICAL SWITCHING CHARACTERISTICS

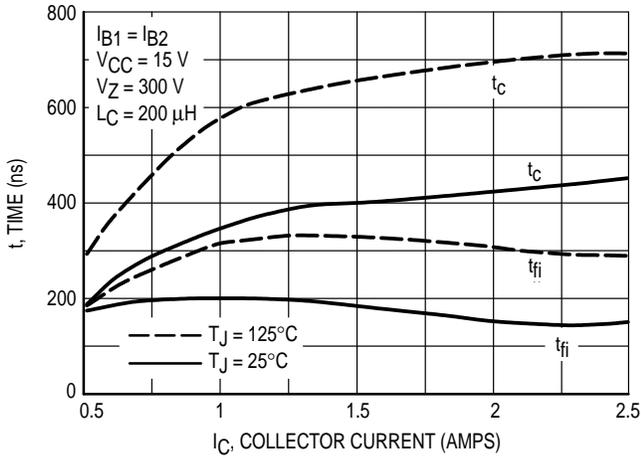


Figure 14. Inductive Storage Time, t_c & t_{fi} @ $I_C/I_B = 5$

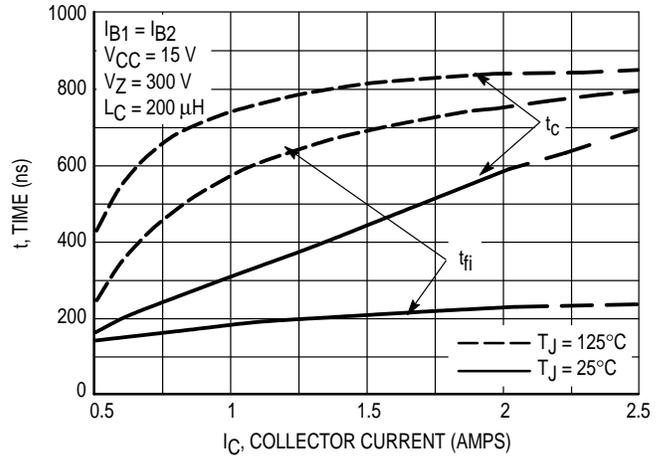


Figure 15. Inductive Storage Time, t_c & t_{fi} @ $I_C/I_B = 10$

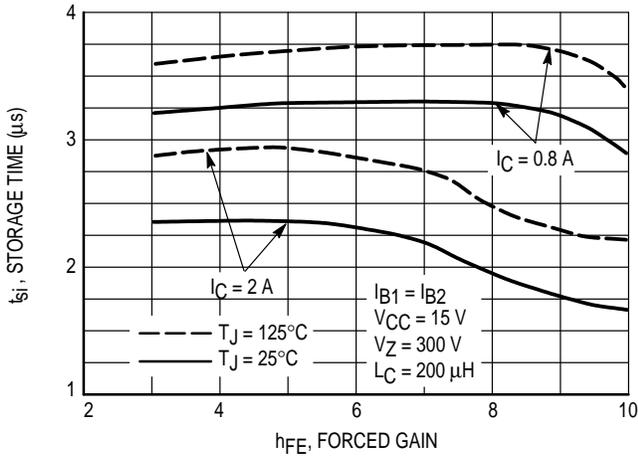


Figure 16. Inductive Storage Time

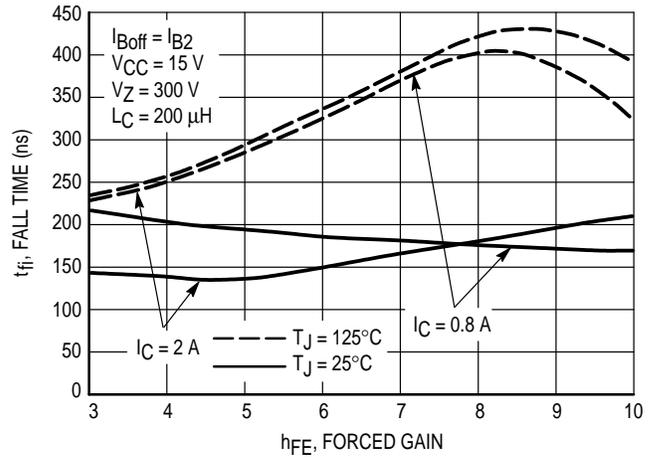


Figure 17. Inductive Fall Time

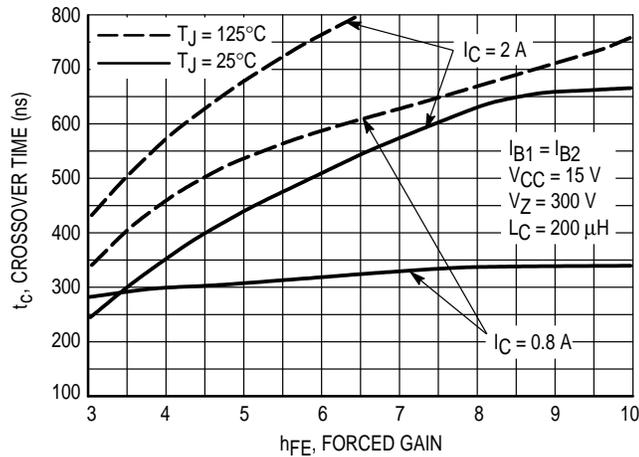


Figure 18. Inductive Crossover Time

TYPICAL SWITCHING CHARACTERISTICS

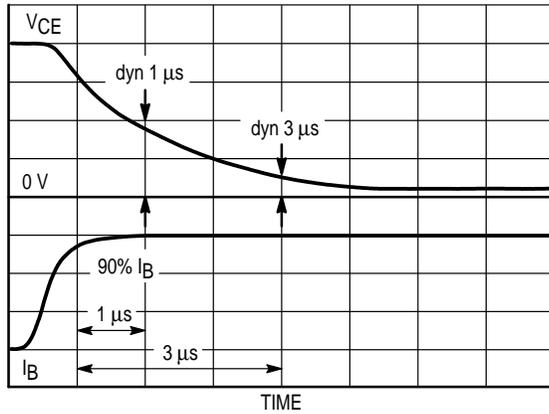


Figure 19. Dynamic Saturation Voltage Measurements

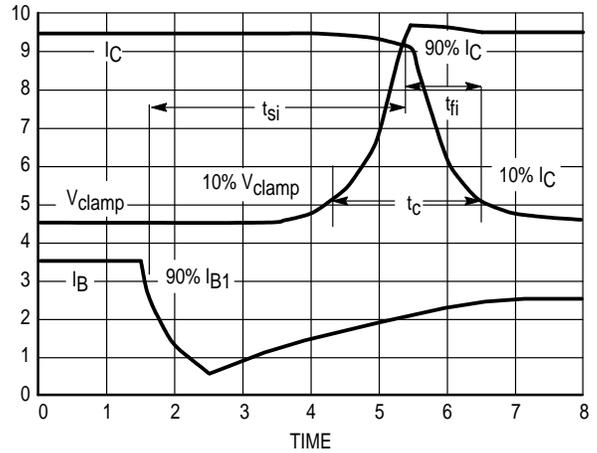
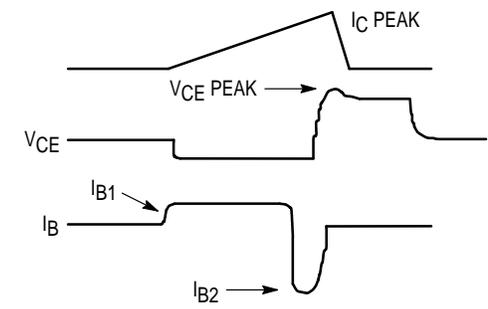
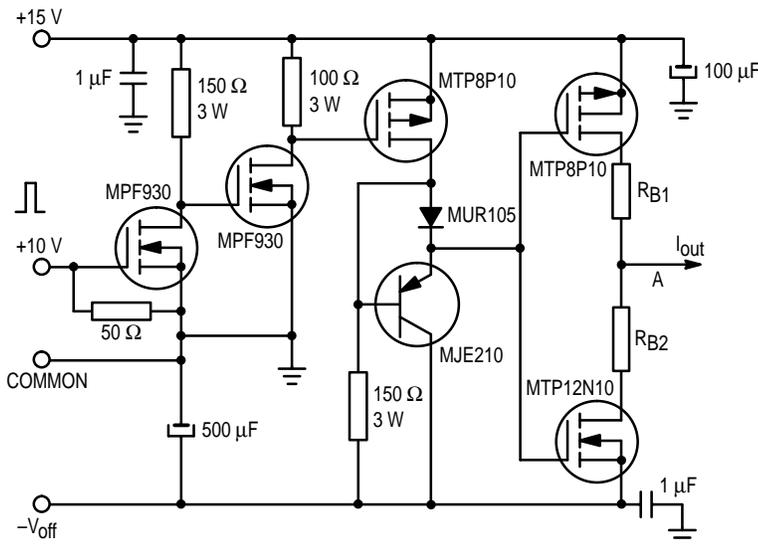


Figure 20. Inductive Switching Measurements

Table 1. Inductive Load Switching Drive Circuit



V(BR)CEO(sus) L = 10 mH RB2 = ∞ VCC = 20 Volts IC(pk) = 100 mA	Inductive Switching L = 200 μH RB2 = 0 VCC = 15 Volts RB1 selected for desired IB1	RBSOA L = 500 μH RB2 = 0 VCC = 15 Volts RB1 selected for desired IB1
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TYPICAL THERMAL RESPONSE

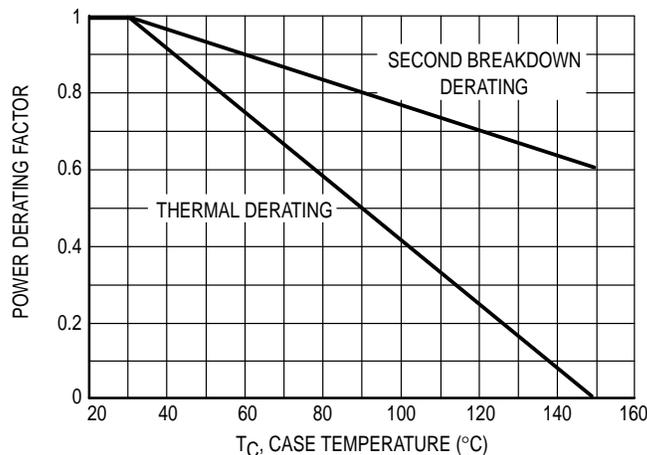


Figure 21. Forward Bias Power Derating

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.

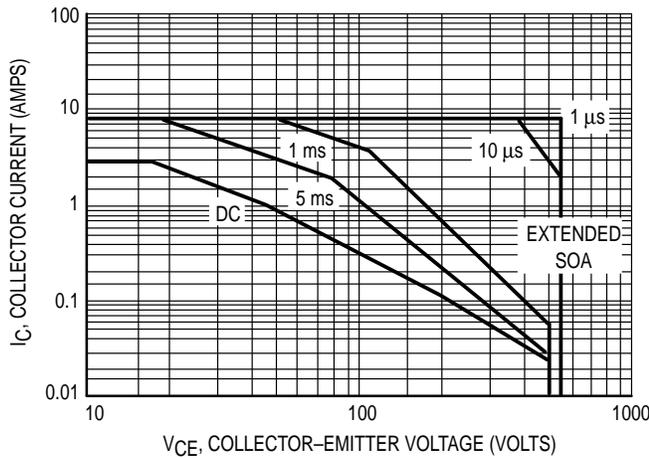


Figure 22. Forward Bias Safe Operating Area

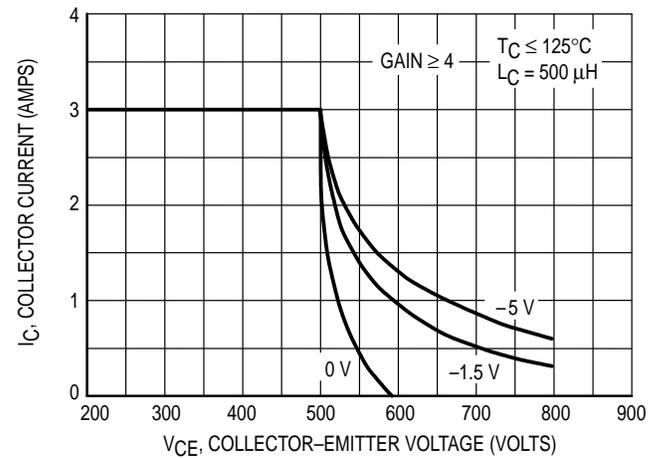


Figure 23. Reverse Bias Safe Operating Area

TYPICAL THERMAL RESPONSE

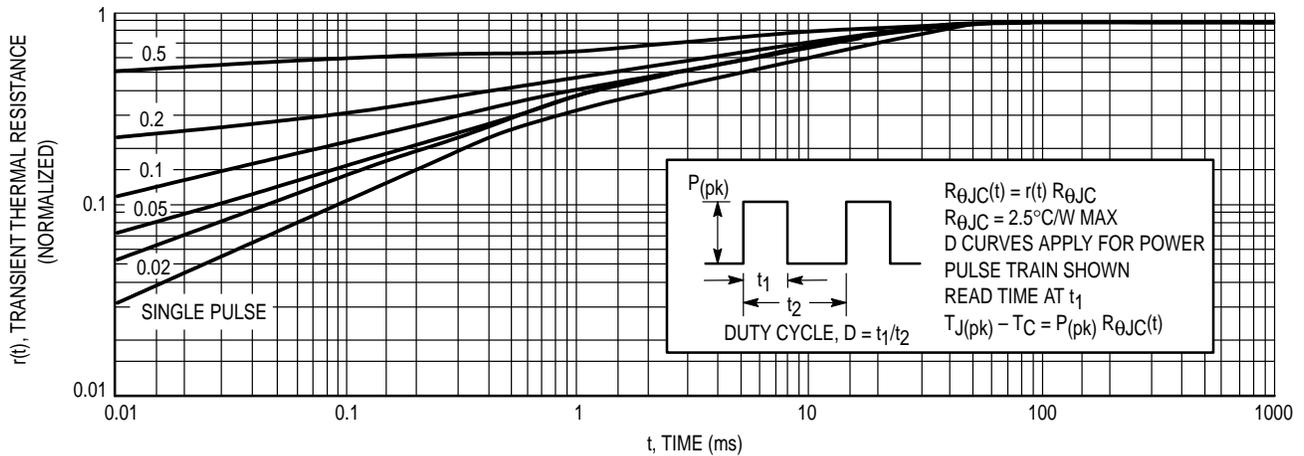
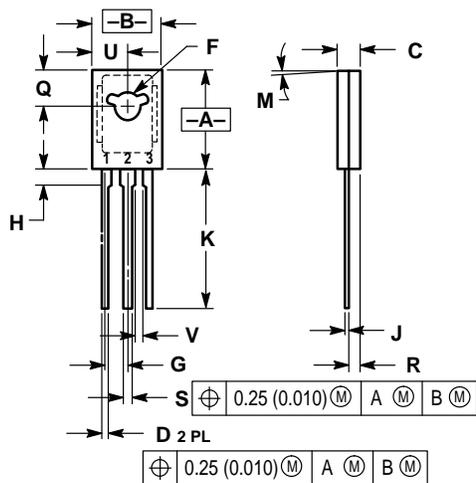


Figure 24. Typical Thermal Response ($Z_{\theta JC}(t)$) for BUH51

PACKAGE DIMENSIONS



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.425	0.435	10.80	11.04
B	0.295	0.305	7.50	7.74
C	0.095	0.105	2.42	2.66
D	0.020	0.026	0.51	0.66
F	0.115	0.130	2.93	3.30
G	0.094 BSC		2.39 BSC	
H	0.050	0.095	1.27	2.41
J	0.015	0.025	0.39	0.63
K	0.575	0.655	14.61	16.63
M	5° TYP		5° TYP	
Q	0.148	0.158	3.76	4.01
R	0.045	0.055	1.15	1.39
S	0.025	0.035	0.64	0.88
U	0.145	0.155	3.69	3.93
V	0.040	—	1.02	—

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

CASE 77-08
 TO-225AA TYPE
 ISSUE V

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