BUH50

Designer's™ Data Sheet

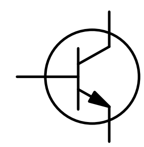
SWITCHMODE NPN Silicon Planar Power Transistor

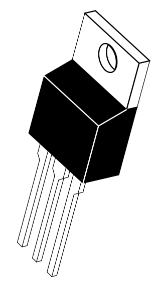
POWER TRANSISTOR
4 AMPERES
800 VOLTS
50 WATTS

The BUH50 has an application specific state–of–art die designed for use in 50 Watts HALOGEN electronic transformers and switchmode applications.

This high voltage/high speed transistor exhibits the following main feature:

- Improved Efficiency Due to Low Base Drive Requirements:
  — High and Flat DC Current Gain h_{FE}
  — Fast Switching
- Motorola "6SIGMA" Philosophy Provides Tight and Reproductible Parametric Distributions
- Specified Dynamic Saturation Data
- Full Characterization at 125°C





CASE 221A–06
TO–220AB

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}	9	Vdc
Collector Current — Continuous — Peak (1)	I_C I_{CM}	4 8	Adc
Base Current — Continuous — Peak (1)	I_B I_{BM}	2 4	Adc
*Total Device Dissipation @ T_C = 25°C *Derate above 25°C	P_D	50 0.4	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	 $R_{\theta JC}$ $R_{\theta JA}$	 2.5 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%.

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.

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)				$V_{CEO(sus)}$	500			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
Emitter–Cutoff Current (V_{EB} = 9 Vdc, I_C = 0)				I_{EBO}			100	µAdc
ON CHARACTERISTICS								
Base–Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.33 Adc) (I_C = 2 Adc, I_B = 0.66 Adc) 25°C (I_C = 2 Adc, I_B = 0.66 Adc) 100°C				$V_{BE(sat)}$		0.86 0.94 0.85	1.2 1.6 1.5	Vdc
Collector–Emitter Saturation Voltage (I_C = 1 Adc, I_B = 0.33 Adc)			@ T_C = 25°C	$V_{CE(sat)}$		0.2	0.5	Vdc
(I_C = 2 Adc, I_B = 0.66 Adc)			@ T_C = 25°C @ T_C = 125°C			0.32 0.29	0.6 0.7	
(I_C = 3 Adc, I_B = 1 Adc)			@ T_C = 25°C			0.5	1	
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)			@ T_C = 25°C	h_{FE}	7	13		—
(I_C = 2 Adc, V_{CE} = 5 Vdc)			@ T_C = 25°C		5	10		—
DYNAMIC CHARACTERISTICS								
Current Gain Bandwidth (I_C = 0.5 Adc, V_{CE} = 10 Vdc, f = 1 MHz)				f_T	4			MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)				C_{ob}		50	100	pF
Input Capacitance (V_{EB} = 8 Vdc)				C_{ib}		850	1200	pF
DYNAMIC SATURATION VOLTAGE								
Dynamic Saturation Voltage: Determined 1 µs and 3 µs respectively after rising I_{B1} reaches 90% of final I_{B1}	I_C = 1 A I_{B1} = 0.33 A V_{CC} = 300 V	@ 1 µs	@ T_C = 25°C @ T_C = 125°C	$V_{CE(dsat)}$		1.75 5		V
		@ 3 µs	@ T_C = 25°C @ T_C = 125°C			0.3 0.5		V
	I_C = 2 A I_{B1} = 0.66 A V_{CC} = 300 V	@ 1 µs	@ T_C = 25°C @ T_C = 125°C			6 14		V
		@ 3 µs	@ T_C = 25°C @ T_C = 125°C			0.75 4		V

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

Characteristic			Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS: Resistive Load (D.C. ≤ 10%, Pulse Width = 20 μs)							
Turn–on Time	I_C = 2 Adc, I_{B1} = 0.4 Adc I_{B2} = 0.4 Adc V_{CC} = 125 Vdc	@ T_C = 25°C	t_{on}		95	250	ns
Turn–off Time		@ T_C = 25°C	t_{off}		2.5	3.5	μs
Turn–on Time	I_C = 2 Adc, I_{B1} = 0.4 Adc I_{B2} = 1 Adc V_{CC} = 125 Vdc	@ T_C = 25°C	t_{on}		110	250	ns
Turn–off Time		@ T_C = 25°C	t_{off}		0.95	2	μs
Turn–on Time	I_C = 1 Adc, I_{B1} = 0.3 Adc I_{B2} = 0.3 Adc V_{CC} = 125 Vdc	@ T_C = 25°C	t_{on}		100	200	ns
Turn–off Time		@ T_C = 25°C	t_{off}		2.9	3.5	μs
SWITCHING CHARACTERISTICS: Inductive Load (V_{clamp} = 300 V, V_{CC} = 15 V, L = 200 μH)							
Fall Time	I_C = 2 Adc I_{B1} = 0.4 Adc I_{B2} = 1 Adc	@ T_C = 25°C @ T_C = 125°C	t_f		80 95	150	ns
Storage Time		@ T_C = 25°C @ T_C = 125°C	t_s		1.2 1.7	2.5	μs
Crossover Time		@ T_C = 25°C @ T_C = 125°C	t_c		150 180	300	ns
Fall Time	I_C = 2 Adc I_{B1} = 0.66 Adc I_{B2} = 1 Adc	@ T_C = 25°C @ T_C = 125°C	t_f		90 100	150	ns
Storage Time		@ T_C = 25°C @ T_C = 125°C	t_s		1.7 2.5	2.75	μs
Crossover Time		@ T_C = 25°C @ T_C = 125°C	t_c		190 220	350	ns

TYPICAL STATIC CHARACTERISTICS

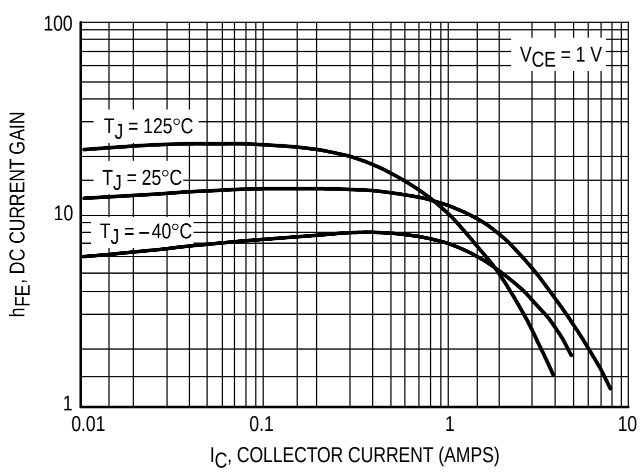


Figure 1. DC Current Gain @ 1 Volt

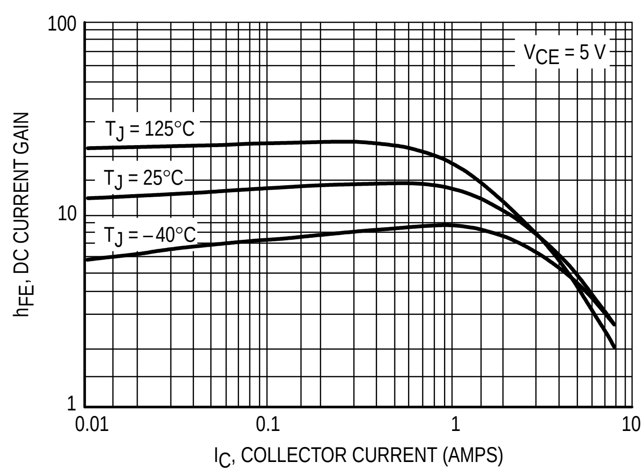


Figure 2. DC Current Gain @ 5 Volt

TYPICAL STATIC CHARACTERISTICS

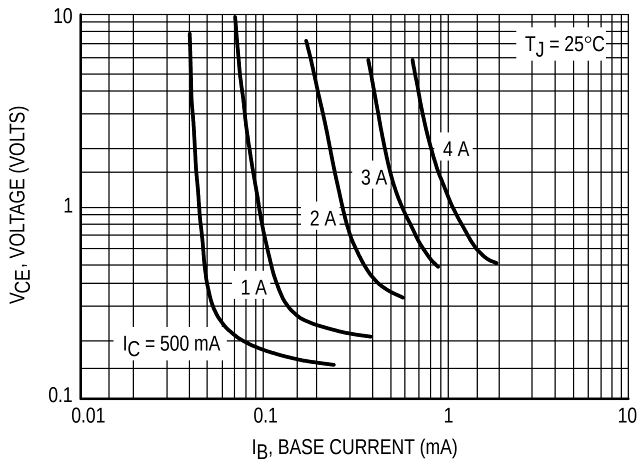


Figure 3. Collector Saturation Region

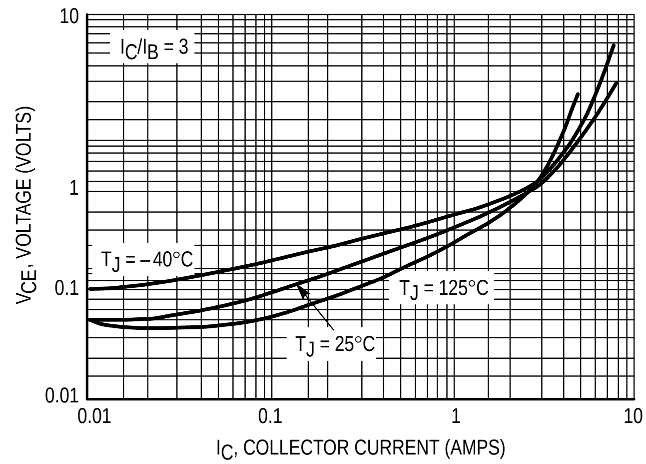


Figure 4. Collector–Emitter Saturation Voltage

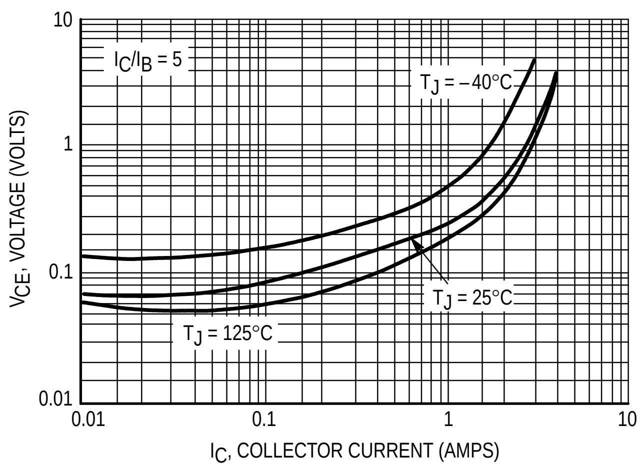


Figure 5. Collector–Emitter Saturation Voltage

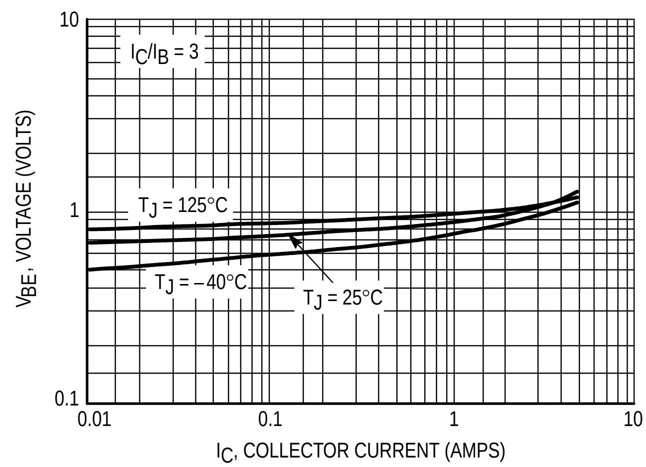


Figure 6. Base–Emitter Saturation Region

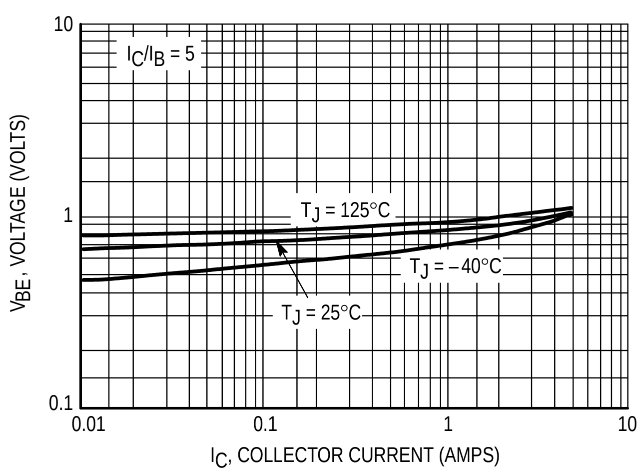


Figure 7. Base–Emitter Saturation Region

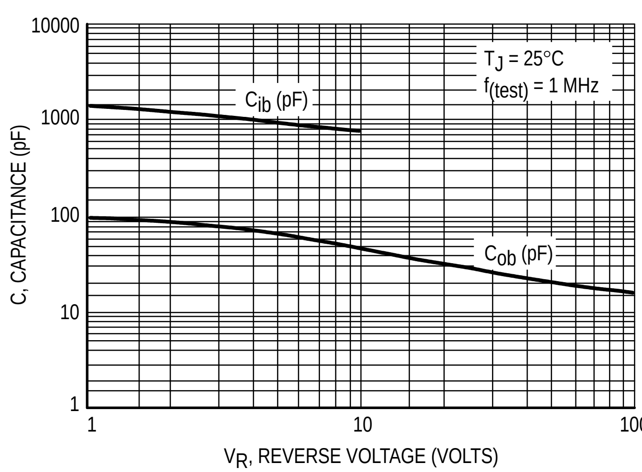


Figure 8. Capacitance

TYPICAL SWITCHING CHARACTERISTICS

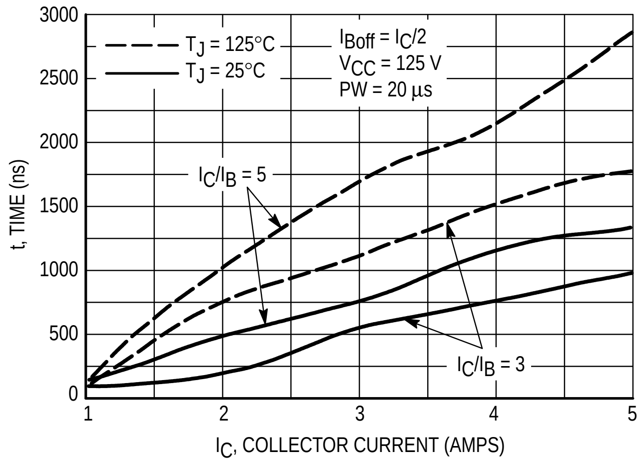


Figure 9. Resistive Switching, t_{on}

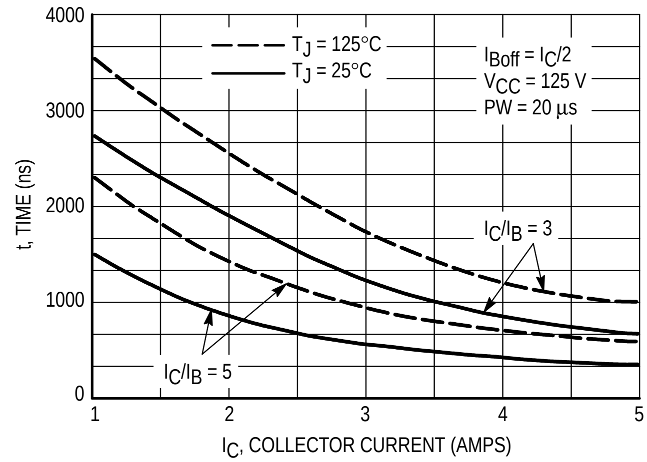


Figure 10. Resistive Switch Time, t_{off}

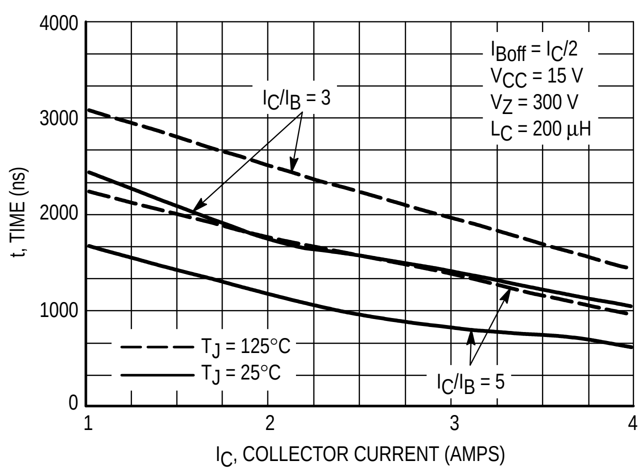


Figure 11. Inductive Storage Time, t_{si}

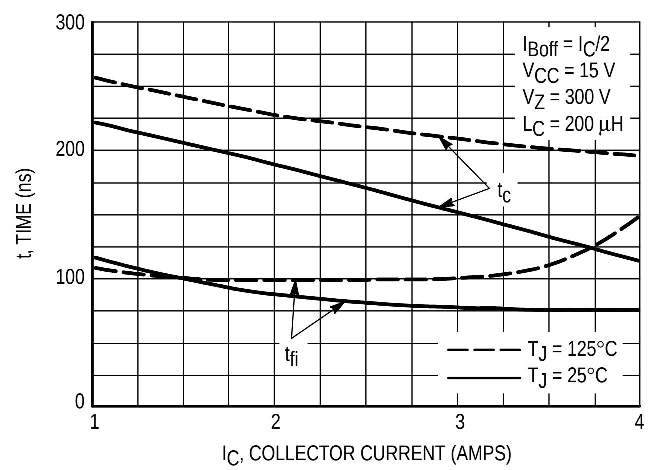


Figure 12. Inductive Storage Time, t_c & t_{fi} @ $I_C/I_B = 3$

TYPICAL CHARACTERISTICS

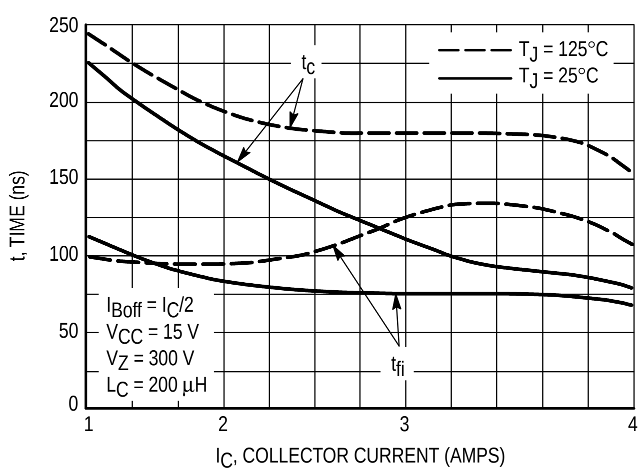


Figure 13. Inductive Switching, t_c & t_{fi} @ $I_C/I_B = 5$

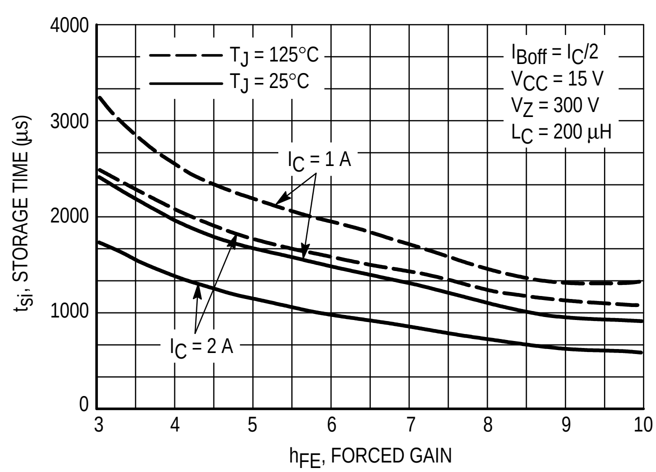


Figure 14. Inductive Storage Time

TYPICAL CHARACTERISTICS

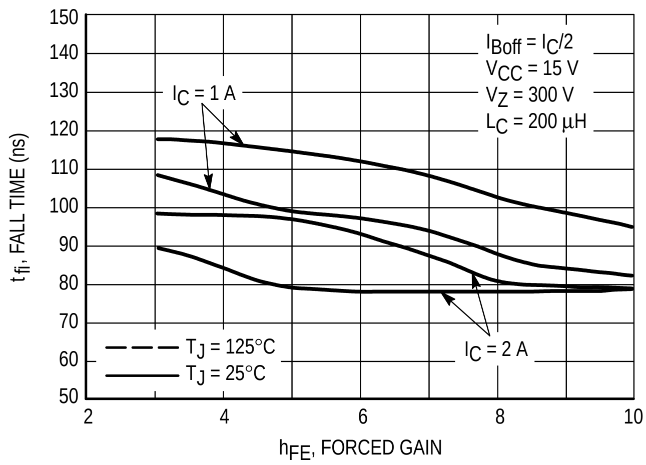


Figure 15. Inductive Fall Time

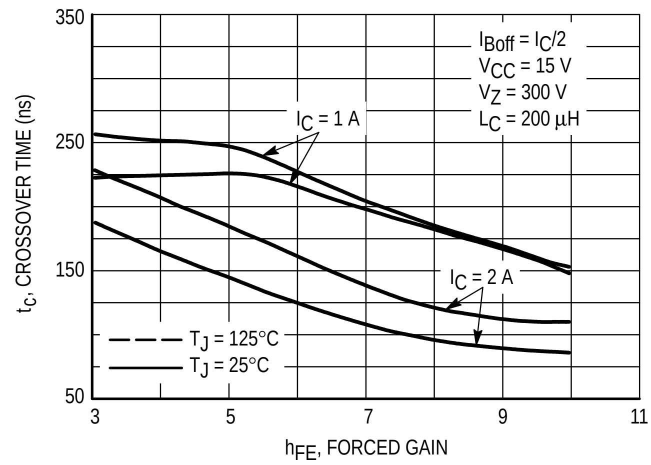


Figure 16. Inductive Crossover Time

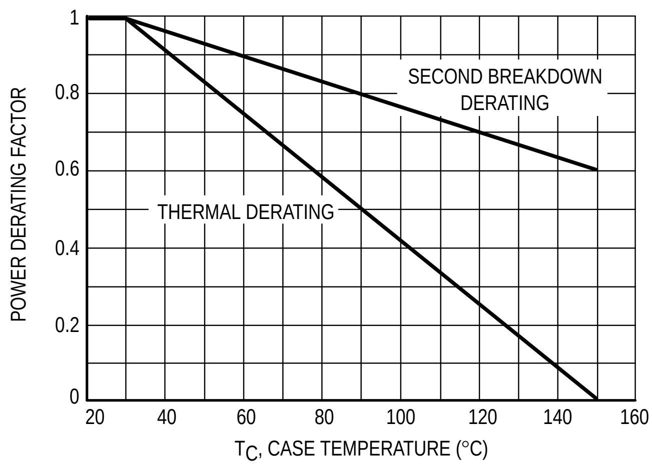


Figure 17. Forward Power Derating

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 20 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 20 may be found at any case temperature by using the appropriate curve on Figure 17.

$T_{J(pk)}$ may be calculated from the data in Figure 22. 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 21). This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode.

TYPICAL CHARACTERISTICS

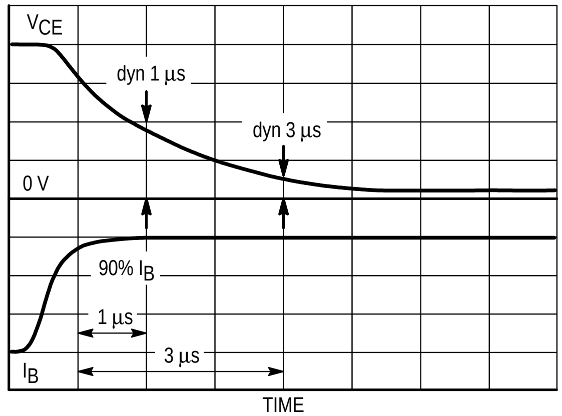


Figure 18. Dynamic Saturation Voltage

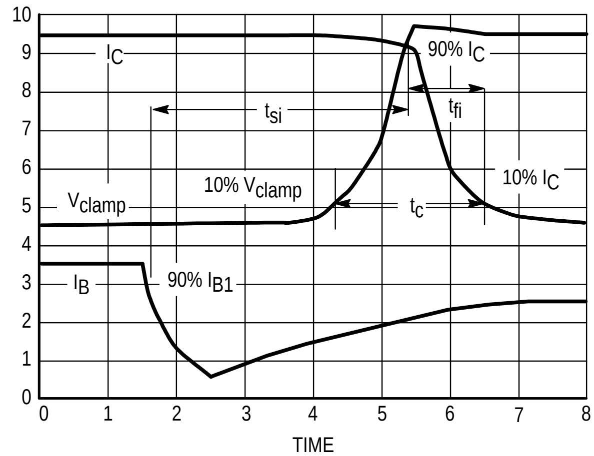


Figure 19. Inductive Switching Measurements

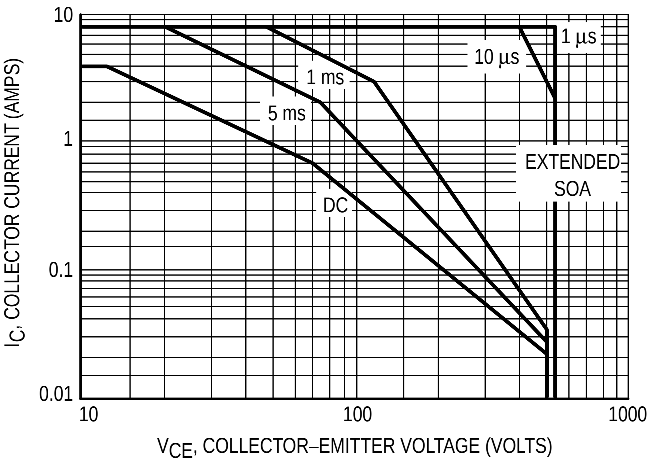


Figure 20. Forward Bias Safe Operating Area

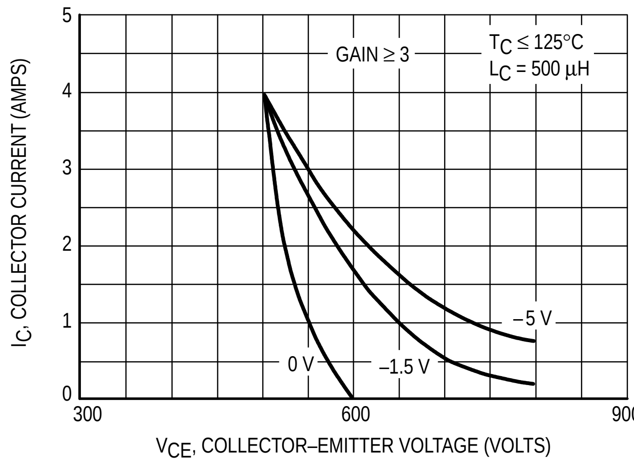
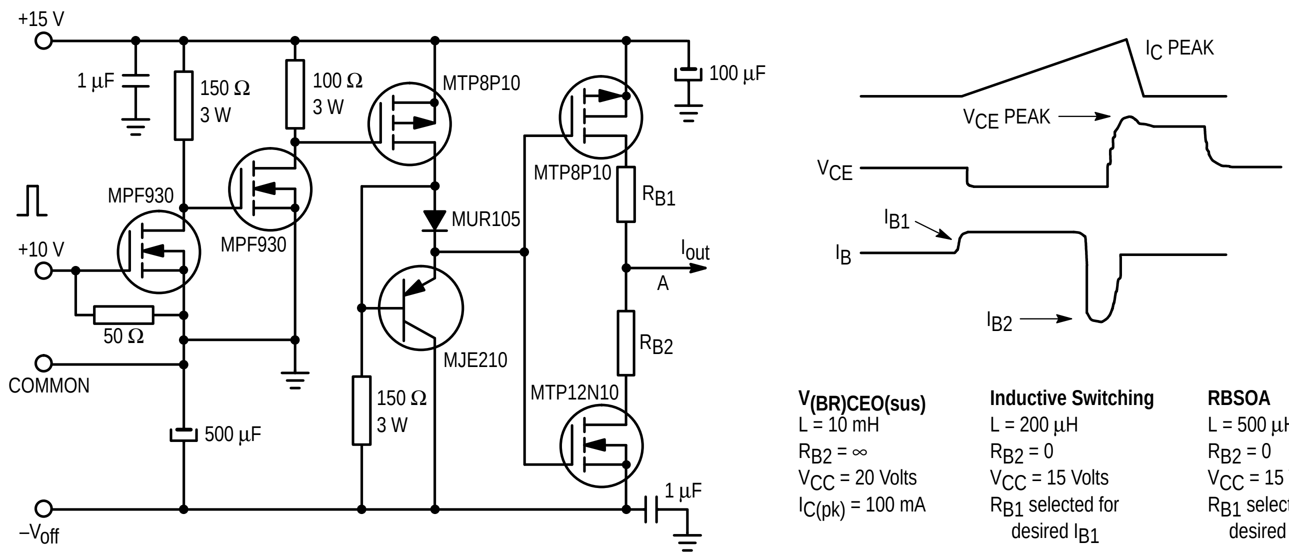


Figure 21. Reverse Bias Safe Operating Area

TYPICAL CHARACTERISTICS

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}

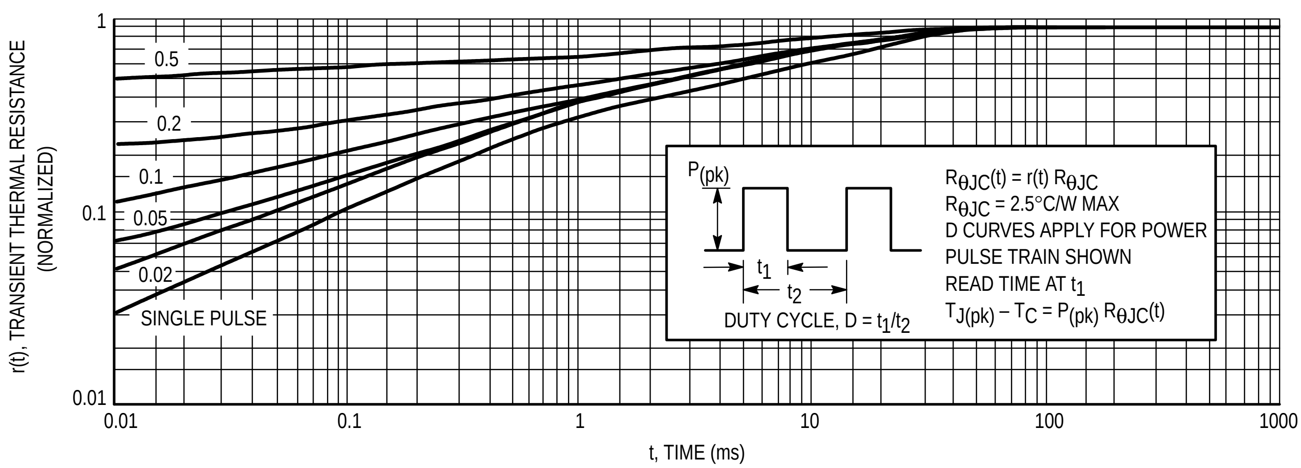
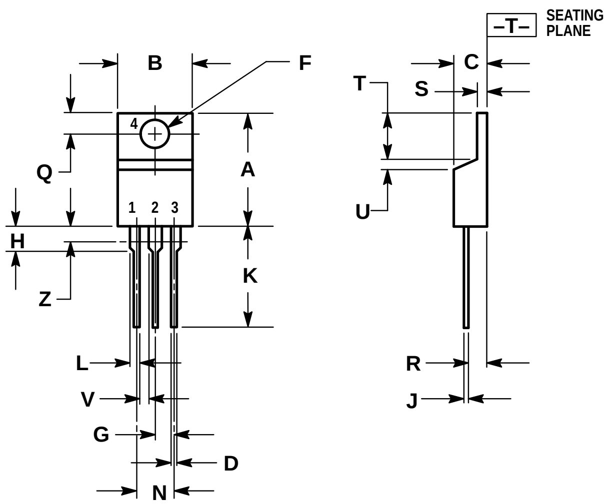


Figure 22. Typical Thermal Response ($Z_{\theta JC}(t)$) for BUH50

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.

	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

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

CASE 221A–06
TO–220AB
ISSUE Y

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