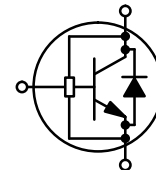


**BUD44D2**

**POWER TRANSISTORS**  
**2 AMPERES**  
**700 VOLTS**  
**25 WATTS**



*Advance Information*

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

The BUD44D2 is state-of-art High Speed High gain BIPolar transistor (H2BIP). High dynamic characteristics and lot to lot minimum spread ( $\pm 150$  ns on storage time) make it ideally suitable for light ballast applications. Therefore, there is no need to guarantee an  $h_{FE}$  window.

Main features:

- Low Base Drive Requirement
- High Peak DC Current Gain (55 Typical) @  $I_C = 100$  mA
- **Extremely Low Storage Time Min/Max Guarantees Due to the H2BIP Structure which Minimizes the Spread**
- Integrated Collector-Emitter Free Wheeling Diode
- Fully Characterized and Guaranteed Dynamic  $V_{CE(sat)}$
- "6 Sigma" Process Providing Tight and Reproducible Parameter Spreads

It's characteristics make it also suitable for PFC application.

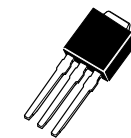
**MAXIMUM RATINGS**

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	$V_{EBO}$	12	Vdc
Collector Current — Continuous	$I_C$	2	Adc
— Peak (1)	$I_{CM}$	5	
Base Current — Continuous	$I_B$	1	Adc
— Peak (1)	$I_{BM}$	2	
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$ *Derate above $25^\circ\text{C}$	$P_D$	25 0.2	Watt W/ $^\circ\text{C}$
Operating and Storage Temperature	$T_J, T_{stg}$	-65 to 150	$^\circ\text{C}$

**THERMAL CHARACTERISTICS**

Thermal Resistance — Junction to Case — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JA}$	5 71.4	$^\circ\text{C}/\text{W}$
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  $\leq 10\%$ .

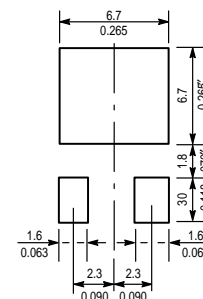


CASE 369-07



CASE 369A-13

**MINIMUM PAD SIZES  
RECOMMENDED FOR  
SURFACE MOUNTED  
APPLICATIONS**



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

**BUD44D2****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 ( $I_C = 100\text{ mA}$ , $L = 25\text{ mH}$ )	$V_{CEQ(sus)}$	400	470		Vdc
Collector–Base Breakdown Voltage ( $I_{CBO} = 1\text{ mA}$ )	$V_{CBO}$	700	920		Vdc
Emitter–Base Breakdown Voltage ( $I_{EBO} = 1\text{ mA}$ )	$V_{EBO}$	12	14.5		Vdc
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CEO}$ , $I_B = 0$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $I_{CEO}$			50 500	$\mu\text{Adc}$
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CES}$ , $V_{EB} = 0$ )  ( $V_{CE} = 500\text{ V}$ , $V_{EB} = 0$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $I_{CES}$			50 500 100	$\mu\text{Adc}$
Emitter–Cutoff Current ( $V_{EB} = 10\text{ Vdc}$ , $I_C = 0$ )	$I_{EBO}$			100	$\mu\text{Adc}$

**ON CHARACTERISTICS**

Base–Emitter Saturation Voltage ( $I_C = 0.4\text{ Adc}$ , $I_B = 40\text{ mAdc}$ )  ( $I_C = 1\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $V_{BE(sat)}$		0.78 0.65	0.9 0.8	Vdc
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		0.87 0.76	1 0.9	
Collector–Emitter Saturation Voltage ( $I_C = 0.4\text{ Adc}$ , $I_B = 20\text{ mAdc}$ )  ( $I_C = 0.4\text{ Adc}$ , $I_B = 40\text{ mAdc}$ )  ( $I_C = 1\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $V_{CE(sat)}$		0.45 0.67	0.65 1	Vdc
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		0.25 0.27	0.4 0.5	
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		0.28 0.35	0.5 0.6	
DC Current Gain ( $I_C = 0.4\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$ )  ( $I_C = 1\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$ )  ( $I_C = 2\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$ $h_{FE}$	20 18	32 26		—
	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	10 7	14 9.5		
	@ $T_C = 25^\circ\text{C}$	8	11		

**DIODE CHARACTERISTICS**

Forward Diode Voltage ( $I_{EC} = 0.2\text{ Adc}$ )  ( $I_{EC} = 0.2\text{ Adc}$ )  ( $I_{EC} = 0.4\text{ Adc}$ )  ( $I_{EC} = 1\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$ $V_{EC}$		0.8	1	V
	@ $T_C = 125^\circ\text{C}$		0.6		
	@ $T_C = 25^\circ\text{C}$		0.9	1.2	
	@ $T_C = 25^\circ\text{C}$		1.1	1.5	
Forward Recovery Time (see Figure 22 bis) ( $I_F = 0.2\text{ Adc}$ , $di/dt = 10\text{ A}/\mu\text{s}$ )  ( $I_F = 0.4\text{ Adc}$ , $di/dt = 10\text{ A}/\mu\text{s}$ )  ( $I_F = 1\text{ Adc}$ , $di/dt = 10\text{ A}/\mu\text{s}$ )	@ $T_C = 25^\circ\text{C}$ $T_{fr}$		415		ns
	@ $T_C = 25^\circ\text{C}$		390		
	@ $T_C = 25^\circ\text{C}$		340		

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

Characteristic			Symbol	Min	Typ	Max	Unit
<b>DYNAMIC SATURATION VOLTAGE</b>							
Dynamic Saturation Voltage: Determined 1 $\mu\text{s}$ and 3 $\mu\text{s}$ respectively after rising $I_{B1}$ reaches 90% of final $I_{B1}$	$I_C = 0.4\text{ A}$ $I_{B1} = 40\text{ mA}$ $V_{CC} = 300\text{ V}$	@ 1 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$V_{CE(dsat)}$		3.3 6.8	V
		@ 3 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$			0.5 1.3	
	$I_C = 1\text{ A}$ $I_{B1} = 0.2\text{ A}$ $V_{CC} = 300\text{ V}$	@ 1 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$			4.4 12.8	
		@ 3 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$			0.5 1.8	

**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 ( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1\text{ MHz}$ )	$C_{ob}$		50	75	pF
Input Capacitance ( $V_{EB} = 8\text{ Vdc}$ )	$C_{ib}$		240	500	pF

**SWITCHING CHARACTERISTICS: Resistive Load** (D.C.  $\leq 10\%$ , Pulse Width = 40  $\mu\text{s}$ )

Turn-on Time	$I_C = 1\text{ Adc}$ , $I_{B1} = 0.2\text{ Adc}$ $I_{B2} = 0.5\text{ Adc}$ $V_{CC} = 300\text{ Vdc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{on}$		90 105	150	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{off}$		1.1 1.5	1.25	$\mu\text{s}$
Turn-on Time	$I_C = 0.5\text{ Adc}$ , $I_{B1} = 50\text{ mAdc}$ $I_{B2} = 250\text{ mAdc}$ $V_{CC} = 300\text{ Vdc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{on}$	400	600	600	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{off}$	750	1300	1000	ns

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

Fall Time	$I_C = 0.4\text{ Adc}$ $I_{B1} = 40\text{ mAdc}$ $I_{B2} = 0.2\text{ Adc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_f$		110 105	150	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_s$		0.55 0.7	0.75	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$		85 80	150	ns
Fall Time	$I_C = 1\text{ Adc}$ $I_{B1} = 0.2\text{ Adc}$ $I_{B2} = 0.5\text{ Adc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_f$		100 90	150	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_s$		1.05 1.45	1.5	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$		100 100	175	ns
Fall Time	$I_C = 0.8\text{ Adc}$ $I_{B1} = 160\text{ mAdc}$ $I_{B2} = 160\text{ mAdc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_f$		110 180	150	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_s$	2.05	2.8	2.35	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$		180 400	300	ns
Fall Time	$I_C = 0.4\text{ Adc}$ $I_{B1} = 40\text{ mAdc}$ $I_{B2} = 40\text{ mAdc}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_f$		150 175	225	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_s$	1.65	2.2	1.95	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$		150 330	250	ns

TYPICAL STATIC CHARACTERISTICS

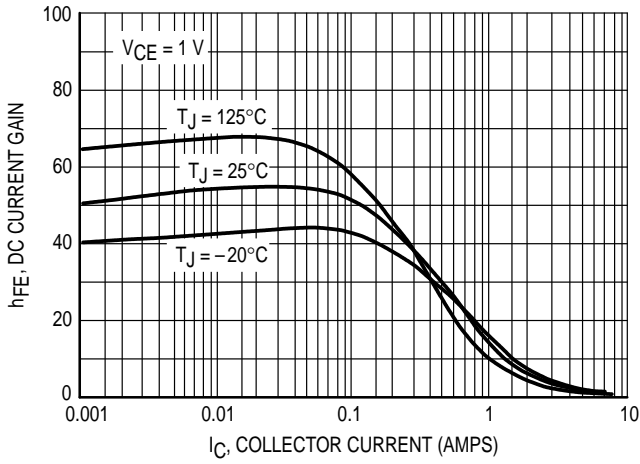


Figure 1. DC Current Gain @ 1 Volt

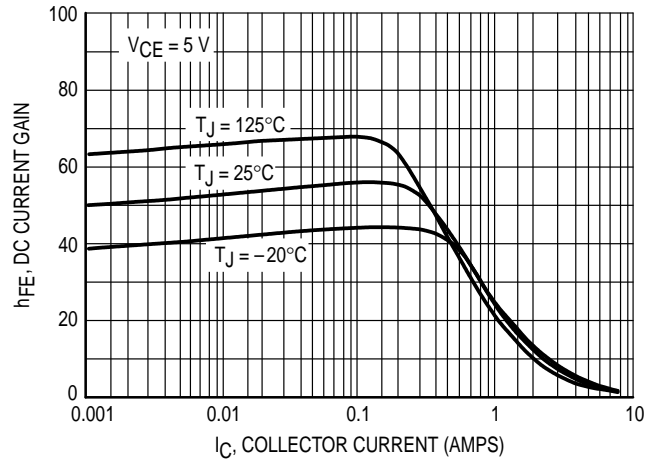


Figure 2. DC Current Gain @ 5 Volt

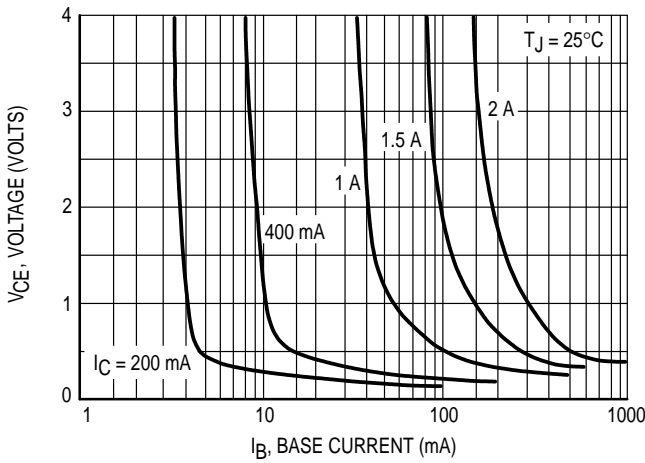


Figure 3. Collector Saturation Region

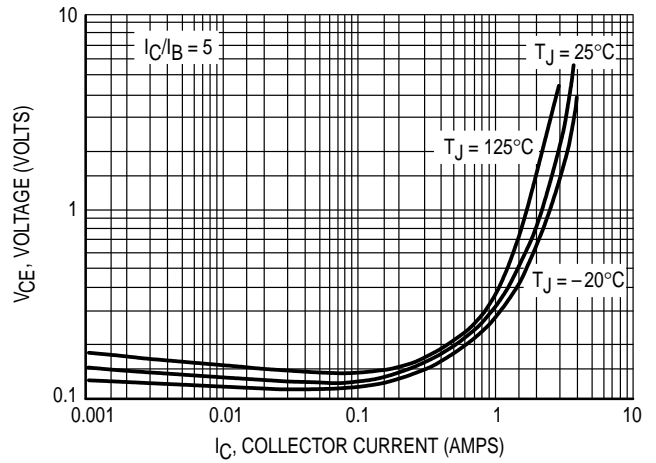


Figure 4. Collector-Emitter Saturation Voltage

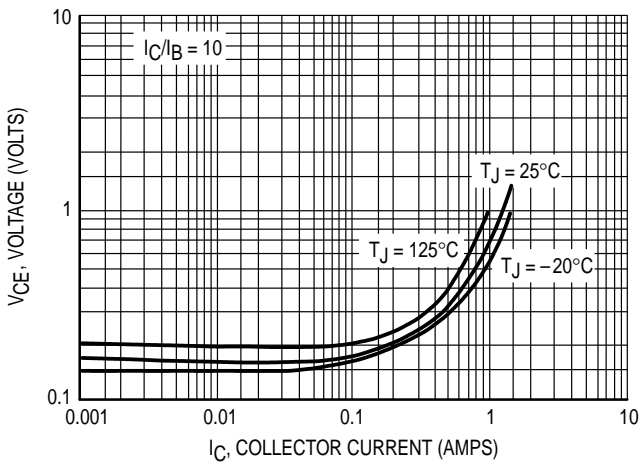


Figure 5. Collector-Emitter Saturation Voltage

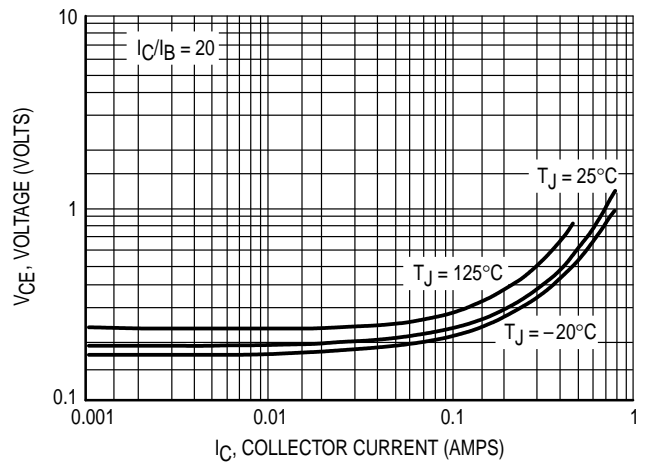


Figure 6. Collector-Emitter Saturation Voltage

TYPICAL STATIC CHARACTERISTICS

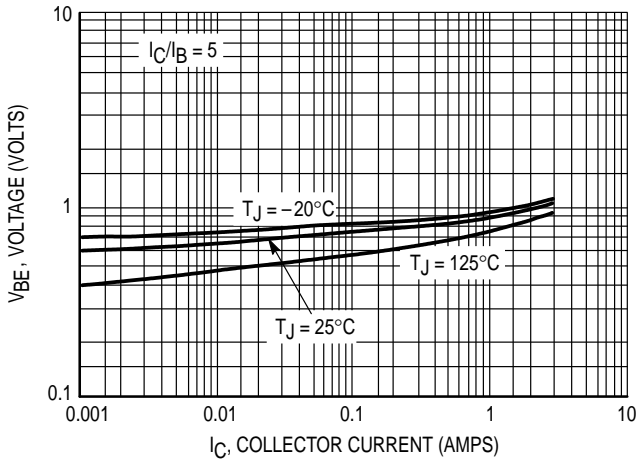


Figure 7A. Base-Emitter Saturation Region

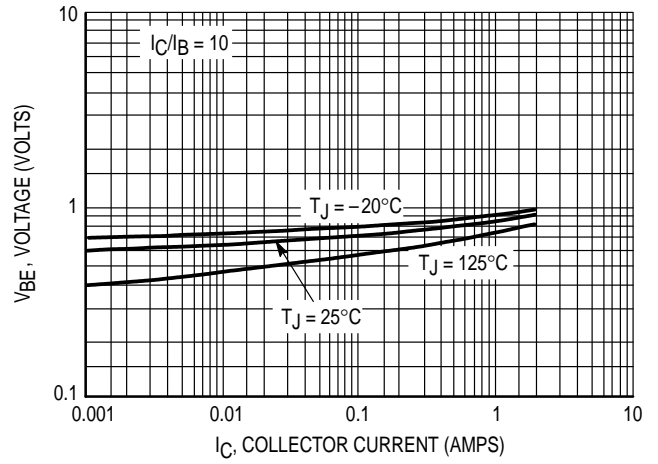


Figure 7B. Base-Emitter Saturation Region

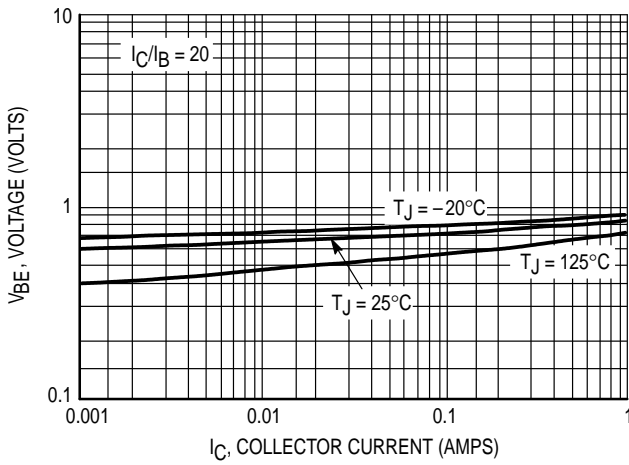


Figure 7C. Base-Emitter Saturation Region

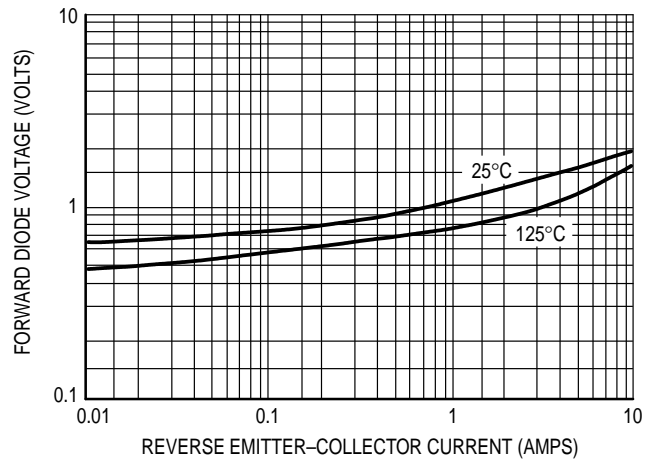


Figure 8. Forward Diode Voltage

TYPICAL SWITCHING CHARACTERISTICS

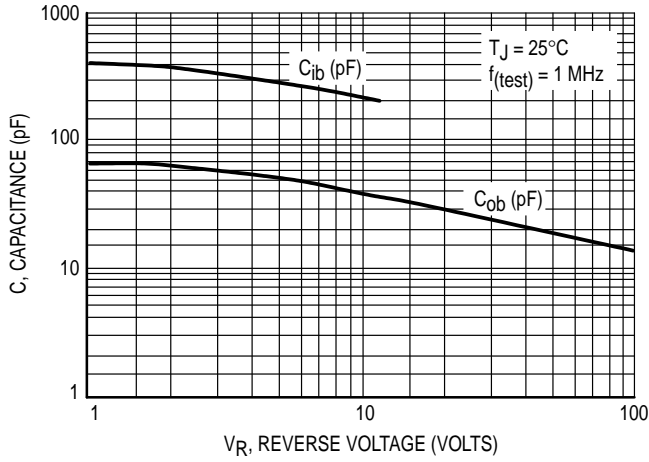


Figure 9. Capacitance

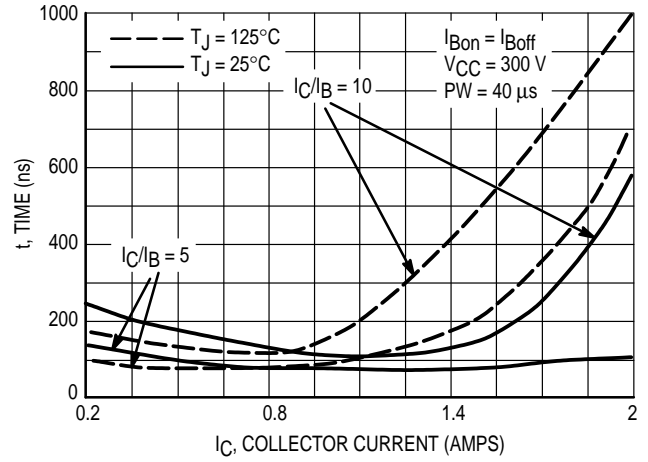


Figure 10. Resistive Switch Time, t<sub>on</sub>

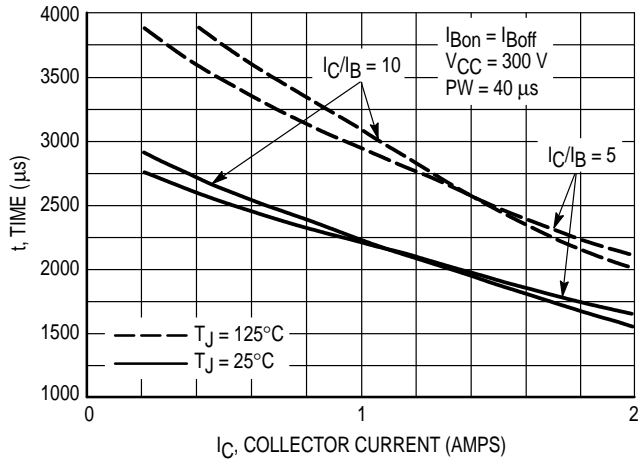


Figure 11. Resistive Switch Time, t<sub>off</sub>

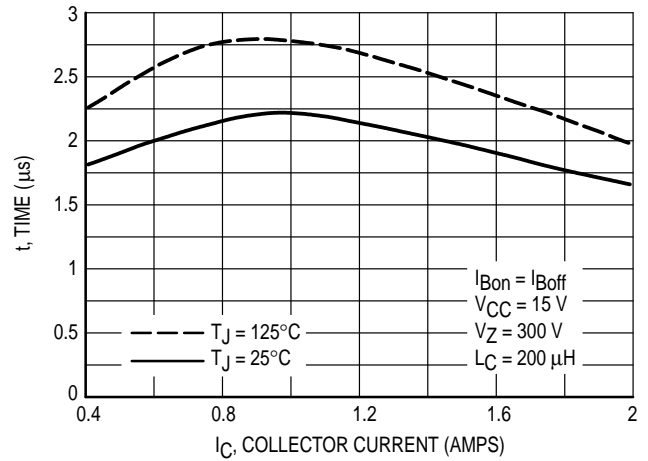


Figure 12. Inductive Storage Time, t<sub>si</sub> @ I<sub>C</sub>/I<sub>B</sub> = 5

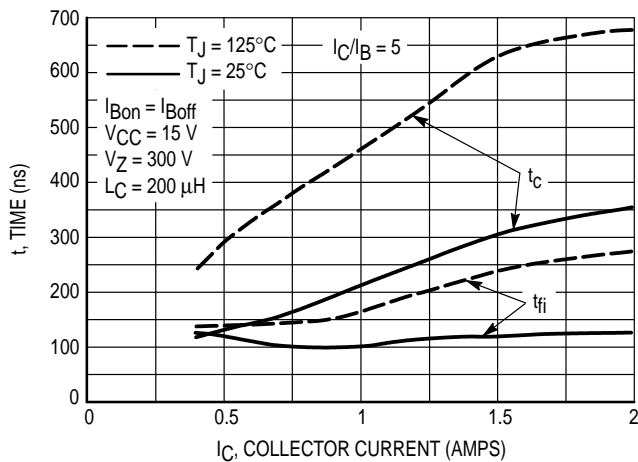


Figure 13. Inductive Switching, t<sub>c</sub> & t<sub>fi</sub> @ I<sub>C</sub>/I<sub>B</sub> = 5

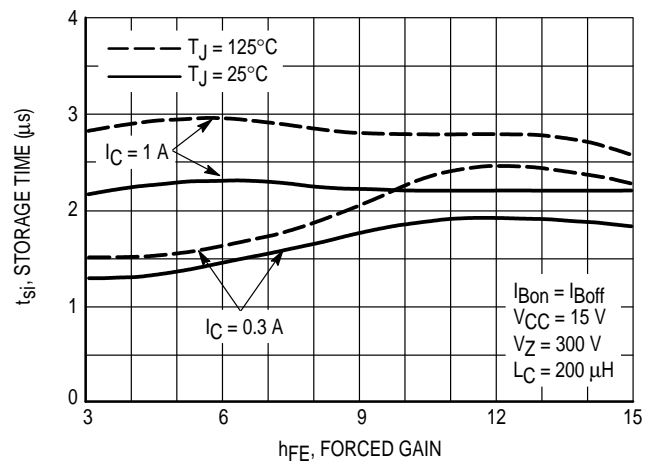


Figure 14. Inductive Storage Time

TYPICAL SWITCHING CHARACTERISTICS

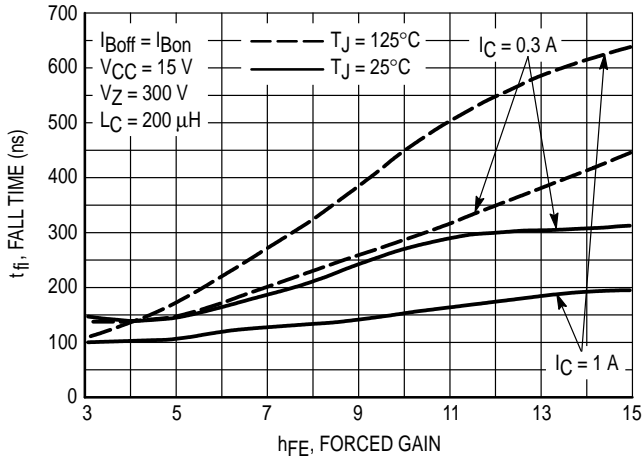


Figure 15. Inductive Fall Time

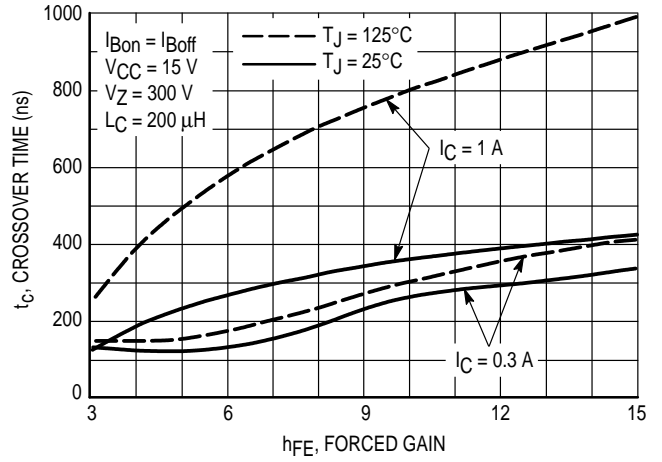


Figure 16. Inductive Crossover Time

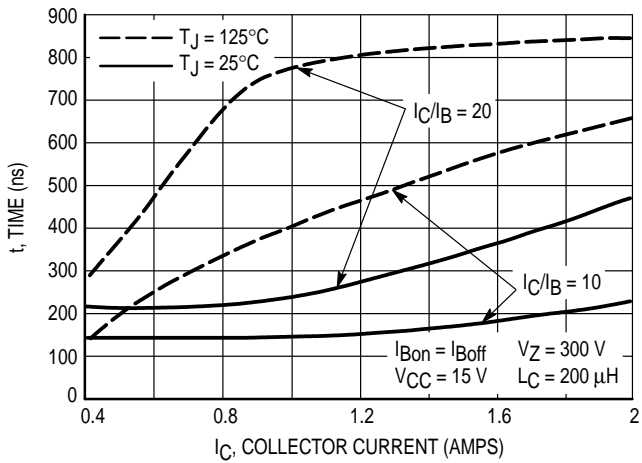


Figure 17. Inductive Switching,  $t_{fi}$

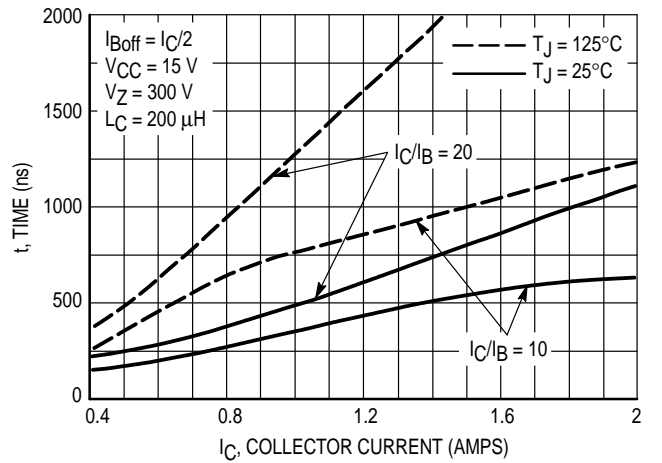


Figure 18. Inductive Switching,  $t_c$

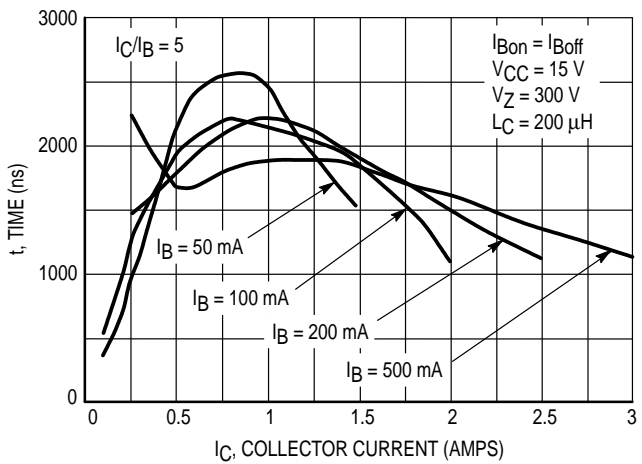


Figure 19. Inductive Storage Time,  $t_{sj}$

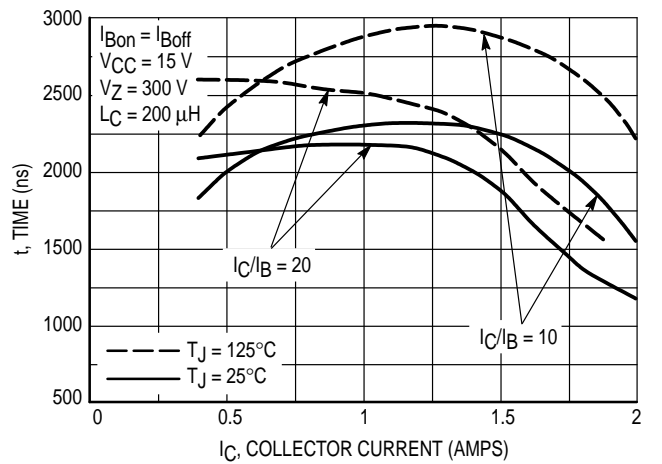


Figure 20. Inductive Storage Time,  $t_{sj}$

TYPICAL SWITCHING CHARACTERISTICS

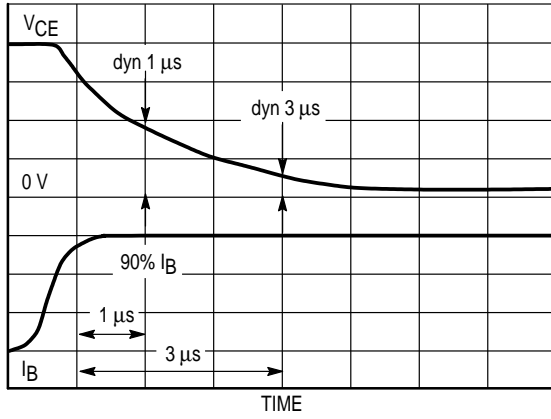


Figure 21. Dynamic Saturation Voltage Measurements

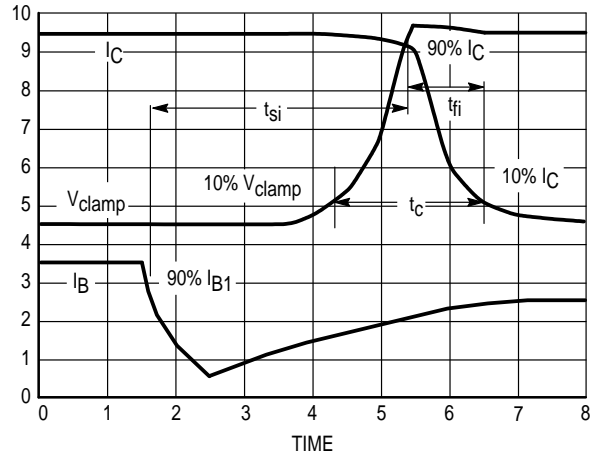


Figure 22. Inductive Switching Measurements

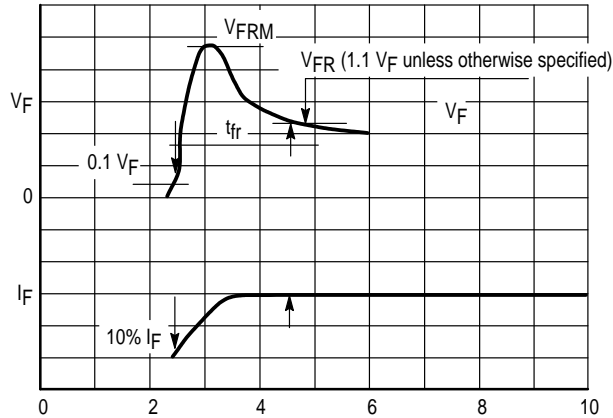
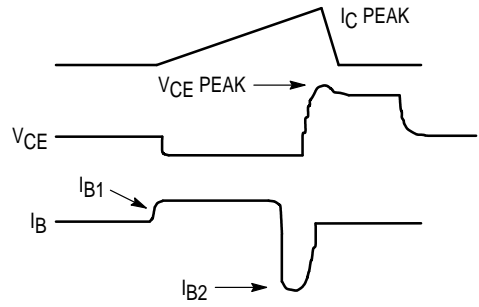
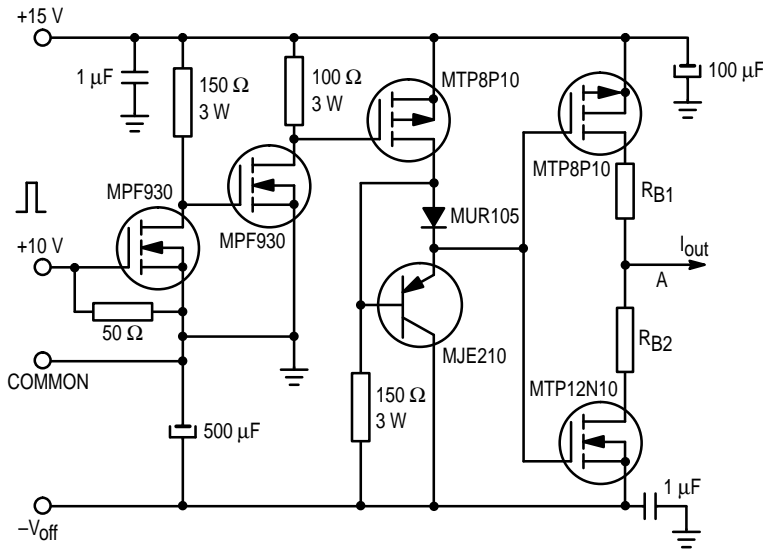


Figure 22 bis.  $t_{fr}$  Measurements



TYPICAL SWITCHING CHARACTERISTICS

Table 1. Inductive Load Switching Drive Circuit



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

TYPICAL STATIC CHARACTERISTICS

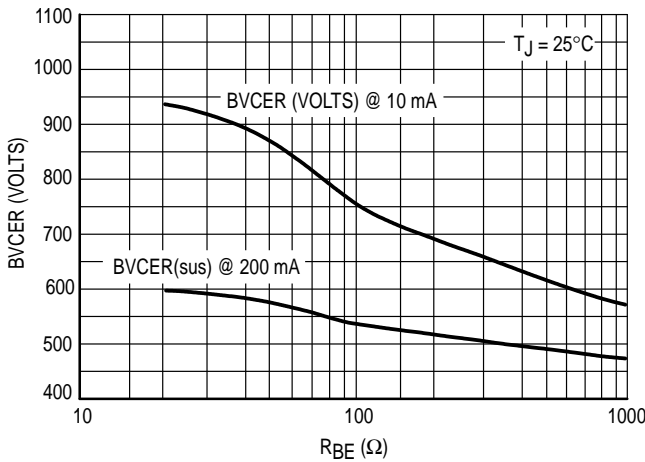


Figure 23. BVCEr

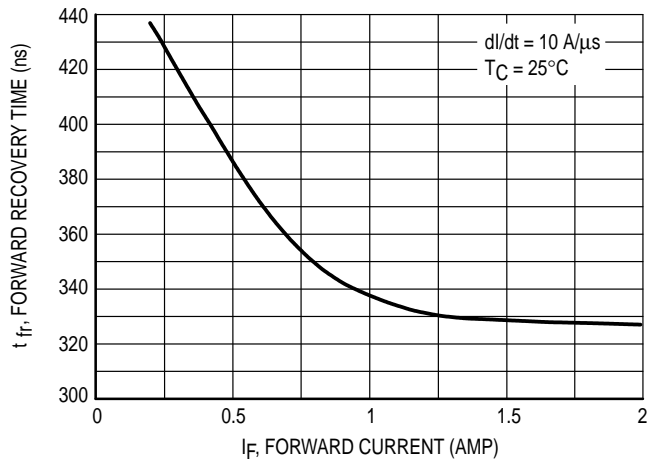
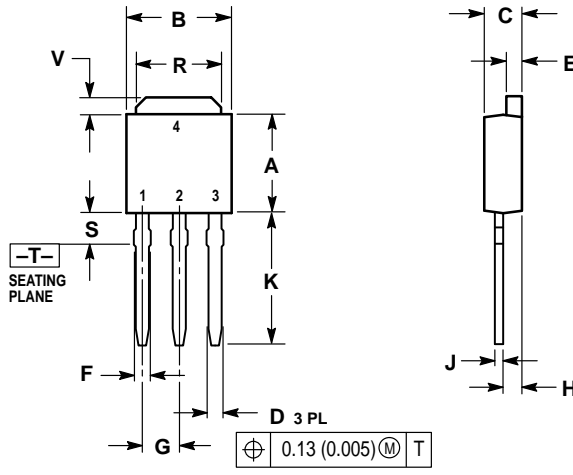


Figure 24. Forward Recovery Time  $t_{fr}$

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PACKAGE DIMENSIONS

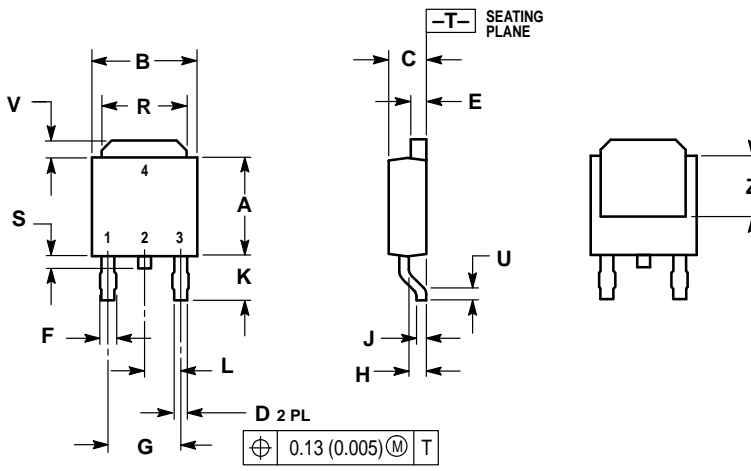


- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.235	0.250	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.033	0.040	0.84	1.01
F	0.037	0.047	0.94	1.19
G	0.090 BSC		2.29 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.350	0.380	8.89	9.65
R	0.175	0.215	4.45	5.46
S	0.050	0.090	1.27	2.28
V	0.030	0.050	0.77	1.27

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

CASE 369-07  
 ISSUE K



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.235	0.250	5.97	6.35
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.027	0.035	0.69	0.88
E	0.033	0.040	0.84	1.01
F	0.037	0.047	0.94	1.19
G	0.180 BSC		4.58 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.102	0.114	2.60	2.89
L	0.090 BSC		2.29 BSC	
R	0.175	0.215	4.45	5.46
S	0.020	0.050	0.51	1.27
U	0.020	—	0.51	—
V	0.030	0.050	0.77	1.27
Z	0.138	—	3.51	—

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

CASE 369A-13  
 ISSUE W

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