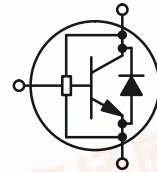


## BUD44D2

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.

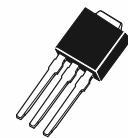
### MAXIMUM RATINGS

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	$^\circ\text{C}$

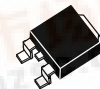
### THERMAL CHARACTERISTICS

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

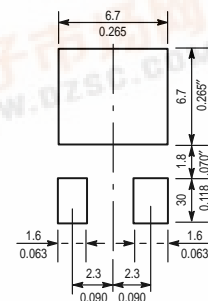


CASE 369-07



CASE 369A-13

MINIMUM PAD SIZES  
RECOMMENDED FOR  
SURFACE MOUNTED  
APPLICATIONS



**BUD44D2****ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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**OFF CHARACTERISTICS**

Collector–Emitter Sustaining Voltage ( $I_C = 100\text{ mA}$ , $L = 25\text{ mH}$ )	$V_{CEO(sus)}$	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 ( $I_C = 0.4\text{ Adc}$ , $I_B = 40\text{ mAdc}$ )  ( $I_C = 1\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$  @ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$V_{BE(sat)}$		0.78 0.65  0.87 0.76	0.9 0.8  1 0.9	Vdc
Collector–Emitter Saturation Voltage ( $I_C = 0.4\text{ Adc}$ , $I_B = 20\text{ mAdc}$ )  ( $I_C = 0.4\text{ Adc}$ , $I_B = 40\text{ mAdc}$ )  ( $I_C = 1\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$  @ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$  @ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$V_{CE(sat)}$		0.45 0.67  0.25 0.27  0.28 0.35	0.65 1  0.4 0.5  0.5 0.6	Vdc
DC Current Gain ( $I_C = 0.4\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$ )  ( $I_C = 1\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$ )  ( $I_C = 2\text{ Adc}$ , $V_{CE} = 5\text{ Vdc}$ )	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$  @ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$  @ $T_C = 25^\circ\text{C}$	$h_{FE}$	20 18  10 7  8	32 26  14 9.5  11	—	

**DIODE CHARACTERISTICS**

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
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**DYNAMIC SATURATION VOLTAGE**

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 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$V_{CE}(\text{dsat})$	3.3		V
		@ 3 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		0.5		
	$I_C = 1\text{ A}$ $I_{B1} = 0.2\text{ A}$ $V_{CC} = 300\text{ V}$	@ 1 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		4.4		
		@ 3 $\mu\text{s}$	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$		0.5		

**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

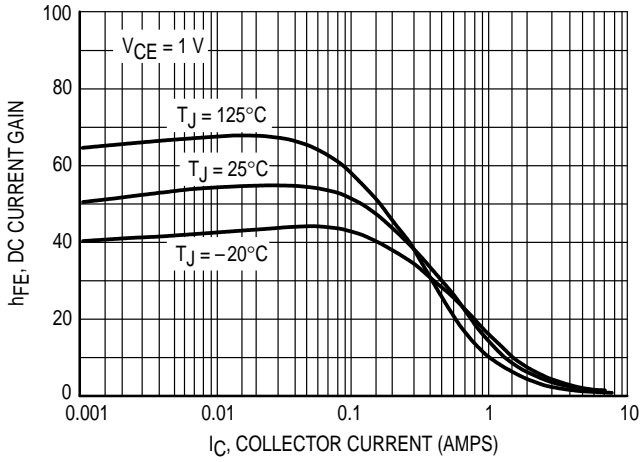
**SWITCHING CHARACTERISTICS: Resistive Load** ( $D.C. \leq 10\%$ , Pulse Width = 40  $\mu\text{s}$ )

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	150	ns
Turn-off Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_{off}$		1.1	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

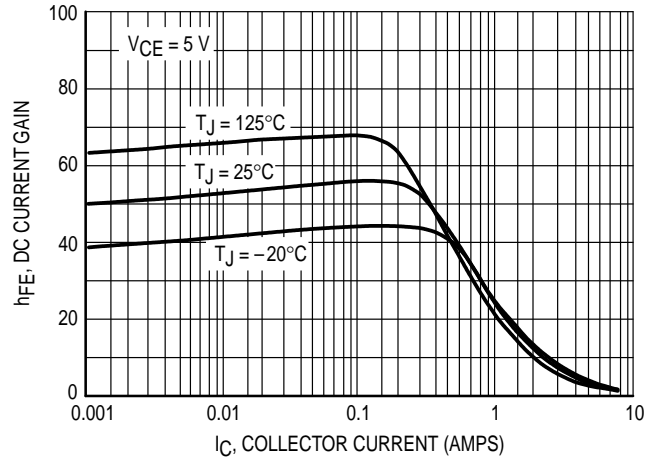
**SWITCHING CHARACTERISTICS: Inductive Load** ( $V_{clamp} = 300\text{ V}$ ,  $V_{CC} = 15\text{ V}$ ,  $L = 200\text{ }\mu\text{H}$ )

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	150	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_s$		0.55	0.75	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$		85	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	150	ns
Storage Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_s$		1.05	1.5	$\mu\text{s}$
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$t_c$		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	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	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	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	250	ns

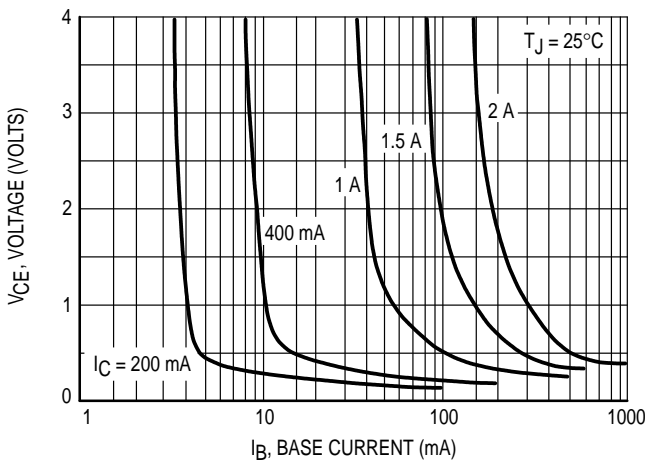
**TYPICAL STATIC CHARACTERISTICS**



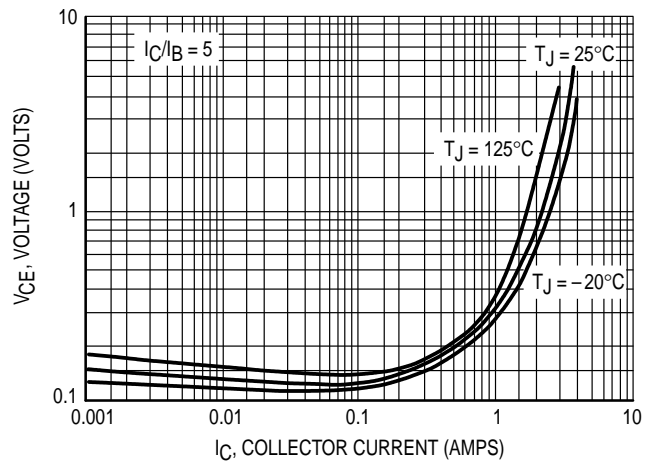
**Figure 1. DC Current Gain @ 1 Volt**



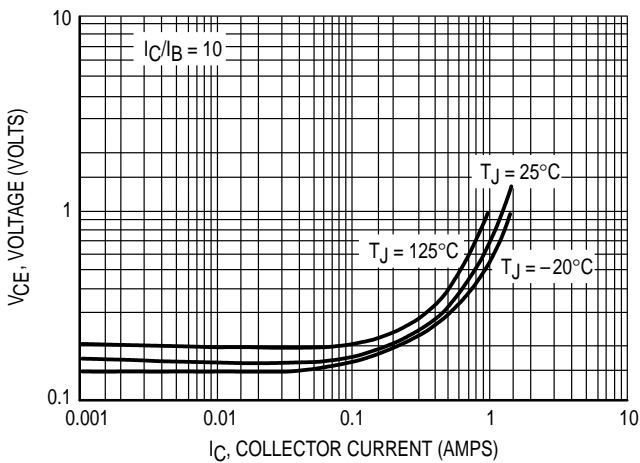
**Figure 2. DC Current Gain @ 5 Volt**



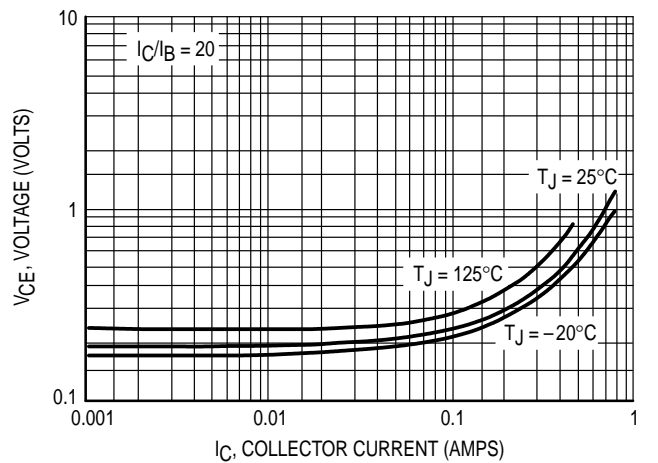
**Figure 3. Collector Saturation Region**



**Figure 4. Collector-Emitter Saturation Voltage**



**Figure 5. Collector-Emitter Saturation Voltage**



**Figure 6. Collector-Emitter Saturation Voltage**

TYPICAL STATIC CHARACTERISTICS

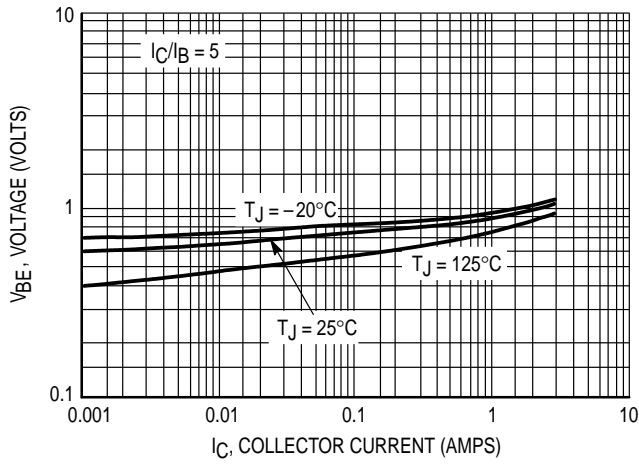


Figure 7A. Base-Emitter Saturation Region

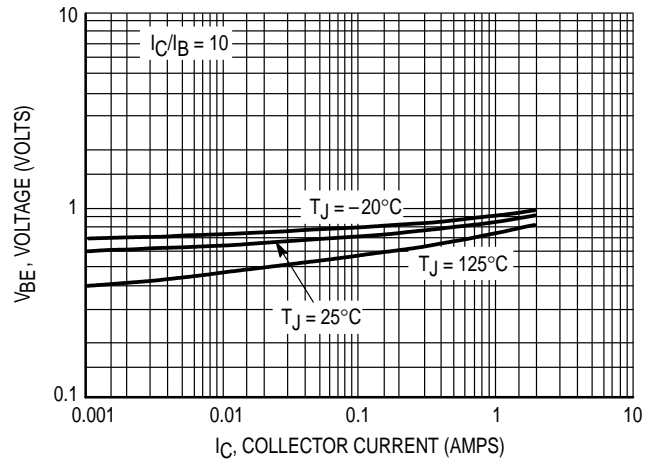


Figure 7B. Base-Emitter Saturation Region

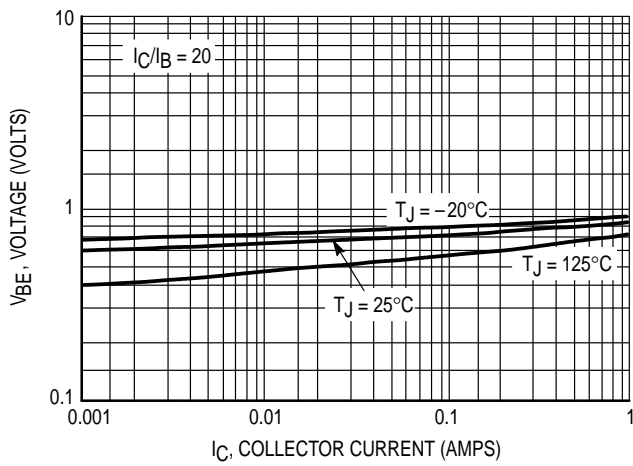


Figure 7C. Base-Emitter Saturation Region

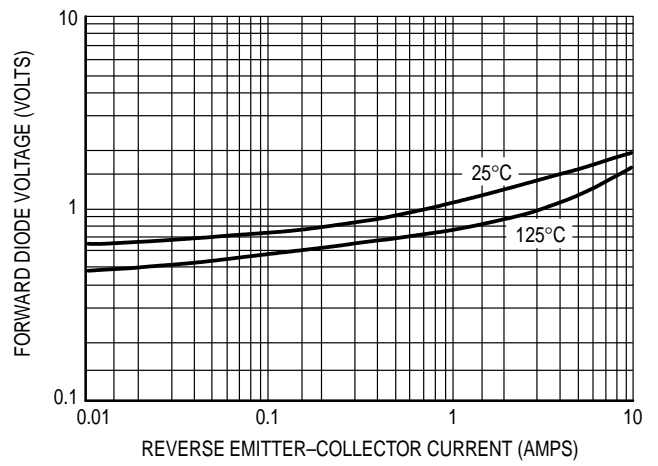
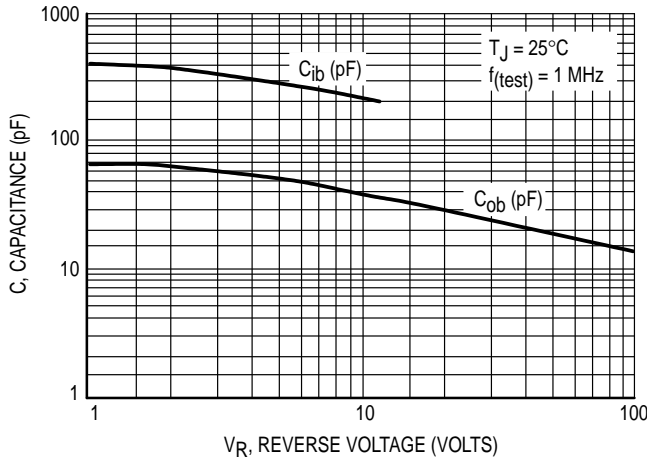
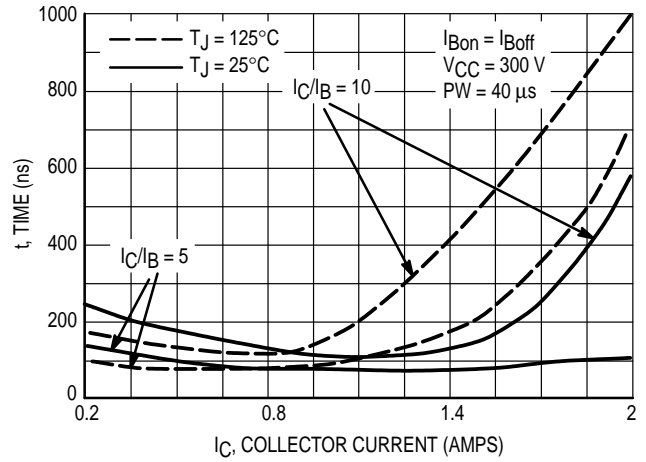


Figure 8. Forward Diode Voltage

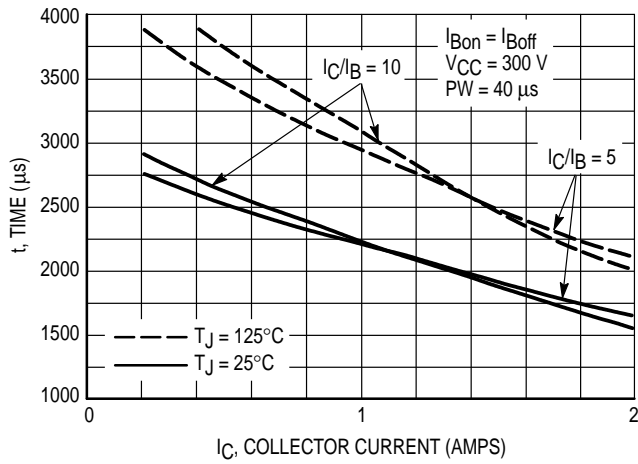
**TYPICAL SWITCHING CHARACTERISTICS**



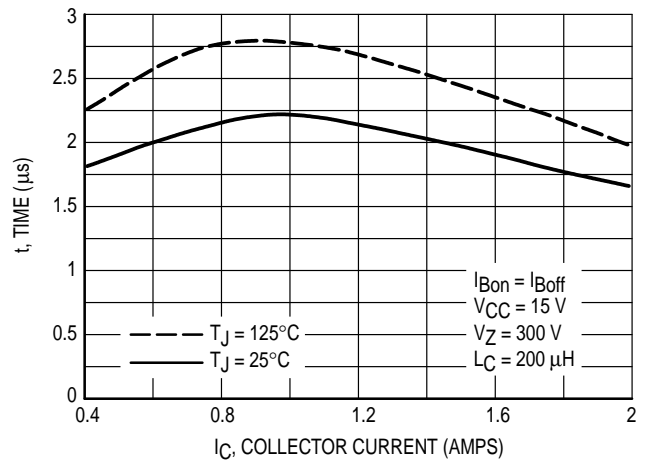
**Figure 9. Capacitance**



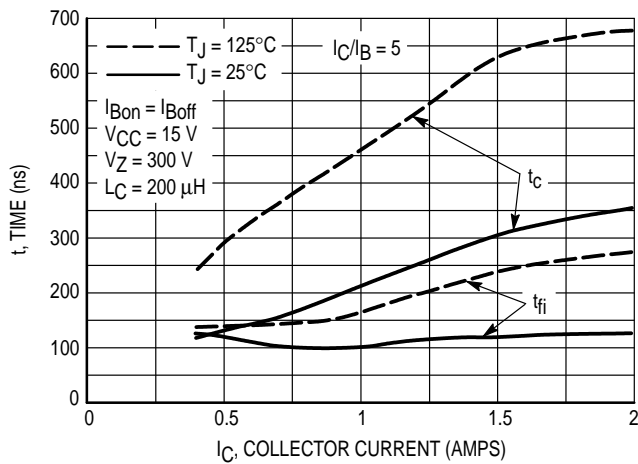
**Figure 10. Resistive Switch Time,  $t_{on}$**



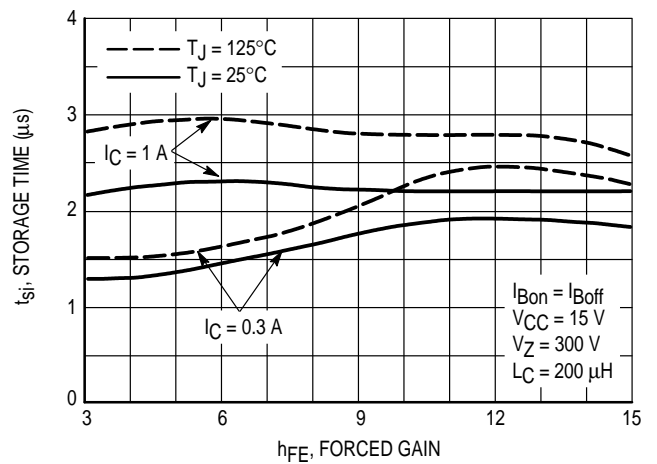
**Figure 11. Resistive Switch Time,  $t_{off}$**



**Figure 12. Inductive Storage Time,  $t_{si}$  @  $I_C/I_B = 5$**



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



**Figure 14. Inductive Storage Time**

TYPICAL SWITCHING CHARACTERISTICS

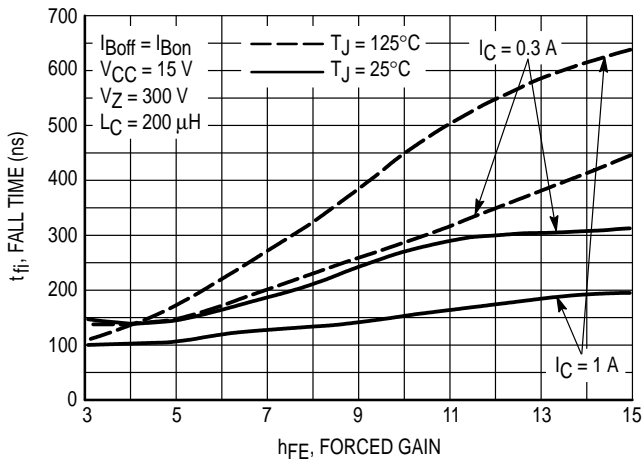


Figure 15. Inductive Fall Time

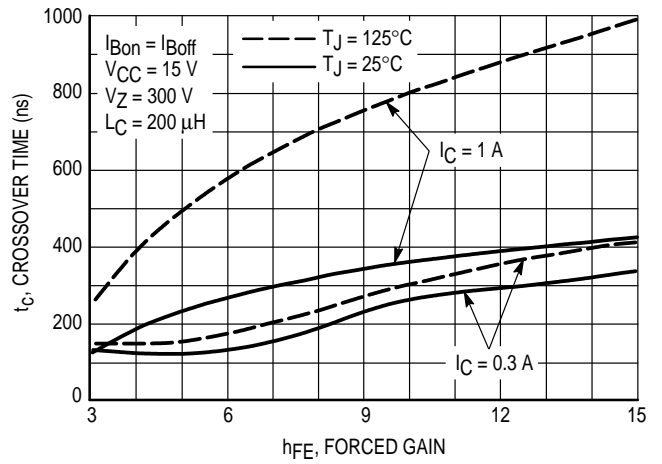


Figure 16. Inductive Crossover Time

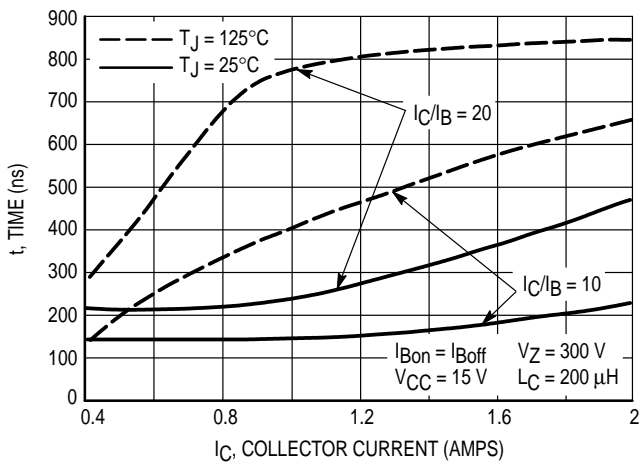


Figure 17. Inductive Switching,  $t_{fi}$

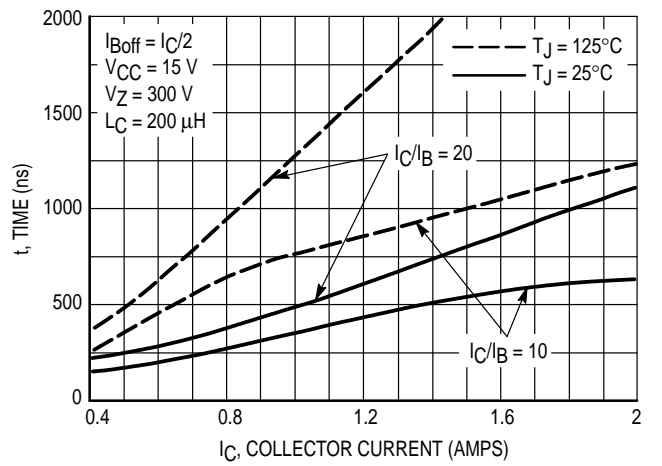


Figure 18. Inductive Switching,  $t_c$

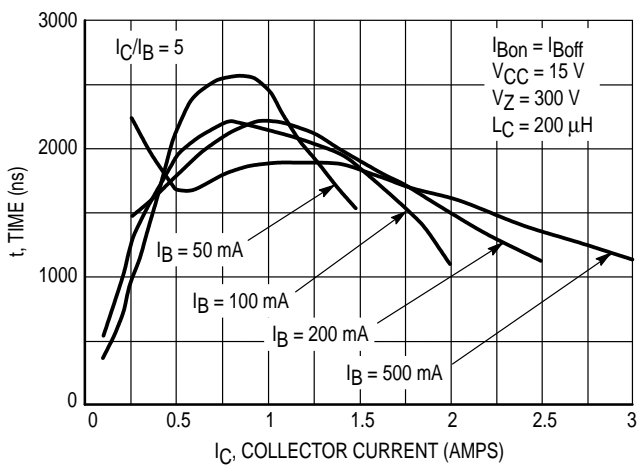


Figure 19. Inductive Storage Time,  $t_{sj}$

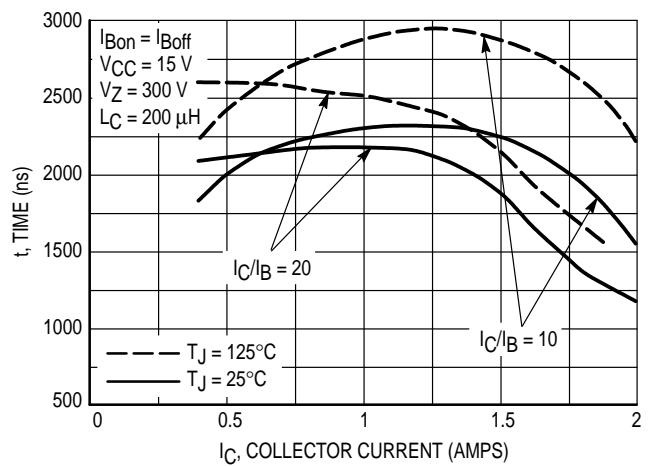
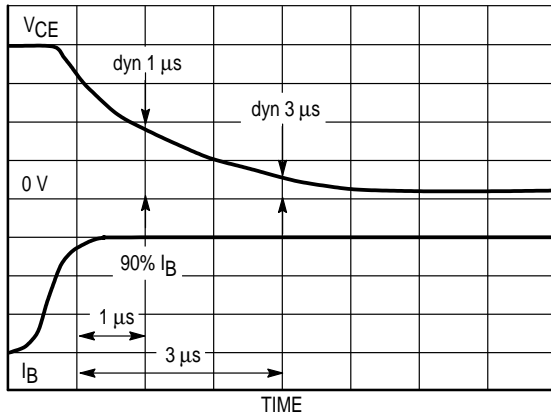
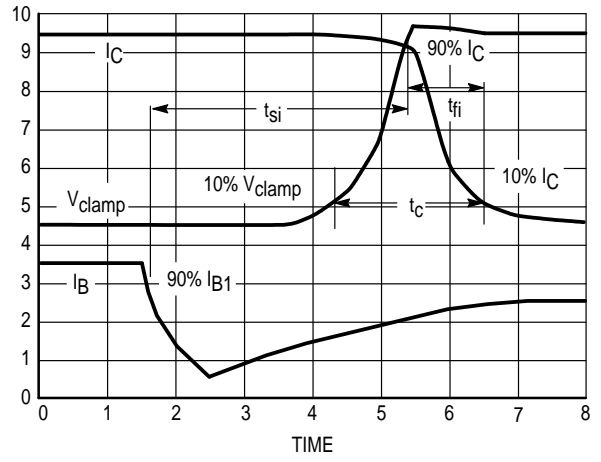


Figure 20. Inductive Storage Time,  $t_{sj}$

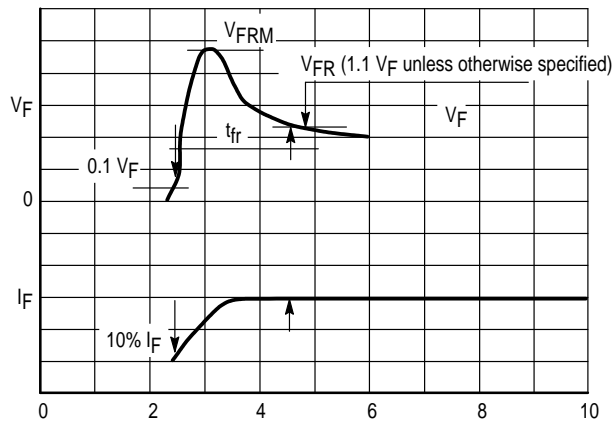
**TYPICAL SWITCHING CHARACTERISTICS**



**Figure 21. Dynamic Saturation Voltage Measurements**



**Figure 22. Inductive Switching Measurements**

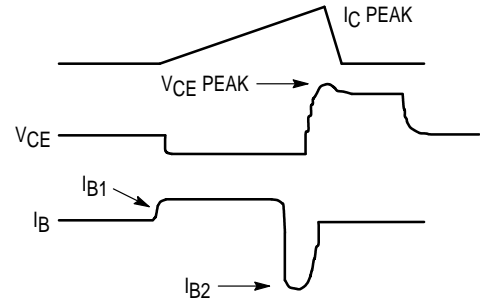
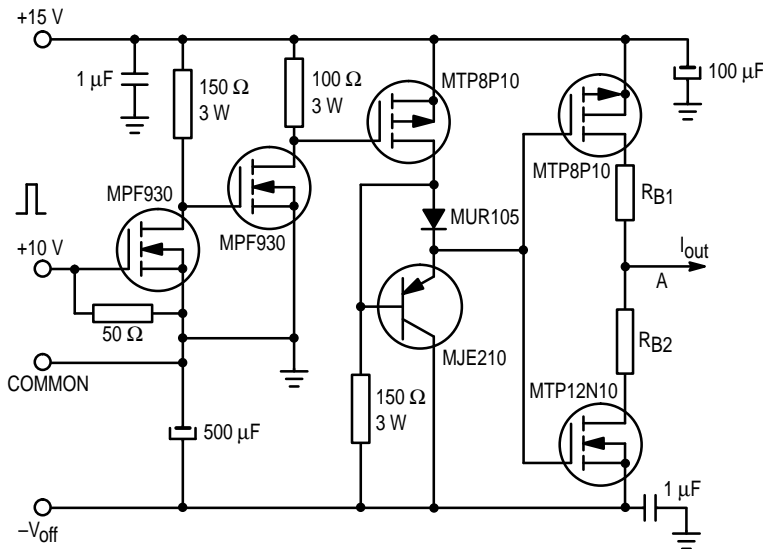


**Figure 22 bis.  $t_{fr}$  Measurements**



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

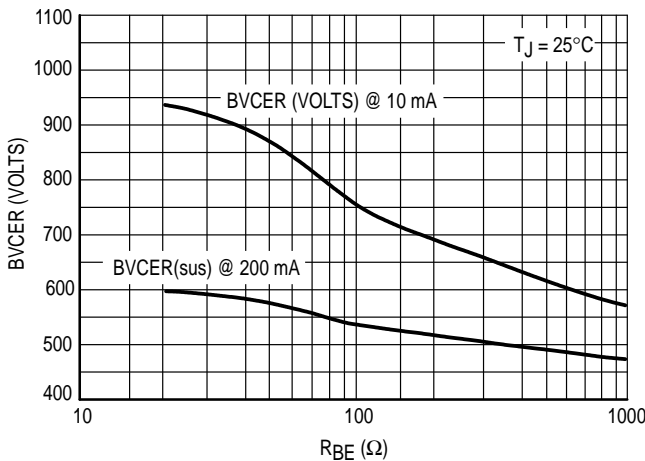


Figure 23. BVCEr

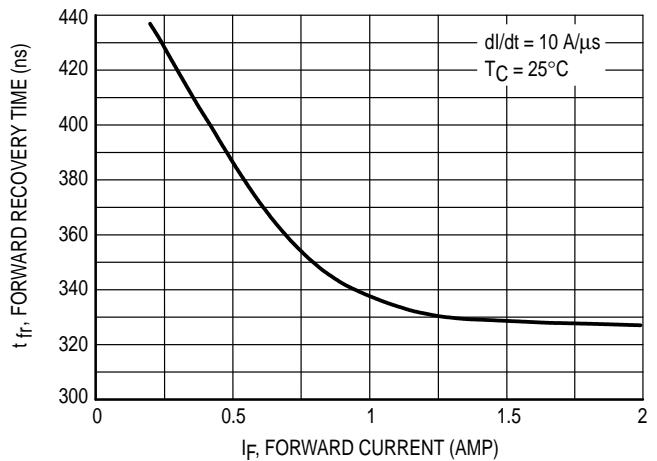
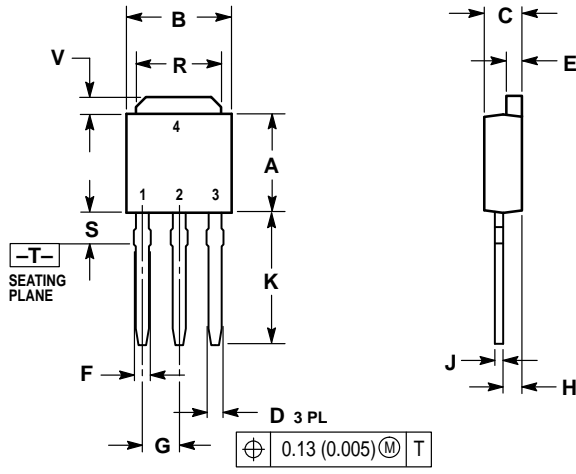


Figure 24. Forward Recovery Time  $t_{fr}$

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**BUD44D2**

**PACKAGE DIMENSIONS**

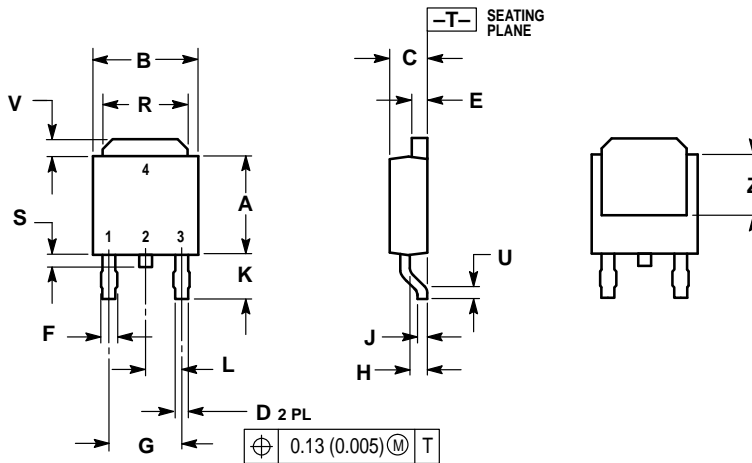


- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

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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