

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 (± 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 $V_{CE(sat)}$
- Six 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 @ $T_C = 25^\circ\text{C}$	P_D	25	Watt
*Derate above 25°C		0.2	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J, T_{stg}	-65 to 150	$^\circ\text{C}$

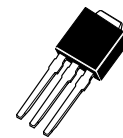
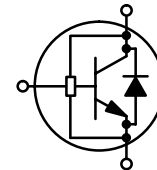
THERMAL CHARACTERISTICS

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

BUD44D2

POWER TRANSISTORS
2 AMPERES
700 VOLTS
25 WATTS

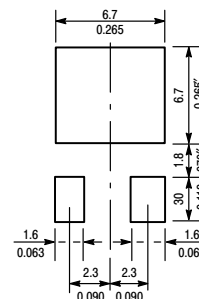


CASE 369-07



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
OFF CHARACTERISTICS					
Collector–Emitter Sustaining Voltage ($I_C = 100\text{ mA}$, $L = 25\text{ mH}$)	$V_{CE(sus)}$	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	μAdc
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	μAdc
Emitter–Cutoff Current ($V_{EB} = 10\text{ Vdc}$, $I_C = 0$)	I_{EBO}			100	μAdc

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		

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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 μs and 3 μs 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 μs	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	$V_{CE(dsat)}$		3.3 6.8		V
		@ 3 μs	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$			0.5 1.3		
	$I_C = 1\text{ A}$ $I_{B1} = 0.2\text{ A}$ $V_{CC} = 300\text{ V}$	@ 1 μs	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$			4.4 12.8		
		@ 3 μs	@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$			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 μs)

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	μs
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

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Characteristic	Symbol	Min	Typ	Max	Unit
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 μs
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 μs
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 μs
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 μs
Crossover Time		@ $T_C = 25^\circ\text{C}$ @ $T_C = 125^\circ\text{C}$	t_c	150 330	250 ns

TYPICAL STATIC CHARACTERISTICS

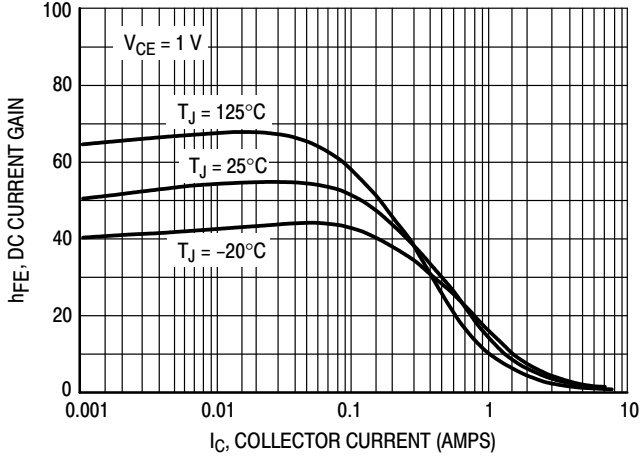


Figure 1. DC Current Gain @ 1 Volt

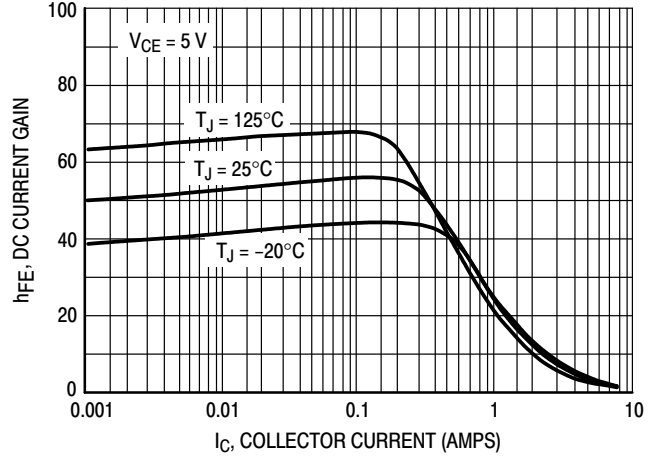


Figure 2. DC Current Gain @ 5 Volt

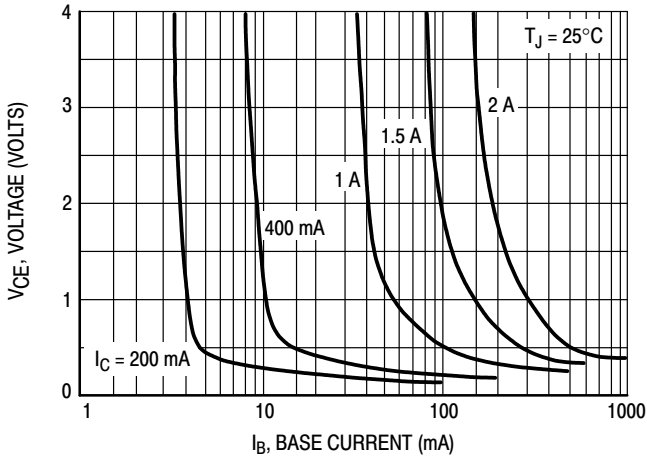


Figure 3. Collector Saturation Region

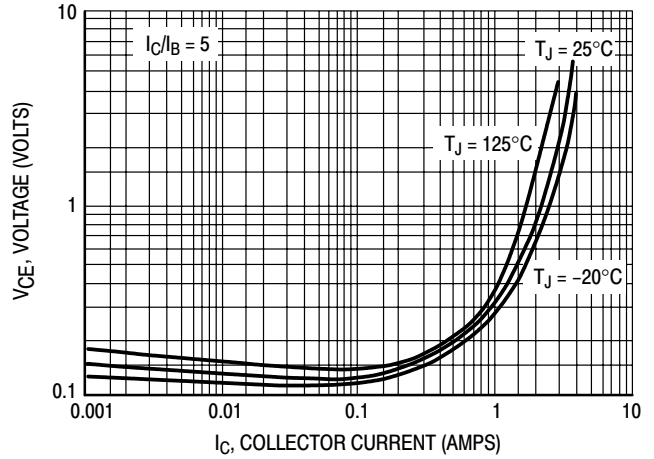


Figure 4. Collector-Emitter Saturation Voltage

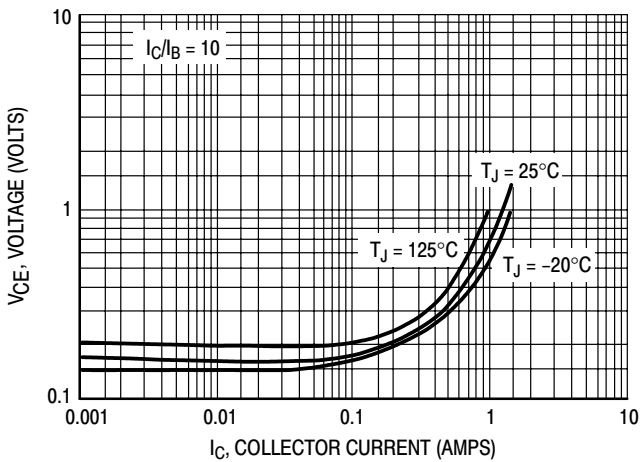


Figure 5. Collector-Emitter Saturation Voltage

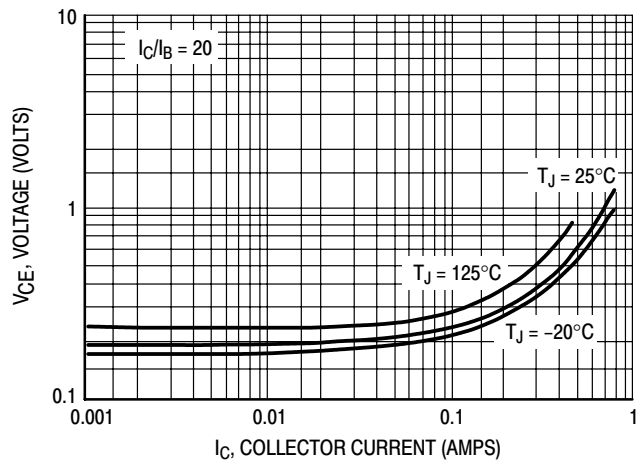


Figure 6. Collector-Emitter Saturation Voltage

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TYPICAL STATIC CHARACTERISTICS

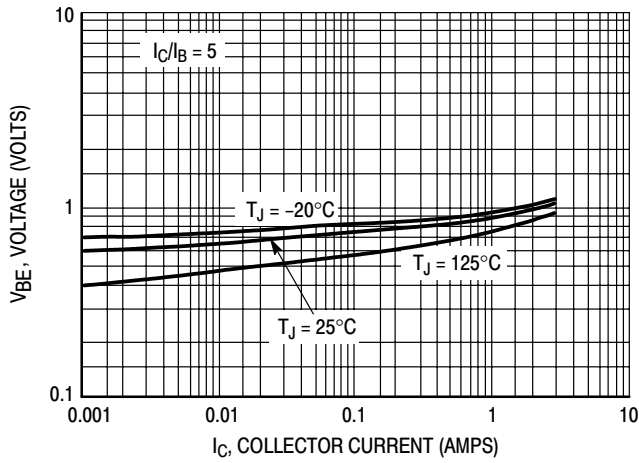


Figure 7A. Base-Emitter Saturation Region

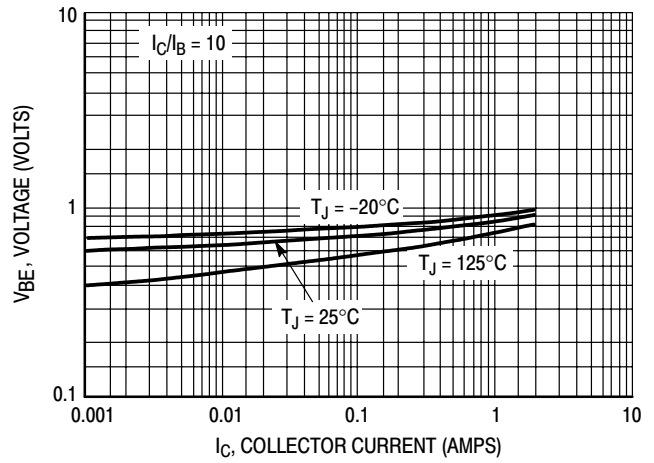


Figure 7B. Base-Emitter Saturation Region

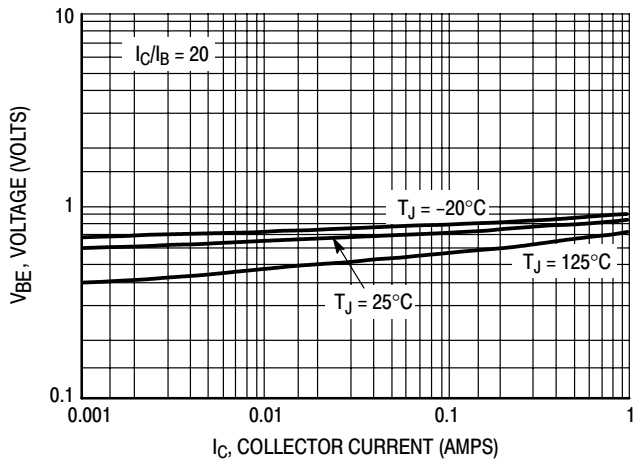


Figure 7C. Base-Emitter Saturation Region

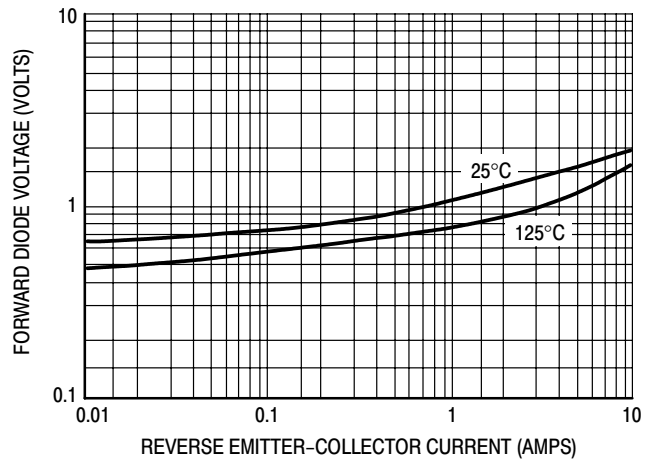


Figure 8. Forward Diode Voltage

TYPICAL SWITCHING CHARACTERISTICS

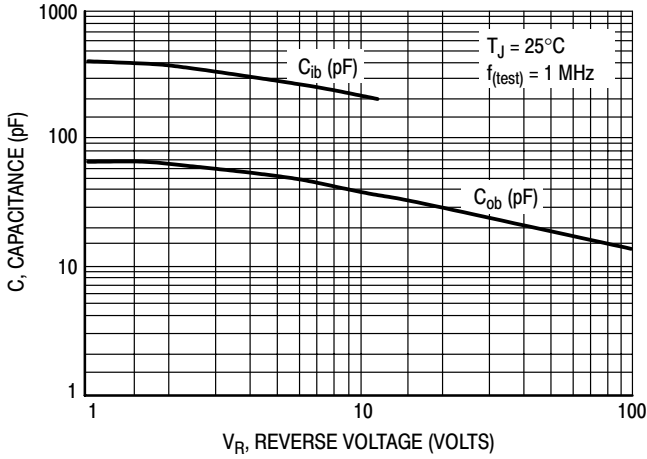


Figure 9. Capacitance

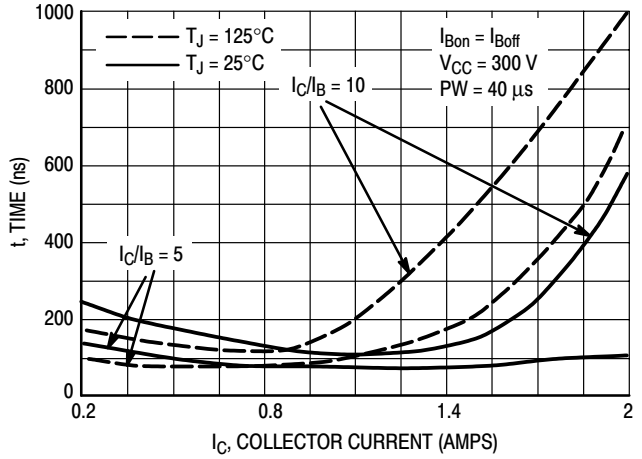


Figure 10. Resistive Switch Time, t_{on}

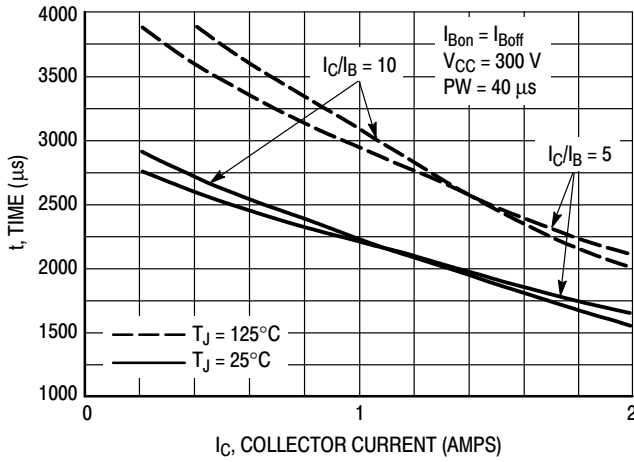


Figure 11. Resistive Switch Time, t_{off}

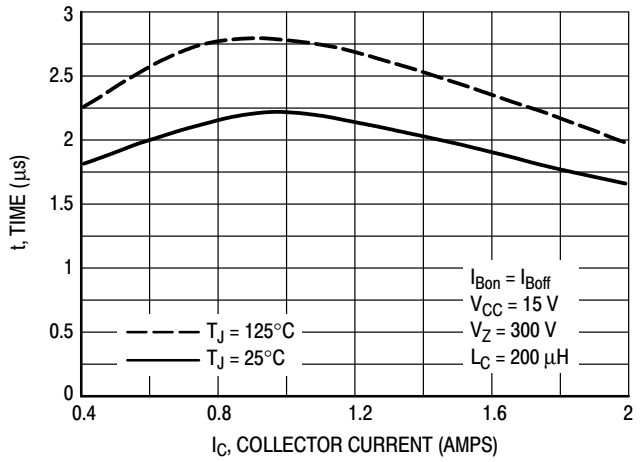


Figure 12. Inductive Storage Time, t_{si} @ $I_C/I_B = 5$

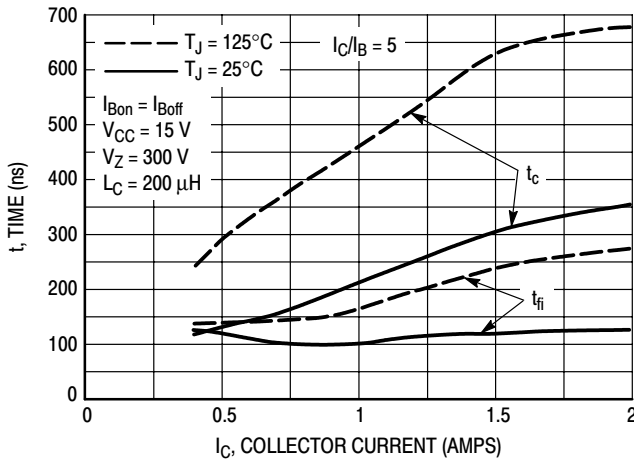


Figure 13. Inductive Switching, t_c & t_{rf} @ $I_C/I_B = 5$

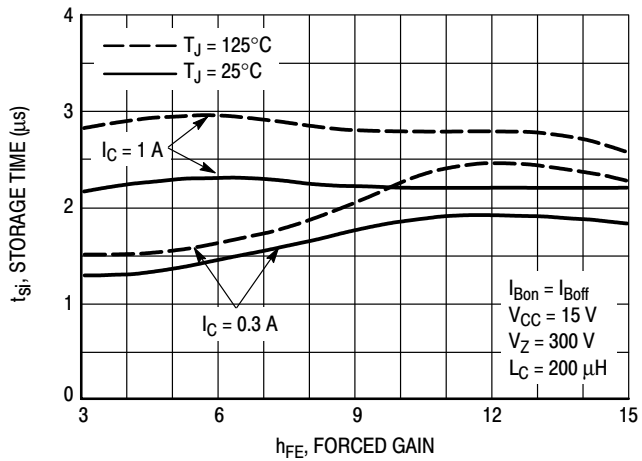


Figure 14. Inductive Storage Time

TYPICAL SWITCHING CHARACTERISTICS

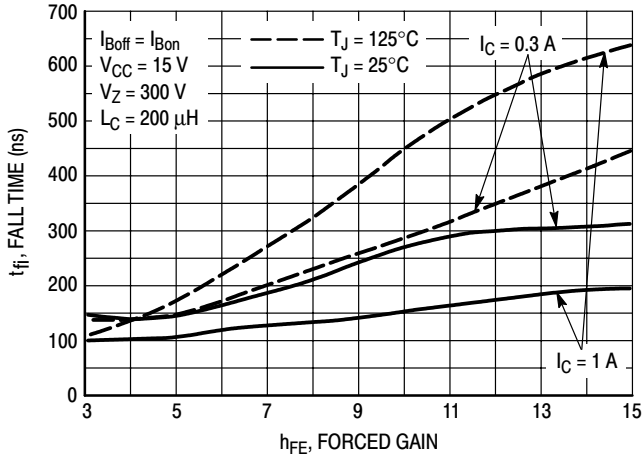


Figure 15. Inductive Fall Time

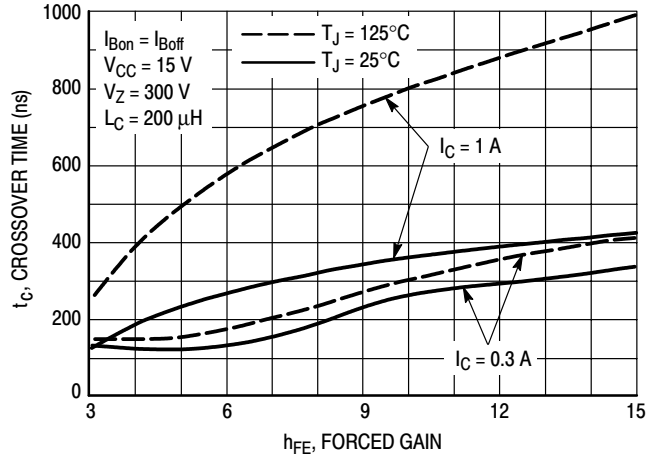


Figure 16. Inductive Crossover Time

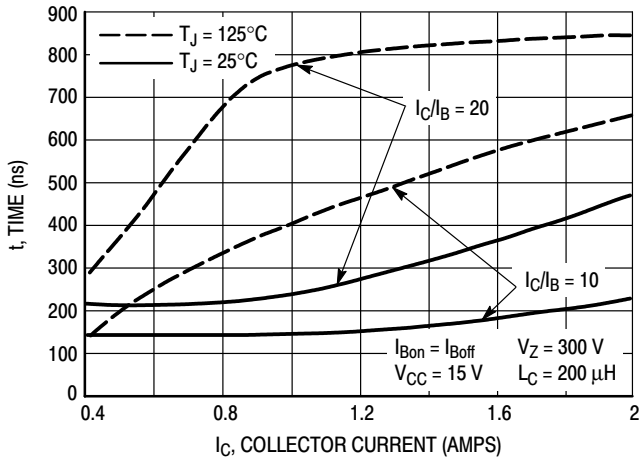


Figure 17. Inductive Switching, t_{fi}

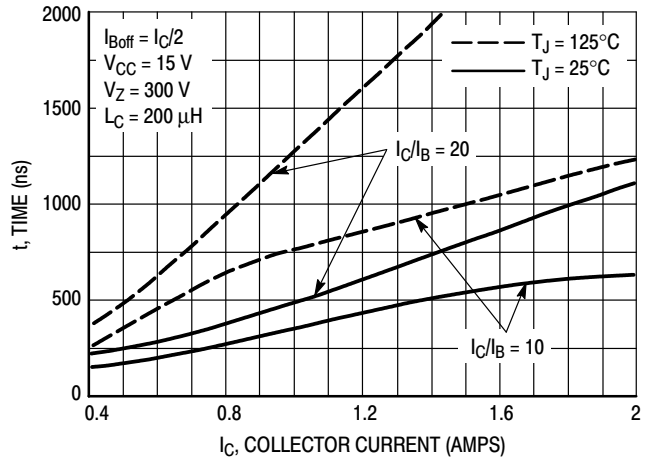


Figure 18. Inductive Switching, t_c

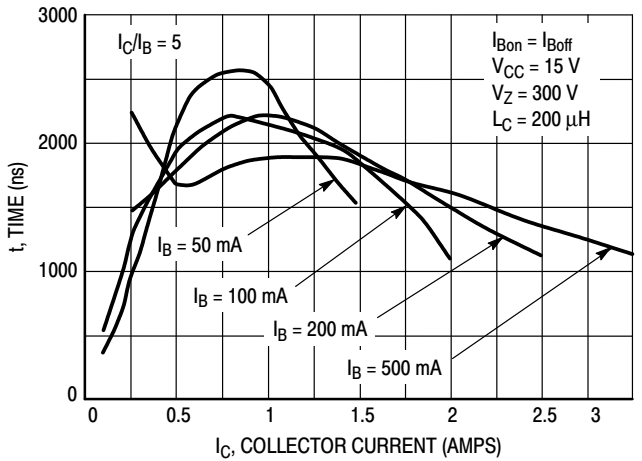


Figure 19. Inductive Storage Time, t_{si}

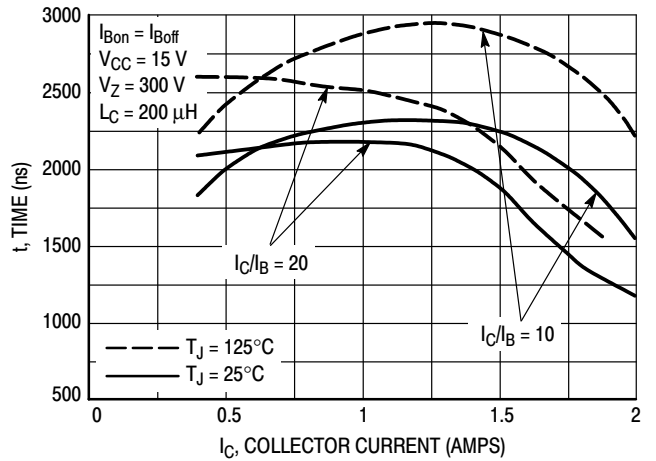


Figure 20. Inductive Storage Time, t_{si}

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TYPICAL SWITCHING CHARACTERISTICS

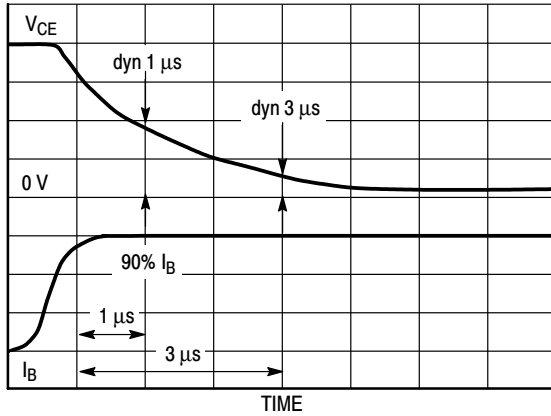


Figure 21. Dynamic Saturation Voltage Measurements

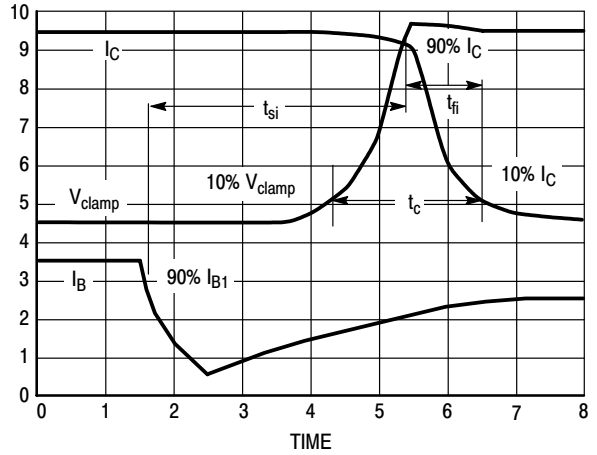


Figure 22. Inductive Switching Measurements

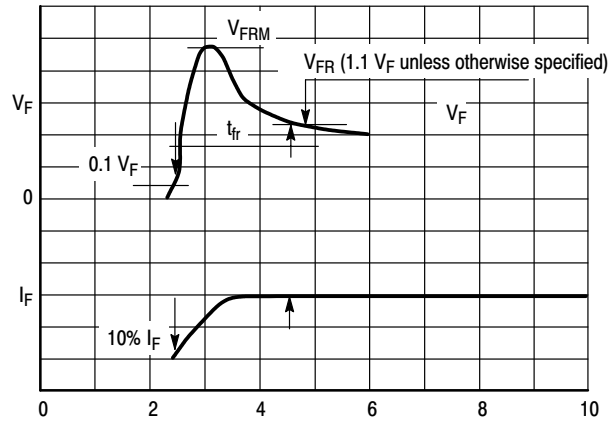
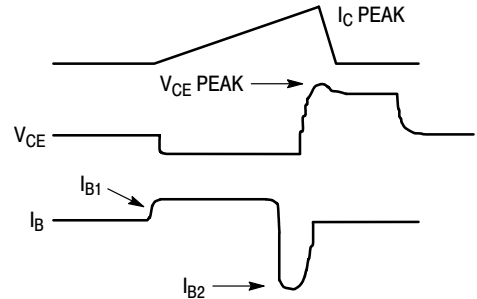
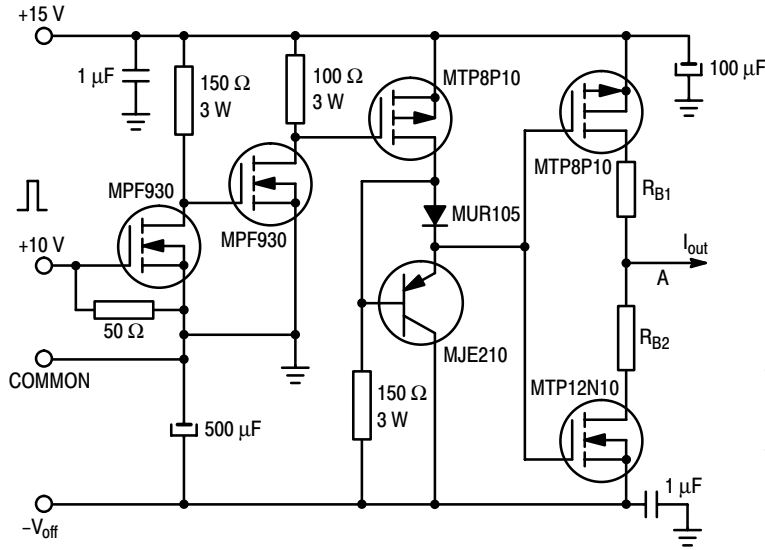


Figure 22 bis. t_{fr} Measurements

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TYPICAL SWITCHING CHARACTERISTICS

Table 1. Inductive Load Switching Drive Circuit



$V_{(BR)CEO(sus)}$
 $L = 10 \text{ mH}$
 $R_{B2} = \infty$
 $V_{CC} = 20 \text{ Volts}$
 $I_{C(pk)} = 100 \text{ mA}$

Inductive Switching
 $L = 200 \mu\text{H}$
 $R_{B2} = 0$
 $V_{CC} = 15 \text{ Volts}$
 R_{B1} selected for
 desired I_{B1}

RBSOA
 $L = 500 \mu\text{H}$
 $R_{B2} = 0$
 $V_{CC} = 15 \text{ Volts}$
 R_{B1} selected for
 desired I_{B1}

TYPICAL STATIC CHARACTERISTICS

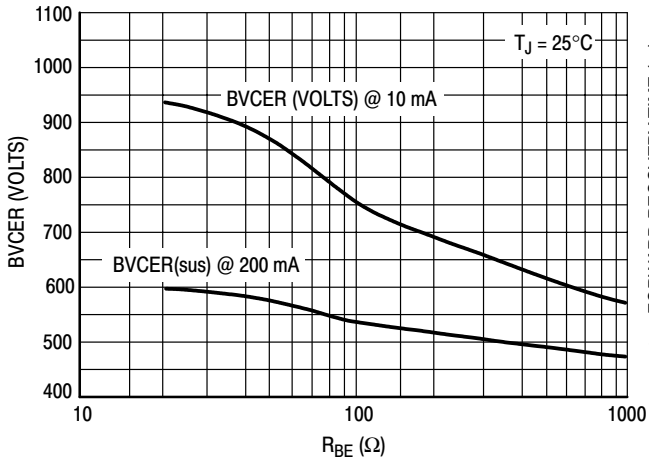


Figure 23. BVCEr

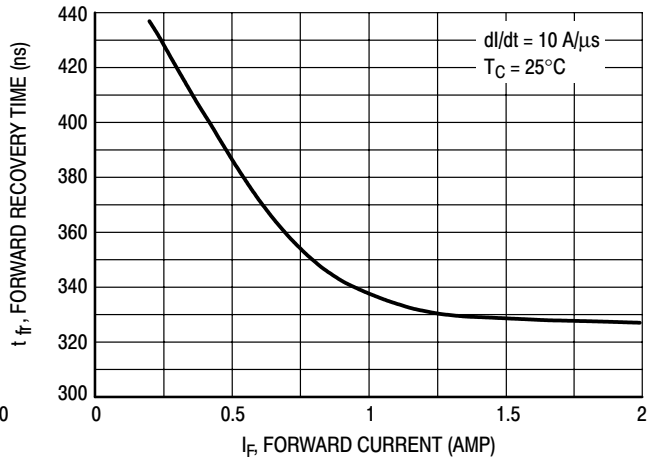
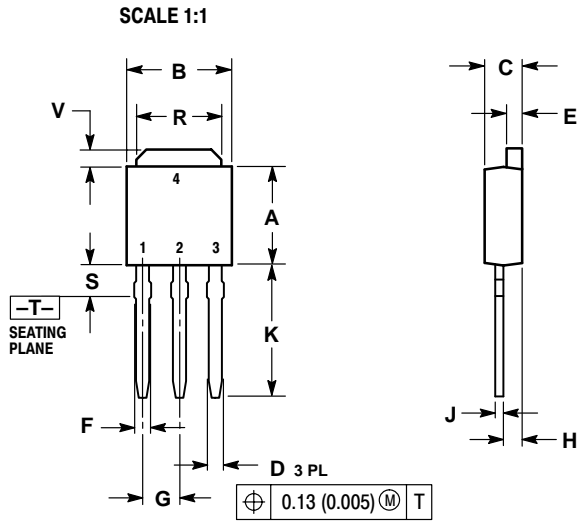


Figure 24. Forward Recovery Time t_{fr}

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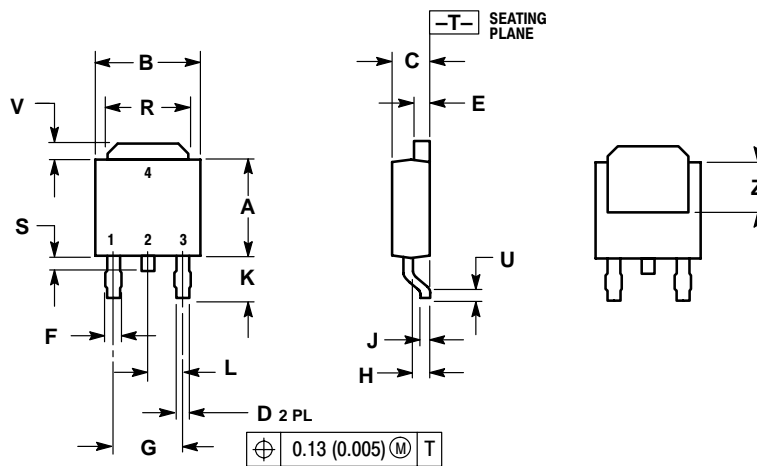
PACKAGE DIMENSIONS DPAK CASE 369-07 ISSUE M



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

INCHES		MILLIMETERS		
DIM	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

DPAK CASE 369A-13 ISSUE AA



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

INCHES		MILLIMETERS		
DIM	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	---

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