SWITCHMODE™

NPN Bipolar Power Transistor For Switching Power Supply Applications

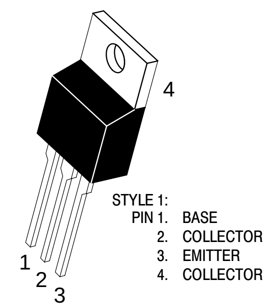
The MJE18002 have an applications specific state–of–the–art die designed for use in 220 V line operated Switchmode Power supplies and electronic light ballasts. These high voltage/high speed transistors offer the following:

- Improved Efficiency Due to Low Base Drive Requirements:
  - High and Flat DC Current Gain h_{FE}
  - Fast Switching
  - No Coil Required in Base Circuit for Turn–Off (No Current Tail)
- Tight Parametric Distributions are Consistent Lot–to–Lot
- Standard TO–220

MJE18002*

*ON Semiconductor Preferred Device

POWER TRANSISTOR
2.0 AMPERES
1000 VOLTS
50 WATTS



CASE 221A–09
TO–220AB
MJE18002

MAXIMUM RATINGS

Rating	Symbol	MJE18002	Unit
Collector–Emitter Sustaining Voltage	V_{CEO}	450	Vdc
Collector–Emitter Breakdown Voltage	V_{CES}	1000	Vdc
Emitter–Base Voltage	V_{EBO}	9.0	Vdc
Collector Current – Continuous – Peak(1)	I_C I_{CM}	2.0 5.0	Adc
Base Current – Continuous – Peak(1)	I_B I_{BM}	1.0 2.0	Adc
Total Device Dissipation (T_C = 25°C) Derate above 25°C	P_D	50 0.4	Watts W/°C
Operating and Storage Temperature	T_J, T_{stg}	–65 to 150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	MJE18002	Unit
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

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

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

OFF CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Collector–Emitter Sustaining Voltage (I_C = 100 mA, L = 25 mH)	$V_{CEO(sus)}$	450	–	–	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 = 125°C (V_{CE} = 800 V, V_{EB} = 0) T_C = 125°C	I_{CES}	– – –	– – –	100 500 100	µAdc
Emitter Cutoff Current (V_{EB} = 9.0 Vdc, I_C = 0)	I_{EBO}	–	–	100	µAdc

ON CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Base–Emitter Saturation Voltage (I_C = 0.4 Adc, I_B = 40 mAdc) (I_C = 1.0 Adc, I_B = 0.2 Adc)	$V_{BE(sat)}$	– –	0.825 0.92	1.1 1.25	Vdc
Collector–Emitter Saturation Voltage (I_C = 0.4 Adc, I_B = 40 mAdc) @ T_C = 125°C (I_C = 1.0 Adc, I_B = 0.2 Adc) @ T_C = 125°C	$V_{CE(sat)}$	 – – – –	 0.2 0.2 0.25 0.3	 0.5 0.5 0.5 0.6	Vdc
DC Current Gain (I_C = 0.2 Adc, V_{CE} = 5.0 Vdc) @ T_C = 125°C (I_C = 0.4 Adc, V_{CE} = 1.0 Vdc) @ T_C = 125°C (I_C = 1.0 Adc, V_{CE} = 1.0 Vdc) @ T_C = 125°C (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	14 – 11 11 6.0 5.0 10	– 27 17 20 8.0 8.0 20	34 – – – – – –	–

DYNAMIC CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Current Gain Bandwidth (I_C = 0.2 Adc, V_{CE} = 10 Vdc, f = 1.0 MHz)	f_T	–	13	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	35	60	pF
Input Capacitance (V_{EB} = 8.0 V)	C_{ib}	–	400	600	pF

Characteristic	Conditions	Time	Temperature	Symbol	Min	Typ	Max	Unit
Dynamic Saturation: determined 1.0 µs and 3.0 µs after rising I_{B1} reach 0.9 final I_{B1} (see Figure 18)	I_C = 0.4 A I_{B1} = 40 mA V_{CC} = 300 V	1.0 µs	@ T_C = 125°C	$V_{CE(dsat)}$	– –	3.5 8.0	– –	Vdc
		3.0 µs	@ T_C = 125°C		– –	1.5 3.8	– –	
	I_C = 1.0 A I_{B1} = 0.2 A V_{CC} = 300 V	1.0 µs	@ T_C = 125°C		– –	8.0 14	– –	
		3.0 µs	@ T_C = 125°C		– –	2.0 7.0	– –	

(1) Pulse Test: Pulse Width = 5.0 ms, Duty Cycle ≤ 10%.
(2) Proper strike and creepage distance must be provided.

ELECTRICAL CHARACTERISTICS – continued (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 = 0.4 Adc I_{B1} = 40 mAdc I_{B2} = 0.2 Adc V_{CC} = 300 V	 @ T_C = 125°C	t_{on}	– –	200 130	300 –	ns
Turn–Off Time		 @ T_C = 125°C	t_{off}	– –	1.2 1.5	2.5 –	μs
Turn–On Time	I_C = 1.0 Adc I_{B1} = 0.2 Adc I_{B2} = 0.5 Adc V_{CC} = 300 V	 @ T_C = 125°C	t_{on}	– –	85 95	150 –	ns
Turn–Off Time		 @ T_C = 125°C	t_{off}	– –	1.7 2.1	2.5 –	μs
SWITCHING CHARACTERISTICS: Inductive Load (V_{clamp} = 300 V, V_{CC} = 15 V, L = 200 μH)							
Fall Time	I_C = 0.4 Adc, I_{B1} = 40 mAdc, I_{B2} = 0.2 Adc	 @ T_C = 125°C	t_{fi}	– –	125 120	200 –	ns
Storage Time		 @ T_C = 125°C	t_{si}	– –	0.7 0.8	1.25 –	μs
Crossover Time		 @ T_C = 125°C	t_c	– –	110 110	200 –	ns
Fall Time	I_C = 1.0 Adc, I_{B1} = 0.2 Adc, I_{B2} = 0.5 Adc	 @ T_C = 125°C	t_{fi}	– –	110 120	175 –	ns
Storage Time		 @ T_C = 125°C	t_{si}	– –	1.7 2.25	2.75 –	μs
Crossover Time		 @ T_C = 125°C	t_c	– –	200 250	300 –	ns
Fall Time	I_C = 0.4 Adc, I_{B1} = 50 mAdc, I_{B2} = 50 mAdc	 @ T_C = 125°C	t_{fi}	– –	140 185	200 –	ns
Storage Time		 @ T_C = 125°C	t_{si}	– –	2.2 2.5	3.0 –	μs
Crossover Time		 @ T_C = 125°C	t_c	– –	140 220	250 –	ns

TYPICAL STATIC CHARACTERISTICS

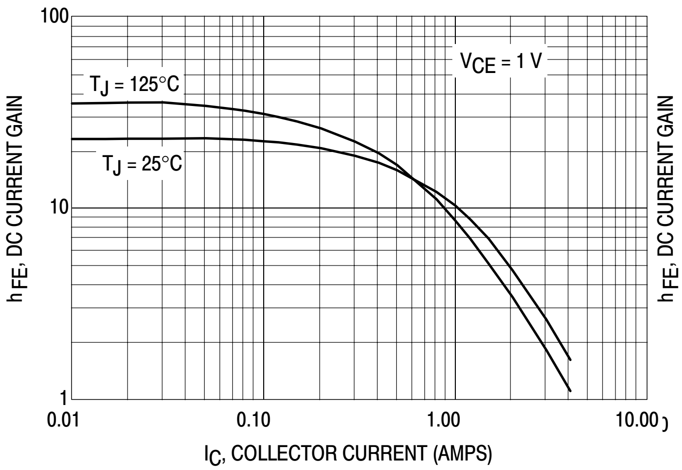


Figure 1. DC Current Gain @ 1 Volt

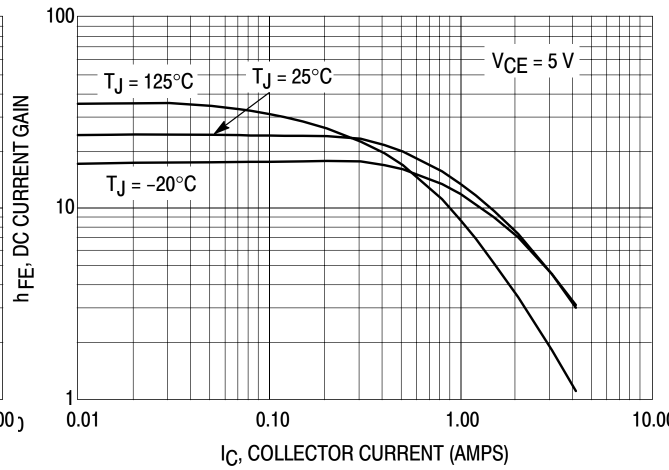


Figure 2. DC Current Gain @ 5 Volts

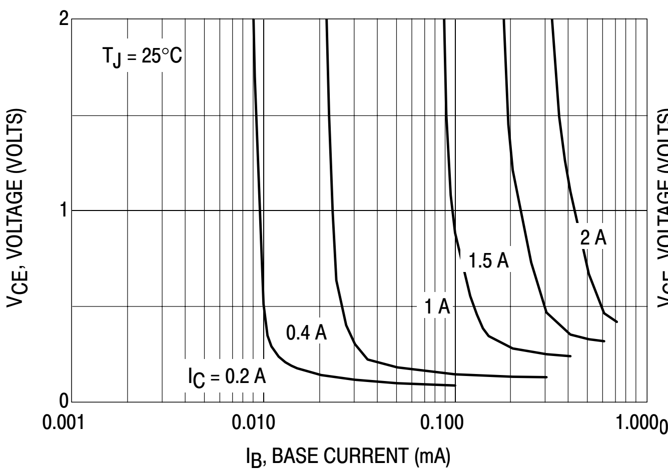


Figure 3. Collector Saturation Region

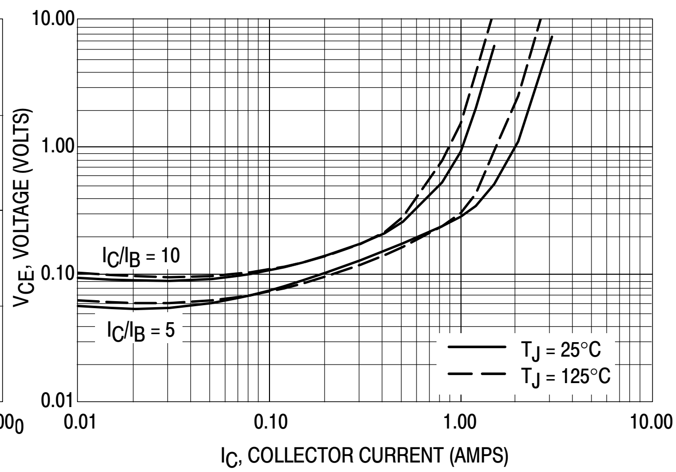


Figure 4. Collector–Emitter Saturation Voltage

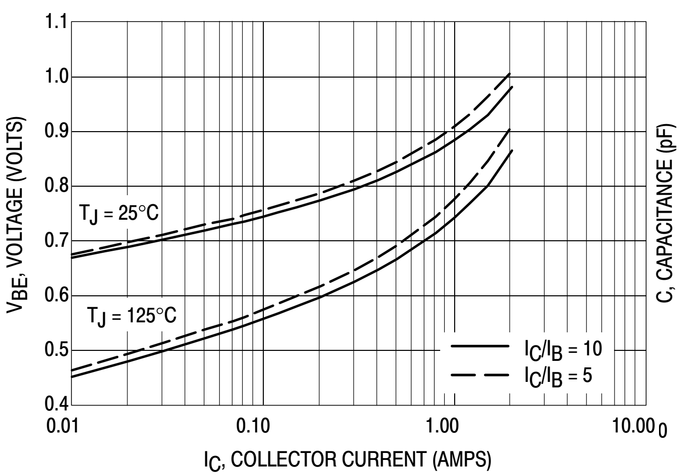


Figure 5. Base–Emitter Saturation Region

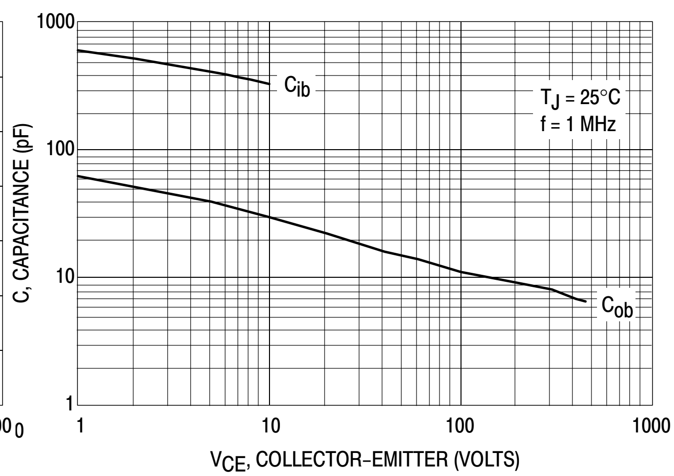


Figure 6. Capacitance

TYPICAL SWITCHING CHARACTERISTICS
($I_{B2} = I_C/2$ for all switching)

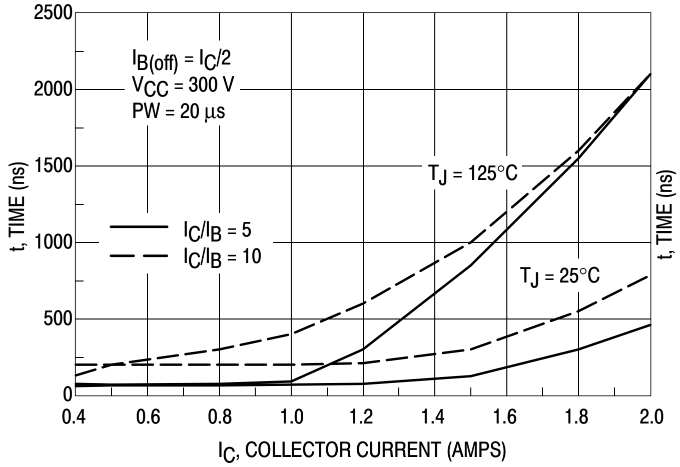


Figure 7. Resistive Switching, t_{on}

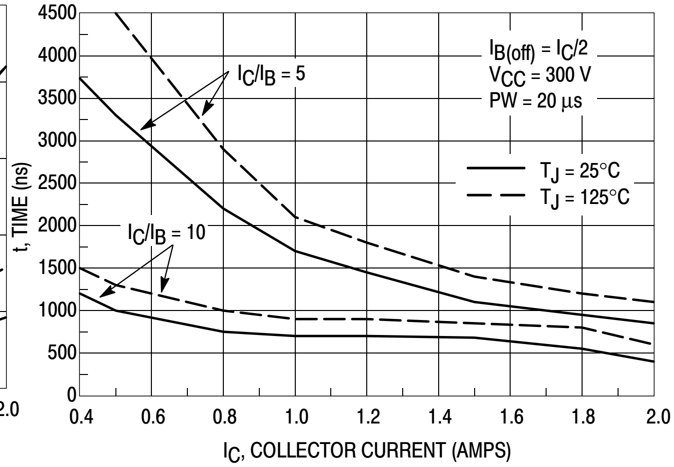


Figure 8. Resistive Switching, t_{off}

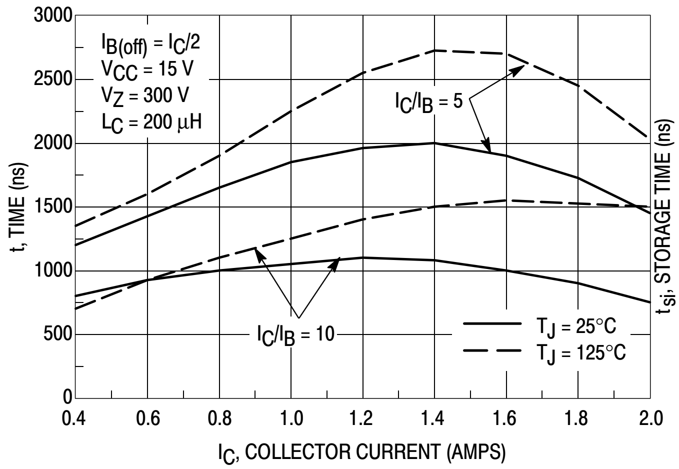


Figure 9. Inductive Storage Time, t_{si}

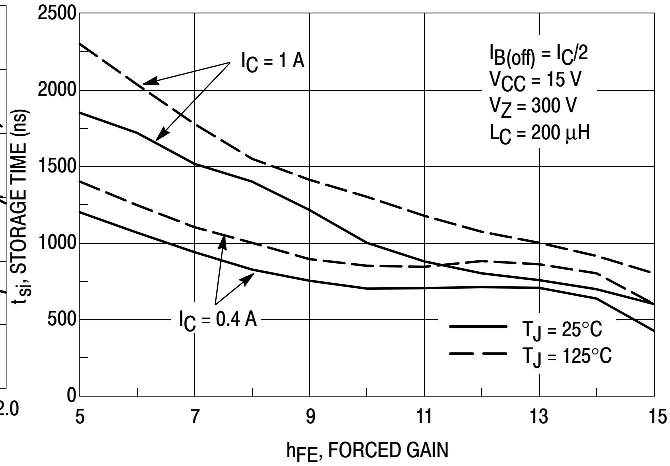


Figure 10. Inductive Storage Time

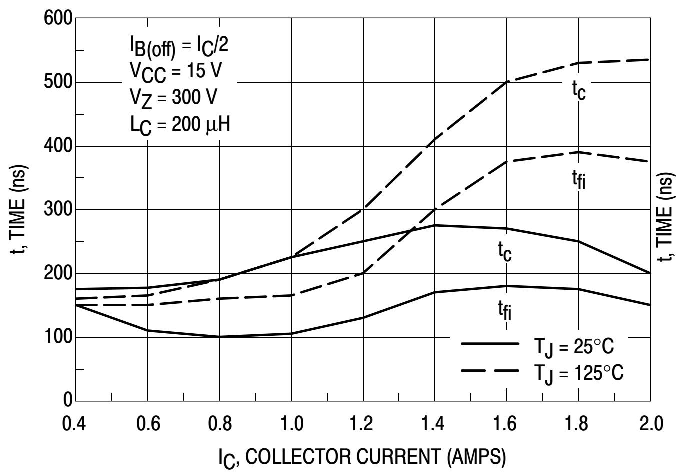


Figure 11. Inductive Switching, t_c and t_{fi}, $I_C/I_B = 5$

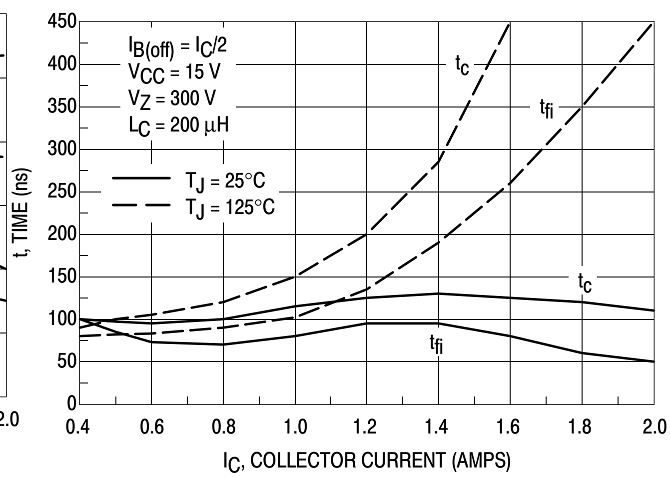


Figure 12. Inductive Switching, t_c and t_{fi}, $I_C/I_B = 10$

TYPICAL SWITCHING CHARACTERISTICS
($I_{B2} = I_C/2$ for all switching)

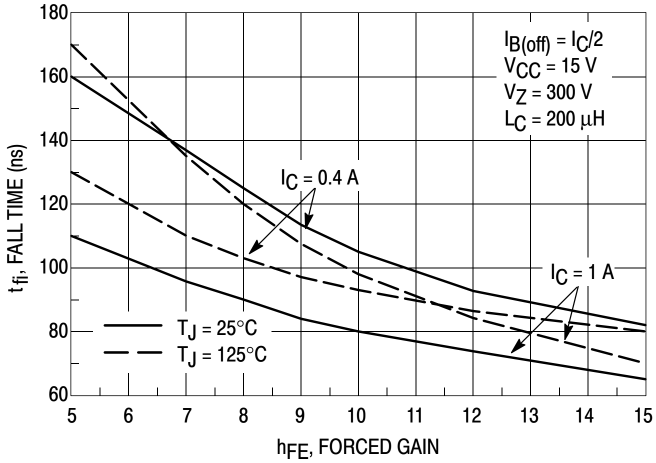


Figure 13. Inductive Fall Time

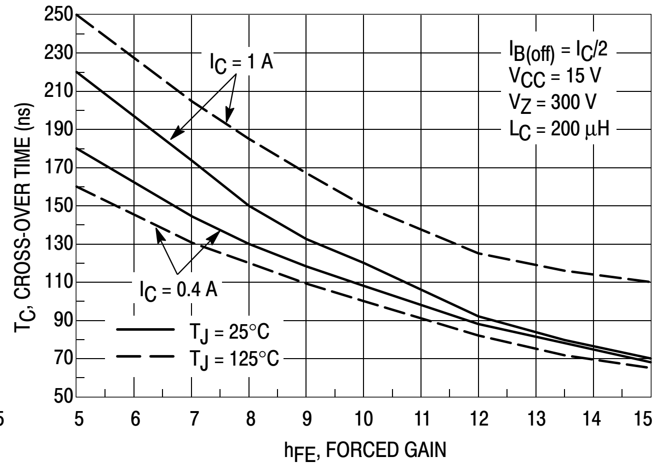


Figure 14. Inductive Crossover Time

GUARANTEED SAFE OPERATING AREA INFORMATION

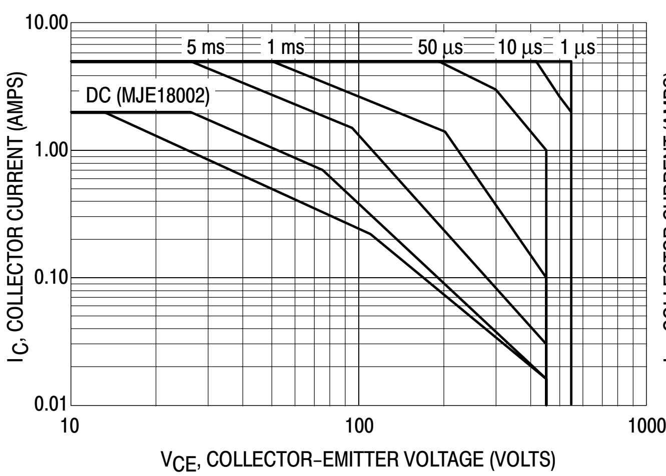


Figure 15. Forward Bias Safe Operating Area

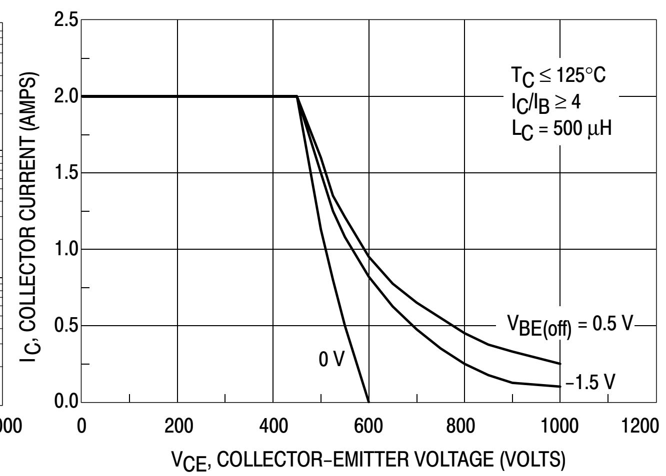


Figure 16. Reverse Bias Switching Safe Operating Area

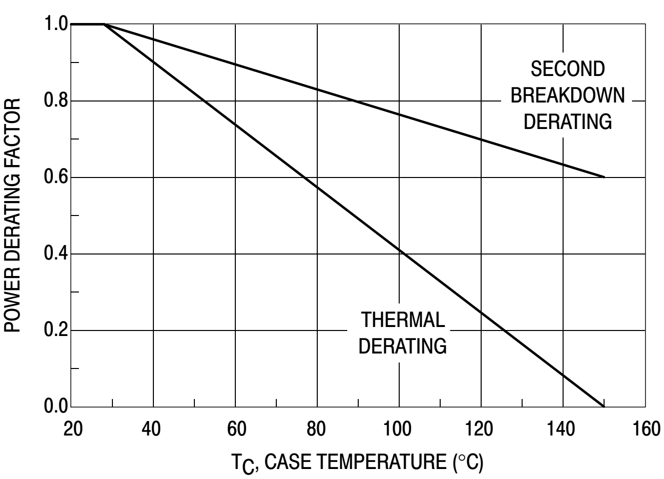


Figure 17. Forward Bias Power Derating

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 15 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 15 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 Figures 20 and NO TAG. At any case temperatures, thermal limitations will reduce the power that can be handled to values less 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 16). This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode.

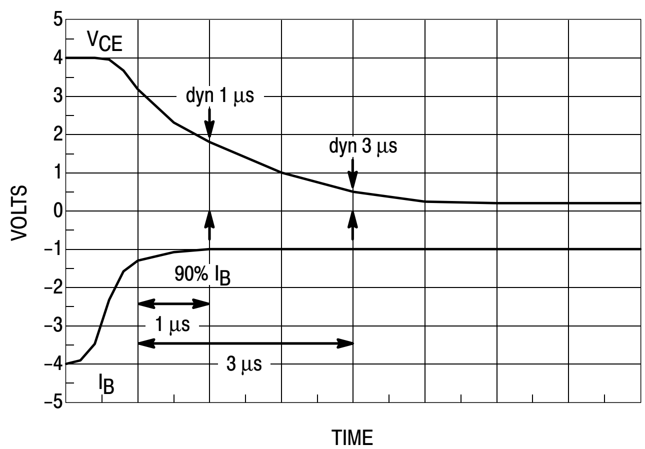


Figure 18. Dynamic Saturation Voltage Measurements

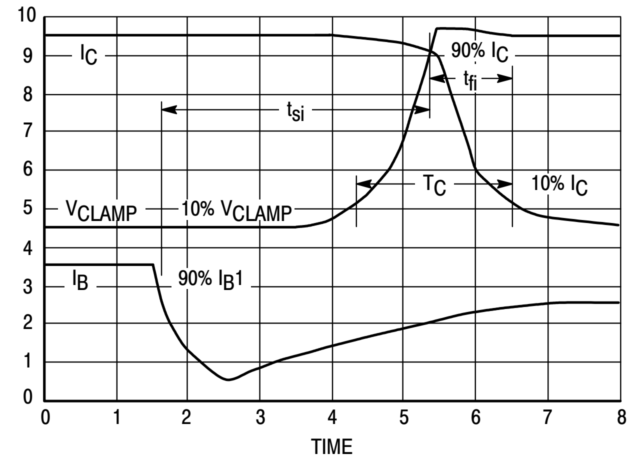
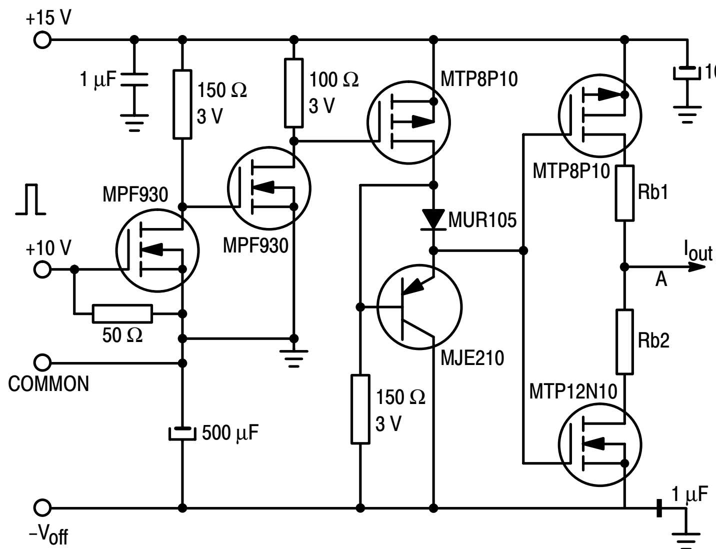
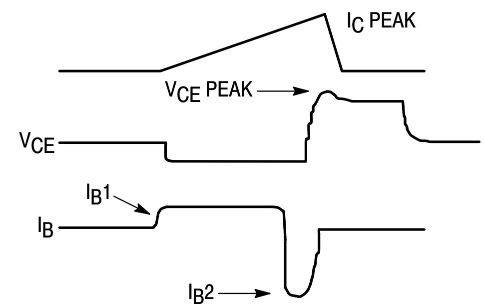


Figure 19. Inductive Switching Measurements





V(BR)CEO(sus)	INDUCTIVE SWITCHING	RBSOA
L = 10 µH	L = 200 µH	L = 500 µH
RB2 = ∞	RB2 = 0	RB2 = 0
V_{CC} = 20 VOLTS	V_{CC} = 15 VOLTS	V_{CC} = 15 VOLTS
$I_{C(pk)}$ = 100 mA	RB1 SELECTED FOR DESIRED I_{B1}	RB1 SELECTED FOR DESIRED I_{B1}

Table 1. Inductive Load Switching Drive Circuit

TYPICAL THERMAL RESPONSE

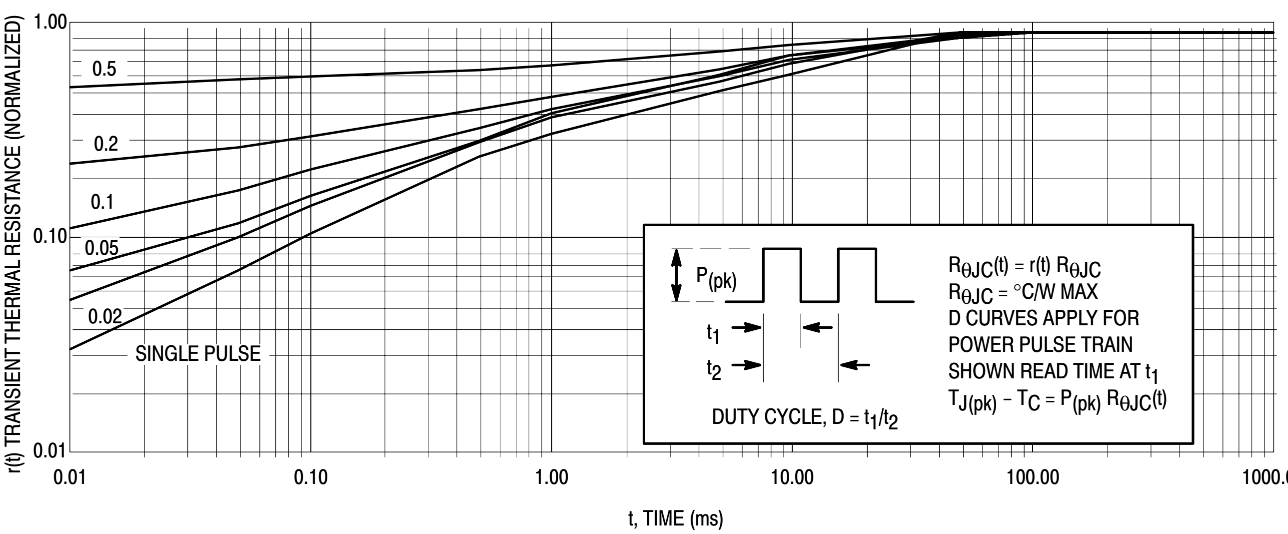
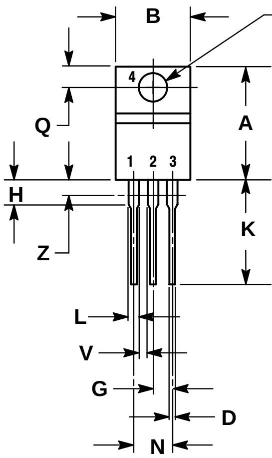
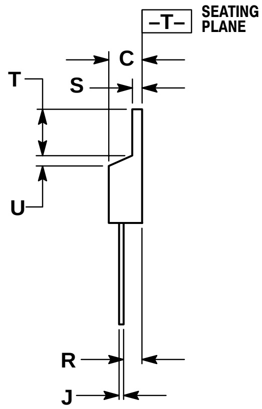


Figure 20. Typical Thermal Response ($Z_{\theta JC}(t)$) for MJE18002

PACKAGE DIMENSIONS

TO–220AB
CASE 221A–09
ISSUE AA





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

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.

DIM	INCHES		MILLIMETERS	
	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

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