MJE18004, MJF18004

Preferred Device

SWITCHMODE™

NPN Bipolar Power Transistor For Switching Power Supply Applications

The MJE/MJF18004 have an applications specific state−of−the−art die designed for use in 220 V line−operated SWITCHMODE Power supplies and electronic light ballasts.

Features

- 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)
- Full Characterization at 125°C
- ON Semiconductor Six Sigma Philosophy Provides Tight and Reproducible Parametric Distributions
- Two Package Choices: Standard TO−220 or Isolated TO−220
- MJF18004, Case 221D, is UL Recognized at 3500 V_{RMS}: File #E69369
- Pb−Free Packages are Available*

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector−Emitter Sustaining Voltage	V_{CEO}	450	Vdc
Collector−Base Breakdown Voltage	V_{CES}	1000	Vdc
Emitter−Base Voltage	V_{EBO}	9.0	Vdc
Collector Current − Continuous − Peak (Note 1)	I_C I_{CM}	5.0 10	Adc
Base Current − Continuous − Peak (Note 1)	I_B I_{BM}	2.0 4.0	Adc
RMS Isolation Voltage (Note 2) Test No. 1 Per Figure 22a Test No. 2 Per Figure 22b Test No. 3 Per Figure 22c (for 1 sec, R.H. < 30%, T_A = 25°C)	V_{ISOL}	**MJF18004** 4500 3500 1500	V
Total Device Dissipation @ T_C = 25°C MJE18004 MJF18004 Derate above 25°C MJE18004 MJF18004	P_D	 75 35 0.6 0.28	W W/°C
Operating and Storage Temperature	T_J, T_{stg}	−65 to 150	°C

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction−to−Case MJE18004 MJF18004	$R_{\theta JC}$	 1.65 3.55	°C/W
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	62.5	°C/W
Maximum Lead Temperature for Soldering Purposes 1/8″ from Case for 5 Seconds	T_L	260	°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

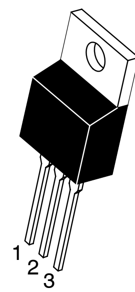
1. Pulse Test: Pulse Width = 5 ms, Duty Cycle ≤ 10%.
2. Proper strike and creepage distance must be provided.

ON Semiconductor®

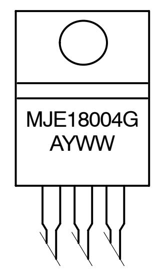
http://onsemi.com

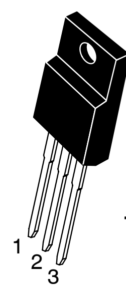
POWER TRANSISTOR
5.0 AMPERES
1000 VOLTS
35 and 75 WATTS

MARKING DIAGRAMS

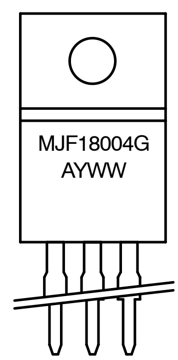


TO−220AB
CASE 221A−09
STYLE 1





TO−220 FULLPACK
CASE 221D
STYLE 2
UL RECOGNIZED



G	=	Pb−Free Package
A	=	Assembly Location
Y	=	Year
WW	=	Work Week

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

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

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

April, 2006 − Rev. 8

Publication Order Number:
MJE18004/D

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
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 = 25°C) (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					
Base−Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 0.1 Adc) (I_C = 2.0 Adc, I_B = 0.4 Adc)	$V_{BE(sat)}$	– –	0.82 0.92	1.1 1.25	Vdc
Collector−Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 0.1 Adc) (T_C = 125°C) (I_C = 2.0 Adc, I_B = 0.4 Adc) (T_C = 125°C) (I_C = 2.5 Adc, I_B = 0.5 Adc)	$V_{CE(sat)}$	 – – – – –	 0.25 0.29 0.3 0.36 0.5	 0.5 0.6 0.45 0.8 0.75	Vdc
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 2.5 Vdc) (T_C = 125°C) (I_C = 0.3 Adc, V_{CE} = 5.0 Vdc) (T_C = 125°C) (I_C = 2.0 Adc, V_{CE} = 1.0 Vdc) (T_C = 125°C) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	12 – 14 – 6.0 – 10	21 20 – 32 11 7.5 22	– – 34 – – – –	–
DYNAMIC CHARACTERISTICS					
Current Gain Bandwidth (I_C = 0.5 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}	–	50	65	pF
Input Capacitance (V_{EB} = 8.0 V)	C_{ib}	–	800	1000	pF
Dynamic Saturation Voltage: Determined 1.0 μs and 3.0 μs respectively after rising I_{B1} reaches 90% of final I_{B1} (see Figure 18); (I_C = 1.0 Adc, I_{B1} = 100 mAdc, V_{CC} = 300 V) 1.0 μs (T_C = 125°C)	$V_{CE(dsat)}$	– –	6.8 14	– –	Vdc
(I_C = 1.0 Adc, I_{B1} = 100 mAdc, V_{CC} = 300 V) 3.0 μs (T_C = 125°C)		– –	2.4 5.6	– –	
(I_C = 2.0 Adc, I_{B1} = 400 mAdc, V_{CC} = 300 V) 1.0 μs (T_C = 125°C)		– –	11.3 15.5	– –	
(I_C = 2.0 Adc, I_{B1} = 400 mAdc, V_{CC} = 300 V) 3.0 μs (T_C = 125°C)		– –	1.3 6.1	– –	

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise specified)

Characteristic		Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS: Resistive Load (D.C. ≤ 10%, Pulse Width = 20 μs)						
Turn−On Time	(I_C = 1.0 Adc, I_{B1} = 0.1 Adc, I_{B2} = 0.5 Adc, V_{CC} = 300 V) (T_C = 125°C)	t_{on}	– –	210 180	300 –	ns
Turn−Off Time	(T_C = 125°C)	t_{off}	– –	1.0 1.3	1.7 –	μs
Turn−On Time	(I_C = 2.0 Adc, I_{B1} = 0.4 Adc, I_{B1} = 1.0 Adc, V_{CC} = 300 V) (T_C = 125°C)	t_{on}	– –	75 90	110 –	ns
Turn−Off Time	(T_C = 125°C)	t_{off}	– –	1.5 1.8	2.5 –	μs
Turn−On Time	(I_C = 2.5 Adc, I_{B1} = 0.5 Adc, I_{B2} = 0.5 Adc, V_{CC} = 250 V) (T_C = 125°C)	t_{on}	– –	450 900	800 1400	ns
Storage Time	(T_C = 125°C)	t_s	– –	2.0 2.2	3.0 3.5	μs
Fall Time	(T_C = 125°C)	t_f	– –	275 500	400 800	ns
SWITCHING CHARACTERISTICS: Inductive Load (V_{clamp} = 300 V, V_{CC} = 15 V, L = 200 μH)						
Fall Time	(I_C = 1.0 Adc, I_{B1} = 0.1 Adc, I_{B2} = 0.5 Adc) (T_C = 125°C)	t_{fi}	– –	100 100	150 –	ns
Storage Time	(T_C = 125°C)	t_{si}	– –	1.1 1.4	1.7 –	μs
Crossover Time	(T_C = 125°C)	t_c	– –	180 160	250 –	ns
Fall Time	(I_C = 2.0 Adc, I_{B1} = 0.4 Adc, I_{B2} = 1.0 Adc) (T_C = 125°C)	t_{fi}	– –	90 150	175 –	ns
Storage Time	(T_C = 125°C)	t_{si}	– –	1.7 2.2	2.5 –	μs
Crossover Time	(T_C = 125°C)	t_c	– –	180 250	300 –	ns
Fall Time	(I_C = 2.5 Adc, I_{B1} = 0.5 Adc, I_{B2} = 0.5 Adc, $V_{BE(off)}$ = −5.0 Vdc) (T_C = 125°C)	t_{fi}	– –	70 100	130 175	ns
Storage Time	(T_C = 125°C)	t_{si}	– –	0.75 1.0	1.0 1.3	μs
Crossover Time	(T_C = 125°C)	t_c	– –	250 250	350 500	ns

TYPICAL STATIC CHARACTERISTICS

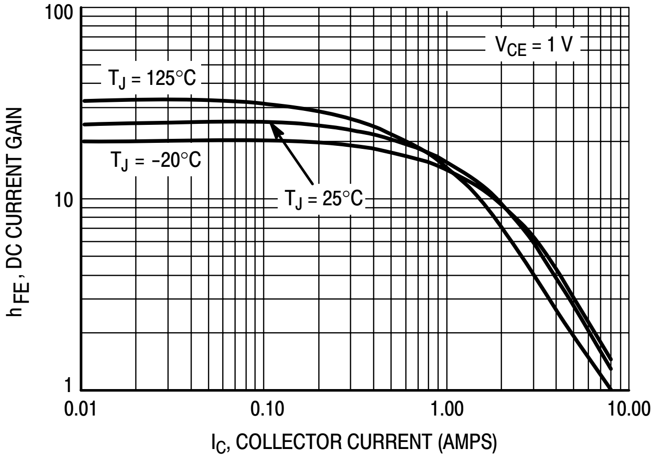


Figure 1. DC Current Gain @ 1 Volt

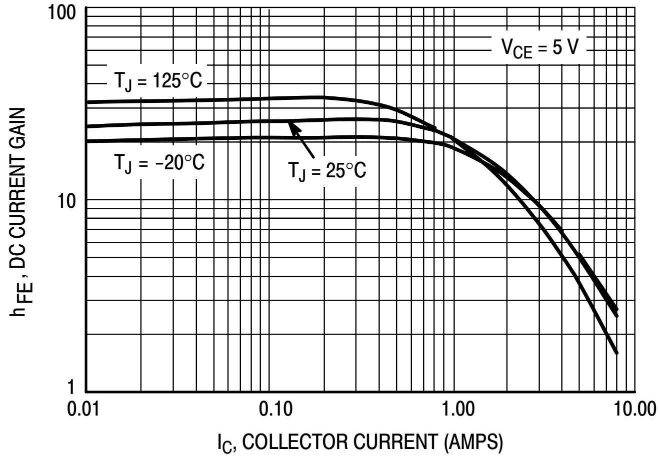


Figure 2. DC Current Gain @ 5 Volts

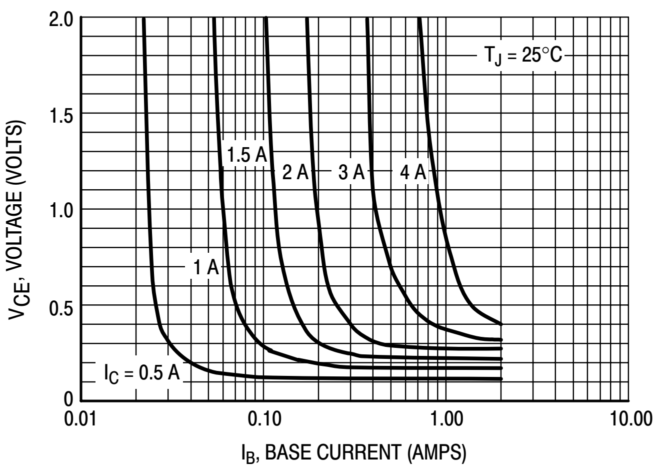


Figure 3. Collector Saturation Region

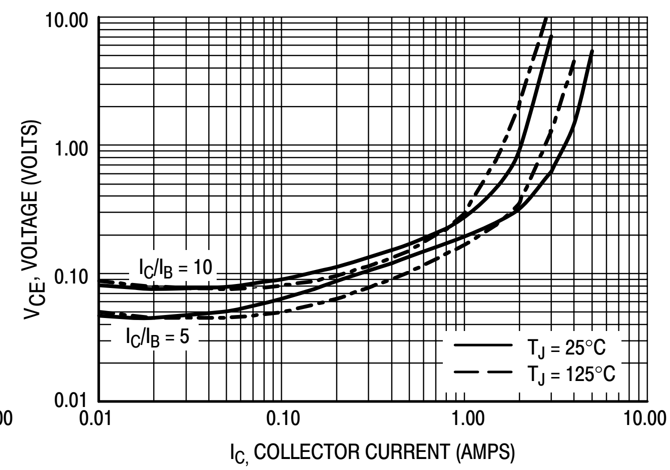


Figure 4. Collector−Emitter Saturation Voltage

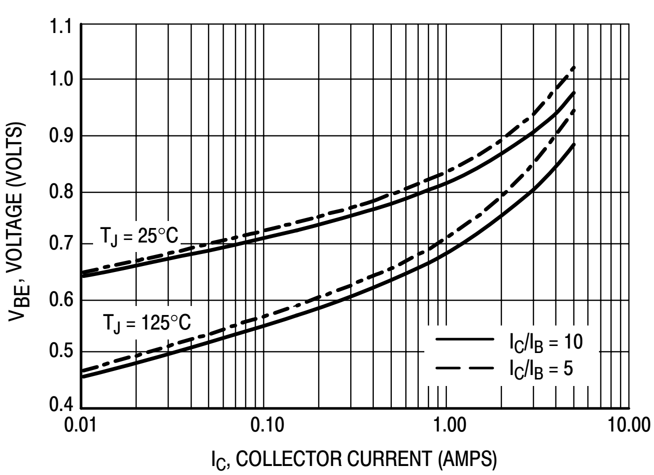


Figure 5. Base−Emitter Saturation Region

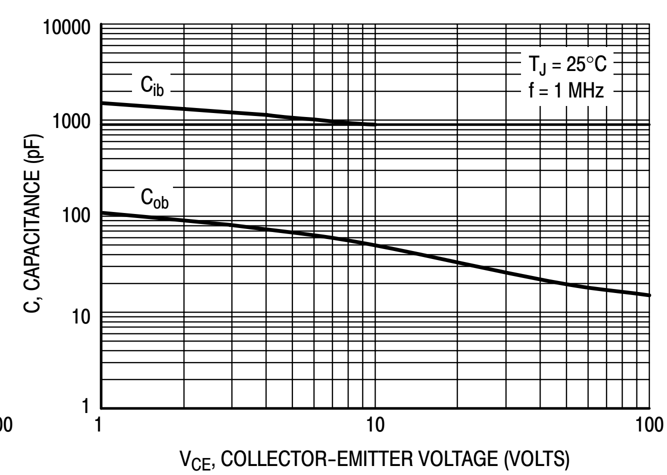


Figure 6. Capacitance

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

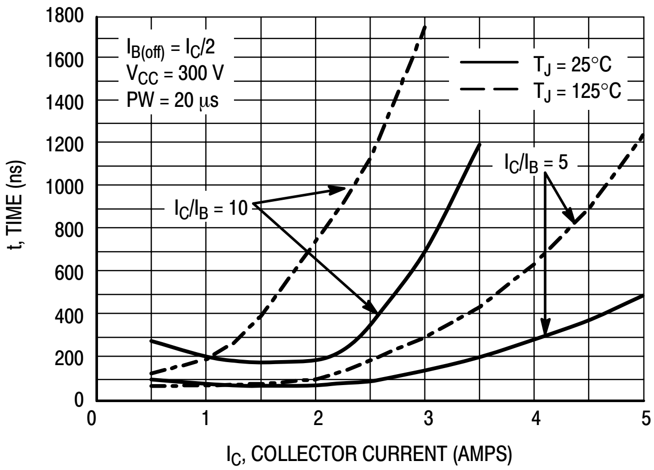


Figure 7. Resistive Switching, t_{on}

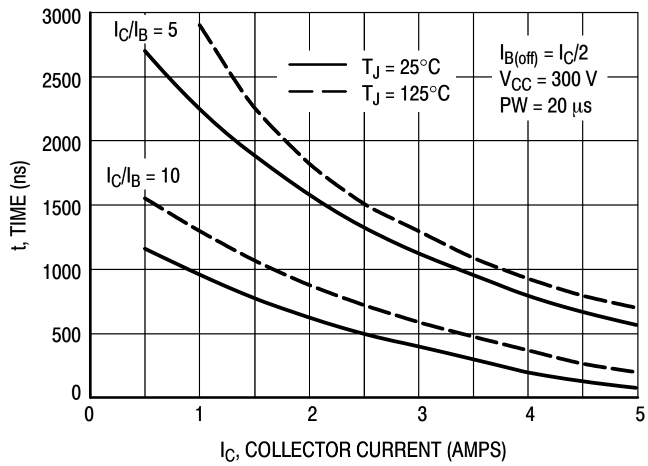


Figure 8. Resistive Switching, t_{off}

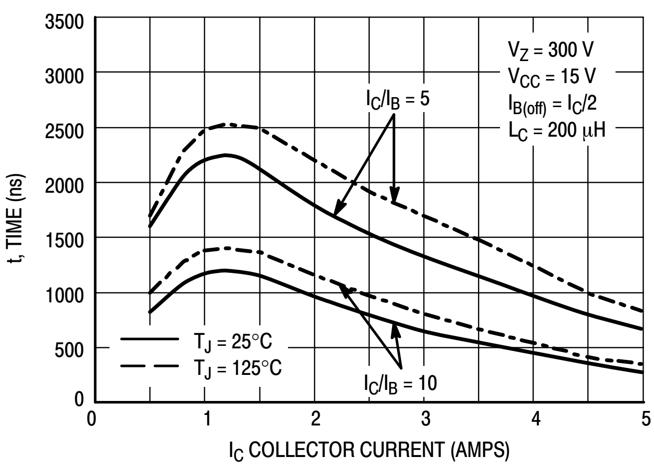


Figure 9. Inductive Storage Time, t_{si}

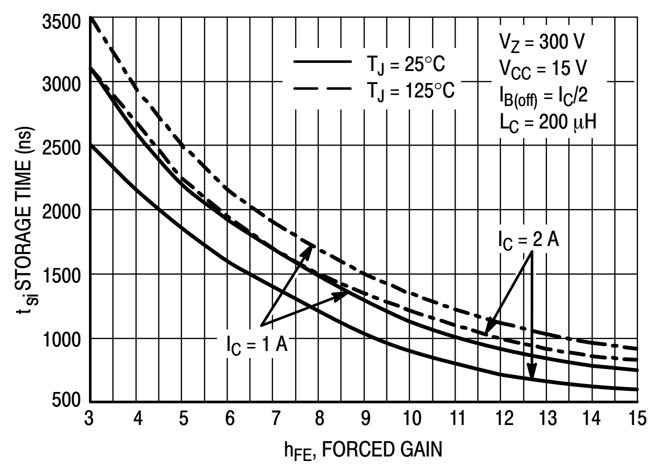


Figure 10. Inductive Storage Time, $t_{si}(h_{FE})$

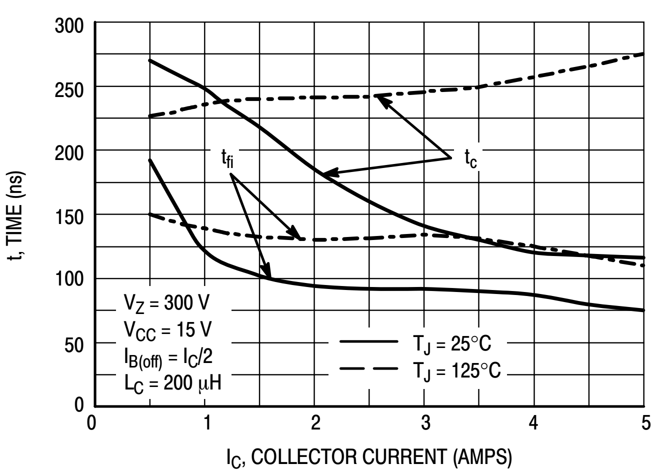


Figure 11. Inductive Switching, t_c and t_{fi}, $I_C/I_B = 5$

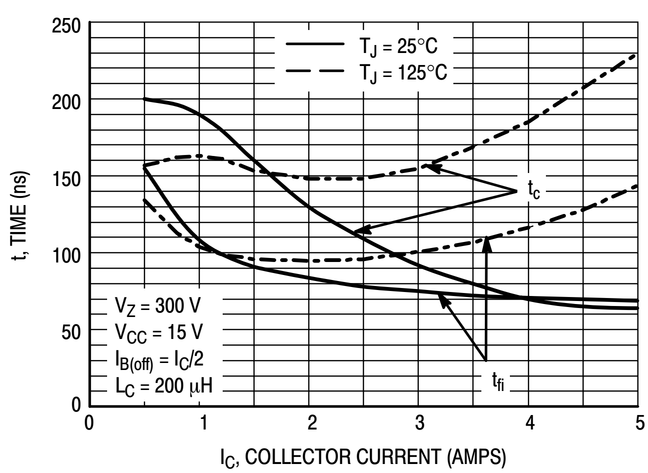


Figure 12. Inductive Switching, t_c and t_{fi}, $I_C/I_B = 10$

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

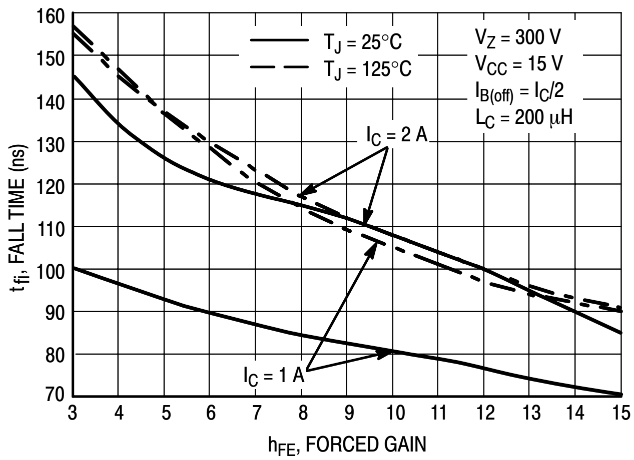


Figure 13. Inductive Fall Time

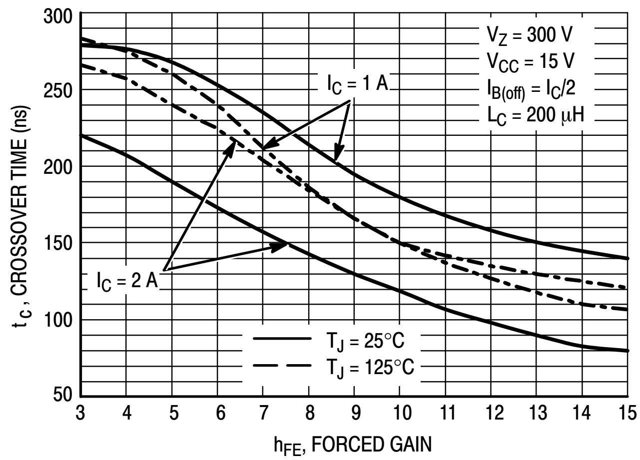


Figure 14. Inductive Crossover Time

GUARANTEED SAFE OPERATING AREA INFORMATION

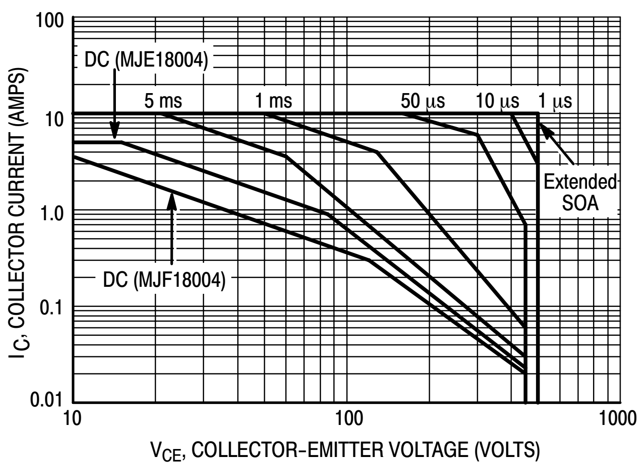


Figure 15. Forward Bias Safe Operating Area

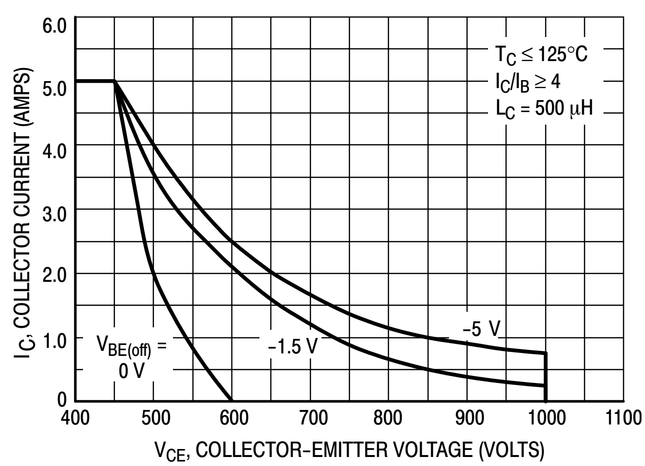


Figure 16. Reverse Bias Safe Operating Area

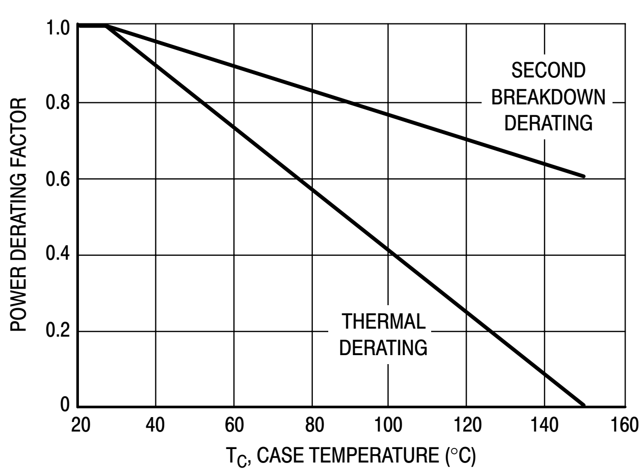


Figure 17. Forward Bias Power Derating

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 $T_C \geq$ 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 21. 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.

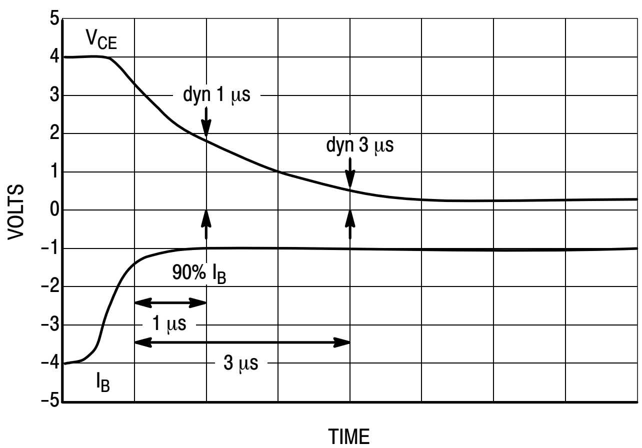


Figure 18. Dynamic Saturation Voltage Measurements

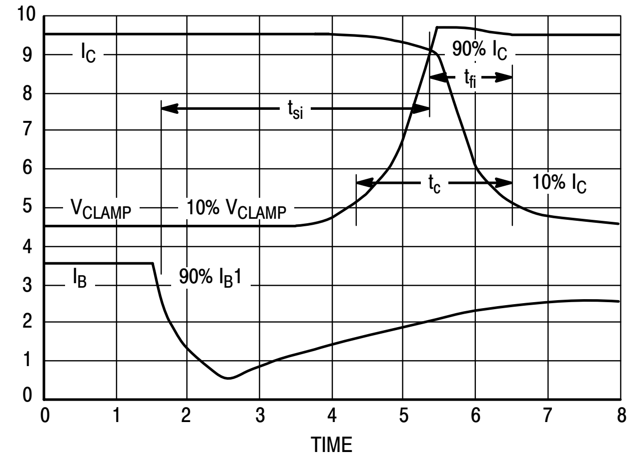
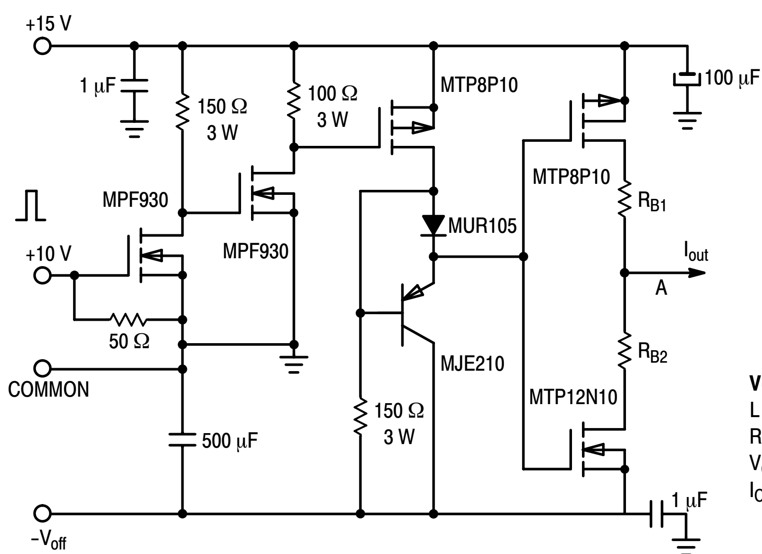
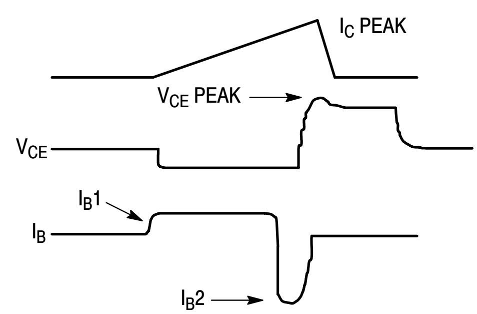


Figure 19. Inductive Switching Measurements





V(BR)CEO(sus)	INDUCTIVE SWITCHING	RBSOA
L = 10 mH	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

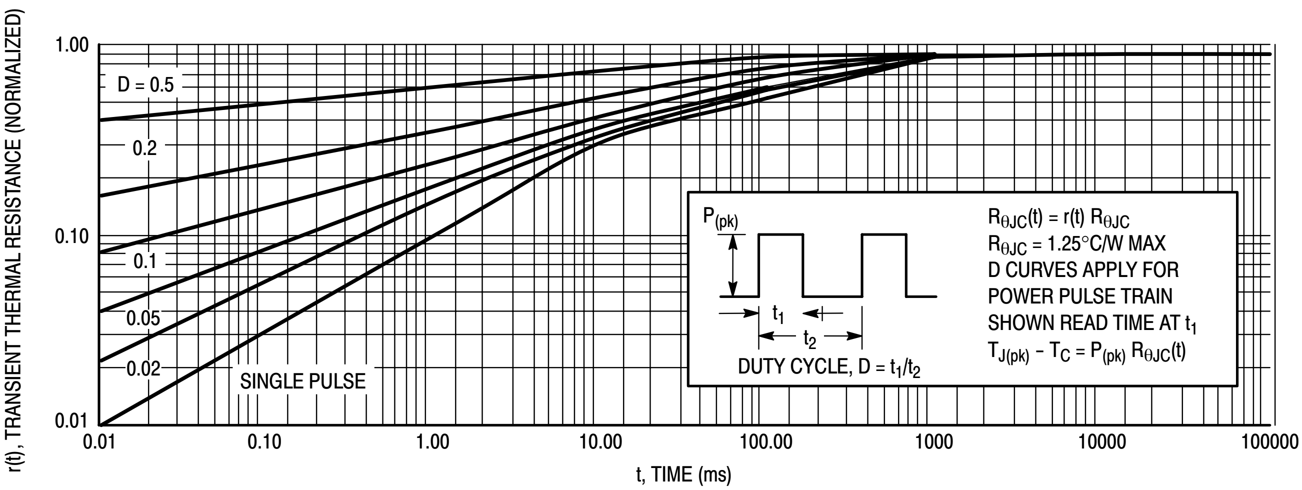


Figure 20. Typical Thermal Response ($Z_{\theta JC(t)}$) for MJE18004

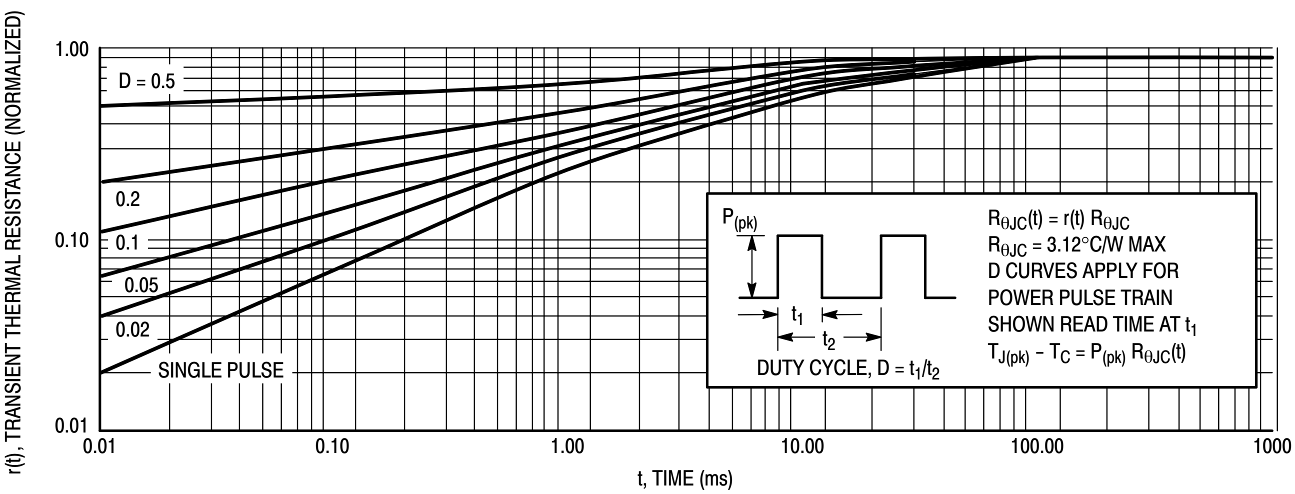


Figure 21. Typical Thermal Response for MJF18004

ORDERING INFORMATION

Device	Package	Shipping
MJE18004	TO−220AB	50 Units / Rail
MJE18004G	TO−220AB (Pb−Free)	50 Units / Rail
MJF18004	TO−220 (Fullpack)	50 Units / Rail
MJF18004G	TO−220 (Fullpack) (Pb−Free)	50 Units / Rail

TEST CONDITIONS FOR ISOLATION TESTS*

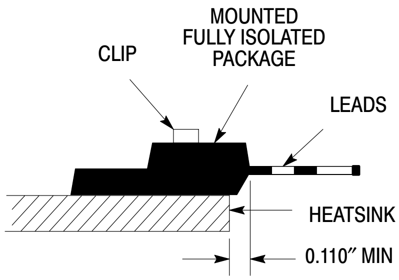


Figure 22a. Screw or Clip Mounting Position for Isolation Test Number 1

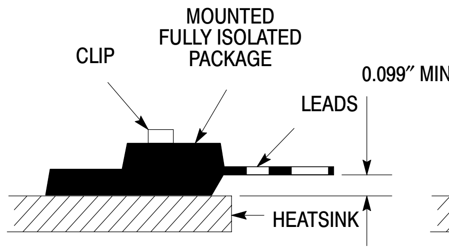


Figure 22b. Clip Mounting Position for Isolation Test Number 2

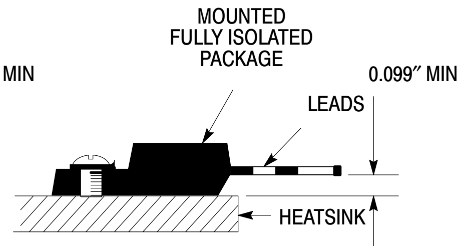


Figure 22c. Screw Mounting Position for Isolation Test Number 3

*Measurement made between leads and heatsink with all leads shorted together

MOUNTING INFORMATION**

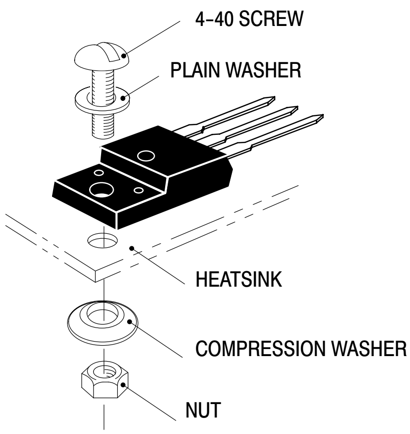


Figure 23a. Screw−Mounted

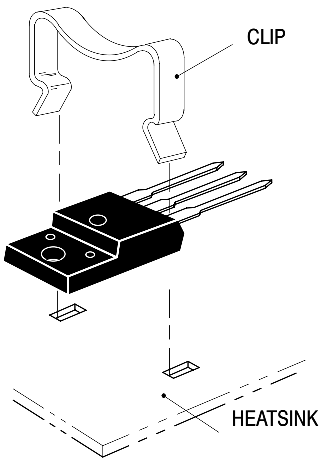


Figure 23b. Clip−Mounted

Figure 23. Typical Mounting Techniques for Isolated Package

Laboratory tests on a limited number of samples indicate, when using the screw and compression washer mounting technique, a screw torque of 6 to 8 in · lbs is sufficient to provide maximum power dissipation capability. The compression washer helps to maintain a constant pressure on the package over time and during large temperature excursions.

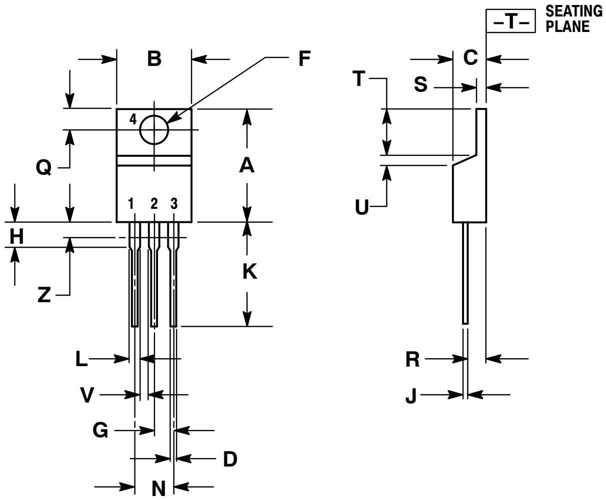
Destructive laboratory tests show that using a hex head 4−40 screw, without washers, and applying a torque in excess of 20 in · lbs will cause the plastic to crack around the mounting hole, resulting in a loss of isolation capability.

Additional tests on slotted 4−40 screws indicate that the screw slot fails between 15 to 20 in · lbs without adversely affecting the package. However, in order to positively ensure the package integrity of the fully isolated device, ON Semiconductor does not recommend exceeding 10 in · lbs of mounting torque under any mounting conditions.

** For more information about mounting power semiconductors see Application Note AN1040.

PACKAGE DIMENSIONS

TO−220AB
CASE 221A−09
ISSUE AA

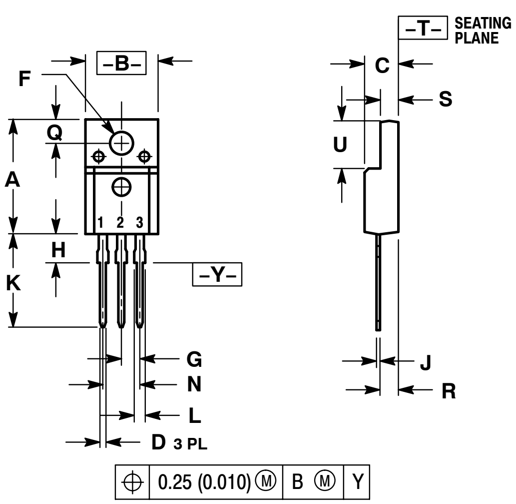


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

	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

TO−220 FULLPAK
CASE 221D−03
ISSUE G



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.625	0.635	15.88	16.12
B	0.408	0.418	10.37	10.63
C	0.180	0.190	4.57	4.83
D	0.026	0.031	0.65	0.78
F	0.116	0.119	2.95	3.02
G	0.100 BSC		2.54 BSC	
H	0.125	0.135	3.18	3.43
J	0.018	0.025	0.45	0.63
K	0.530	0.540	13.47	13.73
L	0.048	0.053	1.23	1.36
N	0.200 BSC		5.08 BSC	
Q	0.124	0.128	3.15	3.25
R	0.099	0.103	2.51	2.62
S	0.101	0.113	2.57	2.87
U	0.238	0.258	6.06	6.56

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

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