

SWITCHMODE™

NPN Bipolar Power Transistor For Switching Power Supply Applications

The MJE18006 has an applications specific state-of-the-art die designed for use in 220 V line-operated SWITCHMODE Power supplies and electronic light ballasts. This high voltage/high speed transistor offers 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

MAXIMUM RATINGS

| Rating | Symbol | MJE18006 | 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 | I_C | 6.0 | Adc |
| — Peak(1) | I_{CM} | 15 | |
| Base Current — Continuous | I_B | 4.0 | Adc |
| — Peak(1) | I_{BM} | 8.0 | |
| Total Device Dissipation (T _C = 25°C) Derate above 25°C | P_D | 100 0.8 | Watts W/°C |
| Operating and Storage Temperature | T _J , T _{stg} | -65 to 150 | °C |

THERMAL CHARACTERISTICS

| Rating | Symbol | MJE18006 | Unit |
|--|-----------------|----------|------|
| Thermal Resistance — Junction to Case | $R_{\theta JC}$ | 1.25 | °C/W |
| — Junction to Ambient | $R_{\theta JA}$ | 62.5 | |
| Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds | T _L | 260 | °C |

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) | I_{CES} | — | — | 100 | μAdc |
| (V _{CE} = 800 V, V _{EB} = 0) | | — | — | 500 | |
| (T _C = 125°C) | | — | — | 100 | |
| (T _C = 125°C) | | — | — | 100 | |
| Emitter Cutoff Current (V _{EB} = 9.0 Vdc, I _C = 0) | I_{EBO} | — | — | 100 | μAdc |

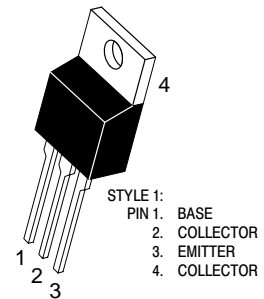
- (1) Pulse Test: Pulse Width = 5.0 ms, Duty Cycle ≤ 10%.
 (2) Proper strike and creepage distance must be provided.

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

MJE18006*

*ON Semiconductor Preferred Device

POWER TRANSISTOR
6.0 AMPERES
1000 VOLTS
100 WATTS



CASE 221A-09
TO-220AB

MJE18006

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise specified)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|---------------|-----------------------------------|----------------------------------|-----------------------------|------|
| ON CHARACTERISTICS | | | | | |
| Base–Emitter Saturation Voltage ($I_C = 1.3 \text{ Adc}$, $I_B = 0.13 \text{ Adc}$) ($I_C = 3.0 \text{ Adc}$, $I_B = 0.6 \text{ Adc}$) | $V_{BE(sat)}$ | — — | 0.83 0.94 | 1.2 1.3 | Vdc |
| Collector–Emitter Saturation Voltage ($I_C = 1.3 \text{ Adc}$, $I_B = 0.13 \text{ Adc}$) ($T_C = 125^\circ\text{C}$) ($I_C = 3.0 \text{ Adc}$, $I_B = 0.6 \text{ Adc}$) ($T_C = 125^\circ\text{C}$) | $V_{CE(sat)}$ | — — — — | 0.25 0.27 0.35 0.4 | 0.6 0.65 0.7 0.8 | Vdc |
| DC Current Gain ($I_C = 0.5 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 3.0 \text{ Adc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 1.3 \text{ Adc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$) | h_{FE} | 14 — 6.0 5.0 11 10 | — 32 10 8.0 17 22 | 34 — — — — — | — |

DYNAMIC CHARACTERISTICS

| | | | | | | | | |
|--|----------------|---|--|--|--------------------------------------|--|--------------------------------------|-------|
| Current Gain Bandwidth ($I_C = 0.5 \text{ Adc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ MHz}$) | f_T | — | 14 | — | MHz | | | |
| Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$) | C_{ob} | — | 75 | 120 | pF | | | |
| Input Capacitance ($V_{EB} = 8.0 \text{ V}$) | C_{ib} | — | 1000 | 1500 | 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) | $V_{CE(dsat)}$ | $(I_C = 1.3 \text{ Adc}$ $I_{B1} = 130 \text{ mAdc}$ $V_{CC} = 300 \text{ V}$) $(I_C = 3.0 \text{ Adc}$ $I_{B1} = 0.6 \text{ Adc}$ $V_{CC} = 300 \text{ V}$) | 1.0 μs 3.0 μs 1.0 μs 3.0 μs | $(T_C = 125^\circ\text{C})$ $(T_C = 125^\circ\text{C})$ $(T_C = 125^\circ\text{C})$ $(T_C = 125^\circ\text{C})$ | — — — — — — — — | 5.5 12 3.0 7.0 9.5 14.5 2.0 7.5 | — — — — — — — — | Volts |

SWITCHING CHARACTERISTICS: Resistive Load ($D.C. \leq 10\%$, Pulse Width = 20 μs)

| | | | | | | |
|---------------|---|-----------|--------|------------|----------|---------------|
| Turn–On Time | $(I_C = 3.0 \text{ Adc}$, $I_{B1} = 0.6 \text{ Adc}$, $I_{B2} = 1.5 \text{ Adc}$, $V_{CC} = 300 \text{ V}$) $(T_C = 125^\circ\text{C})$ | t_{on} | — — | 90 100 | 180 — | ns |
| Turn–Off Time | | t_{off} | — — | 1.7 2.1 | 2.5 — | μs |
| Turn–On Time | $(I_C = 1.3 \text{ Adc}$, $I_{B1} = 0.13 \text{ Adc}$, $I_{B2} = 0.65 \text{ Adc}$, $V_{CC} = 300 \text{ V}$) $(T_C = 125^\circ\text{C})$ | t_{on} | — — | 200 130 | 300 — | ns |
| Turn–Off Time | | t_{off} | — — | 1.2 1.5 | 2.5 — | μs |

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

| | | | | | | |
|----------------|--|----------|--------|--------------|----------|---------------|
| Fall Time | $(I_C = 1.5 \text{ Adc}$, $I_{B1} = 0.13 \text{ Adc}$, $I_{B2} = 0.65 \text{ Adc}$) $(T_C = 125^\circ\text{C})$ | t_{fi} | — — | 100 120 | 180 — | ns |
| Storage Time | | t_{si} | — — | 1.5 1.9 | 2.5 — | μs |
| Crossover Time | | t_c | — — | 220 230 | 350 — | ns |
| Fall Time | $(I_C = 3.0 \text{ Adc}$, $I_{B1} = 0.6 \text{ Adc}$, $I_{B2} = 1.5 \text{ Adc}$) $(T_C = 125^\circ\text{C})$ | t_{fi} | — — | 85 120 | 150 — | ns |
| Storage Time | | t_{si} | — — | 2.15 2.75 | 3.2 — | μs |
| Crossover Time | | t_c | — — | 200 310 | 300 — | ns |

TYPICAL STATIC CHARACTERISTICS

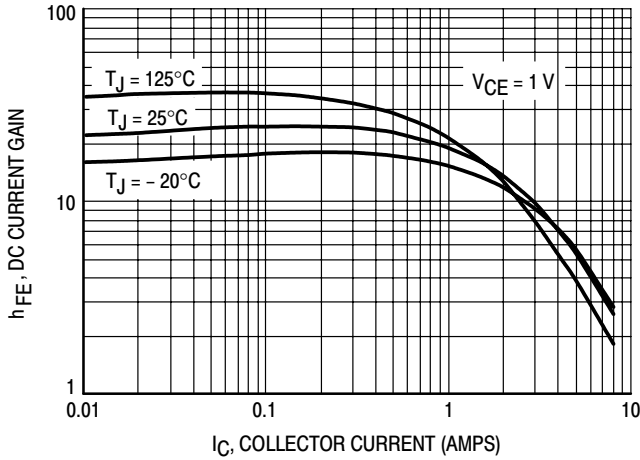


Figure 1. DC Current Gain @ 1 Volt

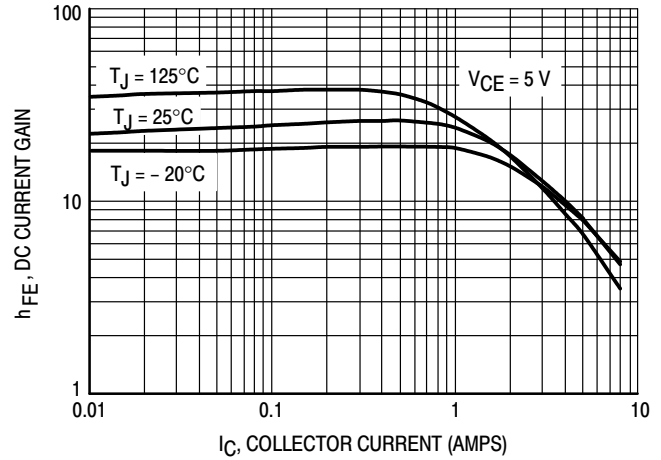


Figure 2. DC Current Gain @ 5 Volts

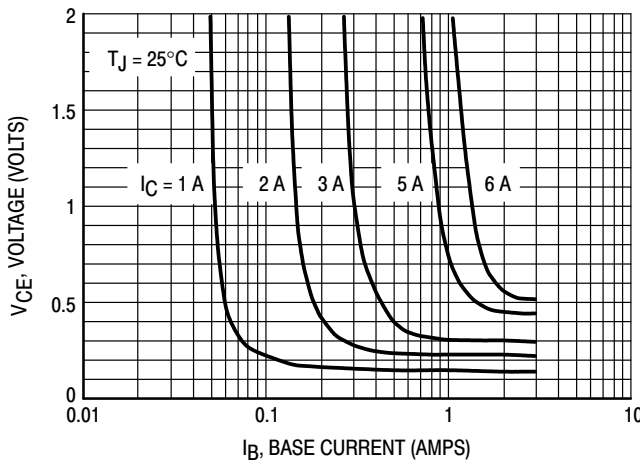


Figure 3. Collector Saturation Region

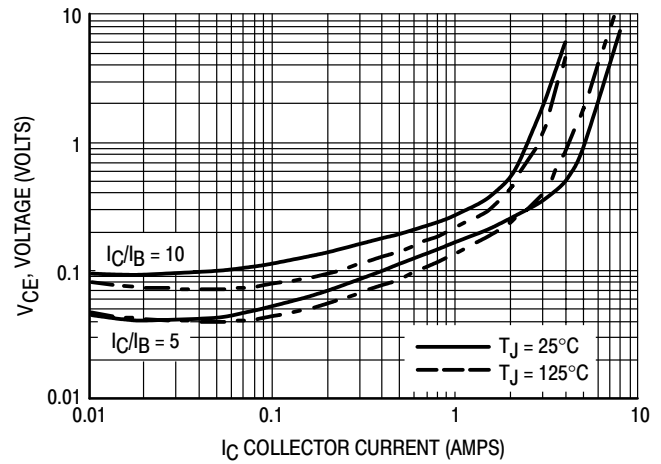


Figure 4. Collector-Emitter Saturation Voltage

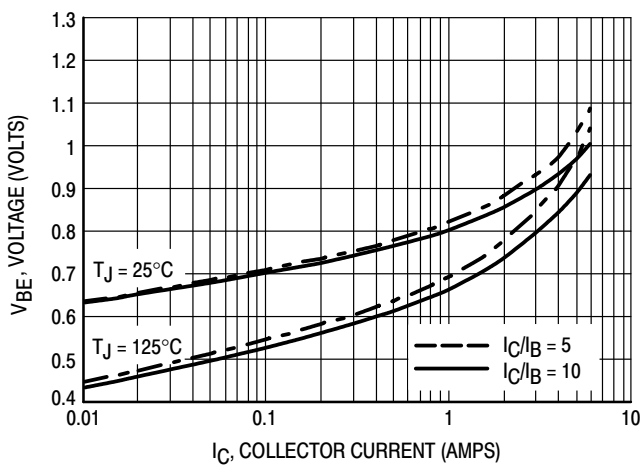


Figure 5. Base-Emitter Saturation Region

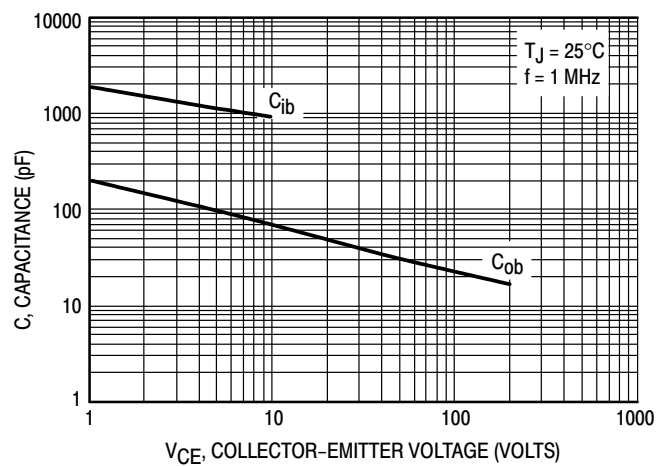


Figure 6. Capacitance

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

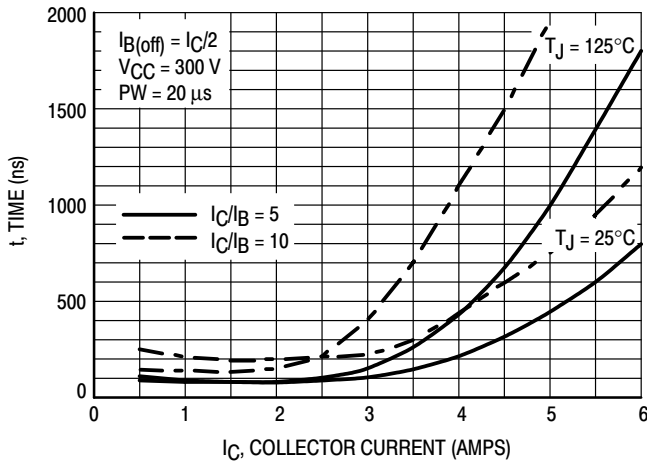


Figure 7. Resistive Switching, t_{on}

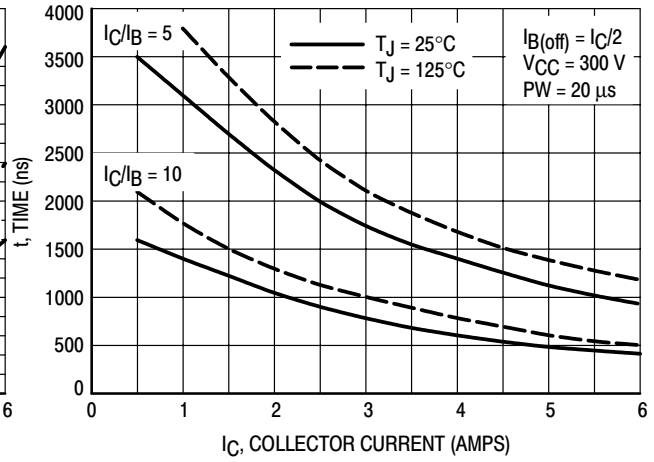


Figure 8. Resistive Switching, t_{off}

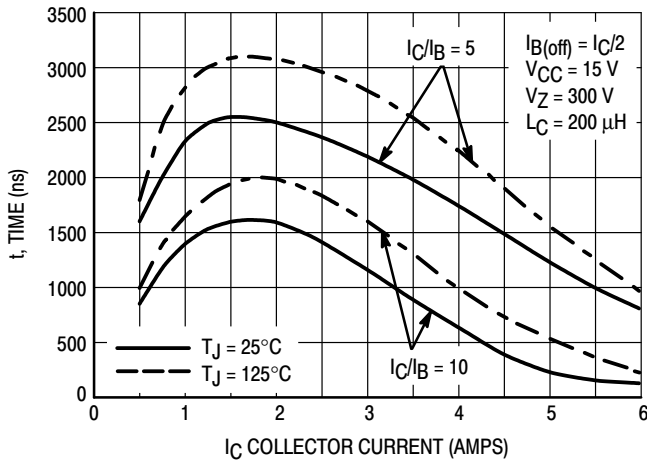


Figure 9. Inductive Storage Time, t_{si}

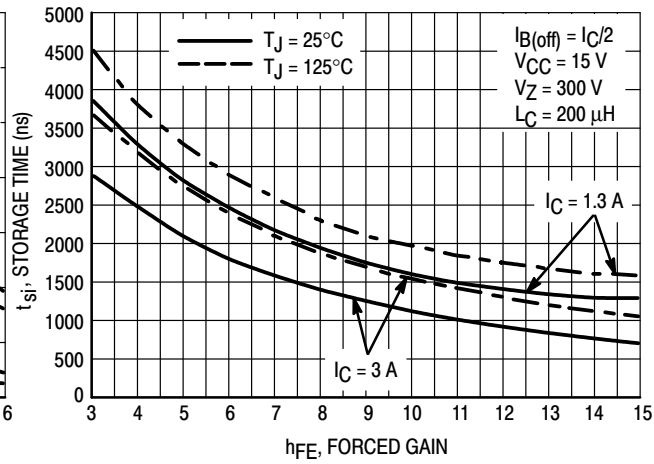


Figure 10. Inductive Storage Time, $t_{si}(h_{FE})$

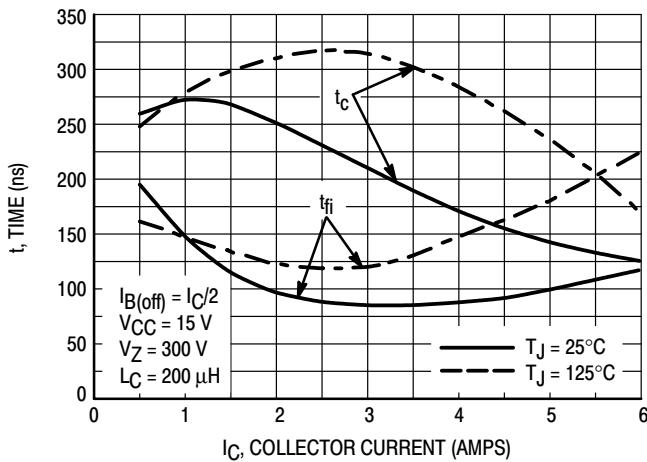


Figure 11. Inductive Switching, t_c and t_{fi}
 $I_C/I_B = 5$

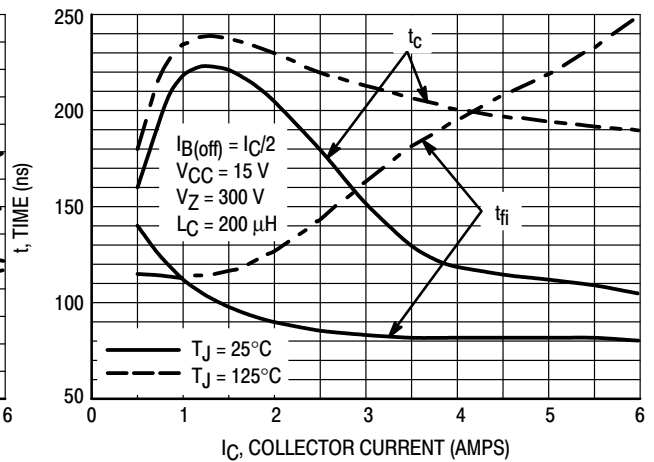


Figure 12. Inductive Switching, t_c and t_{fi}
 $I_C/I_B = 10$

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

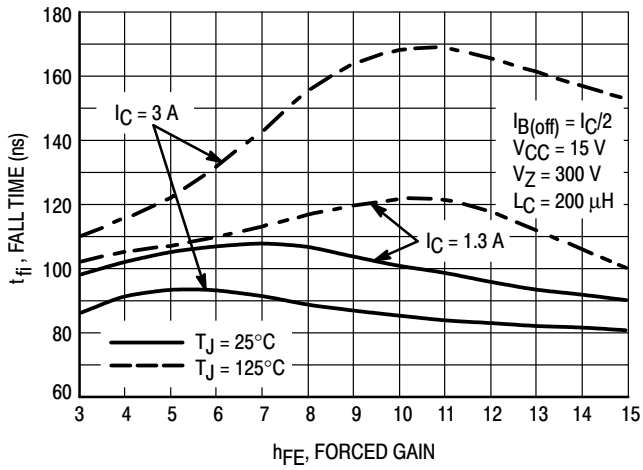


Figure 13. Inductive Fall Time

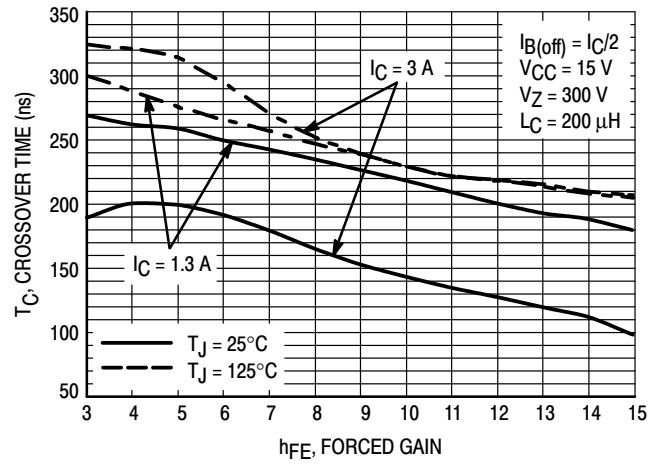


Figure 14. Inductive Crossover Time

GUARANTEED SAFE OPERATING AREA INFORMATION

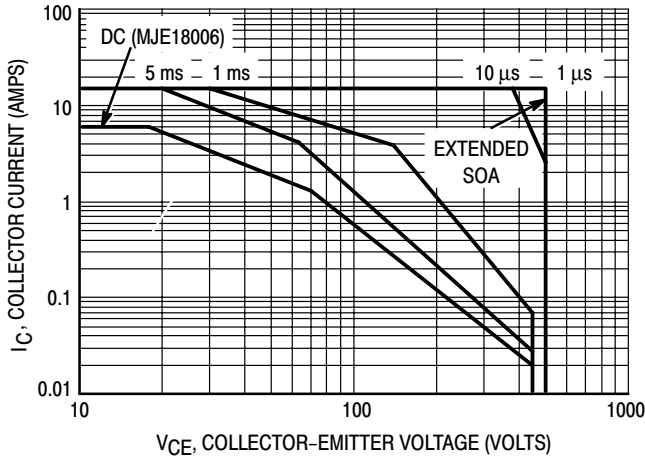


Figure 15. Forward Bias Safe Operating Area

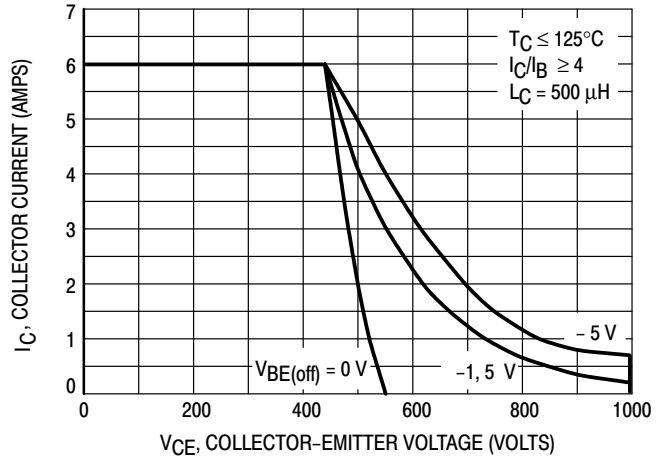


Figure 16. Reverse Bias Switching Safe Operating Area

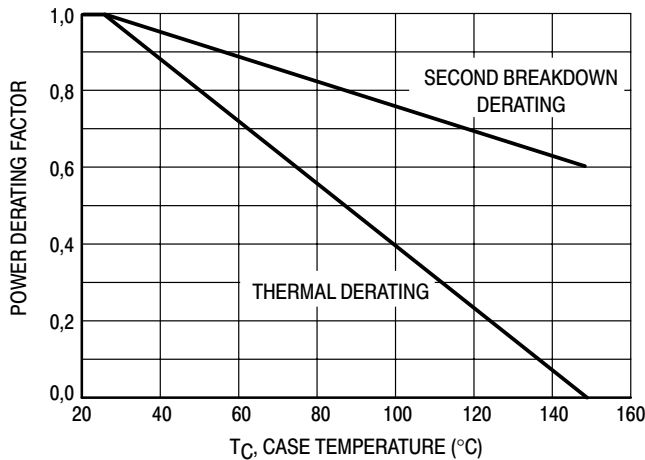


Figure 17. Forward Bias Power Derating

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 $T_C = 25^\circ\text{C}$; $T_{J(pk)}$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when $T_C \geq 25^\circ\text{C}$. Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown in 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 Figure 20. At any case temperatures, thermal limitations will reduce the power that can be handled to values less than 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.

MJE18006

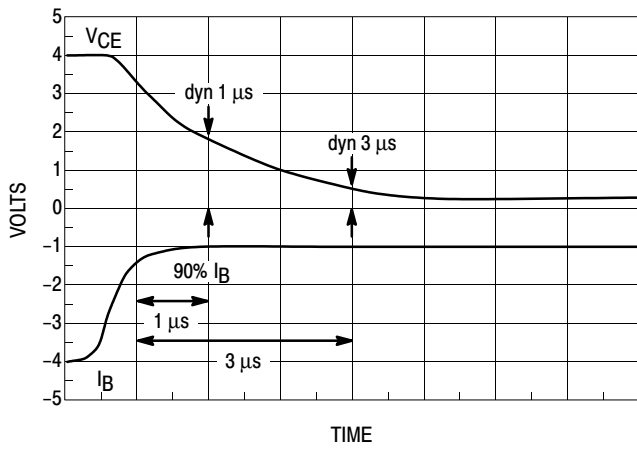


Figure 18. Dynamic Saturation Voltage Measurements

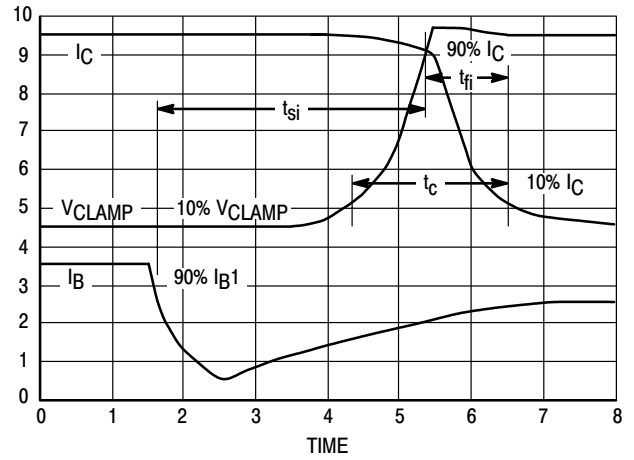
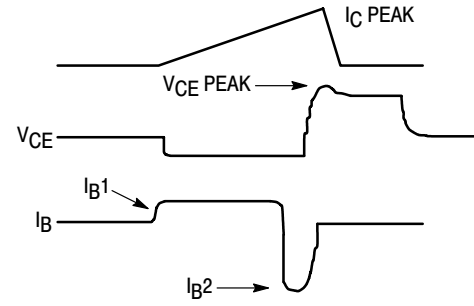
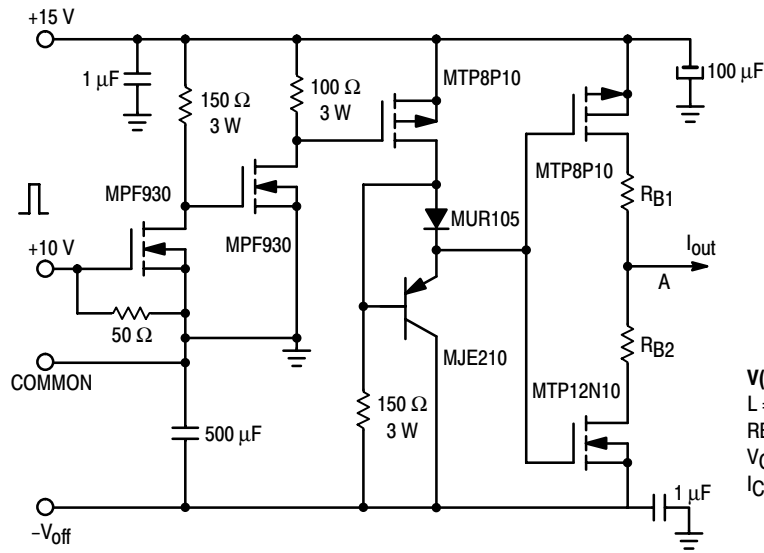


Figure 19. Inductive Switching Measurements



| V(BR)CEO(sus) | INDUCTIVE SWITCHING | RBSOA |
|-----------------|------------------------------|------------------------------|
| L = 10 mH | L = 200 μH | L = 500 μH |
| RB2 = ∞ | RB2 = 0 | RB2 = 0 |
| VCC = 20 VOLTS | VCC = 15 VOLTS | VCC = 15 VOLTS |
| IC(pk) = 100 mA | RB1 SELECTED FOR DESIRED IB1 | RB1 SELECTED FOR DESIRED IB1 |

Table 1. Inductive Load Switching Drive Circuit

TYPICAL THERMAL RESPONSE

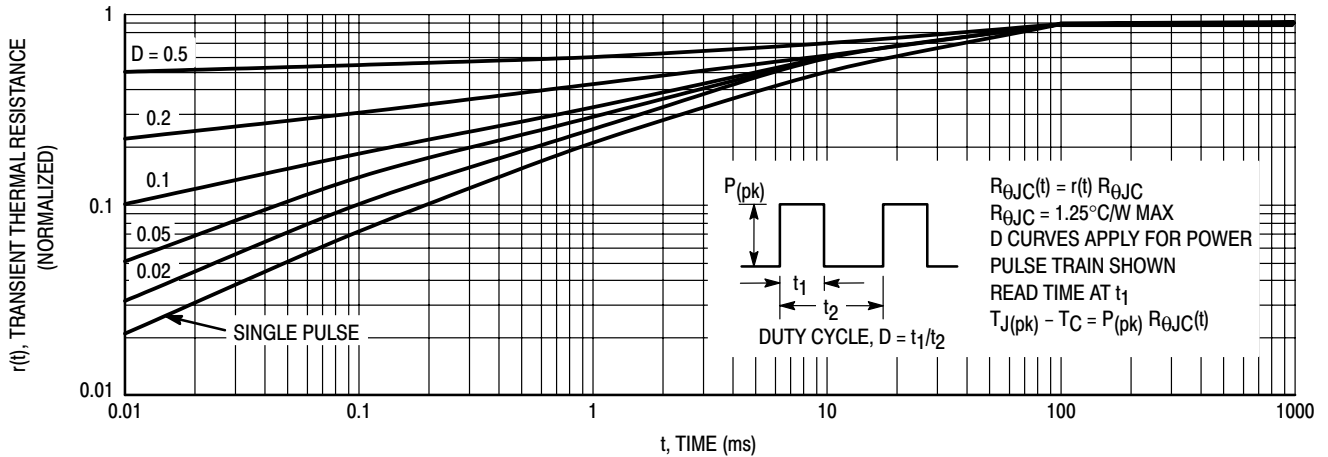
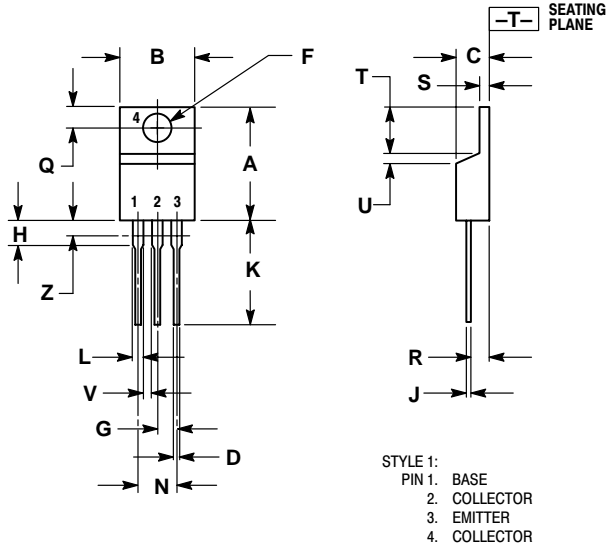


Figure 20. Typical Thermal Response ($Z_{\theta JC}(t)$) for MJE18006

MJE18006

PACKAGE DIMENSIONS

TO-220AB
CASE 221A-09
ISSUE AA




NOTES:

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