

1. General description

High voltage, high speed, planar passivated NPN power switching transistor in a SOT186A (TO220F) "full pack" plastic package.

2. Features and benefits

- Fast switching
- Isolated package
- Very high voltage capability
- Very low switching and conduction losses

3. Applications

- DC-to-DC converters
- High frequency electronic lighting ballasts
- Inverters
- Motor control systems

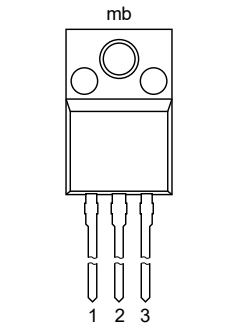
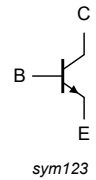
4. Quick reference data

Table 1. Quick reference data

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|--------------------------------|---|-----|-----|------|------|
| I_{CM} | peak collector current | Fig. 1 ; Fig. 2 ; Fig. 3 | - | - | 10 | A |
| P_{tot} | total power dissipation | $T_h \leq 25\text{ °C}$; Fig. 4 | - | - | 32 | W |
| V_{CESM} | collector-emitter peak voltage | $V_{BE} = 0\text{ V}$ | - | - | 1000 | V |
| Static characteristics | | | | | | |
| h_{FE} | DC current gain | $I_C = 5\text{ mA}$; $V_{CE} = 5\text{ V}$; $T_h = 25\text{ °C}$; Fig. 11 | 10 | 22 | 35 | |
| | | $I_C = 500\text{ mA}$; $V_{CE} = 5\text{ V}$; $T_h = 25\text{ °C}$; Fig. 11 | 14 | 25 | 35 | |

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-------------------------|--|---|
| 1 | B | base |  <p>mb</p> <p>TO-220F (SOT186A)</p> |  <p>sym123</p> |
| 2 | C | collector | | |
| 3 | E | emitter | | |
| mb | n.c. | mounting base; isolated | | |

6. Ordering information

Table 3. Ordering information

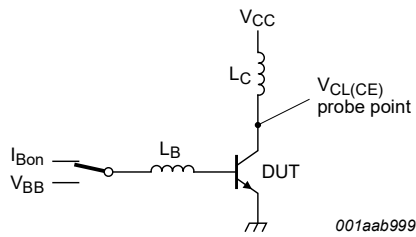
| Type number | Package | | |
|-------------|---------|---|---------|
| | Name | Description | Version |
| BUJ303AX | TO-220F | plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack" | SOT186A |

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|------------|--------------------------------|--|-----|------|------|
| V_{CESM} | collector-emitter peak voltage | $V_{BE} = 0\text{ V}$ | - | 1000 | V |
| V_{CEO} | collector-emitter voltage | $I_B = 0\text{ A}$ | - | 500 | V |
| I_C | collector current | Fig. 1 ; Fig. 2 ; Fig. 3 | - | 5 | A |
| I_{CM} | peak collector current | | - | 10 | A |
| I_B | base current | DC | - | 2 | A |
| I_{BM} | peak base current | | - | 4 | A |
| P_{tot} | total power dissipation | $T_h \leq 25\text{ °C}$; Fig. 4 | - | 32 | W |
| T_{stg} | storage temperature | | -65 | 150 | °C |
| T_j | junction temperature | | - | 150 | °C |



$V_{CL(CE)} \leq 1000\text{ V}$; $V_{CC} = 150\text{ V}$; $V_{BB} = -5\text{ V}$;
 $L_B = 1\text{ }\mu\text{H}$; $L_C = 200\text{ }\mu\text{H}$

Fig. 1. Test circuit for reverse bias safe operating area

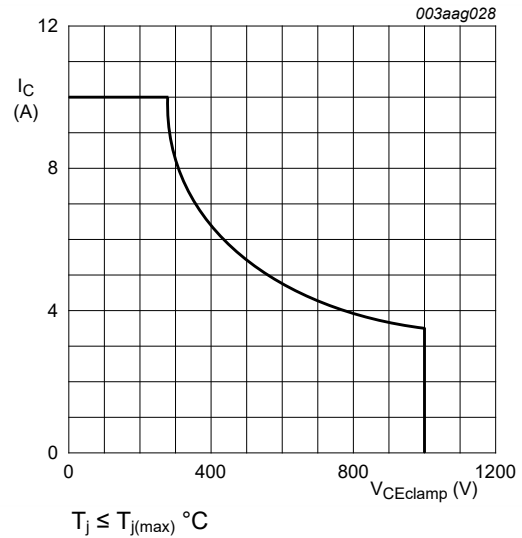
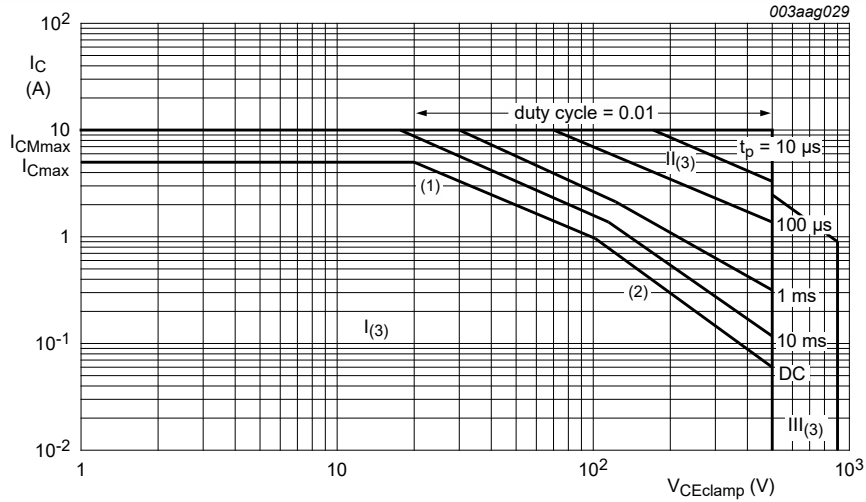


Fig. 2. Reverse bias safe operating area



- (1) P_{tot} maximum and P_{tot} peak maximum lines.
- (2) Second breakdown limits.
- (3) I = Region of permissible DC operation.
 II = Extension for repetitive pulse operation.
 III = Extension during turn-on in single transistor converters provided that $R_{BE} \leq 100 \Omega$ and $t_p \leq 0.6 \mu s$.

Fig. 3. Forward bias safe operating area for $T_{mb} \leq 25 \text{ }^\circ\text{C}$

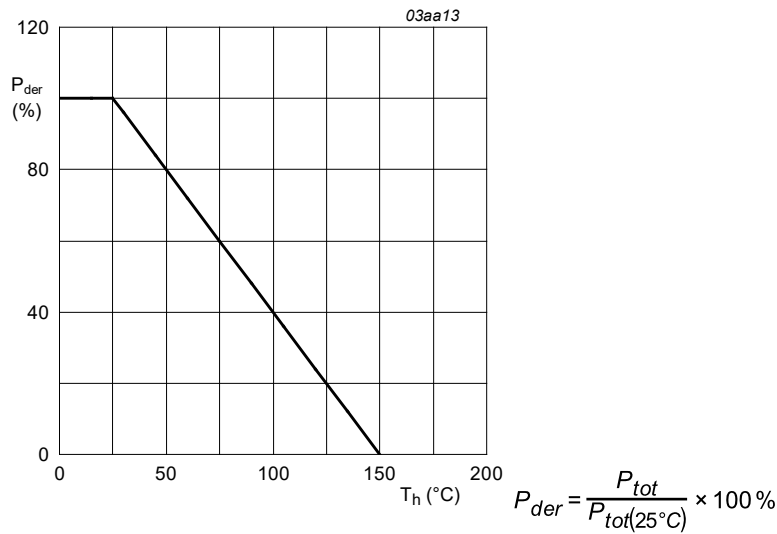


Fig. 4. Normalized total power dissipation as a function of heatsink temperature

8. Thermal characteristics

Table 5. Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------|--|--|-----|-----|------|------|
| $R_{th(j-h)}$ | thermal resistance from junction to heatsink | with heatsink compound; Fig. 5 | - | - | 3.95 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient free air | in free air | - | 55 | - | K/W |

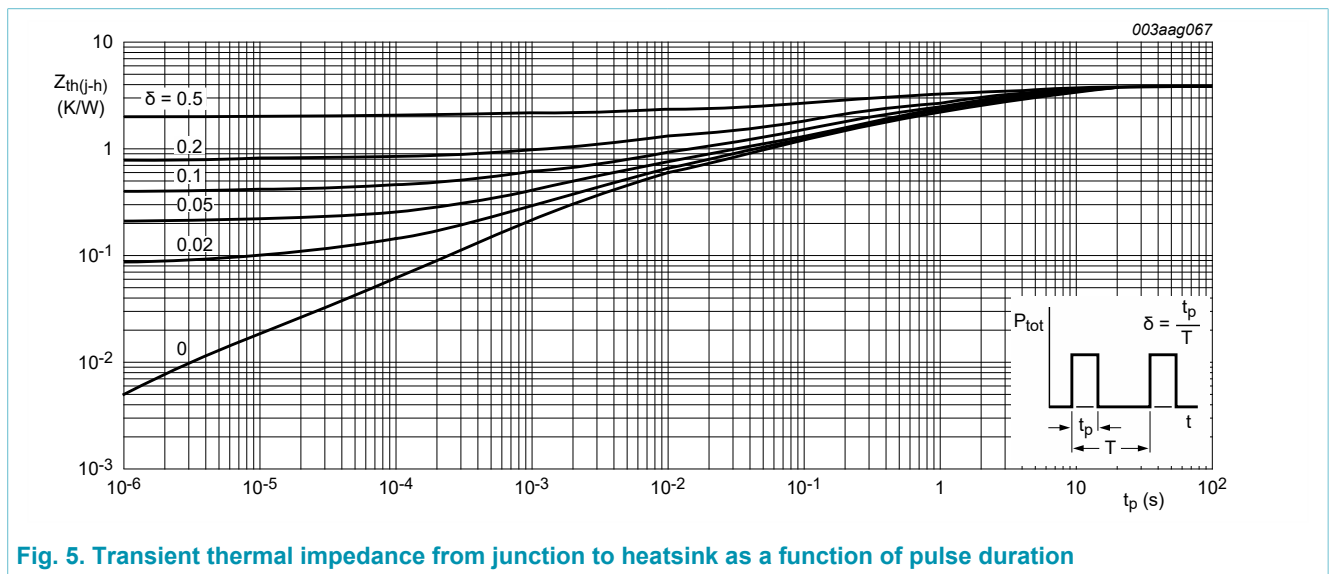


Fig. 5. Transient thermal impedance from junction to heatsink as a function of pulse duration

9. Isolation characteristics

Table 6. Isolation characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------|-----------------------|--|-----|-----|------|------|
| $V_{isol(RMS)}$ | RMS isolation voltage | $50 \text{ Hz} \leq f \leq 60 \text{ Hz}$; $RH \leq 65 \%$; $T_h = 25 \text{ }^\circ\text{C}$; from all terminals to external heatsink; clean and dust free | - | - | 2500 | V |
| C_{isol} | isolation capacitance | from collector to external heatsink; $f = 1 \text{ MHz}$; $T_h = 25 \text{ }^\circ\text{C}$ | - | 10 | - | pF |

10. Characteristics

Table 7. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|--|--|-----|------|------|---------------|
| Static characteristics | | | | | | |
| I_{CES} | collector-emitter cut-off current (base shorted) | $V_{BE} = 0\text{ V}$; $V_{CE} = 1000\text{ V}$; Measured with half-sine wave voltage (curve tracer) | - | - | 1 | mA |
| | | | - | - | 2 | mA |
| I_{CBO} | collector-base cut-off current (emitter open) | $V_{CB} = 1000\text{ V}$; $I_E = 0\text{ A}$; $T_h = 25\text{ °C}$; Measured with half-sine wave voltage (curve tracer) | - | - | 1 | mA |
| I_{CEO} | collector-emitter cut-off current (base open) | $V_{CE} = 500\text{ V}$; $I_B = 0\text{ A}$; $T_h = 25\text{ °C}$; Measured with half-sine wave voltage (curve tracer) | - | - | 0.1 | mA |
| I_{EBO} | emitter-base cut-off current (collector open) | $V_{EB} = 9\text{ V}$; $I_C = 0\text{ A}$; $T_h = 25\text{ °C}$ | - | - | 0.1 | mA |
| V_{CEOsus} | collector-emitter sustaining voltage (base open) | $I_B = 0\text{ A}$; $I_C = 100\text{ mA}$; $L_C = 25\text{ mH}$; $T_h = 25\text{ °C}$; Fig. 6 ; Fig. 7 | 500 | - | - | V |
| V_{CEsat} | collector-emitter saturation voltage | $I_C = 3\text{ A}$; $I_B = 0.6\text{ A}$; $T_h = 25\text{ °C}$; Fig. 8 ; Fig. 9 | - | 0.35 | 1.5 | V |
| V_{BEsat} | base-emitter saturation voltage | $I_C = 3\text{ A}$; $I_B = 0.6\text{ A}$; $T_h = 25\text{ °C}$; Fig. 10 | - | 1.01 | 1.3 | V |
| h_{FE} | DC current gain | $I_C = 5\text{ mA}$; $V_{CE} = 5\text{ V}$; $T_h = 25\text{ °C}$; Fig. 11 | 10 | 22 | 35 | |
| | | $I_C = 500\text{ mA}$; $V_{CE} = 5\text{ V}$; $T_h = 25\text{ °C}$; Fig. 11 | 14 | 25 | 35 | |
| h_{FEsat} | DC saturation current gain | $I_C = 2.5\text{ A}$; $V_{CE} = 5\text{ V}$; $T_h = 25\text{ °C}$; Fig. 11 | 10 | 13.5 | 17 | |
| | | $I_C = 3\text{ A}$; $V_{CE} = 5\text{ V}$; $T_h = 25\text{ °C}$; Fig. 11 | - | 11 | - | |
| Dynamic characteristics (switching times - resistive load) | | | | | | |
| t_s | turn-off delay time | $I_C = 2.5\text{ A}$; $I_{B(on)} = 0.5\text{ A}$; $I_{B(off)} = -0.5\text{ A}$; $R_L = 75\text{ }\Omega$; $T_h = 25\text{ °C}$; Fig. 12 ; Fig. 13 | - | 3.3 | 4 | μs |
| t_f | fall time | | - | 0.33 | 0.45 | μs |
| Dynamic characteristics (switching times - inductive load) | | | | | | |
| t_s | turn-off delay time | $I_C = 2.5\text{ A}$; $I_{B(on)} = 0.5\text{ A}$; $V_{BB} = -5\text{ V}$; $L_B = 1\text{ }\mu\text{H}$; $T_h = 25\text{ °C}$; Fig. 14 ; Fig. 15 | - | 1.4 | 1.6 | μs |
| | | $I_C = 2.5\text{ A}$; $I_{B(on)} = 0.5\text{ A}$; $V_{BB} = -5\text{ V}$; $L_B = 1\text{ }\mu\text{H}$; $T_h = 100\text{ °C}$; Fig. 14 ; Fig. 15 | - | 1.7 | 1.9 | μs |
| t_r | rise time | $I_C = 2.5\text{ A}$; $I_{B(on)} = 0.5\text{ A}$; $V_{BB} = -5\text{ V}$; $L_B = 1\text{ }\mu\text{H}$; $T_h = 25\text{ °C}$; Fig. 14 ; Fig. 15 | - | 145 | 160 | ns |
| | | $I_C = 2.5\text{ A}$; $I_{B(on)} = 0.5\text{ A}$; $V_{BB} = -5\text{ V}$; $L_B = 1\text{ }\mu\text{H}$; $T_h = 100\text{ °C}$; Fig. 14 ; Fig. 15 | - | 160 | 200 | ns |

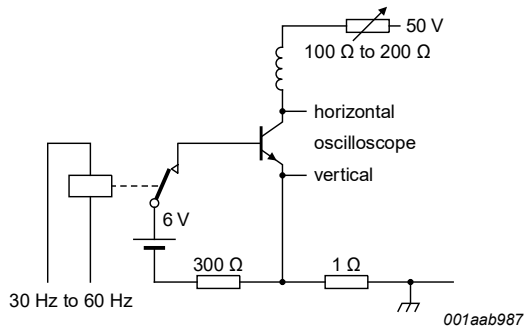


Fig. 6. Test circuit for collector-emitter sustaining voltage

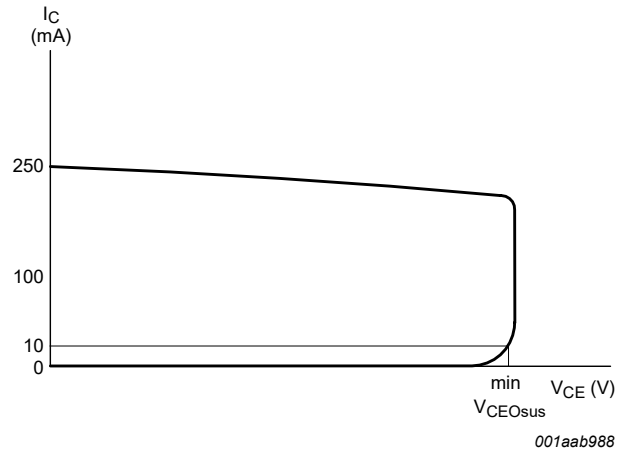


Fig. 7. Oscilloscope display for collector-emitter sustaining voltage test waveform

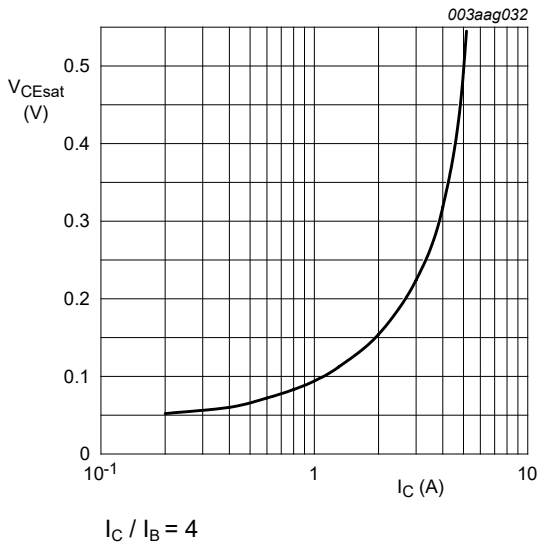


Fig. 8. Collector-emitter saturation voltage as a function of collector current; typical values

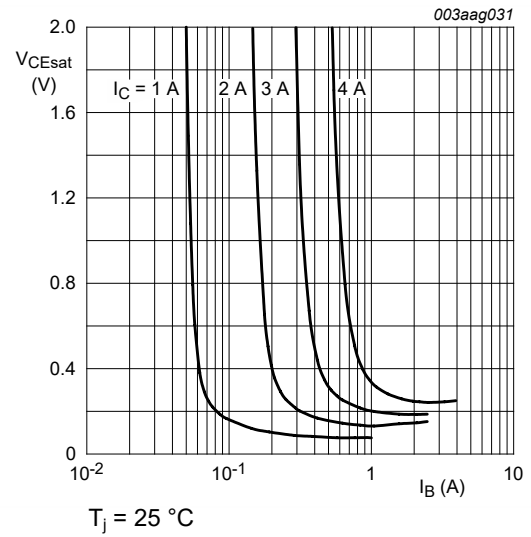


Fig. 9. Collector-emitter saturation voltage as a function of base current; typical values

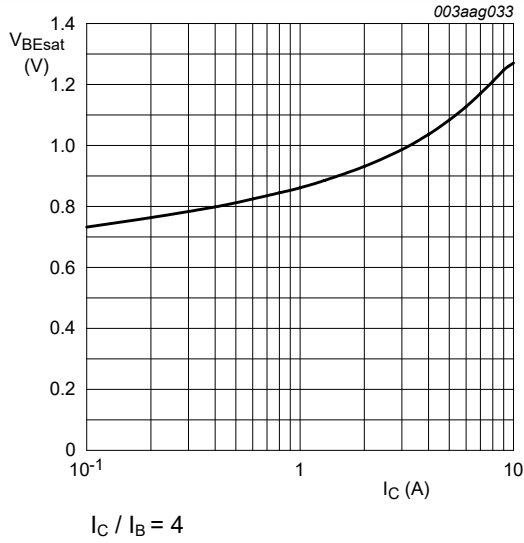


Fig. 10. Base-emitter saturation voltage as a function of collector current; typical values

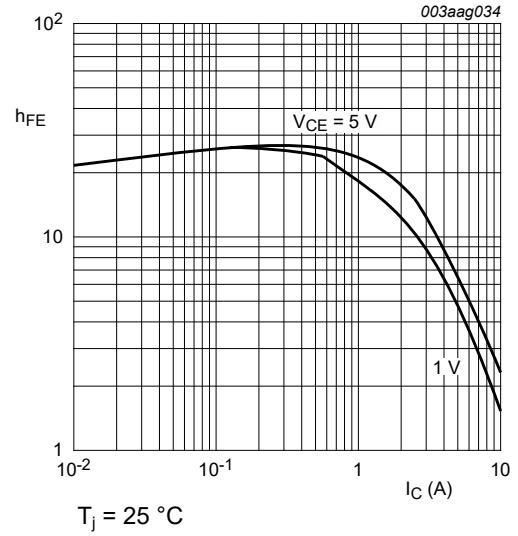
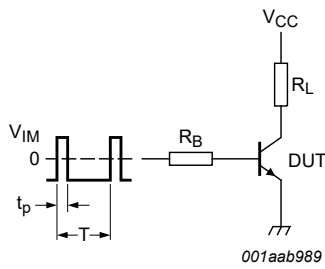


Fig. 11. DC current gain as a function of collector current; typical values



$V_{IM} = -6$ to 8 V ; $V_{CC} = 250\text{ V}$; $t_p = 20\text{ }\mu\text{s}$; $\delta = t_p/T = 0.01$
 R_B and R_L calculated from I_{Con} and I_{Bon} requirements.

Fig. 12. Test circuit for resistive load switching

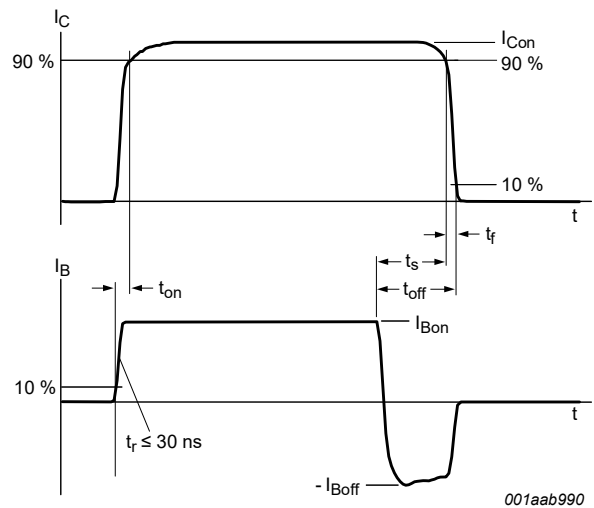
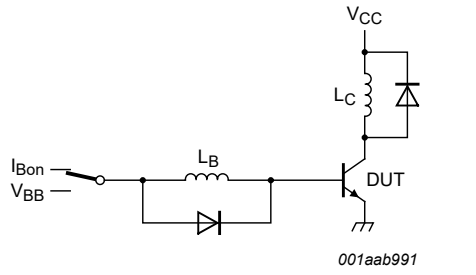


Fig. 13. Switching times waveforms for resistive load



$V_{CC} = 300\text{ V}; V_{BB} = -5\text{ V}; L_C = 200\ \mu\text{H}; L_B = 1\ \mu\text{H}$

Fig. 14. Test circuit for inductive load switching

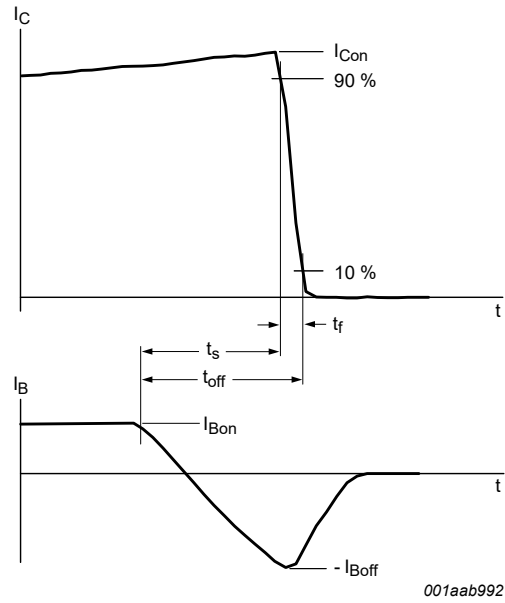


Fig. 15. Switching times waveforms for inductive load

11. Package outline

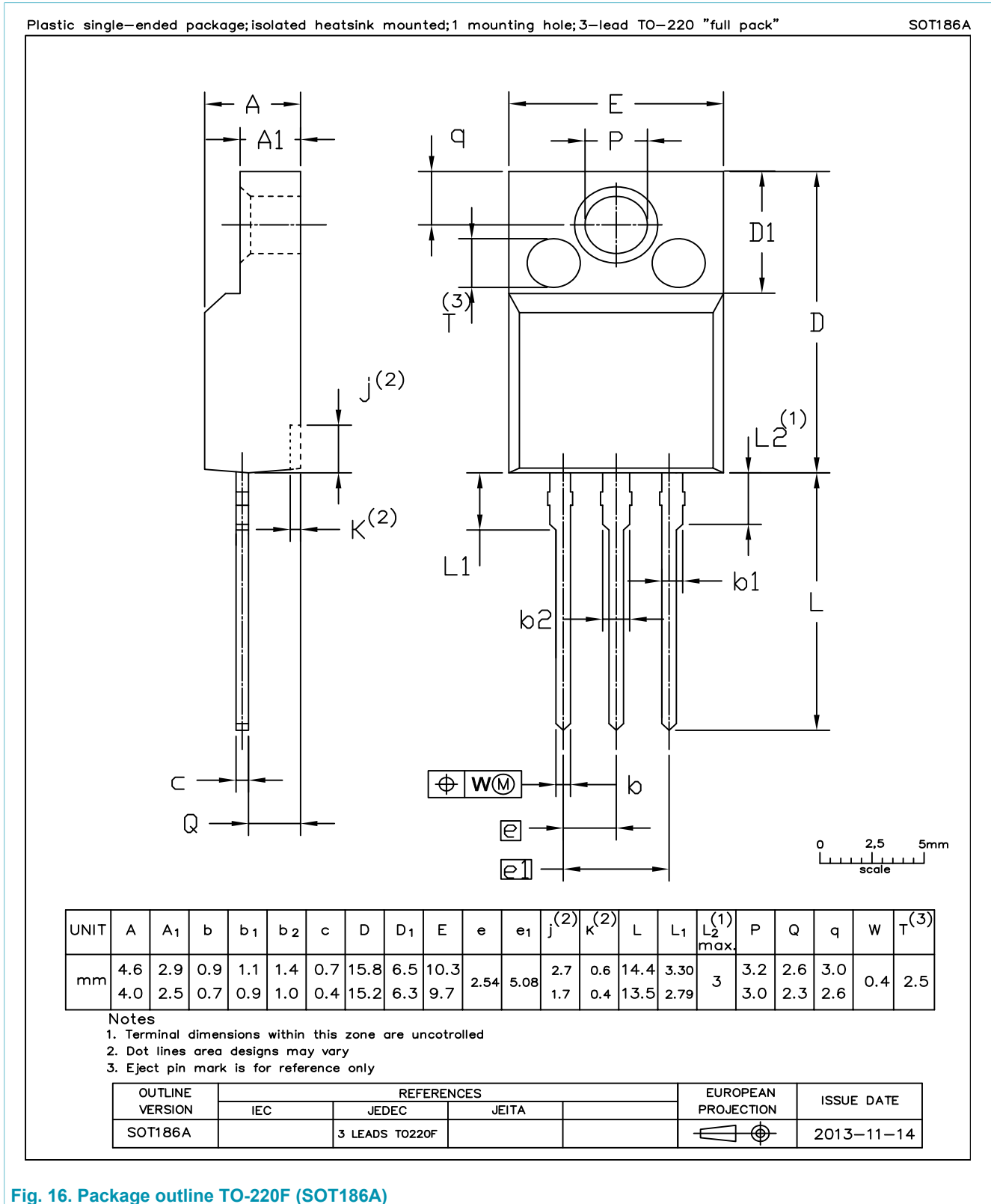


Fig. 16. Package outline TO-220F (SOT186A)

12. Legal information

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|--------------------------------|--------------------|---|
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