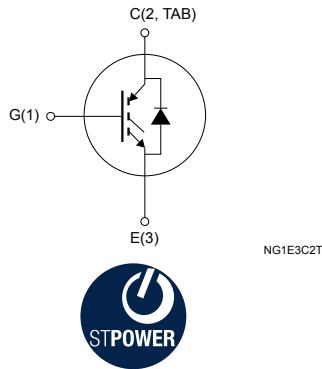
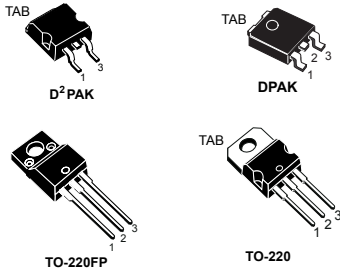


10 A, 600 V short-circuit rugged IGBT



NG1E3C2T

Features

- Lower on voltage drop ($V_{CE(sat)}$)
- Lower C_{res} / C_{ies} ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- Short-circuit withstand time 10 μ s

Applications

- High frequency motor controls
- SMPS and PFC in both hard switch and resonant topologies
- Motor drives

Description

These devices are very fast IGBTs developed using advanced PowerMESH technology. This process guarantees an excellent trade-off between switching performance and low on-state behavior. These devices are well-suited for resonant or soft-switching applications.

Product status links

[STGB10NC60KDT4](#)

[STGD10NC60KDT4](#)

[STGF10NC60KD](#)

[STGP10NC60KD](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|--------------------------------|---|-------------------------------|------|----------|------|
| | | D ² PAK, TO-220 | DPAK | TO-220FP | |
| V _{CES} | Collector-emitter voltage (V _{GE} = 0 V) | 600 | | | V |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 25 °C | 20 | | 9 | A |
| | Continuous collector current at T _C = 100 °C | 10 | | 6 | |
| I _{CL} ⁽²⁾ | Turn-off latching current | 30 | | | A |
| I _{CP} ⁽³⁾ | Pulsed collector current | 30 | | | A |
| V _{GE} | Gate-emitter voltage | ±20 | | | V |
| I _F | Diode RMS forward current at T _C = 25 °C | 10 | | | A |
| I _{FSM} | Surge non repetitive forward current t _p = 10 ms sinusoidal | 20 | | | A |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T _C = 25 °C) | | | 2.5 | kV |
| t _{scw} | Short-circuit withstand time V _{CE} = 0.5, V _{CES} , T _J = 125 °C, R _G = 10 Ω, V _{GE} = 12 V | 10 | | | μs |
| P _{TOT} | Total power dissipation at T _C = 25 °C | 65 | 62 | 25 | W |
| T _{stg} | Storage temperature range | -55 to 150 | | | °C |
| T _J | Operating junction temperature range | | | | °C |

1. Calculated according to the iterative formula:
$$I_C(T_C) = \frac{T_{J(max)} - T_C}{R_{thJC} \times V_{CE(sat)(max)}(T_{J(max)}, I_C(T_C))}$$
2. V_{clamp} = 80% V_{CES}, T_J = 150 °C, R_G = 10 Ω, V_{GE} = 15 V.
3. Pulse width limited by maximum junction temperature and turn-off within RBSOA.

Table 2. Thermal data

| Symbol | Parameter | Value | | | Unit |
|-------------------|--|-------------------------------|------|----------|------|
| | | D ² PAK, TO-220 | DPAK | TO-220FP | |
| R _{thJC} | Thermal resistance, junction-to-case IGBT | 1.9 | 2 | 5 | °C/W |
| | Thermal resistance, junction-to-case diode | 4 | 4.5 | 7 | |
| R _{thJA} | Thermal resistance, junction-to-ambient | 62.5 | 100 | 62.5 | °C/W |

2 Electrical characteristics

$T_C = 25\text{ °C}$ unless otherwise specified

Table 3. Static

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|--------------------------------------|---|------|------|-----------|------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage | $V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$ | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}, I_C = 5\text{ A}$ | | 2.2 | 2.5 | V |
| | | $V_{GE} = 15\text{ V}, I_C = 5\text{ A}, T_J = 150\text{ °C}$ | | 1.8 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$ | 4.5 | | 6.5 | V |
| I_{CES} | Collector cut-off current | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ | | | 0.15 | mA |
| | | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ °C}^{(1)}$ | | | 1 | |
| I_{GES} | Gate-emitter leakage current | $V_{CE} = 0\text{ V}, V_{GE} = \pm 20\text{ V}$ | | | ± 100 | nA |
| $g_{fs}^{(2)}$ | Forward transconductance | $V_{CE} = 15\text{ V}, I_C = 5\text{ A}$ | | 15 | | S |

1. Specified by design, not tested in production.

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

Table 4. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$ | - | 380 | - | pF |
| C_{oes} | Output capacitance | | - | 46 | - | pF |
| C_{res} | Reverse transfer capacitance | | - | 8.5 | - | pF |
| Q_g | Total gate charge | $V_{CC} = 390\text{ V}, I_C = 5\text{ A}, V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 19. Gate charge test circuit) | - | 19 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 5 | - | nC |
| Q_{gc} | Gate-collector charge | | - | 9 | - | nC |

Table 5. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|--|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, | - | 17 | - | ns |
| t_r | Current rise time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | - | 6 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform) | - | 655 | - | A/ μ s |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, | - | 16.5 | - | ns |
| t_r | Current rise time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ | - | 6.5 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform) | - | 575 | - | A/ μ s |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, | - | 33 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | - | 72 | - | ns |
| t_f | Current fall time | (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform) | - | 82 | - | ns |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, | - | 60 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ | - | 106 | - | ns |
| t_f | Current fall time | (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform) | - | 136 | - | ns |

Table 6. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|---|------|------|------|---------|
| $E_{on}^{(1)}$ | Turn-on switching energy | $V_{CE} = 390\text{ V}$, $I_C = 5\text{ A}$, | - | 55 | - | μ J |
| $E_{off}^{(2)}$ | Turn-off switching energy | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | - | 85 | - | μ J |
| E_{ts} | Total switching energy | (see Figure 17. Test circuit for inductive load switching) | - | 140 | - | μ J |
| $E_{on}^{(1)}$ | Turn-on switching energy | $V_{CE} = 390\text{ V}$, $I_C = 5\text{ A}$, | - | 87 | - | μ J |
| $E_{off}^{(2)}$ | Turn-off switching energy | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ | - | 162 | - | μ J |
| E_{ts} | Total switching energy | (see Figure 17. Test circuit for inductive load switching) | - | 249 | - | μ J |

1. Including the reverse recovery of the diode.

2. Including the tail of the collector current.

Table 7. Diode switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|--|------|------|------|------|
| V_F | Forward on-voltage | $I_F = 5\text{ A}$ | - | 2 | - | V |
| | | $I_F = 5\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$ | - | 1.6 | - | |
| t_{rr} | Reverse recovery time | $I_F = 5\text{ A}$, $V_R = 40\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$ | - | 22 | - | ns |
| Q_{rr} | Reverse recovery charge | (see Figure 18. Diode reverse recovery waveform) | - | 14 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 1.3 | - | A |
| t_{rr} | Reverse recovery time | $I_F = 5\text{ A}$, $V_R = 40\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$, | - | 35 | - | ns |
| Q_{rr} | Reverse recovery charge | $T_J = 125\text{ }^\circ\text{C}$ (see Figure 18. Diode reverse recovery waveform) | - | 40 | - | nC |
| I_{rr} | Reverse recovery current | | - | 2.2 | - | A |

2.1 Electrical characteristics (curves)

Figure 1. Typical output characteristics

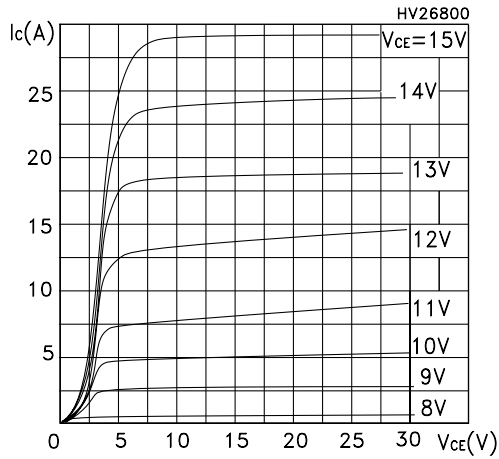


Figure 2. Typical transfer characteristics

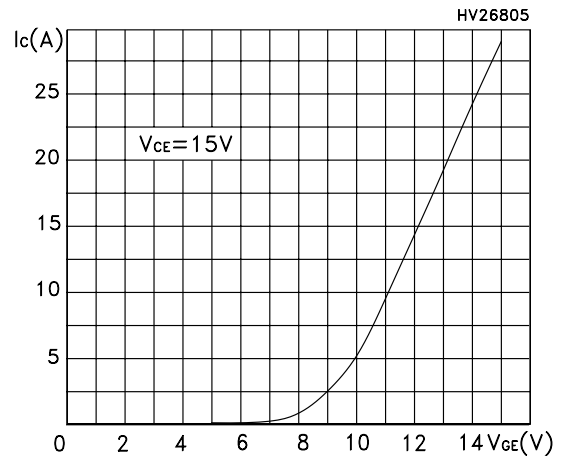


Figure 3. Typical transconductance characteristics

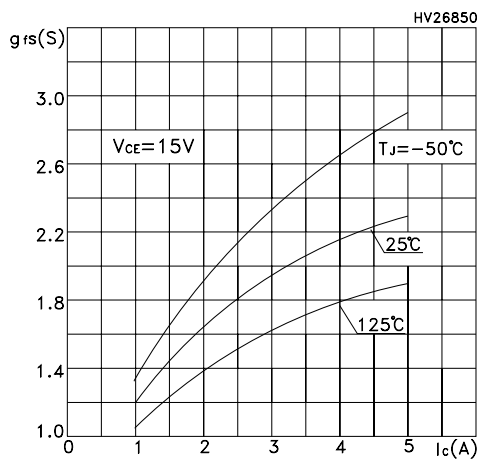


Figure 4. Typical collector-emitter on voltage vs temperature

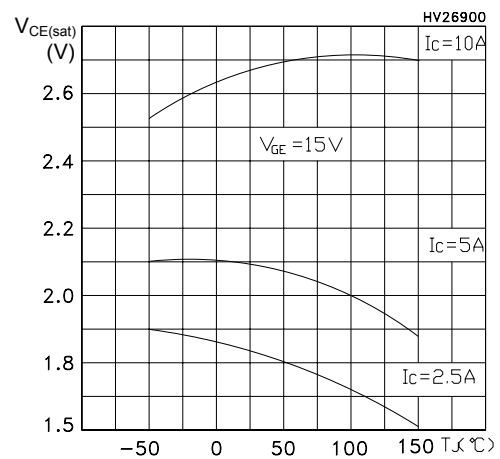


Figure 5. Typical gate charge characteristics

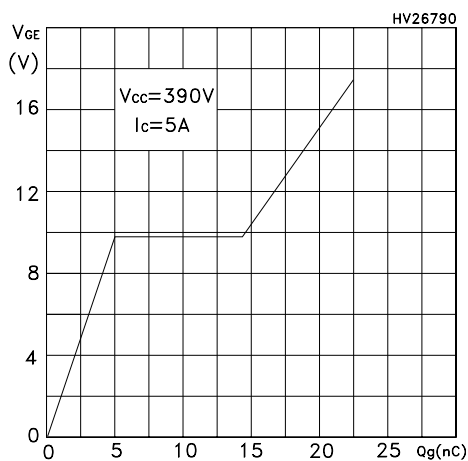


Figure 6. Typical capacitance characteristics

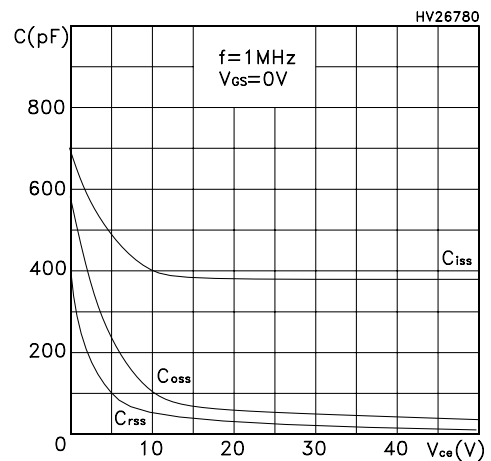


Figure 7. Normalized gate threshold vs temperature

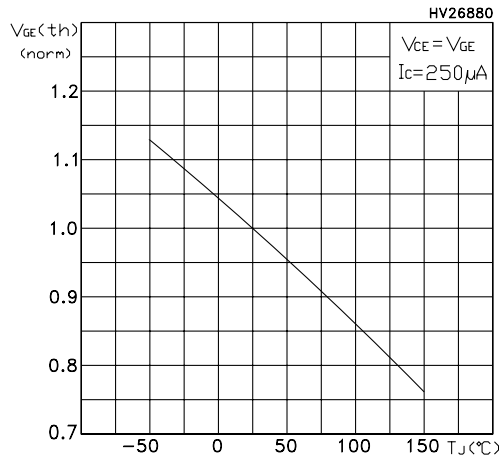


Figure 8. Typical collector-emitter on voltage vs collector current

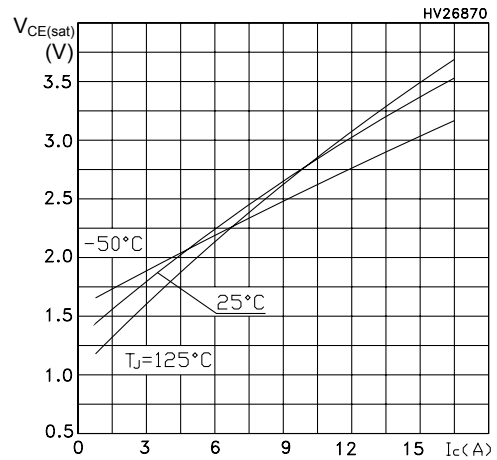


Figure 9. Normalized breakdown voltage vs temperature

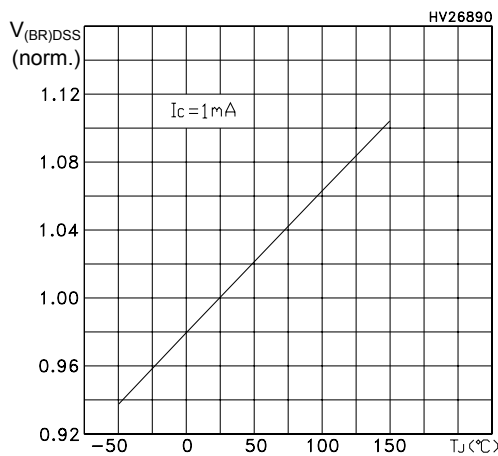


Figure 10. Typical switching energy vs temperature

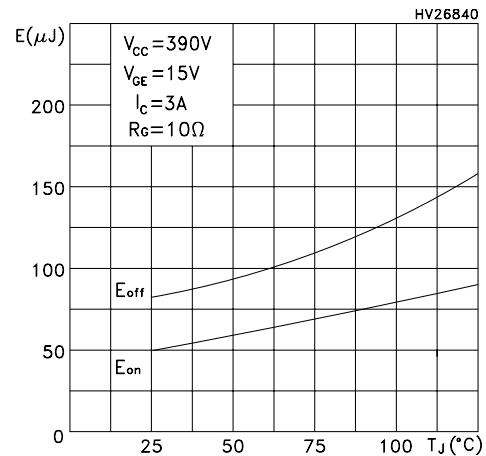


Figure 11. Typical switching energy vs gate resistance

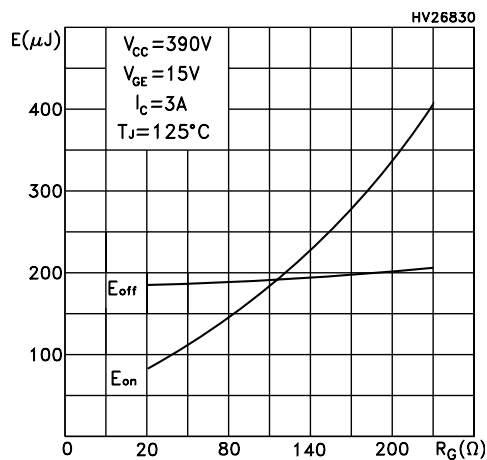


Figure 12. Typical switching energy vs collector current

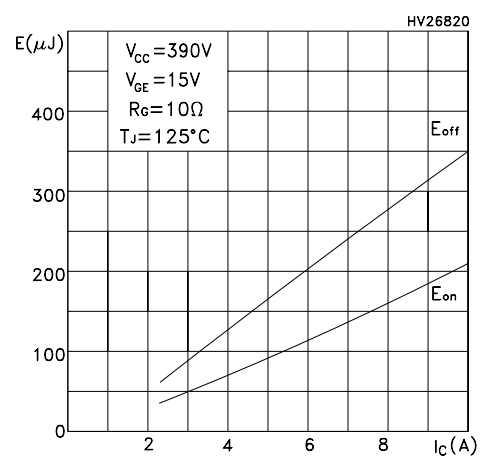


Figure 13. Reverse bias safe operating area

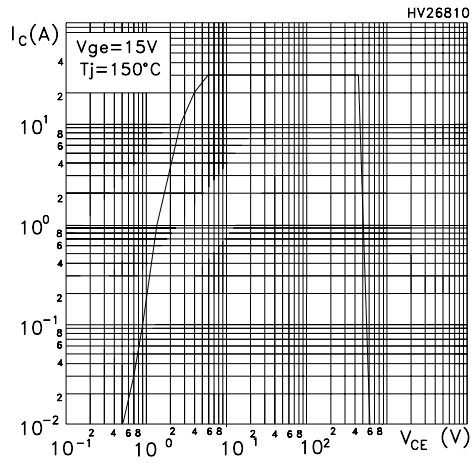


Figure 14. Normalized transient thermal impedance for D²PAK, DPAK and TO-220

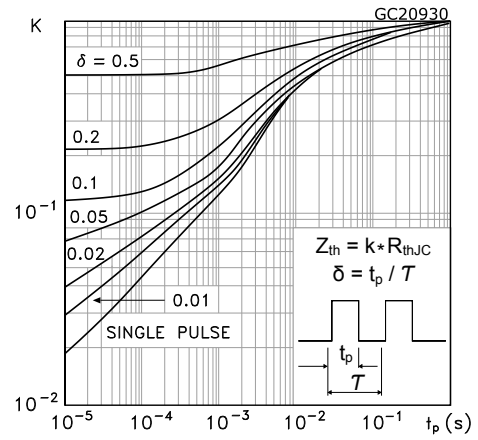


Figure 15. Normalized transient thermal impedance for TO-220FP

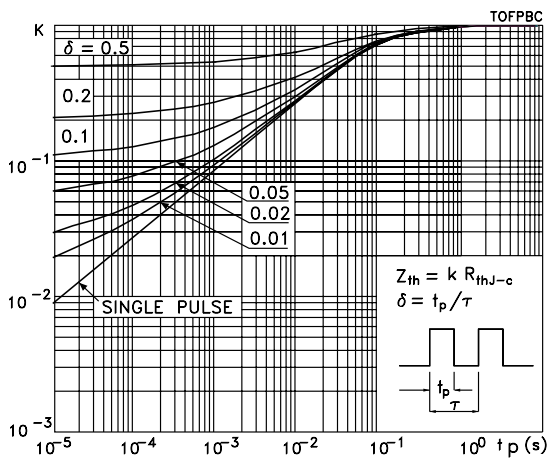
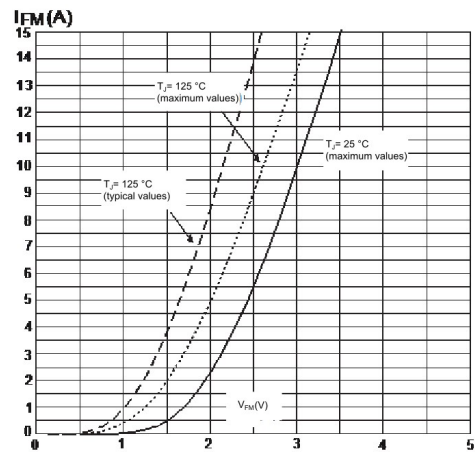


Figure 16. Typical emitter-collector diode characteristics



3 Test circuits

Figure 17. Test circuit for inductive load switching

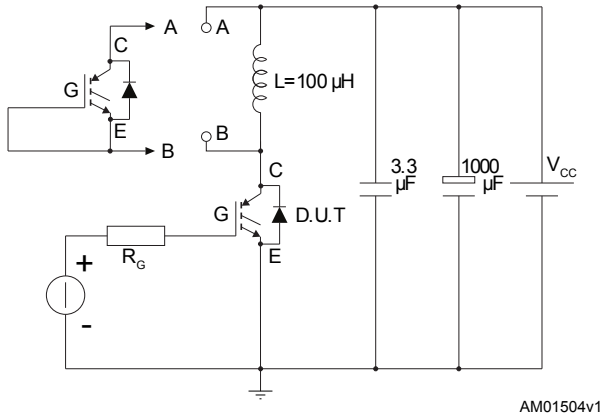


Figure 18. Diode reverse recovery waveform

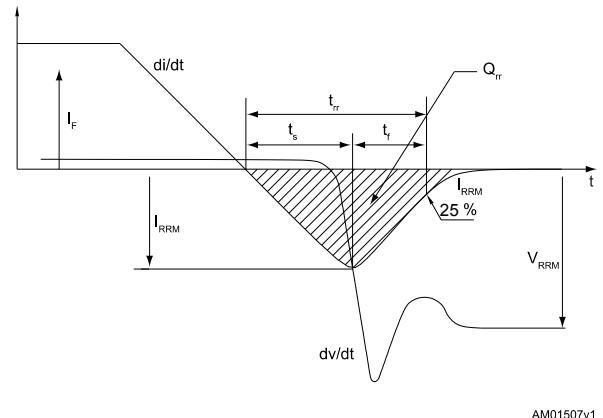


Figure 19. Gate charge test circuit

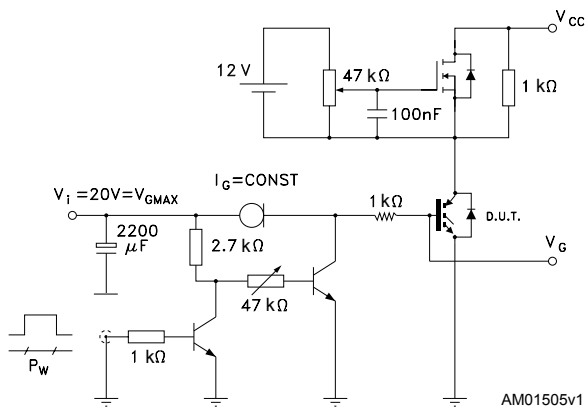
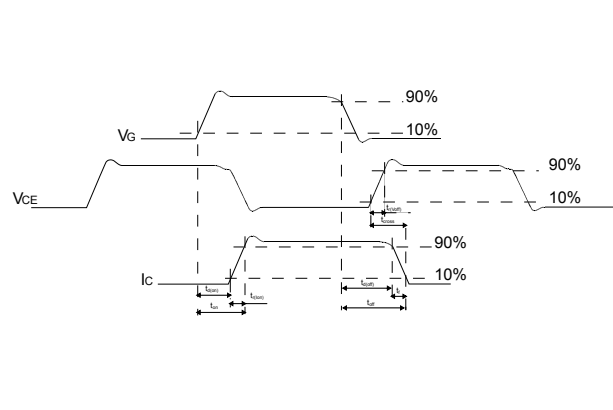


Figure 20. Switching waveform

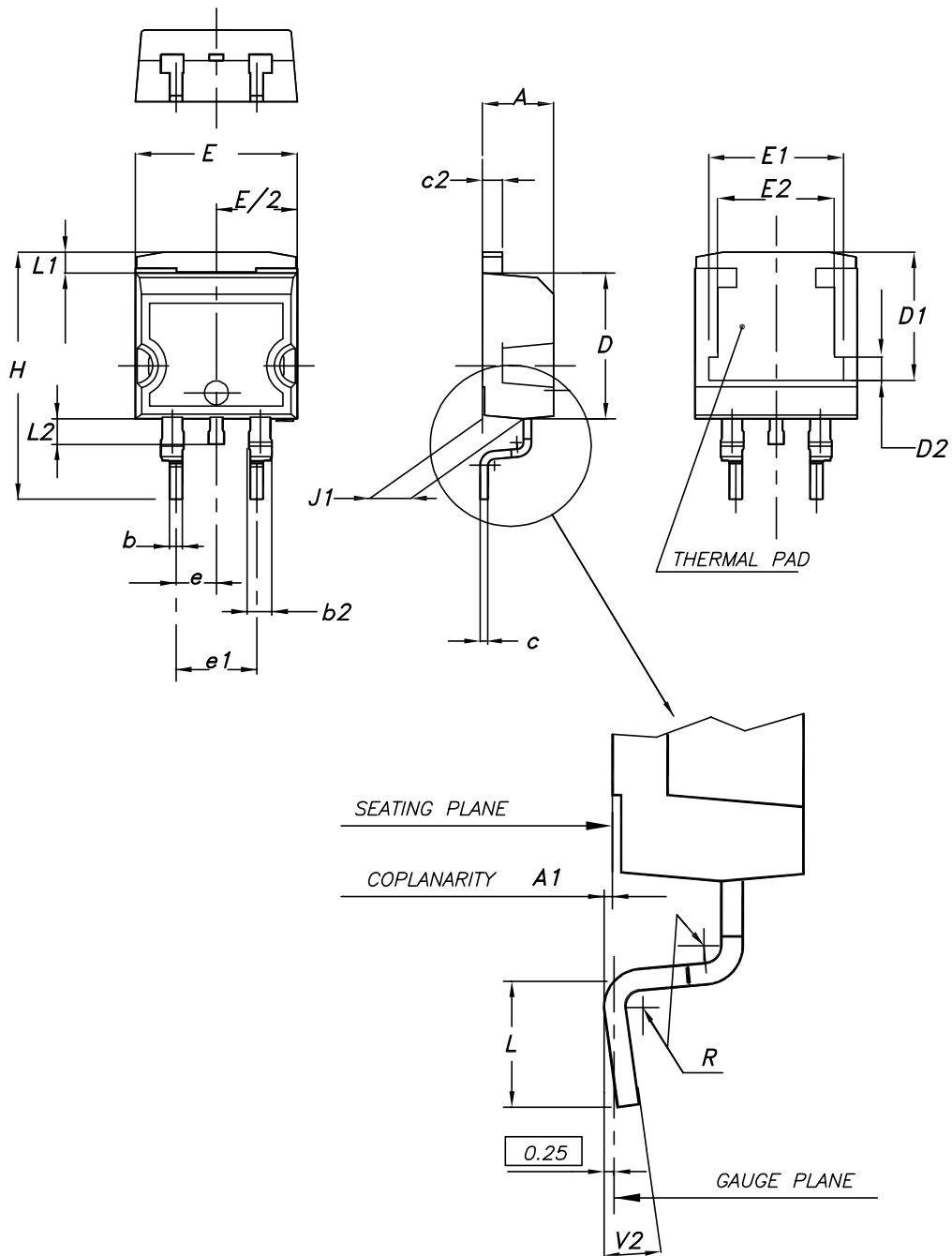


4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

4.1 D²PAK (TO-263) package information

Figure 21. D²PAK (TO-263) type A package outline



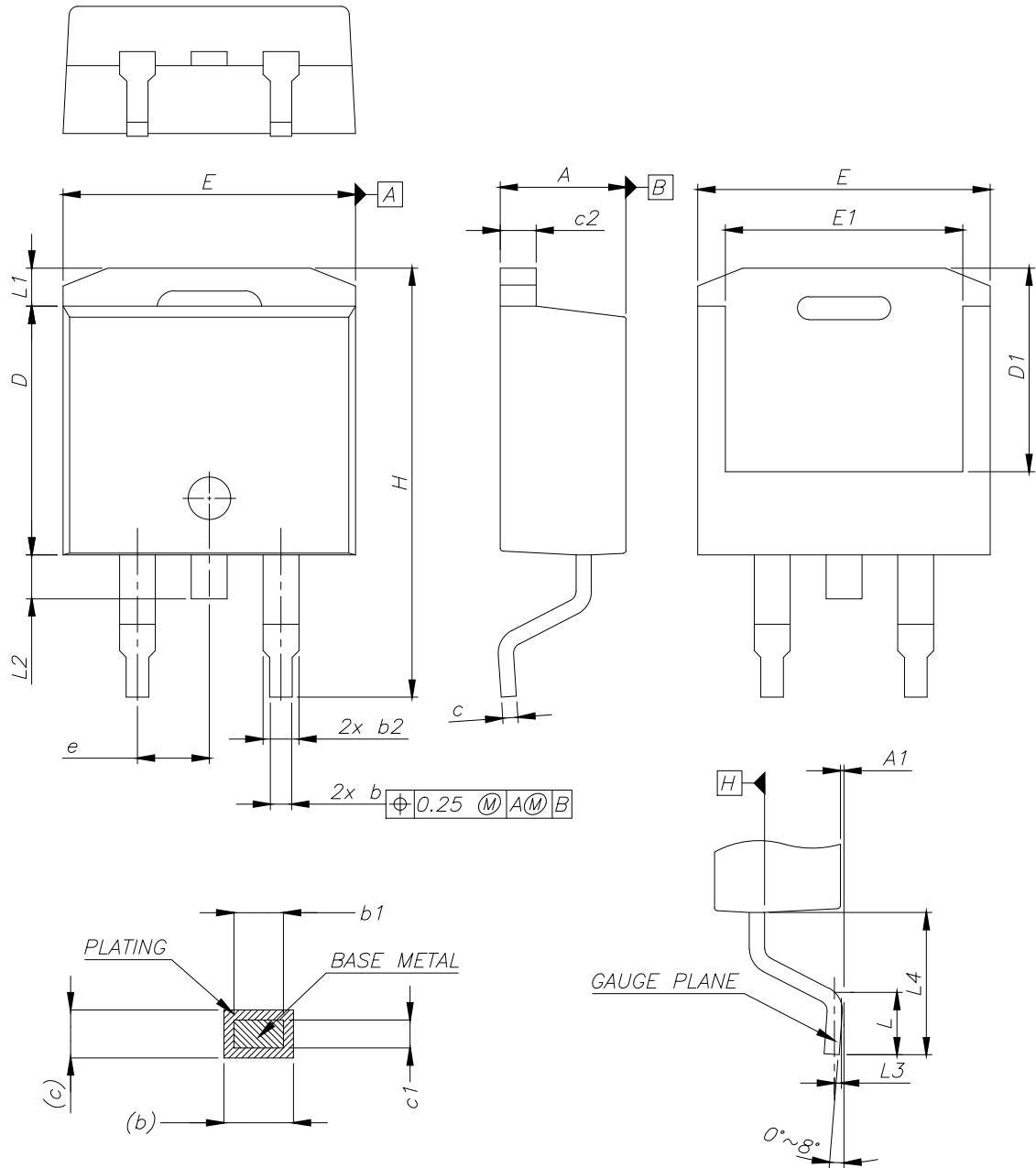
0079457_26



Table 8. D²PAK (TO-263) type A package mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| A1 | 0.03 | | 0.23 |
| b | 0.70 | | 0.93 |
| b2 | 1.14 | | 1.70 |
| c | 0.45 | | 0.60 |
| c2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | 7.50 | 7.75 | 8.00 |
| D2 | 1.10 | 1.30 | 1.50 |
| E | 10.00 | | 10.40 |
| E1 | 8.30 | 8.50 | 8.70 |
| E2 | 6.85 | 7.05 | 7.25 |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15.00 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.40 | |
| V2 | 0° | | 8° |

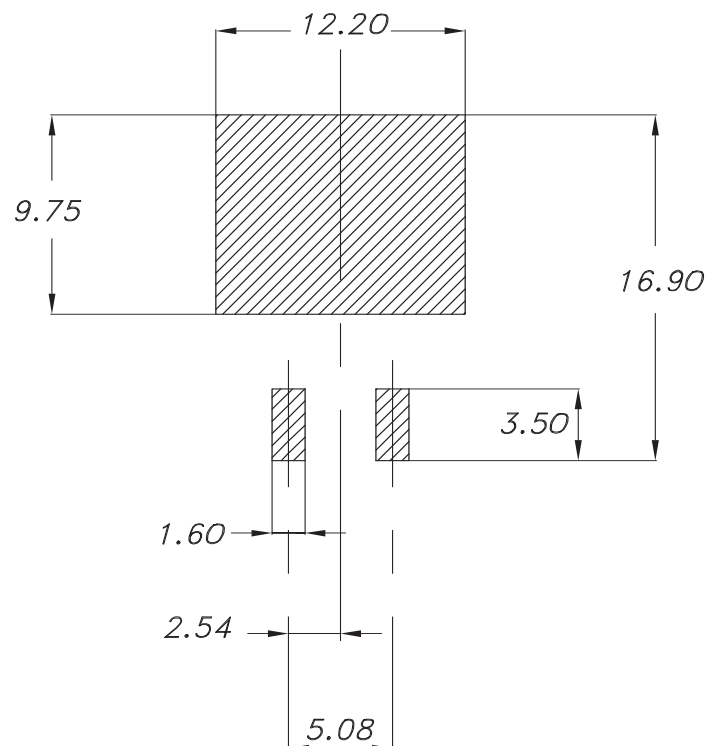
Figure 22. D²PAK (TO-263) type B package outline



0079457_26_B

Table 9. D²PAK (TO-263) type B mechanical data

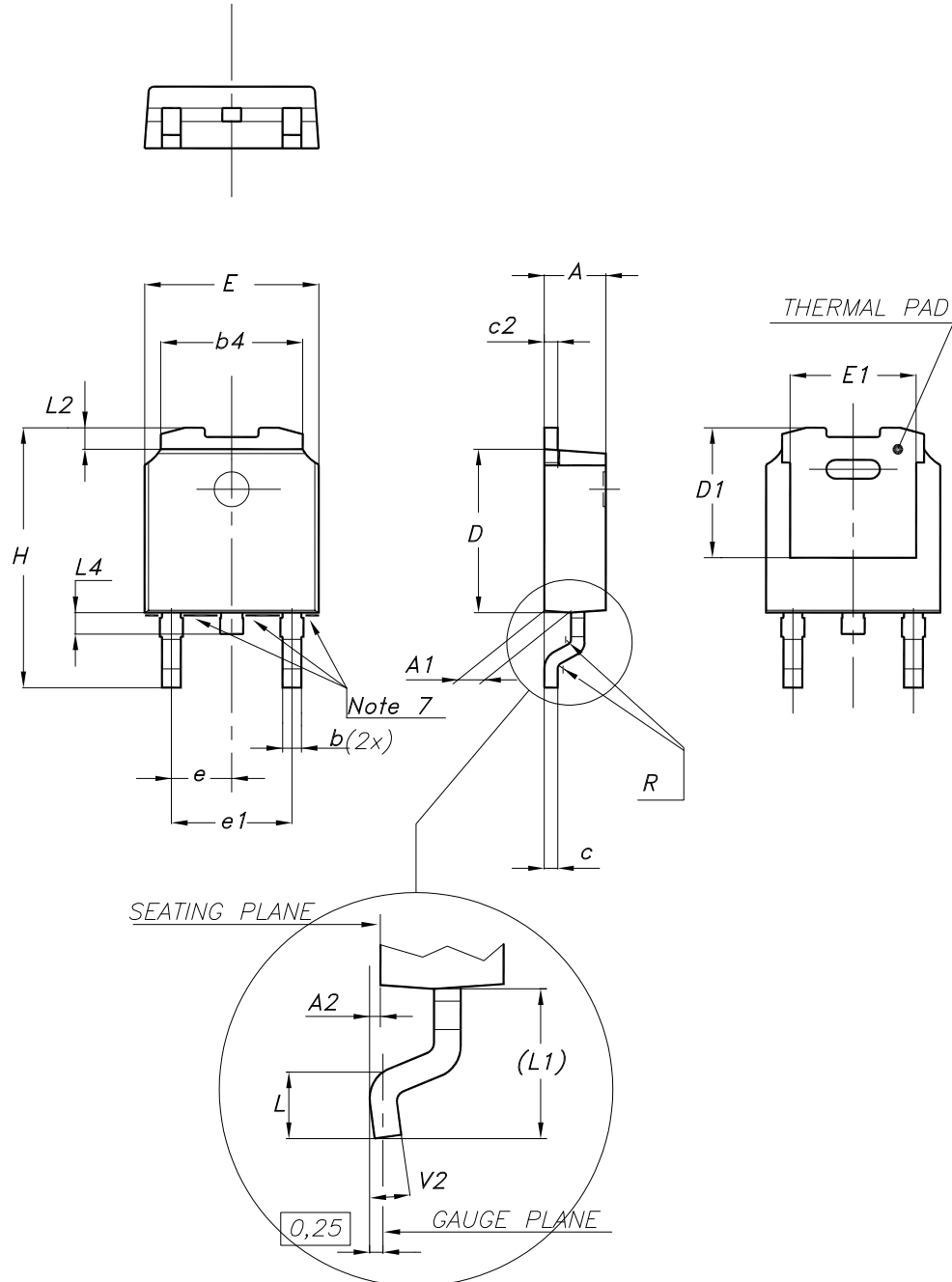
| Dim. | mm | | |
|------|----------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.36 | | 4.56 |
| A1 | 0 | | 0.25 |
| b | 0.70 | | 0.90 |
| b1 | 0.51 | | 0.89 |
| b2 | 1.17 | | 1.37 |
| c | 0.38 | | 0.694 |
| c1 | 0.38 | | 0.534 |
| c2 | 1.19 | | 1.34 |
| D | 8.60 | | 9.00 |
| D1 | 6.90 | | 7.50 |
| E | 10.15 | | 10.55 |
| E1 | 8.10 | | 8.70 |
| e | 2.54 BSC | | |
| H | 15.00 | | 15.60 |
| L | 1.90 | | 2.50 |
| L1 | | | 1.65 |
| L2 | | | 1.78 |
| L3 | | 0.25 | |
| L4 | 4.78 | | 5.28 |

Figure 23. D²PAK (TO-263) recommended footprint (dimensions are in mm)


0079457_Rev26_footprint

4.2 DPAK (TO-252) type A package information

Figure 24. DPAK (TO-252) type A package outline



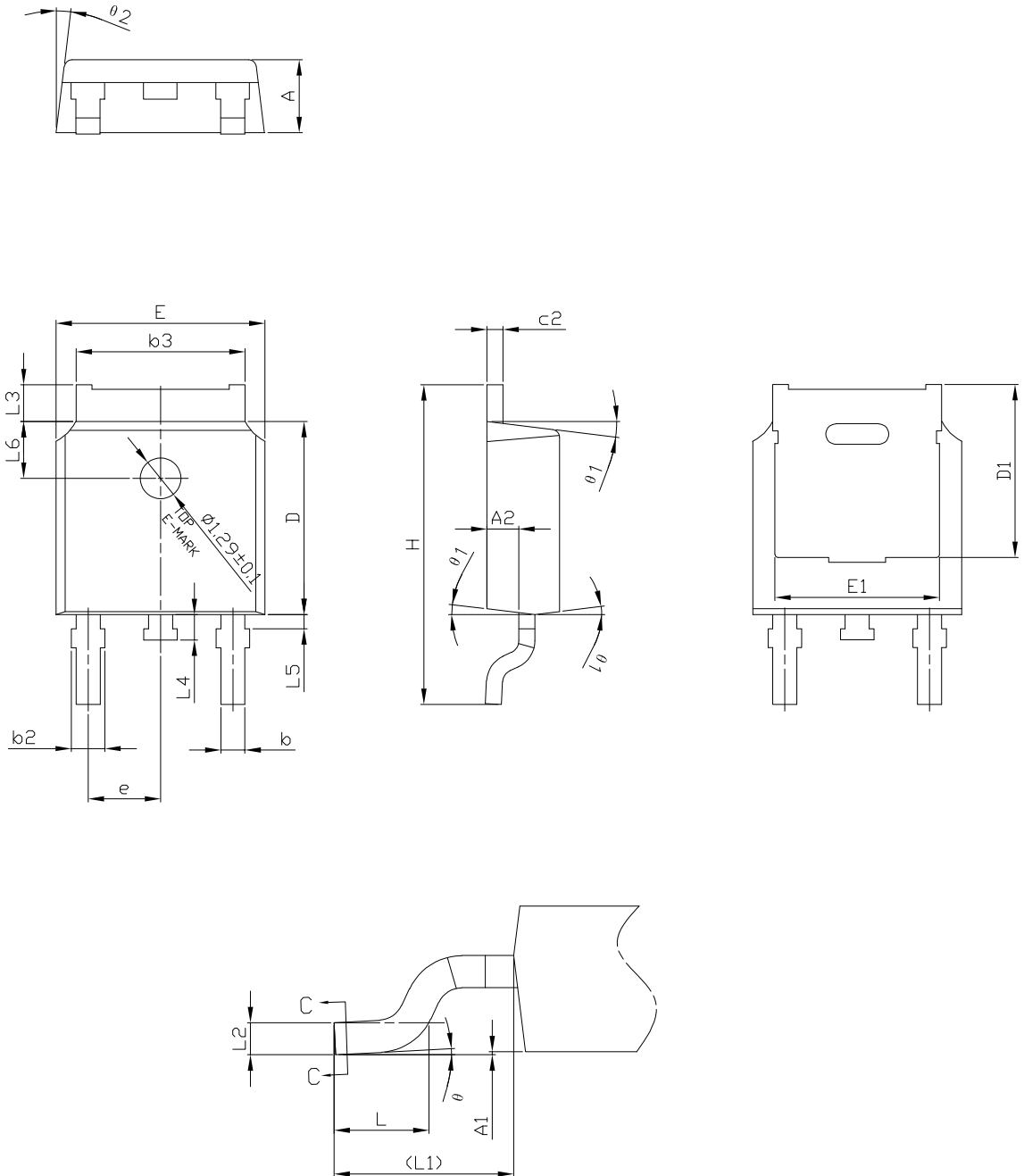
0068772_A_34

**Table 10. DPAK (TO-252) type A mechanical data**

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| A2 | 0.03 | | 0.23 |
| b | 0.64 | | 0.90 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| D1 | 4.95 | 5.10 | 5.25 |
| E | 6.40 | | 6.60 |
| E1 | 4.60 | 4.70 | 4.80 |
| e | 2.159 | 2.286 | 2.413 |
| e1 | 4.445 | 4.572 | 4.699 |
| H | 9.35 | | 10.10 |
| L | 1.00 | | 1.50 |
| (L1) | 2.60 | 2.80 | 3.00 |
| L2 | 0.65 | 0.80 | 0.95 |
| L4 | 0.60 | | 1.00 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

4.3 DPAK (TO-252) type C3 package information

Figure 25. DPAK (TO-252) type C3 package outline

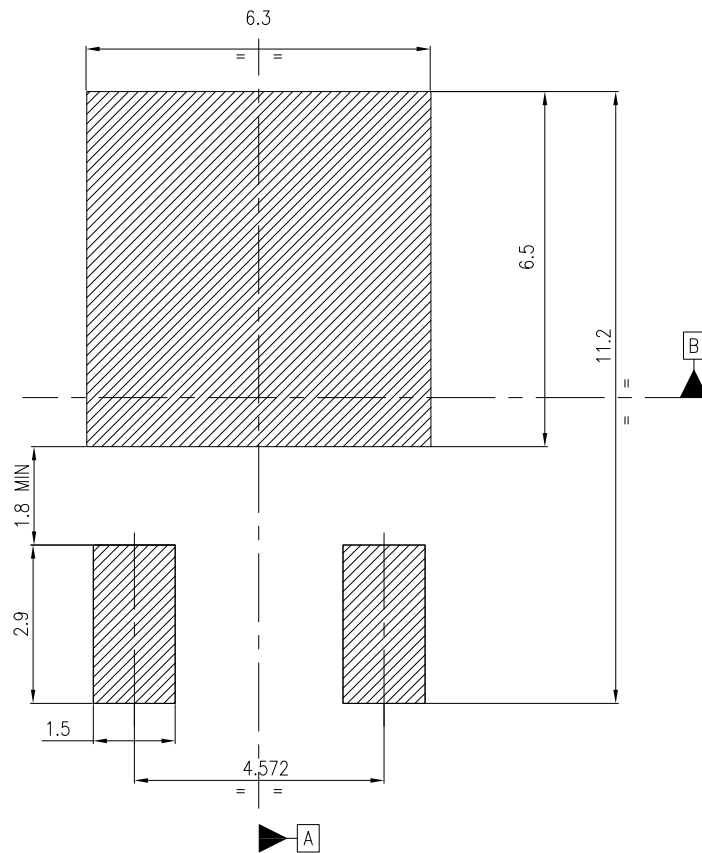


0068772_type-C3_rev34

Table 11. DPAK (TO-252) type C3 mechanical data

| Dim. | mm | | |
|------|----------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | 2.30 | 2.38 |
| A1 | 0.00 | | 0.10 |
| A2 | 0.90 | 1.01 | 1.10 |
| b | 0.72 | | 0.85 |
| b2 | 0.72 | | 1.10 |
| b3 | 5.13 | 5.33 | 5.46 |
| c | 0.47 | | 0.60 |
| c2 | 0.47 | | 0.60 |
| D | 6.00 | 6.10 | 6.20 |
| D1 | 5.20 | 5.45 | 5.70 |
| E | 6.50 | 6.60 | 6.70 |
| E1 | 5.00 | 5.20 | 5.40 |
| e | 2.186 | 2.286 | 2.386 |
| H | 9.80 | 10.10 | 10.40 |
| L | 1.40 | 1.50 | 1.70 |
| L1 | 2.90 REF | | |
| L2 | 0.51 BSC | | |
| L3 | 0.90 | | 1.25 |
| L4 | 0.60 | 0.80 | 1.00 |
| L5 | 0.15 | | 0.75 |
| L6 | 1.80 REF | | |
| θ | 0° | | 8° |
| θ1 | 5° | 7° | 9° |
| θ2 | 5° | 7° | 9° |

Figure 26. DPAK (TO-252) recommended footprint (dimensions are in mm)



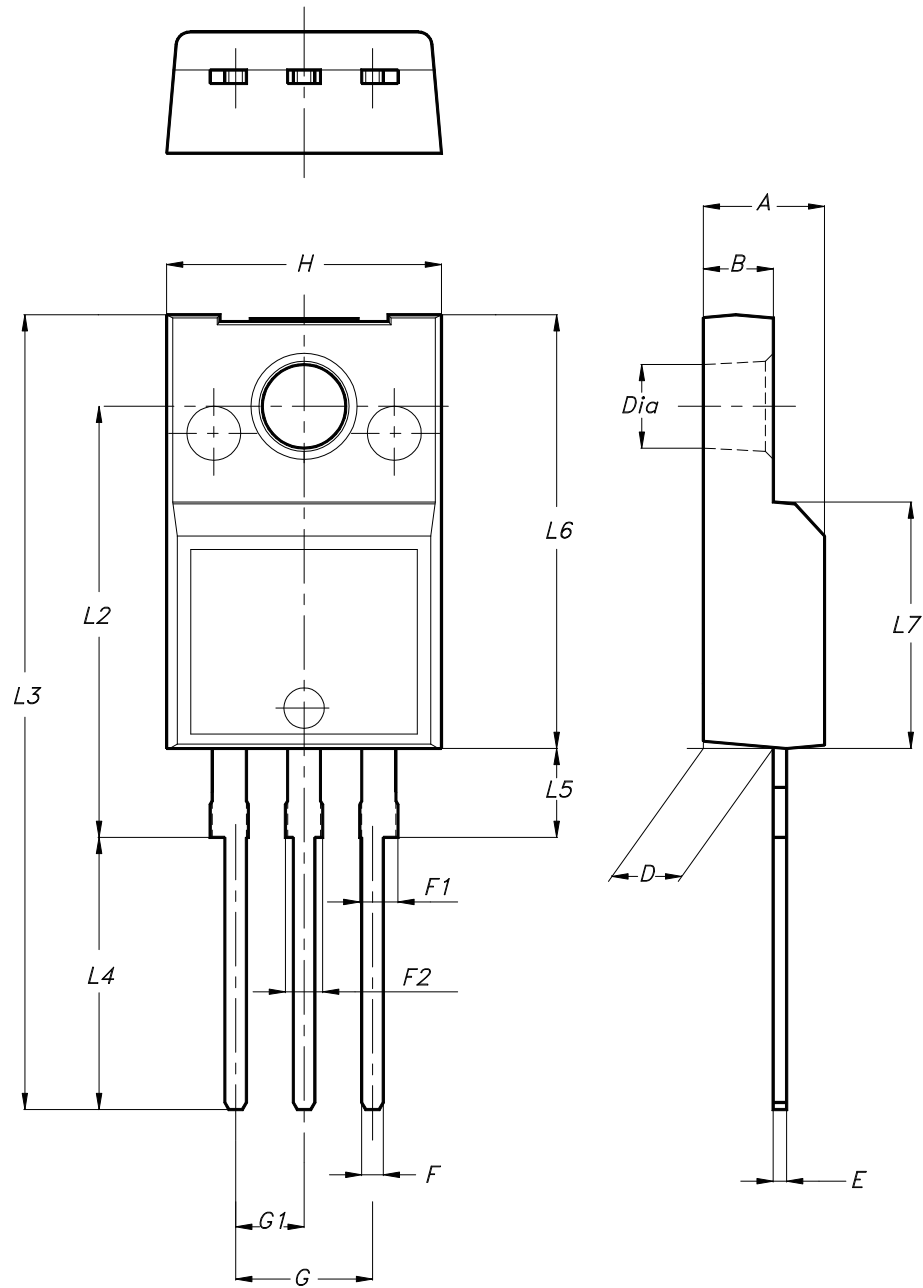
Notes:

- 1) This footprint is able to ensure insulation up to 630 Vrms (according to CEI IEC 664-1)
- 2) The device must be positioned within $\boxed{\oplus 0.05 \text{ A B}}$

FP_0068772_34

4.4 TO-220FP type B package information

Figure 27. TO-220FP type B package outline



7012510_B_rev.14

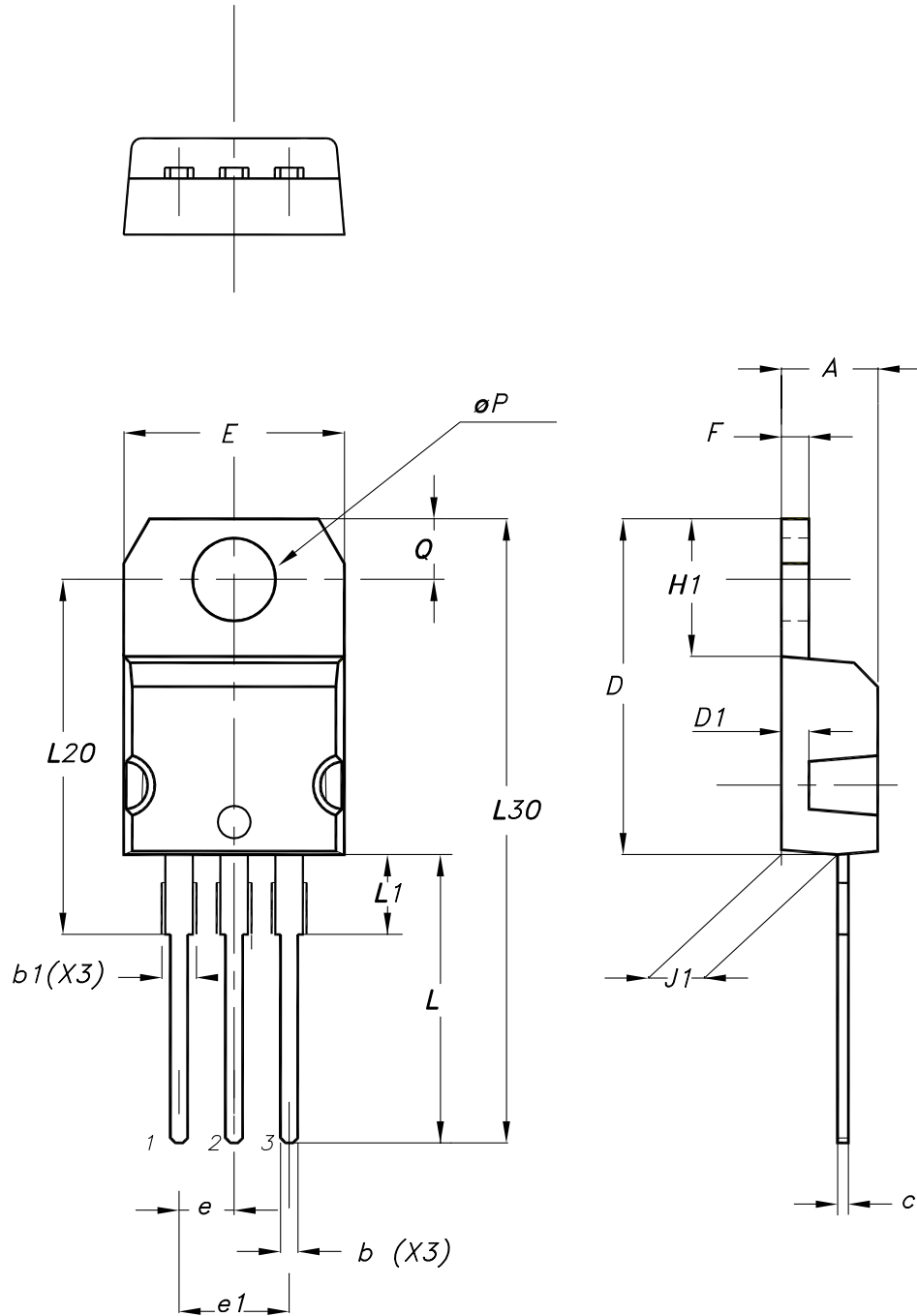


Table 12. TO-220FP type B package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| B | 2.50 | | 2.70 |
| D | 2.50 | | 2.75 |
| E | 0.45 | | 0.70 |
| F | 0.75 | | 1.00 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.20 |
| G1 | 2.40 | | 2.70 |
| H | 10.00 | | 10.40 |
| L2 | | 16.00 | |
| L3 | 28.60 | | 30.60 |
| L4 | 9.80 | | 10.60 |
| L5 | 2.90 | | 3.60 |
| L6 | 15.90 | | 16.40 |
| L7 | 9.00 | | 9.30 |
| Dia | 3.00 | | 3.20 |

4.5 TO-220 type A package information

Figure 28. TO-220 type A package outline



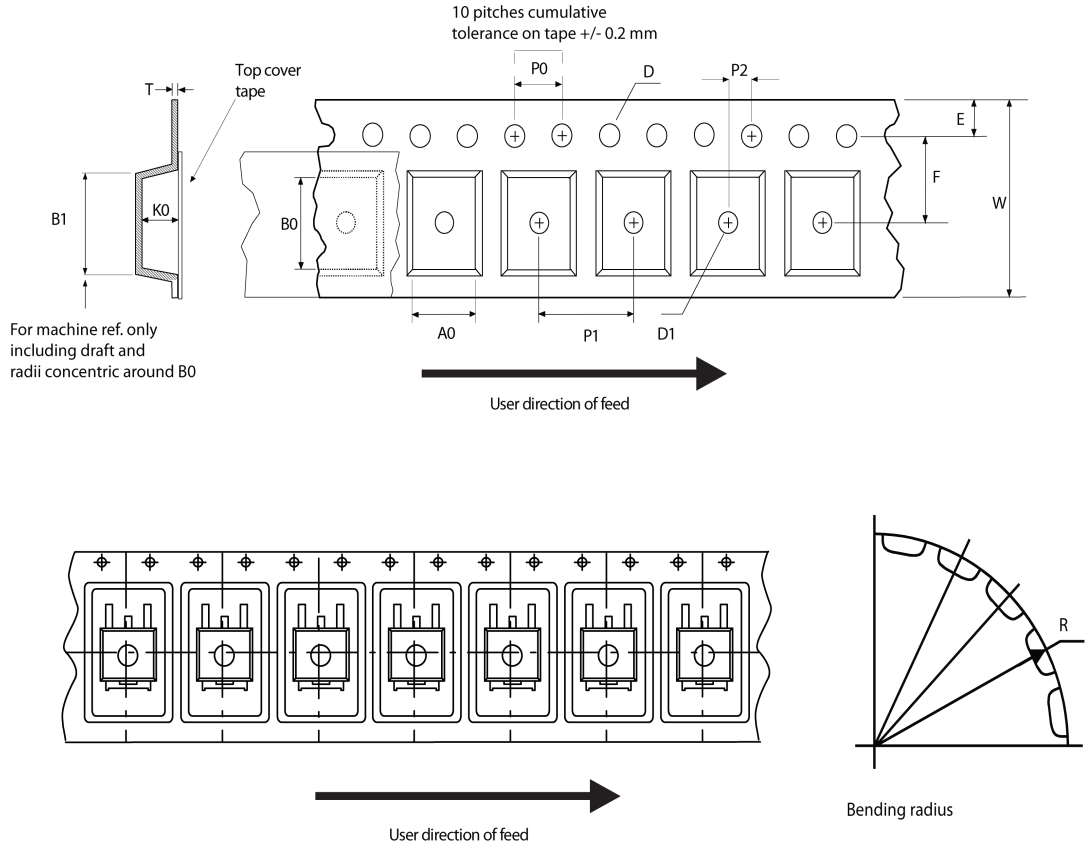
0015988_typeA_Rev_23

Table 13. TO-220 type A package mechanical data

| Dim. | mm | | |
|---------------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.55 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10.00 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13.00 | | 14.00 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| øP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |
| Slug flatness | | 0.03 | 0.10 |

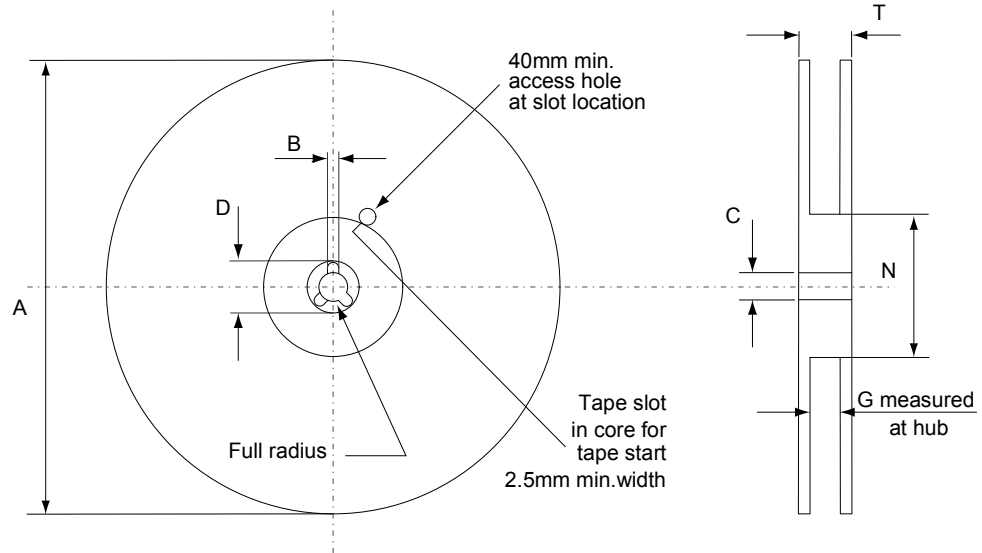
4.6 D²PAK type A packing information

Figure 29. D²PAK tape outline



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Figure 30. D²PAK reel outline



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Table 14. D²PAK tape and reel mechanical data

| Dim. | Tape | | Dim. | Reel | |
|------|------|------|---------------|------|------|
| | mm | | | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 26.4 |
| F | 11.4 | 11.6 | N | 100 | |
| K0 | 4.8 | 5.0 | T | | 30.4 |
| P0 | 3.9 | 4.1 | | | |
| P1 | 11.9 | 12.1 | Base quantity | | 1000 |
| P2 | 1.9 | 2.1 | Bulk quantity | | 1000 |
| R | 50 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 23.7 | 24.3 | | | |

4.7 D²PAK type B packing information

Figure 31. D²PAK type B tape outline

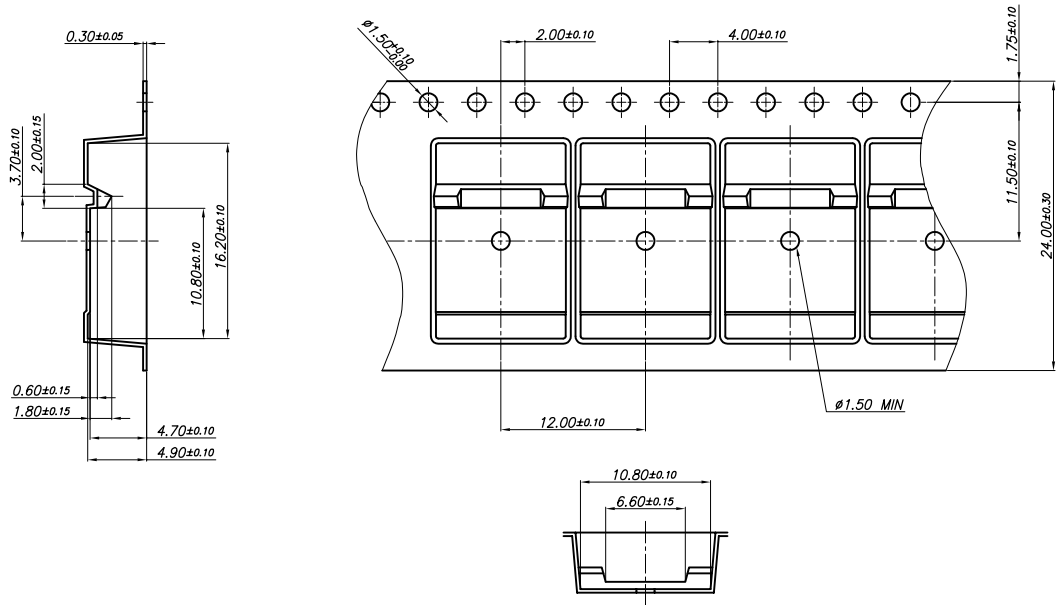
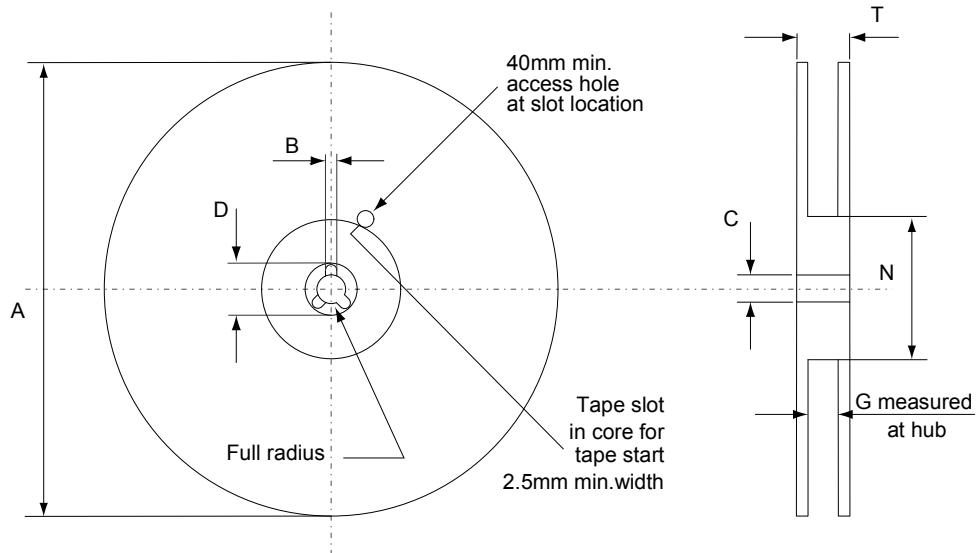


Figure 32. D²PAK type B reel outline



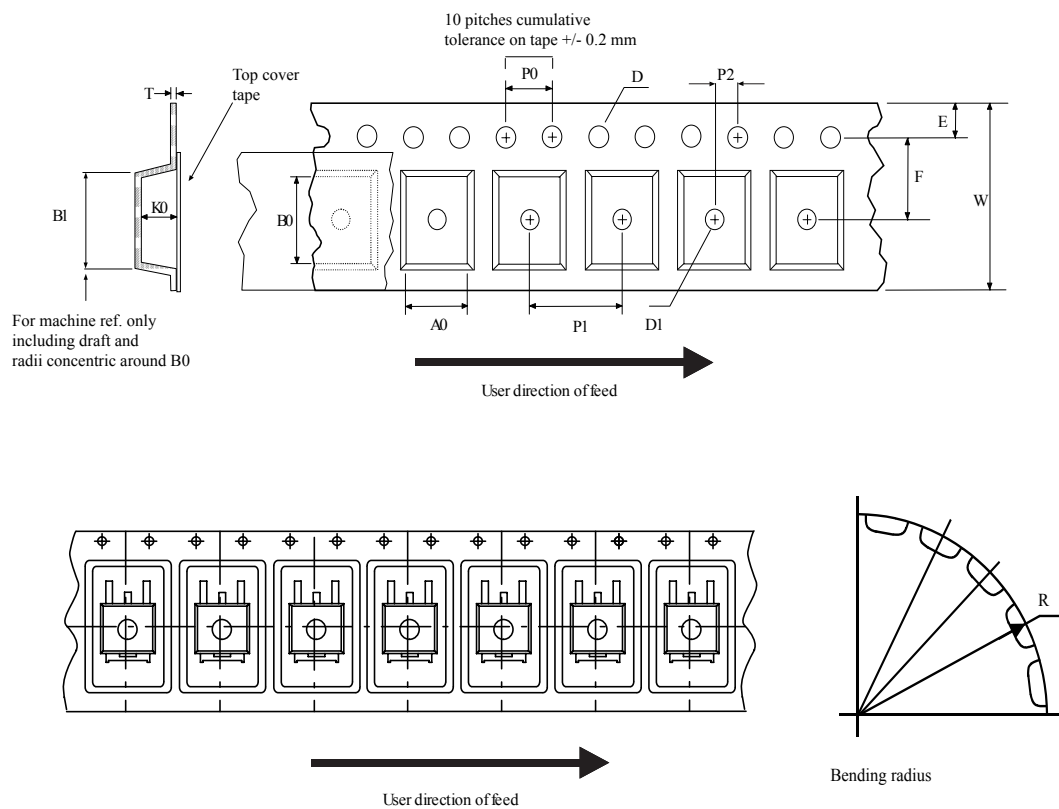
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Table 15. D²PAK type B reel mechanical data

| Dim. | mm | |
|------|------|------|
| | Min. | Max. |
| A | | 330 |
| B | 1.5 | |
| C | 12.8 | 13.2 |
| D | 20.2 | |
| G | 24.4 | 26.4 |
| N | 100 | |
| T | | 30.4 |

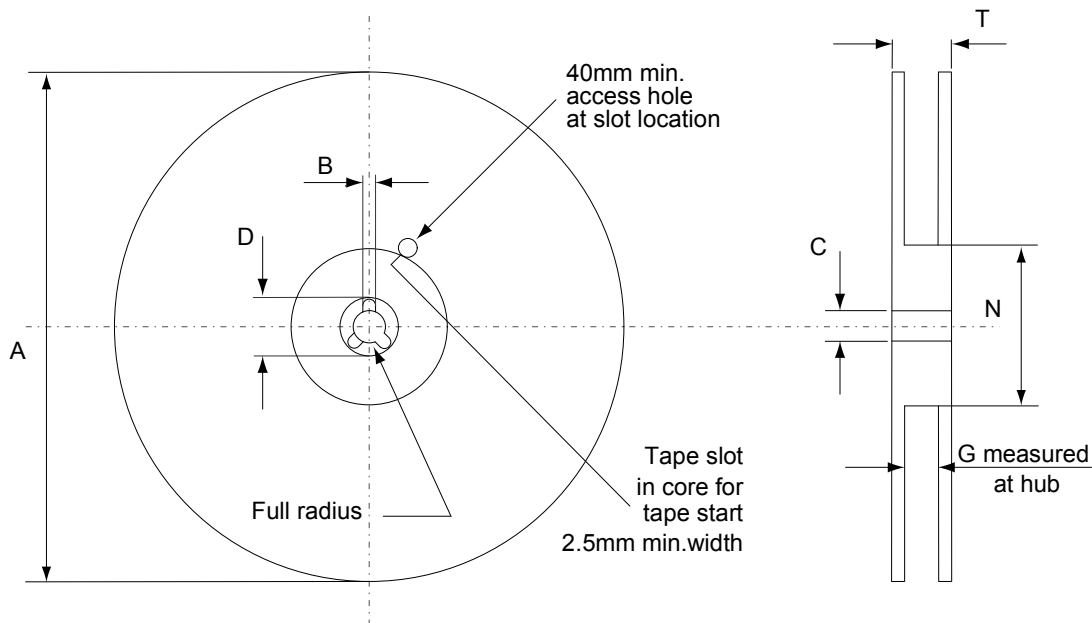
4.8 DPAK (TO-252) packing information

Figure 33. DPAK (TO-252) tape outline



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Figure 34. DPAK (TO-252) reel outline



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Table 16. DPAK (TO-252) tape and reel mechanical data

| Dim. | Tape | | Dim. | Reel | |
|------|------|------|-----------|------|------|
| | mm | | | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 6.8 | 7 | A | | 330 |
| B0 | 10.4 | 10.6 | B | 1.5 | |
| B1 | | 12.1 | C | 12.8 | 13.2 |
| D | 1.5 | 1.6 | D | 20.2 | |
| D1 | 1.5 | | G | 16.4 | 18.4 |
| E | 1.65 | 1.85 | N | 50 | |
| F | 7.4 | 7.6 | T | | 22.4 |
| K0 | 2.55 | 2.75 | | | |
| P0 | 3.9 | 4.1 | Base qty. | | 2500 |
| P1 | 7.9 | 8.1 | Bulk qty. | | 2500 |
| P2 | 1.9 | 2.1 | | | |
| R | 40 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 15.7 | 16.3 | | | |



5 Ordering information

Table 17. Order codes

| Order codes | Marking | Package | Packing |
|----------------|------------|--------------------|---------------|
| STGB10NC60KDT4 | GB10NC60KD | D ² PAK | Tape and reel |
| STGD10NC60KDT4 | GD10NC60KD | DPAK | |
| STGF10NC60KD | GF10NC60KD | TO-220FP | Tube |
| STGP10NC60KD | GP10NC60KD | TO-220 | |



Revision history

Table 18. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 14-Jun-2005 | 1 | First release. |
| 19-Jul-2005 | 2 | Complete version. |
| 27-Jan-2006 | 3 | Inserted ecopack indication. |
| 01-Mar-2006 | 4 | The document has been reformatted. |
| 08-Feb-2007 | 5 | Modified value on <i>Table 6.: Switching on/off (inductive load)</i> . |
| 24-Nov-2009 | 6 | Inserted DPAK package option. |
| 06-Jun-2017 | 7 | Modified part numbers on cover page. Updated <i>Section 4: "Package information"</i> . Minor text changes. |
| 26-May-2023 | 8 | Updated the entire Section 4 Package information . Minor text changes. |



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