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# STGB19NC60KDT4, STGF19NC60KD, STGP19NC60KD

## 20 A, 600 V short-circuit rugged IGBT

Datasheet - production data

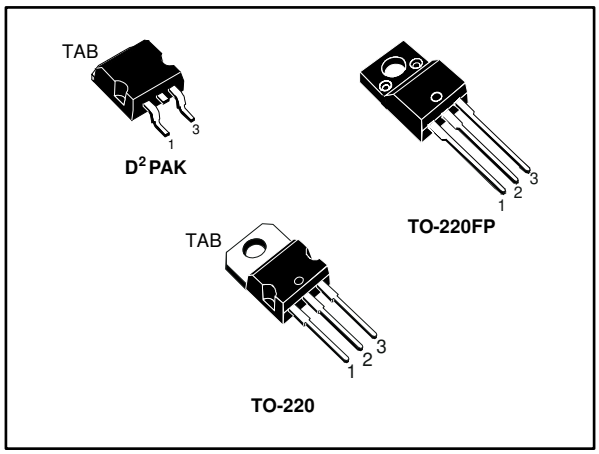
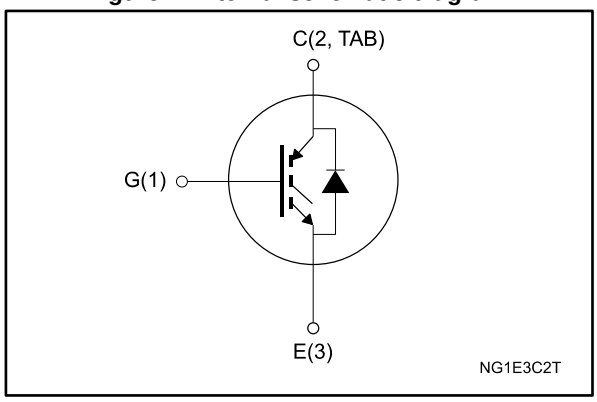



**Figure 1: Internal schematic diagram**




## Features

- Low on voltage drop ($V_{CE(sat)}$)
- Low $C_{RES}$ / $C_{IES}$ ratio (no cross-conduction susceptibility)
- Short-circuit withstand time 10 µs
- IGBT co-packaged with ultrafast free-wheeling diode

## Applications

- High frequency inverters
- 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.

**Table 1: Device summary**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STGB19NC60KDT4 | GB19NC60KD | D²PAK | Tape and reel |
| STGF19NC60KD | GF19NC60KD | TO-220FP | Tube |
| STGP19NC60KD | GP19NC60KD | TO-220 | |



This is information on a product in full production. www.st.com

# Contents

# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | D²PAK, TO-220 | TO-220FP | |
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0 V) | 600 | | V |
| $I_C$(1) | Continuous collector current at $T_C$ = 25 °C | 35 | 16 | A |
| | Continuous collector current at $T_C$ = 100 °C | 20 | 10 | A |
| $I_{CL}$(2) | Turn-off latching current | 75 | | A |
| $I_{CP}$(3) | Pulsed collector current | 75 | | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | | V |
| $I_F$ | Diode RMS forward current at $T_C$= 25 °C | 20 | | A |
| $I_{FSM}$ | Surge non repetitive forward current $t_p$= 10 ms sinusoidal | 50 | | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 125 | 32 | W |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat-sink (t=1 s; $T_C$= 25 °C) | | 2500 | V |
| $t_{scw}$ | Short-circuit withstand time $V_{CE}$ = 300 V, $T_j$ = 125 °C, $R_G$ = 10 Ω, $V_{GE}$ = 12 V | 10 | | µs |
| $T_{stg}$ | Storage temperature range | - 55 to 150 | | °C |
| $T_J$ | Operating junction temperature range | | | |

**Notes:**

(1)Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

(2)$V_{clamp}$ = 80 % $V_{CES}$, $V_{GE}$ = 15 V, $R_G$ = 10 Ω, $T_J$ = 150 °C.

(3)Pulse width limited by maximum junction temperature.

**Table 3: Thermal data**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | D²PAK, TO-220 | TO-220FP | |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case IGBT | 1 | 3.9 | °C/W |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case diode | 3 | 5.6 | |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient | 62.5 | | |

# 2 Electrical characteristics

$T_C$ = 25 °C unless otherwise specified

**Table 4: Static characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage | $I_C$ = 1 mA, $V_{GE}$ = 0 V | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ =15 V, $I_C$ = 12 A | | 2.0 | 2.75 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 12 A, $T_C$= 125 °C | | 1.65 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 µA | 4.5 | | 6.5 | V |
| $I_{CES}$ | Collector cut-off current | $V_{CE}$ = 600 V, $V_{GE}$ = 0 V | | | 150 | µA |
| | | $V_{CE}$=600 V, $V_{GE}$ = 0 V, $T_C$= 125 °C (1) | | | 1 | mA |
| $I_{GES}$ | Gate-emitter leakage current | $V_{CE}$ = 0 V, $V_{GE}$ = ±20 V | | | ±100 | nA |

**Notes:**

(1)Defined by design, not subject to production test.

**Table 5: Dynamic characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input capacitance | $V_{CE}$= 25 V, f = 1 MHz, $V_{GE}$ = 0 V | - | 1170 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 127 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 28 | - | |
| $Q_g$ | Total gate charge | $V_{CE}$ = 480 V, $I_C$ = 12 A, $V_{GE}$ = 0 to 15 V (see *Figure 20: " Gate charge test circuit"*) | - | 55 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 11 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 26 | - | |

**Table 6: Switching on/off (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 480 V, $I_C$ = 12 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V (see *Figure 19: " Test circuit for inductive load switching"* and *Figure 21: " Switching waveform"*) | - | 30 | - | ns |
| $t_r$ | Current rise time | | - | 8 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1450 | - | A/µs |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 480 V, $I_C$ = 12 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V, $T_C$=125 °C (see *Figure 19: " Test circuit for inductive load switching"* and *Figure 21: " Switching waveform"*) | - | 30 | - | ns |
| $t_r$ | Current rise time | | - | 8 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1380 | - | A/µs |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC}$ = 480 V, $I_C$ = 12 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V (see *Figure 19: " Test circuit for inductive load switching"* and *Figure 21: " Switching waveform"*) | - | 35 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 105 | - | ns |
| $t_f$ | Current fall time | | - | 85 | - | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC}$ = 480 V, $I_C$ = 12 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V, $T_C$=125 °C (see *Figure 19: " Test circuit for inductive load switching"* and *Figure 21: " Switching waveform"*) | - | 65 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 145 | - | ns |
| $t_f$ | Current fall time | | - | 125 | - | ns |

**Table 7: Switching energy (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $E_{on}$ (1) | Turn-on switching energy | $V_{CC}$ = 480 V, $I_C$ = 12 A, $R_G$ = 10 Ω , $V_{GE}$ = 15 V (see *Figure 19: " Test circuit for inductive load switching"*) | - | 165 | - | µJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 255 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 420 | - | µJ |
| $E_{on}$ (1) | Turn-on switching energy | $V_{CC}$ = 480 V, $I_C$ = 12 A, $R_G$ = 10 Ω , $V_{GE}$ = 15 V, $T_C$=125 °C (see *Figure 19: " Test circuit for inductive load switching"*) | - | 250 | - | µJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 445 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 695 | - | µJ |

**Notes:**

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

**Table 8: Collector-emitter diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_F$ | Forward on-voltage | $I_F$=12 A | - | 1.9 | - | V |
| | | $I_F$=12 A, $T_C$=125 °C | - | 1.6 | - | V |
| $t_{rr}$ | Reverse recovery time | $I_F$=12 A, $V_R$=40 V, di/dt=100 A/µs (see *Figure 22: " Diode reverse recovery waveform"*) | - | 31 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 30 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 2 | - | A |
| $t_{rr}$ | Reverse recovery time | $I_F$=12 A, $V_R$=40 V, $T_C$=125 °C, di/dt=100 A/µs (see *Figure 22: " Diode reverse recovery waveform"*) | - | 50 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 70 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 4 | - | A |

## 2.1 Electrical characteristics (curves)

**Figure 2: Output characteristics**

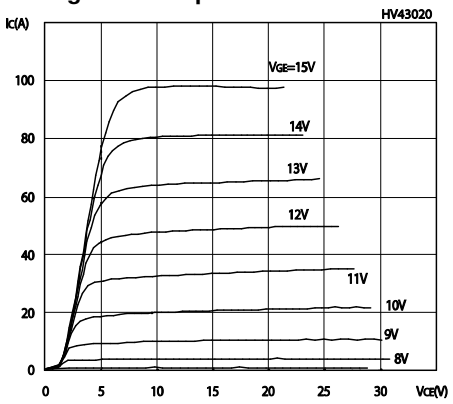



**Figure 3: Transfer characteristics**

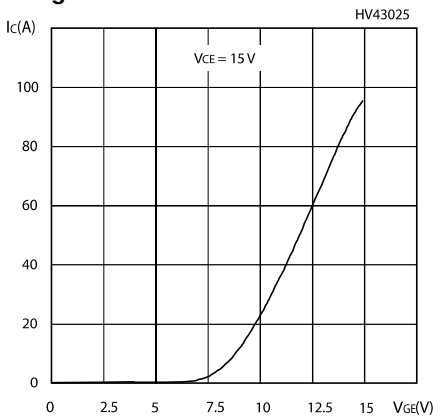



**Figure 4: Collector-emitter on voltage vs temperature**

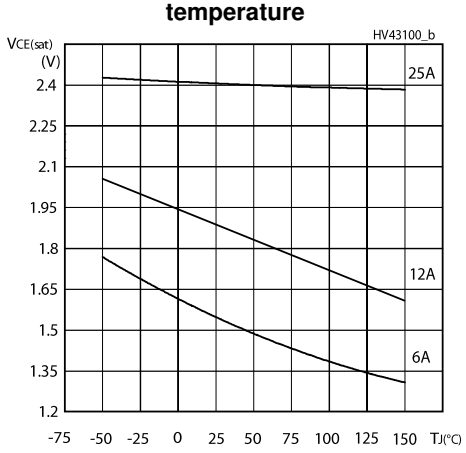



**Figure 5: Gate charge vs gate-source voltage**

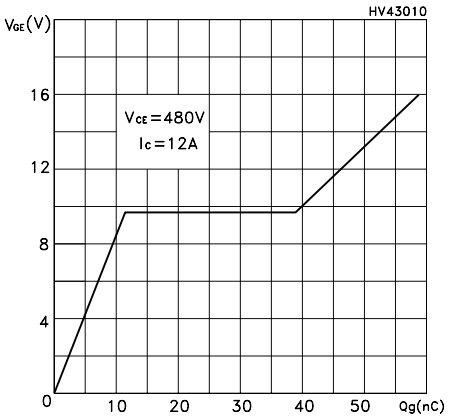



**Figure 6: Capacitance variations**

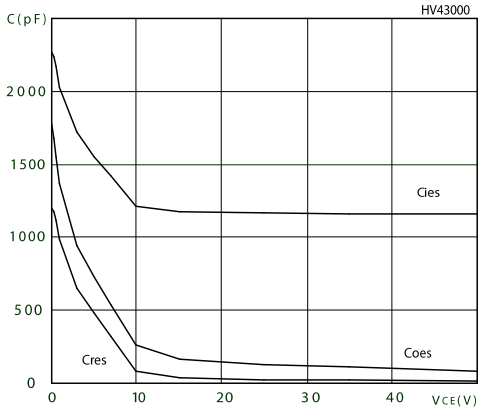



**Figure 7: Normalized gate threshold voltage vs temperature**

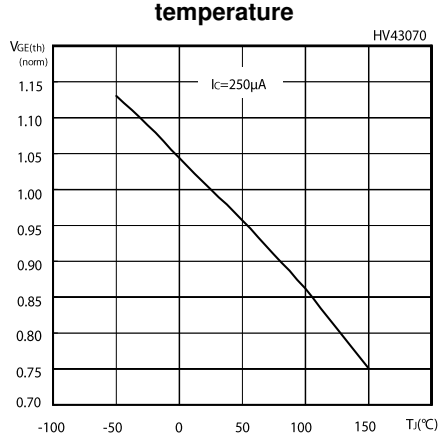


**Figure 8: Collector-emitter on voltage vs collector current**

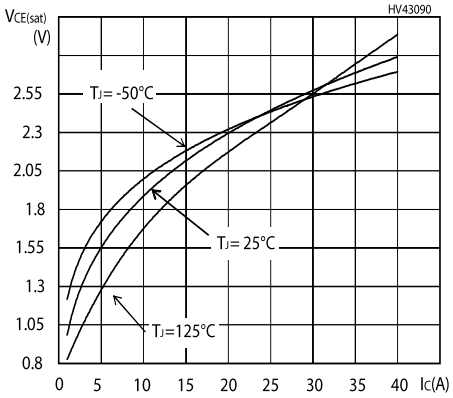



**Figure 9: Normalized breakdown voltage vs temperature**

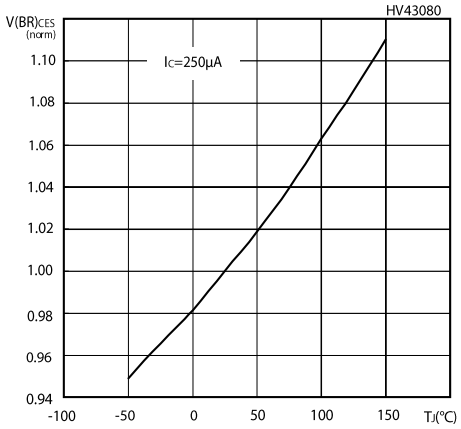



**Figure 10: Switching energy vs temperature**

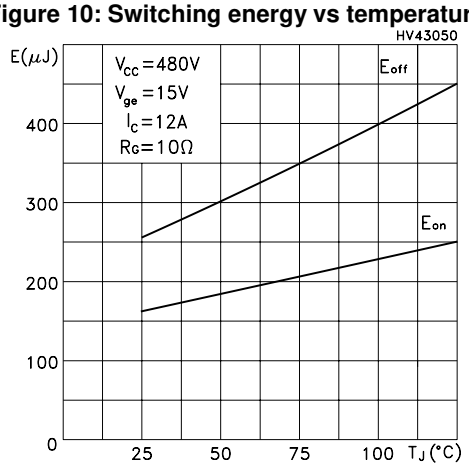



**Figure 11: Switching energy vs. gate resistance**

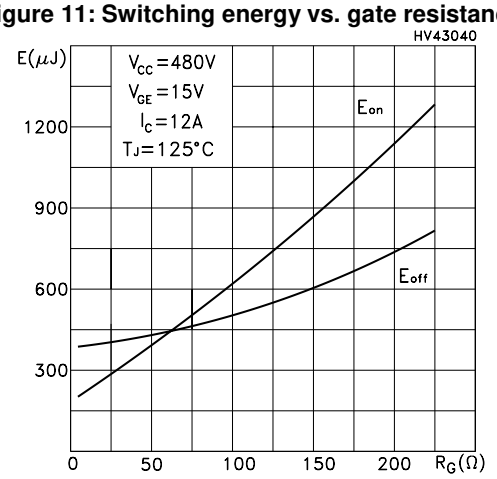



**Figure 12: Switching energy vs collector current**

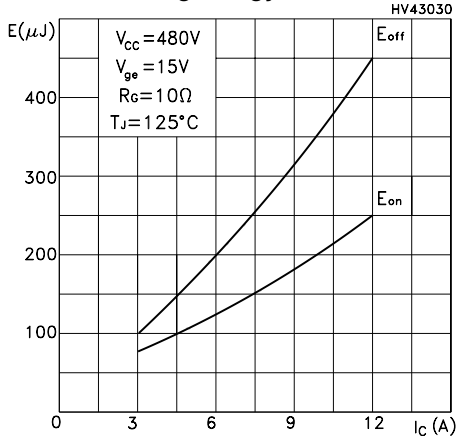



**Figure 13: Turn-off SOA**

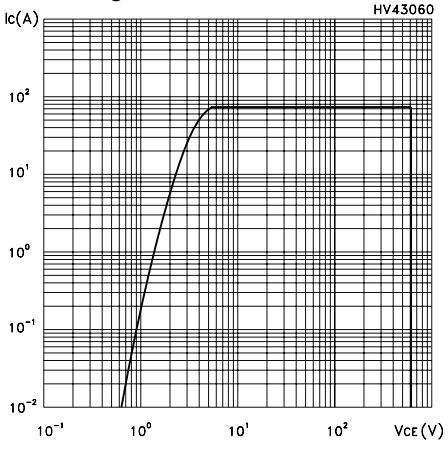


**Figure 14: Emitter-collector diode characteristics**

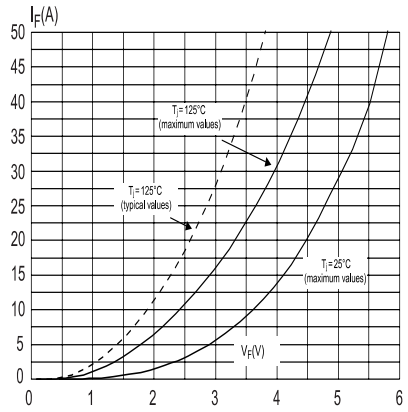



**Figure 15: Thermal impedance for TO-220, D²PAK**

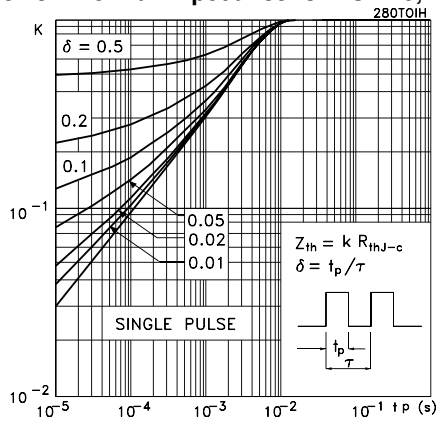



**Figure 16: Thermal impedance for TO-220FP**

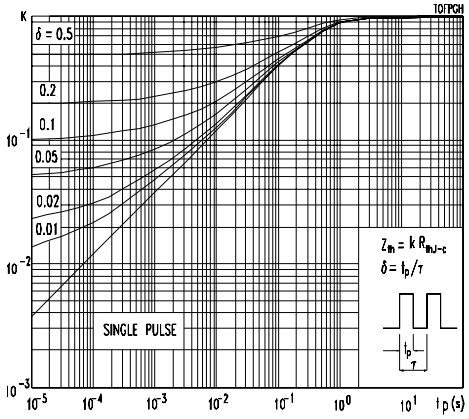



**Figure 17: Maximum DC collector current vs $T_{CASE}$ for TO-220FP**

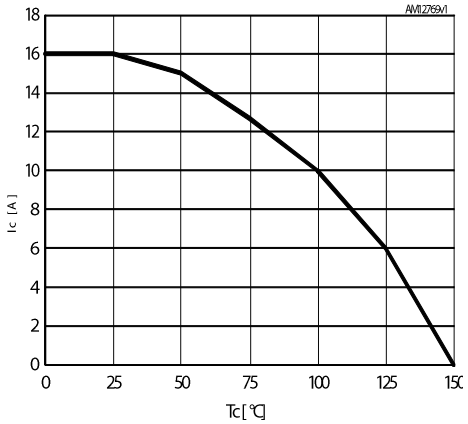
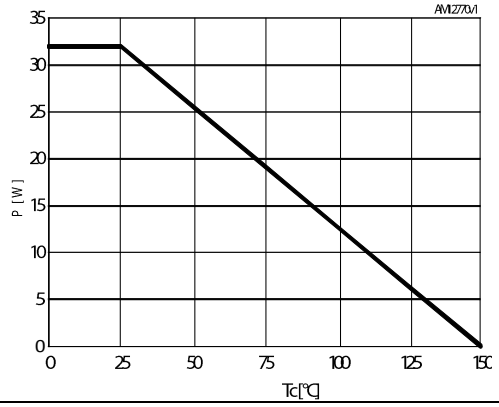



**Figure 18: Maximum power dissipation vs $T_{CASE}$ for TO-220FP**



# 3 Test circuits

**Figure 19: Test circuit for inductive load switching**

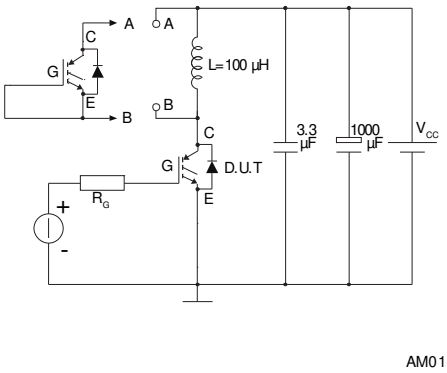



**Figure 20: Gate charge test circuit**

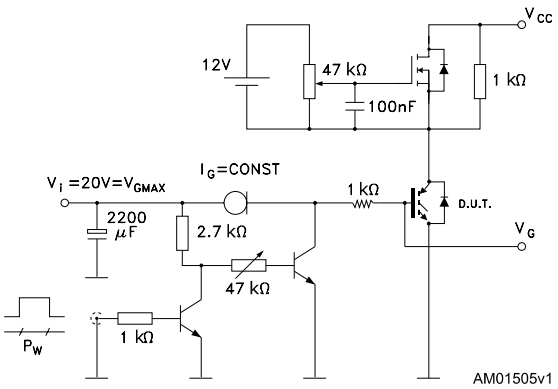



**Figure 21: Switching waveform**

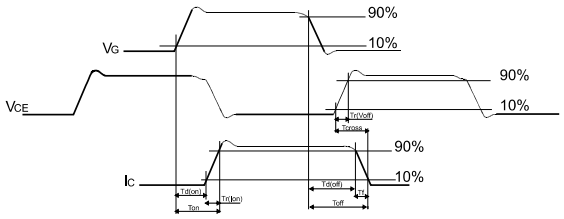
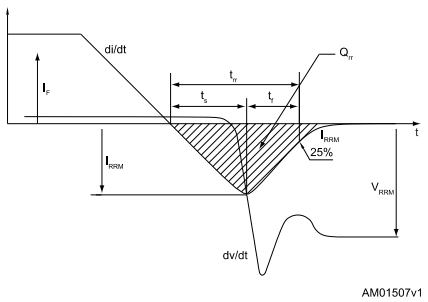



**Figure 22: Diode reverse recovery waveform**



# 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) type A package information

**Figure 23: D²PAK (TO-263) type A package outline**

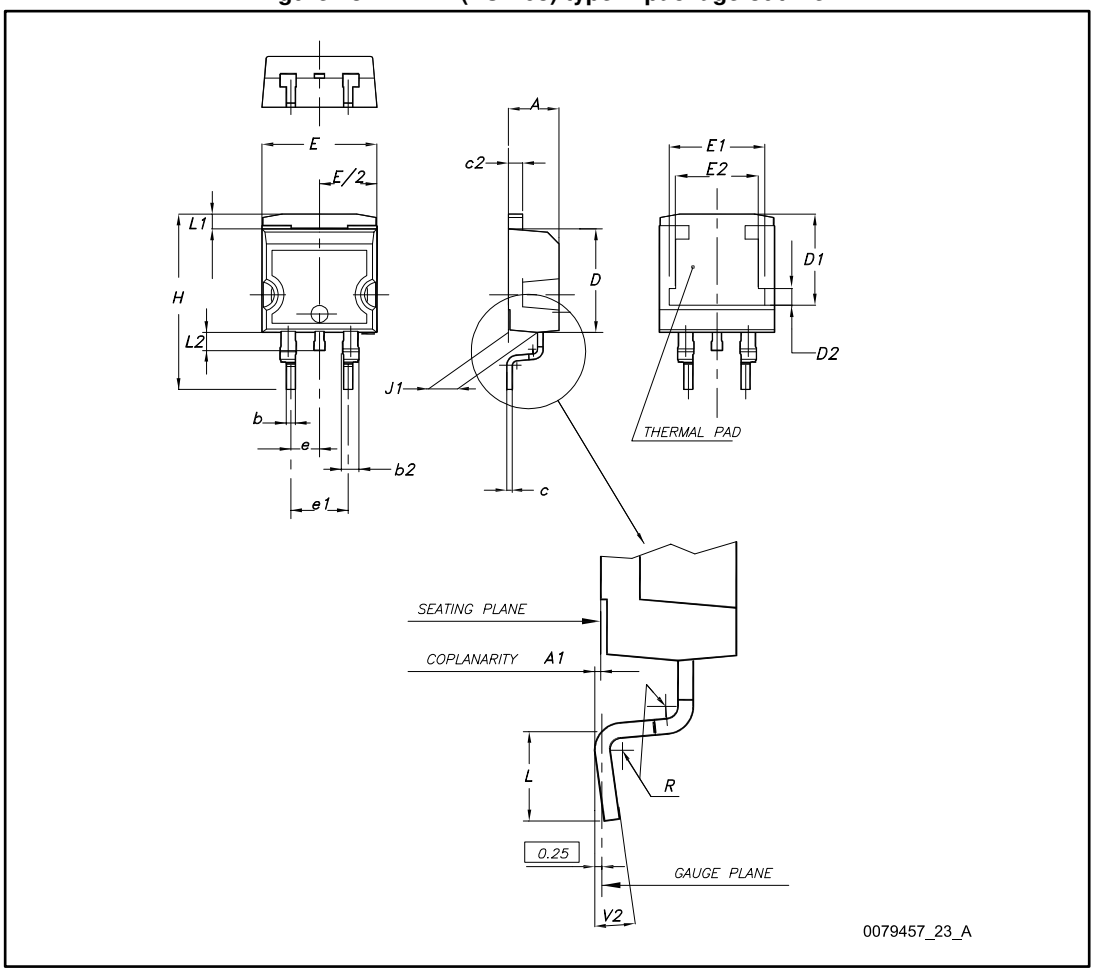
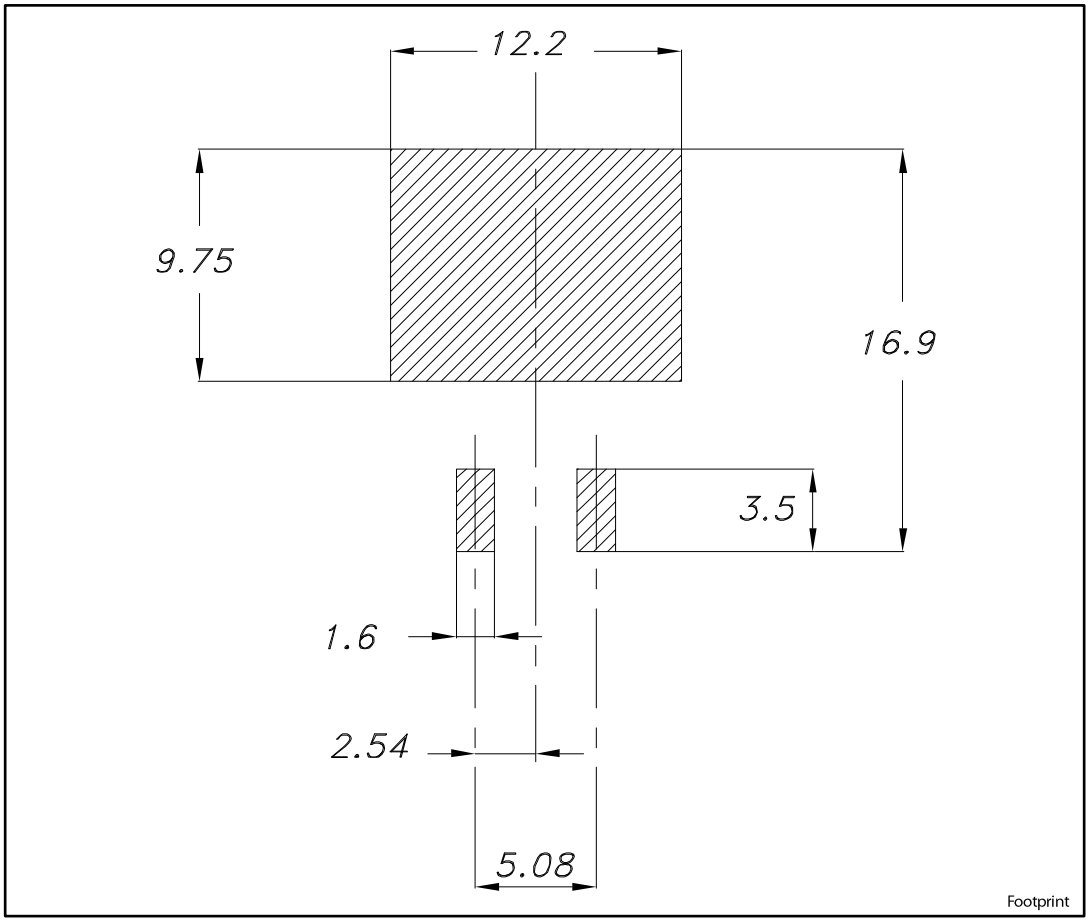


Table 9: D²PAK (TO-263) type A package mechanical data

| 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 | 8.50 | 8.70 | 8.90 |
| 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 24: D²PAK (TO-263) type A recommended footprint (dimensions are in mm)



## 4.2 D²PAK (TO-263) type B package information

**Figure 25: D²PAK (TO-263) type B package outline**

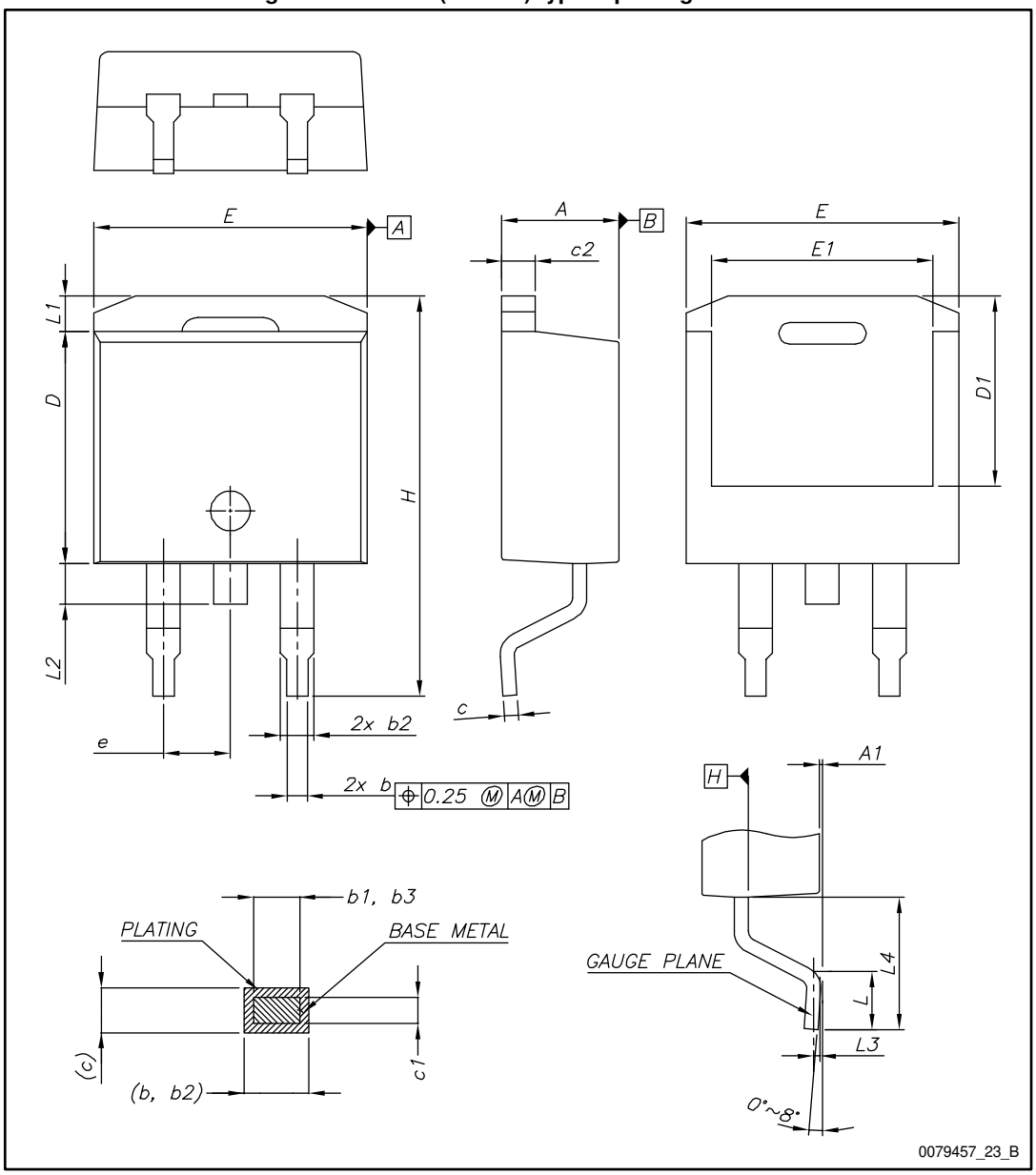
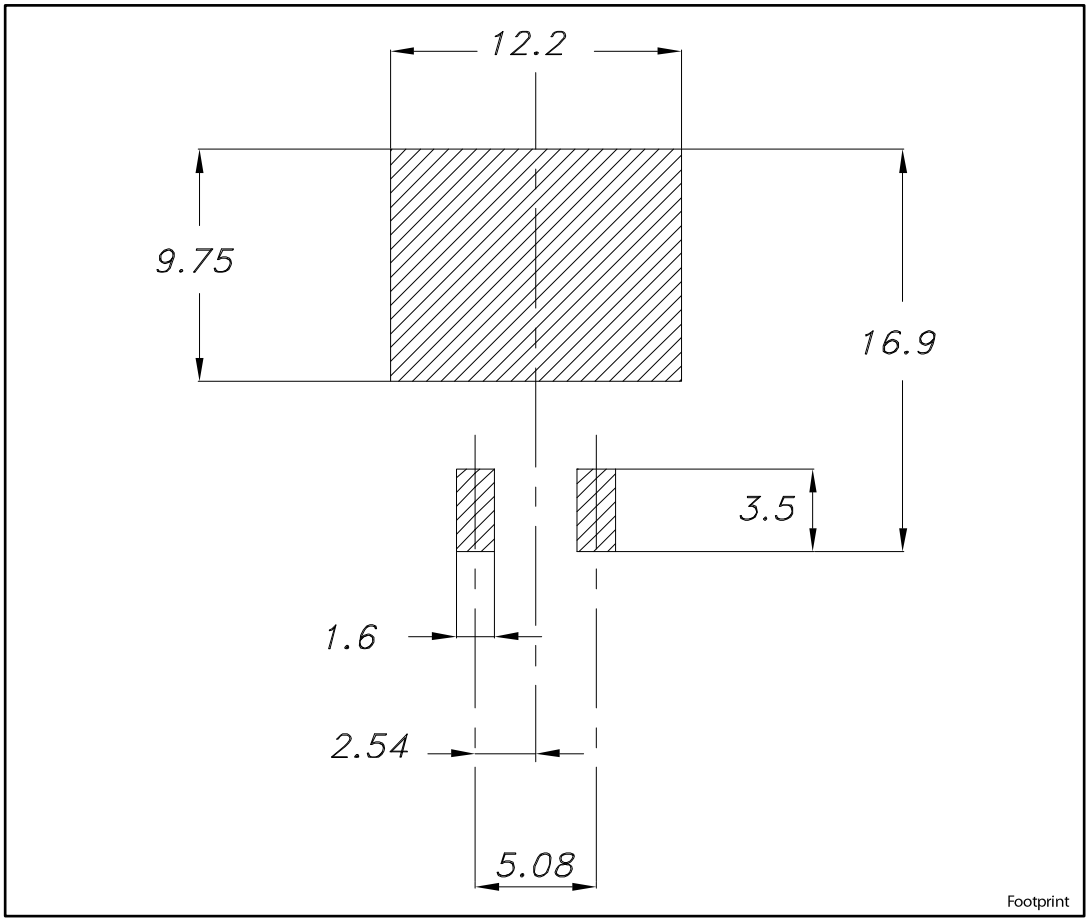


Table 10: D²PAK (TO-263) type B mechanical data

| 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 |
| b3 | 1.36 | | 1.46 |
| 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 26: D²PAK (TO-263) type B recommended footprint (dimensions are in mm)



## 4.3 D²PAK type A packing information

**Figure 27: D²PAK type A tape outline**

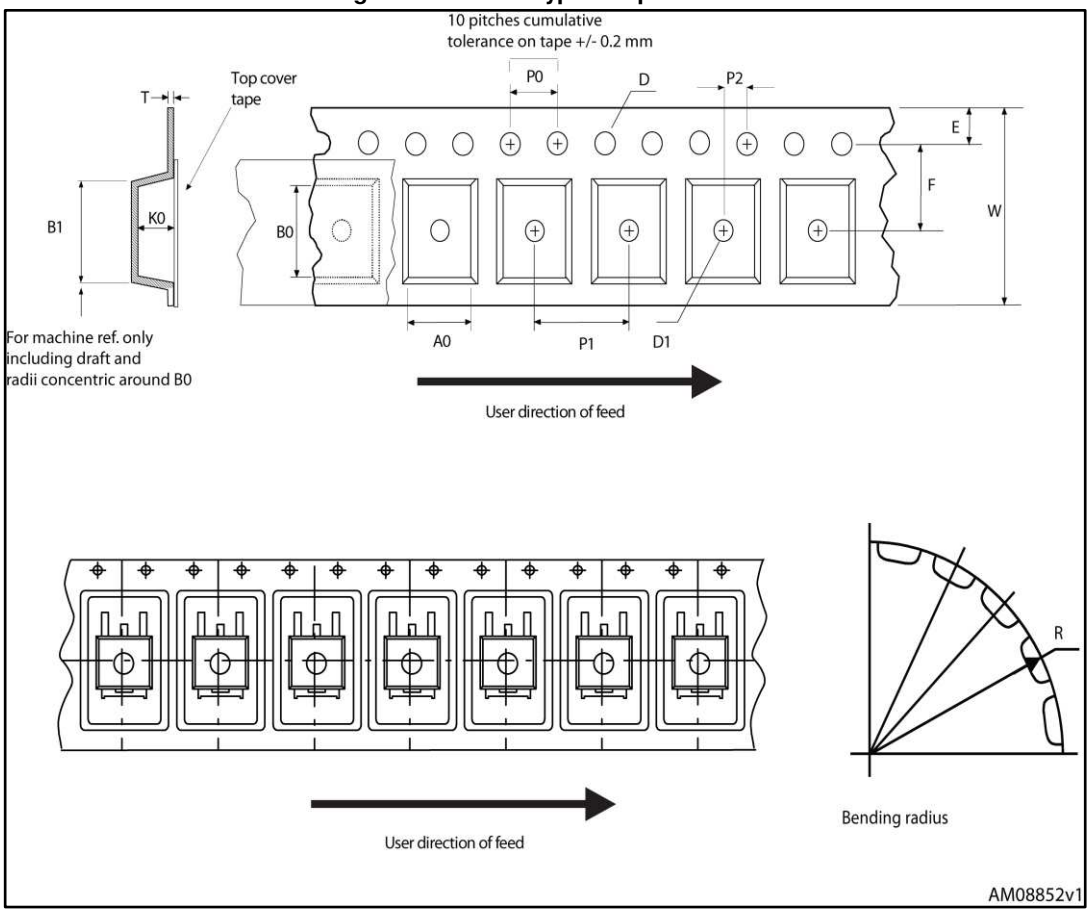


Figure 28: D²PAK type A reel outline

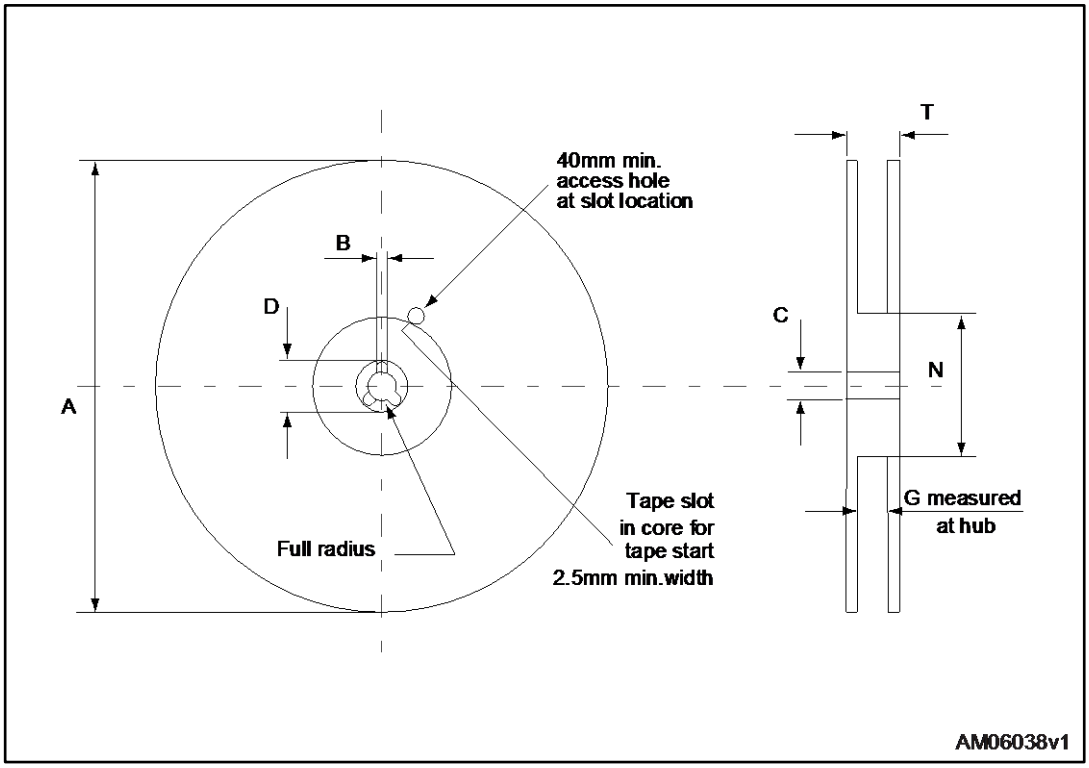



Table 11: D²PAK type A tape and reel mechanical data

| Tape | | | Reel | | |
|---|---|---|---|---|---|
| Dim. | mm | | Dim. | 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 | | | |

## 4.4 D²PAK type B packing information

Figure 29: D²PAK type B tape outline

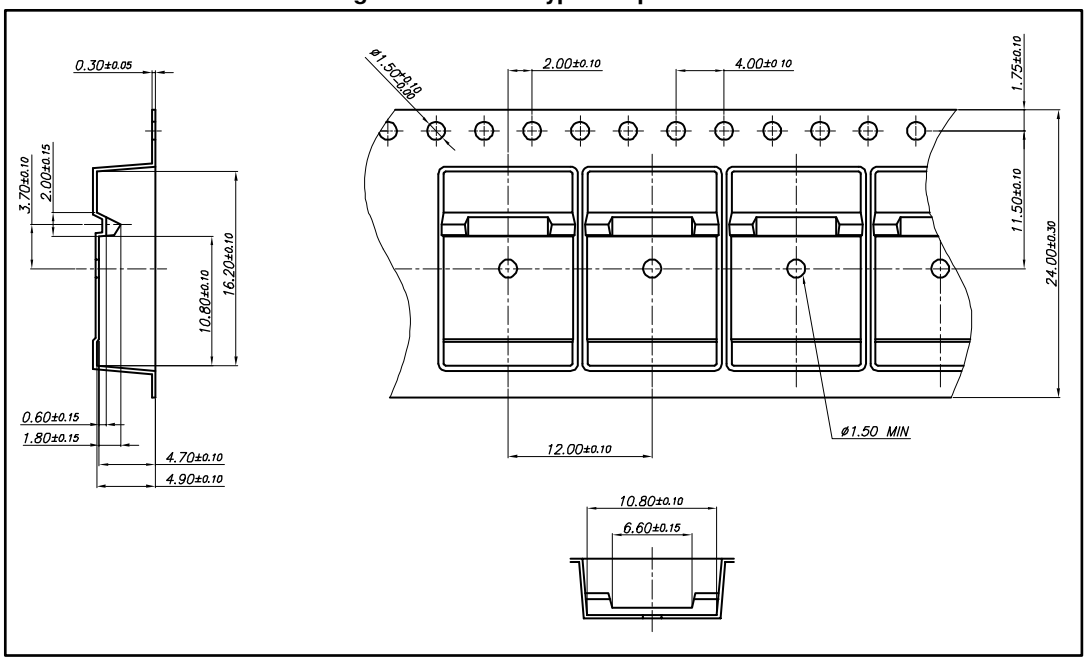



Figure 30: D²PAK type B reel outline

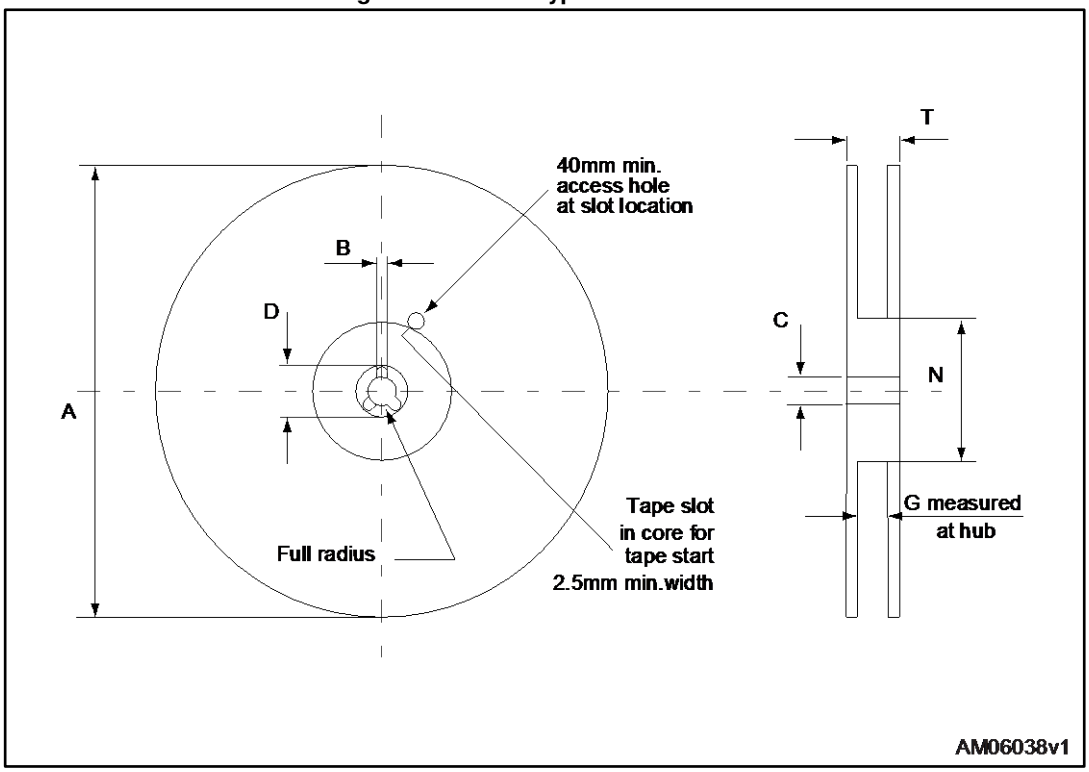


Table 12: D²PAK type B reel mechanical data

| 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 |

## 4.5 TO-220FP package information

Figure 31: TO-220FP package outline

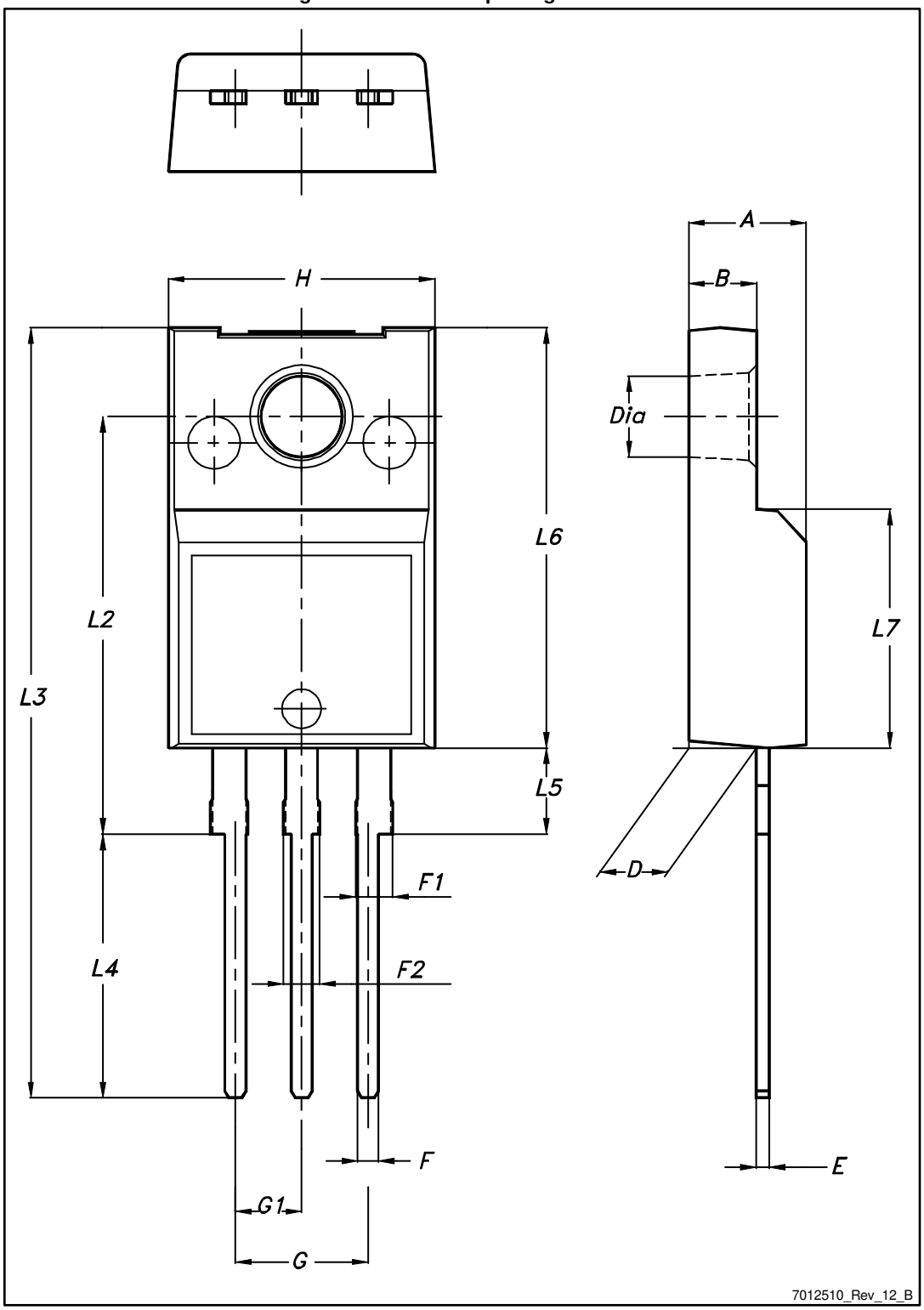


Table 13: TO-220FP package mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.4 | | 4.6 |
| B | 2.5 | | 2.7 |
| D | 2.5 | | 2.75 |
| E | 0.45 | | 0.7 |
| F | 0.75 | | 1 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.2 |
| G1 | 2.4 | | 2.7 |
| H | 10 | | 10.4 |
| L2 | | 16 | |
| L3 | 28.6 | | 30.6 |
| L4 | 9.8 | | 10.6 |
| L5 | 2.9 | | 3.6 |
| L6 | 15.9 | | 16.4 |
| L7 | 9 | | 9.3 |
| Dia | 3 | | 3.2 |

## 4.6 TO-220 type A package information

**Figure 32: TO-220 type A package outline**

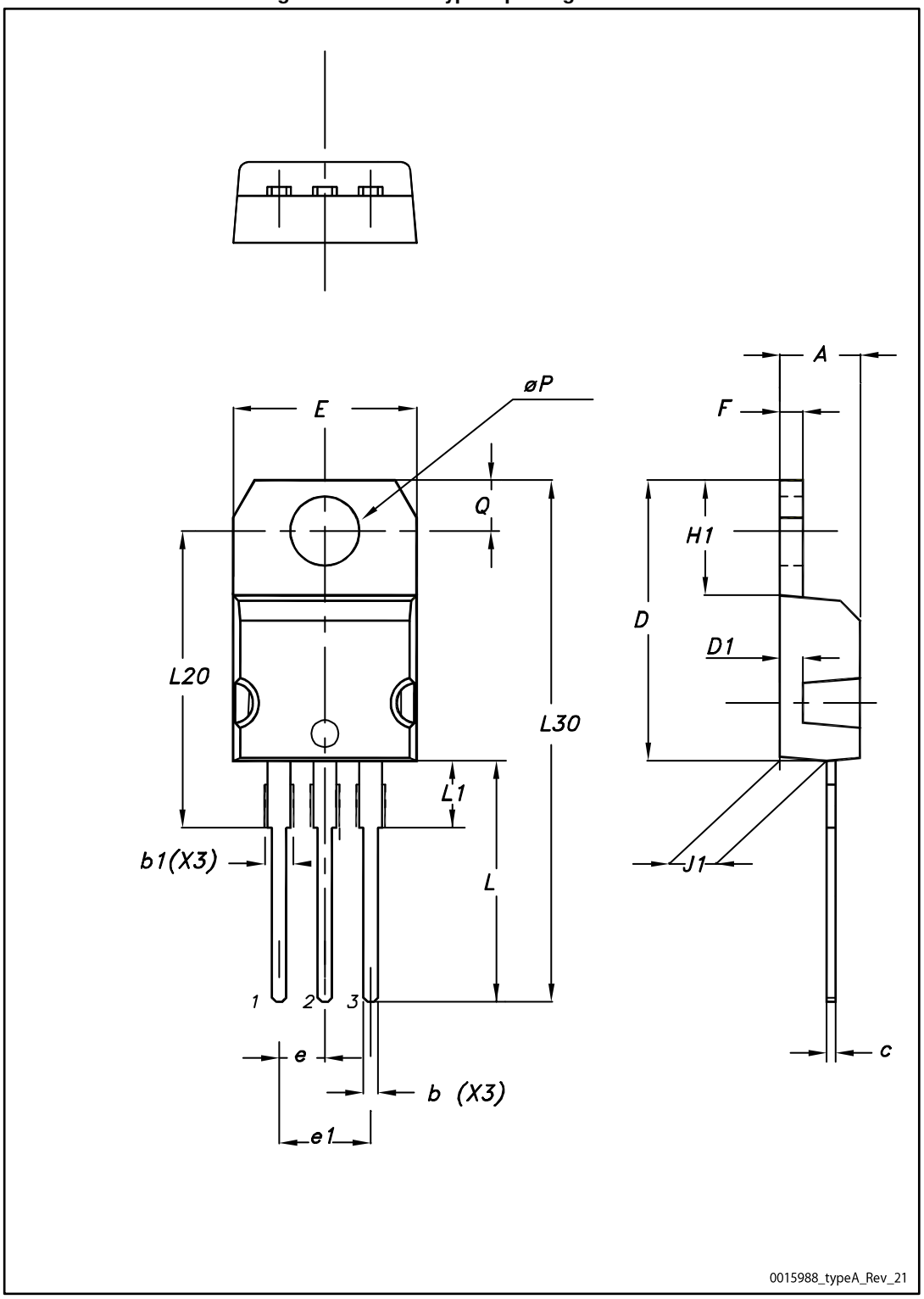


Table 14: TO-220 type A package mechanical data

| 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 |

# 5 Revision history

Table 15: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 08-May-2008 | 1 | Initial release |
| 28-May-2008 | 2 | – Value on Table 3: Thermal resistance has been changed.<br>– Inserted Figure 16: Thermal impedance for TO-220, D²PAK and Figure 17: Thermal impedance for TO-220FP |
| 31-Jul-2012 | 3 | Added: Figure 18 and Figure 19 on page 8. |
| 17-Jul-2017 | 4 | Modified internal schematic diagram on cover page<br>Modified *Table 2: "Absolute maximum ratings"*, *Table 3: "Thermal data"*, and *Table 4: "Static characteristics"*.<br>Modified *Figure 3: "Transfer characteristics"*, *Figure 4: "Collector-emitter on voltage vs temperature"* and *Figure 8: "Collector-emitter on voltage vs collector current"*.<br>Updated *Section 4: "Package information"*.<br>Minor text changes. |

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