

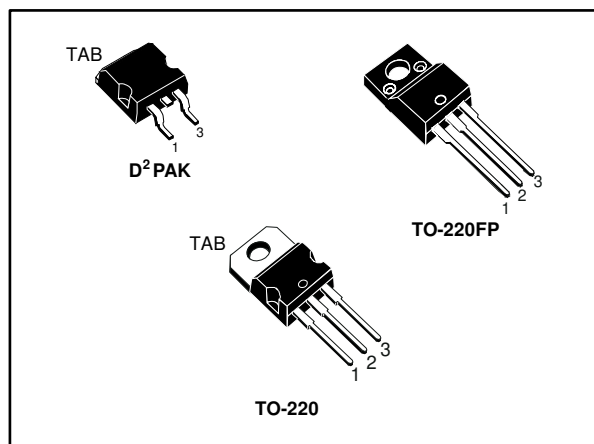
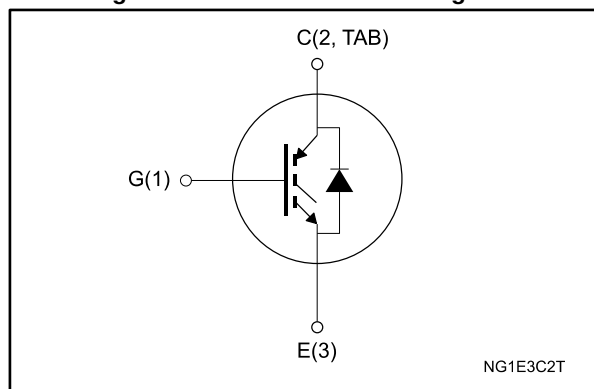


Figure 1: Internal schematic diagram



### Features

- Low on voltage drop ( $V_{CE(sat)}$ )
- Low  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Short-circuit withstand time 10  $\mu s$
- 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   |               |

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol                         | Parameter                                                                                                                    | Value                      |          | Unit |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------|------|
|                                |                                                                                                                              | D <sup>2</sup> PAK, TO-220 | TO-220FP |      |
| V <sub>CES</sub>               | Collector-emitter voltage (V <sub>GE</sub> = 0 V)                                                                            | 600                        |          | V    |
| I <sub>C</sub> <sup>(1)</sup>  | Continuous collector current at T <sub>C</sub> = 25 °C                                                                       | 35                         | 16       | A    |
|                                | Continuous collector current at T <sub>C</sub> = 100 °C                                                                      | 20                         | 10       | A    |
| I <sub>CL</sub> <sup>(2)</sup> | Turn-off latching current                                                                                                    | 75                         |          | A    |
| I <sub>CP</sub> <sup>(3)</sup> | Pulsed collector current                                                                                                     | 75                         |          | A    |
| V <sub>GE</sub>                | Gate-emitter voltage                                                                                                         | ±20                        |          | V    |
| I <sub>F</sub>                 | Diode RMS forward current at T <sub>C</sub> = 25 °C                                                                          | 20                         |          | A    |
| I <sub>FSM</sub>               | Surge non repetitive forward current t <sub>p</sub> = 10 ms sinusoidal                                                       | 50                         |          | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                                  | 125                        | 32       | W    |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat-sink (t = 1 s; T <sub>C</sub> = 25 °C)              |                            | 2500     | V    |
| t <sub>scw</sub>               | Short-circuit withstand time V <sub>CE</sub> = 300 V, T <sub>J</sub> = 125 °C, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 12 V | 10                         |          | μs   |
| T <sub>stg</sub>               | Storage temperature range                                                                                                    | - 55 to 150                |          | °C   |
| T <sub>J</sub>                 | Operating junction temperature range                                                                                         |                            |          |      |

**Notes:**

<sup>(1)</sup>Calculated according to the iterative formula:

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

<sup>(2)</sup>V<sub>clamp</sub> = 80 % V<sub>CES</sub>, V<sub>GE</sub> = 15 V, R<sub>G</sub> = 10 Ω, T<sub>J</sub> = 150 °C.

<sup>(3)</sup>Pulse width limited by maximum junction temperature.

Table 3: Thermal data

| Symbol                | Parameter                              | Value                      |          | Unit |
|-----------------------|----------------------------------------|----------------------------|----------|------|
|                       |                                        | D <sup>2</sup> PAK, TO-220 | TO-220FP |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case IGBT  | 1                          | 3.9      | °C/W |
| R <sub>thj-case</sub> | Thermal resistance junction-case diode | 3                          | 5.6      |      |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient    | 62.5                       |          |      |

## 2 Electrical characteristics

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

Table 4: Static characteristics

| Symbol        | Parameter                            | Test conditions                                                                                         | Min. | Typ. | Max.      | Unit          |
|---------------|--------------------------------------|---------------------------------------------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage  | $I_C = 1\text{ mA}$ , $V_{GE} = 0\text{ V}$                                                             | 600  |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 12\text{ A}$                                                            |      | 2.0  | 2.75      | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$T_C = 125\text{ }^{\circ}\text{C}$                   |      | 1.65 |           |               |
| $V_{GE(th)}$  | 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            | $V_{CE} = 600\text{ V}$ , $V_{GE} = 0\text{ V}$                                                         |      |      | 150       | $\mu\text{A}$ |
|               |                                      | $V_{CE} = 600\text{ V}$ , $V_{GE} = 0\text{ V}$ ,<br>$T_C = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 1         | mA            |
| $I_{GES}$     | Gate-emitter leakage current         | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$                                                      |      |      | $\pm 100$ | nA            |

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

Table 5: Dynamic characteristics

| Symbol    | Parameter                    | Test conditions                                                                                                                                       | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0\text{ V}$                                                                                | -    | 1170 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                                       | -    | 127  | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                                       | -    | 28   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CE} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$V_{GE} = 0\text{ to }15\text{ V}$<br>(see <a href="#">Figure 20: "Gate charge test circuit"</a> ) | -    | 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    | $V_{CC} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$R_G = 10\ \Omega$ ,<br>$V_{GE} = 15\text{ V}$<br>(see <a href="#">Figure 19: "Test circuit for inductive load switching"</a> and <a href="#">Figure 21: "Switching waveform"</a> )                                     | -    | 30   | -    | ns         |
| $t_r$          | Current rise time     |                                                                                                                                                                                                                                                                            | -    | 8    | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope |                                                                                                                                                                                                                                                                            | -    | 1450 | -    | A/ $\mu$ s |
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$R_G = 10\ \Omega$ ,<br>$V_{GE} = 15\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 19: "Test circuit for inductive load switching"</a> and <a href="#">Figure 21: "Switching waveform"</a> ) | -    | 30   | -    | ns         |
| $t_r$          | Current rise time     |                                                                                                                                                                                                                                                                            | -    | 8    | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope |                                                                                                                                                                                                                                                                            | -    | 1380 | -    | A/ $\mu$ s |
| $t_{r(Voff)}$  | Off voltage rise time | $V_{CC} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>(see <a href="#">Figure 19: "Test circuit for inductive load switching"</a> and <a href="#">Figure 21: "Switching waveform"</a> )                                        | -    | 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 | $V_{CC} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 19: "Test circuit for inductive load switching"</a> and <a href="#">Figure 21: "Switching waveform"</a> )    | -    | 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  | $V_{CC} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>(see <a href="#">Figure 19: "Test circuit for inductive load switching"</a> )                                        | -    | 165  | -    | $\mu$ J |
| $E_{off(2)}$ | Turn-off switching energy |                                                                                                                                                                                                                        | -    | 255  | -    | $\mu$ J |
| $E_{ts}$     | Total switching energy    |                                                                                                                                                                                                                        | -    | 420  | -    | $\mu$ J |
| $E_{on(1)}$  | Turn-on switching energy  | $V_{CC} = 480\text{ V}$ , $I_C = 12\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 19: "Test circuit for inductive load switching"</a> ) | -    | 250  | -    | $\mu$ J |
| $E_{off(2)}$ | Turn-off switching energy |                                                                                                                                                                                                                        | -    | 445  | -    | $\mu$ J |
| $E_{ts}$     | Total switching energy    |                                                                                                                                                                                                                        | -    | 695  | -    | $\mu$ J |

**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       | $I_F=12\text{ A}$                                                                                                                                                        | -    | 1.9  | -    | V    |
|           |                          | $I_F=12\text{ A}$ , $T_C=125\text{ °C}$                                                                                                                                  | -    | 1.6  | -    | V    |
| $t_{rr}$  | Reverse recovery time    | $I_F=12\text{ A}$ , $V_R=40\text{ V}$ , $di/dt=100\text{ A}/\mu\text{s}$<br>(see <a href="#">Figure 22: "Diode reverse recovery waveform"</a> )                          | -    | 31   | -    | ns   |
| $Q_{rr}$  | Reverse recovery charge  |                                                                                                                                                                          | -    | 30   | -    | nC   |
| $I_{rrm}$ | Reverse recovery current |                                                                                                                                                                          | -    | 2    | -    | A    |
| $t_{rr}$  | Reverse recovery time    | $I_F=12\text{ A}$ , $V_R=40\text{ V}$ , $T_C=125\text{ °C}$ ,<br>$di/dt=100\text{ A}/\mu\text{s}$<br>(see <a href="#">Figure 22: "Diode reverse recovery waveform"</a> ) | -    | 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

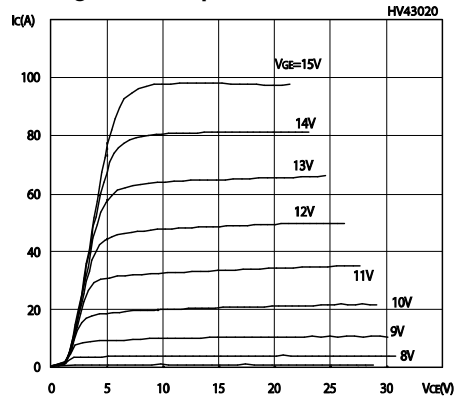


Figure 3: Transfer characteristics

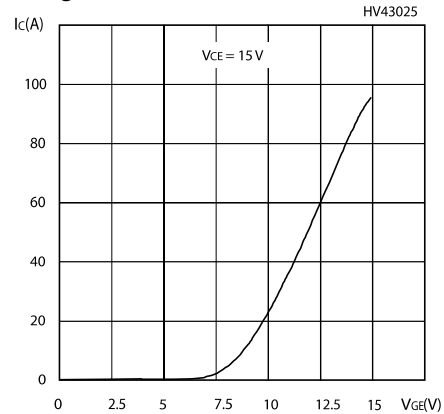


Figure 4: Collector-emitter on voltage vs temperature

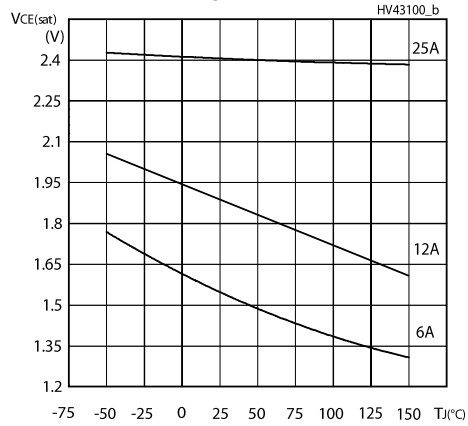


Figure 5: Gate charge vs gate-source voltage

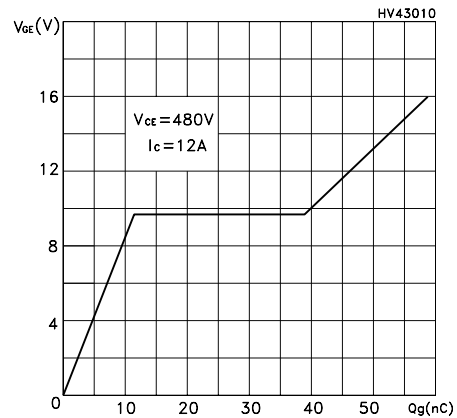


Figure 6: Capacitance variations

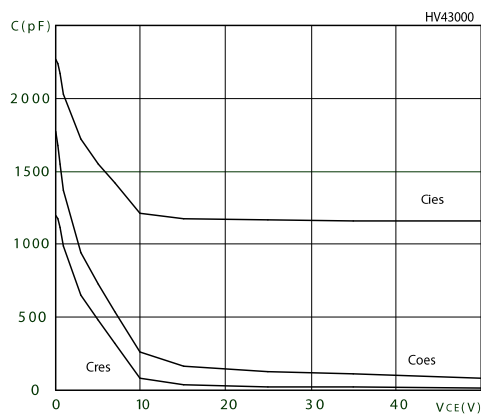


Figure 7: Normalized gate threshold voltage vs temperature

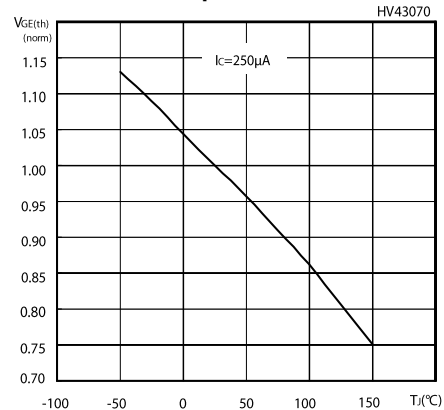


Figure 8: Collector-emitter on voltage vs collector current

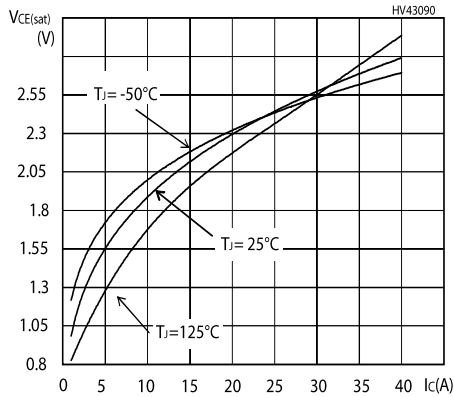


Figure 9: Normalized breakdown voltage vs temperature

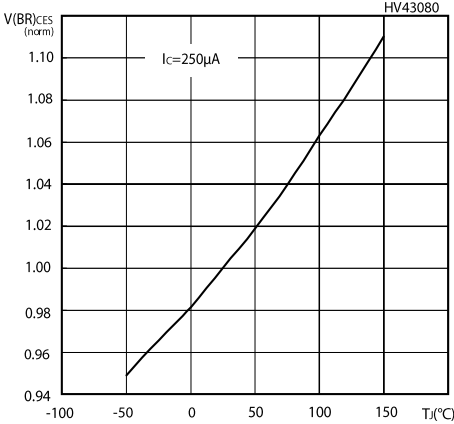


Figure 10: Switching energy vs temperature

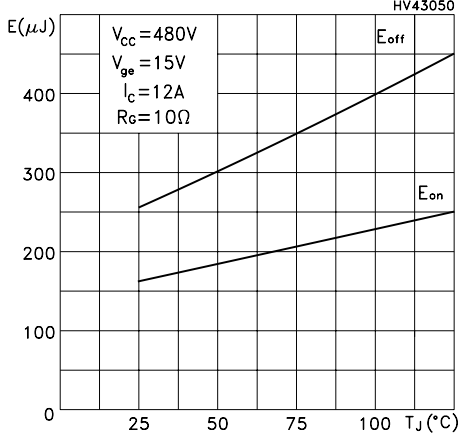


Figure 11: Switching energy vs. gate resistance

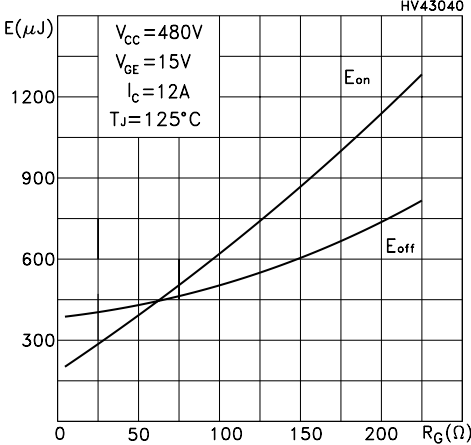


Figure 12: Switching energy vs collector current

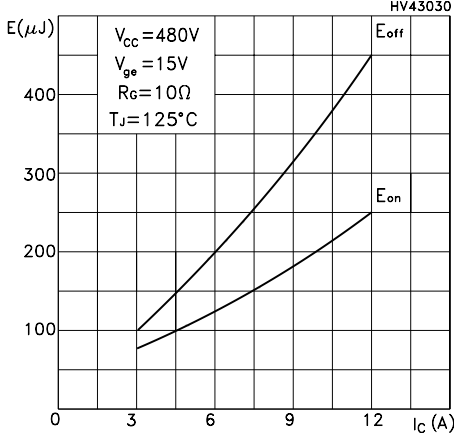


Figure 13: Turn-off SOA

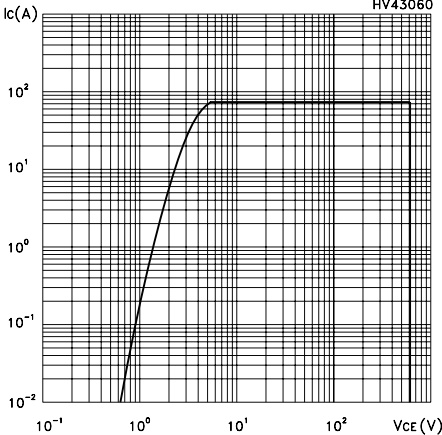




Figure 14: Emitter-collector diode characteristics

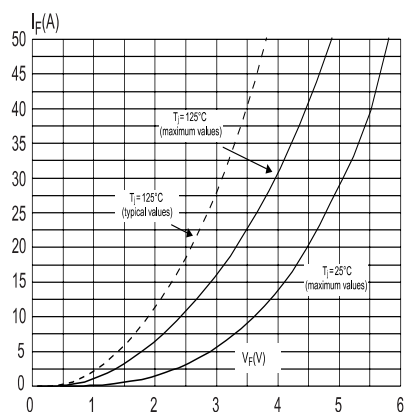


Figure 15: Thermal impedance for TO-220, D<sup>2</sup>PAK

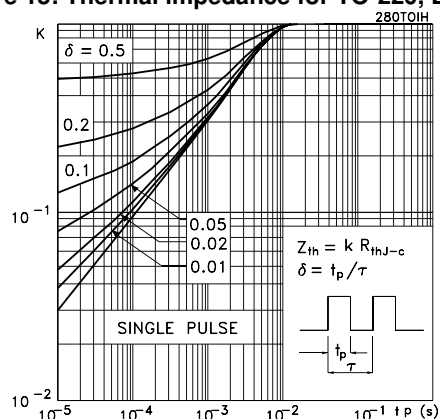


Figure 16: Thermal impedance for TO-220FP

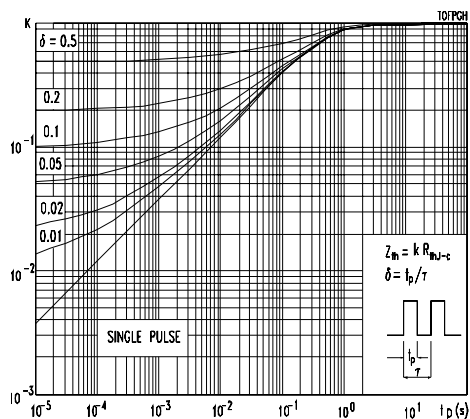


Figure 17: Maximum DC collector current vs  $T_{CASE}$  for TO-220FP

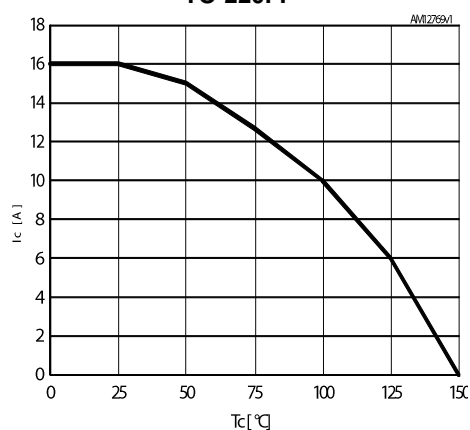
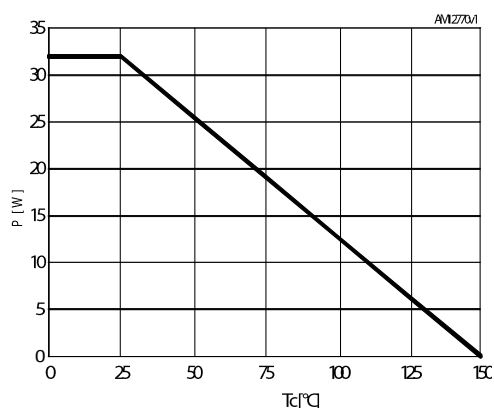


Figure 18: Maximum power dissipation vs  $T_{CASE}$  for TO-220FP



AM01507v1

## 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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 D<sup>2</sup>PAK (TO-263) type A package information

Figure 23: D<sup>2</sup>PAK (TO-263) type A package outline

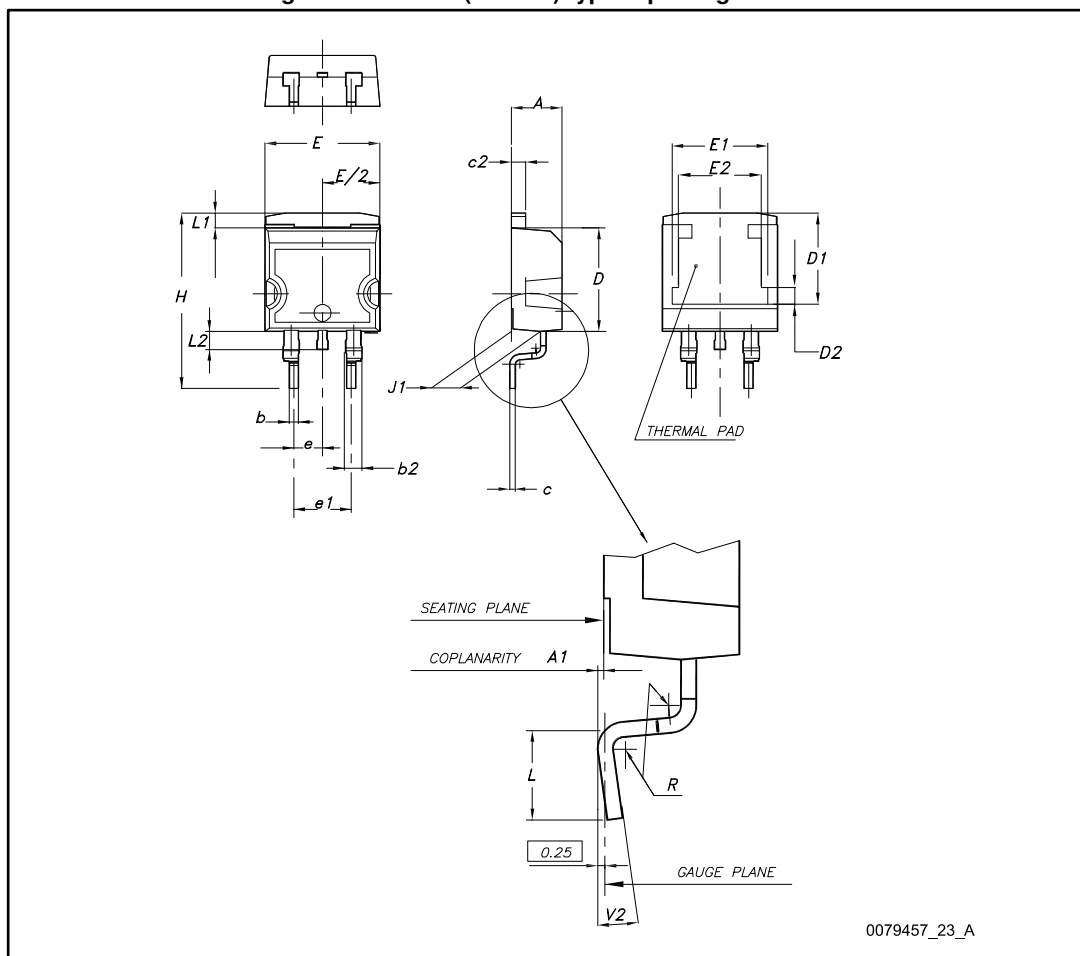
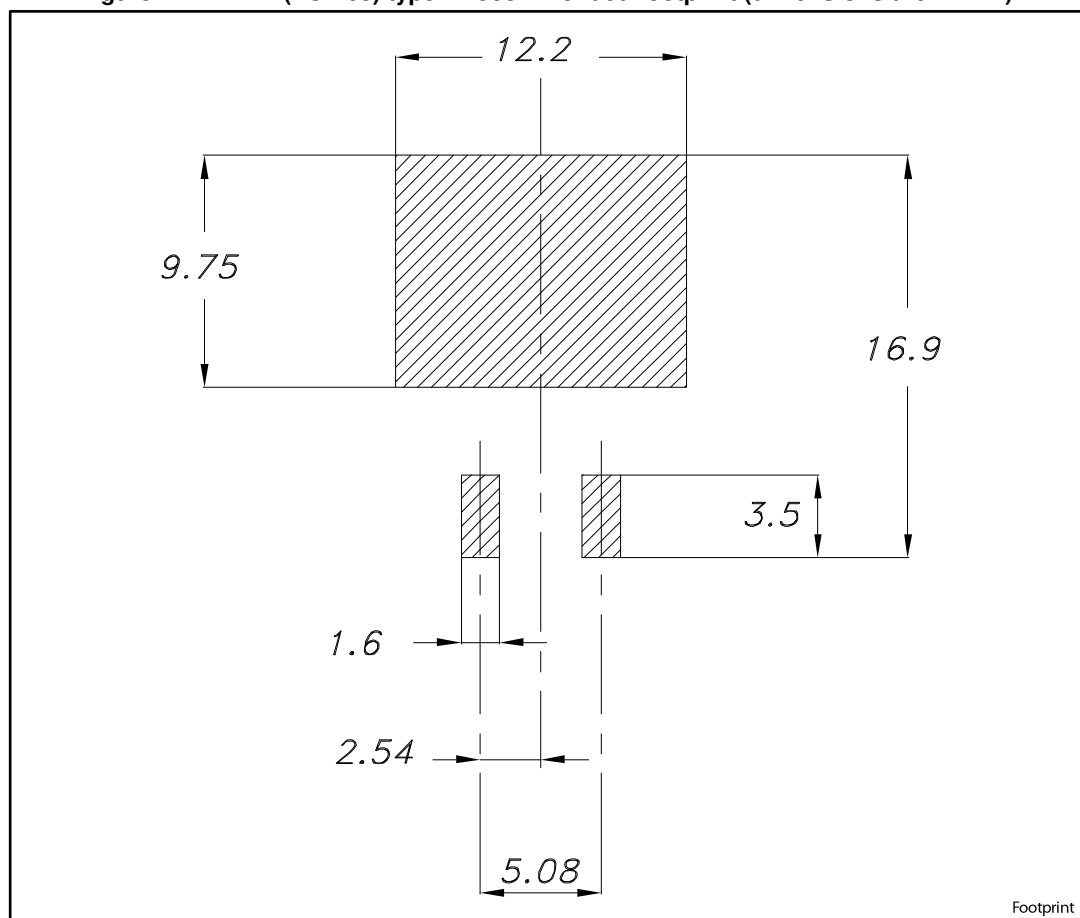


Table 9: D<sup>2</sup>PAK (TO-263) type A package mechanical data

| 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: D<sup>2</sup>PAK (TO-263) type A recommended footprint (dimensions are in mm)



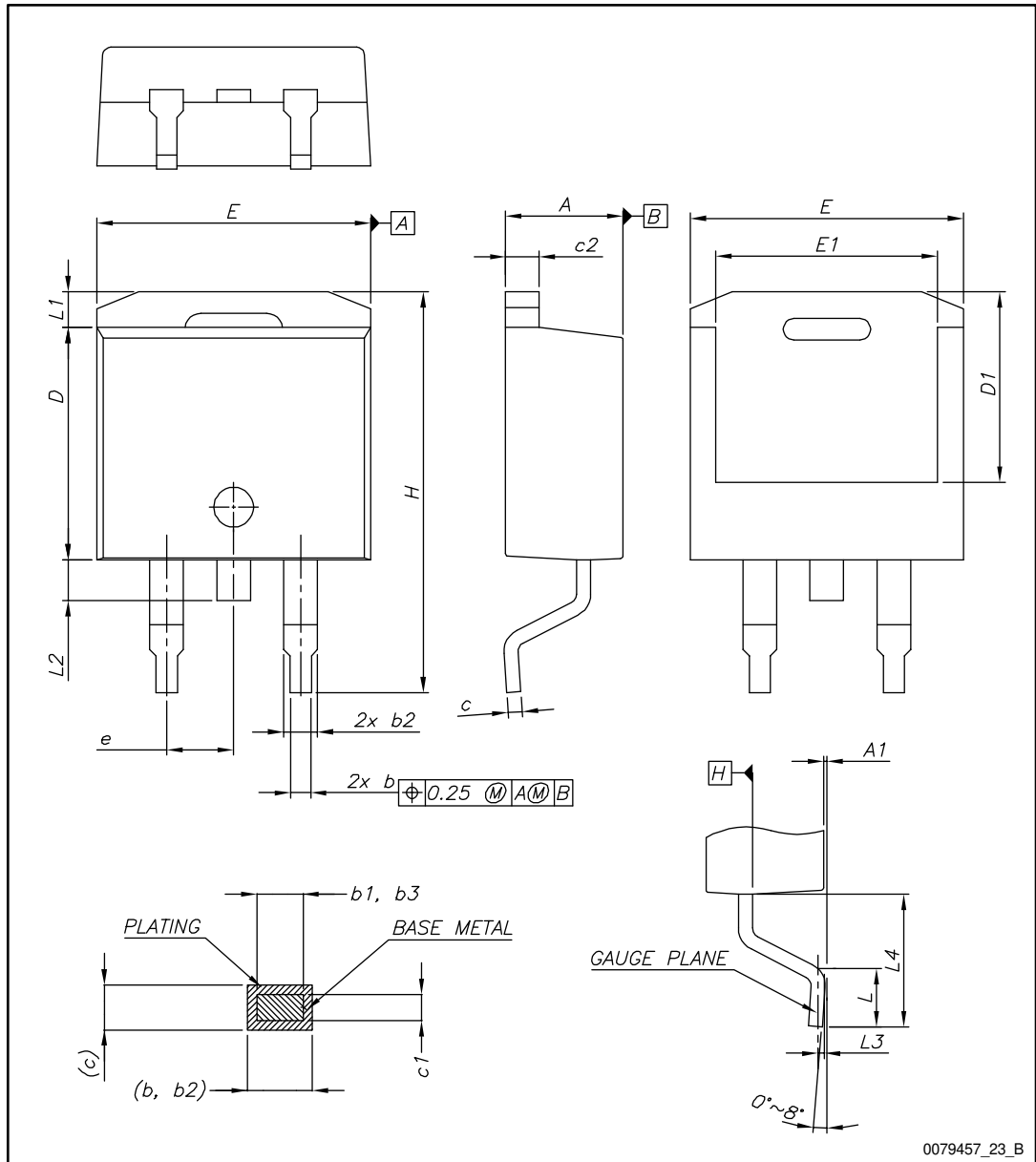
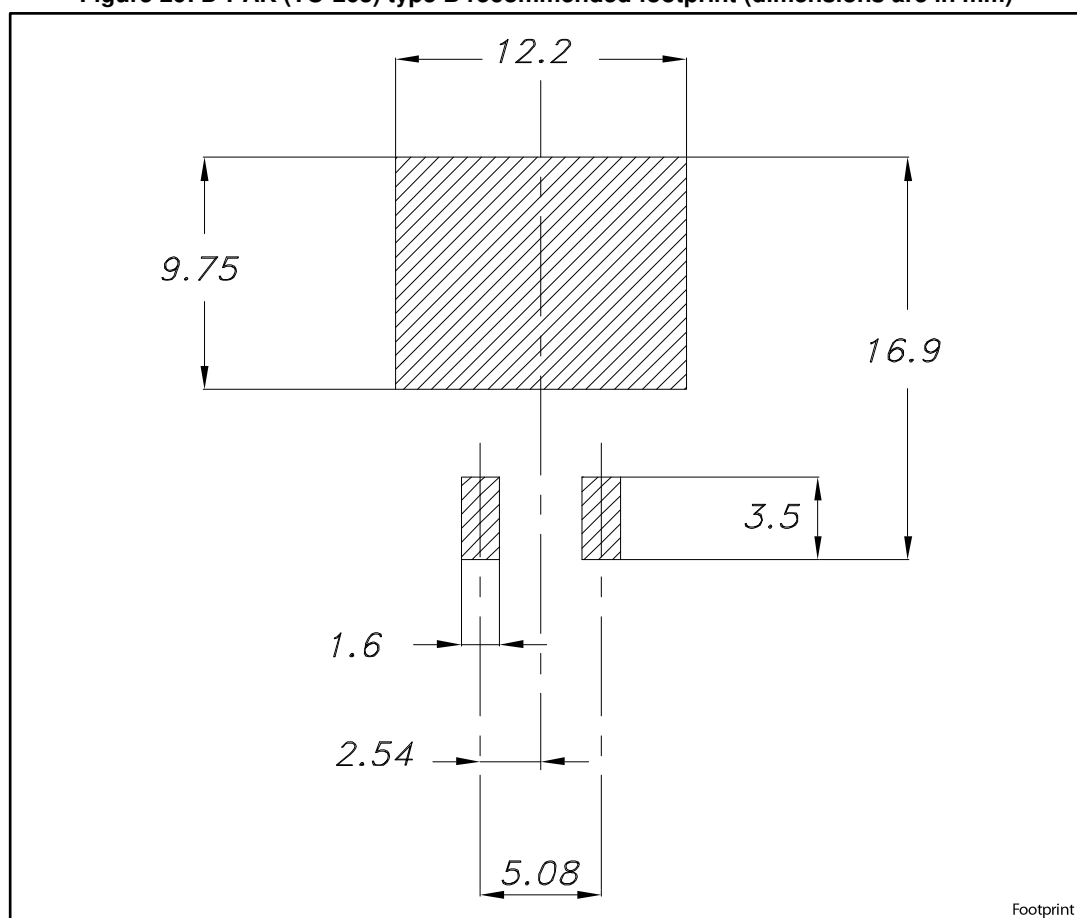
4.2 D<sup>2</sup>PAK (TO-263) type B package informationFigure 25: D<sup>2</sup>PAK (TO-263) type B package outline

Table 10: D<sup>2</sup>PAK (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: D<sup>2</sup>PAK (TO-263) type B recommended footprint (dimensions are in mm)



### 4.3 D<sup>2</sup>PAK type A packing information

Figure 27: D<sup>2</sup>PAK type A tape outline

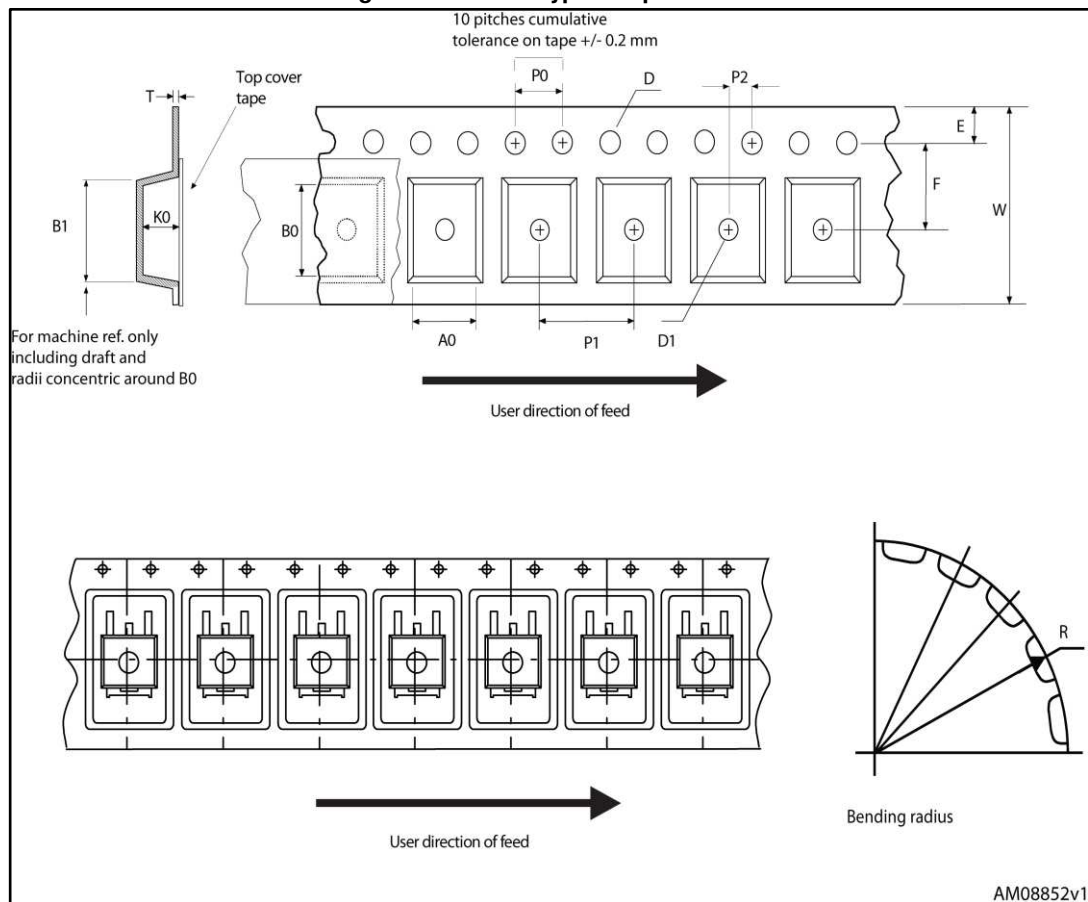
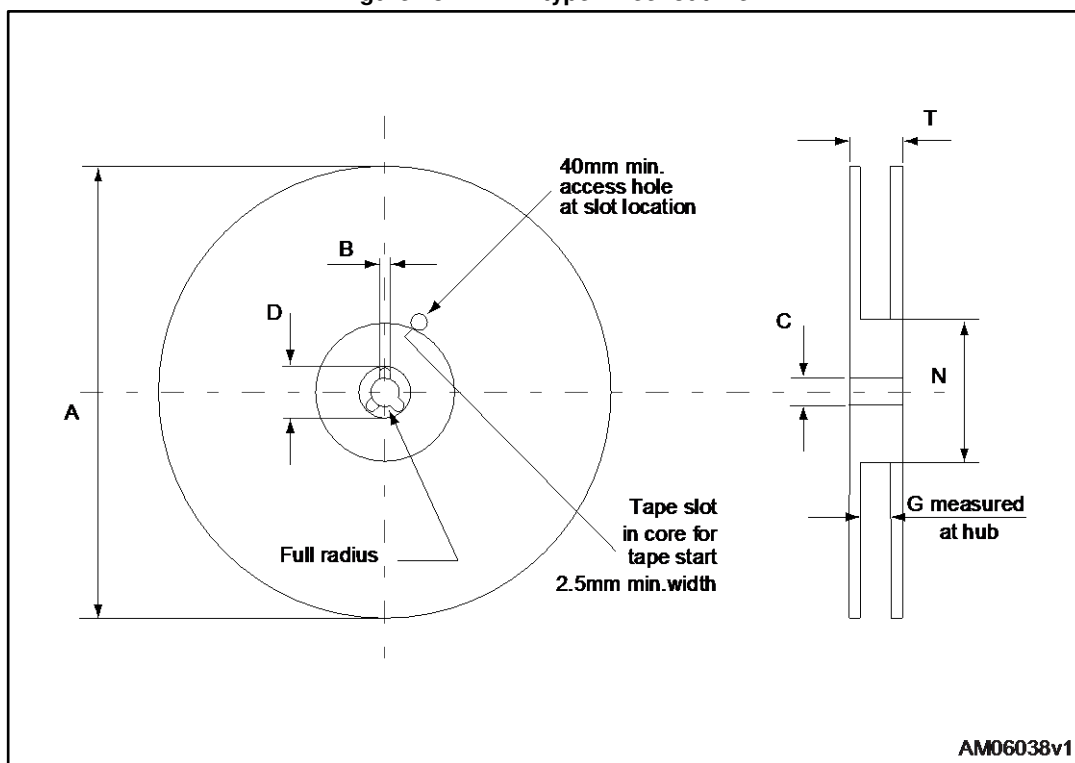
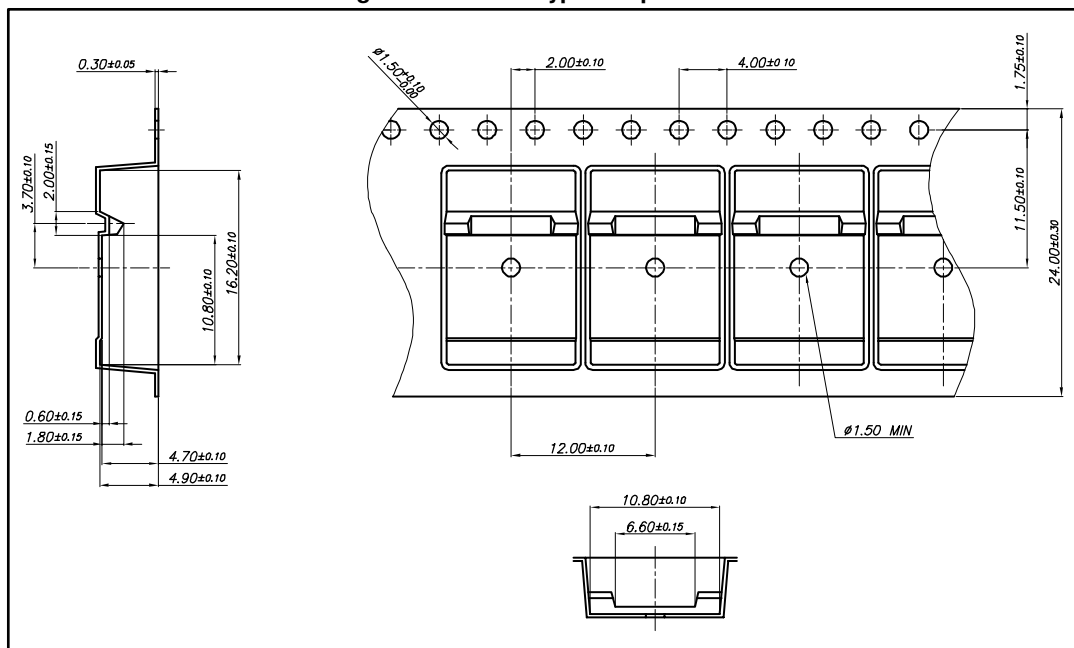


Figure 28: D<sup>2</sup>PAK type A reel outlineTable 11: D<sup>2</sup>PAK type A tape and reel mechanical data

| 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 D<sup>2</sup>PAK type B packing information

**Figure 29: D<sup>2</sup>PAK type B tape outline**



**Figure 30: D<sup>2</sup>PAK type B reel outline**

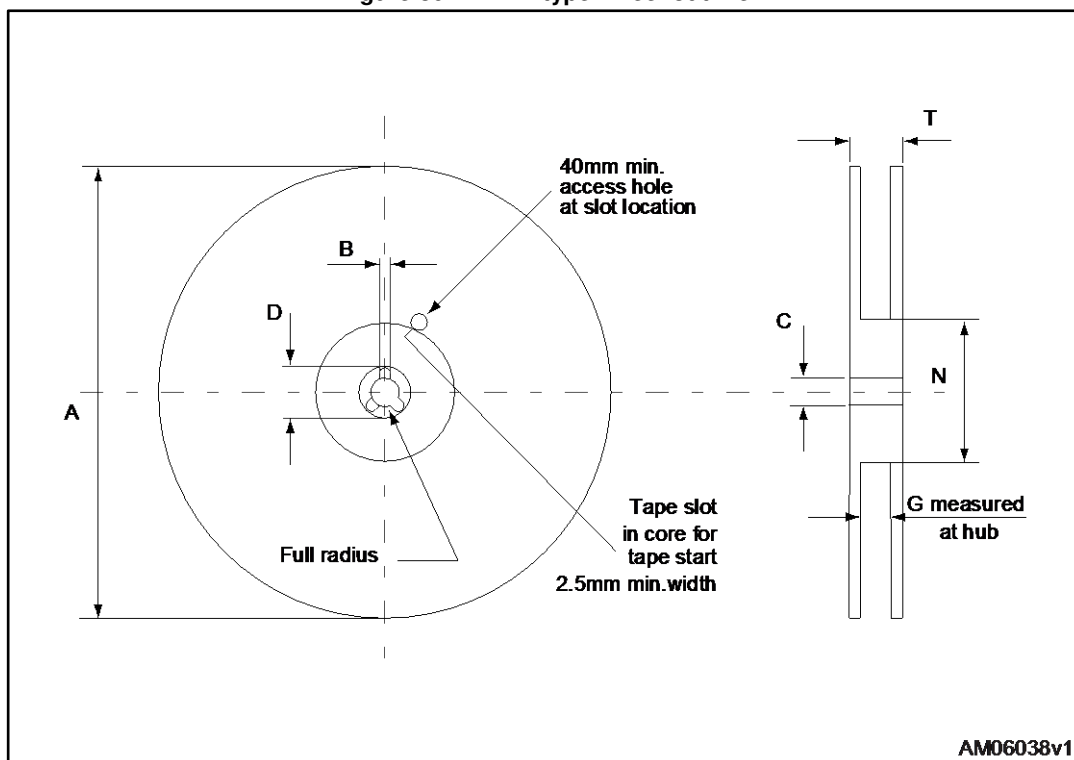


Table 12: D<sup>2</sup>PAK type B reel mechanical data

| 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

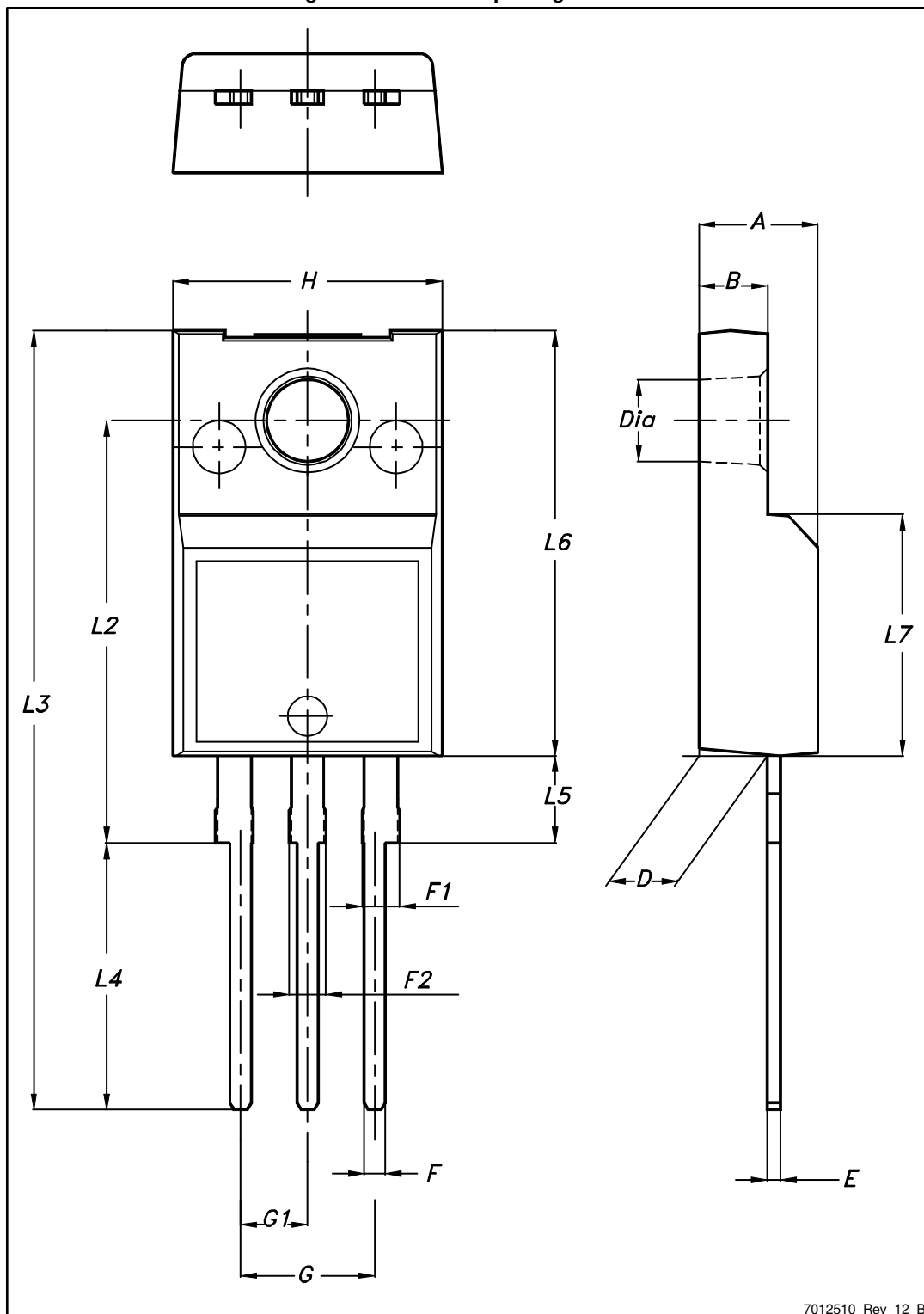


Table 13: TO-220FP package mechanical data

| 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

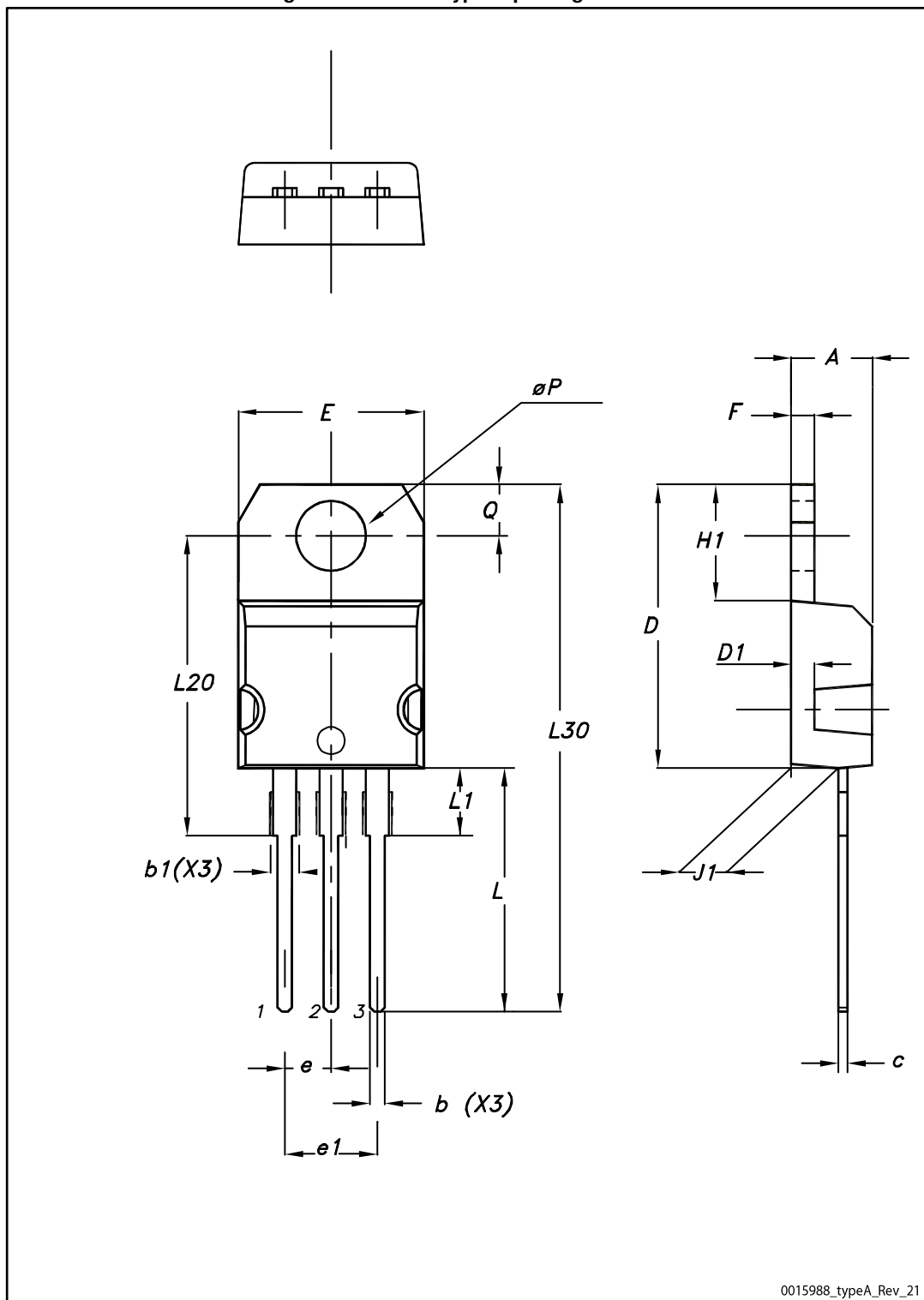


Table 14: TO-220 type A package mechanical data

| 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, D <sup>2</sup> PAK and<br>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 <a href="#">Table 2: "Absolute maximum ratings"</a> , <a href="#">Table 3: "Thermal data"</a> , and <a href="#">Table 4: "Static characteristics"</a> .<br>Modified <a href="#">Figure 3: "Transfer characteristics"</a> , <a href="#">Figure 4: "Collector-emitter on voltage vs temperature"</a> and <a href="#">Figure 8: "Collector-emitter on voltage vs collector current"</a> .<br>Updated <a href="#">Section 4: "Package information"</a> .<br>Minor text changes. |

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