

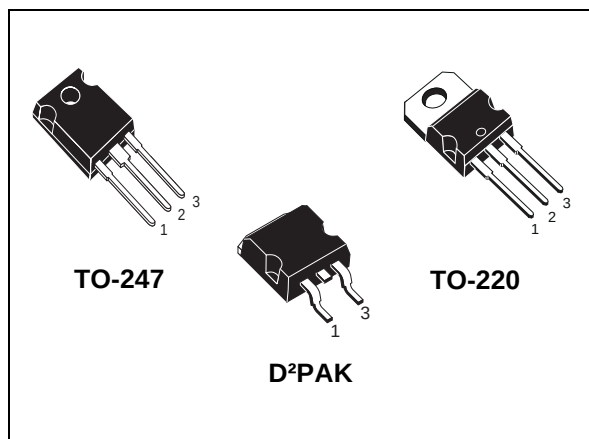
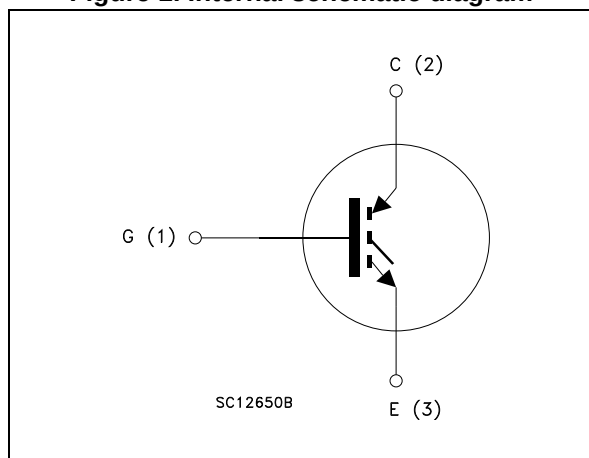


Figure 1. Internal schematic diagram



### Features

- High frequency operation up to 50 kHz
- Lower  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- High current capability

### Applications

- High frequency inverters
- UPS, motor drivers
- HF, SMPS and PFC in both hard switch and resonant topologies

### Description

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

Table 1. Device summary

| Order codes | Marking   | Package | Packaging     |
|-------------|-----------|---------|---------------|
| STGB20NC60V | GB20NC60V | D²PAK   | Tape and reel |
| STGP20NC60V | GP20NC60V | TO-220  | Tube          |
| STGW20NC60V | GW20NC60V | TO-247  | Tube          |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                  | Value       | Unit |
|----------------|--------------------------------------------|-------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ ) | 600         | V    |
| $I_C^{(1)}$    | Collector current (continuous) at 25 °C    | 60          | A    |
| $I_C^{(1)}$    | Collector current (continuous) at 100 °C   | 30          | A    |
| $I_{CL}^{(2)}$ | Turn-off latching current                  | 100         | A    |
| $I_{CP}^{(3)}$ | Pulsed collector current                   | 100         | A    |
| $V_{GE}$       | Gate-emitter voltage                       | ± 20        | V    |
| $P_{TOT}$      | Total dissipation at $T_C = 25$ °C         | 200         | W    |
| $T_j$          | Operating junction temperature             | – 55 to 150 | °C   |

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

2.  $V_{clamp} = 80\%(V_{CES})$ ,  $T_j = 150$  °C,  $R_G = 10$  Ω,  $V_{GE} = 15$  V  
 3. Pulse width limited by max junction temperature allowed

**Table 3. Thermal resistance**

| Symbol         | Parameter                               | Value  |                              | Unit |
|----------------|-----------------------------------------|--------|------------------------------|------|
|                |                                         | TO-247 | TO-220<br>D <sup>2</sup> PAK |      |
| $R_{thj-case}$ | Thermal resistance junction-case max    | 0.62   |                              | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 50     | 62.5                         | °C/W |

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  unless otherwise specified)

**Table 4. Static electrical characteristics**

| Symbol         | Parameter                                            | Test conditions                                                                                                | Min. | Typ.       | Max.      | Unit                |
|----------------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------|------------|-----------|---------------------|
| $V_{(BR)CES}$  | Collector-emitter breakdown voltage ( $V_{GE} = 0$ ) | $I_C = 1 \text{ mA}$                                                                                           | 600  |            |           | V                   |
| $V_{CE(sat)}$  | Collector-emitter saturation voltage                 | $V_{GE}=15 \text{ V}, I_C= 20 \text{ A}$<br>$V_{GE}=15 \text{ V}, I_C= 20 \text{ A}, T_C= 125^{\circ}\text{C}$ |      | 1.8<br>1.7 | 2.5       | V<br>V              |
| $V_{GE(th)}$   | Gate threshold voltage                               | $V_{CE}= V_{GE}, I_C= 250 \mu\text{A}$                                                                         | 3.75 |            | 5.75      | V                   |
| $I_{CES}$      | Collector-emitter cut-off current ( $V_{GE} = 0$ )   | $V_{CE} = 600 \text{ V}$<br>$V_{CE} = 600 \text{ V}, T_C=125^{\circ}\text{C}$                                  |      |            | 10<br>1   | $\mu\text{A}$<br>mA |
| $I_{GES}$      | Gate-emitter cut-off current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20 \text{ V}$                                                                                    |      |            | $\pm 100$ | nA                  |
| $g_{fs}^{(1)}$ | Forward transconductance                             | $V_{CE} = 15 \text{ V}, I_C= 20 \text{ A}$                                                                     |      | 15         |           | S                   |

1. Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 5. Dynamic electrical characteristics**

| Symbol    | Parameter                    | Test conditions                                                                              | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|----------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25 \text{ V}, f = 1 \text{ MHz},$<br>$V_{GE}=0$                                    | -    | 2200 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                              | -    | 225  | -    | pF   |
| $C_{res}$ | Reverse transfer capacitance |                                                                                              | -    | 50   | -    | pF   |
| $Q_g$     | Total gate charge            | $V_{CE} = 390 \text{ V}, I_C = 20 \text{ A},$<br>$V_{GE} = 15 \text{ V},$<br>(see Figure 17) | -    | 100  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                                              | -    | 16   | -    | nC   |
| $Q_{gc}$  | Gate-collector charge        |                                                                                              | -    | 45   | -    | nC   |

Table 6. Switching on/off (inductive load)

| Symbol         | Parameter             | Test conditions                                                                                                                                        | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 3.3\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see Figure 16)                                     | -    | 31   | -    | ns         |
| $t_r$          | Current rise time     |                                                                                                                                                        | -    | 11   | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope |                                                                                                                                                        | -    | 1600 | -    | A/ $\mu$ s |
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 3.3\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$ (see Figure 16)   | -    | 31   | -    | ns         |
| $t_r$          | Current rise time     |                                                                                                                                                        | -    | 11.5 | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope |                                                                                                                                                        | -    | 1500 | -    | A/ $\mu$ s |
| $t_{r(voff)}$  | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 3.3\ \Omega$ , $V_{GE} = 15\text{ V}$<br>(see Figure 18)                                     | -    | 28   | -    | ns         |
| $t_{d(off)}$   | Turn-off delay time   |                                                                                                                                                        | -    | 100  | -    | ns         |
| $t_f$          | Current fall time     |                                                                                                                                                        | -    | 75   | -    | ns         |
| $t_{r(voff)}$  | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 3.3\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$ (see Figure 18) | -    | 66   | -    | ns         |
| $t_{d(off)}$   | Turn-off delay time   |                                                                                                                                                        | -    | 150  | -    | ns         |
| $t_f$          | Current fall time     |                                                                                                                                                        | -    | 130  | -    | ns         |

Table 7. Switching energy (inductive load)

| Symbol          | Parameter                 | Test conditions                                                                                                                                      | Min. | Typ. | Max. | Unit    |
|-----------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------|
| $E_{on}$        | Turn-on switching losses  | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 3.3\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see Figure 18)                                   | -    | 220  | -    | $\mu$ J |
| $E_{off}^{(1)}$ | Turn-off switching losses |                                                                                                                                                      | -    | 330  | -    | $\mu$ J |
| $E_{ts}$        | Total switching losses    |                                                                                                                                                      | -    | 550  | -    | $\mu$ J |
| $E_{on}$        | Turn-on switching losses  | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 3.3\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$ (see Figure 18) | -    | 450  | -    | $\mu$ J |
| $E_{off}^{(1)}$ | Turn-off switching losses |                                                                                                                                                      | -    | 770  | -    | $\mu$ J |
| $E_{ts}$        | Total switching losses    |                                                                                                                                                      | -    | 1220 | -    | $\mu$ J |

1. Turn-off losses include also the tail of the collector current.

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

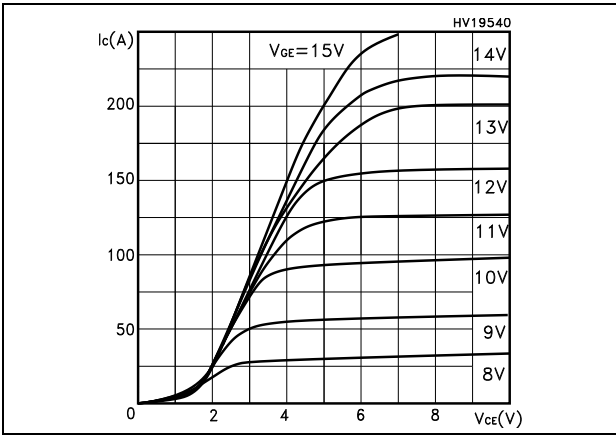


Figure 3. Transfer characteristics

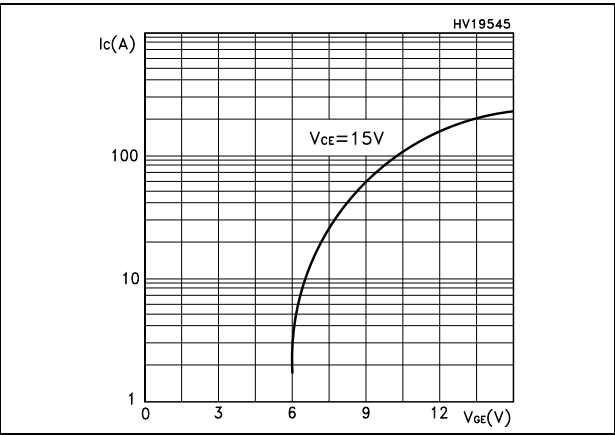


Figure 4. Transconductance

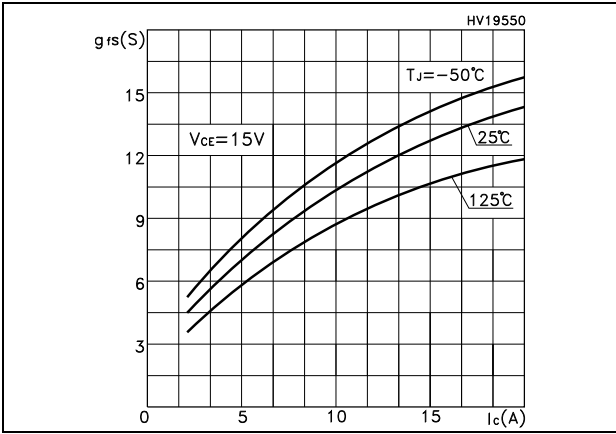


Figure 5. Collector-emitter on voltage vs temperature

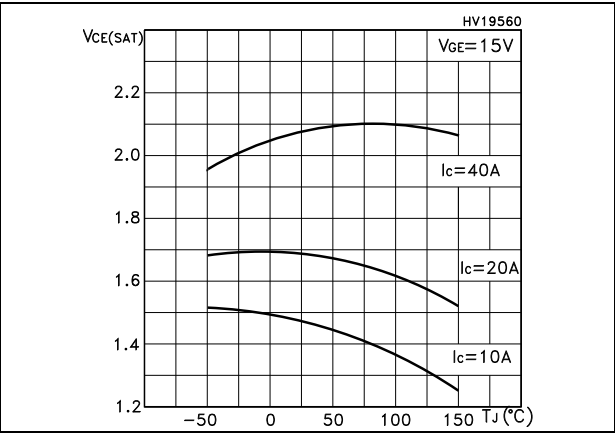


Figure 6. Gate charge vs gate-source voltage

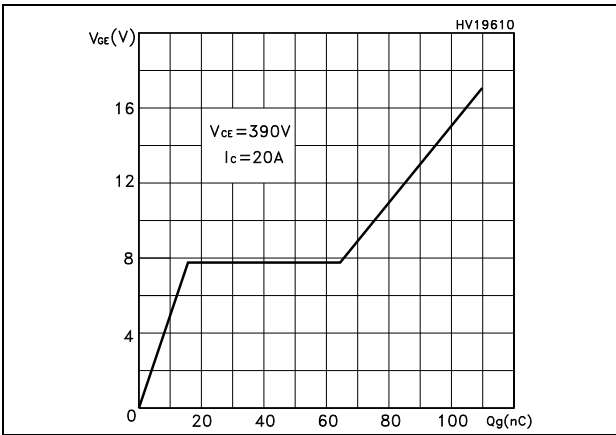


Figure 7. Capacitance variations

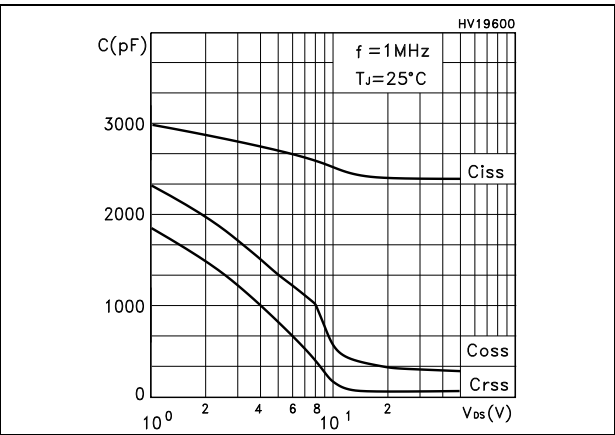


Figure 8. Normalized gate threshold voltage vs temperature

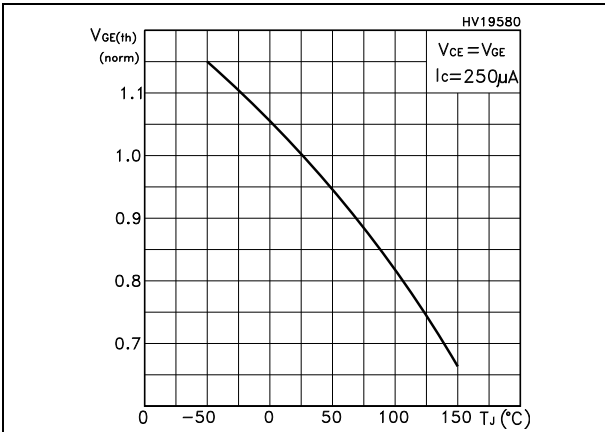


Figure 9. Collector-emitter on voltage vs collector current

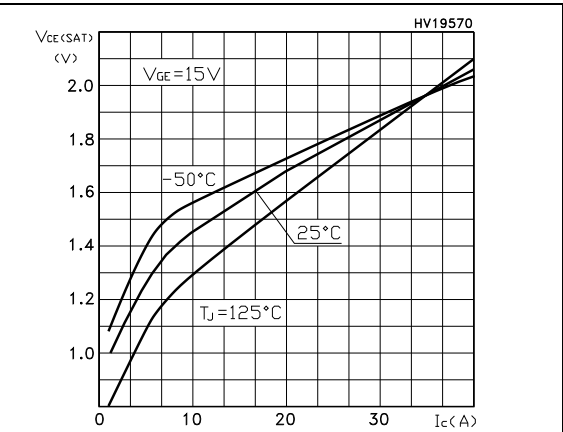


Figure 10. Normalized breakdown voltage vs temperature

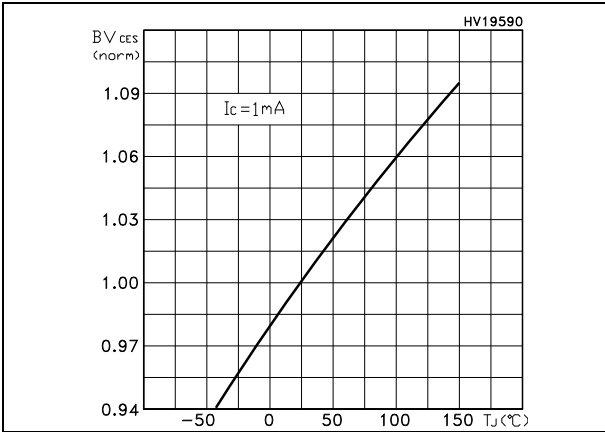


Figure 11. Switching losses vs temperature

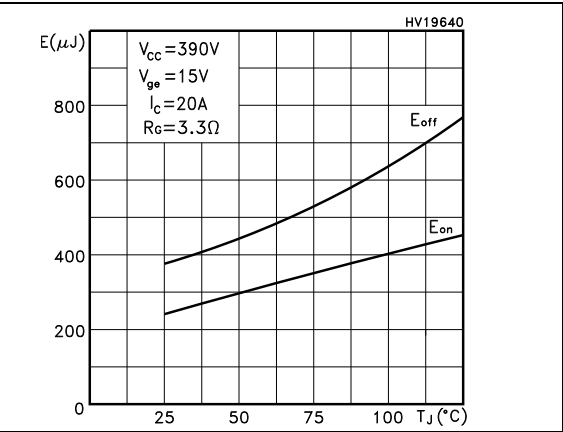


Figure 12. Switching losses vs gate resistance

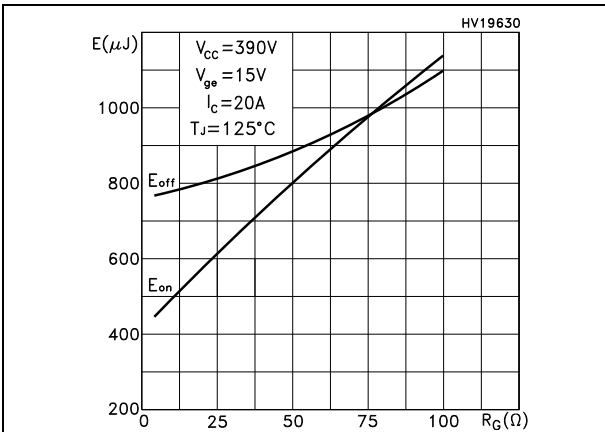


Figure 13. Switching losses vs collector current

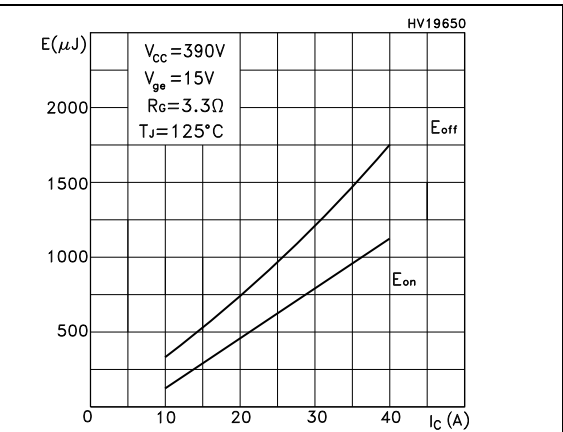


Figure 14. Thermal impedance

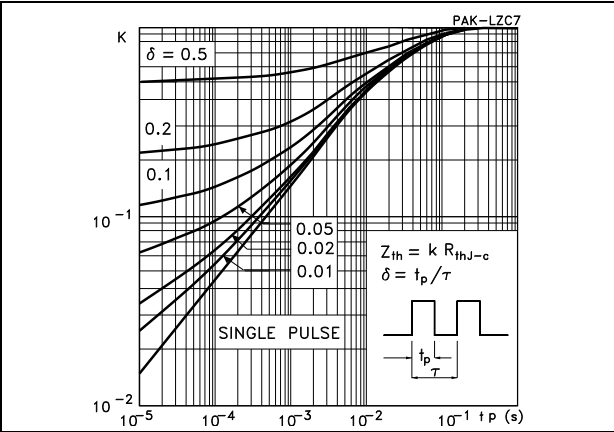
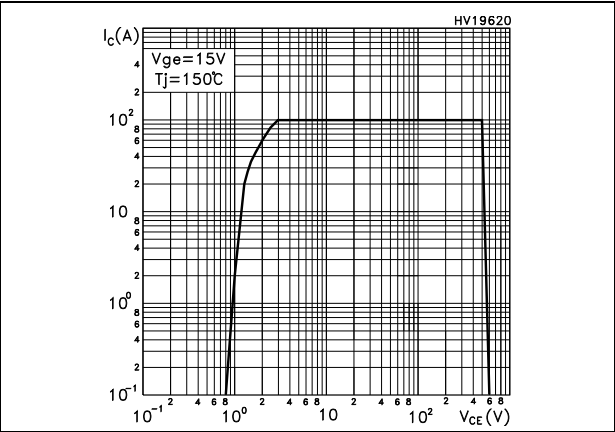


Figure 15. Turn-off SOA



# 3 Test circuits

Figure 16. Test circuit for inductive load switching

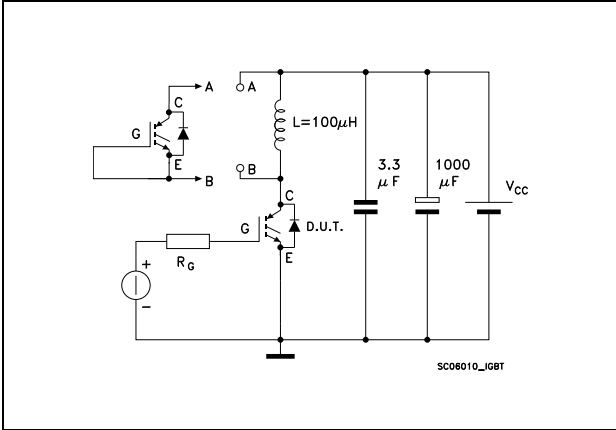


Figure 17. Gate charge test circuit

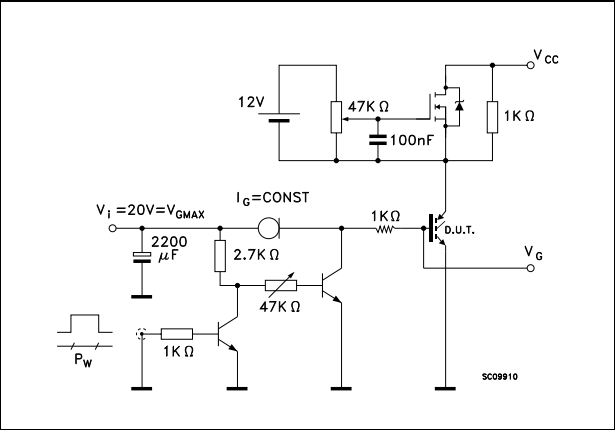
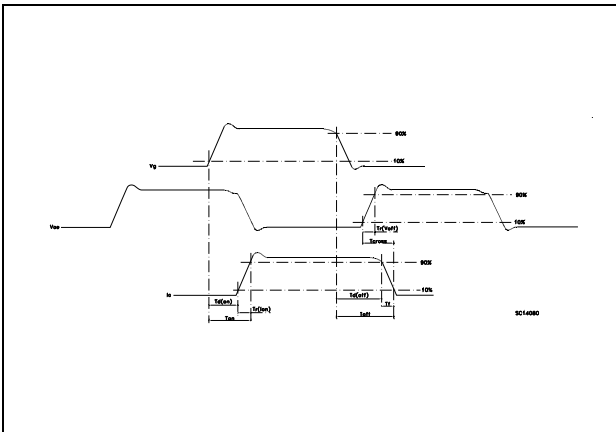


Figure 18. Switching waveform



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

### 4.1 D<sup>2</sup>PAK type A package information

Figure 19. D<sup>2</sup>PAK (TO-263) type A package outline

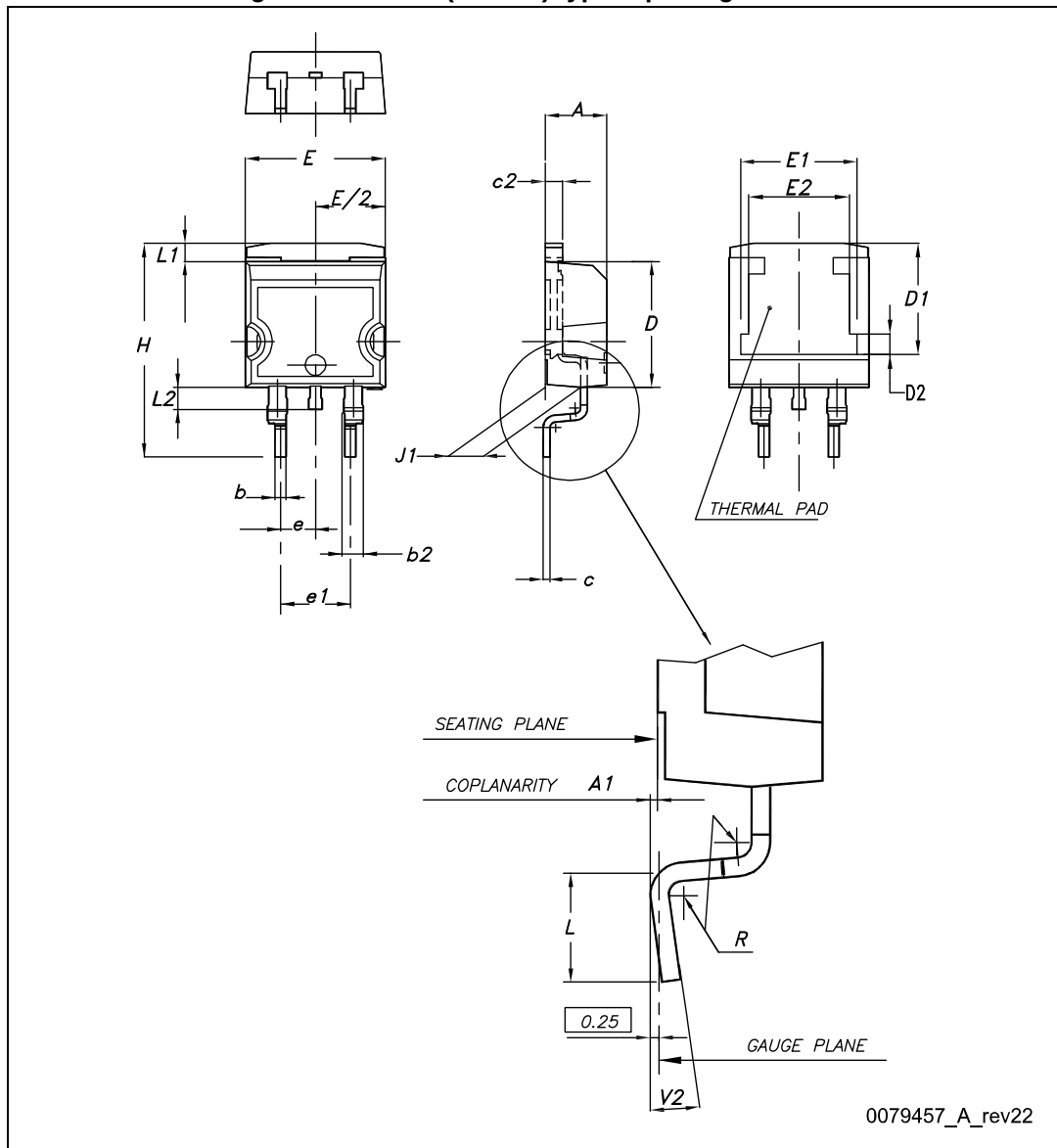
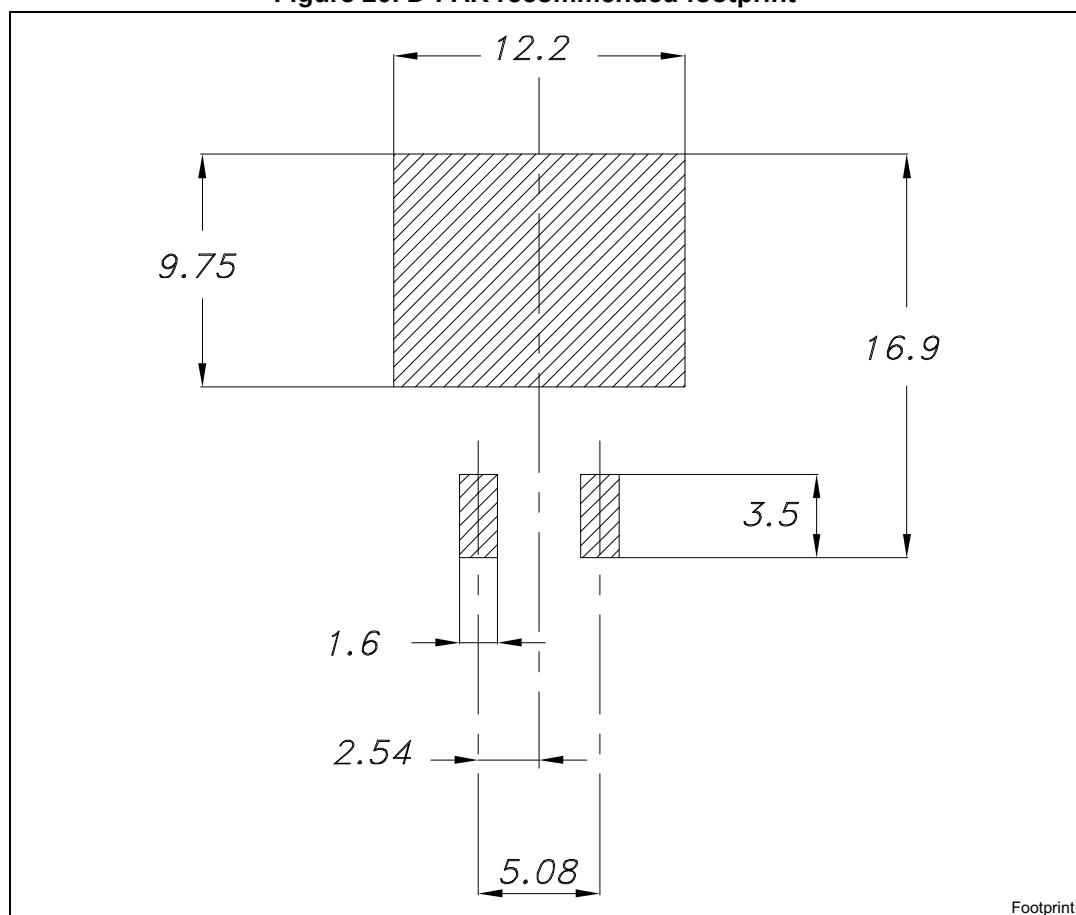


Table 8. D<sup>2</sup>PAK (TO-263) type A mechanical data

| 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   |      | 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   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

Figure 20. D<sup>2</sup>PAK recommended footprint<sup>(a)</sup>

a. All dimension are in millimeters

## 4.2 TO-220 type A package information

Figure 21. TO-220 type A package outline

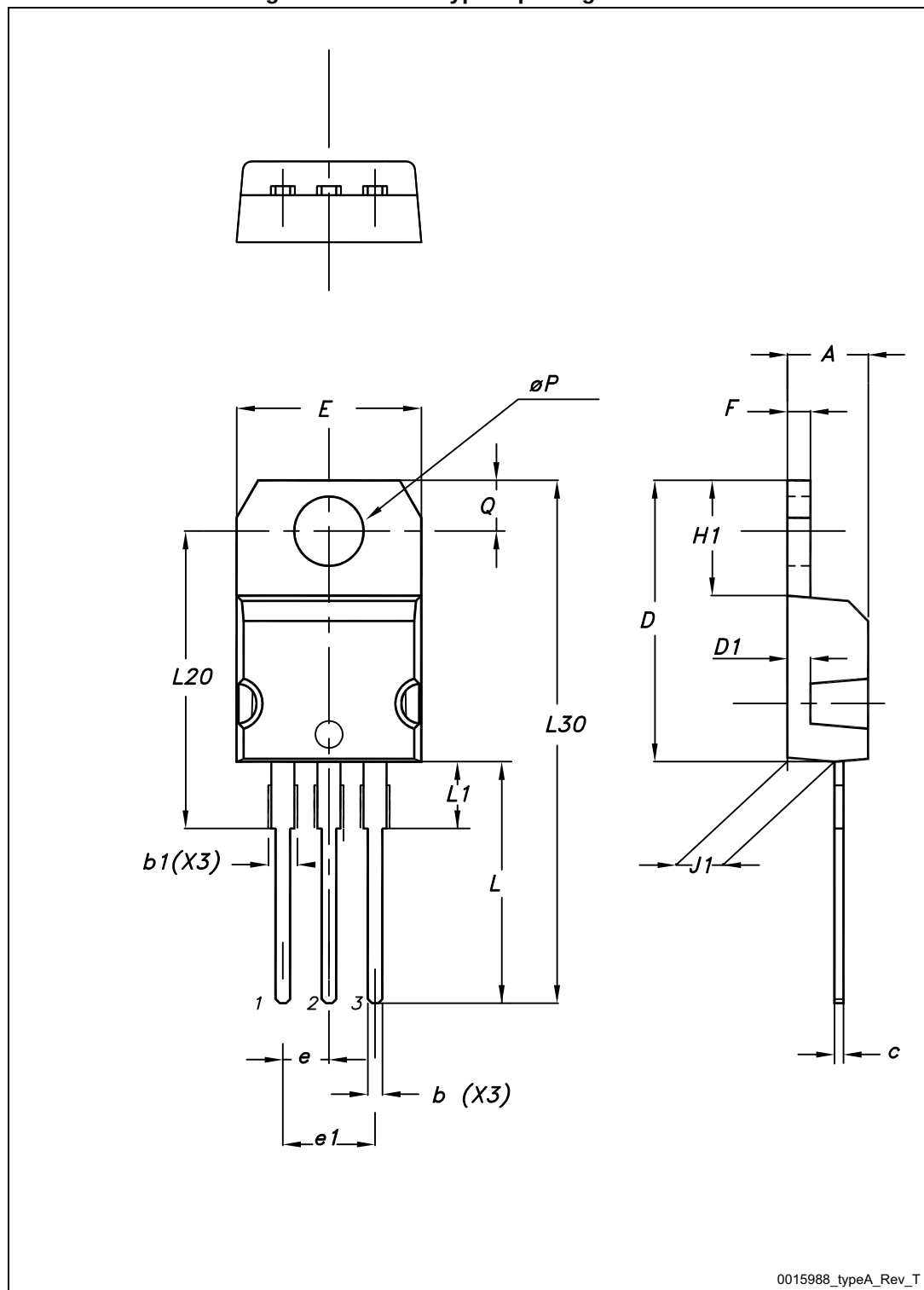


Table 9. TO-220 type A package mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 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    |       | 14    |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| øP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

### 4.3 TO-247 package information

Figure 22. TO-247 package outline

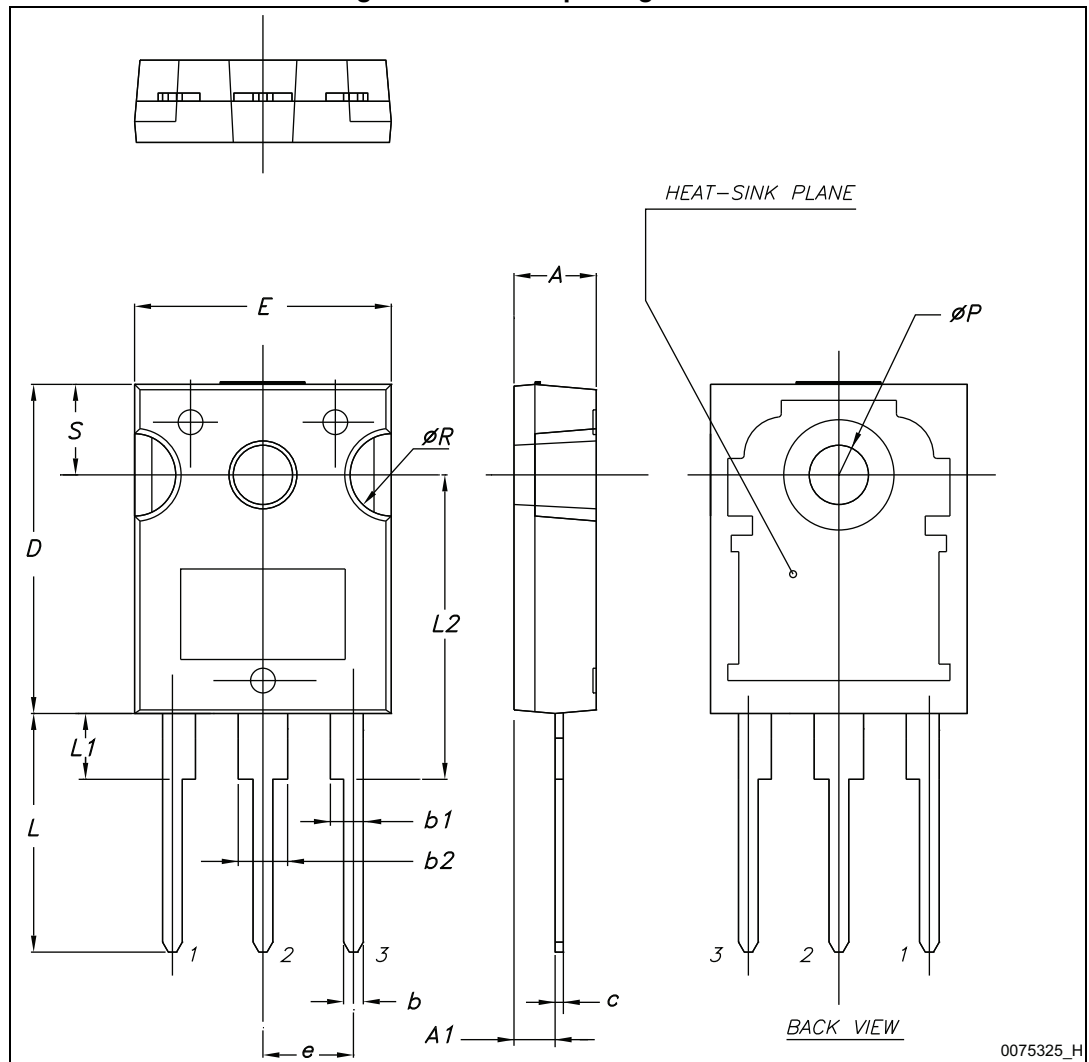


Table 10. TO-247 package mechanical data

| Dim. | mm.   |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| b    | 1.0   |       | 1.40  |
| b1   | 2.0   |       | 2.40  |
| b2   | 3.0   |       | 3.40  |
| c    | 0.40  |       | 0.80  |
| D    | 19.85 |       | 20.15 |
| E    | 15.45 |       | 15.75 |
| e    | 5.30  | 5.45  | 5.60  |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    | 5.30  | 5.50  | 5.70  |

5 Packing information

Figure 23. Tape

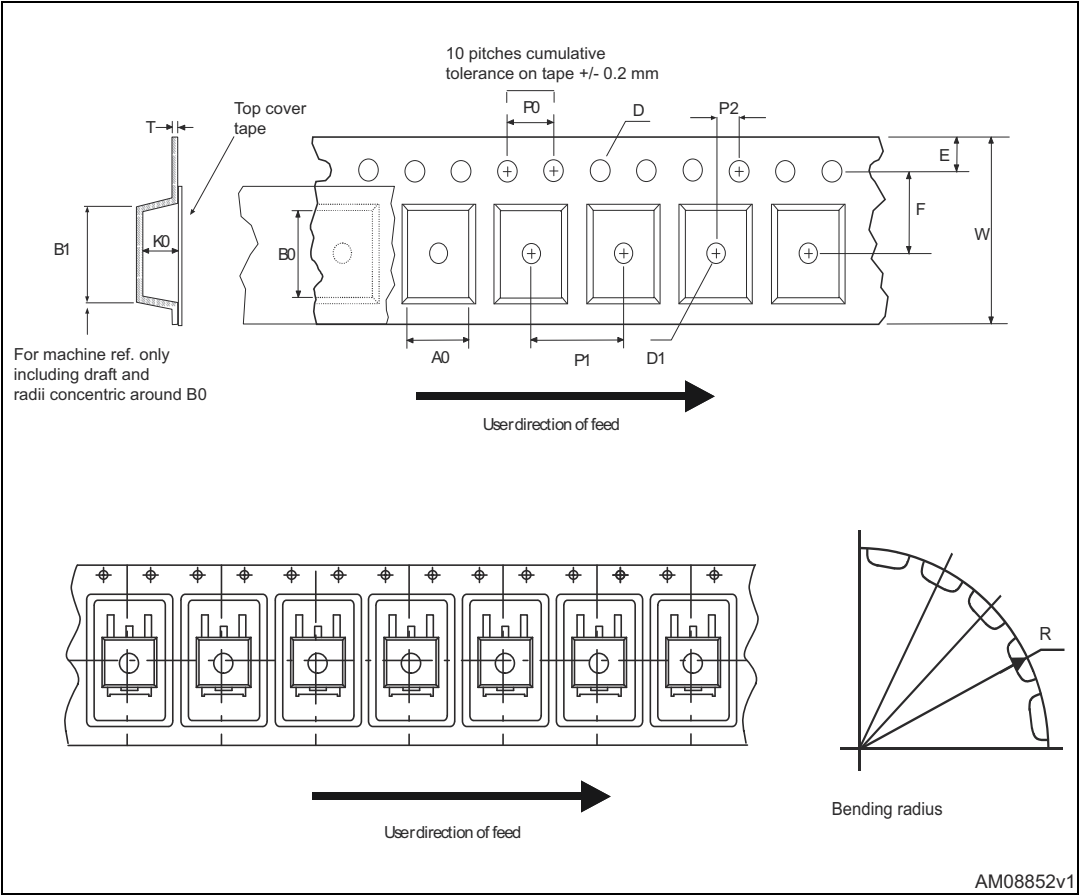
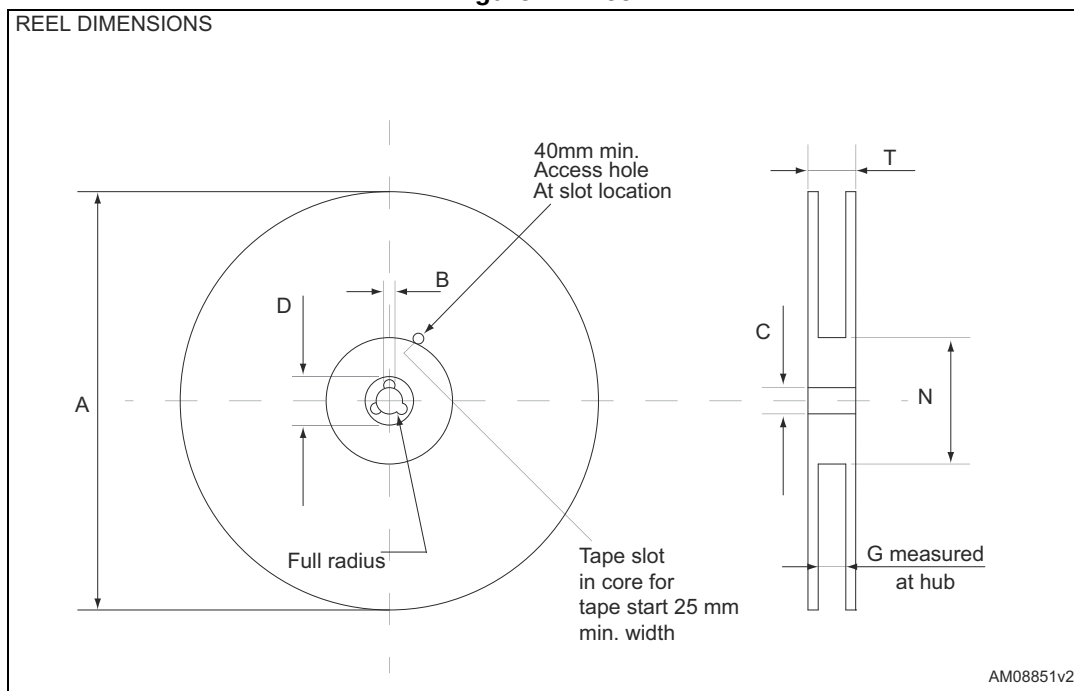


Figure 24. Reel

Table 11. D<sup>2</sup>PAK (TO-263) 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 qty |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk qty |      | 1000 |
| R    | 50   |      |          |      |      |
| T    | 0.25 | 0.35 |          |      |      |
| W    | 23.7 | 24.3 |          |      |      |

## 6 Revision history

Table 12. Document revision history

| Date        | Revision | Changes                                                                                                                                                          |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 07-Jun-2004 | 4        | Stylesheet update. No content change                                                                                                                             |
| 14-May-2008 | 5        | Inserted D <sup>2</sup> PAK                                                                                                                                      |
| 18-Jun-2015 | 6        | Updated <a href="#">Table 1: Device summary</a> .<br>Updated <a href="#">Section 4: Package information</a> and <a href="#">Section 5: Packing information</a> . |

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