



# STGB19NC60HDT4, STGF19NC60HD STGP19NC60HD, STGW19NC60HD

19 A, 600 V, very fast IGBT with Ultrafast diode

## Features

- Low on-voltage drop ( $V_{CE(sat)}$ )
- Very soft Ultrafast recovery anti-parallel diode

## Applications

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

## Description

This device is an ultrafast IGBT. It utilizes the advanced Power MESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

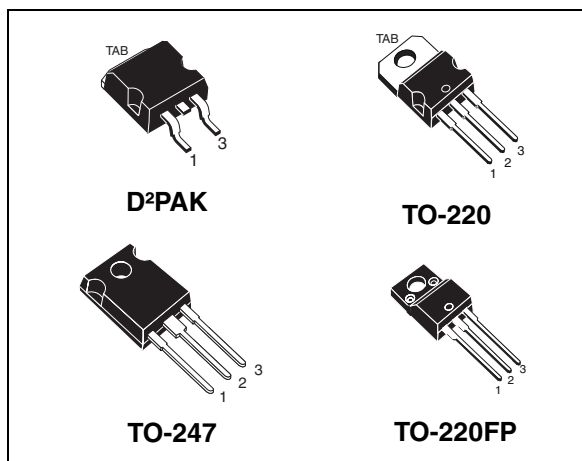


Figure 1. Internal schematic diagram

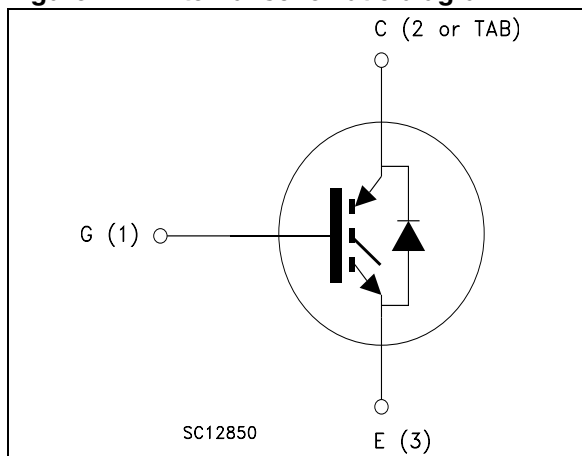


Table 1. Device summary

| Part numbers   | Marking    | Package            | Packaging     |
|----------------|------------|--------------------|---------------|
| STGB19NC60HDT4 | GB19NC60HD | D <sup>2</sup> PAK | Tape and reel |
| STGF19NC60HD   | GF19NC60HD | TO-220FP           | Tube          |
| STGP19NC60HD   | GP19NC60HD | TO-220             | Tube          |
| STGW19NC60HD   | GW19NC60HD | TO-247             | Tube          |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter  | Value                        |          |        | Unit |
|--------------------------------|--|------------------------------|----------|--------|------|
|                                |  | TO-220<br>D <sup>2</sup> PAK | TO-220FP | TO-247 |      |
| V <sub>CES</sub>               | Collector-emitter voltage (V <sub>GE</sub> = 0)  | 600                          |          |        | V    |
| I <sub>C</sub> <sup>(1)</sup>  | Continuous collector current at T <sub>C</sub> = 25 °C   | 40                           | 16       | 42     | A    |
| I <sub>C</sub> <sup>(1)</sup>  | Continuous collector current at T <sub>C</sub> = 100 °C  | 19                           | 10       | 21     | A    |
| I <sub>CL</sub> <sup>(2)</sup> | Turn-off latching current  | 40                           |          |        | A    |
| I <sub>CP</sub> <sup>(3)</sup> | Pulsed collector current   | 60                           |          |        | A    |
| I <sub>F</sub>                 | Diode RMS forward current at T <sub>C</sub> = 25 °C  | 20                           |          |        | A    |
| I <sub>FSM</sub>               | Surge not repetitive forward current<br>t <sub>p</sub> =10 ms sinusoidal                                       | 50                           |          |        | A    |
| V <sub>GE</sub>                | Gate-emitter voltage   | ±20                          |          |        | V    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C  | 130                          | 32       | 140    | W    |
| V <sub>ISO</sub>               | Isolation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C) | 2500                         |          |        | V    |
| T <sub>J</sub>                 | Operating junction temperature   | - 55 to 150                  |          |        | °C   |

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<sub>clamp</sub>=80%V<sub>CES</sub>, T<sub>J</sub>= 150 °C, R<sub>G</sub>=1 0 Ω, V<sub>GE</sub> = 15 V

3. Pulse width limited by maximum permissible junction temperature and turn-off within RBSOA

**Table 3. Thermal data**

| Symbol                | Parameter                              | Value                        |          |        | Unit |
|-----------------------|--|------------------------------|----------|--------|------|
|                       |  | TO-220<br>D <sup>2</sup> PAK | TO-220FP | TO-247 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case IGBT  | 0.95                         | 3.9      | 0.9    | °C/W |
|                       | Thermal resistance junction-case diode | 3                            | 5.5      | 3      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient    | 62.5                         |          | 50     | °C/W |

## 2 Electrical characteristics

( $T_J = 25\text{ °C}$  unless otherwise specified)

**Table 4. Static**

| 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                 | $V_{GE} = 15\text{ V}, I_C = 12\text{ A}$<br>$V_{GE} = 15\text{ V}, I_C = 15\text{ A}$<br>$V_{GE} = 15\text{ V}, I_C = 30\text{ A}, T_J = 100\text{ °C}$<br>$V_{GE} = 15\text{ V}, I_C = 12\text{ A}, T_J = 125\text{ °C}$ |      | 1.8<br>2<br>2.5<br>1.6 | 2.5       | V                   |
| $V_{GE(th)}$   | Gate threshold voltage                               | $V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$  | 3.75 |                        | 5.75      | V                   |
| $I_{CES}$      | Collector cut-off current ( $V_{GE} = 0$ )           | $V_{CE} = 600\text{ V}$<br>$V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$  |      |                        | 150<br>1  | $\mu\text{A}$<br>mA |
| $I_{GES}$      | Gate-emitter leakage current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20\text{ V}$   |      |                        | $\pm 100$ | nA                  |
| $g_{fs}^{(1)}$ | Forward transconductance                             | $V_{CE} = 15\text{ V}, I_C = 12\text{ A}$  |      | 5                      |           | S                   |

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

**Table 5. Dynamic**

| Symbol    | Parameter                    | Test conditions                            | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| $C_{ies}$ | Input capacitance            |  |      | 1180 |      | pF   |
| $C_{oes}$ | Output capacitance           | $V_{CE} = 25\text{ V}, f = 1\text{ MHz},$  | -    | 130  | -    | pF   |
| $C_{res}$ | Reverse transfer capacitance | $V_{GE} = 0$                               |      | 36   |      | pF   |
| $Q_g$     | Total gate charge            | $V_{CE} = 390\text{ V}, I_C = 5\text{ A},$ |      | 53   |      | nC   |
| $Q_{ge}$  | Gate-emitter charge          | $V_{GE} = 15\text{ V},$                    | -    | 10   | -    | nC   |
| $Q_{gc}$  | Gate-collector charge        | <a href="#">Figure 20</a>                  |      | 23   |      | nC   |

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

| Symbol                                  | Parameter   | Test conditions   | Min. | Typ.             | Max. | Unit                   |
|---|---|---|------|------------------|------|------------------------|
| $t_{d(on)}$<br>$t_r$<br>$(di/dt)_{on}$  | Turn-on delay time<br>Current rise time<br>Turn-on current slope  | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br><i>Figure 21</i>                                      | -    | 25<br>7<br>1600  | -    | ns<br>ns<br>A/ $\mu$ s |
| $t_{d(on)}$<br>$t_r$<br>$(di/dt)_{on}$  | Turn-on delay time<br>Current rise time<br>Turn-on current slope  | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 125\text{ }^\circ\text{C}$<br><i>Figure 21</i> | -    | 24<br>8<br>1400  | -    | ns<br>ns<br>A/ $\mu$ s |
| $t_{r(Voff)}$<br>$t_{d(Voff)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br><i>Figure 21</i>                                      | -    | 27<br>97<br>73   | -    | ns<br>ns<br>ns         |
| $t_{r(Voff)}$<br>$t_{d(Voff)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 125\text{ }^\circ\text{C}$<br><i>Figure 21</i> | -    | 58<br>144<br>128 | -    | ns<br>ns<br>ns         |

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

| Symbol                                  | Parameter   | Test conditions   | Min. | Typ.              | Max. | Unit                          |
|---|---|---|------|-------------------|------|-------------------------------|
| $E_{on}$<br>$E_{off}^{(1)}$<br>$E_{ts}$ | Turn-on switching losses<br>Turn-off switching losses<br>Total switching losses | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br><i>Figure 21</i>                                      | -    | 85<br>189<br>274  | -    | $\mu$ J<br>$\mu$ J<br>$\mu$ J |
| $E_{on}$<br>$E_{off}^{(1)}$<br>$E_{ts}$ | Turn-on switching losses<br>Turn-off switching losses<br>Total switching losses | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 125\text{ }^\circ\text{C}$<br><i>Figure 21</i> | -    | 187<br>407<br>594 | -    | $\mu$ J<br>$\mu$ J<br>$\mu$ J |

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

**Table 8. Collector-emitter diode**

| Symbol                            | Parameter  | Test conditions   | Min. | Typ.           | Max. | Unit          |
|-----------------------------------|--|---|------|----------------|------|---------------|
| $V_F$                             | Forward on-voltage   | $I_F = 12\text{ A}$<br>$I_F = 12\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$  | -    | 2.6<br>2.1     | -    | V<br>V        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_F = 12\text{ A}$ , $V_R = 40\text{ V}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$<br><i>Figure 22</i>                                     | -    | 31<br>30<br>2  | -    | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_F = 12\text{ A}$ , $V_R = 40\text{ V}$ ,<br>$T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br><i>Figure 22</i> | -    | 59<br>102<br>4 | -    | ns<br>nC<br>A |

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

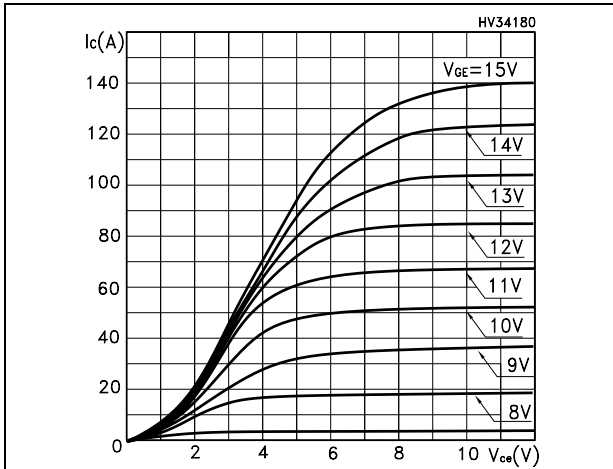


Figure 3. Transfer characteristics

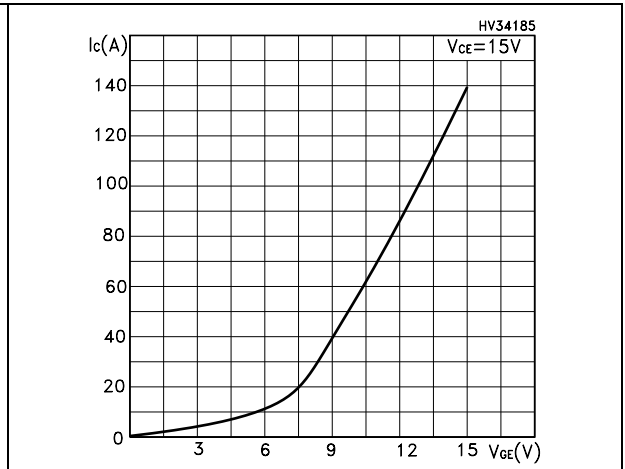


Figure 4. Transconductance

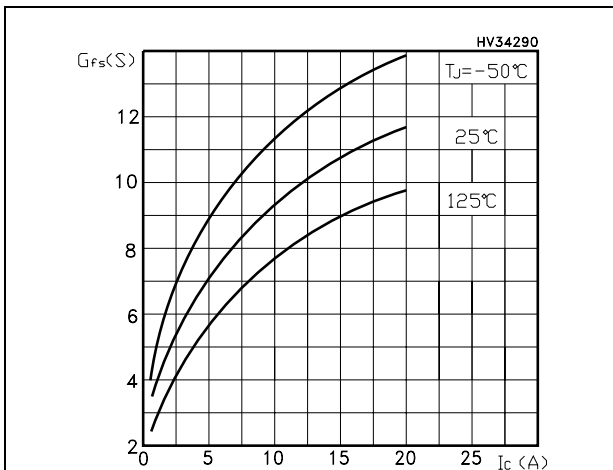


Figure 5. Collector-emitter on voltage vs. temperature

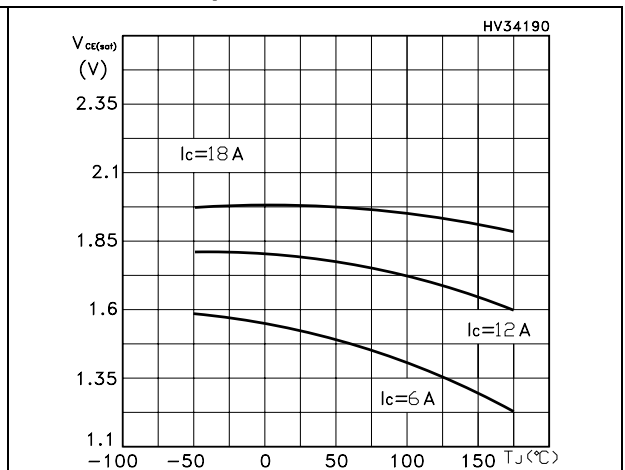


Figure 6. Gate charge vs. gate-source voltage

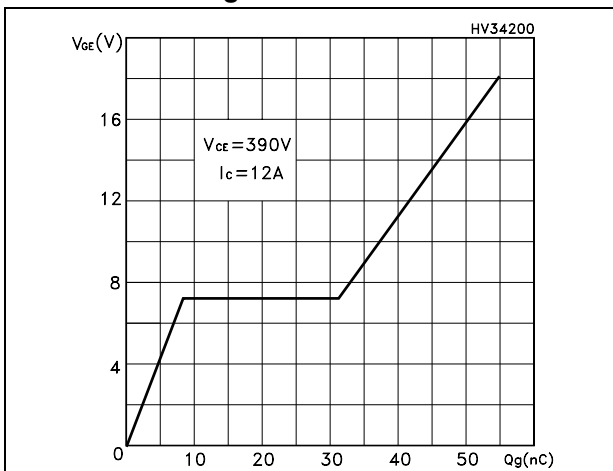
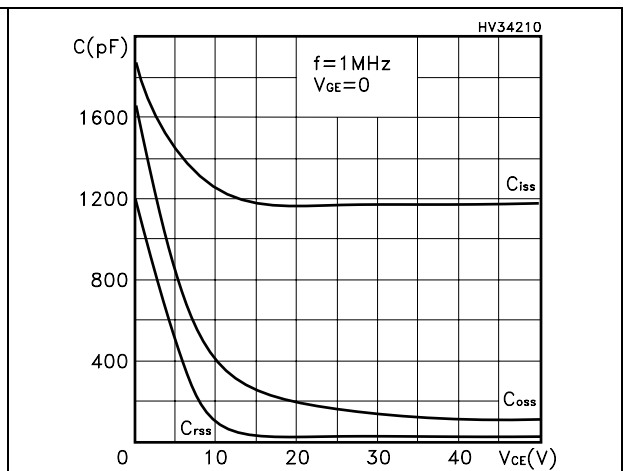
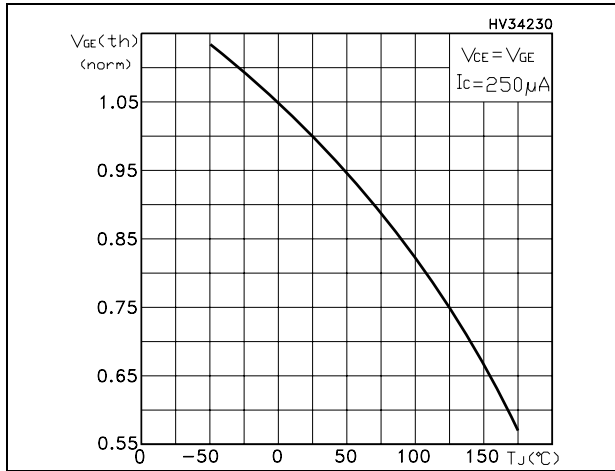


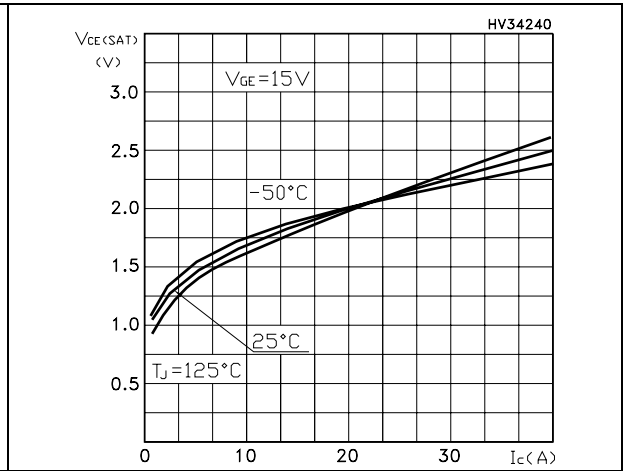
Figure 7. Capacitance variations



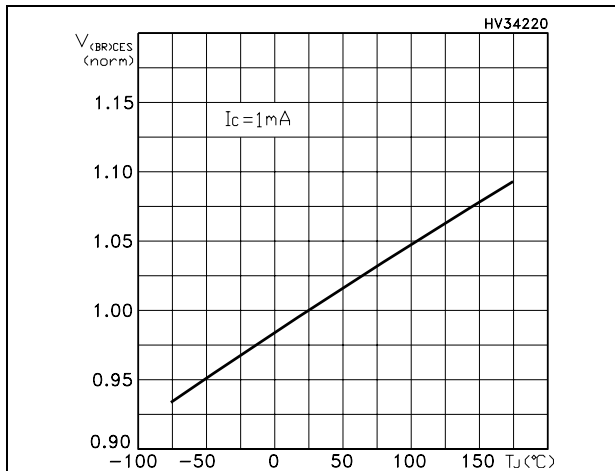
**Figure 8. Normalized gate threshold voltage vs. temperature**



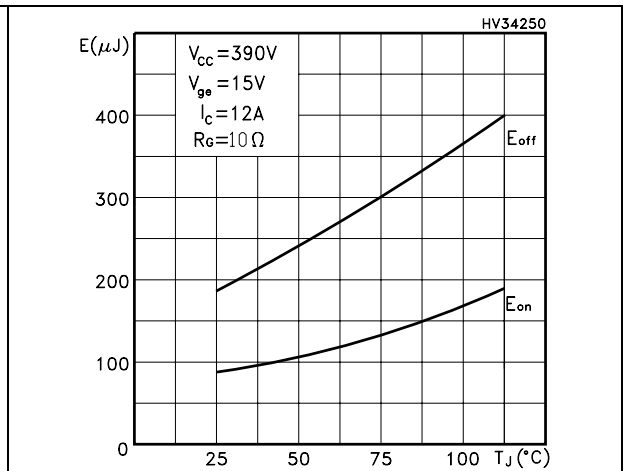
**Figure 9. Collector-emitter on voltage vs. collector current**



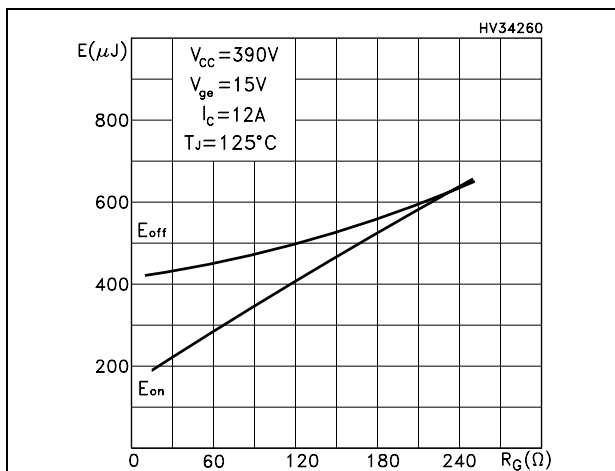
**Figure 10. Normalized breakdown voltage vs. temperature**



**Figure 11. Switching losses vs. temperature**



**Figure 12. Switching losses vs. gate resistance**



**Figure 13. Switching losses vs. collector current**

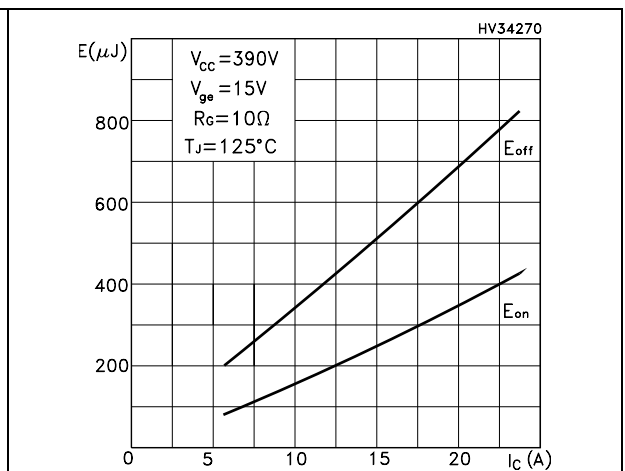


Figure 14. Turn-off SOA

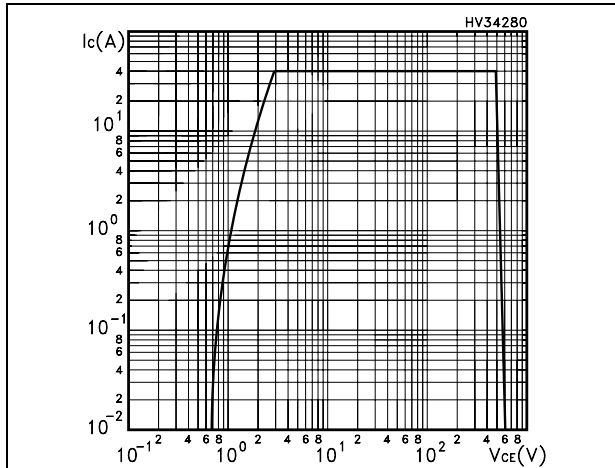


Figure 15. Thermal impedance for TO-247

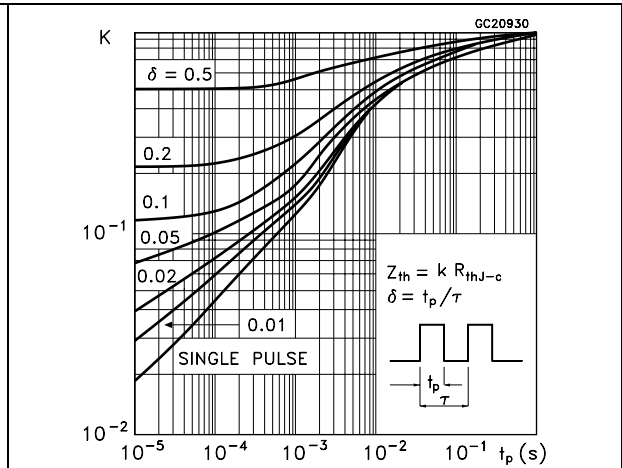


Figure 16. Thermal impedance for TO-220, D<sup>2</sup>PAK

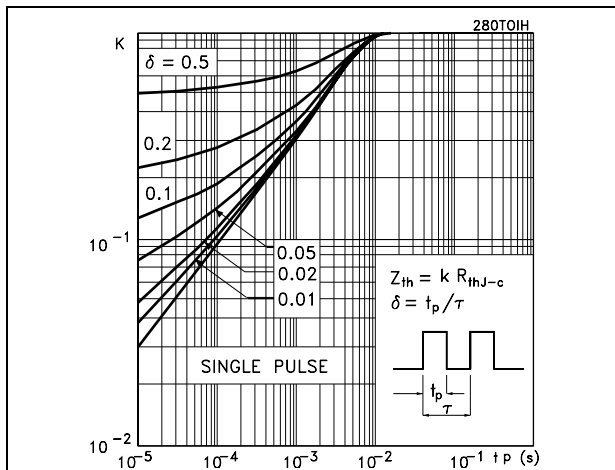


Figure 17. Thermal impedance for TO-220FP

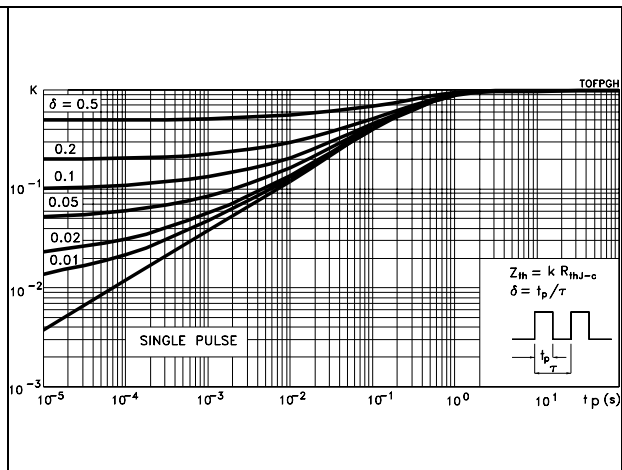
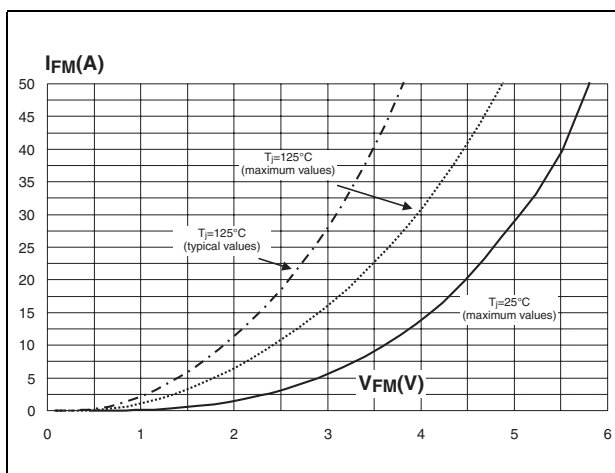


Figure 18. Forward voltage drop vs. forward current





### 3 Test circuits

Figure 19. Test circuit for inductive load switching

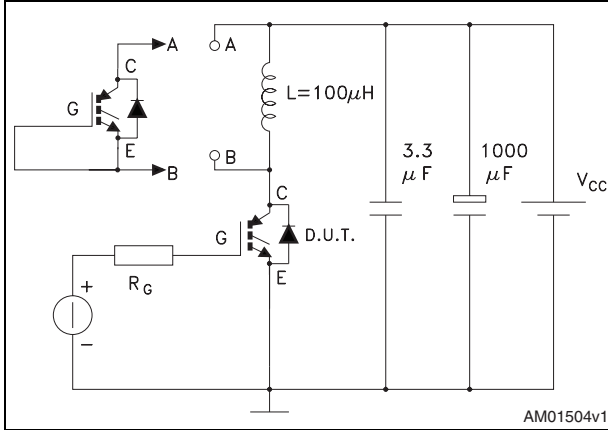


Figure 20. Gate charge test circuit

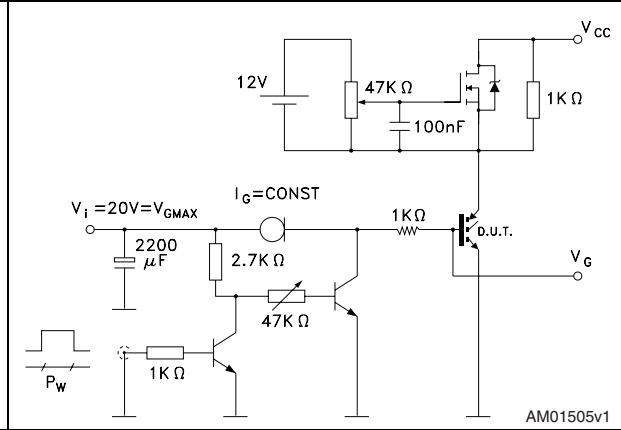


Figure 21. Switching waveform

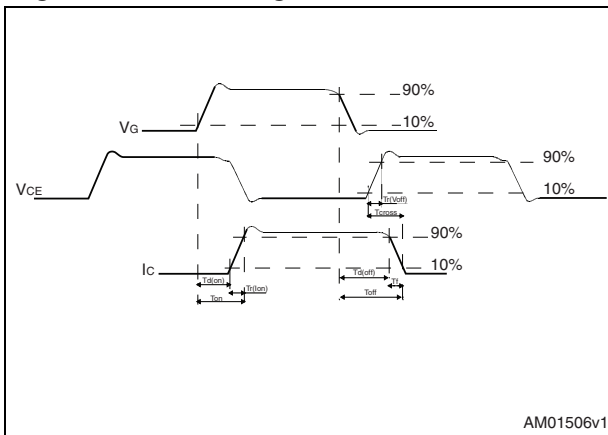
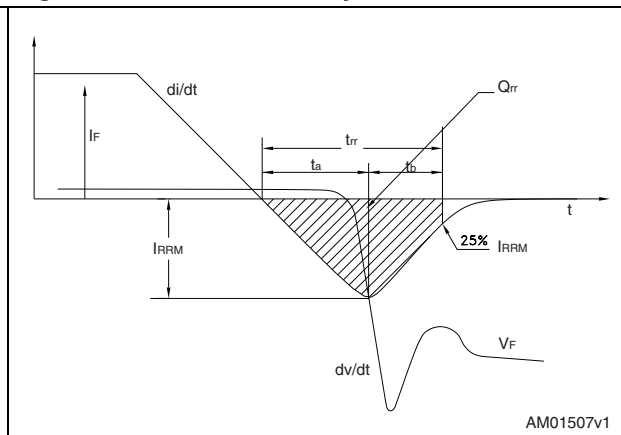


Figure 22. Diode recovery time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

Table 9. TO-220FP 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  |

Figure 23. TO-220FP drawing

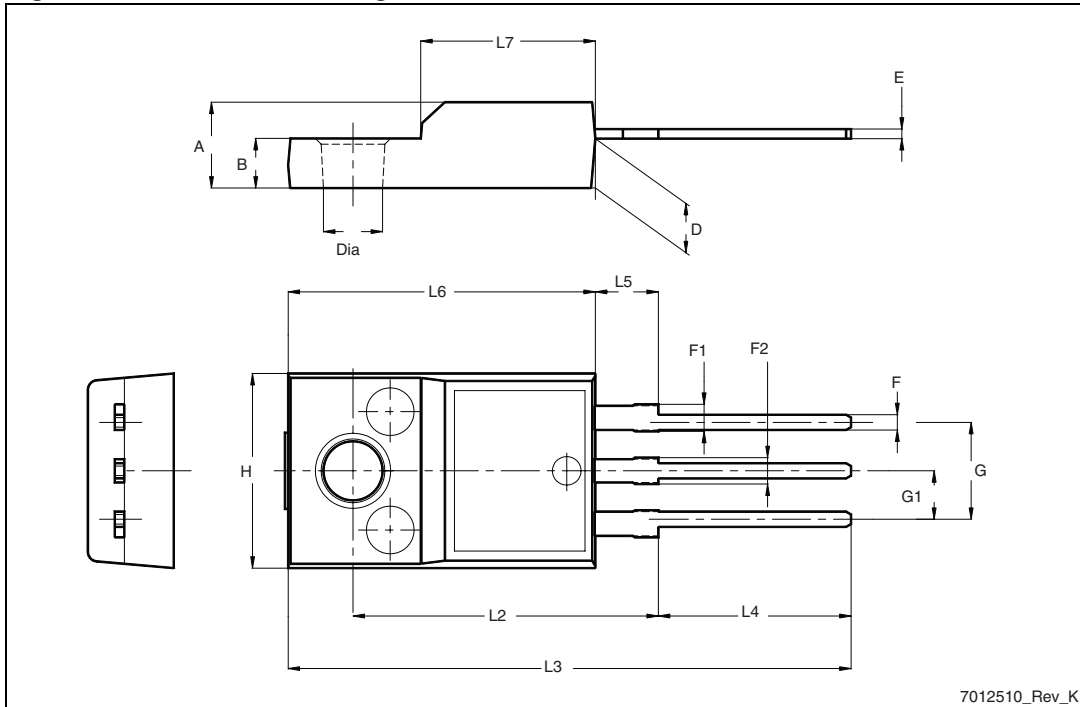


Table 10. D<sup>2</sup>PAK (TO-263) mechanical data

| 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 |      |       |
| E    | 10   |      | 10.40 |
| E1   | 8.50 |      |       |
| 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 24. D<sup>2</sup>PAK (TO-263) drawing

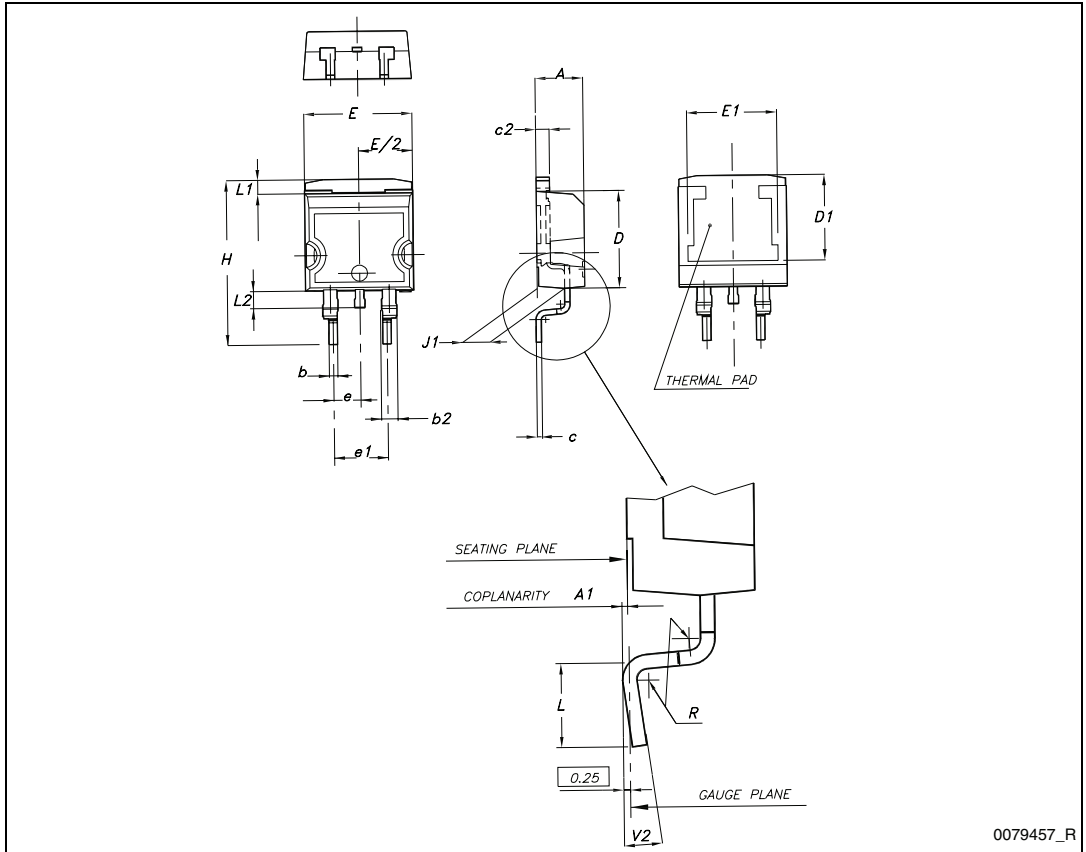
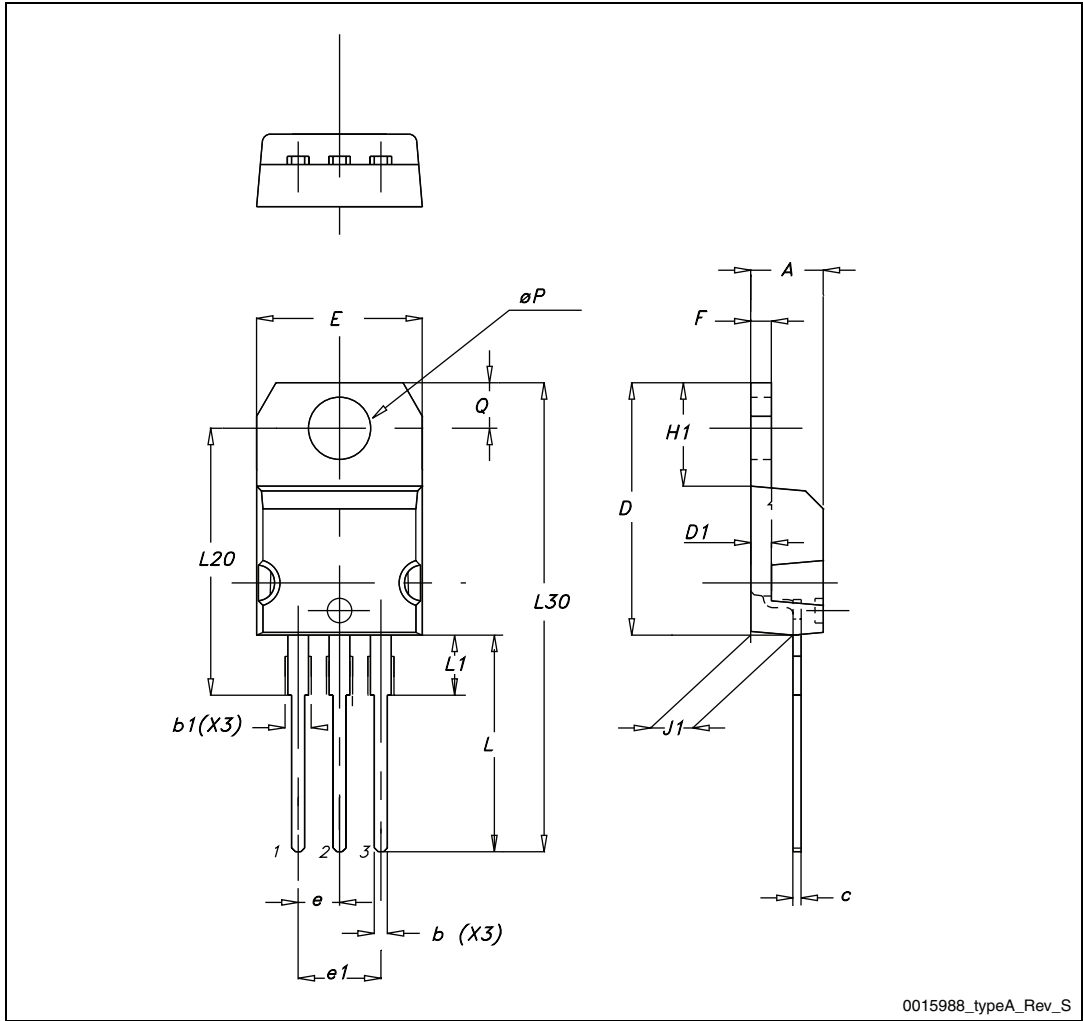


Table 11. TO-220 type A mechanical data

| 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  |

Figure 25. TO-220 type A drawing

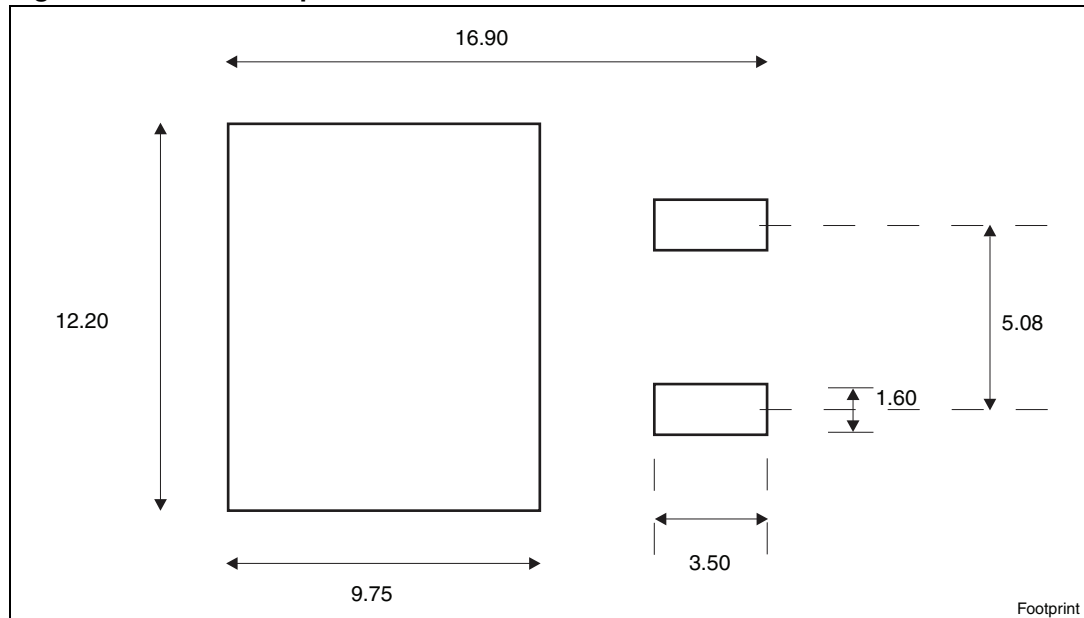


## 5 Packaging mechanical data

Table 12. 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 |      |          |      |

Figure 26. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters



Figure 27. Tape

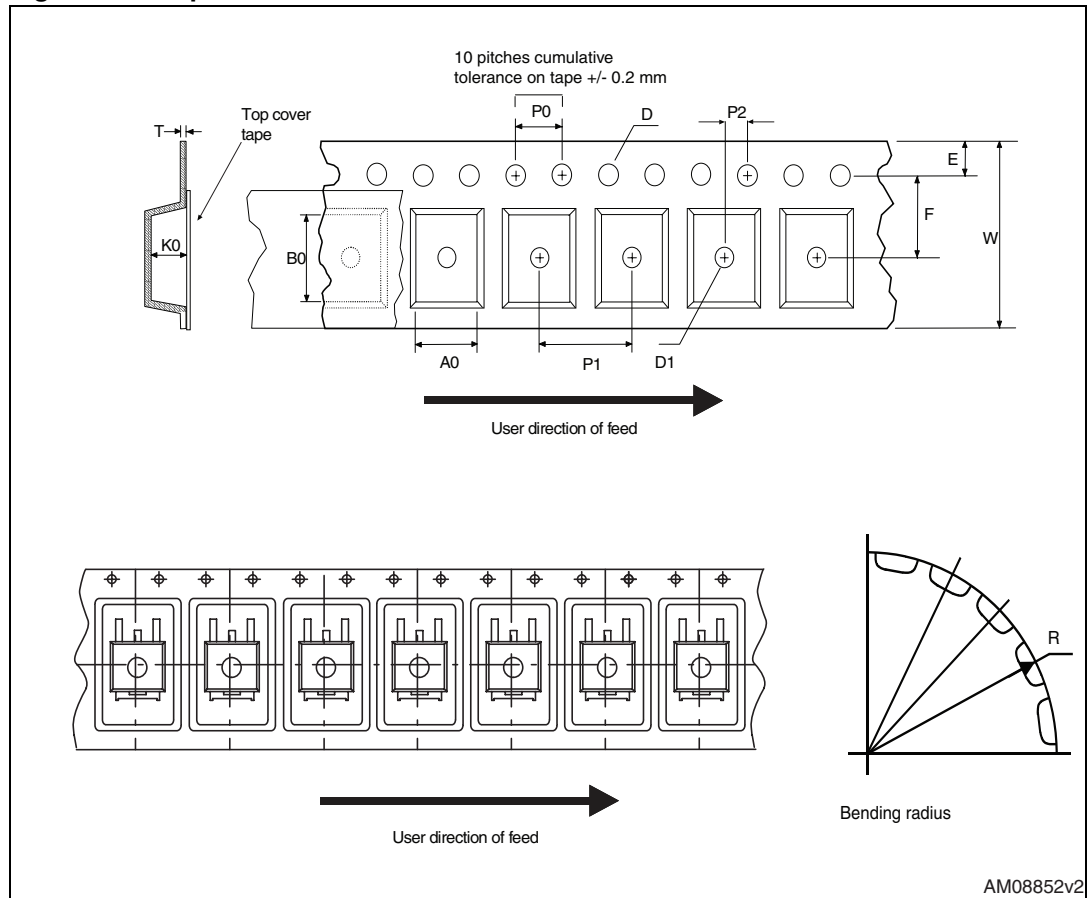
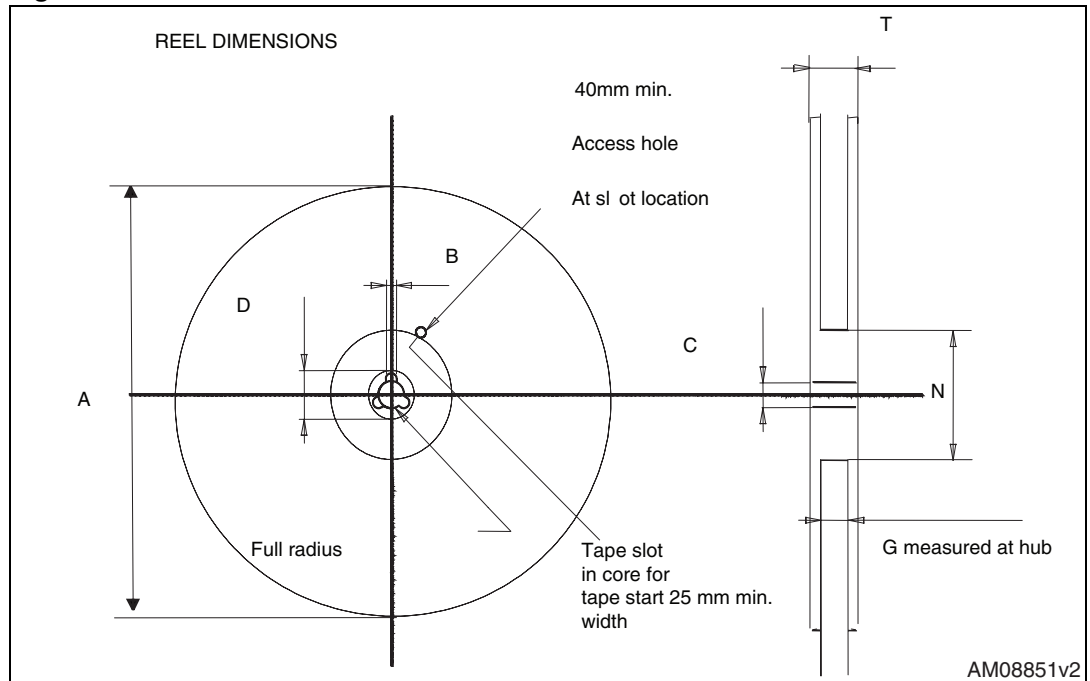


Figure 28. Reel



## 6 Revision history

**Table 13. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 02-Nov-2006 | 1        | Initial release.   |
| 05-Jan-2007 | 2        | Complete version.  |
| 01-Jul-2008 | 3        | Modified: <a href="#">Table 2: Absolute maximum ratings</a> .<br>Inserted new packages, mechanical data: TO-220FP, TO-247. |
| 13-Oct-2008 | 4        | $V_{ISO}$ inserted in <a href="#">Table 2</a> for TO-220FP.  |
| 15-May-2009 | 5        | Updated $I_{CP}$ value.  |
| 19-May-2009 | 6        | Updated: mechanical data for TO-220FP.   |
| 24-Nov-2010 | 7        | Inserted new order code STGWA19NC60HD in TO-247 long leads package.  |
| 14-Dec-2010 | 8        | Updated <a href="#">Table 4: Static</a> .  |
| 02-Sep-2011 | 9        | Removed order code STGWA19NC60HD in TO-247 long leads package.   |

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