



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.

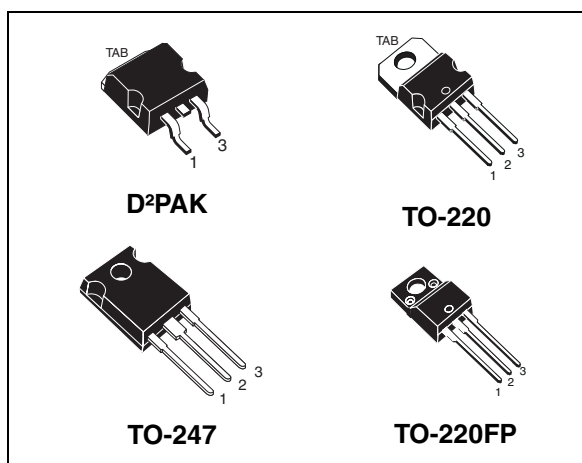


Figure 1. Internal schematic diagram

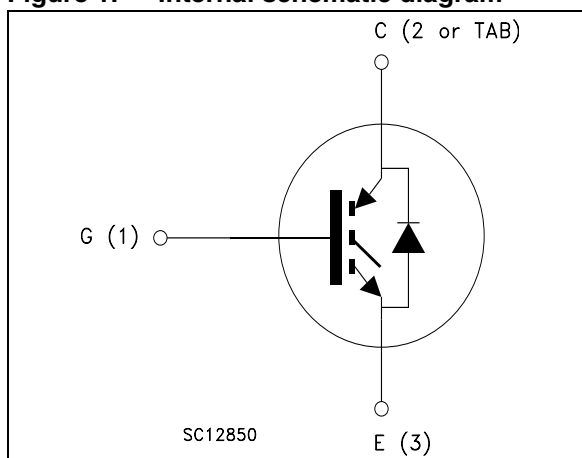


Table 1. Device summary

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

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 4 |
| 2.1 | Electrical characteristics (curves) | 6 |
| 3 | Test circuits | 9 |
| 4 | Package mechanical data | 10 |
| 5 | Packaging mechanical data | 16 |
| 6 | Revision history | 18 |

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|--------------------------------|--|------------------------------|----------|--------|------|
| | | TO-220 D ² PAK | TO-220FP | TO-247 | |
| V _{CES} | Collector-emitter voltage (V _{GE} = 0) | 600 | | | V |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 25 °C | 40 | 16 | 42 | A |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 100 °C | 19 | 10 | 21 | A |
| I _{CL} ⁽²⁾ | Turn-off latching current | 40 | | | A |
| I _{CP} ⁽³⁾ | Pulsed collector current | 60 | | | A |
| I _F | Diode RMS forward current at T _C = 25 °C | 20 | | | A |
| I _{FSM} | Surge not repetitive forward current t _p =10 ms sinusoidal | 50 | | | A |
| V _{GE} | Gate-emitter voltage | ±20 | | | V |
| P _{TOT} | Total dissipation at T _C = 25 °C | 130 | 32 | 140 | W |
| V _{ISO} | Isolation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C) | 2500 | | | V |
| T _J | 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_{clamp}=80%V_{CES}, T_J= 150 °C, R_G=1 0 Ω, V_{GE} = 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 D ² PAK | TO-220FP | TO-247 | |
| R _{thj-case} | 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 _{thj-amb} | 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 | $V_{GE} = 15\text{ V}, I_C = 12\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 15\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 30\text{ A}, T_J = 100\text{ °C}$ $V_{GE} = 15\text{ V}, I_C = 12\text{ A}, T_J = 125\text{ °C}$ | | 1.8 2 2.5 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 ($V_{GE} = 0$) | $V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$ | | | 150 1 | μA mA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{ V}$ | | | ± 100 | nA |
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{CE} = 15\text{ V}, I_C = 12\text{ A}$ | | 5 | | S |

1. Pulsed: pulse duration = 300 μs , 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 | Figure 20 | | 23 | | nC |

Table 6. Switching on/off (inductive load)

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

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|------|-------------------|------|-------------------------------|
| E_{on} $E_{off}^{(1)}$ E_{ts} | Turn-on switching losses Turn-off switching losses Total switching losses | $V_{CC} = 390\text{ V}$, $I_C = 12\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, <i>Figure 21</i> | - | 85 189 274 | - | μ J μ J μ J |
| E_{on} $E_{off}^{(1)}$ E_{ts} | Turn-on switching losses Turn-off switching losses Total switching losses | $V_{CC} = 390\text{ V}$, $I_C = 12\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ <i>Figure 21</i> | - | 187 407 594 | - | μ J μ J μ 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 | $I_F = 12\text{ A}$ $I_F = 12\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$ | - | 2.6 2.1 | - | V V |
| t_{rr} Q_{rr} I_{rrm} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_F = 12\text{ A}$, $V_R = 40\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 22</i> | - | 31 30 2 | - | ns nC A |
| t_{rr} Q_{rr} I_{rrm} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_F = 12\text{ A}$, $V_R = 40\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 22</i> | - | 59 102 4 | - | ns nC A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

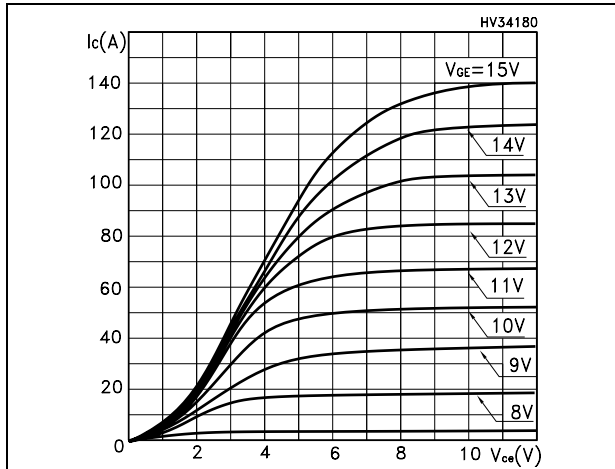


Figure 3. Transfer characteristics

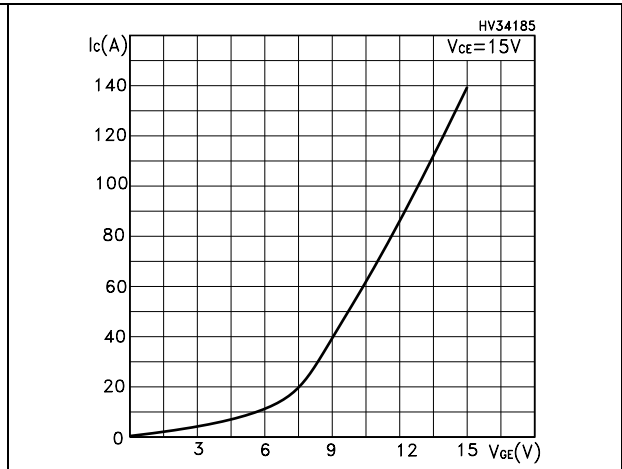


Figure 4. Transconductance

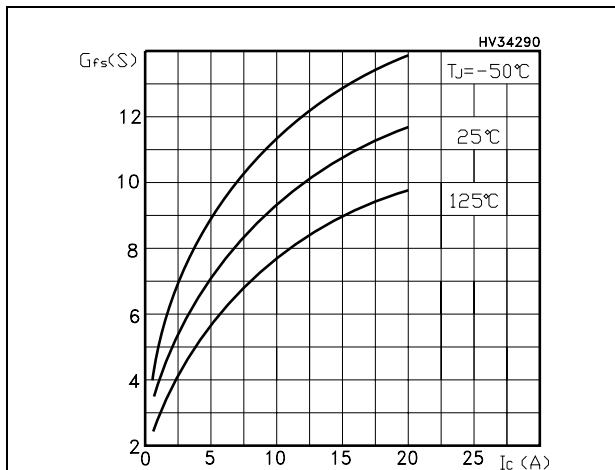


Figure 5. Collector-emitter on voltage vs. temperature

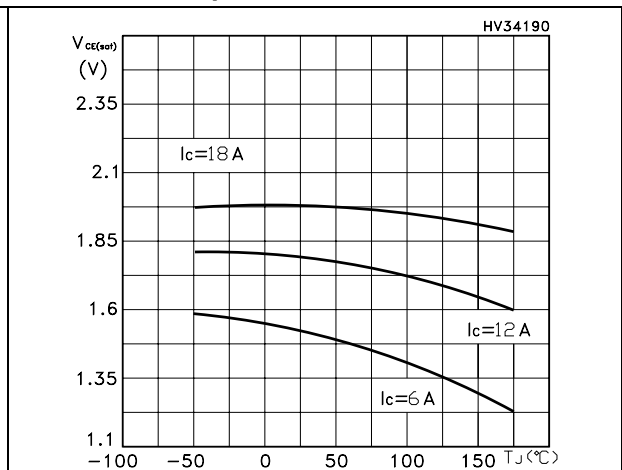


Figure 6. Gate charge vs. gate-source voltage

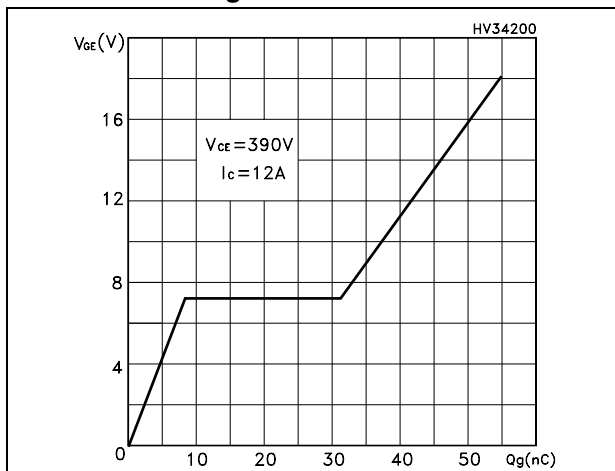


Figure 7. Capacitance variations

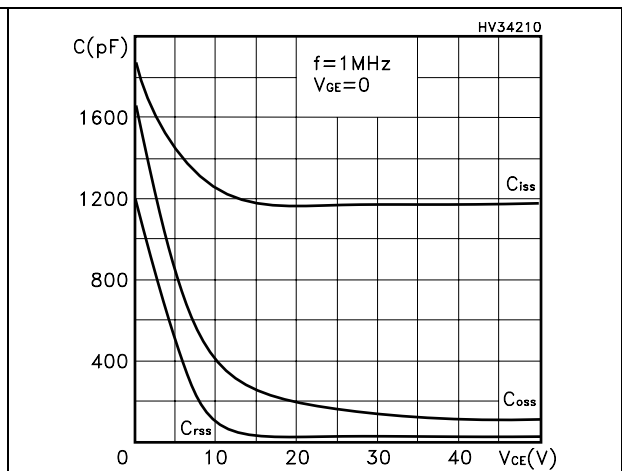


Figure 8. Normalized gate threshold voltage vs. temperature

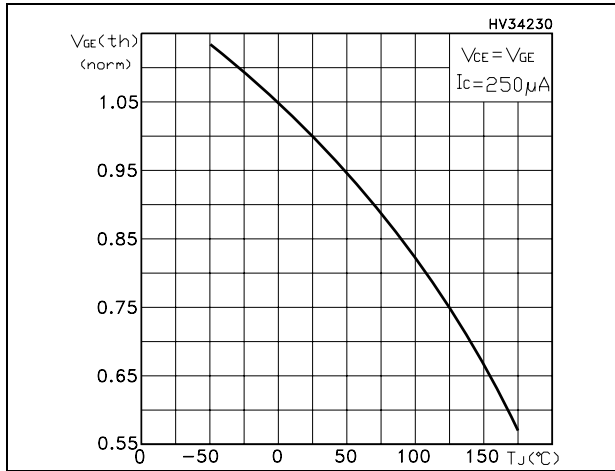


Figure 9. Collector-emitter on voltage vs. collector current

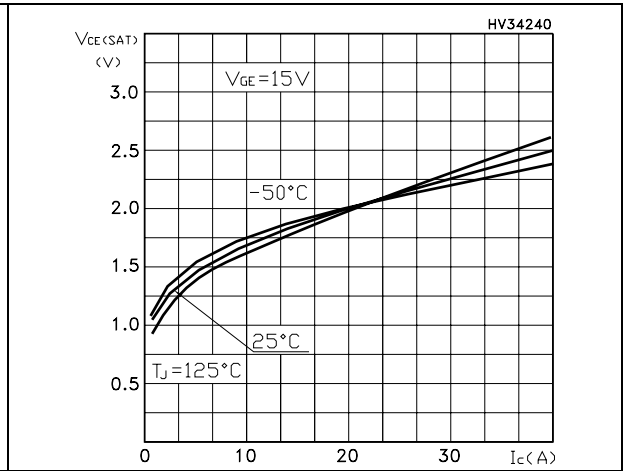


Figure 10. Normalized breakdown voltage vs. temperature

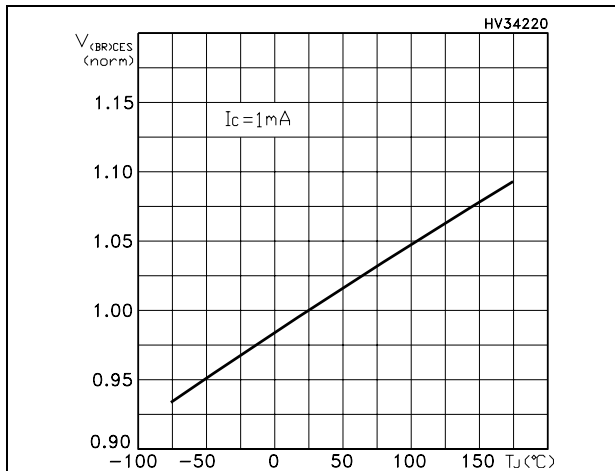


Figure 11. Switching losses vs. temperature

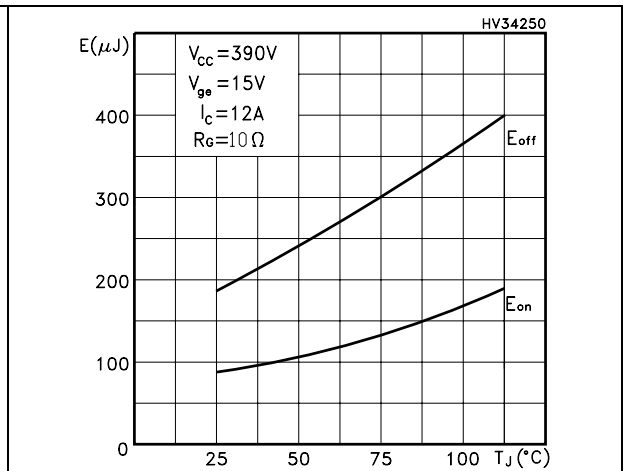


Figure 12. Switching losses vs. gate resistance

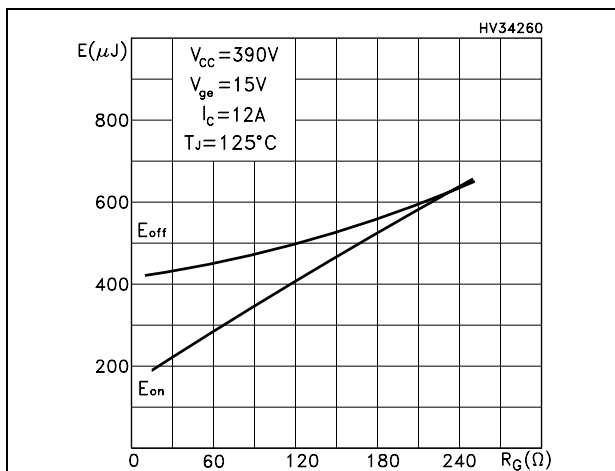


Figure 13. Switching losses vs. collector current

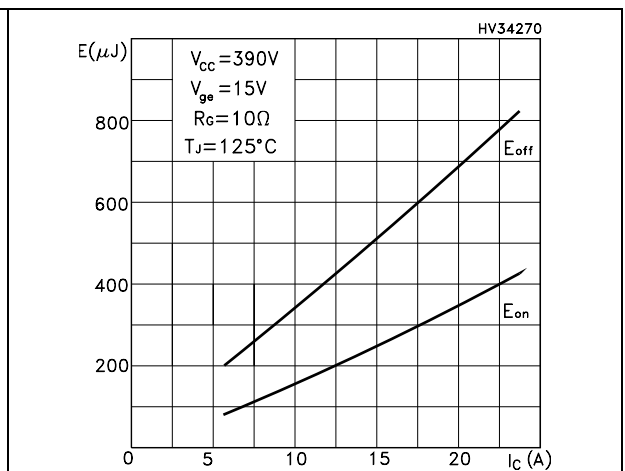


Figure 14. Turn-off SOA

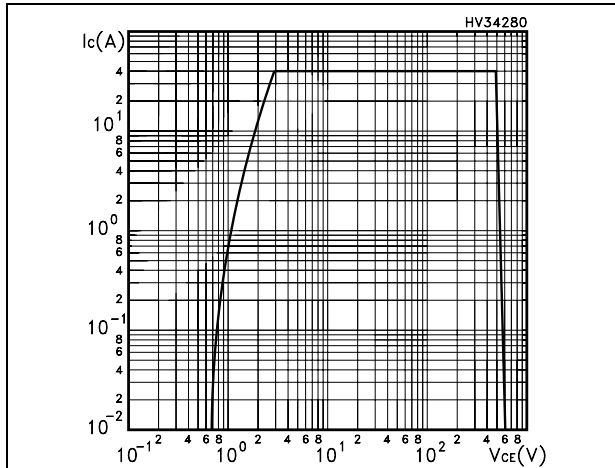


Figure 15. Thermal impedance for TO-247

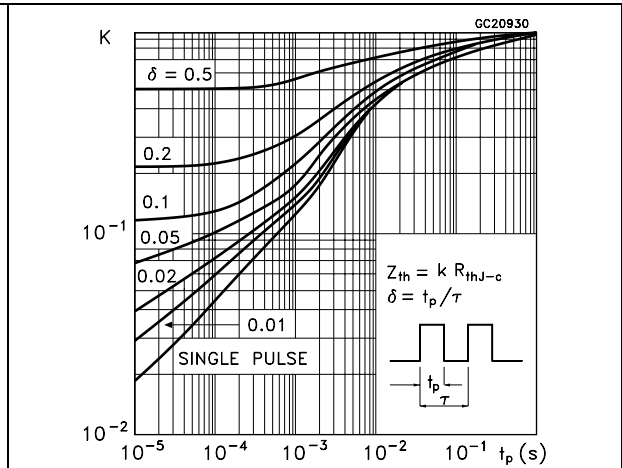


Figure 16. Thermal impedance for TO-220, D²PAK

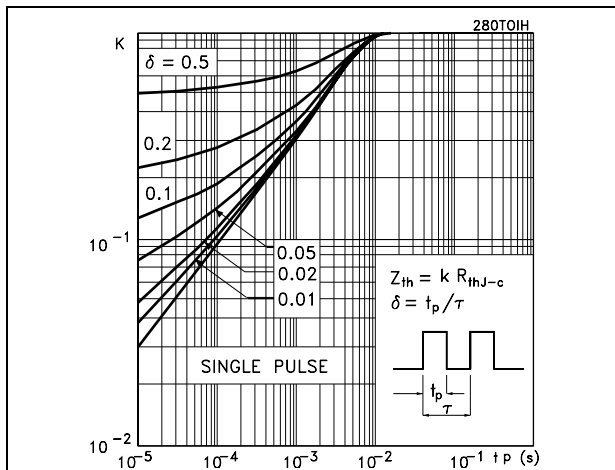


Figure 17. Thermal impedance for TO-220FP

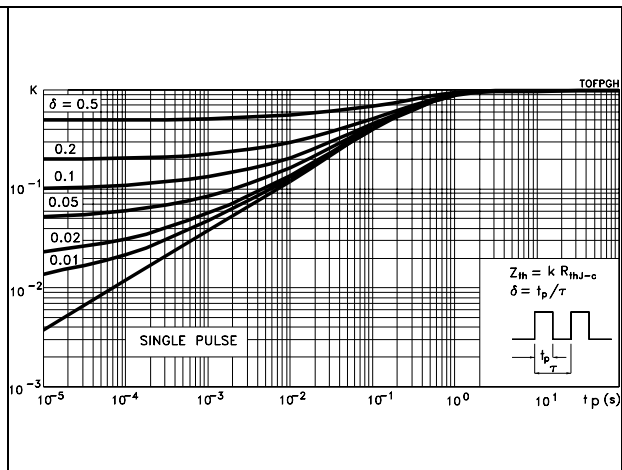
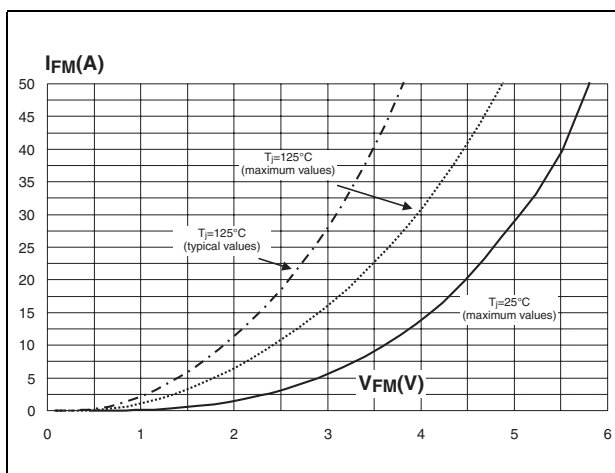


Figure 18. Forward voltage drop vs. forward current



3 Test circuits

Figure 19. Test circuit for inductive load switching

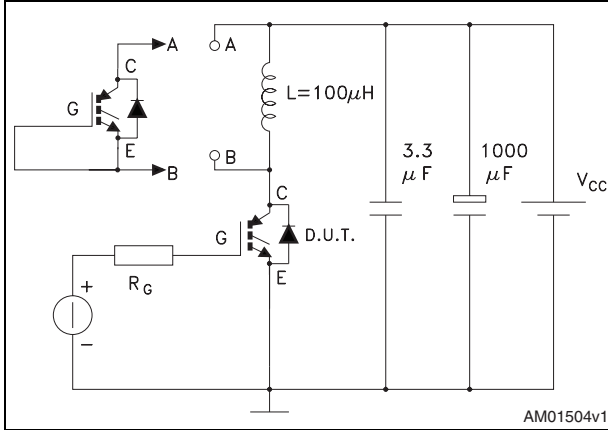


Figure 20. Gate charge test circuit

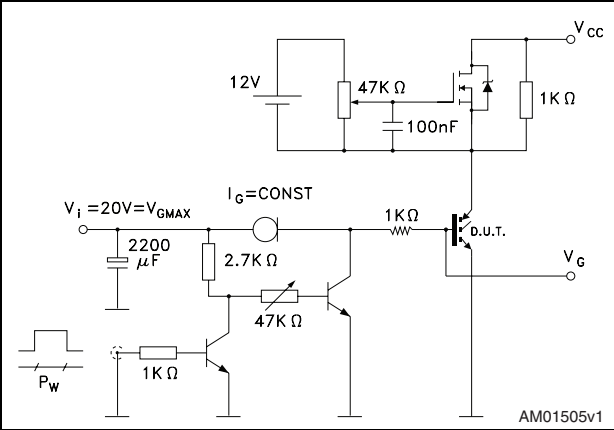


Figure 21. Switching waveform

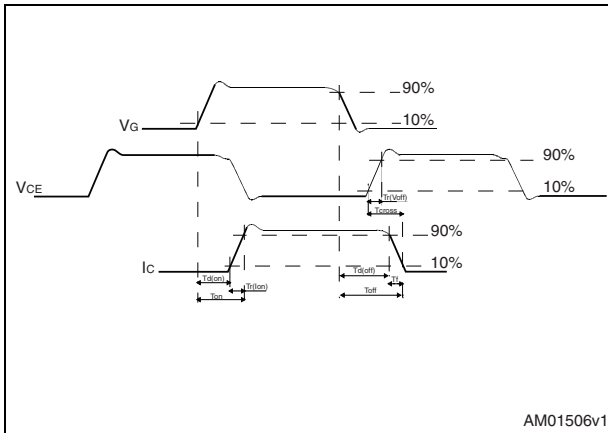
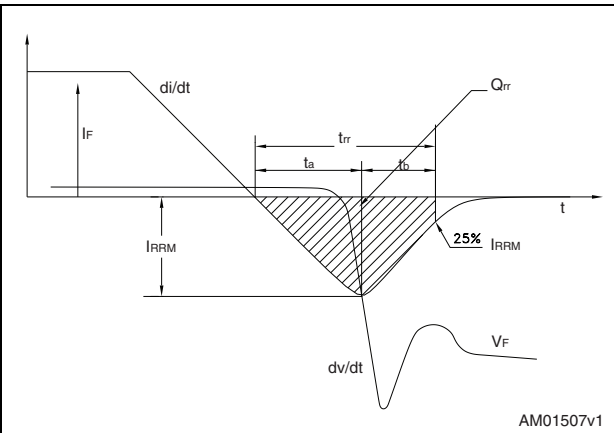


Figure 22. Diode recovery time waveform



4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® 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.

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

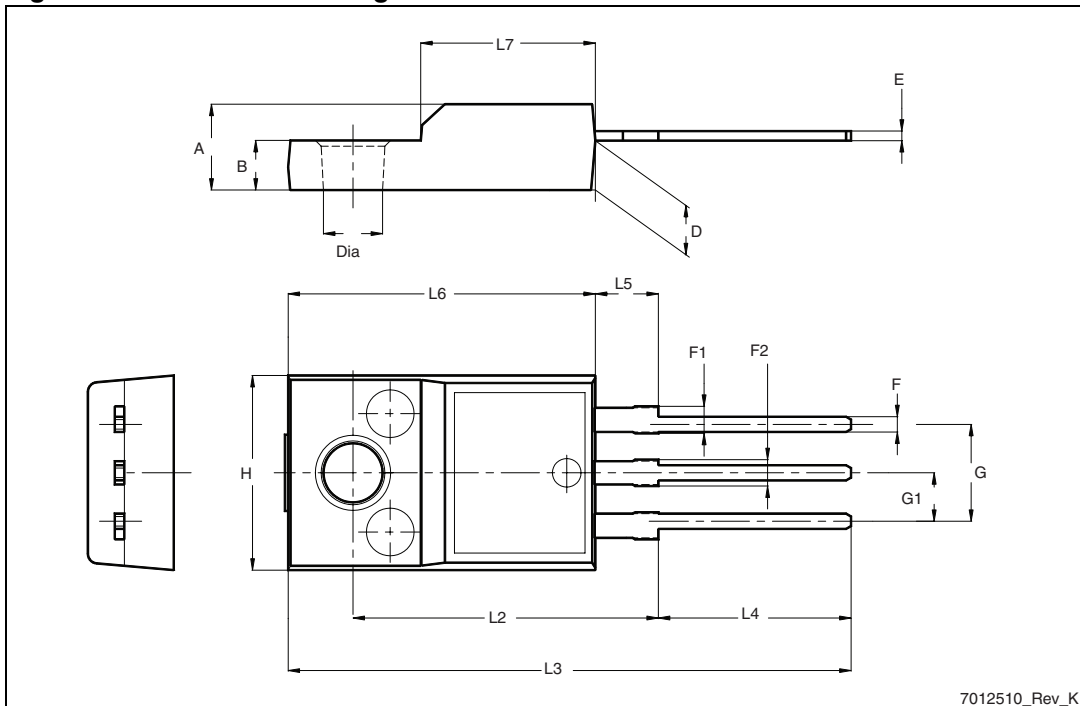


Table 10. D²PAK (TO-263) mechanical data

| 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. D²PAK (TO-263) drawing

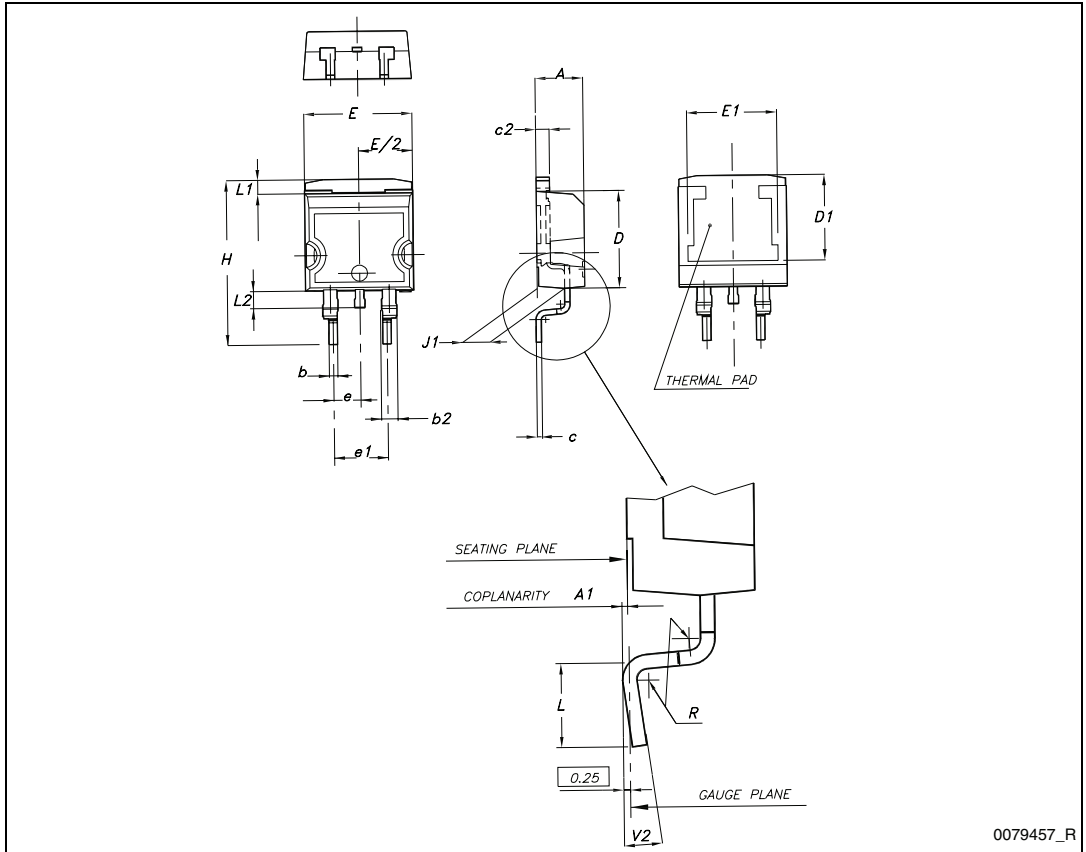
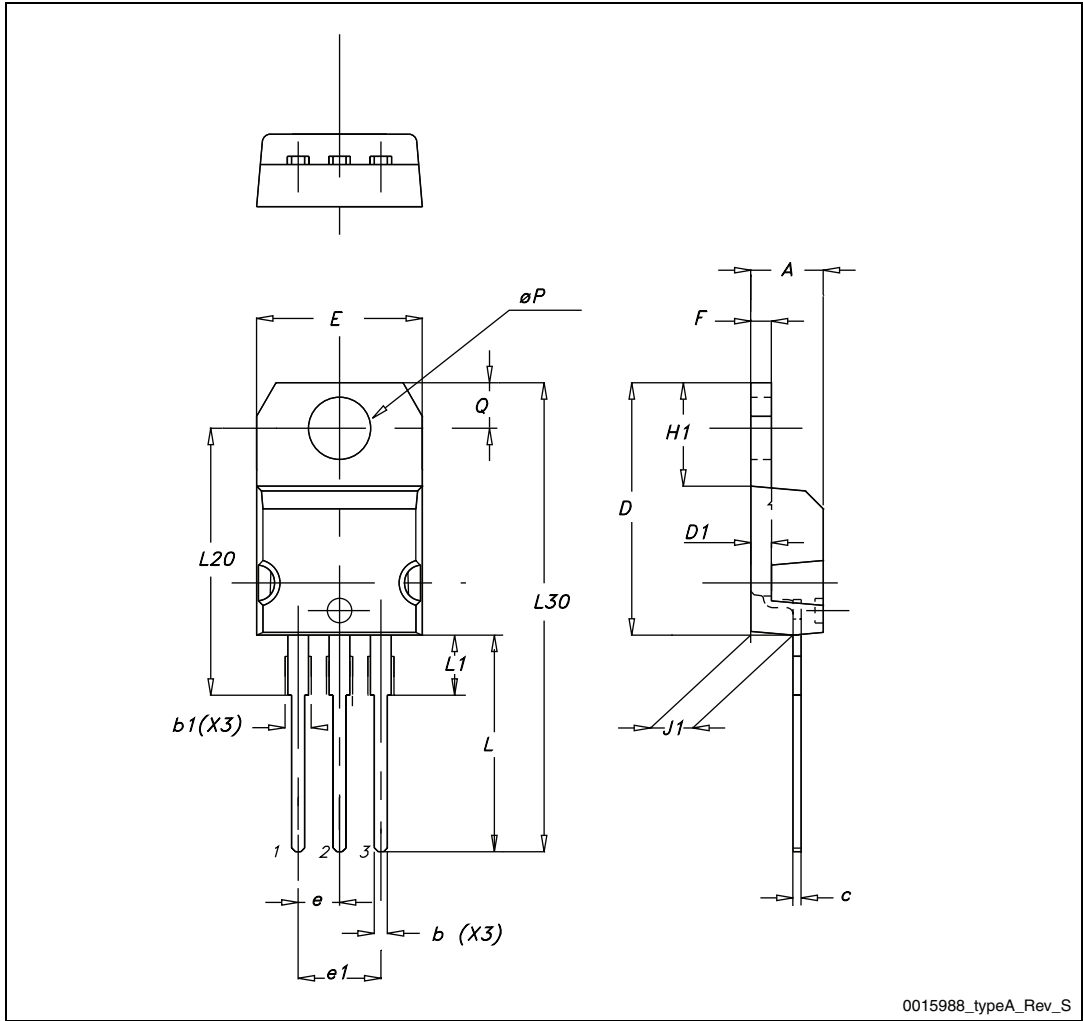


Table 11. TO-220 type A mechanical data

| 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



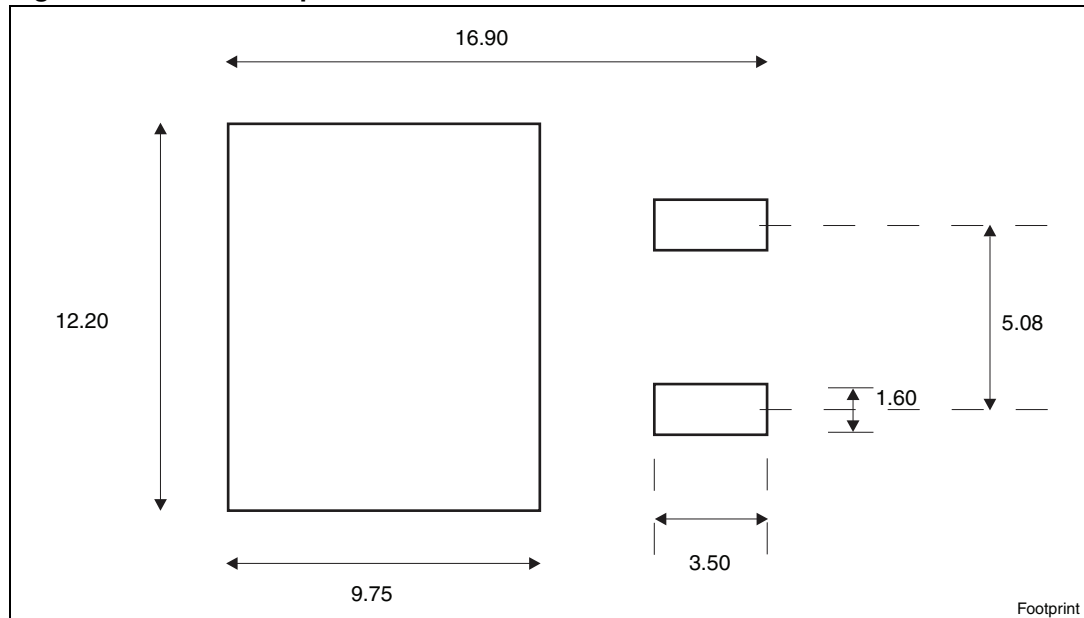
0015988_typeA_Rev_S

5 Packaging mechanical data

Table 12. D²PAK (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. D²PAK footprint^(a)



a. All dimension are in millimeters

Figure 27. Tape

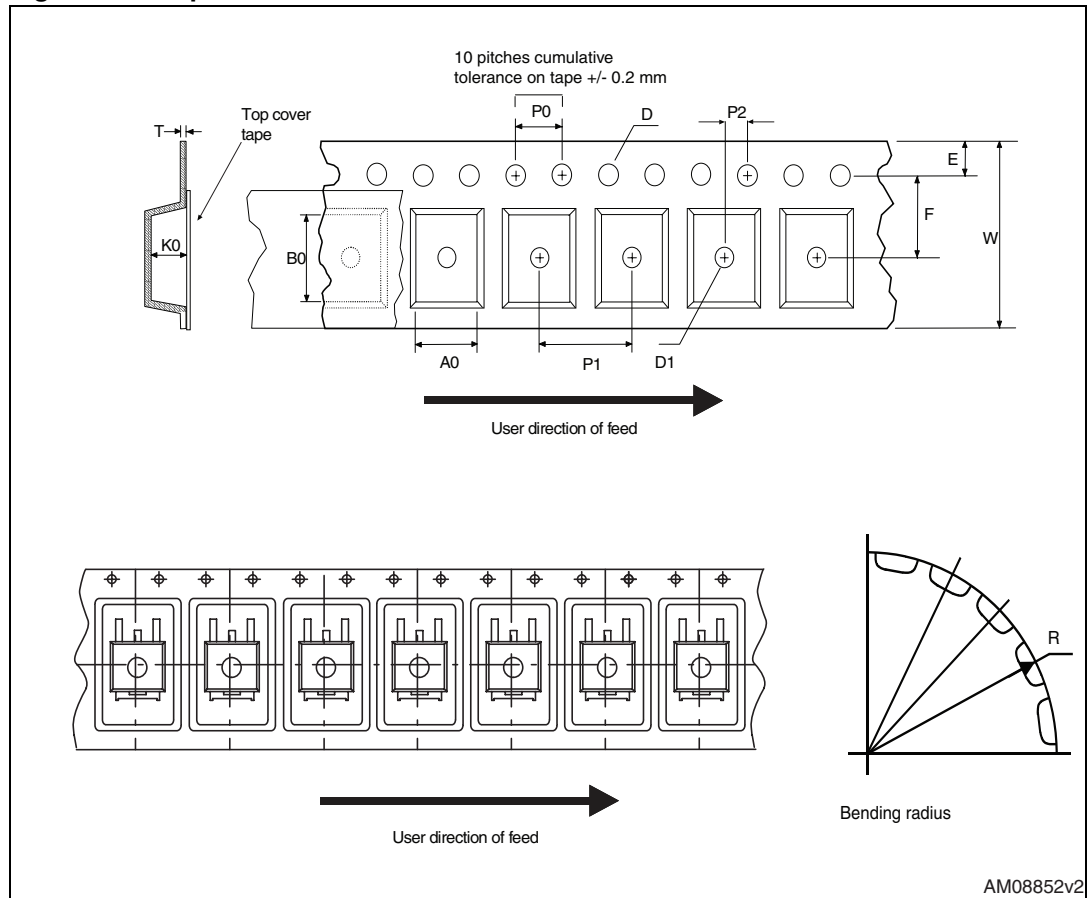
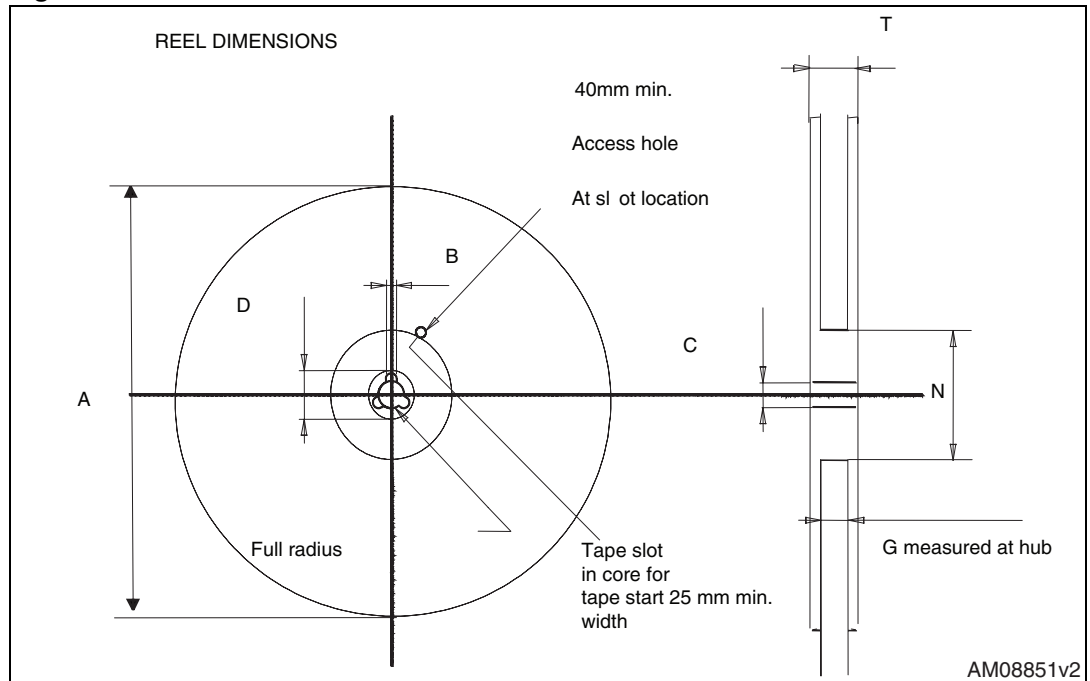


Figure 28. Reel



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: Table 2: Absolute maximum ratings . Inserted new packages, mechanical data: TO-220FP, TO-247. |
| 13-Oct-2008 | 4 | V_{ISO} inserted in Table 2 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 Table 4: Static . |
| 02-Sep-2011 | 9 | Removed order code STGWA19NC60HD in TO-247 long leads package. |

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