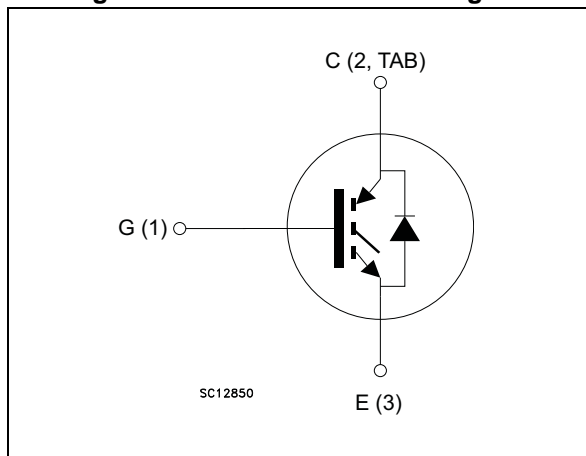


Figure 1. Internal schematic diagram



Features

- High speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Short-circuit rated
- Ultrafast soft recovery antiparallel diode

Applications

- Motor control
- UPS, PFC

Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT series offers the optimum compromise between conduction and switching losses, maximizing the efficiency of very high frequency converters. Furthermore, a positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Table 1. Device summary

| Order codes | Marking | Packages | Packaging |
|-------------|-----------|--------------------|---------------|
| STGB20H60DF | GB20H60DF | D ² PAK | Tape and reel |
| STGF20H60DF | GF20H60DF | TO-220FP | Tube |
| STGP20H60DF | GP20H60DF | TO-220 | Tube |

Contents

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | TO-220 D ² PAK | TO-220FP | Unit |
|-------------------------|---|------------------------------|-------------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$) | 600 | | V |
| I_C | Continuous collector current at $T_C = 25\text{ °C}$ | 40 | 40 ⁽¹⁾ | A |
| | Continuous collector current at $T_C = 100\text{ °C}$ | 20 | 20 ⁽¹⁾ | A |
| I_{CP} ⁽²⁾ | Pulsed collector current | 80 | 80 ⁽¹⁾ | A |
| V_{GE} | Gate-emitter voltage | ±20 | | V |
| I_F | Continuous forward current $T_C = 25\text{ °C}$ | 40 | 40 ⁽¹⁾ | A |
| | Continuous forward current at $T_C = 100\text{ °C}$ | 20 | 20 ⁽¹⁾ | |
| I_{FP} ⁽²⁾ | Pulsed forward current | 80 | 80 ⁽¹⁾ | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 167 | 37 | W |
| T_{STG} | Storage temperature range | - 55 to 150 | | °C |
| T_J | Operating junction temperature | - 55 to 175 | | |

1. Limited by maximum junction temperature.

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

Table 3. Thermal data

| Symbol | Parameter | TO-220 D ² PAK | TO-220FP | Unit |
|------------|--|------------------------------|----------|------|
| R_{thJC} | Thermal resistance junction-case IGBT | 0.9 | 4 | °C/W |
| R_{thJC} | Thermal resistance junction-case diode | 2.5 | 5.6 | °C/W |
| R_{thJA} | Thermal resistance junction-ambient | 62.5 | | °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 ($V_{GE} = 0$) | $I_C = 2\text{ mA}$ | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ | | 1.6 | 2.0 | V |
| | | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 125\text{ °C}$ | | 1.75 | | |
| | | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $T_J = 175\text{ °C}$ | | 1.8 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}, I_C = 1\text{ mA}$ | 5.0 | 6.0 | 7.0 | V |
| I_{CES} | Collector cut-off current ($V_{GE} = 0$) | $V_{CE} = 600\text{ V}$ | | | 25 | μA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{ V}$ | | | 250 | nA |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$ | - | 2750 | - | pF |
| C_{oes} | Output capacitance | | - | 110 | - | pF |
| C_{res} | Reverse transfer capacitance | | - | 65 | - | pF |
| Q_g | Total gate charge | $V_{CC} = 400\text{ V}, I_C = 20\text{ A},$ $V_{GE} = 15\text{ V}$ | - | 115 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 22 | - | nC |
| Q_{gc} | Gate-collector charge | | - | 45 | - | nC |

Table 6. Switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|------------------------------|---|------|------|------|------------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | | 42.5 | - | ns |
| t_r | Current rise time | | | 11.9 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1345 | - | A/ μs |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ | | 42.5 | - | ns |
| t_r | Current rise time | | | 13.4 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1180 | | A/ μs |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | | 20 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 177 | - | ns |
| t_f | Current fall time | | | 55 | - | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ | | 26 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 173 | - | ns |
| t_f | Current fall time | | | 86 | - | ns |
| t_{sc} | Short-circuit withstand time | $V_{CC} \leq 360\text{ V}$, $V_{GE} = 15\text{ V}$ | 3 | 5 | - | μs |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit | |
|-----------------|---------------------------|---|------|------|------|---------------|---------------|
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | - | 209 | - | μJ | |
| $E_{off}^{(2)}$ | Turn-off switching losses | | | - | 261 | - | μJ |
| E_{ts} | Total switching losses | | | - | 470 | - | μJ |
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CE} = 400\text{ V}$, $I_C = 20\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ | - | 480 | - | μJ | |
| $E_{off}^{(2)}$ | Turn-off switching losses | | | - | 416 | - | μJ |
| E_{ts} | Total switching losses | | | - | 896 | - | μJ |

1. Energy losses include reverse recovery of the diode.
2. 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 | $I_F = 20\text{ A}$ $I_F = 20\text{ A}, T_J = 175\text{ °C}$ | - | 1.8 | 2.2 | V |
| | | | | 1.3 | | V |
| t_{rr} | Reverse recovery time | $V_r = 60\text{ V}; I_F = 20\text{ A};$ $di_F/dt = 100\text{ A} / \mu\text{s}$ | - | 90 | - | ns |
| Q_{rr} | Reverse recovery charge | | | 110 | | nC |
| I_{rrm} | Reverse recovery current | | | 2.4 | | A |
| t_{rr} | Reverse recovery time | $V_r = 60\text{ V}; I_F = 20\text{ A};$ $di_F/dt = 100\text{ A} / \mu\text{s}$ $T_J = 175\text{ °C}$ | - | 180 | - | ns |
| | | | | 466 | | nC |
| I_{rrm} | Reverse recovery current | | - | 5.2 | - | A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics ($T_J = 25^\circ\text{C}$)

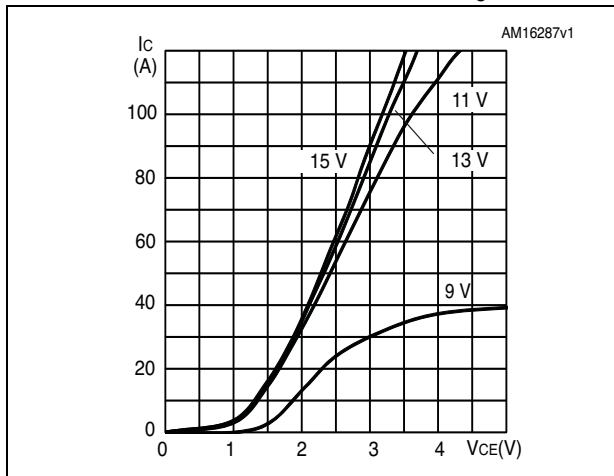


Figure 3. Output characteristics ($T_J = 175^\circ\text{C}$)

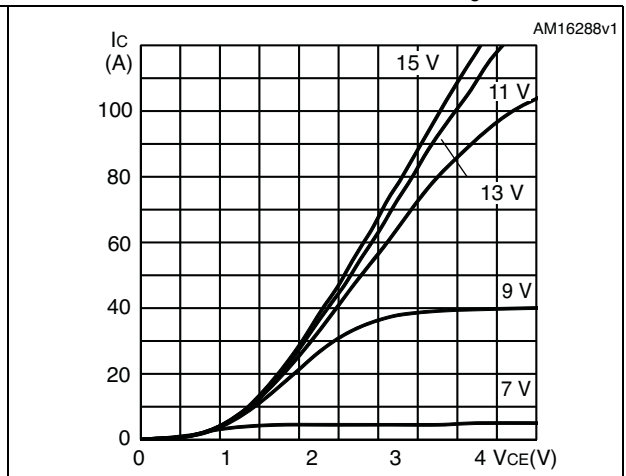


Figure 4. Transfer characteristics

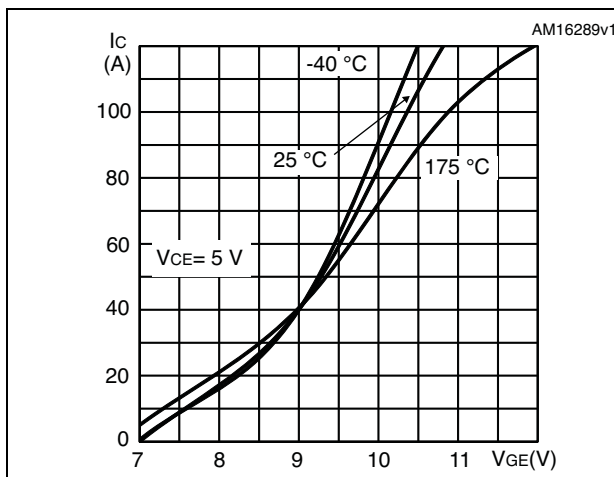


Figure 5. Normalized $V_{GE(th)}$ vs junction temperature

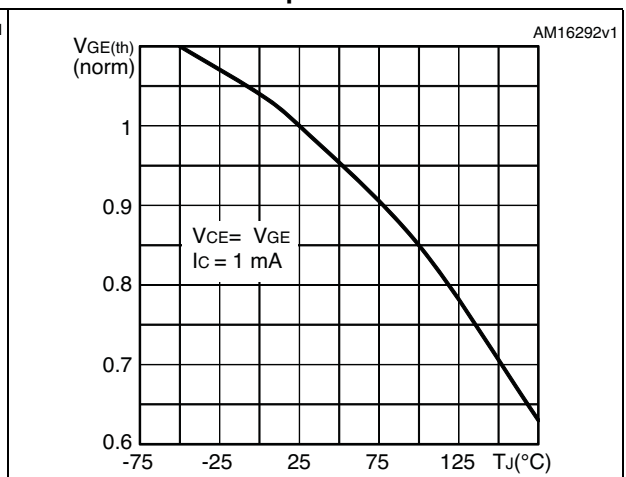


Figure 6. Collector current vs. case temperature for D²PAK and TO-220 Figure 7. Collector current vs. case temperature for TO-220FP

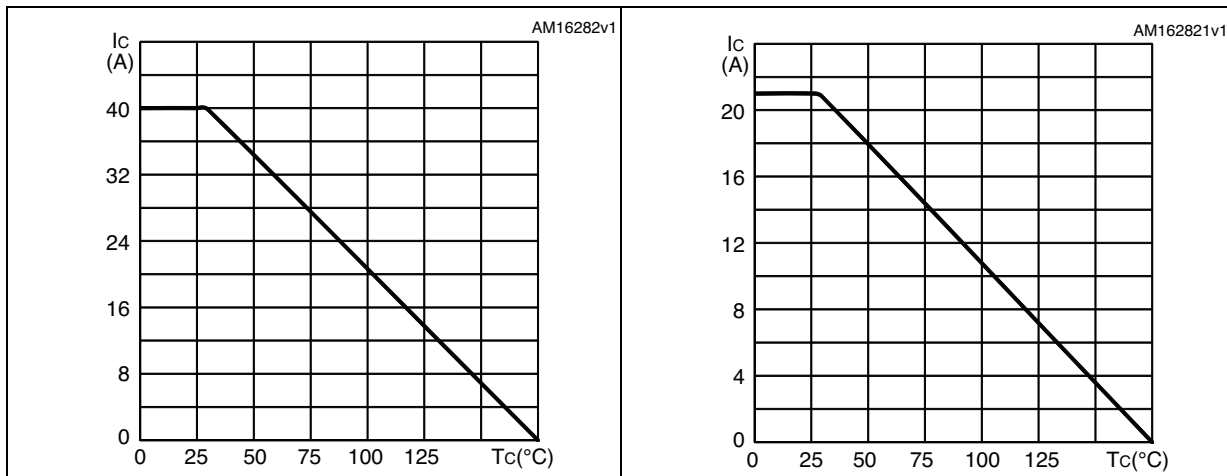


Figure 8. Collector current vs. frequency for D²PAK and TO-220

Figure 9. Collector current vs. frequency for TO-220FP

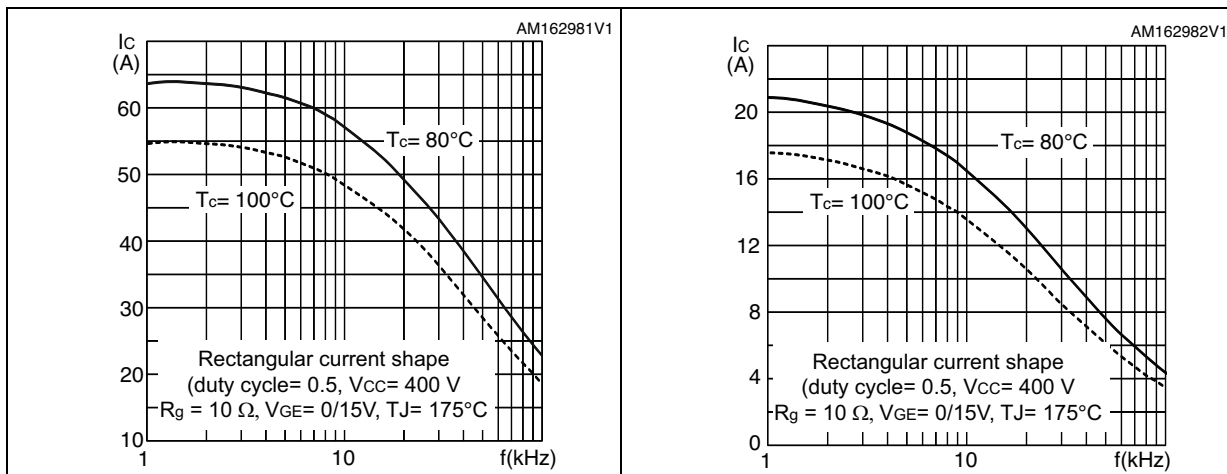


Figure 10. Power dissipation vs. case temperature for D²PAK and TO-220

Figure 11. Power dissipation vs. case temperature for TO-220FP

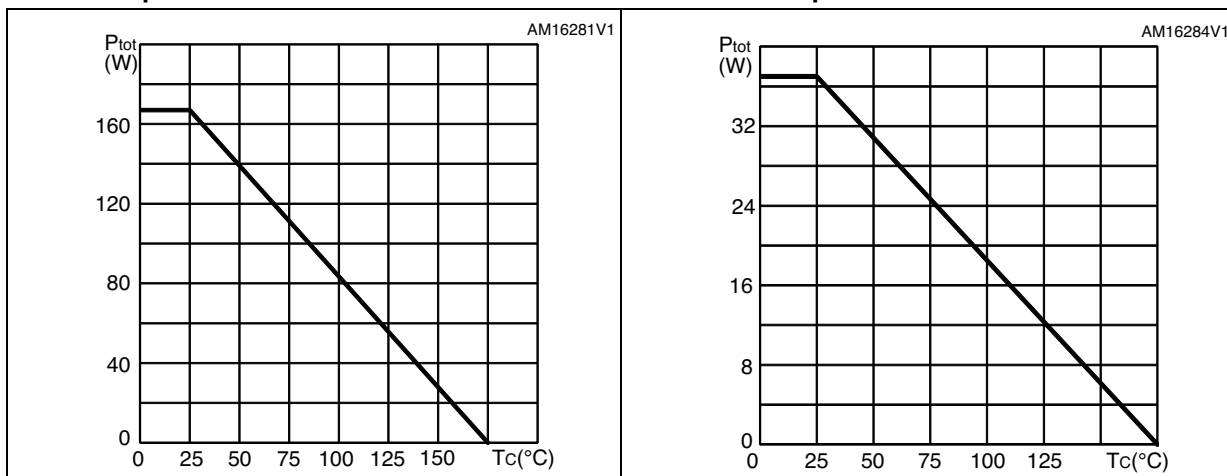


Figure 12. $V_{CE(sat)}$ vs. junction temperature

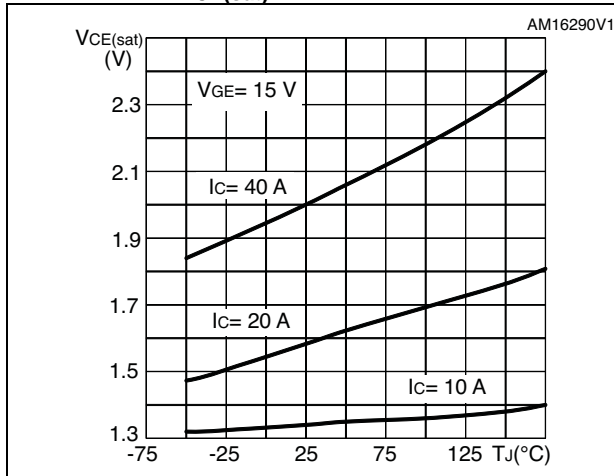


Figure 13. $V_{CE(sat)}$ vs. collector current

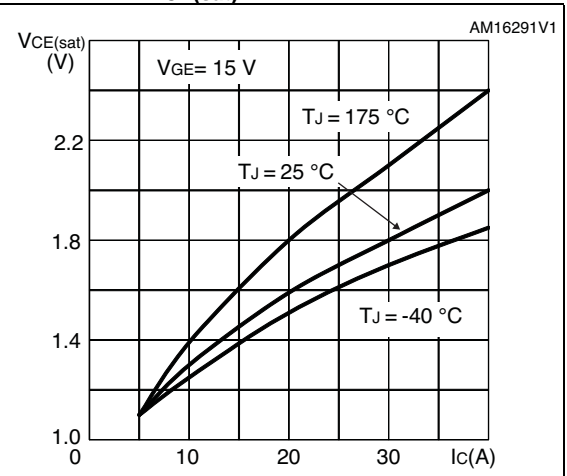


Figure 14. Forward bias safe operating area for D²PAK and TO-220

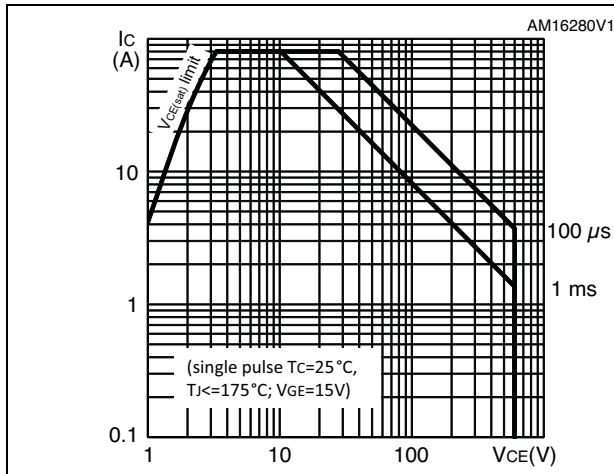


Figure 15. Thermal impedance for D²PAK and TO-220

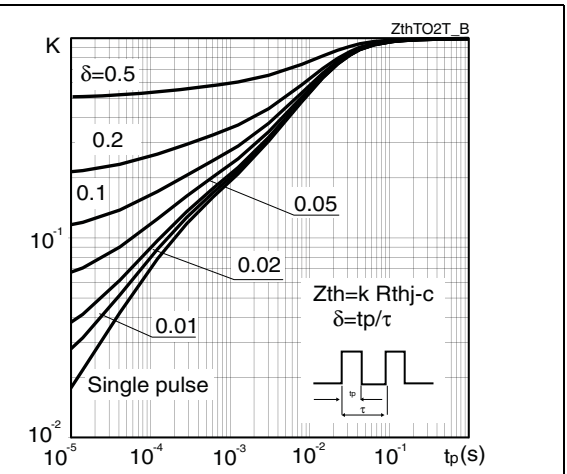


Figure 16. Forward bias safe operating area for TO-220FP

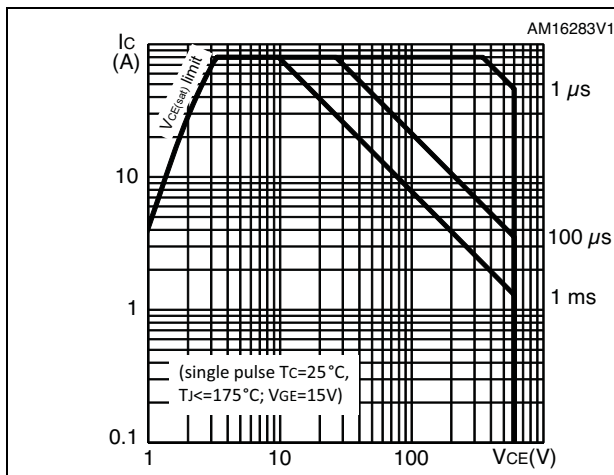


Figure 17. Thermal impedance for TO-220FP

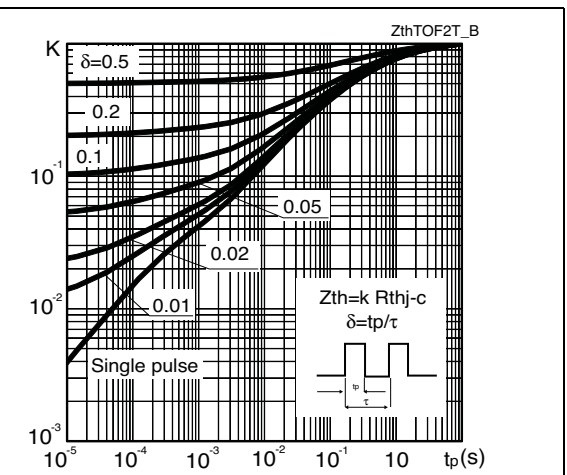


Figure 18. Diode V_F vs. forward current

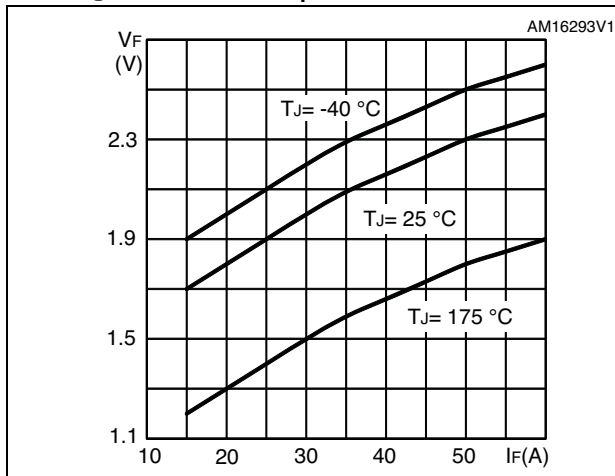


Figure 19. Gate charge vs. gate-emitter voltage

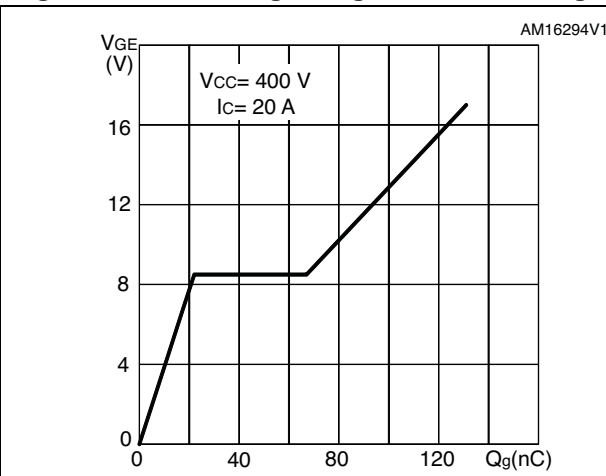


Figure 20. Capacitance variations vs. V_{CE}

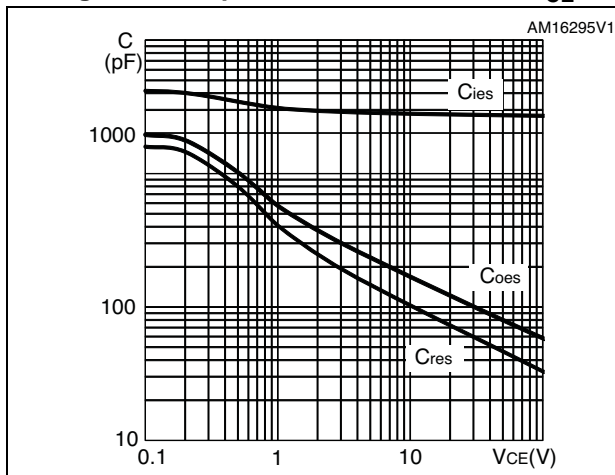


Figure 21. Switching losses vs. gate resistance

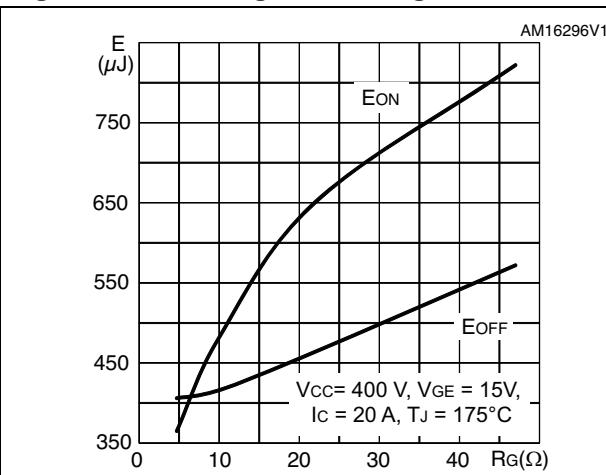


Figure 22. Switching losses vs. collector current

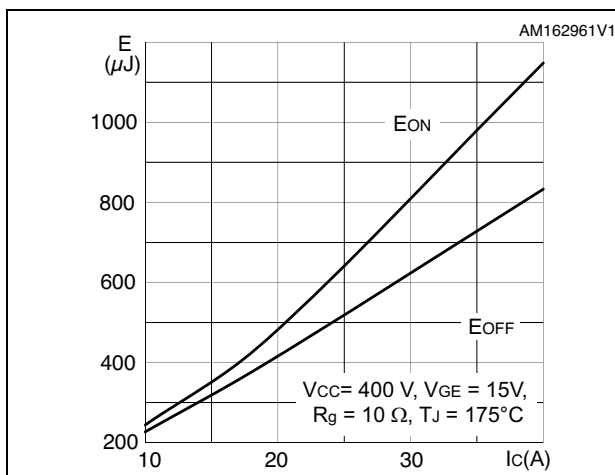


Figure 23. Switching losses vs. temperature

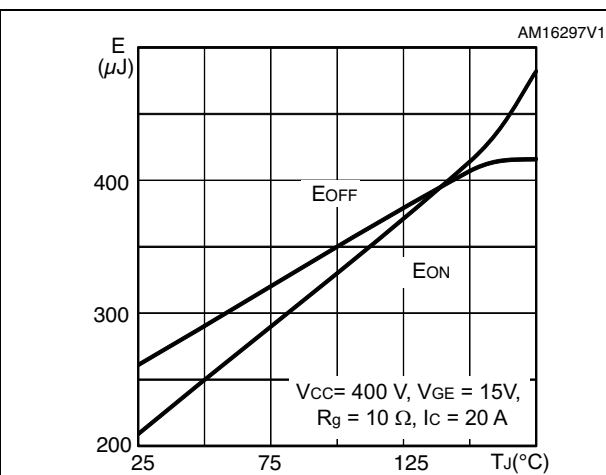
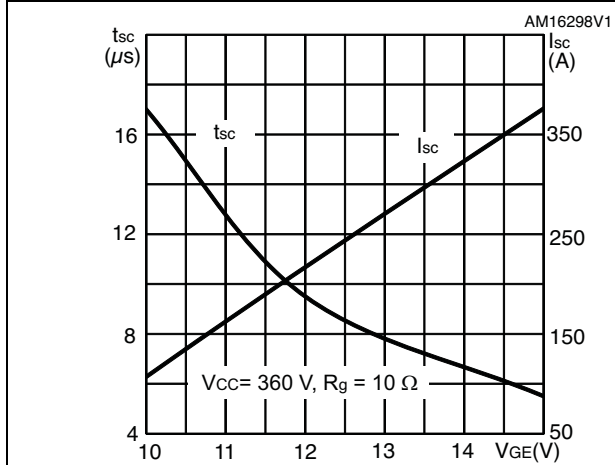
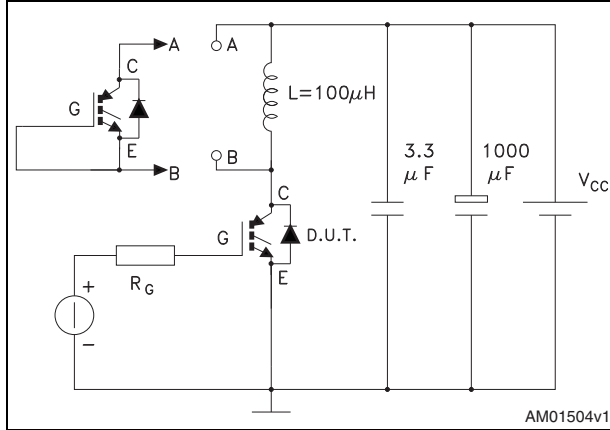


Figure 24. Short-circuit time and current vs. V_{GE}



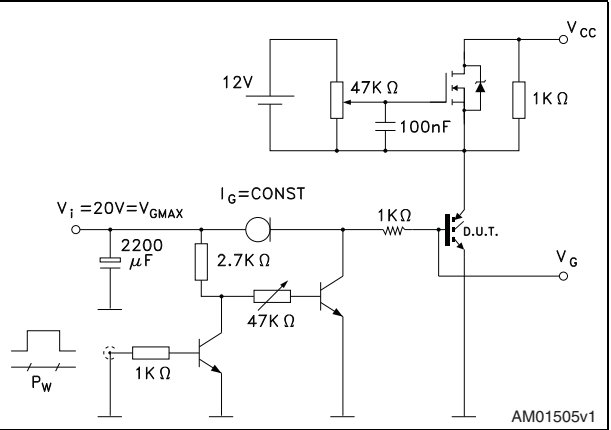
3 Test circuits

Figure 25. Test circuit for inductive load switching



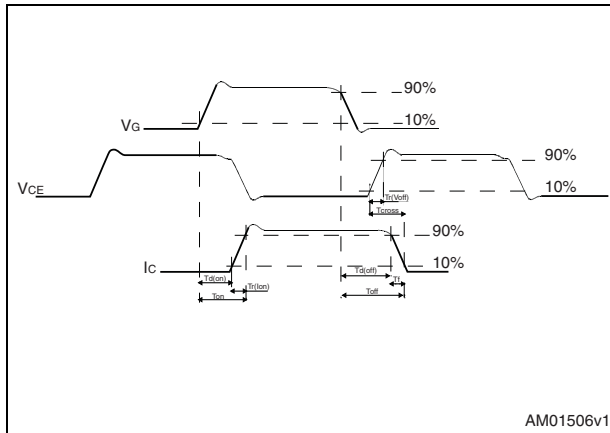
AM01504v1

Figure 26. Gate charge test circuit



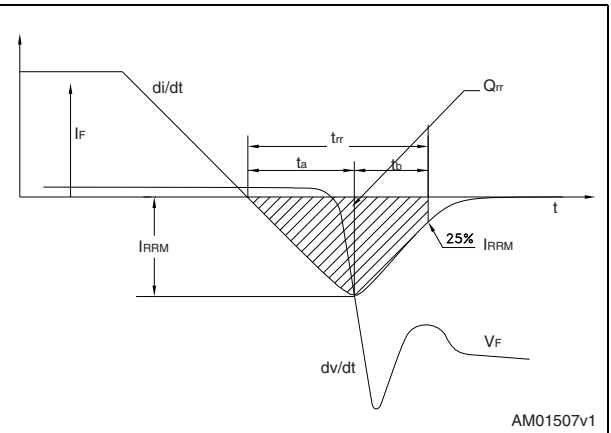
AM01505v1

Figure 27. Switching waveform



AM01506v1

Figure 28. Diode recovery time waveform



AM01507v1

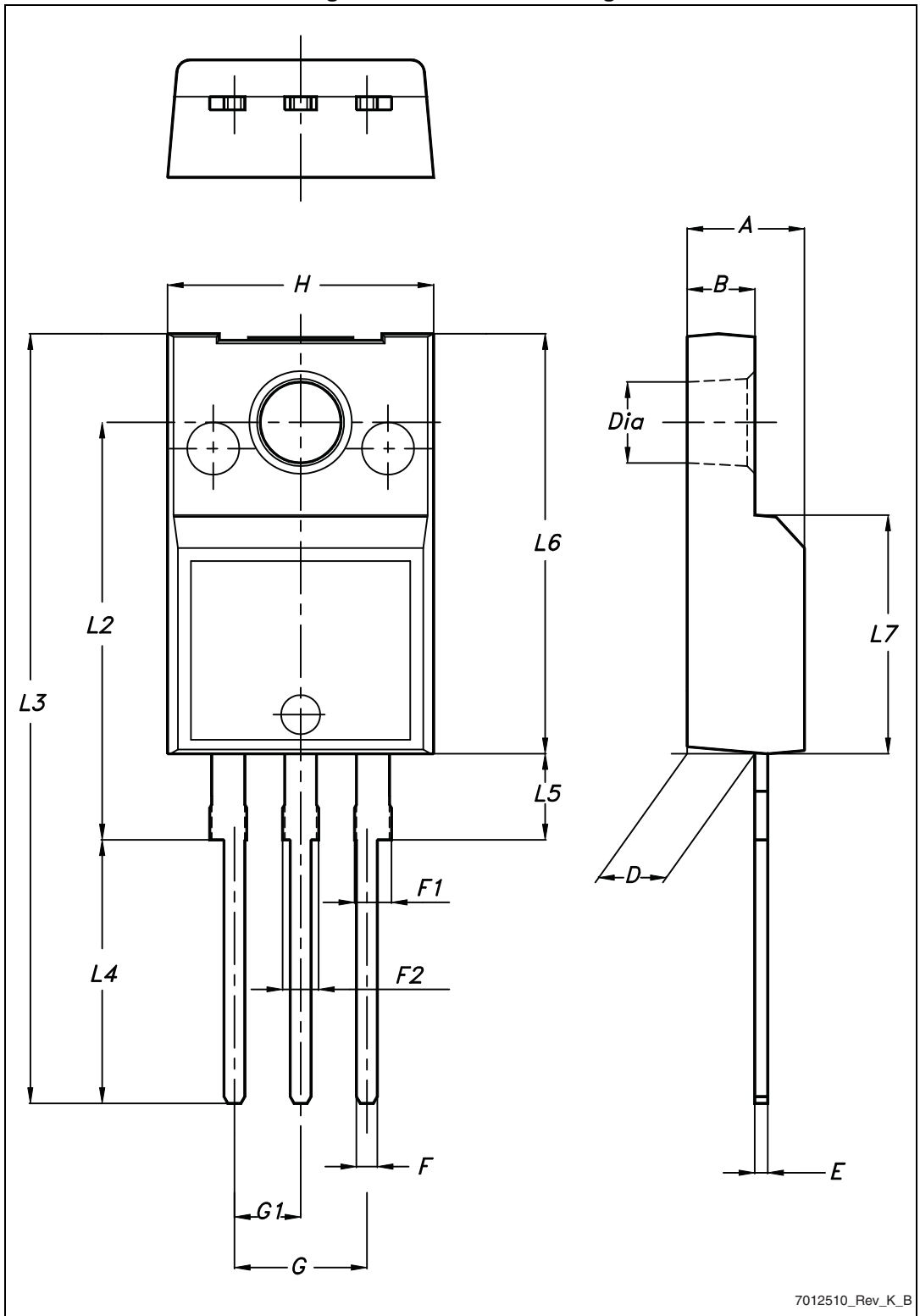
4 Package mechanical data

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 29. TO-220FP drawing



7012510_Rev_K_B

Table 10. 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 30. TO-220 type A drawing

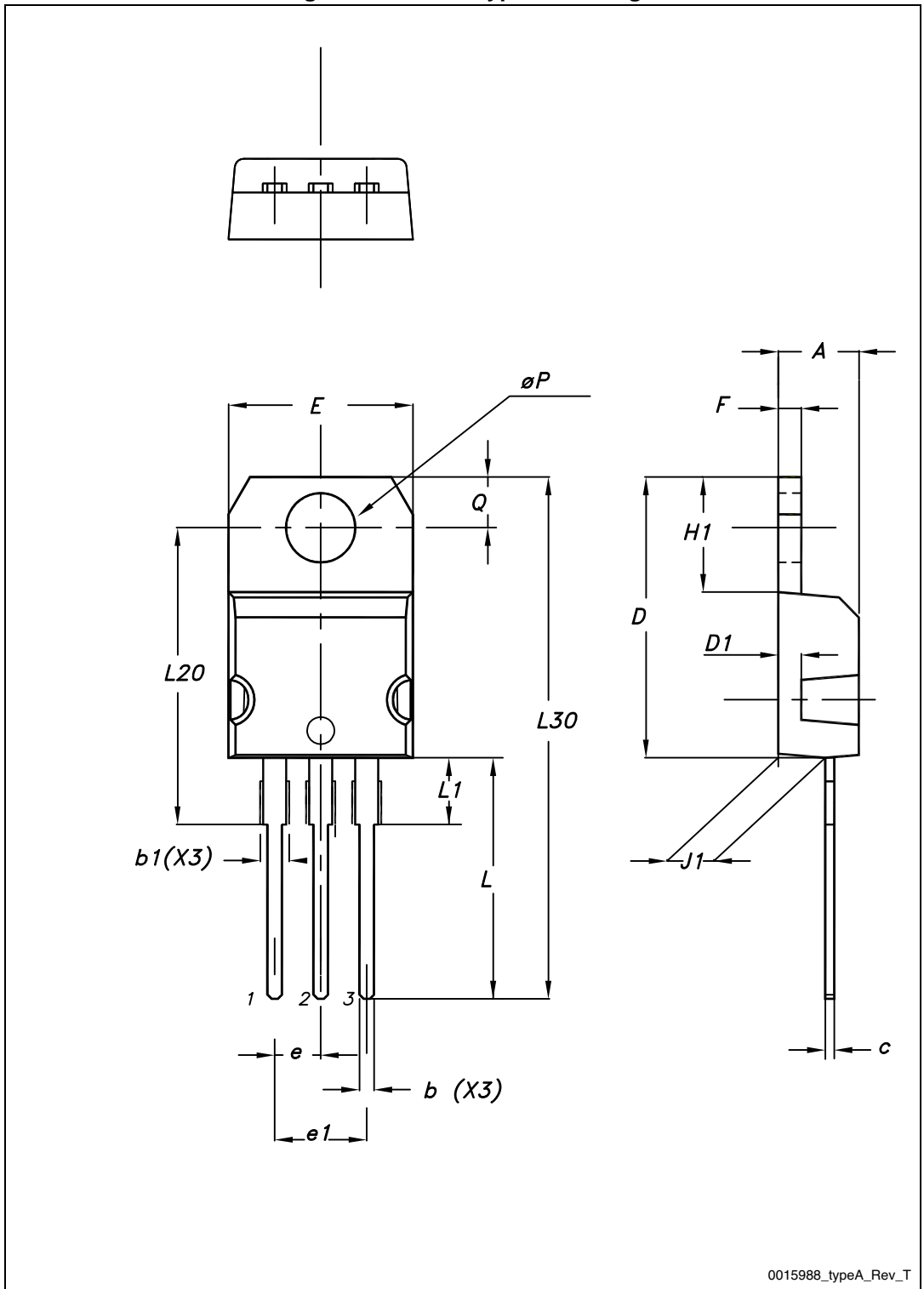


Table 11. D²PAK mechanical data

| 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 31. D²PAK drawing

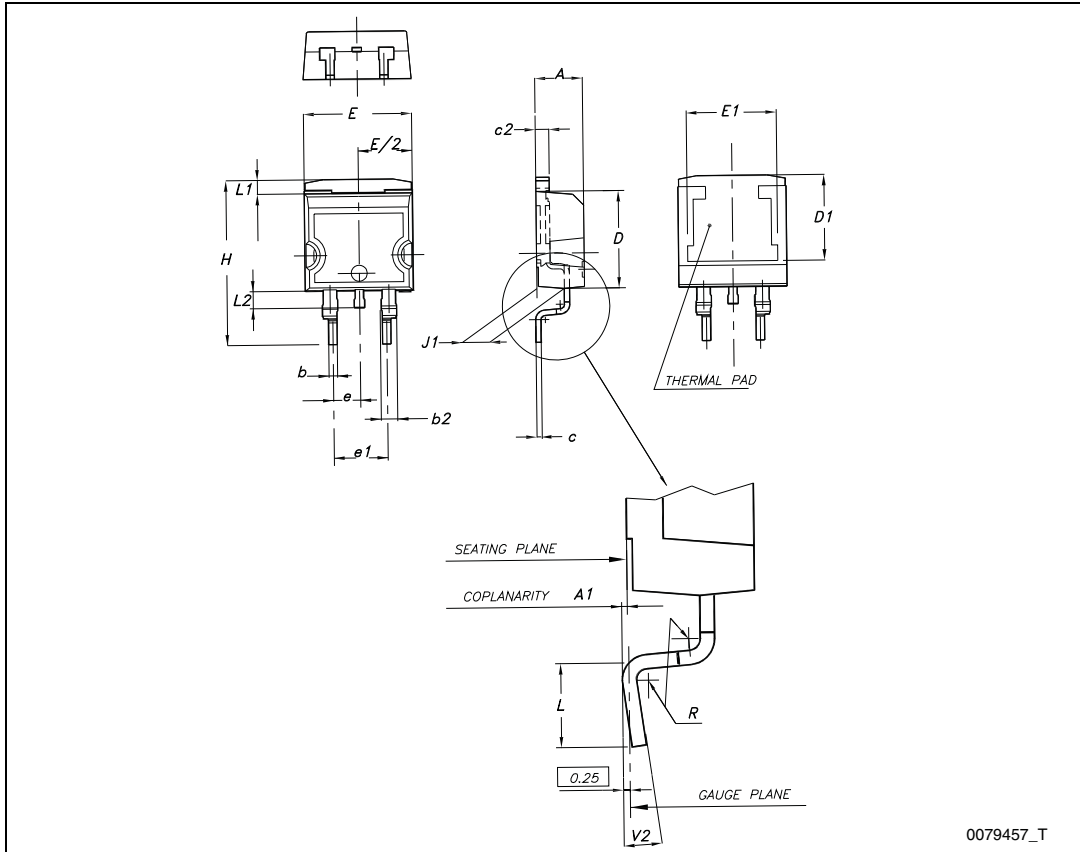
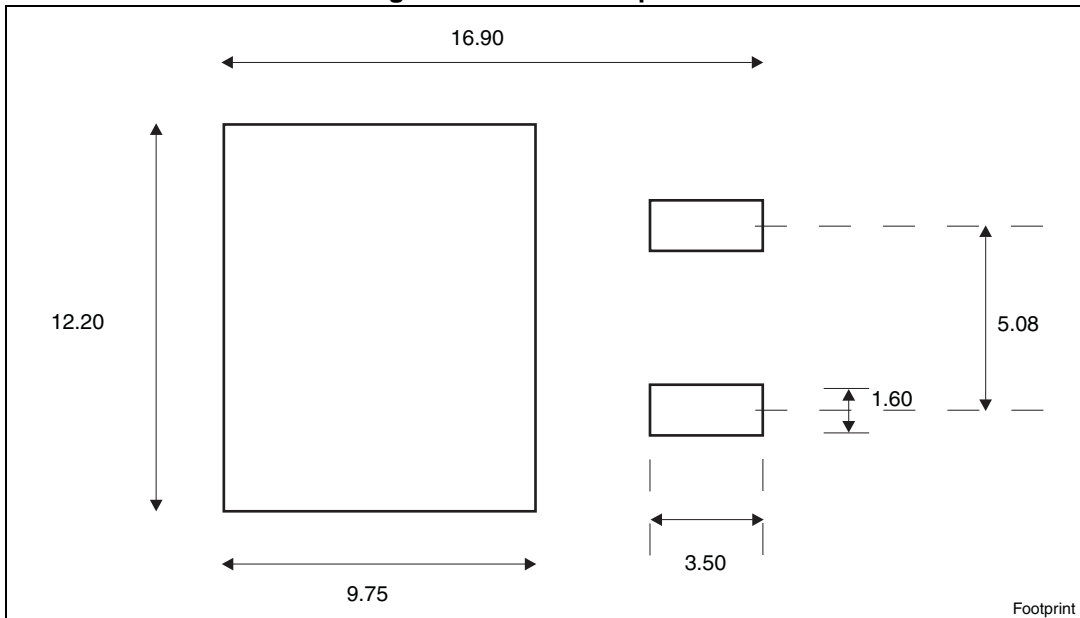


Figure 32. D²PAK footprint^(a)



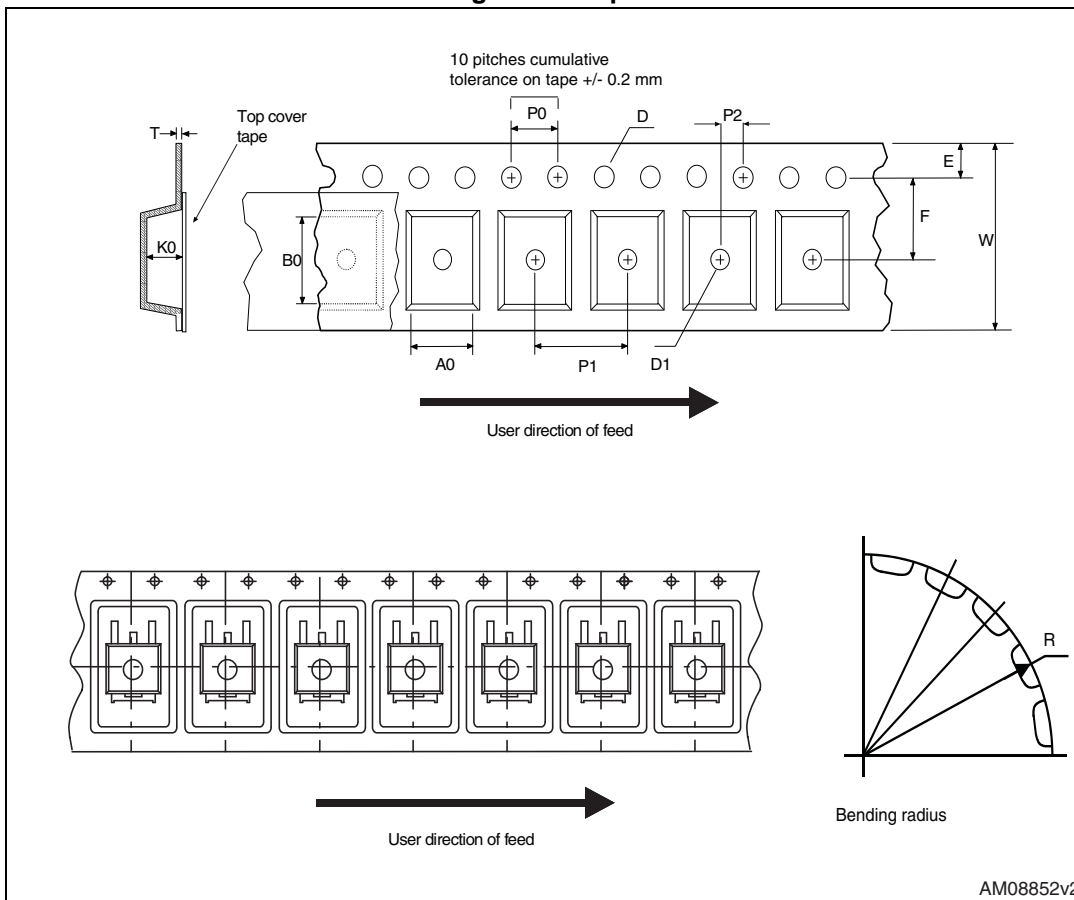
a. All dimension are in millimeters

5 Packaging mechanical data

Table 12. D²PAK tape and reel mechanical data

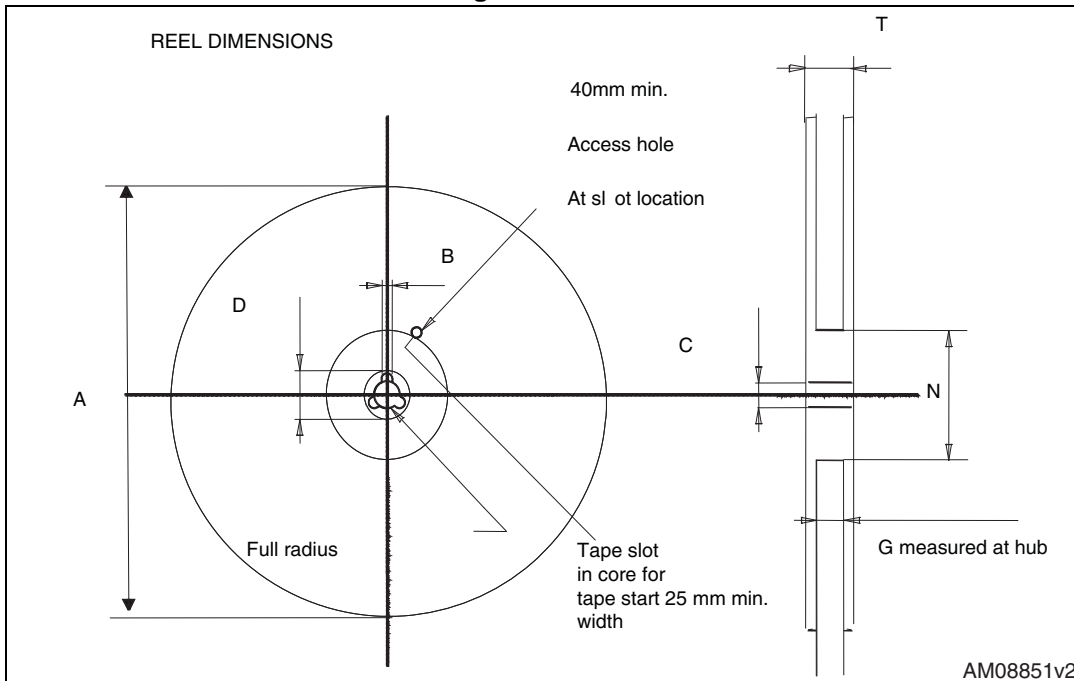
| Tape | | | Reel | | |
|------|------|------|----------|------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 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 33. Tape



AM08852v2

Figure 34. Reel



AM08851v2

6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 03-Oct-2012 | 1 | Initial release. |
| 18-Mar-2013 | 2 | Added new order code STGF20H60DF, mechanical data Table 9 and Figure 29 on page 14 . Added Chapter 2.1: Electrical characteristics (curves) . |
| 22-Mar-2013 | 3 | Document status promoted from preliminary to production data. |
| 03-Jun-2013 | 4 | Updated P_{TOT} in Table 2: Absolute maximum ratings , R_{thJC} in Table 3: Thermal data and Figure 10: Power dissipation vs. case temperature for D²PAK and TO-220 . Updated Section 4: Package mechanical data for TO-220. |

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