

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.

Figure 1. Internal schematic diagram

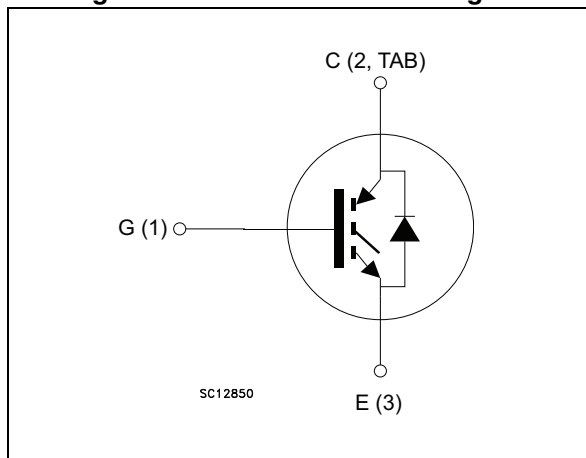


Table 1. Device summary

| Order codes | Marking | Packages | Packaging |
|-------------|-----------|--------------------|---------------|
| STGB15H60DF | GB15H60DF | D ² PAK | Tape and reel |
| STGF15H60DF | GF15H60DF | TO-220FP | Tube |
| STGP15H60DF | GP15H60DF | 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 $T_C = 25\text{ °C}$ | 30 | 30 ⁽¹⁾ | A |
| | Continuous collector current at $T_C = 100\text{ °C}$ | 15 | 15 ⁽¹⁾ | A |
| I_{CP} ⁽²⁾ | Pulsed collector current | 60 | 60 ⁽¹⁾ | A |
| V_{GE} | Gate-emitter voltage | ±20 | | V |
| I_F | Continuous forward current $T_C = 25\text{ °C}$ | 30 | 30 ⁽¹⁾ | A |
| | Continuous forward current at $T_C = 100\text{ °C}$ | 15 | 15 ⁽¹⁾ | |
| I_{FP} ⁽²⁾ | Pulsed forward current | 60 | 60 ⁽¹⁾ | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 115 | 30 | 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.

Table 3. Thermal data

| Symbol | Parameter | TO-220 D ² PAK | TO-220FP | Unit |
|------------|--|------------------------------|----------|------|
| R_{thJC} | Thermal resistance junction-case IGBT | 1.3 | 5 | °C/W |
| R_{thJC} | Thermal resistance junction-case diode | 2.78 | 6.25 | °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 | $V_{GE} = 15\text{ V}, I_C = 15\text{ A}$ | | 1.6 | 2.0 | V |
| | | $V_{GE} = 15\text{ V}, I_C = 15\text{ A}$ $T_J = 125\text{ °C}$ | | 1.7 | | |
| | | $V_{GE} = 15\text{ V}, I_C = 15\text{ A}$ $T_J = 175\text{ °C}$ | | 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 | $V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$ | - | 1952 | - | pF |
| C_{oes} | Output capacitance | | - | 78 | - | pF |
| C_{res} | Reverse transfer capacitance | | - | 45 | - | pF |
| Q_g | Total gate charge | $V_{CC} = 480\text{ V}, I_C = 15\text{ A},$ $V_{GE} = 15\text{ V}$ | - | 81 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 8 | - | nC |
| Q_{gc} | Gate-collector charge | | - | 42 | - | nC |

Table 6. Switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|------------------------------|---|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | | 24.5 | - | ns |
| t_r | Current rise time | | | 8.2 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1470 | - | A/ μ s |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ | | 25 | - | ns |
| t_r | Current rise time | | | 9 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1370 | - | A/ μ s |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | | 18 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 118 | - | ns |
| t_f | Current fall time | | | 69 | - | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ | | 27 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 124 | - | ns |
| t_f | Current fall time | | | 101 | - | ns |
| t_{sc} | Short-circuit withstand time | $V_{CC} \leq 360\text{ V}$, $V_{GE} = 15\text{ V}$, $R_G = 10\ \Omega$ | 3 | 5 | - | μ s |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit | |
|-----------------|---------------------------|---|------|------|------|---------|---------|
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ | - | 136 | - | μ J | |
| $E_{off}^{(2)}$ | Turn-off switching losses | | | - | 207 | - | μ J |
| E_{ts} | Total switching losses | | | - | 343 | - | μ J |
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CE} = 400\text{ V}$, $I_C = 15\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ | - | 224 | - | μ J | |
| $E_{off}^{(2)}$ | Turn-off switching losses | | | - | 329 | - | μ J |
| E_{ts} | Total switching losses | | | - | 553 | - | μ J |

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 | $I_F = 15 \text{ A}$ $I_F = 15 \text{ A}, T_J = 175 \text{ }^\circ\text{C}$ | - | 1.8 | 2.2 | V |
| | | | | 1.3 | | V |
| t_{rr} | Reverse recovery time | $V_r = 60 \text{ V}; I_F = 15 \text{ A};$ $di_F/dt = 100 \text{ A} / \mu\text{s}$ | - | 103 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 128 | | nC |
| I_{rrm} | Reverse recovery current | | - | 2.5 | | A |
| t_{rr} | Reverse recovery time | $V_r = 60 \text{ V}; I_F = 15 \text{ A};$ $di_F/dt = 100 \text{ A} / \mu\text{s}$ $T_J = 175 \text{ }^\circ\text{C}$ | - | 182 | | ns |
| | | | | | 437 | |
| I_{rrm} | Reverse recovery current | | - | 4.8 | | A |

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature for D²PAK and TO-220

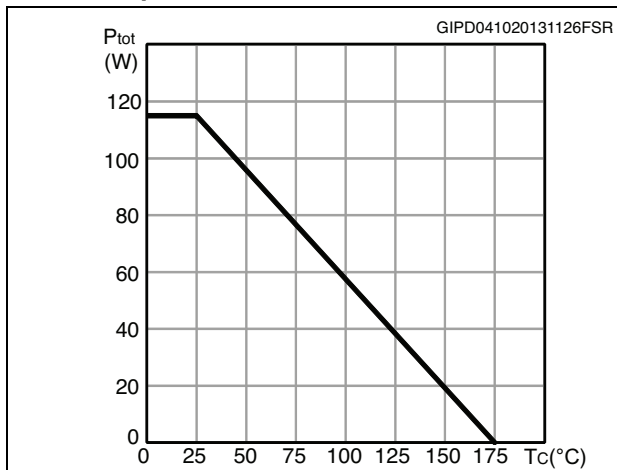


Figure 3. Collector current vs. case temperature for D²PAK and TO-220

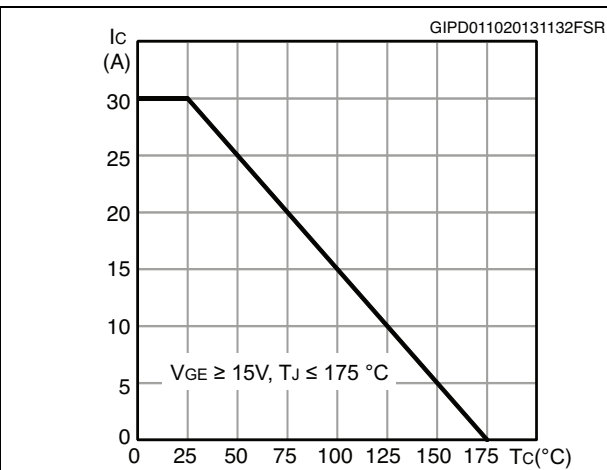


Figure 4. Power dissipation vs. case temperature for TO-220FP

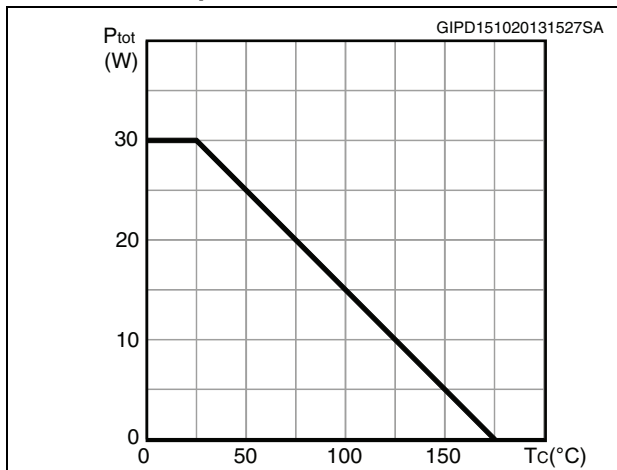


Figure 5. Collector current vs. case temperature for TO-220FP

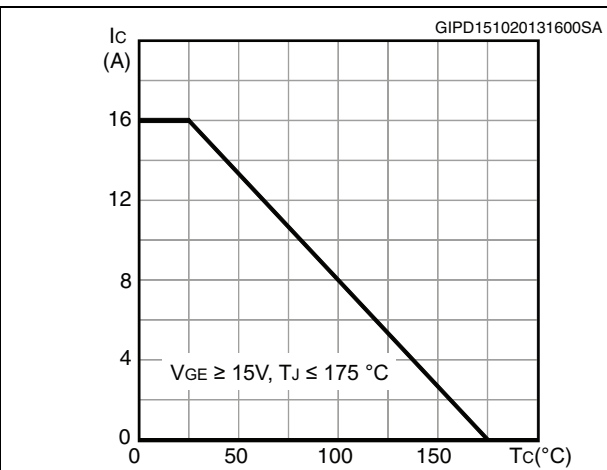


Figure 6. Output characteristics ($T_J = 25\text{ °C}$)

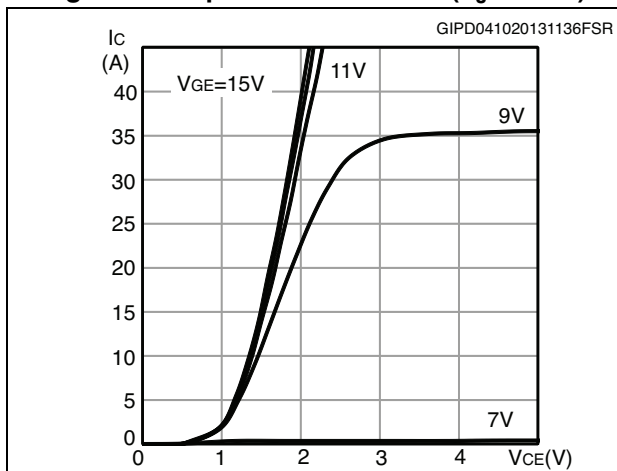


Figure 7. Output characteristics ($T_J = 175\text{ °C}$)

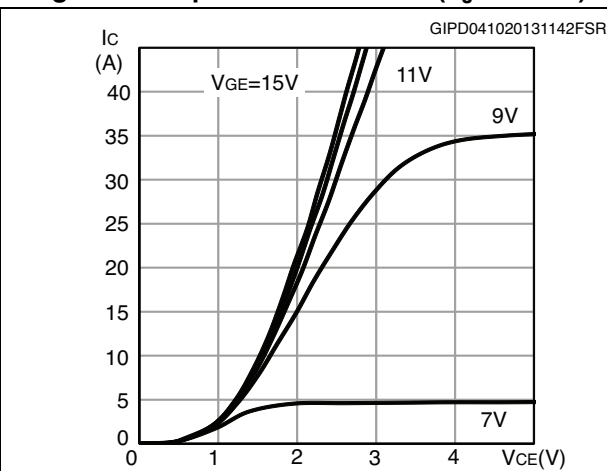


Figure 8. $V_{CE(sat)}$ vs. junction temperature

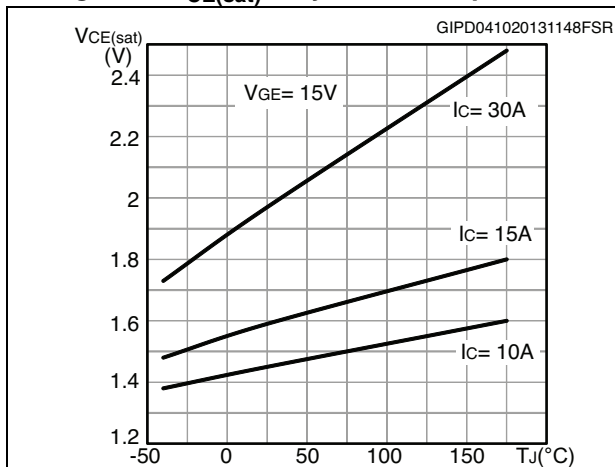


Figure 9. $V_{CE(sat)}$ vs. collector current

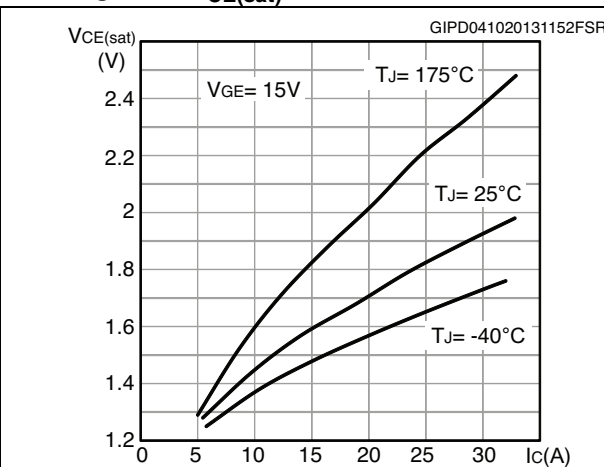


Figure 10. Collector current vs. switching frequency for D²PAK and TO-220

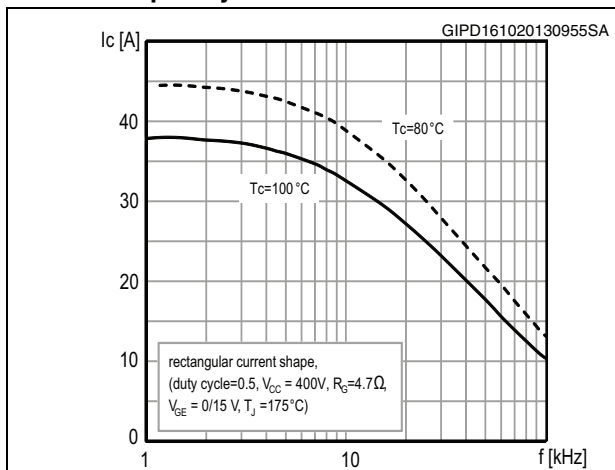


Figure 11. Collector current vs. switching frequency for TO-220FP

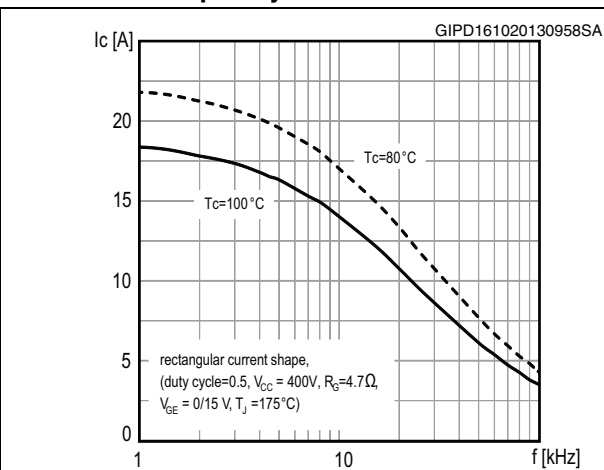


Figure 12. Forward bias safe operating area for D²PAK and TO-220

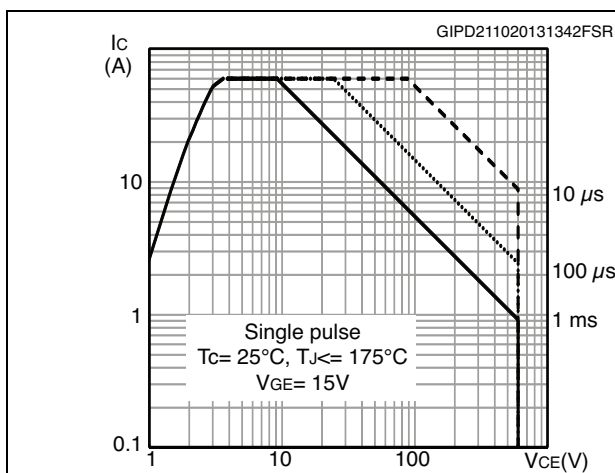


Figure 13. Forward bias safe operating area for TO-220FP

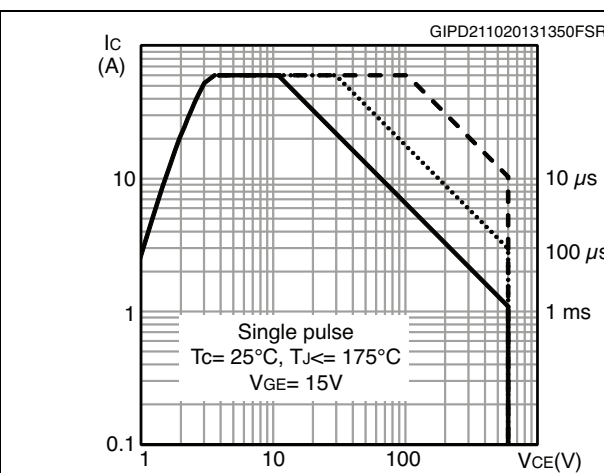


Figure 14. Transfer characteristics

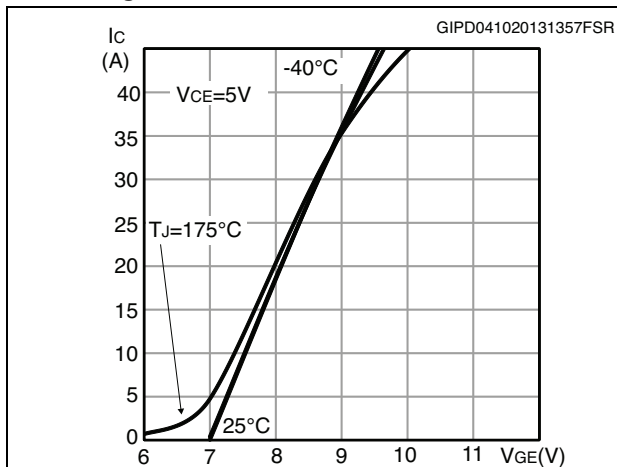


Figure 15. Diode V_F vs. forward current

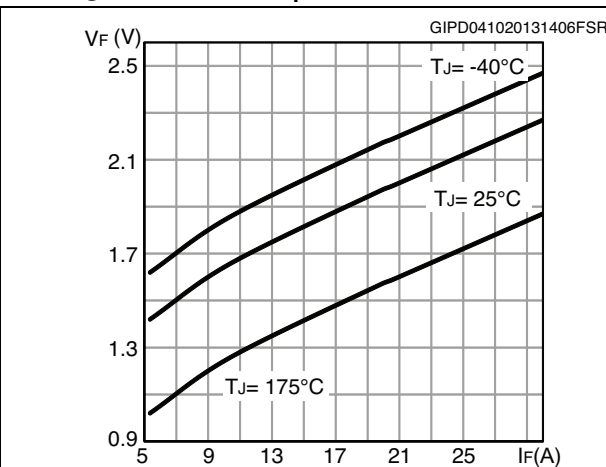


Figure 16. Normalized $V_{GE(th)}$ vs junction temperature

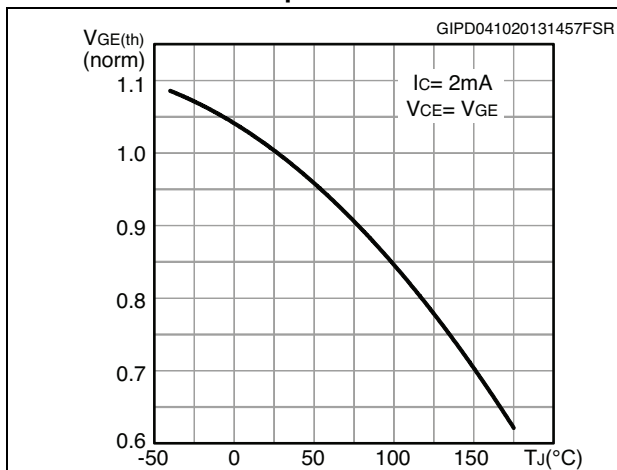


Figure 17. Normalized $V_{(BR)CES}$ vs. junction temperature

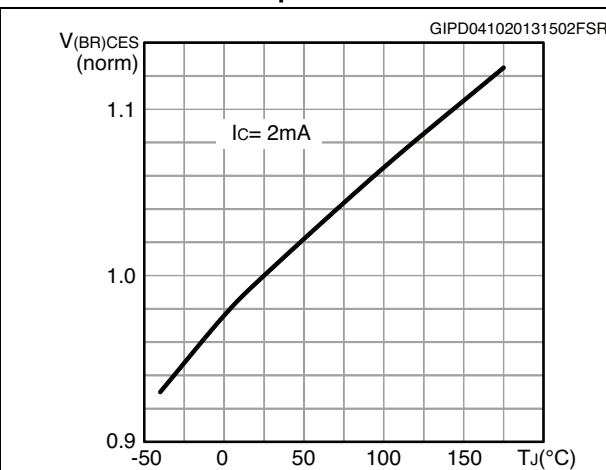


Figure 18. Capacitance variation

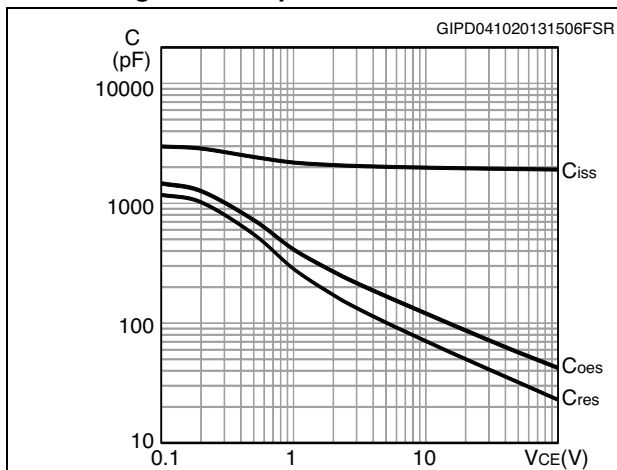


Figure 19. Gate charge vs. gate-emitter voltage

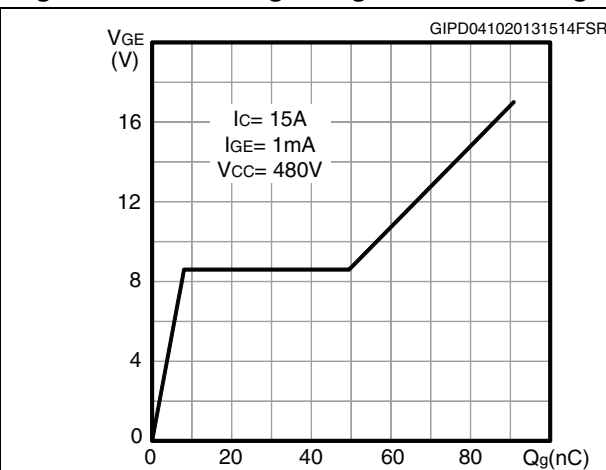


Figure 20. Switching-off loss vs collector current

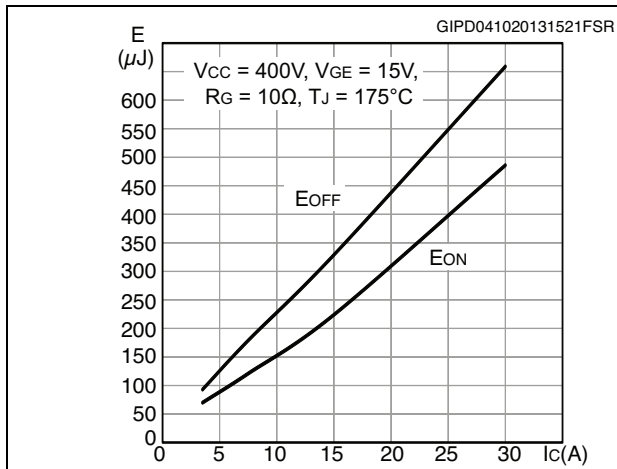


Figure 21. Switching-off loss vs gate resistance

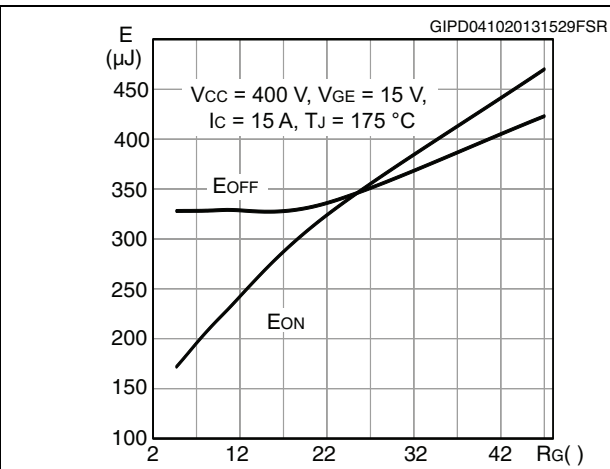


Figure 22. Switching-off loss vs temperature

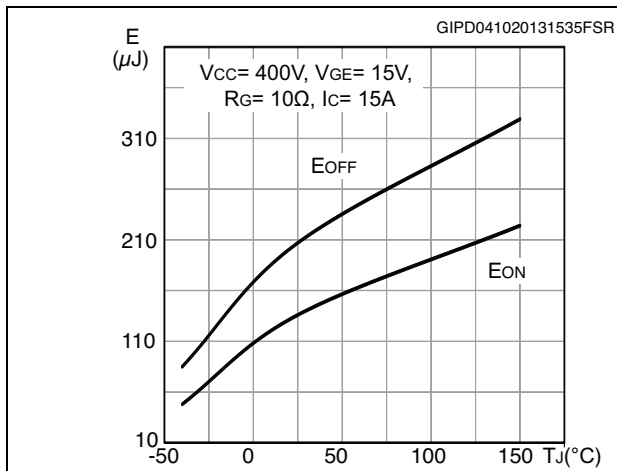


Figure 23. Switching-off loss vs collector-emitter voltage

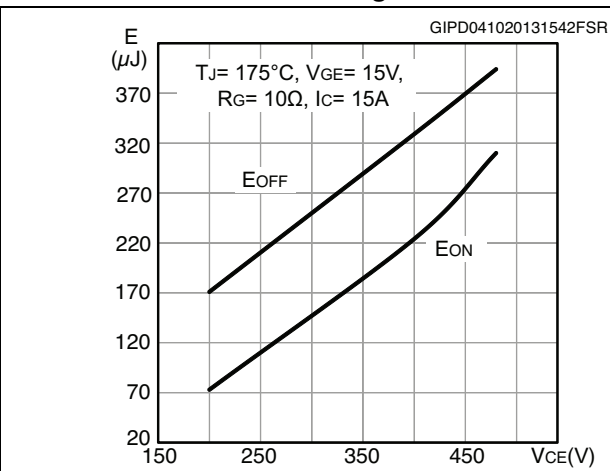


Figure 24. Short circuit time and current vs VGE

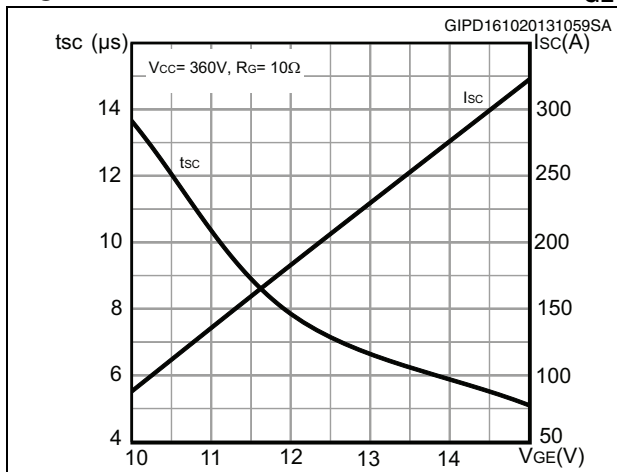


Figure 25. Switching times vs. collector current

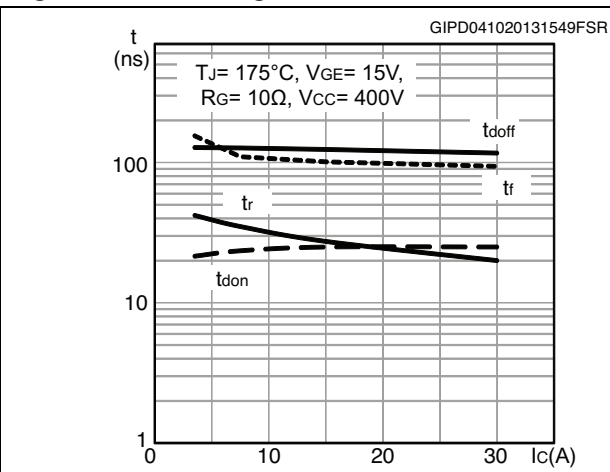


Figure 26. Switching times vs. gate resistance

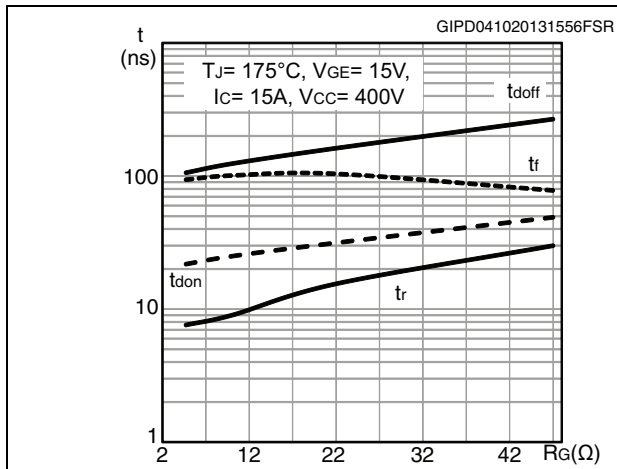


Figure 27. Reverse recovery current vs. diode current slope

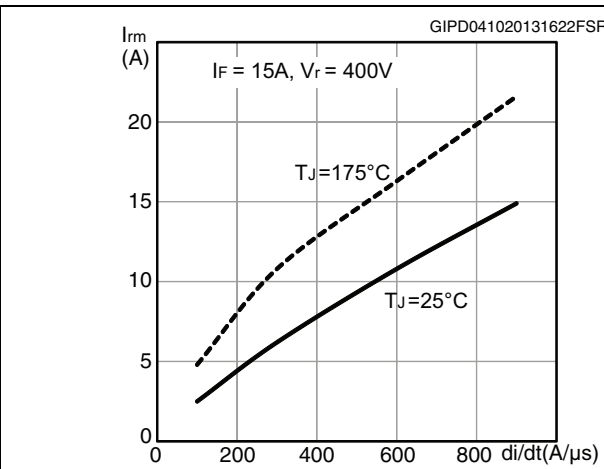


Figure 28. Reverse recovery time vs. diode current slope

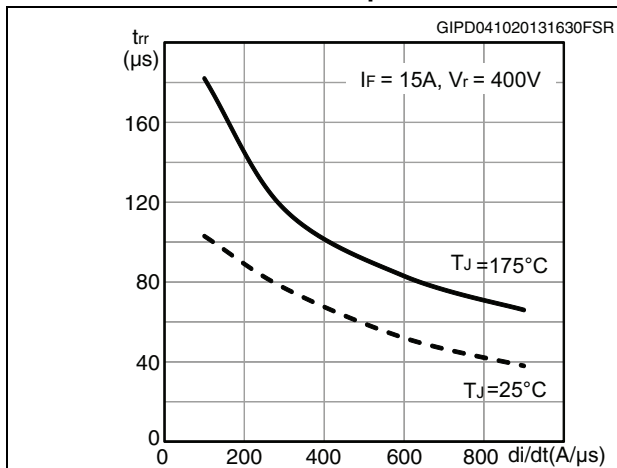


Figure 29. Reverse recovery charge vs. diode current slope

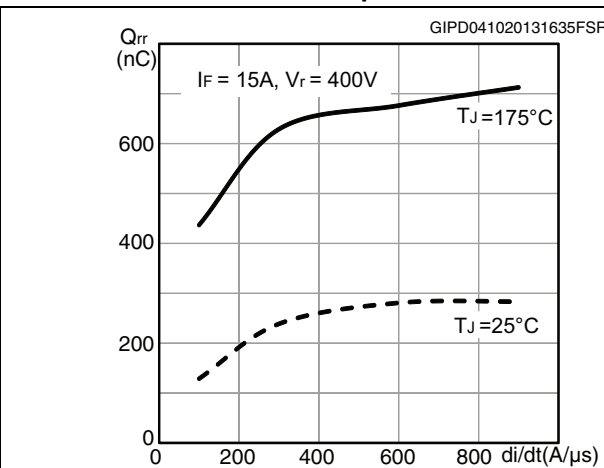


Figure 30. Reverse recovery energy vs. diode current slope

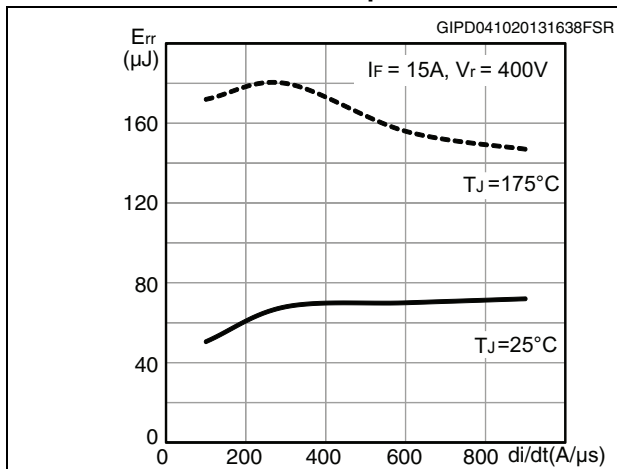


Figure 31. Thermal impedance for IGBT

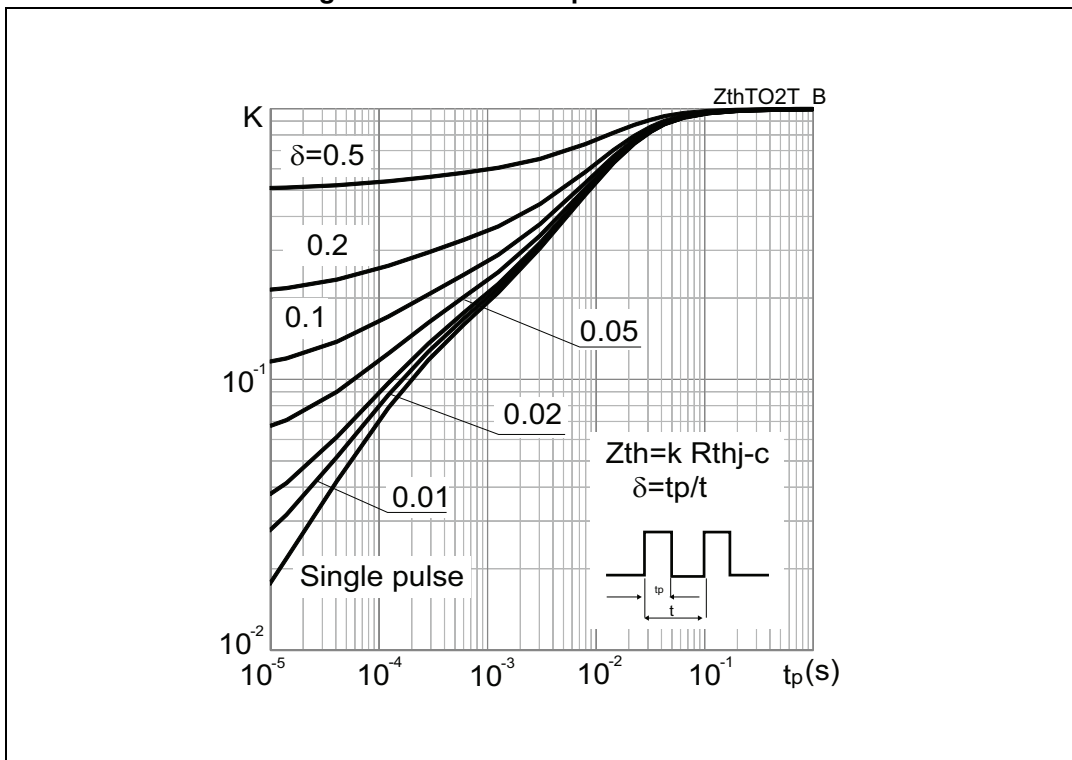
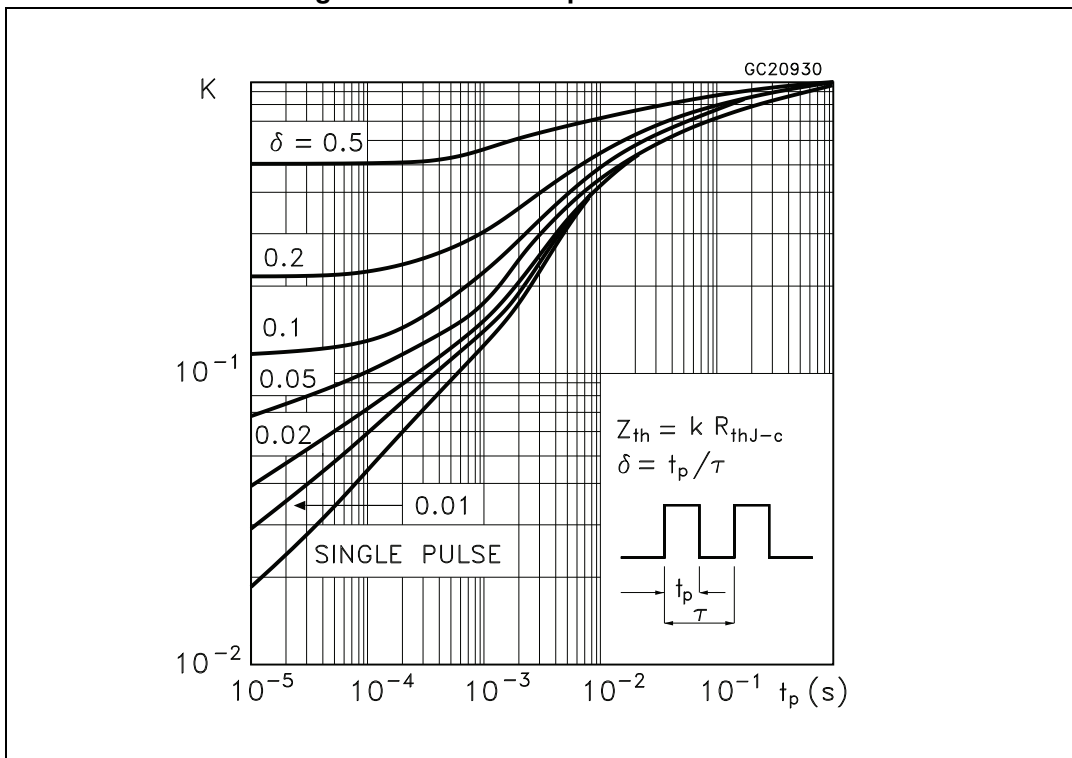
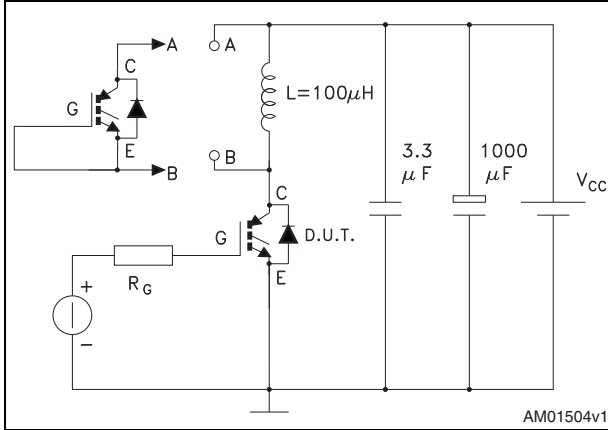


Figure 32. Thermal impedance for diode



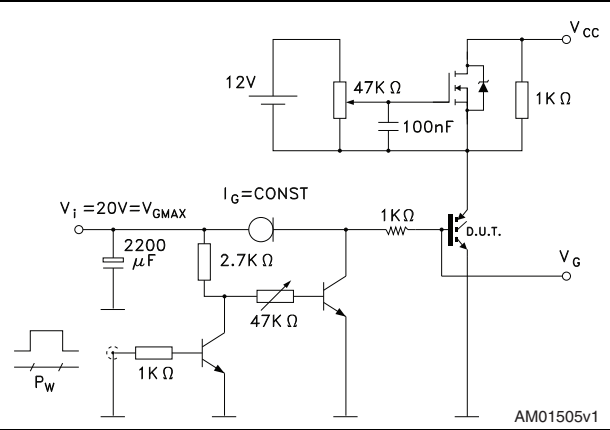
3 Test circuits

Figure 33. Test circuit for inductive load switching



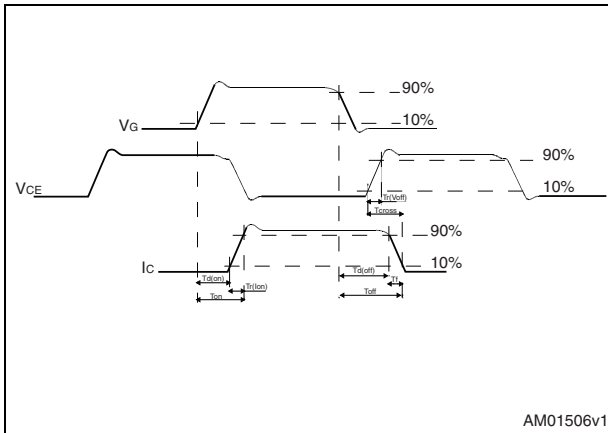
AM01504v1

Figure 34. Gate charge test circuit



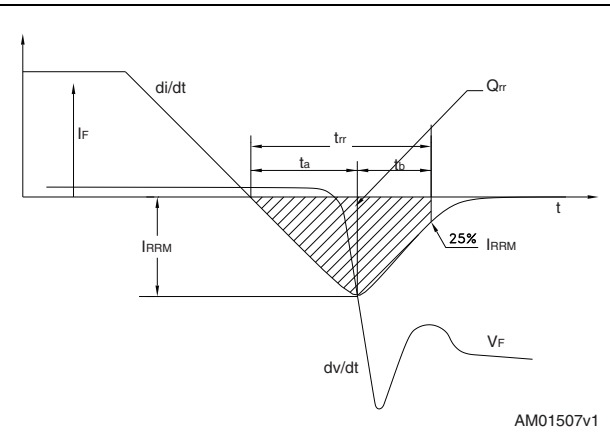
AM01505v1

Figure 35. Switching waveform



AM01506v1

Figure 36. Diode recovery time waveform



AM01507v1

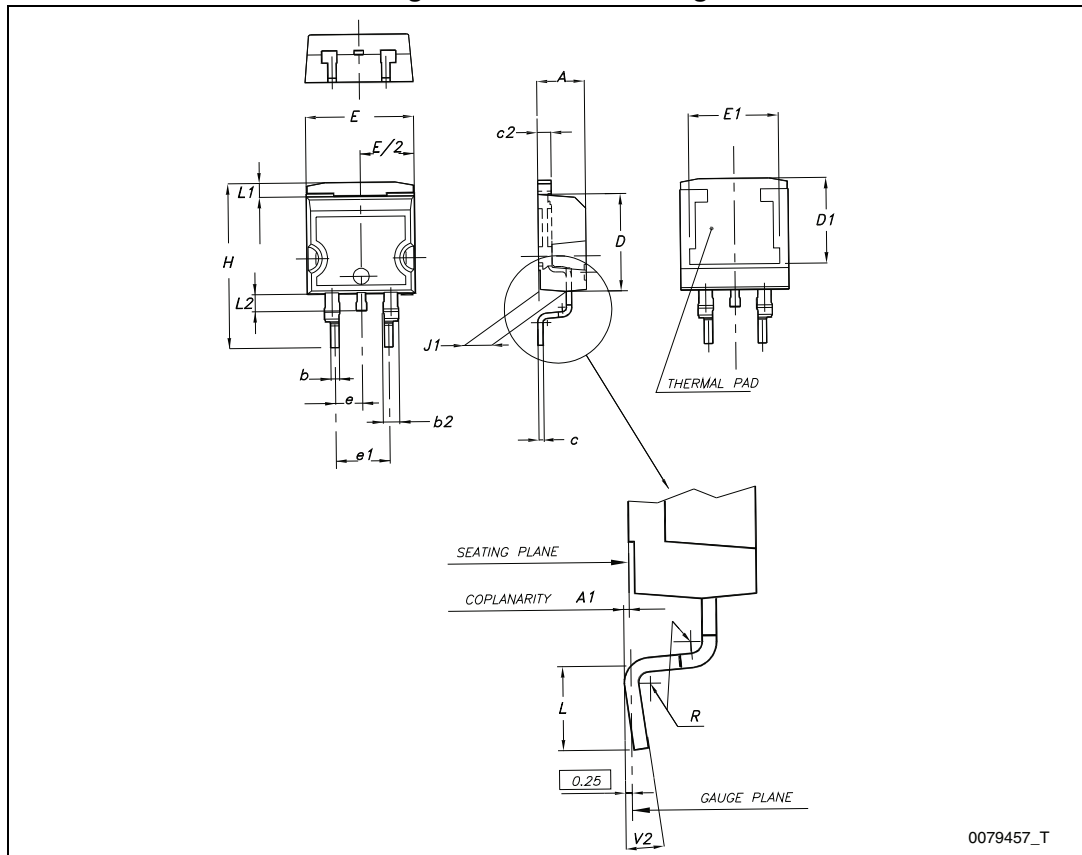
4 Package mechanical data

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. D²PAK mechanical data

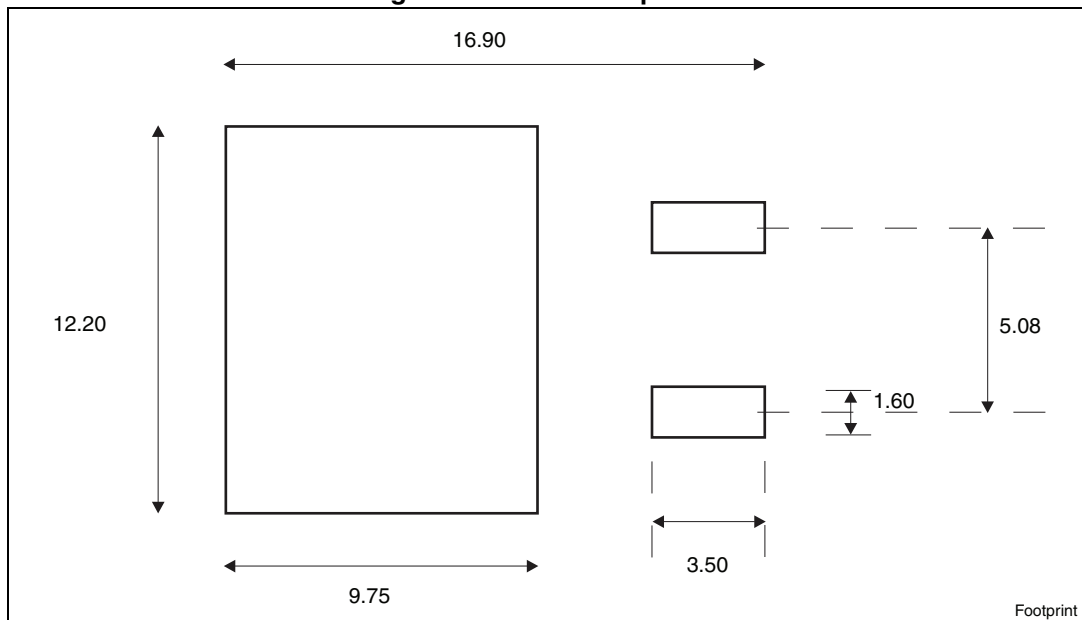
| Dim. | mm | | |
|------|------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| A1 | 0.03 | | 0.23 |
| b | 0.70 | | 0.93 |
| b2 | 1.14 | | 1.70 |
| c | 0.45 | | 0.60 |
| c2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | 7.50 | | |
| E | 10 | | 10.40 |
| E1 | 8.50 | | |
| e | | 2.54 | |
| 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 37. D²PAK drawing



0079457_T

Figure 38. D²PAK footprint^(a)

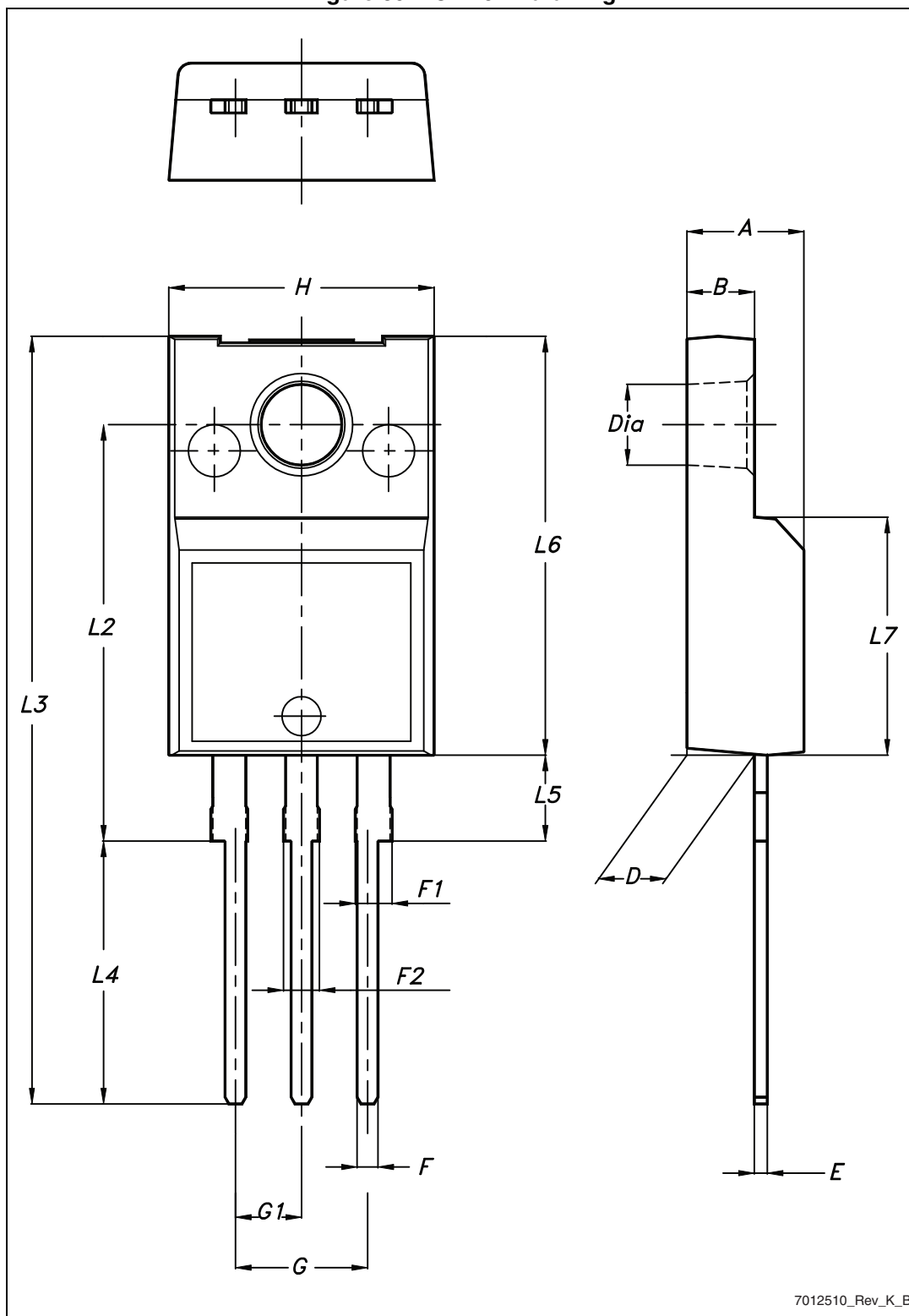


a. All dimension are in millimeters

Table 10. 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 39. TO-220FP drawing

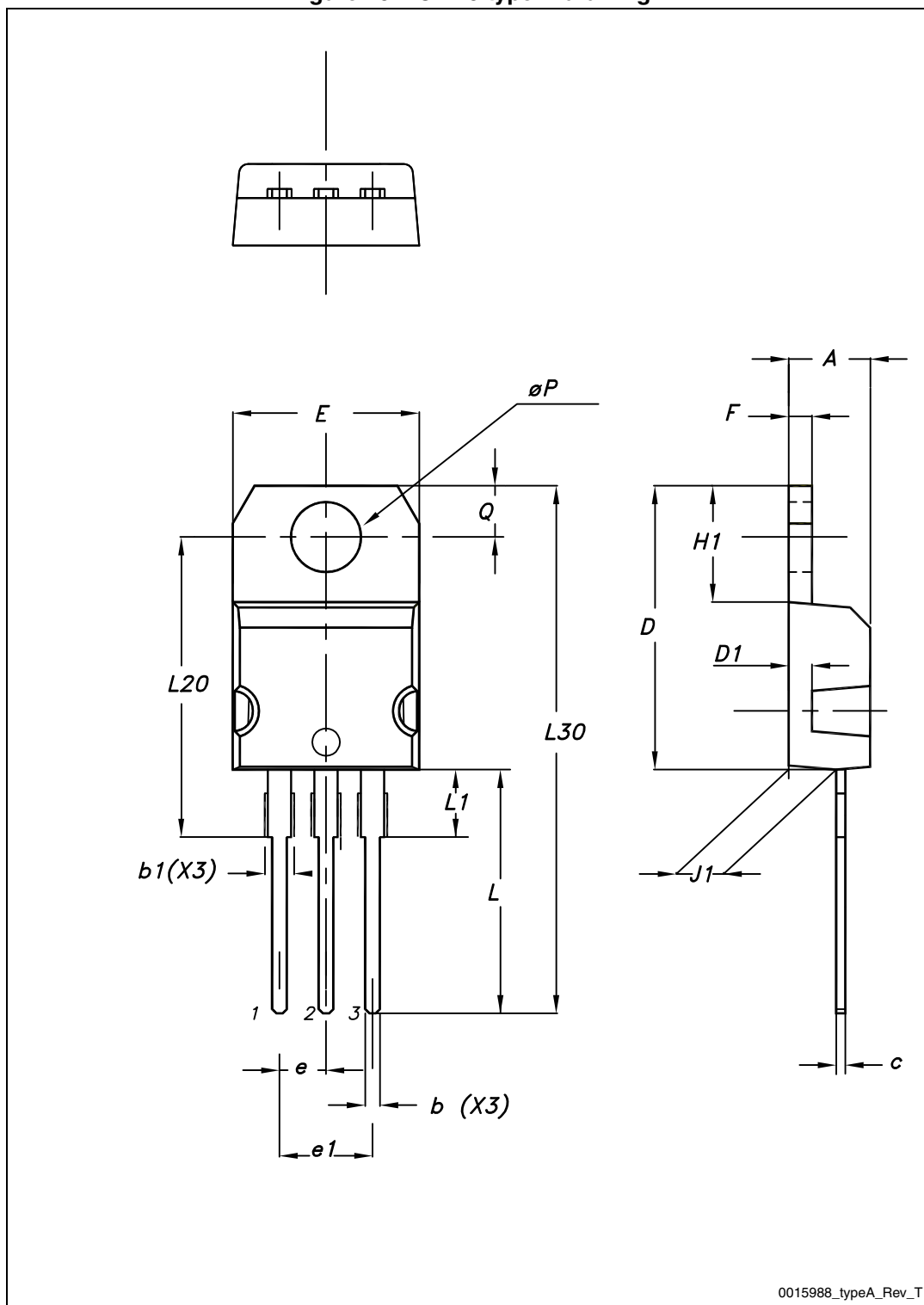


7012510_Rev_K_B

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 40. TO-220 type A drawing

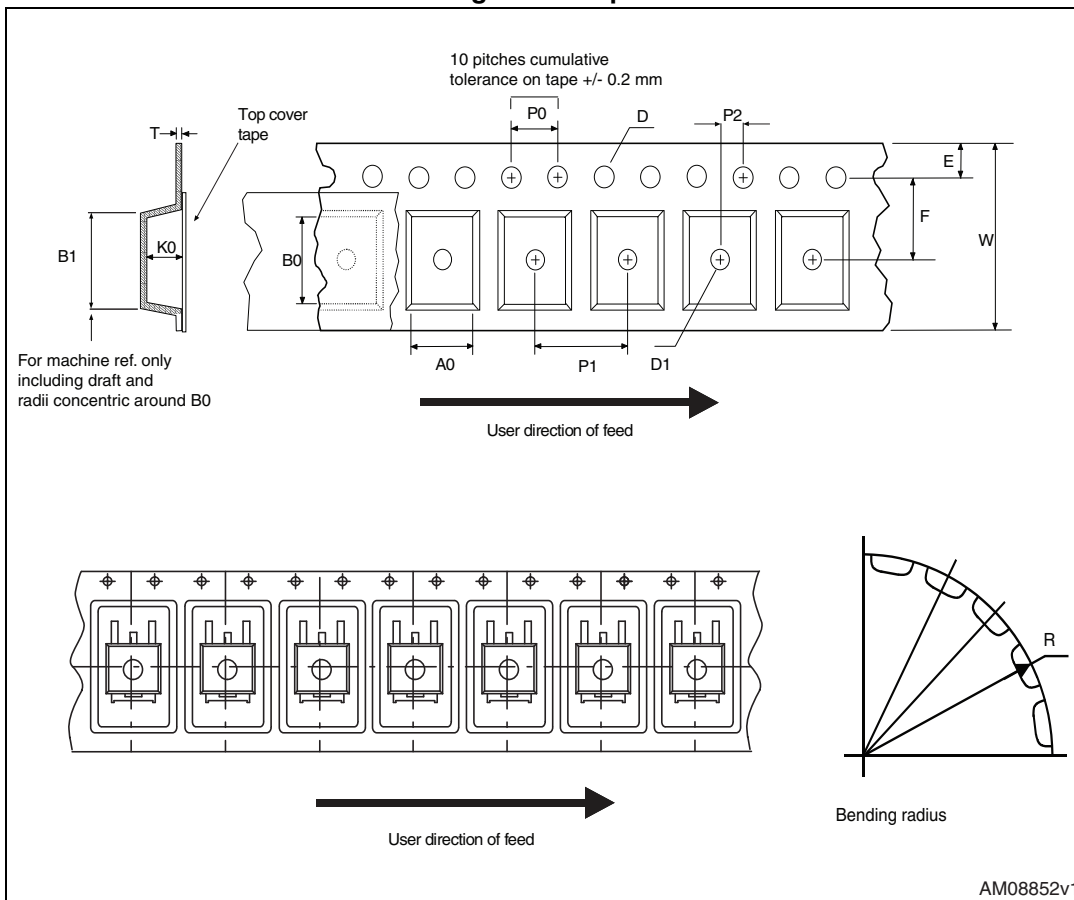


5 Packaging mechanical data

Table 12. D²PAK tape and reel mechanical data

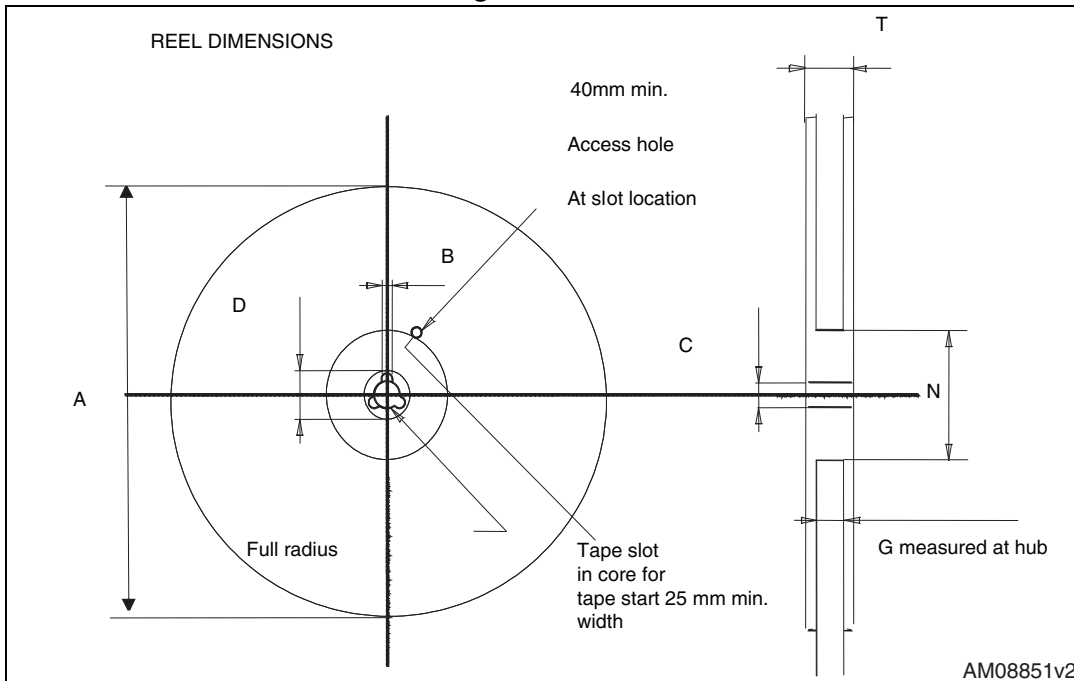
| Tape | | | Reel | | |
|------|------|------|------|----------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 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 41. Tape



AM08852v1

Figure 42. Reel



AM08851v2

6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 12-Aug-2013 | 1 | Initial release. |
| 17-Oct-2013 | 2 | <ul style="list-style-type: none">– Document status promoted from preliminary to production data.– Added Section 2.1: Electrical characteristics (curves).– Minor text changes. |

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