

## Trench gate field-stop IGBT, M series 650 V, 30 A low-loss in a D<sup>2</sup>PAK package

Datasheet - production data

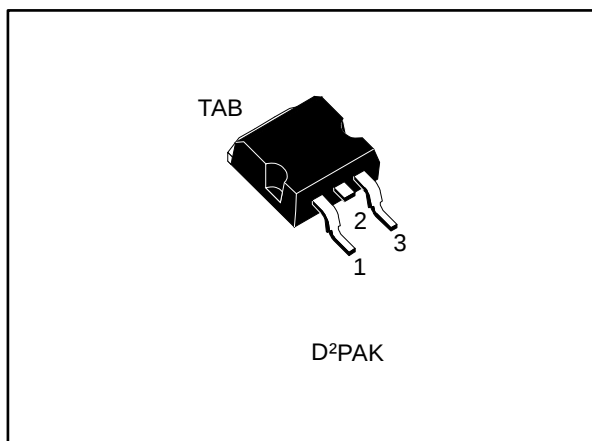
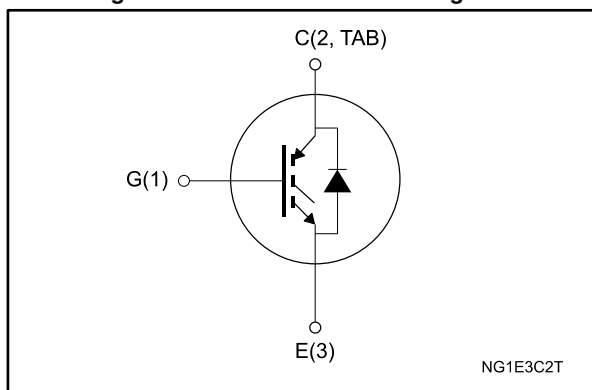


Figure 1: Internal schematic diagram



### Features

- 6  $\mu$ s of short-circuit withstand time
- $V_{CE(sat)} = 1.55$  V (typ.) @  $I_C = 30$  A
- Tight parameters distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

### Applications

- Motor control
- UPS
- PFC

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where low-loss and short-circuit functionality are essential. Furthermore, the positive  $V_{CE(sat)}$  temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

| Order code   | Marking   | Package            | Packaging     |
|--------------|-----------|--------------------|---------------|
| STGB30M65DF2 | G30M65DF2 | D <sup>2</sup> PAK | Tape and reel |

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                      | Value      | Unit |
|----------------|------------------------------------------------|------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ V)    | 650        | V    |
| $I_C$          | Continuous collector current at $T_C = 25$ °C  | 60         | A    |
| $I_C$          | Continuous collector current at $T_C = 100$ °C | 30         | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current                       | 120        | A    |
| $V_{GE}$       | Gate-emitter voltage                           | $\pm 20$   | V    |
| $I_F$          | Continuous forward current at $T_C = 25$ °C    | 60         | A    |
| $I_F$          | Continuous forward current at $T_C = 100$ °C   | 30         | A    |
| $I_{FP}^{(1)}$ | Pulsed forward current                         | 120        | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25$ °C             | 258        | W    |
| $T_{STG}$      | Storage temperature range                      | -55 to 150 | °C   |
| $T_J$          | Operating junction temperature range           | -55 to 175 | °C   |

**Notes:**

<sup>(1)</sup>Pulse width limited by maximum junction temperature.

Table 3: Thermal data

| Symbol     | Parameter                              | Value | Unit |
|------------|----------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case IGBT  | 0.58  | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 1.47  | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient    | 62.5  | °C/W |

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified

**Table 4: Static characteristics**

| Symbol        | Parameter                            | Test conditions                                                         | Min. | Typ. | Max.      | Unit          |
|---------------|--------------------------------------|-------------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage  | $V_{GE} = 0\text{ V}$ , $I_C = 250\text{ }\mu\text{A}$                  | 650  |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$                            |      | 1.55 | 2.0       | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$T_J = 125\text{ °C}$ |      | 1.95 |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$T_J = 175\text{ °C}$ |      | 2.1  |           |               |
| $V_F$         | Forward on-voltage                   | $I_F = 30\text{ A}$                                                     |      | 1.85 | 2.65      | V             |
|               |                                      | $I_F = 30\text{ A}$ , $T_J = 125\text{ °C}$                             |      | 1.6  |           |               |
|               |                                      | $I_F = 30\text{ A}$ , $T_J = 175\text{ °C}$                             |      | 1.5  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 500\text{ }\mu\text{A}$                      | 5    | 6    | 7         | V             |
| $I_{CES}$     | Collector cut-off current            | $V_{GE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$                         |      |      | 25        | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current         | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$                      |      |      | $\pm 250$ | $\mu\text{A}$ |

**Table 5: Dynamic characteristics**

| Symbol    | Parameter                    | Test conditions                                                                                                                                       | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0\text{ V}$                                                                                | -    | 2490 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                                       | -    | 143  | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                                       | -    | 46   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 520\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$V_{GE} = 0\text{ to }15\text{ V}$<br>(see <a href="#">Figure 30: "Gate charge test circuit"</a> ) | -    | 80   | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                                                                                                       | -    | 18   | -    |      |
| $Q_{gc}$  | Gate-collector charge        |                                                                                                                                                       | -    | 32   | -    |      |

Table 6: IGBT switching characteristics (inductive load)

| Symbol         | Parameter                    | Test conditions                                                                                                                                                                                                      | Min. | Typ. | Max. | Unit       |
|----------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$<br>(see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )                                      |      | 31.6 | -    | ns         |
| $t_r$          | Current rise time            |                                                                                                                                                                                                                      |      | 13.4 | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |                                                                                                                                                                                                                      |      | 1791 | -    | A/ $\mu$ s |
| $t_{d(off)}$   | Turn-off-delay time          |                                                                                                                                                                                                                      |      | 115  | -    | ns         |
| $t_f$          | Current fall time            |                                                                                                                                                                                                                      |      | 110  | -    | ns         |
| $E_{on(1)}$    | Turn-on switching energy     |                                                                                                                                                                                                                      |      | 0.3  | -    | mJ         |
| $E_{off(2)}$   | Turn-off switching energy    |                                                                                                                                                                                                                      |      | 0.96 | -    | mJ         |
| $E_{ts}$       | Total switching energy       |                                                                                                                                                                                                                      |      | 1.26 | -    | mJ         |
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$<br>$T_J = 175\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> ) |      | 30   | -    | ns         |
| $t_r$          | Current rise time            |                                                                                                                                                                                                                      |      | 17   | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |                                                                                                                                                                                                                      |      | 1435 | -    | A/ $\mu$ s |
| $t_{d(off)}$   | Turn-off-delay time          |                                                                                                                                                                                                                      |      | 116  | -    | ns         |
| $t_f$          | Current fall time            |                                                                                                                                                                                                                      |      | 194  | -    | ns         |
| $E_{on(1)}$    | Turn-on switching energy     |                                                                                                                                                                                                                      |      | 0.67 | -    | mJ         |
| $E_{off(2)}$   | Turn-off switching energy    |                                                                                                                                                                                                                      |      | 1.36 | -    | mJ         |
| $E_{ts}$       | Total switching energy       |                                                                                                                                                                                                                      |      | 2.03 | -    | mJ         |
| $t_{sc}$       | Short-circuit withstand time | $V_{CC} \leq 400\text{ V}$ , $V_{GE} = 13\text{ V}$ ,<br>$T_{Jstart} = 150\text{ }^\circ\text{C}$                                                                                                                    | 10   |      | -    | $\mu$ s    |
|                |                              | $V_{CC} \leq 400\text{ V}$ , $V_{GE} = 15\text{ V}$ ,<br>$T_{Jstart} = 150\text{ }^\circ\text{C}$                                                                                                                    | 6    |      | -    |            |

**Notes:**

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

Table 7: Diode switching characteristics (inductive load)

| Symbol       | Parameter                                                  | Test conditions                                                                                                                                                                                                                      | Min. | Typ. | Max. | Unit       |
|--------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 30\text{ A}$ , $V_R = 400\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$<br>(see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )                                        | -    | 140  | -    | ns         |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                                                      | -    | 880  | -    | nC         |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                                                      | -    | 17   | -    | A          |
| $dl_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                                                      | -    | 650  | -    | A/ $\mu$ s |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                                                      | -    | 115  | -    | $\mu$ J    |
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 30\text{ A}$ , $V_R = 400\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ ,<br>$T_J = 175\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> ) | -    | 244  | -    | ns         |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                                                      | -    | 2743 | -    | nC         |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                                                      | -    | 25   | -    | A          |
| $dl_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                                                      | -    | 220  | -    | A/ $\mu$ s |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                                                      | -    | 320  | -    | $\mu$ J    |

## 2.1 Electrical characteristics (curves)

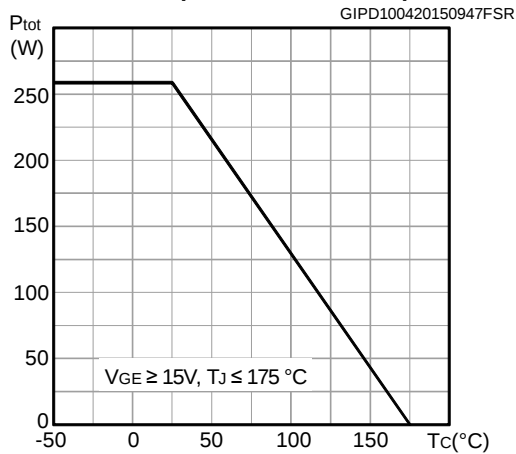
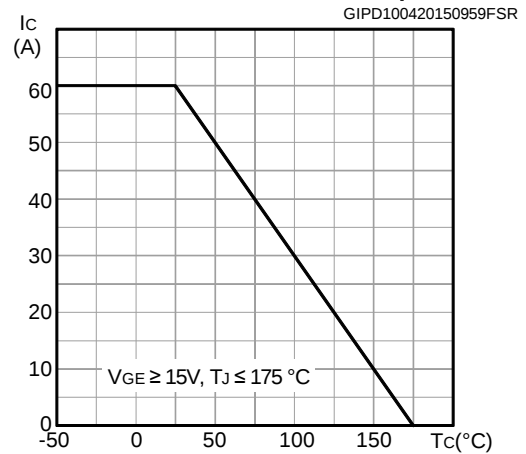
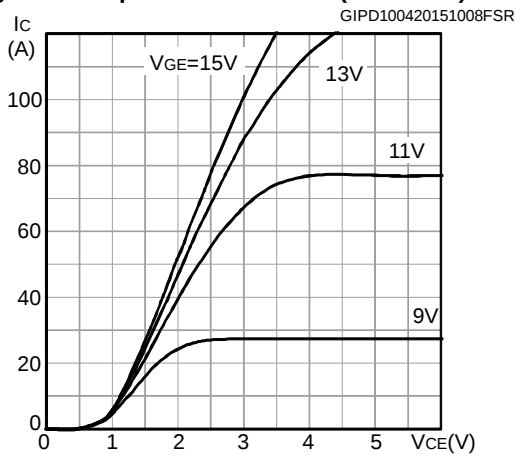
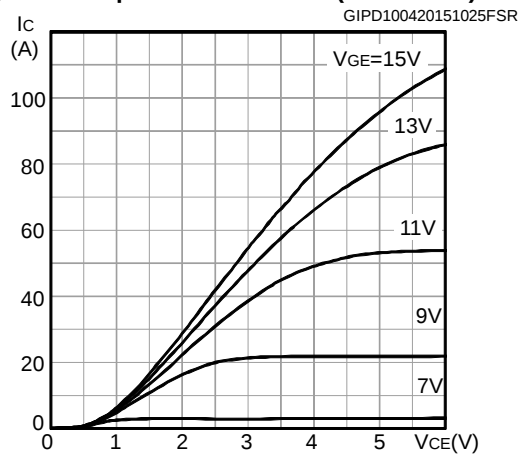
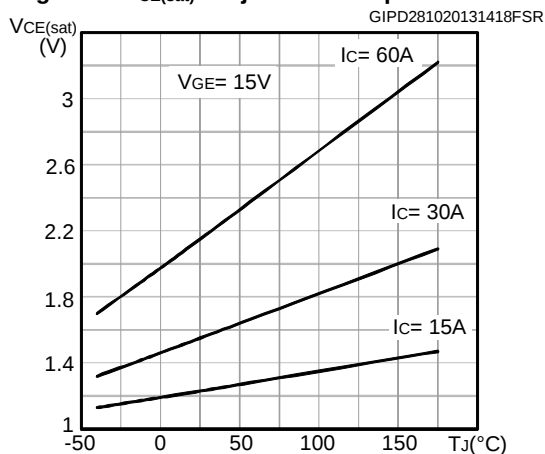
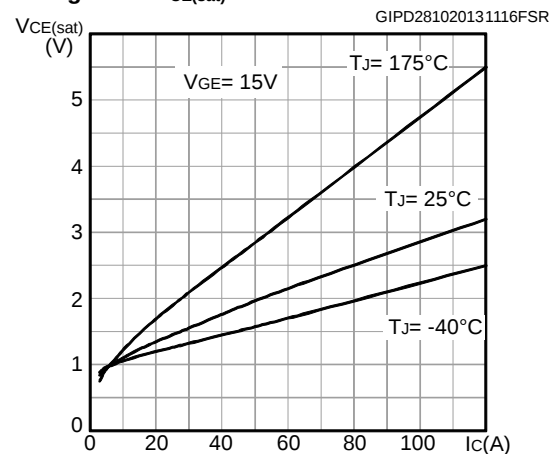
**Figure 2: Power dissipation vs. case temperature**

**Figure 3: Collector current vs. case temperature**

**Figure 4: Output characteristics ( $T_J = 25^\circ C$ )**

**Figure 5: Output characteristics ( $T_J = 175^\circ C$ )**

**Figure 6:  $V_{CE(sat)}$  vs. junction temperature**

**Figure 7:  $V_{CE(sat)}$  vs. collector current**


Figure 8: Collector current vs. switching frequency

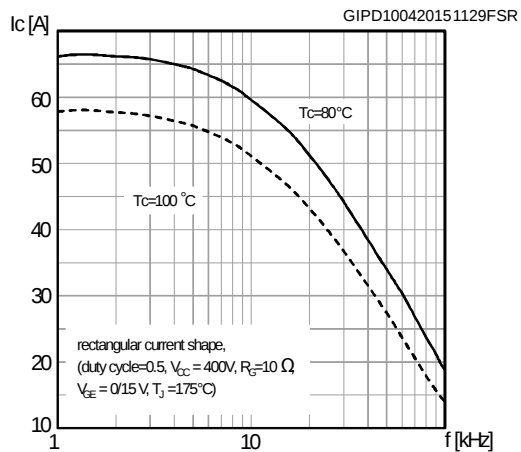


Figure 9: Forward bias safe operating area

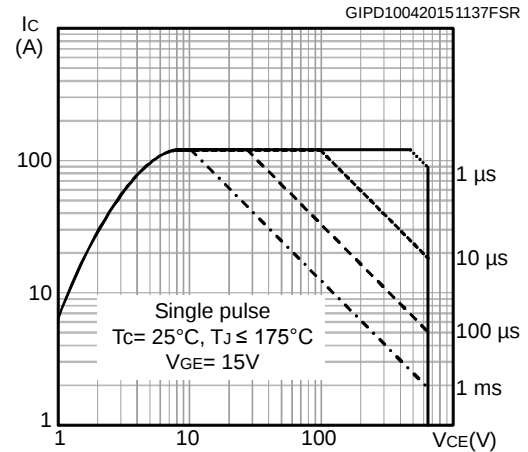


Figure 10: Transfer characteristics

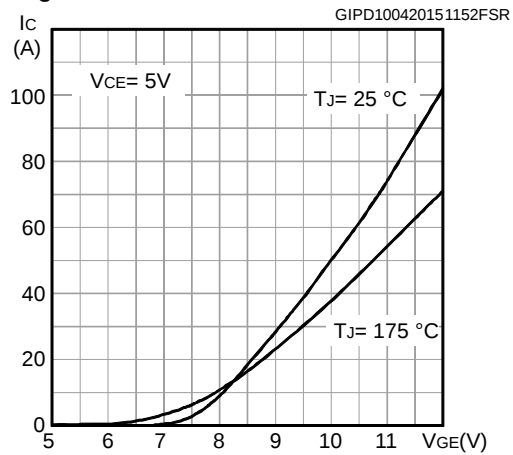
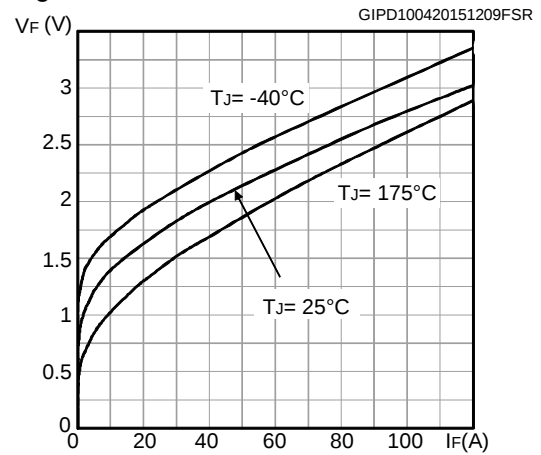
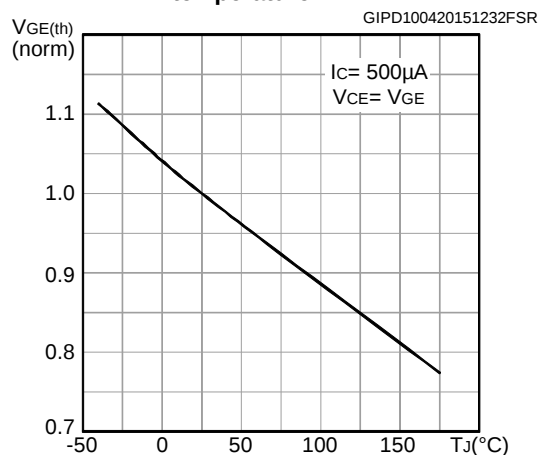
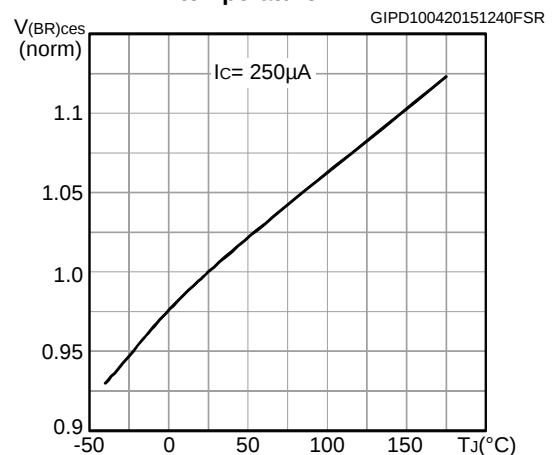
Figure 11: Diode  $V_F$  vs. forward currentFigure 12: Normalized  $V_{GE(th)}$  vs. junction temperatureFigure 13: Normalized  $V_{(BR)CES}$  vs. junction temperature

Figure 14: Capacitance variations

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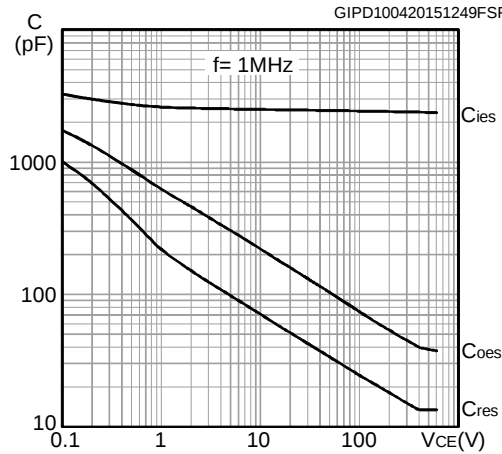


Figure 15: Gate charge vs. gate-emitter voltage

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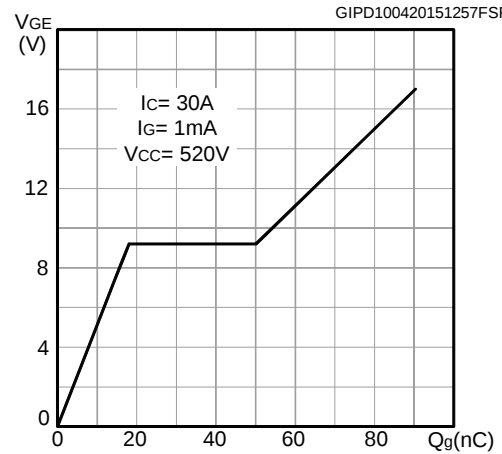


Figure 16: Switching energy vs. collector current

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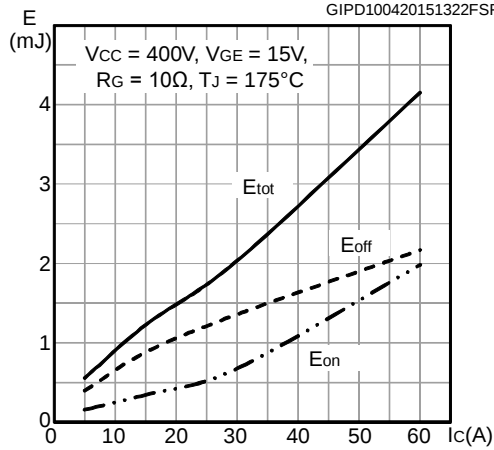


Figure 17: Switching energy vs. gate resistance

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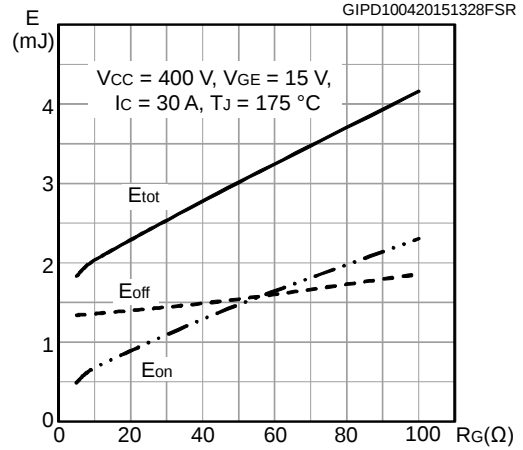


Figure 18: Switching energy vs. temperature

GIPD100420151336FSR

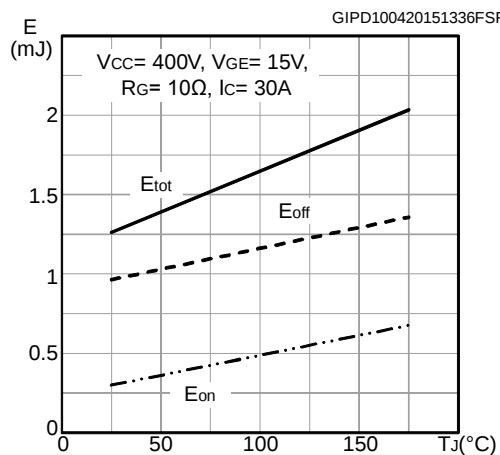


Figure 19: Switching energy vs. collector emitter voltage

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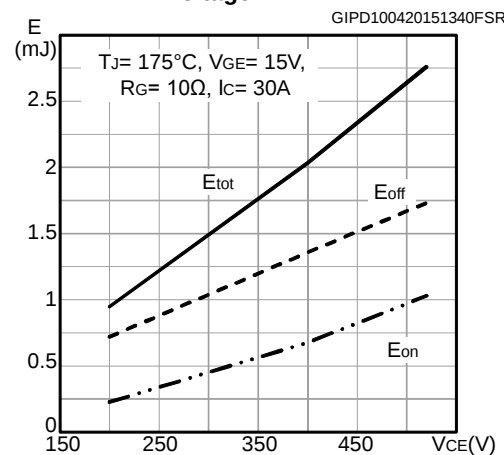


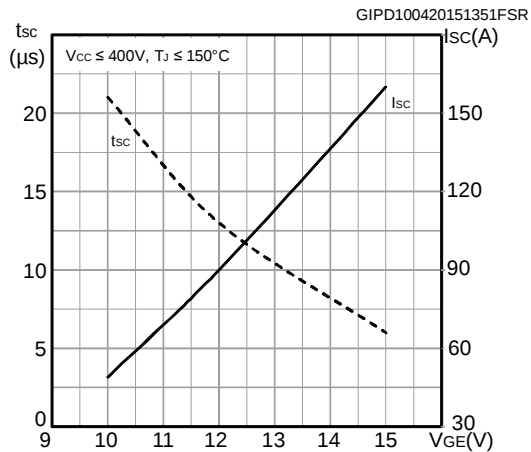
Figure 20: Short-circuit time and current vs.  $V_{GE}$ 

Figure 21: Switching times vs. collector current

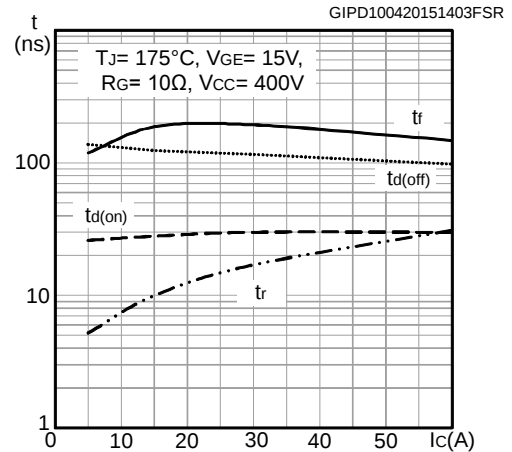


Figure 22: Switching times vs. gate resistance

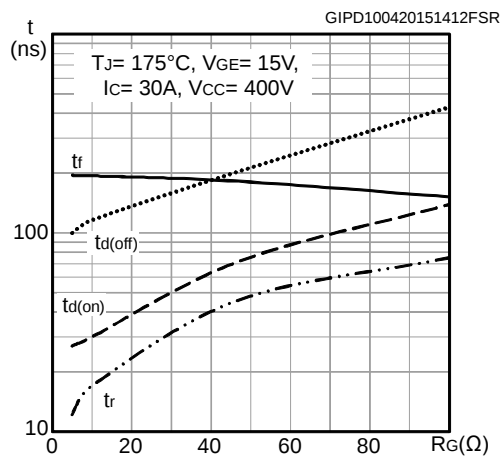


Figure 23: Reverse recovery current vs. diode current slope

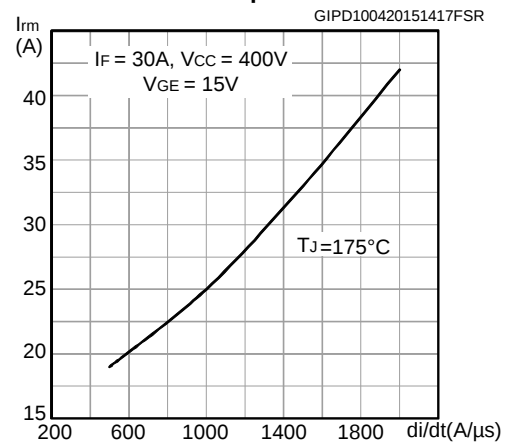


Figure 24: Reverse recovery time vs. diode current slope

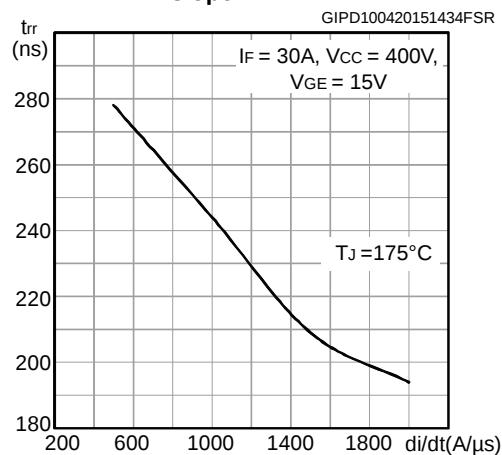


Figure 25: Reverse recovery charge vs. diode current slope

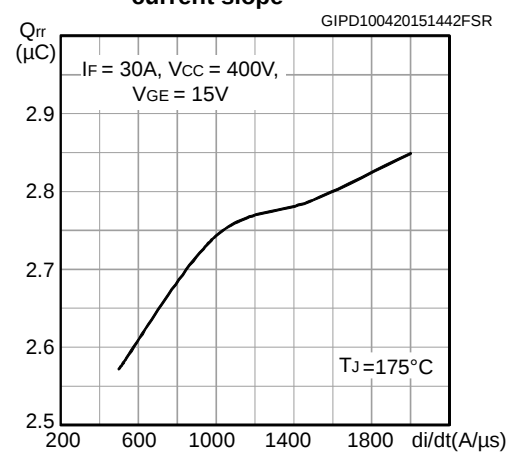


Figure 26: Reverse recovery energy vs. diode current slope

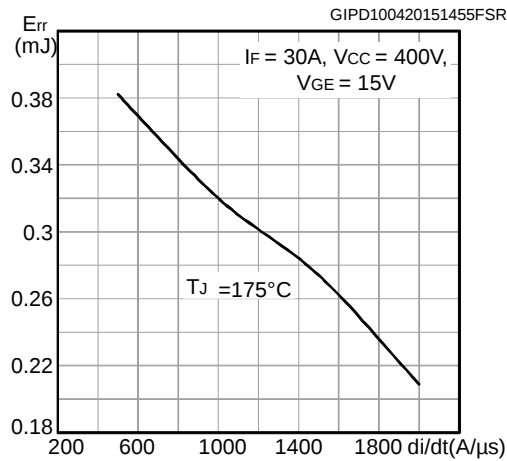


Figure 27: Thermal impedance for IGBT

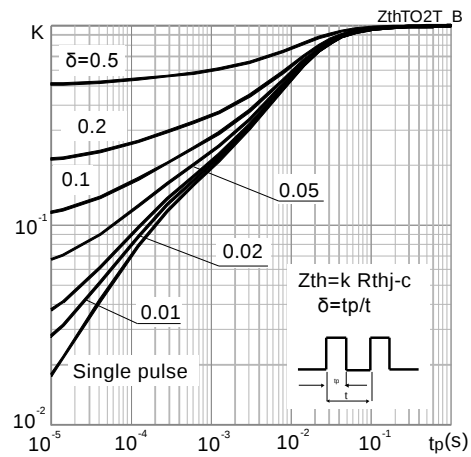
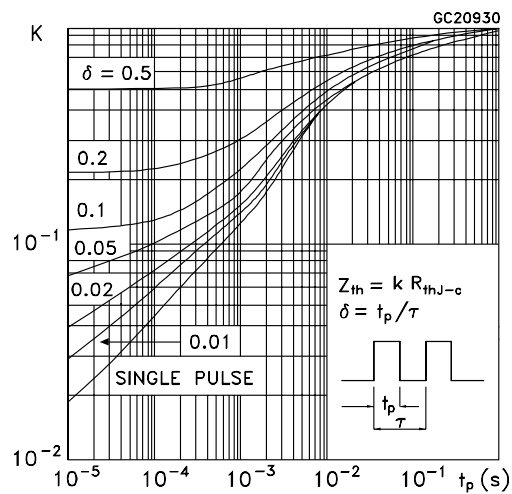


Figure 28: Thermal impedance for diode



AM01504v1

AM01505v1

AM01506v1

AM01507v1

## 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 (TO-263) type A package information

Figure 33: D<sup>2</sup>PAK (TO-263) type A package outline

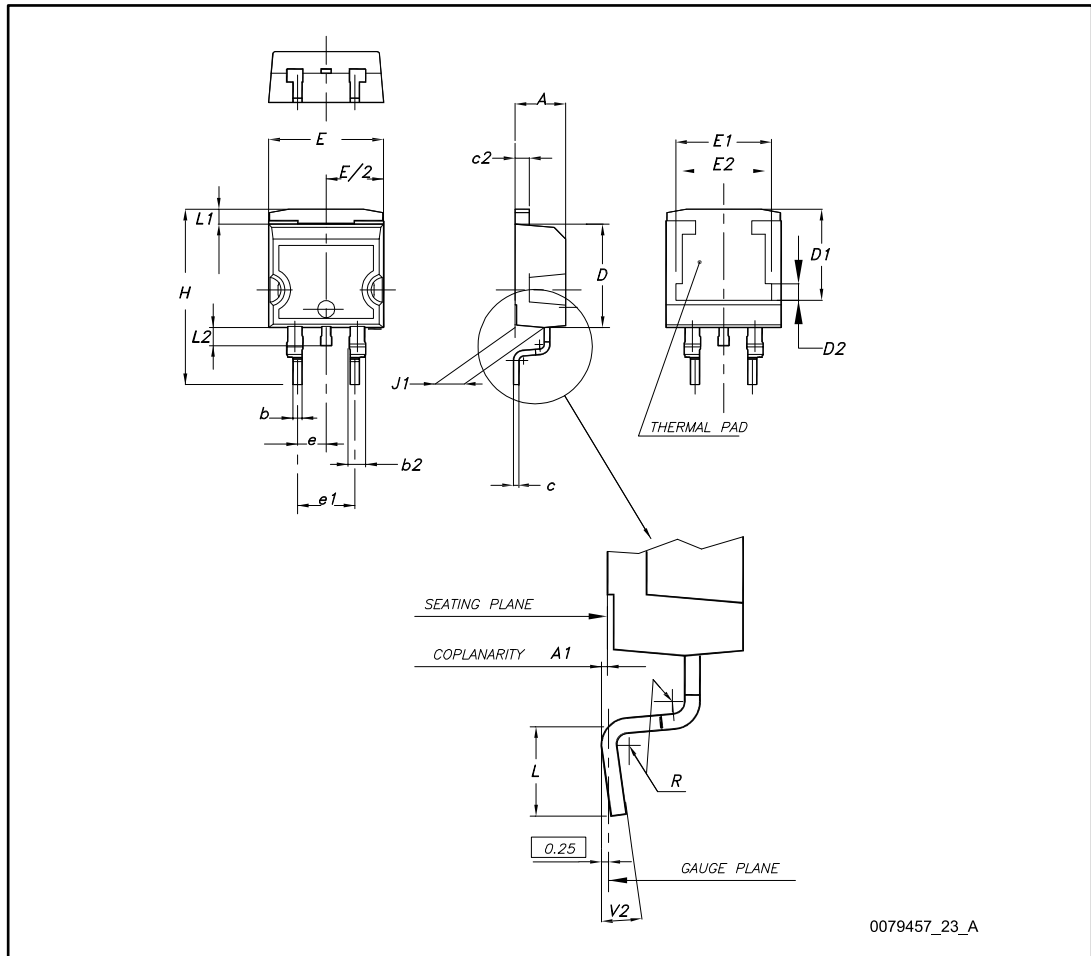
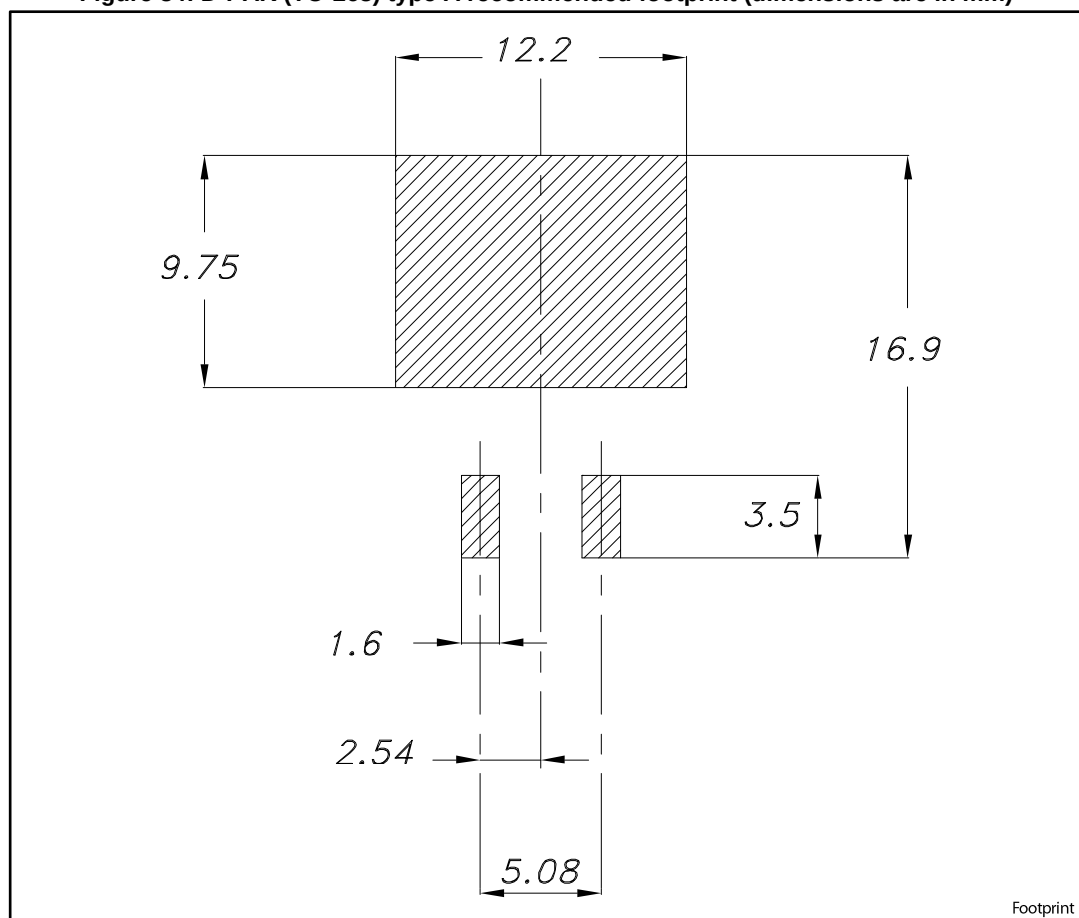


Table 8: D<sup>2</sup>PAK (TO-263) type A package mechanical data

| 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    | 10.00 |      | 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    | 15.00 |      | 15.85 |
| J1   | 2.49  |      | 2.69  |
| L    | 2.29  |      | 2.79  |
| L1   | 1.27  |      | 1.40  |
| L2   | 1.30  |      | 1.75  |
| R    |       | 0.40 |       |
| V2   | 0°    |      | 8°    |

Figure 34: D<sup>2</sup>PAK (TO-263) type A recommended footprint (dimensions are in mm)

## 4.2 D<sup>2</sup>PAK (TO-263) type A packing information

Figure 35: D<sup>2</sup>PAK type A tape outline

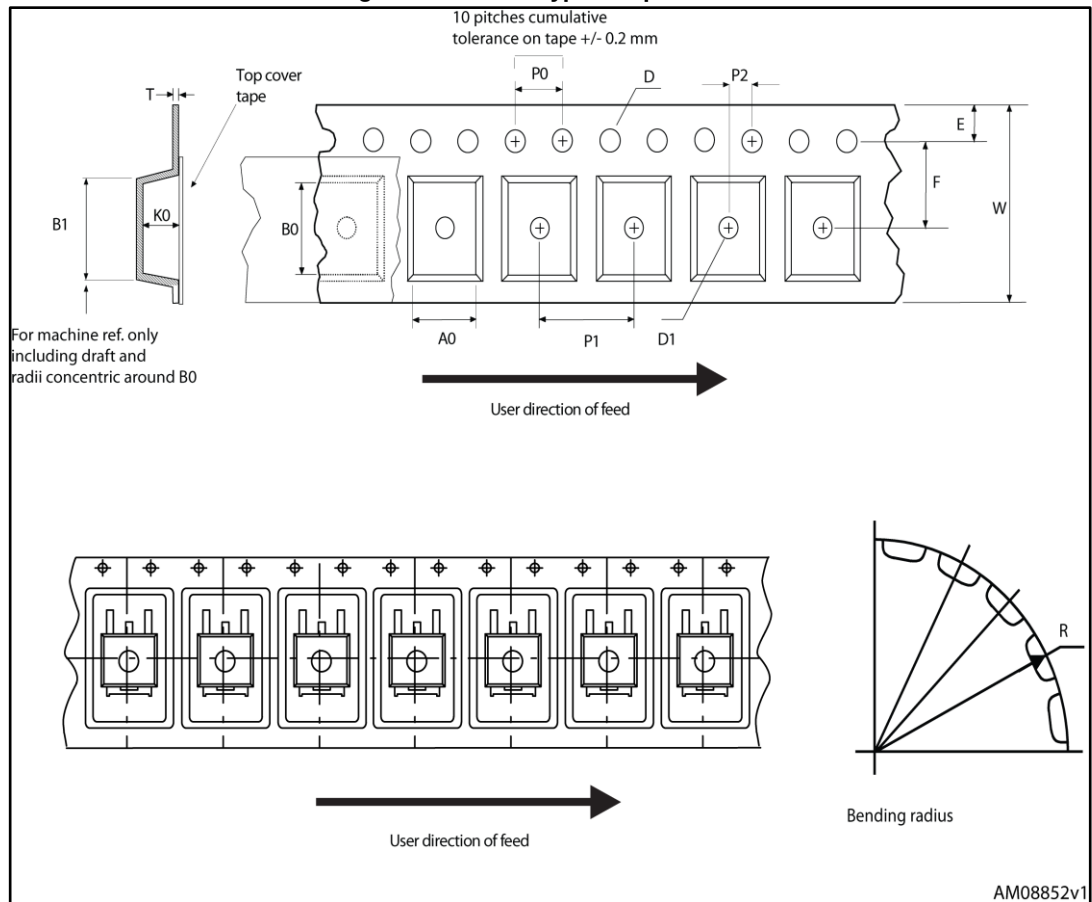
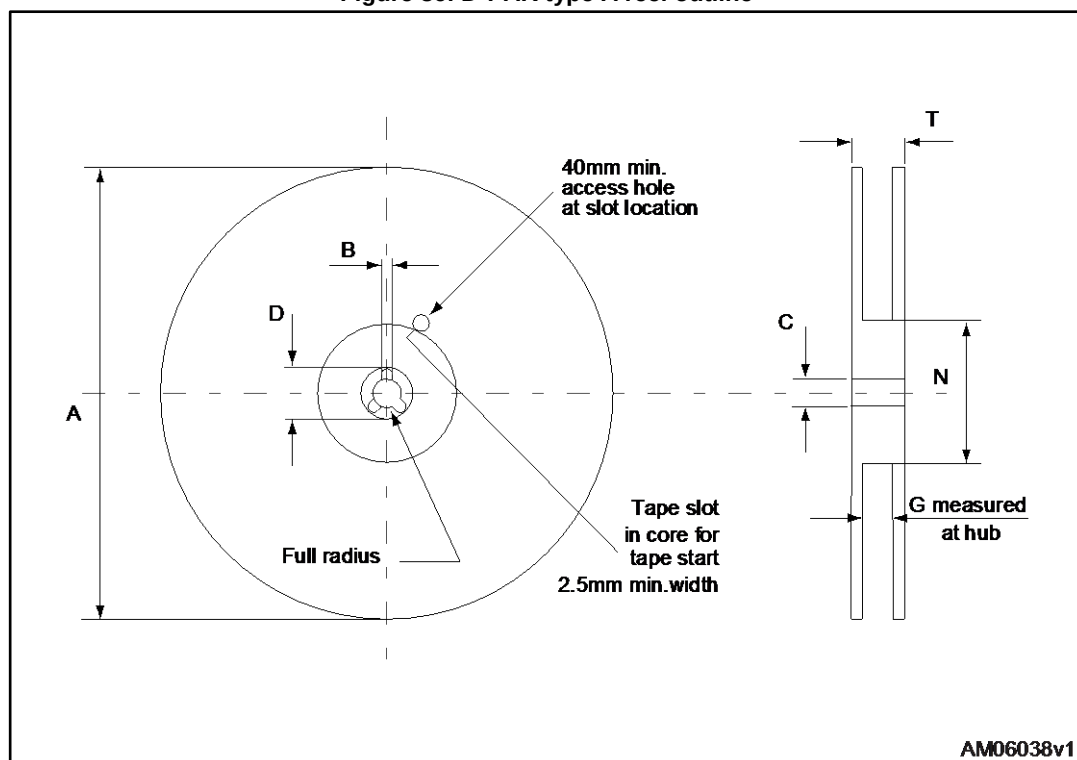


Figure 36: D<sup>2</sup>PAK type A reel outlineTable 9: D<sup>2</sup>PAK type A tape and reel mechanical data

| 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 quantity |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk quantity |      | 1000 |
| R    | 50   |      |               |      |      |
| T    | 0.25 | 0.35 |               |      |      |
| W    | 23.7 | 24.3 |               |      |      |

## 5 Revision history

**Table 10: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10-Feb-2015 | 1        | First release.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 13-Apr-2015 | 2        | Document status promoted from preliminary to production data.<br>Updated <i>Section 2: "Electrical characteristics"</i><br>Added <i>Section 2.1: "1.1 Electrical characteristics (curve)"</i>                                                                                                                                                                                                                                         |
| 11-Apr-2017 | 3        | Updated document title.<br>Updated <i>Table 4: "Static characteristics"</i> , <i>Table 6: "IGBT switching characteristics (inductive load)"</i> and <i>Table 7: "Diode switching characteristics (inductive load)"</i> .<br>Updated <i>Figure 13: "Normalized <math>V_{(BR)CES}</math> vs. junction temperature "</i> .<br>Updated <i>Section 4.1: "D<sup>2</sup>PAK (TO-263) type A package information"</i> .<br>Minor text changes |

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