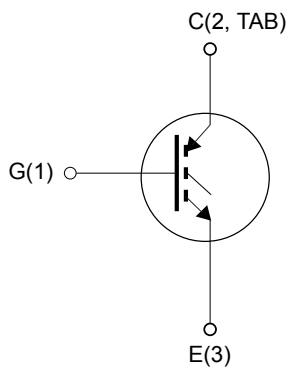
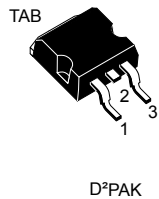


## Trench gate field-stop IGBT, HB series 650 V, 40 A high speed



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^{\circ}\text{C}$
- High speed switching series
- Minimized tail current
- Low saturation voltage:  $V_{CE(sat)} = 1.6\text{ V (typ.) @ } I_C = 40\text{ A}$
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance

### Applications

- Photovoltaic inverters
- High frequency converters

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the new HB series of IGBTs, which represents an optimum compromise between conduction and switching loss to maximize the efficiency of any frequency converter. Furthermore, the slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

#### Product status link

[STGB40H65FB](#)

#### Product summary

|            |                    |
|------------|--------------------|
| Order code | STGB40H65FB        |
| Marking    | GB40H65FB          |
| Package    | D <sup>2</sup> PAK |
| Packing    | Tape and reel      |

## 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                             | Value       | Unit |
|----------------|-------------------------------------------------------|-------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0\text{ V}$ )   | 650         | V    |
| $I_C$          | Continuous collector current at $T_C = 25\text{ °C}$  | 80          | A    |
|                | Continuous collector current at $T_C = 100\text{ °C}$ | 40          |      |
| $I_{CP}^{(1)}$ | Pulsed collector current                              | 160         | A    |
| $V_{GE}$       | Gate-emitter voltage                                  | $\pm 20$    | V    |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ °C}$       | 283         | W    |
| $T_{STG}$      | Storage temperature range                             | - 55 to 150 | °C   |
| $T_J$          | Operating junction temperature range                  | - 55 to 175 |      |

1. Pulse width limited by maximum junction temperature.

**Table 2. Thermal data**

| Symbol     | Parameter                           | Value | Unit |
|------------|-------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case    | 0.53  | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 62.5  |      |

## 2 Electrical characteristics

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

**Table 3. Static characteristics**

| Symbol        | Parameter                            | Test conditions                                                      | Min. | Typ. | Max.      | Unit          |
|---------------|--------------------------------------|----------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage  | $V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$                          | 650  |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$                         |      | 1.6  | 2         | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ , $T_J = 125\text{ °C}$ |      | 1.7  |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ , $T_J = 175\text{ °C}$ |      | 1.8  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$                              | 5    | 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         | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$                   |      |      | $\pm 250$ | nA            |

**Table 4. Dynamic characteristics**

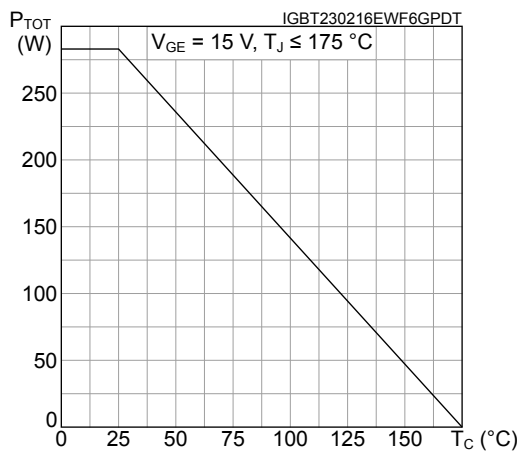
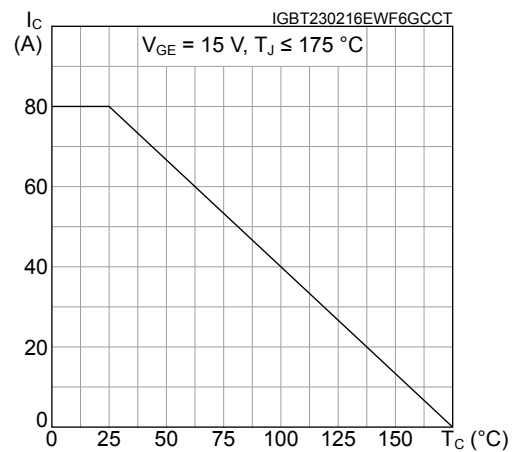
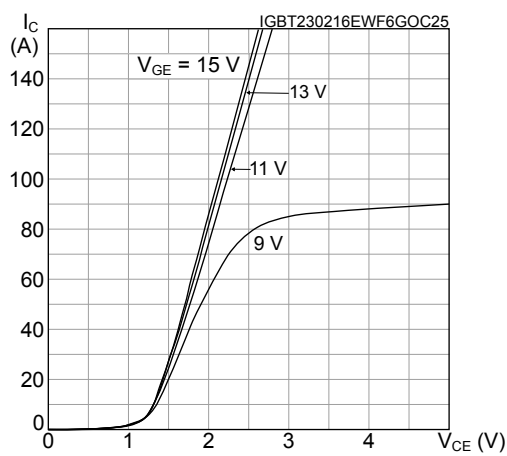
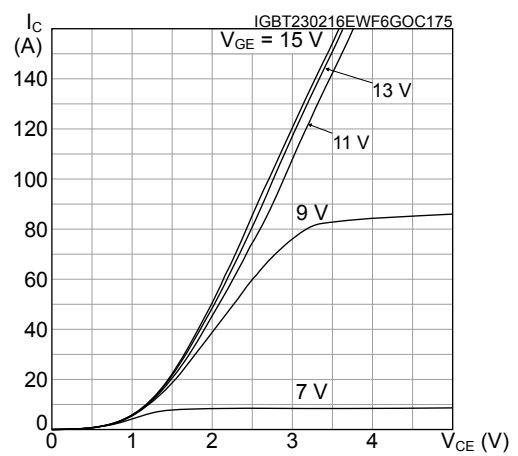
| Symbol    | Parameter                    | Test conditions                                                                                                                 | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$                                                             | -    | 5412 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                 | -    | 198  | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                 | -    | 107  | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 520\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$<br>(see Figure 22. Gate charge test circuit) | -    | 210  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                                                                                 | -    | 39   | -    |      |
| $Q_{gc}$  | Gate-collector charge        |                                                                                                                                 | -    | 82   | -    |      |

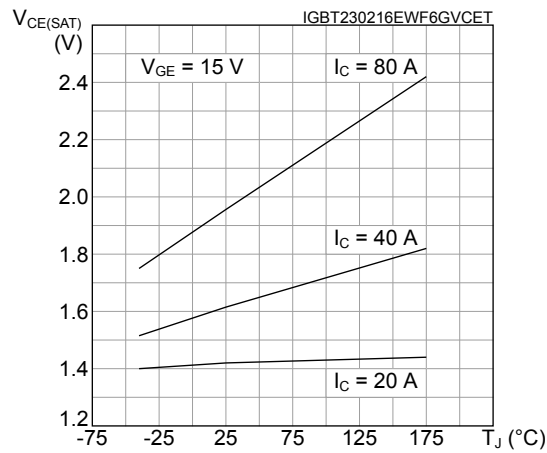
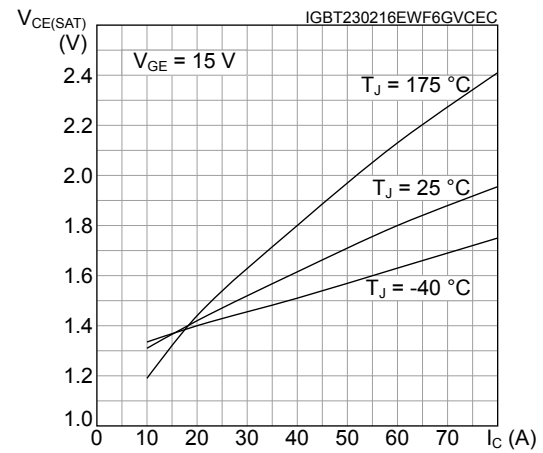
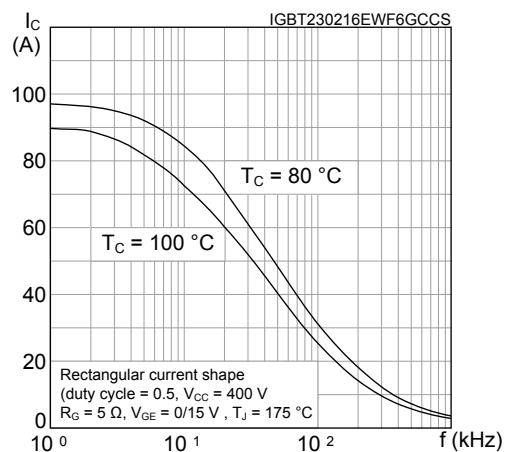
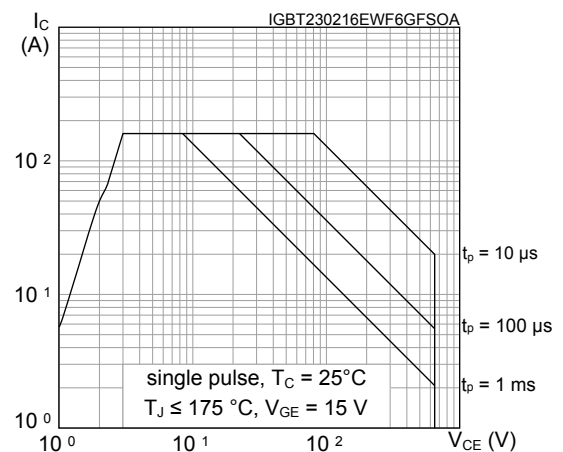
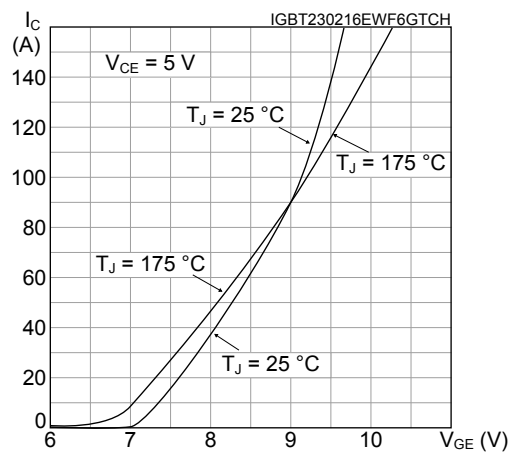
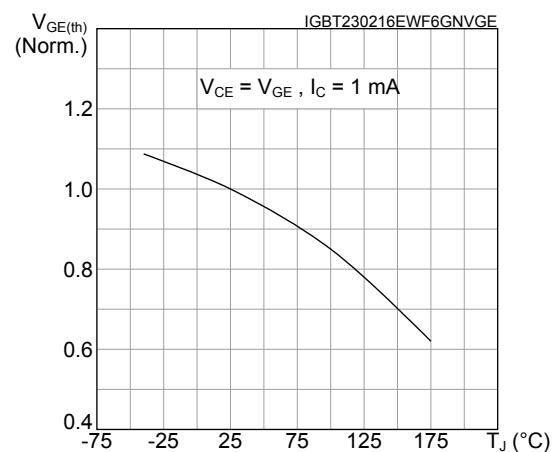
**Table 5. Switching characteristics (inductive load)**

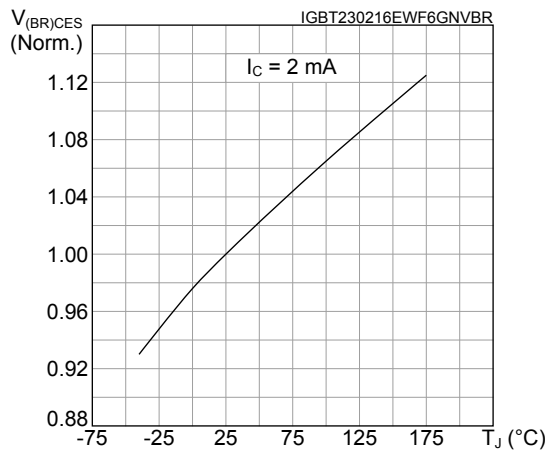
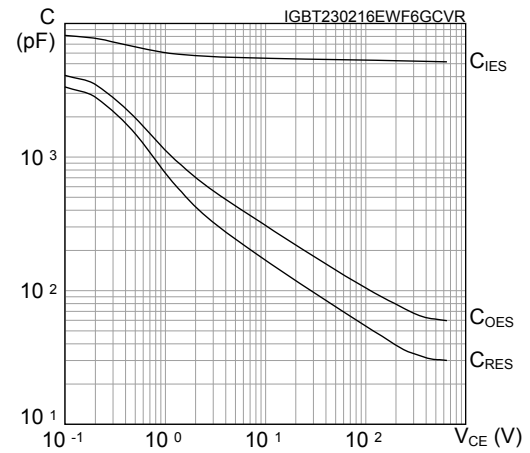
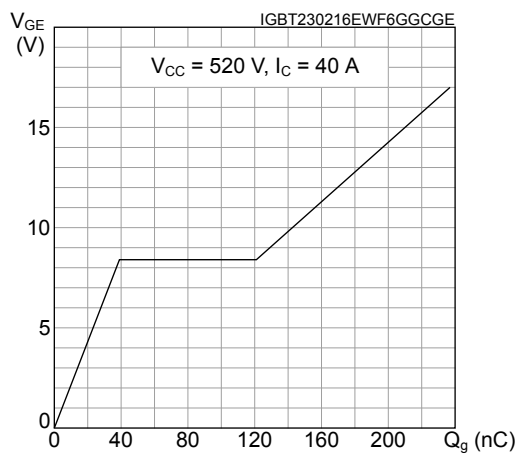
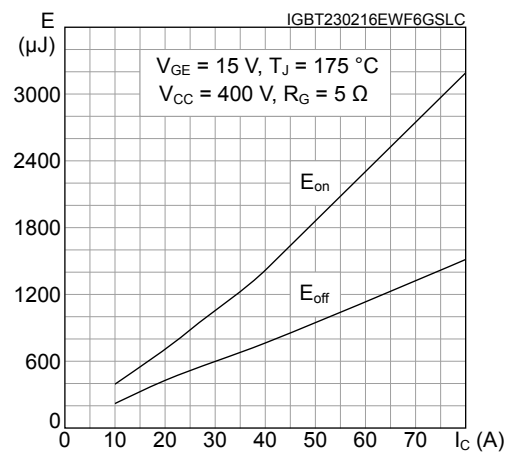
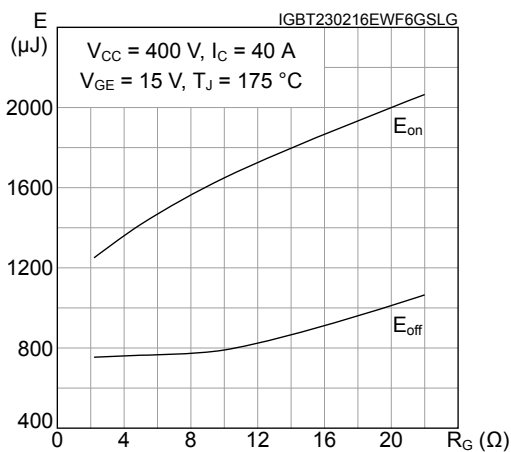
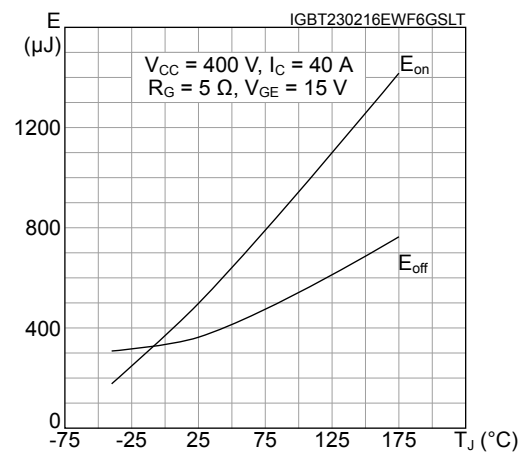
| Symbol          | Parameter                 | Test conditions                                                                                                                                                                              | Min. | Typ. | Max. | Unit       |
|-----------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$     | Turn-on delay time        | $V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 5\ \Omega$<br>(see Figure 21. Test circuit for inductive load switching)                                     | -    | 40   | -    | ns         |
| $t_r$           | Current rise time         |                                                                                                                                                                                              | -    | 13   | -    |            |
| $(di/dt)_{on}$  | Turn-on current slope     |                                                                                                                                                                                              | -    | 2413 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off-delay time       |                                                                                                                                                                                              | -    | 142  | -    | ns         |
| $t_f$           | Current fall time         |                                                                                                                                                                                              | -    | 27   | -    |            |
| $E_{on}^{(1)}$  | Turn-on switching energy  |                                                                                                                                                                                              | -    | 498  | -    | $\mu$ J    |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                              | -    | 363  | -    |            |
| $E_{ts}$        | Total switching energy    |                                                                                                                                                                                              | -    | 861  | -    |            |
| $t_{d(on)}$     | Turn-on delay time        | $V_{CE} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 5\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$<br>(see Figure 21. Test circuit for inductive load switching) | -    | 38   | -    | ns         |
| $t_r$           | Current rise time         |                                                                                                                                                                                              | -    | 14   | -    |            |
| $(di/dt)_{on}$  | Turn-on current slope     |                                                                                                                                                                                              | -    | 2186 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off-delay time       |                                                                                                                                                                                              | -    | 141  | -    | ns         |
| $t_f$           | Current fall time         |                                                                                                                                                                                              | -    | 61   | -    |            |
| $E_{on}^{(1)}$  | Turn-on switching energy  |                                                                                                                                                                                              | -    | 1417 | -    | $\mu$ J    |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                              | -    | 764  | -    |            |
| $E_{ts}$        | Total switching energy    |                                                                                                                                                                                              | -    | 2181 | -    |            |

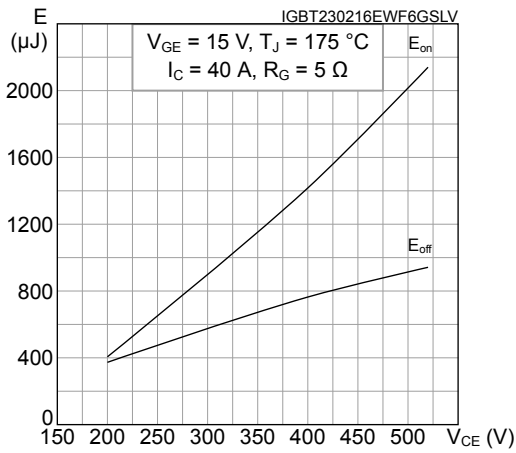
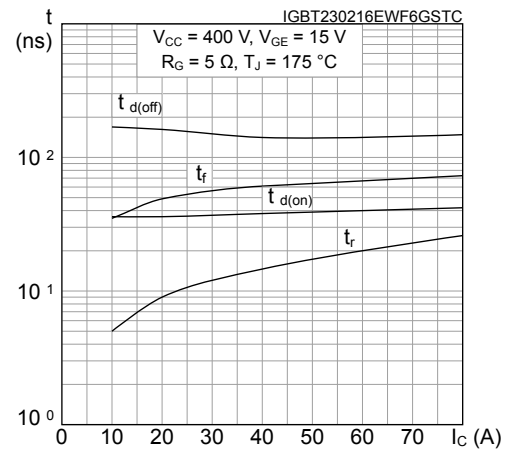
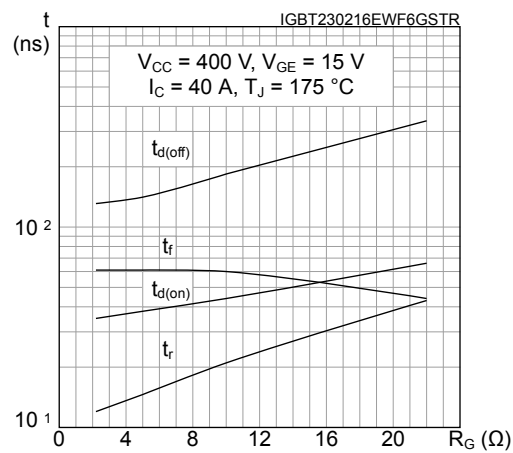
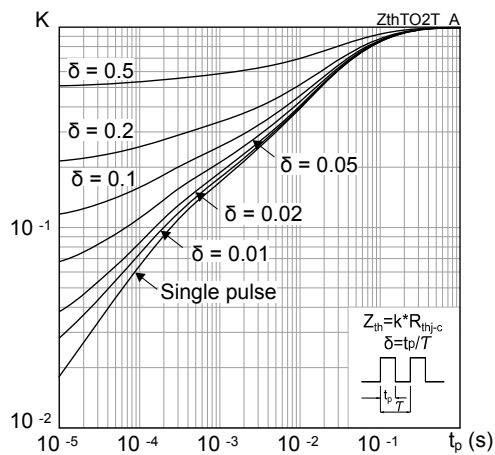
1. Including the reverse recovery of the external diode.
2. Including the tail of the collector current.

## 2.1 Electrical characteristics (curves)

**Figure 1. Power dissipation vs. case temperature**

**Figure 2. Collector current vs. case temperature**

**Figure 3. Output characteristics ( $T_J = 25$  °C)**

**Figure 4. Output characteristics ( $T_J = 175$  °C)**


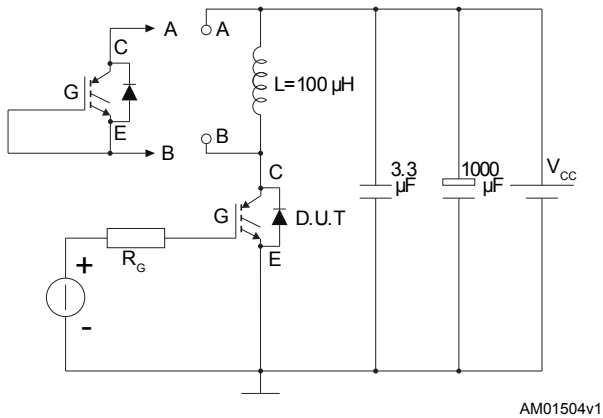
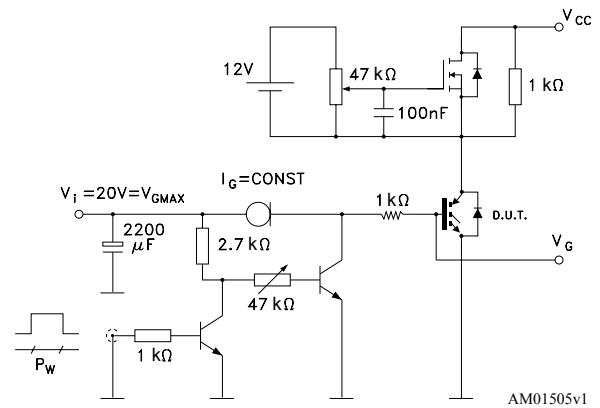
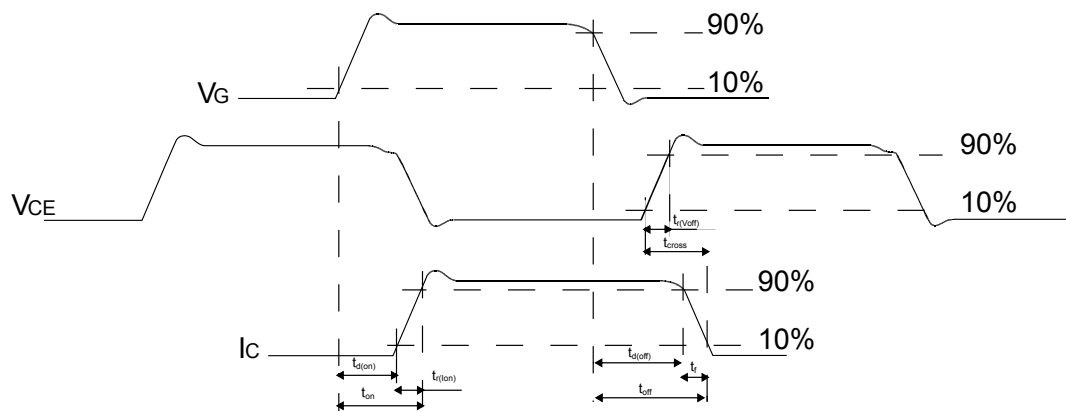
**Figure 5.  $V_{CE(sat)}$  vs. junction temperature**

**Figure 6.  $V_{CE(sat)}$  vs. collector current**

**Figure 7. Collector current vs. switching frequency**

**Figure 8. Forward bias safe operating area**

**Figure 9. Transfer characteristics**

**Figure 10. Normalized  $V_{GE(th)}$  vs. junction temperature**


**Figure 11. Normalized  $V_{(BR)CES}$  vs. junction temperature**

**Figure 12. Capacitance variations**

**Figure 13. Gate charge vs. gate-emitter voltage**

**Figure 14. Switching energy vs. collector current**

**Figure 15. Switching energy vs. gate resistance**

**Figure 16. Switching energy vs. temperature**


**Figure 17. Switching energy vs. collector emitter voltage**

**Figure 18. Switching times vs. collector current**

**Figure 19. Switching times vs. gate resistance**

**Figure 20. Thermal impedance**




### 3 Test circuits

**Figure 21. Test circuit for inductive load switching**

**Figure 22. Gate charge test circuit**

**Figure 23. Switching waveform**


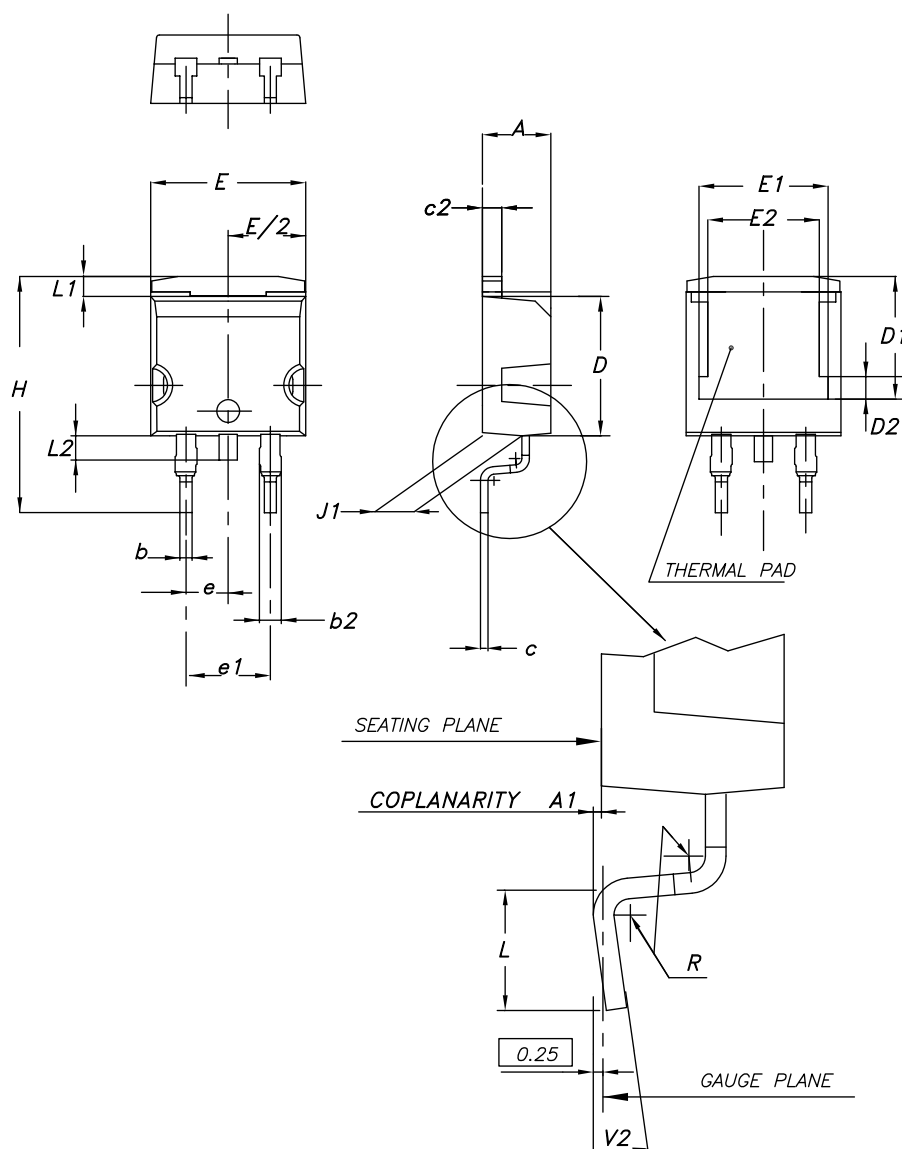
## **4**      **Package information**

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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 A2 package information

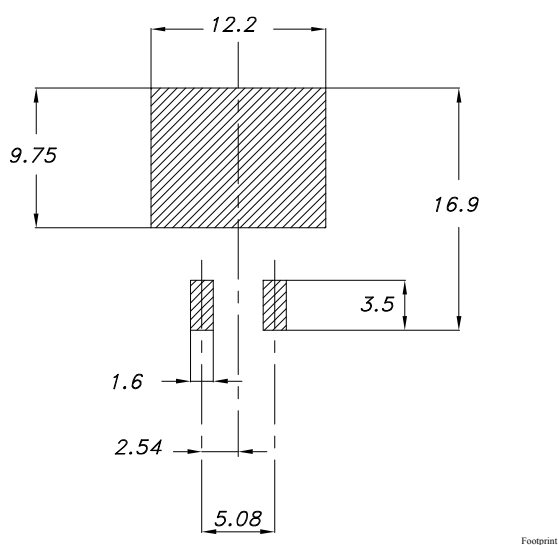
**Figure 24.** D<sup>2</sup>PAK (TO-263) type A2 package outline



0079457\_A2\_25

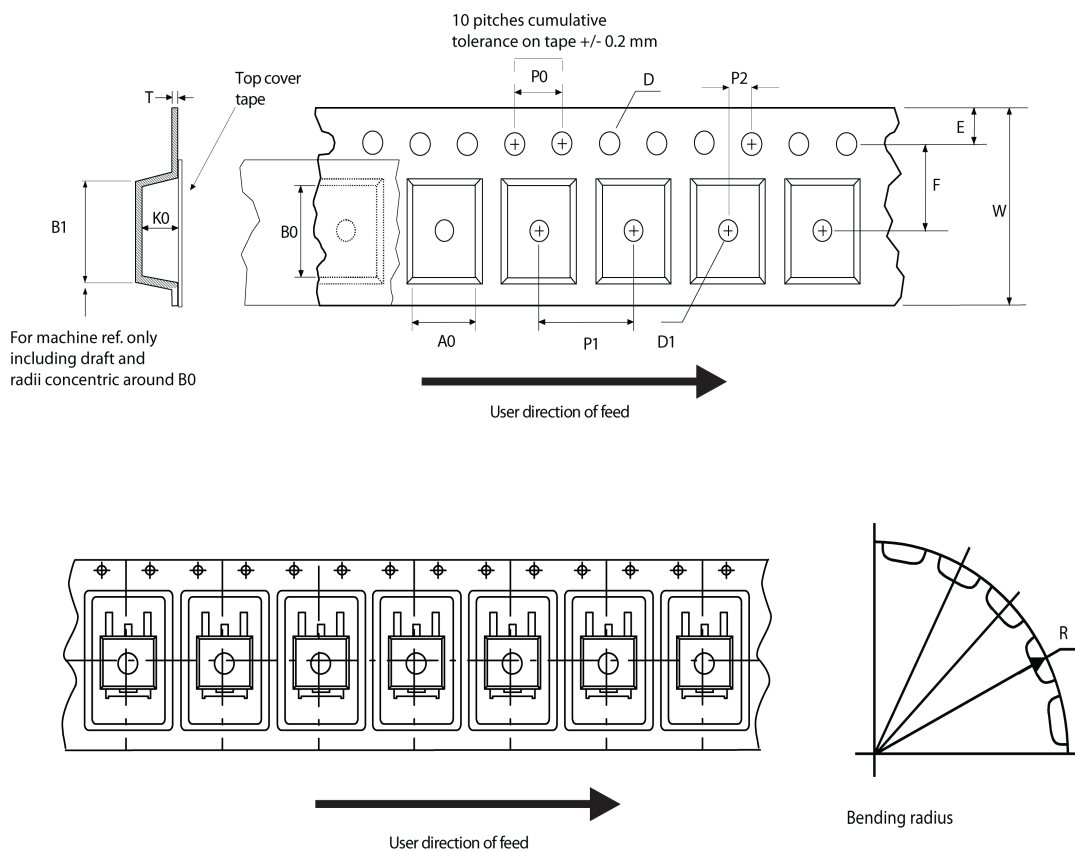
**Table 6. D<sup>2</sup>PAK (TO-263) type A2 package mechanical data**

| 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   | 8.70  | 8.90 | 9.10  |
| E2   | 7.30  | 7.50 | 7.70  |
| 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°    |

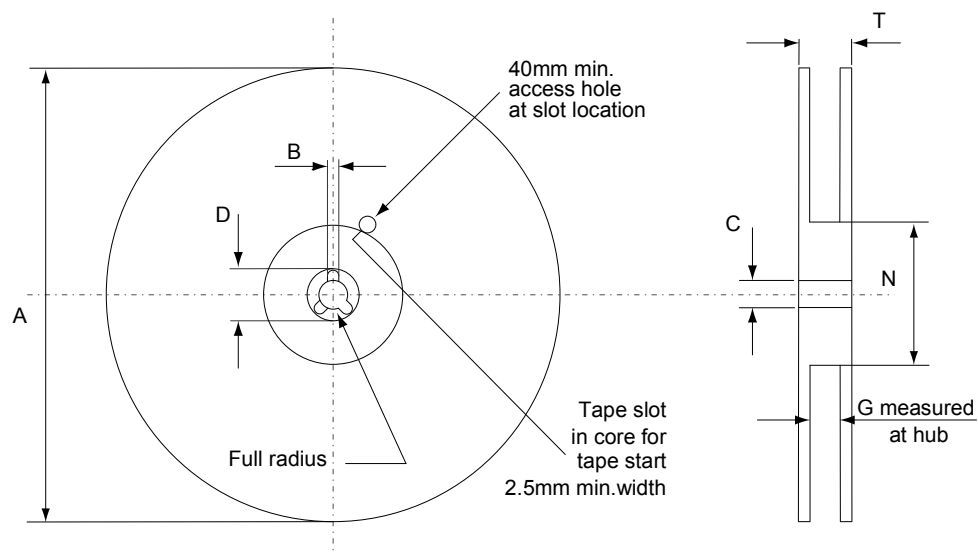
**Figure 25. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**


## 4.2 D<sup>2</sup>PAK packing information

**Figure 26. D<sup>2</sup>PAK tape outline**



AM08852v1

**Figure 27. D<sup>2</sup>PAK reel outline**


AM06038v1

**Table 7. D<sup>2</sup>PAK 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 |               |      |      |

## Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                                                     |
|-------------|----------|---------------------------------------------------------------------------------------------|
| 27-Jun-2016 | 1        | Initial release.                                                                            |
| 13-Feb-2019 | 2        | Updated <a href="#">Section 4.1 D<sup>2</sup>PAK (TO-263) type A2 package information</a> . |

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