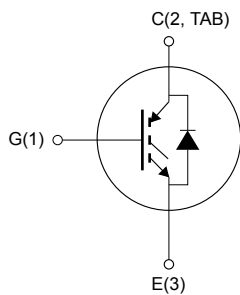
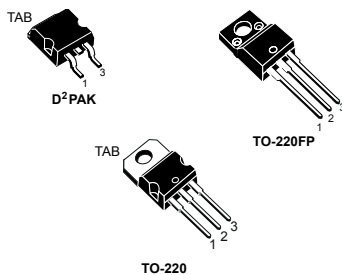


## Trench gate field-stop 600 V, 10 A high speed H series IGBT



NG1E3C2T

### 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

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the H series of IGBTs, which represents an optimum compromise between conduction and switching losses to maximize the efficiency of high switching frequency converters. Furthermore, a slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.



#### Product status link

[STGB10H60DF](#)
[STGF10H60DF](#)
[STGP10H60DF](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter   | Value                      |                   | Unit |
|--------------------------------|---|----------------------------|-------------------|------|
|                                |   | D <sup>2</sup> PAK, TO-220 | TO-220FP          |      |
| V <sub>CES</sub>               | Collector-emitter voltage (V <sub>GE</sub> = 0 V)   | 600                        |                   | V    |
| I <sub>C</sub>                 | Continuous collector current at T <sub>C</sub> = 25 °C  | 20                         | 20 <sup>(1)</sup> | A    |
|                                | Continuous collector current at T <sub>C</sub> = 100 °C   | 10                         | 10 <sup>(1)</sup> |      |
| I <sub>CP</sub> <sup>(2)</sup> | Pulsed collector current  | 40                         | 40                | A    |
| V <sub>GE</sub>                | Gate-emitter voltage  | ±20                        |                   | V    |
|                                | Transient gate-emitter voltage  | ±30                        |                   |      |
| I <sub>F</sub>                 | Continuous forward current T <sub>C</sub> = 25 °C   | 20                         | 20 <sup>(1)</sup> | A    |
|                                | Continuous forward current at T <sub>C</sub> = 100 °C   | 10                         | 10 <sup>(1)</sup> |      |
| I <sub>FP</sub> <sup>(2)</sup> | Pulsed forward current  | 40                         | 40                | A    |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C) |                            | 2.5               | kV   |
| P <sub>TOT</sub>               | Total power dissipation at T <sub>C</sub> = 25 °C   | 115                        | 30                | W    |
| T <sub>STG</sub>               | Storage temperature range   | -55 to 150                 |                   | °C   |
| T <sub>J</sub>                 | Operating junction temperature range  | -55 to 175                 |                   |      |

1. Limited by maximum junction temperature.
2. Pulse width limited by maximum junction temperature.

**Table 2. Thermal data**

| Symbol            | Parameter                              | Value                      |          | Unit |
|-------------------|--|----------------------------|----------|------|
|                   |  | D <sup>2</sup> PAK, TO-220 | TO-220FP |      |
| R <sub>thJC</sub> | Thermal resistance junction-case IGBT  | 1.3                        | 5        | °C/W |
| R <sub>thJC</sub> | Thermal resistance junction-case diode | 2.78                       | 6.25     | °C/W |
| R <sub>thJA</sub> | Thermal resistance junction-ambient    | 62.5                       | 62.5     | °C/W |

## 2 Electrical characteristics

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

**Table 3. Static**

| Symbol        | Parameter                            | Test conditions  | Min. | Typ. | Max.      | Unit          |
|---------------|--------------------------------------|--|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage  | $V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$                          | 600  |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 10\text{ A}$                         |      | 1.50 | 1.95      | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 10\text{ A}$ , $T_J = 125\text{ °C}$ |      | 1.65 |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 10\text{ A}$ , $T_J = 175\text{ °C}$ |      | 1.70 |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$                   | 5    | 6    | 7         | V             |
| $I_{CES}$     | Collector cut-off current            | $V_{CE} = 600\text{ V}$ , $V_{GE} = 0\text{ V}$                      |      |      | 25        | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current         | $V_{GE} = \pm 20\text{ V}$ , $V_{CE} = 0\text{ V}$                   |      |      | $\pm 250$ | nA            |

**Table 4. Dynamic**

| Symbol    | Parameter                    | Test conditions   | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$   | -    | 1300 | -    | pF   |
| $C_{oes}$ | Output capacitance           |   |      | 60   |      |      |
| $C_{res}$ | Reverse transfer capacitance |   |      | 30   |      |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 480\text{ V}$ , $I_C = 10\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$<br>(see Figure 33. Gate charge test circuit) | -    | 57   | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |   |      | 8    |      |      |
| $Q_{gc}$  | Gate-collector charge        |   |      | 27   |      |      |

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

| Symbol         | Parameter                    | Test conditions  | Min. | Typ. | Max. | Unit    |
|----------------|------------------------------|--|------|------|------|---------|
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ ,                         | -    | 19.5 | -    | ns      |
| $t_r$          | Current rise time            | $V_{GE} = 15\text{ V}$   |      | 6.9  |      |         |
| $(di/dt)_{on}$ | Turn-on current slope        | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 1170 |      |         |
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ ,                         | -    | 20   | -    | ns      |
| $t_r$          | Current rise time            | $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$                                   |      | 6.8  |      |         |
| $(di/dt)_{on}$ | Turn-on current slope        | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 1176 |      |         |
| $t_{r(voff)}$  | Off voltage rise time        | $V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ ,                         | -    | 19.6 | -    | ns      |
| $t_{d(off)}$   | Turn-off delay time          | $V_{GE} = 15\text{ V}$   |      | 103  |      |         |
| $t_f$          | Current fall time            | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 73   |      |         |
| $t_{r(voff)}$  | Off voltage rise time        | $V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ ,                         |      | 28   |      |         |
| $t_{d(off)}$   | Turn-off delay time          | $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$                                   |      | 104  |      |         |
| $t_f$          | Current fall time            | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) | 110  |      |      |         |
| $t_{sc}$       | Short-circuit withstand time | $V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$                     | 3    | 5    | -    | $\mu$ s |

**Table 6. Switching energy (inductive load)**

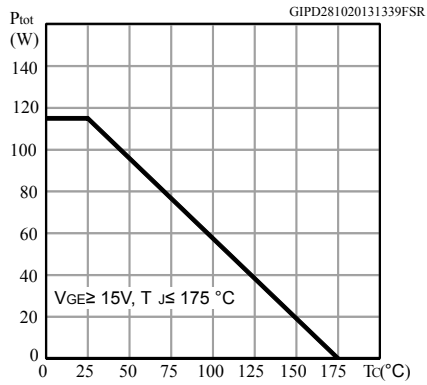
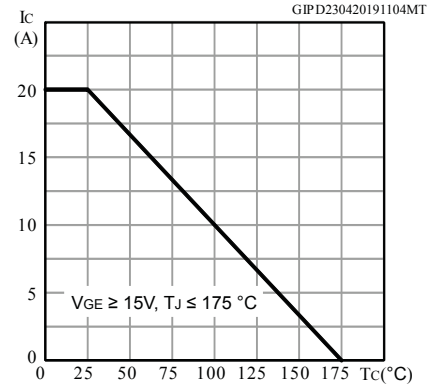
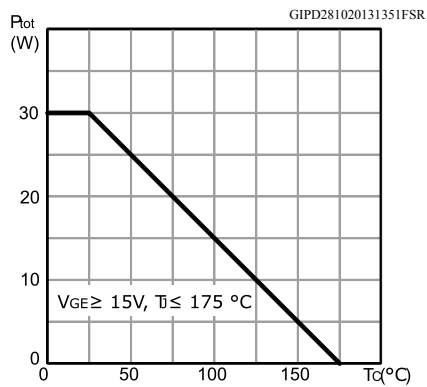
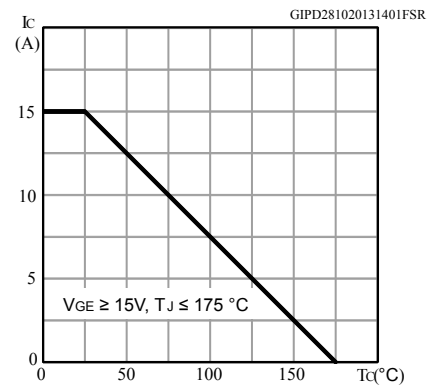
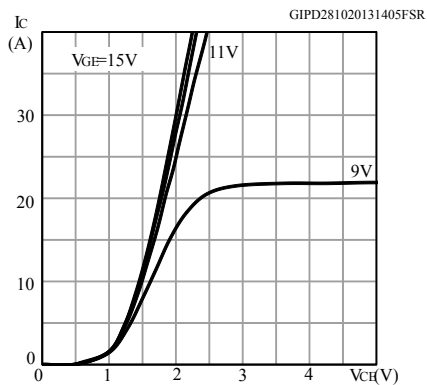
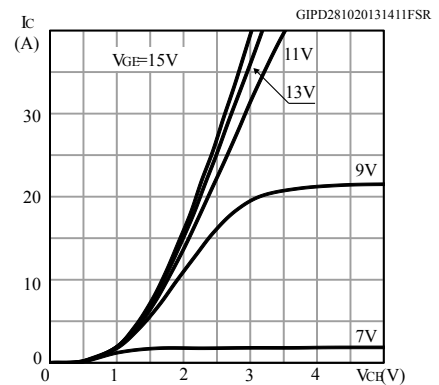
| Symbol          | Parameter                 | Test conditions  | Min. | Typ. | Max. | Unit    |
|-----------------|---------------------------|--|------|------|------|---------|
| $E_{on}^{(1)}$  | Turn-on switching energy  | $V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ ,  | -    | 83   | -    | $\mu$ J |
| $E_{off}^{(2)}$ | Turn-off switching energy | $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>(see Figure 32. Test circuit for inductive load switching)                                      |      | 140  |      |         |
| $E_{ts}$        | Total switching energy    |  |      | 223  |      |         |
| $E_{on}^{(1)}$  | Turn-on switching energy  | $V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ ,  |      | 148  |      |         |
| $E_{off}^{(2)}$ | Turn-off switching energy | $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$<br>(see Figure 32. Test circuit for inductive load switching) |      | 214  |      |         |
| $E_{ts}$        | Total switching energy    |  |      | 362  |      |         |

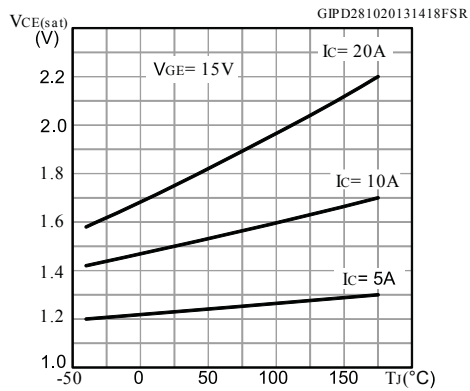
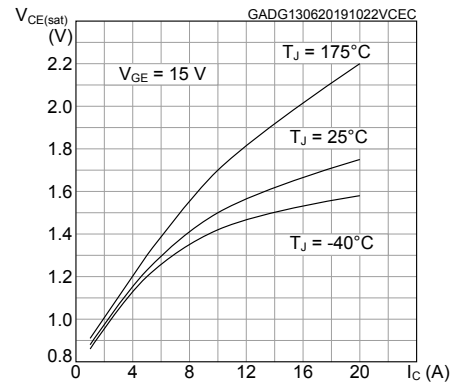
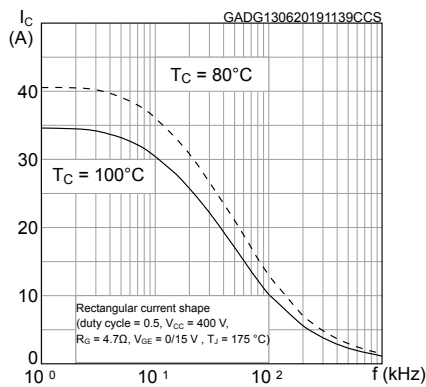
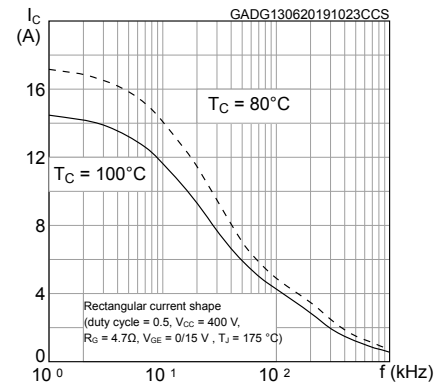
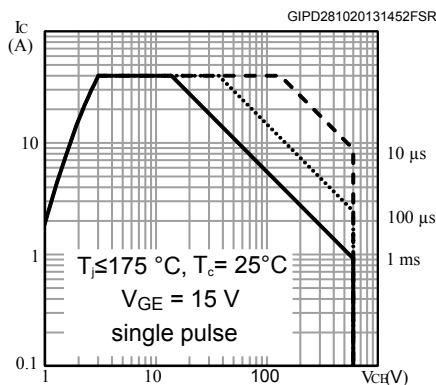
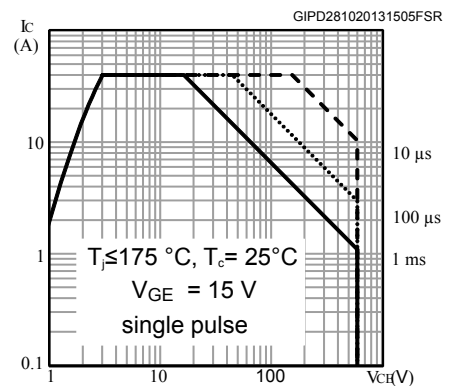
1. Including the reverse recovery of the diode.

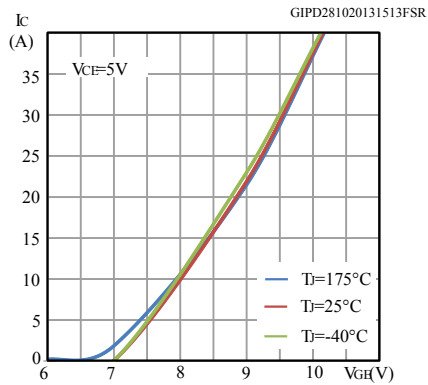
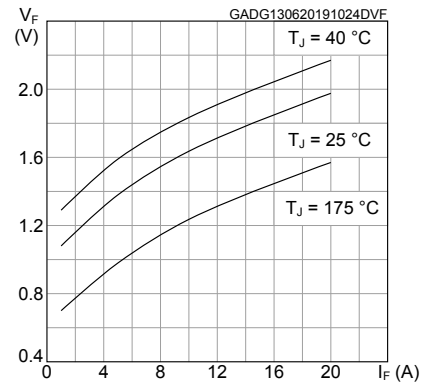
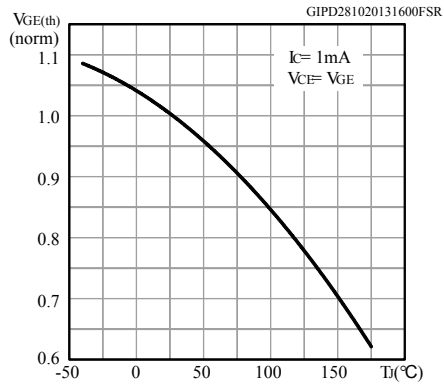
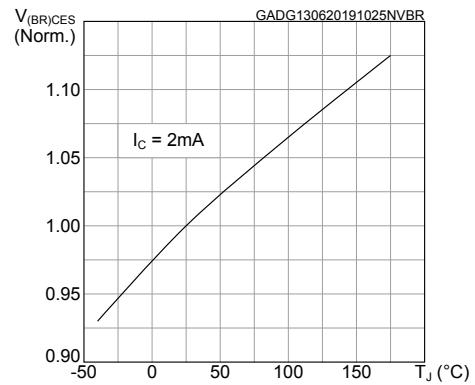
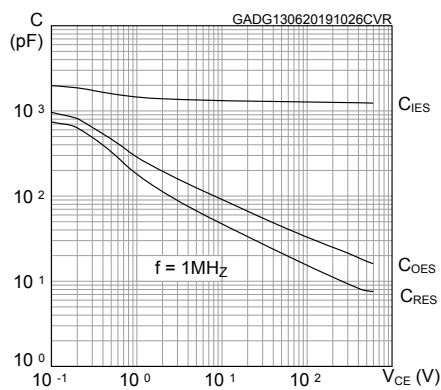
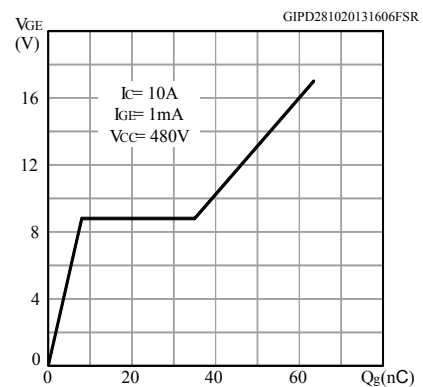
2. Including the tail of the collector current.

**Table 7. Collector-emitter diode**

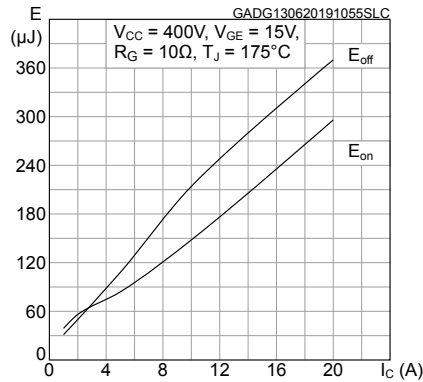
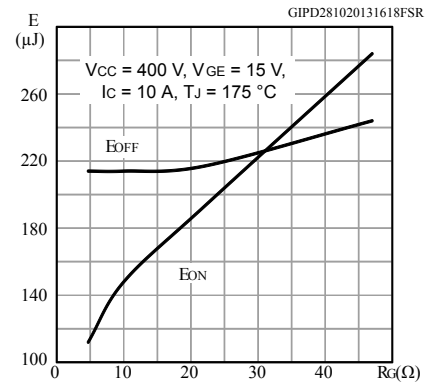
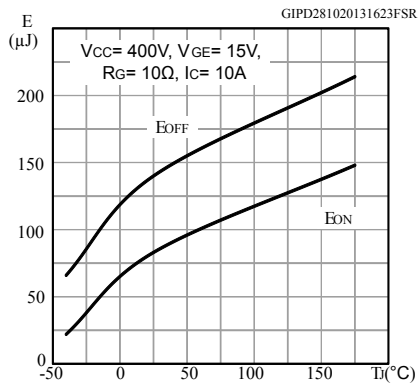
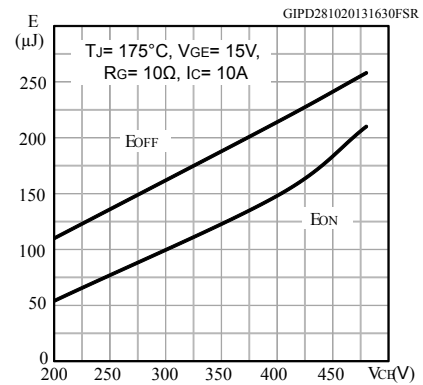
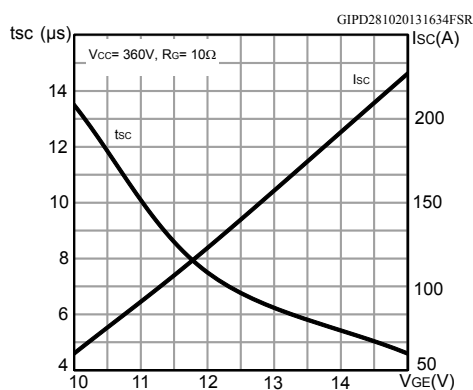
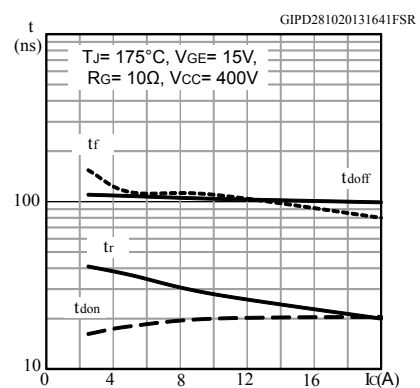
| Symbol    | Parameter                | Test conditions   | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|---|------|------|------|------|
| $V_F$     | Forward on-voltage       | $I_F = 10 \text{ A}$  | -    | 1.7  | 2.2  | V    |
|           |                          | $I_F = 10 \text{ A}, T_J = 175 \text{ °C}$  |      | 1.3  |      |      |
| $t_{rr}$  | Reverse recovery time    | $V_r = 60 \text{ V}; I_F = 10 \text{ A}, di_F/dt = 100 \text{ A} / \mu\text{s}$<br>(see Figure 35. Diode reverse recovery waveform)                           | -    | 107  |      | ns   |
| $Q_{rr}$  | Reverse recovery charge  |   |      | 120  |      | nC   |
| $I_{rrm}$ | Reverse recovery current |   |      | 2.24 |      | A    |
| $t_{rr}$  | Reverse recovery time    | $V_r = 60 \text{ V}; I_F = 10 \text{ A}, di_F/dt = 100 \text{ A} / \mu\text{s}$<br>$T_J = 175 \text{ °C}$<br>(see Figure 35. Diode reverse recovery waveform) | -    | 161  |      | ns   |
| $Q_{rr}$  | Reverse recovery charge  |   |      | 362  |      | nC   |
| $I_{rrm}$ | Reverse recovery current |   |      | 4.5  |      | A    |

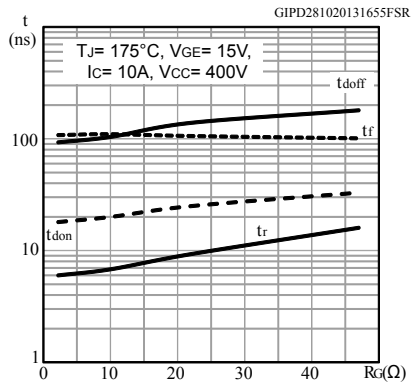
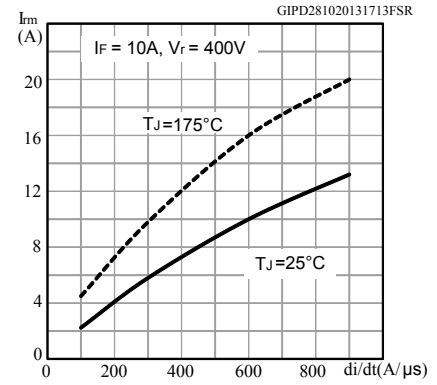
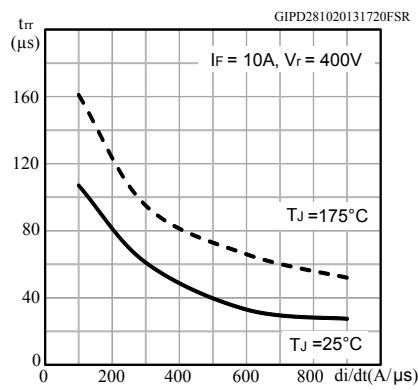
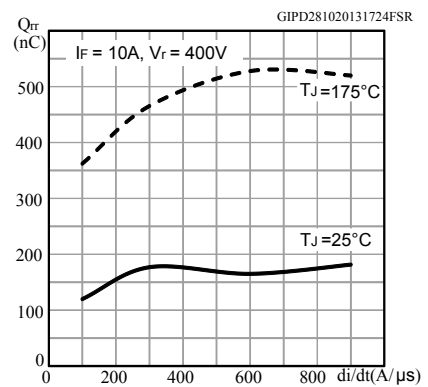
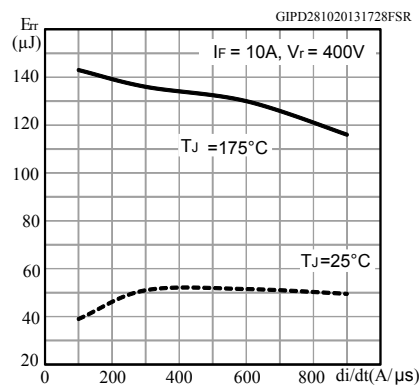
**2.1 Electrical characteristics (curves)**
**Figure 1. Power dissipation vs case temperature for D<sup>2</sup>PAK and TO-220**

**Figure 2. Collector current vs case temperature for D<sup>2</sup>PAK and TO-220**

**Figure 3. Power dissipation vs case temperature for TO-220FP**

**Figure 4. Collector current vs case temperature for TO-220FP**

**Figure 5. Output characteristics (T<sub>J</sub> = 25°C)**

**Figure 6. Output characteristics (T<sub>J</sub> = 175°C)**


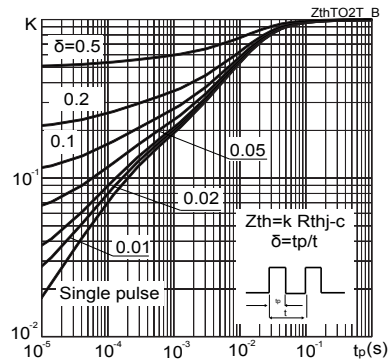
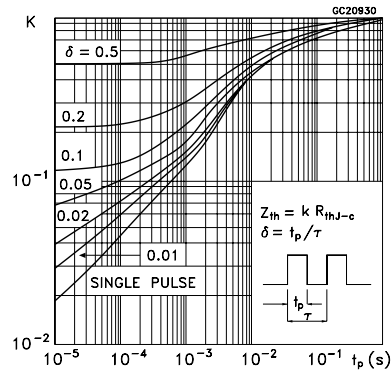
**Figure 7.  $V_{CE(sat)}$  vs junction temperature**

**Figure 8.  $V_{CE(sat)}$  vs collector current**

**Figure 9. Collector current vs switching frequency for D<sup>2</sup>PAK and TO-220**

**Figure 10. Collector current vs switching frequency for TO-220FP**

**Figure 11. Forward bias safe operating area for D<sup>2</sup>PAK and TO-220**

**Figure 12. Forward bias safe operating area for TO-220FP**


**Figure 13. Transfer characteristics**

**Figure 14. Diode  $V_F$  vs forward current**

**Figure 15. Normalized  $V_{GE(th)}$  vs junction temperature**

**Figure 16. Normalized  $V_{(BR)CES}$  vs junction temperature**

**Figure 17. Capacitance variation**

**Figure 18. Gate charge vs gate-emitter voltage**


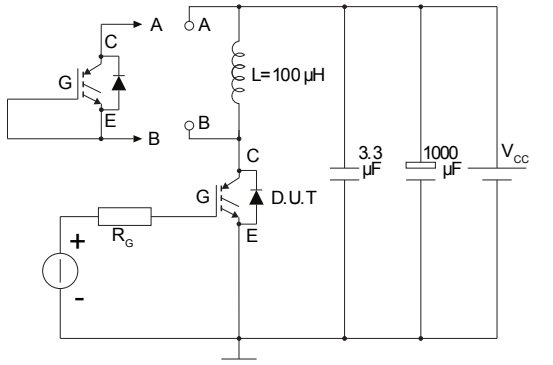
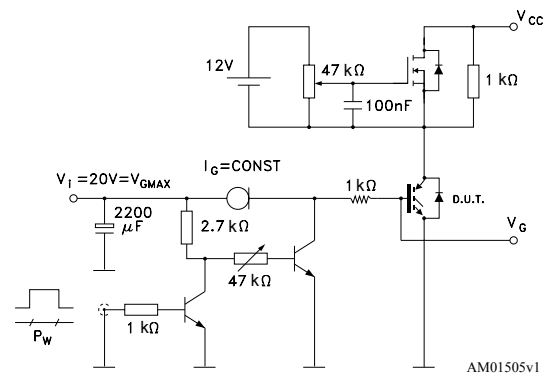
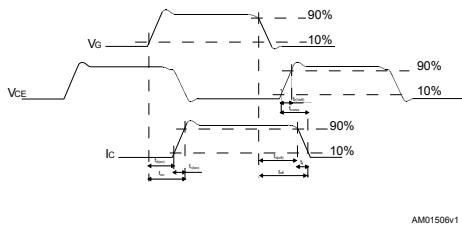
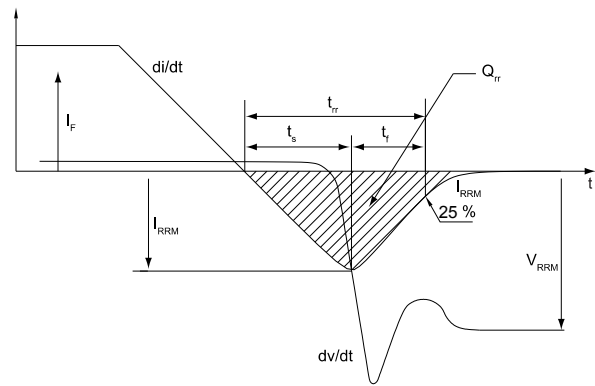


**Figure 19. Switching energy vs collector current**

**Figure 20. Switching energy vs gate resistance**

**Figure 21. Switching energy vs temperature**

**Figure 22. Switching energy vs collector-emitter voltage**

**Figure 23. Short circuit time and current vs VGE**

**Figure 24. Switching times vs collector current**


**Figure 25. Switching times vs gate resistance**

**Figure 26. Reverse recovery current vs diode current slope**

**Figure 27. Reverse recovery time vs diode current slope**

**Figure 28. Reverse recovery charge vs diode current slope**

**Figure 29. Reverse recovery energy vs diode current slope**


**Figure 30. Thermal impedance for IGBT**

**Figure 31. Thermal impedance for diode**


### 3 Test circuits

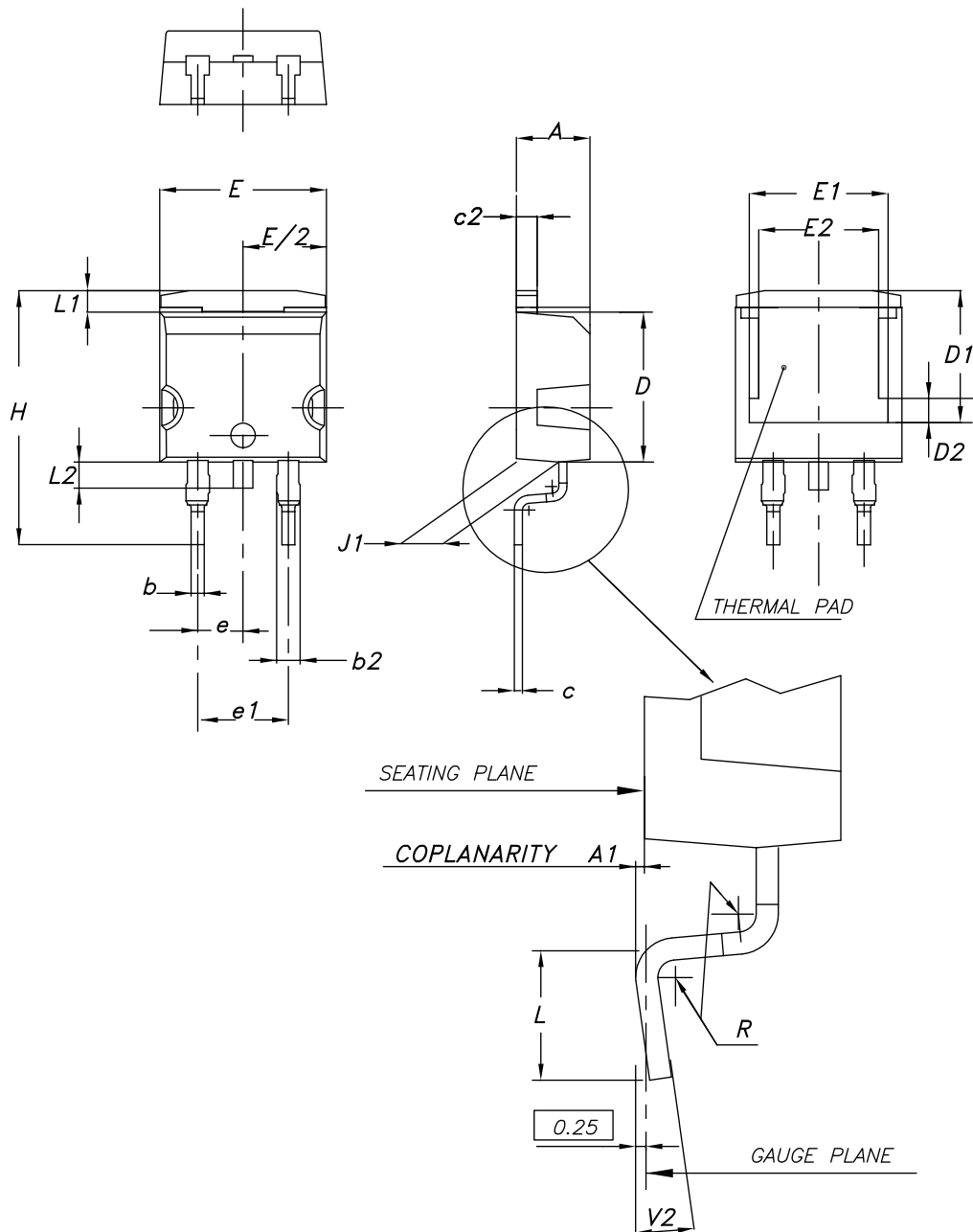
**Figure 32. Test circuit for inductive load switching**

**Figure 33. Gate charge test circuit**

**Figure 34. Switching waveform**

**Figure 35. Diode reverse recovery waveform**


## 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 A2 package information

**Figure 36. D<sup>2</sup>PAK (TO-263) type A2 package outline**

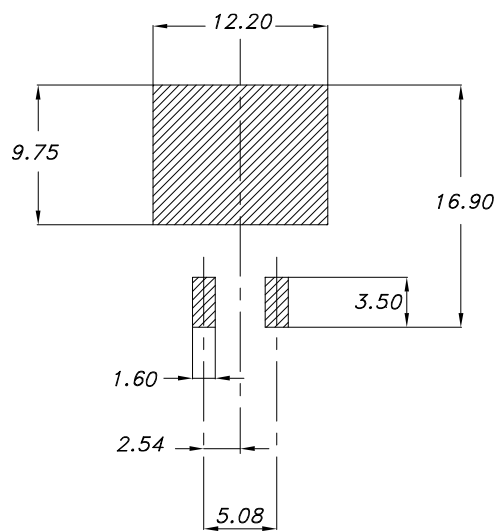


0079457\_A2\_26

Table 8. 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°    |

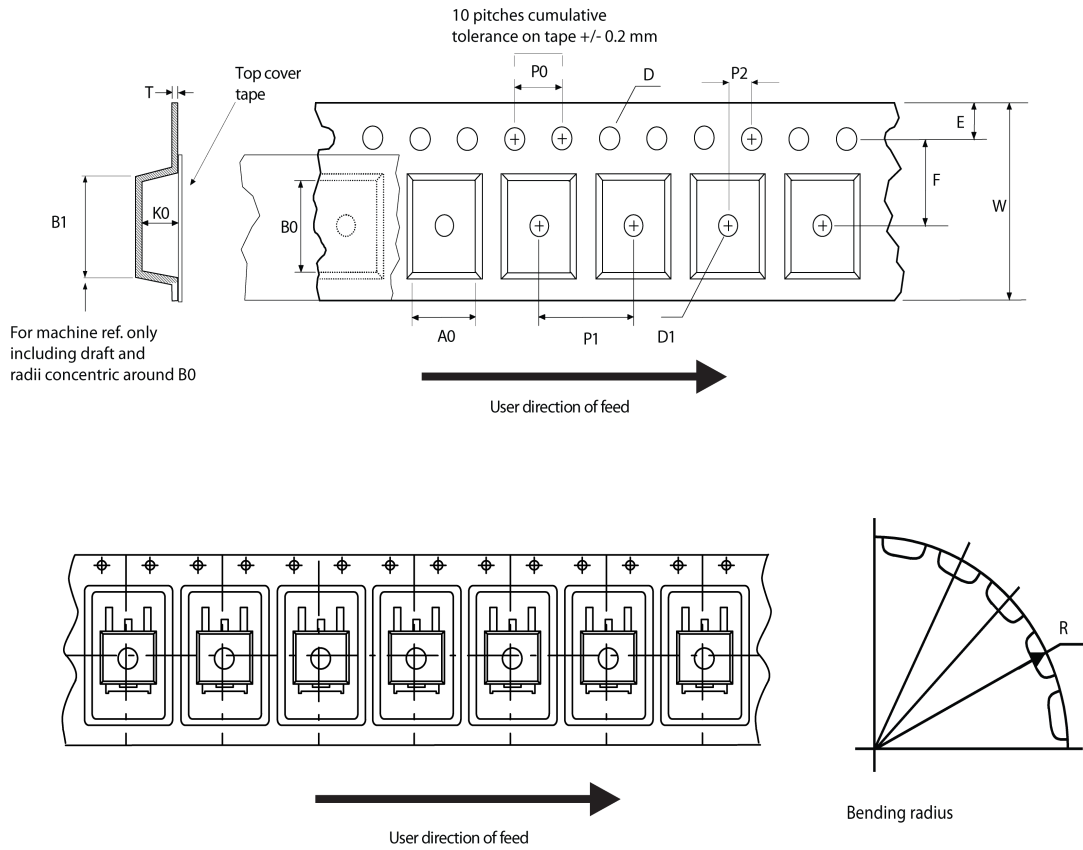
Figure 37. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



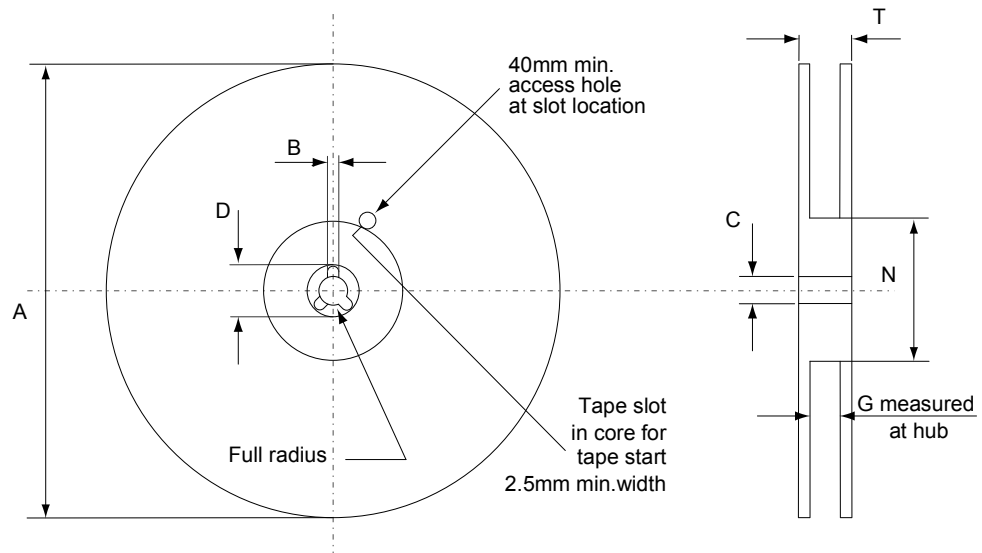
Footprint\_26

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

Figure 38. D<sup>2</sup>PAK tape outline



AM08852v1

**Figure 39. D<sup>2</sup>PAK reel outline**


AM06038v1

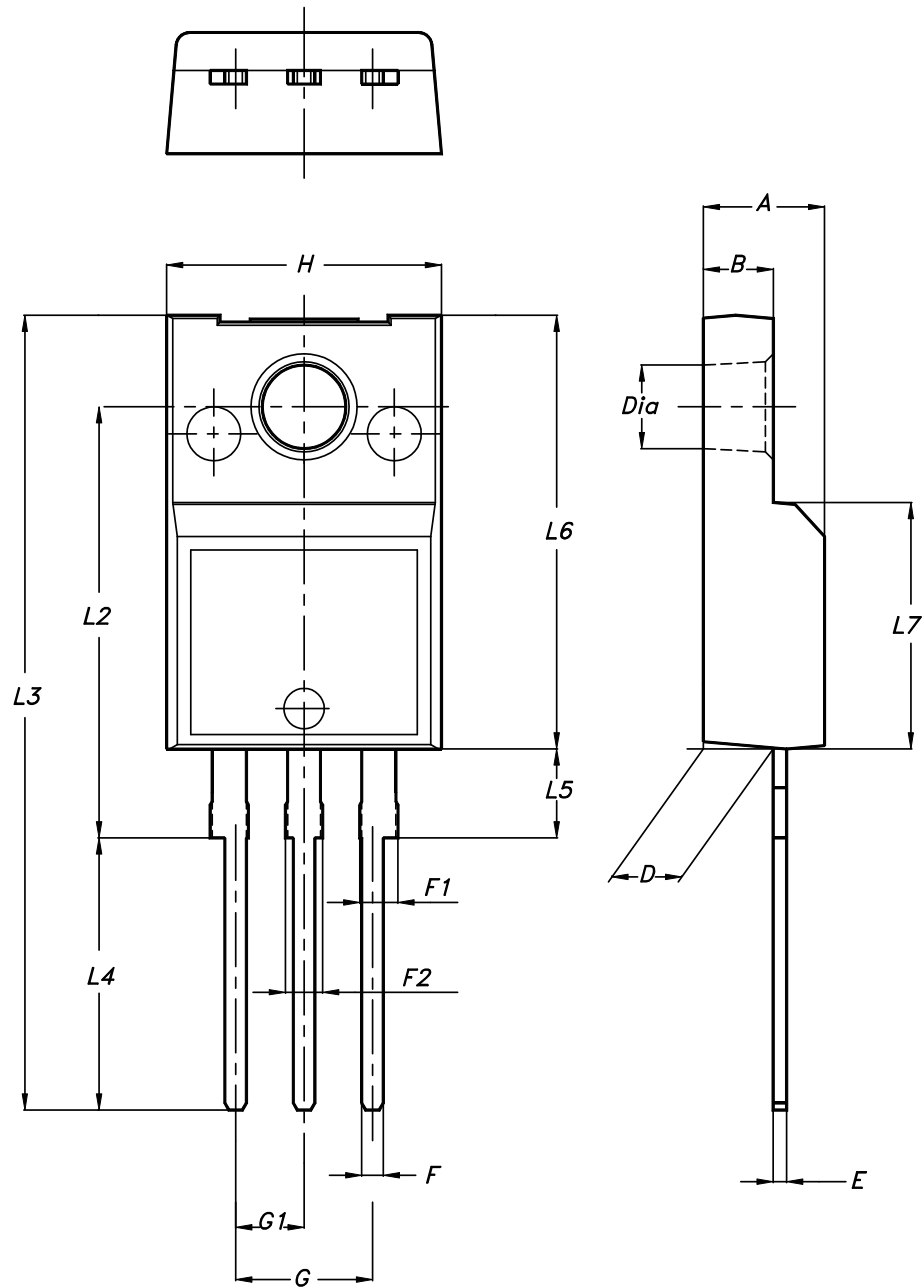
**Table 9. D<sup>2</sup>PAK tape and reel mechanical data**

| 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 |               |      |      |



### 4.3 TO-220FP package information

Figure 40. TO-220FP package outline



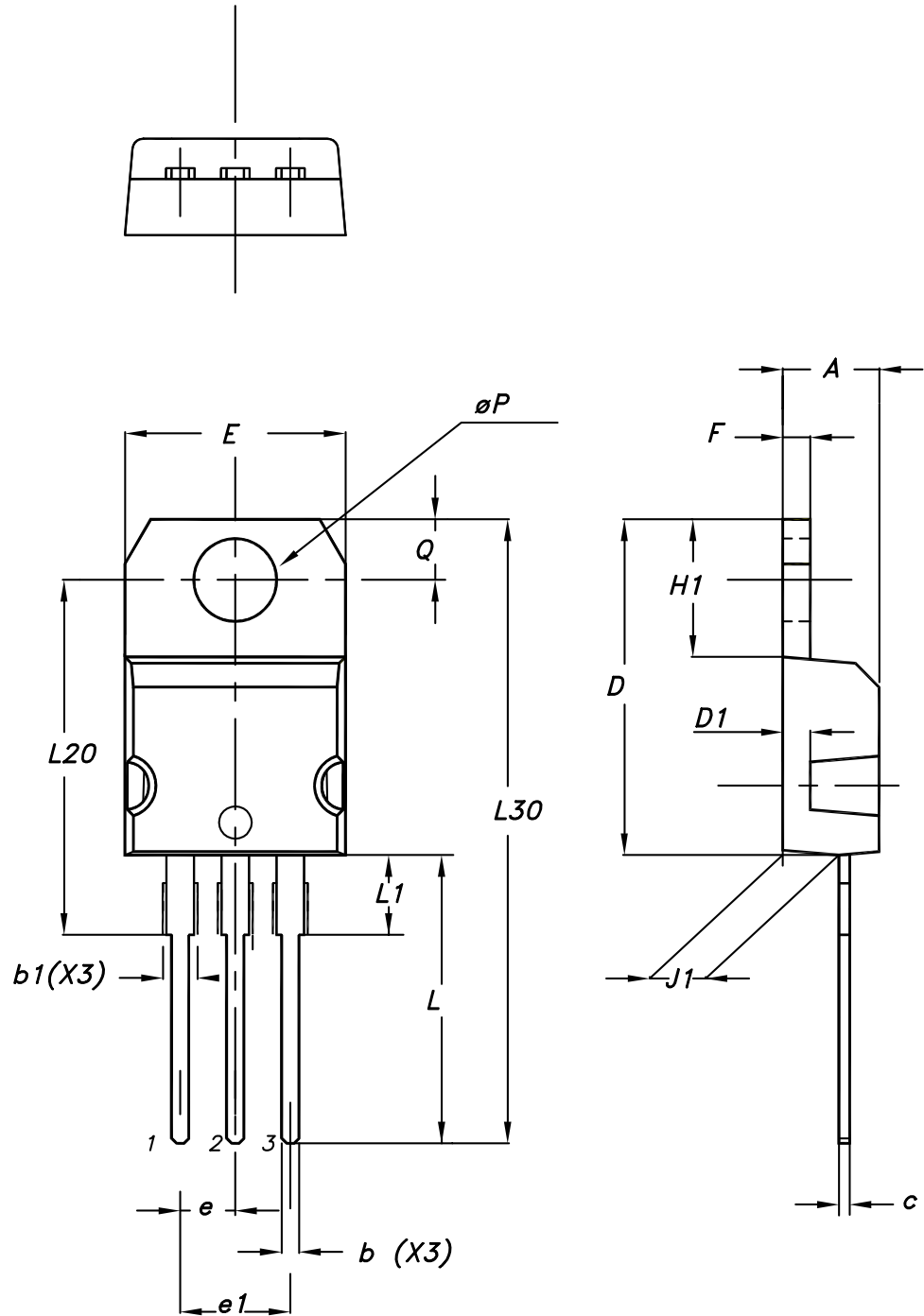
7012510\_Rev\_13\_B

**Table 10. TO-220FP package mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| B    | 2.50  |       | 2.70  |
| D    | 2.50  |       | 2.75  |
| E    | 0.45  |       | 0.70  |
| F    | 0.75  |       | 1.00  |
| F1   | 1.15  |       | 1.70  |
| F2   | 1.15  |       | 1.70  |
| G    | 4.95  |       | 5.20  |
| G1   | 2.40  |       | 2.70  |
| H    | 10.00 |       | 10.40 |
| L2   |       | 16.00 |       |
| L3   | 28.60 |       | 30.60 |
| L4   | 9.80  |       | 10.60 |
| L5   | 2.90  |       | 3.60  |
| L6   | 15.90 |       | 16.40 |
| L7   | 9.00  |       | 9.30  |
| Dia  | 3.00  |       | 3.20  |

#### 4.4 TO-220 type A package information

Figure 41. TO-220 type A package outline



0015988\_typeA\_Rev\_22

**Table 11. TO-220 type A package mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.55  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10.00 |       | 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    | 13.00 |       | 14.00 |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| øP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

## 5 Ordering information

**Table 12. Order codes**

| Order code  | Marking   | Package            | Packing       |
|-------------|-----------|--------------------|---------------|
| STGB10H60DF | GB10H60DF | D <sup>2</sup> PAK | Tape and reel |
| STGF10H60DF | GF10H60DF | TO-220FP           | Tube          |
| STGP10H60DF | GP10H60DF | TO-220             |               |

## Revision history

**Table 13. Document revision history**

| Date        | Version | Changes  |
|-------------|---------|--|
| 12-Aug-2013 | 1       | Initial release.   |
| 31-Oct-2013 | 2       | Document status promoted from preliminary to production data.<br>Inserted <i>Section 2.1: Electrical characteristics (curves)</i> .<br>Minor text changes.   |
| 20-Jun-2019 | 3       | Updated title, applications and description in cover page.<br>Added <i>Section 5 Ordering information</i> .<br>Updated <i>Section 2.1 Electrical characteristics (curves)</i> .<br>Minor text changes. |
| 05-Mar-2020 | 4       | Updated <a href="#">Table 3. Static</a> and <a href="#">Table 4. Dynamic</a> .<br>Minor text changes.  |

## Contents

|            |   |           |
|------------|---|-----------|
| <b>1</b>   | <b>Electrical ratings</b> .....                               | <b>2</b>  |
| <b>2</b>   | <b>Electrical characteristics</b> .....                       | <b>3</b>  |
| <b>2.1</b> | Electrical characteristics (curves) .....                     | 6         |
| <b>3</b>   | <b>Test circuits</b> .....                                    | <b>12</b> |
| <b>4</b>   | <b>Package information</b> .....                              | <b>13</b> |
| <b>4.1</b> | D <sup>2</sup> PAK (TO-263) type A2 package information ..... | 13        |
| <b>4.2</b> | D <sup>2</sup> PAK packing information .....                  | 15        |
| <b>4.3</b> | TO-220FP package information .....                            | 17        |
| <b>4.4</b> | TO-220 type A package information .....                       | 19        |
| <b>5</b>   | <b>Ordering information</b> .....                             | <b>21</b> |
|            | <b>Revision history</b> .....                                 | <b>22</b> |

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to [www.st.com/trademarks](http://www.st.com/trademarks). All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2020 STMicroelectronics – All rights reserved



# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[STMicroelectronics:](#)

[STGP10H60DF](#) [STGF10H60DF](#) [STGB10H60DF](#)