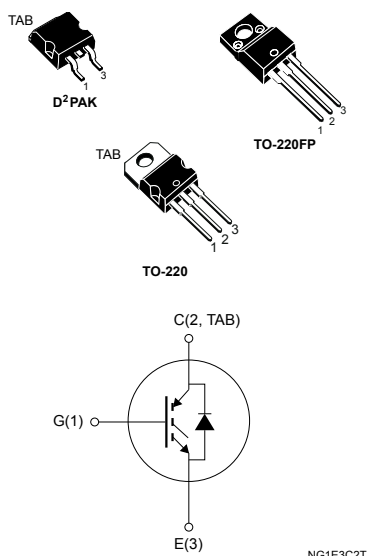


## Trench gate field-stop 600 V, 10 A high speed H series IGBT



### 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

$T_C = 25\text{ }^{\circ}\text{C}$  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 | $V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$                                       |      | 1.5  | 1.95      | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ , $T_J = 125\text{ }^{\circ}\text{C}$ |      | 1.65 |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ , $T_J = 175\text{ }^{\circ}\text{C}$ |      | 1.7  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$                                | 5.0  | 6.0  | 7.0       | 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            | $V_{CC} = 480\text{ V}$ , $I_C = 5\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$<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 <sub>d(on)</sub>    | Turn-on delay time    | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 10 A, R <sub>G</sub> = 10 Ω,                       |      | 19.5 | -    | ns   |
| t <sub>r</sub>        | Current rise time     | V <sub>GE</sub> = 15 V                                                                       |      | 6.9  |      |      |
| (di/dt) <sub>on</sub> | Turn-on current slope | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 1170 |      | A/μs |
| t <sub>d(on)</sub>    | Turn-on delay time    | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 10 A, R <sub>G</sub> = 10 Ω,                       |      | 20   |      | ns   |
| t <sub>r</sub>        | Current rise time     | V <sub>GE</sub> = 15 V, T <sub>J</sub> = 175 °C                                              |      | 6.8  |      |      |
| (di/dt) <sub>on</sub> | Turn-on current slope | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 1176 |      | A/μs |

| Symbol               | Parameter                    | Test conditions                                                                              | Min. | Typ. | Max. | Unit |
|----------------------|------------------------------|----------------------------------------------------------------------------------------------|------|------|------|------|
| t <sub>r(Voff)</sub> | Off voltage rise time        | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 10 A, R <sub>G</sub> = 10 Ω,                       |      | 19.6 | -    | ns   |
| t <sub>d(off)</sub>  | Turn-off delay time          | V <sub>GE</sub> = 15 V                                                                       |      | 103  |      |      |
| t <sub>f</sub>       | Current fall time            | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 73   |      |      |
| t <sub>r(Voff)</sub> | Off voltage rise time        | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 10 A, R <sub>G</sub> = 10 Ω,                       |      | 28   |      |      |
| t <sub>d(off)</sub>  | Turn-off delay time          | V <sub>GE</sub> = 15 V, T <sub>J</sub> = 175 °C                                              |      | 104  |      |      |
| t <sub>f</sub>       | Current fall time            | (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform) |      | 110  |      |      |
| t <sub>sc</sub>      | Short-circuit withstand time | V <sub>CC</sub> ≤ 360 V, V <sub>GE</sub> = 15 V, R <sub>G</sub> = 10 Ω                       | 3    | 5    | -    | μs   |

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

| Symbol                          | Parameter                 | Test conditions                                                                                                                                                                           | Min. | Typ. | Max. | Unit |
|---------------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| E <sub>on</sub> <sup>(1)</sup>  | Turn-on switching energy  | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 10 A,<br>R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 15 V<br>(see Figure 32. Test circuit for inductive load switching)                            | -    | 83   | -    | μJ   |
| E <sub>off</sub> <sup>(2)</sup> | Turn-off switching energy |                                                                                                                                                                                           |      | 140  |      |      |
| E <sub>ts</sub>                 | Total switching energy    |                                                                                                                                                                                           |      | 223  |      |      |
| E <sub>on</sub> <sup>(1)</sup>  | Turn-on switching energy  | V <sub>CE</sub> = 400 V, I <sub>C</sub> = 10 A,<br>R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 15 V<br>T <sub>J</sub> = 175 °C<br>(see Figure 32. Test circuit for inductive load switching) |      | 148  |      |      |
| E <sub>off</sub> <sup>(2)</sup> | Turn-off switching energy |                                                                                                                                                                                           |      | 214  |      |      |
| E <sub>ts</sub>                 | Total switching energy    |                                                                                                                                                                                           |      | 362  |      |      |

1. Including the reverse recovery of the diode.

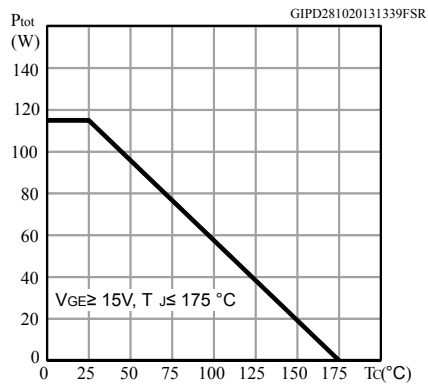
2. Including the tail of the collector current.

**Table 7. Collector-emitter diode**

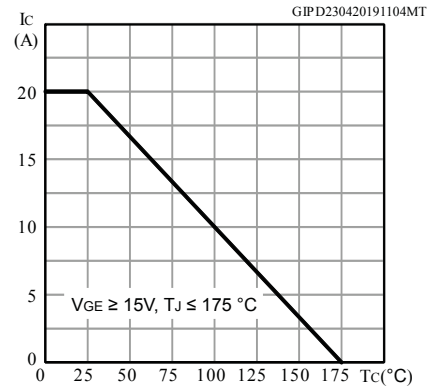
| Symbol           | Parameter                | Test conditions                                                                                                                                     | Min. | Typ. | Max. | Unit |
|------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| V <sub>F</sub>   | Forward on-voltage       | I <sub>F</sub> = 10 A                                                                                                                               | -    | 1.7  | 2.2  | V    |
|                  |                          | I <sub>F</sub> = 10 A, T <sub>J</sub> = 175 °C                                                                                                      |      | 1.3  |      |      |
| t <sub>rr</sub>  | Reverse recovery time    | V <sub>r</sub> = 60 V; I <sub>F</sub> = 10 A, di <sub>F</sub> /dt = 100 A / μs<br>(see <a href="#">Figure 35. Diode reverse recovery waveform</a> ) | -    | 107  |      | ns   |
| Q <sub>rr</sub>  | Reverse recovery charge  |                                                                                                                                                     |      | 120  |      | nC   |
| I <sub>rrm</sub> | Reverse recovery current |                                                                                                                                                     |      | 2.24 |      | A    |
| t <sub>rr</sub>  | Reverse recovery time    | V <sub>r</sub> = 60 V; I <sub>F</sub> = 10 A, di <sub>F</sub> /dt = 100 A / μs                                                                      |      | 161  |      | ns   |
| Q <sub>rr</sub>  | Reverse recovery charge  | T <sub>J</sub> = 175 °C<br>(see <a href="#">Figure 35. Diode reverse recovery waveform</a> )                                                        |      | 362  |      | nC   |
| I <sub>rrm</sub> | Reverse recovery current |                                                                                                                                                     |      | 4.5  |      | A    |

## 2.1 Electrical characteristics (curves)

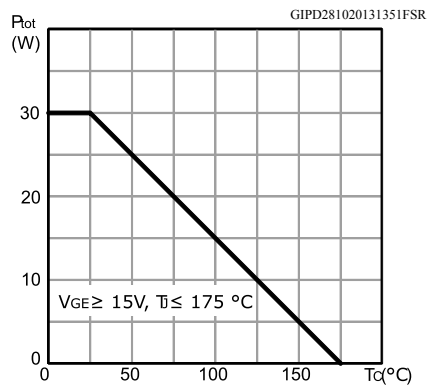
**Figure 1. Power dissipation vs case temperature for D<sup>2</sup>PAK and TO-220**



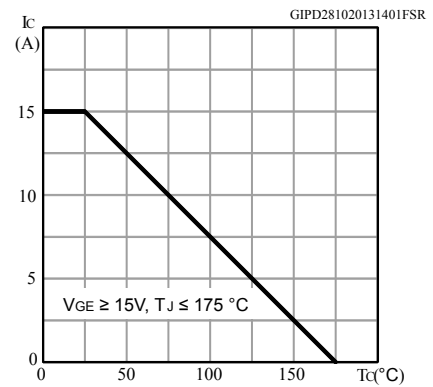
**Figure 2. Collector current vs case temperature for D<sup>2</sup>PAK and TO-220**



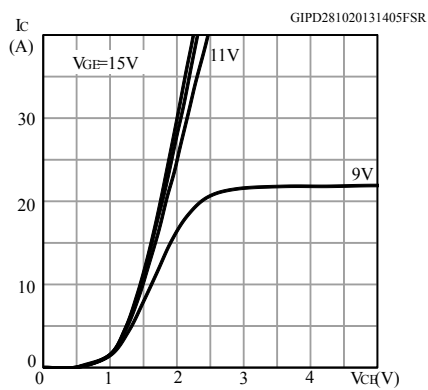
**Figure 3. Power dissipation vs case temperature for TO-220FP**



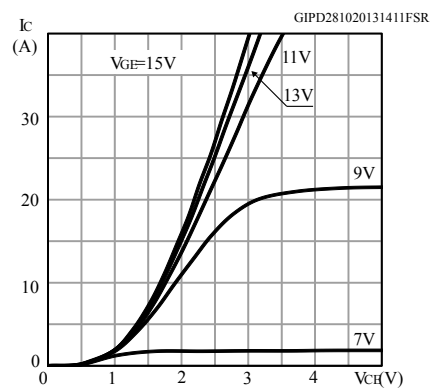
**Figure 4. Collector current vs case temperature for TO-220FP**



**Figure 5. Output characteristics ( $T_J = 25^\circ C$ )**



**Figure 6. Output characteristics ( $T_J = 175^\circ C$ )**



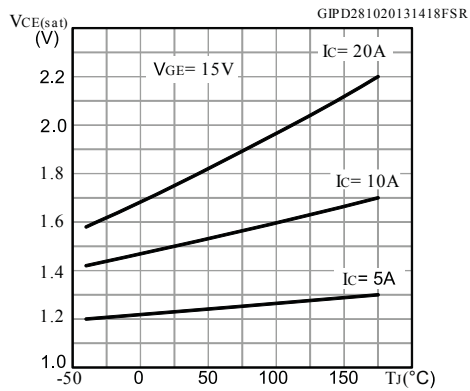
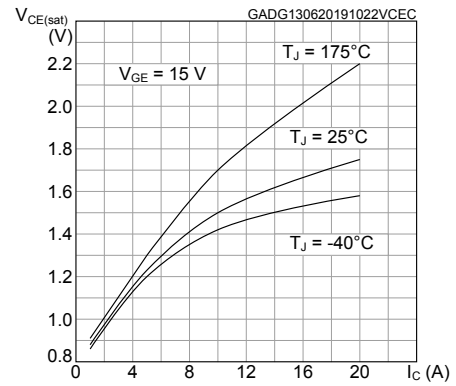
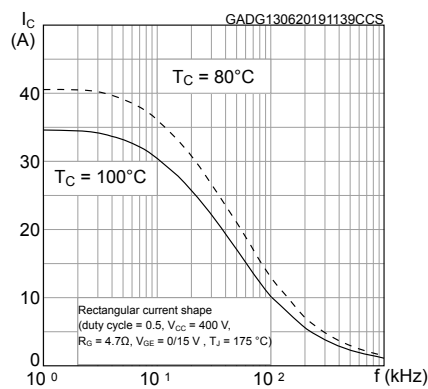
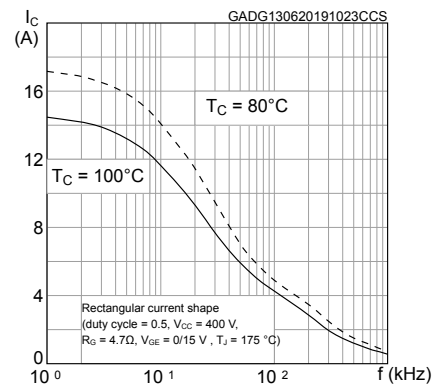
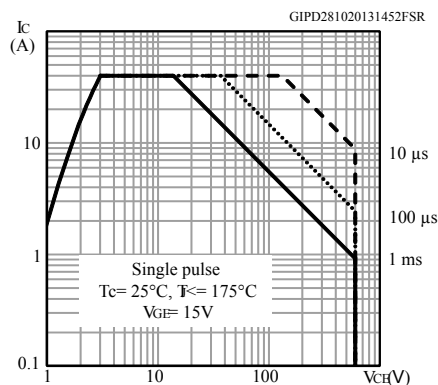
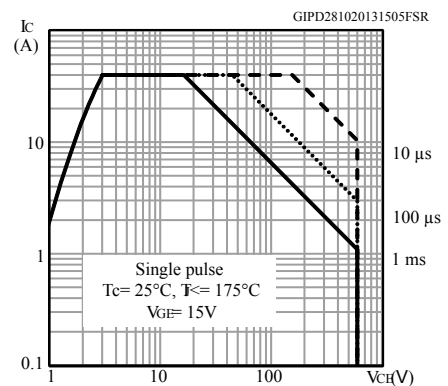
**Figure 7.  $V_{CE(sat)}$  vs junction temperature**

**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

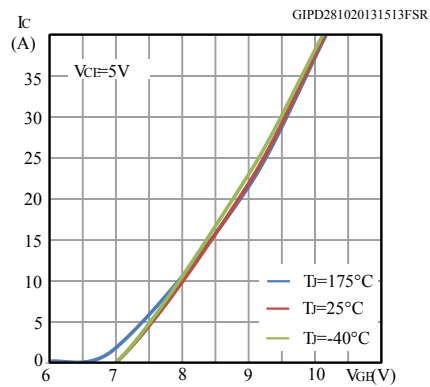


Figure 14. Diode  $V_F$  vs forward current

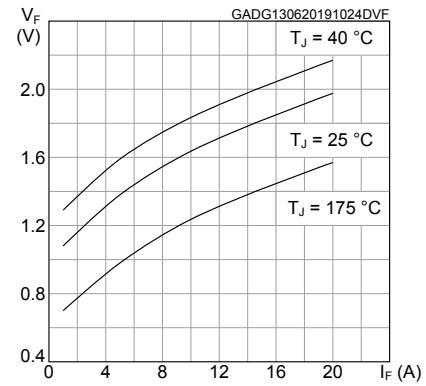


Figure 15. Normalized  $V_{GE(th)}$  vs junction temperature

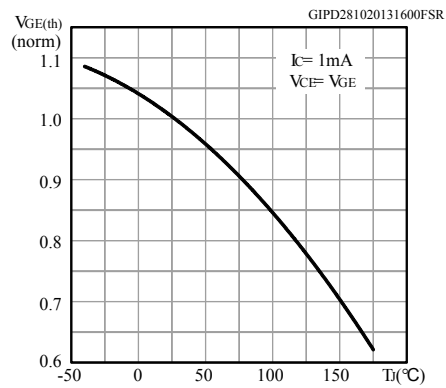


Figure 16. Normalized  $V_{(BR)CES}$  vs junction temperature

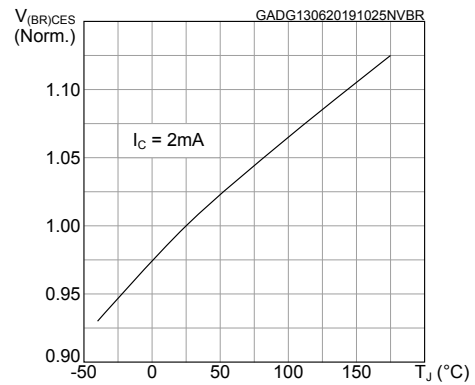


Figure 17. Capacitance variation

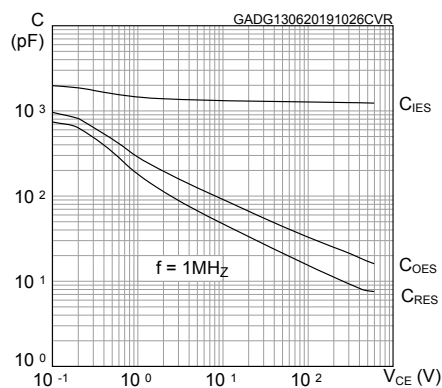


Figure 18. Gate charge vs gate-emitter voltage

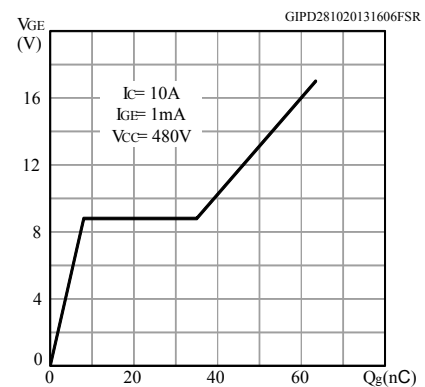


Figure 19. Switching energy vs collector current

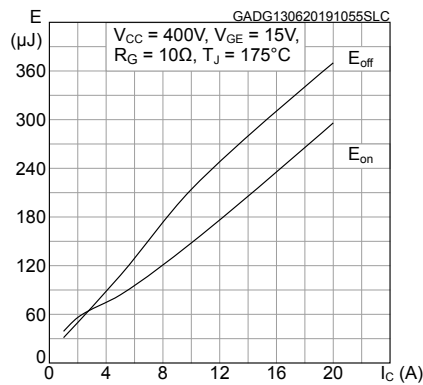


Figure 20. Switching energy vs gate resistance

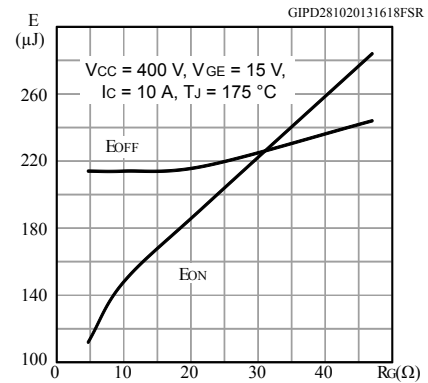


Figure 21. Switching energy vs temperature

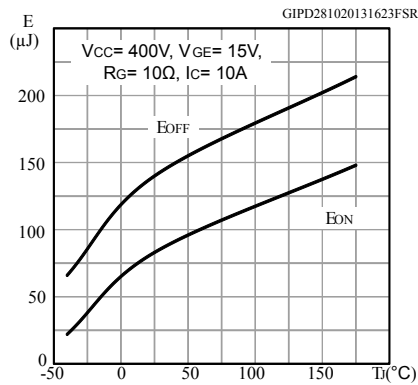


Figure 22. Switching energy vs collector-emitter voltage

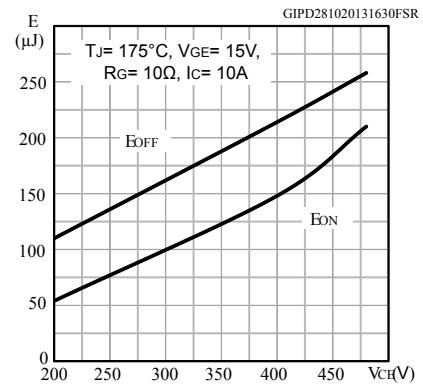


Figure 23. Short circuit time and current vs VGE

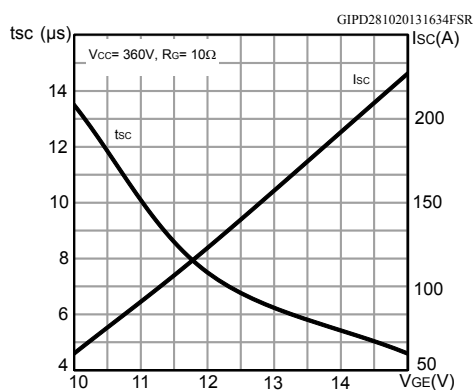


Figure 24. Switching times vs collector current

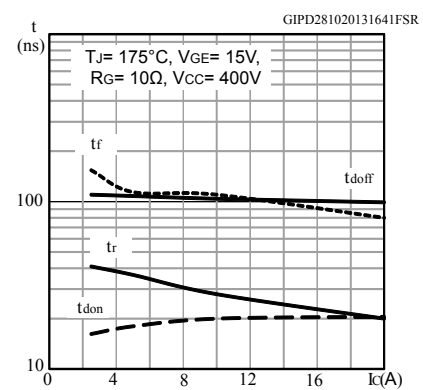


Figure 25. Switching times vs gate resistance

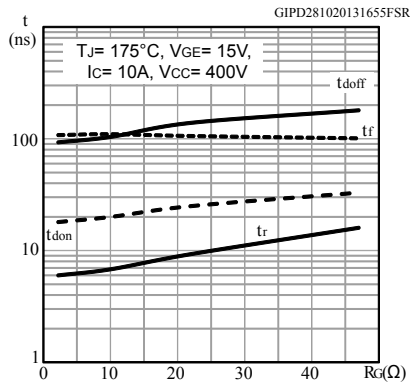


Figure 26. Reverse recovery current vs diode current slope

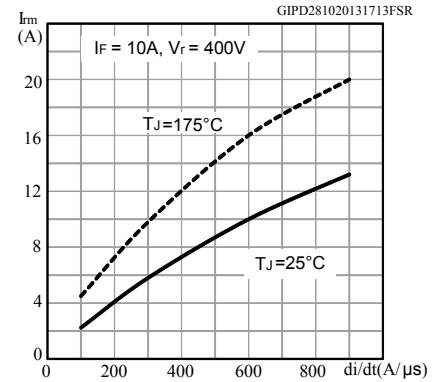


Figure 27. Reverse recovery time vs diode current slope

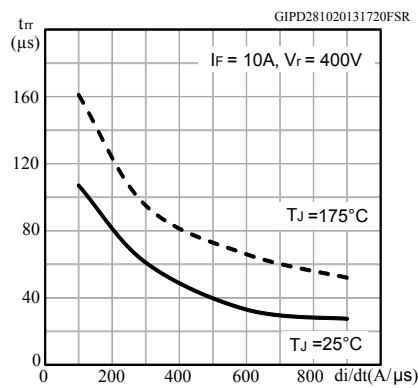


Figure 28. Reverse recovery charge vs diode current slope

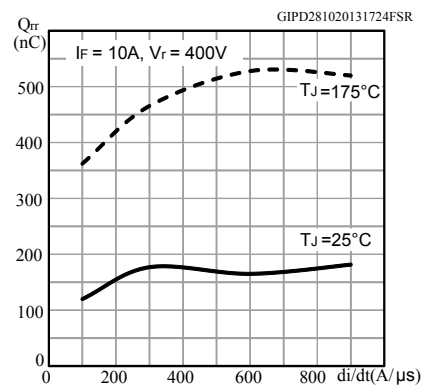
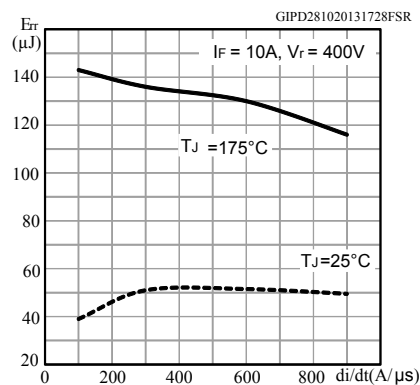
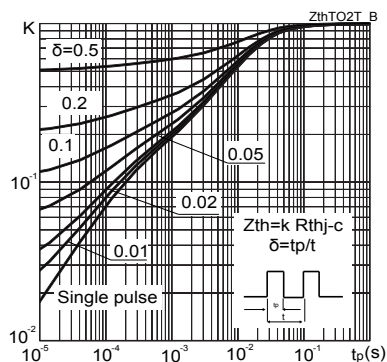
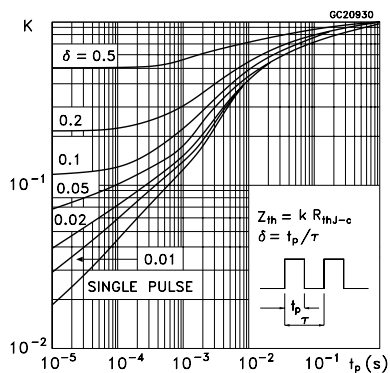
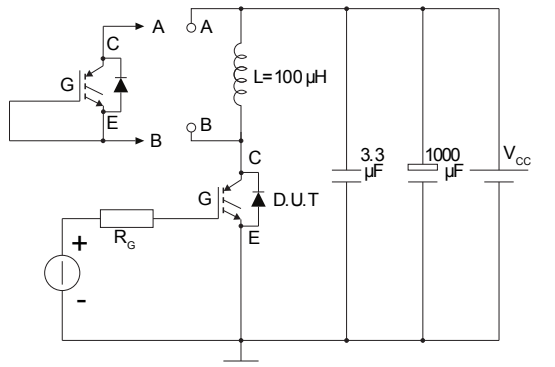
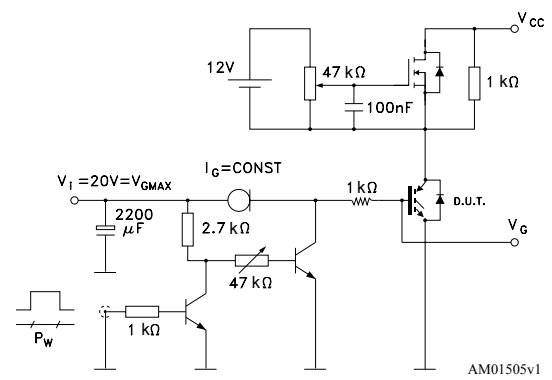
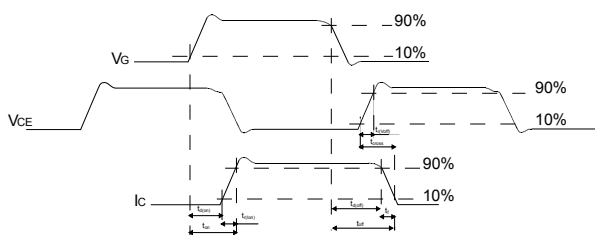
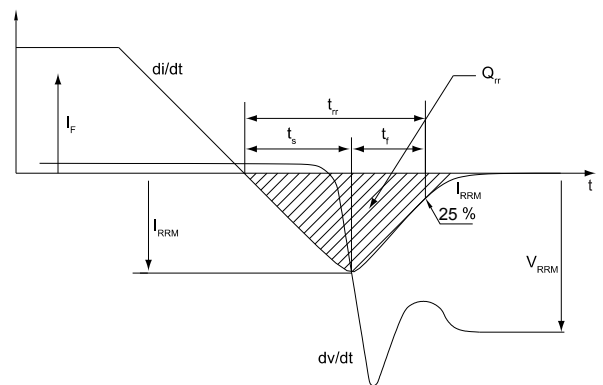


Figure 29. Reverse recovery energy vs diode current slope



**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**


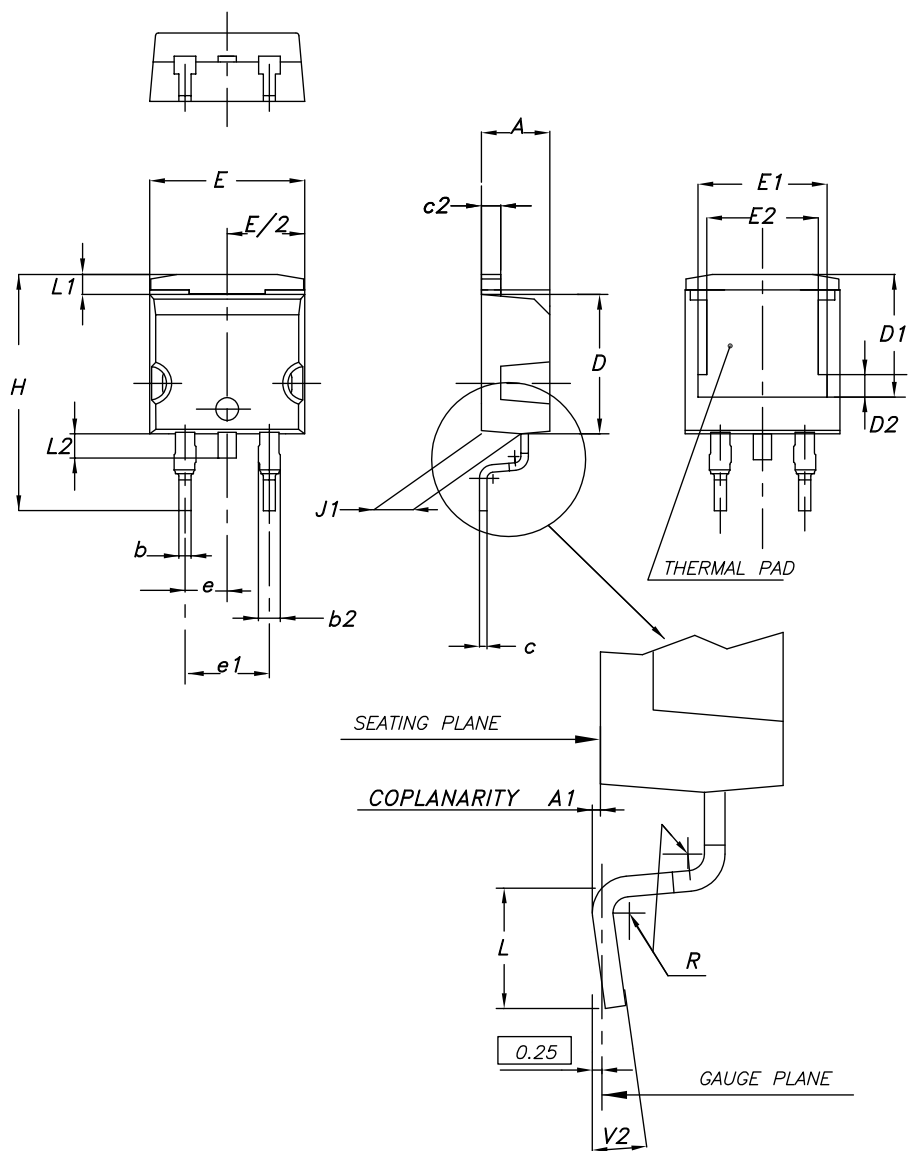
## 4 Package information

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

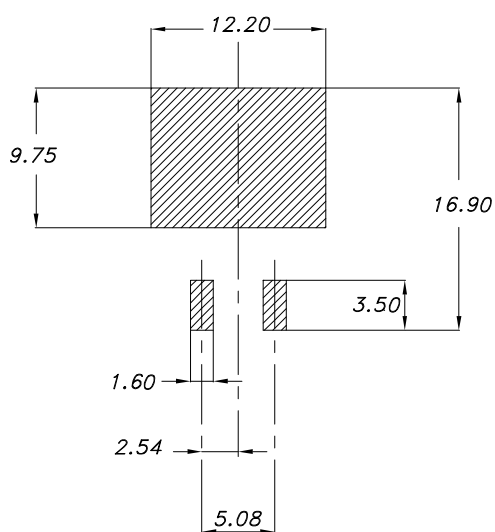


0079457\_A2\_26

**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°    |

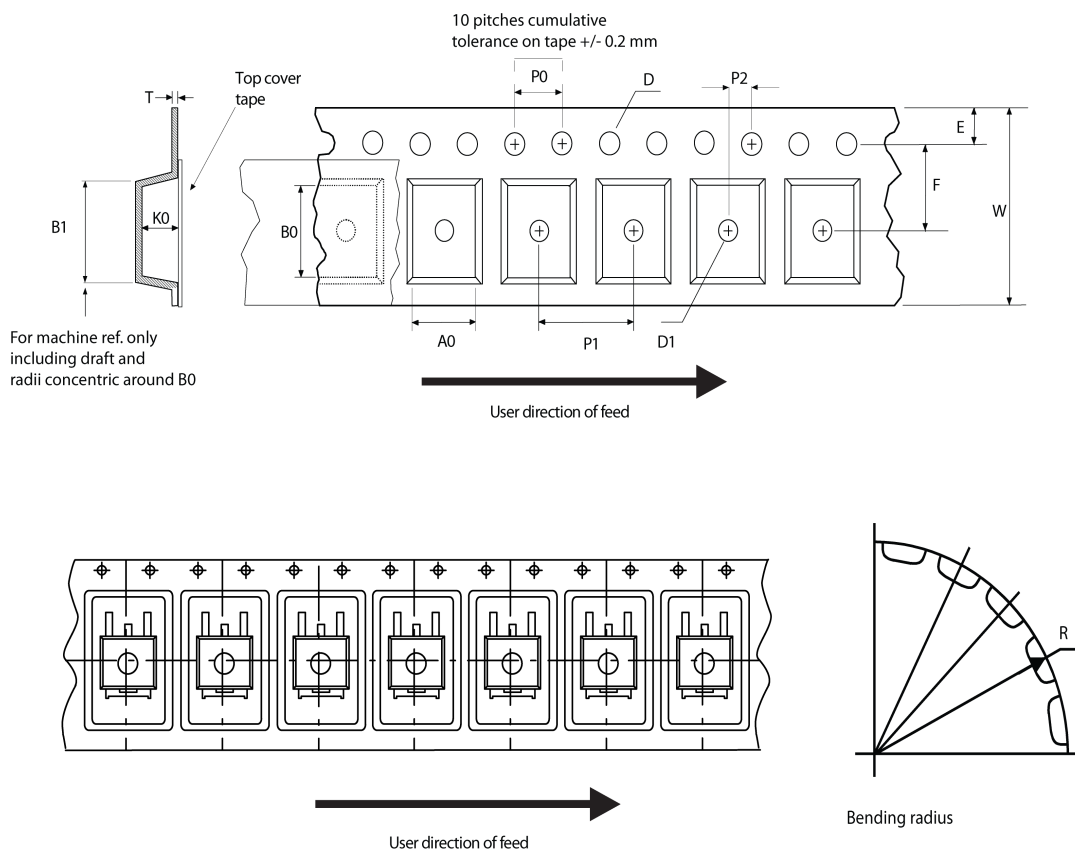
**Figure 37. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**



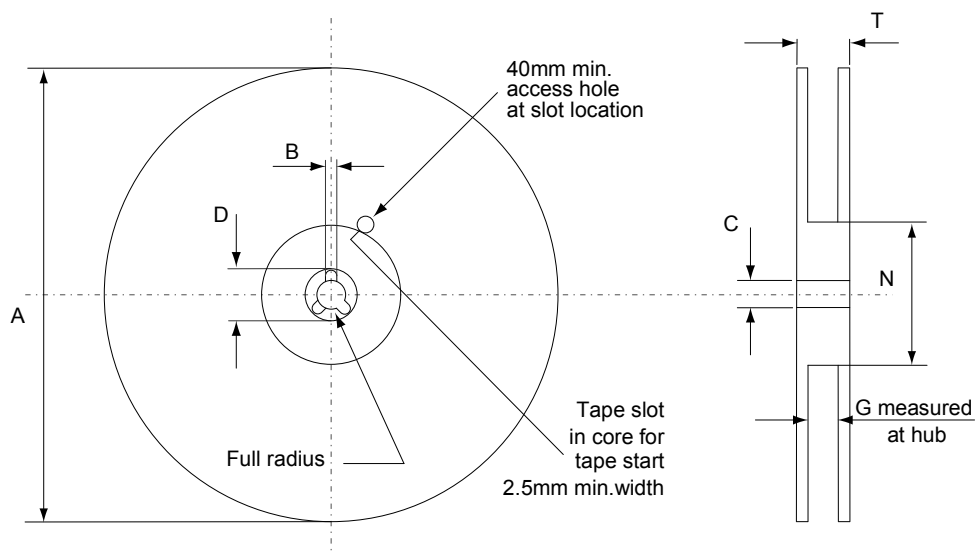
Footprint\_26

## 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**


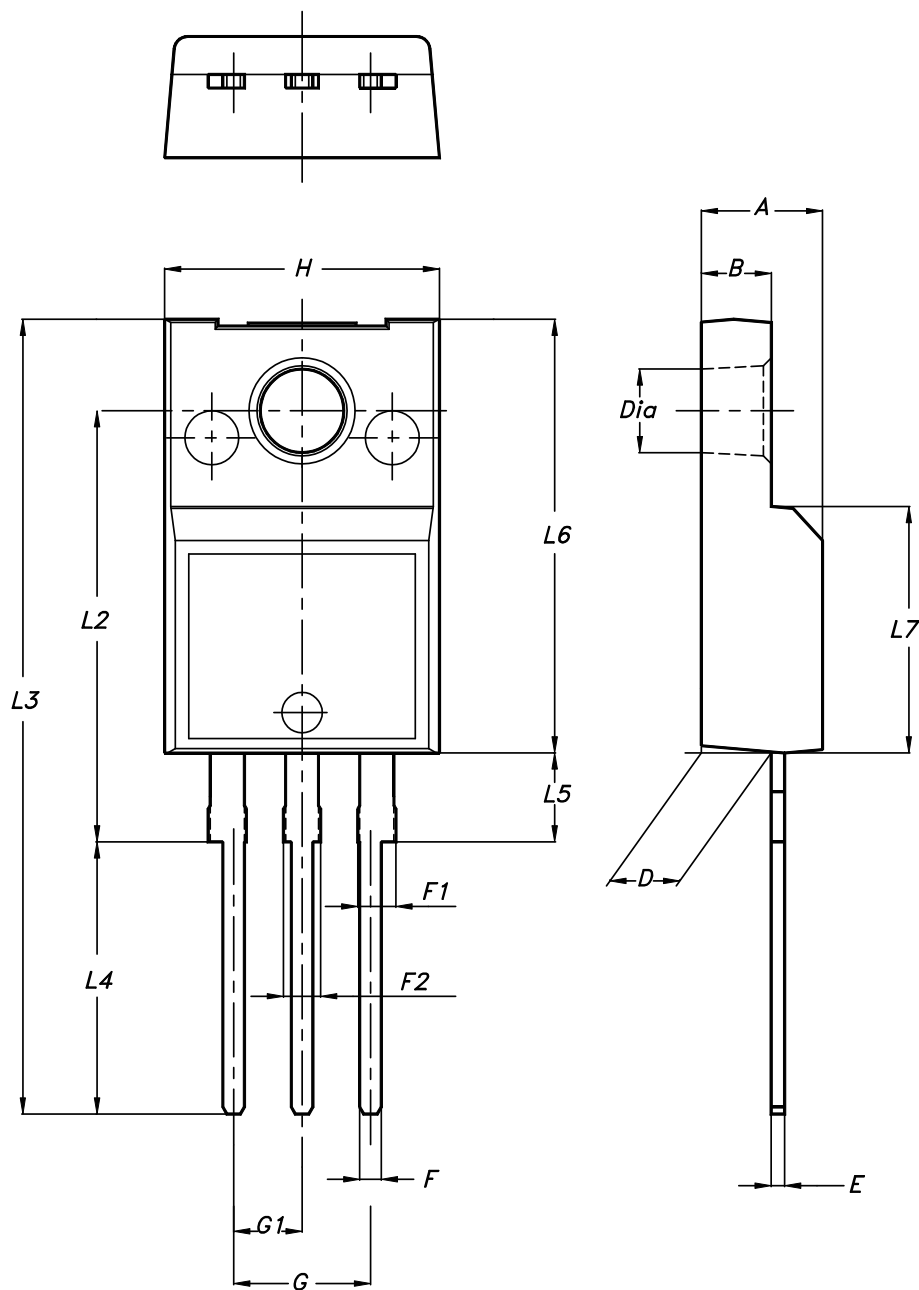
AM06038v1

**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



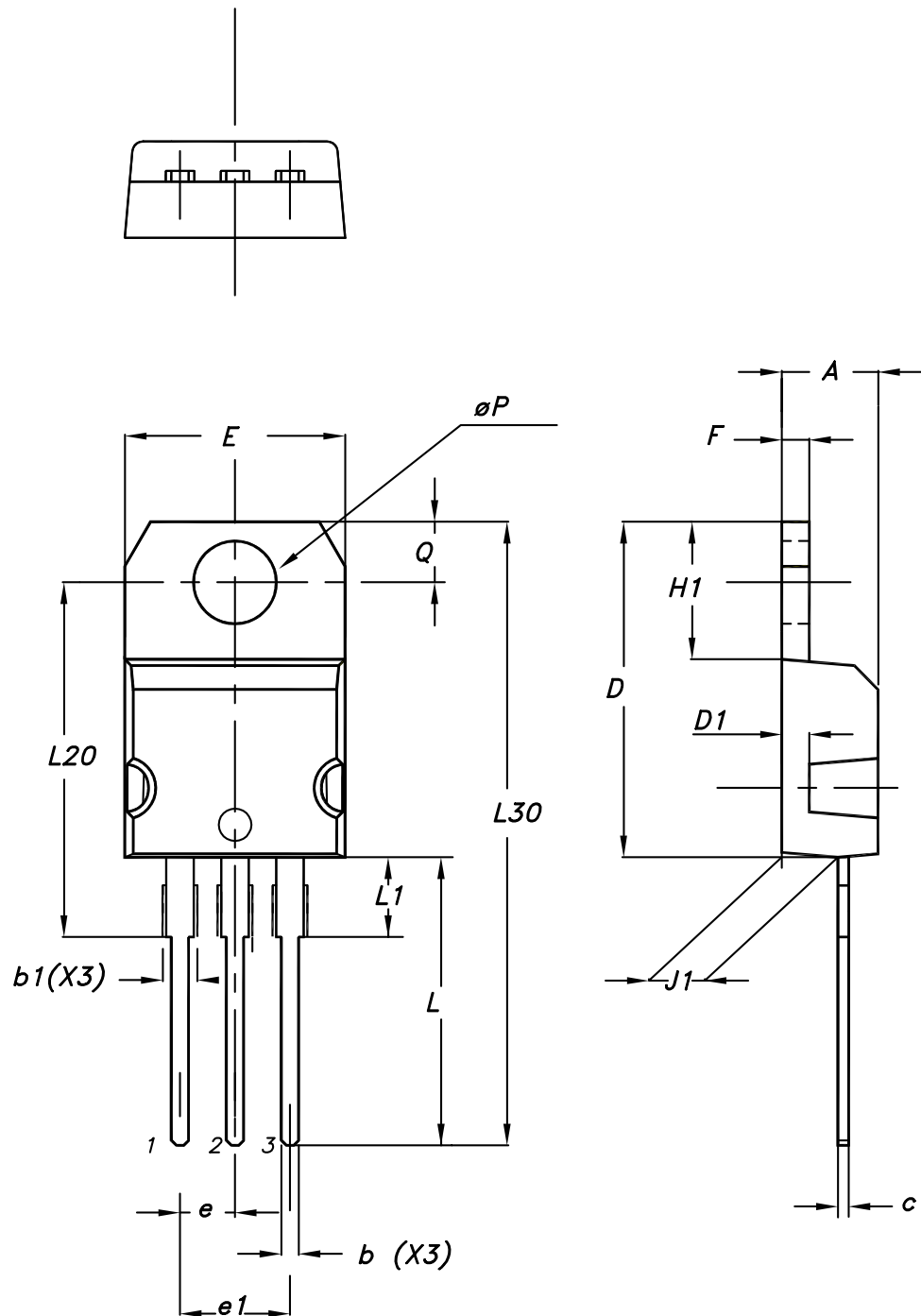
7012510\_Rev\_13\_B

**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 <a href="#">Section 5 Ordering information</a> .<br>Updated <a href="#">Section 2.1 Electrical characteristics (curves)</a> .<br>Minor text changes. |

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