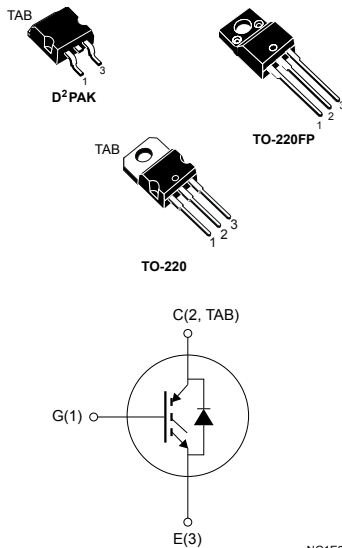


## Trench gate field-stop 600 V, 10 A high speed H series IGBT



### 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 at 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-to-case IGBT	1.3	5	°C/W
R <sub>thJC</sub>	Thermal resistance, junction-to-case diode	2.78	6.25	°C/W
R <sub>thJA</sub>	Thermal resistance, junction-to-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	$V_{GE} = 15\text{ V}$ , $I_C = 10\text{ A}$		1.50	1.95	V
		$V_{GE} = 15\text{ V}$ , $I_C = 10\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$		1.65		
		$V_{GE} = 15\text{ V}$ , $I_C = 10\text{ A}$ , $T_J = 175\text{ }^\circ\text{C}$		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	-	$\mu\text{F}$
$C_{oes}$	Output capacitance			60		
$C_{res}$	Reverse transfer capacitance			30		
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}$ , $I_C = 10\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 35. 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	$V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)	-	19.5	-	ns
$t_r$	Current rise time			6.9		
$(di/dt)_{on}$	Turn-on current slope			1170		
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)	-	20	-	ns
$t_r$	Current rise time			6.8		
$(di/dt)_{on}$	Turn-on current slope			1176		
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)	-	19.6	-	ns
$t_{d(off)}$	Turn-off delay time			103		
$t_f$	Current fall time			73		
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)	-	28	-	ns
$t_{d(off)}$	Turn-off delay time			104		
$t_f$	Current fall time			110		
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$	3	5	-	$\mu\text{s}$

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 34. Test circuit for inductive load switching)	-	83	-	$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching energy			140		
$E_{ts}$	Total switching energy			223		
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 400\text{ V}$ , $I_C = 10\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 34. Test circuit for inductive load switching)	-	148	-	$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching energy			214		
$E_{ts}$	Total switching energy			362		

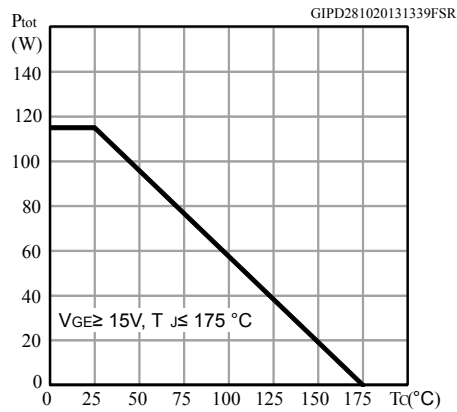
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

**Table 7. Collector-emitter diode**

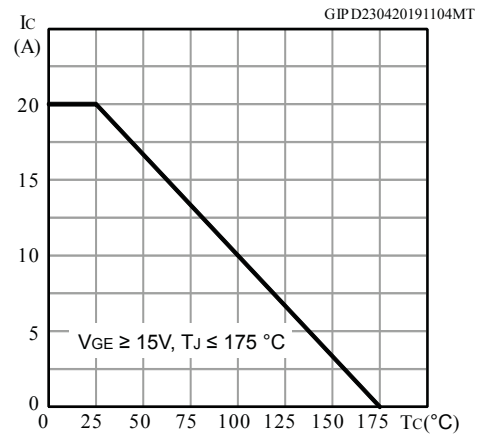
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 10 \text{ A}$	-	1.7	2.2	V
		$I_F = 10 \text{ A}, T_J = 175 \text{ °C}$		1.3		
$t_{rr}$	Reverse recovery time	$V_r = 60 \text{ V}; I_F = 10 \text{ A}, di_F/dt = 100 \text{ A} / \mu\text{s}$ (see Figure 37. Diode reverse recovery waveform)	-	107		ns
$Q_{rr}$	Reverse recovery charge			120		nC
$I_{rrm}$	Reverse recovery current			2.24		A
$t_{rr}$	Reverse recovery time	$V_r = 60 \text{ V}; I_F = 10 \text{ A}, di_F/dt = 100 \text{ A} / \mu\text{s}$ $T_J = 175 \text{ °C}$ (see Figure 37. 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)

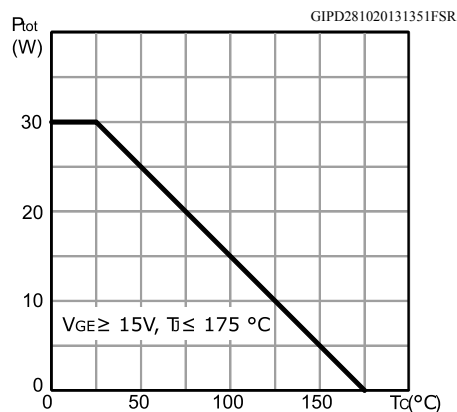
**Figure 1. Power dissipation vs case temperature for D<sup>2</sup>PAK and TO-220**



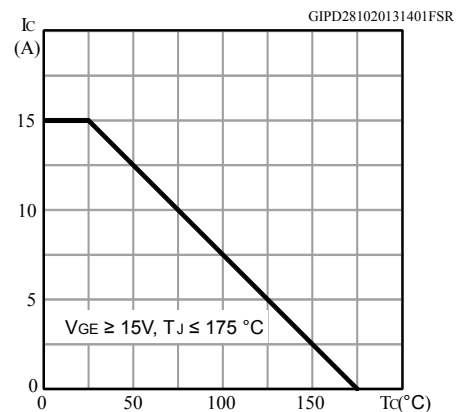
**Figure 2. Collector current vs case temperature for D<sup>2</sup>PAK and TO-220**



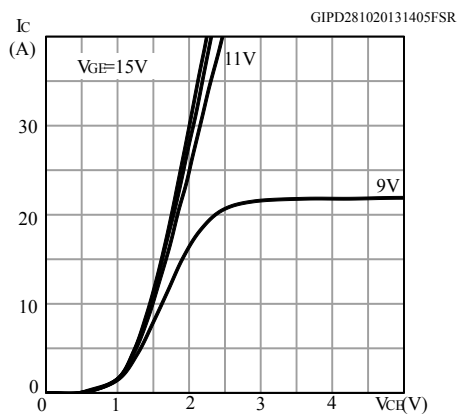
**Figure 3. Power dissipation vs case temperature for TO-220FP**



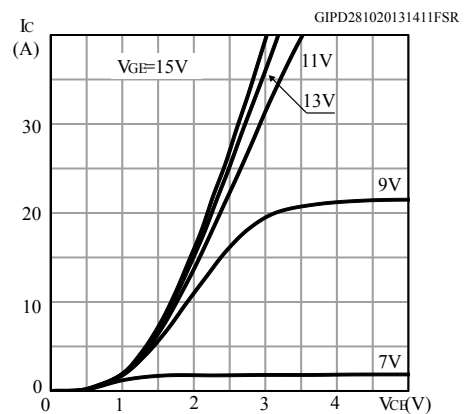
**Figure 4. Collector current vs case temperature for TO-220FP**

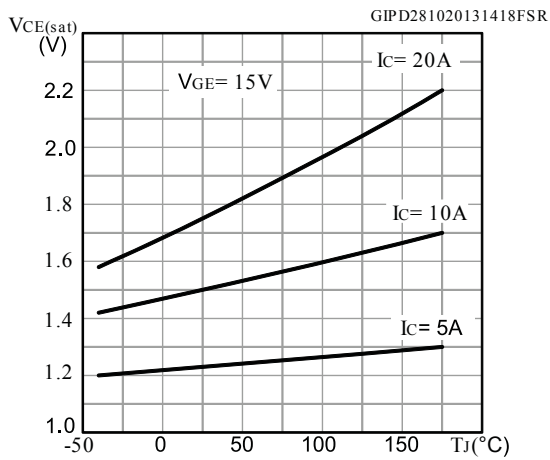
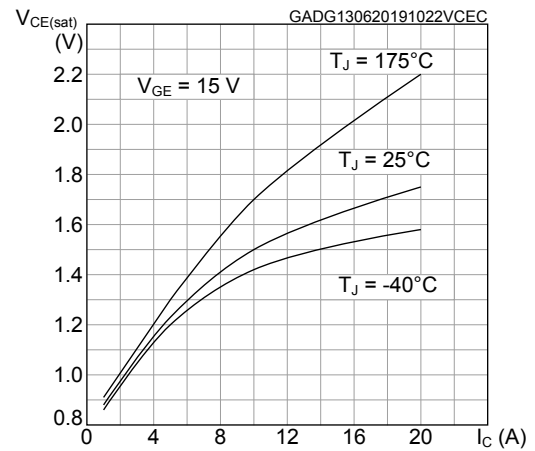
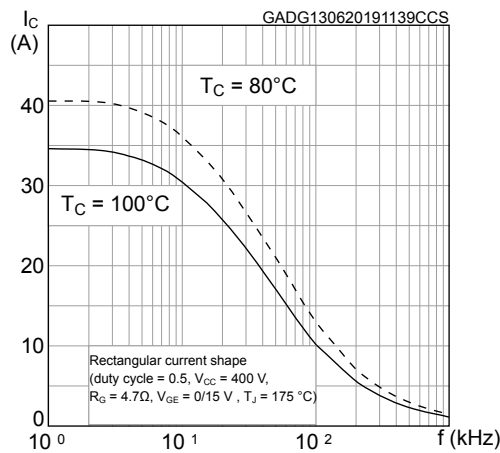
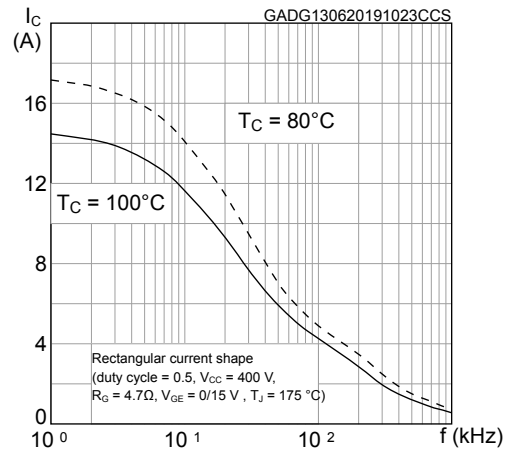
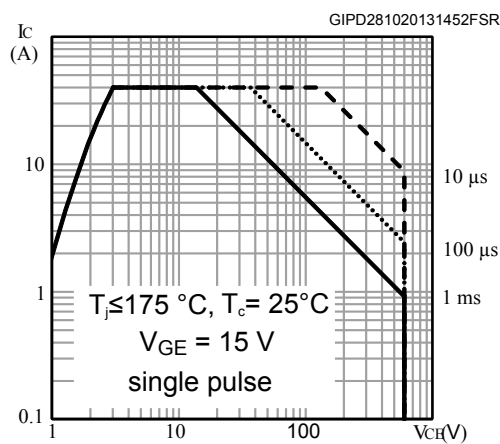
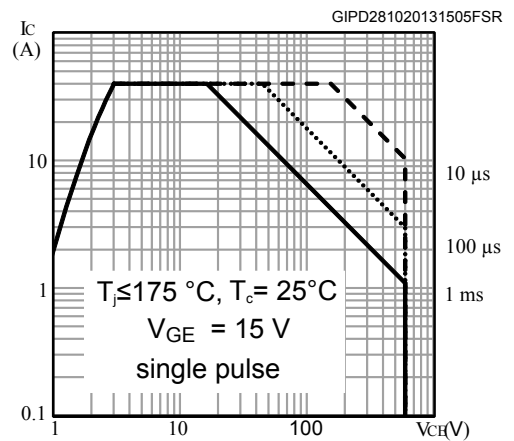


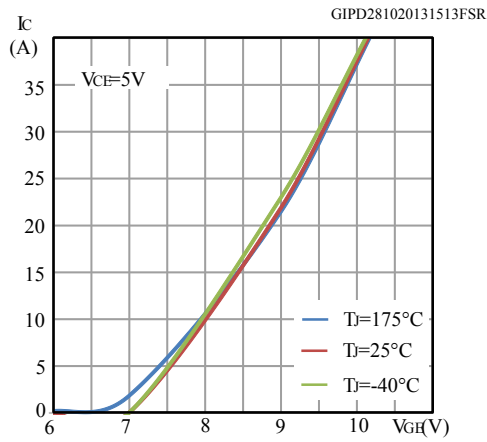
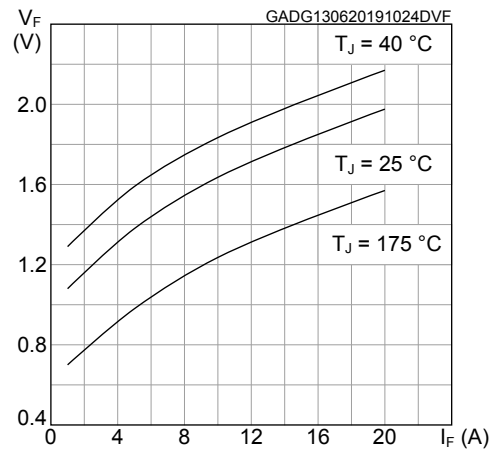
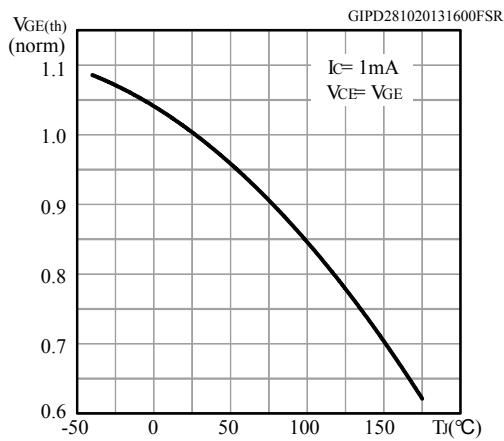
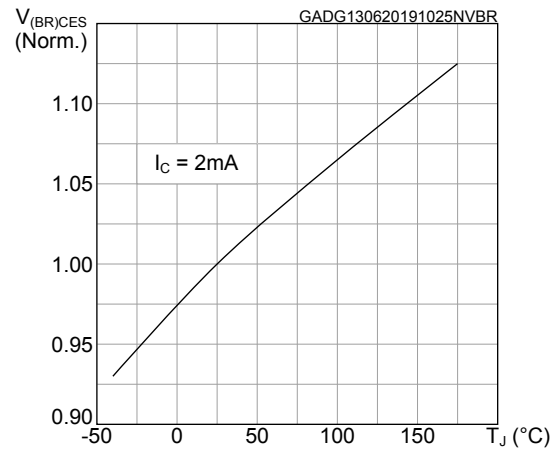
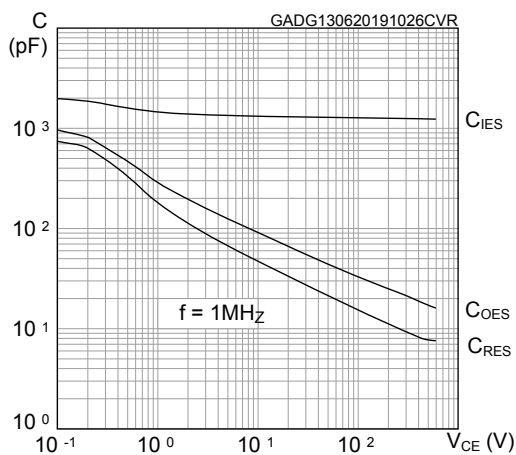
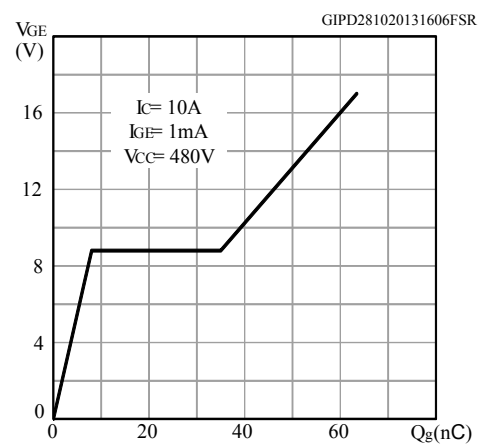
**Figure 5. Output characteristics ( $T_J = 25^\circ C$ )**



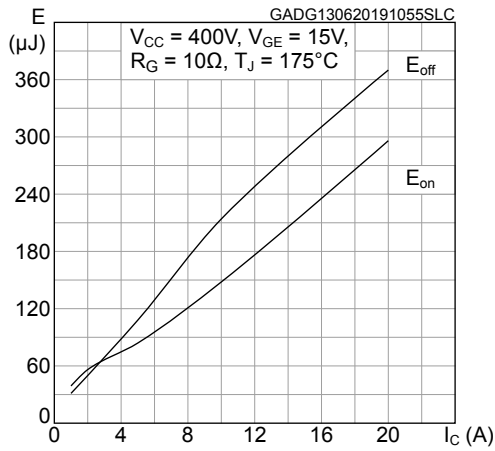
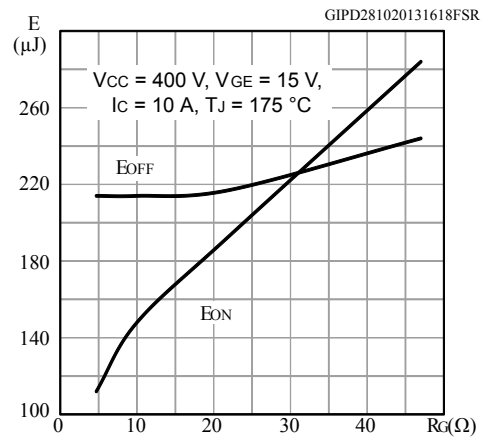
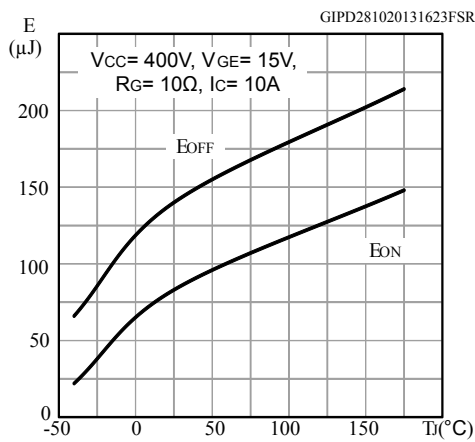
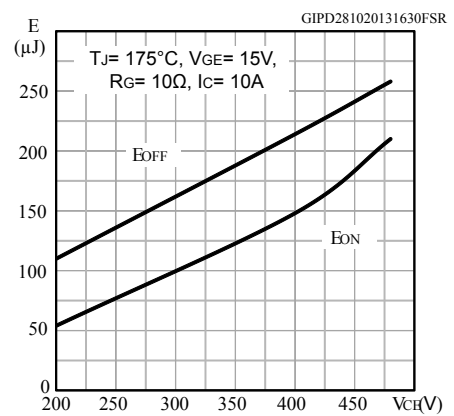
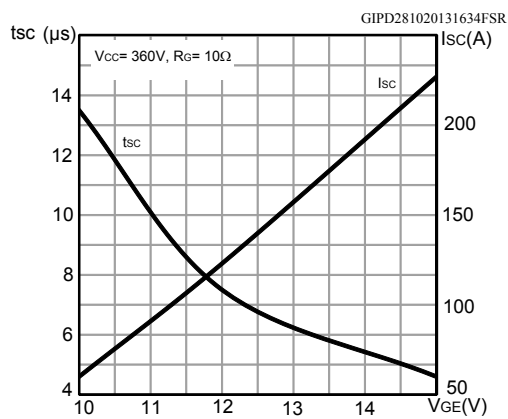
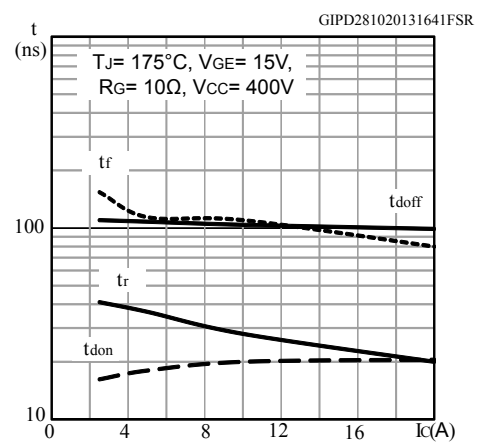
**Figure 6. Output characteristics ( $T_J = 175^\circ C$ )**

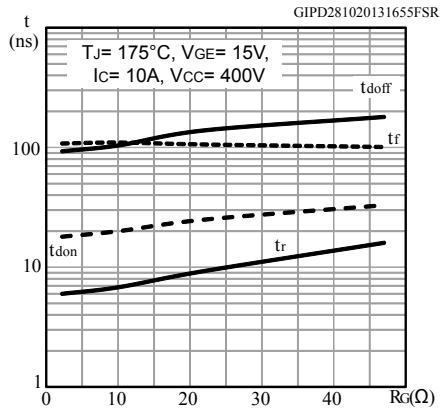
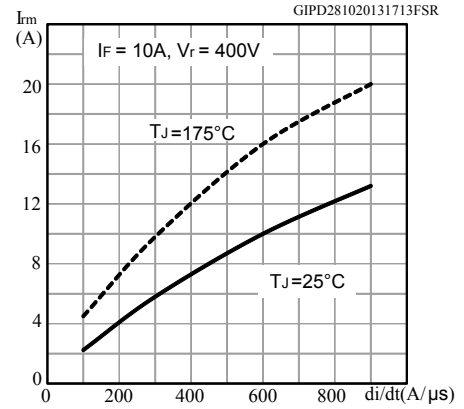
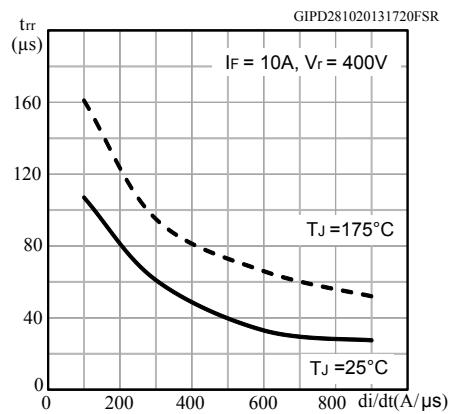
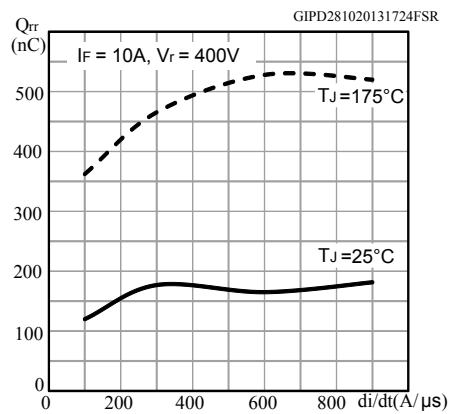
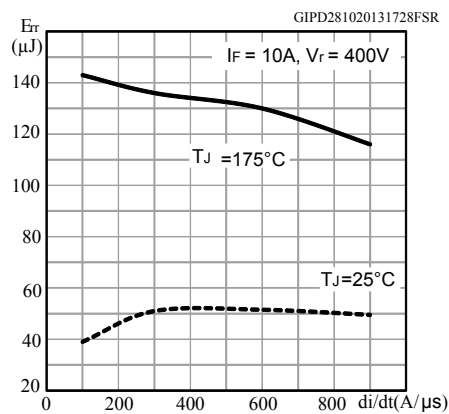
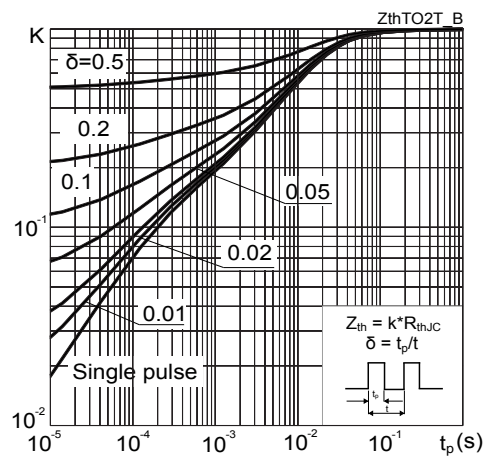


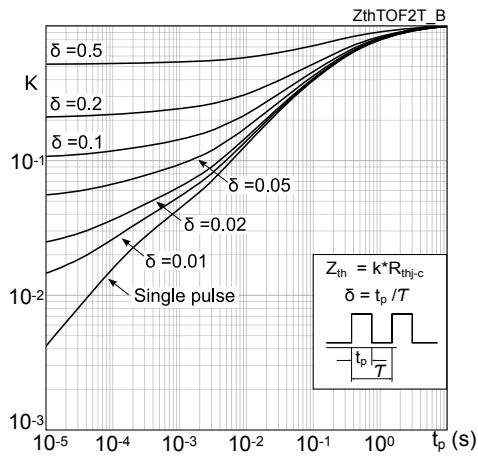
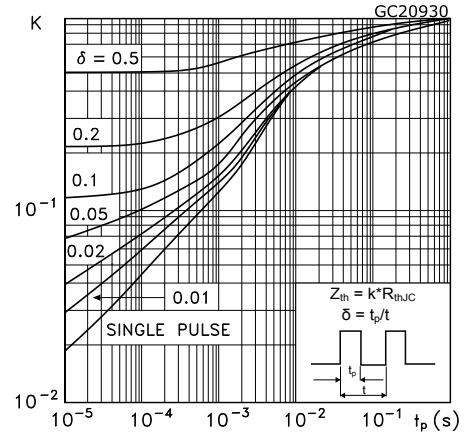
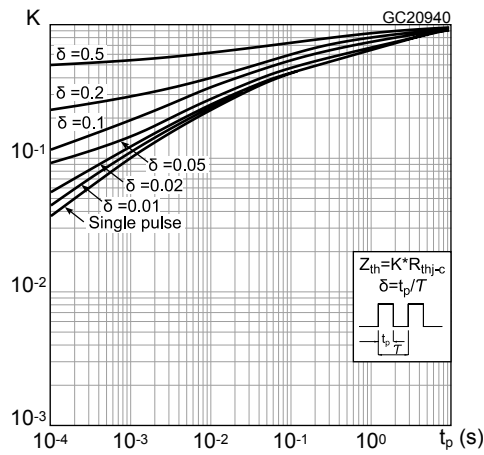
**Figure 7.  $V_{CE(sat)}$  vs junction temperature**

**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**


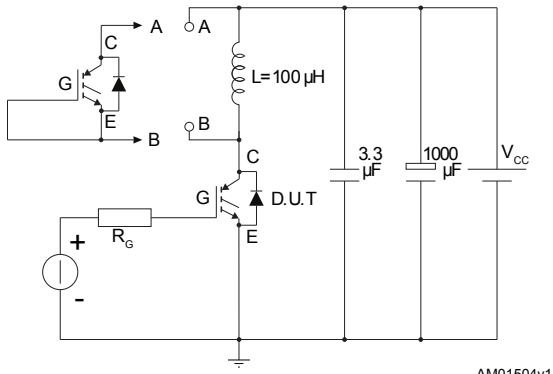
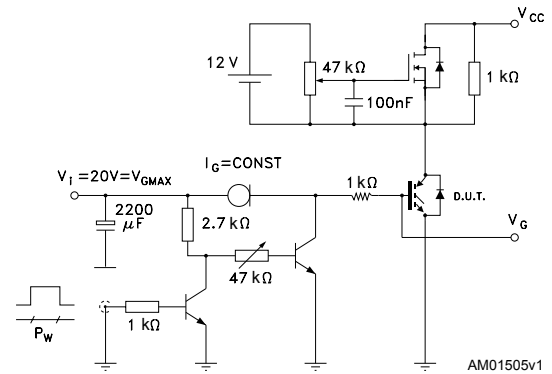
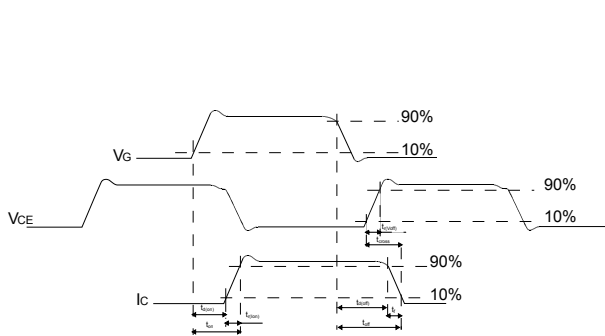
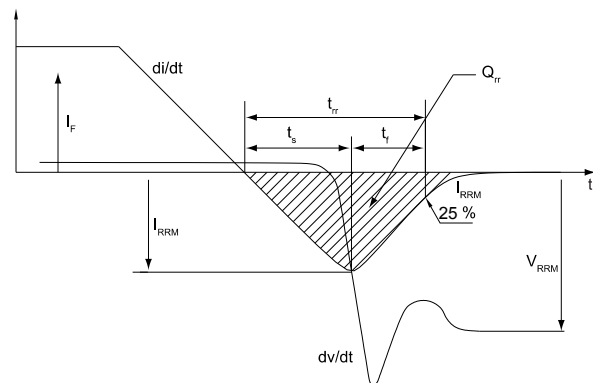


**Figure 19. Switching energy vs collector current**

**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. Normalized transient thermal impedance for TO-220 and D<sup>2</sup>PAK (IGBT)**


**Figure 31. Normalized transient thermal impedance for TO-220FP (IGBT)**

**Figure 32. Normalized transient thermal impedance for TO-220 and D<sup>2</sup>PAK (diode)**

**Figure 33. Normalized transient thermal impedance for TO-220FP (diode)**


### 3 Test circuits

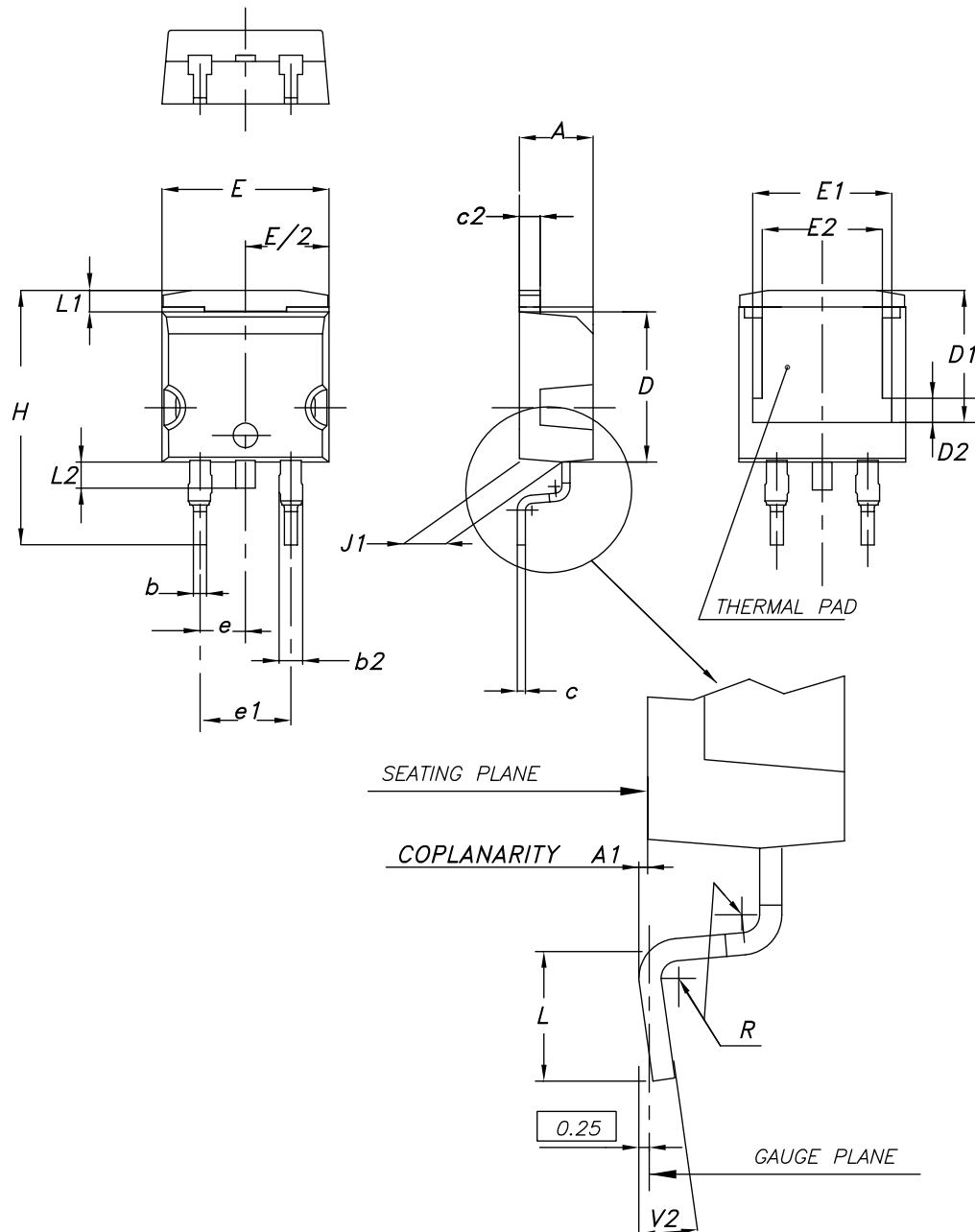
**Figure 34. Test circuit for inductive load switching**

**Figure 35. Gate charge test circuit**

**Figure 36. Switching waveform**

**Figure 37. 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 38. D<sup>2</sup>PAK (TO-263) type A2 package outline**

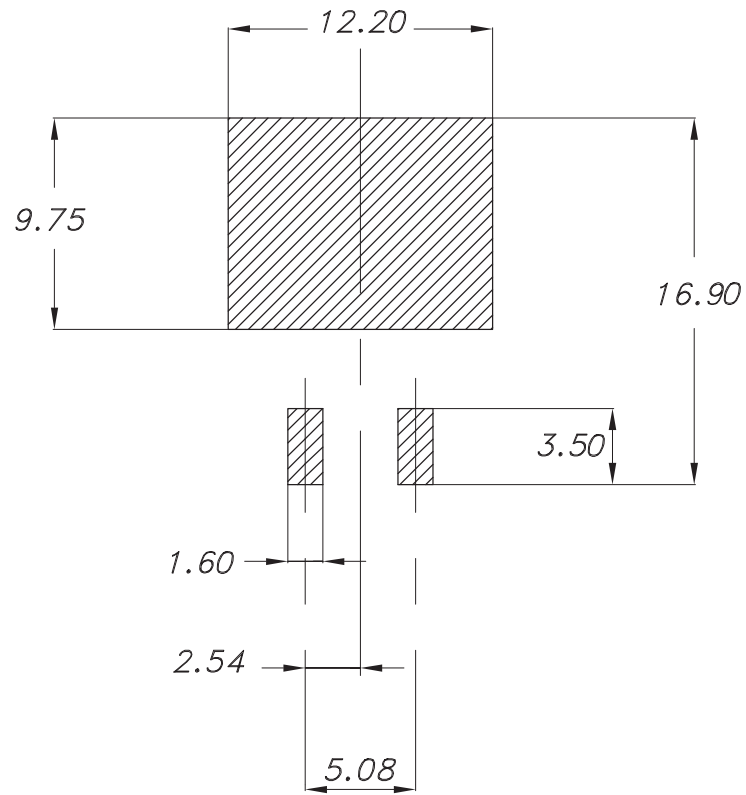


0079457\_A2\_26

**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°

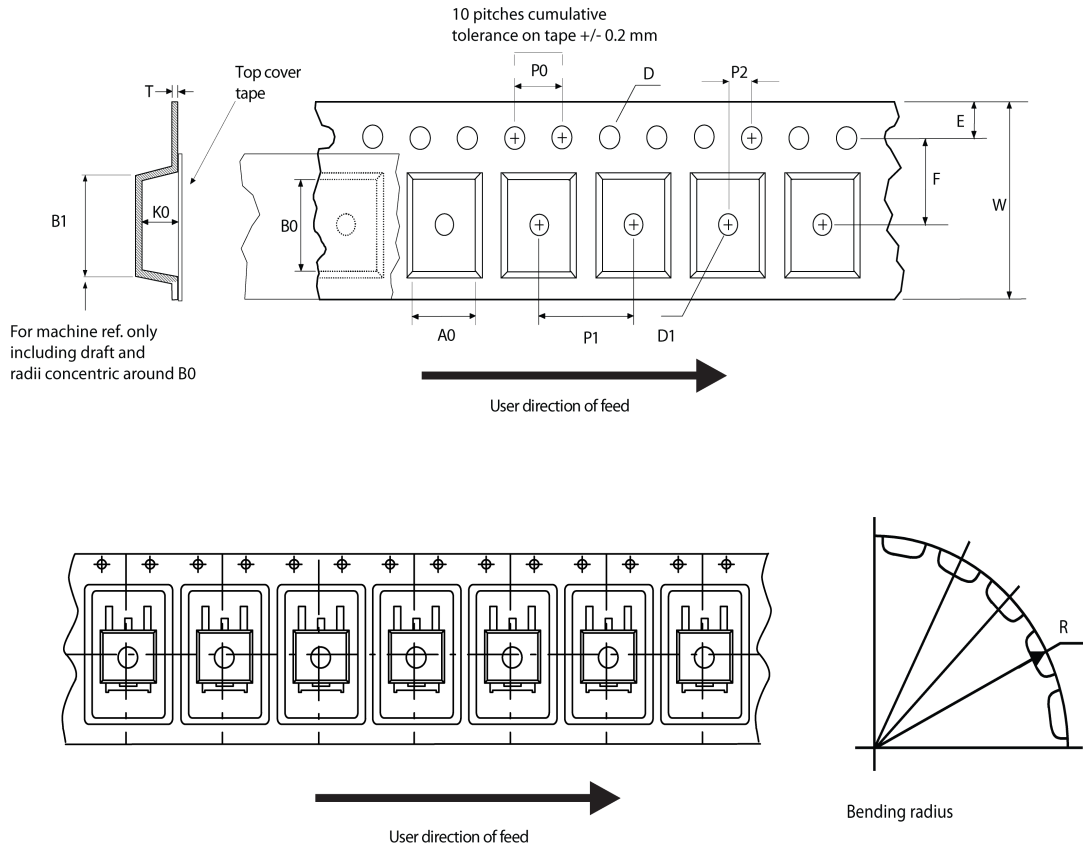
Figure 39. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



0079457\_Rev26\_footprint

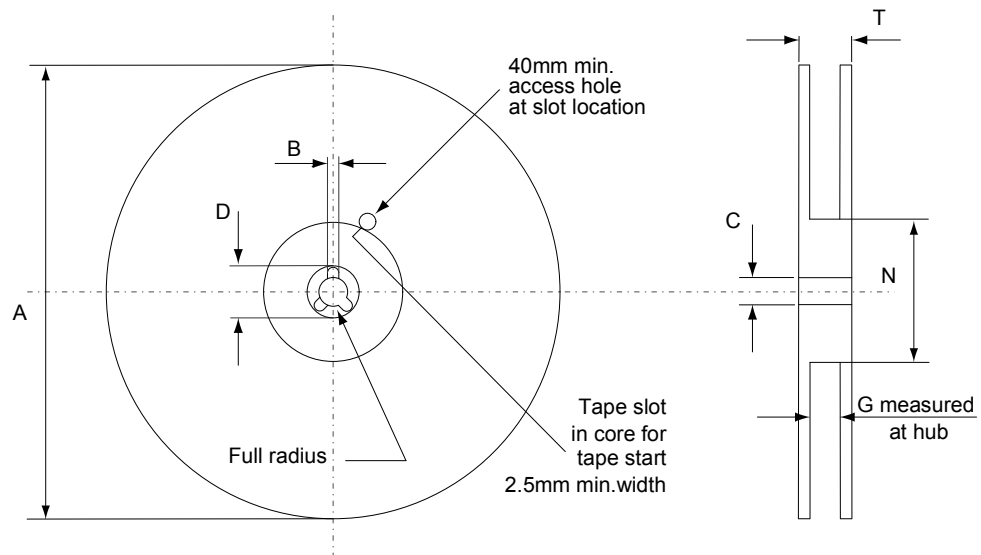
## 4.2 D<sup>2</sup>PAK packing information

Figure 40. D<sup>2</sup>PAK tape outline



AM08852v1



**Figure 41. D<sup>2</sup>PAK reel outline**


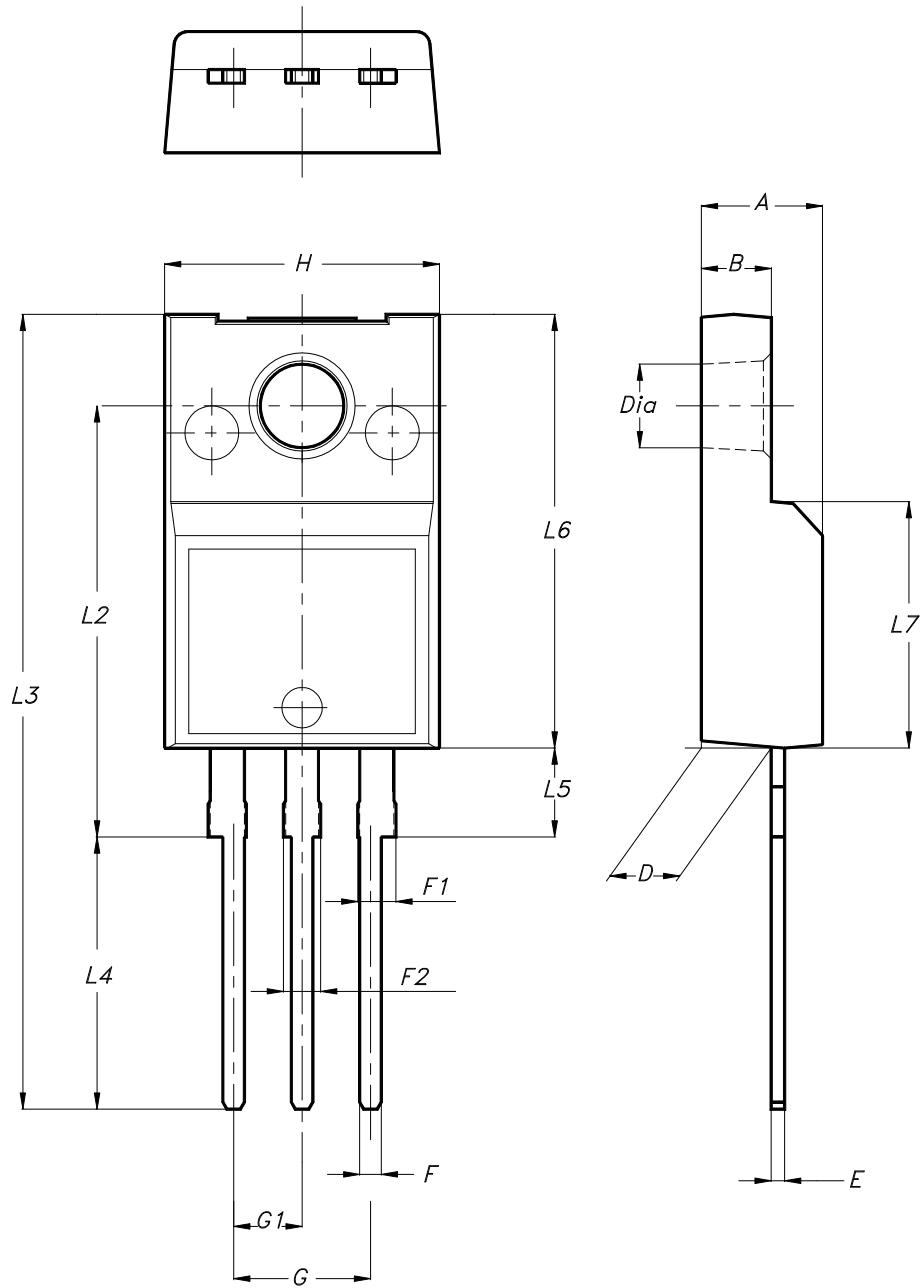
AM06038v1

**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 42. TO-220FP package outline



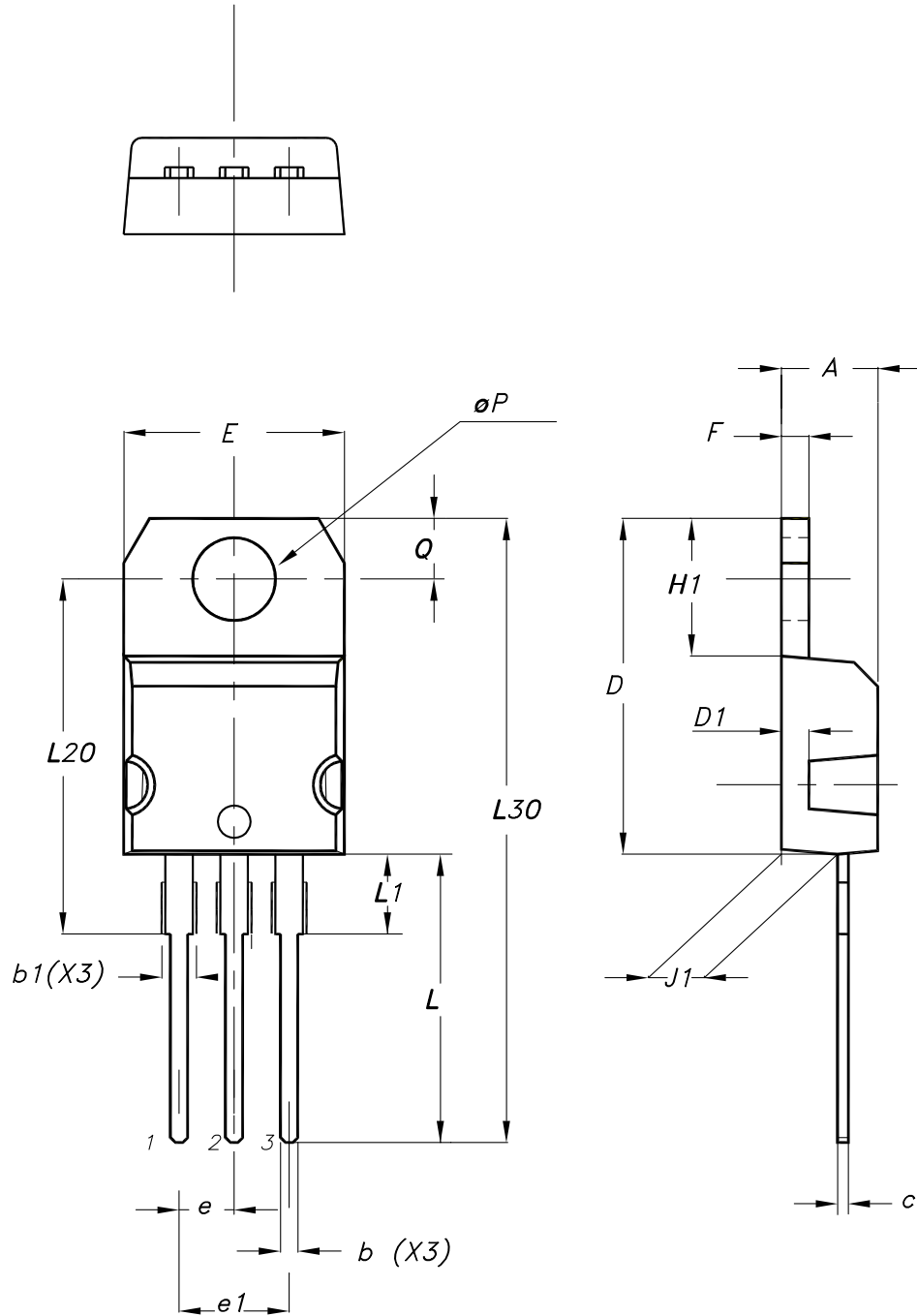
7012510\_Rev\_13\_B

**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 43. TO-220 type A package outline



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**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
Slug flatness		0.03	0.10

## 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. Inserted <i>Section 2.1: Electrical characteristics (curves)</i> . Minor text changes.
20-Jun-2019	3	Updated title, applications and description in cover page. Added <i>Section 5 Ordering information</i> . Updated <i>Section 2.1 Electrical characteristics (curves)</i> . Minor text changes.
05-Mar-2020	4	Updated <i>Table 3. Static</i> and <i>Table 4. Dynamic</i> . Minor text changes.
21-Jan-2022	5	Modified <i>Figure 30. Normalized transient thermal impedance for TO-220 and D<sup>2</sup>PAK (IGBT)</i> and <i>Figure 32. Normalized transient thermal impedance for TO-220 and D<sup>2</sup>PAK (diode)</i> . Added <i>Figure 31. Normalized transient thermal impedance for TO-220FP (IGBT)</i> and <i>Figure 33. Normalized transient thermal impedance for TO-220FP (diode)</i> . Minor text changes.

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