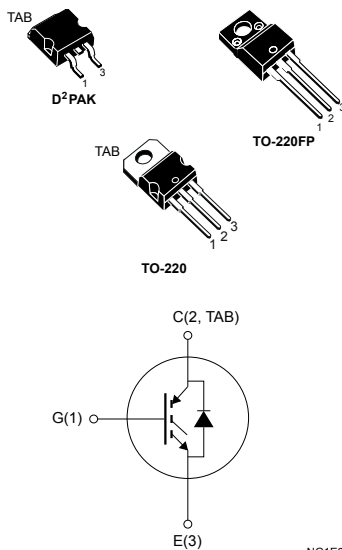


## Trench gate field-stop IGBT, H series 600 V, 14 A high speed



### 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

[STGB15H60DF](#)
[STGF15H60DF](#)
[STGP15H60DF](#)

# 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	30	30 <sup>(1)</sup>	A
	Continuous collector current at T <sub>C</sub> = 100 °C	15	15 <sup>(1)</sup>	
I <sub>CP</sub> <sup>(2)</sup>	Pulsed collector current	60	60	A
V <sub>GE</sub>	Gate-emitter voltage	±20		V
I <sub>F</sub>	Continuous forward current T <sub>C</sub> = 25 °C	30	30 <sup>(1)</sup>	A
	Continuous forward current at T <sub>C</sub> = 100 °C	15	15 <sup>(1)</sup>	
I <sub>FP</sub> <sup>(2)</sup>	Pulsed forward current	60	60	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)		2500	V
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	$V_{GE} = 15\text{ V}$ , $I_C = 15\text{ A}$		1.6	2.0	V
		$V_{GE} = 15\text{ V}$ , $I_C = 15\text{ A}$ $T_J = 125\text{ °C}$		1.7		
		$V_{GE} = 15\text{ V}$ , $I_C = 15\text{ A}$ $T_J = 175\text{ °C}$		1.8		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$	5.0	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	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	1952	-	$\mu\text{F}$
$C_{oes}$	Output capacitance			78		
$C_{res}$	Reverse transfer capacitance			45		
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}$ , $I_C = 15\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see <a href="#">Figure 33. Gate charge test circuit</a> )	-	81	-	nC
$Q_{ge}$	Gate-emitter charge			8		
$Q_{gc}$	Gate-collector charge			42		

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform</a> )		24.5	-	ns
$t_r$	Current rise time			8.2		
$(di/dt)_{on}$	Turn-on current slope			1470		
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ °C}$ (see <a href="#">Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform</a> )		25	-	ns
$t_r$	Current rise time			9		
$(di/dt)_{on}$	Turn-on current slope			1370		

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform)		18		ns
$t_{d(off)}$	Turn-off delay time			118		
$t_f$	Current fall time			69		
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 32. Test circuit for inductive load switching and Figure 34. Switching waveform)		27	-	ns
$t_{d(off)}$	Turn-off delay time			124		
$t_f$	Current fall time			101		
$t_{sc}$	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	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see Figure 32. Test circuit for inductive load switching)		136		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching energy			207		
$E_{is}$	Total switching energy			343		
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 32. Test circuit for inductive load switching)	-	224	-	$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching energy			329		
$E_{is}$	Total switching energy			553		

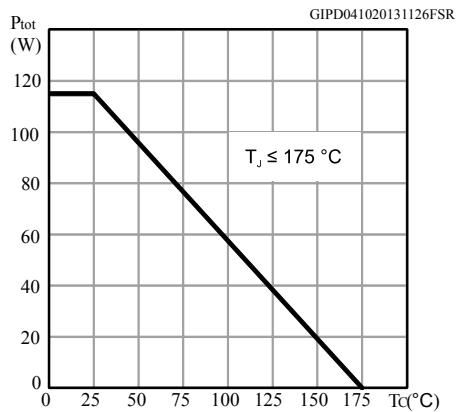
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

**Table 7. Collector-emitter diode**

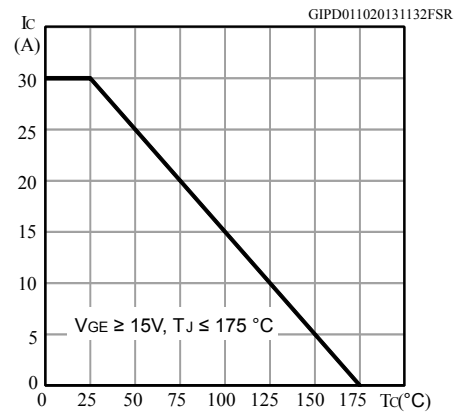
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 15\text{ A}$	-	1.8	2.2	V
		$I_F = 15\text{ A}$ , $T_J = 175\text{ }^\circ\text{C}$		1.3		
$t_{rr}$	Reverse recovery time	$V_r = 60\text{ V}$ ; $I_F = 15\text{ A}$ ; $di_F/dt = 100\text{ A}/\mu\text{s}$ (see Figure 35. Diode reverse recovery waveform)		103		ns
$Q_{rr}$	Reverse recovery charge			128		nC
$I_{rrm}$	Reverse recovery current			2.5		A
$t_{rr}$	Reverse recovery time	$V_r = 60\text{ V}$ ; $I_F = 15\text{ A}$ ; $di_F/dt = 100\text{ A}/\mu\text{s}$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 35. Diode reverse recovery waveform)	-	182		ns
$Q_{rr}$	Reverse recovery charge			437		nC
$I_{rrm}$	Reverse recovery current			4.8		A

## 2.1 Electrical characteristics (curves)

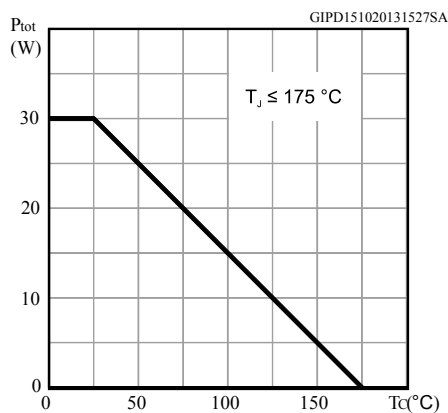
**Figure 1. Power dissipation vs case temperature for D<sup>2</sup>PAK and TO-220**



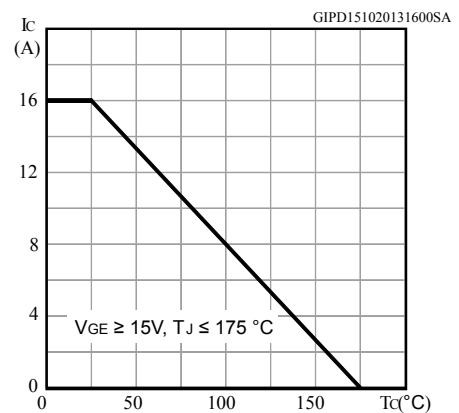
**Figure 2. Collector current vs case temperature for D<sup>2</sup>PAK and TO-220**



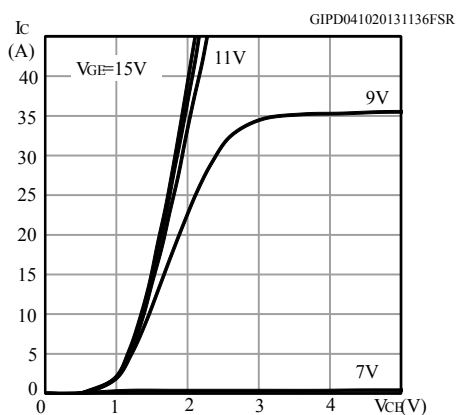
**Figure 3. Power dissipation vs case temperature for TO-220FP**



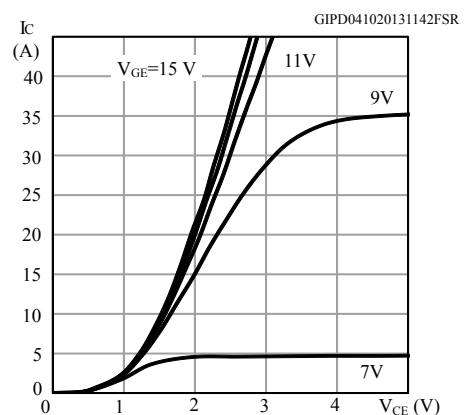
**Figure 4. Collector current vs case temperature for TO-220FP**

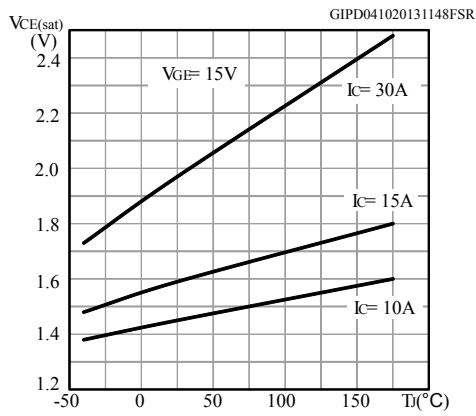
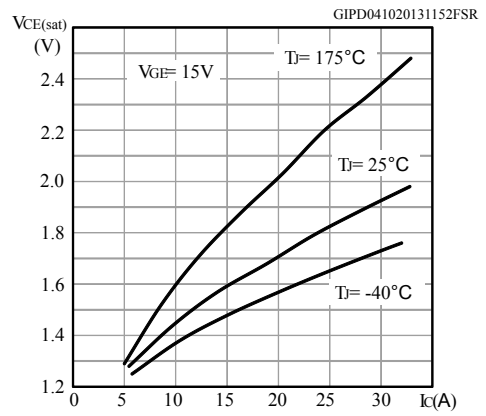
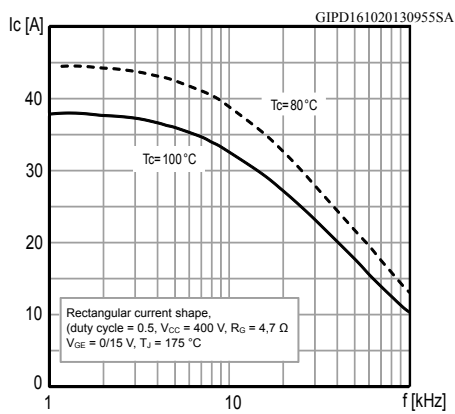
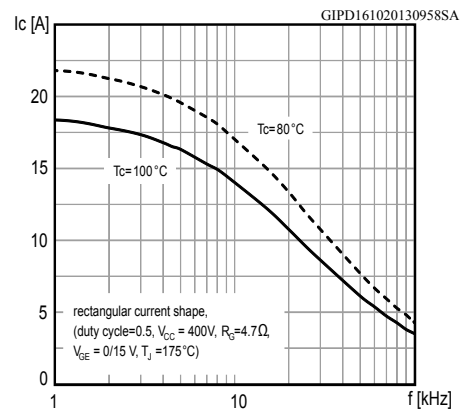
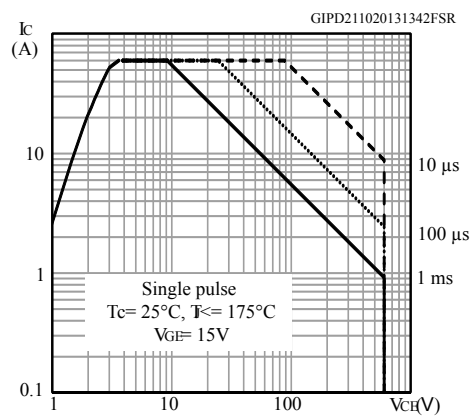
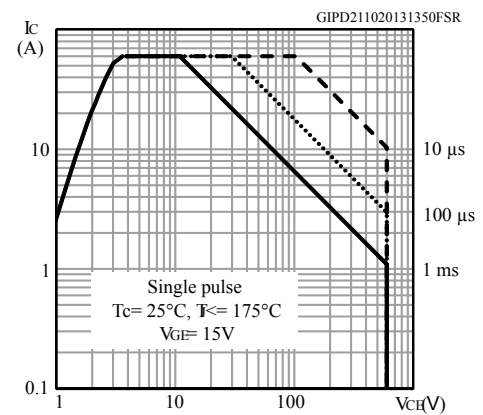


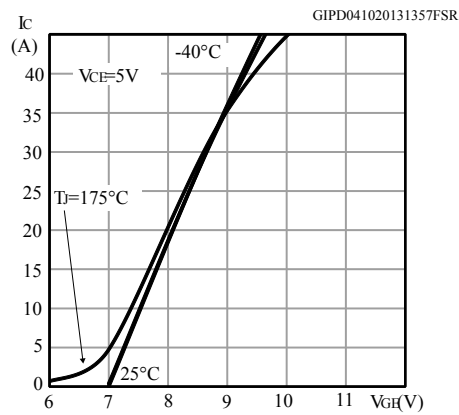
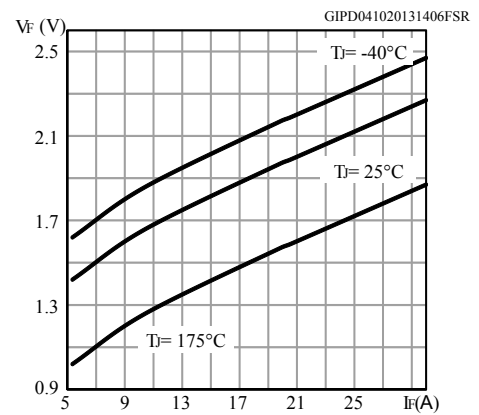
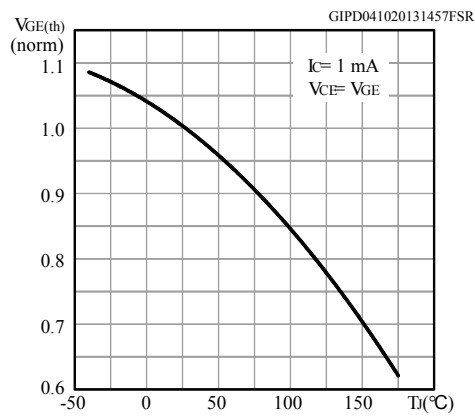
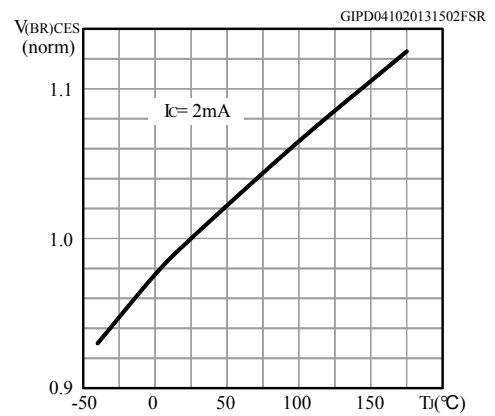
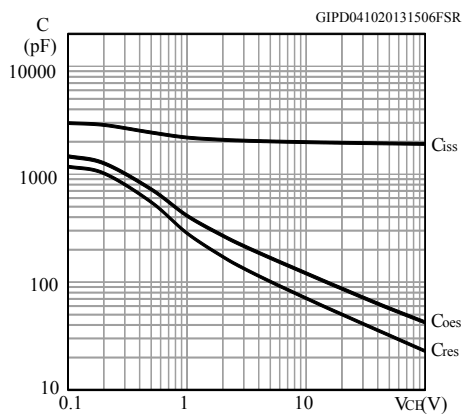
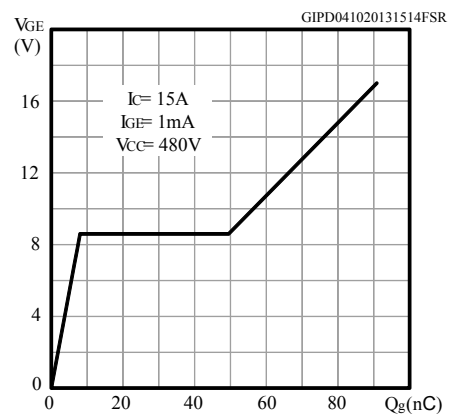
**Figure 5. Output characteristics ( $T_j = 25^\circ\text{C}$ )**

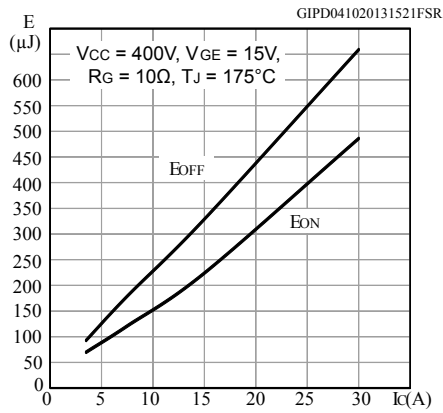
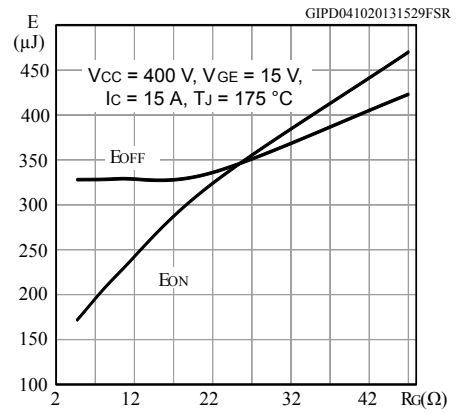
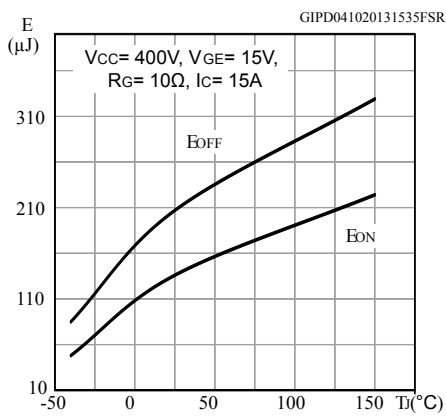
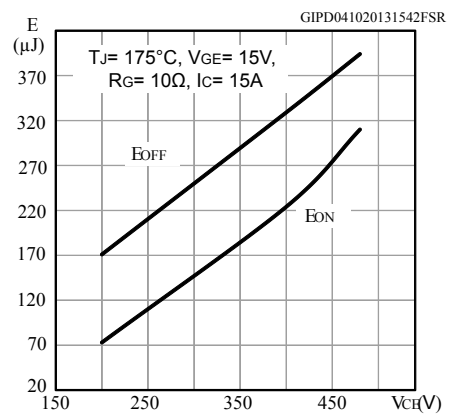
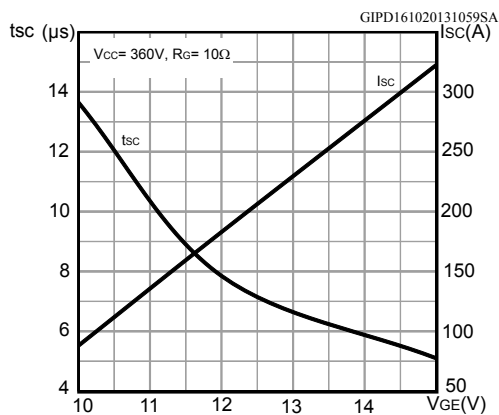
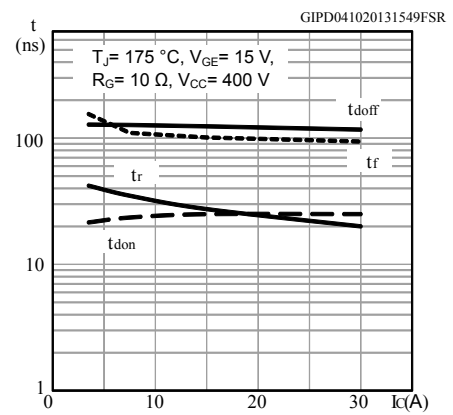


**Figure 6. Output characteristics ( $T_j = 175^\circ\text{C}$ )**

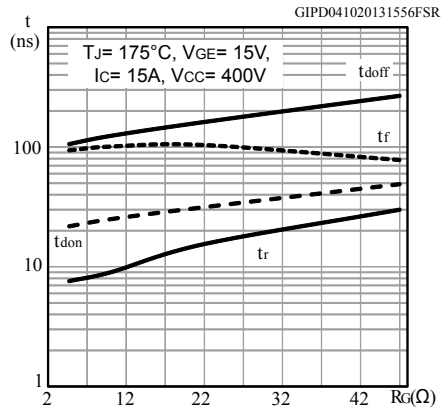
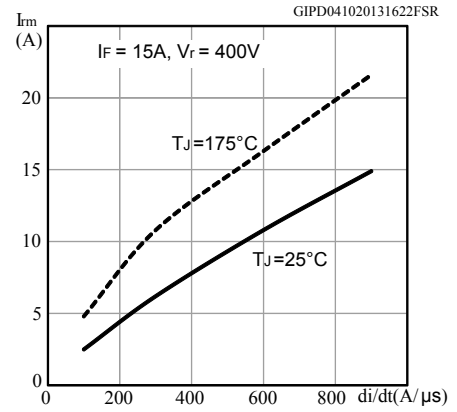
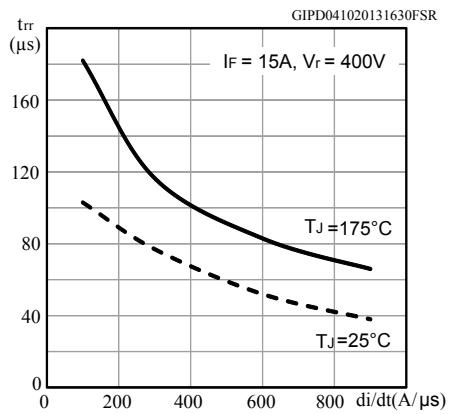
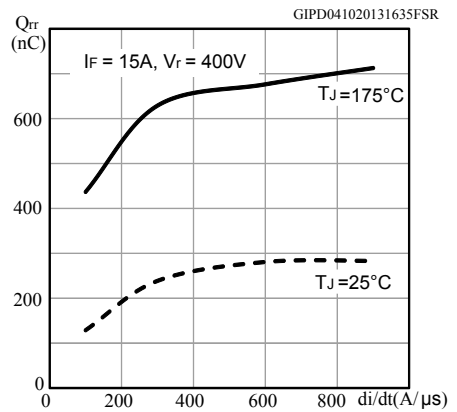
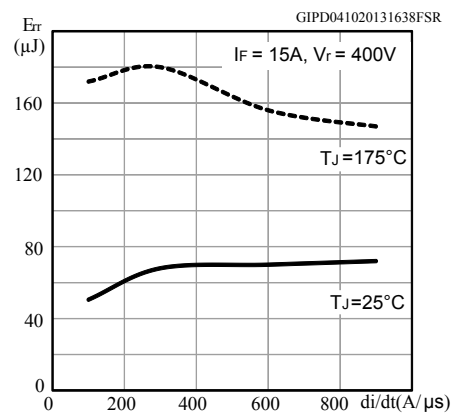


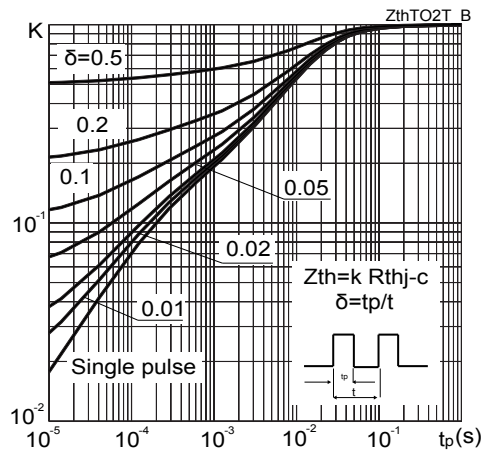
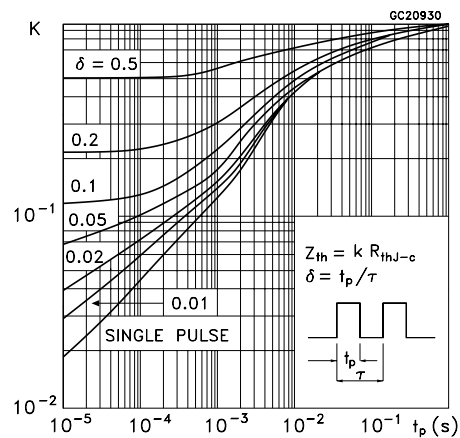
**Figure 7.  $V_{CE(sat)}$  vs junction temperature**

**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  $V_{GE}$** 

**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

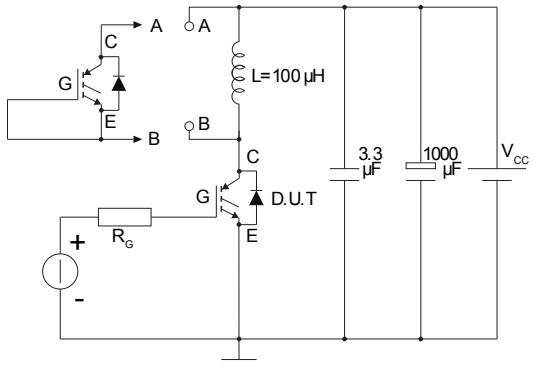


Figure 33. Gate charge test circuit

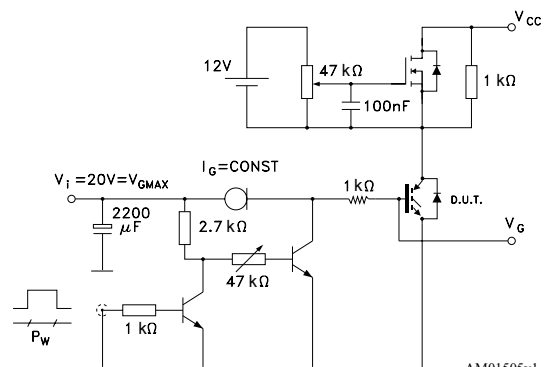


Figure 34. Switching waveform

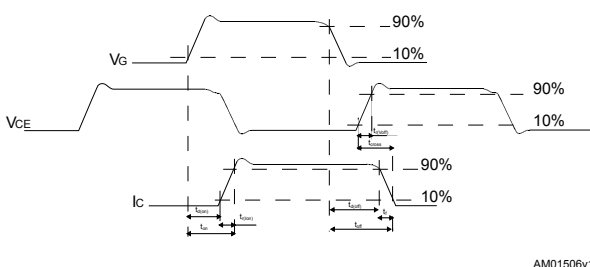
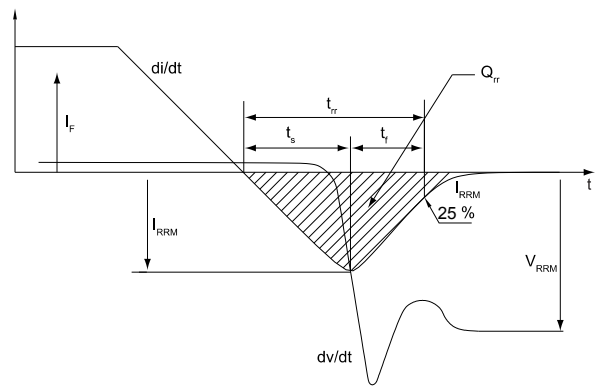


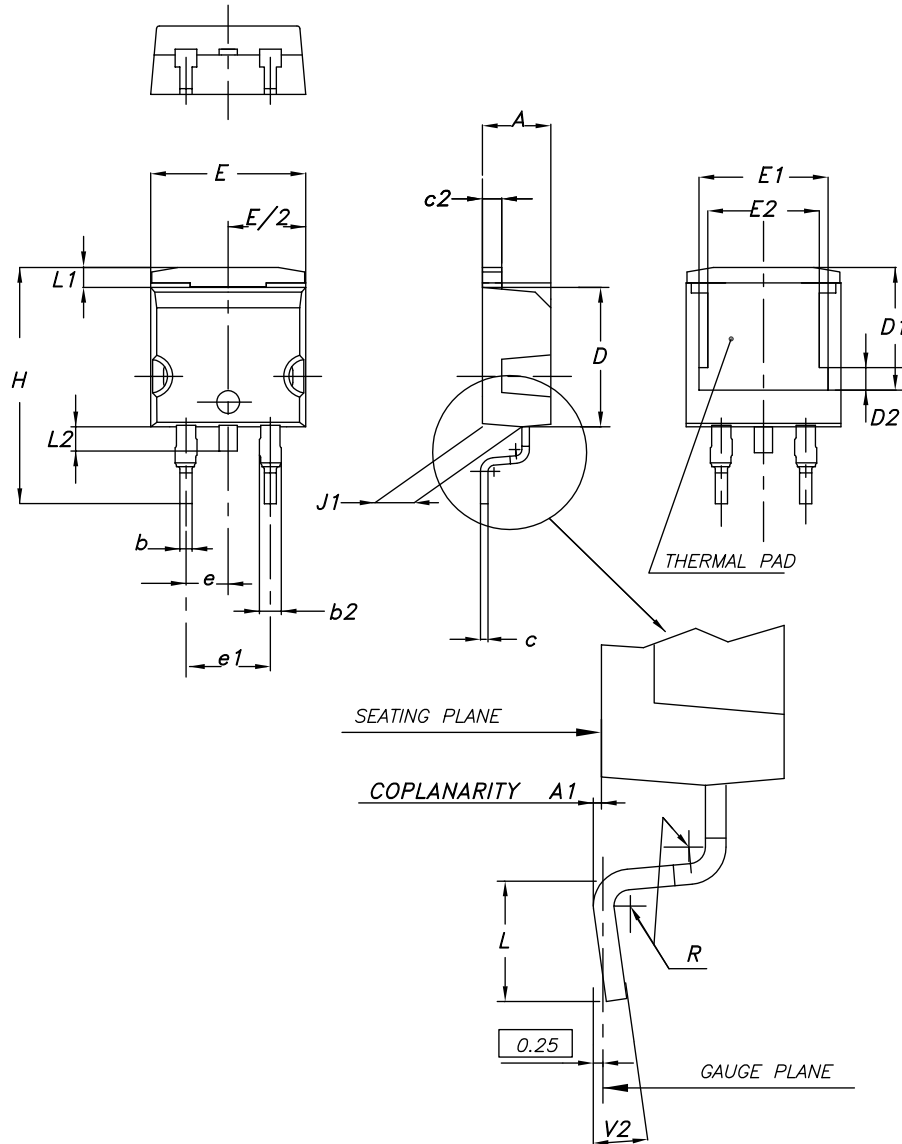
Figure 35. Diode reverse recovery waveform



## **4 Package information**

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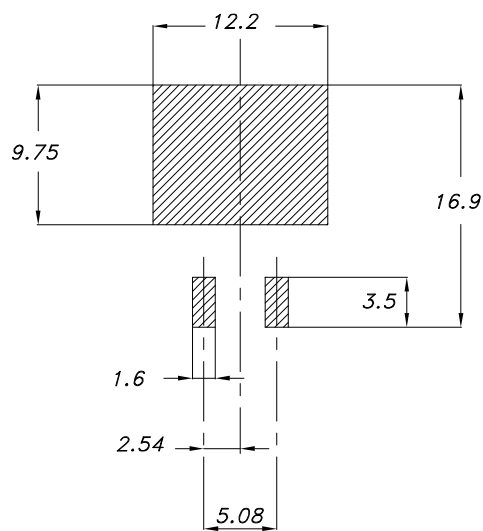
In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

**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\_25

**Table 8. D<sup>2</sup>PAK (TO-263) type A2 package mechanical data**

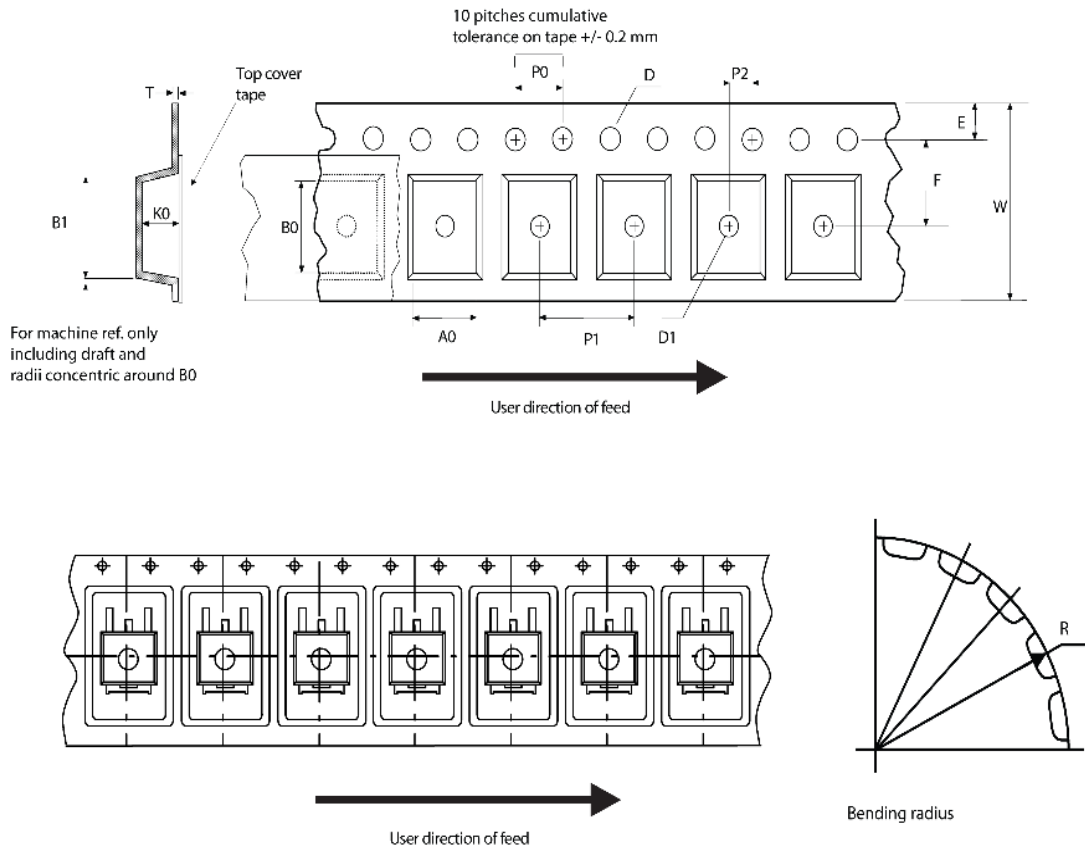
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.70	8.90	9.10
E2	7.30	7.50	7.70
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

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


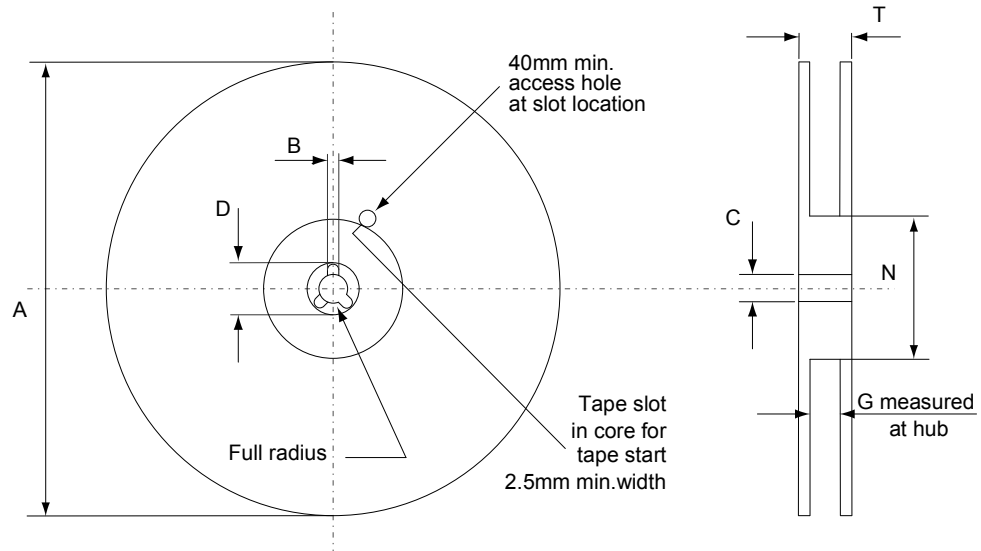
Footprint

## 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

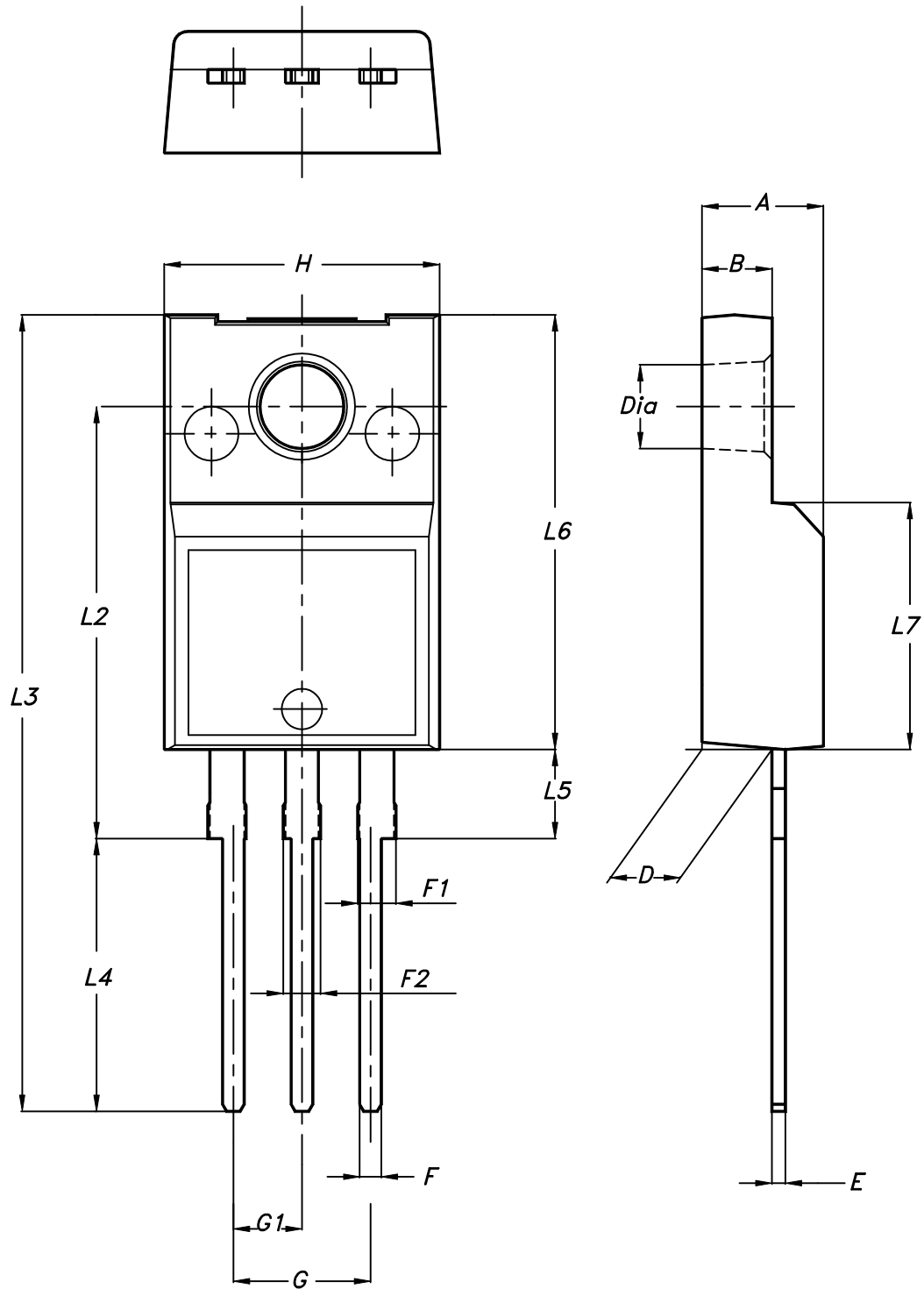
**Table 9. D<sup>2</sup>PAK tape and reel mechanical data**

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



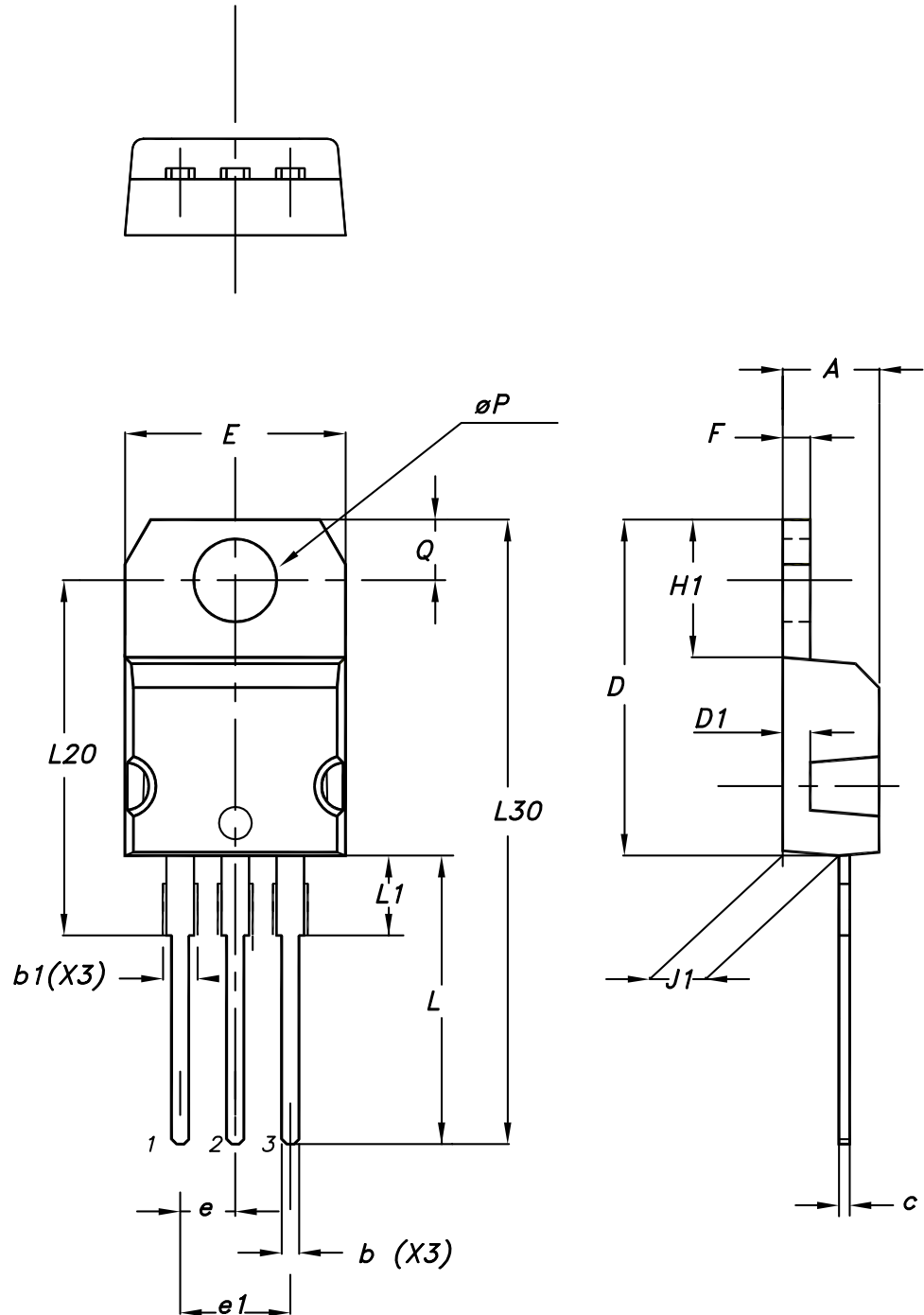
7012510\_Rev\_12\_B

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

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

#### 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
STGB15H60DF	GB15H60DF	D <sup>2</sup> PAK	Tape and reel
STGF15H60DF	GF15H60DF	TO-220FP	Tube
STGP15H60DF	GP15H60DF	TO-220	

## Revision history

**Table 13. Document revision history**

Date	Version	Changes
12-Aug-2013	1	Initial release.
17-Oct-2013	2	Document status promoted from preliminary to production data. Added <i>Section 2.1: Electrical characteristics (curves)</i> . Minor text changes.
09-Apr-2019	3	Updated applications and description on cover page. Updated <a href="#">Section 4 Package information</a> . Minor text changes.

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