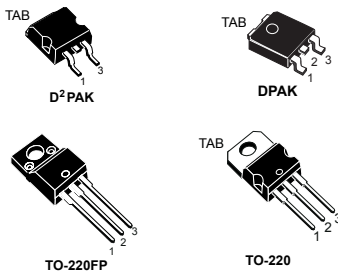


## Trench gate field-stop 600 V, 5 A high speed H series IGBT

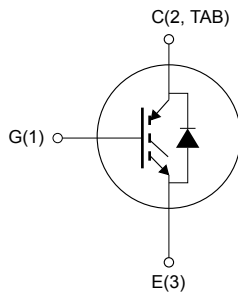


### Features

- High-speed switching
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance
- Short-circuit rated
- Ultrafast soft recovery antiparallel diode

### Applications

- Motor control
- UPS
- PFC



NG1E3C2T

### 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

[STGB5H60DF](#)

[STGD5H60DF](#)

[STGF5H60DF](#)

[STGP5H60DF](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK, TO-220	DPAK	TO-220FP	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	600			V
I <sub>C</sub>	Continuous collector current at T <sub>C</sub> = 25 °C	10		10 <sup>(1)</sup>	A
	Continuous collector current at T <sub>C</sub> = 100 °C	5		5 <sup>(1)</sup>	
I <sub>CP</sub> <sup>(2)</sup>	Pulsed collector current	20		20 <sup>(1)</sup>	A
V <sub>GE</sub>	Gate-emitter voltage	±20			V
I <sub>F</sub>	Continuous forward current T <sub>C</sub> = 25 °C	10		10 <sup>(1)</sup>	A
	Continuous forward current at T <sub>C</sub> = 100 °C	5		5 <sup>(1)</sup>	
I <sub>FP</sub> <sup>(2)</sup>	Pulsed forward current	20		20 <sup>(1)</sup>	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	88	83	24	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	DPAK	TO-220FP	
R <sub>thJC</sub>	Thermal resistance junction-case IGBT	1.7	1.8	6.2	°C/W
R <sub>thJC</sub>	Thermal resistance junction-case diode	4	4.5	7	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	62.5	100	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	$V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$		1.5	1.95	V
		$V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ , $T_J = 125\text{ °C}$		1.6		
		$V_{GE} = 15\text{ V}$ , $I_C = 5\text{ A}$ , $T_J = 175\text{ °C}$		1.7		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$	4.8	6.2	6.9	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	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	855	-	$\mu\text{F}$
$C_{oes}$	Output capacitance			34		
$C_{res}$	Reverse transfer capacitance			19		
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}$ , $I_C = 5\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 35. Gate charge test circuit)	-	38	-	nC
$Q_{ge}$	Gate-emitter charge			6.5		
$Q_{gc}$	Gate-collector charge			17.5		

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 5\text{ A}$ ,	-	30	-	ns
$t_r$	Current rise time	$R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$		10.8		
$(di/dt)_{on}$	Turn-on current slope	(see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)		370		
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 5\text{ A}$ ,	-	28	-	ns
$t_r$	Current rise time	$R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$		11		
$(di/dt)_{on}$	Turn-on current slope	(see Figure 34. Test circuit for inductive load switching and Figure 36. Switching waveform)		363		
$t_{r(voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$	-	29	-	ns
$t_{d(off)}$	Turn-off delay time			140		
$t_f$	Current fall time			95		
$t_{r(voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$	-	44	-	ns
$t_{d(off)}$	Turn-off delay time			146		
$t_f$	Current fall time			134		
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$ , $R_G = 47\ \Omega$	-	5	-	$\mu$ s

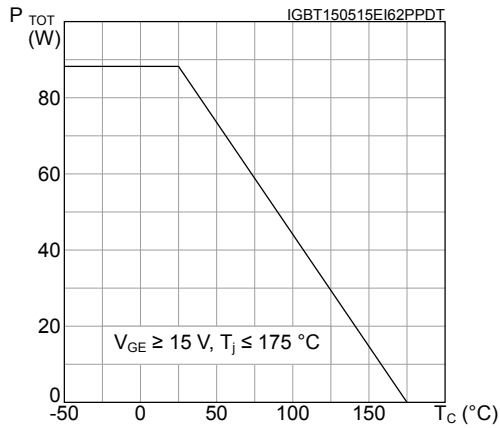
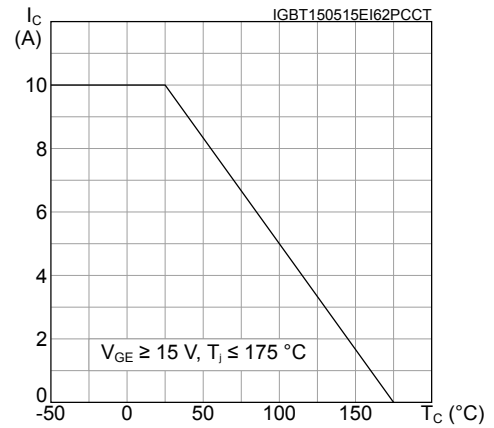
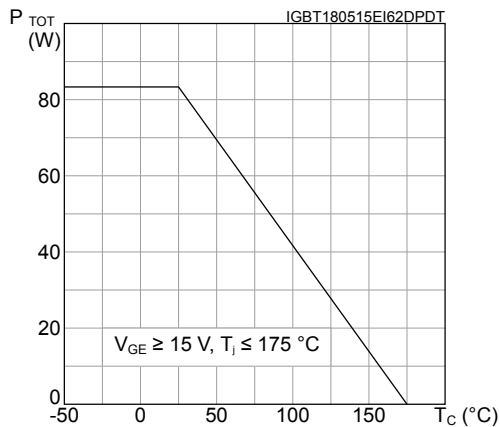
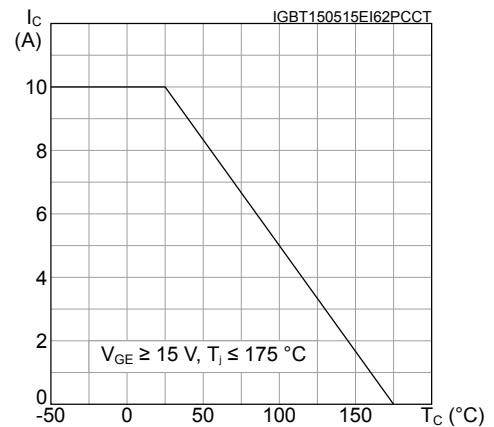
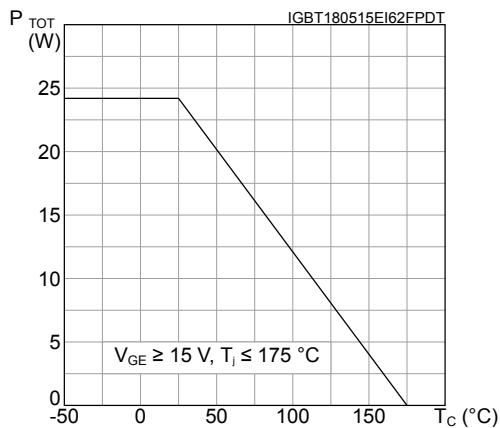
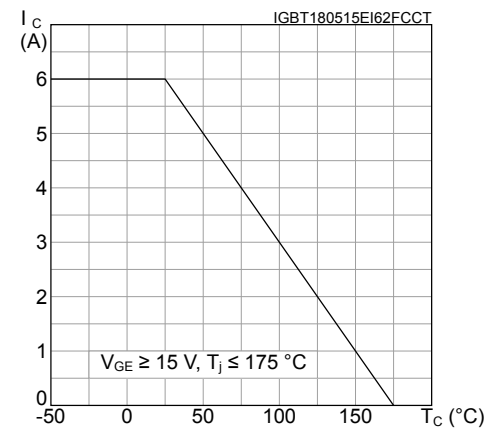
**Table 6. Switching energy (inductive load)**

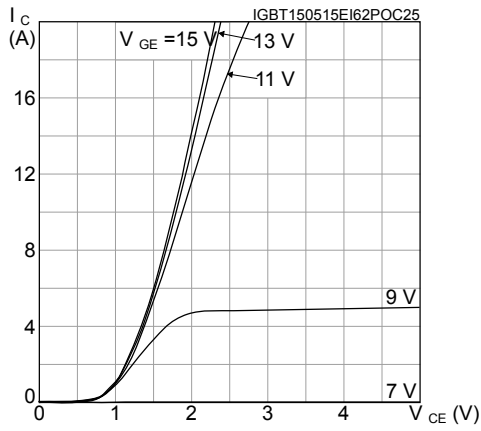
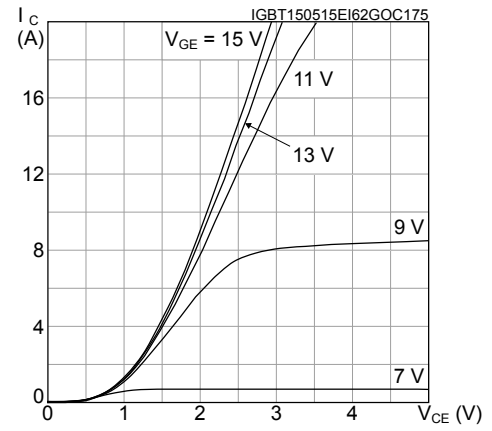
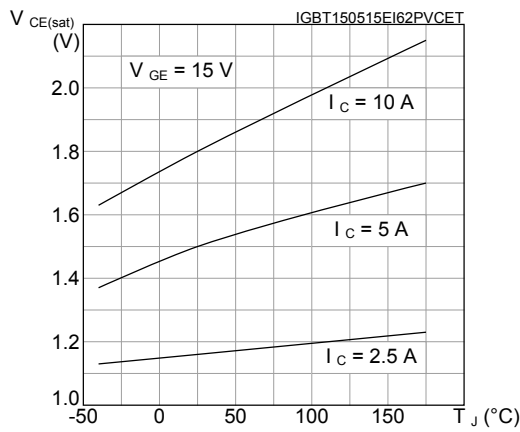
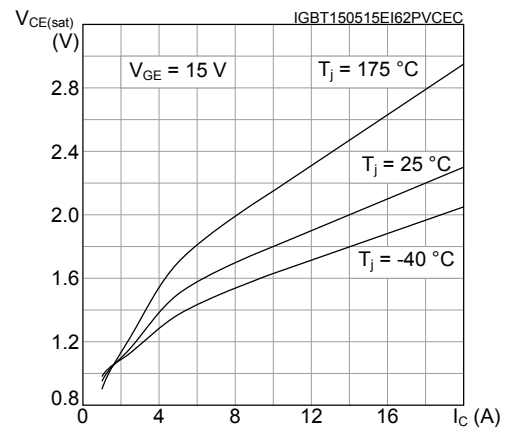
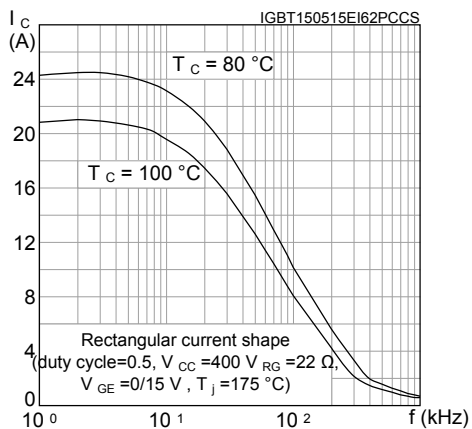
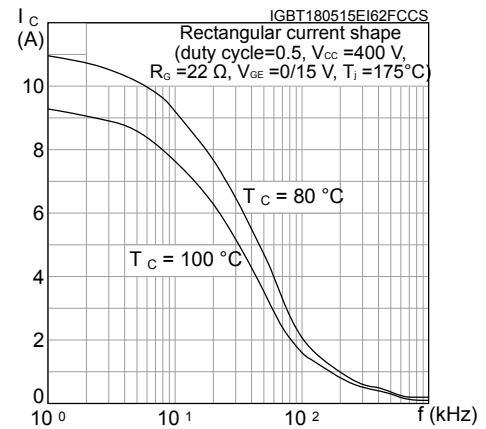
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 400\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$	-	56	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy			78.5		
$E_{ts}$	Total switching energy			134.5		
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 400\text{ V}$ , $I_C = 5\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$	-	87	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching energy			134		
$E_{ts}$	Total switching energy			221		

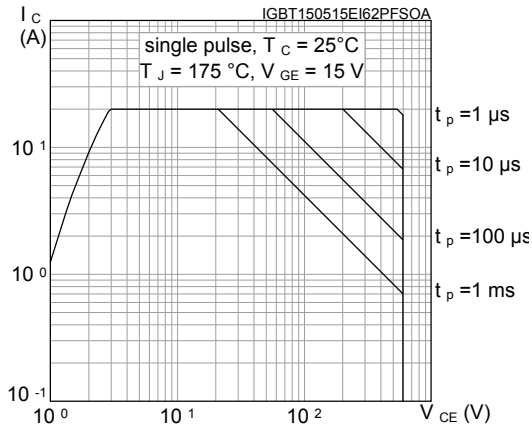
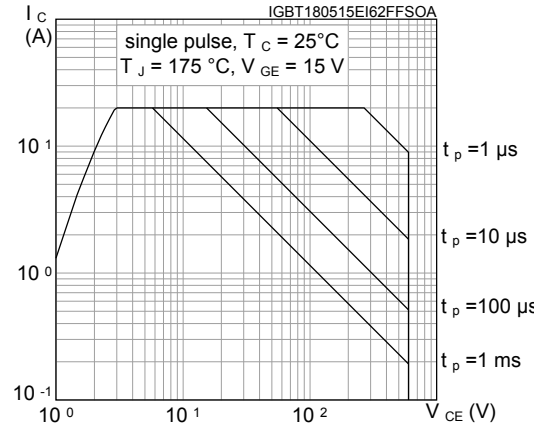
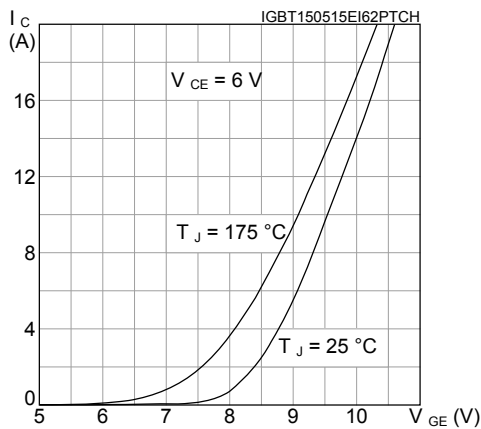
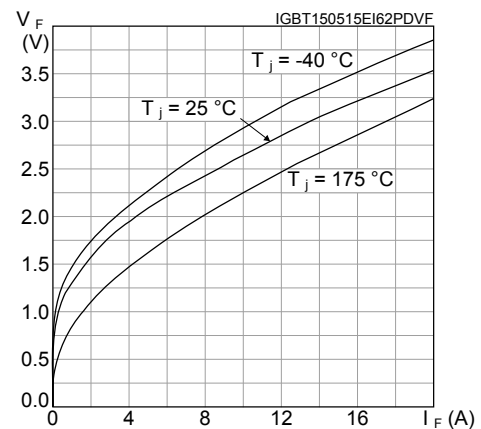
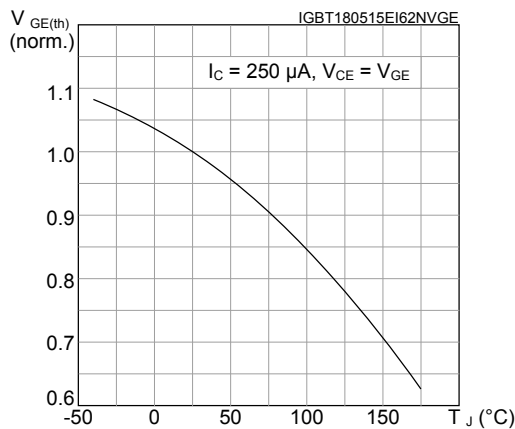
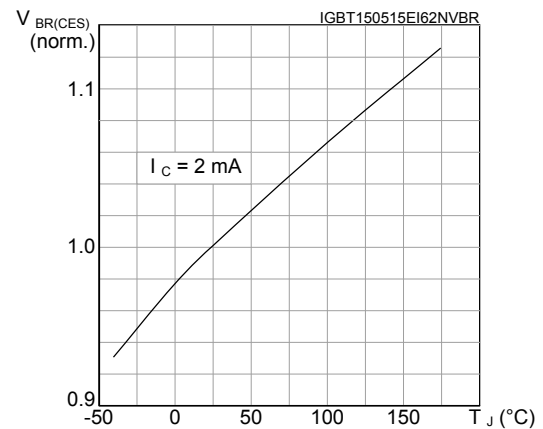
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

**Table 7. Collector-emitter diode**

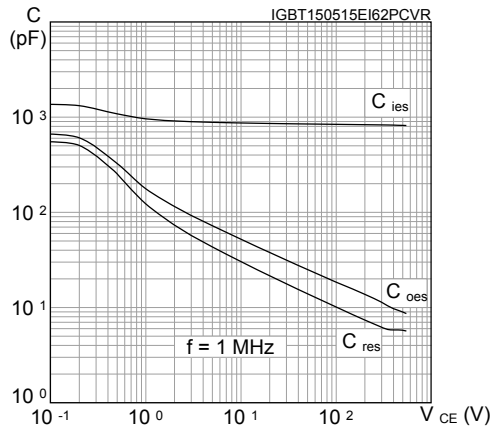
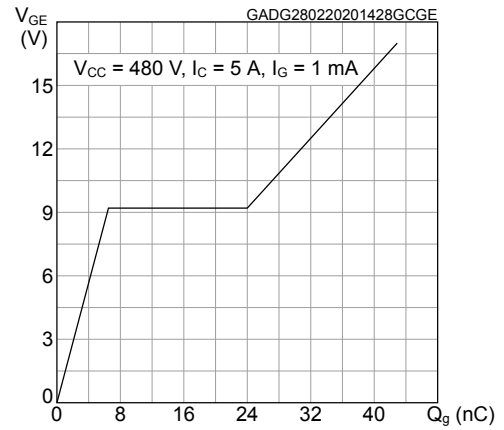
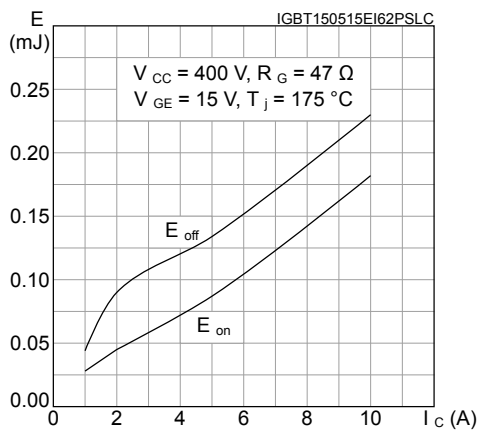
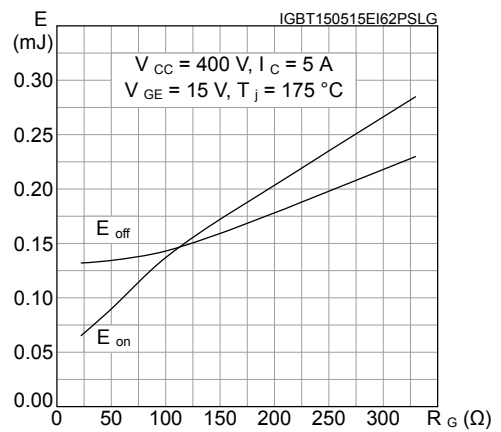
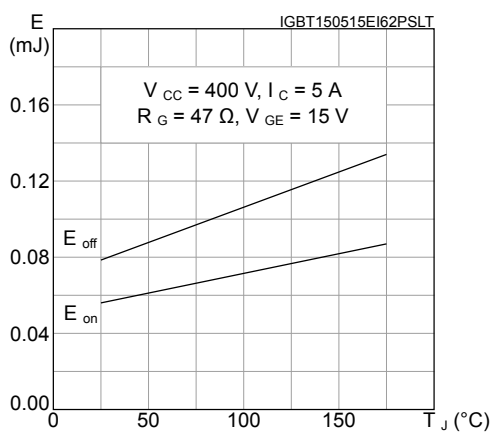
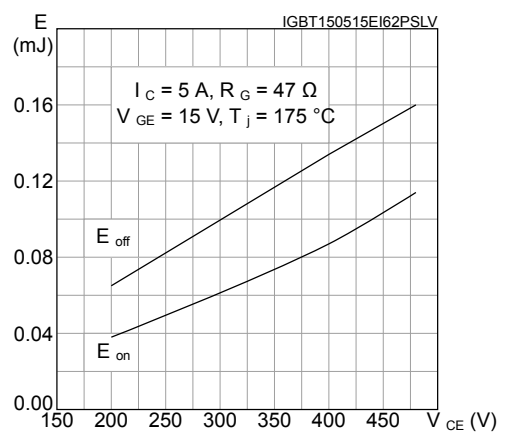
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 5 \text{ A}$	-	2.1	-	V
		$I_F = 5 \text{ A}, T_J = 175 \text{ }^\circ\text{C}$		1.65		
$t_{rr}$	Reverse recovery time	$V_{CC} = 400 \text{ V}; I_F = 5 \text{ A};$ $di_F/dt = 100 \text{ A} / \mu\text{s}$	-	134.5	-	ns
$Q_{rr}$	Reverse recovery charge			48		nC
$I_{rrm}$	Reverse recovery current			1.38		A
$t_{rr}$	Reverse recovery time	$V_{CC} = 400 \text{ V}; I_F = 5 \text{ A};$ $di_F/dt = 100 \text{ A} / \mu\text{s}, T_J = 175 \text{ }^\circ\text{C}$	-	157	-	ns
$Q_{rr}$	Reverse recovery charge			165		nC
$I_{rrm}$	Reverse recovery current			2.4		A

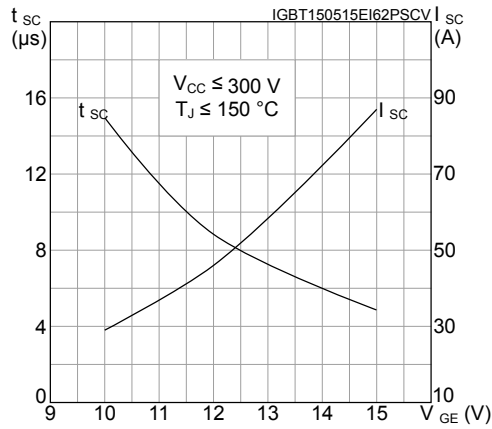
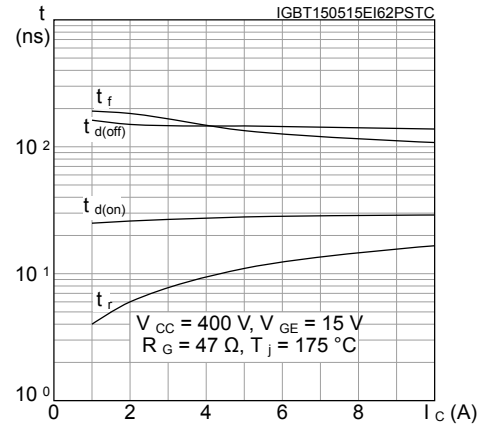
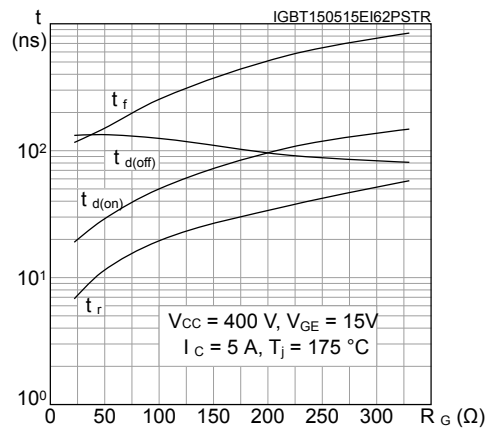
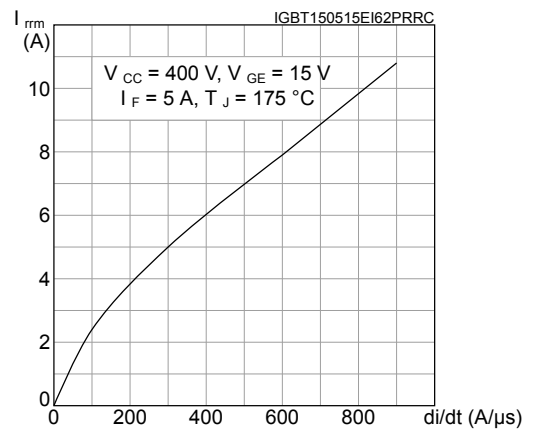
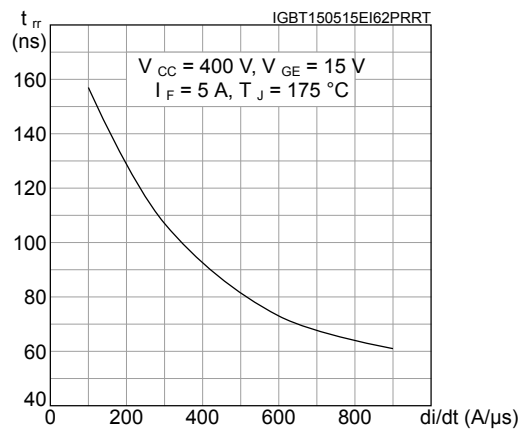
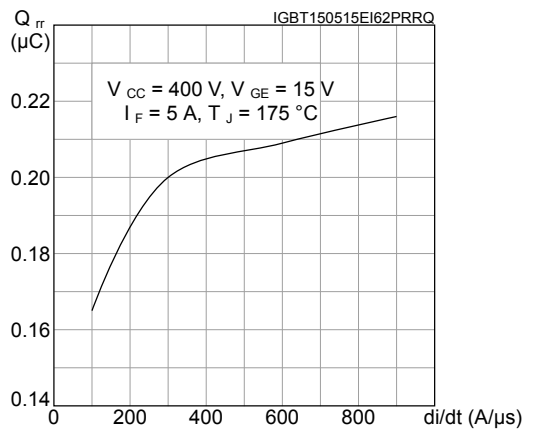
**2.1 Electrical characteristics (curves)**
**Figure 1. Power dissipation vs case temperature for D<sup>2</sup>PAK and TO-220**

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

**Figure 3. Power dissipation vs case temperature for DPAK**

**Figure 4. Collector current vs case temperature for DPAK**

**Figure 5. Power dissipation vs case temperature for TO-220FP**

**Figure 6. Collector current vs case temperature for TO-220FP**


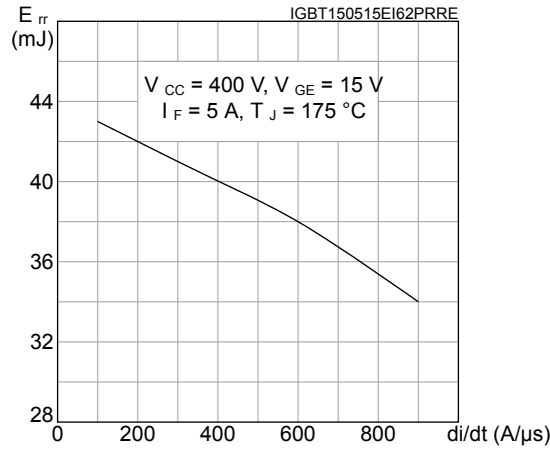
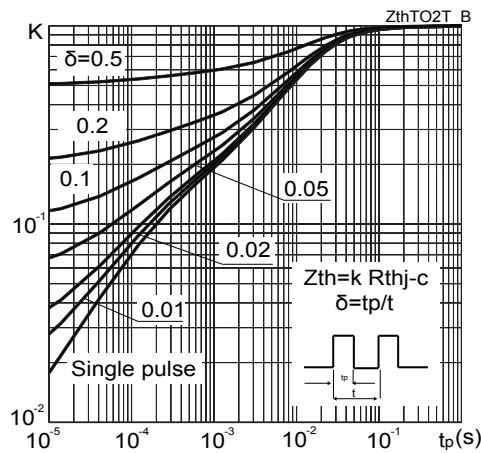
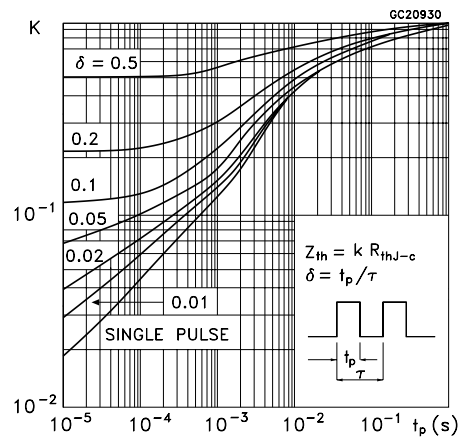
**Figure 7. Output characteristics ( $T_J = 25^\circ\text{C}$ )**

**Figure 8. Output characteristics ( $T_J = 175^\circ\text{C}$ )**

**Figure 9.  $V_{CE(sat)}$  vs junction temperature**

**Figure 10.  $V_{CE(sat)}$  vs collector current**

**Figure 11. Collector current vs switching frequency for D<sup>2</sup>PAK, DPAK and TO-220**

**Figure 12. Collector current vs switching frequency for TO-220FP**


**Figure 13. Forward bias safe operating area for D<sup>2</sup>PAK, DPAK and TO-220**

**Figure 14. Forward bias safe operating area for TO-220FP**

**Figure 15. Transfer characteristics**

**Figure 16. Diode V\_F vs forward current**

**Figure 17. Normalized V\_GE(th) vs junction temperature**

**Figure 18. Normalized V\_BR(CES) vs junction temperature**




**Figure 19. Capacitance variation**

**Figure 20. Gate charge vs. gate-emitter voltage**

**Figure 21. Switching energy vs collector current**

**Figure 22. Switching energy vs gate resistance**

**Figure 23. Switching energy vs temperature**

**Figure 24. Switching energy vs collector-emitter voltage**


**Figure 25. Short circuit time and current vs  $V_{GE}$** 

**Figure 26. Switching times vs collector current**

**Figure 27. Switching times vs gate resistance**

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

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

**Figure 30. Reverse recovery charge vs diode current slope**


**Figure 31. Reverse recovery energy vs diode current slope**

**Figure 32. Thermal impedance for D<sup>2</sup>PAK, DPAK and TO-220 IGBT**

**Figure 33. Thermal impedance for D<sup>2</sup>PAK, DPAK and TO-220 diode**


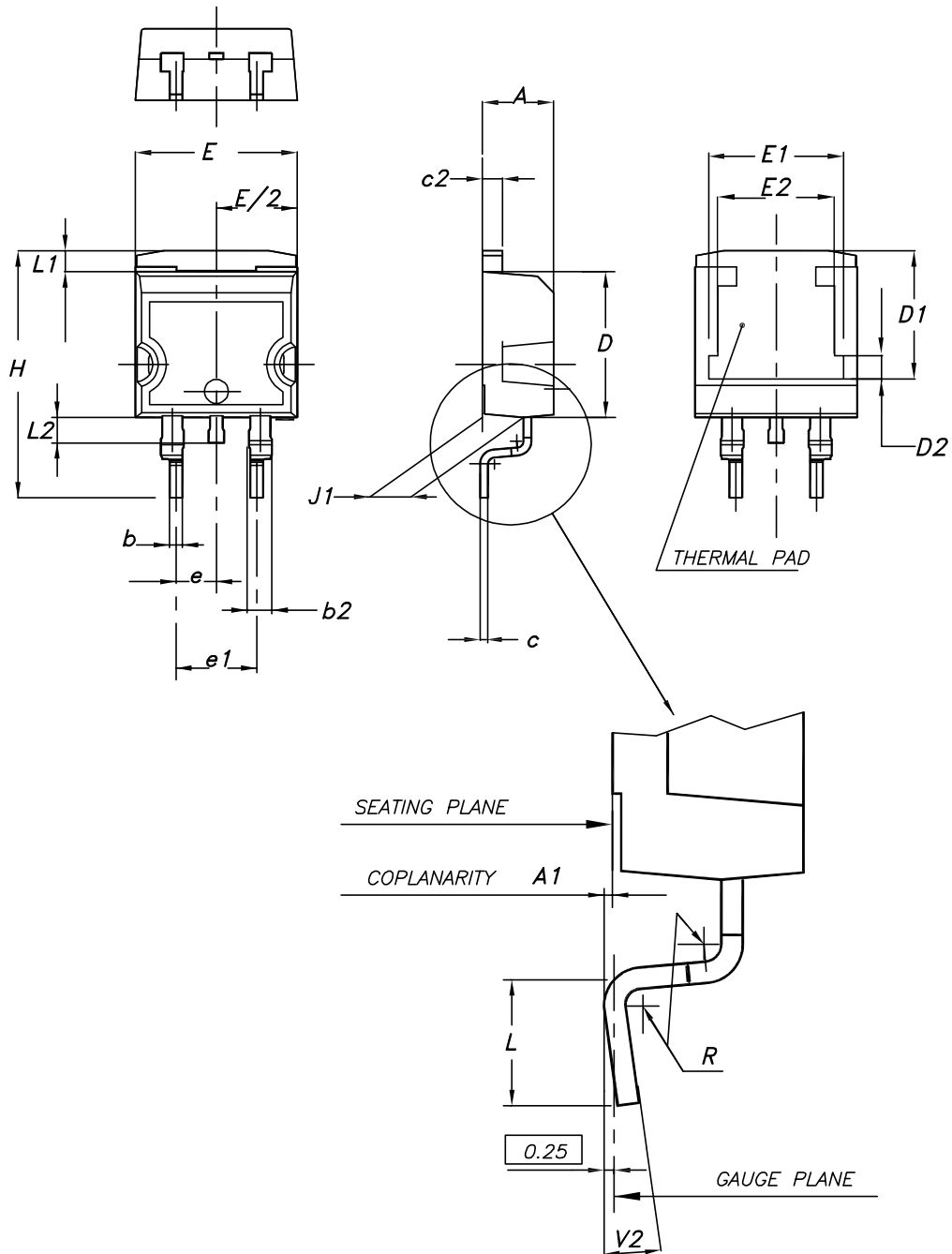


## 4 Package information

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 A package information

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

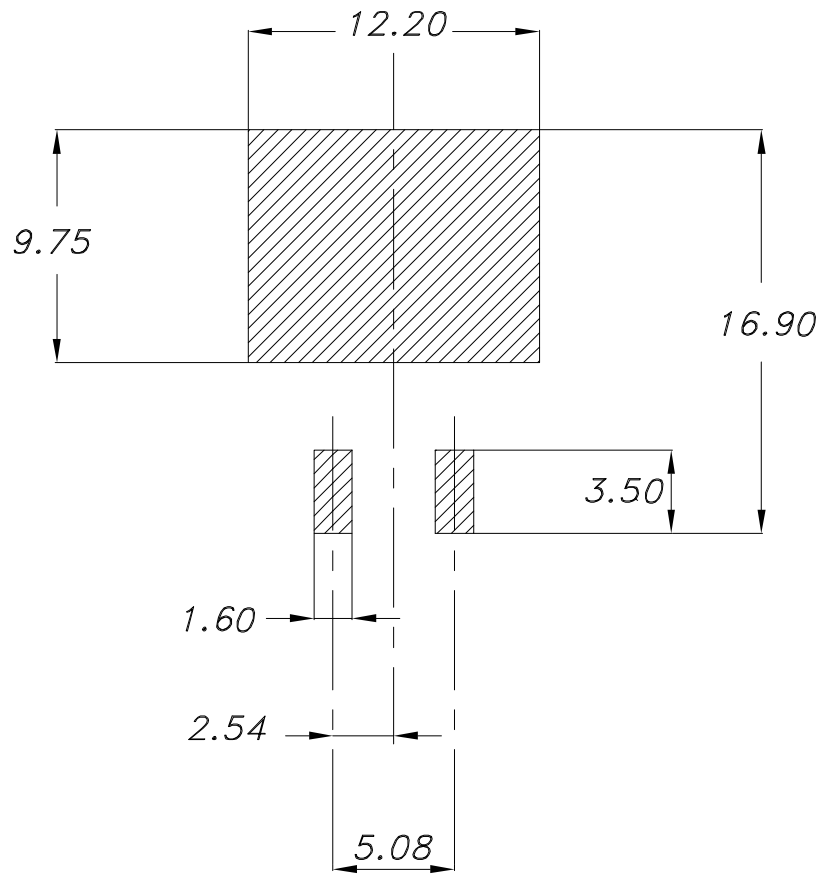


0079457\_26

**Table 8. D<sup>2</sup>PAK (TO-263) type A 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	8.30	8.50	8.70
E2	6.85	7.05	7.25
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°

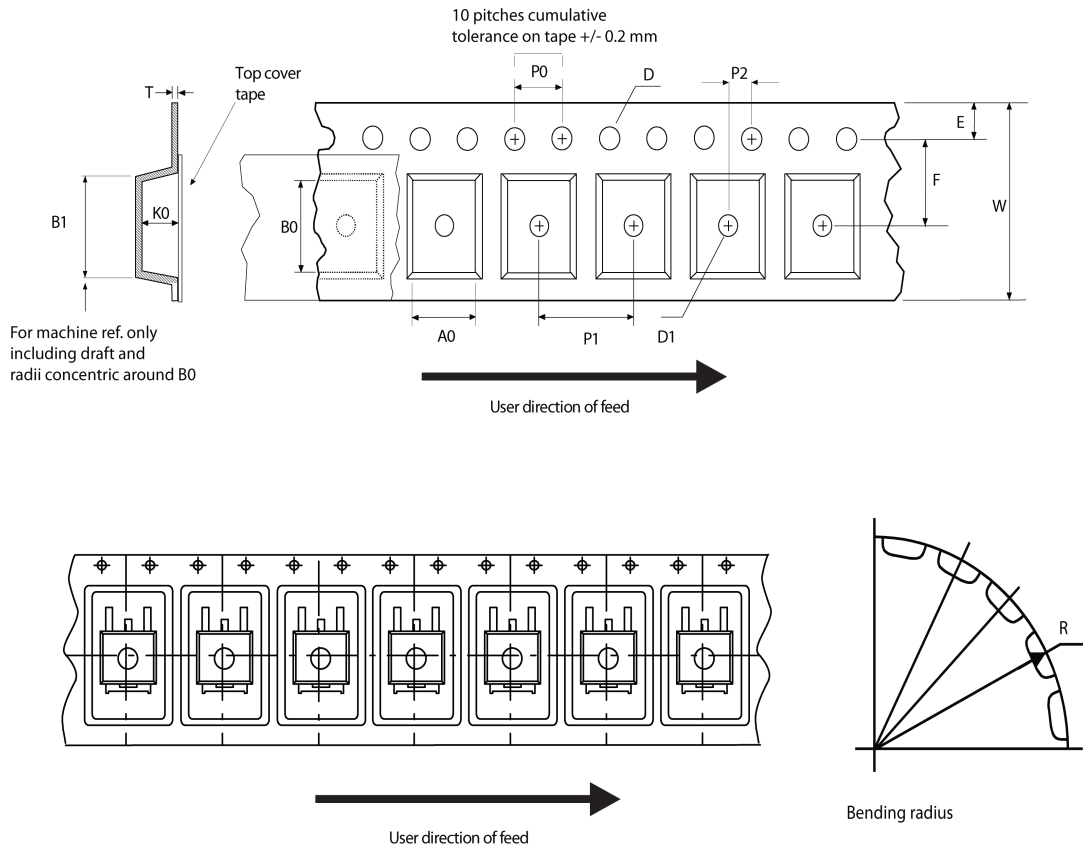
Figure 39. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint\_26

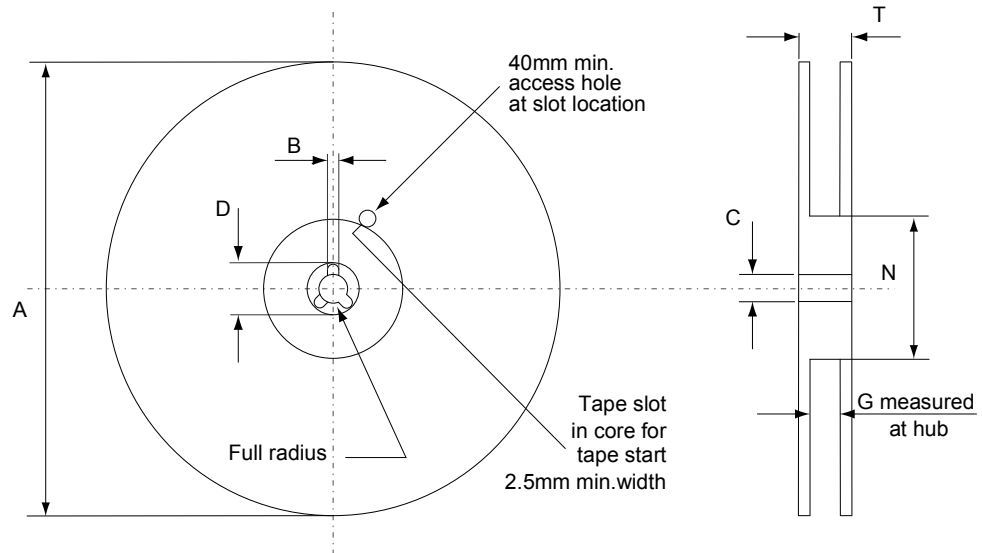
## 4.2 D<sup>2</sup>PAK packing information

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



AM08852v1



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


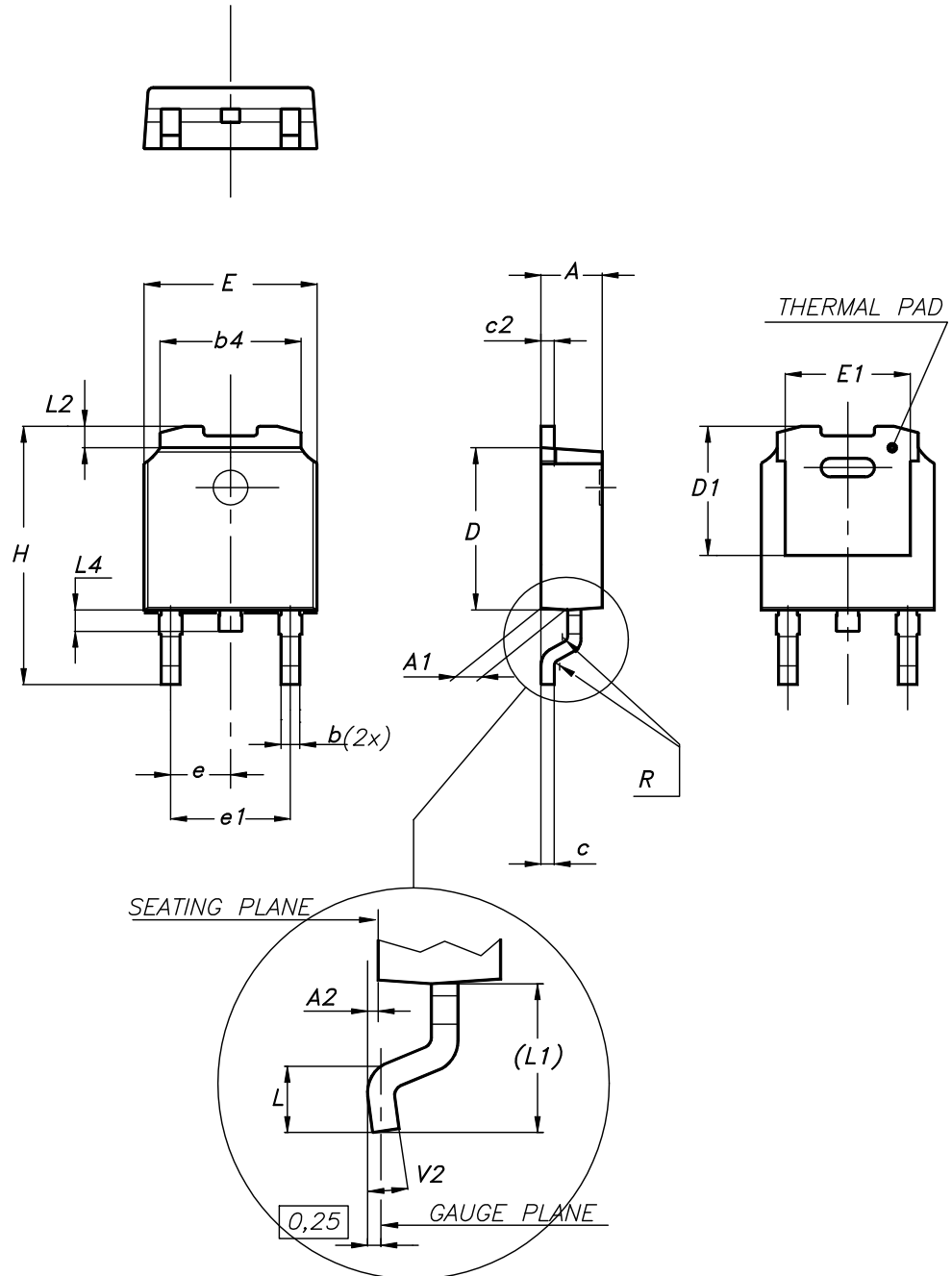
AM06038v1

**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 DPAK (TO-252) type A2 package information

Figure 42. DPAK (TO-252) type A2 package outline



0068772\_type-A2\_rev27

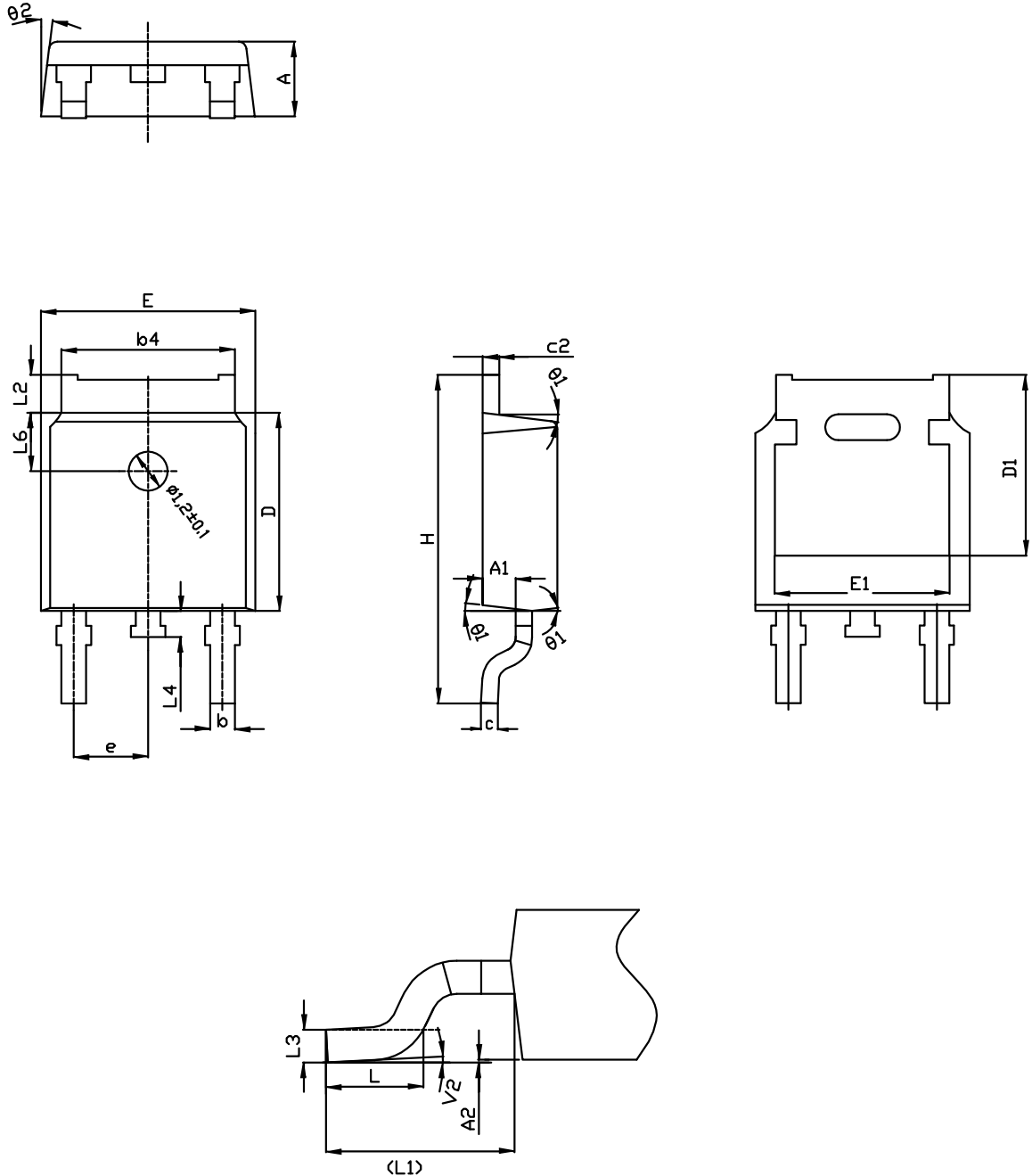
Table 10. DPAK (TO-252) type A2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10

Dim.	mm		
	Min.	Typ.	Max.
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	5.10	5.20	5.30
e	2.159	2.286	2.413
e1	4.445	4.572	4.699
H	9.35		10.10
L	1.00		1.50
L1	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

#### 4.4 DPAK (TO-252) type C2 package information

Figure 43. DPAK (TO-252) type C2 package outline



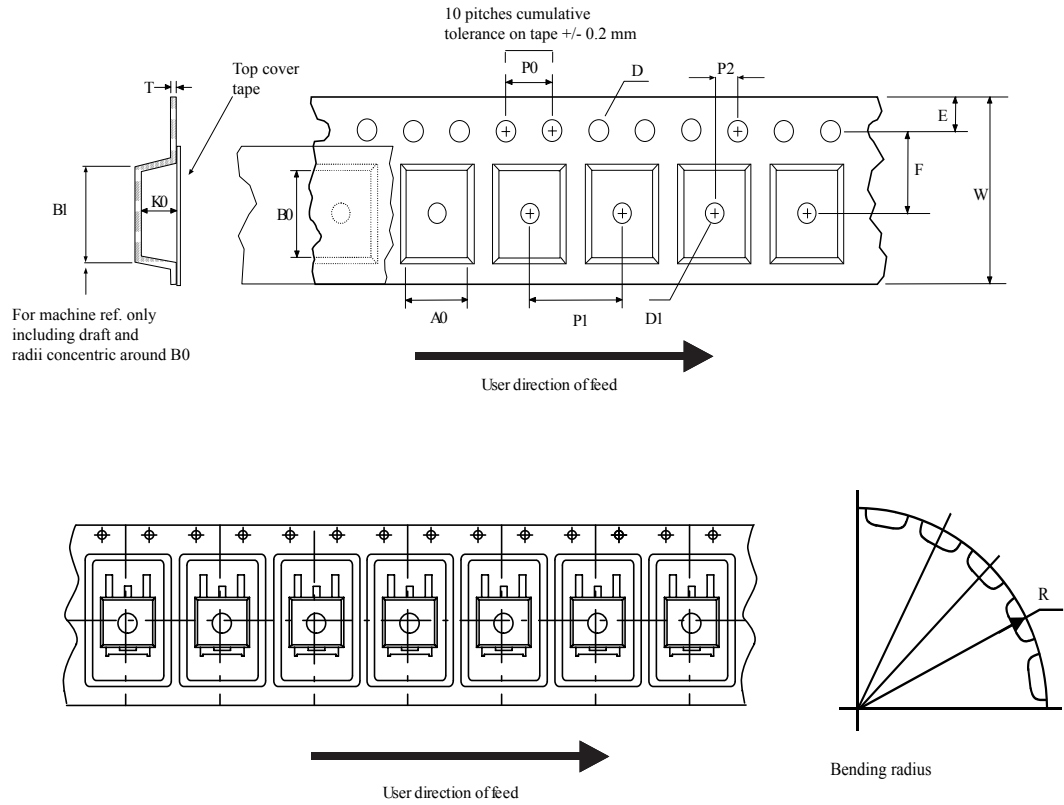
0068772\_C2\_25

**Table 11. DPAK (TO-252) type C2 mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.10		5.60
E	6.50	6.60	6.70
E1	5.20		5.50
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.90		1.25
L3	0.51 BSC		
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

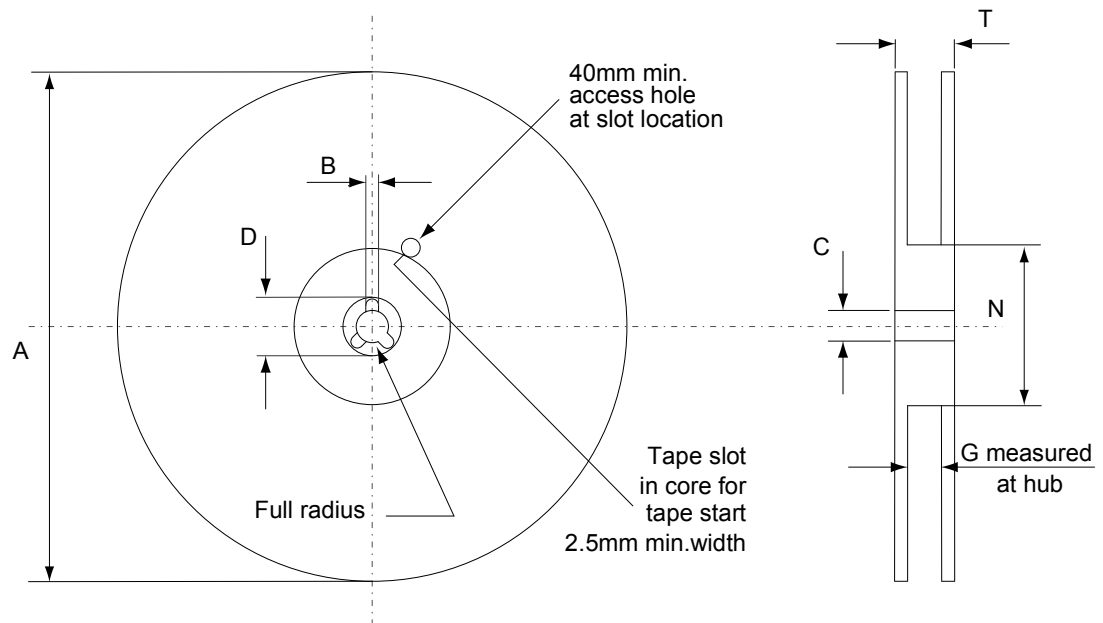
## 4.5 DPAK (TO-252) packing information

Figure 44. DPAK (TO-252) tape outline



AM08852v1

Figure 45. DPAK (TO-252) reel outline



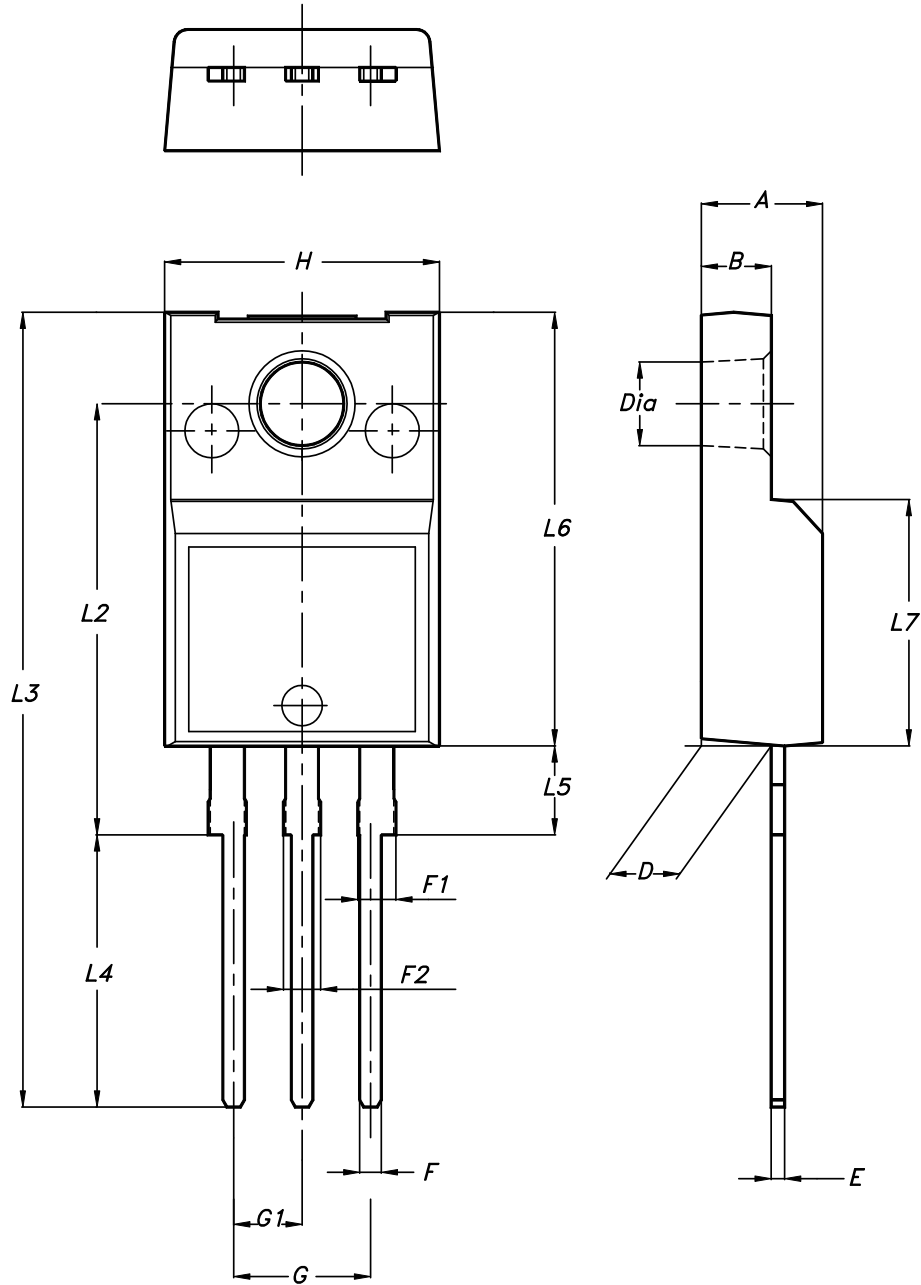
AM06038v1

Table 12. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1		Base qty.	2500
P1	7.9	8.1		Bulk qty.	2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

## 4.6 TO-220FP package information

Figure 46. TO-220FP package outline



7012510\_Rev\_13\_B

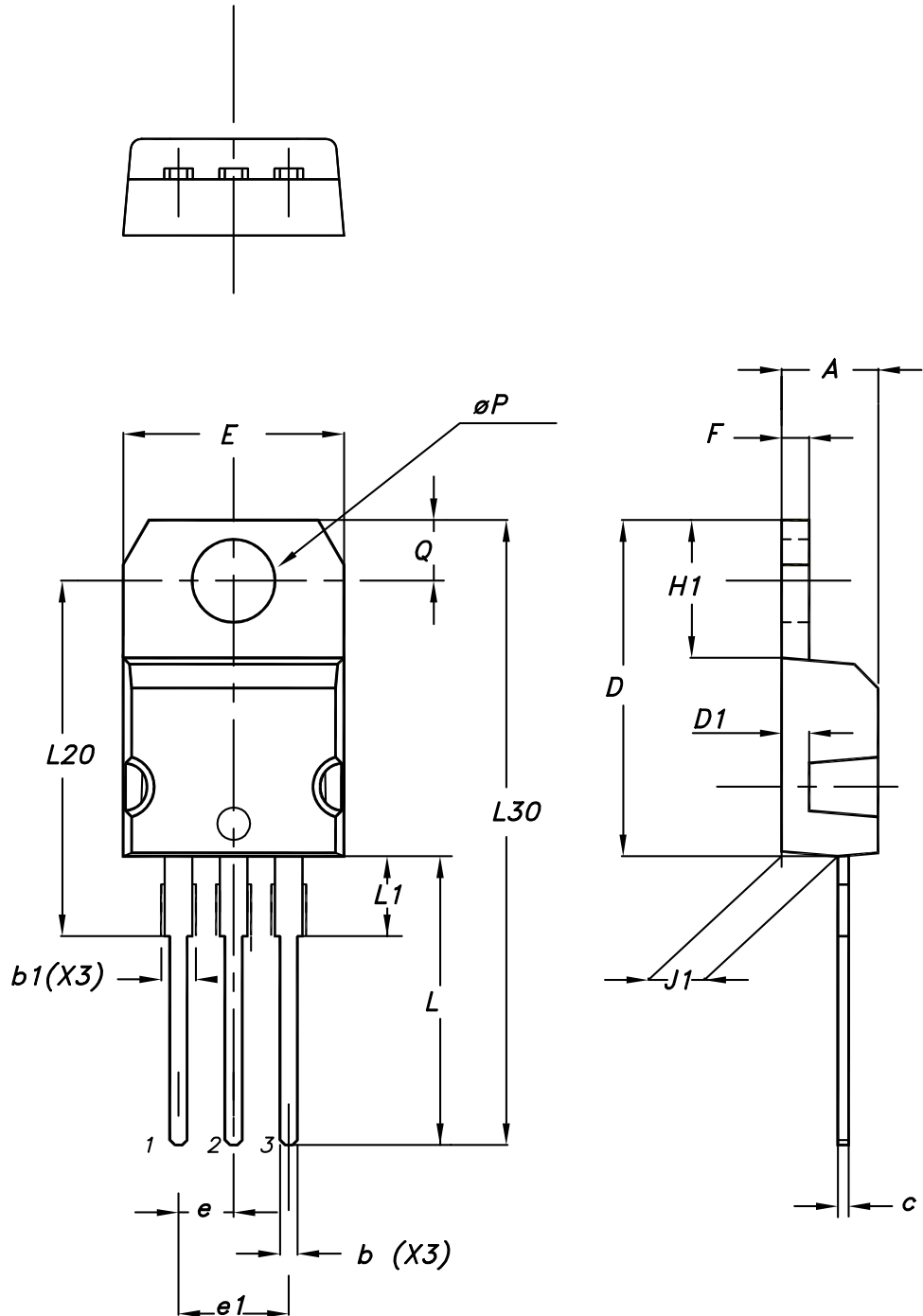


**Table 13. TO-220FP package mechanical data**

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

4.7 TO-220 type A package information

Figure 47. TO-220 type A package outline



0015988\_typeA\_Rev\_22

**Table 14. 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 15. Order codes**

Order code	Marking	Package	Packing
STGB5H60DF	GB5H60DF	D <sup>2</sup> PAK	Tape and reel
STGD5H60DF	GD5H60DF	DPAK	
STGF5H60DF	GF5H60DF	TO-220FP	Tube
STGP5H60DF	GP5H60DF	TO-220	

## Revision history

**Table 16. Document revision history**

Date	Version	Changes
28-Nov-2014	1	Initial release.
23-Feb-2015	2	Updated <i>Section 2: Electrical characteristics</i> and <i>Section 4: Package information</i> . Minor text changes.
18-May-2015	3	Text and formatting changes throughout document In <i>Section 1: Electrical ratings</i> : - updated <i>Table 2</i> and <i>Table 3</i> In <i>Section 2: Electrical characteristics</i> : - updated <i>Table 4</i> , <i>Table 5</i> , <i>Table 6</i> , <i>Table 7</i> and <i>Table 8</i> Added <i>Section 2.1: Electrical characteristics (curves)</i> Updated <i>Section 4.2: DPAK package information</i> Document status promoted from "preliminary data" to "production data"
18-Sep-2018	4	Removed maturity status indication from cover page. Updated <i>Section 4 Package information</i> . Minor text changes.
02-Mar-2020	5	Updated <a href="#">Table 4. Dynamic</a> . Updated <a href="#">Figure 20. Gate charge vs. gate-emitter voltage</a> . 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 A package information .....	13
<b>4.2</b>	D <sup>2</sup> PAK packing information .....	16
<b>4.3</b>	DPAK (TO-252) type A2 package information .....	18
<b>4.4</b>	DPAK (TO-252) type C2 package information .....	20
<b>4.5</b>	DPAK (TO-252) packing information .....	22
<b>4.6</b>	TO-220FP package information .....	24
<b>4.7</b>	TO-220 type A package information .....	26
<b>5</b>	<b>Ordering information</b> .....	<b>28</b>
	<b>Revision history</b> .....	<b>29</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