

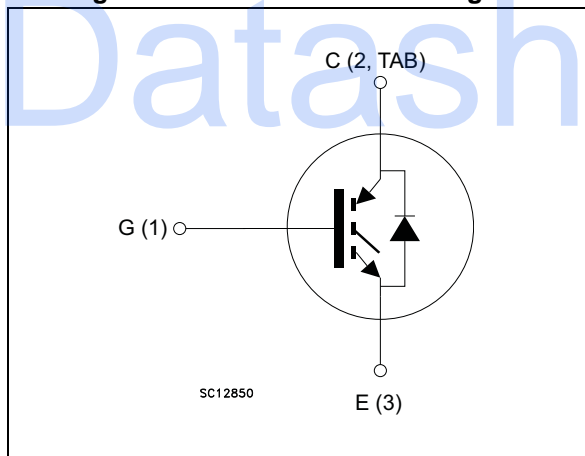
### Features

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

### Applications

- Motor control
- UPS, PFC

Figure 1. Internal schematic diagram



### Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT series offers the optimum compromise between conduction and switching losses, maximizing the efficiency of very high frequency converters. Furthermore, a positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STGB7H60DF	GB7H60DF	D <sup>2</sup> PAK	Tape and reel
STGF7H60DF	GF7H60DF	TO-220FP	Tube
STGP7H60DF	GP7H60DF	TO-220	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	TO-220 D <sup>2</sup> PAK	TO-220FP	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600		V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	14	14 <sup>(1)</sup>	A
	Continuous collector current at $T_C = 100\text{ °C}$	7	7 <sup>(1)</sup>	
$I_{CP}^{(2)}$	Pulsed collector current	28	28 <sup>(1)</sup>	A
$V_{GE}$	Gate-emitter voltage	±20		V
$I_F$	Continuous forward current $T_C = 25\text{ °C}$	14	14 <sup>(1)</sup>	A
	Continuous forward current at $T_C = 100\text{ °C}$	7	7 <sup>(1)</sup>	
$I_{FP}^{(2)}$	Pulsed forward current	28	28 <sup>(1)</sup>	A
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ , $T_C = 25\text{ °C}$ )		2500	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	88	24	W
$T_{STG}$	Storage temperature range	- 55 to 150		°C
$T_J$	Operating junction temperature	- 55 to 175		

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

**Table 3. Thermal data**

Symbol	Parameter	TO-220 D <sup>2</sup> PAK	TO-220FP	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	1.7	6.2	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	2.8	6.25	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	62.5		°C/W

## 2 Electrical characteristics

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

**Table 4. 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	$V_{GE} = 15\text{ V}, I_C = 7\text{ A}$		1.5	1.95	V
		$V_{GE} = 15\text{ V}, I_C = 7\text{ A}$ $T_J = 125\text{ °C}$		1.6		
		$V_{GE} = 15\text{ V}, I_C = 7\text{ A}$ $T_J = 175\text{ °C}$		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 ( $V_{GE} = 0\text{ V}$ )	$V_{CE} = 600\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0\text{ V}$ )	$V_{GE} = \pm 20\text{ V}$			250	nA

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0\text{ V}$	-	1050	-	pF
$C_{oes}$	Output capacitance		-	51	-	
$C_{res}$	Reverse transfer capacitance		-	23	-	
$Q_g$	Total gate charge	$V_{CC} = 480\text{ V}, I_C = 7\text{ A},$ $V_{GE} = 15\text{ V}$	-	46	-	nC
$Q_{ge}$	Gate-emitter charge		-	7	-	
$Q_{gc}$	Gate-collector charge		-	21	-	

Table 6. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 7\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$	-	30	-	ns
$t_r$	Current rise time		-	12.2	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	459	-	A/ $\mu$ s
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 7\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$	-	30	-	ns
$t_r$	Current rise time		-	12.8	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	440	-	A/ $\mu$ s
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 7\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$	-	24	-	ns
$t_{d(off)}$	Turn-off delay time		-	160	-	
$t_f$	Current fall time		-	69	-	
$t_{r(Voff)}$	Off voltage rise time	$V_{CE} = 400\text{ V}$ , $I_C = 7\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$	-	31	-	ns
$t_{d(off)}$	Turn-off delay time		-	164	-	
$t_f$	Current fall time		-	99	-	
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$ , $R_G = 47\ \Omega$	-	5	-	$\mu$ s

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$ , $I_C = 7\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$	-	99	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses		-	100	-	
$E_{ts}$	Total switching losses		-	199	-	
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CE} = 400\text{ V}$ , $I_C = 7\text{ A}$ , $R_G = 47\ \Omega$ , $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$	-	202	-	$\mu$ J
$E_{off}^{(2)}$	Turn-off switching losses		-	149	-	
$E_{ts}$	Total switching losses		-	351	-	

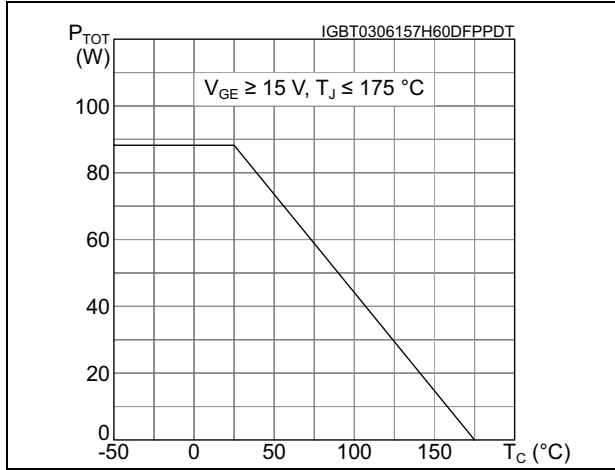
1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

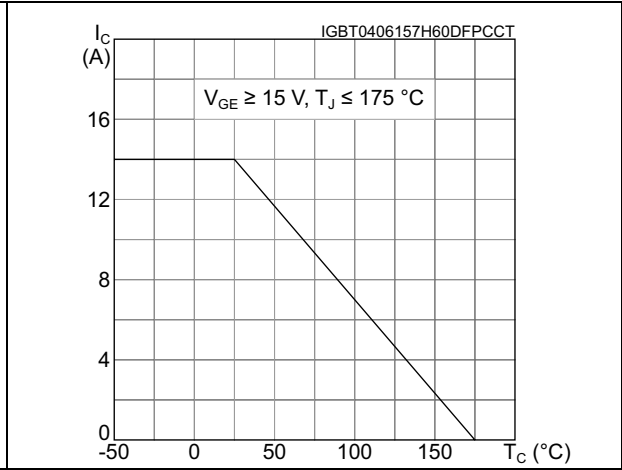
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 7\text{ A}$	-	1.5	2.1	V
		$I_F = 7\text{ A}, T_J = 175\text{ °C}$		1.15		
$t_{rr}$	Reverse recovery time	$V_{CC} = 400\text{ V}; I_F = 7\text{ A};$ $di_F/dt = 100\text{ A}/\mu\text{s}$	-	136		ns
$Q_{rr}$	Reverse recovery charge		-	104		nC
$I_{rrm}$	Reverse recovery current		-	2.25		A
$t_{rr}$	Reverse recovery time	$V_{CC} = 400\text{ V}; I_F = 7\text{ A};$ $di_F/dt = 100\text{ A}/\mu\text{s}$ $T_J = 175\text{ °C}$	-	154		ns
$Q_{rr}$	Reverse recovery charge		-	388		nC
$I_{rrm}$	Reverse recovery current		-	4.6		A

## 2.1 Electrical characteristics (curves)

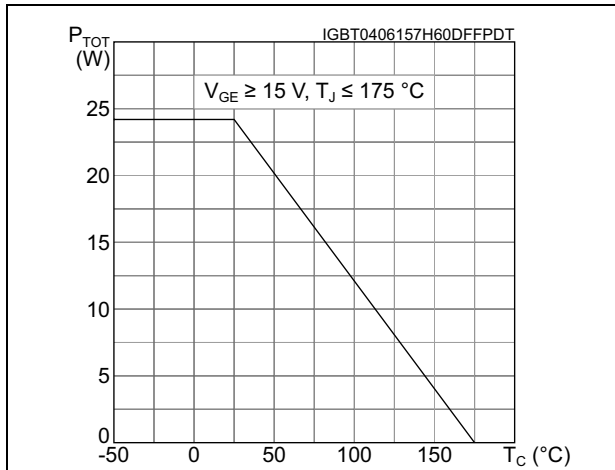
**Figure 2. Power dissipation vs. case temperature for D<sup>2</sup>PAK and TO-220**



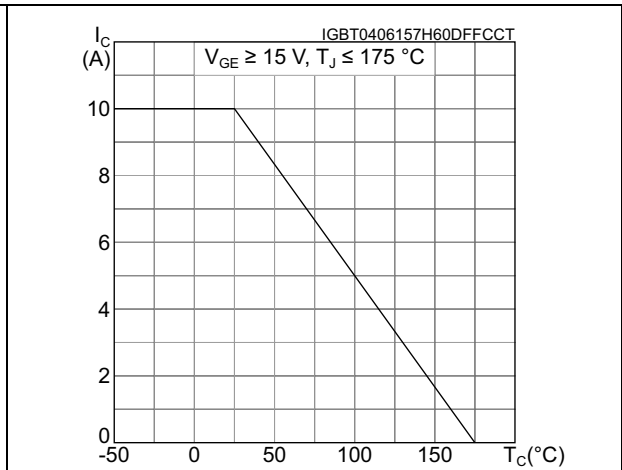
**Figure 3. Collector current vs. case temperature for D<sup>2</sup>PAK and TO-220**



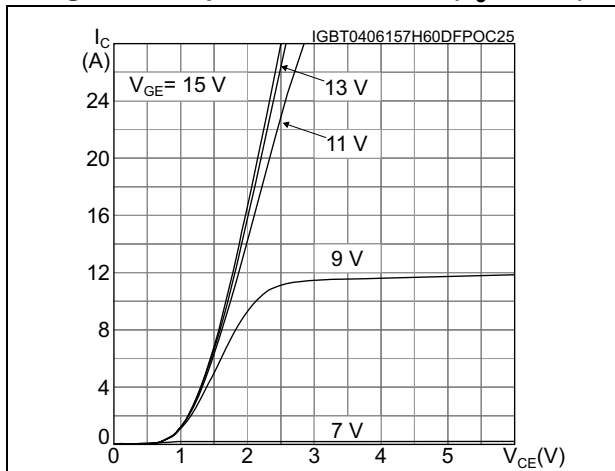
**Figure 4. Power dissipation vs. case temperature for TO-220FP**



**Figure 5. Collector current vs. case temperature for TO-220FP**



**Figure 6. Output characteristics (T<sub>J</sub> = 25°C)**



**Figure 7. Output characteristics (T<sub>J</sub> = 175°C)**

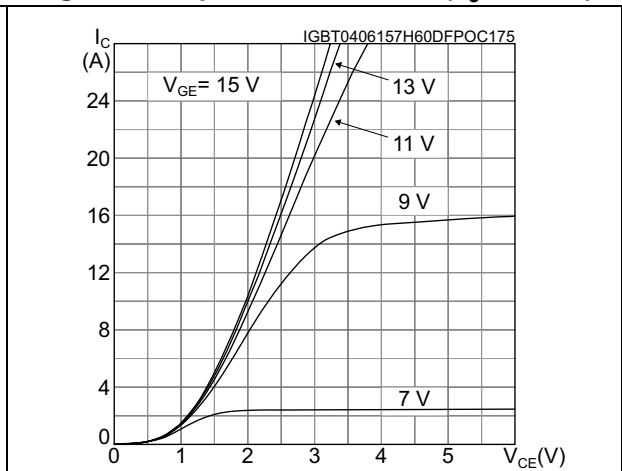


Figure 8.  $V_{CE(sat)}$  vs. junction temperature

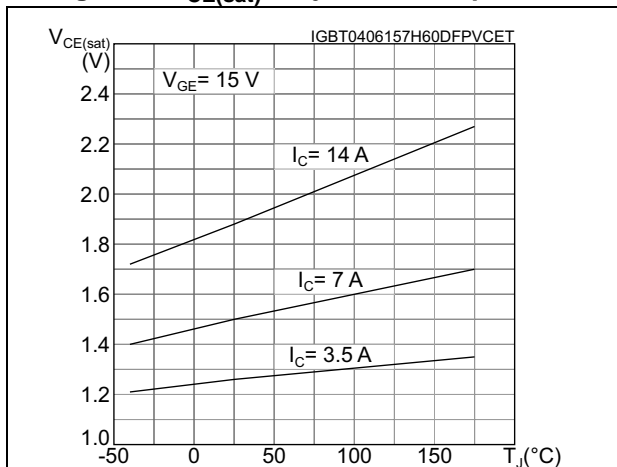


Figure 9.  $V_{CE(sat)}$  vs. collector current

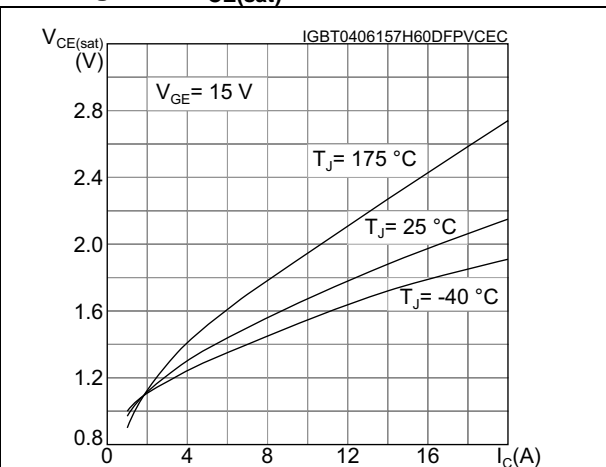


Figure 10. Collector current vs. switching frequency for D<sup>2</sup>PAK and TO-220

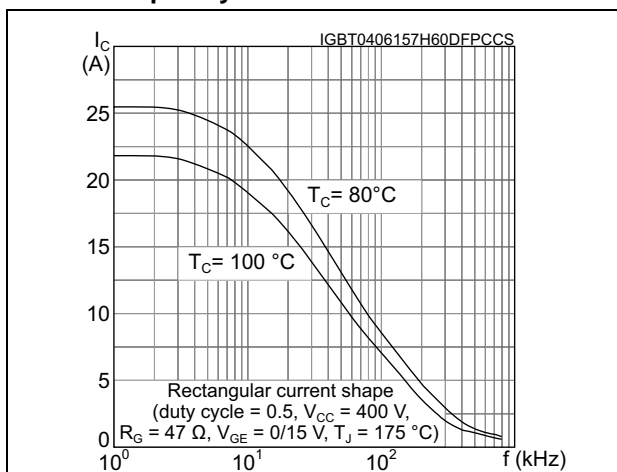


Figure 11. Collector current vs. switching frequency for TO-220FP

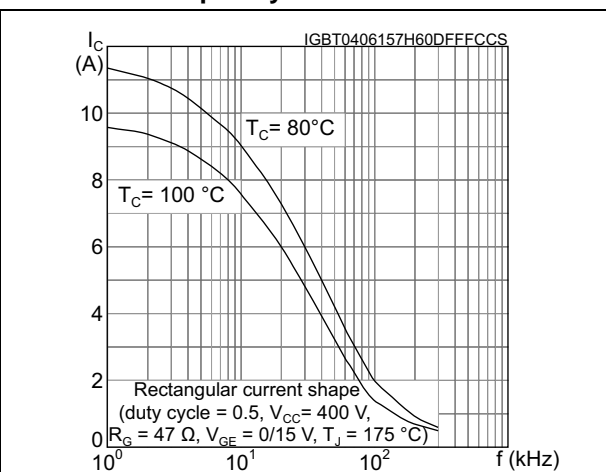


Figure 12. Forward bias safe operating area for D<sup>2</sup>PAK and TO-220

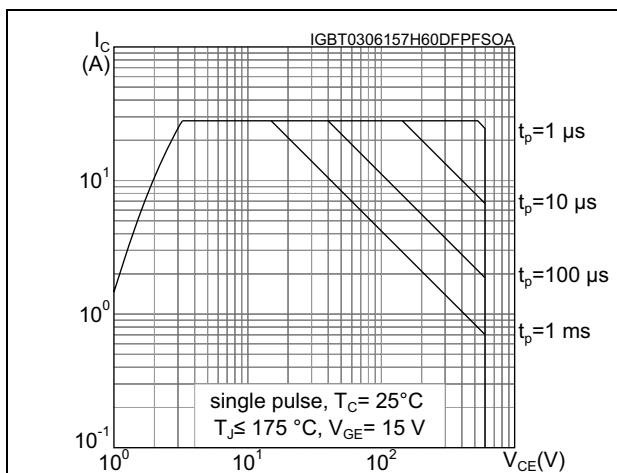


Figure 13. Forward bias safe operating area for TO-220FP

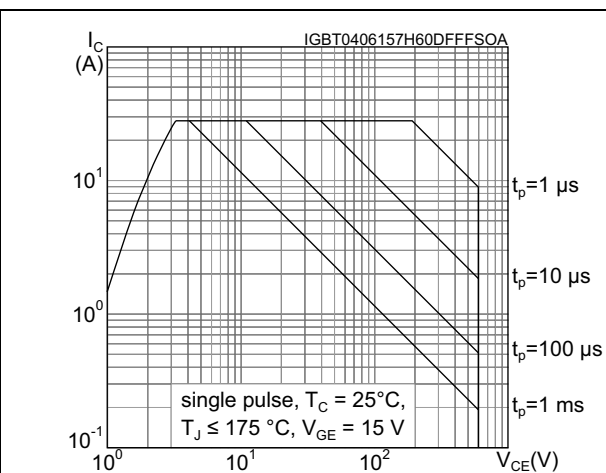




Figure 14. Transfer characteristics

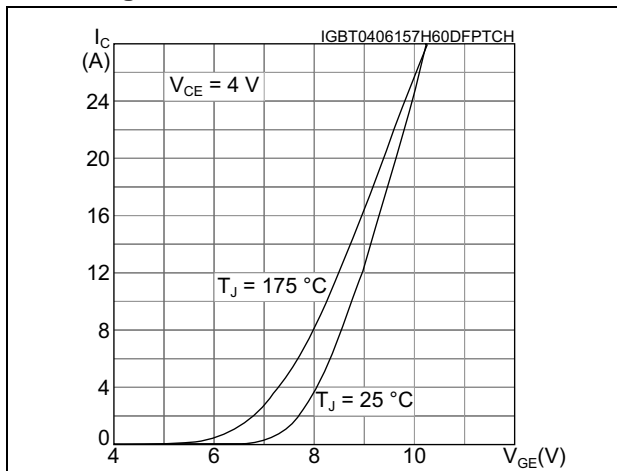


Figure 15. Diode VF vs. forward current

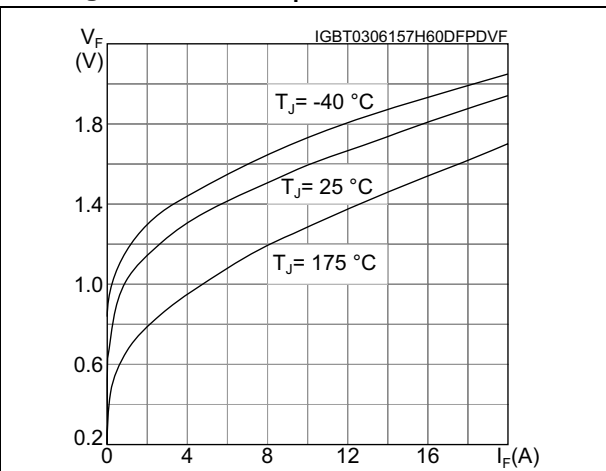


Figure 16. Normalized VGE(th) vs. junction temperature

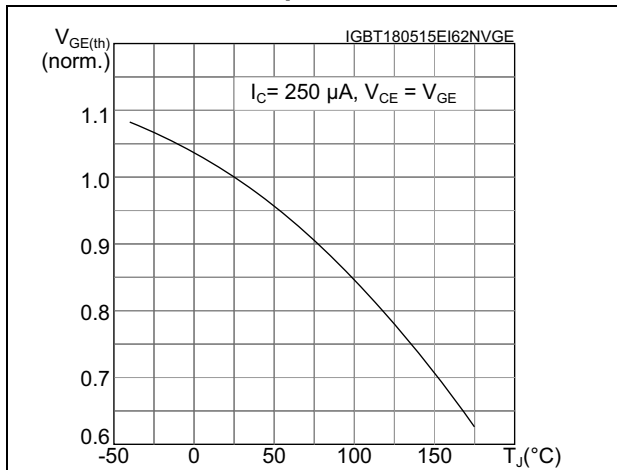


Figure 17. Normalized VBR(CES) vs. junction temperature

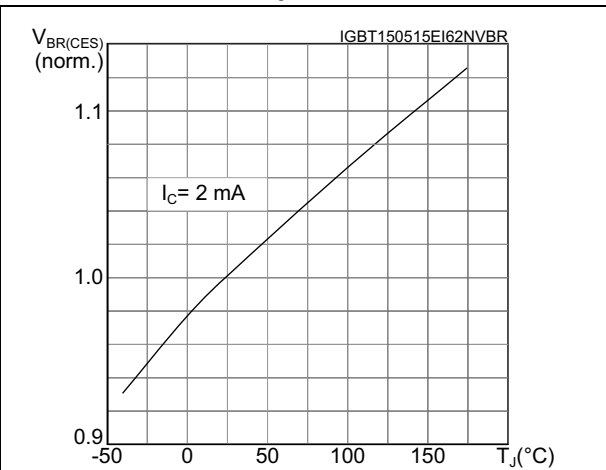


Figure 18. Capacitance variation

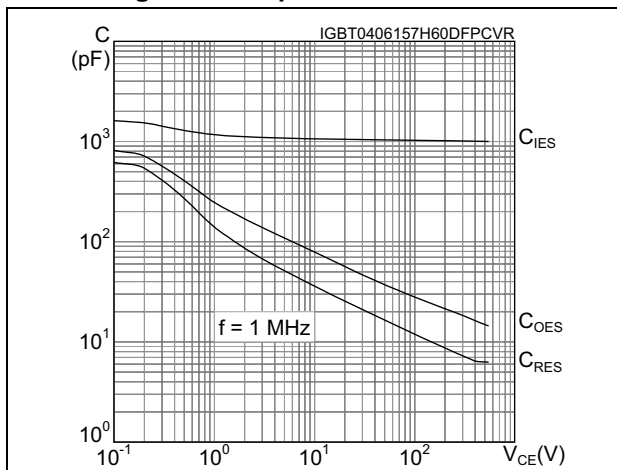


Figure 19. Gate charge vs. gate-emitter voltage

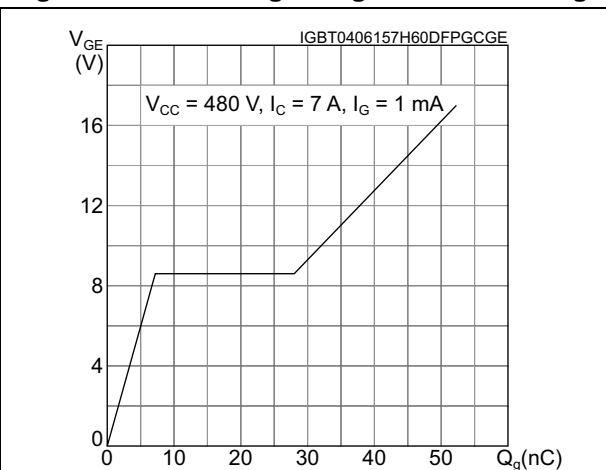


Figure 20. Switching loss vs. collector current

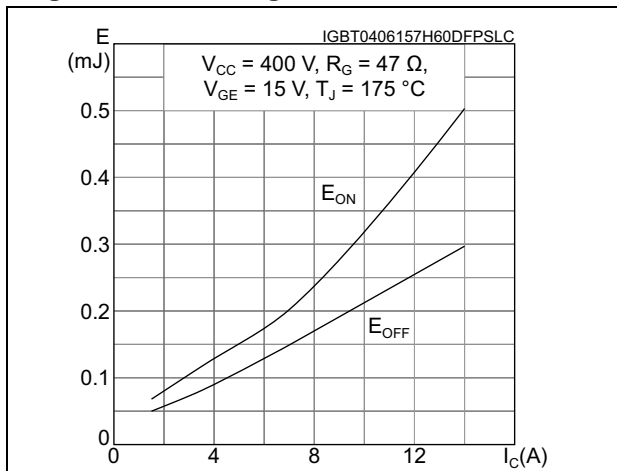


Figure 21. Switching loss vs. gate resistance

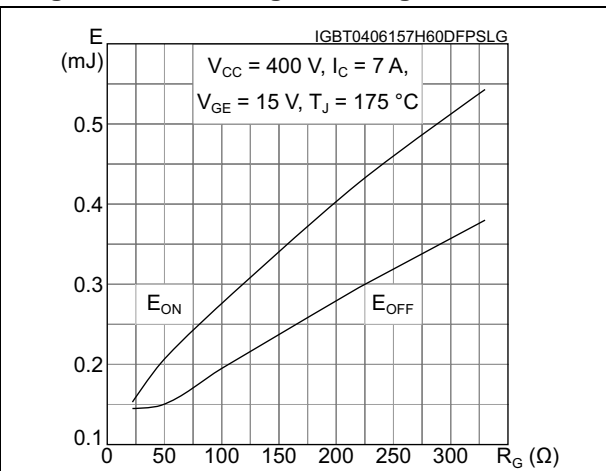


Figure 22. Switching loss vs. temperature

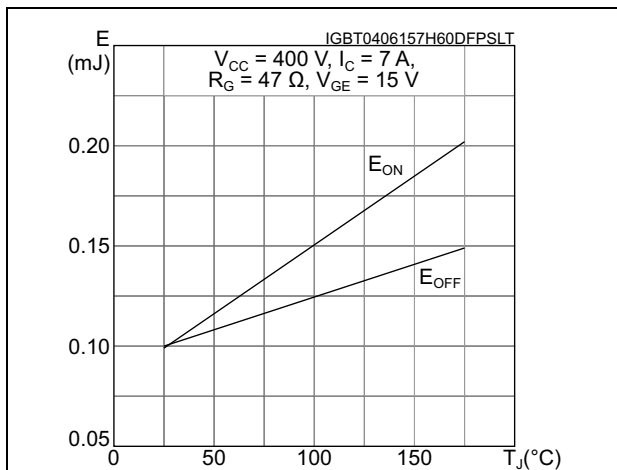


Figure 23. Switching loss vs. collector-emitter voltage

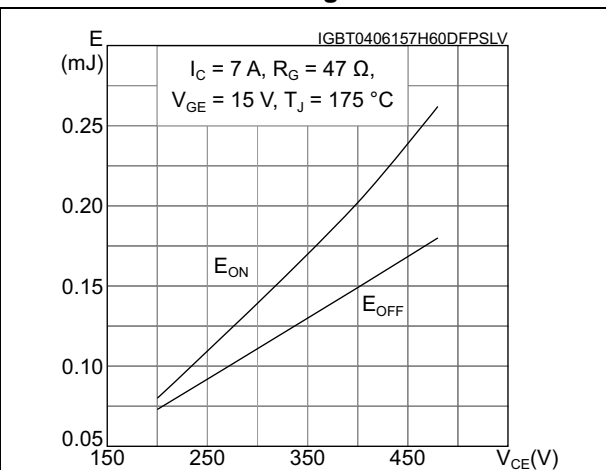


Figure 24. Short circuit time and current vs. Vge

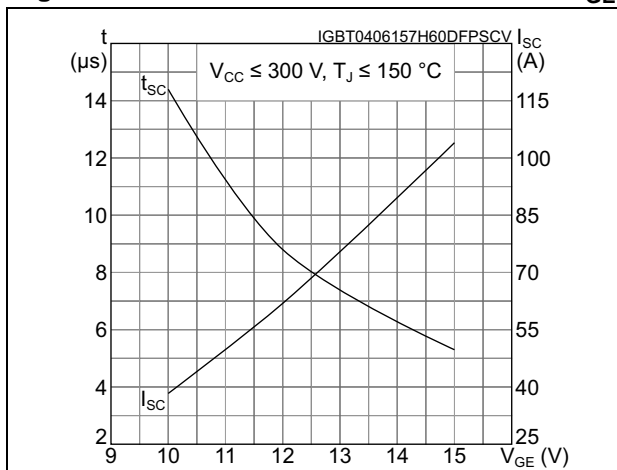


Figure 25. Switching times vs. collector current

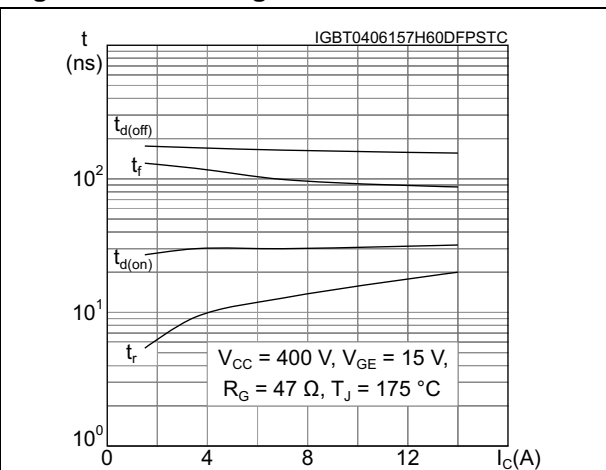


Figure 26. Switching times vs. gate resistance

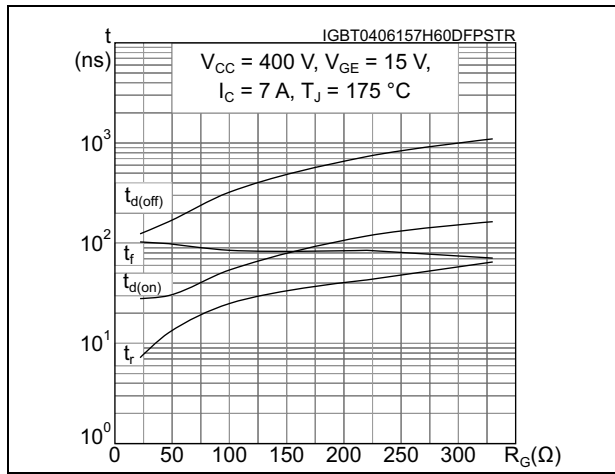


Figure 27. Reverse recovery current vs. diode current slope

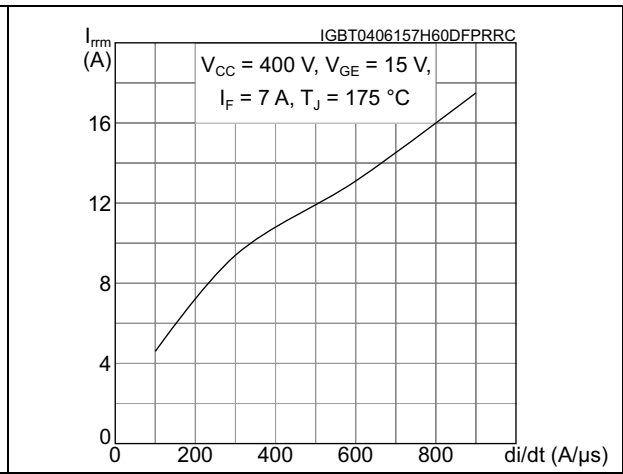


Figure 28. Reverse recovery time vs. diode current slope

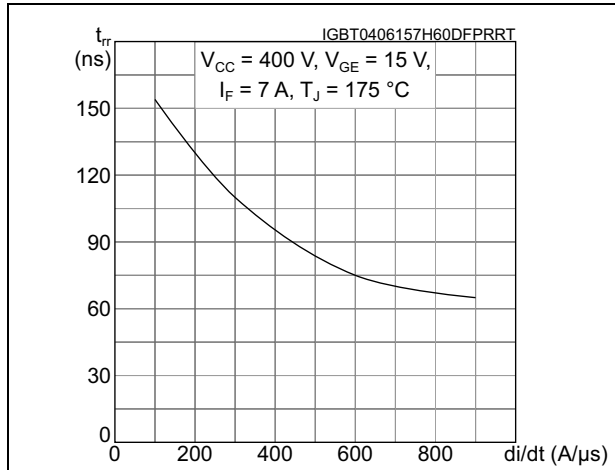


Figure 29. Reverse recovery charge vs. diode current slope

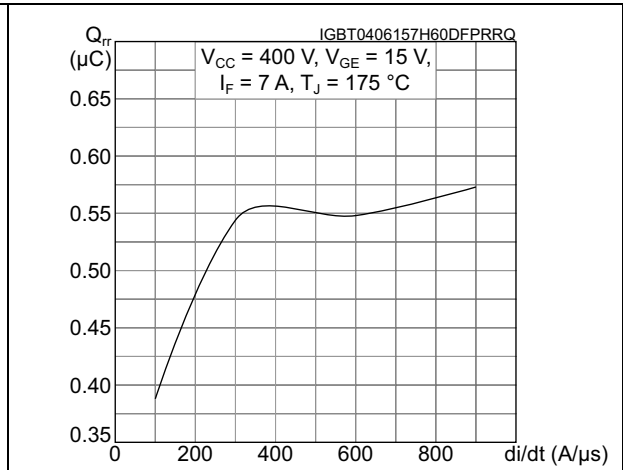


Figure 30. Reverse recovery energy vs. diode current slope

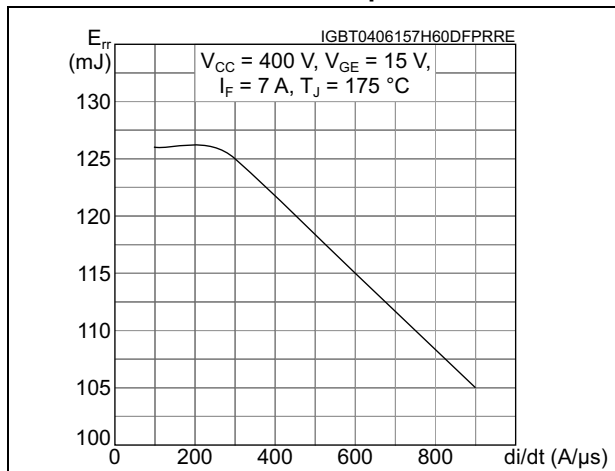


Figure 31. Thermal impedance for D<sup>2</sup>PAK and TO-220 IGBT

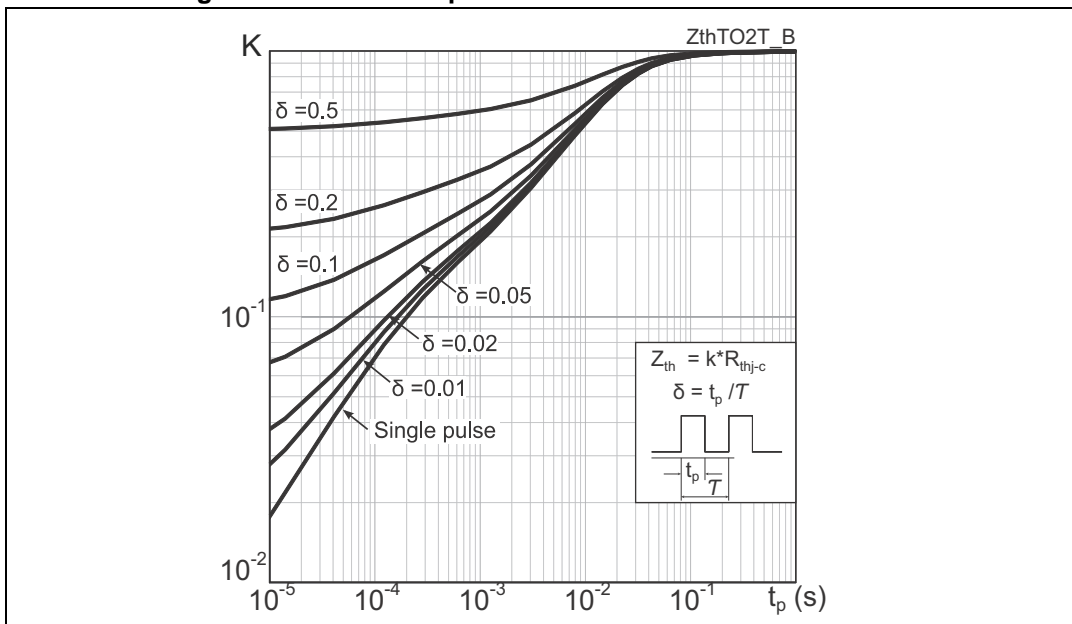


Figure 32. Thermal impedance for D<sup>2</sup>PAK and TO-220 diode

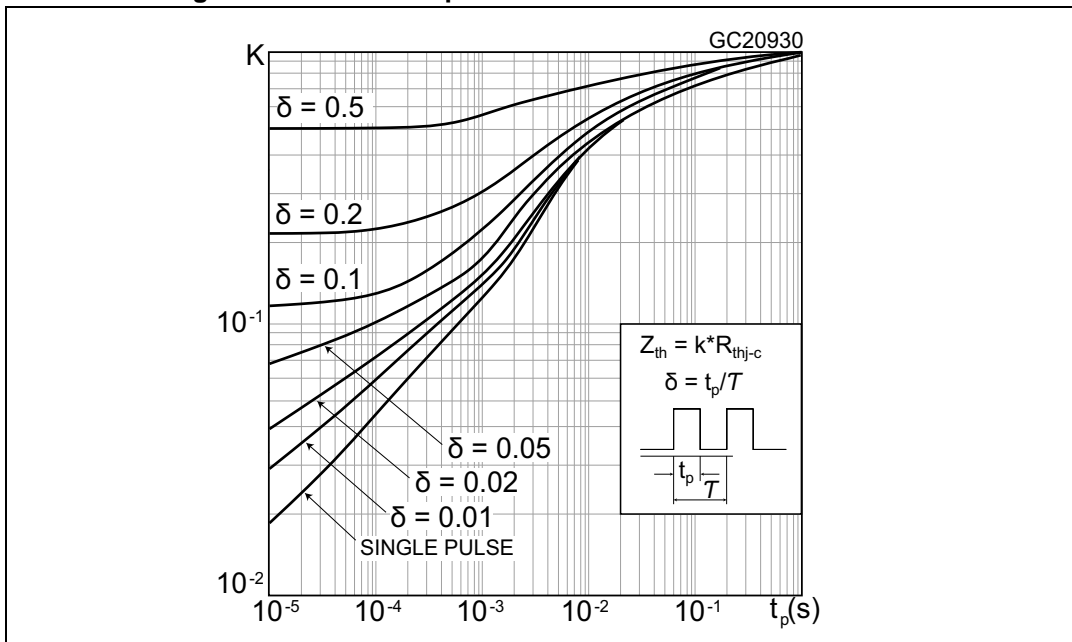


Figure 33. Thermal impedance for TO-220FP IGBT

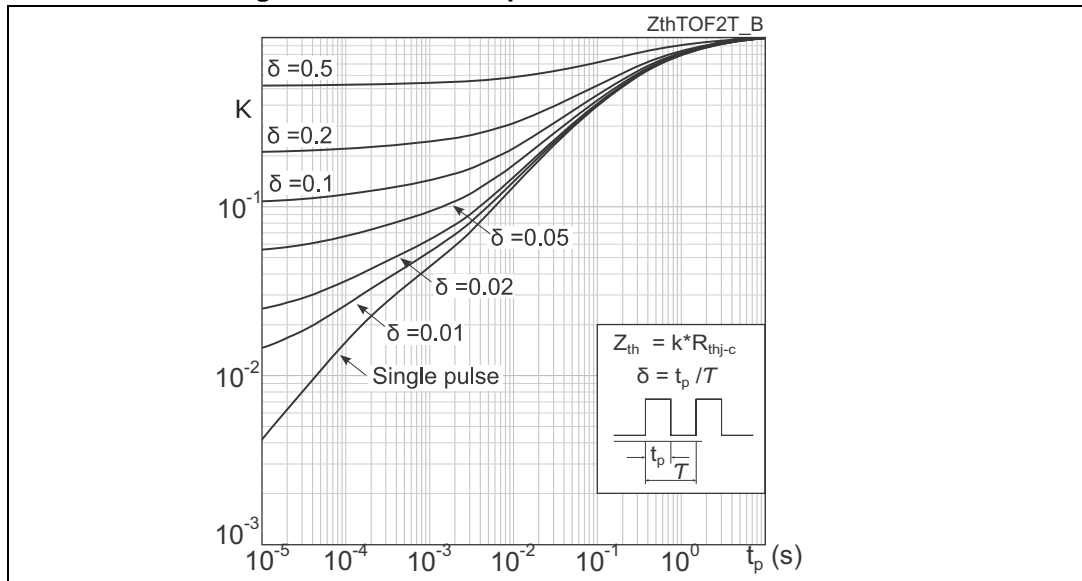
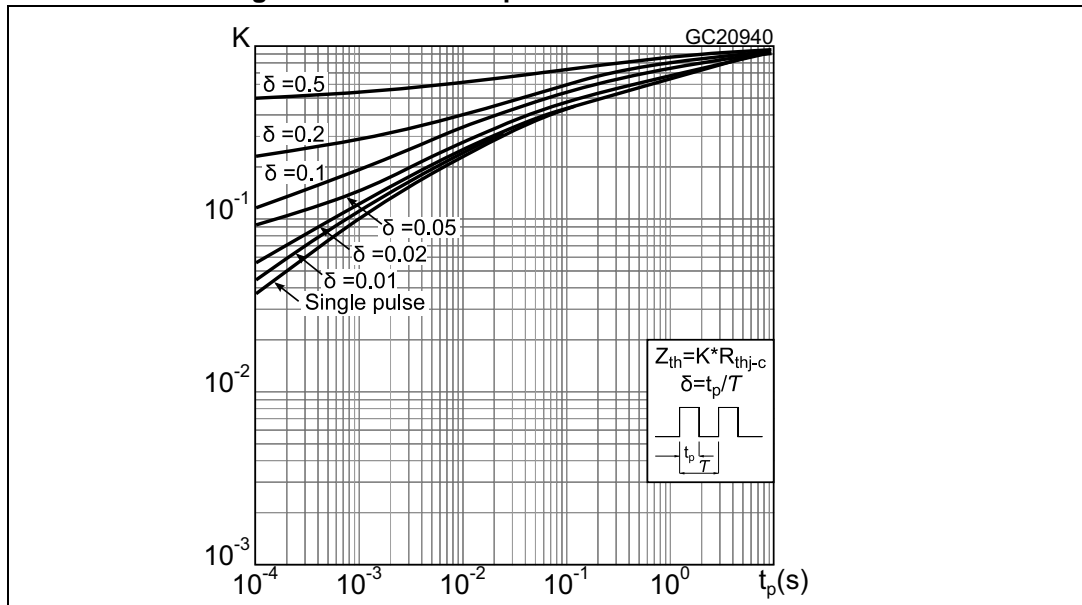


Figure 34. Thermal impedance for TO-220FP diode



### 3 Test circuits

Figure 35. Test circuit for inductive load switching

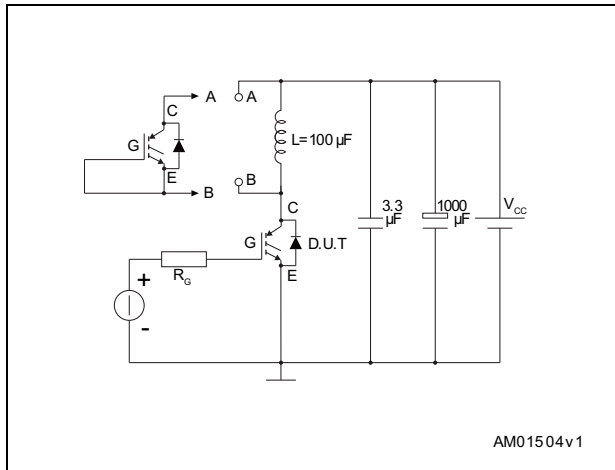


Figure 36. Gate charge test circuit

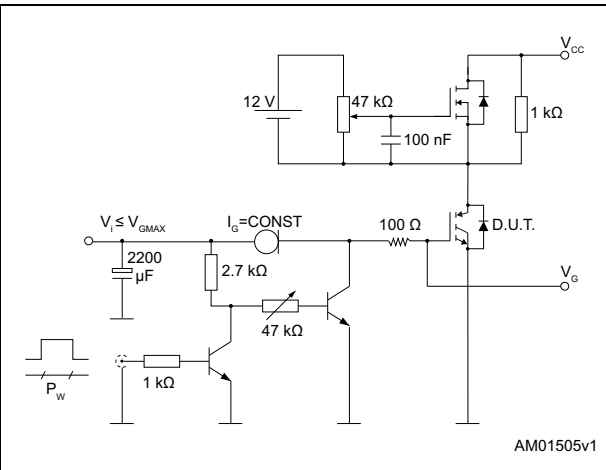


Figure 37. Switching waveform

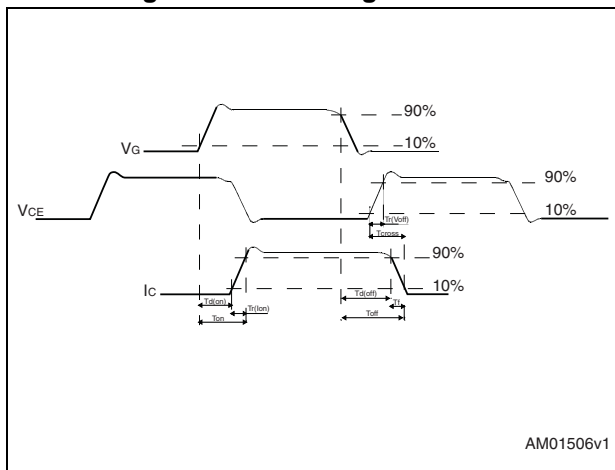
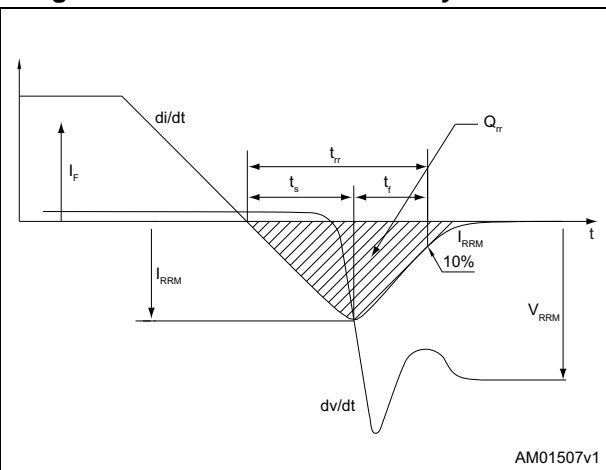


Figure 38. Diode reverse recovery waveform



## 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 package information

Figure 39. D<sup>2</sup>PAK (TO-263) type A package outline

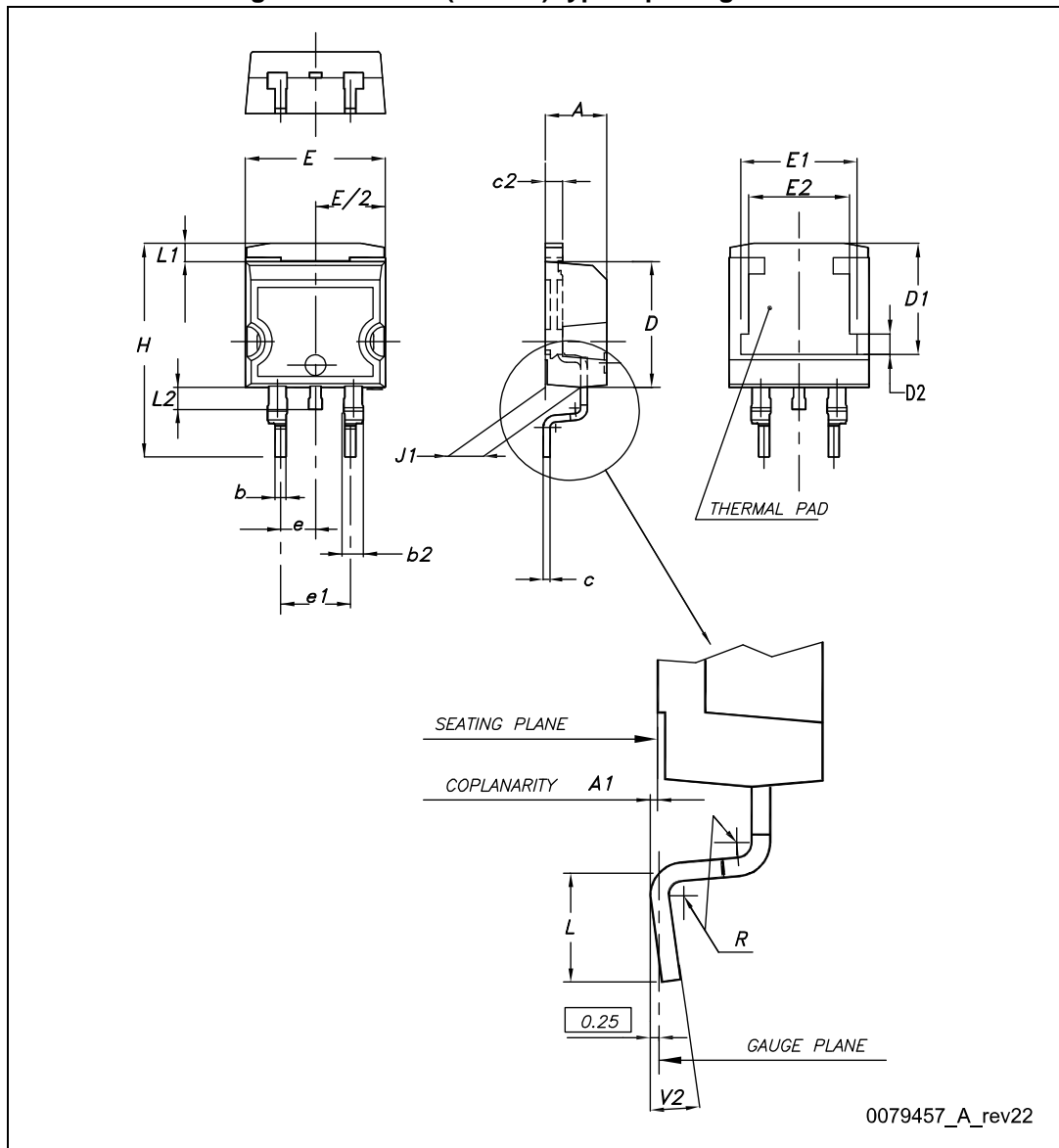
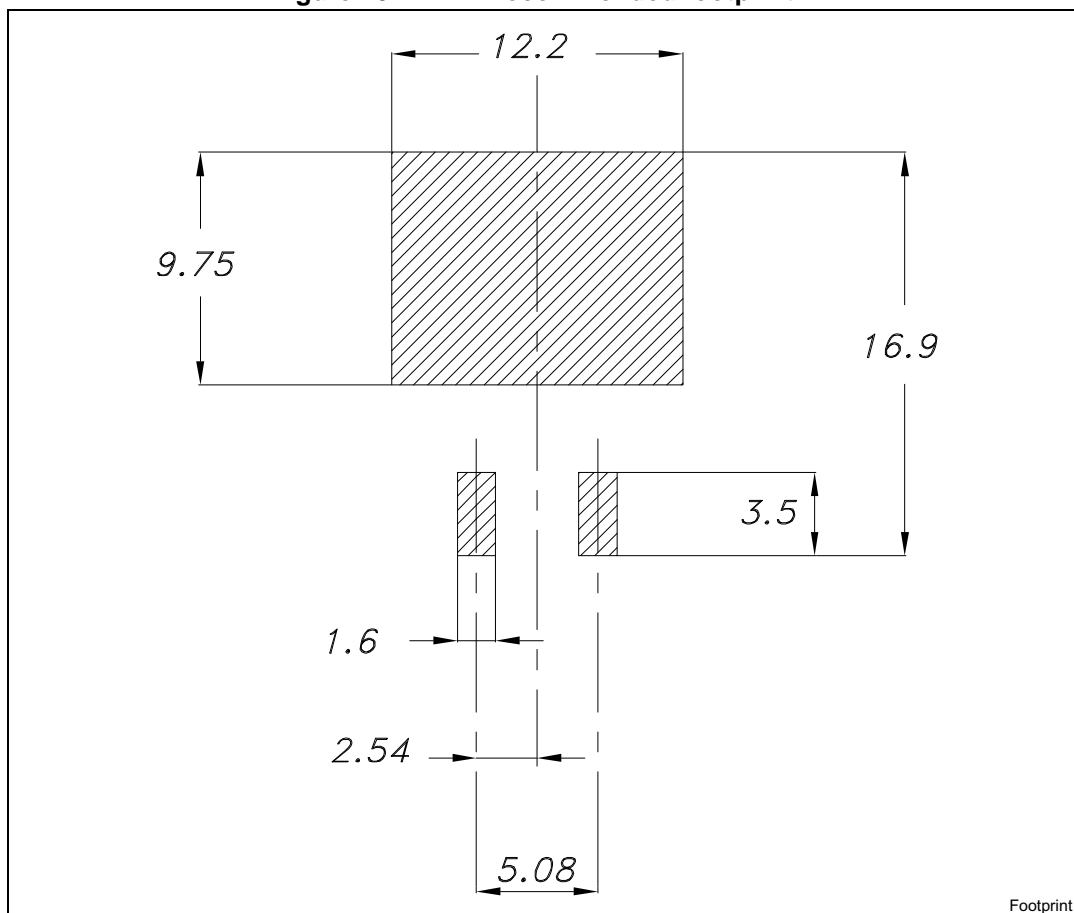


Table 9. D<sup>2</sup>PAK (TO-263) type A mechanical data

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		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°



Figure 40. D<sup>2</sup>PAK recommended footprint<sup>(a)</sup>

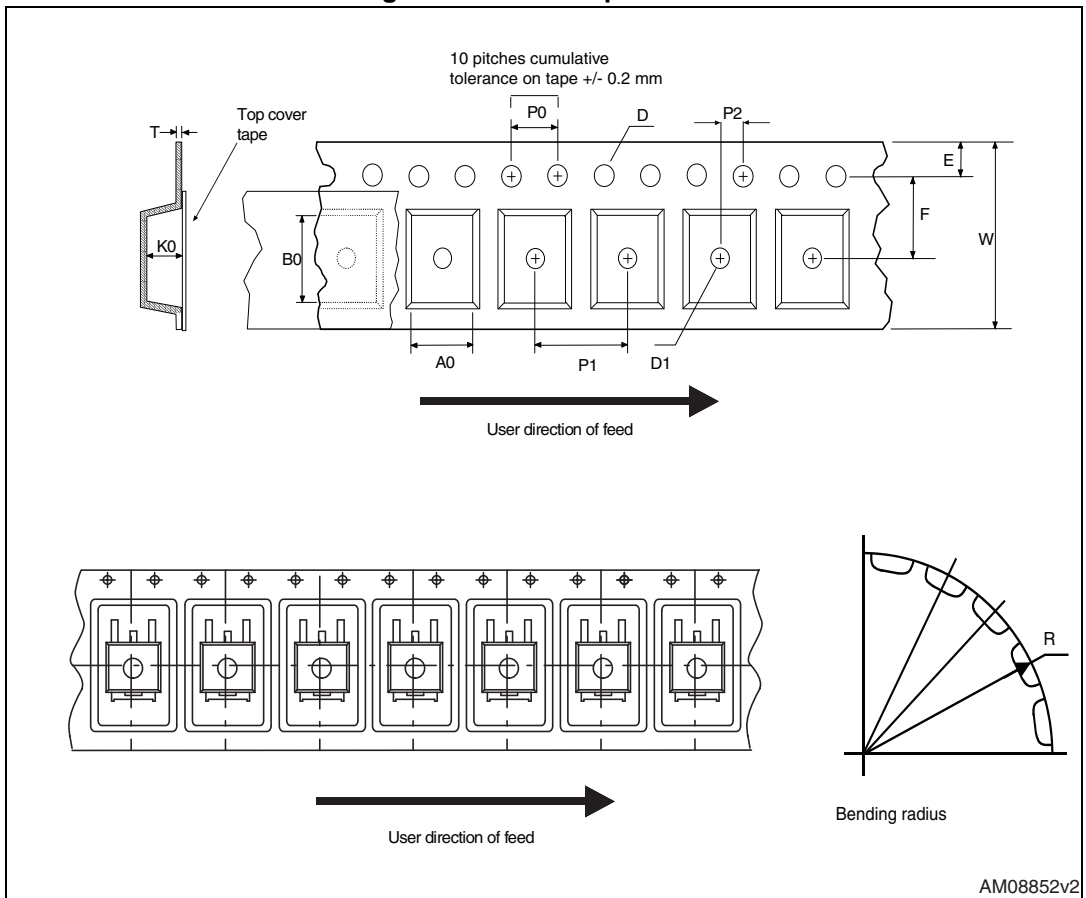


Footprint

a. All dimension are in millimeters

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

Figure 41. D<sup>2</sup>PAK tape outline



AM08852v2

Figure 42. D<sup>2</sup>PAK reel outline

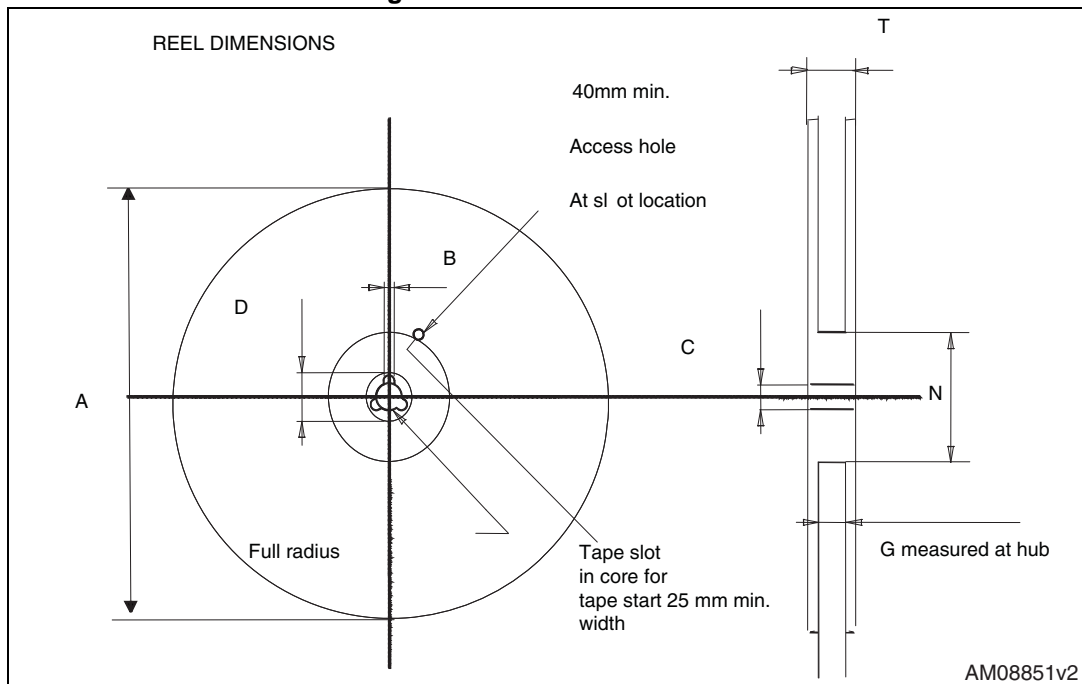
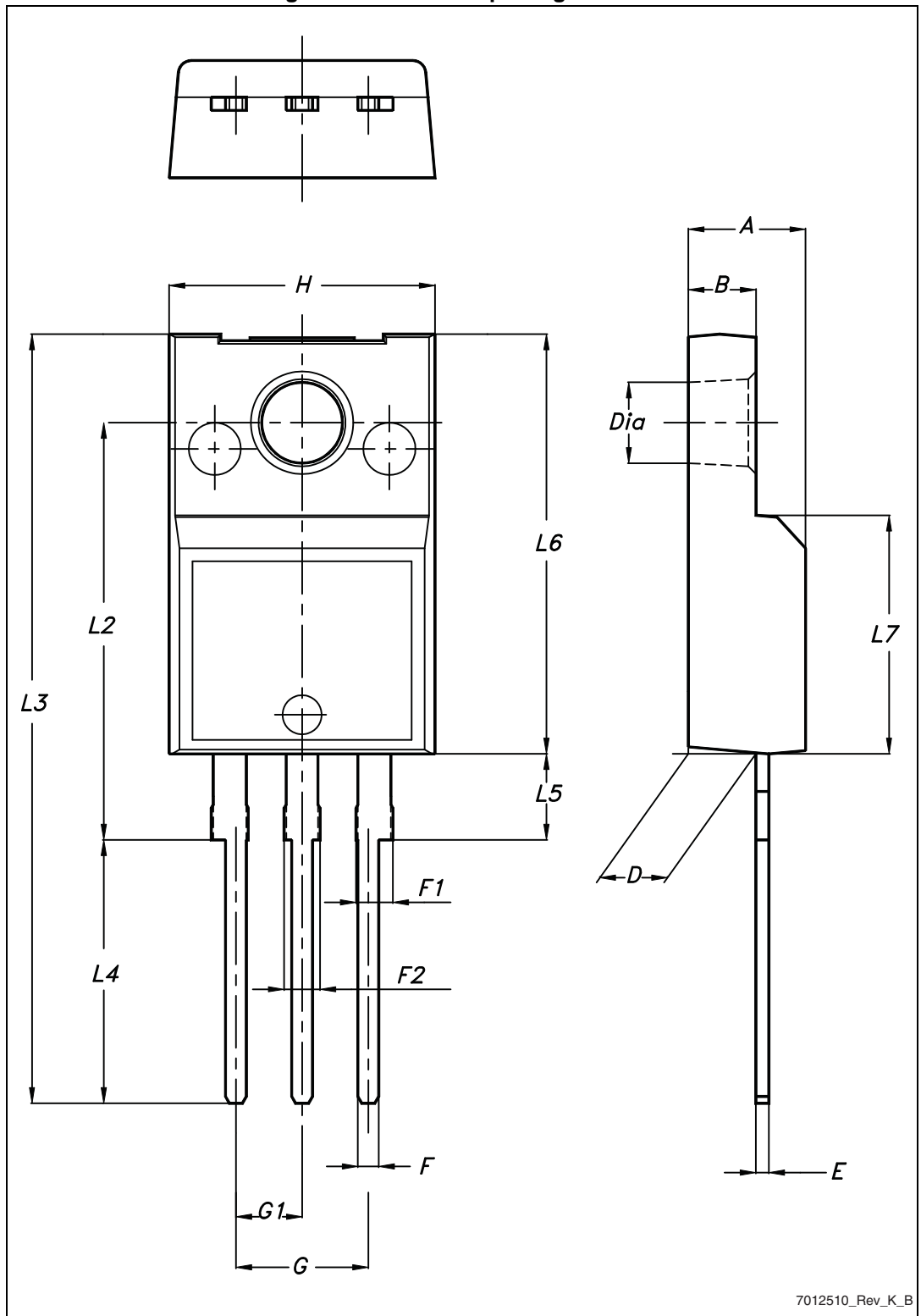


Table 10. D<sup>2</sup>PAK tape and reel mechanical data

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 qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

### 4.3 TO-220FP package information

Figure 43. TO-220FP package outline



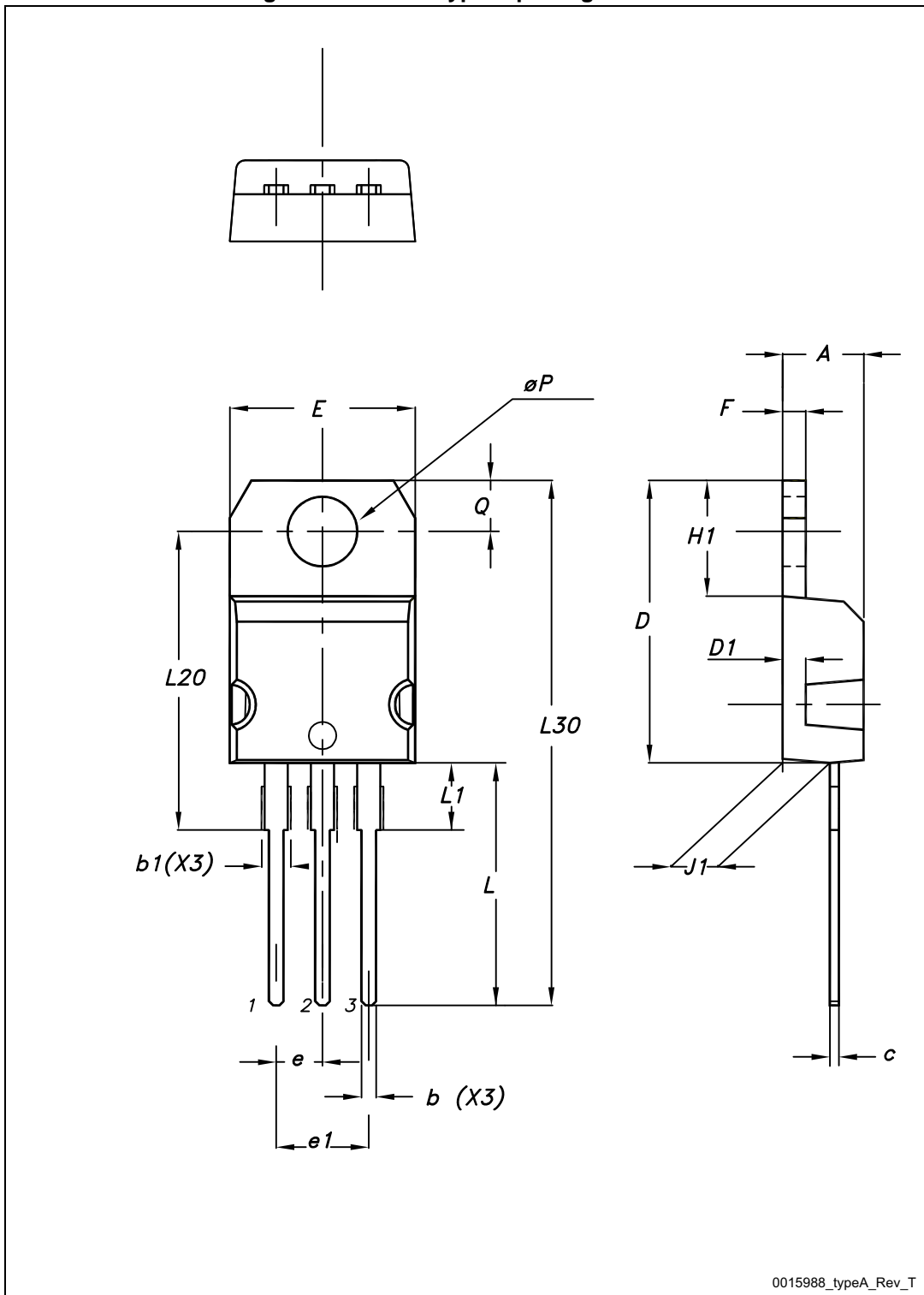
7012510\_Rev\_K\_B

Table 11. 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 package information

Figure 44. TO-220 type A package outline



0015988\_typeA\_Rev\_T

Table 12. 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		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		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		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

## 5 Revision history

Table 13. Document revision history

Date	Revision	Changes
24-Feb-2015	1	Initial release.
05-Jun-2015	2	Text and formatting changes throughout document In <a href="#">Section 1: Electrical ratings</a> - updated <a href="#">Table 3</a> In <a href="#">Section 2: Electrical characteristics</a> - updated <a href="#">Table 4</a> , <a href="#">Table 5</a> , <a href="#">Table 6</a> , <a href="#">Table 7</a> and <a href="#">Table 8</a> - added <a href="#">Section 2.1: Electrical characteristics (curves)</a>



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