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STGB7H60DF, STGF7H60DF, STGP7H60DF

Trench gate field-stop IGBT, H series 600 V, 7 A high speed

Datasheet - production data

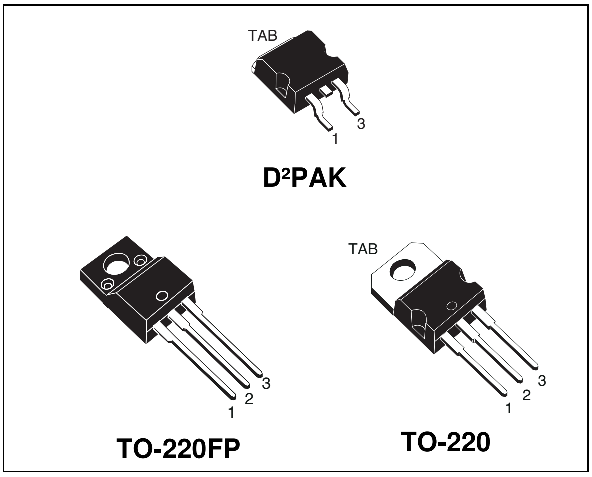
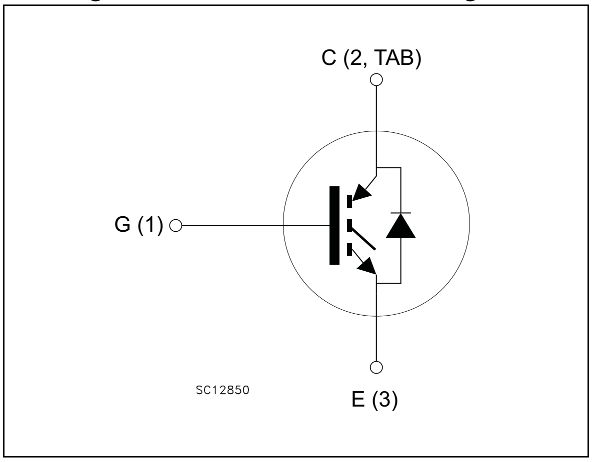


Figure 1. Internal schematic diagram



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

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	D²PAK	Tape and reel
STGF7H60DF	GF7H60DF	TO-220FP	Tube
STGP7H60DF	GP7H60DF	TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	TO-220 D²PAK	TO-220FP	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600		V
I_C	Continuous collector current at T_C = 25 °C	14	14(1)	A
	Continuous collector current at T_C = 100 °C	7	7(1)	
I_{CP} (2)	Pulsed collector current	28	28(1)	A
V_{GE}	Gate-emitter voltage	±20		V
I_F	Continuous forward current T_C = 25 °C	14	14(1)	A
	Continuous forward current at T_C = 100 °C	7	7(1)	
I_{FP}(2)	Pulsed forward current	28	28(1)	A
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T_C = 25 °C)		2500	V
P_{TOT}	Total dissipation at T_C = 25 °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 D²PAK	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 °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 V)	I_C = 2 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 7 A		1.5	1.95	V
		V_{GE} = 15 V, I_C = 7 A T_J = 125 °C		1.6		
		V_{GE} = 15 V, I_C = 7 A T_J = 175 °C		1.7		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 µA	4.8	6.2	6.9	V
I_{CES}	Collector cut-off current (V_{GE} = 0 V)	V_{CE} = 600 V			25	µA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0 V)	V_{GE} = ±20 V			250	nA

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V	-	1050	-	pF
C_{oes}	Output capacitance		-	51	-	
C_{res}	Reverse transfer capacitance		-	23	-	
Q_g	Total gate charge	V_{CC} = 480 V, I_C = 7 A, V_{GE} = 15 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 V, I_C = 7 A, R_G = 47 Ω, V_{GE} = 15 V	-	30	-	ns
t_r	Current rise time		-	12.2	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	459	-	A/µs
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 7 A, R_G = 47 Ω, V_{GE} = 15 V T_J = 175 °C	-	30	-	ns
t_r	Current rise time		-	12.8	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	440	-	A/µs
$t_{r(Voff)}$	Off voltage rise time	V_{CE} = 400 V, I_C = 7 A, R_G = 47 Ω, V_{GE} = 15 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 V, I_C = 7 A, R_G = 47 Ω, V_{GE} = 15 V T_J = 175 °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 V, V_{GE} = 15 V, R_G = 47 Ω	-	5	-	µs

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{on} (1)	Turn-on switching losses	V_{CE} = 400 V, I_C = 7 A, R_G = 47 Ω, V_{GE} = 15 V	-	99	-	µJ
E_{off} (2)	Turn-off switching losses		-	100	-	
E_{ts}	Total switching losses		-	199	-	
E_{on} (1)	Turn-on switching losses	V_{CE} = 400 V, I_C = 7 A, R_G = 47 Ω, V_{GE} = 15 V T_J = 175 °C	-	202	-	µJ
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 A	-	1.5	2.1	V
		I_F = 7 A, T_J = 175 °C		1.15		
t_{rr}	Reverse recovery time	V_{CC} = 400 V; I_F = 7 A; di_F/dt = 100 A/µs	-	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 V; I_F = 7 A; di_F/dt = 100 A/µs T_J = 175 °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 D²PAK and TO-220

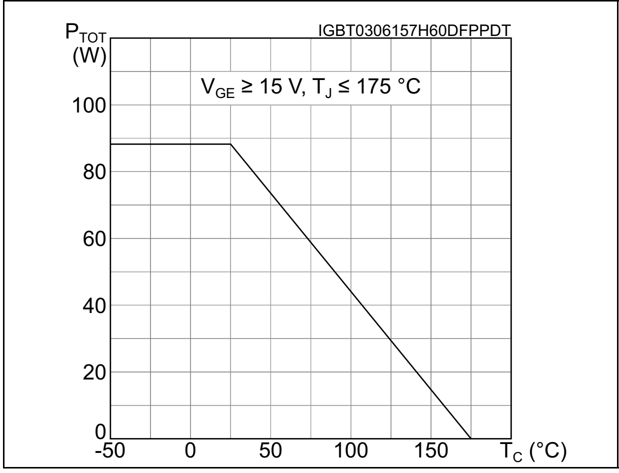


Figure 3. Collector current vs. case temperature for D²PAK and TO-220

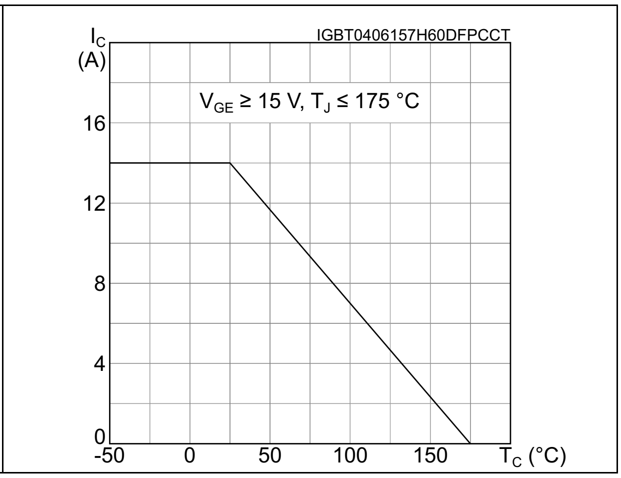


Figure 4. Power dissipation vs. case temperature for TO-220FP

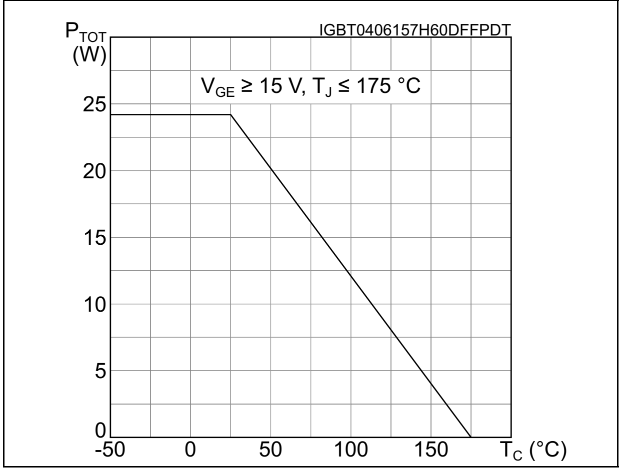


Figure 5. Collector current vs. case temperature for TO-220FP

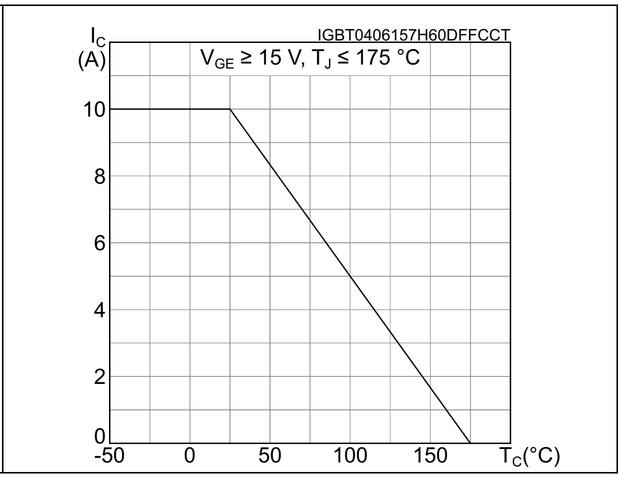


Figure 6. Output characteristics (T_J = 25°C)

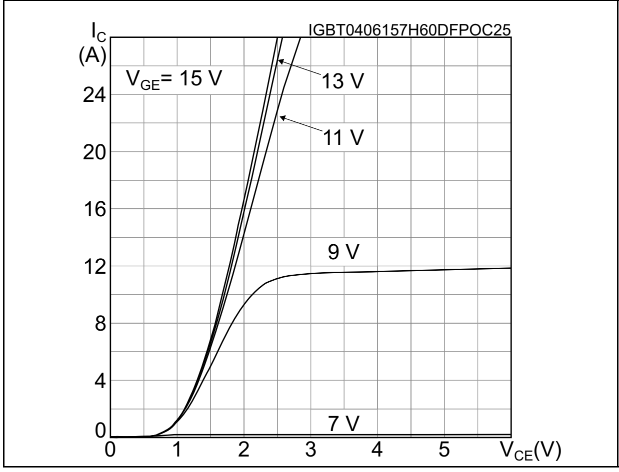


Figure 7. Output characteristics (T_J = 175°C)

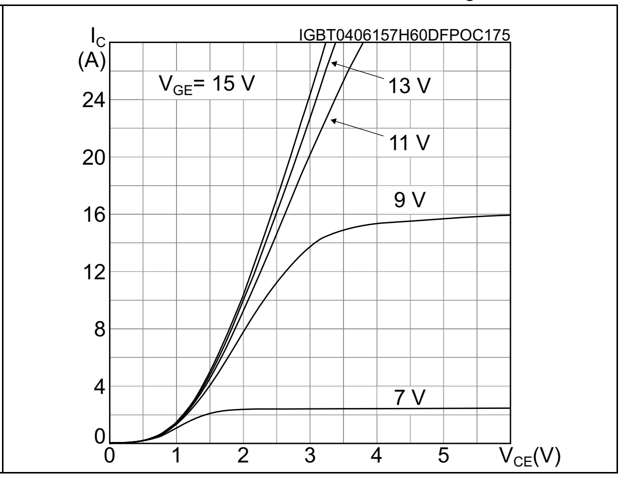


Figure 8. $V_{CE(sat)}$ vs. junction temperature

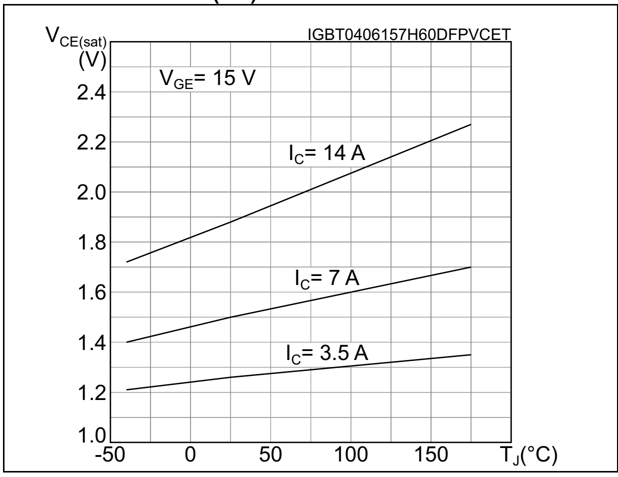


Figure 9. $V_{CE(sat)}$ vs. collector current

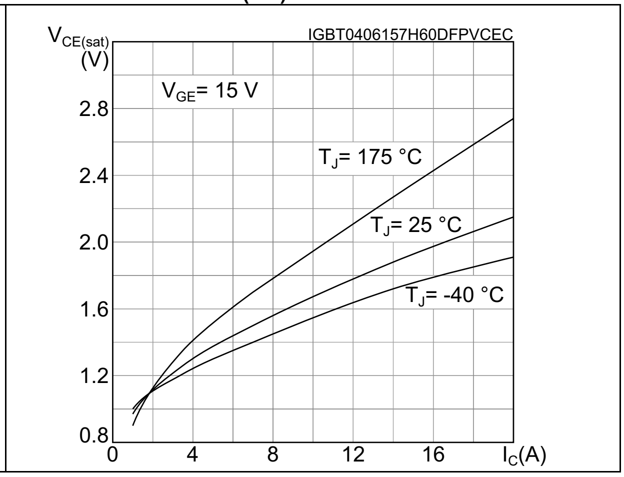


Figure 10. Collector current vs. switching frequency for D^2PAK and TO-220

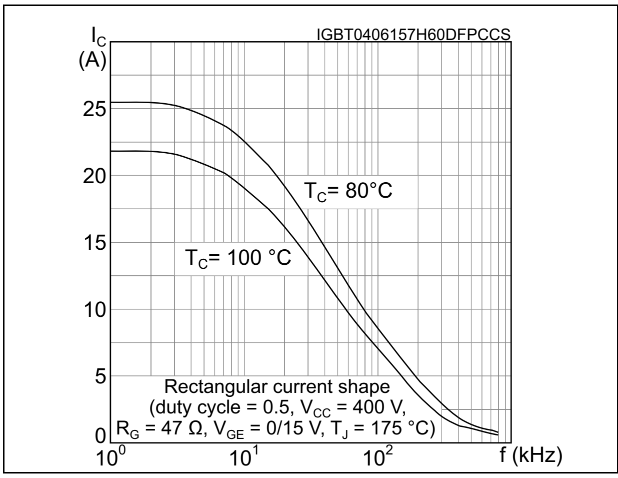


Figure 11. Collector current vs. switching frequency for TO-220FP

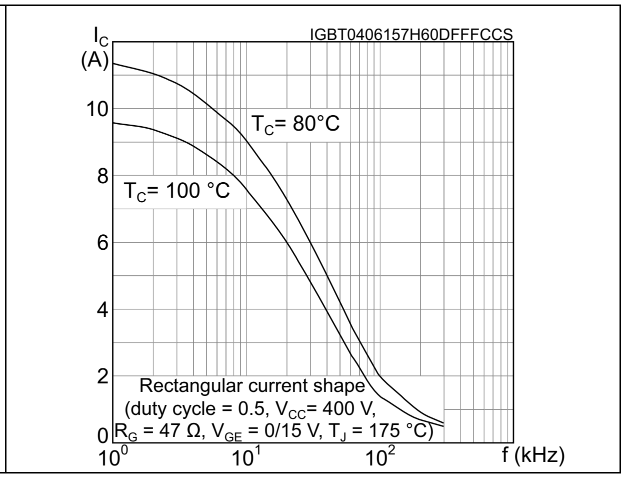


Figure 12. Forward bias safe operating area for D^2PAK and TO-220

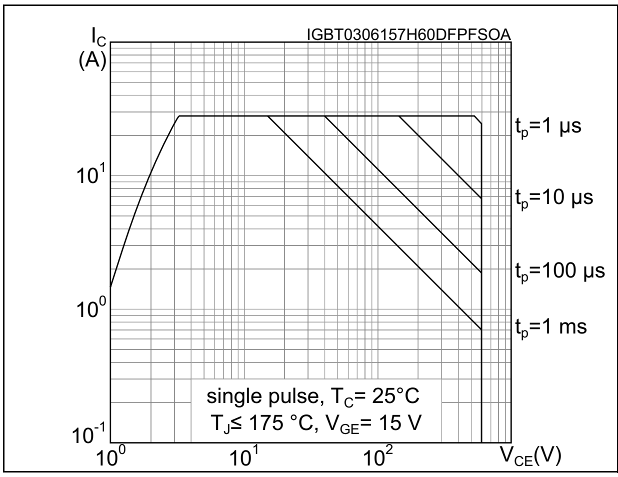


Figure 13. Forward bias safe operating area for TO-220FP

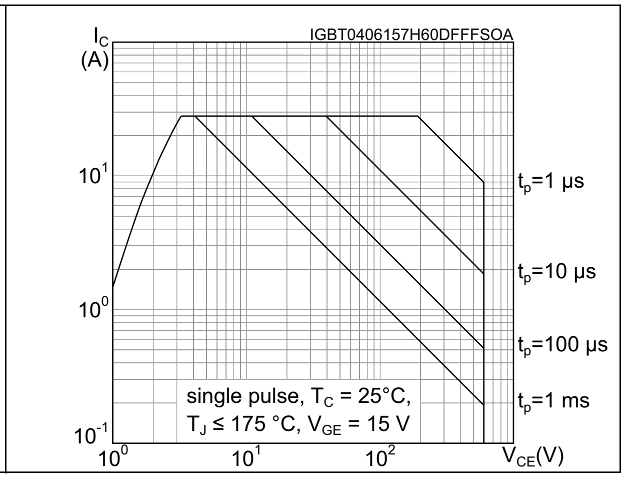


Figure 14. Transfer characteristics

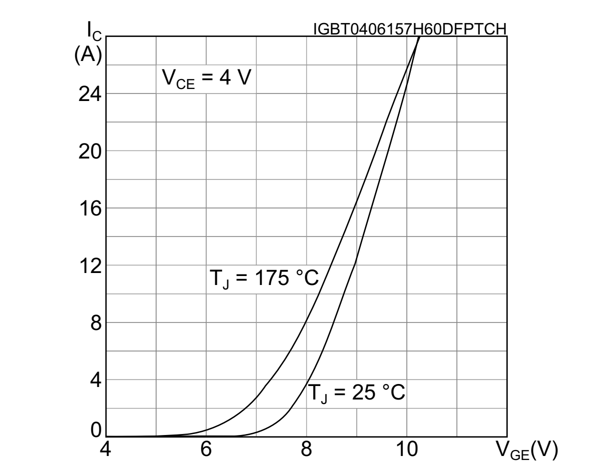


Figure 15. Diode V_F vs. forward current

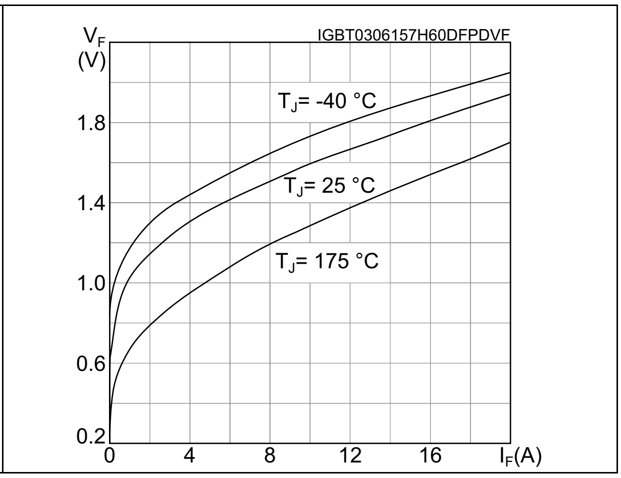


Figure 16. Normalized $V_{GE(th)}$ vs. junction temperature

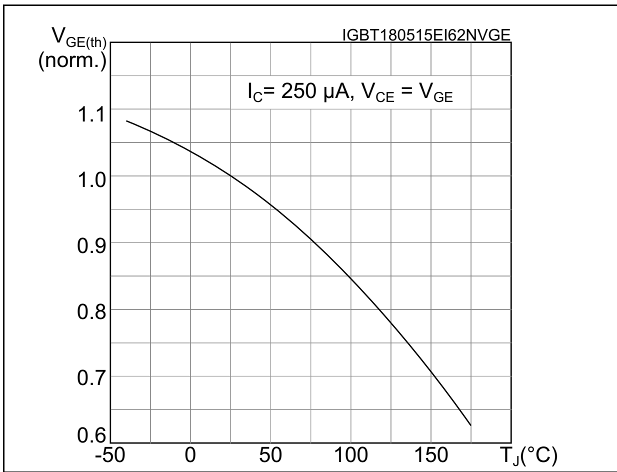


Figure 17. Normalized $V_{(BR)CES}$ vs. junction temperature

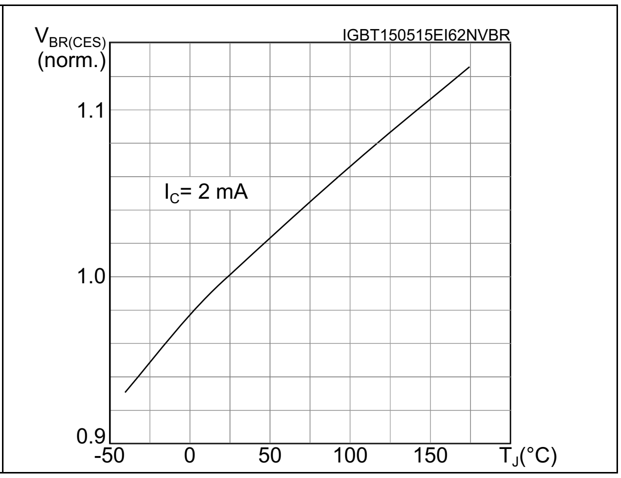


Figure 18. Capacitance variation

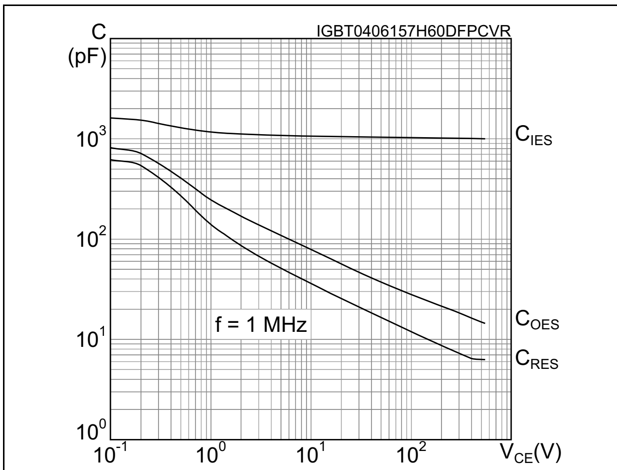


Figure 19. Gate charge vs. gate-emitter voltage

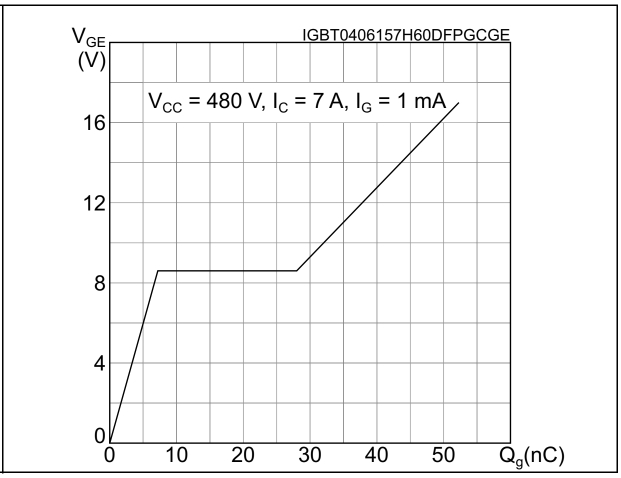


Figure 20. Switching loss vs. collector current

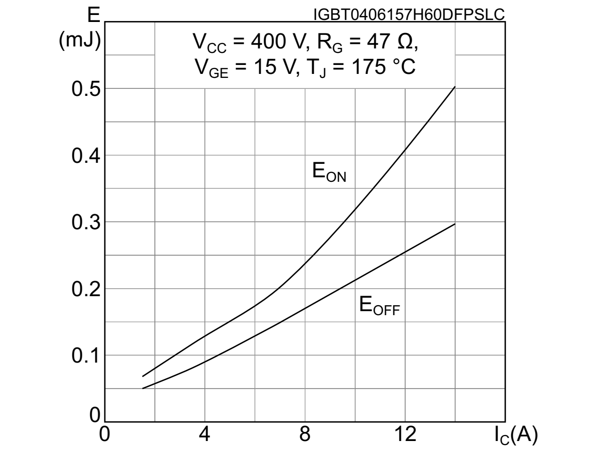


Figure 21. Switching loss vs. gate resistance

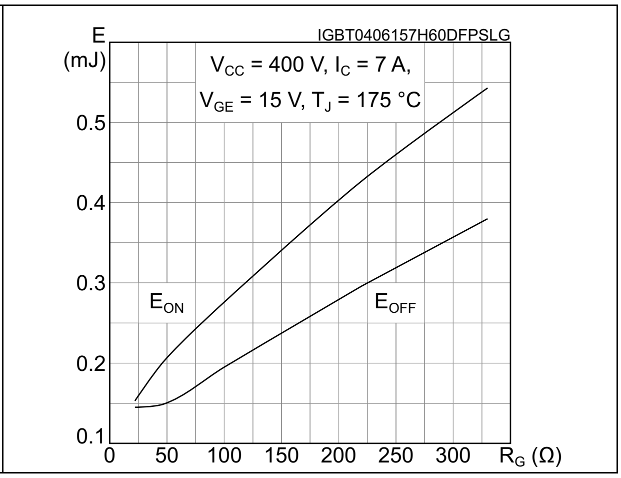


Figure 22. Switching loss vs. temperature

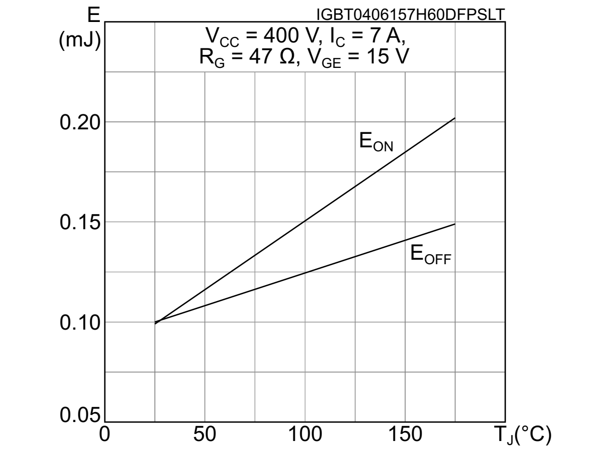


Figure 23. Switching loss vs. collector-emitter voltage

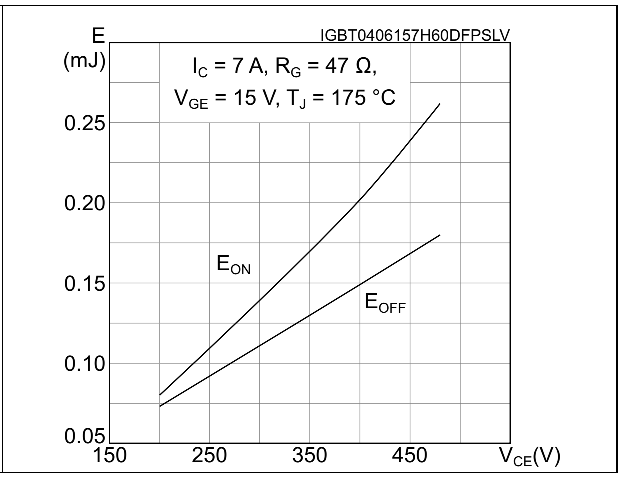


Figure 24. Short circuit time and current vs. V_{GE}

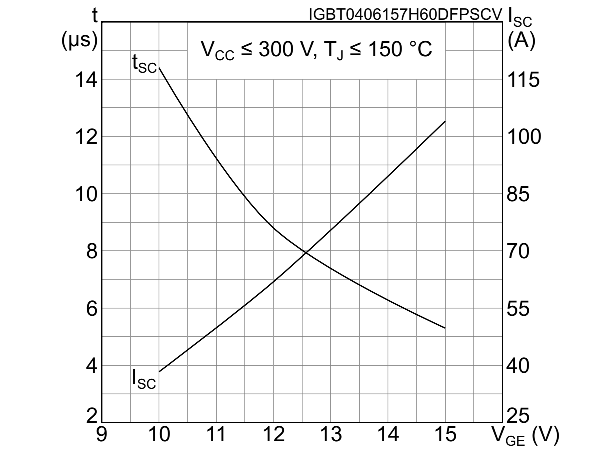


Figure 25. Switching times vs. collector current

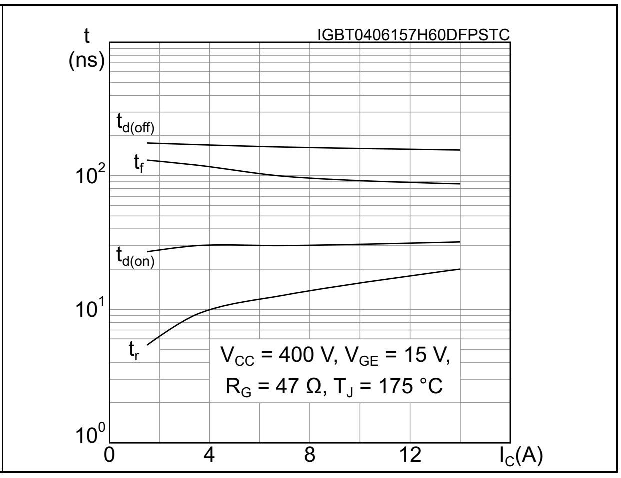


Figure 26. Switching times vs. gate resistance

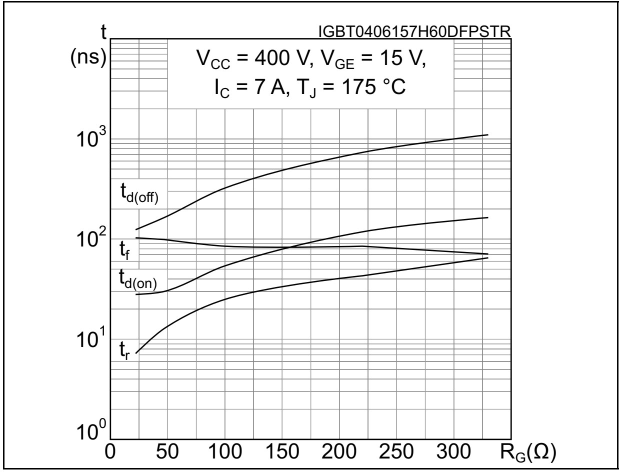


Figure 27. Reverse recovery current vs. diode current slope

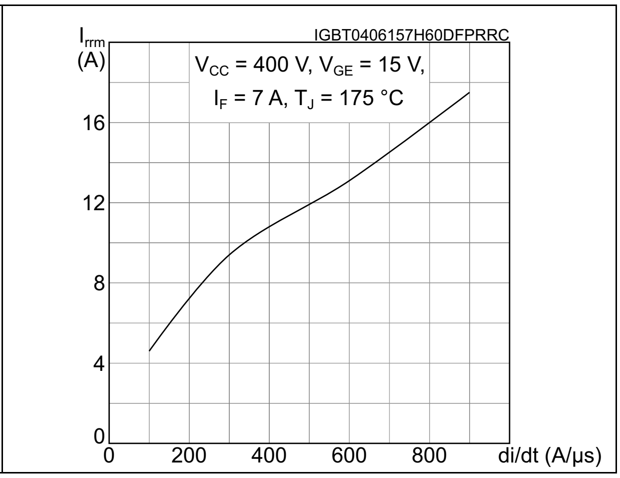


Figure 28. Reverse recovery time vs. diode current slope

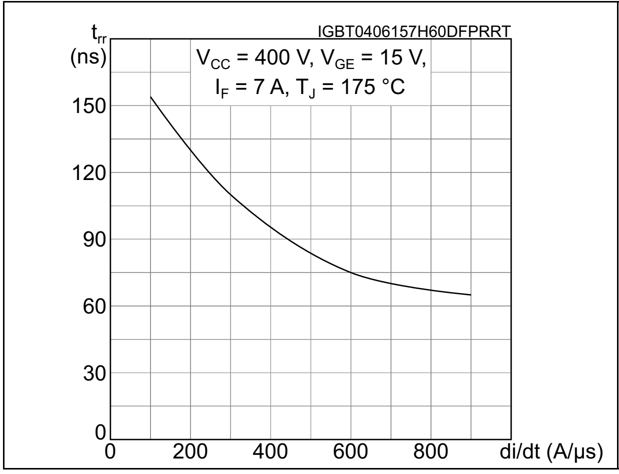


Figure 29. Reverse recovery charge vs. diode current slope

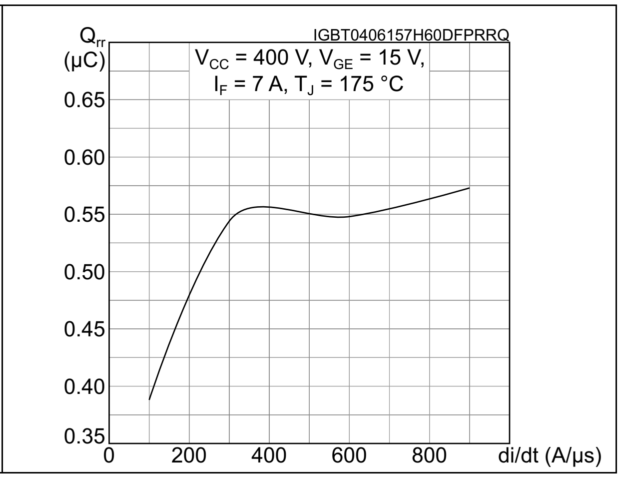


Figure 30. Reverse recovery energy vs. diode current slope

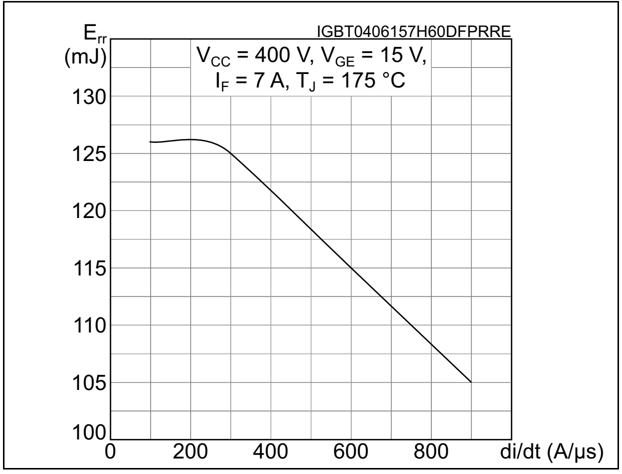


Figure 31. Thermal impedance for D^2PAK and TO-220 IGBT

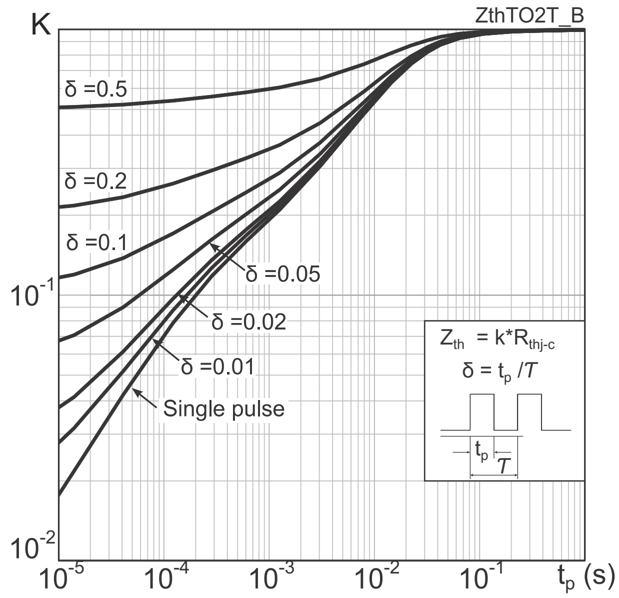


Figure 32. Thermal impedance for D^2PAK and TO-220 diode

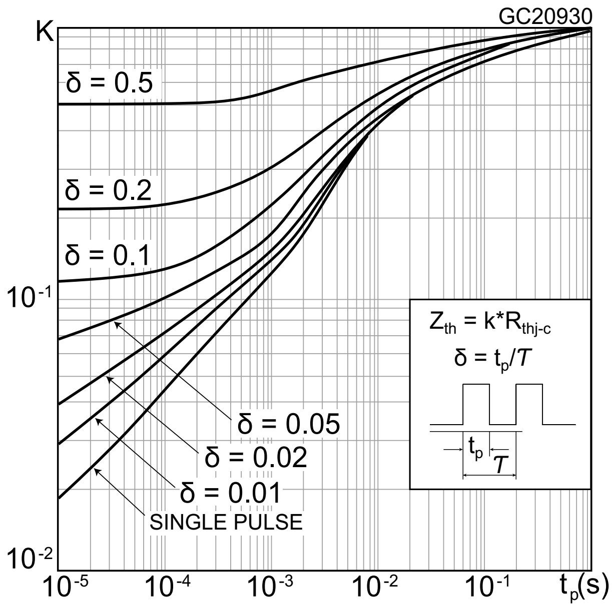


Figure 33. Thermal impedance for TO-220FP IGBT

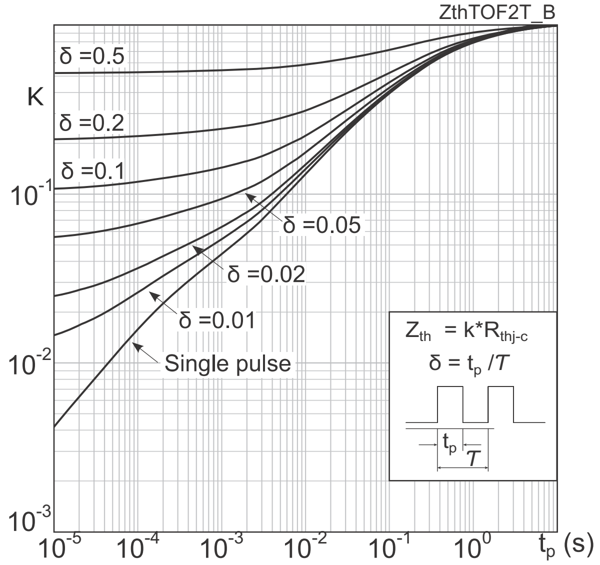
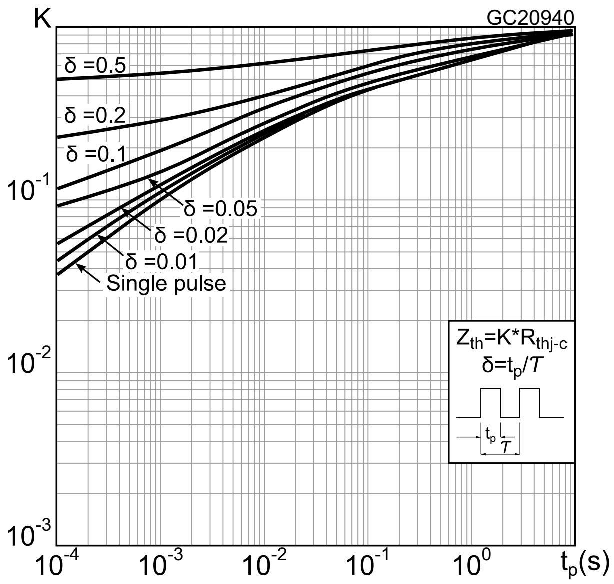


Figure 34. Thermal impedance for TO-220FP diode



3 Test circuits

Figure 35. Test circuit for inductive load switching

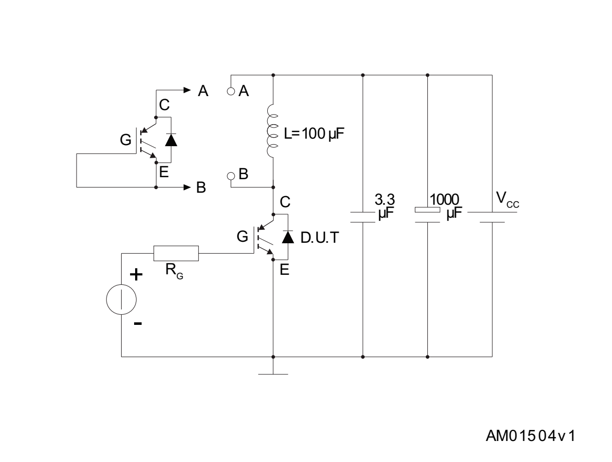


Figure 36. Gate charge test circuit

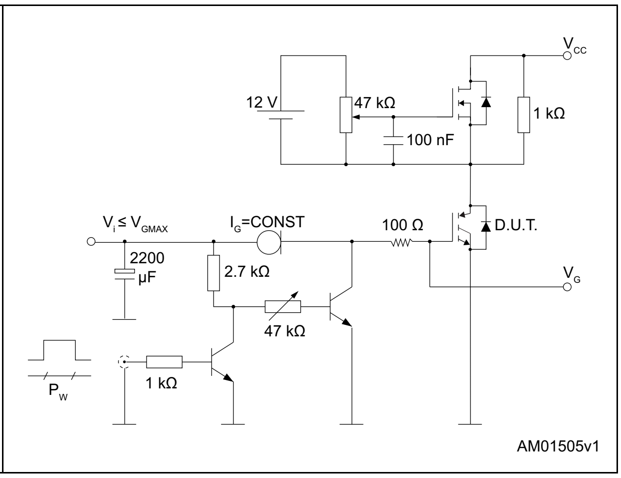


Figure 37. Switching waveform

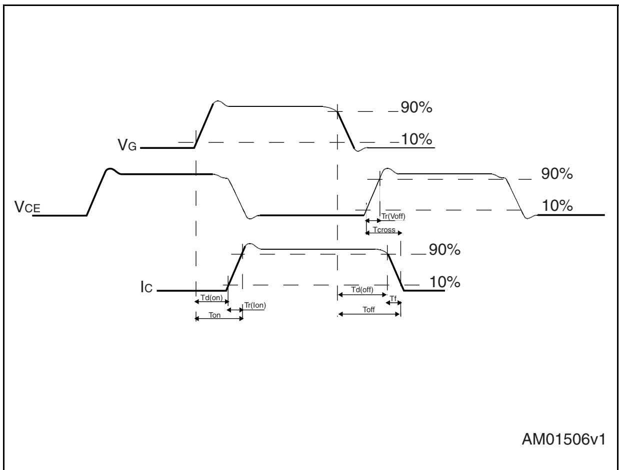
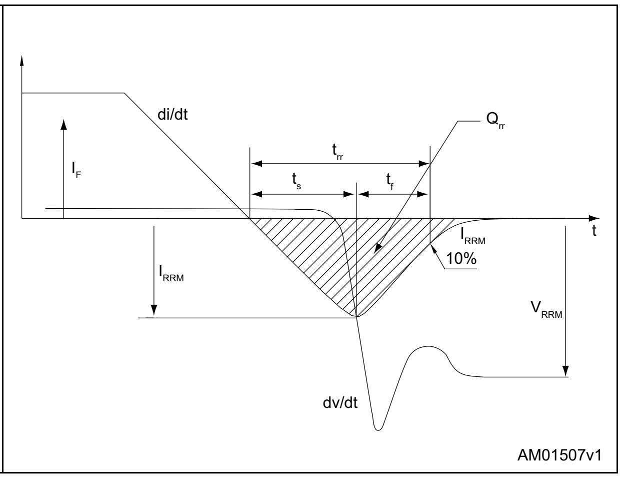


Figure 38. Diode reverse recovery waveform



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. ECOPACK is an ST trademark.

4.1 D²PAK package information

Figure 39. D²PAK (TO-263) type A package outline

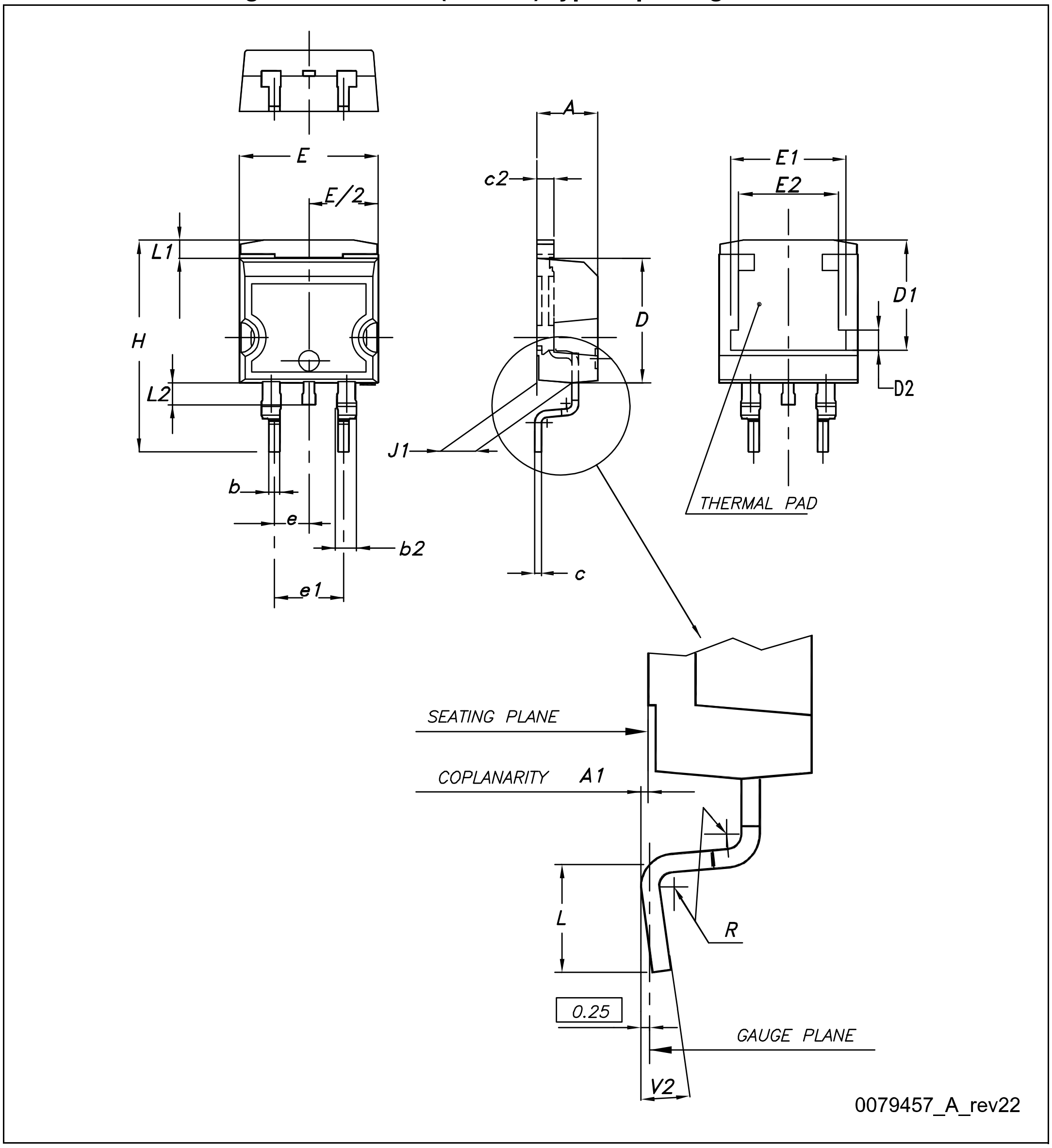
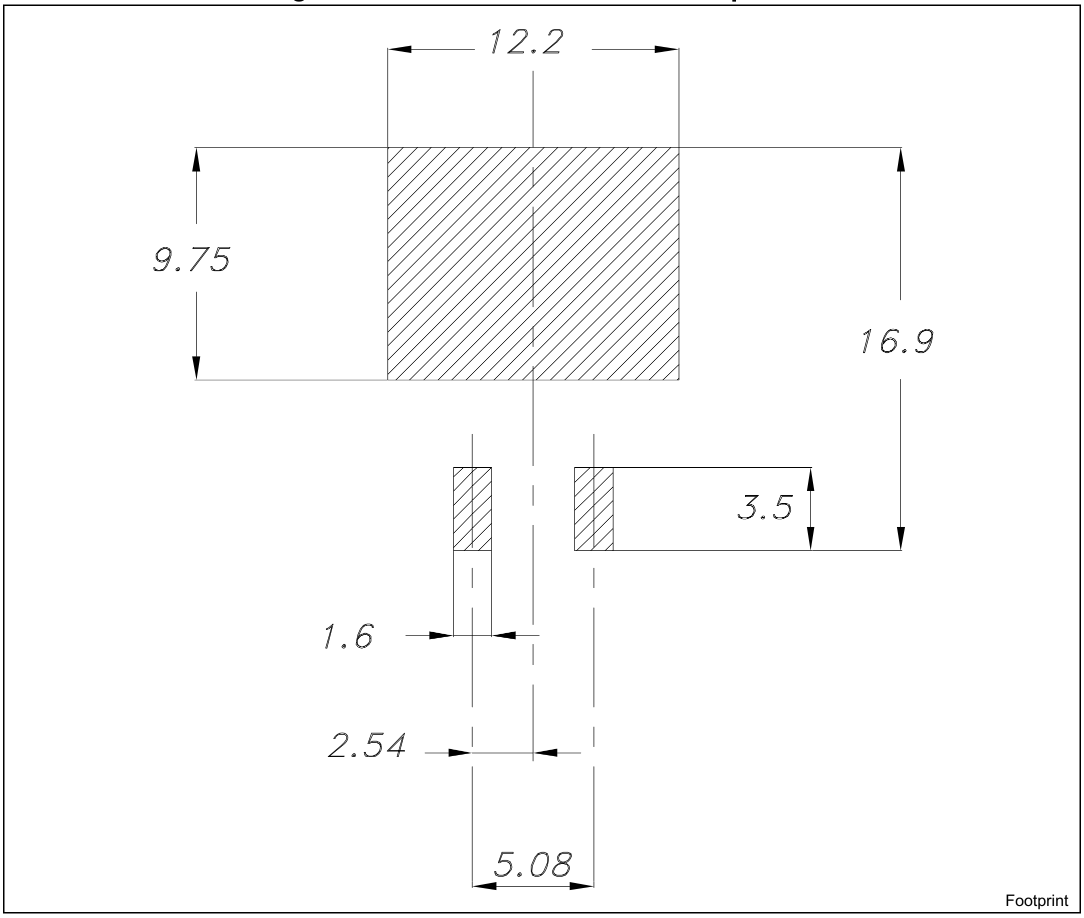


Table 9. D²PAK (TO-263) type A mechanical data

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. D²PAK recommended footprint[(a)]



a. All dimension are in millimeters

4.2 D²PAK packing information

Figure 41. D²PAK tape outline

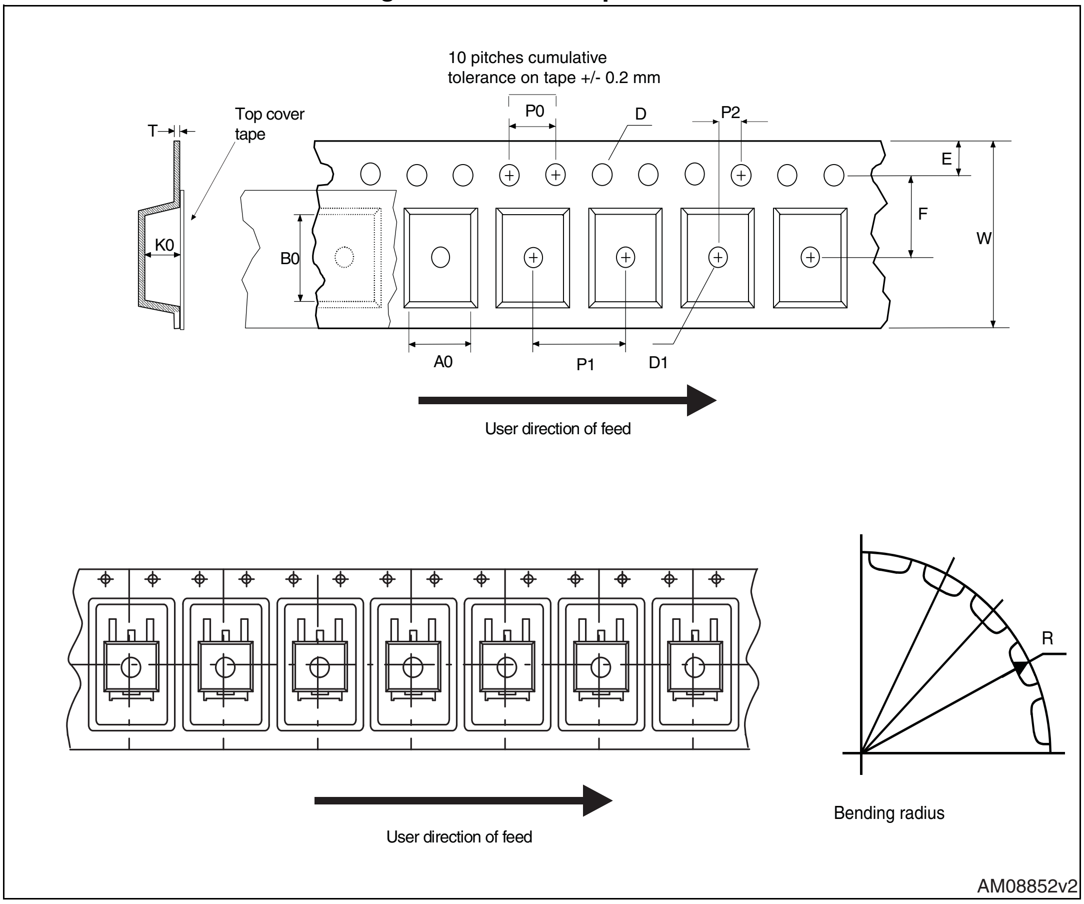


Figure 42. D²PAK reel outline

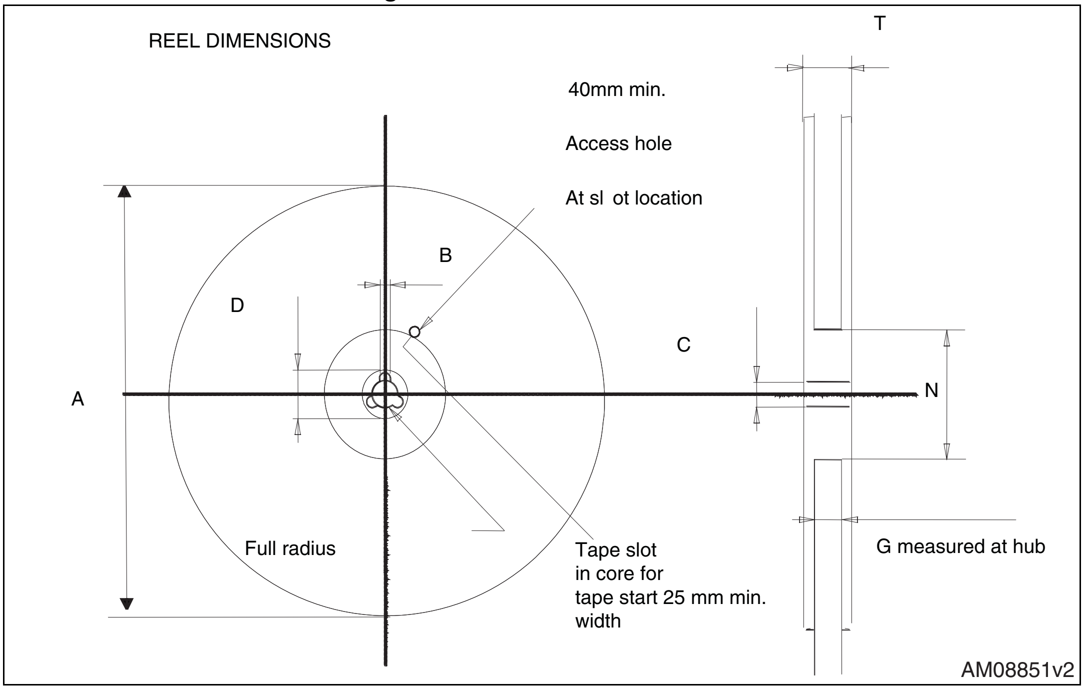


Table 10. D²PAK tape and reel mechanical data

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

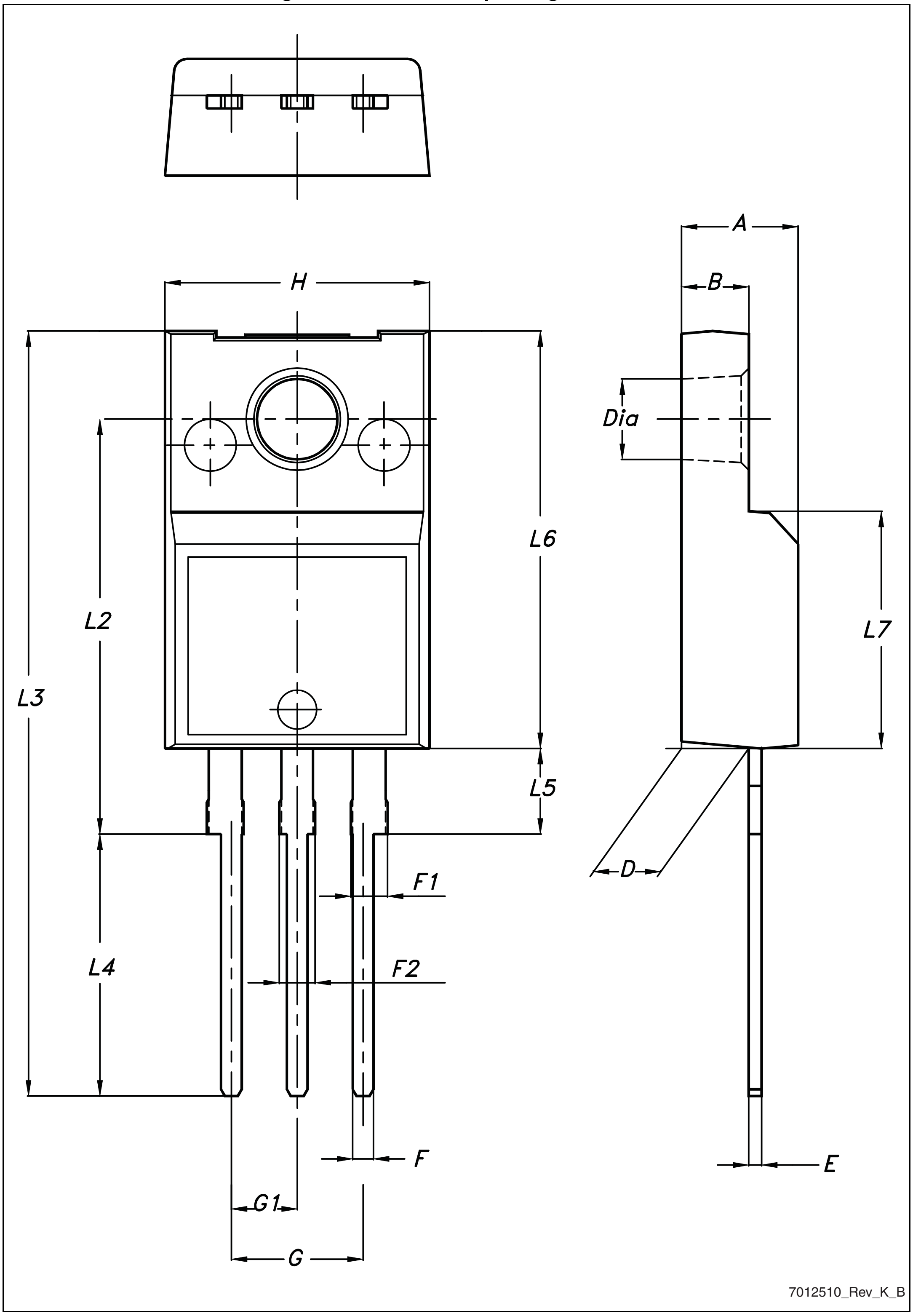


Table 11. TO-220FP package mechanical data

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

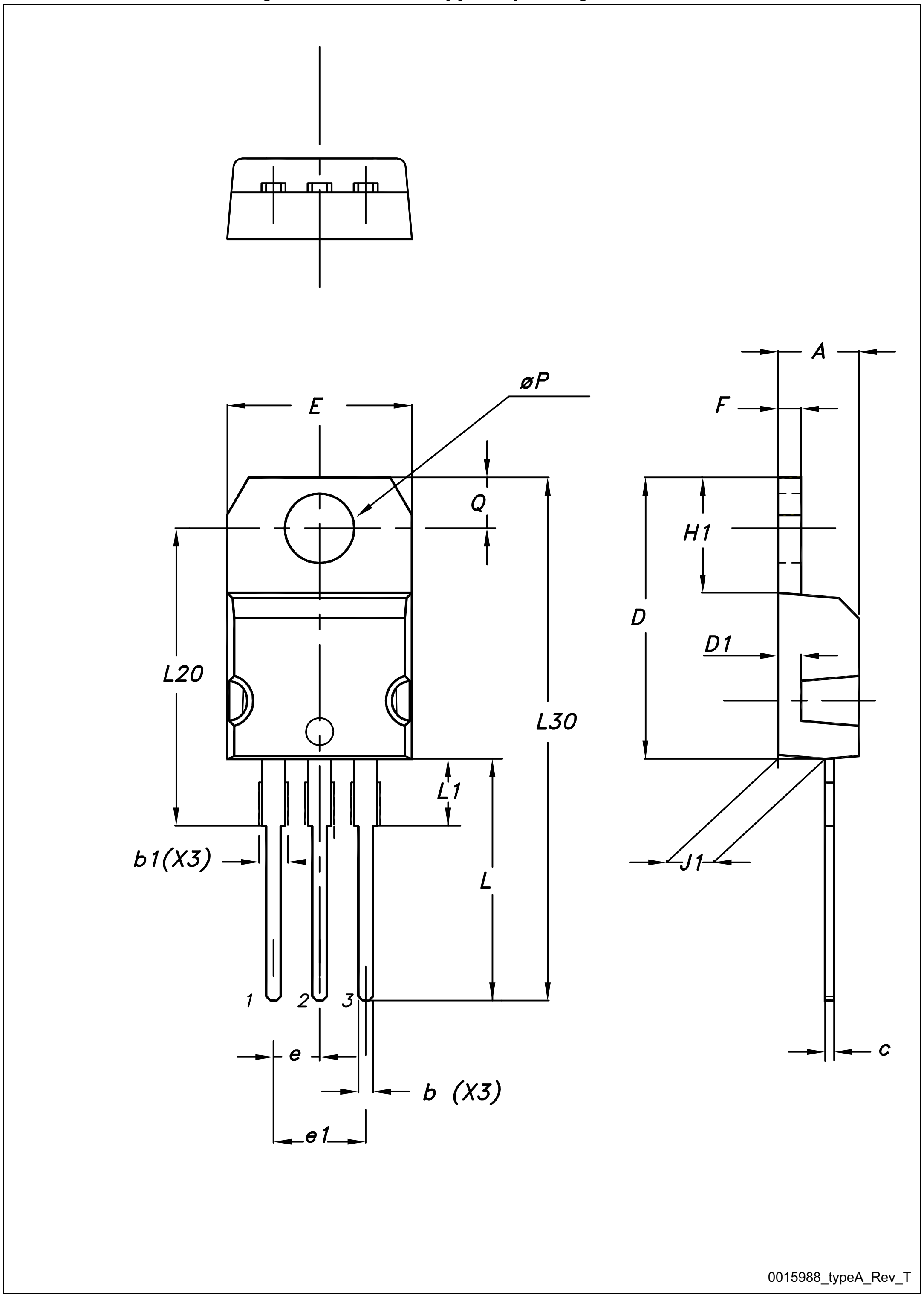


Table 12. TO-220 type A package mechanical data

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	
∅P	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 *Section 1: Electrical ratings* - updated *Table 3* In *Section 2: Electrical characteristics* - updated *Table 4*, *Table 5*, *Table 6*, *Table 7* and *Table 8* - added *Section 2.1: Electrical characteristics (curves)*