STGB5H60DF, STGD5H60DF, STGF5H60DF, STGP5H60DF

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

Datasheet - production data

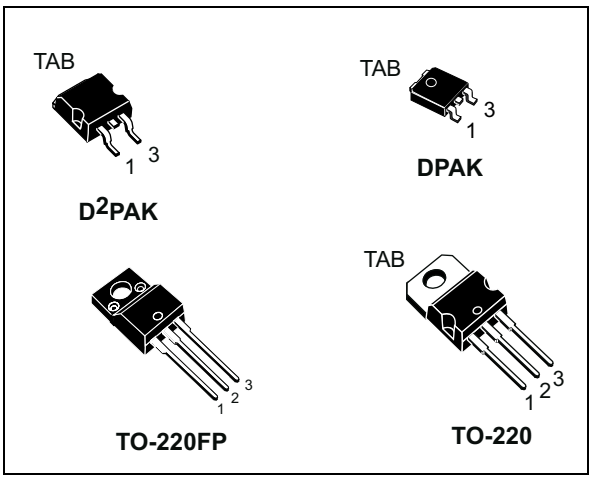
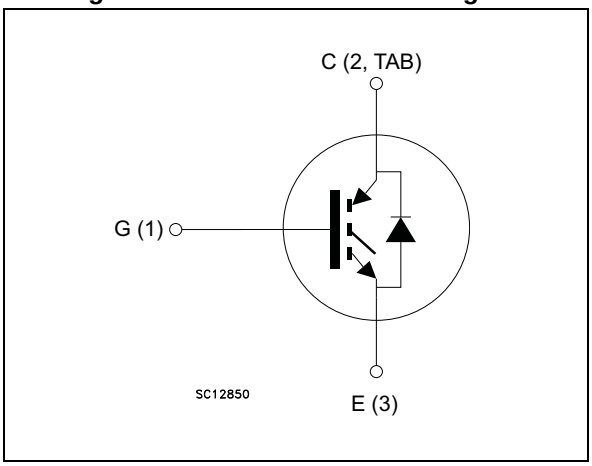


Figure 1. Internal schematic diagram



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

These devices are IGBTs developed using an advanced proprietary trench gate and field-stop structure. The devices are part of the H series of IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of high switching frequency converters. Moreover, a slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1. Device summary

Order codes	Marking	Packages	Packing
STGB5H60DF	GB5H60DF	D²PAK	Tape and reel
STGD5H60DF	GD5H60DF	DPAK	Tape and reel
STGF5H60DF	GF5H60DF	TO-220FP	Tube
STGP5H60DF	GP5H60DF	TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	D²PAK TO-220	DPAK	TO-220FP	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600			V
I_C	Continuous collector current at T_C = 25 °C	10		10(1)	A
	Continuous collector current at T_C = 100 °C	5		5(1)	
I_{CP} (2)	Pulsed collector current	20		20(1)	A
V_{GE}	Gate-emitter voltage	±20			V
I_F	Continuous forward current T_C = 25 °C	10		10(1)	A
	Continuous forward current at T_C = 100 °C	5		5(1)	
I_{FP}(2)	Pulsed forward current	20		20(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	83	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	D²PAK TO-220	DPAK	TO-220FP	Unit
R_{thJC}	Thermal resistance junction-case IGBT	1.7	1.8	6.2	°C/W
R_{thJC}	Thermal resistance junction-case diode	4	4.5	7	
R_{thJA}	Thermal resistance junction-ambient	62.5	100	62.5	

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)	I_C = 2 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 5 A		1.5	1.95	V
		V_{GE} = 15 V, I_C = 5 A T_J = 125 °C		1.6		
		V_{GE} = 15 V, I_C = 5 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_{CE} = 600 V			25	µA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	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	-	855	-	pF
C_{oes}	Output capacitance		-	34	-	pF
C_{res}	Reverse transfer capacitance		-	19	-	pF
Q_g	Total gate charge	V_{CC} = 480 V, I_C = 5 A, V_{GE} = 15 V	-	43	-	nC
Q_{ge}	Gate-emitter charge		-	17.5	-	nC
Q_{gc}	Gate-collector charge		-	6.5	-	nC

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 = 5 A, R_G = 47 Ω, V_{GE} = 15 V	-	30	-	ns
t_r	Current rise time		-	10.8	-	ns
(di/dt)on	Turn-on current slope		-	370	-	A/µs
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 5 A, R_G = 47 Ω, V_{GE} = 15 V T_J = 175 °C	-	28	-	ns
t_r	Current rise time		-	11	-	ns
(di/dt)on	Turn-on current slope		-	363	-	A/µs
$t_{r(Voff)}$	Off voltage rise time	V_{CE} = 400 V, I_C = 5 A, R_G = 47 Ω, V_{GE} = 15 V	-	29	-	ns
$t_{d(off)}$	Turn-off delay time		-	140	-	ns
t_f	Current fall time		-	95	-	ns
$t_{r(Voff)}$	Off voltage rise time	V_{CE} = 400 V, I_C = 5 A, R_G = 47 Ω, V_{GE} = 15 V T_J = 175 °C	-	44	-	ns
$t_{d(off)}$	Turn-off delay time		-	146	-	ns
t_f	Current fall time		-	134	-	ns
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
Eon (1)	Turn-on switching losses	V_{CE} = 400 V, I_C = 5 A, R_G = 47 Ω, V_{GE} = 15 V	-	56	-	µJ
E_{off} (2)	Turn-off switching losses		-	78.5	-	µJ
E_{ts}	Total switching losses		-	134.5	-	µJ
Eon (1)	Turn-on switching losses	V_{CE} = 400 V, I_C = 5 A, R_G = 47 Ω, V_{GE} = 15 V T_J = 175 °C	-	87	-	µJ
E_{off} (2)	Turn-off switching losses		-	134	-	µJ
E_{ts}	Total switching losses		-	221	-	µJ

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 = 5 A	-	2.1	-	V
		I_F = 5 A, T_J = 175 °C	-	1.65		
t_{rr}	Reverse recovery time	V_{CC} = 400 V; I_F = 5 A; di_F/dt = 100 A / µs	-	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 V; I_F = 5 A; di_F/dt = 100 A / µs T_J = 175 °C	-	157	-	ns
Q_{rr}	Reverse recovery charge		-	165	-	nC
I_{rrm}	Reverse recovery current		-	2.4	-	A

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature for D²PAK and TO-220

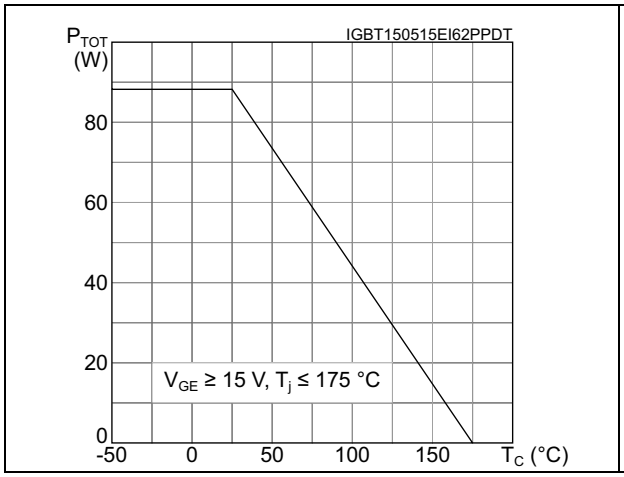


Figure 3. Collector current vs. case temperature for D²PAK and TO-220

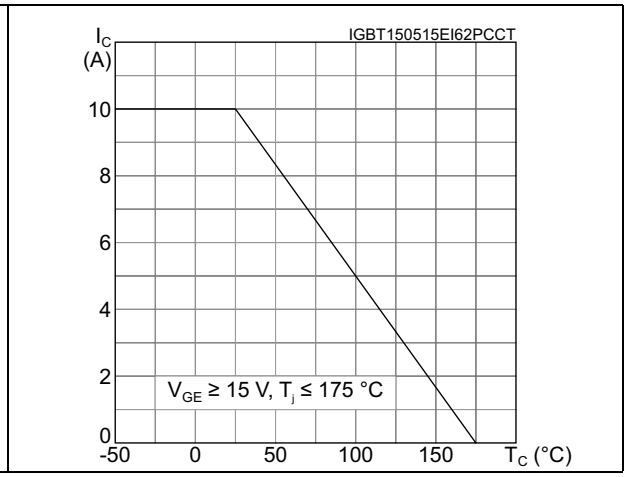


Figure 4. Power dissipation vs. case temperature for DPAK

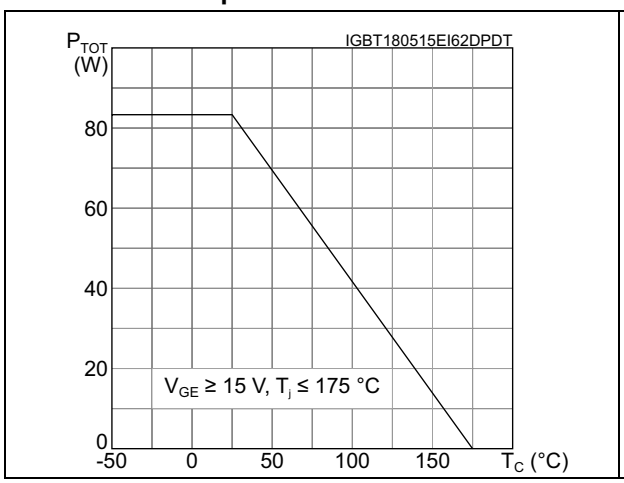


Figure 5. Collector current vs. case temperature for DPAK

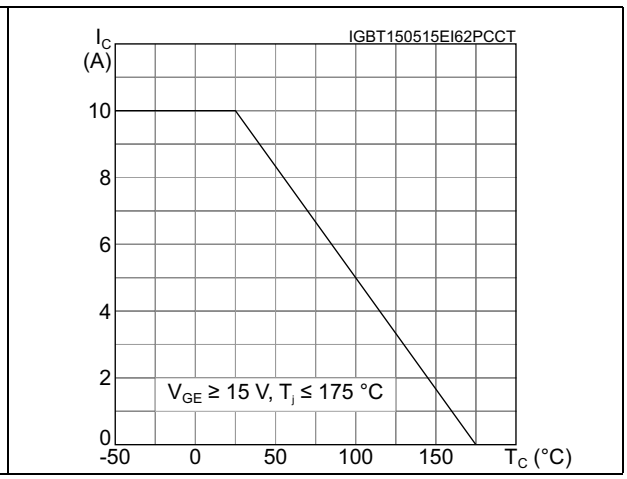


Figure 6. Power dissipation vs. case temperature for TO-220FP

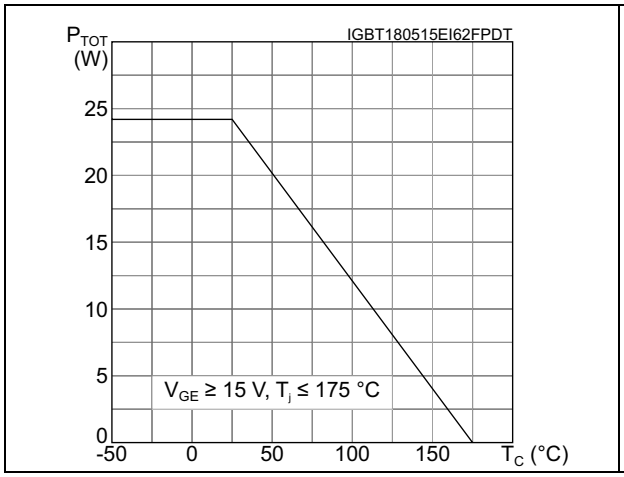


Figure 7. Collector current vs. case temperature for TO-220FP

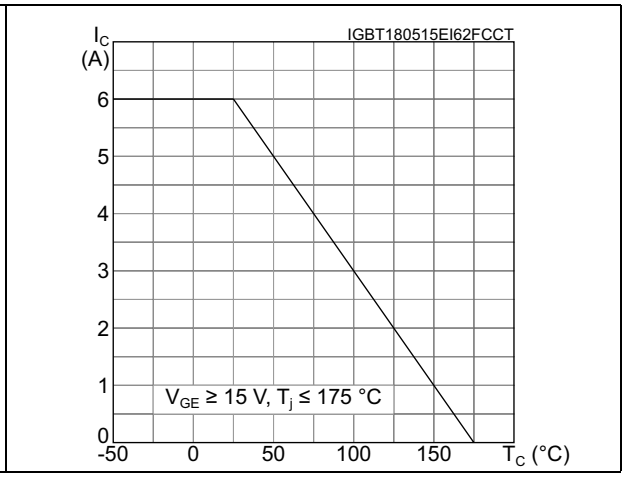


Figure 8. Output characteristics (T_J = 25°C)

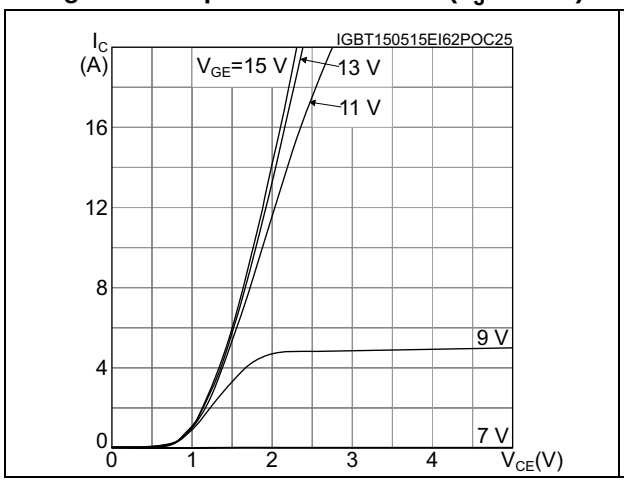


Figure 9. Output characteristics (T_J = 175°C)

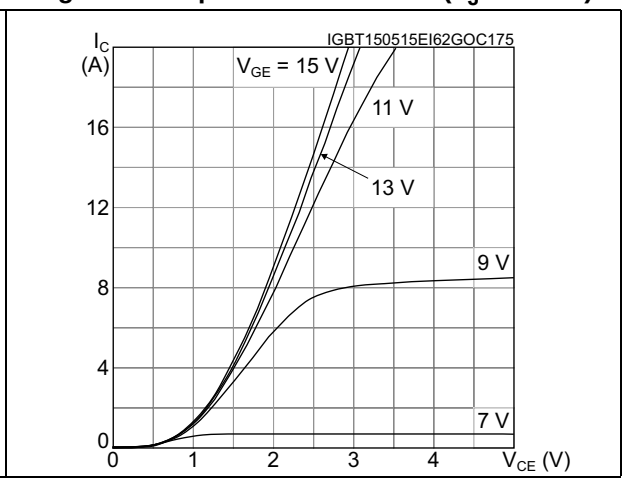


Figure 10. $V_{CE(sat)}$ vs. junction temperature

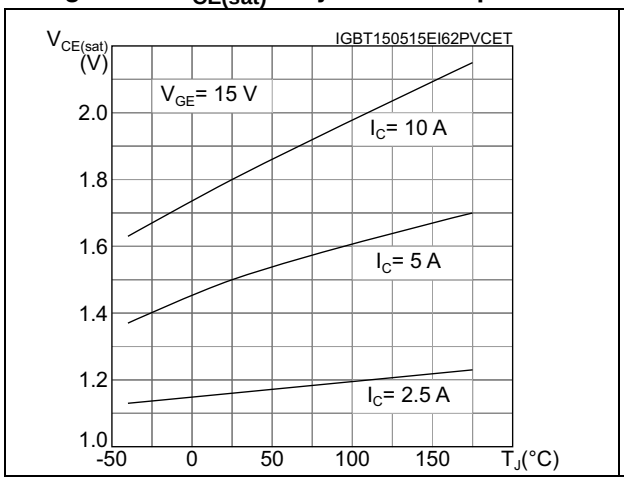


Figure 11. $V_{CE(sat)}$ vs. collector current

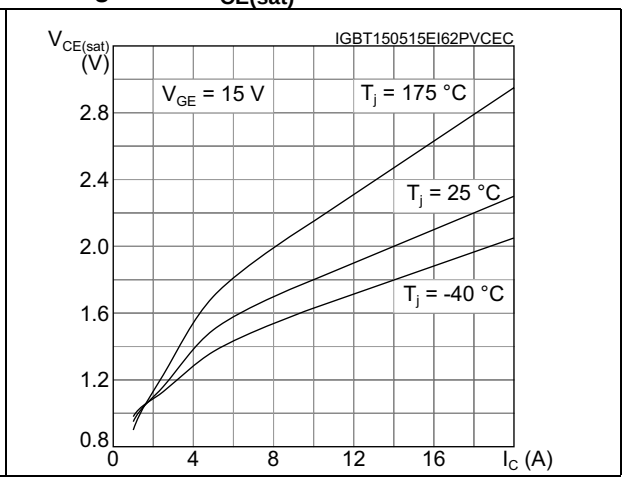


Figure 12. Collector current vs. switching frequency for D²PAK, DPAK and TO-220

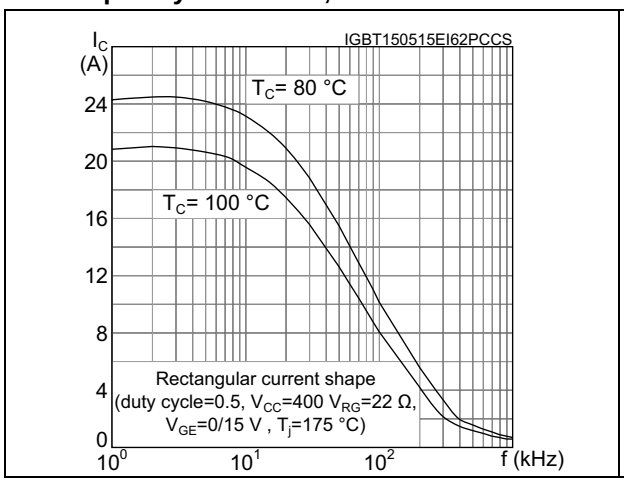


Figure 13. Collector current vs. switching frequency for TO-220FP

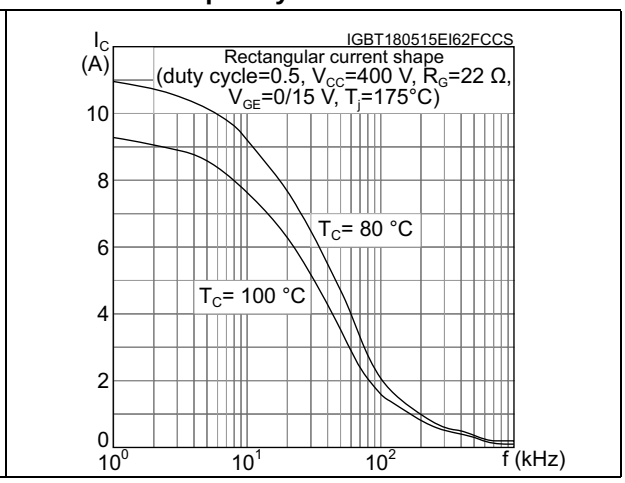


Figure 14. Forward bias safe operating area for D²PAK, DPAK and TO-220

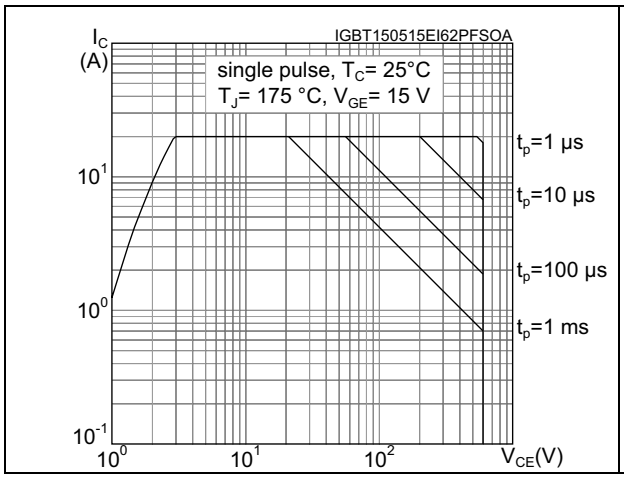


Figure 15. Forward bias safe operating area for TO-220FP

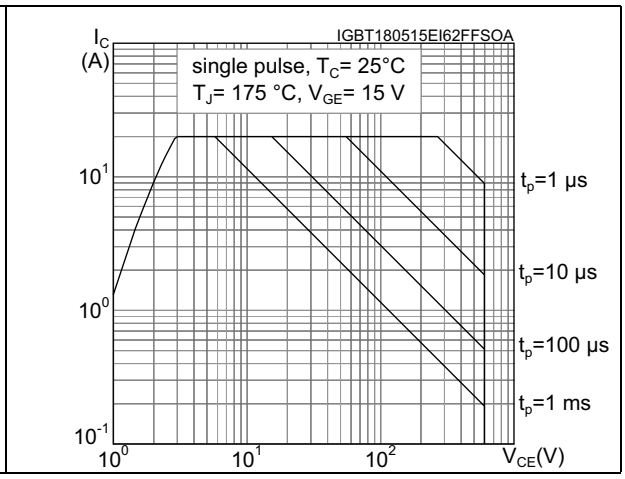


Figure 16. Transfer characteristics

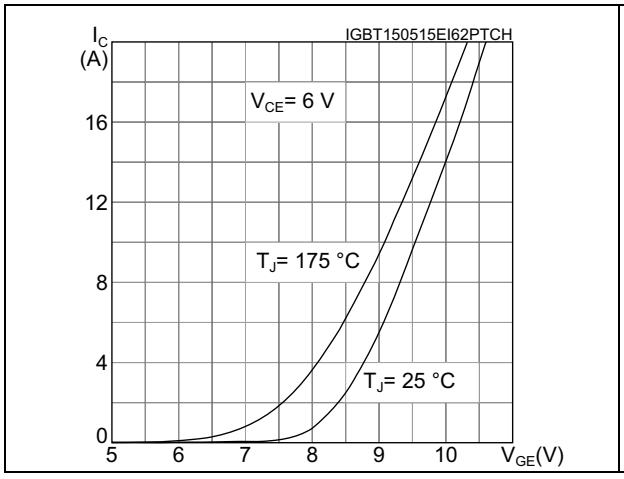


Figure 17. Diode V_F vs. forward current

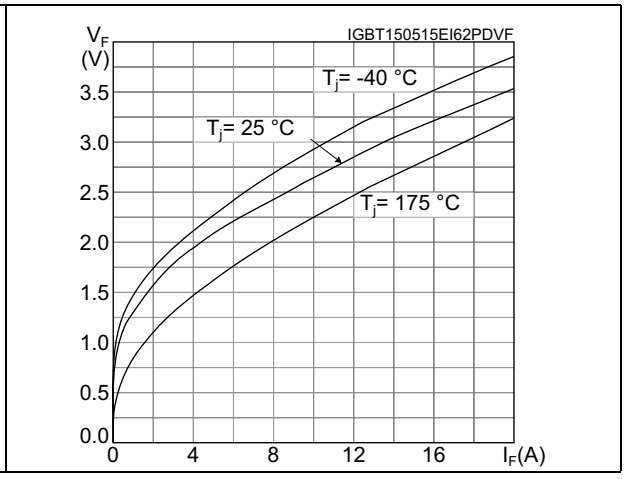


Figure 18. Normalized $V_{GE(th)}$ vs junction temperature

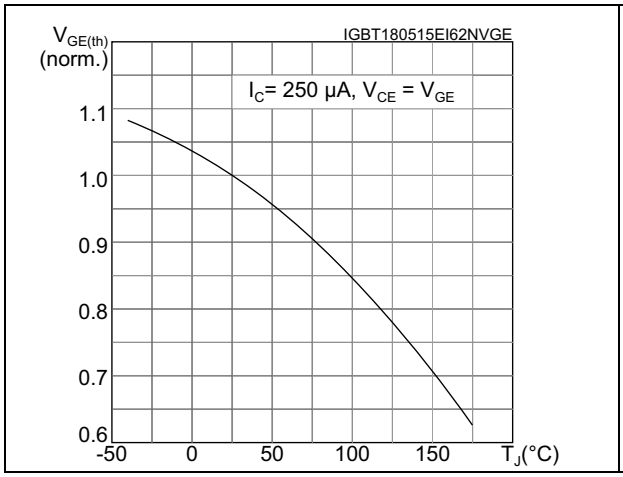


Figure 19. Normalized $V_{(BR)CES}$ vs. junction temperature

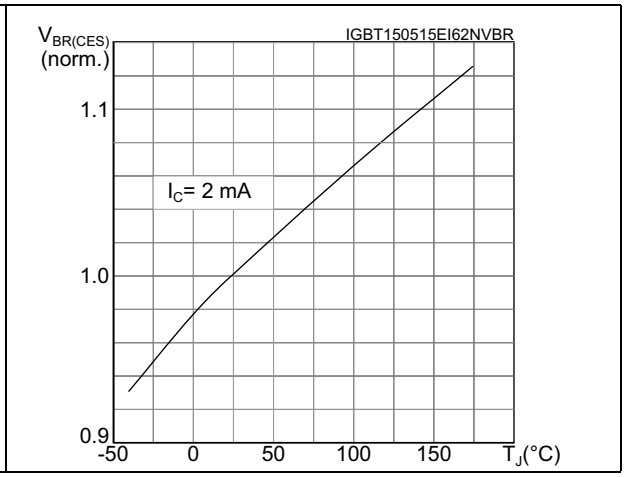


Figure 20. Capacitance variation

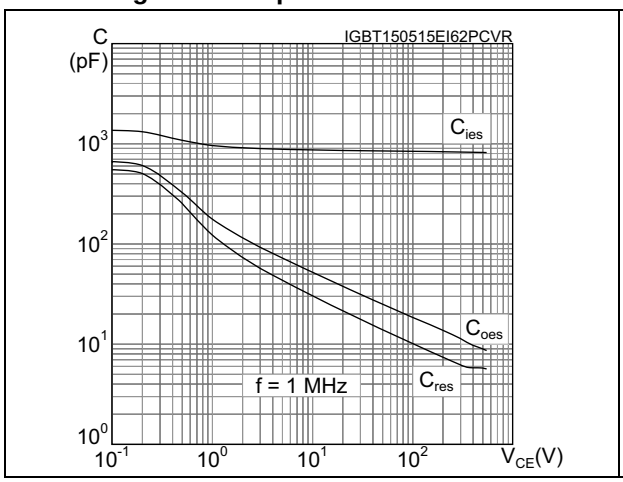


Figure 21. Gate charge vs. gate-emitter voltage

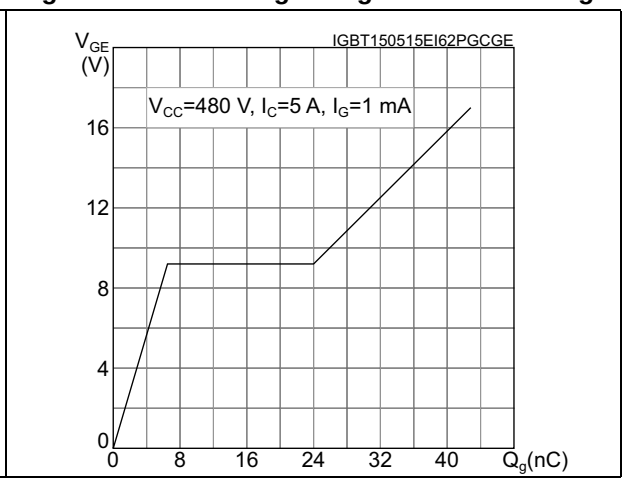


Figure 22. Switching loss vs collector current

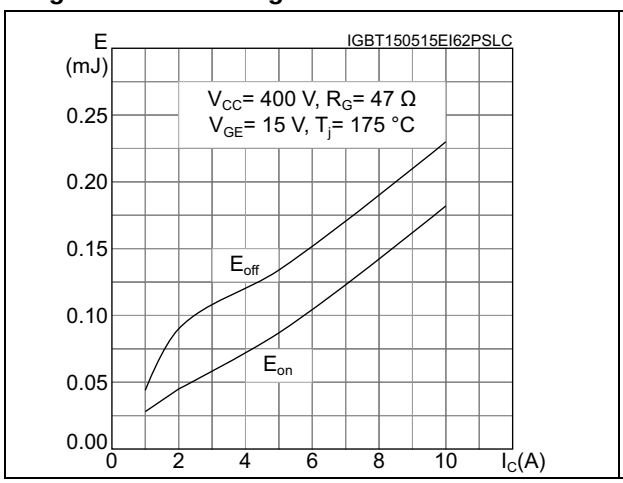


Figure 23. Switching loss vs gate resistance

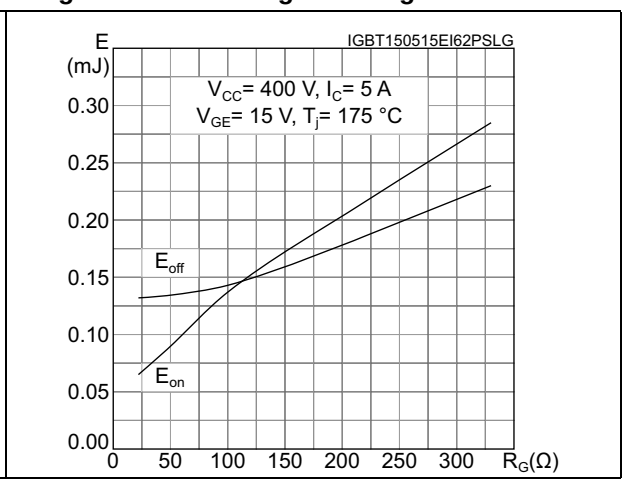


Figure 24. Switching loss vs temperature

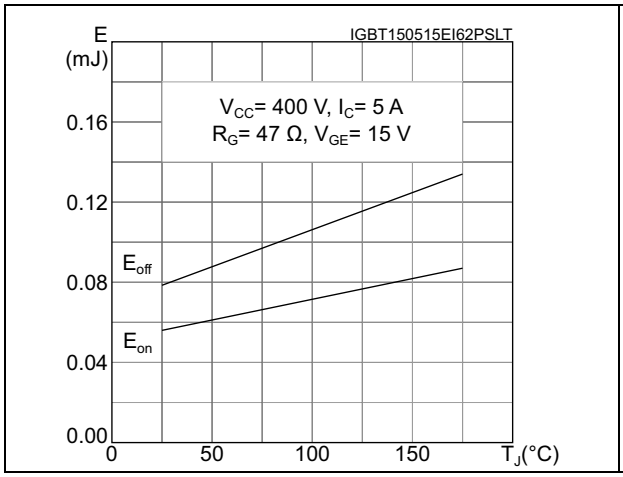


Figure 25. Switching loss vs collector-emitter voltage

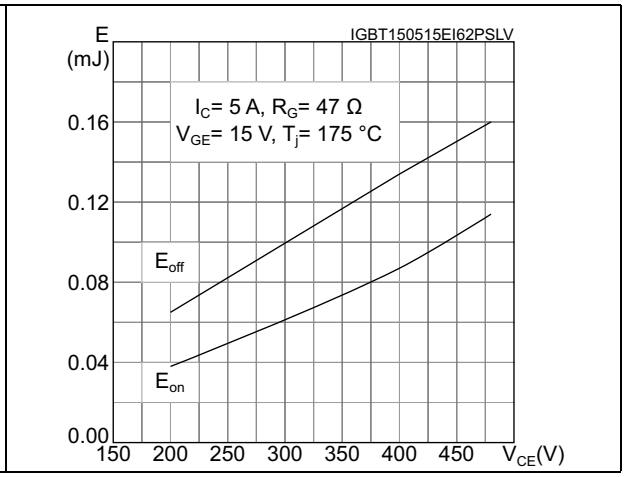


Figure 26. Short circuit time and current vs V_{GE}

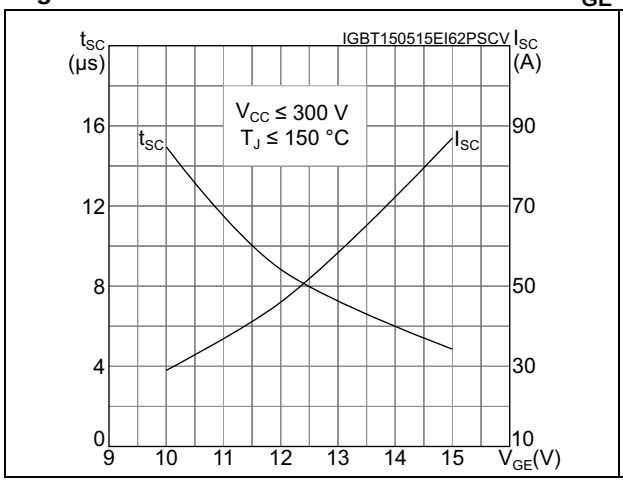


Figure 27. Switching times vs. collector current

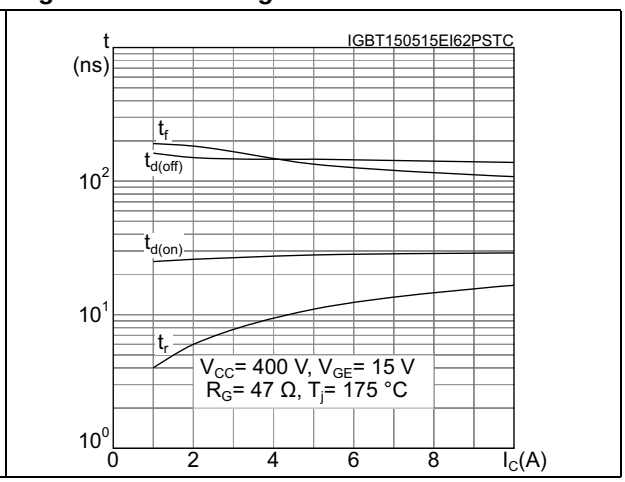


Figure 28. Switching times vs. gate resistance

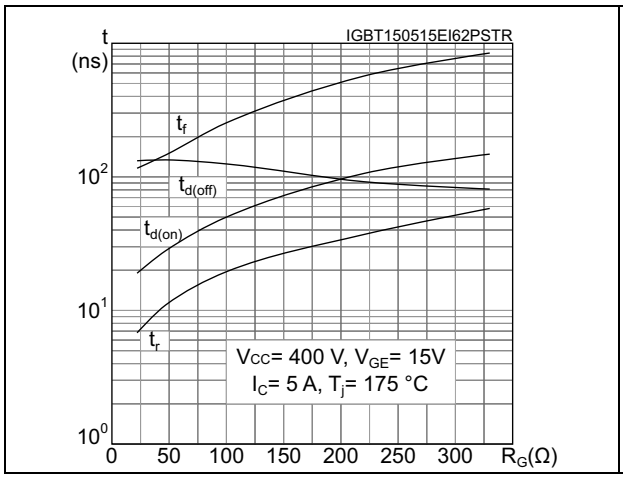


Figure 29. Reverse recovery current vs. diode current slope

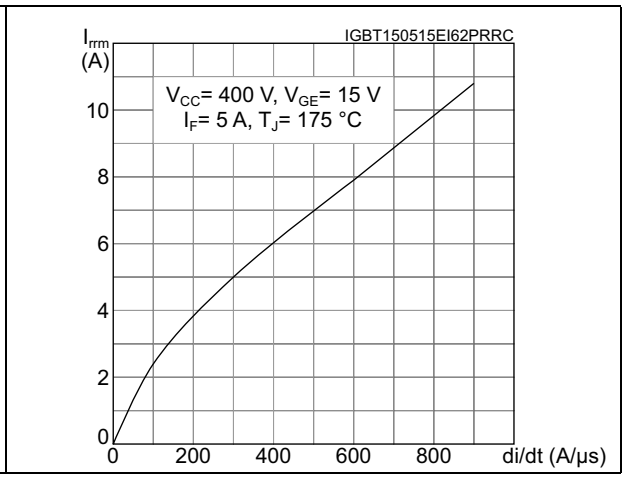


Figure 30. Reverse recovery time vs. diode current slope

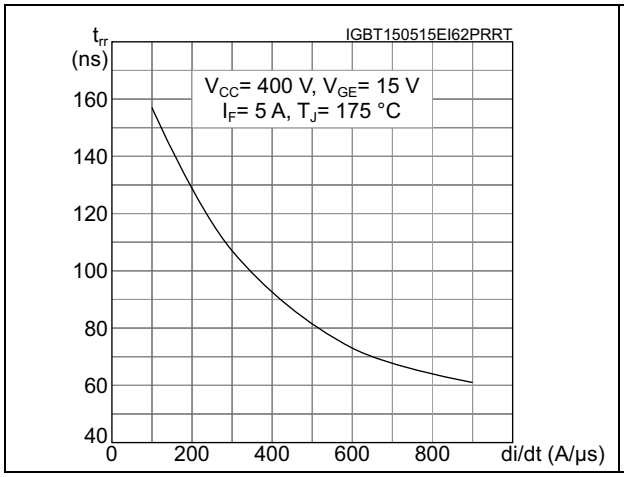


Figure 31. Reverse recovery charge vs. diode current slope

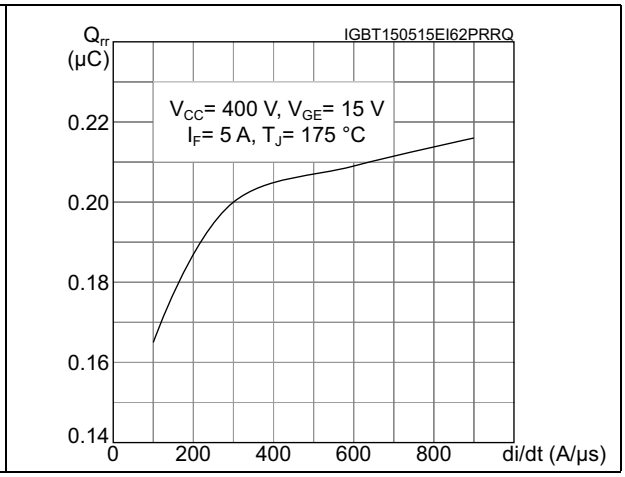


Figure 32. Reverse recovery energy vs. diode current slope

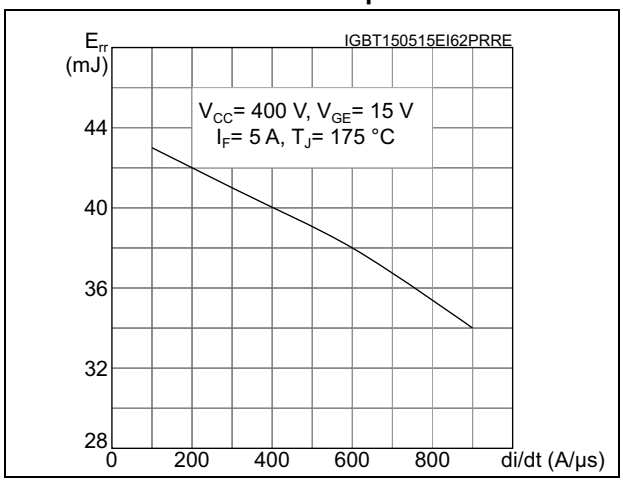


Figure 33. Thermal impedance for D²PAK, DPAK and TO-220 IGBT

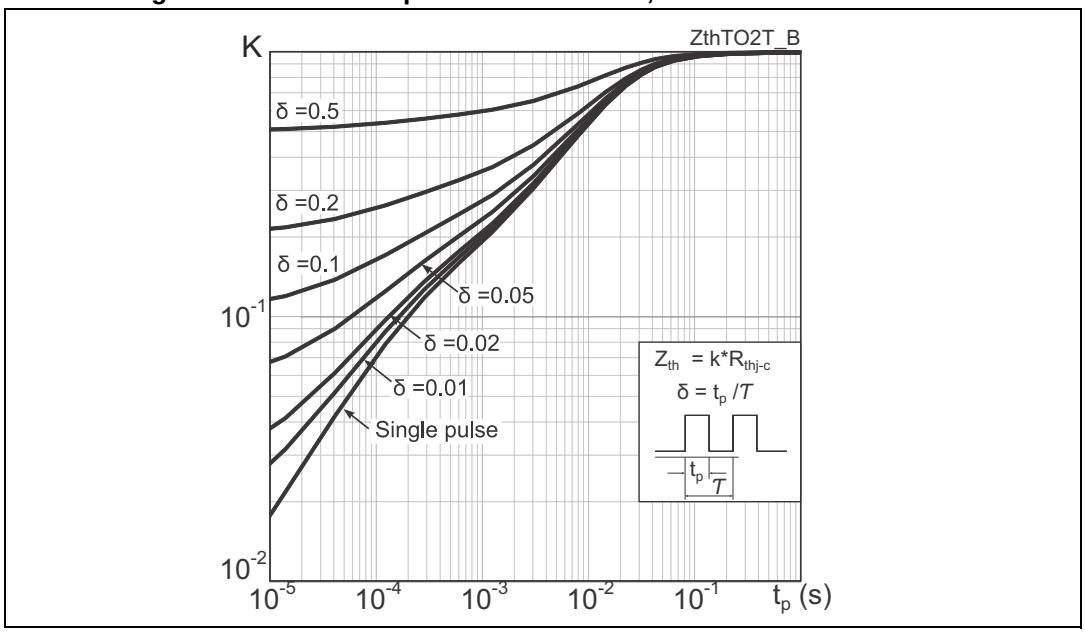


Figure 34. Thermal impedance for D²PAK, DPAK and TO-220 diode

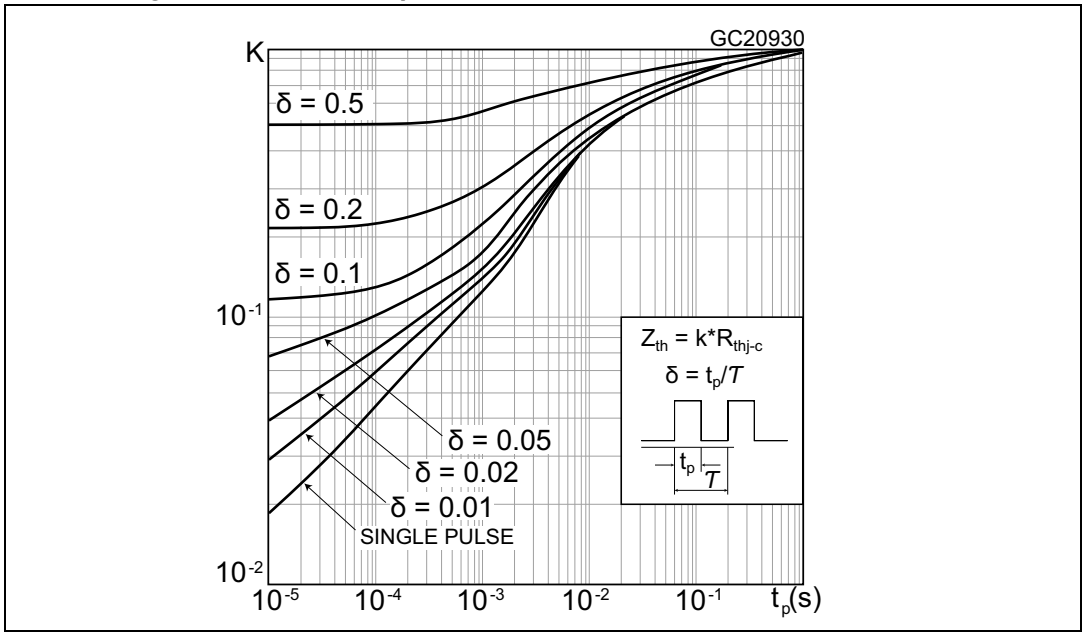


Figure 35. Thermal impedance for TO-220FP IGBT

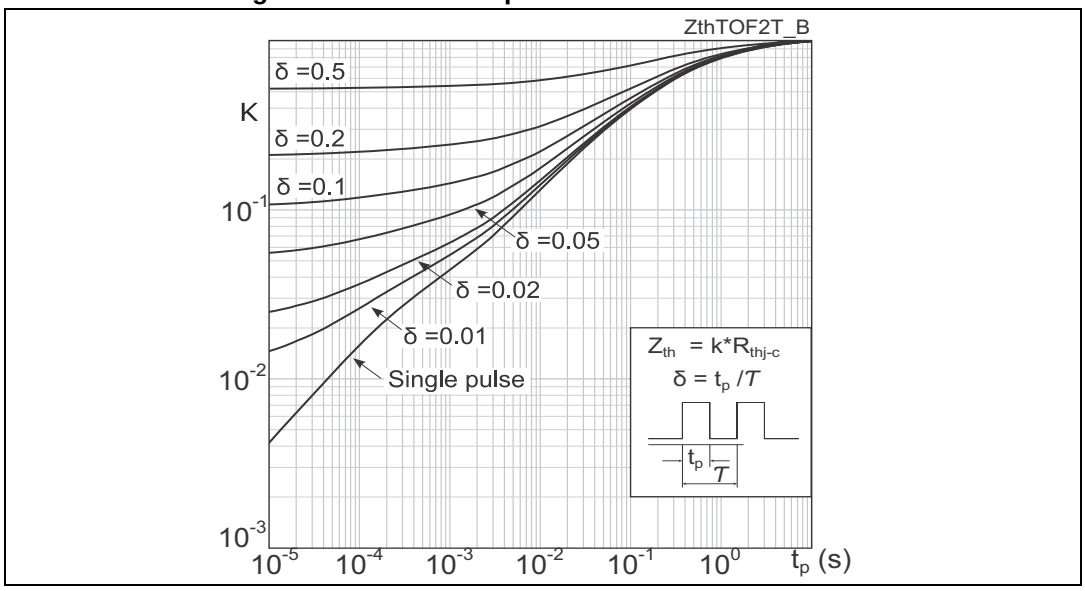
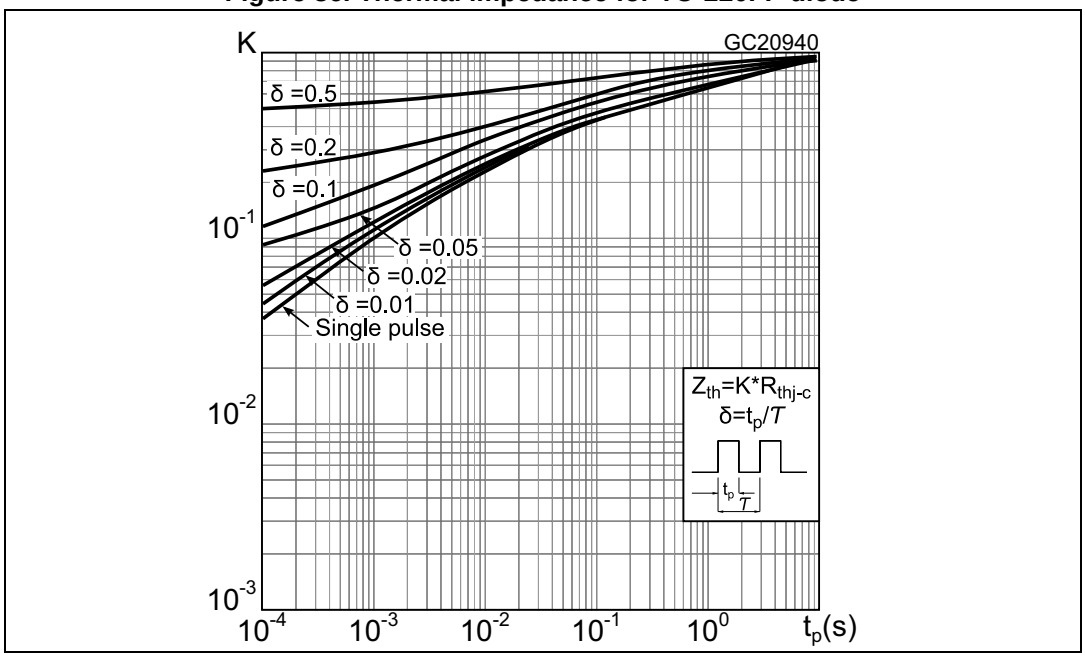


Figure 36. Thermal impedance for TO-220FP diode



3 Test circuits

Figure 37. Test circuit for inductive load switching

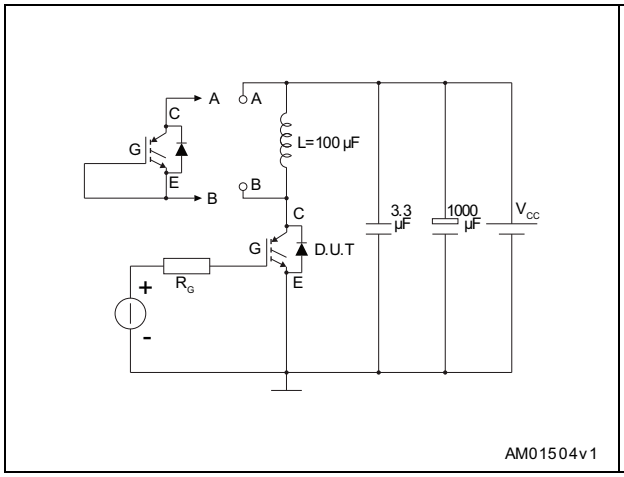


Figure 38. Gate charge test circuit

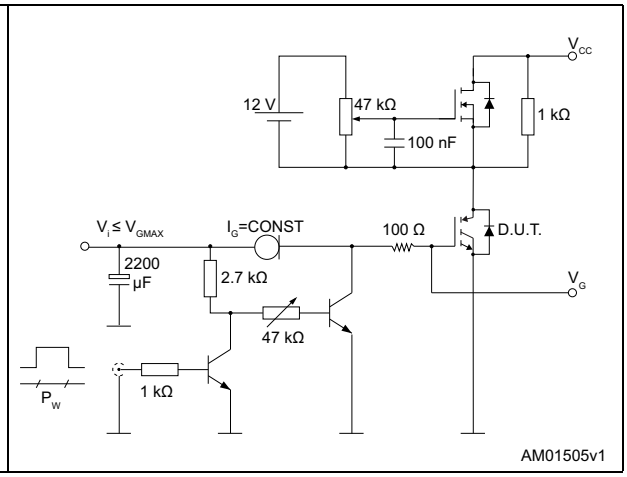


Figure 39. Switching waveform

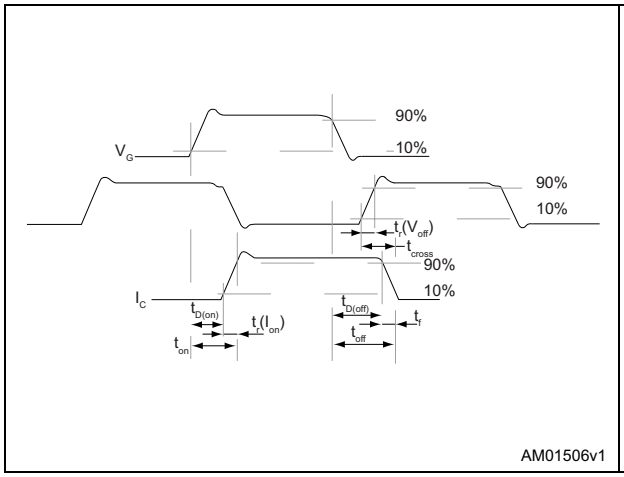
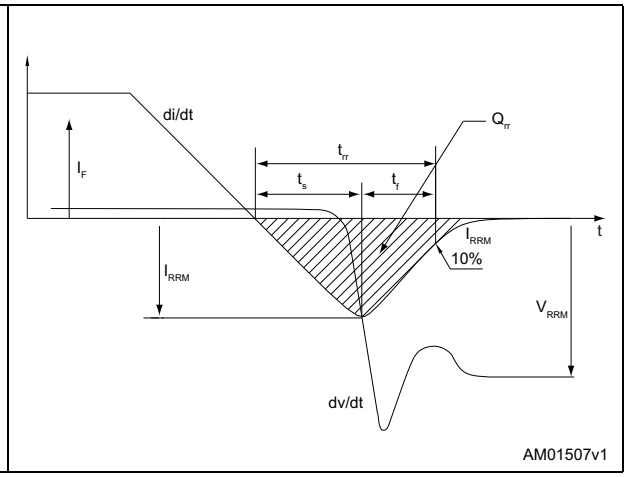


Figure 40. Diode reverse recovery waveform



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 41. D²PAK (TO-263) package outline

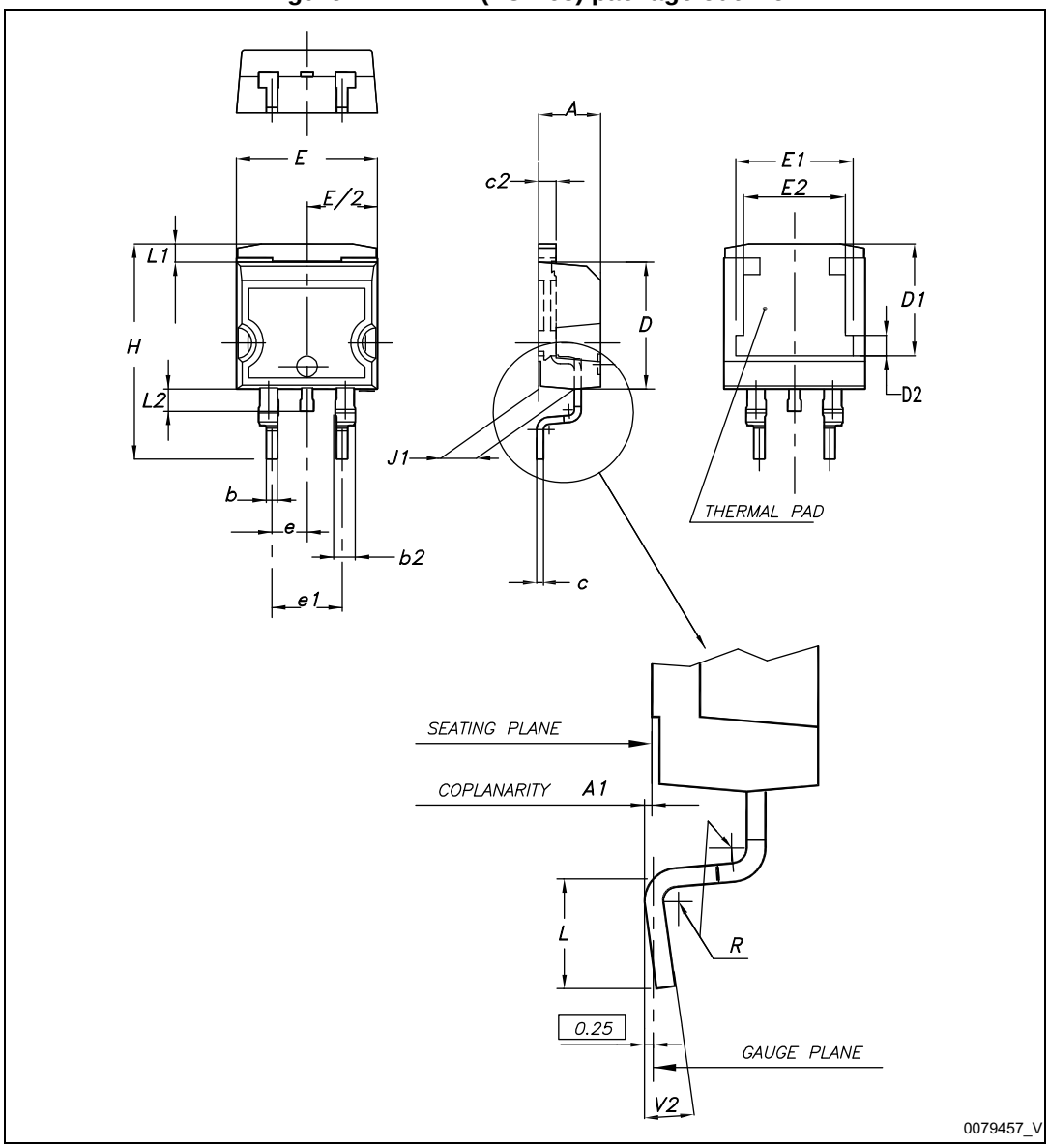
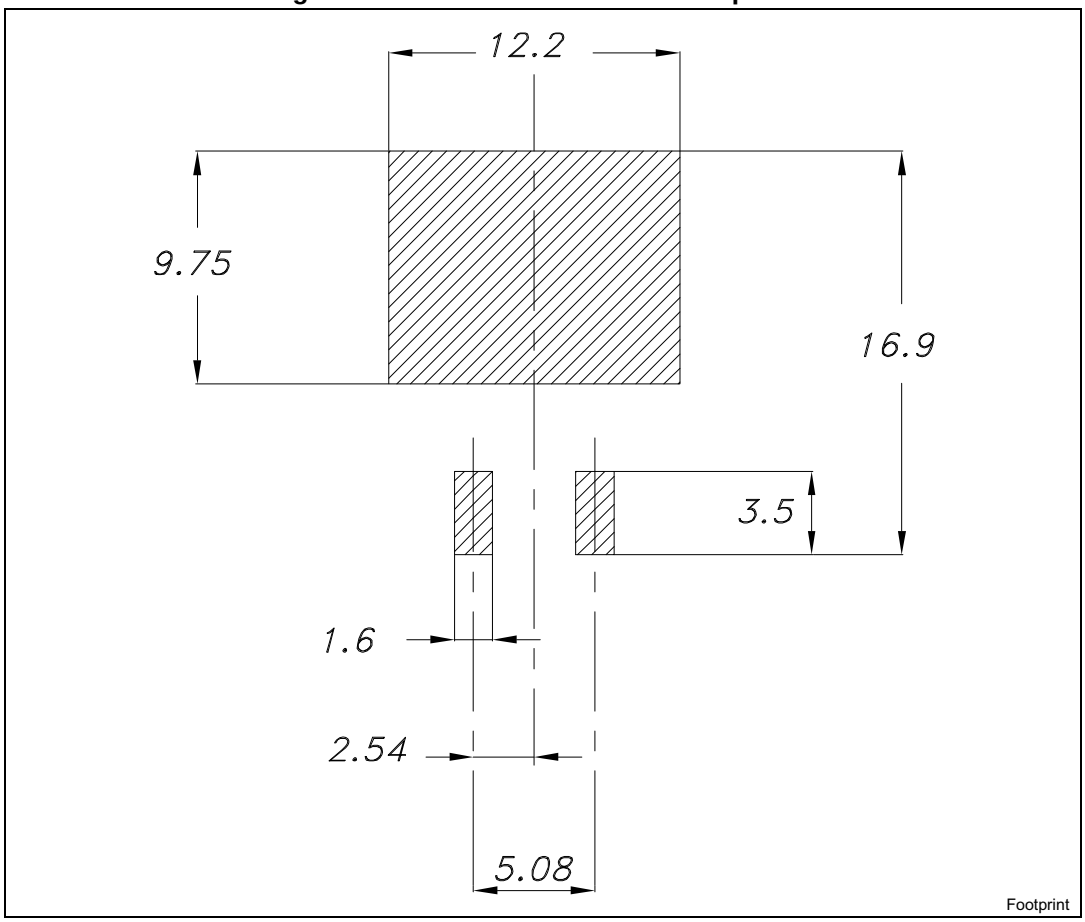


Table 9. D²PAK (TO-263) package mechanical data

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		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 42. D²PAK recommended footprint(a)



a. All dimension are in millimeters

4.2 DPAK package information

Figure 43. DPAK (TO-252) type A2 package outline

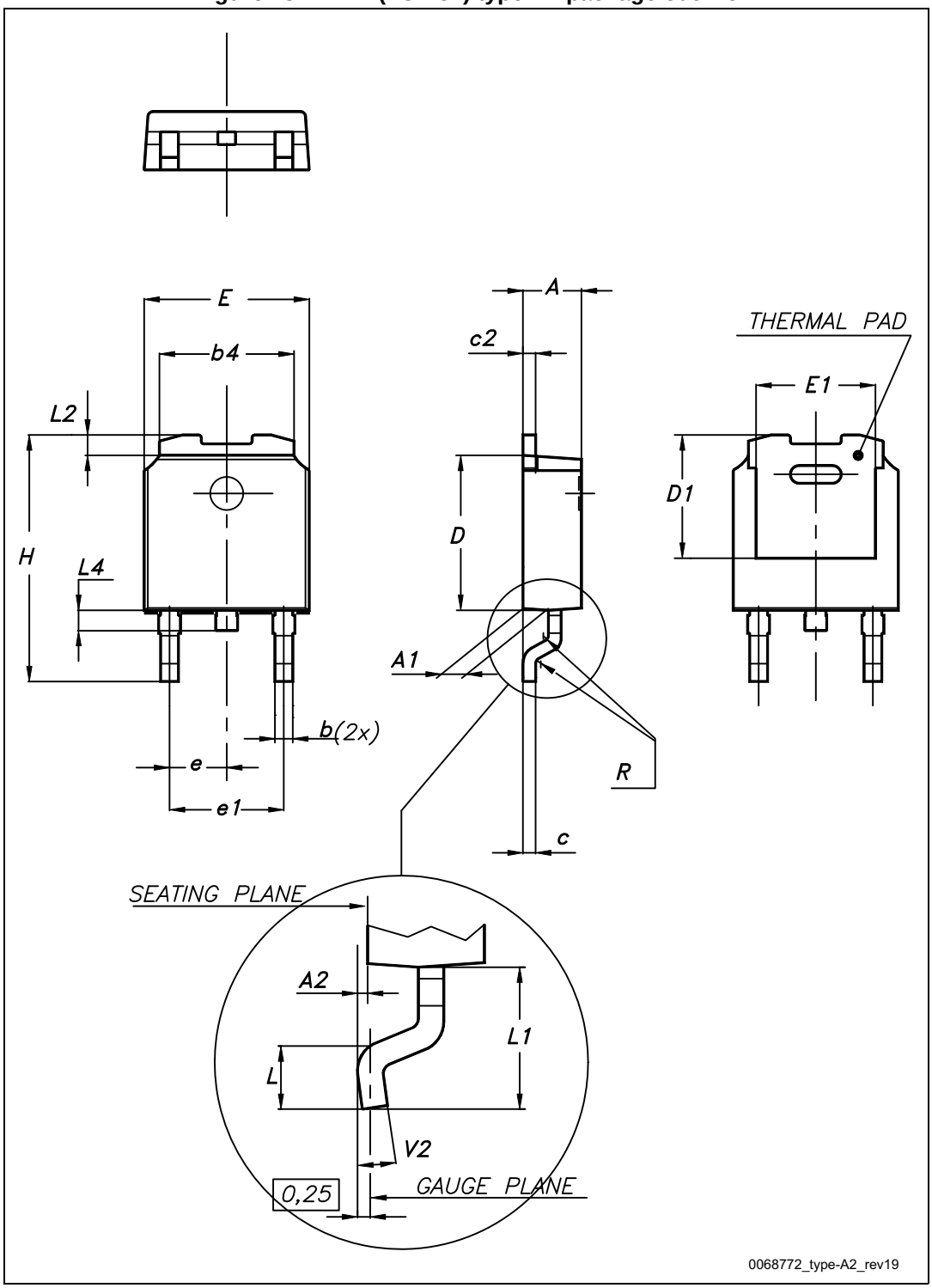
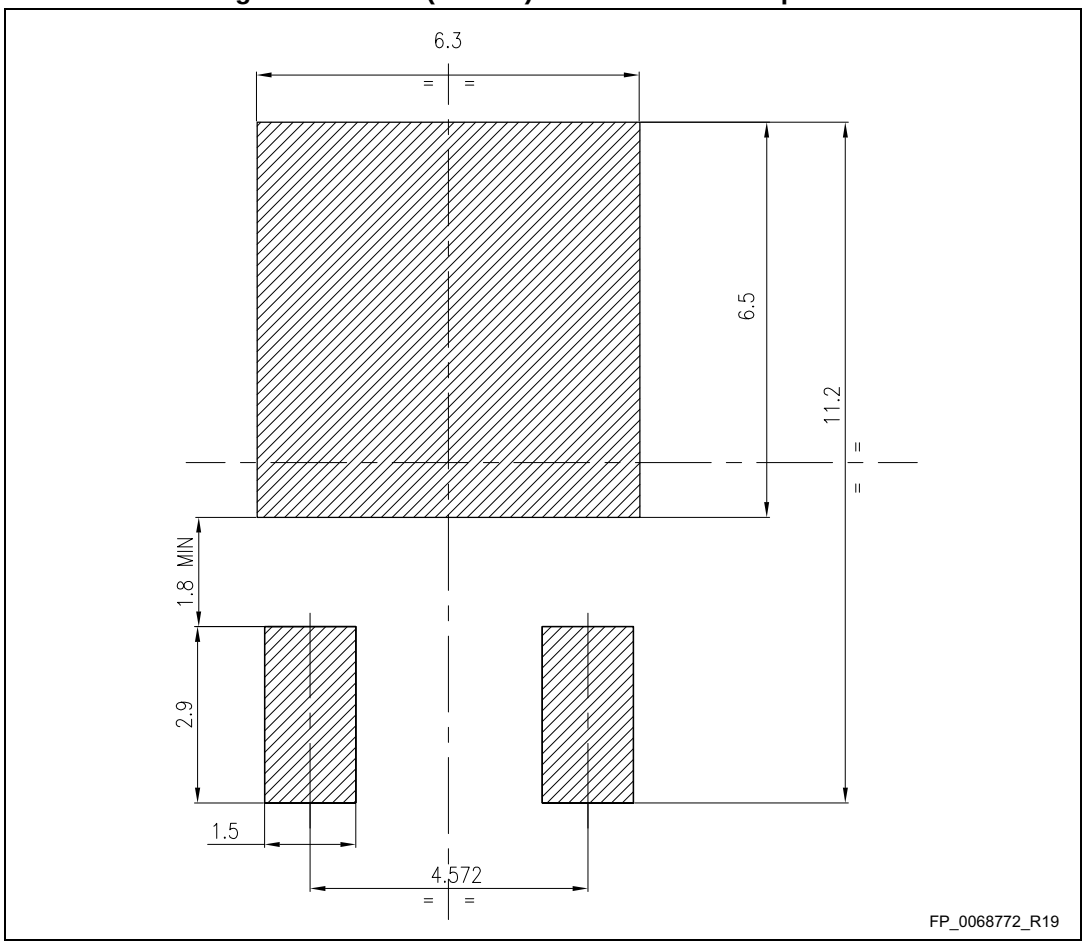


Table 10. DPAK (TO-252) type A2 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
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	2.16	2.28	2.40
e1	4.40		4.60
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°

Figure 44. DPAK (TO-252) recommended footprint (b)



b. All dimensions are in millimeters

4.3 D²PAK and DPAK packing information

Figure 45. D²PAK and DPAK tape outline

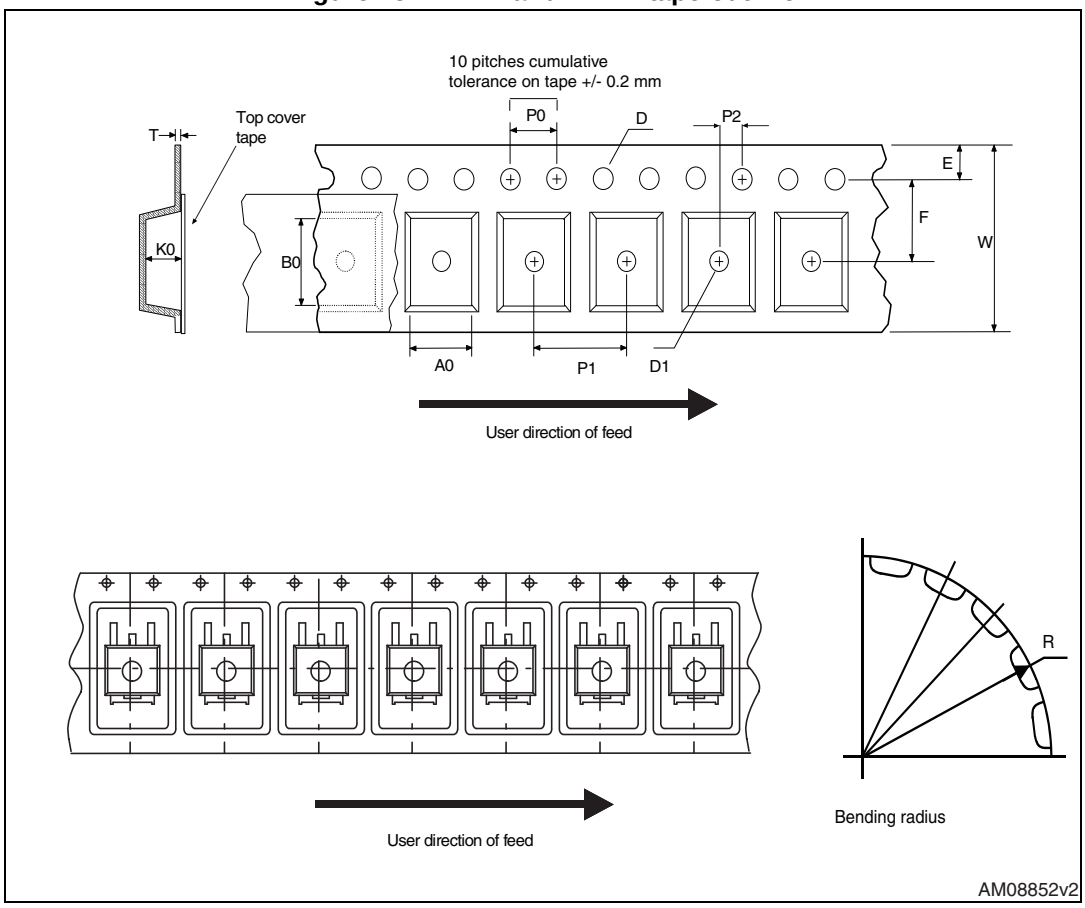


Figure 46. D²PAK and DPAK reel outline

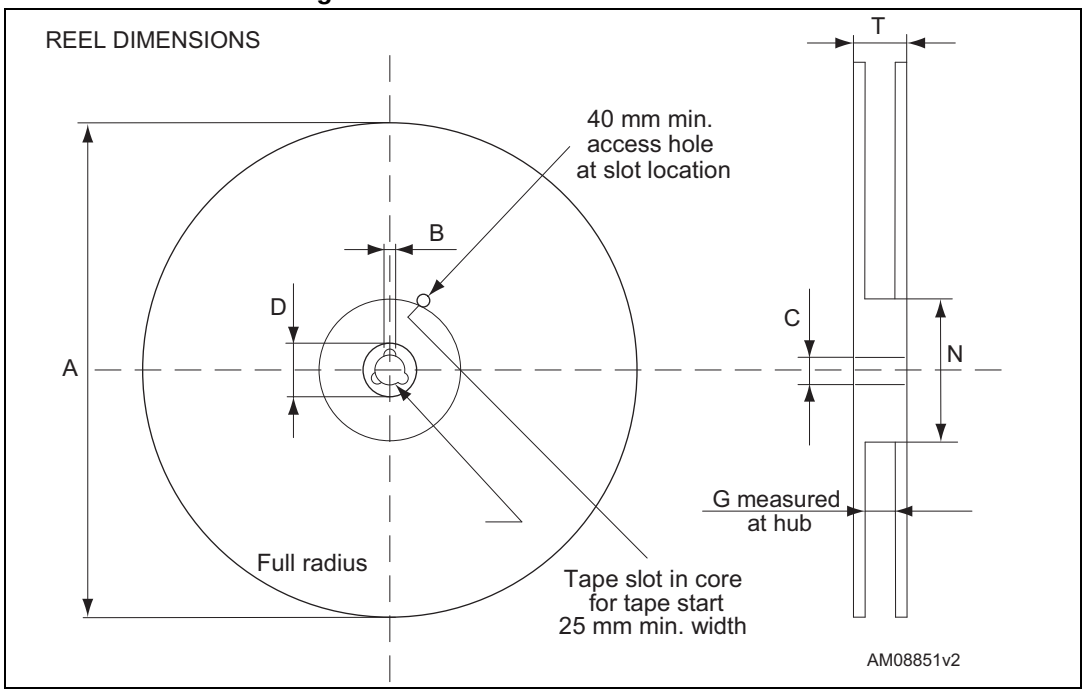


Table 11. D²PAK tape and reel mechanical data

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			

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			

4.4 TO-220FP package information

Figure 47. TO-220FP package outline

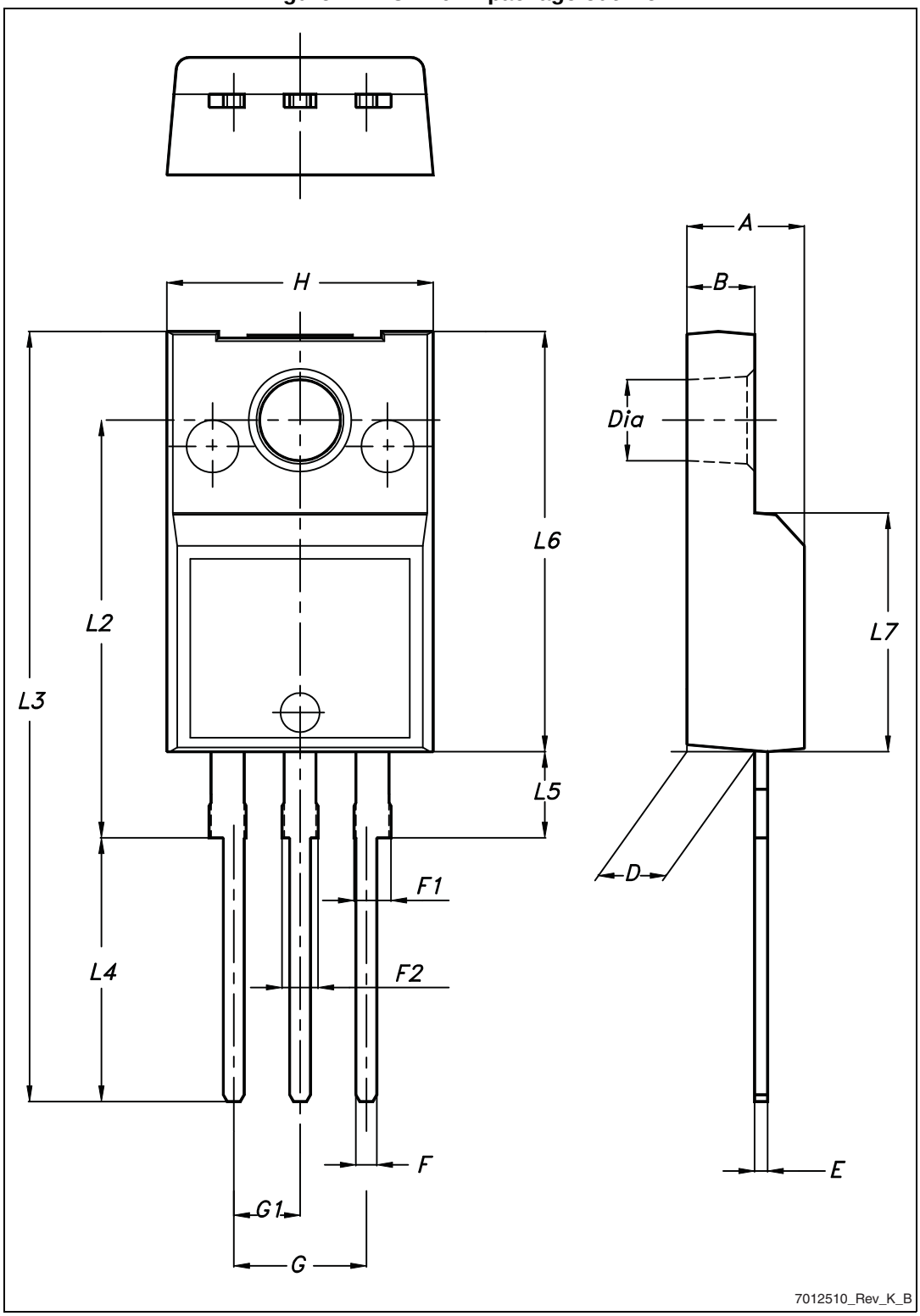


Table 13. TO-220FP package mechanical data

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

4.5 TO-220 package information

Figure 48. TO-220 type A package outline

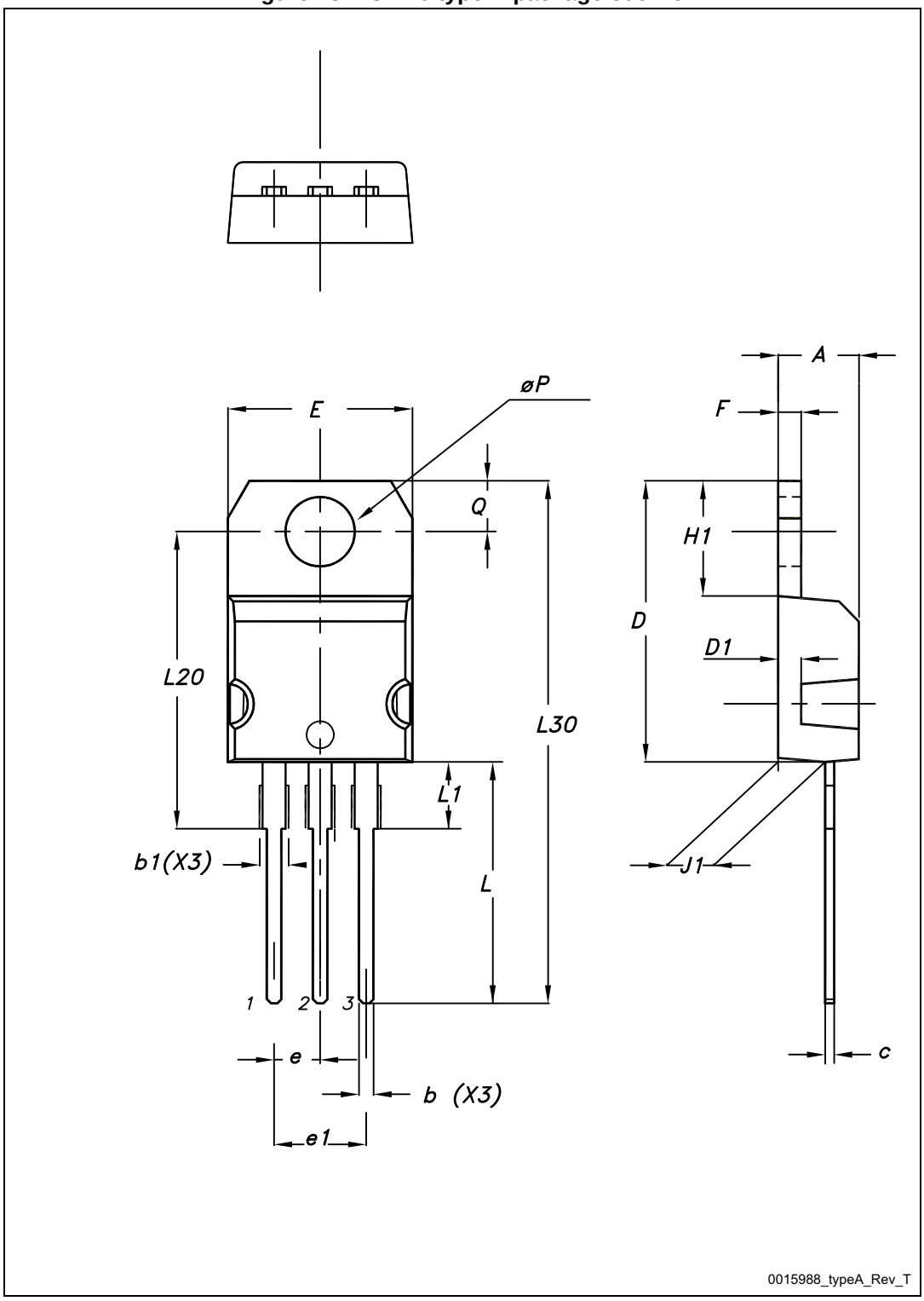


Table 14. TO-220 type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
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 15. Document revision history

Date	Revision	Changes
28-Nov-2014	1	Initial release.
23-Feb-2015	2	Updated *Section 2: Electrical characteristics* and *Section 4: Package information*. Minor text changes.
18-May-2015	3	Text and formatting changes throughout document In *Section 1: Electrical ratings*: - updated *Table 2* and *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)* Updated *Section 4.2: DPAK package information* Document status promoted from “preliminary data” to “production data”

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