Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220FP I²PAKFP	H²PAK-2	TO-220	
V_{DS}	Drain-source voltage	100			V
V_{GS}	Gate-source voltage	± 20			V
I_D (1)	Drain current (continuous) at T_C = 25°C	46	120		A
I_D (1)	Drain current (continuous) at T_C=100°C	29	78		A
I_{DM} (2)	Drain current (pulsed)	184	450		A
P_{TOT}	Total dissipation at T_C = 25°C	35	250		W
dv/dt	Peak diode recovery voltage slope	22			V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T_C = 25 °C)	2500			V
E_{AS} (3)	Single pulse avalanche energy	125			mJ
T_j T_{stg}	Operating junction temperature storage temperature	- 55 to 175			°C

1. Current limited by package.
2. Pulse width limited by safe operating area.
3. Starting Tj = 25 °C, I_D = 50 A, V_{DD} = 50 V for TO-220 and H²PAK-2; Starting Tj = 25 °C, I_D = 29 A, V_{DD} = 60 V for I²PAKFP and TO-220FP.

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220FP I²PAKFP	H²PAK-2	TO-220	
Rthj-case	Thermal resistance junction-case	4.3	0.6	0.6	°C/W
Rthj-a	Thermal resistance junction-ambient	62.5		62.5	°C/W
Rthj-pcb(1)	Thermal resistance junction-pcb		35		°C/W

1. When mounted on FR-4 board, on 1inch², 2oz Cu.

2 Electrical characteristics

(T_{CASE} = 25 °C unless otherwise specified)

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS}= 0, I_D = 250 µA	100	-		V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0, V_{DS}= 100 V T_C=25°C T_C=125°C		-	10 100	µA µA
I_{GSS}	Gate body leakage current	V_{DS} = 0, V_{GS} = ±20 V		-	±200	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS}= V_{GS}, I_D = 250 µA	2	-	4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS}= 10 V, I_D= 23A TO-220FP and I²PAKFP		8	9.6	mΩ
		V_{GS}= 10 V, I_D= 60 A H²PAK TO-220		7.8 8	9.3 9.6	

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{GS} = 0, V_{DS} = 25 V, f = 1 MHz	-	3305 373 23	-	pF pF pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 50 V, I_D = 120 A, V_{GS} = 10 V (see *Figure 20*)	-	57 22 17	-	nC nC nC

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off delay time Fall time	V_{DD} = 50 V, I_D = 60 A R_G = 4.7 Ω V_{GS} = 10 V (see *Figure 19*, *Figure 24*)	-	17 38 52 7.2	-	ns ns ns ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM}(1)	Source-drain current Source-drain current (pulsed)	For TO-220FP and I²PAKFP	-		46 184	A A
I_{SD} I_{SDM}(2)	Source-drain current Source-drain current (pulsed)	For TO-220, H²PAK-2	-		120 450	A A
V_{SD}(3)	Forward on voltage	I_{SD}=120 A, V_{GS}=0; for TO-220, H²PAK-2	-		1.5	V
		I_{SD}=46 A, V_{GS}=0; for TO-220FP and I²PAKFP				
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD}=120 A, di/dt = 100 A/µs, V_{DD}=80 V, Tj=150 °C (see *Figure 21*)	-	68 182 5.4		ns nC A

1. Pulse width limited by safe operating area
2. Pulse width limited by safe operating area
3. Pulsed: pulse duration = 300 µs, duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220FP and I²PAKFP

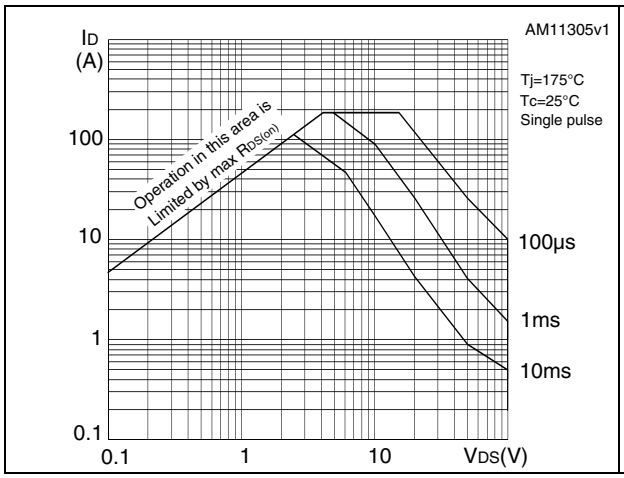


Figure 3. Thermal impedance for TO-220FP and I²PAKFP

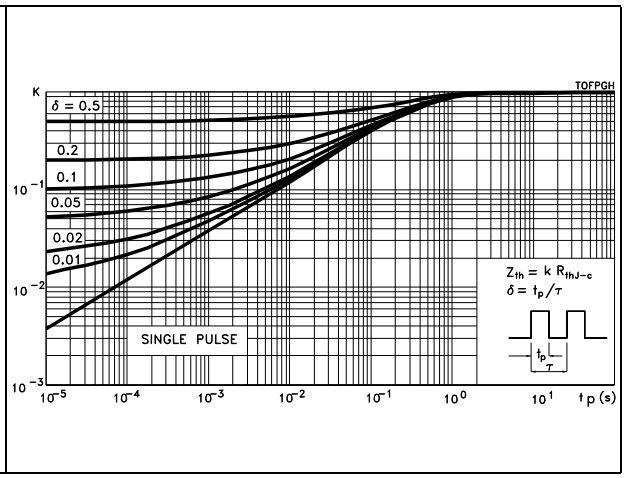


Figure 4. Safe operating area for H²PAK-2 and TO-220

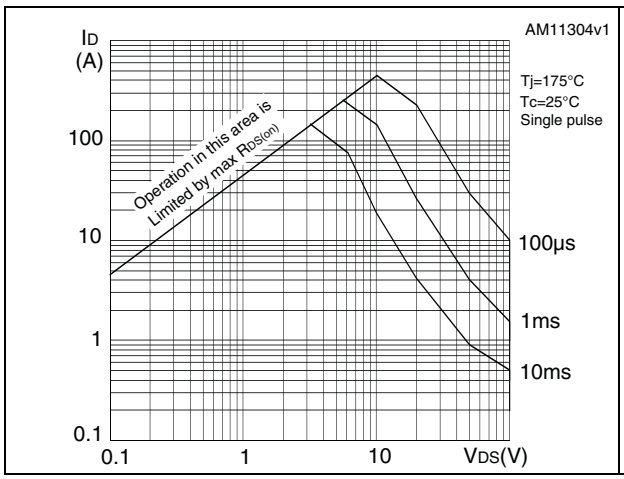


Figure 5. Thermal impedance for H²PAK-2 and TO-220

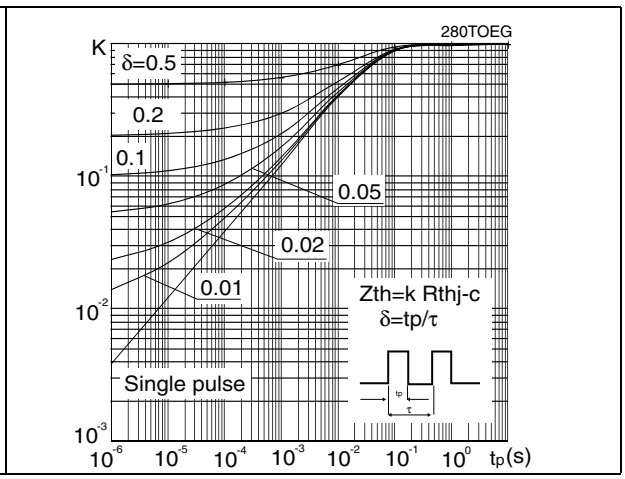


Figure 6. Output characteristics

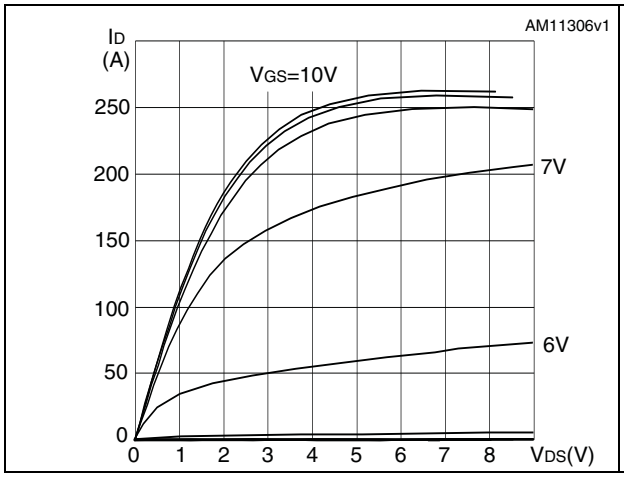


Figure 7. Transfer characteristics

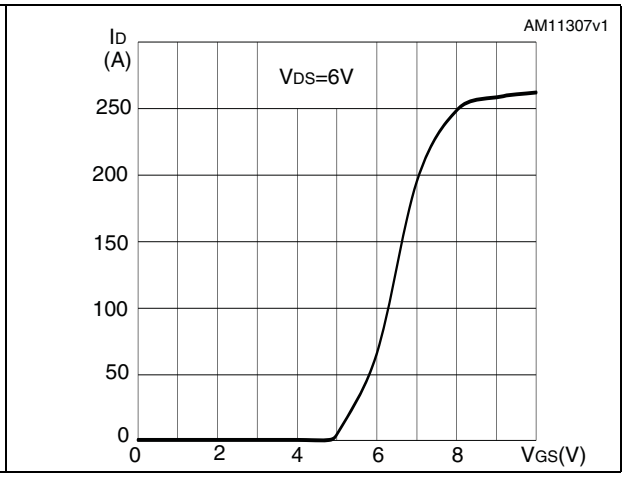


Figure 8. Static drain-source on-resistance for TO-220FP and I²PAKFP

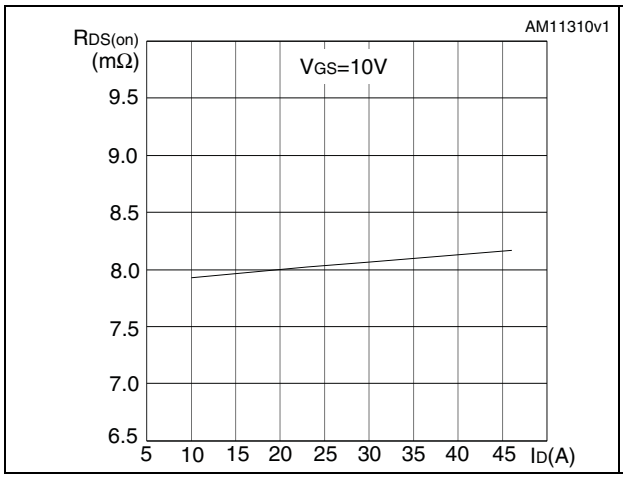


Figure 9. Static drain-source on-resistance for H²PAK-2

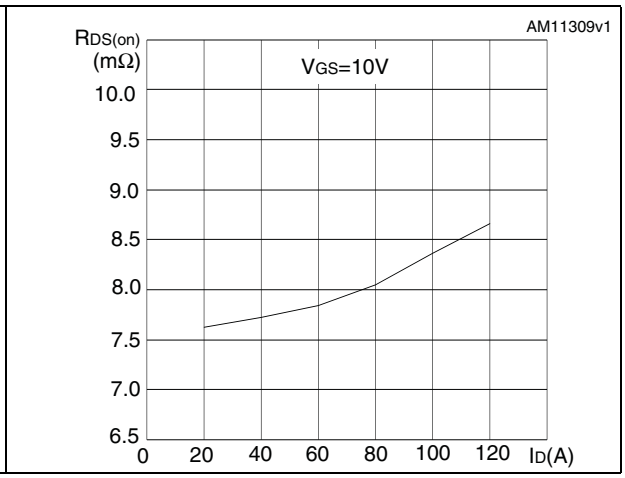


Figure 10. Static drain-source on-resistance for TO-220

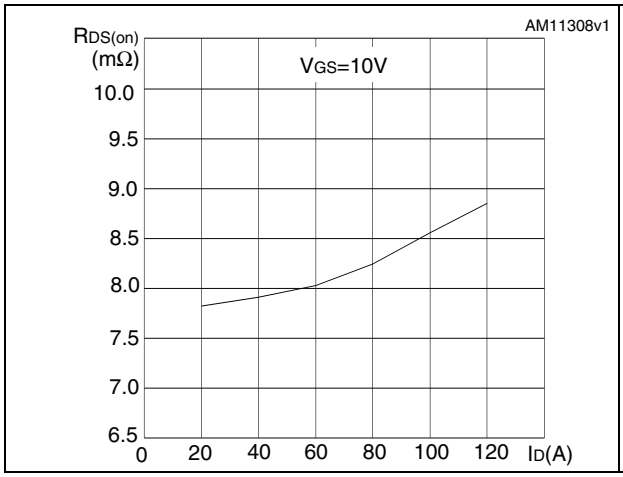


Figure 11. Normalized B_{VDSS} vs temperature

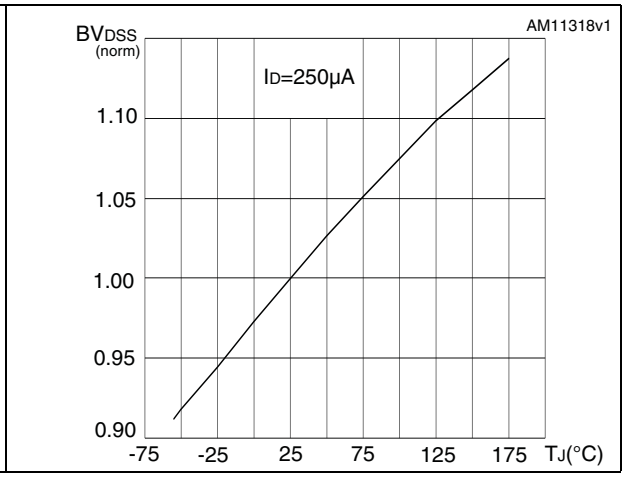


Figure 12. Gate charge vs gate-source voltage

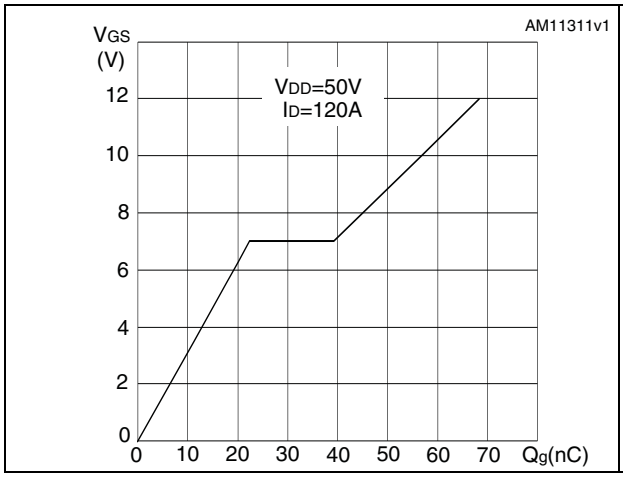


Figure 13. Capacitance variations

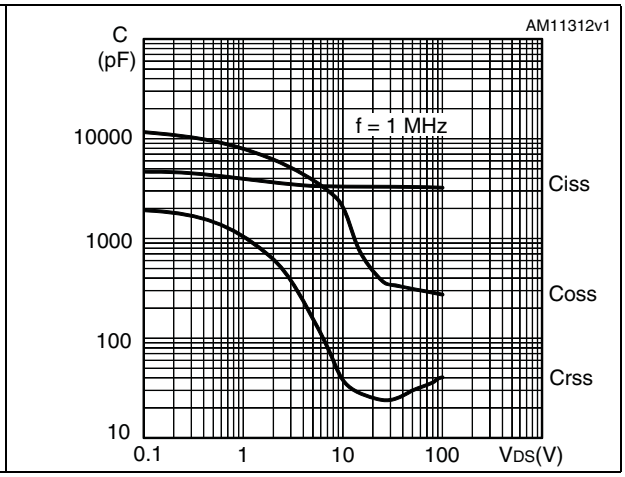


Figure 14. Normalized gate threshold voltage vs temperature

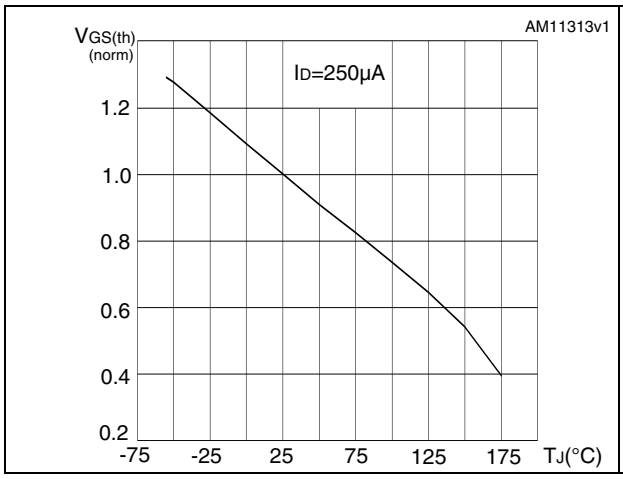


Figure 15. Normalized on-resistance vs temperature for TO-220FP and I²PAKFP

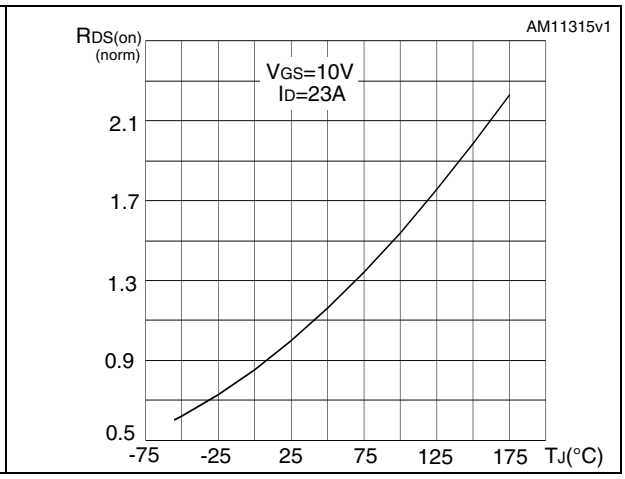


Figure 16. Normalized on resistance vs temperature for H²PAK-2 and TO-220

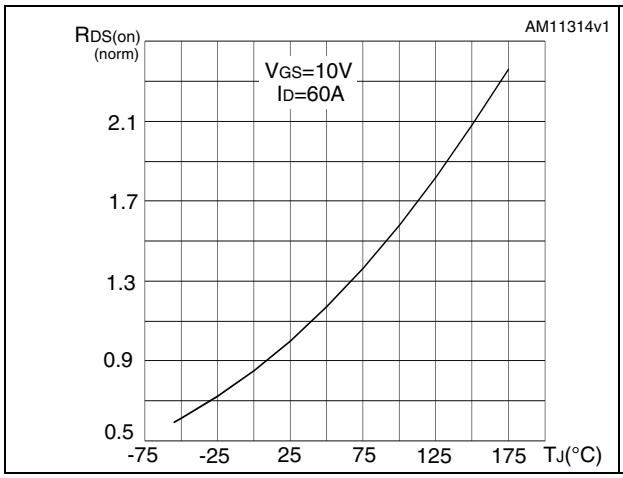


Figure 17. Source-drain diode forward characteristics for TO-220FP and I²PAKFP

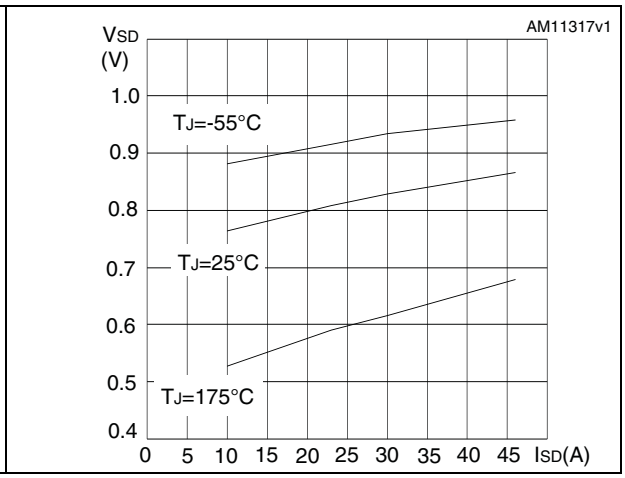
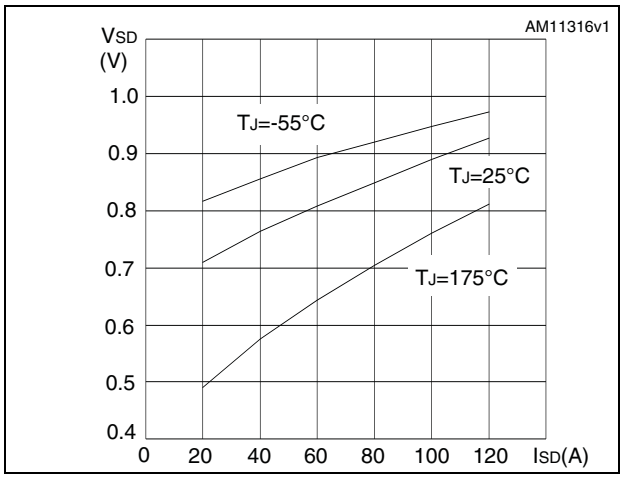


Figure 18. Source-drain diode forward characteristics for H²PAK-2 and TO-220



3 Test circuits

Figure 19. Switching times test circuit for resistive load

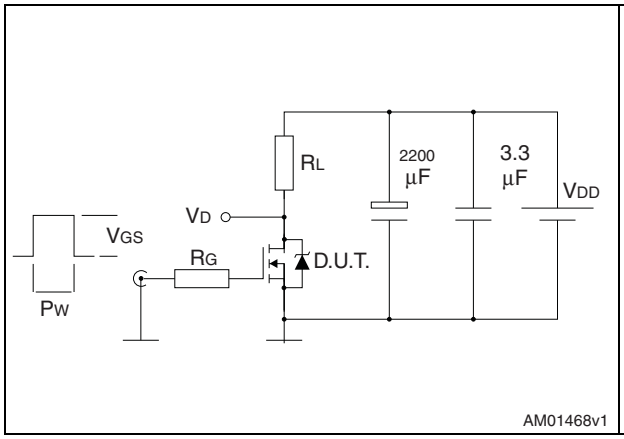


Figure 20. Gate charge test circuit

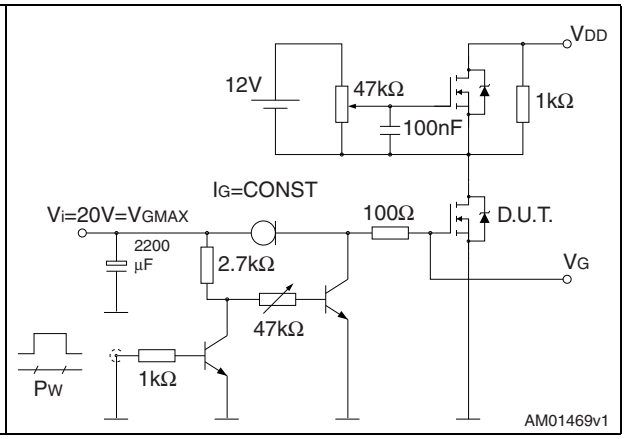


Figure 21. Test circuit for inductive load switching and diode recovery times

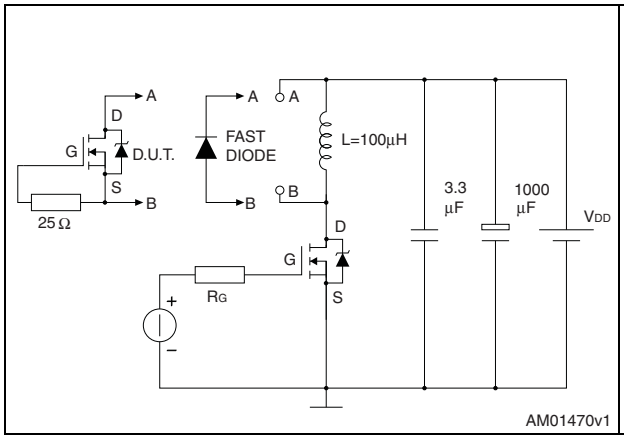


Figure 22. Unclamped inductive load test circuit

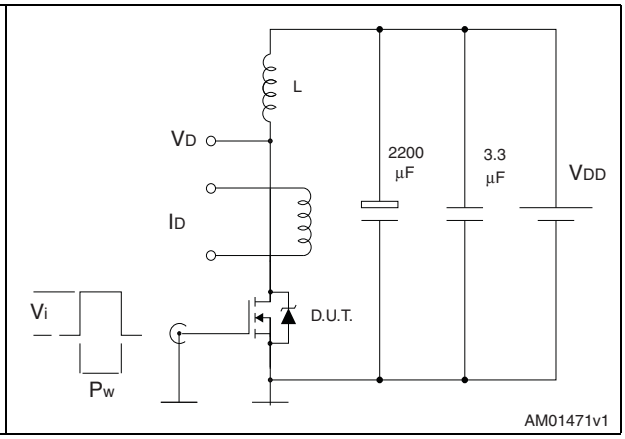


Figure 23. Unclamped inductive waveform

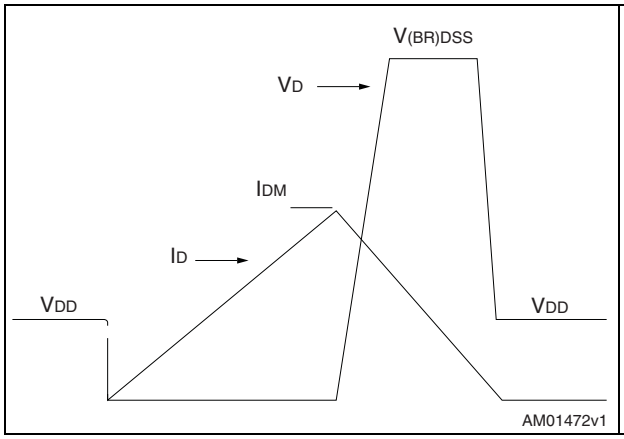
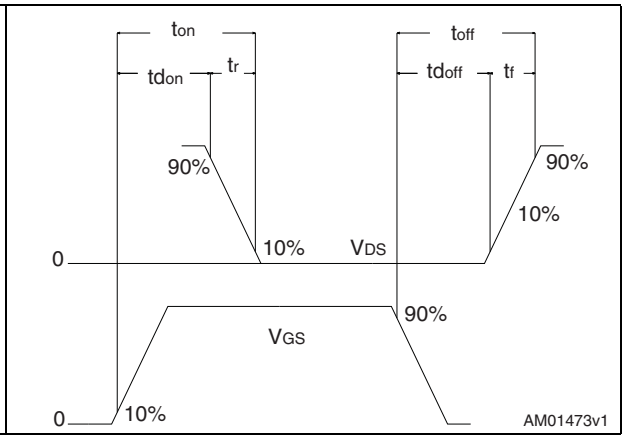


Figure 24. Switching time waveform



4 Package mechanical data

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.

Table 8. TO-220FP 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

Figure 25. TO-220FP drawing

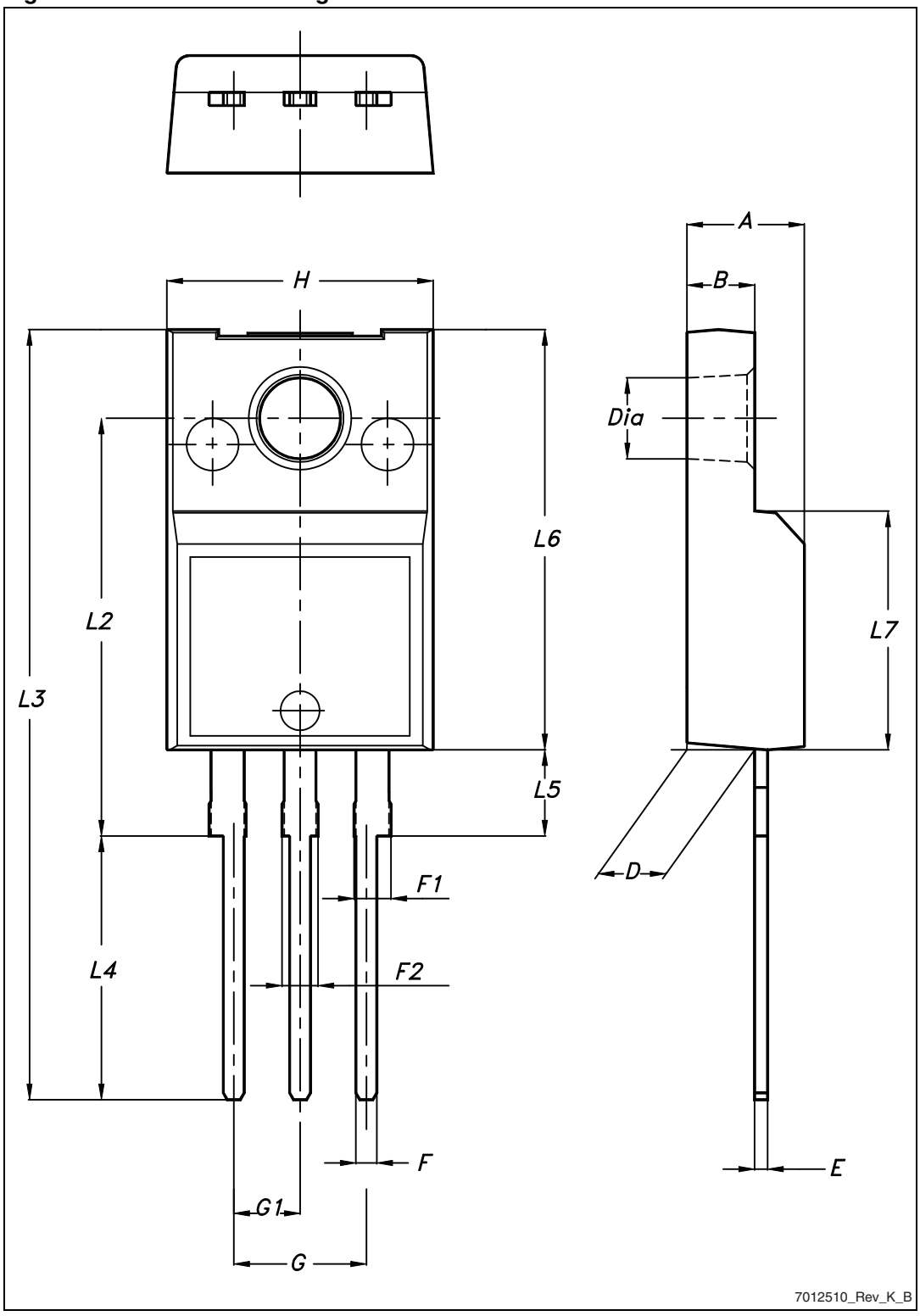


Table 9. I^2PAKFP (TO-281) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
D1	0.65		0.85
E	0.45		0.70
F	0.75		1.00
F1			1.20
G	4.95	-	5.20
H	10.00		10.40
L1	21.00		23.00
L2	13.20		14.10
L3	10.55		10.85
L4	2.70		3.20
L5	0.85		1.25
L6	7.30		7.50

Figure 26. I^2PAKFP (TO-281) drawing

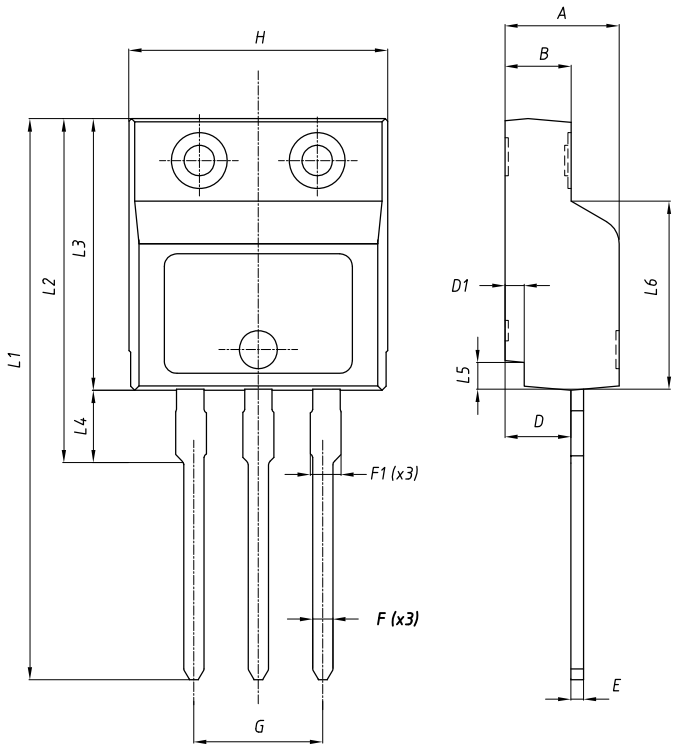


Table 10. H²PAK-2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.30	-	4.80
A1	0.03		0.20
C	1.17		1.37
e	4.98		5.18
E	0.50		0.90
F	0.78		0.85
H	10.00		10.40
H1	7.40		7.80
L	15.30		15.80
L1	1.27		1.40
L2	4.93		5.23
L3	6.85		7.25
L4	1.5		1.7
M	2.6		2.9
R	0.20		0.60
V	0°		8°

Figure 27. H²PAK-2 drawing

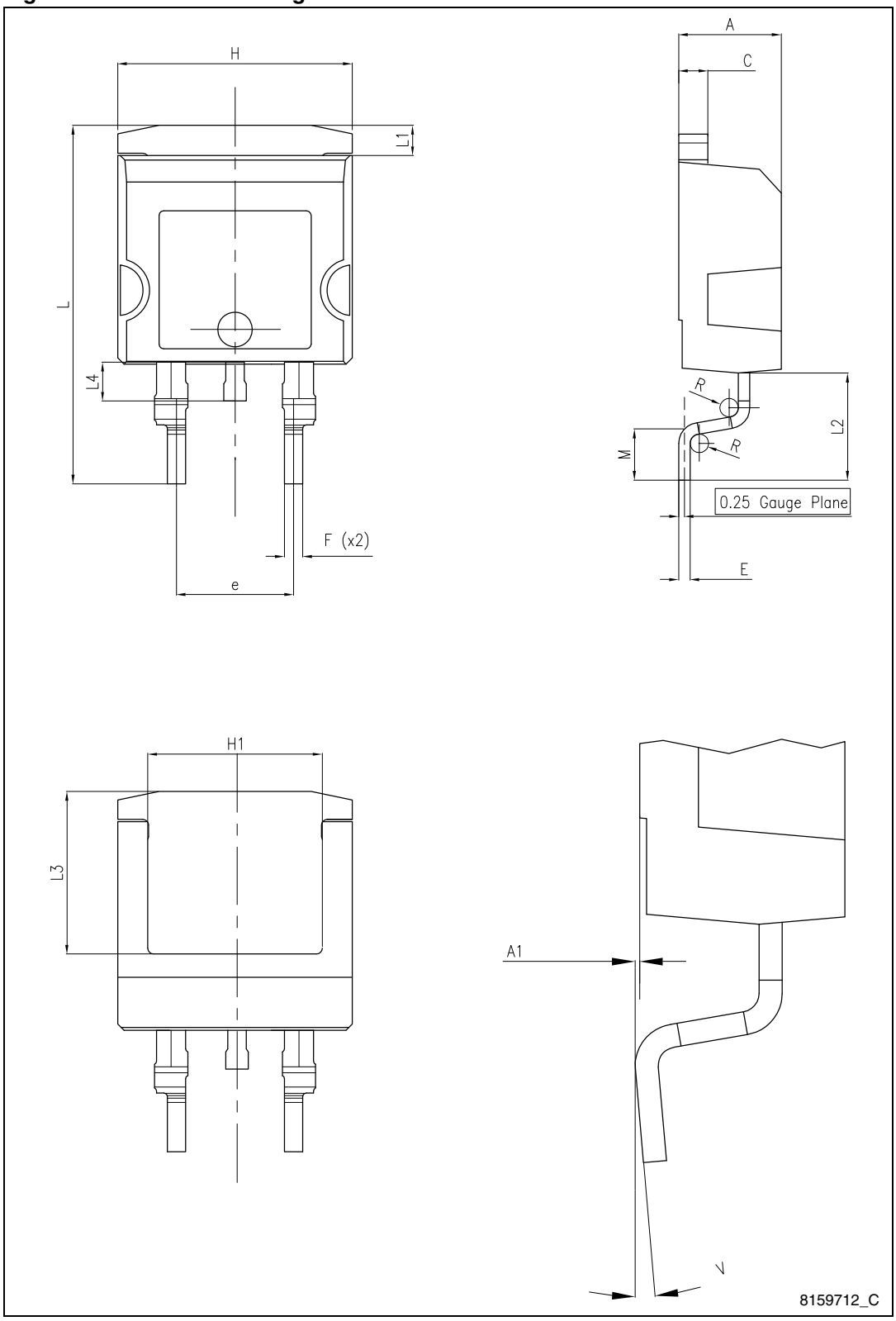


Figure 28. H²PAK-2 recommended footprint (dimensions are in millimeters)

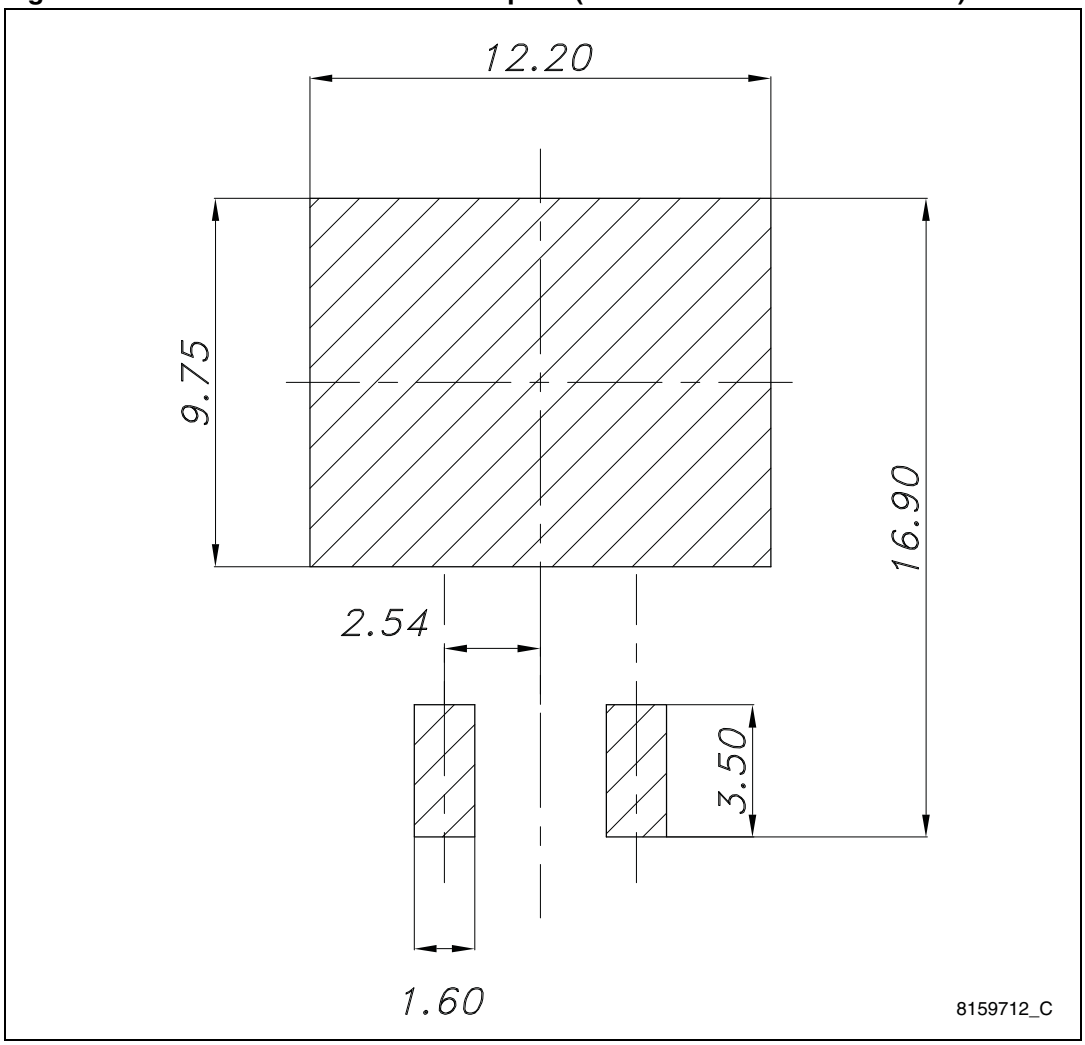
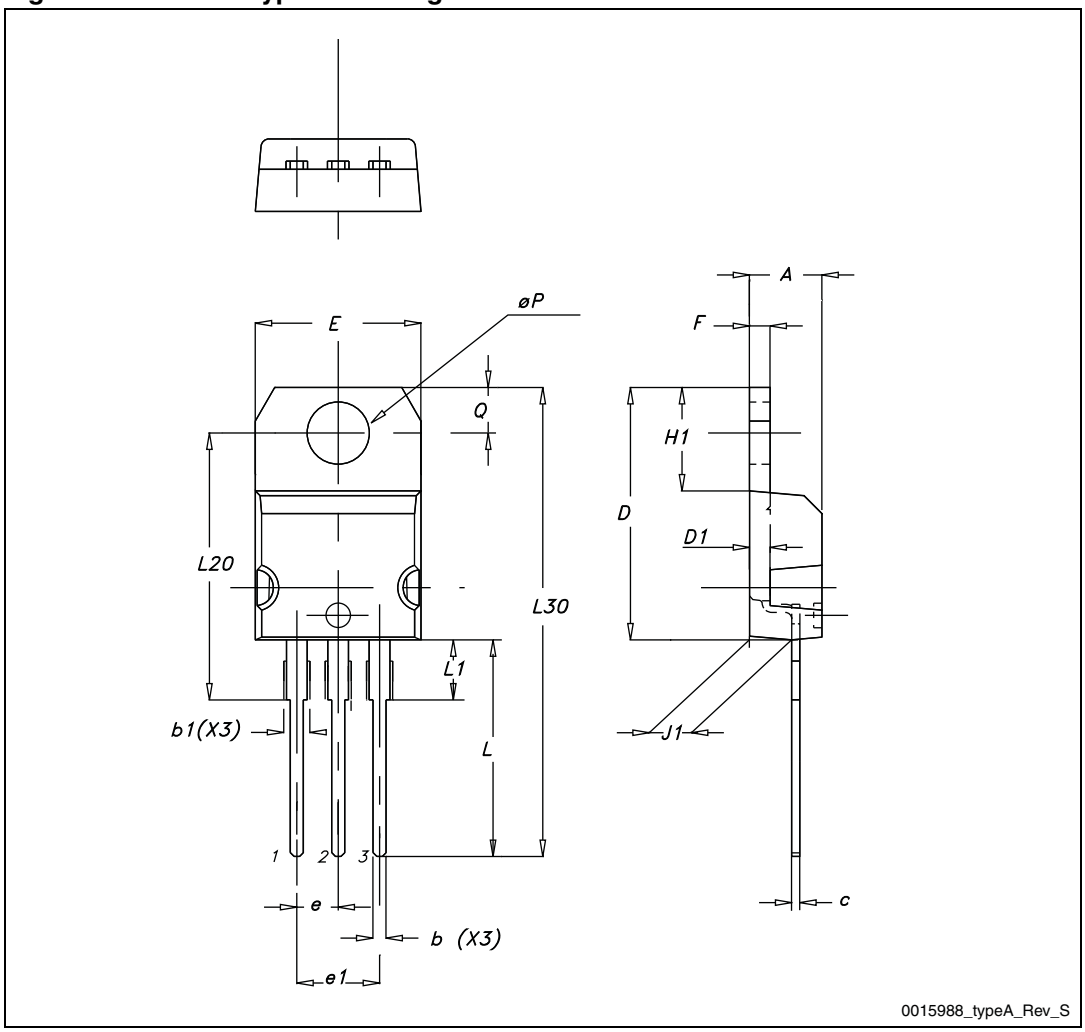


Table 11. TO-220 type A mechanical data

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

Figure 29. TO-220 type A drawing



5 Package mechanical data

Table 12. H²PAK-2 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			

Figure 30. Tape

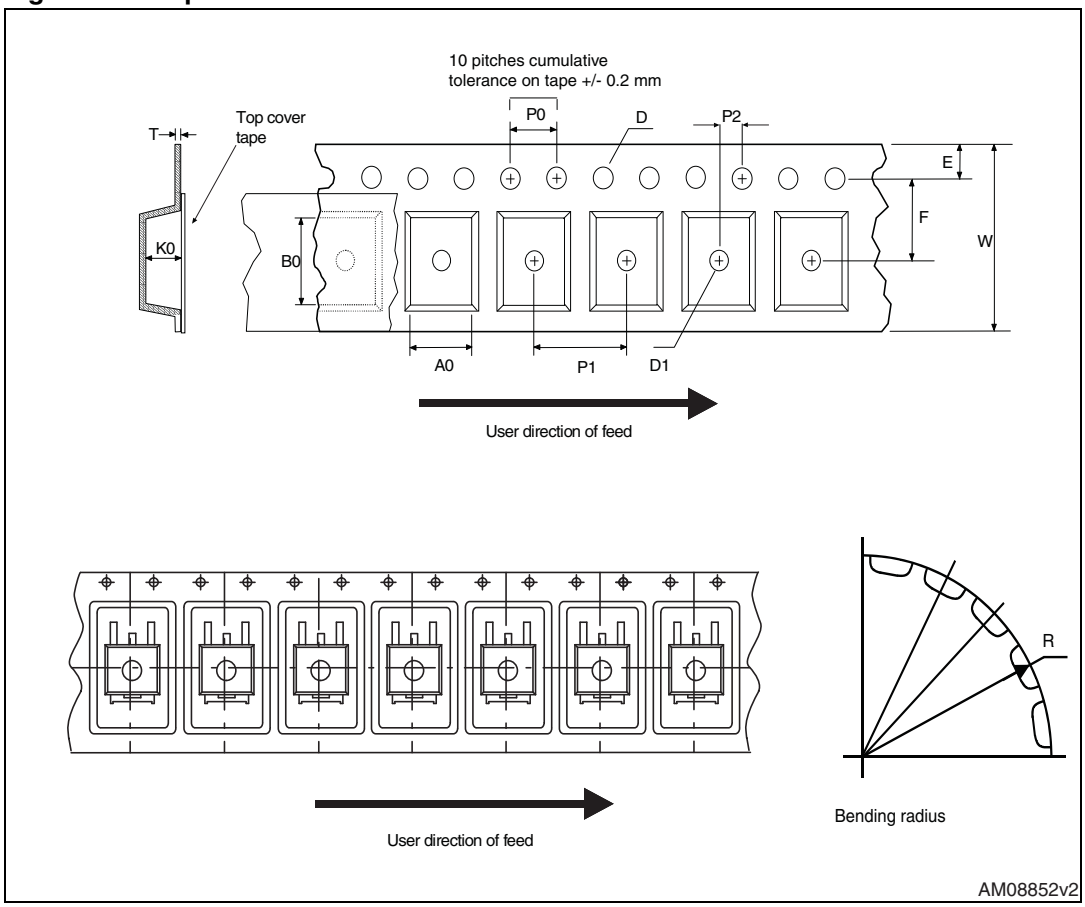
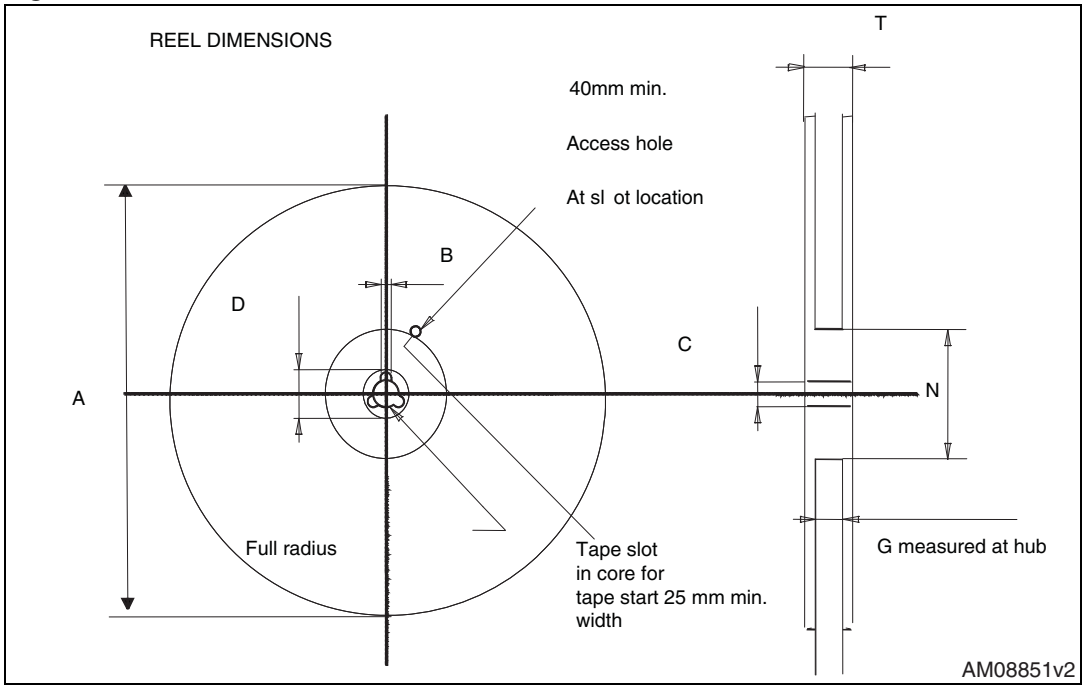


Figure 31. Reel



6 Revision history

Table 13. Document revision history

Date	Revision	Changes
24-Feb-2011	1	First version.
07-May-2012	2	Added *Section 2.1: Electrical characteristics (curves)*. Minor text changes.
07-Nov-2012	3	Added new device in I^2PAKFP and updated the document accordingly. Updated *Section 4: Package mechanical data*.