STB10NK60Z, STP10NK60Z, STP10NK60ZFP, STW10NK60Z

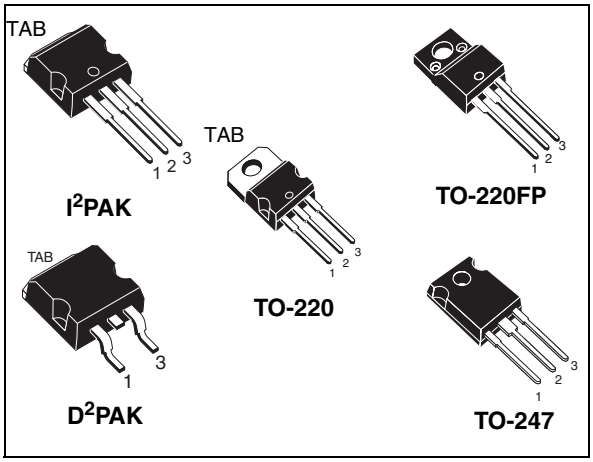
N-channel 600 V, 0.65 Ω typ., 10 A SuperMESH™ Power MOSFET in I²PAK, D²PAK, TO-220, TO-220FP, TO-247 packages

Datasheet – production data

Features

Type	V_{DSS}	$R_{DS(on)}$ max	I_D	P_w
STB10NK60Z-1	600 V	< 0.75 Ω	10 A	115 W
STB10NK60ZT4	600 V	< 0.75 Ω	10 A	115 W
STP10NK60Z	600 V	< 0.75 Ω	10 A	115 W
STP10NK60ZFP	600 V	< 0.75 Ω	10 A	35 W
STW10NK60Z	600 V	< 0.75 Ω	10 A	156 W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Zener-protected



Applications

- Switching applications

Description

These devices are N-channel Zener-protected Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well-established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

Figure 1. Internal schematic diagram

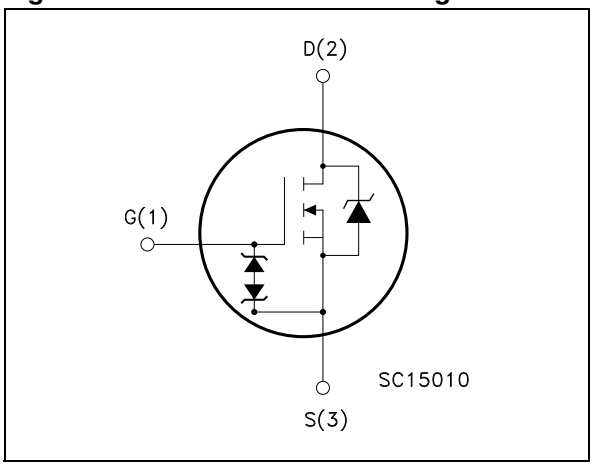


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB10NK60Z-1	B10NK60Z	I²PAK	Tube
STB10NK60ZT4	B10NK60Z	D²PAK	Tape and reel
STP10NK60Z	P10NK60Z	TO-220	Tube
STP10NK60ZFP	P10NK60ZFP	TO-220FP	Tube
STW10NK60Z	W10NK60Z	TO-247	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		I²PAK D²PAK TO-220	TO-220FP	TO-247	
V_{DS}	Drain-source voltage	600			V
V_{GS}	Gate-source voltage	± 30			V
I_D	Drain current (continuous) at T_C = 25 °C	10	10(1)	10	A
I_D	Drain current (continuous) at T_C = 100 °C	5.7	5.7 (1)	5.7	A
I_{DM} (2)	Drain current (pulsed)	36	36 (1)	36	A
P_{TOT}	Total dissipation at T_C = 25 °C	115	35	156	W
	Derating factor	0.92	0.28	1.25	W/°C
ESD	Gate-source human body model (R = 1,5 kΩ, C = 100 pF)	4			kV
dv/dt (3)	Peak diode recovery voltage slope	4.5			V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s;Tc=25 °C)	--	2500	--	V
T_j T_{stg}	Operating junction temperature Storage temperature	-55 to 150			°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3. I_{SD} < 10A, di/dt < 200A/µs, V_{DD} =80% $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		I²PAK D²PAK	TO-220	TO-220FP	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	1.09		3.6	0.8	°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max (when mounted on minimum footprint)	35				°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-amb max	62.5			50	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max)	9	A
E_{AS}	Single pulse avalanche energy (starting Tj=25 °C, I_D=I_{AR}, V_{DD}= 50 V)	300	mJ
E_{AR}	Repetitive avalanche energy (pulse width limited by Tj max)	3.5	mJ

2 Electrical characteristics

(Tcase = 25 °C unless otherwise specified)

Table 5. On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 250 µA, V_{GS}= 0	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V, V_{DS} = 600 V, T_C=125 °C			1 50	µA µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS}= V_{GS}, I_D = 250 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS}= 10 V, I_D= 4.5 A		0.65	0.75	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{DS} =15 V, I_D = 4.5 A	-	7.8		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} =25 V, f=1 MHz, V_{GS}=0		1370 156 37		pF pF pF
$C_{oss\ eq}$ (2)	Equivalent output capacitance	V_{GS}=0, V_{DS} =0 to 480 V		90		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD}=480 V, I_D = 8 A V_{GS} =10 V *(see Figure 20)*		50 10 25	70	nC nC nC

1. Pulsed: pulse duration = 300µs, duty cycle 1.5%
2. $C_{oss\ eq}$. is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80%

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on delay time Rise time	V_{DD}=300 V, I_D=4 A, R_G=4.7 Ω, V_{GS}=10 V *(see Figure 19)*	-	20 20	-	ns ns
$t_{d(off)}$ t_f	Turn-off delay time Fall time	V_{DD}=300 V, I_D=4 A, R_G=4.7 Ω, V_{GS}=10 V *(see Figure 19)*		55 30		ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM}(1)	Source-drain current Source-drain current (pulsed)		-		10 36	A A
V_{SD}(2)	Forward on voltage	I_{SD}=10 A, V_{GS}=0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD}=8 A, di/dt = 100 A/µs, V_{DD}=40 V, Tj=150 °C		570 4.3 15		ns µC A

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

Table 9. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	Igs=± 1 mA, (I_D = 0)	30	-	-	V

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for I²PAK, D²PAK and TO-220

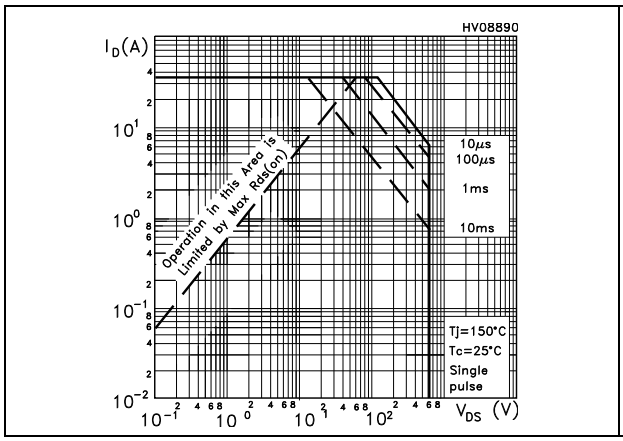


Figure 3. Thermal impedance for I²PAK, D²PAK and TO-220

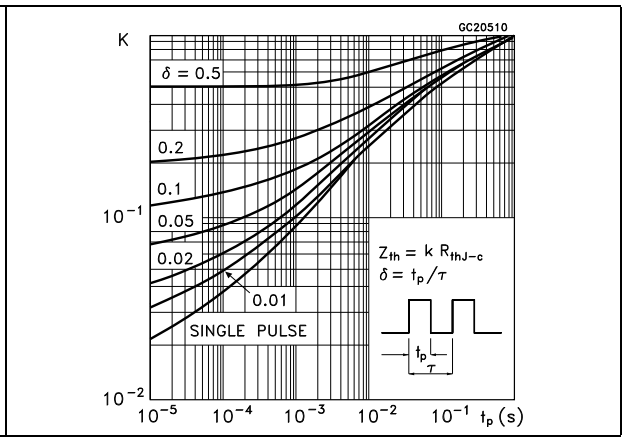


Figure 4. Safe operating area for TO-220FP

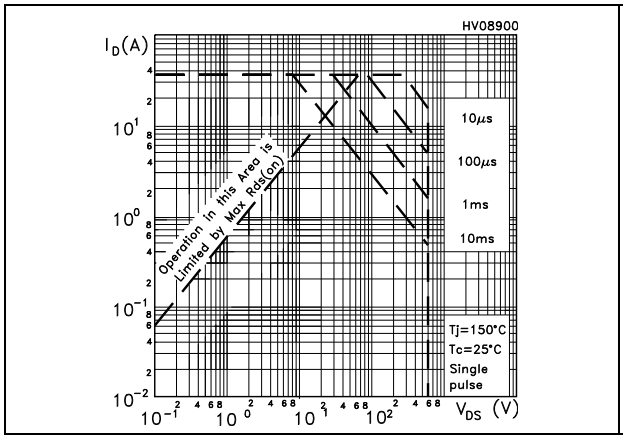


Figure 5. Thermal impedance for TO-220FP

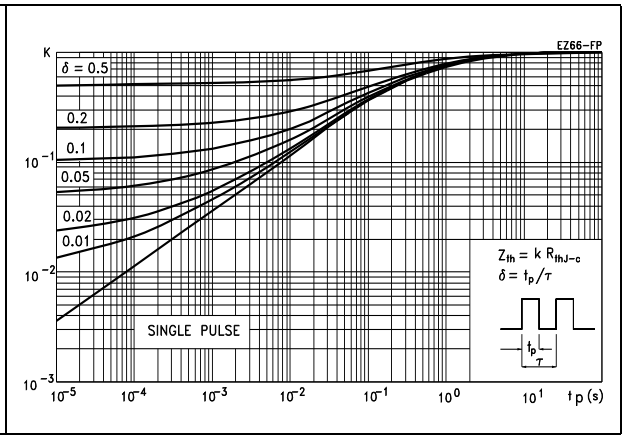


Figure 6. Safe operating area for TO-247

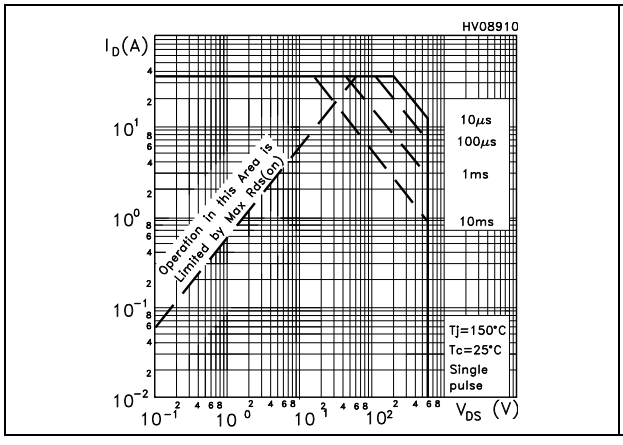


Figure 7. Thermal impedance for TO-247

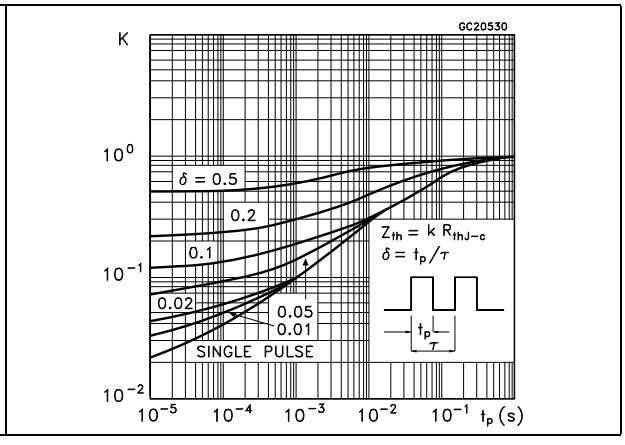


Figure 8. Output characteristics

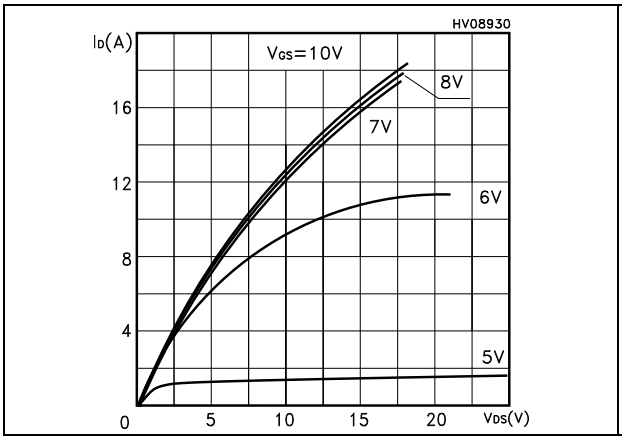


Figure 9. Transfer characteristics

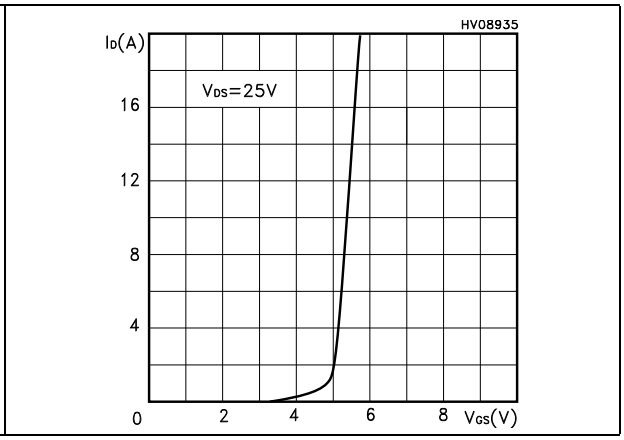


Figure 10. Transconductance

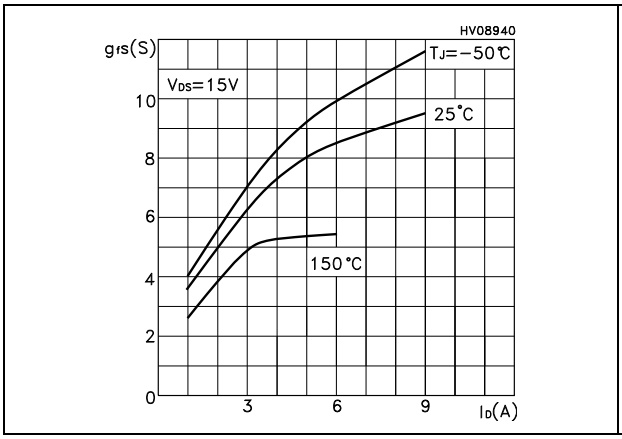


Figure 11. Static drain-source on-resistance

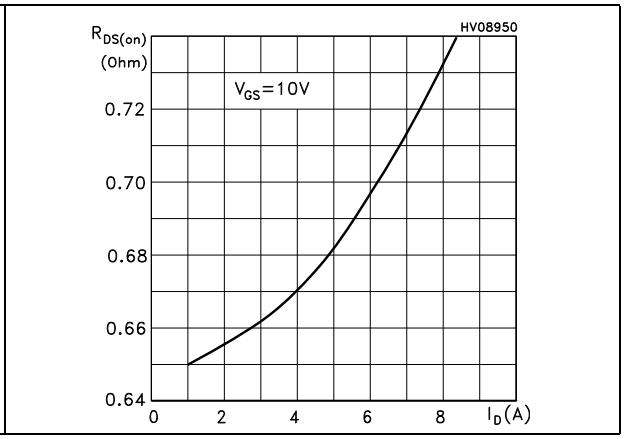


Figure 12. Gate charge vs gate-source voltage

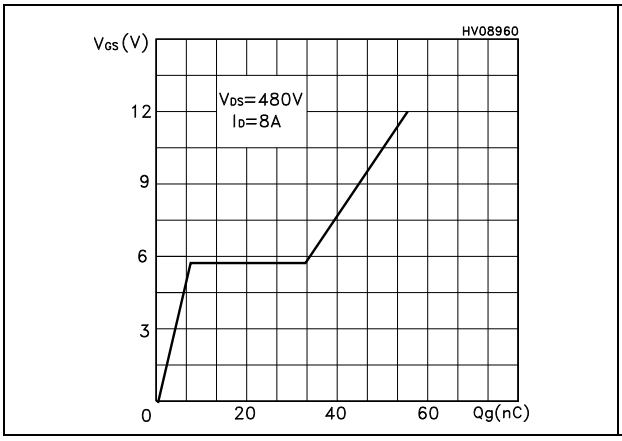


Figure 13. Capacitance variations

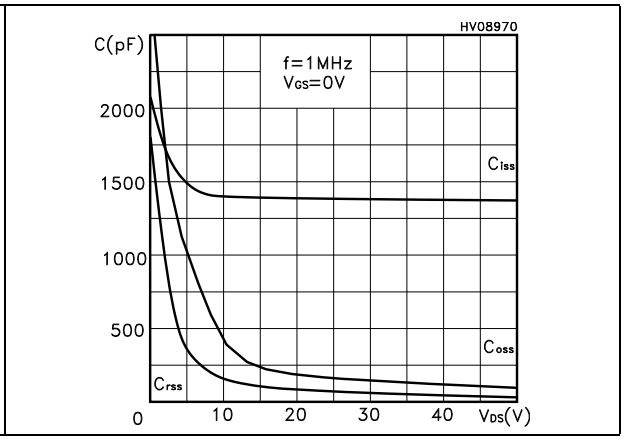


Figure 14. Normalized gate threshold voltage vs temperature

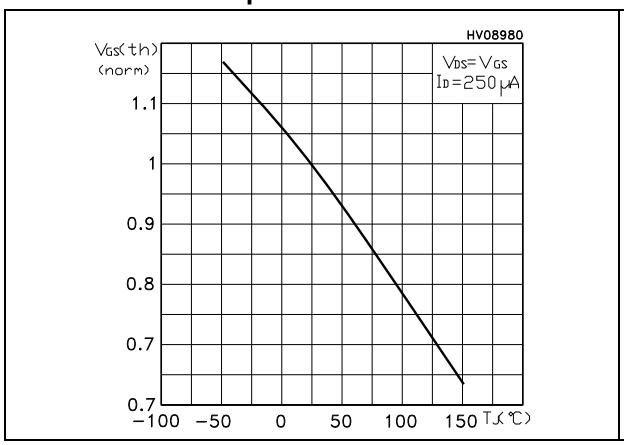


Figure 15. Normalized on-resistance vs temperature

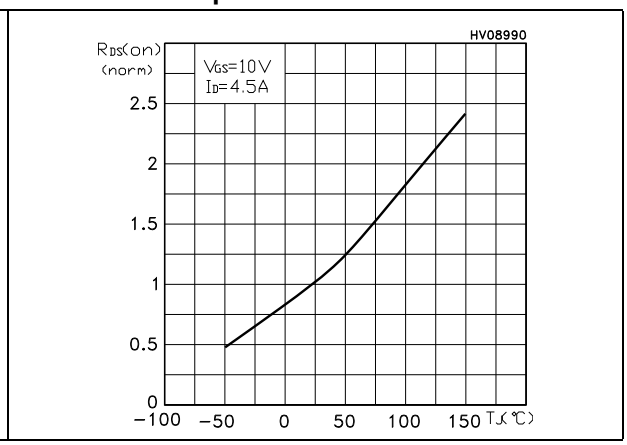


Figure 16. Source-drain diode forward characteristics

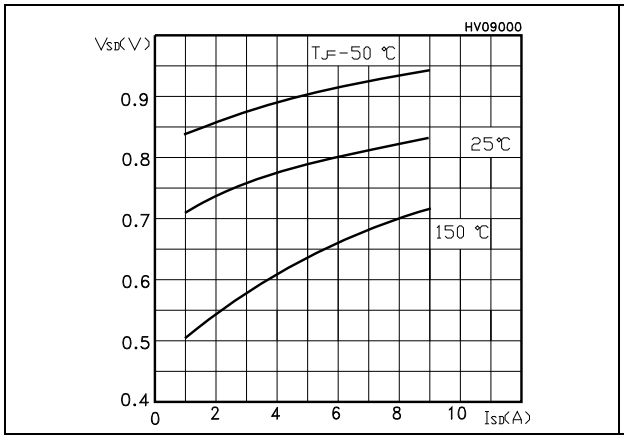


Figure 17. Maximum avalanche energy vs temperature

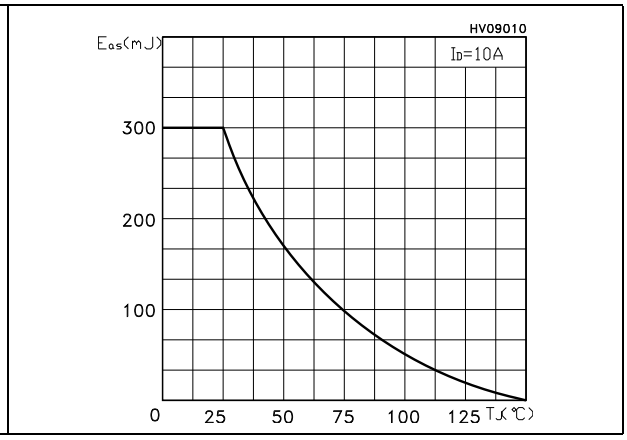
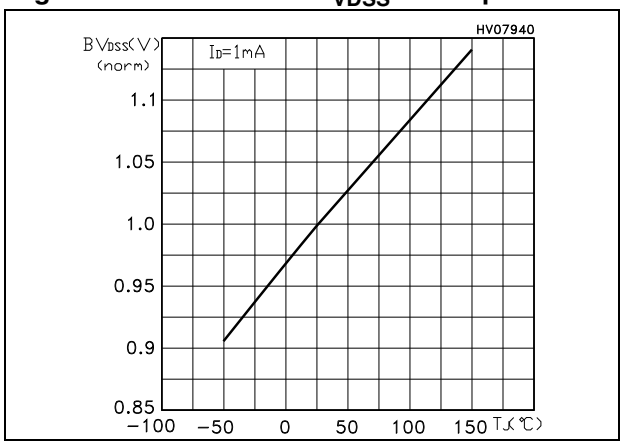


Figure 18. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 19. Switching times test circuit for resistive load

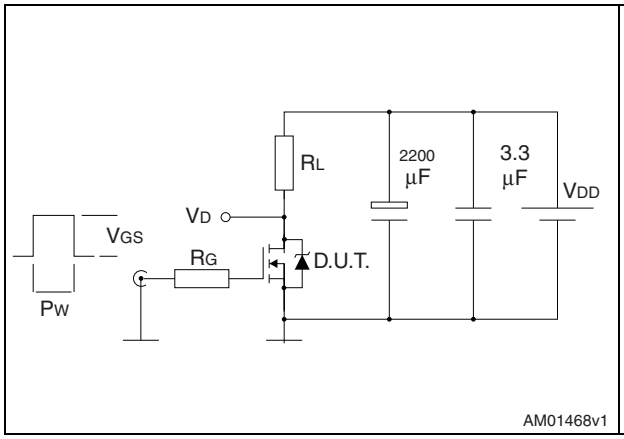


Figure 20. Gate charge test circuit

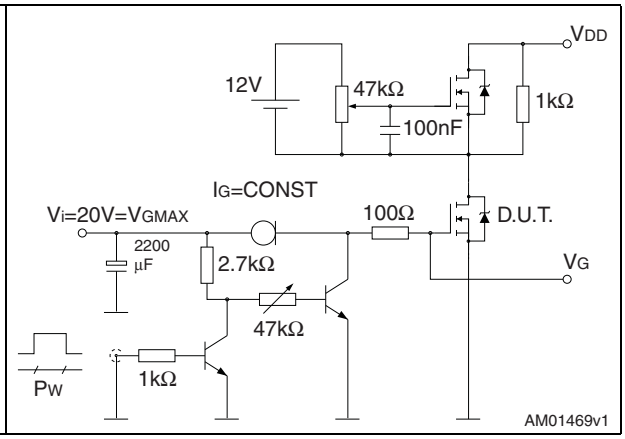


Figure 21. Test circuit for inductive load switching and diode recovery times

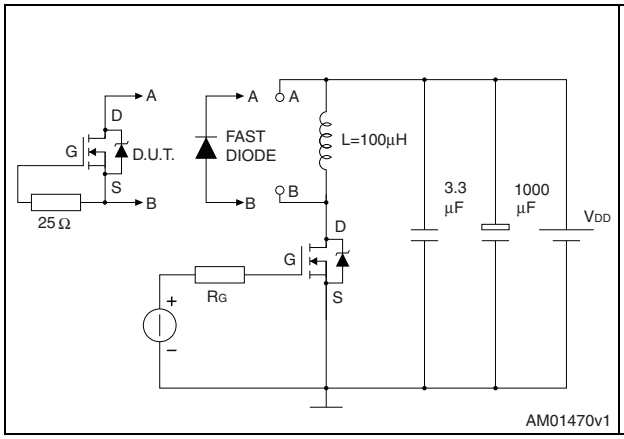


Figure 22. Unclamped inductive load test circuit

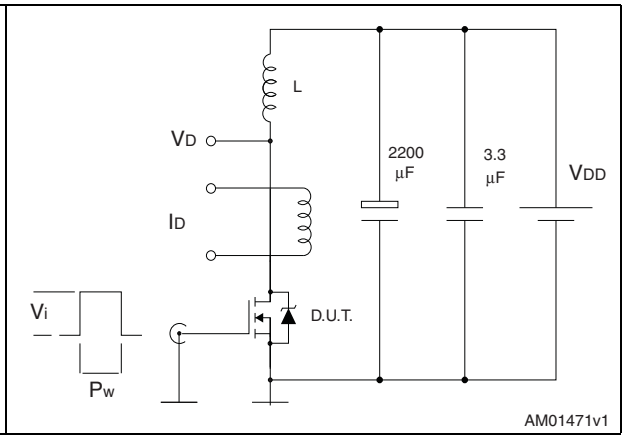


Figure 23. Unclamped inductive waveform

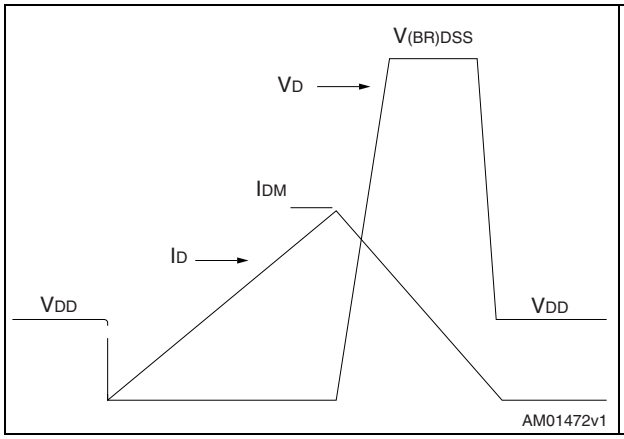
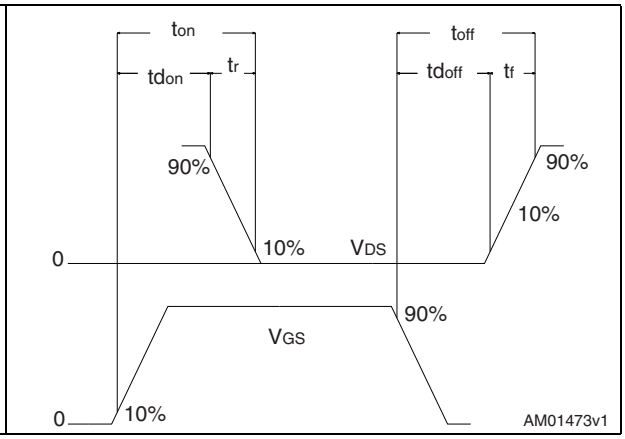


Figure 24. Switching time waveform



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 10. I²PAK (TO-262) mechanical data

DIM.	mm.		
	min.	typ	max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

Figure 25. I²PAK (TO-262) drawing

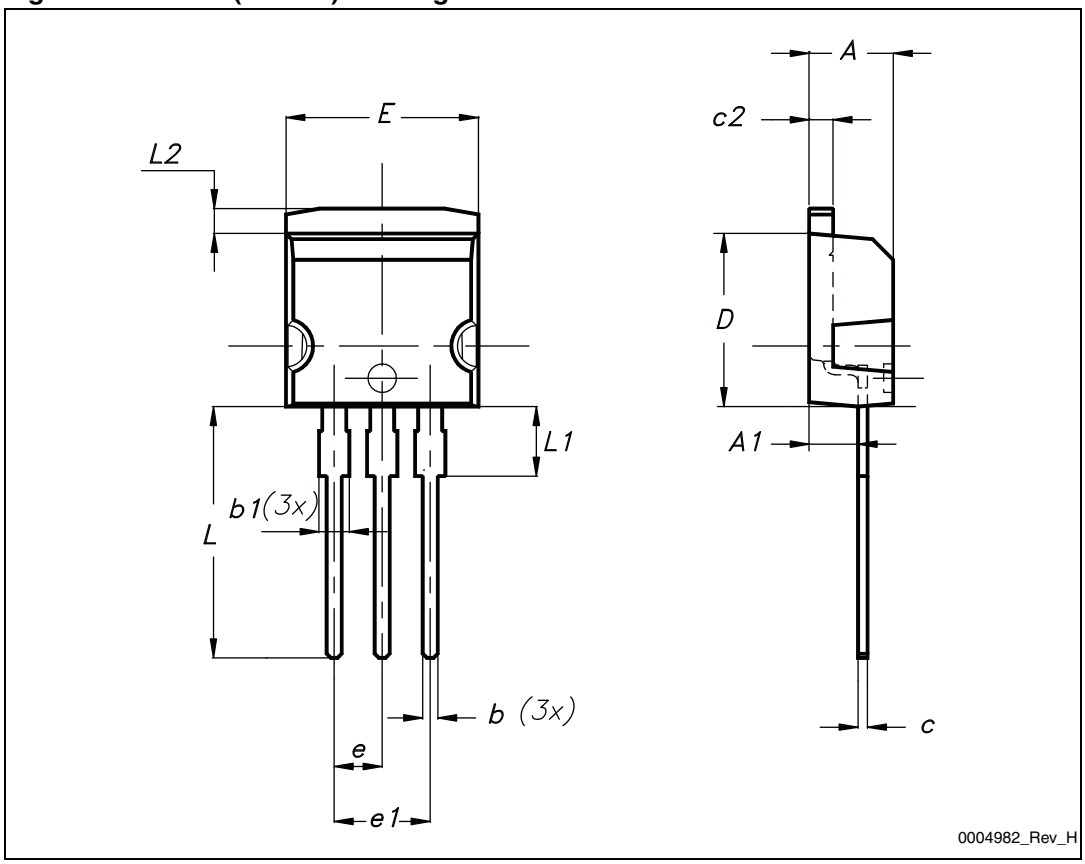


Table 11. D²PAK (TO-263) mechanical data

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		
E	10		10.40
E1	8.50		
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 26. D²PAK (TO-263) drawing

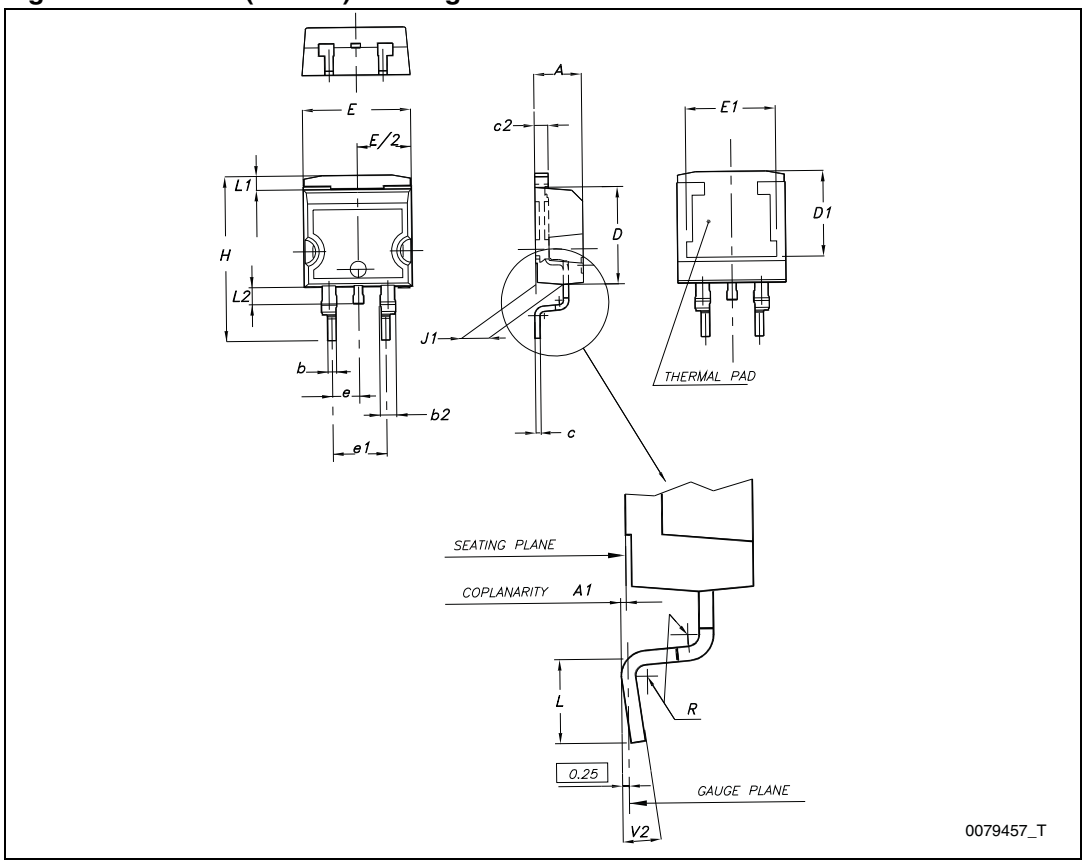
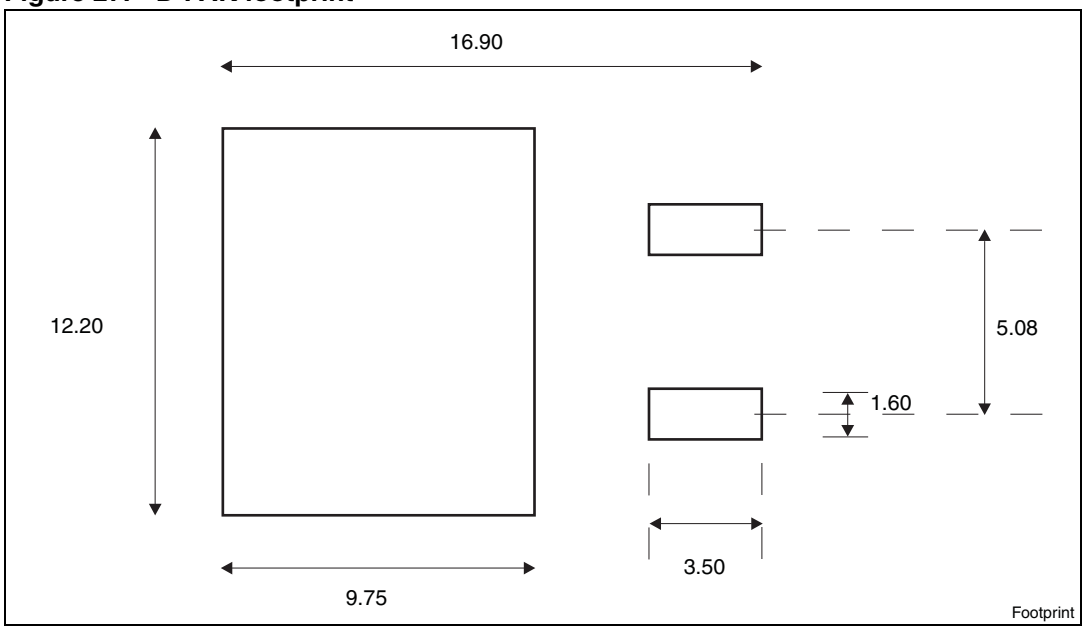


Figure 27. D²PAK footprint[a]



a. All dimensions are in millimeters

Table 12. 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 28. TO-220 type A drawing

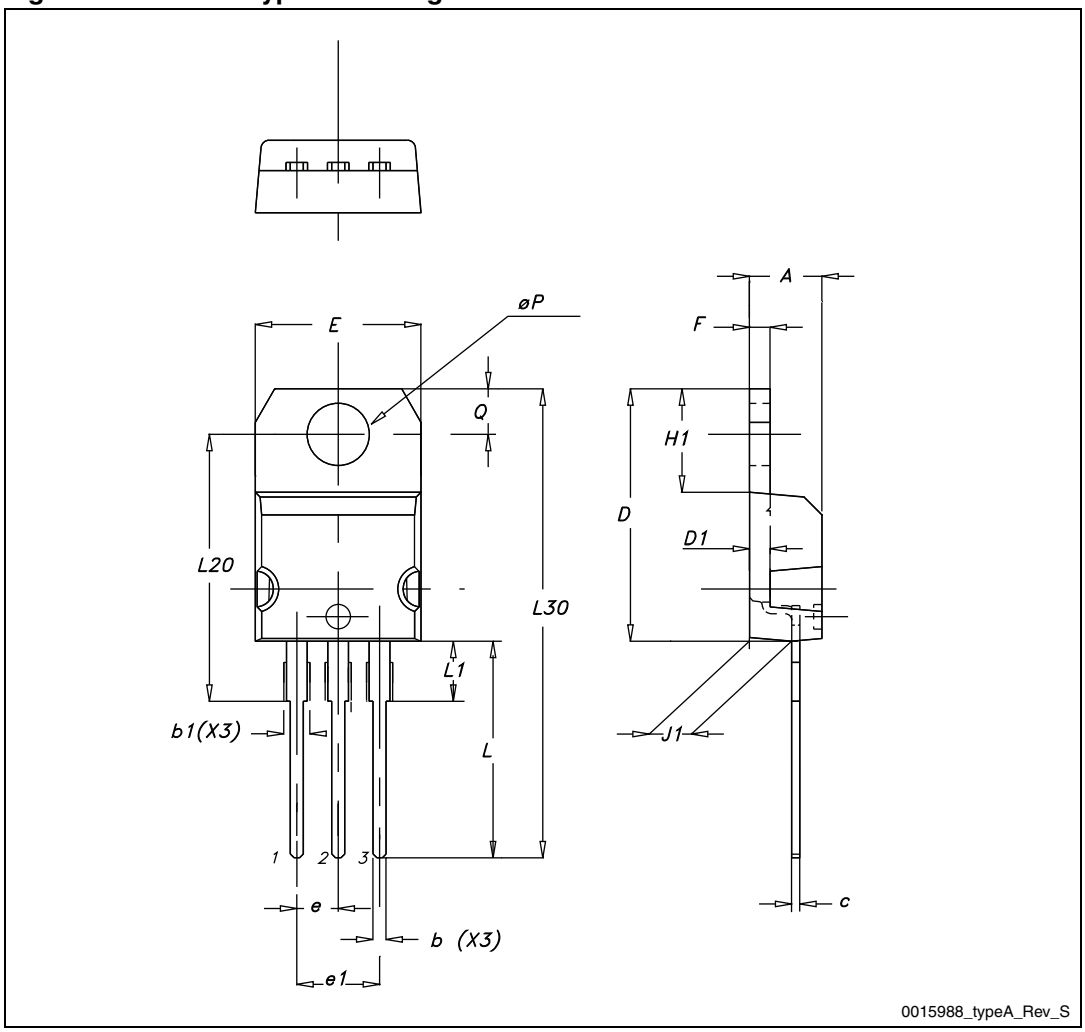


Table 13. TO-220FP mechanical data

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 29. TO-220FP drawing

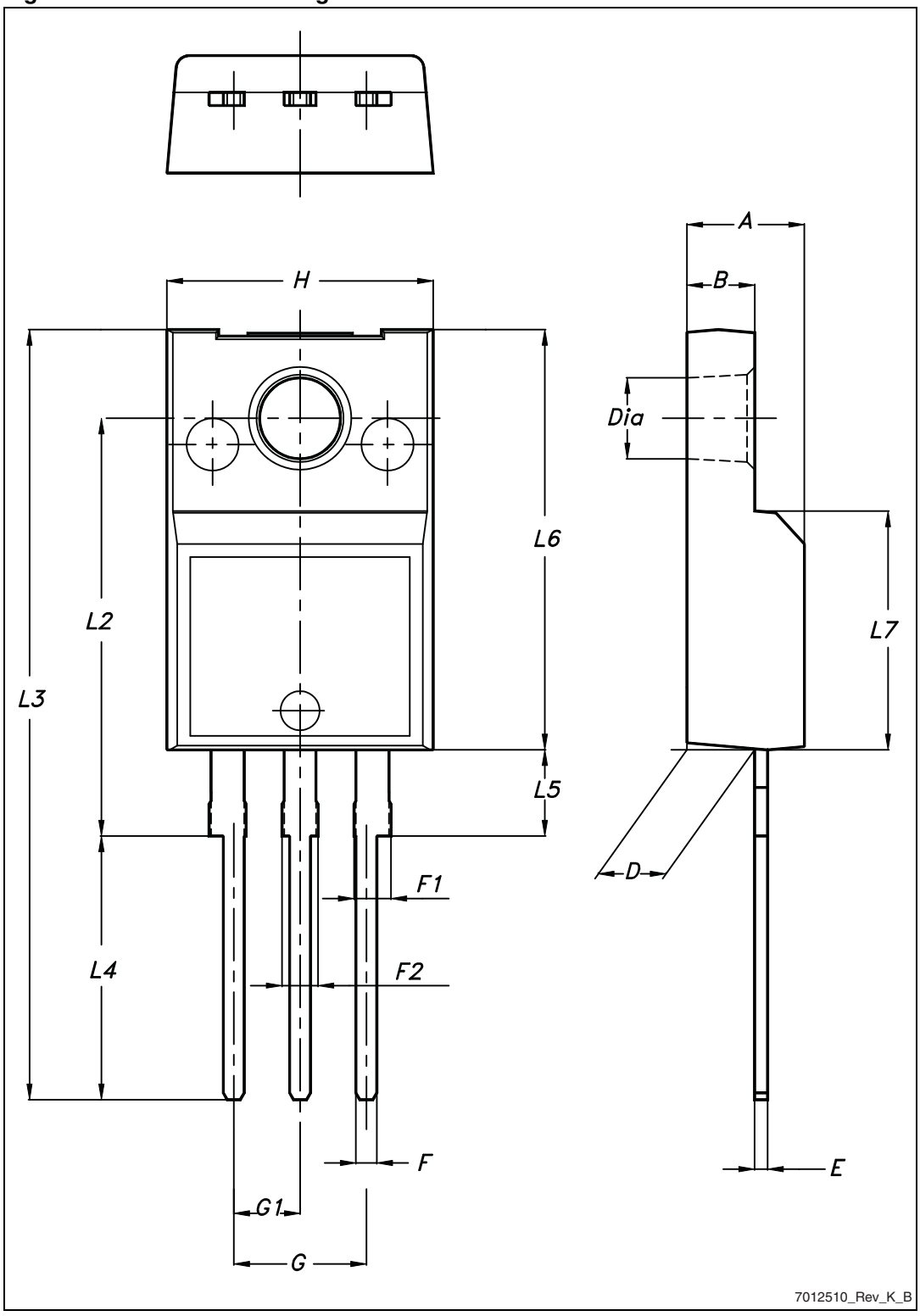
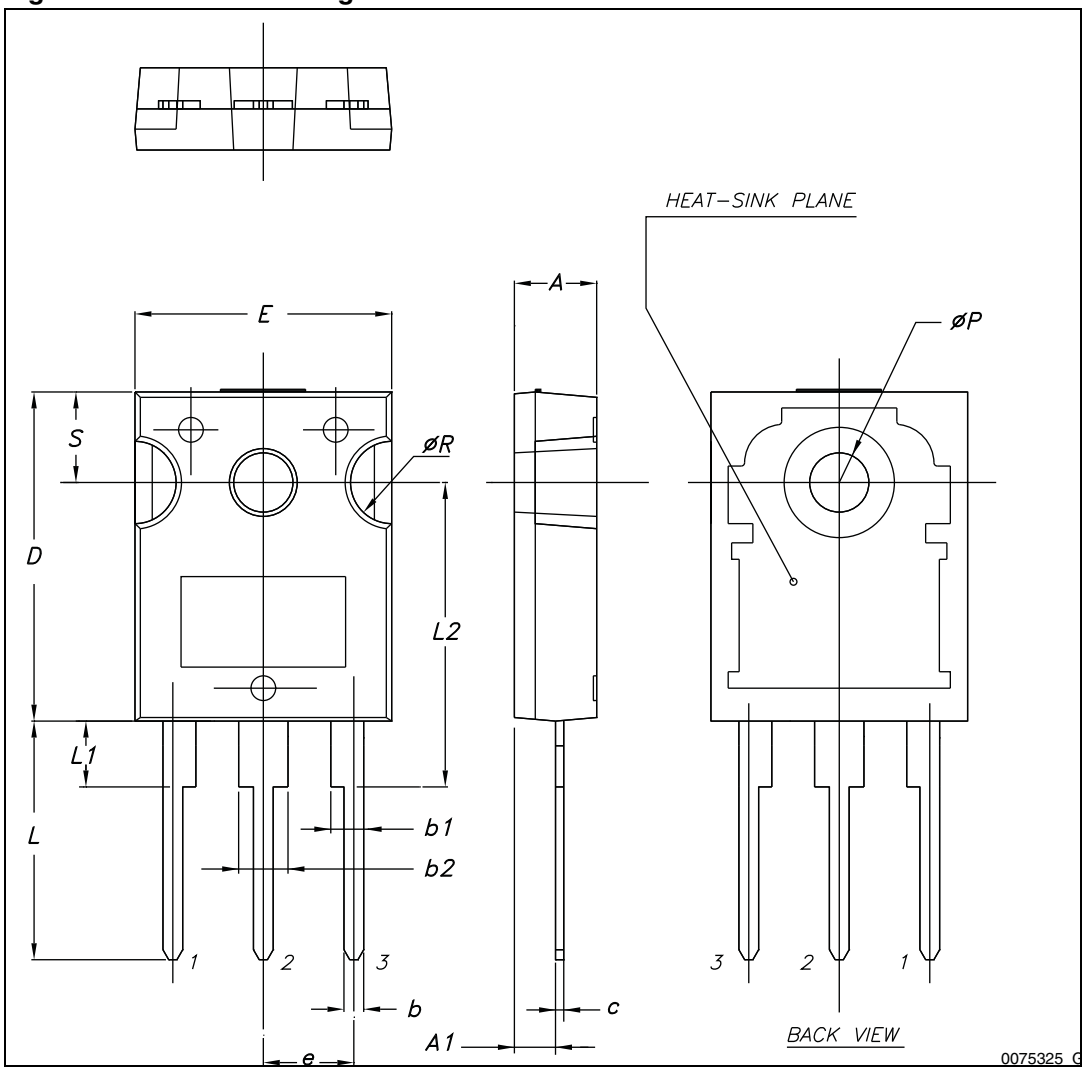


Table 14. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

Figure 30. TO-247 drawing



5 Packaging mechanical data

Table 15. D²PAK (TO-263) 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 31. Tape

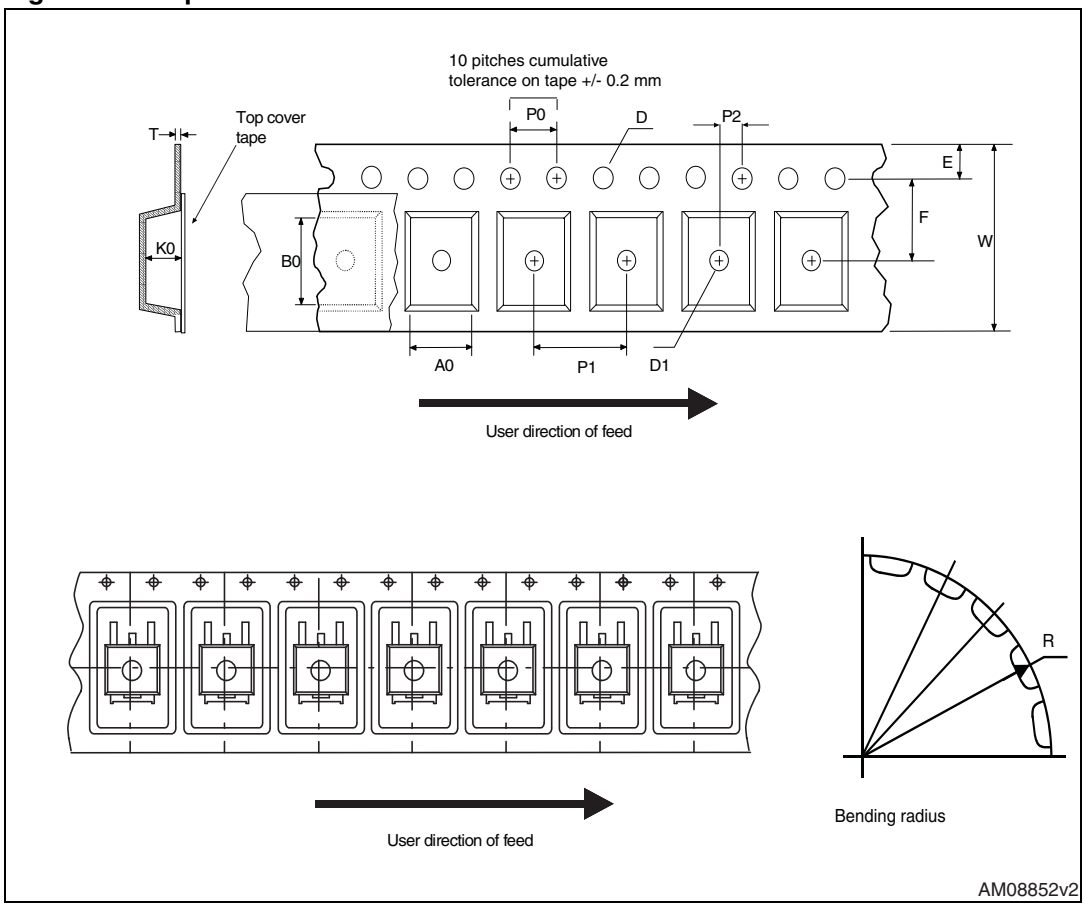
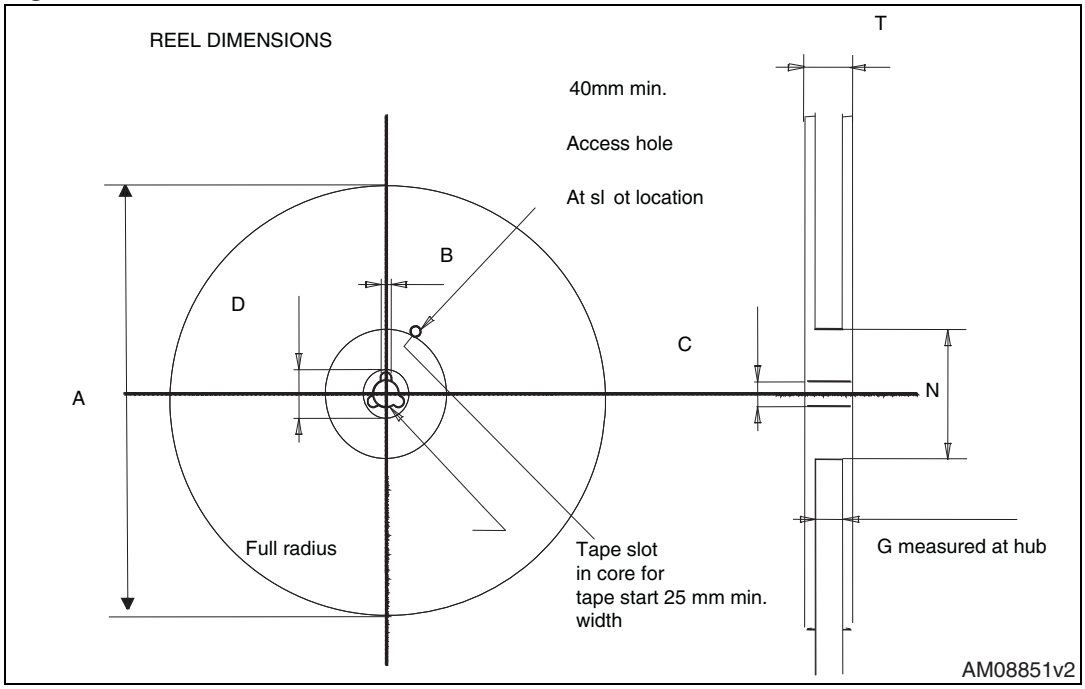


Figure 32. Reel



6 Revision history

Table 16. Document revision history

Date	Revision	Changes
29-Sep-2005	6	Inserted ecopack indication
29-Oct-2005	7	New value inserted in *Table 6*
11-Apr-2006	8	New template
19-Sep-2006	9	Unit changed in *Table 5*
17-Nov-2008	10	Updated *Section 4: Package mechanical data*
15-Nov-2012	11	Updated *Table 2: Absolute maximum ratings*, *Table 3: Thermal data*, *Table 5: On /off states* and *Table 9: Gate-source Zener diode*. Updated *Section 4: Package mechanical data* and *Section 5: Packaging mechanical data*. Minor text changes.

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