STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

N-channel 600 V, 0.150 Ω typ., 19.5 A, FDmesh™ II Power MOSFET (with fast diode) in D²PAK, TO-220FP, TO-220 and TO-247 packages

Datasheet — production data

Features

Order codes	V_{DSS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STB23NM60ND	650 V	< 0.180 Ω	19.5 A
STF23NM60ND			
STP23NM60ND			
STW23NM60ND			

- The worldwide best $R_{DS(on)}$ * area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- High dv/dt and avalanche capabilities

Applications

- Switching applications

Description

These FDmesh™ II Power MOSFETs with intrinsic fast-recovery body diode are produced using the second generation of MDmesh™ technology. Utilizing a new strip-layout vertical structure, these revolutionary devices feature extremely low on-resistance and superior switching performance. They are ideal for bridge topologies and ZVS phase-shift converters.

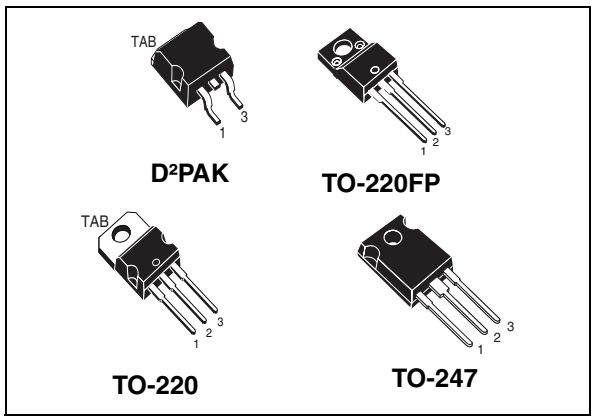


Figure 1. Internal schematic diagram

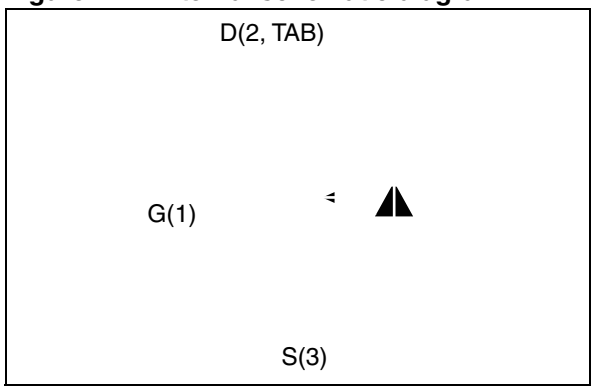


Table 1. Device summary

Oreder codes	Marking	Package	Packaging
STB23NM60ND	23NM60ND	D²PAK	Tape and reel
STF23NM60ND	23NM60ND	TO-220FP	Tube
STP23NM60ND	23NM60ND	TO-220	
STW23NM60ND	23NM60ND	TO-247	

This is information on a product in full production. www.st.com

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK, TO-220, TO-247	TO-220FP	
V_{DS}	Drain-source voltage	600		V
V_{GS}	Gate-source voltage	± 25		V
I_D	Drain current (continuous) at T_C = 25 °C	19.5	19.5 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	11.7	11.7 (1)	A
I_{DM} (2)	Drain current (pulsed)	78	78 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	150	35	W
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max)	9		A
E_{AS}	Single pulse avalanche energy (starting T_j= 25 °C, I_D = I_{AS}, V_{DD} = 50 V)	700		mJ
dv/dt (3)	Peak diode recovery voltage slope	40		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
T_{stg}	Storage temperature	-55 to 150		°C
T_j	Max. operating junction temperature	150		°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3. I_{SD} ≤19.5 A, di/dt ≤600 A/µs, V_{DD} =80% $V_{(BR)DSS}$, $V_{DS(peak)}$ < $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	D²PAK	TO-220FP	TO-220	TO-247	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case max	0.83	3.6	0.83		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-amb max		62.5		50	°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max(1)	30				°C/W

1. When mounted on 1 inch² FR-4, 2 Oz copper board.

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	I_D = 1 mA, V_{GS}= 0	600			V
dv/dt(1)	Drain-source voltage slope	V_{DD} = 480 V, I_D = 19.5 A, V_{GS} = 10 V		30		V/ns
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V, V_{DS} = 600 V, T_c=125 °C			1 100	µA µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = ±20 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS}= V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS}= 10 V, I_D= 10 A		0.150	0.180	Ω

1. Characteristic value at turn off on inductive load

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_{DS} = 50 V, f =1 MHz, V_{GS} = 0	-	2100 80 10	-	pF pF pF
$C_{oss\ eq.}$(1)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 480 V	-	310	-	pF
Rg	Gate input resistance	f=1 MHz Gate DC Bias=0 Test signal level=20 mV open drain	-	4	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 480 V, I_D = 19.5 A V_{GS} = 10 V *(see Figure 18)*	-	69 13 35	-	nC nC nC

1. $C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

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} = 300 V, I_D = 10 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 17)	-	21 19 92 42	-	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)		-		19.5 78	A A
V_{SD}(2)	Forward on voltage	I_{SD} = 19.5 A, V_{GS}=0	-		1.3	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 19.5 A, di/dt =100 A/µs, V_{DD} = 60 V *(see Figure 19)*	-	190 1.2 13		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	V_{DD} = 60 V di/dt =100 A/µs, I_{SD} = 19.5 A T_j = 150 °C *(see Figure 19)*	-	270 2.0 15		ns µC A

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

2.1 Electrical characteristics (curves)

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

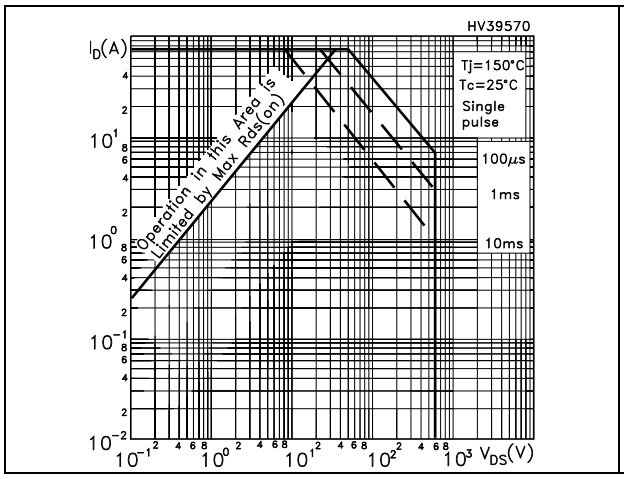


Figure 3. Thermal impedance for D²PAK and TO-220

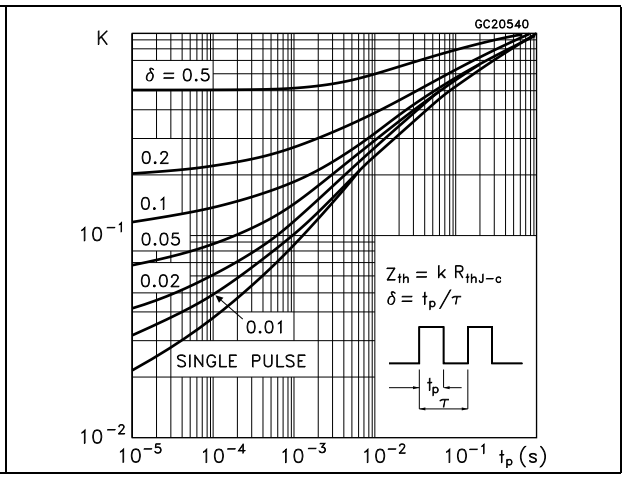


Figure 4. Safe operating area for TO-220FP

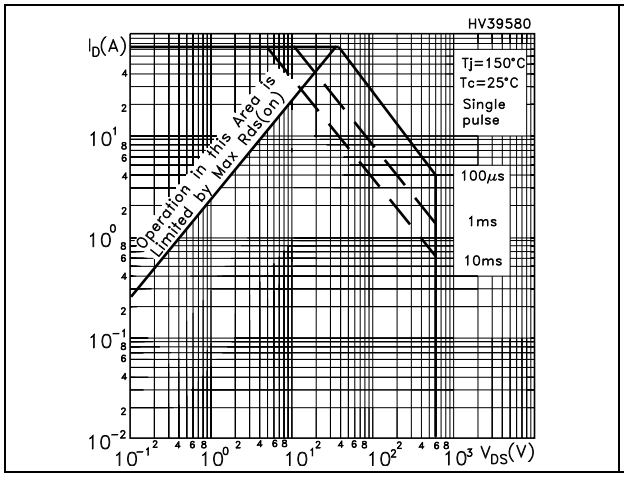


Figure 5. Thermal impedance for TO-220FP

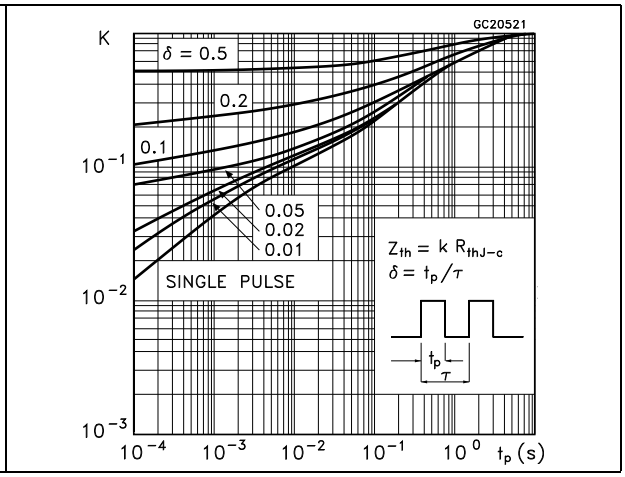


Figure 6. Safe operating area for TO-247

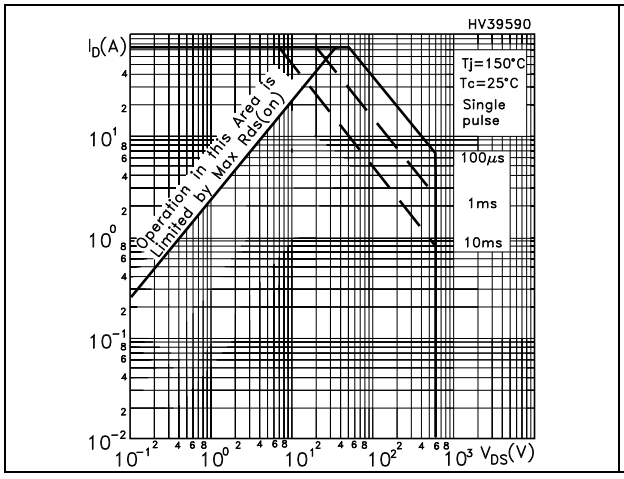


Figure 7. Thermal impedance for TO-247

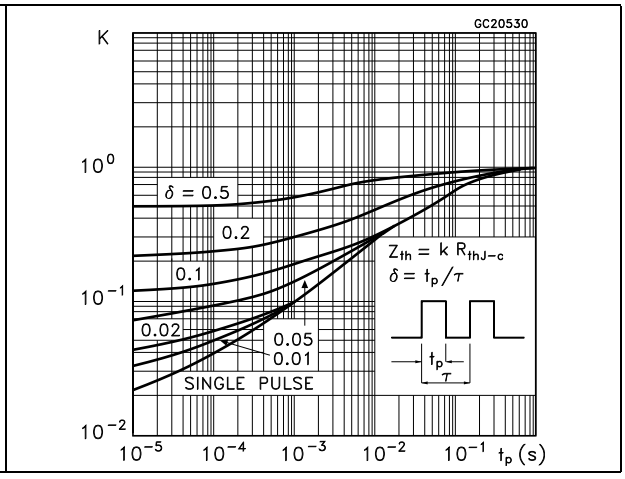


Figure 8. Output characteristics

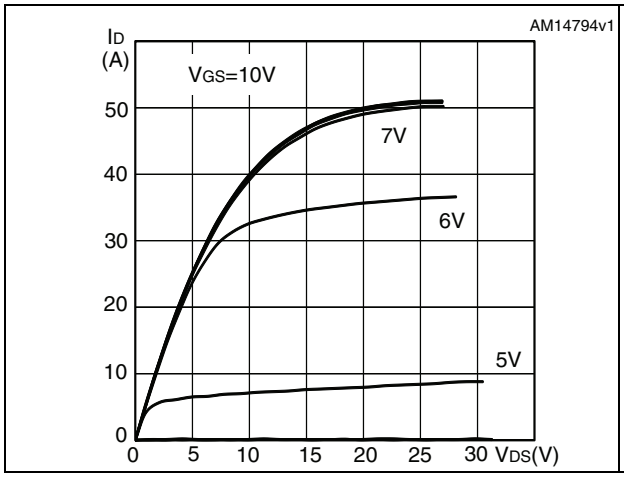


Figure 9. Transfer characteristics

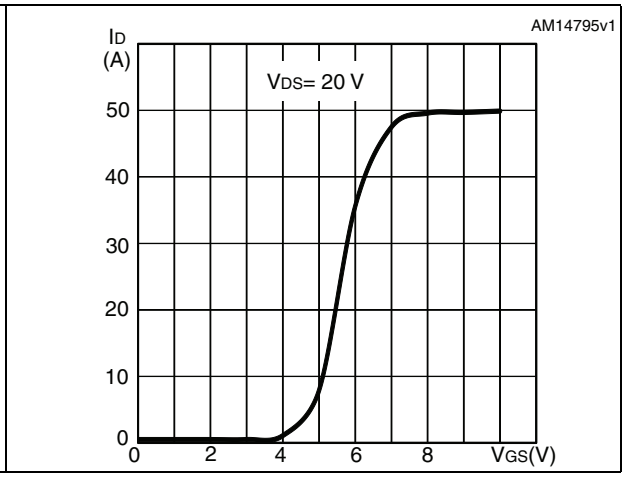


Figure 10. Static drain-source on resistance

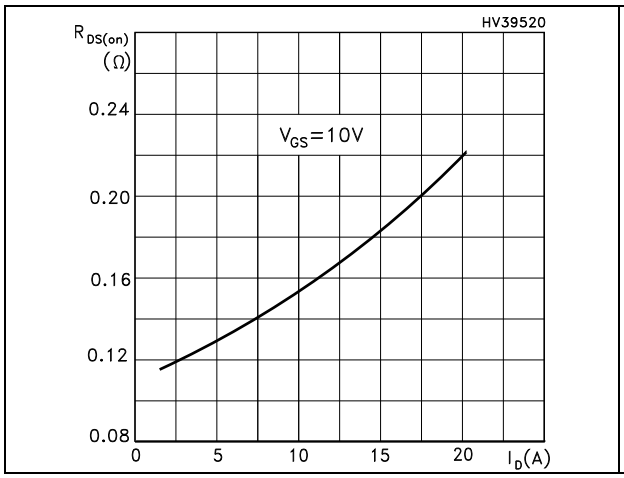


Figure 11. Gate charge vs gate-source voltage

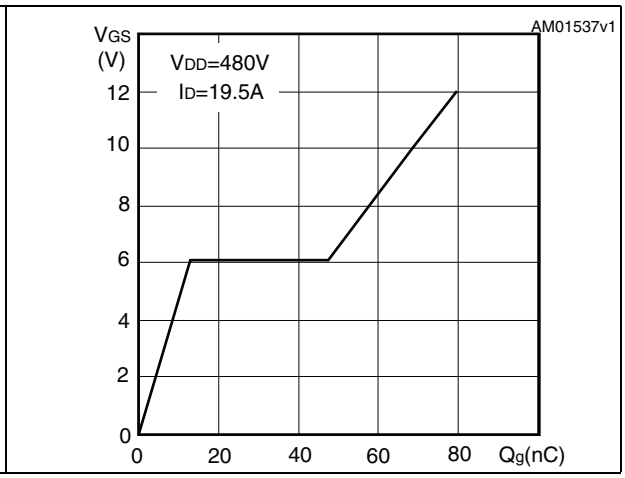


Figure 12. Capacitance variations

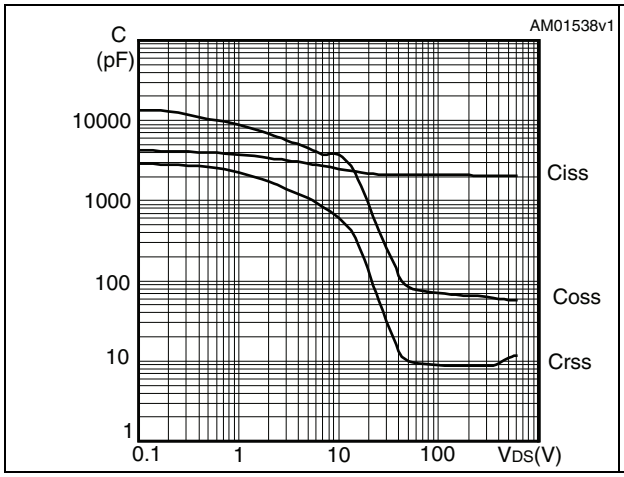


Figure 13. Normalized gate threshold voltage vs temperature

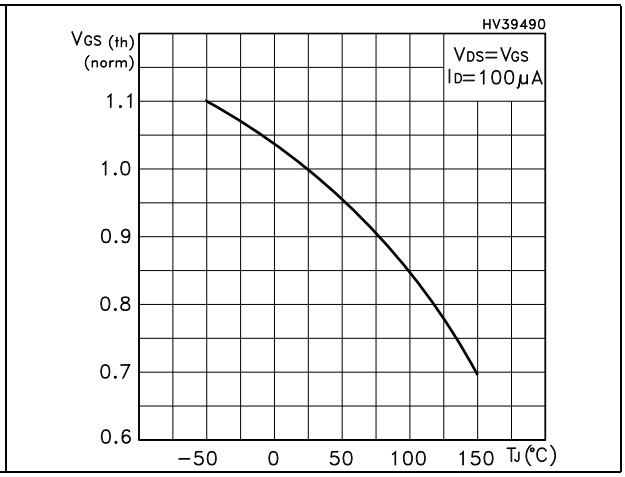


Figure 14. Normalized on resistance vs temperature

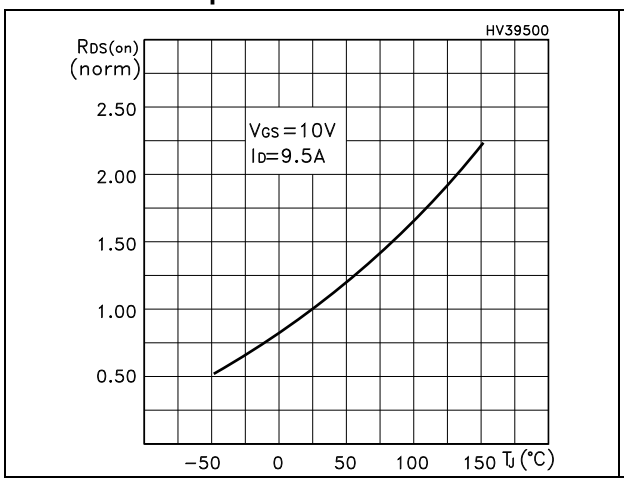


Figure 15. Source-drain diode forward characteristics

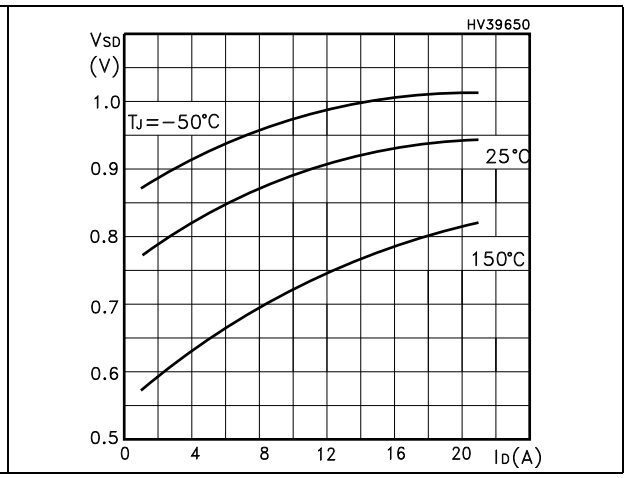
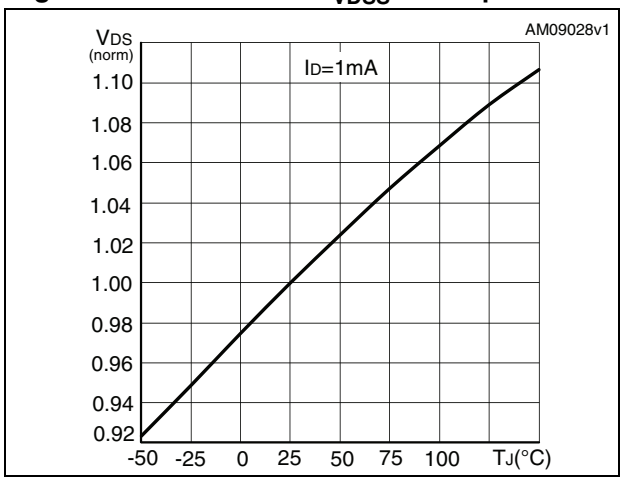


Figure 16. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 17. Switching times test circuit for resistive load

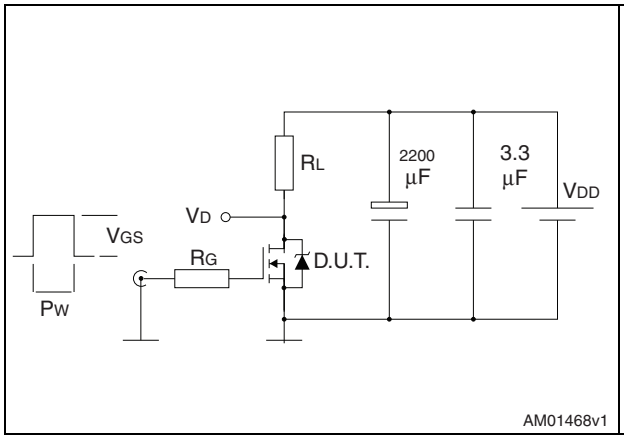


Figure 18. Gate charge test circuit

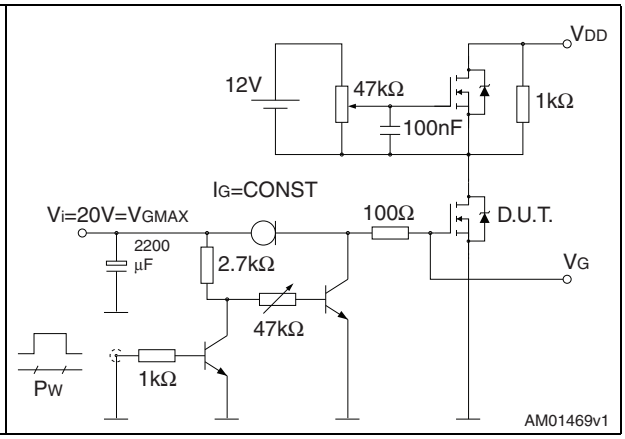


Figure 19. Test circuit for inductive load switching and diode recovery times

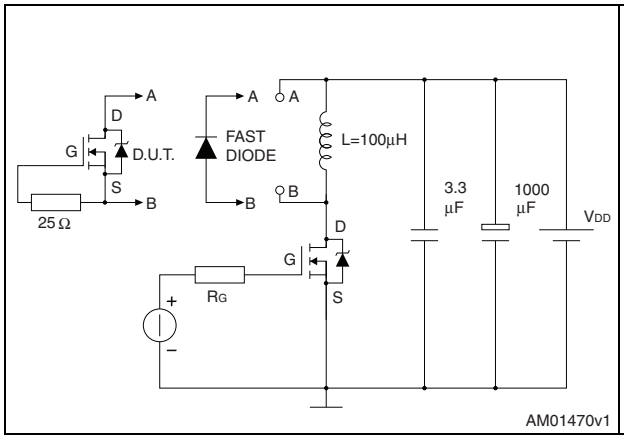


Figure 20. Unclamped inductive load test circuit

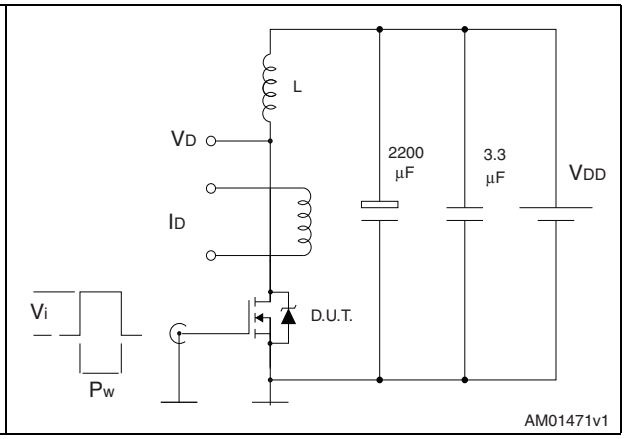


Figure 21. Unclamped inductive waveform

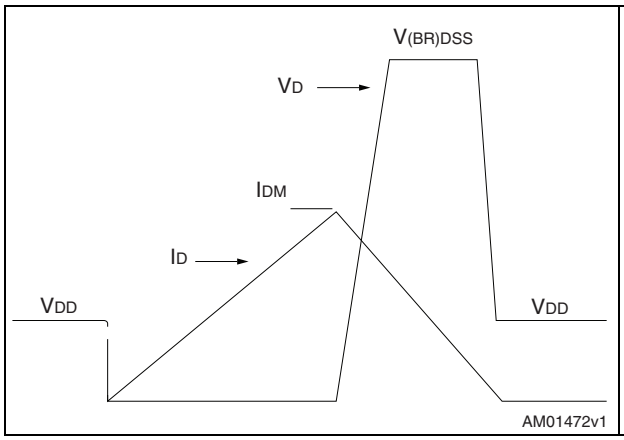
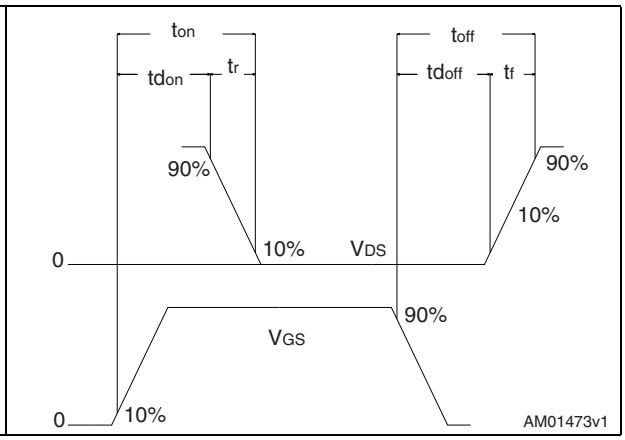


Figure 22. Switching time waveform



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. 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 23. D²PAK (TO-263) drawing

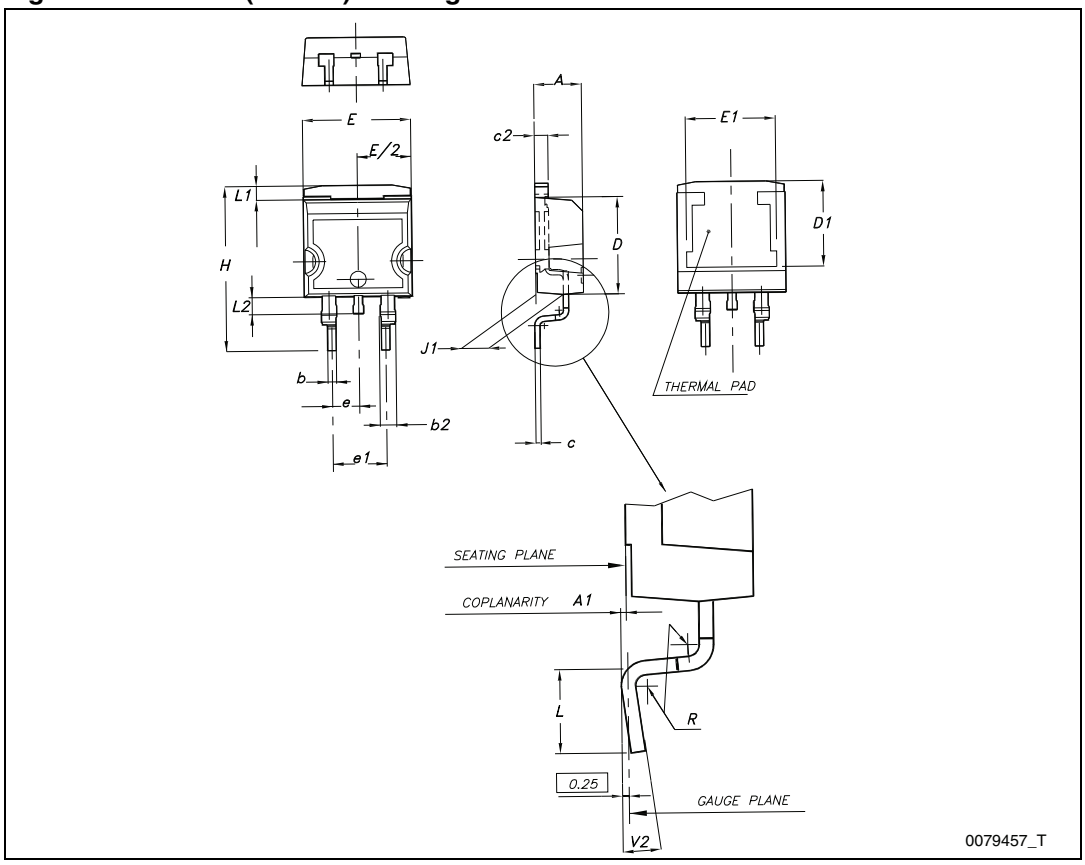
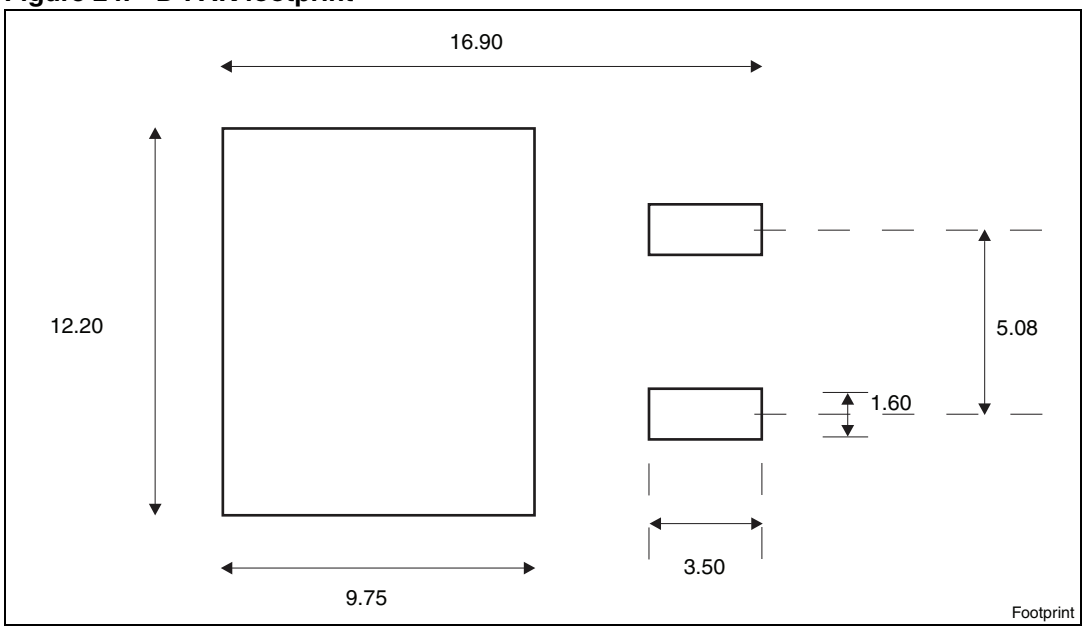


Figure 24. D²PAK footprint[a]



a. All dimensions are in millimeters

Table 9. 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

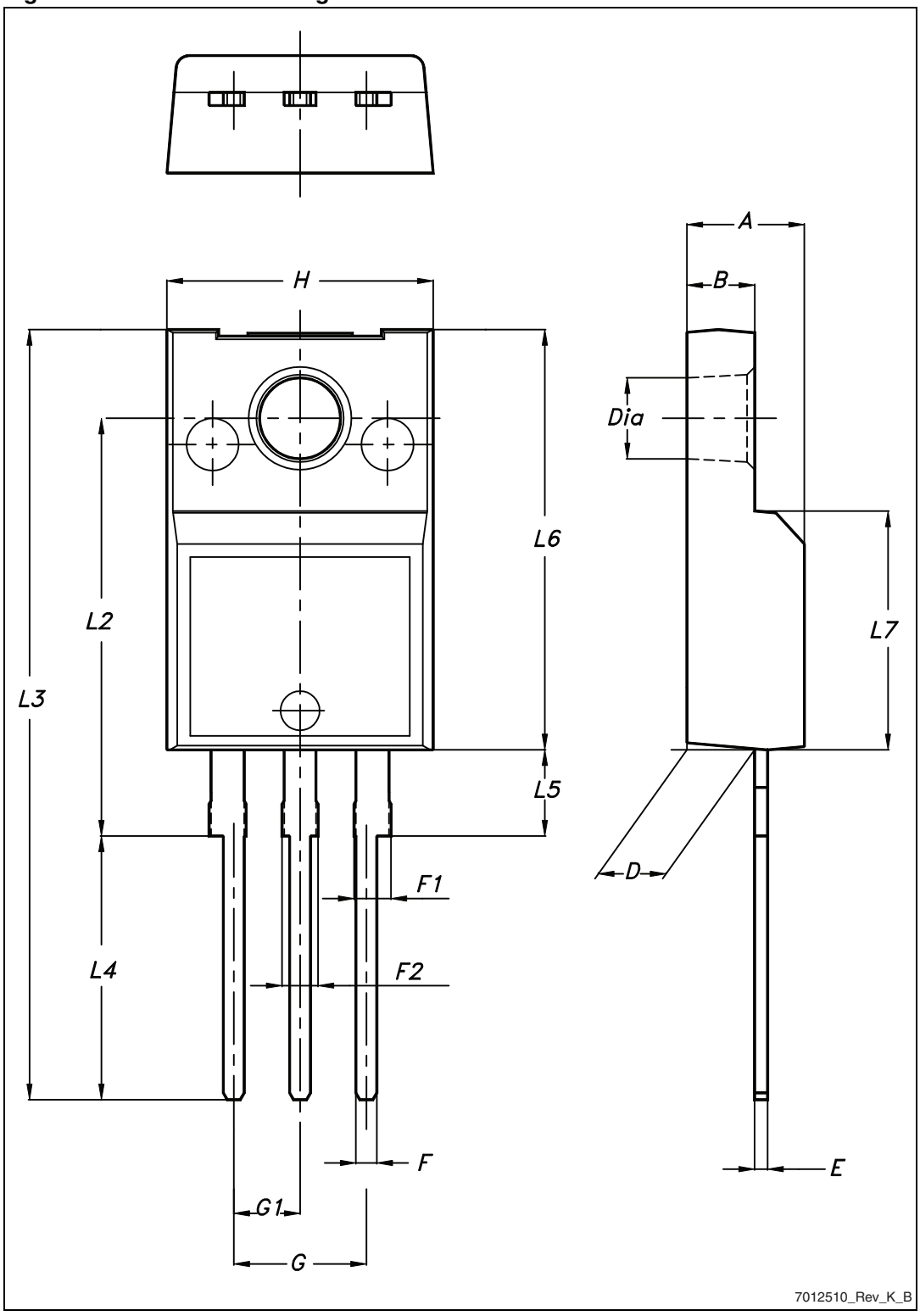


Table 10. TO-220 type A mechanical data

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 26. TO-220 type A drawing

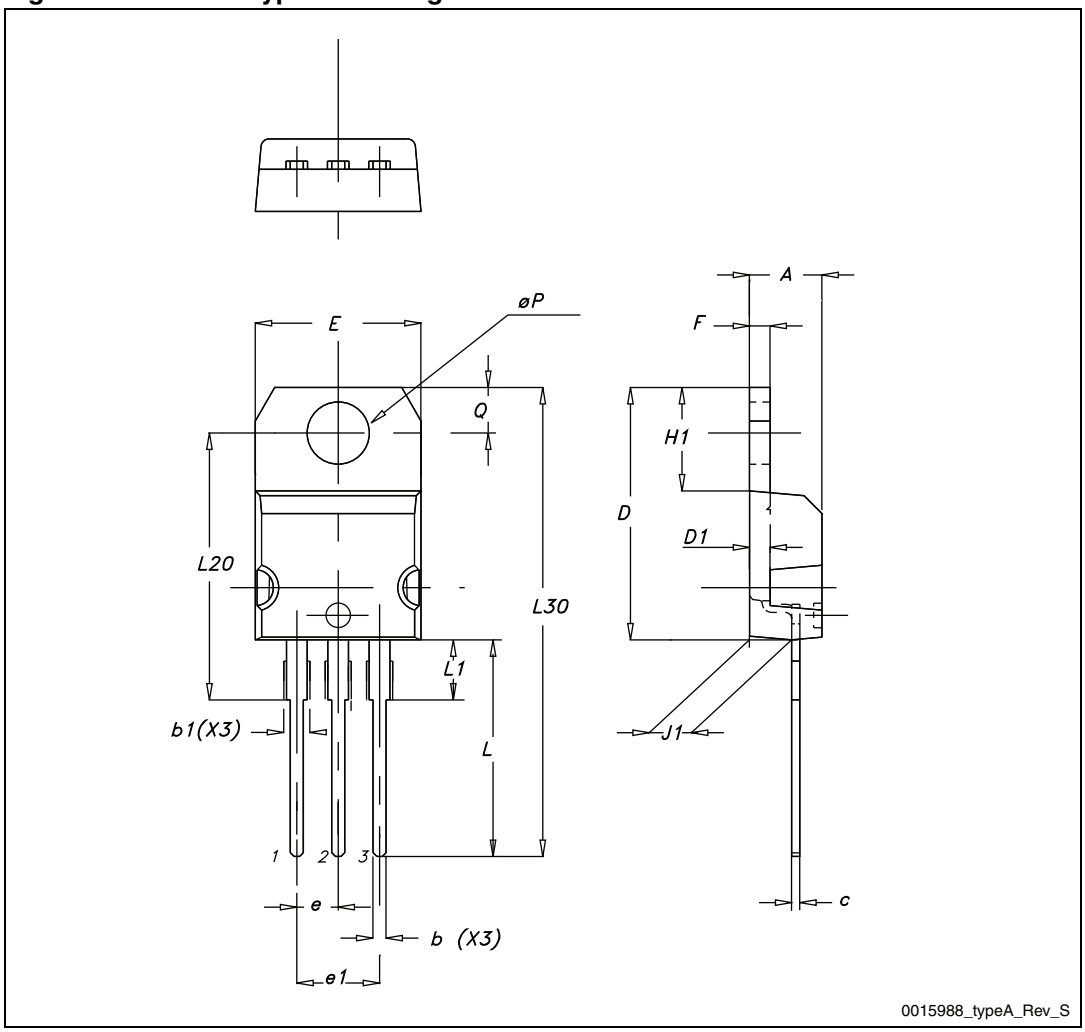
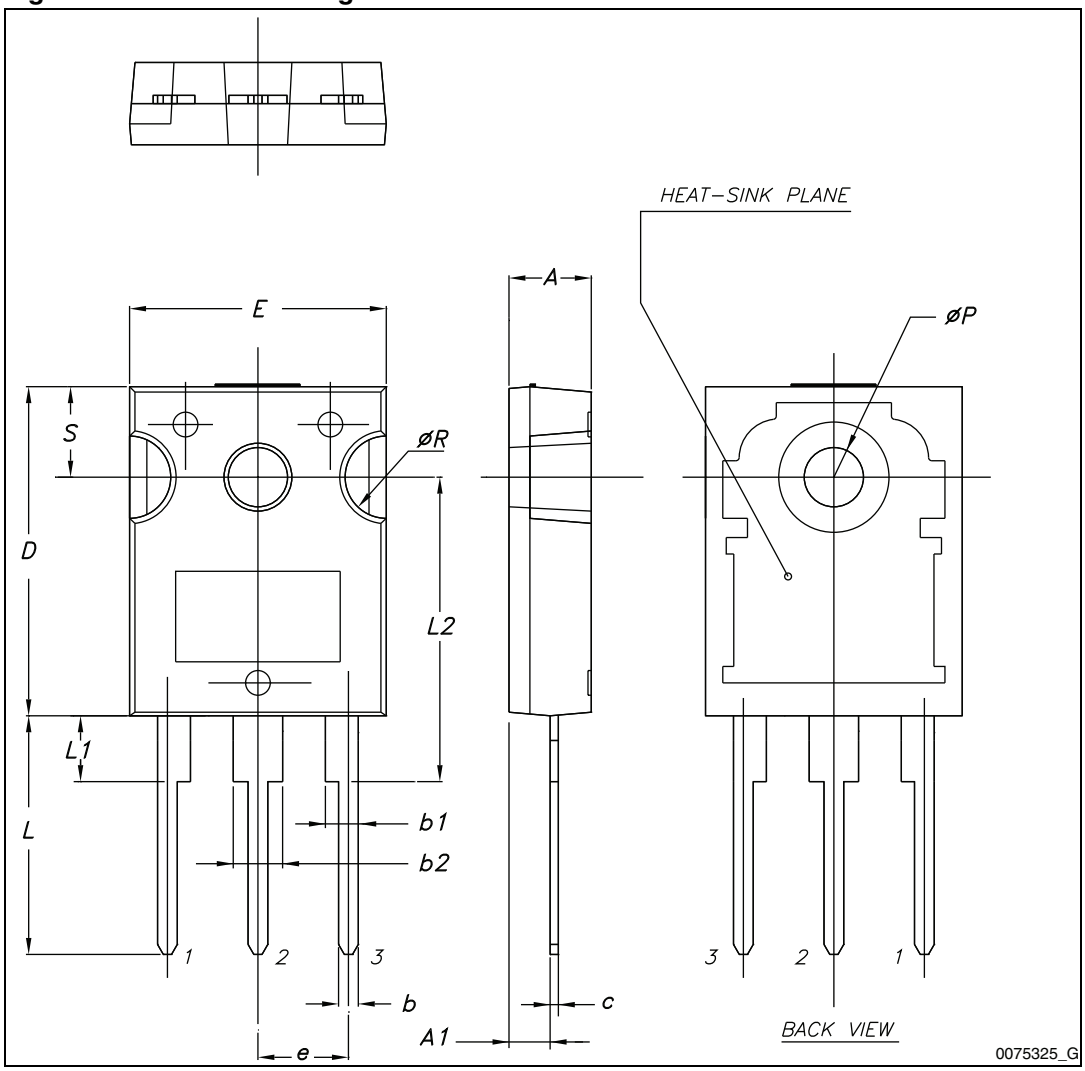


Table 11. TO-247 mechanical data

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 27. TO-247 drawing



5 Packaging mechanical data

Table 12. 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 28. Tape

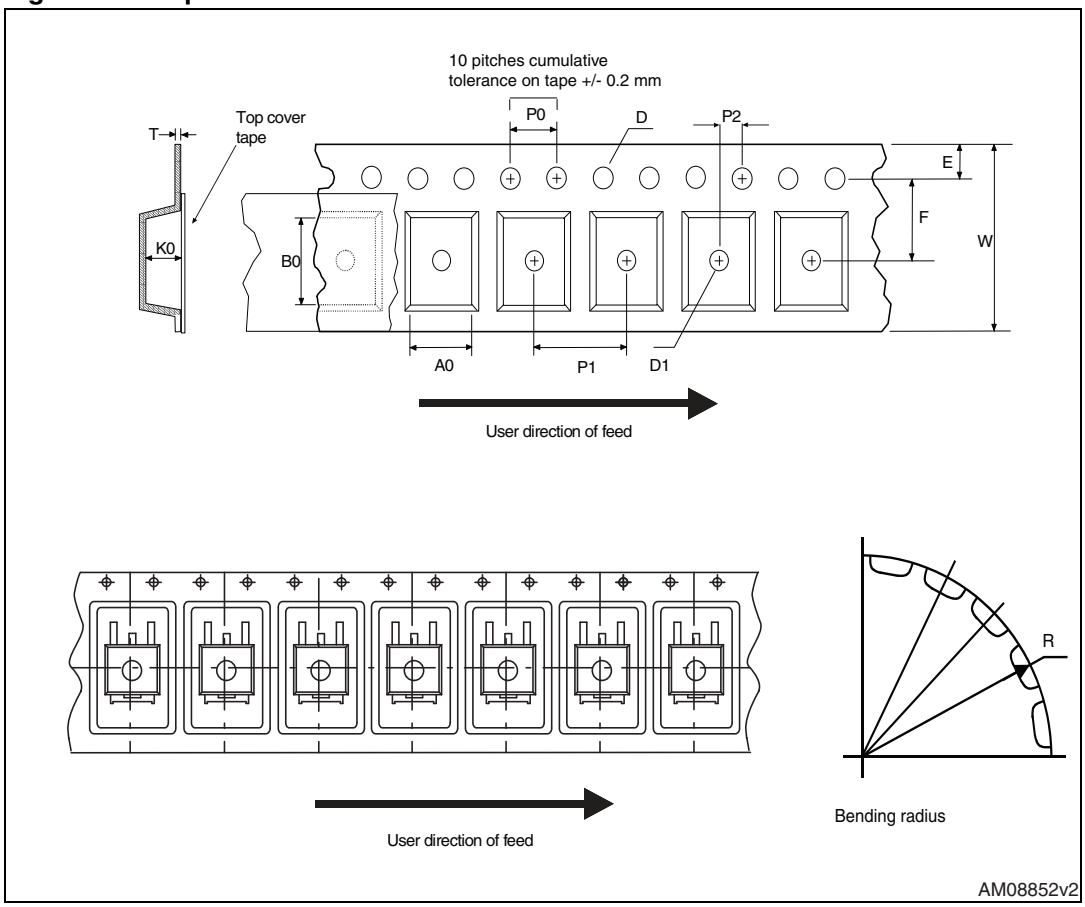
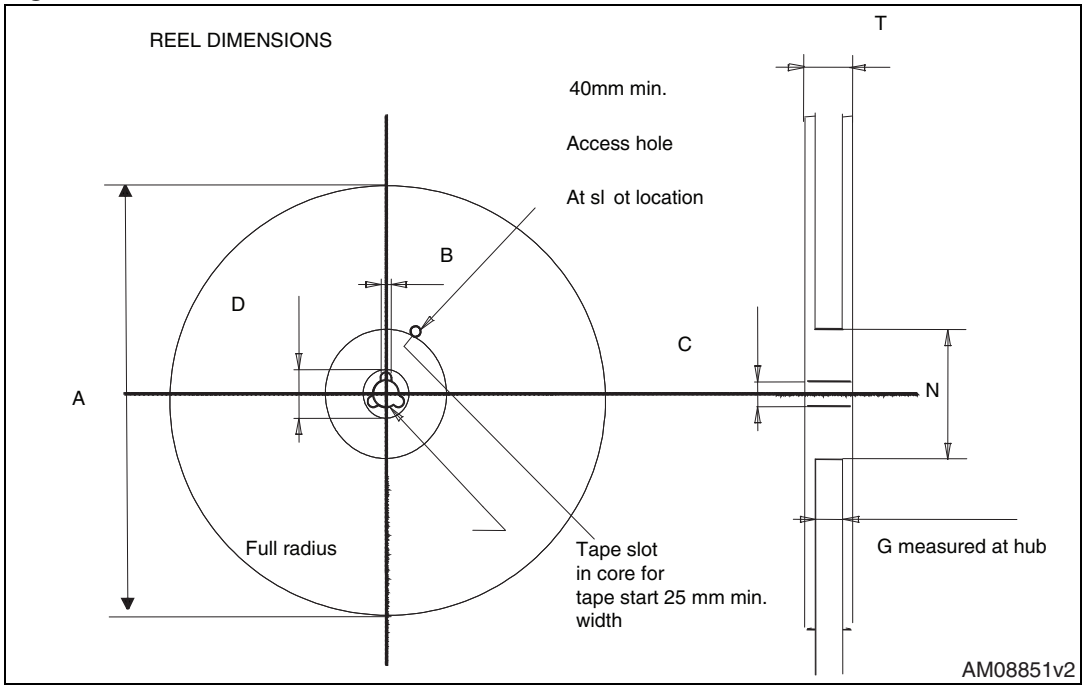


Figure 29. Reel



6 Revision history

Table 13. Document revision history

Date	Revision	Changes
22-Jan-2008	1	First release
11-Dec-2008	2	Document status promoted from preliminary data to datasheet.
06-Oct-2010	3	Corrected unit in *Table 4: On/off states*
18-Dec-2012	4	– Minor text changes in cover page – The part number STI23NM60ND has been moved to a separate datasheet – Modified: *Note 1* and *Note 3* in *Table 2* – Added $R_{thj\text{-}pcb}$ in *Table 3* and *Note 1* – Modified: typ values in *Table 5* and *6* – Modified: *Figure 8*, *9*, *11* and *16* – Updated: *Section 4: Package mechanical data* and *Section 5: Packaging mechanical data*

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