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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.

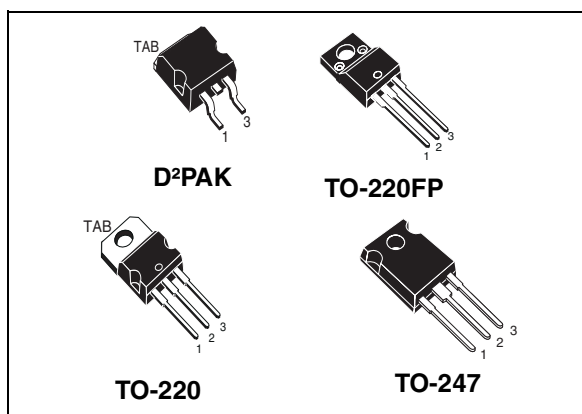


Figure 1. Internal schematic diagram

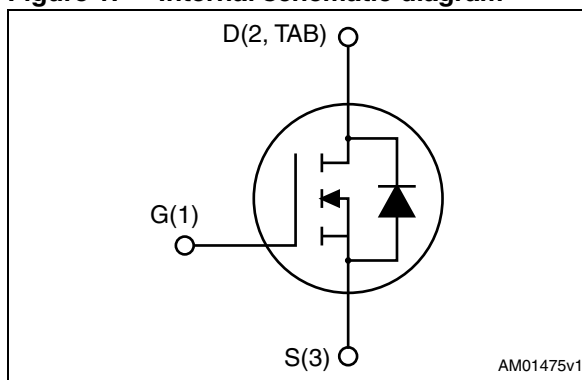


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB23NM60ND	23NM60ND	D ² PAK	Tape and reel
STF23NM60ND	23NM60ND	TO-220FP	Tube
STP23NM60ND	23NM60ND	TO-220	
STW23NM60ND	23NM60ND	TO-247	

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK, 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 T _j 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

- Limited by maximum junction temperature
- Pulse width limited by safe operating area
- 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	D ² PAK	TO-220FP	TO-220	TO-247	Unit
R _{thj-case}	Thermal resistance junction-case max	0.83	3.6	0.83		°C/W
R _{thj-amb}	Thermal resistance junction-amb max		62.5		50	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max ⁽¹⁾	30				°C/W

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

Electrical characteristics

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

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
R _g	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}

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND
Electrical characteristics
Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 10\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 17)		21		ns	
t_r	Rise time			19		ns	
$t_{d(off)}$	Turn-off delay time				92		ns
t_f	Fall time				42		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
I_{SD}	Source-drain current				19.5	A	
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				78	A	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 19.5\text{ A}$, $V_{GS} = 0$			1.3	V	
t_{rr}	Reverse recovery time	$I_{SD} = 19.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 19)		190		ns	
Q_{rr}	Reverse recovery charge				1.2		μC
I_{RRM}	Reverse recovery current				13		A
t_{rr}	Reverse recovery time	$V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $I_{SD} = 19.5\text{ A}$ $T_j = 150\text{ }^\circ\text{C}$ (see Figure 19)		270		ns	
Q_{rr}	Reverse recovery charge				2.0		μC
I_{RRM}	Reverse recovery current				15		A

1. Pulse width limited by safe operating area

 2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

Electrical characteristics

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

2.1 Electrical characteristics (curves)

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

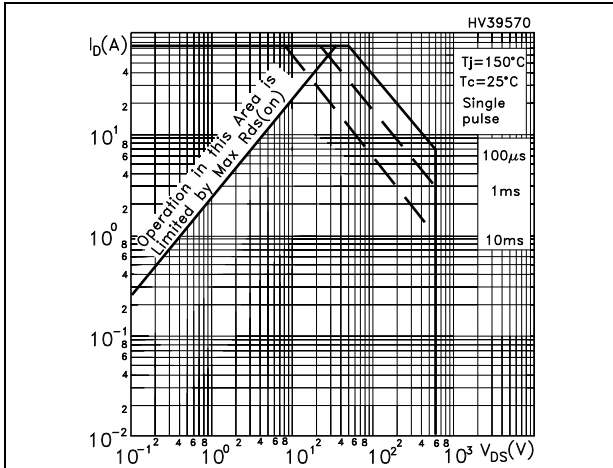


Figure 3. Thermal impedance for D²PAK and TO-220

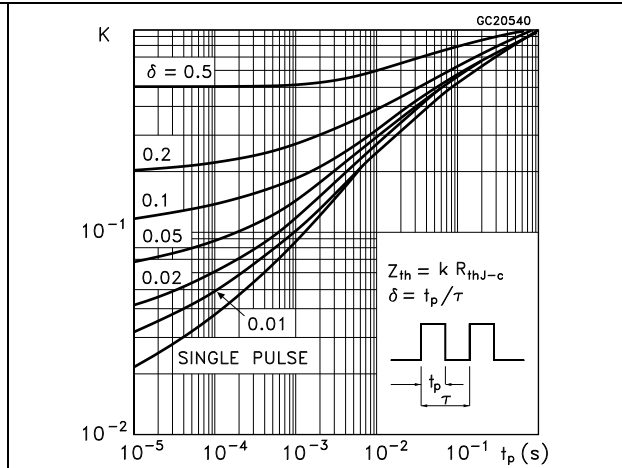


Figure 4. Safe operating area for TO-220FP

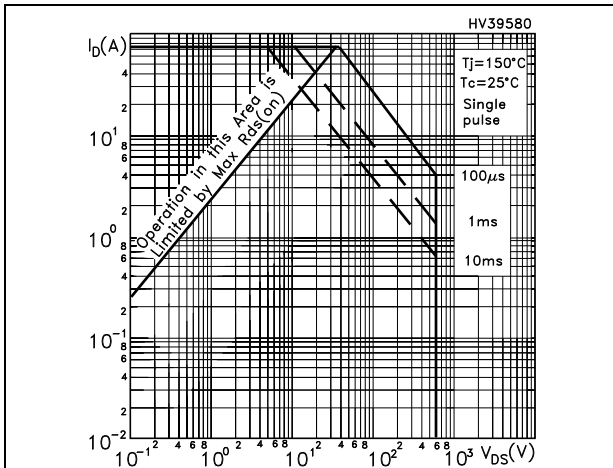


Figure 5. Thermal impedance for TO-220FP

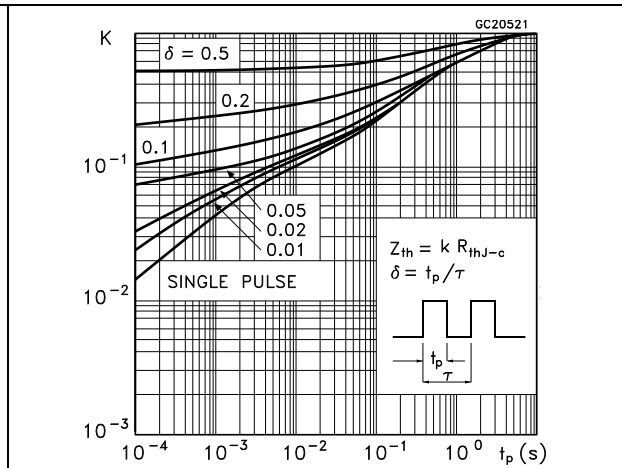


Figure 6. Safe operating area for TO-247

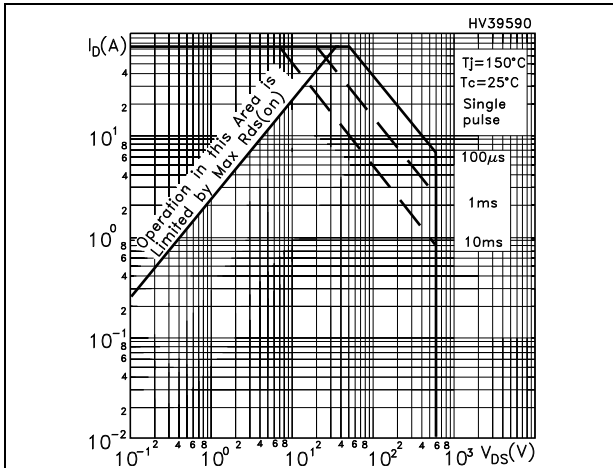
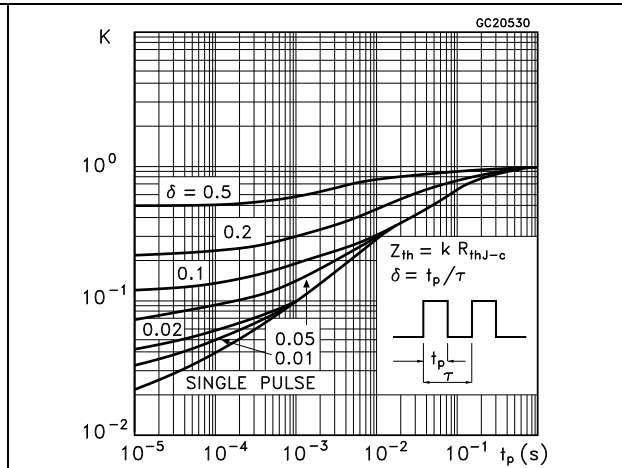


Figure 7. Thermal impedance for TO-247



STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Electrical characteristics

Figure 8. Output characteristics

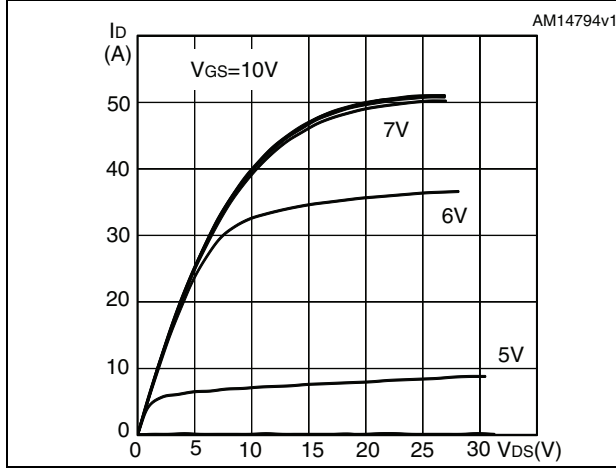


Figure 9. Transfer characteristics

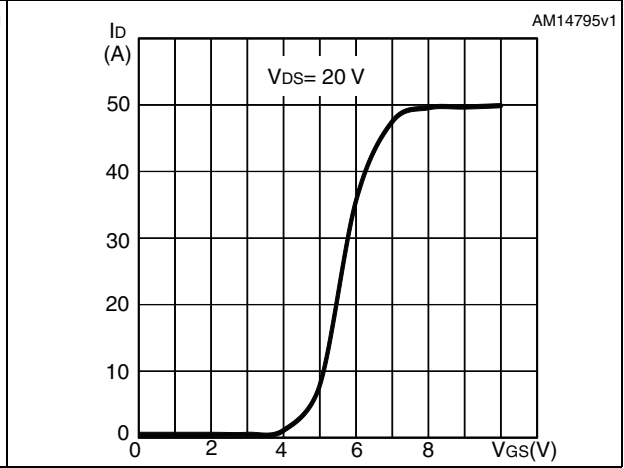


Figure 10. Static drain-source on resistance

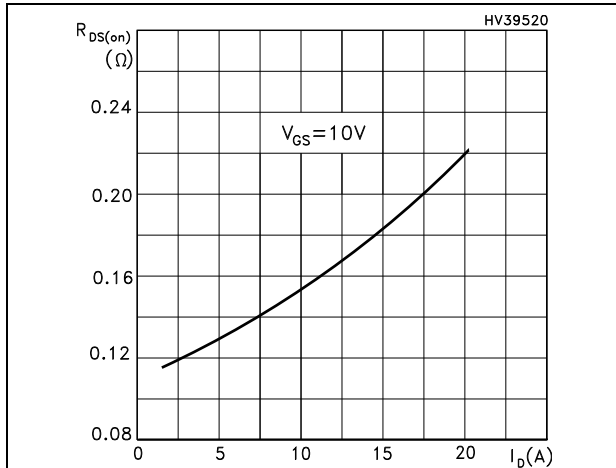


Figure 11. Gate charge vs gate-source voltage

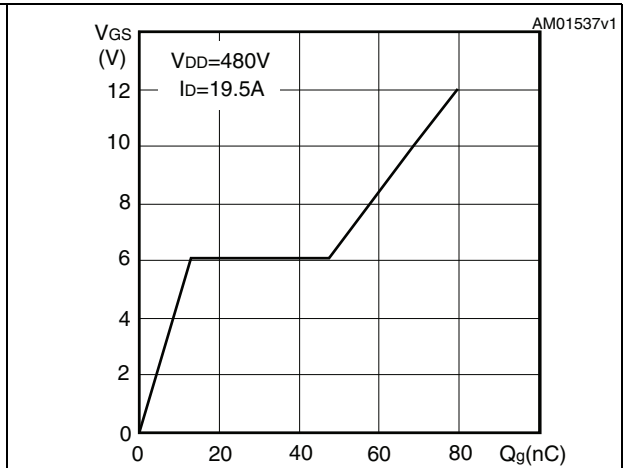


Figure 12. Capacitance variations

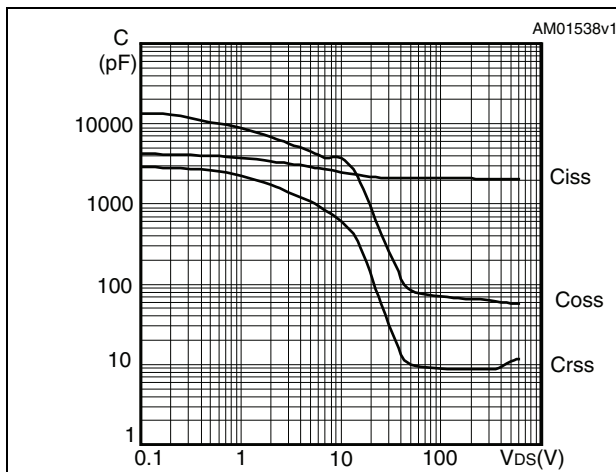
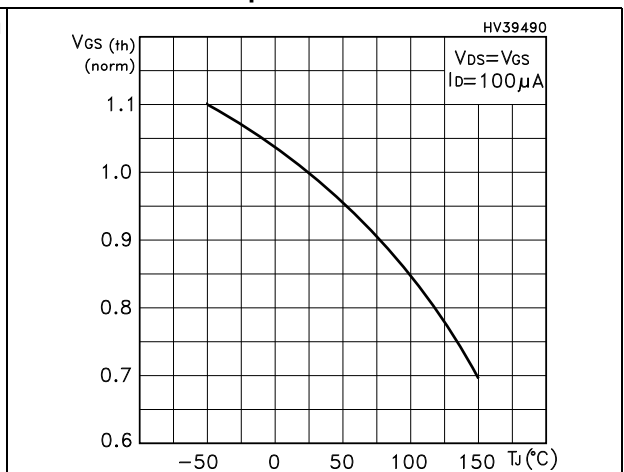


Figure 13. Normalized gate threshold voltage vs temperature



Electrical characteristics

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Figure 14. Normalized on resistance vs temperature

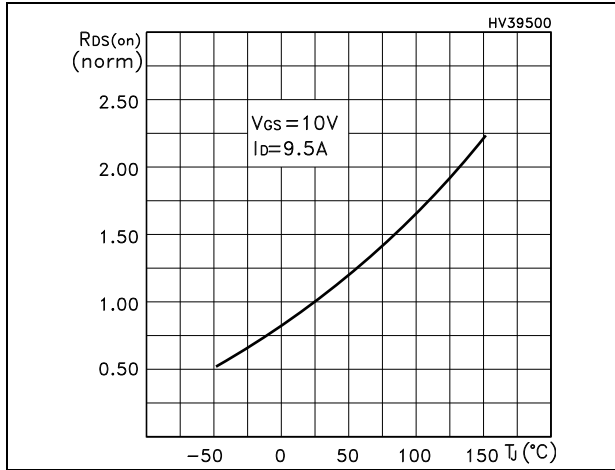


Figure 15. Source-drain diode forward characteristics

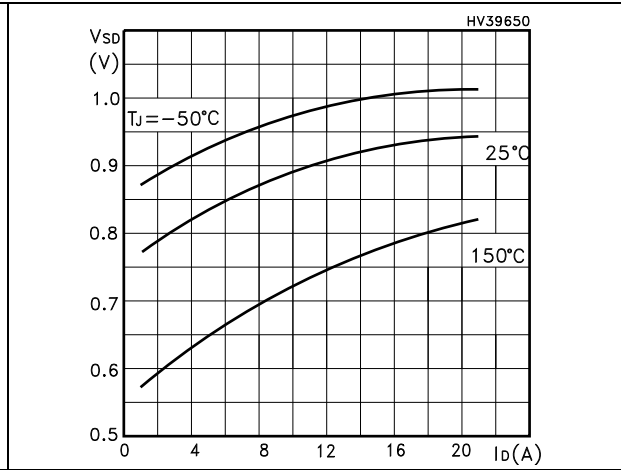
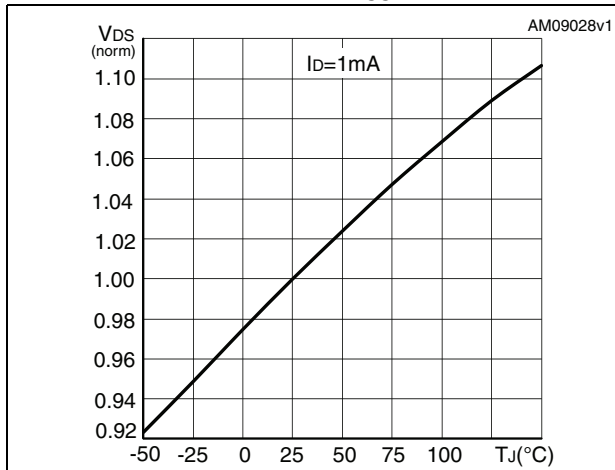


Figure 16. Normalized $B_{V_{DS}}$ vs temperature



3 Test circuits

Figure 17. Switching times test circuit for resistive load

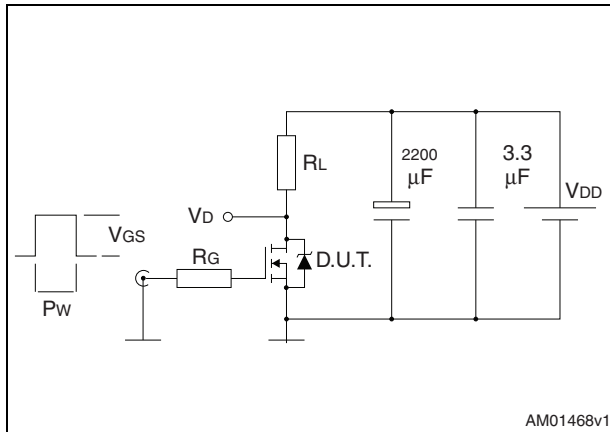


Figure 18. Gate charge test circuit

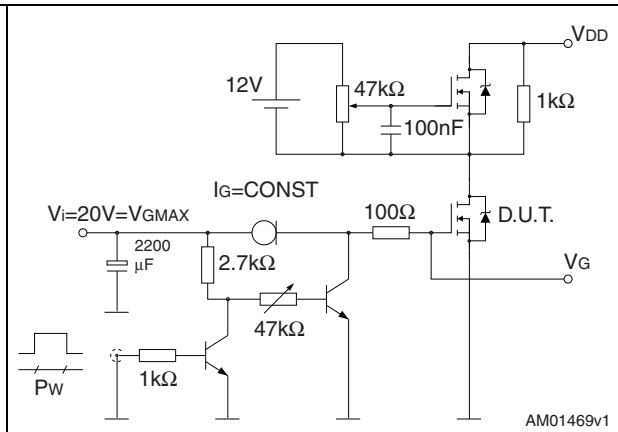


Figure 19. Test circuit for inductive load switching and diode recovery times

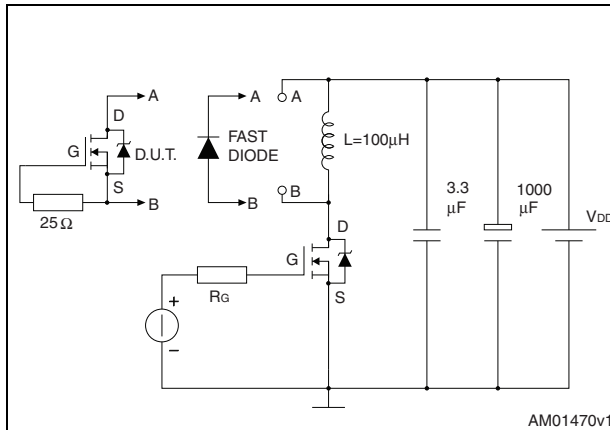


Figure 20. Unclamped inductive load test circuit

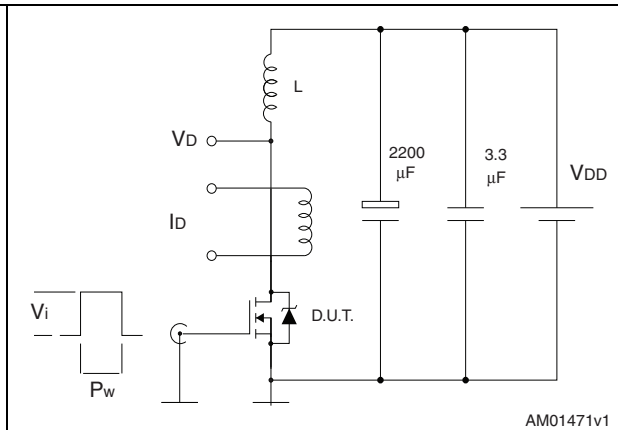
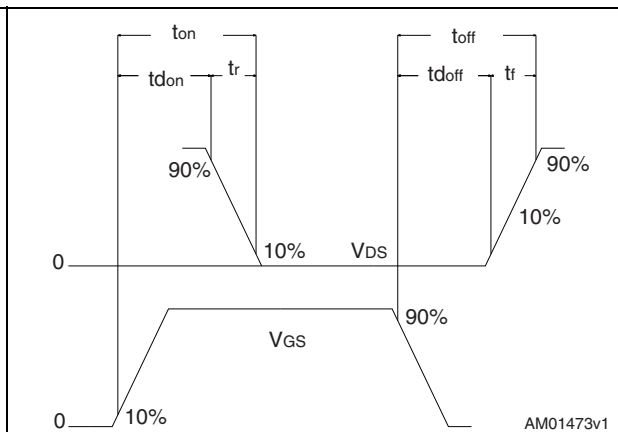
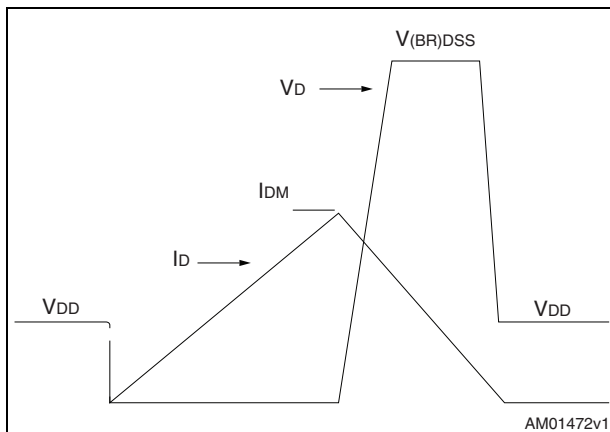


Figure 21. Unclamped inductive waveform

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.

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Package mechanical data

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°

Package mechanical data

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Figure 23. D²PAK (TO-263) drawing

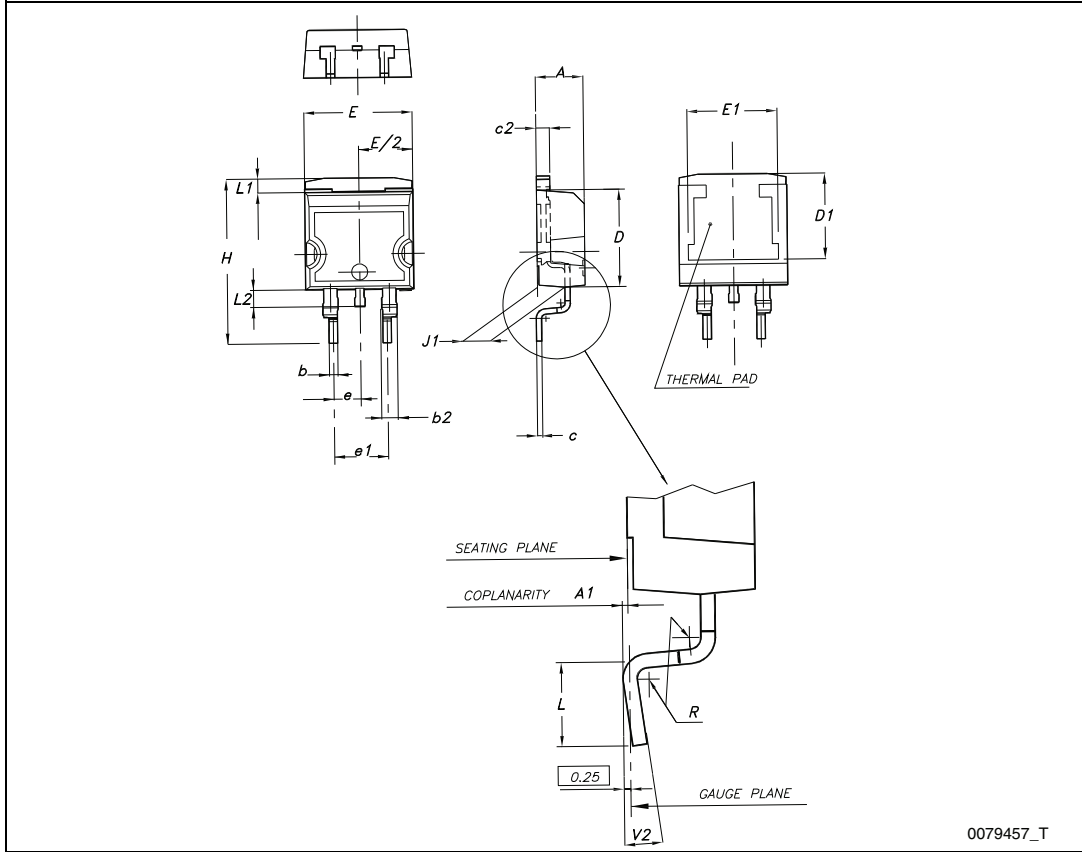
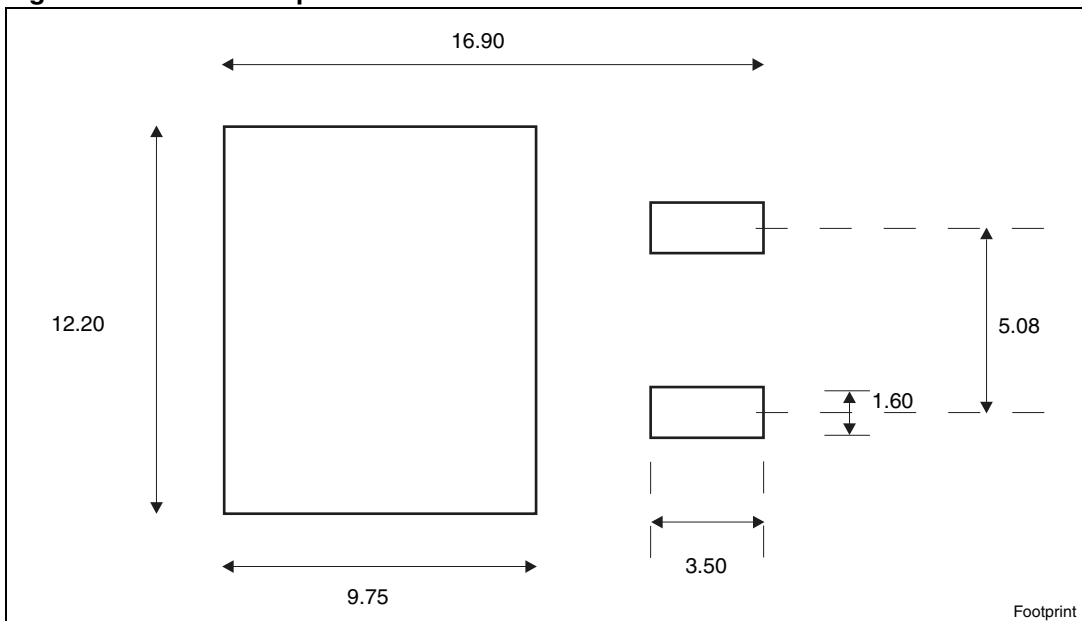


Figure 24. D²PAK footprint^(a)



a. All dimensions are in millimeters

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Package mechanical data

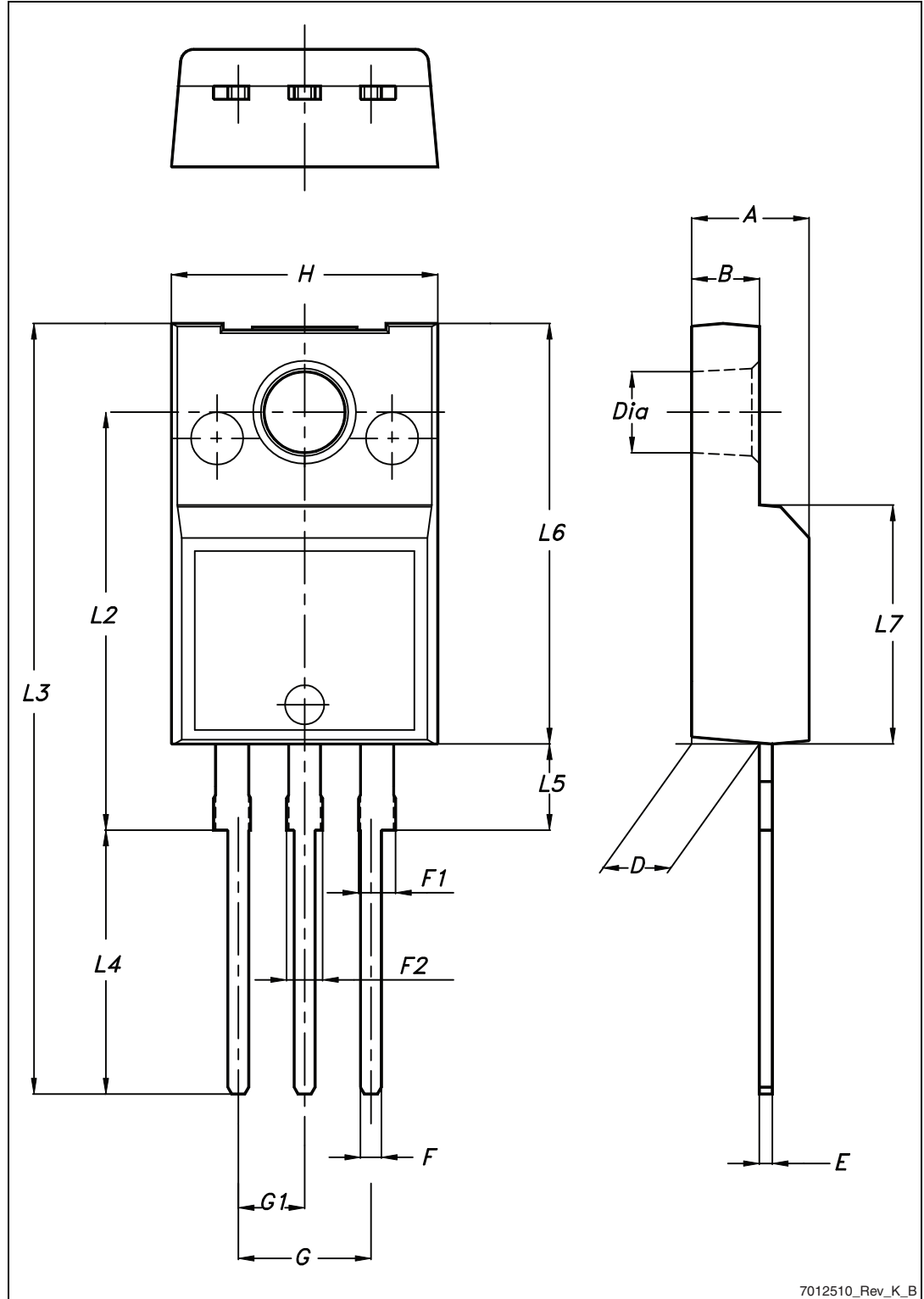
Table 9. TO-220FP mechanical data

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

Package mechanical data

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Figure 25. TO-220FP drawing



7012510_Rev_K_B

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Package mechanical data

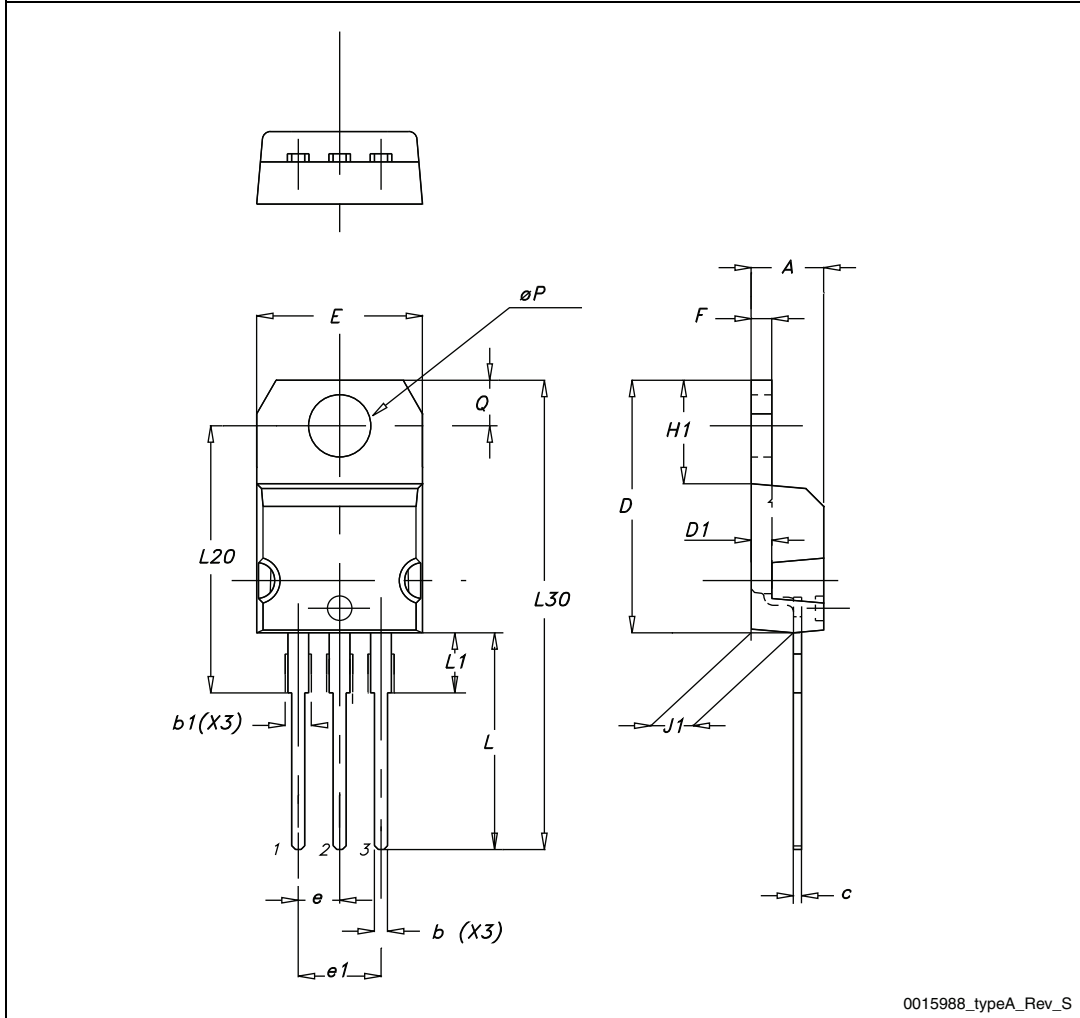
Table 10. TO-220 type A mechanical data

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	
ØP	3.75		3.85
Q	2.65		2.95

Package mechanical data

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Figure 26. TO-220 type A drawing



STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Package mechanical data

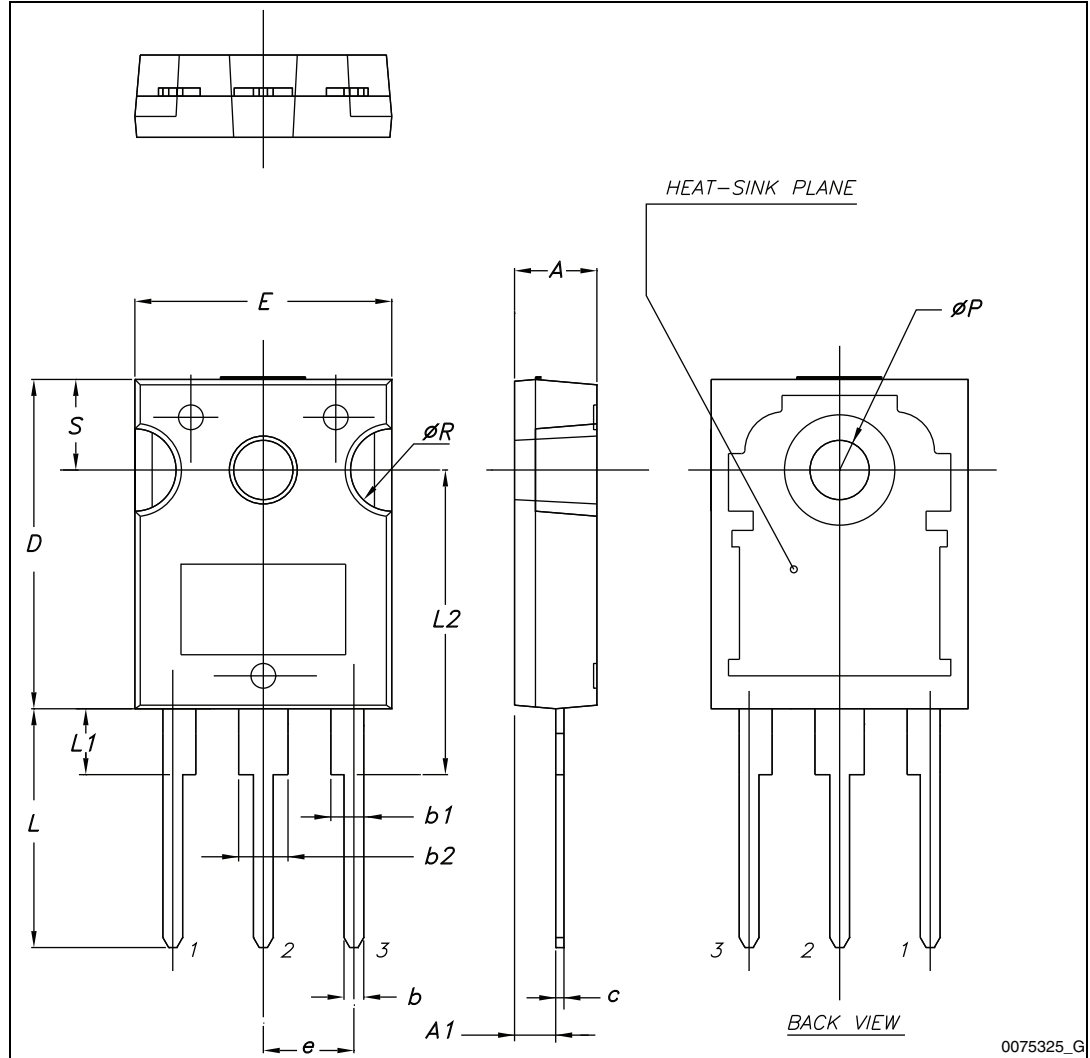
Table 11. TO-247 mechanical data

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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Package mechanical data

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Figure 27. TO-247 drawing



0075325_G

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Packaging mechanical data

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			

Packaging mechanical data

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

Figure 28. Tape

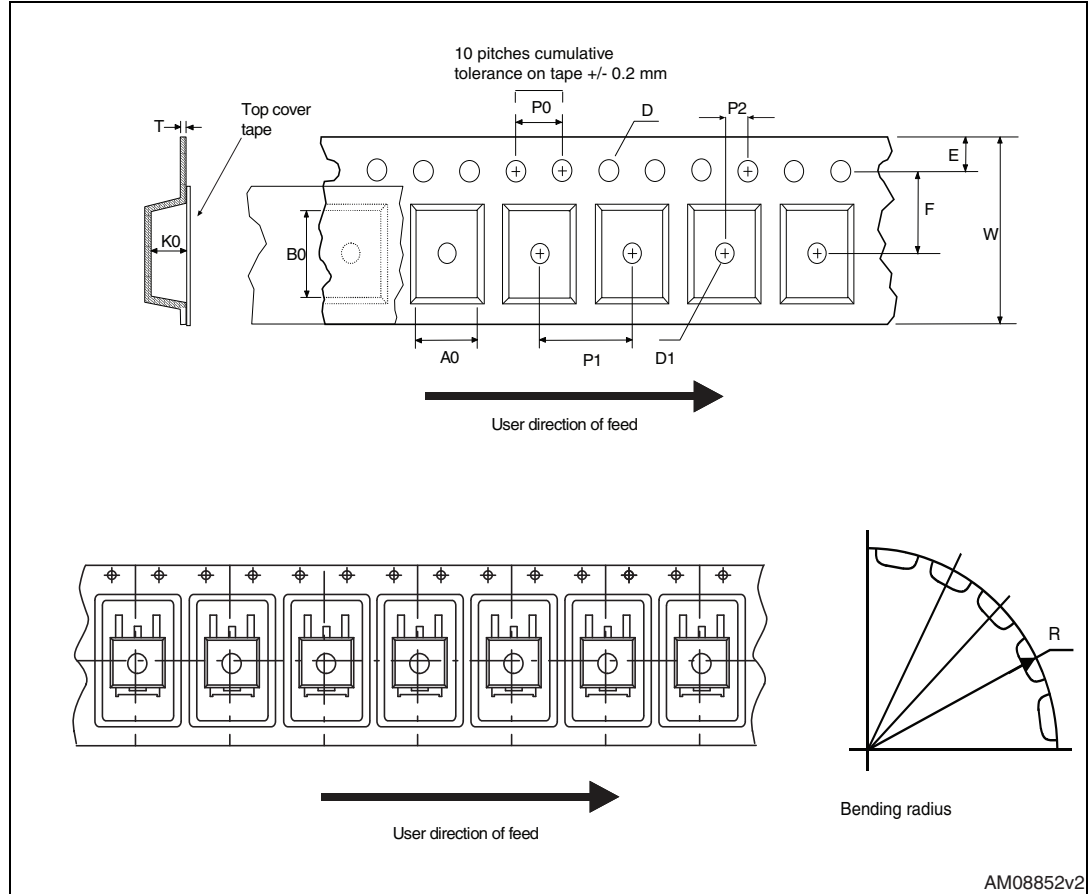
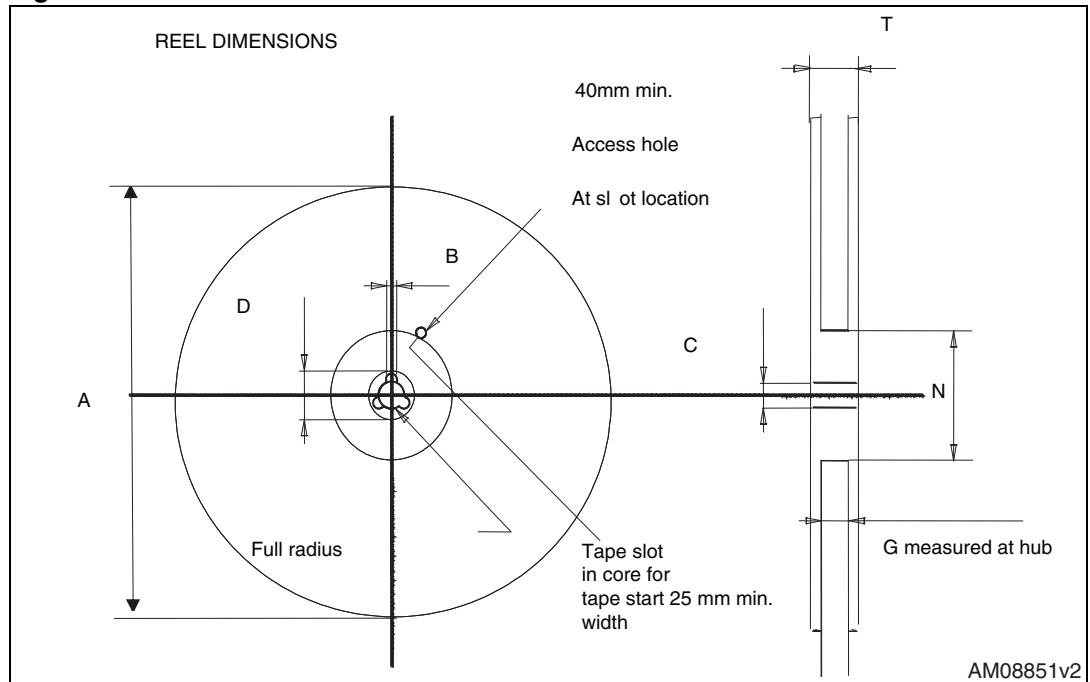


Figure 29. Reel



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	<ul style="list-style-type: none"> – 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 $R_{thj-pcb}$ 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

STB23NM60ND, STF23NM60ND, STP23NM60ND, STW23NM60ND

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