

N-channel 600 V, 0.097  $\Omega$  typ., 29 A FDmesh™ II Power MOSFET  
(with fast diode) in D<sup>2</sup>PAK, TO-220FP, TO-220 and TO-247

Datasheet — production data

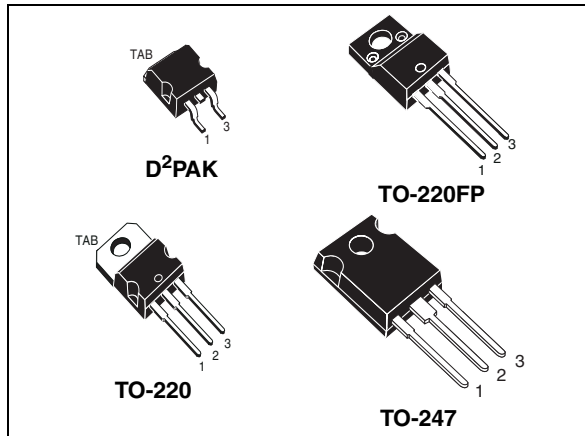
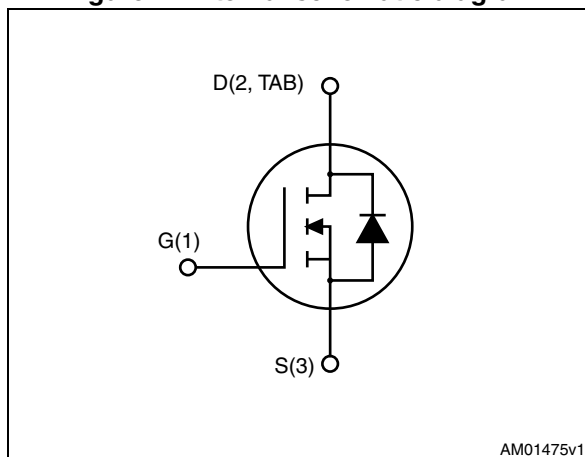


Figure 1. Internal schematic diagram



## Features

Order codes	$V_{DS}$ @ $T_J$ max.	$R_{DS(on)}$ max.	$I_D$
STB34NM60ND	650 V	0.110 $\Omega$	29 A
STF34NM60ND			
STP34NM60ND			
STW34NM60ND			

- The world's best  $R_{DS(on)}$  in TO-220 amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

## Applications

- Switching applications

## Description

These devices are N-channel FDmesh™ V Power MOSFETs produced using ST's MDmesh™ V technology, which is based on an innovative proprietary vertical structure. The resulting product boasts an extremely low on-resistance that is unrivaled among silicon-based Power MOSFETs, and superior switching performance with intrinsic fast-recovery body diode.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STB34NM60ND	34NM60ND	D <sup>2</sup> PAK	Tape and reel
STF34NM60ND		TO-220FP	Tube
STP34NM60ND		TO-220	
STW34NM60ND		TO-247	

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK, TO-220, TO-247	TO-220FP	
V <sub>DS</sub>	Drain-source voltage	600		V
V <sub>GS</sub>	Gate- source voltage	± 25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	29	29 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	18	18 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	116	116 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	190	40	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)		2500	V
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	40		V/ns
T <sub>stg</sub>	Storage temperature	- 55 to 150		°C
T <sub>J</sub>	Max. operating junction temperature	150		

1. Current limited by package
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 29 \text{ A}$ ,  $di/dt \leq 600 \text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ ,  $V_{DSPeak} < V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	TO-220	TO-247	D <sup>2</sup> PAK	TO-220FP	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.66			3.1	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5	50		62.5	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb max			30		°C/W

1. When mounted on FR-4 board of 1 inch<sup>2</sup>, 2 oz Cu.

**Table 4. Avalanche characteristics**

Symbol	Parameter	Max value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max)	7	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	110	mJ

## 2 Electrical characteristics

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

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage ( $V_{GS} = 0$ )	$I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 600\text{ V}, T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}, I_D = 14.5\text{ A}$		0.097	0.110	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance		-	2785	-	pF
$C_{oss}$	Output capacitance	$V_{DS} = 50\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	168	-	pF
$C_{rss}$	Reverse transfer capacitance		-	5	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$	-	438	-	pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}, I_D = 14.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> and <a href="#">23</a> )	-	30	-	ns
$t_r$	Rise time		-	53.4	-	ns
$t_{d(off)}$	Turn-off delay time		-	111	-	ns
$t_f$	Fall time		-	61.8	-	ns
$Q_g$	Total gate charge		$V_{DD} = 480\text{ V}, I_D = 29\text{ A}, V_{GS} = 10\text{ V},$ (see <a href="#">Figure 19</a> )	-	80.4	-
$Q_{gs}$	Gate-source charge	-		16	-	nC
$Q_{gd}$	Gate-drain charge	-		41.4	-	nC
$R_g$	Gate input resistance	f=1 MHz, open drain	-	2.87	-	$\Omega$

1.  $C_{oss\text{ eq.}}$  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 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		29	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		116	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 29\text{ A}, V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 29\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ (see <a href="#">Figure 20</a> )	-	175		ns
$Q_{rr}$	Reverse recovery charge		-	1.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	16		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 29\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 20</a> )	-	255		ns
$Q_{rr}$	Reverse recovery charge		-	2.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	20		A

1. Pulse width limited by safe operating area
2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220FP

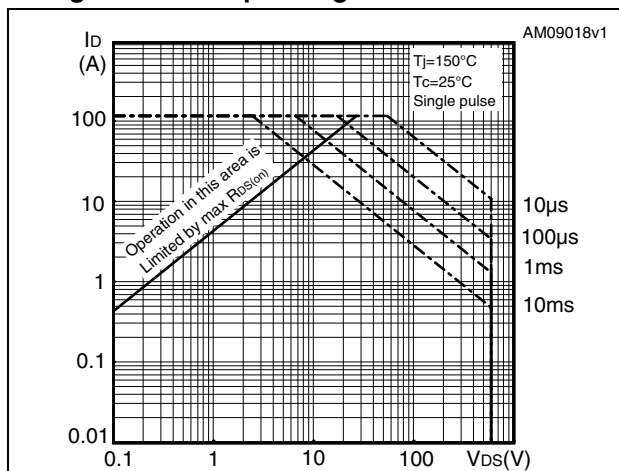


Figure 3. Thermal impedance for TO-220FP

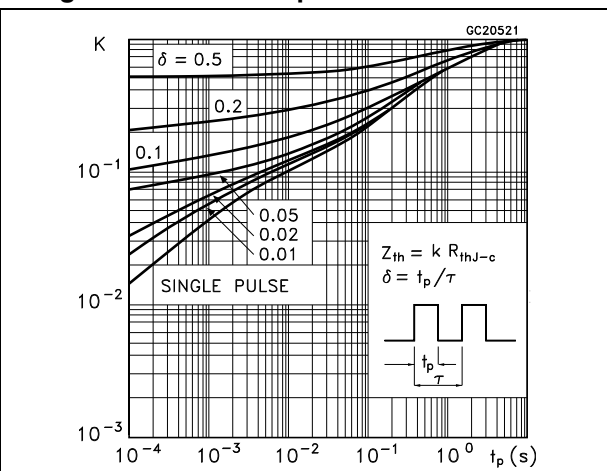


Figure 4. Safe operating area for TO-220 and D<sup>2</sup>PAK

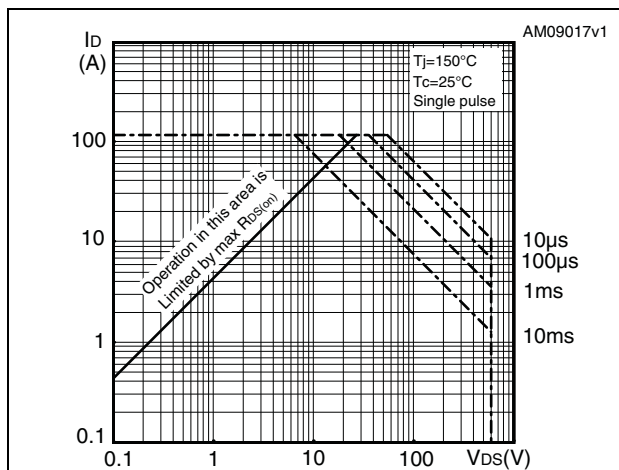


Figure 5. Thermal impedance for TO-220 and D<sup>2</sup>PAK

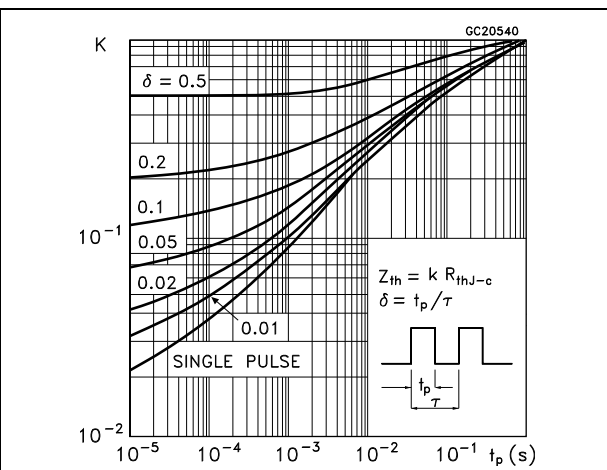


Figure 6. Safe operating area for TO-247

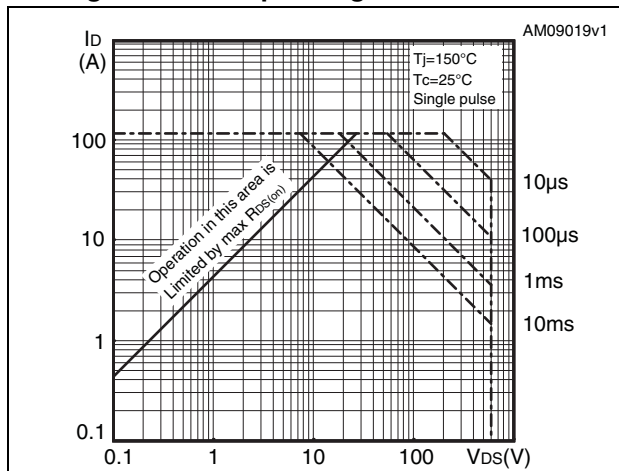


Figure 7. Thermal impedance for TO-247

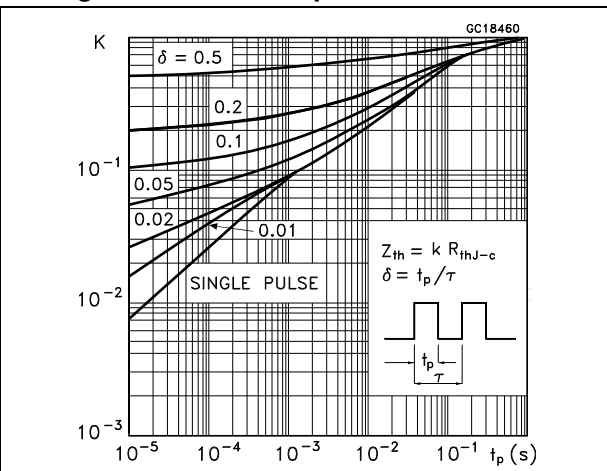


Figure 8. Output characteristics

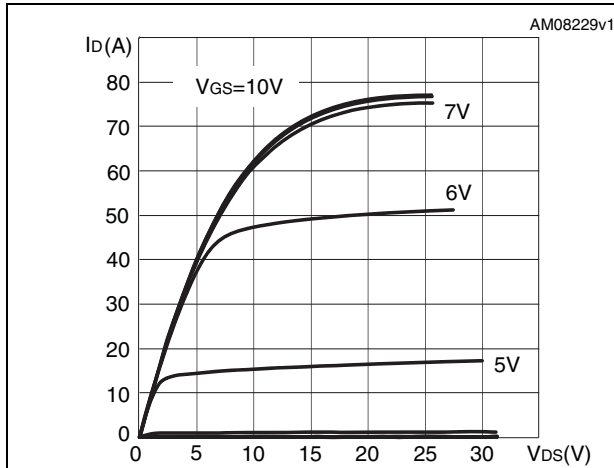


Figure 9. Transfer characteristics

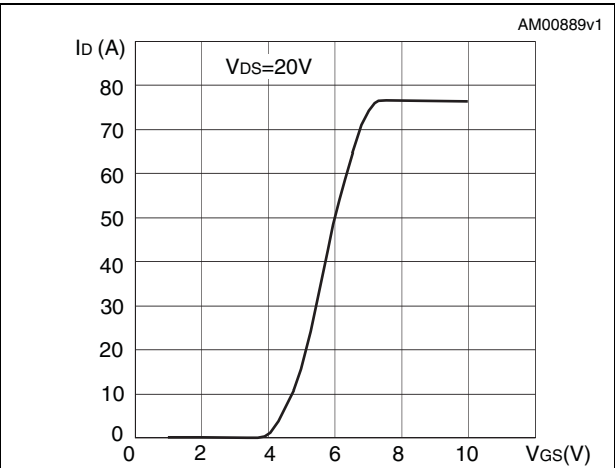


Figure 10. Gate charge vs gate-source voltage

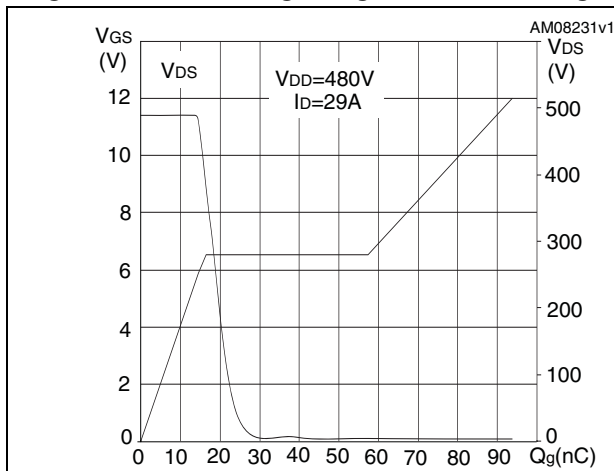


Figure 11. Static drain-source on-resistance

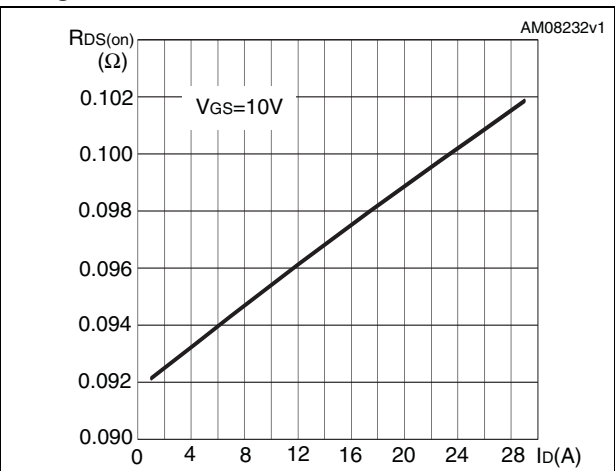


Figure 12. Capacitance variations

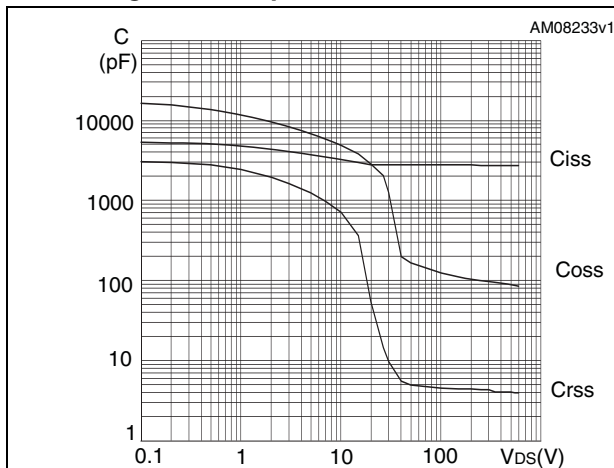


Figure 13. Output capacitance stored energy

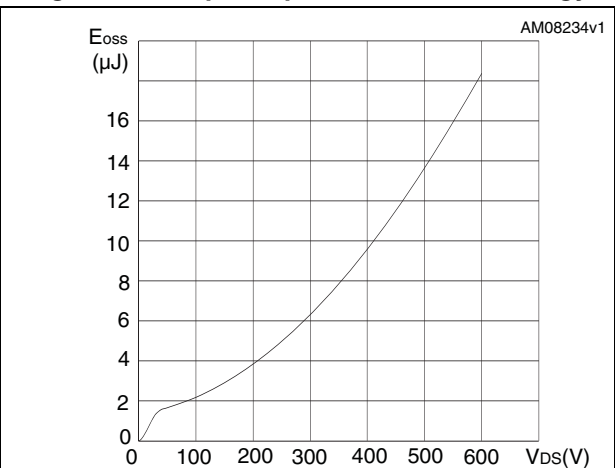


Figure 14. Normalized gate threshold voltage vs temperature

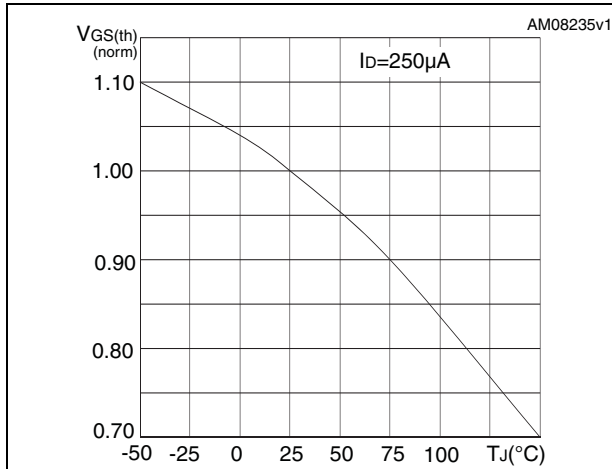


Figure 15. Normalized on-resistance vs temperature

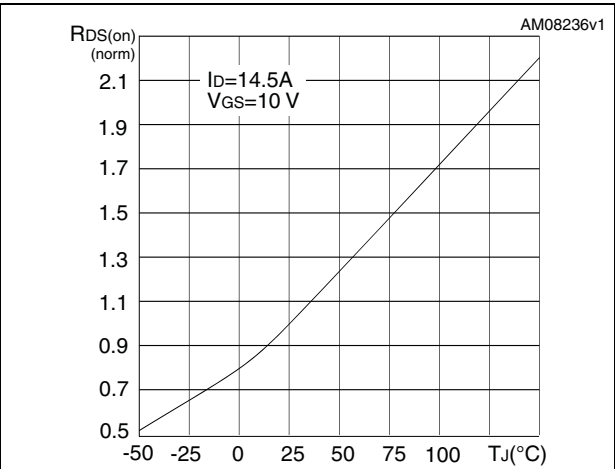


Figure 16. Normalized V<sub>DS</sub> vs temperature

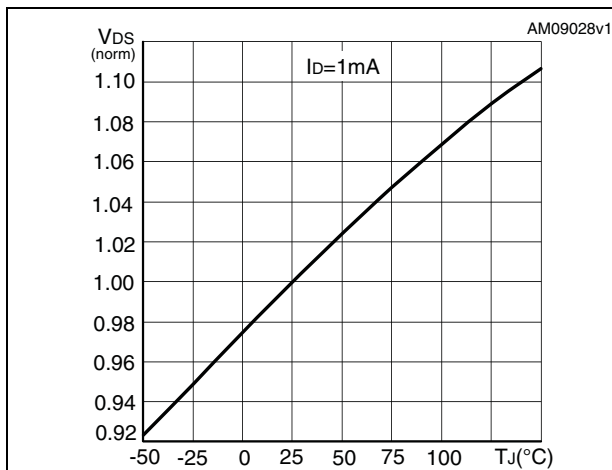
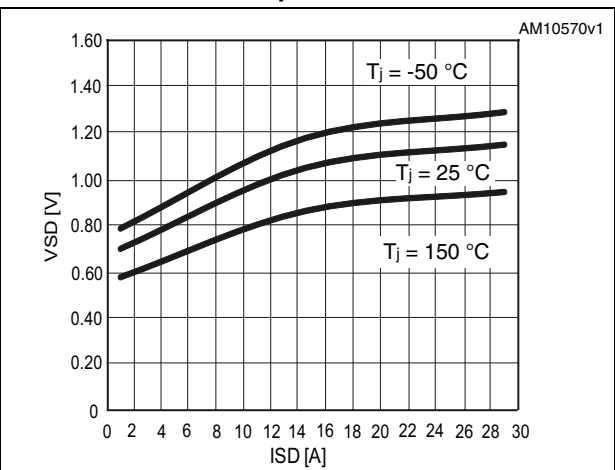


Figure 17. Source-drain diode forward vs temperature





### 3 Test circuits

Figure 18. Switching times test circuit for resistive load



Figure 19. Gate charge test circuit

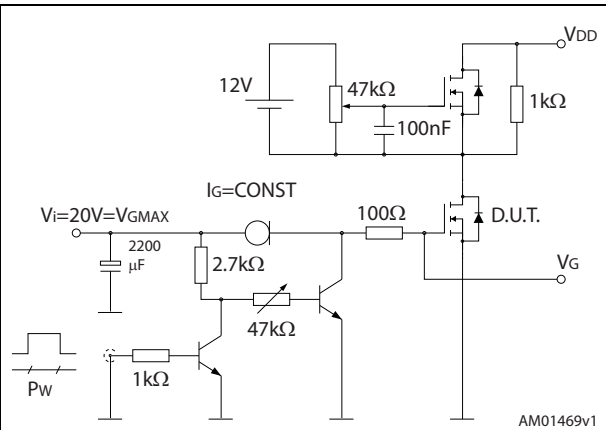


Figure 20. Test circuit for inductive load switching and diode recovery times

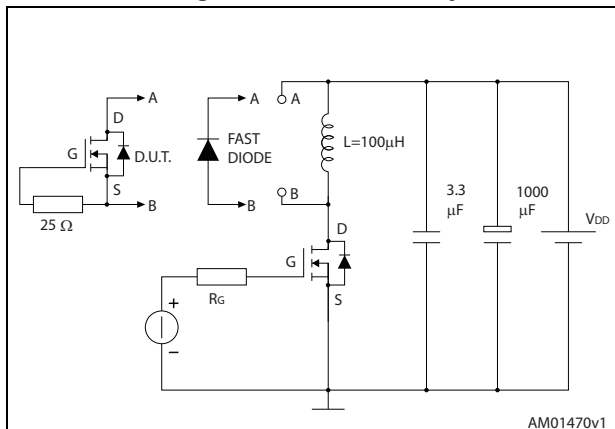


Figure 21. Unclamped inductive load test circuit

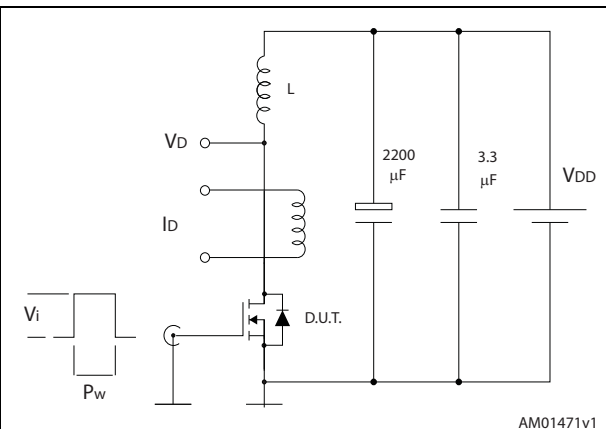


Figure 22. Unclamped inductive waveform

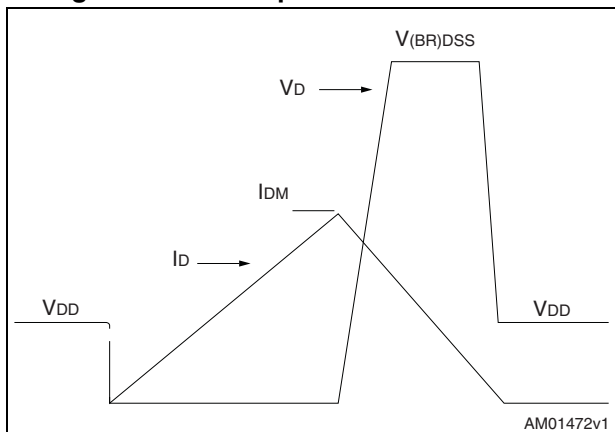
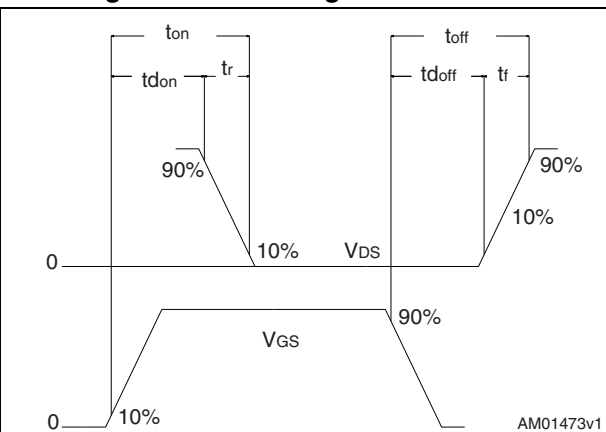


Figure 23. Switching time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

Table 8. D<sup>2</sup>PAK (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 24. D<sup>2</sup>PAK (TO-263) drawing

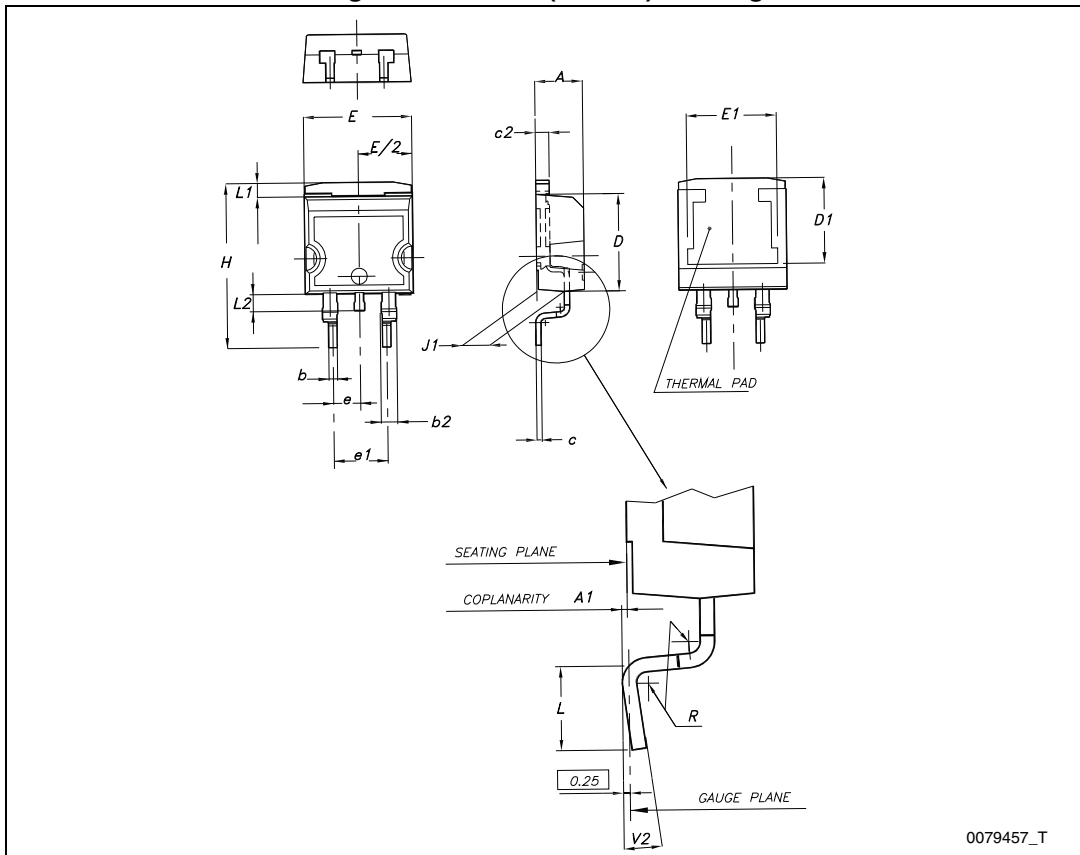
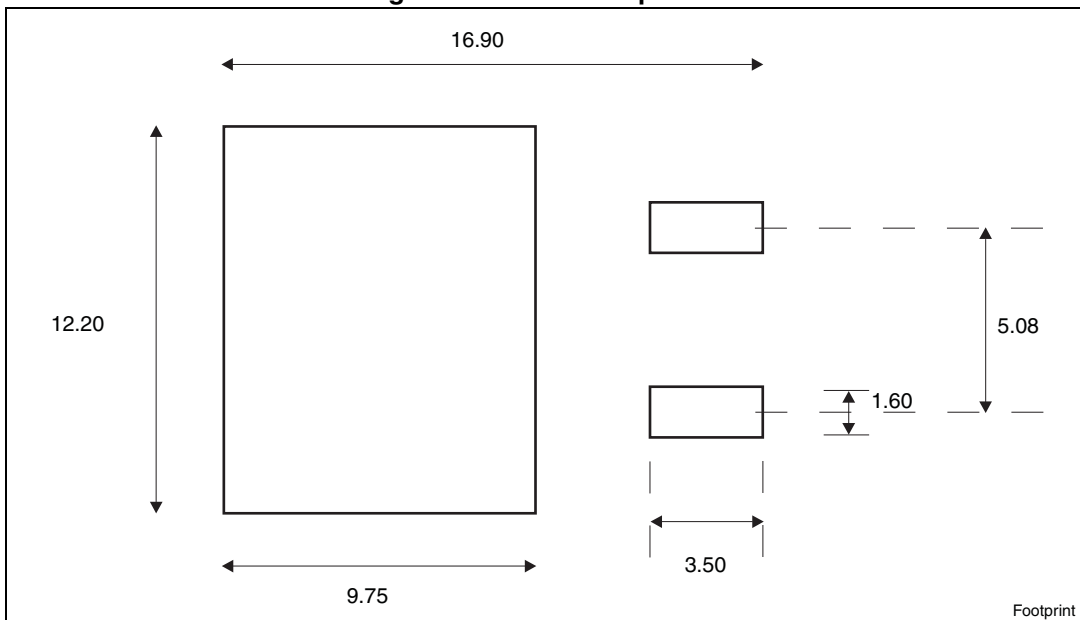


Figure 25. D<sup>2</sup>PAK footprint<sup>(a)</sup>

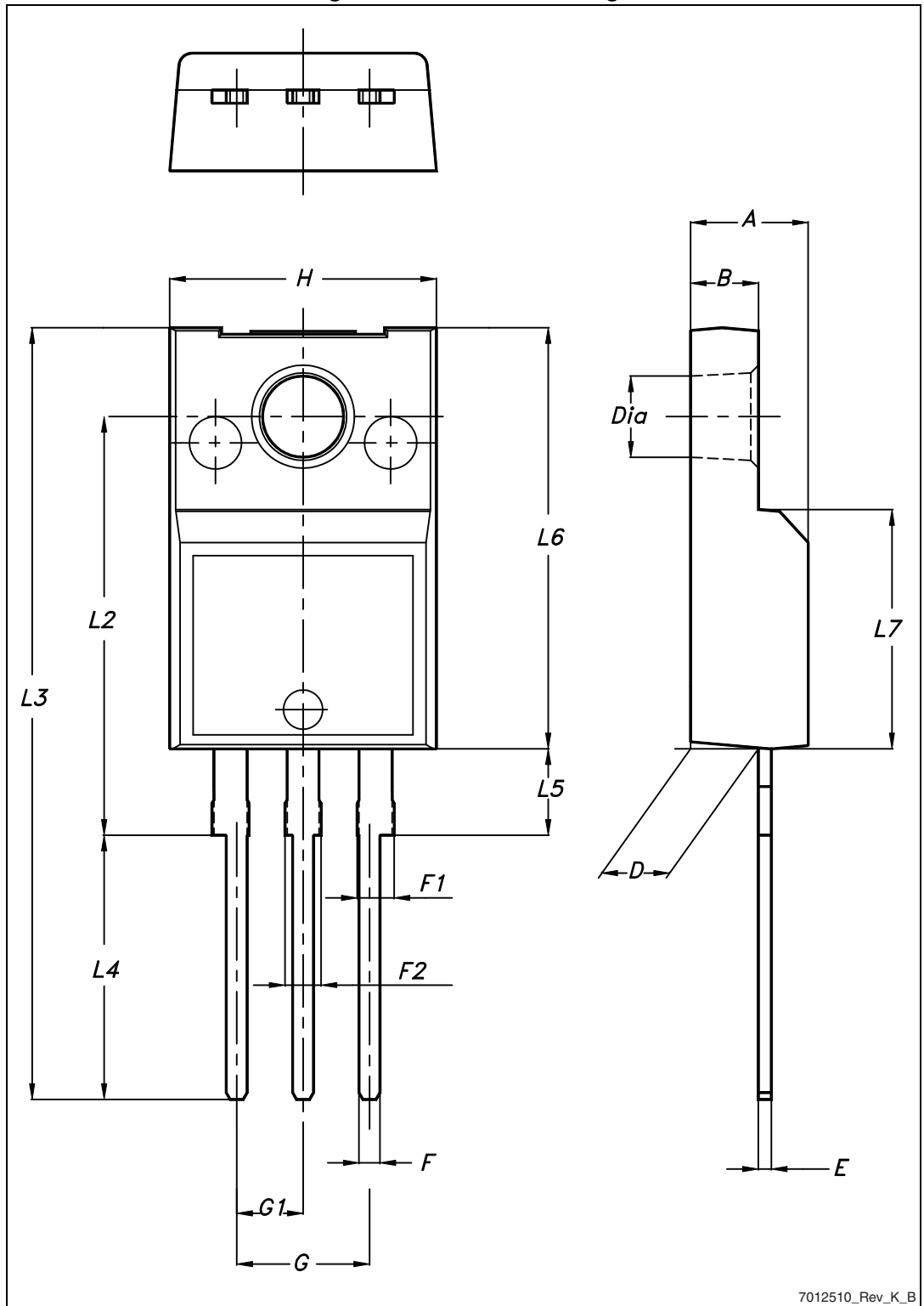


a. All dimension are in millimeters

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 26. TO-220FP drawing



7012510\_Rev\_K\_B

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

Figure 27. TO-220 type A drawing

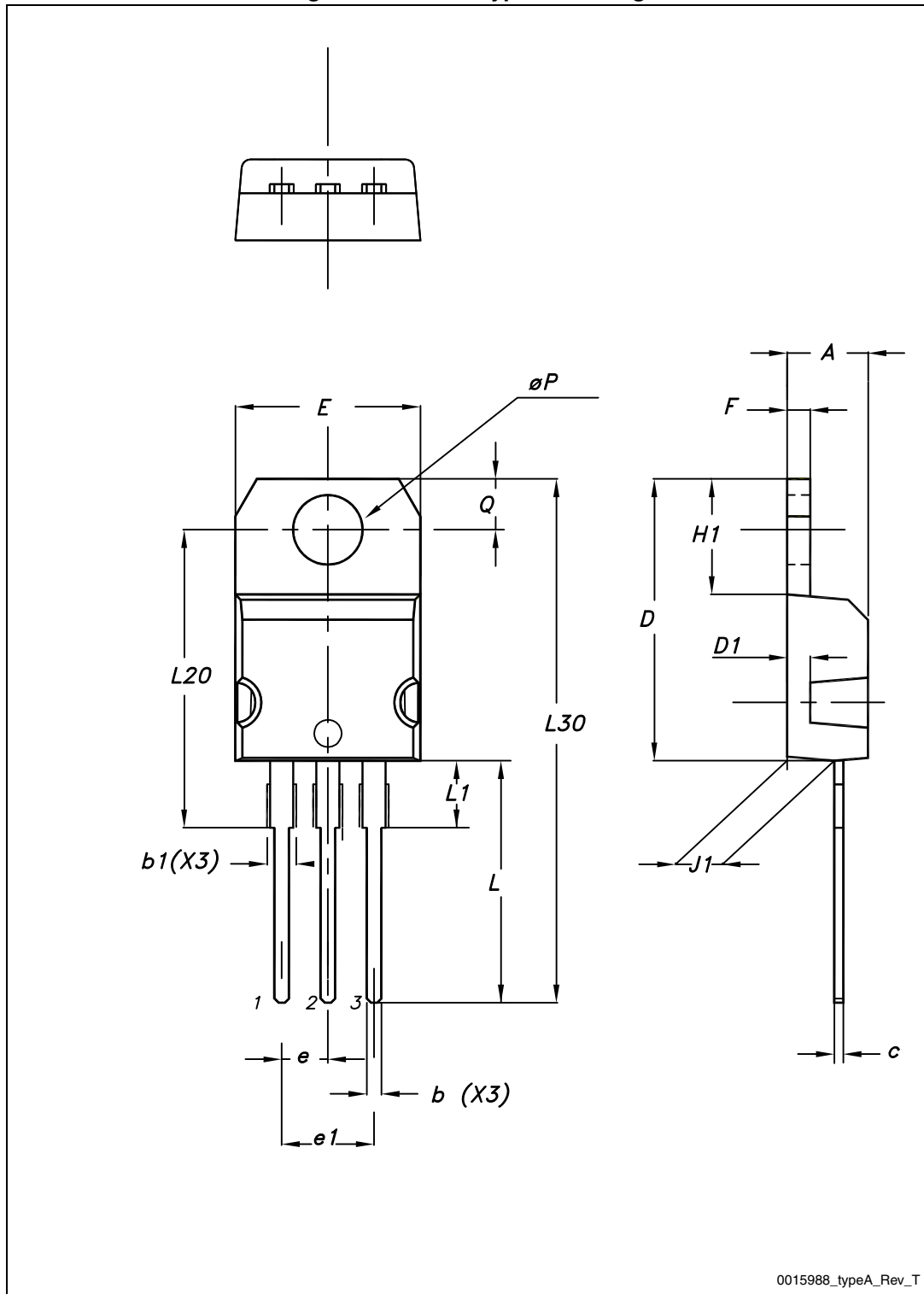
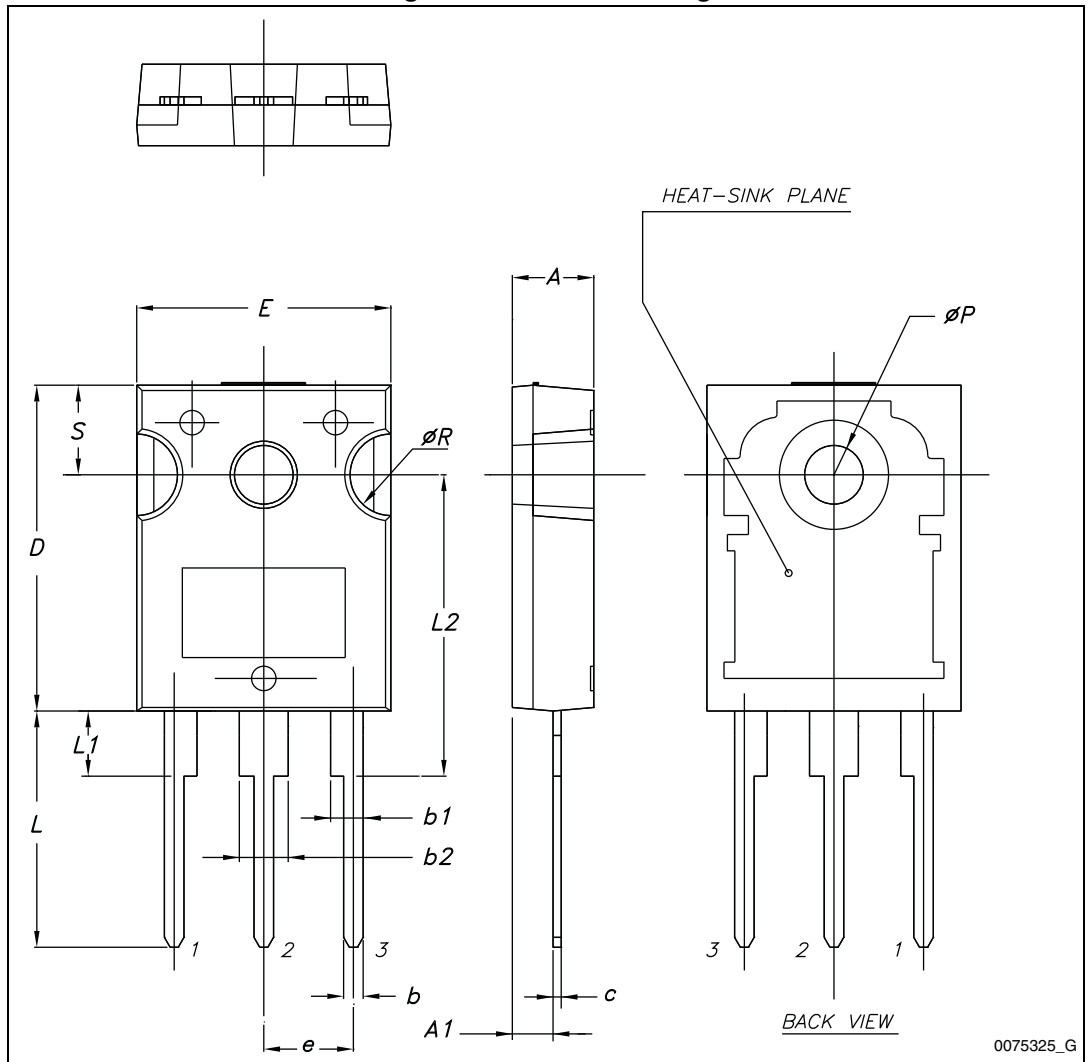




Table 11. TO-247 mechanical data

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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Figure 28. TO-247 drawing



## 5 Packaging mechanical data

Table 12. D<sup>2</sup>PAK (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 29. Tape

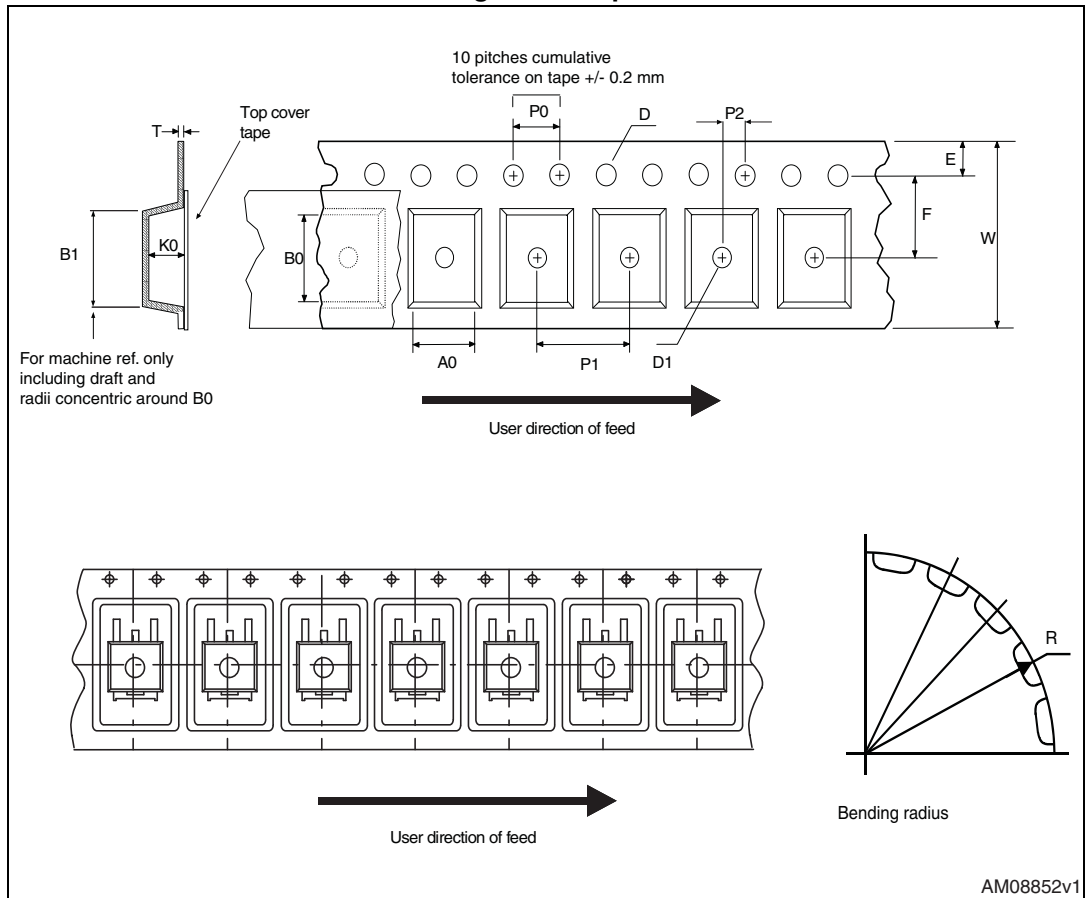
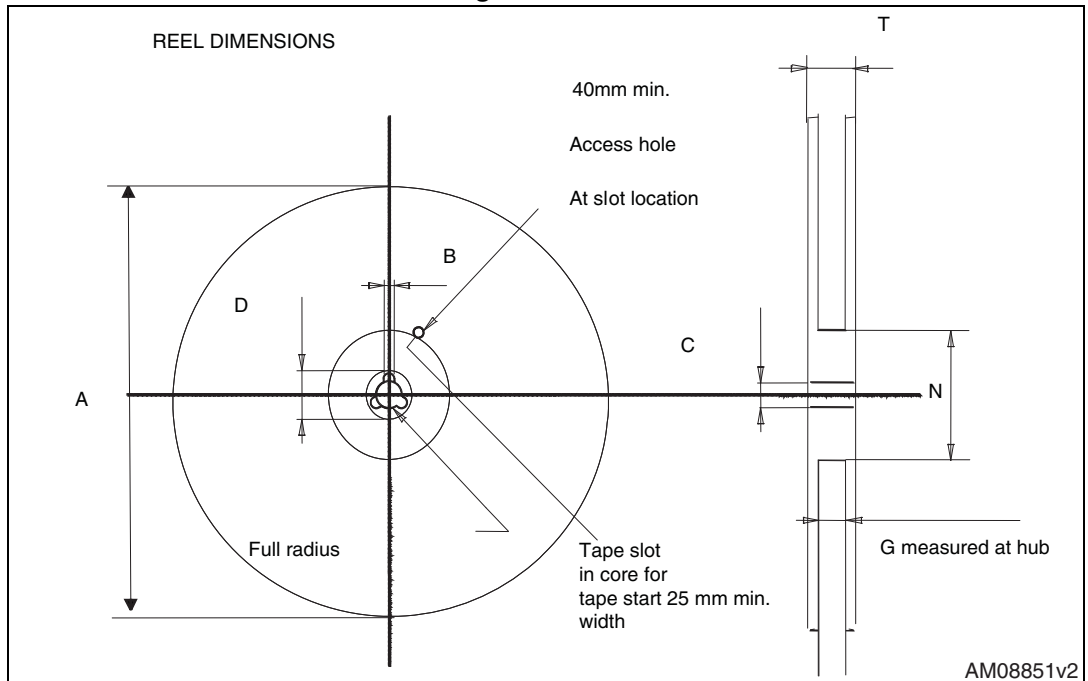


Figure 30. Reel



## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
04-Nov-2010	1	Initial release.
18-Apr-2011	2	Corrected E <sub>AS</sub> value in <a href="#">Table 4: Avalanche characteristics</a>
14-Sep-2011	3	Added order code in D <sup>2</sup> PAK and TO-220FP Updated <a href="#">Table 1: Device summary</a> , <a href="#">Table 2: Absolute maximum ratings</a> and <a href="#">Table 3: Thermal data</a> . Updated <a href="#">Section 4: Package mechanical data</a> . Added <a href="#">Section 5: Packaging mechanical data</a> . Minor text changes.
29-Dec-2011	4	Updated description in cover page.
01-Oct-2012	5	Updated title on the cover page. Updated figures <a href="#">10</a> , <a href="#">11</a> , <a href="#">16</a> and <a href="#">17</a> . Updated <a href="#">Section 4: Package mechanical data</a> . Minor text changes.
02-Oct-2013	6	– Modified: E <sub>AS</sub> in <a href="#">Table 4</a> , C <sub>oss eq.</sub> typical value in <a href="#">Table 6</a> , <a href="#">Figure 13</a> – Modified: <a href="#">Figure 18</a> , <a href="#">19</a> , <a href="#">20</a> and <a href="#">21</a> – Minor text changes

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