

# STB24N60M2, STI24N60M2, STP24N60M2, STW24N60M2

N-channel 600 V, 0.168  $\Omega$  typ., 18 A MDmesh II Plus™ low  $Q_g$   
Power MOSFET in D<sup>2</sup>PAK, I<sup>2</sup>PAK, TO-220 and TO-247 packages

Datasheet – production data

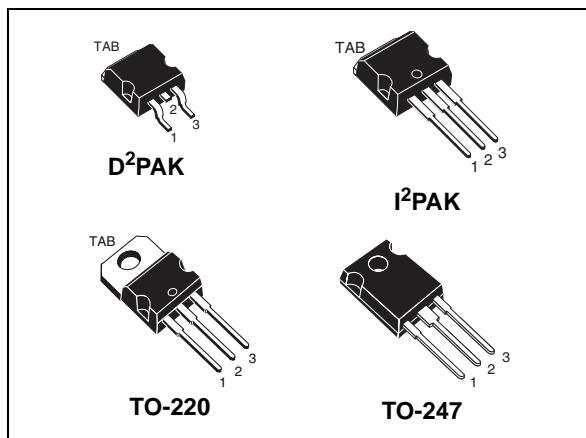
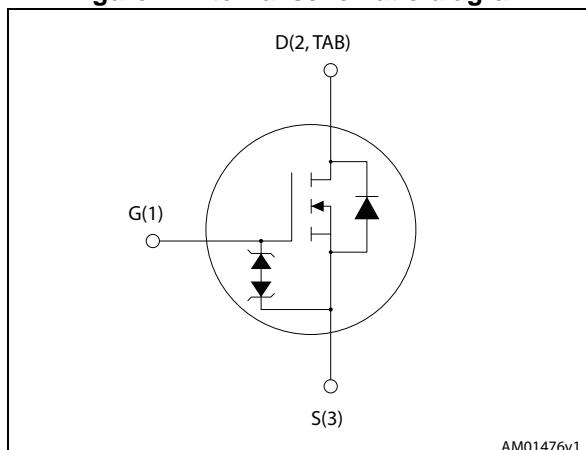


Figure 1. Internal schematic diagram



## Features

Order codes	$V_{DS}$ @ $T_{Jmax}$	$R_{DS(on)}$ max	$I_D$
STB24N60M2			
STI24N60M2	650 V	0.19 $\Omega$	18 A
STP24N60M2			
STW24N60M2			

- Extremely low gate charge
- Lower  $R_{DS(on)} \times$  area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using a new generation of MDmesh™ technology: MDmesh II Plus™ low  $Q_g$ . These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB24N60M2		D <sup>2</sup> PAK	Tape and reel
STI24N60M2		I <sup>2</sup> PAK	
STP24N60M2		TO-220	
STW24N60M2		TO-247	Tube

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25^\circ\text{C}$	18	A
$I_D$	Drain current (continuous) at $T_C = 100^\circ\text{C}$	12	A
$I_{DM}^{(1)}$	Drain current (pulsed)	72	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	150	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(3)}$	MOSFET dv/dt ruggedness	50	V/ns
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature		

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 18$  A,  $dI/dt \leq 400$  A/ $\mu\text{s}$ ;  $V_{DS}$  peak <  $V_{(BR)DSS}$ ,  $V_{DD}=400$  V.
3.  $V_{DS} \leq 480$  V

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		D <sup>2</sup> PAK	I <sup>2</sup> PAK	TO-220	TO-247	
$R_{thj-case}$	Thermal resistance junction-case max	0.83				$^\circ\text{C/W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max <sup>(1)</sup>	30				$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max			62.5	50	$^\circ\text{C/W}$

1. When mounted on 1 inch<sup>2</sup> FR-4, 2 Oz copper board

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	3.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$ , $I_D = I_{AR}$ ; $V_{DD}=50$ )	180	mJ

## 2 Electrical characteristics

( $T_C = 25^\circ\text{C}$  unless otherwise specified)

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{DSS}}$	Drain-source breakdown voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	600			V
$I_{\text{DSS}}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600 \text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 600 \text{ V}, T_C = 125^\circ\text{C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25 \text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(\text{th})}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$	2	3	4	V
$R_{DS(\text{on})}$	Static drain-source on-resistance	$V_{GS} = 10 \text{ V}, I_D = 9 \text{ A}$		0.168	0.19	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0$	-	1060	-	pF
$C_{oss}$	Output capacitance		-	55	-	pF
$C_{rss}$	Reverse transfer capacitance		-	2.2	-	pF
$C_{oss \text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0 \text{ to } 480 \text{ V}, V_{GS} = 0$	-	258	-	pF
$R_G$	Intrinsic gate resistance	$f = 1 \text{ MHz}, I_D = 0$	-	7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480 \text{ V}, I_D = 18 \text{ A}, V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 17</a> )	-	29	-	nC
$Q_{gs}$	Gate-source charge		-	6	-	nC
$Q_{gd}$	Gate-drain charge		-	12	-	nC

- $C_{oss \text{ eq.}}$  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. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300 \text{ V}, I_D = 9 \text{ A}, R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 16</a> and <a href="#">21</a> )	-	14	-	ns
$t_r$	Rise time		-	9	-	ns
$t_{d(off)}$	Turn-off delay time		-	60	-	ns
$t_f$	Fall time		-	15	-	ns

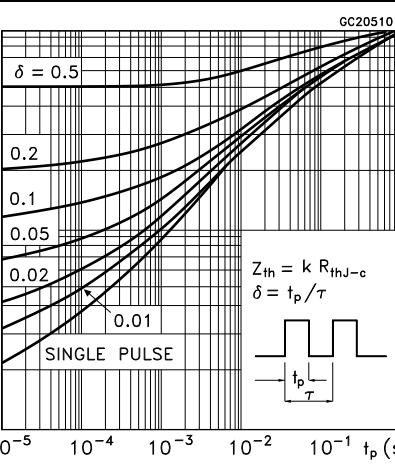
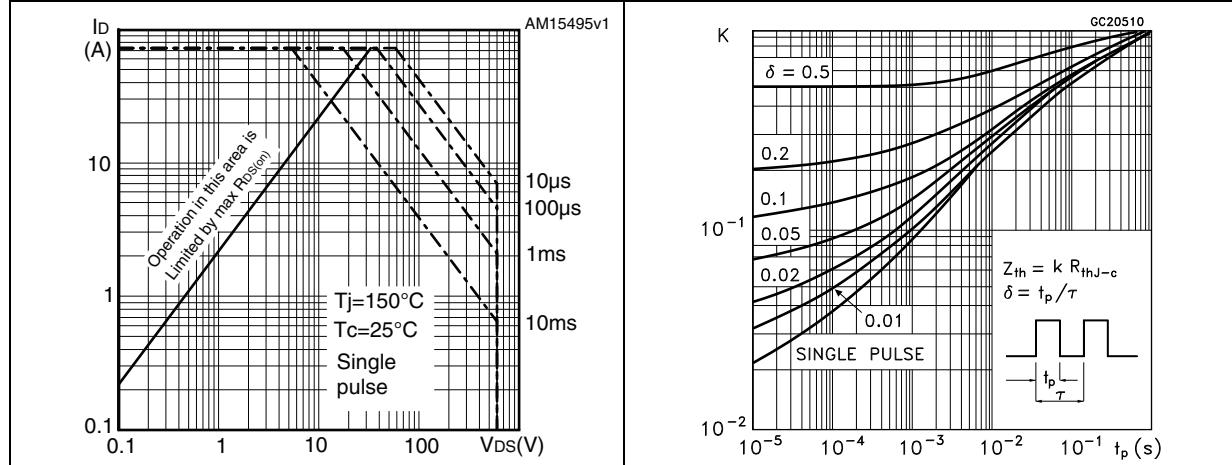
**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		18	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		72	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 18 \text{ A}, V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 18 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <i>Figure 18</i> )	-	332		ns
$Q_{rr}$	Reverse recovery charge		-	4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	24		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 18 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ (see <i>Figure 18</i> )	-	450		ns
$Q_{rr}$	Reverse recovery charge		-	5.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	25		A

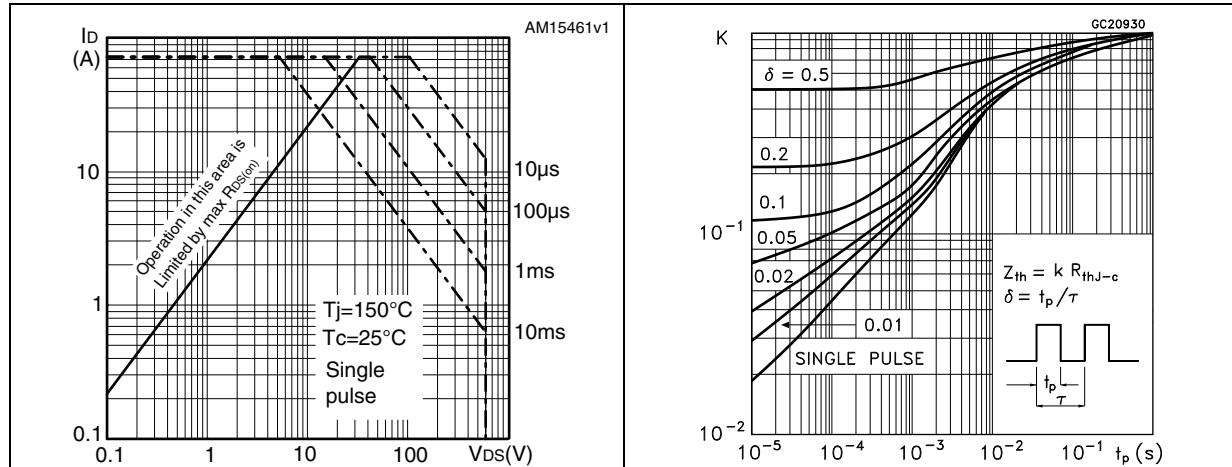
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

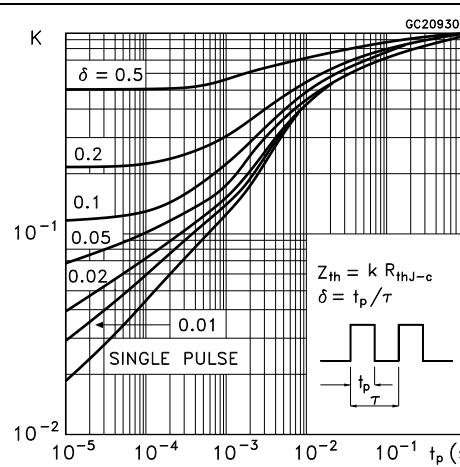
**Figure 2. Safe operating area for D<sup>2</sup>PAK, I<sup>2</sup>PAK and TO-220**



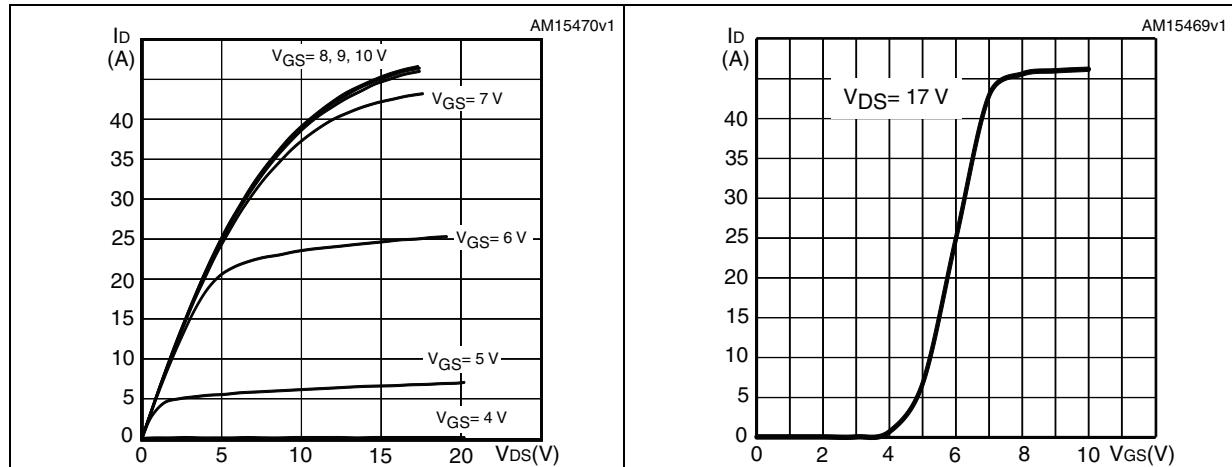
**Figure 4. Safe operating area for TO-247**



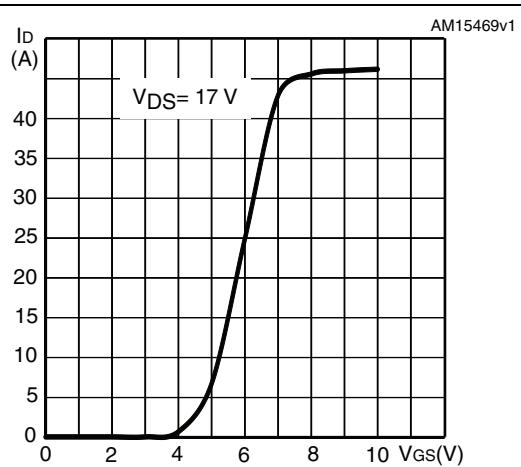
**Figure 5. Thermal impedance for TO-247**

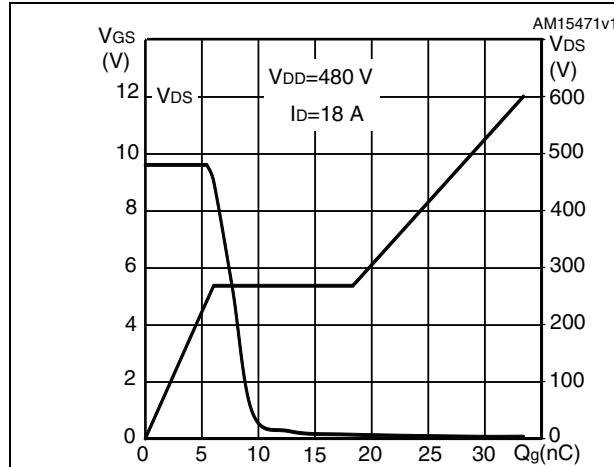
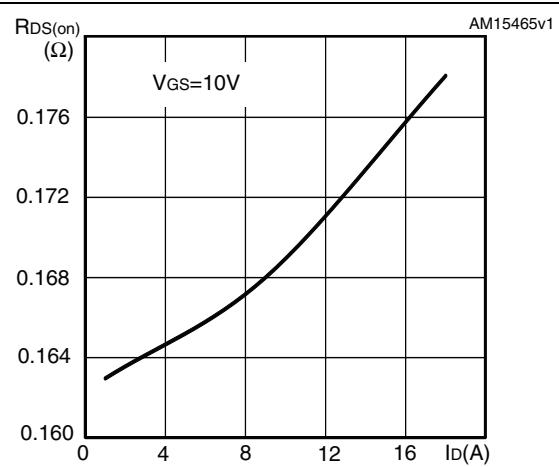
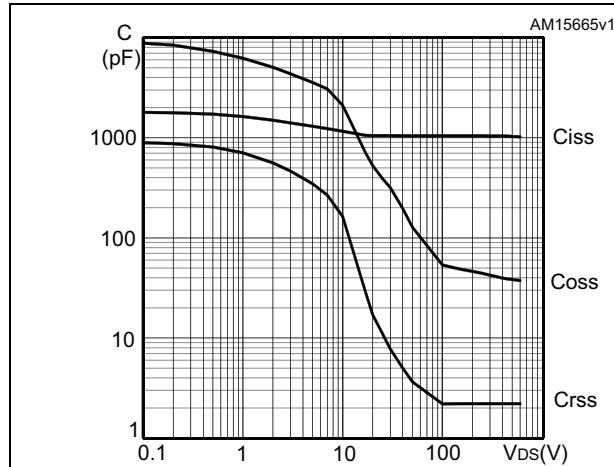
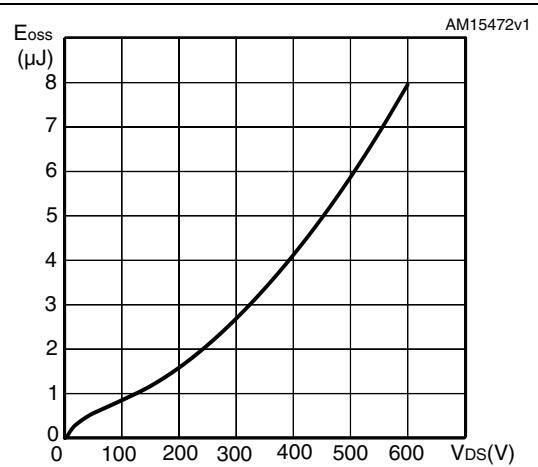
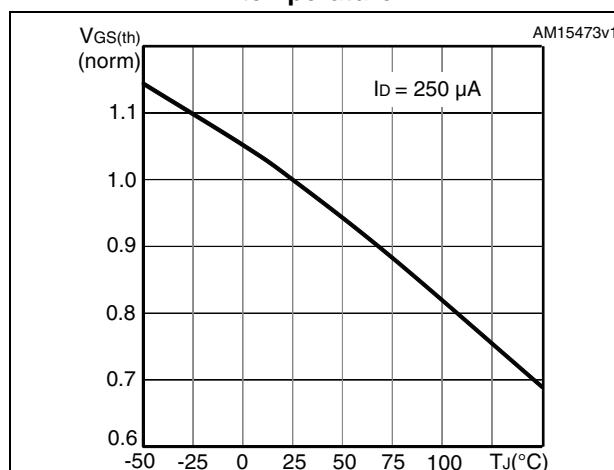
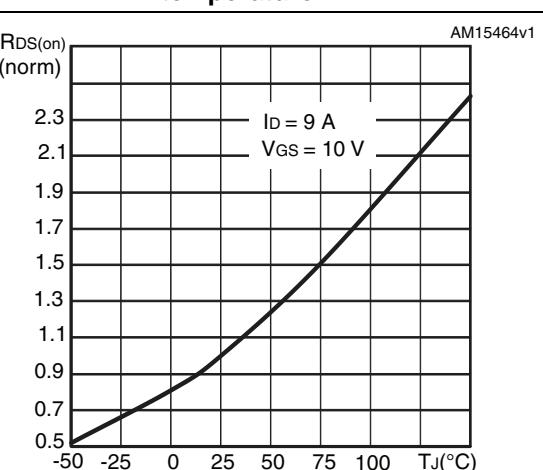


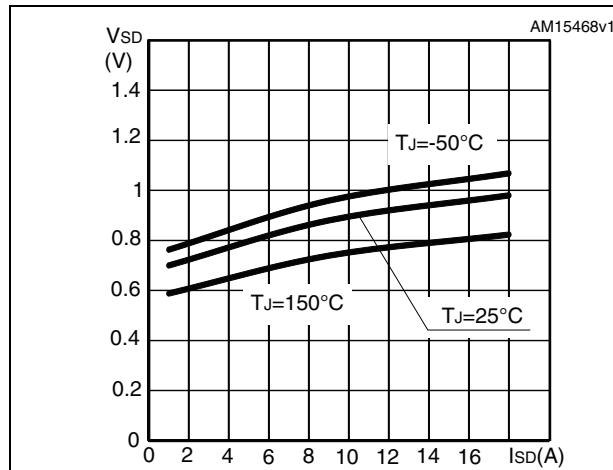
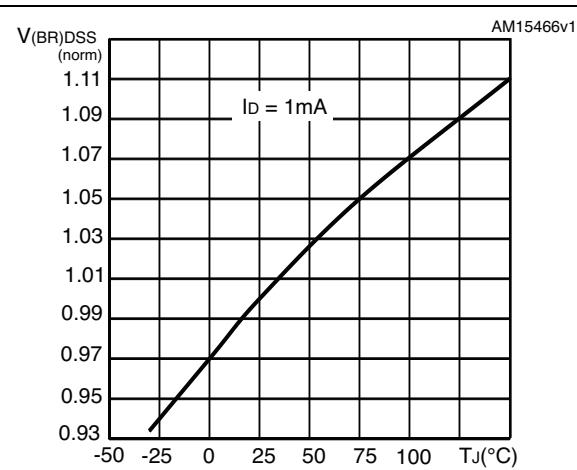
**Figure 6. Output characteristics**



**Figure 7. Transfer characteristics**



**Figure 8. Gate charge vs gate-source voltage****Figure 9. Static drain-source on-resistance****Figure 10. Capacitance variations****Figure 11. Output capacitance stored energy****Figure 12. Normalized gate threshold voltage vs temperature****Figure 13. Normalized on-resistance vs temperature**

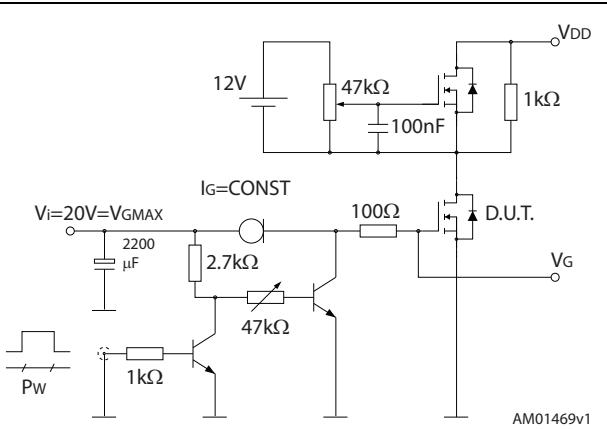
**Figure 14. Source-drain diode forward characteristics****Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature**

### 3 Test circuits

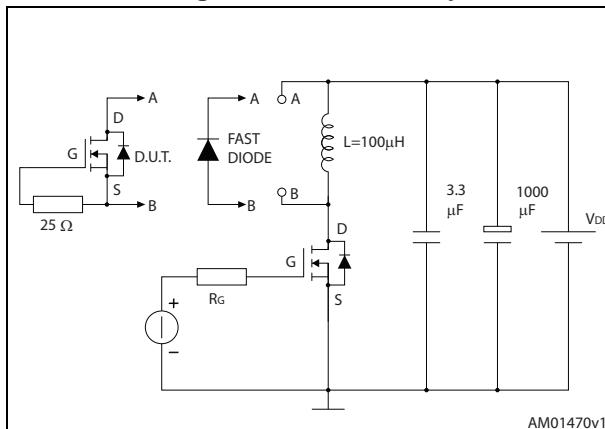
**Figure 16. Switching times test circuit for resistive load**



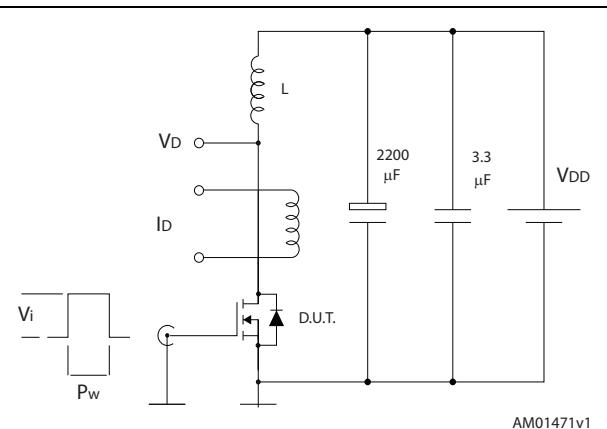
**Figure 17. Gate charge test circuit**



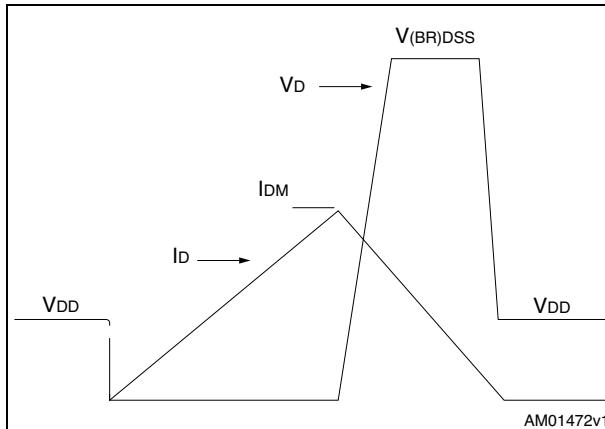
**Figure 18. Test circuit for inductive load switching and diode recovery times**



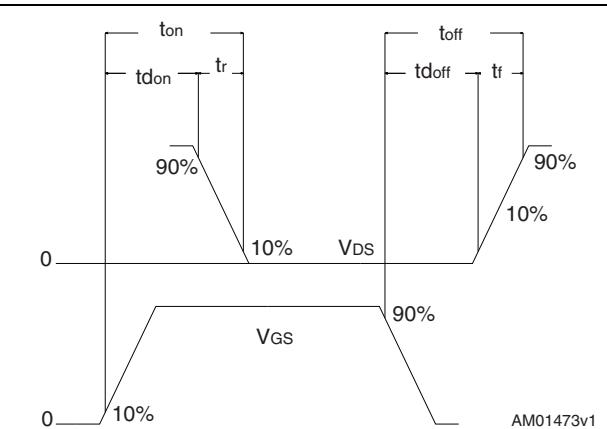
**Figure 19. Unclamped inductive load test circuit**



**Figure 20. Unclamped inductive waveform**



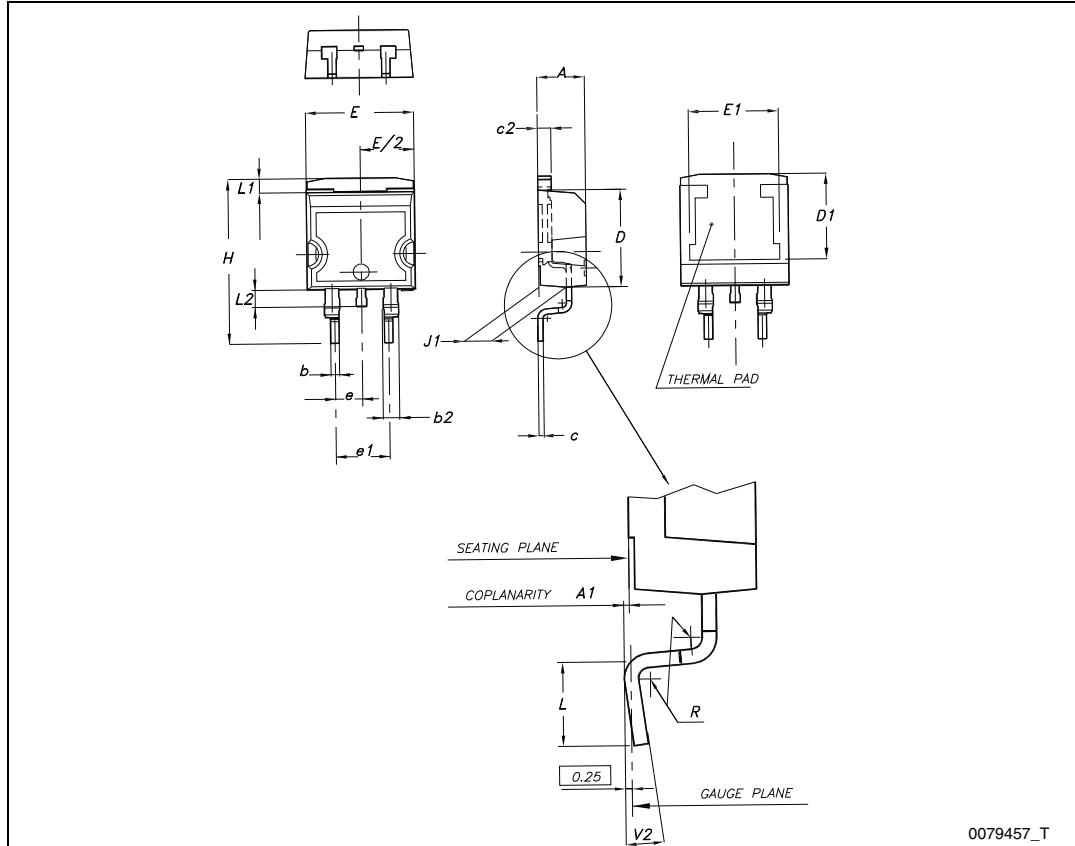
**Figure 21. Switching time waveform**



## 4 Package mechanical data

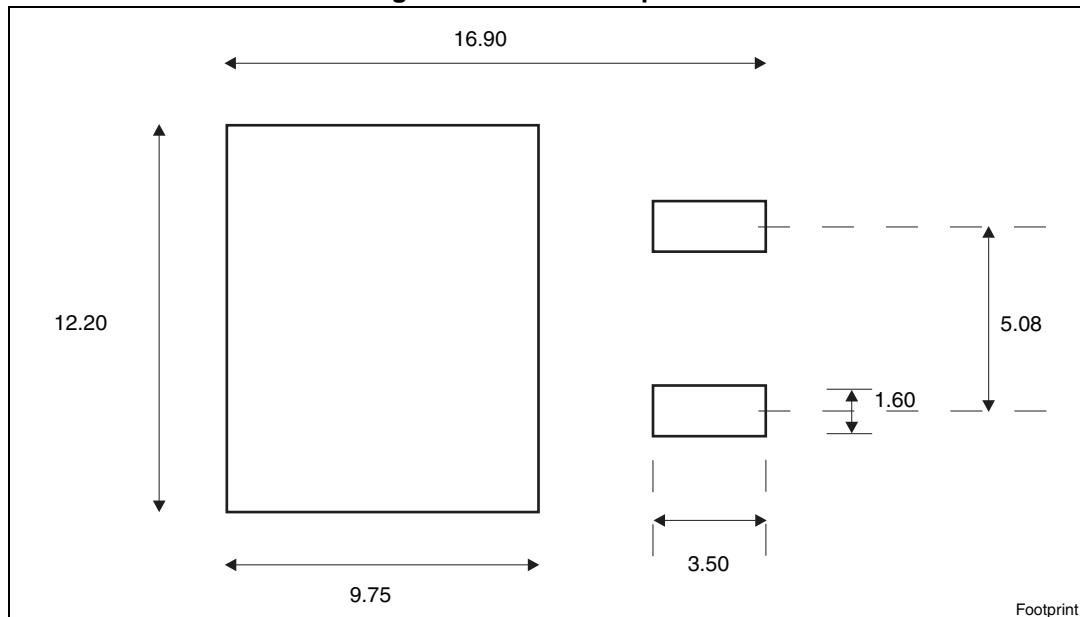
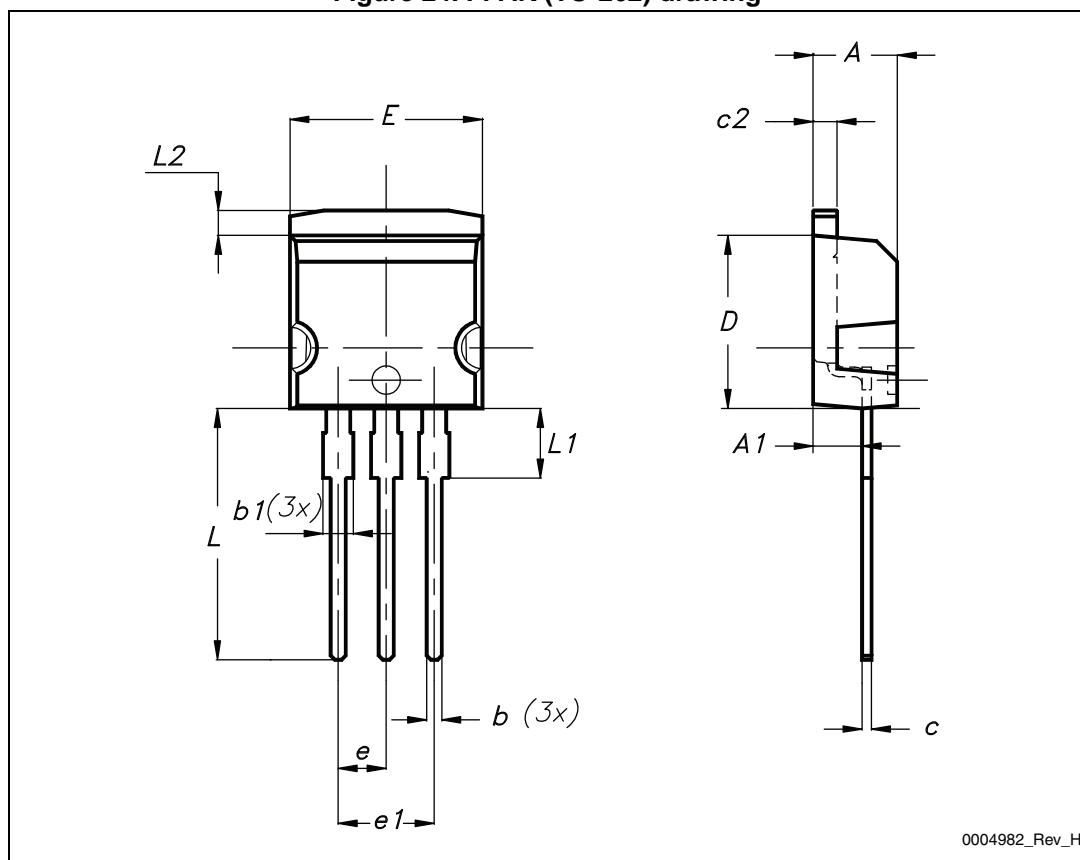
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Figure 22. D<sup>2</sup>PAK (TO-263) drawing



**Table 9. 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 23. D<sup>2</sup>PAK footprint<sup>(a)</sup>****Figure 24. I<sup>2</sup>PAK (TO-262) drawing**

a. All dimension are in millimeters

**Table 10. I<sup>2</sup>PAK (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. TO-220 type A drawing

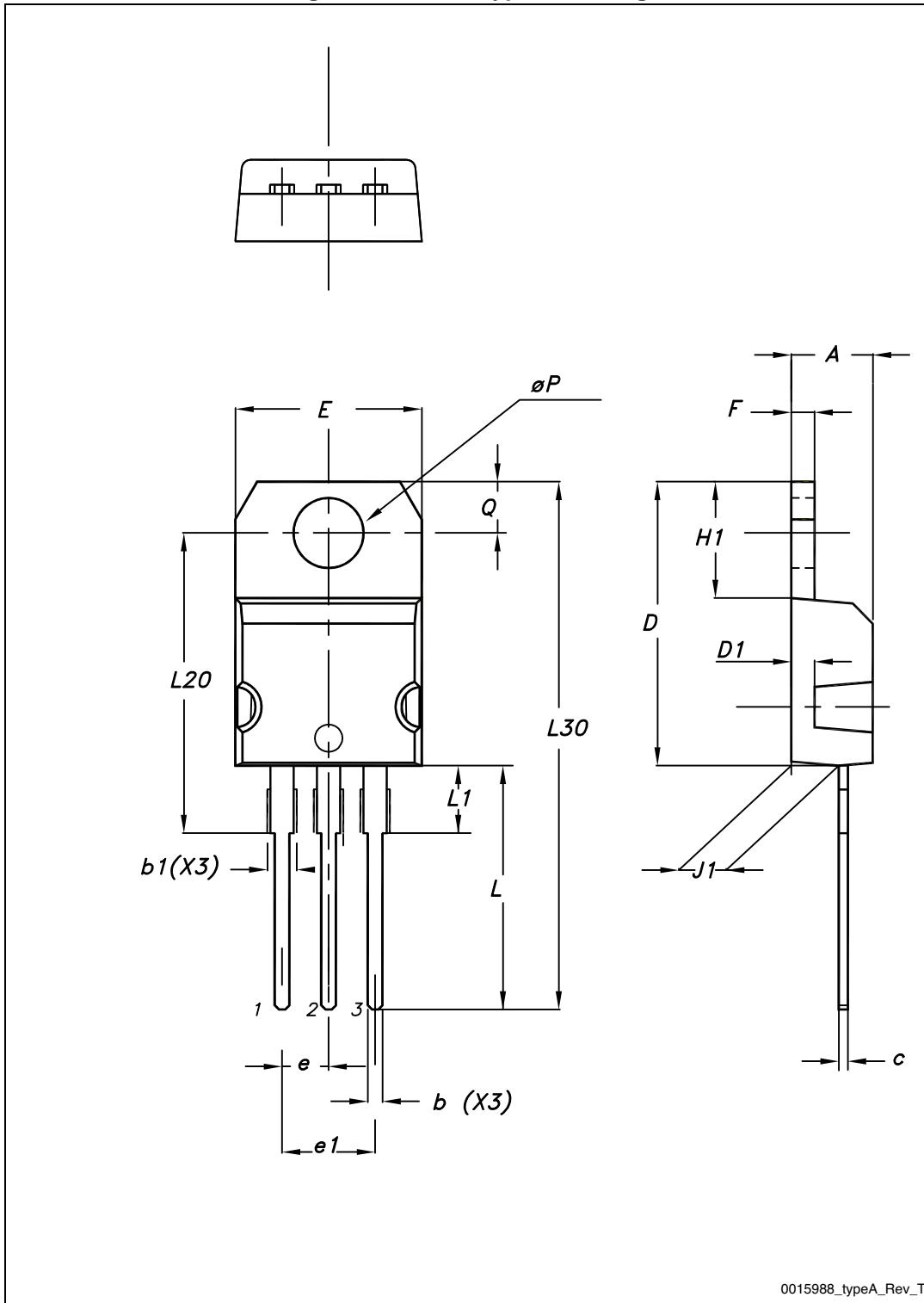
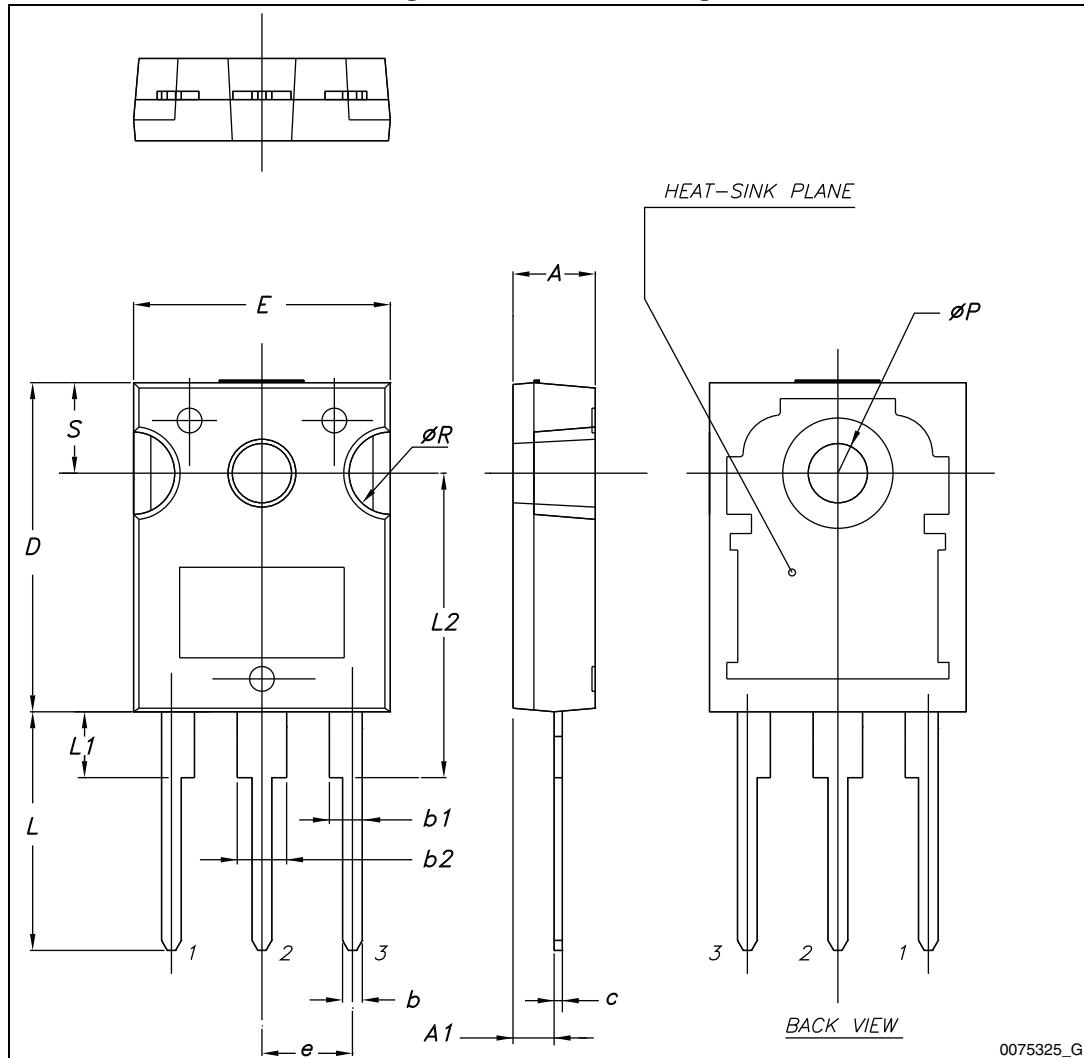


Table 11. TO-220 type A mechanical data

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	
ØP	3.75		3.85
Q	2.65		2.95

Figure 26. TO-247 drawing



**Table 12. 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

## 5 Packaging mechanical data

Figure 27. Tape

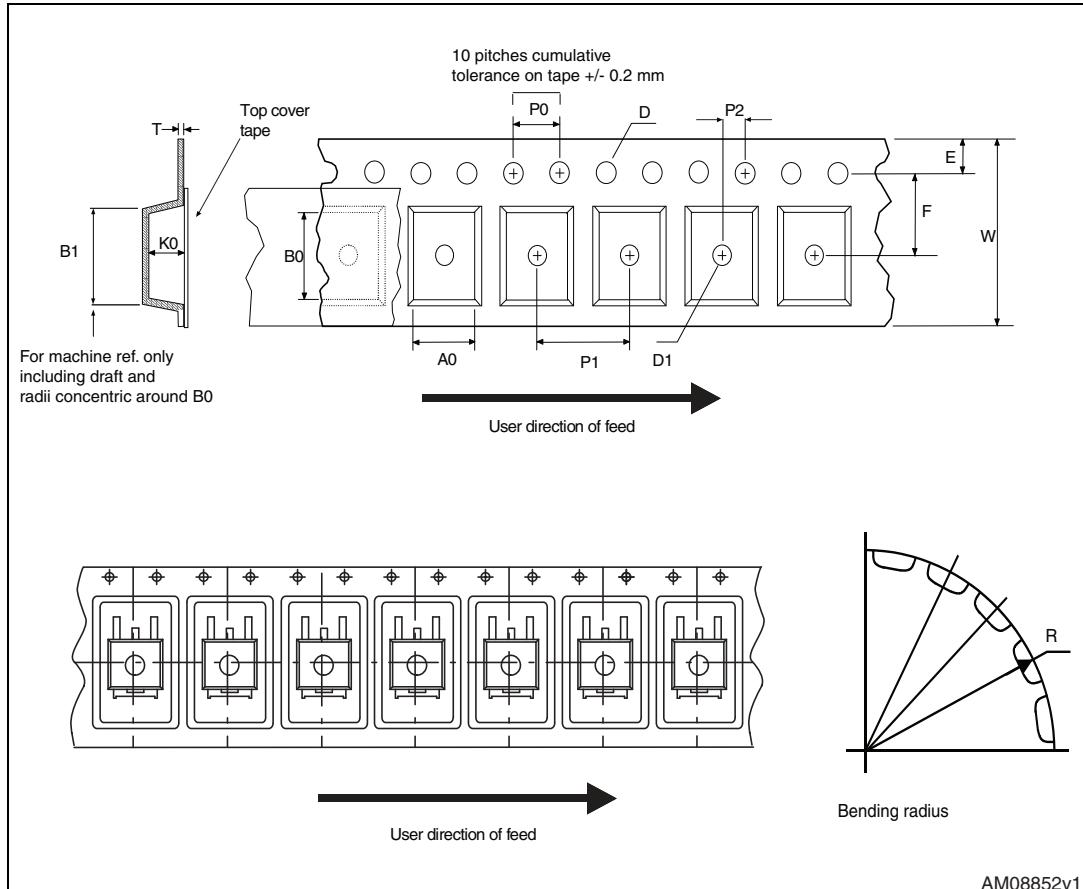
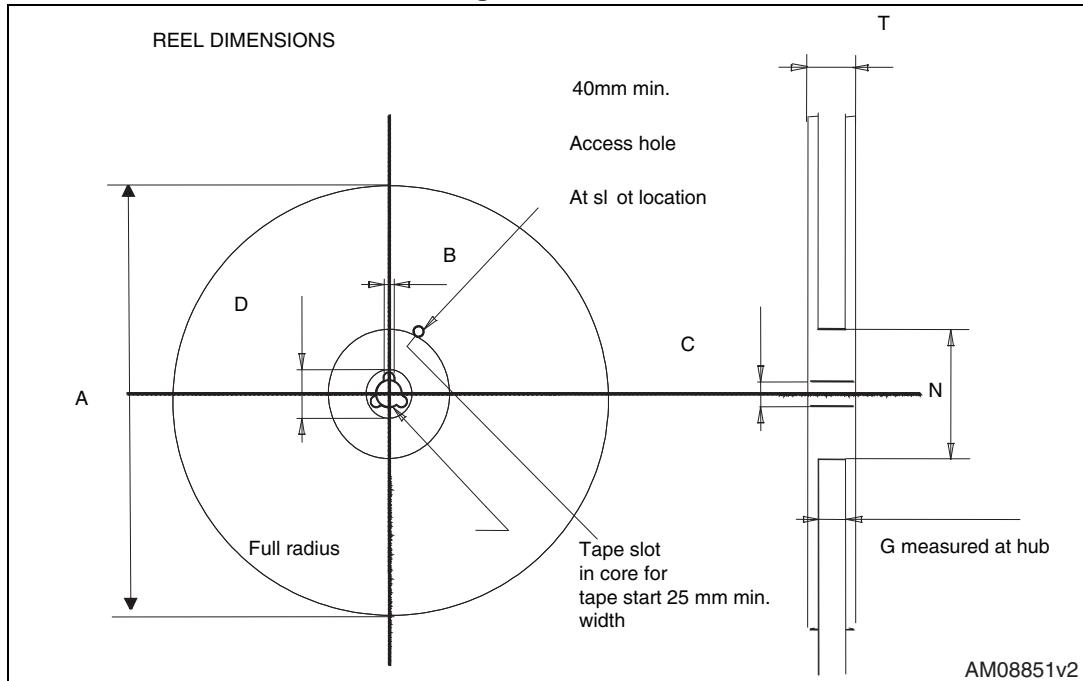


Figure 28. Reel

Table 13. 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			

## 6 Revision history

Table 14. Document revision history

Date	Revision	Changes
10-Dec-2012	1	First release.
20-Dec-2012	2	Added MOSFET dv/dt ruggedness in <a href="#">Table 2: Absolute maximum ratings</a> .
14-Jan-2013	3	Modified: <a href="#">Figure 16</a> , <a href="#">17</a> , <a href="#">18</a> and <a href="#">17</a>
28-May-2013	4	<ul style="list-style-type: none"><li>– Minor text changes</li><li>– Updated: <a href="#">Table 7</a></li><li>– Updated: <a href="#">Table 11</a> and <a href="#">Figure 25</a></li></ul>
28-Feb-2014	5	<ul style="list-style-type: none"><li>– Minor text changes</li><li>– Modified: title of <a href="#">Figure 15</a>.</li><li>– Modified: <a href="#">Figure 16</a>, <a href="#">17</a>, <a href="#">18</a> and <a href="#">19</a></li></ul>

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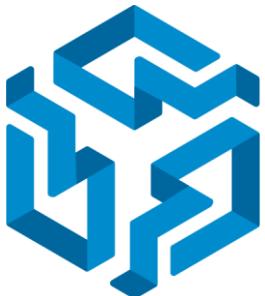
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Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

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