

## Automotive-grade N-channel 600 V, 0.13 $\Omega$ , 21 A FDmesh™ II Power MOSFETs (with fast diode) in D<sup>2</sup>PAK and TO-247 packages

Datasheet - production data

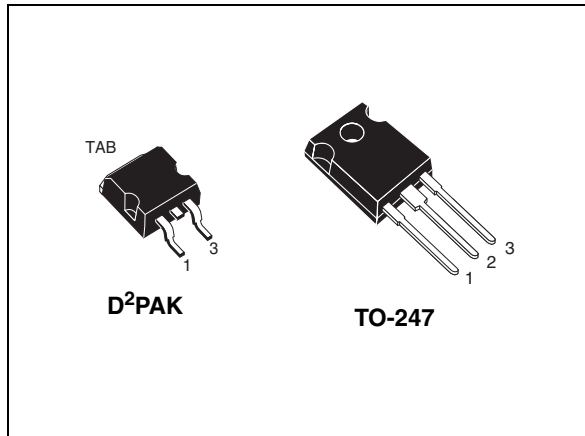
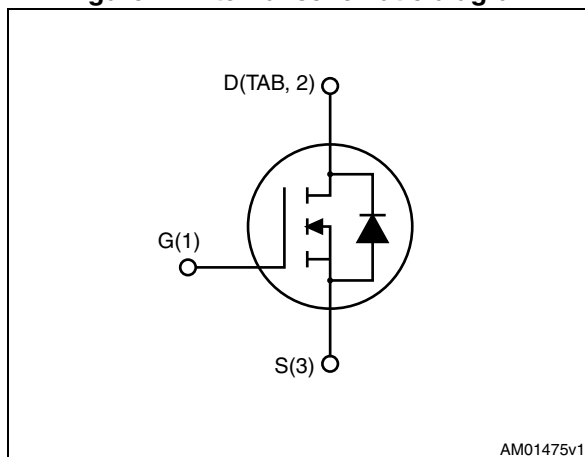


Figure 1. Internal schematic diagram



### Features

Order codes	$V_{DS}@T_{jmax}$	$R_{DS(on)max}$	$I_D$
STB27NM60ND	650 V	0.16 $\Omega$	21 A
STW27NM60ND			

- Designed for automotive applications and AEC-Q101 qualified
- 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
- Extremely 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.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STB27NM60ND	27NM60ND	D <sup>2</sup> PAK	Tape and reel
STW27NM60ND	27NM60ND	TO-247	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	21	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	13	A
$I_{DM}^{(1)}$	Drain current (pulsed)	84	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	160	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	V/ns
$T_{stg}$	Storage temperature	-55 to 150	$^\circ\text{C}$
$T_J$	Max. operating junction temperature	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 21\text{ A}$ ,  $di/dt \leq 600\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	D <sup>2</sup> PAK	TO-247	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.78		$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max		50	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-ambient max	30		$^\circ\text{C}/\text{W}$

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

**Table 4. Avalanche characteristics**

Symbol	Parameter	Max value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max)	10	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )	850	mJ

## 2 Electrical characteristics

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

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}, V_{GS} = 0$	600			V
$dv/dt^{(1)}$	Drain source voltage slope	$V_{DD} = 480\text{ V}, I_D = 21\text{ A}, V_{GS} = 10\text{ V}$	48			V/ns
$I_{DSS}$	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 ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 100$	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	$V_{GS} = 10\text{ V}, I_D = 10.5\text{ A}$		0.13	0.16	$\Omega$

1. Characteristic value at turn off on inductive load.

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}, I_D = 10.5\text{ A}$	-	17	-	S
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	2400	-	pF
$C_{oss}$	Output capacitance		-	150	-	pF
$C_{rss}$	Reverse transfer capacitance		-	15	-	pF
$C_{oss}^{eq. (2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$	-	320	-	pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}, I_D = 10.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 21), (see Figure 16)	-	60	-	ns
$t_r$	Rise time		-	30	-	ns
$t_{d(off)}$	Turn-off delay time		-	50	-	ns
$t_f$	Fall time		-	40	-	ns

Table 6. Dynamic (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 21\text{ A}$ , $V_{GS} = 10\text{ V}$ , (see Figure 17)	-	80	-	nC
$Q_{gs}$	Gate-source charge		-	15	-	nC
$Q_{gd}$	Gate-drain charge		-	40	-	nC
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ , gate DC Bias = 0, test signal level = 20 mV, $I_D = 0$	-	1.6	-	$\Omega$

1. Pulsed: pulse duration=300 $\mu$ s, duty cycle 1.5%
2.  $C_{oss\text{ eq}}$  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		-		21	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		84	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 21\text{ A}, V_{GS} = 0$	-		1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 21\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ <i>(see Figure 18)</i>	-	160		ns
$Q_{rr}$	Reverse recovery charge		-	1		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	15		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 21\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s},$ $T_J = 150\text{ }^\circ\text{C}$ <i>(see Figure 18)</i>	-	230		ns
$Q_{rr}$	Reverse recovery charge		-	2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	19		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

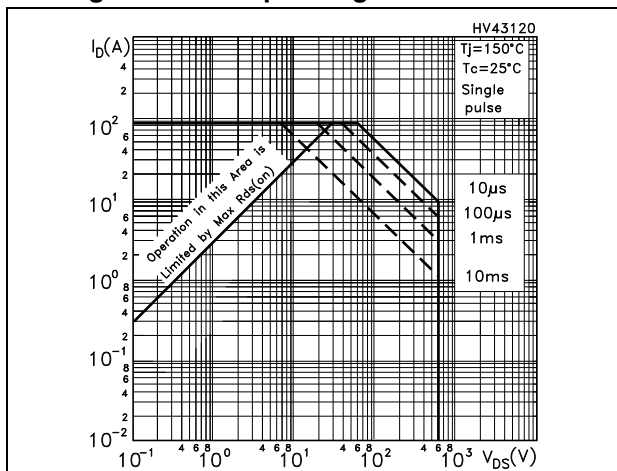


Figure 3. Thermal impedance for D<sup>2</sup>PAK

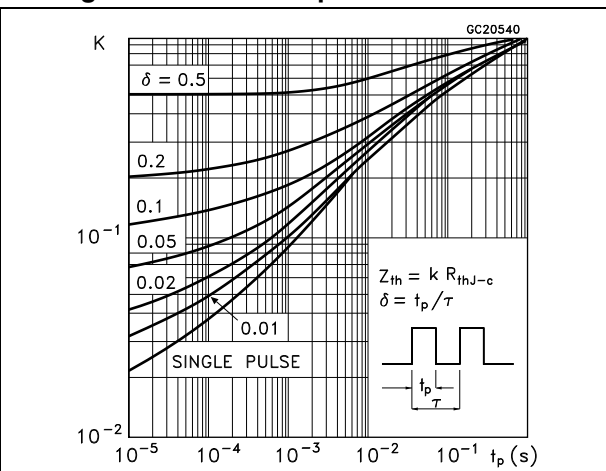


Figure 4. Safe operating area for TO-247

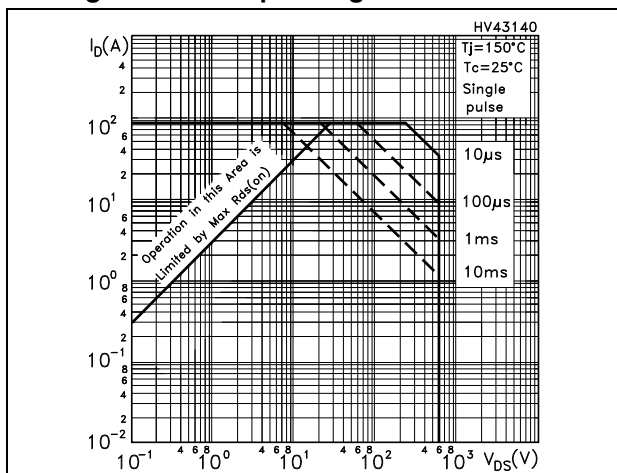


Figure 5. Thermal impedance for TO-247

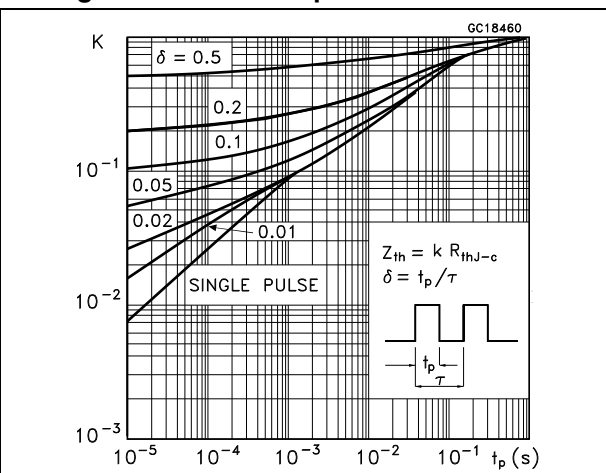


Figure 6. Output characteristics

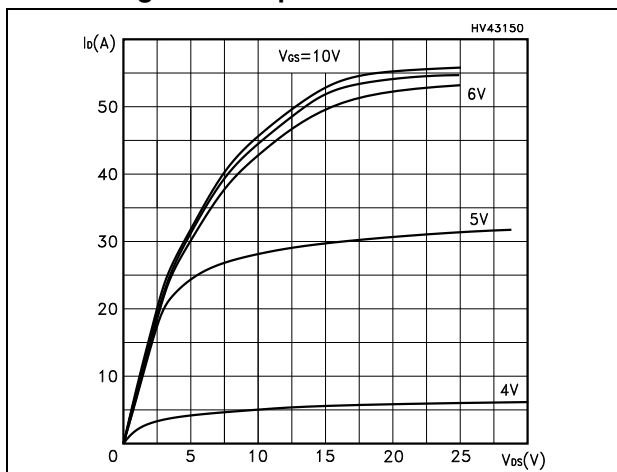


Figure 7. Transfer characteristics

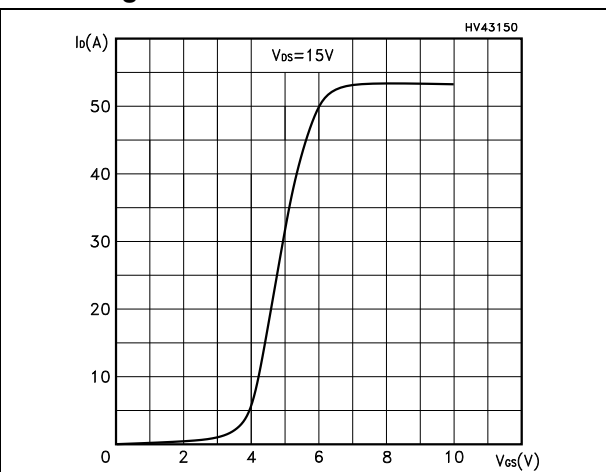


Figure 8. Transconductance

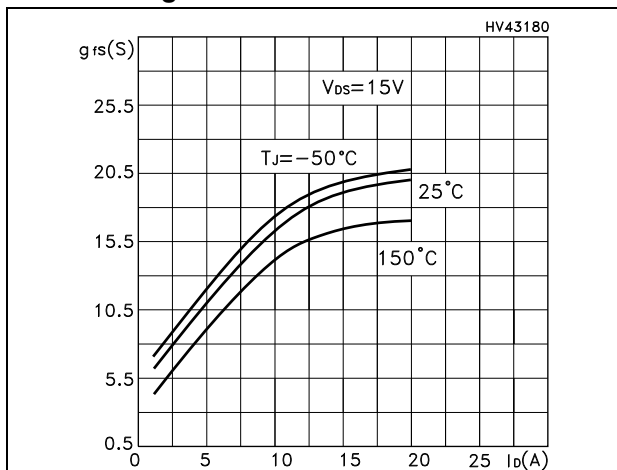


Figure 9. Static drain-source on-resistance

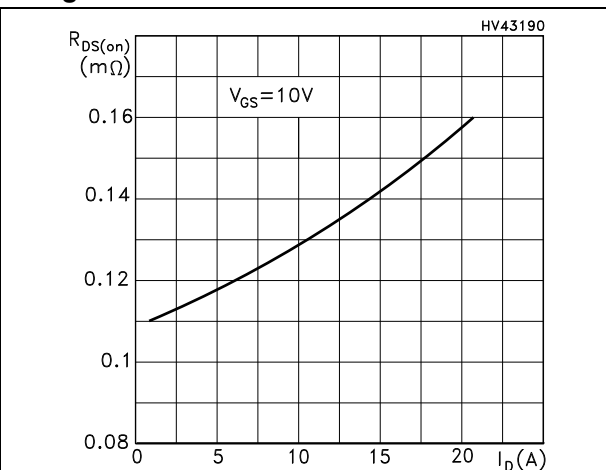


Figure 10. Gate charge vs gate-source voltage

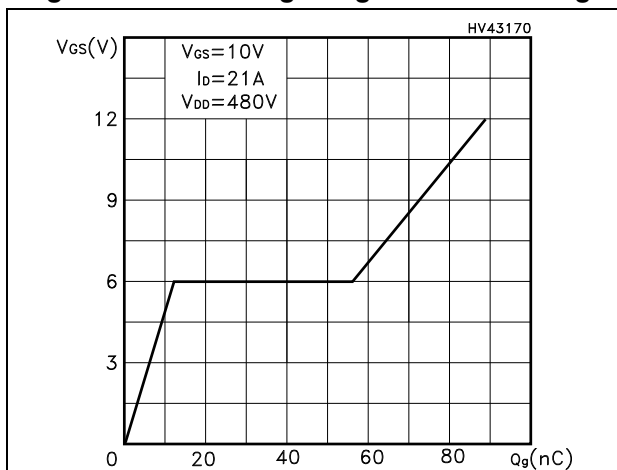


Figure 11. Capacitance variations

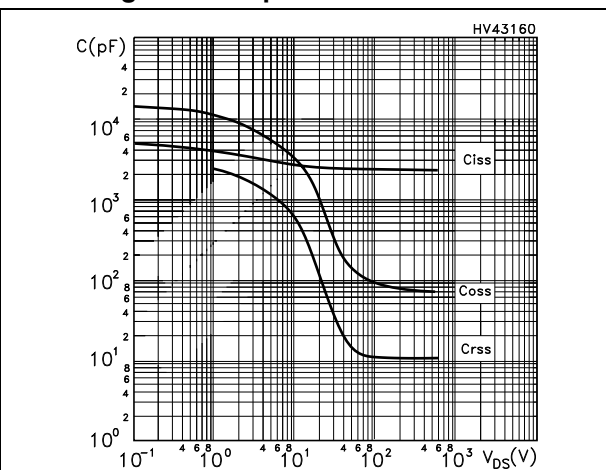


Figure 12. Normalized gate threshold voltage vs temperature

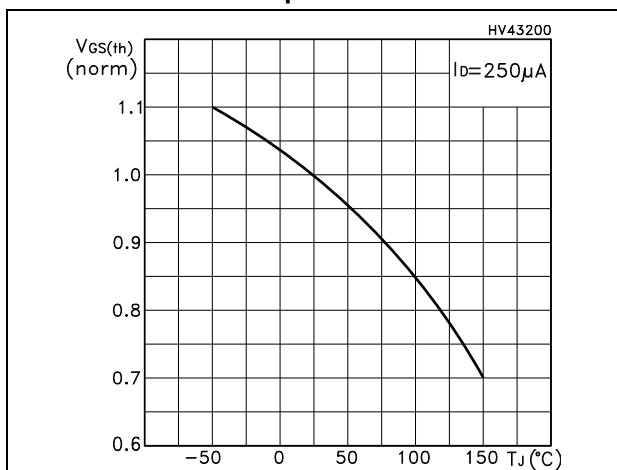


Figure 13. Normalized on-resistance vs temperature

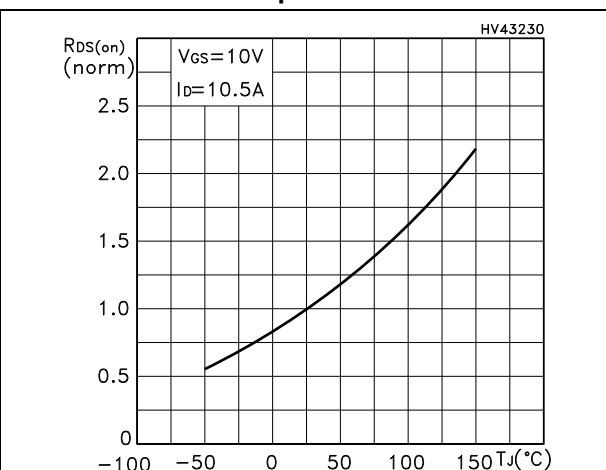




Figure 14. Source-drain diode forward characteristics

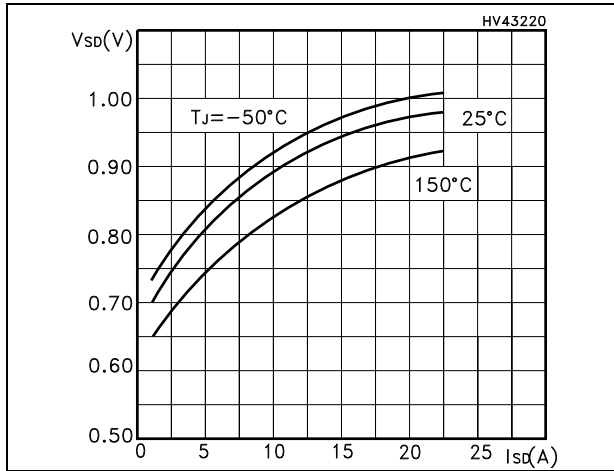
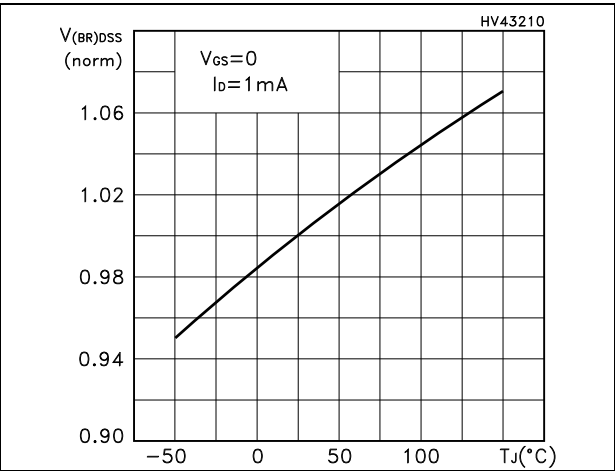


Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature



### 3 Test circuits

Figure 16. Switching times test circuit for resistive load

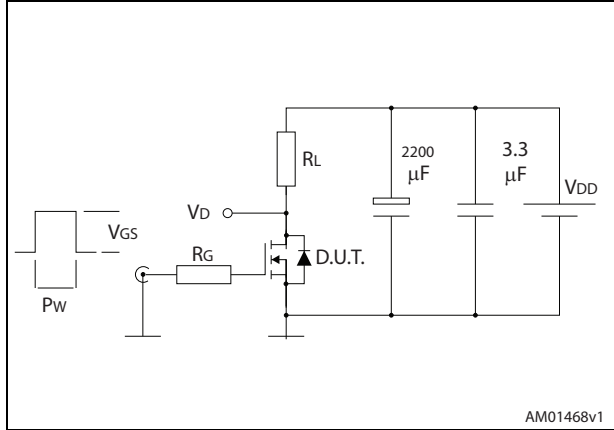


Figure 17. Gate charge test circuit

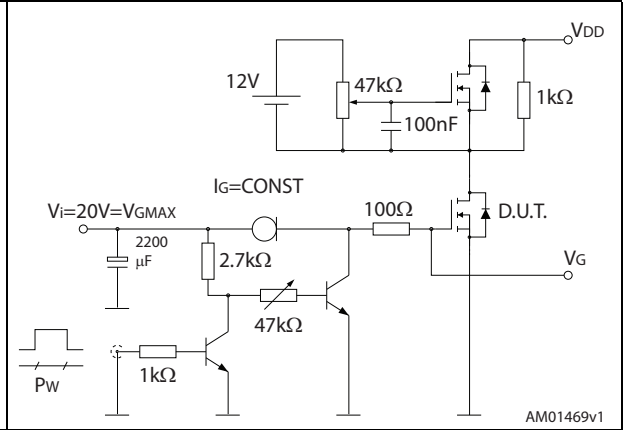


Figure 18. Test circuit for inductive load switching and diode recovery times

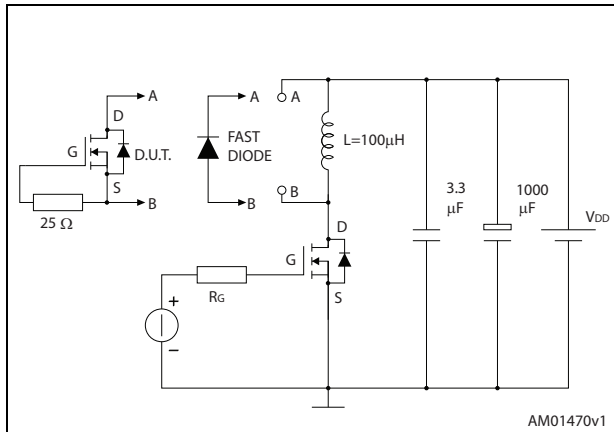


Figure 19. Unclamped inductive load test circuit

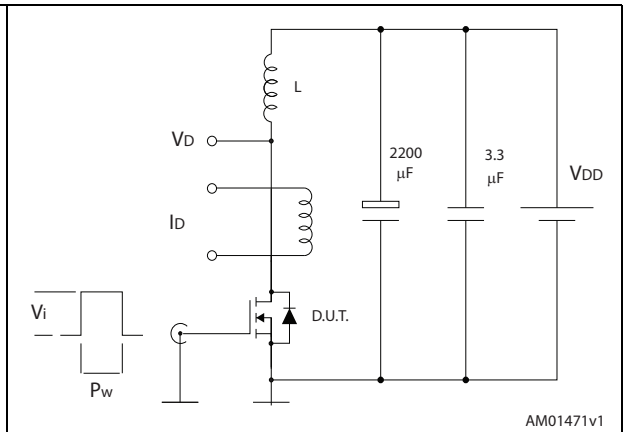


Figure 20. Unclamped inductive waveform

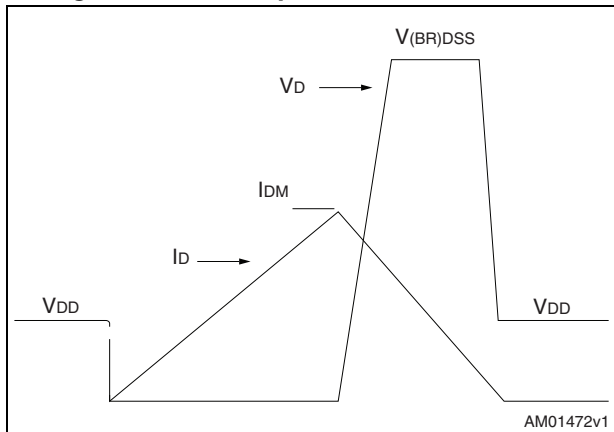
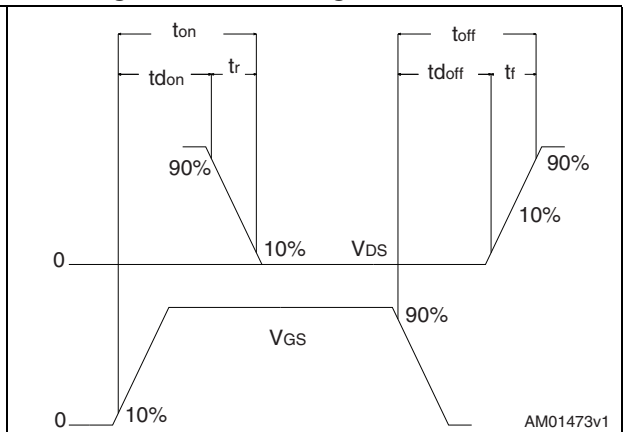


Figure 21. Switching time waveform



## 4 Package mechanical data

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

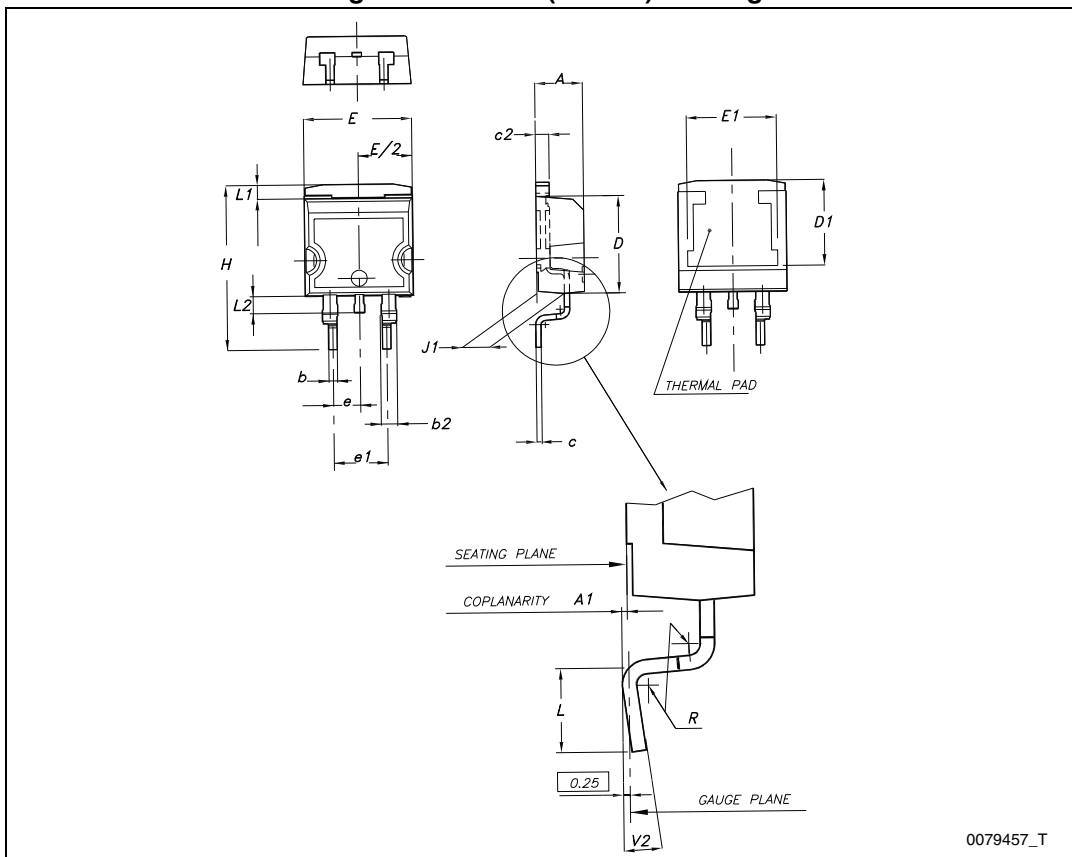
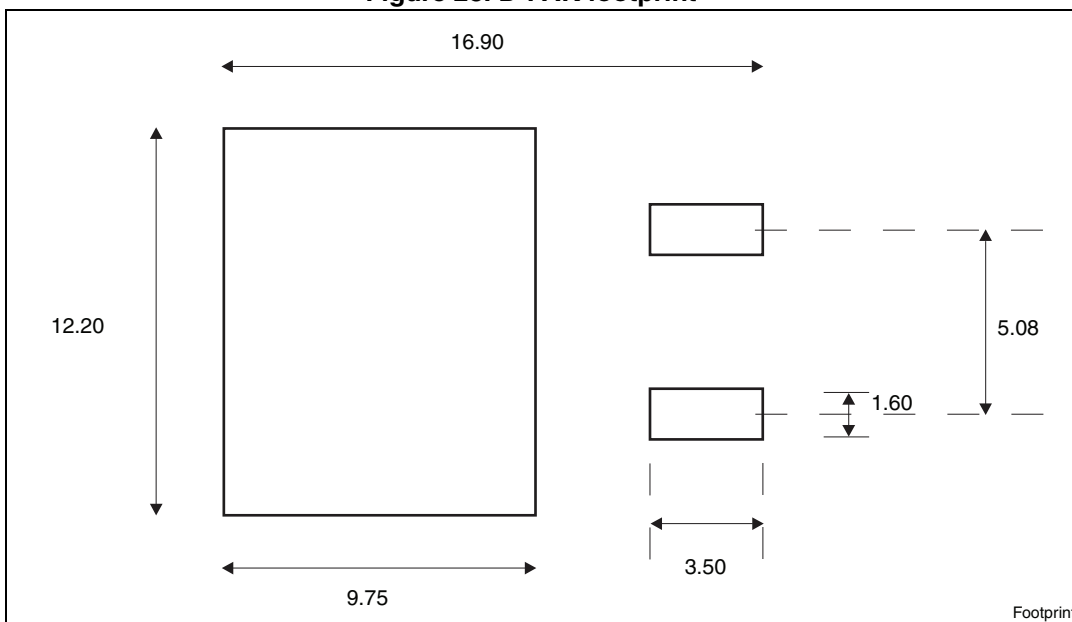


Figure 23. D<sup>2</sup>PAK footprint<sup>(a)</sup>

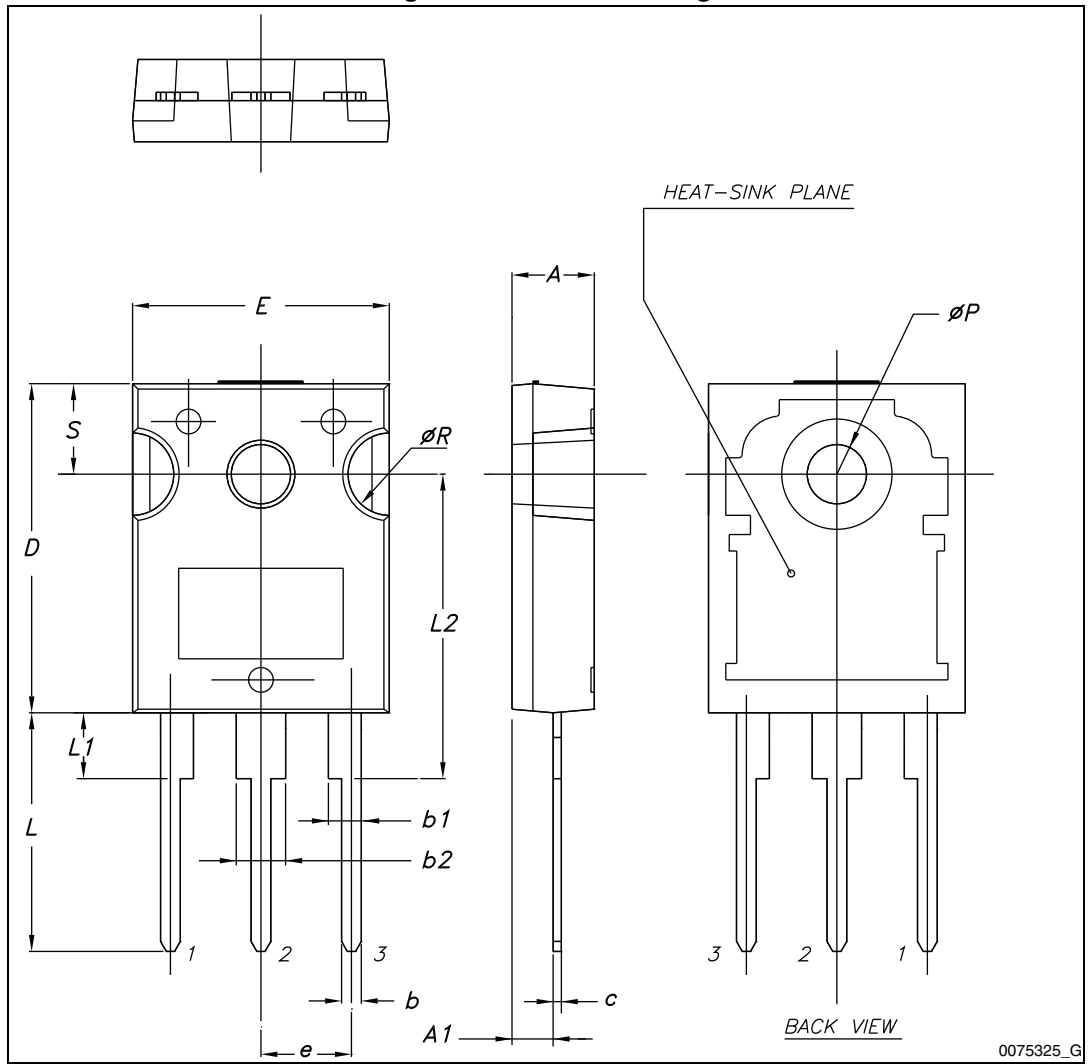


a. All dimension are in millimeters

Table 9. 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 24. TO-247 drawing



0075325\_G

## 5 Packing mechanical data

Table 10. 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 25. Tape

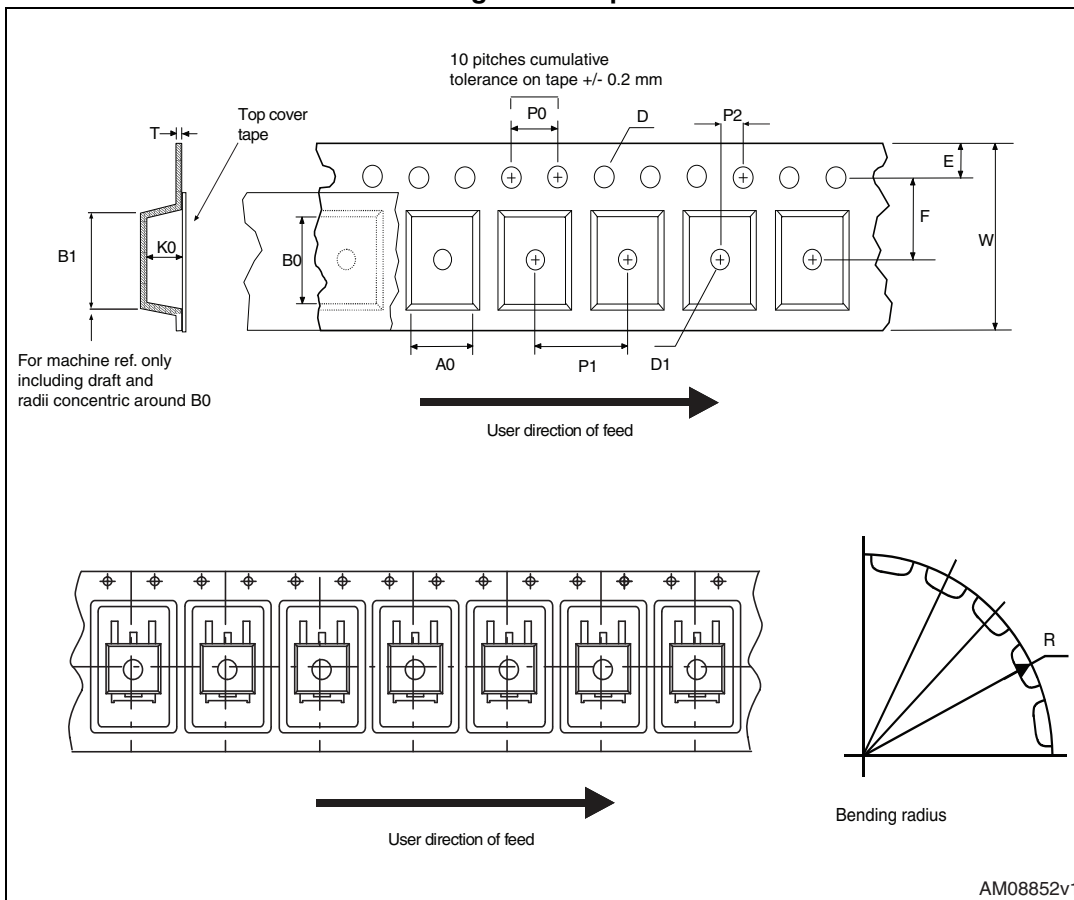
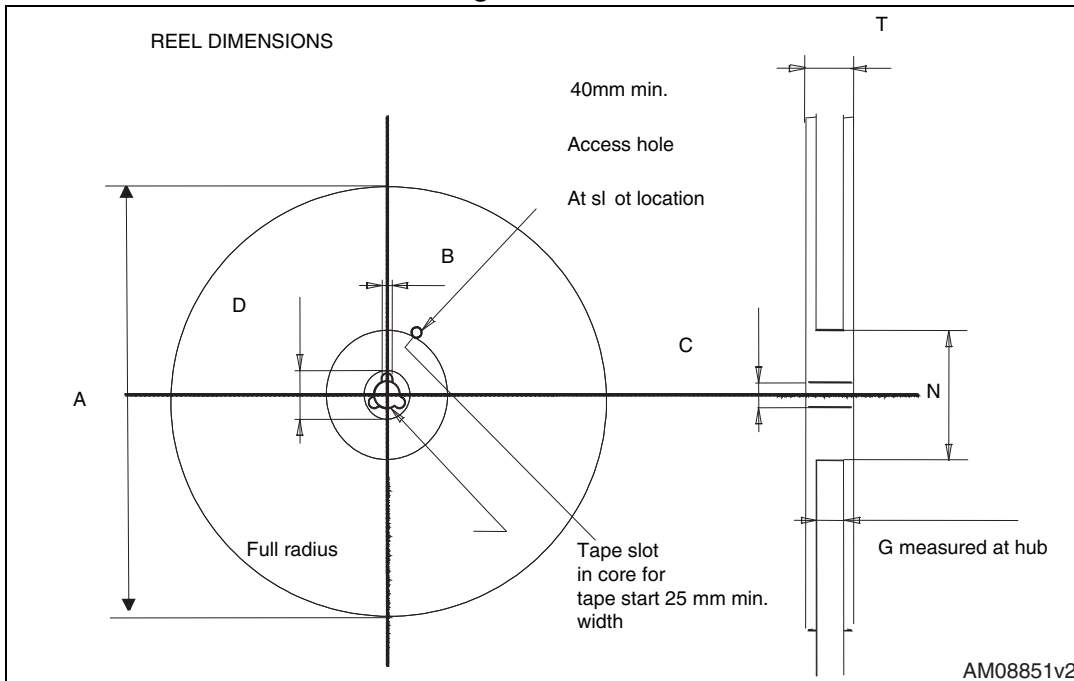


Figure 26. Reel



## 6 Revision history

Table 11. Document revision history

Date	Revision	Changes
02-Mar-2009	1	First release.
08-Mar-2011	2	Document status promoted from preliminary data to datasheet.
28-Nov-2011	3	Inserted new device in D <sup>2</sup> PAK. Updated <a href="#">Table 1: Device summary</a> , <a href="#">Table 3: Thermal data</a> , <a href="#">Section 3: Test circuits</a> and <a href="#">Section 4: Package mechanical data</a> Inserted <a href="#">Section 5: Packing mechanical data</a> . – Minor text changes.
31-Oct-2013	4	– Updated: title and features in cover page – Updated: <a href="#">Section 4: Package mechanical data</a> and <a href="#">Section 5: Packing mechanical data</a> – Minor text changes

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