



# STD10NM50N STF10NM50N, STP10NM50N

N-channel 500 V, 0.53  $\Omega$ , 7 A DPAK, TO-220FP, TO-220  
MDmesh™ II Power MOSFET

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STD10NM50N	550 V	< 0.63 $\Omega$	7 A
STF10NM50N			
STP10NM50N			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

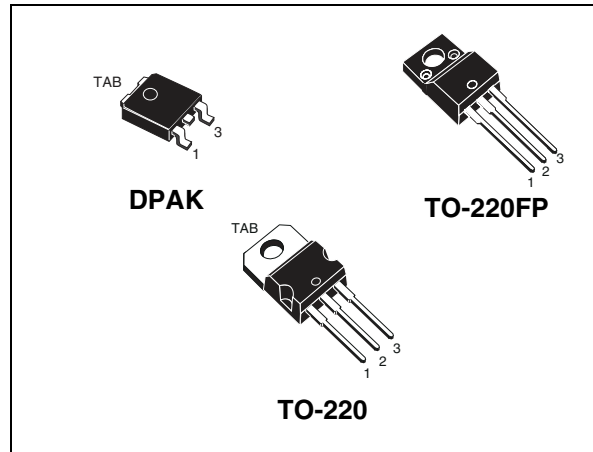


Figure 1. Internal schematic diagram

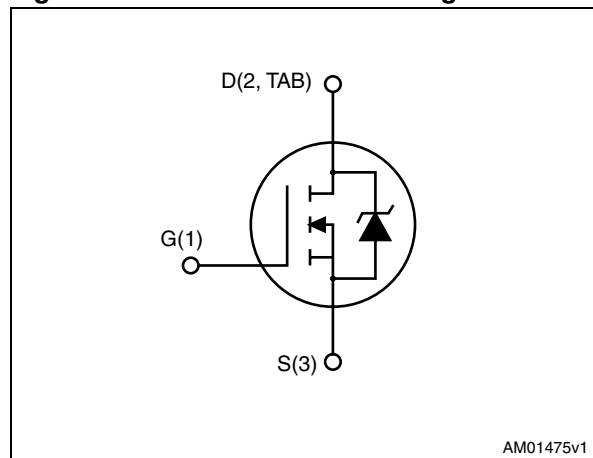


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STD10NM50N	10NM50N	DPAK	Tape and reel
STF10NM50N		TO-220FP	Tube
STP10NM50N		TO-220	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		DPAK, TO-220	TO-220FP	
$V_{DS}$	Drain-source voltage	500		V
$V_{GS}$	Gate- source voltage	± 25		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	7	7 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	5	5 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	28	28 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	70	25	W
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t=1\text{ s}; T_C=25\text{ °C}$ )		2500	V
$dv/dt^{(3)}$	Peak diode recovery voltage slope	15		V/ns
$T_{stg}$	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
- $I_{SD} \leq 7\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ ,  $V_{DSpeak} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		DPAK	TO-220	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	1.79		5	°C/W
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb minimum footprint	50			°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max		62.5		°C/W
$T_l$	Maximum lead temperature for soldering purpose		300		°C

- When mounted on 1inch² FR-4 board, 2 oz Cu

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ Max)	2	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	143	mJ

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage ( $V_{GS} = 0$ )	$I_D = 1 \text{ mA}$	500			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 500 \text{ V}$ $V_{DS} = 500 \text{ V}, T_C = 125^{\circ}C$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25 \text{ V}$			0.1	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}, I_D = 3.5 \text{ A}$		0.53	0.63	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50 \text{ V}, f = 1 \text{ MHz},$ $V_{GS} = 0$	-	450	-	$\text{pF}$
$C_{oss}$	Output capacitance			38		
$C_{rss}$	Reverse transfer capacitance			1.3		
$C_{oss \text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0 \text{ to } 400 \text{ V}$	-	167	-	$\text{pF}$
$Q_g$	Total gate charge	$V_{DD} = 400 \text{ V}, I_D = 7 \text{ A},$ $V_{GS} = 10 \text{ V},$ <i>(see Figure 18)</i>	-	17	-	$\text{nC}$
$Q_{gs}$	Gate-source charge			3.3		
$Q_{gd}$	Gate-drain charge			8.5		
$R_g$	Gate input resistance	$f=1 \text{ MHz}$ Gate DC Bias=0 Test signal level=20 mV open drain	-	4.7	-	$\Omega$

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%  $V_{DS}$ .

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250\text{ V}$ , $I_D = 3.5\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 17)	-	7.8	-	ns
$t_r$	Rise time			4.4		ns
$t_{d(off)}$	Turn-off delay time			7.8		ns
$t_f$	Fall time			12		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current		-		7	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)			28	A	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 7\text{ A}$ , $V_{GS} = 0$	-		1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 7\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 22)	-	177		ns
$Q_{rr}$	Reverse recovery charge			1.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			16		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 7\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 22)	-	216		ns
$Q_{rr}$	Reverse recovery charge			1.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			15.4		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 DPAK

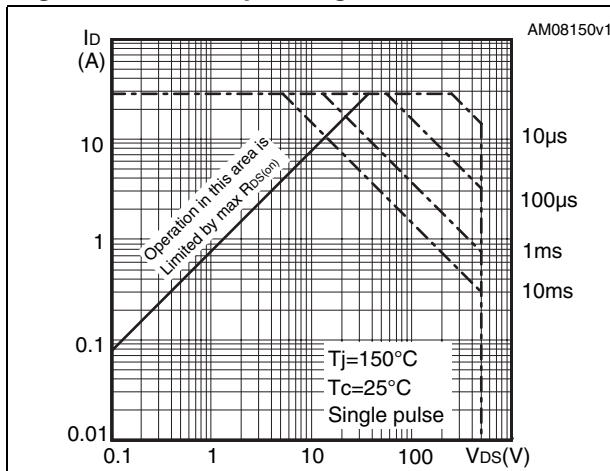


Figure 3. Thermal impedance for DPAK

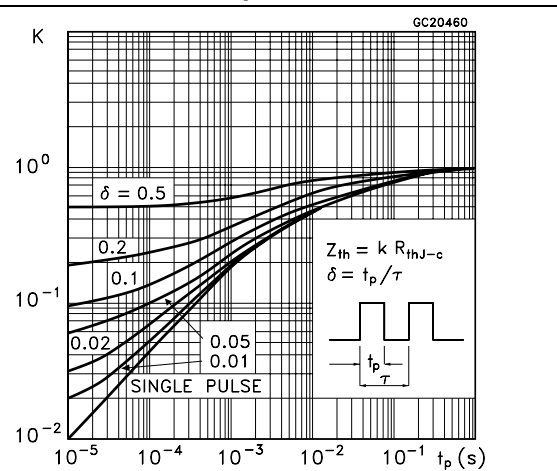


Figure 4. Safe operating area for TO-220FP

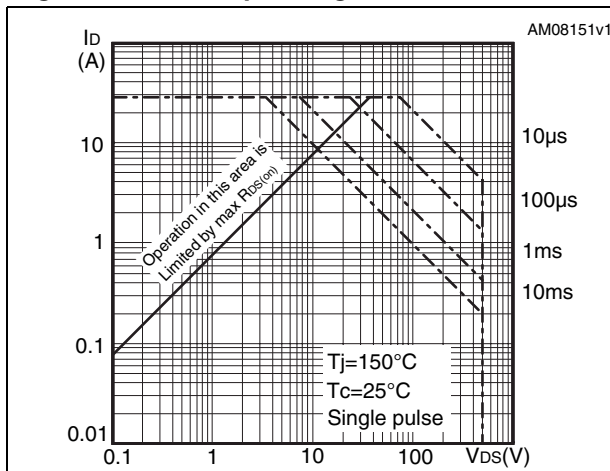


Figure 5. Thermal impedance for TO-220FP

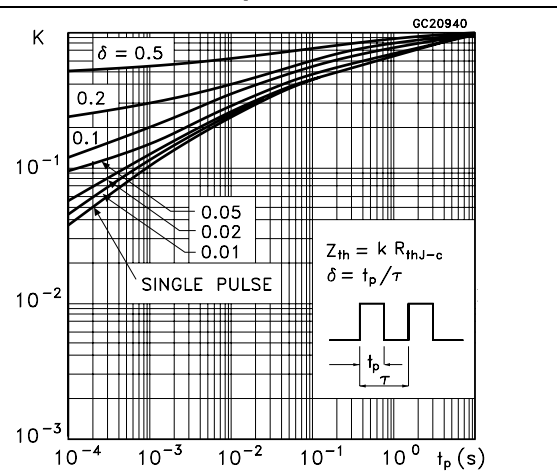


Figure 6. Safe operating area for TO-220

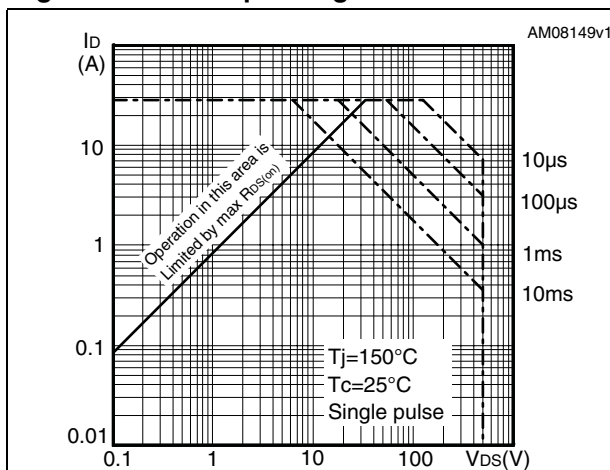


Figure 7. Thermal impedance for TO-220

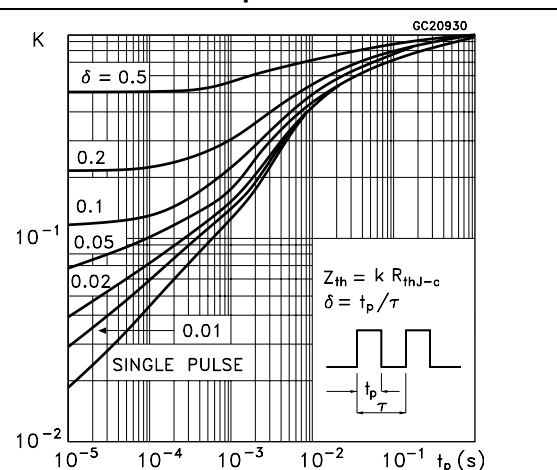


Figure 8. Output characteristics

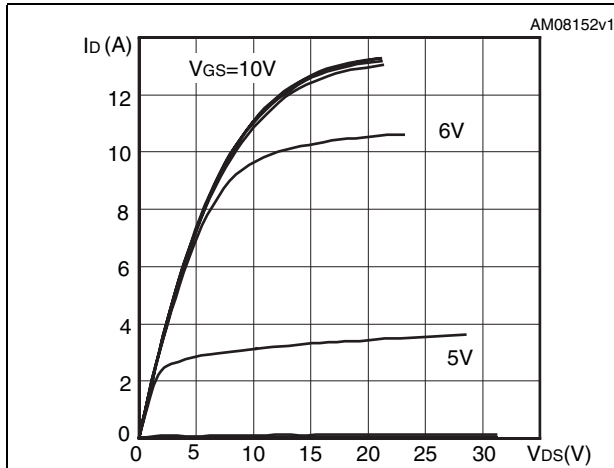


Figure 9. Transfer characteristics

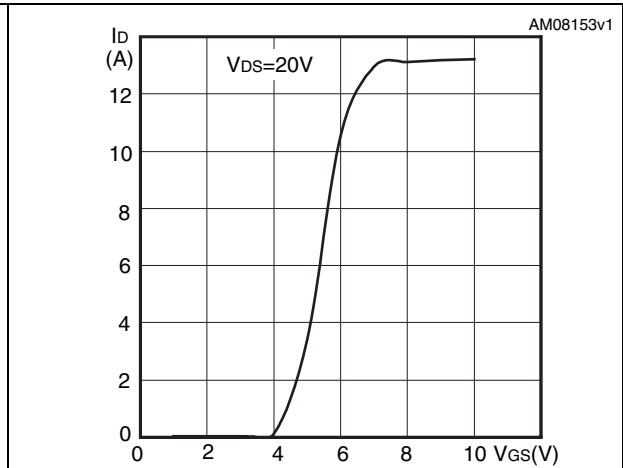


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on resistance

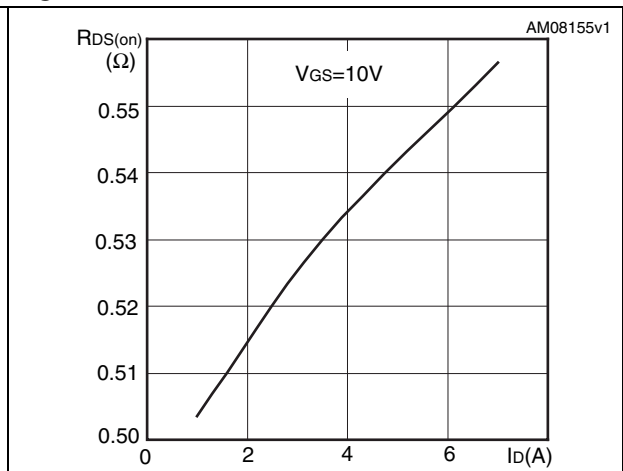
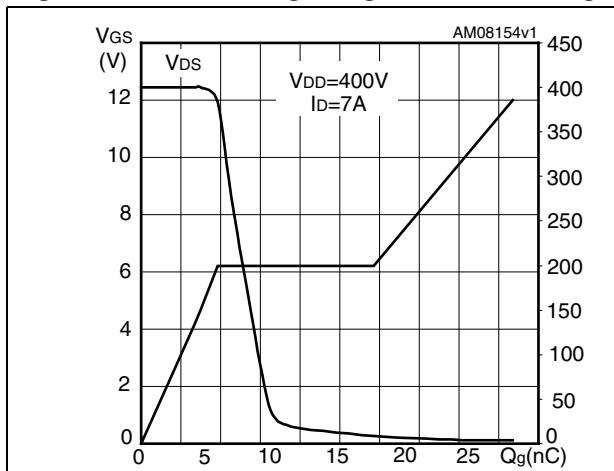


Figure 12. Capacitance variations

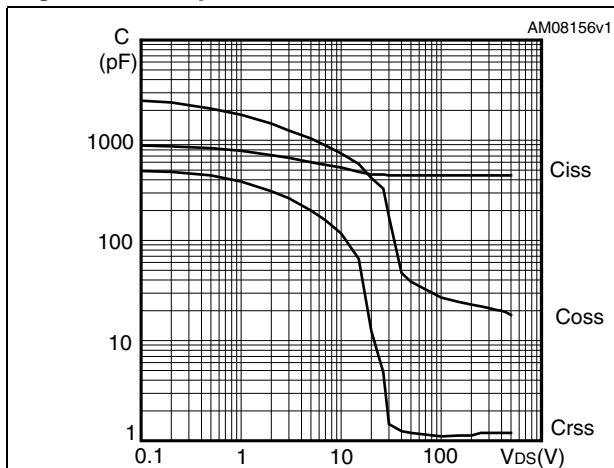


Figure 13. Output capacitance stored energy

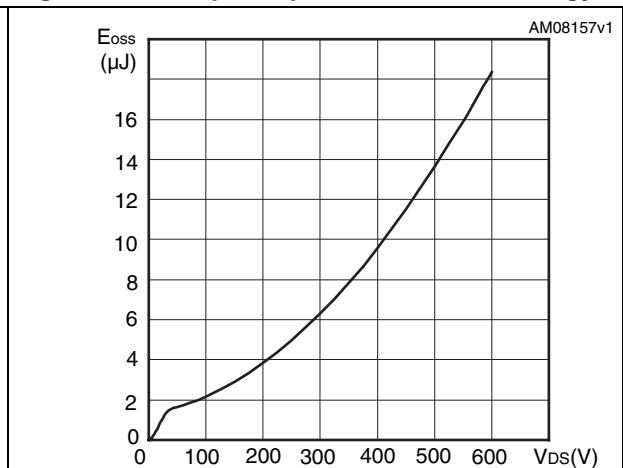


Figure 14. Normalized gate threshold voltage vs temperature

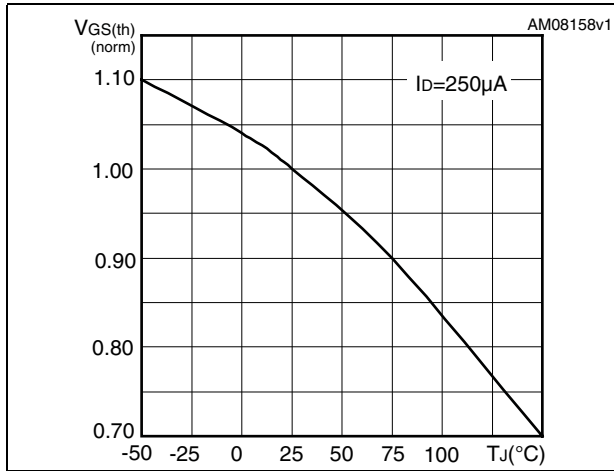


Figure 15. Normalized on resistance vs temperature

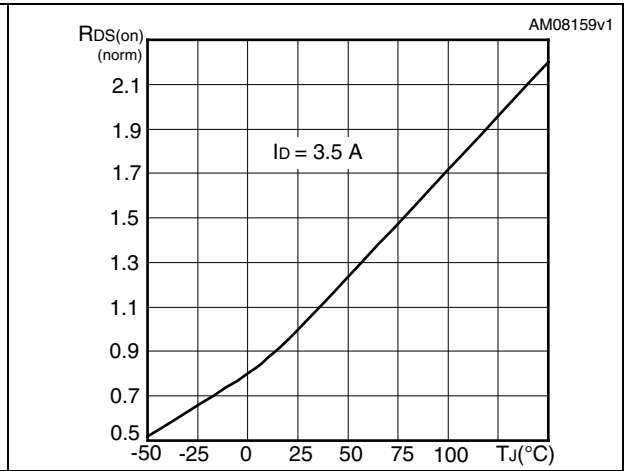
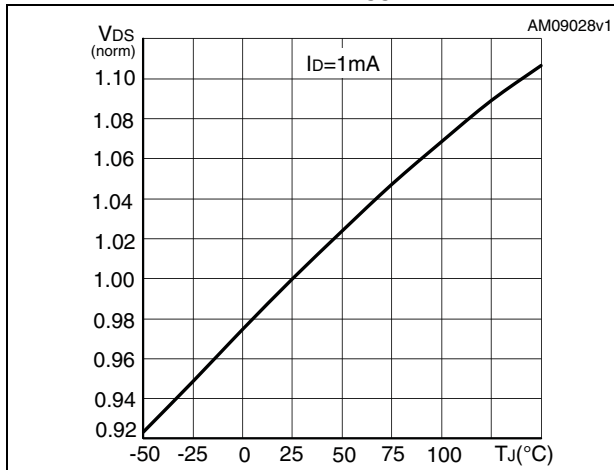


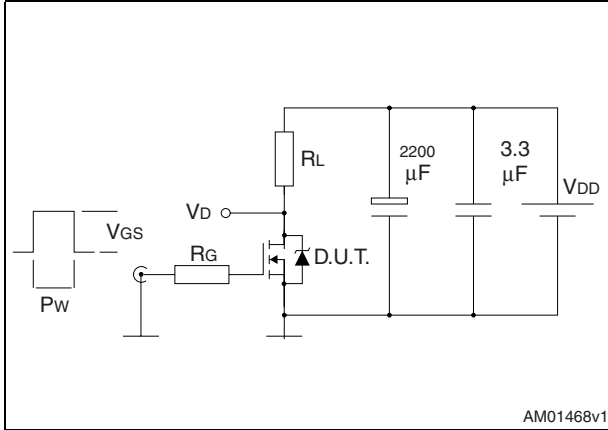
Figure 16. Normalized B<sub>VDS</sub> vs temperature





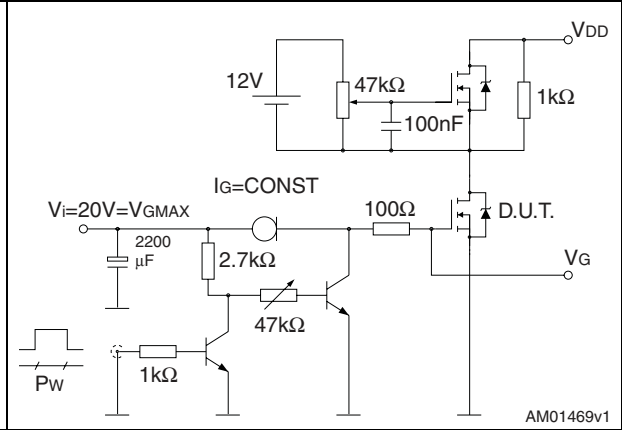
### 3 Test circuits

**Figure 17. Switching times test circuit for resistive load**



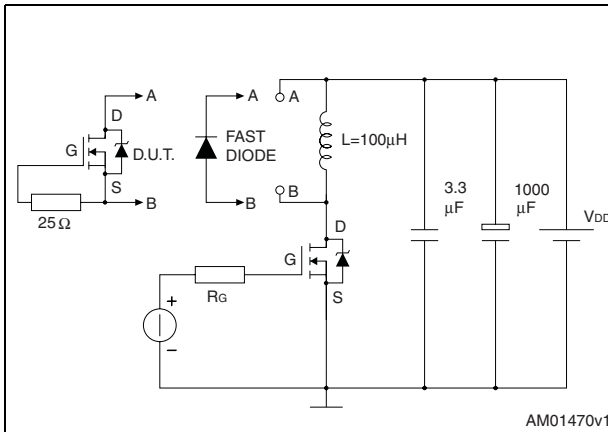
AM01468v1

**Figure 18. Gate charge test circuit**



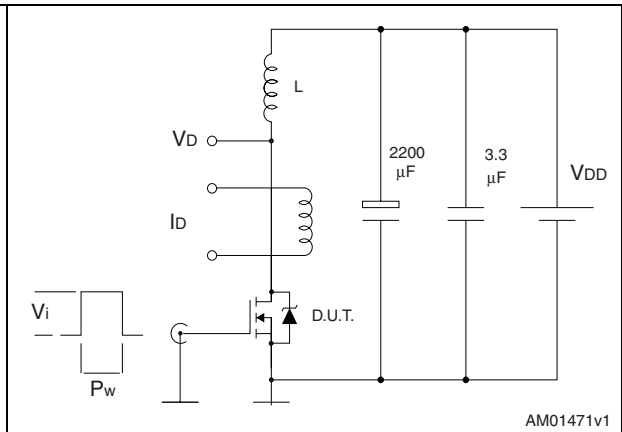
AM01469v1

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



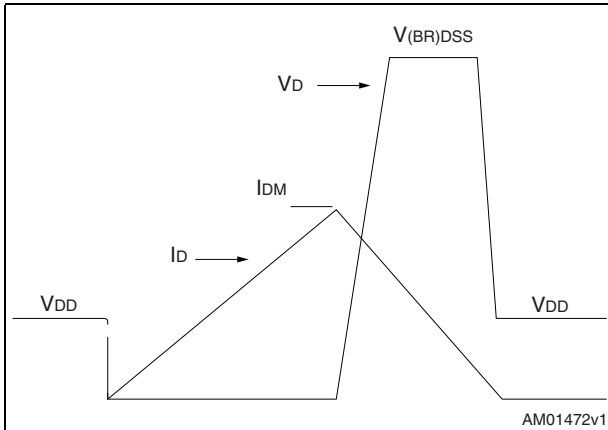
AM01470v1

**Figure 20. Unclamped inductive load test circuit**



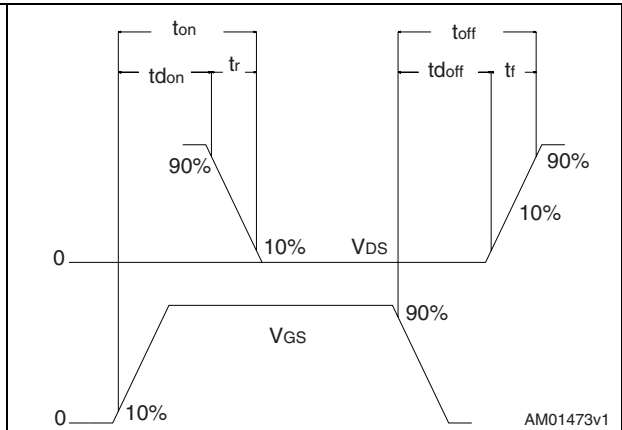
AM01471v1

**Figure 21. Unclamped inductive waveform**



AM01472v1

**Figure 22. Switching time waveform**



AM01473v1

## 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 is an ST trademark.

**Table 9. DPAK (TO-252) mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		1.50
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 23. DPAK (TO-252) drawing

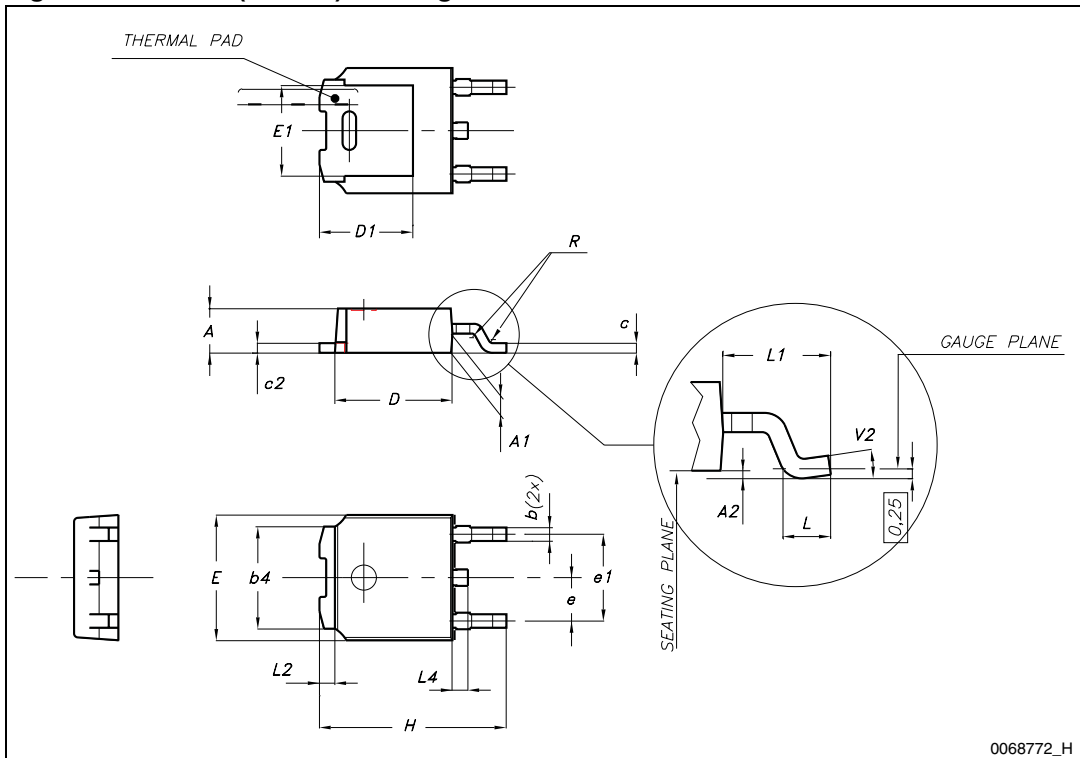
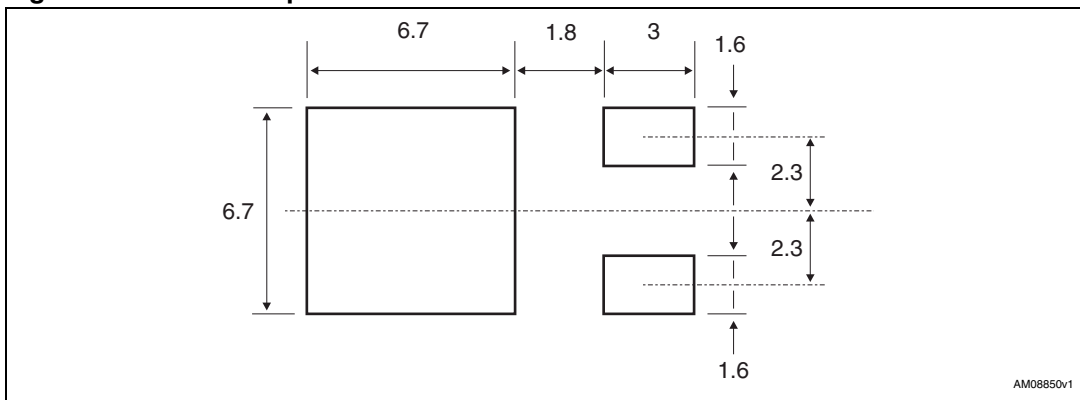


Figure 24. DPAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

Table 10. 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

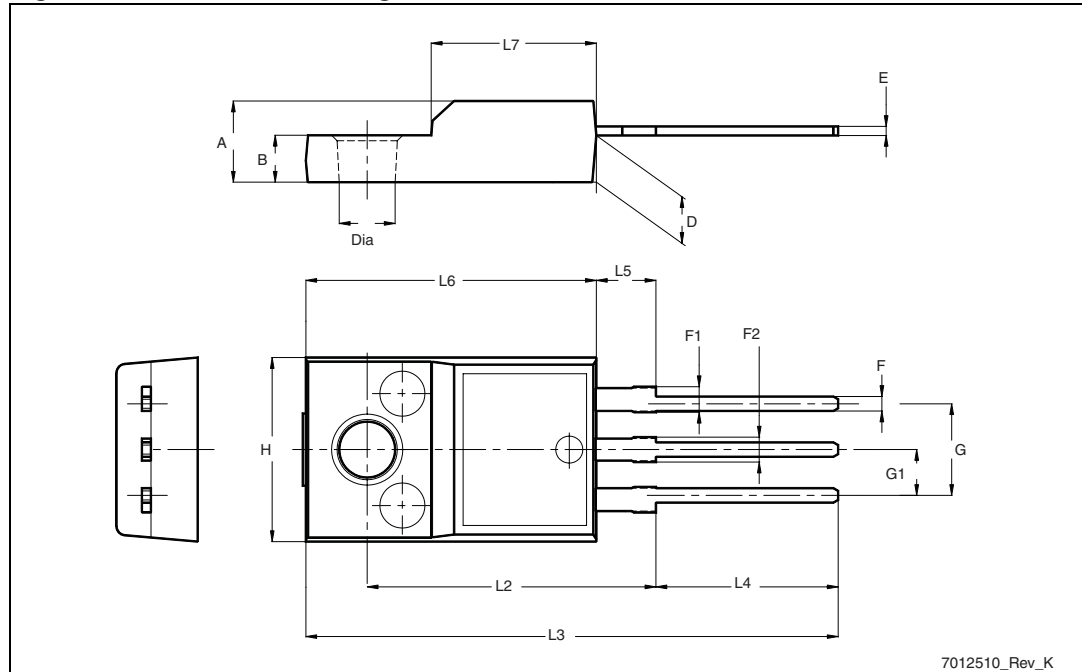
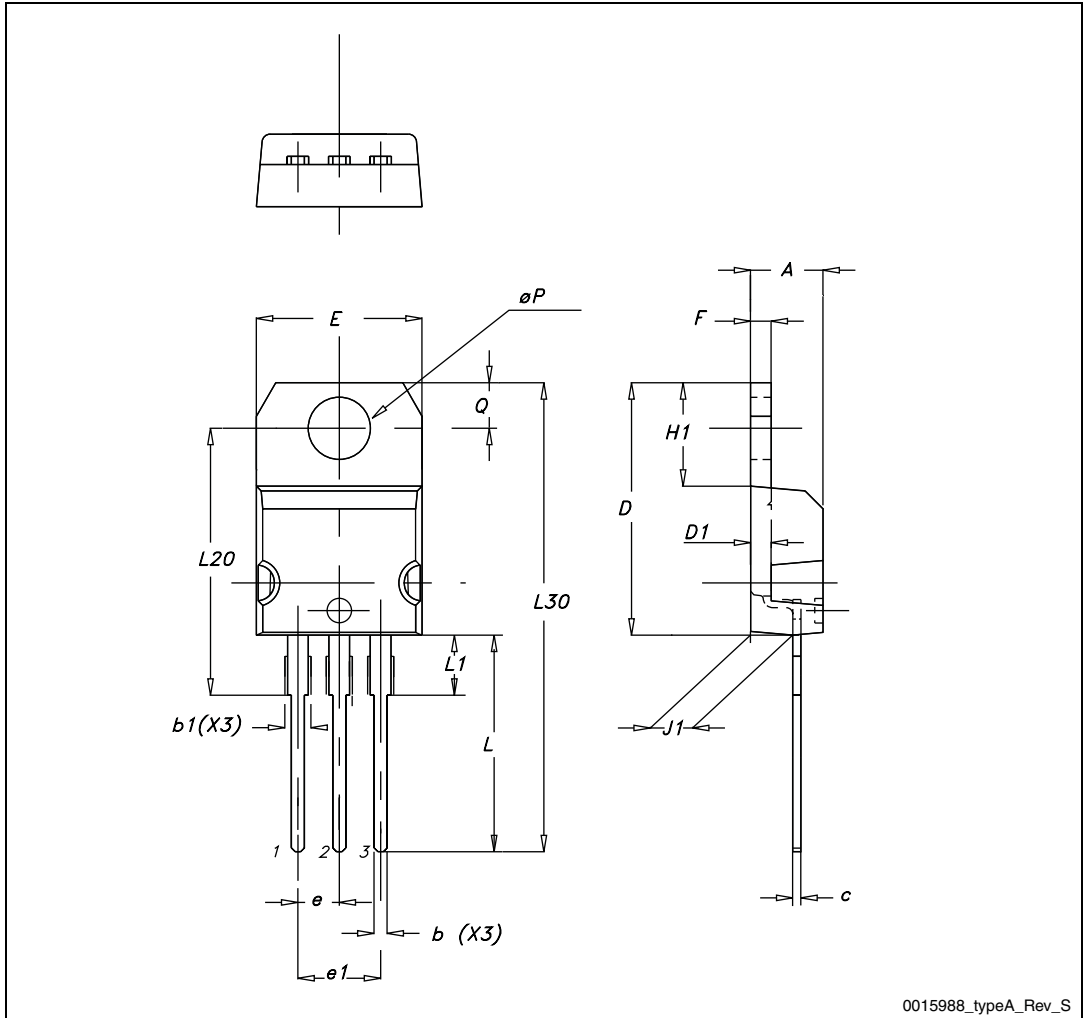


Table 11. TO-220 type A mechanical data

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-220 type A drawing



## 5 Packaging mechanical data

Table 12. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Figure 27. Tape for DPAK (TO-252)

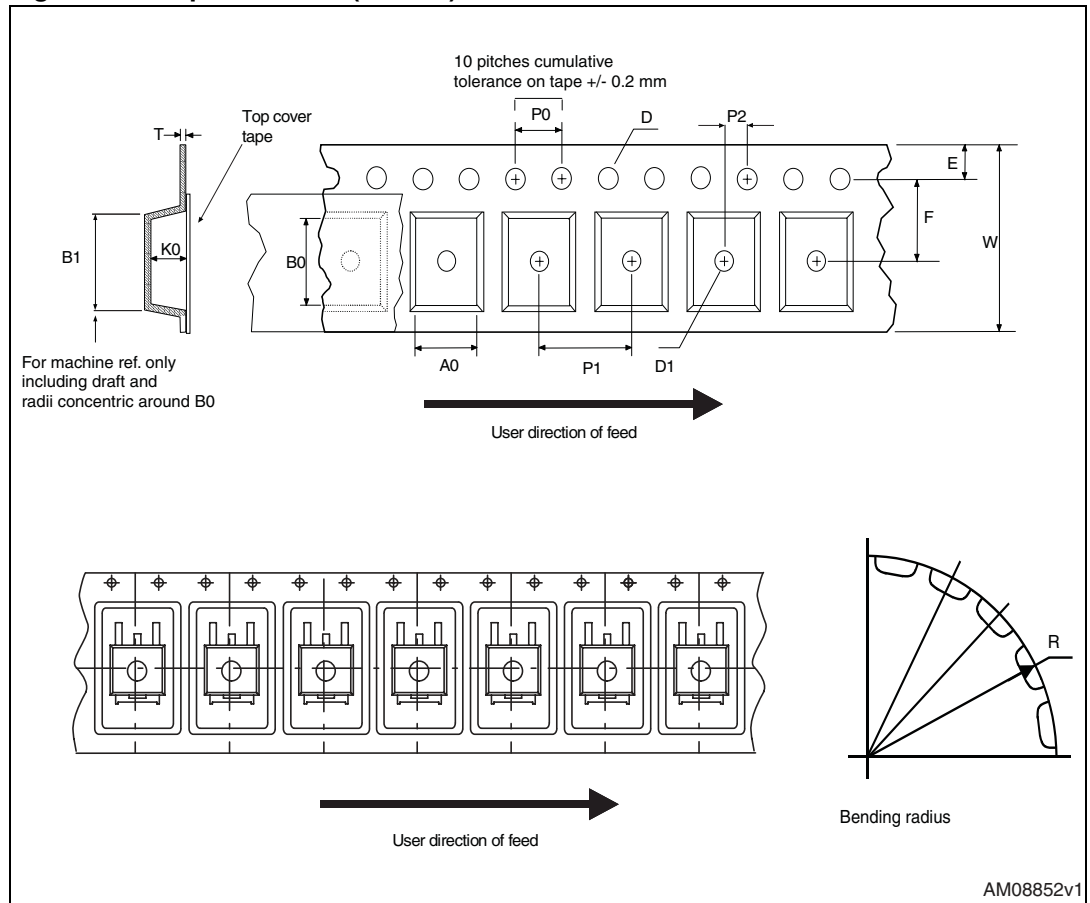
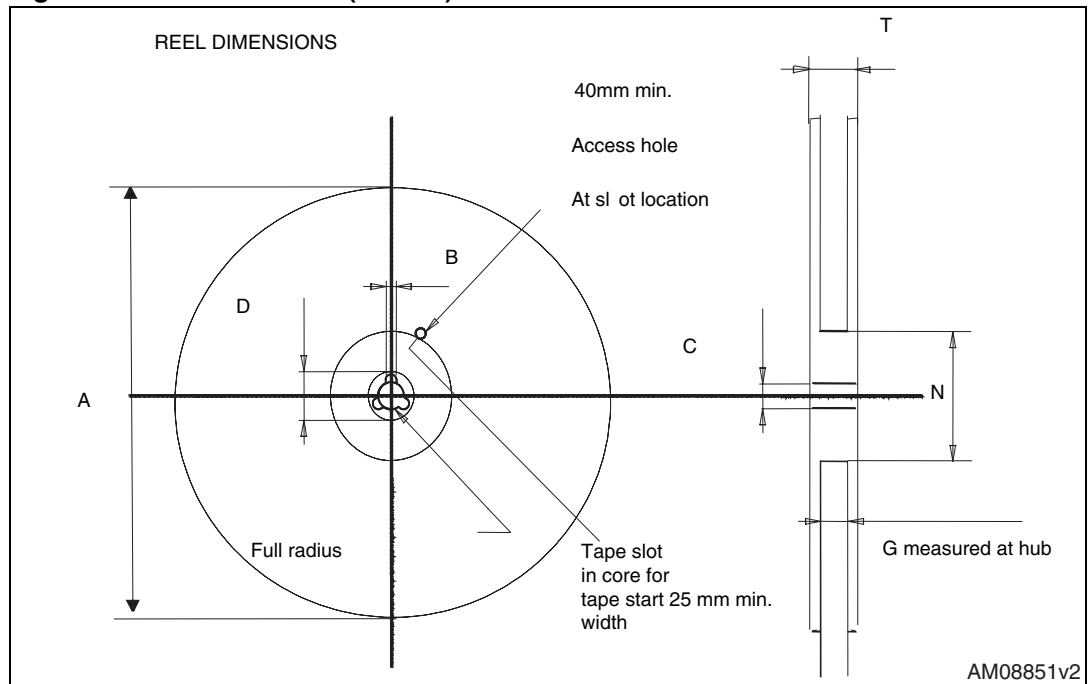


Figure 28. Reel for DPAK (TO-252)





## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
16-Dec-2009	1	First release.
08-Sep-2010	2	Document status promoted from preliminary data to datasheet.
26-Oct-2011	3	Updated $V_{DSS}$ (@Tjmax) in cover page. Updated <a href="#">Section 4: Package mechanical data</a> and <a href="#">Section 5: Packaging mechanical data</a> . Minor text changes.

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